MEG II experiment:

Upgraded Liquid Xe Detector with SiPM

e⁺ drift chamber

& timing counter







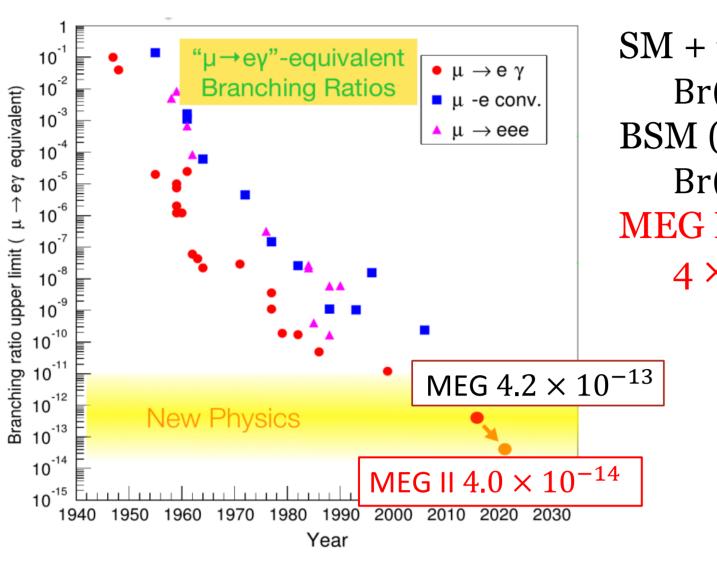
MEG II experiment

Upgrade of LXe γ detector

LXe detector

MEG II experiment will search for cLFV decay $\mu^+ \rightarrow e^+ \gamma$ with 10 times better sensitivity than MEG. Discovery of $\mu \rightarrow e\gamma$ will be a smoking gun signal of new physics.

Kei Ieki on behalf of the MEG II collaboration



SM + ν oscillation: $Br(\mu \rightarrow e\gamma) \sim 10^{-54}$ BSM (e.g. SUSY-seesaw): $Br(\mu \rightarrow e\gamma) \sim O(10^{-14})$ MEG II sensitivity: 4 ×10⁻¹⁴ (90% C.L.)

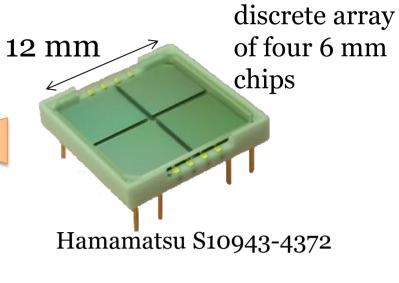
> Overview of the MEG II experimental setup

Liquid Xe (LXe) detector was successfully operated in MEG. LXe has an advantage of high scintillation yield (~75% of NaI), high stopping power ($X_0=2.8$ cm), good uniformity and short decay time (45 ns).

In MEG II, we replace the 2-inch PMTs at the γ -ray entrance surface with 12×12 mm² MPPCs.







In MEG II, we utilize μ^+ beam at PSI with 2 times higher intensity (~7×10⁷ μ /s). In order to cope with the increased amount of accidental BG, the detector resolutions (energy, position and timing resolution) will be improved by a factor of 2.

Upgraded detectors are expected to be ready by 2017.

Thanks to better uniformity and granularity, resolution will improve by a factor of 2!

MEG II MEG Position ~5 mm ~2.5 mm ~2% 0.7 - 1.5% Energy

- Development of new MPPCs which is sensitive to

light at VUV wavelength. → poster by S. Ogawa

- Mass test, signal readout, sensor alignment etc.

4092 MPPCs

installed!

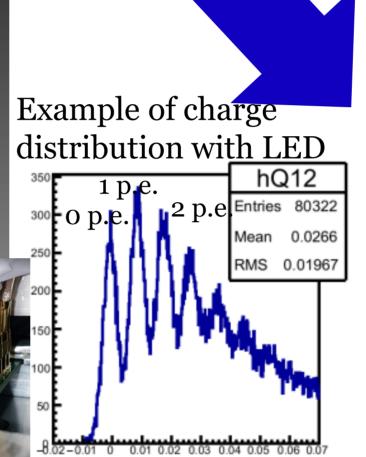
Mass test of MPPCs

Mass test in LXe

Operation test of ~600 MPPCs was done in LXe. We confirmed that the MPPCs and their signal transmission scheme (see below) work OK in LXe.

Bad connection was found for ~5% of MPPCs and signal cables. → Assembly procedure and connector design were revised.

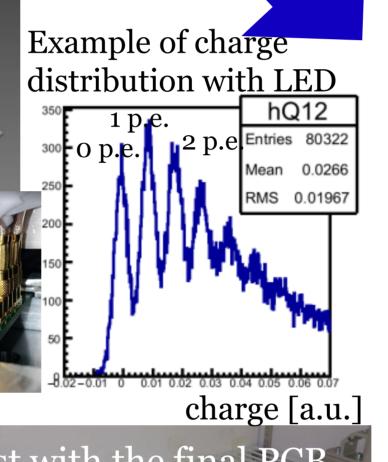
Setup for the test in LXe **PCBs** (12+12)

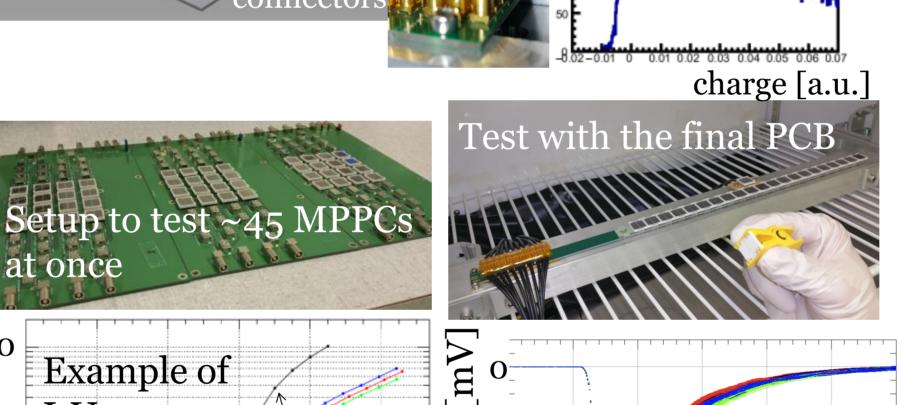


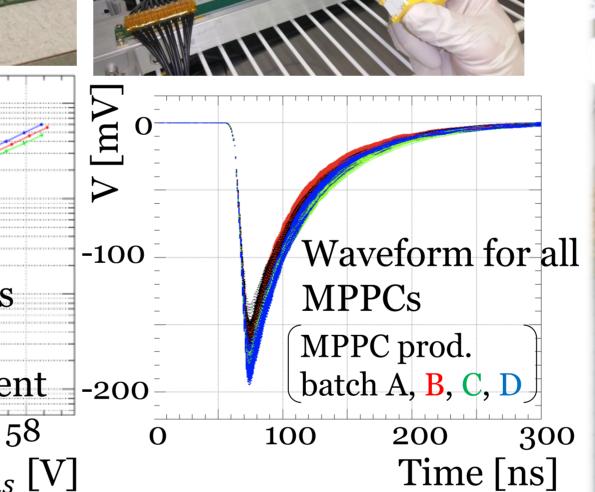
BG identification

Challenges:

counter







Test of all MPPCs in room temperature

All of the MPPCs (4092 pcs + spare) were tested in room temperature before installation.

I-V curve measurement was performed for all chips on all MPPCs. Some of the chips were identified as "bad" due to unexpectedly high/low current. The fraction of bad chips was only ~0.2%.

We mounted good MPPCs on the final PCBs. Waveform of all the channels was measured with LED light. There were 3 bad pins on the PCBs was found and replaced.

suspicious chip with high current -200 50 V_{bias} [V]

new pump

Construction of the detector

Construction is ongoing at the clean booth at PSI. All MPPCs and 60% of PMTs are installed.

at once

Example of

I-V curves

Signal transmission scheme

MPPC signal must be transmitted through a limited space of the cryostat. High density channels with small noise and small crosstalk is realized by using co-axial like structure PCB and PCB-based feed-through.

PCB + MPPCco-axial cable Waveform digitizer PCB-based feed-through co-axial like structure

Cryogenics

Cryogenics system is also being upgraded to cope with increased heat from 4092 MPPCs.

Additional GM refrigerator will be placed far from cryostat to prevent from noise. Sufficient power (430W @ 160K) of new GM refrigerator is already confirmed.

Mounting & signal check

PCBs are aligned on the CFRP boards. Spacers made of FR4 are inserted to the dead space. This is to reduce the material between MPPC and target and to keep high detection efficiency for γ .

the position scan is $\sim 100 \, \mu \text{m}$.

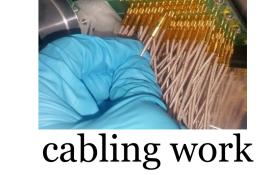
Position of the MPPCs are scanned with a FR4 laser scanning device (FARO). Resolution of

osition scan with scanned data Signal check

Cabling of MPPCs is ongoing. Signal check is being done with LED. MPPCs are illuminated by using a long bar which contains the LEDs and slits. Channel assignment of the cable is also checked.



LEDs Slits





Summary & prospect

The MEG II experiment will search for the $\mu^+ \to e^+ \gamma$ decay with unprecedented sensitivity. All of the detectors are being upgraded, aiming to start the operation in 2017. We have developed VUV-sensitive MPPCs for the upgrade of the LXe γ detector. All of the MPPCs are tested and already installed to the cryostat. The energy and position resolution of the detector are expected to improve from MEG by a factor of 2. We will complete the construction work and start the commissioning in this winter.

refrigerator external stage for GM refrigerator pulse-tube refrigerator