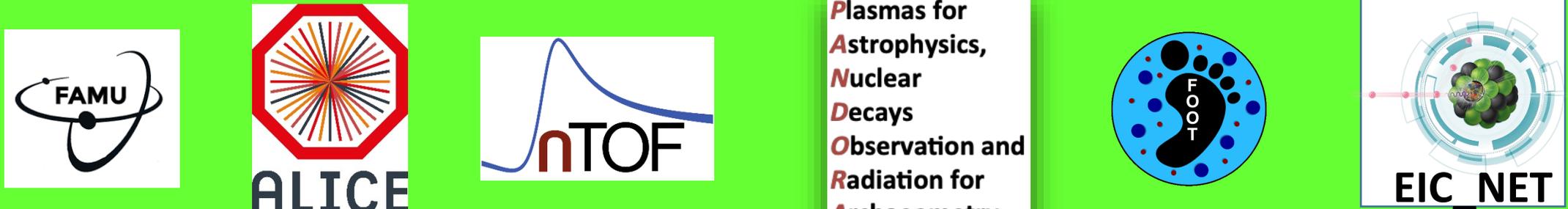


GRUPPO 3: AdS 14/7/2020



FAMU

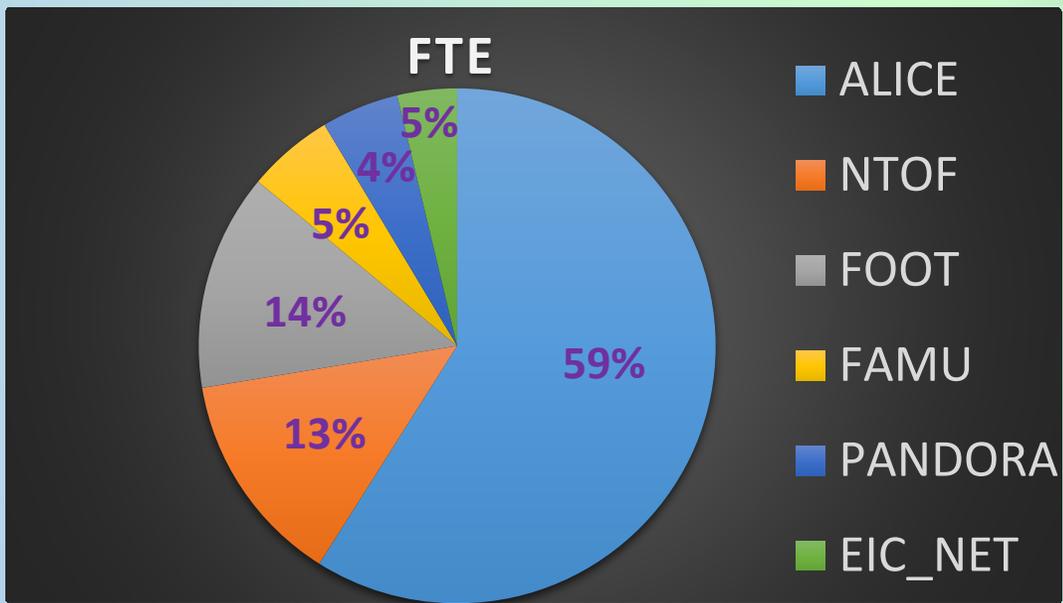
ALICE

nTOF

**Plasmas for
Astrophysics,
Nuclear
Decays
Observation and
Radiation for
Archaeometry**

FOOT

EIC_NET



FTE: 26.8 (2020 27.85)
PERSONE (INFN, UNIV, ENEA): 76

Prof. Mauro Bruno

Un sincero ringraziamento

Una colonna del Gruppo 3: dal 1970 (anno della laurea) fino alla fine

Ricerche in Fisica Nucleare Sperimentale

- ❑ Fissione
- ❑ Fusione
- ❑ Termodinamica nucleare
- ❑ Effetti di clustering
- ❑ Meccanismi di reazione per nuclei pesanti
- ❑ Reazioni nucleari a pochi corpi

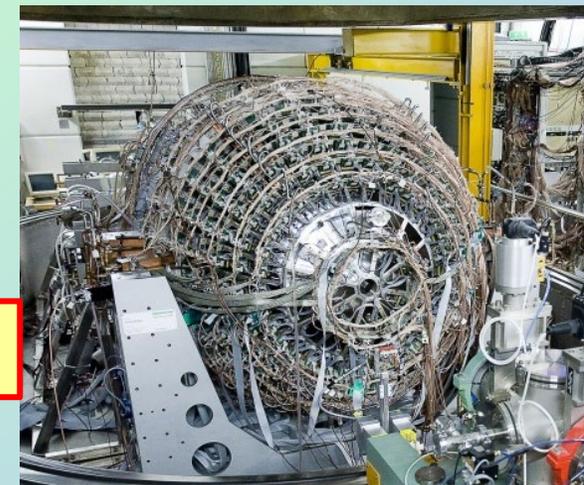
Garfield (InI)



Fazia



Chimera (Ins)



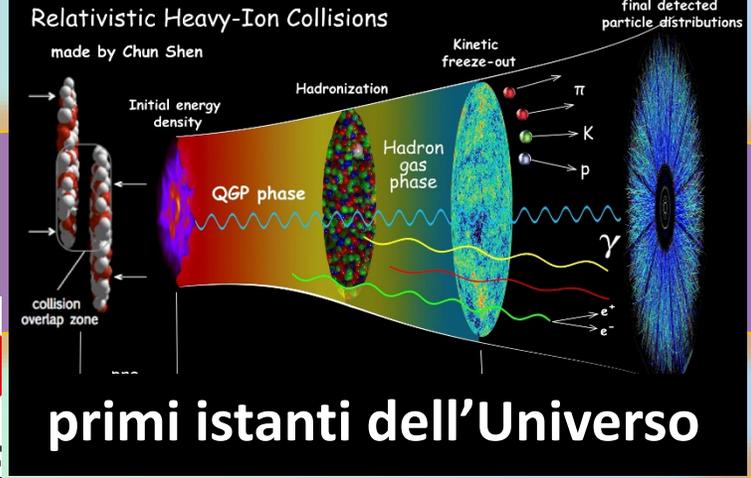
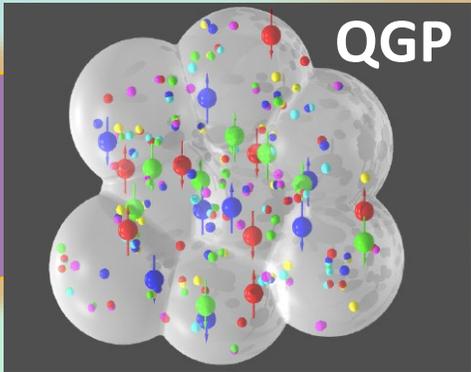
Uno dei fondatori della collaborazione Nuclex

Intensa attività didattica e di formazione di giovani per la fisica nucleare (39 tesi e 8 dottorati)

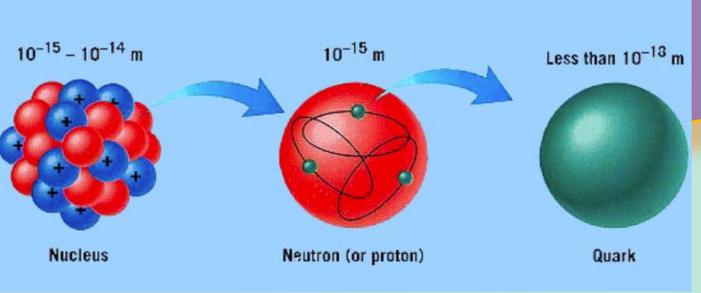
Non disperdere quello che una generazione ci ha lasciato



GR3 a Bologna

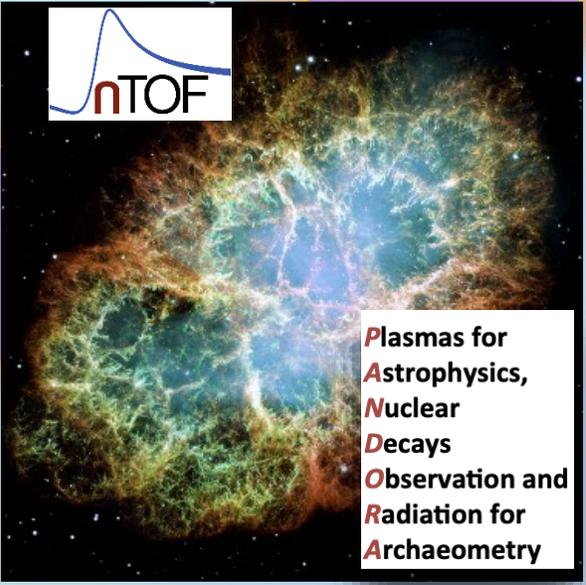


primi istanti dell'Universo



Astrofisica nucleare

- ❑ Evoluzione stellare
- ❑ Nucleosintesi



Fisica nucleare ad ampio spettro

- ❑ Fisica nucleare di base
- ❑ Struttura nucleare
- ❑ Transizioni di fase
- ❑ Livelli iperfini H

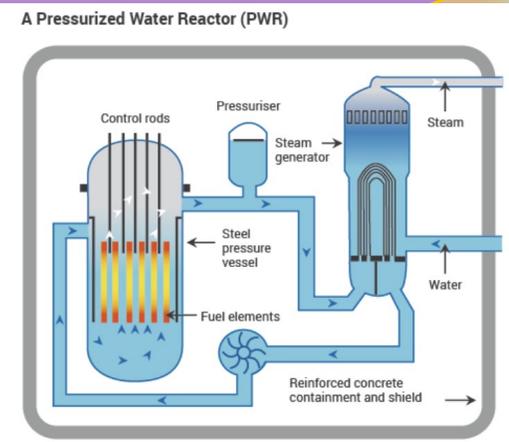


Next QCD frontier

- ❑ e^- ion collider



Gruppo 3: Attività e richieste

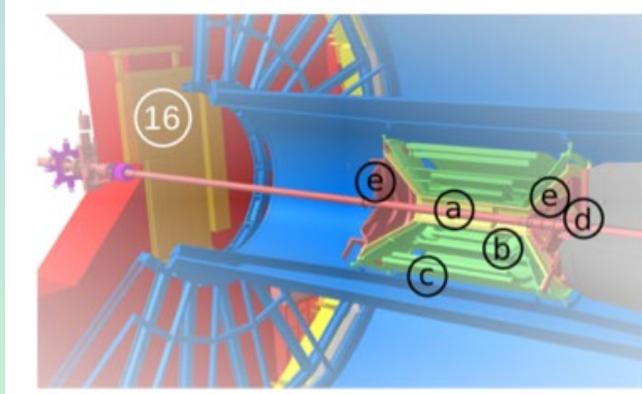
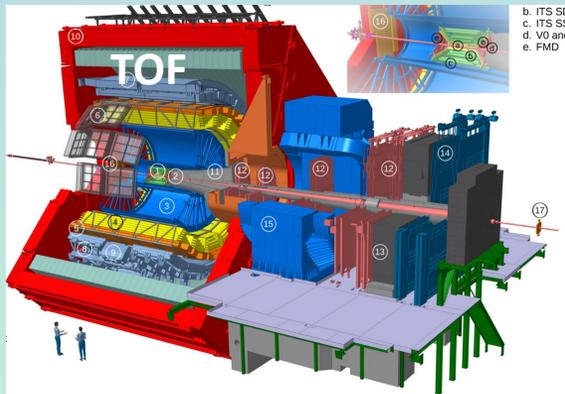


Scopi applicativi

- ❑ reattori
- ❑ Adroterapia
- ❑ Radioprotezione



ALICE



- a. ITS SPD (Pixel)
- b. ITS SDD (Drift)
- c. ITS SSD (Strip)
- d. V0 and T0
- e. FMD

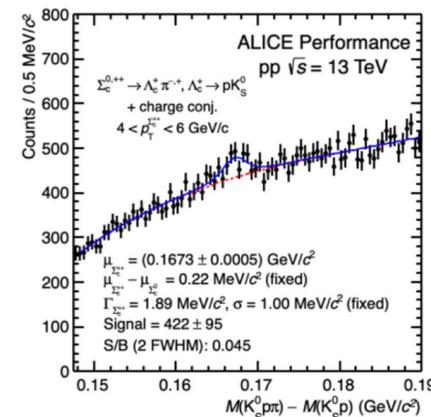
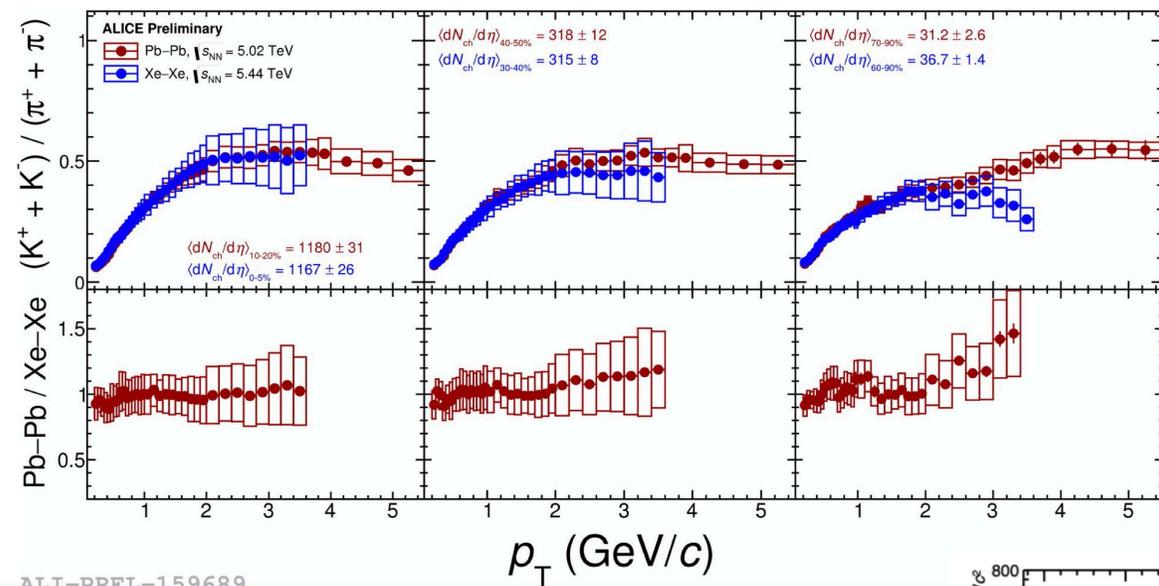
Attività (update febbraio 2020):

□ Rivelatori

- TOF
- ITS (Inner Tracking System)
- R&D

□ Analisi (7 papers previsti in 2020)

- Light & heavy Flavour
- studio spettri identificati in Xe-Xe
- canale $\Sigma_c^{++} \rightarrow \Lambda_c^+ \pi^+$, $\Lambda_c^+ \rightarrow pK_s^0$
- Alice white paper
- Produzione Λ_c e $\Lambda(1520)$
- <https://agenda.infn.it/event/21942/contributions/111035/attachments/70833/88595/AdS-ALICE-20200220.pdf>



Bologna:

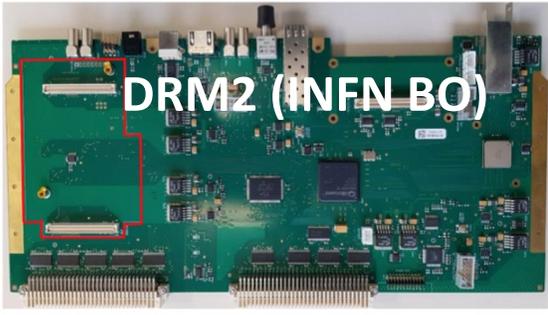
- 15 staff:(4 UniBo, 10 INFN, 1 ENEA) → 15.8 FTE (16.8 in 2020)
- 3 post doc, 3 PhD, 2 Cern Fellows, 2 Master students
- Servizi (elettronica, STG, off. Meccanica,...) grandissimo lavoro!!!



TOF

ALICE

- ❑ Estrazione dei moduli
- ❑ Irradiazione a Trento
- ❑ Sviluppi FW e SW nonostante lockdown
- ❑ Upgrade da remoto Slow Control
- ❑ Installazione (un po' ritardata) schede DRM2



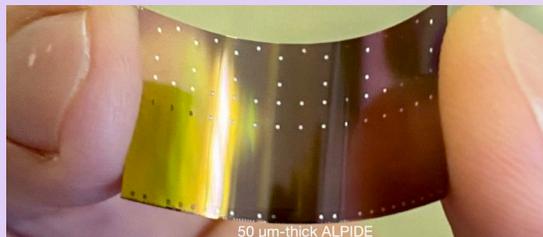
From alice-newsletter (ALICE newsletter) <alice-newsletter@cern.ch> ☆
 Subject The ALICE Newsletter No. 111
 To alice-member (ALICE Collaboration Database Employment Record) <alice-member@cern.ch> ★
 Cc ALICE Spokesperson <alice.spokesperson@cern.ch> ★

03/07/2020, 16:10

• **TOF: the last 2 DRM2 were successfully installed this week. The installation of all 72 TOF crates, with DC/DC and new DRM2 card (housing GBTx link) is finally complete.** This marks the end of a huge effort, lasted for many years, which involved several TOF colleagues in developing new electronics and related firmware & software, doing irradiation tests (either for DRMs or DC/DC components), commissioning of cards, and in the tiring work of dismounting/mounting cards in the pit.

ITS3

- ❑ layer Si (20-40 μm) per LS3



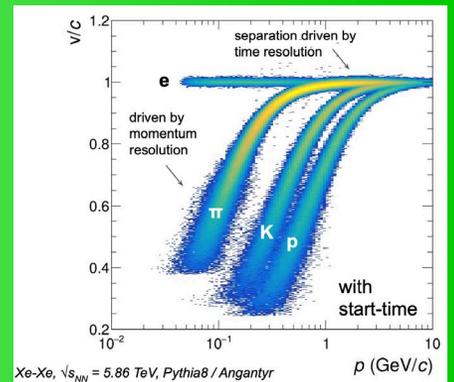
R&D (in ambito AIDA Innova, da approvare)

- ❑ **MRPC** Multigap Res Plate Chamb
 - ❑ materiali → risoluzione t
- ❑ **Pico TDC** → risoluzione 3 ps (ora ~20 ps)



Alice 3.0 (post LS4)

- ❑ Studio timing



FAMU

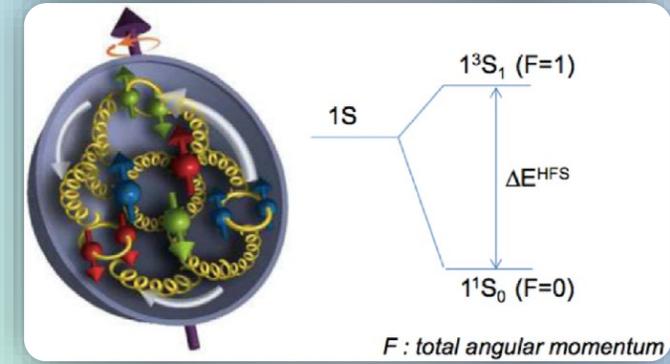
Misura del raggio di Zemach del protone (sensibile sia alla struttura elettrica che magnetica) attraverso la spettroscopia γ del livello iperfine 1s dell'**atomo muonico**

$$m_{\mu} \cong 200m_e$$

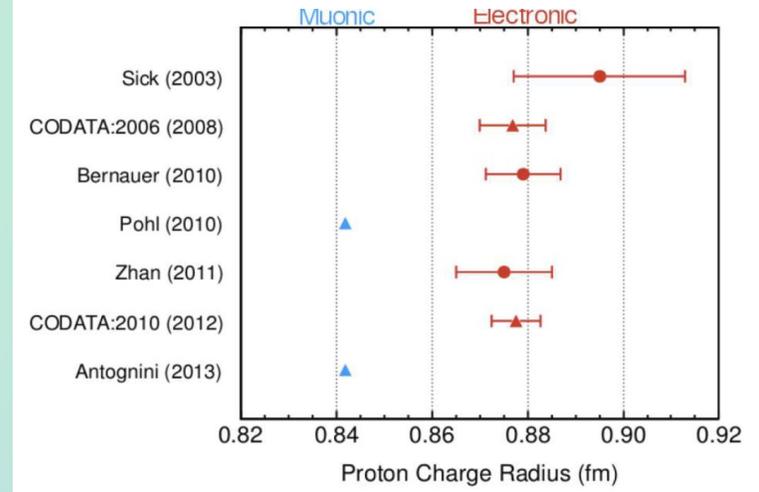
$$r_{\mu} \cong \frac{1}{200} r_e$$



più sensibile alla struttura del protone

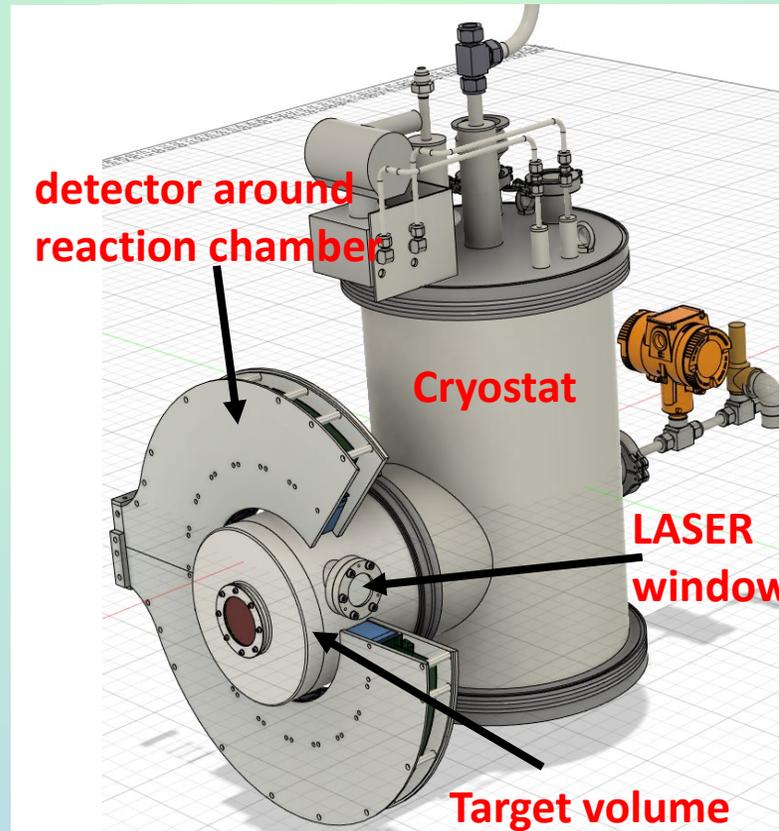


Puzzle del raggio del protone

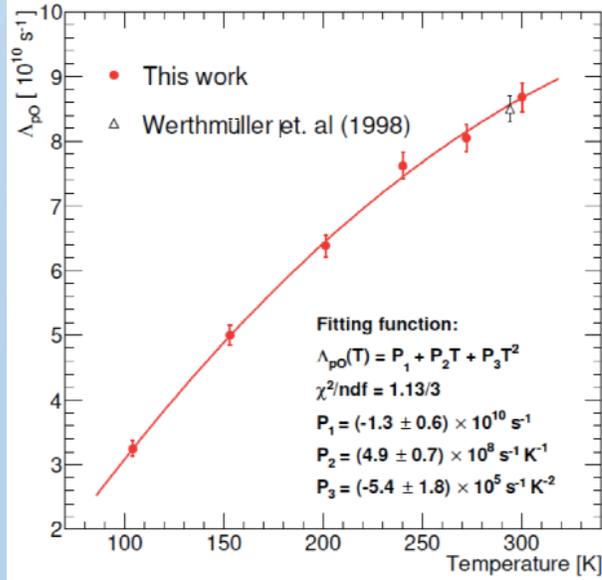


Procedura:

- mistura H e O
- $\mu p(\uparrow \downarrow)$
- Laser $\rightarrow \mu p(\uparrow \uparrow)$
- μp catturato da O \rightarrow emessi γ
- Misura tempi dei γ emessi da O



μ transfer rate $\mu_H \rightarrow \mu_O$ in
funzione di T e E_{kin}



Bologna:

❑ Ricercatori 6, FTE=1.45

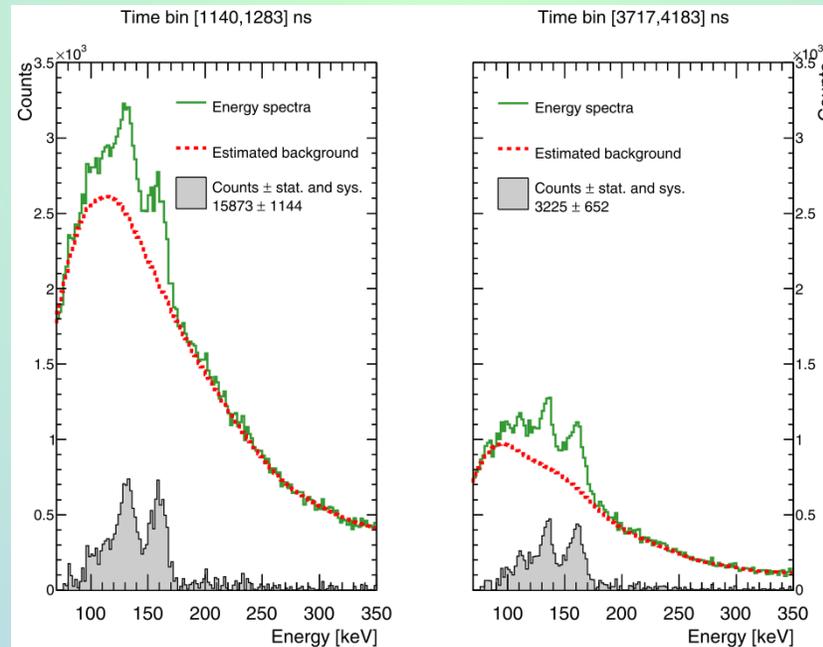
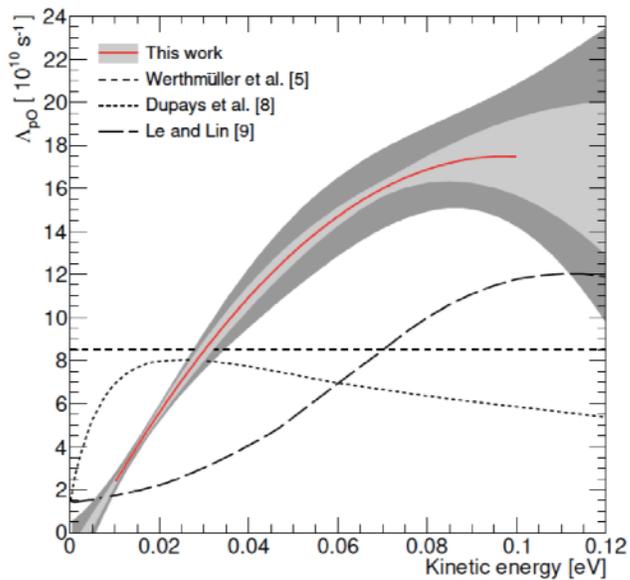
Attività: sviluppo del rivelatore $\text{LaBr}_3:\text{Ce}$

❑ cristalli scintillanti

❑ PM

❑ Signal sampling 1 GS/s

Spettro energetico in due intervalli temporali

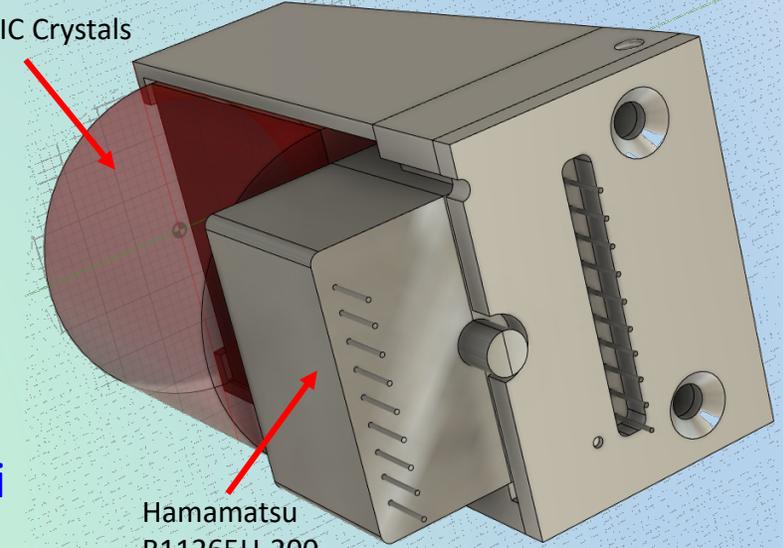


FAMU



$\text{LaBr}_3:\text{Ce}$

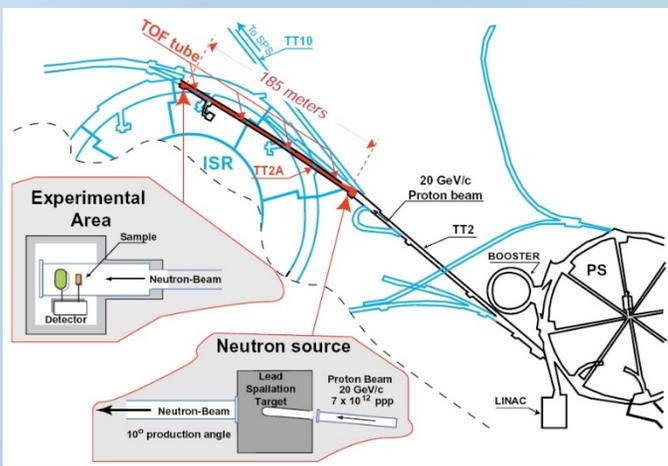
EPIC Crystals



Hamamatsu
R11265U-200

light-tight container





n_TOF



Attività analisi 2020

Studio della sezione d'urto (n, γ) del ^{140}Ce
nucleosintesi del processo-s negli ammassi globulari

Spokespersons:
C Massimi, A Mengoni

Studio della sezione d'urto (n, γ) del ^{154}Gd
nucleosintesi del processo-s nelle giganti rosse

Spokesperson:
C Massimi

studio della sezione d'urto di fissione dell' ^{235}U ad alta energia
($E_n > 200 \text{ MeV}$)
determinazione di uno standard ad alta energia

Tesi di dottorato di Alice Manna

Attività di calcolo e simulazioni

Uso di Cloud@CNAF (che ringraziamo!) per simulazioni per la misura $^{235}\text{U}(n, f)$ e di altri dispositivi. Confronto Geant4 - MCNP

Nicholas Terranova (ex BO)
Patrizio Console Camprini

Calcoli vari di modelli di struttura & reazioni nucleari

A Ventura, A Mengoni

Bologna:

- ❑ **8 membri → 3.6 FTE**
- ❑ Cristian Massimi: **resp. Nazionale**
- ❑ Alice Manna (PhD)
- ❑ Gianni Vannini (ass. senior)
- ❑ Alberto Ventura (ass. senior)
- ❑ Alberto Mengoni (ENEA) **spokesperson**
- ❑ Donato Maurizio Castelluccio (ENEA)
- ❑ Patrizio Console Camprini (ENEA)
- ❑ Antonio Guglielmelli (ENEA)

Publicazioni & Tesi: 2019-20

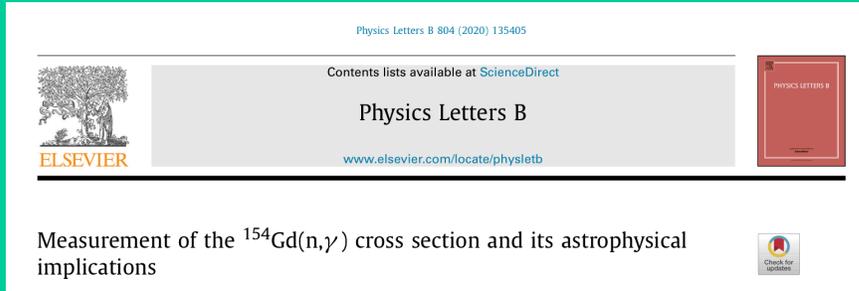
20 articoli di cui 11 su rivista (12 con primo autore INFN)

1 tesi magistrale

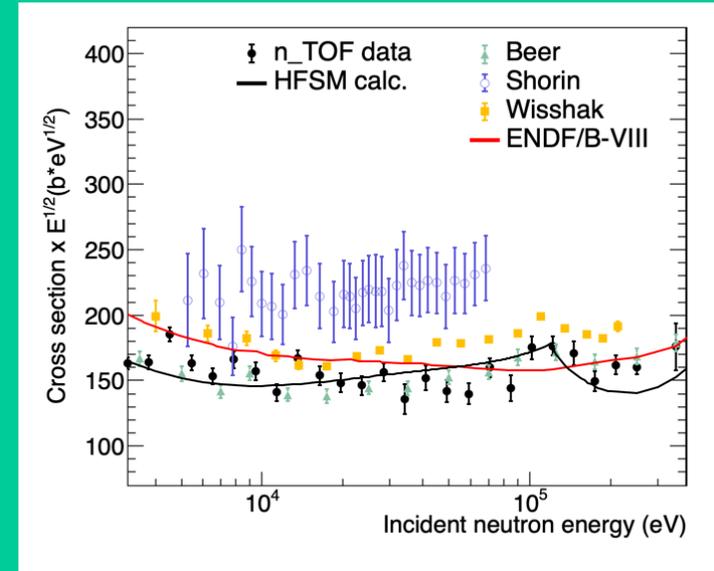
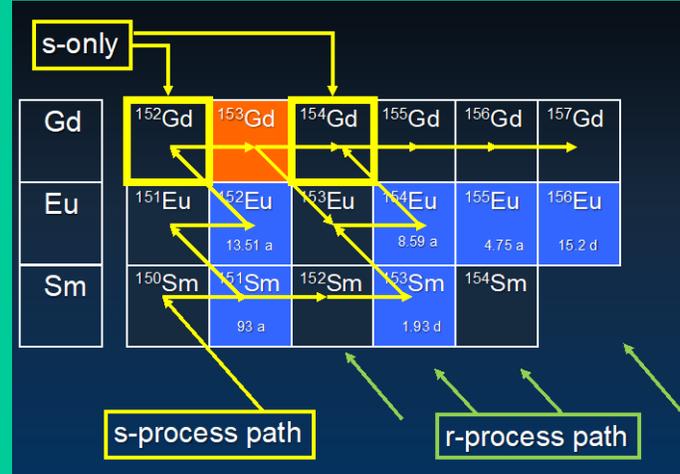
1 tesi dottorato (fine anno)

La lista delle pubblicazioni in backup

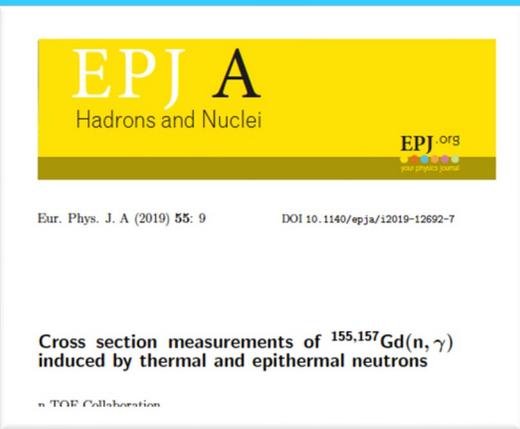
Astrofisica Nucleare: spokesperson & corresponding author: C. Massimi



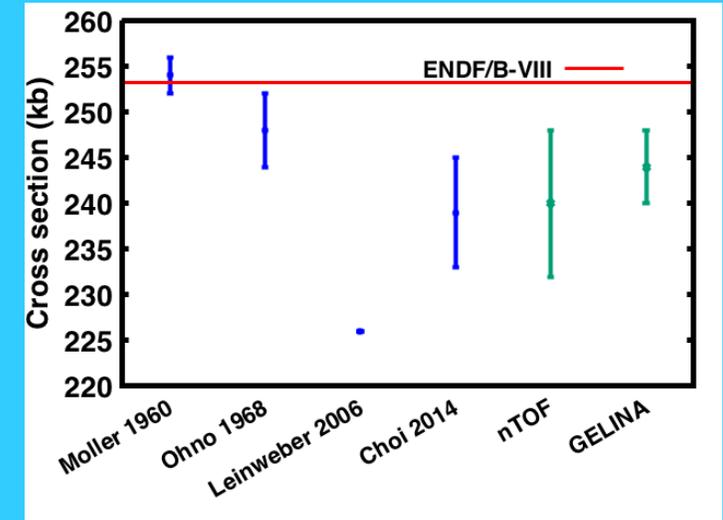
^{154}Gd formato solo dal processo s. La misura ha confermato la sovrastima della sezione d'urto $^{154}\text{Gd}(n,\gamma)$ predetta dai modelli astrofisici



Applicazioni Nucleari: spokesperson & corresponding author: C. Massimi



Sezione d'urto di cattura per il ^{155}Gd e ^{157}Gd , importanti implicazioni nello studio dei reattori Light Water Reactor LWR. \rightarrow Misura complementare a GELINA \rightarrow riduzione dell'incertezza!



PANDORA



2020

Costruzione Plasma trap & prime misure

2024



Studiare il comportamento di alcuni nuclei

processi di nucleosintesi delle stelle

Verifica di modelli teorici

Ambiente caldo
($T_{e^-} \sim 10^9$ °C) e ionizzato

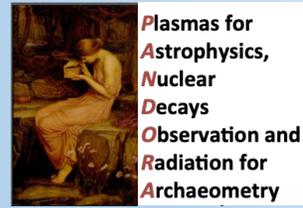
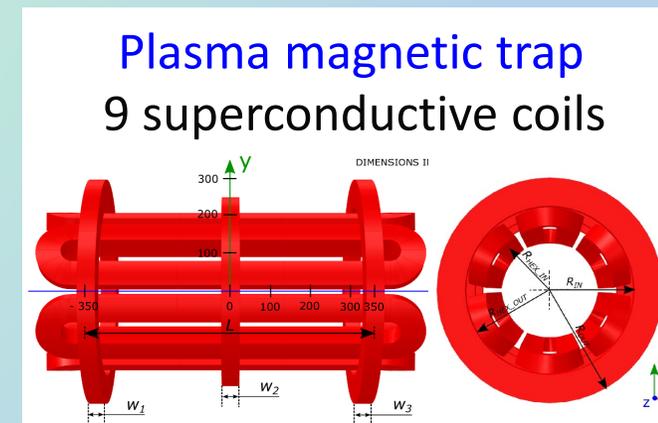
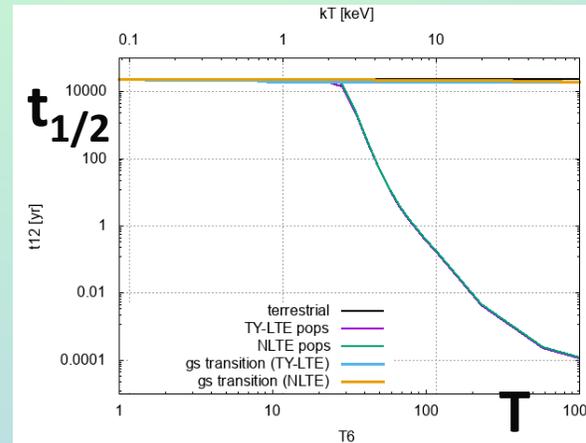
Gas nobile ionizzato +
isotopo da studiare

Bologna (4 ricercatori, 1.3 FTE):

- ❑ Odorici F. (0.5 FTE), resp. Locale
- ❑ Cuffiani M. (0.2 FTE)
- ❑ Malferrari L. (0.4 FTE)
- ❑ Mengoni A. (0.2 FTE)

Responsabilità

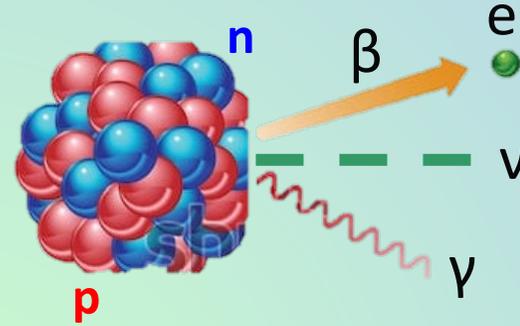
- ❑ Plasma Chamber: (resp. F. Odorici)
 - ❑ design, costruzione, controllo
- ❑ Modelli teorici (resp. A. Mengoni)
- ❑ Analisi dei dati



PANDORA

Isotope	$T_{1/2}$ (yr)	E_g (keV)
^{176}Lu	3.78×10^{10}	88-400
^{134}Cs	2.06	>600
^{94}Nb	2.03×10^4	>700

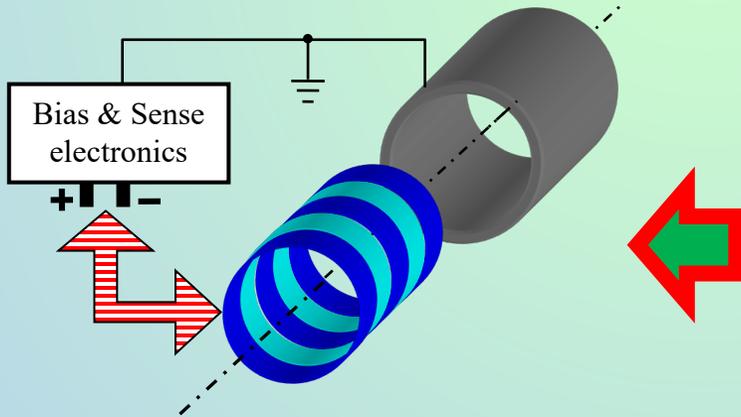
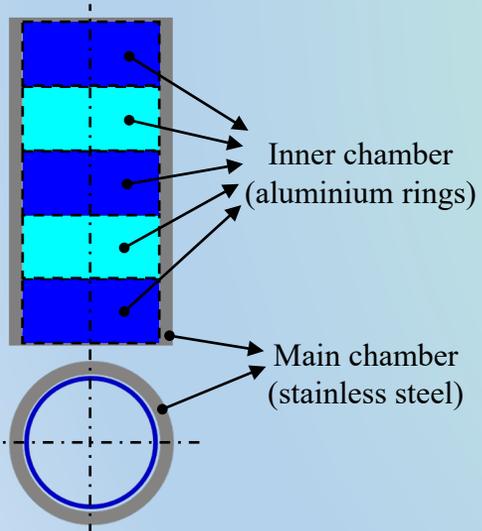
Misurare il tempo del decadimento β



Attese variazioni di $t_{1/2}$ (8-9 ordini di grandezza!)
in un ambiente fortemente ionizzato (plasma)



Può far luce sui processi slow e
rapid di nucleosintesi nelle stelle



Gas nobile of He, Ar, or ... (10^{13} atoms/cm³)
dove è flussato l'isotopo

Rivelato il γ del decadimento β



2020: prototipo dell'Inner plasma Chamber (per covid, i tests sono spostati al 2021)

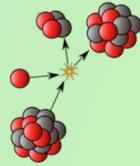
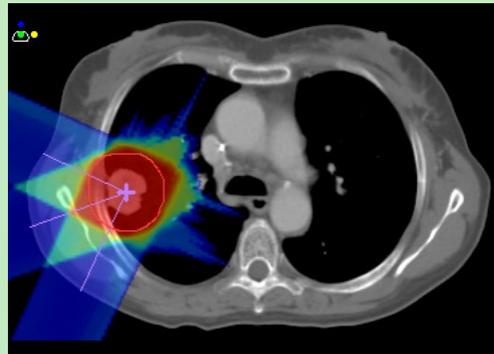
FOOT: FragmentatiOn Of Target



GOAL: pA cross section fragmentation

Nuclear physics

Hadrontherapy

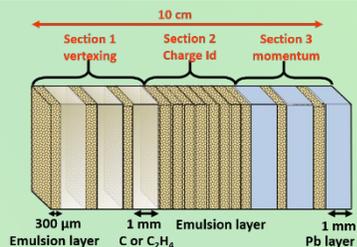
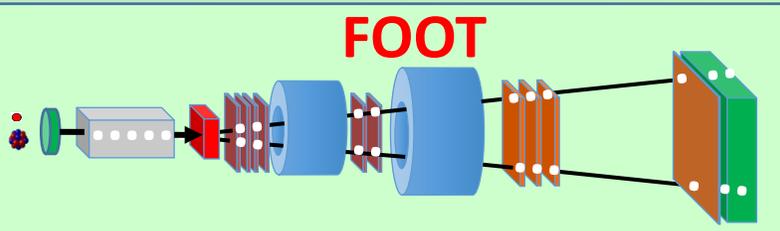


Spacecraft shielding



2 detector setups

FOOT



- SC: **ready**
- BM: **ready**
- VTX: **test**
- ITR: **construction**
- MSD: **test**
- Magnet: **purchase**
- SCN: **ready**
- CAL: **test**
- DAQ: **development**
- EMC: **ready**

Collaboration

- Accepted end of 2017
- 13 Sections/Labs (National and Internat)
- 100 members, ~45 FTE

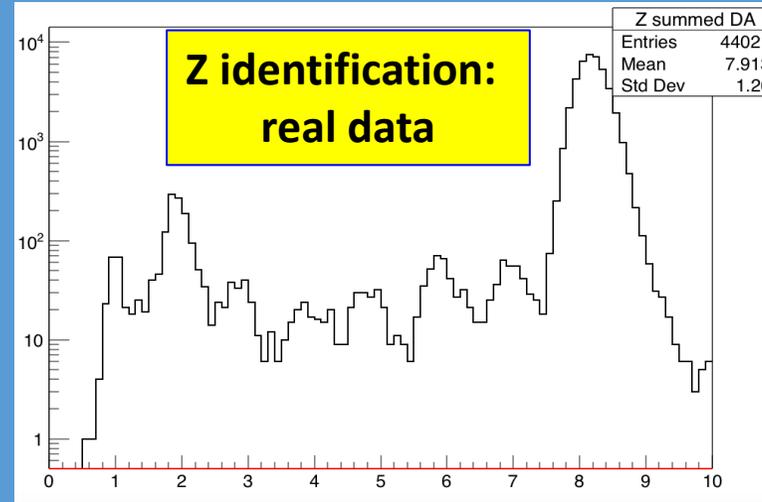
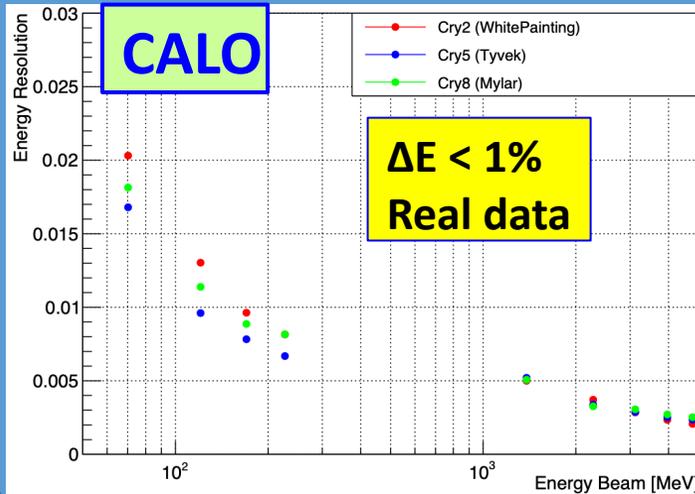
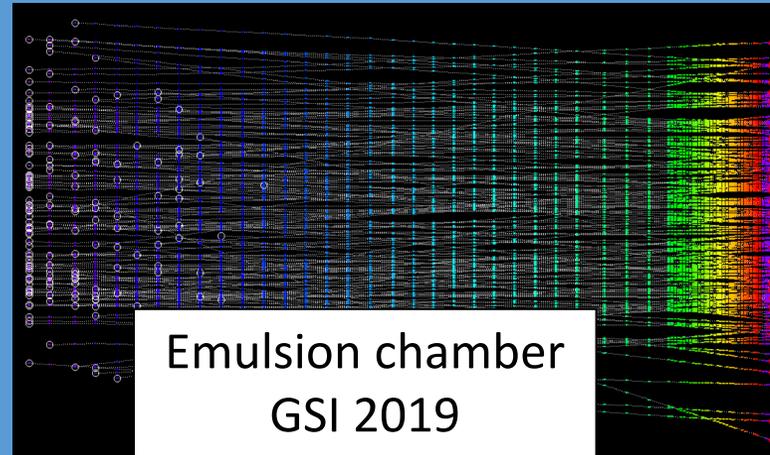
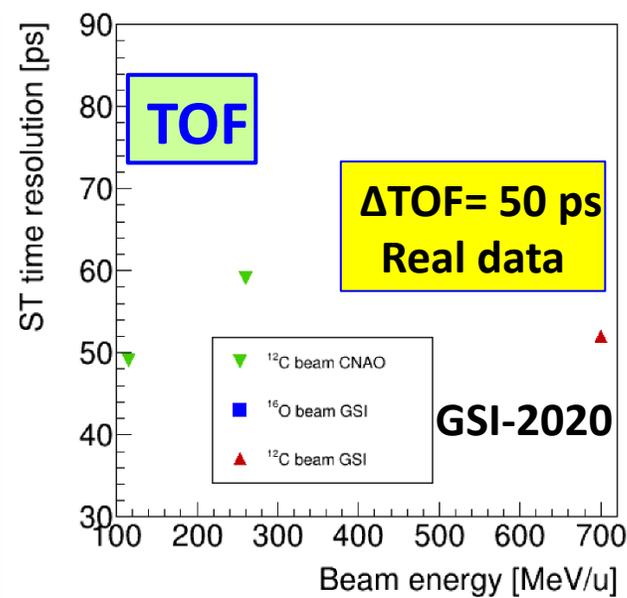
FOOT Status 2020:

- Apparatus simulation in final phase
- Several test beam on parts of detector
- 2020 data taking at GSI
 - Emulsion Chamber (results end of 2020)
- 2019-20: 5 papers published

Bologna:

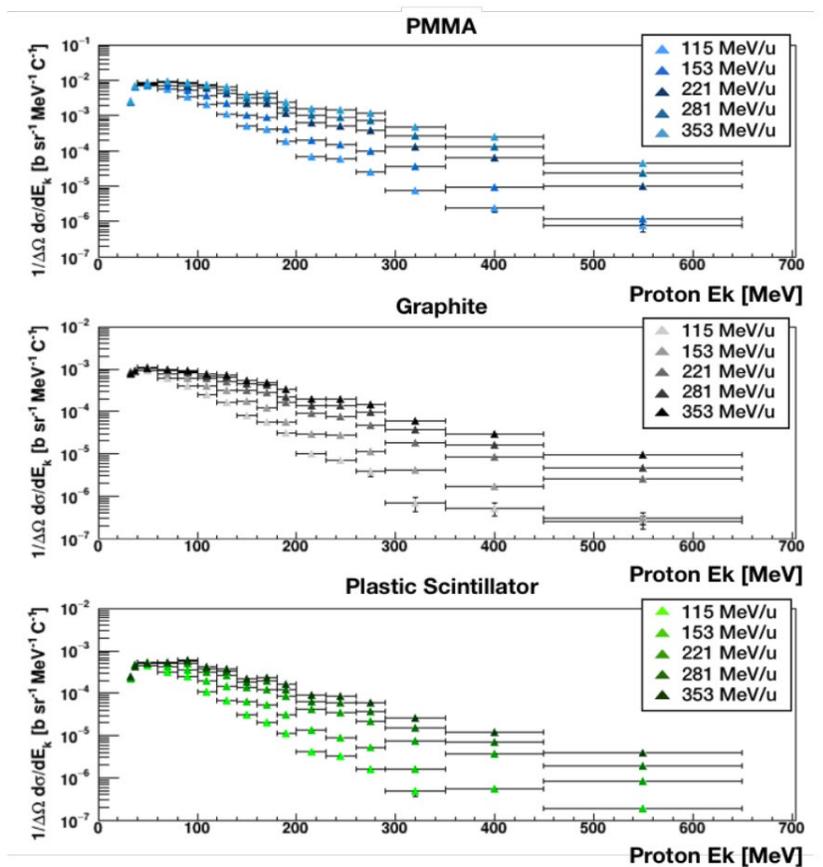
- 10 members: 3.65 FTE (-1.3 vrt 2019)
- M.U: Elettronica (2), Officina (2), Calcolo (1)
- Responsibilities:
 - Physics coordinator
 - Editorial board coordinator
 - TDAQ coordinator
- Win a divulgation project
- > 20 FOOT theses (physics and engineering)

Performance



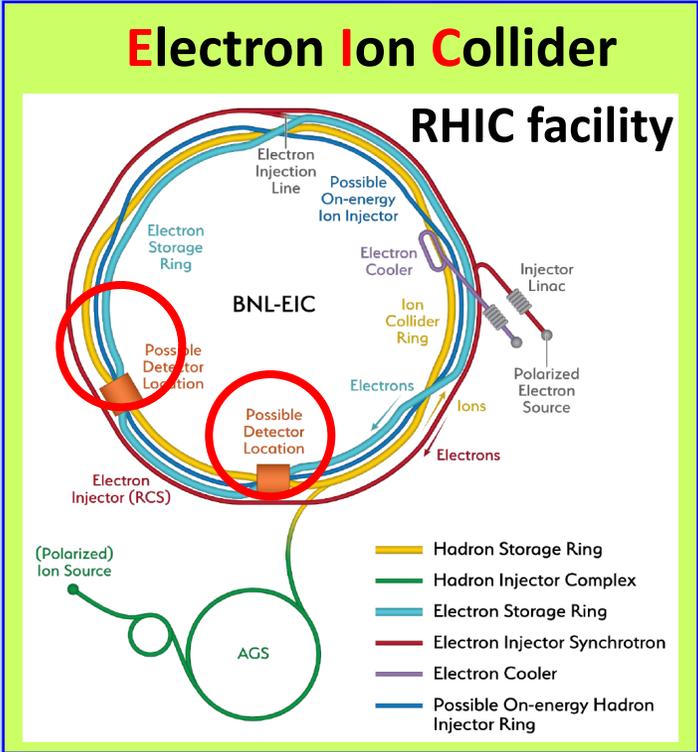
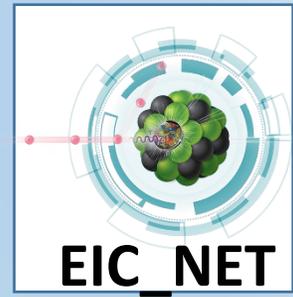
Measurement of ^{12}C Fragmentation Cross Sections on C, O and H in the Energy Range of interest for Particle Therapy Applications.

I. Mattei¹, A. Alexandrov⁶, L. Alunni Soletizi^{21,7}, G. Ambrosi⁷, S. Argirò^{8,9}, N. Bartosik⁸, G. Battistoni¹, N. Belcarì^{10,11}, S. Biondi^{12,13}, M.G. Bisogni^{10,11}, G. Bruni¹², N. Camarlinghi^{10,11}, P. Carra^{10,11}, E. Catanzani^{21,7}, E. Ciarrocchi^{10,11}, P. Cerello⁸, A. Clozza¹⁴, S. Colombi^{15,16}, G. De Lellis^{6,17,32}, A. De Guerra^{10,11}, M. De Simoni^{5,2}, A. Di Crescenzo^{17,6}, M. Donetti^{18,8}, Y. Dong^{1,19}, M. Durante¹⁵, A. Embricaco¹, M. Emde²⁰





EIC_NET



19/12/2019

- Approve mission need

9/1/2020

- BNL as laboratory

5/2020

- Submission of Expression of Interest



- PID
- Vertexing
- Readout
- Software

Collaboration

- 1089 people
- 229 institutes
- 31 countries



Italy

- INFN sigla dal 2019
- 10 sezioni + 2 Lab.
- > 40 persone (> 8 FTE)

Bologna

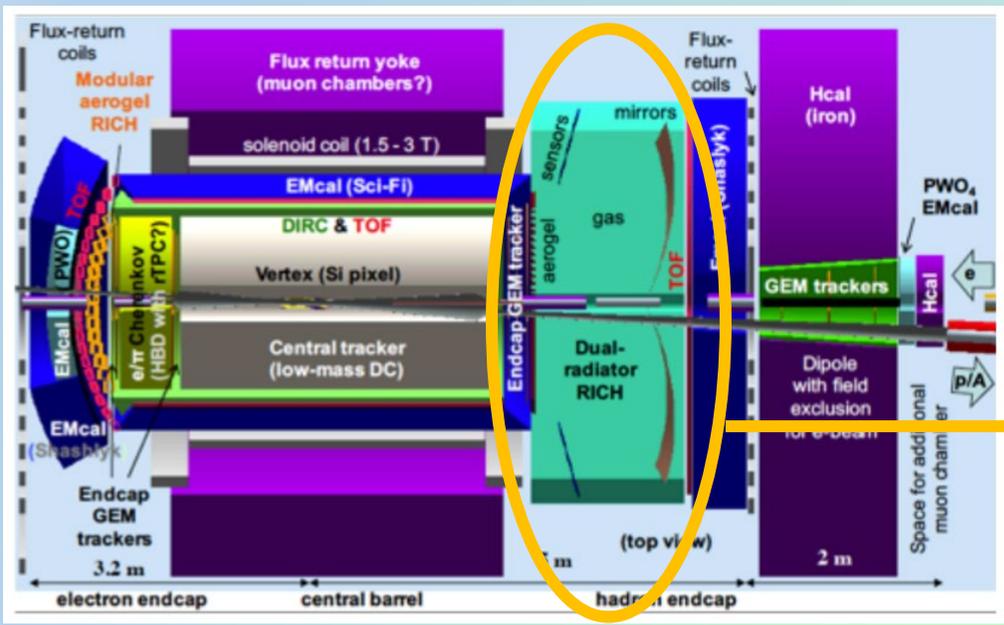
- 5 persone (1.0 FTE)

\sqrt{s} : 20-141 GeV \mathcal{L} up to $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

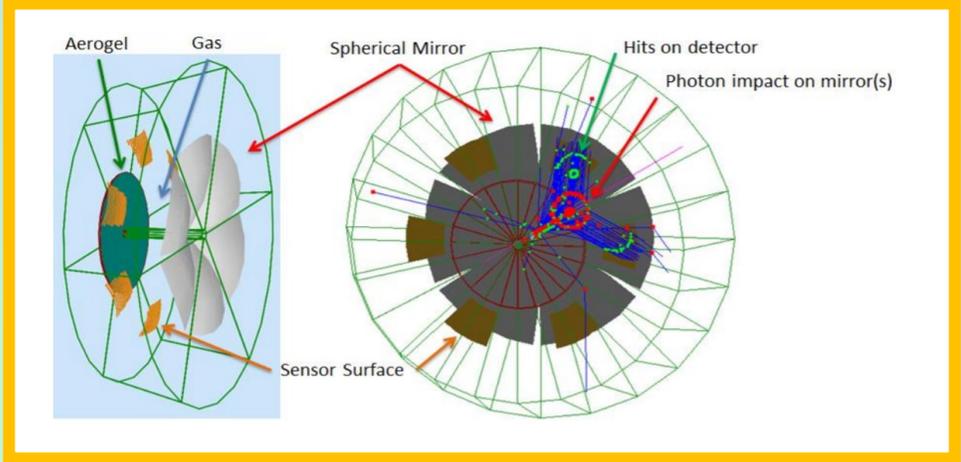


Beams polarized 80%

p-ion
→



e⁻
←

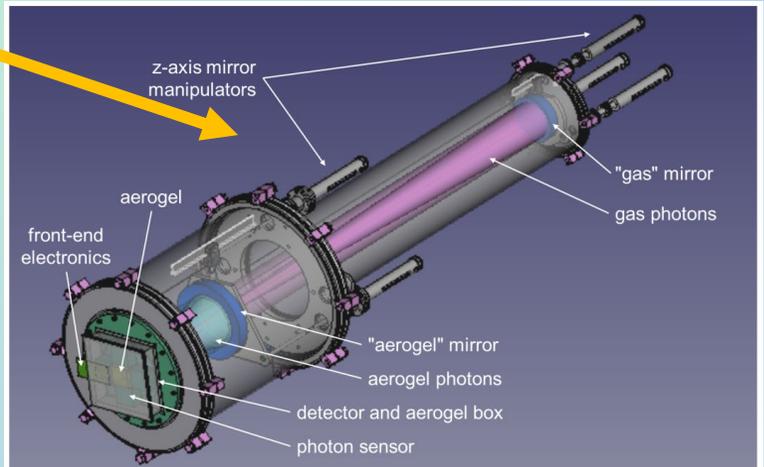
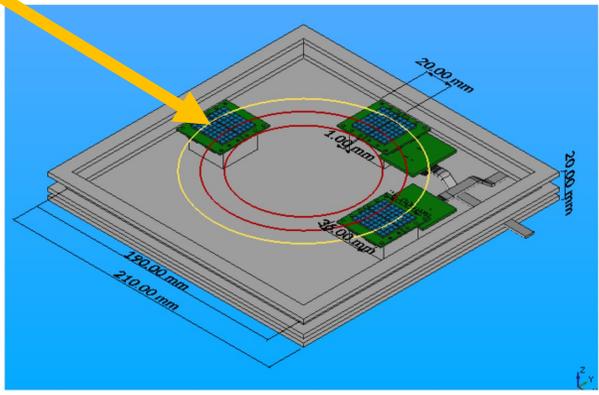


BOLOGNA: Realisation of dRICH prototype (test beam 2021)

- ❑ Design of SiPM boards
- ❑ SiPM studies
 - ❑ Irradiation test (@ Trento)
 - ❑ Annealing at high T ~ 170 °
 - ❑ Operation at low T ~ -40 °
- ❑ DAQ for front-end readout
 - ❑ Front end based on ALCOR
- ❑ Analysis
 - ❑ PID

Dual Radiator RICH (dRICH)

- ❑ Aerogel + gas
- ❑ PID e/π/k/p



Richieste servizi Mesi Uomo

Esperimento	Lab Elettronica	S. Tecnico Gen	Officina	Progettazione	Calcolo
ALICE	7	2	1.5		1
EIC_NET	3	1	0.5		
FAMU	2		2		
FOOT	2		2		1
N_TOF					
PANDORA	0,2		2	3	
TOTALE	14,2	3	8	3	2

GR3 ha attività importanti:

- ❑ Ricerca di base: struttura del nucleo, nucleosintesi, ...
- ❑ Ricerca applicate: reattori, adroterapia, radioprotezione, ...
- ❑ Tecnologie avanzate
- ❑ Tutte proiettate nel futuro

Grazie!

roberto a nome di tutto il Gruppo 3 di Bologna

Backup slides

16. *Gd-155,157 neutron capture cross sections measured at n_TOF (CERN)*
M. Mastroraro, D.M. Castelluccio, G. Clai, A. Manna, C. Massimi, F. Rocchi, on behalf of, n_TOF Collaboration
Il Nuovo Cimento C - EUNPC 2018 **42**, 1–4 (2019) Open Access
[10.1393/ncci/2019-19136-4](https://doi.org/10.1393/ncci/2019-19136-4)
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