Nuclear Astrophysics with the 1MV TANDETRON ACCELERATOR at IFIN-HH

In April 2012 at IFIN-HH was commissioned a Crockoft Walton type 1 MV HVEE Tandetron Accelerator and it is dedicated to ultrasensitive measurements of C, Be, Al, I and Pu isotopes using Accelerator mass spectrometry (AMS) method. Accelerator Mass Spectrometry (AMS) allows to separate isotopes of the same element but with different mass by means of an accelerator setup.

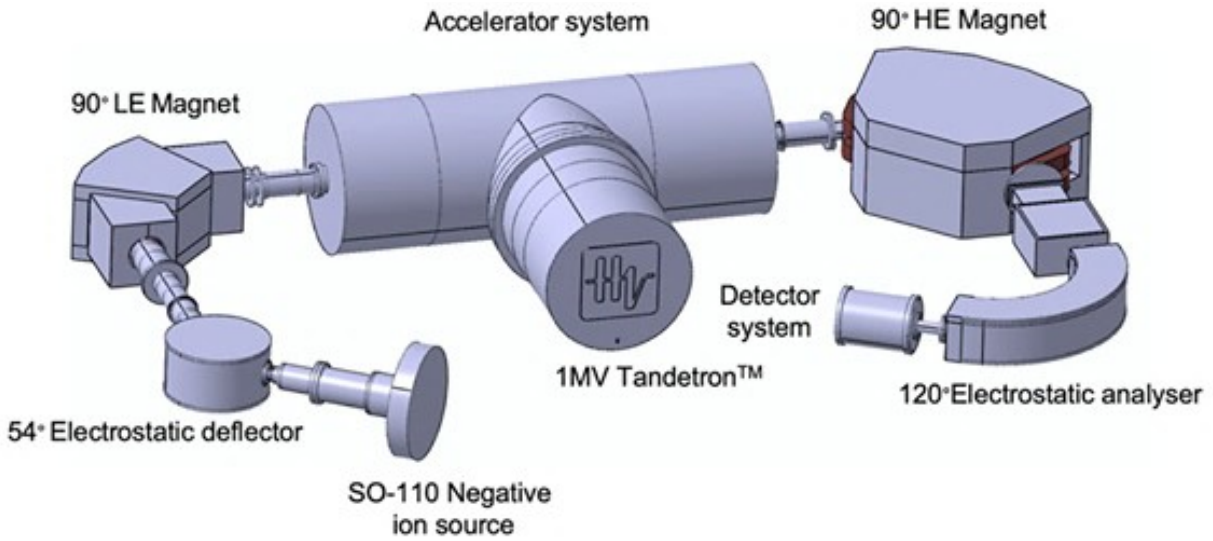

Fig. 1 CAD 3D Design of the 1MV Tandetron™ Accelerator (Pacesila, D.G. 2019)

There are three essential components within an AMS system:

- An ion source (SO-110 Negative ion source), that ionizes the atoms within the sample material into a beam of charged particles
- An accelerator system (1MV Tandetron™) that receives the charged particles and accelerates them to high kinetic energy
- A charged particle detector (Gas Ionization Chamber) that detects and counts each charged particle it receives from the accelerator

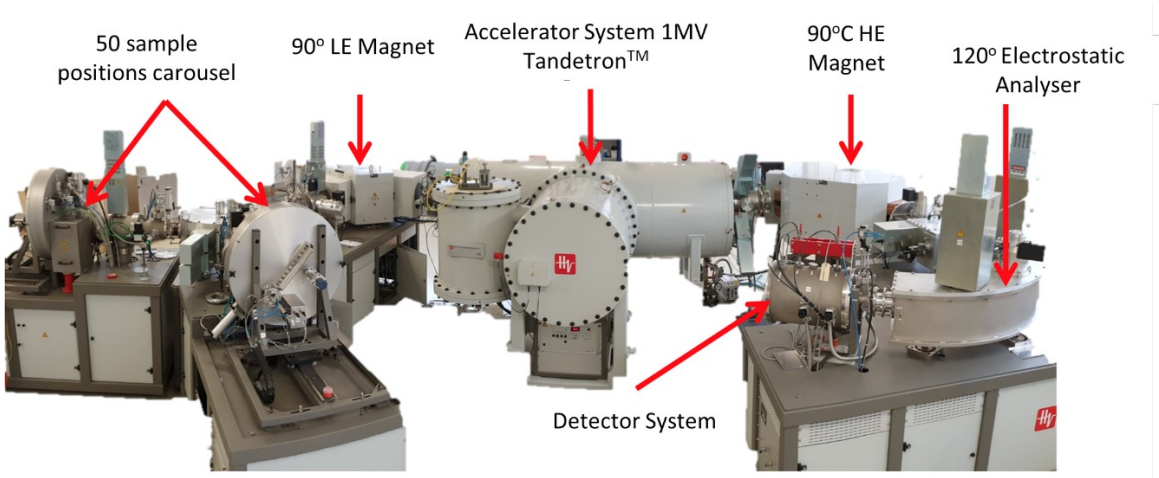

Fig. 2 The 1MV Accelerator HVEE installed at IFIN-HH

The types of isotopes sought in AMS measurements are typically those that have sufficiently long half-lives to be of use for archaeological, geophysical, and astrophysical significance. For example, the isotopes that were already measured at the 1MV Accelerator from IFIN-HH and can be studied in astrophysical context are C^{14} (Fig. 3) and Pu^{244} (Fig. 4).

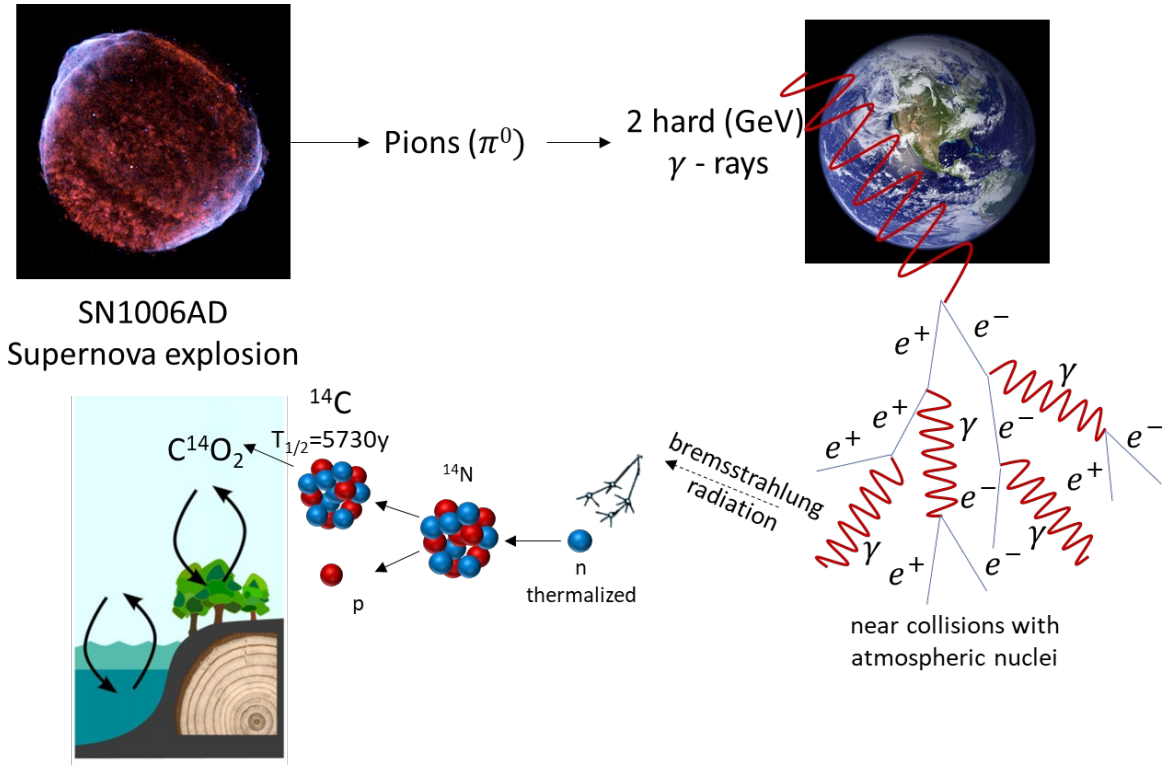

Fig. 3 Production of C^{14} from Supernova Explosions, adapted from Damon et al.,2000 and Steinhilber et al., 2012

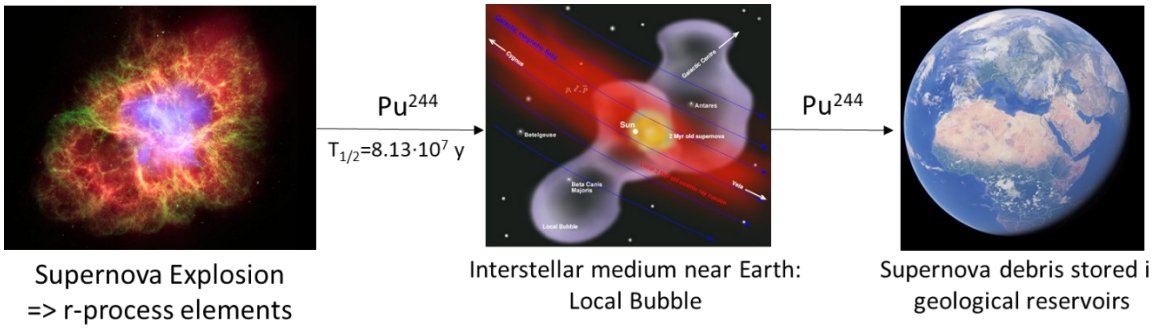

Fig. 4 Production of Pu^{244} and arrival on earth, adapted from Kachelrieß et al., 2015

In order to measure an isotope by AMS method using the 1MV Accelerator from IFIN-HH it should meet a few requirements like: the half-life of the isotope of interest should be between 100Ma (for >100Ma problem – primordial background) and weeks (<weeks – better use of decay counting), it should not have stable or long half-life isobar, it should produce negative ions (i.e. C^-) or molecules (i.e. PuO^-) and there should be a standard material available since AMS measures relative it is necessary to obtain concentrations.

References

1. Pacesila, D. G. “Accelerator Mass Spectrometry in the Actinides Field”, PhD thesis. Polytechnic University of Bucharest, 2019
2. P. E. Damon, A. N. Peristykh, RADIOCARBON, Vol 42, Nr 1, 2000, p 137–150.
3. F.Steinhilber et al., PNAS April 17, 2012 109 (16) 5967-5971.
4. M. Kachelrieß et al., Phys. Rev. Lett. 115, 2015, 181103.