

Pixilated TOF with LYSO crystal and G-APD array

J. Va'vra, SLAC

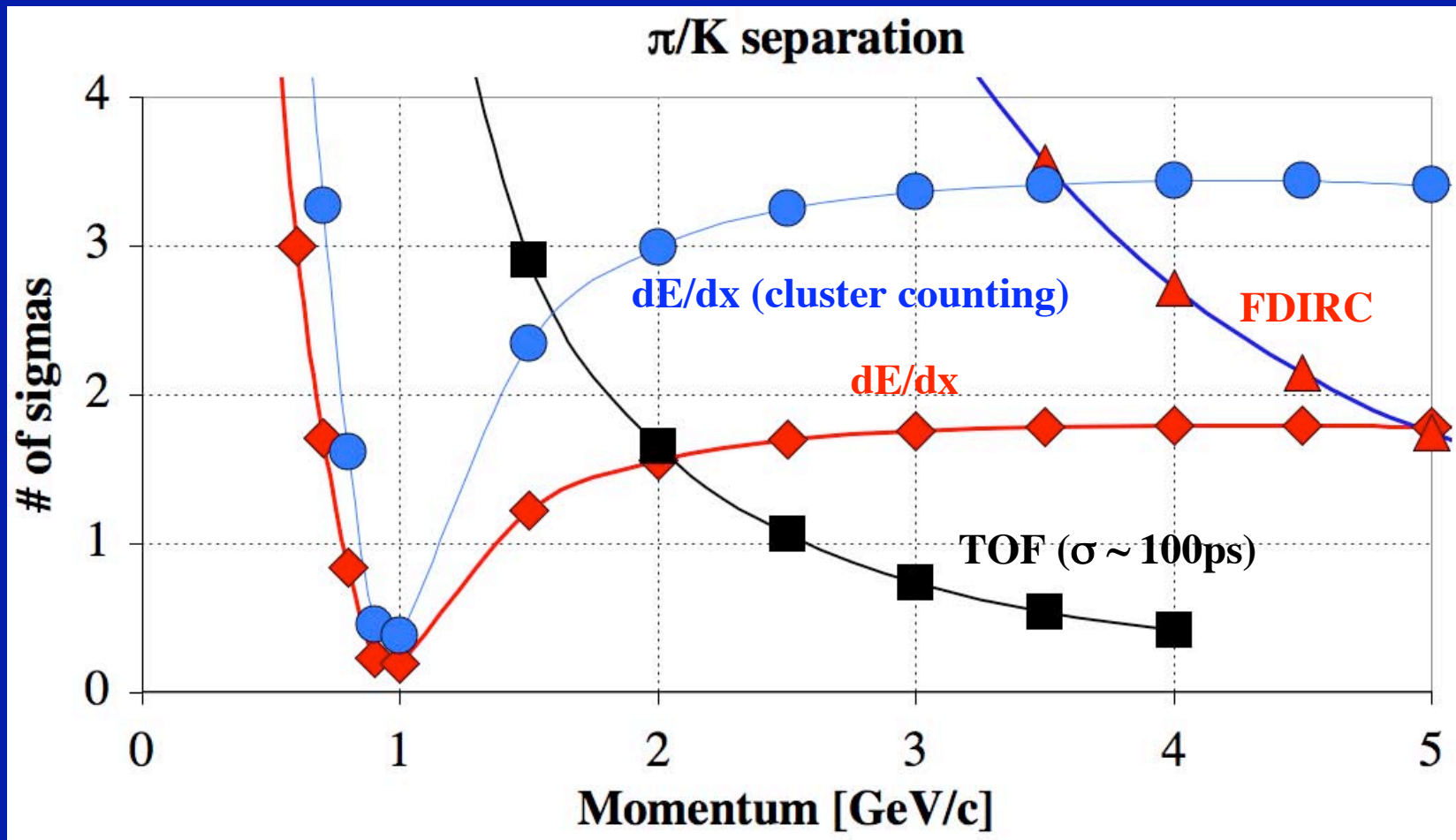
Content

- **Choices.**
- **Present test setup.**
- **Next step.**

PID on forward region

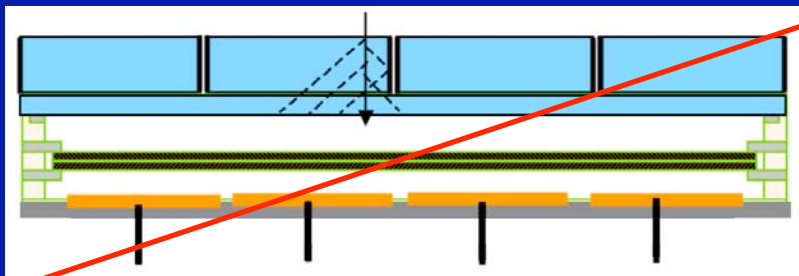
J. Va'vra, RICH 2010, Cassis, France, 2010

~1.8 m flight path:



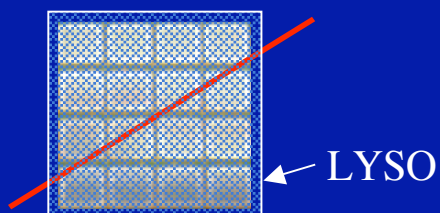
Pixilated TOF possibilities

1) Photonis 10 μ m-hole MCP-PMTs + quartz radiators:



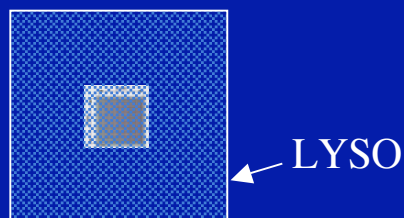
Although this would have been the best choice of all TOF schemes, in my opinion, it was rejected because of too high cost of MCP-PMTs at present (\$5k/tube, need 500, total ~ \$2.5M; expected $\sigma \sim 40$ ps)

2) Hamamatsu 4x4 G-APD array + LYSO crystal:



This detector is being tested right now, however, the cost would be too high even in a monolithic version (\$3.1k/4x4 array in small quantity; need 4,500 arrays; total cost is prohibitively too high at present).

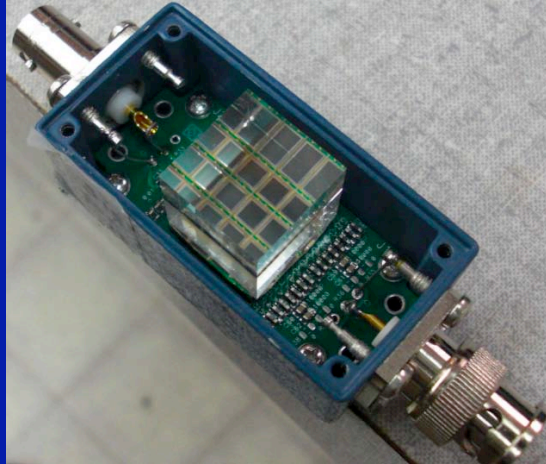
3) Hamamatsu single 3mmx3mm G-APD + LYSO crystal:



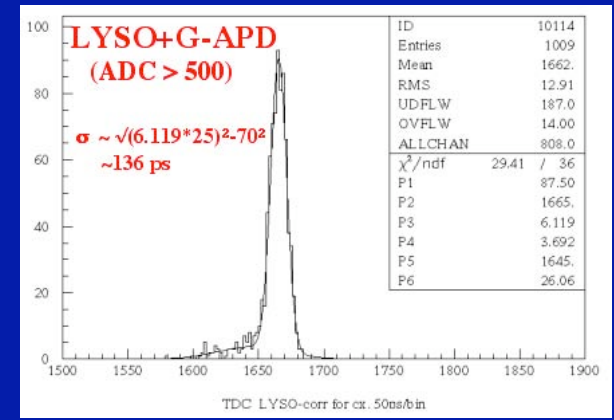
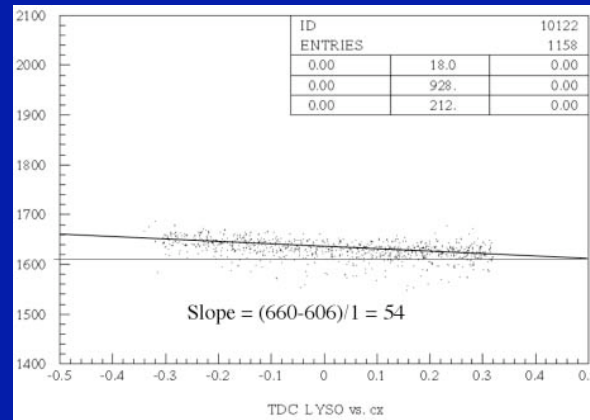
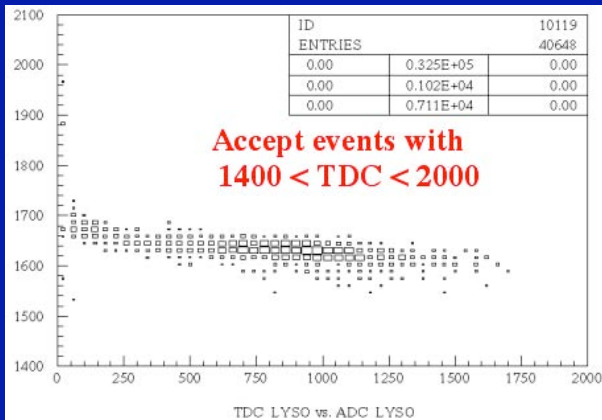
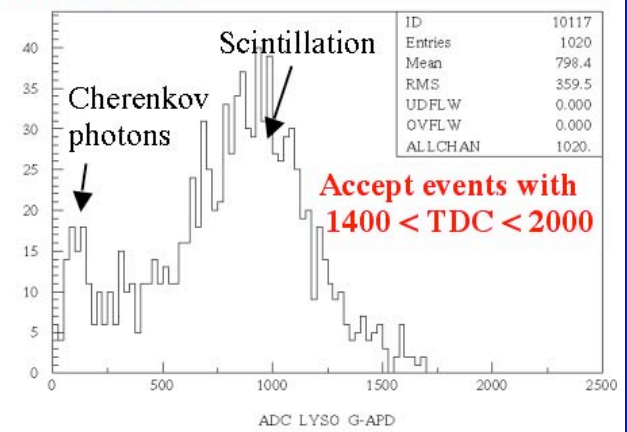
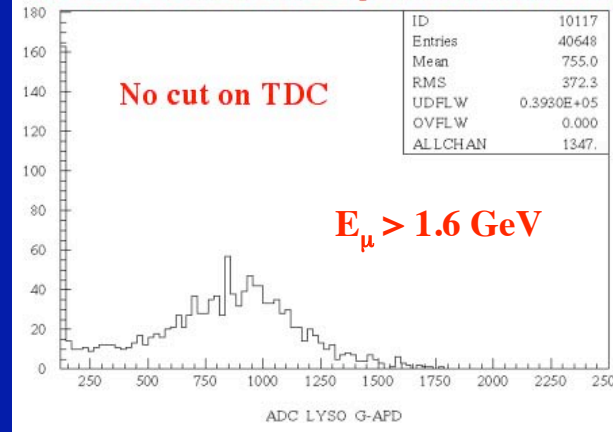
Will be tested in January, cost may be acceptable (\$300/piece in small quantity of 10; need 4,500 or less if we want to gang channels together)

- **There is no solution yet.**

4x4 G-APD array + small LYSO



- LYSO + G-APD ADC spectrum with & without TDC cut:

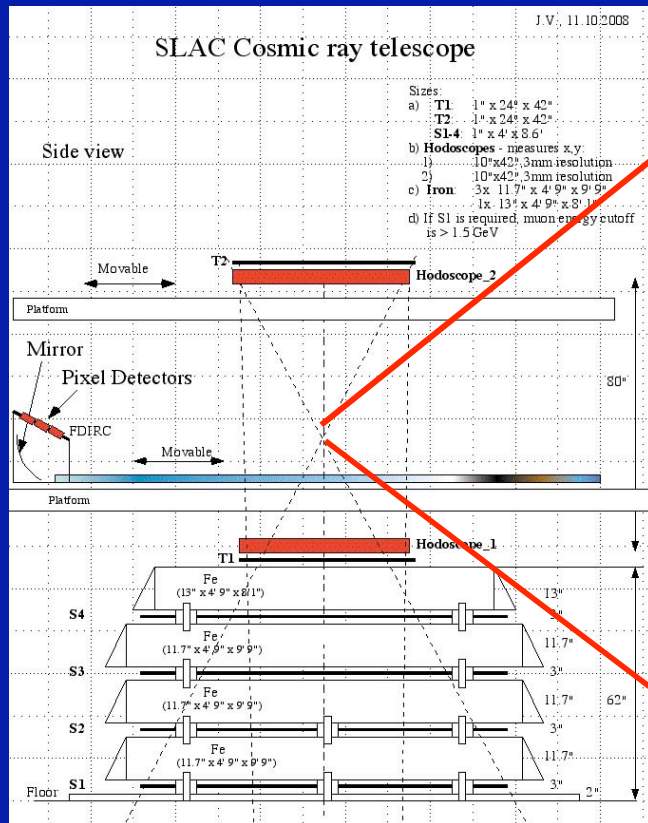


- The resolution with a small crystal seemed to be promising. So, decided to check it with a full size LYSO crystal.
- Nice thing about a G-APD is that you cannot damage it with a light overload.

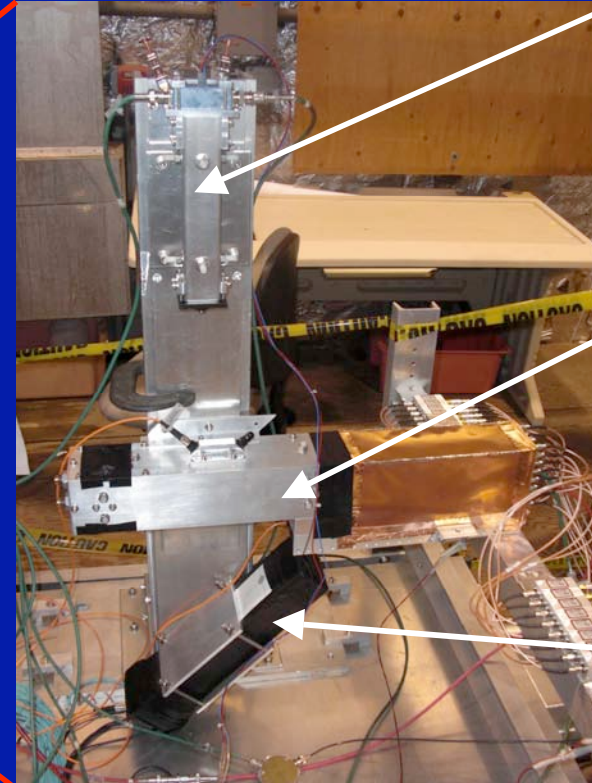
Present FDIRC prototype tests in CRT

Cosmic Ray Telescope (CRT):

(described in SLAC-PUB-13873 (2010):



Present tests:



LYSO
+ G-APD
array

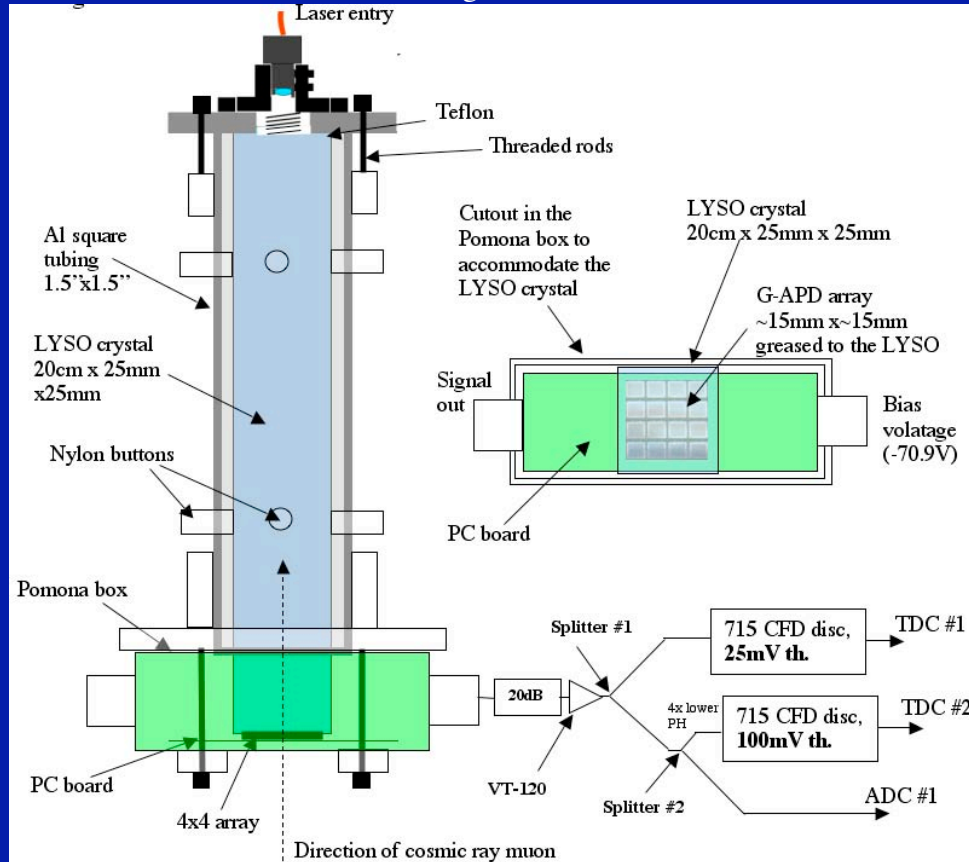
DIRC-like
TOF

Start
Counter
(t_0 defining
counter in
CRT)

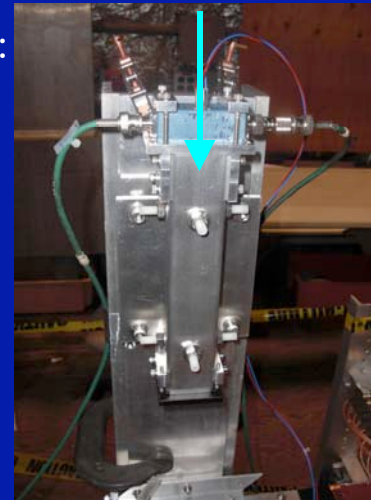
- T1*T2*S1*Qtz_counter rate ~ 6k/24 hours $\Leftrightarrow E_{\text{muon}} > 1.6 \text{ GeV}$
- Hope to collect ~200k triggers with the LYSO crystal.

Long LYSO crystal test

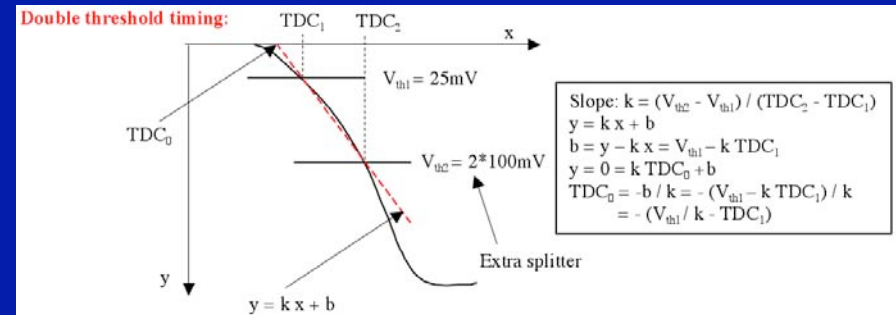
LYSO: 25mm x 25mm x 20cm-long



CRT setup:



G-APD array is at the top, muons are coming down. The G-APD array sees a scintillation coming back from a track.



- All G-APD array elements summed up. VT-120 amplifier+14dB attenuator: 20x eff. gain.
- Set the G-APD voltage to -70.9V initially !!
- Timing method: (a) double threshold timing with two CFD discriminators, (b) single threshold CFD disc plus an ADC-based correction.
- G-APD array on loan from Fermilab, a full size LYSO crystal on loan from Caltech.

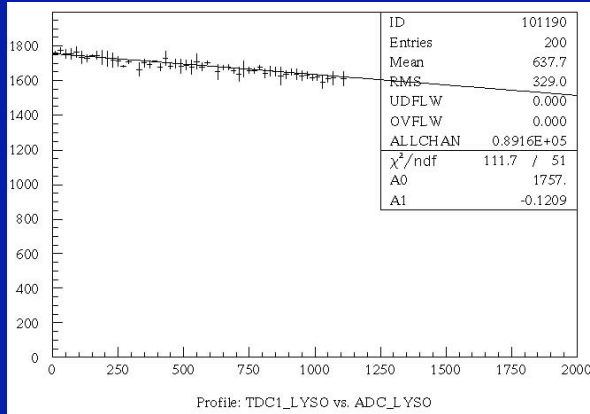
Do I operate the G-APD correctly ?

1 V/div

LYSO pulses before splitters:

LYSO ADC after two splitters:

TDC #1
[counts]



ADC [counts]



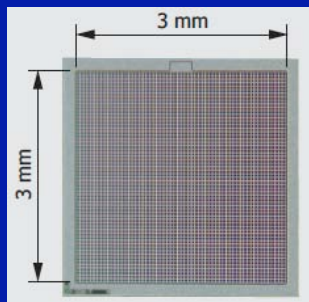
80 ns/div

Signals seems to be 2-3x larger than with a small LYSO crystal.

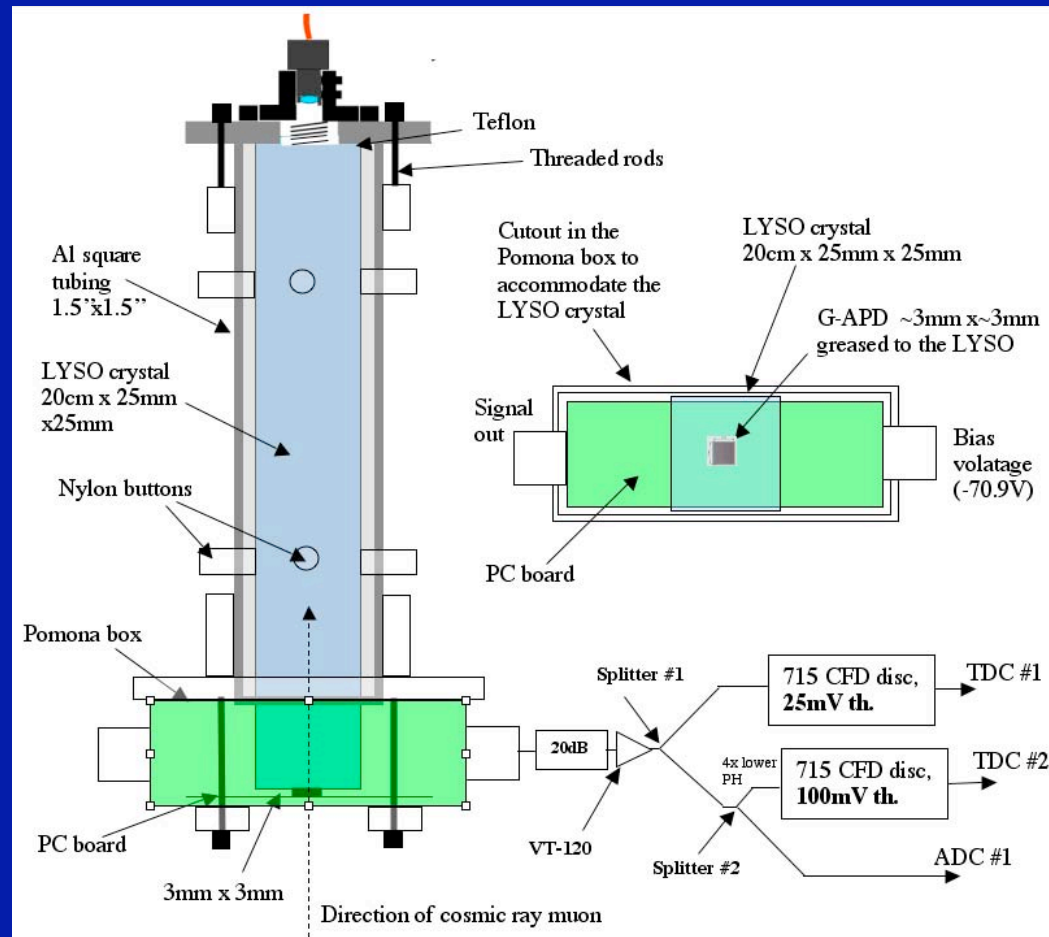
- **Analysis of data has started, but still have a very small statistics to say anything.**

Next step

S10362-33 MPPC:



\$305 in small quantity
of < 10.



- **Even a monolithic 4x4 G-APD array is presently too expensive.**
- **Will try also a single 3mm x 3mm array. One probably will have to make a track-position dependent correction.**

Conclusion

- **A test with 25mm x 25mm x 25cm-long LYSO coupled to a 4x4 GAPD array is under way. Will have results in the 1-st week of January.**
- **However, 4x4 G-APD arrays are too expensive for this project presently.**
- **Another test with a small 3mm x 3mm G-APD will start then.**