Development of a Tracking System of Exotic Nuclear Beams for FAIR

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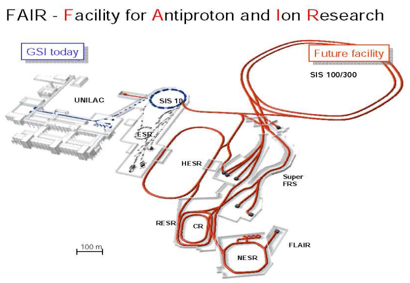
New accelerators like SPIRAL2 (GANIL, France) or FAIR (GSI, Germany) will be built soon, and they will be able to produce radioactive ion beams (RIB) with high intensities of current (≥10⁶pps). These beams, at low energy, lower than 20 MeV/u, usually have high emittance, which imposes the use of tracking detectors before the target in order to reconstruct the trajectory of the ions. The group of Nuclear Physics at CNA (National Accelerator Center), is in charge of developing a tracking system for the low energy branch of FAIR (HISPEC/DESPEC project). Within this aim, a collaboration with CEA-SACLAY was established, with the following objectives: develop, build and test low pressure Secondary electron Detectors (SeD). Results of a first prototype are presented. In parallel we have projected and constructed a new Nuclear Physics Line in the CNA with the aim of being able to receive any kind of detector tests and nuclear instrumentation related.

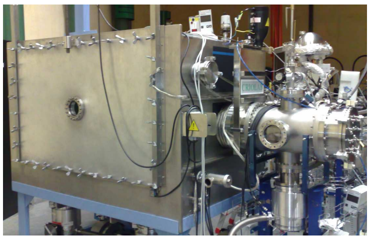
The project HISPEC/DESPEC at FAIR

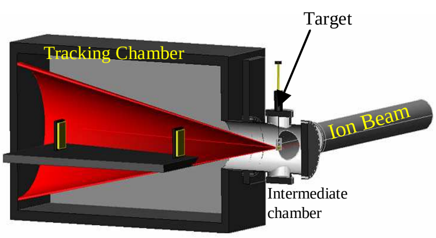
The CNA is one of the institutions in charge of producing a technical report about beam tracking system for the Heavy Ion Spectroscopy and Decay Spectroscopy (HISPEC/DESPEC) project, of the low energy branch of FAIR.



The New Nuclear Physics Line at CNA

Dedicated to test different kind of beam tracking detectors, their electronics and data acquisition system



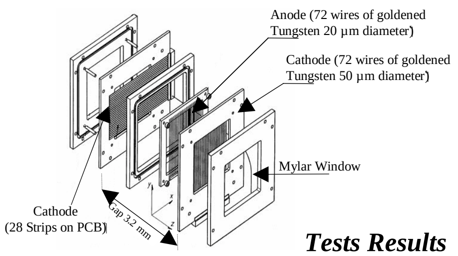


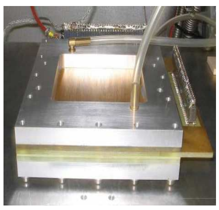
- **Vacuum system reaching a pressure up to 10^{-6} mbar**
- **Gas control station, cooling system, hight voltage and current connections**
- **MIDAS : A system to monitor experiments and acquire data**
- **Target installed in the intermediate chamber**
- **Control and optimization of the beam delivered from the accelerator**
- **Tracking detector system and connections mounted in the big chamber**

The Mini-SeD Detector Prototype

In a collaboration with CEA – Saclay, we built and tested a low pressure gaseous detector for tracking : the Mini-SeD. The Mini-SeD is a mini version (70x70 mm² active area) of the Secondary electron Detector operating in the spectrometer VAMOS in GANIL – France.

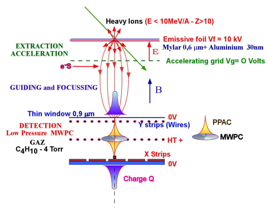
The Structure

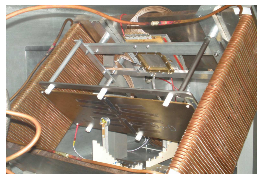




Mini-SeD Sevilla

The Configuration





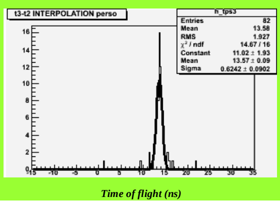
- **The ion beam pass through emissive foil**
- **The Secondary electrons (Se⁻) drift and are focused towards the detector (E, B)**
- **The Se⁻ ionize the gas inside the detector . An avalanche is produced around the anode**
- **The movement of the electrons induces signals on the cathode.**

Tests Results

The Mini-SeD, filled with C_4H_{10} at 4 Torr, was tested at CEA Saclay for its time and spatial resolution using a ²⁵²CF Source

Time Resolution Results

At the optimum value of voltage, the Mini-SeD gives, for the fission fragments of a ²⁵²Cf source a ***Time Resolution (σ) around 200 ps***



Time of flight (ns)

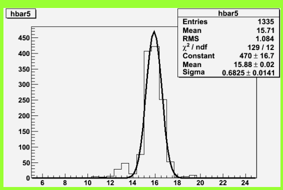
Spatial Resolution Results for different configuration

Spatial resolution results for the Mini-SED at 12,5 cm from EF

B [Gauss]	Voltage [V]	P [torr]	σ [mm] (± 0.05) (bary / sech) Cathode wires	Cathode strips
130	510	4	---	**0.48 / 0.45**
130	490	4	---	**0.68 / 0.48**
130	520	4	**0.57 / 0.85**	---

Spatial resolution results for the Mini-SED at 20 cm from EF

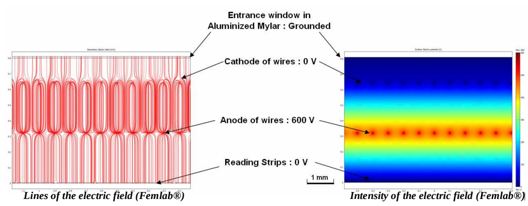
B [Gauss]	Voltage [V]	P [torr]	σ [mm] (± 0.05) (bary / sech) Cathode wires	Cathode strips
110	510	4	**0.68 / 0.50**	**0.62 / 0.80**
110	490	4	---	**0.50 / 0.67**



Spatial resolution (mm)

Electric Field Simulation

In order tostudy the gain of the Mini-SeD, we are simulating the electric field inside the detector. In the figures below, resulting from a 2-D simulation with the program Femlab(R), we can see in red, the parallel field lines, and in colors the homogeneous intensity of the electric field according to the Y plane (in 2-D). For memory related issues, the simulations were done in 2-D, however, they are as valid since the detector is symmetric.



Lines of the electric field (Femlab®)   *Intensity of the electric field (Femlab®)*

Presently, we are in the process of improving our simulations. In order to have more detailed plots, we are using the simulation program "GARFIELD" developed by CERN.

***DITANET Supported by the EU under contract PITN-GA-2008-215080**

The International Summer School on Nuclear Physics
La Rabida 04/07/09 – 10/07/09