Development of detectors for the diagnostics of ELI-NP photons beams

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The ELI-NP facility (Extreme Light Infrastructure - Nuclear Physics) is being built in Magurele, Romania and it is the pillar of the European project ELI, dedicated to the development of laser beams and the generation of high intensity gamma beams for frontier research in nuclear physics [1]. In particular, gamma polarized beams, made with ELI-NP, will have tunable energy in the range from 1 to 20 MeV and a monochromaticity and brightness of 1-2 orders of magnitude better than those at state of the art of similar gamma sources. The narrow bandwidth (0.5 %) of the gamma–ray beams allows for the selective population of individual excited states in nuclei opening new possibilities for nuclear photonics, astrophysics studies and for a wide range of applications. The ELI-NP gamma beam is obtained by Compton backscattering of a laser beam off relativistic electrons. It will consist of macro-pulses separated by 10 ms, which contain 32 micro-pulses with a duration of 1-2 ps and a separation of 16 ns.

A gamma beam with these features requires a characterization system [2] to provide detailed information on the intensity, the energy spectrum and the spatial distribution of the beam. The very short duration of the gamma pulse prevent to easly disentangle the response to each single photon by using any traditional gamma spectroscopic detector directly exposed to the beam. Therefore specific techniques and detectors must be developed to suit the gamma beam characteristics.

The project is to develope and characterize two separated detectors that rely on different approaches. The first is based on sampling Compton interactions of single photons in a micro-metric target. By measuring the energy and positions of the resulting electron and photon it's possible to measure the shape of energy spectrum with an energy resolution better than the expected bandwith of ELI-NP gamma beam. The advantage of this technique is the minimal interference with beam operation, making it an ideal tool also for beam energy monitoring. The second approach consists in a measurement of the total beam energy by absorbing the gamma pulses in a longitudinally segmented calorimeter. Using this kind of approach it's possible to measure the gamma average energy, obtained from the longitudinal profile of the energy deposition, and the beam intensity from the total energy release. The advantage of this approach is that the full photon statistics can be exploited and, using fast detectors, the measurement can be performed for every single pulse. The combination of the measurement performed by the Compton spectrometer and the absorption calorimeter will make possible to fully characterize the gamma beam energy distribution and intensity with the needed precision.

References

[1] The ELI-Nuclear Physics working groups. *The White Book of ELI Nuclear Physics*. Bucharest-Magurele, RomaniaSS.

[2] O.Adriani *et al. Gamma Beam Characterisation Design Report.* arXiv:1407.3669 [physics.acc-ph], Luglio 2014.