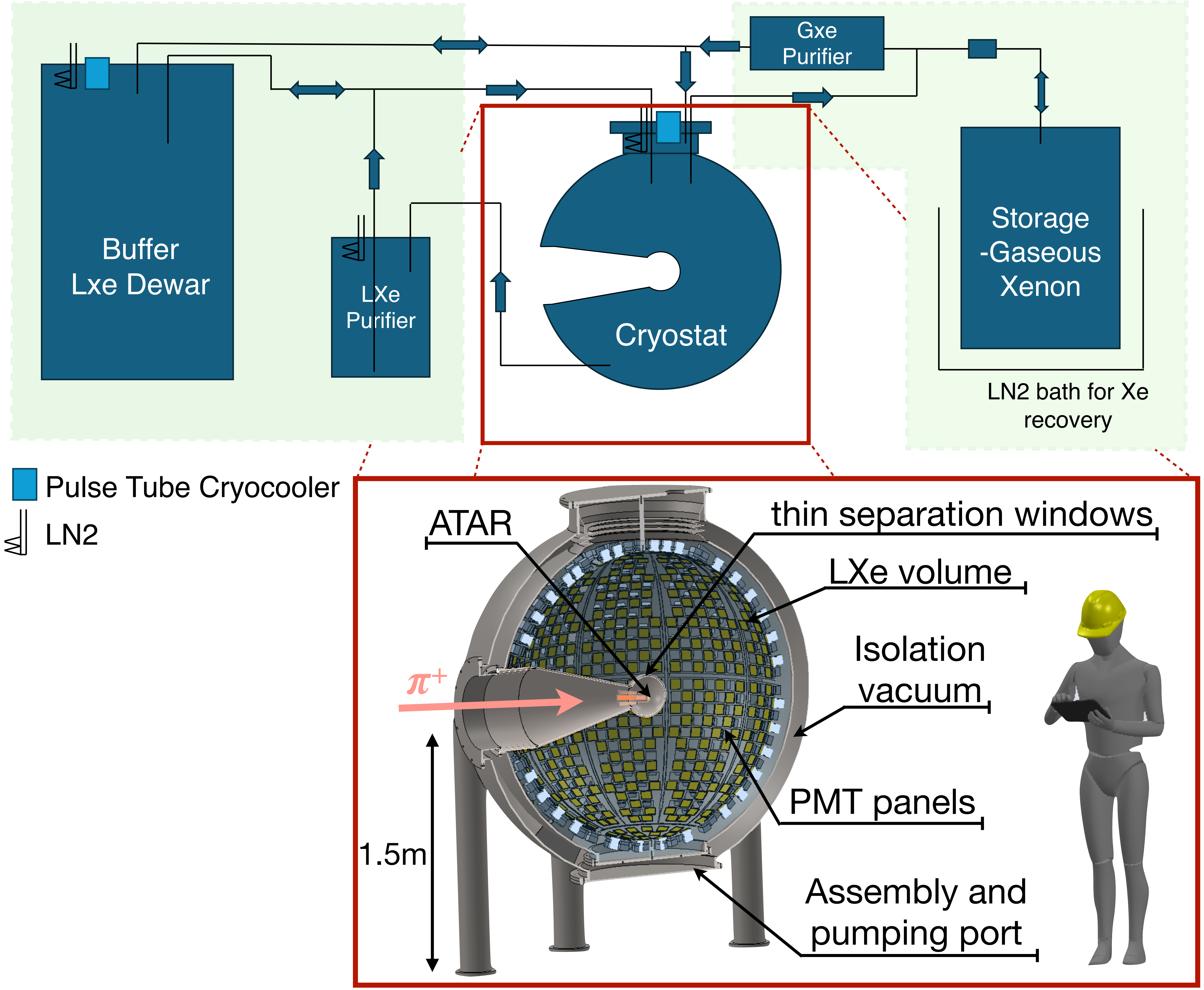
PIONEER LXe CALORIMETER

CONCEPTUAL DESIGN & COSTING

CONCEPTUAL DESIGN



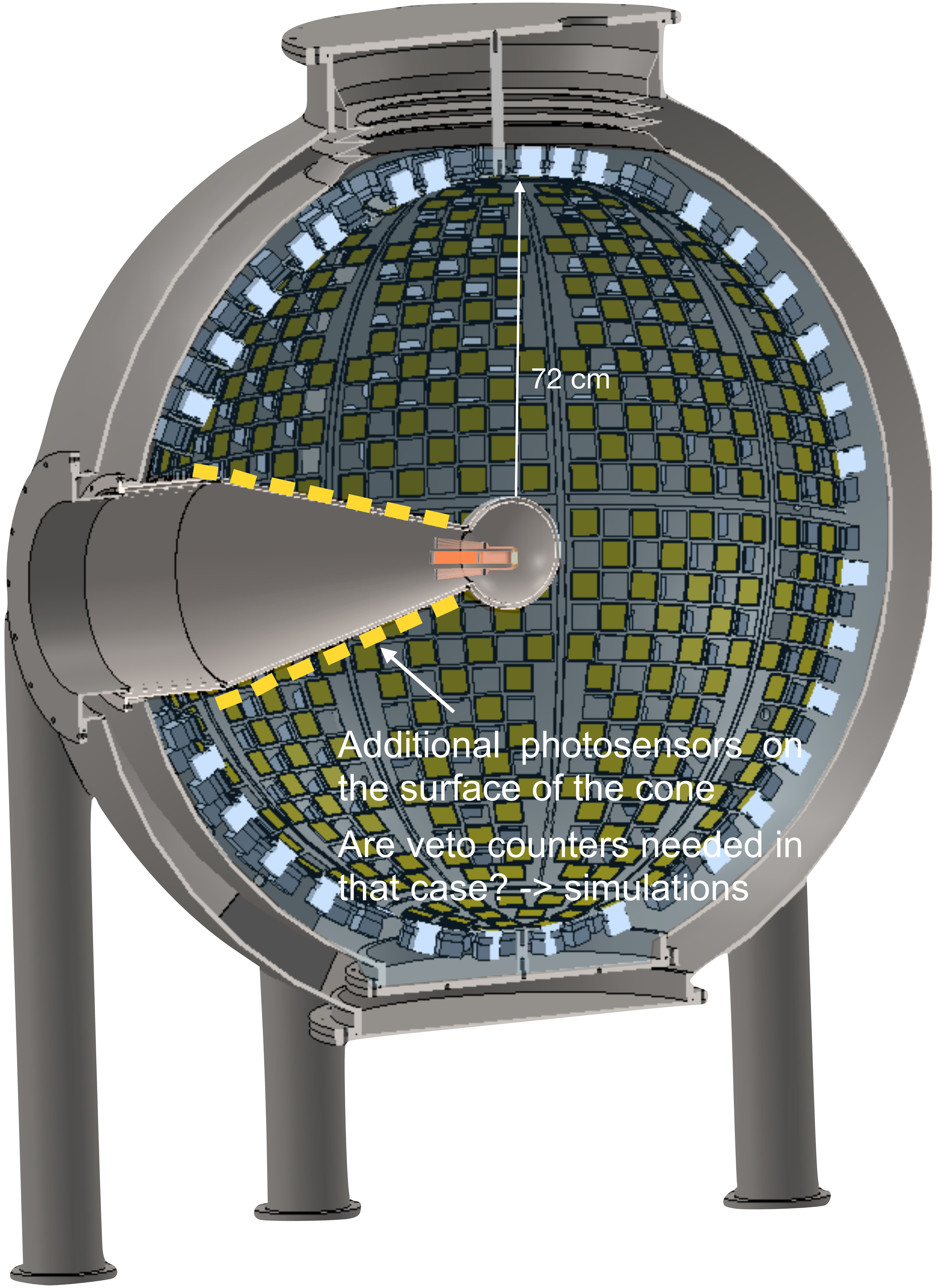
CONCEPTUAL DESIGN

- “Initial” geometry
  25X0, IR=10cm
  1000/500 PMT channels

Keyhole concept : minimizes angle dependent energy loss (contribution is small compared to other, including ATAR but this is a CALO-only contribution)

Important : homogeneity of the surface coverage with photosensors
 - add photosensors on the cone (can be PMTs - will slightly reduce the acceptance angle - or SiPMs) -> design being updated - simulation ongoing

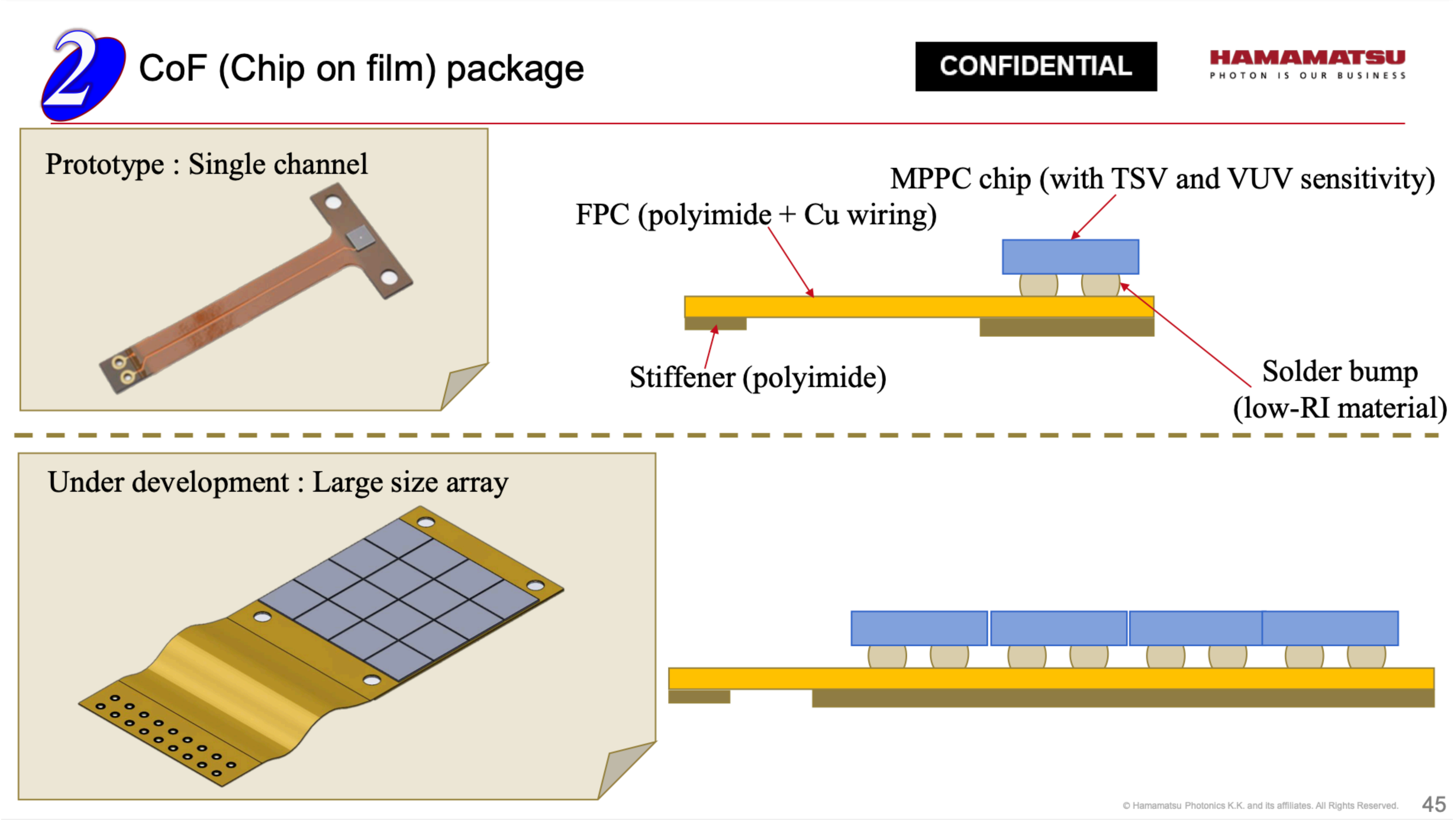
- add photosensors on the inner sphere using e.g. very thin VUV-MPPC package (Chip on File package) -> simulation ongoing (see Ben’s talk)



Development of low material solutions

Hamamatsu presentation
https://indico.phys.ethz.ch/event/45/contributions/658/attachments/372/901/Hamamatsu%20Introduction%20(Symposium)%2020231017.pdf

SiPM chips are directly bonded onto a flex film



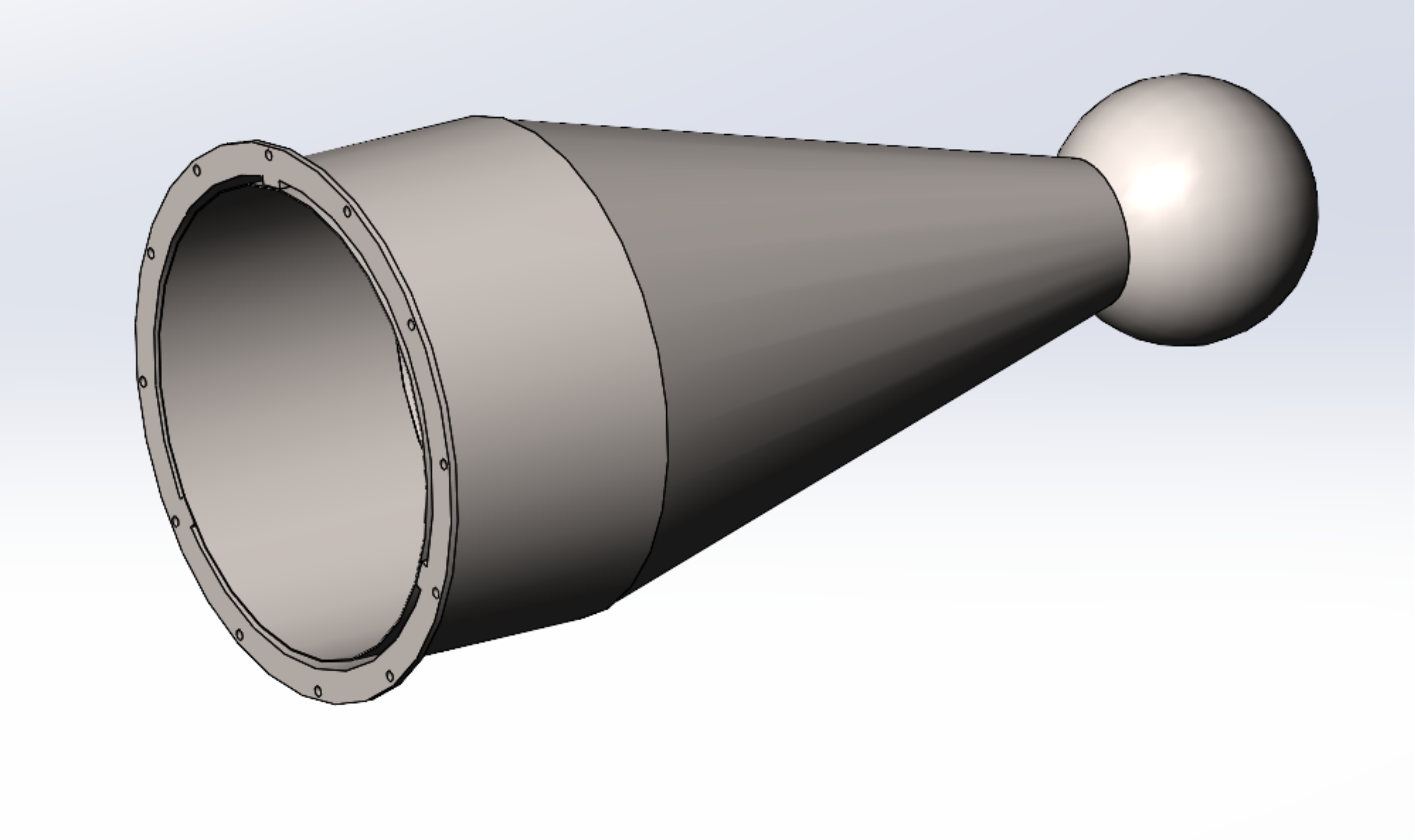
From internal discussions a MIP crossing the SiPM would likely produce ~1PE

Still in prototype phase but Wataru got some pricing estimates from Hamamatsu (see costing slide)

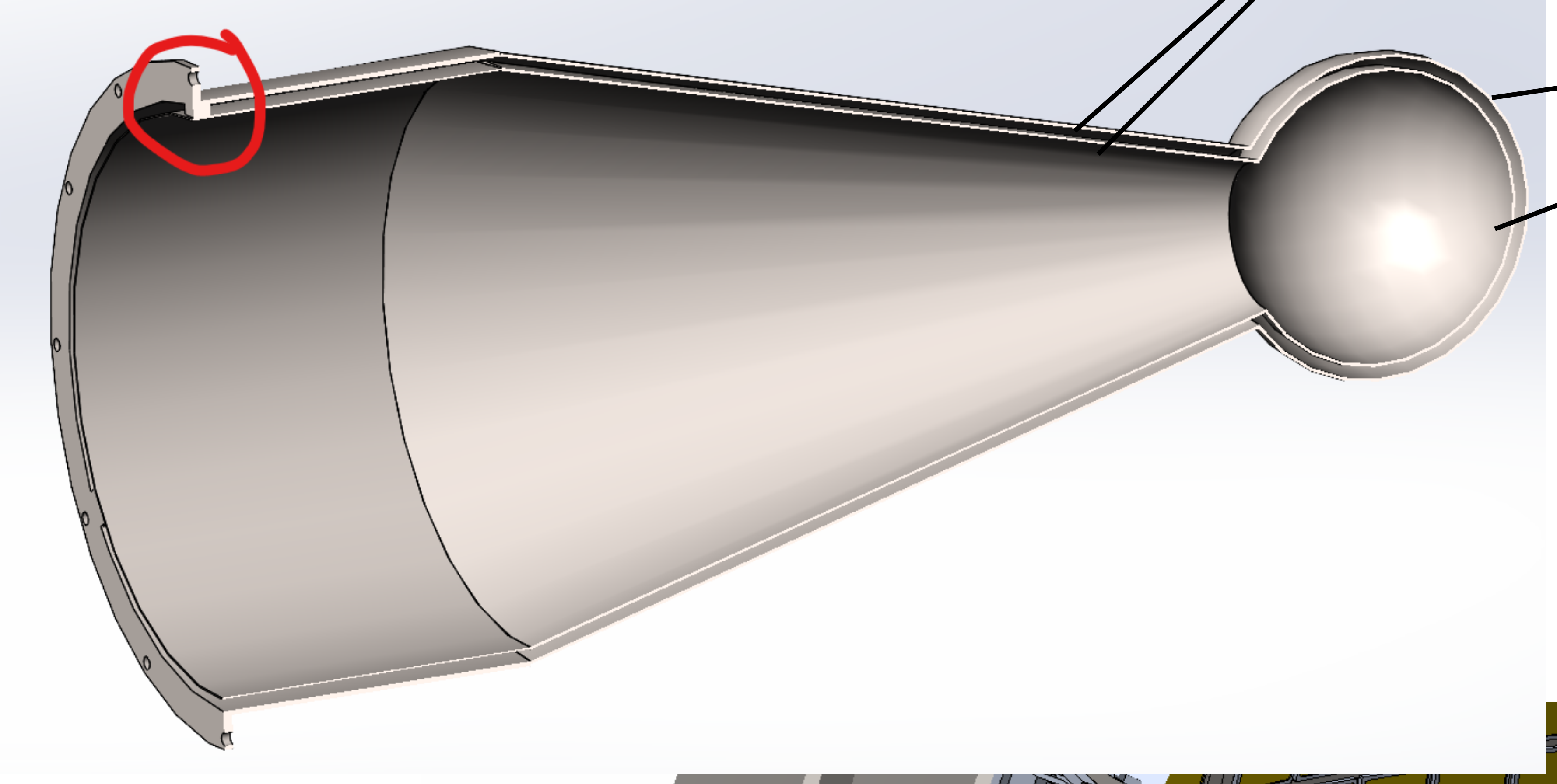
DETAILS OF INNER REGION

Stainless steel cones
Outer cone can support additional PMT assembly

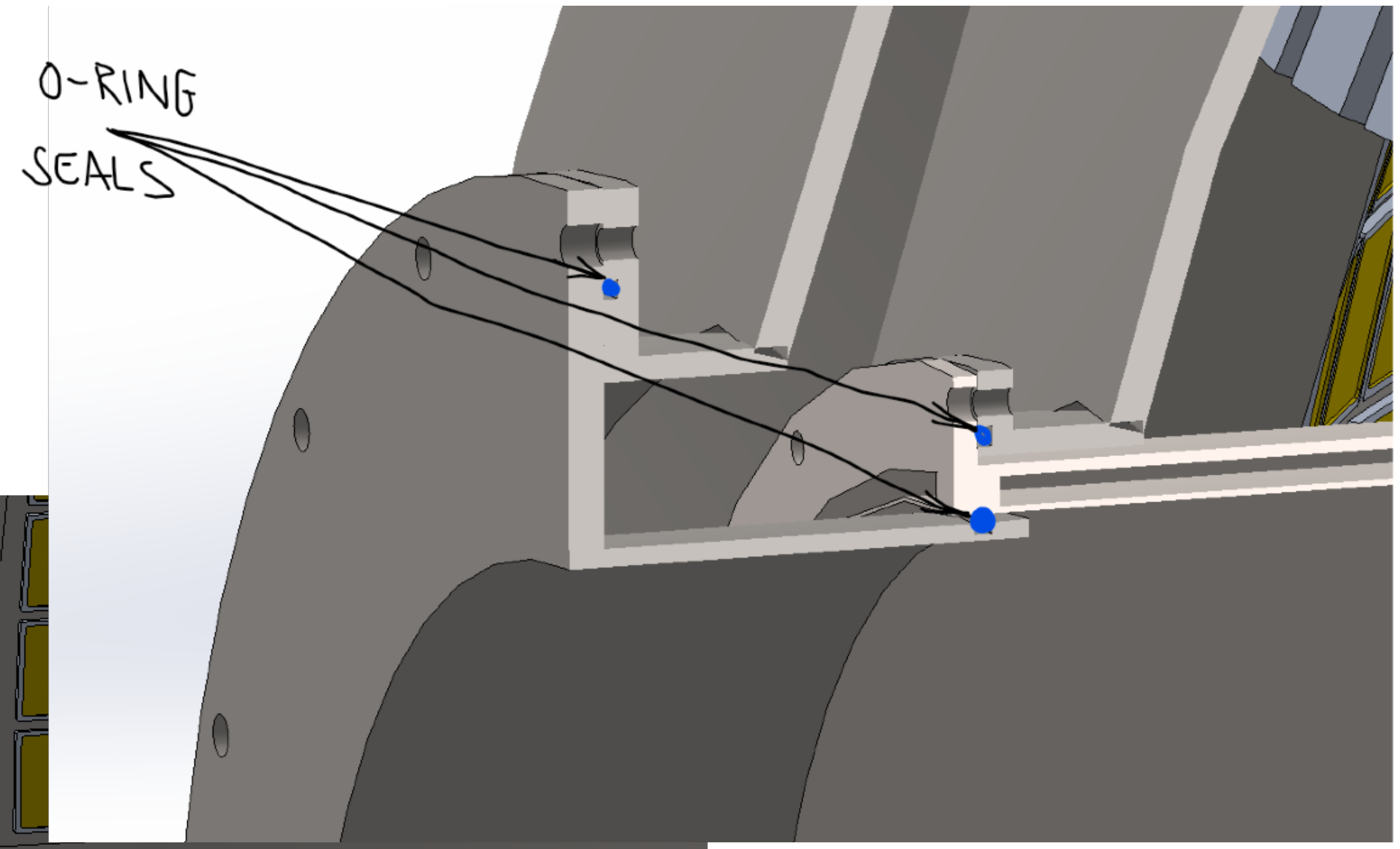
Inner cone: a single, all-welded piece

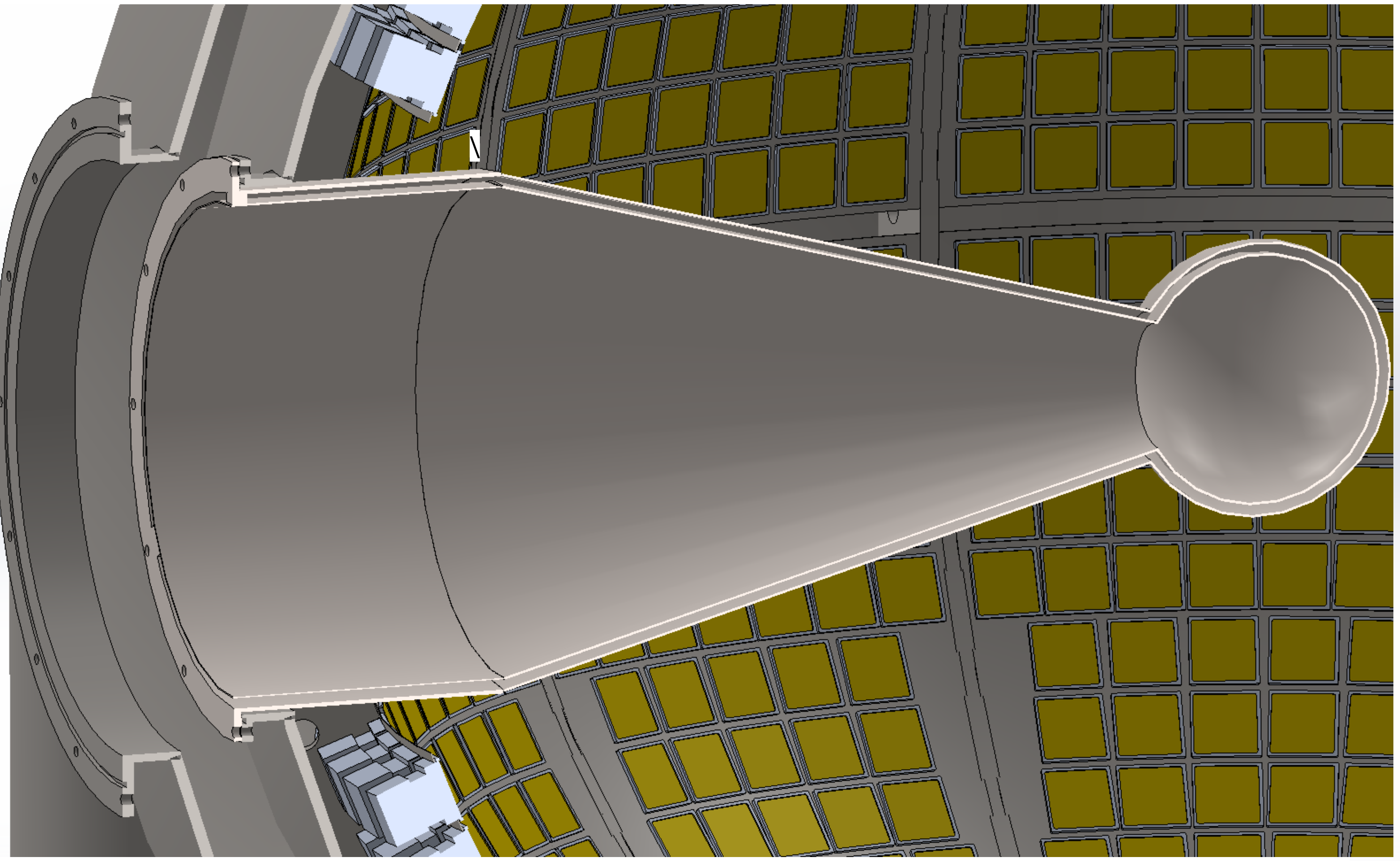


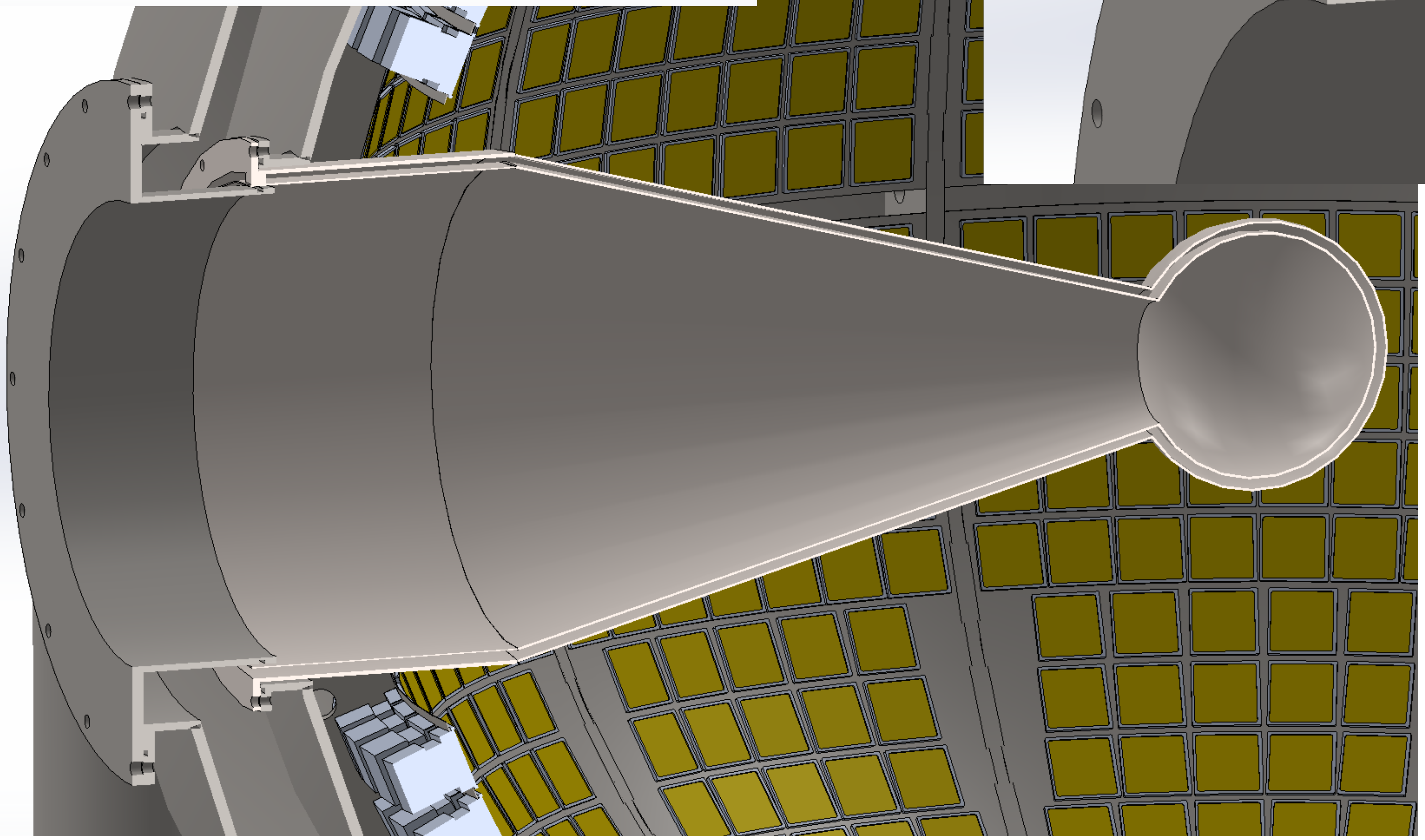
welding of the outer cone/sphere



thin windows

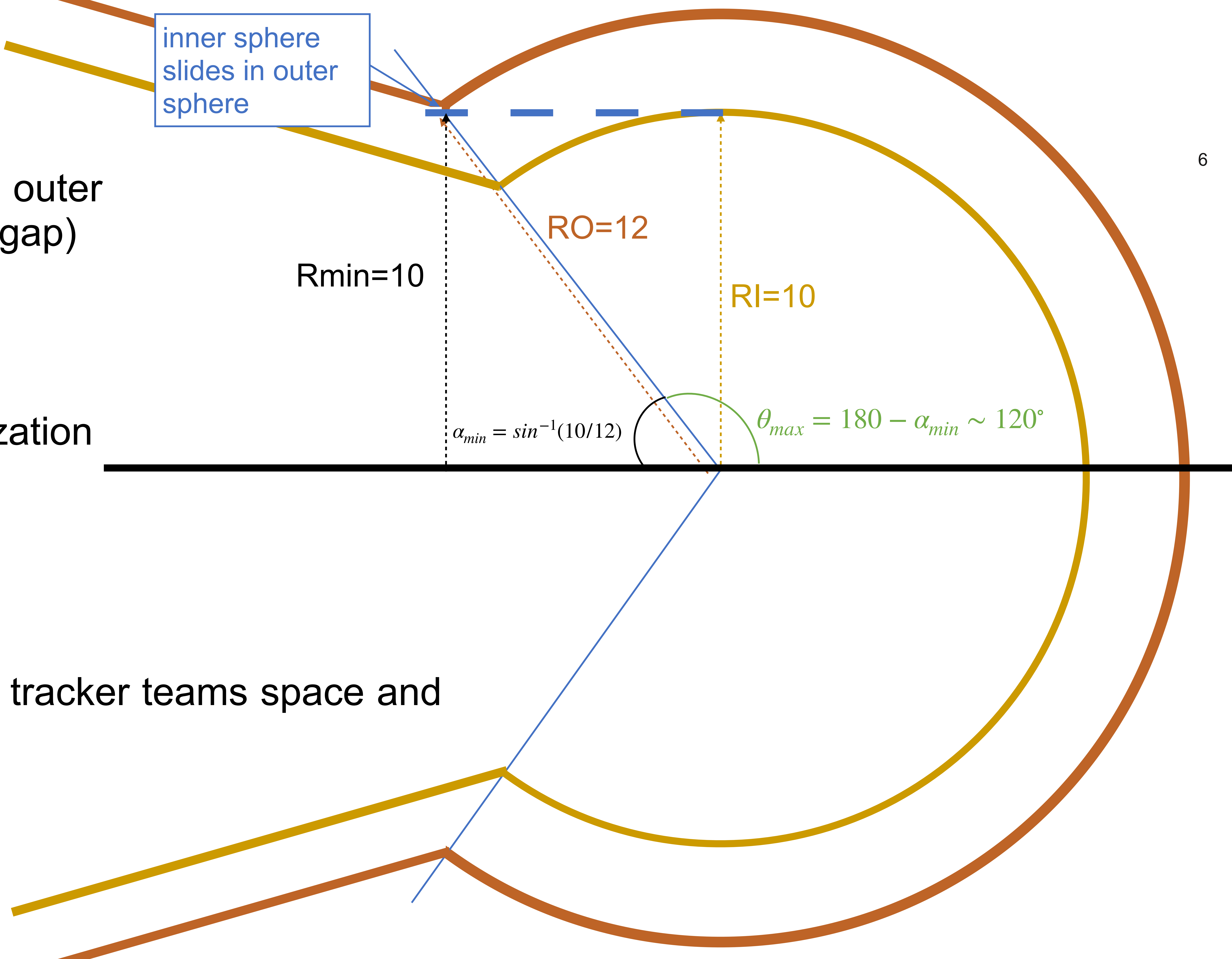






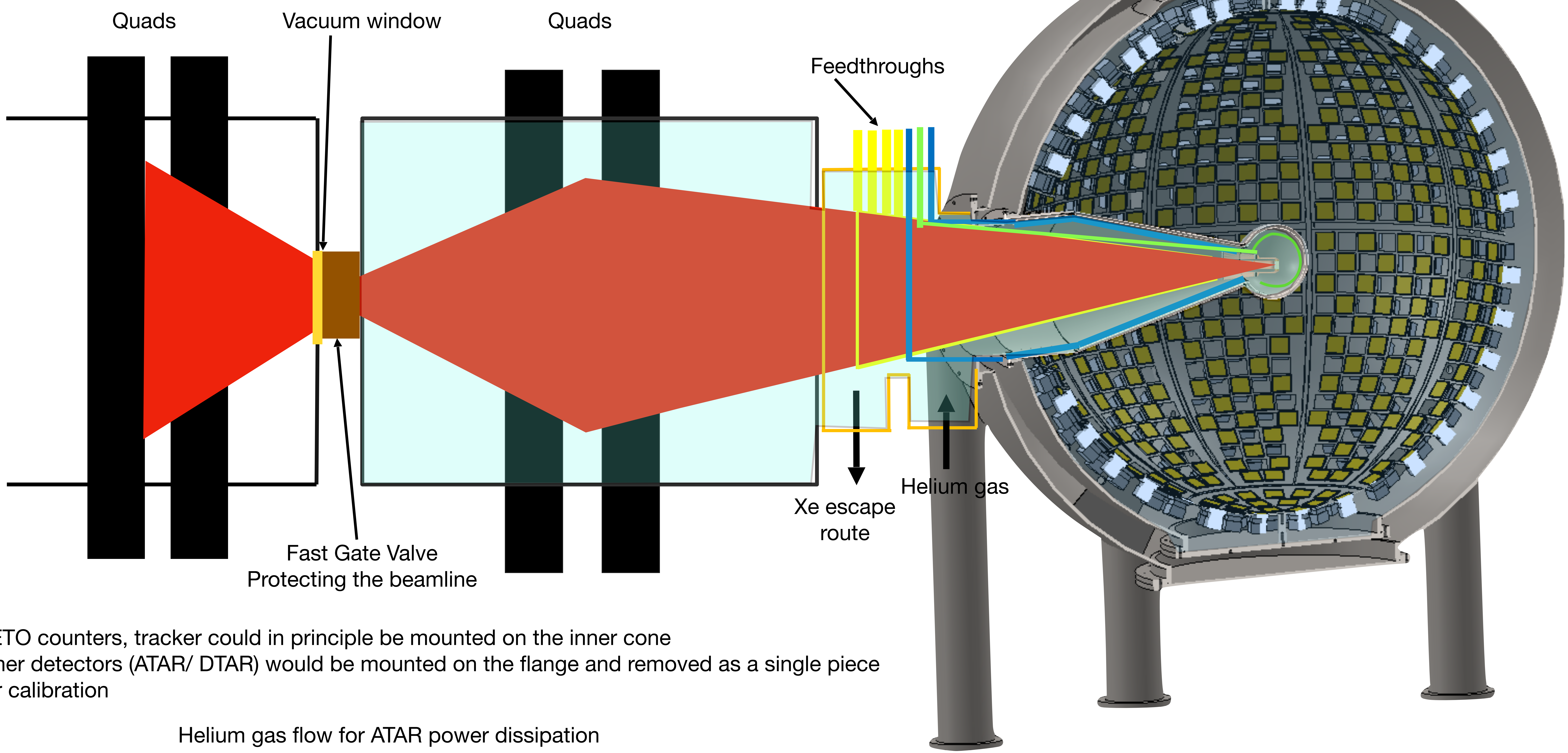
ALTERNATIVE OPTIONS

- Smaller IR / Larger outer radius (= larger vacuum gap)
- Smaller opening angle
- Overall geometry optimization exercice
- Work out with ATAR and tracker teams space and geometry constraints



LXe Escape Route Design

NOT TO SCALE



VETO counters, tracker could in principle be mounted on the inner cone
Inner detectors (ATAR/ DTAR) would be mounted on the flange and removed as a single piece for calibration

Helium gas flow for ATAR power dissipation

flange with ports. Supports the entire inner structure . Can be removed/inserted at once and replaced e.g. by a calibration assembly

ADVANTAGE OPEN QUESTIONS - BEING INVESTIGATED

- Main advantage
  - Resolution is proven to be very good <2% by MEG
  - Xenon is a liquid : detector can be reshaped for pibeta
  - *Xenon is a commodity*
  - Cryogenics is a *complication* but it shouldn't be a decision factor

  Other experiments manage "maintenance-free" system

- How to do calibration?

  Inside Calo : LEDs, alpha sources

  Outside Calo :
  - Mott elastic scattering from ATAR (Toshiyuki's slides)
  - with inner structure removed : forward acceptance
    - 17 MeV gamma from CW
    - pi^- charge exchange on H2 target: back to back gammas. have to carefully consider space restrictions

- Is forward calibration/ lineshape measurement enough to understand full detector response?

- Optimization of # of channels

- Pileup : simulations ongoing (move to"realistic" beam parameters) / optical segmentation being investigated

  Remark: simulations and R&D will/need to extend well beyond the current CDR timeline

COSTING - BASELINE

- Scenario with 19X0, 25% PMT coverage (2" square PMT), open 1/2 angle: 30deg, IR=10cm, 15% dead LXe volume

	volume/number	price / unit	Remark	TOTAL price
Material LXe	4.05 t	US$1.275/g	3 t from MEG	$1,338,750
VUV PMTs new flat version : R12699-406-M4	500	3110	quote from Hamamatsu to Satoshi	$1,555,000
power supply	500	$168	as per CAEN quote	$83,800
Cabling and feedthroughs	1000	100	estimate	$100,000
Digitizers	500	1000	estimate	$500,000
Cryostat	$1	$160,000	as per budgetary quote	$160,000
LXe storage and HP tanks Platform			estimate + part of the MEG xenon gas system as in kind	$1,000,000
LXe recovery (GV) /flange/ feedthrough system			estimate	$100,000
Calibration	500	$300	LEDs, Am275 sources etc (rest considered as in-kind)	$150,000
TOTAL				**$4,987,550**

COSTING - ALTERNATIVE OPTIONS for PHOTOSENSORS

- PMT R9869 (MEG's PMT - 860) discontinued - gain decreasing - not re-usable for PIONEER

	volume/number	price / unit	Remark	TOTAL price
PMTs older versions	500		PMT R9869 discontinued	
VUV MPPC (S13371-6050/75CQ-02)	8,168	US$104	same as MEG - new quote from Hamamatsu (Wataru)	$849,472
VUV MPPC (S13371-6050/75CQ-02)			4000 provided by MEG	$433,472
VUV PMTs	600		Available from other collaborations	?
VUV-MPPC package COF package	5,700		80% coverage of the sphere (OR=15cm)	$158,000 to $222,000

- Add cost readout for the MPPCs / combine channels
- Study : would inner SiPM mitigate requirements on tracker?