Development of beam line for n production using D(d, n) ^{3}He

P.K. Rath, E. Vardaci, L. Campajola, , G. Larana, Md Ashaduzzaman
Department of Physics, University of Naples "Federico II" and INFN, I-80125 Napoli, Italy
**email:*rath@na.infn.it

Introduction

Two-body reactions are a convenient and powerful way to produce mono-energetic neutrons. Therefore the neutron source must be viewed at with an eye on the application. Basically there are three types of applications:
a) Scientific ones (physics)
b) Technical ones and
c) Medical ones .
In most cases such neutron sources will be accelerator based. The D (d, n)^{3}He reaction is widely used as a source of mono-energetic neutrons. The reaction has often been employed in the determination of neutron detector efficiencies over a wide range of neutron energies by measuring an angular distribution for a fixed deuteron bombarding energy. In many cases there will be a contamination with intrinsic neutron background (other neutron lines from the excitation of non-ground-state levels or neutrons from break-up reactions) and/or with structural and room background.

The demand for reliable nuclear data [1], is still open and has now been enhanced by the need of precise fast neutron data for fusion reactor development. Keeping all the things on mind we try to developed a beam line for n production using two body D(d, n)^{3}He reaction.

Beam line arrangements

To develop the beam line we have used the 3.3MV Tandem accelerator (TTT-3) at Department of Physics, University of Naples Federico II. Fig.1 shows the schematics of the different beam line present now. We have used new beam line for the neutron production using the D(d,n)^{3}He reaction. The schematic of the beam line for the neutron production is shown in Fig 2.

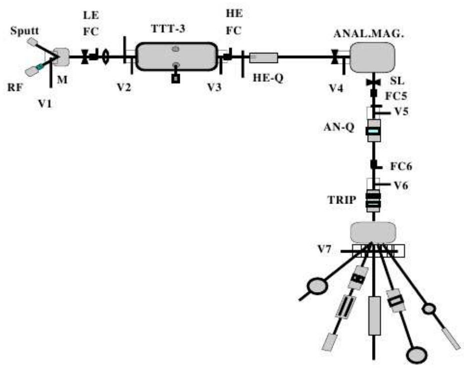

Fig. 1. The schematic of the Tandem accelerator (TTT-3) at University of Naples Federico II . Different beam lines are 45^0 ion implantation, 30^0 ^{14}C line, 15^0 the neutron line (newly developed) 0^0 ,15^0 scattering chamber (left to right).

From the above figure we can see that the beam line having 15^0 has been further used and extended for neutron production as shown in Fig 2. The basic components, shown in the figure, are : (1) external chamber in triangular shape thin metal window for passage of neutron without any spoil of resolution ;
(2) rotating target assembly suitable for self-supporting deuterated polyethylene and thin targets;
(3) charged particle detector holder;
(4) Beam collimator system ;
(5) External scattering table with sliding neutron detector mounting ;
(6) highly sensitive vacuum system .

From the Fig.2 one can see that beam collimator system the quadruple magnet is placed in between two faraday cup such that the focus point of the beam is at the target holder position. The two beam diagnosis component (

Faraday cup) were connected with the highly sensitive vacuum system.

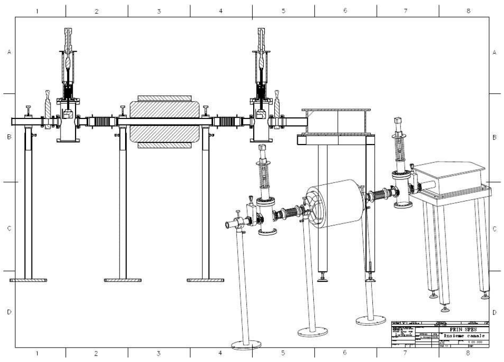

Fig. 2. Beam line for the neutron production. This is the extension of the beam line 15^0 of Fig. 1. In the above figure the quadruple is place between two highly sensitive beam demonist component (FC).

The chamber is specially designed like triangular shape such that neutron can be easily detected by fast response neutron detector (usually an organic scintillateor).The chamber is made of up aluminum with special deigned such that it will be more convenient to use the associated particle technique (APT) with D(d, n) ^{3}He [2-3] which provides a simple method for producing "clean" mono-energetic neutron beams of accurately determined intensity in a wide neutron energy range. The APT takes advantage of the time and energy correlation between a neutron and the associated recoil nucleus (^{3}He or ^{4}He) in agreement with the kinematics of the reaction involved .

Testing by using p beam

The testing of any beam line starts with the testing from alignment for our case also the test has been done in two ways a) the mechanical alignment which has been performed by telescope b) alignment by proton beam. We used a 3MeV p beam for alignment of the quadruple and the chamber. A test result has been shown In Fig. 3..

Fig. 3. Alignment testing by using the p beam of 3 MeV . From the figure we can see that the p having well focused (1mm) diameter has been achieved and very well focused by the quadruple. The transmission of the beam from the switching magne to the last FC was more than than 95%..

Summary and Future work

So far we have completed the installation of the whole beam line including the beam diagnostic component and the focusing unit. Also we have tested with the alignment and all the unit like focusing and steering unit by using the p beam of 3.3 MeV. The FC are also well working. Now in the recent future we will try to accelerate the d beam using the sputtering source and RF ion source. The experiment D(d,n)^{3}He to produce neutron for the research and development program will be conducted very soon.

Acknowledgment

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References

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[3]Nuclear Physics A136 (1969) 25-34