BESIII TOF Monitoring System

UH: Fred Harris, Jim Kennedy, Qian Liu, Steve Olsen, Marc Rosen, Chengping Shen, and Gary Varner
Crucial for particle ID and for fast trigger.

- **Barrel**
  - 50mm x 60mm x 2320 mm (inner layer).
  - BC408
  - 2 layers - 88 in each
  - Radius from 810 to 930 mm.
- **Endcap**
  - 48 fan shaped pieces - each end.
  - BC404
- **PMT**: Hamamatsu R5942 fine mesh
  - 2 on each barrel scintillator
  - 1 on each endcap counter
- **Resolution**
  - Barrel: $\sigma_T = 100$ ps
  - Endcap: $\sigma_T = 110$ ps

**TOF - IHEP TOF group**
**TOF electronics - USTC**
TOF Status Oct. 23, 2007
BESIII TOF Calibration System
(Fred Harris, Jim Kennedy, Qian Liu, Steve Olsen, Marc Rosen, Chengping Shen, and Gary Varner)

• Hawaii is building a state-of-the-art TOF calibration system for BESIII.
• Important as system monitor and for calibration.
• UH built such systems for both BESII and Belle.
• Major improvements:
  - Diode Laser
  - High quality multi fiber - fiber optic cable
BESIII TOF Monitoring System

- Monitor the amplitude and time performance of each channel including PMTs and electronics.

- Concept:
  - Use fiber cable bundles (2 cables) to distribute light to barrel and endcap TOF counters.
  - Use light splitter to illuminate one bundle at a time.
Use PicoQuant 440M Laser Diode.

- Simple to use and maintain.
- Long lifetime (6 k hours at full power).
- Peak power: ~1W
- Pulse width < 70 ps.
- Wavelength 440 ± 10 nm.
- Power stability 1% RMS.

BESIII TOF Monitoring System

- State-of-the-art TOF monitoring system built by Hawaii.
- Major improvements:
  - Diode Laser
  - High quality multi fiber - fiber optic cables

PicoQuant LDH-P-440M
Fiber Bundle Cables (need 2)

NOTES:
1) Cylindrical ferrule, suitable for clamping to, with strain relief.
2) If bundle feeds into break-out box, then it needs a mechanical termination suitable for sheet metal.
3) Customer will design panel or box, upon acceptance of fiber design.
4) Space constraints require that 32 fibers are able to terminate onto a (customer designed) panel 40mm x 80mm.

Barrel TOF

EC TOF
Fiber Bundles

Design done by UH in conjunction with vendors. Manufactured by RoMack Fiberoptics.
Distribution boxes built at UH.

Barrel fibers - each box supplies $\frac{1}{2}$ of one end.

Endcap fibers
Fiber relative time measurement

Scheme: measure relative times between each delivery fiber and a reference fiber with two reference PMTs.
Time difference measurement setup

Laser diode illuminating common end of bundle through diffuser.

Two distribution fibers connected to reference PMTs.
**Time difference measurement results**

**Barrel**
- Time diff. \( \sigma = 83 \text{ ps} \)
- \( M = 1.811771 \text{ ns} \)
- \( \sigma = 0.083239 \text{ ns} \)

**Endcap**
- Time diff. \( \sigma = 66 \text{ ps} \)
- \( M = -13.779988 \text{ ns} \)
- \( \sigma = 0.066638 \text{ ns} \)

**Ref. PMT**
- Pulse height \( \sigma = 0.8\% \)
- \( M = 1443.755673 \)
- \( \sigma = 11.196010 \)

**All other PMTs**
- Pulse height \( \sigma = 3.4\% \)
- \( M = 1606.430077 \)
- \( \sigma = 55.243983 \)

Measures PH stability of laser and length and light transmission uniformity of bundle fibers. Also illumination uniformity.
TOF Monitor System - Light Coupling

1. Laser diode
2. Beam splitter (5%-95%)
3. Prismatic beam splitters (50-50)
4. Shutters
5. Reference PMTs
6. Diffusers
7. Fiber bundles
Laser Box
Control Box - J. Kennedy

Supplies PMT voltages, solenoid currents, laser interlock, and laser pulse train. Accepts control pulses from USTC VME module. Interfaces to PC.

Xilinx programable board

Power supplies
All fibers successfully installed on east side of detector – Nov. 10, 2007.
2 layers of tubes

Fibers
Workers installing the fibers. Liu Qian (Hawaii) supervised installation at IHEP.
TOF Monitoring

10,000 laser pulses @ 1kHz

West Barrel TOF’s Tmean and Tsigma vs. PMT number.

Barrel Time of Flight - last run.

Barrel TOF's $Q_m$ and $Q_{sigma}$ vs. PMT number.

~5 % resolution

Liu Qian
Data Base Information for BIE01

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HV is stable.

Liu Qian
History Database (BIE01)
TOF monitoring status

• Liu Qian developed monitoring software and has developed a nice web user interface for people to check the results.

• Results can be correlated with run number, B, and HV. Will allow monitoring system performance with time.

The collaboration between IHEP TOF group, USTC (interface), and Hawaii on the TOF monitoring system has worked extremely well.