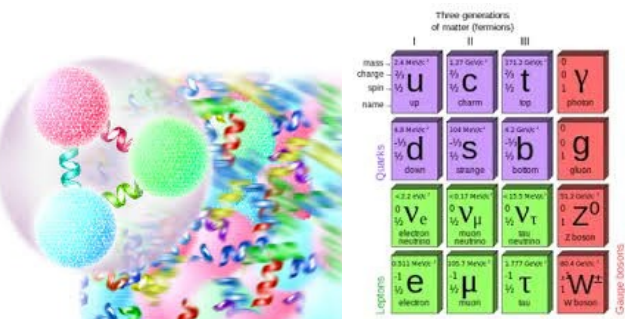
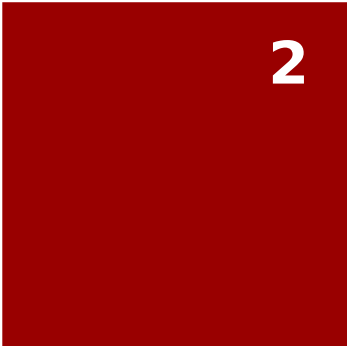




Nuclear Structure at the extremes:
what about the atomic nucleus?

Speaker: Daniele Mengoni

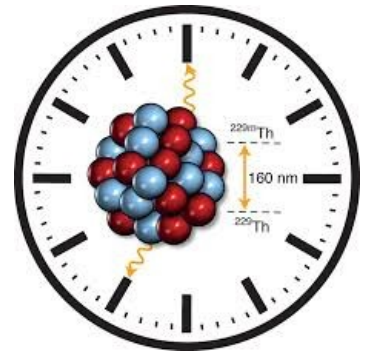
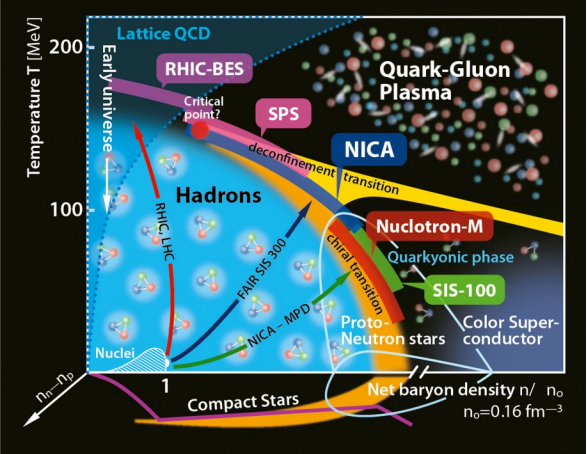
Intro: CSN3 INFN research lines [700 pp, 26 exp]



Three generations of matter (fermions)

	I	II	III
mass	2.4 MeV/c ²	1.27 GeV/c ²	171.2 GeV/c ²
charge	2/3	2/3	0
spin	1/2	1/2	1
name	u up	c charm	t top
	d down	s strange	b bottom
Quarks			g gluon
	ν _e	ν _μ	ν _τ
	e	μ	τ
Leptons			W [±]
			Z ⁰
			γ
			photon

Charge carriers



Quark/gluon dynamics,
fundamental interactions, QGP

Nuclear structure/dynamics,
nuclear astrophysics

Applications

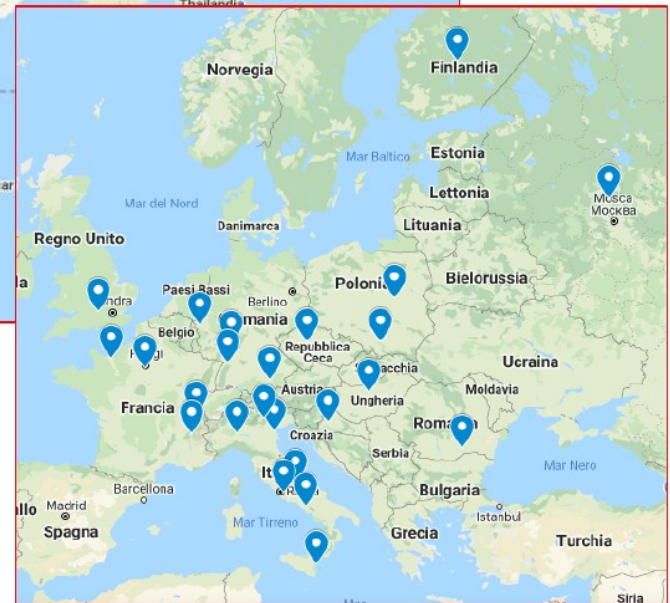
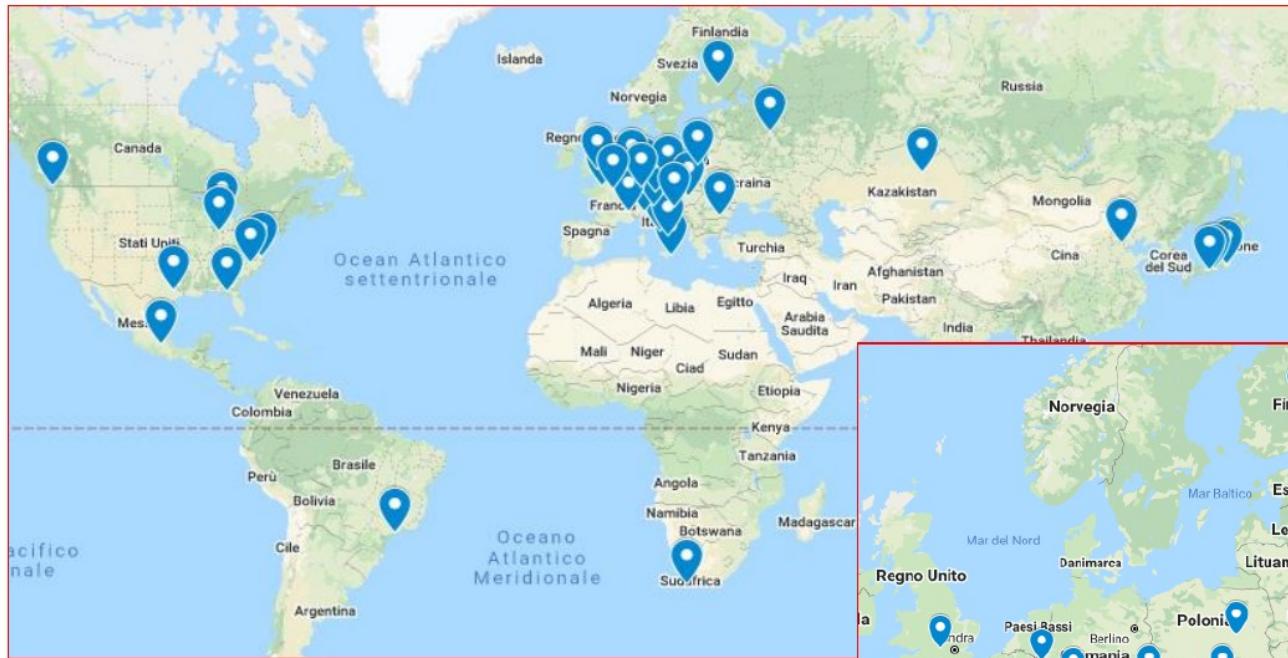
<https://www.pd.infn.it/it/gruppo3-fiscanucleare/>
<https://web.infn.it/csn3/index.php/it/>



Follow also the next
talks in this session

CSN3

National/International activity



Istituto Nazionale di Fisica Nucleare



BSc and MSc Scholarships CSN3 INFN

4

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

INFN

Istituto Nazionale di Fisica Nucleare
COMMISSIONE SCIENTIFICA NAZIONALE CSN3

HOME LA STRUTTURA ESPERIMENTI GESTIONE RIUNIONI EVENTI TERZA MISSIONE

News

Definire il futuro a medio termine della fisica nucleare italiana I prossimi anni vedranno il completamento dei programmi di potenziamento nei...

Ricerca in fisica nucleare

Nuclear Physics
Mid Term Plan in Italy

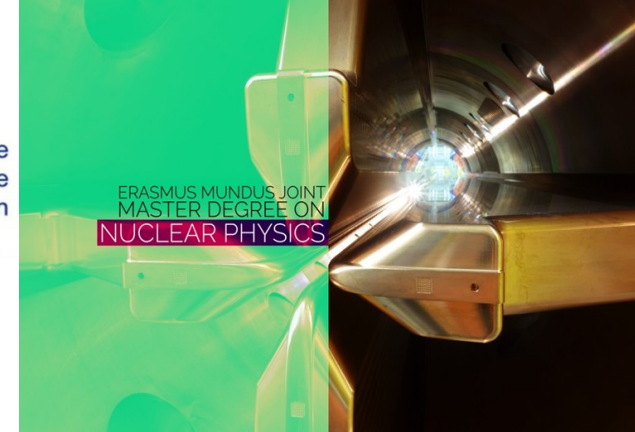
Visita il sito web per maggiori dettagli:

Borse CSN3 e offerte lavoro

- Concorso per il conferimento di n. 4 borse di studio per attività di formazione per studenti universitari iscritti al 3° anno della laurea di primo livello in fisica nell'ambito del progetto formativo "Esplorando la Fisica Nucleare" (Bando n. 23791 - elenco laboratori ospitanti - elenco dei programmi di ricerca).
- Concorso per il conferimento di 4 borse di studio, per attività di formazione per laureandi o neolaureati magistrali in Fisica nell'ambito del progetto formativo "La Fisica Nucleare nei Laboratori" (Bando n. 23792 - elenco laboratori

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

Call 2023 is over → next call Sept. 2024



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)



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



7 Unis + 30 associated partners

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



Organization paths Internationality/Sustainability



Experiments
Theoretical
Applications

in large experimental facilities and instrumentation
nuclear physics
of nuclear physics and smaller accelerator facilities

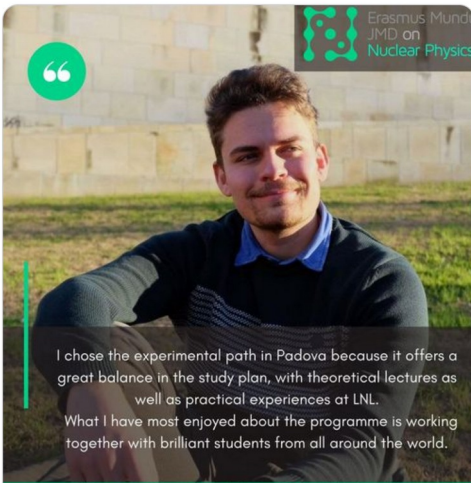
Funding options:

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

Testimonials

<https://www.facebook.com/Nucphys>

Erasmus Mundus Master in Nuclear Physics - Nucphys
November 11, 2021



Erasmus Mundus JMD on Nuclear Physics

I chose the experimental path in Padova because it offers a great balance in the study plan, with theoretical lectures as well as practical experiences at LNL. What I have most enjoyed about the programme is working together with brilliant students from all around the world.

Filippo Angelini - student of EMJMD Nuclear Physics Path 1

Dipartimento di Fisica e Astronomia "Galilei" - DFA - Unipd
November 9, 2021

The application period for the Erasmus Mundus Master in Nuclear Physics - Nucphys will be open next November 15th, 2021 and will last until January 15th, 2022!... See more

ERASMUS MUNDUS JOINT MASTER DEGREE IN NUCLEAR PHYSICS



"NucPhys program has been like a springboard for my future. I interacted with people coming from all over the world that shared with me their culture and their passion in the field of Nuclear Physics. I had the opportunity to learn several languages and to create professional bonds with professors in important cities for the Nuclear Physics discipline. During this period I had the chance to travel a lot in Europe and to discover small and big towns."

Alice Barbon
Experiments and instrumentation in large accelerators
ITALY

Erasmus Mundus Association

EMA: The Erasmus Mundus Students and Alumni Association

Learn more about us

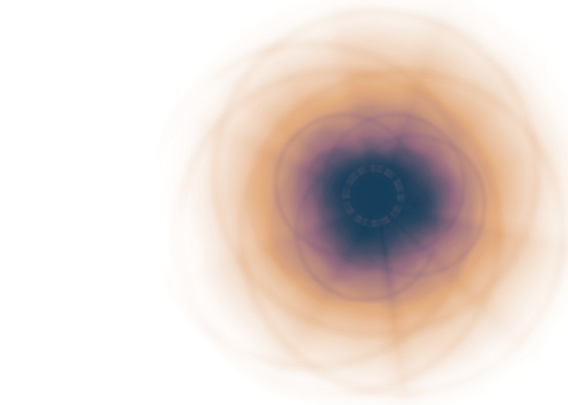
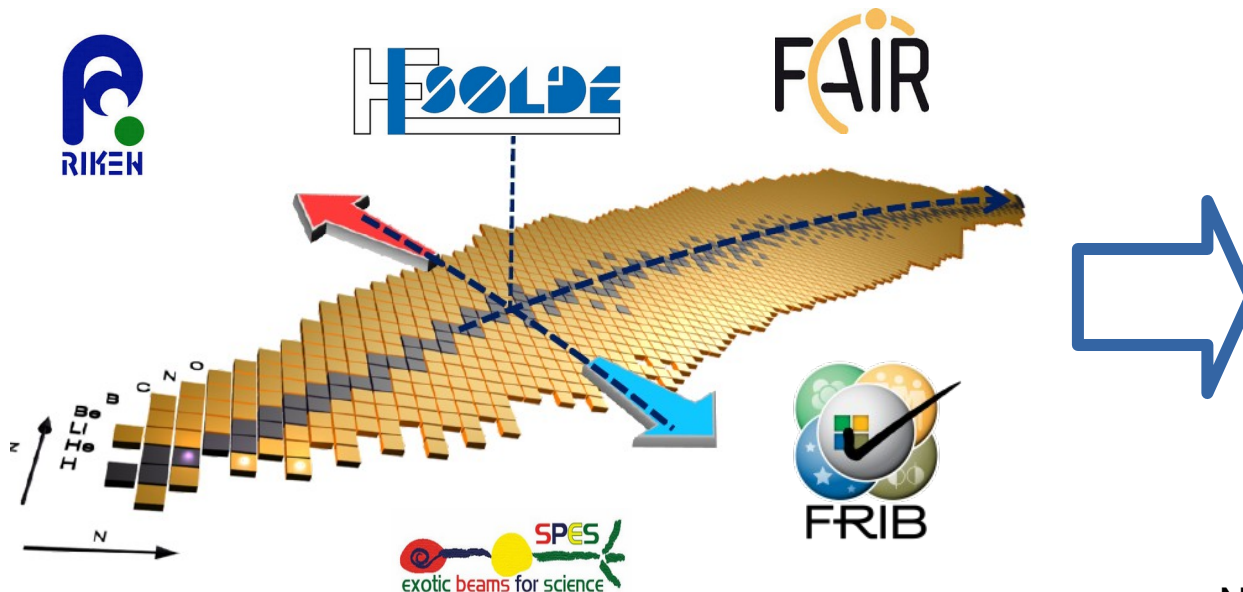
Prospective Students
Are you interested in applying to...?

Students and Alumni
Are you a current student or...?

Partners
Are you interested in working more...?

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:



Hands-on
activity



Coding



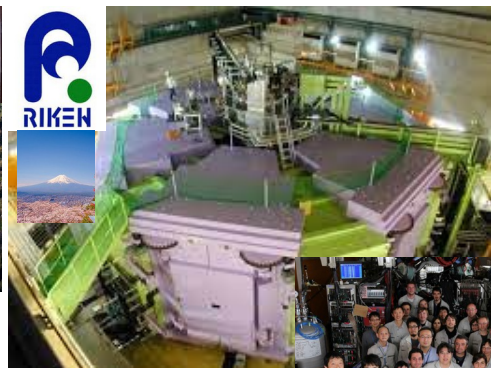
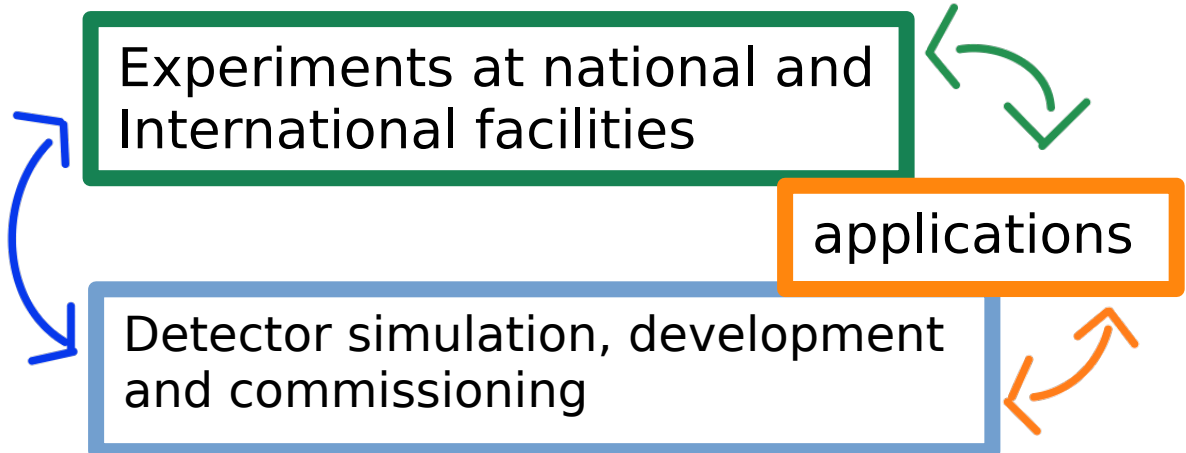
Analysis



Thesis-opportunity
tag

What am I doing?

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



International environment



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

AGATA@LNL:'21-'26

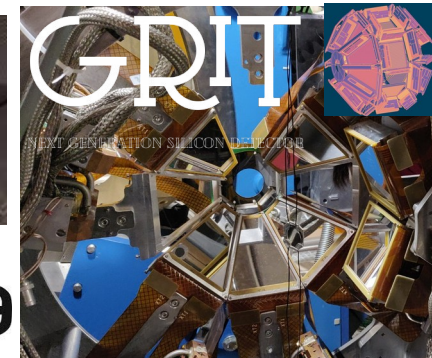
first worldwide operational **tracking** array



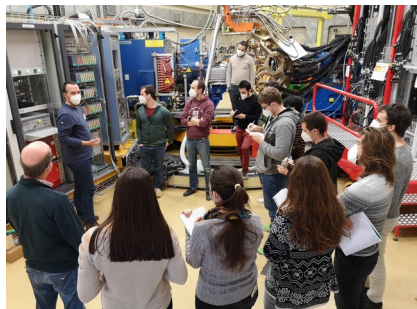
10



- 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

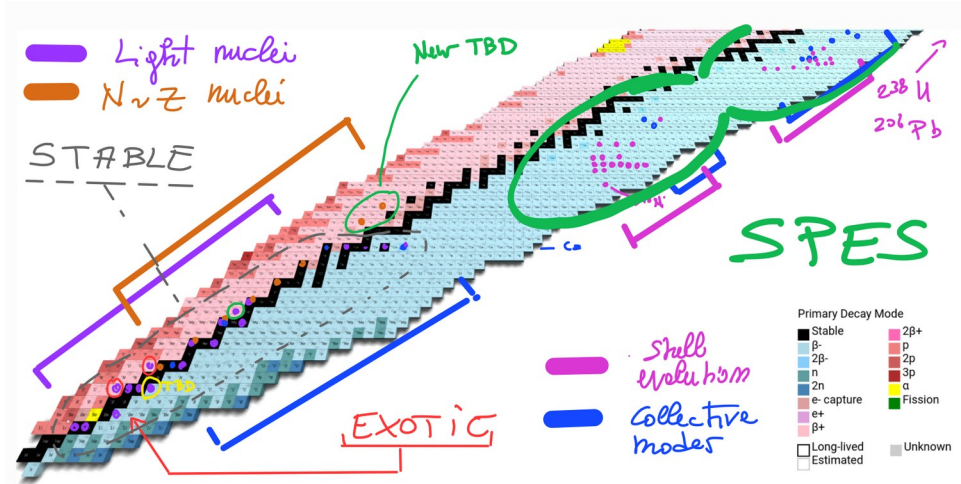


Preparation and participation to scientific campaign@ LNL, in particular: preparation, run, analysis, simulation, theoretical interpretation.

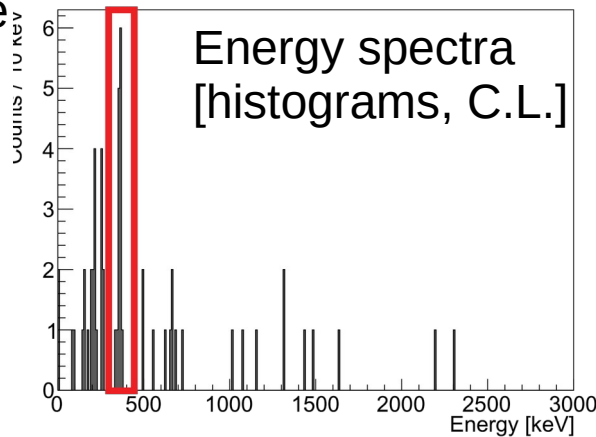
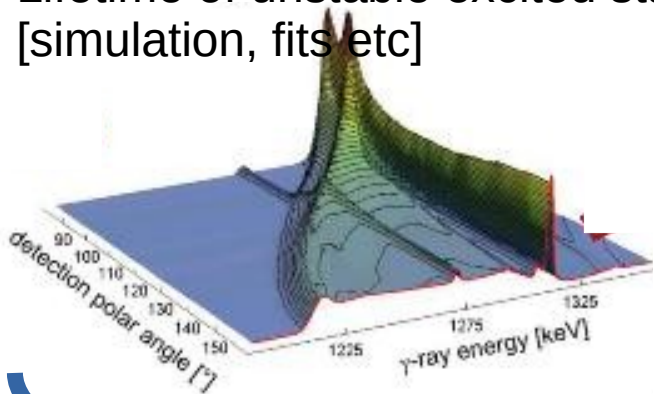


LNL Experimental campaign

typically dozen of expts and TBs of data



Lifetime of unstable excited state [simulation, fits etc]



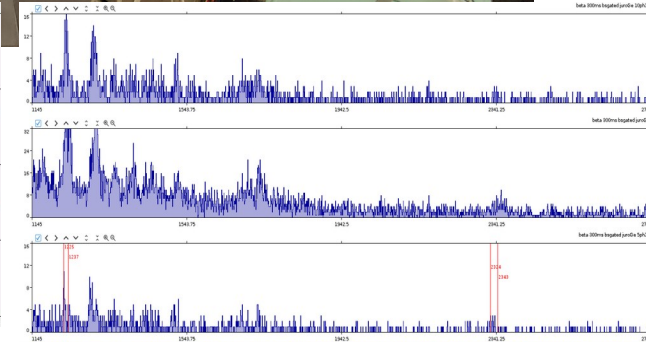
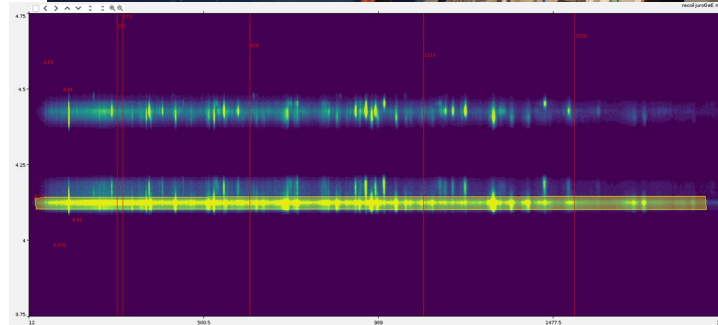
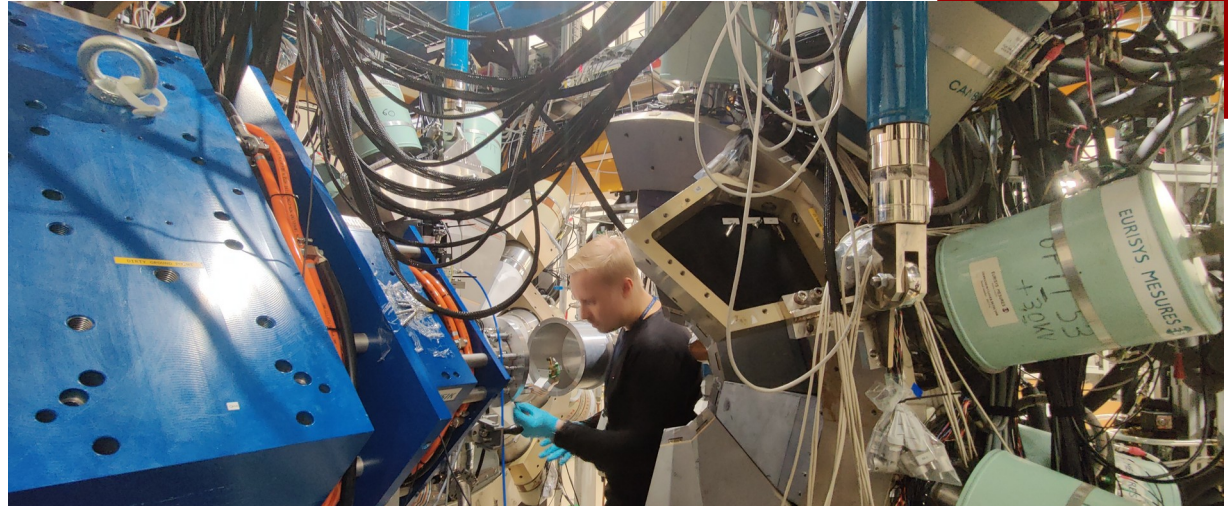
- Exp. routine: thinking, preparing, running, analyzing, reporting



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

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

13

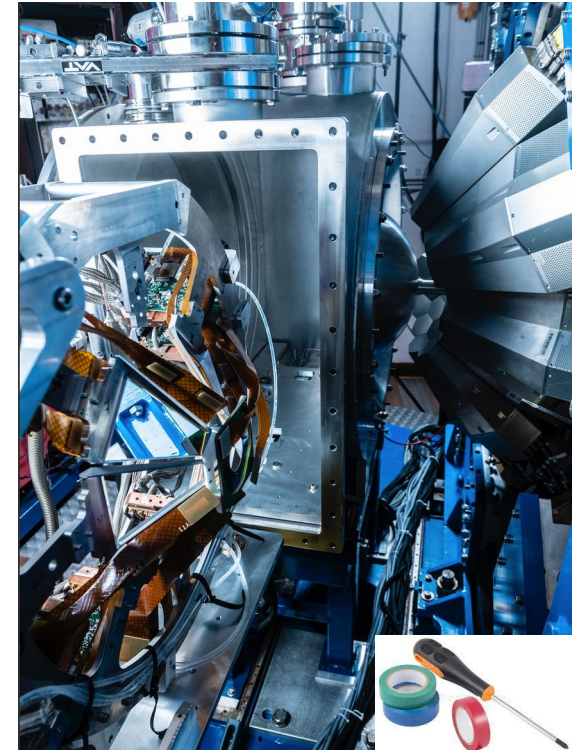
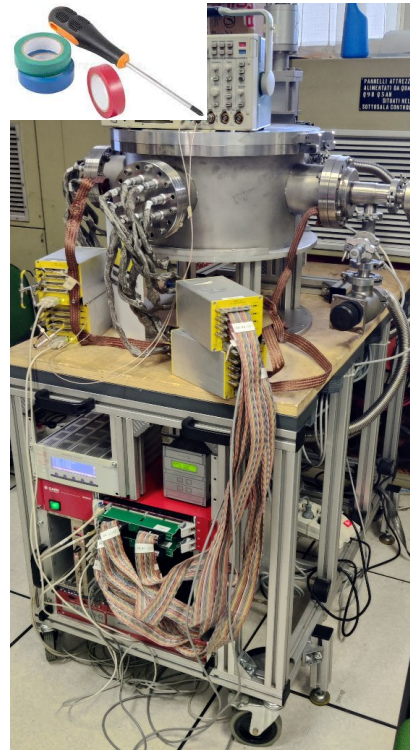
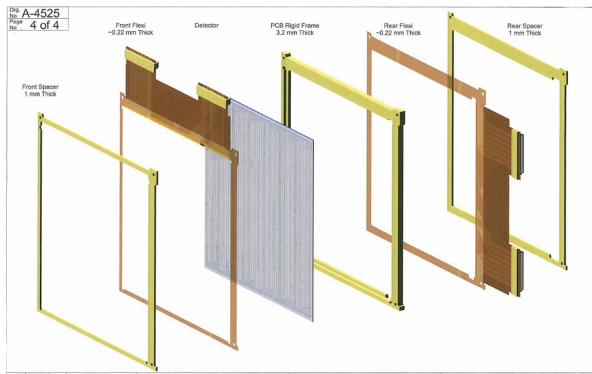
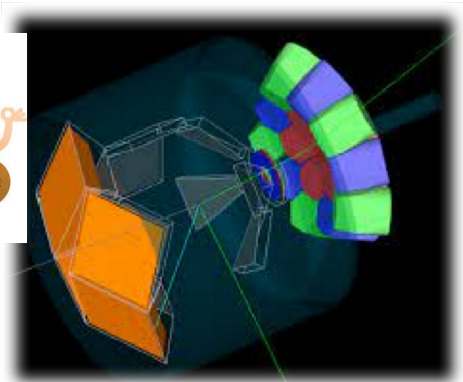


- Data presort (~calibrations)
- Data analysis
- Conferences, papers, dissemination



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



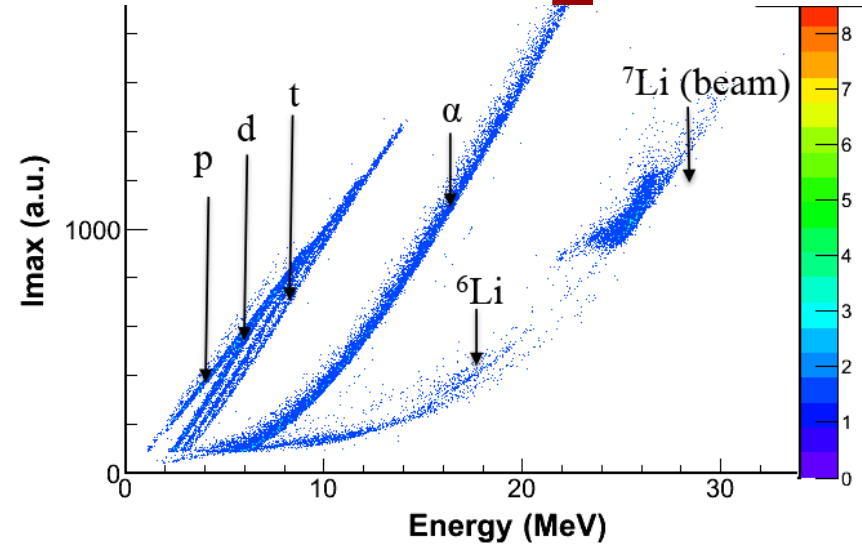
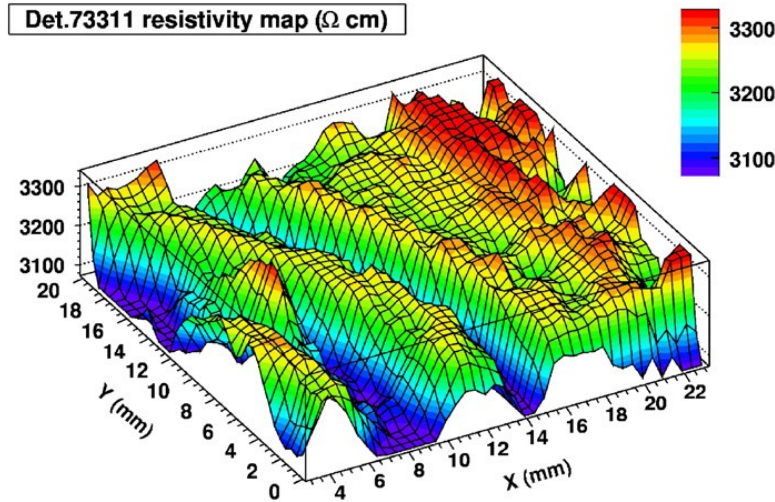
Detector development and characterization



15

M i u r

PRIN



- 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)

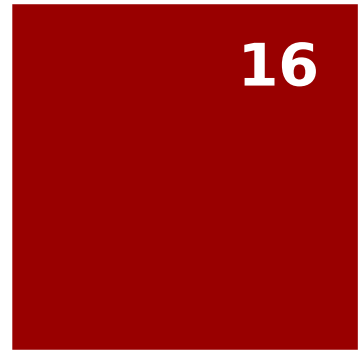


Application: BETASMART

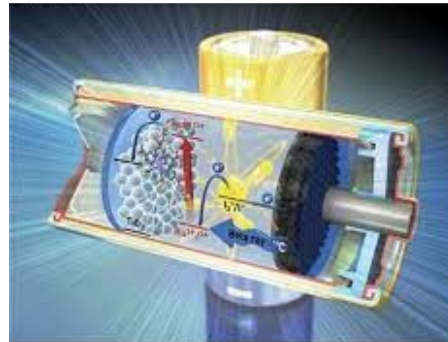
Development of batteries with long lifetime (~**10 years**) and low power for space, medicine and remote sensing



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



Fundamental Physics

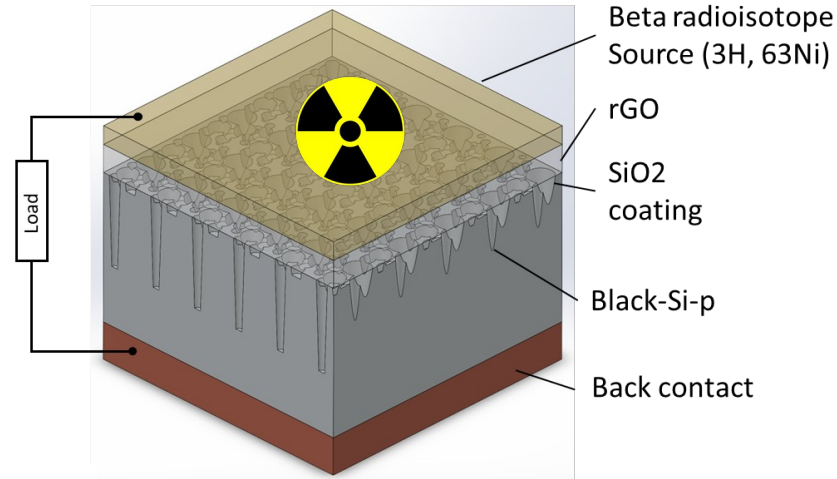
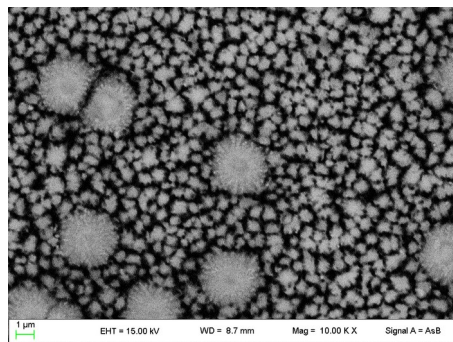
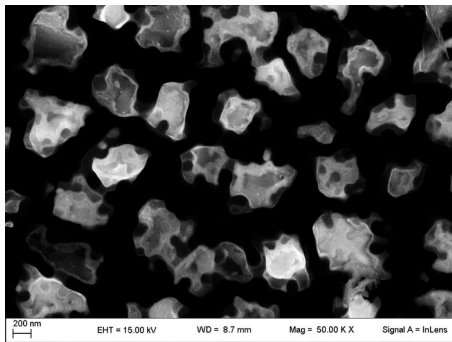
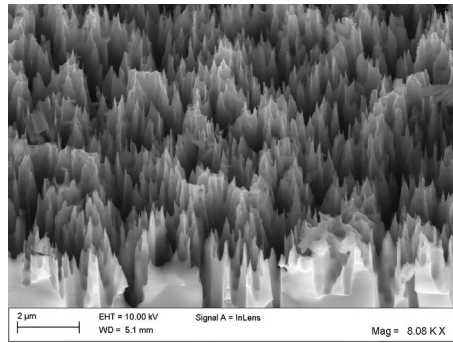
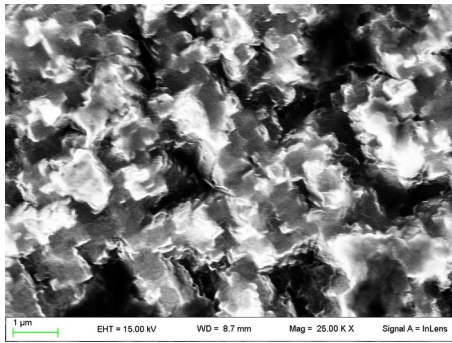


Applications



Environment

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



Structure of nuclear betavoltaic cell



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

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

SEM image of Black Silicon samples (UNIPG)



Motori



AUTO ELETTRICA

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

di Barbara Crimardo

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nature > nature communications > articles > article

Article | [Open access](#) | [Published: 23 June 2021](#)

Mn²⁺ induced significant improvement and robust stability of radioluminescence in Cs₃Cu₂I₅ 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

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

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



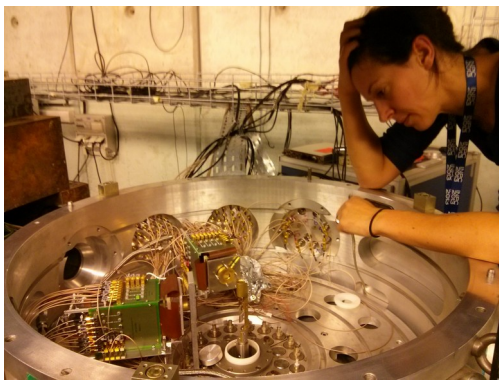
"Dai diamanti non nasce niente", cantava Fabrizio De André. In California c'è chi la pensa diversamente e progetta una batteria potenzialmente eterna, con minuscoli diamanti generati da rifiuti radioattivi. Un obiettivo visionario eppure fattibile, quello della NDB – Nano Diamond Battery – che ha ipotizzato 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

And so .. why with us

19

- 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

20

Contacts

Daniele Mengoni, office 322 (edificio via F. Marzolo 8)
(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)

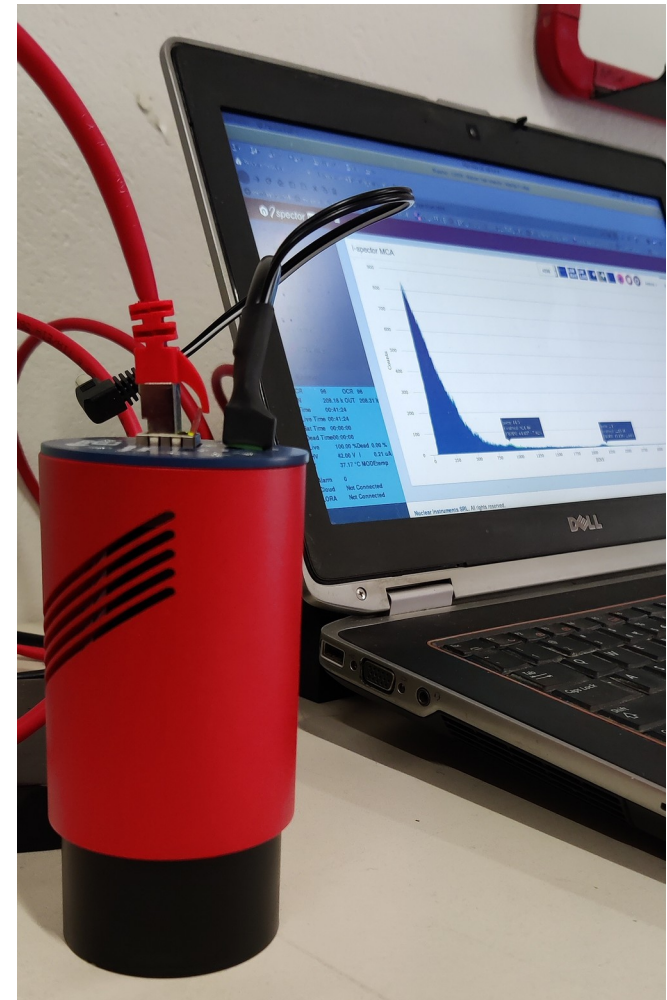
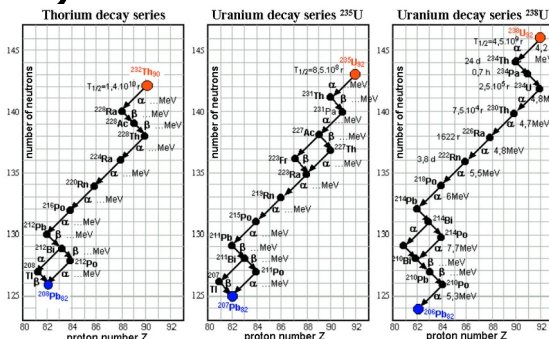
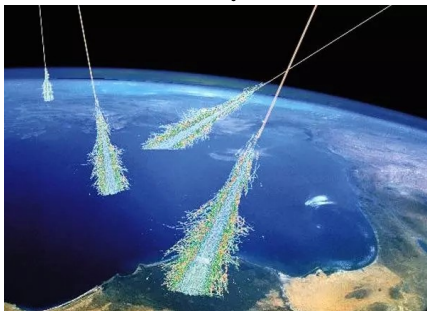
Alain Goasduff (goasduff@lnl.infn.it)
Andrea Gottardo (gottardo@lnl.infn.it)
José Javier Valiente Dobon (valiente@lnl.infn.it)

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



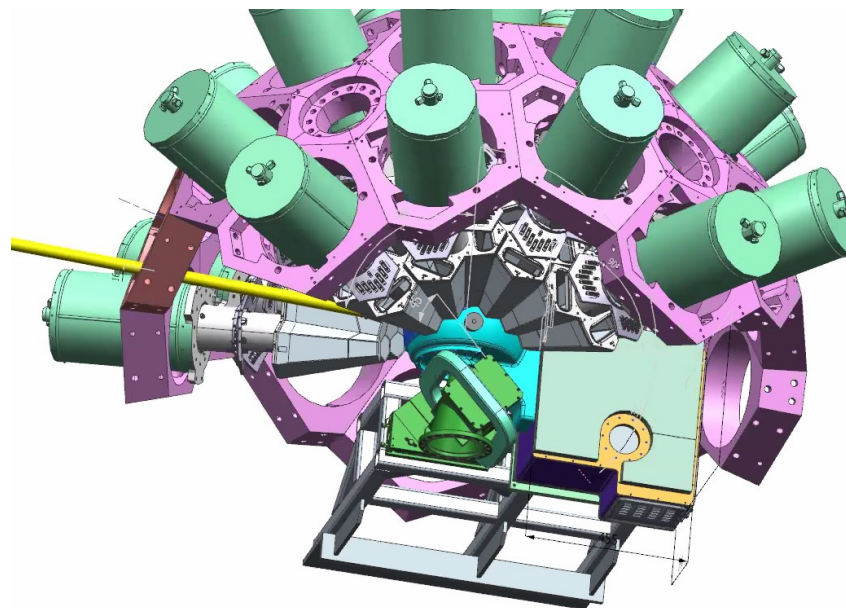
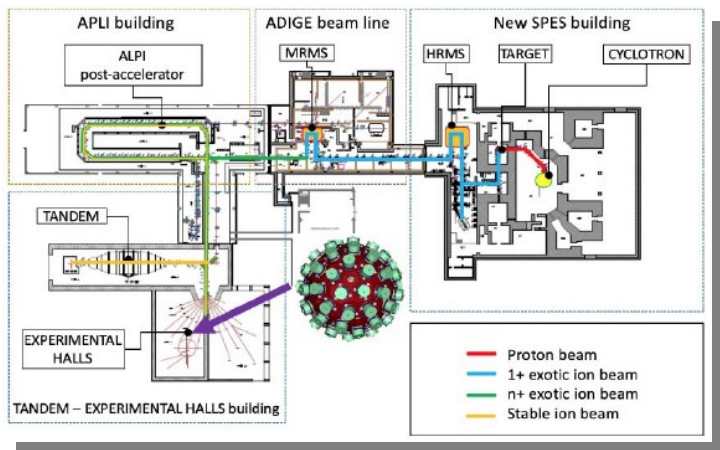
Design a didactic experiment

- 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

2
3



Installation - ongoing
Commissioning – April 2022

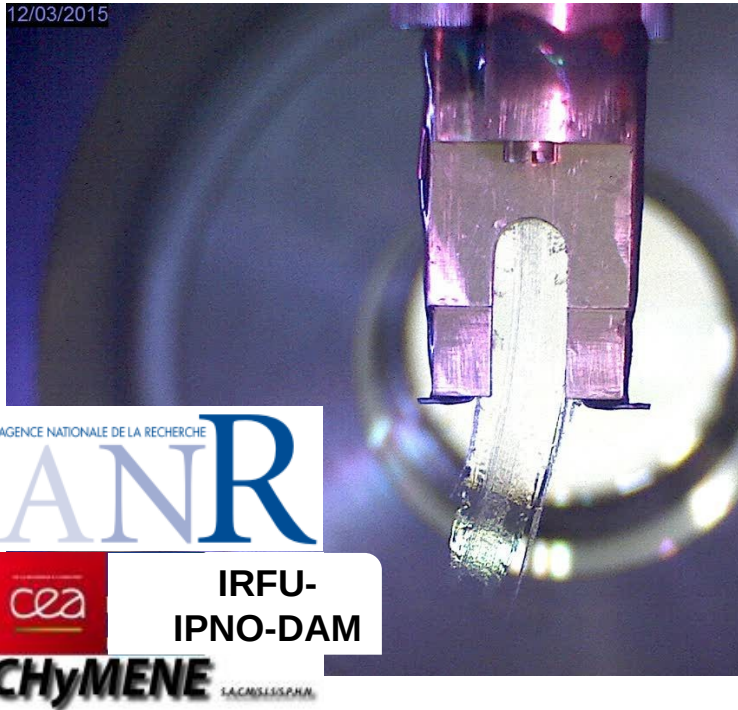


Preparation and participation to commissioning and scientific campaign@ LNL (preparation, run, analysis, simulation, theoretical interpretation,):
mengoni@pd.infn.it, menegazzo@pd.infn.it,
valiente @Inl.infn.it, goasduff@Inl.infn.it et al



Cryo/jelly target development

24



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

