

Status of the PRIOR Project*

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High energy proton microscopy (HEPM) is a novel diagnostic technique for probing the interior of dense objects. Using HEPM, it is possible to image an object with high spatial resolution and to reconstruct its density distribution with sub-percent accuracy. The PRIOR (Proton Microscope for FAIR) facility will be the first magnifying proton radiography system, which will use mono-energetic protons in the multi-GeV-range. This will allow to reach a spatial resolution of less than 10 μm and a time resolution of about 10 ns.

The GSI accelerator facility is able to deliver up to 4.5 GeV protons in bunches of 10^{10} particles from the SIS-18 synchrotron to the HHT experimental area, where PRIOR is being installed. The HHT area had to be modified due to a large drift length needed for the imaging system. Additional shielding and beam dump have been built in order to fit safety requirements.

The ion optical system of PRIOR contains four permanent magnetic quadrupoles (PMQs) made of an NdFeB alloy. Their pole tip field is about 1.83 T with an inner aperture of 30 mm. Between the second and the third PMQ, the protons are sorted by their scattering angle in a Fourier plane by a collimator (Fig. 1).

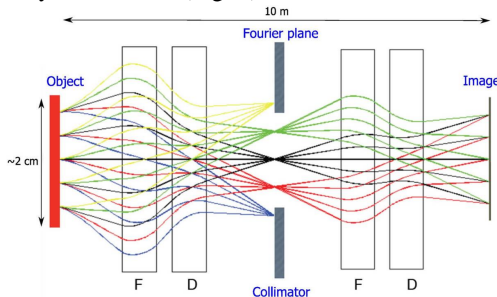


Figure 1: Proton trajectories in the ion optical system of PRIOR.

The PRIOR PMQs have been manufactured at ITEP, Moscow, and were assembled at GSI on a high precision rail with motorized tables. The next step will be to perform high accuracy field measurements in order to adjust the lenses precisely and include the obtained results into the simulation codes. Furthermore, vacuum and alignment systems have to be constructed and cameras and a scintillator screen as detectors have to be installed. Commissioning of PRIOR as well as first experiments will start within 2013.

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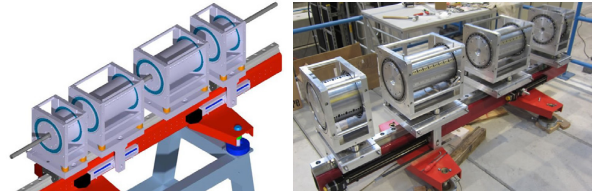


Figure 2: PRIOR PMQ setup

One of the first proposed experiments with PRIOR will be related to the PaNTERA (Proton Therapy and Radiography) project [1], to investigate the feasibility of using HEPM as an imaging method in particle therapy. First studies have already been made at ITEP in 2011 [3], producing the first radiograph of a zebra fish using an 800 MeV proton beam. Those experiments were continued at the pRad facility at the Los Alamos National Laboratory. A set of PMMA-targets, encapsulated fishes, a mouse and the MATROSHKA human phantom (Fig. 3) were used as test objects with a biologically relevant structure [2]. This experiments will be continued with PRIOR at GSI and at FAIR making it possible to achieve much higher precision.

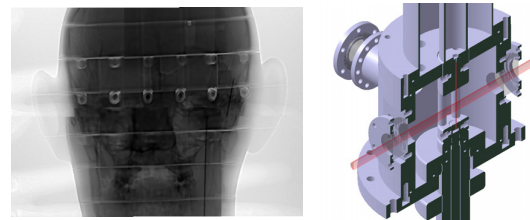


Figure 3: Proton radiograph of the MATROSHKA head taken at pRad (left) and the new setup for UWE experiments (right).

PRIOR will be also used in HEDP dynamic experiments. The first one will use a setup for Underwater Electrical Wire Explosions (UWE), which is currently designed in cooperation with Technion, Haifa. At FAIR, PRIOR will be the key diagnostic tool for the HEDgeHOB collaboration experiments.

References

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