Ion beam characterization by AMS

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Precedents

Since 2018, our group at the Institute of Physics of the National Autonomous University of Mexico (IFUNAM) have had established a protocol called Activation Followed by Accelerator Mass Spectrometry (AFAMS) to study different cross-sections, by neutron and ion sample irradiation. Such technique combines the sample irradiation (neutron irradiation with a nuclear reactor and ion irradiation delivered by electrostatic accelerators) followed by the Accelerator Mass Spectrometry analysis at the "Laboratorio Nacional de Espectrometría de Masas con Aceleradores" (LEMA) at IFUNAM.

Precedents

BeO and Uracil samples were prepared and irradiated with thermal neutron flux at the TRIGA MARK III nuclear research reactor in the "Instituto Nacional de Investigaciones Nucleares (ININ).

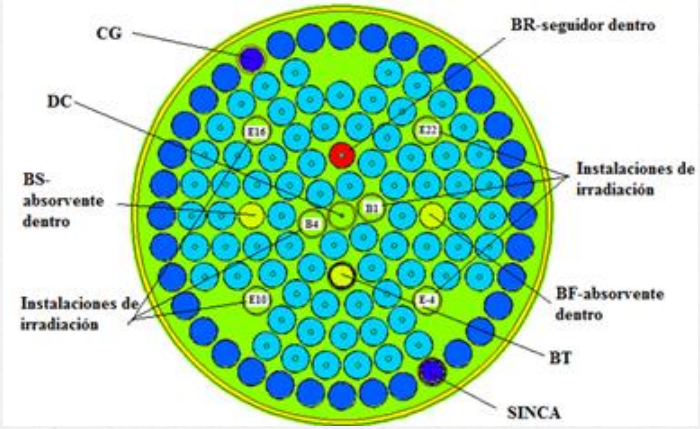

Fig. 1. Nuclear Reactor Core of TRIGA MARK III, ININ Reports, México.

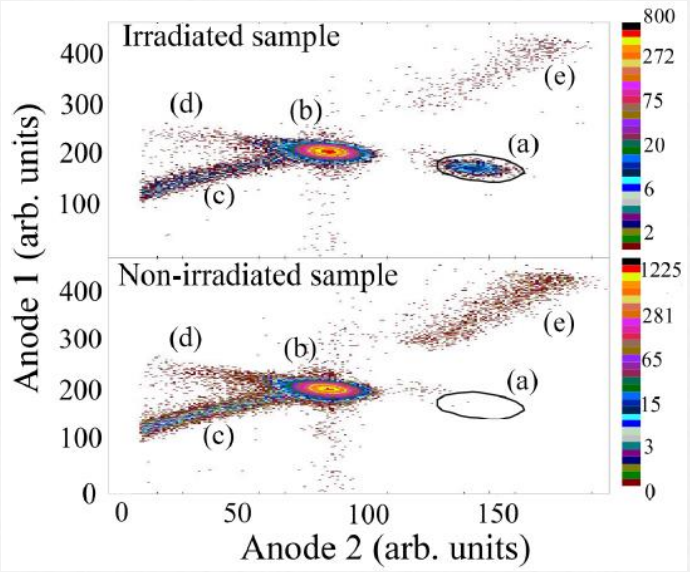

Fig. 2. A two-dimensional plot, where the pulse height signals from each anode are plotted against each other, allows particle identification by the *E*-$\triangle E$ technique.

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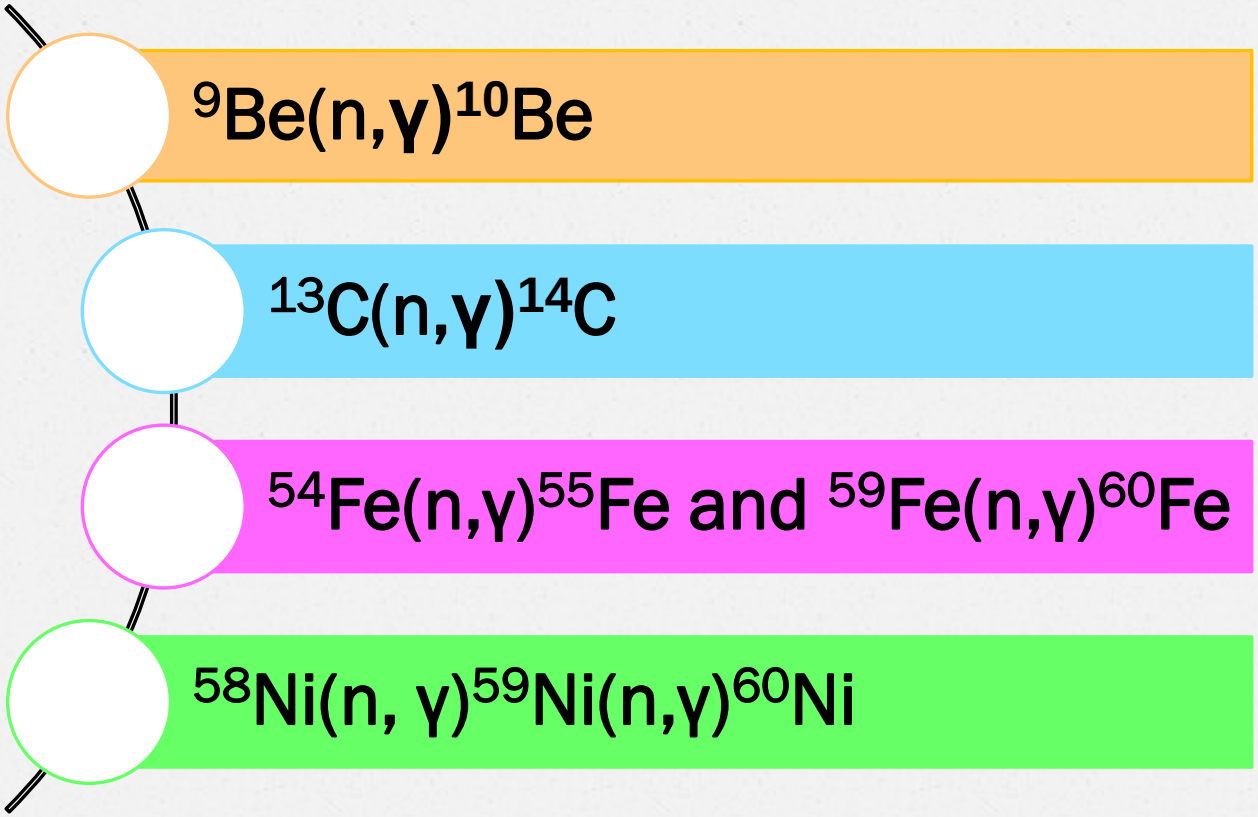
Neutron capture cross sections



Accelerator Mass Spectrometry-AMS

AMS system at LEMA is a nuclear facility at IF-UNAM.

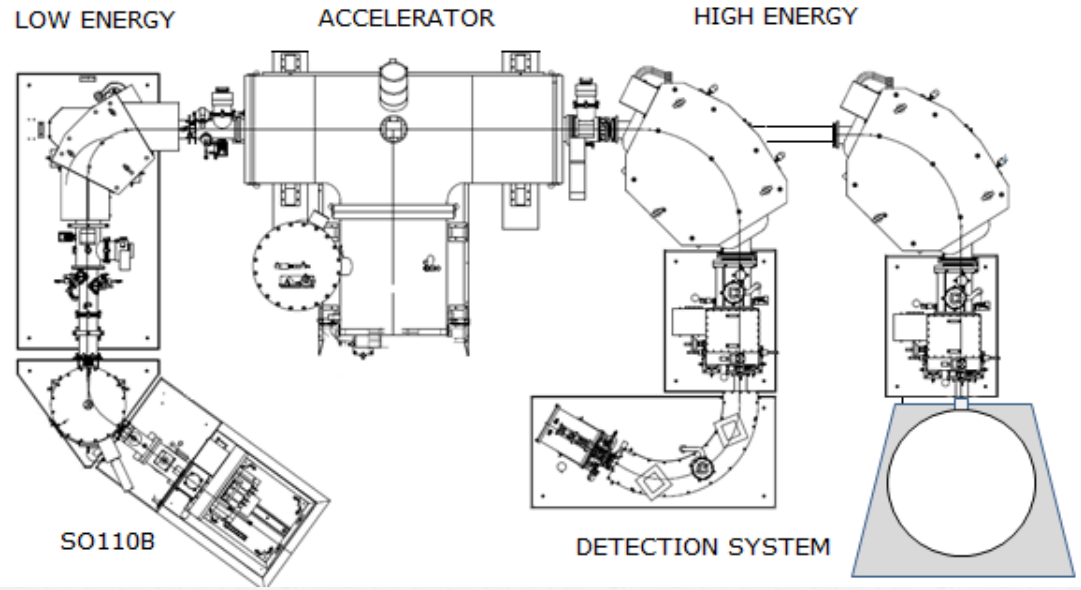


Fig. 2. Floor plan of AMS system at LEMA.

Eur. Phys. J. Plus 134:590 (2019).

Beam production

In LEMA is possible to produce a highly stable, collimated negative and singly charged ion beams with variable low energies from 30 to 200 keV and current intensities few nA to μA.

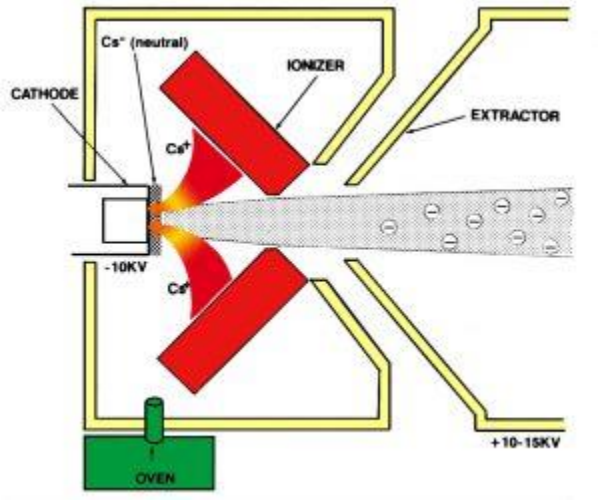


Fig.3. Sputter Negative Ion Cesium Source (SNICS) schematic diagram.

https://www.pelletron.com/products/snics/

AMS measurements

The main use of the facility is ^{14}C dating, but also other cosmogenic isotopes are used, ^{10}Be, ^{26}Al, ^{129}I and actinides.

Astrophysics line of stable and radiactive beams

Experimental Setup

- Cathodes preparation were made under the reccomendations given by Ion cookbook.
- Aproximately 6 to 8 mg of sample were required.

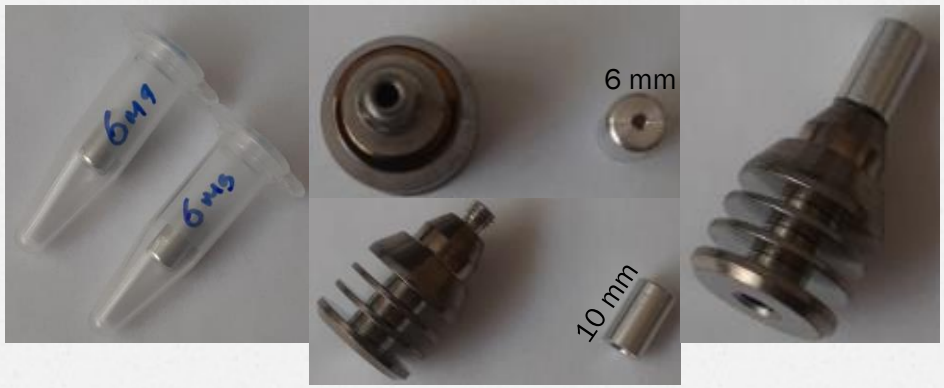


Fig. 4. Iron cathodes and cathode holder used in the SNICS of LEMA's isotope separator for AMS analysis.

R. Middleton, A Negative Ion Cookbook, University of Pennsylvania, 1989.

Experimental Setup

- A thin gold foil deposited on thick carbon target with a thickness of 5μg/cm^2 and size 1.78 x 1.78 cm was set in a holder, into the astrophysics chamber.
- A heavy particle detector was fixed at 50° backward angle.

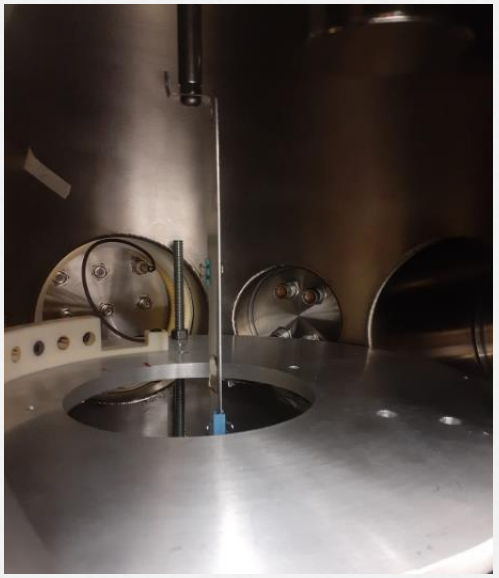


Fig. 5. Experimental arrangement.

Iron

- In the SNICS, iron ions are extracted from a Aluminum sample holder.
- The ion current extracted from the ion source was 0.26 μA.
- Charge state 2+,3+,4+ and 5+ for ^{56}Fe and 2+,3+,4+ for ^{54}Fe.

Iron beam preeliminary characterization

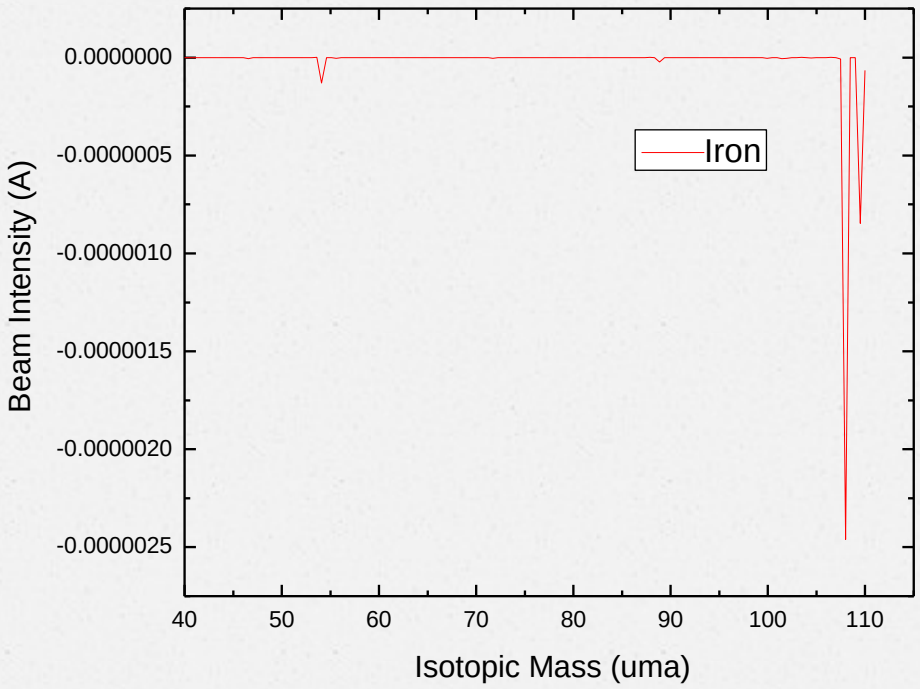


Fig. 6. Iron spectrum obtained with a gold target by Rutherford Back Scattering (RBS) technique.

Nickel

- In the SNICS, nickel ions are extracted from a cooper sample holder containing the sample material approximately 10 mg.
- Current 2.9 μA
- Charge state 2+,3+,4+,5+,6+ and 7+ for ^{58,60,}Ni.
- Charge state 2+,3+,4+ and 5+ for ^{61,62,64}Ni.

Nickel beam characterization

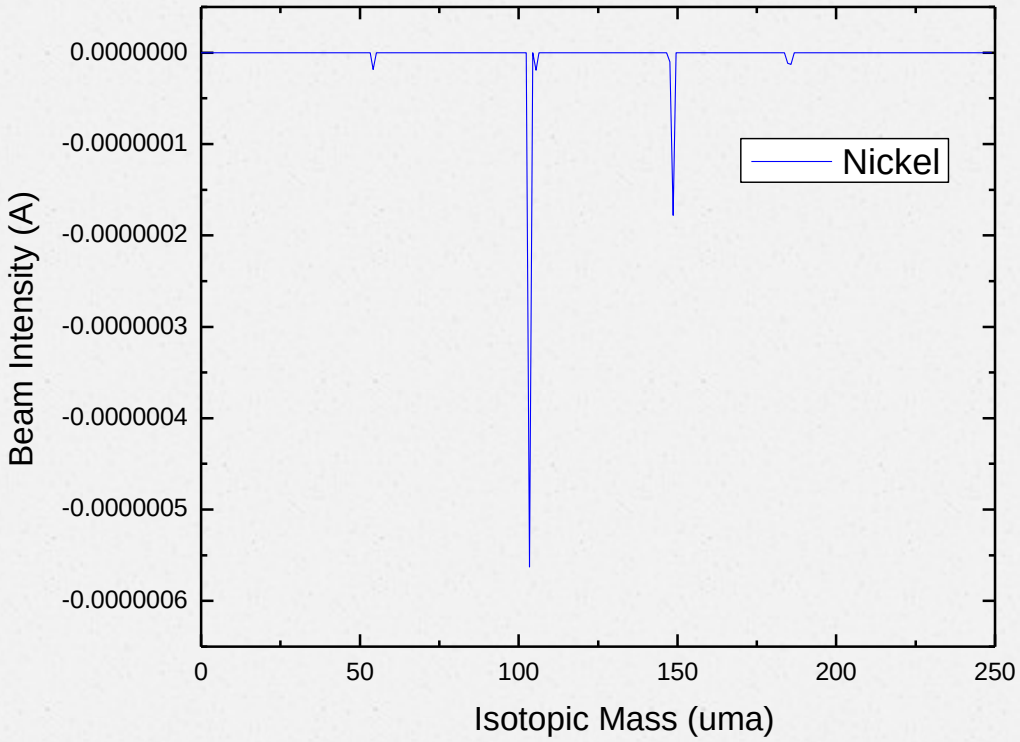


Fig. 7. Nickel spectrum obtined with a gold target by RBS technique.

Conclusions

- The nickel beam characterization was made in the nuclear astrophysics line at the LEMA.
- Preeliminary results were obtained for iron beam, we'll continue to develop this beam.
- AMS system is capable of creating over sixty different types of negative ion beams.

Acknowledgments

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Thank You...