"Horia-Hulubei" National Institute for Physics and Nuclear Engineering (IFIN-HH)
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TNA IFIN-HH Bucharest – 3 MV Tandetron, Romania

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IFIN-HH Bucharest-Magurele

ChETEC-INFRA kick-off meeting, May 4-5, 2021

NA facilities and methods @IFIN-HH

- Three tandem accelerators:
  - 3 MV tandetron - 200 hrs/yr offered
  - 9 MV pelletron tandem
  - 1 MV – AMS dedicated
- Methods
  - deactivation:
    - Tandetron + ultra-low background salt mine – for $T_{1/2}$ > 1-2 hrs
    - BEGA $\beta\gamma$ coincidence – efficient and reprod for $T_{1/2}$ >2-3 min
  - Spectroscopy of resonances @ 9 MV + ROSPHERE + n-detectors
  - Others: prompt gamma-rays, Si det systems, n-dets, …)
- There is a PAC that meets annually – we will apply for the 200 hrs/yr for ChETEC-INFRA
- IFIN-HH has accommodation facilities, own or nearby

Home infrastructure

1) 3 MV tandetron accelerator: 0.2 – 3.3 MV

- Good currents for alpha and light ion induced reactions

Detection

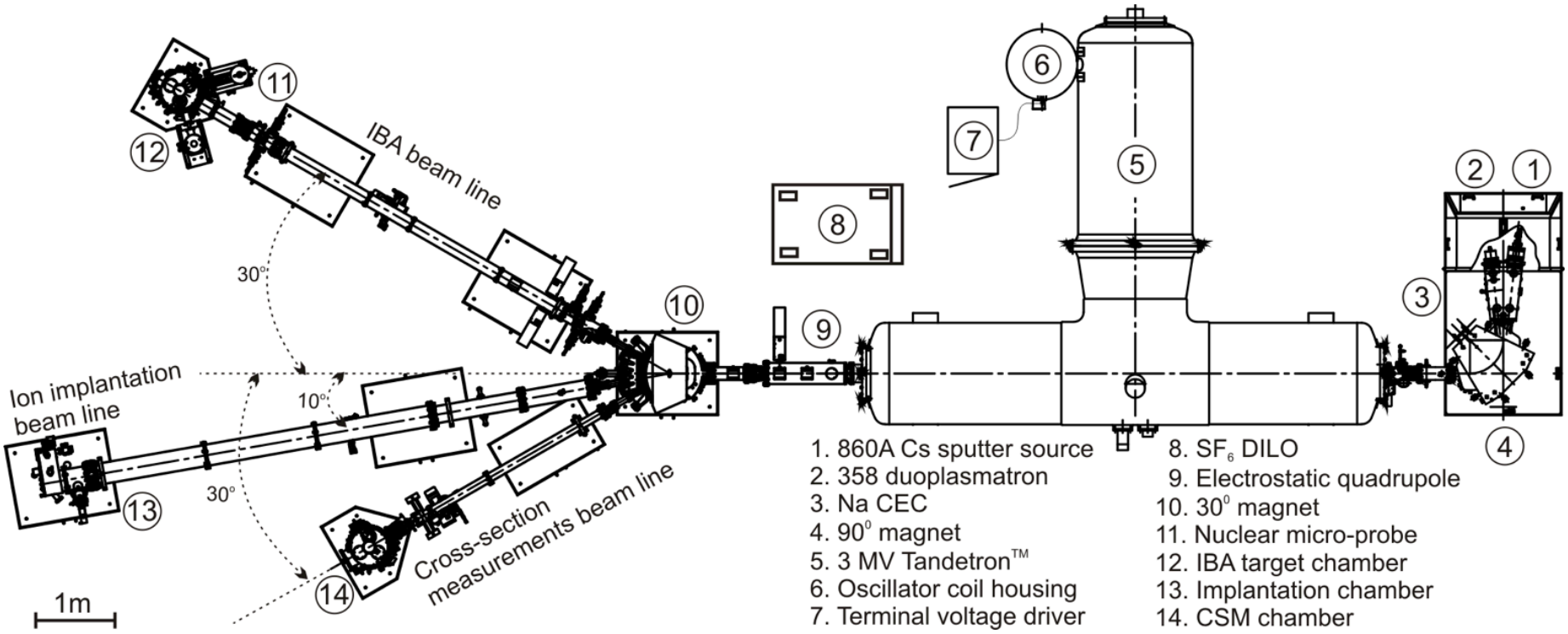
- Gamma-ray detection:
  - Prompt
  - From activation
- Ultra-low background lab in salt mine
- Large (120 cm diameter) new target chamber (+ several Si DSSSD detectors)

2) 9 MV pelletron + ROSPHERE + neutron dets

860A Sputter Source

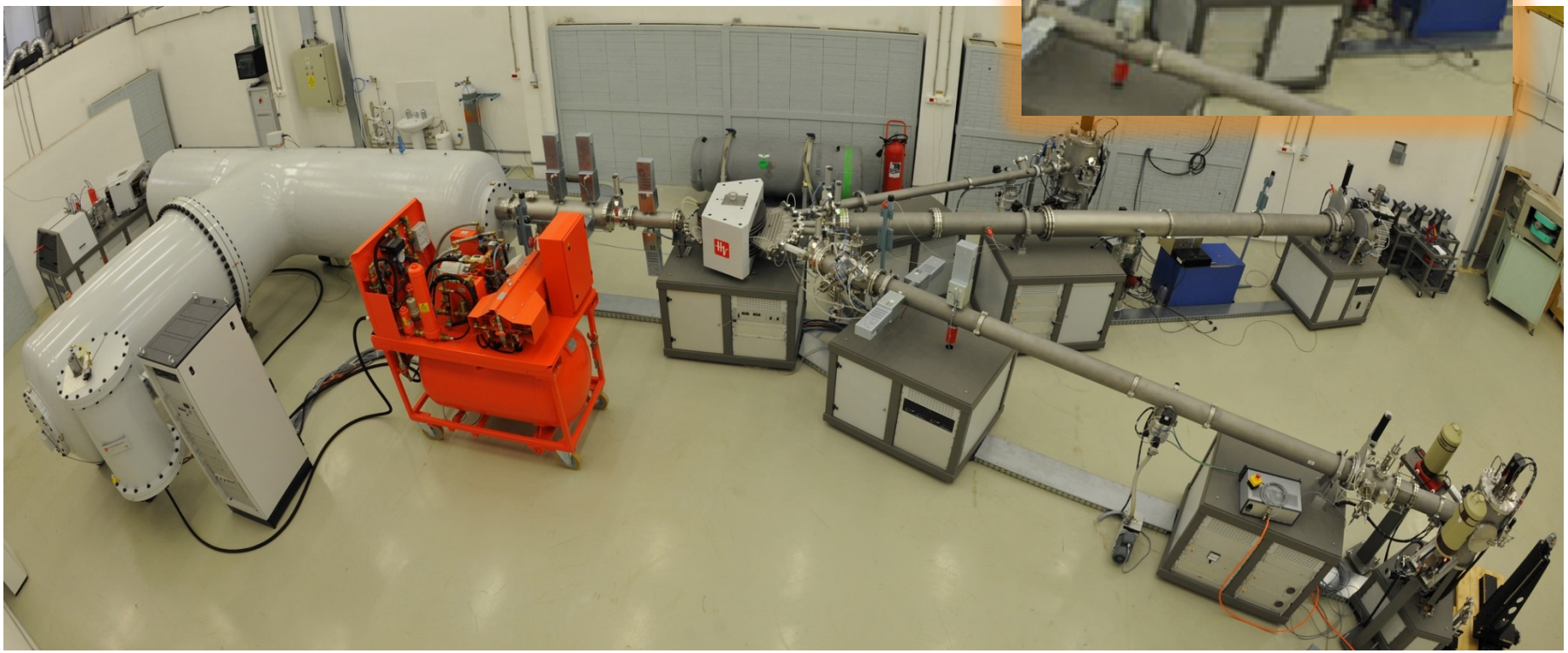
$^{11}B^{3+}$	>50 eμA
$^{12}C^{3+}$	>80 eμA
$^{16}O^{3+}$	>80 eμA
$^{28}Si^{3+}$	>70 eμA
$^{31}P^{3+}$	>70 eμA
$^{58}Ni^{3+}$	>20 eμA
$^{63}Cu^{2+}$	>20 eμA
$^{75}As^{2+}$	>10 eμA
$^{197}Au^{2+}$	>80 eμA

3 MV Tandetron™



I. Burducea et al., NIM B, vol. 359, 15: 12–19, 2015

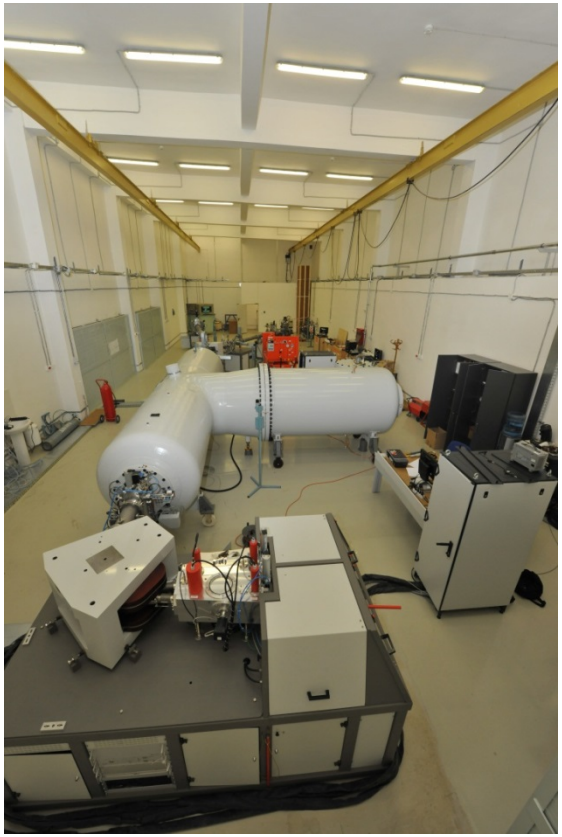
3 MV Tandetron™

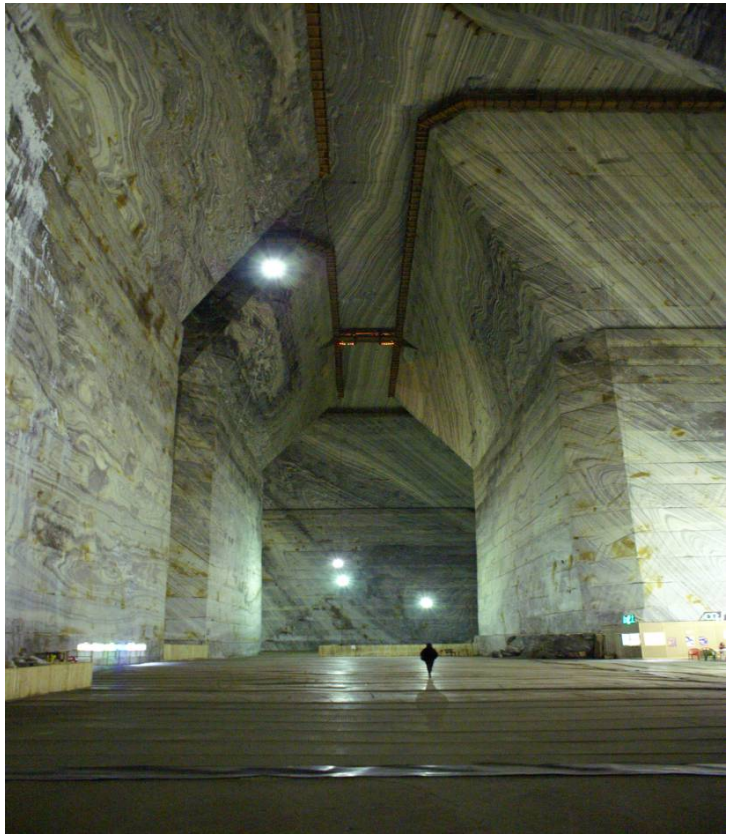


Activation and measurements in environments with ultralow background: (some) salt mines

Activation in nuclear laboratory (this is the 3 MV tandetron)

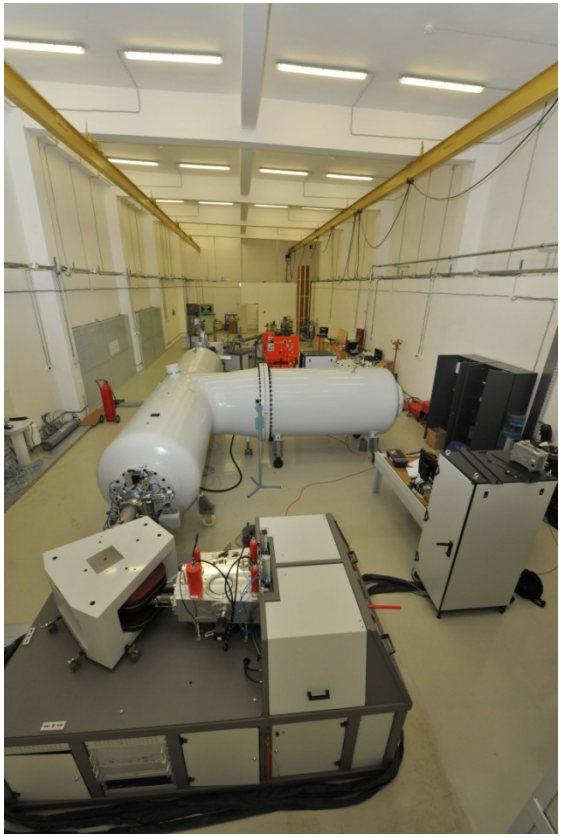
Measurement in salt mine Slanic Prahova (2.5 hrs from Bucharest - very low gamma-ray bkg)



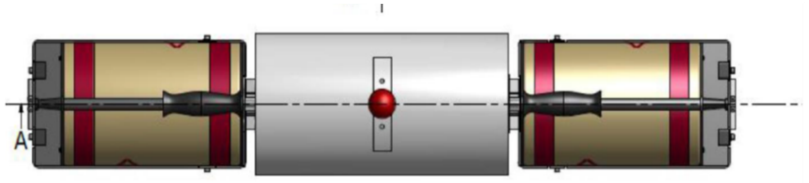


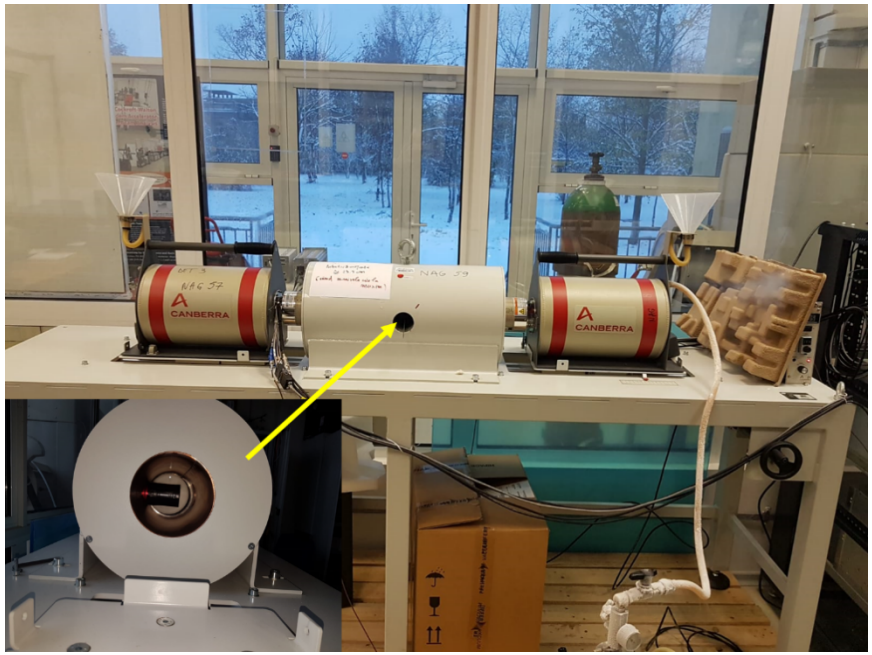
Activation and measurements in environments with reduced background

Irradiation in nuclear laboratory - the 3 MV tandetron



Deactivation measurements in BEGA coincidence system



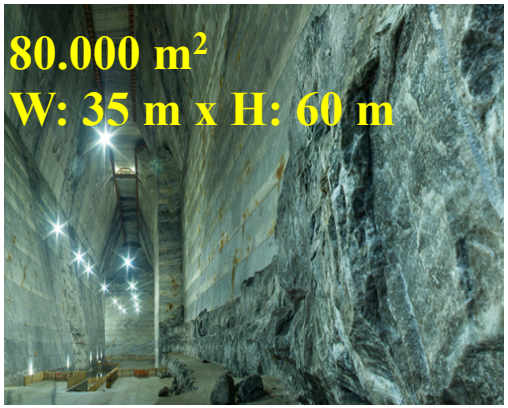


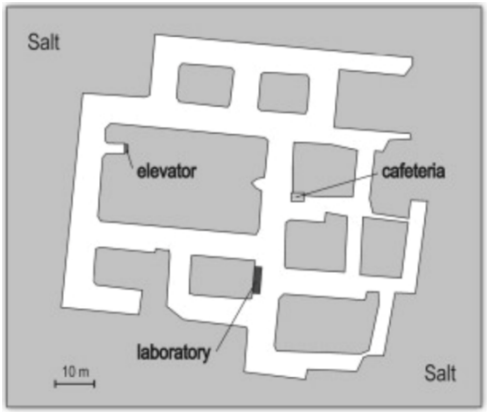
“microBq” Lab

Offline γ-ray technique

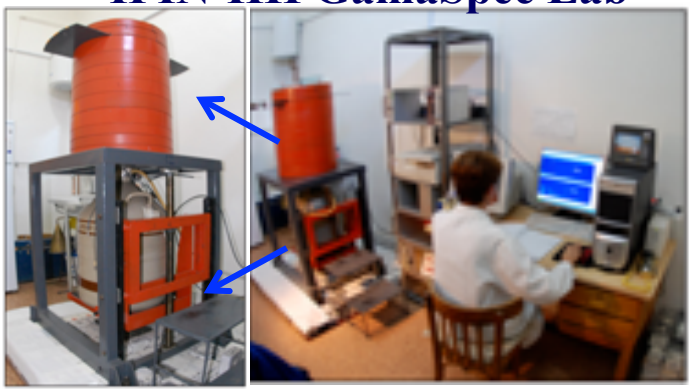
Underground

R. Margineanu et al., Applied Radiation and Isotopes 66,1501– 1506, 2008





IFIN-HH GamaSpec Lab

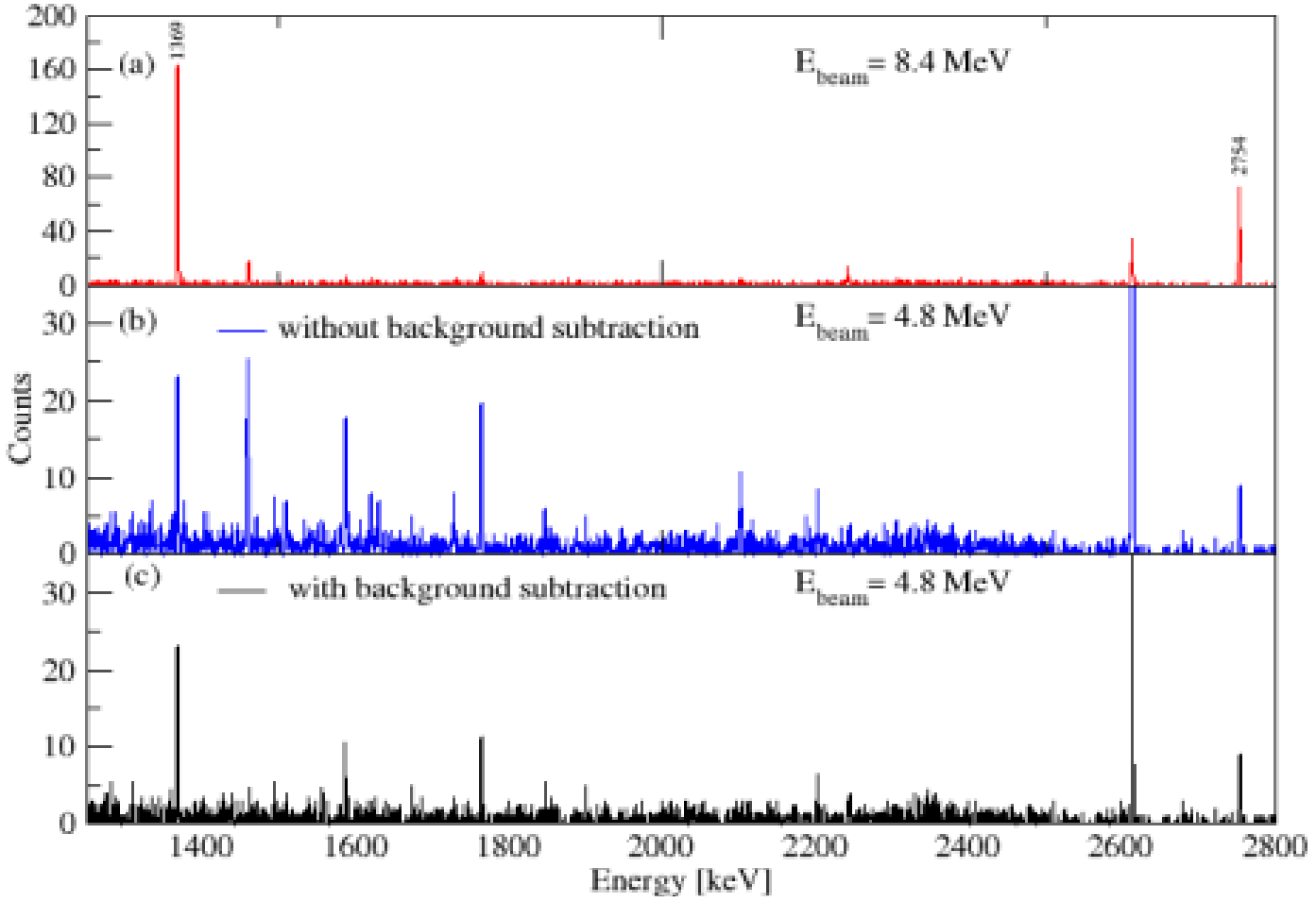


Gamma background

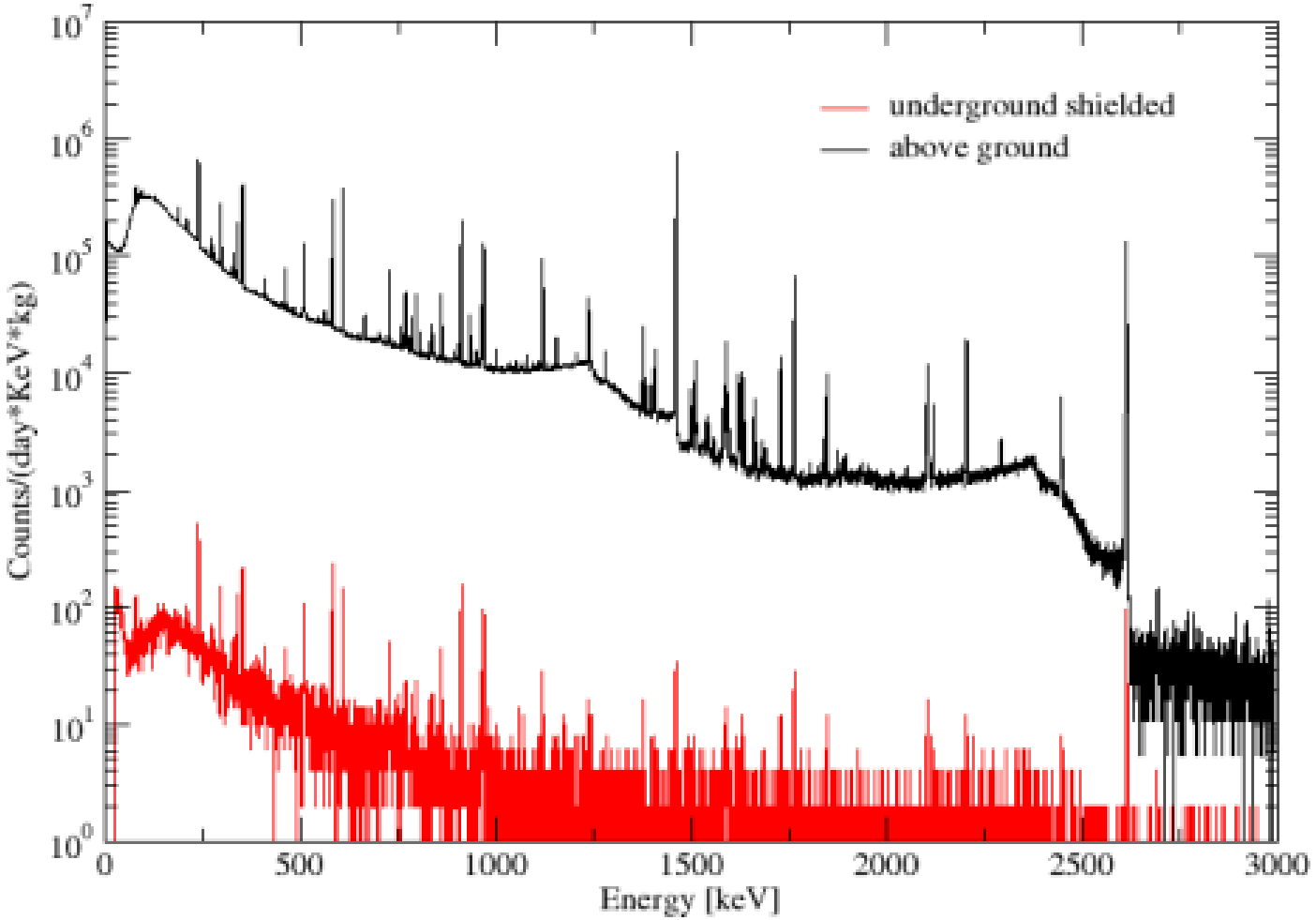
- LUNA facility (accelerator and detectors), under 1.4 km of rock in Gran Sasso, reports a rate of 4870 cts/hr the 1461 keV peak (40K) and 1325 cts/hr at the 2614 keV peak
- In a similar detector in Slanic we measure a rate of 1.81 cts/hr and 4.8 cts/hr in the same peaks. With special shielding, including anti-radon box with dry nitrogen gas flow around the detector, the rates at LUNA become 0.93 cts/hr and 0.42 cts/hr
- at the location of LUNA2: 2190(10) cts/hr and 680(15) cts/hr unshielded, 14.8(3) cts/hr and 15.2(3) shielded
- CASPAR, the background for 40-2700 keV is essentially the same underground as is at the surface (due to the proximity of rock walls).

Actual data

(4000 times bkg reduction)



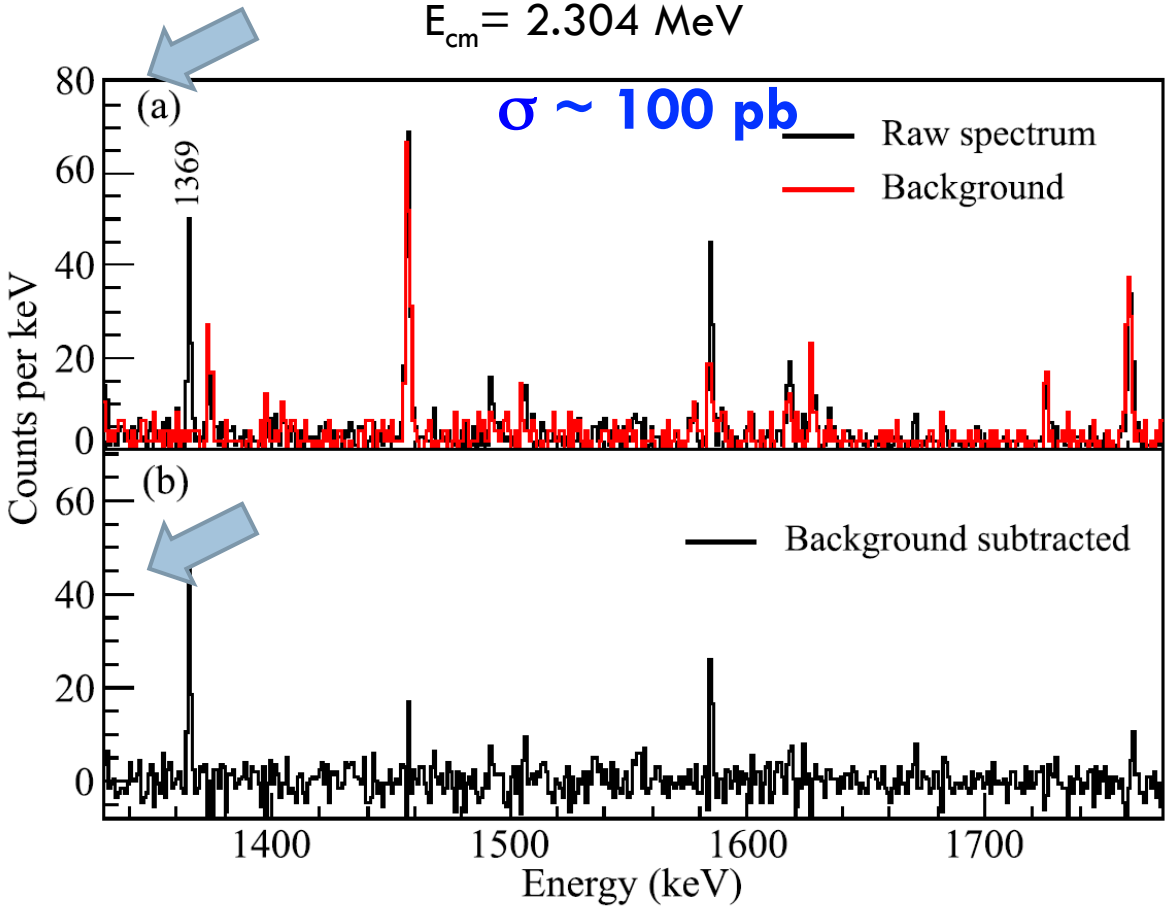
A facility for direct measurements for nuclear astrophysics at IFIN-HH - a 3 MV tandem accelerator and an ultra-low background laboratory, D.Tudor et al., NIM A 953, 2020



***A facility for direct measurements for nuclear astrophysics at IFIN-HH - a 3 MV tandem accelerator and an ultra-low background laboratory*, D.Tudor et al., NIM A 953, 2020**

Ultra-low level background measurements

activation: 3.4 days measurements: 3.9 days



Constraining the 12C+12C astrophysical S-factors with the 12C+13C measurements at very low energies, N.T.Zhang et al., Physics Letters B Volume 801, 10 February 2020, 135170, 2020

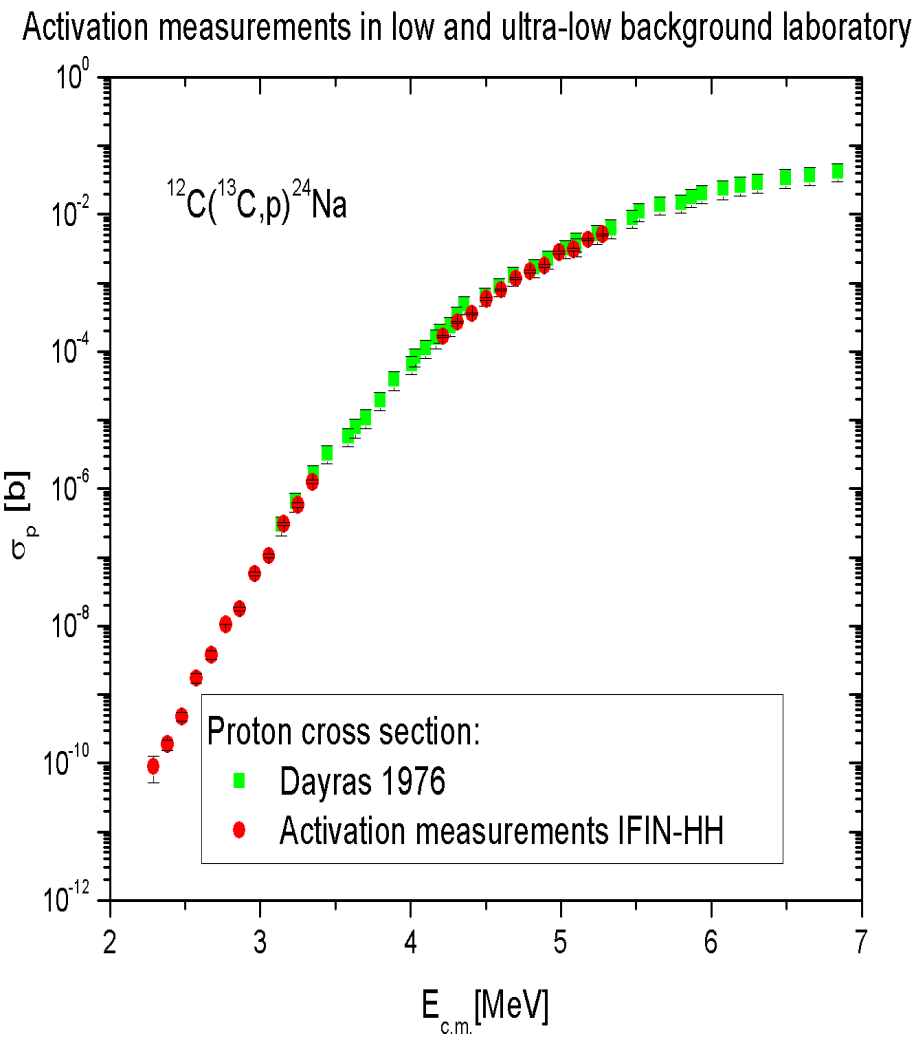
Experimental cross section

Thick target method

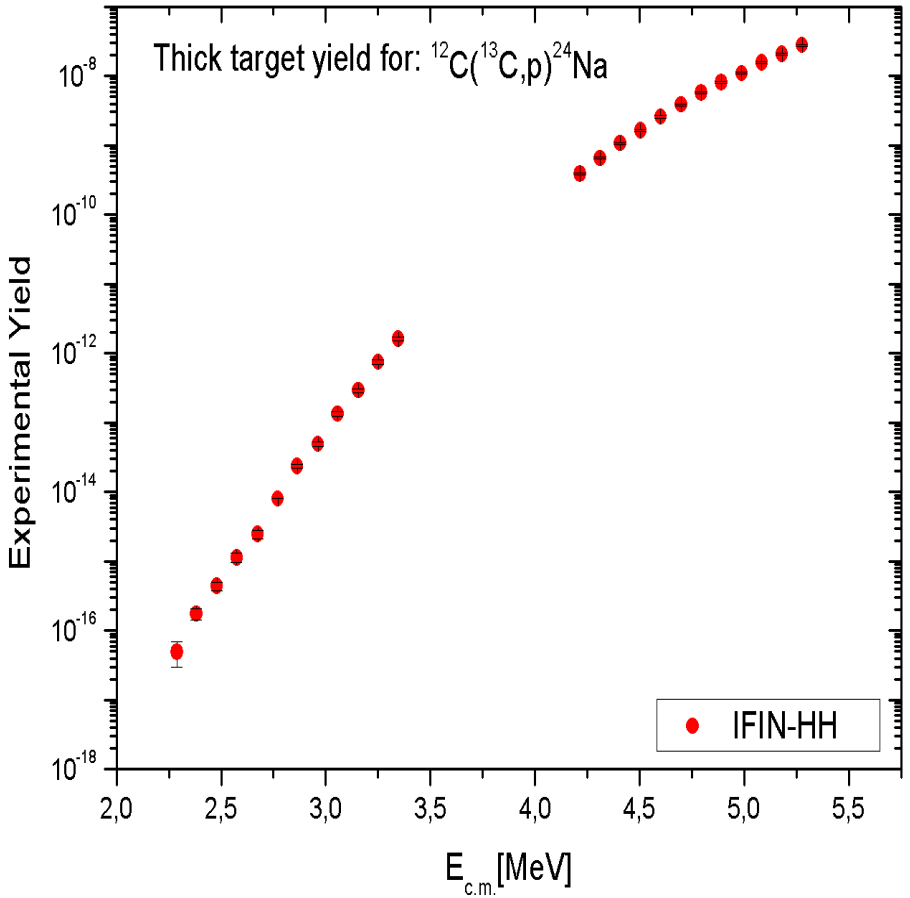
Cross sections were calculated start

yield: $Yield=\Lambda\downarrow end\ irr\ /\lambda\ /[I*\Delta t]/q*e$

$Y(E)=\int 0\uparrow E \blacksquare \sigma(E)dx/dE\ N\downarrow A\ /A\downarrow t\ d$



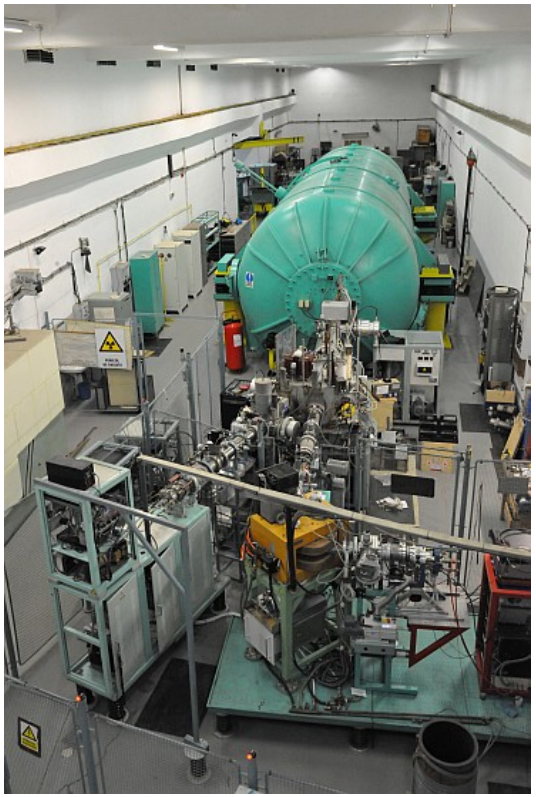
Experimental cross section

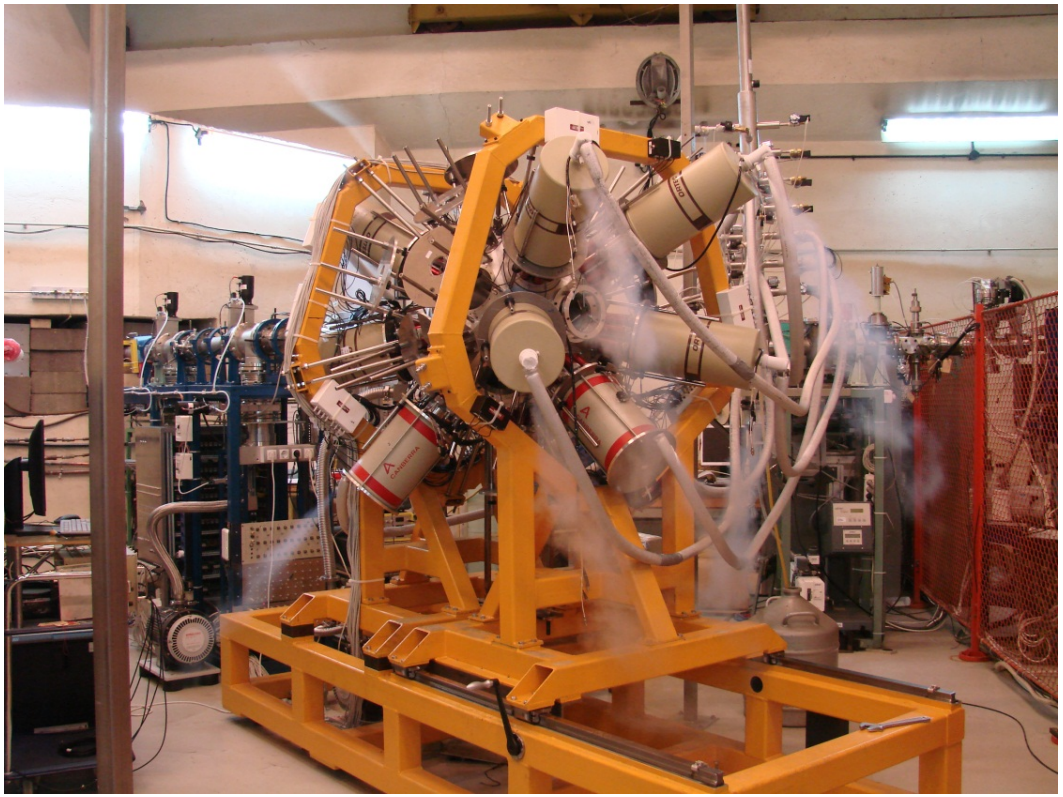


Other facilities & possibilities

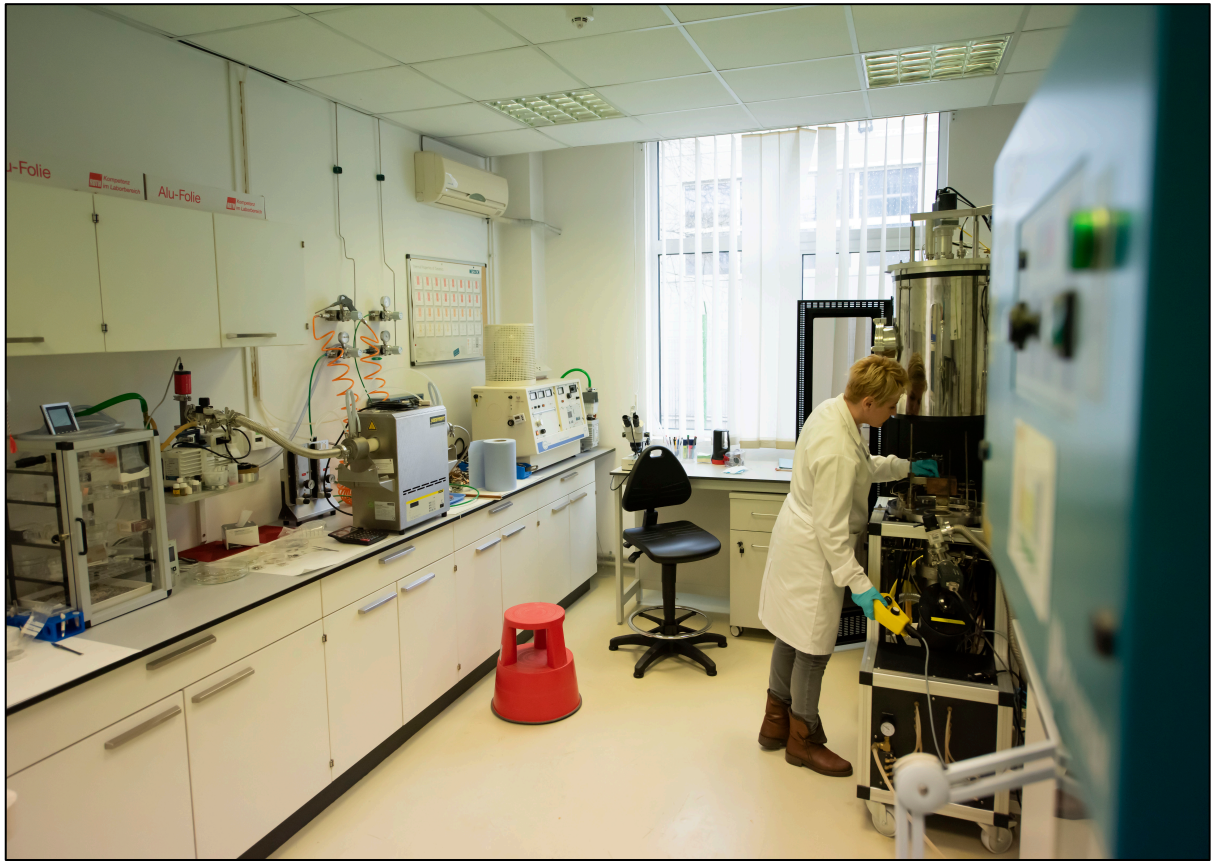
9 MV tandem pelletron (e.g. for spectroscopy of resonances) and RoAMS – 1 MV accelerator mass spectrometry

ROSPHERE detector array





IFIN-HH TARGET PREPARATION LABORATORY



FULLY EQUIPPED TARGET LABORATORY:

Thin-film fabrication technologies:

- *Physical Vapor Deposition Methods (PVD)*
- *Mechanical rolling*

SCIENTIFIC & TECHNICAL TEAM:

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Dr. Andreea MITU (married RADU)
(andreea.mitu@nipne.ro)

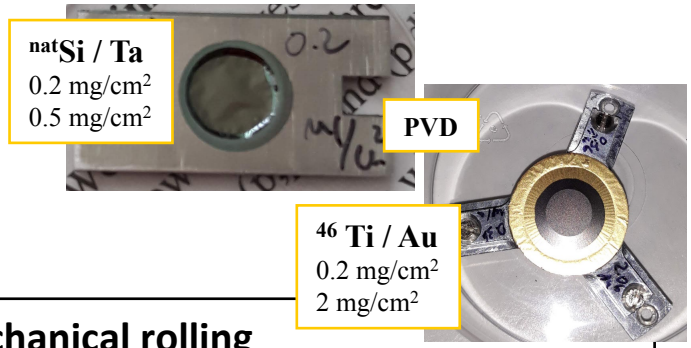
RESEARCH :

- different thin films "targets" for nuclear structure experiments for ***IFIN-HH 9 MV Tandem Accelerator and international research facilities: CERN, IN2P3, TUM, IKP, JINR, etc***.

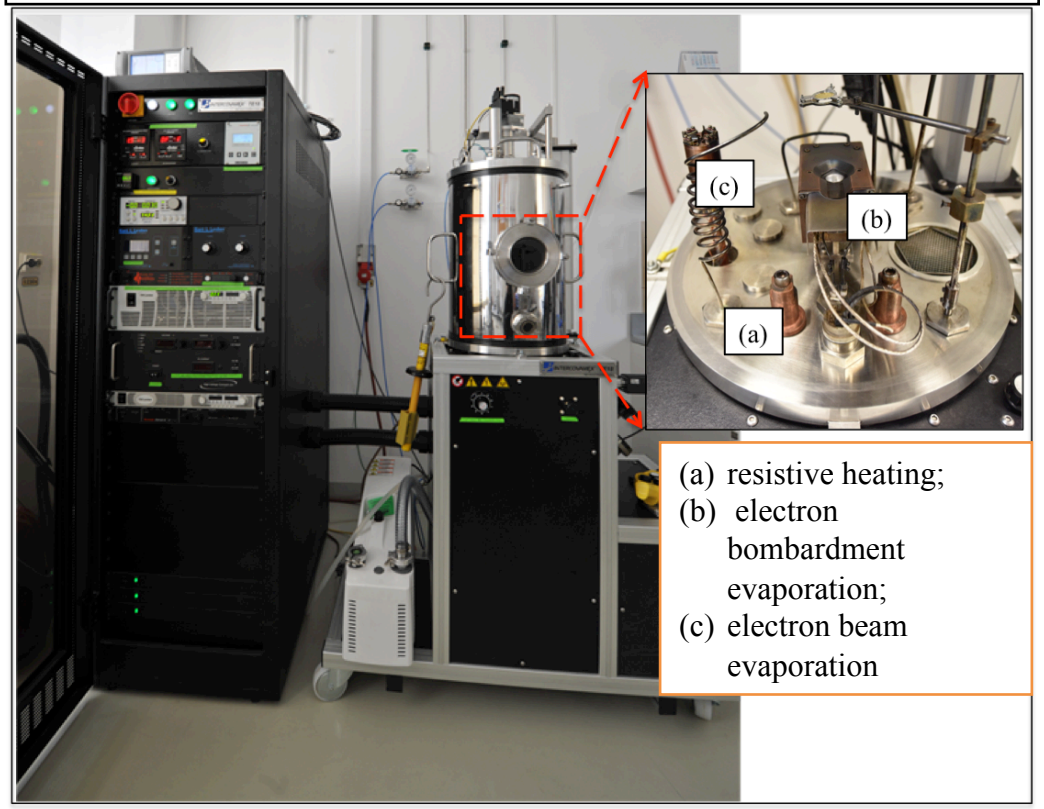
- target characterization

ISOTOPIC THIN FILMS “TARGETS”:

- **self - supported** or **deposited** on various backings;
- **surfaces** not larger than 2 cm^2;
- the **thicknesses** in units of mg/cm^2 or $\mu g/cm^2$;
- **isotopically enriched material** to ensure that the target will contain the nuclei from the desired species.



Physical Vapor Deposition Methods (PVD)



(a) resistive heating;
(b) electron bombardment evaporation;
(c) electron beam evaporation

Mechanical rolling