Study of "QGSP_BIC_HP" and "QGSP_BERT_HP" physics models to simulate neutron transport and transmutation by adiabetic resonance crossing in accelerator driven system

Abhijit Bhattacharyya*
Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA

Introduction

Transmutation by Adiabetic Resonance Crossing ($TARC$) [1, 2] concept was first conceived by Carlo Rubbia at CERN-PS facility to test physics concepts related to the radioactive waste management and due to concurrent fission process estimation of energy gained in Energy Amplifier. The Energy Amplifier (EA) [1, 2] is a fast neutron subcritical system driven where high energy proton from a proton accelerator is bombarded on a spallation target. For subsequent reactions, EA also contains neutron moderator, heat extraction agent and neutron confinement medium. Beside this, TARC facility may also generate radio-active elements for medical treatment through neutron capture on stable elements.

Natural lead is usually used as spallation target as it shows transparency to neutrons, possessing high and energy independent elastic scattering cross section, moderate slowing down effect owing to small lethargic steps and nearly isotropic elastic scattering helping long neutron storage [1, 2].

The present paper discusses simulation of neutronics for TARC comparing Geant4 physics models and also comparing with TARC experimental data establishing the reliability of this code.

Development of simulation tools

The simulation was performed using *Geant4* - 10.5.0-*beta* - *multithreading mode* - a toolkit written in *C++*. The results were compared for two physics lists namely (*QGSP Binary Cascade Model* $<\sim 10GeV$) and (*QGSP Bertini Cascade model* $<\sim 10GeV$) both coupled to *High Precision Model for neutrons* ($HP < 20MeV$). Here *QGSP* stands for Quark Gluon String Physics model.

While the paper compares results with two physics models as stated, simulation results are compared with TARC experimental data to check the reliability of the code. For this purpose, 2.5 GeV/c protons were used for spallation. The Geometry used in this simulation was taken from TARC group as $GDML$ file. This ensures possibility of transferring any geometry for test from CAD drawing to GDML directly.

Figures and Tables

Here, few results are presented.

Acknowledgments

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References

[1] The TARC Experiment (PS-211) report, CERN-99-11, Dec 15(1999)
[2] Results from the TARC experiment, NIM A, **478**, 577(2002)

*Electronic address: `vega@barc.gov.in,abhihere@gmail.com`

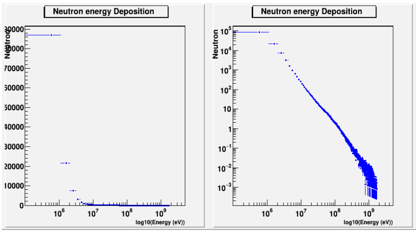

FIG. 1: Neutron Energy Deposition : QGSP_BIC_HP

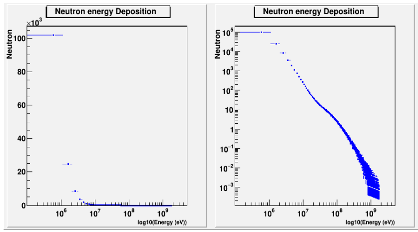

FIG. 2: Neutron Energy Deposition : QGSP_BERT_HP

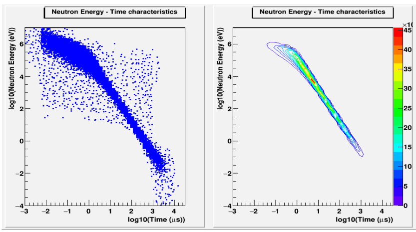

FIG. 3: Correlation of Neutron Energy - Time : QGSP_BIC_HP

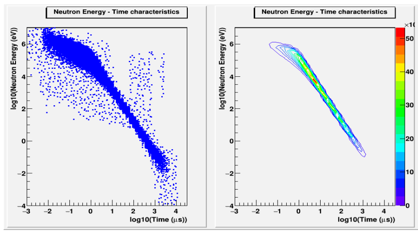

FIG. 4: Correlation of Neutron Energy - Time : QGSP_BERT_HP

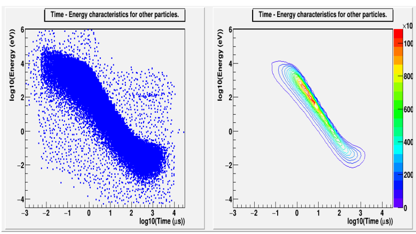

FIG. 5: Correlation of Other particles Energy - Time : QGSP_BIC_HP

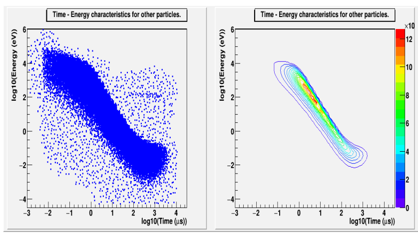

FIG. 6: Correlation of Other particles Energy - Time : QGSP_BERT_HP

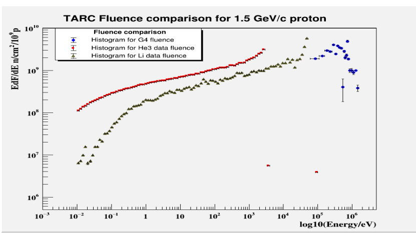

FIG. 7: Distribution of Fluence with Energy : QGSP_BIC_HP

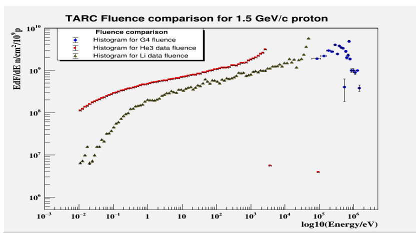

FIG. 8: Distribution of Fluence with Energy : QGSP_BERT_HP

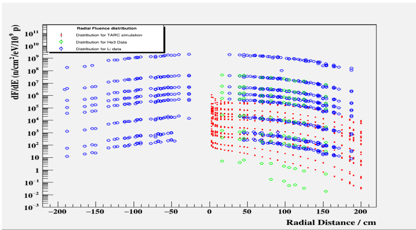

FIG. 9: Distribution of Fluence with Radial distance : QGSP_BIC_HP

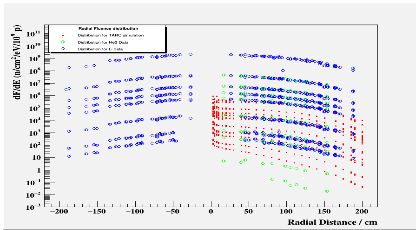

FIG. 10: Distribution of Fluence with Radial distance : QGSP_BERT_HP

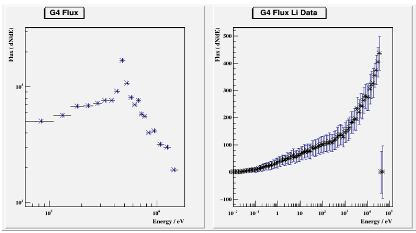

FIG. 11: Distribution of Flux : QGSP_BIC_HP

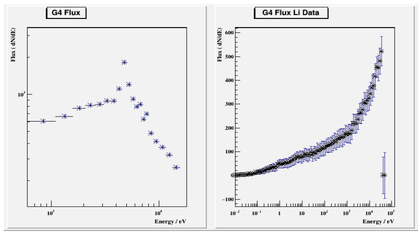

FIG. 12: Distribution of Flux : QGSP_BERT_HP

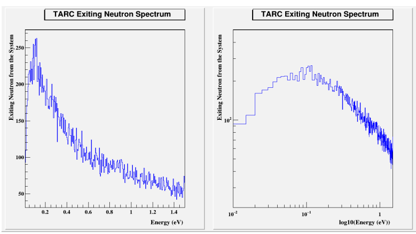

FIG. 13: Spectrum of neutrons exiting from the system : QGSP_BIC_HP

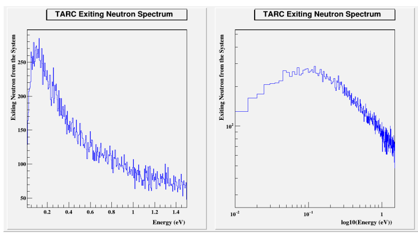

FIG. 14: Spectrum of neutrons exiting from the system : QGSP_BERT_HP