



Centro Nacional de Aceleradores (CNA)

B. Fernández, C. Guerrero, J.Gómez-Camacho,
F.J.Ferrer, J.P.Fernández, G. Auñón, A. Vegas, J.
Bartolomé, et.al.

The Centro Nacional de Aceleradores in Seville

Interdisciplinary Research Centre



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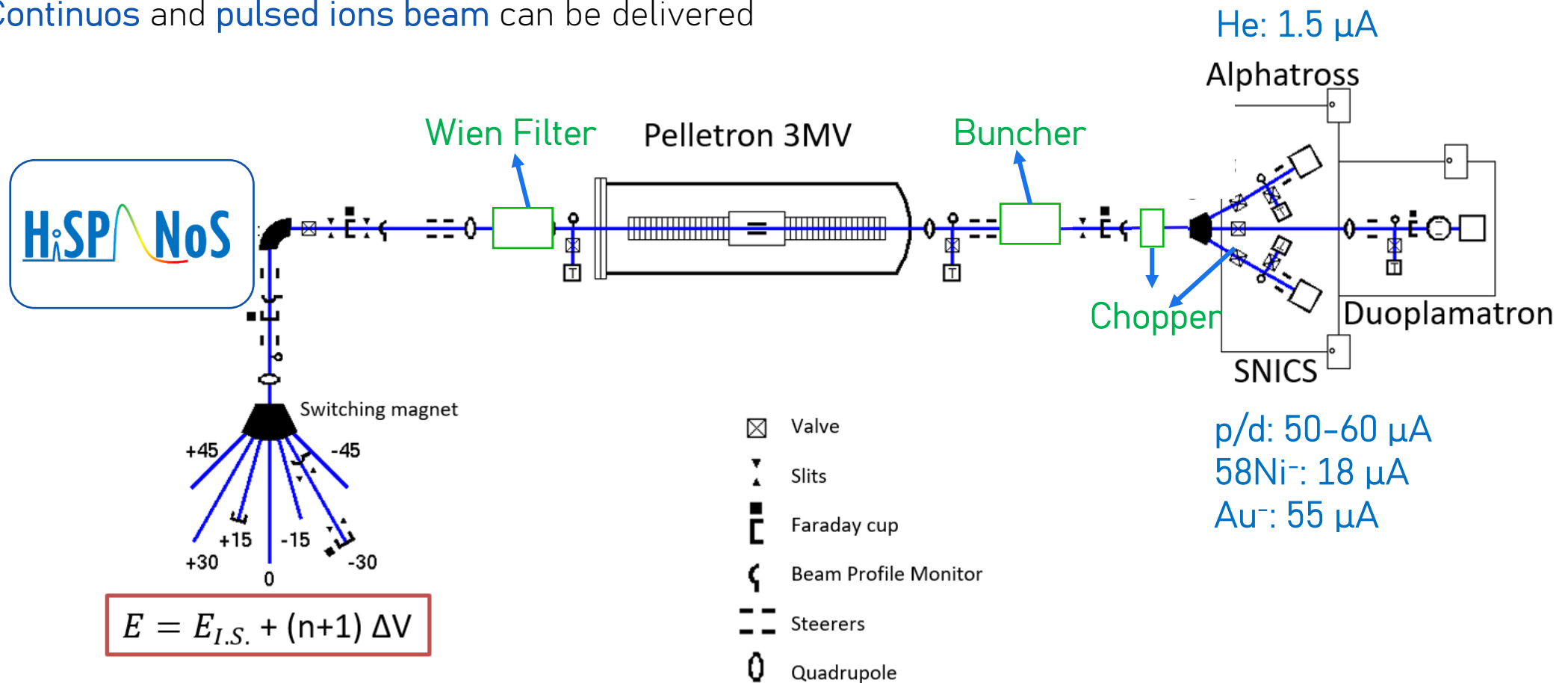


- **1 MV Tandetron** for accelerator mass spectroscopy (experts in actinides)
- **MiCaDaS**: Micro Carbon Dating System
- **18/9 Cyclotron**: Max. Proton energy. Medical radioisotopes production + external beam line for research (18 MeV for protons and 9 MeV for deuterium)
- **RADLAB**: 357 TBq (2014) Co-60 for irradiation purposes (mainly aerospace)
- **3 MV Tandem accelerator**

Ions, photons and neutron irradiation capabilities at the same centre

The 3 MV Tandem Accelerator

- 3 different ion source: from light (p, d, α) to heavy ions (Ni, Au,...) can be extracted and accelerated
- Maximum energy reached at the experimental lines depends on the ion, terminal voltage and analyzing magnet
- **Continuous** and **pulsed ions beam** can be delivered

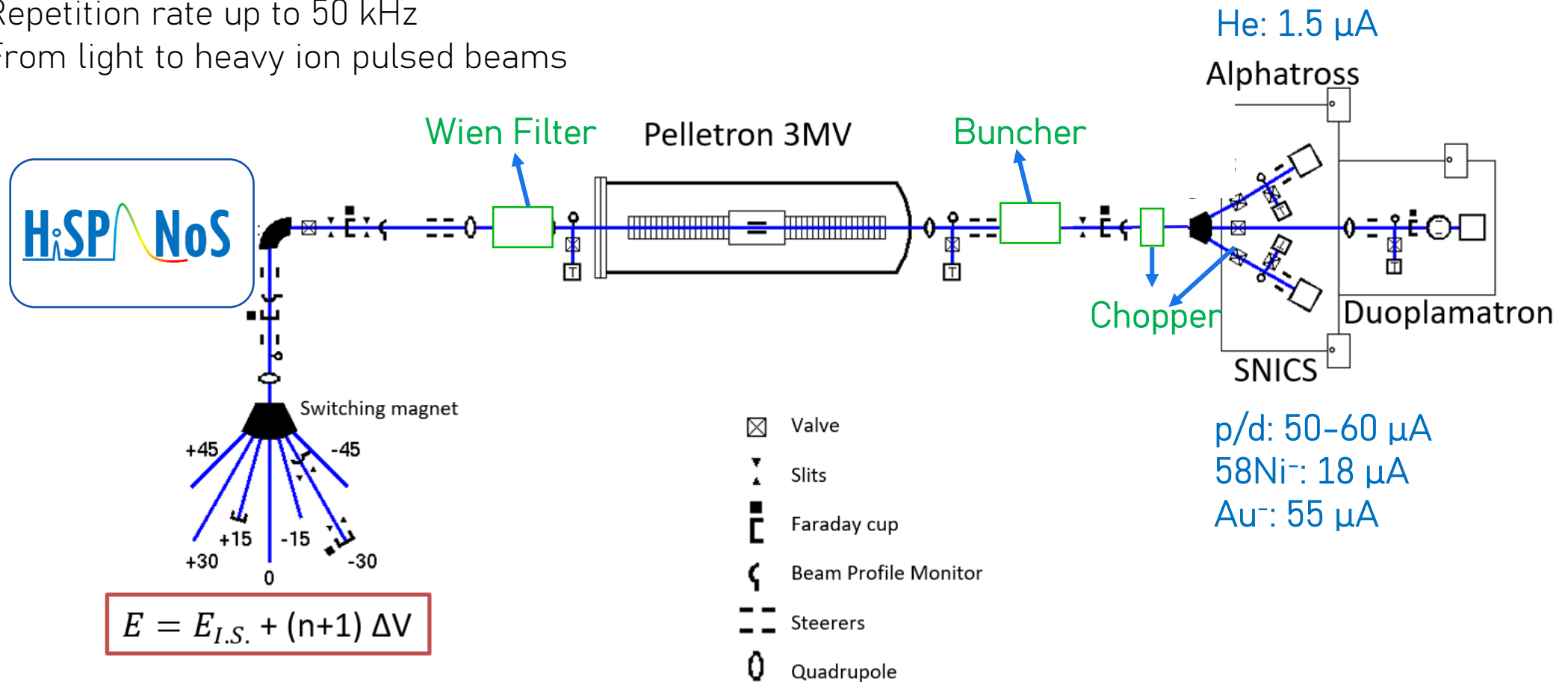


$$E = E_{I.S.} + (n+1) \Delta V$$

Pulsed ion beams at CNA

Belke switch connected to the steerer of the ion source:

- Pulse generated through a Generation function
- Minimum Pulse width: 100 ns
- Repetition rate up to 50 kHz
- From light to heavy ion pulsed beams



Nanosecond p, d and α beams at CNA

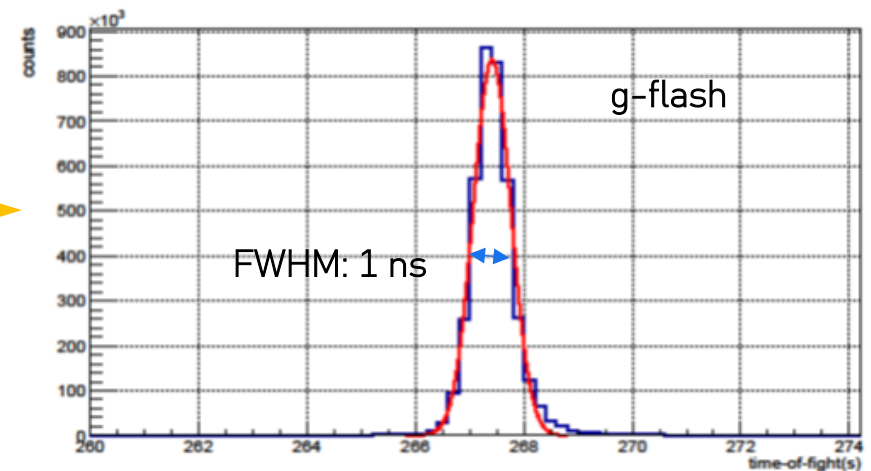
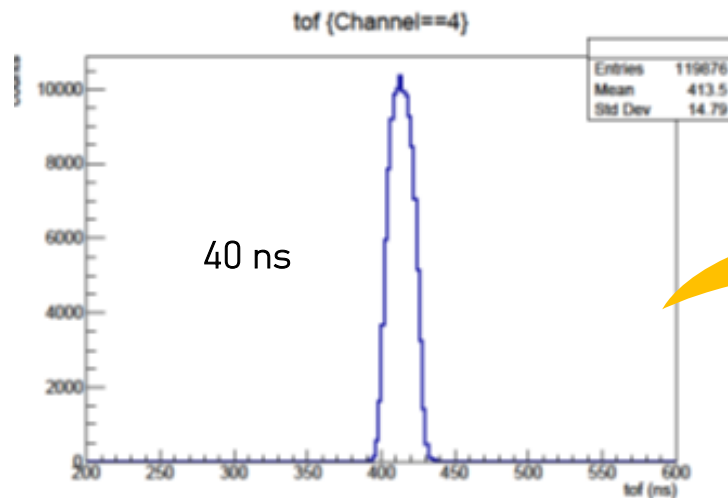
Pulsing system composed by a **chopper** & a **NEW buncher** (Dec. 2025) able to compress not only **p** and **d** but also **α**

Chopper:

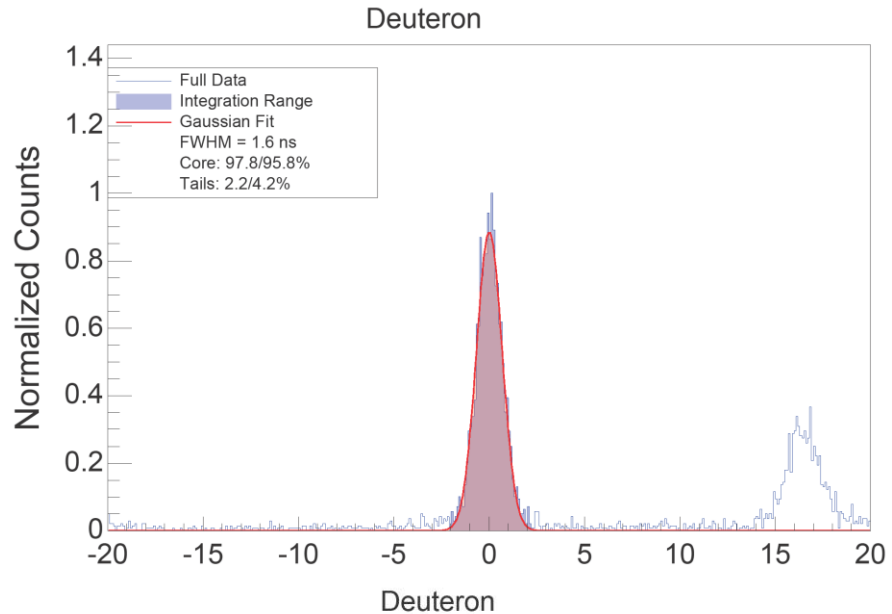
- Variable width: 40 ns-250 ns
- RR: 31.25 kHz-2 MHz

Buncher:

- RF 8 MHz
- To achieve 1-2 ns (p, d, α) pulse width

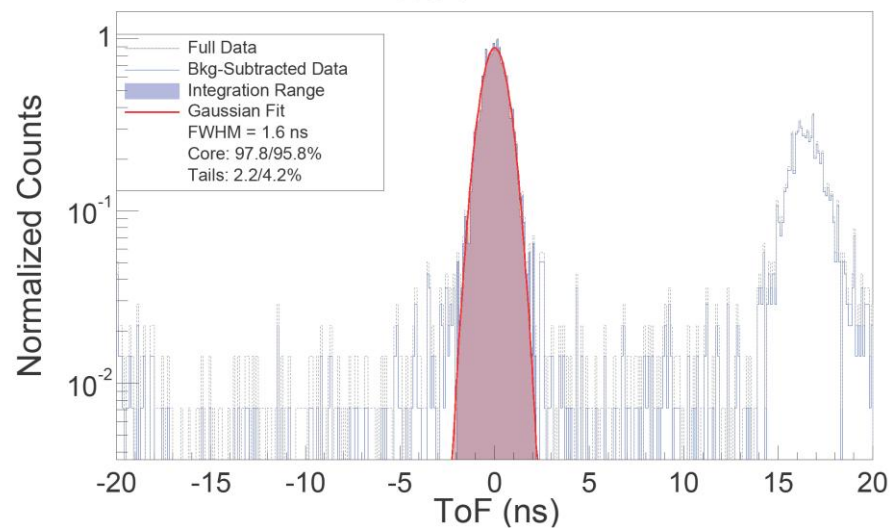


New Buncher Commissioning at CNA

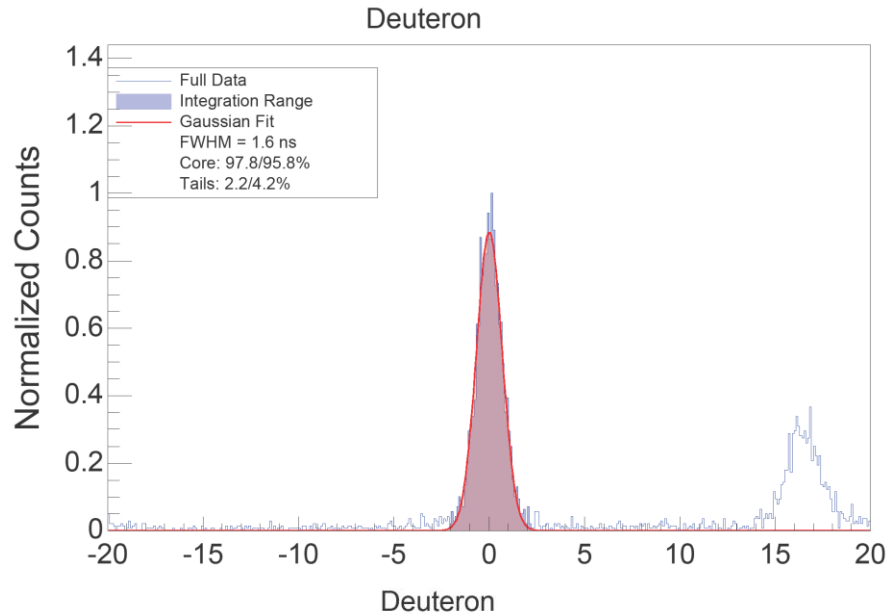


Deuterium pulsed beams

- Injection Energy from the ion source
71 keV (optimal value) instead 59 keV
- **Pulse width: 1.6 ns**
- Minimal **tail** contribution: only **2%**
- Current at target position: 10 nA

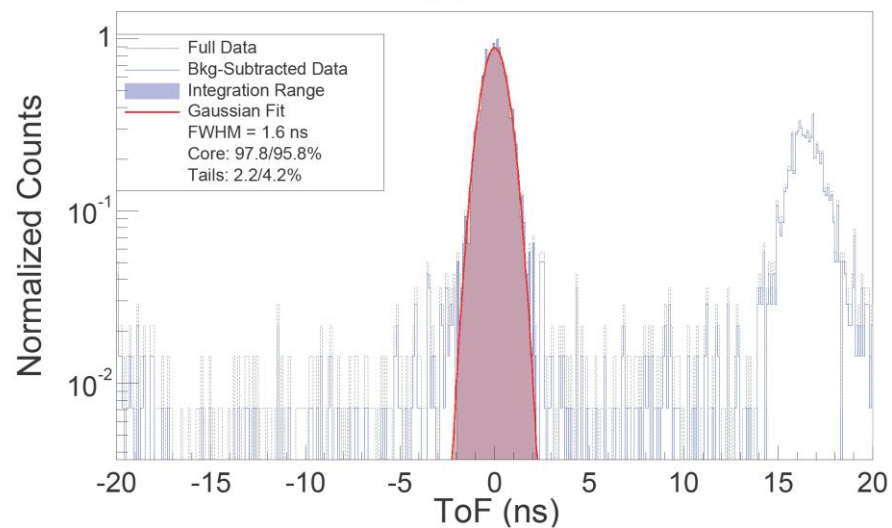


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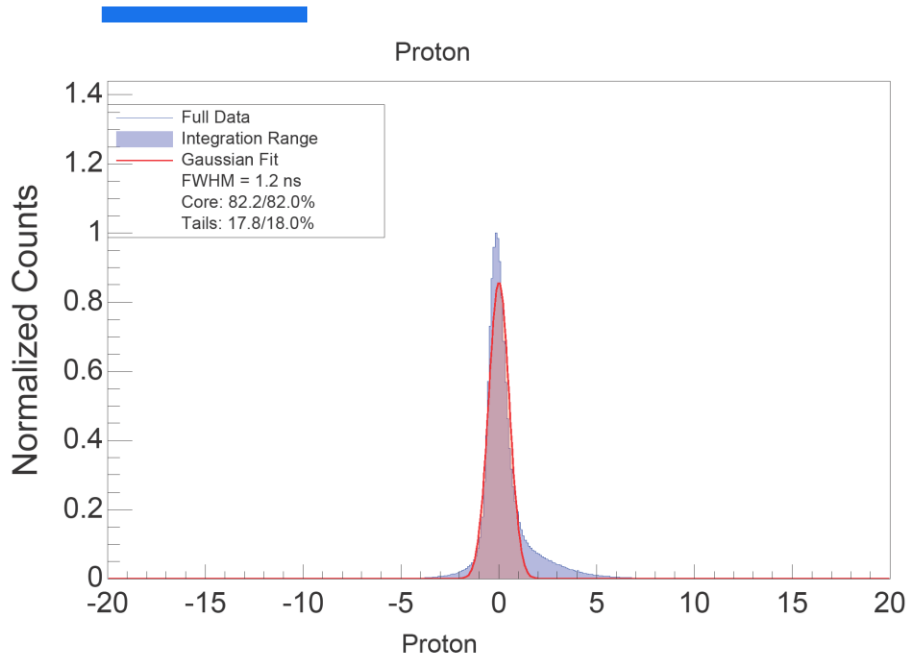
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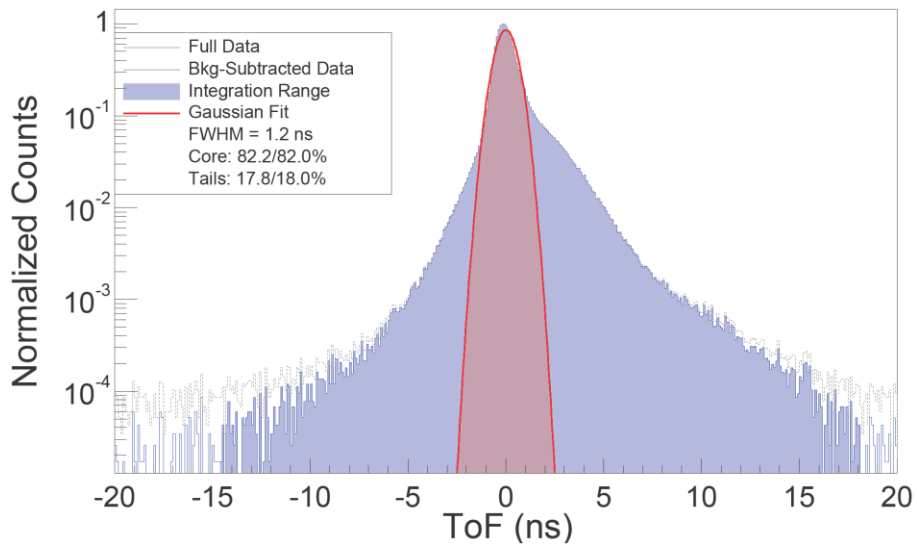
PULSING SYSTEM WORKING PROPERLY!!!

New Buncher Commissioning at CNA

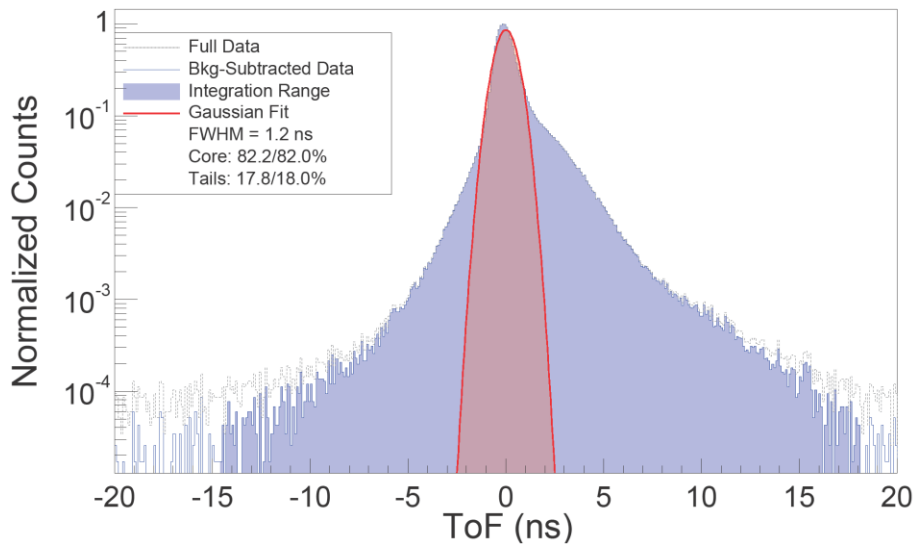
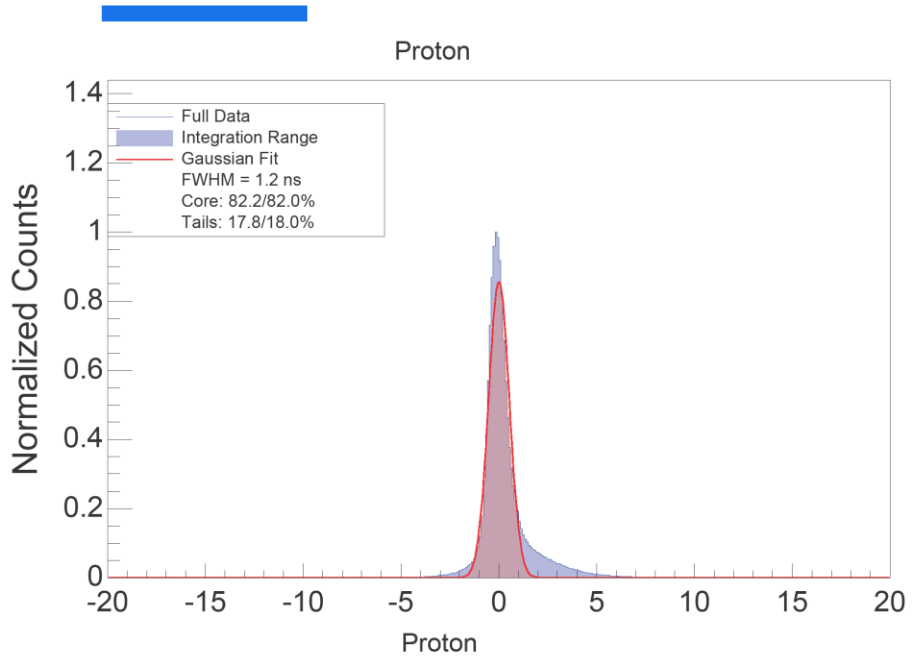


Proton pulsed beams

- Injection Energy from the ion source
71 keV (optimal value) instead 59 keV
- **Pulse width: 1.24 ns**
- **Tails contribution: 13%**
- Current at target position: 35 nA



New Buncher Commissioning at CNA

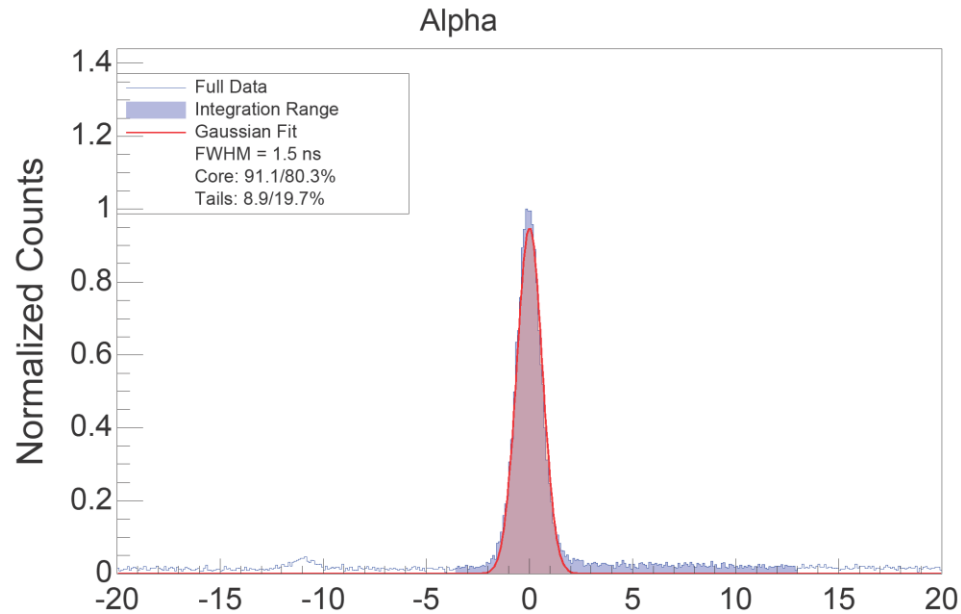


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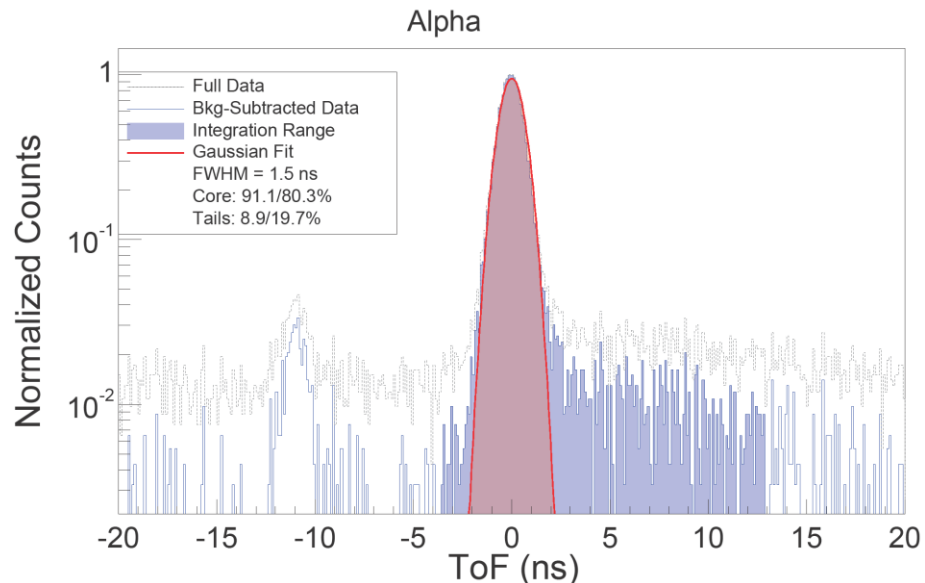
STILL WORKING ON TO IMPROVE THE RESULTS!!!

New Buncher Commissioning at CNA

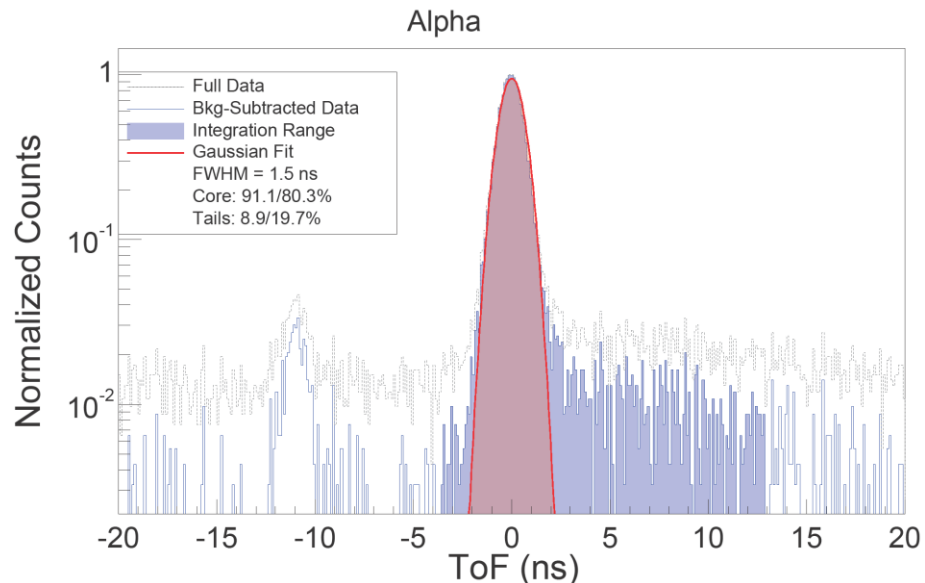
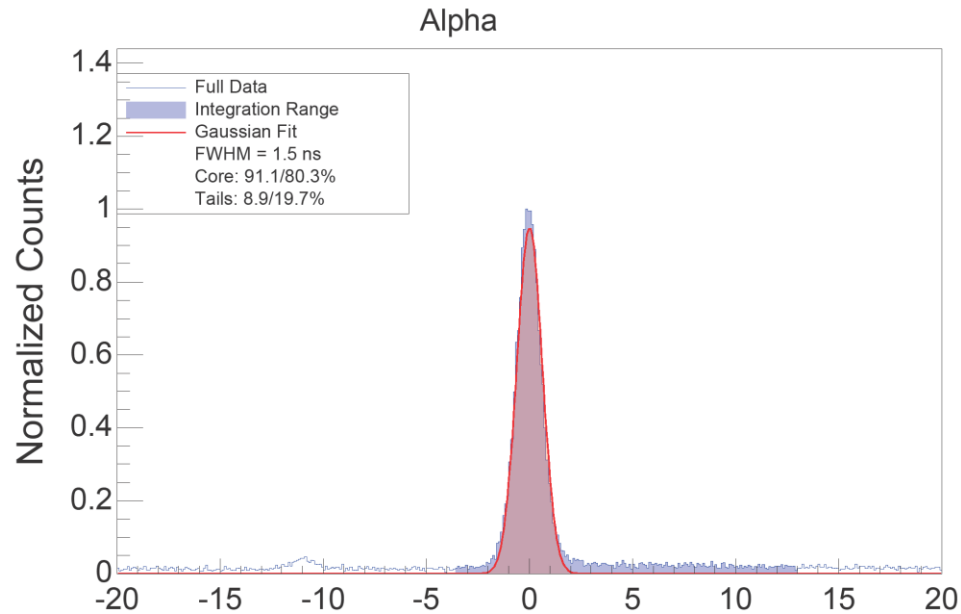


Alpha pulsed beams

- Injection Energy from the ion source
70 keV (optimal value) instead 59 keV
- **Pulse width: 1.3 ns**
- **Tails contribution: 4%**
- Current at target position: 1-2 nA

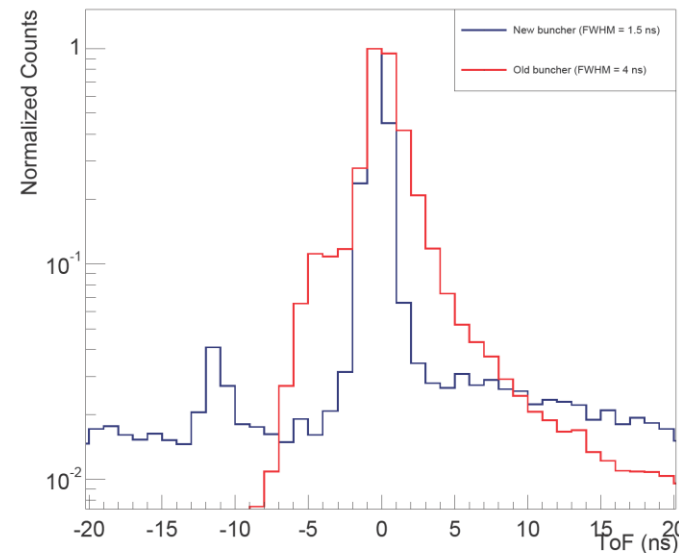


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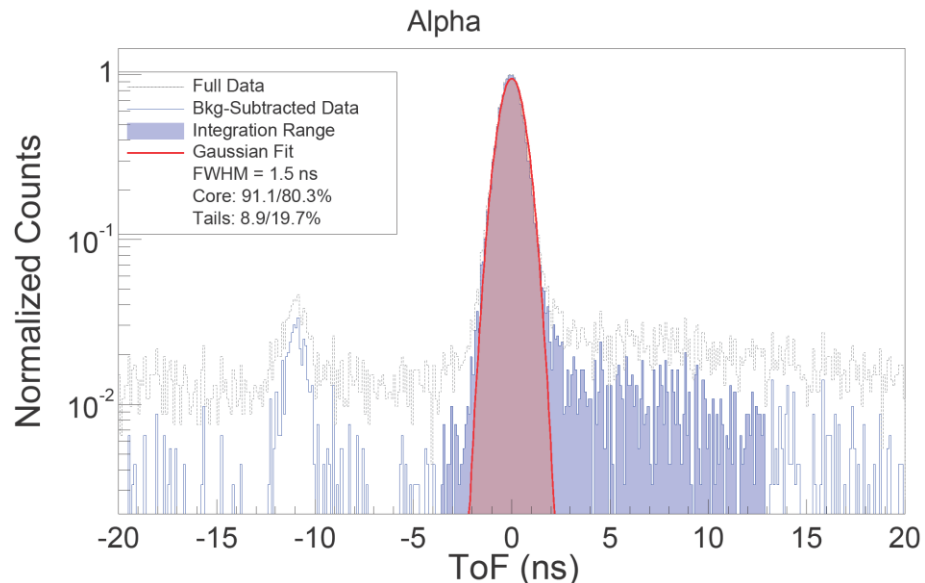
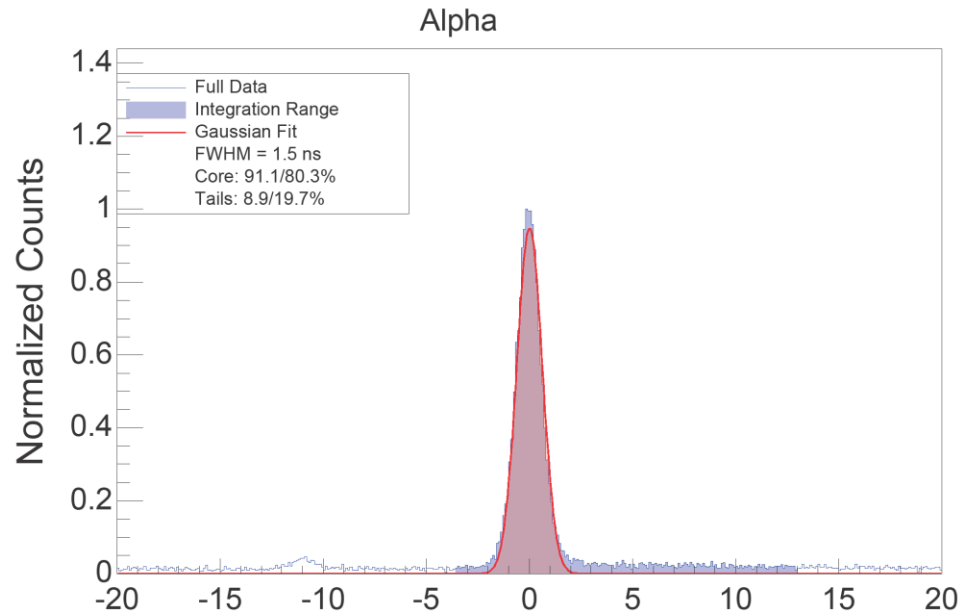


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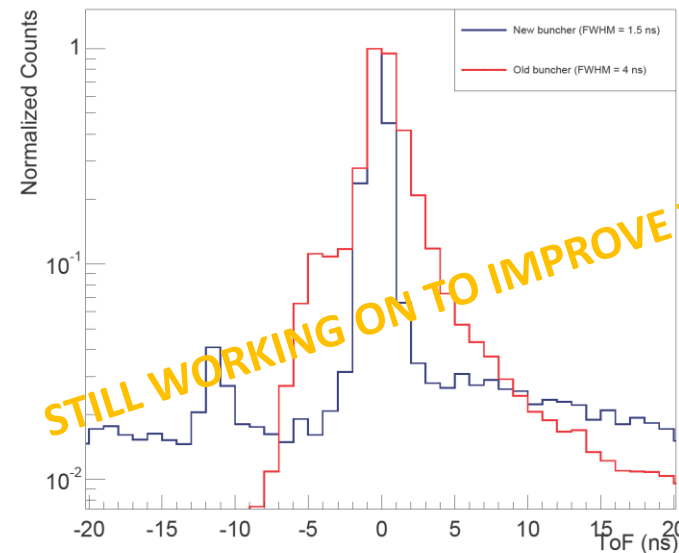


New Buncher Commissioning at CNA



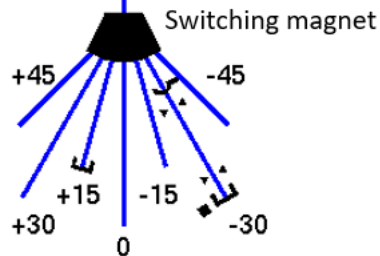
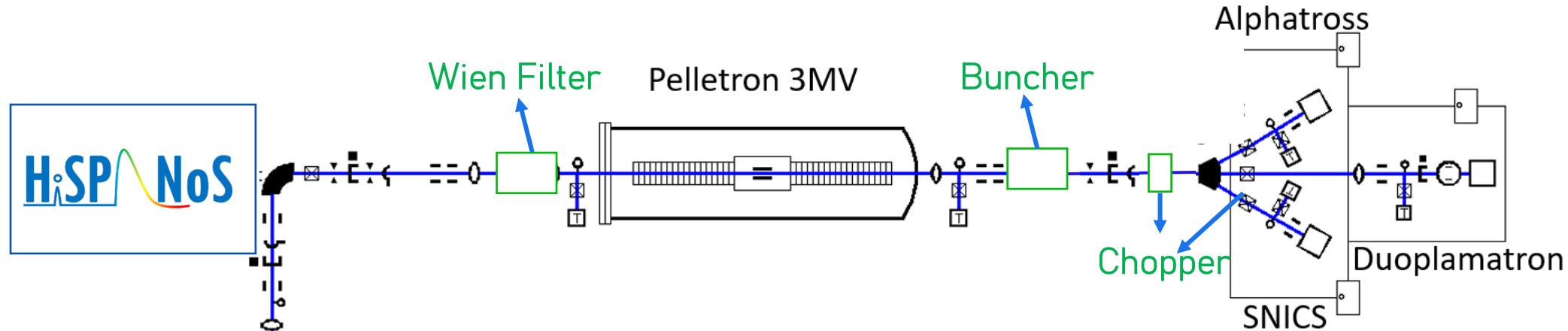
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STILL WORKING ON TO IMPROVE THE RESULTS!!!

Experimental lines at 3 MV Tandem Accelerator

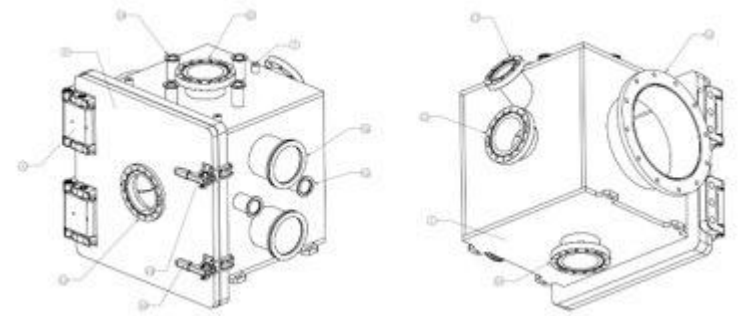
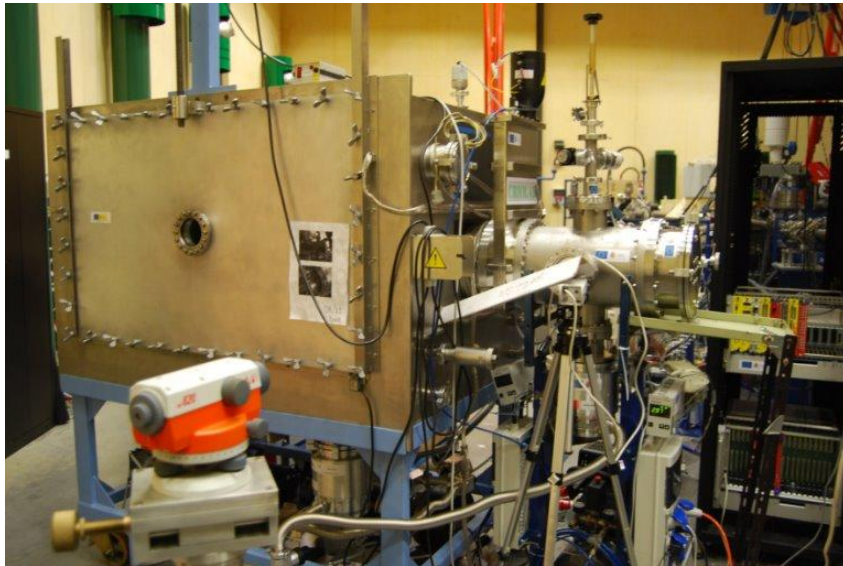


$$E = E_{I.S.} + (n+1) \Delta V$$

- **External beam** line (-45°): PIXE technique for Cultural Heritage
- **Charles-Evan** line (-30°): for Channeling technique (defects in crystalline materials for ex.)
- **Irradiation** line (-15°): for ion implantation on samples or electronic devices irradiation purposes
- **0° line**: multipurpose chamber for IBA techniques (RBS, NRA, PIGE) for material science applications
- **Microprobe** line (15°): IBIC and TRIBIC technique for detectors characterization
- **FNB** line (30°): for nuclear reactions studies
- **HiSPANoS**: neutron time of flight line

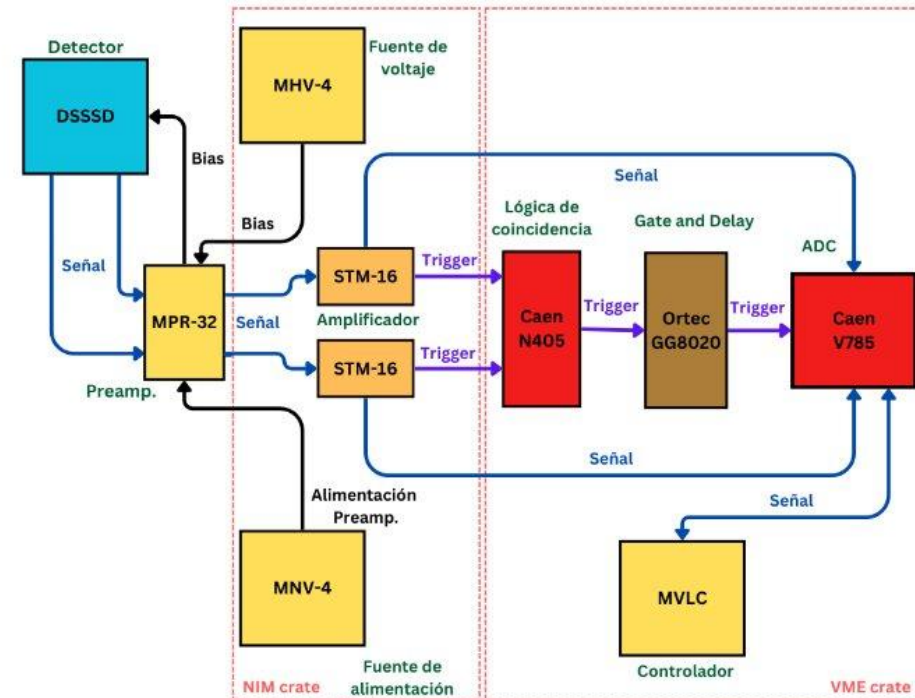
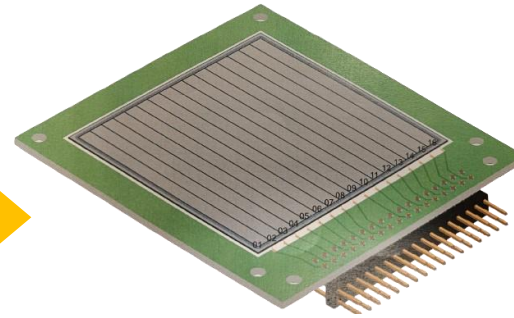
Experimental Basic Nuclear Physics (FNB) Line at CNA

Since 2 years ago working on some technical improvements to be able to stablish a permanent experimental set up for nuclear reactions with light samples and low energy beams (A.Vegas PhD).



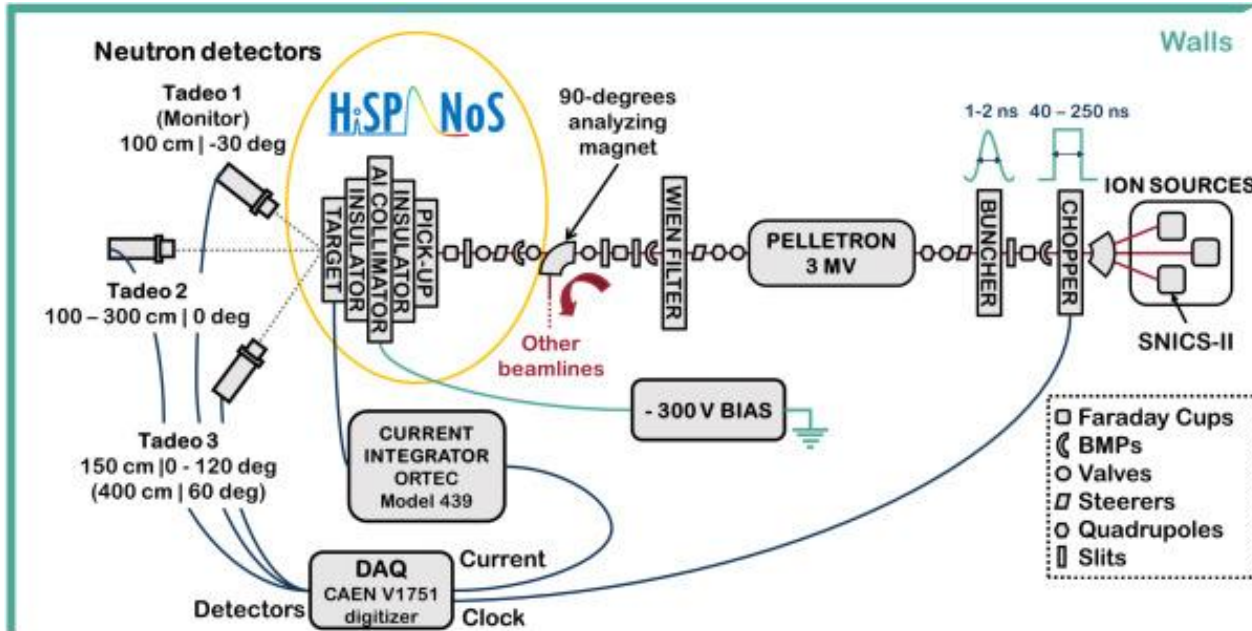
New Al cubic (40 cm^3)
nuclear reaction chamber
located at the end of the line

Experimental Basic Nuclear Physics (FNB) Line at CNA

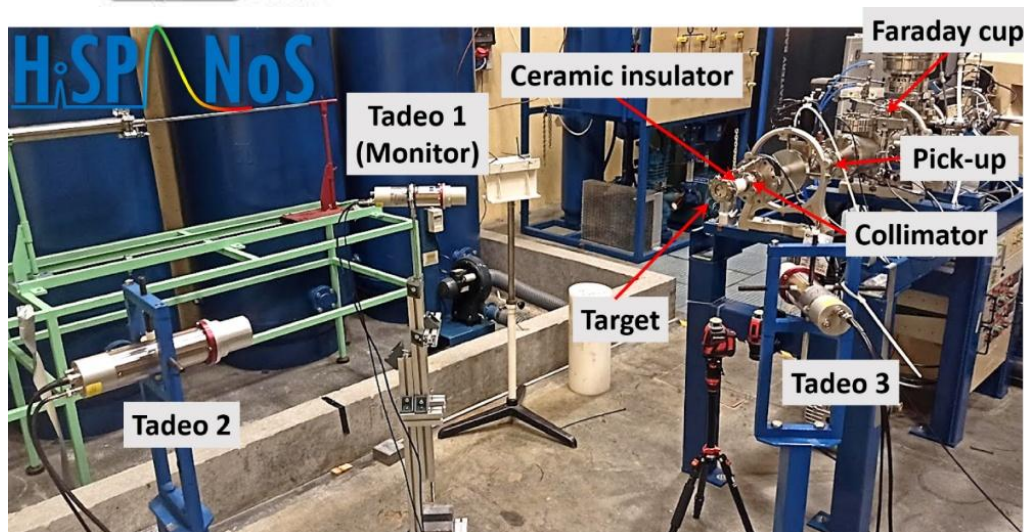


- Espesores S/DSSSD
- 40 μm (x2)
 - 20 μm (x2)
 - 500 μm (x1)
 - 300 μm (PAD x2)

HiSPANoS: the experimental neutron beam line at CNA



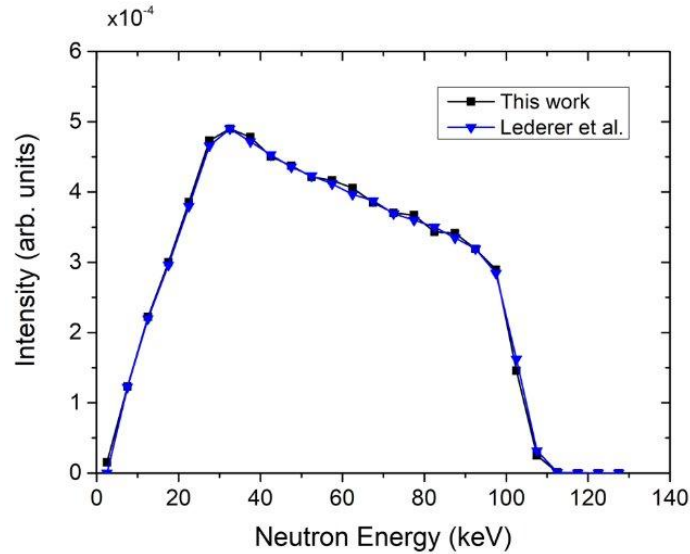
HiSPANoS is a Compact Accelerator Neutron Source



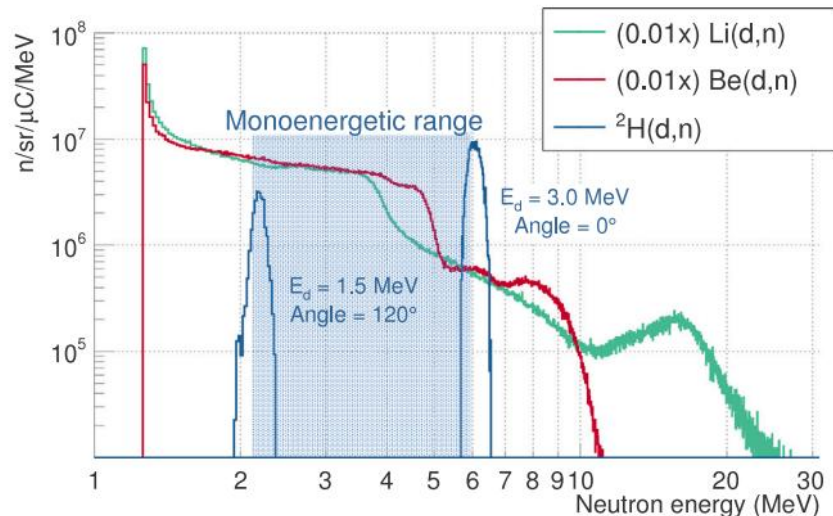
HiSPANoS: the experimental neutron beam line at CNA



Epithermal neutrons



Fast neutrons



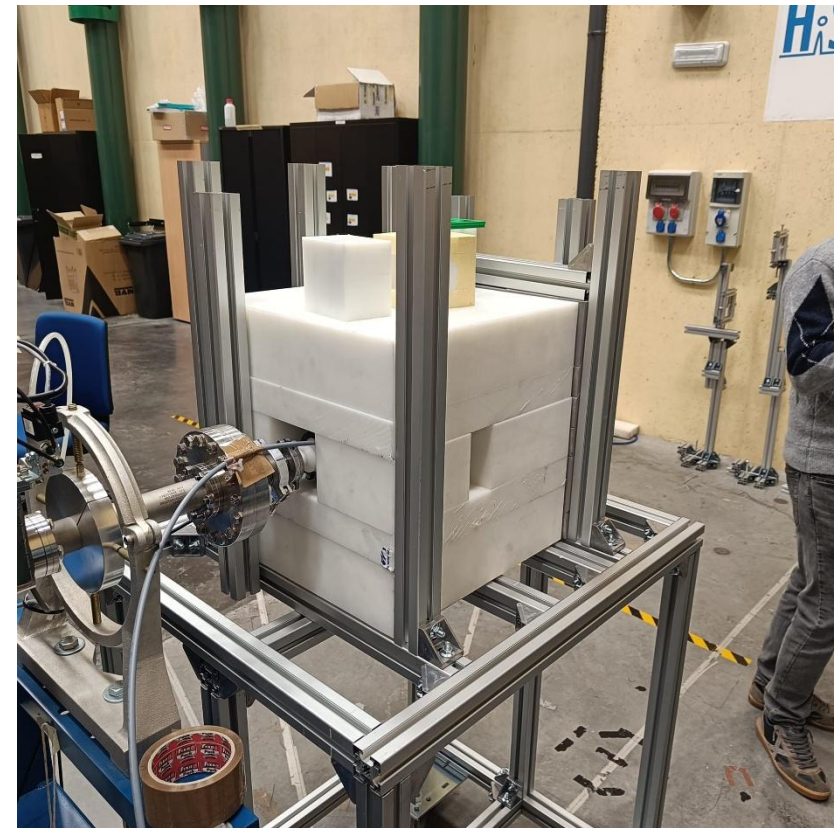
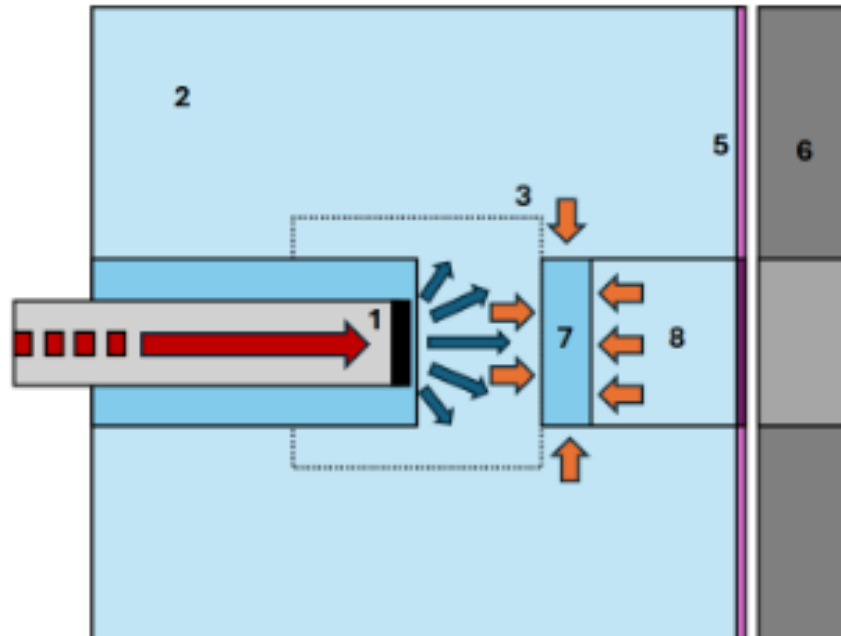
HiSPANoS is a Compact Accelerator Neutron Source

- Time domain: Continuous & Pulsed (1 MHz, 2 ns)
- Energy domain:
 - Thermal via moderated ${}^7\text{Li}(p,n)$ \rightarrow 25 meV
 - Epithermal via ${}^7\text{Li}(p,n)$ \rightarrow 1-100 keV
 - Fast monoenergetic via ${}^2\text{H}(d,n)$ \rightarrow 2,5 to 6 MeV
 - Fast white beam via ${}^9\text{Be}(d,n)$ \rightarrow 1 to 10 MeV
- Neutron fluxes:
 - Thermal via moderated ${}^7\text{Li}(p,n)$ \rightarrow in progress
 - Epithermal via ${}^7\text{Li}(p,n)$ \rightarrow 10^7 n/sr/ μC
 - Fast monoenergetic via ${}^2\text{H}(d,n)$ \rightarrow 10^7 n/sr/ μC
 - Fast white beam via ${}^9\text{Be}(d,n)$ \rightarrow 10^{10} n/sr/ μC

HiSPANoS: the experimental neutron beam line at CNA

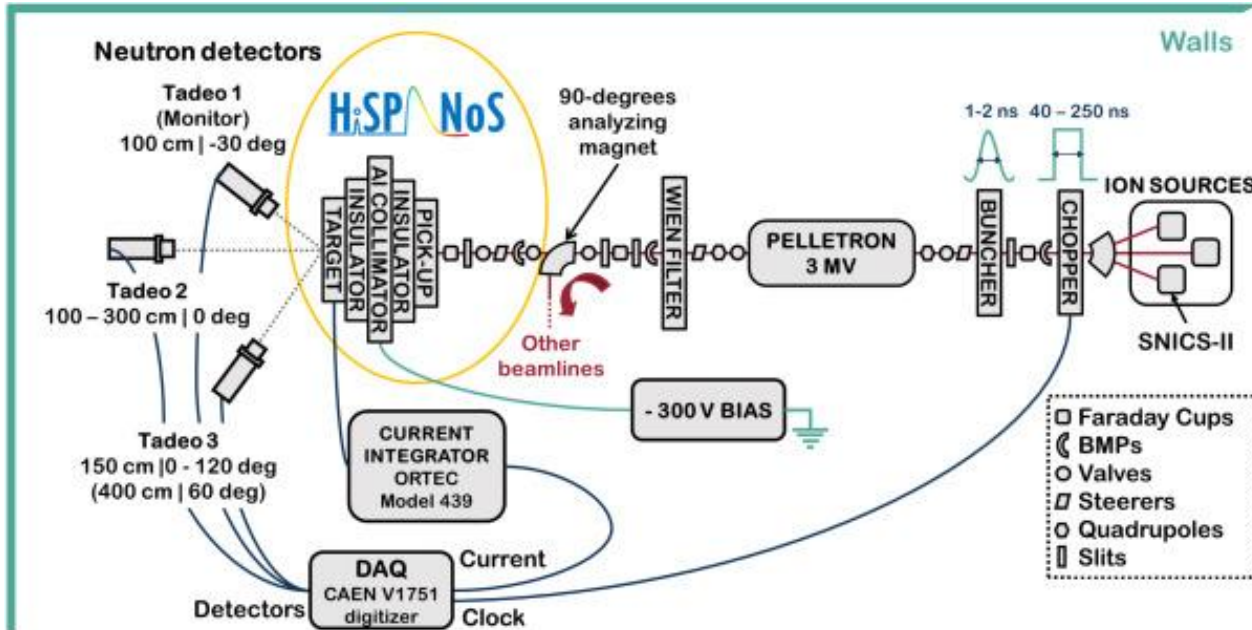


New moderator for thermal neutrons production at HiSPANoS: Commissioning in progress



$$\text{CNA HiSPANoS}_{\text{thermal}} : \Phi_{\text{field}} = 10^7, \Phi_{\text{beam}} = 10^4 \text{ n/cm}^2/\text{s}$$

HiSPANoS: the experimental neutron beam line at CNA



HiSPANoS is a Compact Accelerator Neutron Source

Neutron Detectors:

- 3 Li-Glass detectors (1", 0.5" & 3mm) for epitermal
- 3 EJ-309 liquid scintillatotr (2"x2") for fast

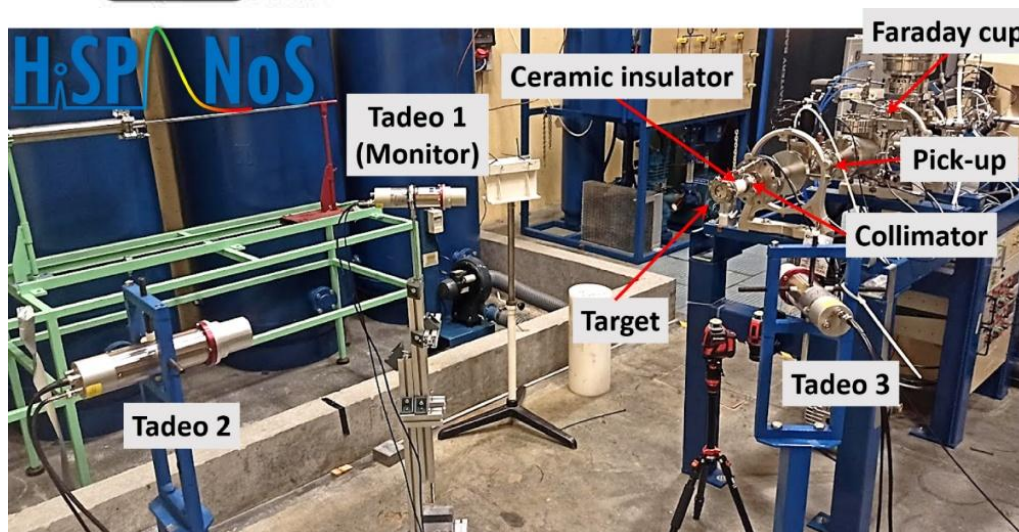
Gamma detectors:

- 2 La3Br (2"x2")
- HPGe

DAQ @ CAEN:

- VX2751 Digitizer 16 channels 14 bits 1 GS/s
- V1751 Digitizer 8 channels 10 bits 1 GS/s

Current Integrator Model 439 ORTEC



Access to CNA

Beam Time Applications for the 3 MV Tandem Accelerator @ CNA through IABA webpage:
https://www.iaba.es/index_es.html#acceso

Important info to be taken into account:

- Currently, there are only two accelerator operators working at CNA (one of them partially working on the Cyclotron also)
- Beam Available 12h almost every day (from 9:00 am to 9:00 pm). No beam available during nights or weekend.
- Cost of One day of beam time at the tandem: 400 €-600€ (some transnational Access projects were availabled last years)
- New beam time coordinator at CNA: Dra. M^a Carmen Jiménez
- At least 3 months for organizing the Access to the facility

Future Upgrades at CNA

New manipulator for accurate sample positioning at FNB experimental line (Spring 2026)

Precise target positioning is essential for achieving high-accuracy nuclear reaction measurements: $\sigma(E,\theta)$



New manipulator system:

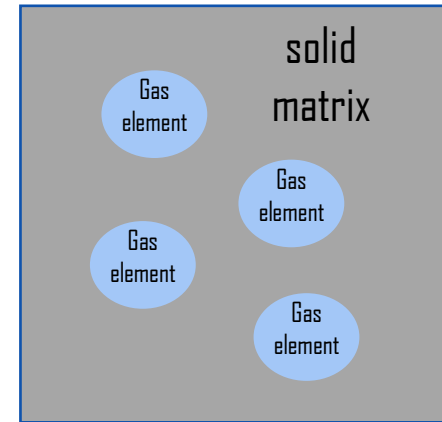
- Remote controlled motorized movement
- 3D positioning with 10 μm precision.
- 360° rotation

Future Upgrades at CNA

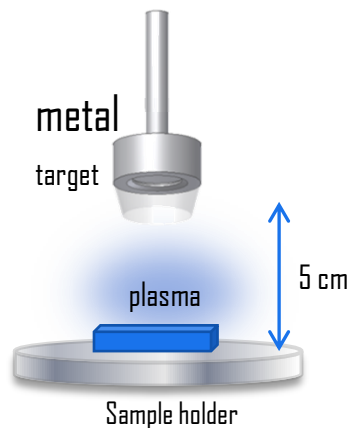
Magnetron-Sputtering to make solid-gas targets for CNA and other Facilities

Many of the isotopes of interest in nuclear reactions correspond to gaseous elements, which poses a serious problem

=> A solution is to “grow” samples that incorporate the gas into substrate in sufficient amounts, which has been demonstrated by our group and now at CNA we will be able to make such targets for nuclear physics experiments at CNA, CERN/ISOLDE, TRIUMF, LNS, etc.



Magnetron Sputtering



UNIVEX 250 for RF sputtering
by Leybold

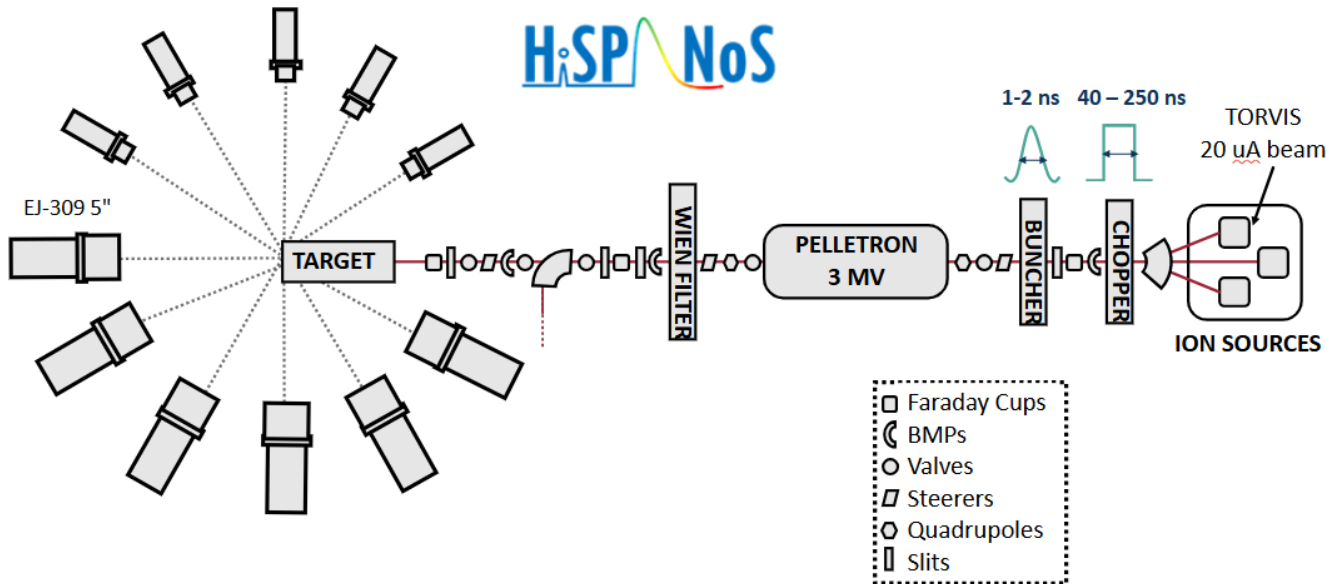
- Industrially well established
- Large areas feasible
- Wide range of substrates
- Control of microstructure
- Control of composition

F.J Ferrer



Self supported Si-He target

Future Upgrades at CNA



- **New Ion Source:** TORVIS from NEC (Dec. 2026):
 - More stable and reliable ion source
 - 20 μA (**X 10 intensity**) for alphas
- 5 new detectors for Fast n: **5" x 2" EJ-309** liquid scintillation (Spring 2026)
- New D-T neutron Generator (Infrastructure Project)



Thanks for
your
attention!!