The HPS hodoscope work status

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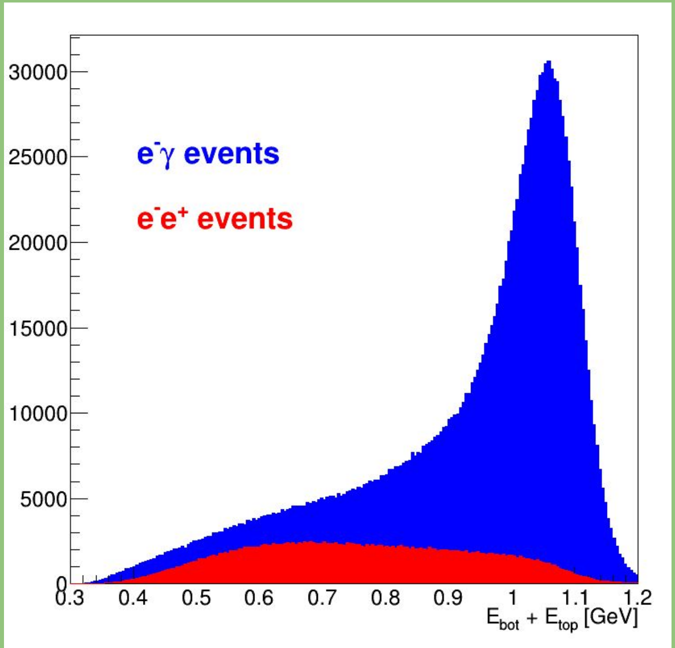
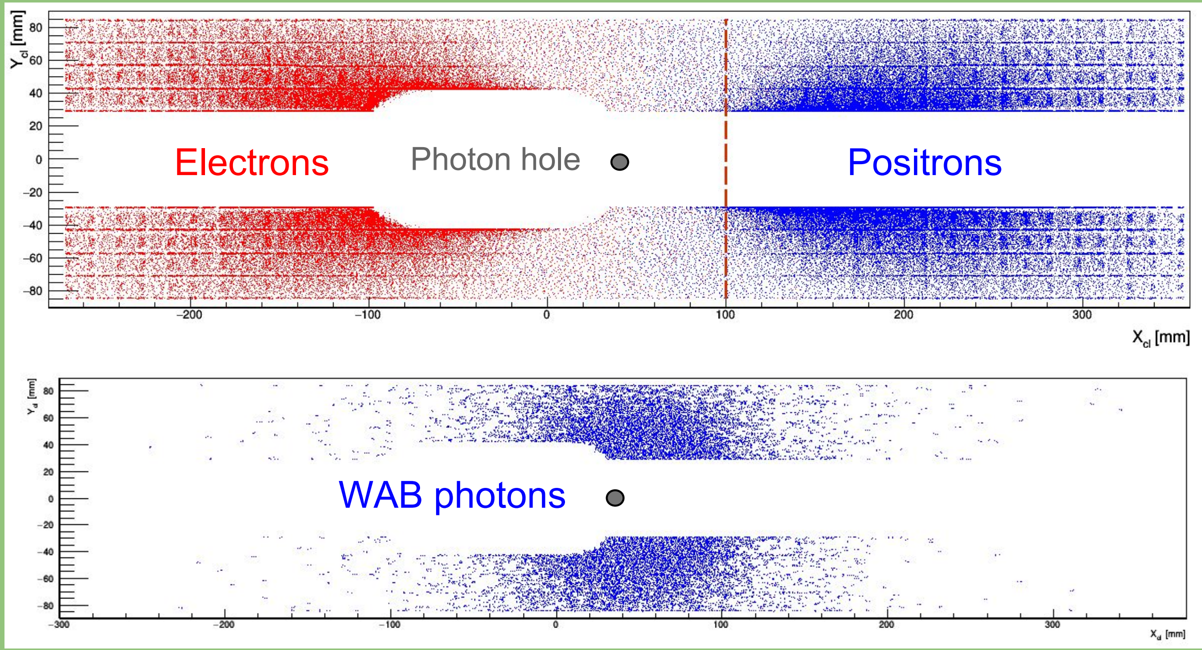
Main trigger in 2015 and 2016 runs

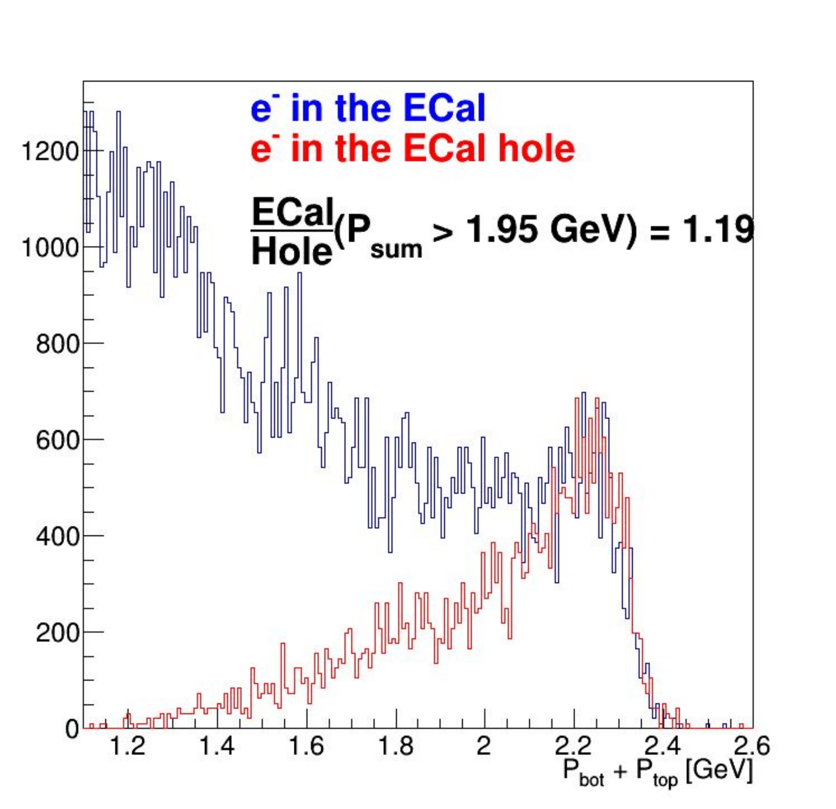
Pair1: Two coincident clusters, one in each detector half, and being coplanar

Tridents, where electrons passes through to the ECal gap, will be lost
Actual e-e+ pairs are only a small fraction of pair1 triggered events, pair1 is dominated by WABs





Events with electron in the ECal hole



≈ Half of events with Esum >0.85 E_b, have electrons escaped through ECal hole

Triggering only on clusters in the positron side will recover these events, however, just the ECal rate on the positron side is quite large (exceeds DAQ capabilities). This large rate dominated by high energy photons from WABs.

Placing a hodoscope before the Calorimeter will help to suppress photons, and bring the rate down to an acceptable level for the DAQ

The conceptual design considerations

A. Cover most (close to 100%) of the “Trident” positrons that will have an electron in the SVT

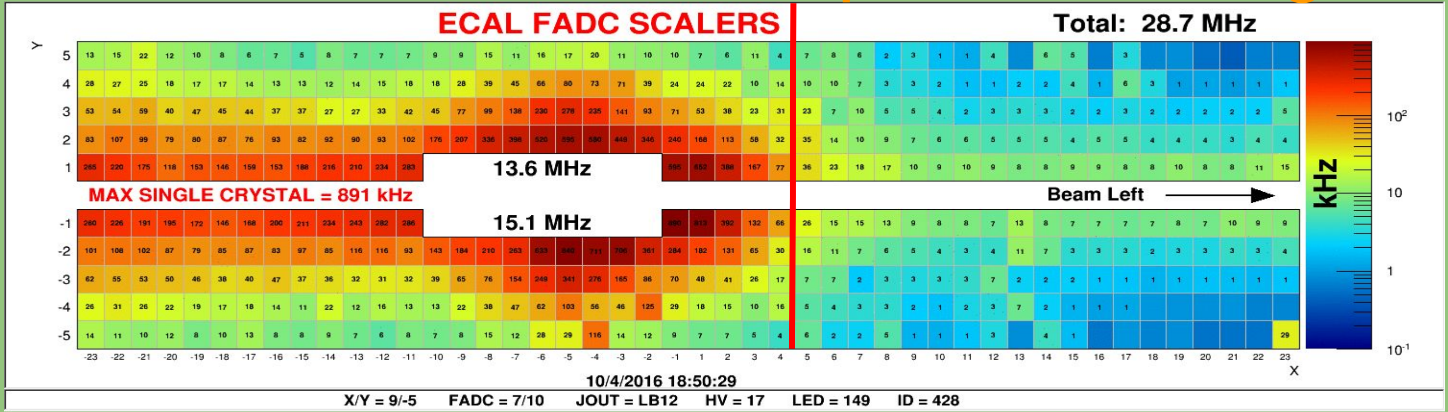
B. Be as compact as possible, without affecting the condition A., to avoid unnecessary rates

C. Keep rate in individual pixels below 200 kHz

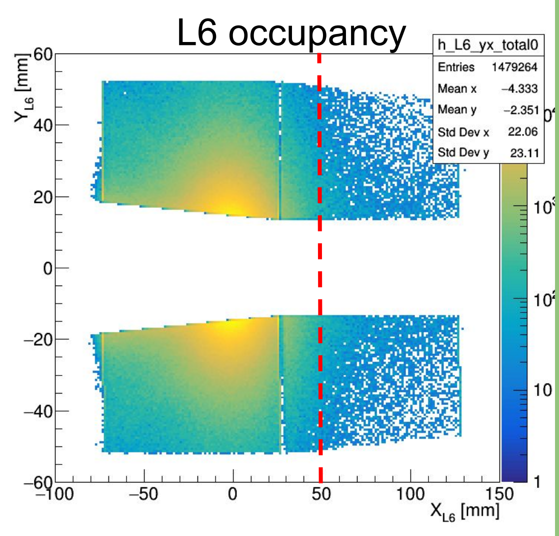
D. Not to be too close to EC, to avoid back splash from the EC

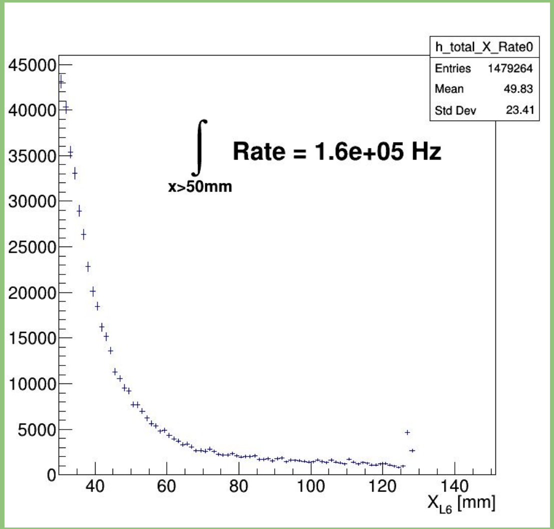
Initial studies were started by looking into MC simulations and already taken data
from 2015 and 2016 Runs and

Estimate of occupancies using data



Few 100 of KHz
On ECal





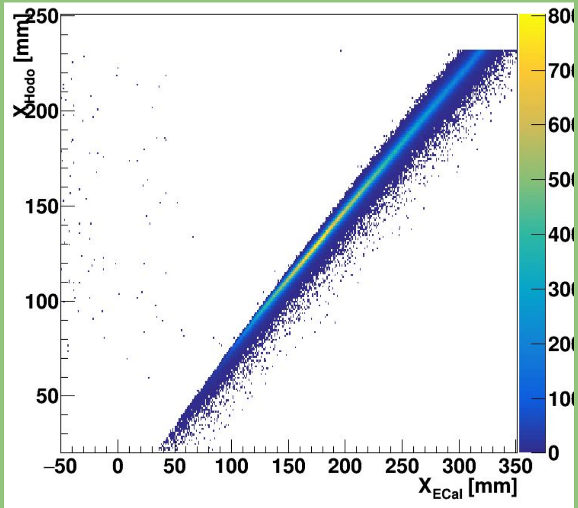
As a proxy to Hodo rate, L6 3D hits were used

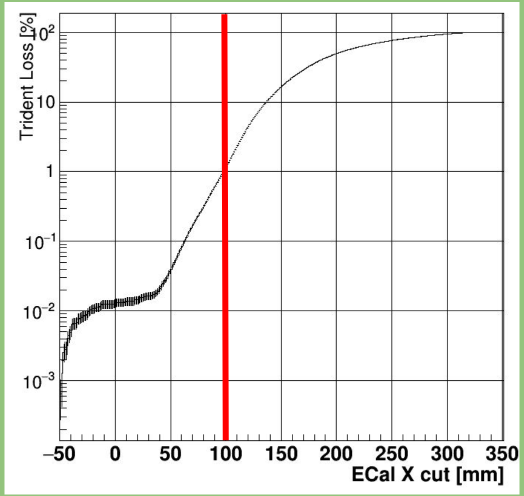
Top and Bottom together gives 160 KHz in the positron region.

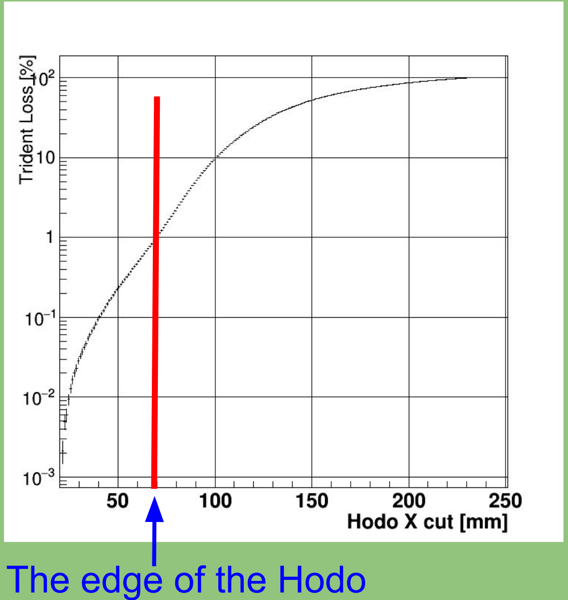
In terms of readout these are quite tolerable rates for PMTs

Hodoscope dimensions

Trident simulations



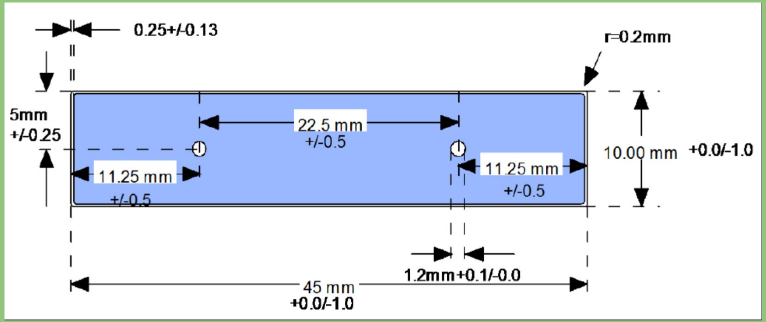


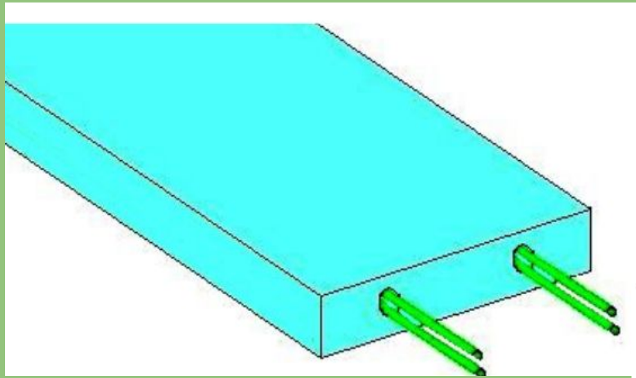


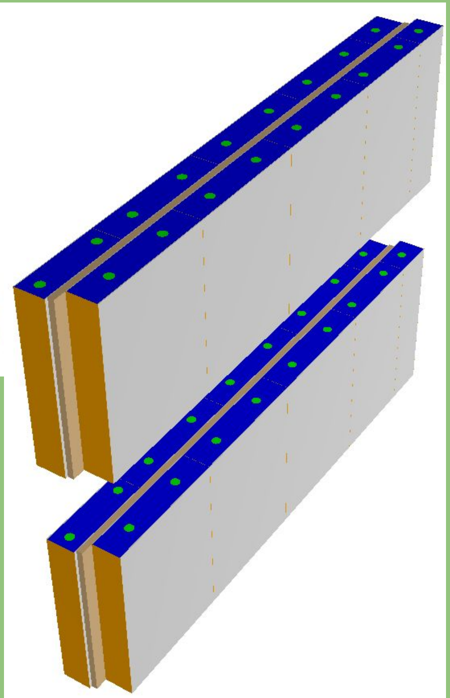
A clear correlation between the hodo coordinates and ECal coordinates

Triggering as a coincidence of hodo hit and ECal cluster > 100, will keep 98-99% of tridents

Hodo dimensions and materials



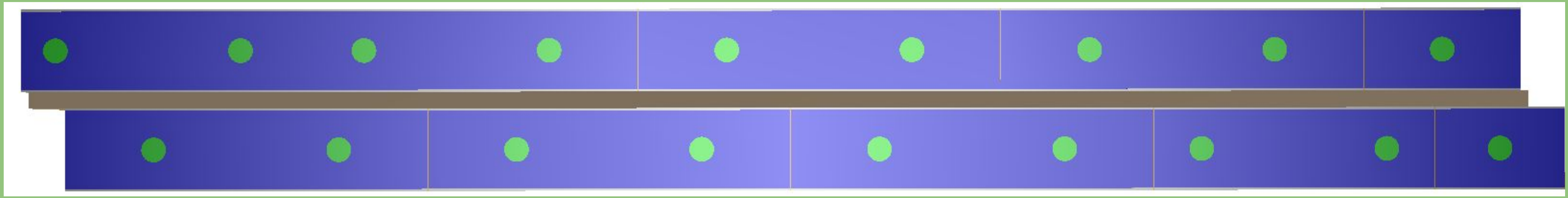




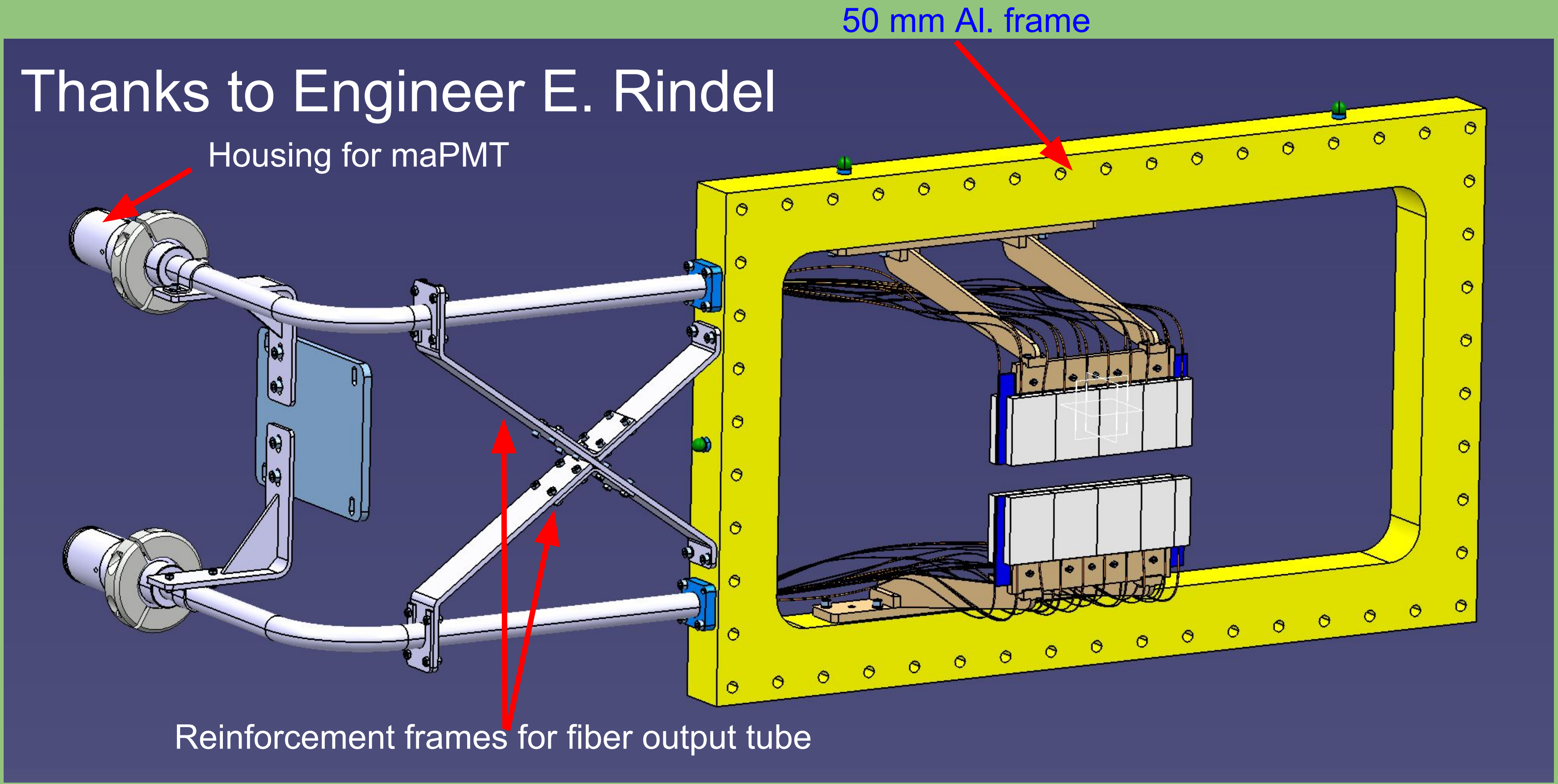
There are enough scintillator and fiber left overs from the CLAS12 PCal project to build the hodoscope (including all kinds of prototyping)

Extruded scintillators with two hole and TiO2 coating
Kuraray Y11 multi-clad 1mm diameter wavelength shifting fibers
Hodoscope design: two layers to reduce the accidental background from the Vacuum chamber walls.

182.2 mm



Engineering design

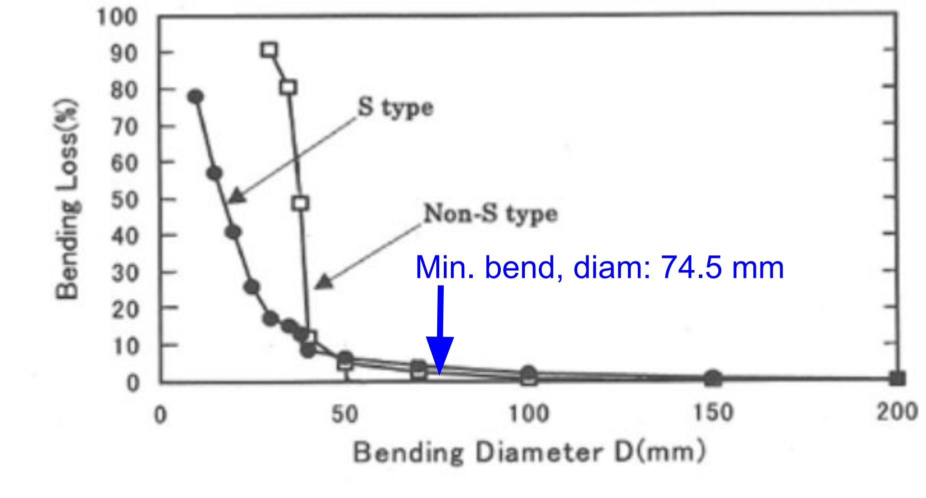


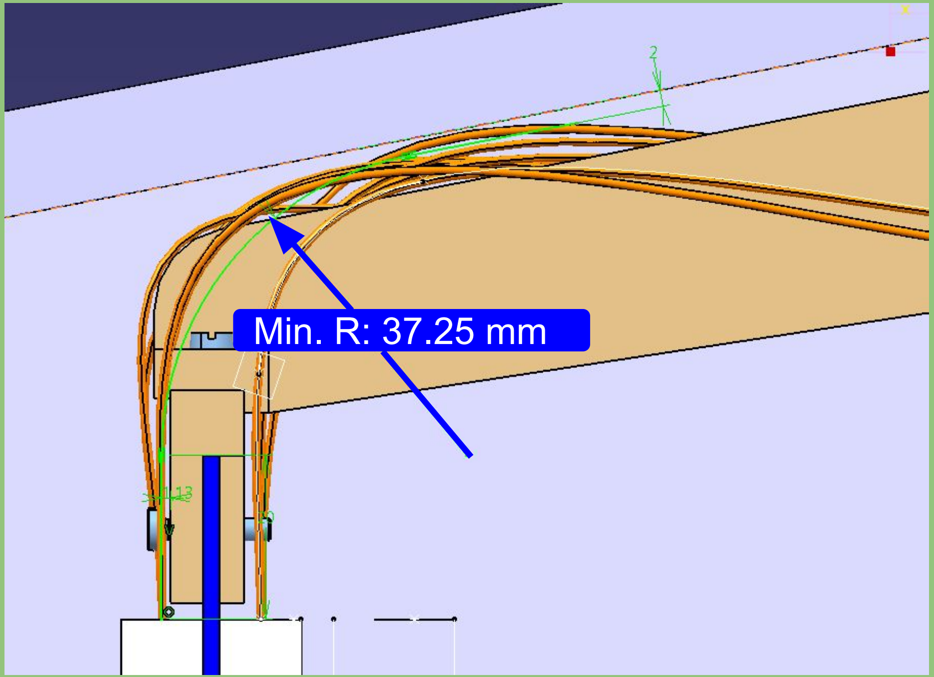
Light loss because of fiber bending

Due to limited workspace, from scintillator tile to PMT, fibers should be bent.
The minimum bending diameter is 74.5 mm (R=37.25 mm)

The light loss because of fiber bending is not expected to be more than few %

This loss also is planned be measured during the prototyping in EEL building

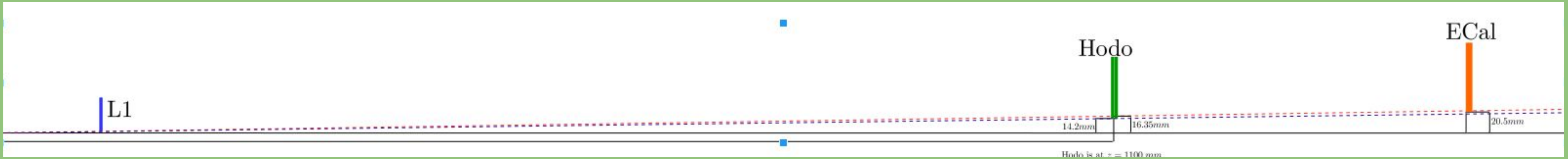


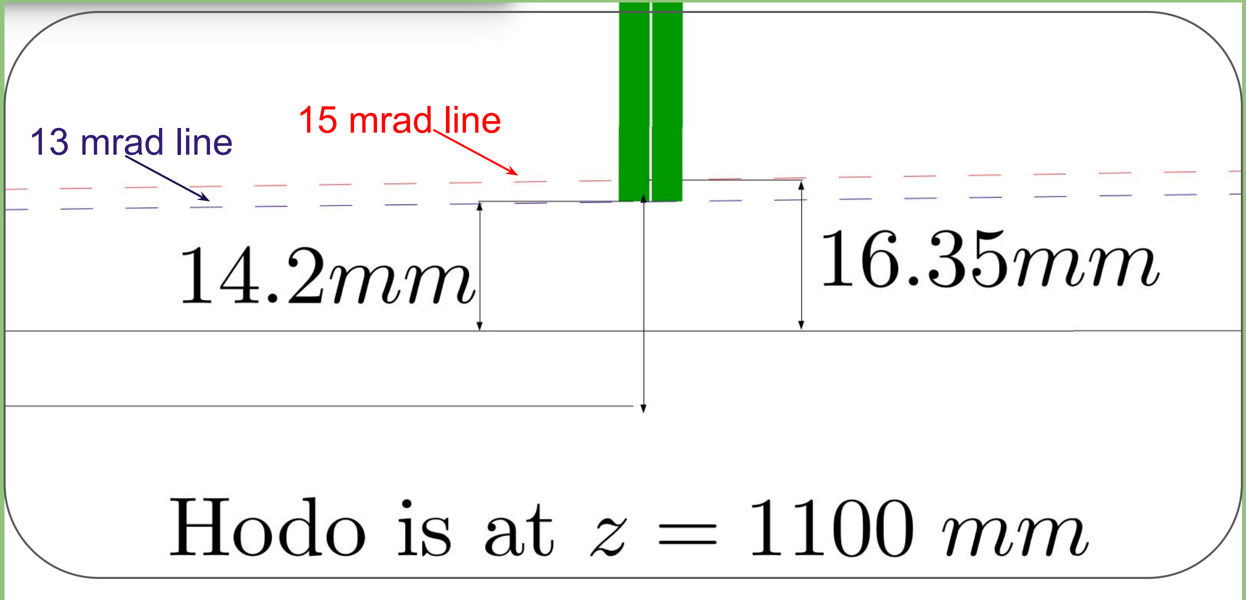


Vertical positioning of the Hodo

The hodoscope vertically will be placed in a way, to make sure that it covers the SVT and ECal

With the current plan Hodo starts from 13 mrad which is 2mm closer to the beam at the presumed position of the hodoscope than the 15mrad

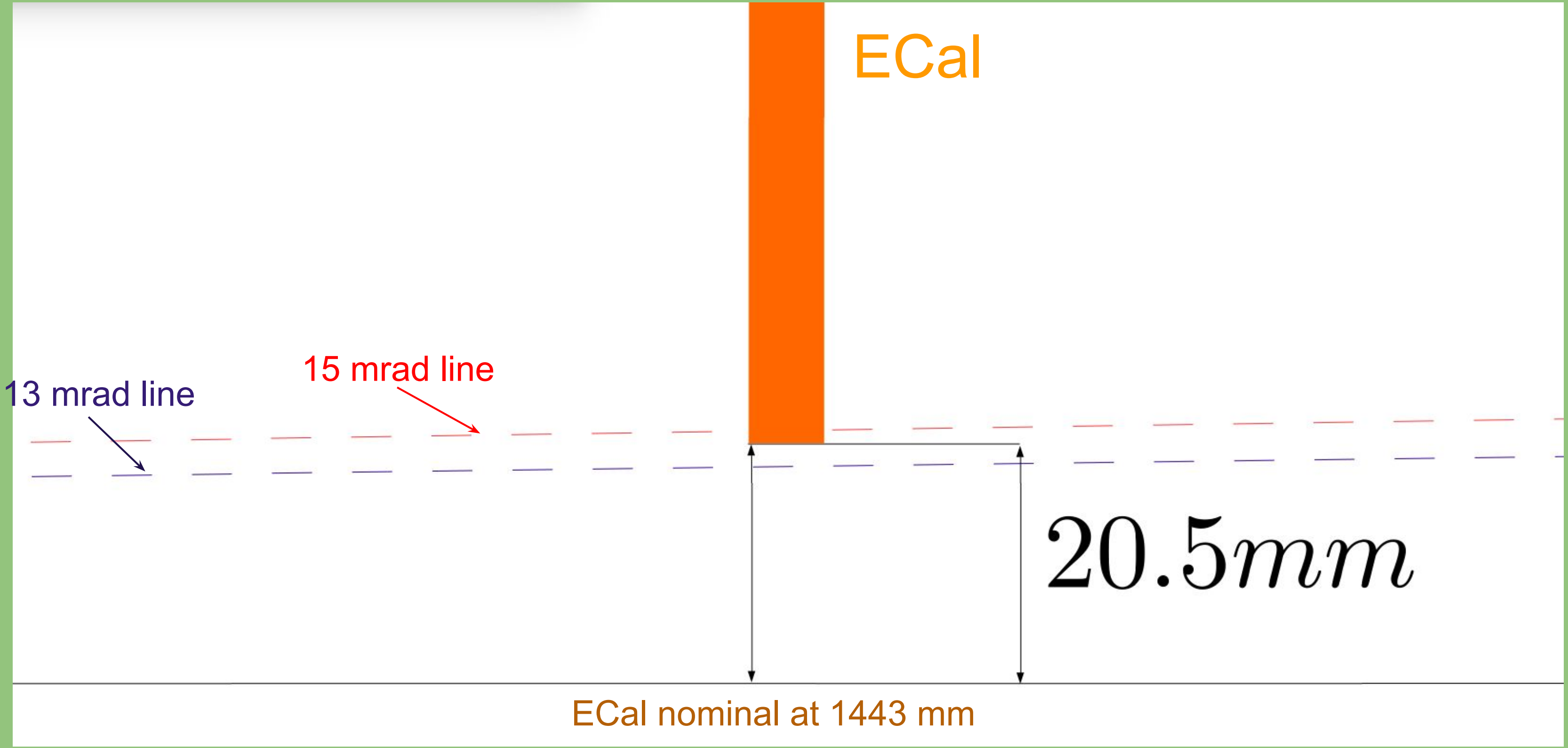




Vertical positioning of the Hodo

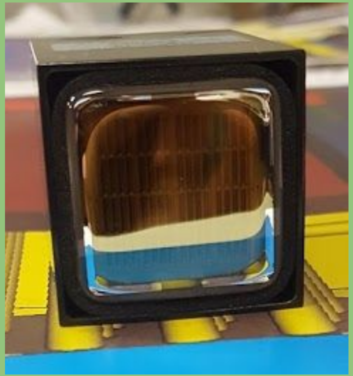
Mounting the hodoscope requires moving the ECal downstream by ~50mm.

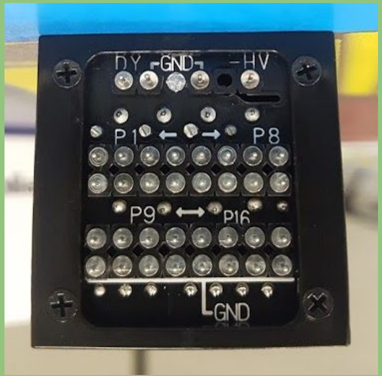
Moving 50 mm downstream, ECal nominal angle will become 14.2 mrad



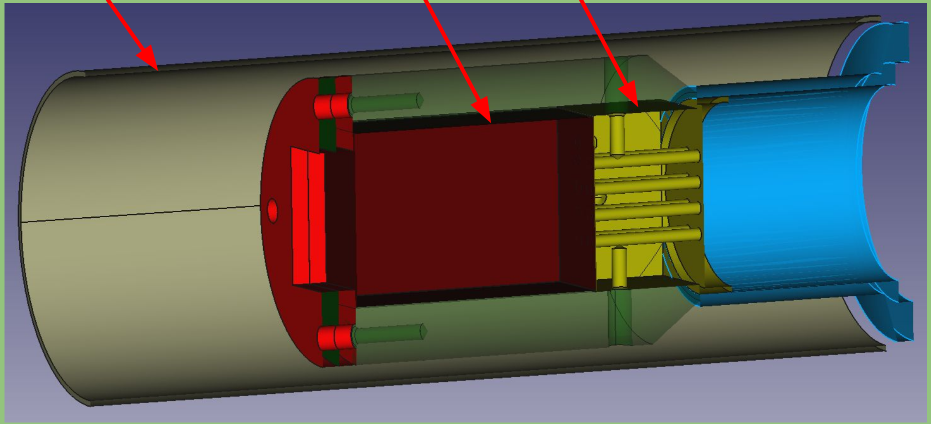
PMT and the housing

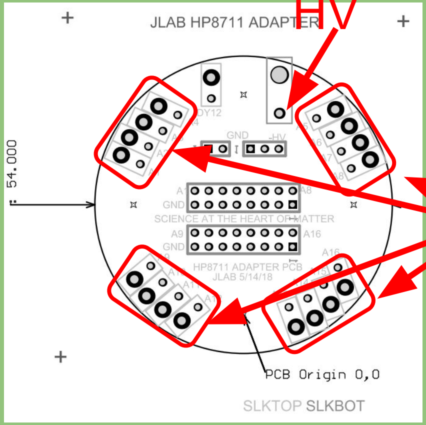
PMT H8711-10, 16 channel Hamamatsu multi anode PMT

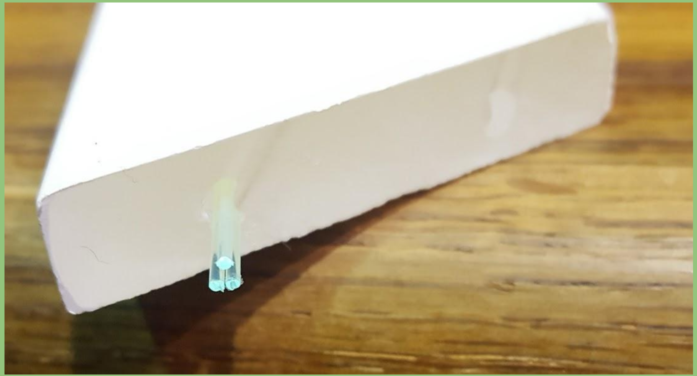


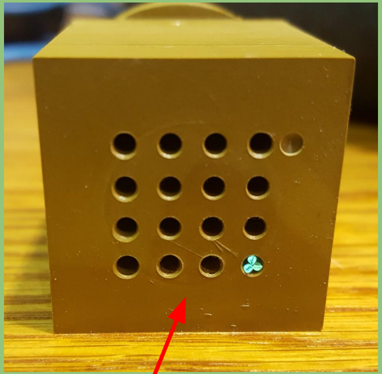


The PMT order is placed!



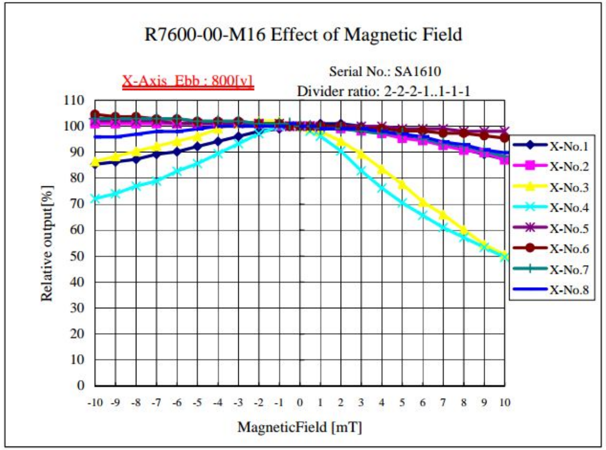


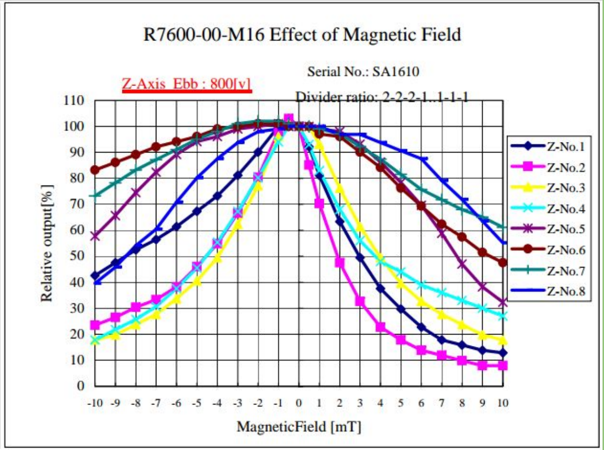


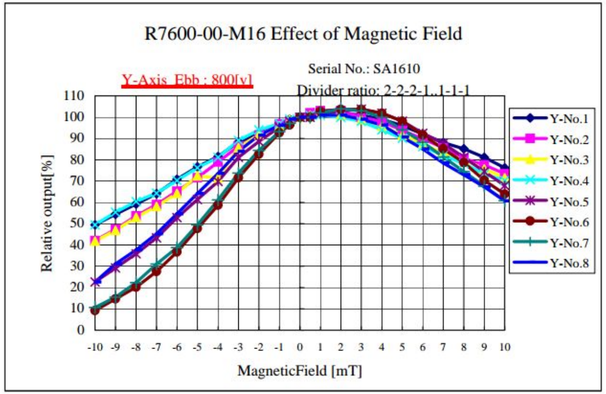


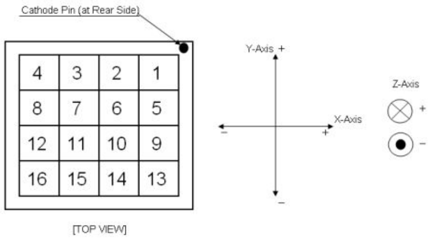
Effect of the magnetic field to the PMT

The most dramatic effect induces the z component of the field









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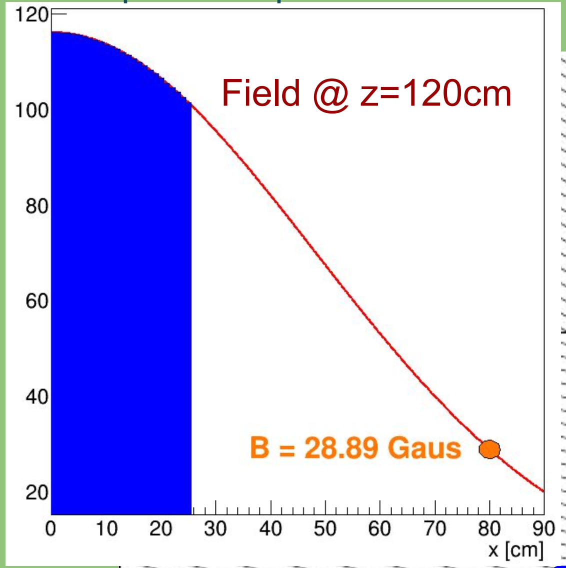
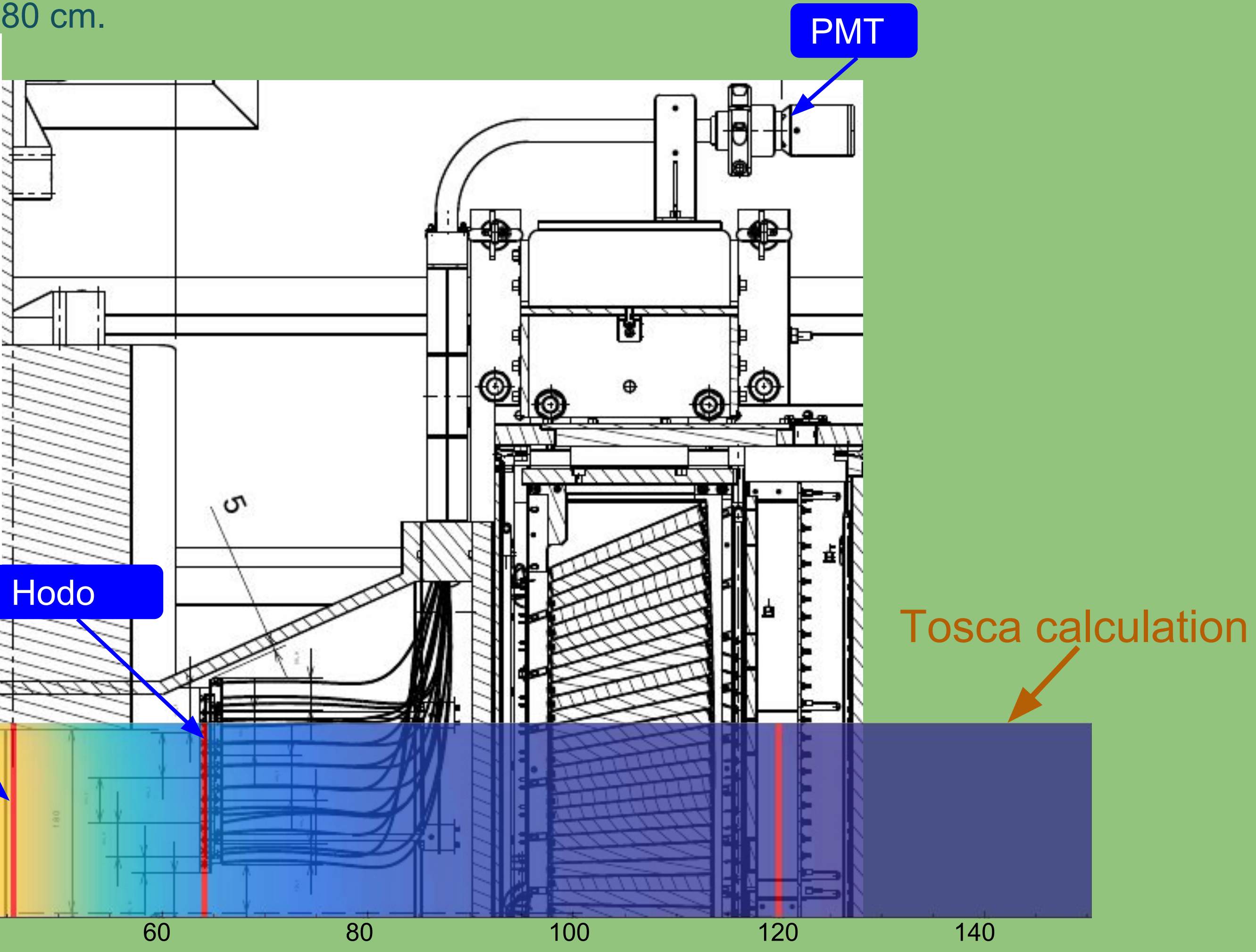
Even 10 Gaus “Z” field can reduce the gain by 30%

The mildest effect will induce field parallel to the “X” of PMT.

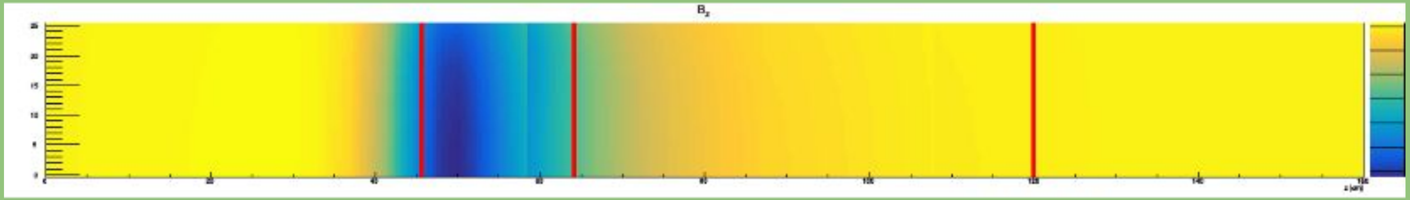
PMT X axis will be placed parallel to the Lab Frame “Y” axis

In the calculated area, field is a Gaussian function of x.
Extrapolated up to the PMT x = 80 cm.



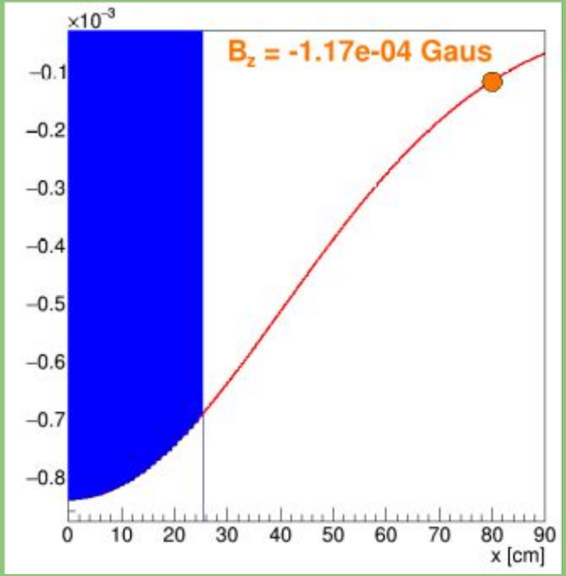


Z component of the field



Z of PMT

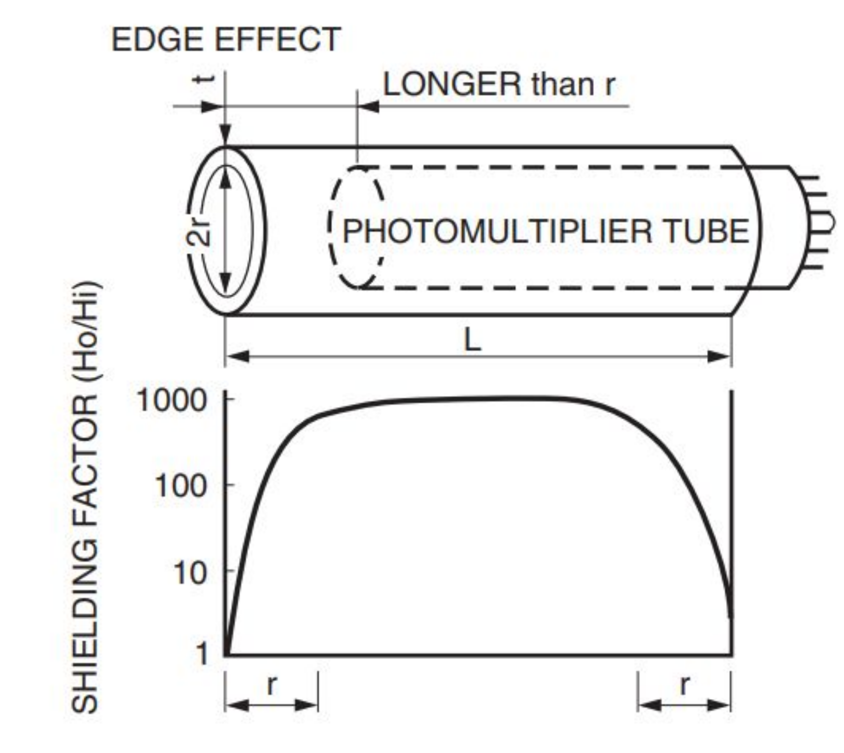
Extrapolated to PMT position



The most sensitive component of the field is the "Z" component (parallel to PMT axis)

The extrapolated magnetic field at PMT location is too small.

Expected reduction of the magnetic field



Expected Magnetic field inside the mu-metal shield is calculated

$$H_{in} = H_{out}\frac{4r}{3\mu t}$$

Material	Ad-Mu 80
μ Permeability at 40 Gaus:	55.000 - 75.000
R (Inner diameter)	60 mm
t (thickness)	1 mm

Earth magnetic field ranges from 0.25 - 0.65 Gaus

$$H_{in} = H_{out}\frac{4r}{3\mu t} = 30[\mathrm{Gaus}]\frac{4 \cdot 60[mm]}{3 \cdot 55000 \cdot 1[mm]} = 0.04\ \mathrm{Gaus}$$

The Hodoscope support @ Orsay

Special thanks to R. Emmanuel and R. Dupre

The hodoscope support is ready, and will be shipped to JLab soon

The work schedule, milestones

The conceptual design is finalized	Aug 2018
The engineering design is finalized	Nov 2018, approved Dec 2018
Optical glues are purchased	Summer 2017
PMTs are ordered	Arrival end of June
Hodo support is ready	Arrival end of May/Early June
DarkBox/Electronics/DAQ	Almost ready at EEL building
Testing light loss vs bending radius	June - July 2018
Machining of strips	End of June 2018
Other parts: PCB/housing/shielding	July 2018
Prototyping	July - August 2018
All parts are ready -> start assembly	September - October 2018
Should be ready	November 2018