MEG II実験陽電子タイミングカウンターのコミッションング -エンジニアリングラン最初の結果–

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Overview of Timing Counter

Fast Plastic Scintillator
BC422, rise time 0.35 ns
attenuation length 8 cm
With reflector (3M film)

Optical Fiber
for laser light
Inter-counter time offset is calibrated by laser.

256 x 2
(up and down stream) counters

6 SiPMs in series at the both ends
AdvanSiD (Italy) 3x3 mm², 50x50 um² pixels

Cable (RG178)
Non-magnetic

σ~30 ps (with 9 counters)
was demonstrated.

Calibration → Next talk
M. Nakao

Back plane
Long PCB ~80 cm
Multi layer, coaxial like
¼ TC installation is Completed
TC Pilot Run

¼ counters are installed and tested in MEG II site, πE5 beam line at PSI in Switzerland.

• Beam: DC muon beam. Muons are stopped at target (~7x10^7 μ/s)
• Installed: ¼ TC, magnet, target, frame of drift chamber, DAQ full system

Goal

• Check mechanical integrity
• Operate TC all systems
  • counters, laser calibration systems, DAQ, trigger, slow control such as temperature and HV
• Apply full analysis
  • Measure positrons time
  • Calibrate inter counter jitter

Half of DS counters are installed.

256 x 2
(up and down stream) counters

126 counters

→ Next talk: M. Nakao
Installation and Assembly

- Mount the counters one by one and check the signals after cabling
  - To Check the signal from cosmic ray.
    - We did not check waveform detail behavior at that moment.

Signals from ALL counters!
Installation and Assembly

- Installation system are confirmed.
- We did not see any conflict b/w DCH and TC.
**DAQ**

- **Amplifier**
  - Factor 1, 10, **100**

- **Shaper**
  - Pole zero cancellation (on/off)

- **Digitizer (DRS)**
  - Sampling speed **2GHz**
  - Calibration of intra channels, and inter chips are not implemented in the system for the moment. *External calibration* were used for time.

- **Trigger**
  - Pedestal, Single hit, coincidence, Track-like, and Laser trigger are prepared.

- **Problems due to delay of preparation (to be fixed)**
  - Noise (> 10 mV RMS)
  - Half of ADC readout are not reliable; many dead channels and digital noise
  - Dynamic range is not optimized.
  - ...
Data Taking

• Data taking started on 14th Dec.

• Preparation for DAQ system was delayed.
  • We performed pilot run with several problems in DAQ system. (It will be fixed.)

• Waveform readout started on 19th.
  • DAQ debugging took time.
  • Meaningful data (from timing view point) were taken last 10 hours.
  • Data quality of the run is not so good due to several DAQ problems.

• What we did
  • Current check
  • Test several trigger configurations
  • Threshold scan
  • Debugging of DAQ system
  • Calibration
Current of each channel (6 SiPMs)

Operating current is < 10 uA at MEG II nominal beam intensity.

MEG-II 30% (~ MEG-I)

Beam started
Event

Typical clean event with multiple hits
Event

Event with multiple clusters
The hit rate is consistent with MC.
TC is operated at 50-150 kHz positron hits.

MC set up
- No DCH frame
- Muon beam (Muons which penetrate the target are also simulated)

Data
- Pedestal trigger data
- Count no signal events.
Timing Analysis

- Timing from the signal is calculated by constant fraction
- Cut
  - Energy and signal height cut are performed to remove saturated signal (due to problem of DAQ dynamic range) and too small signal.
- Use first hit, even if a counter has more than two hits.
- The difference b/w two adjacent counters. \((T_2 - T_1)/2\).
  - We don’t have enough data for analyze time with more than 3 hits.

Example of the signal height distribution

Problematic ADC

Used for analysis
Resolutions Compare with $^{90}\text{Sr}$ data

- Lab data with $^{90}\text{Sr}$ Calculated from single counter resolutions.
  - No energy correction, scattering effect, position dependence
- Optimal fraction is 35 % for the pilot run data, though it’s 20 % in lab test because of noise.
- With optimal fraction, difference of the resolution is $\sim15\%$ while expected decreasing from difference of energy deposit is $5\text{-}10\%$ from MC.
- Probably it comes from DAQ bad quality.
- We cannot conclude the reason because DAQ had problems.

*Mass production of the counters was reported in last JPS. Final counter resolutions are 70-80 ps.
*Fraction is for constant fraction analysis
**Summary of Resolutions**

With 2 counters the resolutions are

- 60-80 ps in the same chip, 70-100 ps in the different chip
- In Lab 55-65 ps is expected

The differences of the resolutions in the same or different chips come from the synchronization among chips.

→ Final chips will have the clock for the synchronization, and the effect will be small.
Plan and Status

Since DAQ system had problems, we plan another run with the same set up of TC and modified DAQ.

We are preparing remaining part:
- Machining of new support structure is on going.
- Mass production of the last pixels is currently on going.

Every staff will be completed in few months.
Summary

• Installation of $\frac{1}{4}$ TC was completed.
  • All counters worked properly.
  • Installation system is confirmed without any conflict with other detectors.

• Though we had DAQ problems, we succeeded to extract timing information.
  • With 2 counters the resolutions are 60-80 ps in the same chip, and 70-100 ps in the different chip.
  • They are worse than expected resolutions ~ 60 ps.

• In May we’ll have 2\textsuperscript{nd} pilot run with modified DAQ.
Back Up
Counter Mass Test

Check the resolution for every final counter. (measure at 3 points)
Trigger

Five trigger are prepared.
- Pedestal
- Single hit
- coincidence
- Track-like
- Laser

- Discriminator threshold scan
- Separation b/w signal and noise doesn’t seem so good.
  - Signal size should be large enough.
  - Baseline fluctuation (different offset over channels, event-by-event fluctuation) & large noise

Trigger rates measured with the TCB scalers

Linear
- TRG2: Single hit
- TRG0: Track-like
- TRG1: coincidence
- TRG3: Laser

Log
- Laser is flashed at 10 Hz

Discriminator threshold scan

$\log_{10} \approx 1.7 \text{ MHz}$