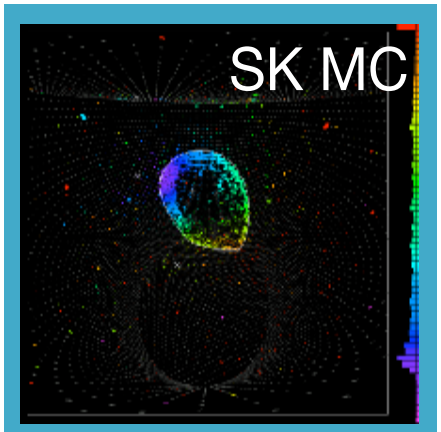
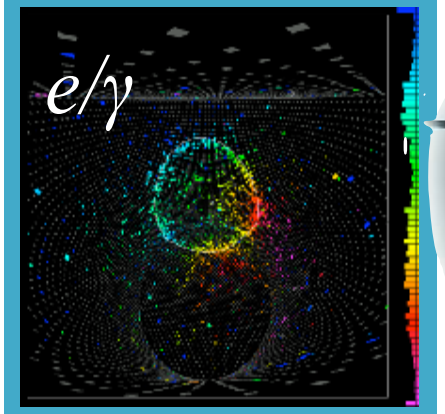
T2K/SK/T2K-II (Hyper-K) 2020

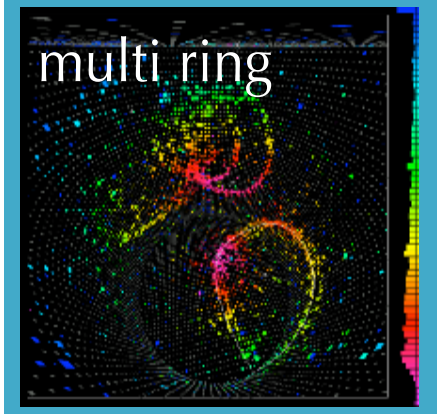
- T2K in a “Nutshell”
- T2K “δcp Discovery Potential” e misure in corso (2019-2021)
- Super-Kamiokande (SK-GD)
- Prospettive a medio termine (2020-2025)=> **T2K-II**
  - Upgrade ND280 (Attivita’ alla Neutrino Platform del CERN)
- Prospettive a lungo termine => Hyper-K
  - R&D mPMT

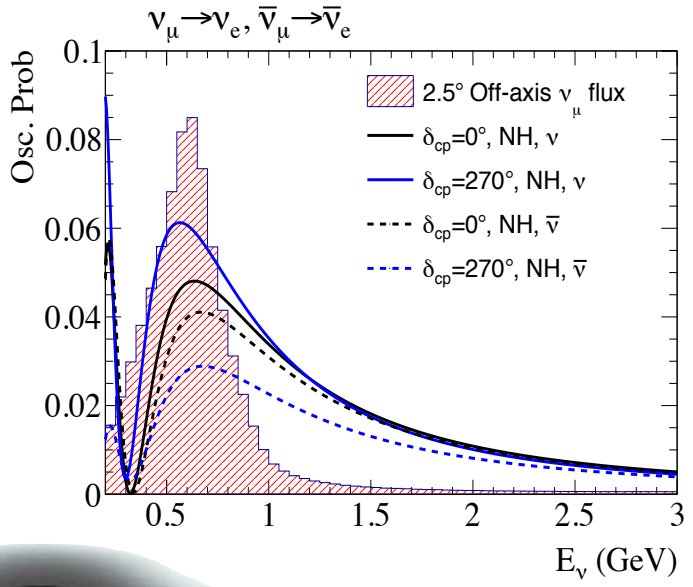
- **Composizione del gruppo e richieste di servizi**

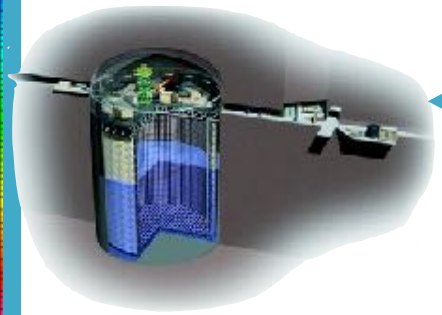
T2K in a "Nutshell"

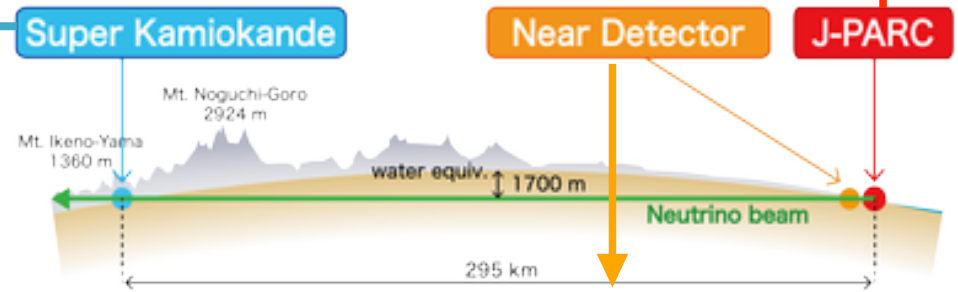


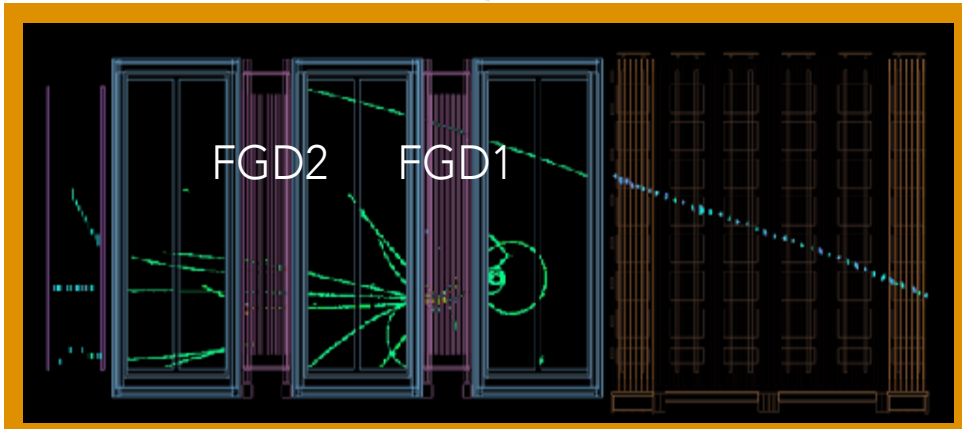




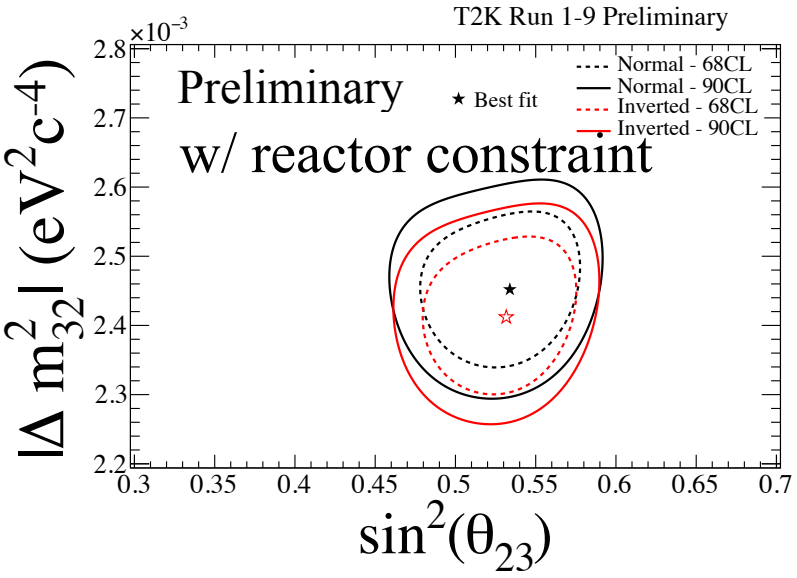




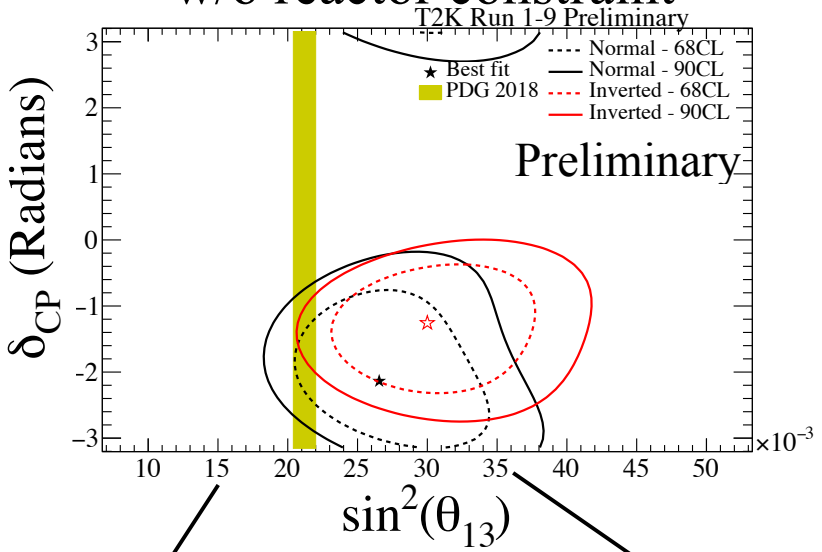


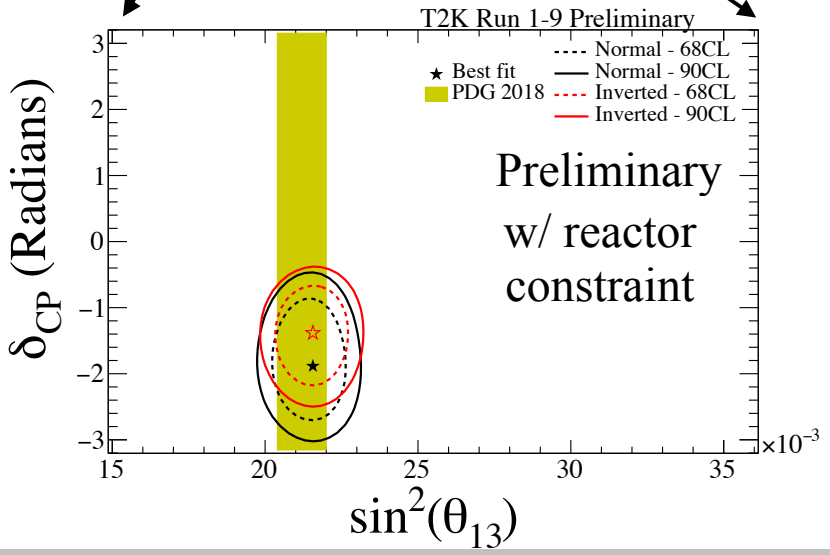


Oscillation results (θ_{23}, $|\Delta m^2_{32}|$, θ_{13}, δ_{CP})



w/o reactor constraint





T2K data compatible with maximal mixing

Parameter	Best Fit NH (HI)	±1σ NH (IH)
$\sin^2\theta_{32}$	0.54 (0.53)	[0.490,0.558] ([0.496,0.560])
$\lvert\Delta m^2_{32}\rvert$ ($10^{-3}eV^2/c^4$)	2.46 (2.43)	[2.370,2.498] ([2.362,2.502])
$\sin^2\theta_{13}$	0.0268 (0.0305)	[0.0222,0.0319] ([0.0253,0.0369])

ND280: Bari

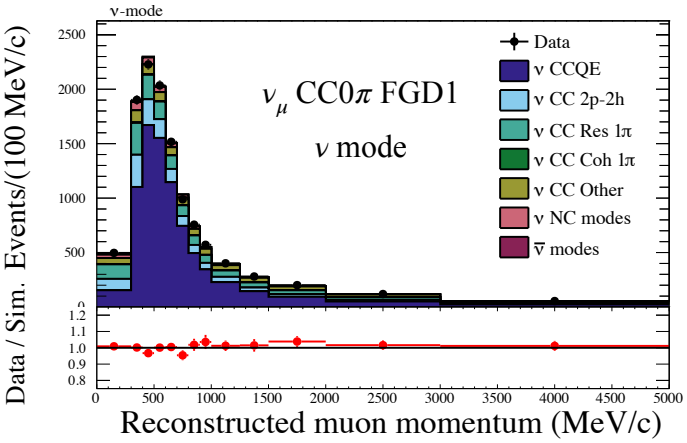
- TPC Co-convener e N280 Steering Comm. member (E.Radicioni)
- Analisi : X-section Co-convener (L. Magaletti)
- Attivita' di Data Taking e TPC maintenance (tutti)

M.G. Catanesi :

✓ Executive Committee di T2K

✓ CERN T2K-Contact

ND280 fit results

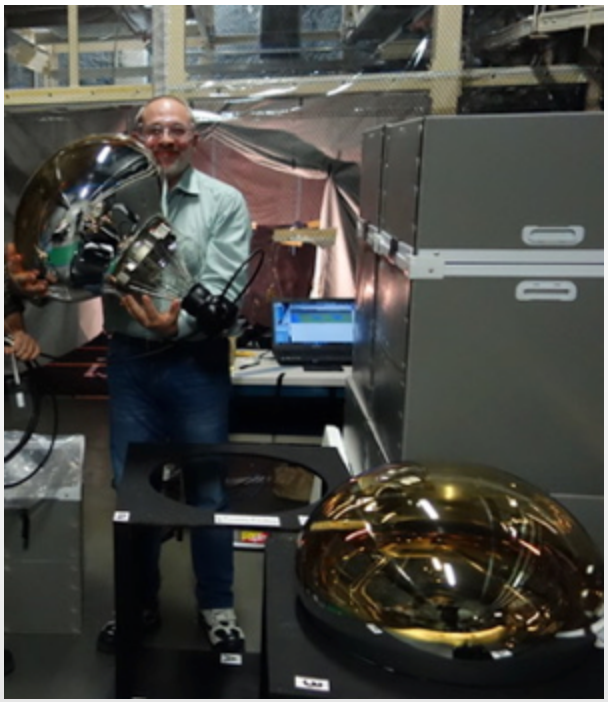


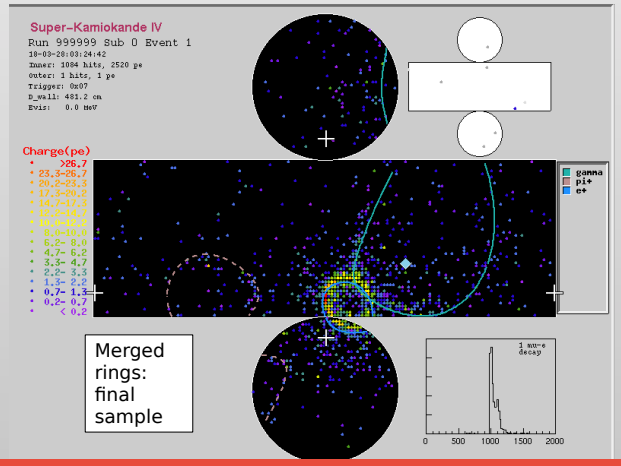
Impact on SK:

Sample	w/o ND280	w/ ND280
ν 1Rμ	14,6%	5,1%
$\bar{\nu}$ 1Rμ	12,5%	4,5%
ν 1Re	16,9%	8,8%
$\bar{\nu}$ 1Re	14,4%	7,1%
ν 1Re+1π^+	22,0%	18,7%

Contributo del gruppo di Bari a SK

- Realizzazione di un monitor (PSM) del LINAC (calibrazione elettroni) con lettura a sipm : E. Radicioni , R.A. Intonti (Tesi PHD)
- Caratterizzazione dei nuovi photosensori Box&Line a Kamioka (V.Berardi)
- Ricerca del decadimento del protone in SK (M.G. Catanesi, N.F. Calabria (Tesi Magistrale)
- Contributo al "Tank OPEN" con personale tecnico e ricercatore (V. Berardi, E. Radicioni, N. Lacalamita)

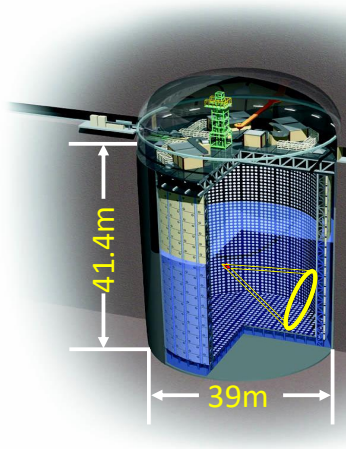




p->νK, K->$\pi^+\pi^0$ search

T2K far neutrino detector ~ Super-Kamiokande ~

50000 tons Ring imaging Water Cherenkov detector



Super−Kamiokande IV
(2008 Sept. − 2018 May 31st)
New software trig. DAQ system

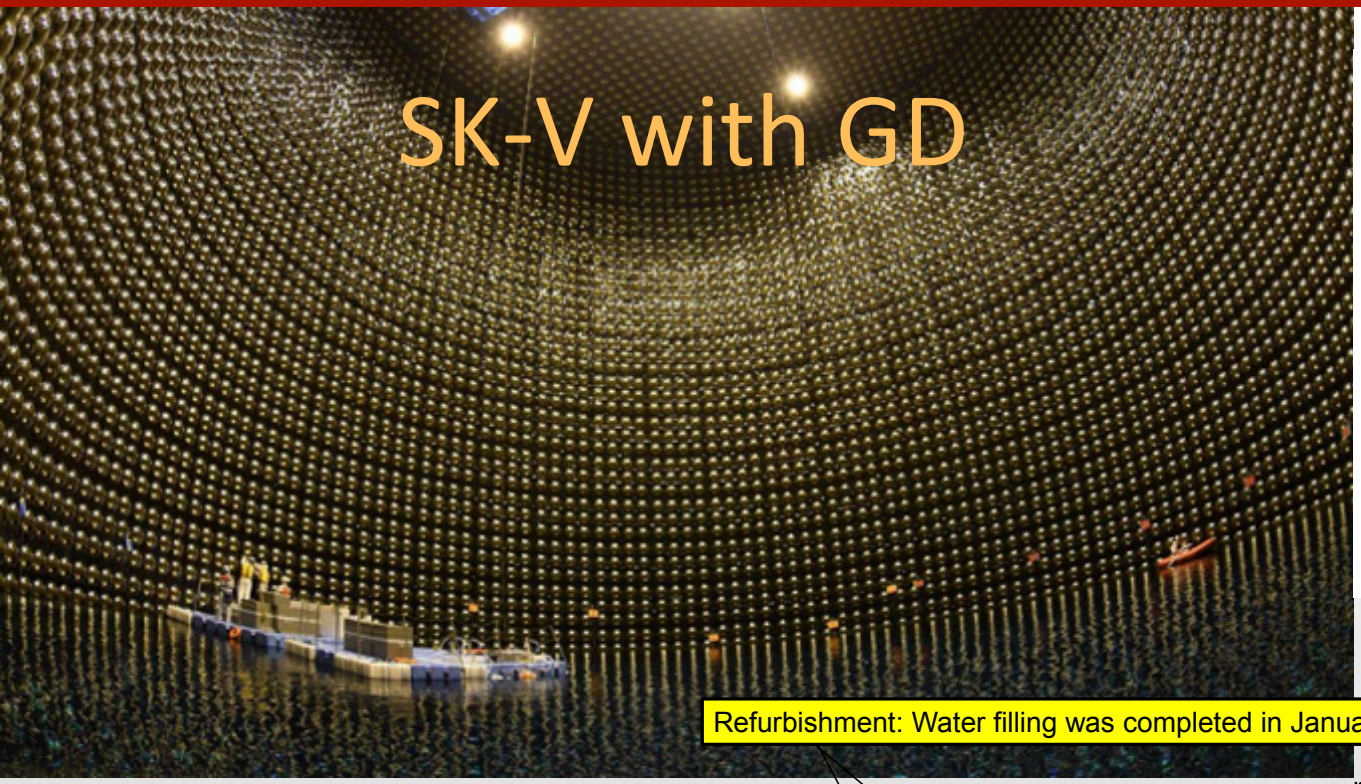
Inner detector 11129 20" PMTs

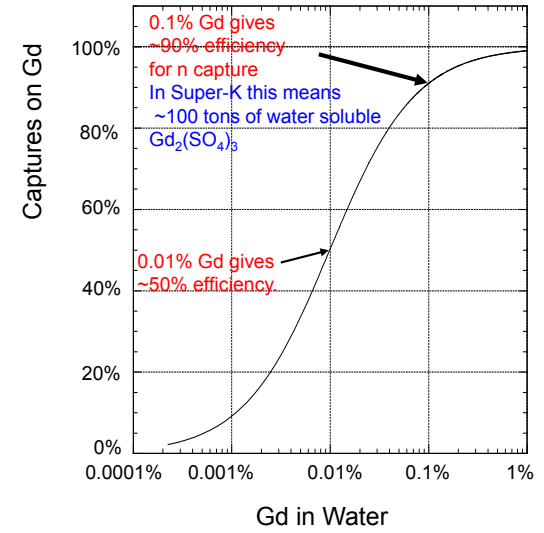
Outer detector 1885 8" PMTs

T2K neutrino beam data is stored using the beam GPS information from the accelerator.

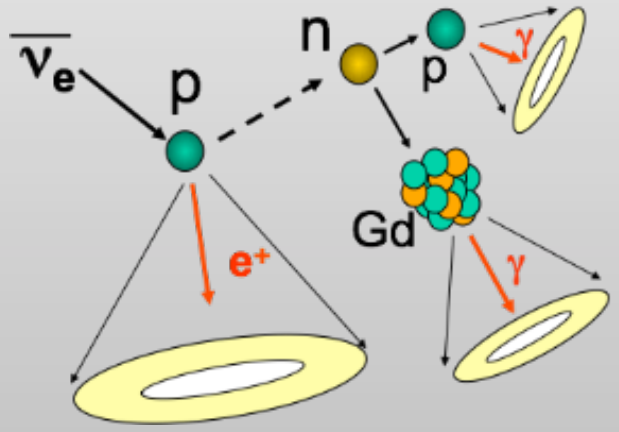
Efficiency is ~99% during the T2K operation period.

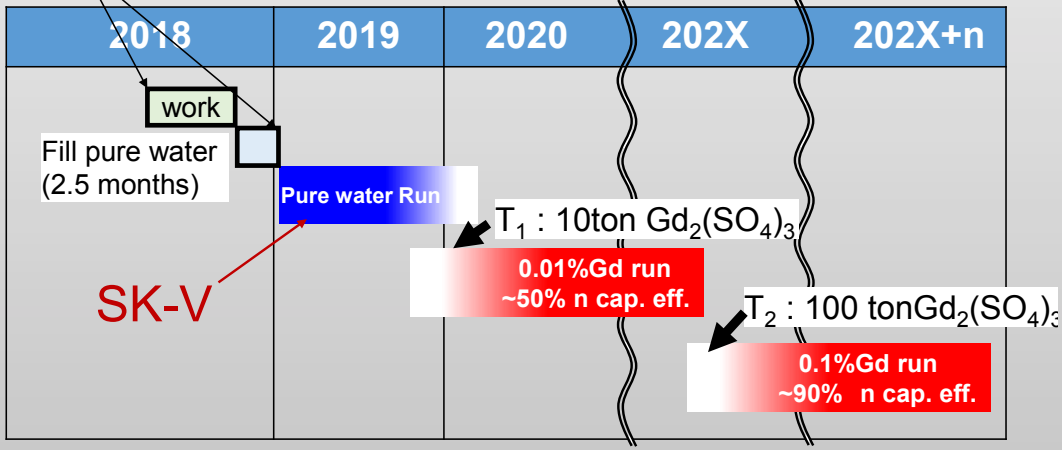
SK-V with GD





Refurbishment: Water filling was completed in January 2019.

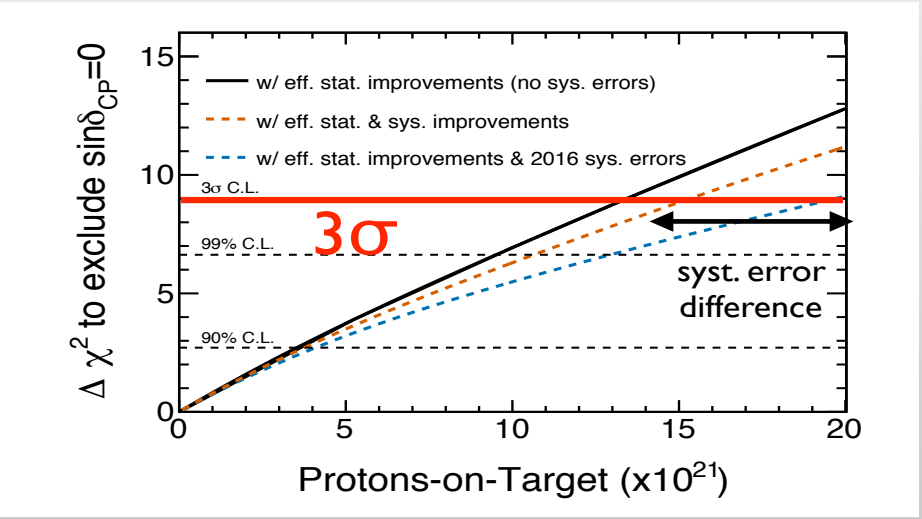


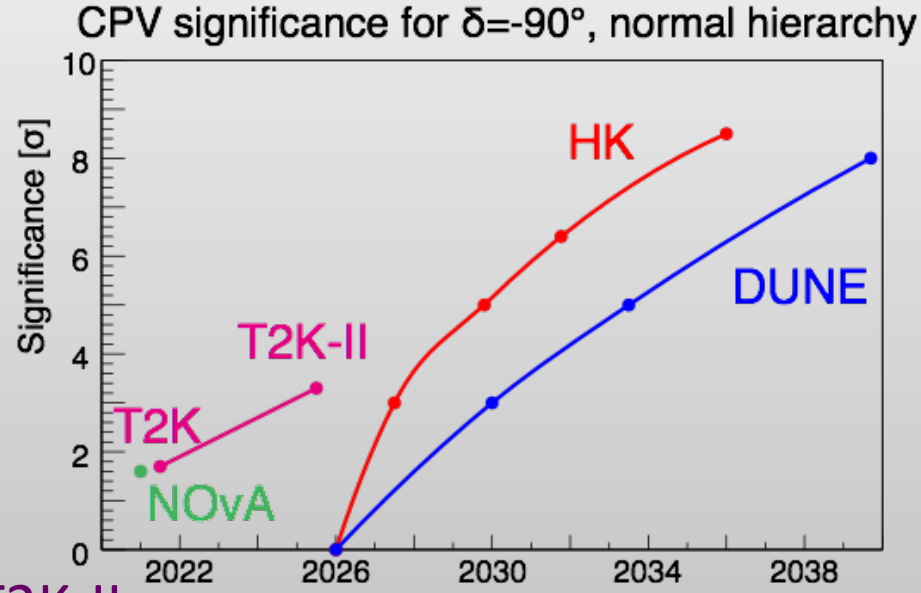


Plan to start 0.01% Gd run in early 2020.
(Adjusting schedule with T2K)

T2K Phase II (T2K-II)

- ~400 events expected for ν_e appearance signal
  - Analysis improvement to increase statistical significance
- Systematics Error 5.8 => 4% (<3% HyperK/Dune)
  - Near Detectors measurements are a key!
- Approved by PAC (Jan 2019).
- **TDR ND280-Upgrade @ CERN => NP07 (il CERN e' entrato in T2K)**

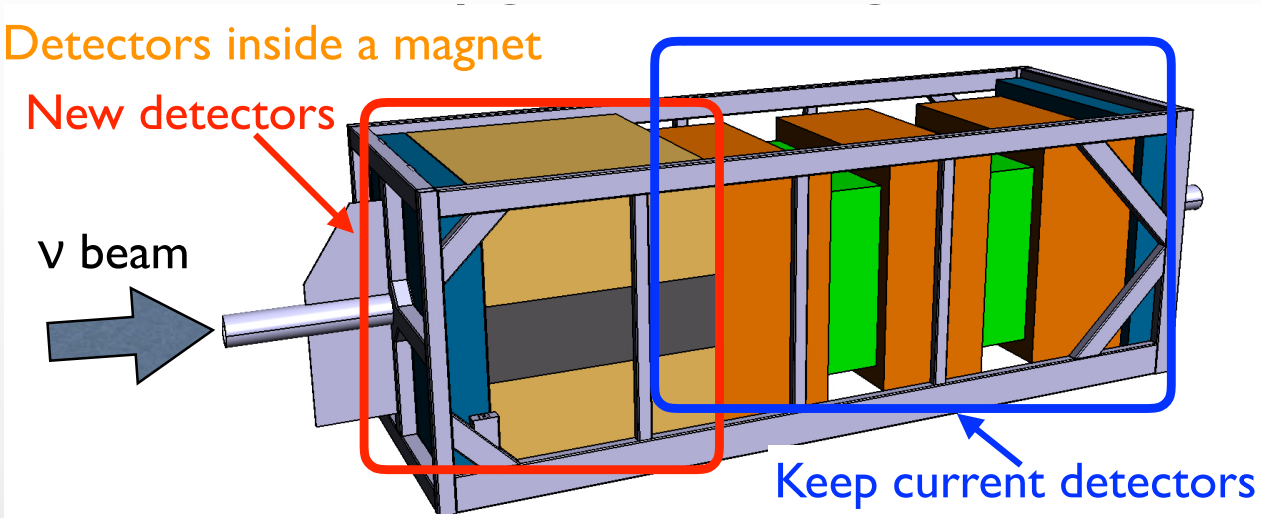


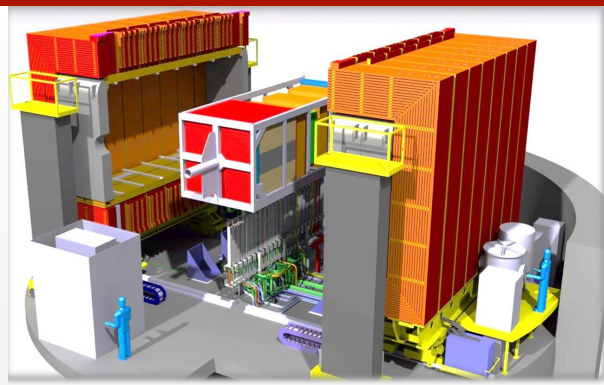


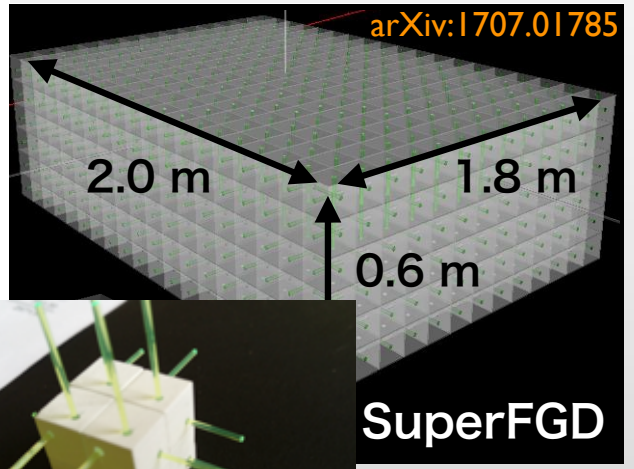
~3σ indication with T2K→T2K-II,

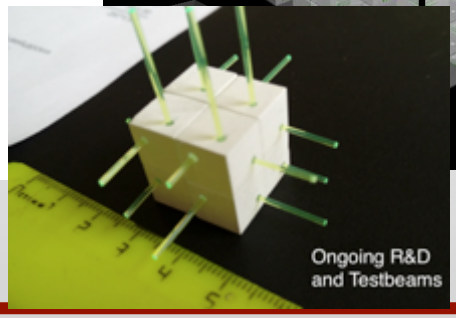
>5σ discovery and measurement with HK/DUNE

ND280 Upgrade Project (NP07)







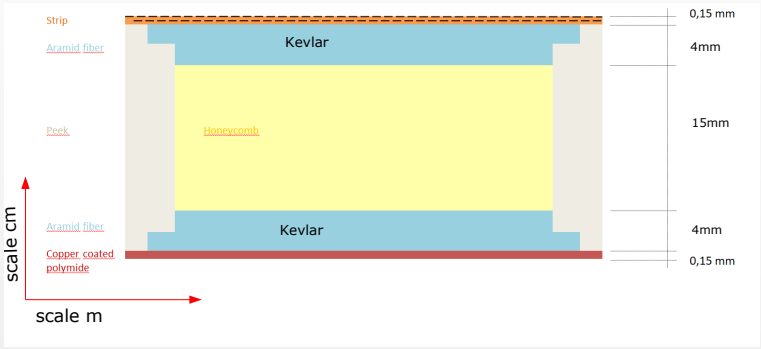


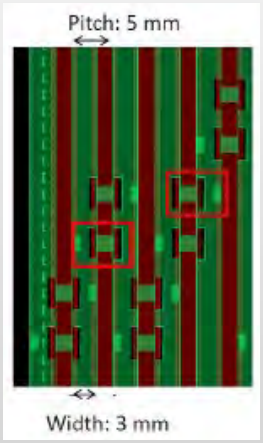
- Replace (most of) P0D with **Scintillator Detector** + 2 High-Angle TPCs + TOF
- Keep current "tracker" [2 FGDs + 3 TPCs] (& upstream part of P0D) as well as ECal, magnet & SMRD
  - For keeping continuity and forward acceptance

- **2018-2019** Prototype of TPC and SFGD in a testbeam. Define the detector options (granularity etc). Prepare for production.
- **2019-2021** Production, integration at CERN. System test (cosmics).
- **2021-2022** Shipment to Japan, installation, commissioning.

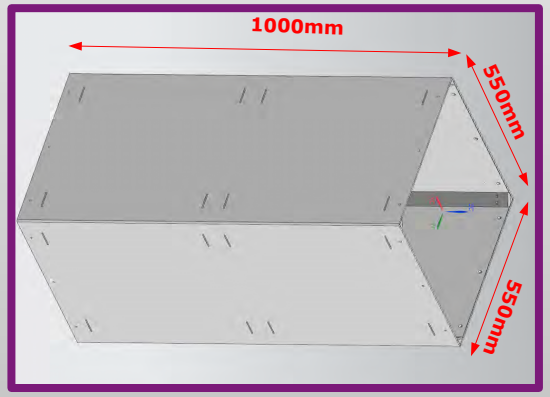
New Horizontal TPCs whit Resistive MM readout

Field-cages a minimo ingombro (geometrico & radiation length)





Strip Configuration
Double sided
Mirror strips
Foils dim : 55x220 cm



Mold Design

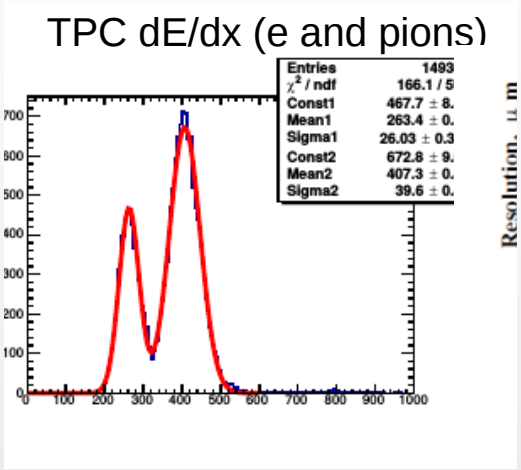
RESPONSABILITA' INFN

Field-cages:

- INFN Bari
- INFN Padova
- INFN LNL
- IFAE Barcellona

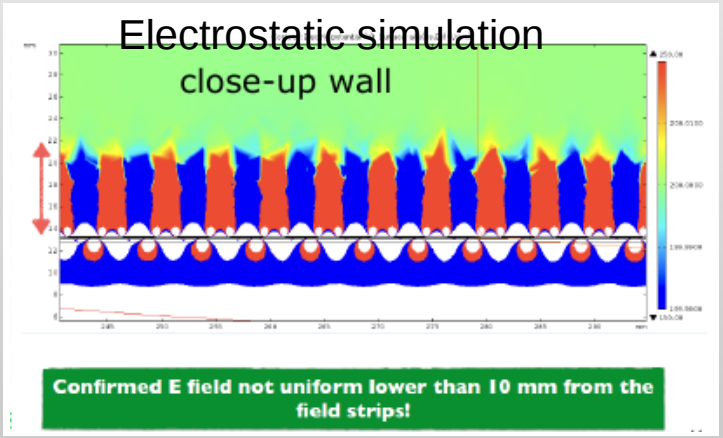
- Prototipo finanziato dalla CSN2 nel 2018 (50 Keuro circa)
- Simulazione (COMSOL) e realizzazione dei strips foils del prototipo completata
- Realizzazione del MOLD (prototipo) completata
- Assemblaggio e tests in corso

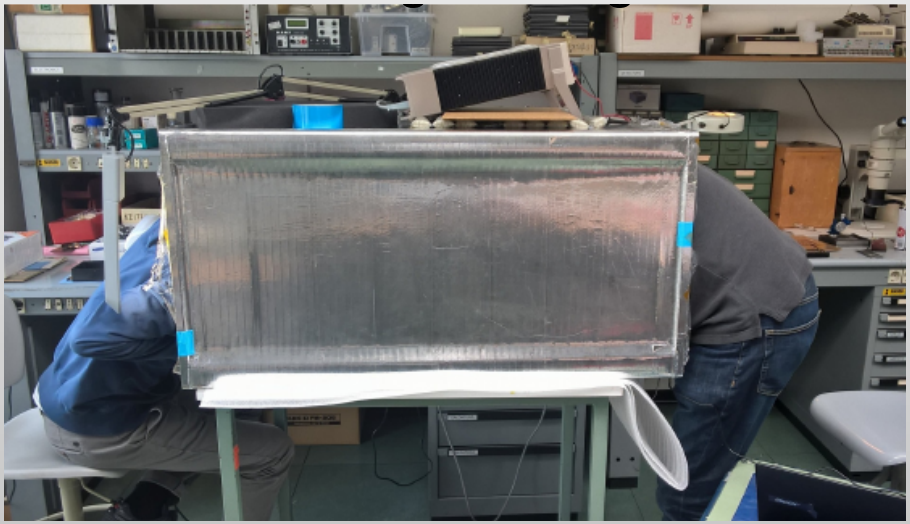
HA-TPC: INFN Contribution



Test Beam Summer 2018

The space point resolution is 300 µm, twice better than the existing TPC

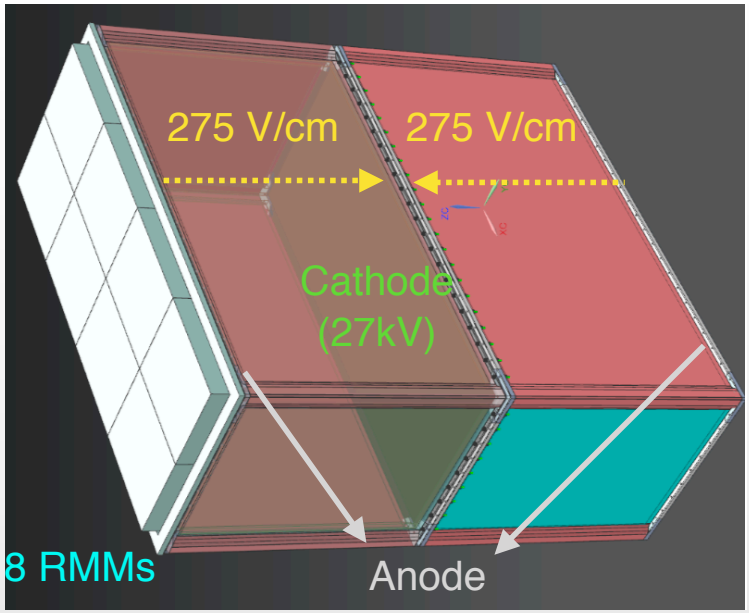




Field Cage Prototype

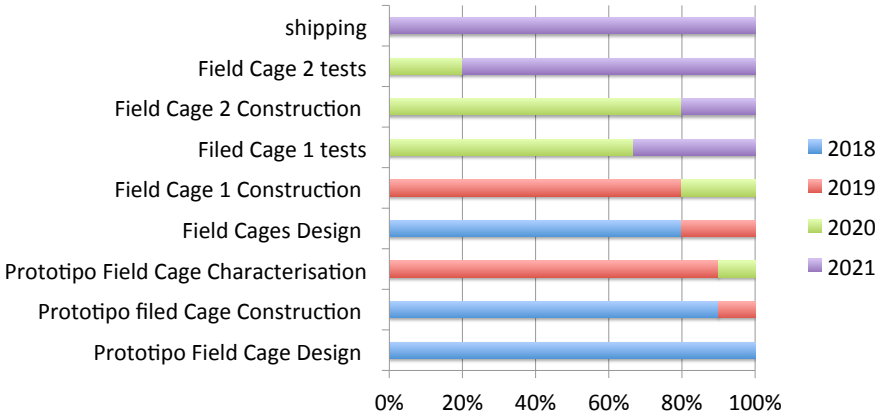
L.Magaletti, E.Radicioni , C. Pastore , N. Lacalamita

Field-Cage (2020): Bari



- La realizzazione delle Field-cages e' stata approvata e finanziata a settembre 2018
- Costo previsto (su 3 anni) circa 0.5 Meuro
- Nel 2019
  - Finalizzazione del design e inizio costruzione
  - Inizio realizzazione del MOLD (180cm x 100cm x 86cm)
- Nel 2020
  - Completamento del MOLD
  - Realizzazione prima Field Cage
  - Test e caratterizzazione della prima TPC alla Platform del CERN

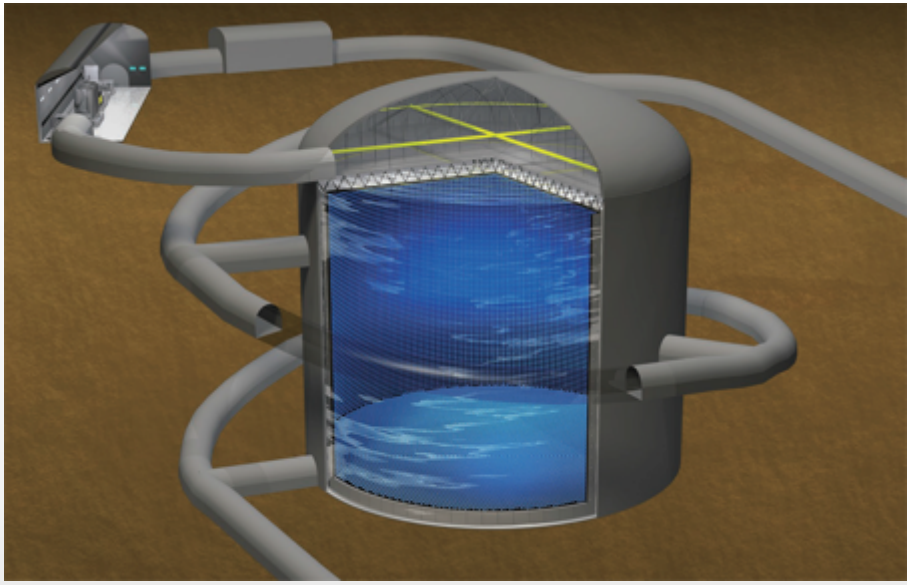
Chart table for the HTPC Field Cages of T2K



M.G. Catanesi, L. Magaletti, E Radicioni
C.Pastore (MOLD)

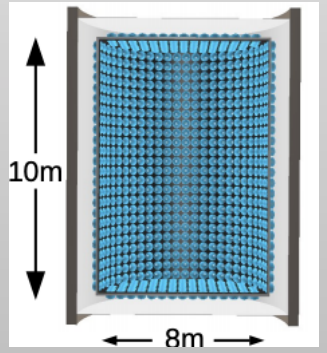
Hyper-K : Status del progetto

- ✓ **L'approvazione definitiva del progetto da parte del governo giapponese e' attesa in autunno**
- ✓ **Inizio previsto per lo scavo :Aprile 2020**
- ✓ **2 Meetings a Tokyo (gennaio/giugno 2019) con le F.A.(incluso INFN) per discutere della partecipazione internazionale**
- ✓ **Il contributo internazionale si sta focalizzando sulla realizzazione di circa 5000 mPMT, Elettronica e Veto System**

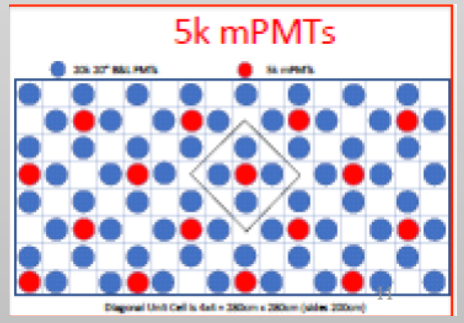


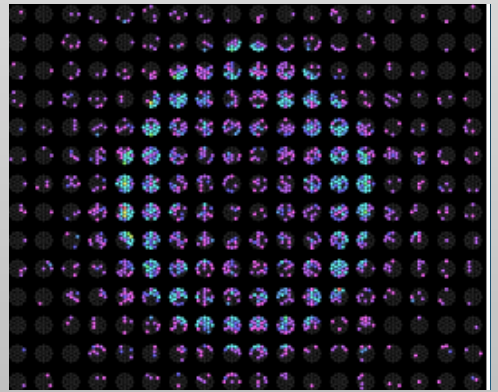
The IWCD detector utilizzera' la stessa tecnologia dei multi-PMT

IWC



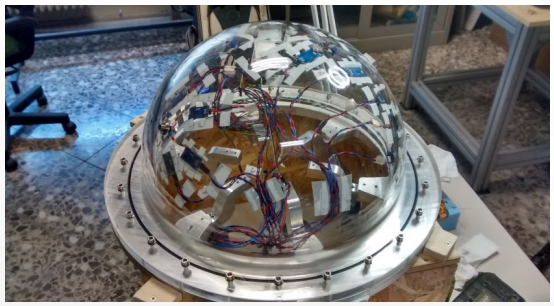
ID

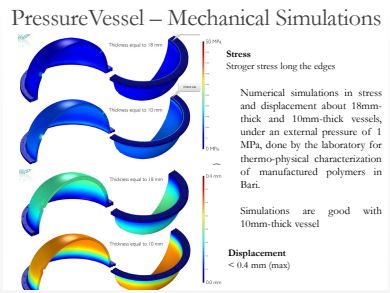




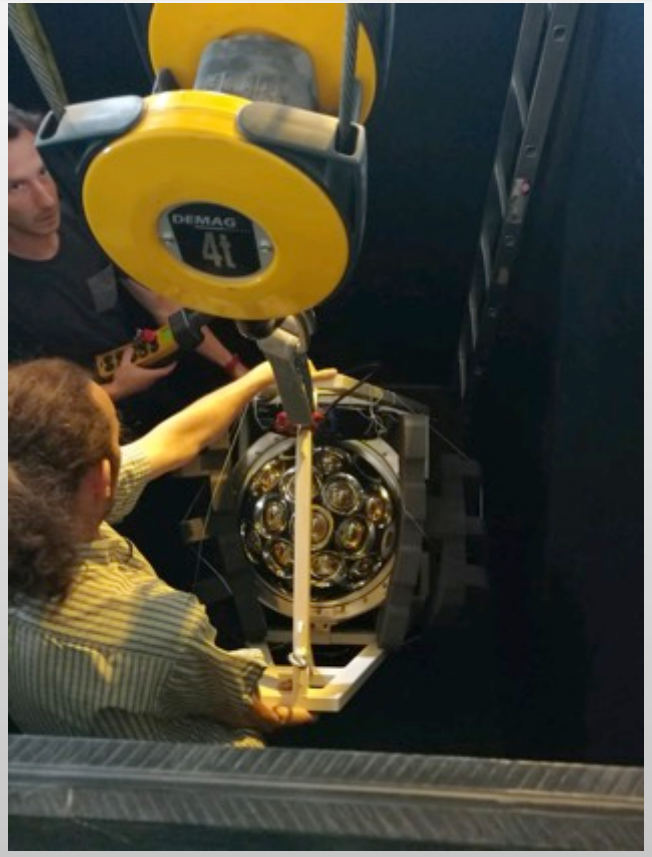
Multi-PMT @ INFN

KM3Net Inspired (MoU with them)
Proposed first by INFN in 2015
To be used for both IWC and ID
R&D finanziato dalla CSN2 dal 2016



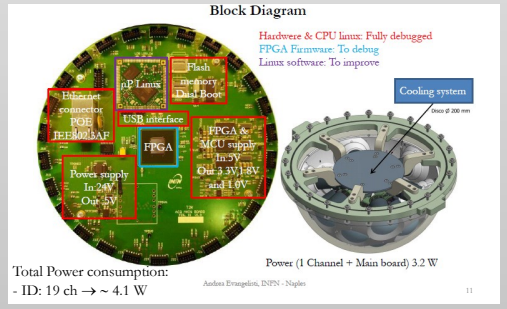


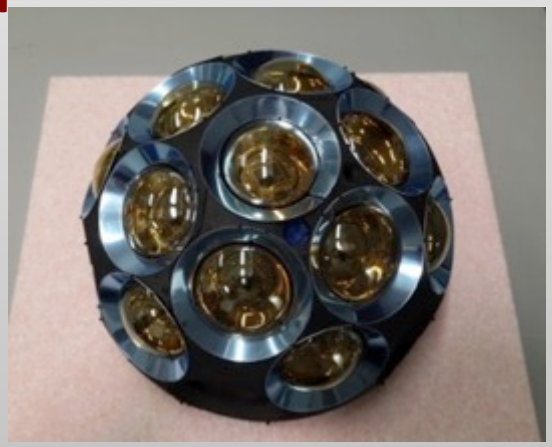
Acrylic Cover pressure test & simulations



Multi-PMT R&D

- ✓ Readout and HV electronics
- ✓ Acrylic covers (design and production)
- ✓ **Prototypes: Tests and Characterization**





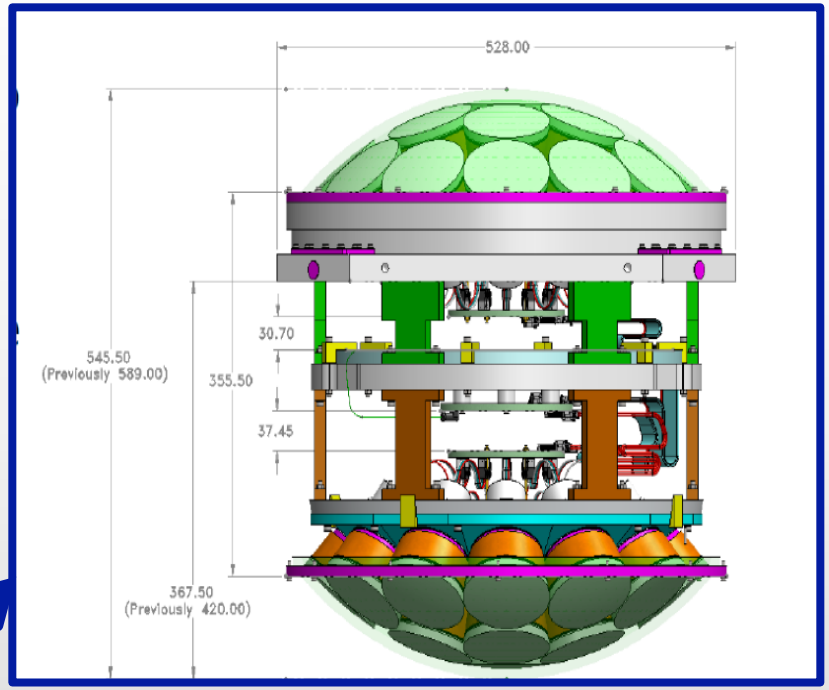
Prototype Test @ Memphyno

Readout Electronics

First Prototype

mPMT 2019-2020: Bari

- Caratterizzazione e test dei prototipi (Test a Memphyno)
- Simulazione (ottimizzazione) dei covers (geometrica e di materiale)
- Misure specifiche di stress meccanico,
- Realizzazione e test di un ulteriore prototipo “ottimizzato” di nuovo tipo.



V.Berardi, B.R. de Melo, R. Spina
M.Mongelli per il CAD meccanico

The 27th International Workshop on Weak Interactions and Neutrinos

Scientific Topics:

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EW symmetry breaking & Higgs
Astroparticle physics
Flavor and precision physics

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Alexis Pompili (Università di Bari)
Emilio Radicioni (INFN Bari)

Administrative and technical support

A. Catalano (Università di Bari)
E. D'Alba (INFN Bari)
L. Napolitano (Università di Bari)
S. Nicotri (INFN Bari)
G. Salente (INFN Padova)
A. Silvestri (INFN Bari)

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Grazie a tutti per l'aiuto !

T2K a Bari

Responsabile Nazionale :M.G. Catanesi

- Staffs :
  - Vincenzo Berardi (70%) 5% ENUBET_CSN2)
  - Maria-Gabriella Catanesi (70%) (5% ENUBET_CSN2)
  - Lorenzo Magaletti(100%) (10% ENUBET_CSN2)
  - Emilio Radicioni(40%)
  - Roberto Spina(50%)
- Dottorandi e borsisti
  - Bruno Ricardo De Melo Cavalcante (100%) (10% ENUBET_CSN2)
  - + Nicola Fulvio Calabria (borsista INAF => dottorato)

➢ <u>Percentuali : 4.3 FTE</u>

“ENUBET_una sigla tecnica di un progetto ERC e quindi richiede piccole percentuali. Inoltre, visto che ENUBET e' un R&D funzionale a T2K le percentuali T2K e ENUBET si sommano”

Richieste finanziarie :

- Missioni: si prevedono 3 mesi di run per T2K , shift SK , Test alla neutrino platform CERN (NP07) => 70 Ke
- SPServizi => 70 Ke (CF T2K + Spese comuni al CERN JPARC,Kamioka)
- Consumi/Costruzioni = 90K Costruzione TPC +10K R&D mPMT per Hyper-K)

Richieste servizi

- Officina meccanica: 4 mesi
  - 3 mesi TPC field Cage , 1 MultiPMT Water Cherenkov
- Disegno Meccanico 3 mesi
  - 2 TPCs + 1 meccanica MultiPMT
- Elettronica 1 mese
  - Prototipi (cavi , assemblaggi)