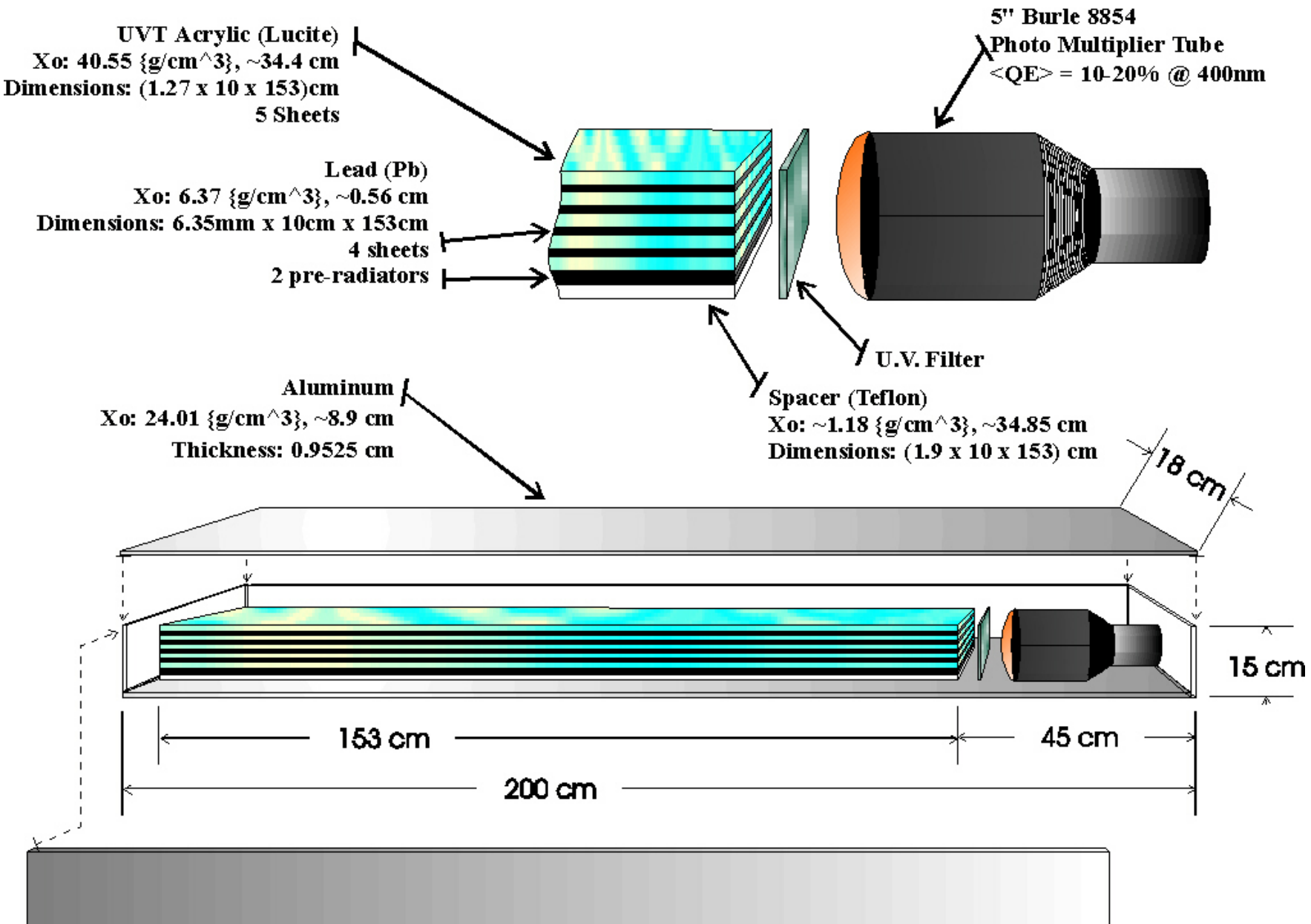
HAPPEX-3 DETECTORS

Anatoly Ponomarev

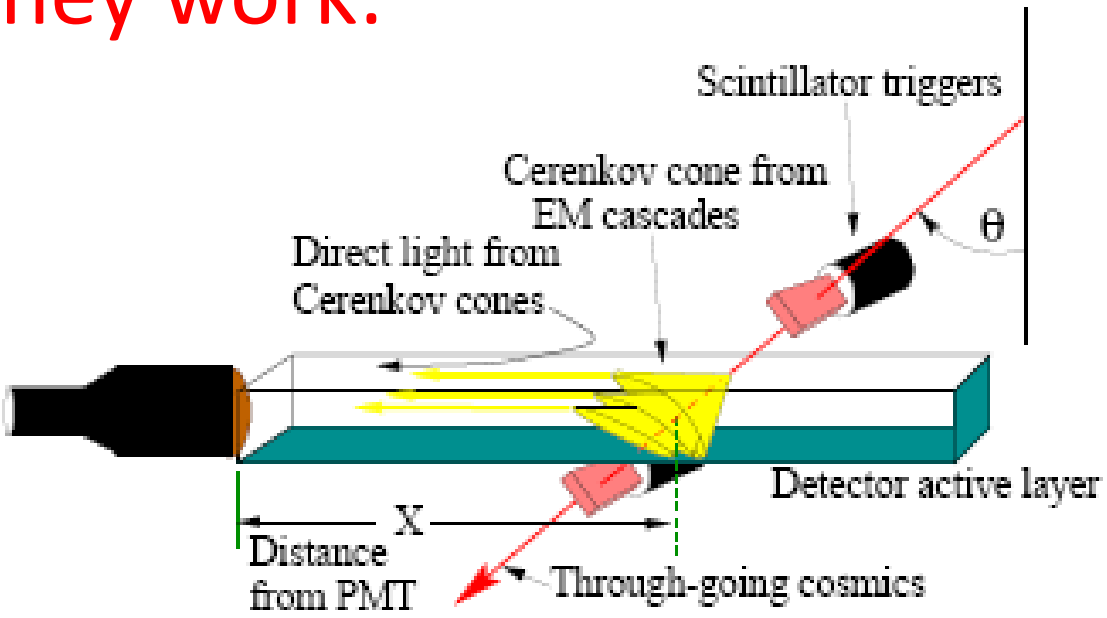
- Detectors – the same as for HAPPEX-1.



What do they consist of :

- Scattered electron encounter 0.5 inch lead radiator, followed by 5 layers of 0.5 inch Lucite, interspersed with 4 layers of 0.25 inch lead.
- Each layer of Lucite is wrapped with Teflon → to preserve total internal reflection.
- The entire stack including PMT is made light-tight by wrapping with black Tedlar paper.
- The frame box is sealed with black silicone.
- All components in active region are made of non-ferric materials to reduce possibility of polarized Moeller-scattered electrons from depositing energy in the detectors which could lead to false asymmetry issue.

How do they work:



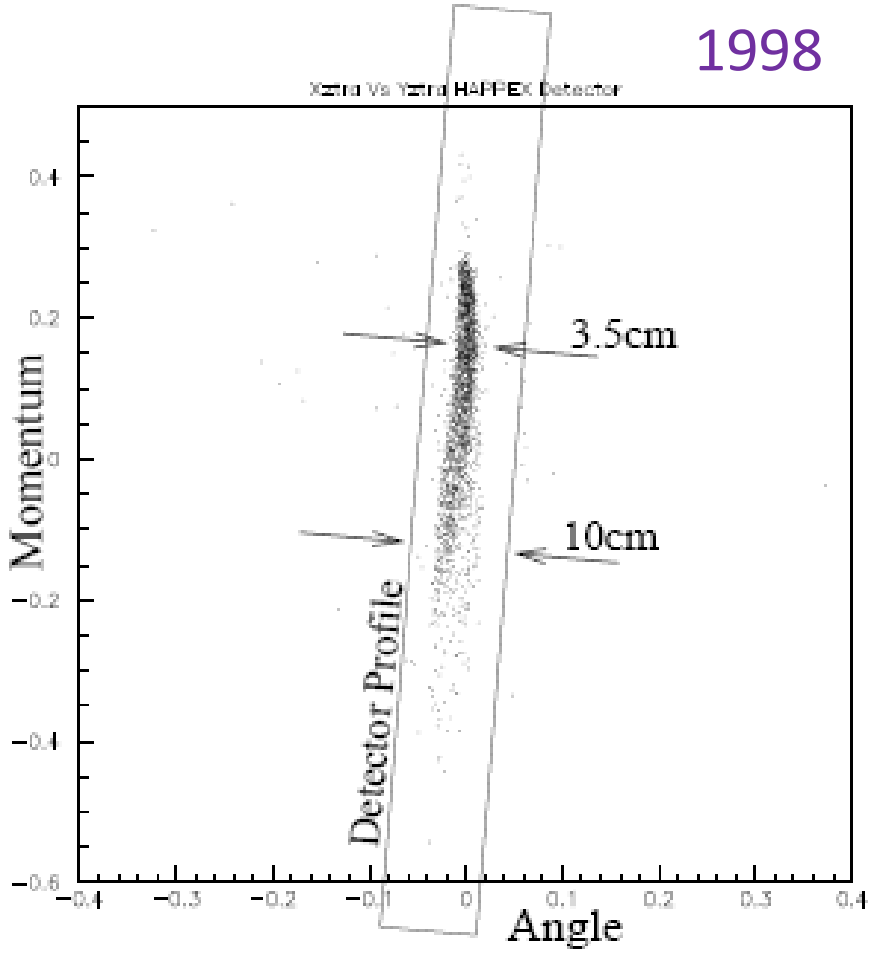
1) Cherenkov light from electromagnetic shower in lead/Lucite transfers, directly and by internal reflection, to PMT.

2) Lucite – long radiation length, → lead/Lucite layered configuration to increase signal.

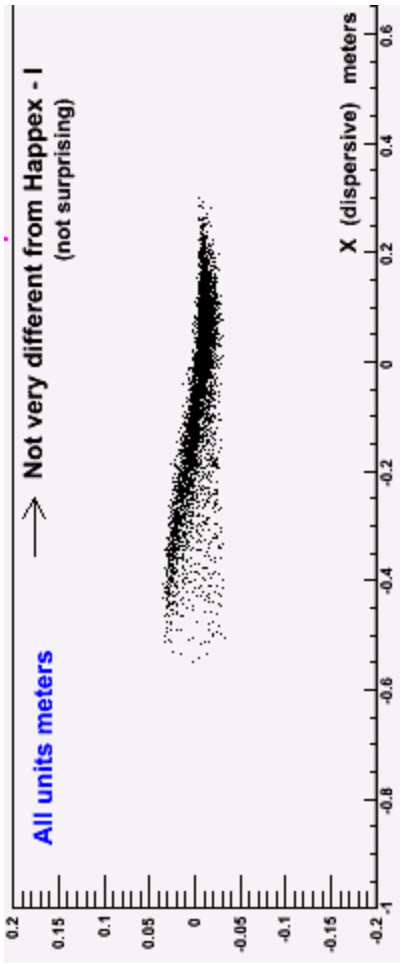
3) Radiation damage resistance → Lucite, not glass.

- Detector shape is determined by the spatial resolution of the events :

HAPPEX-1
1998

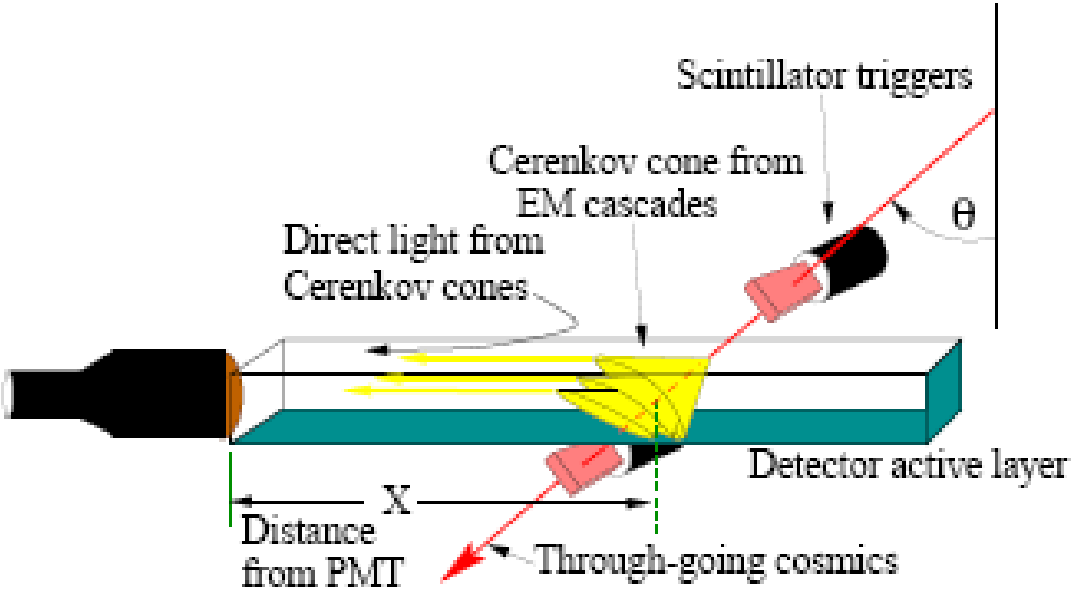


HAPPEX-3
simulation



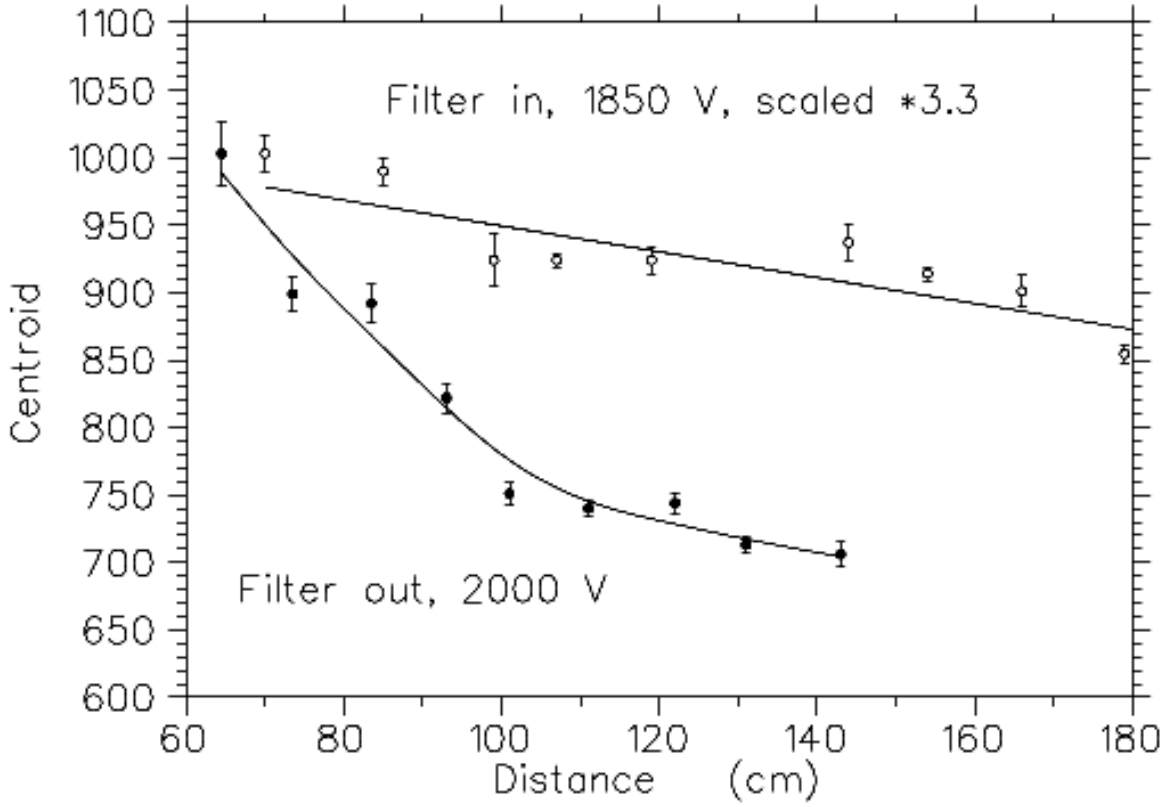
- Detector size is determined by the compromise between edge effects (requires increase the size) and reducing accepting background electrons (requires decrease the size).

Light attenuation



- Lucite – strong attenuation for wavelengths shorter than 330nm → signal dependence on length due to the UV absorption.
- → two particles with different Q^2, and therefore different distances from the PMT, give different amount of light.
- Solution – to cut off the strongly attenuated light by the price of reducing the signal → UV filter (glass or Plexiglas).
- It decreases the signal, but makes it more linear and more homogeneous.

Detector UV attenuation as a function of length.



HAPPEX-1
Measurement
1998

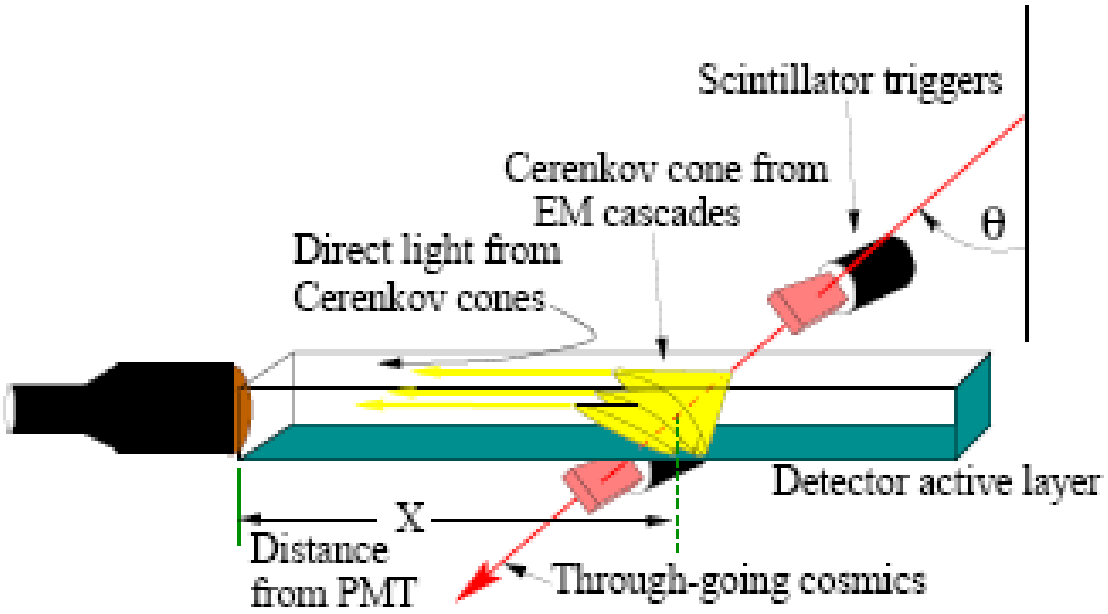
- The slope with filter in is 8 times less than that with filter out;
- The amplitude of the signal with filter in is about 3 times less.

Photo-Multiplier Tubes and Linearity.

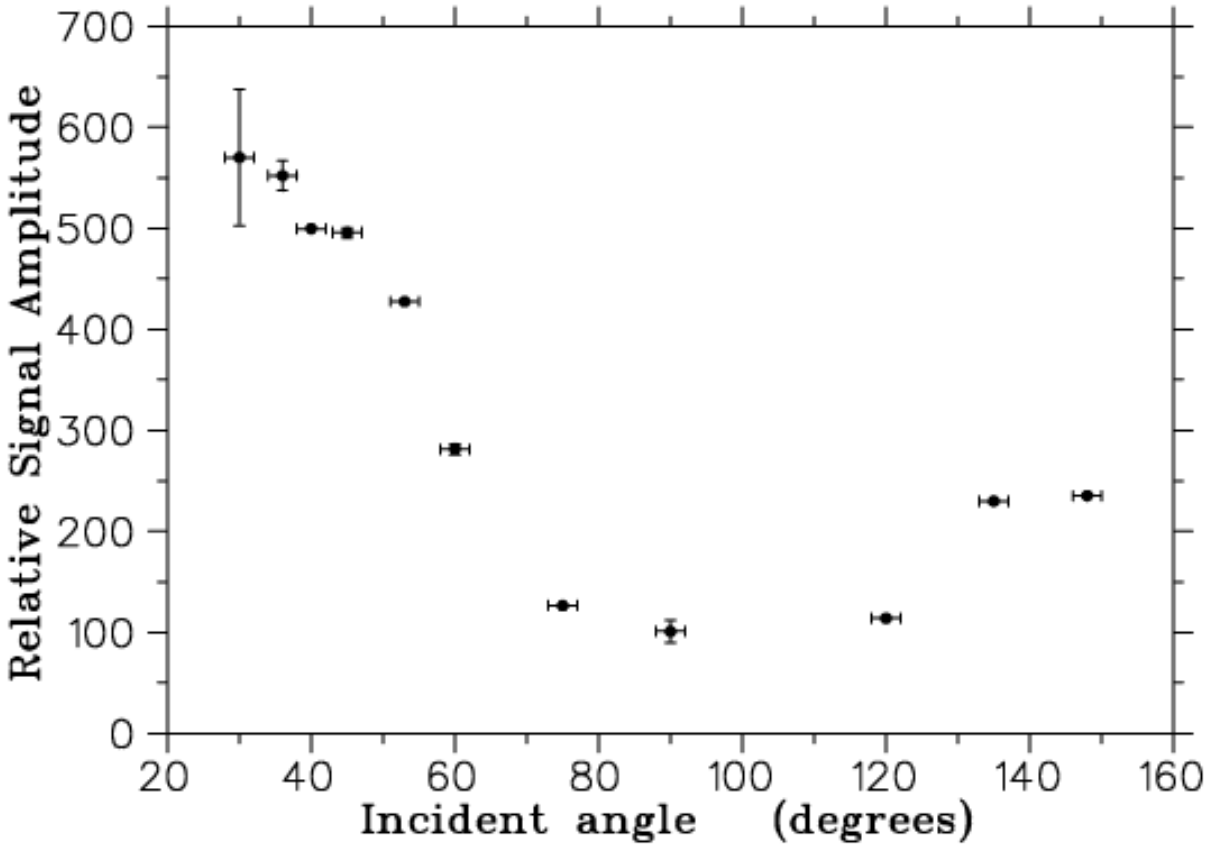
- 5-inch Burle 8854 PMT
- Voltage – 1200 – 2400 V, Gain — $\approx 5.1 \times 10^7$ at 2000 V
- To calibrate linearity of PMTs and bases – 2 high-intensity, blue LED, mounted in the far end of the central Lucite layer, facing towards the PMT.
- Linearity test – comparison of PMT signal of both LEDs together with the addition of both LEDs separately.
- Ideally, the output of LED A + LED B must be equal to the sum of the LED A output plus LED B output.
- Upper limit of 0.14% was set based on this test (HAPPEX-1 measurement, 1998).

Detector positioning

- According to simulations detectors are very sensitive to the angle of the particle path → necessity of careful alignment and angle tests.
- Angle tests – using cosmic rays and scintillators to determine particle trajectory and, therefore, angle.



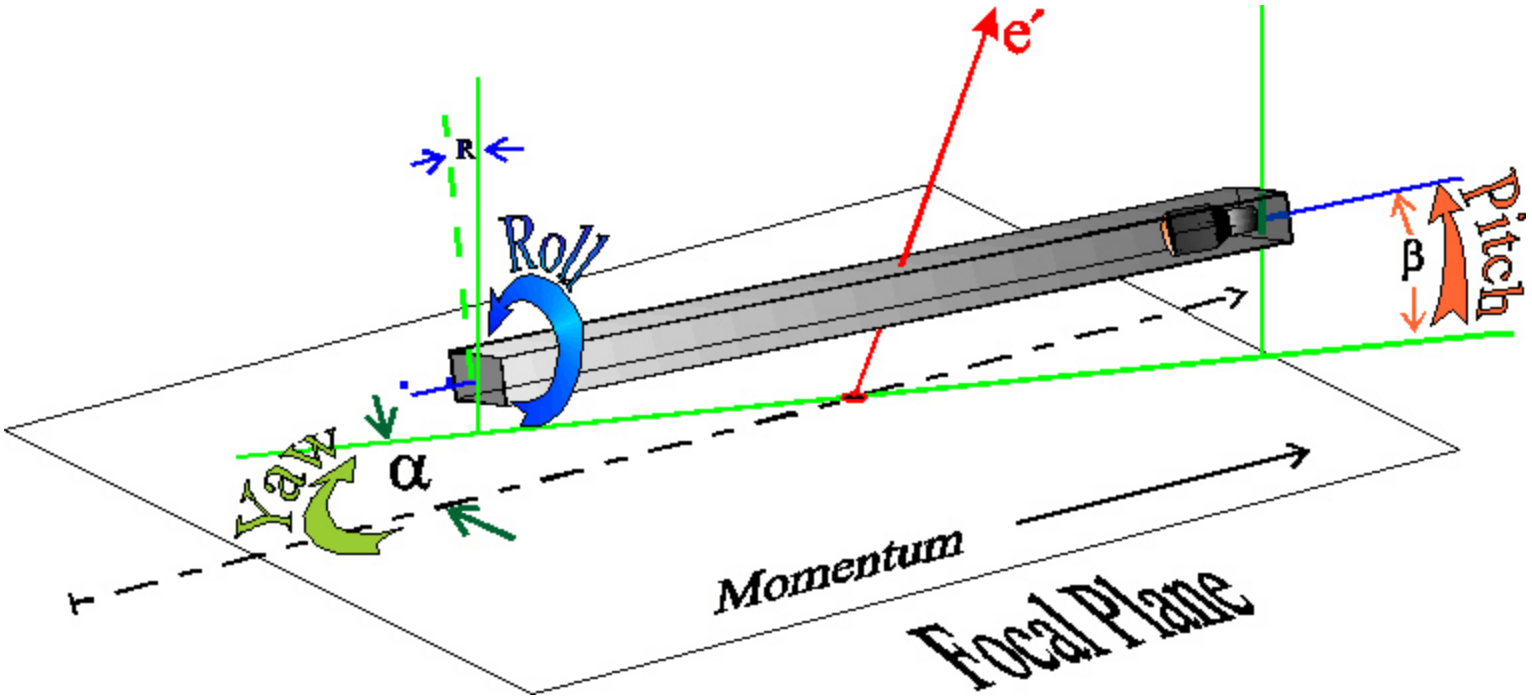
Detector angle response



HAPPEX-1
Measurement
1998

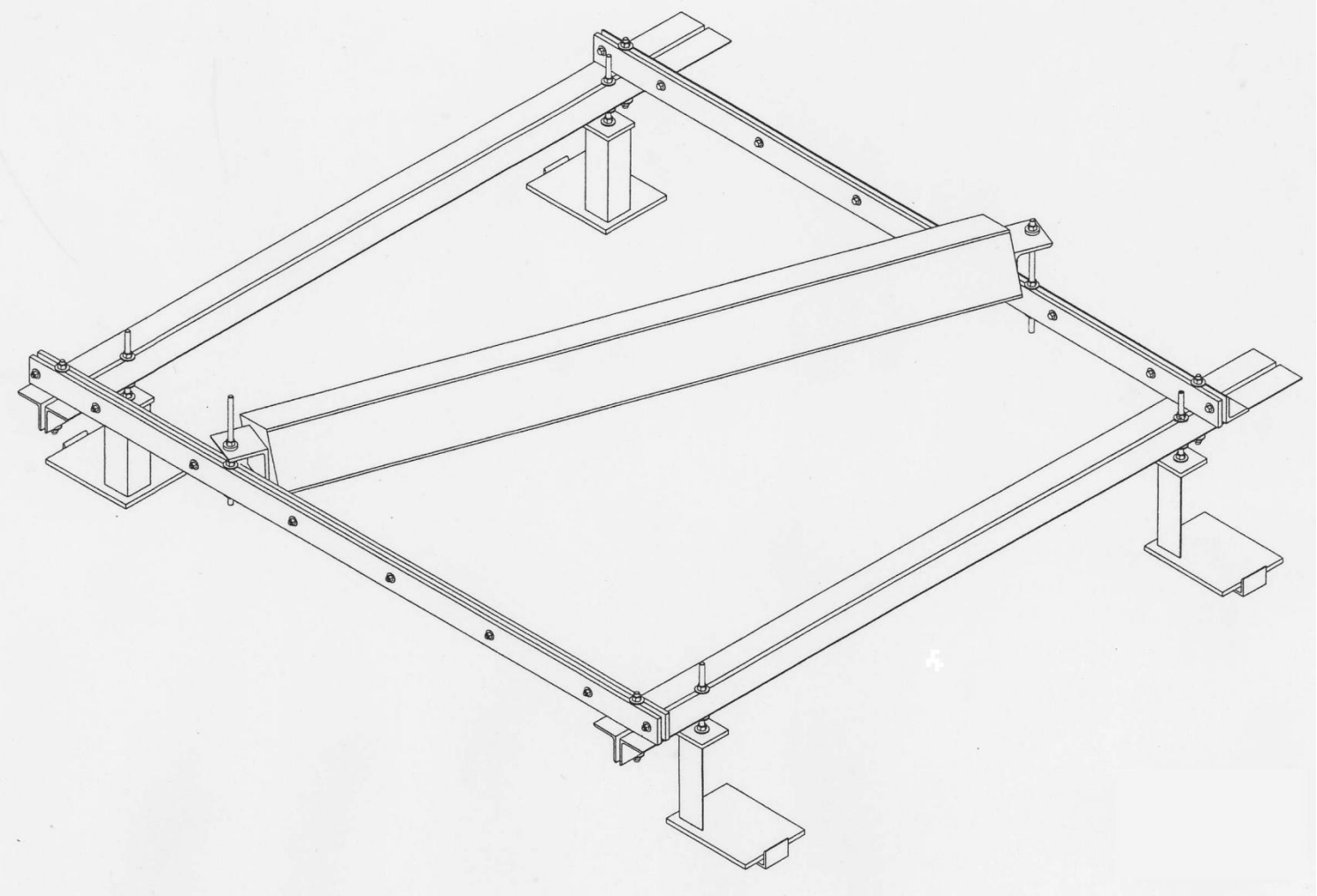
- Maximum sensitivity – 30-40˚
- Minimum sensitivity – 80-120˚

- Knowledge of the maximum-gain-angle allows adjustment of the detector ‘pitch’:



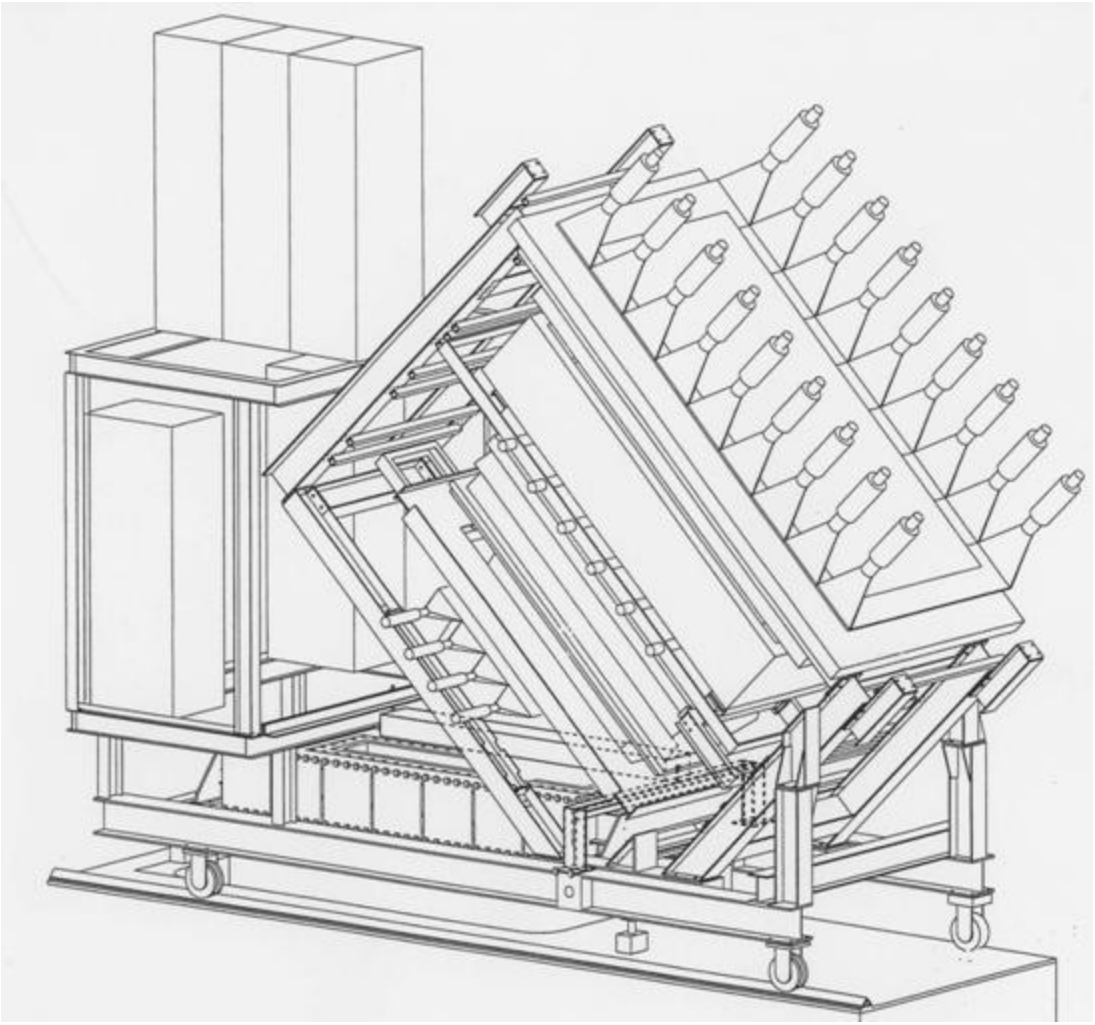
- Setting the pitch to the maximum-gain-angle for known trajectories significantly decreases the contribution of background electrons since they cross the detector at different angles.

Mounting frame for detector adjustment



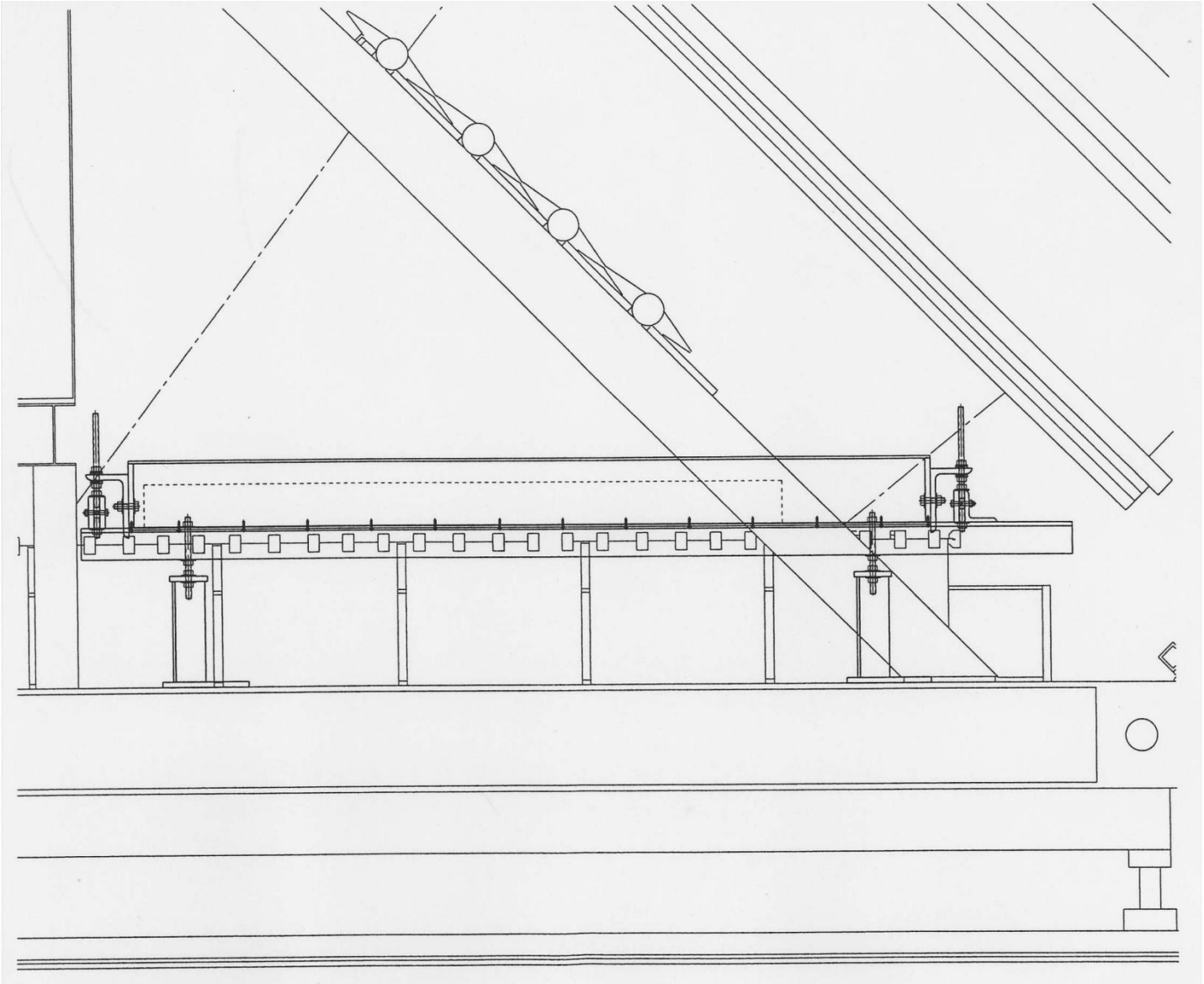
- It allows to set all the necessary angles.

Detector positioning



- One needs to remove 2 scintillators from S1 line in order to set HAPPEX detectors.
- Triggering can be made by using S2 scintillators or S0 scintillators.

Detector positioning (detail)



Up to date information

- There are 2 detectors with PMT and 2 detectors without PMT. There is 1 spare PMT.
- In fact only 2 detectors are needed – in each arm of the spectrometer. 2 others were used for background measurement and gave little useful information (background was small).
- All detectors are without UV filters.
- 2 detectors with PMT work, in the sense that after applying high voltage the give adequate response on the scope, due to cosmic rays.
- However the amplitude of the signal from detectors at 2200 V is insufficient for ADC to make a histogram.

Up to date information (cont'd)

- This is probably due to the fact that the amplification of the PMTs was changed in HAPPEX-2 experiment. Therefore it is necessary to restore the original amplification by changing the resistive base used in HAPPEX-2 to the active one.