

PMT Placement 101

Great Progress is being made on the PMT System:

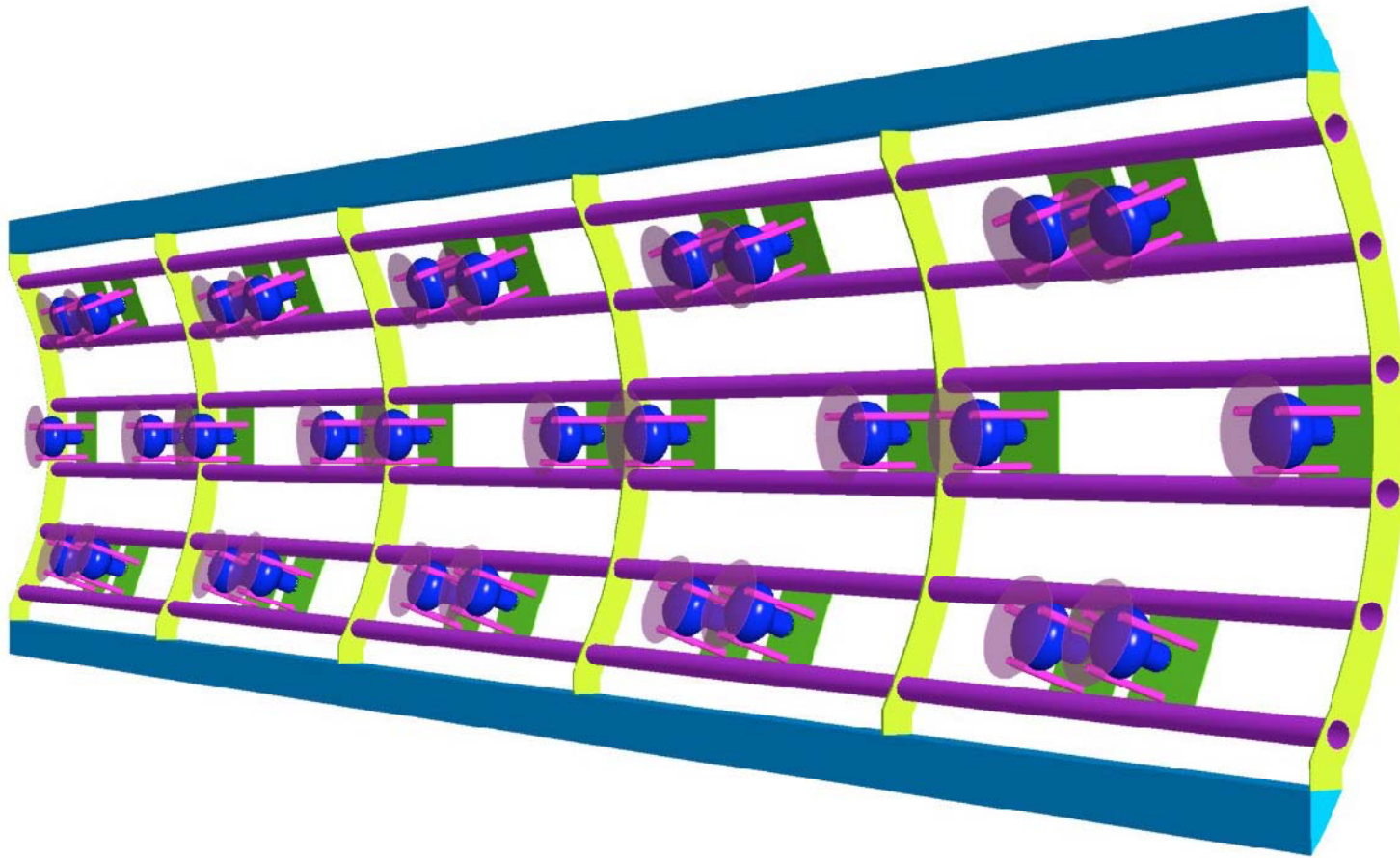
Ben's Simulation Work

Tess's design work on PMT mounting.

Before getting into too much technical mounting detail, I was curious how PMT placement would affect light detection performance.

So I made a very simple calculation to study that.

An example of PMT Placement



Light Collection Goal

If the goal of light detection is to trigger efficiently on events at all locations,

then the most relevant number is the light collection where it is the poorest.

This is, as expected, for events near the cathode plane.

Method

I took a simplified, but realistic, look at PMT light gathering versus PMT location.

To do that I calculated the wave shifter disk solid angle as seen from an assumed event location.

I sum over the disks.

I assume further that :

--the detector is uniform along the tank axis, hence I calculate a longitudinal slice (a 2-D problem).

--There are no reflecting surfaces

--No Rayleigh scattering

Taking care of the Z-axis

One can get from these solid angles to the 3-D solid angles by multiplying by roughly a factor 2.5

At the TPC ends one needs to double up PMT's at these Z-location to make up for the "absent" PMT's beyond the end of the detector (This is also what Ben found)

Data Presentation

We define (see next slide) 5 vertical planes (at constant X and Z) and plot the total solid angle spanned by the waveshifter disks, as a function of elevation (Y).

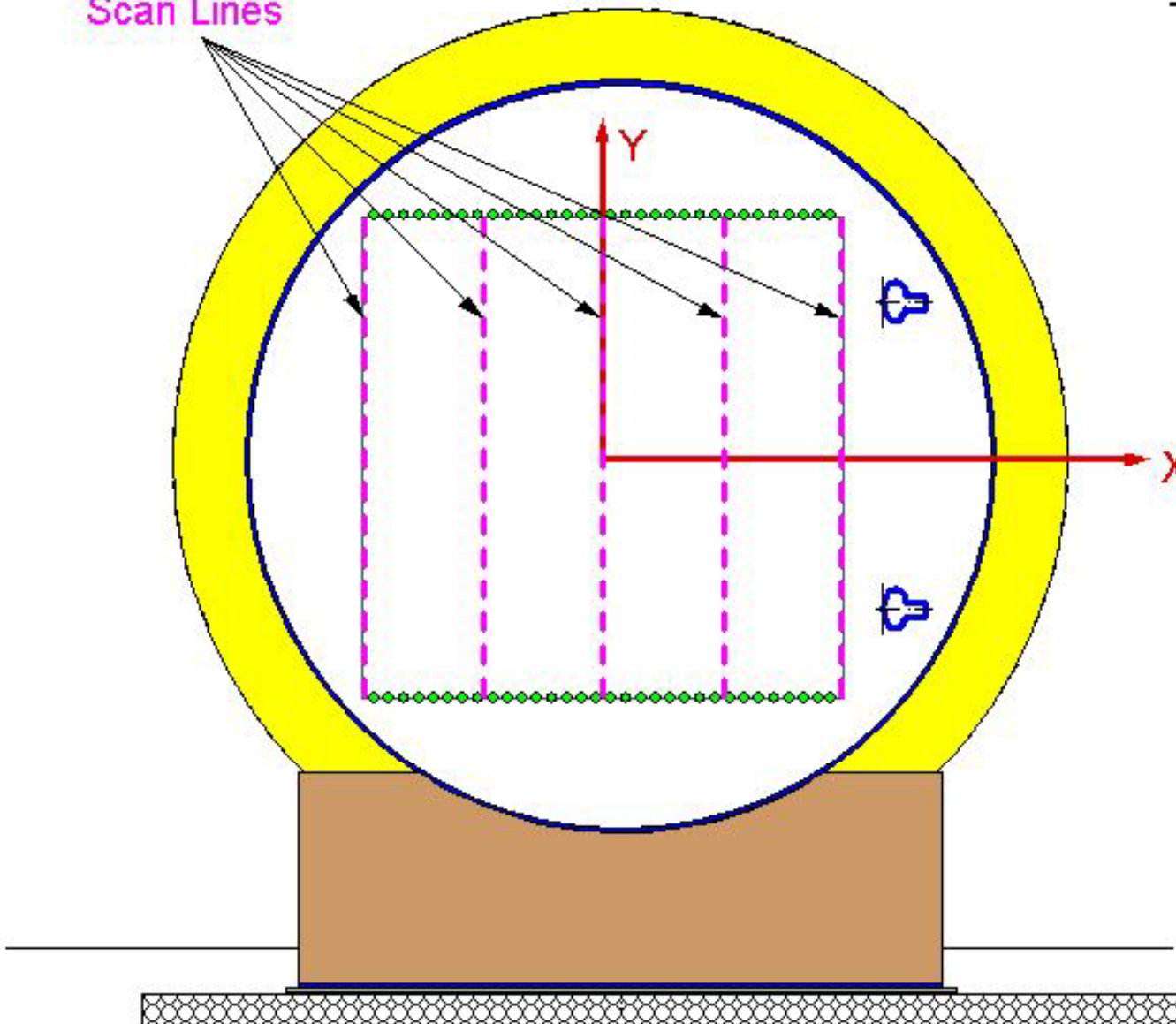
The light collection near the cathode plane is poorest, hence the curve near the cathode plane is at the bottom in all graphs.

We would like to maximize the light collection there, and get it to be as uniform as can be reasonably achieved.

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Scan Lines

TPC and PMT's



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7/29/2010

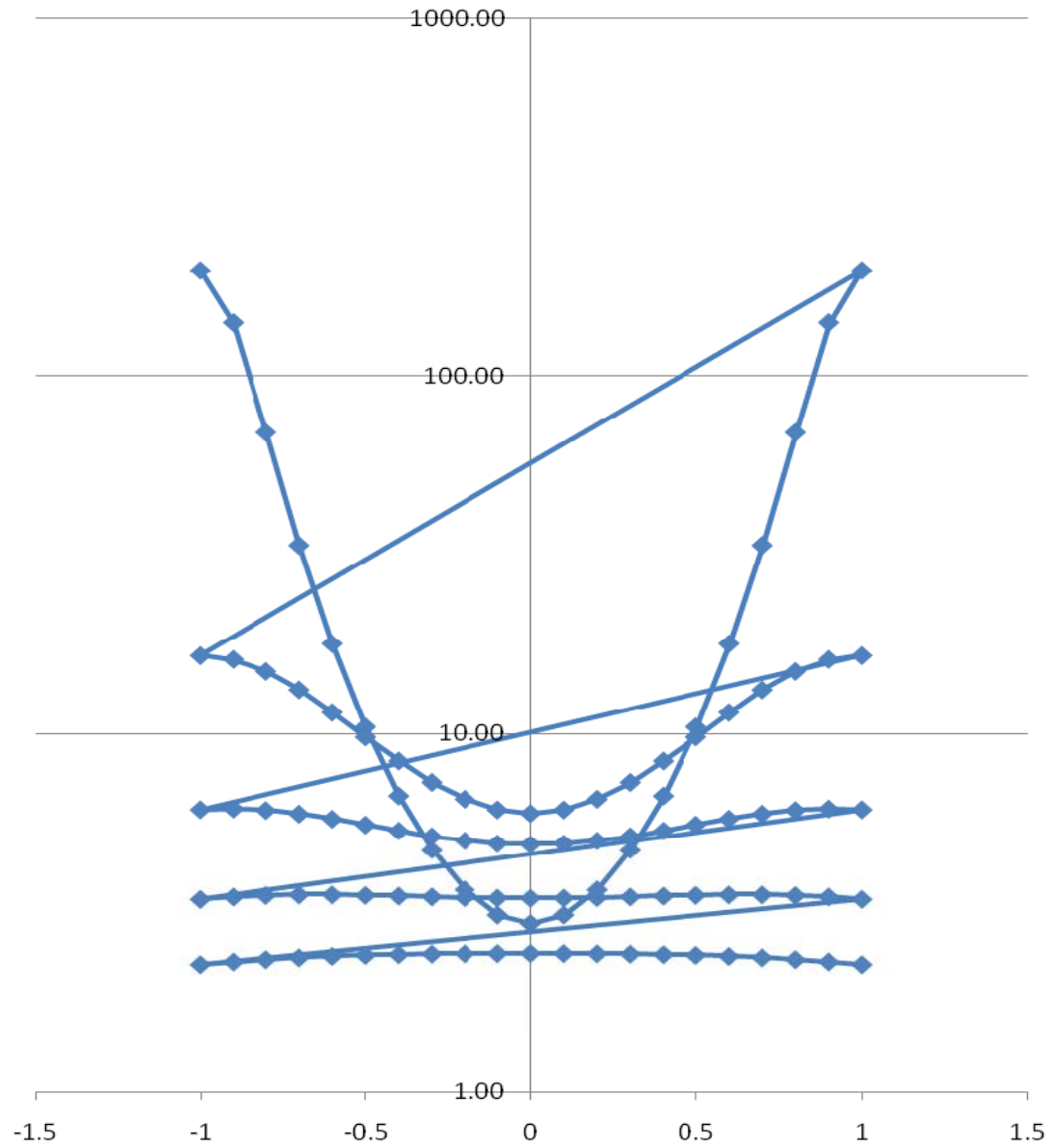
PMT's at Top and Bottom ($Y = \pm 1 \text{ m}$)

(Note that there is no room to use that location in reality)

Event locations at $X = -1\text{m}$, -0.5 m , center, $X=0.5\text{m}$, and $X= 1\text{m}$

The bottom curve(near the cathode) is nearly uniform.

sum solid angle msr

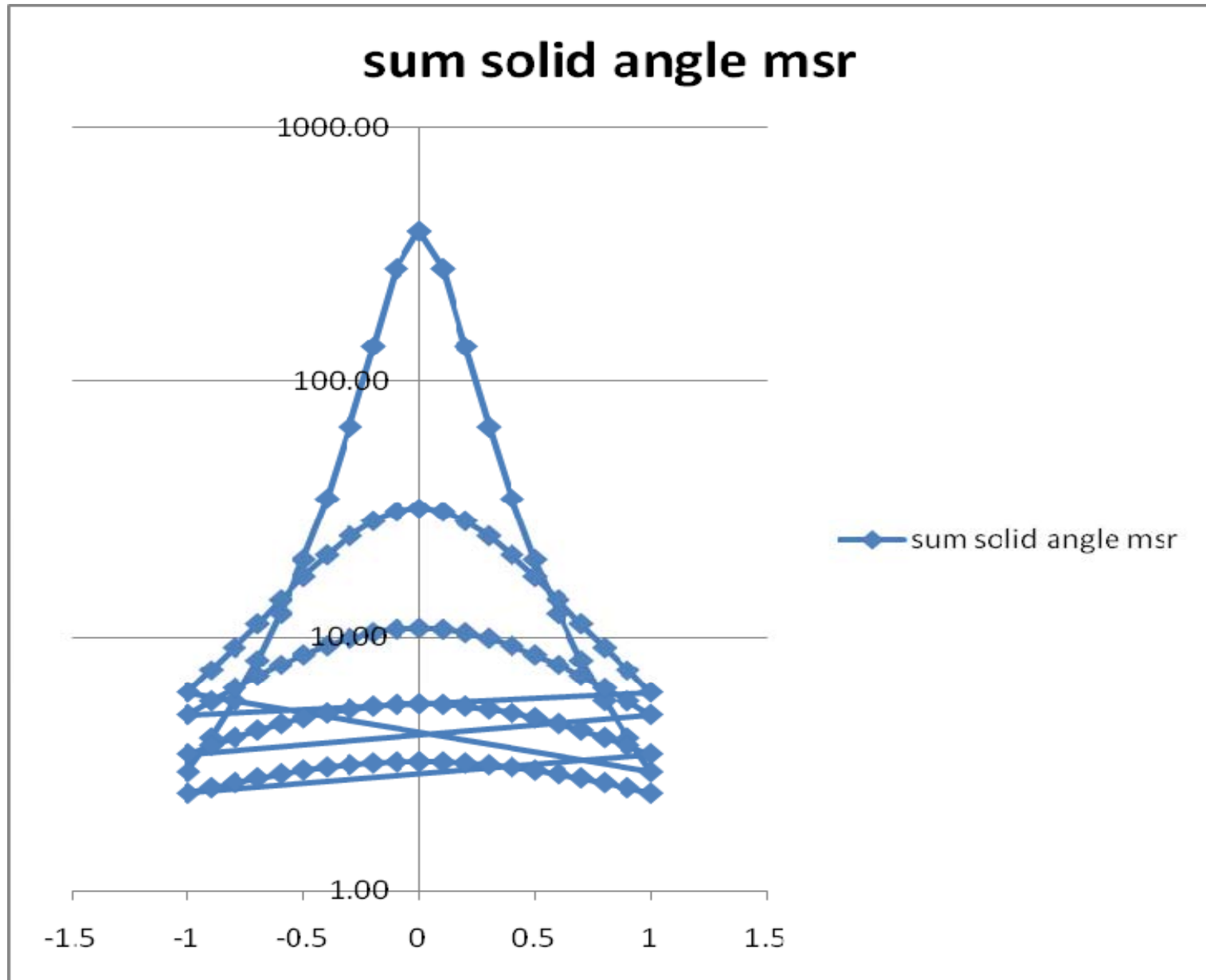


sum solid angle msr

PMT's at Top and Bottom (+- 1 m)

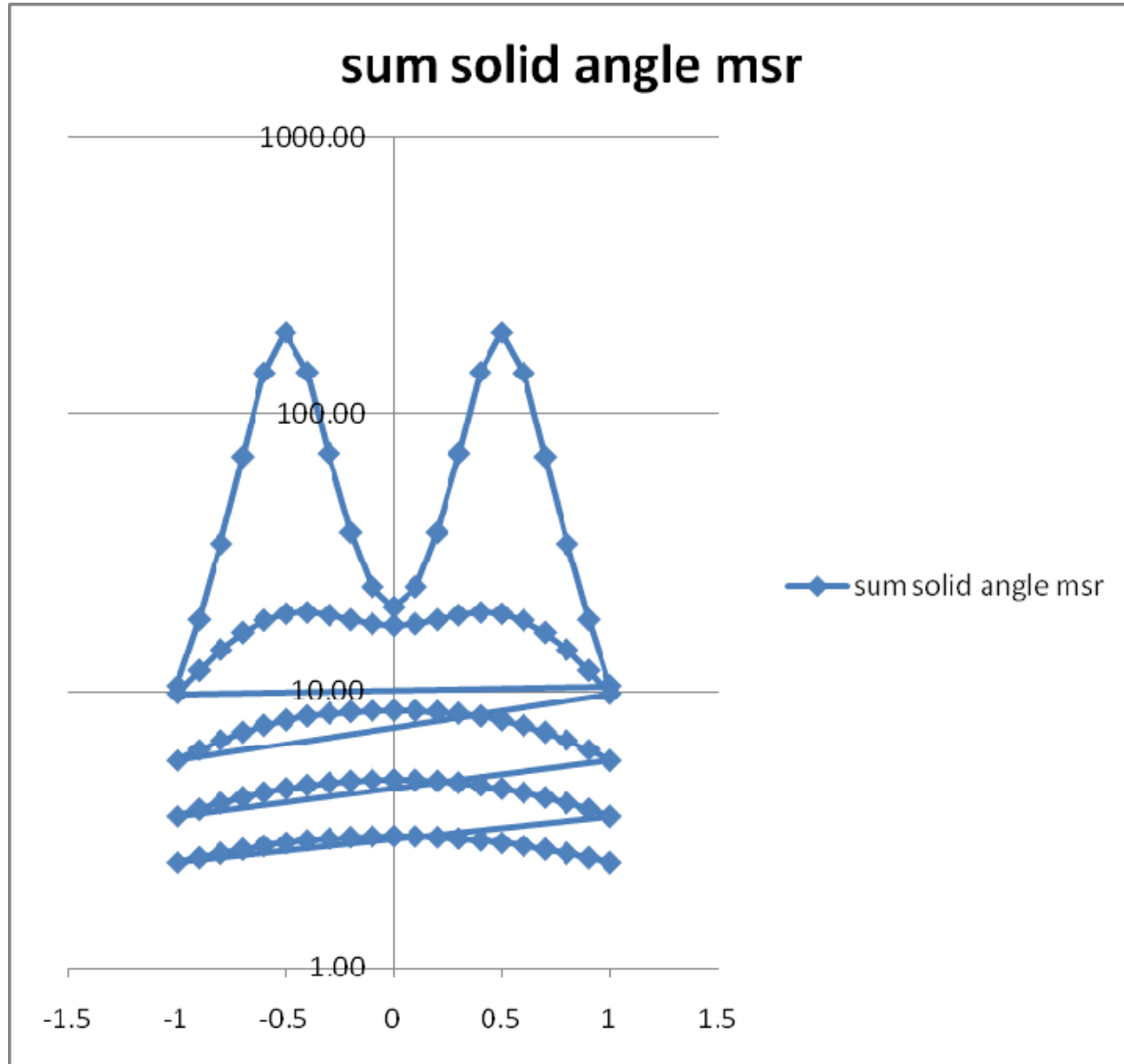
PMT's all at Mid-Height ($y=0$)

Event locations at $X = -1\text{m}$, -0.5 m , center, $X=0.5\text{m}$, and $X= 1\text{m}$.

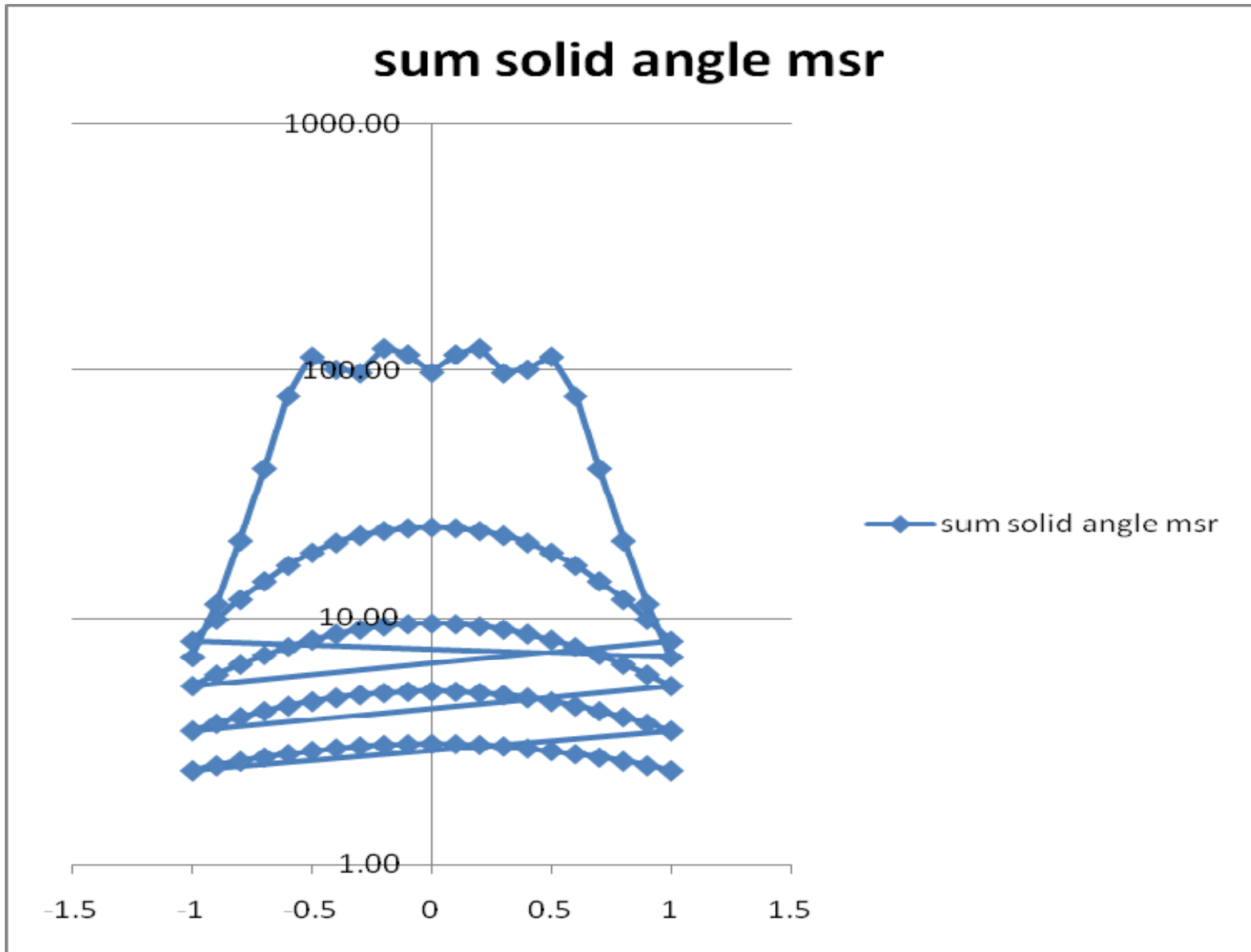


PMT's at half-heights ($y = \pm 0.5$ m)

Event locations at $X = -1$ m, -0.5 m, center, $X = 0.5$ m, and $X = 1$ m.



PMT's evenly distributed between $Y=-0.5\text{m}$ and $Y=0.5\text{ m}$
Event locations at $X = -1\text{m}$, $-.5\text{ m}$, center, $X=-.5\text{m}$, and $X= 1\text{m}$.



Conclusions

--The light distribution near the cathode plane, where it matters most, is reasonably insensitive to PMT placement.

--It is flattest when there are just two elevations where PMT's are placed. Both should be as far from the mid-plane as space allows

--The mounting scheme might be simplest if just two elevations are populated

--For events near the wires there is a "blind spot" near the upper and lower TPC edges; tilting the disks toward the TPC center makes the blind spot worse (and may kill all light detection along those edges).

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