Diamond ΔE-E telescope with an ultra-thin ΔE-diamond detector

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Heavy-ion beams are used extensively in nuclear physics research, in production of rare isotopes, as well as in nuclear medicine. Currently, most charged-particle detectors used in nuclear physics and space exploration are made of ΔE−E radiation telescopes. In order to identify low energy heavy ions with high LET having very short ranges, the front ΔE-detector must be extremely thin, with a thickness less than 10 μm. The process for fabrication of ultra-thin single crystal diamond (SCD) free-standing films and membranes was improved and achieved thickness down to 5 μm with good thickness uniformity. Diamond ΔE−E telescope was made from 5 μm thick ΔE-detector and 500 μm thick E-detector. The telescope was attached to fast actuator (precision 10 μm) allowing scanning of the ion-beam core and the halo around the beam. The telescope was installed at the MARS spectrometer (Cyclotron Institute) and tested in vacuum with multiple alpha sources. Plots of ΔE vs. E demonstrated good spectral resolution around 100 keV for a ^{228}Th alpha source. Simulations with the LISE++ program indicate that the telescope will be suitable to measure low energy heavy ion beams at energies as low as 3 MeV/u for Au ions, and even lower energies for lighter ions. The diamond telescope will be superior to common Si telescopes having a low life-time in heavy ion-beams.