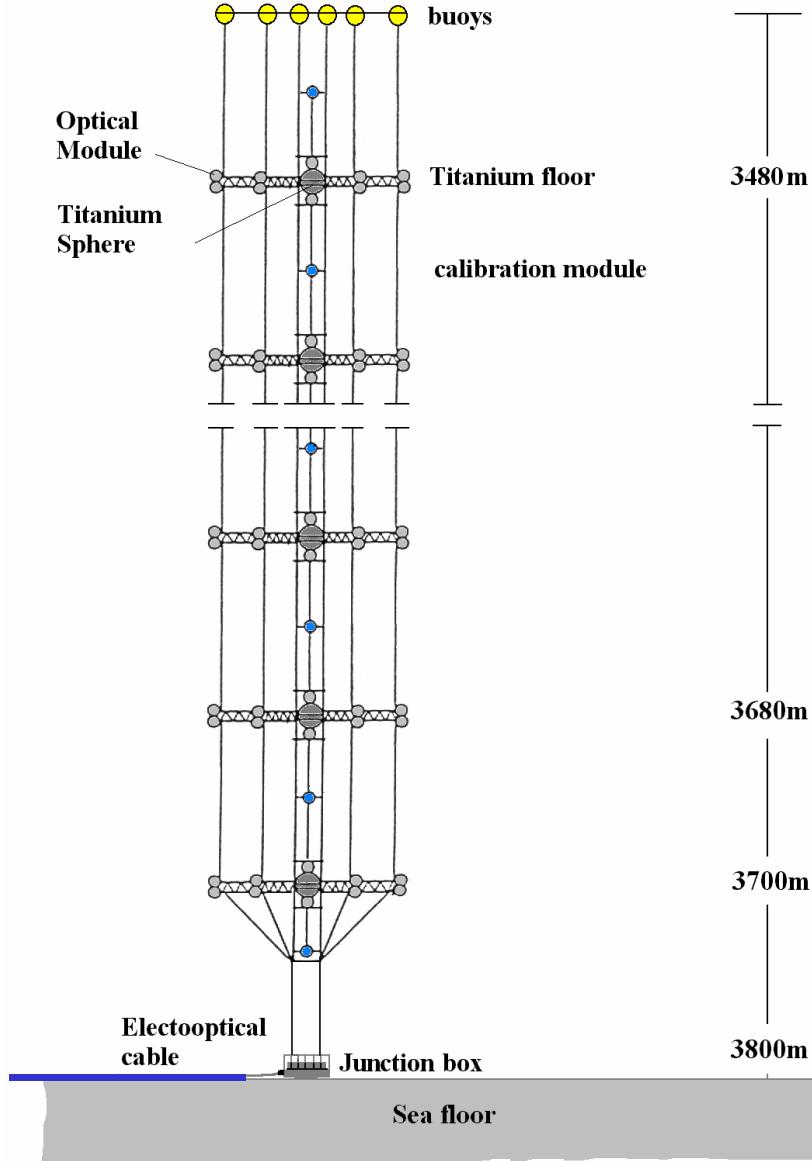


# NESTOR

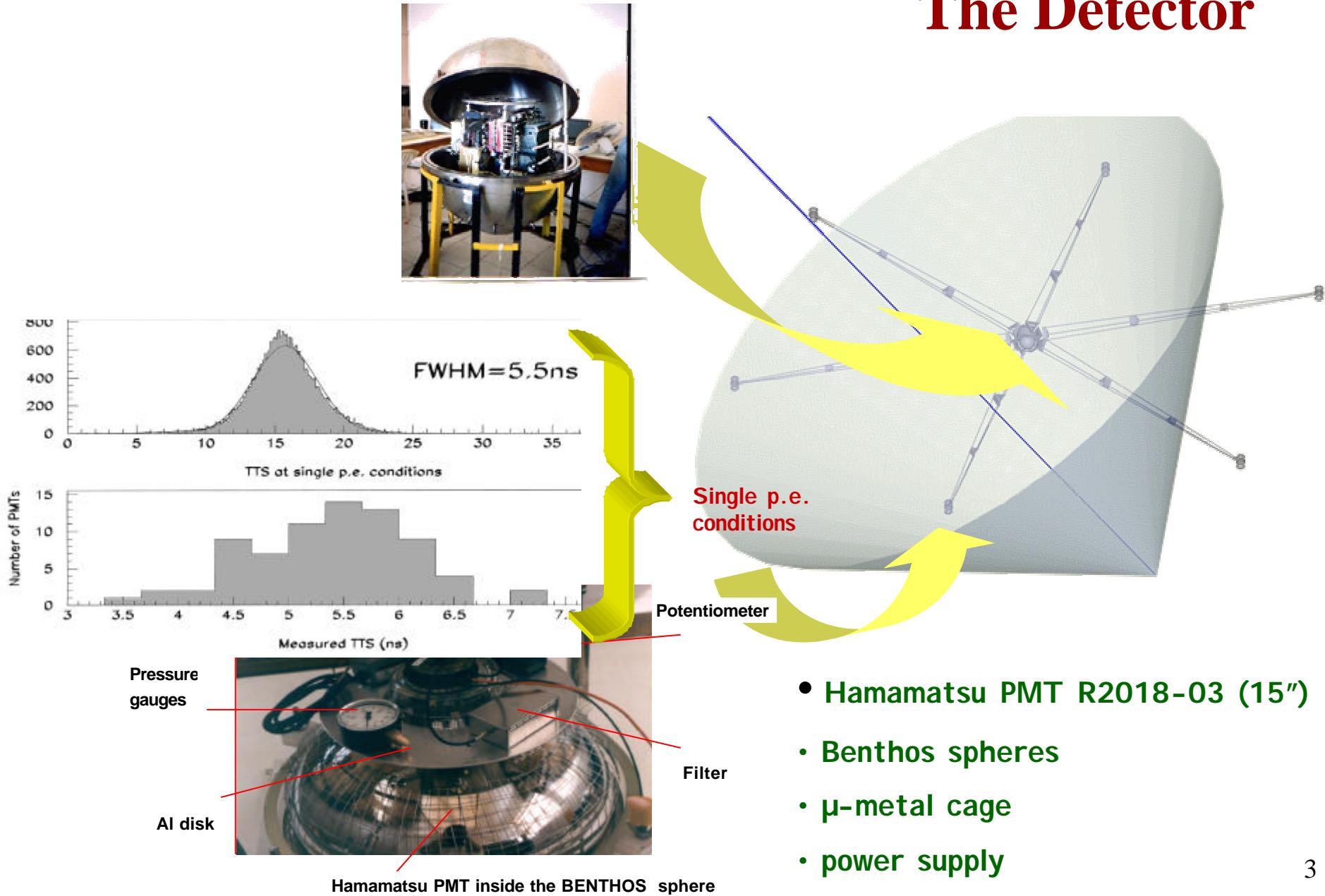
Neutrino Extended Submarine Telescope with Oceanographic Research

## Readout Electronics DAQ & Calibration

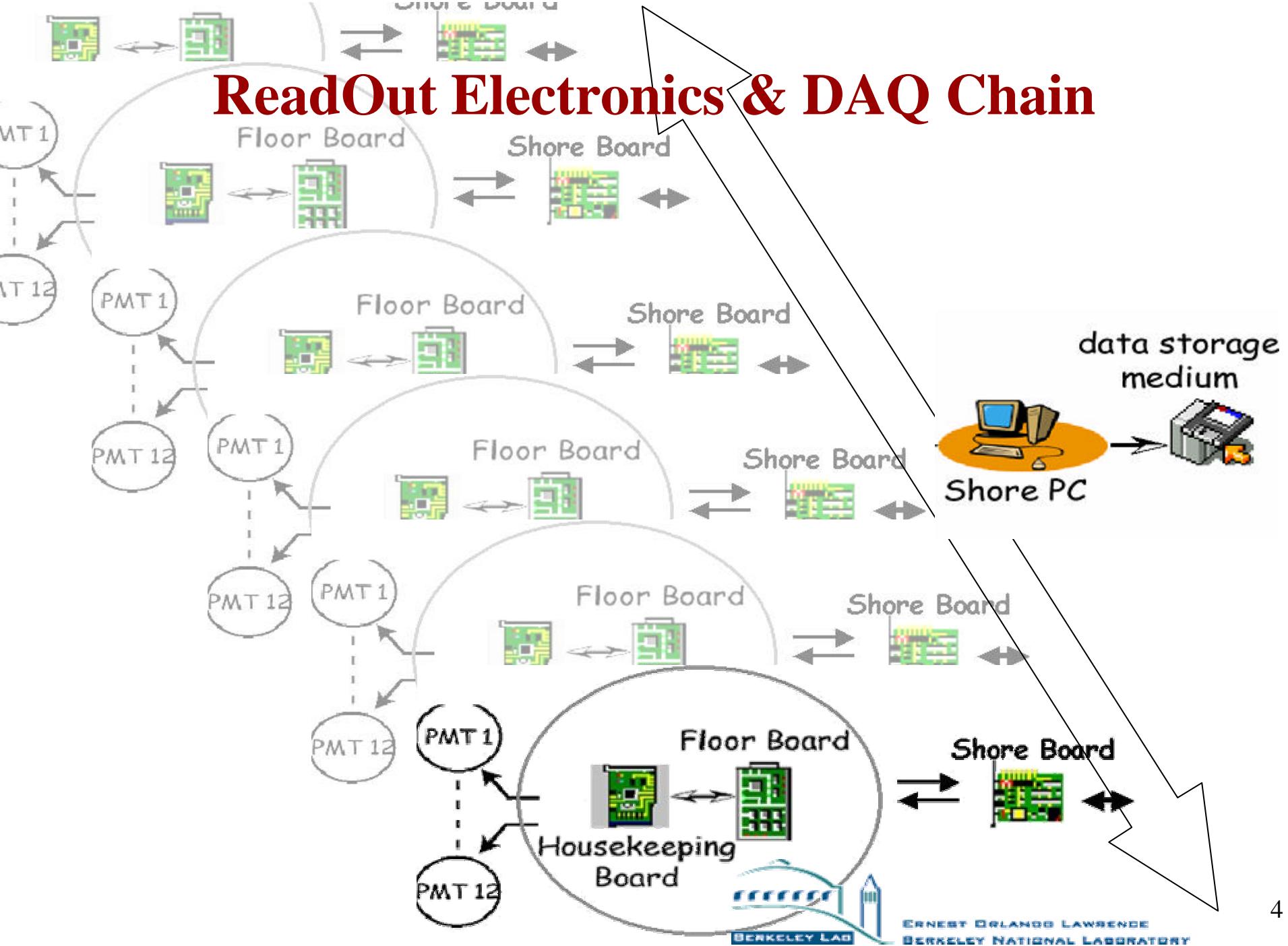
# NESTOR TOWER



# The Detector



# ReadOut Electronics & DAQ Chain



# Ti-Sphere Electronics

## Floor Board

- PMT pulse sensing
- Majority logic event triggering
- Single & coincidence rate scaling
- Waveform capture & digitization
- Data formatting & transmission
- FPGA & PLD reprogramming

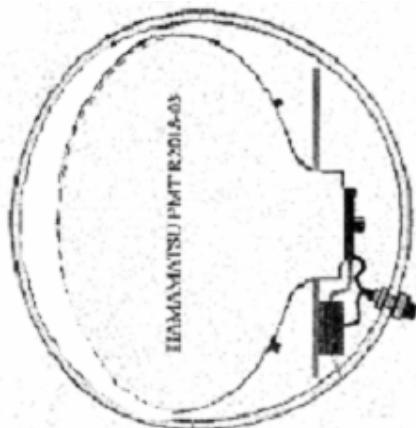
## House Keeping Board

- PMT control
- Calibration Beakon control
- PMT HV monitor
- Power Supply monitors
- Environmental monitors

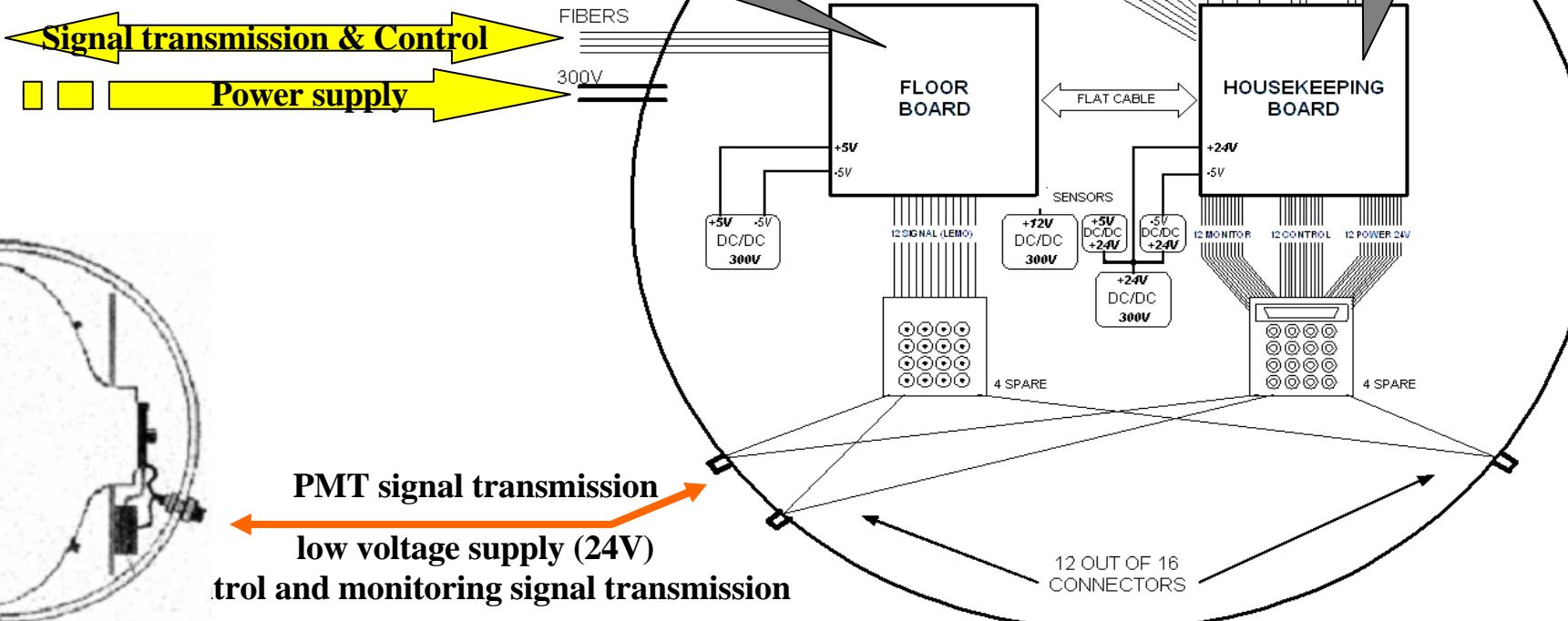
Shore  
Laboratory

Signal transmission & Control

Power supply



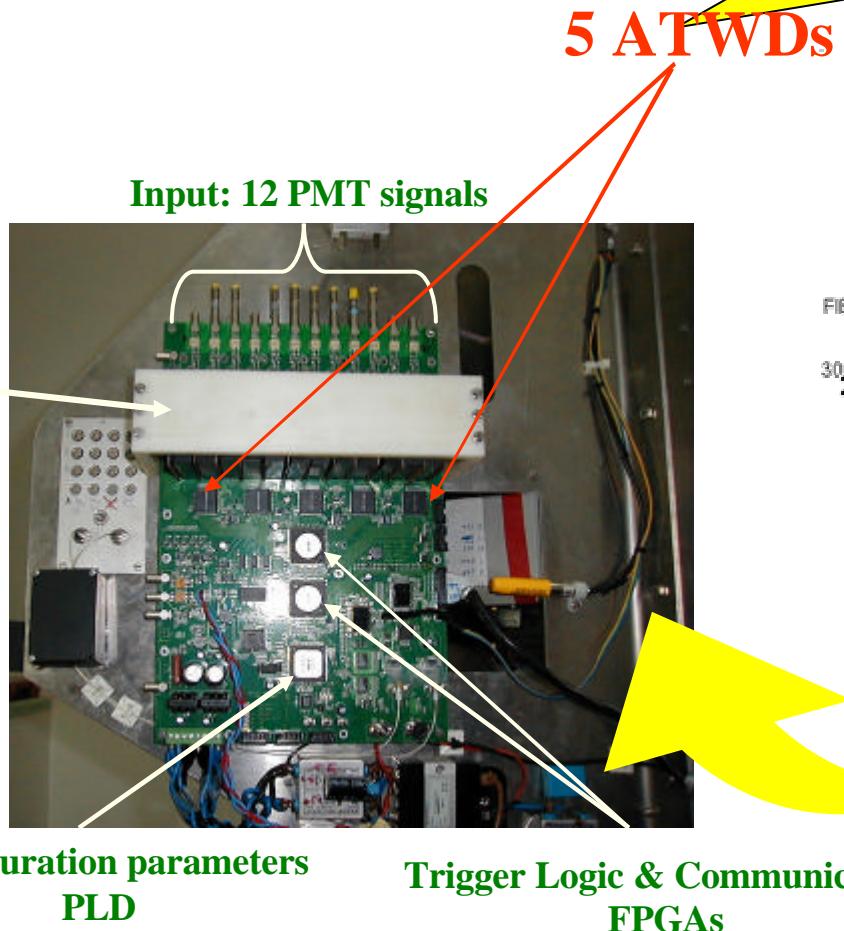
PMT signal transmission  
low voltage supply (24V)  
control and monitoring signal transmission



# Floor Board

- PMT pulse sensing
- Majority logic event triggering
- Single & coincidence rate scaling
- Waveform capture & digitization
- Data formatting & transmission
- FPGA & PLD reprogramming

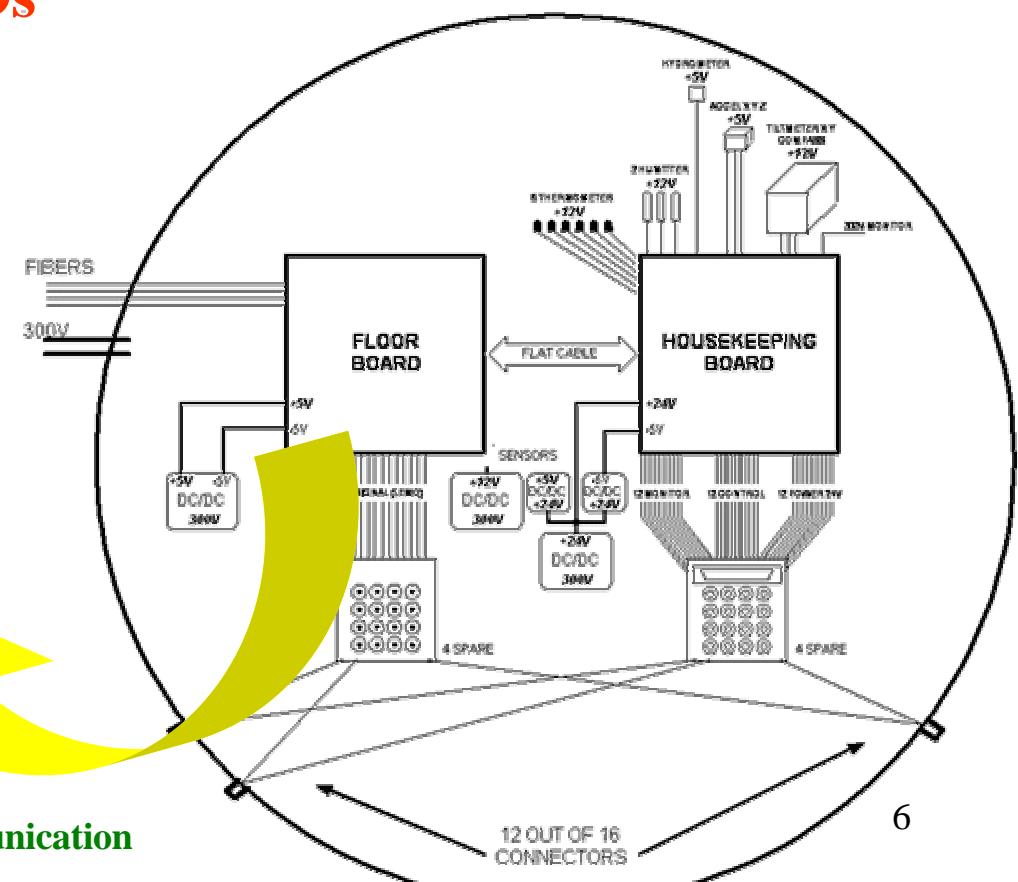
## PMT Signal Capture & Digitization



5 ATWDs

Configuration parameters  
PLD

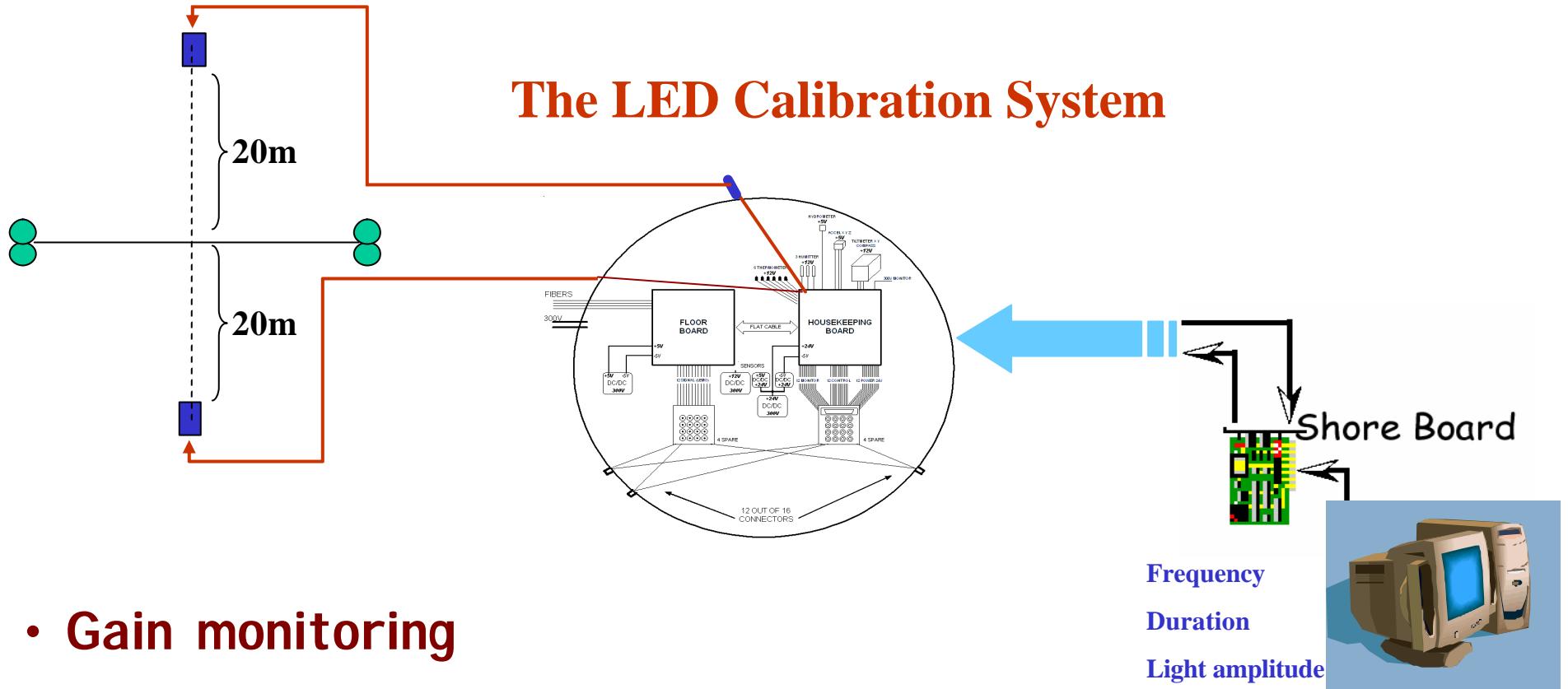
Trigger Logic & Communication  
FPGAs



12 OUT OF 16  
CONNECTORS

6

# The LED Calibration System



- Gain monitoring
- Timing
- Free running Calibration Trigger
- Adjustable Trigger frequency
- Adjustable LED's light output

dc/dc converter

PMT base

Pressure gauges

Potentiometer

AI disk

Filter

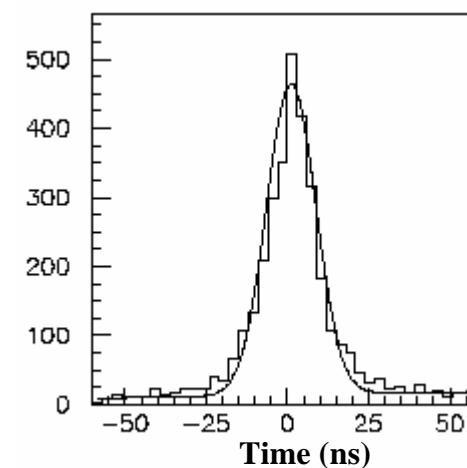
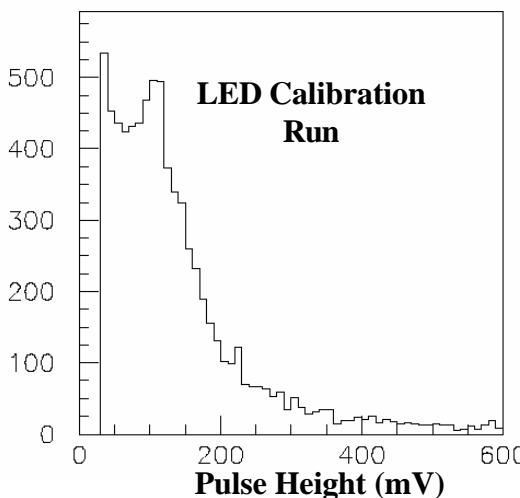
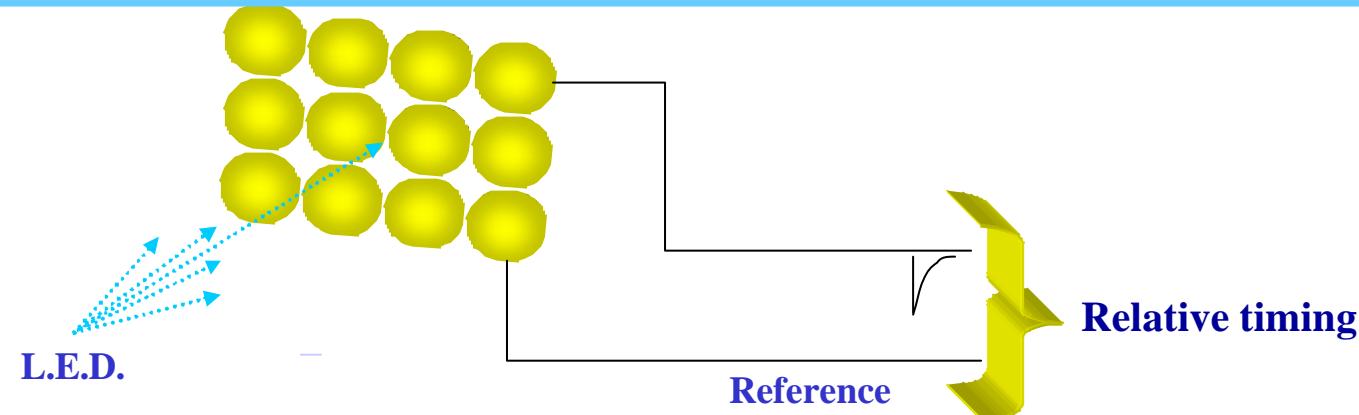
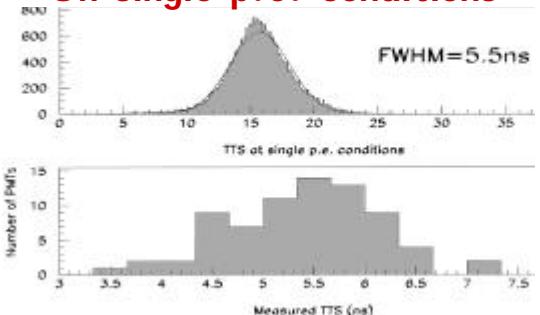
Hamamatsu PMT inside the BENTHOS sphere

# Detector Preparation

## Calibration at the Lab

Extensive Lab tests

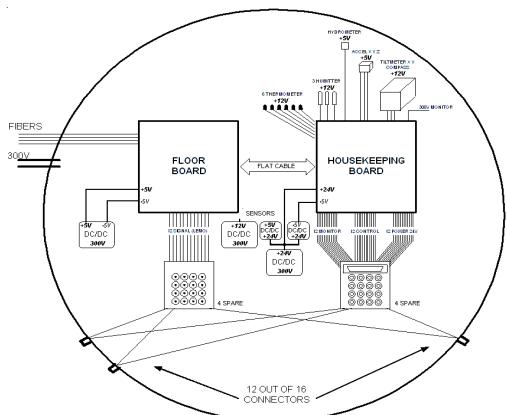
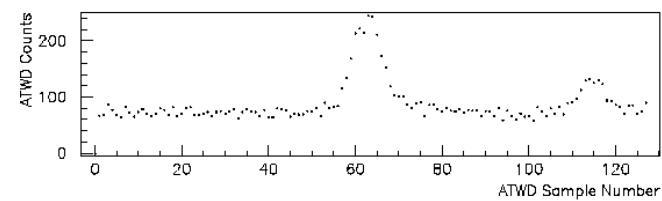
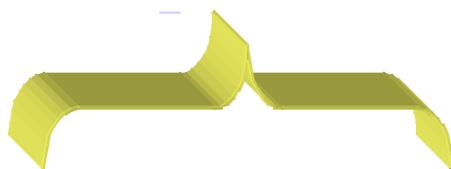
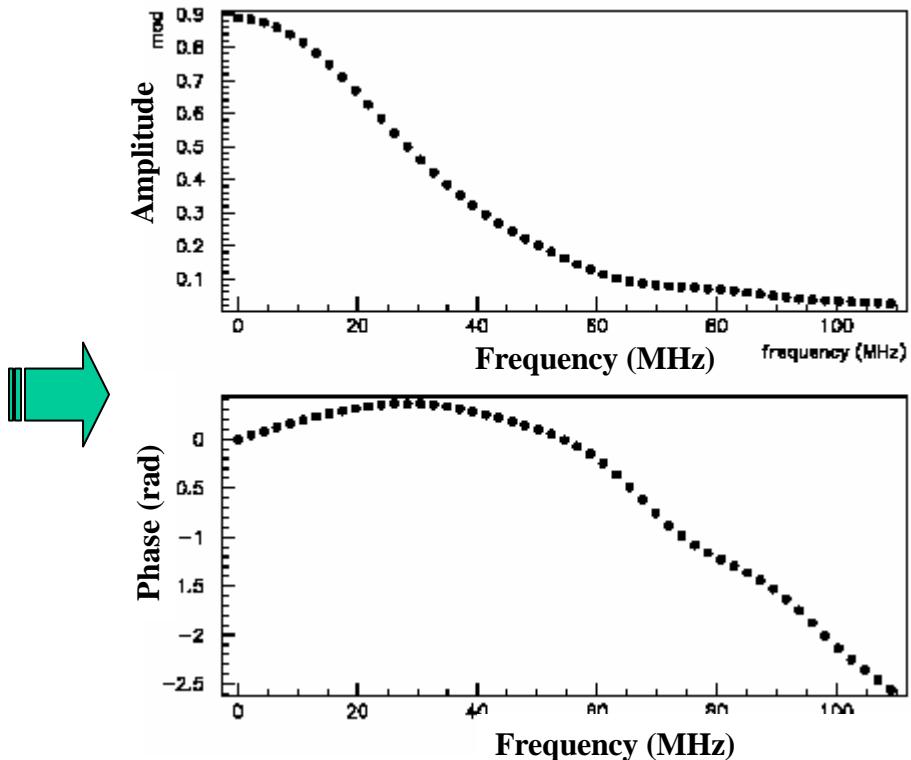
On single p.e. conditions



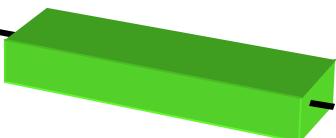
# Detector Preparation

## Attenuation Correction

### Fourier Transform-Comparison



Electronic delay lines  
and  
amplifier

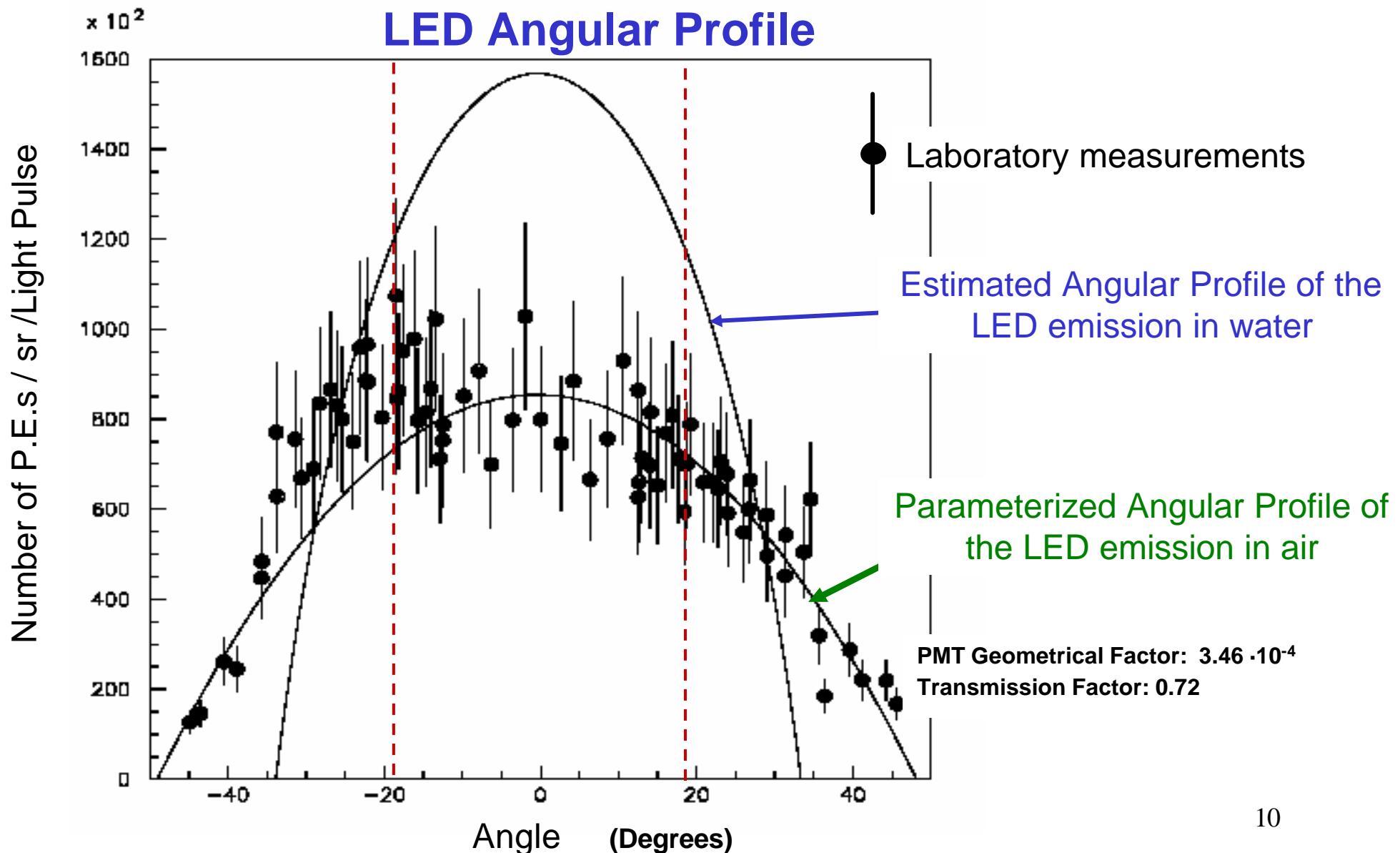


Coaxial cable

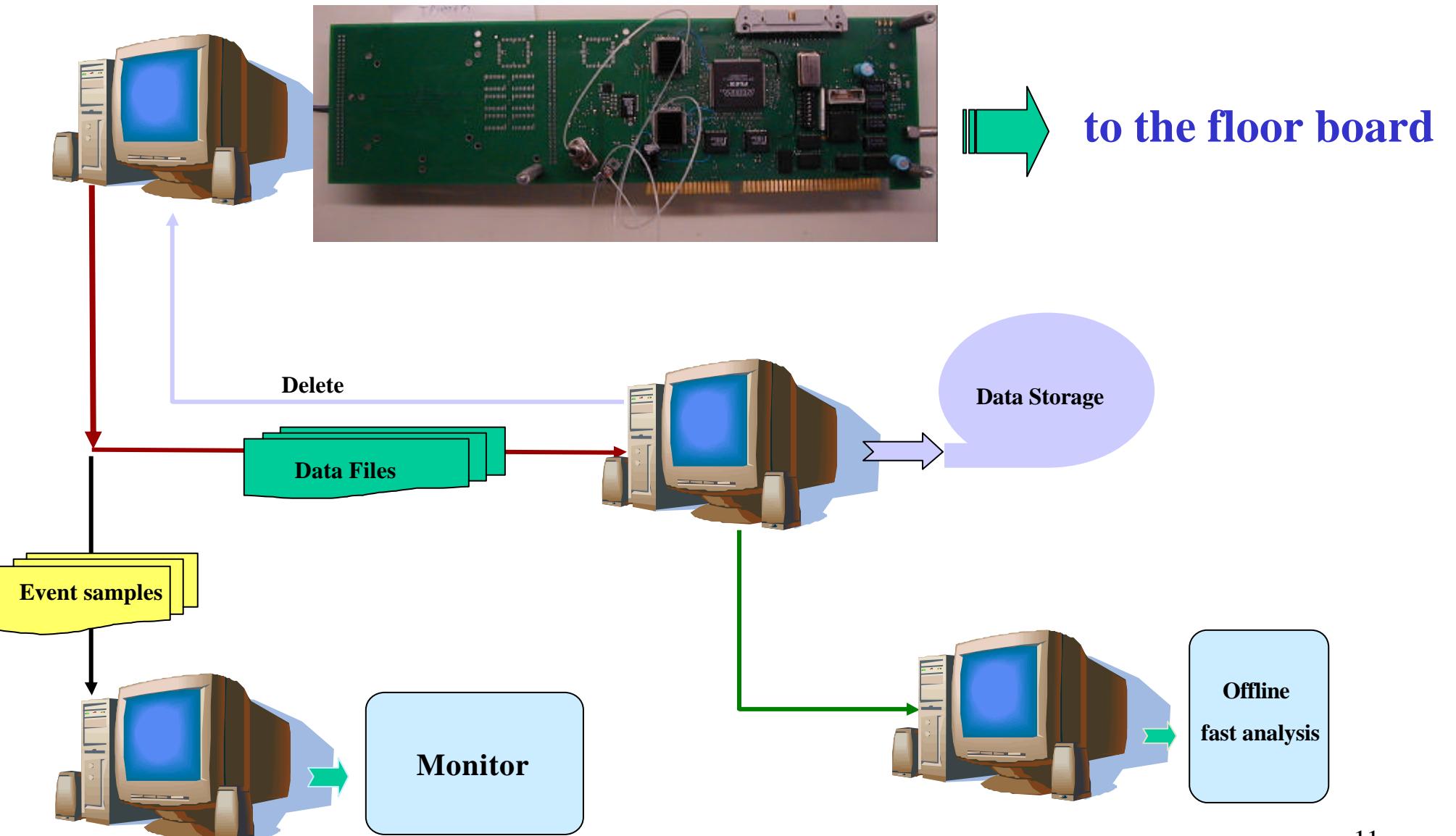


Reference waveform

9



# DAQ Architecture





Berkeley Electronics DAQ

v.2001H



Configure Shore PC FPGAs  
This should be done only once after power-up

RIFO Read Interval  
Select Folder

Start Acquisition

Stop Acquisition

Clear Messages

## PMT CONTROL

PMT A.1 HV | PMT B.1 HV

PMT A.2 HV | PMT B.2 HV

PMT A.3 HV | PMT B.3 HV

PMT A.4 HV | PMT B.4 HV

PMT A.5 HV | PMT B.5 HV

PMT A.6 HV | PMT B.6 HV

PMT A.7 HV | PMT B.7 HV

PMT A.8 HV | PMT B.8 HV

PMT A.9 HV | PMT B.9 HV

PMT A.10 HV | PMT B.10 HV

PMT A.11 HV | PMT B.11 HV

PMT A.12 HV | PMT B.12 HV

PMT Enable

B. Relay Switches

## CALIBRATION PULSE

A.Calib Pulse Amplit

B.Calib Pulse Amplit

A.Calibration Pulser

B.Calibration Pulser

## TRIGGER OPTIONS

A.Maj. Log Scaler

B.Maj Log Scaler

A.Majority Prescaler

B.Majority Prescaler

A.CoincTime Window

B.CoincTime Windo

A.Adjust Thresholds

B.Adjust Thresholds

## Reserved Options

UnLock | Lock

A.Send Event | B.Send Event

A.Clear FIFO | B.Clear FIFO

B.Send TEST

A.Atwd Offsets | B.Atwd Offsets

A.Clock Mode | B.Clock Mode

A.Soft Reset | B.Soft Reset

## Set Thresholds

CAUTION: You have to ENTER the desired PMT threshold(s) and then UPDATE the corresponding group for the change(s) to be activated on the floor board

## ACTION

Enter Threshold of PMT12

Enter Threshold of PMT12

UPDATE Thresholds of PMTs 1-4

UPDATE Thresholds of PMTs 5-8

UPDATE Thresholds of PMTs 9-12

DEFAULT

Value: (mV)

30

OK

Cancel

## PMT Enable Selection

- |                                  |   |
|----------------------------------|---|
| <input type="checkbox"/> PMT A1  | <input checked="" type="checkbox"/> PMT B1  |
| <input type="checkbox"/> PMT A2  | <input checked="" type="checkbox"/> PMT B2  |
| <input type="checkbox"/> PMT A3  | <input checked="" type="checkbox"/> PMT B3  |
| <input type="checkbox"/> PMT A4  | <input checked="" type="checkbox"/> PMT B4  |
| <input type="checkbox"/> PMT A5  | <input checked="" type="checkbox"/> PMT B5  |
| <input type="checkbox"/> PMT A6  | <input checked="" type="checkbox"/> PMT B6  |
| <input type="checkbox"/> PMT A7  | <input checked="" type="checkbox"/> PMT B7  |
| <input type="checkbox"/> PMT A8  | <input checked="" type="checkbox"/> PMT B8  |
| <input type="checkbox"/> PMT A9  | <input checked="" type="checkbox"/> PMT B9  |
| <input type="checkbox"/> PMT A10 | <input checked="" type="checkbox"/> PMT B10 |
| <input type="checkbox"/> PMT A11 | <input checked="" type="checkbox"/> PMT B11 |
| <input type="checkbox"/> PMT A12 | <input checked="" type="checkbox"/> PMT B12 |

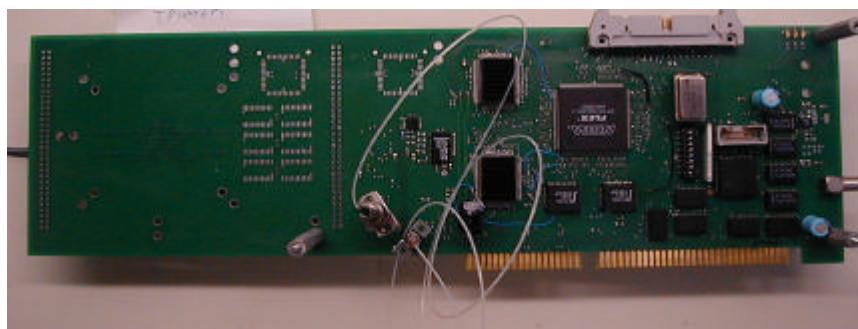
Check

OK

Cancel

READ OLD VALUES

Exit



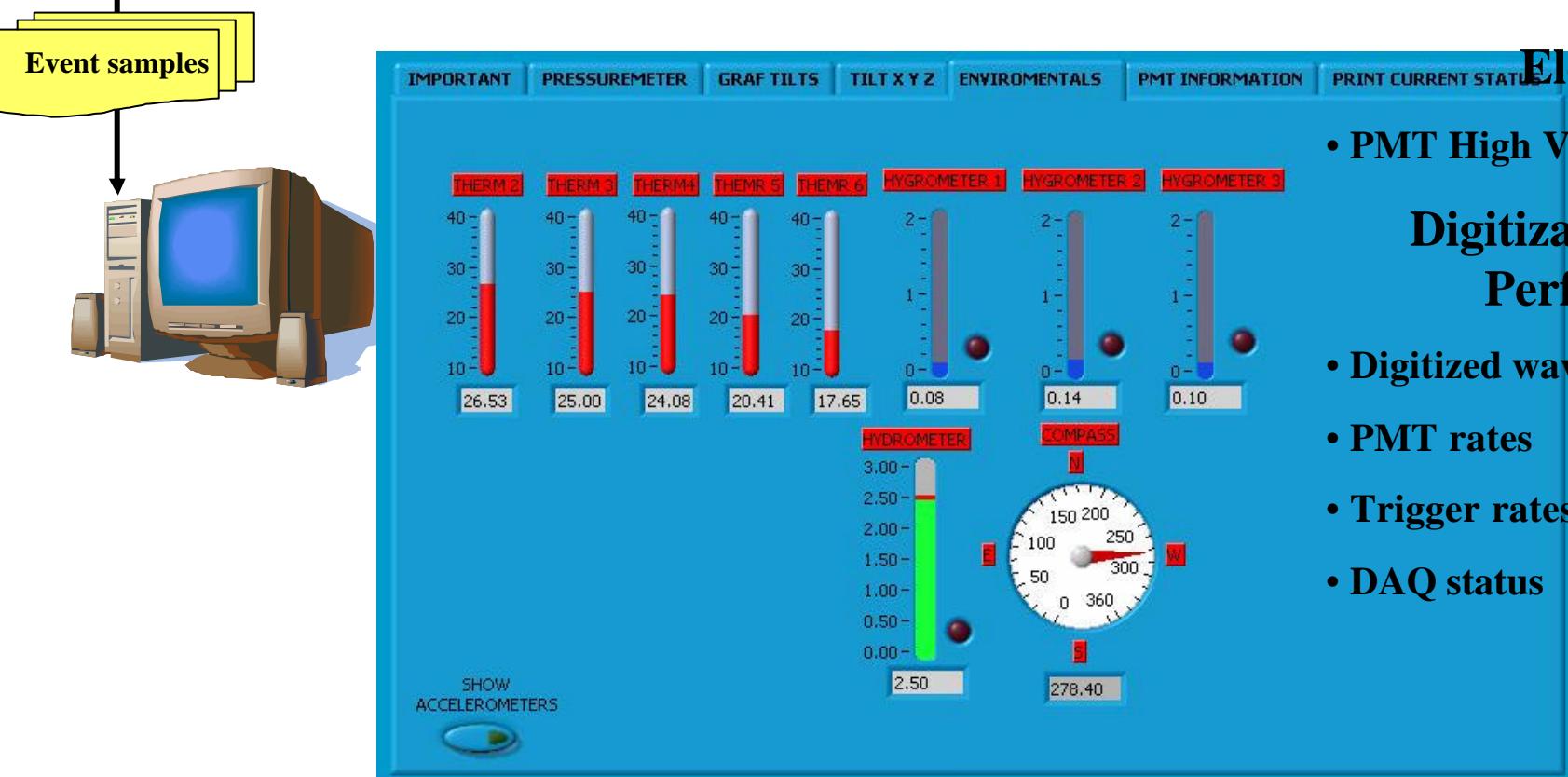
## Shore Board

- Downloads the FPGAs & PLD of the Floor Board
- Broadcasts the 40Mhz clock
- Receives Data from the Floor Board
- Transmits Data to the Run Control System

# Real Time Monitor

Environmental

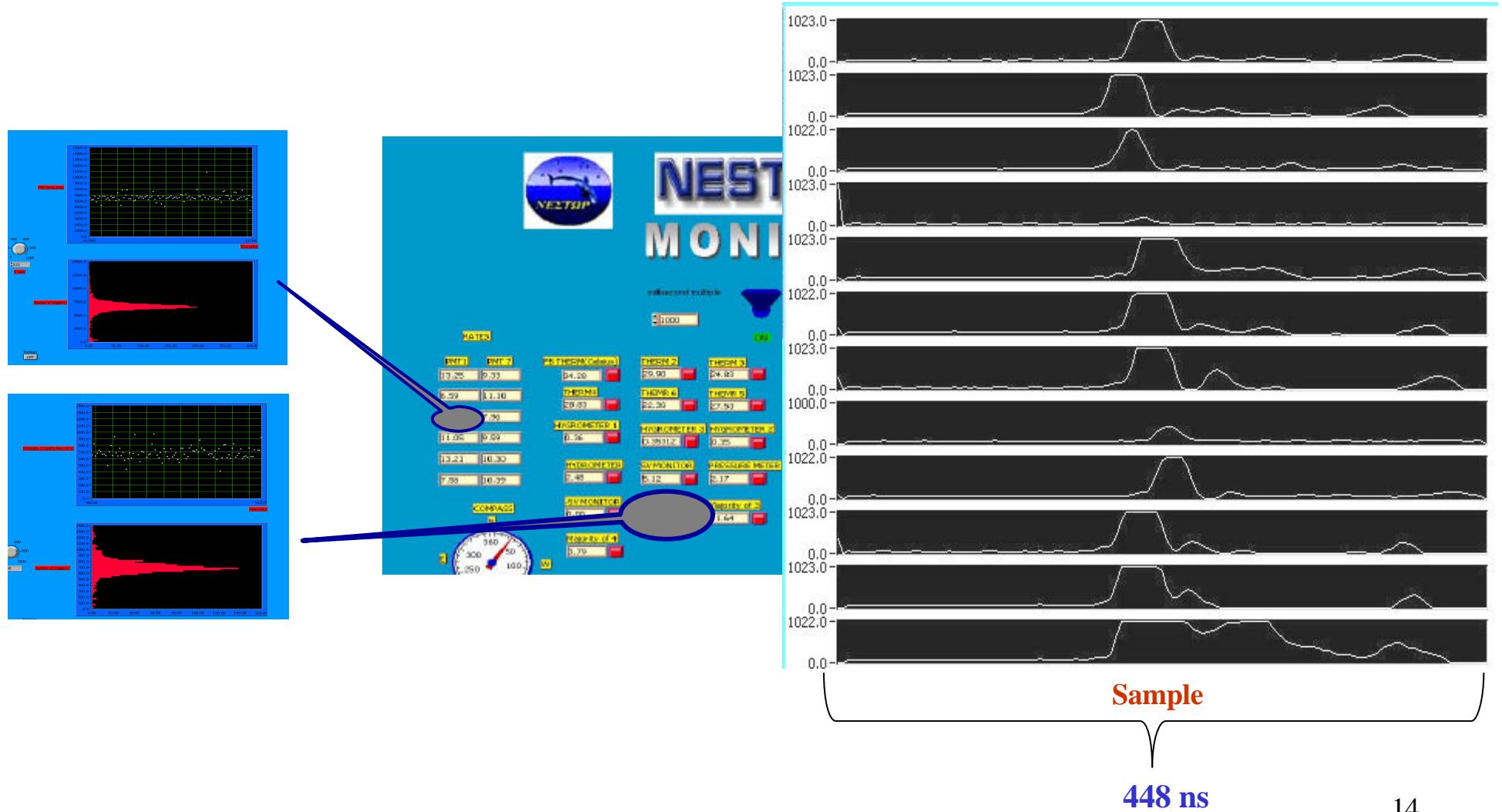
- Thermometers
- Hygrometers
- Compass
- Inclinometer/Accelerometer
- Pressure meter



Electrical  
Digitization & DAQ Performance

- Digitized waveforms
- PMT rates
- Trigger rates
- DAQ status

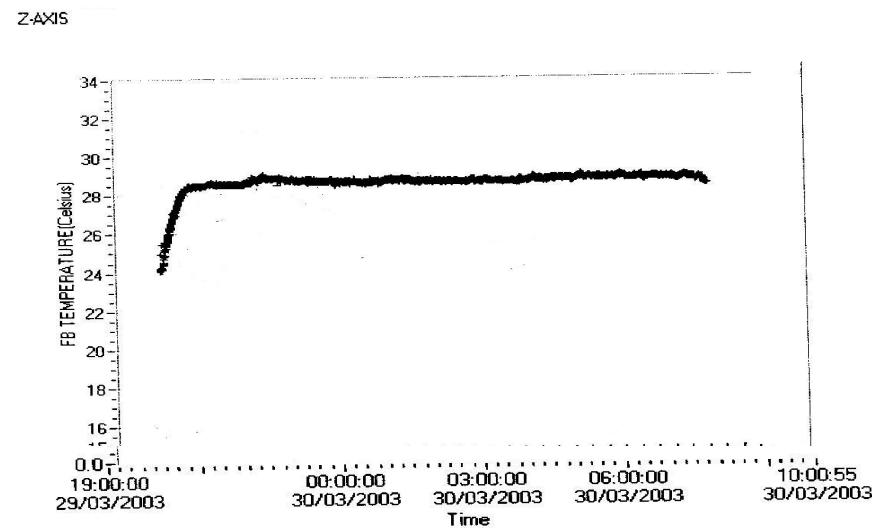
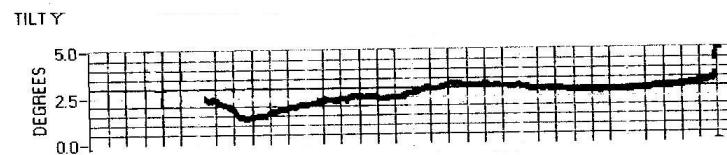
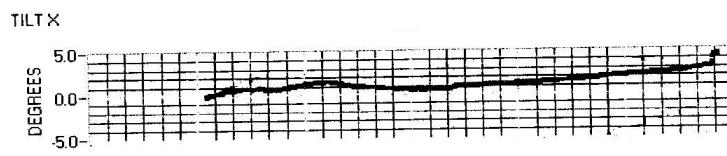
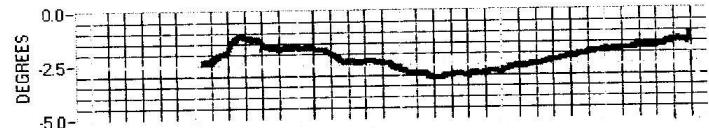
# Real Time Monitors



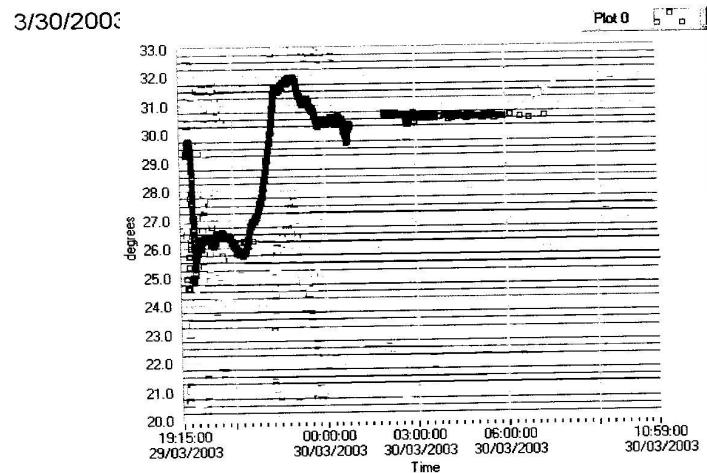
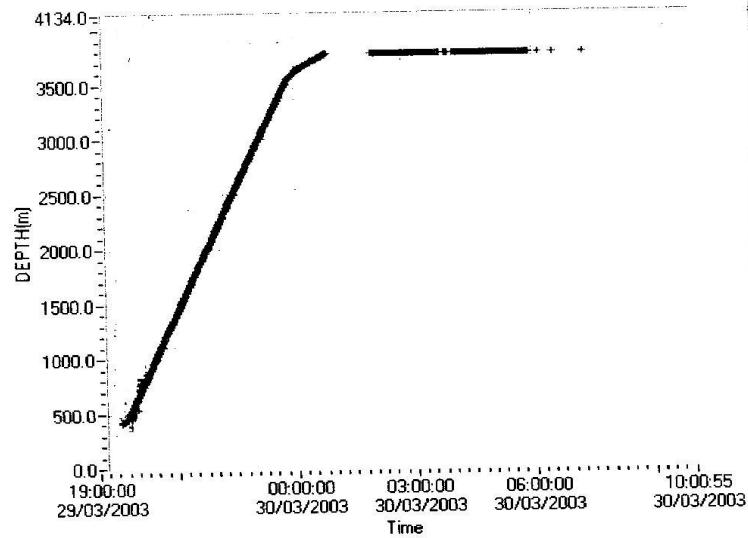
448 ns

14

## During deployment

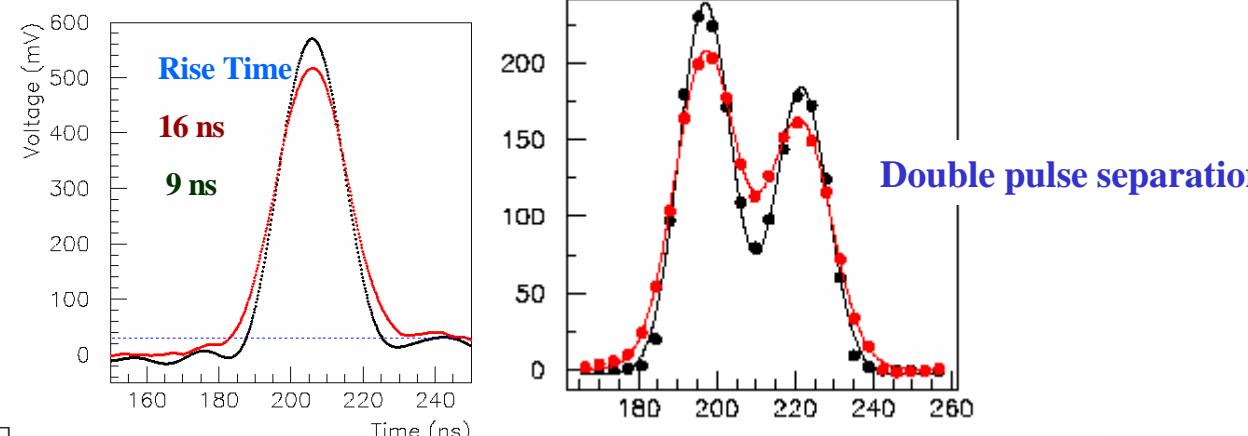
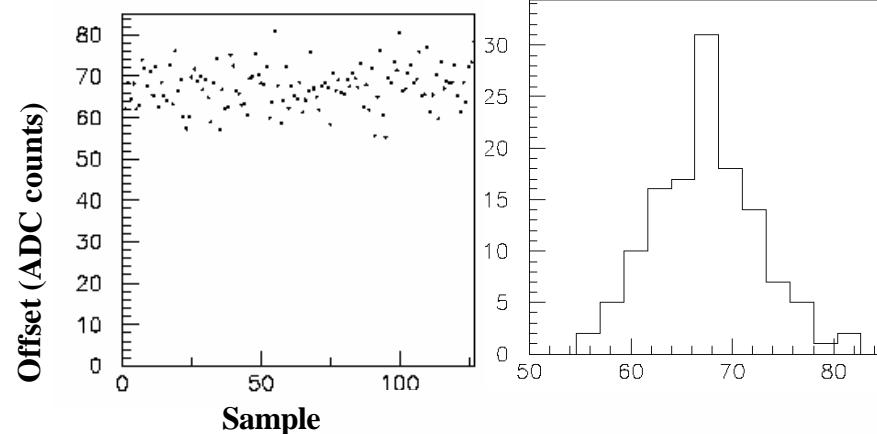
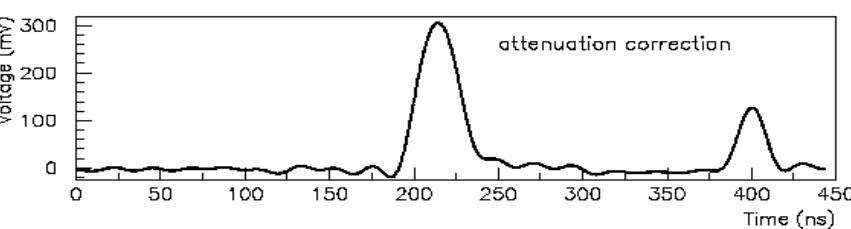
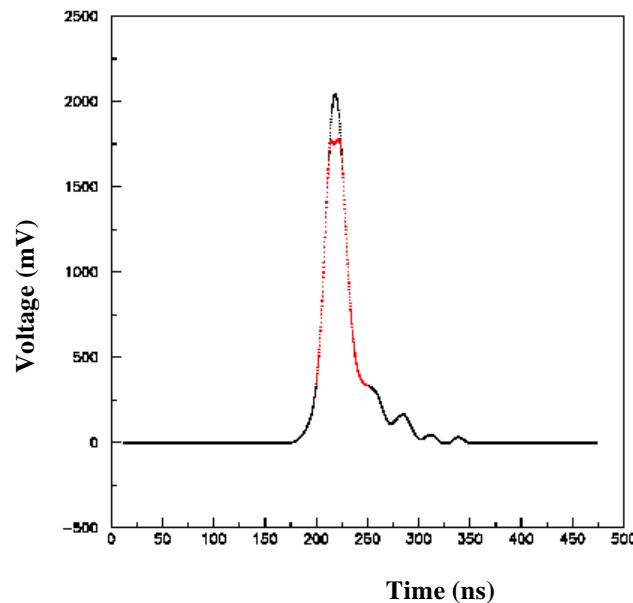
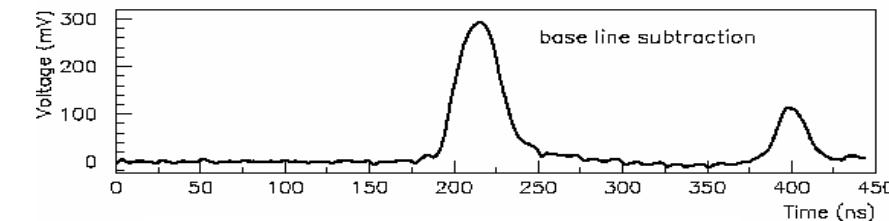
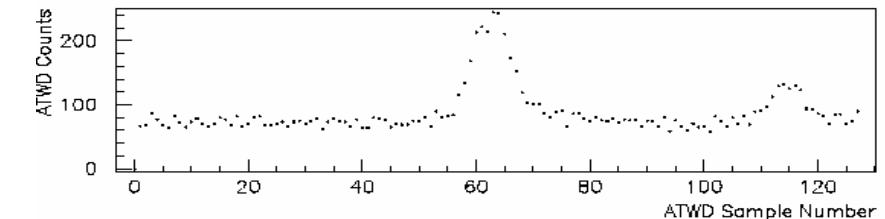


3/30/2003 1:26 AM



3/30/2003 6:58 AM

# Waveform Reconstruction

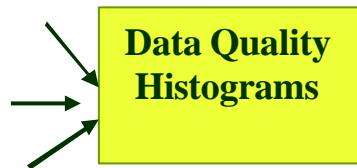


— Before the F.F.T. and the attenuation corrections  
— After the F.F.T. and the attenuation corrections

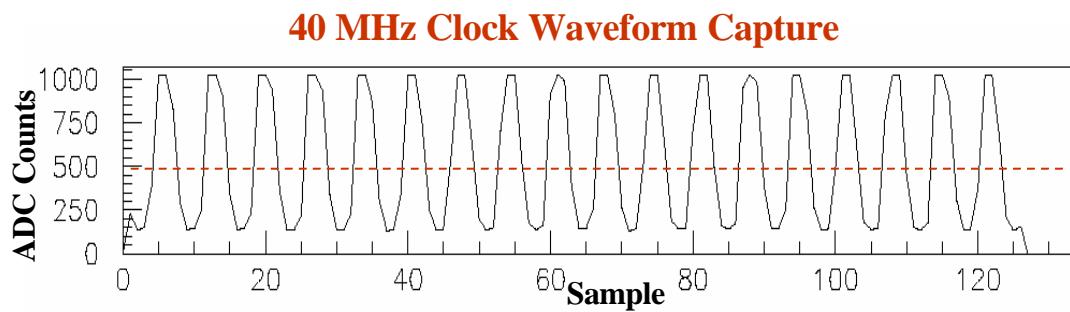
## Waveform Reconstruction

Hit Definition

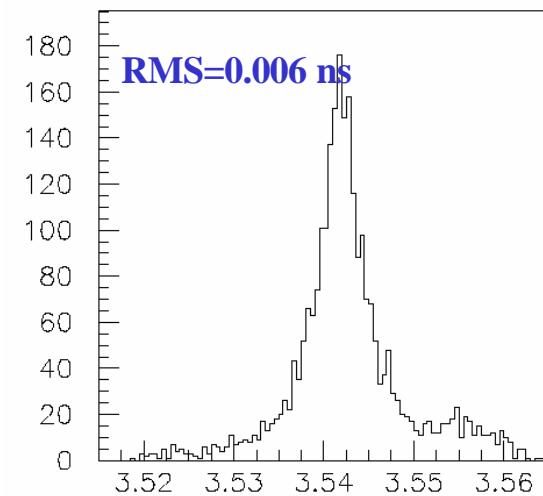
DST Production



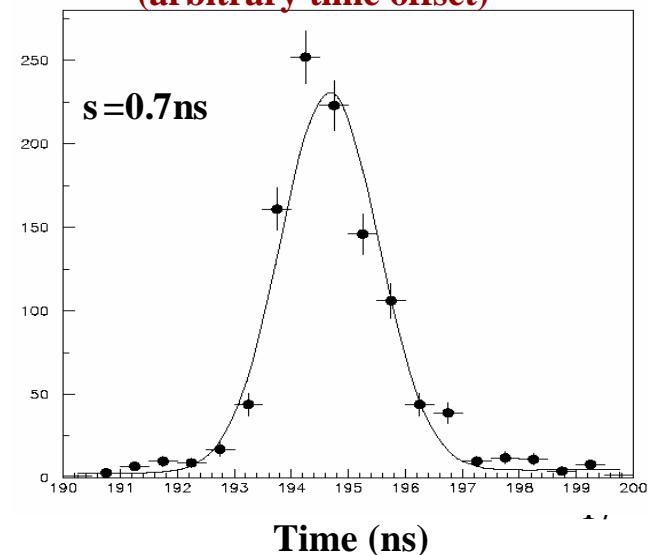
Data Quality  
Histograms



## Event by Event Sampling Interval Variation (Constant Temperature)

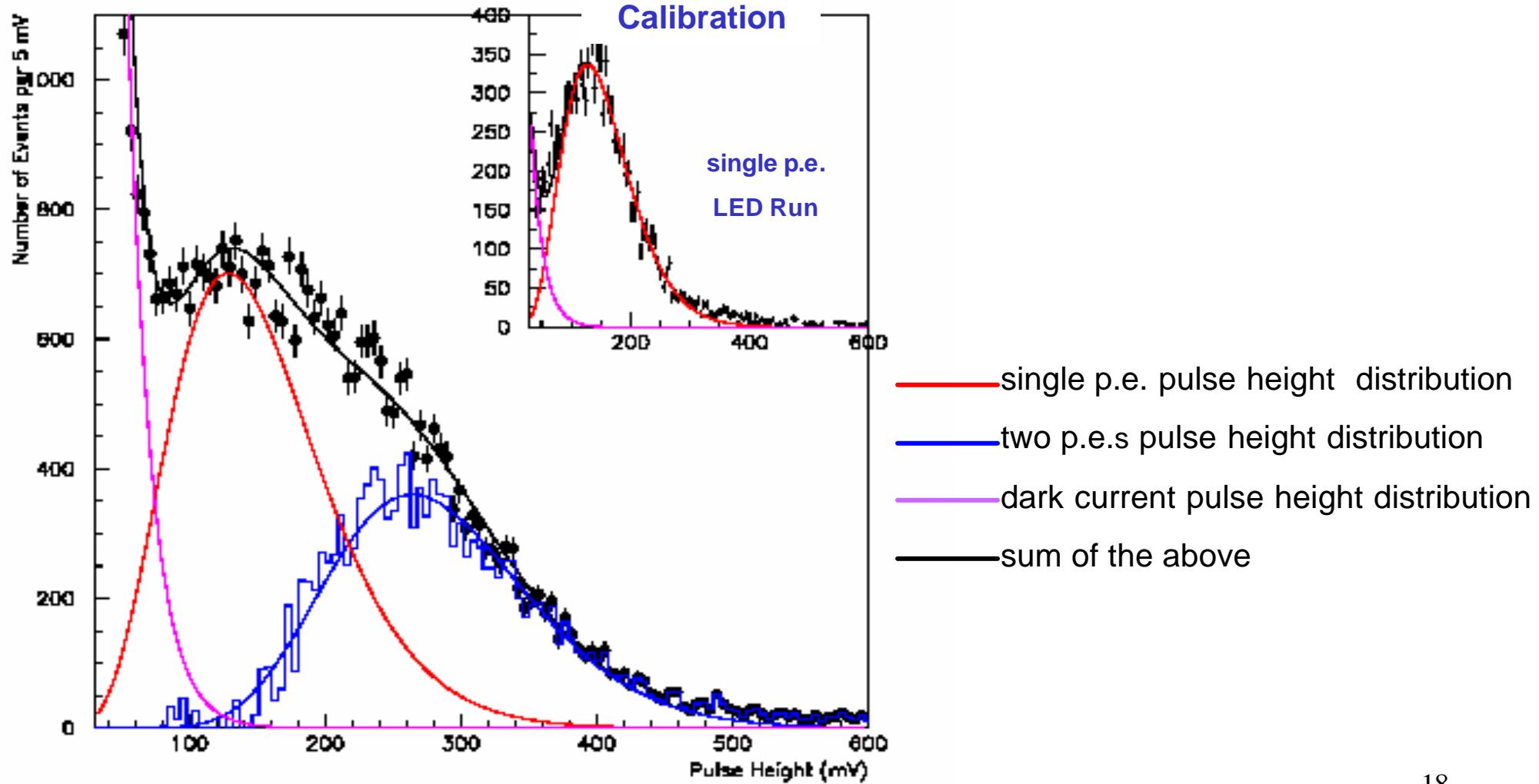


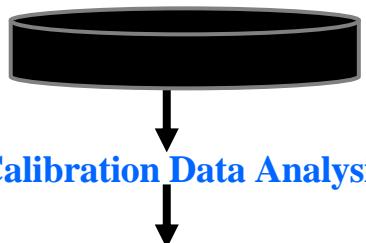
## Software to Hardware Trigger Time Difference (arbitrary time offset)



# Data from a depth of 4000 m

## Calibration using the natural radiactivity ( $K^{40}$ )



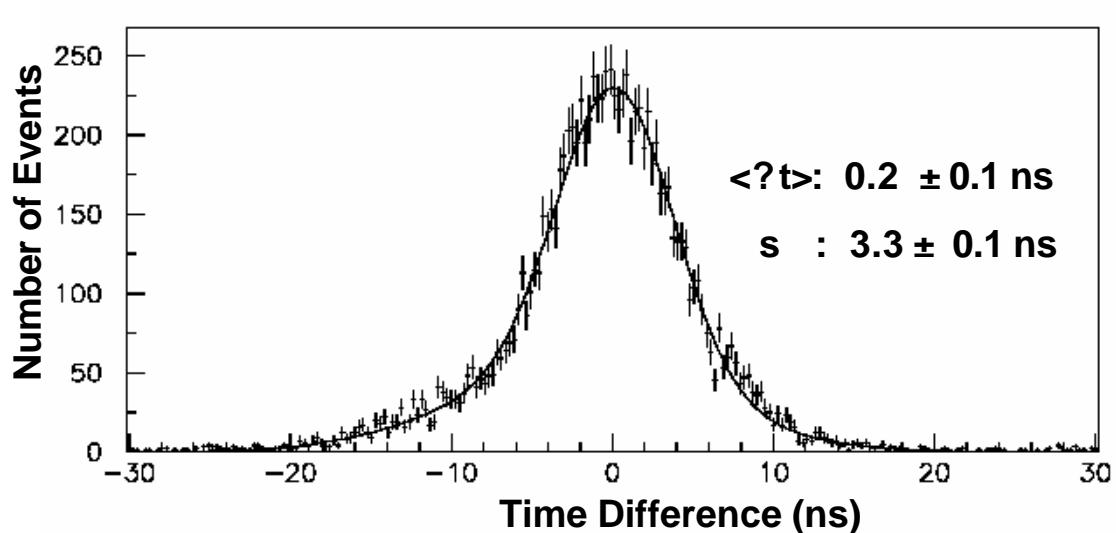
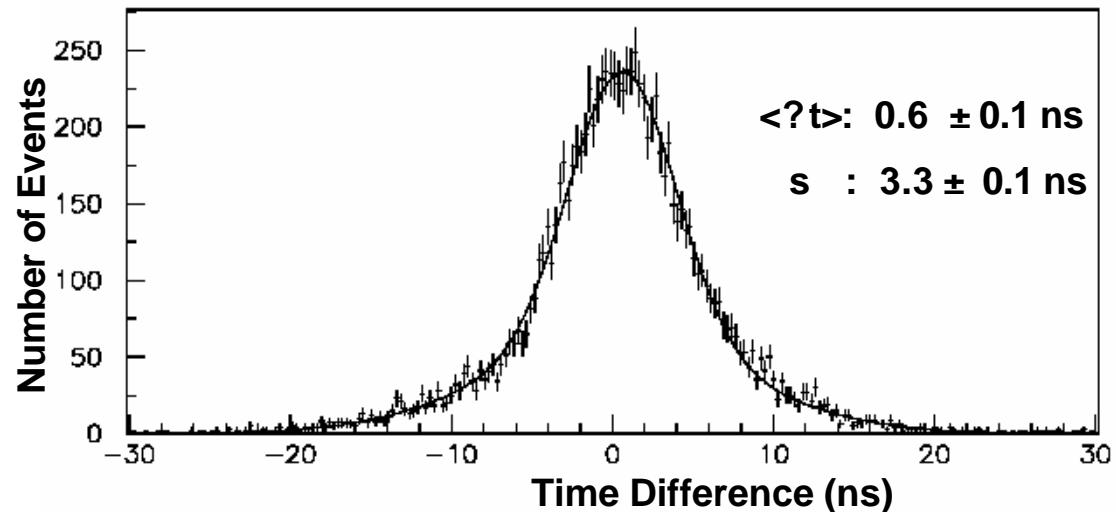
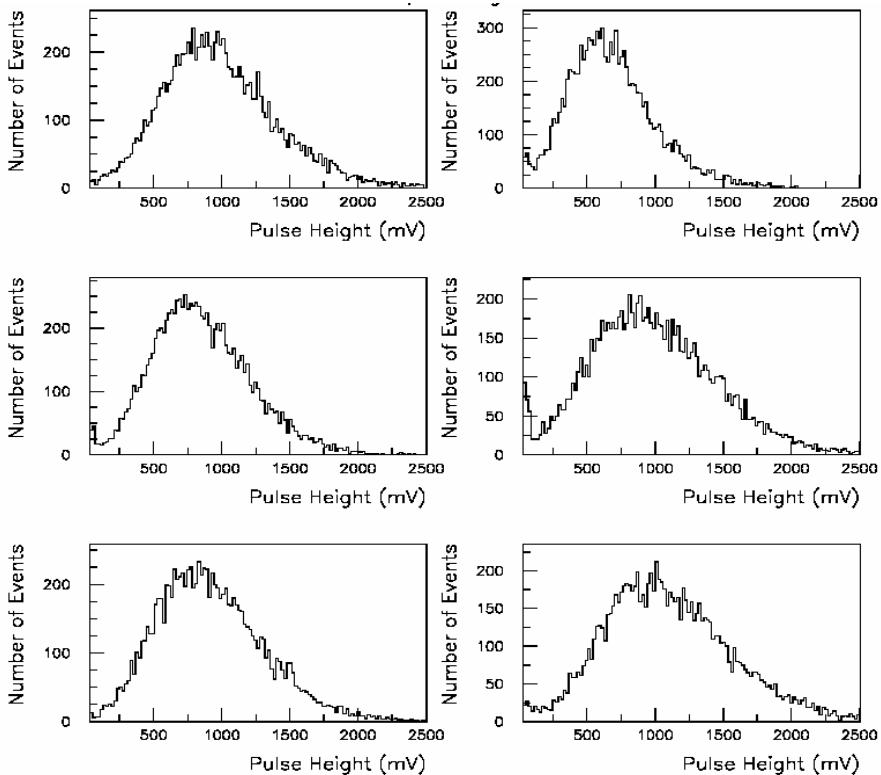


# Data from a depth of 4000 m

## Calibration Run

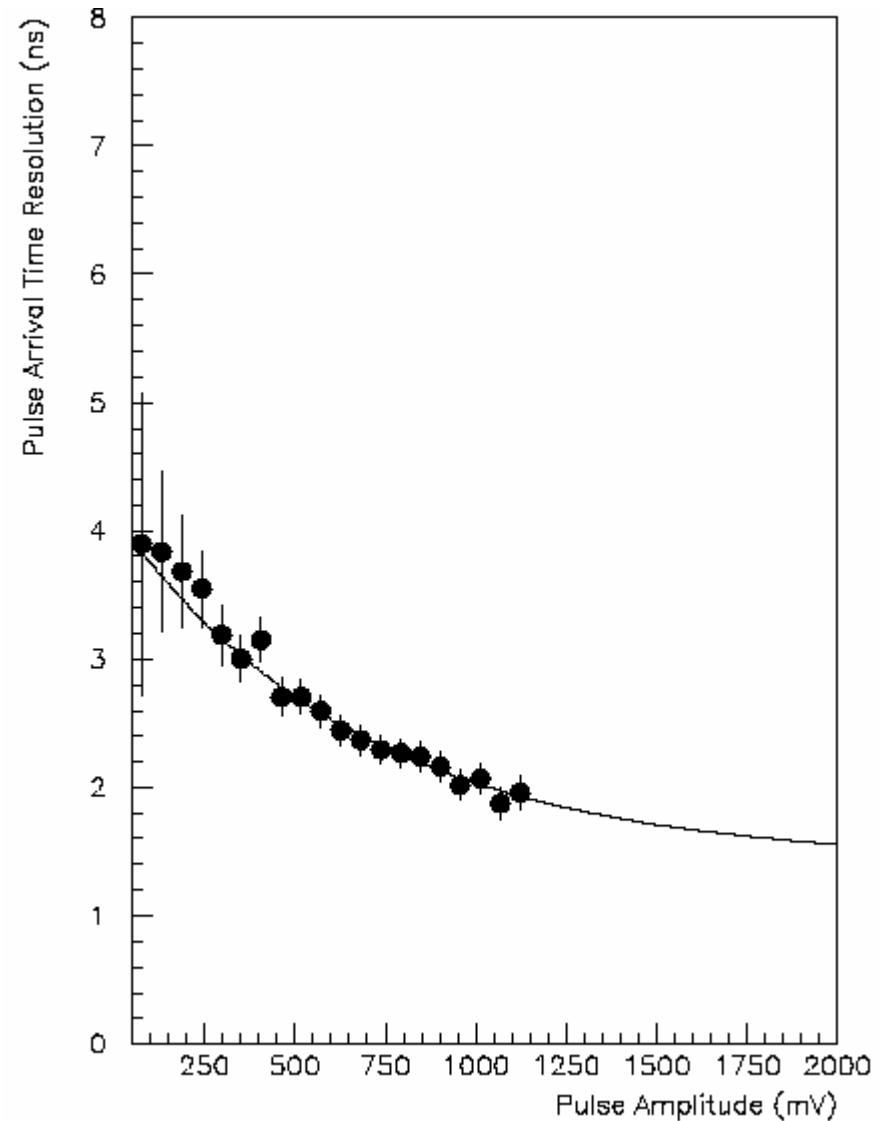
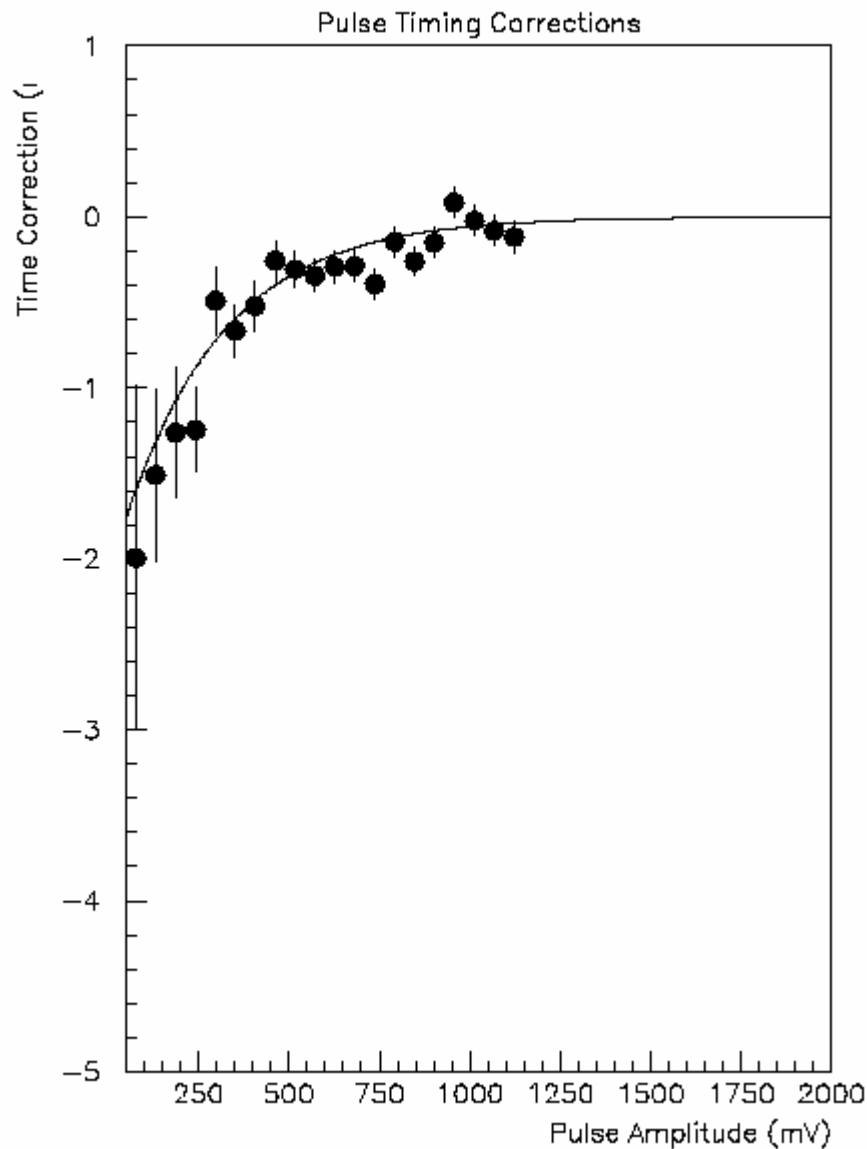
Calibration Data Analysis

Calibration Database  
Quality Histograms



# Data from a depth of 4000 m

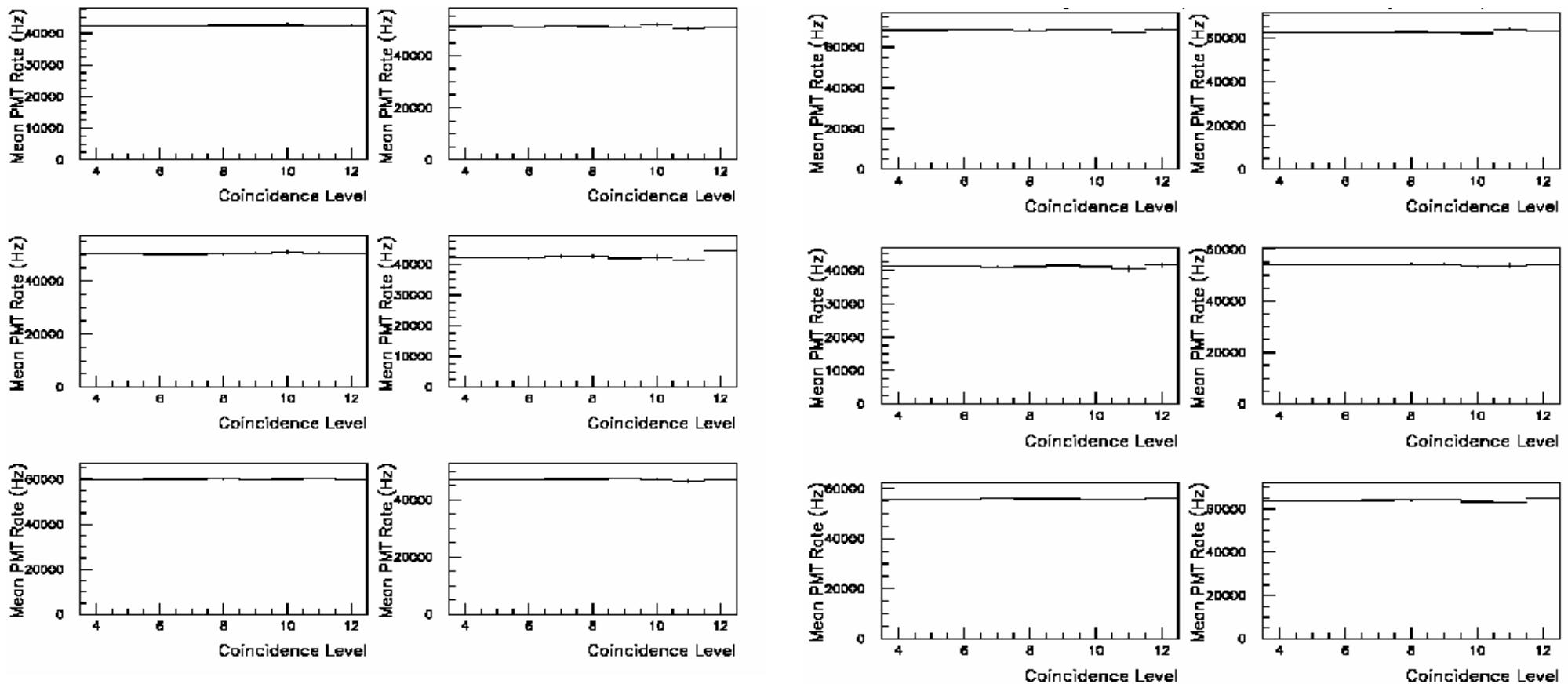
## Calibration Run



# Data from a depth of 4000 m

## Single PMT Rates

**Trigger:** =4fold Coincidence

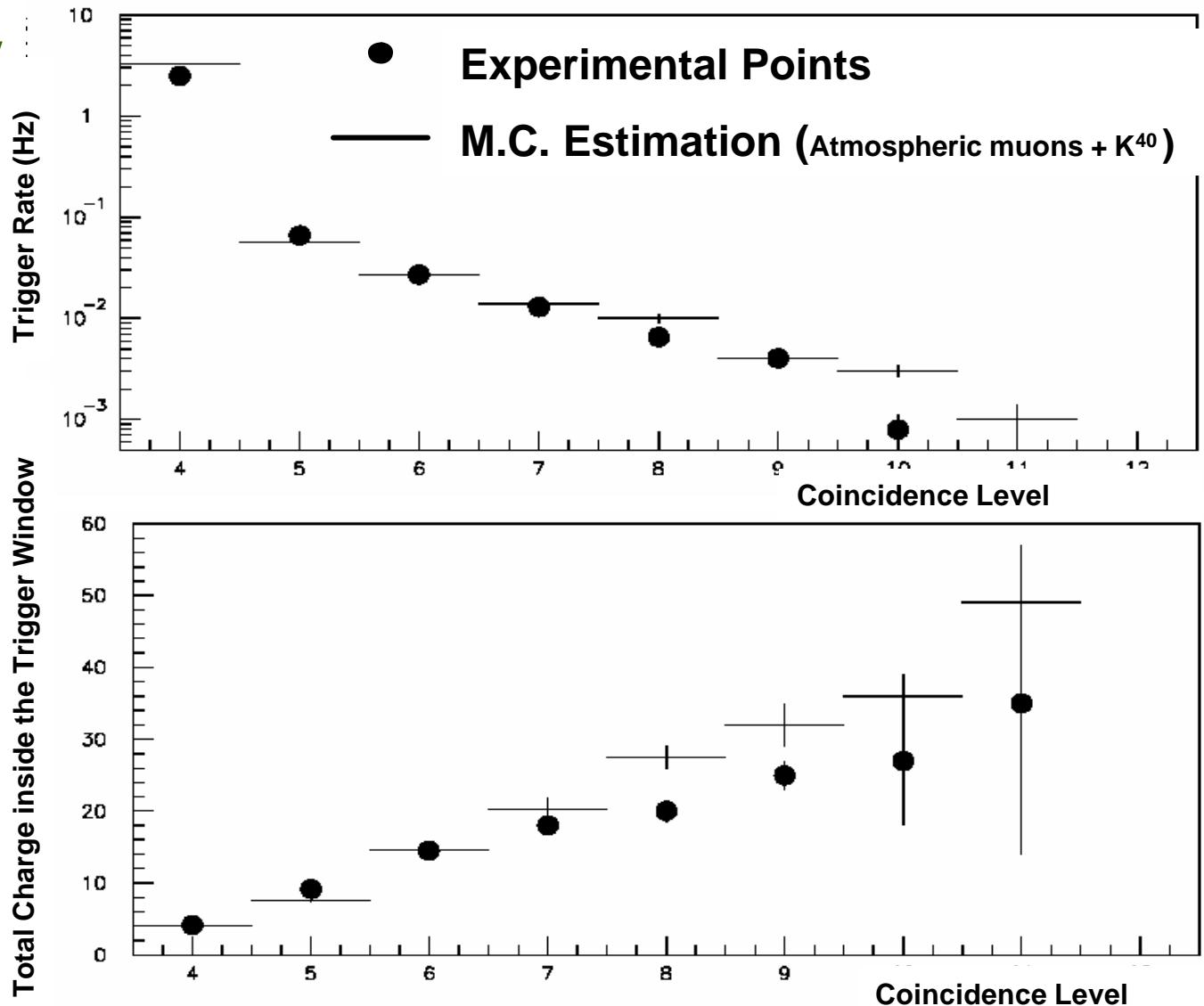


Data Collected with  
4fold Majority Trigger  
Thresholds at 30mV  
(1/4 P.E.)

# Data from a depth of 4000 m

## Trigger Studies

### Preliminary



Data Collected with  
4fold Majority Trigger  
Thresholds at 120mV  
(1 P.E.)

# Data from a depth of 4000 m

## Trigger Studies

### Preliminary

