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Online detection of radioactive fission isotopes following laser accelerated proton induced fission of 238U

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To explain astrophysical phenomena, in particular those related to heavy nuclei synthesis and to verify theoretical models, we need laboratory nuclear reaction experiments under high en-ergy density conditions to get benchmark data.
In conventional linear accelerators the duration of proton pulses is of the timescale of many nanoseconds. If we use a high energy short-pulse laser, we can create similar proton pulses in a timescale of a few picoseconds and accordingly much higher intensity. Even in comparison to world leading proton accelerators like LANSCE in Los Alamos and FAIR at GSI in Darm-stadt, the intensity is one order of magnitude higher. Already today, this provides a larger particle intensity for the nuclear processes, although still lower than in astrophysical scenar-ios.
The experiment was performed at the Petawatt High-Energy Laser for Heavy Ion Experiments (PHELIX) at GSI. By using laser pulses of 0.7 ps duration with energies up to 200 J, proton pulses in excess of 1012 protons with energies up to 70 MeV were achieved. These pulses were used for proton induced fission of 238U.
In this experiment, an on-line detection method was applied. A key problem to be solved was the impact of the elector-magnetic pulse perturbation on the very sensitive nuclear detector.
A gas flow in a capillary tube provided rapid transport of the fission products over several meters to a germanium detector. Different gases were used to optimize capture and transport and to reduce radioactive background from the activated gas. The fission products were caught in a carbon filter in direct contact to the detector. Since all fission isotopes are pro-duced almost instantaneously, short-lived isotopes could be studied in detail, and avoiding the background from the longer lived nuclei. So it was possible after a few seconds to identify short-lived isotopes.
This demonstration represents a first step to illustrate the relevance of laser-accelerated par-ticles for applications in nuclear physics.

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