

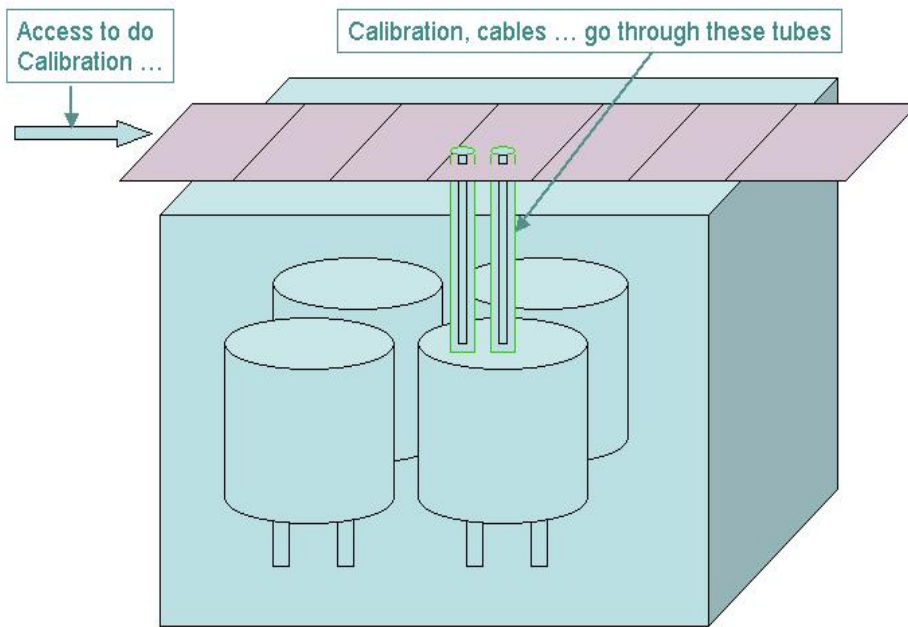
Veto with Plastic Scintillator Strips

Daya Bay Group Meeting
Changgen Yang
2006/02/15

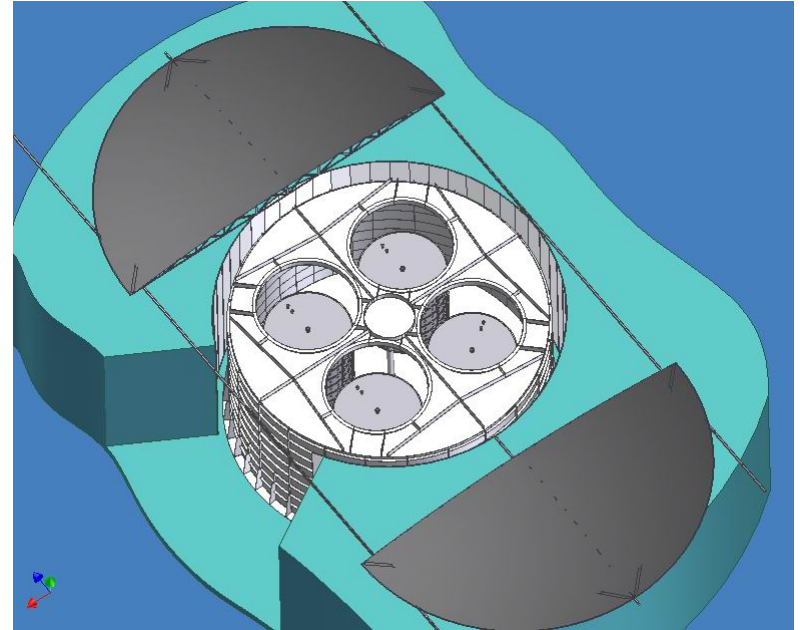
Advantages of a Water Pool-based Configuration

- Could be cheaper and faster to assemble
- Easy to accommodate bigger detector modules
- Easy to have thicker water to reduce the neutron background, this is particular important
- Reduce ambient radiation, e.g. ^{222}Rn , in the air or dust from entering the detector
- Muon veto and detector modules form one single active element
- Better veto efficiency (less wall)
- Could gain overburden above the pool
- Easier to perform calibration with more open space.
- Large volume of water helps to keep the temperature of the detector relative stable
- Easier to circulate and purify water in the pool
- To reach the same goal of physics, water pool is the simplest from mechanical point view.

Water Pool Options



Concrete wall
Scintillator Detector
on six side



SS Water tank
RPC mounted on the concrete wall
(no bottom detector)

Reasons of plastic scintillator

Reliability;

Long term stability;

Low maintenance;

Simple and robust construction;

Good track measurement;

High efficiency;

Good energy resolution

Experimental Scenarios (Far Site)

- 4 far detectors
- Water(Swimming)-Pool (15m X 15m X 9m)
- Veto detector: modules (size: e.g., 7.5m X 7.5m, too big?)
- Veto module:

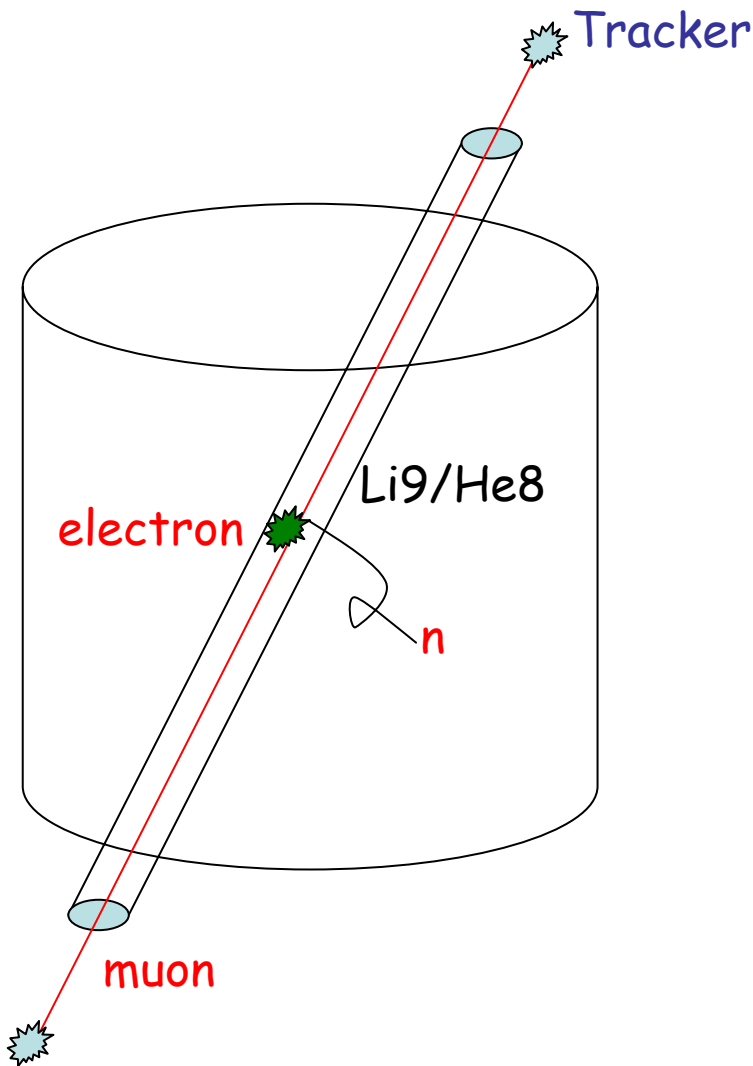
X + Y scintillator strip with fibre + Cerenkov PMT

16cm wide?
but necessary

(Keep access hole for calibration, support structure and so on,
how to keep >98% efficiency? some overlap?)

Modules on top of pool need reinforce structure
- Scintillator strips are sealed in PVC/HDPE envelope
- Light tight problem solve by other method (turn off all lights/black cloth cover?)
- Simple + easy to control + not so expensive ...
- **Veto covers all direction with good track information**

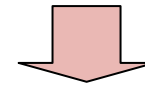
To measure $\text{Li9}/\text{He8}$?



Tracker \rightarrow muon track $\rightarrow r < 20\text{cm}$
cylindrical bar \rightarrow find e^- in the
bar \rightarrow find $n \rightarrow$ A $\text{Li9}/\text{He8}$
event.

The region out of this bar is still
active for neutrino events (less
dead time).

By clear tagging $\text{Li9}/\text{He8}$ events,
the b.g. might be able to be
fitted which further reduce
the sys. error of such
background.



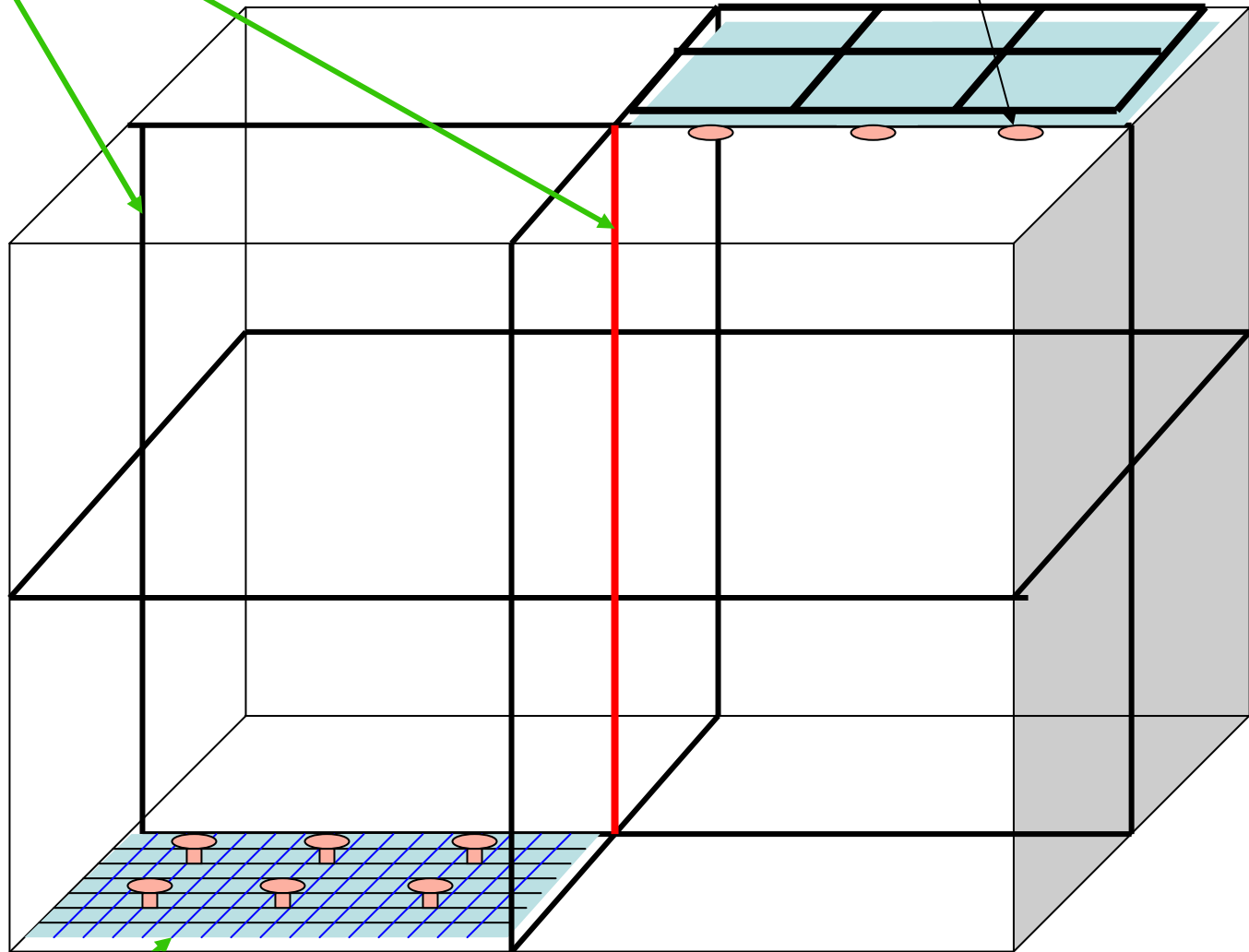
**Need both good position reconst.
of tracker and main detector**

Waterproof for scintillator strips

- PVC Envelope (need some kind of envelope anyway)
Water absorption rate: 0.07~0.75
melding point: ~ 60 degree
Price: Cheaper, ~ 9 Yuan/kg
Density: ~ 1.6
Thickness: 3mm
- HDPE Envelope
Water absorption rate: 0.01
melding point: Higher (70~100 degree)
Density: ~ 1
- PVC/HDPE Box are reinforced by out-side structure

Support Structure(SS bar)

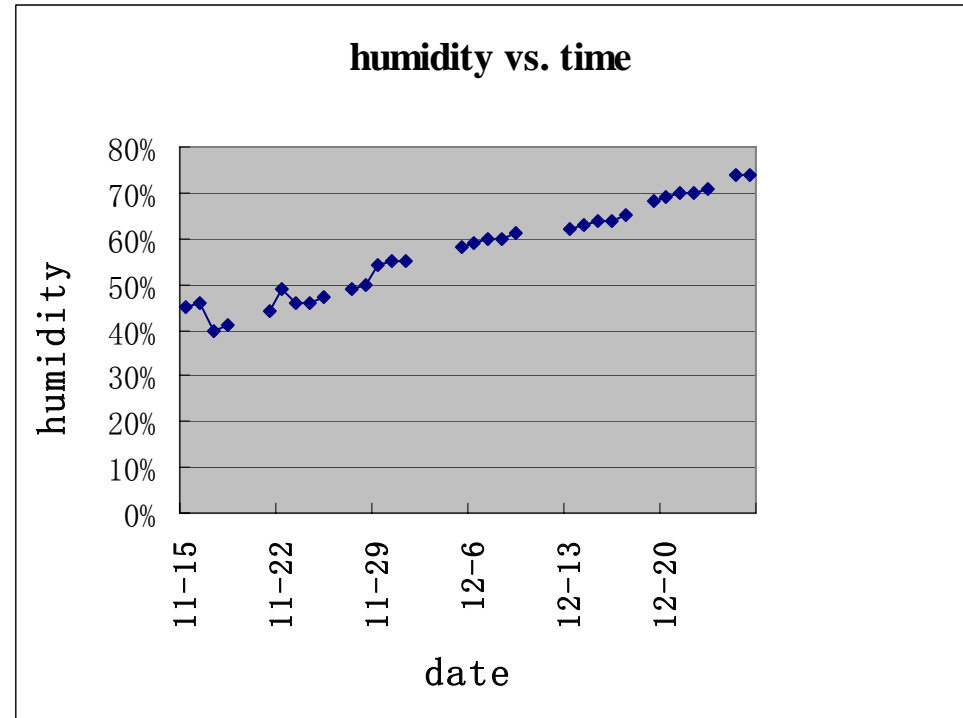
Are these PMTs necessary?/Reflection Tevyc?



Veto Module

Veto Module is fixed on the support structure

Waterproof of PVC box



Plan to make another box with a tube to flush air for testing.

Acrylic cover with higher water absorption rate (1.2 ~ 2.8).

The L3+C Detector

NIM A488:209-225, 2002



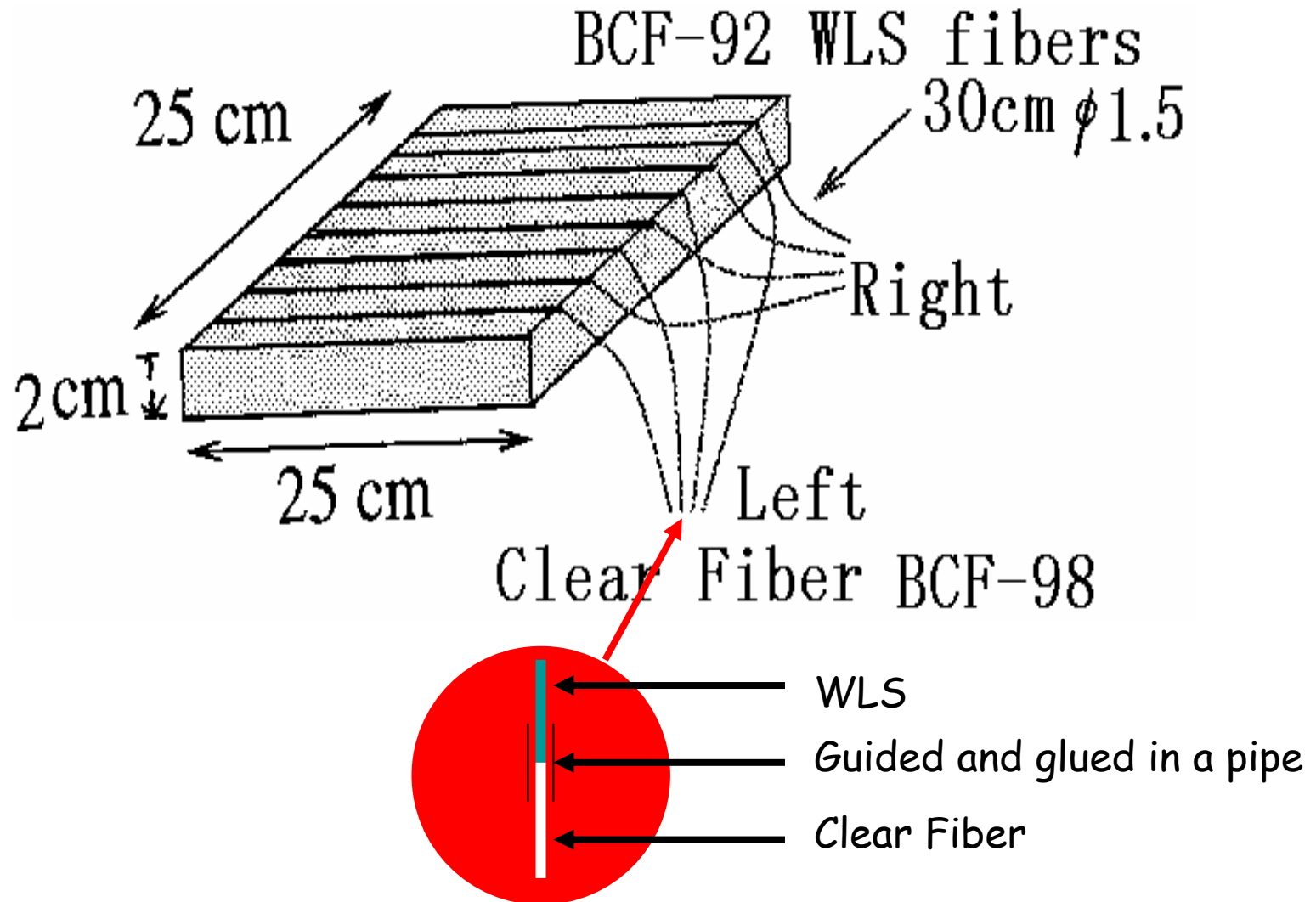
Detector:

- Magnet (0.5 T, 1000 m^3)
- High precision drift chambers
- t_0 - detector (202 m^2 of scintillator)
- 50 scint.s at surface (air shower detector)

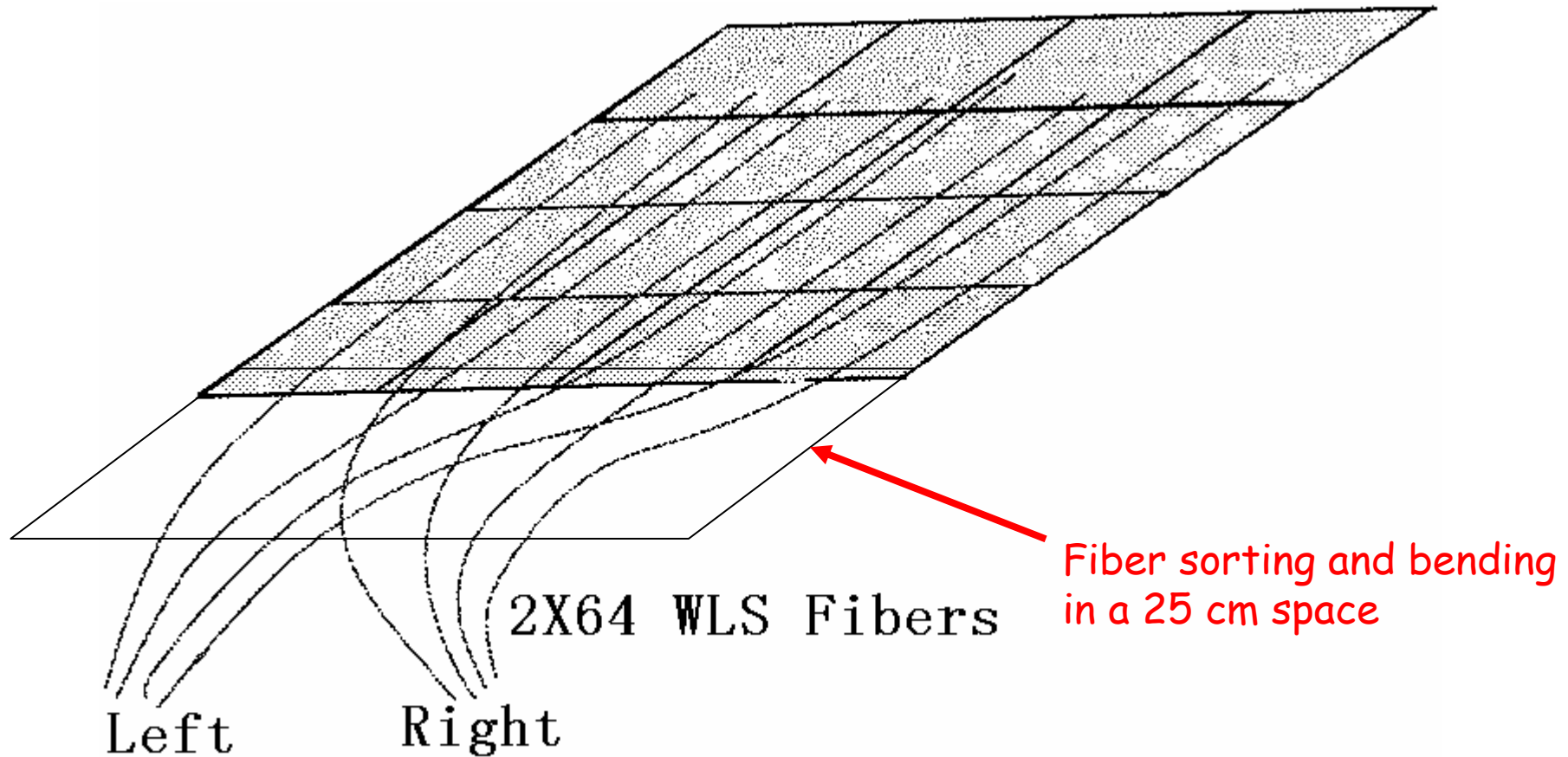
L3+C T0 Detector Module



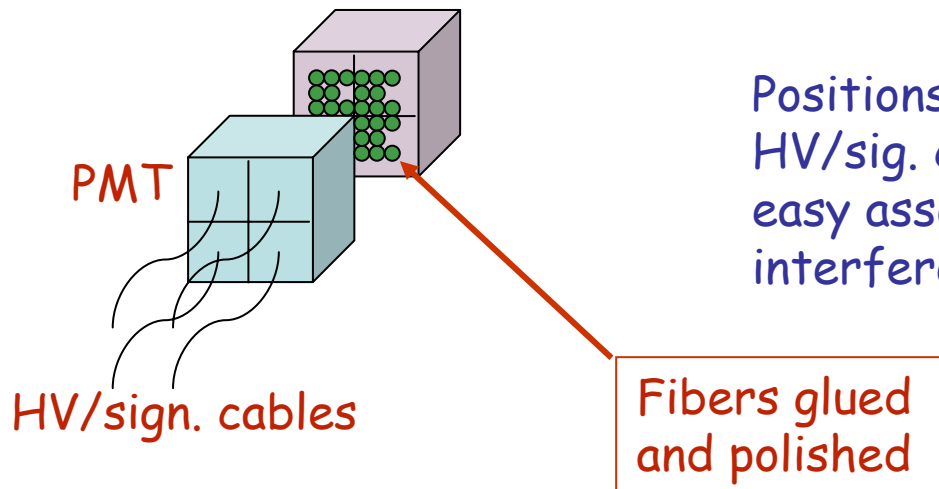
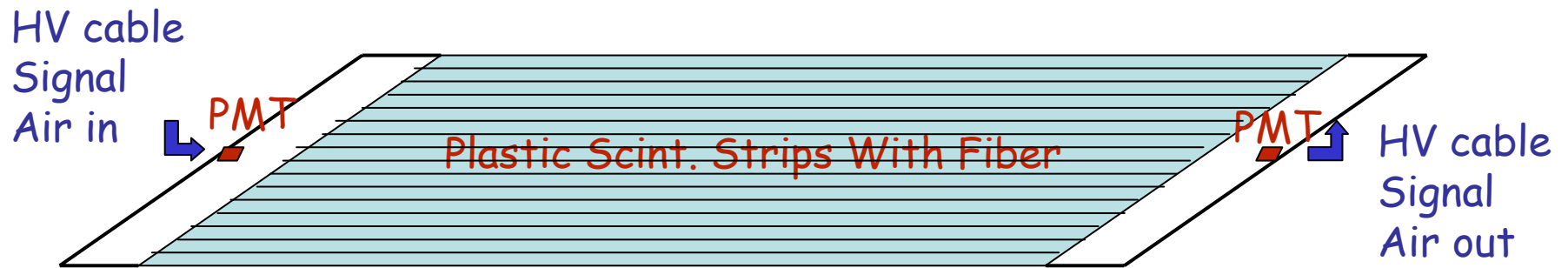
Scintillator tile



Cassette Consisting of 16 Tiles



Bundled fiber to PMT and
fixed there with PMT

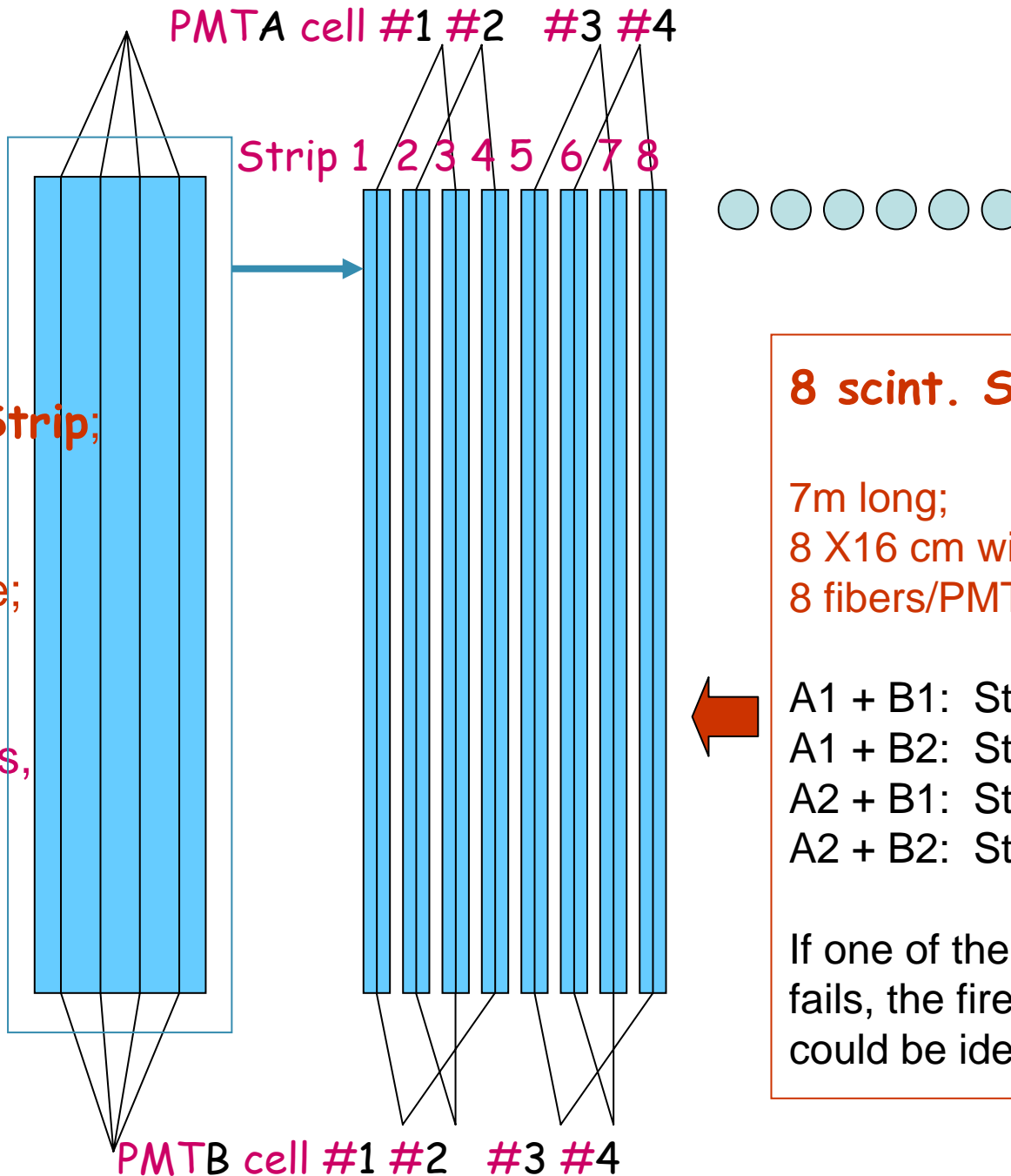


Positions of the tubes for air flush and HV/sig. cables have to be optimized for easy assembling and reducing the interference with other modules.

A scint. Strip;

7m long;
16 cm wide;
4 fibers;

Wider strips,
less gaps,
Higher eff.



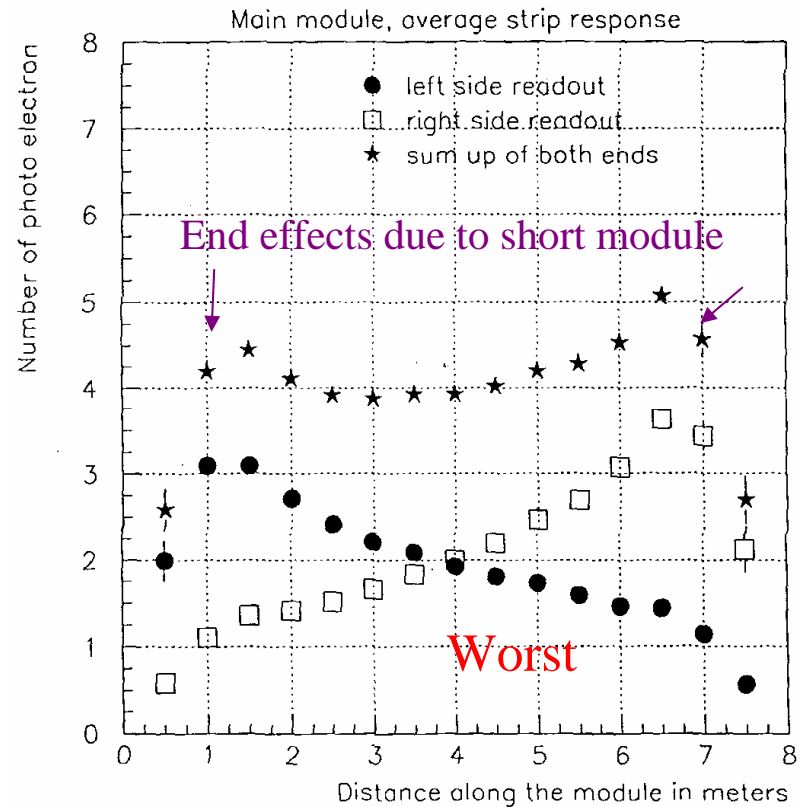
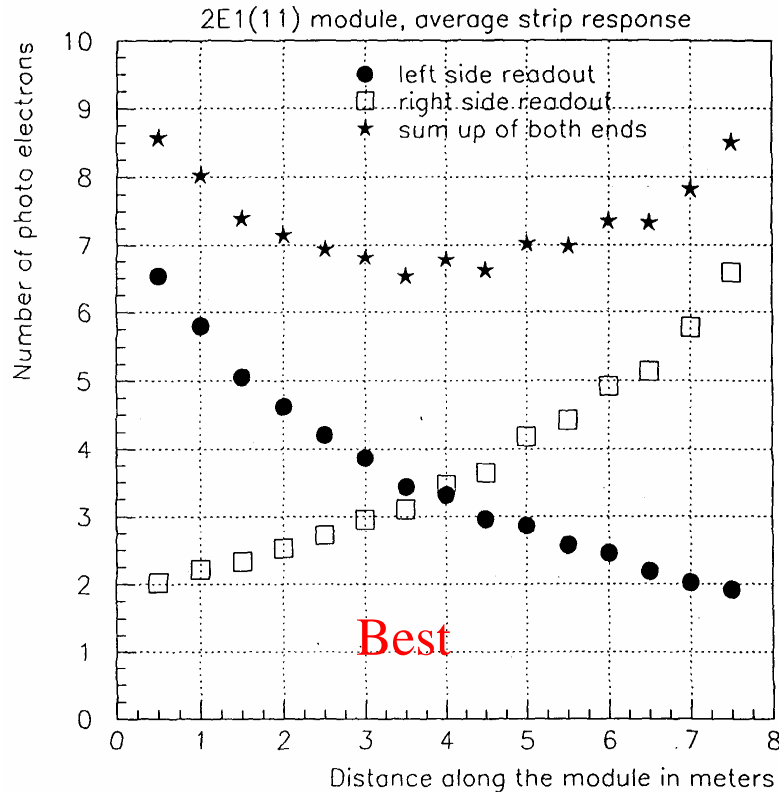
8 scint. Strips;

7m long;
8 X16 cm wide;
8 fibers/PMT cell;

A1 + B1: Strip 1 fired
A1 + B2: Strip 3 fired
A2 + B1: Strip 4 fired
A2 + B2: Strip 2 fired

If one of the 4 PMT cells fails, the fired strip still could be identified;

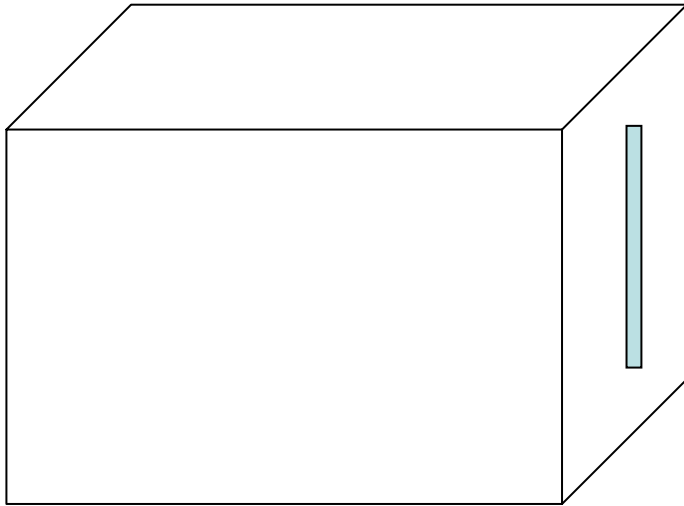
For short strips, less WLS fibre/ One side readout ?



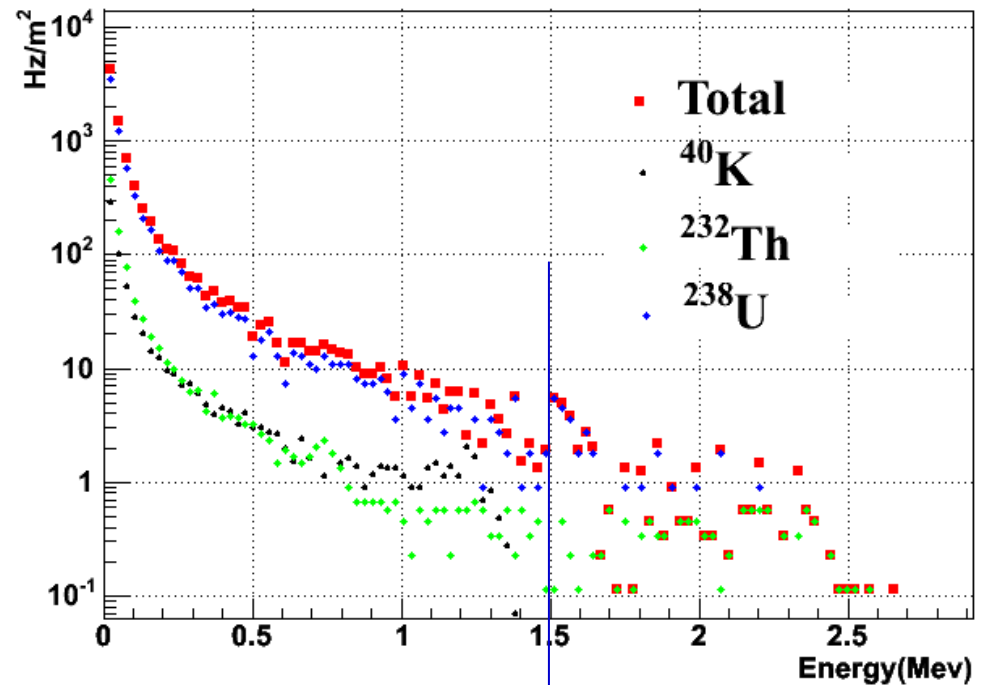
- Light output for the best and worst module produced. The light is for single, minimum-ionizing particles and includes the full effect of connections, etc.

Radiation Background Simulation

(Preliminary, J.C. Liu)

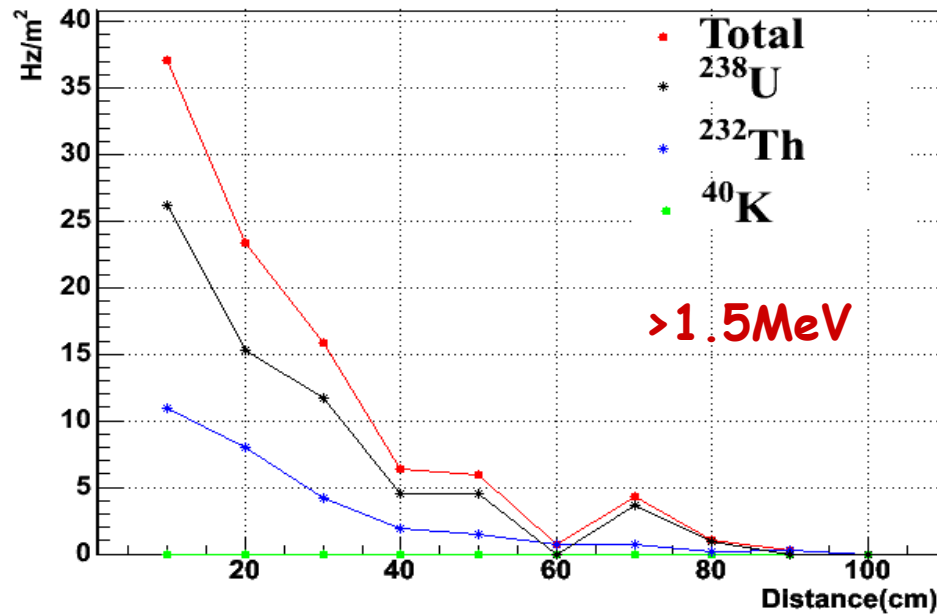


Two layers of scintillator (size 700cm X 15cm X 1cm) overlaps;
5cm(Thicker for construction?)
of concrete on the wall, no
radioactivity was put in;
U, Th, K radioactivity according
to DYB rock sample.



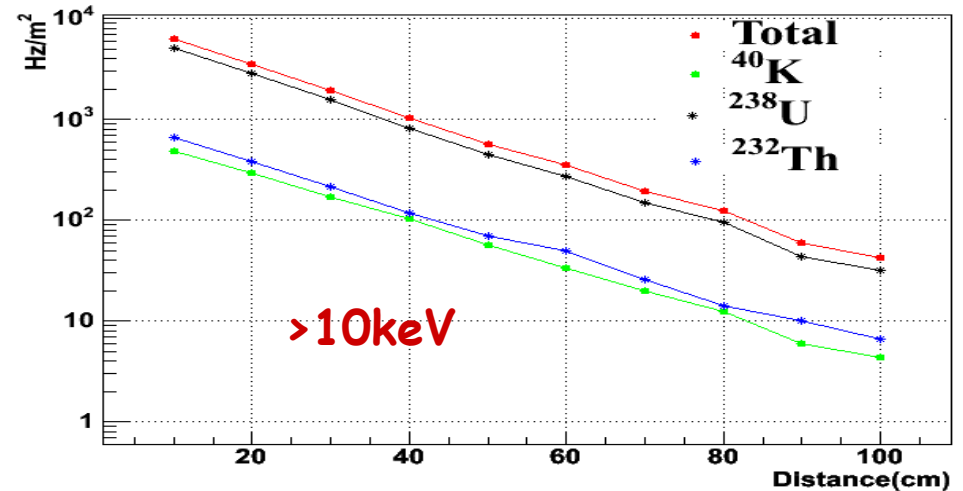
>1.5MeV
37Hz/m² @ 10cm

B.G. vs Distance

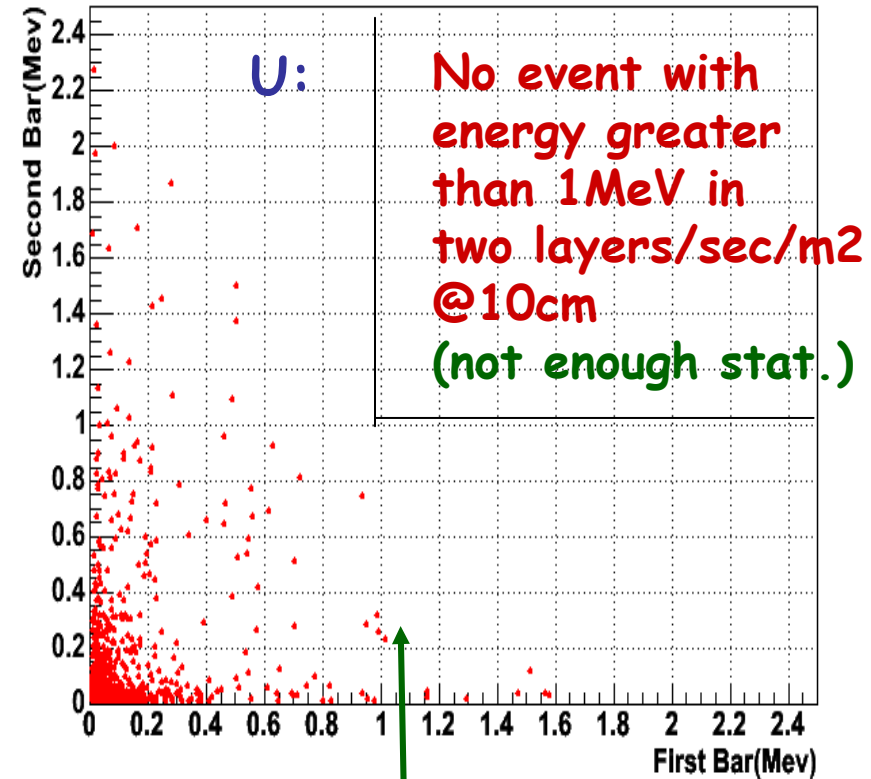
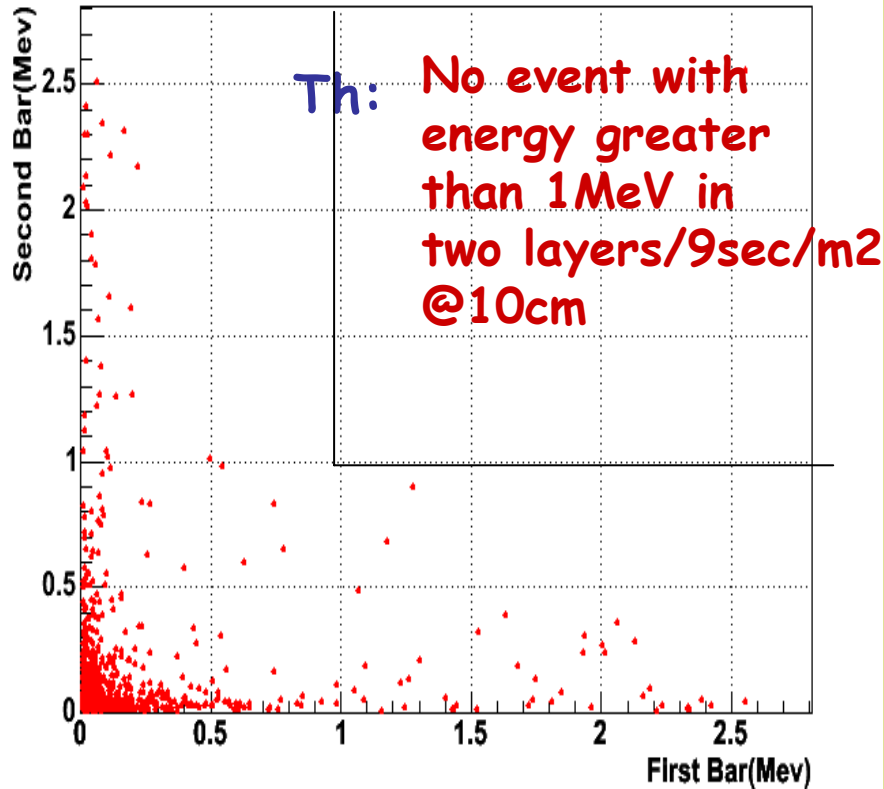


37 Hz/m^2 @ 10cm
6 Hz/m^2 @ 50cm
2 Hz/m^2 @ 80cm
??? @ 100cm

**B.G. is not low enough
with only one layer**



B.G. of two layers



Energy deposition by one conversion ???

Cost of Plastic Scint. Veto

- 3 Exp. Halls, size: one $15 \times 15 \times 9 \text{ m}^3$, two $15 \times 9 \times 9 \text{ m}^3$; double layer of plastic scint., total area: $\sim 4800 \text{ m}^2$

(Cost scaled from MINOS proposal):

- Plastic Scintillator 720k\$($\sim 150\$/\text{m}^2$)
- Fiber 720k\$($\sim 6\$/\text{m}$, $25\text{m}/\text{m}^2$)
- PMT: 1 cell (channel)/ 1.2m^2 , 4000 channels, 250 R5900U-00-M16 PMT, 85\$/channel, 340k\$
- Electronics: 150\$/80\$/channel, 600/320k\$
- HV, 500\$/PMT, 125k\$
- PVC container, 150k\$
- Mechanical structure, 300k\$ (?)
- Total cost: 2.9M\$

Summary

- (Scintillator strips) can cover **all direction with good track** information;
- Cheaper (without out SS container), and clean signals;
- **The cost of MINOS' solid scintillator strips is comparable to the RPC system.**
- **Solid scintillator strips is superior due to long- term stability, low maintenance, reliability.....**
- High veto efficiency;
- Good tracker can help tagging the Li9/He8 background?
- All details need optimization;