Preventivi 2024: Gruppo 2

A. Longhin

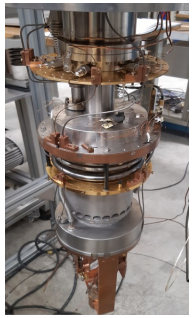
Consiglio di Sezione INFN Padova

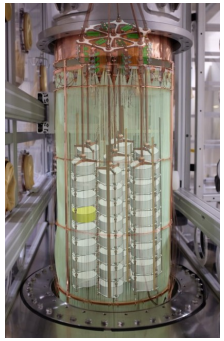
6 Luglio 2023

Segreteria: G. Salente

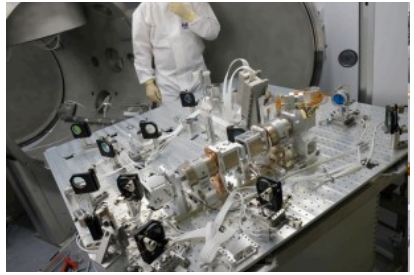
Istituto Nazionale di Fisica Nucleare

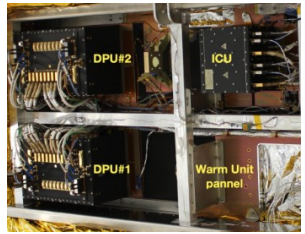
Gruppo 2 INFN-PD





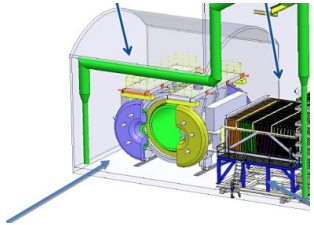
Un gruppo **consistente** (75 FTE) e distribuito su di un **ampio spettro di temi di ricerca** su **quasi tutte le linee** della CSN2. Forte sinergia con INFN-LNL (laboratori al "LAE").





Significativi **ruoli di reponsabilità**:

- **spokespersons** di GERDA, QUAX, ENUBET (ERC-CoG)
- Leadership su detectors in costruzione:
  - Elettronica per ICARUS e JUNO
  - Controllo del Near Infrared Spectrometer (NISP) dell'esperimento spaziale EUCLID
  - Coordinamento del Near detector on-axis di DUNE (SAND)
  - Nuove camere TPC per l'upgrade di T2K
  - Meccanica dei telescopi Cherenkov per CTA
  - Nuovo sistema di "squeezing" di VIRGO

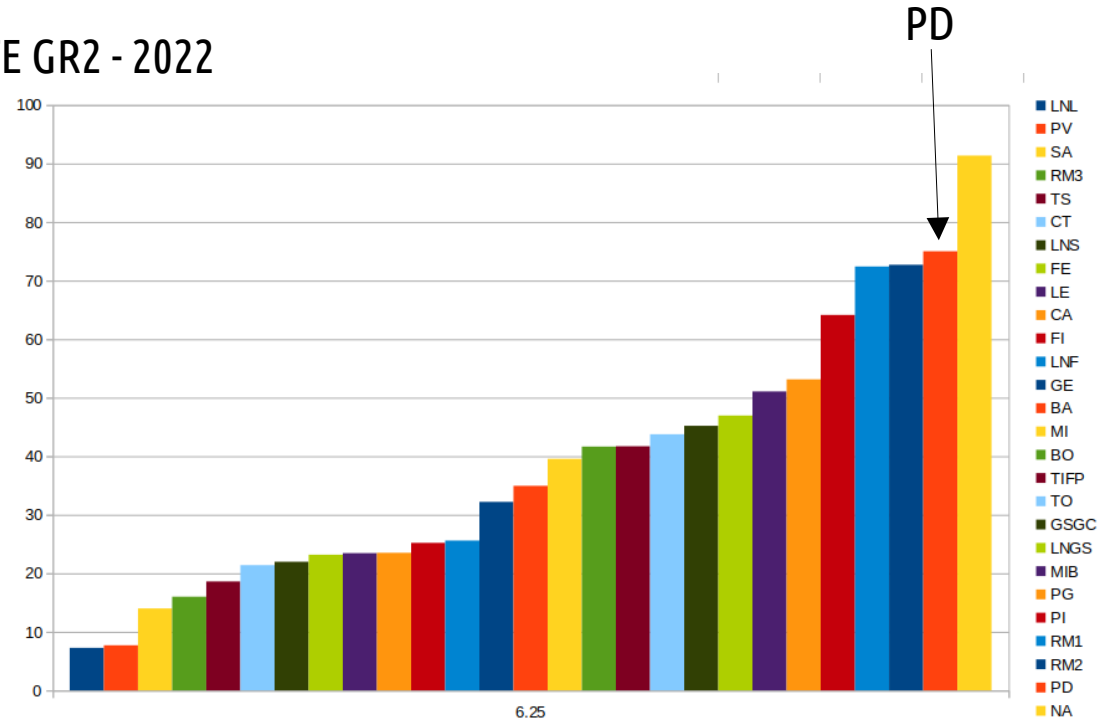


Contributi e visibilità sempre molto consistenti anche all'interno delle grandi collaborazioni anche attraverso i gruppi di analisi (p.e. nelle onde gravitazionali).

FTE Padova

PD (123 PERSONE - 75 FTE)	70 fte	108 pers.	5 fte	15 pers.
	75.00 fte / 123 pers. (media 0.61)			
TOTALE (1622 PERSONE - 1039.83 FTE)	918.62 FTE	1379 PERS.	121.21 FTE	243 PERS.

FTE GR2 - 2022

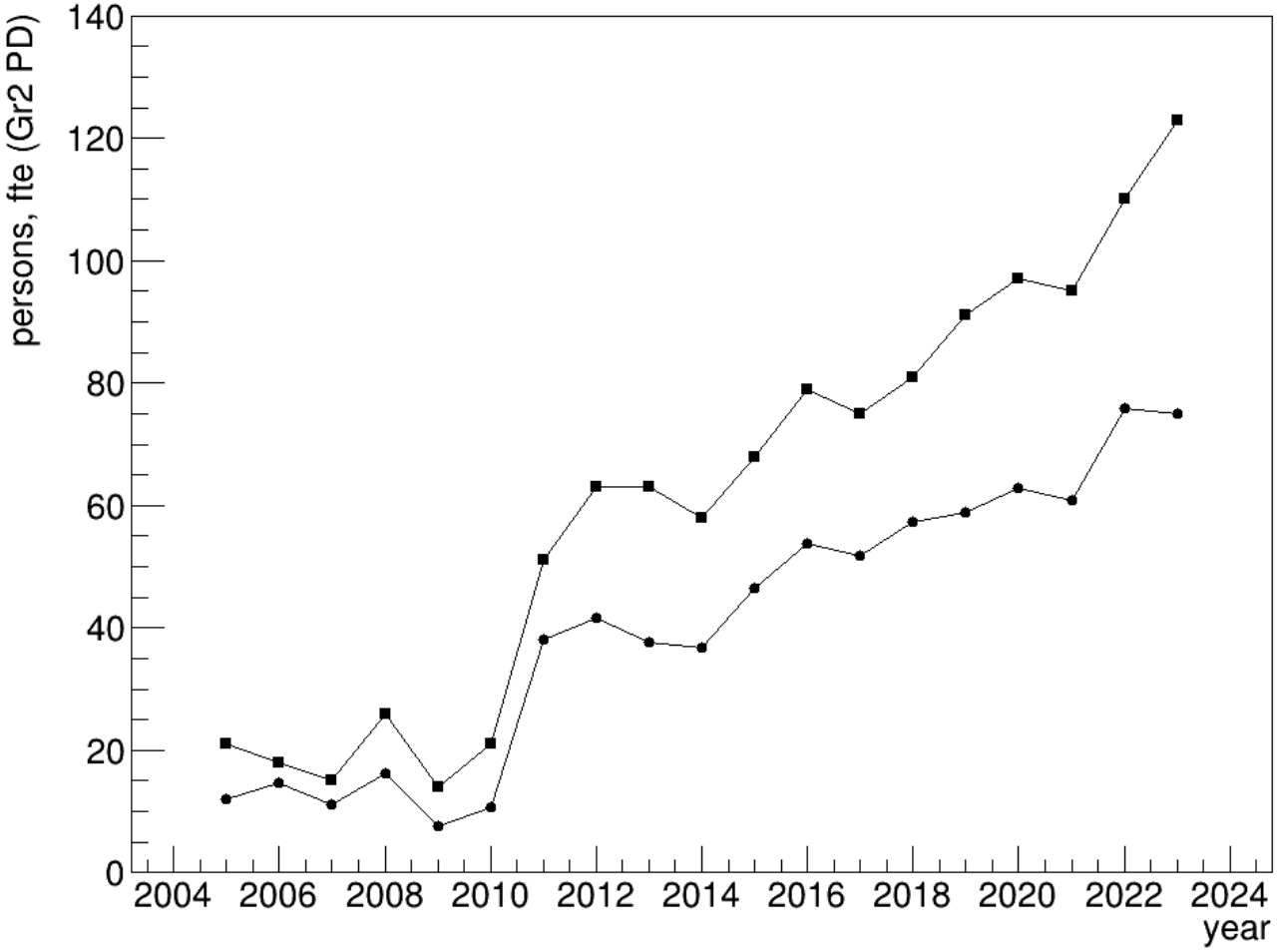


BA (45 PERSONE - 34.95 FTE)
BO (85 PERSONE - 41.65 FTE)
CA (50 PERSONE - 23.5 FTE)
CNAF (1 PERSONE - 0 FTE)
CT (32 PERSONE - 21.4 FTE)
FE (40 PERSONE - 23.17 FTE)
FI (39 PERSONE - 25.2 FTE)
GE (48 PERSONE - 32.2 FTE)
GSGC (55 PERSONE - 45.2 FTE)
LE (29 PERSONE - 23.45 FTE)
LNF (52 PERSONE - 25.6 FTE)
LNGS (80 PERSONE - 46.95 FTE)
LNL (12 PERSONE - 7.26 FTE)
LNS (37 PERSONE - 21.97 FTE)
MI (69 PERSONE - 39.55 FTE)
MIB (79 PERSONE - 51.07 FTE)
NA (134 PERSONE - 91.35 FTE)
PD (123 PERSONE - 75 FTE)
PG (66 PERSONE - 53.12 FTE)
PI (107 PERSONE - 64.13 FTE)
PV (17 PERSONE - 7.7 FTE)
RM1 (115 PERSONE - 72.4 FTE)
RM2 (106 PERSONE - 72.71 FTE)
RM3 (20 PERSONE - 16 FTE)
SA (29 PERSONE - 14 FTE)
TIFP (63 PERSONE - 41.7 FTE)
TO (65 PERSONE - 43.75 FTE)
TS (29 PERSONE - 18.6 FTE)
UD (10 PERSONE - 6.25 FTE)

FTE Padova

https://assegnazioni.dsi.infn.it/sito/index.php?anno=2022&riunione=%

Dal sito delle assegnazioni




Track_1
Electron
Observational cosmology
Neutrinoless ββ decay
EUCLID
CUORE/CUPID
GERDA/LEGEND
Neutrino oscillations
JUNO, T2K-HyperK, ICARUS, DUNE, ENUBET
Gr2 Padova
75 FTE in 2023
Gravitational waves
VIRGO, ET
MAGIC, CTA, SWGO
MOONLIGHT2
Tests of gravitation
QUAX
FERMI
Cosmic rays, gamma astronomy
Axion searches
Satellite experiments

Gr2 Padova

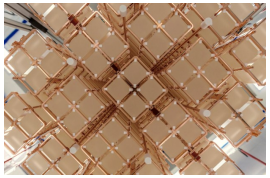
75 → ~50 FTE

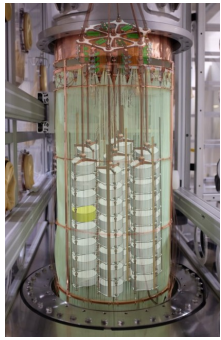
Observational cosmology

EUCLID

Neutrinoless ββ decay

CUORE/CUPID
GERDA/LEGEND



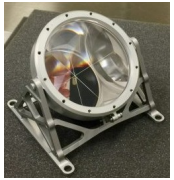


Gravitational waves

VIRGO, ET

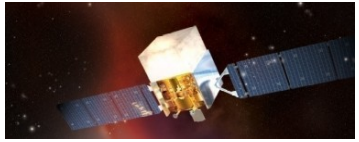
Tests of gravitation

MOONLIGHT2



Satellite experiments

FERMI



Axion searches

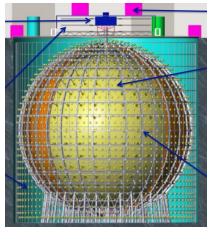
QUAX

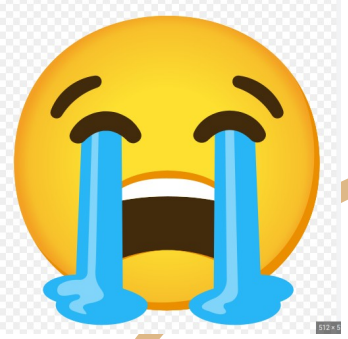
Cosmic rays, gamma astronomy

MAGIC, CTA, SWGO

Neutrino oscillations

JUNO





Impatto neutrini con acceleratori al Gr1

2023	PhD	Assegno	RTD-A	RTD-B	Post-doc INFN	RIC UNI	RIC INFN	PA/1RIC/TEC	PO/DdR
CTA/MAGIC (8.9) →	Ivana, Viale, Boscolo Meneguolo	Fiori (1) Mallamaci (1) Spolon (1) Miceli	Prandini (0.95)					Doro (0.95) Naletto (0.8) Bastieri (0.3) Dima (0.2) Bottacini 0.2) Rando (0.4)	**Mariotti** (1) De Angelis (0.7) Busetto (0.7) **Bernardini (0.5)**
FERMI (3.1)	Zhu (1)							Bastieri (0.6), Rando (0.6) Bottacini (0.6)	De Angelis (0.3)
CUORE (0.6)								**Taffarello (0.6)**	
ET (2.9)	Di Carlo (0.1)	Spera(0.1) Pasquato (0.1) Giacobbo (0.1) Ballone (0.1)	Bertacca(0.1)Lazzaro (0.1)		Ricciardone (0.1)	Pasquato (0.1) Bazzan (0.1)	**L. Conti (0.2)**	**Zendri** (0.4) Ciani (0.2) Bartolo (0.1) Peloso (0.1) Mapelli (0.1) Liguori (0.1)	Matarrese (0.1)
VIRGO (10.9)	Favaro, Chiarini, Bonavena,Bordignon	Spera (0.5) Bouffanais (0.5)	Lazzaro (0.9)			Bazzan (0.6) Ciolfi (0.5)	**L. Conti (0.8)**	Zendri (0.6) Ciani (0.6) De Pietri (0.5) Mapelli (0.4) Pegoraro (0.4)	
EUCLID (9)	Verza (1) Gabarra (1) DeCaro (1)	Troja (1), Anselmi, Opizzi	Renzi (0.8) Bertacca (0.1)	Raccanelli (0.1)	Jung (0.1)	Sirignano (0.7) Liguori (0.1)	**Dusini (0.8)**	Bartolo (0.1) Naletto (0.2)	Matarrese (0.1) Stanco (0.6)
GERDA (5.2)	Biancacci (1) Calgaro (1)	Redchuck (1)					Lippi (0.6)	**Brugnera (0.7)** Garfagnini (0.3) Sada (0.6)	
JUNO (4.6)	Marini (1) Jelmini (1)	Von Sturm (0.3)		Grassi (0.4)		Sirignano (0.3)	Dusini (0.1) Lippi (0.4) Bergnoli (0.5)	Brugnera (0.3) **Garfagnini (0.7)** Bellato (0.1) Dal Corso (0.1) Fanin (0.2)	Stanco (0.1)
NU_AT_FNAL (1.3)			Cicerchia (1)						**Stanco** (0.3)
ICARUS (8.5)	Artero Pons (1)						Farnese (1) Varanini (1)Baibussinov (0.6)	Braggiotti (1) Meng (1) Gibin (1) Pietropaolo (1) Ventura (0.2)	**Guglielmi (1)**
MOON LIGHT-2 (2.9)	Scriminich (0.7) Zaidi (0.15)	F. Vedovato (0.4) A. Stanco (0.4) Agnesi (0.4) Avesani (0.3)						Vallone (0.1)	**Villoresi (0.4)**
QUAX (3.7)	1 NEW	1 NEW				Braggio (0.5)	Fanzago (0.1) Montecassiano (0.3)	Taffarello (0.4), Bellato (0.1)	**Carugno** (0.6)
T2K (8.3)	Delogu (0.6) Mattiazzi Feltre	Iacob (0.9) Pari (0.6)		Grassi (0.6)	Lamoureux (1.0)	Laveder (0.8)		**Collazuol (0.8)** Longhin (0.4)	Mezzetto (0.8)
ENUBET (2.8)	Delogu (0.4)	Pari (0.4), Iacob (0.4)					**Pupilli (0.6)**	Longhin (0.6) Dal Corso (0.2)	Mezzetto (0.2)

Disclaimer: some data needs checking/update (ie SWGO 3FTE)

F
RESP LOC
Aff GR4
Aff GR1

3+8.9+3.1+0.6+2.9+10.9+9+5.2+4.6+1.3+8.5+2.9+3.7+8.3+2.8 = 75.7
3+8.9+3.1+0.6+2.9+10.9+9+5.2+4.6+1.3+8.5+2.9+3.7+8.3+2.8 = 75.7
75.7 – (20.9) → 54.8 (riduzione del -28%)

Approssimativamente ...

Padova Gruppo 2

Dark Matter
- SABRE
- NEWS
- CYGNO
- CRESST
- DAMA
- XENON
- DARKSIDE
- COSINUS

Tests of gravitation
- GINGER
- SATOR-G
- **MOONLIGHT2**

Observational cosmology
- **EUCLID**
- LSPE
- QUBIC
- LiteBIRD

0νββ
- **CUORE_CUPID**
- **GERDA_LEGEND**

Cosmic rays, gamma astronomy
- AUGER
- **CTA+MAGIC**
- **SWGO**

Gravitational waves
- **VIRGO**
- **ET**
- LISA

Fundamental phys.
- ARCHIMEDES
- GRAFIQ0
- SUPREMO

Axion searches
- VMBCERN
- **QUAX**

Neutrino telescopes
- KM3

Neutrino oscillations
- BOREXINO
- **JUNO**
- **T2K**
- **ICARUS**
- **NUATFNAL**
- **ENUBET**

Nu mass, relics, sterile, Coherent scatt.
- HOLMES
- TRISTAN
- NUCLEUS

Satellite experiments
- AMS-02
- DAMPE+HERD
- XRO
- SPB2
- **FERMI**
- LIMADOU-CSES
- GAPS

INFN-PD Gr2: binning per temi scientifici

Fisica "dallo spazio"
multimessenger,
cosmology

EUCLID DE S. Dusini **SWGO** γ terra M. Doro
CTA/MAGIC γ (Ch, terra) M. Mariotti
FERMI γ (CAL, sat) R. Rando
VIRGO GW L. Conti
ET J. P. Zendri

CUORE/CUPID L. Taffarello
GERDA/LEGEND R. Brugnera

ββ0ν @ Gran Sasso

MOONLIGHT-2 P. Villoresi

Quantum science/test fondamentali GRAV.

QUAX G. Carugno

Assioni/quantum science

JUNO A. Garfagnini
Oscillazioni neutrini (reattori)

ICARUS A. Guglielmi
DUNE L. Stanco
T2K G. Collazuol
ENUBET F. Pupilli

Oscillazioni neutrini (acceleratori)

INFN-PD Gr2: binning per sedi

#oscilloneutrinisti
#doppiobetisti
#cosmologiosservativi

#gammisti

Variegati anche nella geografia locale

Migratori periodici verso il South-East alle ricerca degli sterminati spazi sperimentali

#assionisti
#gravitondisti

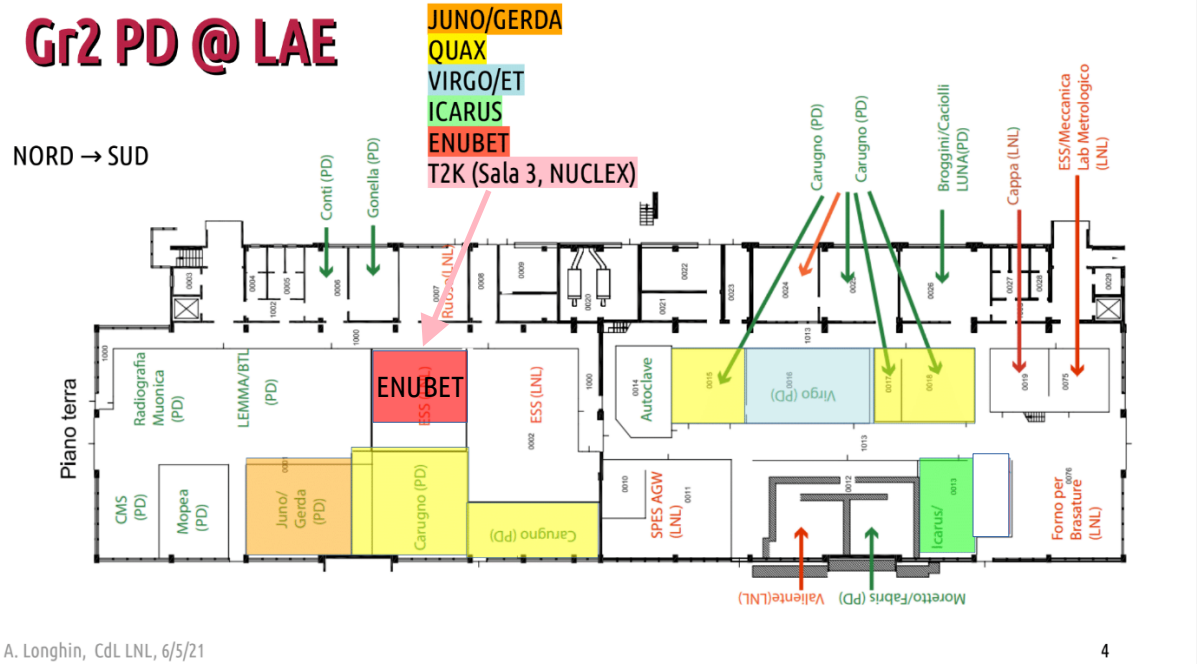
DEI #stregatidallaluna

LAE@LNL

LAE

Il LAE e' **un'ambiente prezioso per le attivita' di Gruppo 2** in generale e per Padova in particolare.

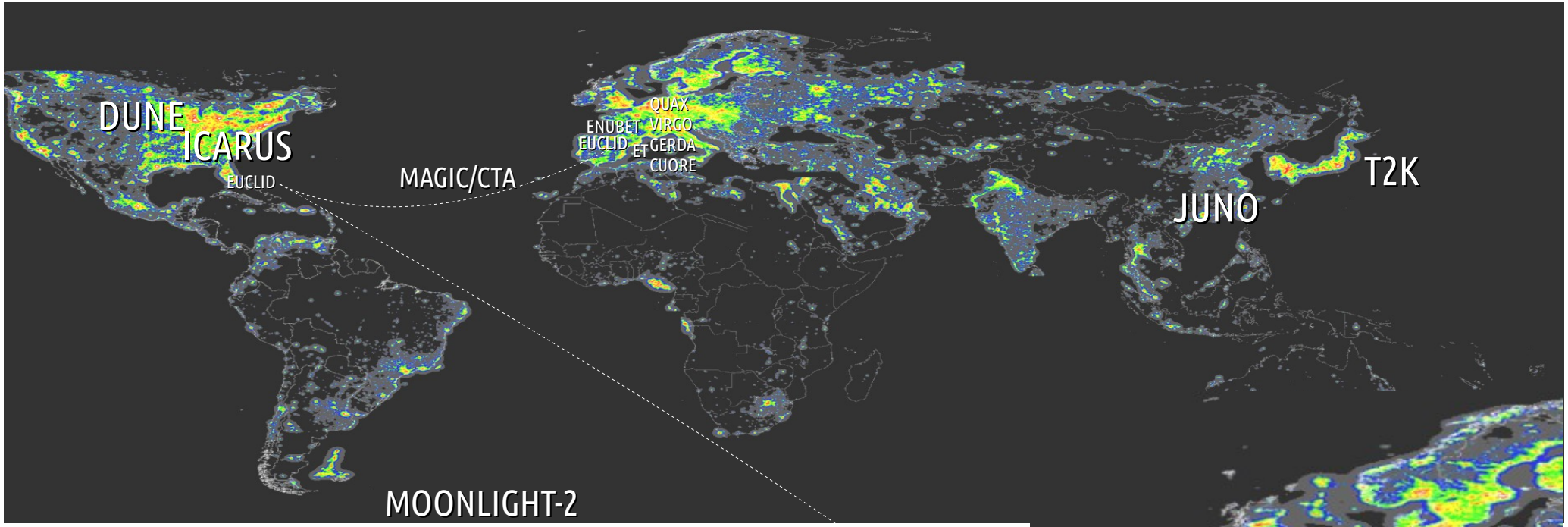
Esperimenti che fanno fisica (QUAX), costruzione/test/sviluppo di sistemi di rivelatori per grandi apparati su cui la CSN2 sta investendo molto (JUNO, LEGEND, DUNE, HYPER-K, ET, VIRGO upgrades), progetti ERC (ENUBET).

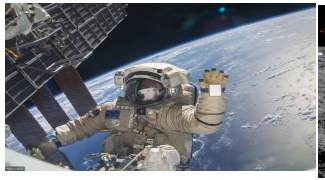


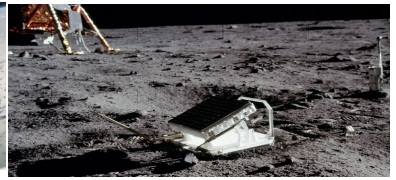
Un grazie particolare a M. Bellato, T. Marchi!

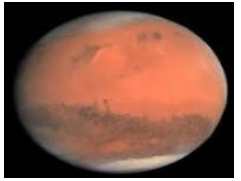
https://www.dropbox.com/s/9sam0vlc2icw38j/Longhin_review_Gr2atLAE_20210506_v3.pdf?dl=0

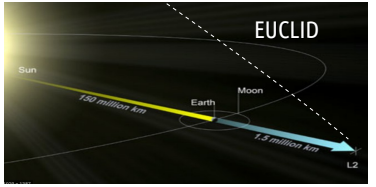
INFN-PD Gr2: binning geografico



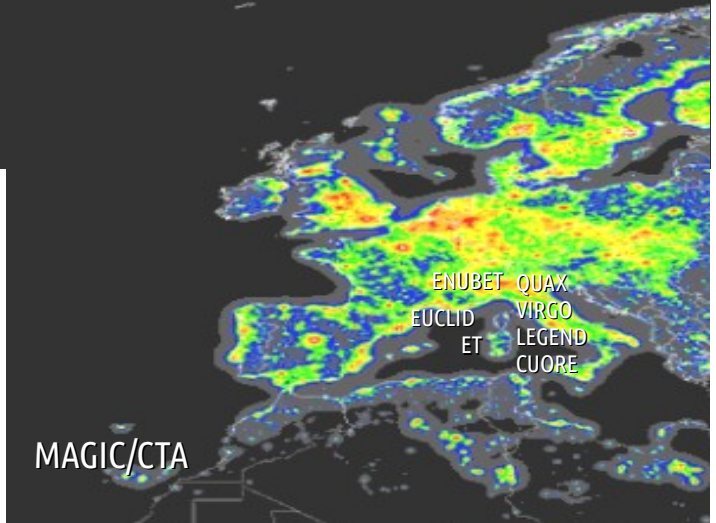




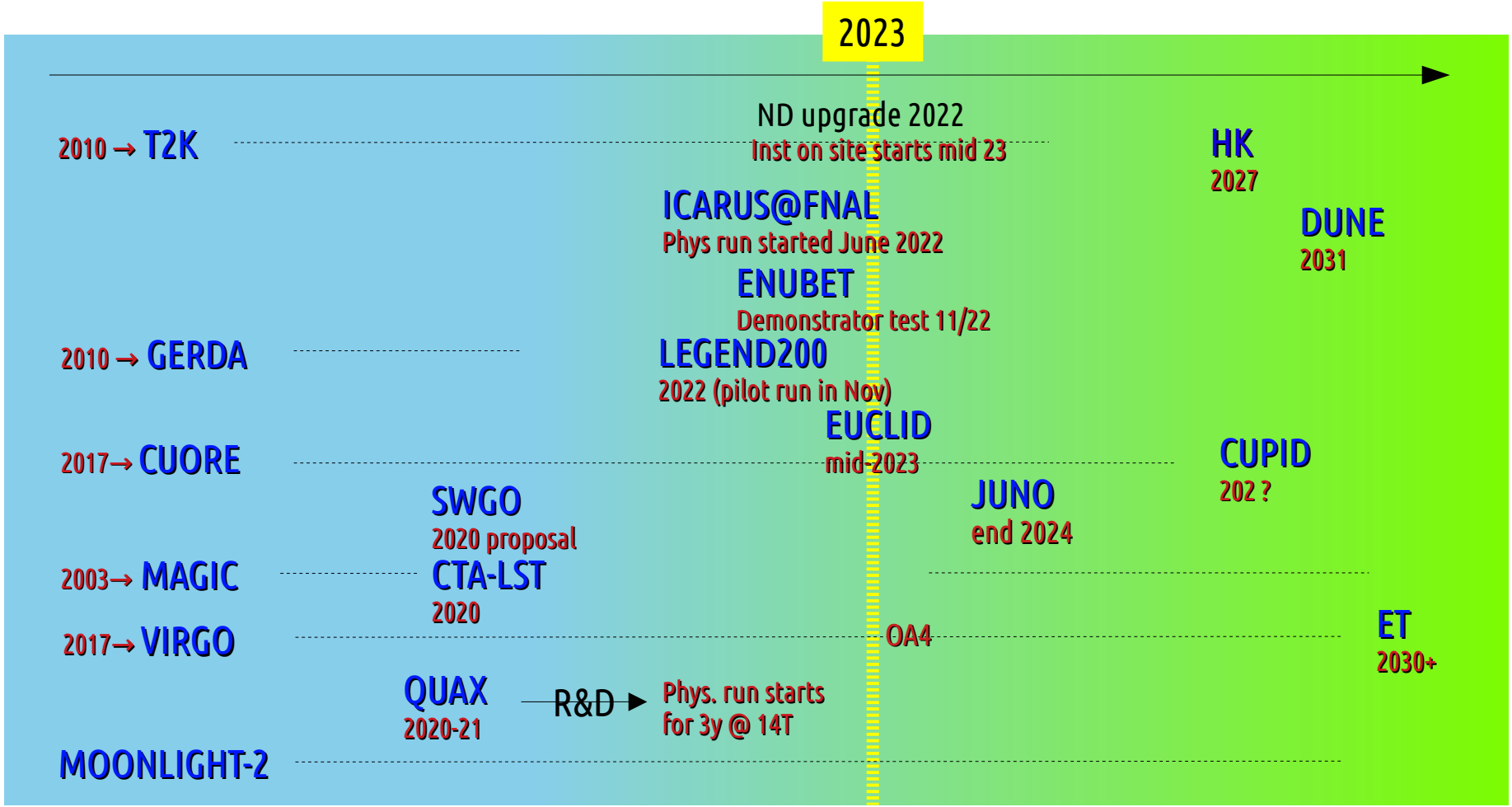




Per questi ultimi non si chiedono fondi missione



INFN-PD Gr2: sviluppo storico



Binning: fasi della vita degli esperimenti

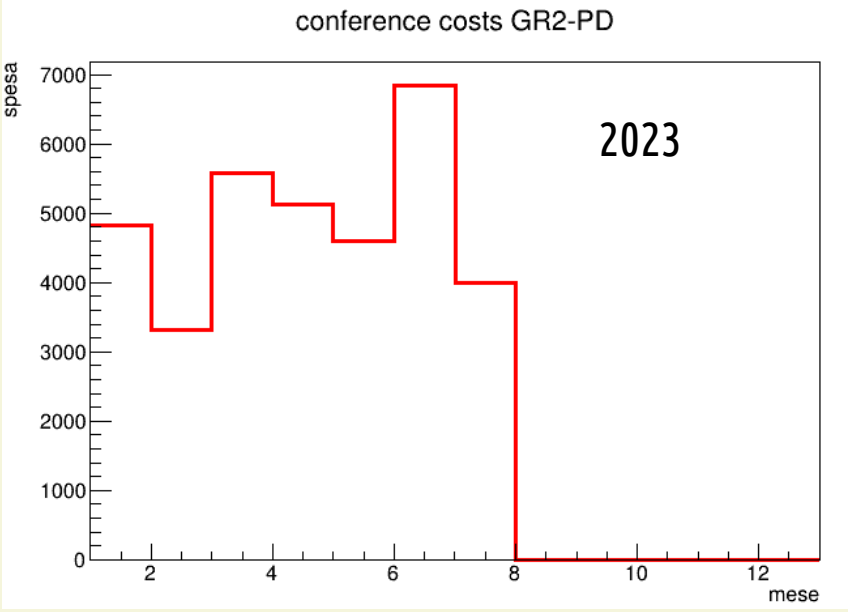
inossidabili	In presa dati	Commissioning/ ~inizio presa dati lancio	end design	Inizio costruzione	Non ancora in costruzione
FERMI MAGIC	QUAX T2K VIRGO GERDA CUORE MOONLIGHT-2	ICARUS (FNAL) LEGEND-200 CTA EUCLID	ENUBET	JUNO Hyper-K DUNE	ET SWGO CUPID

Novita` dalla CSN2

- Nuove regole anagrafiche e common funds

https://web.infn.it/csn2/images/Files/Regolamenti/INFN-CSN2-QA-103-30.pdf
https://web.infn.it/csn2/images/Files/Regolamenti/FAQ-regole-CSN2.pdf

Novita' gestione conferenze:
→ sui fondi del coordinatore.



Lake Louise, CISF, Dark Matter, UNIVERSUM 4, GWADW, IFAE, TevPa, ICRC, La Biodola, PLANCK2023, GWADW, EPS-HEP2023, MAYORANA23, Cogne scuola, TAUP23, EPS, COSMO23

Nuove regole anagrafiche

%: minima del **20%** per ogni sigla di CSN2, **quantizzata al 10%**, fino ad un **massimo di 2 sigle di CSN2**

Resp. Naz.: % >= 50%

Junior: PhD e borsisti post-laurea che intendono dedicarsi ad attività di CSN2: **al massimo 2 sigle**

Controlli: nella riunione di maggio, il gruppo di lavoro in carica comunica alla CSN2 la situazione anagrafica in termini di FTE dei diversi esperimenti, segnalando eventuali anomalie, che verranno comunicate dal gruppo di lavoro stesso successivamente ai responsabili nazionali degli esperimenti. Sarà cura dei RN intervenire e sanare le anomalie prima della chiusura dei preventivi di luglio.

Coordinatore di Sezione : >= 4 elettori, >= 2.5 FTE in CSN2, >= 1 sigla di CSN2

Aprire una sigla in CSN2: sufficiente l'apertura della sigla in una singola sezione. Le sigle locali sono aperte se raccolgono un impegno complessivo di almeno 1.5 FTE. Il caso contrario è da considerare solo in fase di start up di una nuova sigla in una sezione: in questo caso il finanziamento dell'attività è possibile sotto i fondi di dotazione per un periodo di massimo 3 anni.

Nuove regole common funds

Common funds: alla consegna del progress report ed entro il 31/7 di ogni anno il RN comunica al pres. della CSN2:

- L'importo dei CF che l'esperimento è tenuto a pagare nell'anno successivo (k€)
- Il numero di tutte le firme concesse ai dipendenti o associati INFN (F)
- La somma degli FTE del personale coinvolto nell'esperimento (FTE_Tot)
- Il numero di persone coinvolte nell'esperimento (P_Tot), esclusi i senior.

La CSNII riconosce due categorie di CF:

- CF di costruzione, antecedente alla prima presa dati;
- CF di operazione, fase di presa dati o aggiornamento.

L'impegno minimo medio di FTE per persona <FTE> su scala nazionale che ogni singolo esperimento deve rispettare è normato secondo le seguenti tabelle.

CF di costruzione	
R = CF(k€) / P_Tot	<FTE> = FTE_Tot / P_Tot
0-1	40 %
1-2	50 %
2-3	60 %
3-4	70 %
> 4	≥ 70 % *

CF di operazione	
R = CF(k€) / F	<FTE> = FTE_Tot / F
0-2	40 %
2-4	50 %
4-6	60 %
6-8	70 %
> 8	≥ 70 % **

Rassegna 2023 sulle linee scientifiche della CSN2

(17-19 Aprile, Lecce)

Molto interessante per fare il punto sulla **fisica**

https://agenda.infn.it/event/34896/timetable/

09:45 **Proprieta' dei neutrini e loro misura**

Speaker: Andrea Longhin (Padova)

link

Spoiler: richieste ai servizi

2023 → 2024 (mesi persona)	OFF. MECC. (L. Ramina)	S. T. OFF. EL. (M.Nicoletto)	PROG. EL. (M.Bellato)	UFF. TECH. (M. Benettoni)	CALCOLO e RETI (M. Michelotto)
CTA/MAGIC	3.5 → 3.5		8 → 8	2 → 2	
ET	2 → 2	1 → 1	2		
VIRGO	4 → 3	3 → 1		3 → 2	
EUCLID	2 → 1	1 → 1		1	0.3-0.5 → 1
LEGEND200	0.5 → 0.5	0.5 → 0.5		0.5 → 5	0.5 → 0.5
JUNO	3 → 0.5	0.5	12	1	
NU_AT_FNAL					
ICARUS	2 → 2	20 → 20			4 → 4
QUAX	15 → 15	16 → 12	1	2 → 2	
T2K	3 → 5	2 → 1	3 → 2	1 → 2	
ENUBET2					
SWGO					
Totale	35 → 32.5	43.5 → 37	23 → 13	8.5 → 15	5 → 5.5

NB: In alcuni casi ancora da discutere coi capo-servizi.
Numeri dalle slides.

Impegno previsto per i servizi dal Gr2 stabile

Spoiler: anagrafiche

	2023	2024
CTA/MAGIC	8.9	8.9
FERMI	3.1	2.6
SWGO	2.4	3.8
CUORE	0.6	0.6
ET	2.9	3.1 + x
VIRGO	10.9	7.8
EUCLID	9	8.1 + y
GERDA/LEGEND200	5.2	4.6
JUNO	4.6	4.3
NU_AT_FNAL	1.3	1.3 ?
ICARUS	8.5	8.5
MOON LIGHT-2	2.9	2.9 ?
QUAX	3.7	3.7
T2K	8.3	7.1
ENUBET	2.8	1.2
TOTAL	**75.1**	**68.5 + x + y**

x, y = Gr 4 10% FTE →
for ET, EUCLID
quite reasonable/precious!

But. Violates the new 20% rule … a pity
→ discussion with referees

Spoiler: richieste finanziarie

WIP = work in progress

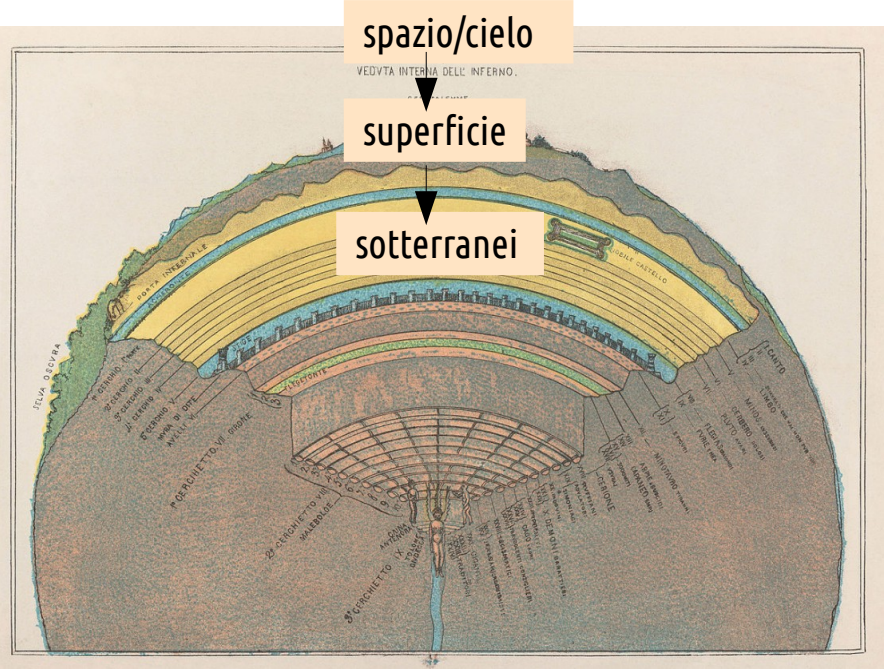
2024 (kEUR)	Missioni	Costruzione app.	Consumo	Inv.	SP-servizi	TRASP	MAN.
CTA/MAGIC	71.5		35		45		
FERMI	7.8						
SWGO	WIP						
CUORE	6						
ET	45						
VIRGO	WIP						
EUCLID	WIP						
GERDA/LEGEND200	25		5	19			
JUNO	90		2	5			
NU_AT_FNAL	WIP						
ICARUS	72	13.5	6		3	10	
MOON LIGHT-2	WIP						
QUAX	80						
T2K	90	30	10	50	25		
ENUBET2	WIP						

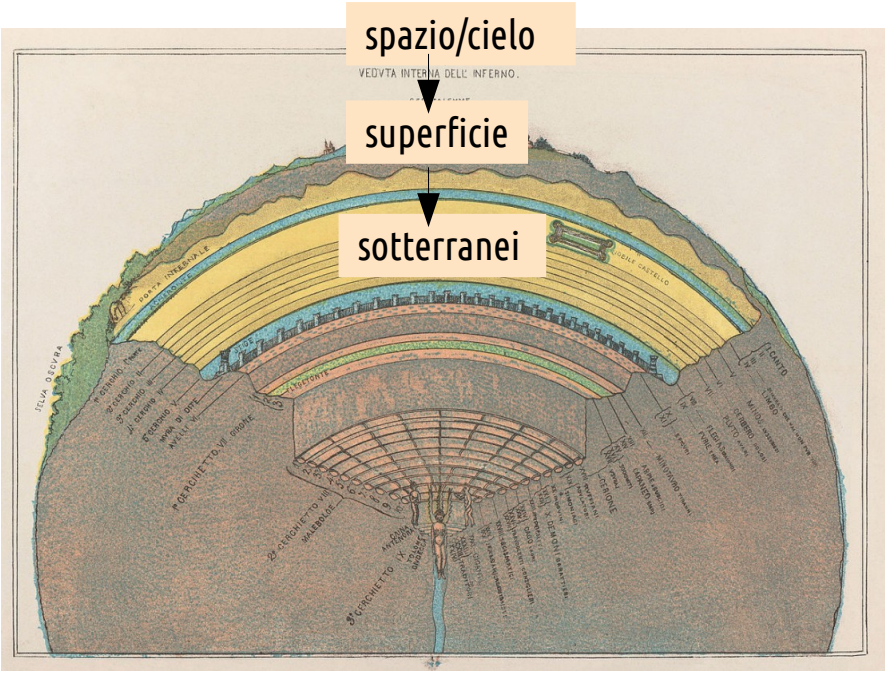
Descrizione delle richieste

Grazie ai responsabili per il materiale!

CTA/MAGIC	M. Mariotti
FERMI	R. Rando
CUORE/CUPID	L. Taffarello
DUNE	L. Stanco
ENUBET	F. Pupilli
ET	J. P. Zendri
EUCLID	S. Dusini
GERDA	R. Brugnera
ICARUS	A. Guglielmi
JUNO	A. Garfagnini
MOONLIGHT-2	P. Villoresi
QUAX	G. Carugno
SWGO	M. Doro
T2K	G. Collazuol
VIRGO	L. Conti

Ordine di presentazione:





CTA/MAGIC
FERMI
SWGO

VIRGO
ET

EUCLID

MOONLIGHT-2

QUAX

DUNE
ENUBET
ICARUS
T2K

JUNO

GERDA/LEGEND
CUORE/CUPID

CTA/MAGIC

M. Mariotti

Sommario

MAGIC status
- Activity 2023
- recent scientific results and highlights

CTA status (in particolare LST)
- Commissionig status
- Activity 2023/24

Richieste finanziarie ed ai servizi di Sezione

MAGIC: presa dati, costante produzione scientifica. MAGIC anche per il commissioning di LST. Molto interessanti sono i risultati dell'analisi fatta con 3 telescopi LST+MAGIC: raggiungiamo una sensibilità con incremento significativo (oltre 50% sulle besse energie) che ci porta ad essere ottimisti sulla early-science con i nuovi telescopi LST. Per LST (CTA) sono iniziati i lavori di infrastrutturali (fondazioni), si prosegue anche se con un piccolo ritardo dovuto alla lentezza dei permessi per costruire. Come INFN Padova abbiamo già consegnato tutto il materiale di nostra responsabilità in sito per i prossimi 3 telescopi. Portiamo avanti la parte R&D per le camere di prossima generazione (Advanced cam) con progettazione elettronica. Le camere in uso adesso (anche quelle per LST) iniziano ad essere obsolete.

CTA/ MAGIC

Padova CTA/MAGIC group (2021- 2022) anagrafica

MAGIC Major Atmospheric Gamma-Ray Imaging Cherenkov Telescopes

M. Mariotti

17 + X (in reclutamento) Researcher Tot= 8.9 FTE + 3 Tecnologi + 2 Tecnici

Mose' Mariotti
group leader

Alessandro de Angelis PO

Michele Doro
PA

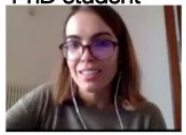
Eugenio Bottacini
PA

Elisa Prandini
RTDA

Riccardo Rando
RC

Ilaria Viale
PhD
student

Caterina Boscolo Meneguolo
PhD student



Davide Miceli
Tecnologo

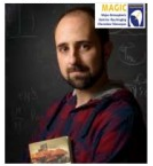
Denis Bastieri
PA

Giovanni Busetto
PO

Giampiero Naletto
PA

Marine Pihet
Student

Michele Fiori
Pos doc

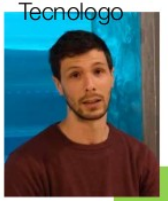


Ivana
PhD
student

Elisa bernardini
PA

Cornelia Arcaro
Tecnologo

Filippo Marini
Tecnologo



Progettazione elettronica

Marco bellato

Razvan Dima

Sandro Ventura
Tecnologo

Daniele Corti

Technical supporters

MAGIC

Main MAGIC papers published in the last 12 months

1) **A lower bound on intergalactic magnetic fields from time variability of 1ES 0229+200 from MAGIC and Fermi/LAT observations**
MAGIC collaboration, Acciari *et al.*
Astron. & Astroph. **670** (2023) A145

2) **Long-term multi-wavelength study of 1ES 0647+250**
MAGIC collaboration, Acciari *et al.*
Astron. Astrophys. **670** (2023) A49

3) **MAGIC observations provide compelling evidence of the hadronic multi-TeV emission from the putative PeVatron SNR G106.3+2.7**
MAGIC collaboration, Abe *et al.*
Astron. & Astroph. **671** (2023) A12

4) **Multimessenger Characterization of Markarian 501 during Historically Low X-Ray and gamma-Ray Activity**
MAGIC collaboration, Abe *et al.*
Astroph.J. Suppl. **266** (2023)

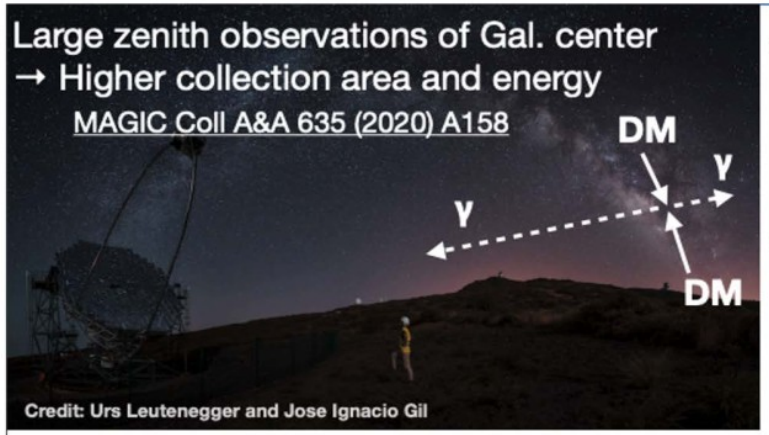
5) **Search for Gamma-ray Spectral Lines from Dark Matter Annihilation up to 100 TeV towards the Galactic Center with MAGIC**
MAGIC collaboration, Abe *et al.*
Phys. Rev. Lett. **130** (2023) 061002

6) **Study of the GeV to TeV morphology of the gamma-Cygni SNR (G78.2+2.1) with MAGIC and Fermi-LAT**
MAGIC collaboration, Acciari *et al.*
Astron. & Astroph. **670** (2023) A8

7) **Combined searches for dark matter in dwarf spheroidal galaxies observed with the MAGIC telescopes, including new data from Coma Berenices and Draco**
MAGIC collaboration, Acciari *et al.*
Phys. Dark Universe **35** (2022) 100912

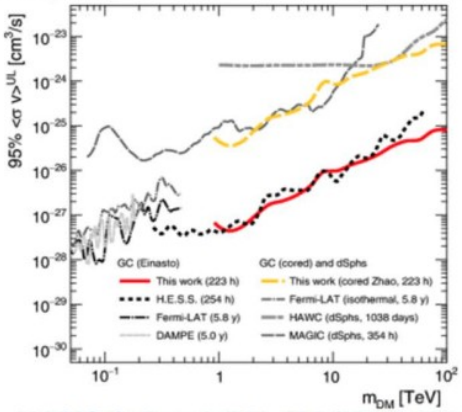
8) **Gamma-ray observations of MAXI J1820+070 during the 2018 outburst**
MAGIC collaboration, Abe *et al.*
Monthly Notices of the Royal Astronomical Society **517** (2022) 4736–4751

MAGIC Highlight: MAGIC search for dark matter



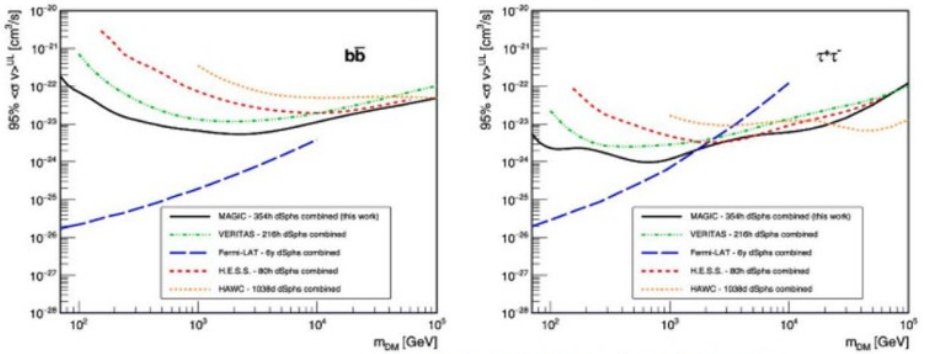
- Galactic Center: Best limits for $\chi\chi \rightarrow \gamma\gamma$ in the 20-100 TeV DM mass range
- dSphs: Best limits for 9 annihilation channels in the multi-TeV DM mass range with IACTs

DM γ-ray lines in the Galactic Center



MAGIC Coll et al. PRL 130 (2023) 061002

Combined searches for DM in dwarf spheroidal galaxies

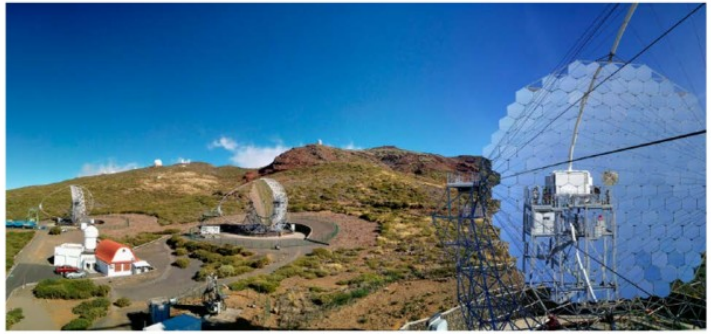


MAGIC Coll. PDU 35 (2022) 100912

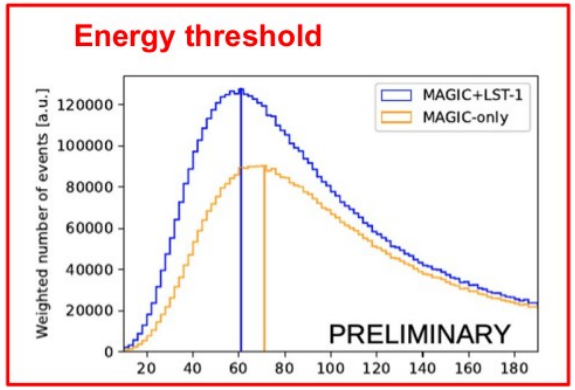
MAGIC

Highlight: MAGIC + CTA LST-1

LST = Large Size Telescope

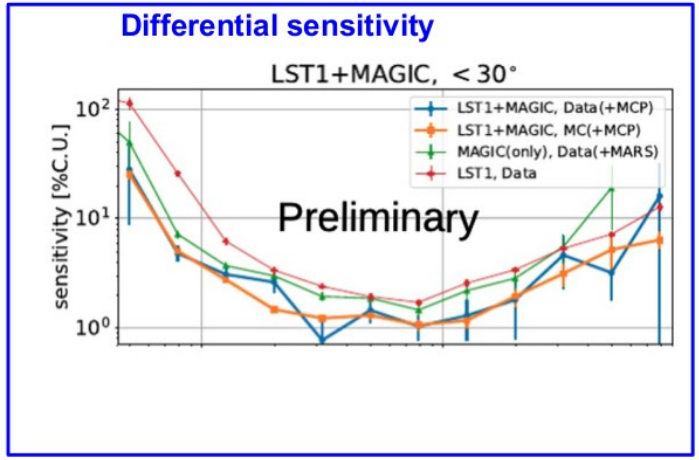


Results of the combined analysis:



Energy threshold

- 15% improvement in the threshold w.r.t. MAGIC only
- A factor of 2 improvement in the collection area at 30 GeV



Differential sensitivity

- Joint observations allow detection of 30% (40%) lower flux than MAGIC alone (LST-1-alone).
- This corresponds to the detection of the same flux in twice (nearly three times) shorter time.
- MAGIC and LST-1 work together better than each instrument alone

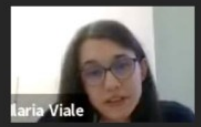
MAGIC

M. Mariotti

Attività 2024: MAGIC

Presa Dati

- 3+1 turni di pesa dati


Analisi dati partecipazione ai Gruppi scientifici

- AGN Physics working group
- Astroparticle and fundamental
- Galactic
- Transient: neutrino, GRB, GW


EB member

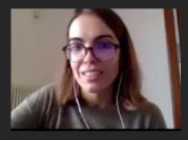





CB member



Neutrino PI




+

CTA

Progressi LST e CTA NORD

M. Mariotti

A. Longhin

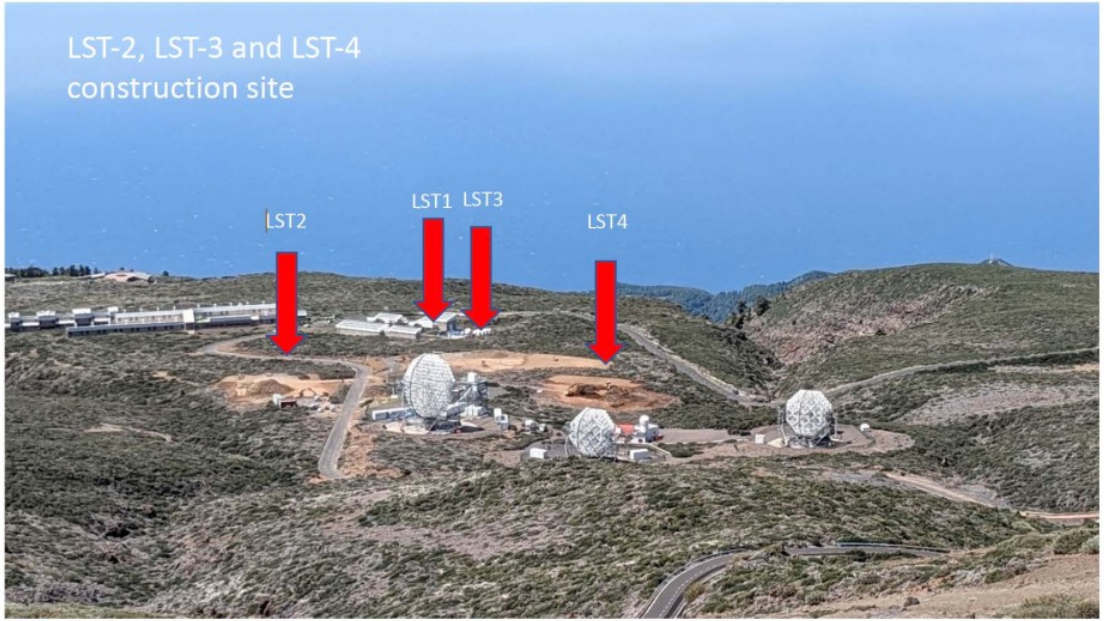
CTA

Progressi LST e CTA NORD

M. Mariotti

LST2-4 construction
A Great Step forward

Contract LIC-22-044 with UTE Dragados/Geocisa



Unión Europea
Fondo Europeo
de desarrollo Regional
"Una manera de hacer Europa"

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN

Gobierno de Canarias
Agencia Canaria de Investigación, Innovación y Sociedad de la Información

CTA General Meeting, Granada, 24 - 28 May 2023

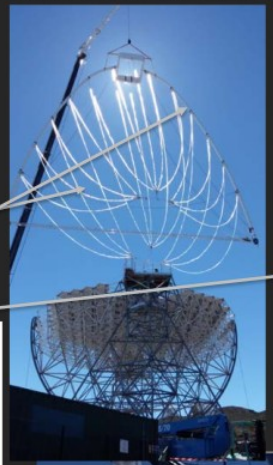
A. Longhin

CTA

Responsabilità meccanica INFN PD LST di CTA

M. Mariotti

- **Razvan** è l'ingegnere di supporto che segue la preparazione delle gara e della documentazione necessaria, con l'aiuto di Loris Ramina come RUP
- Ringrazio tutta l'amministrazione per il
- Supporto che ci ha dato e che continuerà
- a darci



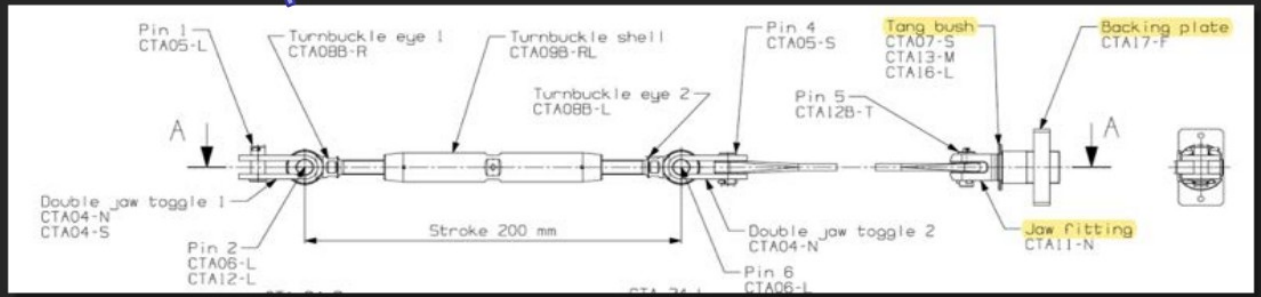
ITEM/telescopio	LST1	LST2	LST3	LST4
Funi	fatto	Ordine fatto	Ordine fatto 2022	Ordine fatto 2022
Tenditori	fatto	In fase di consegna	In fase di consegna	In fase di consegna
Elementi titanio	fatto	Già consegnati	Già consegnati	Già consegnati
Chain plates	Fatto	Già consegnati	Già consegnati	Già consegnati

M. Mariotti

Responsabilità meccanica INFN PD LST di CTA

Un ringraziamento sentito a
- Loris (rup)
- Amministrazione tutta
- Razvan

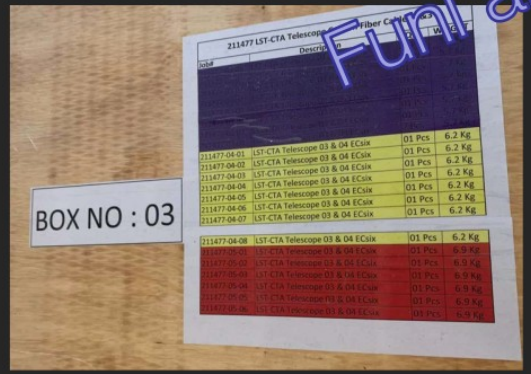
Produzioni terminate

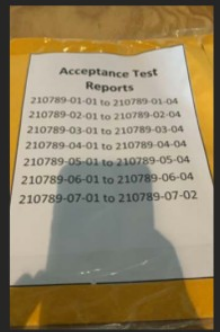


M. Mariotti

Responsabilità meccanica INFN PD LST di CTA

Funi arrivate a La Palma

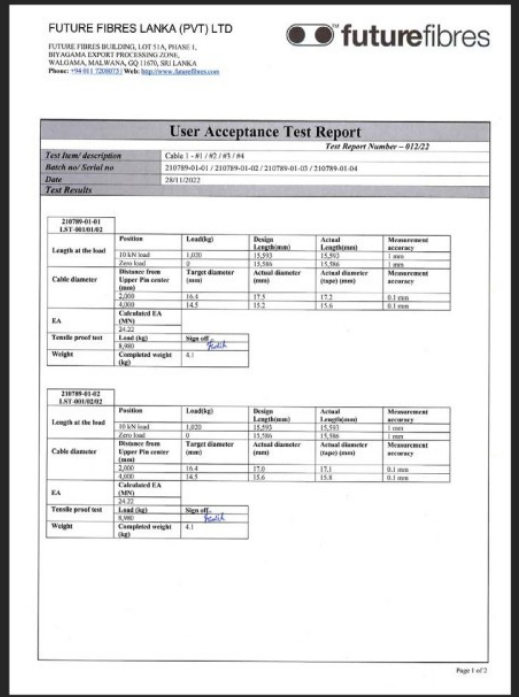




M. Mariotti

Responsabilità meccanica INFN PD LST di CTA

CF ropes LST2-4 received in MIRCA



FUTURE FIBRES LANKA (PVT) LTD

futurefibres

User Acceptance Test Report

Test Report Number – 012/22

Test Item/ description	Cable 1 - #1 / #2 / #3 / #4
Batch no/ Serial no	210789-01-01 / 210789-01-02 / 210789-01-03 / 210789-01-04
Date	28/11/2022

Test Results

210789-01-01 LST-001/01/02	Position	Load(kg)	Design Length(mm)	Actual Length(mm)	Measurement accuracy
Length at the load	10 kN load	1,020	15,593	15,592	1 mm
	Zero load	0	15,586	15,586	1 mm
Cable diameter	Distance from Upper Pin center (mm)	Target diameter (mm)	Actual diameter (mm)	Actual diameter (tape) (mm)	Measurement accuracy
	2,000	16.4	17.5	17.2	0.1 mm
	4,000	14.5	15.2	15.6	0.1 mm
EA	Calculated EA (MN)				
	24.22				
Tensile proof test	Load (kg)	Sign off			
	8,080				
Weight	Completed weight (kg)	4.1			

210789-01-02 LST-001/02/02	Position	Load(kg)	Design Length(mm)	Actual Length(mm)	Measurement accuracy
Length at the load	10 kN load	1,020	15,593	15,593	1 mm
	Zero load	0	15,586	15,586	1 mm
Cable diameter	Distance from Upper Pin center (mm)	Target diameter (mm)	Actual diameter (mm)	Actual diameter (tape) (mm)	Measurement accuracy
	2,000	16.4	17.0	17.1	0.1 mm
	4,000	14.5	15.6	15.8	0.1 mm
EA	Calculated EA (MN)				
	24.22				
Tensile proof test	Load (kg)	Sign off			
	8,080				
Weight	Completed weight (kg)	4.1			

Page 1 of 2

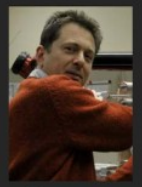
Documents that are following the box Acceptance test with measurements with and without 10kN load

CTA

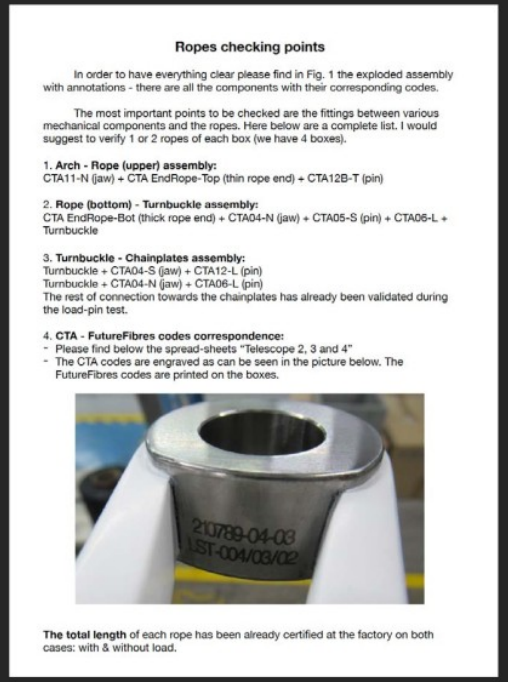
Responsabilità meccanica INFN PD LST di CTA

M. Mariotti

New document provided by Razvan to link Standard LST doc with received documentation



Razvan
Dima



Ropes checking points

In order to have everything clear please find in Fig. 1 the exploded assembly with annotations - there are all the components with their corresponding codes.

The most important points to be checked are the fittings between various mechanical components and the ropes. Here below are a complete list. I would suggest to verify 1 or 2 ropes of each box (we have 4 boxes).

1. **Arch - Rope (upper) assembly:**
CTA11-N (jaw) + CTA EndRope-Top (thin rope end) + CTA12B-T (pin)

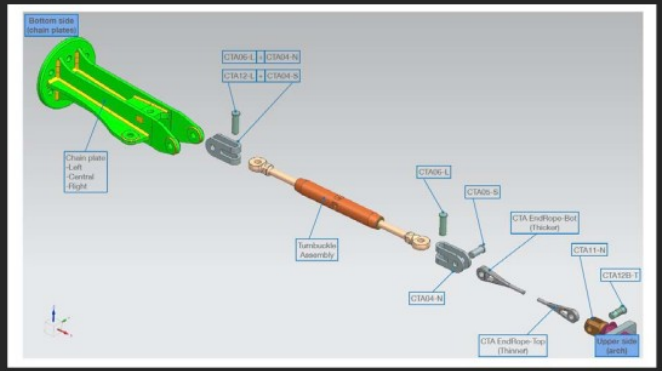
2. **Rope (bottom) - Turnbuckle assembly:**
CTA EndRope-Bot (thick rope end) + CTA04-N (jaw) + CTA05-S (pin) + CTA06-L + Turnbuckle

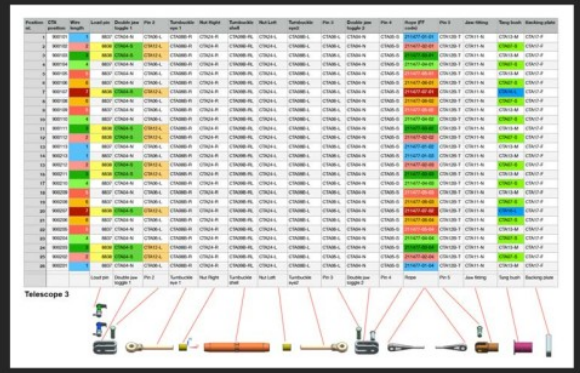
3. **Turnbuckle - Chainplates assembly:**
Turnbuckle + CTA04-S (jaw) + CTA12-L (pin)
Turnbuckle + CTA04-N (jaw) + CTA06-L (pin)
The rest of connection towards the chainplates has already been validated during the load-pin test.

4. **CTA - FutureFibres codes correspondence:**
- Please find below the spread-sheets "Telescope 2, 3 and 4"
- The CTA codes are engraved as can be seen in the picture below. The FutureFibres codes are printed on the boxes.

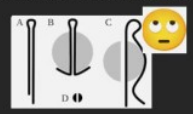
210789-04-03
LST-004/03/02

The total length of each rope has been already certified at the factory on both cases: with & without load.





During this review we realize that we miss the procurement of CotterPins



A. Longhin

CTA/ MAGIC

R&D advanced SiPM camera per LST/MAGIC

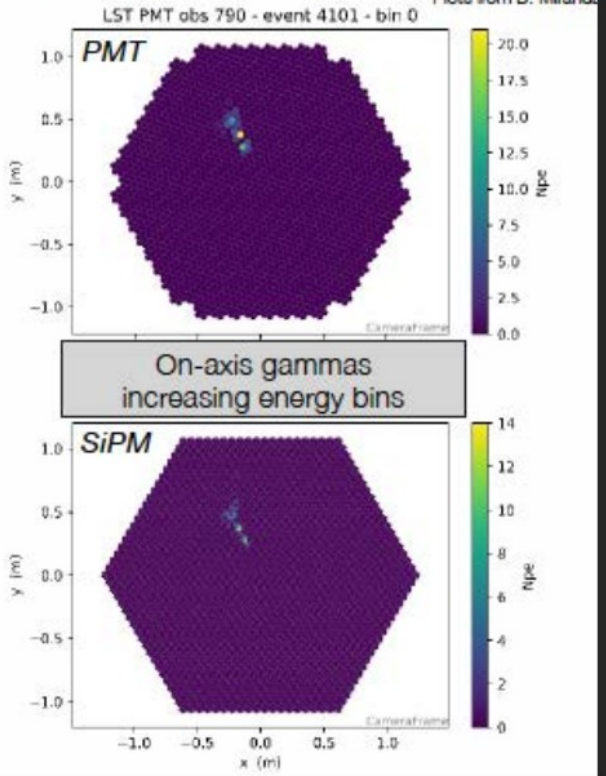
M. Mariotti

The LST Advanced SiPM Camera

Plots from D. Mirando

Baseline

- Decreasing pixel size **from 0.1° to 0.05°**:
  - Increase capabilities of feature extractions for gamma/ hadron separation
  - Limit dark count rate influence
  - Decrease dynamic range (dual to single gain)
- Going for **fully digital readout** (12 bit FADC @1GSps)
  - Higher flexibility for:
    - Advanced trigger implementation
    - Data processing inside the camera
  - Updatability/Reprogrammability
- But this poses many challenges:
  - Power consumption
  - Data throughput
  - Cost



3

A. Longhin

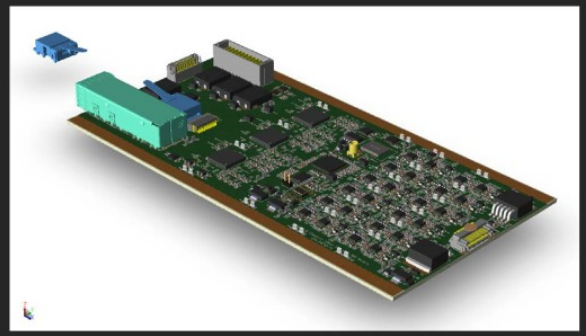
CTA/
MAGIC

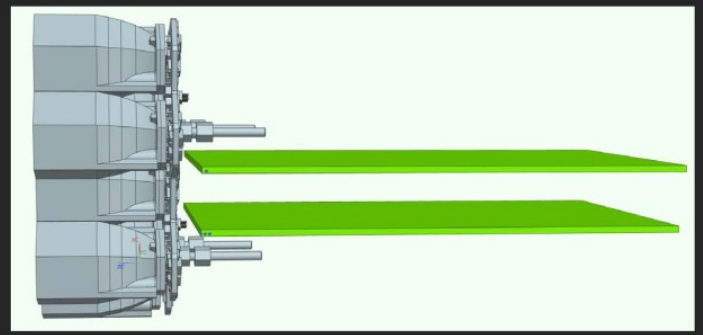
M. Mariotti

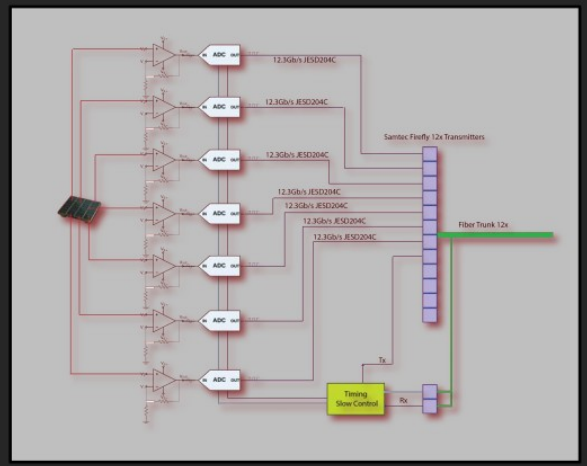
R&D advanced SiPM camera per LST/MAGIC

Demonstrator Proposal

- Readout of a cluster of pixels
- 12 ADC channels @ 1 Gsample/s
- 1 Firefly 12x TX @ 14 Gb/s/ch
- 1 Fiber trunk 12x for data
- 1 Fiber Rx channel for timing





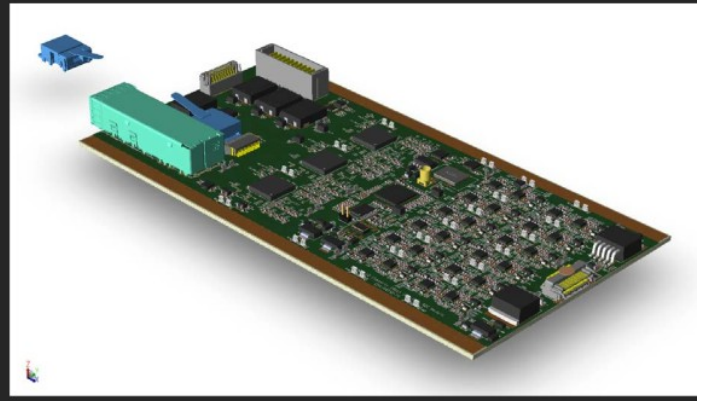


CTA/
MAGIC

M. Mariotti

Advanced SiPM camera per LST/MAGIC: 2023

Status of FADC Board

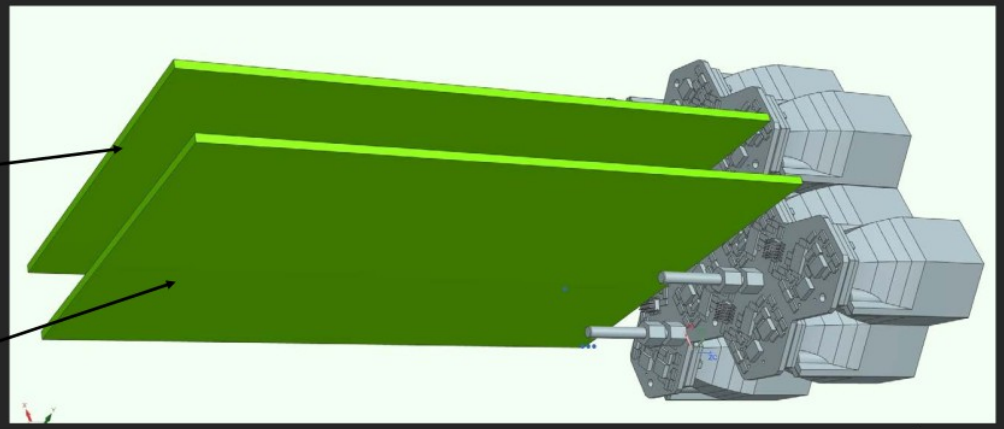


- Fully routed
- Currently under signal, temperature and power integrity simulation
- Ready for production in few weeks
- Components for the FADC board ordered
  - the vast majority has reasonable lead time
- Asked ISOLA for PCB dielectrics Terragreen and I-TERA MT40
  - lead time 8 weeks
- Constantly monitoring component delivery for starting the production
- Working on test mockup with Ge University

CTA/
MAGIC

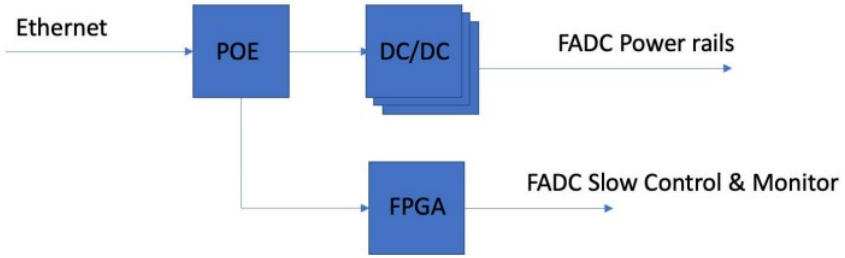
Advanced SiPM camera per LST/MAGIC: 2023/25

M. Mariotti



Power /SC Board

- Artix Ultrascale evaluation board 2.5KE
- Power board Prototyping 20KE
- Xilinx JESD204C IP core 20KE



A. Longhin

CTA/ MAGIC

M. Mariotti

Bozza richieste economiche commissione II 2024

Capitolo	Descrizione	Parziali (k€)		Rimuovi	Modifica	Totale (k€)	
		Richieste	SJ			Richieste	SJ
consumo	Materiale elettronico per completare il prototipo del sistema di readout per Advanced Camera di LST	35.00	0.00			35	0
missioni	3 turni di presa dati esperimento MAGIC 3x4 = 12 k	12.00	0.00			71.5	0
	2 truni di presa dati LST	7.00	0.00				
	6 turni tecnici per montaggio funi nei telescopi LST2-4, Prevediamo 2 interventi con 3 tecnici meccanici per installazione tenditori nei telescopi LST4. Il costo stimanto di 2.5 k/turno	15.00	0.00				
	3 turni tecnici di meccanici per manutenzione specchi MAGIC: un team di tre meccanici per 10 giorni 2.5x3 k	7.50	0.00				
	Partecipazione ai meeting LST, MAGIC 10 FTE:2 x 2.5 x FTE/2 = 20	25.00	0.00				
	Meeting del responsabile nazionale: 5	5.00	0.00				
spservizi	Common funds Costruzione LST di CTA per tutte le sezioni INFN	45.00	0.00			45	0
Totale						151.5	0

CTA/
MAGIC

M. Mariotti

Richieste ai servizi di Sezione 2024

RICHIESTE Servizi di Sezione CTA 2024

Progettazione elettronica 8 mU + 20% tecnologo

• Sviluppo elettronica front end SiPm	1,0 mese/uomo
• Produzione Collaudo FADC 12 ch board	4,0 mese/uomo
• Sviluppo Power /SC board	4,0 mese/uomo

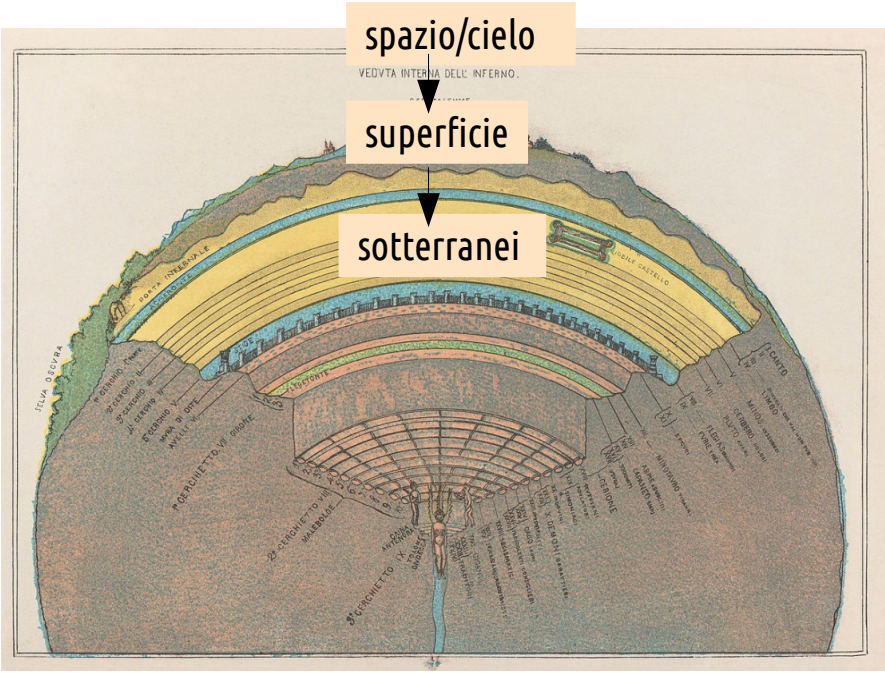
OM 3.5 mU

• Supporto manutenzione specchi MAGIC	1.5 mese/uomo
• Supporto per ricevimento e montaggio funi sul telescopio	2.0 mese/uomo

UT 2 mU

• Supporto funi, ricevimento e collaudo tenditori e funi	2.0 mese/uomo

A. Longhin



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SWGO

VIRGO
ET

EUCLID

MOONLIGHT-2

QUAX

DUNE
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T2K

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Fermi LAT 2023

–=≡ Gruppo 2 ≡=–

Denis Bastieri
Eugenio Bottacini
Alessandro De Angelis
Riccardo Rando
Jingtian Zhu

FERMI: attività

R. Rando

Alcune attività di collaborazione:

- 4th catalog of Active Galactic Nuclei (data v3)
- Fermi LAT light curve repository
- Brightest GRB: 221009A (submitted)

Alcuni output e attività di ricerca a Padova:

- “Fermi-LAT” capitolo del libro “Handbook of X-ray and gamma-ray astrophysics, Springer (finalmente pubblicato, Rando)
- follow up di nuovi transienti del LAT con INTEGRAL e con Swift/XRT, studio con il LAT e GBM di un flare di una sorgente galattica (ongoing, Bottacini)
- "Exploring TeV candidates of Fermi blazars through machine learning" (submitted), catalogo potenziali sorgenti al TeV da proporre a LHAASO (Bastieri, Zhu)

Studenti:

- 1 PhD (J. Zhu, 3° anno)
- 1 resi triennale (Rando, 4/2023)
- 1 tesi magistrale (Bottacini, est. 9/2023)

Summary of Fermi LAT science publications

1 March 2023

Category I and II papers in refereed journals (here category II.5 are counted as category II)

Journal	Published	In press	Total
Advances in Space Research	0+1=1	-	1
Astronomy and Astrophysics	8+114=122	0+2=2	124
Astroparticle Physics	2+6=8	-	8
Astrophysical Journal	110+201=311	0+1=1	312
Astrophysical Journal Letters	34+46=80	-	80
Astrophysical Journal Supplement	22+8=30	1+0=1	31
Astrophysics and Space Science	0+1=1	-	1
Journal of Cosmology and Astroparticle Physics	4+15=19	-	19
Journal of Geophysical Research	0+3=3	-	3
Monthly Notices of the RAS: Letters	0+2=2	-	2
Monthly Notices of the Royal Astronomical Society	1+78=79	-	79
Nature	2+4=6	-	6
Nature Astronomy	1+2=3	-	3
Nature Physics	0+2=2	-	2
Nuclear Instruments and Methods	0+1=1	-	1
Physical Review D	11+20=31	-	31
Physical Review Letters	12+3=15	-	15
Physics Reports	0+1=1	-	1
Publ.Astron.Soc.Austral.	0+1=1	-	1
Publications of The Korean Astronomical Society	0+1=1	-	1
Publications of the ASJ	0+3=3	-	3
Research in Astronomy and Astrophysics	0+1=1	-	1
Science	24+0=24	-	24
Science China Physics, Mechanics & Astronomy	0+1=1	-	1
Total	231+515=746	1+3=4	750

15th Launch Anniversary: June 11, 2023

R. Rando

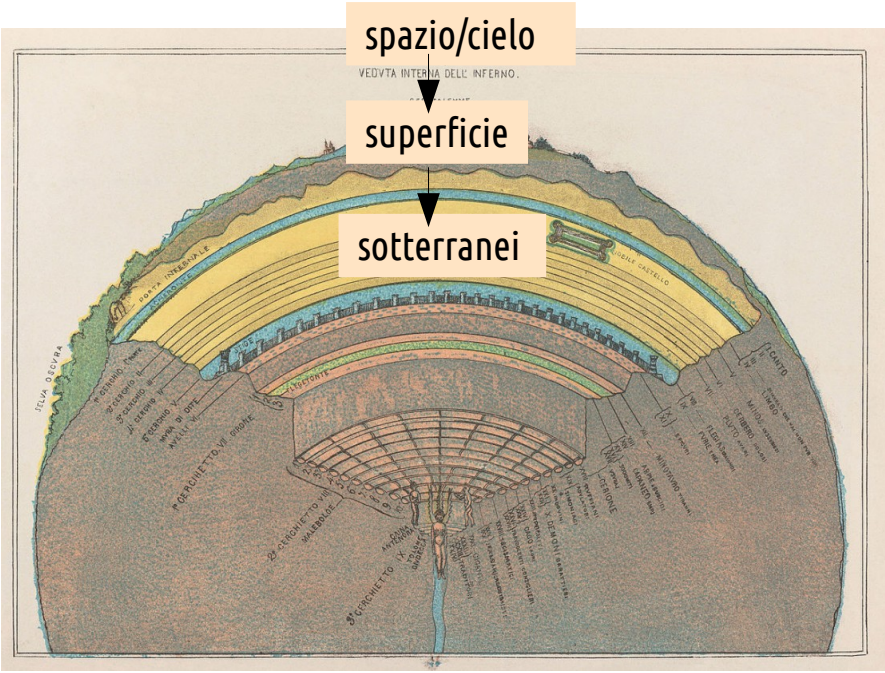
Anagrafica e richieste

Nome	Qualifica	%
Bastieri Denis	Prof. Associato	60
Bottacini Eugenio	Prof. Associato	20
De Angelis Alessandro	Prof. Ordinario	20
Rando Riccardo	Prof. Associato	60
Jingtian Zhu	Dottorando	100
	FTE	2.6

Nessuna variazione significativa
Richieste (coordinate a livello nazionale):
~3k€/FTE per

- 1 collaboration meeting internazionale
- 1 collaboration meeting nazionale
- 1 F2F working group

Nessuna richiesta servizi



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SWGO

M. Doro


SWGO
The Southern Wide-field Gamma-ray Observatory
SWGO X 2024
Michele Doro, University of Padova

SWGO

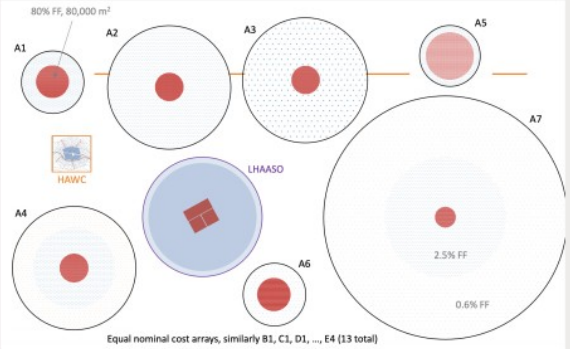
M. Doro

The Southern Wide-field Gamma-ray Observatory

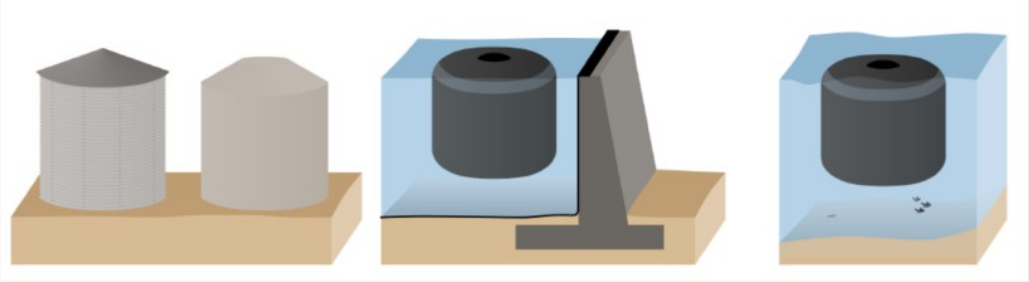
Important activities for 2024

SWGO R&D Phase Milestones	
✓	R&D Phase Plan Established
✓	Science Benchmark Cases Chosen
✓	Reference Configuration & Options Defined
✓	Site Shortlist Complete
M5	Candidate Configurations Defined
M6	Performance of Candidate Configurations Evaluated
M7	Preferred Site Identified
M8	Design Finalised
M9	Construction & Operation Proposal Complete

1/ Final array layout under study: 200-1200m radius



2/ Tanks mechanics (tank, pond, lake) and **photosensors**



3/ **Site**:
- Argentina
- Cile
- Perù

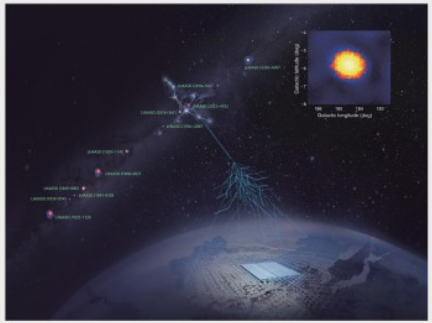
Padova (10 persone, 3.8 CFU):
- **Staff: Doro (RL)**, Dorigo, Mariotti, de Angelis, Prandini, Bottacini
- PD/PhDs: Batkovic, Nardi (phd), Ruina (new)
- 3 tesi in 2022/23

2

M. Doro

@PD: PeV showers simulations

[Doro, Dorigo, Nardi, Lui, Visentini]

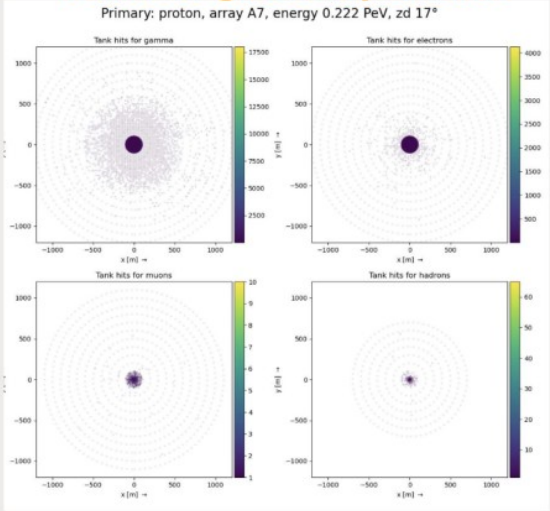


Massive simulations at CNAF of 0.1-10 PeV showers

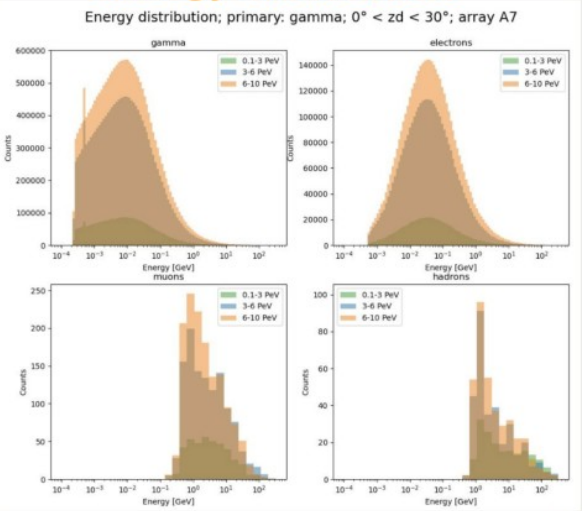
Template reconstruction required to the massive CPU time

Motivated by LHAASO incredible nr of PeV-atrons detected

Particle ground pattern

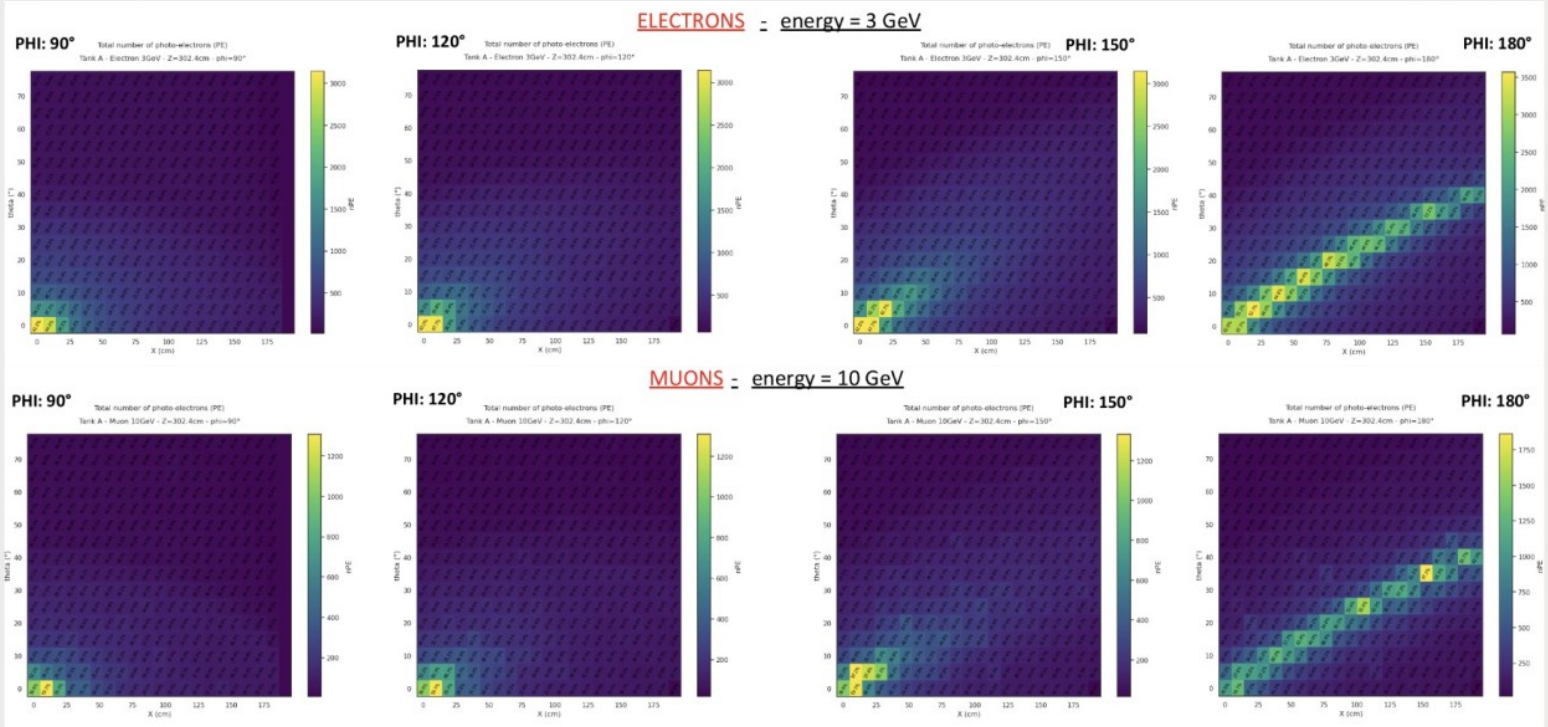


Energy distribution



M. Doro

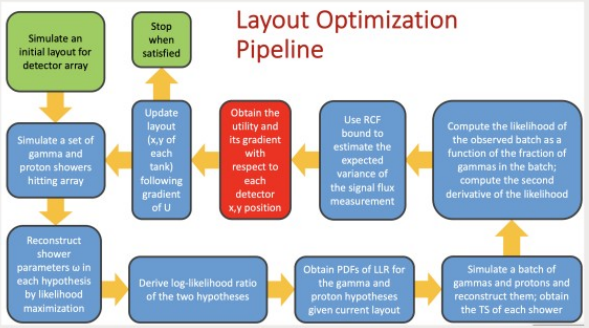
Look-up tables for fast reconstruction



M. Doro

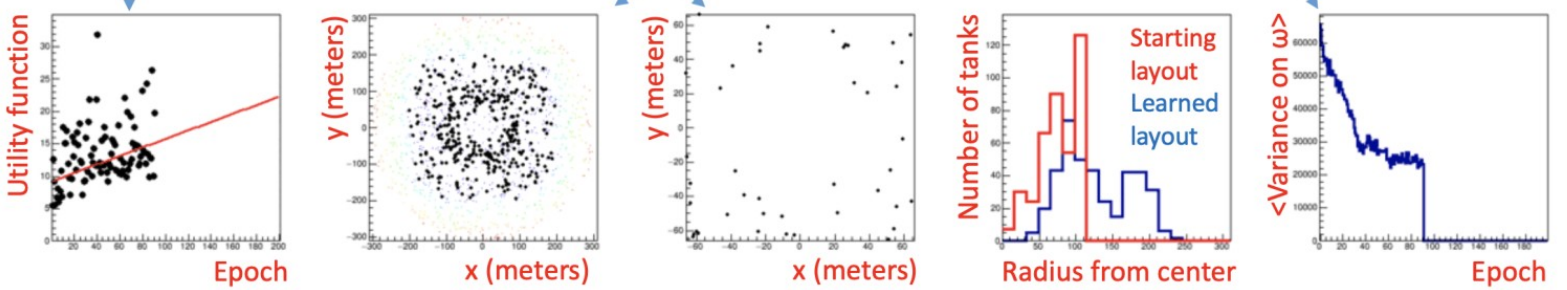
@PD2: layout optimization

[Doro, Dorigo, Nardi + Cornegie (US)]



End-to-End Optimization of the SWGO Layout using gradient descent and machine learning

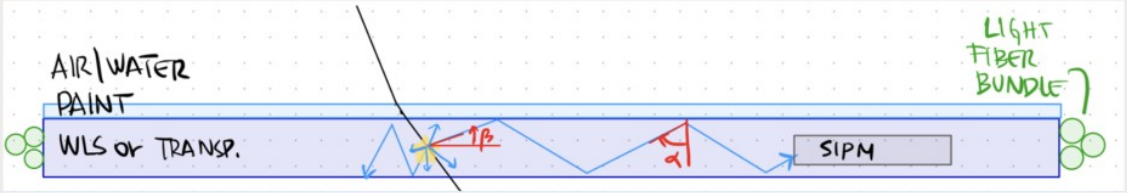
Below is shown a run where the initial position of detector elements placed in a uniform circular pattern (black points in second and third diagram) gets updated as the system maximizes U, finding layouts that better discriminate p/γ and improve/extend reconstruction

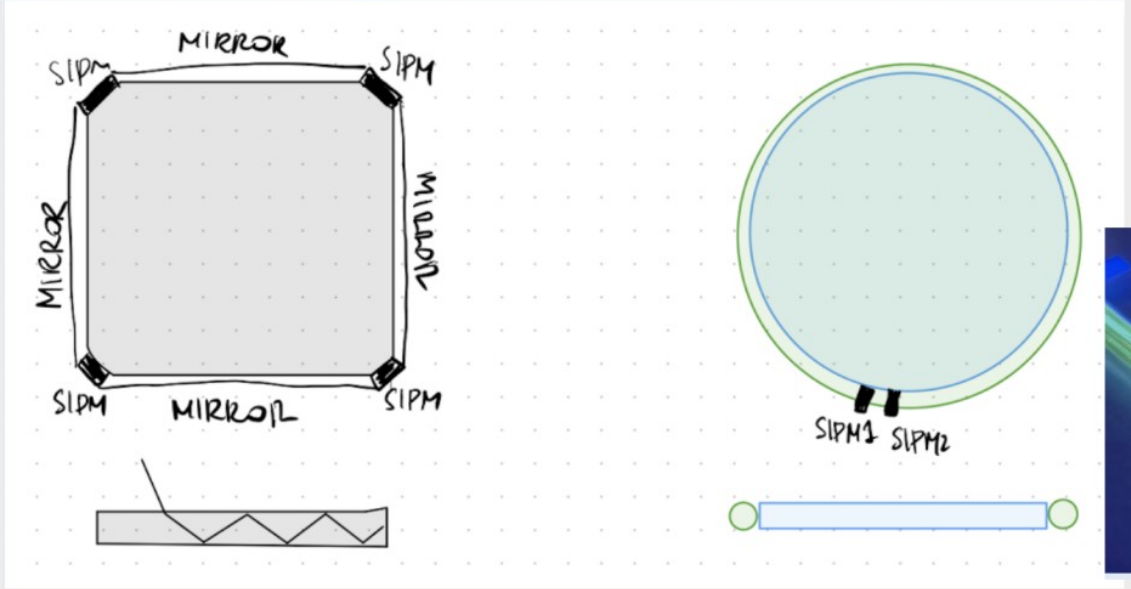


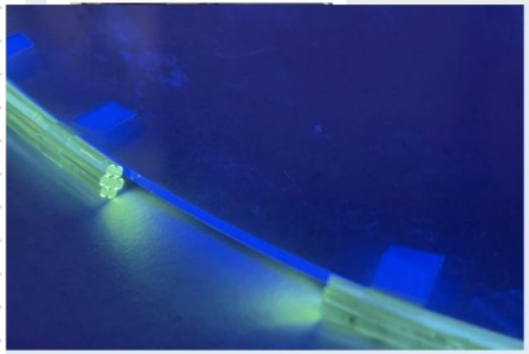
M. Doro

@PD3: wavelength-shift light-traps

[Mariotti, Arcaro, Pihet, Silvestrin]

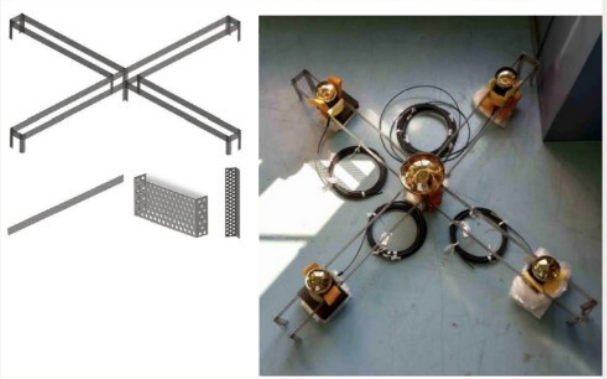






M. Doro

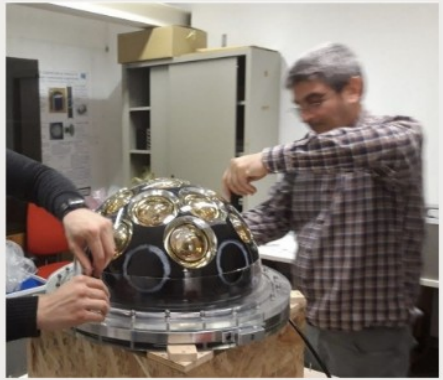
@SWGO-IT



Prototype tank at Milano with flexible mounting system for photosensors

Multiple-PMT system (a-la KM3net) under study at Napoli

An half-sphere as an alternative to the large PMTs in the mercedes tank



SWGO

M. Doro

FTE 2024

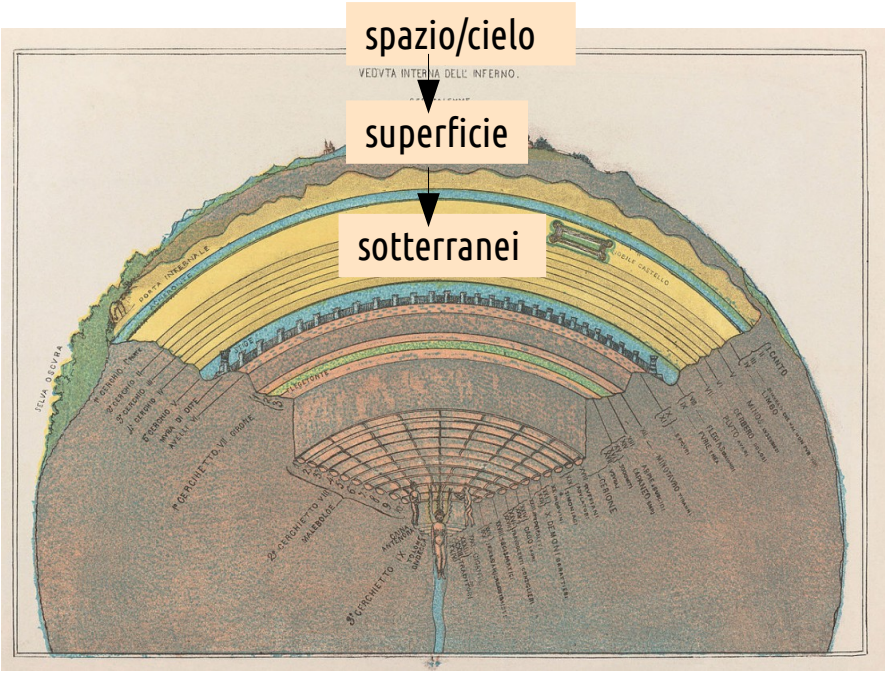
Cognome	Nome	Mail	Ruolo	SWGO
				380
Ruina	Arshia	arshia.ruina@pd.infn.it	INFN-stranieri	70
Batkovic	Ivana	ivana.batkovic@phd.unipd.it	PhD	60
Doro	Michele	michele.doro@unipd.it	PA	50
Nardi	Federico	federico.nardi@phd.unipd.it	PhD	50
De Angelis	Alessandro	alessandro.deangelis@unipd.it	PO	40
Dorigo	Tommaso	tommaso.dorigo@pd.infn.it	INFN	30
Mariotti	Mosè	mose.mariotti@unipd.it	PO	30
Bottacini	Eugenio	eugenio.bottacini@unipd.it	PA	20
Prandini	Elisa	elisa.prandini@unipd.it	RTDB	20
Zangrando	Lisa	lisa.zangrando@pd.infn.it	INFN	10

Richieste 2024

Nessuna per servizi

Solo richiesta missioni

3



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Virgo

Stato e prospettive Advanced Virgo

Maggio 24, 2023: iniziato il run O4, con i due rivelatori Advanced LIGO (sensibilità migliorata di circa il 30% rispetto a O3, 130-160MPc) e per il primo mese KAGRA (ma con sensibilità minimale, 1Mpc)

Advanced Virgo ha deciso di continuare il commissioning per raggiungere l'obiettivo minimo di sensibilità (60Mpc)

Articolazione del gruppo Virgo a INFN Padova:

- ricerca sperimentale (hardware) per il rivelatore @Pd @LNL @EGO
- distribuzione dei public alerts (low latency): @Parma
- ricerca astrofisica @Pd

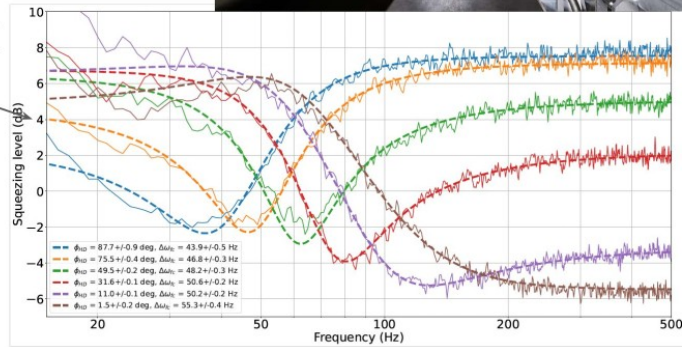
L. Conti

Quantum Noise Reduction (QNR)

Jean Pierre Zendri is the coordinator of the QNR system of Virgo

Status:

- Frequency Dependent vacuum squeezed source commissioned
- ready for injection on the ITF.
- Preliminary injection test.



Paper to appear in PRL

In progress

- Experimental estimation of the interferometer internal losses.
- Frequency Independent vacuum squeezing injection (Virgo O4 initial).
- Fiber phase noise cancellation loop implementation.
- Frequency Dependent Vacuum source injection (depending on the ITF status)

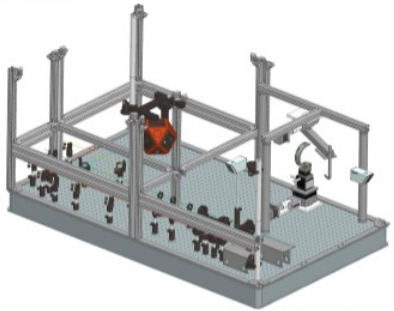
Direct Digital Synthetizer
Phase-Lock Loop

Activity 2024:

- O4 Long term operation with quantum noise reduction
- R&D on squeezing angular jitter-noise reduction (broad band PLLs and low noise DDS) for O5 and post-O5

Stray light: characterizing scattering (Virgo&ET)

Experimental setup for measuring the two most relevant metrics of scattering (angle-resolved scattering BSDF, and total integrated scattering TIS) of surfaces, materials.

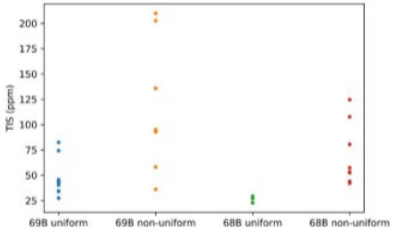


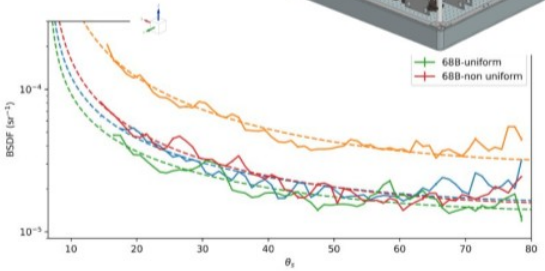
In 2023 we moved the setup to the clean room in 3rd floor Polo didattico:

- re-started the clean room
- new upgraded mechanics, in collaboration with Uff. Tecnico& Off. Mecc
- extended to 3 wavelengths (532nm, 1064nm, 1550nm), including ET laser wav
- now setting up the new facility

✔ Measured samples of baffles for the Test Masses of AdV-Phase2 (run O5)

Soon measurements of samples of steels for ET beam pipe





Activity 2023-24:

- Completing the setup for 1550nm, 1064nm and 532nm, including power control. Possibly also 2000nm
- Measurements of scattering of optical components and materials/coatings
- Upgrading the setup for measurements of BSDF out of the plane of incidence

VIRGO

Stray light: dust contamination in Virgo

Particle fallout can scatter stray light and contribute to stray light noise.

Since Nov 2022 we have setup and are following a procedure to monitor particulate contamination across Virgo exposing clean Si wafers and then imaging them after fallout accumulation.

Particles found in North End Tower (June 2023)

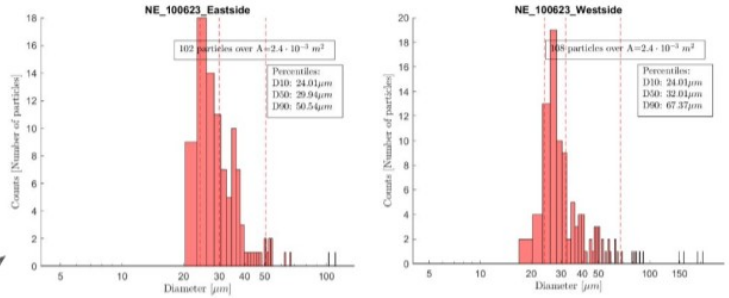
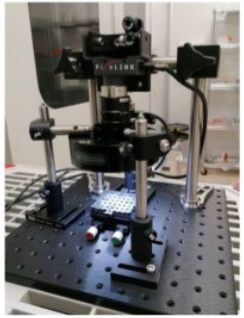


Figure 2: particles count histograms of the two NE_100623 wafers. Those wafers were exposed during the installation of the PAY. As stated in the result discussion, the apparatus is sensible to particles larger than 8μm in diameter and counts of particles with diameter D<25μm are underestimated.

In 2023 upgrading the wafer imaging setup to resolve smaller particles:
from a camera based system (@EGO, resolution ~10um) to a digital microscope (@Pd, resolution ~0.3um)



Activity 2023-24:

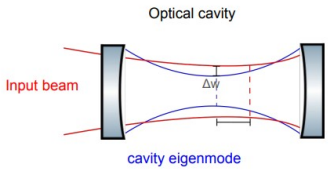
- Dust monitoring@ Virgo
- Evaluation of procedures for cleaning optics
- TIS, BSDF measurement of contaminated sample to test model and improve reliability of predictions

VIRGO

Coating R&D

- **Status and results**: the activity went along several lines, worked out in parallel thanks to the help of 1PhD and several master students.
  - Crystallization of Ta_2O_5: successful proposal at the ESRF synchrotron, data analysis in progress; optical studies in partially crystallized samples (phase contrast microscopy, Raman, in-situ X-Ray diffraction and reflectivity); preliminary results on the impact of partial crystallization on mechanical properties.
  - Crystallization of Ti:Ge: study of the crystallization kinetics during the annealing
  - Service to the Virgo Coating R&D collaboration (mainly LMA) by characterizing several samples by means of RBS and other techniques (Ti:Ge, SiN, Zr:Ta_2O_5, a-Si)
  - Setting up of new experiments to perform new and sensitive characterizations of the optical and mechanical properties of GW coatings: (scatterometer, cryomembrane)
- **Publications:**
  - Optical and Mechanical Properties of Ion-Beam-Sputtered MgF_2 Thin Films for Gravitational-Wave Interferometers, Physical Review Applied, 2022, 17,
  - Measurement and Simulation of Mechanical and Optical Properties of Sputtered Amorphous SiC Coatings, Physical Review Applied, 2022, 18
  - Characterization of Ion-Beam-Sputtered Al F3 Thin Films for Gravitational-Wave Interferometers, Physical Review Applied, 2022, 18, -
- **Activity 2024:**
  - Completion of the new facilities under construction, and start of an investigation campaign on actual coating membranes.
  - Completion of the crystallization analysis on Ta_2O_5 and link between mechanical and optical properties for crystallized Ta_2O_5 film

What is mode mismatch ?



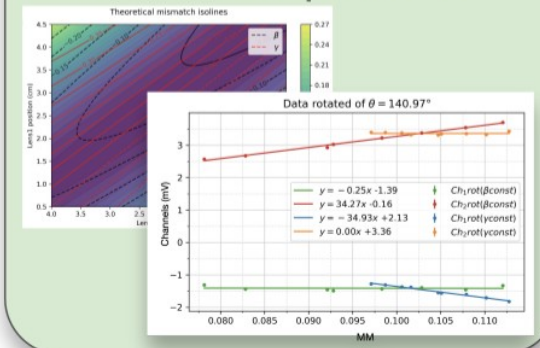
VIRGO

RF sensing technique for mode matching:

development of sensor for relative mode mismatch between optical cavity and laser beam

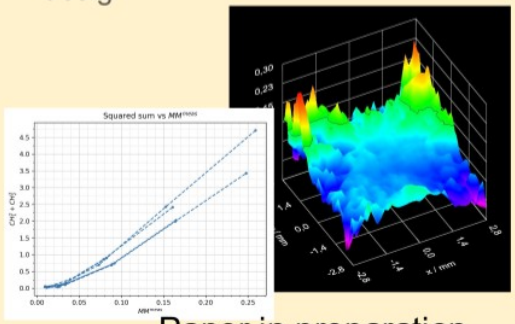
Done in 2022/23:

- New telescope design to better explore parameters' space
- Implementation and functional testing of new EOL design using a mode-conversion telescope
- **Experimental demonstration of decoupled sensing of the two mode-mismatch parameters**



In progress/objectives 2023

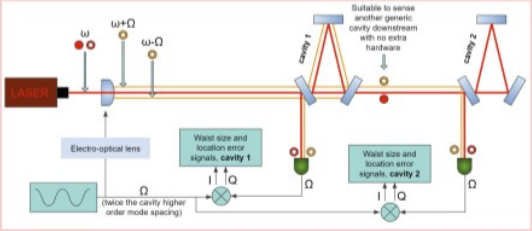
- Characterization of offsets + calibration of the sensing signals
- Test mismatch correction based on sensing signals
- Direct measurement of wavefront modulation produced by new EOL design



Paper in preparation

Planned for 2024

- Integration of mode-cleaner to test the technique at lower mode-mismatch values
- Test of technique on two cavities in series (with single EOL)



Population and rates

- **Status and results**
  - New framework for population models (SEVN) ready and public (https://gitlab.com/sevncodes/sevn),
  - new framework for hierarchical mergers (FASTCLUSTER) ready and public (https://gitlab.com/micmap/fastcluster_open)

- **Publications**
  - Arca Sedda, Mapelli, Benacquista, Spera "**Isolated and dynamical black hole mergers with B-POP: the role of star formation and dynamics, star cluster evolution, natal kicks, mass and spins, and hierarchical mergers**" 2023, MNRAS, 520, 5259
  - Iorio, Mapelli, et al. "**Compact object mergers: exploring uncertainties from stellar and binary evolution with SEVN**" 2023, MNRAS, in press
  - Ballone, Costa, Mapelli et al., "**Formation of black holes in the pair-instability mass gap: hydrodynamical simulations of a head-on massive star collision**" 2023, MNRAS, 519, 5191
  - Codazzo et al. (including Mapelli), "**Study on the detectability of gravitational radiation from single-binary encounters between black holes in nuclear star clusters: The case of hyperbolic flybys**", Phys. Rev. D, 107, 3023

- **Activity 2024**
  - Astrophysical interpretation of preliminary O4 results (Iorio, Mapelli, Périgois)
  - Submission and address of referee report of O3 eccentric BBH LVK collaboration paper (Mapelli)
  - Upgrade of FASTCLUSTER to include AGN disc scenario (Mapelli)
  - Development of new tool for stochastic background analysis in LVK data (Périgois)

LVK = Ligo Virgo Kagra

Low-latency

The activity is the implementation and running of the LVK alert infrastructure that provides real-time **Public Alert** distribution of the candidate detection of the collaboration (usually within 1 minute after the arrival of the GW)

Roberto De Pietri (Univ Parma, INFN-Pd) is the **VIRGO co-chair of the LowLatency LVK group**, and he participated at the February 2023 NSF review of the LIGO Lab 4 years grants as a VIRGO host ad he is coordinating the development of the LVK alert infrastructure.

Activity 2024 and current research projects of the PD member (De Pietri/Feo/Franceschetti) of the EMfollow group are:

- Coordination of the low-latency LVK group
- Deployment of the low-latency infrastructure using k8s distributed deployment and of the development infrastructure (the-full-system-on-a-desktop) to allow rapid and effective improvement of the alert system.
- Improvement of the information provided in real-time and how to make them of more easy usage for follow-up research.
- Analysis of the quality of the provided alerts.

L. Conti

VIRGO

Anagrafica e richieste ai servizi di sezione

cognome	nome	FTE VIRGO
Bazzan	Marco	50
Bonavena	Luis Diego	100
Chiarini	Gabriella	100
Ciani	Giacomo	40
Ciolfi	Riccardo	40
Conti	Livia	50
De Pietri	Roberto	50
Favaro	Giulio	60
Feo	Alessanddra	20
Franceschetti	Kevin	50
Iorio	Giuliano	40
Mapelli	Michela	20
Moscatello	Andrea	50
Perigois	Carole Frederique	50
Vedovato	Gabriele	0
Zendri	Jean Pierre	60

Tot: 7.8 FTE

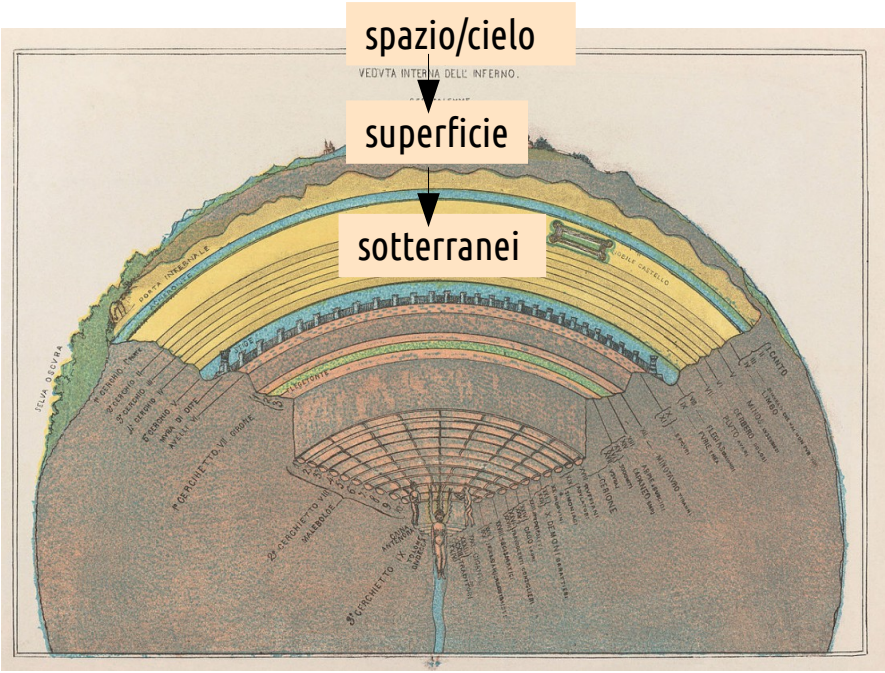
Richieste ai servizi di sezione per supporto alle varie attività sperimentali:

- 2 mesi persona UFF Tecnico
- 3 mesi persona officina meccanica
- 1 mese persona officina elettronica

Personale PNRR:

- Valeria Milotti 0% FTE

→ Vedovato: in pensione, continua a lavorare molti intensamente alla analisi LVK con la pipeline cWB



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ET Internazionale e sigle “affini”

Prosegue la stesura del ET-TDR coordinata dal ***Instrument science board***. La Sezione di Padova rappresentata da

- **Livia Conti** Co-chair del working package «scattered light».
- **Giacomo Ciani** Co-chair del working package «squeezed light».

La candidature italiana è supportata da **ETIC** sia per la caratterizzazione del sito (Padova non coinvolta) sia per lo sviluppo di infrastrutture di ricerca a supporto delle tecnologie abilitanti.

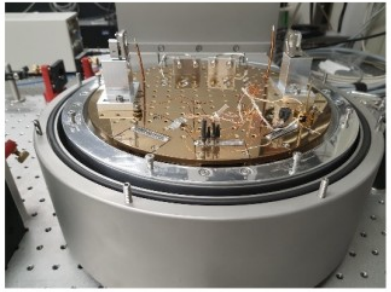
PNRR-ETIC: COMET facility per studio dei materiali per coating avanzati

- In corso preparazione del sito (Rovigo presso Laboratorio Te.Si. di UniPd). Completamento lavori edilizia previsto per inizio 2024.
- Gare per acquisizione di due coaters in corso
- 4 contratti a tempo determinate assegnati
  - Valeria Milotti:RTDA-UniPd
  - Hanna Skliarova: tecnologo UniPd
  - Massimiliano Bonesso: tecnologo INFN-Pd
  - PhD UniPd presa servizio inizio ottobre.

ET Sezione di Padova stato 2023

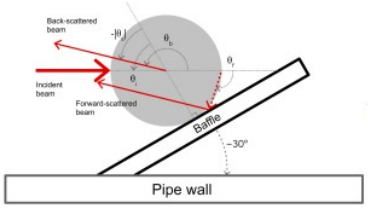
J. P. Zendri

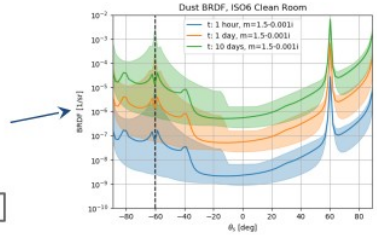
Un criostato a basse vibrazioni (DFA progetto eccellenza) è stato installato e collaudato a LNL. Attualmente in esso è in corso l'installazione dell'esperimento per la caratterizzazione opto- meccanica criogenca dei coatings dielettrici.



Luce diffusa:

- La stima della massima tollerabile contaminazione da polvere nei tubi per evitare rumore da luce diffusa è in fase di finalizzazione. Un requirement per l'installazione dei tubi
- Set-up per la misura della luce diffusa a 1550 nm da elementi ottici in allestimento.





Rumore termico fuori equilibrio: la calibrazione delle misure in equilibrio è quasi completata.

A. Longhin

ET Sezione di Padova 2024

J. P. Zendri

Nominativo	Percentuale	Nominativo	Percentuale
Bartolo Nicola	TBD (ex10%)		
Bazzan Marco	30%	Matarrese Sabino	TBD (ex10%)
Bertacca Daniele	TBD(ex10%)	Moscatello Andrea	50%
Ciani Giacomo	60%	Peloso Marco	TBD (ex10%)
Ciolfi Riccardo	TBD (ex10%)	Perigois Carole	20%
Conti Livia	50%	Valbusa Dall'Armi Lorenzo	TBD (ex10%)
Favaro Giulio	40%	Zendri Jean-Pierre	40%
Iorio Giuliano	20%	Zendri Jean-Pierre	40%
Liguori Michele	TBD (ex10%)		
		TOTALE FTE	3.1+TBD

Attività per il 2024

La scrittura del caso scientifico e del TDR procederà anche nel prossimo anno.
Completamento della facility per la caratterizzazione optomeccanica criogenica dei coatings.
caratterizzazione sperimentale scattering per componenti di interesse per ET (per il setup vedere slide virgo stray light).
Studi di cleanliness per le torri dei payload.
Misura rumore termico fuori equilibrio.
Ripresa della attività phase noise reduction per lo squeezing (PLL e fiber phase noise rejection).

Progetti Esterni (affini)

PNRR completamento laboratorio ed installazione dei coaters.
Progetto di eccellenza DFA: realizzazione squeezer con ottica integrata. Disegno ed allestimento Lab

ET Padova attività e richieste 2024

J. P. Zendri

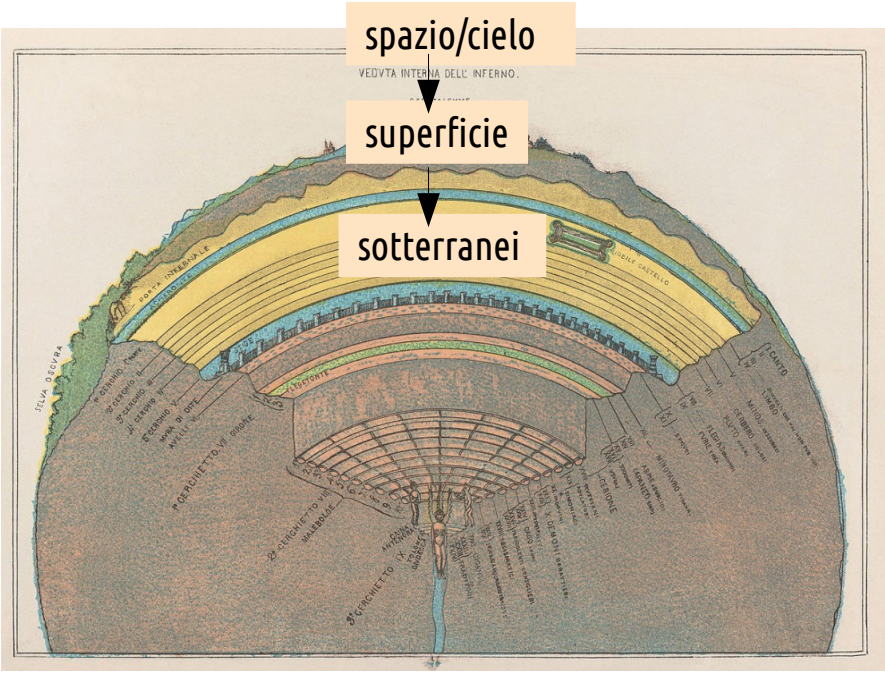
- Studio del caso scientifico e scrittura del TDR di ET
- Luce diffusa: completamento della messa a punto del sensore a 1550 nm ed indagine polveri
  - Campioni ed ottiche @1550nm 5 keuro
  - Laser a 1550 nm 4 keuro
- Squeezing: Riduzione del rumore in fase delle fibre ottiche
  - Componenti in fibra per 1550 nm 5 keuro
  - Prototipo PLL ad alta frequenza basato su FPGA 10 keuro
- Caratterizzzione optomeccanica coatings a 1550 nm
  - Lenti, specchi, beam splitter a 1550 nm consumo 7 keuro
  - Driver Attocube 6 keuro
- NonEquilibrium Thermal Noise
  - pompa ionica con controller 8 keuro

TOTALE 2024 45 keuro

RICHIESTE SERVIZI

2 mesi officina meccanica per realizzare supporti ottiche, 1 mese elettronica per elettronica controllo cavità ottica, 2 mesi servizio progettazione elettronica per progetto PLL al GHz (da discutere con responsabili servizio).

NOTA: La presente proposta non è ancora stata discussa collegialmente a livello di ET-Italia



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S. Dusini

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S. Dusini

Attività a Padova

B.DeCaro, S.Dusini, L.Gabarra, F.Passalacqua, A.Renzi, C.Sirignano, L.Stanco, A.Troja,

Analisi e calibrazione dello strumento NISP

- Calibrazione in volo dello strumento
- Supporto alle attivita di analisi per la calibrazione
- Simulazioni per la validazione dei prodotti scientifici (Cloud Veneto e ReCas)

Baryonic Acoustic Oscillations

Euclid data analysis related to cosmological parameter estimation

- Analisi of BAO
- Sviluppo di simulazioni N-Body per studio Galaxy Clustering (GC) con dati di Euclid
- Studio della purezza e completezza della survey di Euclid per GC
- CMB-Large Scale Structure coss-correlation

S.Anselmi A.Begnoni, B.DeCaro, P.Monaco (UniTs), F.Passalacqua, A.Renzi, C.Sirignano, A.Troja.

Calcolo scientifico per analisi cosmologiche Euclid

- Coodinamento attivita di calcolo e gestione risorse

G.Maron, A.Renzi, L.Stanco

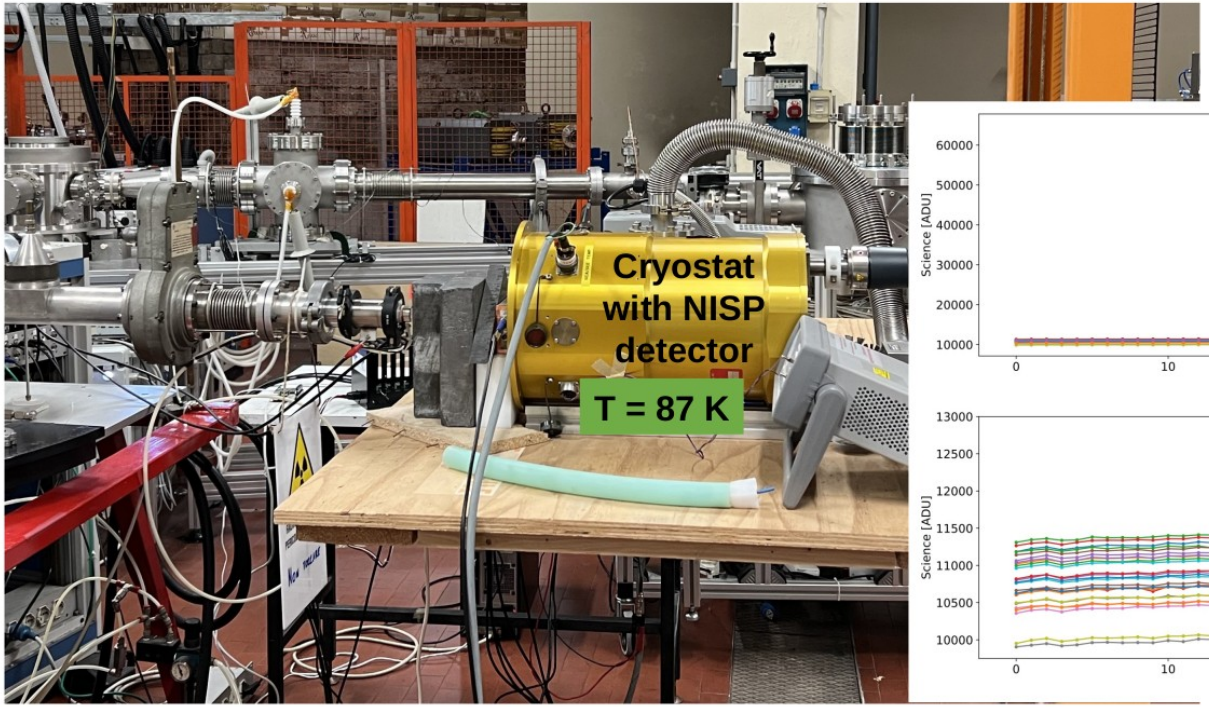
EUCLID

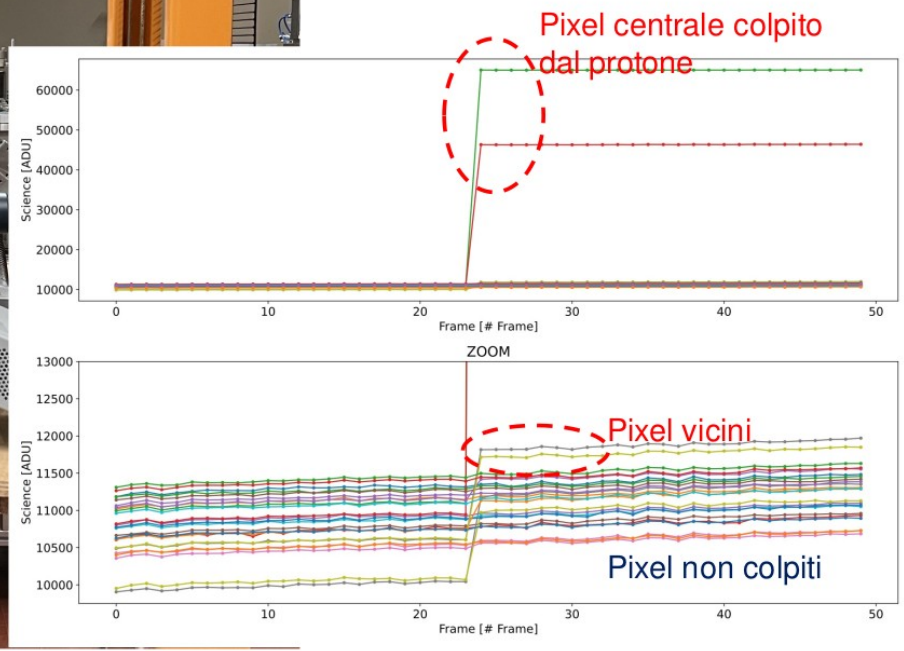
S. Dusini

Caratterizzazione della risposta dei rivelatori di H2RG a raggi cosmici

- Misurare segnale indotto da protone singolo
- Protone su LiF per produrre neutroni che convertono in protoni in uno strato di polietilene nel criostato davanti al detector
- In questo modo e' possibile vedere il singolo protone anche se il tempo di lettura del detector e' ~1.4 sec per frame
- Test beam al CN (8-9 giugno).
- Dati in fase di analisi. Si prevede un secondo TB in autunno o primavera 2024.

S.Dusini, P.Zotto, E.Borsato, F.DalCorso, F.Passalacqua, C.Sirignano, A.Troja, L.Gabarra, G.Maron L.Taffarello





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Anagrafica e Richieste 2024

Anagrafica +/- stabile
- **Antonino Troja ⊟ PNRR INFN**
- **Due nuovi dottorandi (Francesca Passalacqua e Andrea Begnoni)**

Responsabile Nazionale Euclid 2024
Luca ⊟ Stefano

Contratto ASI per supporto alle operazione e calcolo per validazione scientifica prorogato al 2025 e in fase di rinnovo fino al 2027.

Richieste finanziarie INFN in fase di definizione.

Nome	Contratto	Qualifica	Aff. CSN	Percentuale
Andrea Begnoni	Associato	Dottorando	2	100
Bartolo Nicola	Associato	Prof. Associato	4	TBD
Bertacca Daniele	Associato	Ricercatore DFA	4	TBD
Bianca De Caro	Associato	Dottorando	2	100
Francesca Passalacqua	Associato	Dottorando	2	100
Gaetano Maron	Dipendente	Dirigente Ricerca	1	30
Jung Gabriel	Associato	Post-Doc	4	TBD
Liguori Michele	Associato	Ricercato	4	TBD
Pierluigi Monaco	Associato	Prof	4	20
Louis Gabarra	Associato		2	100
Matarrese Sabino	Associat	ario	4	TBD
Naletto Giampiero	Ass	Associato	2	20
Pierluigi Zotto		Prof. Associato DFA	1	30
Raccanelli Alvise		RTD-B DFA	4	TBD
Renzi Alessandro	pendente	RTD-A DFA	2	40 (TBC)
Sirignano Chiara	Associato	Prof. Associato DFA	2	70
Stanco Luca	Dipendente	Dirigente Ricerca	2	20
Stefano Anselmi	Associato	Assegno INFN	2	100
Stefano Dusini	Dipendente	Ricercatore INFN	2	80
Totale FTE				8.1

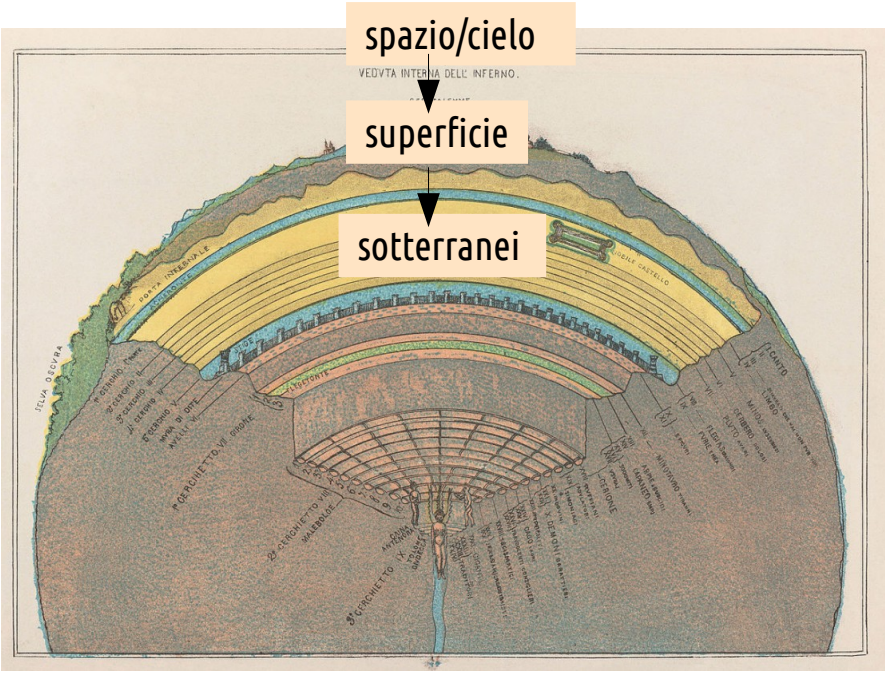
Preliminary TBC

Richieste Servizii:

Calcolo: 30 gg, assistenza su Cloud Veneto

Progettazione e Officina Meccanica: 1-2 (TBC) mesi per modifiche cryostato test beam

Officina Elettronica: 1 mese per elettronica test beam



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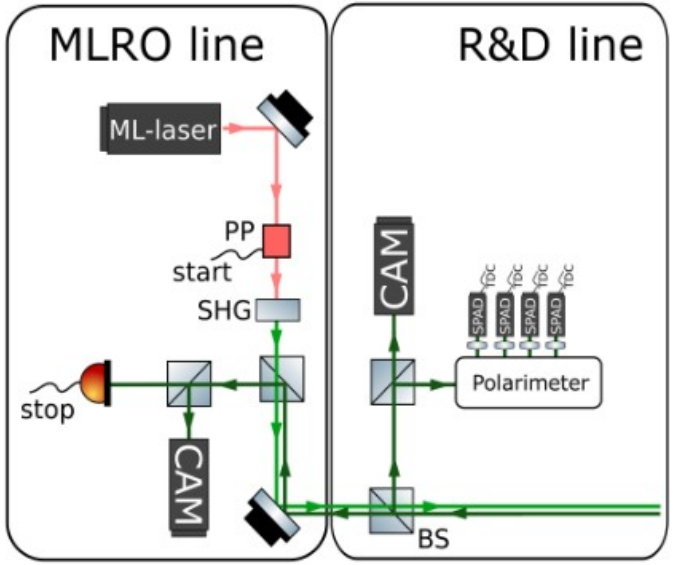
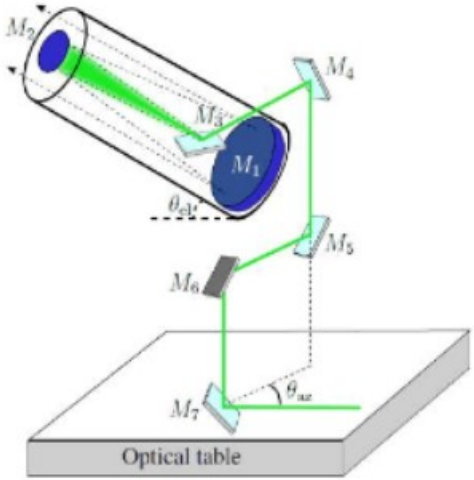
P. Villoresi

Concept of INFN-Padova activities for Moonlight-2



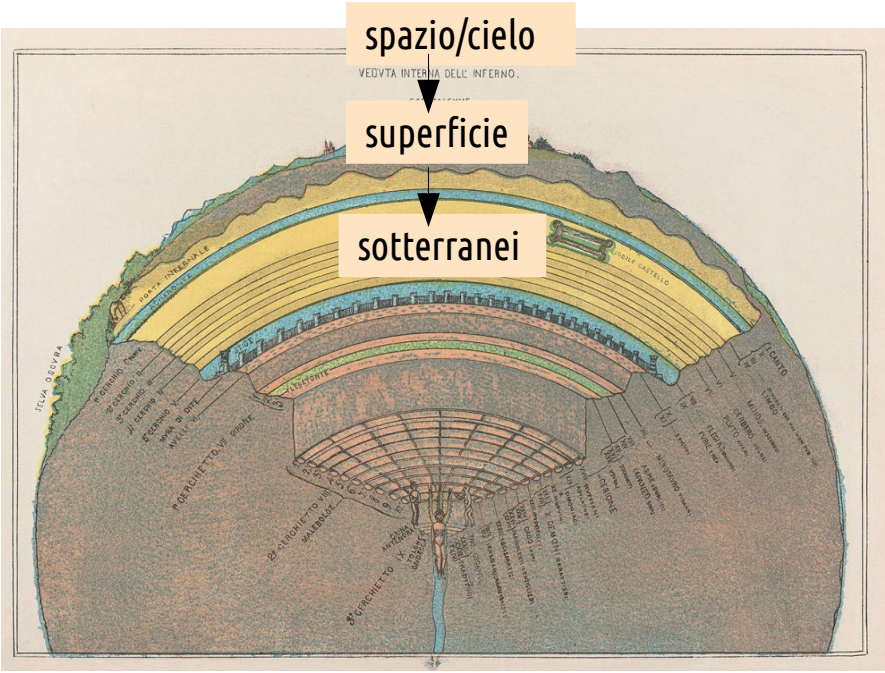


CAM = camera
SPAD = single-photon detector
TDC = tagging electronics

P. Villoresi

Situazione acquisti:

- Fondi 2023:
  - Acquisti in definizione: materiale per realizzazione setup di polarimetria e accoppiamento detector
- Fondi 2022:
  - Spesi internamente per l'acquisto di una Camera ad alta sensitivita' per imaging lunare MARANA 4BV6U della Andor (Oxford Instruments)
  - La camera e' stata collaudata in laboratorio a Padova, ma non e' stato possibile installarla presso MLRO (Matera)
- Fondi 2020:
  - Ordine di 4x SPAD a coda corta. Ritardi da parte del fornitore MPD: sono stati prodotti nel 2023.



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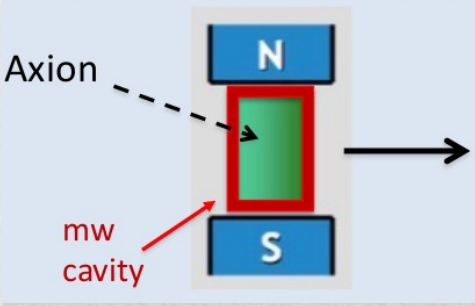
G. Carugno

QUAX – QUaerere AXion

Main Activity

- **Photon coupling**: **Due to the motion of the solar system in the galaxy, Dark Matter axions** are converted into **rf photons** inside a **resonant cavity** immersed in a **strong magnetic field**

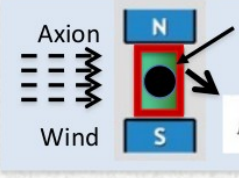


Expected rf power

$$P_a = 1.85\times10^{-25}\,\mathrm{W}\left(\frac{V}{0.036\,\mathrm{l}}\right)\left(\frac{B}{2\,\mathrm{T}}\right)^2\left(\frac{g_\gamma}{-0.97}\right)^2 \times\left(\frac{C}{0.589}\right)\left(\frac{\rho_a}{0.45\,\mathrm{GeV\,cm^{-3}}}\right)\left(\frac{\nu_c}{9.067\,\mathrm{GHz}}\right)\left(\frac{Q_L}{201000}\right)$$

R&D Activity

- **Electron coupling**: the axion DM cloud acts as an **effective RF magnetic field** on electron spin exciting magnetic transitions in a magnetized sample and **producing rf photons**



MS – Magnetized sample

Expected rf power

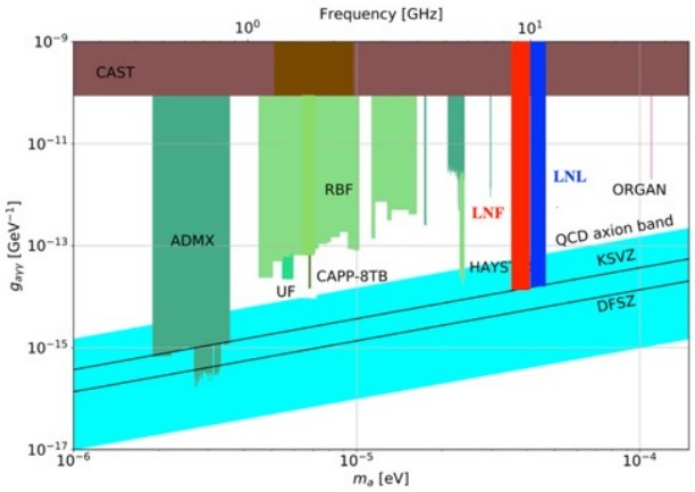
$$P_{\mathrm{out}} = \frac{P_{\mathrm{in}}}{2} = 8\times10^{-26}\left(\frac{m_a}{2\cdot10^{-4}\,\mathrm{eV}}\right)^3\left(\frac{V_s}{1\ \mathrm{liter}}\right)\left(\frac{n_S}{10^{28}/\mathrm{m}^3}\right)\left(\frac{\tau_{\min}}{10^{-6}\,\mathrm{s}}\right)\mathrm{W},$$

QUAX experiment

G. Carugno

- The **CSN2 has approved the QUAX experiment for a 3 + 2/3 years** to run an observatory for searching axion via the **axion-photon coupling**
- The R&D activity on the axion – electron coupling will proceed with low priority
- **Two haloscopes** will be built: one in **Legnaro** and the other in **LNF**

	LNF	LNL
Magnetic field	9 T	14 T
Magnet length	40 cm	50 cm
Magnet inner diameter	9 cm	12 cm
Frequency range	8.5 - 10 GHz	9.5 - 11 GHz
Cavity type	Hybrid SC	Dielectric
Scanning type	Inserted rod	Mobile cylinder
Number of cavities	7	1
Cavity length	0.3 m	0.4 m
Cavity diameter	25.5 mm	58 mm
Cavity mode	TM010	pseudoTM030
Single volume	$1.5 \cdot 10^{-4}$ m^3	$1.5 \cdot 10^{-4}$ m^3
Total volume	7⊗0.15 liters	0.15 liters
Q_0	300 000	1 000 000
Single scan bandwidth	630 kHz	30 kHz
Axion power	$7 \otimes 1.2 \cdot 10^{-23}$ W	$0.99 \cdot 10^{-22}$ W
Preamplifier	TWJPA/INRIM	DJJAA/Grenoble
Operating temperature	30 mK	30 mK



Quax 2025 projection: 2 GHz scan to the KSVZ line

- The **LNL haloscope** will be based on dielectric cavities, travelling wave parametric amplifiers and 14 T magnet
- Cryogenic system a dilution refrigerator to work below 60 mK

QUAX

G. Carugno

LNL Haloscope

2023 Many improvements on the WET DU System but some piece still missing

- New TWPA from Grenoble
  T_{system} = 2 kelvin
- High Q cavity = 200.000
  Tunability = 80 MHz
- Improved Security Control of cryogenic system
- Installed 8 T magnet + Shielding Magnetic Field
- PLC Control still waiting

G. Carugno

QUAX LNL 14 Tesla Magnet

Attention : Dr. Umberto Gambardella
INFN - Sezione di Napoli
Dipartimento di Fisica, Università di Salerno
Via Giovanni Paolo II 132, 84084 Fiscian

JASTEC SUPERCONDUCTOR
Japan Superconductor Technology, Inc.
5-9-12 Kitashinagawa, Shinagawa-ku
Tokyo 141-8688 JAPAN
Tel: +81-3-5739-5210 Fax: +81-3-5739-5211
http://www.jastec-inc.com

3rd of March, 2023
Our Ref: MO22-036E

QUOTATION

We are pleased to quote Superconducting Magnets as follows:

1. Technical Specification and Scope of Suuply :

   TBD

2. Price :

	Model	Q'ty	Price in Yen
1	**JMTA-14T103**	**1 Set**	**¥32,000,000**

[Remarks]

- The price include PCS, protection circuit, export packing and installation at the site.
- VAT is not included in the price, and VAT will be charged to buyer.

3. Terms and conditions:

   - Delivery : DDP at INFN National Laboratories of Legnaro(incoterms 2010)
   - Lead time : 14 months after PO

   Payment Terms:

   - 70%: after order acceptance
   - 30% : before shipment

   Validity: Firm and valid until 3rd of April, 2023

4. Consequential Damage and Max Liability

   If cost or price of raw material, labor or others that comprises the Goods materially changes after the effective date of the Contract,

JASTEC SUPERCONDUCTOR 1

1. Introduction

This document describes the draft technical specifications of JMTA-14T103 superconducting magnet. This specification is based on the preliminary design. The values may subject to change in final design.

2. Scope of Supply

2-1 Followings are included

(1) Superconducting Magnet	1 unit
(2) Overseas packing	1 set
(3) Overseas transportation and import duty (DDP)	1 set
Delivery site : INFN Laboratori Nazionali di Legnaro Viale dell'Università, 2 – 35020- Legnaro (PD) , Italia	
(4) Installation and supervising works at site	1 set

2-2 Followings are NOT included

(1) Power supply unit
(2) Vacuum pump
(3) Temperature sensor and monitor
(4) Liquid Helium level probe and monitor
(5) Helium transfer siphon

3. Specifications

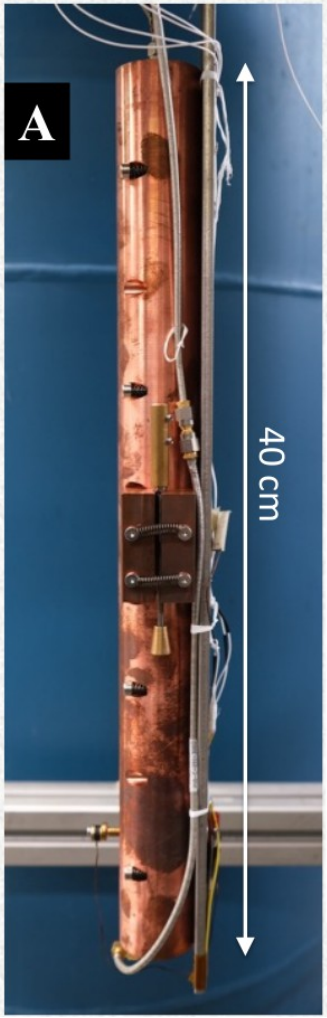
Model	: JMTA-14T103
Coil configuration	: Solenoid coil
Maximum central field	: 14 Tesla
Free bore diameter	: 103 mm
Outer diameter of the solenoid	: 400 mm excluding protrusion (tentative)
Total height of the solenoid	: 500 mm (tentative)
Total weight (approximately)	: 250 kg (tentative)
Field direction	: Vertical two-way
Operating current (nominal)	: 183 A (tentative)
Inductance	: 66 Henries (tentative)
Field homogeneity (designed value)	: Better than 0.1% at 10mm D.S.V.
Persistent current switch (PCS)	: Attached
Switch heater current (nominal)	: 60 mAmps (tentative)
Switch heater resistance (nominal)	: 100 ohms (tentative)
Field stability at PC mode	: Less than 0.5 ppm/h
Protection circuit for quenching	: diode circuit attached on the magnet
5 Gauss stray field limit from magnet center (Note 1)	
Axial	: 5.0 m (tentative)
Radial	: 4.0 m (tentative)

Note 1: Any magnetic material should be placed at less than 5 Gauss area.

QUAX

G. Carugno

Cavity developments 1



Three different novel cavity designs are being studied to maximize $C^2 V^2 Q$:

A. Empty "double-shell" cylindrical cavity with simple tuning

B. High volume, high C factor single-shell dielectrical cavity

C. High volume, high C factor empty "polygonal" cavity

A tunable clamshell cavity for wavelike dark matter searches

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C. Braggio,[1,2,a)] G. Carugno,[2] R. Di Vora,[3,b)] A. Ortolan,[3] G. Ruoso,[3] and D. Seyler[4]

AFFILIATIONS

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[2] INFN, Sezione di Padova, Padova, Italy
[3] INFN, Laboratori Nazionali di Legnaro, Legnaro, Padova, Italy
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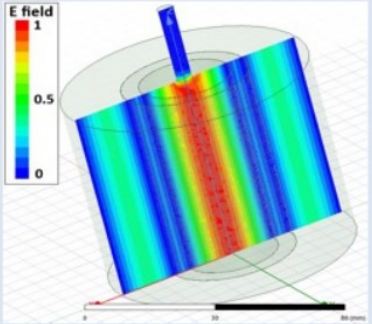
[b)] divora@pd.infn.it

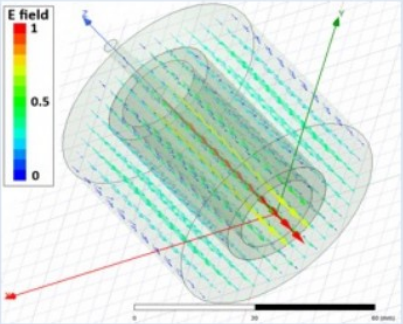
QUAX

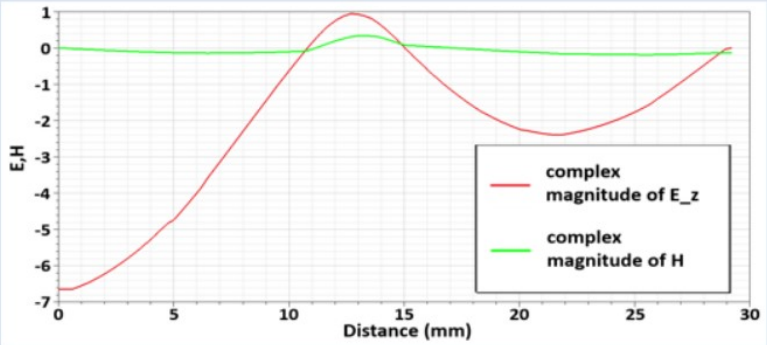
Cavity developments 2

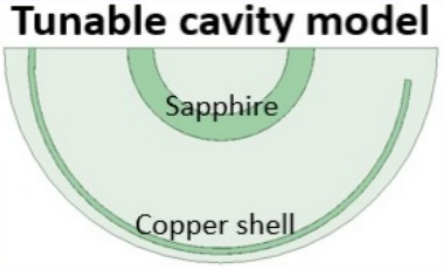
G. Carugno

B



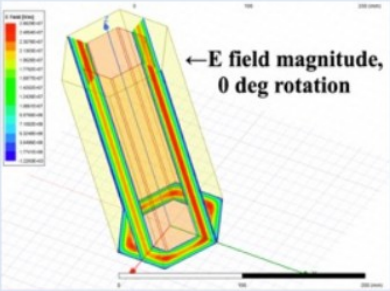


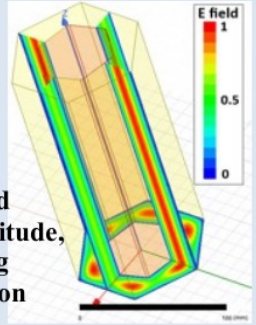




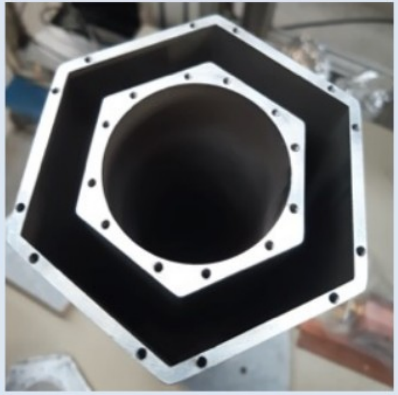
C ~ 0.47
V ~ 1.15 l
Q ~ 250000
Δf ~ 200 MHz

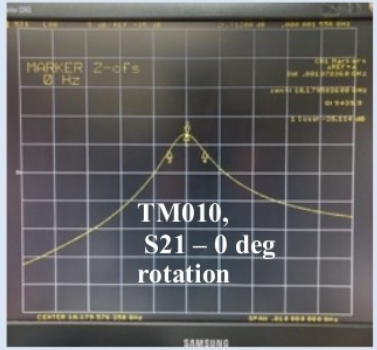
C

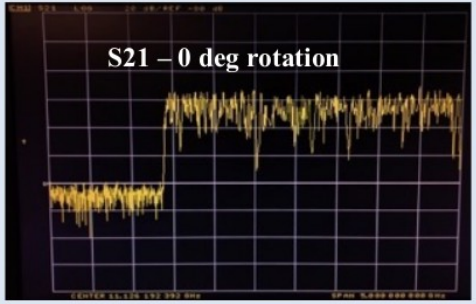




E field magnitude, 15 deg rotation







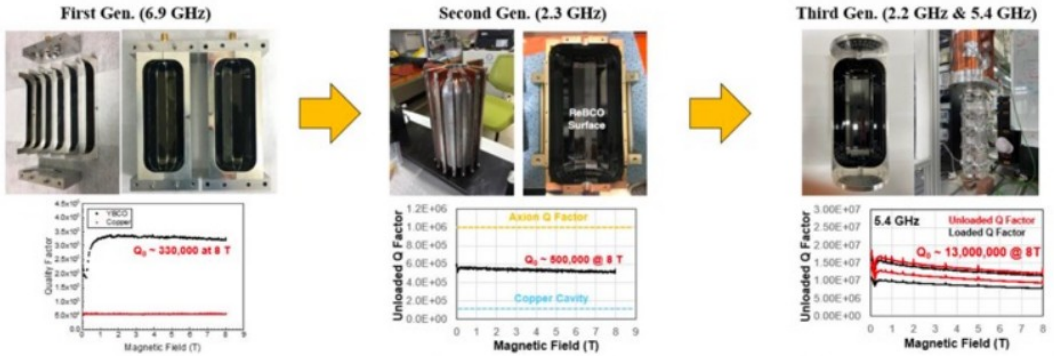
C ~ 0.8
V ~ 1.76 l
Q ~ 62000
Δf ~ 500 MHz

G. Carugno

Developments @ CAPP – Korea High Tc Rebco Strips

We are trying to set-up a collaboration to use RebCo tape to increase the Q factor of our cavities

Summary of HTS Cavity Development



Generation	Material	Substrate	Volume [liters]	Frequency [GHz]	Q-factor
1st Gen	YBCO	NiW	0.3	6.9	150,000 @ 8 T 330,000 @ 8 T
2nd Gen	GdBCO	Hastelloy	1.5	2.3	~ 500,000 @ 8 T
3rd Gen	EuBCO + APC	Hastelloy	1.5	2.2	4,500,000 @ 0 T Waiting for Magnet Test
	EuBCO + APC	Hastelloy	0.2	5.4	~ 13,000,000 @ 8 T

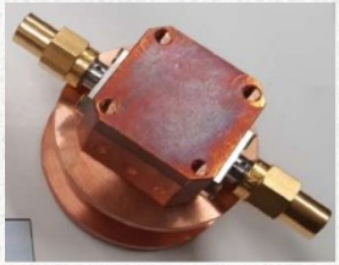
2022-12-07 2022 December Dissertation Defense 47

ReBCO (Rare-earth barium copper oxide) high temperature superconducting tape

QUAX

G. Carugno

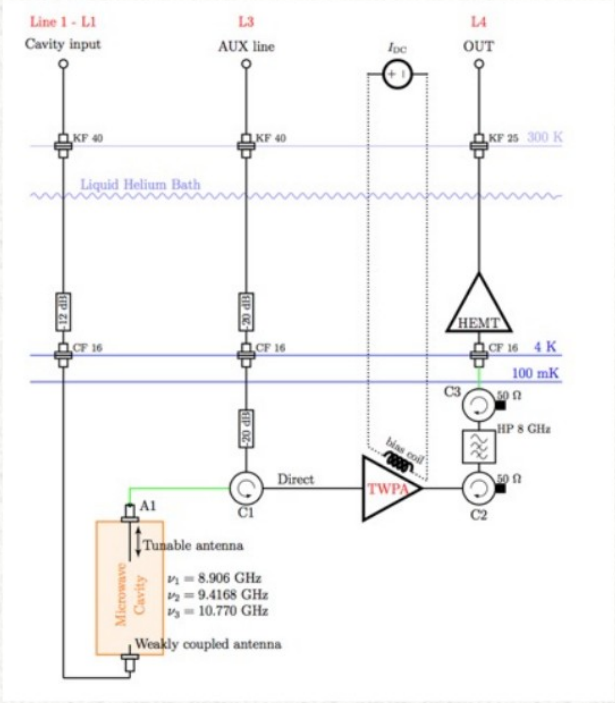
PD-LNL 2022 achievement – II – TWPA ampli

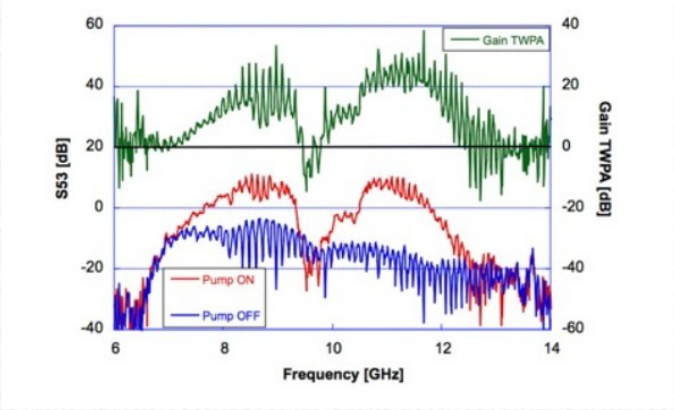


Large bandwidth ~ 1 GHz

Noise T ~ 2 photons

This allowed us to start testing **a new Quantum Limited rf amplifier** provided us from Nicholas Roch (Grenoble)





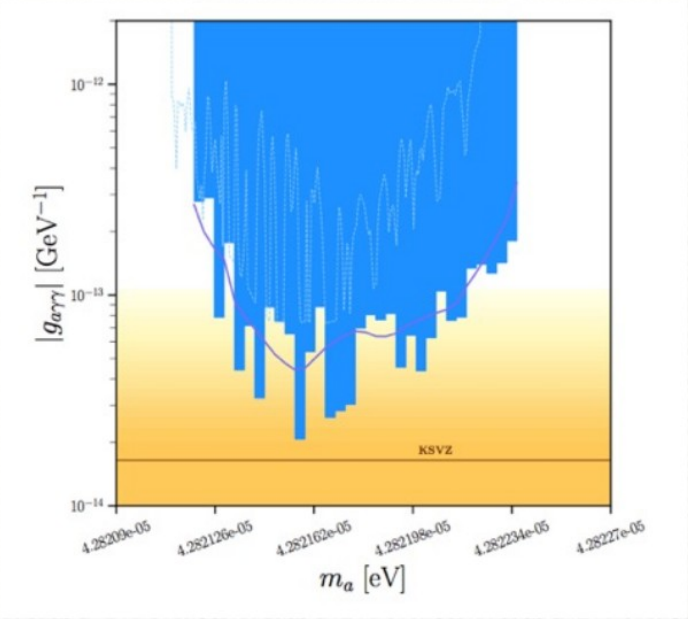
$$T_{\rm sys} \approx \frac{h\nu_c}{2k_B}\coth\frac{h\nu_c}{2k_BT_c} + \Lambda_1 T_{\rm TWPA} + \frac{\Lambda_2\Lambda_1}{G_{\rm TWPA}}T_{\rm HEMT}$$

T_{noise} = 2 Kelvin with 8 Tesla

Possible improvements expected

G. Carugno

Latest Results : QUAX-aγ search Run with TWPA



Search for galactic axions with a traveling wave parametric amplifier

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INFN, Laboratori Nazionali di Legnaro, 35020 Legnaro (Padova), Italy

C. Braggio
INFN, Sezione di Padova, 35100 Padova, Italy and
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G. Carugno and L. Taffarello
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G. Cappelli, N. Crescini, M. Esposito,† L. Planat, A. Ranadive, and N. Roch
Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, 38000 Grenoble, France

D. Alesini, D. Babusci, A. D'Elia, D. Di Gioacchino, C. Gatti, C. Ligi, G. Maccarrone, A. Rettaroli, and S. Tocci
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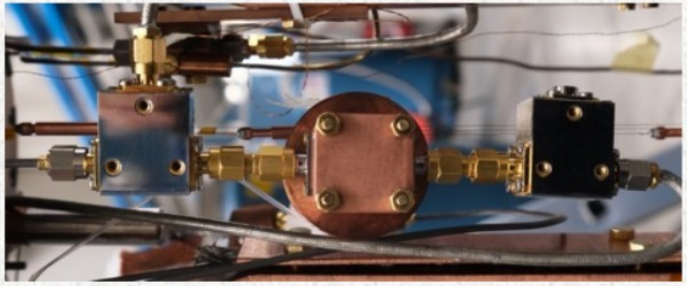
P. Falferi
Istituto di Fotonica e Nanotecnologie, CNR Fondazione Bruno Kessler, I-38123 Povo, Trento, Italy and
INFN, TIFPA, 38123 Povo (Trento), Italy
(QUAX Collaboration)
(Dated: April 13, 2023)

A traveling wave parametric amplifier has been integrated in the haloscope of the QUAX experiment. A search for dark matter axions has been performed with a high Q dielectric cavity immersed in a 8 T magnetic field and read by a detection chain having a system noise temperature of about 2.1 K at the frequency of 10.353 GHz. Scanning has been conducted by varying the cavity frequency using sapphire rods immersed into the cavity. At multiple operating frequencies, the sensitivity of the instrument was at the level of viable axion models.

We are at 1,2 away from QCD KSVZ line



Run with high Q cavity @ 100 mK
8 T magnetic field
Tsys = 2,1 K (TWPA)

@ 10.35 GHz

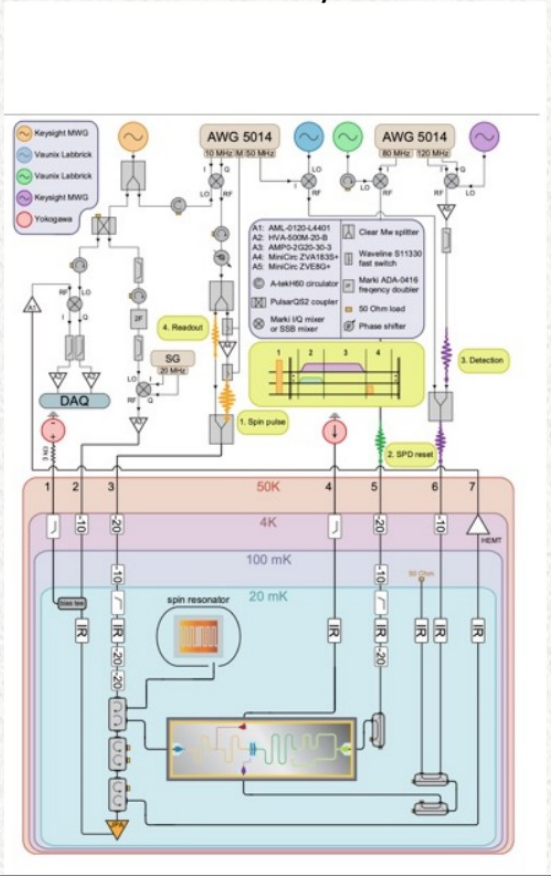
QUAX

G. Carugno

Single Microwave Photon Detector in Italy

Paris run was successful the device will be mounted @ LNL

Electronics layout



DRY dilution unit

G. Carugno

QUAX 2024: Starting Physics Phase (2024 - 2026)

PD activity for 2024:

1) **Dilution Unit Refrigerator to be Implemented via PLC (Not yet arrived)**
2) **Install New magnet 14 Tesla, 0,5 m Lenght, 0,1 m inner bore diameter**
3) **Install New Photonic Cavity with tunable frequency**
4) **New Dilution Machine for Quantum Counter based on Trasmon Qubit**
5) **Complete the set up for axion photon coupling high sensitivity search**
6) **Continue R&D on axion electron coupling**

Sezioni INFN partecipanti all'esperimento: **LNL, Padova, LNF, Napoli/Salerno, Trento**

Resp. Naz.: **Giovanni Carugno**

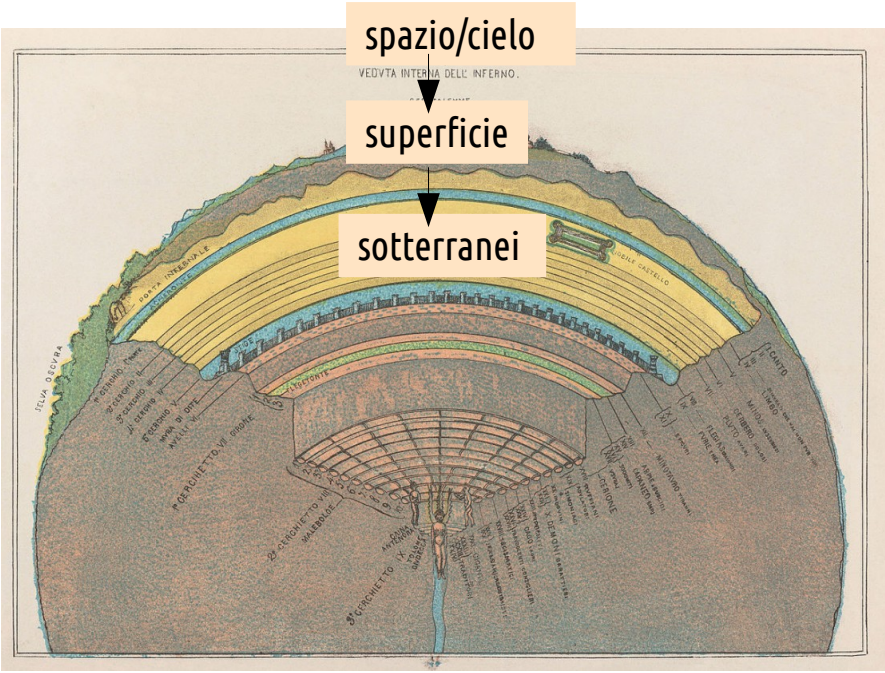
Partecipazione PD : G.Carugno 60%, C.Braggio 100%,A.Gardikiotis 100% L.Taffarello 40%, F.Fanzago 15%, F.Montecassiano 30% , M.Bellato 20%

Totale 3.7 FTE

Richieste 2024 PD: **80 Keuro KE**

Richieste Servizi: 15 M.U. O.M. , 12 M.U. S.T.G..E. , 2 M.U. U.T, 1M.U. O.E.

VOGLIO RINGRAZIARE LA PROFESSIONALITA' DEI NOSTRI SERVIZI TECNICI ED AMMINISTRATIVI PER IL LORO SUPPORTO ALL'ESPERIMENTO
(Supporto Tecnico * Messa in Opera Esperimento E' stato ed e' **Cruciale!!**



CTA/MAGIC
FERMI
SWGO

VIRGO
ET

EUCLID

MOONLIGHT-2

QUAX

DUNE
ENUBET
ICARUS
T2K

JUNO

GERDA/LEGEND
CUORE/CUPID

Padova: Nu_at_FNAL

Luca Stanco

- Luca Stanco (Dir.Ric.)
- Bagdat Baubussinov (Ric. INFN)
- Magda Cicerchia RTDA

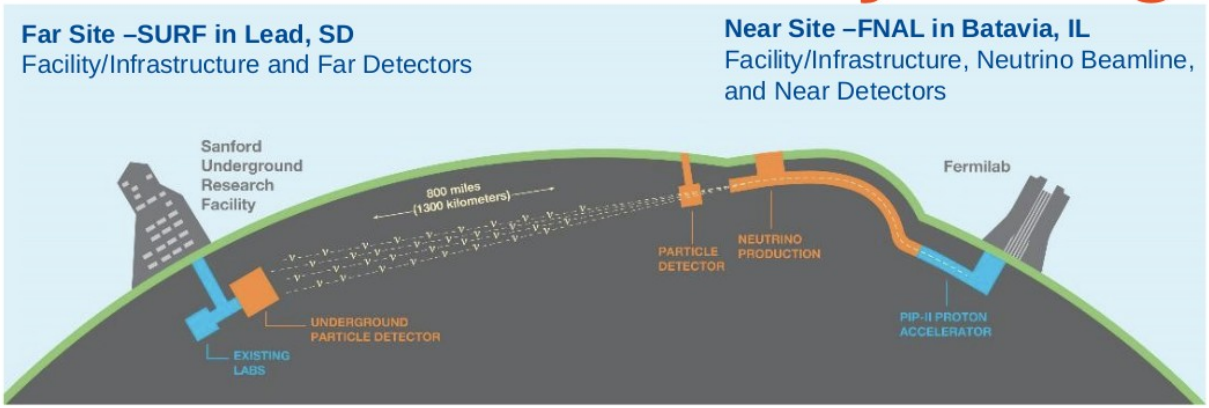
- Gruppo Icarus, iscritto in DUNE:
  - Alberto Guglielmi (Dir.Ric.)
  - Filippo Varanini (Ric. INFN)
  - Christian Farnese (Ric. INFN)
  - Meng Guang (Tecnologo)
  - Sandro ventrua (Pr.Tec.)
  - Daniele Gibin (Prof. ass.)
  - Sandro Centro (Prof.Ord. – out)

Coinvolgimenti:
- Sand (management, STT)
- SBN (Icarus, TPC reconstruction)

Prospettive:
- Possibili contributi dal Lab.Elettronica
- Piccola meccanica
- Eventuale sito di produzione STT/Tracker al capannone HEP di Legnaro

- Icarus group -> DUNE in the near future

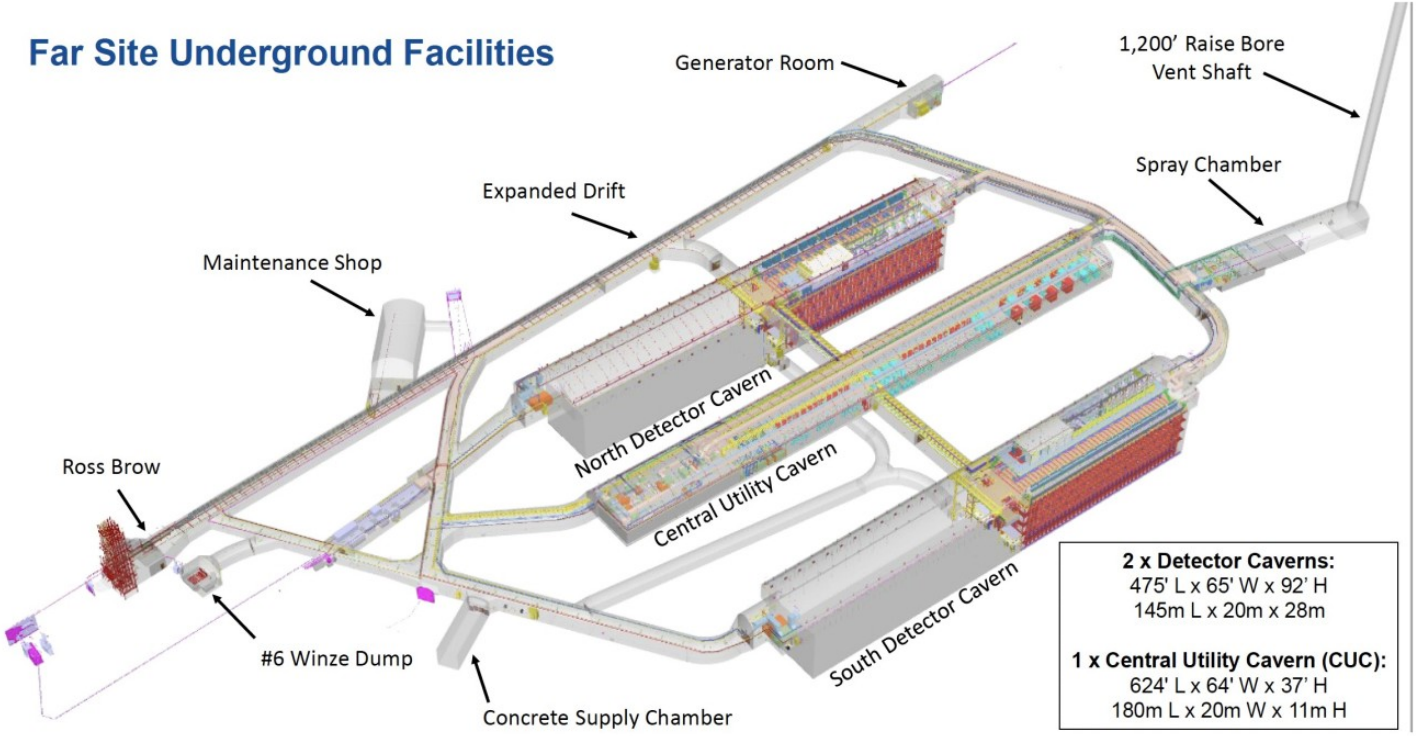
DUNE is on its way along



Major steps:

- DOE approval of CD1-RR for the full project of Phase-I (3.3 B$)
- Excavation is over half complete
- Phase-I corresponds to 20 kton of fiducial volume
- Construction of the two tanks are on the way
- Spent already almost half of the budget
- Phase-II structure has been setup to add 20 kton more, doubling the beam power to 2.4 MW and upgrading the Near site system

Far Site Underground Facilities

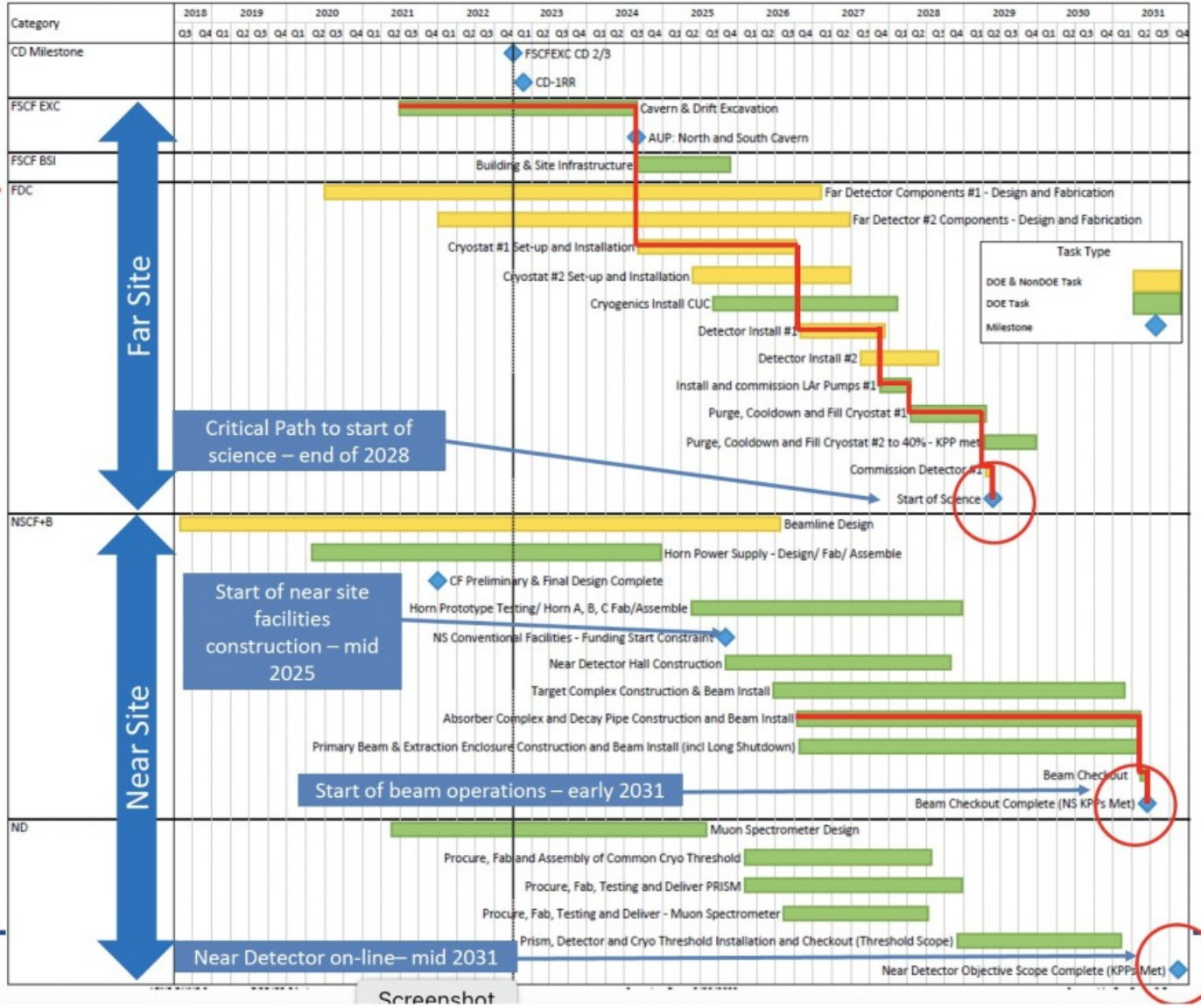


2 x Detector Caverns:
475' L x 65' W x 92' H
145m L x 20m x 28m

1 x Central Utility Cavern (CUC):
624' L x 64' W x 37' H
180m L x 20m W x 11m H

L. Stanco

Summary Schedule with Critical Paths through Start of Science (FD1) and Beam-on



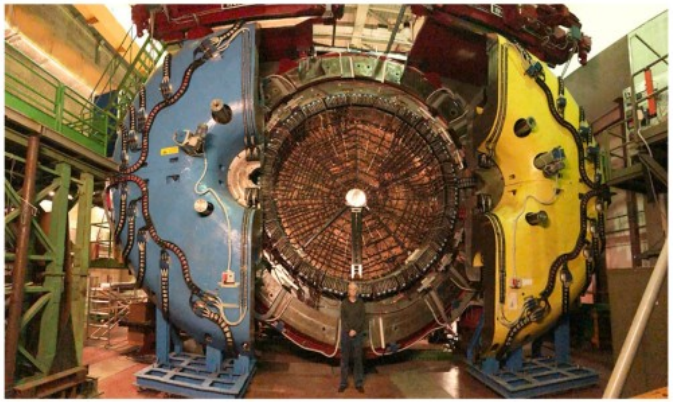
Favorable execution schedule enabled by new DOE funding profile in March 2022

Notes:
- Fiscal Year display
- Early completion dates shown

LBNF/DUNE

L. Stanco

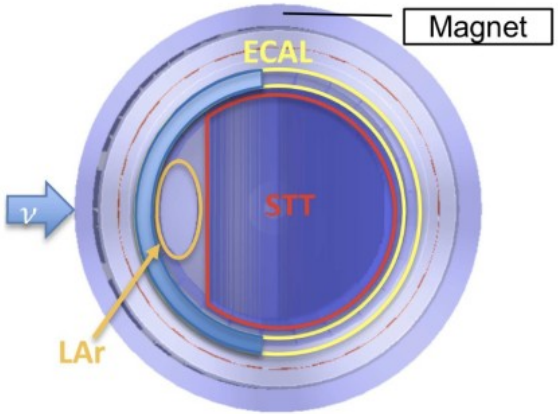
SAND



STT FV mass:
4.7 t CH_2
557 kg C

GRAIN mass:
1 t LAr

Front ECAL mass:
22.8 t Pb

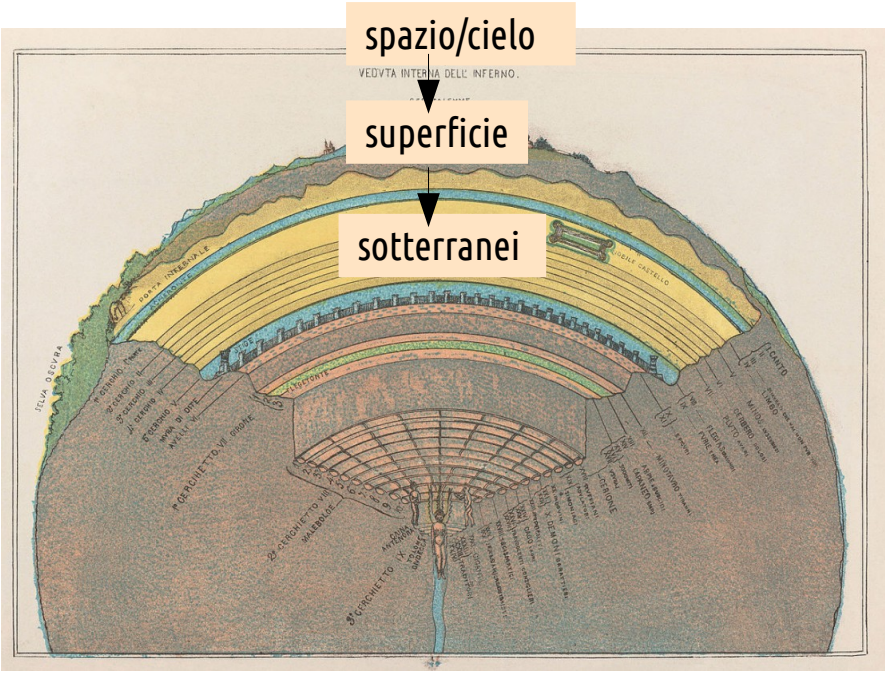


It should be ready to install in 2028

KLOE ▭ FNAL in a very good shape (ready to go from 2024)

GRAIN (LAr lens) in various challenging but promising R&D activities

TRACKER: is it the STT (Straw Tube) the good solution?



CTA/MAGIC
FERMI
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ET

EUCLID

MOONLIGHT-2

QUAX

DUNE
ENUBET
ICARUS
T2K

JUNO

GERDA/LEGEND
CUORE/CUPID

ENUBET in 2023

https://cds.cern.ch/record/2856999/files/SPSC-SR-327.pdf

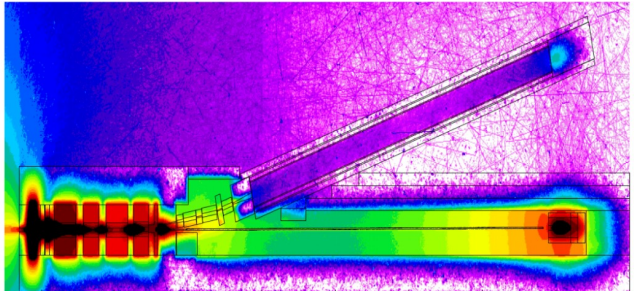
A key moment for ENUBET:
the **ERC project deadline (Nov. 2022)** brought substantial achievements:

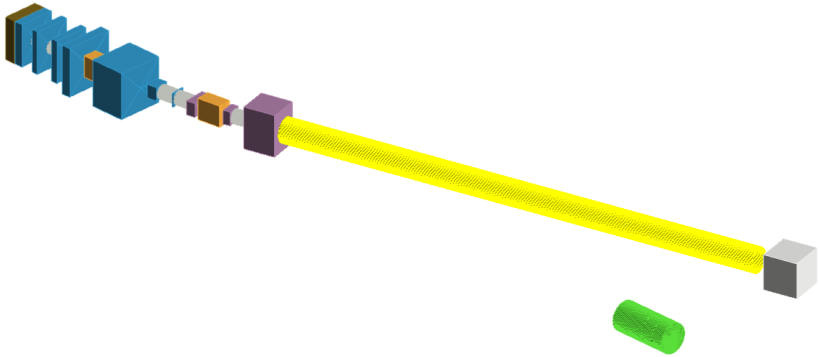
- The finalization of the **optimization and design of the beamline**
- The analysis on **systematic errors** on the flux reached a level of maturity
- Construction and tests of the **demonstrator** of the instrumented decay regio
- We are in the process of completing the documentation/paper writing
- Working towards a possible **implementation as a full-fledged experiment**

NP06/ENUBET annual report 2023 for the SPSC

The ENUBET Collaboration

F. Acerbi[a,b], I. Angelis[x], L. Bomben[e,p], M. Bonesini[e], F. Bramati[e,f], A. Branca[e,f], C. Brizzolari[e,f], G. Brunetti[f], M. Calviani[r], S. Capelli[e,p], S. Carturan[d,g], M.G. Catanesi[h], S. Cecchini[i], N. Charitonidis[r], F. Cindolo[i], G. Cogo[d], G. Collazuol[c,d], F. Dal Corso[c], C. Delogu[c,d], G. De Rosa[j,k], A. Falcone[e,f], B. Goddard[r], A. Gola[a], F. Guffanti[e,f], L. Halić[m], F. Iacob[c,d], C. Jollet[l], V. Kain[r], A. Kallitsopoulou[w], B. Kliček[m], Y. Kudenko[n,u,v], Ch. Lampoudis[x], M. Laveder[c,d], P. Legou[w], A. Longhin[c,d], L. Ludovici[o], E. Lutsenko[e,p], L. Magaletti[h,q], G. Mandrioli[i], S. Marangoni[e,f], A. Margotti[i], V. Mascagna[y,z], N. Mauri[i], J. McElwee[l], L. Meazza[e,f], A. Meregaglia[l], M. Mezzetto[c], M. Nessi[r], A. Paoloni[t], M. Pari[c,d,r], T. Papaevangelou[w], E.G. Parozzi[e,f,r], L. Pasqualini[i,s], G. Paternoster[a], L. Patrizii[i], M. Pozzato[i], M. Prest[e,p], F. Pupilli[c,d], E. Radicioni[h], A.C. Ruggeri[j,k], D. Sampsonidis[x], C. Scian[c,d], G. Sirri[i], M. Stipčević[m], M. Tenti[i], F. Terranova[e,f], M. Torti[e,f,1], S. E. Tzamarias[x], E. Vallazza[e], F.M. Velotti[r], and L. Votano[t]





ENUBET 2024

F. Pupilli (RIC INFN) 40 %
M. Mezzetto (DR) 20 % (tbc)
A. Longhin (PA) 60 %

3 students

ERC project completed → Established technique.

- **Finalize publication on reduction of flux systematics**
- **Tests of the fully instrumented demonstrator** from mid Aug. 2023 for two weeks at CERN-PS

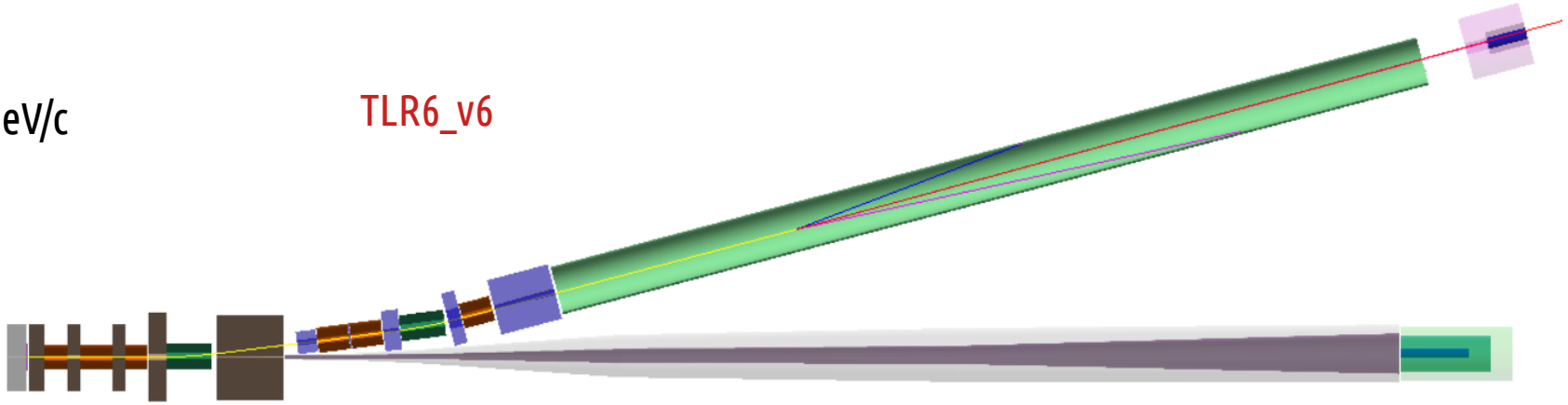
- **CERN Physics Beyond Colliders**:
  - investigate the possibility of implementing ENUBET at CERN in parallel with the running of DUNE and Hyper-K, using the ProtoDUNEs (HD+VD) as neutrino detectors → **CERN fellow starting Oct. 2023**

- **ESSνSB+ EU project**
  - WP6: feasibility a monitored neutrino beam at the ESSource using the LINAC in its present configuration
  - Opening soon an **INFN-PD AdR**

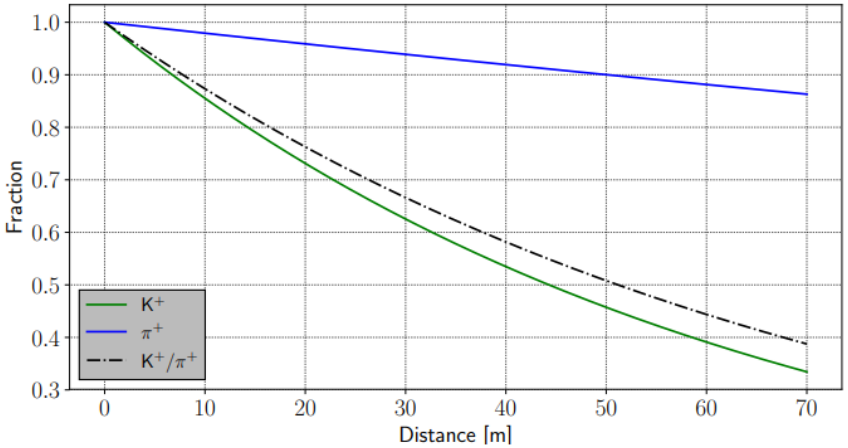
The ENUBET hadron beamline

- Focuses 8.5 ± 5% GeV/c

TLR6_v6



A short beamline



- Employing standard/existing warm magnets
- The optimization based on the genetic algorithm finalized.
- TLR6 v6: an evolution of the 2022 version.
- Comparison with other simulation programs (G4beamline).
- Tuning of single parts (W foil, hadron dump).
- We consider it our baseline →

Design and performance of the ENUBET monitored neutrino beam*

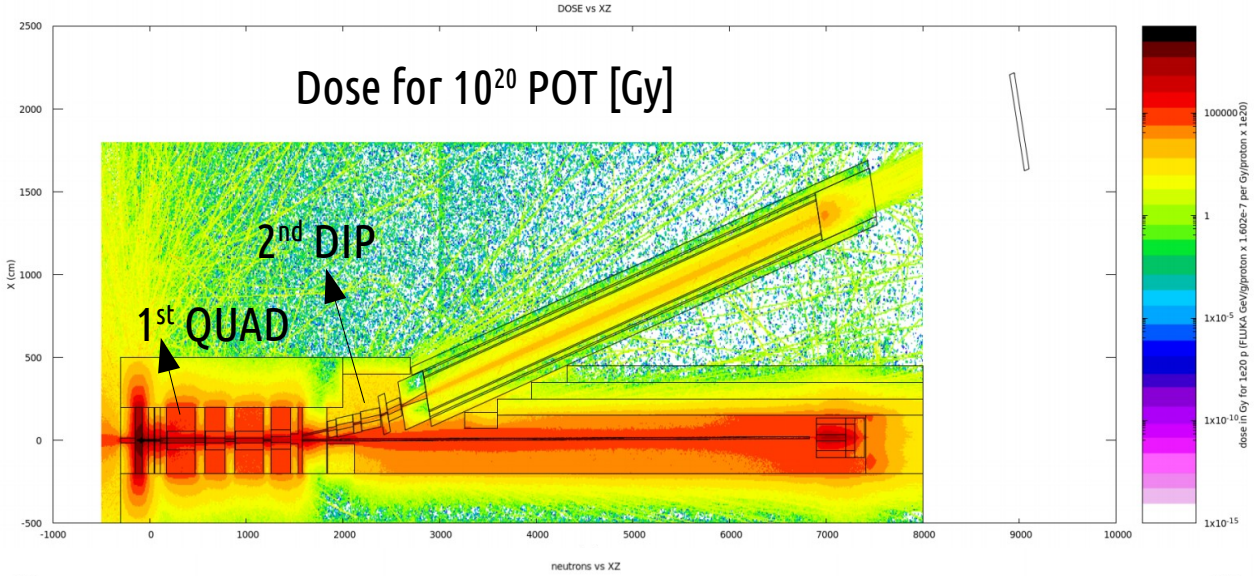
Publication submission EPJC next week

FLUKA irradiation studies

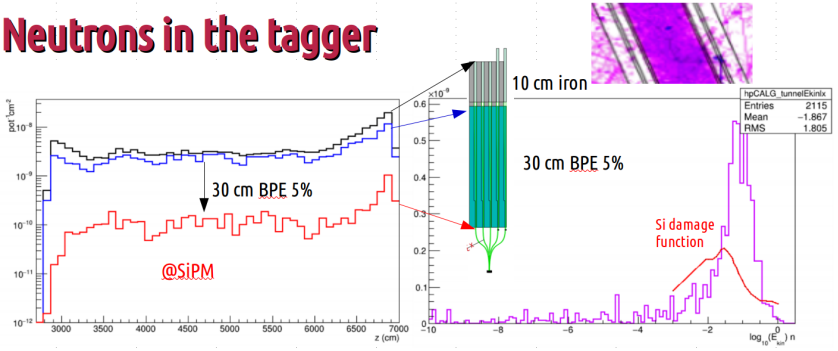
Detailed FLUKA simulation of the setup

Guided the design of the detector technology for the demonstrator

Good lifetime of instrumentation and focusing elements achieved.

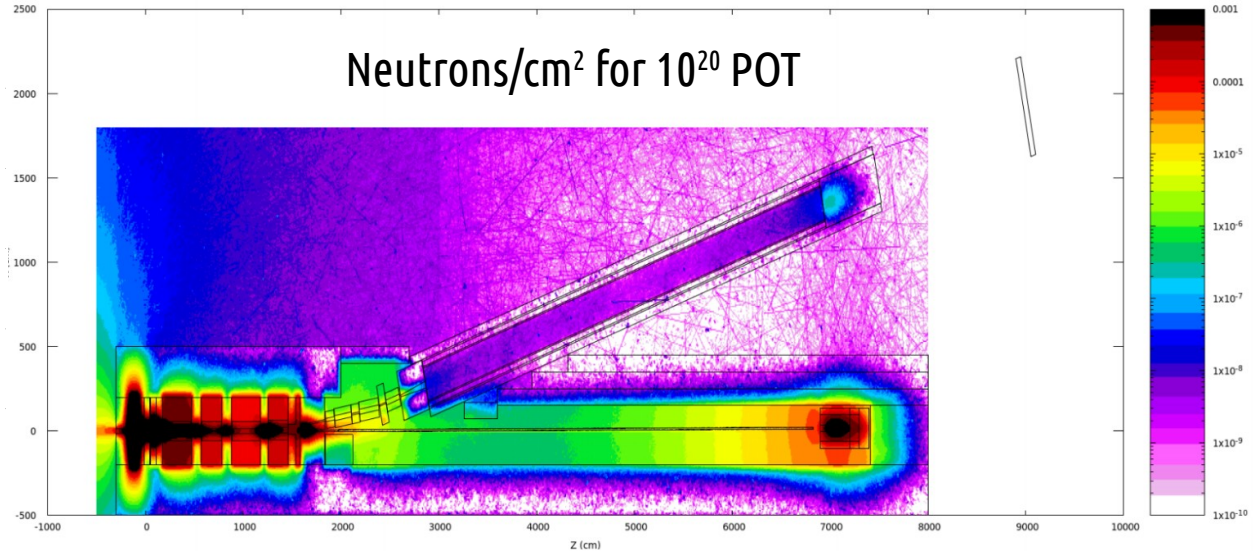


Neutrons in the tagger



BPE shielding has a **reduction effect ~ x 20**
W.r.t. to the single dipole beamline
7×10^{-11} n/POT/cm^2 ~ **10 x reduction**
(7×10^9 n/cm^2 for 10^{20} POT)

E_{kin} of surviving neutrons is O(10-100) MeV



Time-tagging with full simulation

Potentials for time-tagging with a 2s long spill and 4.5 x 10^{13} protons.

NEW Evaluated for the first time with a full simulation also taking into account the contributions of fake matches generated by wrong positron candidates and neutrinos produced in the tagger or outside of it.

Intrinsic spread related to the difference in path between the lepton and the neutrino (vertex position is assumed not constrained here):
$\sigma_{\Delta t}$=134 ps

True $e^+ + \nu_e$ match (both from tagger region)
Fake $e^+ + \nu_e$ match (ν_e from tagger)
Fake $e^+ + \nu_e$ match (ν_e from outside tagger)

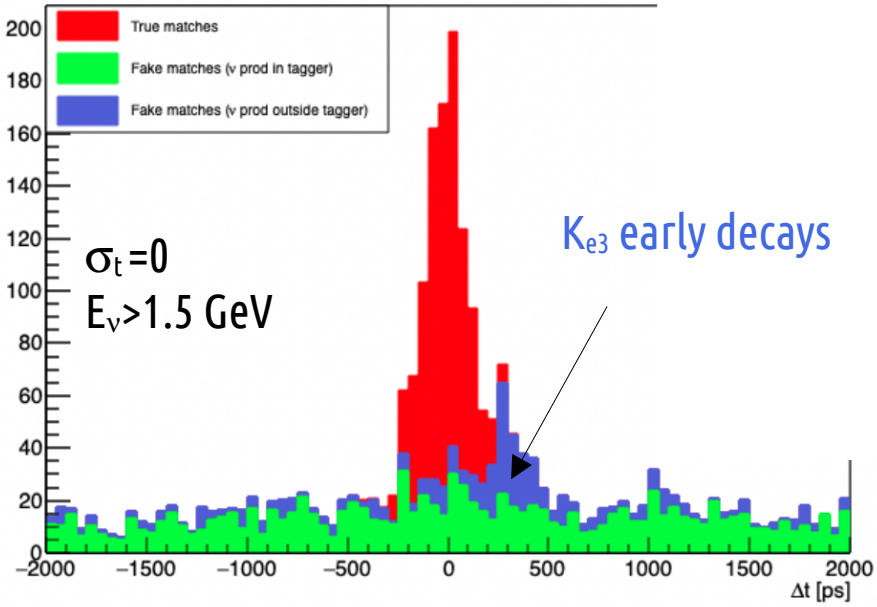


Fig. 24 Distribution of time differences between all time tagged pairs of ν_e^{CC} and positron events within a ±2 ns time window. True matches (red) are tagged pairs from the same K_{e3} decays, whereas fake matches are tagged pairs between unrelated candidate positrons and ν_e^{CC} where the neutrino is produced inside (green) or outside (blue) the tagger volume.

Design and performance of the ENUBET monitored neutrino beam*

Publication submission EPJC next week

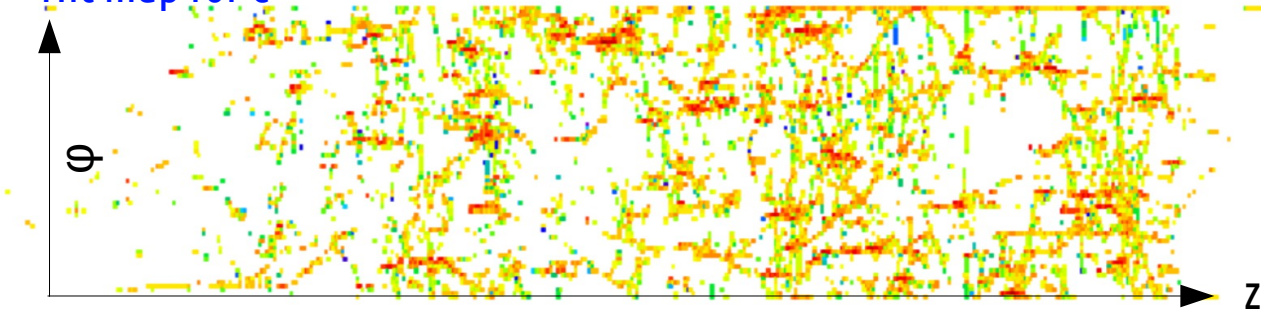
ENUBET: lepton reconstruction

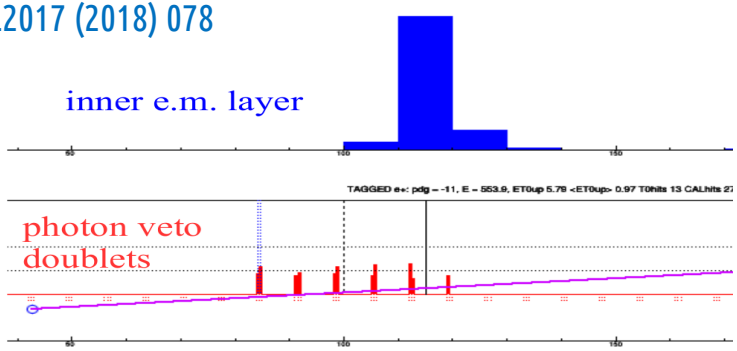
Talk by F. Pupilli

GEANT4 simulation of the detector, **validated** by prototype tests at CERN in 2016-2018.
Clustering of cells in space and time. Treat **pile-up** with waveform analysis. Multivariate analysis.

F. Pupilli et al., PoS NEUTEL2017 (2018) 078

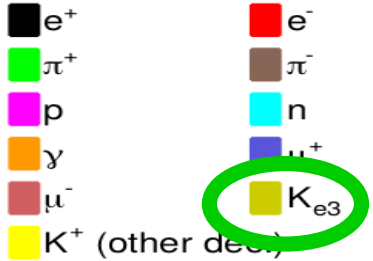
Hit map for e^+

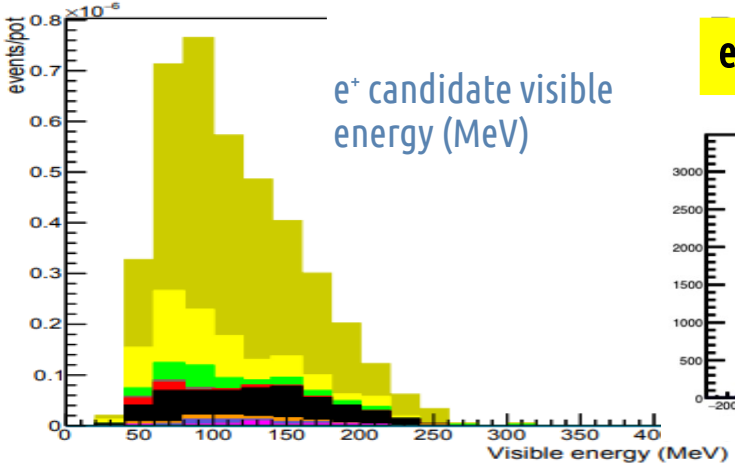




K_{e3} e+: Efficiency ~22%, S/N of ~2

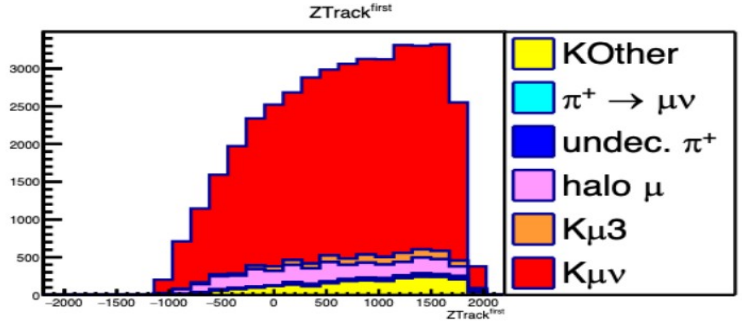
Half of efficiency loss is geometrical





e^+ candidate visible energy (MeV)

efficiency 34% ($K_{\mu 2}$) and 21% ($K_{\mu 3}$) S/B ~ 6.1



μ^+ candidate z coord (cm)

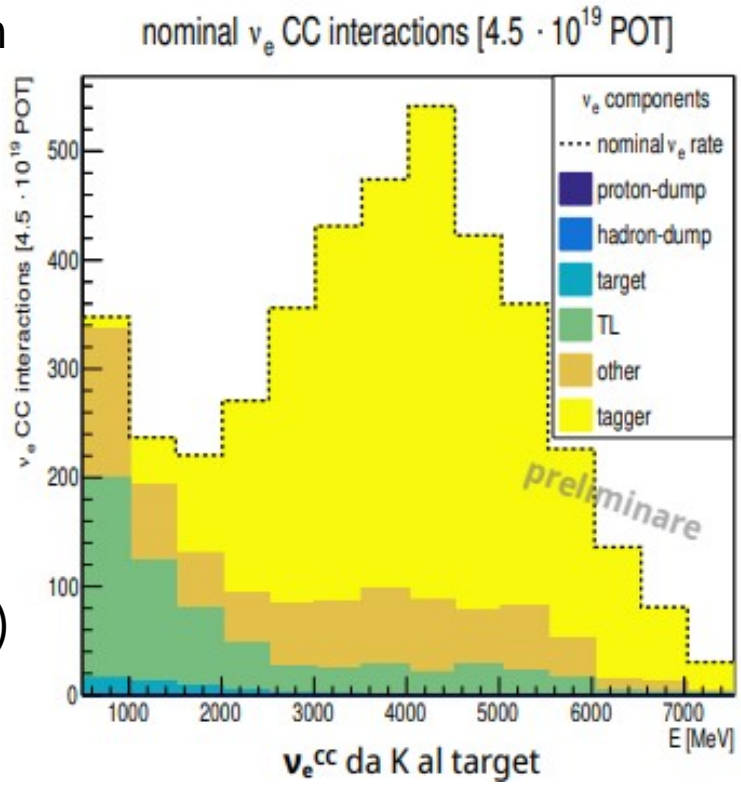
Flux constraint: reduction of hadro-prod. syst.

Employ hadro-production model fitted on NA56/SPY data

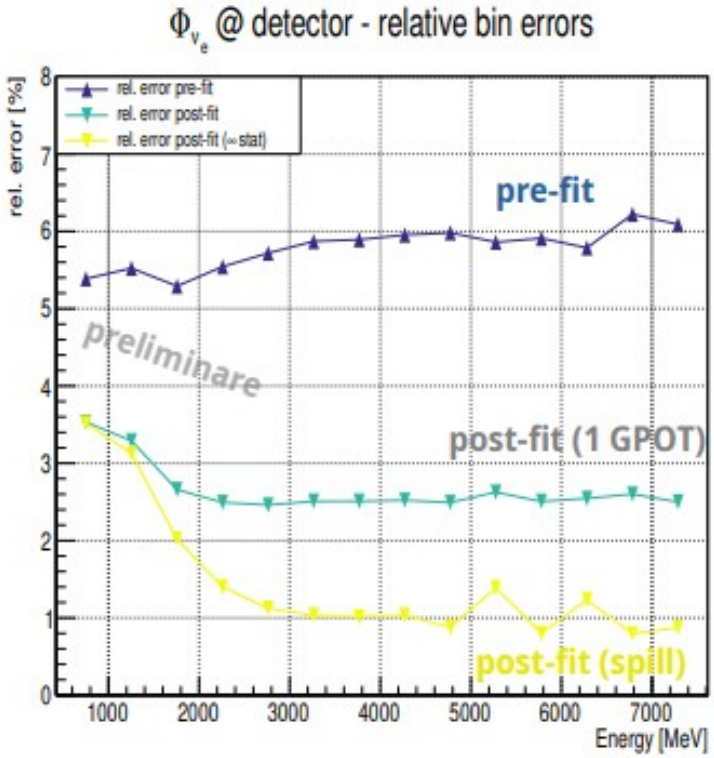
→ fit e+ rates to constraint the model hadro-production parameters

Reduction in the error envelope on the electron neutrino flux (6% → ~1%)

rate di interazione ν_e CC al rivelatore



errori relativi su rate ν_e CC : pre e post-fit



The lepton tagger

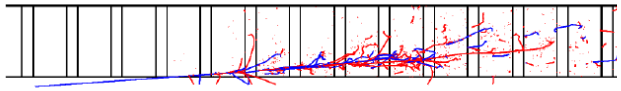
Calorimeter

Longitudinal segmentation

Plastic scintillator + Iron absorbers

Integrated light readout with SiPM

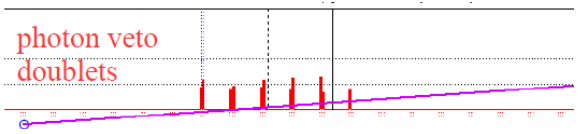
→ $e^+/\pi^\pm/\mu$ separation

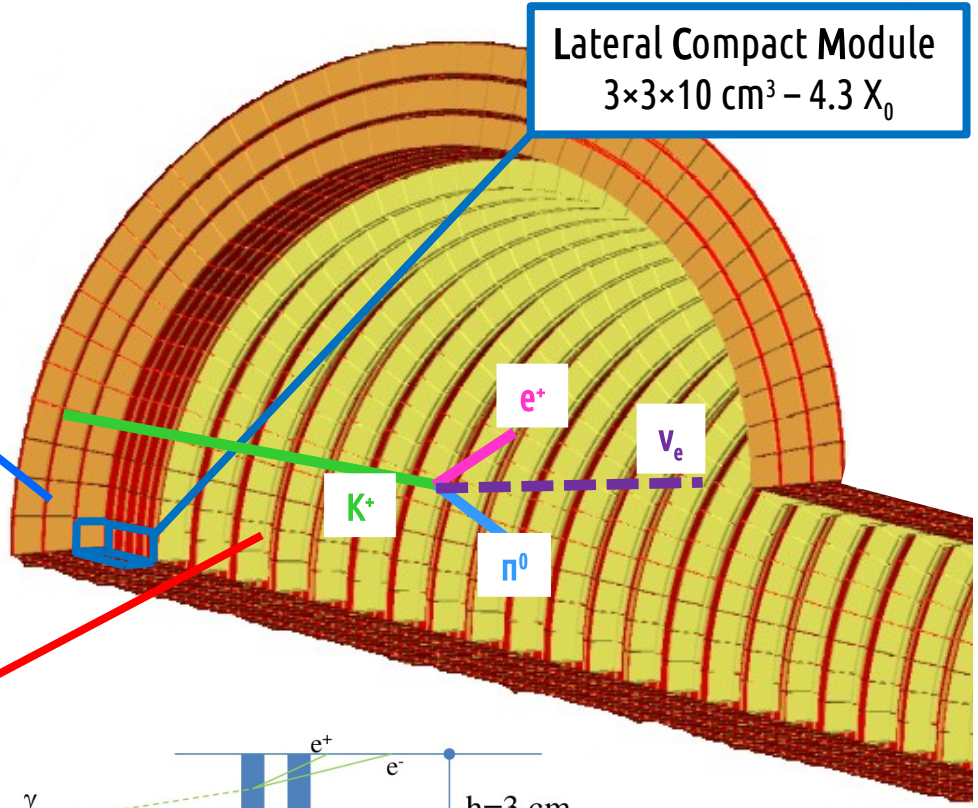


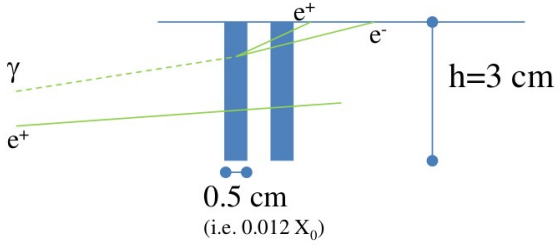
Integrated photon veto

- Plastic scintillators rings of 3×3 cm² pads

→ π^0 rejection







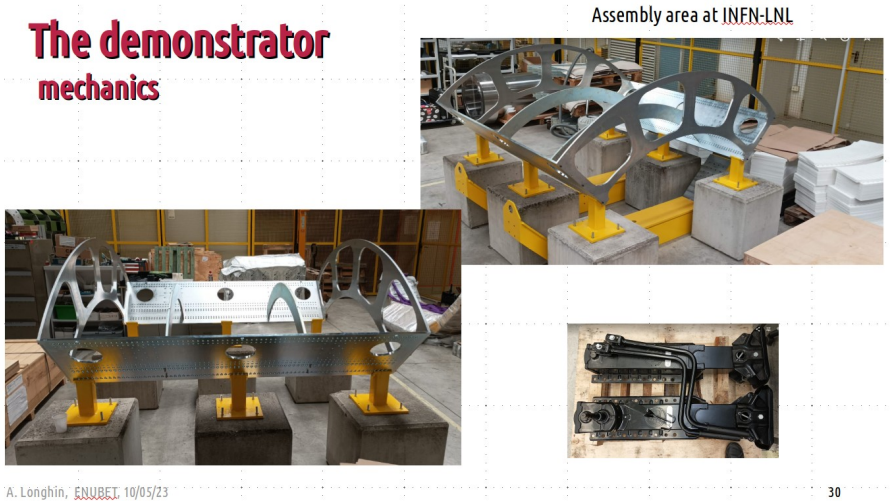
e^+ (signal) topology

π^0 (background) topology

π^+ (background) topology

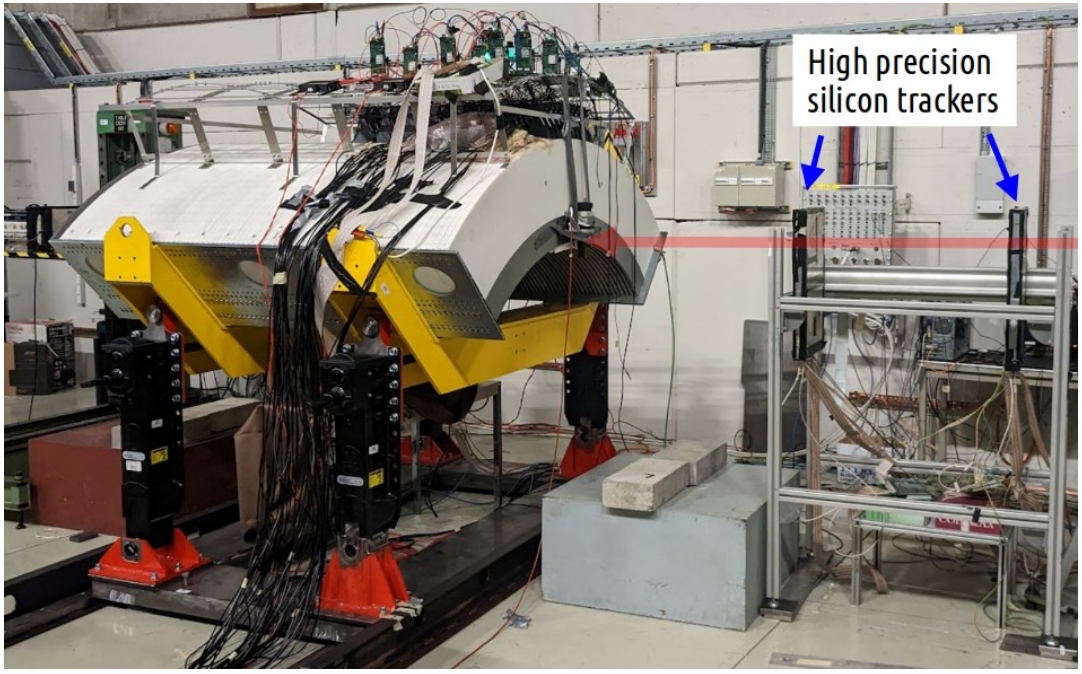
Progress on the demonstrator

April 2022



From the presentation at last year SPSC

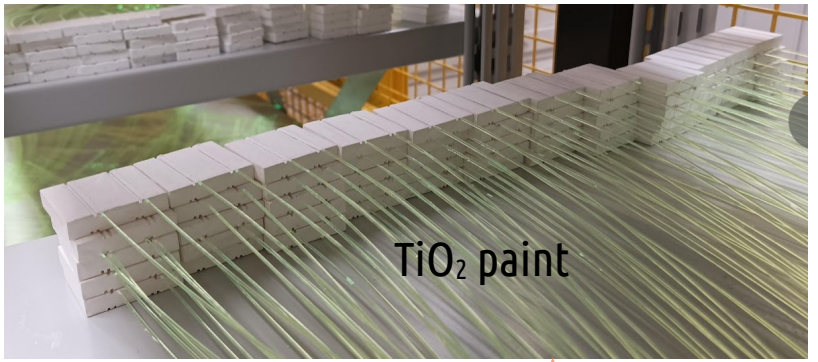
October 2022

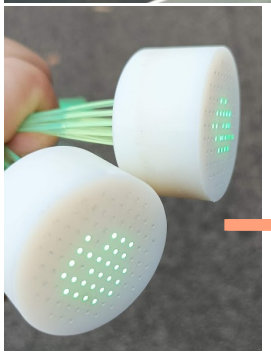


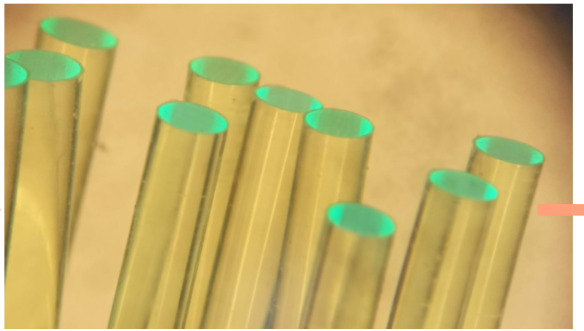
Scintillators + WLS light readout handling

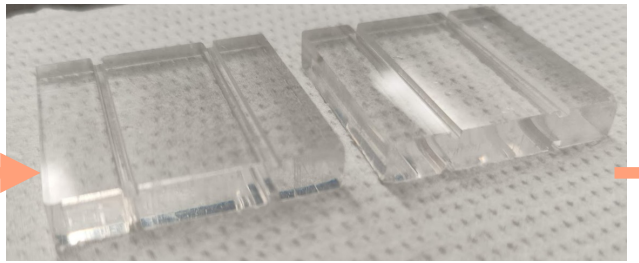
Summer 2022
@ INFN-LNL

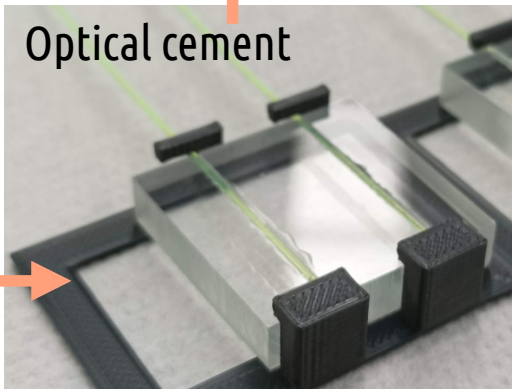
Injection molding INR could not be finalized → commercial scintillator slabs + cutting/milling in Italy.
Critical impact → polishing, fibre gluing, tiles painting **with personnel from the collaboration**.





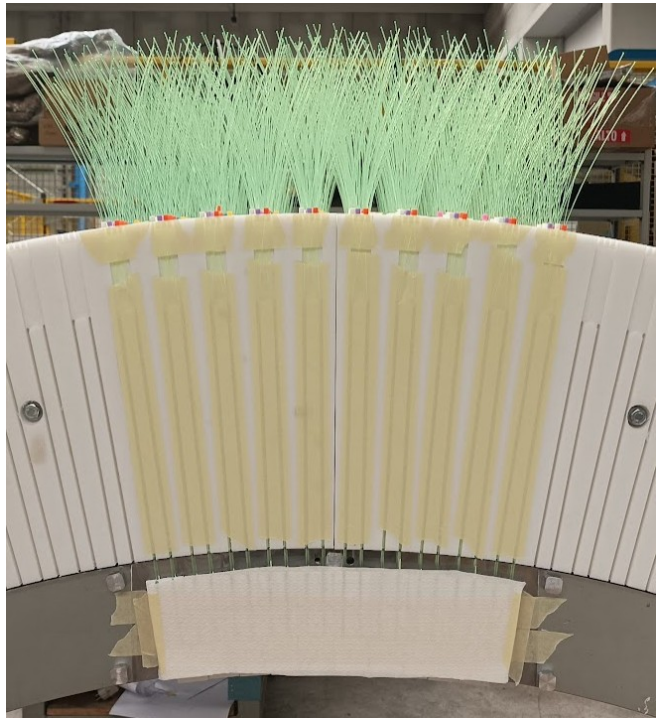






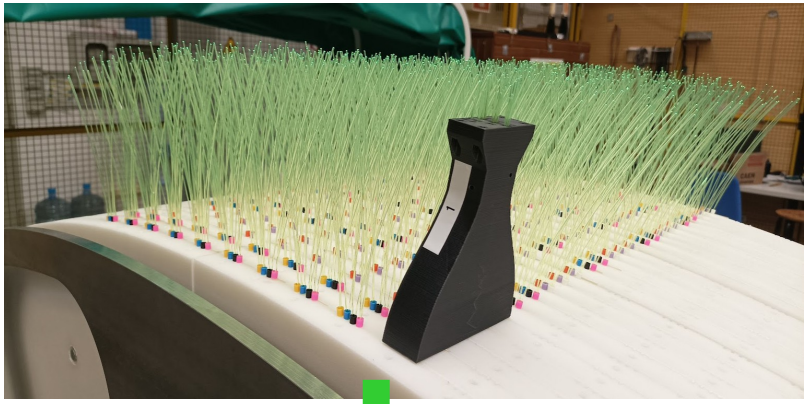
Assembly of the iron / scintillators/ BPE planes

Summer 2022 @ INFN-LNL

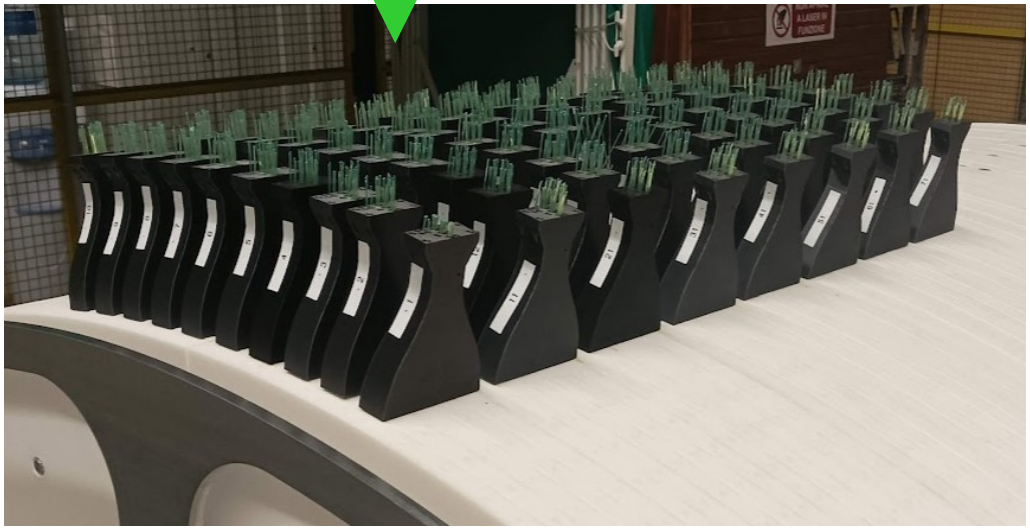


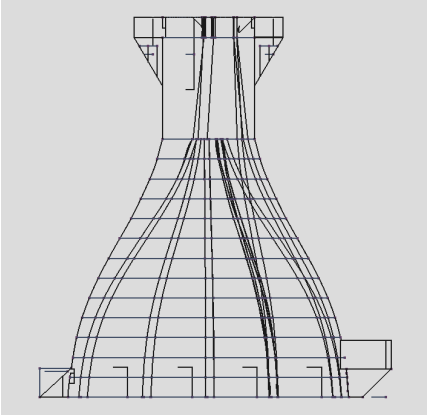
Fiber bundling with new “concentrators”

Summer 2022 @ INFN-LNL



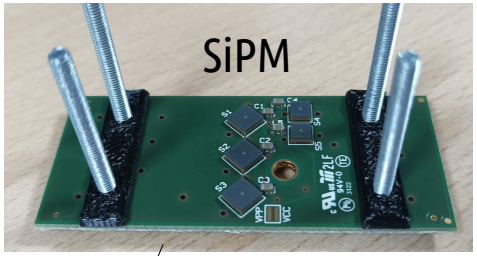
bundling of the WLS fibers with 3D printed “fiber concentrators”+ in situ polishing

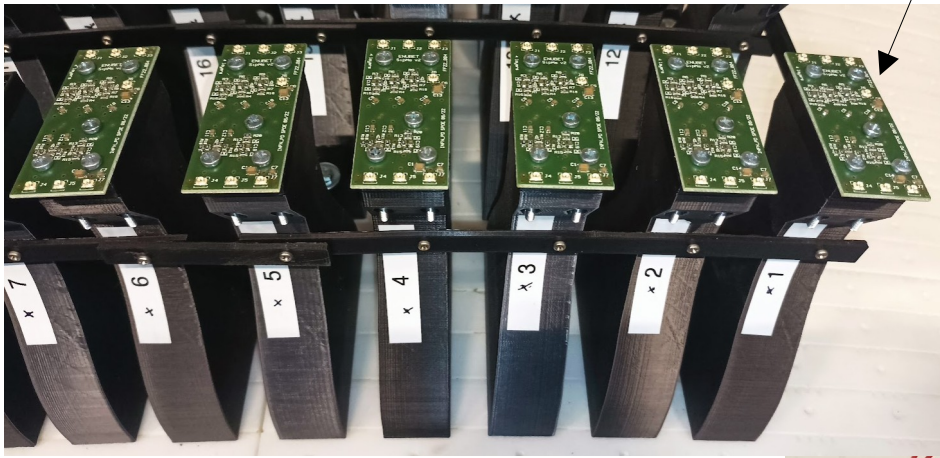


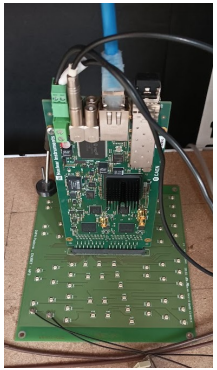


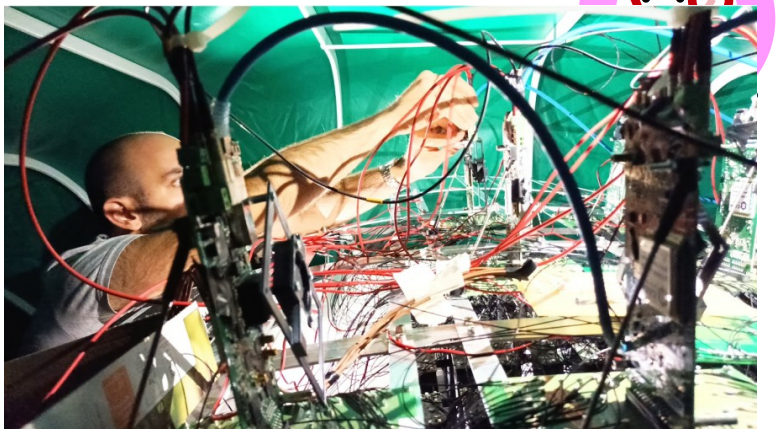
Readout electronics

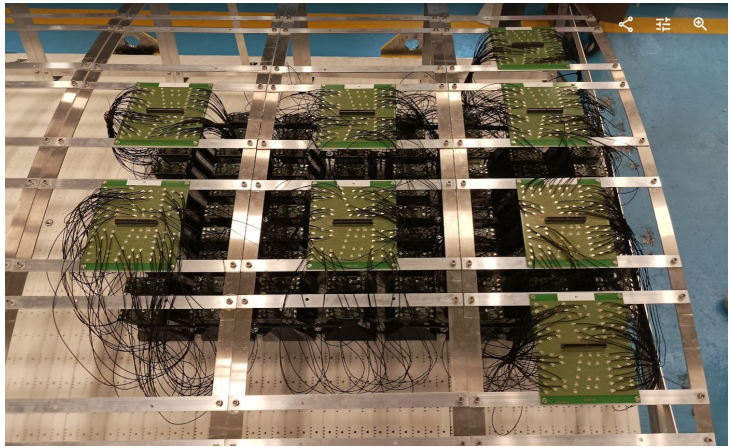
Oct 2022 @ CERN

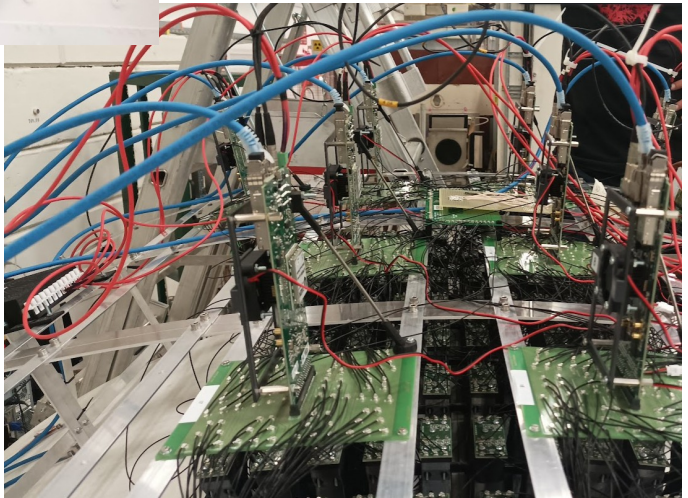












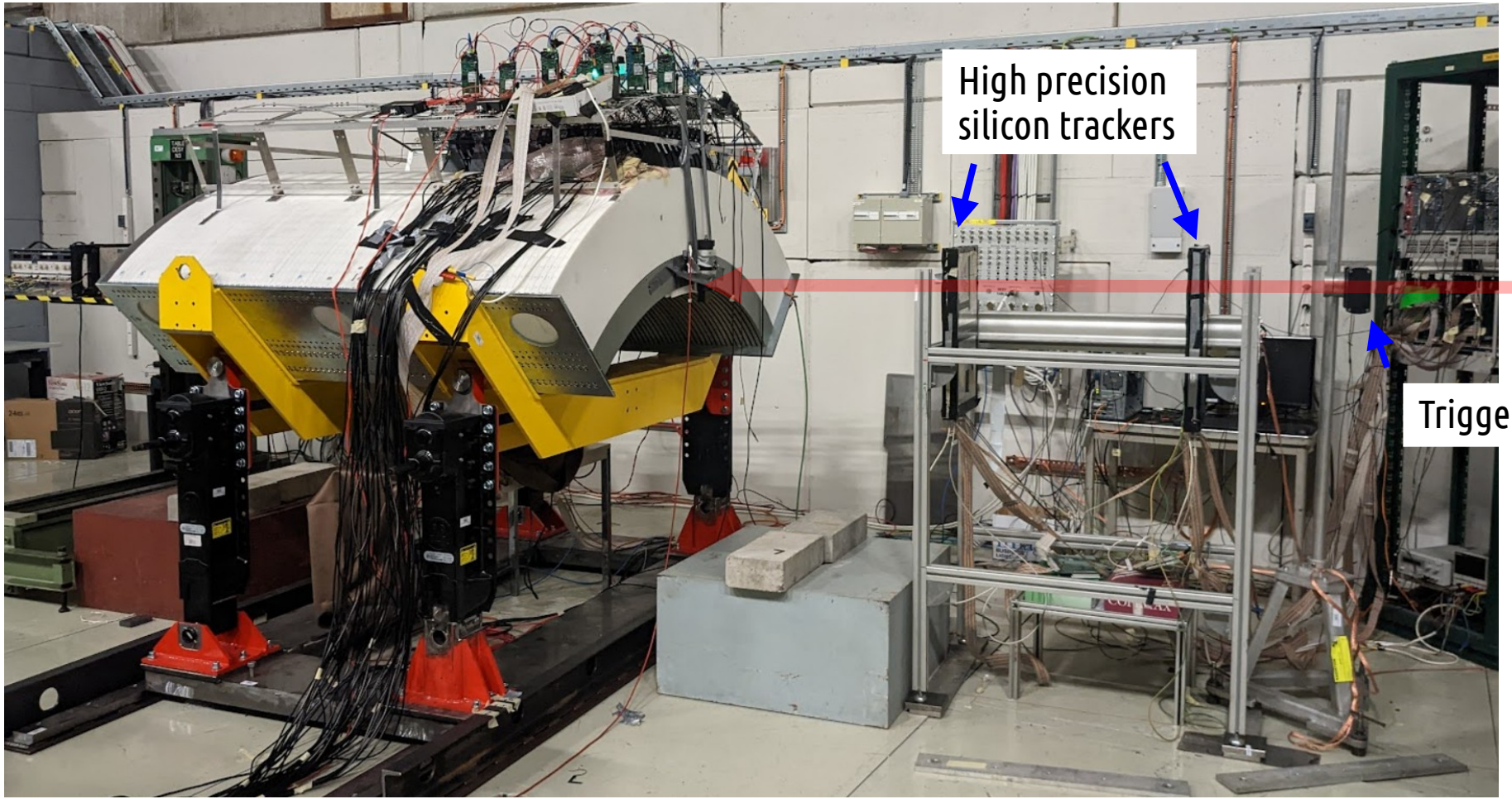
Launch ...

3 Oct 2022 @ building 157,
CERN Meyrin PS East Hall
T9 area

Movable platform “landing site” @ T9 test beam area.

Landing at T9

Oct 2022 CERN-PS-T9

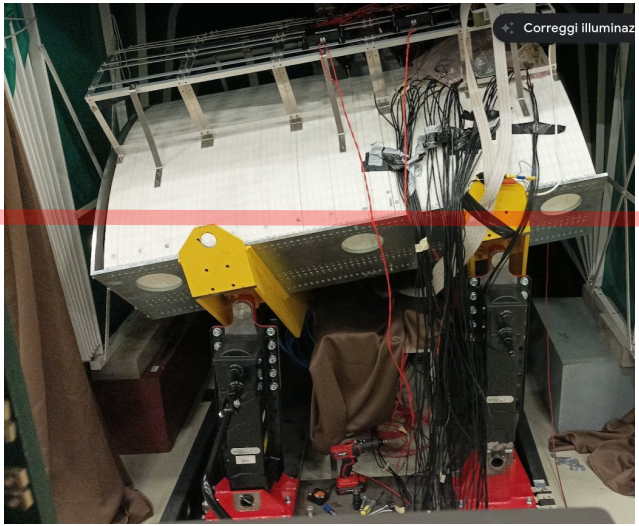


Data taking

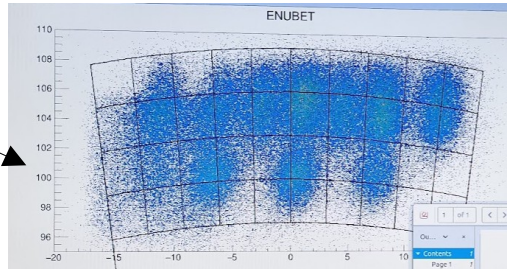
Oct 2022 CERN-PS-T9

horizontal run with darkening cover

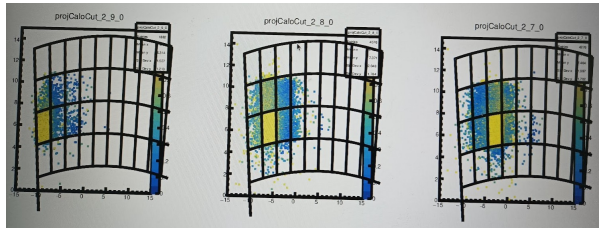
200 mrad tilt run



Beam spot at the detector upstream face after several runs illuminating different regions of the detector



Efficiency maps



Demonstrator-22 → Demonstrator-23

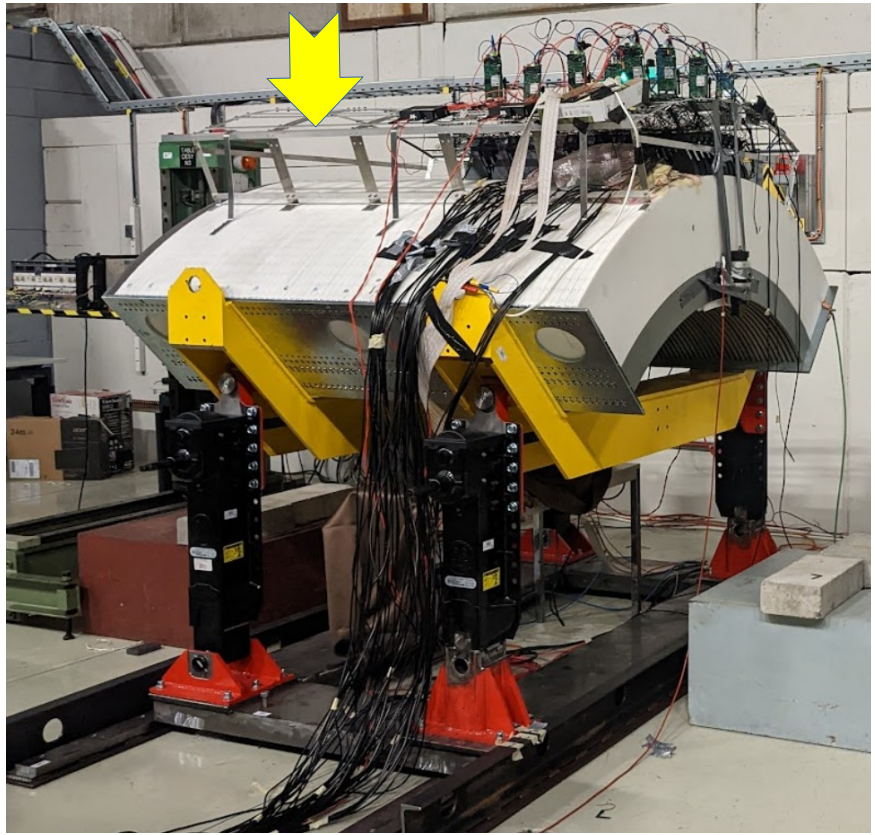
2022: 8 upstream z layers with 10 ϕ sectors (400 ch)
2023:

- add 7 downstream z layers with 25 ϕ sectors
  - passing from 400 to 400+875 = **1275 channels**
- Possibly instrument a few channels with **custom digitizers**
- Larger acceptance:
  - we will take a run in "decay region" mode i.e. with the detector off-beam to try and detect K decay products

2022

Parameter	Quantity or range
Scintillator tiles (7 shapes)	1360
WLS	1.5 km
Channels (SiPM) Hamamatsu (50 μm cell)	400 240, 4×4 mm^2 - calo, 160 3×3 mm^2, t_0
Fiber concentrators (FE boards)	80
Interface boards	8
read-out boards (A5202)	8
CAEN digitizers	45 ch
horizonthal movement	$\sim$ 1 m
vertical tilt	up to $\sim$ 200 mrad

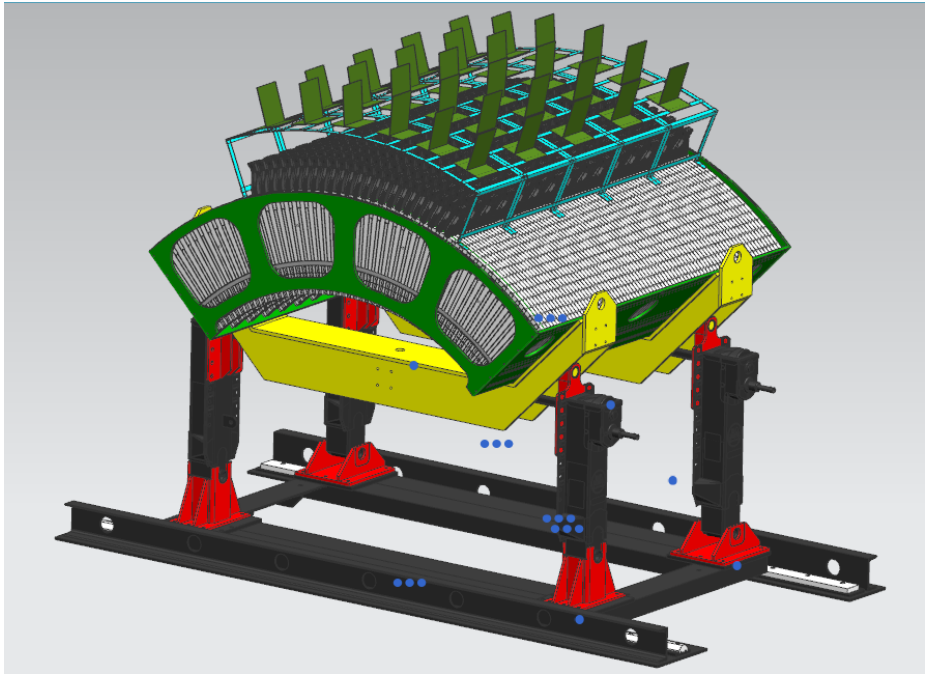
2023

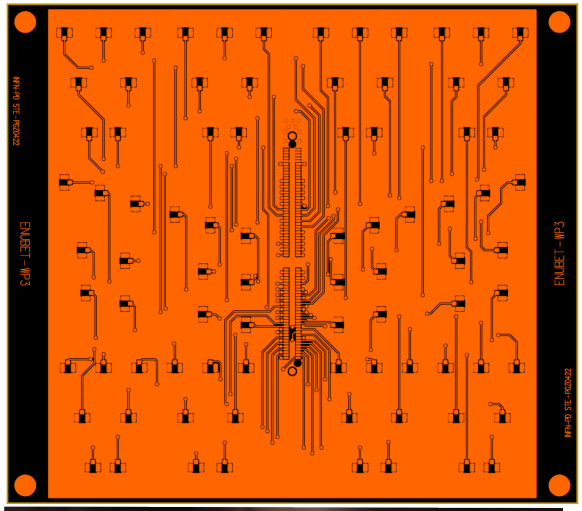


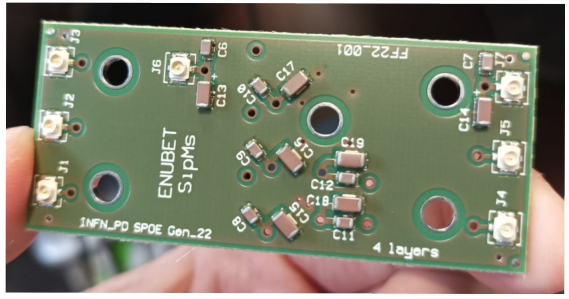
Huge thank you for the support during last year from INFN-PD

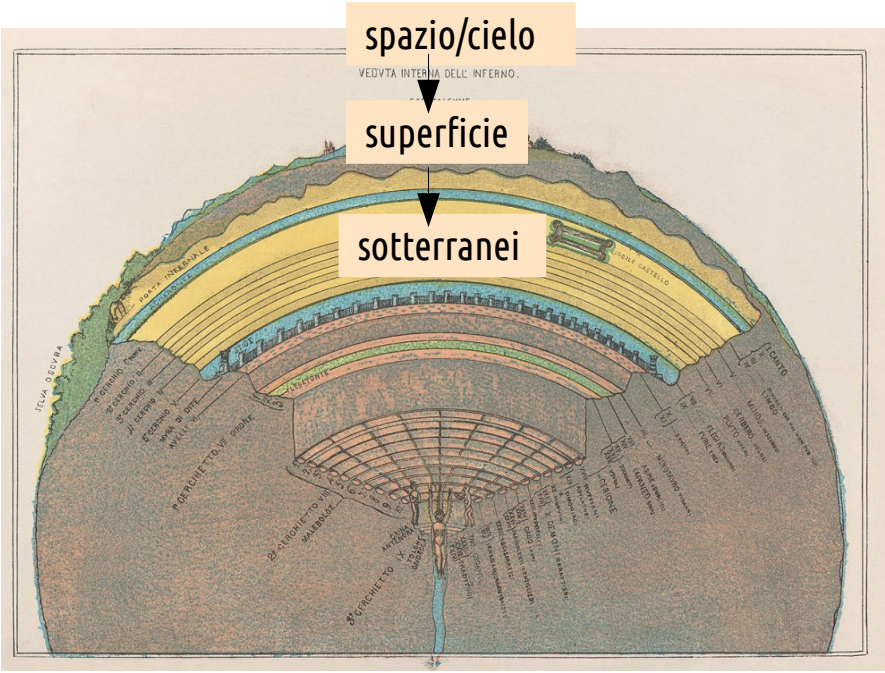
F. Pupilli

Officina meccanica (**Loris, F. Veronese**): mechanics of the demonstrator, RUP
Servizio elettronica (**M. Nicoletto**): FE boards, concentrator boards, RUP
Progettazione meccanica (**M. Benettoni, M. Rampazzo**): FE calculations, CAD.
M. Bellato for the space at LNL and a recent collaboration on development of digitizers (**Corti**, joint with CTA). Adm: **L. Iacono**, **A. Lombardo** & **S. Hemmer** (as RUP).









CTA/MAGIC
FERMI
SWGO

VIRGO
ET

EUCLID

MOONLIGHT-2

QUAX

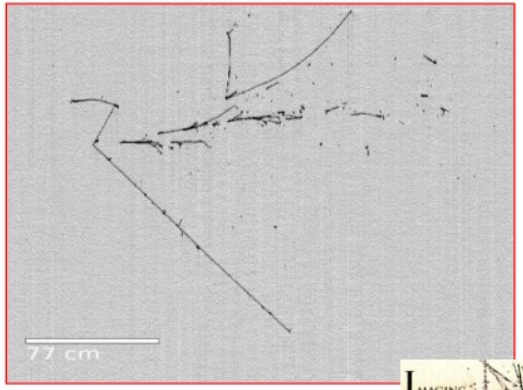
DUNE
ENUBET
ICARUS
T2K

JUNO

GERDA/LEGEND
CUORE/CUPID

Short base-line neutrino oscillation searches with the ICARUS detector

A. Guglielmi



European Commission

H2020, M. Sklodowska-Curie
R&I No. 822185, 858199, 101003460, 101081478

ICARUS Collaboration at SBN

A. Guglielmi

P. Abratenko[19], A. Aduszkiewicz[21], F. Akbar[23], M. Artero Pons[15], J. Asaadi[24], M. Babicz[2], W.F. Badgett[5], L.F. Bagby[5], B. Baibussinov[15], B. Behera[4], V. Bellini[7], O. Beltramello[2], R. Benocci[13], J. Berger[4], S. Berkman[5], S. Bertolucci[6], M. Betancourt[5], K. Biery[5], M. Bonesini[13], T. Boone[4], B. Bottino[8], A. Braggiotti[15], J Bremer[2], S. Brice[5], V. Brio[7], C. Brizzolari[13], J. Brown[5], H. Budd[23], A. Campani[8], A. Campos[27], D. Carber[4], M. Carneiro[1], H. Carranza[24], D. Casazza[8], A. Castro[3], M. Cicerchia[15], S. Centro[15], G. Cerati[5], M. Chalifour[2], A.Chatterjee[26],D. Cherdack[21], S. Cherubini[11], N. Chitirasreemadam[25], T. Coan[18], A. Cocco[14], M. R. Convery[17], S. Copello[16], A. De Roeck[2], S. Di Domizio[8], D. Di Ferdinando[6], L. Di Noto[8], M. Diwan[1], S. Donati[25], J. Dyer[4], S. Dytman[22], S. Dolan[2], F. Dolek[27], L. Domine[17], R. Doubnik[5], F. Drielsma[17], C. Fabre[2], A. Falcone[13], C. Farnese[15], A. Fava[5], F. Ferraro[8], F. Garcia[17], C. Gatto[14], M. Geynisman[5], D. Gibin[15], A. Gioiosa[25], W. Gu[1], M. Guerzoni[6], A. Guglielmi[15], S. Hahn[5], A. Heggestuen[4], B. Howard[5], R.Howell[23], J. Hrivnak[2], C. James[5], W. Jang[24],L. Kashur[4],W. Ketchum[5], J.S. Kim[23], D.H. Koh[17], U. Kose[2], J. Larkin[1], G. Laurenti[6], G. Lukhanin[5], A. Maria[26], C. Mariani[27], C. Marshall[23], S. Martinenko[1], N. Mauri[6], A. Mazzacane[5], K.S. McFarland[23], D.P. Mendez[1], G. Meng[15], A. Menegolli[16], O.G. Miranda[3], D. Mladenov[2], A.Mogan[4], N. Moggi[6], N.Montagna[6], A. Montanari[6], C. Montanari[5,b], M. Mooney[4], G. Moreno Granados[3], J. Mueller[4], M. Murphy[27], D. Naples[22], M. Nessi[2], T. Nichols[5], S. Palestini[2], M. Pallavicini[8], V. Paolone[22], R. Papaleo[11], L. Pasqualini[6], L. Patrizii[6], G. Petrillo[17], C. Petta[7], V. Pia[6], F. Pietropaolo[2,a], F. Poppi[6], M. Pozzato[6], A. Prosser[5], G. Putnam[20], X. Qian[1], A. Rappoldi[16], R. Rechenmacher[5], L. Rice[22], E. Richards[22], F. Resnati[2], A.M. Ricci[25], A.Rigamonti[2], G.L. Raselli[16], M. Rosemberg[19], M. Rossella[16], C. Rubbia[9],G. Savage[5],A. Scaramelli[16],D. Schmitz[20],A. Schukraft[5], F. Sergiampietri[2], G. Sirri[6], J. Smedley[23], A. Soha[5],L. Stanco[15],J. Stewart[1],N.B. Suarez[22], H.Tanaka[17], M. Tenti[6], K.Terao[17], F. Terranova[13], V.Togo[6], D.Torretta[5], M.Torti[13], Y.T. Tsai[17], S.Tufanli[2], T. Usher[17], *F.Varanini[15], S. Ventura[15], M.Vicenzi[1], C. Vignoli[10],* B.Viren[1], D. Warner[4], Z. Williams[24], P. Wilson[5], R.J. Wilson[4], J. Wolfs[23], T. Wongjirad[19], A. Wood[21], E. Worcester[1], M. Worcester[1], M. Wospakrik[5], H. Yu[1], J. Yu[24], A. Zani[12], C. Zhang[1], J. Zennamo[5], J. Zettlemoyer[5], S. Zucchelli[6], M. Zuckerbrot[5]

a On Leave of Absence from INFN Padova
b On Leave of Absence from INFN Pavia

1. Brookhaven National Lab., USA
2. CERN, Switzerland
3. CINVESTAV, Mexico,
4. Colorado State University, USA
5. Fermi National Accelerator Lab., USA
6. INFN Bologna and University, Italy
7. INFN Catania and University, Italy
8. INFN Genova and University, Italy
9. INFN GSSI, L'Aquila, Italy
10. INFN LNGS, Assergi, Italy
11. INFN LNS, Catania, Italy
12. INFN Milano, Milano, Italy
13. INFN Milano Bic. and University, Italy
14. INFN Napoli, Napoli, Italy
15. INFN Padova and University, Italy
16. INFN Pavia and University, Italy
17. SLAC National Accelerator Lab., USA
18. Southern Methodist University, USA
19. Tufts University, USA
20. University of Chicago, USA
21. University of Houston, USA
22. University of Pittsburgh, USA
23. University of Rochester, USA
24. University of Texas (Arlington),USA
25. INFN Pisa and University, Italy
26. Ramanujan Faculty Phys. Res. India
27. Virginia Tech Institute

12 INFN groups, 12 US institutions, CERN, 1 Mexican institution, 1 Indian Institution

Spokesperson: C. Rubbia, GSSI

ICARUS Installation, Commissioning and Data taking

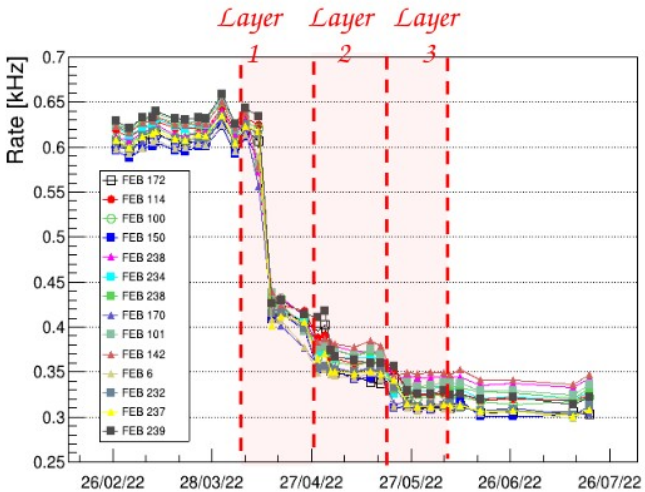
A. Guglielmi

Dec. '21: CRT installation to recognize cosmics

June '22: overburden installation to reduce cosmics

Steady data taking with BNB, NuMI beams since March 2021, in parallel with commissioning activities.
Cosmic rays, ν_μ, and ν_e samples collected for trigger/calibration/event reconstruction studies.

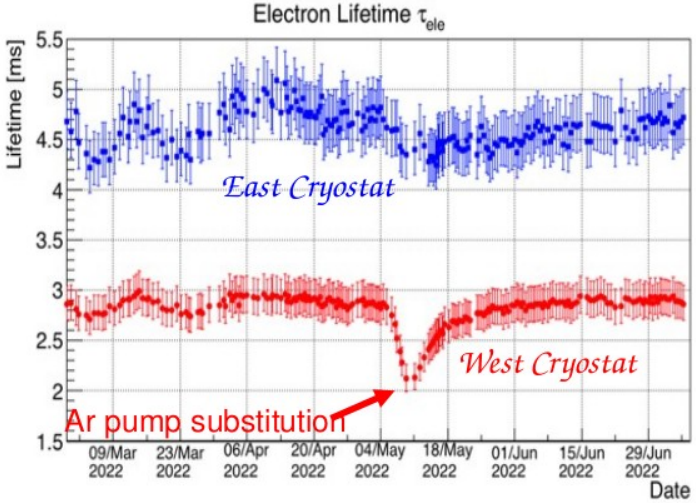
- *Installation of concrete overburden (3 layers ~2.85 m thickness) lasted to June 7 2021 concluding the ICARUS detector installation:*
  - *Cosmic rates reduced by ~2 and start of ICARUS physics data taking!*



Run 1: first ICARUS physics run, June 9th – July 10th 2022

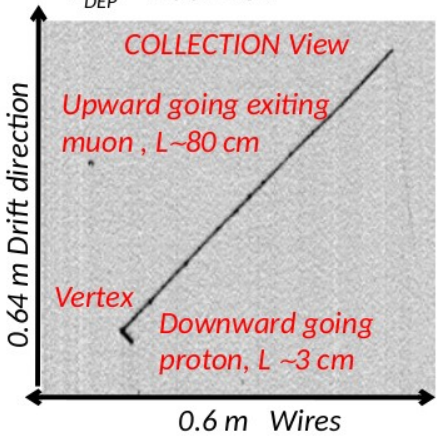
A. Guglielmi

- *ICARUS operated in physics mode with TPC, PMT, Top/Side CRT in stable conditions taking data with a PMT signal trigger in coincidence with NuMI or BNB beam spill;*
- *The cryogenic system performed smoothly guaranteeing a LAr purity adequate for data taking, with a free e-lifetime measured by cosmic μs at ~4.5 ms (~ 3 ms) for East (West) cryostat.*

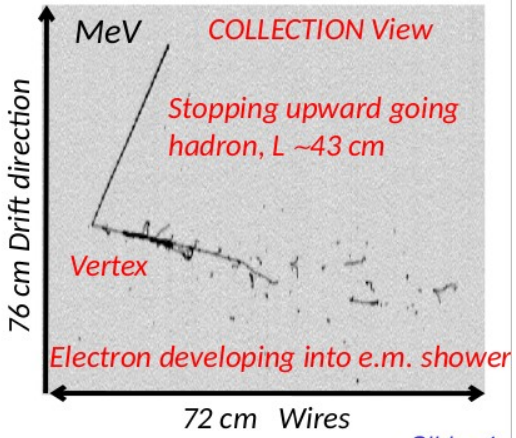


- *Data acquisition largely successful, with ~93% collection efficiency for both BNB/NuMI:*
  - *Total collected beam amounts to ~6.8 10^{19} POT for NuMI and ~4.1 10^{19} POT for BNB.*

BNB CCQE $\nu\mu$ candidate, E_{DEP} ~ 200 MeV



Contained NuMI CCQE νe, candidate, E_{DEP} ~ 800



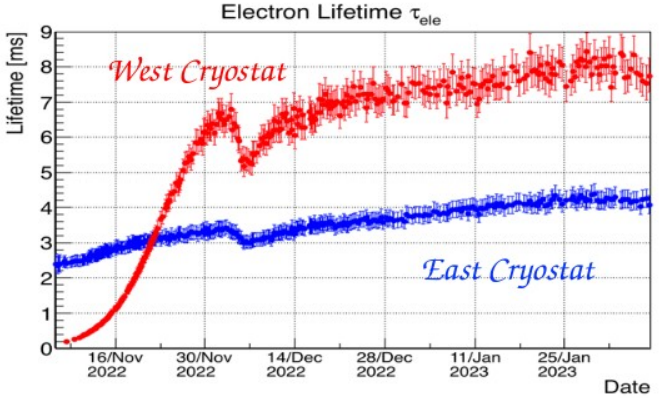
Activities on the 2022 summer shutdown and beyond

A. Guglielmi

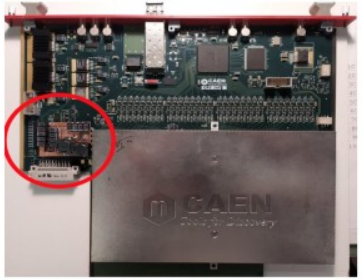
Several activities take place, to improve the detectors performance, stability and related calibration and monitor:

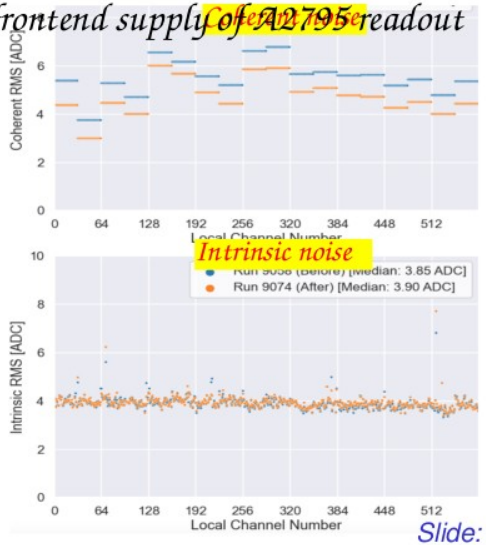
- ***Regeneration of the WEST module's liquid Ar recirculation filters,*** *cryogenic pumps maintenance and LAr refill maintenance and LAr*

  … as a result free e-lifetime in West cryo increased to 8 ms in allowing for ~ optimal track detection; a similar intervention planned for East Cryo in summer '23



- ***Further ~20 % reduction of TPC readout electronics coherent noise*** *in Induction-1 (9 m long wires) by Chebyshev low-pass filters installed on +7 V frontend supply of A2795 readout boards*





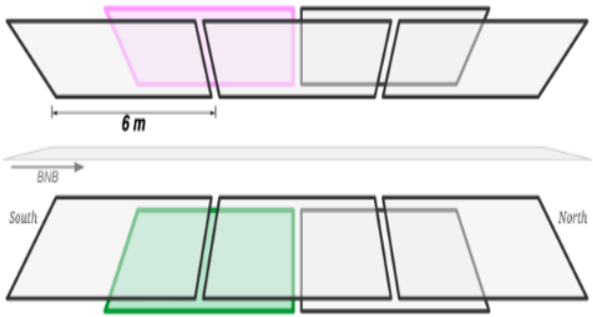
~ 0.9 ADC # coherent noise reduction (-20%), leaving virtually unaffected the intrinsic one

Triggering the neutrino events

A. Guglielmi

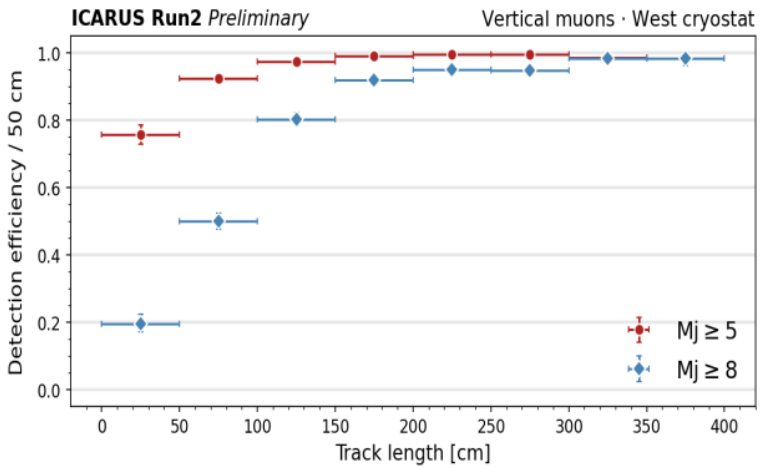
- ***ICARUS trigger system*** *relies on PMT light signals in coincidence with beam spills, 1.6 μs BNB and 9.5 μs NuMI, using Early warning signals of proton beam extractions, synchronized to ICARUS detector by White Rabbit.*

  - *Beam events collected by requiring Mj >= 5 fired PMT pairs inside one of 3 longitudinal slices (6 m long) of a cryostat, 13 phe PMT threshold.*
  - *PMT and CRT signals also recorded in 2 ms around the trigger with Mj >= 10 to recognize cosmics crossing LAr-TPCs in 1 ms e-drift time.*



Each 6 m slice includes 30 left + 30 right PMTs

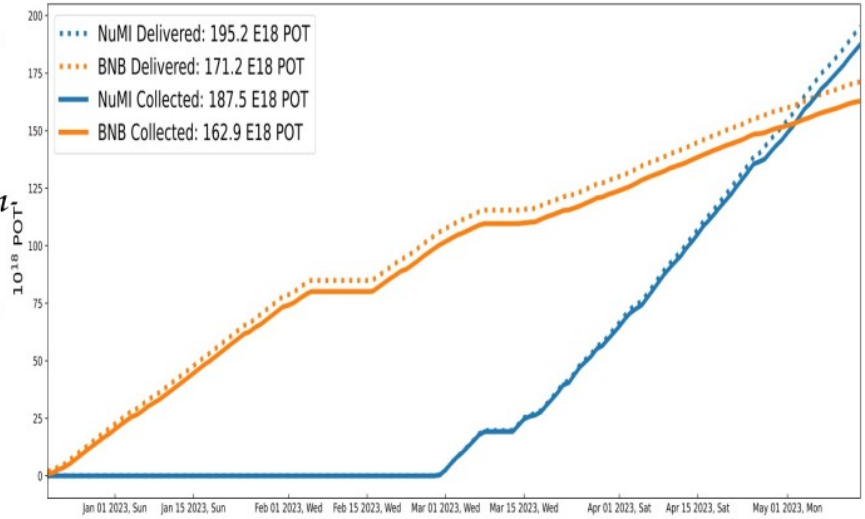
- *New "sliding slices" logic: two extra 6 m slices partially superposed to original ones along the beam (z) direction:*
  - *Significant improvement of out-of-spill cosmics μ recognition*
  - *Trigger efficiency has been measured with ~ vertical cosmic μs independently selected by TPC tracks matched to CRT signals.*



Run 2 Data taking: from December ‘ 22 to July 9 2023

A. Guglielmi

- *Run 2 started on Dec. '22 taking data smoothly with an acquisition efficiency >95 % using the improved trigger system.*
- *Occasional beam stops due to technical problems on beam lines were used for detector calibration/tests .*
- *Collected events statistics: 1.6 10^{20} POT BNB and ~1.9 10^{20} POT NuMI.*



First ICARUS published paper:

Eur. Phys. J. C (2023) 83:467
https://doi.org/10.1140/epjc/s10052-023-11610-y

THE EUROPEAN PHYSICAL JOURNAL C

Check for updates

Regular Article - Experimental Physics

ICARUS at the Fermilab Short-Baseline Neutrino program: initial operation

P. Abratenko[1], A. Aduszkiewicz[2], F. Akbar[3], M. Artero Pons[4], J. Asaadi[5], M. Aslin[6,27], M. Babicz[7,28,29], W. F. Badgett[6], L. F. Bagby[6], B. Baibussinov[4], B. Behera[8], V. Bellini[9], O. Beltramello[7], R. Benocci[10], J. Berger[8], S. Berkman[6], S. Bertolucci[11], R. Bertoni[10], M. Betancourt[6], M. Bettini[4], S. Biagi[12], K. Biery[6], O. Bitter[6,30],

Gruppo ICARUS Padova

A. Guglielmi

- *ICARUS Pd: 11 physicists/engineers, 8.5 FTE inseriti nel RISE INTENSE:*
  - *M. Artero-Pons (PhD stud.), B. Baibussinov, A. Braggiotti, S. Centro (Affiliate), C. Farnese, D. Gibin, A. Guglielmi (Senior Associate), G. Meng, F. Pietropaolo, F. Varanini, S. Ventura.*

    sinergia con Nu_at_FNAL: L. Stanco, M. Cicerchia

    => lavoro in comune su ICARUS a SBN FNAL ma non solo!
- *B. Baibussinov, F. Pietropaolo e F. Varanini: R&D per DUNE con realizzazione/test a Legnaro di specifiche Multilayer LEM TPC in collaborazione con Proto-DUNE al CERN!*
- *Grosso impegno del Gruppo Padovano nella gestione hardware/software dell'elettronica di read-out della TPC e nello sviluppo del trigger dell'esperimento.*
- *Il Gruppo Padovano è fortemente impegnato nel software di ricostruzione degli eventi e analisi dati: esprime anche uno dei 2 Software/Analysis Coordinator per tutto il programma SBN al FNAL,~ 250 fisici impegnati in ICARUS e nel rivelatore Near SBND. Componenti del gruppo coordinano anche attività nei Working Groups di TPC, Trigger, Detector Calibration, TPC Track reconstruction e Neutrino Identification.*
- *Al Gruppo di Padova è sempre stato riconosciuto un ruolo di preminenza con il diritto di esprimere uno dei due Deputy della Collaborazione.*

Attivita' in ICARUS/ SBN e oltre: paving the way

A. Guglielmi

- *Padova è richiesta garantire l'impegno in SBN nei prossimi ~ 5 anni per la prevista presa dati e quindi per il completamento delle analisi.*
- *L'attività hardaware prevista per la fine 2023 e il 2024 da Padova include lo studio della mitigazione del rumore residuo presente nella TPC con interventi dedicati, la naturale manutenzione dei 54000 canali elettronici della TPC e del sistema di Trigger. In parallelo l'analisi dei dati raccolti impegnerà buona parte del gruppo.*
- *Continuerà inoltre l'attività di R&D a Legnaro con lo studio di configurazioni di TPC alternative al sistema a filo per ProtoDUNE.*
- *Sarà quindi naturale, in prospettiva, aumentare gradualmente l'impegno in DUNE trasferendo tutto il bagaglio di conoscenze sull'interazione del neutrino con l'argon liquido accumulate con ICARUS ai fasci Booster e NuMI Off Axis (misure di sezioni d'urto, software di ricostruzione degli eventi, …)*

Financial requests 2024

A. Guglielmi

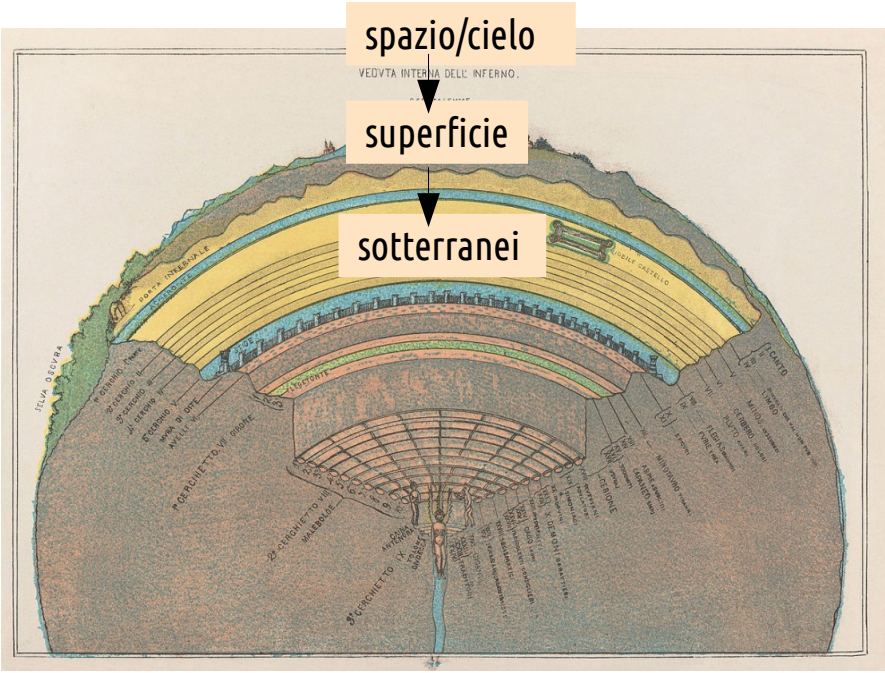
- *Financial requests include:*
  - *New custom boards to check TPC channels, substitution of 4 HP servers, out of warranty;*
  - *Consumable materials for the T600 detector maintenance, SP-Servizi and transport;*
  - *ICARUS presence at FNAL determined accounting for detector experts, trigger tuning, detector maintenance and 3 months RUN-Coordinator.*

Richieste finanziarie di Padova per 2024		k€	sub-j k€
Apparati	Substitution of 4 HP servers (out of warranty) Custom Test board for TPC signals	13.5 5	
Consumo	Electronics Service/custom electronics repair	6	
SP-Servizi	Mechanics workshop (Mini-crates/flanges recovery)	3	
Trasporti	To CERN/FNAL	10	
Missioni	Fnal, Cern	72	
Total		109.5	

Richieste Servizi 2024: 20 MU Servizio di Elettronica: manutenzione/test electronica TPC a Padova e al FNAL, nuove test boards della TPC,

2 MU Servizio Off. Meccanica

4 MU Calcolo e Reti.



CTA/MAGIC
FERMI
SWGO

VIRGO
ET

EUCLID

MOONLIGHT-2

QUAX

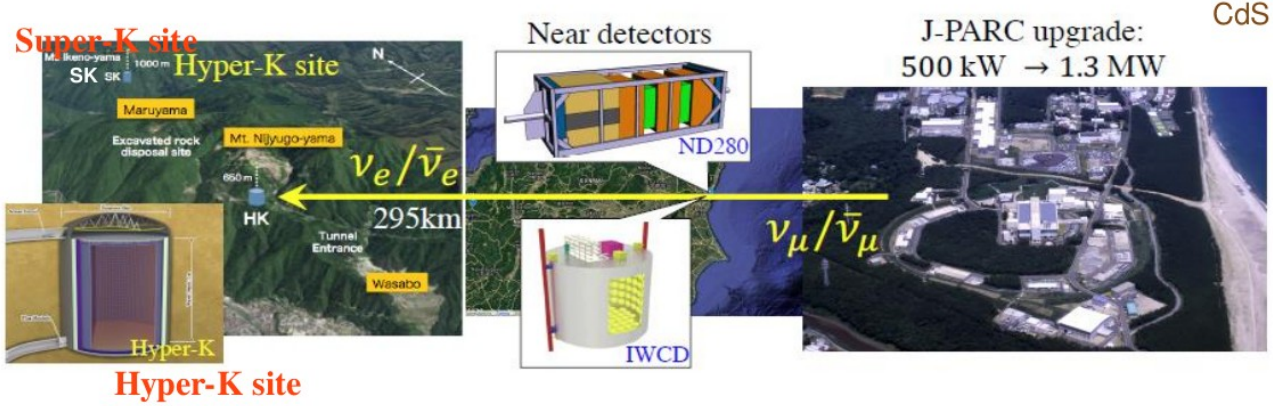
DUNE
ENUBET
ICARUS
T2K

JUNO

GERDA/LEGEND
CUORE/CUPID

Prospettive esperimenti
T2K & SuperK & HyperK

G.Collazuol
CdS 2023/7/6



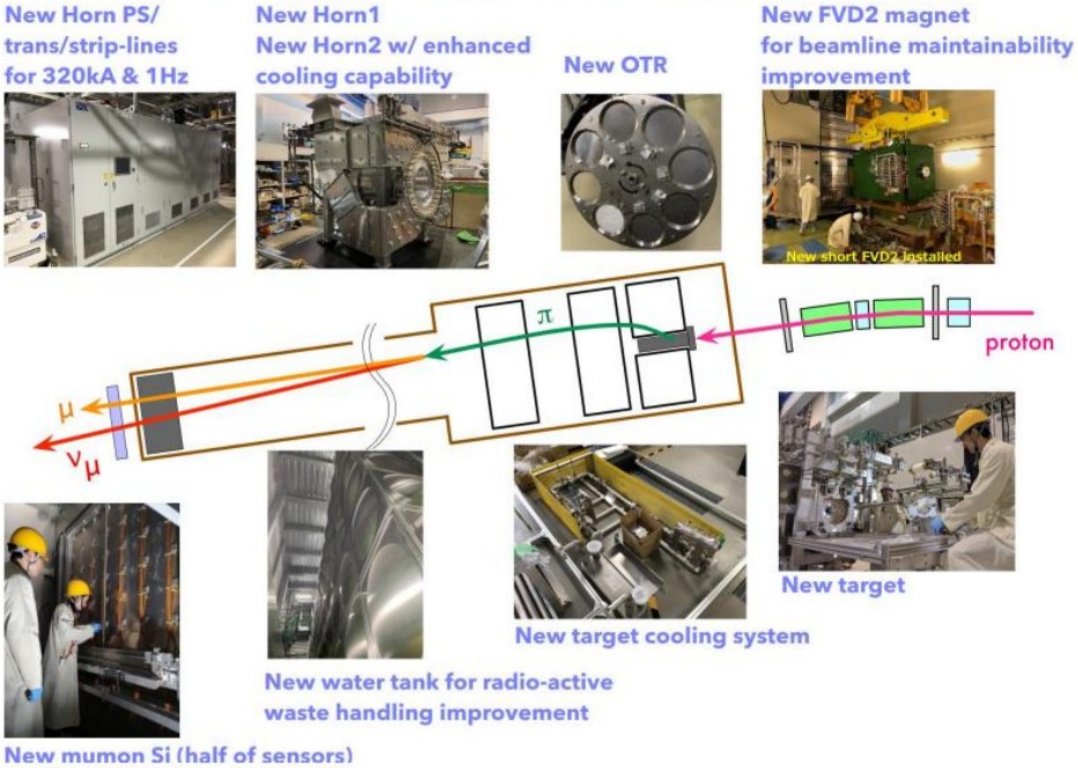
Intensa attivita` neutrini "in Giappone" per diversi anni
- T2K Near Detector upgrade in fase avanzata di costruzione → completamento 2024
- Super-K nuova fase H O + Gd → "Run 7"
- Hyper-K approvato INFN nel 2022 → fase di costruzione dal 2024

Gruppo locale in costante espansione
Staff: G.Collazuol, E.Bernardini, M.Grassi, M.Laveder, A.Longhin, M.Mezzetto, F.Pupilli, S.Levorato
Post-Doc: D.D'Ago, M.Pari, D.Henaff (da fine 2023)
Dottorandi: M.Feltre, M.Mattiazzi + diversi Laureandi
Personale DFA: G.Cogo

Neutrino BEAM @ JPARC

G. Collazuol

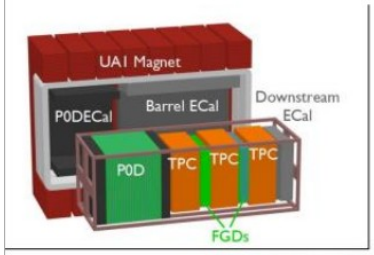
2020-2022 upgrades completed



- 2020-22 upgrade from 500kW to 900kW completed
- PS fire accident in Hadron Hall
  → neutrino Beam postponed to end 2023
- Further upgrade to 1.3MW programme started toward HK running (2027)

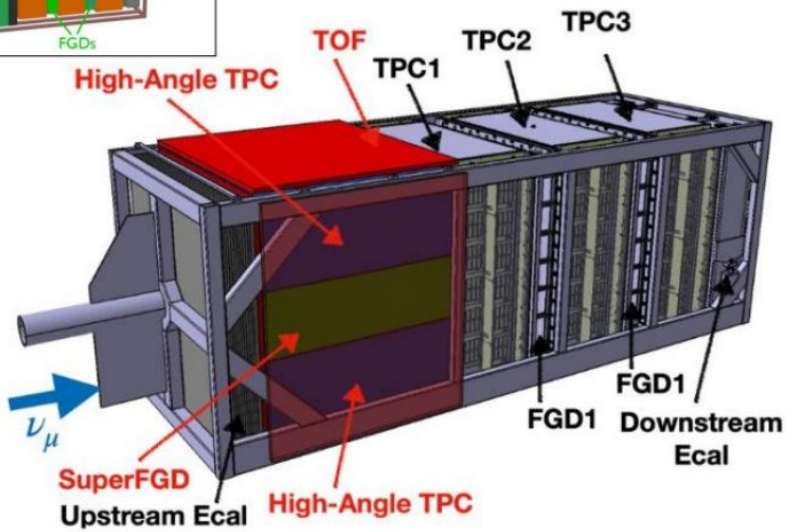
ND280 Status → Upgrade

G. Collazuol



Preparation for upgrade

- dismount old gas system
- Re-install TPC1 → Remove P0D → Re-install TPC1



New gas system
Installation Mid 2023
Commissioning Sept 2023

Upgrade detector installation
1) bottom HATPC (2023)
2) SFGD (2023)
3) top HATPC (2024)
4) TOF (2023-24)

Beam in JFY2023
Commissioning Upgraded detectors w/ Beam

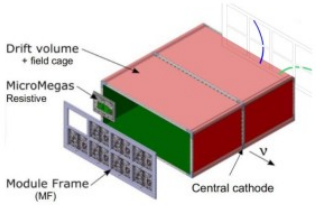
ND280 Upgrade – INFN PD

G. Collazuol

Importante coinvolgimento INFN PD in costruzione delle TPC "orizzontali" (High Angle TPC):

→ **coordinamento intero progetto** di HA-TPC → G.Collazuol

→ **disegno** e **costruzione Field Cage** INFN-PD con LNL e Bari



Attivita` 2020-24

- realizzazione e test prototipi (2020-21)
- **costruzione Field Cages HA-TPC** @ CERN (2022-23)
- **installazione HA-TPC** @ JPARC (2023-24)

Nota: INFN PD / LNL / Bari
- reponsabillita` di Field Cages
- responsabilita` Gas system @ JPARC

Grazie al Servizio Officina Meccanica per realizzazione molte parti meccaniche e mockup meccanici/elettrici vari

Grazie per importante supporto all'Amministrazione INFN PD

Field Cages

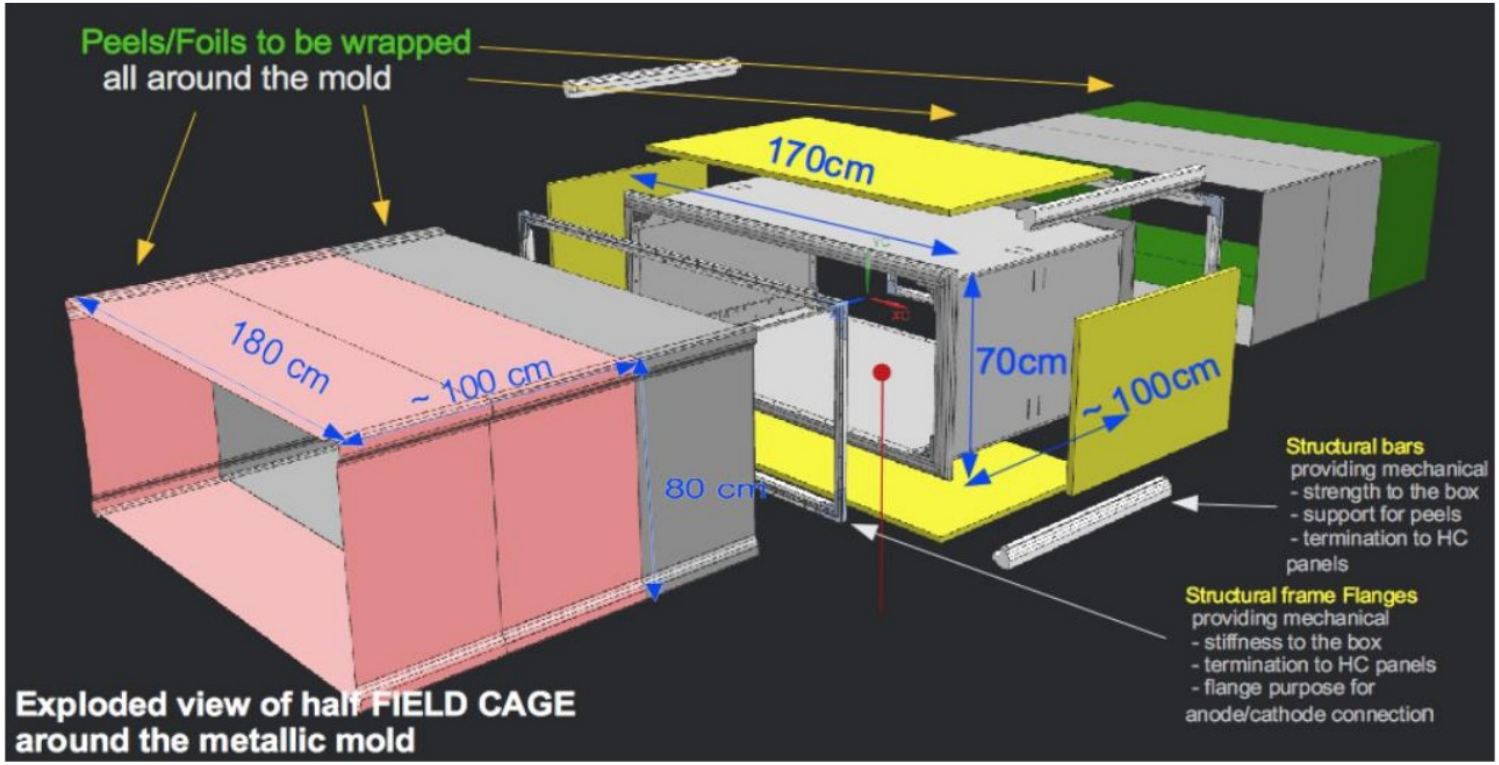
G. Collazuol

HATPC made of 2 half rectangular Field Cages

- Dielectric, low-Z materials
- Composite materials techniques
- Thin walls laminated on a mold

Mechanical tolerances

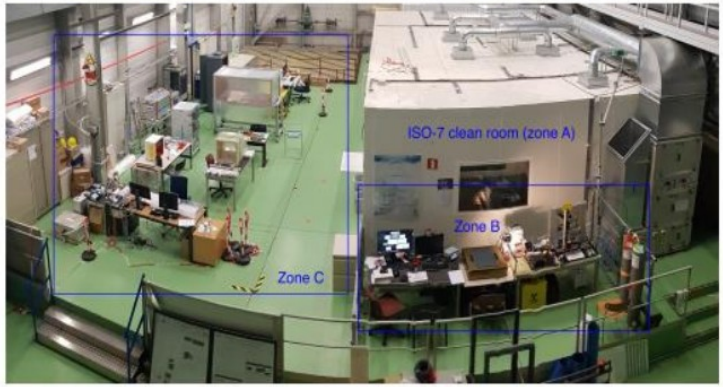
- Cathode flatness and ERAM plane flatness better 0.2mm/m
- Field Cage walls flatness better tham 0.2mm/m
- Cathode/Anode planes parallel to within 0.2mm/m

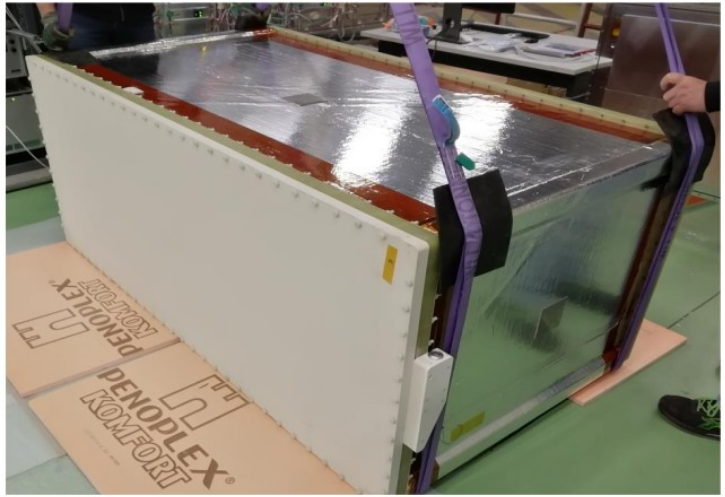


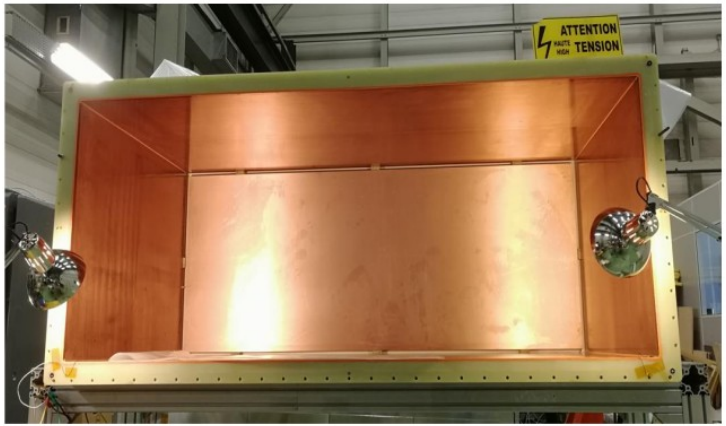
Field Cage validation @ CERN

G. Collazuol

NP07 HA-TPC working area at bdg. 182





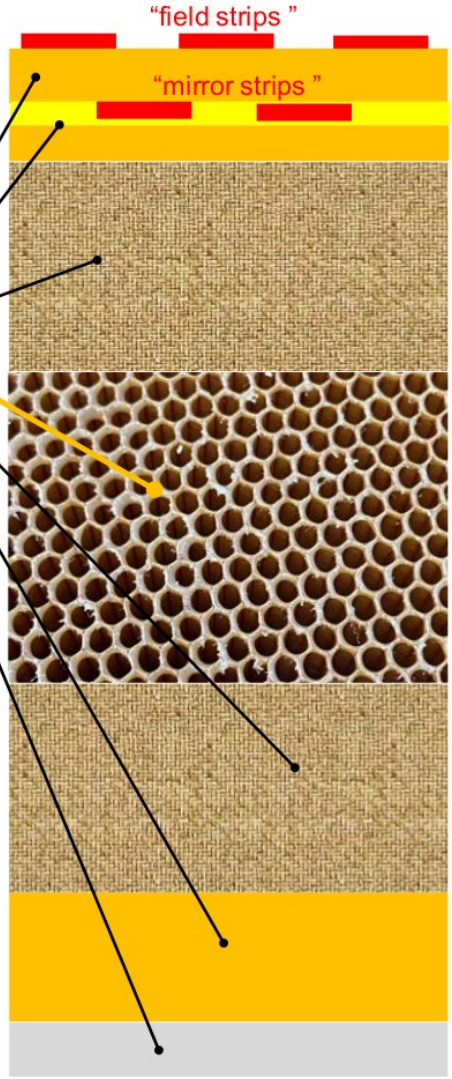


Field Cage – layers

See G.C. talk at
15th Pisa Meeting on Advanced Detectors
La Biodola, Isola d'Elba, May 22-28, 2022

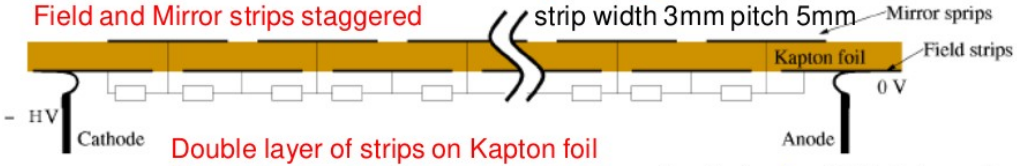
Material	Thickness
Cu Strips on Kapton foil (electrodes)	Cu 17μm / Kapton 50μm / Cu 17μm
"Coverlay" (strip insulation / protection)	Glue 20μm / Kapton 25μm
Aramid Fiber Fabric (Twaron™)	2mm
Aramide HoneyComb panel	35mm
Aramid Fiber Fabric (Twaron™)	2mm
Kapton foil (insulation)	125μm
Aluminum foil (external shield)	50μm
Total	~ 4 cm / ~ 2% radiation length

Note: V-TPC ~ 12cm / ~ 3.4% radiation length

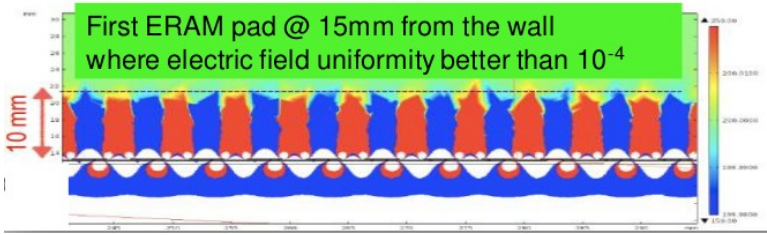


Electric field shaping

Field and Mirror strips staggered



Double layer of strips on Kapton foil
Dimensions = 5m (inner surface cage perimeter) x 1m (drift distance)



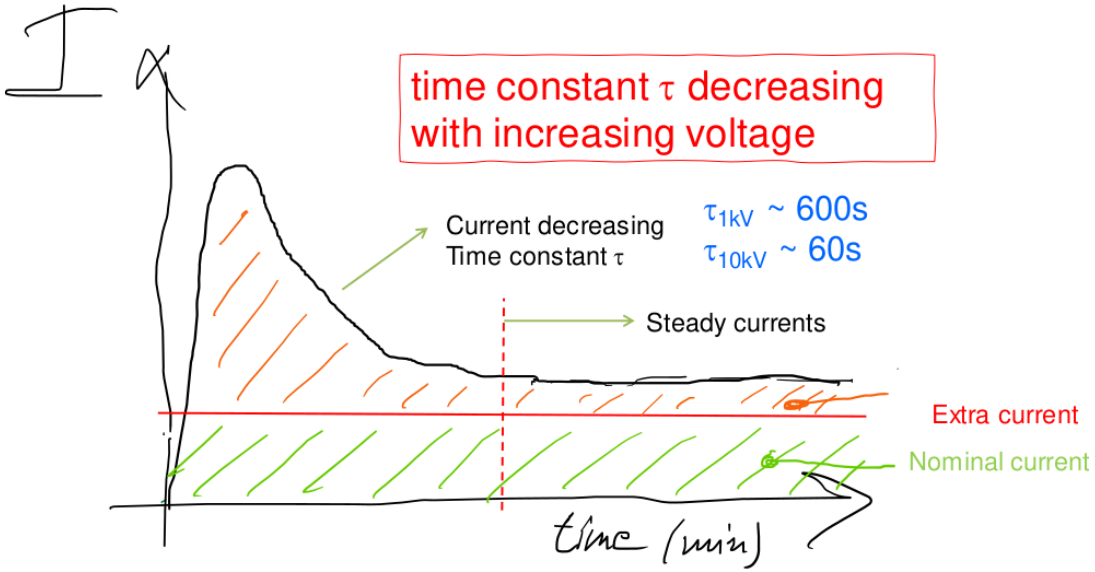
Simulation
Electric Field
near walls

G. Collazuol

Issue with HV in 2022 - extra current in FC0

G. Collazuol

Current drawn by voltage divider starting in large excess wrt nominal at power on and slowly decreasing to lower value but still in excess



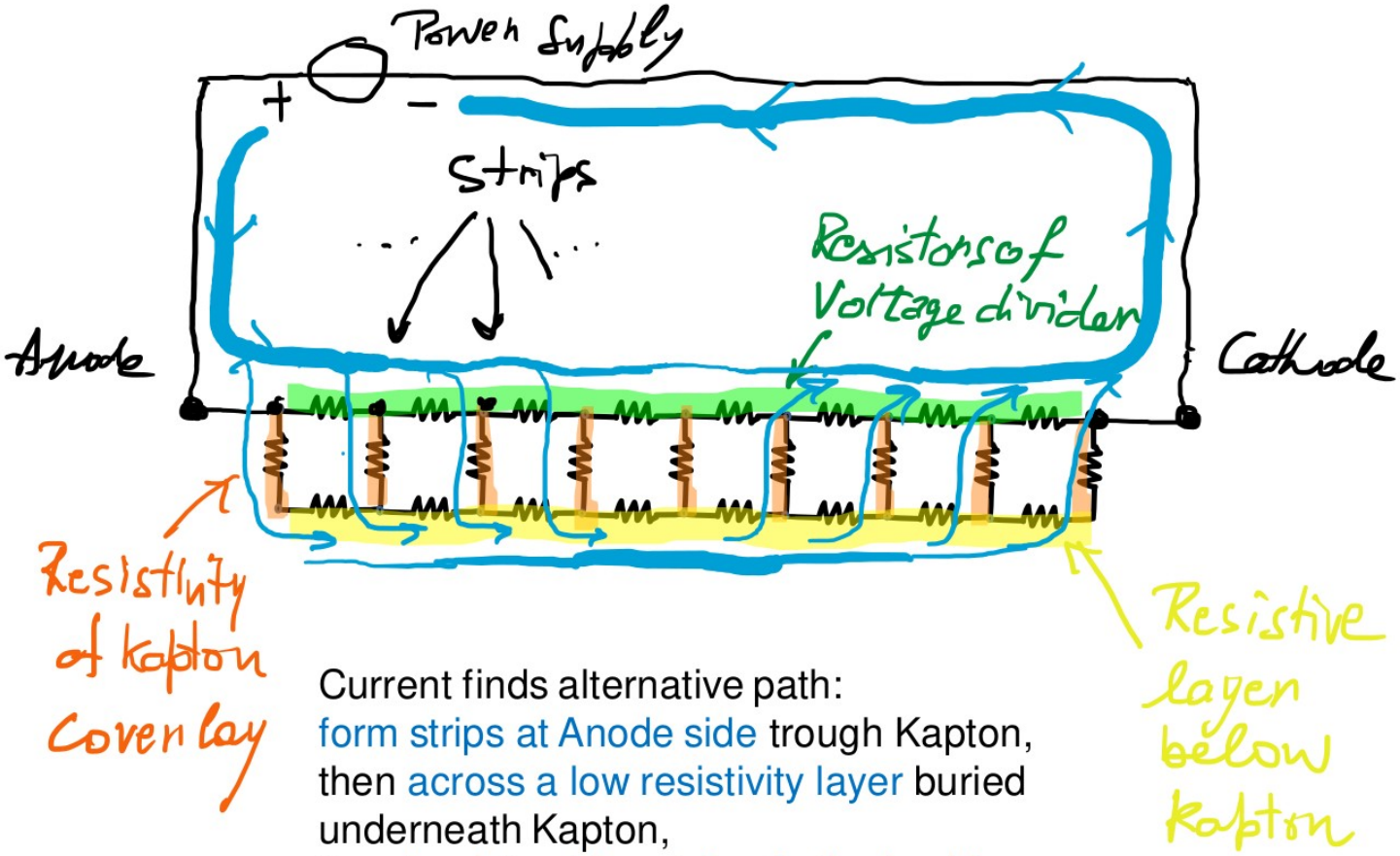
Extra current is internal – flowing trough / in parallel to voltage divider

- Divider current same as delivered by Power Supply
- No leakage current from divider to shield (R > 1TOhm)

Reproducible I values (up to 25kV… when hysteresis happened)

Model to explain extra-current flowing in buried layer

G. Collazuol

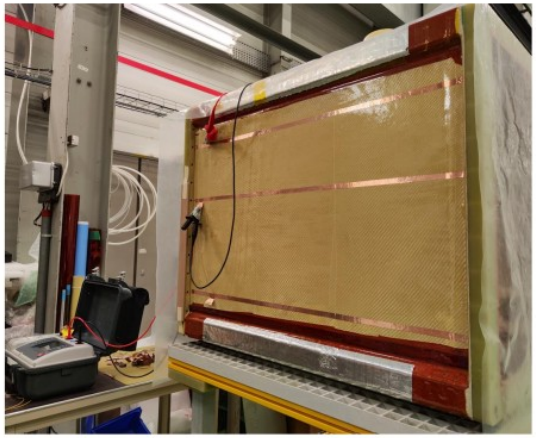


Current finds alternative path:
form strips at Anode side trough Kapton,
then across a low resistivity layer buried underneath Kapton,
then back to strips at the Cathode side

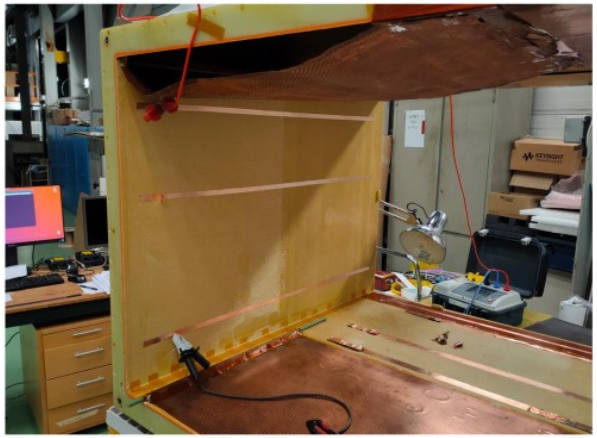
Twaron surface resistivity – FC0 inner / outer layer

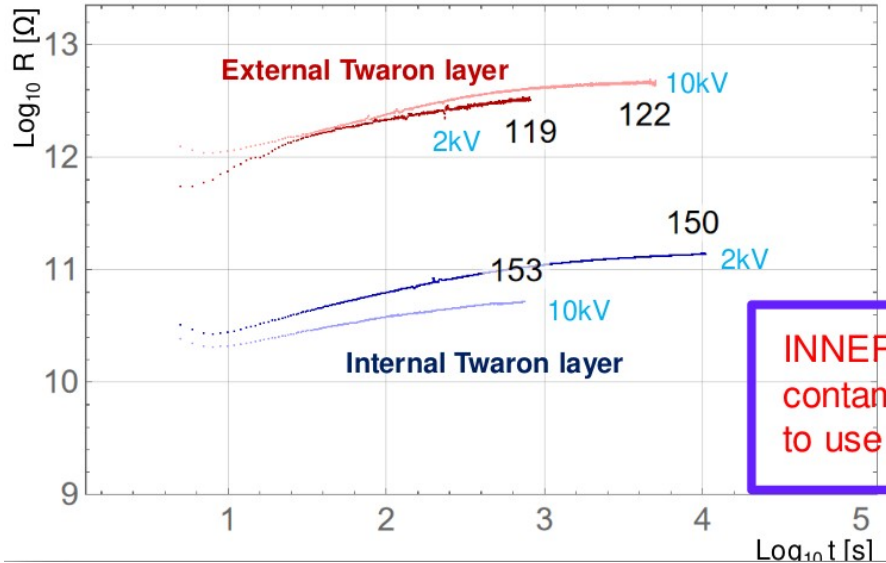
G. Collazuol

External Twaron layer



Internal Twaron layer





Conclusions

Large resistivity difference between Inner and outer Twaron by factor ~ 50

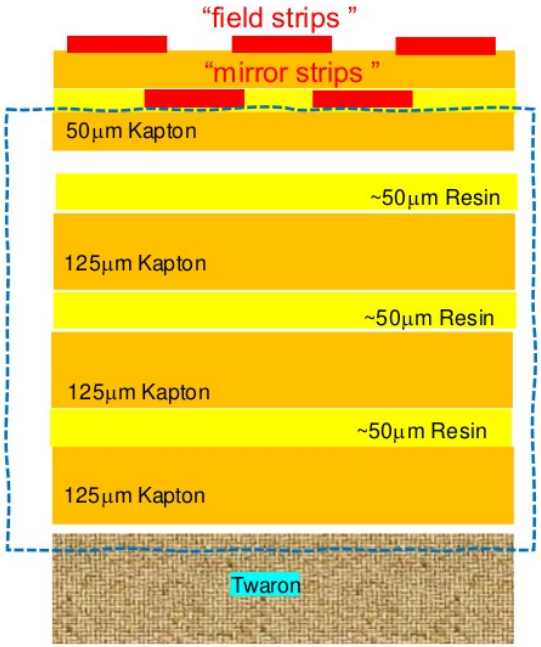
INNER TWARON LAYER CORRUPTED contaminated at NEXUX company due to use of Antistatic Spray (resistive !!!)

Adopted Solution for new F.Cages

G. Collazuol

Key points to avoid failures

- No resin contamination !!!
- Interpose between strips and Twaron layers a "thick" layer of insulator featuring
  - High resistivity $\rho_v > 10^{15}$ Ωcm
  - Dielectric strength > 150kV/mm



Layout of next cages: minimal changes to design

- new strip foil w/ coverlay 50μm Kapton + 25μm glue (produced at CERN, gluing in vacuum with press)
- 3x layers of Kapton: 125μm + 50μm resin each (to be applied on the back of strip foil on the mold)

→ thickness Kapton+Resin ~0.5mm → "vertical R" below 1 strip O(10TΩ) @ 10kV

Materials: Same insulating materials (Kapton + Aramide) and same resin (Resoltech)

Production procedure

- drying Kapton just before use
- proper control of mixing and de-gasing process (new mixing / degassing tools and QC)
- … avoid antistatic spray…

New Field Cage (FC1) HV tests at NEXUS

G. Collazuol

1) Direct measurement of "extra-currents "

Two large electrodes made by connecting10 Mirror strips

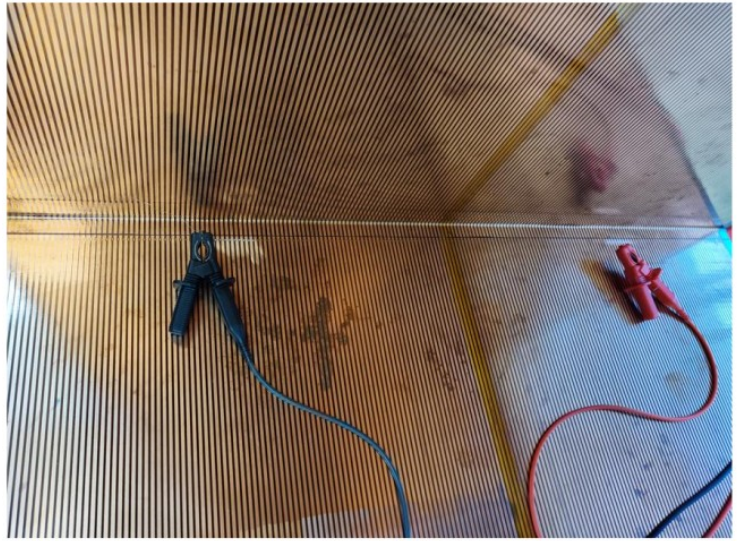
Voltage applied and current (and R) measured with Megger instrument

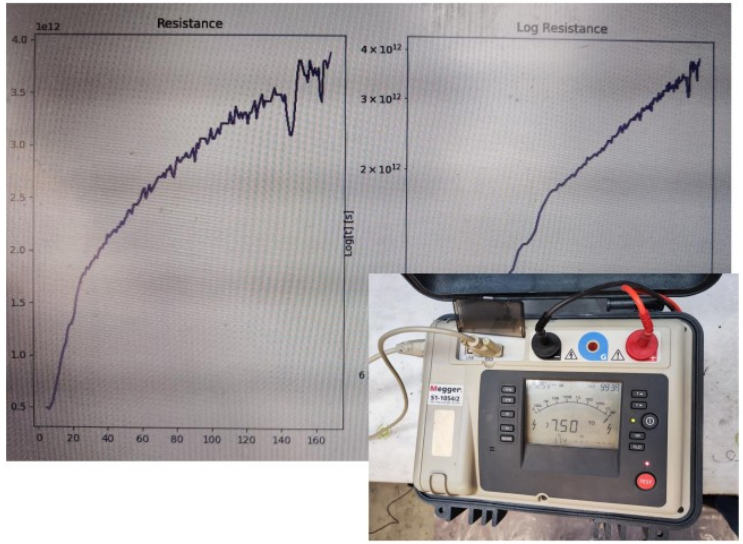
@ 2kV measure R > 3 TΩ on FC1
(no plateau → no conduction current)
Same configuration resulted in R ~ 30GΩ on FC0

@ 2.5kV measure R > 7.5 TΩ

Summary:
"extra-currents" in FC1 are more than x100 smaller in FC1 than in FC0

Note: in FC1 measured currents are so small that contribution of currents above Kapton surface are non negligible, so for FC1 we can only set a limits on measured R and evaluate conduction (ie asymptotical) "extra-currents" at a level well below 100pA





HV ISSUE SOLVED for 2nd Cage (FC1) and further

HV tests successful: no extra-currents & strips voltage properly degraded towards outside
- HV issue we had on FC0 fully understood
- Solutions for avoiding it successf

Paper about this tricky subject & HATPC episode is almost ready

This work was successful THANKS to the discussions, help and support involving many colleagues and experts, namely and in random order:

- The whole HATPC group (personal comment: great environment in this Team !!!)
- Bernat Calpe` and the team dedicated to building our FCs at NEXUS
- Rui De Oliveira and colleagues at the CERN MPGD Lab
- Davide Tommasini, Cedric Urscheler, Sebastien Clement and Roland Piccin and colleagues at CERN PolymerLab

Special support from INFN was very much appreciated and acknowledged

Assembling the first HATPC with FC#1 and FC#2

G. Collazuol

FC1 delivered at CERN Feb 20th 2023
FC2 delivered at CERN June 8th 2023

Per each Field Cage (corresponfing to ½ HATPC) we perform validation tests and characterization at CERN

- Cleaning surfaces & Insulation tests
- Voltage dividers setup & HV tests
- Gas Tightness tests
- Cathode assembly
- Mechanical characterization & Metrology
- Detectors Assemply (Micromegas)
- Inner Volume and Surfaces (moisture) purging with Ar gas (very long time to dry inner Kapton surfaces from water …)
- Fluxing w/ T2k Gas mixture
- Characterization & Commissioning with Cosmic Rays at CERN

Example - Voltage divider (2 in parallel)

G. Collazuol

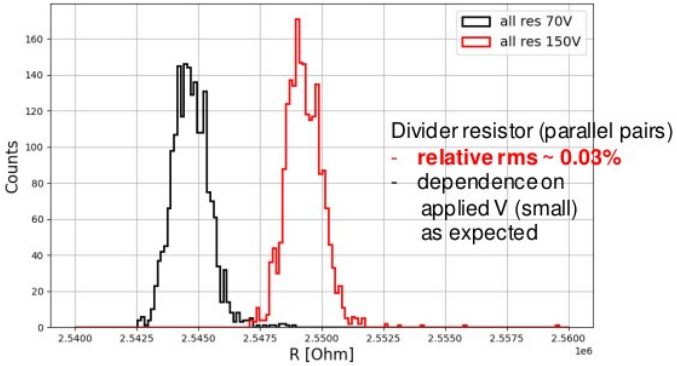
- Soldering 200 resistors on divider #1

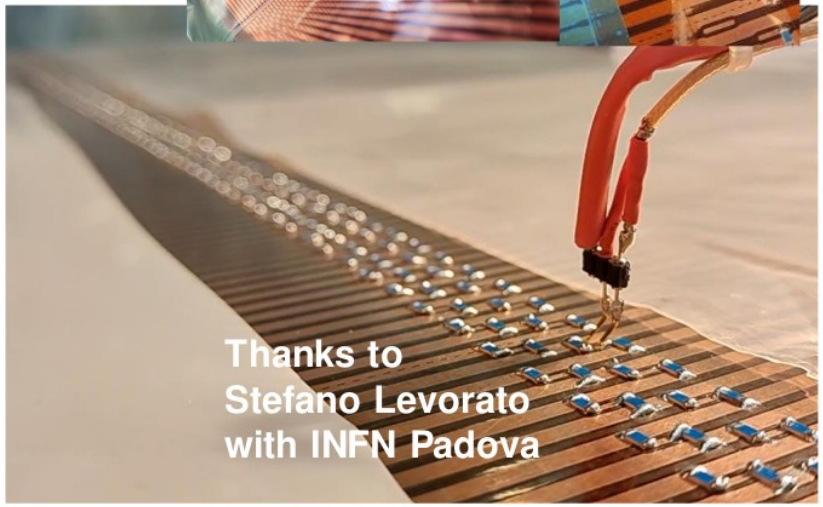
  New soldering procedure – ensuring clean Kapton underneath resistors

- Cleaning
- Measuring resistors (single resostors) @ HV

  R selection for minimizing rms
- Soldering 200 resistors on divider #2
- Cleaning

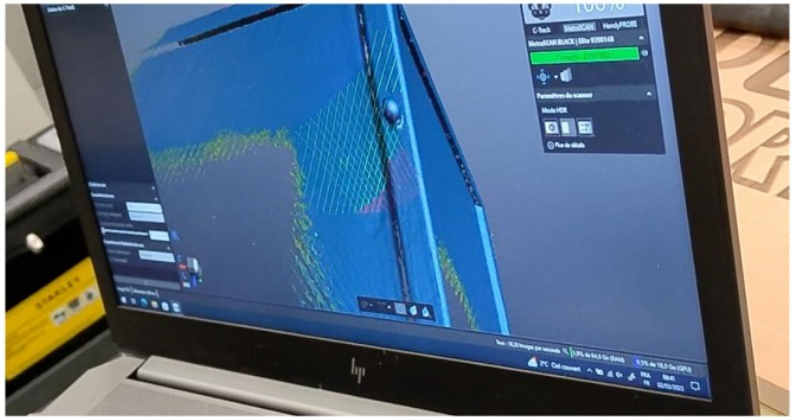
- Measuring resistors (parallel of 2 resistors)

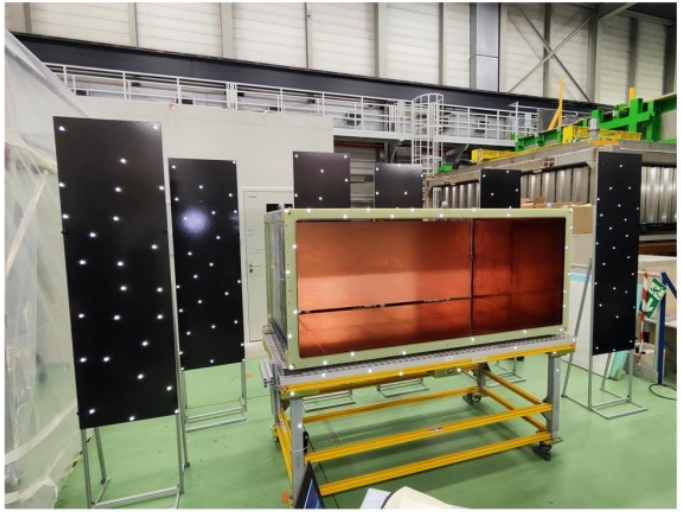




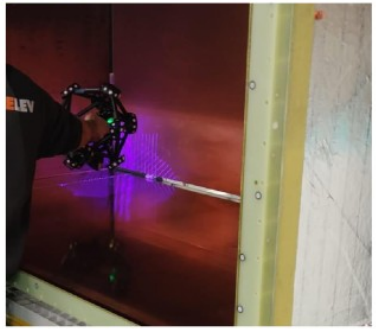
Metrology at CERN

G. Collazuol



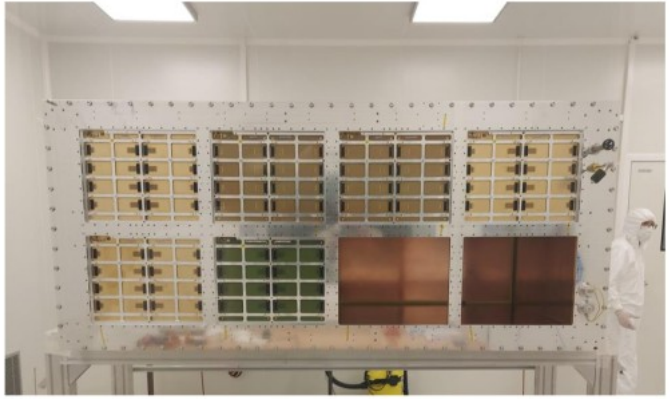


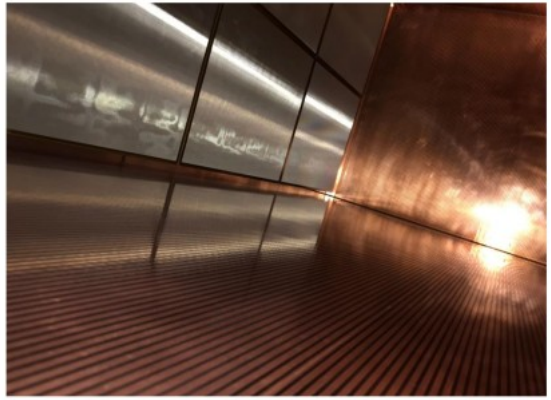
Full 3D (4π) laser scan
of whole cage including cathode
with 30um accuracy

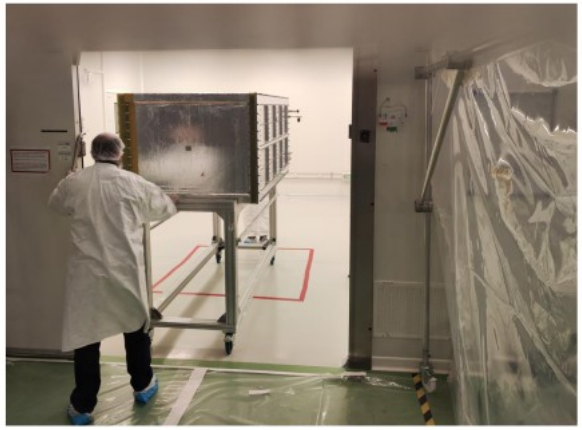


First ½ TPC – ERAM assembly in clean room

G. Collazuol







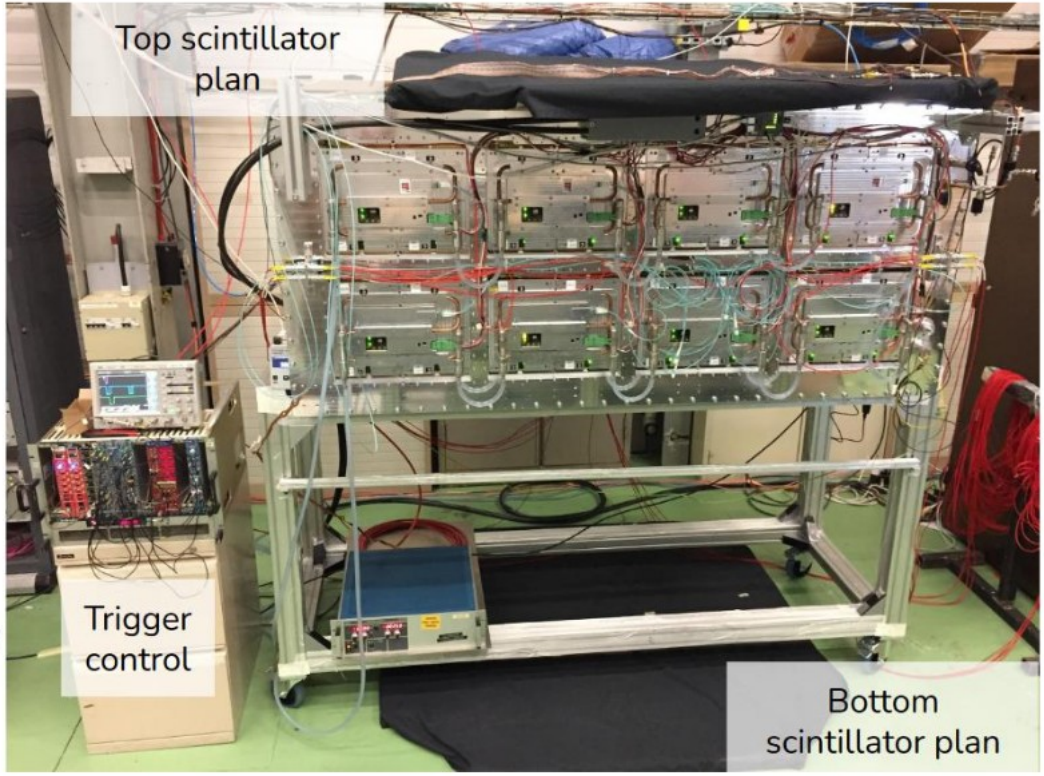
Next phases

- purge with Argon
- O2 and H2O monitoring
- study of surface degassing
- ERAMs and Electronics power up soon
- Then commissioning w/ Cosmic Rays for 15 days

Cosmic Rays setup - first tracks w/ FC1 only (1/2 TPC)

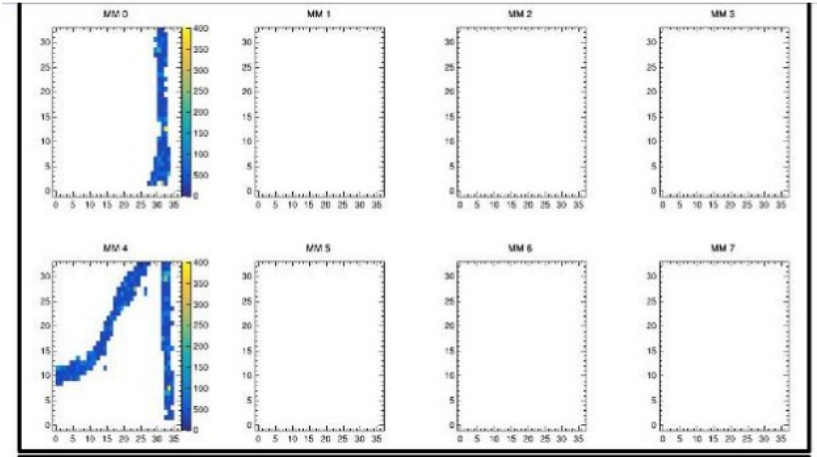
G. Collazuol

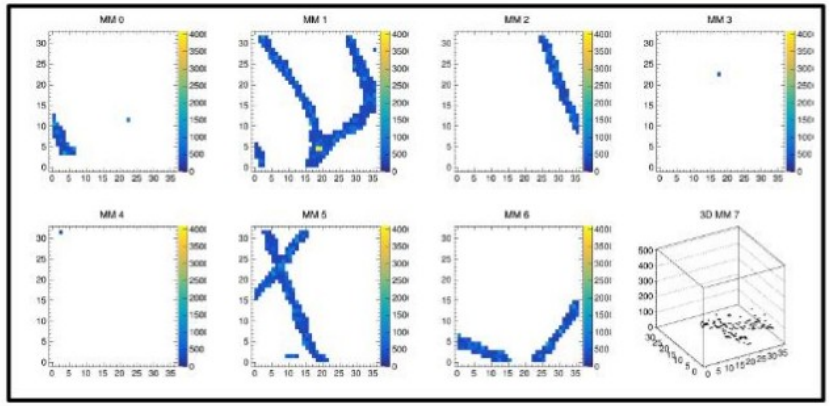
- Trigger: 2 scintillator plans (with 2 PMTs each)
- Current setup: Coincidence between the 4 PMTs
- Threshold: -30 mV (very low, close to electronic noise amplitude)
- Veto: 3 μs after signal to cut afterpulses
- Rate observed: 15-20 Hz
- Other setup to be tested: 1 coincidence per plan only, but with a higher threshold

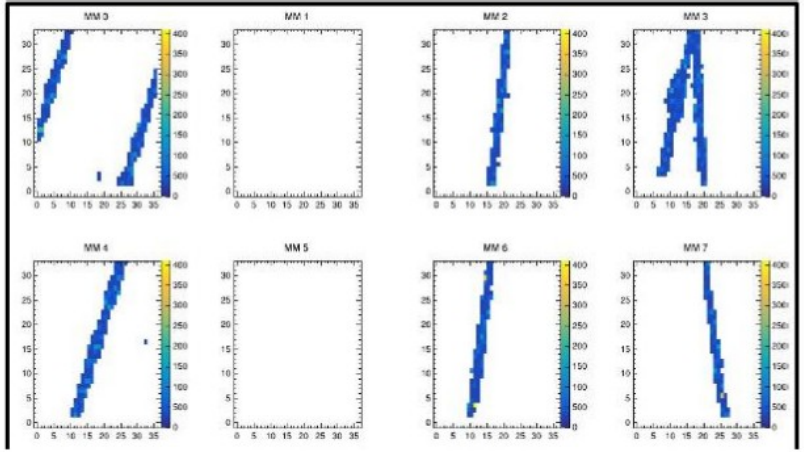


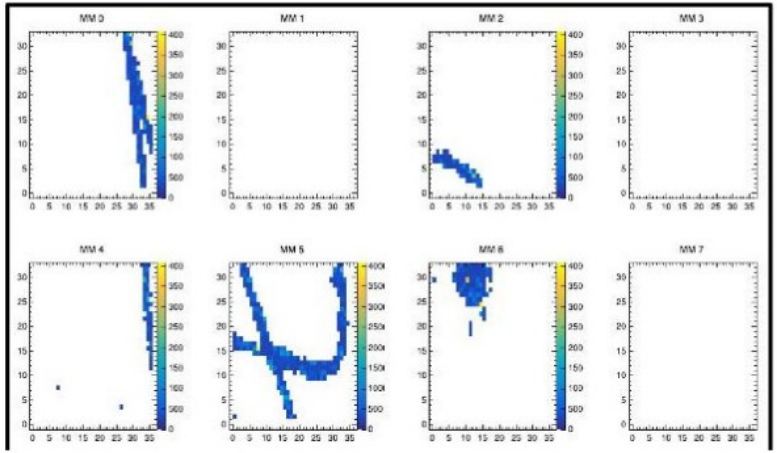
Cosmic Rays setup - first tracks with FC1 only (1/2 TPC)

G. Collazuol



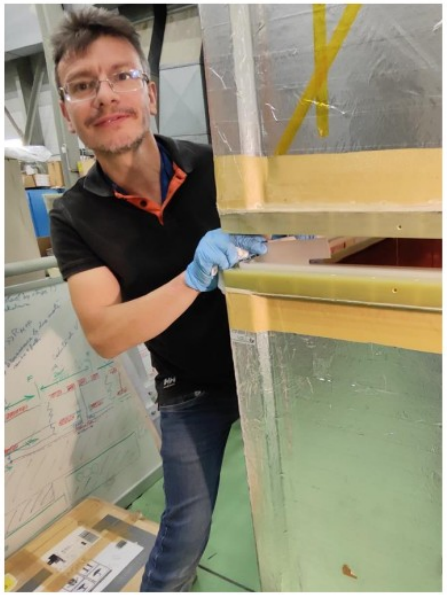


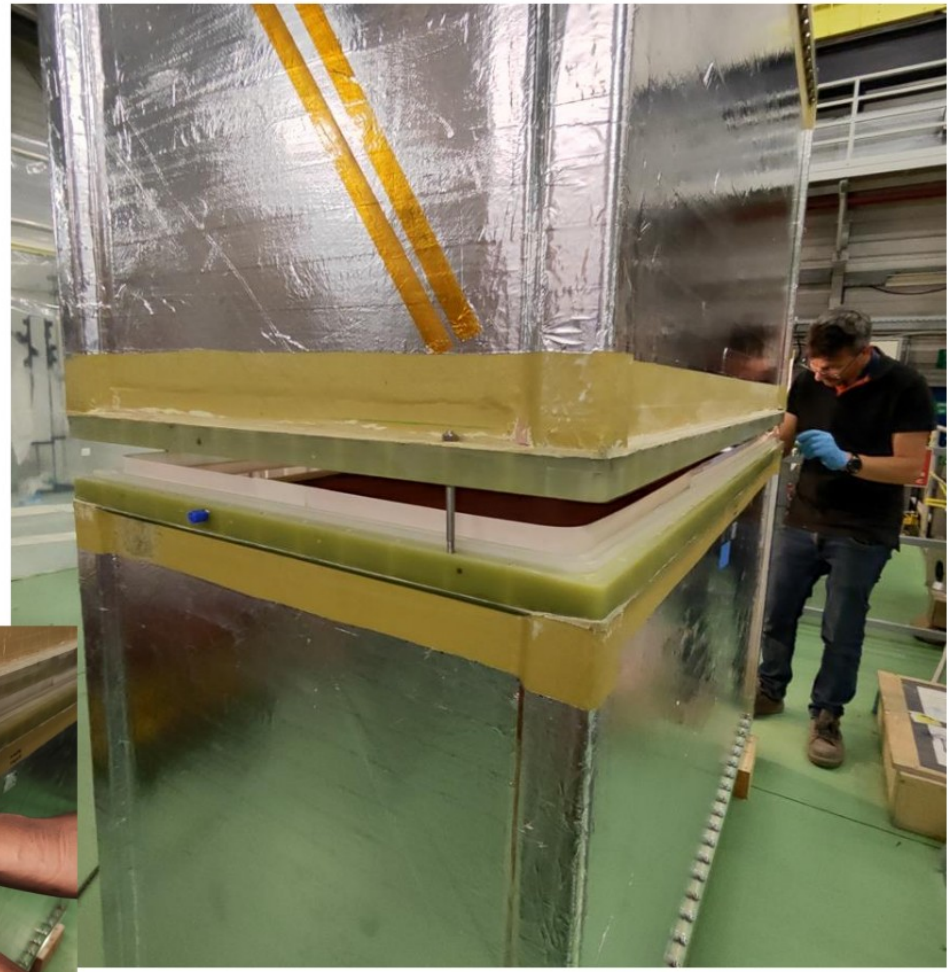




FC1-FC2 Vertical alignment and closure

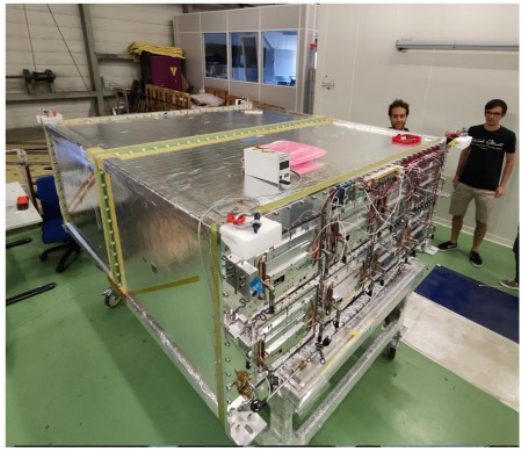
G. Collazuol





Today first full HATPC assembled with ERAMs mounted

G. Collazuol



Must underline (GC) that within the Upgrade collaboration only very few people are involved in hardware tour de force

for Padova thanks to
S.Levorato, F.Pupilli, D.D'Ago, M.Feltre

…ready for gas purge and then taking Cosmics data

HATPC Next Steps in the Timeline

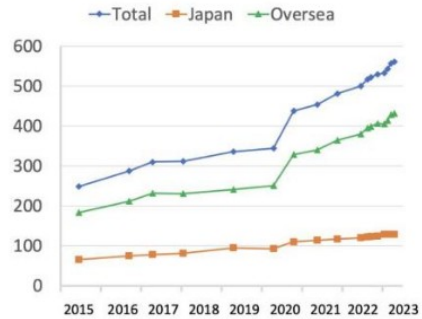
- Bottom HATPC Commissioning at CERN – July 2023
- B-HAPTC Shipment to JPARC – August 2023
- B-HATPC Installation in ND280 – September 2023

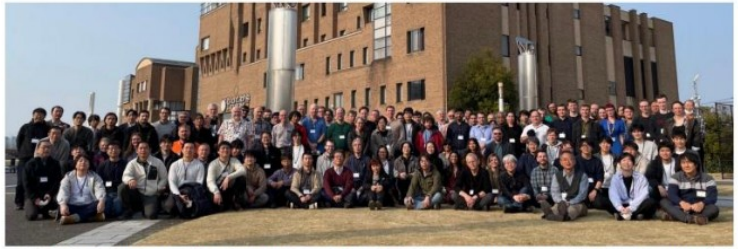
- Next Cage (FC3) for Top HATPC to be delived – Oct 2023
- FC4 to be delivered - Jan 2024
- T-HATPC shipment to JPARC – March 2024
- T-HATPC installation in ND280 – April 2024

Hyper-Kamikande Status → Approved by INFN in 2022

G. Collazuol

21 paesi, 101 istituti, ~560 collaboratori





Primo in-person meeting (Toyama, 6-11/3/2023) dopo approvazione (2020) e pandemia

Hosts: UTokyo & KEK
75% non-Giapponese
Italia ~10% Collaborazione

INFN contribution fixed 2023

	Item	Cost (K€)	Cost (K€)
mPMTs	300 mPMTs Electronic TestBench	2940 50	2990
Electronics	20" PMTs front-end Cables, feedthroughs (sharing) Timing distribution	2000 (*) 215 72	2287
	Computing (2022-26)	621	621

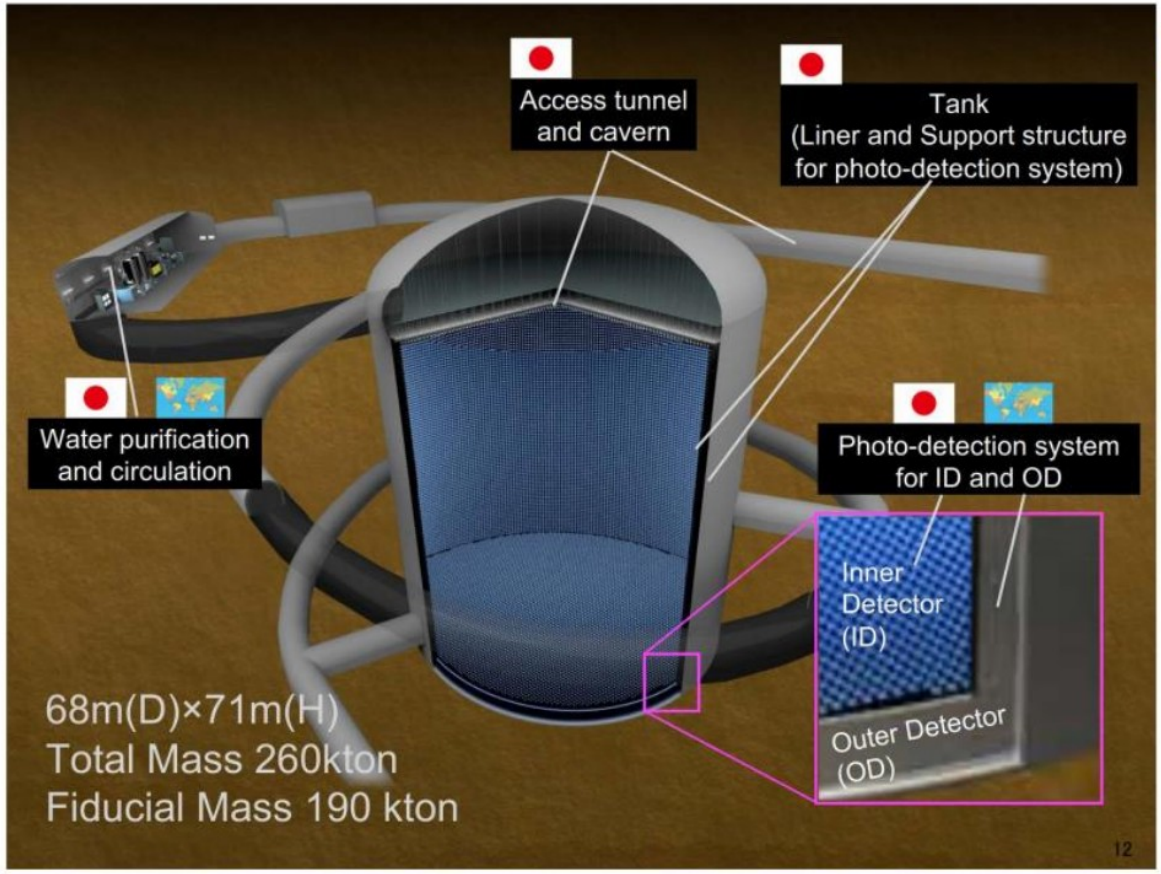
5.3(+0.7M) capital costs

+

0.6M computing

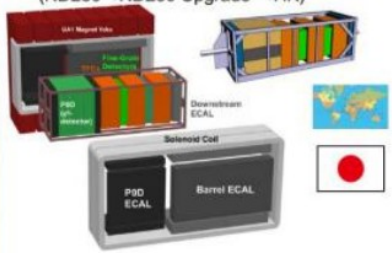
Hyper-Kamikande International contribution

G. Collazuol

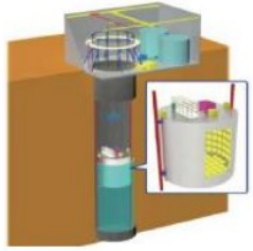


Neutrino Beam

Off-axis Magnetized Tracker
(ND280→ND280 Upgrade →HK)

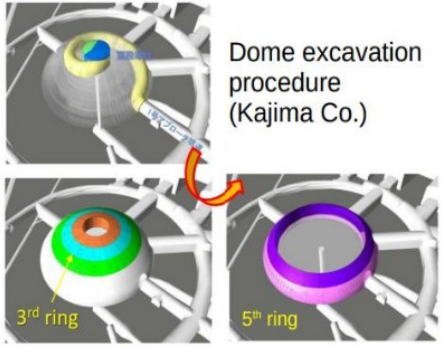


Off-axis spanning intermediate water Cherenkov detector
(IWCD)



Status Excavation → Significant Milestone

G. Collazuol

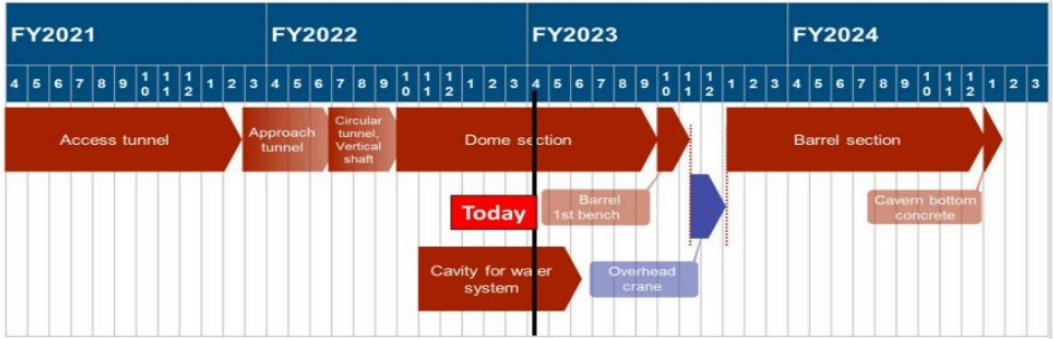


Dome excavation procedure (Kajima Co.)

Tunnels excavation completed

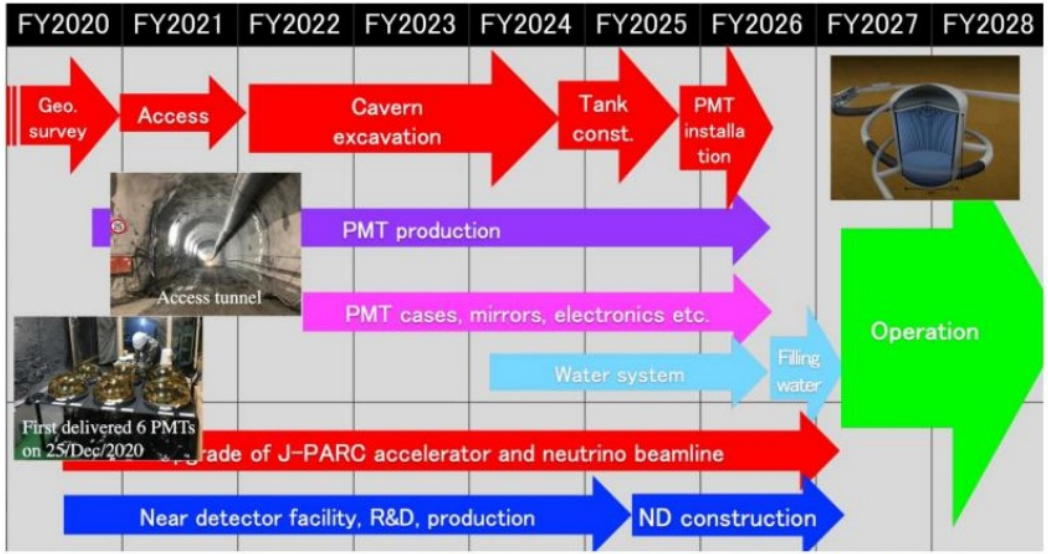
Excavation of water purification and main cavern on-going

Construction on schedule



HK Timeline

G. Collazuol

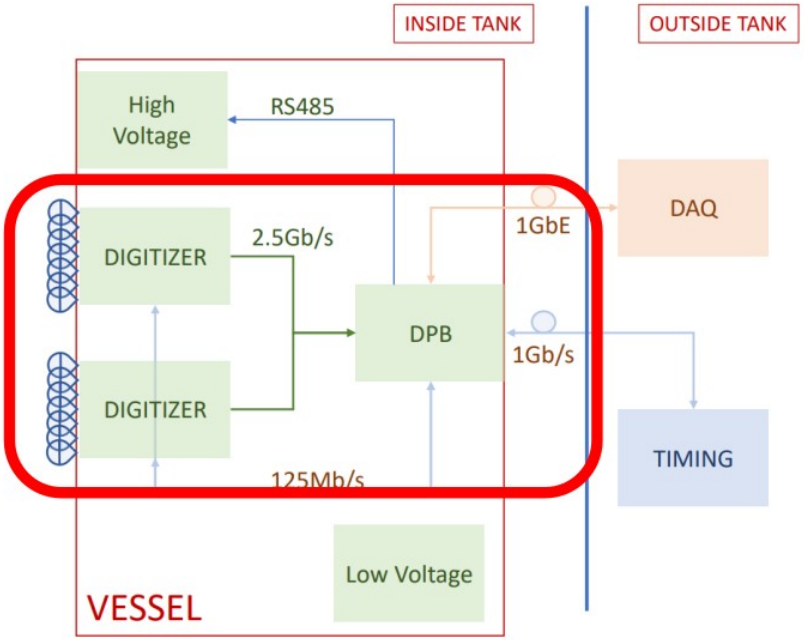


- **All detector components need to be ready for installation by end 2025**
- **Beam steadily upgraded from 500kW → 900kW(now) → 1.3MW(2027)**
- **IWCD site and detector completed for data taking**
- **ND280 transfer from T2K to HK completed and detector operational**

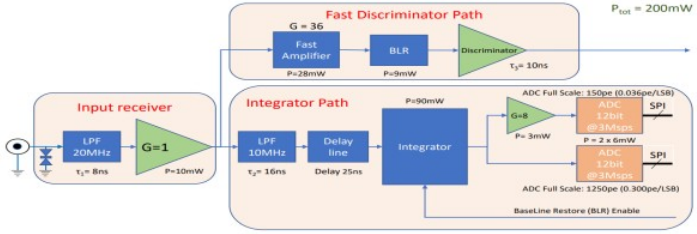
Principale impegno per INFN Padova in prossimi anni

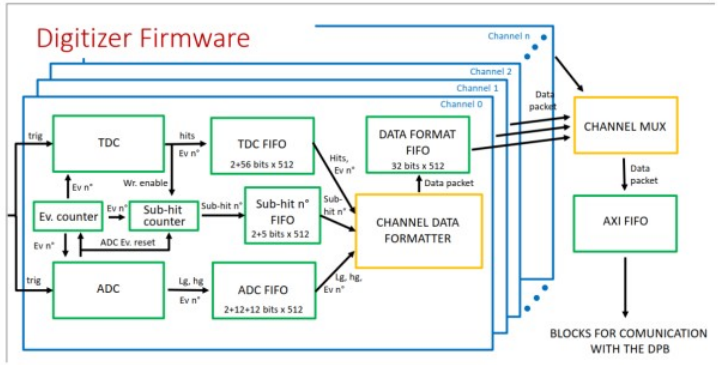
G. Collazuol

FE & Digitizer RO Electronics for ID PMTs



- The circuit is based on discrete ICs
  - Developed by NA group
- PMT input signal feeds 2 paths:
  - Integrator for CHARGE measurement
  - Fast Discriminator for TIME STAMPING
- Design uses Baseline Restore Enable technique





Anagrafica 2024

Nome	Contratto	Qualifica	%	Esperimenti
G.Collazuol	Associato	PA	80	T2K + SK + HK
M.Bellato	INFN	DR	10	HK
E.Bernardini	Associato	PO	20	HK
D.D'Ago	Associato	Assegnista	80	T2K + HK
S.Levorato	INFN	Tecnologo	40	T2K + HK
M.Feltre	Associato	Dottorando	80	T2K + HK
M.Grassi	Associato	PA	60	T2K + HK
M.Laveder	Associato	RU	80	T2K + HK
A.Longhin	Associato	PA	40	T2K + HK
M.Mezzetto	INFN	DR	80	T2K + HK
M.Mattiazzi	Associato	Dottorando	20	SK + HK
M.Pari	Associato	Assegnista	60	T2K
F.Pupilli	INFN	RI	60	T2K + HK
		Tot	7.1 FTE	

Preventivi gruppo PD 2024

Missioni ……. 90 k€
Apparati …….. 30 k€
Consumabile ……..…… 10 k€
Inventariabile ……..…….. 50 k€
SP-Servizi ……..… 25 k€

gare per un totale di circa 600 kE per parti meccaniche di HK

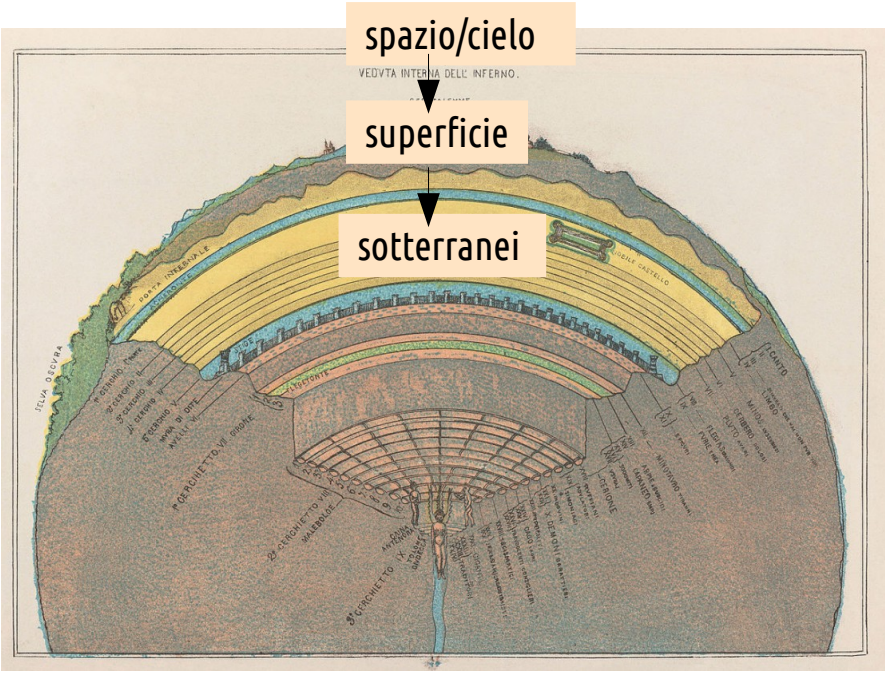
Richieste Servizi Sezione 2024

Servizi Tecnici ed Elettronici
- Test elettrici e assemblaggio mPMT per HK – attivita` a Napoli/Caserta ~ 1 m.p.

Servizio Elettronica
- Test boards elettronica digitale RO HK – attivita` al CERN ~ 2 m.p.

Servizio Progettazione Meccanica
- Disegno parti meccaniche per HK ~ 2 m.p.

Servizio Officina Meccanica
- Realizzazione parti per attivita' T2K CERN e JPARC ~ 2 m.p.
- Realizzazione parti per attivita` HK CERN ~ 3 m.p.



CTA/MAGIC
FERMI
SWGO

VIRGO
ET

EUCLID

MOONLIGHT-2

QUAX

DUNE
ENUBET
ICARUS
T2K

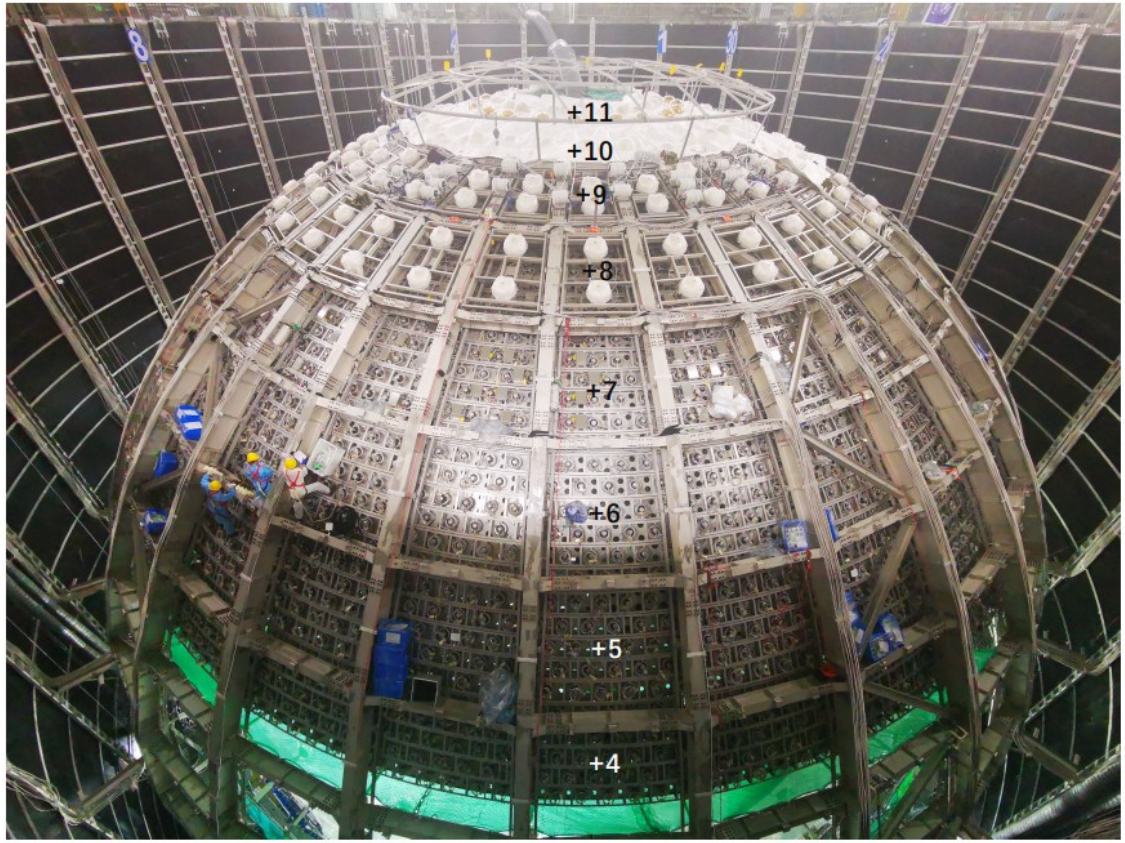
JUNO

GERDA/LEGEND
CUORE/CUPID

A. Garfagnini

JUNO detector. Large PMT module installation status on June 26, 2023

- Layer +4 almost finished
  (1130 out of 3460) modules installed
  4600 out of 17612 PMTs installed
- 6400 PMTs shipped to JUNO from Pan-Asia assembly facility, and 5000 successfully tested at JUNO site, before installation
- Modules assembly going on for ring N19 (last ring in window +4)



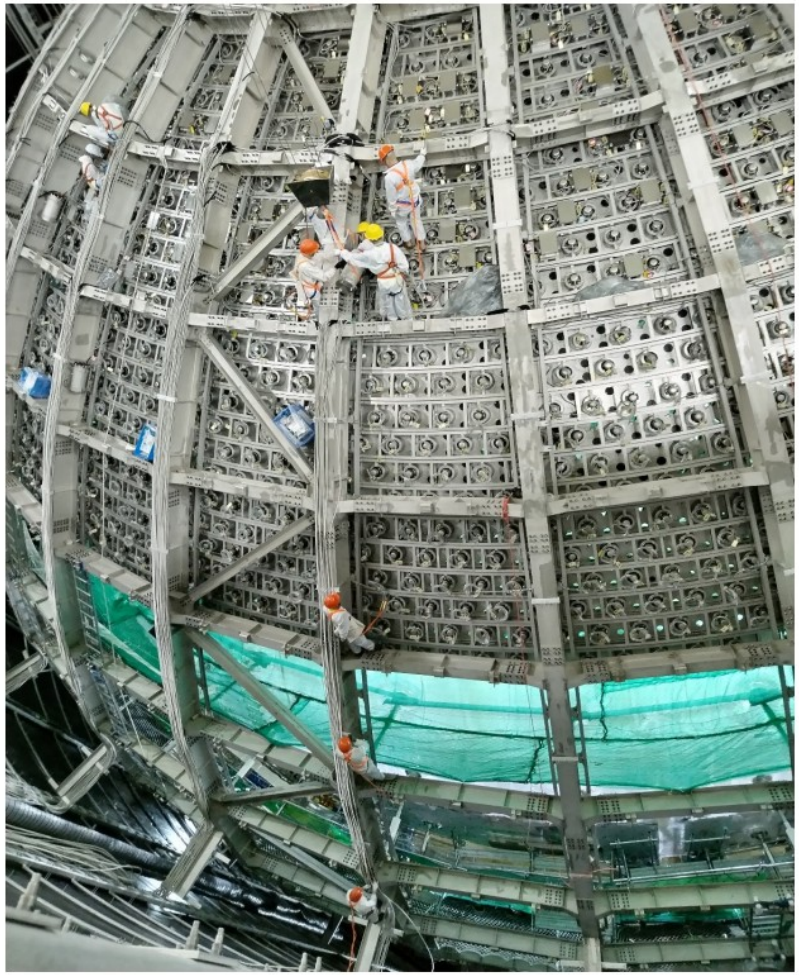
JUNO

A. Garfagnini

JUNO detector. small PMT module installation status on June 26, 2023

- Already installed ~3088/25600 (~12%),
- sPMT installation in Windows +7 - +11 finished;

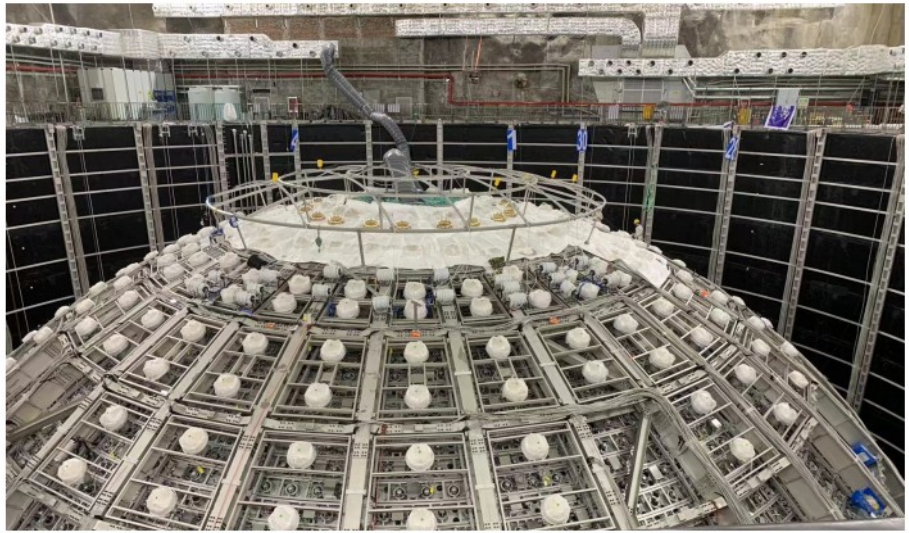
- sPMT electronics installation:
  - Finished this batch of installation, 20 UWBs.
  - Total installed 30 UWBs (~15%).



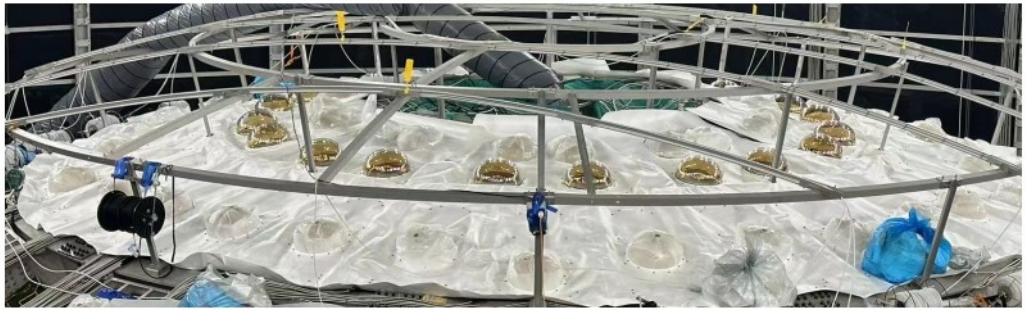
A. Garfagnini

JUNO detector. VETO PMts modules installation - June 26, 2023

- Veto module and PMT
  - Finished veto modules +11 layer, +10 layer, +9layer , +8(29windows) layer , +7(24windows) layer installation;
    - 123 modules , 256 veto PMTs (tot 2400 veto PMTs), 60 veto electronics ;
- Tyvek film installation
  - +11 layer, +10 layer, Tyvek installation finished.



Tyvek layer installation



A. Garfagnini

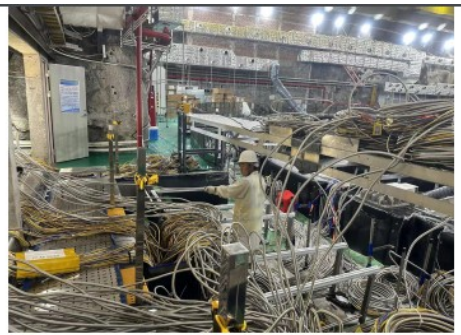
Large PMT Electronics installation

- Testing approximately 40 Under Water Box (containing the electronics) per day
- About 1040 (out of 7000) have been completed and all have passed the test

- Central Detector (CD)： 929
- VETO： 80
- Backup： 31

- The electronic boxes required for the layers +12, +11, +10, +9, +8 and +7 are tested and are being installed in July.

A. Garfagnini



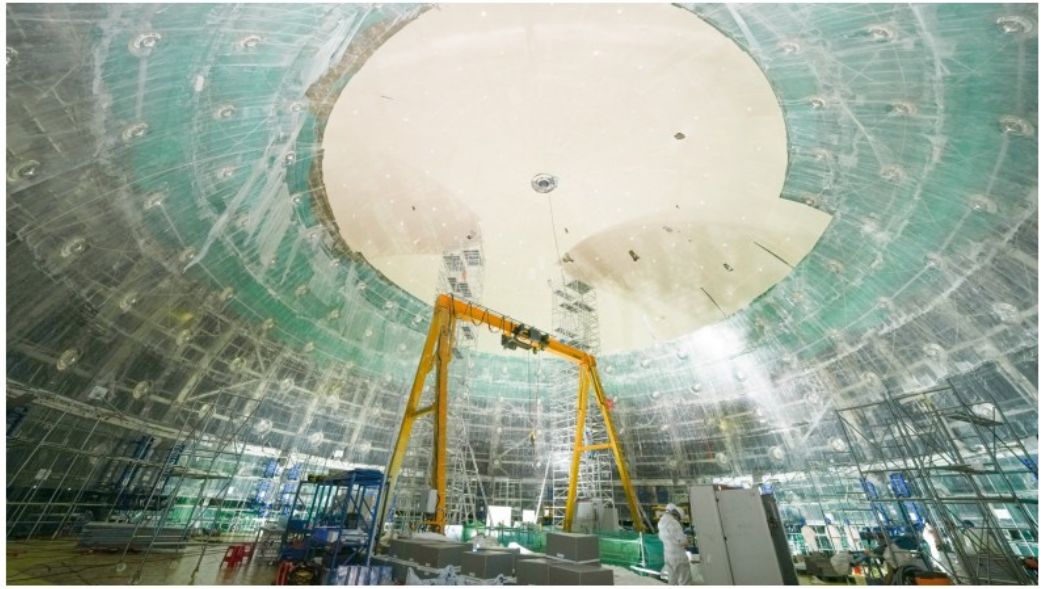
Large PMT Electronics installation: electronics room

- After installation, each Under Water Box (UWB) must pass a leak detection test and a full electronic testing.
- The long bellows (holding the CAT5 and power cables) needs to be cut.
- Each cable is properly labelled and connected to the proper module:
  - (LV Power Supply
  - network switchs (DAQ connection)
  - Back End Card (trigger and clock)

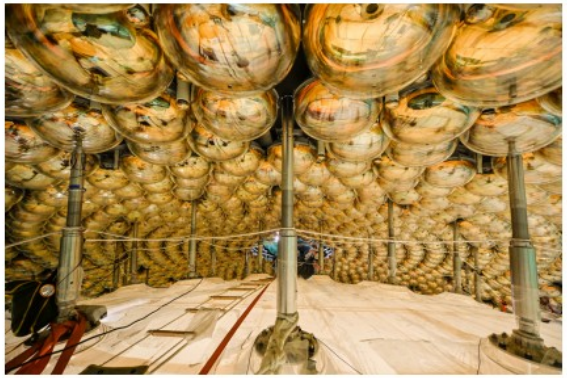
- It takes few days to install all the cables
- Finally, a global and extensive test is performed

JUNO

A. Garfagnini

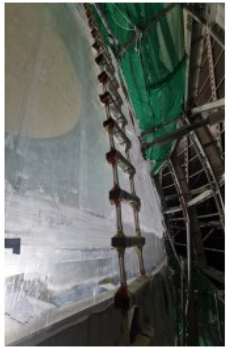


JUNO inner acrylic vessel installation



Auto-sanding machine

Cleaning inner surface



Rope ladder outside

Scaffolding inside

A. Garfagnini

Attività di Padova per il 2024

- Partecipazione ai turni di installazione dell'elettronica nell'esperimento
- Partecipazione al commissioning dell'esperimento durante riempimento

- Studio della risposta dei rivelatore: ricostruzione dell'energia e del vertice con metodi di Machine Learning

- Studi di sensibilità sui parametri di oscillazione dei neutrini

- Test di lunga durata con l'apparato mini-JUNO a LNL e calibrazioni con nuove sorgenti alfa

JUNO

A. Garfagnini

Anagrafica

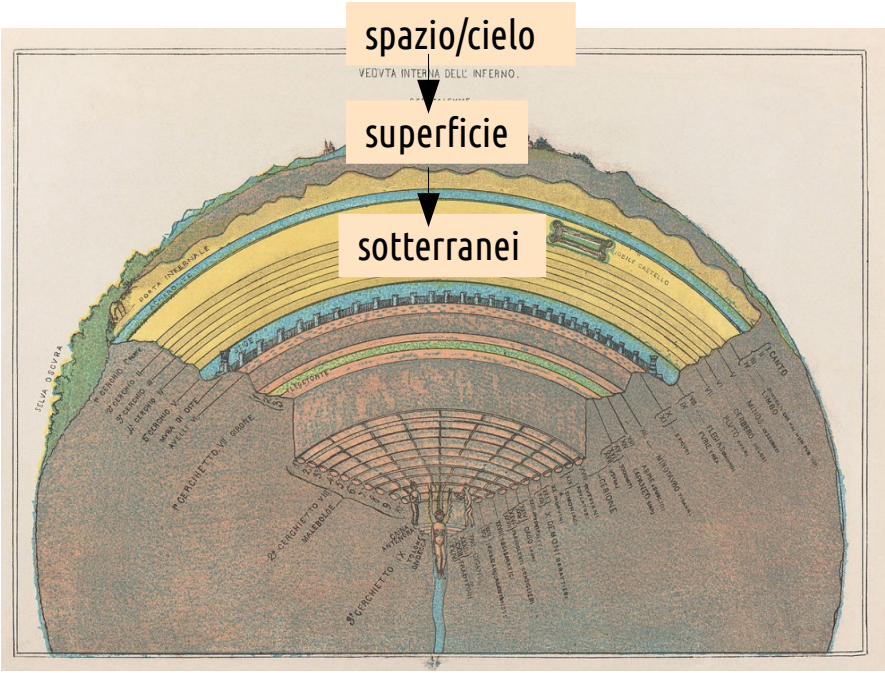
Brugnera R.	PA	30%
Garfagnini A.	PA	70%
Lippi I.	Ric. INFN	40%
Grassi M.	PA	40%
Serafini A.	Assegnista UniPD	100%
Jelmini B.	Dottoranda	100%
Gavrikov A.	Dottorando Marie Curie	100%
Stanco L.	Dirigente INFN	10%
Sirignano C.	PA	30%
Dusini S.	I Ric. INFN	20%

Richieste servizi Sezione

Off. Meccanica	0.5 m.u.
Prog. Meccanica	1 m.u
Off. Elettronica	0.5 m.u.

Richieste Finaziarie

Missioni	90 kEuro
Consumo	2 kEuro
Inventario	5 kEuro



CTA/MAGIC
FERMI
SWGO

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QUAX

DUNE
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ICARUS
T2K

JUNO

GERDA/LEGEND
CUORE/CUPID

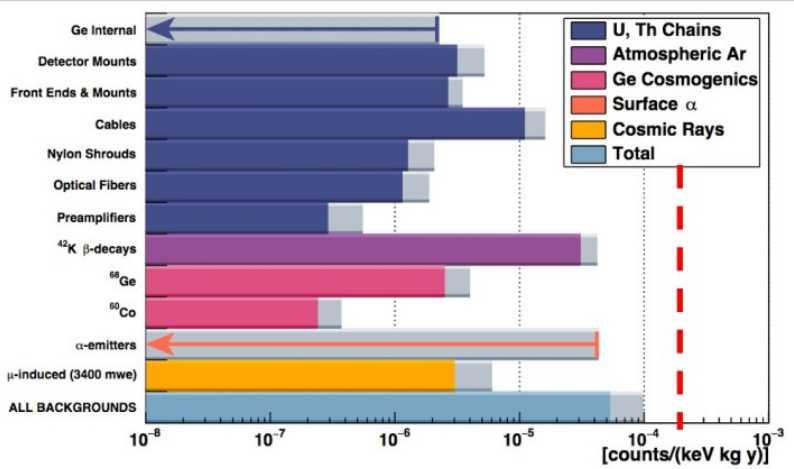
LEGEND 200

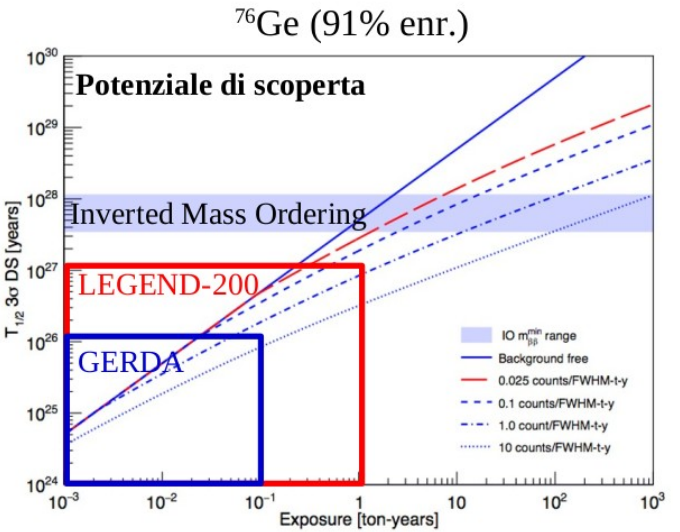
R. Brugnera

A. Longhin

LEGEND-200: obbiettivi

R. Brugnera





Background Index di LEGEND-200

Riduzione di un fattore 2.5 rispetto allo stato dell'arte raggiunto da GERDA

LEGEND-200 ricercherà 0νββ fino ad una sensibilità di scoperta massima di 10^{27} yr

LEGEND 200

verso il data-taking di LEGEND-200

- commissioning delle varie componenti (LAr veto interno ed esterno, diodi a Ge, FE elettronica, ...)

Maggio 2022

- LEGEND-60: 60 kg di rivelatori a Ge con LAr veto completo. Ulteriori tests e primo data-taking per ~1 mese

Ottobre 2022

- LEGEND-60: smontaggio
- **LEGEND-200:** 101 rivelatori a Ge per un totale di circa 140 kg

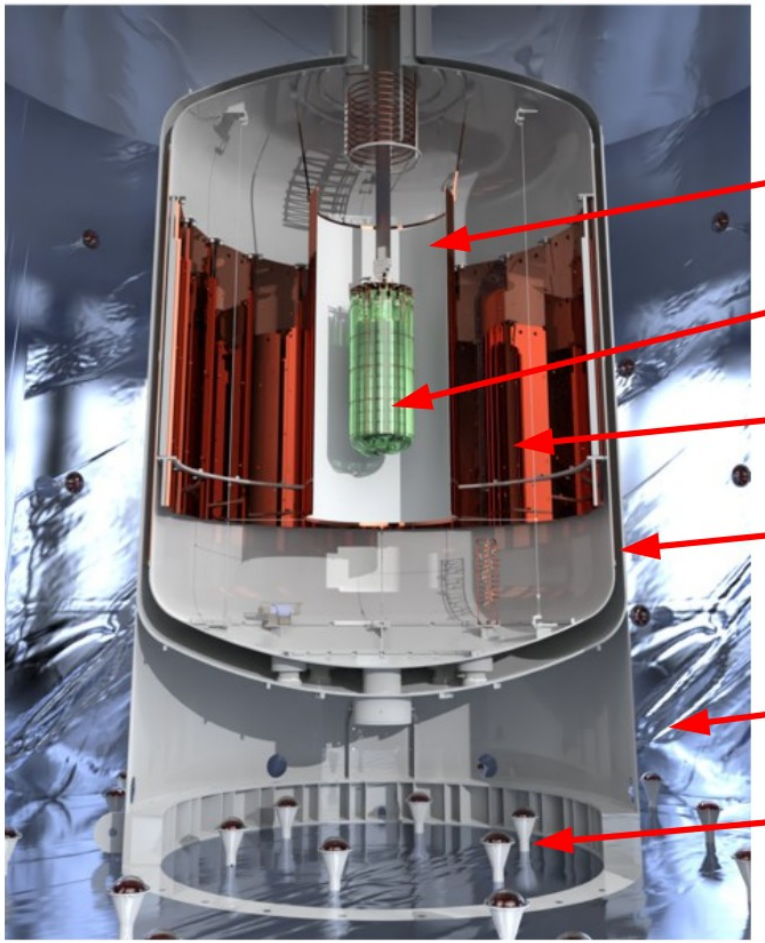
Dicembre 2022

- LEGEND-200: tuning di vari parametri (HV, LV, sequenza di calibrazione, studio di un trigger con solo LAr veto, studio delle rates, pole zero correction, miglioramenti del DAQ)

Marzo 2023

- LEGEND-200: **inizio presa dati**

LEGEND-200: aspetto generale

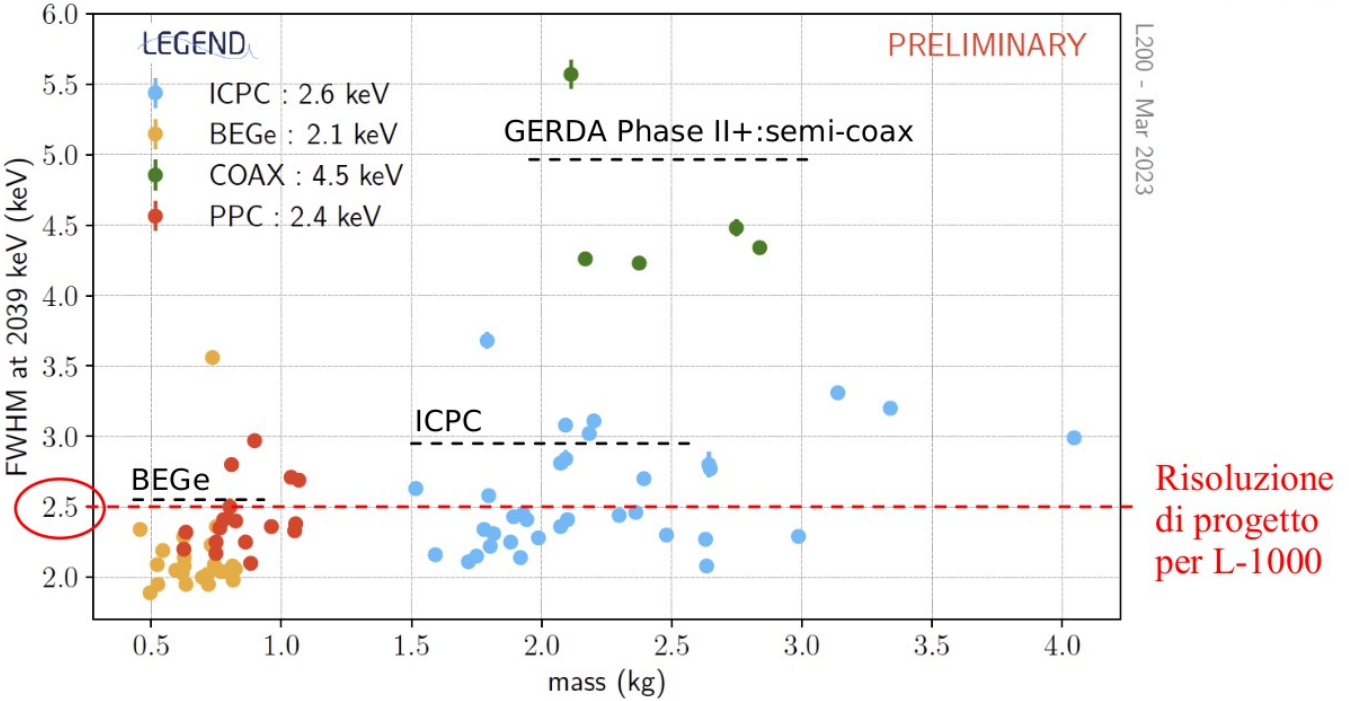


Stringhe di rivelatori

- Disposizione dei 101 rivelatori a germanio in 10 stringhe per un totale di 142.5 kg
- Al momento solo **83** funzionano bene, per una massa totale di **122.4 kg**

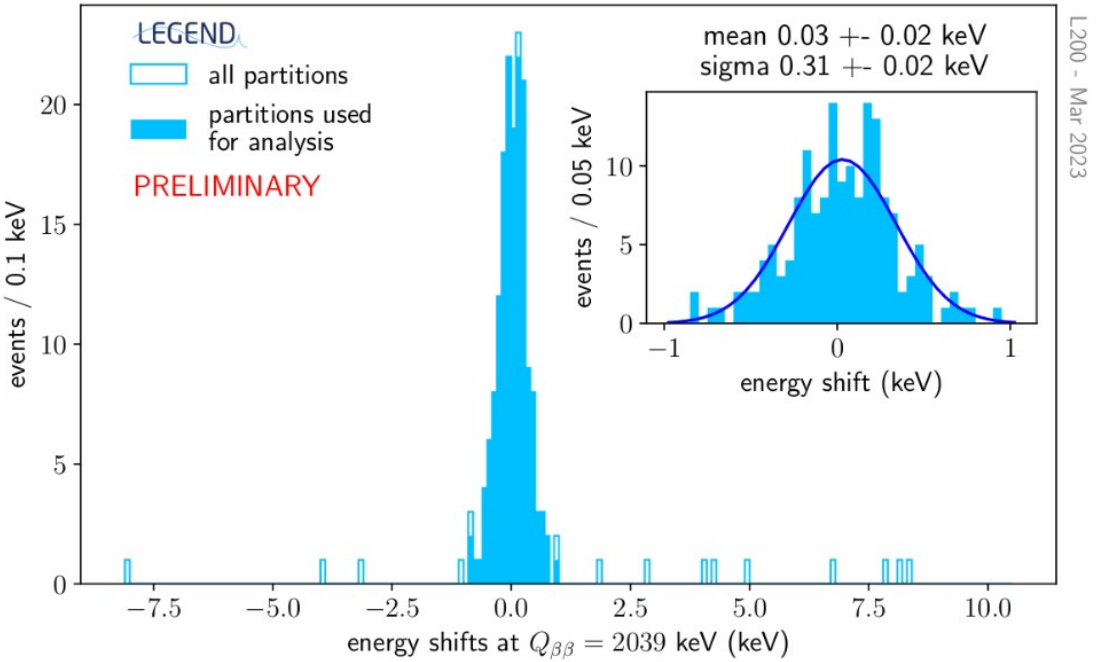
LEGEND 200

Risoluzione energetica al $Q_{\beta\beta}$



- Risoluzione energetica (FWHM) estrapolata al $Q_{\beta\beta}$ dei rivelatori a Ge in funzione della loro massa
- 56 rivelatori hanno FWHM migliore di 2.5 keV

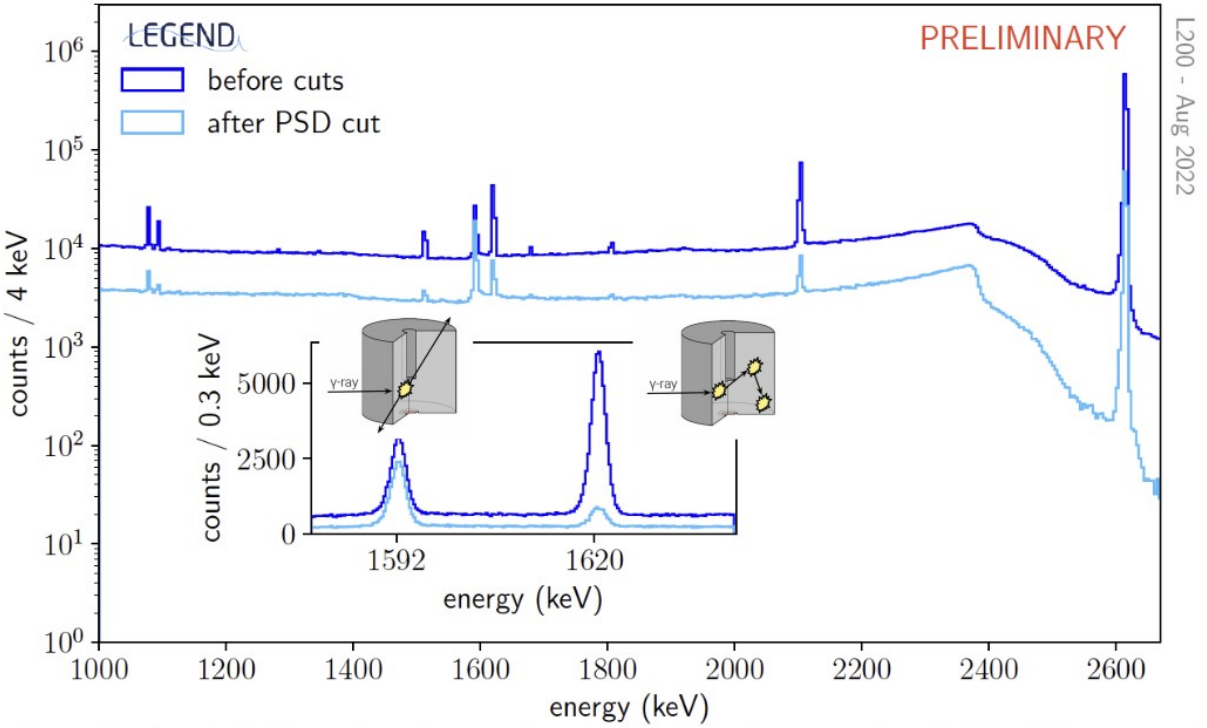
Stabilità della scala energetica



- Shifts della scala d'energia al $Q_{\beta\beta}$ tra calibrazioni successive < 0.3 keV
- L'istogramma vuoto mostra il comportamento di tutti i rivelatori
- L'istogramma blu il comportamento degli 83 rivelatori utilizzati nell'analisi

LEGEND 200

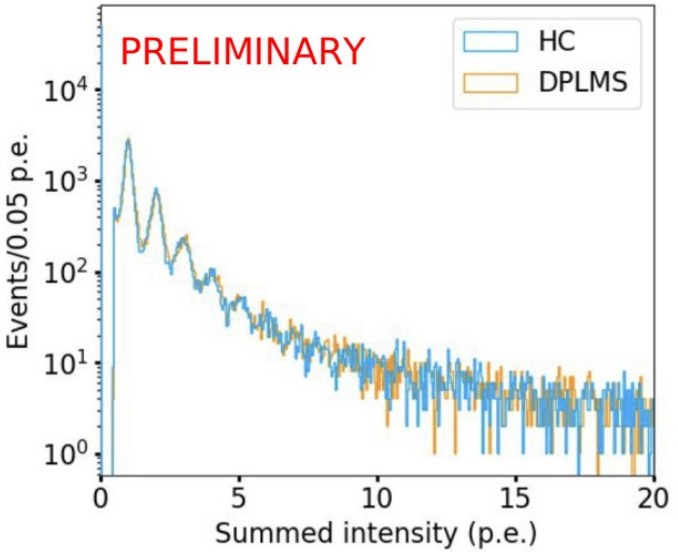
Pulse Shape Discrimination



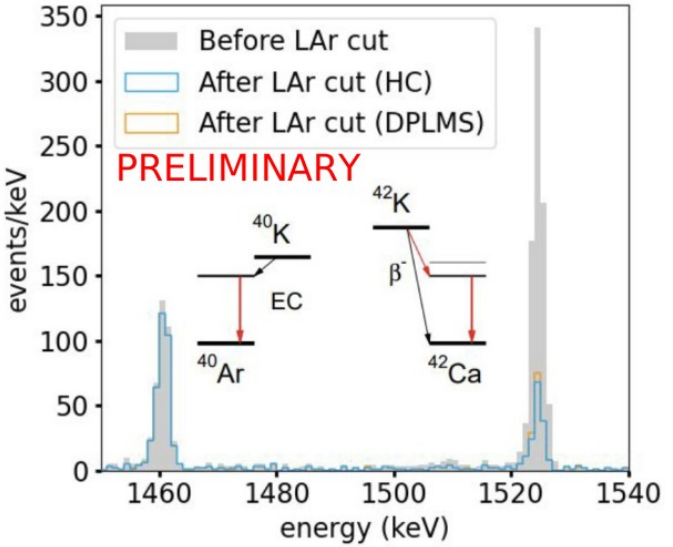
- Studi preliminari della pulse shape discrimination (parametro A/E) utilizzando i dati di calibrazione.
- I BEGe e ICPC soddisfano le richieste di L-200 e L-1000
- I rivelatori PPC e semi-coassiali necessitano di approfondimenti ulteriori

LEGEND 200

Primi risultati: LAr veto



Digital Penalized Least Mean Square (DPLMS)



- spettro in p.e. sommando tutti i canali
- buona calibrazione di ciascun canale

- ^{42}K altamente soppresso, molta energia nell'argon liquido
- ^{40}K non soppresso (processo di EC con nessuna energia rilasciata nel LAr)

Attività di Padova

GERDA

- analisi dati (studio contaminazione di ^{85}Kr, ricerca di superwimps, ...)
- vari duties all'interno della Collaborazione

LEGEND-200

- coordinazione e lavori sul DAQ, slow control
- coordinamento e partecipazione ai tests sui nuovi rivelatori (Inverted Coaxial) ad HADES (Belgio) con relativa analisi dei dati
- creazione dei tools di data quality dell'esperimento
- modellizzazione mediante MC della risposta del FE e della pulse shape discrimination
- partecipazione al data-taking del rivelatore (shifts)
- vari duties all'interno della Collaborazione

LEGEND-1000

- partecipazione al CD-1(coordinazione del WBS: elettronica & DAQ)
- coordinazione dei gruppi italiani coinvolti in LEGEND-1000
- partecipazione allo sviluppo del neutron-moderator

LEGEND 200

Richieste finanziarie

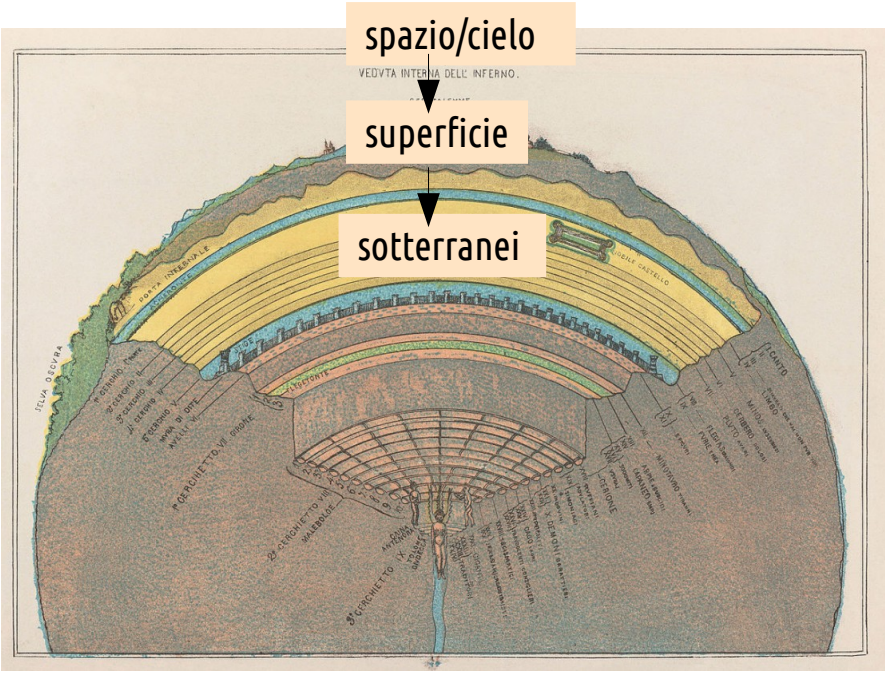
Missioni	25.0 keuro
Consumo	5.0 keuro
Inventario	19.0 keuro
Apparati	---

Richieste ai Servizi della Sezione

Officina Meccanica	0.5 m.u.
Progettazione Mecc.	5.0 m.u.
Officina elettronica	0.5 m.u.
Calcolo e reti	0.5 m.u.

Anagrafica

Bettini A.	PO	0%
Brugnera R.	PA	70%
Calgaro S.	dottoranda	100%
Garfagnini A.	PA	30%
Lippi I.	INFN	60%
Pertoldi L.	ric. estero	100%
Redchuk M.	Assegnista	40%
Sada C.	PO	60%



CTA/MAGIC
FERMI
SWGO

VIRGO
ET

EUCLID

MOONLIGHT-2

QUAX

DUNE
ENUBET
ICARUS
T2K

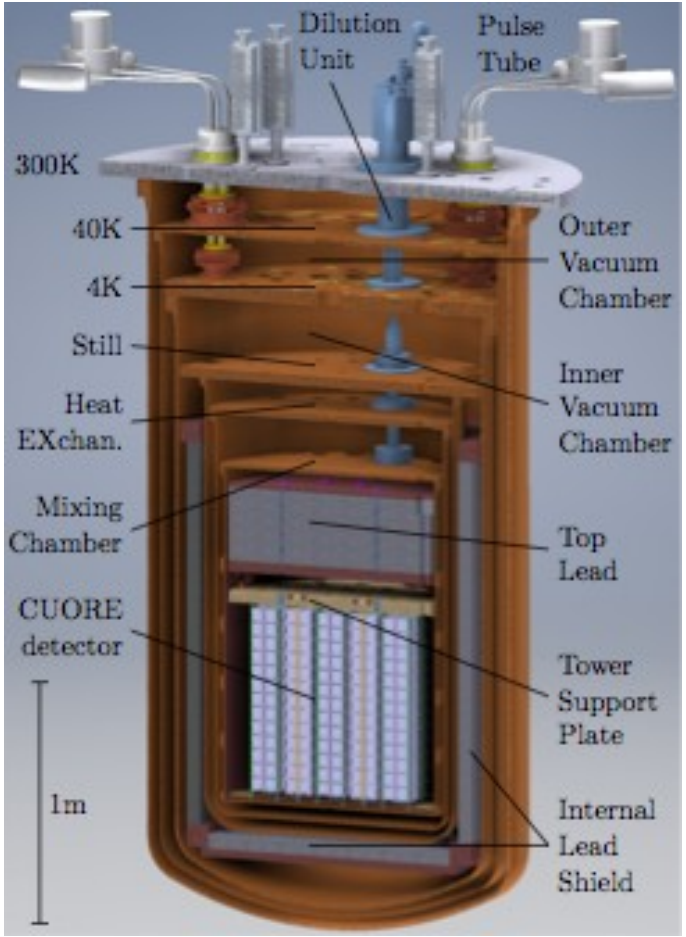
JUNO

GERDA/LEGEND
CUORE/CUPID

L. Taffarello

CUORE

Cryogenic **U**nderground **O**bservatory for **R**are **E**vents



Powerful ^{3}He-^{4}He dilution refrigerator
cooling power: 5 μW at 10 mK

Precooled by 4 pulse tubes

Cryogenic vessels and shielding:

13 t < 4 K

5 t < 50 mK

1.5 t @ 10 mK (detectors + materials)

Experimental volume ~1 m^3 a.k.a "Coldest cubic meter in the known universe"

Cooldown time ~ 1 month

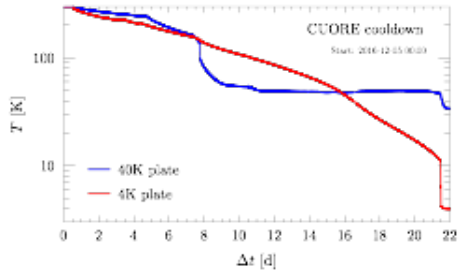
External Shielding:

- 18 cm polyethylene + 2 cm B material
- 30 cm lead

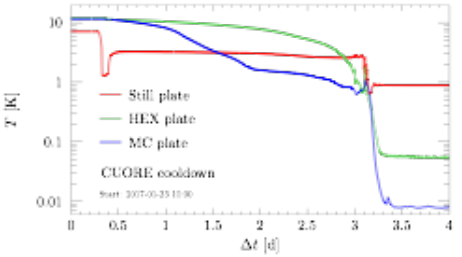
Cryogenics **102**, 9-21 (2019). arxiv:1904.05745

Cryogenics **93**, 56-65 (2018). arxiv:1712.02753

Cooldown 300K → 4K

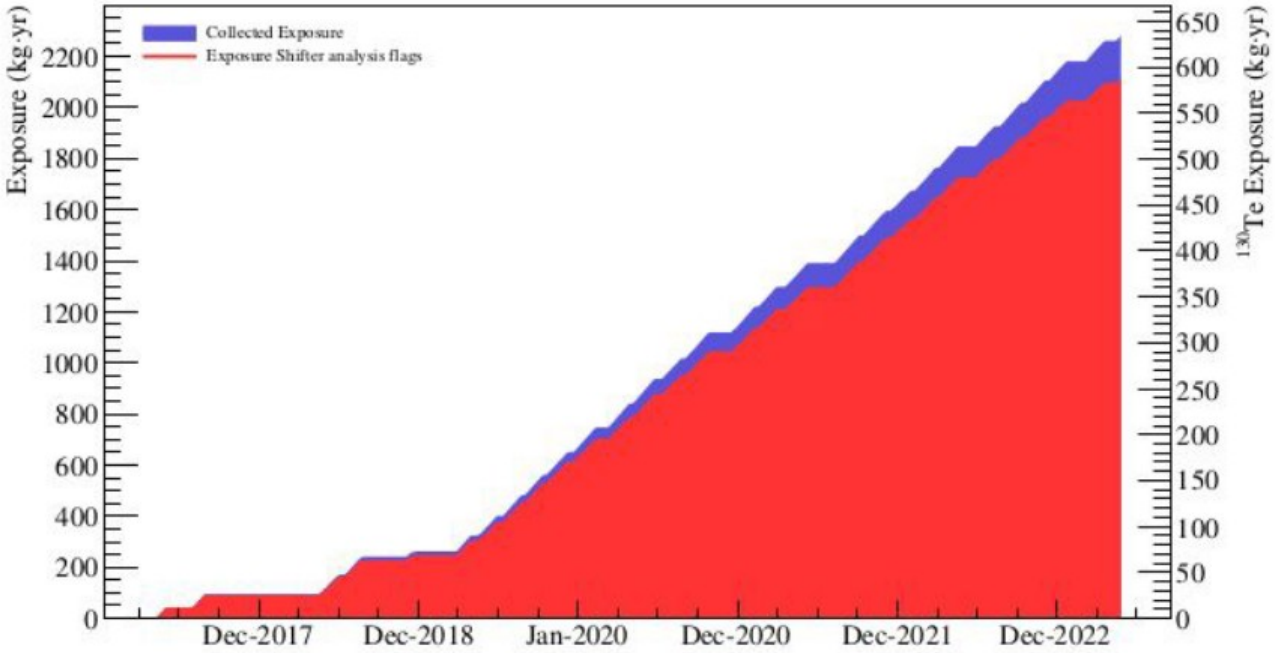


Cooldown 4 K → 10 mK

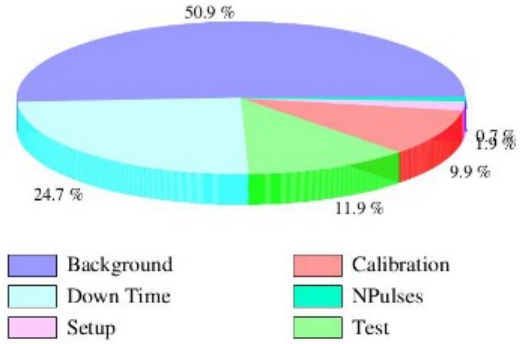


We will exploit the cryogenics for
CUPID: Cuore Upgrade Particle IDentification

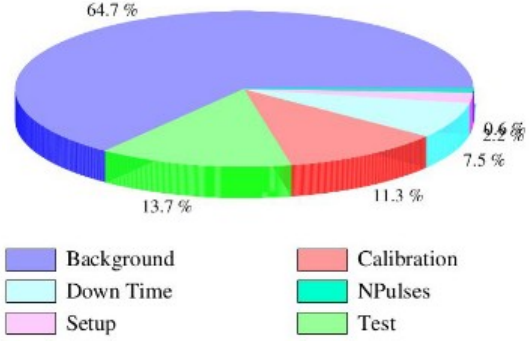
CUORE data taking



Breakdown total



Breakdown since March 2019



- Uninterruptedly cold at mK temperature since March 2019
- Collected exposure well above 2 ton × year
- Next data release planned at TAUP (2 ton x year)

CUORE plan

L. Taffarello

CUORE

- The end of the CUORE data taking (end of 2024) was decided taking into account:
  - the completion of the CUORE scientific program (3 tonne/year of TeO_2 exposure ≈ 1 tonne/year of ^{130}Te exposure)
  - the CUPID schedule
  - the decommissioning of CUORE was then integrated in the CUPID schedule
- The war in Ukraine affected also the CUPID schedule
- It is important to have a running experiment while CUPID is in construction
  - PhD theses, papers
  - Experience on the operation and analysis of a large bolometer array
- We decided that it is not worthwhile to prosecute the data taking as it is
  - We will proceed with the cryogenic upgrade planned for CUPID
  - We expect a relevant reduction of the mechanical noise and a consequent improvement of the detector performances especially at low energies

L. Taffarello

Richieste economiche Cuore_Cupid-Pd 2024

Anagrafica: Tecn. 0.55/1 FTE: LT

Capitolo	Descrizione	Parziali Richiesta	Parziali SJ	Totale Richieste	Totale SJ
	1. Attivita' Criogenica propedeutica Cupid	1.50			
	2. meeting di collaborazione in Italia	1.50			
MISSIONI	**3.** meeting di collaborazione all'estero (USA)	3.00			
				6.00	0.00

Non si richiedono attività dei servizi

Fine!

Euclid successfully launched into space by Falcon 9 rocket

In three months, the tool will begin a six year exploration of dark energy and dark matter.

Loukia Papadopoulos

Created: Jul 01, 2023 10:24 AM EST

SCIENCE

FTE Padova

SEDE	NOMINATIVO	TIPO	CONTRATTO	QUALIFICA	STRUTT.	RICERCATORI	TECNOLOGI	NOTE
PD	Bastieri Denis	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Batkovic Ivana	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Bellato Marco Angelo	DIP	Tecnologo	Dirigente Tecnologo	PD		40	
	Bernardini Elisa	ASSOC	Incarico di Ricerca scientif...	Prof. Ordinario	PD	60		
	Bernardos Martin Maria Isabel					0		
	Boscolo Meneguolo Caterina	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	70		
	Bottacini Eugenio Alessio	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Busetto Giovanni	ASSOC	Incarico di Ricerca scientif...	Prof. Ordinario	PD	100		
	De Angelis Alessandro	ASSOC	Scientifica Ricercatori/Prof...	Prof. Ordinario	PD	100		
	Dima Razvan	DIP	Tecnologo	Primo Tecnologo	PD		10	
	Doro Michele	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Fiori Michele					0		
	Giro Enrico						0	
	Grespan Pietro					0		
	Mariotti Mose'	ASSOC	Incarico di Ricerca scientif...	Prof. Ordinario	PD	100		
	Naletto Giampiero	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Prandini Elisa	ASSOC	Incarico di Ricerca scientif...	Ricercatore B Temp...	PD	100		
	Rando Riccardo	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Spolon Alessia	ASSOC	Scientifica Assegno universi...	Assegnista	PD	100		
	Ventura Sandro	DIP	Tecnologo	Dirigente Tecnologo	PD		30	
	Viale Ilaria	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Taffarello Luca	DIP	Tecnologo	Primo Tecnologo	PD	97		
	Patelli Alessandro	ASSOC	Scientifica Ricercatori/Prof...	Prof. Associato	PD	100		
	Dal Corso Flavio	DIP	Tecnologo	Primo Tecnologo	PD		40	
	Delogu Claudia Caterina					100		
	Iacob Fabio	ASSOC	Scientifica Assegno cofinanz...	Assegnista	PD	100		
	Longhin Andrea	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Mezzetto Mauro	DIP	Ricercatore	Dirigente di Ricerca	PD	98		
	Pari Michelangelo	ASSOC	Scientifica Assegno universi...	Assegnista	PD	100		
	Pupilli Fabio	DIP	Ricercatore	Ricercatore	PD	95		
	Ballone Alessandro					10		
	Bari Pritha	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	10		
	Bartolo Nicola	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	20		
	Bazzan Marco	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	80		
	Bertacca Daniele	ASSOC	Scientifica Ricercatori/Prof...	Ricercatore B Temp...	PD	20		
	Ciani Giacomo	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Ciolfi Riccardo	ASSOC	Scientifica Dipendenti altri...	Ricercatore Confer...	PD	50		
	Conti Livia	DIP	Ricercatore	Primo Ricercatore	PD	100		
	Greco Alessandro	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	10		
	Lazzaro Claudia					0		
	Libanore Sarah	ASSOC	Scientifica Assegno universi...	Assegnista	PD	10		
	Liguori Michele	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	20		
	Mapelli Michela	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	60		
	Matarrese Sabino	ASSOC	Incarico di Ricerca scientif...	Prof. Ordinario	PD	20		
	Pasquato Mario	ASSOC	Scientifica Assegno universi...	Assegnista	PD	10		
	Peloso Marco	ASSOC	Incarico di Ricerca scientif...	Prof. Ordinario	PD	10		
	Perna Gabriele	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	30		
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	Anselmi Stefano	ASSOC	Scientifica Assegno cofinanz...	Assegnista	PD	100		
	De Caro Bianca	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
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	Gabarra Louis Pierre Marie	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Jung Gabriel Pierre Jean-Luc					10		
	Maron Gaetano	DIP	Tecnologo	Dirigente Tecnologo	LNL		30	
	Oppizzi Filippo	ASSOC	Scientifica Assegno cofinanz...	Assegnista	PD	100		
	Passalacqua Francesca	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Renzi Alessandro	ASSOC	Incarico di Ricerca scientif...	Ricercatore A Temp...	PD	80		
	Sirignano Chiara	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Stanco Luca	DIP	Ricercatore	Dirigente di Ricerca	PD	100		
	Verza Giovanni Alberto	DIP	Assegno di Ricerca	Assegno di Ricerca	PD	0		
	Zotto Pierluigi	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	30		
	Zhu Jingtian	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Bettini Alessandro	ASSOC	Affiliato	Pensionato	PD	0		
	Biancacci Valentina	ASSOC	Scientifica Assegno universi...	Assegnista	GSGC	100		
	Brugnera Riccardo	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Calgaro Sofia	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Garfagnini Alberto	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Lippi Ivano	DIP	Ricercatore	Ricercatore	PD	100		
	Pertoldi Luigi	ASSOC	Scientifica Enti stranieri	Ricercatore strani...	PD	100		
	Redchuk Mariia	DIP	Borsista	Borse post doc str...	PD	100		
	Sada Cinzia	ASSOC	Scientifica Ricercatori/Prof...	Prof. Ordinario	PD	60		
	Von Sturm Zu Vehlingen Katharina Caecilie	ASSOC	Scientifica Assegno universi...	Assegnista	PD	100		
	Artero Pons Maria	ASSOC	Scientifica Assegno universi...	Assegnista	PD	100		
	Baibussinov Bagdat	DIP	Ricercatore	Ricercatore	PD	100		
	Braggiotti Alberto	ASSOC	Tecnologica Altri Enti (laur...	Tecnologo	PD		100	
	Centro Sandro	ASSOC	Affiliato	Pensionato	PD	0		
	Farnese Christian	DIP	Ricercatore	Ricercatore	PD	100		
	Gibin Daniele	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Guglielmi Alberto	DIP	Ricercatore	Dirigente di Ricerca	PD	100		
	Meng Guang	DIP	Tecnologo	Tecnologo	PD		80	
	Pietropaolo Francesco	DIP	Ricercatore	Primo Ricercatore	PD	100		
	Varanini Filippo	DIP	Ricercatore	Ricercatore	PD	100		
	Bergnoli Antonio	DIP	Tecnologo	Tecnologo	PD		20	
	Campese Stefano	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Grassi Marco	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Jelmini Beatrice	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Serafini Andrea	ASSOC	Scientifica Assegno universi...	Assegnista	PD	100		
	Agnesi Costantino					40		
	Avesani Marco					30		
	Scriminich Alessia					0		
	Vallone Giuseppe	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	10		
	Vedovato Francesco	ASSOC	Scientifica Ricercatori/Prof...	Ricercatore Univer...	PD	40		
	Villoresi Paolo	ASSOC	Scientifica Ricercatori/Prof...	Prof. Ordinario	PD	40		
	Cicerchia Magda	ASSOC	Scientifica Ricercatori/Prof...	Ricercatore A Temp...	PD	100		
	Braggio Caterina	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	100		
	Carugno Giovanni	DIP	Ricercatore	Dirigente di Ricerca	PD	60		
	Cerdonio Massimo	ASSOC	Affiliato	Pensionato	PD	0		
	Fanzago Federica	DIP	Tecnologo	Tecnologo	PD		10	
	Montecassiano Fabio	DIP	Tecnologo	Tecnologo	PD		30	
	Dorigo Tommaso	DIP	Ricercatore	Primo Ricercatore	PD	10		
	Nardi Federico	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	10		
	Strong Giles Chatham	DIP	Assegno di Ricerca	Assegno di Ricerca	PD	10		
	Zangrando Lisa	DIP	Tecnologo	Tecnologo	PD		10	
	Cogo Giacomo	ASSOC	Associazione Tecnica	Tecnico Categoria C	PD		100	
	Collazuol Gianmaria	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PD	80		
	Feltre Matteo	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	70		
	Laveder Marco	ASSOC	Incarico di Ricerca scientif...	Ricercatore Univer...	PD	80		
	Mattiazzi Marco	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	30		
	Ospina Escobar Nataly					0		
	Bonavena Luis Diego	ASSOC	Scientifica Dottorando senza...	Dottorando	PD	100		
	Bordignon Stefano					0		
	Bouffanais Yann					0		
	Chiarini Gabriella	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	De Pietri Roberto	ASSOC	Incarico di Ricerca scientif...	Prof. Associato	PR	50		
	Favaro Giulio	ASSOC	Scientifica Dottorando con b...	Dottorando	PD	100		
	Franceschetti Kevin	ASSOC	Scientifica Dottorando con b...	Dottorando	PR	50		
	Iorio Giuliano	ASSOC	Scientifica Assegno universi...	Assegnista	PD	40		
	Pegoraro Matteo						0	
	Perigois Carole Fr◆derique	ASSOC	Scientifica Assegno universi...	Assegnista	PD	50		
	Vedovato Gabriele	ASSOC	Associazione Senior	Pensionato	PD		0	

	70 fte	108 pers.	5 fte	15 pers.
PD (123 PERSONE - 75 FTE)	75.00 fte / 123 pers. (media 0.61)			

PNRR... DRD...

stara’ alla CSN2 stabilire il grado di affinità’ delle varie attivita’ ma in ogni caso il messaggio e’ che missioni, dotazioni e conferenze sono rendicontabili PNRR. Resta aperto il problema dei CF che discuteremo in riunione. Come potete vedere poi, per i DRD siamo gia’ passati alla fase “operativa”. Ho cercato di spiegare che le necessita’/strategie della CSN2 non si adeguano bene alla struttura DRD ma non avendo ancora una chiara proposta non ci resta che analizzare eventuali richieste legate ai DRD. Passate l’informazione.Il punto 3 e’ forse il piu’ oscuro (ma vi garantisco che le finalità’ sono chiare) ma l’idea e’ quella di semplificare e automatizzare la generazione di molti (troppi) report chiesti a breve scadenza per CVI, consuntivi, CSN2, PR,

1) Anagrafica del personale PNRR.
TD sul PNRR al 100% sul PNRR → anagrafica delle sigle solo allo 0% e i presidenti con i referee devono valutare quanto l'attivita' in quel programma PNRR e' sinergica con la sigla, per eventuali attivita' che si decida di finanziare comunque su fondi di commissione. Missioni e spese di dotazione per qs persone dovrebbero essere rendicontabili sui fondi della sigla PNRR. Inoltre anche per le persone staff che mettono una % sul PNRR , l 'attivita' PNRR deve essere fattivamente svolta e quindi le missioni devono, di norma, essere pagate sui fondi PNRR (con opportuni storni interni). Questo vale anche per gli associati che hanno fondi PNRR presso la loro universita'. Si sottolinea che l'attività di persone pagate sul PNRR mal si concilia con attivita' di presa dati , conferenze o altro all'interno del loro tempo PNRR.

2) Afferenza a una commissione scientifica Si ricorda l importanza di verificare che il campo afferenza sia stato obbligatoriamente compilato dal personale e dagli incaricati. Tale scelta e' vincolante per poter esercitare il diritto di voto per tutto il 2024. Va da se che un cambio di afferenza da un anno a un altro deve essere motivato da un cambio di linea scientifica. Quindi tutti i partecipanti dune e icarus dovranno decidere sulla loro attivita' scientifica prevalente.

3) Inserimento dati utili per consuntivi e preparazione tabelle Piano Triennale attività PTA 2024-2026 Vi abbiamo anticipato che e' stato digitalizzato il travaso automatico delle informazioni inserite nei preventivi nelle schede tecniche chieste dal MUR , come allegati al PTA 2024-2026.Vorremo quindi ribadire l' importanza che la tabella EC6 (previsioni spesa anni futuri) sia compilata con delle cifre ragionevoli , referate alla riunione di settembre. Anche per le schede generali di descrizione dell attivita' si raccomanda di verificare che la descrizione sia aggiornata e non sia troppo autoreferenziale e possa essere capita almeno come linea generale.

4) European strategy e DRD In questa fase di transizione verso la definizione dei programmi delle future collaborazioni internazionali DRD* e' importante che le attività di R&D avviate o giudicate importanti possano proseguire e possano essere riconosciute come un contributo INFN alla Roadmap dei detectors invitiamo quindi tutti a sottomettere le richieste nei preventivi come in precedenza, rispettando la pertinenza delle linee scientifica di ricerca interessate nelle commissioni scientifiche CSN. In particolare per tener traccia di quanto sara' avviato nelle collaborazioni DRD dal 2024, si chiede di specificare nella richiesta esplicita il DRD dove l'attività viene considerata oggetto di una milestone/deliverable di un WP (se già definito nella preparazione del programma) Ad esempio: descrizione dell attivita': DRDx-WPn: materiale consumo e/o strumentazione

QUAX: ricerca di nuove particelle (assione)

G. Carugno

Ai LNL. Esperimento approvato dalla CSN2 per 3+2 anni. A coordinamento padovano.

Alla frontiera su cavità a radiofrequenza ad altissimo Q-fattore (~10^7) in campi magnetici di > 10 T, sistemi criogenici (mK), **rivelatori di fotoni singoli nelle microonde**.

Produce già fisica interessante (vd paper recente su PRD) →

Arriverà entro pochi anni ad escludere (scoprire?!) l'**assione predetto dalla Quantum Cromo Dynamics** per masse tra 10^{-4} e 10^{-5} eV.

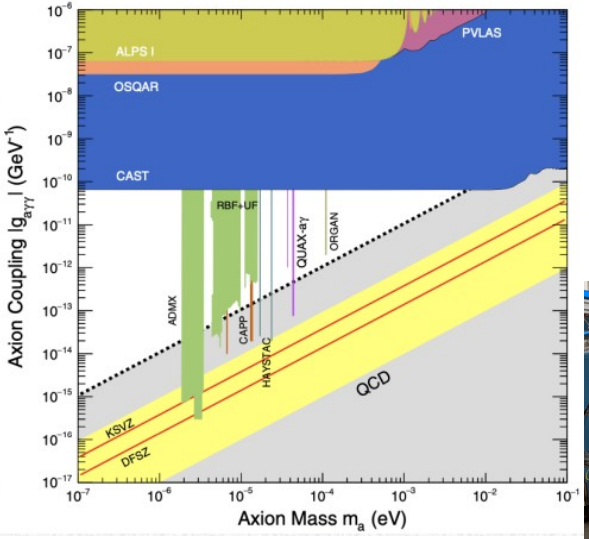
Last publication: QUAX-aγ limits on axion-photon coupling

Improved sensitivity by using a 40 cm long copper cavity, JPA amplifier and 8 T

PHYSICAL REVIEW D **103**, 102004 (2021)

Search for invisible axion dark matter of mass $m_a = 43\ \mu eV$ with the QUAX–$a\gamma$ experiment

D. Alesini,[1] C. Braggio,[2,3] G. Carugno,[2,3] N. Crescini,[4,3,*] D. D'Agostino,[5,6] D. Di Gioacchino,[1] R. Di Vora,[2,7,†] P. Falferi,[8,9] U. Gambardella,[5,6] C. Gatti,[1] G. Iannone,[5,6] C. Ligi,[1] A. Lombardi,[4] G. Maccarrone,[1] A. Ortolan,[4] R. Pengo,[4] A. Rettaroli,[1,10,‡] G. Ruoso,[4] L. Taffarello,[2] and S. Tocci[1]



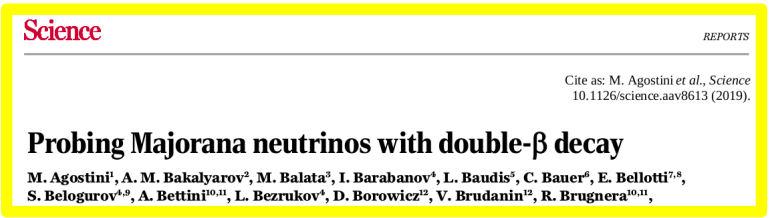
Decadimento 0νββ ai LNGS

Forte legame con gli esperimenti per la ricerca del decadimento doppio beta senza neutrini con il ^{76}Ge e ^{130}Te al Gran Sasso.

GERDA/LEGEND @LNGS: leadership padovana (spokesperson).
Una serie di articoli su riviste di primo livello:

- **Nature**: doi:10.1038/nature21717 → Primo esperimento "background free" (<1 eventi di fondo durante la durata dell'esperimento)
- **Science** 10.1126/science.aav8613 (2019) → migliore sensibilità al mondo.
- **Physical Review Letters** 125, 252502 (2020) → Campione completo. Il minimo livello di rumore, milgiore sensibilità e limite di esclusione a livello mondiale
- Grazie a questi risultati di GERDA, **LEGEND-1000 (il successore) ha recentemente vinto la selezione americana del DOE-NP (Nuclear Physics) come esperimento di futura generazione ai LNGS**.

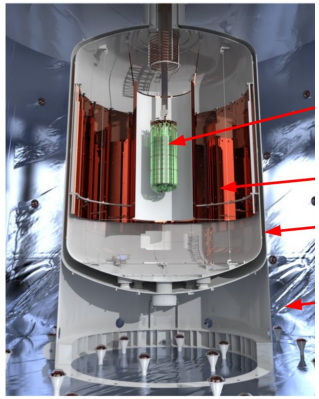
CUORE @LNGS : a PD expertise essenziale per il **sistema criogenico**. Anche l'evoluzione di CUORE (**CUPID**) è supportata come esperimento di nuova generazione ai LNGS.


Science REPORTS

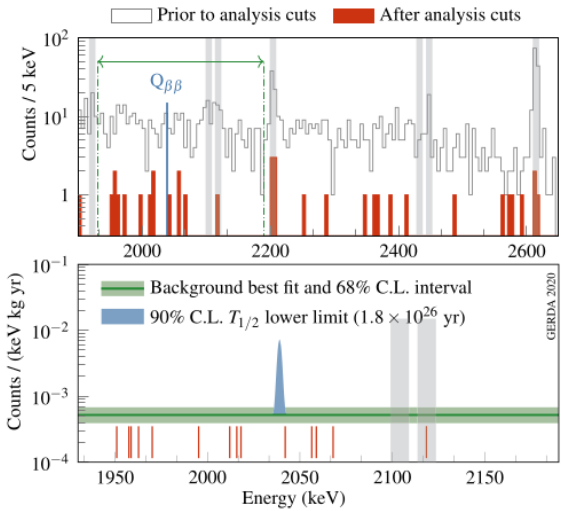
Cite as: M. Agostini *et al.*, *Science* 10.1126/science.aav8613 (2019).

Probing Majorana neutrinos with double-β decay

M. Agostini[1], A. M. Bakalyarov[2], M. Balata[3], I. Barabanov[4], L. Baudis[5], C. Bauer[6], E. Bellotti[7,8], S. Belogurov[4,9], A. Bettini[10,11], L. Bezrukov[4], D. Borowicz[12], V. Brudanin[12], R. Brugnera[10,11],



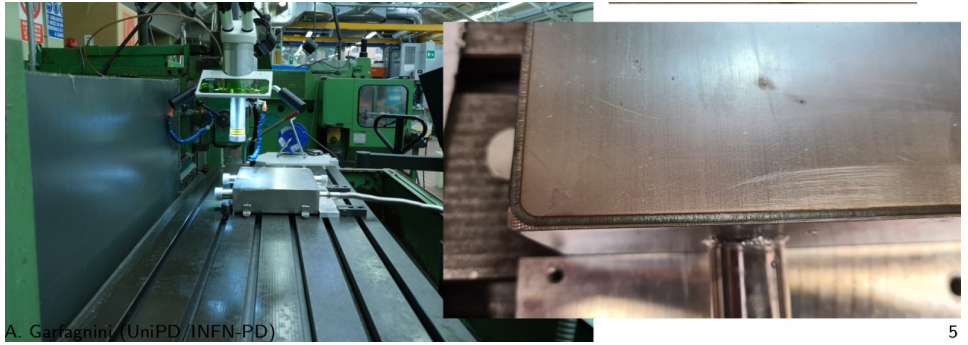
R. Brugnera



JUNO: elettronica

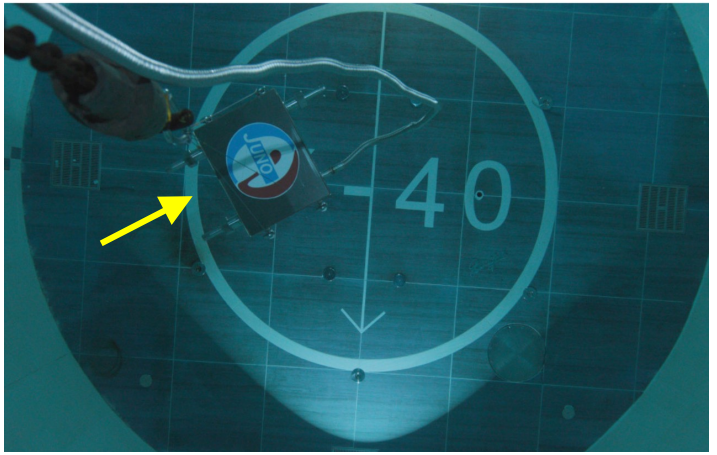
Padova ha un ruolo di leadership nell'**elettronica di JUNO**, esperimento in costruzione in Cina per lo studio delle masse dei neutrini. Un test recente a **Y-40 (una piscina profonda 40 m vicino a Padova)** è stata un occasione per testare l'elettronica in profondità e ottenere un'ampia copertura nei **social media e riviste di divulgazione scientifica**.

A. Garfagnini



Le scatole a tenuta @ INFN-PD officina meccanica

A. Longhin

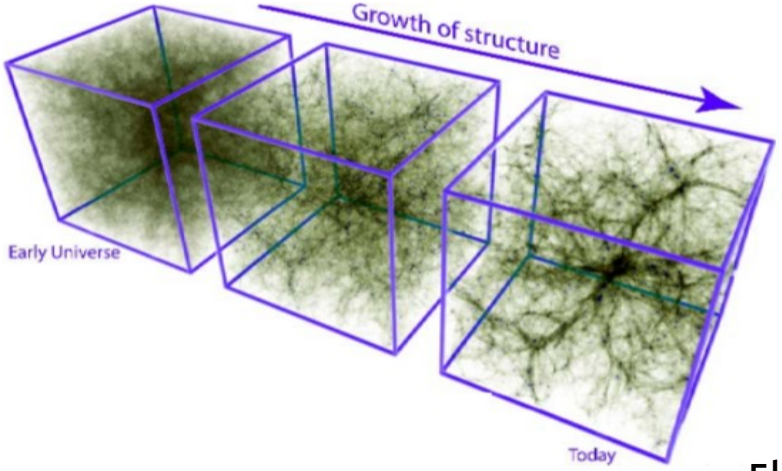


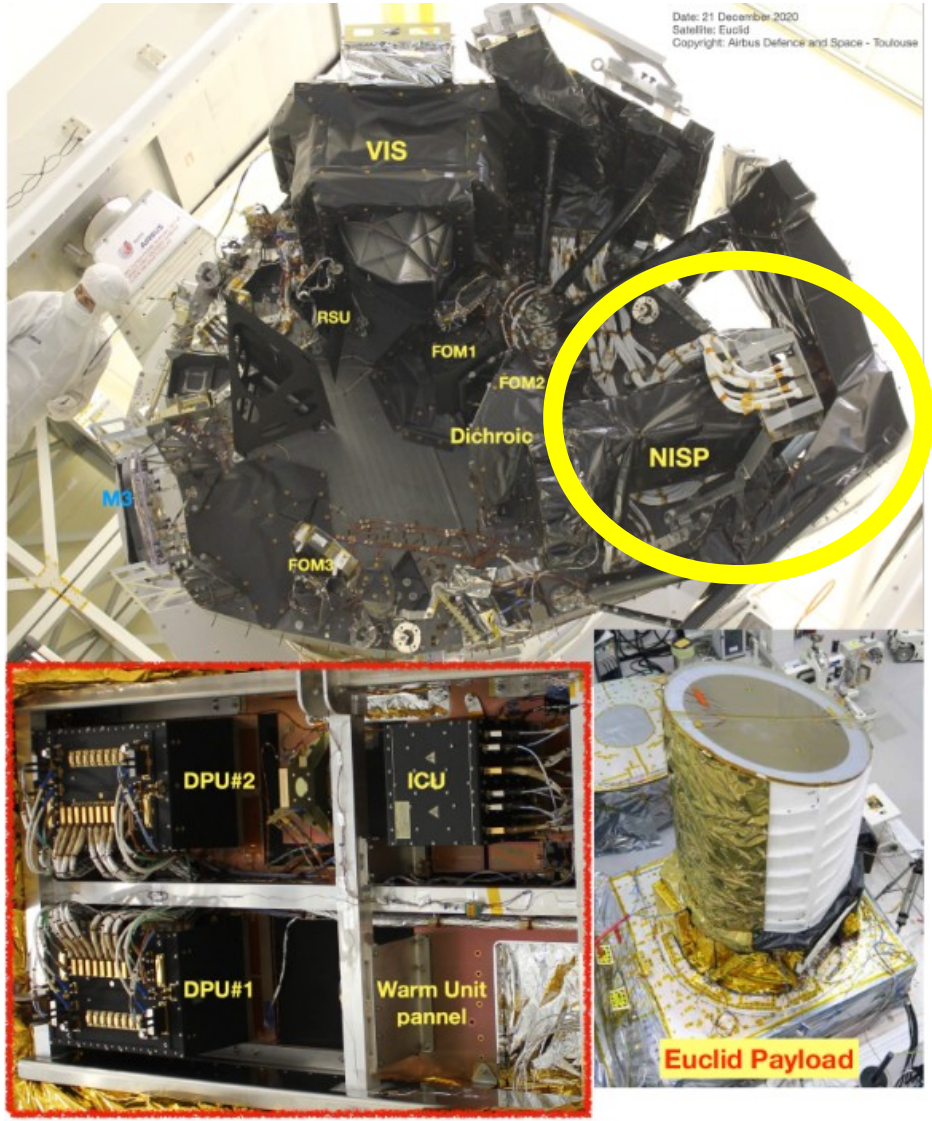
CACCIA AI NEUTRINI

Insomma, una ricerca senza confini. E non solo in ambito medico, ma persino nel campo della fisica delle particelle: nelle acque di Y-40, infatti, il mese scorso sono stati testati i circuiti elettronici di Juno, un osservatorio di neutrini in costruzione a Jiangmen, in Cina. È una sfera di acrilico del diametro di 35 metri (come un palazzo di 12 piani) che sarà immersa in acqua, dentro un contenitore d'acciaio largo 45 m sepolto a 700 metri sotto terra. L'osservatorio è stato costruito a 50 km da due centrali nucleari che emettono una cascata di queste sfuggenti particelle (*v. articolo a pag. 100*). Le interazioni con lo scintillatore liquido contenuto nella sfera consentiranno di stabilire le masse relative dei diversi tipi di neutrini. «La progettazione dell'elettronica di questo esperimento è stata affidata all'Infn (Istituto Nazionale di Fisica Nucleare) di Padova», racconta Alberto Garfagnini, fisico sperimentale all'Università di Padova. «Sono 7 mila scatole in acciaio di 20x30 cm, che contengono i circuiti necessari: dovranno essere a perfetta tenuta stagna, dato che saranno immerse nella vasca piena d'acqua che circonderà il rivelatore centrale. Questa piscina artificiale sarà profonda 40 metri, come Y-40: ecco perché è venuto naturale testare l'elettronica nella piscina». Una volta installato sotto terra, Juno registrerà anche i neutrini emessi dal Sole e da supernovae, le esplosioni stellari che avvengono in galassie lontane. Dagli abissi alle stelle.

EUCLID. Near Infrared Spectrometer.

Questo telescopio dallo spazio (punto lagrangiano L2) fornirà dei dati cruciali per mettere alla prova il modello cosmologico Λ-CDM e la “Dark Energy”. Test teorie di gravità modificata. Misurerà gli spettri e le distorsioni delle galassie remote dovute alla materia oscura a diverse distanze-tempi (“redshift”).

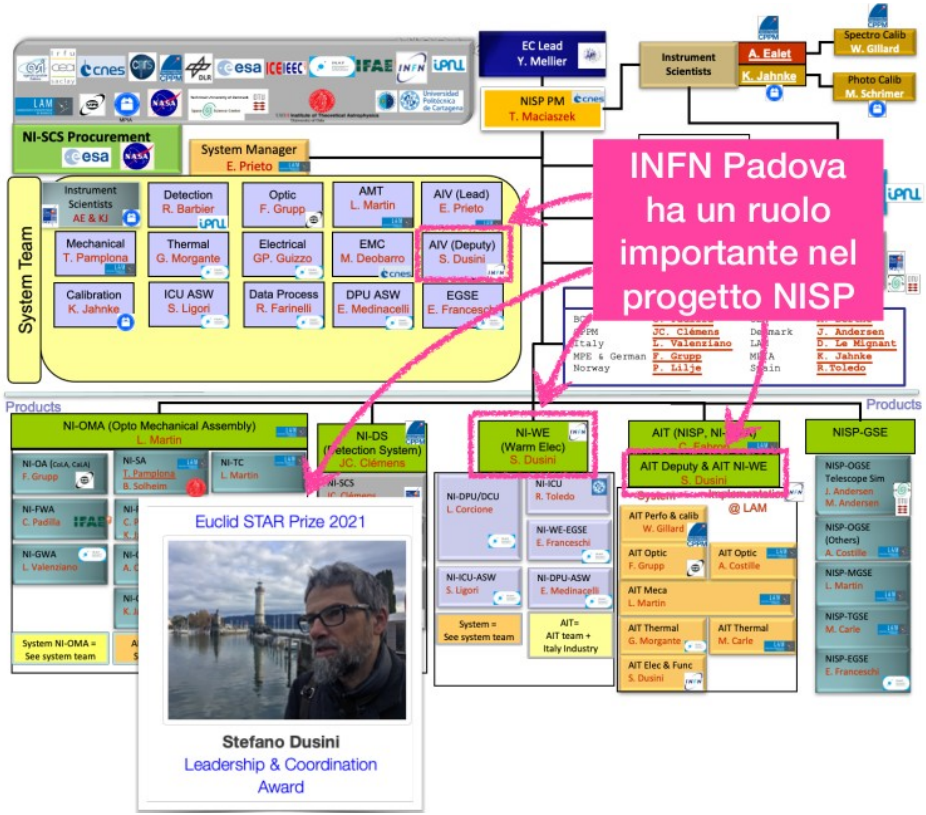




Elettronica NISP

EUCLID. Near Infrared Spectrometer.

Padova ha un ruolo di leadership sull'**elettronica di controllo del NISP** (Near Infrared Spectrometer), uno dei due sistemi principali per la scienza.



https://www.esa.int/Science_Exploration/Space_Science/Euclid_telescope_ready_for_extreme_space_environment

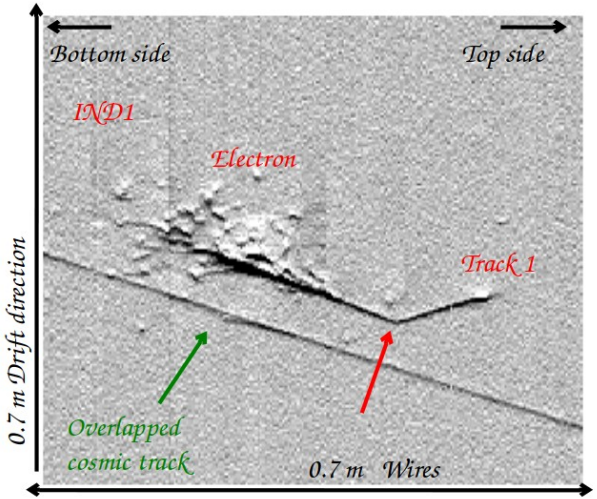
Si sono recentissimamente **conclusi con successo i test di integrazione** a Marseille. Sarà lanciato da Kourou **entro fine 2022.**

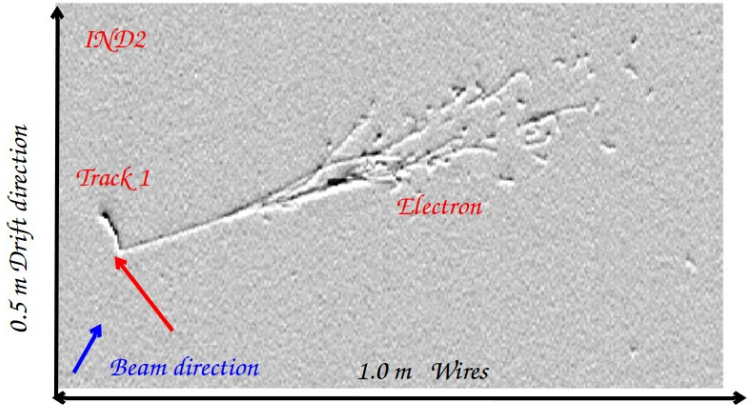
ICARUS

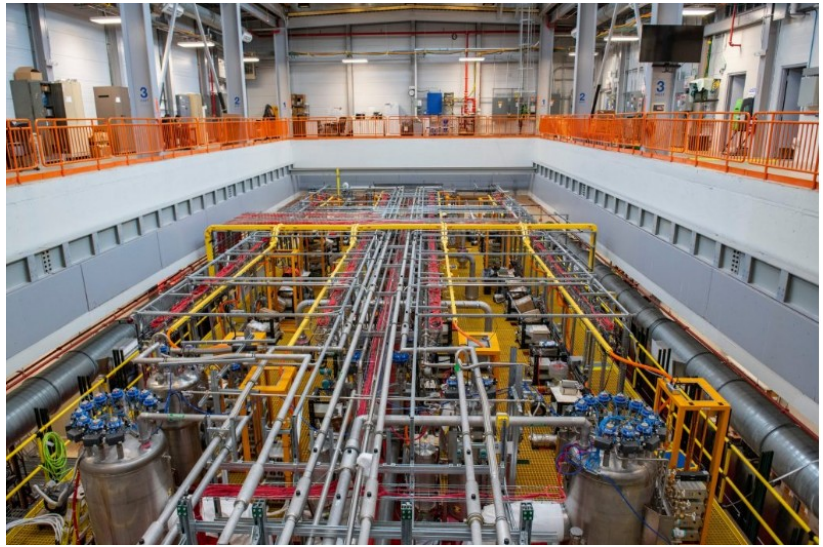
Estate 2021:

ICARUS vede i primi neutrini dal fascio del Booster al FERMILAB dove il rivelatore è in fase finale di collaudo.

Ruolo centrale di Padova:
elettronica li lettura della Liquid Argon Time Projection Chamber







Group II - Astroparticle Physics

Research activities | Seminars | Budget Estimates

Coordinator

Andrea Longhin
Tel.: 049.967.7316
Office: 174 – DFA Via Marzolo, 8
E-mail: andrea.longhin@pd.infn.it
Web: https://userswww.pd.infn.it/~longhin/

Research Activities in the Division

The experiments within the INFN "Group II" focus on experimental astroparticle physics, neutrino physics and gravitational waves. There are many research lines, each investigating in more detail different aspects of the field.

The following list contains the experiments being active in Padova, in collaboration with other INFN sections and/or facilities, laboratories, national and international organizations. Some of these projects are made possible with funding from organizations other than INFN (e.g. the EU, the Italian Ministry of Research – MIUR – and more).

Secretariat

Giuseppina Salente
Phone: 049.9677220
Office: 365 (III floor)
E-mail: salente@pd.infn.it
Skype: pinasalente

Contact the Secretariat

The Secretary Office is in charge of:

P. Grutta (AdR)
S. Hemmers (Servizio F.E.)
Responsabili locali
Pina & AL

GRAZIE!

Nuove intro divulgative alle attivita` GR2@PD

Astroparticle Physics at INFN Padova

The activities of *Gruppo 2* in Padova span a wide range of topics: gravitational waves, the properties of neutrinos from accelerators or nuclear reactors, from the Earth, the Sun, from SuperNovae or cosmic rays. We search for new particles (the "axion"), tiny anomalies in the theory of general relativity or the existence of particular radioactive "neutrino-less" beta decays. We make astronomy with photons of the highest energies and we map galaxies to shed some light on the so-called "dark energy".

Astroparticle physics research activities at INFN are coordinated on national scale by *CSN2*. Below you can find a list of the local research activities in which Padova is involved.

CTA/MAGIC | CUORE | DUNE | ET | ENUBET
EUCLID | FERMI | GERDA | ICARUS | JUNO
MOONLIGHT | QUAX | T2K | VIRGO

CTA/MAGIC

is a large observatory at the Canary islands dedicated to the study of high energy gamma rays from the universe. High energy gamma rays are messengers of some of the most powerful objects in the universe, like black holes and supernove, and can be used to test physics laws in extreme conditions of energy and gravity. The telescope is a gigantic array of mirrors detecting the faint light that is emitted by cosmic ray particles as they travel through the atmosphere. More info

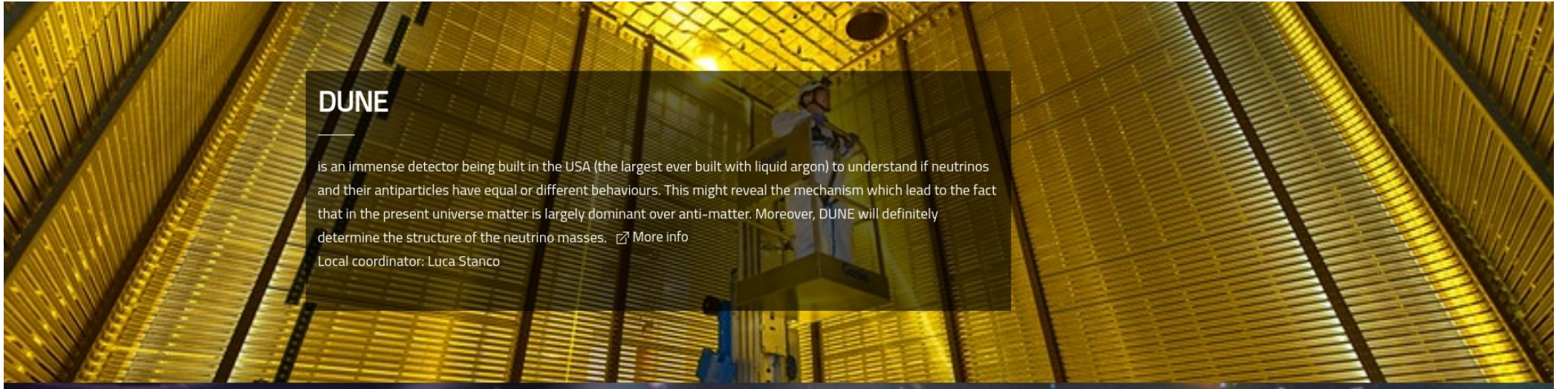
Credits to Alice Donini for the background picture.

Local coordinator: Mosé Mariotti

Cuore

is an experiment located at the Gran Sasso National Laboratory in Assergi, Italy. Its goal is to unveil the fundamental nature of the neutrino by checking the existence of a very peculiar radioactive decay of Tellurium, where only two electrons and nothing else are emitted. It is also renowned as *the coldest meter cube of the Universe!* More info

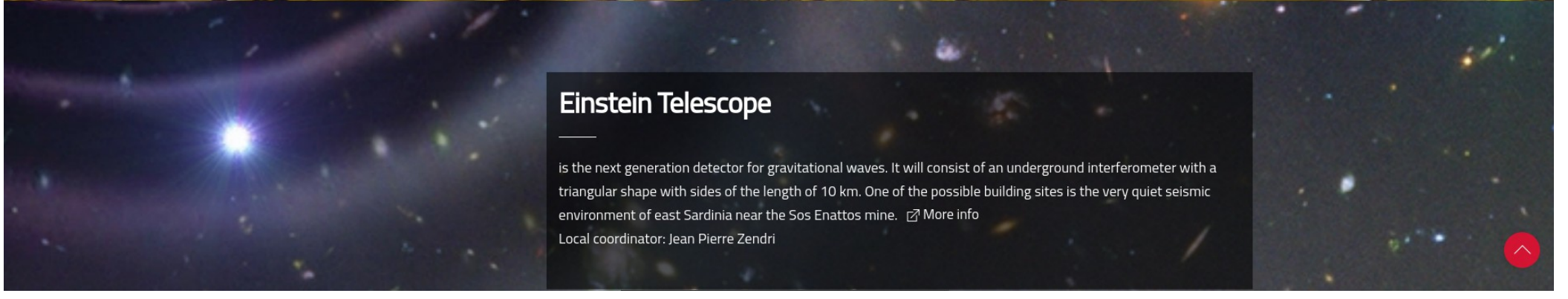
Local coordinator: Luca Taffarello



DUNE

is an immense detector being built in the USA (the largest ever built with liquid argon) to understand if neutrinos and their antiparticles have equal or different behaviours. This might reveal the mechanism which lead to the fact that in the present universe matter is largely dominant over anti-matter. Moreover, DUNE will definitely determine the structure of the neutrino masses. More info

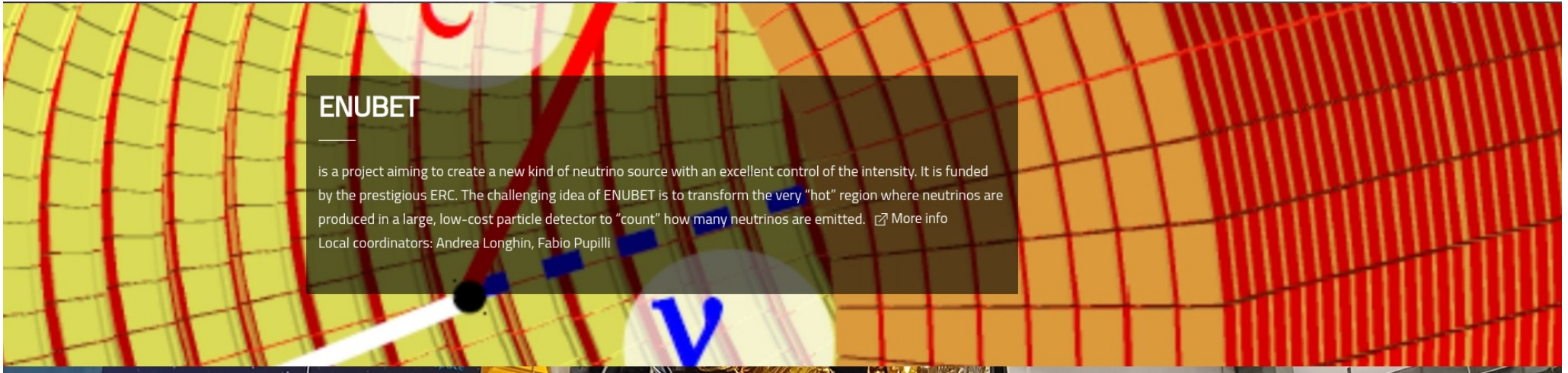
Local coordinator: Luca Stanco



Einstein Telescope

is the next generation detector for gravitational waves. It will consist of an underground interferometer with a triangular shape with sides of the length of 10 km. One of the possible building sites is the very quiet seismic environment of east Sardinia near the Sos Enattos mine. More info

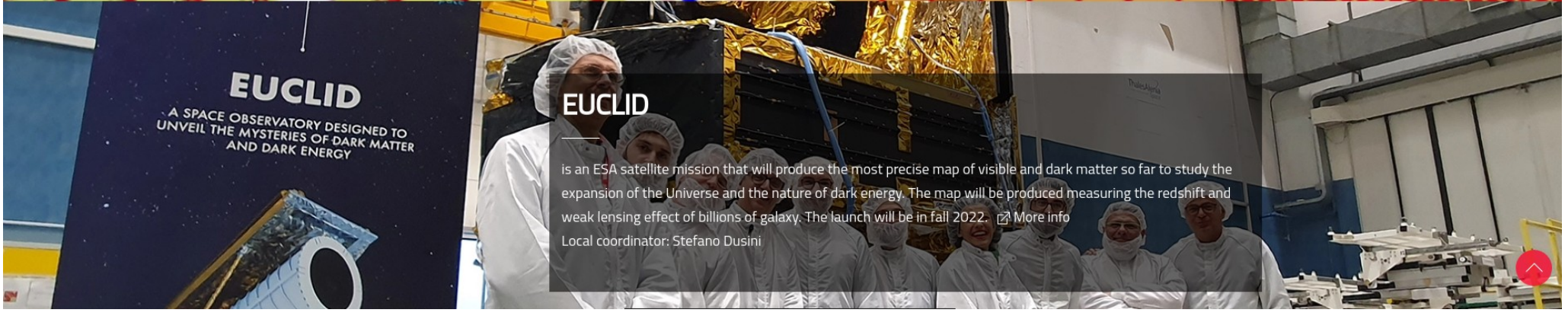
Local coordinator: Jean Pierre Zendri



ENUBET

is a project aiming to create a new kind of neutrino source with an excellent control of the intensity. It is funded by the prestigious ERC. The challenging idea of ENUBET is to transform the very "hot" region where neutrinos are produced in a large, low-cost particle detector to "count" how many neutrinos are emitted. More info

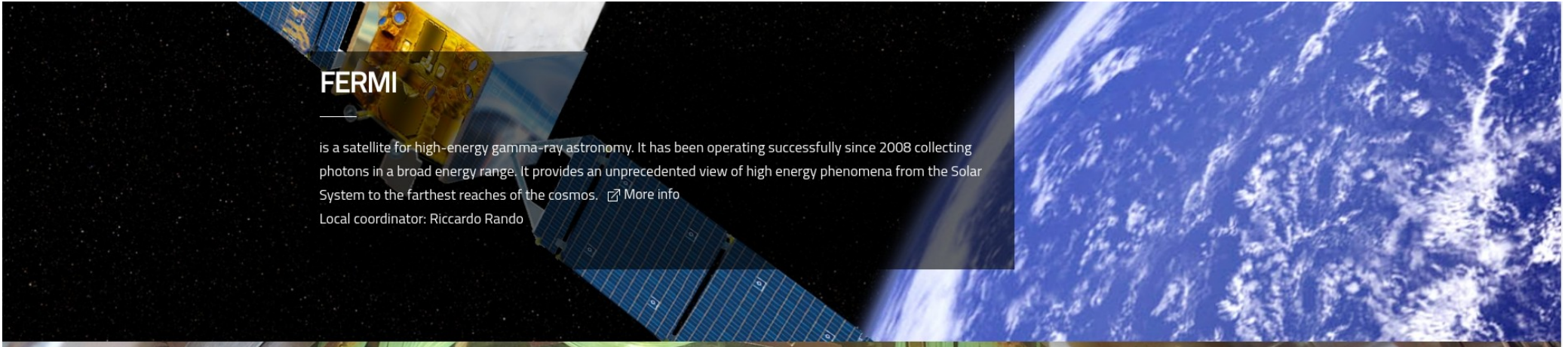
Local coordinators: Andrea Longhin, Fabio Pupilli



EUCLID

is an ESA satellite mission that will produce the most precise map of visible and dark matter so far to study the expansion of the Universe and the nature of dark energy. The map will be produced measuring the redshift and weak lensing effect of billions of galaxy. The launch will be in fall 2022. More info

Local coordinator: Stefano Dusini



FERMI

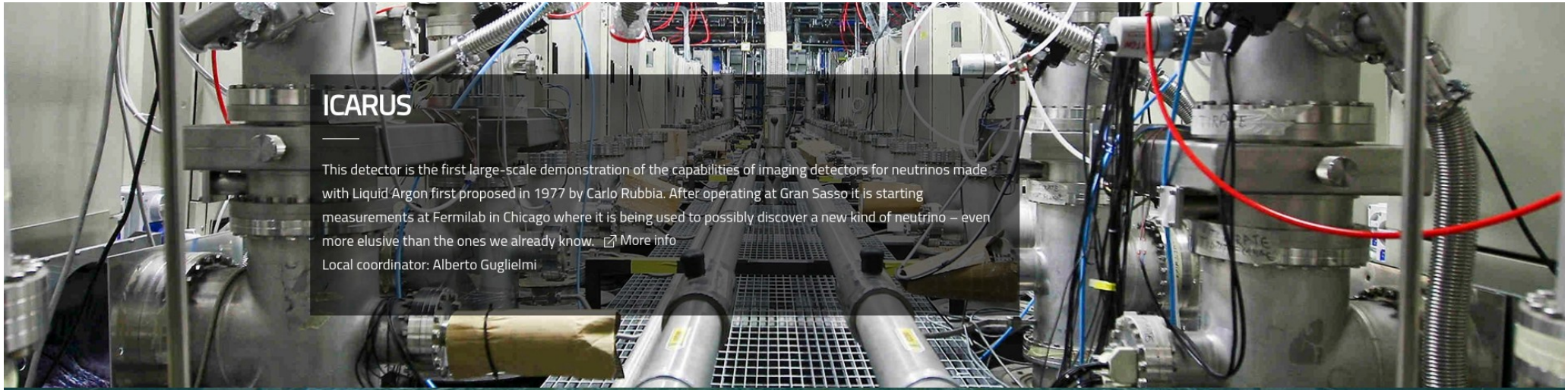
is a satellite for high-energy gamma-ray astronomy. It has been operating successfully since 2008 collecting photons in a broad energy range. It provides an unprecedented view of high energy phenomena from the Solar System to the farthest reaches of the cosmos. More info

Local coordinator: Riccardo Rando

GERDA/LEGEND

is an experiment located at the Laboratori Nazionali del Gran Sasso in Italy. Its goal is to unveil the nature of the neutrino, by checking the existence of a very peculiar radioactive decay of ^{76}Ge, where only two electrons and nothing else are emitted. More info

Local coordinator: Riccardo Brugnera



ICARUS

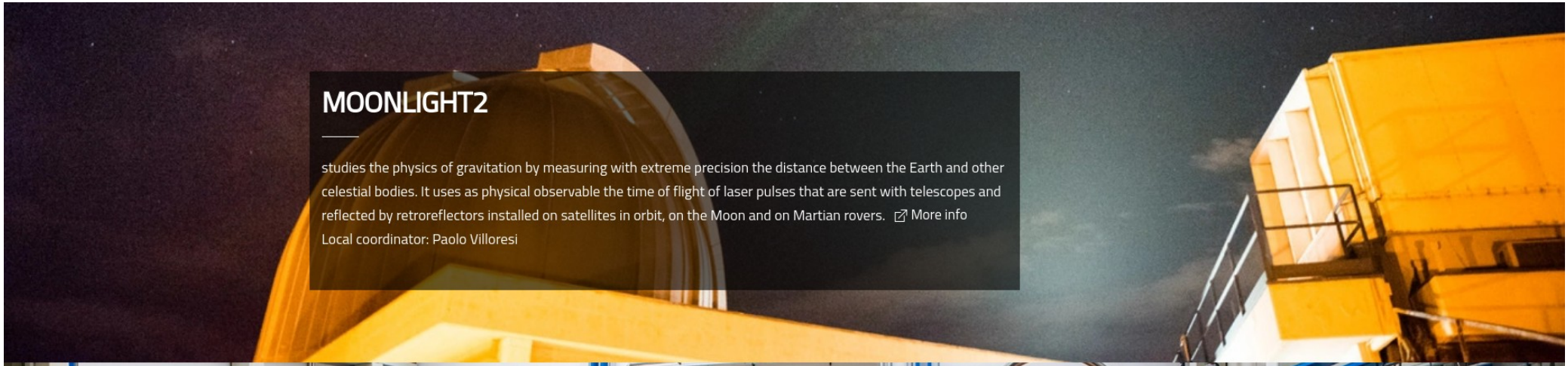
This detector is the first large-scale demonstration of the capabilities of imaging detectors for neutrinos made with Liquid Argon first proposed in 1977 by Carlo Rubbia. After operating at Gran Sasso it is starting measurements at Fermilab in Chicago where it is being used to possibly discover a new kind of neutrino – even more elusive than the ones we already know. More info

Local coordinator: Alberto Guglielmi

JUNO

The state-of-the-art large liquid scintillator detector for neutrino physics, JUNO, will measure with unprecedented precision the energy of neutrinos produced from two large nuclear power plants, each at 53 km distance. It will shed light on how the masses of the three known neutrinos are arranged (the so-called "mass hierarchy"). More info

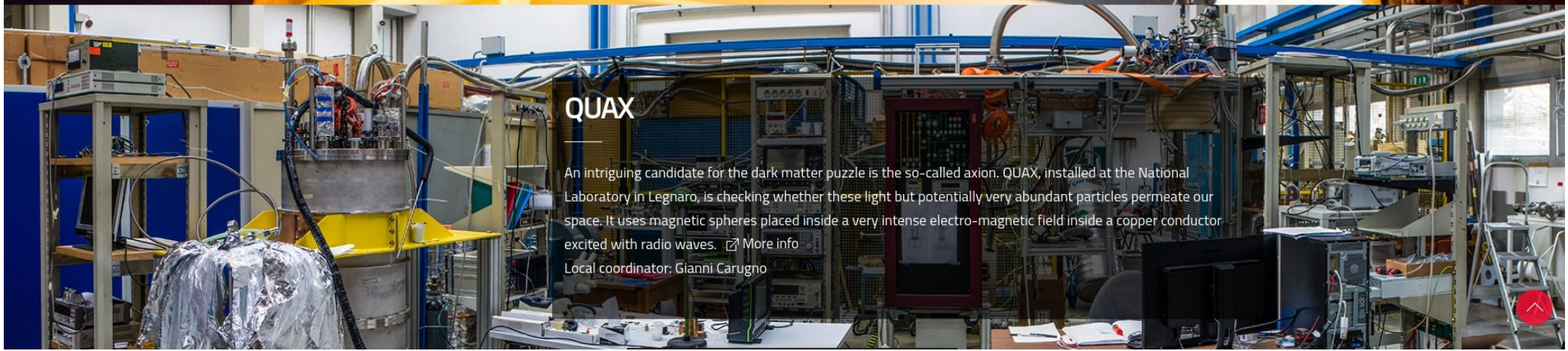
Local coordinator: Alberto Garfagnini



MOONLIGHT2

studies the physics of gravitation by measuring with extreme precision the distance between the Earth and other celestial bodies. It uses as physical observable the time of flight of laser pulses that are sent with telescopes and reflected by retroreflectors installed on satellites in orbit, on the Moon and on Martian rovers. More info

Local coordinator: Paolo Villoresi



QUAX

An intriguing candidate for the dark matter puzzle is the so-called axion. QUAX, installed at the National Laboratory in Legnaro, is checking whether these light but potentially very abundant particles permeate our space. It uses magnetic spheres placed inside a very intense electro-magnetic field inside a copper conductor excited with radio waves. More info

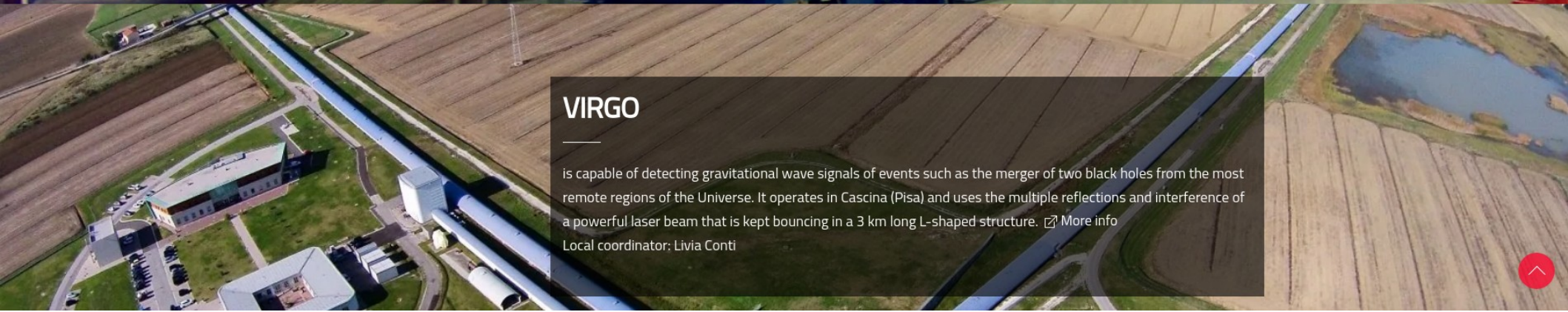
Local coordinator: Gianni Carugno

T2K

studies how neutrinos change their kind ("flavour") as they travel through 295 km from the Pacific coast up to the Japanese alps. There, in the core of a mountain, a gigantic cylindrical tank of ~40x40x40 m^3 called Super-Kamiokande filled with water and very sensible detectors of light measures the neutrino characteristics.

More info

Local coordinator: Gianmaria Collazuol

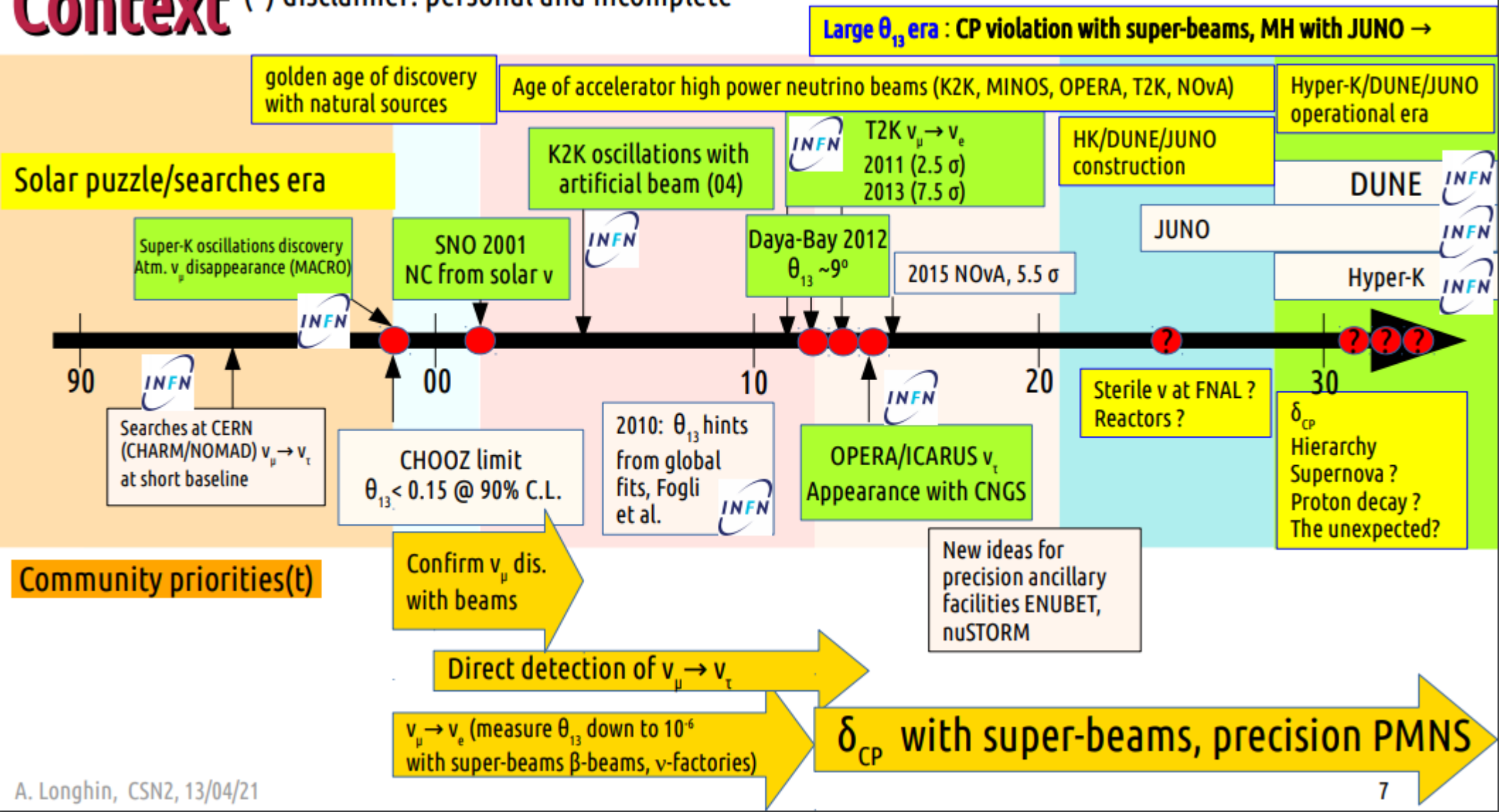


VIRGO

is capable of detecting gravitational wave signals of events such as the merger of two black holes from the most remote regions of the Universe. It operates in Cascina (Pisa) and uses the multiple reflections and interference of a powerful laser beam that is kept bouncing in a 3 km long L-shaped structure. More info

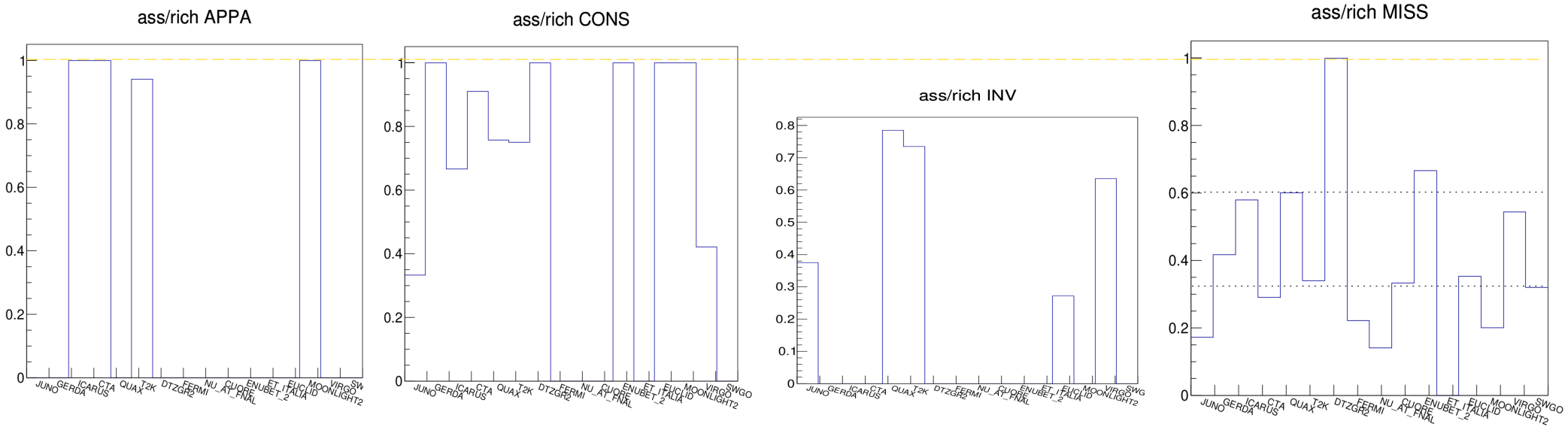
Local coordinator: Livia Conti

Context (*) disclaimer: personal and incomplete



Assegnazioni @ PD: tagli non missioni (2022)

Assegnato/richiesto per sigla: apparati/consumabili ~ accettate le proposte. Tagli piu' consistenti su inventariabile e missioni (referees+commissione).



2022	PhD	Assegno	RTD-A	RTD-B	Post-doc INFN	RIC UNI	RIC INFN	PA/1RIC/TEC	PO/DdR
CTA/MAGIC* (16.3) agg →	*Spolor 1) +1 new ?*	*Bernardos M. (1)* Fiori (1) *Mallamaci* (1)	*Prandini (0.95)*		Lopez-Coto	Rando (0.4)		Doro (0.95) Naletto (0.8) *Bernardini (0.5)* Bastieri (0.3) Dima (0.2) Bottacini 0.2)	**Mariotti** (1) De Angelis (0.7) Busetto (0.7)
FERMI (2.8)*	Jingtian Zhu (1)							Bastieri (0.3), Rando (0.5) Bottacini (0.8)	De Angelis (0.2)
CUORE (0.6)*								**Taffarello (0.6)**	
ET (2.7)*	Di Carlo (0.1)	Spera(0.1) Pasquato (0.1) Giacobbo (0.1) Ballone (0.1)	Bertacca(0.1) *Lazzaro* (0.1)		Ricciardone (0.1)	Pasquato (0.1) Bazzan (0.1)	*L.Conti* (0.2)	**Zendri** (0.4) Ciani (0.2) Bartolo (0.1) Peloso (0.1) *Mapelli (0.1)* Liguori (0.1)	Matarrese (0.1)
VIRGO (10.9)*	Favaro, Chiarini, Bonavena,Bordignon	Spera (0.5) Bouffanais (0.5)	*Lazzaro (0.9)*			Bazzan (0.6) Ciolfi (0.5)	***L. Conti* (0.8)** Vedovato (1)	Zendri (0.6) Ciani (0.6) De Pietri (0.5) *Mapelli (0.4)* Pegoraro (0.4)	
EUCLID (7.7+)*	Verza (1) Gabarra (1) DeCaro (1)	Troja (1), Anselmi (?)	Renzi (0.8) Bertacca (0.1)	Raccanelli (0.1)	Jung (0.1)	*Sirignano* (0.7) Liguori (0.1)	**Dusini** (0.8)	Bartolo (0.1) Naletto (0.2)	Matarrese (0.1) Stanco (0.6)
GERDA (5.2)*	*Biancacci (1)*	*Redchuck* (1), Pertoldi (1) (→ DE)					Lippi (0.6)	**Brugnera (0.7)** Garfagnini (0.3) *Sada* (0.6)	
JUNO (4.6)	Marini (1) *Jelmini (1)* +1 new ?	*Von Sturm* (0.3)		Grassi (0.4)		*Sirignano* (0.3)	Dusini (0.1) Lippi (0.4) Bergnoli (0.5)	Brugnera (0.3) **Garfagnini (0.7)** Bellato (0.1) Dal Corso (0.1) Fanin (0.2)	Stanco (0.1)
NU_AT_FNAL (1.3)*			NEW (1)						**Stanco** (0.3)
ICARUS (8.6)*	*Artero Pons (1)*						Farnese (1) Varanini (1)Baibussinov (0.6)	Braggiotti (1) Meng (1) Gibin (1) Pietropaolo (1) Ventura (0.2)	**Guglielmi (1)**
MOON LIGHT-2 (2.9)	*Scriminich* (0.7) Zaidi (0.15)	F. Vedovato (0.4) A. Stanco (0.4) Agnesi (0.4) Avesani (0.3)						Vallone (0.1)	**Villoresi (0.4)**
QUAX (3.5)*	Di Vora (1)	NEW (1)				*Braggio* (0.5)	*Fanzago (0.1) TBC* Montecassiano (0.2)	Taffarello (0.4) Pepato (0.2) Pegoraro (0.1)	**Carugno** (0.6)
T2K (8.4)	*Delogu (0.4)*	*Ospina (0.9)* Iacob (0.9) Pari (0.6)		Grassi (0.6)	Lamoureux (1.0)	Laveder (0.8)		**Collazuol (0.8)** Longhin (0.4)	Mezzetto (0.8)
ENUBET (3.8)	*Delogu (0.6)*	Pari (0.4), Iacob (0.4)					**Pupilli (1.0)**	Longhin (0.6) Dal Corso (0.2)	Mezzetto (0.2)

Work in progress

Donna
RESP LOC
Aff GR4
Aff GR1

Assegnazioni @ PD: qualche statistica (2022)

INFN Istituto Nazionale di Fisica Nucleare

Assegnazioni INFN

Tutti i capitoli | Tutte le sigle

Esper. & Suf.	MISS				CON				ALTRICONS				SEM				TRA				PUB				MAN				INV				APP				LIC-SW				SPSERVIZI				TOTALE			
		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.
CTA	141.5				22.0																								12.0				304.0								32.0				511.5			
	31.0	10.0			20.0																								0.0				0.0			304.0					32.0				83.0	10.0		304
CUORE_CUPID	9.0																																												9			
	3.0																																												3.0			0
ENUBET_2	4.0	8			2.0																																								6	8		
	2.5	5.5			2.0																																								4.5	5.5		0
ET_ITALIA	14.0				14.0																				5.0				22.0				2.0												57			
	0.0				0.0																				0.0				0.0				0.0															0
EUCLID	52.5				1.0																								31.0	4															84.5	4		
	16.0	2.5			0.0	1.0																							5.5	4.0															21.5	7.5		0
FERMI	18.0																																												18			
	4.0																																												4.0			0
GERDA	30.0				5.0																								3.5																38.5			
	12.5				5.0																								0.0																17.5			0
ICARUS	66.5				6.0												10.0												8.0				13.0								3.0				106.5			
	38.5				4.0												0.0	6.0											0.0				13.0								1.0				56.5	6.0		0
JUNO	81.0				3.0												5.0												4.0																93			
	5.5	9.5			1.0												5.0												1.5																13.0	9.5		0
MOONLIGHT-2	15.0				7.0																												25.0												47			
	3.0				7.0																												0.0	25.0											10.0	25.0		0
NU_AT_FNAL.DTZ	32.0																												1.0																33			
	4.5																												0.0																4.5			0
QUAX	15.0				33.0																				14.0				14.0																76			
	9.0				25.0																				14.0				11.0																59.0			0
SWGO	12.5				10.0																																								22.5			
	4.0				0.0																																								4.0			0
T2K	134.0				24.0												12.0								3.0				24.5				51.0				4.5				25.0				278			
	45.5				18.0												12.0								3.0				0.0			18.0	3.0			45.0	2.5				15.0				99.0			63
VIRGO	25.5	14			24.5				7.5								0.5												31.5																89.5	14		
	16.5	5.0			13.5				0.0								0.0												20.0																50.0	5.0		0
Dotazioni	17.5				5.5								1.0																20.0																44			
	33.5				37.0								0.0																0.0																70.5			0
TOTALE	668	22			157				7.5				1				27.5								22				171.5	4			395				4.5				60				1514	26		
				690				157				7.5				1				27.5				0				22				175.5				395				4.5				60				1540
	229	32.5	0	0	132.5	1	0	0	0		0	0	0		0	0	17	6	0	0				0	17	0	0		38	4	0	18	16	25	0	349	2.5		0	0	48		0	0	500	68.5	0.0	367.0
				261.5				133.5				0.0				0.0				23.0				0.0				17.0				60.0				390.0				2.5				48.0				935.5

Accede come: R.N. ENUBET ; R.N. NUTECH ; R.L. NESSIE-RD_LNF ; R.L. SCENTT_LNF ; Referee TRISTAN ; ; Coordinatore Gruppo II ;
In questo momento come: Coordinatore Gruppo II da 192.84.143.3

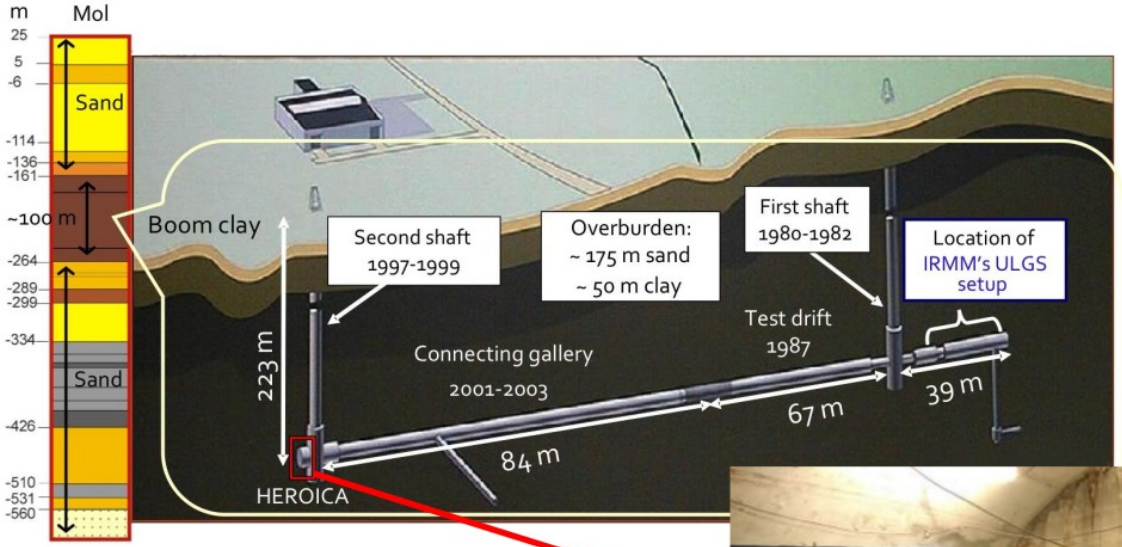
Evoluzione anagrafica

Promettente iniezione di nuovi PhD/assegni (alcuni ex PhD PD)/RUA. Sovracompensano alcuni giovani che sono usciti → Molte sigle aumentano FTE e si fortificano (alcune anche grazie e significative progressioni di carriera - UniPD e INFN). Alcune criticita' specifiche messe in luce (vd VIRGO).

2021	PhD	Assegno	RTD-A	RTD-B	Post-doc INFN (+FELLINI)	RIC UNI	RIC INFN	PA/1RIC/TEC	PO/DdR
CTA/MAGIC (10.3)	*Spolon (1)*	*Bernardos M. (1)* Fiori (1) *Mallamaci* (1)	*Prandini (0.95)*		Lopez-Coto	Rando (0.4)		**Mariotti** (1) Doro (0.95) Naletto (0.8) *Bernardini (0.5)* Bastieri (0.3) Dima (0.2) Bottacini 0.2)	De Angelis (0.7) Busetto (0.7)
FERMI (3.8)	Pei (1) Hubing (1)					Rando (0.5)		Bastieri (0.3) Bottacini (0.8)	De Angelis (0.2)
CUORE (0.6)								**Taffarello (0.6)**	
ET (2.5)	Ganz (0.1) Di Carlo (0.1)	Spera(0.1) Orlando (0.1) Pasquato (0.1) Giacobbo (0.1) Ballone (0.1)	Bertacca (0.1) *Lazzaro* (0.2)		Ricciardone (0.1) (?)	Liguori (0.1) Pasquato (0.1) Bazzan (0.1)	*L.Conti* (0.2)	**Zendri** (0.4) Ciani (0.2) Bartolo (0.1) Peloso (0.1) *Mapelli (0.1)*	Matarrese (0.1)
VIRGO (7.3)		Spera (0.5) Bouffanais (0.5)	*Lazzaro (0.8)*			Bazzan (0.5) Ciolfi (0.5)	***L. Conti* (0.8)** Vedovato (1)	Zendri (0.6) Ciani (0.8) De Pietri (0.5) *Mapelli (0.4)* Pegoraro (.2)	
EUCLID (4.7)	Verza (1) + 2 NEW	+1 NEW	Renzi (0.8) Bertacca (0.1)	Raccanelli (0.1)	Jung (0.1)	*Sirignano* (0.7) Liguori (0.1)	**Dusini** (0.8)	Bartolo (0.1) Naletto (0.1)	Matarrese (0.1) Stanco (0.6)
GERDA (4.9)	Pertoldi (1) Biancacci (1)	*Von Sturm* (0.7)					Lippi (0.6)	**Brugnera (0.7)** Garfagnini (0.3) *Sada* (0.6)	
JUNO (4.6)	Marini (1)	*Von Sturm* (0.3)		Grassi (0.4)		*Sirignano* (0.3)	Dusini (0.1) Lippi (0.4) Bergnoli (0.5)	Brugnera (0.3) **Garfagnini (0.7)** Bellato (0.1) Dal Corso (0.1) Fanin (0.2)	Mezzetto (0.1) Stanco (0.1)
NU_AT_FNAL		Brunetti (.05)							**Stanco** (0.3)
ICARUS (7.8)							Farnese (1) Varanini (1) Baibussinov (0.6)	Braggiotti (1) Meng (1) Gibin (1) Pietropaolo (1) Ventura (0.2)	**Guglielmi (1)**
MOON LIGHT-2 (2.9)	*Scriminich* (0.7) Zaidi (0.15)	F. Vedovato (0.4) A. Stanco (0.4) Agnesi (0.4) Avesani (0.3)						Vallone (0.1)	**Villoresi (0.4)**
QUAX (2.7)	Di Vora (1) +NEW					*Braggio* (0.5)		Taffarello (0.4) Pepato (0.2) Pegoraro (0.1)	**Carugno** (0.5)
T2K (8.4)	Jacob (0.9) Pari (0.6) *Delogu (0.4)*	*Ospina (0.9)* Cogo (1.0)		Grassi (0.6)	Lamoureux (1.0)	Laveder (0.8)		**Collazuol (0.8)** Longhin (0.4)	Mezzetto (0.8)
ENUBET (3.8)	*Delogu (0.6)* Pari (0.4)	**Pupilli (1.0)** *Brunetti* (0.95)						Longhin (0.6) Dal Corso (0.2)	Mezzetto (0.1)

HADES (High Activity Disposal Experimental Site) Facility Underground (a Mol, vicino al sito della Canberra di Olen).

R. Brugnera



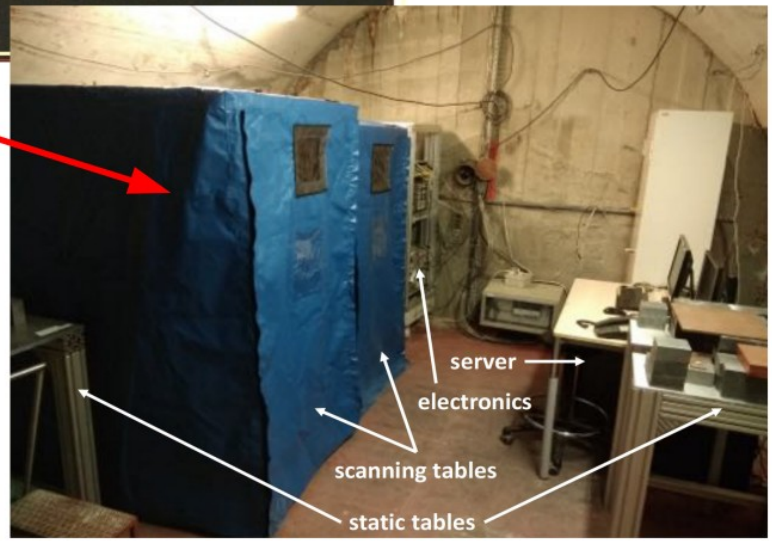
HADES è sotto la direzione dell'ente SCK-EN

Setup sperimentale in HADES:

2 tavoli per lo scanning della superficie laterale dei rivelatori

+

2 tavoli per lo studio delle prestazioni in termini di pulse shape discrimination



GERDA Fase II

R. Brugnera

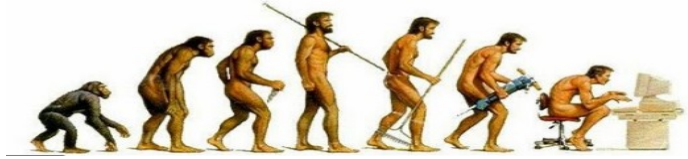
- L'esperimento ha finito la presa dati nel Novembre 2019
- Ha pubblicato nel 2020 i risultati finali della sua ricerca sul decadimento **0νββ** (*PRL 125, 252502 (2020)*):

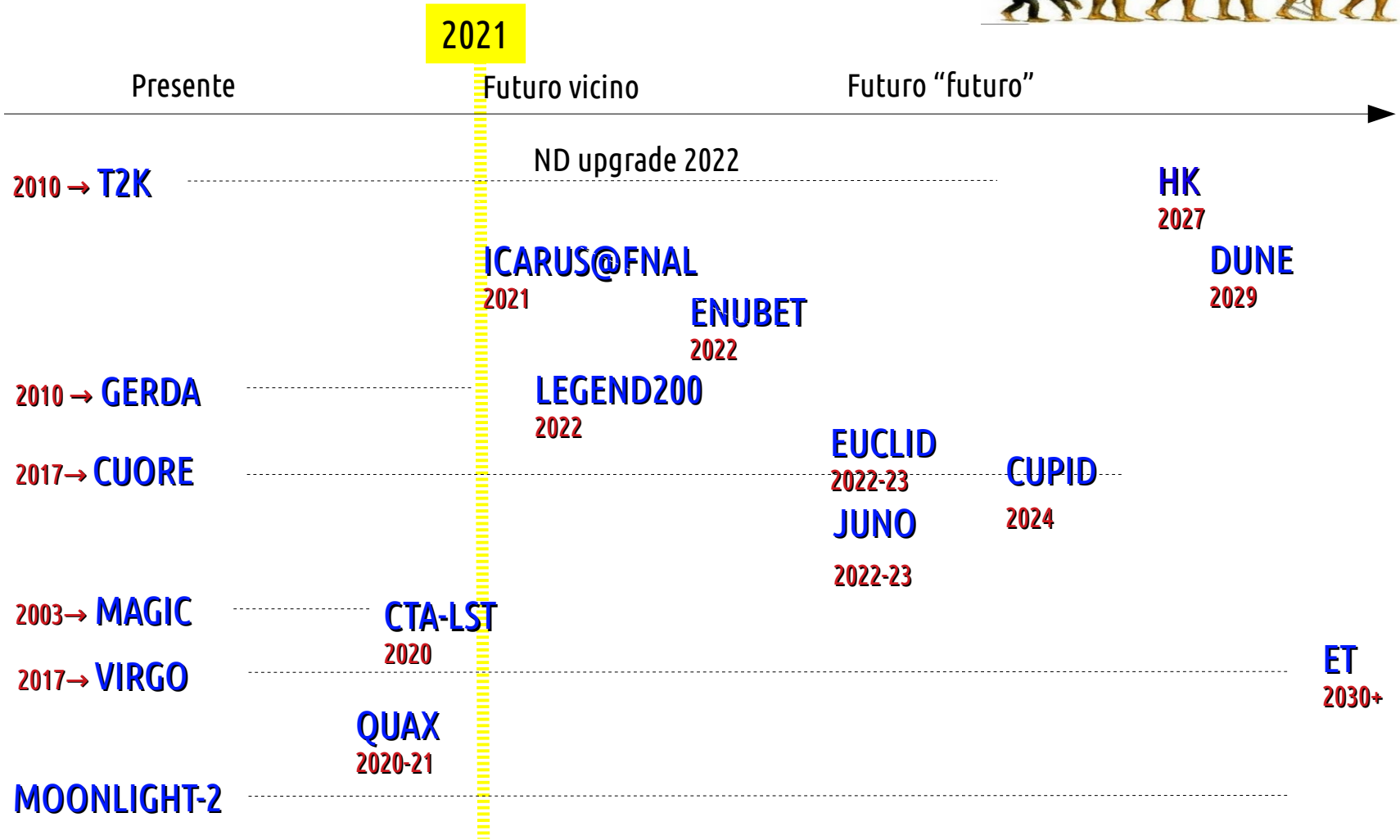
Al momento i migliori risultati rispetto a quelli di tutti gli altri esperimenti di 0νββ

- nessuna indicazione di segnale
- upper limit (Phase II+Phase I): $T^{0\nu}_{1/2} > 1.8 \cdot 10^{26}$ **yr (90% CL)**
- median sensitivity (Phase II+Phase I): $T^{0\nu}_{1/2} = 1.8 \cdot 10^{26}$ **yr (90% CL)**
- background index @ $Q_{\beta\beta}$ (Phase II): $5.2^{+1.6}_{-1.3} \cdot 10^{-4}$ **cts/(keV·kg·yr)**
- Majorana effective mass: $\langle m_{\beta\beta} \rangle$ **< 79 - 180 meV**

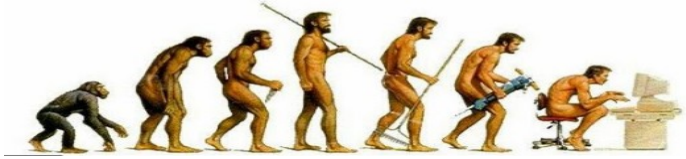
- Altri lavori pubblicati:
  - Modeling of GERDA Phase II data, JHEP 03 (2020) 139;
  - First search for bosonic superweakly interacting massive particles with masses up to 1 MeV/c^2 with GERDA, PRL 125, 011801 (2020);
  - Characterization of inverted coaxial ^{76}Ge detectors in GERDA for future double-decay expeeiments, Eur. Phys. J. C 81 (2021) 505;
  - Calibration of the GERDA experiment, accettato da Eur. Phys. J. C
- molte altre analisi (su differenti processi esotici e su eventi di fondo rari) sono in fase avanzata di sviluppo.

INFN-PD Gr2: "Time wise"





INFN-PD Gr2: “Time wise”



2022

Presente | Futuro vicino | Futuro “futuro”

2010 → T2K

ND upgrade 2022

Inst on site starts end 22

HK
2027

ICARUS@FNAL
Phys run started June 2022

DUNE
2030

ENUBET
Demonstrator test 11/22

2010 → GERDA

LEGEND200
2022 (pilot run in Nov)

EUCLID
>mid-2023

2017→ CUORE

CUPID
2024

JUNO
mid 22:
mechanics done

2003→ MAGIC

CTA-LST
2020

2017→ VIRGO

ET
2030+

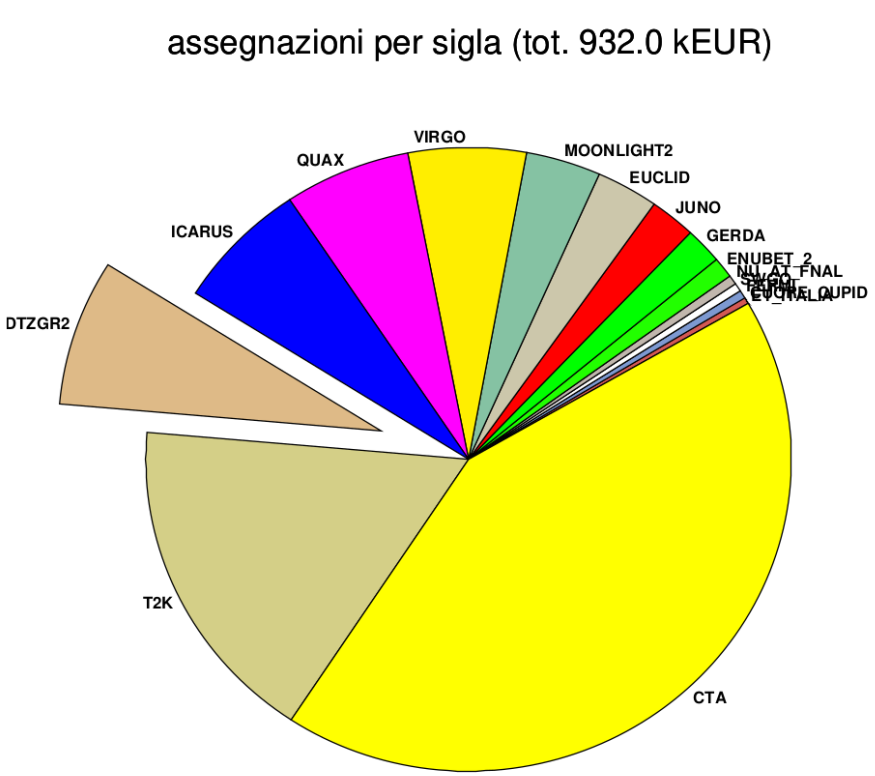
QUAX
2020-21

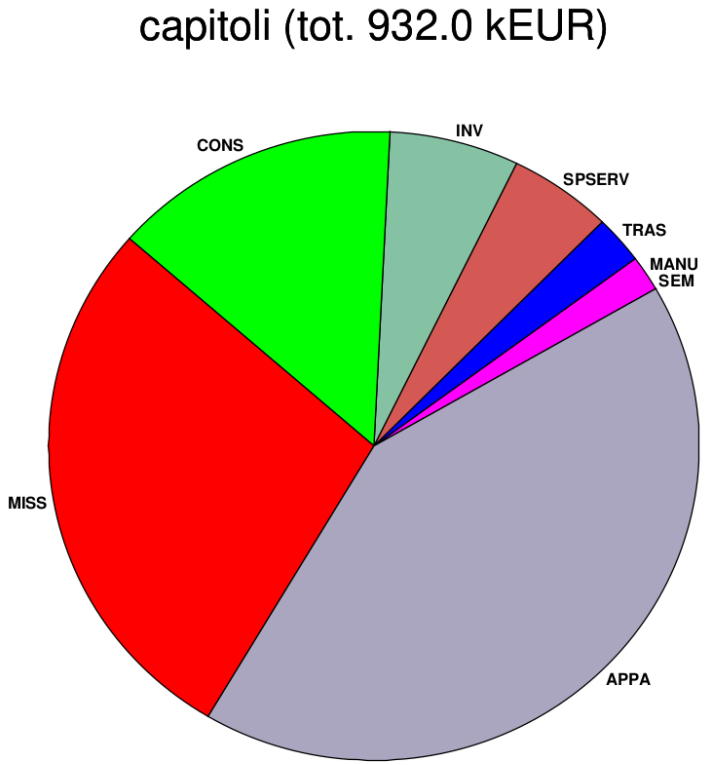
R&D →

Phys. run starts
for 3y @ 14T

MOONLIGHT-2

Assegnazioni @ PD: qualche statistica (2022)

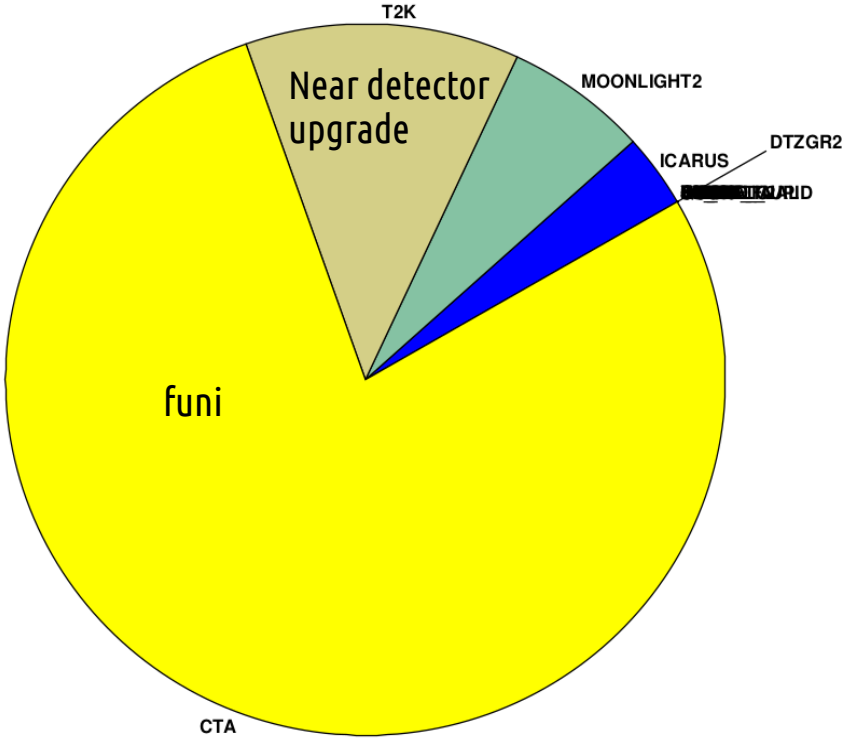




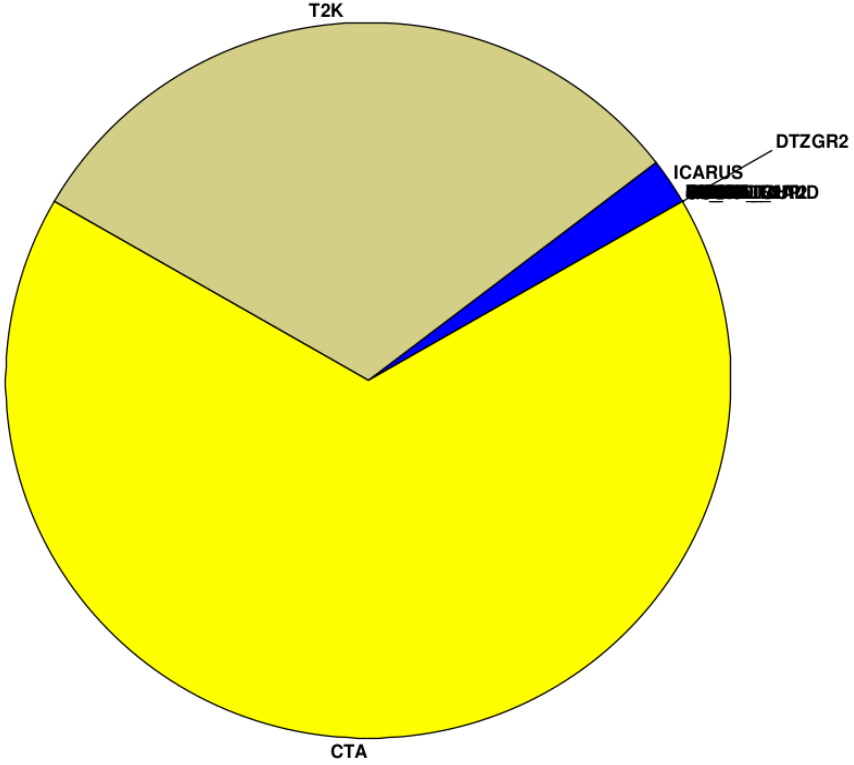
CTA, T2K grossi contributi per apparati (~390 k), missioni essendo in fase di costruzione (l'anno scorso era successo anche per LEGEND e JUNO)

Assegnazioni @ PD: apparati (2022)

assegnazioni APP per sigla (tot. 390.0 kEUR)



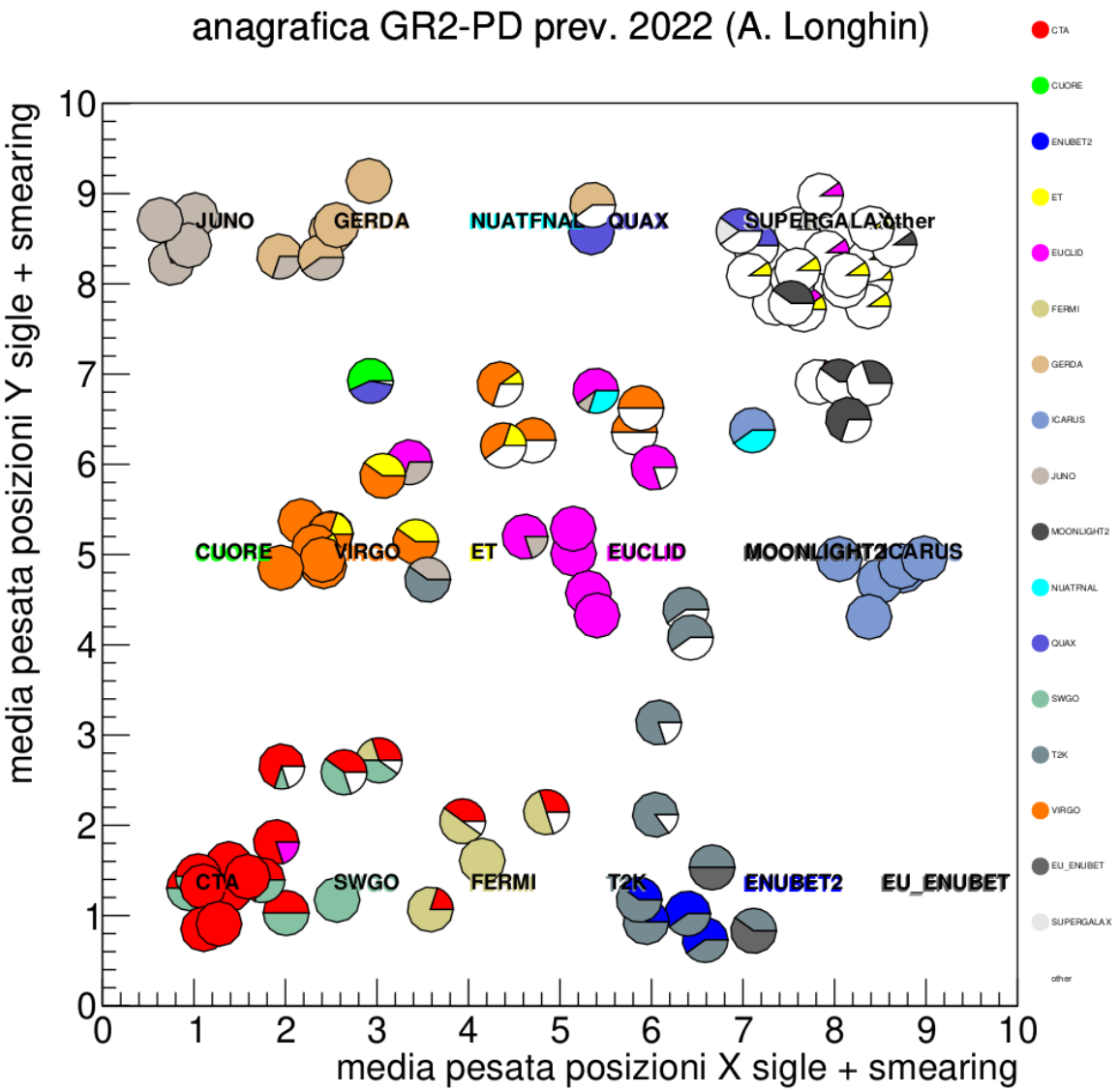
assegnazioni SPS per sigla (tot. 48.0 kEUR)



Anagrafica @ PD

59 → 77 FTE

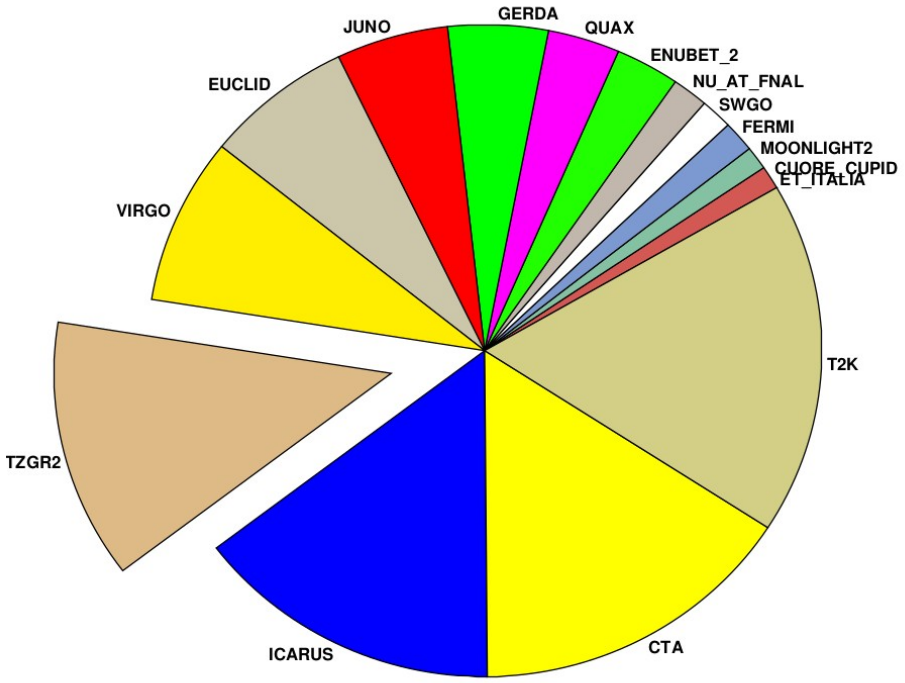
- Tentativo di fare un “foto”
  - 1 pie chart = 1 persona
  - Ogni sigla occupa una posizione in una griglia come indicato dalle labels
  - I colori nelle pie charts indicano le percentuali sulle sigle delle persone
  - La posizione della pie chart è la media pesata delle posizioni delle sigle con uno smearing gaussiano (per evitare che due persone che hanno il 100% sulla stessa sigla risultino completamente sovrapposte)



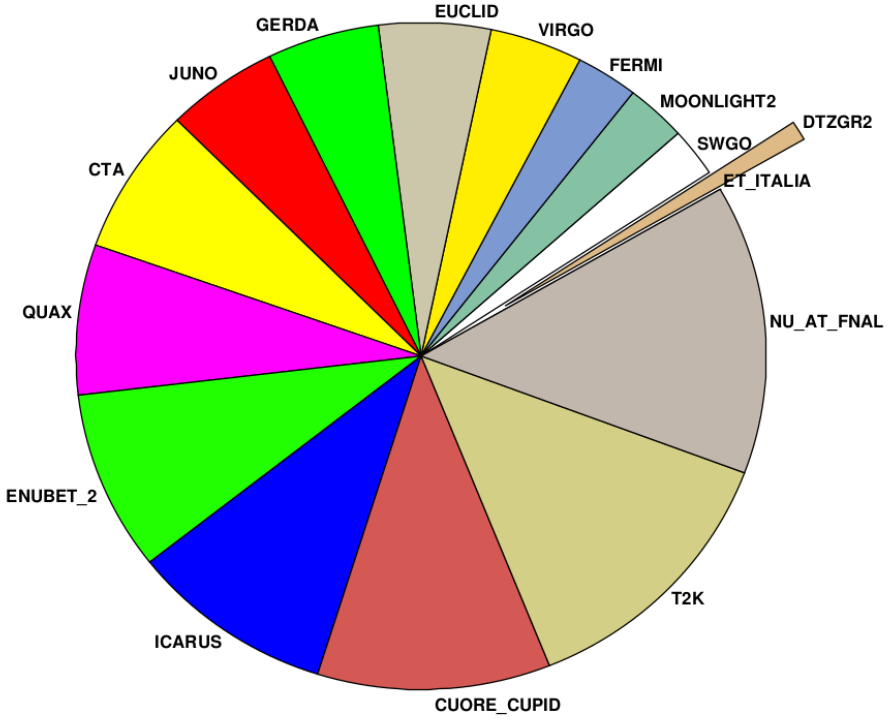
Assegnazioni @ PD: missioni (2022)

~ 3.4k/FTE (4.1 FTE nel 2021). Abbastanza ben bilanciato sulle varie sigle con fluttuazioni da bassa statistica + dipendenza dalle destinazioni (extra-EU + penalizzate)

assegnazioni MISS per sigla (tot. 260.5 kEUR)



assegnazioni MISS/FTE (tot. 260.5 kEUR 77.1 fte)



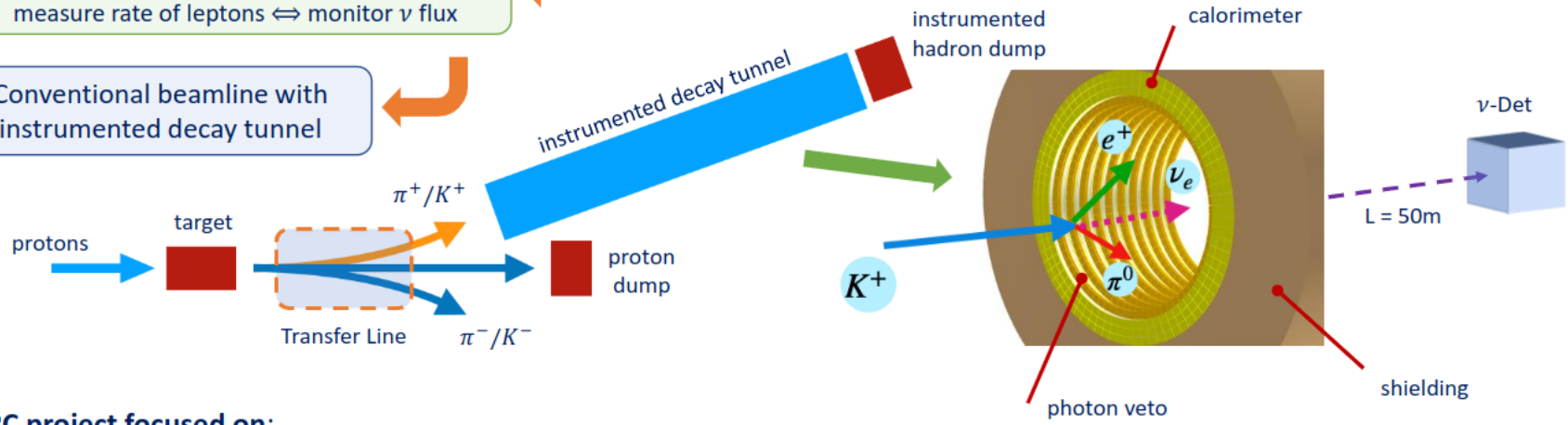
ENUBET: the first monitored neutrino beams

How do we achieve such a precision on the neutrino cross-section, flavor composition and energy?

Monitored ν flux from narrow-band beam
measure rate of leptons ⟺ monitor ν flux

Conventional beamline with instrumented decay tunnel

A. Longhin, L. Ludovici, F. Terranova, EPJ C75 (2015) 155



- **ERC project focused on**:
  measure positrons (instrumented decay tunnel) from K_{e3} $\Longrightarrow$ determination of ν_e flux;
- **As CERN NP06 project**:
  extend measure to muons (instrumented decay tunnel) from $K_{\mu\nu}$ and (replacing hadron dump with range meter) $\pi_{\mu\nu}$ $\Longrightarrow$ determination of ν_μ flux;

Main systematics contributions are bypassed: hadron production, beamline geometry & focusing, POT;

MOONLIGHT-2

P. Villoresi