Contribution ID: **134** Type: **Oral**

An extreme high resolution Timing Counter for the MEG II experiment

Monday, 25 May 2015 16:35 (15 minutes)

The development of a Timing Counter detector with a ~30ps resolution is presented. The detector has been designed for the upgrade of the MEG experiment, looking for the μ->eγ decay with an improved sensitivity of about a factor 10 with respect to the previous MEG setup.
It is based on 2 sets of scintillating pixels arranged on a semi-cylindrical structure (this shape being optimized to fit in the MEG spectrometer); each sub-detector consists of 256 counters. Each pixel is made of a 120x50x5mm3 tile of fast scintillator, with a dual-side read-out based on SiPMs arrays in series connection. The pixelated structure has 2 main advantages:
- pixel sizes allow to achieve optimal resolution (~75ps) for the single module, since uncertainties in e+ path length and in scintillation light arrival time to the SiPMs are small;
- a signal e+ crosses more than 1 pixel (mean number from MC is ~9) thus improving resolution by averaging the times measured by hit pixels.
The pixel design has been studied using e- from a 90Sr source, comparing different scintillators, pixel sizes and SiPMs, in order to find the best devices and materials to be used. Prototype with few pixels has been built and tested both in BTF and PSI facilities in order to prove the multi-hit scheme in MEG-like beam conditions. A ~35ps resolution with 8 hits has been obtained with e+ beam @100kHz. The R&D is currently finished: the first sub-detector will be tested in the MEGII pre-engineering run planned at the end of 2015.

Collaboration

MEG II Collaboration

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Session Classification: Photo Detectors and PID

Track Classification: S2 - Photon Detector and PID