**Abstract**

The lepton flavor violating decay $\mu \to e\gamma$ is being searched for by MEG experiment. We plan to upgrade the experiment to search for the decay with a better sensitivity. In this poster, upgrade for positron timing counter, which result in a reduced accidental background, is described. We are developing a pixelated timing counter composed of many small plastic scintillator pixels with SiPM readout. Single pixel R&D and simulation study on detector performance are presented.

$\mu \to e\gamma$

In MEG experiment, we search for the lepton flavor violation decay, $\mu \to e\gamma$, which is forbidden in Standard model(SM). However, beyond SM theories such as SUSY predict large branching ratio $\sim 10^{-12}$, $10^{-14}$.

**Present MEG ➔ upgrade**

Present MEG set the most stringent upper limit of $5.7 \times 10^{-12}$ using data taken in 2009 - 2011. We are already exploring the region predicted by BSM physics. The search with better sensitivity is of great importance. Thus we plan to upgrade the experiment to improve the sensitivity to push the down the sensitivity to $5 \times 10^{-14}$.

**Detector upgrade**

1. Double the beam intensity ($7 \times 10^{30}$ stopped $\mu$)
2. Replace stopping target (205 mm) with thinner (140 mm) or active target
3. Replace DC planes by larger single-volume DC with stereo wire configuration
4. Replace TC bars + PMT readout with pixels + SiPM readout
5. New high-bandwidth DAQ boards
6. Increase acceptance and improve coverage by modifying PMT layout at lateral walls
7. Replace PMTs on inner wall by SiPMs

**Positron timing counter**

For reducing background better positron timing counter is required. We employ small plastic scintillator counter with 3 SiPMs each side. ~600 counters will be set at upstream and downstream. It has a lot of advantage such as following:

- **A higher level of segmentation**
- **Using multiple hit time**
- **Flexible detector layout**
- **small counter with SiPM**
- **A good timing resolution**
- **Less pileup**
- **Additional track information**
- **Insensitivity to magnetic field**

In addition, this new timing counter solves present problem such as Sensitivity to the magnetic field, large ambiguity along $Z$.

**Single Pixel R&D**

Obtaining good single pixel performance, single pixel test is done.

**Set up**

**Test Counter**

HAMA MATSU MIPPC (S10362-33-05OC)
3x3 mm2, 50mm-3600 pixels
- glued with optical grease (OKEH5626A)
- fast plastic scintillator BC422
- Source Si90 (2.28 MeV, 8-ray)
- Reference counter
- 5 × 5 × 5 mm
- Readout by a MIPPC
- Waveshaper (GAIN=20, 600 MHz bandwidth)
- Long cable before amplifiers
- Keithley Pico ammeter for MIPPC bias (HV)
- Bias 218V-222V (for series connection)

**Bias scan**

We took data with each over voltage. With higher over voltage resolution becomes better. Finally good resolution of 43 ps was obtained.

**Analysis**

Signal time is picked-off by Constant-Fraction method (~10%)
- very leading-edge is relevant to precise timing
- $e$ hit time is reconstructed by the average of times measured at the both ends resolution of test counter is evaluated from $(t_f + t_k)/2 - t_{ref}$

**Position reconstruct**

Position resolution is also calculated. Hit position can be reconstructed by $x \times (t_f - t_k)/2$ ($r$; scintillation light speed) and position resolution of 8 mm was obtained.

**Summary and Prospect**

- For MEG upgrade, the better performance positron timing counter is required.
- Pixelated timing counter with MPPCs and fast plastic scintillator is employed as new timing counter.
- As single pixel R&D, dependence on bias voltage, temperature, and position are investigated. We can obtain good timing resolution and position resolution.
- Pixel layout is also studied. By increasing number of hits, better resolution of 30-35 ps can be obtained.
- We did the beam test last week for multiple hit scheme test! Analysis is on going!