ALICE	CERN	QGP	8.1 FTE	F. Ronchetti
FOOT	CNAO/TIFPA/ LNS/BTF	Framm. Nucleare	2.1 FTE.	E. Spiriti
e-JLab12	JLAB	Fisica adronica	2.1 FTE	M. Mirazita
BGOOD	Bonn/Mainz	Fisica adronica	1.2 FTE	P. Levi Sandri
	LNF	Fisica nucleare	16.3 FTE	C. Curceanu
	LNGS	Fisica nucleare	7.3 FTE	C. Curceanu
EIC_net	RHIC	Fisica adronica	0.1 FTE	M. Mirazita
nTOF	CERN	Astrofisica nucleare	1.0 FTE	F. Murtas

INFN
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

Attività in CSNIII@LNF

Presentazione dedicata

Silvia Pisano – CSN3 local coordinator
Laboratori Nazionali di Frascati

Funding for the current year
Assegnazioni 2020 (k€)

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

Exp	Ricercatori	Tecnici	FTE	Missioni	Consumo	Apparati	Inventario	Altri consumi
ALICE	9	3	8.1	34	2.5			11 2
FOOT	3	2	2.1	7 4	8.5	15	1	2
JLAB	4	1	2.1	23	3	300		
KAONNIS	21	2	16.3	13	21		21.5	16 2
MAMBO	2		1.2	4	3			
N_TOF	3		1.0	5	6	9		
VIP	11	2	7.3	16.5 6	3		21.5	9
DTZ (1.5 per EIC_net + 1)				30.5	15		20	7

LNF activities

Researchers and Technologists: **8.1 FTE**

Bianchi N.	1.0
Danè E.	0.2
Fantoni A.	0.9 (0.1 PAPRICA)
Gianotti P.	0.7
Larionov P.	1.0
Matuoka P.	0.5
Muccifora V.	0.9 (0.1 PAPRICA)
Pisano S.	1.0
Ronchetti F.	0.9 (0.1 PAPRICA)
Spiriti E.	0.1
Toppi M.	0.9 (0.1 PAPRICA)

Technicians: Orlandi, Paoletti, Passamonti, Pierluigi, Russo

FORTE SINERGIA CON PAPRICA (CSN5)

+ Saputi per ITS3

+ contributo Viticchié (pensionato)

The LNF Group Joined ALICE in 2006

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

Responsibilities at CERN

Management Board (AF, 11/2019-in carica)

Collaboration Board (VM, 06/2017-in carica)

Run Coordinator (FR, 2015, 10/2019-in carica fino 2022)

Period Run Coordinator (AF, 2015)

Head of LS1 Consolidation ALICE Task Force (FR, 2013-2014)

Period Run Coordinator (FR, PDN, 2012)

EMCAL Deputy Project Leader (AF, 2013-in carica; NB, 2007-2012)

EMCAL/DCAL Euro-Asian Coordinator (AF, 2008-2012)

EMCAL System Run Coordinator (FR, 2011-2012)

EMCAL High Level Trigger Coordinator (FR, 2009)

ALICE Activities at LNF

ITS Upgrade production Local Technical Coordinator (FR, 2016-2019)

Physics Analysis Coordinator (SP, 2016-in carica)

EMCAL/DCAL production Local Technical Coordinator (AF, 2010-2011)

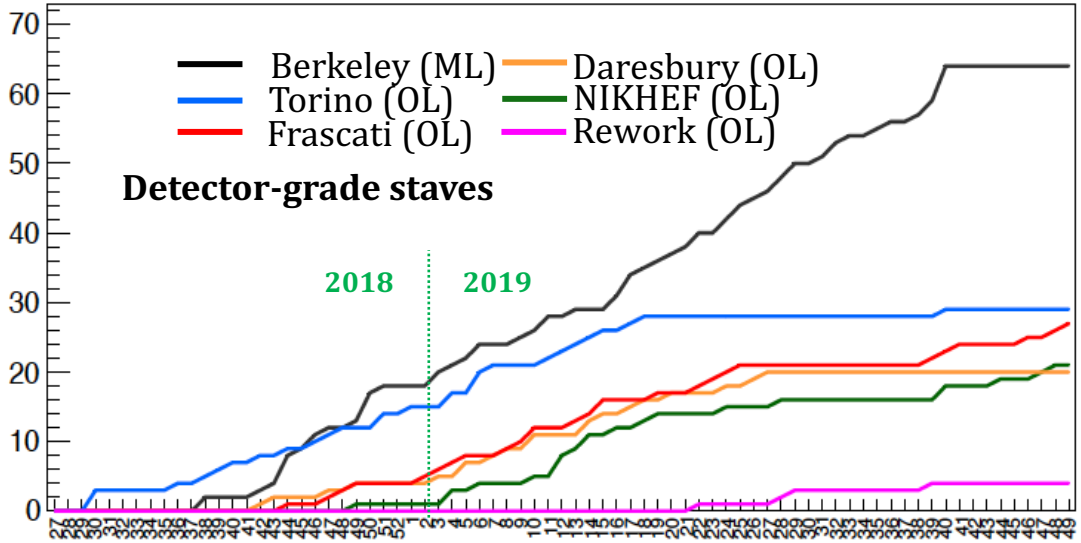
EMCAL production Local Technical Coordinator (FR, 2006-2009)

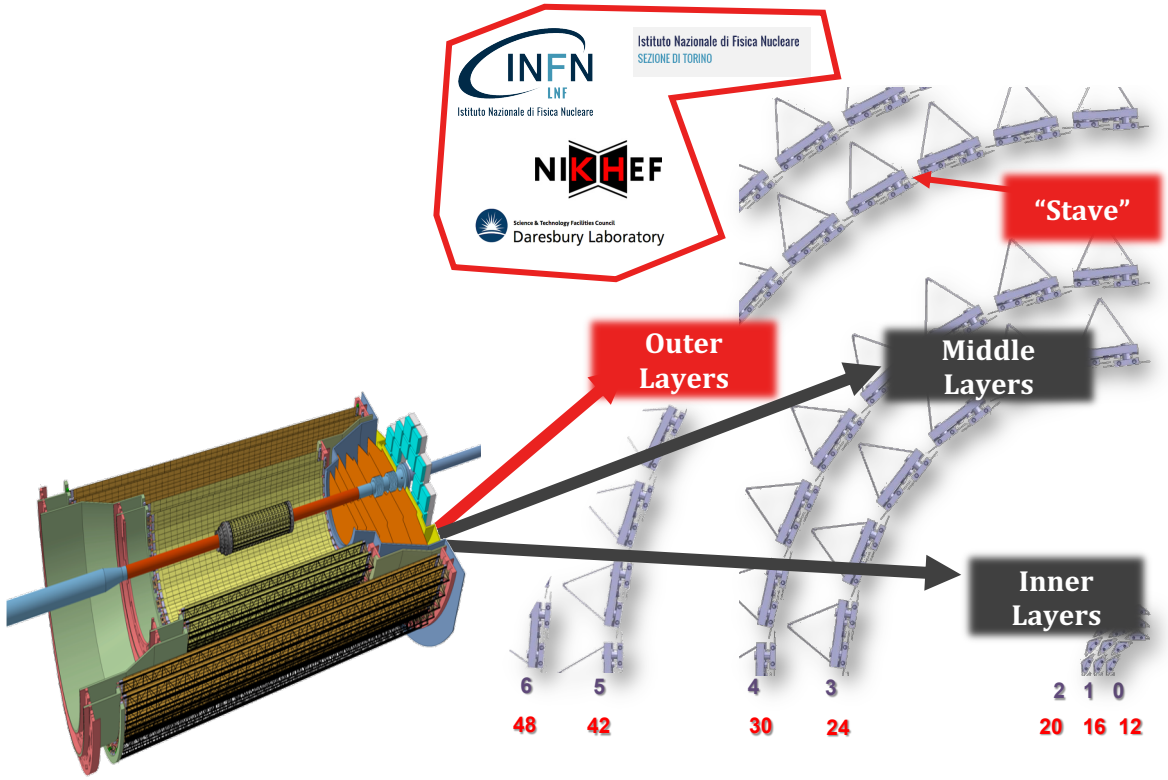
LNF production summary – ITS2

Full production at LNF started in Feb 2018 and ended in June 2019.

The LNF group also contributed to the development and debug of the procedures

- Debug of the readout system
- Development of wire bond repairs using conductive glues
- Development of mechanical procedures and tooling to rework finished staves





ML Staves Total: 64

- ML completed in August
- Spares completed in September

OL Staves Total: **101**

- OL completed in September
  a Spares followed in December (ITS.14)

LNF production summary

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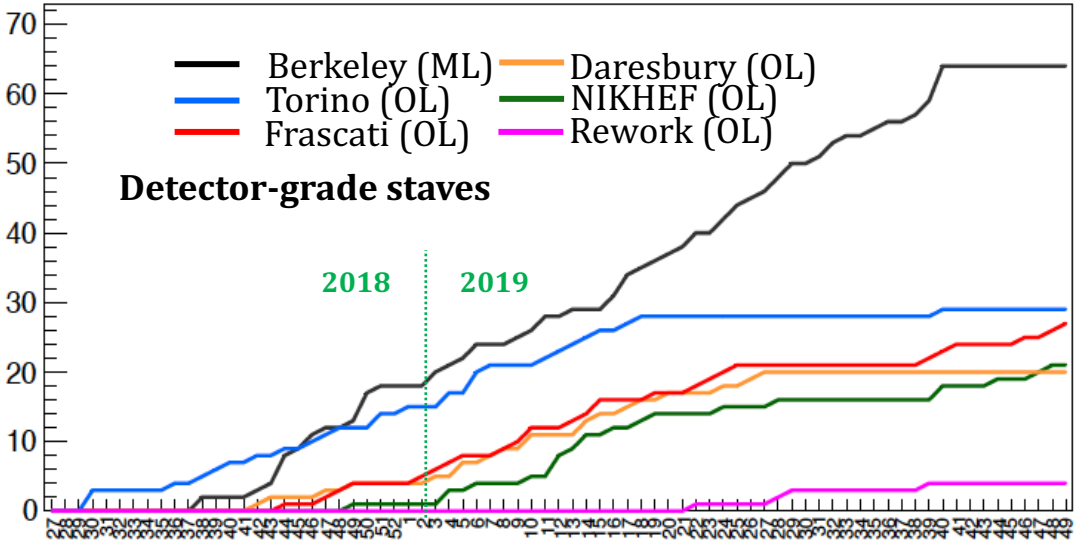
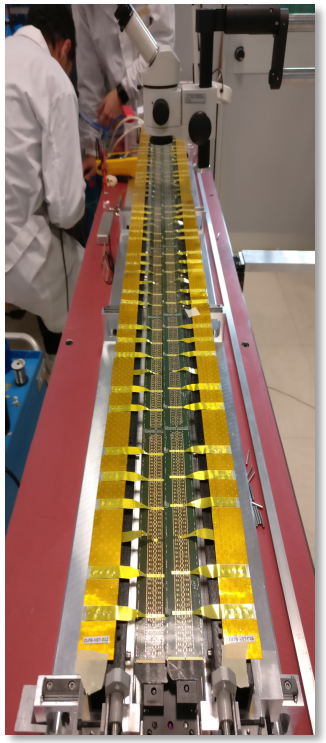


Production@LNF: 29 (27+2)

It served as the only remaining site for spare production, hard rework

97% yield



ML Staves Total: 64

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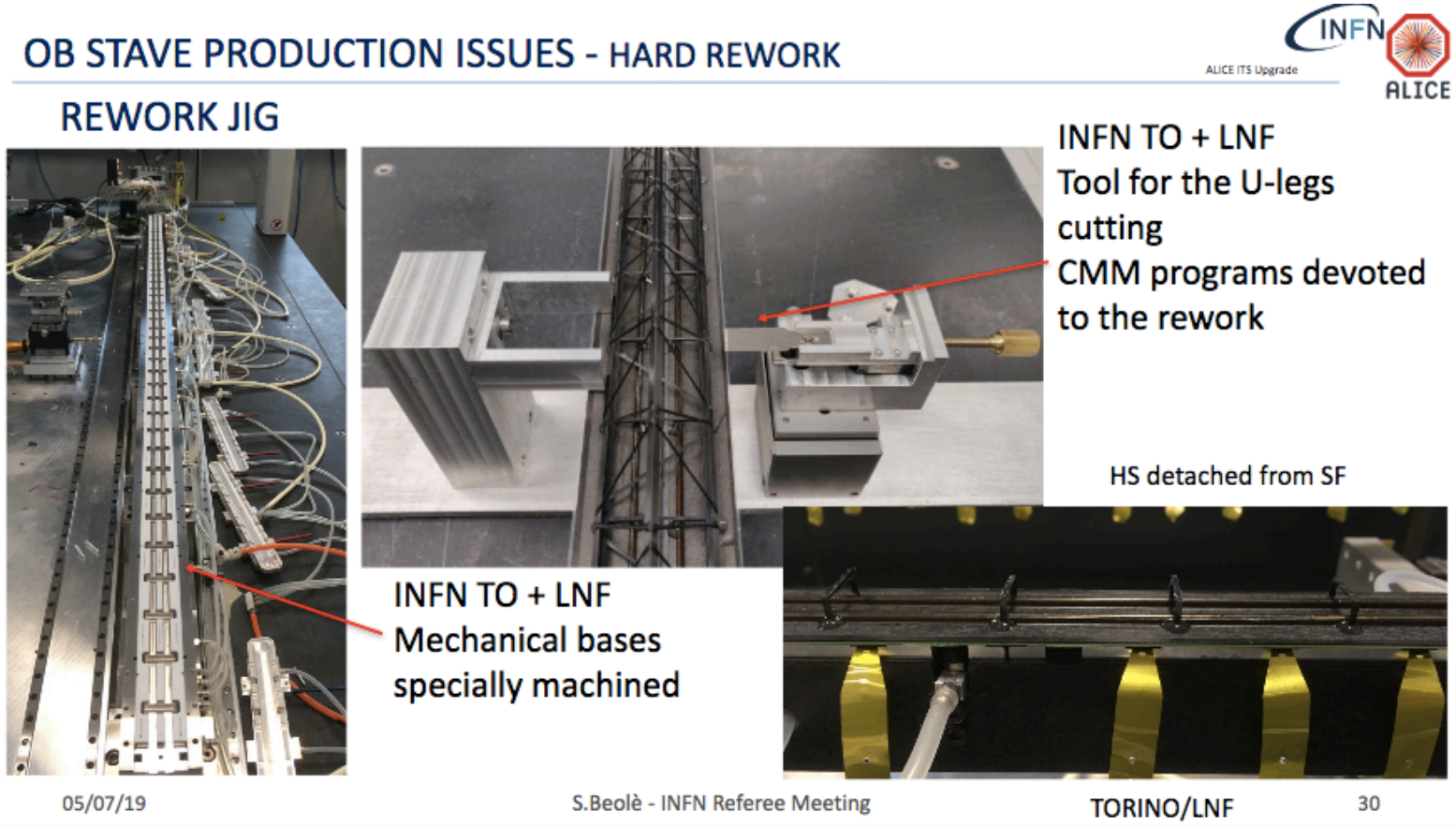
OL Staves Total: **101**

- OL completed in September a Spares followed in December (ITS.14)

Strong contribution on tool and procedure development



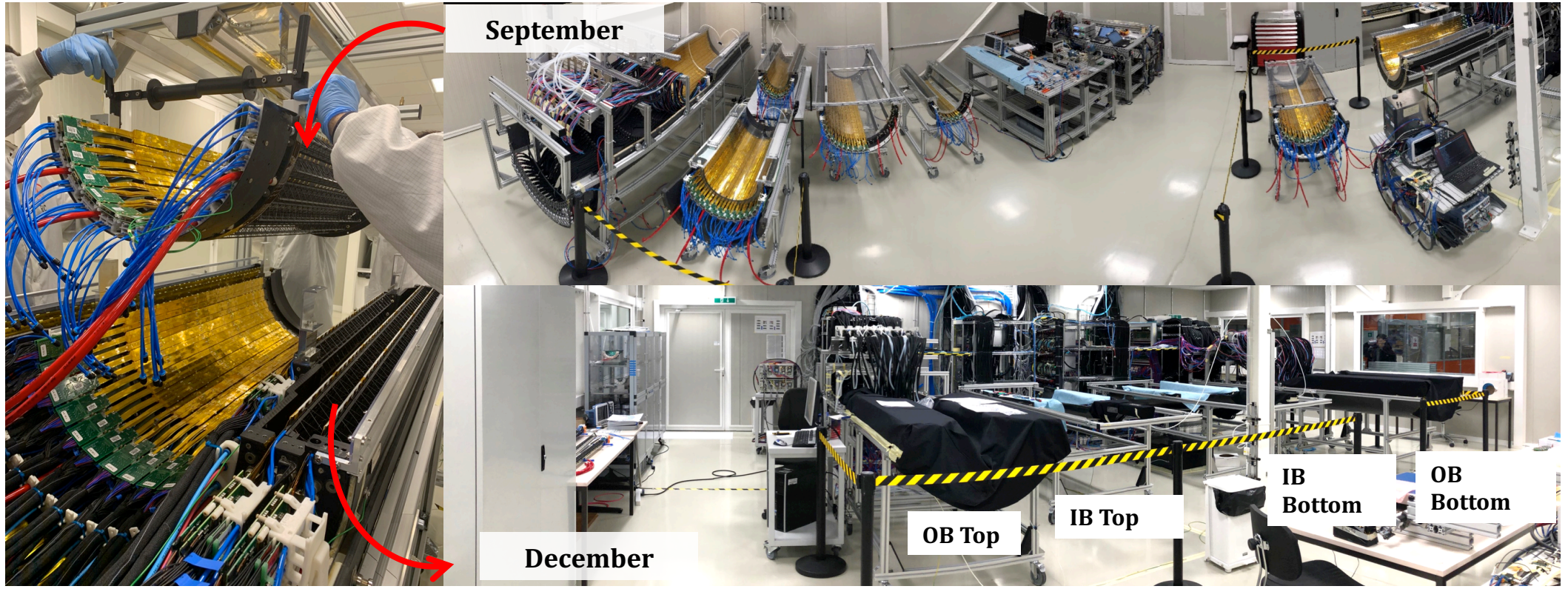
High recognition of the relevant contribution from LNF technical personell in terms of timing respected, quantity and quality of the production and tool/procedure developments.

Thanks to E. Danè and all the technicians involved!

Outer barrel assembly at CERN

OB HB-TOP: Install L4-TOP (WK 39) → Install L3-TOP (11 OCT) → connection services (PP2-PP1) → commissioning

OB HB-BOT: L5-BOT (install 9 staves), L3-BOT (install 4 staves) → Install L5-BOT (31 Oct), L4-BOT (11Nov), L3-BOT (25 Nov) → connection services (PP2-PP1) → commissioning → Data cables lowering in the Service Barrel



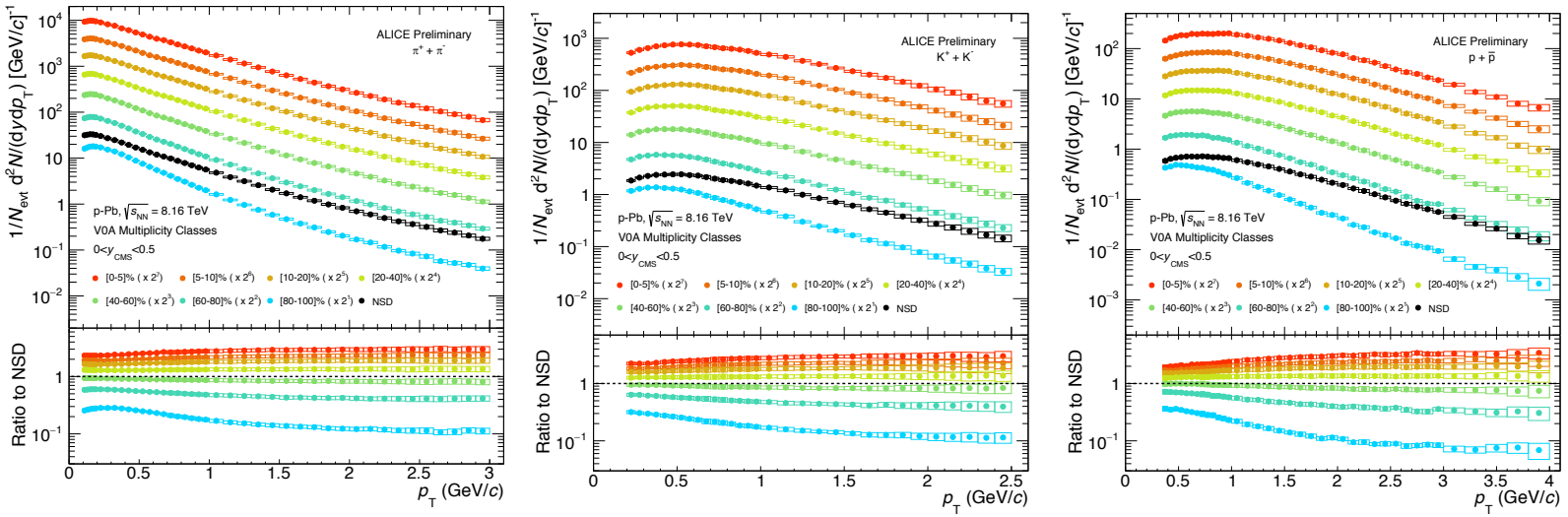
Analysis activity

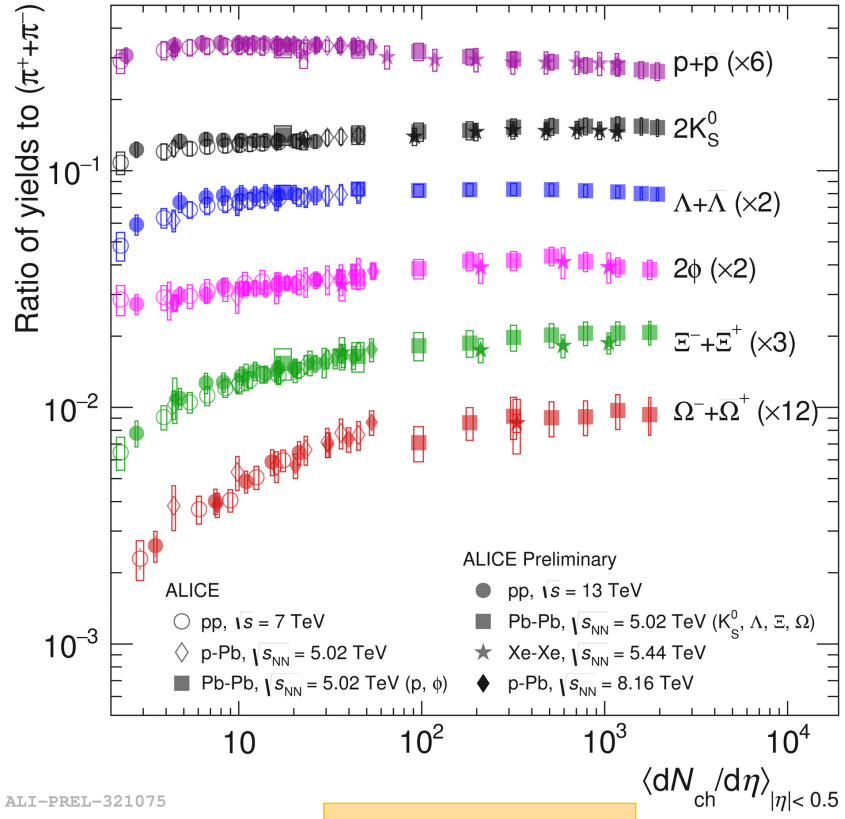
Light-flavour hadron production vs. multiplicity in pp and in p-Pb collisions with ALICE

Low-p_{T} hadrons containing light flavours (u, d, s) constitute the bulk of the particle production at LHC (99%)

They allow one to study the whole system, analyzing its thermodynamic properties and exploring the emergence of collective phenomena

Are phenomena typical of QGP such as collectivity, chemical abundances, strangeness enhancement present in small systems?





P. Larionov ITSsa
S. Pisano TPC
M. Toppi TOF

Analysis activity

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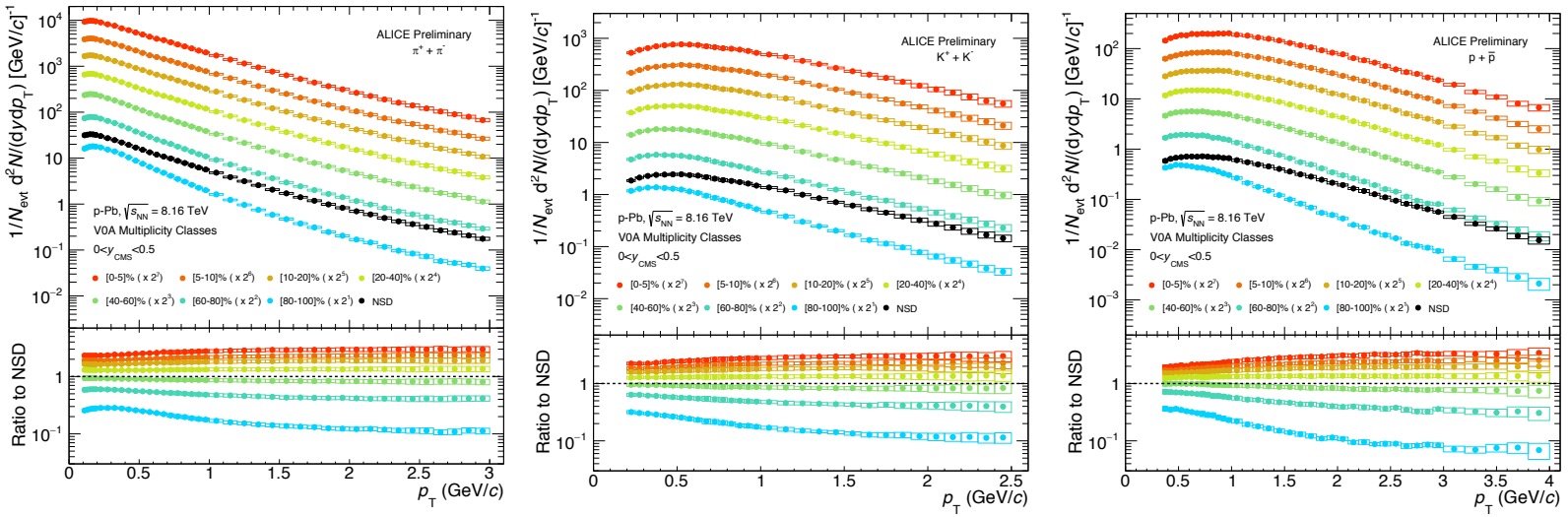


Plans for 2020-2021

Analysis approved on 2019 and results presented at international conferences.

Poster by P. Larionov and talk by S.P. at Quark Matter 2019

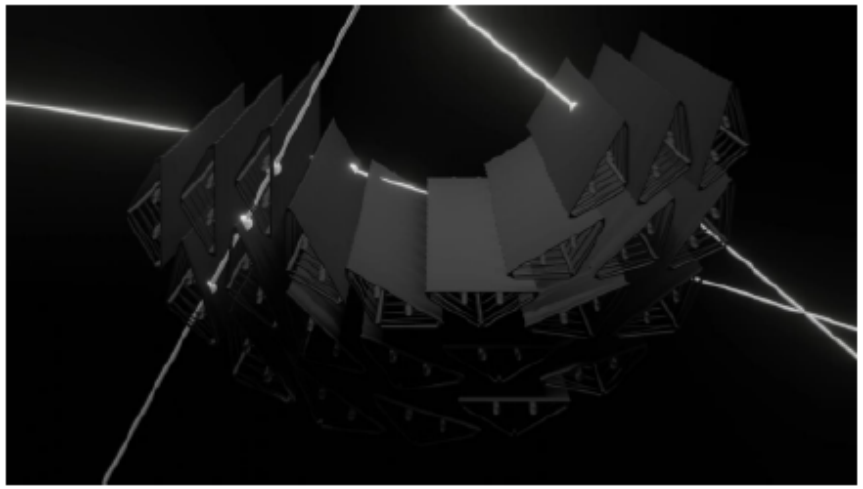
Paper in preparation.

New analysis started for spectra measurement in *pp* data at 5.02 TeV with an undergraduate student from Sapienza University (A. Pournaghi)

Attività nel 2020-2021 e richieste

Completamento commissioning ITS2 @ CERN (with technicians):

- shifts for OL commissioning to be resumed in August/September 2020 (two full months needed for the whole commissioning)



- moving of the ITS from the clean room@167 (CERN) to P2 in 2021
- installation
- standalone and global commissioning in ALICE da giugno 2021

Contributo tecnici per commissioning OL ed installazione ITS 2

Contributo A. Saputi per meccanica (cooling) ITS 3

Nessuna richiesta importante ai servizi

Richieste esigue 1 m.u. per piccole lavorazioni e elettronica per silici PAPRICA

Richieste economiche principalmente di missioni:

- circa 50k per 2021 per missioni
  1. turni commissioning ITS2, ALICE
  2. test beam per caratterizzazione e test sensori, sviluppo e test cooling ITS3
  3. riunioni/discussioni fisica per ITS3
  4. riunioni MB, CB, TB
- circa 5k per manutenzione e sviluppo camera pulita

FOOT: FragmentatiOn Of Target

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

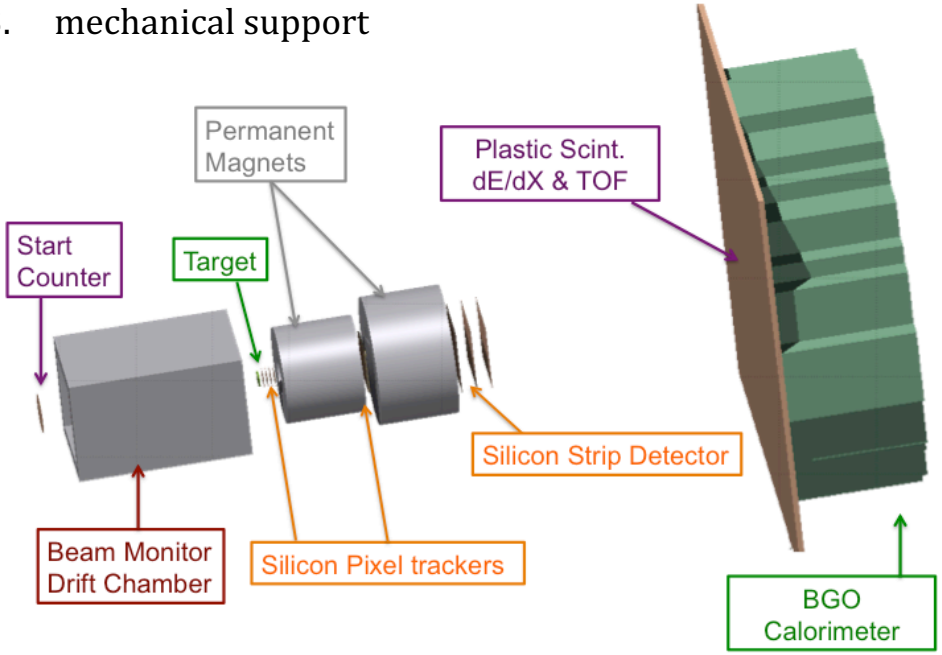
Approved as R&D in CSN3 in 2017

5 Physicists for 2.1 FTE
Average participation of 42%

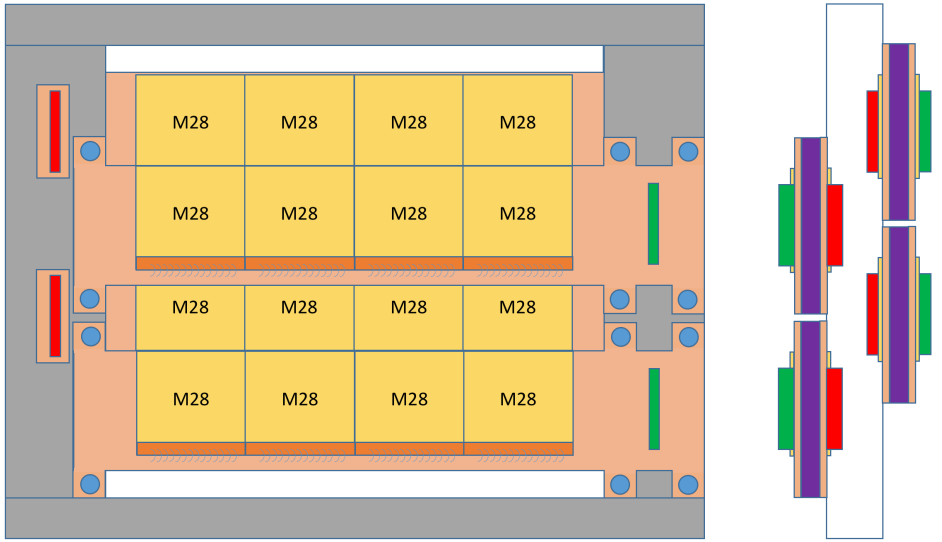
Study of the target fragmentation to improve the nuclear fragment description in the next generation Treatment Planning Systems

Main LNF responsabilities:

1. vertex tracker
2. inner tracker
3. mechanical support



Inner (pixel) tracking system



1 module = 4 Mimosa sensors M28
1 Ladder = 2 modules
1 Layer = 2 Ladder
Inner tracker = 2 Layer (4 Ladder)

Attività 2021

Due to two issues, part of the 2020 activity was postponed to 2021:

1. **The company for the ladder assembly procedure (Ultimate sensors) for the Inner Tracker cannot accomplish the task → new strategy under definition**
2. **Bid for magnets started only recently – it should be over by mid July**

- Finalization and test for the FPC (Flexible Printed Circuit) for the middle tracker (SEA)
- Magnet bid finalization and test@**Laboratorio Misure Magnetiche (**LNF)
- Construction and test of the Inner Tracker (SEA)
- Development of an integrated redout system for the middle tracker (SEA)
- Design of the support system integrated on the readout board of the middle tracker (SPAS)
- Desing finalization and construction of the mechanical structure for the whole tracking system - *start counter, beam monitor, vertex detector, middle tracker, magnets, MSD* (SPAS)
- First data taking RUN@CNAO
- R&D of new «analog» pixel sensors (STRONG2020 project involving LNF, Trento, Bari, Strasburgo, GSI, DMKZ)

LNF ricercatori&tecnologi		
1.	Raffone G.	0.5
2.	Sanelli C.	0.0
3.	Sciubba A.	0.9
4.	**Spiriti E.**	**0.6**
5.	Tomassini S.	0.1
Totale		**2.1**

Richieste finanziarie:

Missioni	12 k€	(riunioni collaborazione, presa dati)
Apparato	10 k€	(Meccanica, Inner Tracker, Read Out)
Consumo	10 k€	(Materiali per test magnetici, meccanica)
Trasporto	2 k€	(per test GSI, CNAO)

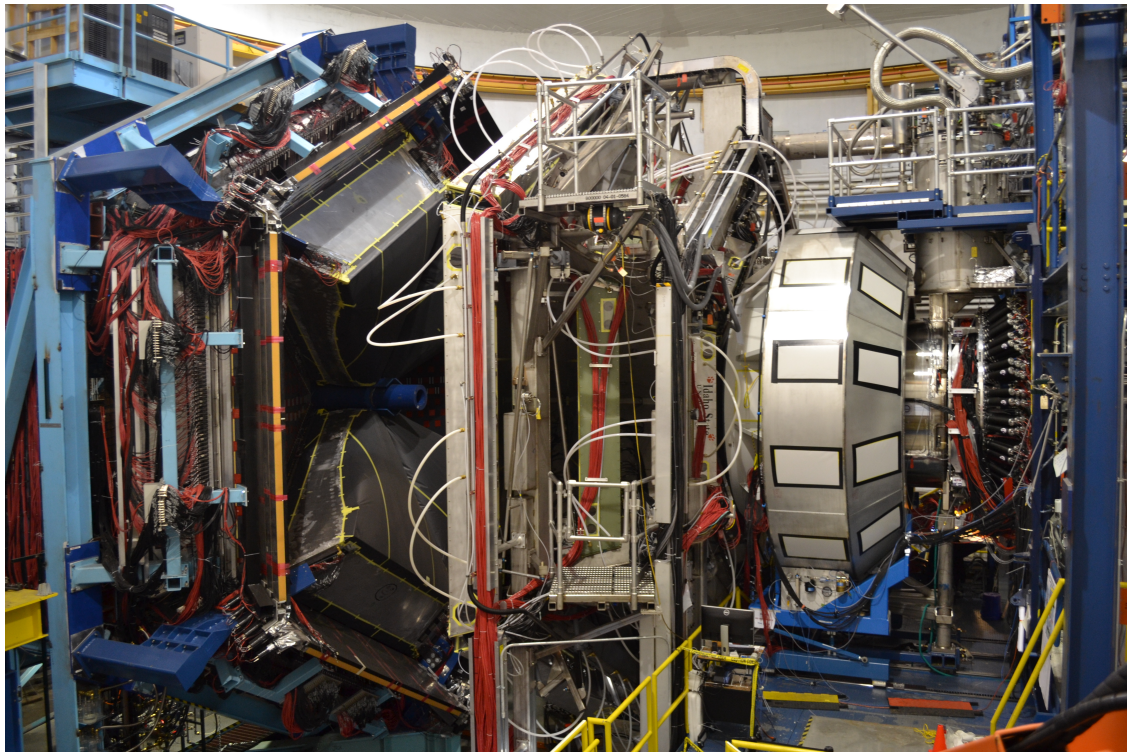
Richieste (indicative) servizi:	
SEA	4 mu
SPAS	3 mu
Off. Mecc.	3 mu
Lab. Mis. Magnetiche	3 mu

Le richieste finanziarie presuppongono un possibile riutilizzo come residui di parte dei fondi del 2020 (vedi ritardi citati)

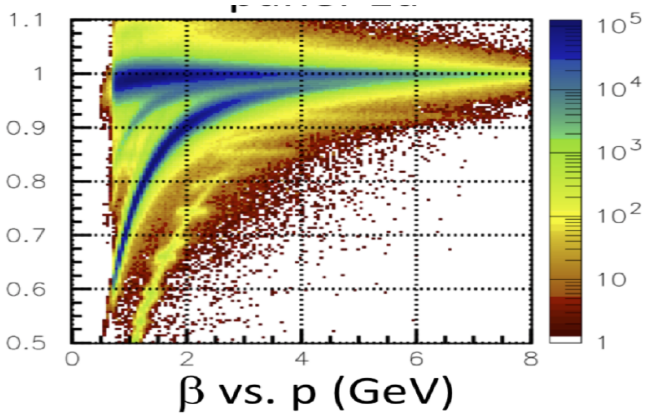
Physics activity at Jefferson Lab in Hall B with the CLAS12 detector

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

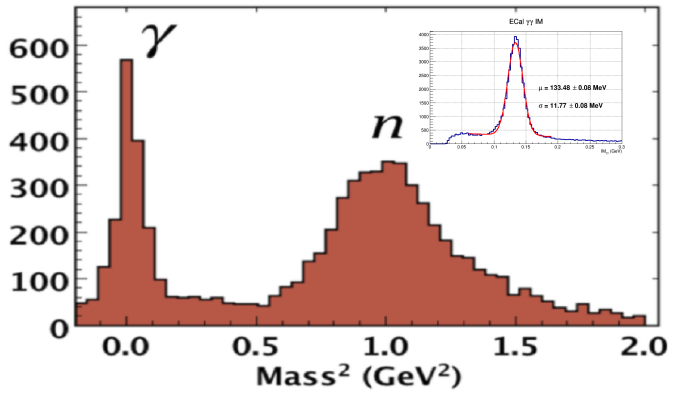
1. study of the 3D structure of the nucleon in eN scattering: semi-inclusive and exclusive measurements in the the Deep Inelastic Scattering region, extraction of partonic functions (GPDs, TMDs)
2. Construction of a RICH detector for the identification of kaons: first module installed in 2018, second module under construction



CLAS12 performance:
identification of charged and neutral particles in 4π



DC+TOF



EC – electromagnetic calorimeter

Data analysis at LNF

$e\,p \rightarrow e'\pi\,\pi\,X$

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

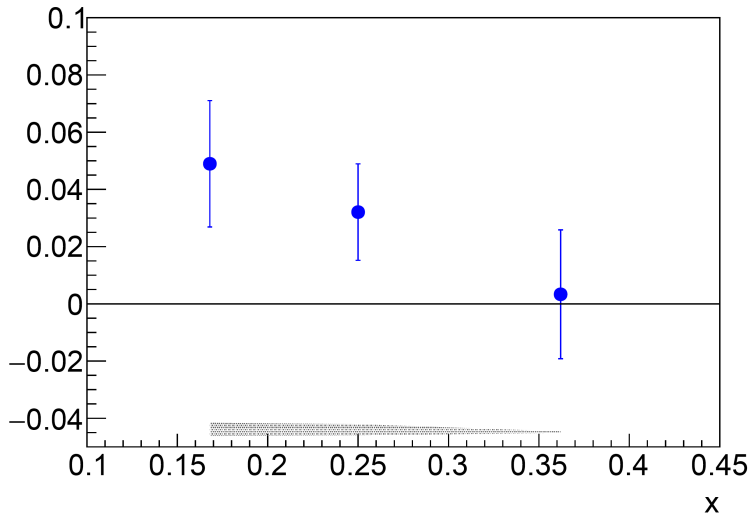
Di-Hadron electroproduction in the DIS regime → provides access to quark-quark and quark-gluon correlations in the collinear approximation

1) Beam-Spin Asymmetry with CLAS 6 GeV data

M. Mirazita

$$A_{LU} = \frac{N^+ - N^-}{N^+ + N^-} \propto \frac{\sigma_{LU}}{\sigma_0}$$

It gives access to the $e(x)$ PDF, related to the nucleon scalar charge



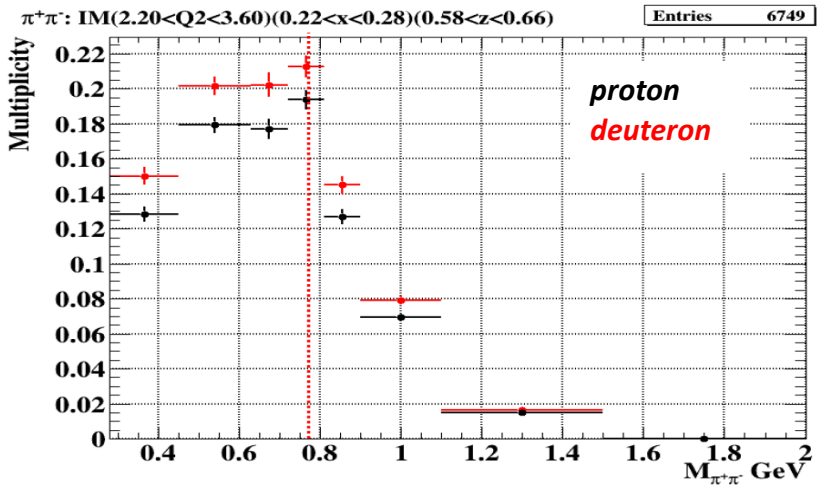
Analysis approved, paper under review by the CLAS Collaboration

2) High precision, multi-D measurement of multiplicities with CLAS12 GeV data on proton and deuteron targets

O. Soto

$$M(z, Q2, x, M_{hh}) = \frac{d\sigma^{hh}/dx_B\,dQ^2\,dz\,dM_{hh}}{d\sigma_e^{DIS}/dx_B\,dQ^2}$$

5D analysis in $x_B, z, Q^2, m_{\pi\pi}, p_T$, flavor separation for di-hadron fragmentation functions



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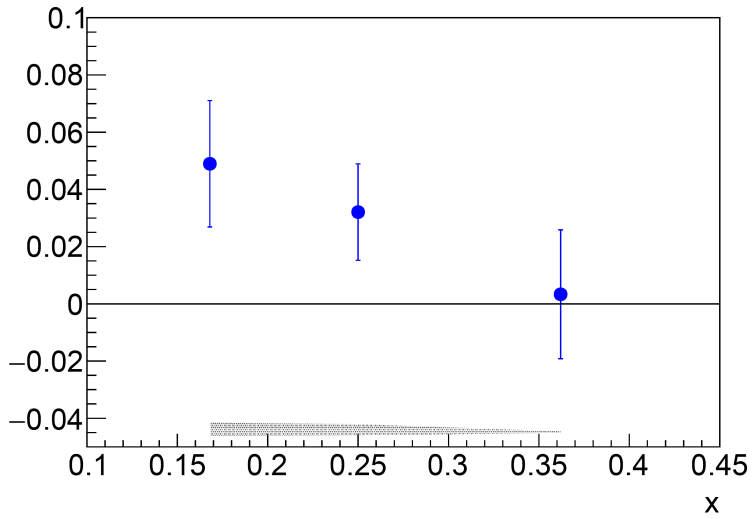

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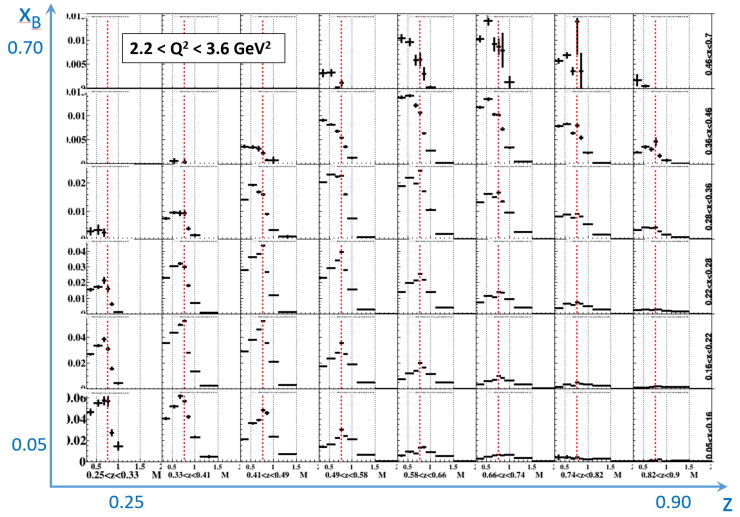
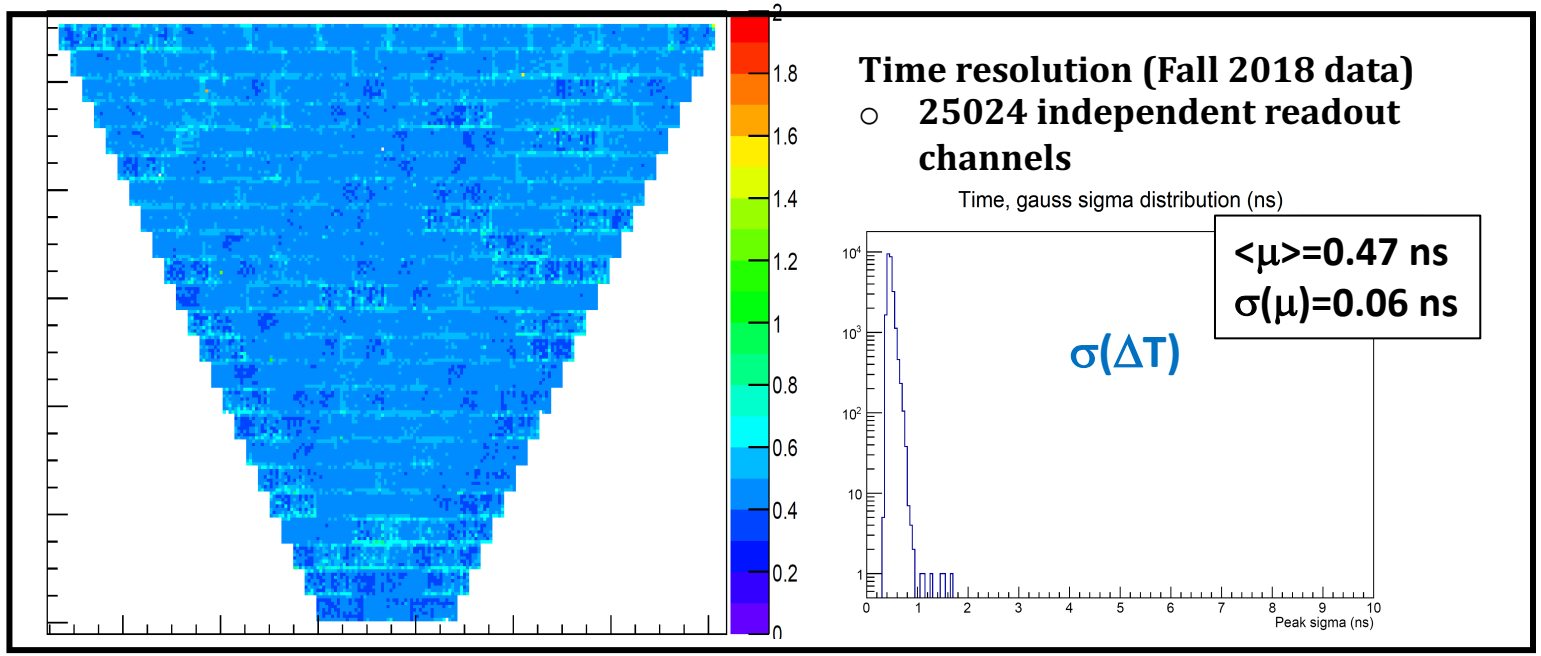


The CLAS12 RICH detector

1. **Extend PID capabilities of CLAS12 to kaons in the 3÷8 GeV/c momentum range**
2. **Hybrid solution: proximity gap plus mirror focusing**
3. **First module installed in January 2018 → smoothly operated since then.**
4. **No major hardware problem have been reported.**

System specifications

- Time resolution
  - Better than 1 ns to distinguish direct from reflected photons
- Cherenkov angle resolution (spe)
  - Direct photons: 4.5 mrad
  - Reflected photons: 5 mrad
- Particle identification
  - π/K rejection better than 500 for p 3÷8 GeV/c
  - p/K rejection better than 100 for p 3÷8 GeV/c

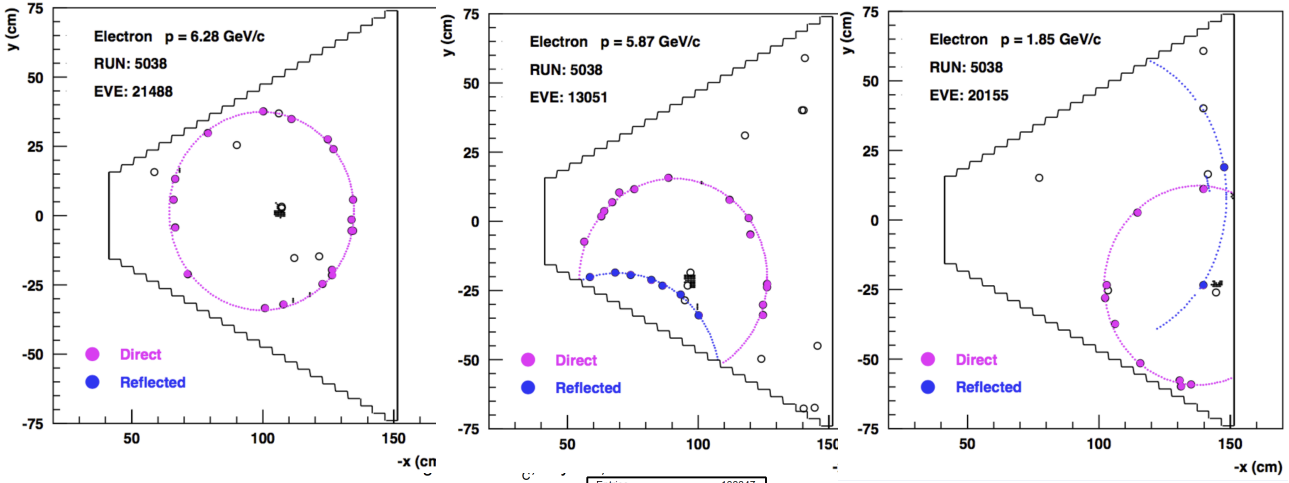


RICH event reconstruction

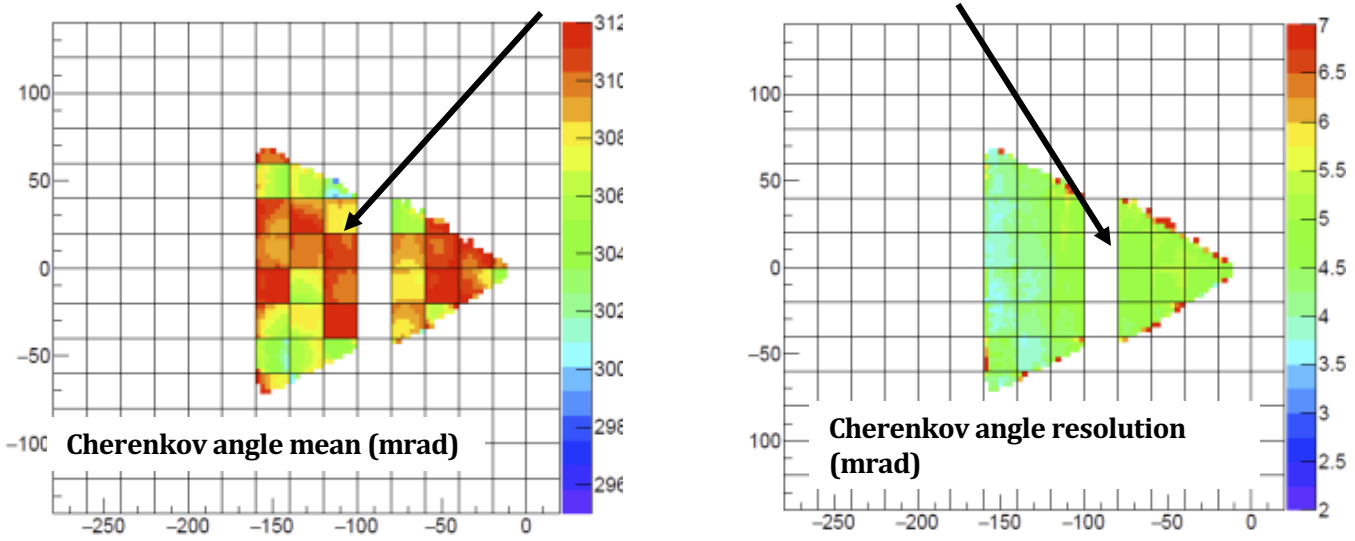
Complex system, requires several calibration steps to reach the ultimate PID performance

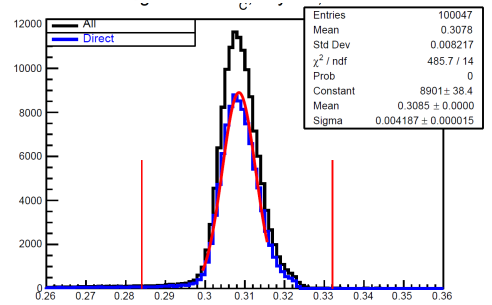
- **25024 readout channels → timing cuts, efficiencies**
- **102 aerogel tiles → different refractive index**
- **7 planar mirrors and 10 spherical mirrors → independent alignment**

Electrons are used as calibration sample → initial results with direct Cherenkov photons (no reflections)



one square = one aerogel tile

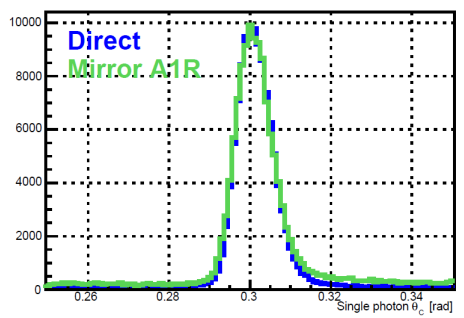


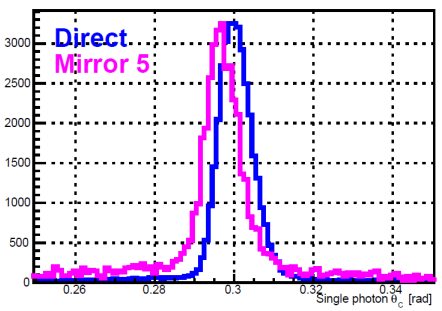


one representative tile

- **direct photons**
- **planar mirror**
- **spherical mirror**

➢ **clear signal also for reflected photons**

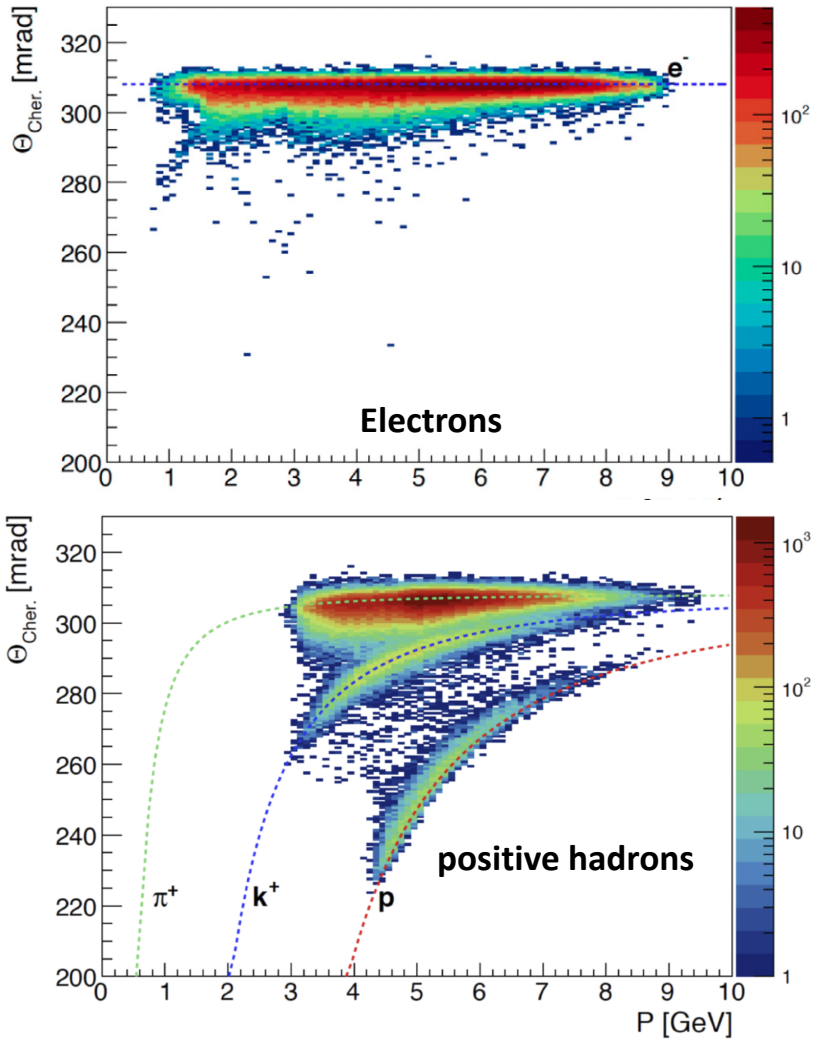




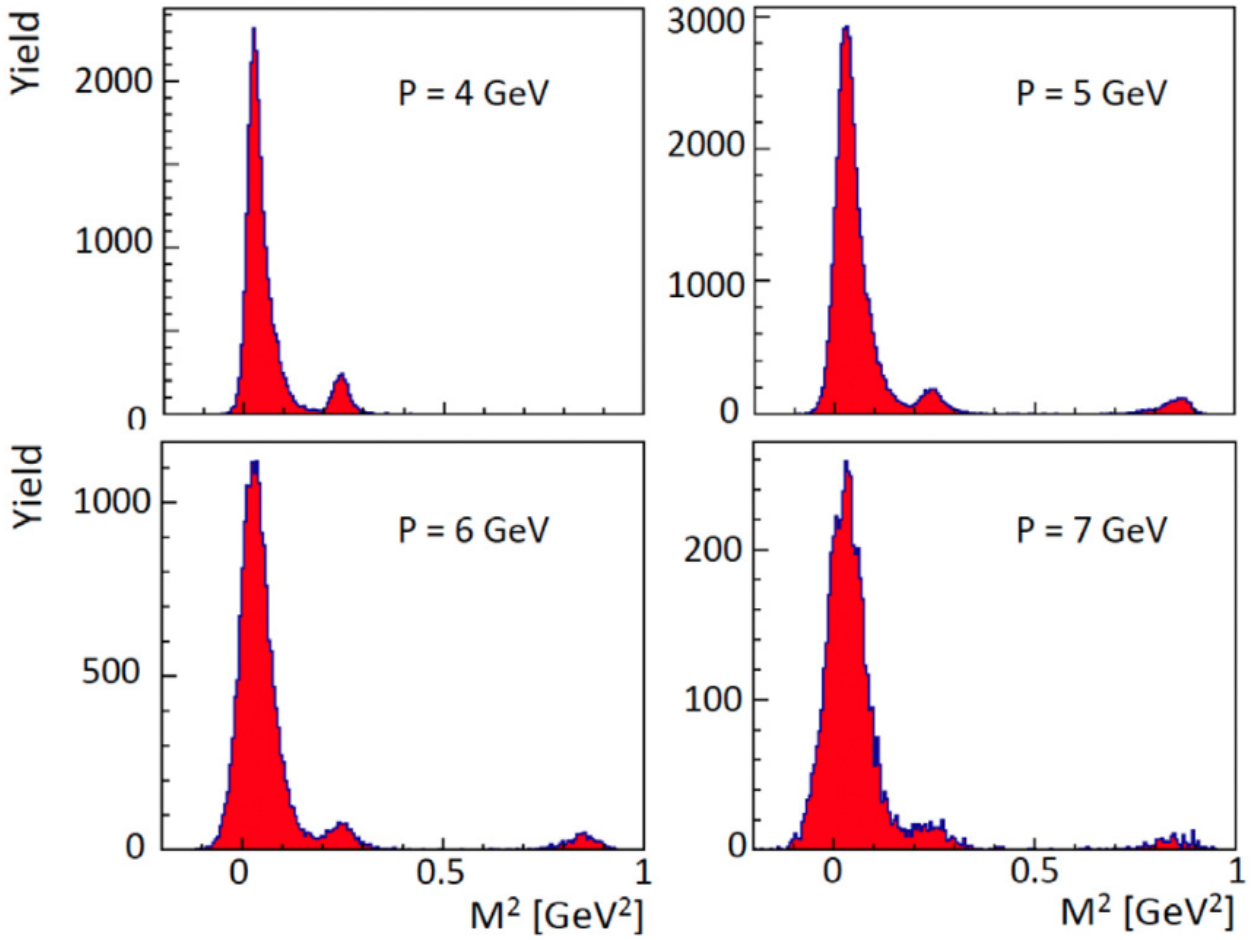
smaller pixelization inside the tiles using the track information

RICH PID performances

Average Cherenkov angle per track



one representative tile



RICH PID performances

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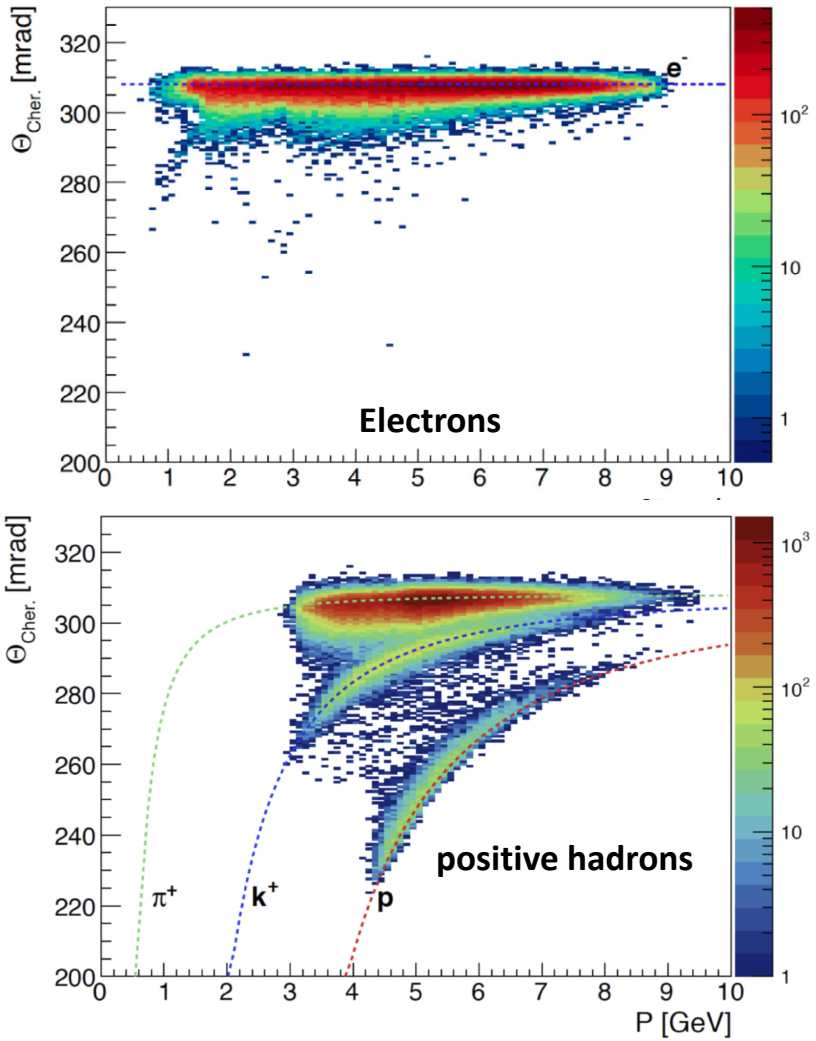

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journal homepage: www.elsevier.com/locate/nima

The CLAS12 Ring Imaging Cherenkov detector

M. Contalbrigo [a,*], V. Kubarovsky [f], M. Mirazita [b], P. Rossi [f,b], G. Angelini [b,j], H. Avakian [f], K. Bailey [g], I. Balossino [a], L. Barion [a], F. Benmokhtar [h], P. Bonneau [f], W. Briscoe [j], W. Brooks [k], E. Cisbani [c], C. Cuevas [f], P. Degtiarenko [f], C. Dickover [f], K. Hafidi [g], K. Joo [i], A. Kim [i], T. Lemon [f], V. Lucherini [b], R. Malaguti [a], R. Montgomery [b], A. Movsisyan [a], P. Musico [d], T. O'Connor [g], D. Orecchini [b], L.L. Pappalardo [a], C. Pecar [h], R. Perrino [e], B. Raydo [f], S. Tomassini [b], M. Turisini [a,b], A. Yegneswaran [f]

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[i] University of Connecticut, Storrs, CT, 06269, USA
[j] The George Washington University, Washington, DC, 20052, USA
[k] Universidad Técnica Federico Santa María, Casilla 110-V Valparaíso, Chile

Plans and requests

Le richieste, sia finanziarie che ai servizi, riguardano la costruzione del secondo modulo del RICH:

1. struttura meccanica: acquisto completato, in produzione
2. aerogel: acquisto compeltato, in produzione
3. specchi piani: produzione quasi completata
4. elettronica: produzione quasi completata
5. MAPMT: acquisto in corso in collaborazione con il JLAB, da completare entro il 2020; produzione in corso
6. specchi sferici: 2021
7. servizi (cooling, HV e LV, DAQ, etc): in corso (JLab)

Installazione prevista nella seconda metà del 2021

Richieste ai servizi LNF

- 0.5 FTE per il supporto alla costruzione, assemblaggio e installazione del secondo modulo
- produzione in officina e da stampante 3D di piccoli componenti (attacchi specchi, distributori azoto e raffreddamento, supporti per aerogel): in corso, proseguira' nel 2021, tutto già realizzato per il primo modulo

Ricercatori/Tecnologi

1.	**M. Mirazita**	**0.9**
2.	P. Rossi (congedo)	0
3.	O. Soto (postdoc)	1.0
4.	S. Tomassini	0.2

Tecnici

A. Orlandi	
D. Orecchini	0.5

Richieste economiche

- apparati: 300keuro
- missioni: 10 keuro (installazione del RICH)
- consumo: 10 k
- missioni: 25 k (installazione del RICH)

Richieste da discutere nella riunione nazionale di JLAB12

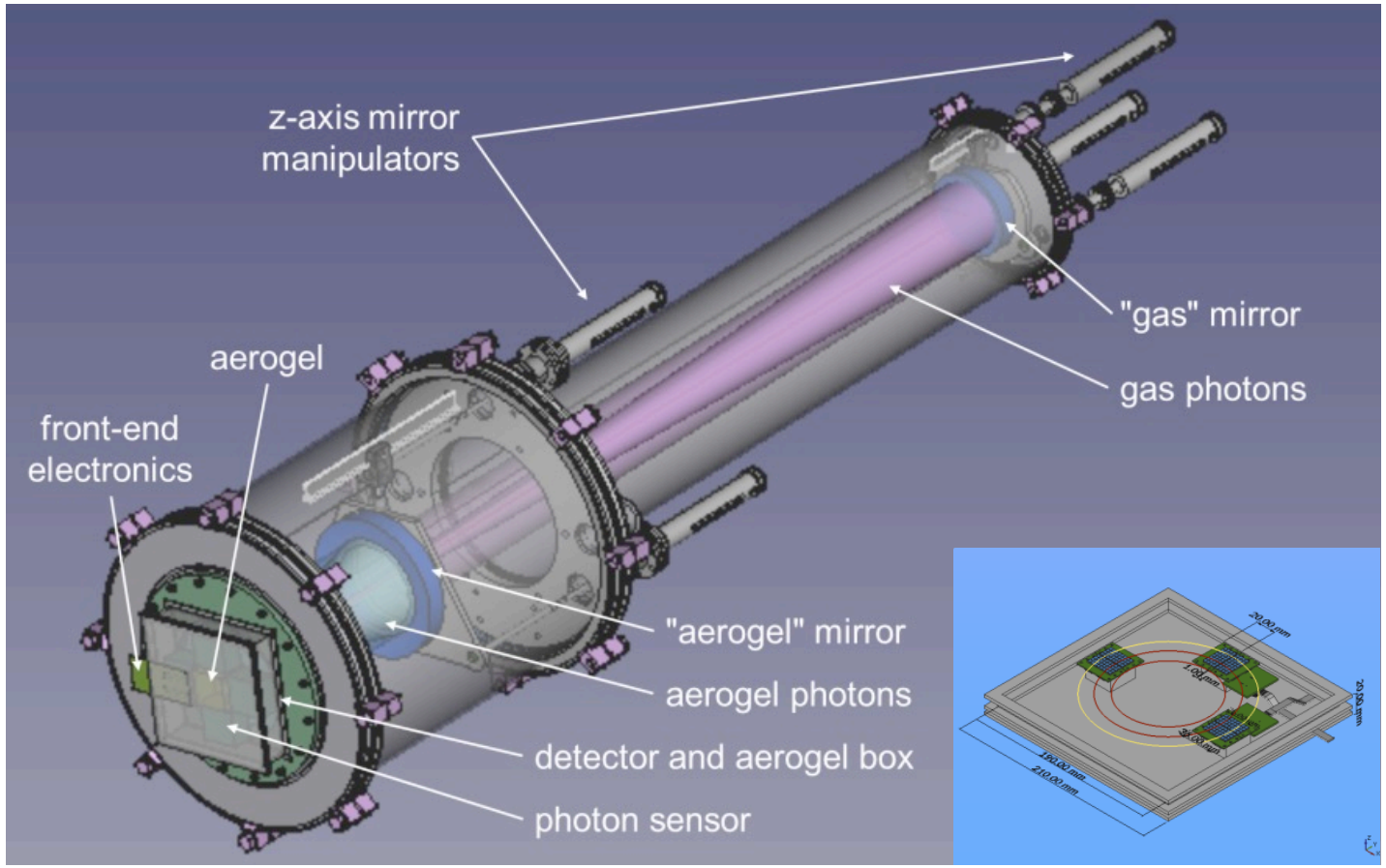
EIC_net: LNF activities

R&D activity on the particle identification detectors
Modular RICH (mRICH): electron end-cap
Dual RICH (dRICH): hadron end-cap

Dual RICH: test beam preparation for summer 2021

- standard vacuum technology to optmize gas handling and allow pressure tuning
- Two movable mirrors for simultaneous imaging
- Common sensitive surface for both aerogel and gas photons
- Detector and aerogel box isolated from the gas tank
- SiPM readout

Design has been defined**; procurement ongoing**
SiPM irradiation tests planned to study radiation hardness



Ricercatori/Tecnologi
1. M. Mirazita 0.1

Richieste economiche
- missioni: 1 keuro (sotto DTZ)

Open Dipole + BGO calorimeter @ Bonn

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

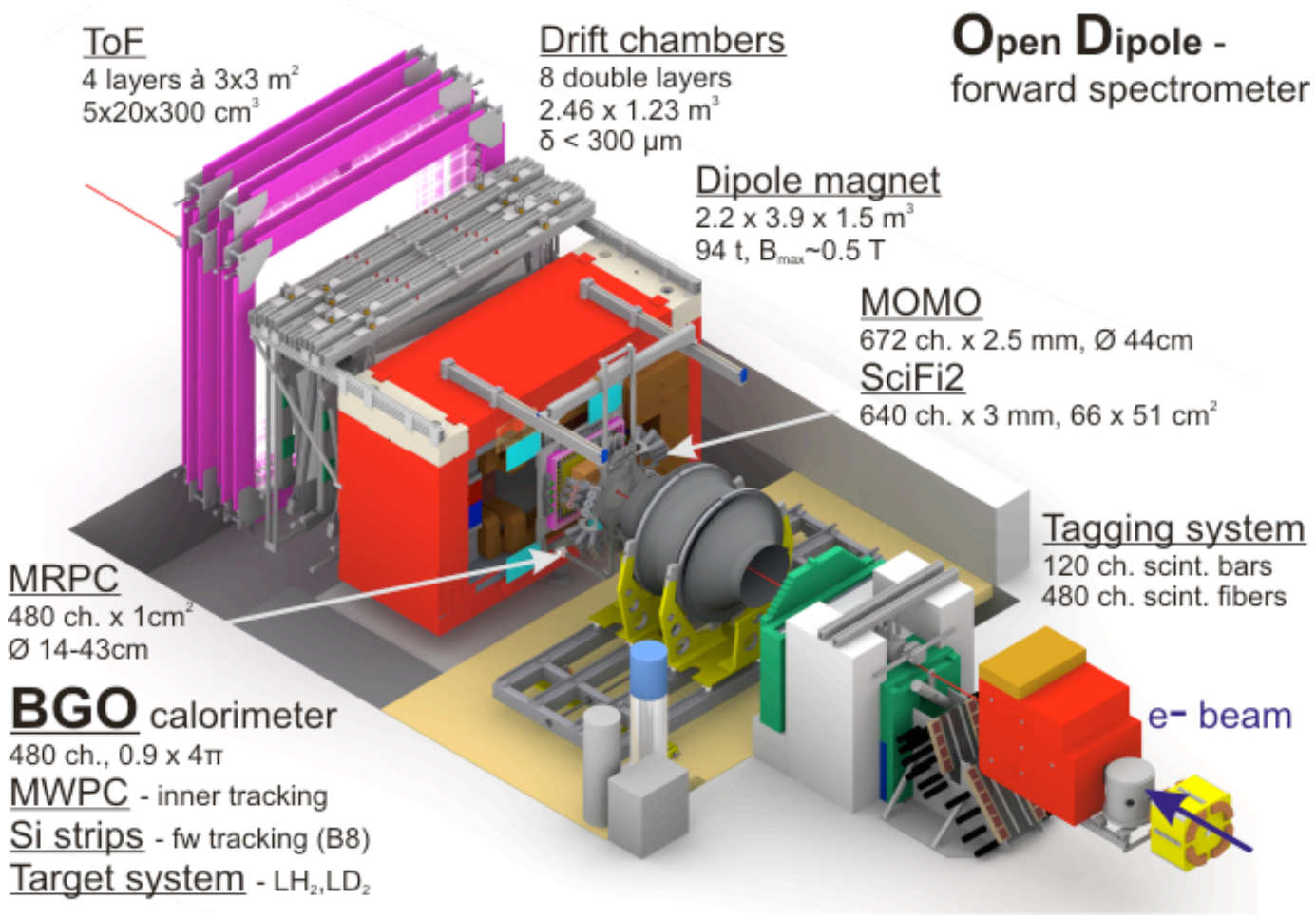
Nucleon excited states via meson photoproduction at MAMIc (A2@Mainz) and ELSA (BGOOD@Bonn)

- Transition form factor
- η' threshold anomaly
- International collaboration: Bonn PI, Bonn HISKP, ISS, LNF, Messina(not INFN), Pavia, Roma2, Torino, Glasgow, Basel, PNPI Gatchina, INR Mosca, IHENP Kharkov, Lamar U. (Texas)

LNF responsibilities (Levi Sandri):

1. **Co-spokesperson BGOOD**
2. **RN**
3. **η' beam asymmetry and x-sect**

2 researchers for 1.2 FTE
Total INFN ~ 11 FTE



LNF activities

INFN task status:

All detectors under INFN supervision (Barrel Calorimeter MWPC) are working, but for the MRPC in its final commissioning

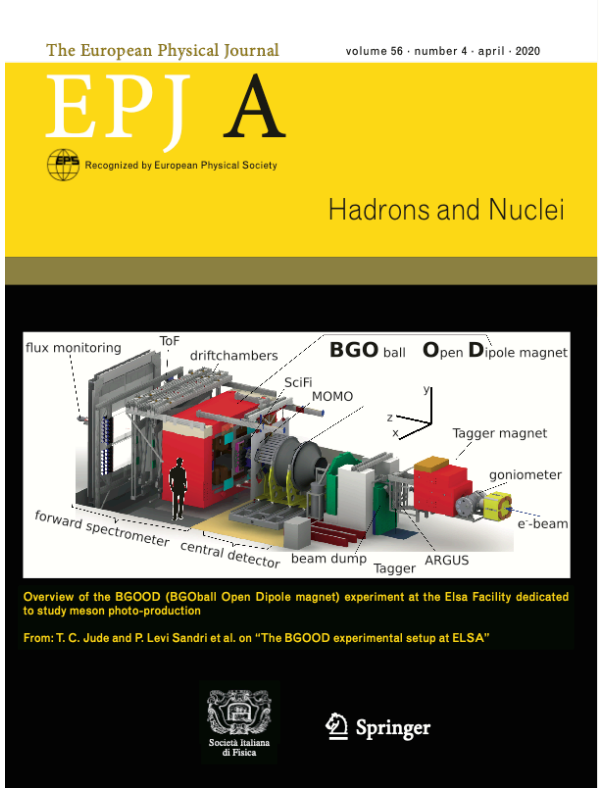
MonteCarlo & event generator under develpment (LNF/Messina/Roma2)

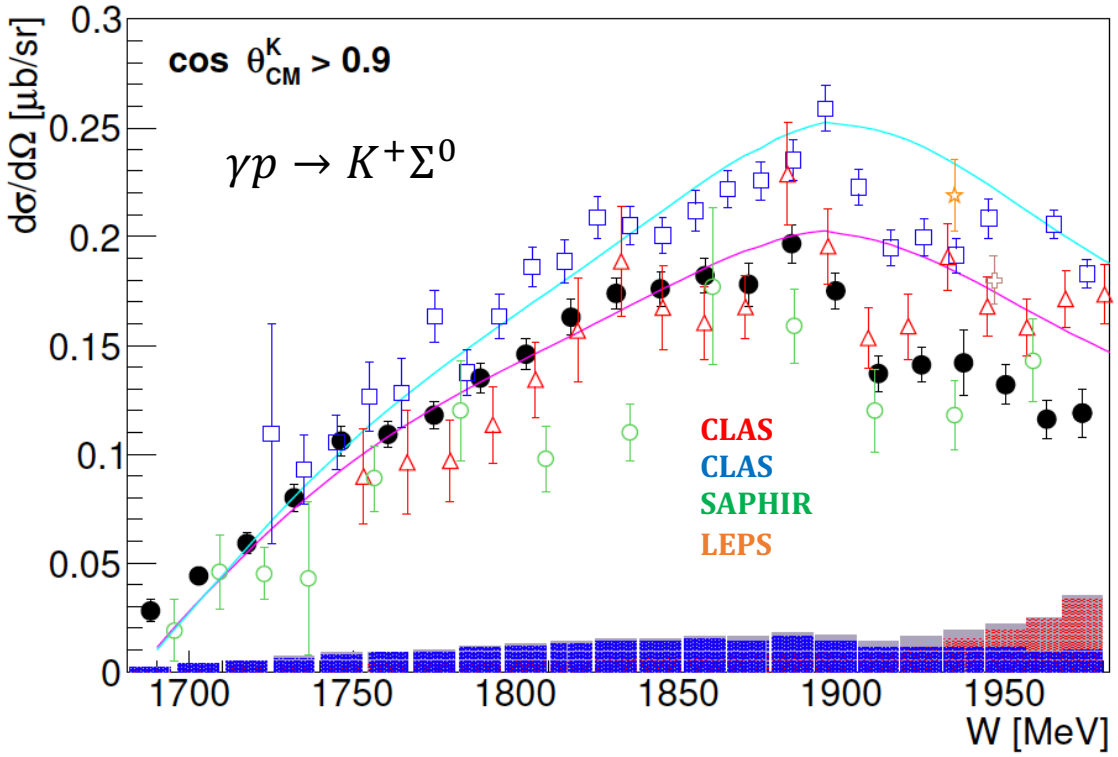
Co-spokespersonship of the BGOOD (LNF)

Spokesperson of the η' photoproduction measureme t (LNF).

RN (LNF)

December 2018: Klystron issue → no beam in 2019.





arXiv:2006.12437v1 ($\gamma p \rightarrow K^+\Sigma^0$)
arXiv:2006.12350v1 ($\gamma p \rightarrow K^+\Lambda$)

Programma 2020-2021 e richieste

Causa guasto ed emergenza COVID PI e Università di Bonn garantiscono il funzionamento di ELSA per esperimenti fino a tutto il 2022 (#2 Finanziamenti DFG approvati)

Chiesto il prolungamento della sigla per altri 4 anni in CSN3:

1. 2021: richieste 1500 ore di beam-time per completare la raccolta dati su bersaglio di idrogeno e di deuterio
2. 2022: misure su Li-6, C-12
3. 2023: possibile estensione per completamento statistiche.

2 Ricercatori e Tecnologi, 1.2 FTE

Richieste finanziarie 25k€

Consumo	0 k€
Inventariabile	0 k€
Manutenzione	0 k€
Missioni	15 k€ (2+13)

Richieste ai servizi

Nessuna salvo imprevisti

LNF activities

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

Spokesperson + ALL Responsabilities in LNF

KAONNIS= Low energy kaons interaction studies at Dafne

- Integrated initiative (SIDDHARTA + AMADEUS)
- Precise measurement of kaonic atoms X-ray transitions and of the charged kaons nuclear interaction processes
- International collaboration: INFN; SMI-OAW (Austria); IFIN-HH (Romania); Politecnico MI; TUM, Helmholtz I. (Germany); RIKEN, Tokyo U. (Japan); Jagellonian U. (Poland); Victoria U. (Canada); Zagreb U. (Croatia) + ELPH Tohoku University & CERN

27 Publications (2019-2020)

Kaonic Atoms to Investigate Global Symmetry Breaking, Symmetry 12 (2020) 4, 547

Prog. di grande rilevanza MAECI:
"Strangeness in the compact stars?"
Italy-Japan 2017-2019

- **STRONG2020: WP8-JRA, WP16-NA, TA3-LNF**
- **Bando regionale SICURA**
- **Croatian Science Foundation research project 8570**

Events (2019-2020)

Symposium, May 2019 @ LNF
Strange Matter Workshop, Oct. 2019 @ LNF
*STRANEX Workshop, Oct. 2019, ECT**
STRANU Workshop ECT@ 2020 -> May 2021

1. M.Cargnelli 0.5
2. M. Bazzi 1.0
3. M. Bragadireanu 1.0
4. A. Clozza 0.4
5. **C. Curceanu. 0.7**
6. S. Dabagov 0.2
7. L. De Paolis 1.0
8. D. Hampai 0.2
9. M. Iliescu 1.0
11. P. Levi Sandri. 0.2
12. A. Khreptak 0.5
13. M. Merafina. 0.6
14. C. Milardi 0.1
15. M. Miliucci. 0.7
16. M. Tuechler. 0.5
17. E. Pace 0.2
18. A. Scordo 1.0
19. D. Sirghi 0.7
20. F. Sirghi 1.0
21. M. Skurzok 1.0
22. A. Spallone. 0.6
23. O. Vazquez D. 1
24. J. Zmeskal 0.5
25. F. T. Zarandi 0.5
26. H. Shi 0.5
27 C. Guaraldo

Main activity: SIDDHARTA-2 - aim and goal

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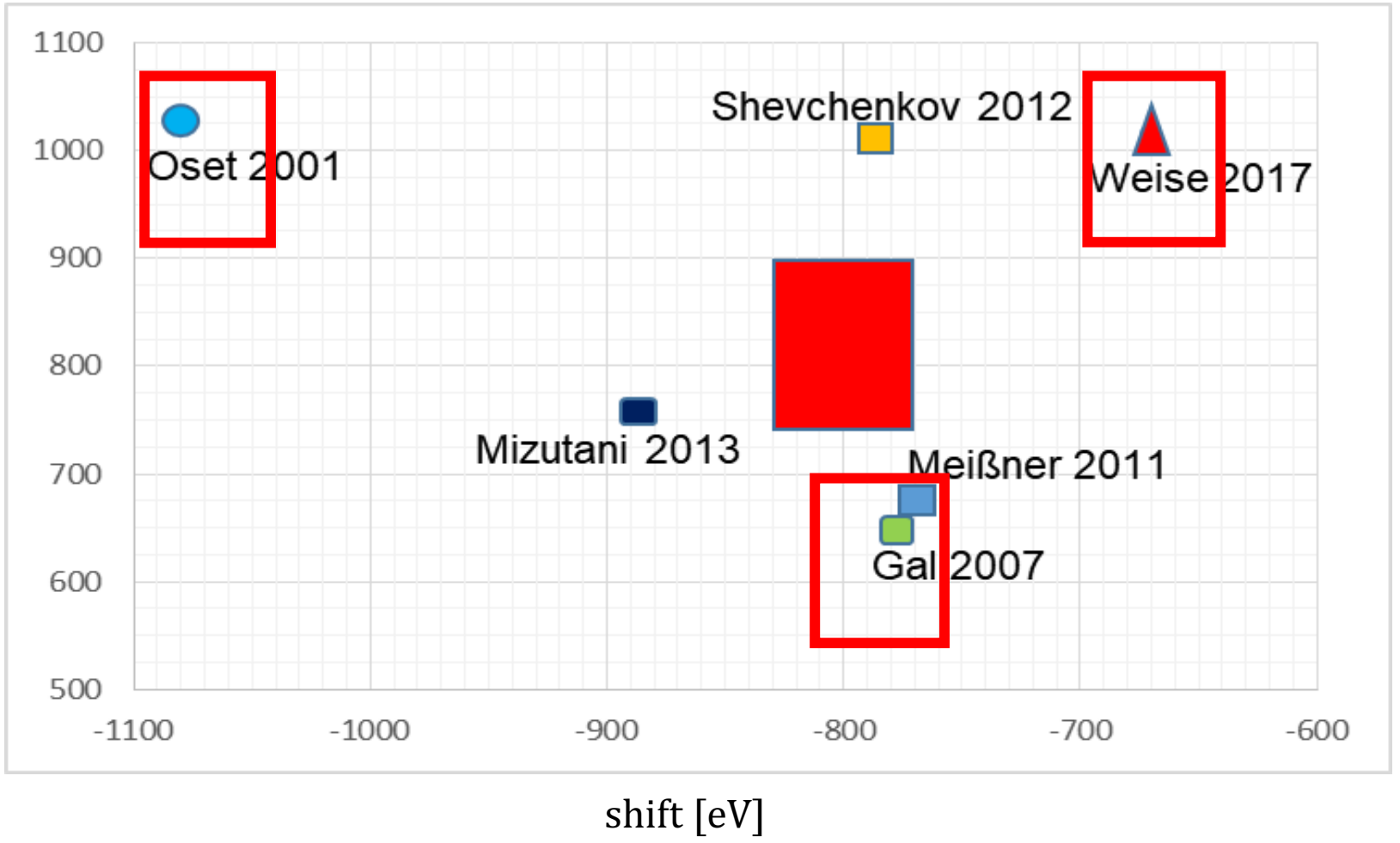
Laboratori Nazionali di Frascati

Perform precision measurement of kaonic atoms X-ray transitions

→ unique info about the QCD in non-perturbative regime in the strangeness sector not obtainable otherwise; impact in astrophysics (EOS neutron stars)

Precision measurement of the shift and of the width of the 1*s* level of kaonic deuterium and of the other types of kaonic atoms

Comparison with various theoretical models



SIDDHARTA-2: phase 1 (SIDDHARTINO)

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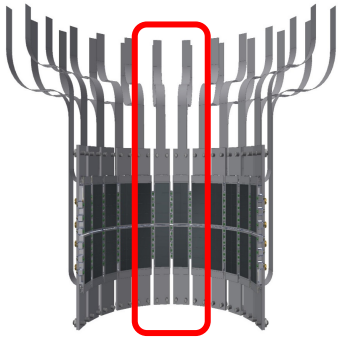
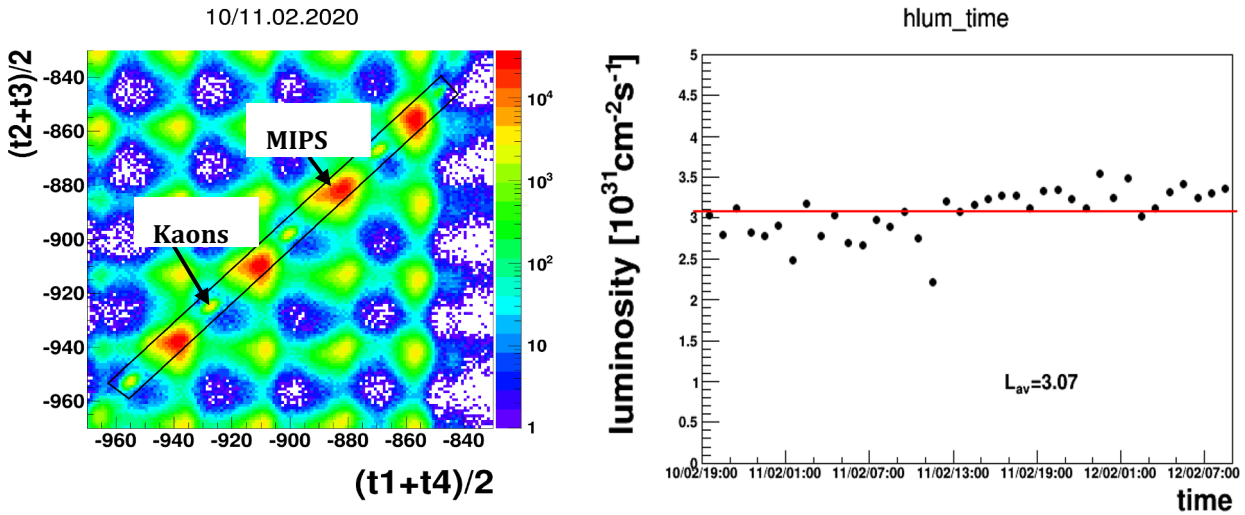


Phase 1 with SIDDHARTINO (8 SDDs KHe)

- Technical run (2020)
- target position 100 mm higher in order to install the DAΦNE luminosity monitor for optimal beam tuning!
- with 8 SDDs (one DAQ bus subsystem)
- with complete Veto I + II
- SIDDHARTA-2 luminosity monitor
- SIDDHARTINO (8 SDD) completely installed in April 2019
- similar beam/background conditions are reached as compared with SIDDHARTA (S/B>100) ⇒ tested with kaonic helium indicators



Luminosity Measurement 10.02 18:22 - 12.02 9:19

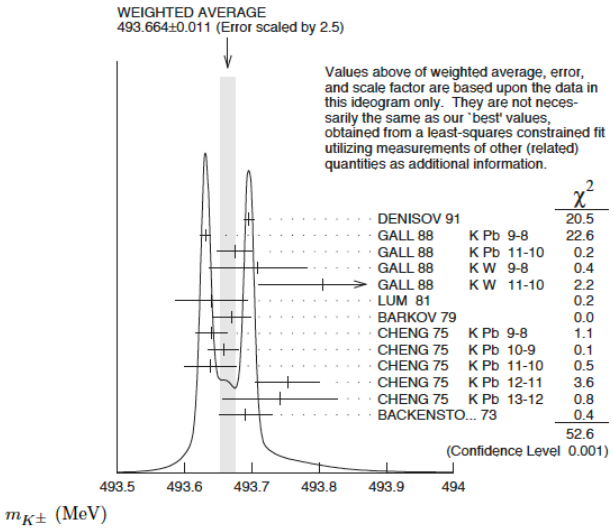
SIDDHARTA 2: phase-2

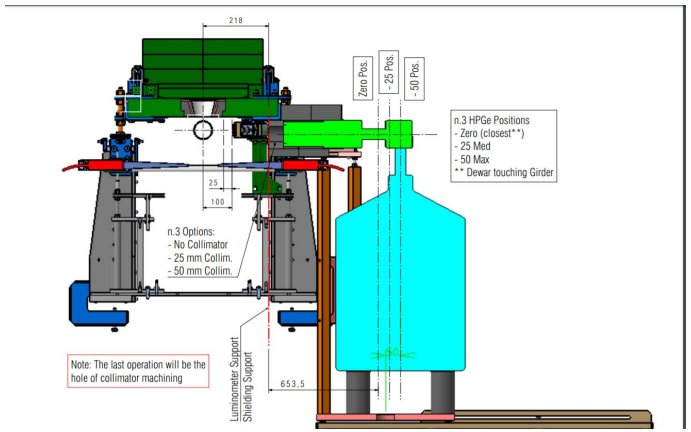
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

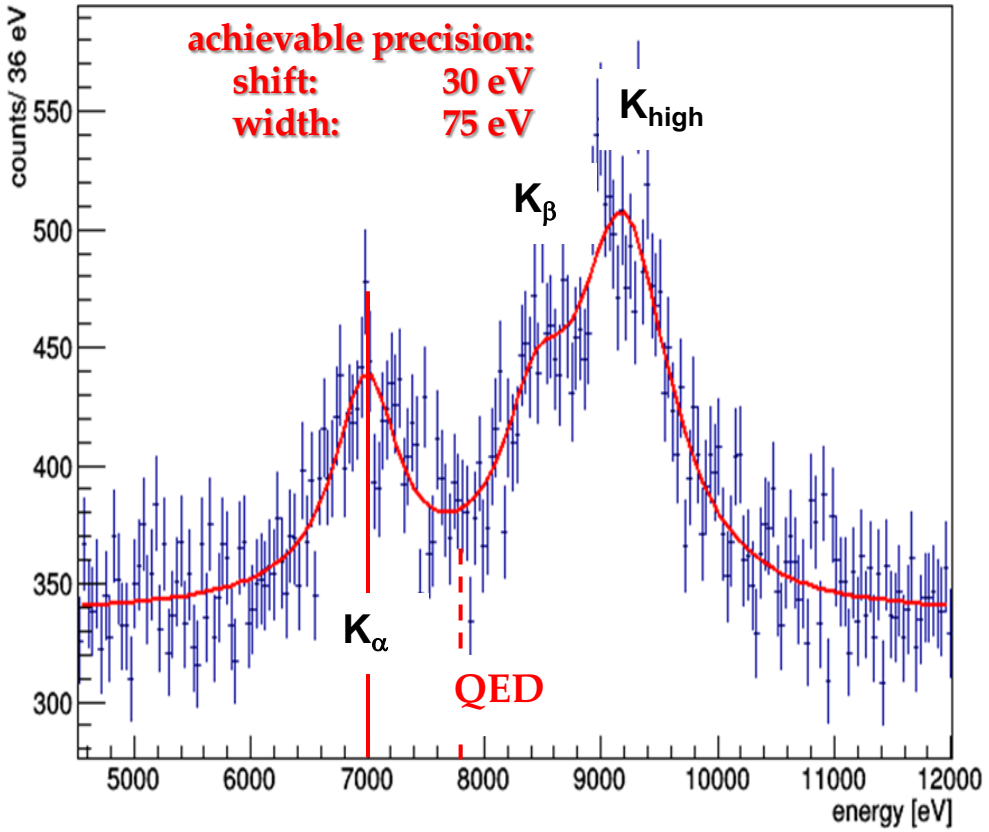
Phase 2 with SIDDHARTA (48 SDDs KD)

Physics run: kaonic deuterium run in 2021
Final installation in Dafne in 2021; request of 800 pb-1 on tape to perform the first measurement of the strong interaction induced energy shift and width of the Kd ground state (similar precision as K-p)
In parallel with SIDDHARTA-2 Kd measurement: feasibility tests for future measurements with Ge and VOXES detectors:

- Kaon mass puzzle (C vs. Pb)
- High precision tests QED (P. Indelicato) – exploring possible dark settor effects







KAONNIS future perspectives

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

Plans for the **extension of the scientific program**:

4 proposals submitted at ICFA mini-workshop on DAFNE as Open Accel Test Facility (LNF December 2018):

- **GeKA ⇒ selected Kaonic Atoms with High Purity Germanium detectors**
- **Knscat ⇒ Low-energy kaon-nucleon scattering**
- **WiKAMP ⇒ kaonic atoms with ultra-high energy resolution detectors (VOXES)**
- **KAHEL ⇒ QCD with strangeness**

Kaon mass - precision measurement at the level < 7 keV
Kaonic helium transitions to the 1s level

Other light kaonic atoms (K^-O, K^-C,…)
Heavier kaonic atoms (K^-Si, K^-Pb…)

Radiative kaon capture – Λ(1405) study

Investigate the possibility of the measurement of other types of hadronic exotic atoms (sigmonic hydrogen?)

Richieste finanziarie 115k

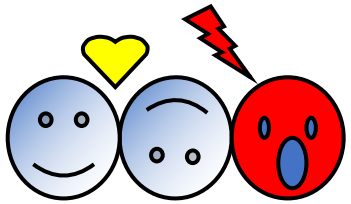
Consumo	50 kE
Inventariabile	25 kE
Manutenzione	15 kE
Missioni	25 kE

Richieste ai servizi

Progettazione: 6 m.u.
supporteria/schermature più nuovo rivelatore veto; misure test Ge e VOXES

Officina meccanica: 6 m.u. per costruzioni supporterie, schermature, frame nuovo veto2 layer, test setup Ge, VOXES

Tecnici: 2 x 0.5 FTE installazioni e costruzioni varie



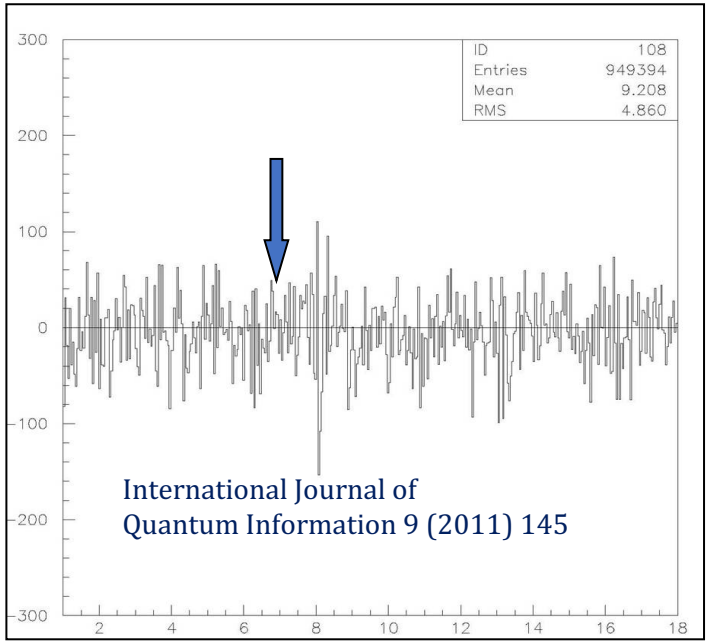
VIP: LNF activities

14 researchers for **7.3 FTE**
Average participation of 52%

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

VIP=Violation Pauli Exclusion Principle (PEP)

- Perform experimental test of PEP for e- at LNGS to reduce X-ray background
- International collaboration: LNF, LNGS, Ts Univ. and INFN; SMI-OAW (Austria); IFIN-HH (Romania); Neuchatel U. (Switzerland); Uni & INFN BO; Fudan Univ. (China), Chengdu Univ. (China); IAS Princeton; Wigner Institute
- VIP already established a probability of PEP violation $\beta^2/2 < 4\times10^{-29}$ → previous limit $<1.7\times10^{-26}$ PLB 328 (1990) 438 ⇒ **VIP-2 aims at an improvement of at least 2 orders of magnitude**
- VIP upgrade (CCD detectors replaced by SDD) : VIP-2 in data taking at LNGS
- Other tests of Quantum Mechanics (collapse models) and quantum applications → collaboration with Roger Penrose, Steve Adler



1.	M. Bazzi	0.3
2.	M. Benfatto	0.5
3.	A. Clozza	0.3
4.	**C. Curceanu**	**0.3**
5.	R. Del Grande	1.0
6.	J. Marton	0.5
7.	M. Miliucci	0.3
8.	E. Pace	0.8
9.	**K. Piscicchia**	**1.0**
10.	D. Sirghi	0.3
11.	M. Bragadireanu	0.5
12.	F. Napolitano	1.0
13.	A. Marciano	0.5
+	C. Guaraldo	0

VIP-2 ⇒ new detectors SDD:

1. higher resolution: 190eV (fwhm)
2. faster (triggerable) ⇒ VETO system
3. higher acceptance
4. higher current ⇒ low background
5. higher efficiency

ALL Responsabilities @ LNF
Spekesperon: C. Curceanu
RN: K. Piscicchia

14 Publications (2019-2020) - *Eur.Phys.J.C 80 (2020) 6, 508*
External projects: *EU FET – TEQ, Centro Fermi, Foundational Questions Institute FQXi*

VIP-2 setup at LNGS and status

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

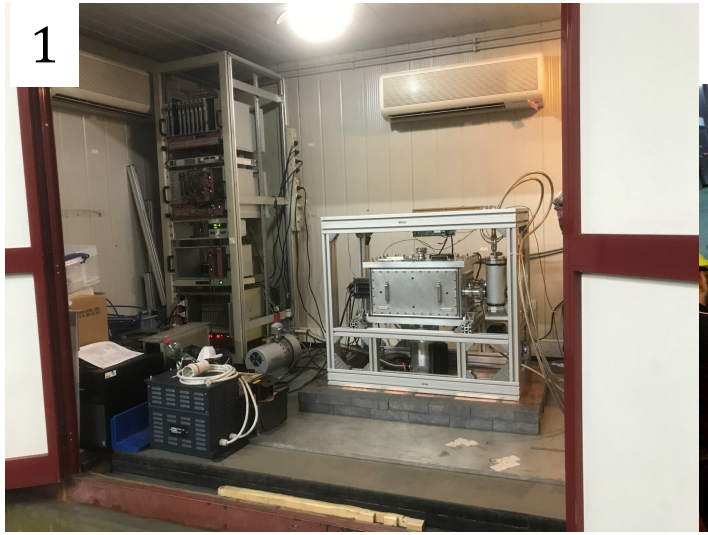
1. VIP-2 version 1 with 6 SDDs (SIDDHARTA type) installed at LNGS end of 2015 – data taking (no shielding) till end of 2017 (**Eur. Phys. J. C (2018) 78: 319**)

2. VIP-2 with upgraded SDDs (4 arrays of 2x4 SDD detectors) installed at LNGS in April 2018; tests and data taking without shielding till November 2018

3. Shielding installed in November 2018 – data taking ongoing (with and without current)

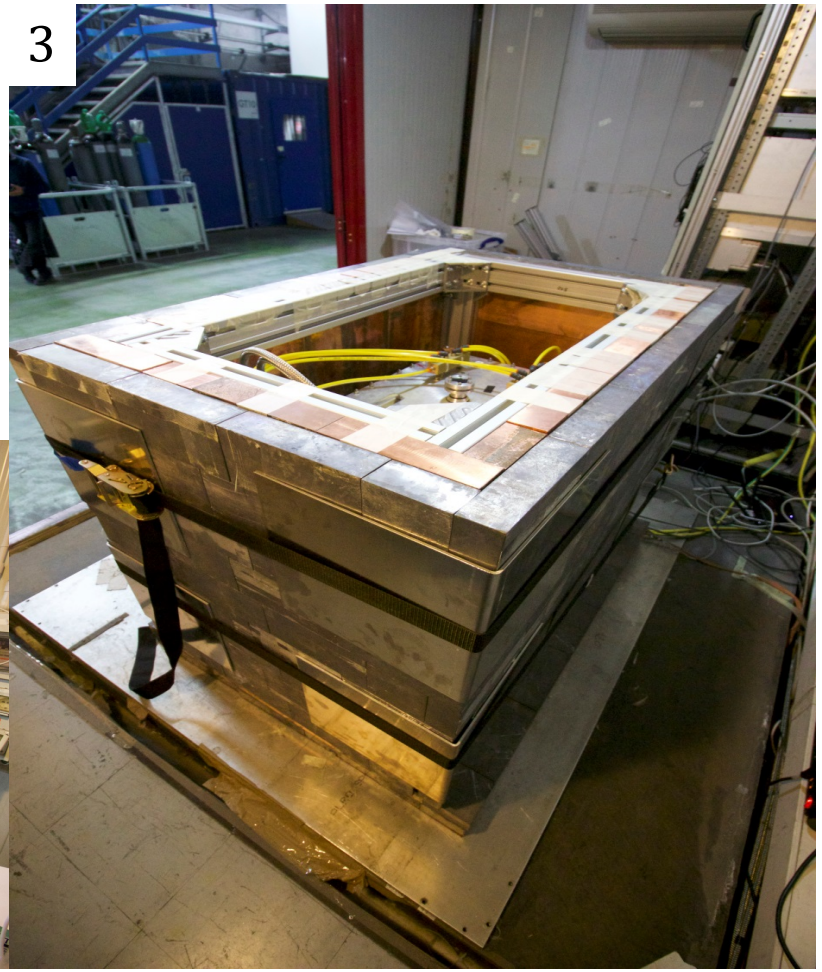
4. Optimization of the shielding ongoing; strategy of data taking optimization

1



2

3



October2019 – present: data analysis (shielding)

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

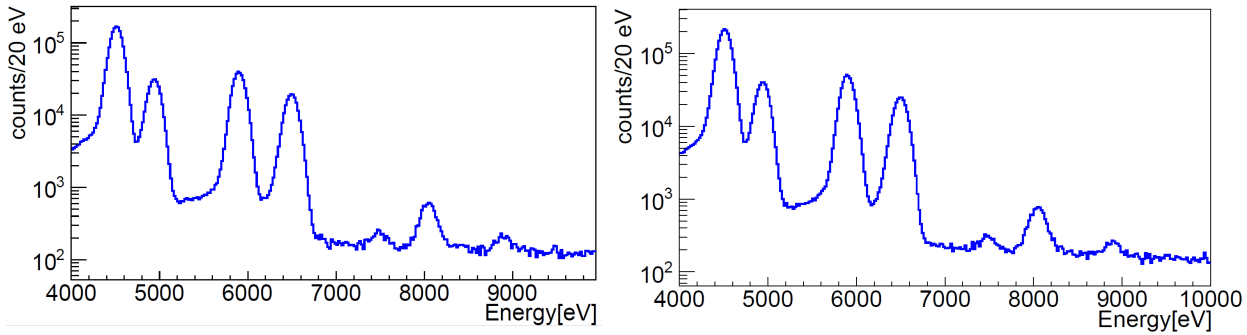
An improved Bayesian data analysis procedure was implemented@LNF

$$p(S, B|\text{data}) = \frac{p(\text{data}|S, B) \cdot p_0(S) \cdot p_0(B)}{\int p(\text{data}|S, B) \cdot p_0(S) \cdot p_0(B) dS dB}.$$

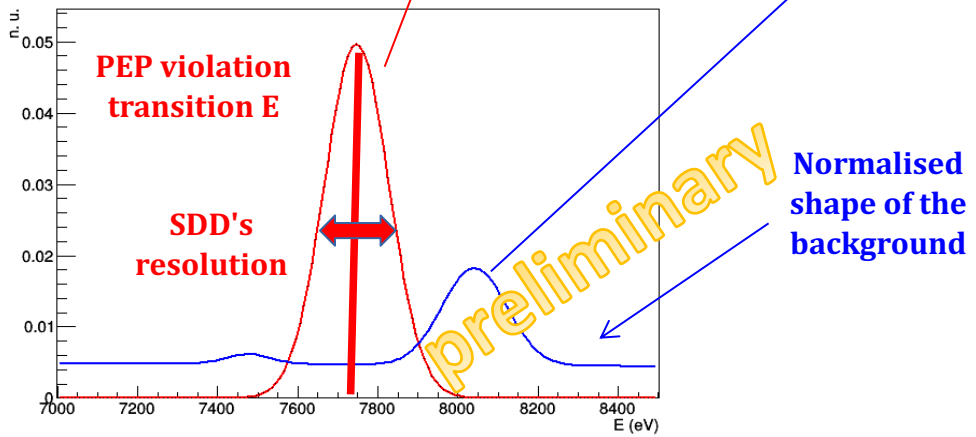
$$P(data|S, B) = \prod_{i=1}^{N} \frac{\lambda_i(S, B)^{n_i} \cdot e^{-\lambda_i(S,B)}}{n_i!}$$

$$\lambda_i = \lambda_i(S, B) = S \cdot \int_{\Delta E_i} f_S(E) dE + B \cdot \int_{\Delta E_i} f_B(E) dE,$$

Calibrated spectra
(data taking period October 2019 – March 2020)



without current **with current**



Upper limit on the PEP violation probability (90% CL): $\beta^2/_2 < 9.5 \times 10^{-31}$
One order of magnitude improvement w.r.t. VIP

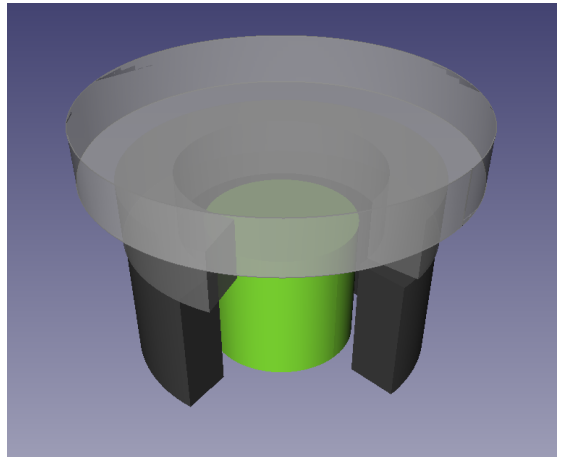
Eur. Phys. J. C (2018) 78:319

VIP Lead (closed systems)

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

High purity Ge detector measurement (M. Laubenstein):

- Ge detector surrounded by roman lead target + complex electrolytic Cu + Pb shielding
- 10B-polyethylene plates reduce the neutron flux towards the detector
- Shield + cryostat enclosed in airtight steel housing flushed with nitrogen to avoid contact with external air (and thus radon)



Extremely low bkg in the two regions of interest, compatible with the mean bkg: b = 4.4 counts/keV

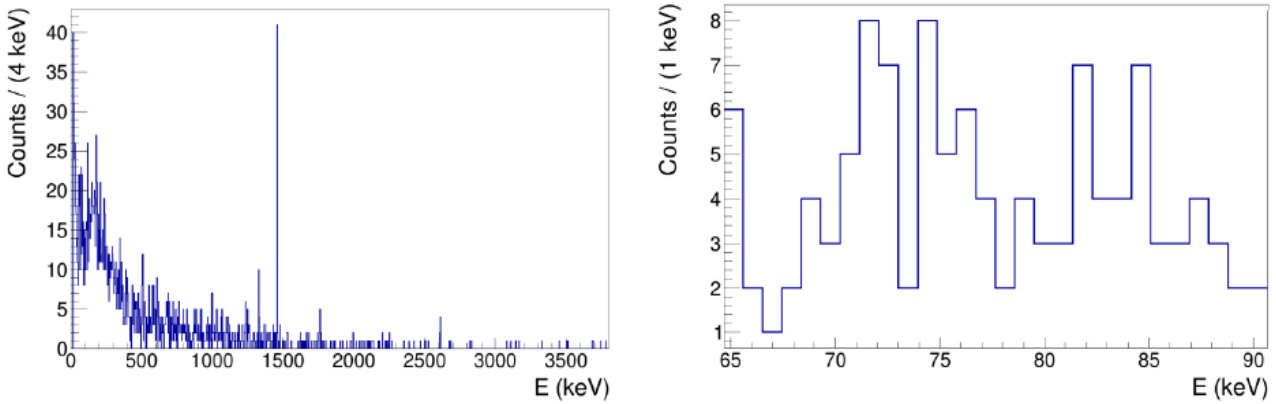


Figure 1. Total measured X-ray spectrum (left); same spectrum in the region of the K_α standard and violating transitions in Pb (right).

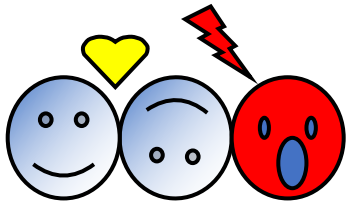
Transitions in Pb	forb.	allow.
$1s - 2p_{3/2}\ K_{\alpha 1}$	73713	74961
$1s - 2p_{1/2}\ K_{\alpha 2}$	71652	72798

(eV)

$$\frac{1}{2}\beta^2 < 1.53 \cdot 10^{-43}$$

Eur. Phys. J. C (2020), 80: 508

Test of the Continuous Spontaneous Localization and gravity-related collapse models. Collaboration with: Roger Penrose



Future plans

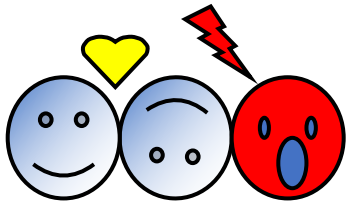
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

VIP-2 setup (open system)

- Finalize and submit for publication the papers on data analyses (at least 1 paper)
- Study and optimization of the shielding and data taking strategy
- Refined statistical data analyses continued
- Refined calculation electrons path inside bulk material
- Continuation of Monte Carlo simulations and studies for optimization of the run
- Study of cross talk background

VIP-Lead or other materials (closed system)

1. Finalize and submit for publication the paper on theoretical interpretation and VIP-lead results (at least 1 paper)
2. Refined data analyses for additional targets: V, Pt, Hf, Ta/existent) and study of the limit of PEP-violation on various materials
3. Probability for violation $< 10^{-45}$ for quantum gravity inspired models
4. Intensive collaboration with theoreticians (in particular with Addazi and Marcianò) for the interpretation of the VIP-results and with Roger Penrose
5. Studies in Frascati laboratory of a possible setup to test anisotropy effects – quantum-gravity tests
6. Preparation of a new setup with a Broad Energy Ge detector
7. Dissemination activities: presentation of the VIP-2 results in at least 3 events (Workshops/conferences) and in dissemination events – such as Open Labs and in talks/seminars at schools.



Future plans

Richieste finanziarie

Consumo	35 k€
Inventariabile	20 k€
Manutenzione	8 k€
Missioni	25 k€

Richieste ai servizi

Progettazione: 2 m.u. per supporteria/schermature; BEGe setup per future misure collasso

Officina meccanica: 2 m.u. per costruzioni supporterie, schermature, setup BEGe

Tecnici: 0.5 FTE installazioni e costruzioni varie

VIP-2 setup (open system)

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Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

backup

ITS3 work packages

	ATTIVITA'	CONSUMO/licenze/manutenzioni	Richiesta (k€)	INVENTARIABILE	Richiesta (k€)	MISSIONI	Richiesta (k€)
WP1						partecipazione a riunioni	DA DEFINIRE (VEDI TABELLA COMUNE)
WP2							
WP3	Test e caratterizzazione	manutenzione camere pulite aggiornamento sistemi test DAQ board (adattare MOSAIC?)	1			Partecipazione a beam test: 5 beam test anno/7 gg per test/ no. shifter? ogni sede fornisce numero di shifter x BT	DA DEFINIRE (VEDI TABELLA COMUNE)
WP4	Interconnessioni						
WP5	Saputi, sistema di cooling					missioni specifiche per Saputi	
ITS2						partecipazione a riunioni - shift commissioning ITS - global commissioning - ruoli di coordinamento ecc....	DA DEFINIRE (VEDI TABELLA COMUNE)

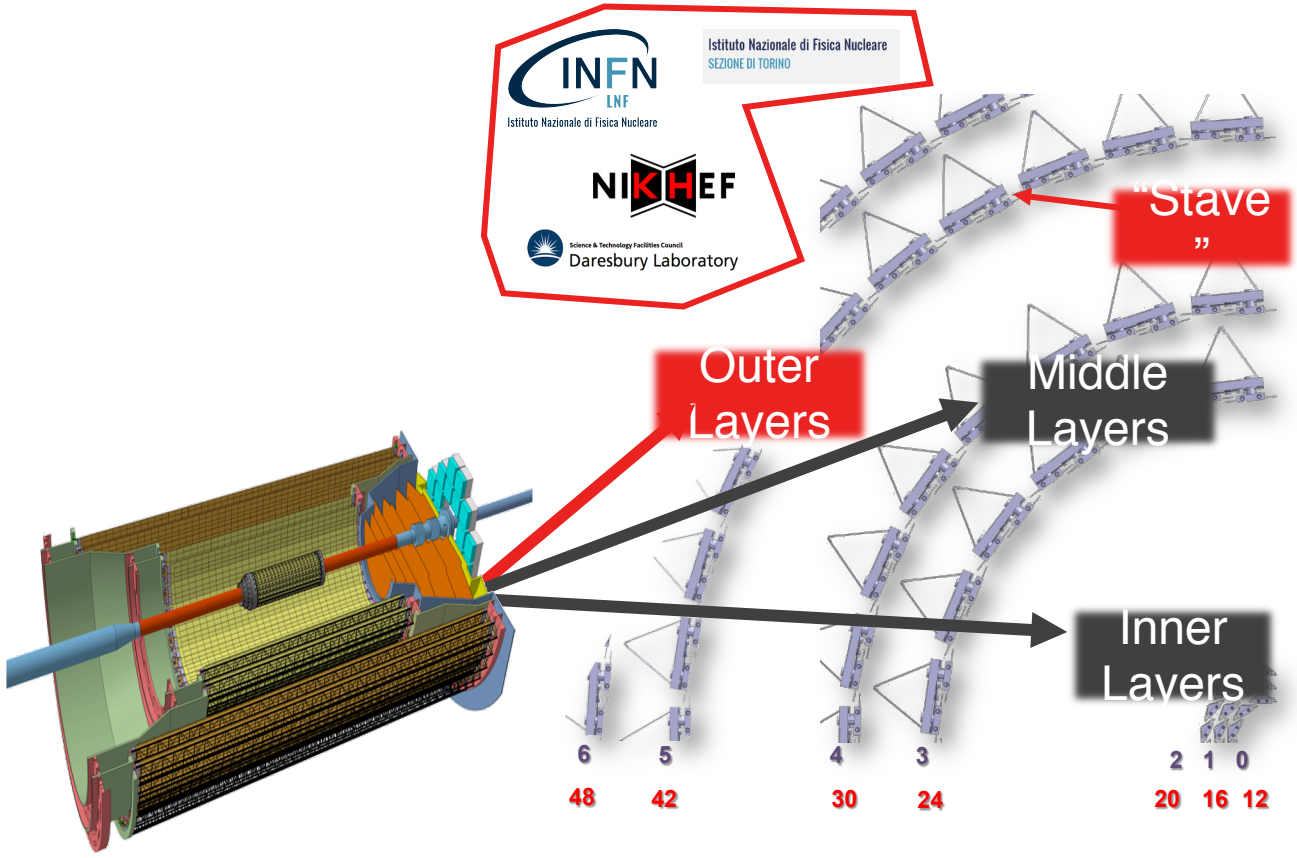
LNF production summary

Full production at LNF started in Feb 2018 and ended in June 2019 + extra staves + rework:

- LNF quota (27+2 staves) was fully produced in time
- Very long preparation and development phase: 2016-17

The LNF group also contributed to the development and debug of the procedures

- Debug of the readout system
- Development of wire bond repairs using conductive glues
- Development of mechanical procedures and tooling to rework finished staves



LNF activities:
Inner Tracker, magneti, setup meccanico

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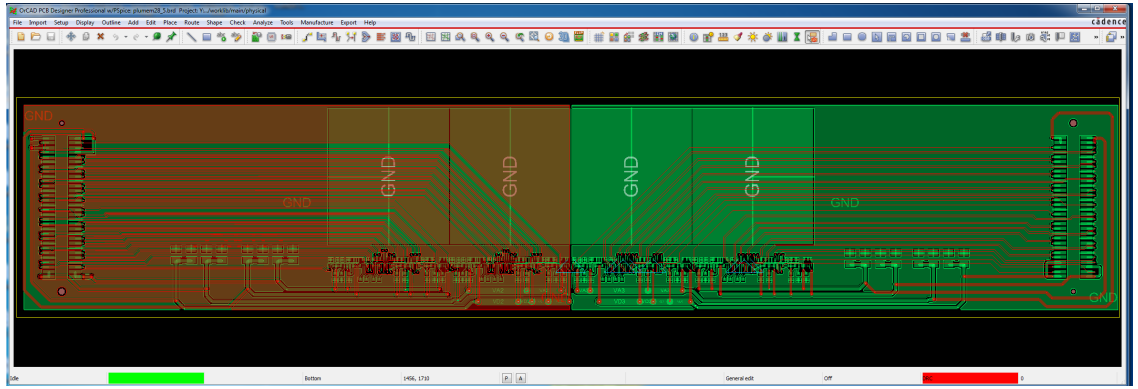
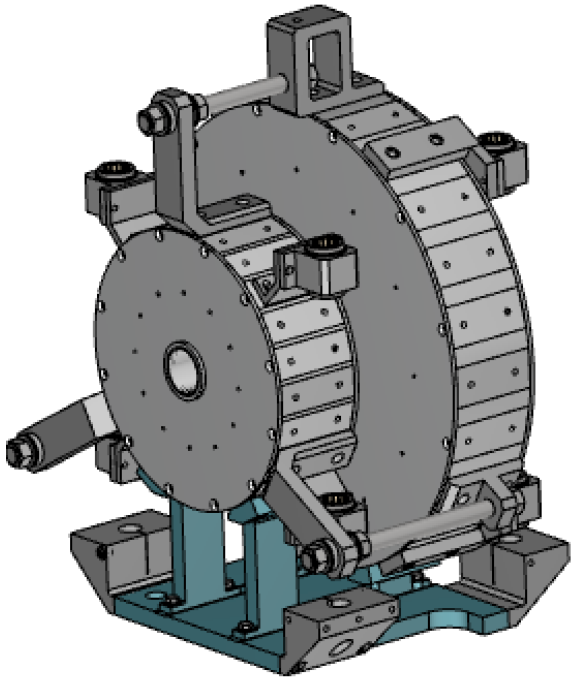
Inner Tracker

- module Kapton PCB in production
- G&A company (take care of module assembly) waiting to start working on ladders
- Two more boards needed (delayed by learning a new electronic CAD system)





Mechanical setup waiting to be finalized by:

- Final magnet design (after new magnet bid)
- Inner Tracker ladder assembly procedure definition by G&A company. Delayed by kapton PlumeM28 PCB availability.

Acquisto magneti problematico.
La gara è partita recentemente,

LNF activities:
Inner Tracker, magneti, setup meccanico

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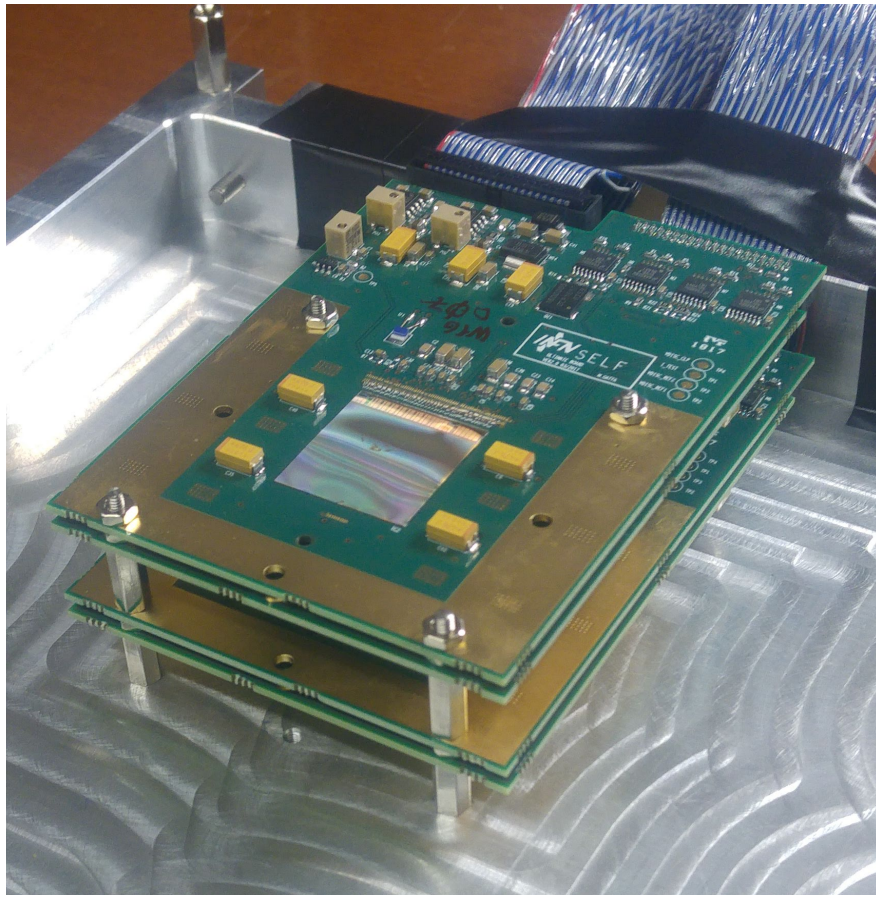
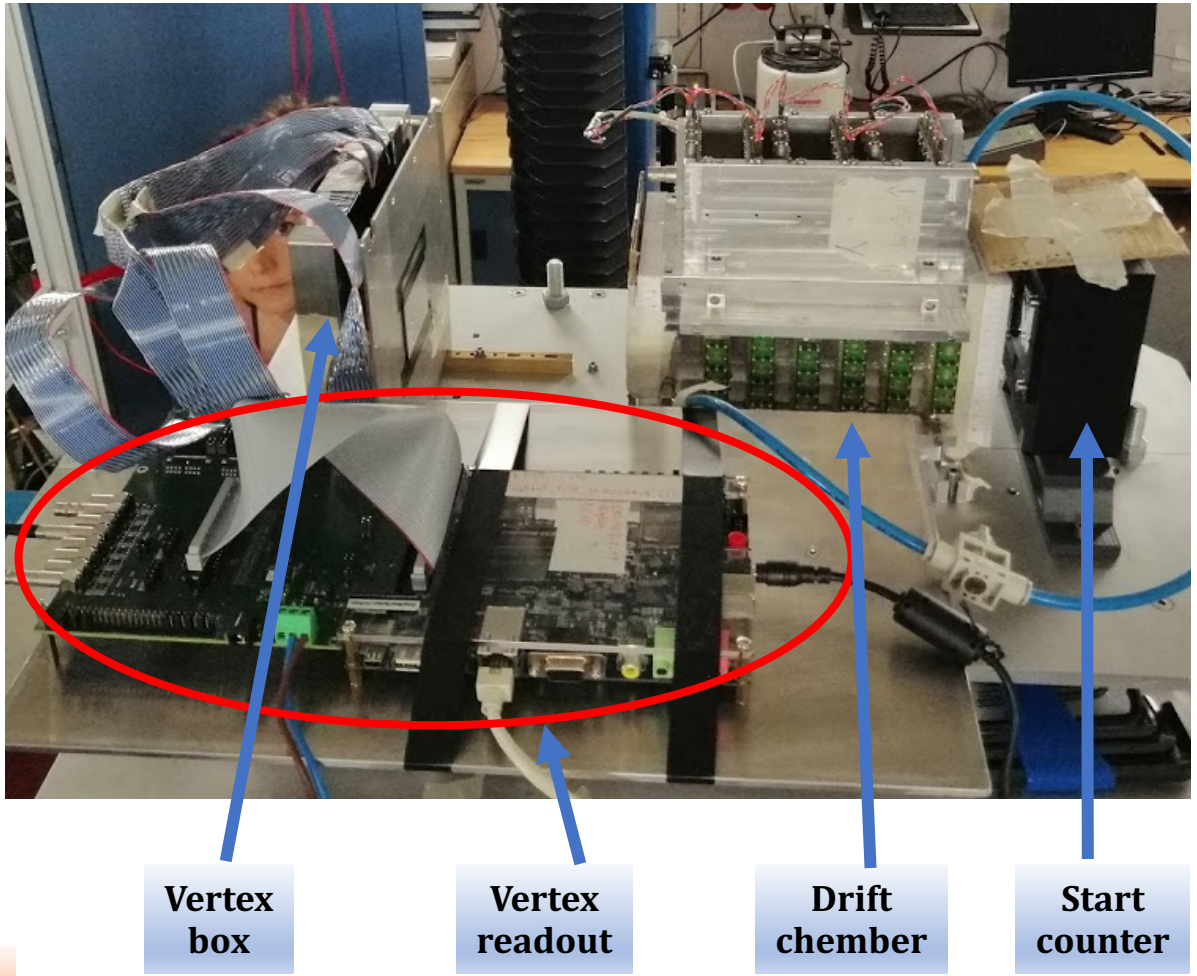
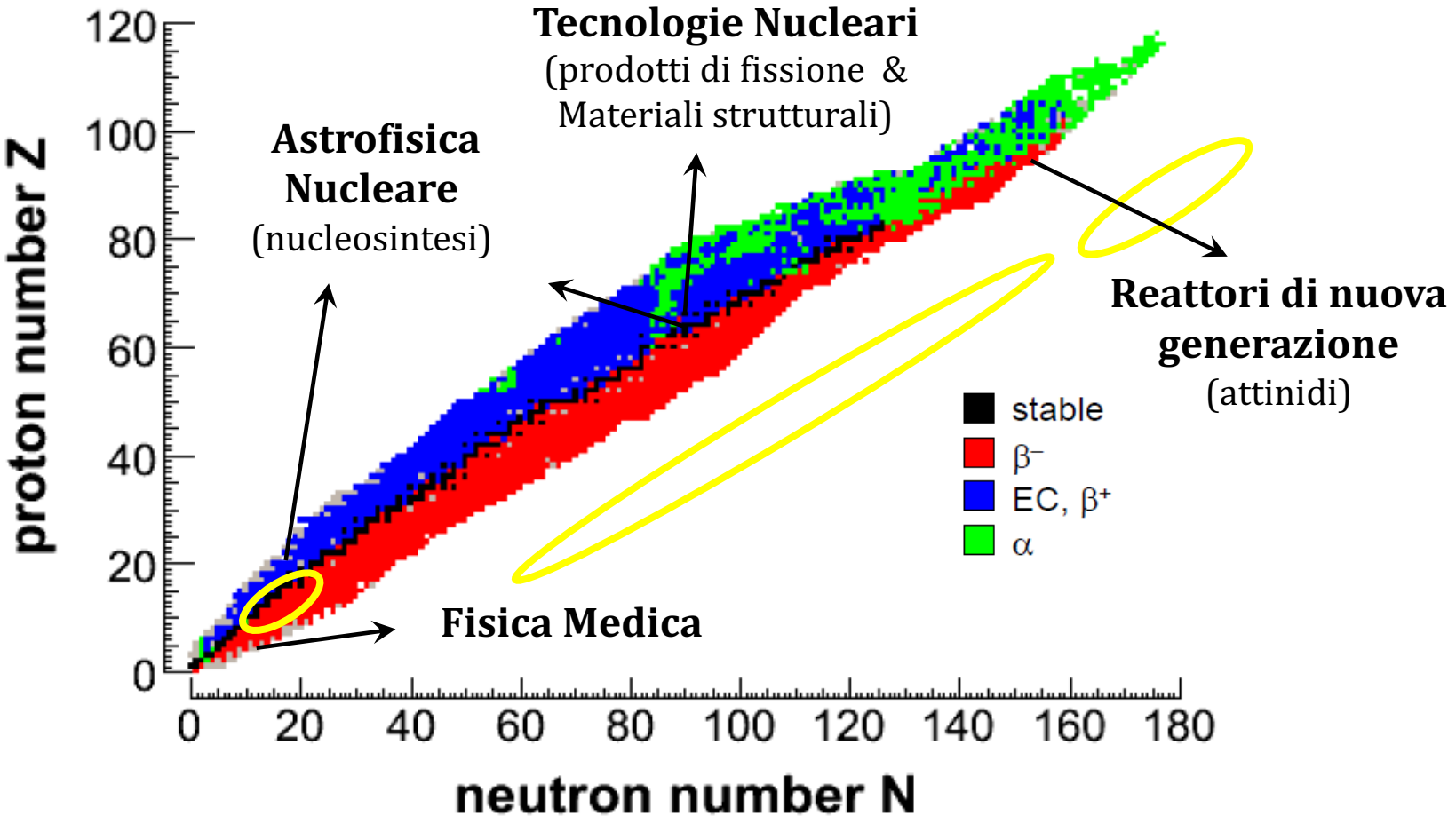


Pixel Vertex: 4 planes of M28 sensor, 50μm thick



Misura di precisione di sezioni d'urto di reazioni indotte da neutroni



n_TOF Italia

22 ricercatori (INFN, Università)
15.5 FTE su 6 sedi INFN

Collaborazioni con ENEA-Bologna, INAF-Teramo, CNR-Bari

LNF per:

- Beam monitor (area beam dump)
- nuovi rivelatori neutroni basati su GEM (Beam4Fusion)