Contribution ID: **60** Type: **Oral presentation**

Characterization of Hamamatsu MPPC for use in liquid xenon scintillation detectors.

Friday 15 June 2012 14:00 (20 minutes)

Liquid xenon is an excellent scintillator with large atomic number, relatively high density, high light yield and short decay time which makes it suitable for a number of applications in particle physics, astrophysics and nuclear medicine. In particular, large liquid xenon detectors are being used in several dark matter experiments. While in most cases the optical readout is done with photomultiplier tubes (PMTs), the possibility of replacing the PMTs by solid state devices such as silicon Multi Pixel Photo Counter (MPPC) are currently under investigation.

There are three main difficulties in using MPPC in a xenon scintillation detector. first, xenon scintillation spectrum lies in the short wavelength region centered at 175 nm. Therefore, for efficient detection of liquid xenon scintillation the photodetectors have to be sensitive to the VUV light. Second, they have to be compatible with high purity liquid xenon environment. Third, they must perform under rather severe conditions, namely, low temperature (about -100°C) and external pressure variations. On the other hand, cooling down the device in many cases helps to considerably reduce the noise, in which case the cryogenic conditions turn in fact into an advantage.

In this work we present the performance results for several types of MPPCs (Hamamatsu) operating at temperatures down to -100°C. Under these conditions, the devices demonstrated drastically reduced noise count rate (<1 Hz for >1 photoelectron) and elevated gain (>10^6). On the downside, the quantum efficiency for the xenon scintillation light is quite low (~3%) compared to a typical PMT (20-30%). Also the afterpulsing fraction seems to increase at low temperature (up to ~20% probability per photoelectron). The operation of MPPCs immersed in liquid xenon will be reported.

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Session Classification: SiPM