

# PMT Placement 101

*Great Progress is being made on the PMT System:*

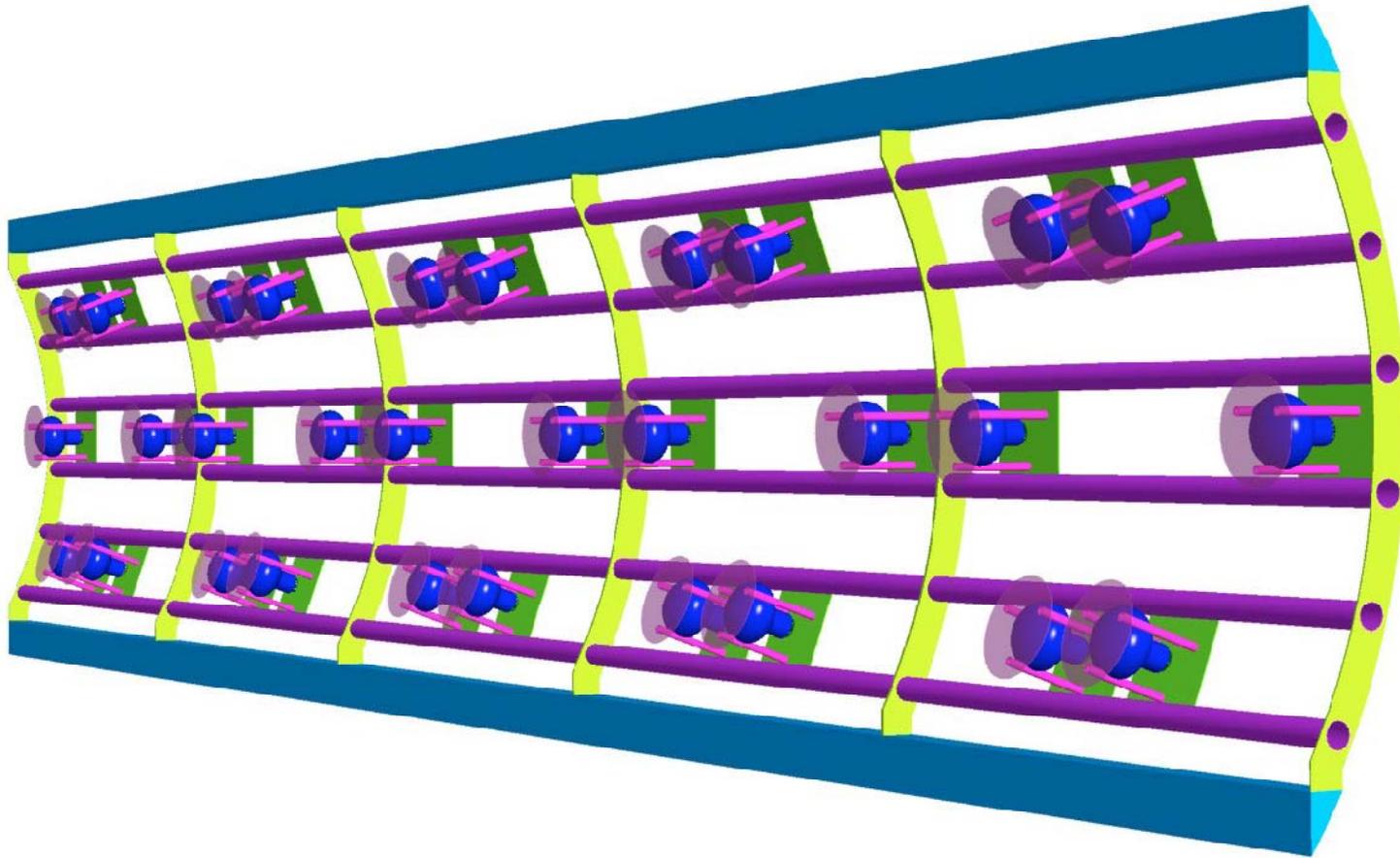
*Ben's Simulation Work*

*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 ( $Y$ ).*

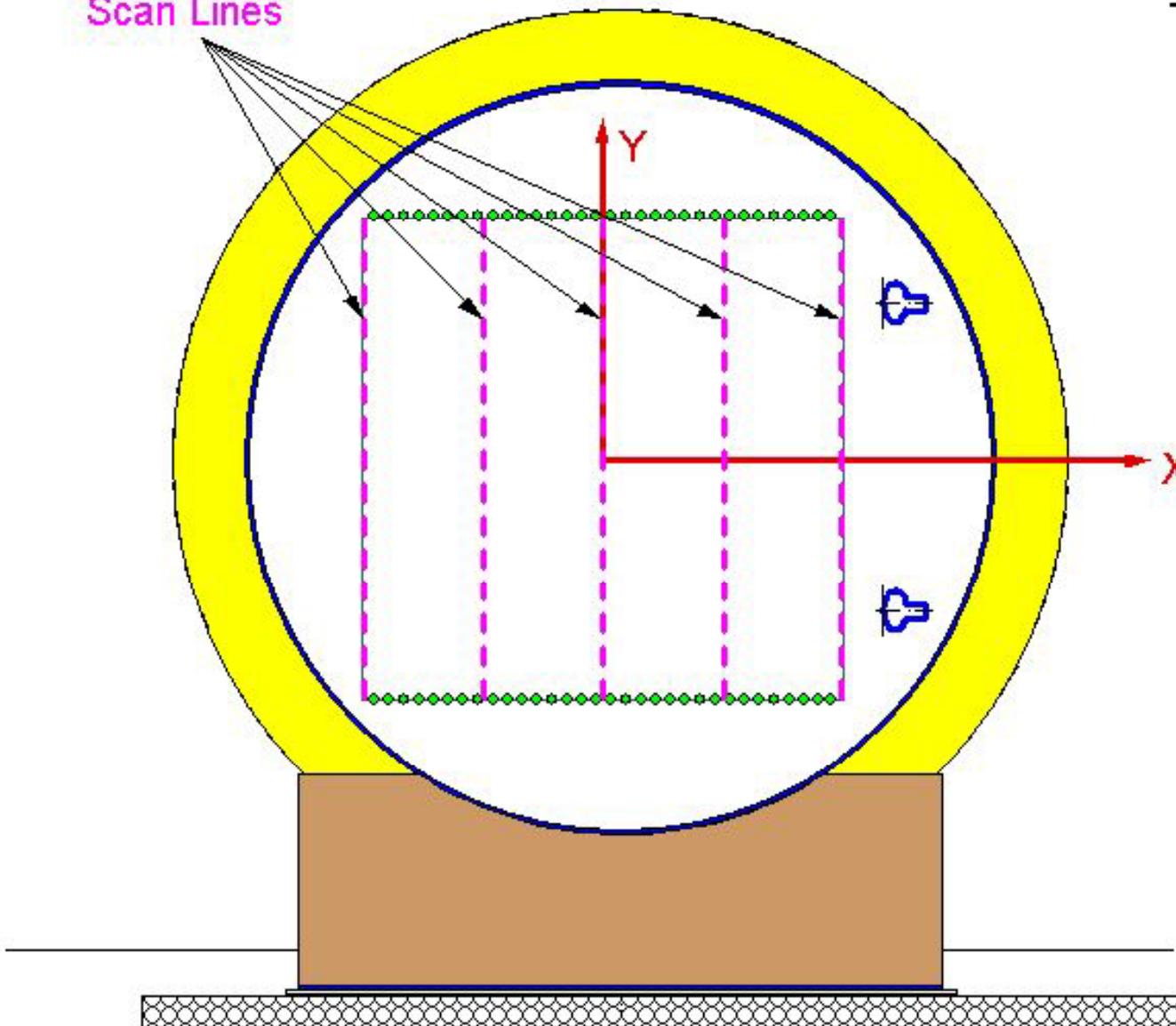
*The light collection near the cathode plane is poorest, hence the curve near the cathode plane is at the bottom in all graphs.*

*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

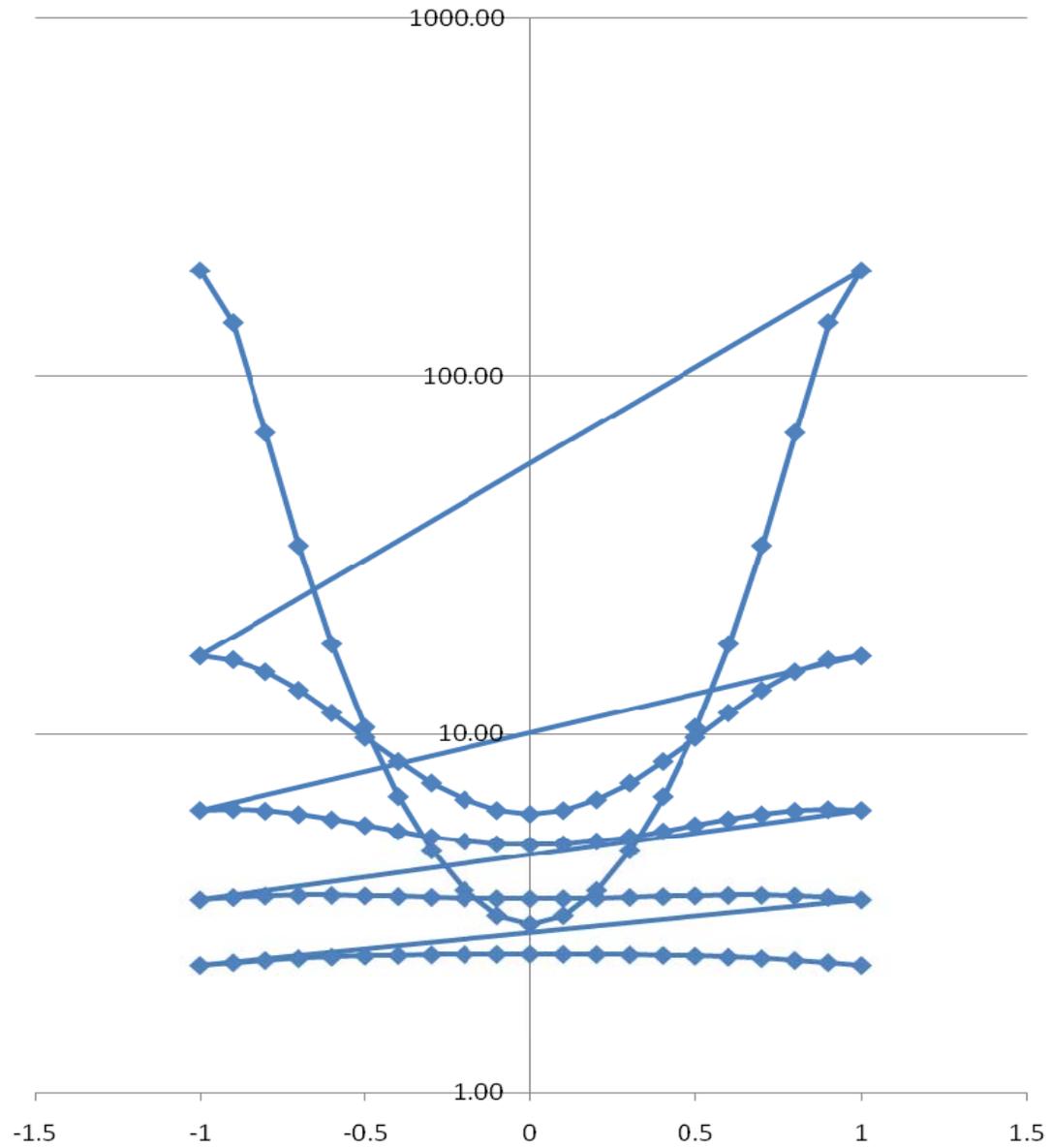
**PMT's at Top and Bottom ( $Y = \pm 1$  m)**

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

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

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

# sum solid angle msr

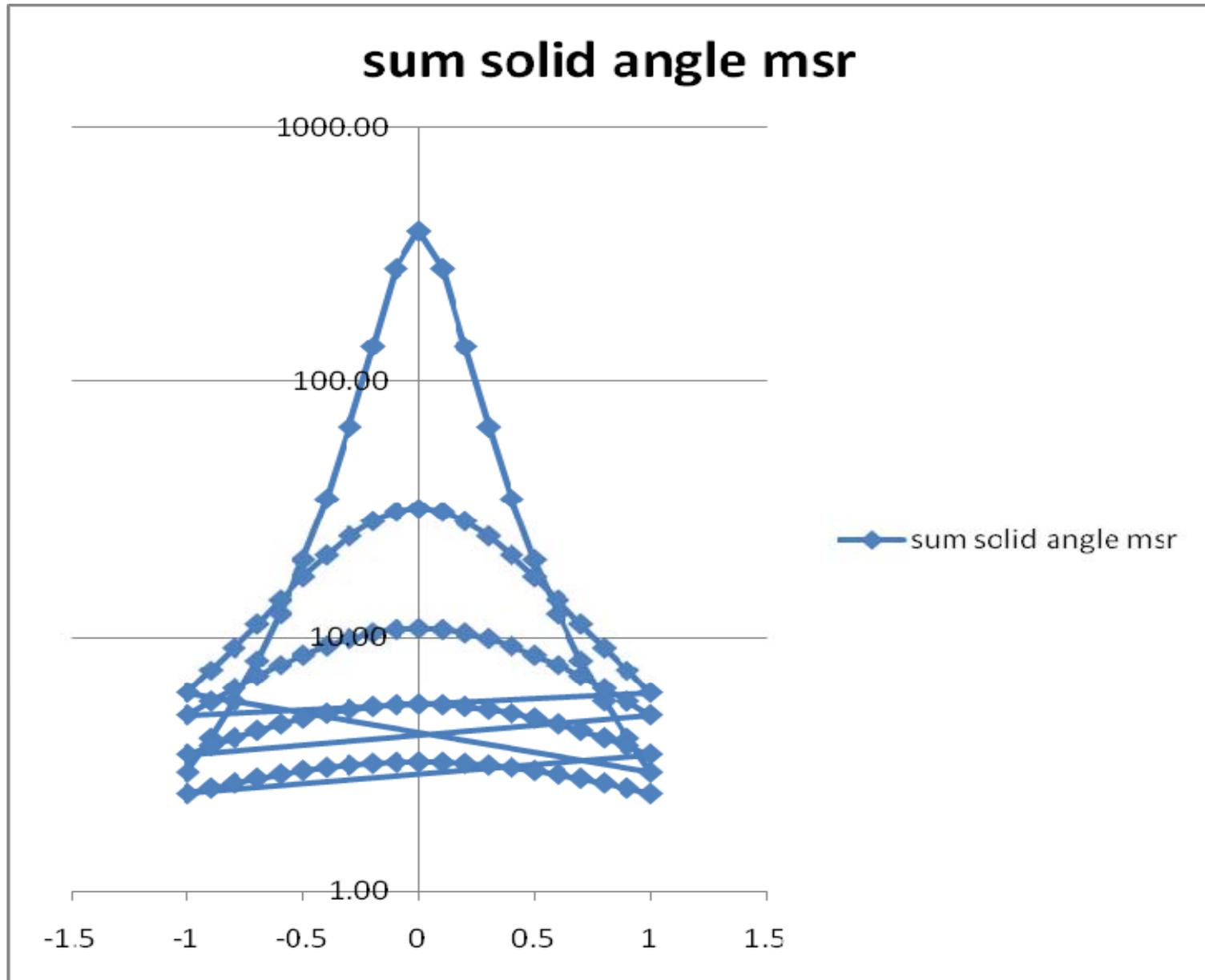


—◆— sum solid angle msr

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

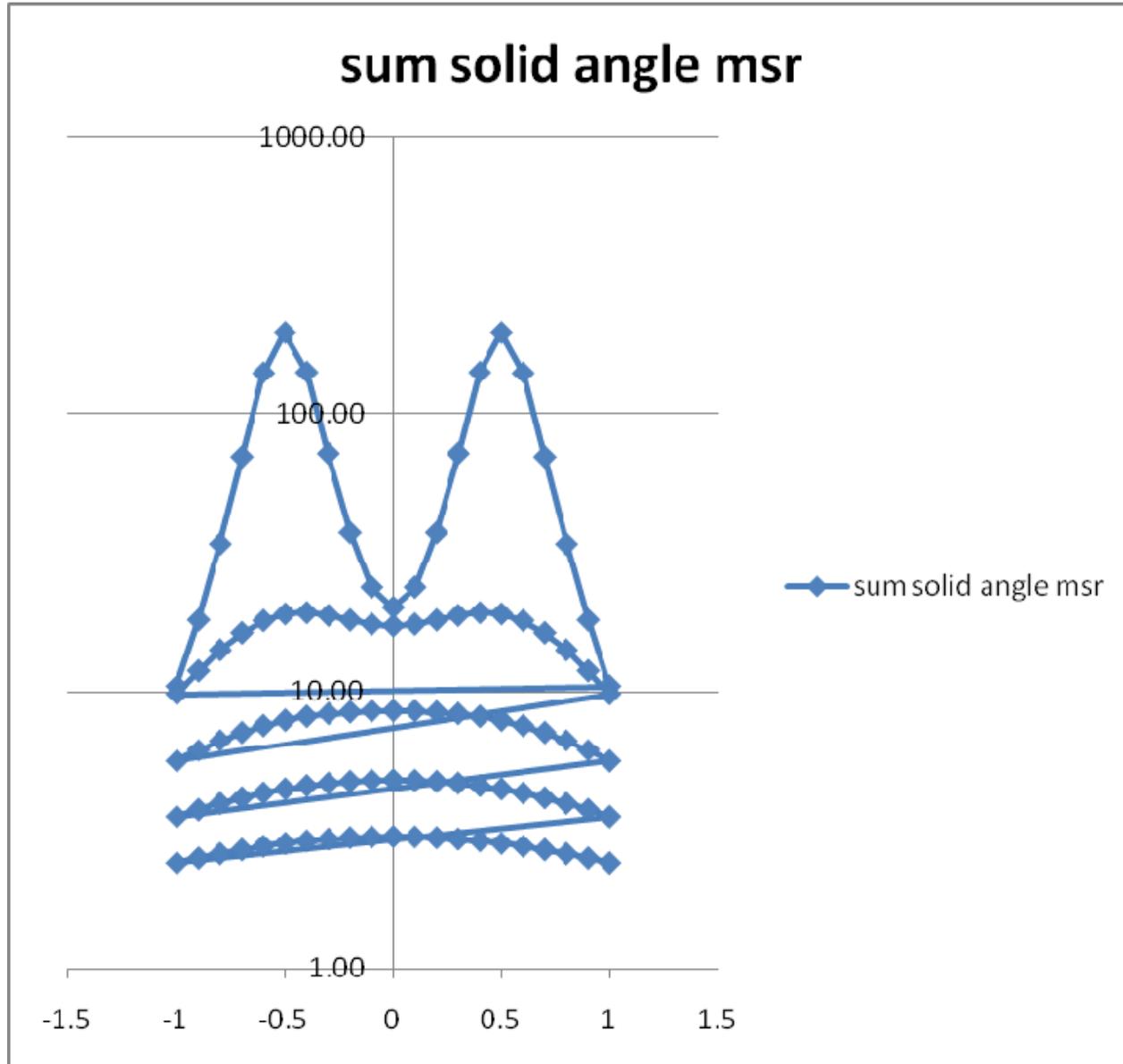
## PMT's all at Mid-Height ( $y=0$ )

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

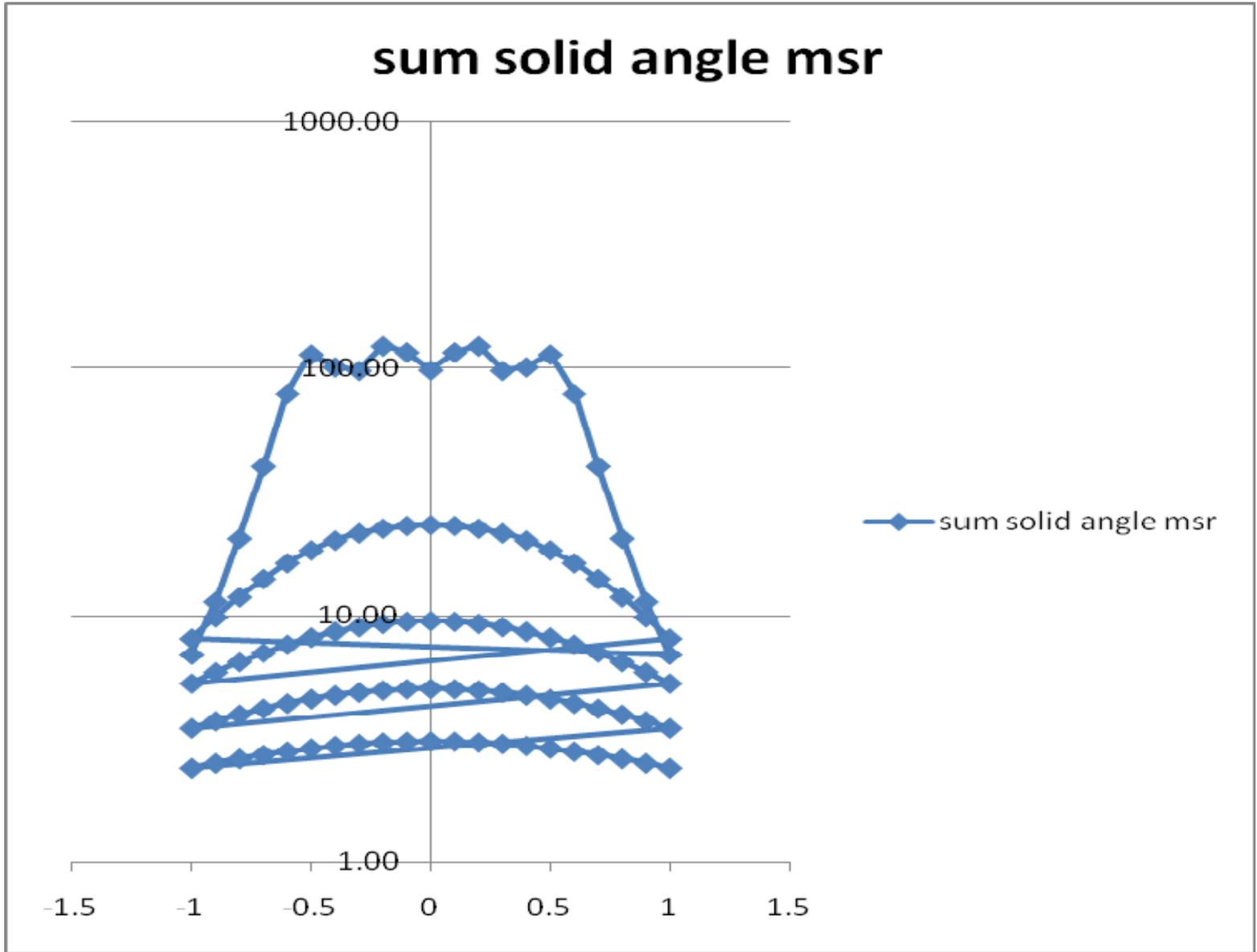


## PMT's at half-heights ( $y = \pm 0.5$ m)

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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