MEG II実験陽電子タイミングカウンターの コミッショニング2017 運用と試験 Commissioning of Positron Timing Counter for MEG II Experiment in 2017 – Operation and test-

宇佐見正志、他MEG IIコラボレーション 日本物理学会第73回年次会、東京理科大学(野田キャンパス) 2018年3月25日

Outline

★Introduction

*µ → eγ search
*MEG II Experiment 2017 detectors
*Timing counter
*2017 Commissioning

★Operation

★Summary

2

 $\mu \rightarrow e \gamma$ search

★charged Lepton Flavor Violation (cLFV) is one of the clear evidence of new physics

 $*O(\sim 10^{-54})$ @SM with neutrino osc. $*O(\sim 10^{-14})$ @Many models like

- SUSY-GUT
- SUSY-Seesaw
- Extra-dimension etc…

★MEG II experiment searches cLFV in this expected region! ★Br($\mu \rightarrow e\gamma$)~ 6×10⁻¹⁴ in 3 years!

SUSY-Seesaw Lorenzo Calibbi et al. "Flavour violation in supersymmetric SO(10) unication with a type II seesaw mechanism." JHEP, 0912:057, 2009.

SO(10) SUSY-GUT: S. Antusch et al. "Impact of $\theta_{13}\,$ on Lepton Flavour Violating processes within SUSY Seesaw" Journal of High Energy Physics 2006 (11), 090



MEG II Experiment 2017 detectors

★ The most sensitive $\mu^+ \rightarrow e^+ \gamma$ search with world's most intense muon beam in PSI



LXe & over all: A.M. Baldini et al. The design of the MEG II experiment arXiv:1801.04688v1 [physics.ins-det] 15 Jan 2018 DCH: Taken by DCH group in Dec. RDC: 2017年秋季大会大強度 μ+粒子ビーム中で動作する MEG II 実験輻射崩壊同定用カウンターの開発 <u>Successive Talks</u> Operation -> Calibration -> Evaluation (-> Time calibration counter for L⁰Xe)^{/26}

Δ

MEG II Experiment 2017 detectors

★ The most sensitive $\mu^+ \rightarrow e^+ \gamma$ search with world's most intense muon beam in PSI ★ LXe, TC, RDC was ready for commissioning 2017, tested



LXe & over all: A.M. Baldini et al. The design of the MEG II experiment arXiv:1801.04688v1 [physics.ins-det] 15 Jan 2018 DCH: Taken by DCH group in Dec. RDC: 2017年秋季大会大強度 μ+粒子ビーム中で動作する MEG II 実験輻射崩壊同定用カウンターの開発 <u>Successive Talks</u> Operation -> Calibration -> Evaluation (-> Time calibration counter for LXe)²⁶

Timing Counter (TC)

★TC is composed of small scintillation counters *256 US + 256 DS = **512 counters**

★6 series connected SiPM (AdvanSiD) + ultra-fast scintillator

★Using multi-hit information, achieve ~ 35 ps on average



Pictures: A.M. Baldini et al. The design of the MEG II experiment arXiv:1801.04688v1 [physics.ins-det] 15 Jan 2018

2017 Commissioning

- ★US & DS TC was installed with mock-up DCH
- ★Beam intensity follows MEG II expected intensity: $\sim 7 \times 10^7 \,\mu^+/s$
- ★512 ch readout electronics for 2 weeks
 - *Divide DAQ period on DS or US

★What's new in 2017?

✓ Full 512 counters (US & DS)
 ✓ Full laser system (next talk in detail)
 ✓ Cooling system



DS data taking



Outline

★Introduction

★TC Commissioning 2017

★Operation

*Cooling systems

Chiller test
 Current monitor

*Maintenance work

★Summary

8

TC Slow Control Systems

DAQ system picture : The design of the MEG II experiment arXiv:1801.04688v1 [physics.ins-det] 15 Jan 2018



Cooling systems: chiller test @ 20°C

- \star To determine the operation temperature, we checked the temperature stability of cooling systems
- ★ Radiation damage was one of the largest problem for TC operation

2dayş

10/29,23:59

10/28,00:00

- $* \sim 30\%$ time resolution deterioration @ 30 degree
- $* \sim 5\%$ time resolution deterioration @ 10 degree
- ★ First we checked @ 20degree

emperature(degree)

21

20

19

10/28,00:00

US: Chiller on



10/29,23:59

2018/3/26

Cooling systems: chiller test 10°C

 \star 10 degree operation test was conducted

 $\star \, {\rm To}$ avoid water due, we flowed dry air

- ✤ By dry air, we confirmed ~10% humidity suppression @ 20 degree
- ★ But dry air is room temperature, so temperature did not become stable
 ★ Cool dry air system is needed

Temperature of US TC









Outline

★Introduction

★Operation

*Cooling systems

- Chiller test -> 20 degree operation
- *****Current monitor
- *Maintenance work

★Summary

Current Monitor / Voltage Tuning

★ During beam test obvious current increase was observed due to radiation damage
 ★ This year's operation voltage was 1V higher than previous year based on "laser bias scan"
 ★ Operation voltage should be tuned based on current & resolution check with laser signal



%2016 commissioning current increase is calculated @ ~28 degree

2018/3/26

Time resolution plot

IV Monitoring

★ With the DAQ setup, we succeeded in continuously taking IV characteristic data of all US counters at once

★ Monitor as sensor to radiation damage, temperature and useful to determine the operation voltage etc ….



Temperature is a bit unstable@Nov.15 compared with the other data

TC Maintenance & Prospect

★Some bad counters were found @ Maintenance work, but we succeeded to operate most of counters properly

Minor problems (Problem # / All #)
*Laser fiber broken (~11/512 fibers)
*Temperature sensor broken (~6/192 sensors)
*SiPM broken (~1/1024 channels)
*Chiller broken (when shutdown)

In 2018 autumn DCH will be installed TC will be installed and operated in best condition With full detector, engineering run will start

Summary

★Commissioning for TC in 2017 was successfully finished *~2 weeks data taking, only 1 ch / 1024 ch broken *Systems tested & worked well during commissioning

★Cooling systems

*Chiller test was done for low temperature & stable operation
*20 degree operation was stable within ~1 degree, more dedicated system is needed for 10 degree operation

★Current monitoring / Voltage optimization

*Obvious current increase due to radiation damage, higher than 2016
 *Voltage tuning method with laser was developed
 *Continuous IV data is sensitive sensor to radiation damage

★In 2018 autumn, engineering run will start *TC will be in best condition by maintenance work