OPTIMIZATION OF ^{10}Be DETECTION

G. Scognamiglio[1], J. M. López Gutiérrez[1,2]
1. Centro Nacional de Aceleradores (Universidad de Sevilla, Junta de Andalucia, CSIC), 41092-Sevilla
2. Departamento de Física Aplicada I, Universidad de Sevilla

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SARA: a compact 1 MV AMS facility

ACCELERATOR

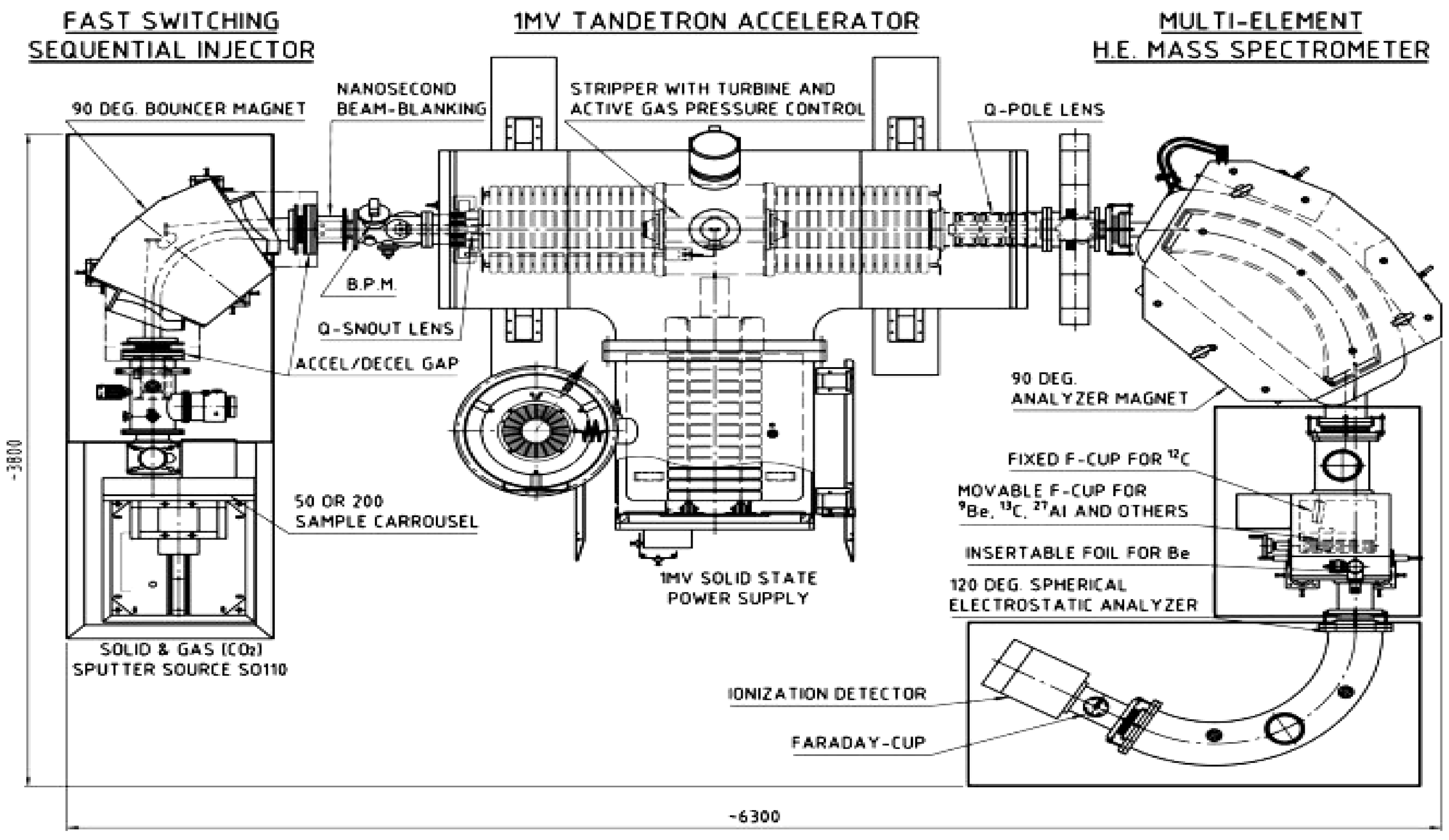
It's a Tandetron working with a terminal voltage of 1 MV. Stripping is the most important process happening inside the accelerator: the beam goes through a channel filled with gas, changes charge and interfering molecules break up.

LOW ENERGY ZONE

This zone represents the injection system and has two principal missions:
- Realizing a first selection of ions
- Achieving an efficient transport of the beam

SOURCE

A Cs^+ beam hits the sample so that a negative ion beam is generated thanks to a sputtering process.



Schematic representation of the AMS apparatus at CNA in Seville, Spain

HIGH ENERGY ZONE

Magnetic and electrostatic deflectors select mass, charge and energy of the ions coming from the accelerator.

DETECTION SYSTEM

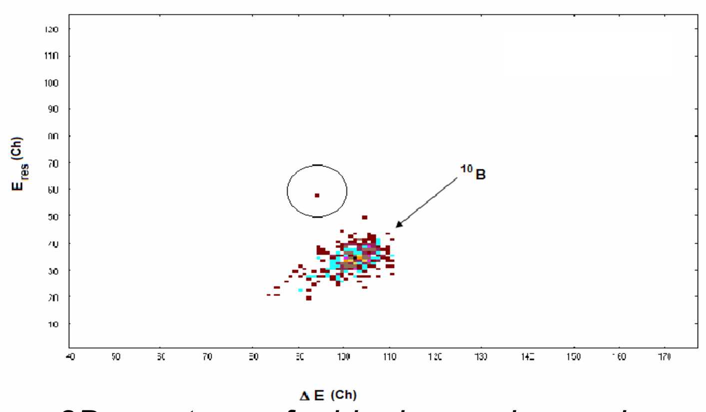
Final detection system is constituted by a Gas Ionization Chamber (GIC) with isobutane as a ionizing gas. The anodic plate is divided into two parts, in order to separate the isotope under study from interfering particles.

PROBLEM! Separating isobars

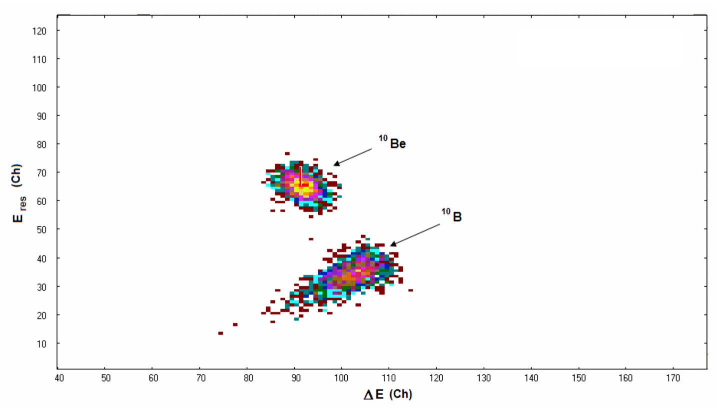
HOW TO SOLVE IT: with the Passive Absorber Technique and by optimizing the detection and the stripping systems

Passive Absorber Technique

Instead of other radionuclides, ^{10}Be has a very abundant and stable isobar: ^{10}B. Separation of ^{10}Be from this interfering is possible introducing a silicon nitride foil on the path of the beam, just before the Electrostatic Deflector. ^{10}Be and ^{10}B have the same mass but different stopping powers, so they arrive on the anodes of the GIC in distinct positions.



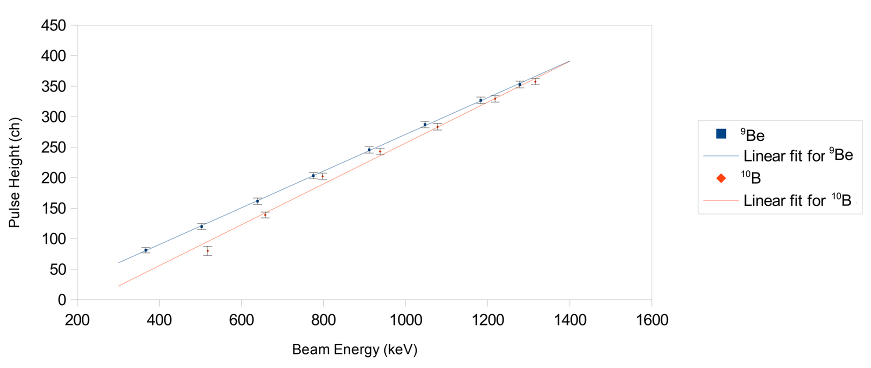
2D spectrum of a blank sample passing through a 150 nm foil with a +1 charge state



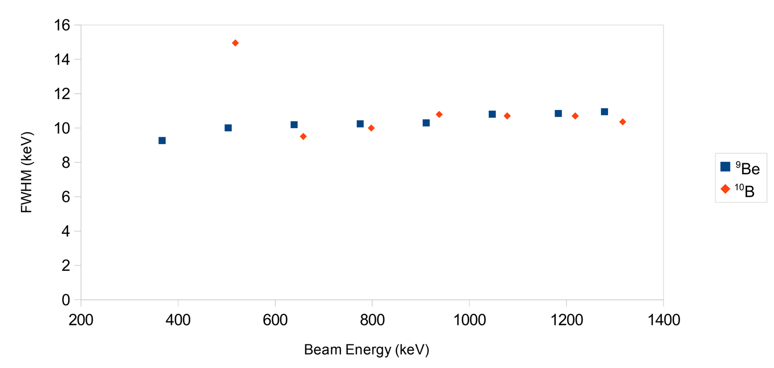
2D spectrum of a standard sample passing through a 150 nm foil with a +1 charge state

Detector calibration and resolution

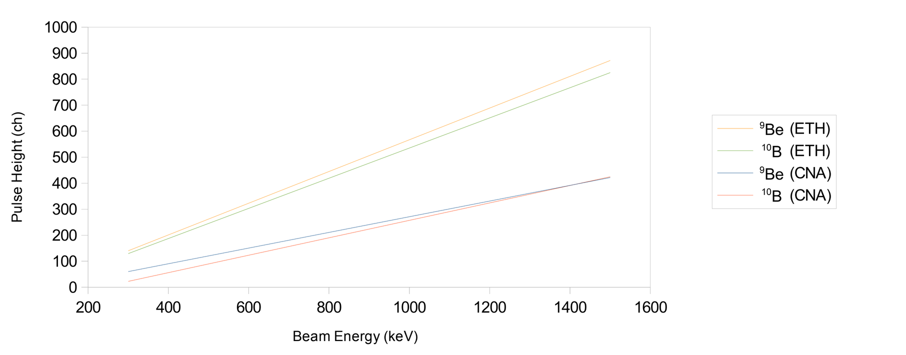
In order to obtain a better separation of isobars particles, a study of GIC performances was realized for both ^{9}Be and ^{10}B at different energies.
Average pulse height was calculated by fitting a Gaussian to the peak in the energy spectrum; then, a calculus of calibration parameters was performed for each projectile type by applying a linear fit.
The FWHM of each Gaussian fit represents a measure of energy resolution, influenced by charge carrier production, by straggling due to silicon nitride foil and by electronic noise.



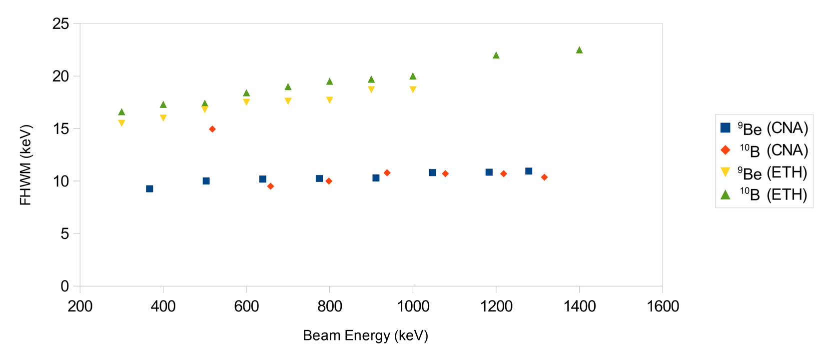
Measured pulse height for ^{9}Be and ^{10}B illustrated as a function of energy



Resolution of the GIC for ^{9}Be and ^{10}B illustrated as a function of energy

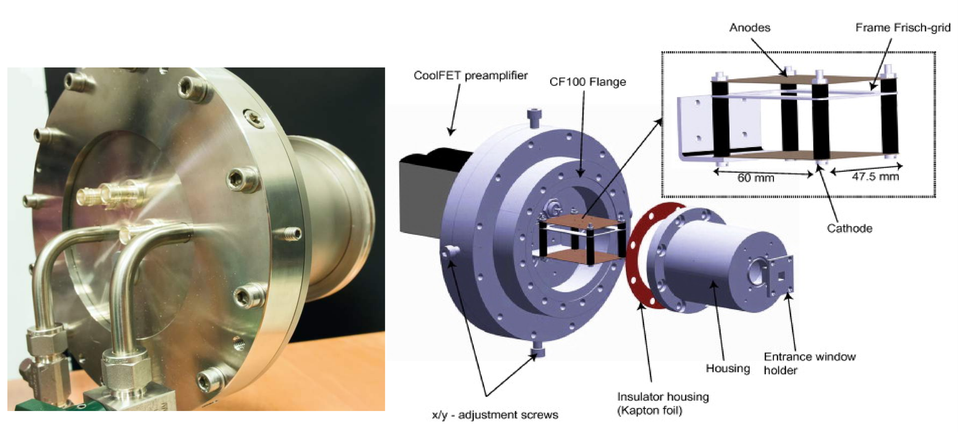


Comparison among linear fits obtained at the CNA and at the ETH-Zürich



Comparison among FHWMs measured at the CNA and at the ETH-Zürich

For AMS at low energies, electronic noise is a significant contribution to the detector resolution, especially for light ions. A more compact detector, developed at the ETH laboratory of Zürich and characterized by a low-noise design, will replace the current one adopted by SARA.

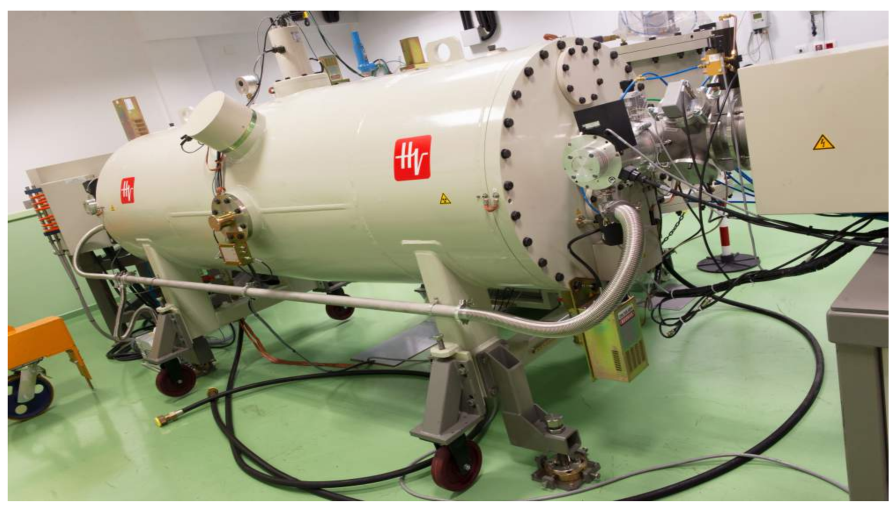


The compact detector which will replace SARA current one

Stripping process

When negative ions arrive inside the accelerator, they lose electrons because of the interaction with ionizing gas molecules.

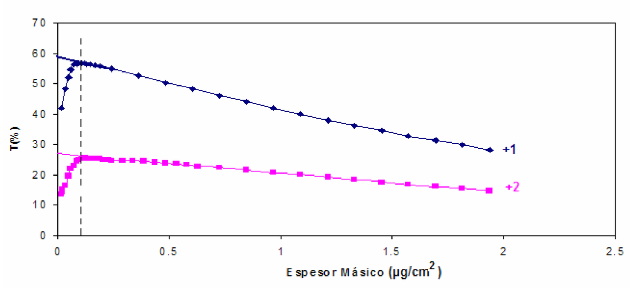
This stripping process has two principal effects on the incoming beam:
- Ions invert their charge
- Molecular noise is reduced because of the breaking up of interfering molecules.



SARA accelerator, where the stripping process happens

The transmission of the particles through the Tandetron is a critical parameter for efficient detection of radionuclides by AMS and it depends strongly from the pressure of the gas contained into the stripper.
Using argon, average measured transmission is about 55%.

Next studies will concern the research of better stripping conditions and the possibility of improving transmission with helium as a stripping gas.



Transmission of ^{9}Be as a function of the gas pressure

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