Status and Performances of the E166 Modified Calorimeter

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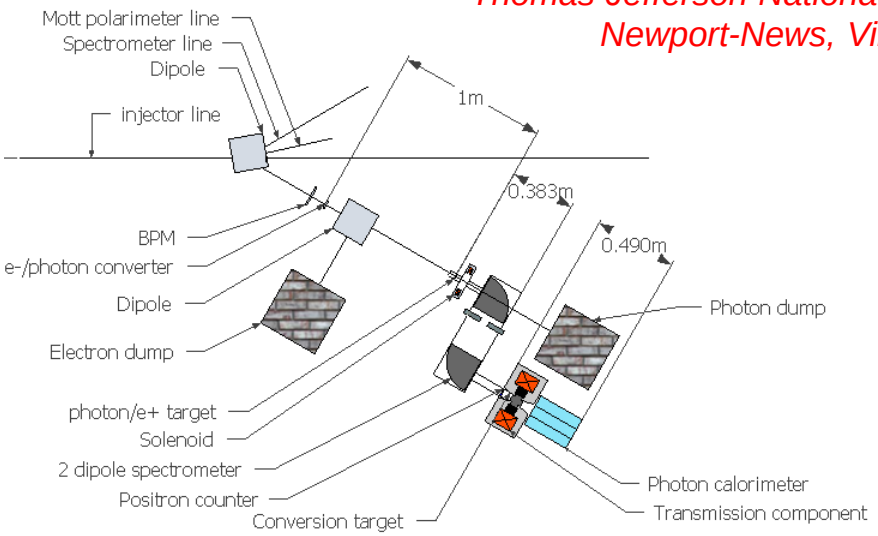


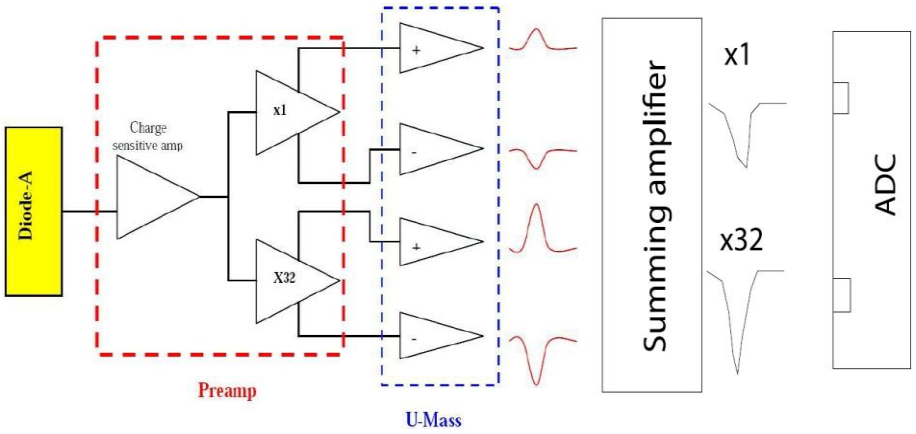
(i) E166 configuration
(ii) PEPPo configuration
(iii) PMT read-out
(iv) Calorimeter operation
(v) Workplan

Principle of Operation

G. Alexander et al, PRL 100 (2008) 210801 G. Alexander et al, NIM A 610 (2009) 451

- The E166 experiment operated with **high** incident **particle flux**, **integrating** the **energy** deposited in the crystal **per beam pulse** and **per target polarization orientation**.

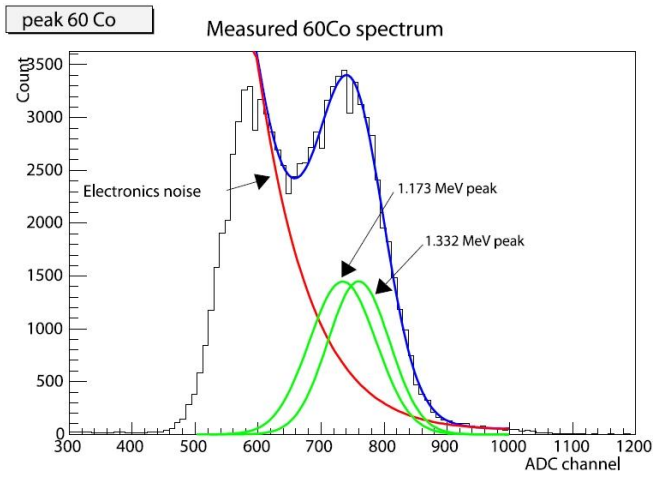
- The signal read-out was realized with BaBar inspired electronics, relying on Hamamatsu **S2744-08 photodiodes**, a set of **amplifiers**, and **ADCs**.

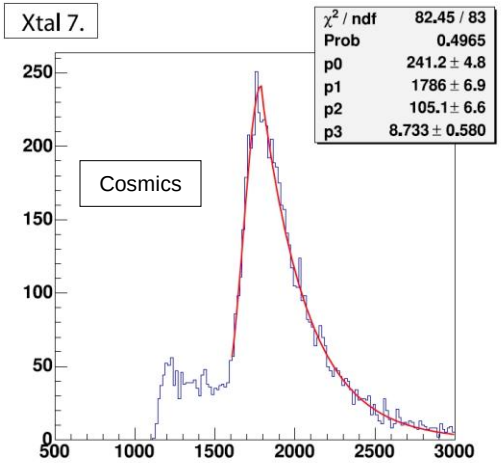


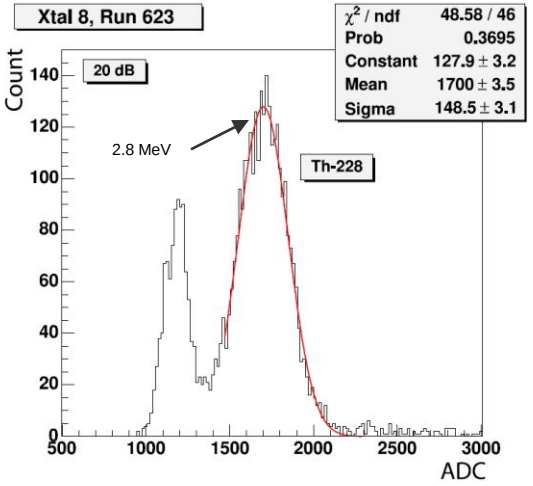
Small experimental **asymmetries** and **large polarization transfer** from **circularly** polarized **photons** to **longitudinally** polarized **positrons** have been reported.

Experimental proof of the undulator based polarized positron source for ILC.

K. Laihem, PhD Thesis, Humboldt Universität zu Berlin (2008)







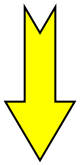
- The **high energy response** of the crystals is **quite good** and well understood.
- **Electronics noise** is a matter of concern for **small energy deposit**.
- **Energy resolution** at small energy deposit does **not** look **impressive**.

Principle of Operation

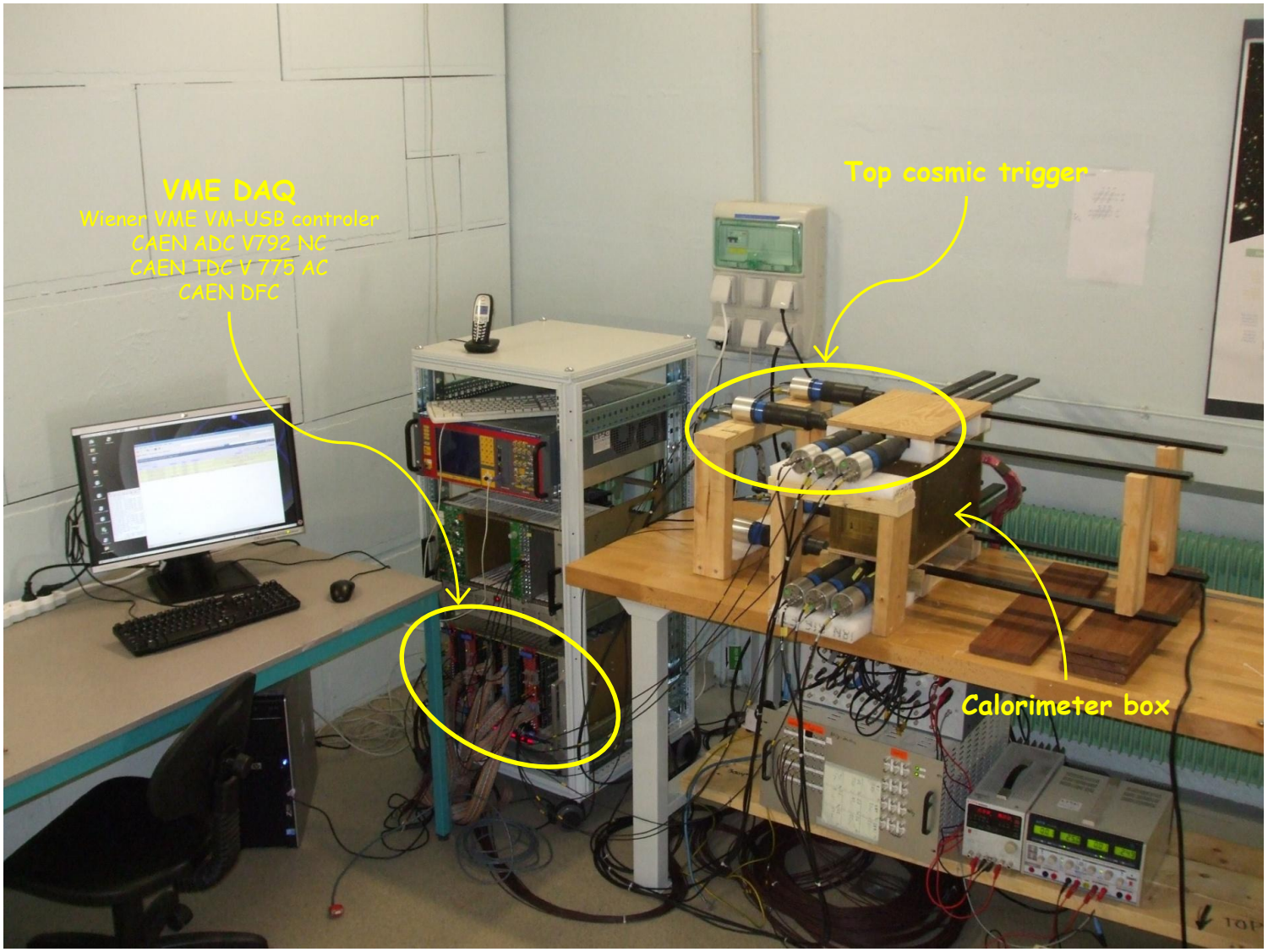
- **PEPPo** will investigate the **longitudinal polarization transfert** from polarized electrons to polarized positrons.

- Experimental **asymmetry** will be measured with respect to the **electron beam helicity** for a **given target polarization** orientation.

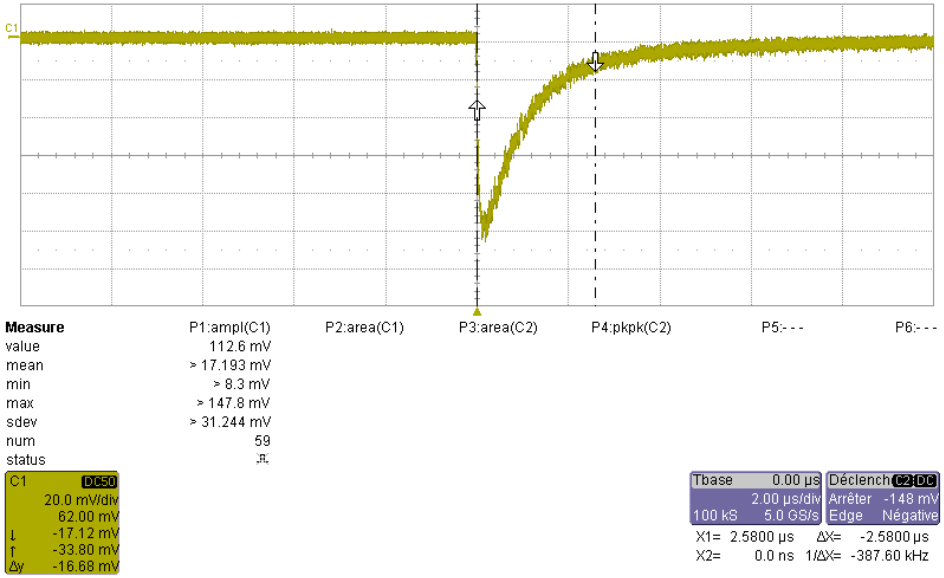
- We aim at **three different analysis schemes** of the experimental signal: **integrated** (**similar to E166**), **semi-integrated** (**energy distributed asymmetry and built-in pulse shape analysis**), and **event-by-event** (**energy distributed asymmetry and off-line pulse shape analysis**).



The PMT read-out is expected to improve
the signal-to-noise ratio and the resolution at small photon energies.


VME DAQ
Wiener VME VM-USB controler
CAEN ADC V792 NC
CAEN TDC V 775 AC
CAEN DFC
Top cosmic trigger
Calorimeter box

PMT Base

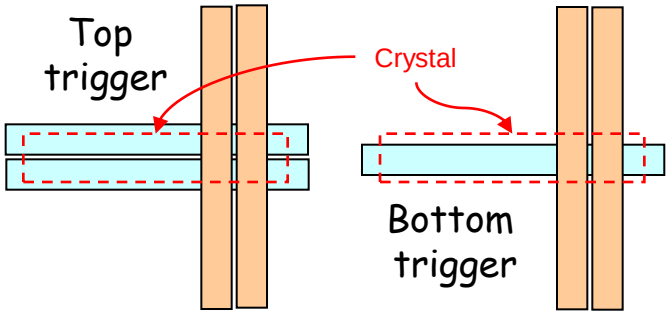


Typical **PMT cosmic signal** at **1000 V** high voltage with a **standard** Hamamatsu **base**.

- Expected **high particle flux** and **large operational high voltage** reduce the PMT life-time.

Custom PMT bases are designed
for PMT **gain reduction** and output **signal amplification**.

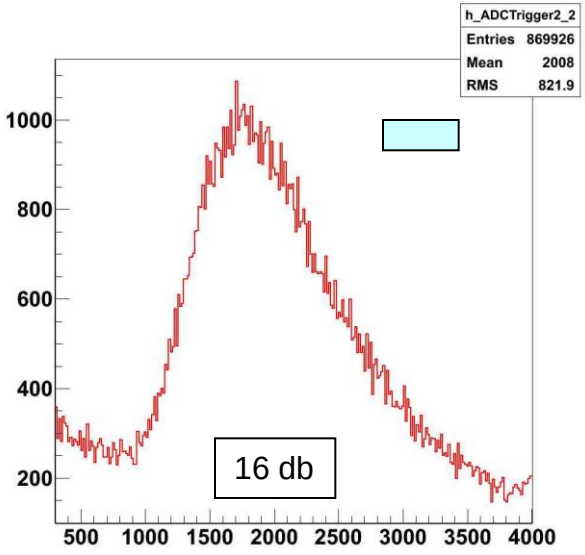
Cosmic Test

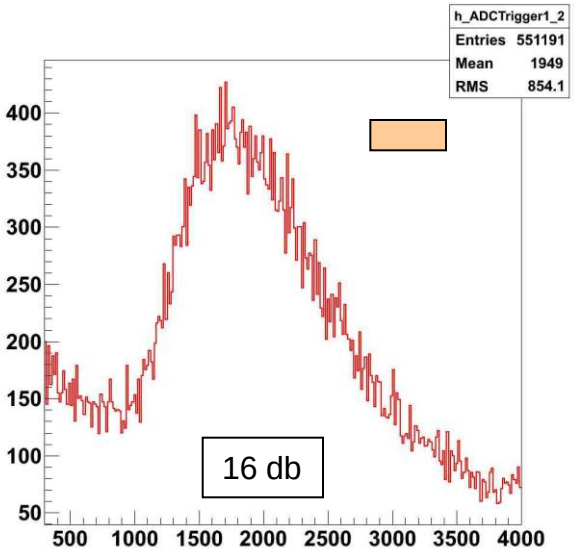


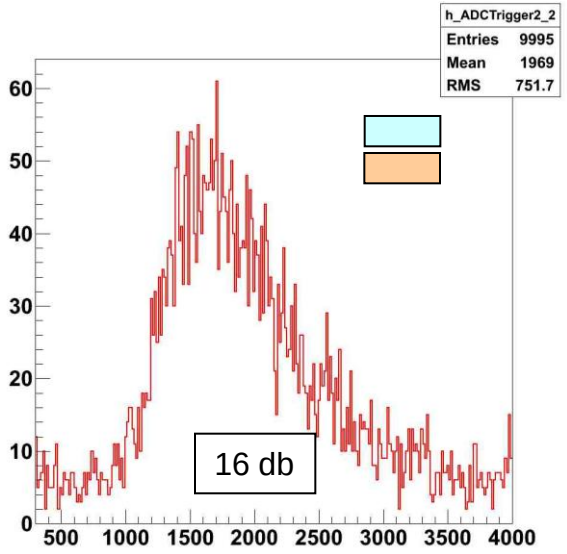
- The trigger scintillator strips **overlap longitudinally** the CsI crystal and define a **transverse location** close to the PMT side.

  HV = 1200 V Δt = 2.5 μs

- After **4** data taking **days**...





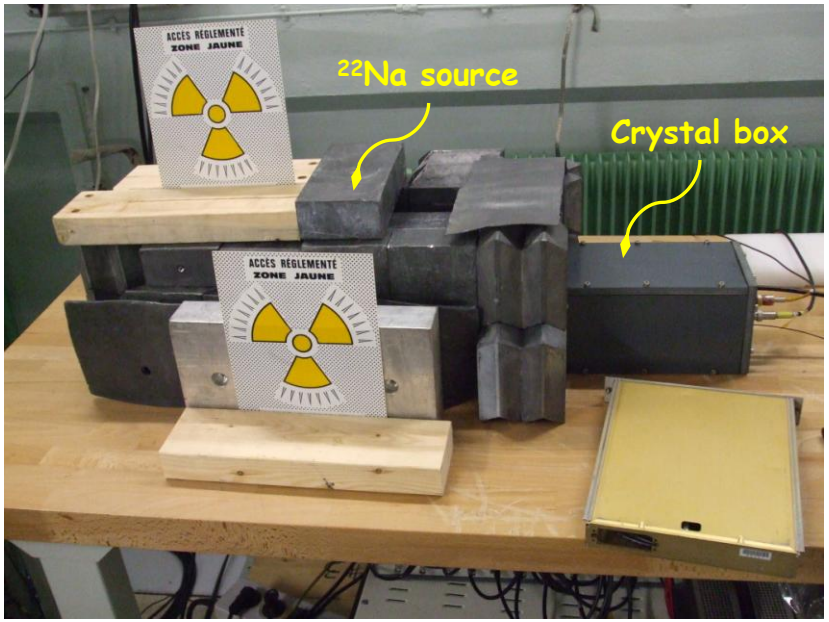


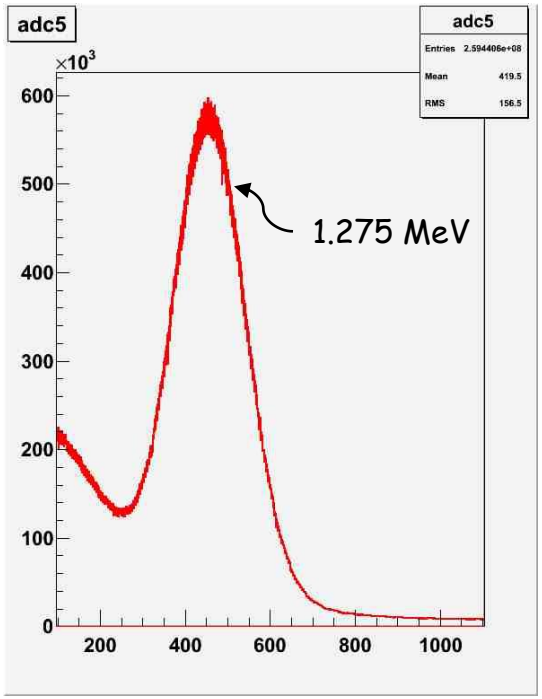
About 50 MeV energy deposit for perpendicular minimum ionizing particles.

Signal Characterization

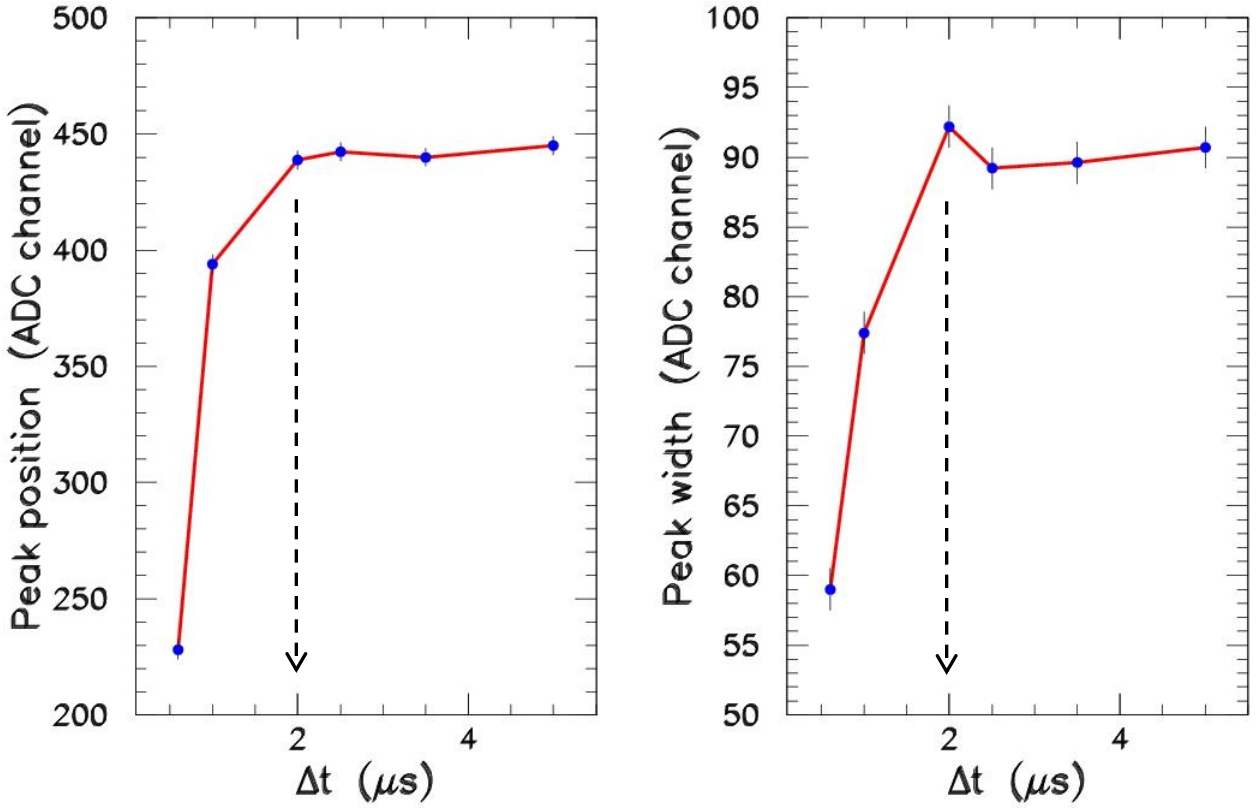
HV = 1400 V Δt = 2.0 μs Th. = 15 mV

^{22}Na (0.511 MeV, 1.275 MeV)



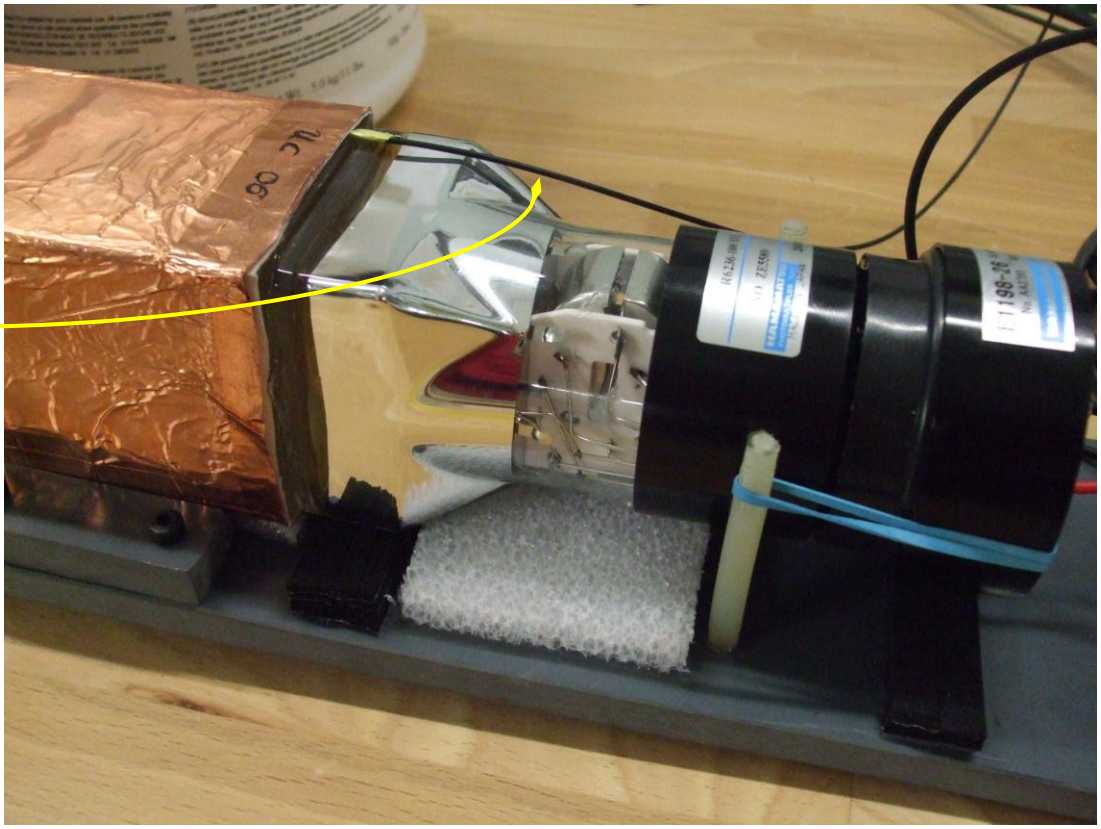


- The test is performed with the same light collection surface as E166 configuration.



- The effective **efficient duration** of the signal is about **2 μs**.

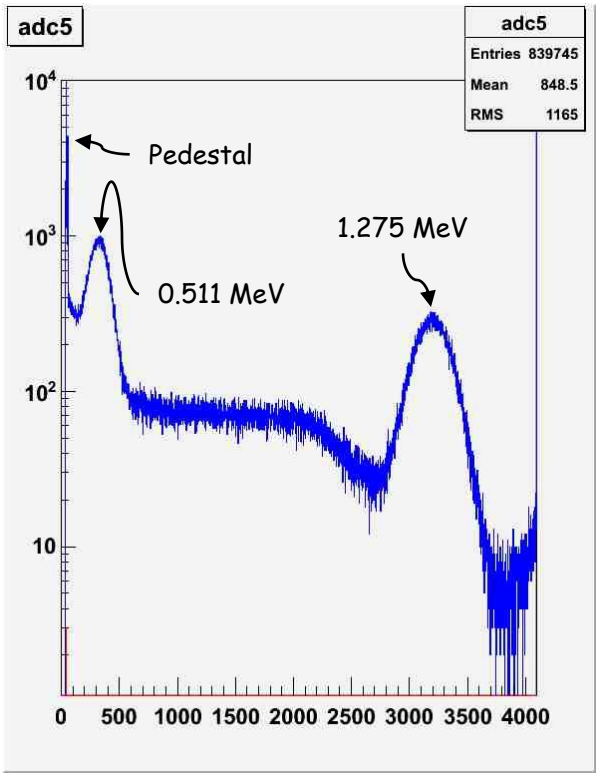
Optical fiber for **LED monitoring** of the experimental chain



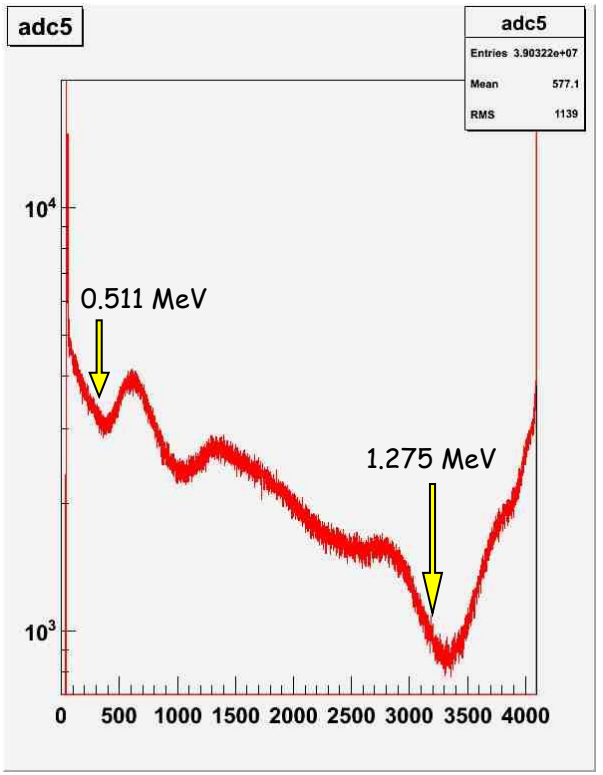
- Improved **light collection surface** together with a direct coupling of the PMT to the crystal using an optical gel.

20 x 20 → **54 x 54** (surface factor = **7.3**)

HV = 1300 V Δt = 2.0 μs Th. = 7 mV



^{22}Na (2 mn DataK)

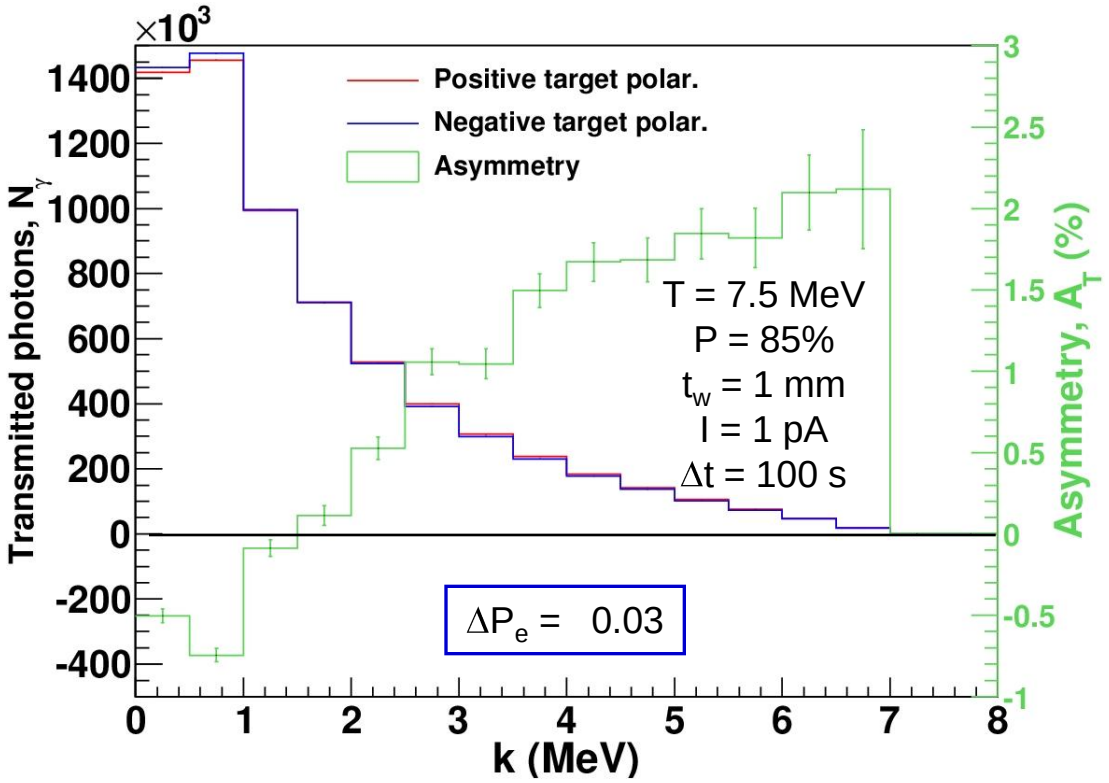


Background (860 mn DataK)

- The improvement of the surface collection and PMT-crystal optical coupling leads to a **100 V** gain **on the operational high voltage**.
- Unexpected behaviours appear… **DAQ** issues… **On-going investigations**…

Compton Transmission Polarimetry

- Polarized **e±** convert into circularly polarized **photons** into a tungsten target.
- The **photon** polarization is analyzed via **Compton** scattering off a magnetized iron target.



$$A_T = \frac{N^+ - N^-}{N^+ + N^-} = \tanh\left(P_\gamma P_t \mu_1 L\right)$$

$$\mu_1 = \rho_e \int d\theta d\varphi \frac{d^2\sigma^0}{d\theta d\varphi} A_C(\theta)$$

$$P_e = \frac{A_T}{P_t A_e}$$

- The analyzing power A_e is obtained from electron beam **calibration** data and **simulations**.
- **High DAQ rates capabilities** will be obtained with the flash ADC FADC 250 developped at JLab.

Experimental Issues

IM
Integrated Method

- ADC samples are **summed** over the time duration of the helicity gate.
- The total energy deposited in a crystal per helicity state is registered (2 x 9 values).
- The DAQ trigger is the helicity gate.
- **Small asymmetries** are expected.
- No threshold, pile-up or dead-time concerns.
- Potential **helicity correlated background** issues.

SIM
Semi Integrated Method

- ADC samples per event are **summed** for a fixed time window and **tagged** by helicity state.
- The energy deposit per crystal, helicity state, and event is registered (2 x 9 x nb of energy bins values).
- The **DAQ trigger** should be external (positron counter ?).
- **Sizeable asymmetries** are expected.
- **Threshold** or **pile-up** issues but no dead-time concerns.
- No helicity correlated background concerns.

EVEM
Event-by-Event Method

- ADC samples for a **fixed time window** (2-3μs) are tagged by helicity state.
- Each ADC sample per crystal, helicity state, and event is registered (9 x 750 values).
- The **DAQ trigger** should be external (positron counter ?).
- **Sizeable asymetries** are expected.
- **Threshold**, **pile-up**, and **dead-time** issues.
- No helicity correlated background concerns.

Technical Issues

Calorimeter Construction

- Operation of the **local electronics** and **DAQ system**
- Development of an **improved cosmic trigger** (scintillator hodoscope, lead absorber for MIPs selection…); possible use at JLab ?

- **Selection** of the **wrapping** material (tyvek, aluminized mylar, millipore…)
- **Quality** tests of the **crystals** (signal-to-noise ratio, resolution…)
- Test of the **LED monitoring** system
- Test of the **modified calorimeter** before shipment to JLab (mechanics, PMT bases…)

Calorimeter Operation

- **Operation** of the calorimeter with the **FADC 250**
- Development of **solutions** and practices for each **experimental issues**
- Exhaustive simulations (analyzing power, transverse polarization effects, misalignement effects, positron distribution sensitivity…)

…