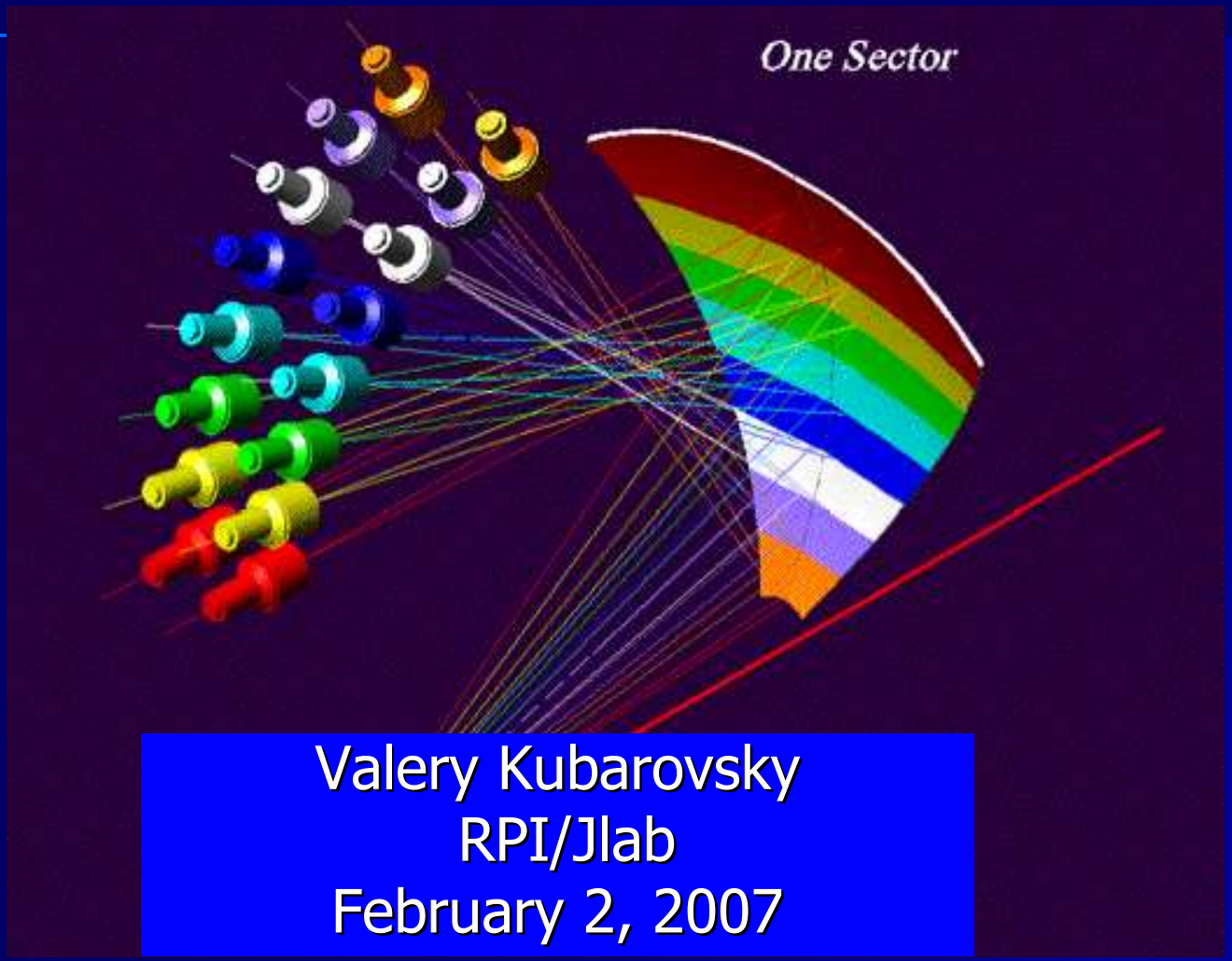
CLAS12 High Threshold Cherenkov Counter R&D



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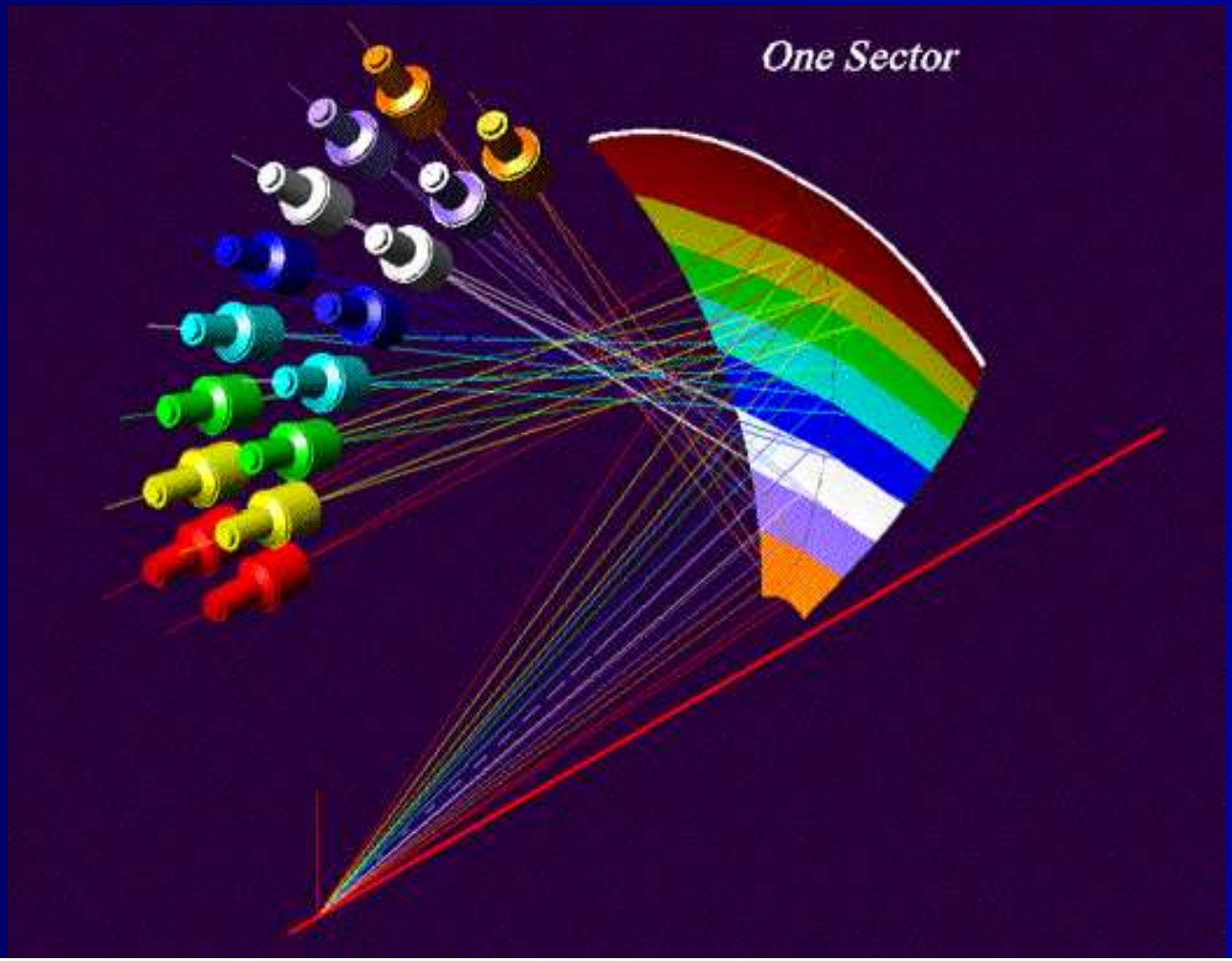
RPI/Jlab
February 2, 2007

Plan

- Cosmic PMT stand
- Optical PMT stand
- Magnetic shielding

HTCC optical design



Photonis XP4508B

- UV sensitive, 10 stage , 5” diameter PMT
- Window: fused sillica
- Bialkali photocathode
- High QE (24% at 420 nm)
- Uniform electron collection over photocathode
- Rise time 2.1 ns
- Duration at half height 3.0 ns
- Transit time 49 ns

Magnetic Shielding

- Gain halved for a magnetic field of:
- 0.4 gauss perpendicular to axis
- 1.3 gauss parallel with tube axis

- The strength of the field at the Earth's surface ranges from less than 0.6 gauss around the magnetic poles in northern Canada.

PMT Operating Characteristics

- Quantum Efficiency (QE) vs wave length
- QE vs. Photocathode spot position
- Dark Current
- Gain
- Pulse height resolution
- Gain vs. High Voltage
- Linearity and pulse-rate dependence
- Rise-time

PMT Input Window

- UV-transmitting Glass
  - UV cut-off wavelength is 185 nm
- Synthetic Silica
  - UV cut-off wavelength is 160 nm

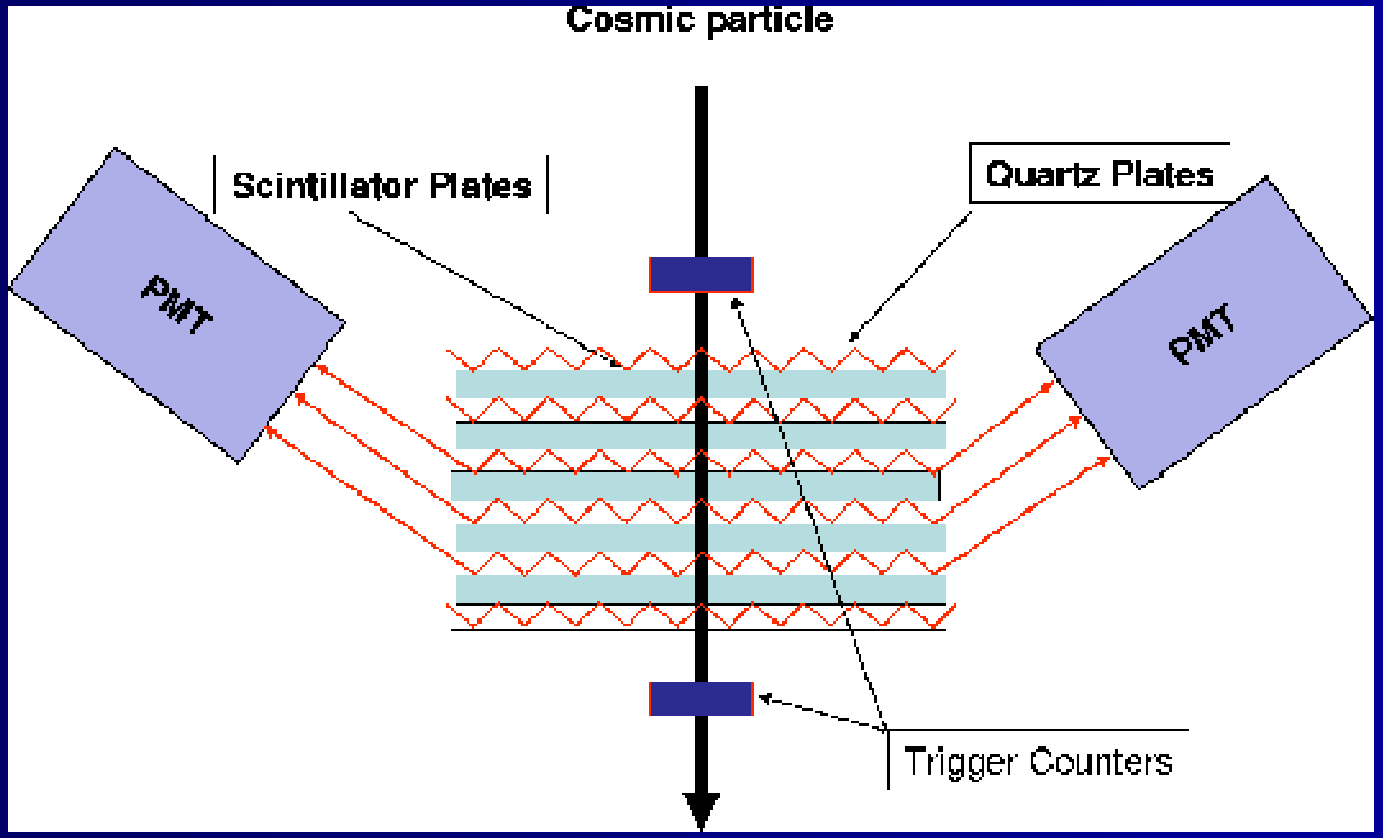
Main Goal

- Compare UV-transmitting Glass Input Window

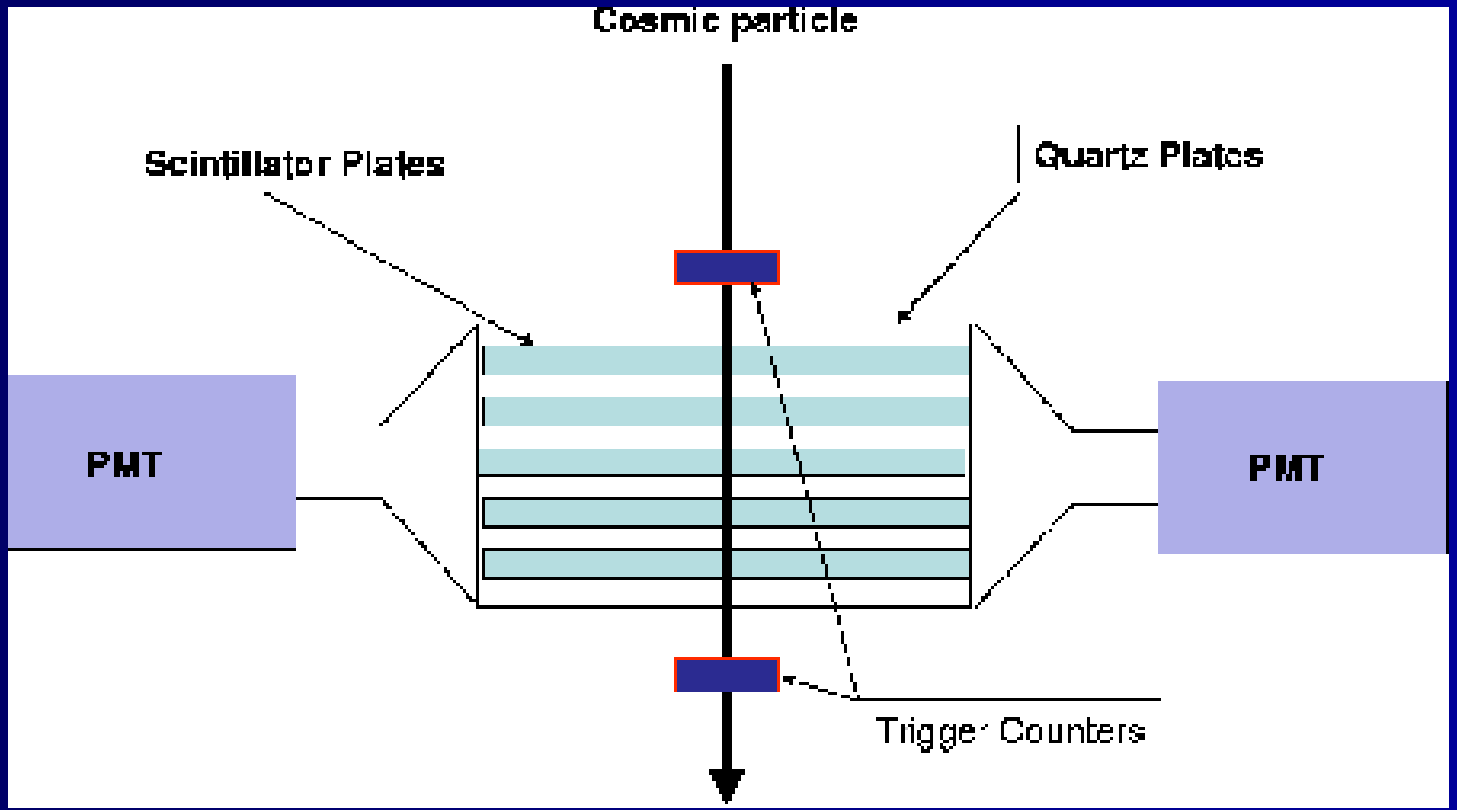
  and

- Quartz Input window

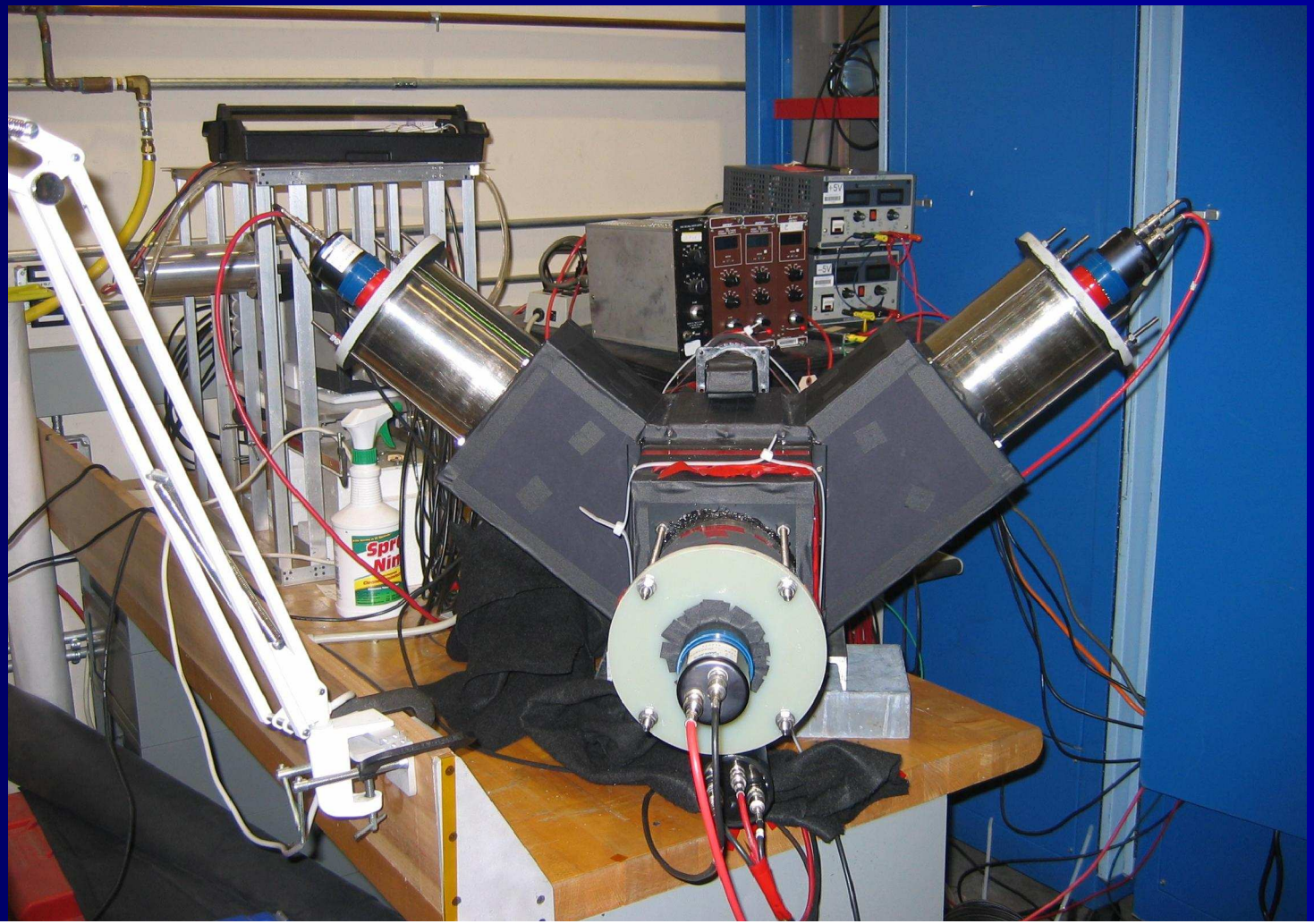
Cosmic Stand



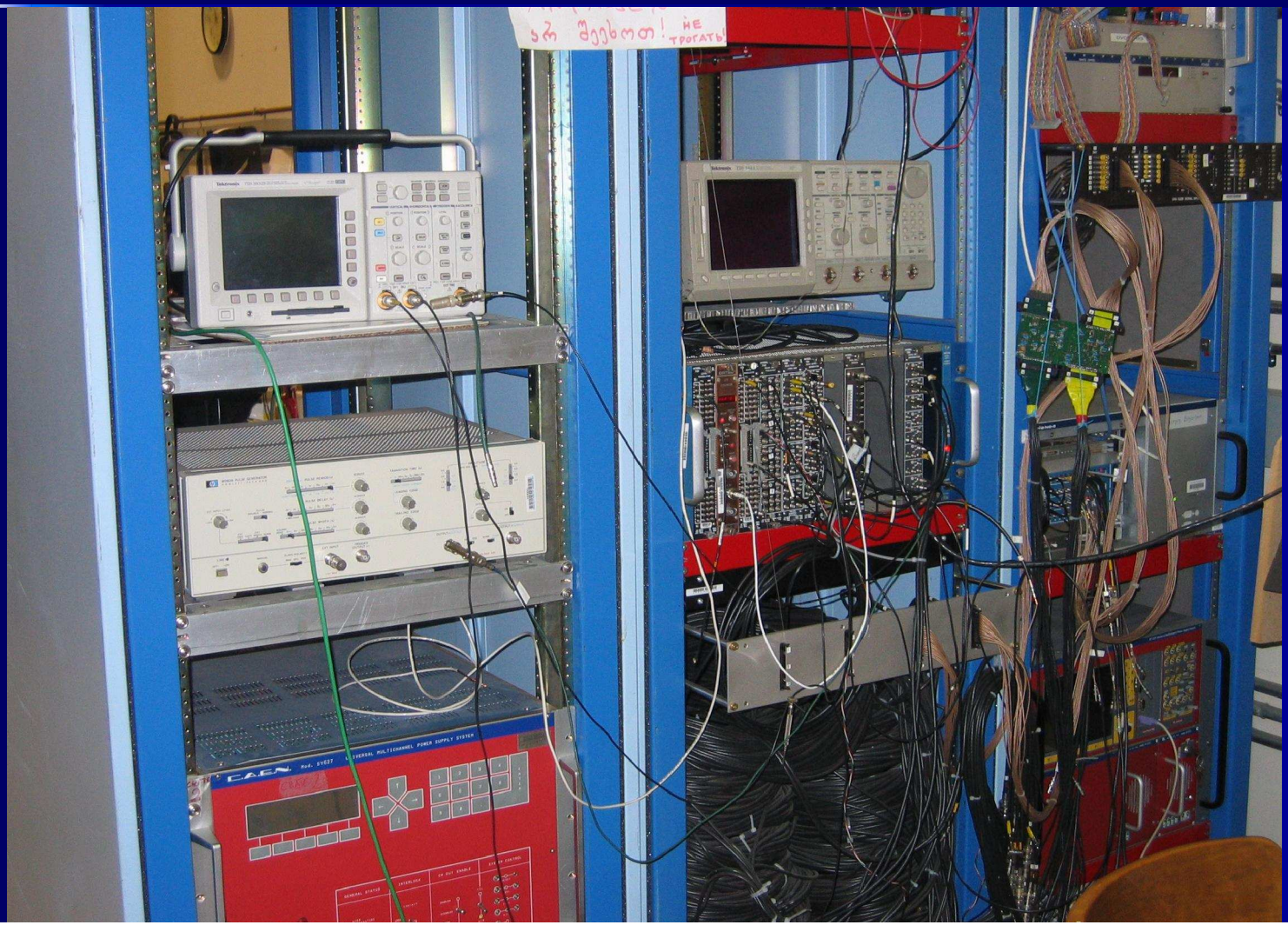
Scintillator part



Cosmic Stand



DAQ

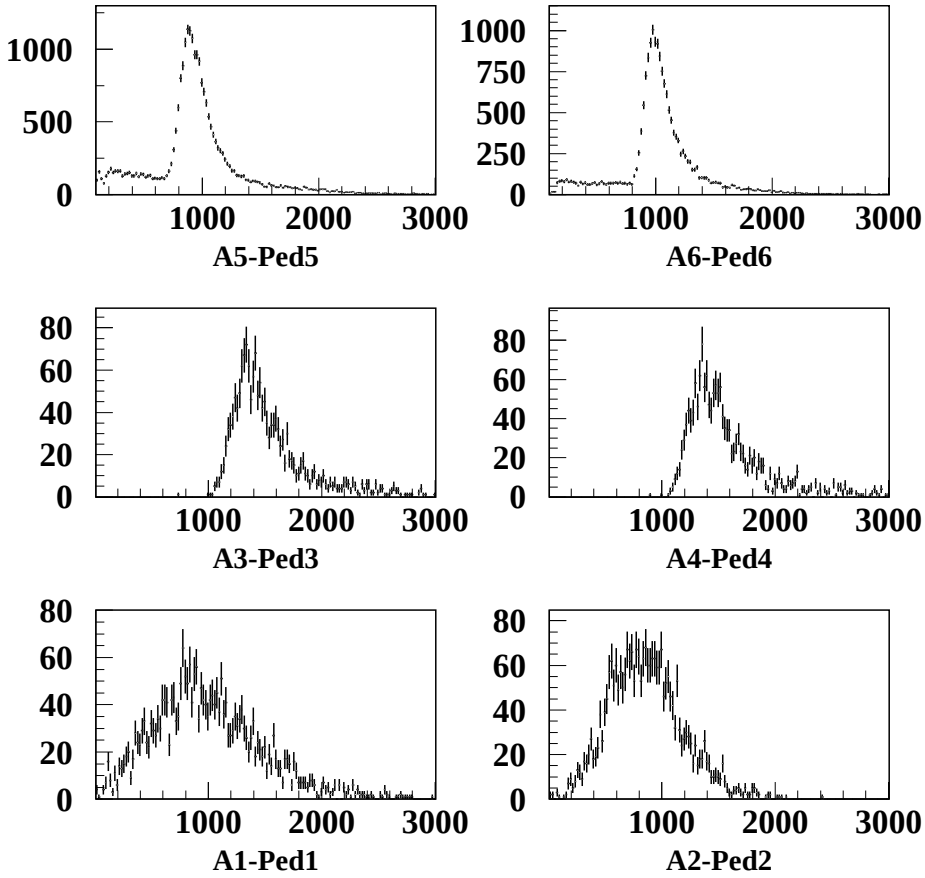


Raw ADC Spectra

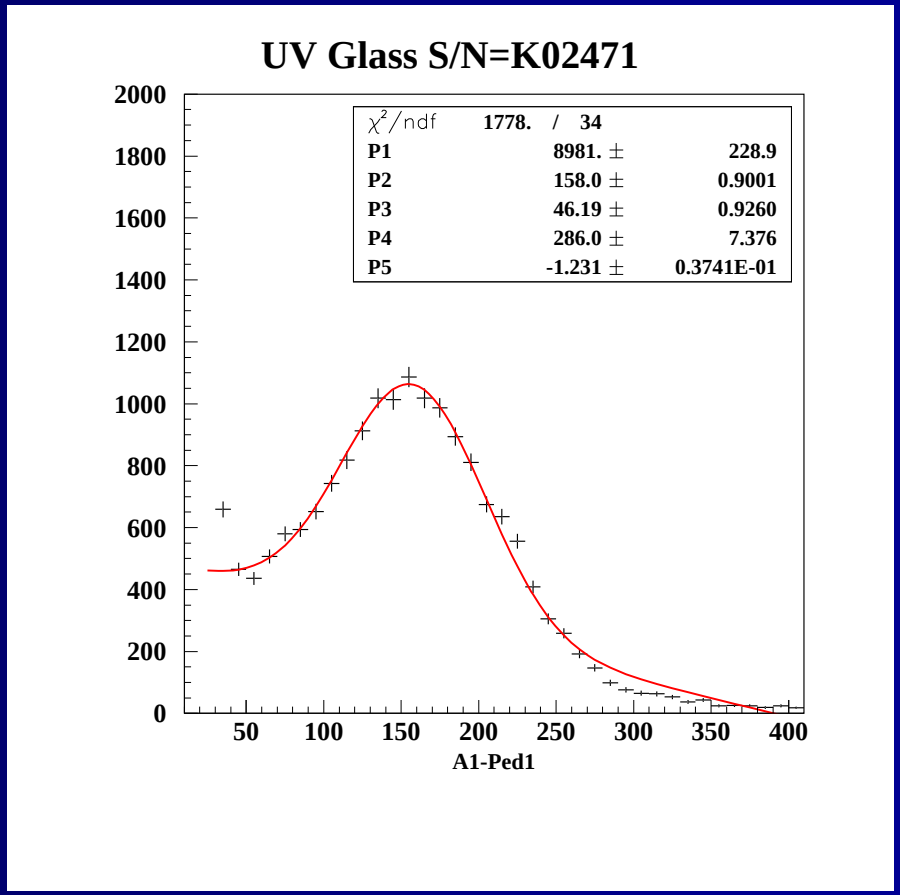
Trigger Counters

Scintillator Counters

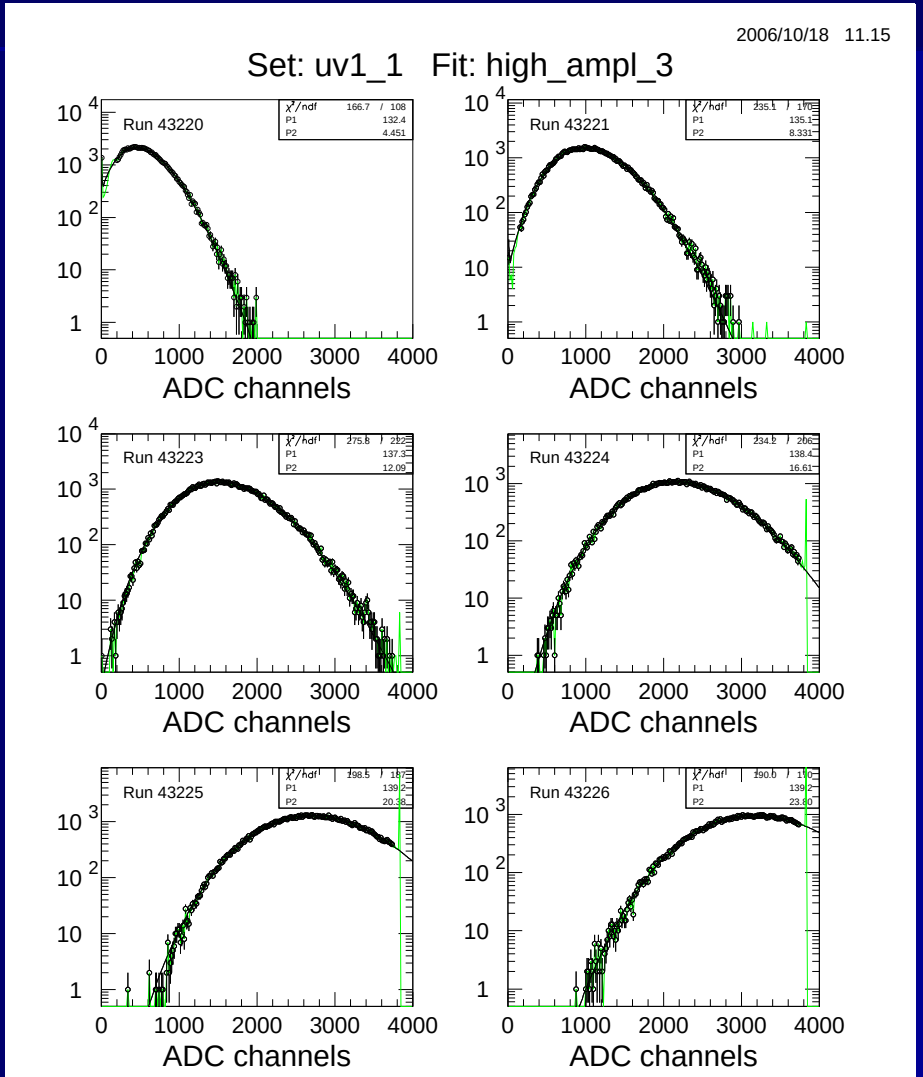
Cerenkov Counters



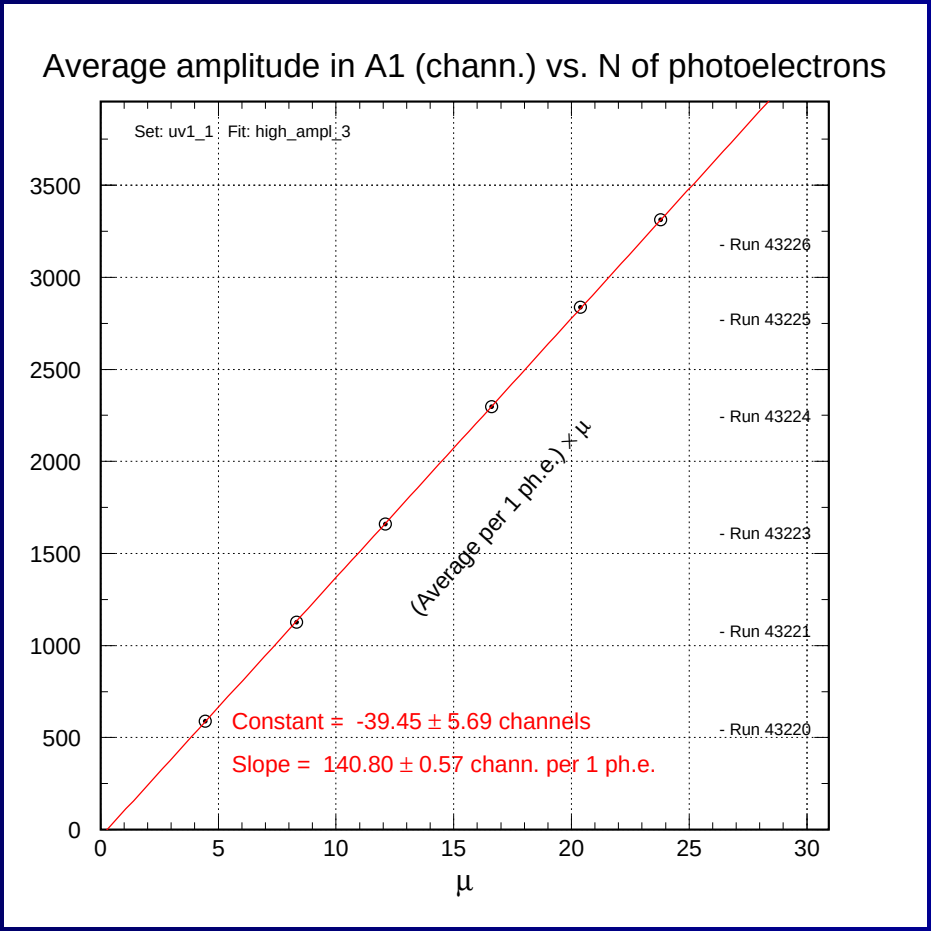
One Photoelectron Peak



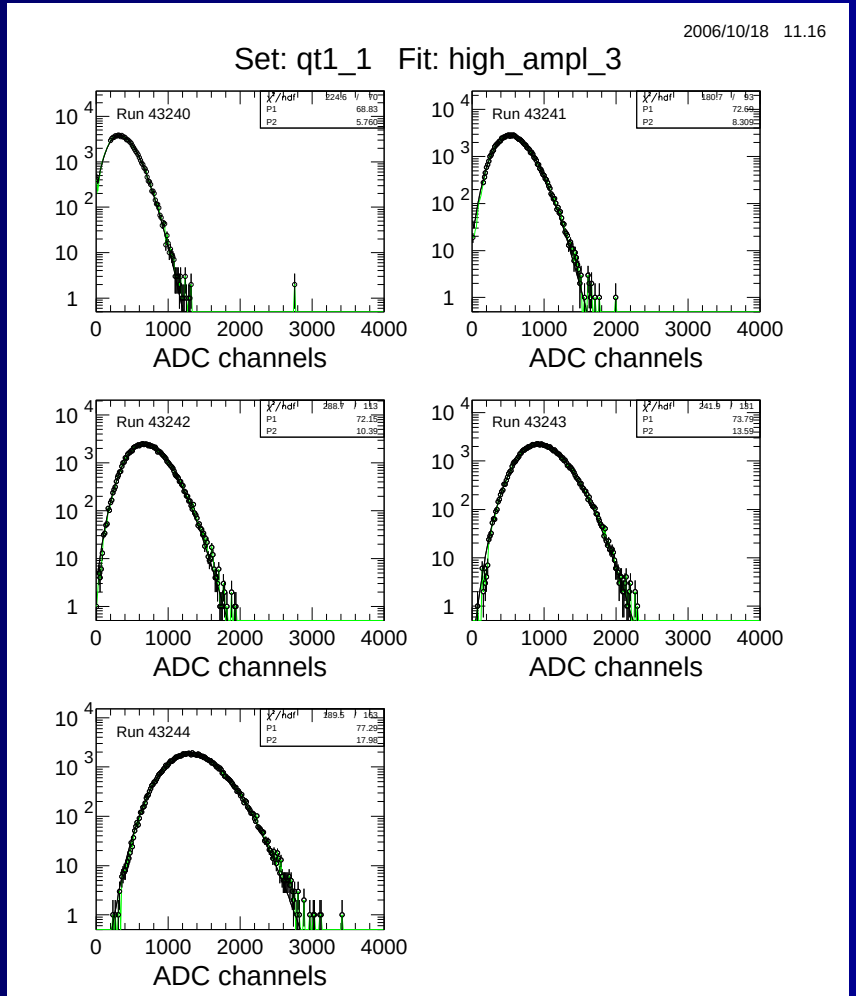
LED spectra UV Window PMT



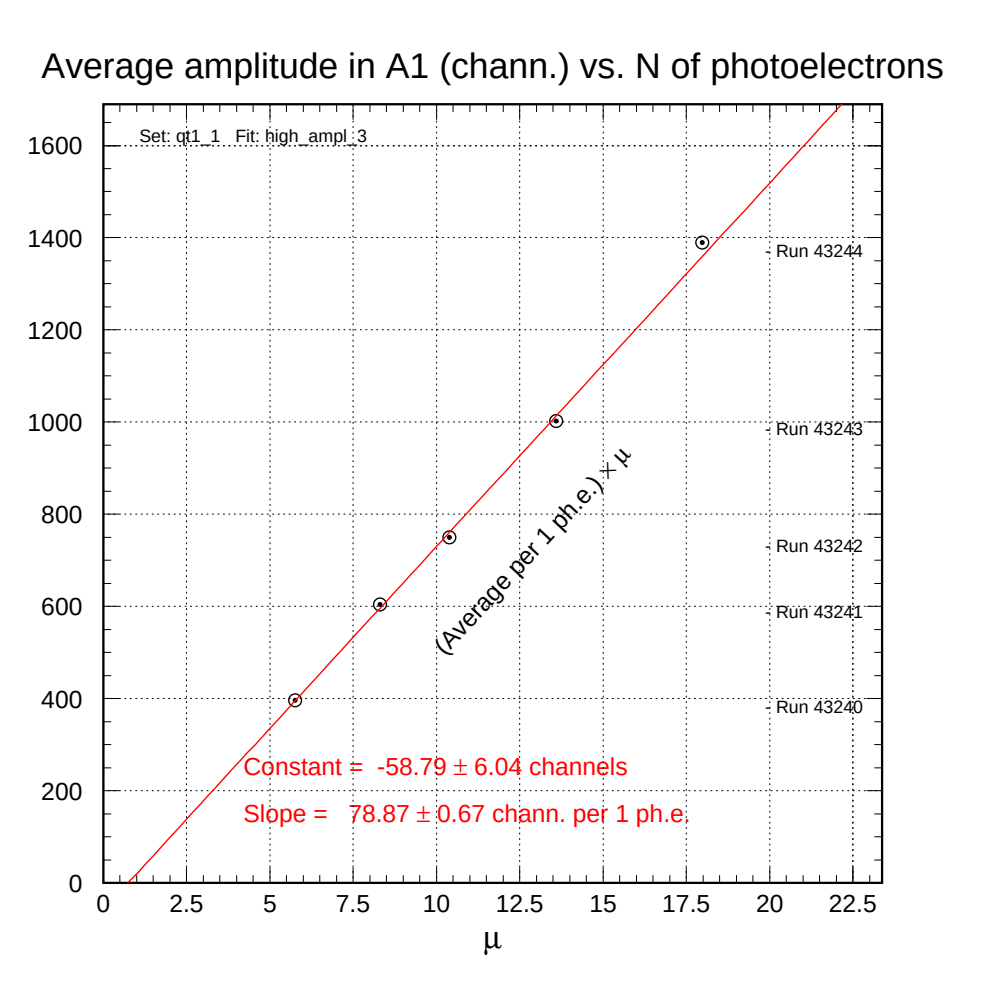
ADC vs Fitted number of photoelectrons (UV)



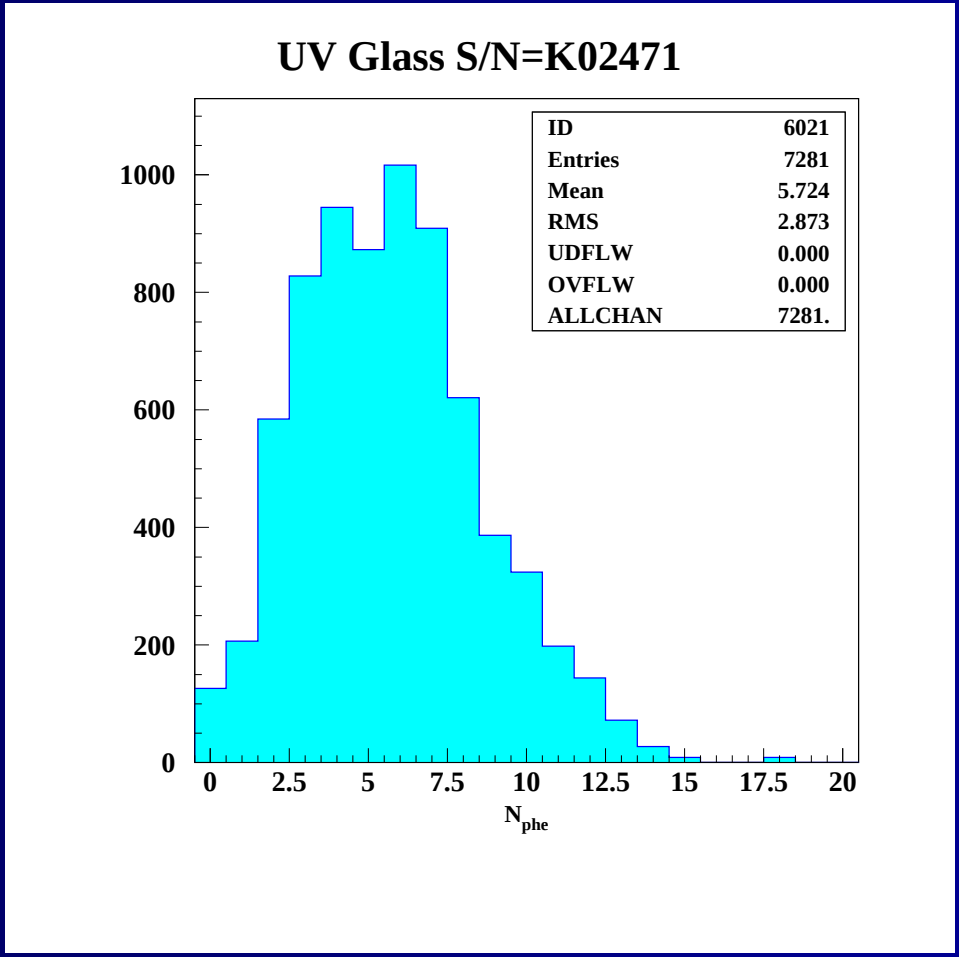
LED spectra Quartz Window PMT



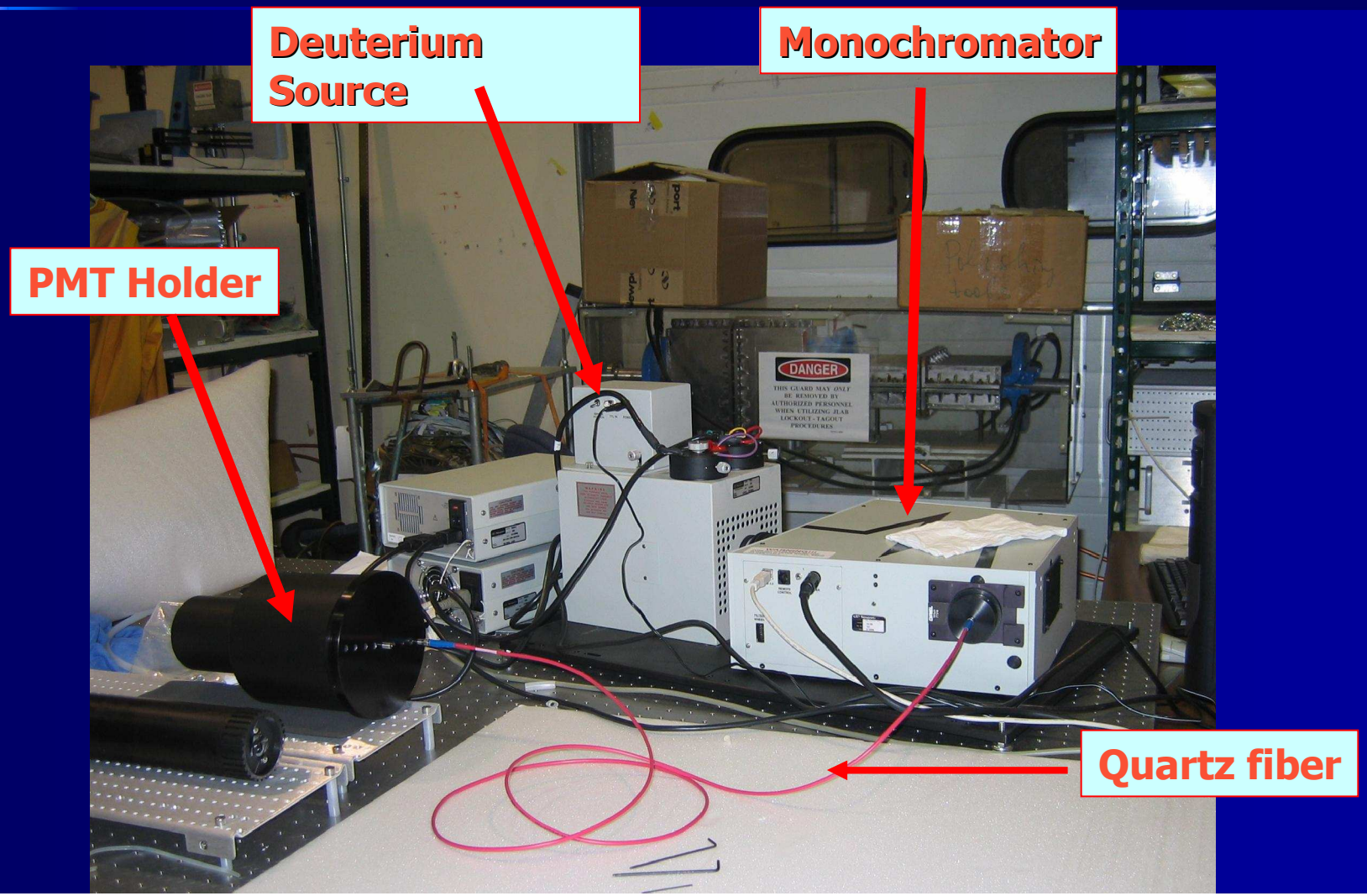
ADC vs Fitted number of photoelectrons (Quartz)



Number of Photoelecrons



Optic Stand


Deuterium Source
Monochromator
PMT Holder
Quartz fiber
DANGER

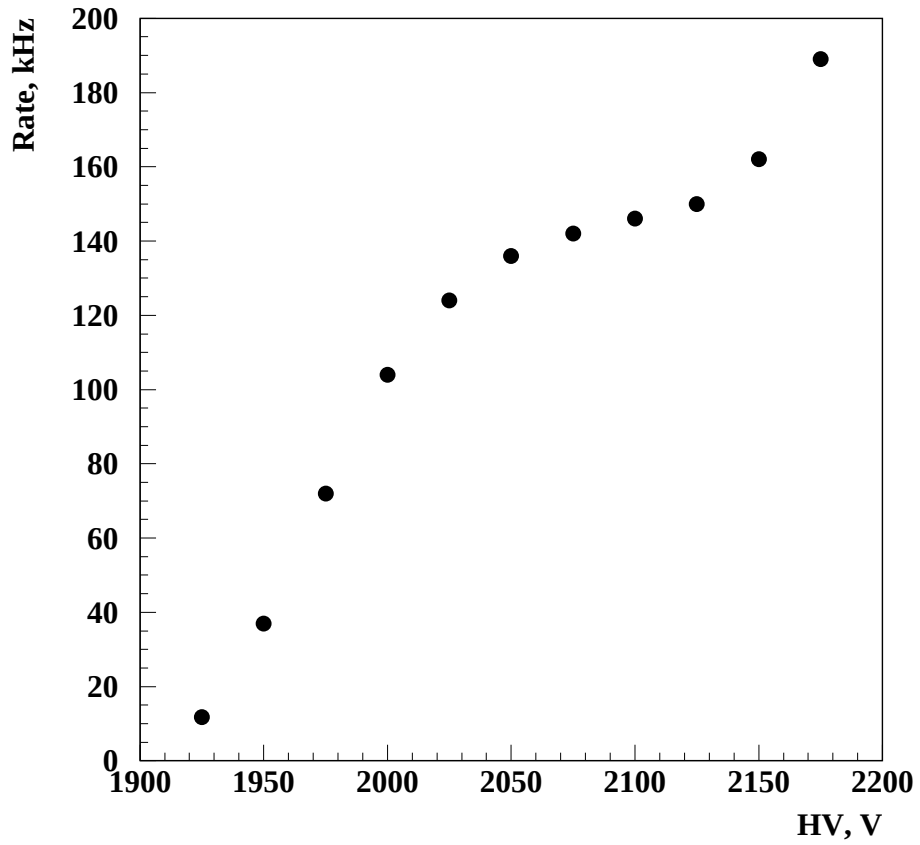
Deuterium Source (ORTEC 66080)

- Spectral output 160-500 nm
- Output is 33 mm diameter
- We can focus it to a tight spot for fiber or monochromator illumination

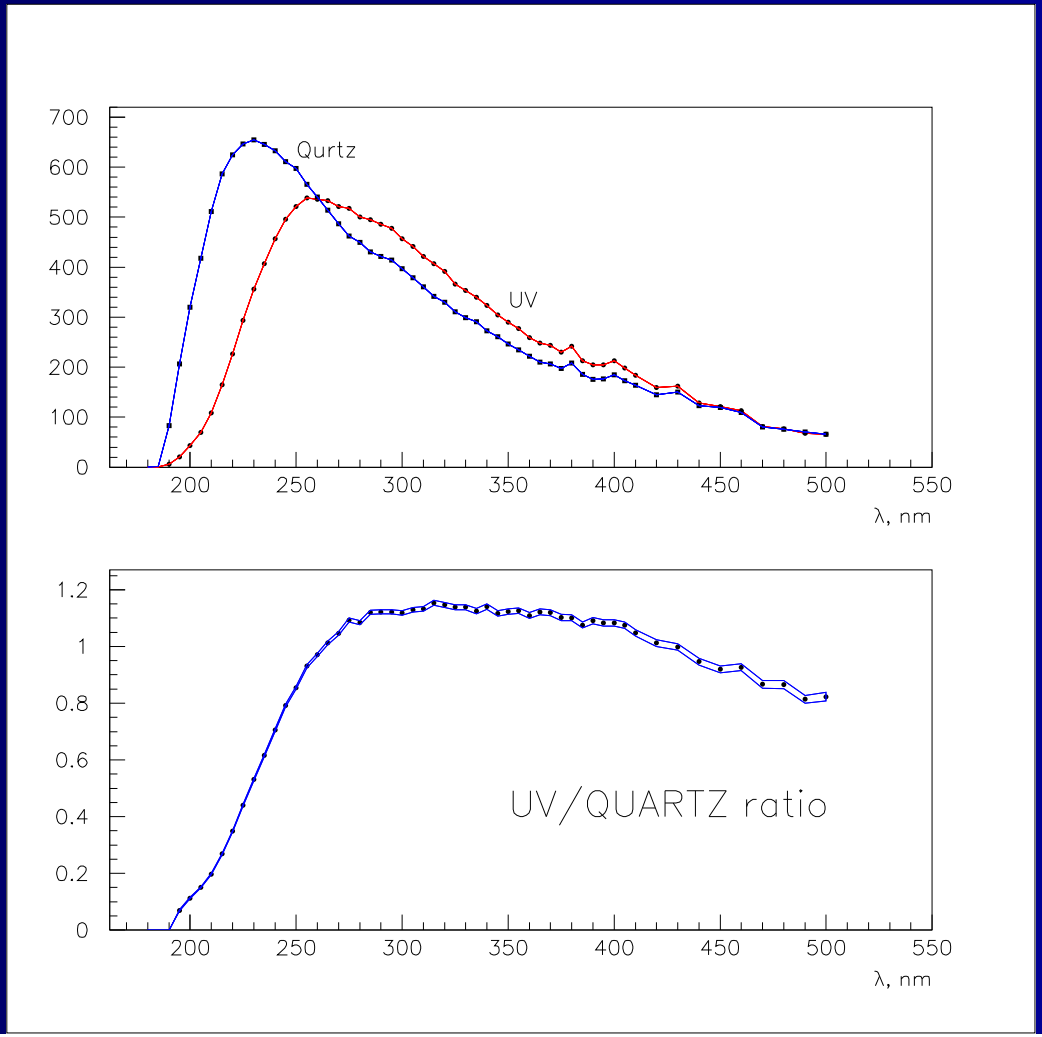
Monochromator (ORTEC 77200)

- Spectral range 180nm – 24 um
- 0.1 nm resolution

The PMT rate vs HV

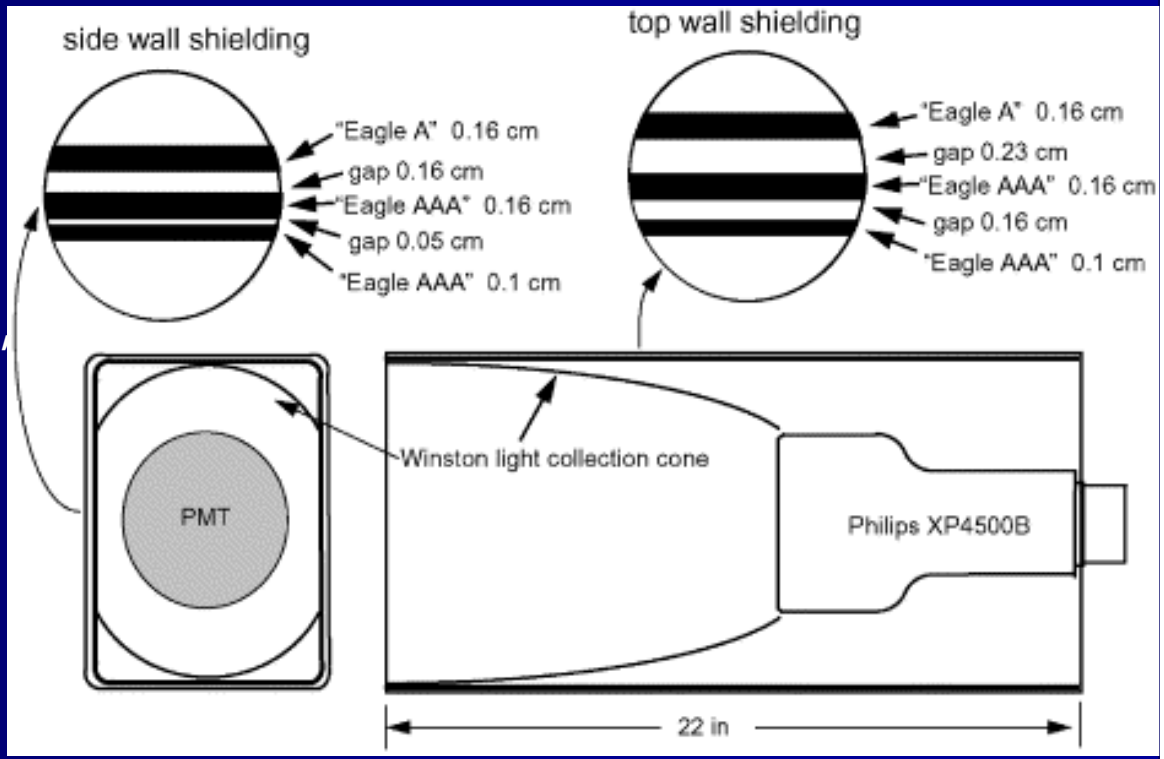


Rate vs Wave Lenth



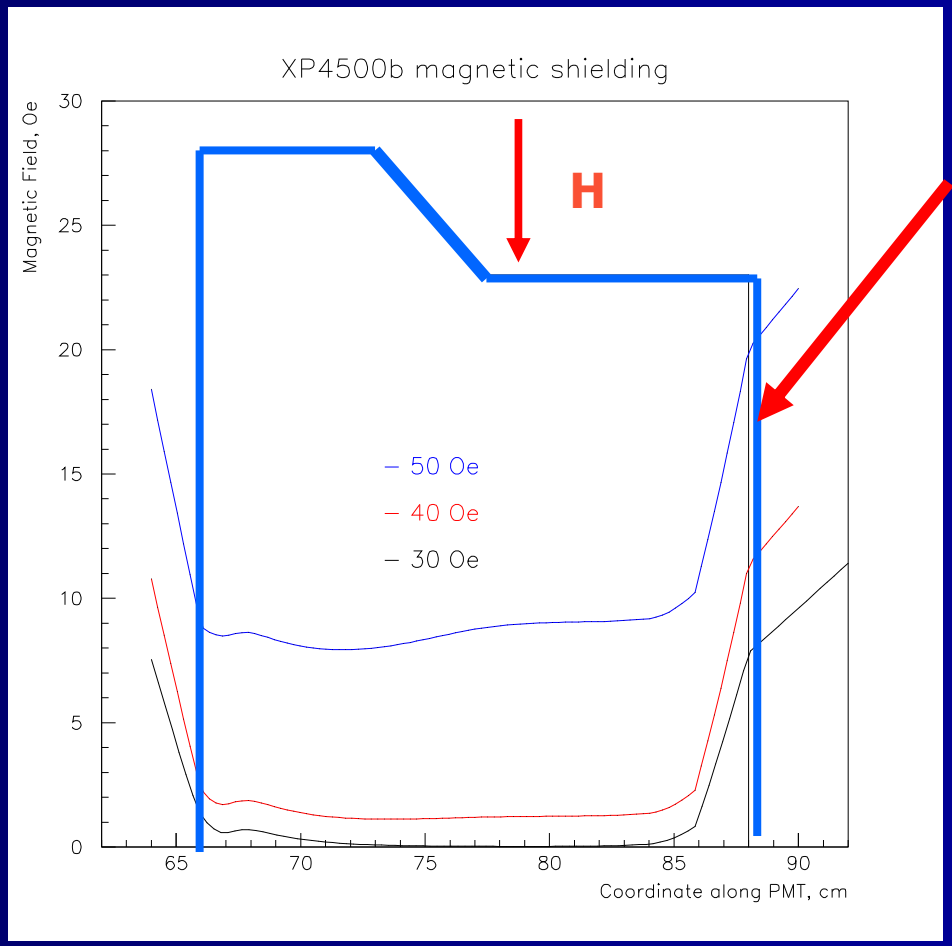
CLAS PMT Magnetic Shielding

The shield consists of three layers of magnetic Material. The inner and middle Layers are composed of high permeability (saturation 8500 G), the outer layer material consists of moderate permeability (saturation 21500 G)

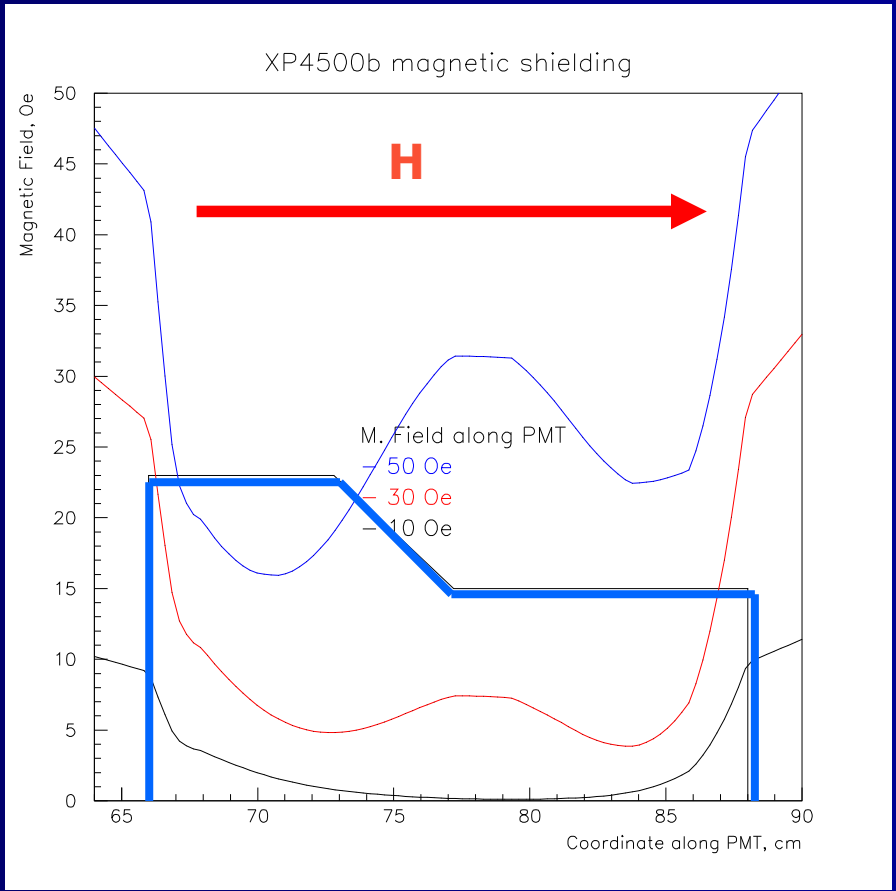


Magnetic Shielding

TOSCA calculation



Magnetic Shielding (co-netic)

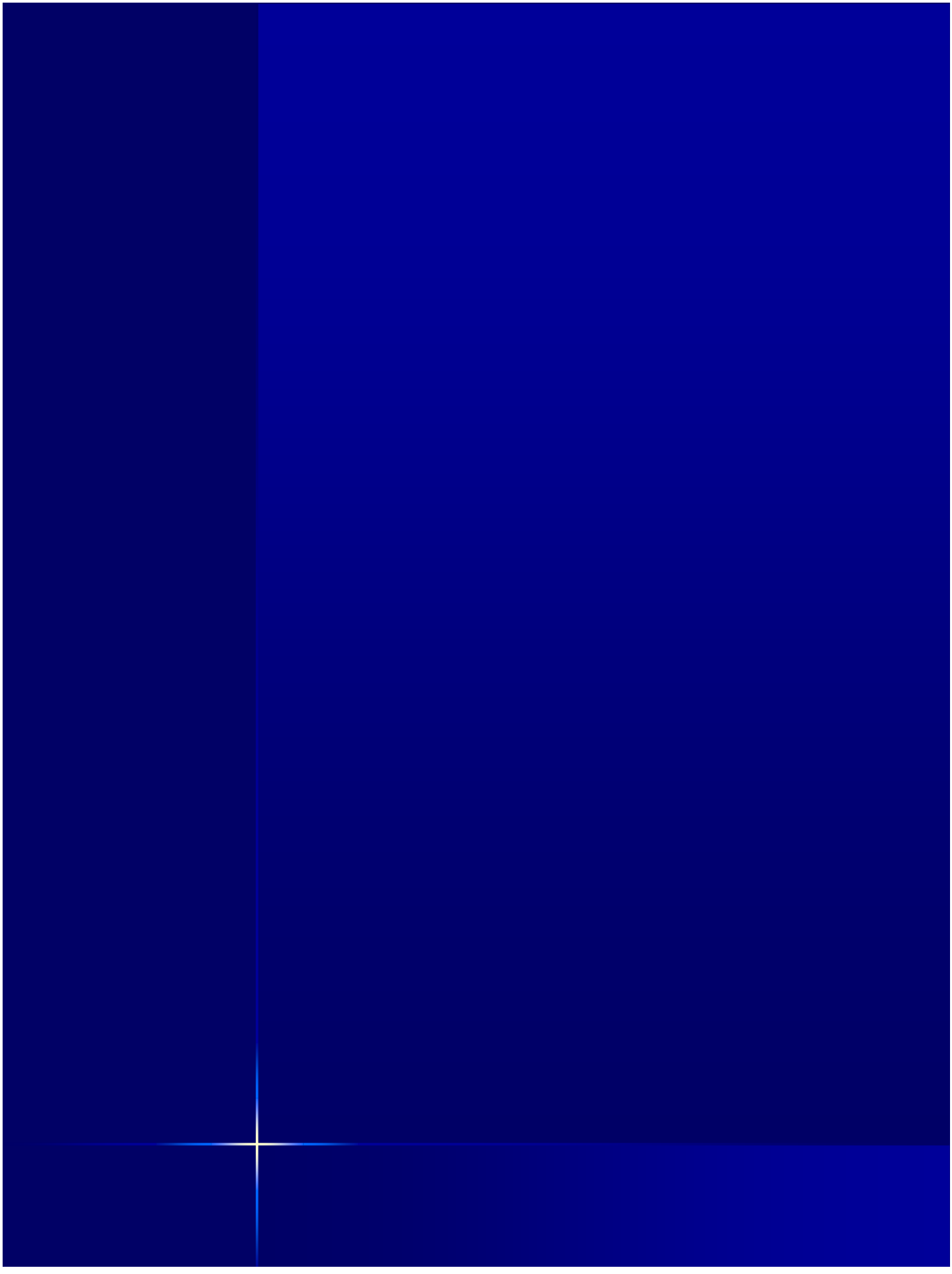


Conclusion

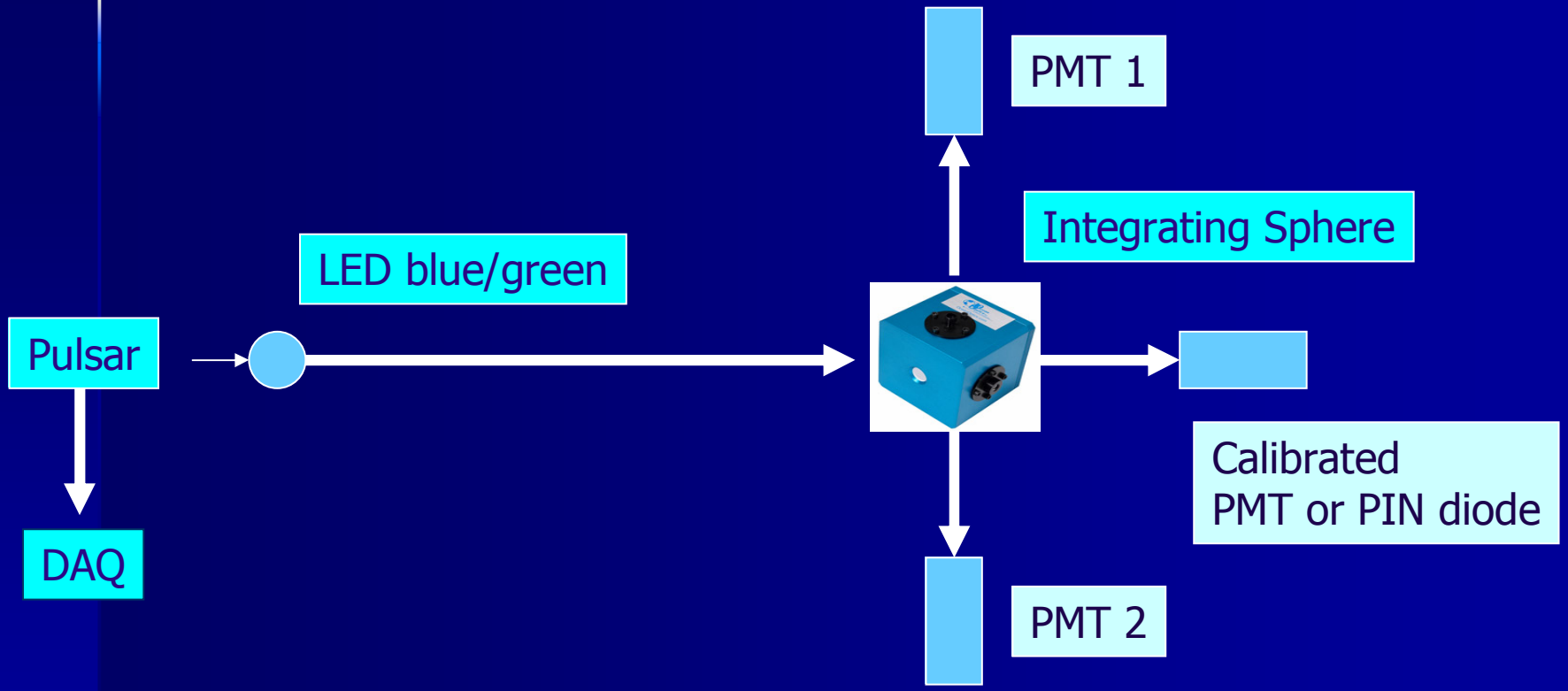
- Setup LED stand with DAQ running.
- Setup Cherenkov stand
- Setup Optic Stand with D2 lamp
- Software for all stands is ready
- Magnetic shielding calculations are in progress
- Stand for magnetic measurements is ready

Burle 8854 PMT

- 5” diameter
- 14 stage Quantacon (high gain)
- Bialkali photocathode
- High QE (22.5% at 385 nm)
- Uniform electron collection over photocathode
- Fast time response (rise time 2.9 ns)
- Low noise and dark current
- Discrimination of up to 5 photoelectrons



Test Setup 1 (pulse mode)



PULSE mode linearity setup

Method :

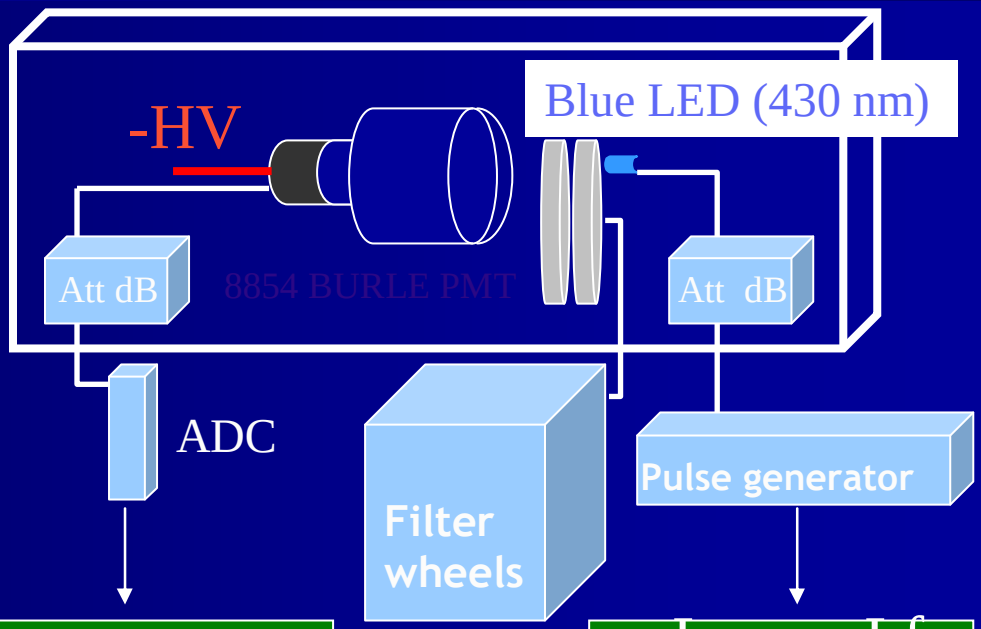
$$G(L) = \frac{S(L_F)}{S(L_A)}$$

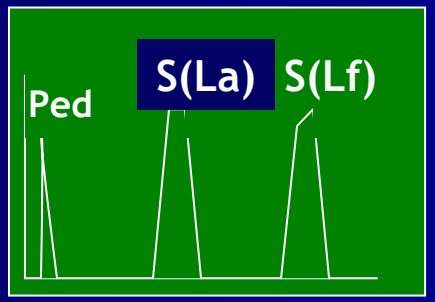
Deviation from linearity :

$$\frac{\Delta G}{G} = \frac{G(L) - G(L_0)}{G(L_0)}$$

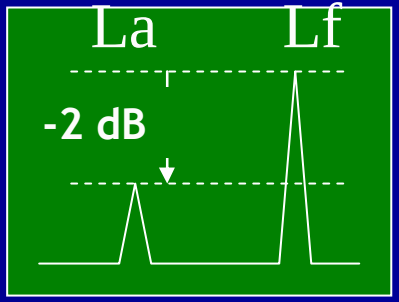
Normalization (1st order) :

$$\frac{\beta}{\alpha} L \approx \frac{1}{(1 - \frac{L_A}{L_F})} \frac{\Delta G}{G}$$



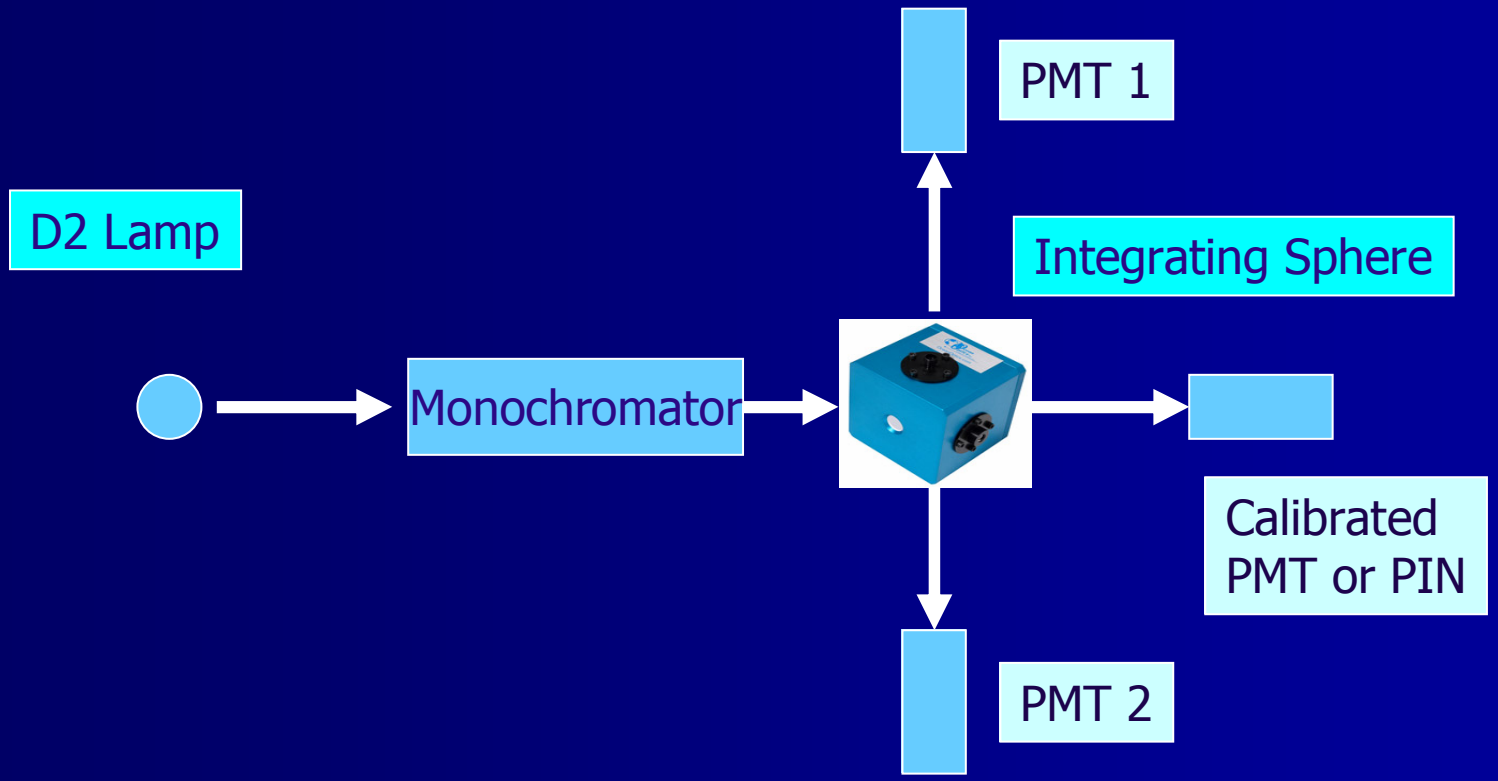


PMT response



Light flux

Test Setup 2 (continuous mode)

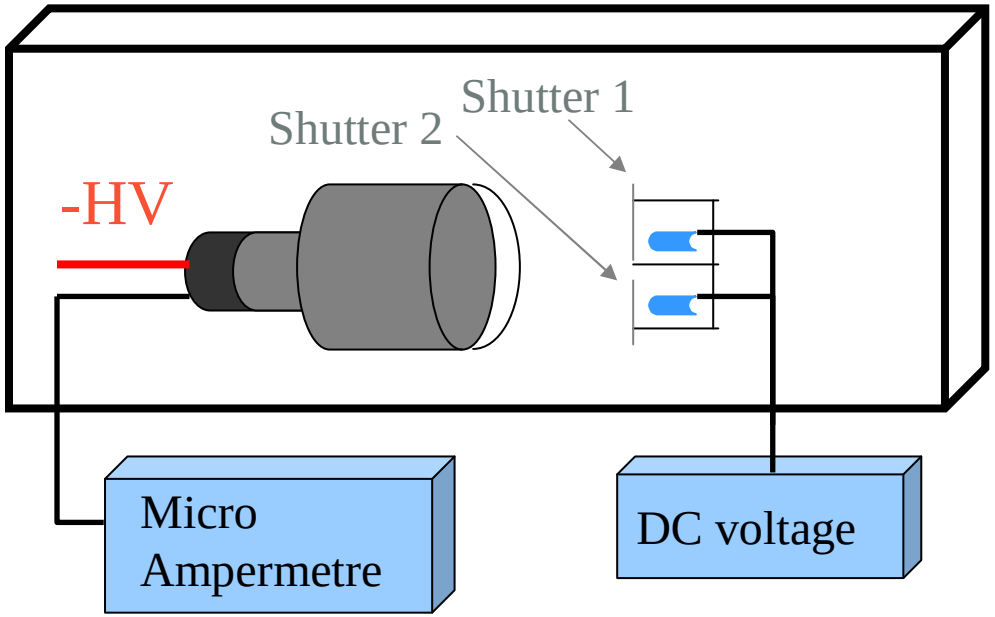


Linearity in continuous mode setup

Method :

Use of additivity

$$\frac{\Delta G}{G} = \frac{S(L_1 + L_2)}{S(L_1) + S(L_2)} - 1$$



HF PMT Test Station