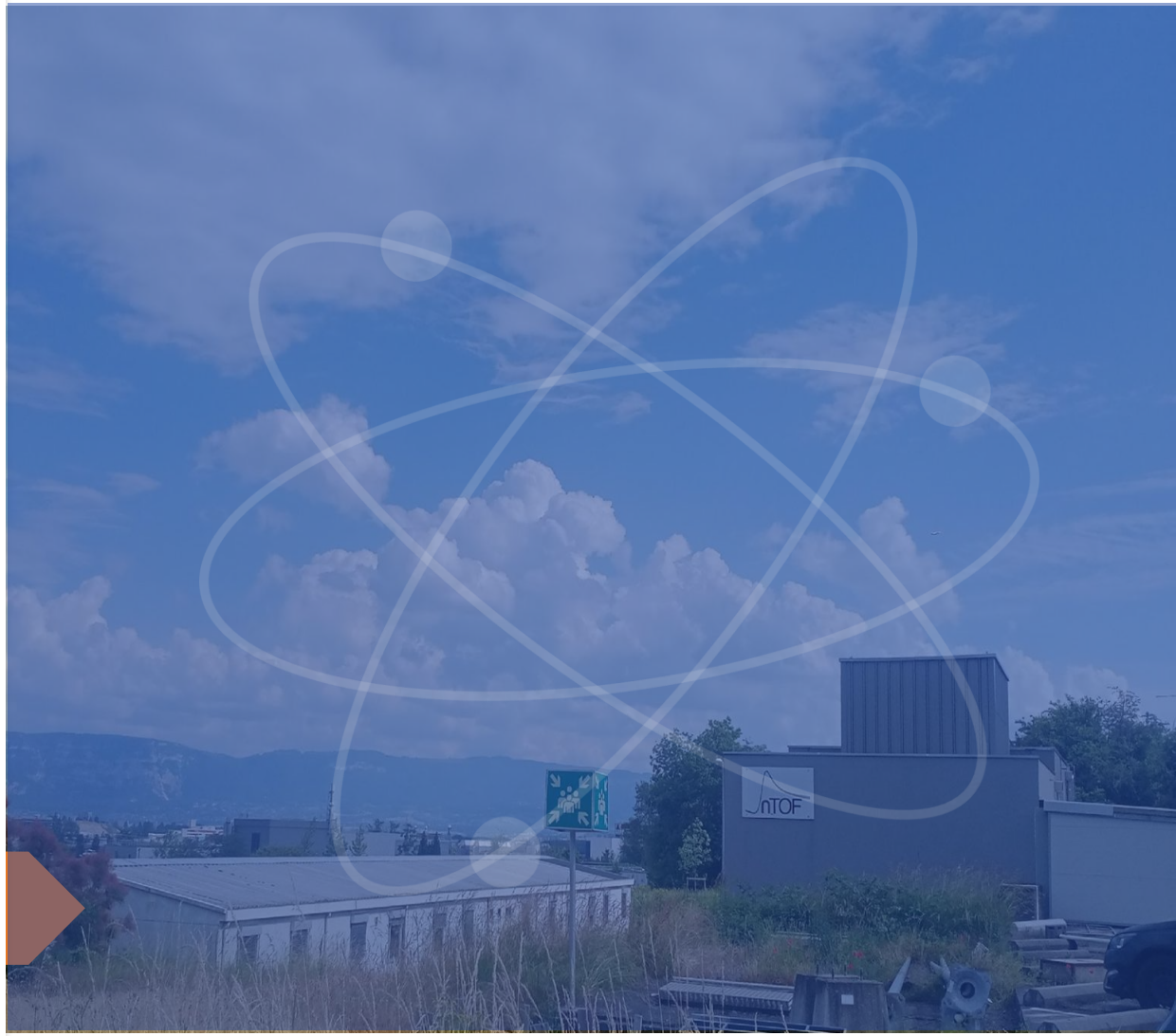
Horia Hulubei National Institute for R&D
in Physics and Nuclear Engineering

Romanian participation at CERN: The n_TOF Collaboration

Scientific Report 2025

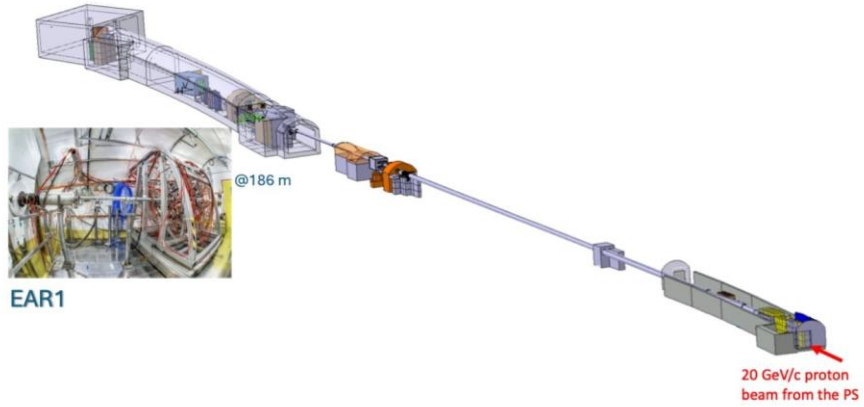
A. Negret, M. Boromiza, G. Ciocan, A. Coman, A. Cristescu, A. Gandhi, A. Ionita, C. Neacsu, C. Petrone, and A. Radu



n_TOF collaboration @ CERN

The n_TOF facility consists of a spallation neutron source fed by the CERN's PS with unique capabilities in terms of energy, flux and resolution of the generated neutrons. Measurements are run in parallel on 3 experimental areas:

- one at the end of a 185-m horizontal flight path (EAR1).

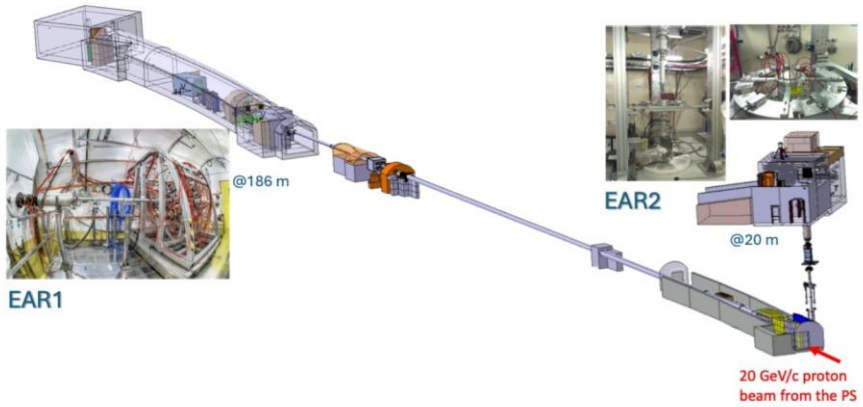


n_TOF collaboration @ CERN

The n_TOF facility consists of a spallation neutron source fed by the CERN's PS with unique capabilities in terms of energy, flux and resolution of the generated neutrons. Measurements are run in parallel on 3 experimental areas:

- one at the end of a 185-m horizontal flight path (EAR1),

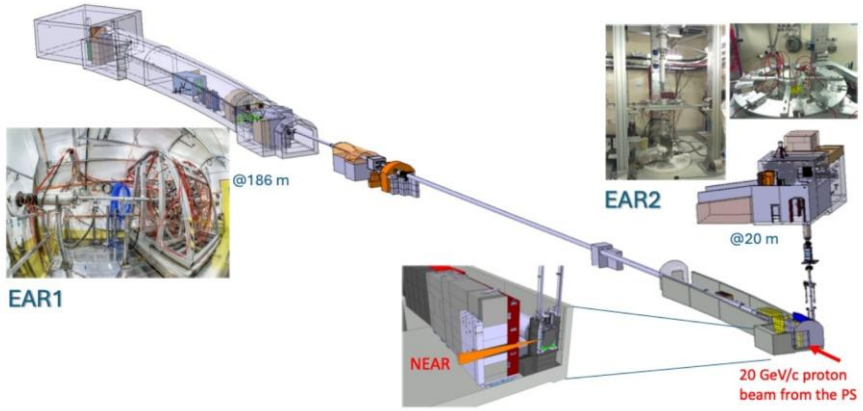
- one at the end of a 20-m vertical flight path (EAR2),



n_TOF collaboration @ CERN

The n_TOF facility consists of a spallation neutron source fed by the CERN's PS with unique capabilities in terms of energy, flux and resolution of the generated neutrons. Measurements are run in parallel on 3 experimental areas:

- one at the end of a 185-m horizontal flight path (EAR1),
- one at the end of a 20-m vertical flight path (EAR2),
- one located in the vicinity of the neutron-producing target (NEAR).



Specific scientific focus of the Romanian team

- High-resolution γ detector development (Use of $LaBr_3$ detectors at n_TOF),
- GEANT4 simulations and pulse shape analysis algorithms,
- Inelastic (^{24}Mg, ^{28}Si, ^{19}F) neutron scattering and $^{10}B(n, \alpha_1)^7Li$ cross section measurements,
- Neutron capture measurements: $^{124}Sn(n, \gamma)$ cross sections important for background subtraction in neutrinoless double beta decay searches,
- Clarifying the X17 boson existence.

Workplan 2025

ACTIVITIES:

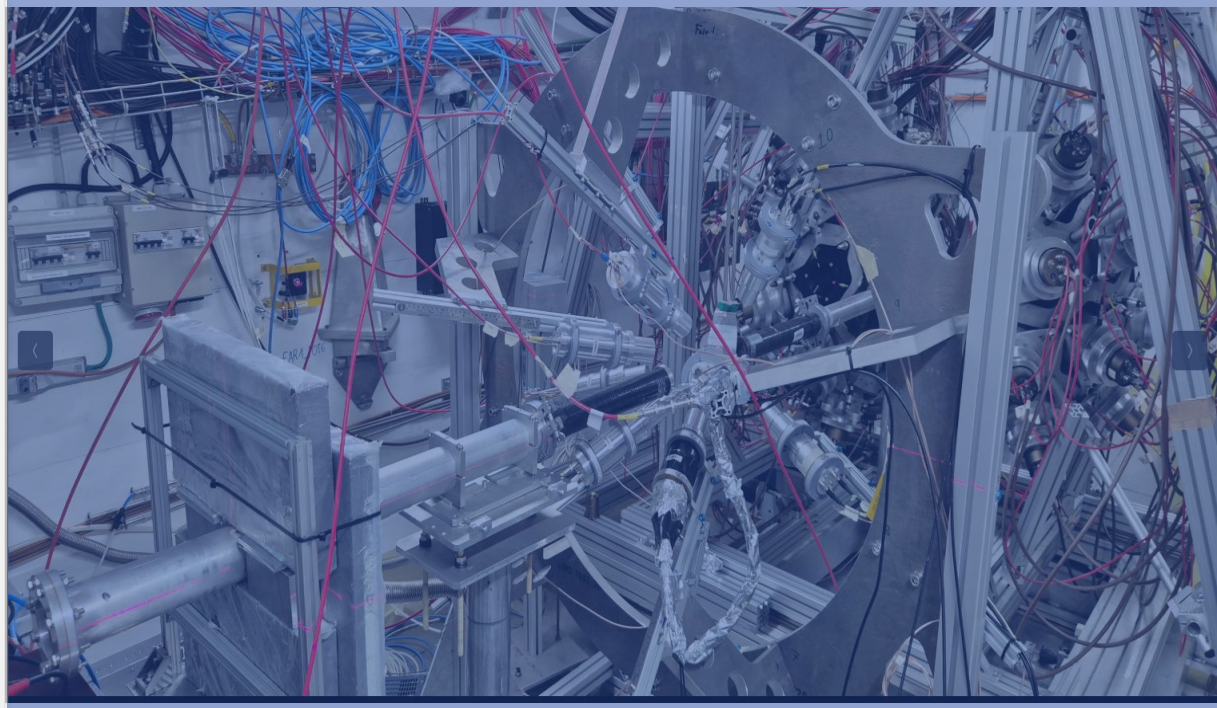
1. Finalization of the new high-resolution γ-spectroscopy detector array

2. Preparation of the ^{28}Si target for the $^{28}Si(n, n' \gamma)^{28}Si$ experiment

3. Preparation of the ^{124}Sn target for the $^{124}Sn(n, \gamma)$ experiment

ACTIVITY 1:

A new $LaBr_3$ array at n_TOF



A new $LaBr_3$ array at n_TOF

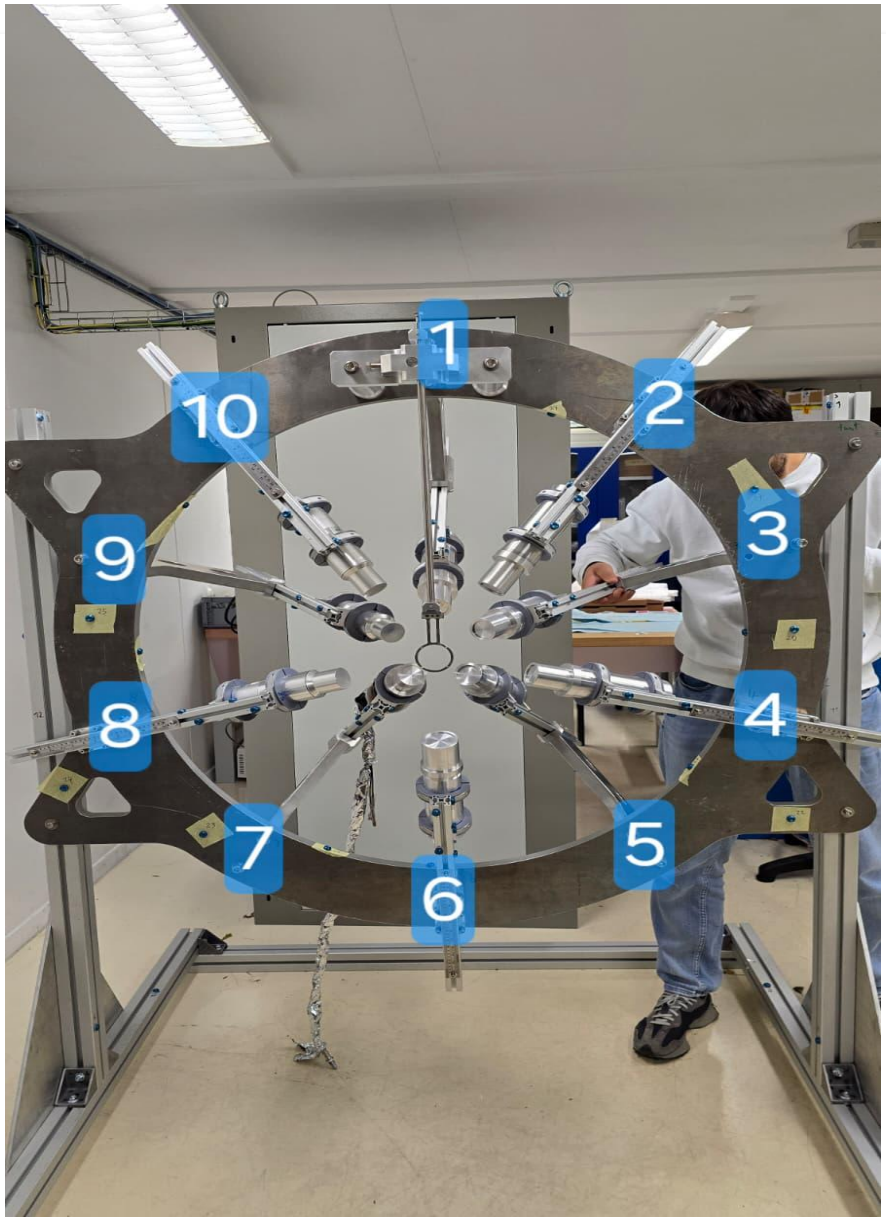
- Minimalistic profile based on aluminium
- 10 $LaBr_3$ at backward angles: 110° & 150°
- Sample holder integrated into the frame (better control over alignment)

- **Optional upgrade**: another hemisphere with 10 detectors at forward angles

- **Mounting & commissioning beamtime (October 2025)**
- **We also mounted a ^{235}U-based FC upstream the sample**

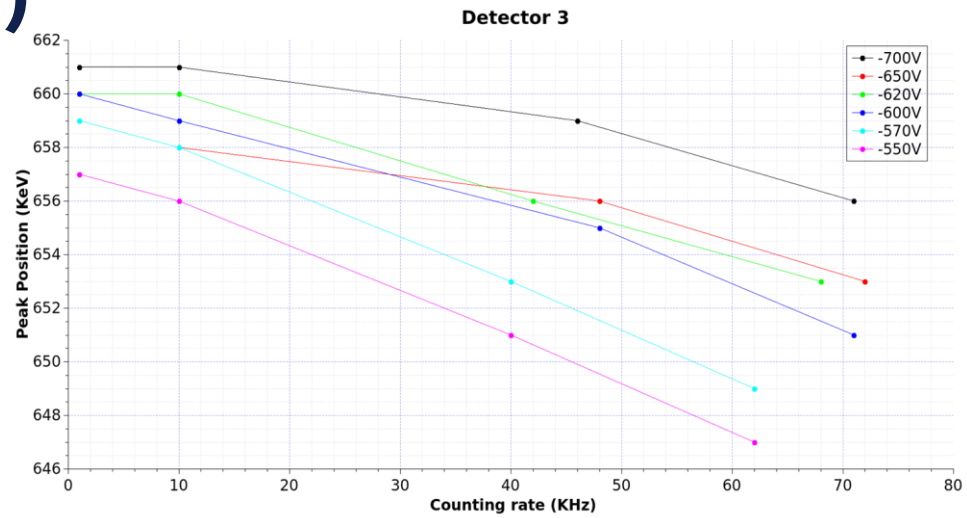
- **Ongoing $^{19}F(n, n'\gamma)$ campaign**

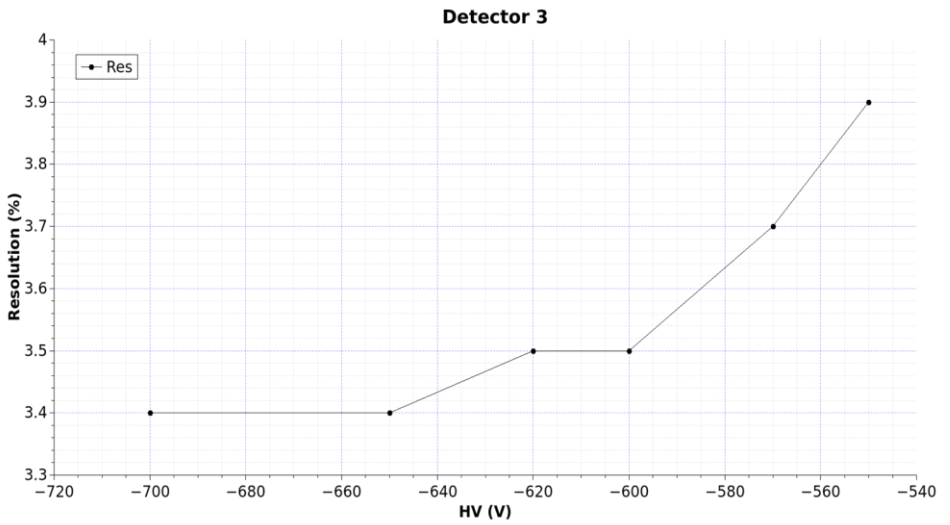
- **$^{28}Si(n, n'\gamma)$ data taking: in the near future**



Detector tunning for the (upcoming) ^{28}Si campaign

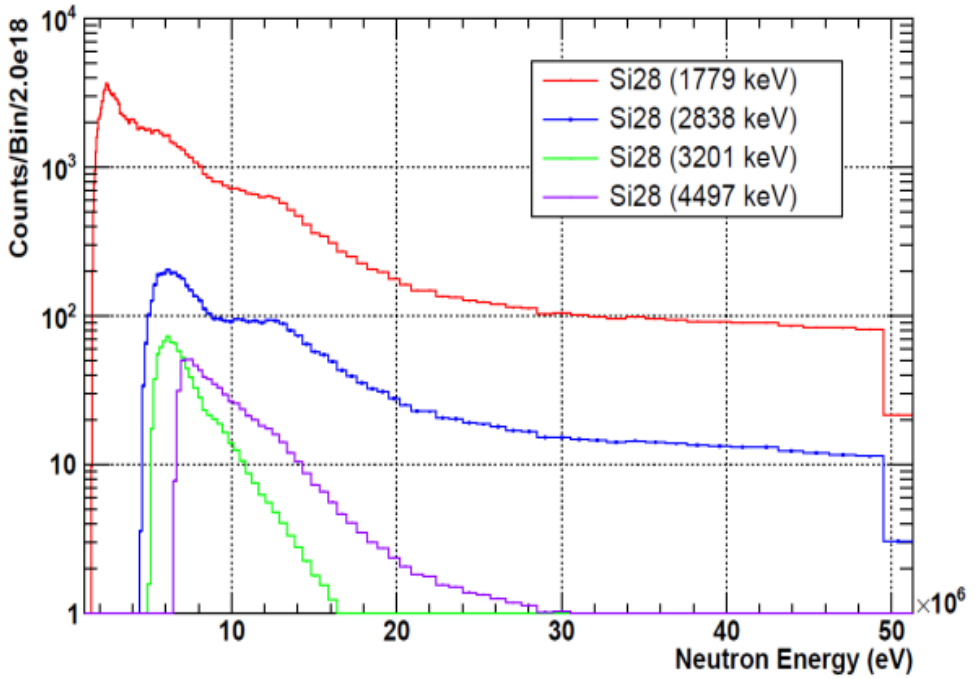
- Very high counting rates expected: HV optimization to limit the gain drift
- We used a ^{137}Cs calibration source (662-keV line)
- Optimizing the γ-energy resolution for the ^{28}Si transitions: 1779, 2838, 3201 and 4497 keV





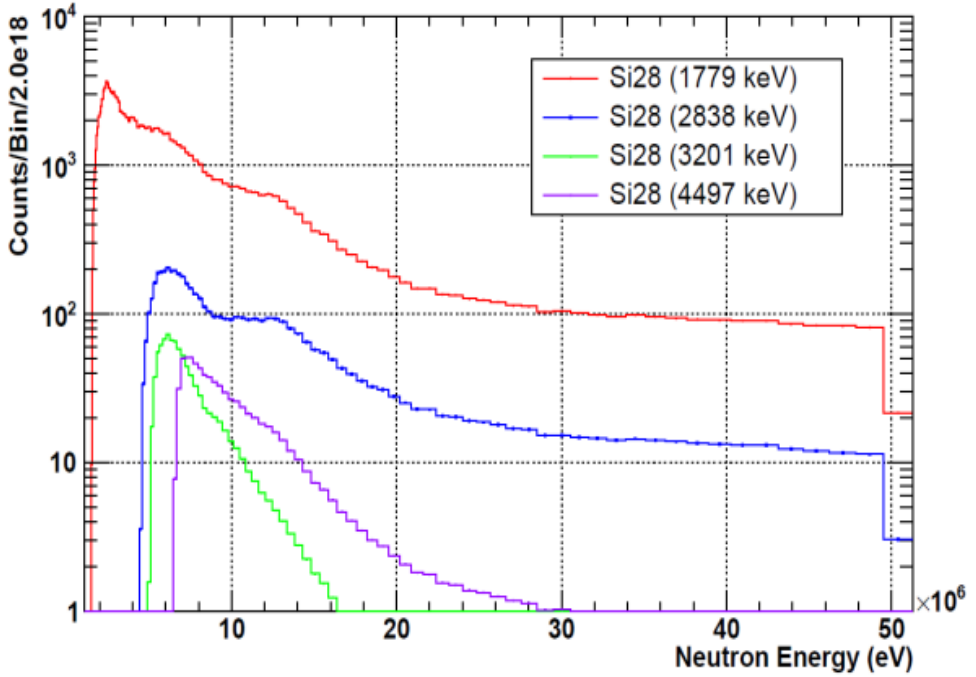
Simulations for the (upcoming) ^{28}Si campaign: statistics optimization

- Calibration sources used to measure the $LaBr_3$ detectors efficiency
- Monte Carlo simulations of the neutron flux + sample + detectors
- => statistics estimate for the approved number of protons for the ^{28}Si lines (1779, 2838, 3201 and 4497 keV)



Simulations for the (upcoming) ^{28}Si campaign: statistics optimization

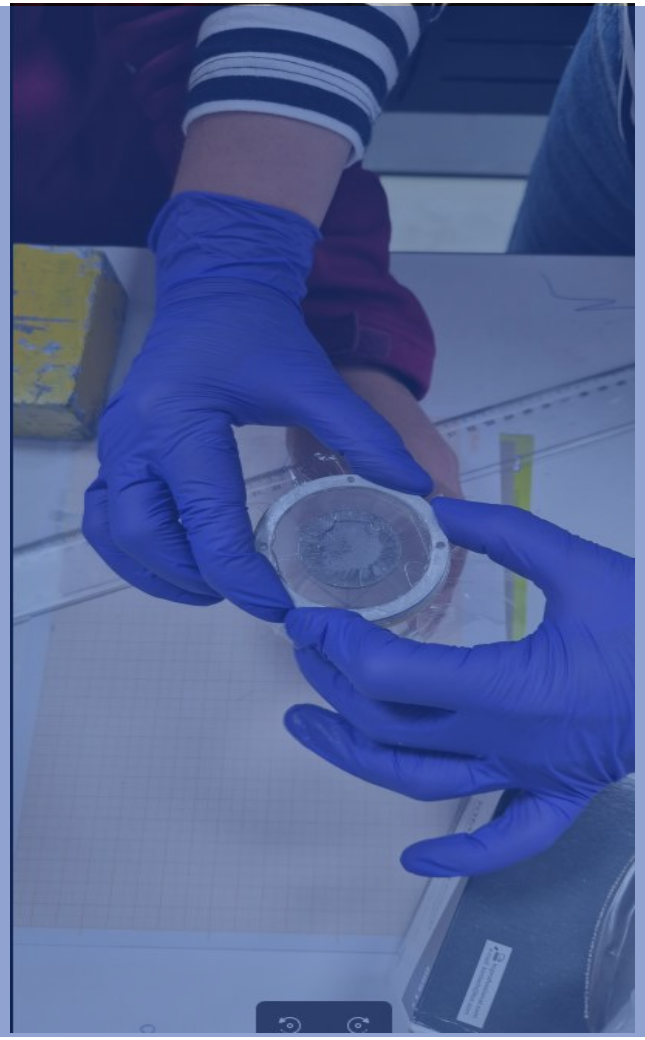
- Calibration sources used to measure the $LaBr_3$ detectors efficiency
- Monte Carlo simulations of the neutron flux + sample + detectors
- => statistics estimate for the approved number of protons for the ^{28}Si lines (1779, 2838, 3201 and 4497 keV)



Optimization of the experimental setup:
(detector positions, sample thickness, etc.)

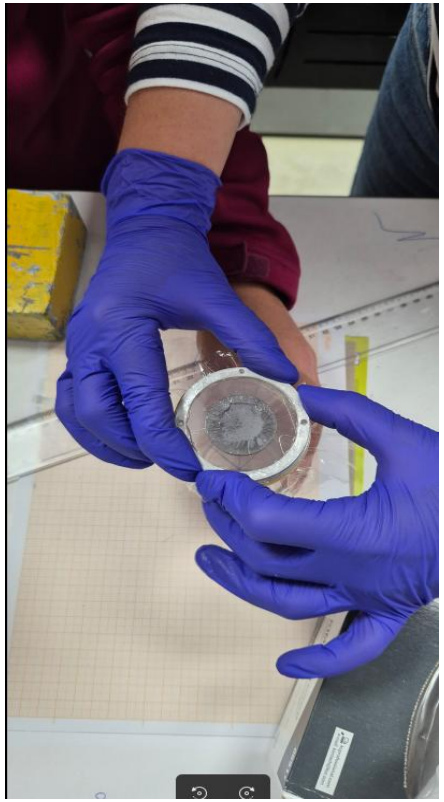
ACTIVITIES 2 & 3

Preparation of the ^{28}Si and ^{124}Sn samples at IFIN-HH



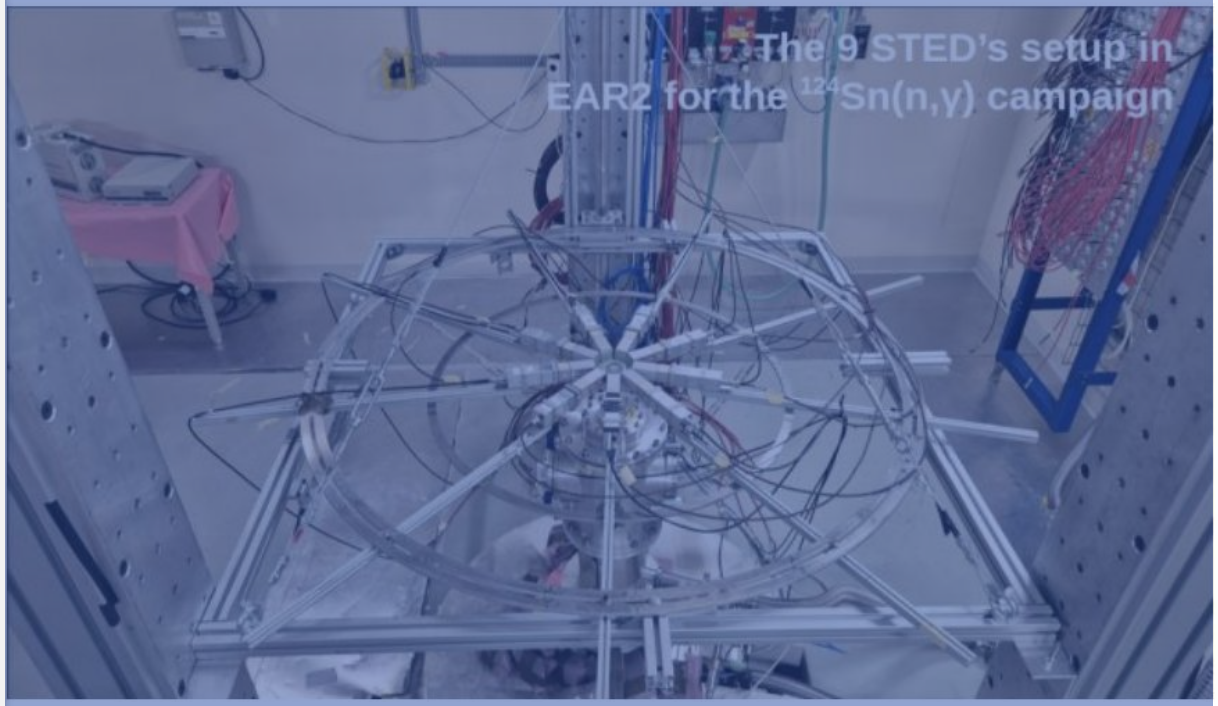
Preparation of the ^{28}Si and ^{124}Sn samples at IFIN-HH

- Isotopically enriched material procured from Trace Sciences International & ISOFLEX,
- metallic powder pressed at 40 T in the target lab. of IFIN-HH,
- Thickness & mass optimized with regard to the counting rate and multiple scattering corrections,
- Main samples characteristics:
  - ^{124}Sn: 2.0-cm diameter and 1-g mass
  - ^{28}Si: 3.2-cm diameter and 2-g mass
- Several backup and other samples (background check/subtraction, MSC check, etc.) also produced: ^{12}C, ^{nat}Sn, 3-g ^{124}Sn,...



OTHER ACTIVITIES

The $^{124}Sn(n, \gamma)$ experiment

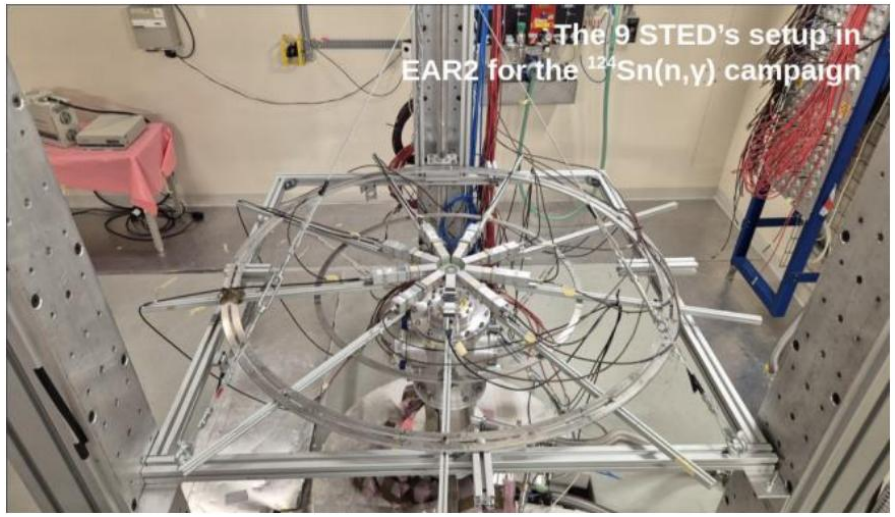


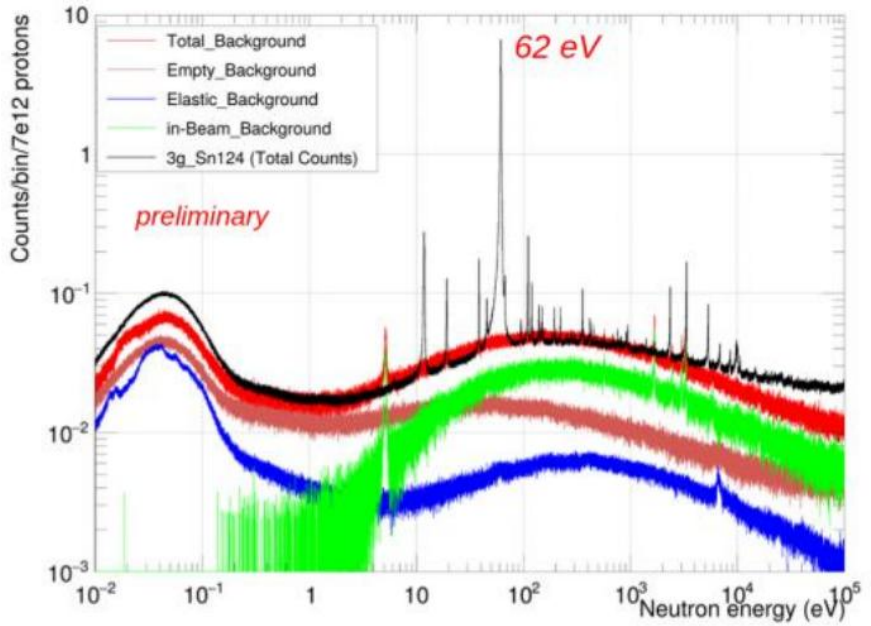
The 9 STED's setup in EAR2 for the $^{124}Sn(n,\gamma)$ campaign

The ^{124}Sn(n, γ) campaign

- **Only partially supported by the project (sample procurement and preparation)**

- Data taking April-May 2025
- Setup: 9 STEDs in EAR2 + SIMON2 detector (beam monitoring) + 1-g / 3-g ^{124}Sn samples
- Data analysis performed by A. Gandhi (supervised by M. Boromiza) is ongoing
- <u>Preliminary data analysis confirms a successful experiment</u>





CONSLUSIONS

Papers, Conference talks, Collaboration meetings

- 10 papers published in 2025 with our team members as co-authors
- ND2025 (International Conference on Nuclear Data for Science and Technology, June 2025, Madrid, Spain) Contributions:
    - *^{24}Mg(n, n'γ) measurement at n_TOF CERN*, by M. Birch, C. Petrone, M. Boromiza, A. Negret, and the n_TOF Collaboration,
    - *Developments and future prospects for neutron induced inelastic cross section measurements at CERN n_TOF*, by M. Bacak, C. Petrone, M. Boromiza, A. Negret, and the n_TOF Collaboration,
- Regularly presenting at Collaboration Meetings the status of ^{124}Sn and ^{28}Si campaigns + a new experiment proposal dedicated to the ^{10}B(n,α) channel (*beam time approved by INTC*)
- DUROCERN: numerous groups guided during 2025

Outreach

The **DUROCERN** permanent ehibition, where students and researchers involved in this project interact with the public and present our activities at ISOLDE and n_TOF together with the importance of studying cross sections.

In 2025, the joint ISOLDE and n_TOF stand was visited by approximately **400** students from schools and high schools in Romania.

All members of the team are involved as guides.

Courtesy of R. Lica, ISOLDE

Conclusions

Highlights of the year:

- Successful commissioning of the $LaBr_3$ array in EAR1
- Manufacturing of the ^{124}Sn and ^{28}Si samples
- Preparation the $^{28}Si(n, n'\gamma)$ campaign. Experiment scheduled soon.
- A new experiment proposal: $^{10}B(n,\alpha_1\gamma)^7Li$; beam time approved by INTC (Spokesperson: C. Petrone)
- *Completion of the $^{124}Sn(n, \gamma)$ experiment*

Diploma thesis:

- A. Cristescu, thesis on the the $^{28}Si(n, n'\gamma)^{28}Si$ measurement, to be submitted in 2026

Thanks

Do you have any questions?

negret@nipne.ro
https://www.nipne.ro/

Contact Us

Address: Str. Reactorului no.30, P.O.BOX MG-6,
Bucharest - Magurele, ROMANIA
Phone: +(4021) 404.23.00
Fax: +(4021) 457.44.40