A beam line for production of a neutron beam using D(d, n) ^{3}He reaction at the 3MV Tandem accelerator

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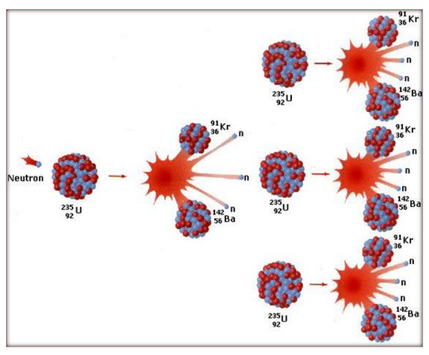
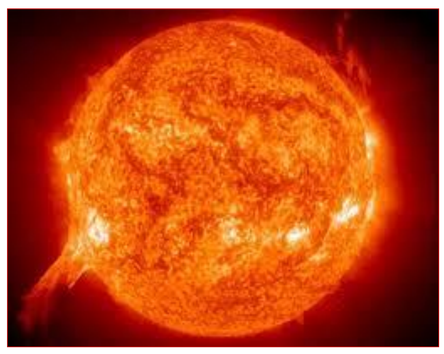
Introduction / Motivations

Neutrons are everywhere, from Natural Phenomena to high Tech Laboratory.

Traditional way of neutron production is from reactors (wide spectrum of energy window).



Fission (Reactor)



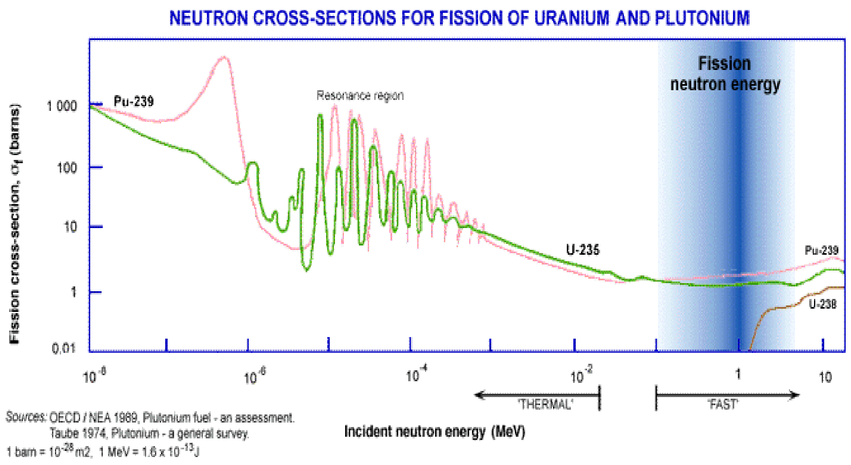
Fusion (Natural- Sun)

There are very few data at the higher neutron energies.

Requirement of mono energetic neutrons for many applications starting from Physical problem to Biological system.

The renew interest of experimental Dark matter group in addition with the nuclear physics research interest is boosting nowadays using neutron beam.

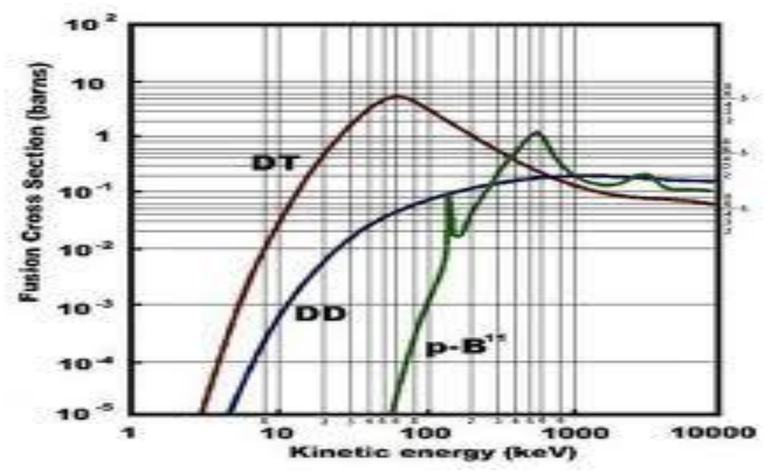
Neutron imaging is another promising upcoming technology for many applications.



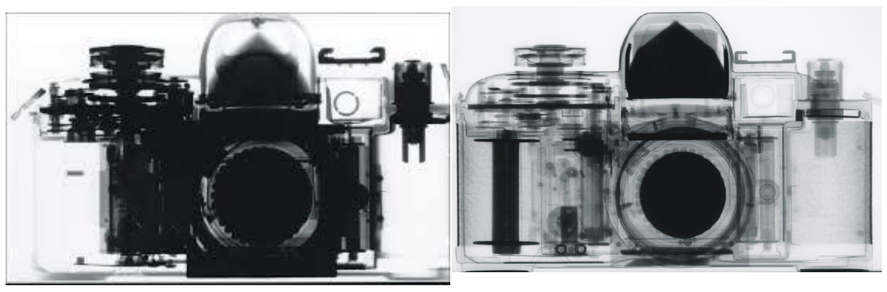
There are many reactions used to generate Neutrons of many varieties and of a range of energy.

To Produce mono energetic neutrons it is more easier using D(D,n)^{3}He reaction compared to others due to practical advantages:

1. Better energy selection can be done by using the Associated Particle method.
2. The cross section at higher energy is almost the same for all the reactions.



A comparison between x-ray imaging and neutron radiography.

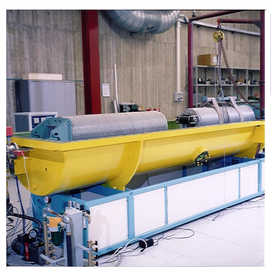


TTT-3 & Beam Line Development

Existing TTT-3 Accelerator facility at Napoli.

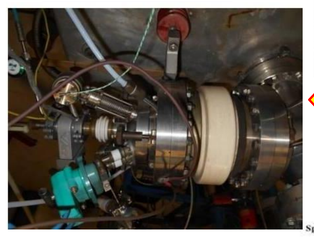
High beam stability with fine energy resolution

Different mode ion sources, multiple charge exchange modes and available space is suitable for the neutron beam line development

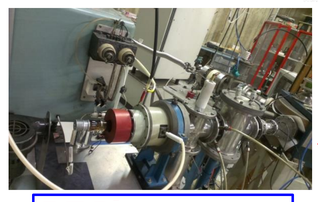


Inside Tank of TTT-3

Sputtering Source



Bending Magnet

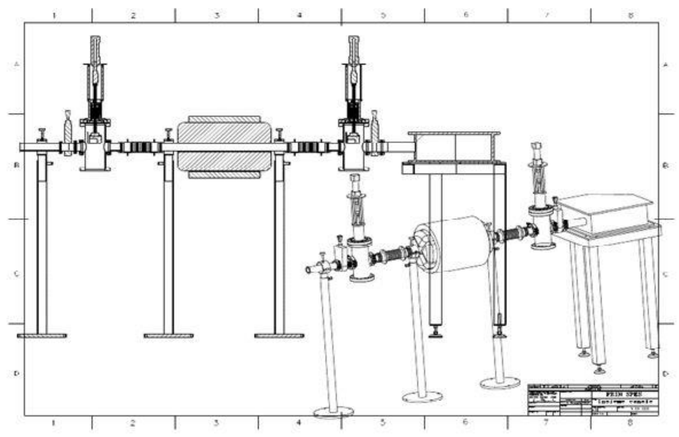


RF Plasma source

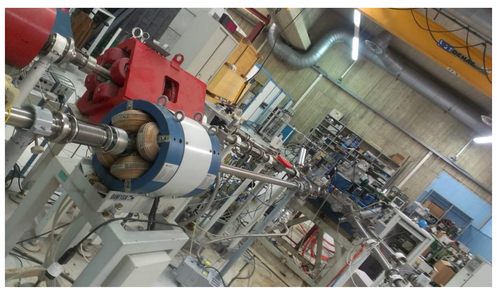
Switching Magnet

PRIN - Line

PRIN Project

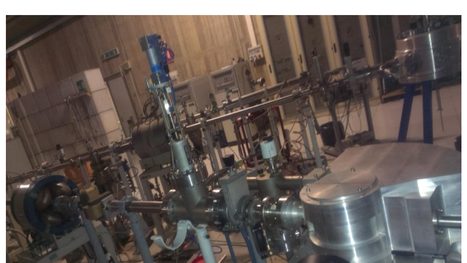


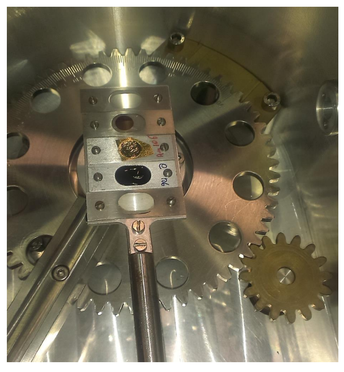
Different components of the neutron beam line (CAD view). FC, Chamber & Focusing unit are clearly seen.

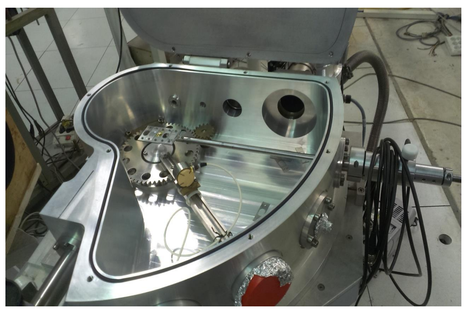


A new beam line extended for the production of mono energetic neutrons. . The new line with installed focusing unit is shown.

The experimental chamber with the Faraday Cup (FC) is shown. Target ladder mounted with ^{12}C,^{197}Au and Quartz shown below for the testing of the beam line and the detection system.



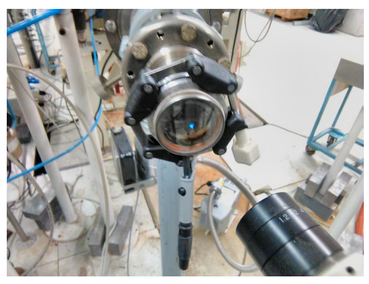




Test measurement & Result

The complete set up with neutron detector (Organic scintillator).

The SSB particle detector (^{3}He) is inside.



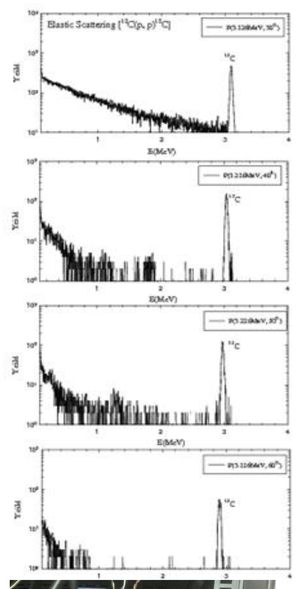
The beam line alignment has been tested by using the 3 MeV Proton beam. The beam spot (3mm) after the chamber is very clear and focused.

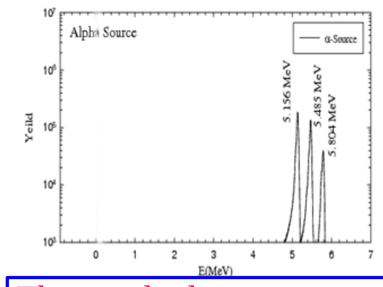
The Focusing effect of Quadropole has been tested.

The RF plasma source with D gas produced the D plasma. Further the D ions are extracted and passed through the charge exchange cannel.

Electronics & Data Acquasition

Electronic chain has been tested and a typical raw spectra using SSB has been shown.





The standard α– source was used for the detector testing . The V 1720 Caen Digitizer has been used to record the spectrum for the n-detector. The newly developed PSA algorithm has been tested using the result of other experiment and produced an effective n-γ discrimination.

Conclusion and future plan

A dedicated beam line for the production of mono-energetic neutrons has been installed and tested(10^5 n/s can be reached).The APT method has been used to tag the neutron of required energy (Dark matter expt.). A fully tested PSA algorithm has been written for n-γ discrimination. Testing of new generation of n-detectors in addition with search for new material for the detector is on the way.