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Advances in GEM-based cryogenic avalanche detectors

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Cryogenic avalanche detectors combine dense noble gas media at cryogenic temperatures with electron avalanche multipliers, namely with Gas Electron Multipliers (GEMs) or thick GEMs (THGEMs). Such detectors are relevant in the field of rare-event experiments, in particular in those of coherent neutrino-nucleus scattering, dark matter search and solar neutrino detection, and in the medical imaging field such as Positron Emission Tomography. We summarize the recent progress made in cryogenic two-phase avalanche detectors, including those operated in Ar and Xe, with THGEM charge readout and with Silicon Photomultiplier (SiPM) optical readout.

Summary (Additional text describing your work. Can be pasted here or give an URL to a PDF document):

See http://www.inp.nsk.su/~buzulu/TalkSummary.pdf

See also text below:

We summarize the progress made in cryogenic two-phase avalanche detectors since the last Vienna Conference. We consider the performance of two-phase Ar avalanche detectors, in particular the charge readout using THGEMs and the electron emission processes through the liquid-gas interface. These are illustrated in the following figures, showing gain-voltage characteristics of THGEMs in two-phase Ar compared to that of thin GEMs and the effect of disappearance of the slow electron emission component in two-phase Ar doped with N2.

We present new results on cryogenic avalanche detectors operated in Ar and Xe, with THGEM charge readout and with Silicon Photomultiplier (SiPM) optical readout. In particular the following two figures show preliminary results on gain characteristics of a single- and double-THGEM multiplier respectively measured in Xe, for the first time at cryogenic temperatures. In the latter case the THGEM performance in saturated Xe vapour, i.e. in a two-phase mode, is demonstrated. The data were obtained in a new dedicated experimental setup developed in 2009, with a 9 l cryogenic chamber, which will be also described.

We also present the results on SiPM-based optical readout of the avalanche signal from the THGEM multiplier operated at cryogenic temperatures in Ar and Xe. This technique is of interest for the development of two-phase avalanche detectors having an ultimate sensitivity, namely single electron sensitivity at reduced noises, which is of primary importance for coherent neutrino scattering and dark matter search experiments. The following figure demonstrates the ability of SiPM to effectively detect optical signal from the double-THGEM in two-phase Ar. The figure shows the signal from a 1 mm2 SiPM (upper trace) placed behind the second THGEM and that from the double-THGEM (lower trace), induced by a 60 keV X-ray at THGEM gain 1000, SiPM gain 5*105, liquid Ar layer thickness 0.6 cm and electric emission field 2 kV/cm.

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