## 22nd International Workshop on Radiation Imaging Detectors



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## High-contrast proton radiography of thin samples with the pixel detector Timepix3

We examined the application of proton imaging [1] on thin samples at the proton and light-ion Tandetron accelerator [2] of the NPI-CAS in Rez near Prague. We make use of high-sensitivity hybrid semiconductor pixel detectors Medipix/Timepix equipped with integrated per-pixel signal processing electronics. We use the Timepix3 ASIC chip [3] equipped with a 500  $\mu$ m Si sensor operated with the fast data rate AdvaPix readout electronics interface.

Measurements were performed in air with a 2.9 MeV proton microbeam on thin samples (< 100  $\mu$ m thick). Mylar and aluminium foils were stacked into closely packed assemblies of varying well-defined thickness. The samples were placed in front of the detector in orthogonal geometry (beam axis perpendicular to the sensor plane –see Fig. 1). Radiographies were collected with standard (few mm size) and a focused microbeam (few  $\mu$ m size).

The imaging principle is based on high-resolution spectrometry of single transmitted particles. Contrast is obtained by registration of small changes in the deposited energy of the proton after passing through the sample [4]. These changes can be measured in wide-range by detailed spectral-tracking analysis of the pixelated clusters in the detector [5]. The track parameters we utilize for imaging contrast are deposited energy, cluster area (number of pixels) and cluster height (maximum energy value of the pixels in the cluster) [5]. The position of interaction in the detector is registered in sub-pixel resolution [4] down to few  $\mu$ m scale for the particles and geometry used [6]. Radiographies are reconstructed based on these individual parameters imaged in image bins of adjustable size (few  $\mu$ m up to few tens of  $\mu$ m). The radiography of a sample assembled from several aluminium foils stacked in stairs geometry is shown in Fig. 2. No post-processing was applied in the image. The technique developed with different cluster parameters will be presented together with evaluation of image contrast sensitivity on various types of samples and beam energies.

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[5] Granja, C., et al. Resolving power of pixel detector Timepix for wide-range electron, proton and ion detection Nuc. Inst. Met. A 908 (2018) 60-71

[6] Granja, C., et al. Directional detection of charged particles and cosmic rays with the miniaturized radiation camera MiniPix Timepix Nuc. Inst. Met. A 911 (2018) 142-152

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