Energy and efficiency calibration for a fast high-resolution neutron spectrometer FNS-100

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2016 PAC PROPOSAL

The purpose of this proposal was:

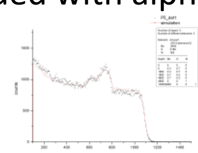
- determine the best experimental set-up for neutron detector
- characterize the neutron spectrometer FNS-100 efficiency, resolution
- determine the energy range for neutrons which may be measured
- run two experiments for the energy calibration for the 3MV accelerator

For energy calibration of the FNS-100 spectrometer, ideally is to use mono-energetic sources of neutrons, difficult to achieve using neutron sources such as ^{252}Cf, ^{241}AmBe or ^{239}PuBe. The best is to use a nuclear reaction with a well known energy for the neutrons coming out the reaction in an angular range. Such reactions are ^{7}Li(p,n)^{7}Be and ^{9}Be(α,n)^{12}C.
We asked 2016 PAC for 4 days of beamline at the 3MV accelerator.

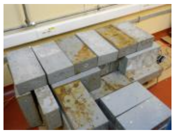
2016 PAC experimental results

Our activities:

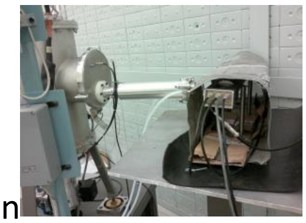
1- home-made target fabrication LiF and BeO of different thicknesses
   a) LiF target was characterized by RBS method at the 3MV accelerator, but didn't work in neither characterization method (Ta backing) nor neutron producing during bombarding with protons from the 3MV accelerator
   b) BeO targets were RBS well characterized and produced neutrons while bombarded with alphas produced at the 3MV accelerator

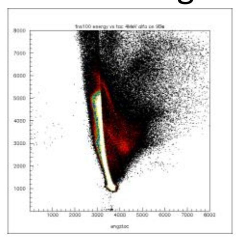
 

2- check FNS100 detector functioning using two ^{239}PuBe and ^{241}AmBe neutron sources with about 10^6 neutrons/second 



3- 2 X runs at the 3 MV accelerator creating neutrons using $^{9}Be(\alpha,n)^{12}C$ reaction

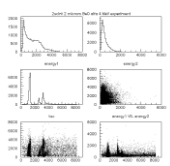


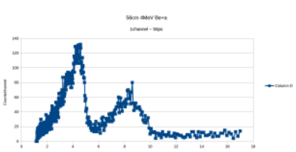


4- home-made 2 plastic scintillators NE102 with XP2020 were created

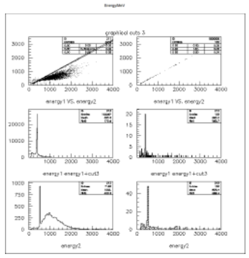
5- time calibration for the acquisition system

6- check neutron energies using TOF with the 2 plastic scintillator detectors





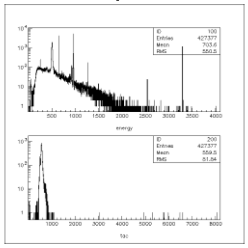
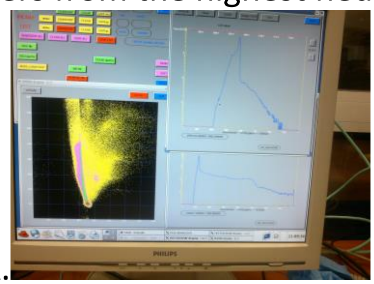
7- data analysis



CONCLUSIONS UP TO NOW

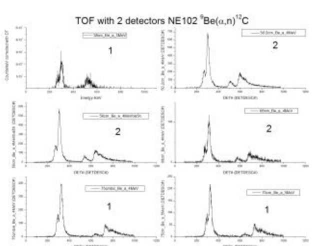
FNS100

The FNS10 detector works fine, detecting neutrons.
The data from the first run has several spikes and the acquisition system needed several improvements. The extra peaks from the data are mostly

probably due to accelerator sparks recorded by the FNS100 detector due to its internal construction. 
We decided to run again to get a clean spectrum.
At the second run of only 12 hours the statistics is very low and the acquired spectrum goes as high as three quarters from the highest neutron energy, so the spectrum has no full energy peak. 
Multi-parametric spectra were analyzed using PAW and the method we used could separate parts of the neutron spectra by risetime after the corresponding phenomenon taking place inside the detection gas of the FNS100 detector.
Thus the electronic acquisition and the analysis method were successful for our experiment proposal purpose.

TOF

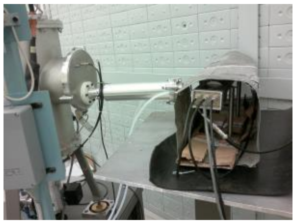
The TOF method was used to see the neutrons energies. It came out a wide spread of the neutrons energies due to an unknown cause at that moment.



Based on the fact that recently this accelerator situation was corrected, a new run is required to get mono-energetic neutrons from the nuclear reaction necessary for the FNS100 and for TOF for a selected solid angle done with an adequate paraffin shielding.

BEAM-LINE

The 3rd line CSM at the 3MV accelerator proved to have not the necessary space (length and wideness at the end of the line) to construct any shielding around the FNS100 detector or do a 0^0 TOF using the two NE102 detectors.




We want to continue our work at the 2nd line of the 3MV accelerator usually used for implantation, where we may have to do several adaptations to be sure we have a good current integration, besides the detector shielding constructions.

2017 PAC PROPOSAL

We ask for more time (7 days) to fulfill the proposal from 2016:

-work on the 2nd line IIB at the 3MV accelerator
-proton and alpha beams
-E_p = 2..6 MeV
-E_α = 3..4MeV
-borate paraffin bricks, copper sheets and cadmium sheets
-Pb bricks
-target cooling
-current integration system

In case this method proves to be correct, the FNS100 detector may be used in neutron spectrum characterization in experiments with neutron output with a high neutron rate.

REFERENCES

[1] Bubble Technology Industries Operational Manual for FNS-100