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Contrast resolution limits of Timepix detector based on semi-insulating GaAs material sensor

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Semi–insulating (SI) GaAs is one of the perspective candidates for fabrication of semiconductor X–and gamma–ray detectors applicable in digital radiology instrumentations. Advantage of the bulk SI GaAs is the possibility of fabrication of a monolithic strip or matrix detectors in one substrate due to the creation of the space charge region under each blocking contact. We fabricated pixelated sensor using undoped SI GaAs substrate with thickness of 350 um. The detection area has a size of 14.1 × 14.1 mm2 with 256 × 256 pixels and was connected to Timepix readout chip [1].
In our previous work we compare imaging performance of GaAs-based Timepix detector with Si-based sensor, concentrate on detection efficiency, energy resolution and imaging performance [2]. Overall, prototype GaAs sensor shows very good and promising results in all aspects. In this work we concentrate on contrast resolution limits. For experiments we used various type of testing objects. Using nanomachining we fabricated steps from aluminium board. The height of steps is variable and changed from 2 um up to 100 um. The X-ray source with micro-focal spot size (about 8 um) was used in testing contrast resolution. GaAs sensor can operate at positive and also negative polarity. All our presented results were done at positive polarity. Now we study also the imaging performance at negative polarity of GaAs sensor. The advantage is that the space charge region is spreading from further part of GaAs material to Timepix readout chip surface. We have no dead layer if the sensor is not fully depleted. The drawback is higher reverse current (about three times) and worse energy resolution but the detection efficiency is much better especially for energy of X-rays below 20 keV. The silicon based Timepix detector was also used for comparison discussion of obtained results.

REFERENCES
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