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Operation of an InGrid based X-ray detector at the CAST experiment

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The CERN Axion Solar Telescope (CAST) is searching for axions and other particles which could be candidates for Dark Matter and even Dark Energy. These particles could be produced in the Sun and detected by a conversion into soft X-ray photons inside a strong magnetic field. This field is provided by a decommissioned LHC prototype dipole magnet accurately pointed towards the Sun. In order to increase the sensitivity for physics beyond the Standard Model it is unavoidable to deal with low energies and weak couplings resulting in very low detection rates, therefore requiring efficient background rejection methods as well as a detection threshold below 1 keV.

Those criteria are fulfilled by an InGrid based X-ray detector. The InGrid (Integrated Grid) combines the high spatial resolution of a pixelized readout with a highly granular Micromegas gas amplification stage. Application of photolithographic postprocessing techniques allows for fabricating the amplification grid directly on top of the pixelized readout, e.g. on a Timepix ASIC. This results in a close to perfect match of grid and pixels facilitating the detection of single electrons on the active chip surface. The energy of an X-ray photon can be determined by simple electron (or pixel) counting and the good spatial resolution allows for using an event-shape analysis for background rejection. The detection threshold of such an InGrid based X-ray detector was explored at an X-ray generator and found to be well below the carbon K-alpha line at 277 eV. In an optimized setup an energy resolution of down to 3.85 % at 5.9 keV could be achieved.

After the successful demonstration of the detectors key features like e.g. the low detection threshold, the detector was mounted at one of CAST's four detector stations behind an X-ray telescope in 2014. After several months of successful operation without any detector related interruptions the InGrid based X-ray detector continues data taking at CAST in 2015.

As a result of the successful operation background rates in the order of 10E-5 /keV/cm²/s will be presented along with the likelihood based method used to discriminate the non-photon background originating mostly from cosmic rays. As well future detector upgrades like integrated veto scintillators, sampling of the analog signal induced on the grid and ultra-thin detector windows will be shown as an outlook.

Primary author: Mr KRIEGER, Christoph (University of Bonn)

Co-authors: Mr KAMINSKI, Jochen (University of Bonn); Prof. DESCH, Klaus (University of Bonn); Mr LUPBERGER, Michael (University of Bonn)

Presenter: Mr KRIEGER, Christoph (University of Bonn)

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