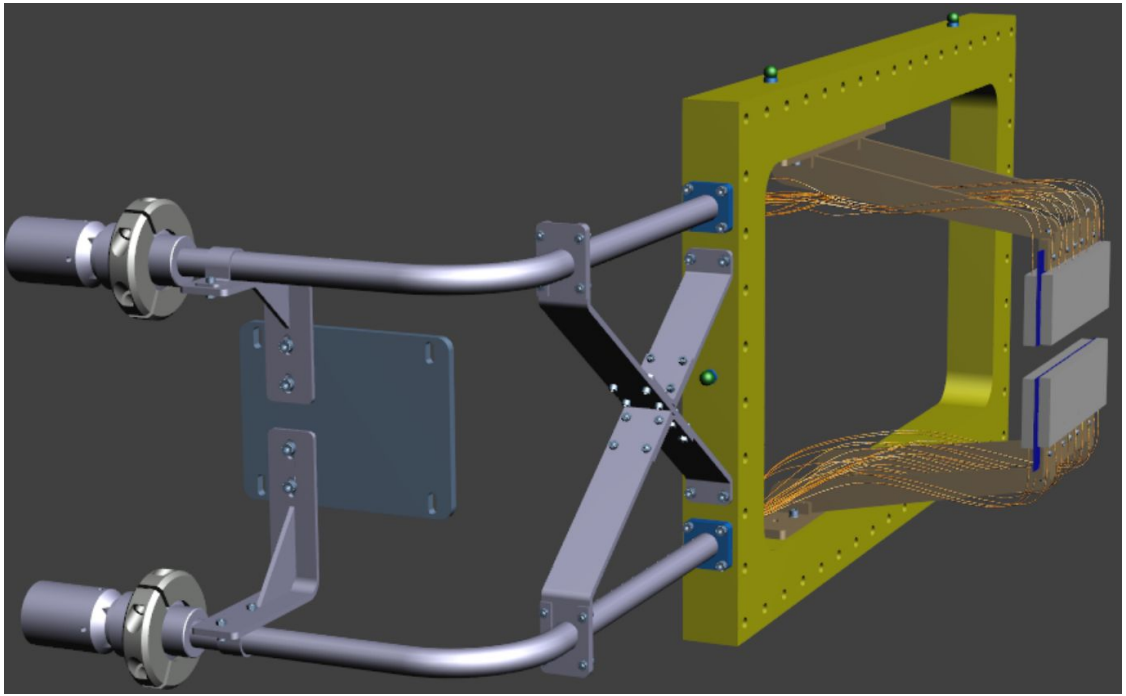
Design of the Hodoscope for the HPS experiment

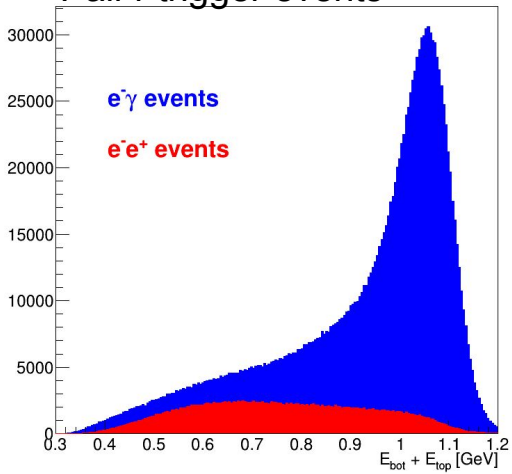


Rafayel Paremuzyan

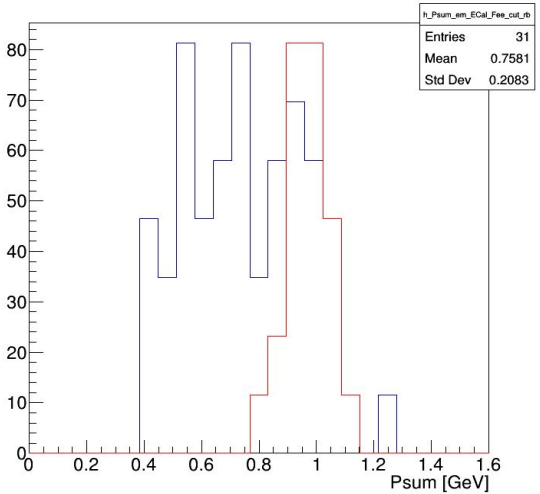
HPS Upgrade review by EC : 18 Dec 2017

Introduction

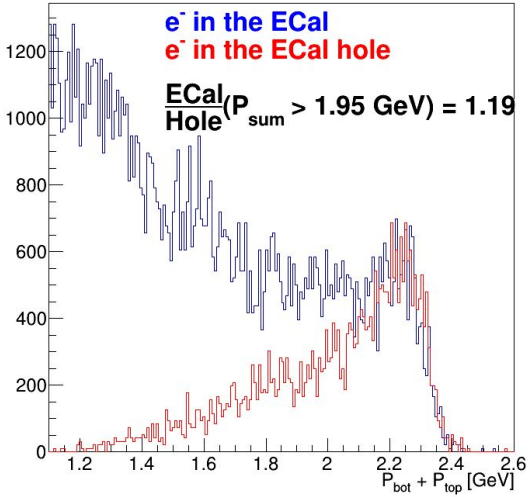
"2-cluster energy sum for Pair1 trigger events



2015 data pusler Run



2.3 GeV MC



Analysis of data from 2015 and 2016 runs showed that we have quite high rate from WABs from the pair1 trigger.

In the high ESum region about x2 of trident electrons enter into the ECal hole, and hence pair1 doesn't pick them

Revising the the current pair1 trigger seems to be a good thing to do

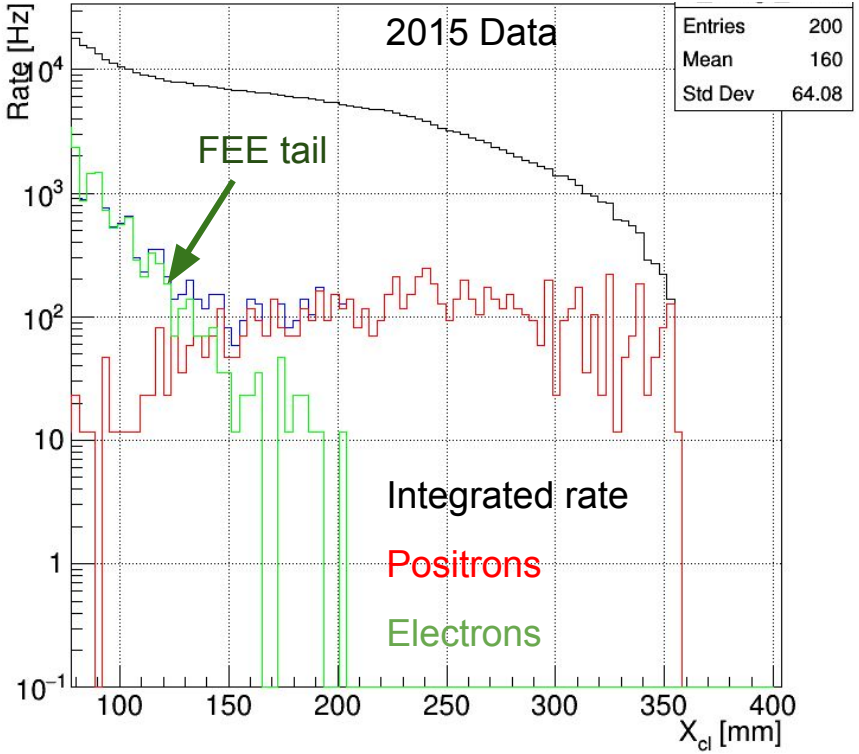
Study with a random trigger data

On the ECal face positrons are populated in the x > 100 region

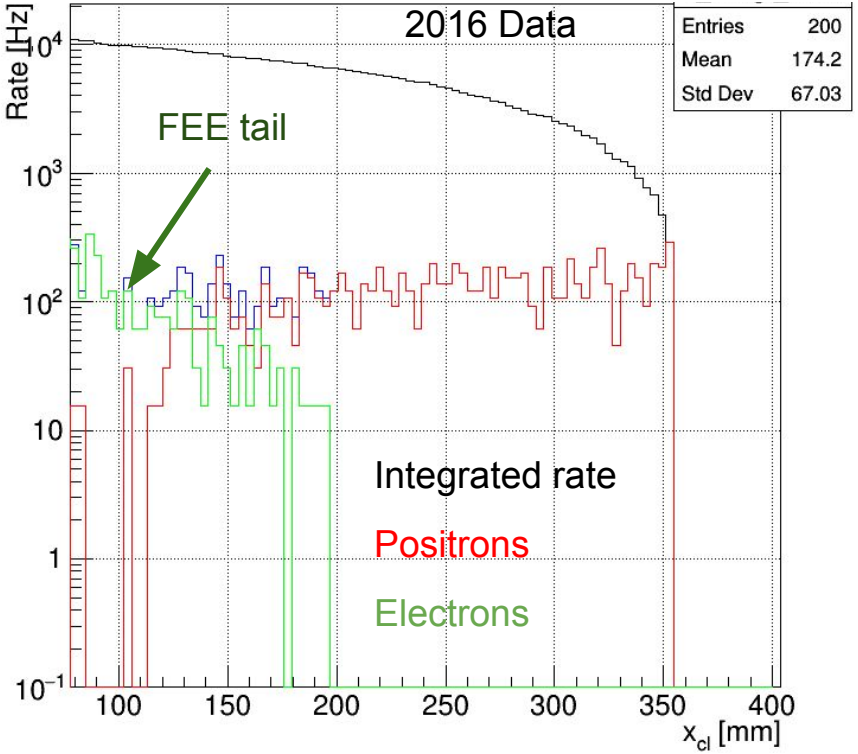
On the positron side, just the rate of tracks is about 10 kHz

This fact prompted to think about triggering on charged particle in the positron region

Rate of tracks matched with clusters



Rate of tracks matched with clusters



The conceptual design considerations

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

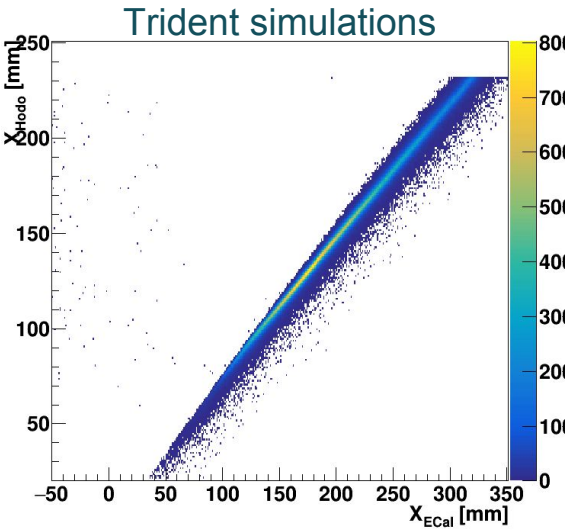
B. Be as compact as possible, without affecting the condition A., to avoid unnecessary rates

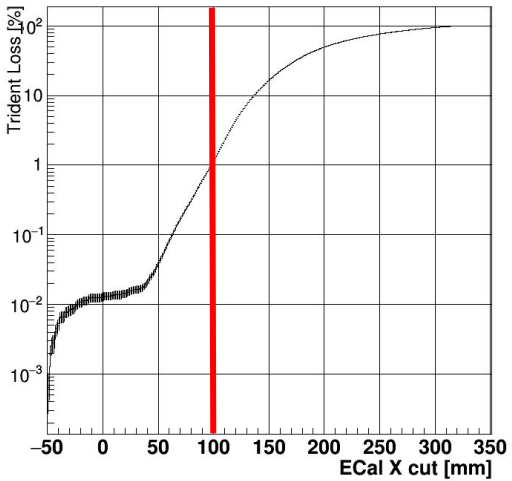
C. Keep rate in individual pixels below 200 kHz

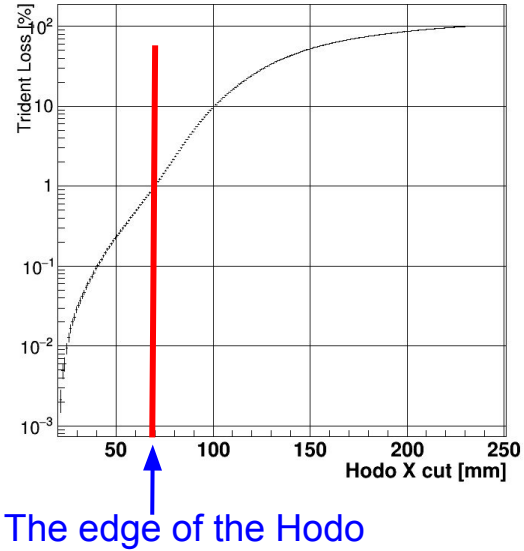
D. Not to be too close to EC, to avoid back splash from the EC

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

Hodoscope dimensions







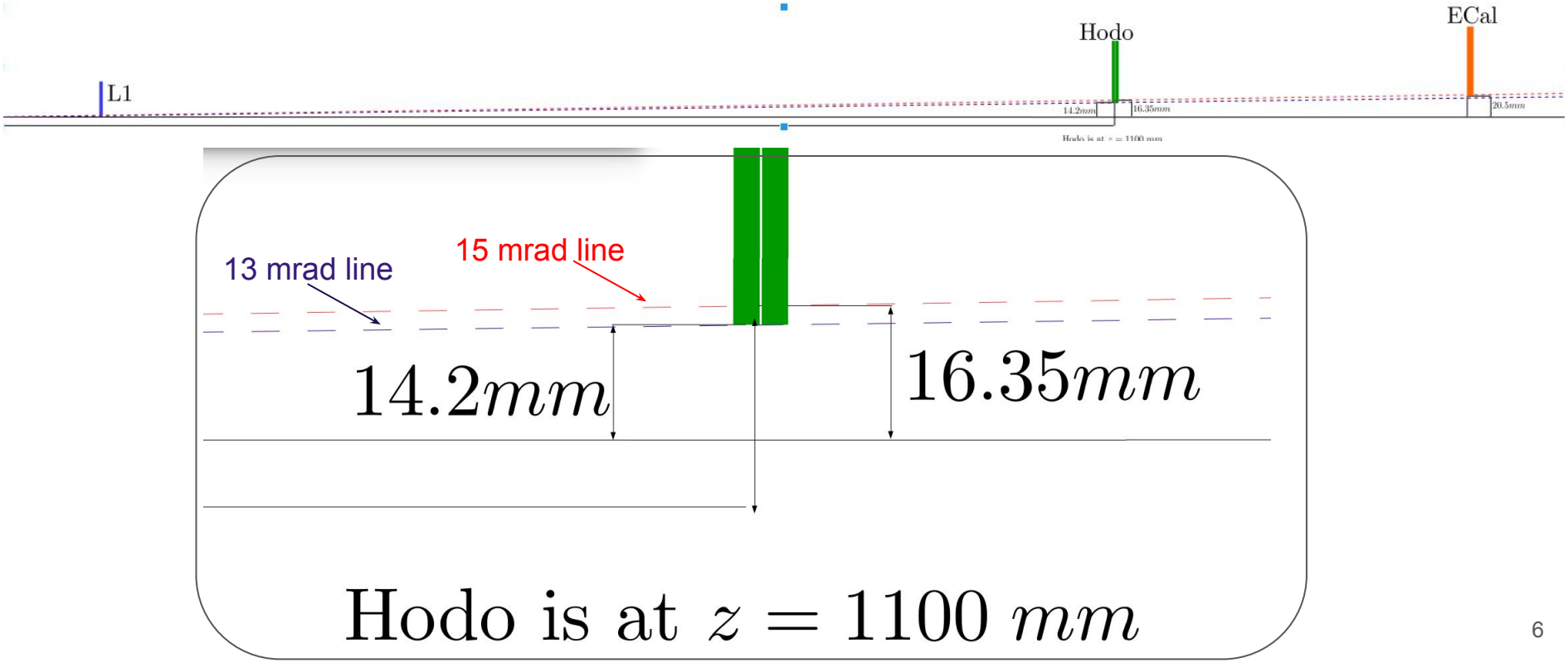
A clear correlation between the hodo coordinates and ECal coordinates

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

Vertical positioning of the Hodo

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

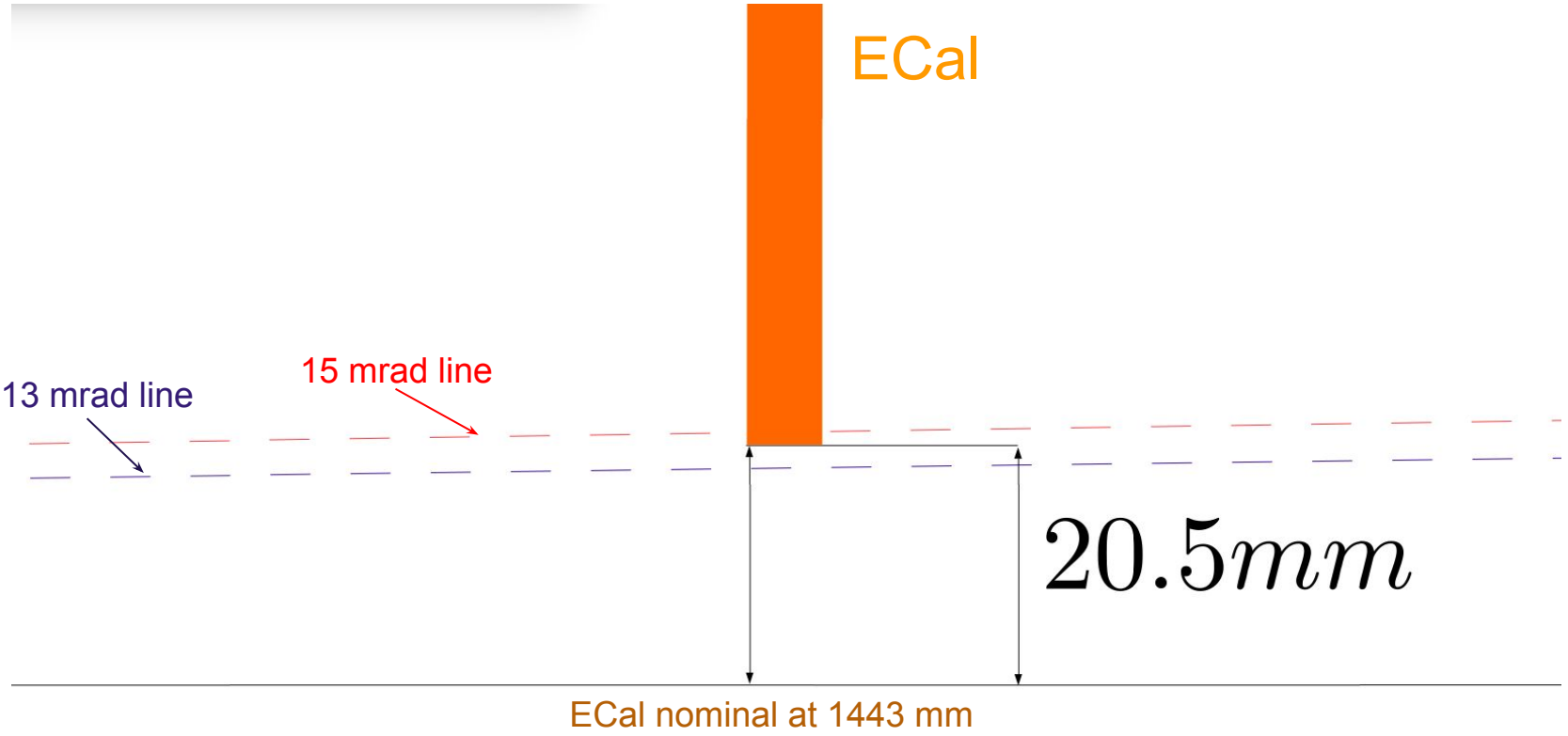
With the current plan Hodo starts from 13 mrad which is 2mm closer to the beam at the presumed position of the hodoscope than the 15mrad



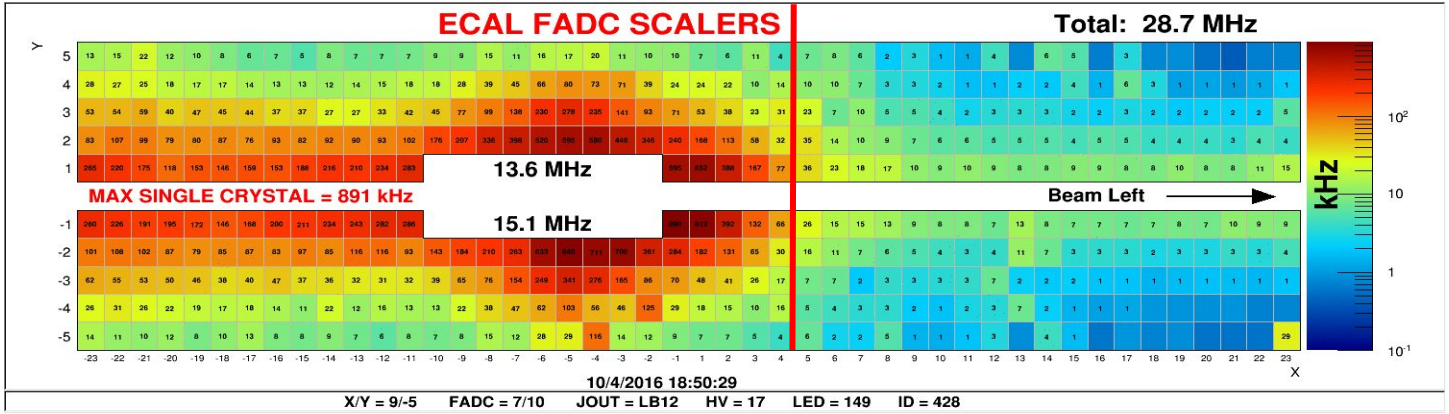
Vertical positioning of the Hodo

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

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

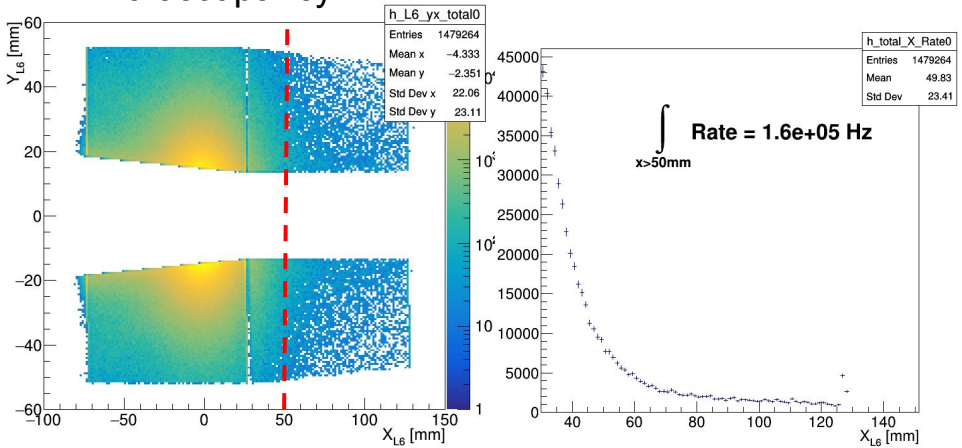


Estimate of occupancies using data



Singles rates in ECal on the positron side are few 100 kHz

L6 occupancy



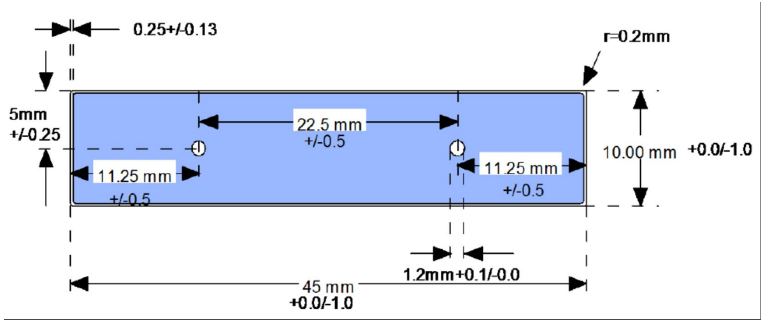
As a proxy to Hodo rate, L6 3D hits were used

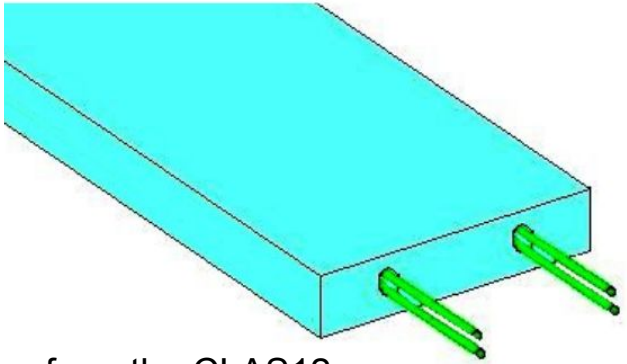
Top and Bottom together gives 160 of kHz in the positron region.

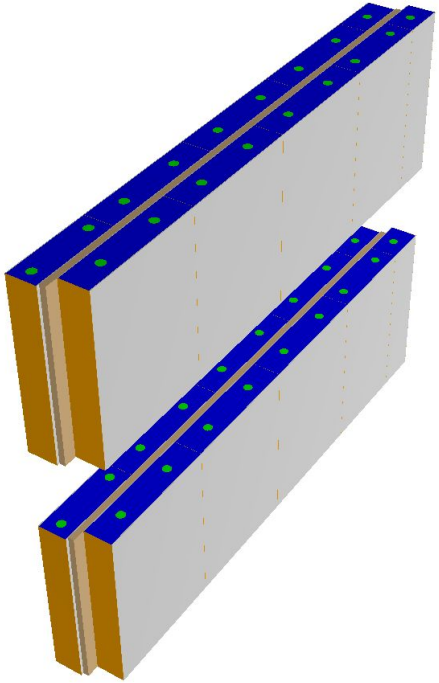
In terms of readout these are quite tolerable rates for PMTs

The conclusion is, any pixelation will be ok in terms of readout

Hodo dimensions and materials



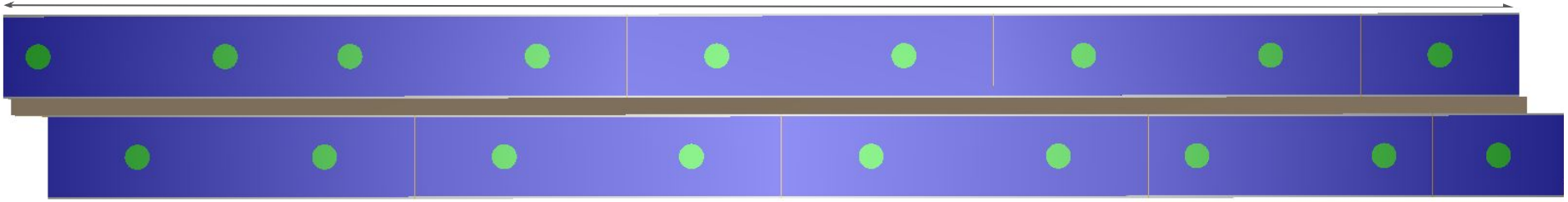




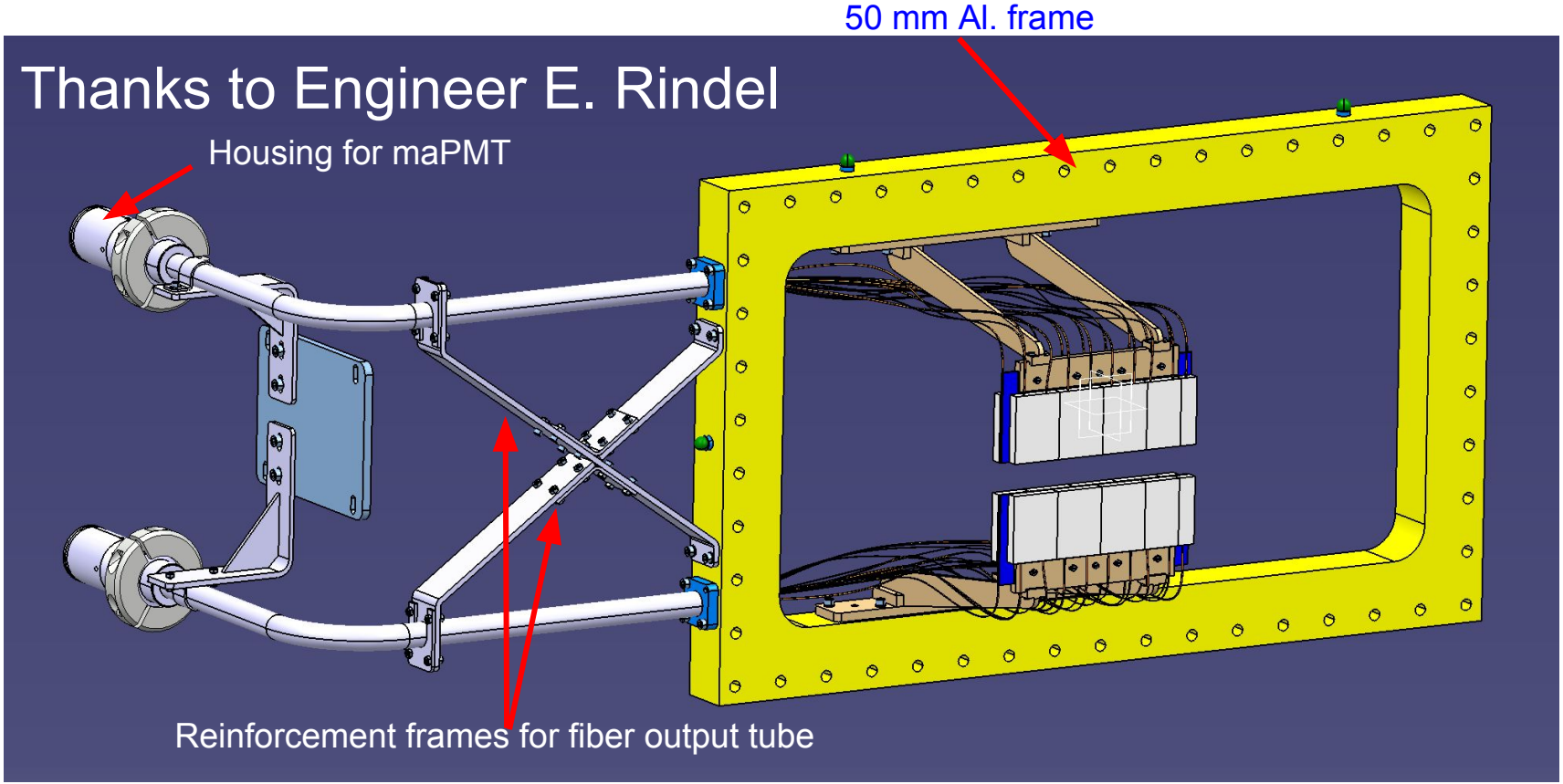
There are enough scintillator and fiber left overs from the CLAS12 PCal project to build the hodoscope (including all kinds of prototyping)

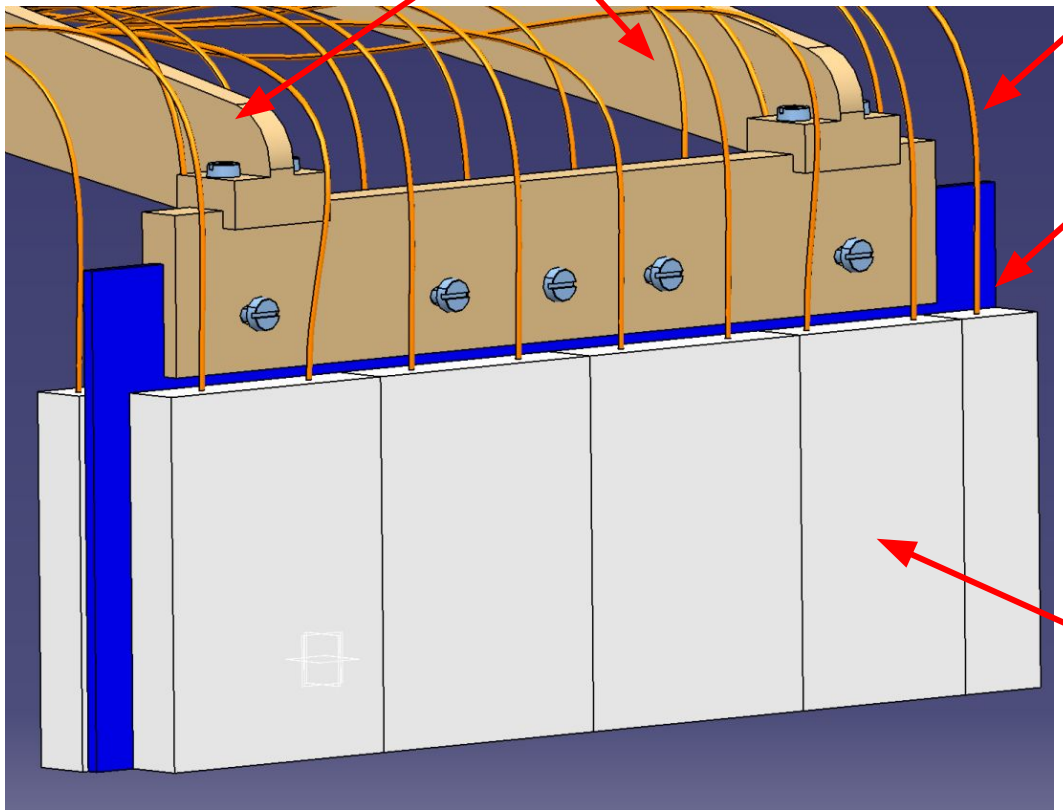
Extruded scintillators with two hole and TiO2 coating
Kuraray Y11 multi-clad 1mm diameter wavelength shifting fibers
Proposed hodoscope design: two layers to reduce the accidental background from the Vacuum chamber walls.

182.2 mm

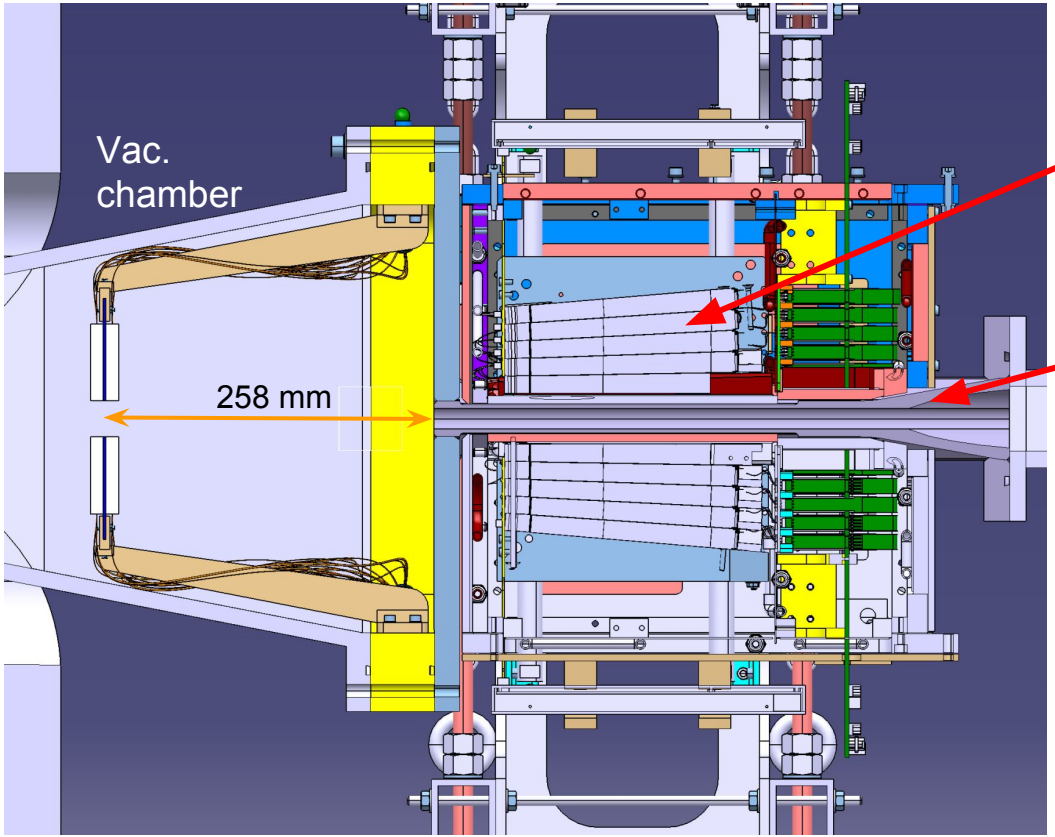


Engineering design



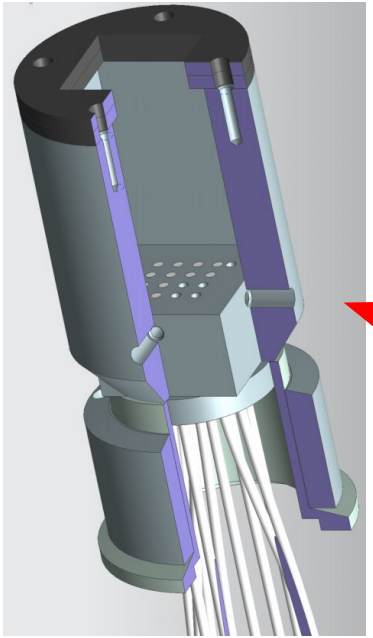

Epoxy glass support arms
Kuraray Y11 wavelength shifting fibers 1 mm in diameter
Scintillators will be glued On a 2mm Carbon plate
Scintillators

Side view cross-section



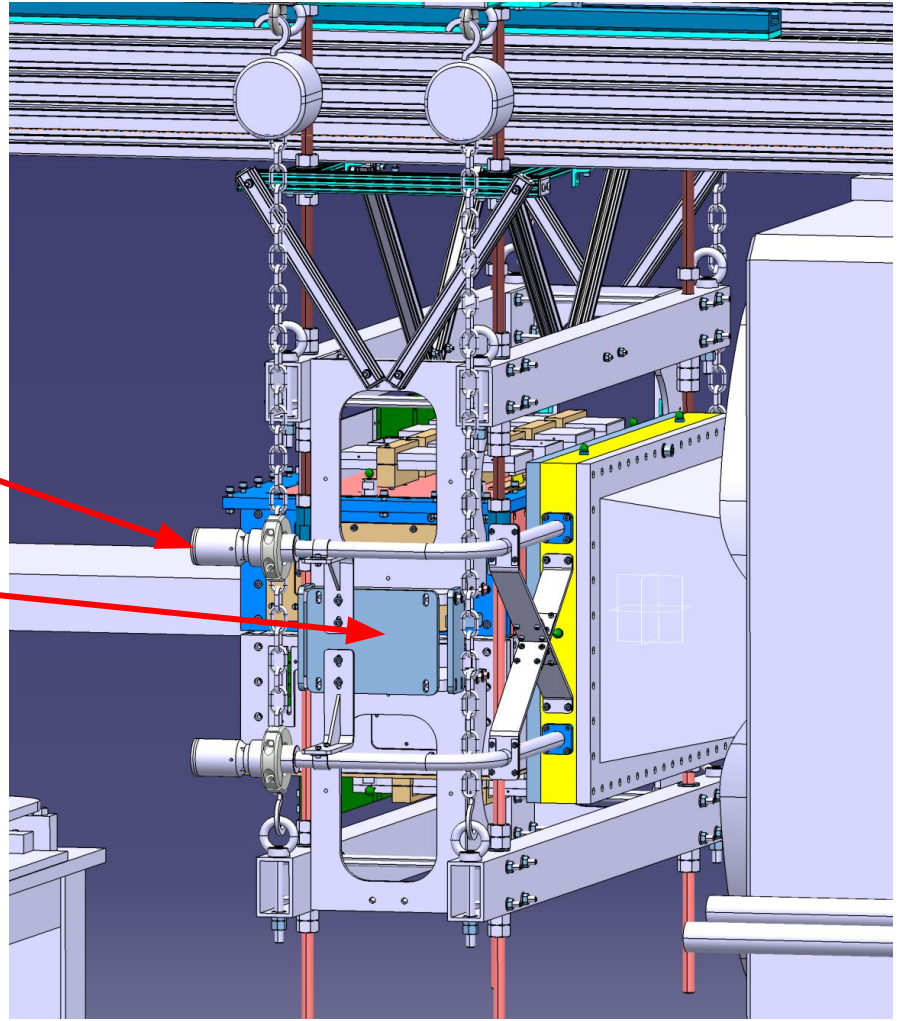
ECal crystals

ECal Vacuum chamber



PMT Housing

Reinforcement plate



The whole system should be tested with cosmic muons in EEL building, before moving to the Hall

Summary

More than 98% of SVT tridents will have positron in the proposed Hodoscope acceptance

Rates on the positron side are low and any pixelation will work, so the CLAS12 PCal scintillator strips can be used as is.

The acceptance of the active region is larger than needed, hodoscope edge will be 2 mm closer to the beam than is needed for 15 mrad coverage.

The hodoscope design is finalized, Orsay waits for feedback till the end of Dec., to start construction

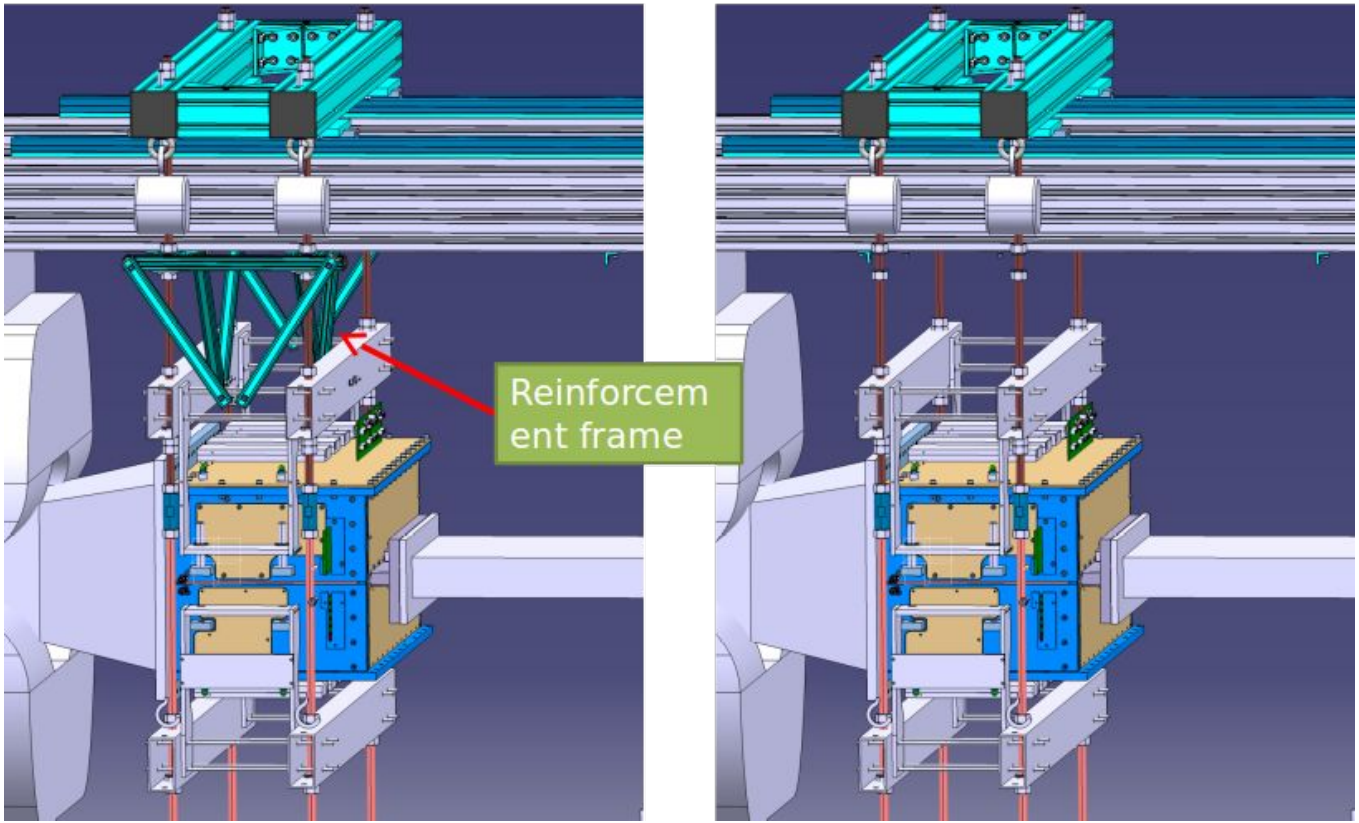
Before moving to the hall, the whole system will be tested with cosmic muons in the EEL building

Installation procedure is described in backup slides
Slides from E. Rindel

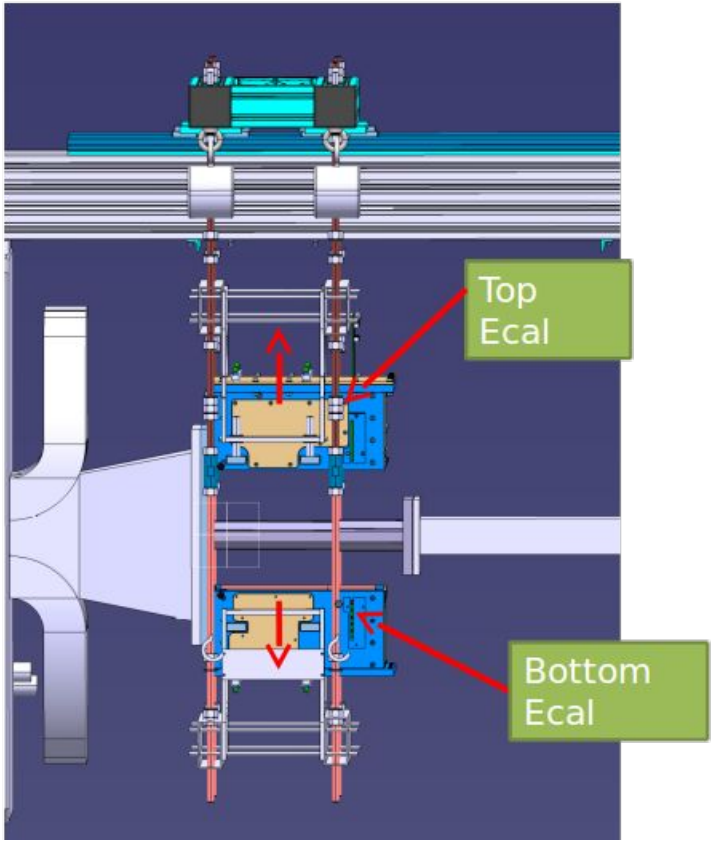
Backup slides, installation procedure

Slides from E. Rindel

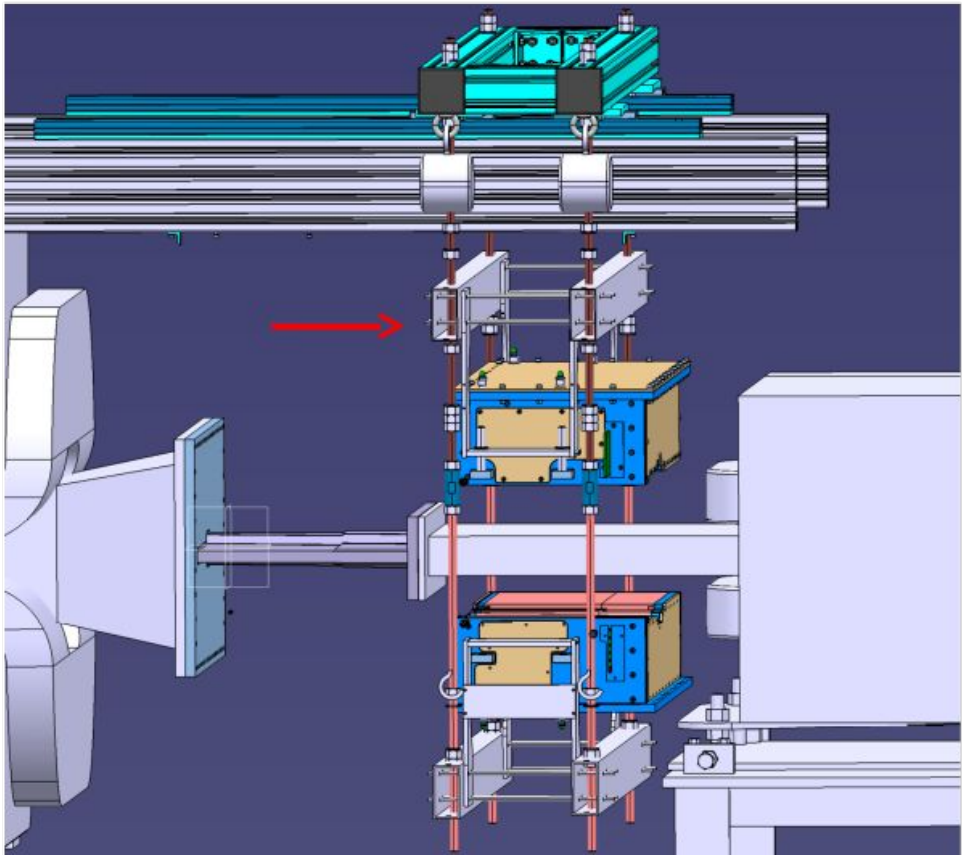
Remove reinforcement frame



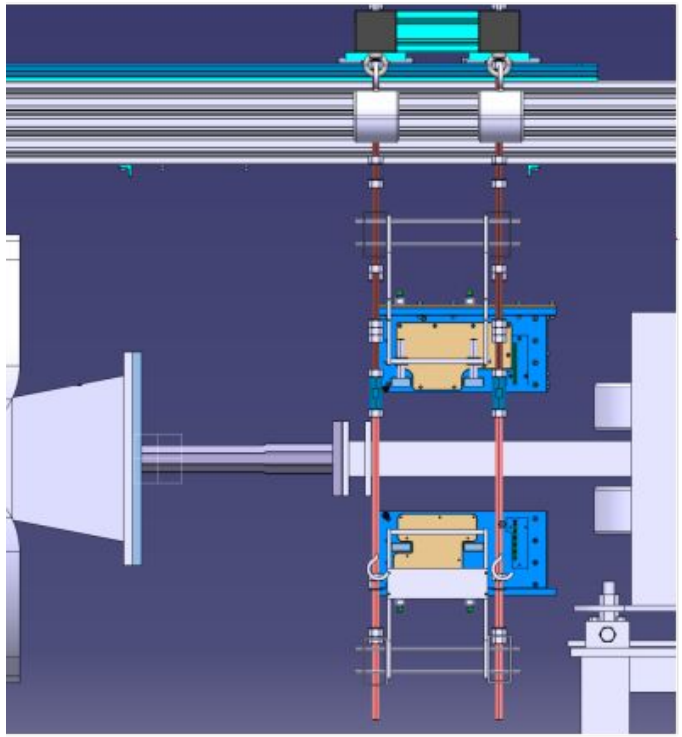
move Top and bottom Ecal with cranks

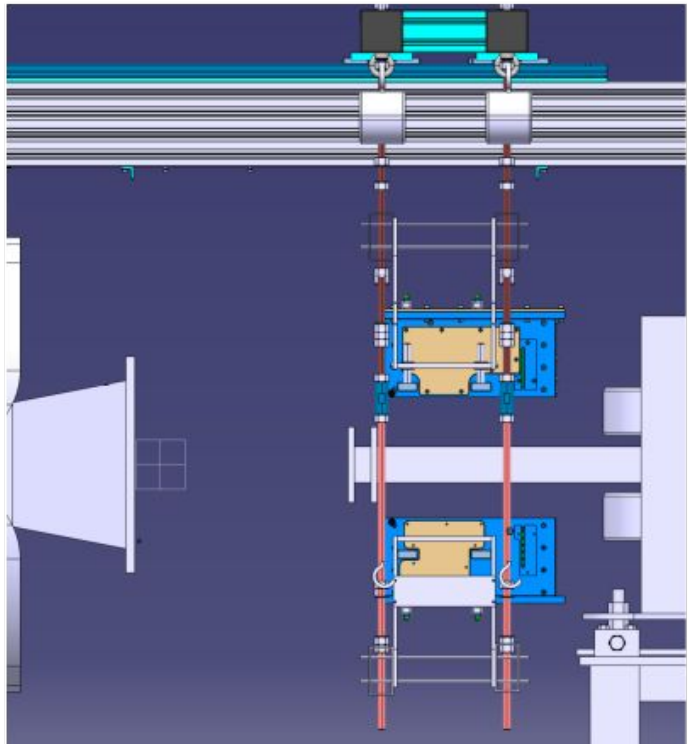


Move 500mm Downstream the trolley + Ecals

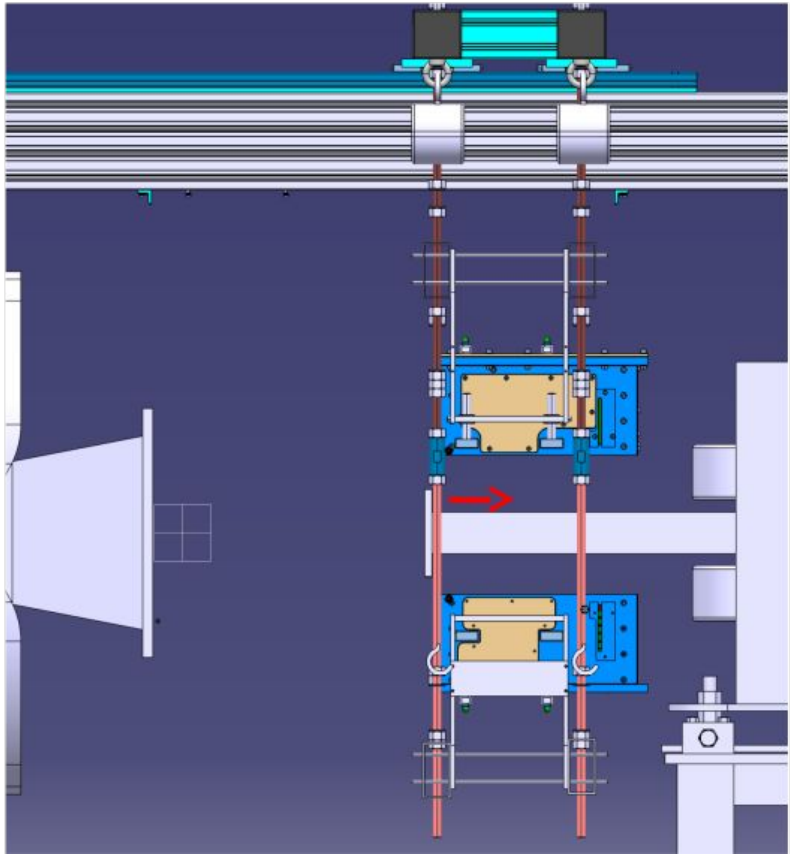


Remove the flat vacuum chamber



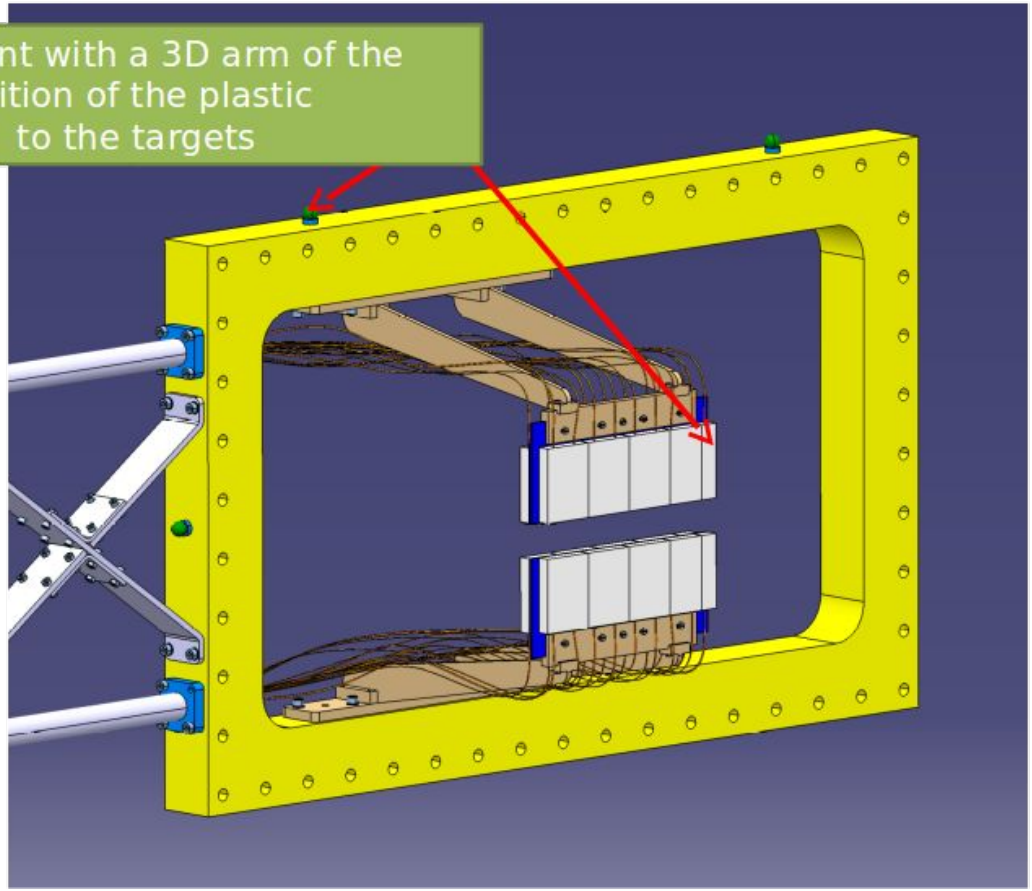


Shift more than 50mm downstream frascati vacuum chamber

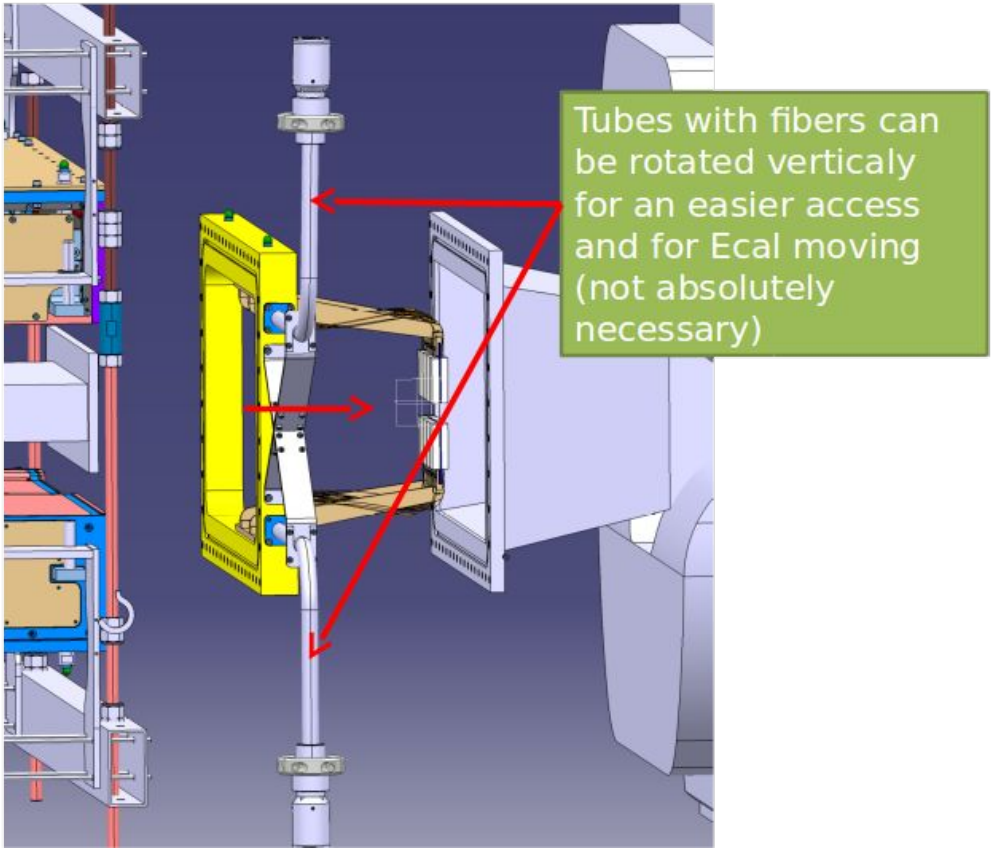


Survey of the hodoscope with a 3D arm

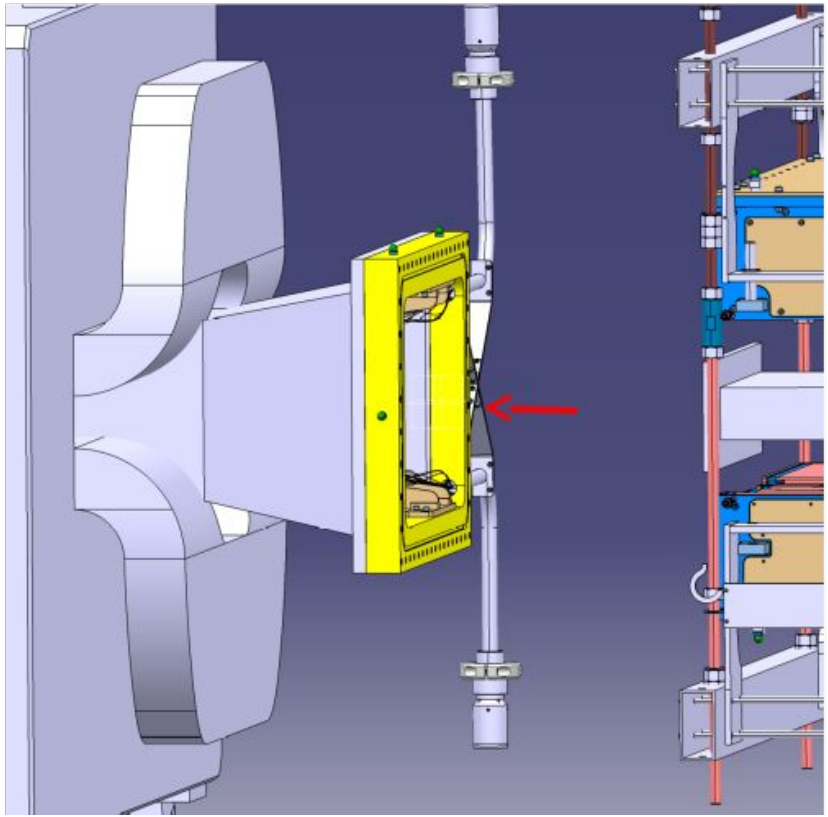
Measurement with a 3D arm of the relative position of the plastic scintillators to the targets



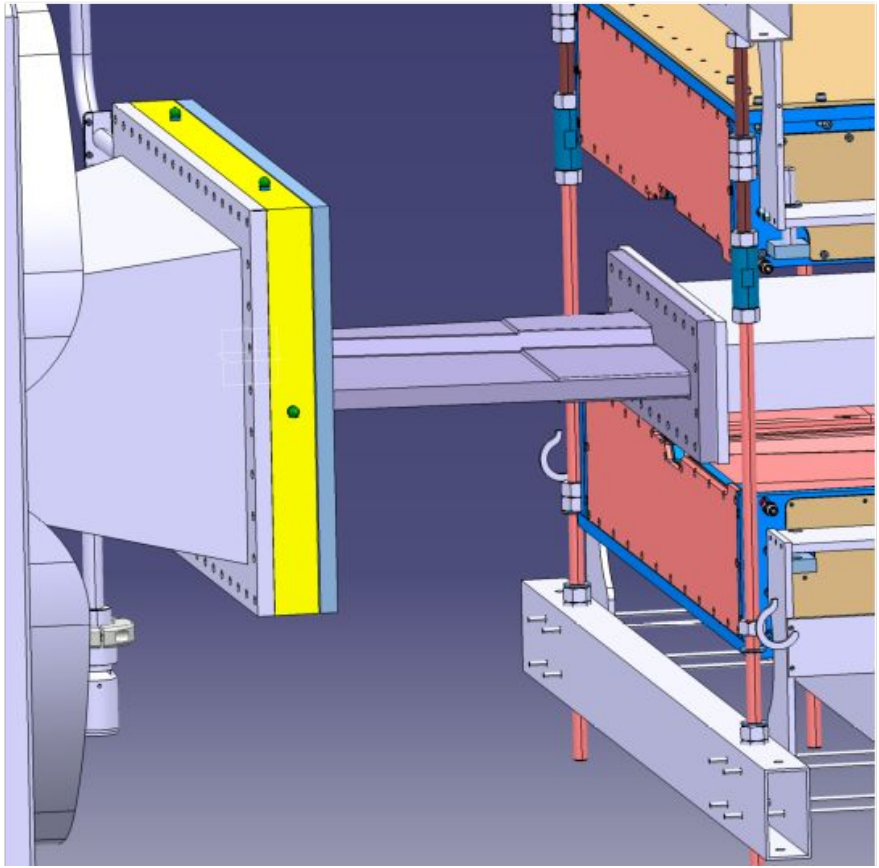
Insert the hodoscope in the pair spectrometer chamber



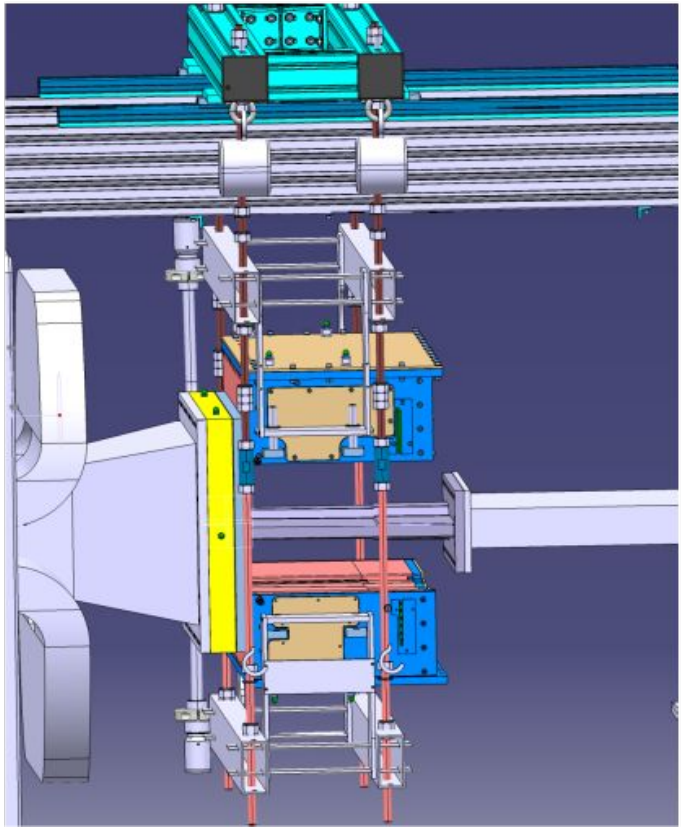
Insert the hodoscope in the pair spectrometer chamber



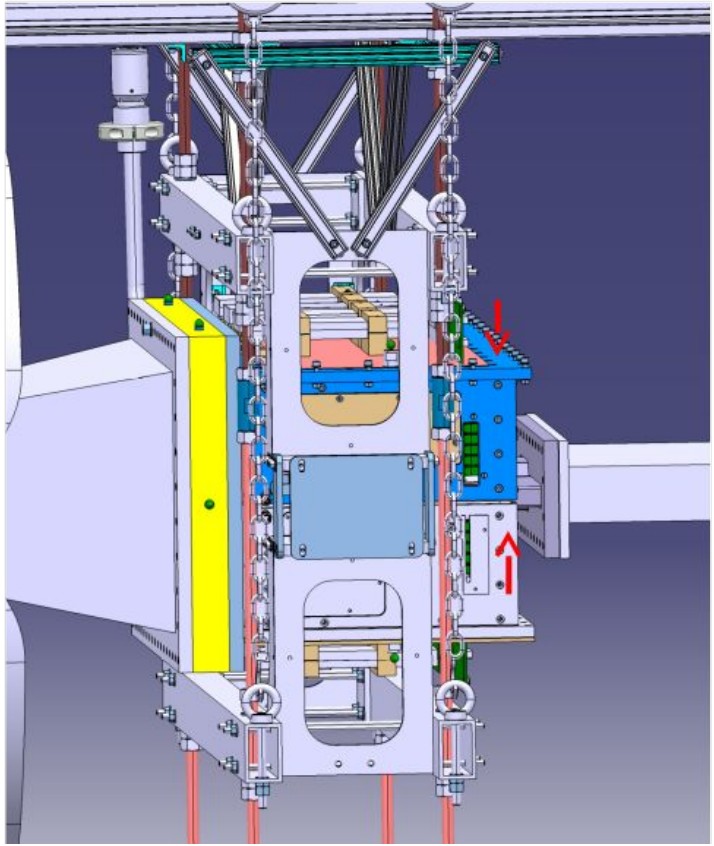
Mounting of the flat vacuum chamber



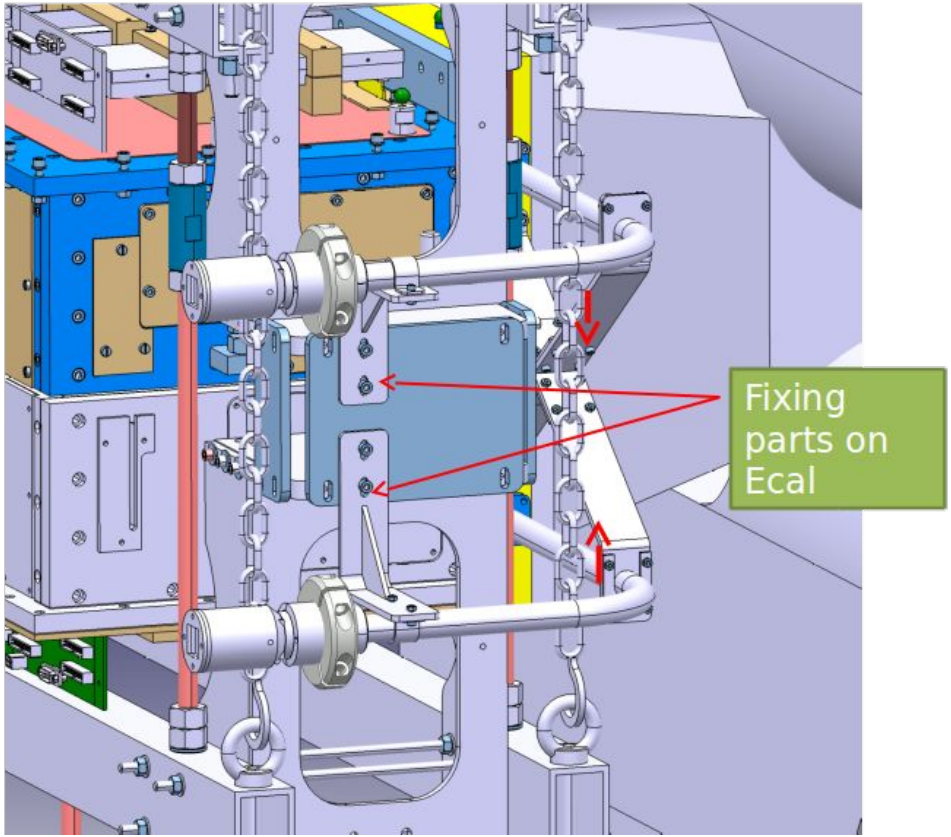
Move Upstream the trolley



Move the Ecals Top and Bottom and put the reinforcement frames



Fixing of the PMT and its fibers tube



SURVEY of the Ecal and the hodoscope

Targets

4 targets for Top Ecal
4 targets for Bottom Ecal
4 targets for Hodoscope