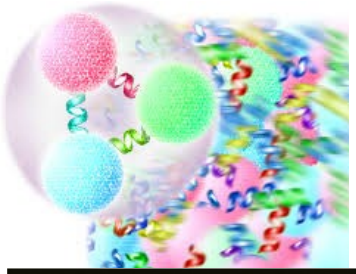
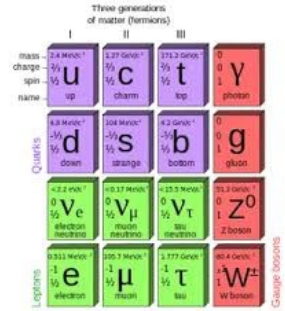
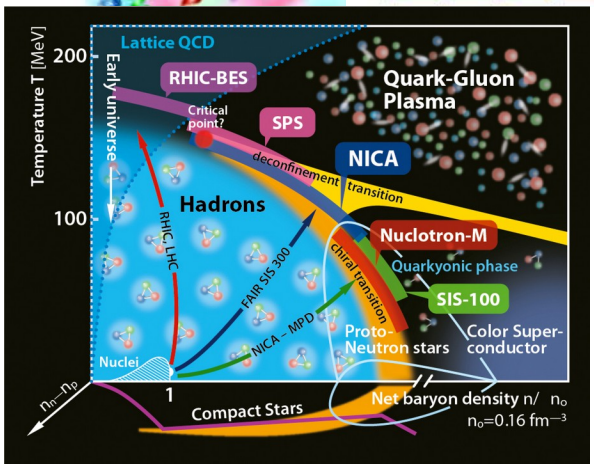
Nuclear Structure at the extremes: what about the atomic nucleus?

Speaker: Daniele Mengoni

Intro: CSN3 INFN research lines [700 pp, 26 exp]

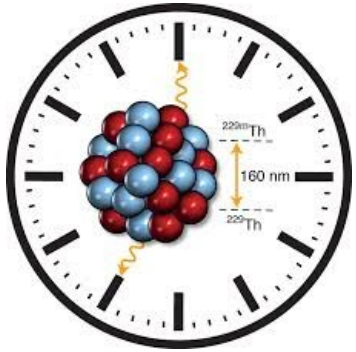






Quark/gluon dynamics, fundamental interactions, QGP

Nuclear structure/dynamics, nuclear astrophysics



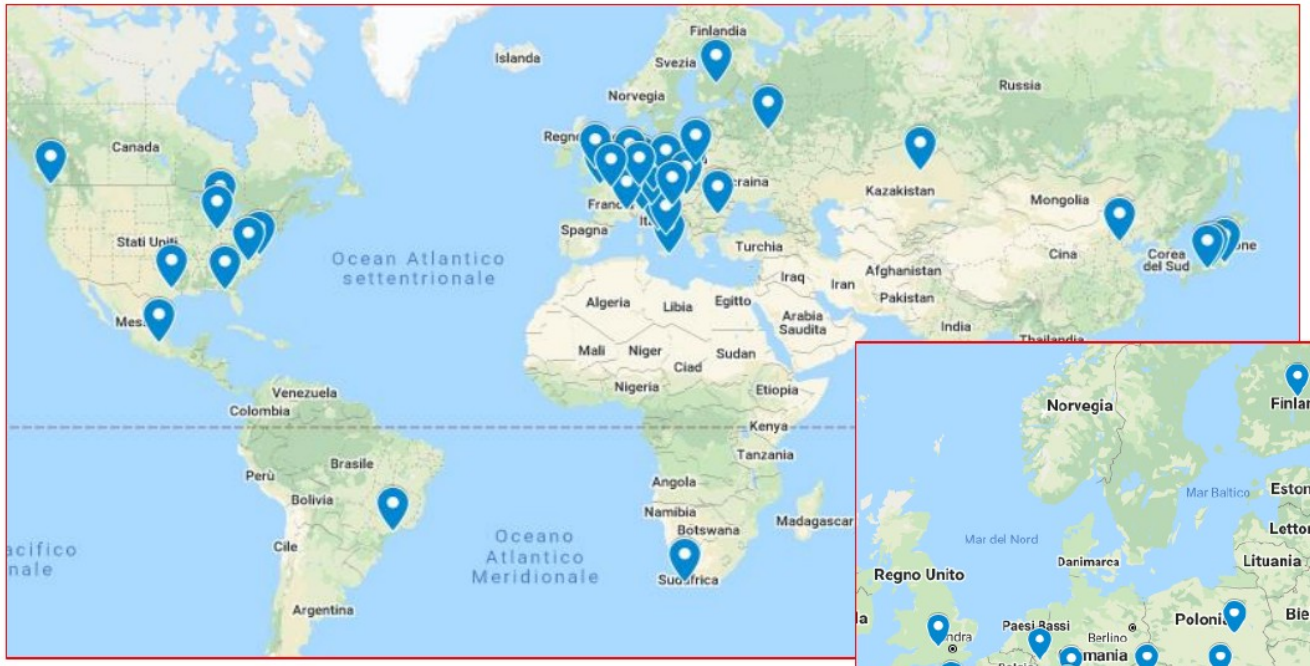
Applications

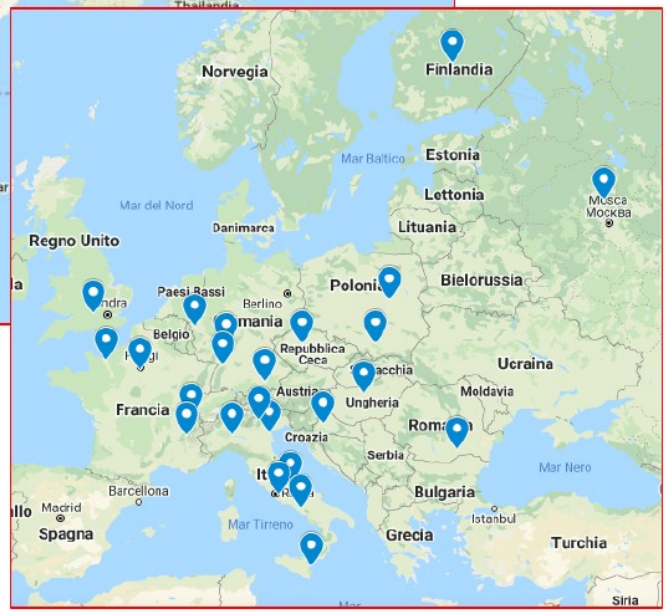
https://www.pd.infn.it/it/gruppo3-fisicanucleare/
https://web.infn.it/csn3/index.php/it/

INFN PADOVA
Istituto Nazionale di Fisica Nucleare
Sezione di Padova

Follow also the next talks in this session

CSN3
National/International activity





Istituto Nazionale di Fisica Nucleare

BSc and MSc Scholarships
CSN3 INFN

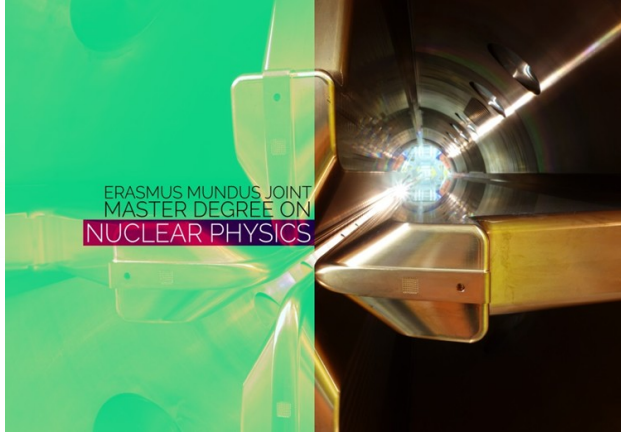
https://web.infn.it/csn3/index.php/it/

Duration:
2 weeks - 3 months at National and Internationas INFN Labs

Call 2023 is over→ next call Sept. 2024

Erasmus Mundus JMD on Nuclear Physics

Co-funded by the Erasmus+ Programme of the European Union



Erasmus Mundus Joint Master Degree on Nuclear Physics (NucPhys)

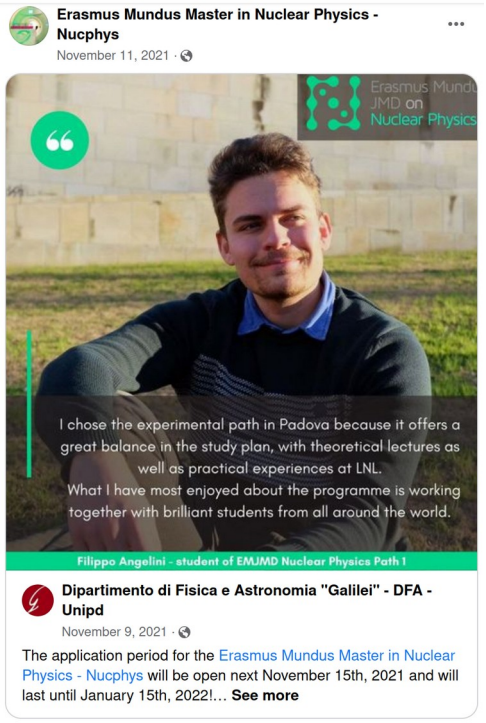
EU Erasmus+ Programme, funded for 3 intake 2016-2021 as multiple degree, renewed up to 2025 and now being resubmitted for a joint degree (February 2024)

7 Unis + 30 associated partners

You will have a multiple Master Degree issued by Italy/France/Spain!!! 🎓🎓🎓

Organization paths
Internationality/Sustainibility

Experiments in large experimental facilities and instrumentation
Theoretical nuclear physics
Applications of nuclear physics and smaller accelerator facilities

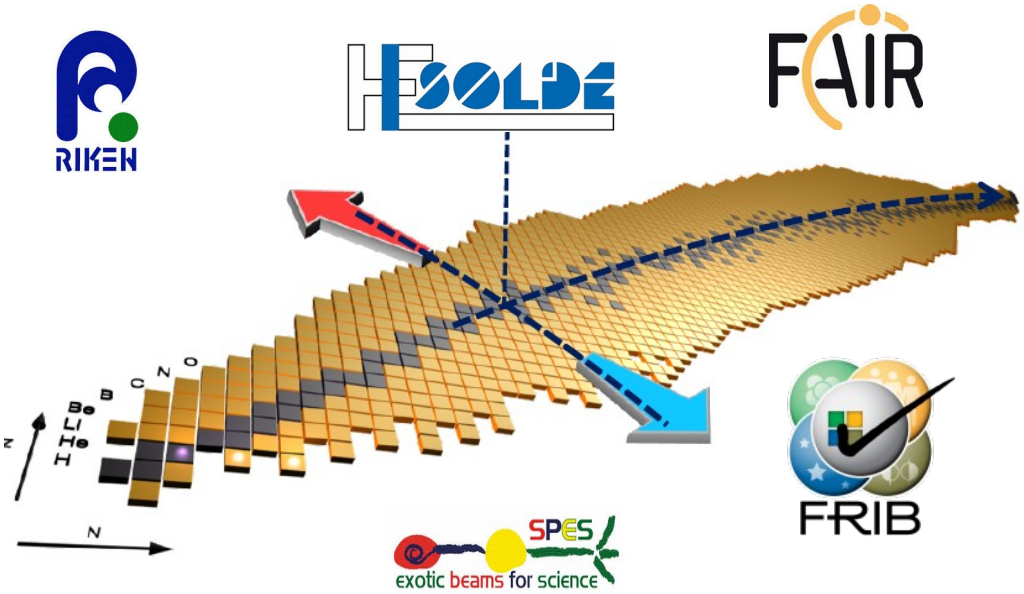


- Funding options:
- Eu funded posts (15 shared by Eu and extra EU)
- Regional/National agency funds (~5)
- Self funding (~5)

Testimonials
https://www.facebook.com//Nucphys

Comprehensive understanding of Nature

- Investigating limits and properties of the nuclear mesoscopic (complex!) system by exploring stable and exotic nuclei by means of strong, electromagnetic and weak interactions



1st class International Laboratories

Nuclear stability, saturation density, nuclear matter and neutron stars, astro processes etc

Encoder:

Thesis-opportunity tag

Hands-on activity

Coding

Analysis

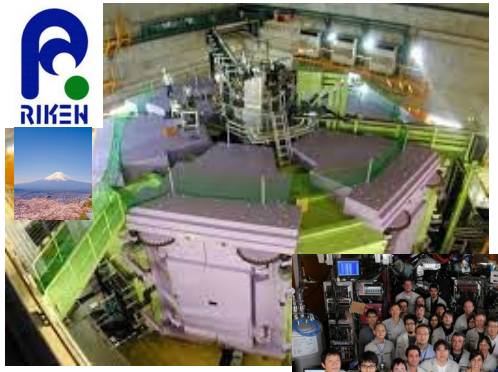
What am I doing?

.. and what's a possible Bsc/MSc thesis about :-)

Experiments at national and International facilities

applications

Detector simulation, development and commissioning



International environment

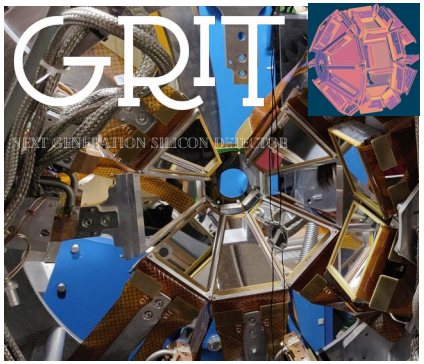
Università di Roma, Padova, Torino e Milano proseguendo la tradizione di Fermi iniziata negli anni '30

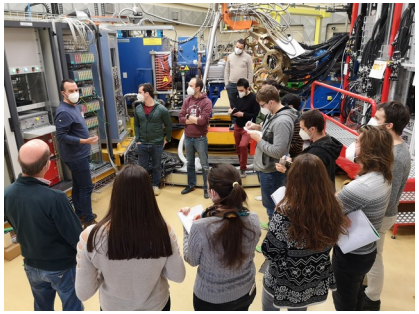
AGATA@LNL:’21-’26

first worldwide operational **tracking** array

10

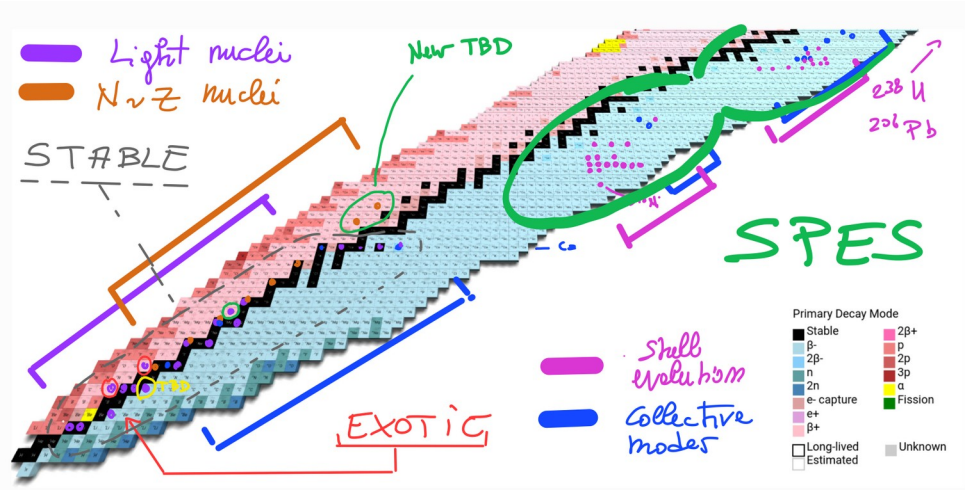
- Proton drip line: around ^{100}Sn using **intense stable beams** and AGATA+NEDA+EUCLIDES
- Neutron drip line: around ^{132}Sn with **SPES** beam and AGATA+GRIT+PARIS



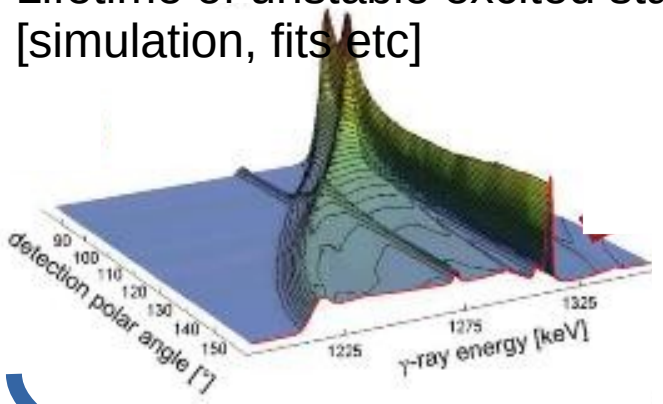


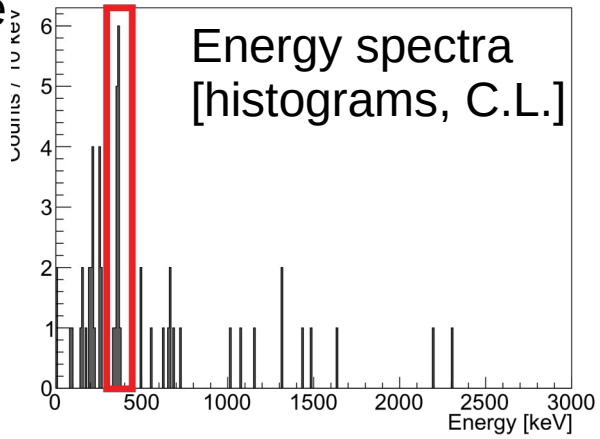
Preparation and participation to scientific campaign@ LNL, in particular: preparation, run, analysis, simulation, theoretical interpretation.

LNL Experimental campaign
typically dozen of exps and TBs of data



Lifetime of unstable excited state [simulation, fits etc]

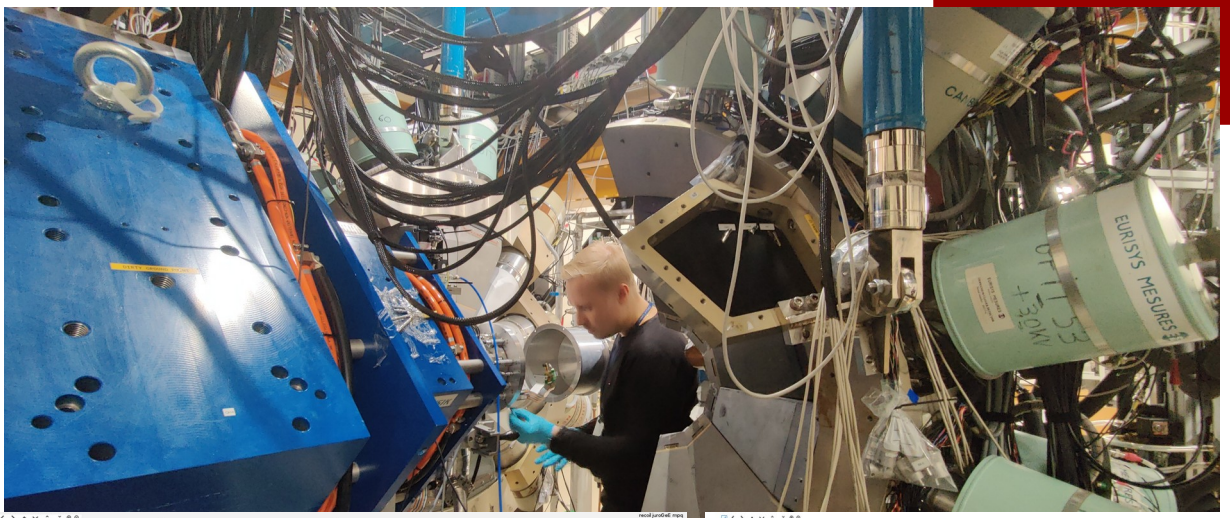


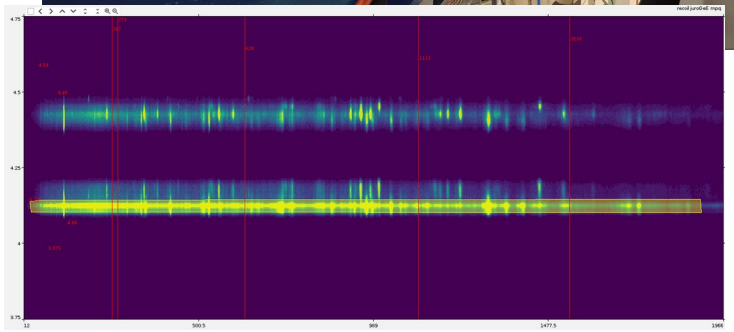


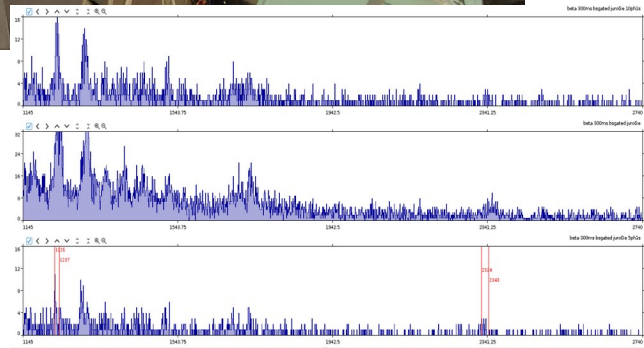
- Exp. routine: thinking, preparing, running, analyzing, reporting

$E, \Psi \leftrightarrow \mathcal{H}$

Stability of quantal rotation and pairing @ JYFL Finland: 62Ga



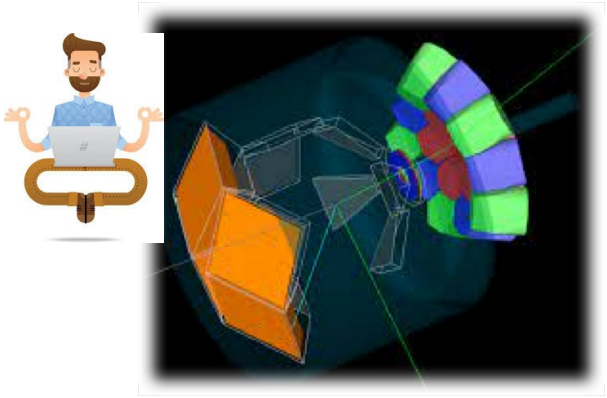


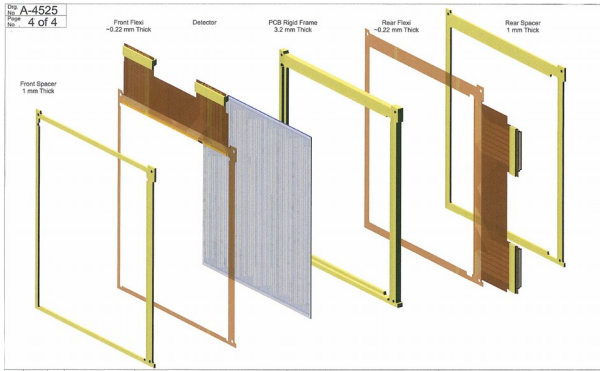


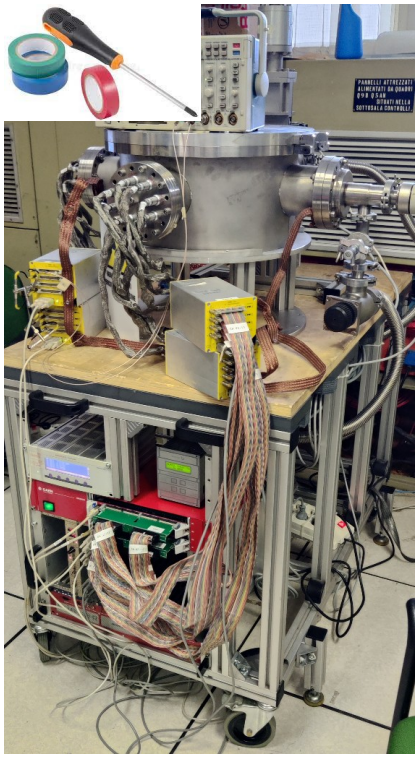
- Data presort (~calibrations)
- Data analysis
- Conferences, papers, dissemination

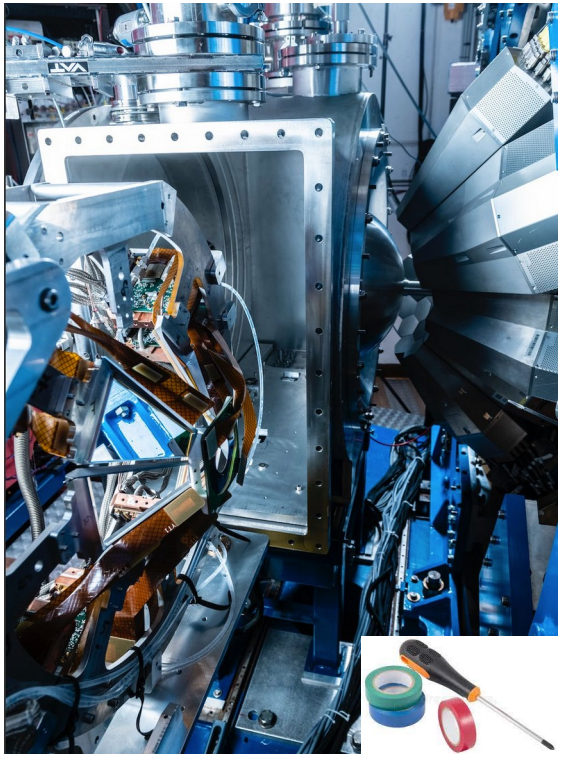
State-of-the-art detectors

- Montecarlo Simulation → manufacturing
- Detector test:Cutting-edge dets high segmentation, NTD (uniformity), 6” inches, Random cut (channeling)
- Exps @ ISOL facility in Italy and worldwide

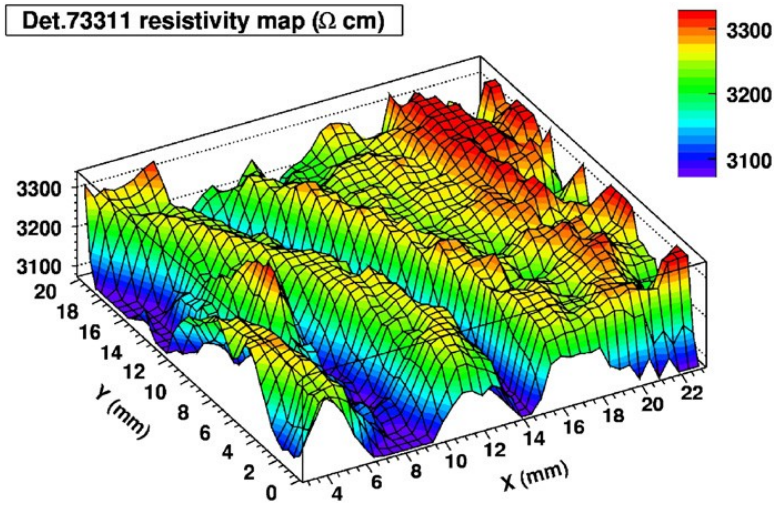


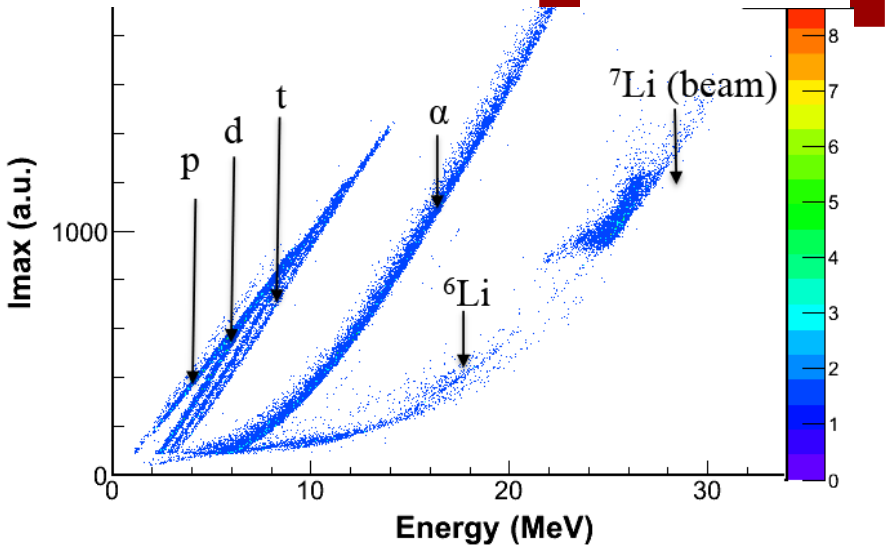






Detector
development and characterization





- Gross properties: energy and time resolution. Correlation matrices for segmented detectors
- Laboratory, non destructive Resistivity measurement: laser and alpha source

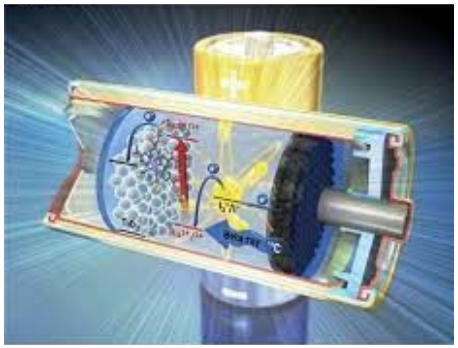
- Fine properties [in beam]:PID capability, Digital Pulse shape analysis, numerical filters, NN (convolutional/ML perceptron)

Application: BETASMART

Development of batteries with long lifetime (**~10 years**) and low power for space, medicine and remote sensing

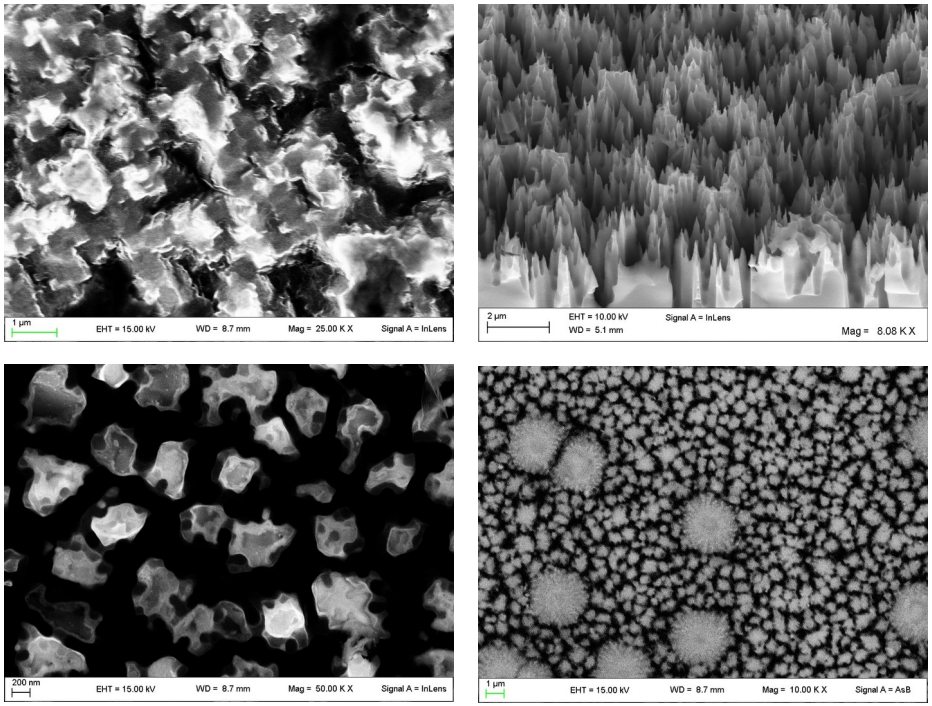
- Montecarlo simulations
- Comsol simulations
- Substrate power estimate
- Electrode deposition

FONDI STRUTTURALI EUROPEI pon 2014-2020
MIUR



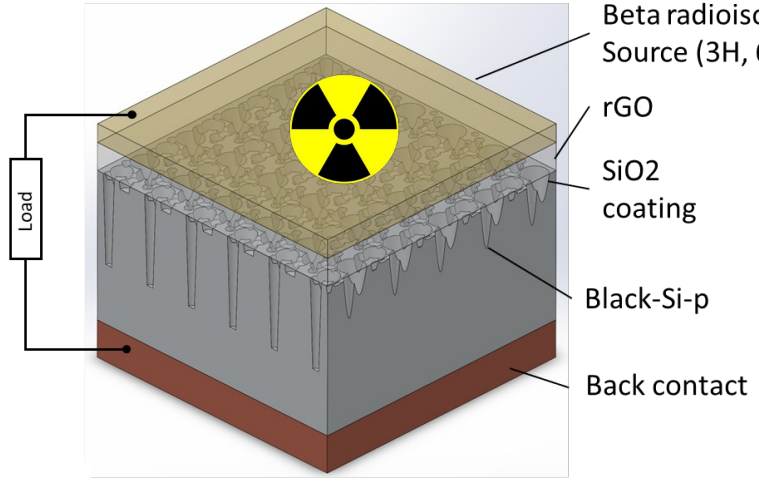
Fundamental Physics **Applications** **Environment**

Radioisotope Energy Harvesting (Betavoltaic/Alphavoltaic Generators - project BETASMART PNRR)



Ni, Graphene Oxide Deposition on Si-p, Black-Si

SEM image of Black Silicon samples (UNIPG)



Structure of nuclear betavoltaic cell

Si-rGO Betavoltaic cell prototypes (Dip. di Fis e Geologia, UNIPG and INFN Perugia)

20:31 52%

la Repubblica

Motori

AUTO ELETTRICA

Arriva la batteria atomica che dura 50 anni ed ha 10 volte più energia. Perché può essere una rivoluzione

di Barbara Crimaudo

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Article | Open access | Published: 23 June 2021

Mn^{2+} induced significant improvement and robust stability of radioluminescence in $Cs_3Cu_2I_5$ for high-performance nuclear battery

Xiaoming Li, Jiaxin Chen, Dandan Yang, Xi Chen, Dongling Geng, Lianfu Jiang, Ye Wu, Cuifang Meng & Haibo Zeng

Una batteria a nano diamanti potenzialmente "eterna"

Dai rifiuti radioattivi un'azienda californiana sta creando dispositivi di accumulo indistruttibili, "circolari", auto-ricaricabili e dotati di una vita incredibilmente lunga

07 Ottobre 2020

"Dai diamanti non nasce niente", cantava Fabrizio De André. In California c'è chi la pensa diversamente e progetta una batteria potenzialmente eterna, con minuscoli diamanti generati da rifiuti radioattivi. Un obiettivo visionario eppure fattibile, quello della NDB – Nano Diamond Battery – che ha ipotizzato la creazione di dispositivi di accumulo indistruttibili, "circolari", auto-ricaricabili e capaci di durare fino a 28 mila anni. L'obiettivo è reinventare l'elettricità, per liberare il mondo dai combustibili fossili

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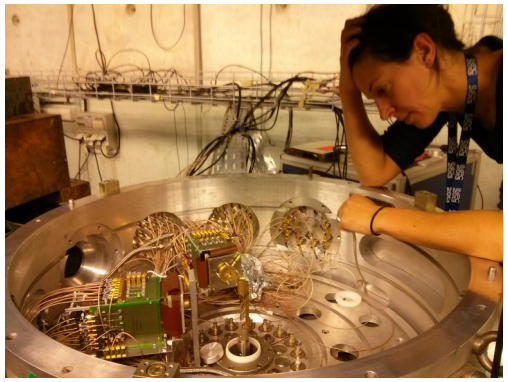
China develops groundbreaking nuclear battery that can last 50 years without charging

ET Online • Last Updated: Jan 18, 2024, 12:11:00 PM IST

And so ..
why with us

■ Utter educational experience: from simulation and detector test to experimental run and data analysis:

→ you like research or you don't



Nuclear Structure at the extremes

Contacts

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(*daniele.mengoni@unipd.it*)

https://www.pd.infn.it/it/gruppo3-fisicanucleare/

Other useful contacts for the proposed activities:

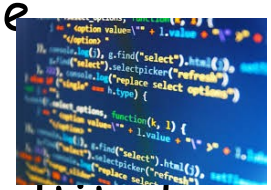
Marta Polettini (marta.polettini@unipd.it)
Franco Galtarossa (franco.galtarossa@pd.infn.it)

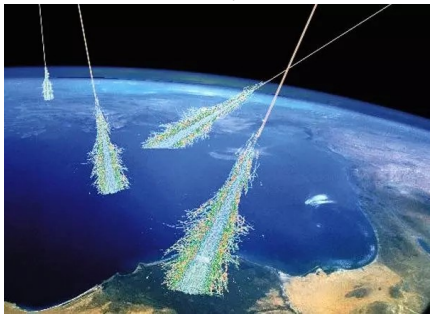
Alain Goasduff (goasduff@lnl.,infn.it)
Andrea Gottardo (gottardo@lnl.infn.it)
José Javier Valiente Dobon (valiente@lnl.infn.it)

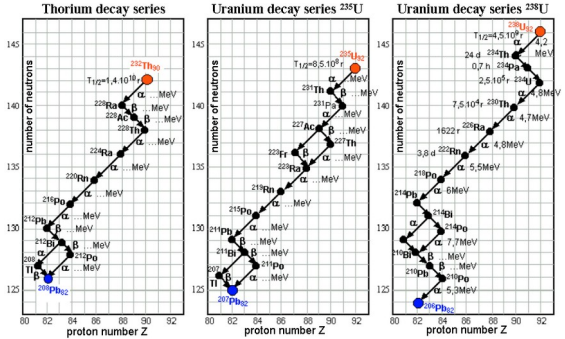
Other colleagues will follow so please pay attention to the other presentations in this session

Design a didactic experiment

- Natural radioactivity (Primordial), Cosmic rays (Cosmogenic), Induced radioactivity …
- Make set of measurements (samples), write a simple decoding programme
- Data analysis
- Evaluation of systematics (place, altitude, operational parameters)



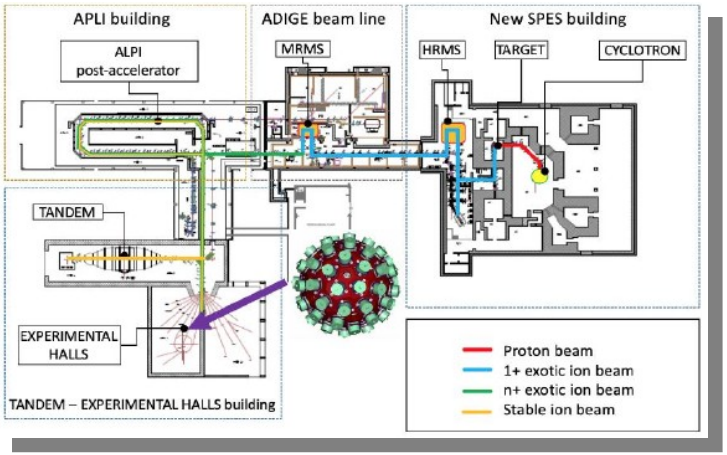


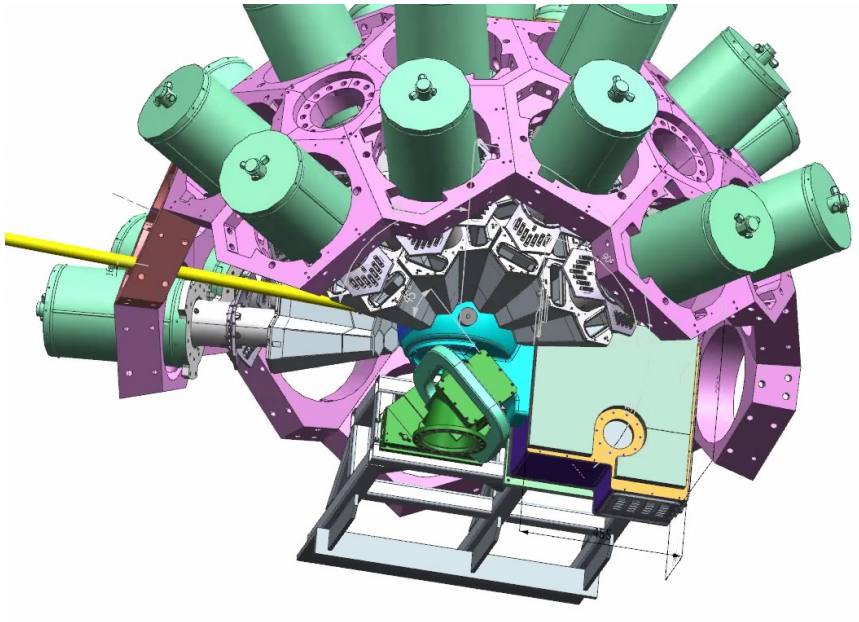


AGATA@LNL
+ SPES: 2021 – 2025

23

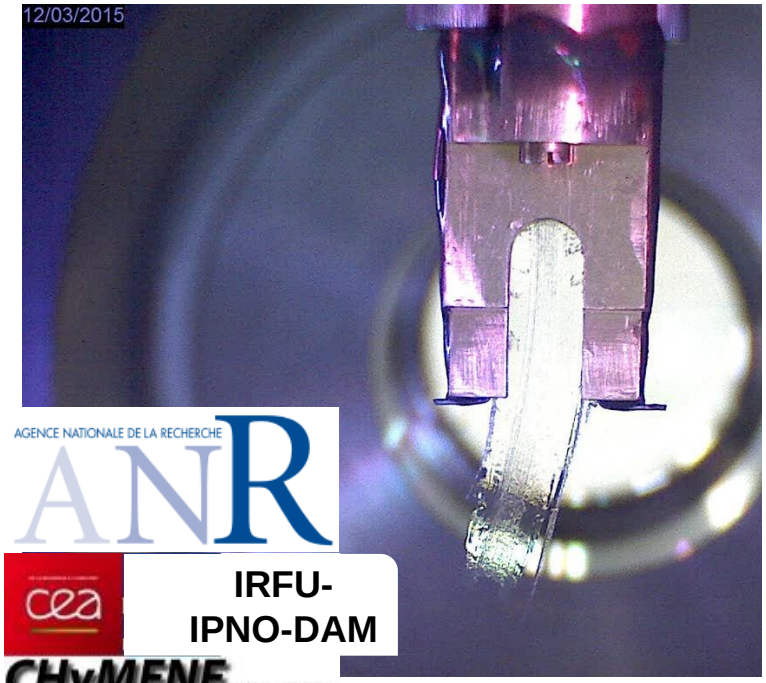
Installation - ongoing
Commissioning – April 2022





Preparation and participation to commissioning and scientific campaign@ LNL (preparation, run, analysis, simulation, theoretical interpretation,):
mengoni@pd.infn.it, menegazzo@pd.infn.it, valiente @lnl.infn.it, goasduff@lnl.infn.it et al

Cryo/jelly target development



AGENCE NATIONALE DE LA RECHERCHE ANR

IRFU-
IPNO-DAM

CHyMENE

CTADIR

PRIN

MIUR

- Hydrogen (h,d) target in a solid phase near triple point (~17K)
- Thickness 50 – 200 µm
- Commissioning: temperature, density and profile
- Exp on Spring/Summer 2023