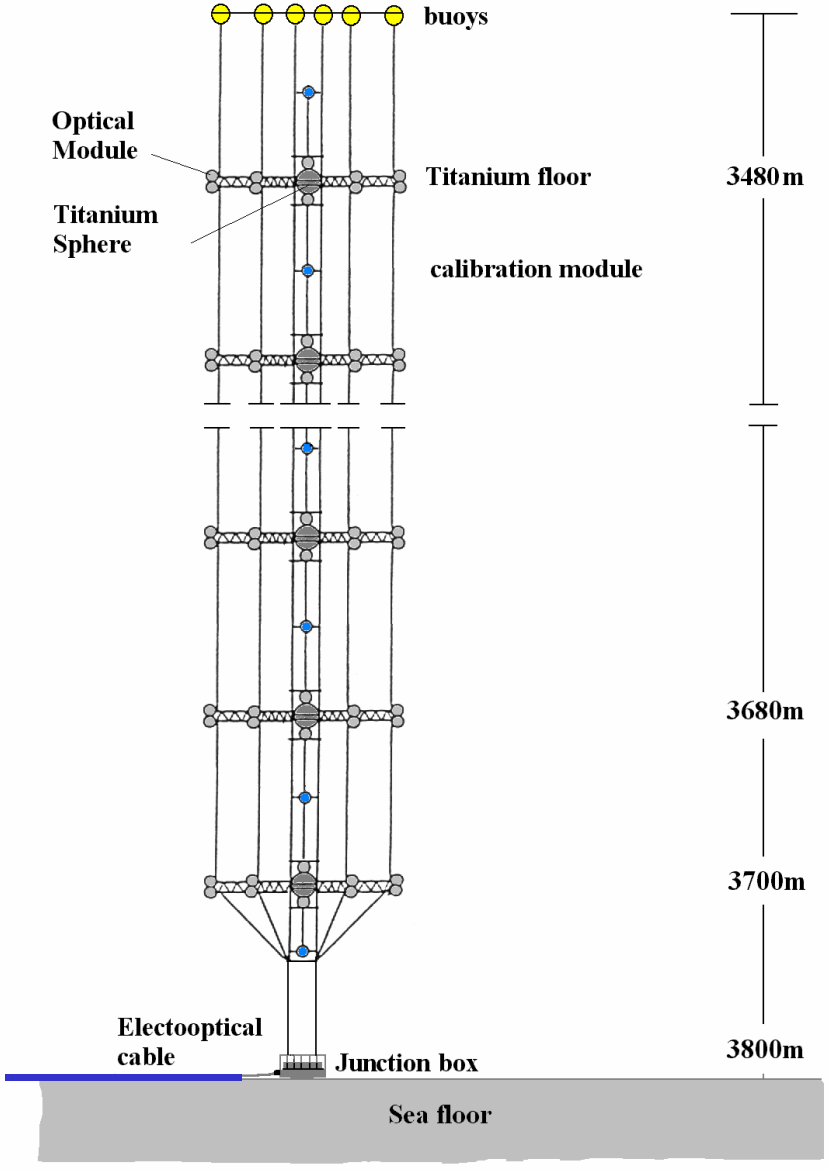
S. E. Tzamarias
Hellenic Open University

NESTOR

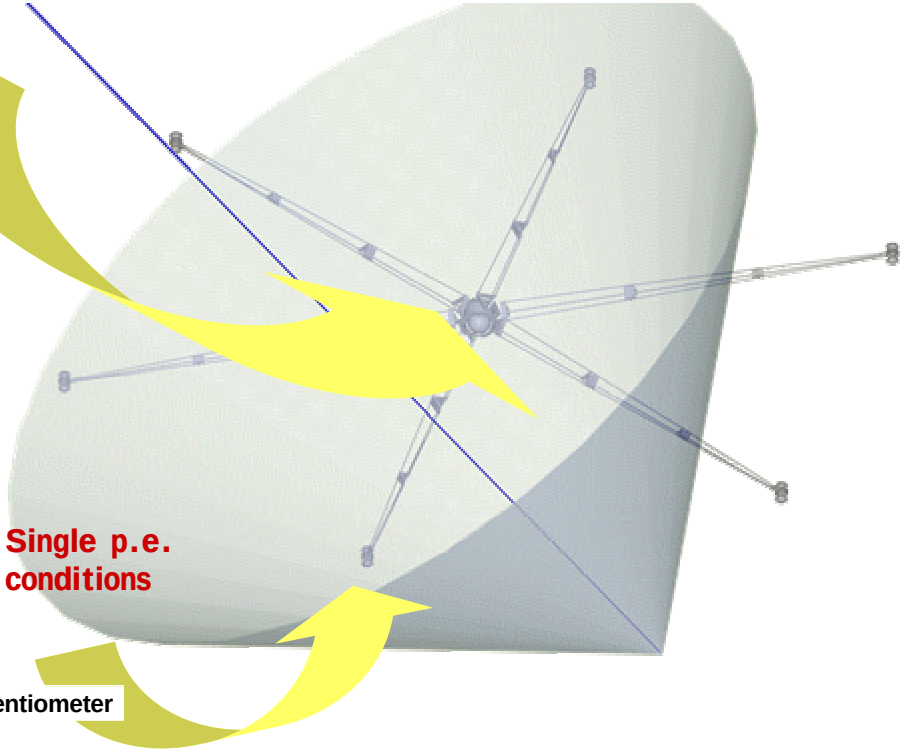
Neutrino Extended Submarine Telescope with Oceanographic Research

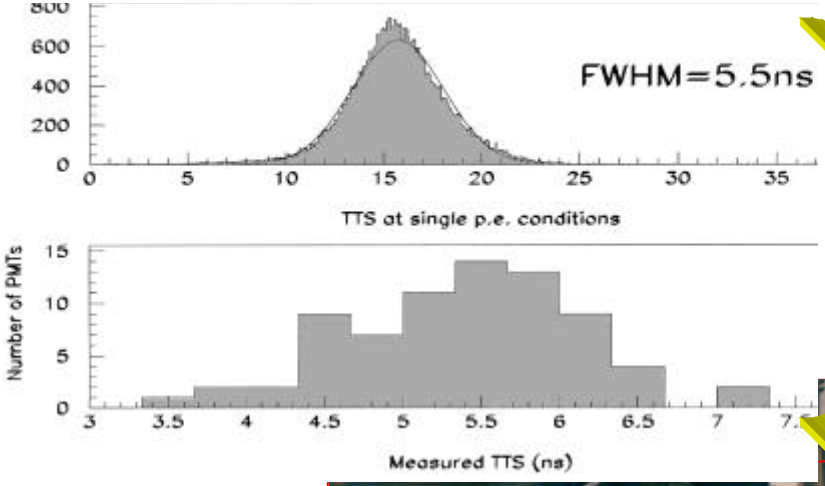
Readout Electronics DAQ & Calibration

NESTOR TOWER

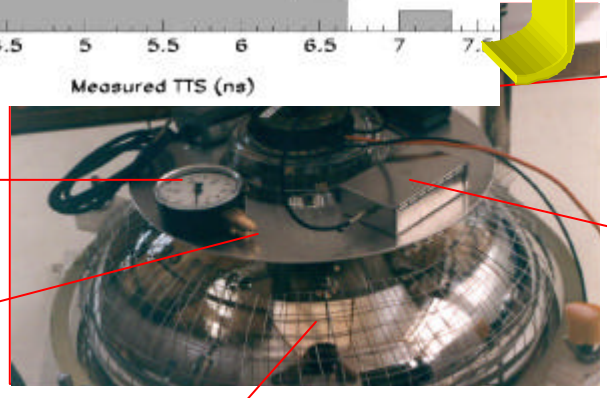


The Detector





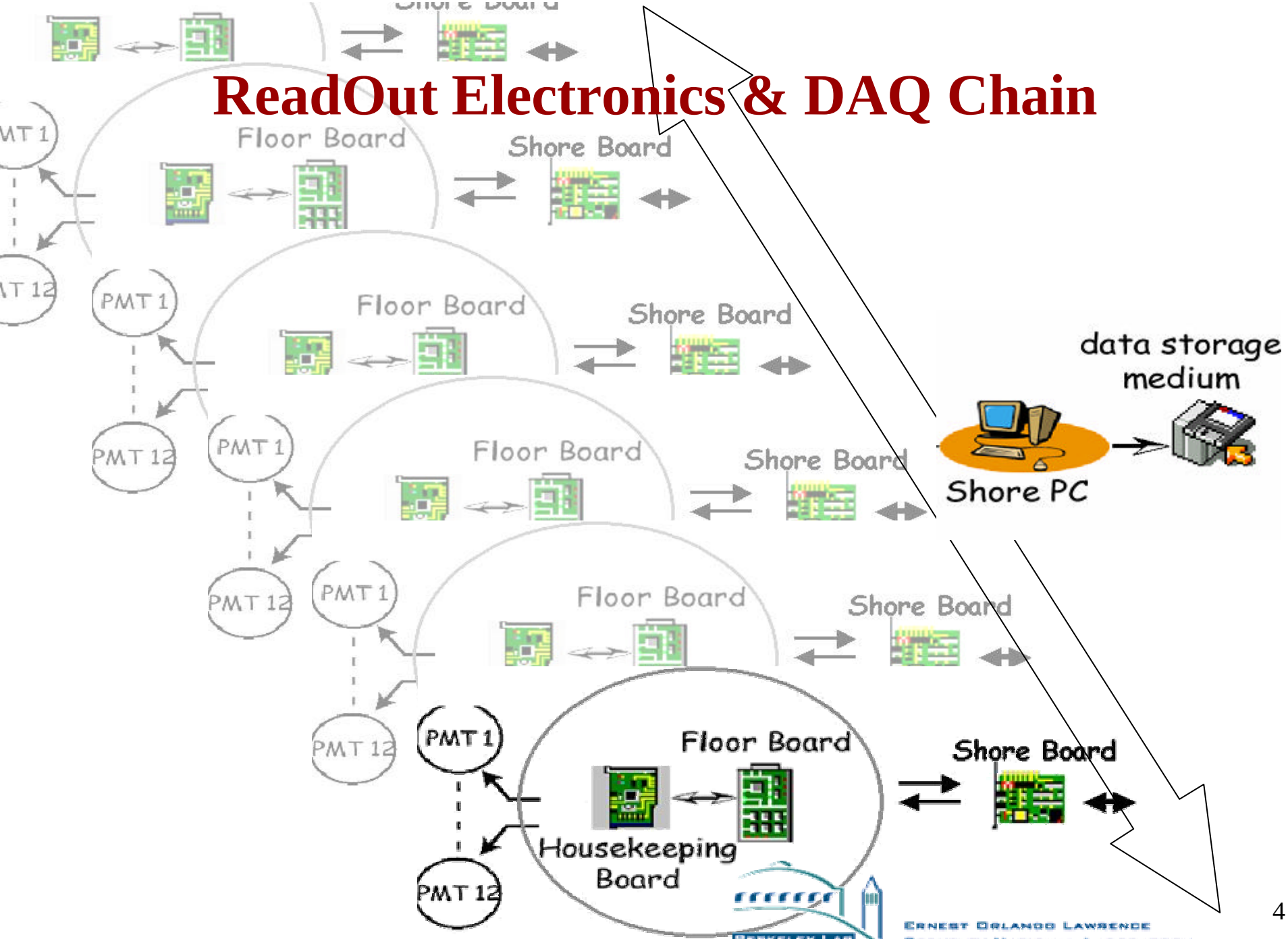
Single p.e. conditions



Hamamatsu PMT inside the BENTHOS sphere

- Hamamatsu PMT R2018-03 (15”)
- Benthos spheres
- μ-metal cage
- power supply

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

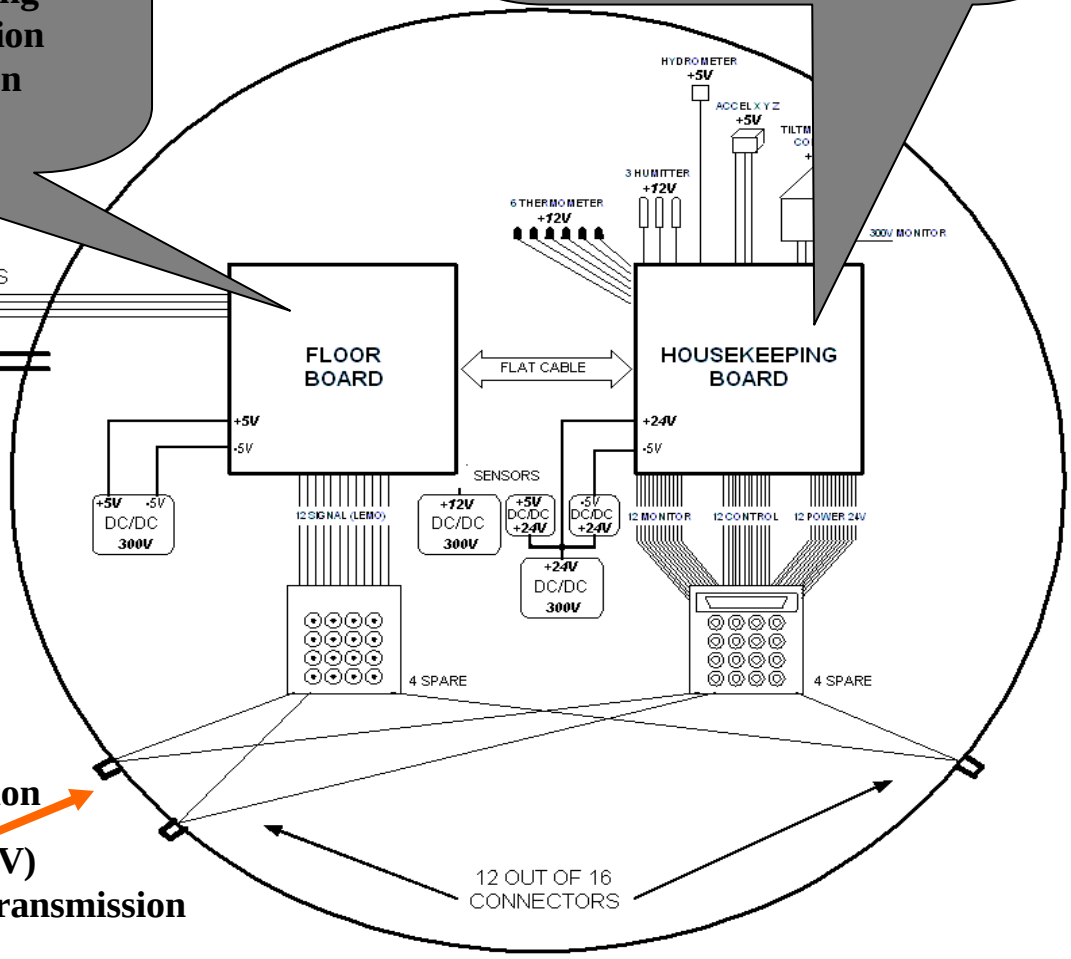
Shore Laboratory

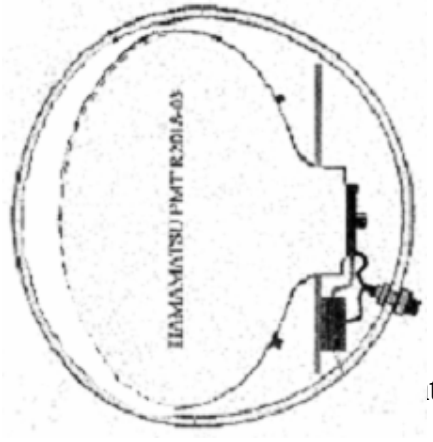
Signal transmission & Control

Power supply

FIBERS

300V





PMT signal transmission

low voltage supply (24V)

trol and monitoring signal transmission

Floor Board

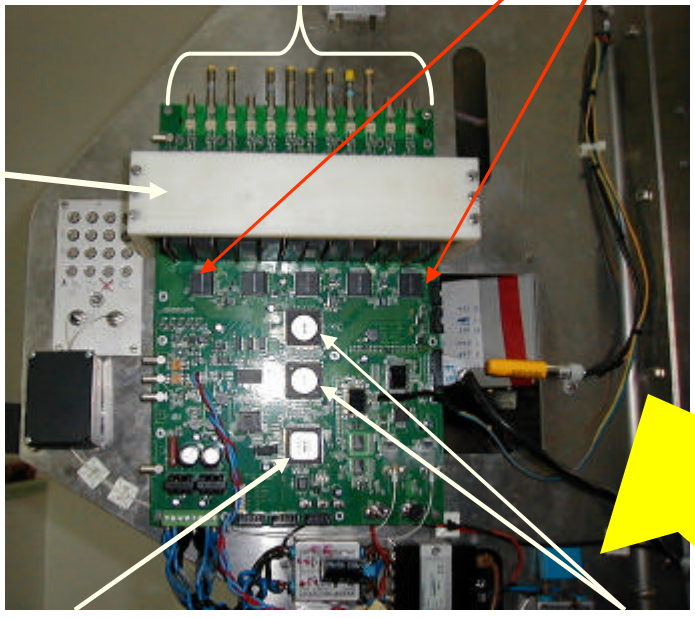
- PMT pulse sensing
- Majority logic event triggering
- Single & coincidence rate scaling
- Waveform capture & digitization
- Data formatting & transmission
- FPGA & PLD reprogramming

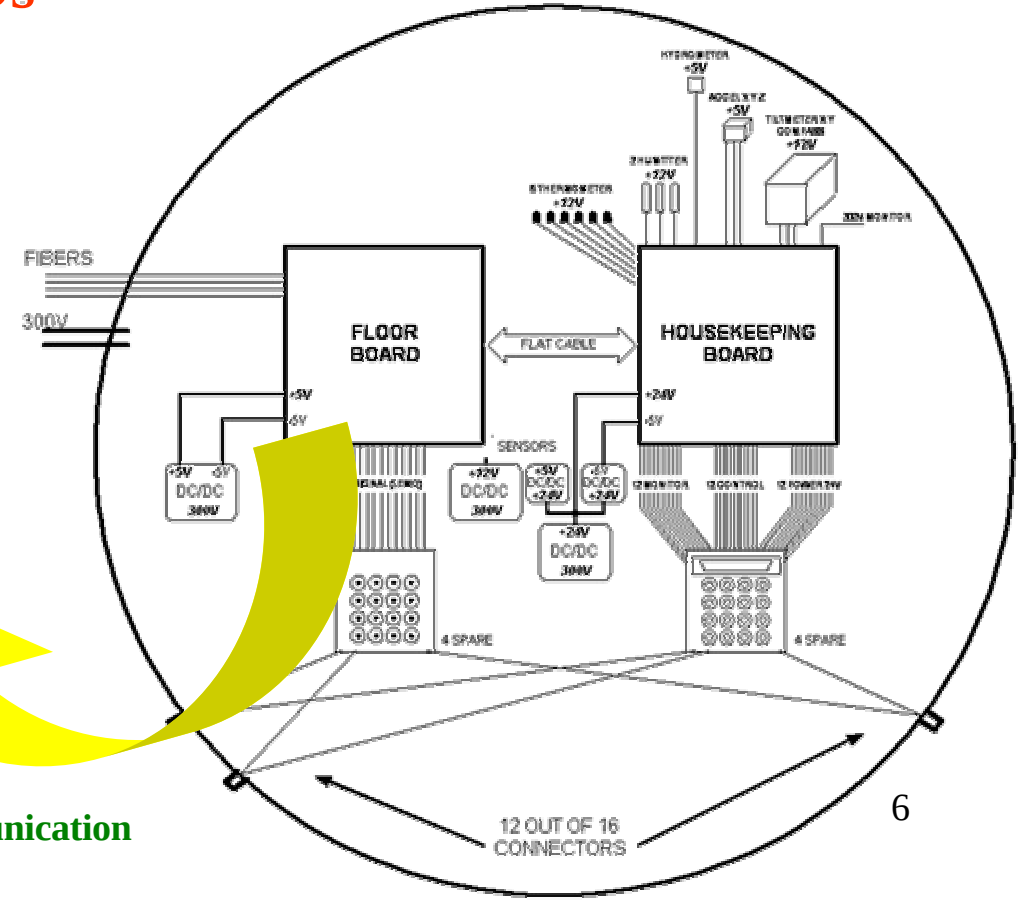
PMT Signal Capture & Digitization

5 ATWDs

Input: 12 PMT signals

Delay lines

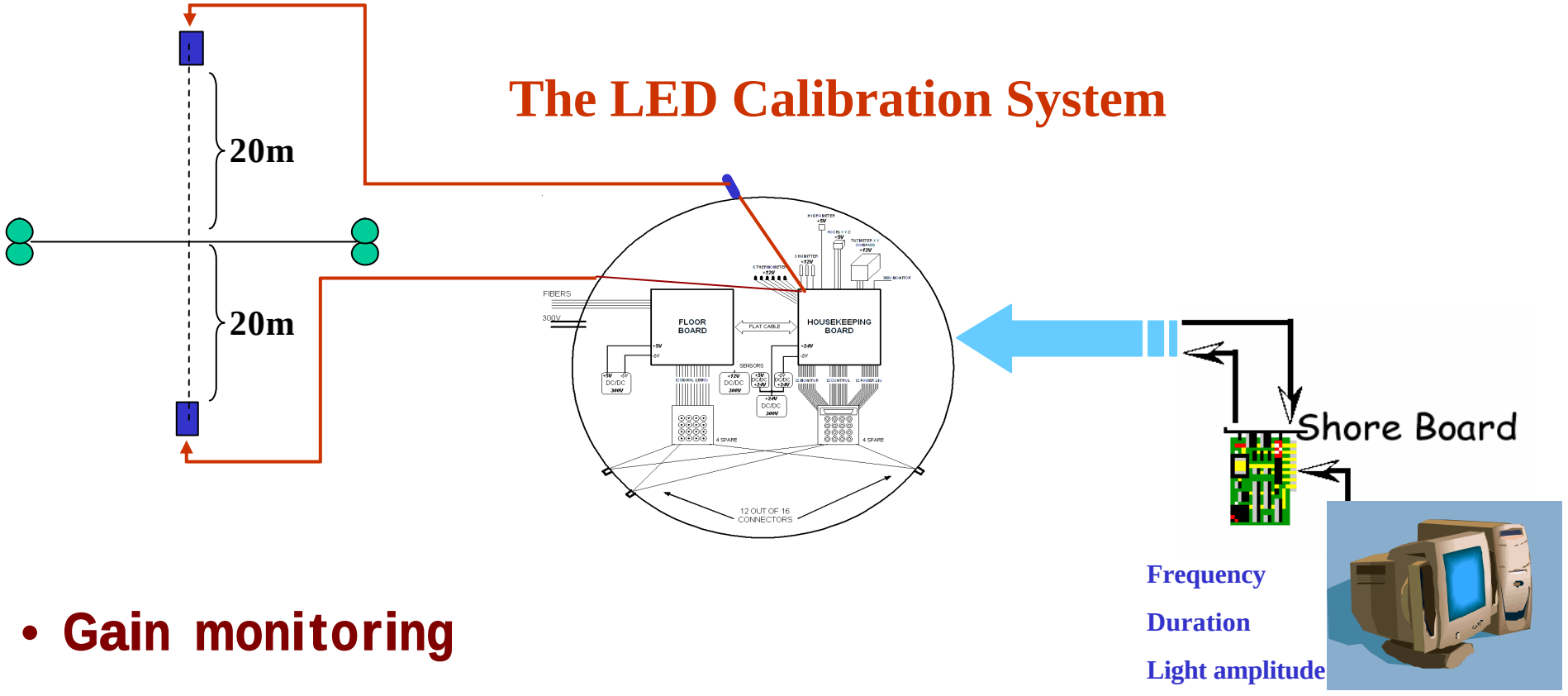




Configuration parameters PLD

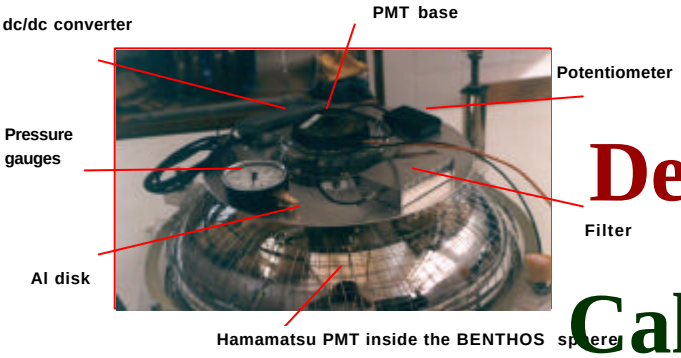
Trigger Logic & Communication FPGAs

The LED Calibration System



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

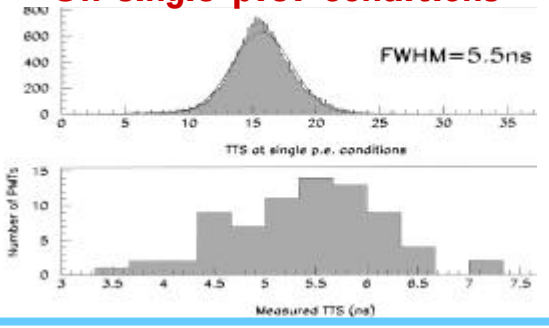
Detector Preparation



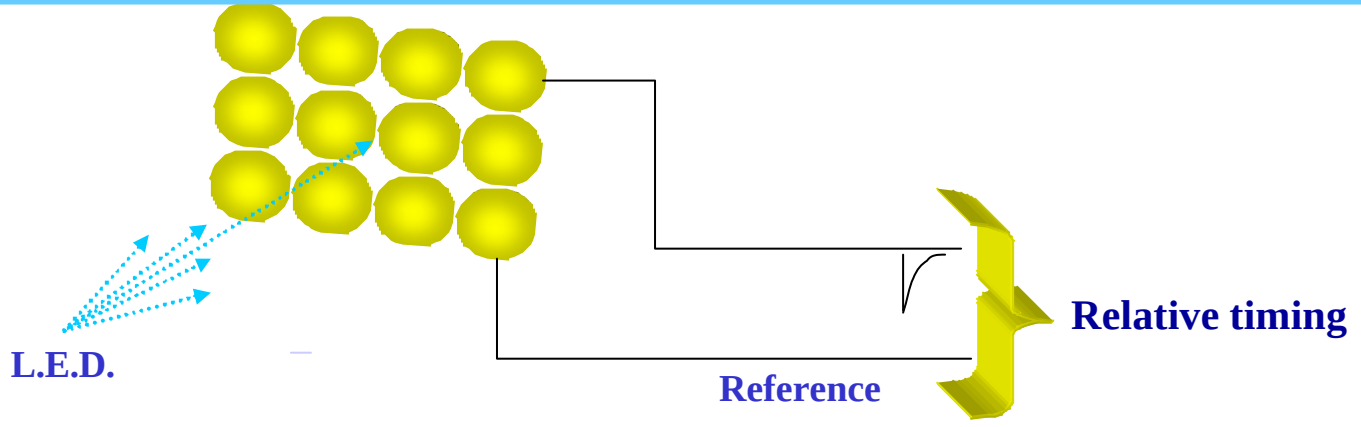
Hamamatsu PMT inside the BENTHOS sphere

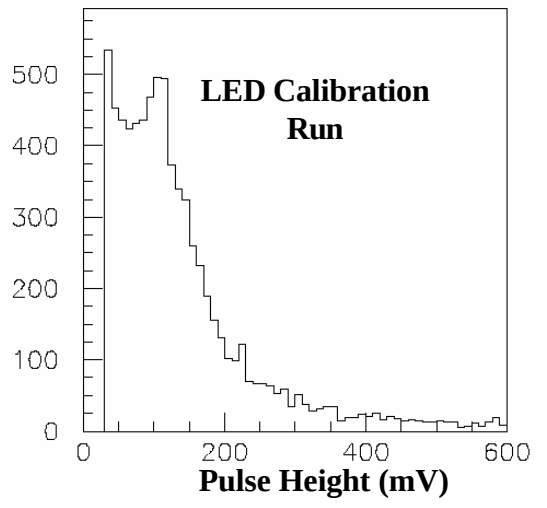
Extensive Lab tests

On single p.e. conditions

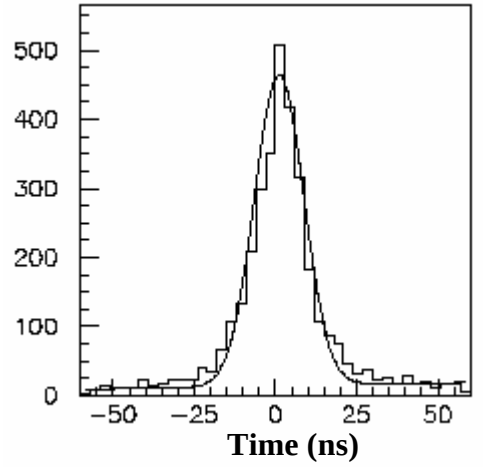


Calibration at the Lab





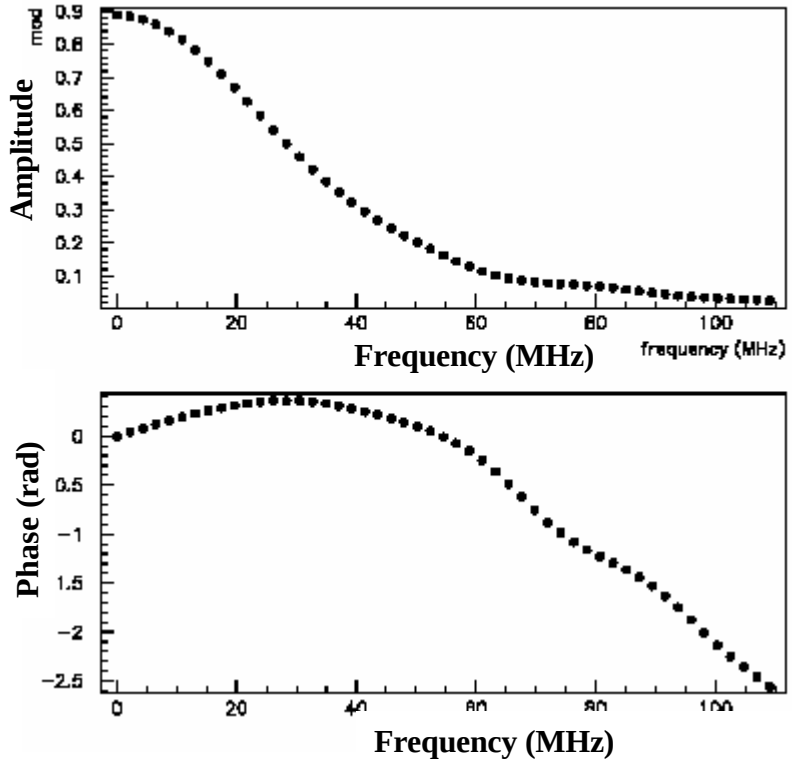
Time Difference in PMTs Response

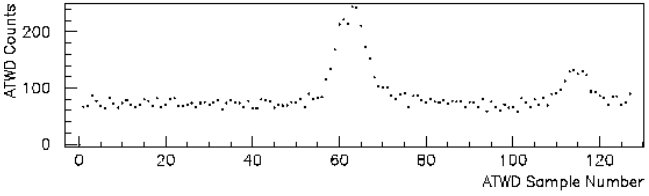


Detector Preparation

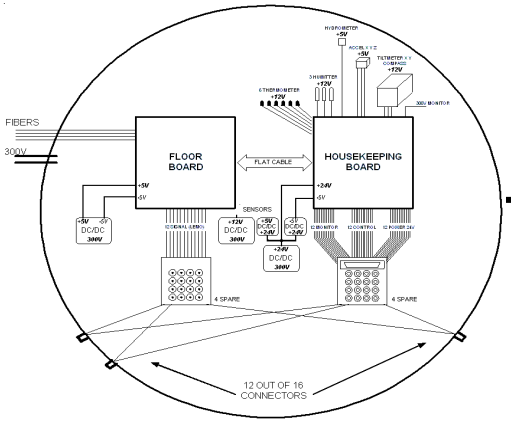
Attenuation Correction

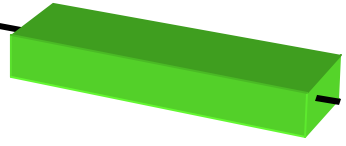
Fourier Transform-Comparison



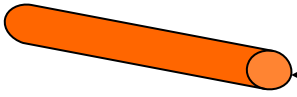


Reference waveform



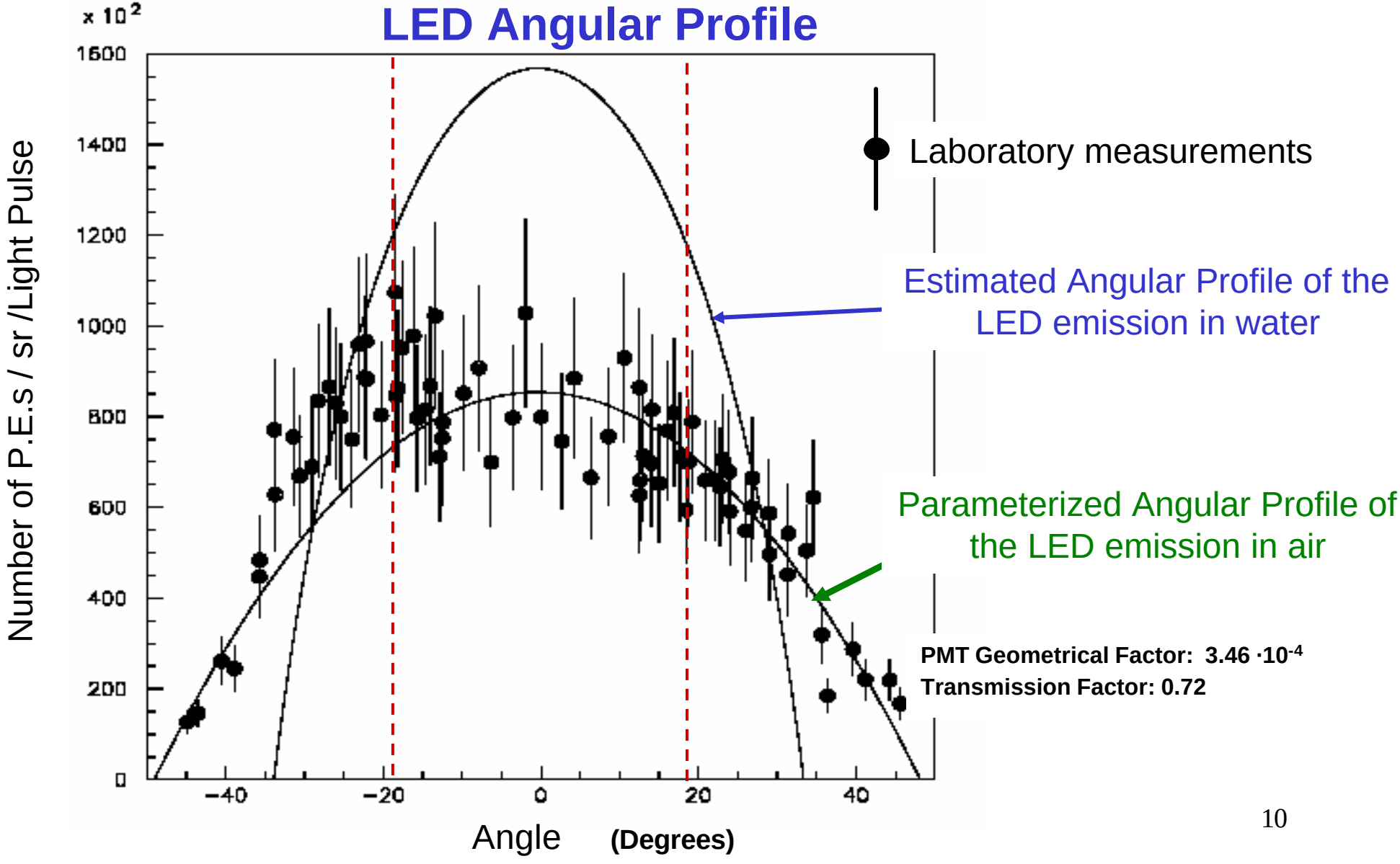


Electronic delay lines and amplifier

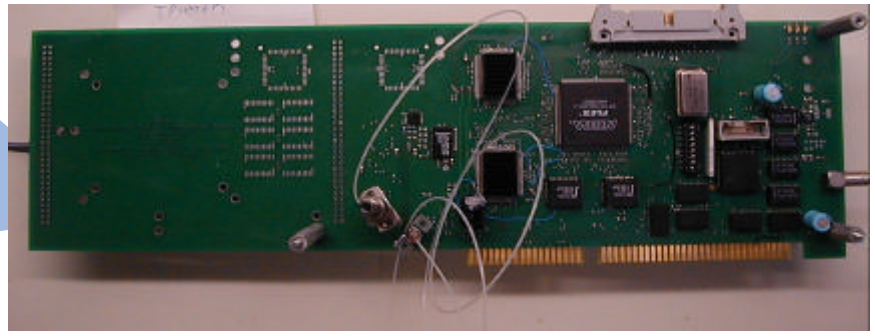


Coaxial cable

LED Angular Profile



DAQ Architecture



to the floor board

Delete

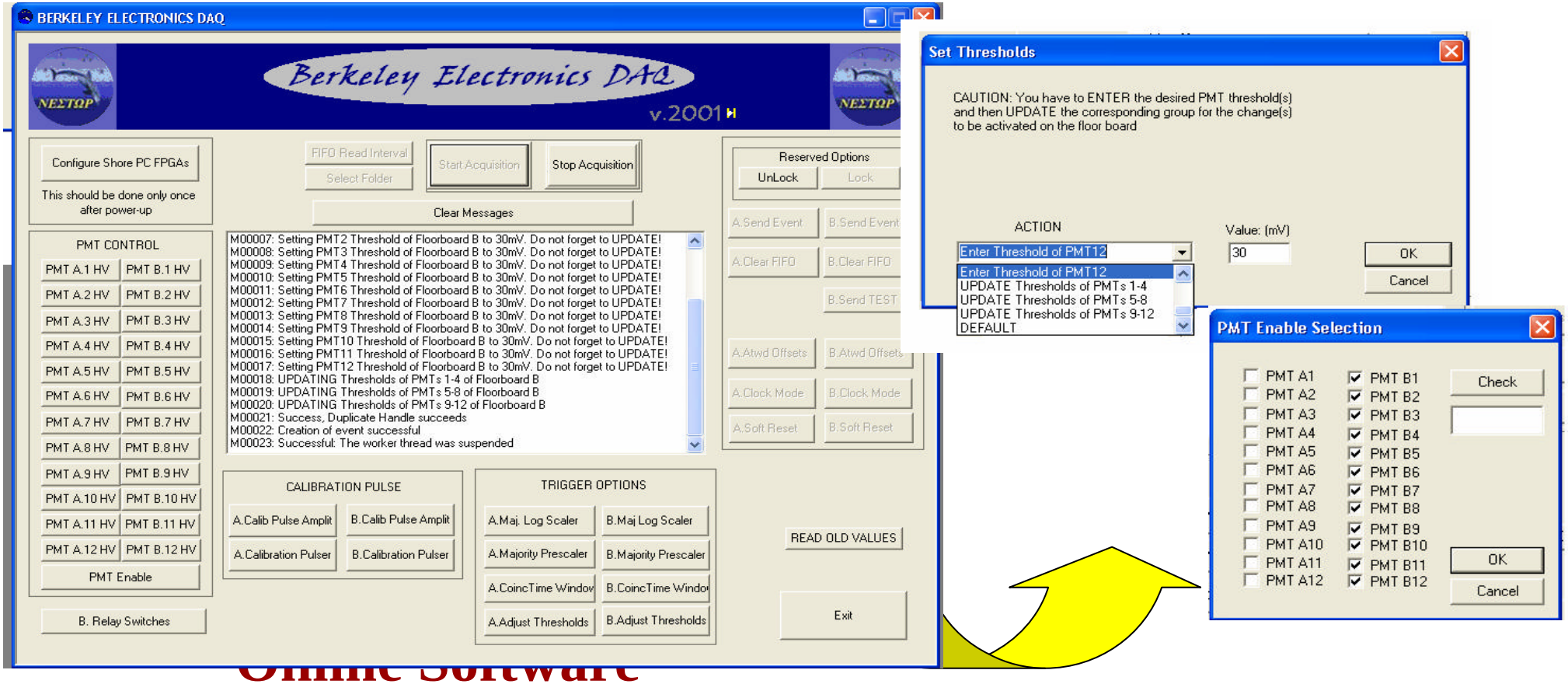
Data Files

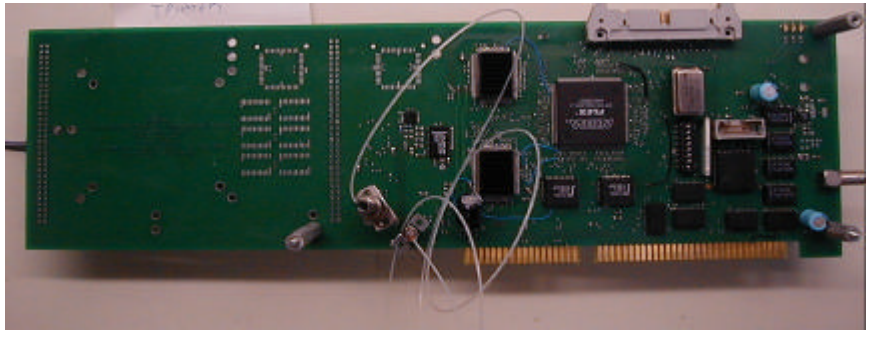
Data Storage

Event samples

Monitor

Offline
fast analysis

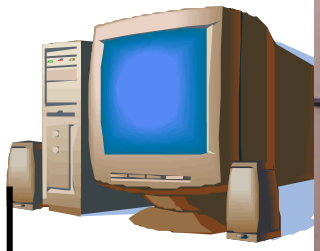


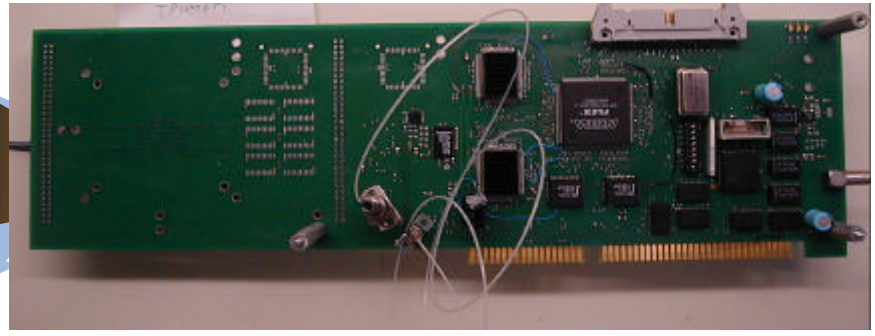


Shore Board

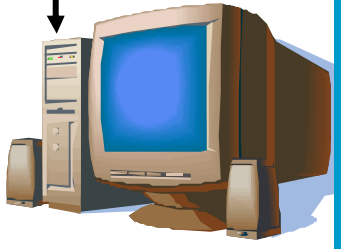
- **Downloads the FPGAs & PLD of the Floor Board**
- **Broadcasts the 40Mhz clock**
- **Receives Data from the Floor Board**
- **Transmits Data to the Run Control System**

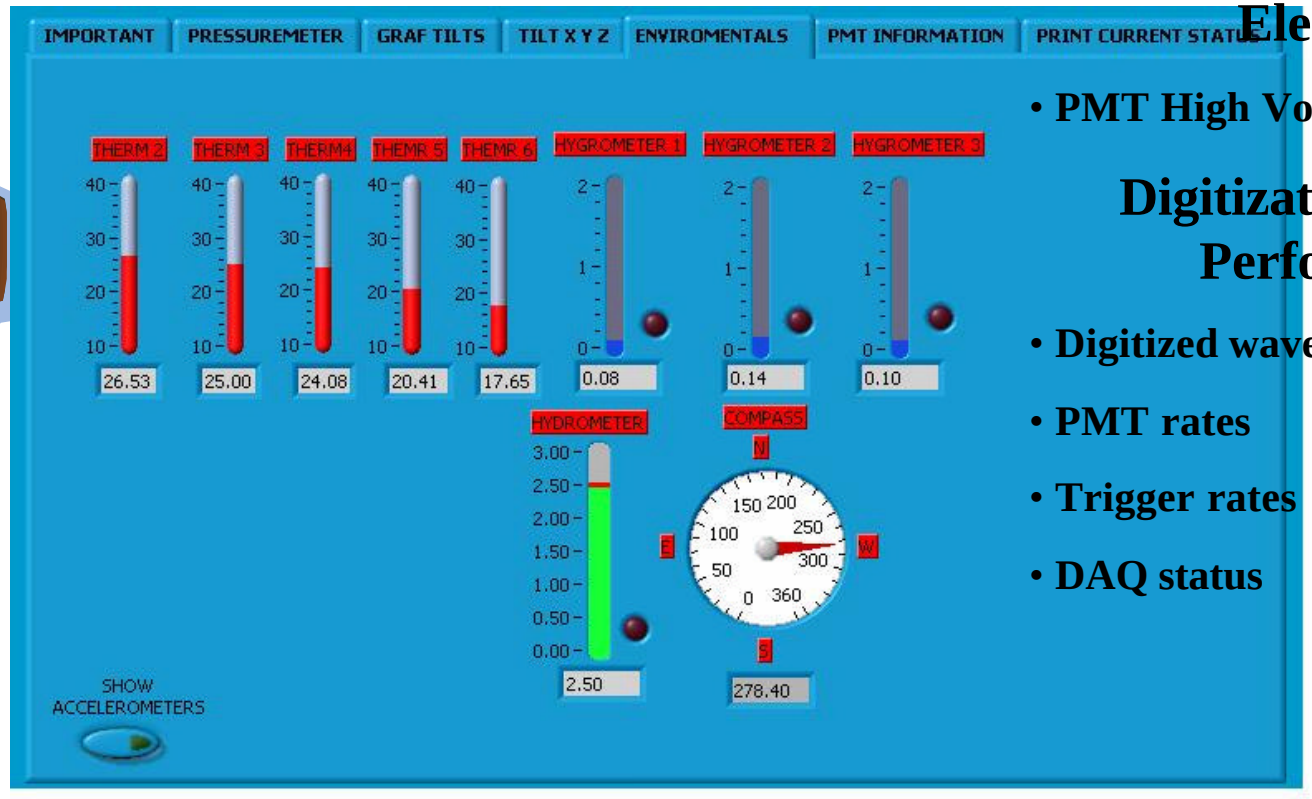
Real Time Monitor





Event samples





Environmental

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

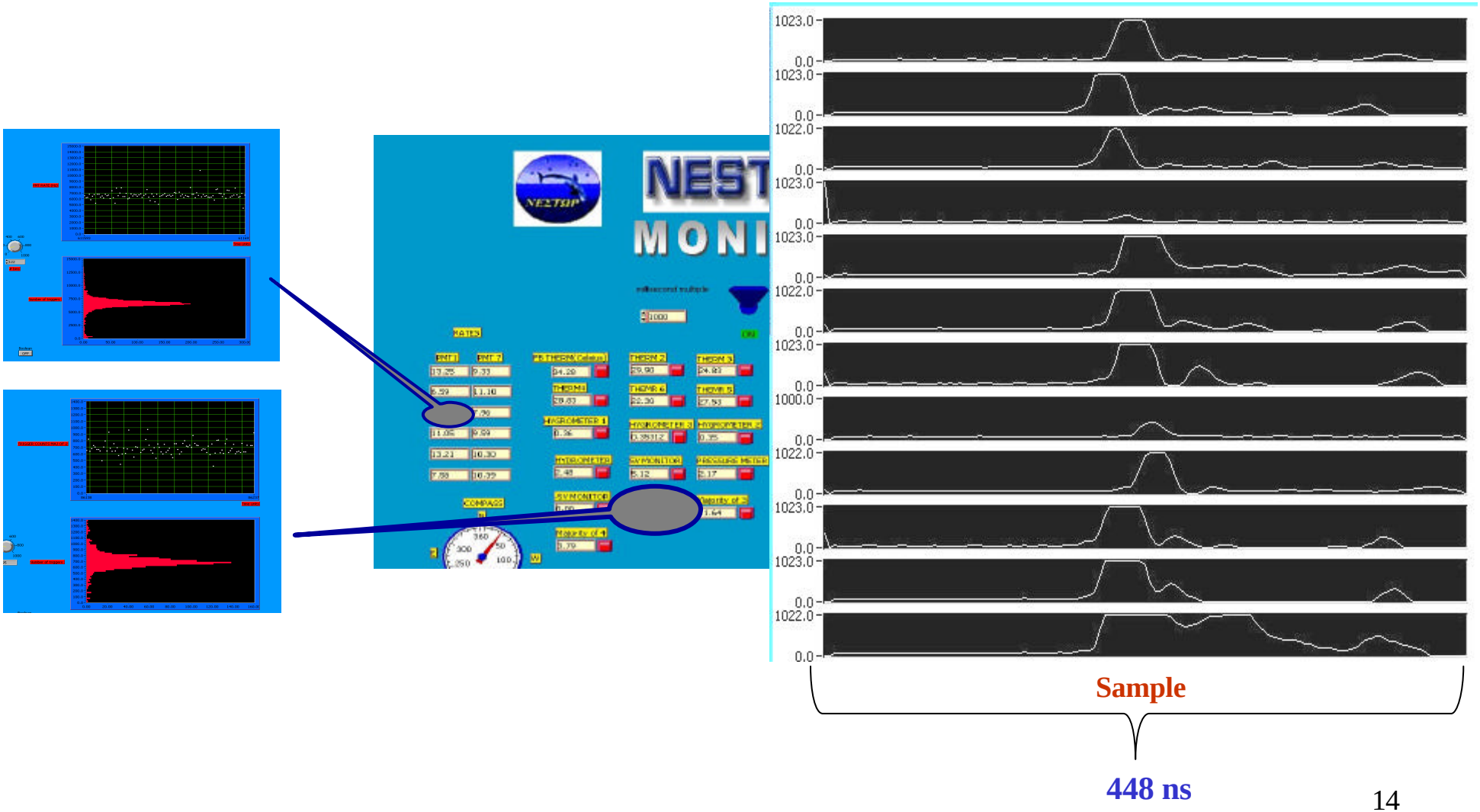
Electrical

- PMT High Voltage etc

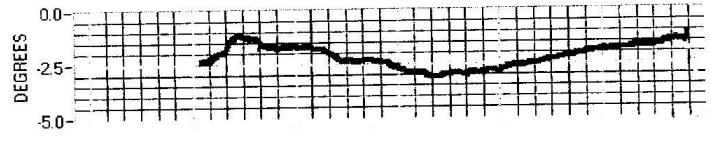
Digitization & DAQ Performance

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

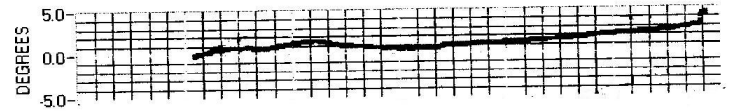
Real Time Monitors



During deployment



TILT X



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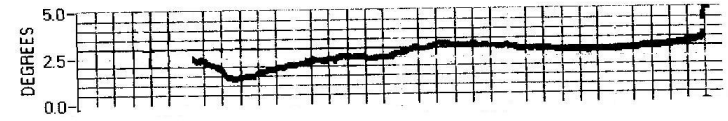
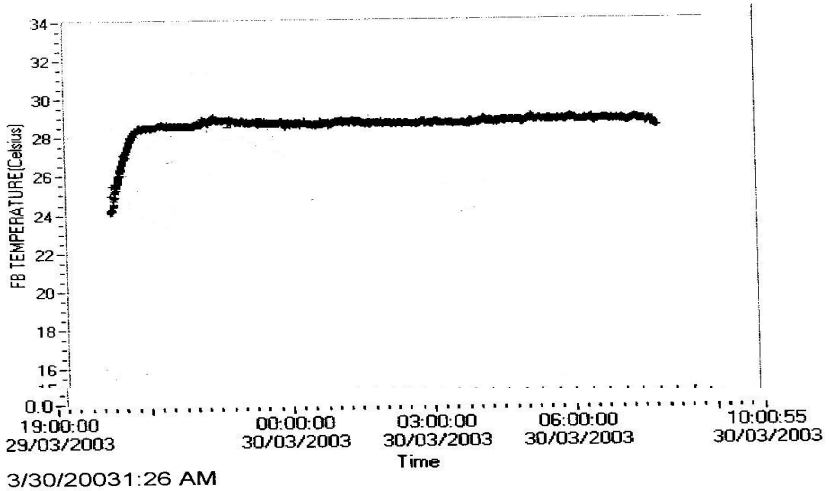
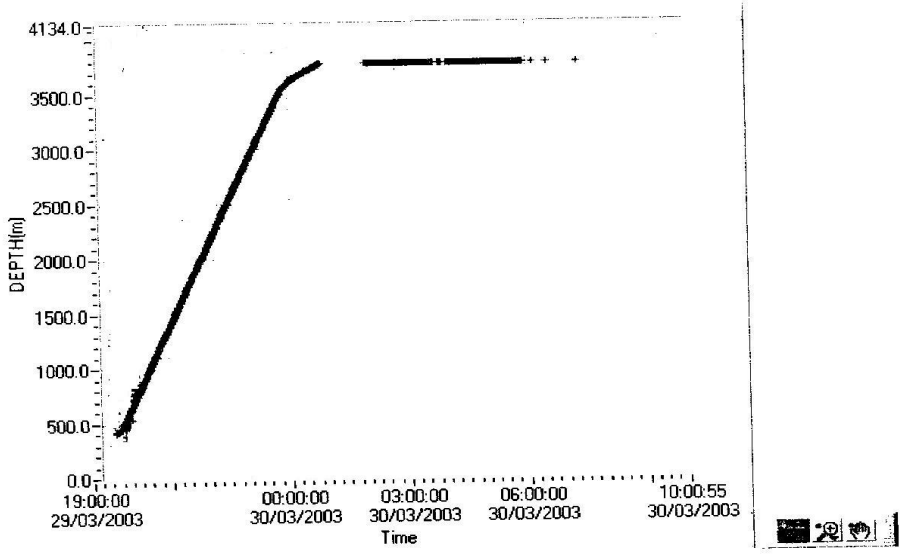


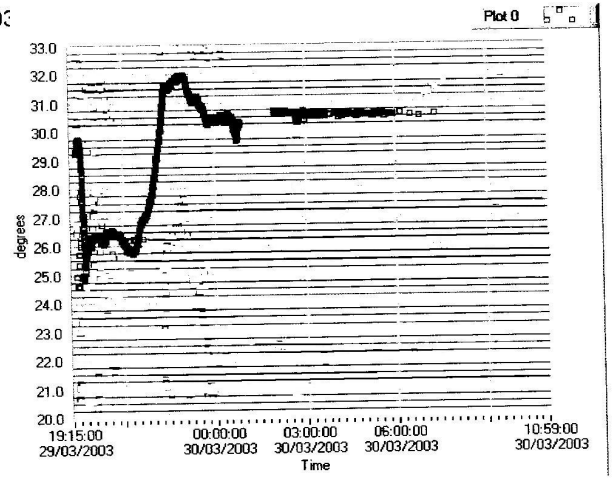
Z-AXIS



3/30/20031:26 AM

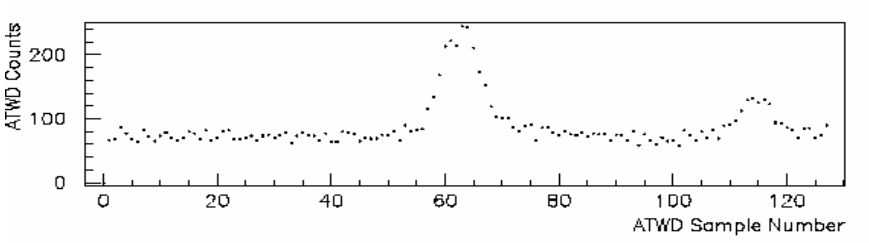


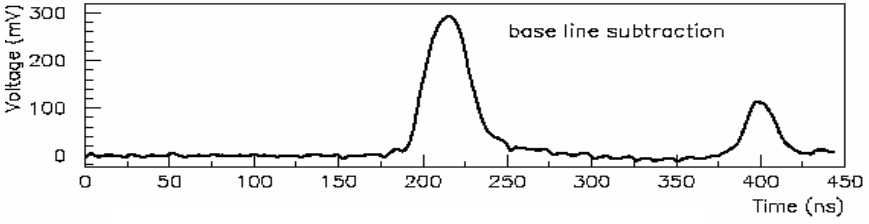
3/30/2003

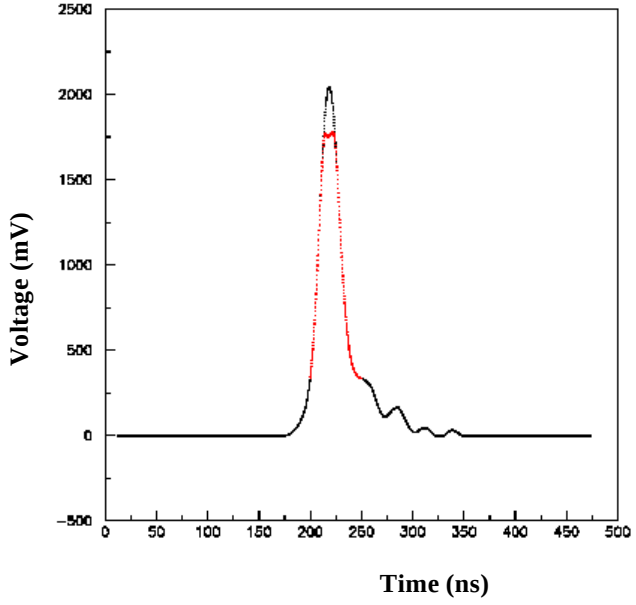


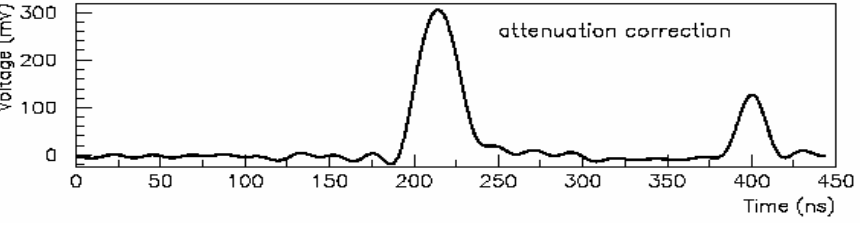
3/30/20036:58 AM

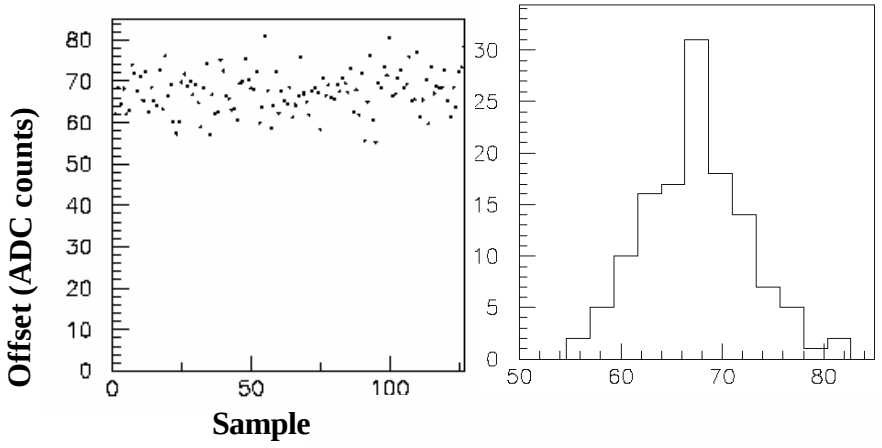
Waveform Reconstruction

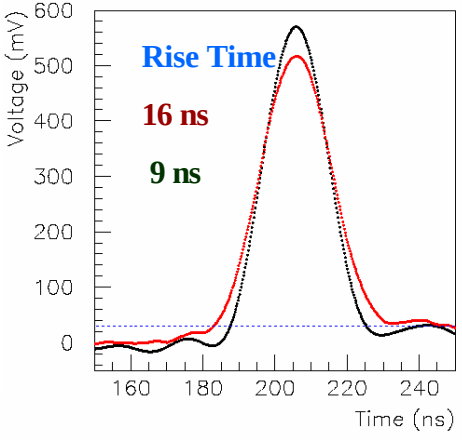


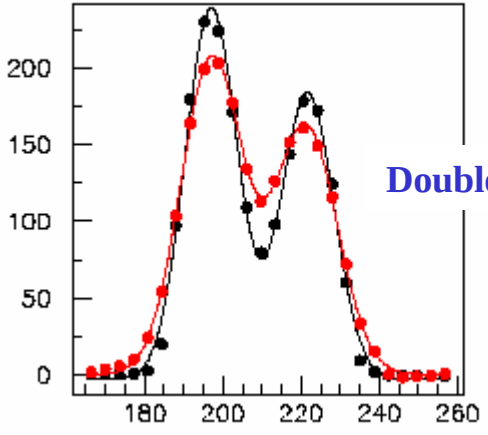












Double pulse separation

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

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

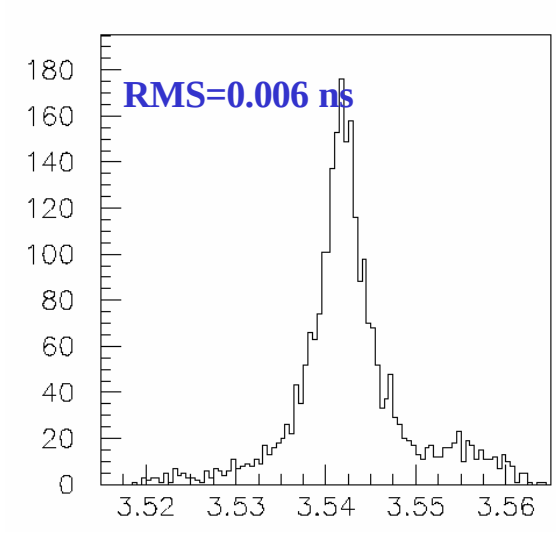
Waveform Reconstruction

Hit Definition

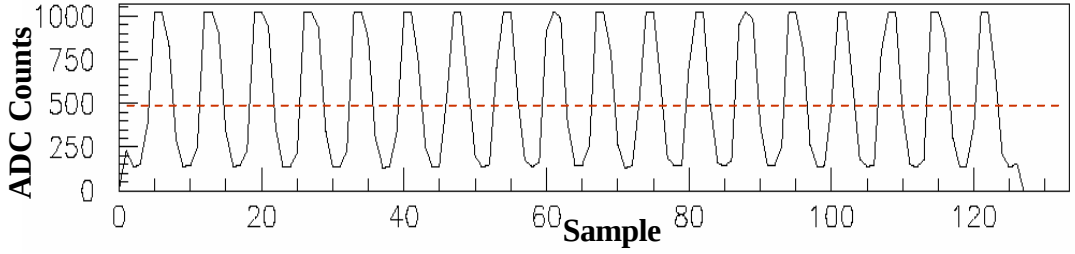
DST Production

Data Quality Histograms

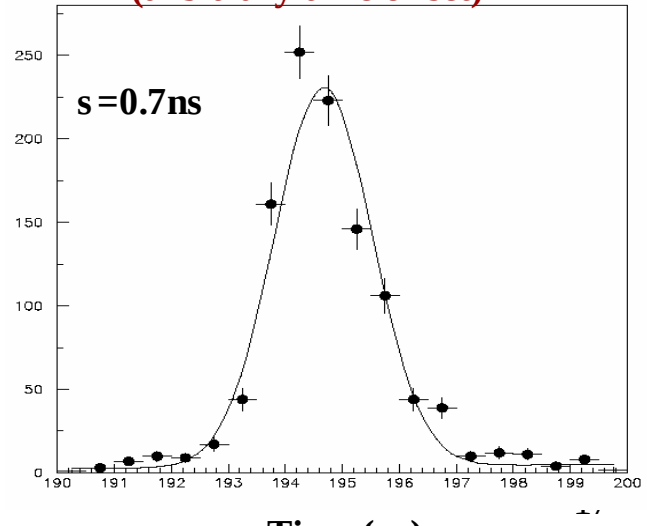
Event by Event Sampling Interval Variation (Constant Temperature)



40 MHz Clock Waveform Capture

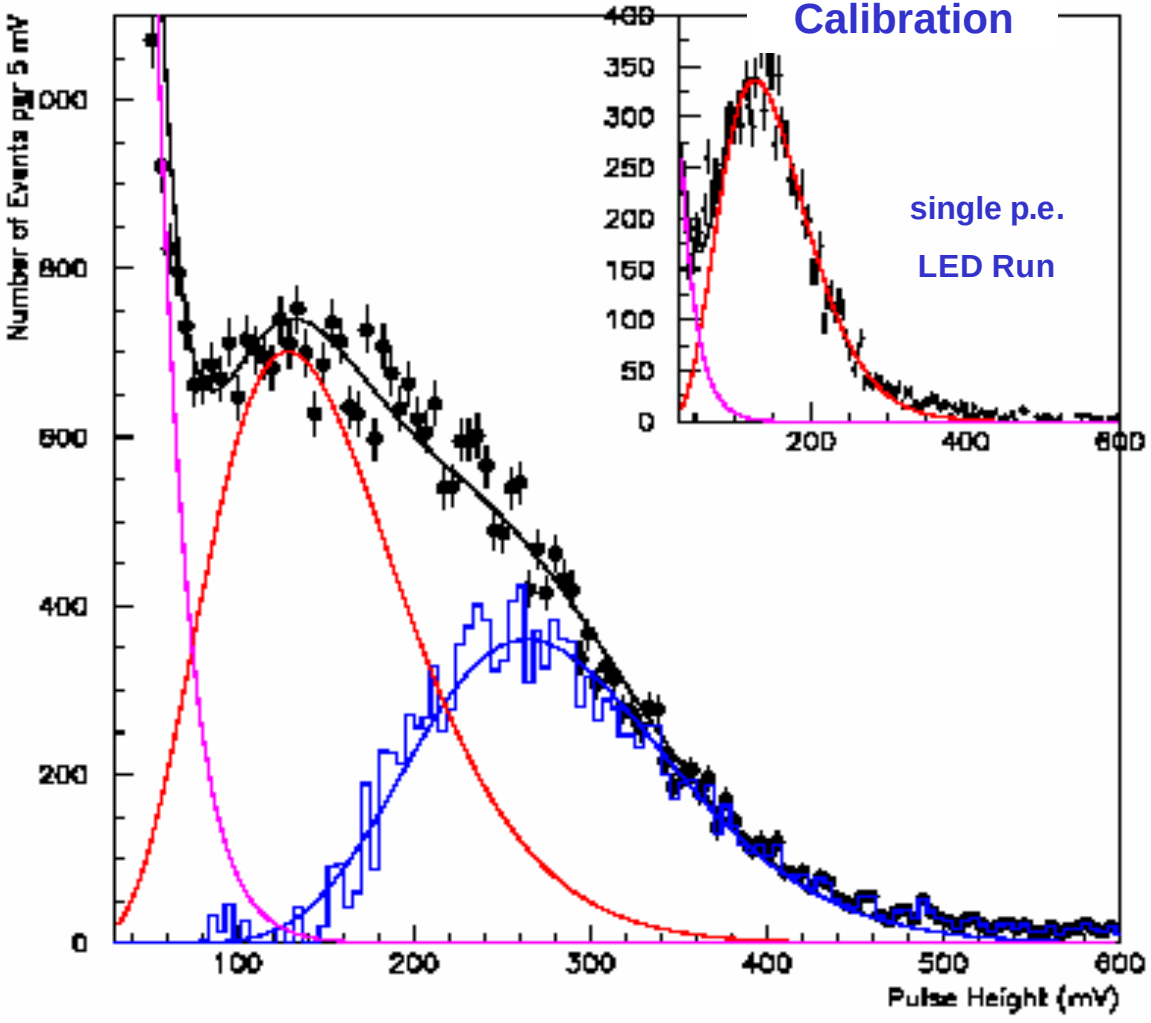


Software to Hardware Trigger Time Difference (arbitrary time offset)



Data from a depth of 4000 m

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



single p.e. pulse height distribution

two p.e.s pulse height distribution

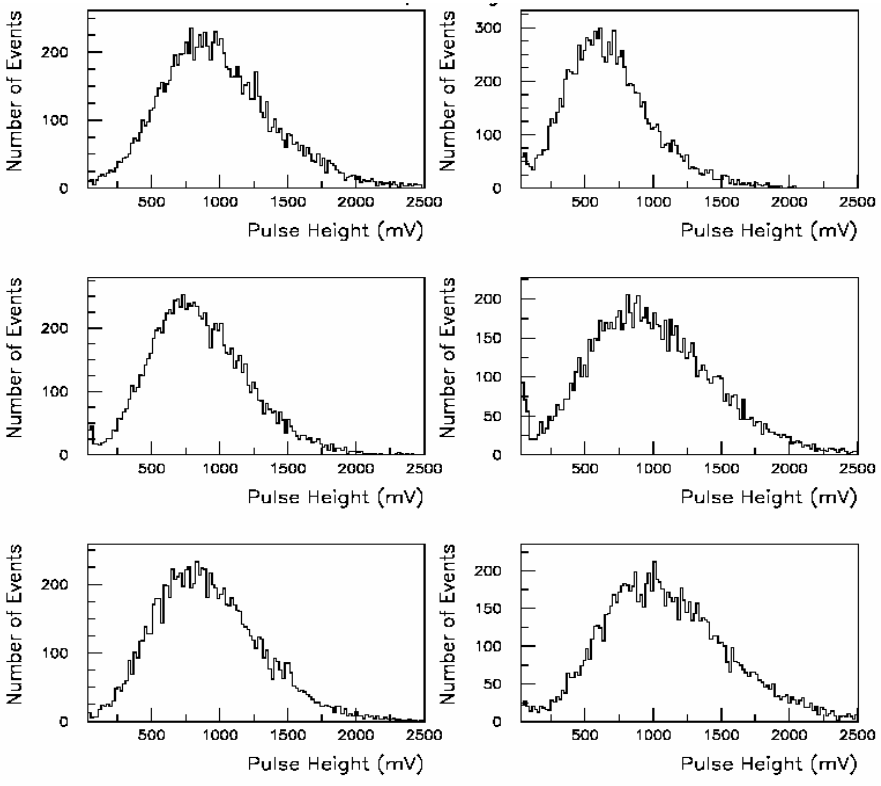
dark current pulse height distribution

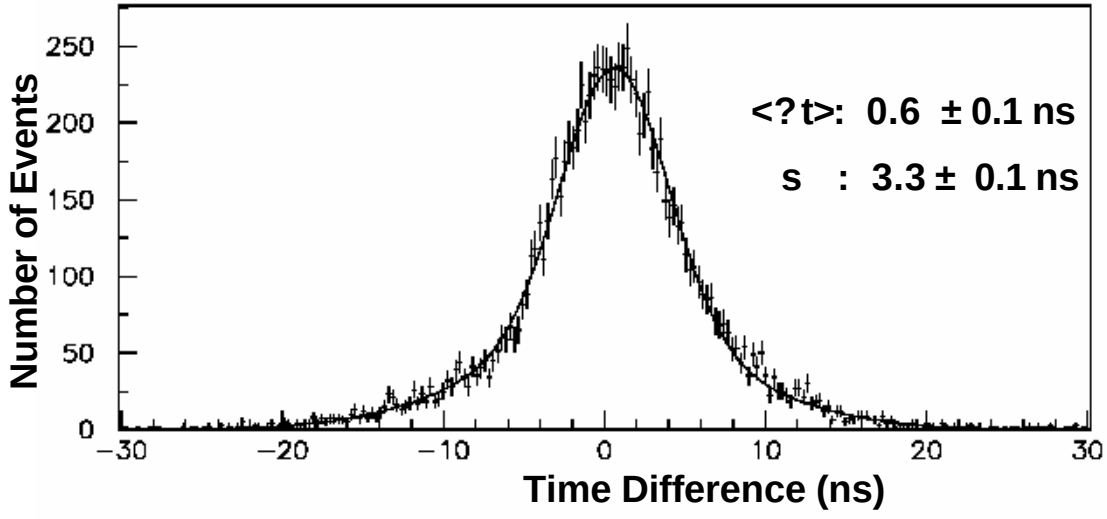
sum of the above

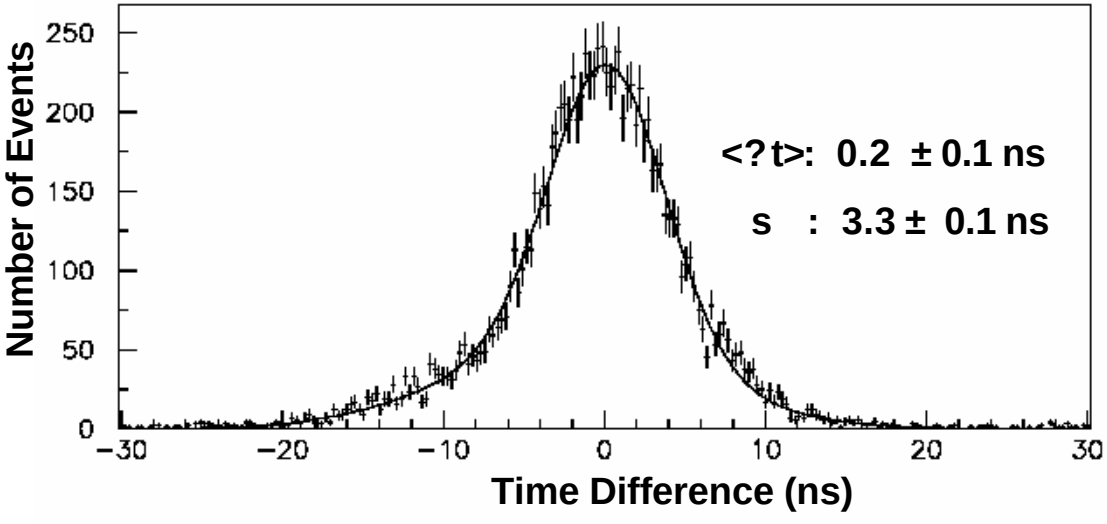
Calibration Data Analysis

Calibration Database
Quality Histograms

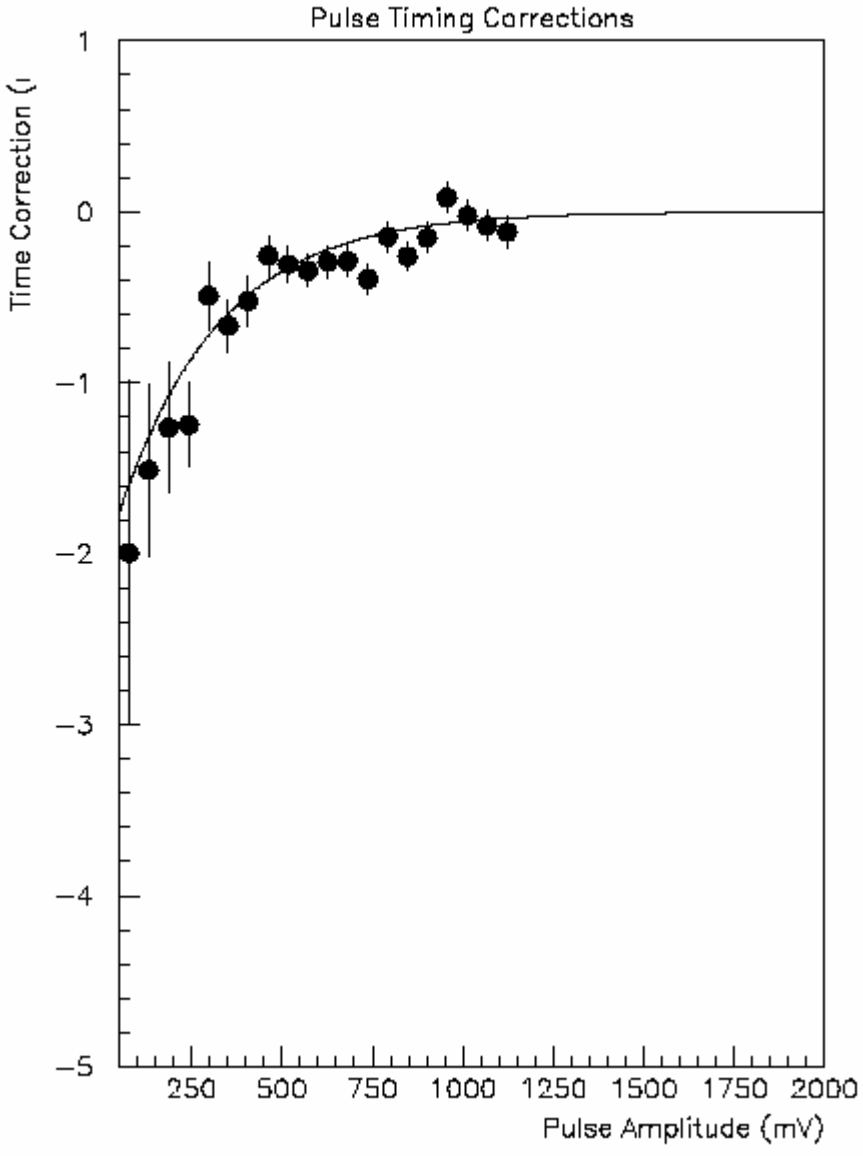
Data from a depth of 4000 m
Calibration Run

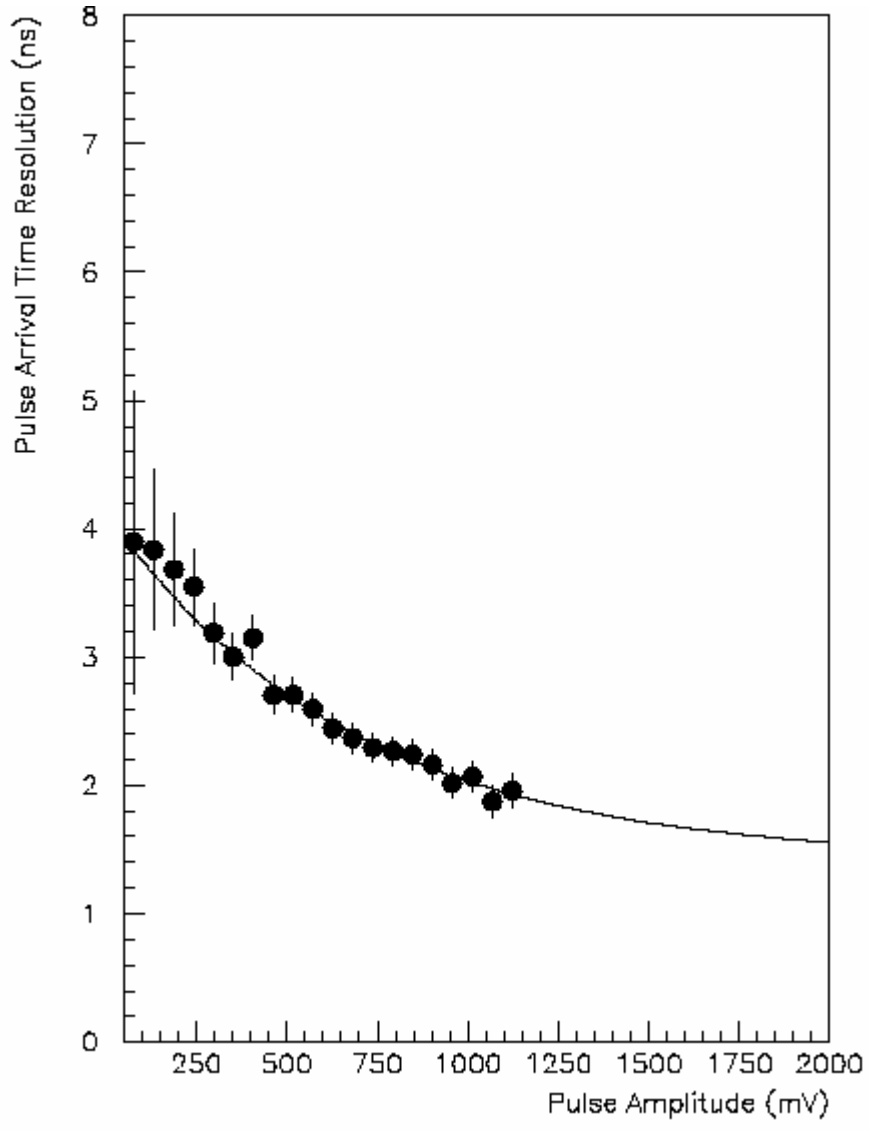






Data from a depth of 4000 m
Calibration Run

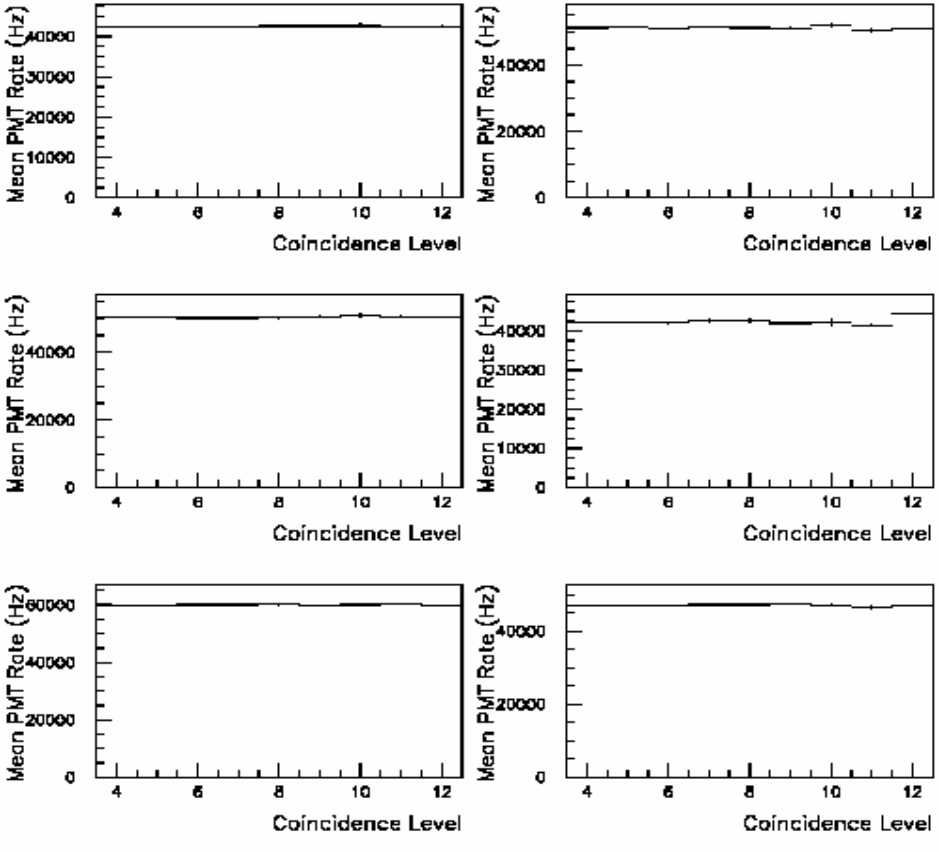


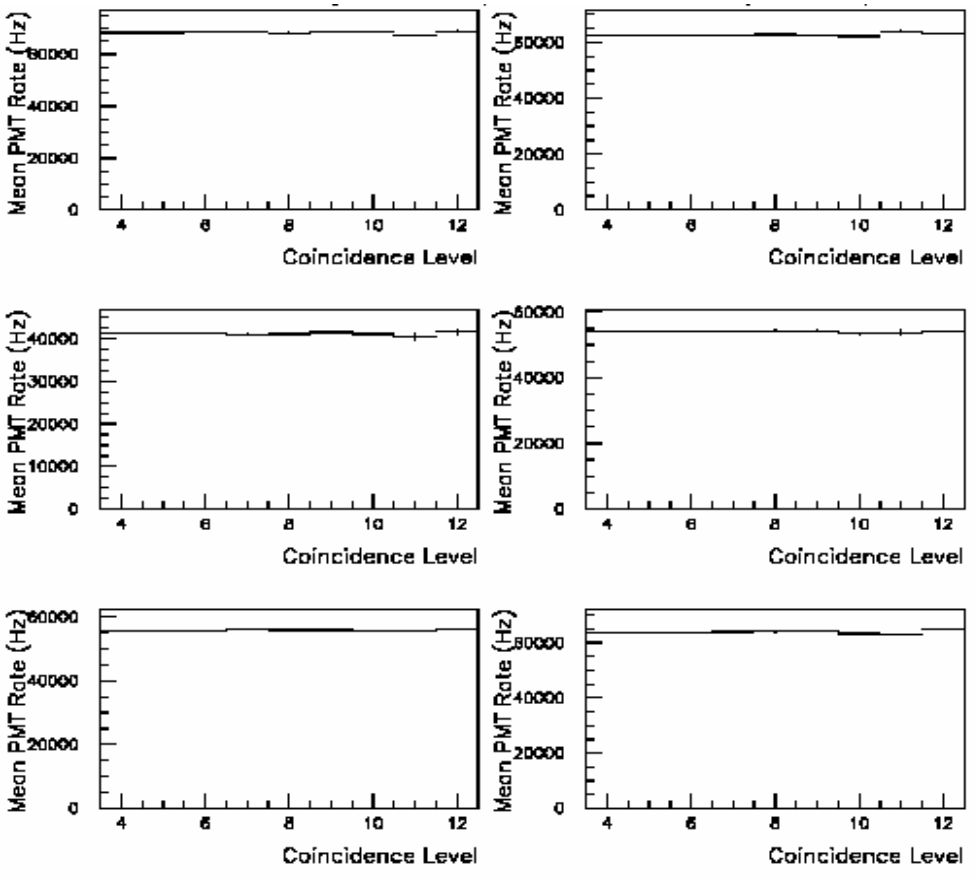


Data from a depth of 4000 m

Single PMT Rates

Trigger: =4fold Coincidence





Data from a depth of 4000 m

Trigger Studies

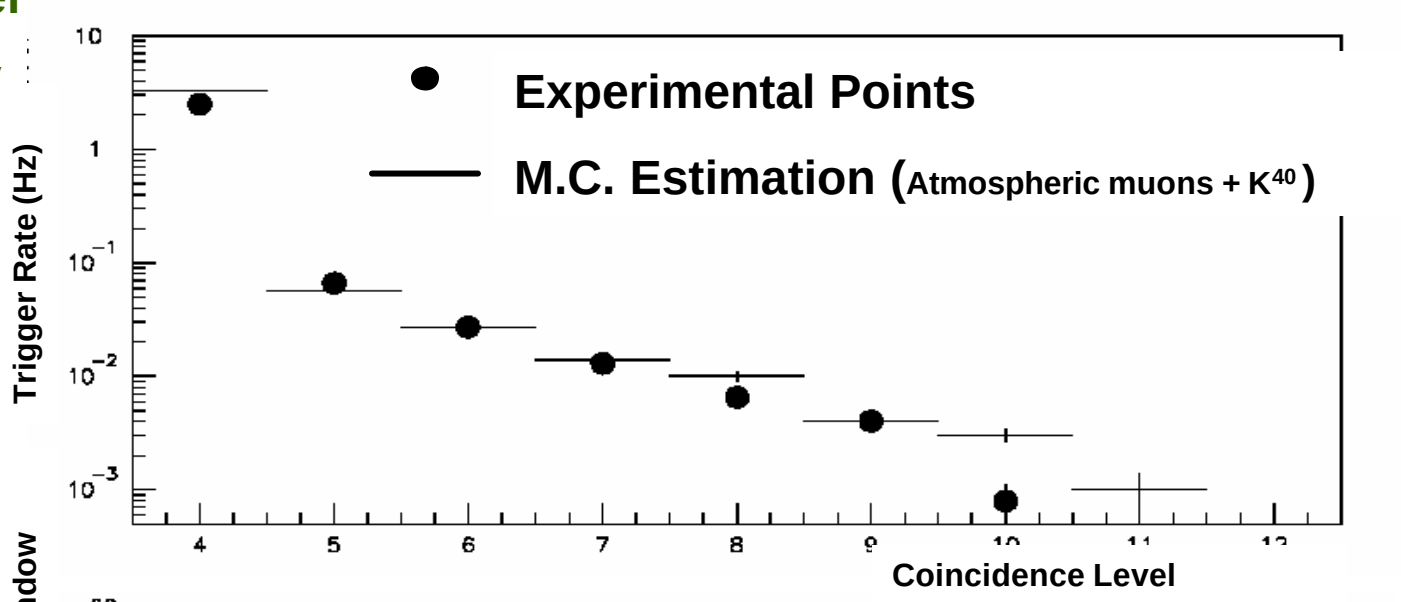
Preliminary

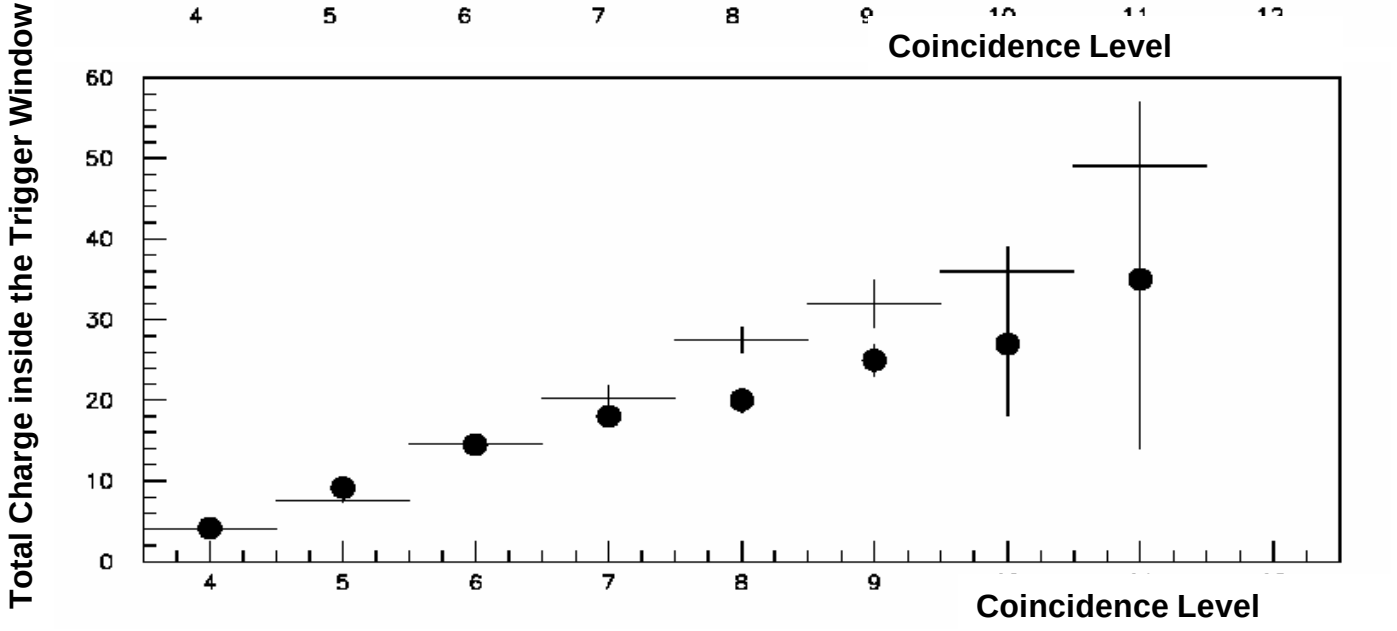
Data Collected with

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.)