Responsabili nazionali: Silvia Leoni e Daniel Napoli
Responsabile Locale: Oliver Wieland

Programma Scientifico della sigla:
Shell structure and warm rotation
Giant Resonances
Multi-nucleon transfer
ß decay

Attivita di R&D della sigla
Sviluppo rivelatori e elettronica dedicata

Laboratori per Misure della sigla

LNL, LNS, GANIL, GSI, CERN, ELI,ILL (EUROPE) RIBF,RCNP (JAPAN)

Sezioni coinvolte: Mi-Pd-LNL-Fi-Pg/Camerino-Na

Sigla Milano

FTE = 17,0
Part. 80,8 %

Tot. 21 persone

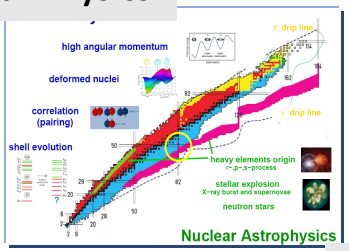
Prof/Ric/1Tec 12
Tecnologi 3
Ass-Dott 6

GAMMA
Gr. III-INFN

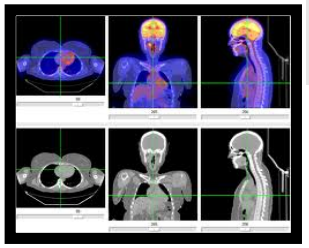
Papers prodotti nel 2017 / 2018	51 / 8
Talks nel 2017	28
Tesi LT e LM nel 2017	7
PHD Conclusi nel 2017	1

SPES project goals

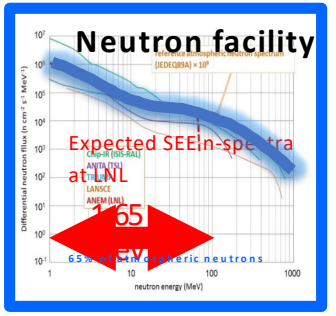
Nuclear Physics



1. **ISOL facility for nuclear physics: Production & re-acceleration** of **exotic beams**. **Neutron–rich ions** from p-induced Fission on **UCx (10^{13} f/s).**
2. Research and Production of **Radio-Isotopes for Nuclear Medicine**
3. Accelerator-based neutron source (**Neutron Facility for Applied Physics**)

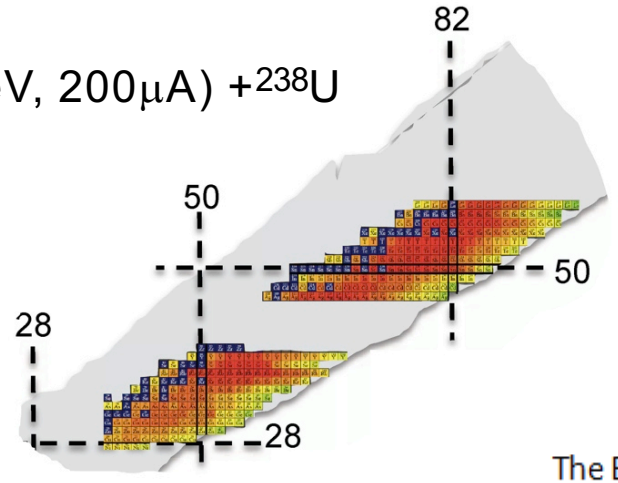


Radioisotopes for medicine

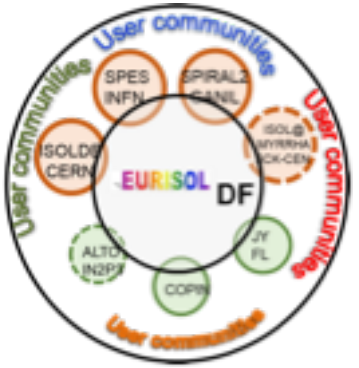


- ❑ **New High power compact CYCLOTRON 70 MeV 750 µA (BEST company)**
- ❑ **New configuration of High power ISOL System (8 kW Target ion source)**
- ❑ **ALPI superconductive linac (up-graded) for RIB's reacceleration**

p (40MeV, 200µA) +^{238}U

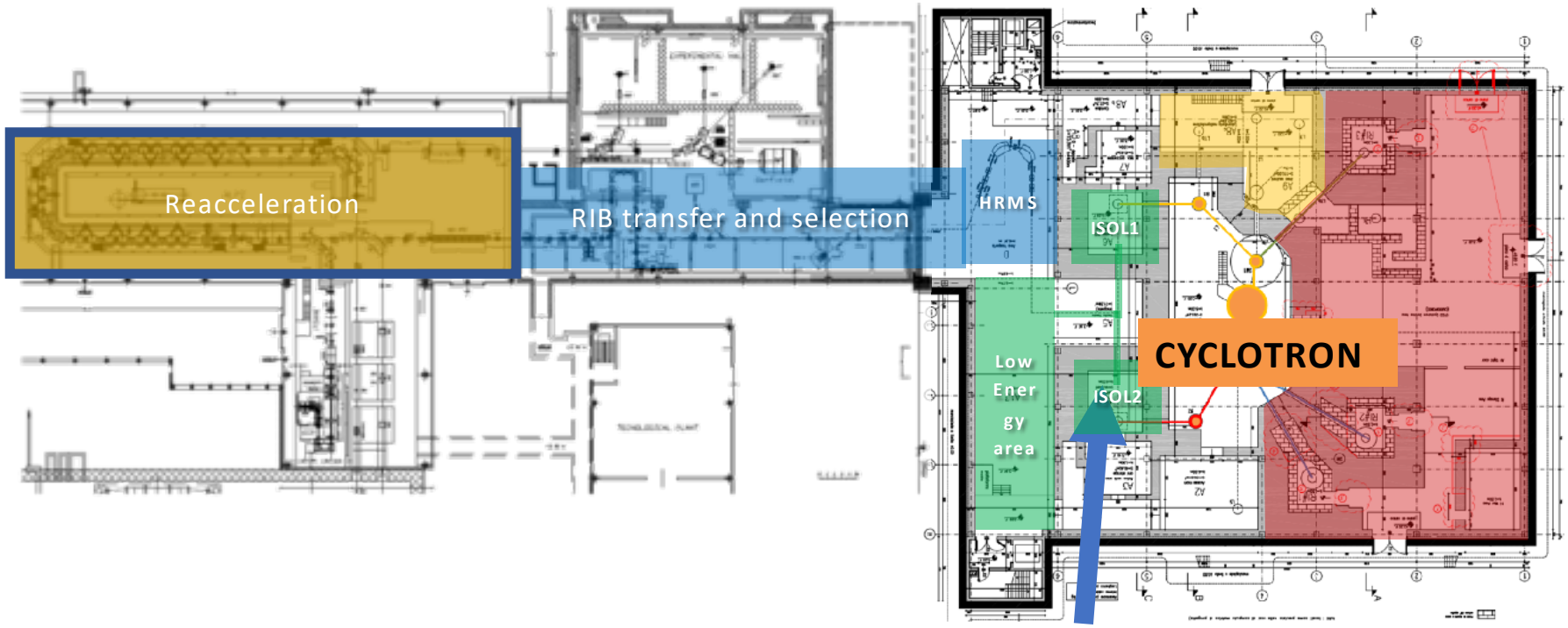


Secondary Beams at the LNL-ALPI energies.
~10MeV/u up to 10^9 pps



The EURISOL Distributed Facility project (http://www.eurisol.org/eurisol_df/) was recognised in the NuPECC 2017 Long Range Plan as an important new initiative of our community and it was recommended among the top priorities.

SPES layout and components



RIB reacceleration:

- new RFQ
- ALPI

1/20.000 Mass separator (Beam Cooler + HRMS)

Elettrostatic beam transport Charge Breeder (n+)

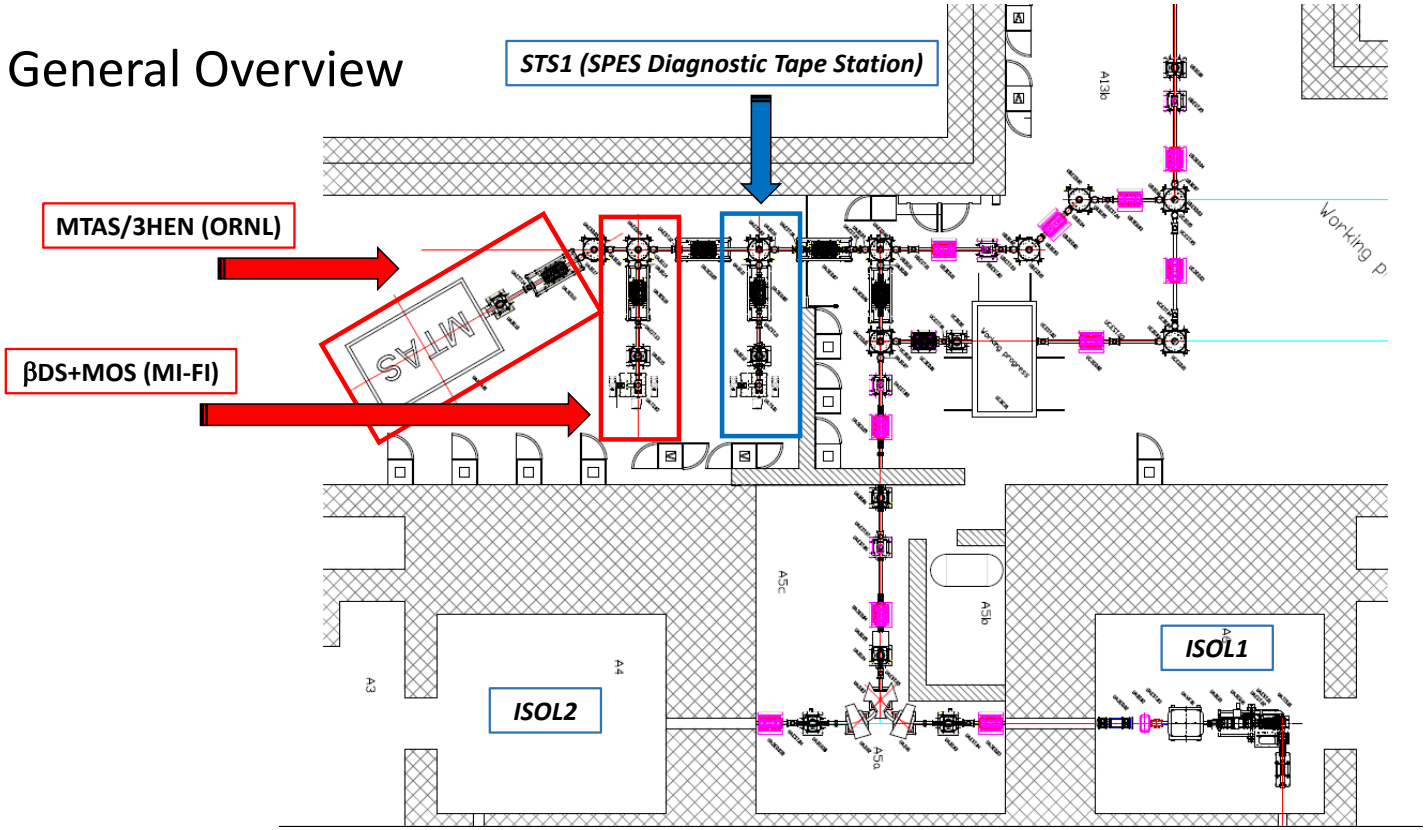
1/1000 mass separator

ISOL bunkers
1/150 mass separator

low energy experimental area

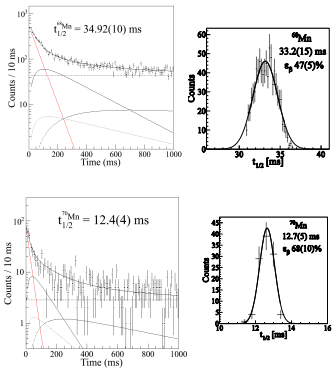
Radioisotopes production area (LARAMED)

- ✓ Non post-accelerated physics will add value to the SPES facility
- ✓ Working group su sale 1+ (M.Cinausero, G.B. for SPES-WPB01: Scientific Support for SPES):
  - ✓ Definizione line di fascio, infrastrutture (distribuzione LN2, sistemi da vuoto, etc)
  - ✓ Presentazione di TDR per richiesta finanziamento linee di fascio
  - ✓ Presentazione di TDR per richiesta finanziamento set-up sperimentali (β-DS + MOS)
  - ✓ Collaboration agreement con ORNL (USA) per MTAS/3Hen in fase di definizione



β-Decay Station (β-DS)

Gross properties of decay :$T_{1/2}$ P_n %β, %α …



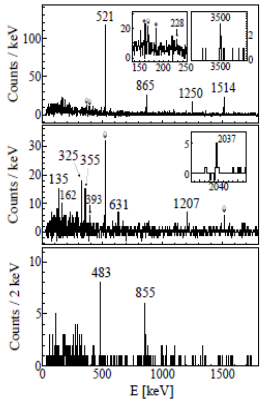
β- decays

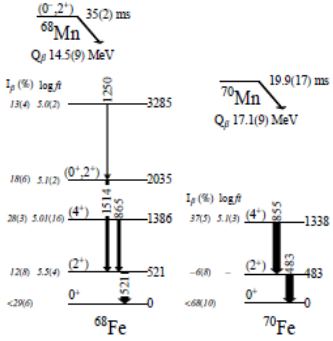
γ transitions

Possible existence of many decaying states

γ–γ coincidences➔ level schemes
Relative intensities Iβ logft

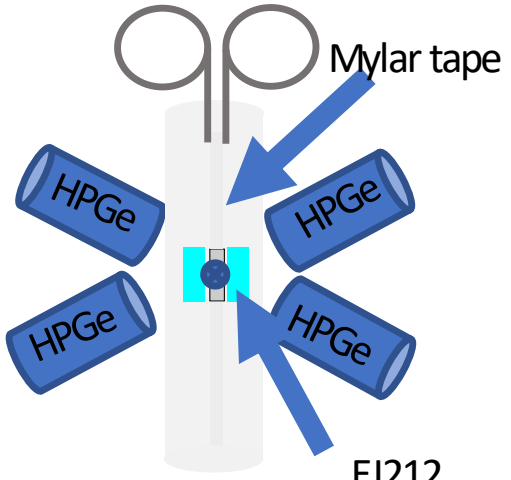
Z+1AN-1





Typical equipment is a TAPE MOVING STATION

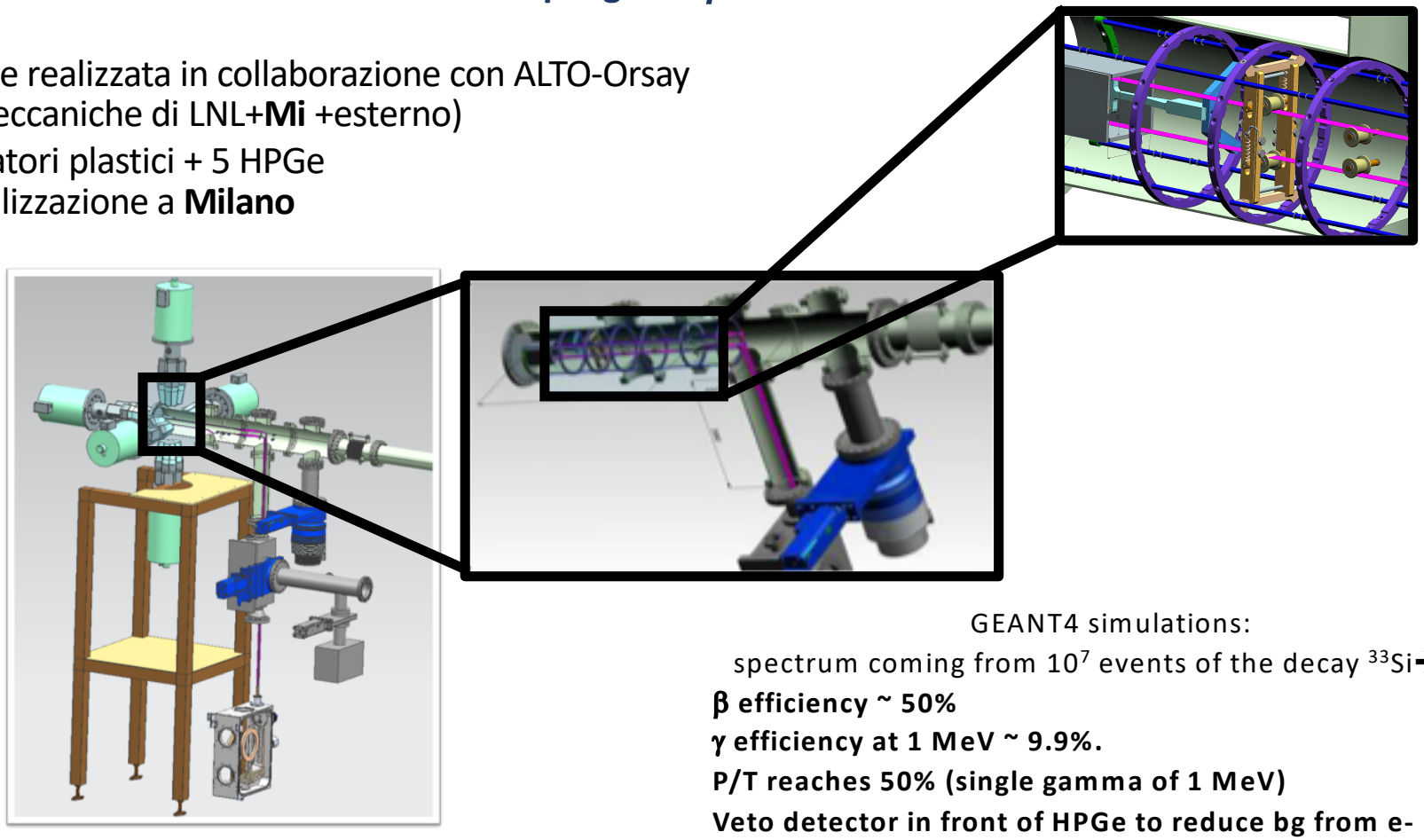
* Aluminized Mylar tape for passive implantation
* Plastic β detectors
* γ detectors
+ additional detectors for specific studies



Experimental requirements of a β-DS at SPES ISOL facility:
* Very low energy incoming beam (40-60 keV)
➔ no signal coming from implanted nucleus
*Possible contaminations egs. Isobaric contaminations and/or long-living species produced in the decay chain
➔ Need for a fresh implantation point for each single measurement

Avanzamento progetto β-DS+MOS

- Tape cassette realizzata in collaborazione con ALTO-Orsay (Officine Meccaniche di LNL+**Mi** +esterno)
- β-DS 5 rivelatori plastici + 5 HPGe
- Design e realizzazione a **Milano**



GEANT4 simulations:

spectrum coming from 10^7 events of the decay $^{33}Si \rightarrow {}^{33}P$

β efficiency ~ 50%

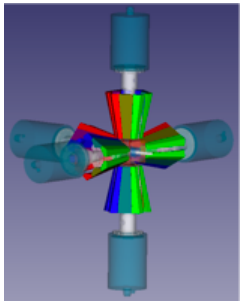
γ efficiency at 1 MeV ~ 9.9%.

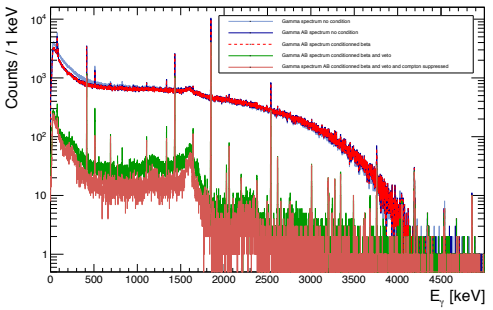
P/T reaches 50% (single gamma of 1 MeV)

Veto detector in front of HPGe to reduce bg from e- interacting in crystal

Commissioning 2018

- Tenuta da vuoto su cassetta di distribuzione
- State machine e high level control per la movimentazione nastro nella cassetta
- **Realizzazione e test del sistema di distribuzione del nastro nella camera di decadimento**
- Realizzazione winding station (Bologna)





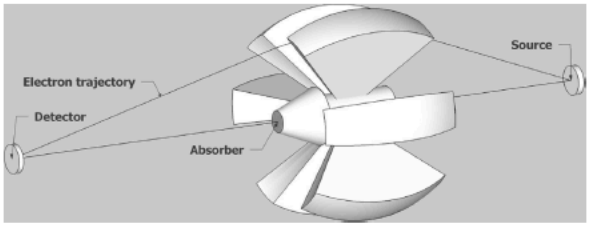
Avanzamento progetto β-DS+MOS

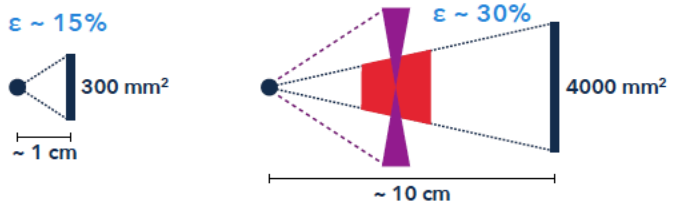
Internal Conversion Electron (ICE) Spectroscopy represents a crucial tool to investigate the nuclear structure, e.g. regarding Shape Coexistence

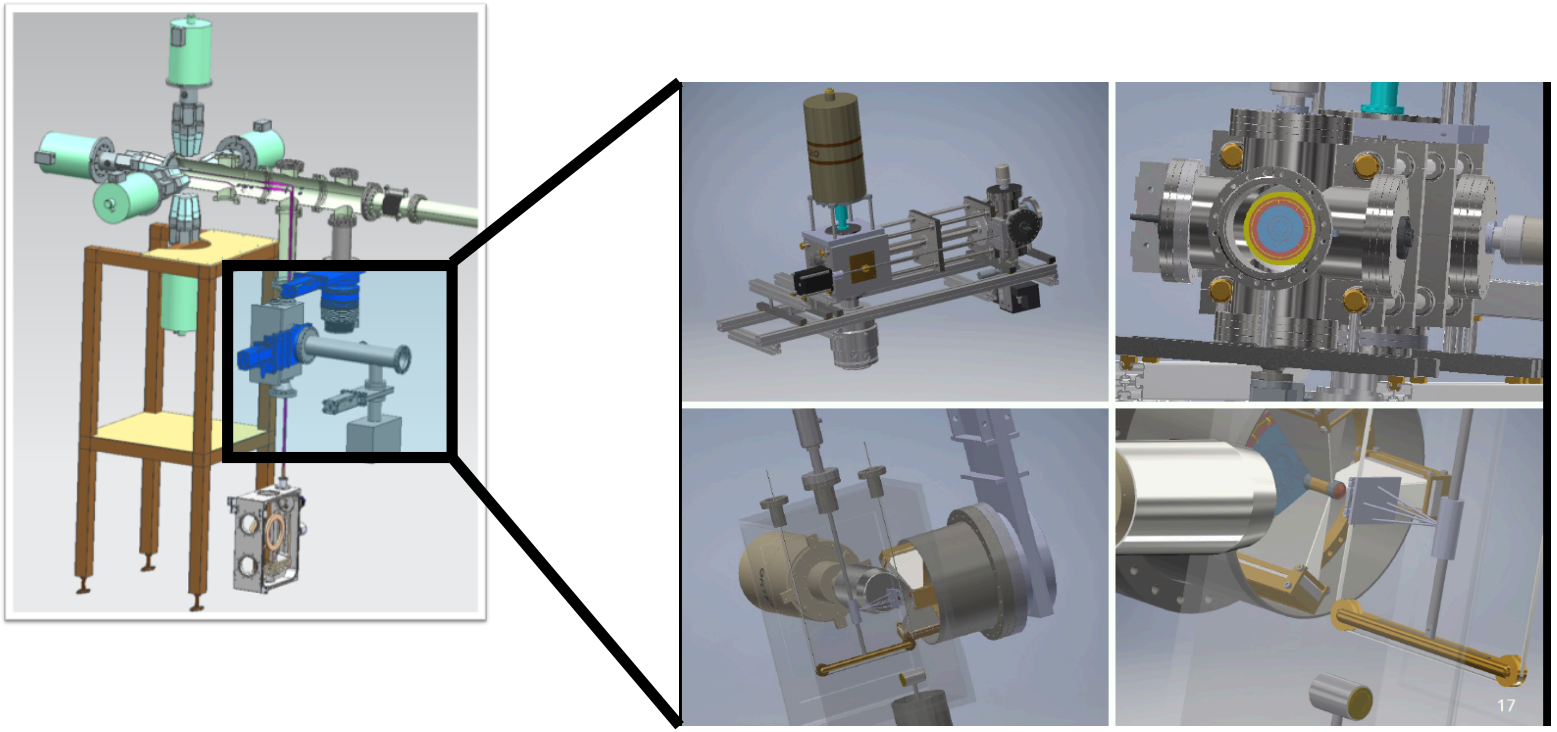
A Magnetic Transport System coupled with a Large-Area Segmented Si(Li) seems to be the best solution to exploit the future SPES beams

The spectrometer dedicated to the SPES 1+ line will be Ready for the First SPES 1+ beam

- Magnetic lenses to re-focalize the electrons increasing their detection efficiency







Coinvolgimento Sezione di Milano:

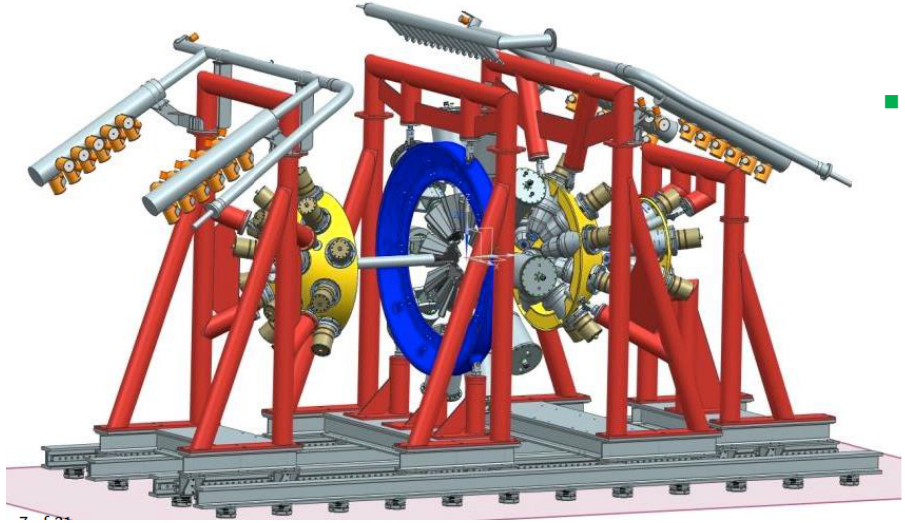
- Principale proponente del progetto
- Mechanical design and realisation of the decay chamber and detector support
  (Tomasi + Coelli, Capsoni, Trotta, Viscione)
- Integrazione con MOS set-up (Tomasi)

➔ Colleghi di Camerino e Firenze in visita questa settimana

- Beta-detector design and development (Boiano)

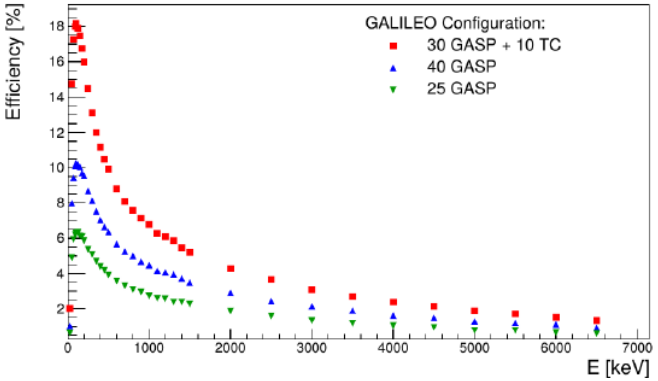
Timeline: prime misure previste nella seconda meta' del 2020

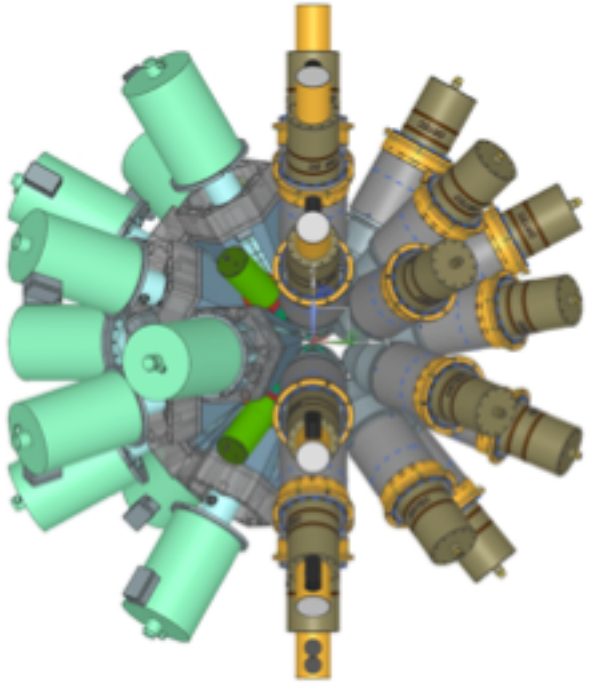
GALILEO



- **30 GASP detectors**
  @ 22.5 cm
- **10 triple cluster detectors**
  @ 24 cm

$E_{ph} \sim 6\%$ $P/T \sim 50\%$



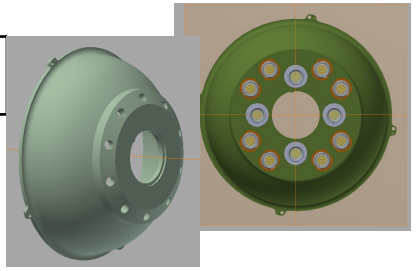


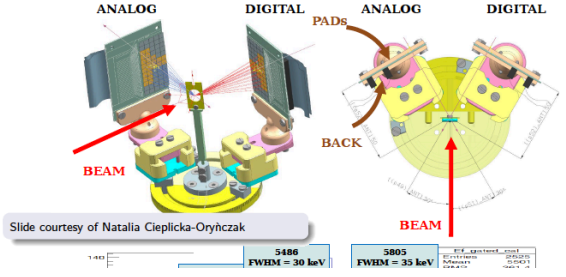
New mechanical design for upgrade to GALILEO phase 2
Fully digital approach

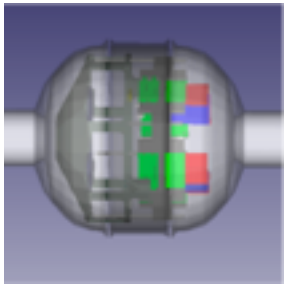
- **Phase II in progress**

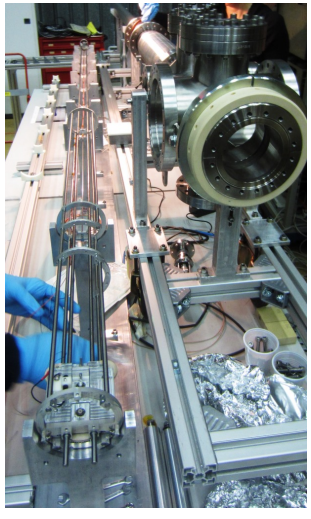
Milano Contribution to GALILEO:

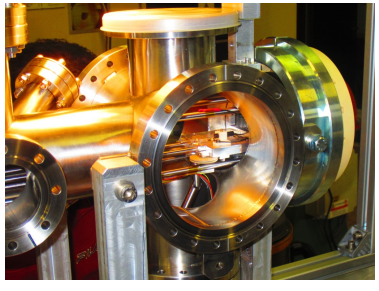
In use	upgrades
Scattering chamber	New design for feedthroughs for TRACE E-ΔE (Officina meccanica)
Pre-amplifiers for EUCLIDES (Boiano)	Asics pre-amplifiers for TRACE E-ΔE telescopes (Pullia-Capra)
10 LaBr3(Ce) detectors: -detectors -holding structure	
Remote Target-handling system	New readout for ancillary detectors using CAEN digitisers and implementation in DAQ (Brambilla)
	Pre-amplifiers for GTC HPGe (Pullia)

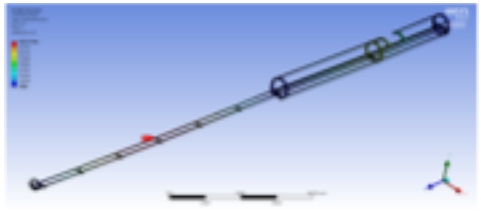










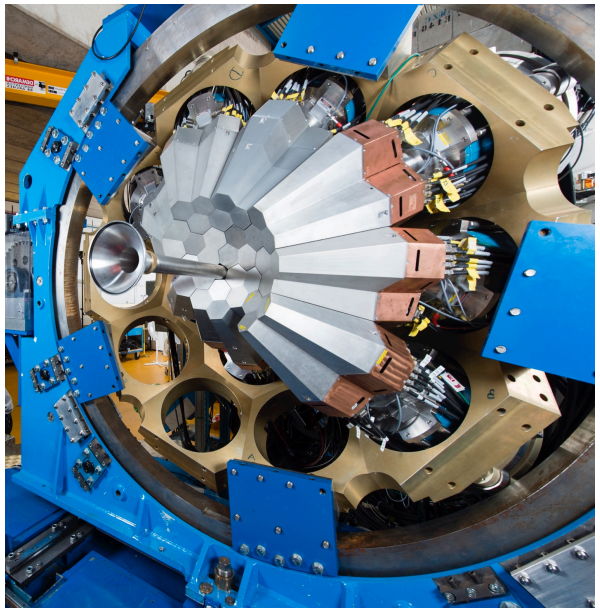


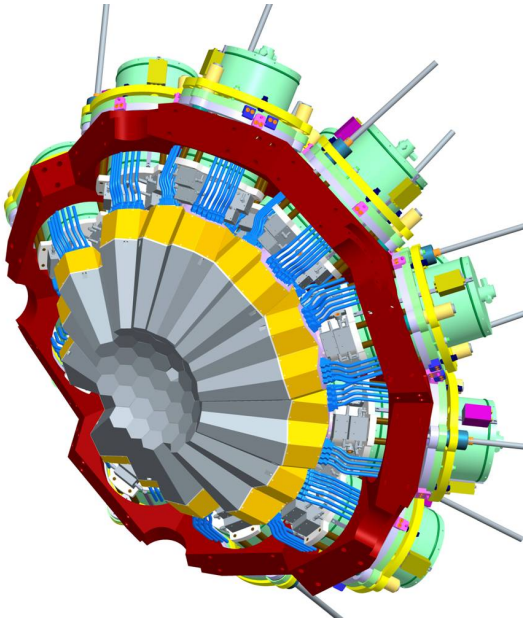
Pubblicazioni tecniche:
Submitted to EPJA
Nota tecnica

Presently AGATA 1π:

Presently at **GANIL**

(measurements with 35 capsules), since 2014 till fall 2020, (up to 45 capsules = 15 triplets: **total eff. 15%)** i.e. 1π completed within 2020.





Up to 1π:

Mechanics:
done with contribution **Milano**

Electronics:
Phase 0/Early phase 1:
24 channels – **preamp + digitizers (Milan-Pullia)** + ATCA carrier (Padova)
Advanced Phase 1:
12 chan. available + 14 chan. on production – **preamp + digitizers (Milan-Pullia)** + GGP (Padova)

New MoU: Towards AGATA 4π
(2021–2030)

Future sites to be decided on readyness of the accelerators and radioactive beams facilities:

GANIL and then **SPES (2023)** and **Jyvaskyla, FAIR/GSI**

From 45 capsules (1π) towards 180 capsules (4π)

White Paper in preparation: contribution of **Milano**

Up to 4π:

Mechanics:

To be done from 2020 with contribution of **Milano**

Electronics:

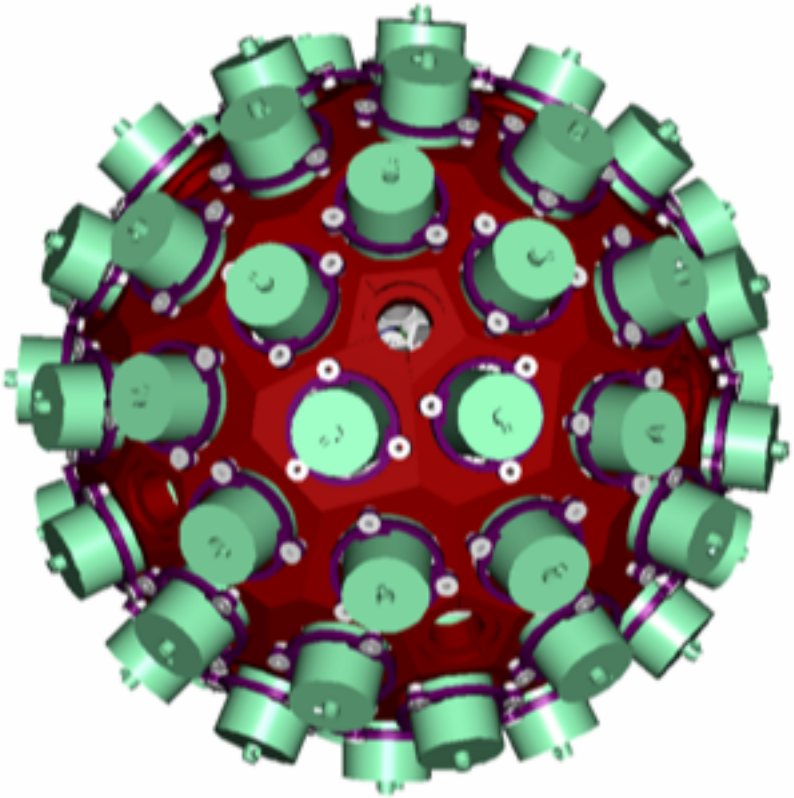
Mid term development ongoing: higher processing capability with Ethernet readout (**Milano**, Orsay, Strasbourg, Daresbury, Valencia)

Infrastructure: new developments to be more compact

DAQ: improvements ongoing

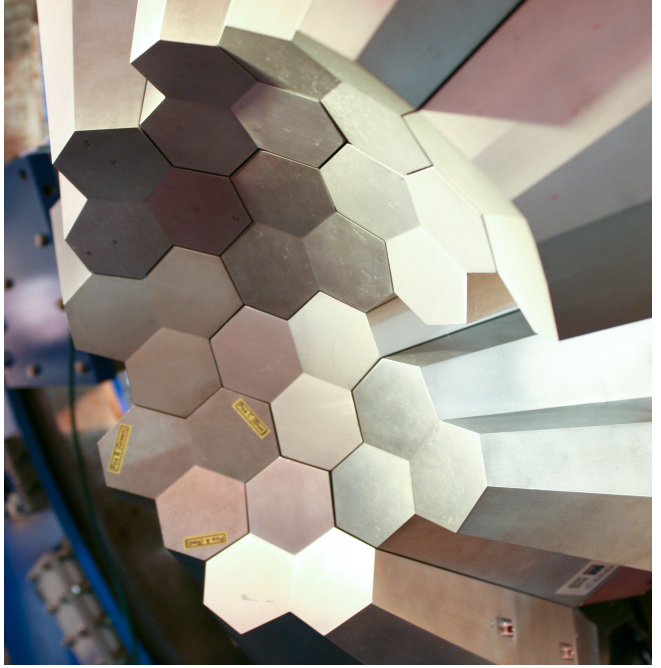
Simulations, performance: improvements ongoing

PSA, Tracking, Data analysis: improvements ongoing



AGATA

when	where	# capsules	efficienza
2018->2020	GANIL	35->45 (1π)	-> 15%
2020 ->2023	SPES		
2023 ->2026	Jyvaskyla		
2026 ->2030	FAIR/GSI		



Leadership a Milano:
Working Group Infrastructure: **B. Million**
Team pre-amp. digitizers: **A. Pullia**
Team data management and distribution: **F. Crespi**
Ressource Manager: **B. Million**

Qualche numero … dal 2011:
>40 Istituzioni
>350 Collaboratori
60 esperimenti effettuati
(di cui 9 sp. Milano + 15 sp. INFN)
85 pubb. tecniche
45 pubb. scientifiche
(2 PRL + 1 PLB + 5 PRC + 1 EPJ + 6 conf. Milano)

Contributi di Milano:
Mechanics: contribution **Milano**
Electronics: 36 channels available, 14 under production
- **preamp + digitizers (Milan-Pullia)**

Preventivi 2019

Capitolo	Richiesta (kE)
Missioni	220
Apparati	235
Consumo	61
Inventariabile	67
Altro	95
Servizi	**Richiesta (mesi/uomo)**
Officina	10
Elettronica	6
Computing	
1 new data-analysis server	