Accelerator Mass Spectrometry at CNA: recent developments

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Why Accelerator Mass Spectrometry?

Mass Spectrometry identifies the amount and the type of chemicals present in a sample.

A very high sensitivity is achieved by accelerating the beam into a gas-filled channel, where the molecules break up and interferings are eliminated. The most common isotopes under study include ^{14}C, ^{10}Be, ^{26}Al, ^{41}Ca, ^{129}I and actinides, with applications in:

- Archeometry
- Environmental sciences
- Geology
- Medicine

The low energy zone realizes a first selection and achieves an efficient transport of the beam.

The stripping process happens in a 1 MV Tandetron.

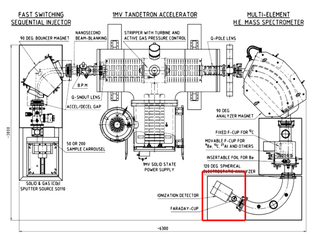
In the high energy zone isotopes are selected on their mass, charge and energy.

A sputtering Cs^+ source generates a negative ions beam.

The detection system is a bianodic Gas Ionization Chamber.

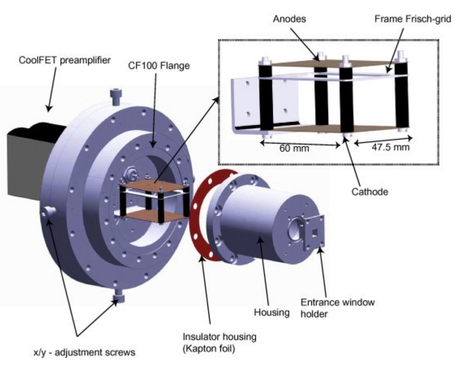
The Spanish Accelerator for Radionuclides Analysis (SARA) with a description of its main parts. It has been designed and assembled by HVEE and it is located in the National Center of Accelerator (Seville) since 2005.

IMPROVING THE DETECTION



The detection system in the SARA is constituted by a bianodic Gas Ionization Chamber (GIC) filled with isobutane.

Electronic noise is a significant contribution to detector resolution, especially for light ions.



Perspective view of the compact ETH gas ionization chamber

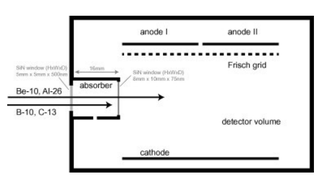
In Winter 2015, a compact GIC provided by ETH-Zürich and characterized by a *very low noise* design was installed

- AMPTEK CoolFET® preamplifiers
- Minimized capacitance
- Minimized cable length
- Minimized dispersion due to the entrance window

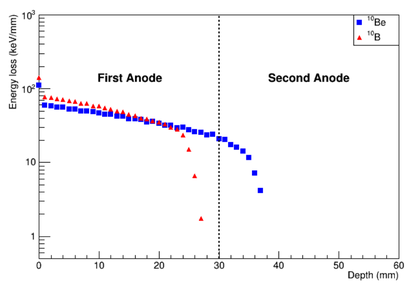
Measured electronic noise less than 8 keV for light ions

Optimizing detection resolution is essential for light isotopes which suffer from abundant interferents, as in the case of ^{10}Be and its isobar ^{10}B. The separation is possible inserting a silicon nitride membrane in the high energy zone. Because of the different stopping powers, ^{10}Be and ^{10}B change their energies and can be identified in the GIC anodes.

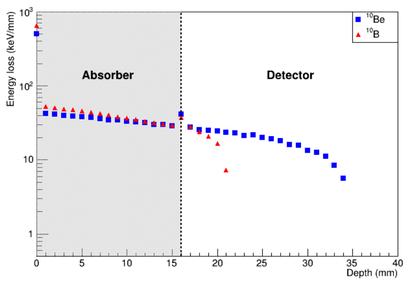
However, the ETH detector can be easily modified to hold a passive absorber, so that there is no need for a degrader foil in the high energy zone.



Schematic representation of a Passive Absorber.

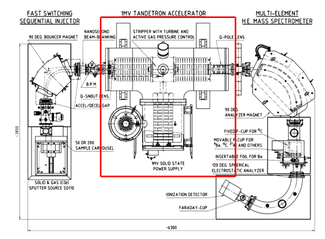


Simulation performed with SRIM of the energy loss in the detector for a $^{10}Be^+$ and $^{10}B^+$ beam at the pressure of 35 mbar. The initial energy amounts to 1400 MeV, but the beam passes through a 70 nm degrader and a 30 nm entrance window constituted by SiN membranes.

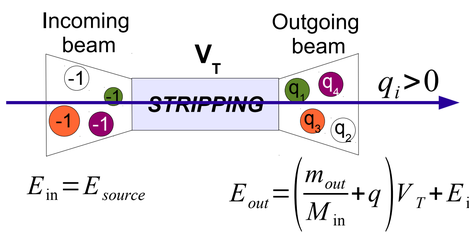


Simulation performed with SRIM of the energy loss in the detector with passive absorber for a $^{10}Be^+$ and $^{10}B^+$ beam at the pressure of 30 mbar.

IMPROVING THE TRANSMISSION



The isotopic transmission through the Tandetron is a critical parameter for AMS.



This stripping process has many effects on the incoming beam.

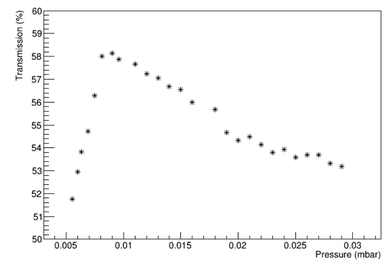
- Ions invert their charge.
- Molecules break up.
- Different charge states appear.

In Autumn 2014, the stripping gas was changed *from argon to helium*

The cross section of the stripping process depends on the isotope and on the stripping gas.

From the first measures, transmission improvements result for every isotope. Also, other charge states can be measured.

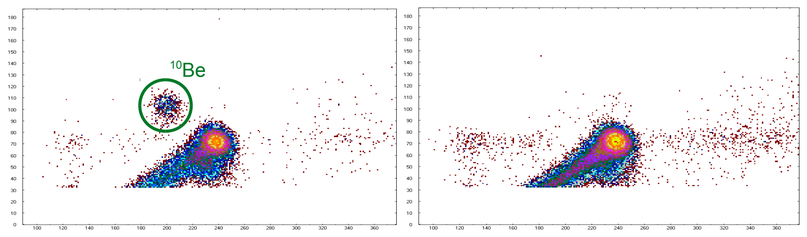
Isotope	Charge state	Transmission through an argon stripper	Transmission through a helium stripper
^{10}Be	+1	55%	58%
^{129}I	+3	10%	25%
^{236}U	+3	13%	35%



Transmission of $^{10}Be^+$ as a function of the stripping gas pressure.

^{10}Be SPECTRA

Following the substitution of the stripping gas and the installation of the new detector, beryllium spectra were acquired. The degrader is a 75 nm SiN foil. Boron peak is evidently well separated.



Spectra of ^{10}Be acquired in the new conditions. On the left, a standard sample spectra is showed: ^{10}Be and ^{10}B peaks are well distinguished. On the right, a blank sample spectra is showed: this is the definitive proof that what we are looking at is ^{10}Be.

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