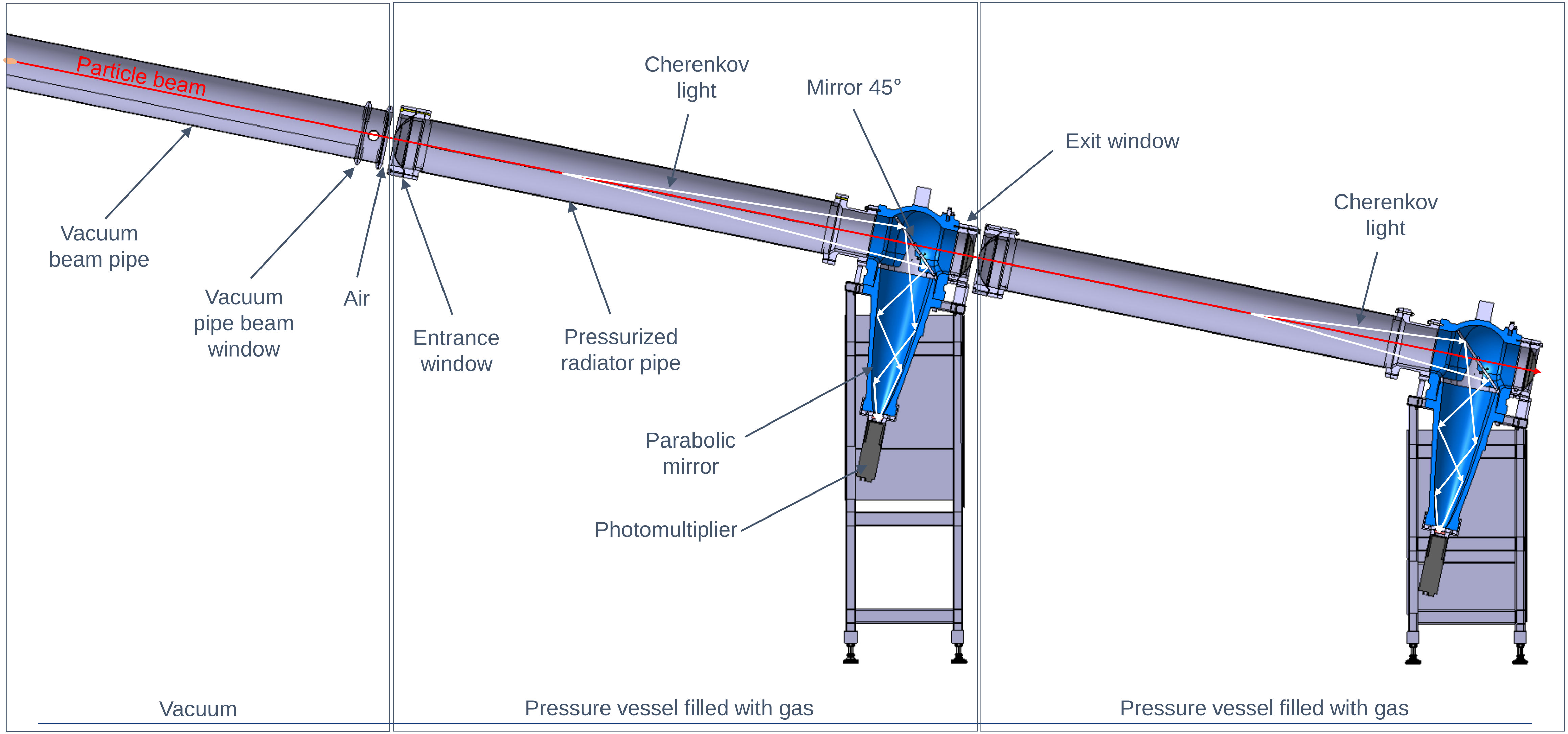
# XCET detector review

26.09.2022

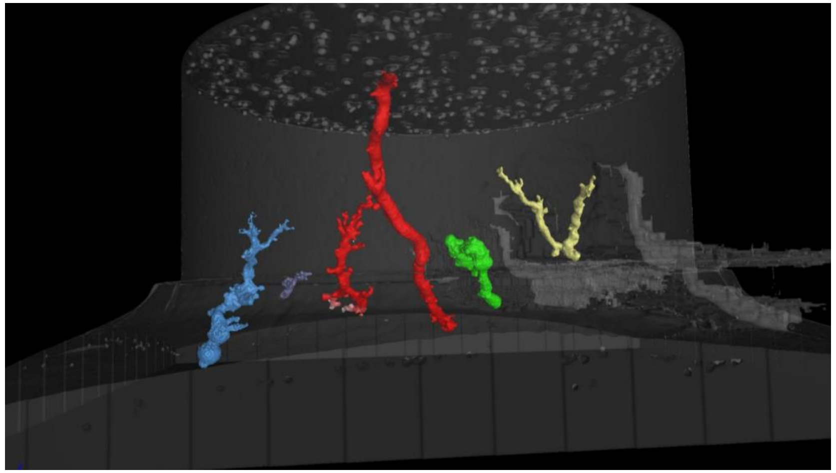
TESTS, SIMULATIONS, UPGRADES

*Jan Buesa Orgaz*

# Threshold Cherenkov Counters (XCET)

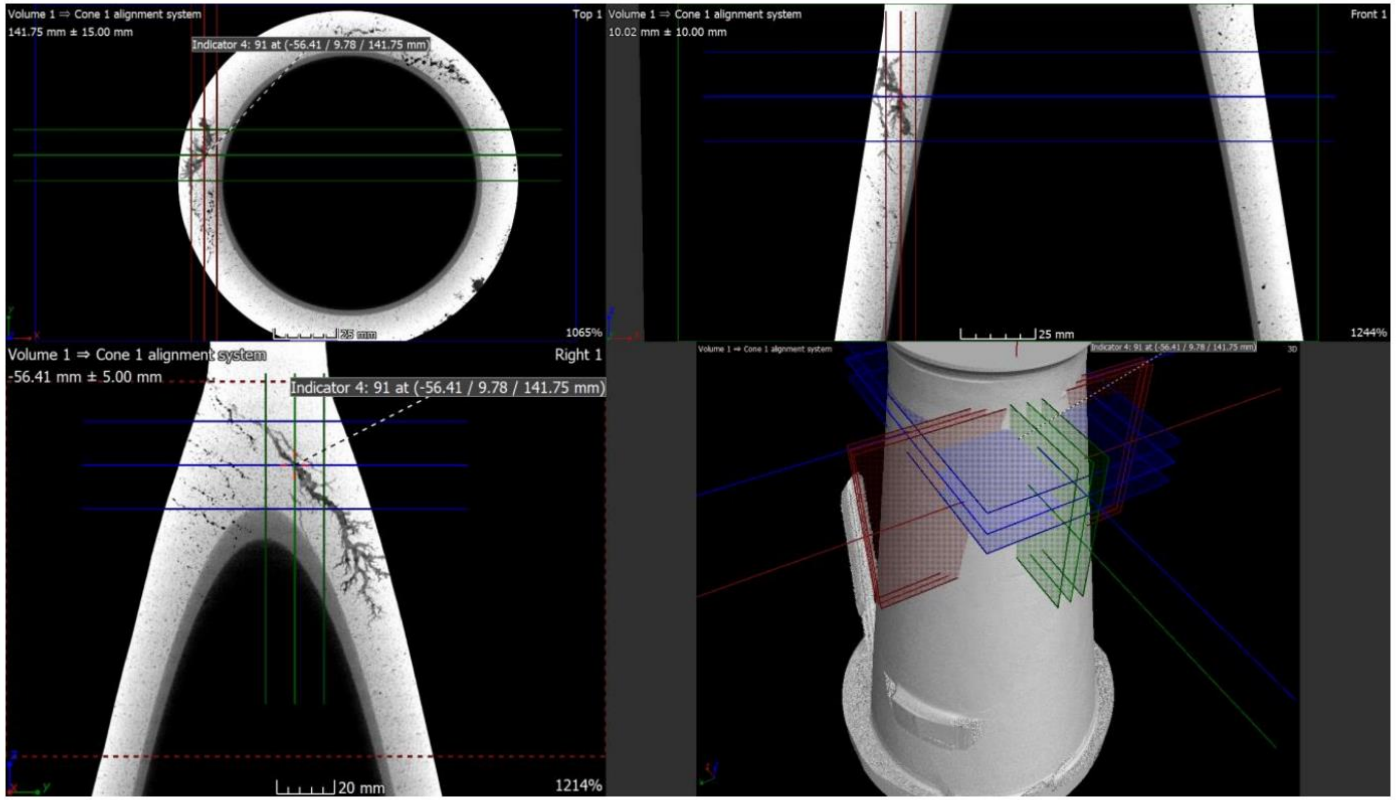


# X-ray Computed Tomography in 2 East Area bodies



HEAD: pores smaller than 1mm^3 and channels at large distance from internal surface

CONE: several channels found



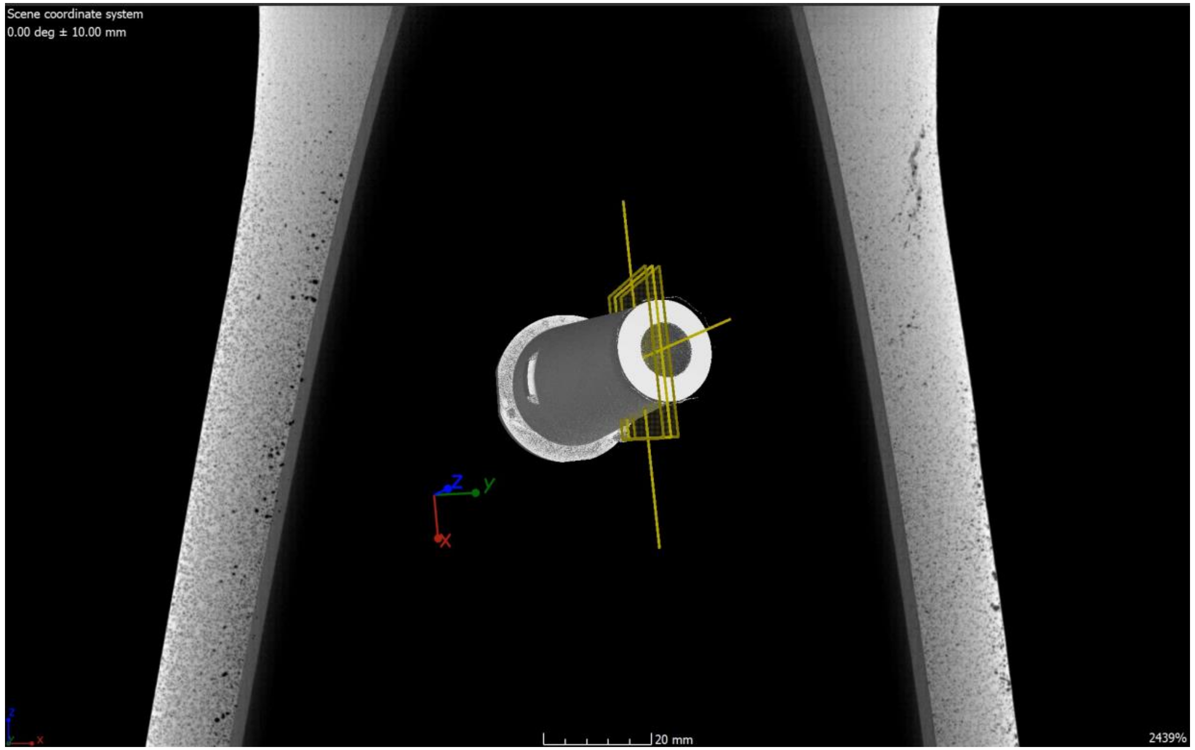

Internal defects were discovered in the conical body and head probably due to the casting manufacturing method used in 1970.

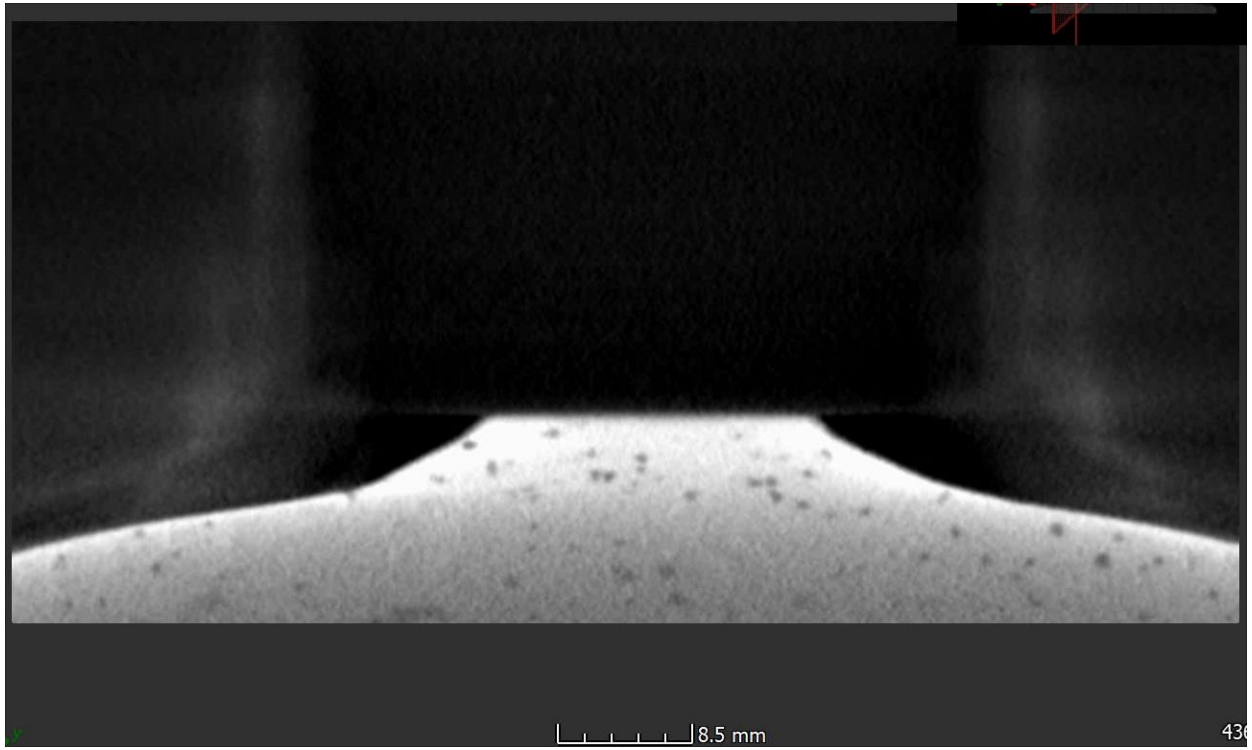
**CONSEQUENCES →**

- LIMIT PRESSURE
- ACCESS RESTRICTIONS
- PERIODIC TESTS

# X-ray Computed Tomography in 2 East Area bodies

EDMS **2322485**




Thanks to MARIUSZ DAWID JEDRYCHOWSKI *(EN-MME)*

# Introduction - New Optical Design

So far, no optical simulations of the XCET detectors were done. Therefore, there were all kind of uncertainties.

- Goal of the study is to understand the internal working operation of the XCET for its different configurations in order to optimize the optics. Thus, improving the efficiency of the detectors.
  - XCET model with current mechanical design in Geant 4
  - Reflectivity and transmittivity tests
  - New coating exploration
  - New designs and materials have been proposed

# Reflectivity Measurements


*New mirror (Al+SiO2)*

*Old mirror*

*Spectrometry of new mirror*

Reflectivity tests in all optical components to understand their optical dependency:

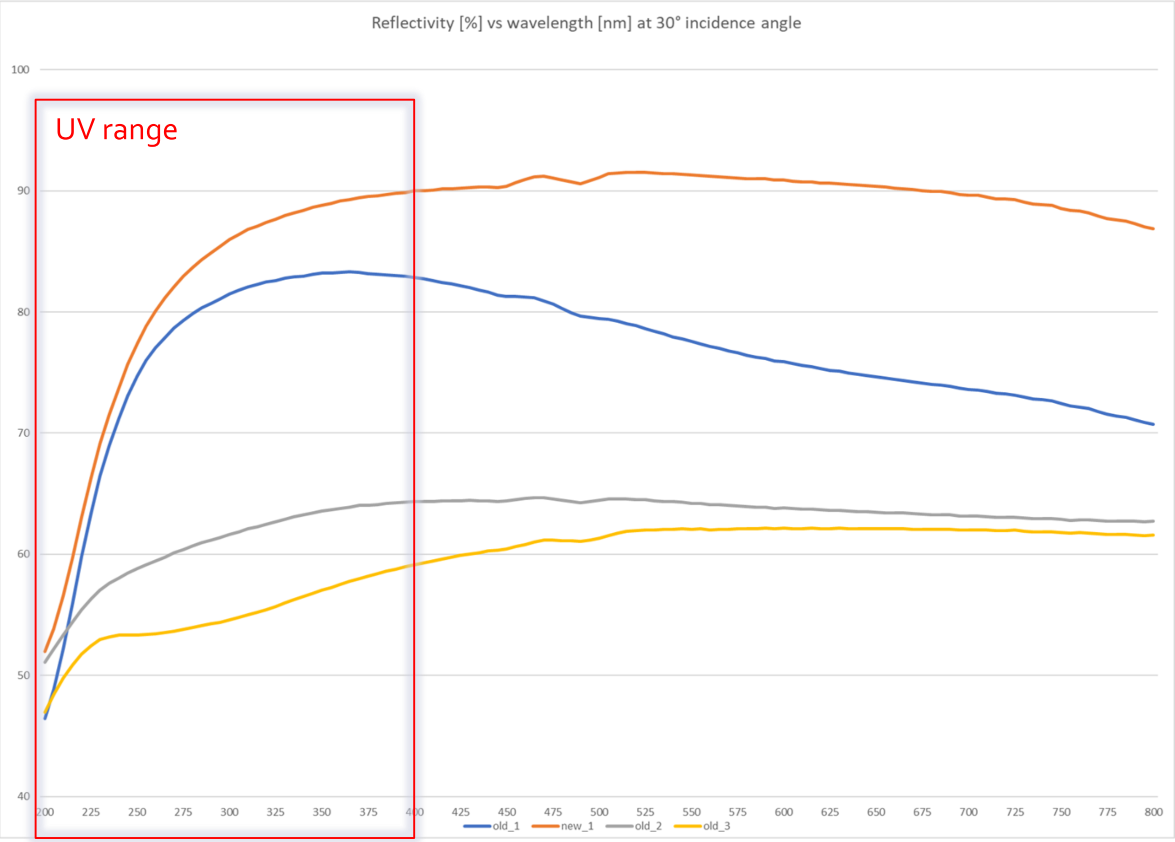
- SS136L electropolished tube
- 45º mirror
- Parabolic mirror
- Optical windows

A mirror with new coating was tested:

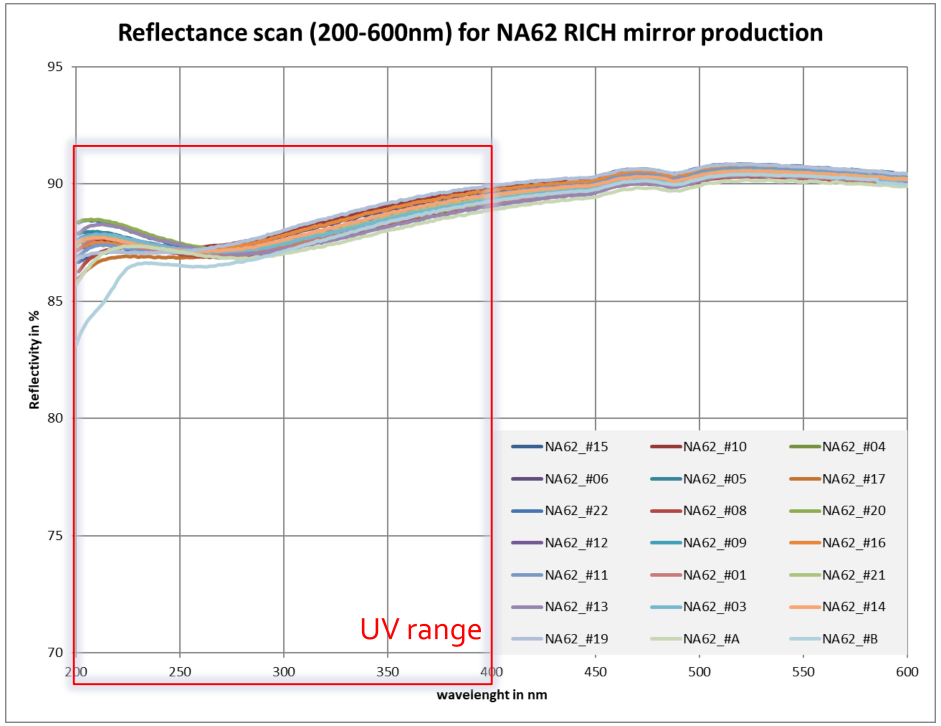
- Mylar layer of 25 um + 100 nm Aluminium coating (UV reflectivity) + 20 nm $SiO_2$ coating (protective coating).

*Thanks to Thomas and Miranda (EP-DT lab)*

# Reflectivity Measurements




Most of the 45° mirrors have poor reflectivity within the UV range.

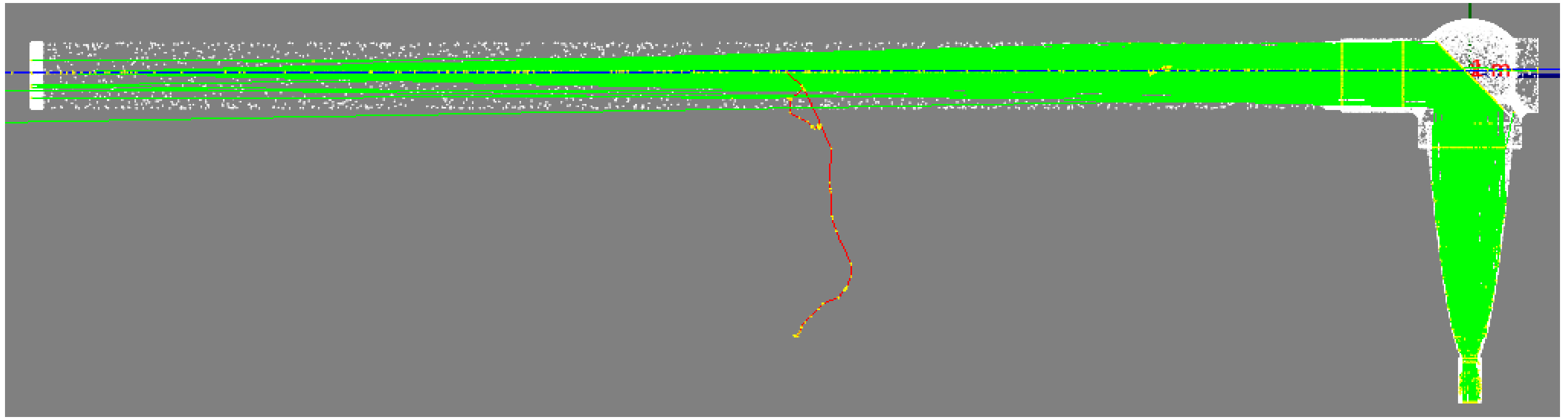



From beginning next year, we can make Al+MgF2 flash coating at CERN to maximize reflectivity in the far UV

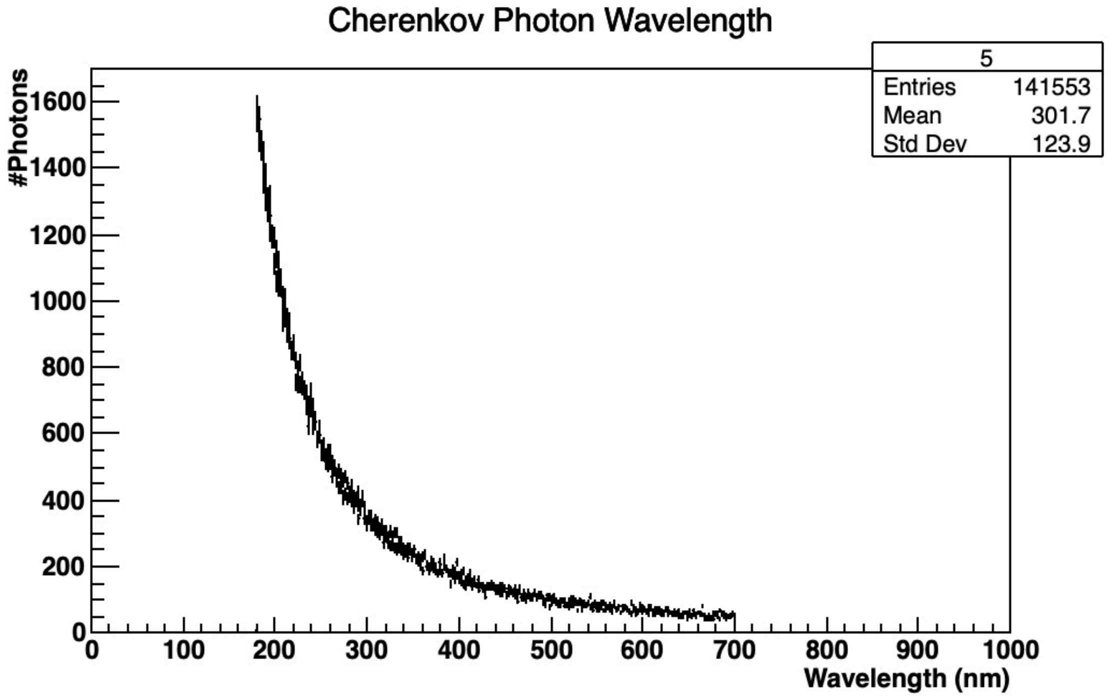
*Thanks to Thomas and Miranda (EP-DT lab)*

# Current Optics Design

- The actual XCET detector was modeled in Geant4 (*Thanks to Jorgen, Martin and Berare*)
- Threshold pressures were crosschecked with beam pressure scan as a first validation of the simulations (*Thanks to Dipanwita*)
- The photon's wavelengths were calculated
- The Cherenkov angles were obtained



# Current Optics Design

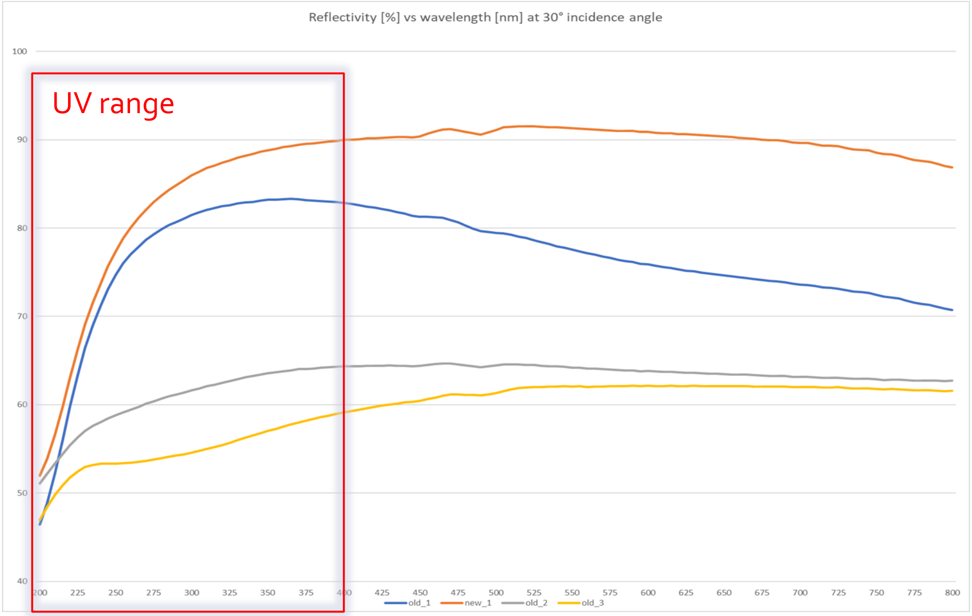



Muon+ at 4 GeV with the XCET filled with CO2 at 1 bar (a)

% photons created at different wavelengths:

- 20 % [180 – 200] nm
- 64% [180 – 300] nm
- **80% [180 – 400] nm**

<u>Critical to maximize reflectivity in the UV range</u>

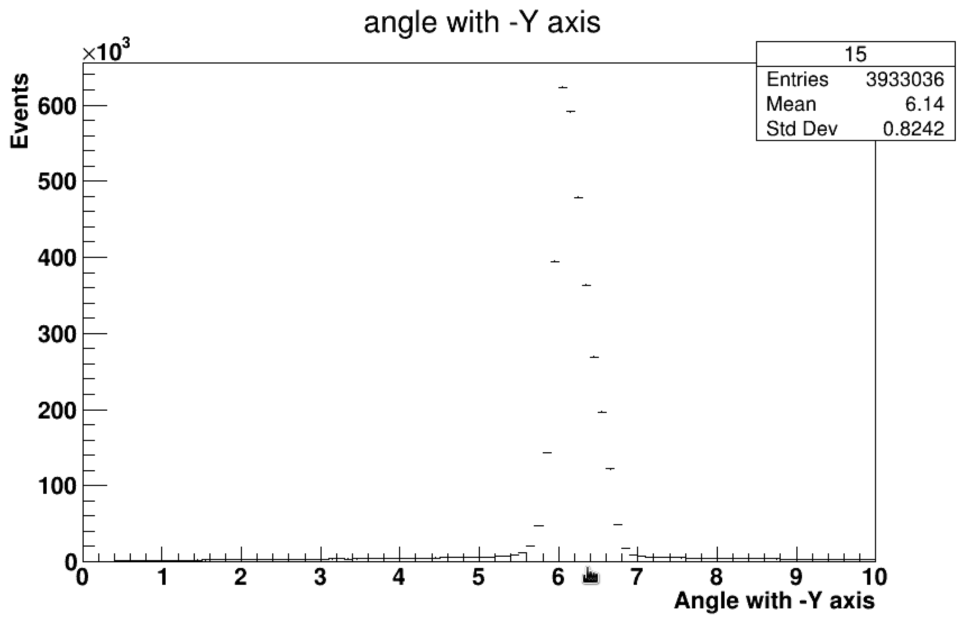


# Current Optics Design

Downsides of current design:

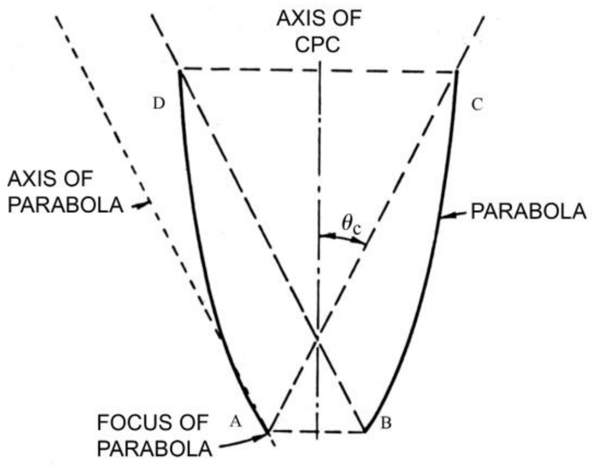
- Head's diameter small → loss of photons
- 45º mirrors → poor surface quality → low reflectivity in UV range
- Parabolic mirror → small exit surface → UV reflectivity could be improved
- Optical windows → UV transmittance could improve (Quartz)

# New Optics Design




- To design new parabolic mirror → we need to know the incoming angle of the photons

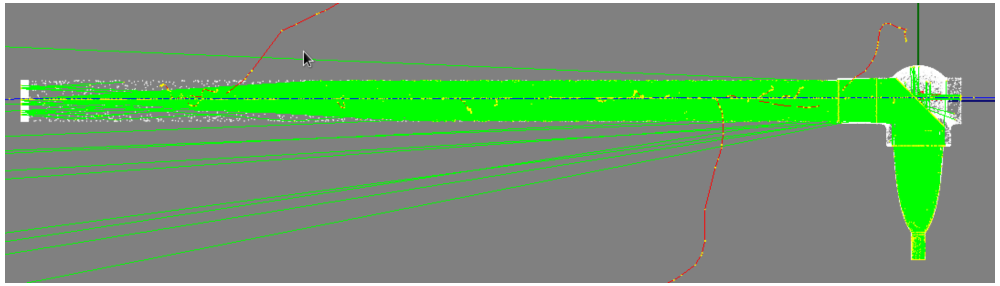
- With the maximum acceptance angle, the entrance aperture and exit aperture → design CPC



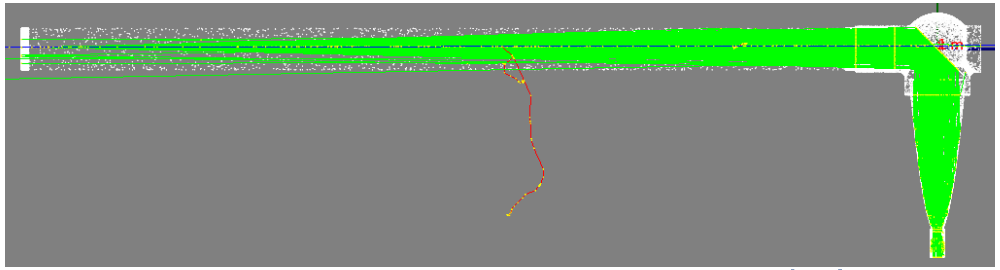
# NEW DESIGN

New design parabolic mirror:

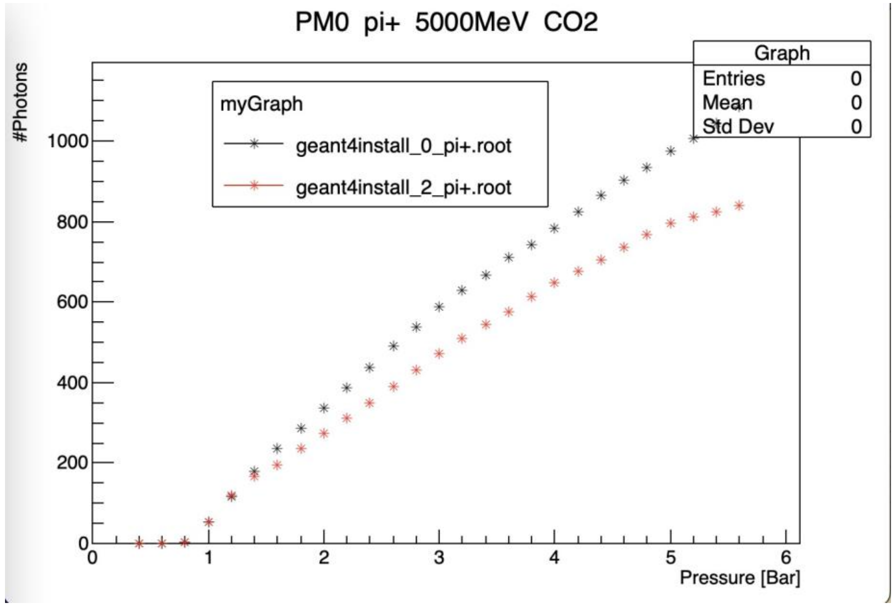
- Decrease ~30% height from actual design
- Has optimal dimensions for 45º mirror and PM
- Improve collection of photons at high Cherenkov angles
- Improve reflectivity at UV range



*New parabolic mirror version 1*



*current parabolic mirror*



# NEW DESIGN

Advantages of new design:

- Head:
  - Increase Head diameter to Neutrino Platform beamline diameter
  - Increase of 18% the diameter → more photons reaching the 45º mirror
- 45º mirror:
  - Improve the absolute reflectivity up to 40% in UV range (better coating)
- Parabolic mirror:
  - Improve reflectivity around 20% (better coating)
  - Maximize exit diameter with PM photocathode→ maximize collection photons
  - Reduce height → optimize collection of photons → reduce cost
- Optical window:
  - Maximize diameter with PM window → maximize collection photons
  - Maximize transmittance in UV (change of material)
  - Minimize reflectivity in UV (coating)

# Thank You!