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DURGA: A novel facility in India to study capture gamma, fission fragment and decay spectroscopy

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The advent of high-efficiency γ ray spectrometers with multiple types of detectors, digital signal processing-based data acquisition system, and the realistic possibility of taking a stride in the hitherto unknown territory of nuclear landscape are driving the low- and medium-energy nuclear physics into the path of exciting exploration. With this in consideration, a novel facility, DURGA (Dhruva Utilization in Research using Gamma Array), has recently been developed in Bhabha Atomic Research Centre, Mumbai, India. The concept and possible utilization of the aforesaid facility is very unique in the sense that it is the only facility in the country (India) for carrying out "prompt" γ-ray spectroscopic investigation using thermal neutron beam.

The facility consists of eight Compton-suppressed clover Germanium detectors and sixteen $LaBr_3$(Ce) fast scintillators. The heart of the DURGA facility is a multi-frequency digitizer-based trigger-less data acquisition system. The digital acquisition system has been tailor-made for the aforesaid array of eight Compton-suppressed Clover Ge detectors and sixteen $LaBr_3$(Ce) fast scintillators, with a provision of expansion in future. The system boasts of many novel features which will be discussed.

Low-spin, low-excitation energy regime has always been a fertile ground in γ ray spectroscopy to explore several exotic nuclear phenomena, such as, β and γ vibration, multi-phonon structures, and even octupole-hexadecapole deformation. The facility is planned to be heavily used in studying Capture Gamma prompt and decay Spectroscopy (CGS). Apart from basic research, such studies will contribute in direct and immediate determination of presence of certain elements/contaminants in a given material/substance (in small quantity) in a non-destructive manner.

Nuclei with higher neutron-to-proton ratios are difficult to study in accelerator-based facilities using stable projectile and target combinations. One of the means to access and study the structure/properties of such nuclei is nuclear fission. Thermal neutron induced fission fragment spectroscopy will provide access to these difficult-to-reach nuclei, and study their medium- and high-spin nuclear structures in detail. Additionally, decay spectroscopy of the neutron-rich fission fragment nuclei will reveal/affirm the decay chain of isotopes and low-spin structures of daughter nuclei. A few preliminary/test experiments have already been carried out using the facility. Details on these measurements will be presented during the conference.

Primary authors: Dr MUKHOPADHYAY, Somsundar (Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai, India); Dr JOHN, Bency (Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai, India); Dr BISWAS, D. C. (Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai, India)

Presenter: Dr MUKHOPADHYAY, Somsundar (Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai, India)

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