Update of the SoLID Cerenkov detector for PVDIS: PMT option

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Outline

- Update of the detector layout

- Update of the simulation details

- Results

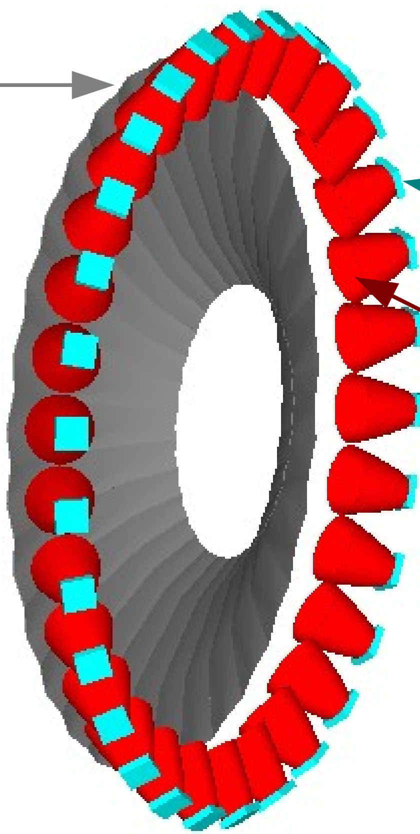
- Summary, prospectives

Update of the detector layout

Similar to what existed before, but some dimensions have changed:

Observer position (unchanged):
240 cm away from beamline
240 cm downstream the
center of the hall

Mirrors:
"Coverage" from
19 to 37 degrees
(relative to the
center of the hall)

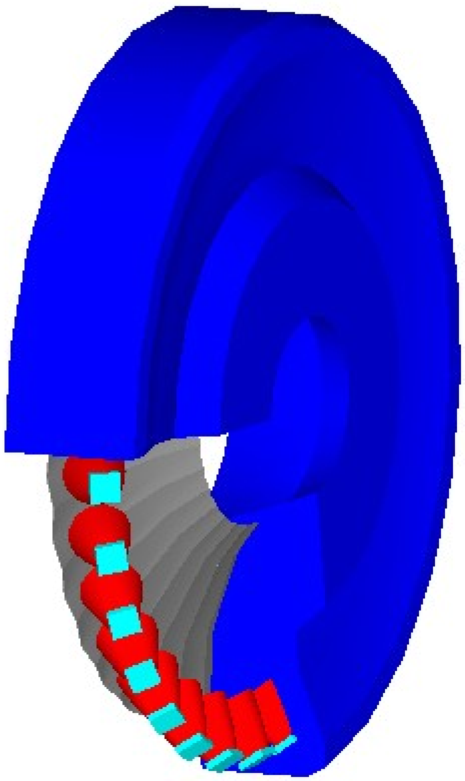


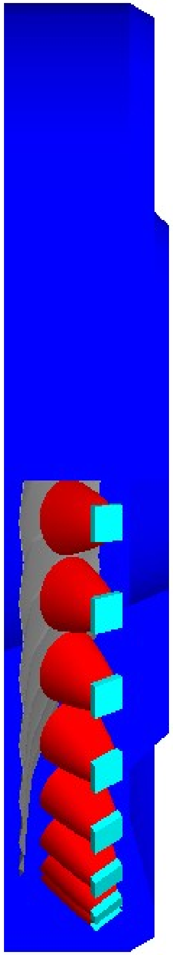
PMT arrays: 4x4 PMTs
(8x8 inches)

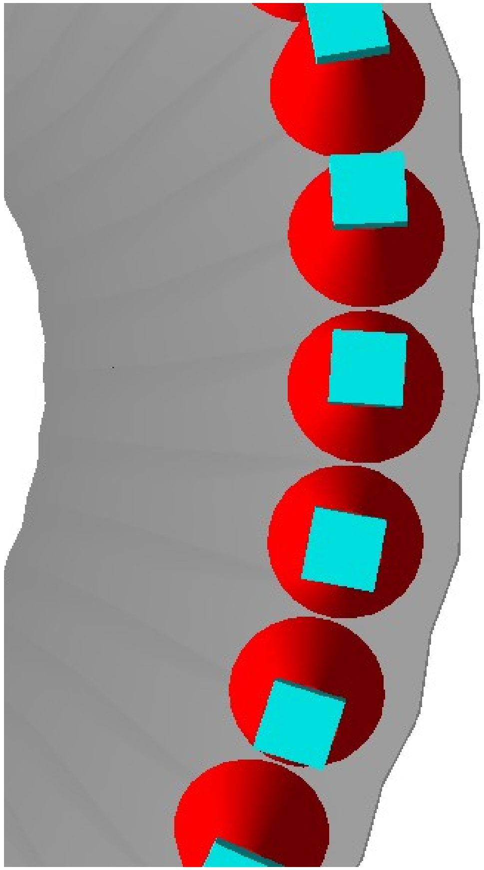
Winston cones:
- input diameter: 42.0 cm
  (16.535 inches)
- length: 39.0 cm
  (15.354 inches)
- output diameter: 10.16 cm
  (8 inches)

Update of the detector layout

Compatibility of this setup has been checked: OK







Observers compatible with tank

Observers compatible with each others

Update of the simulation details

Realistic absorption length for C_4F_{10} has been added:

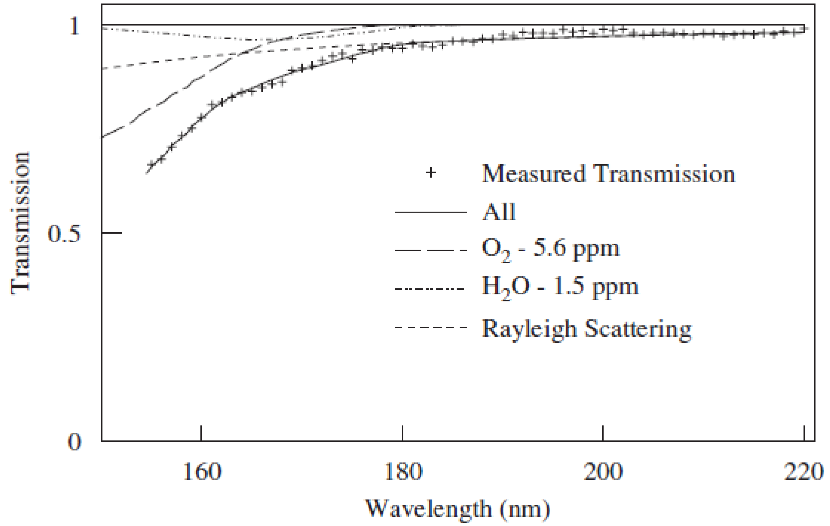


Fig. 35. Typical UV light transmission through 1.87 m of C_4F_{10}, as measured online during data taking (crosses). The solid curve is a fit to the data. The main contributions to the UV light absorption are also shown.

[P. Abbon *et al.*, "the COMPASS experiement at CERN", NIM A577 (2007), pp 455-518]

=> reasonably conservative (may do better, but we can at least achieve this)

Update of the simulation details

Started to set up realistic surfaces in the GEANT 4 simulation;
Currently, surfaces are still perfect, and only include reflectivities (for mirrors) and efficiencies (for PMTs)

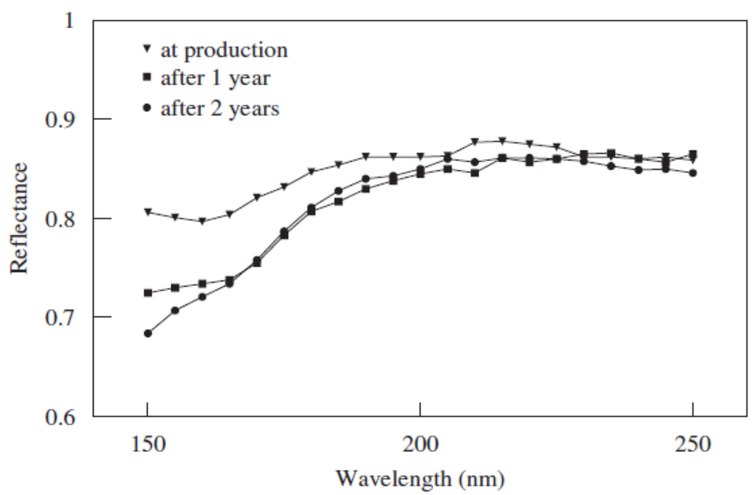
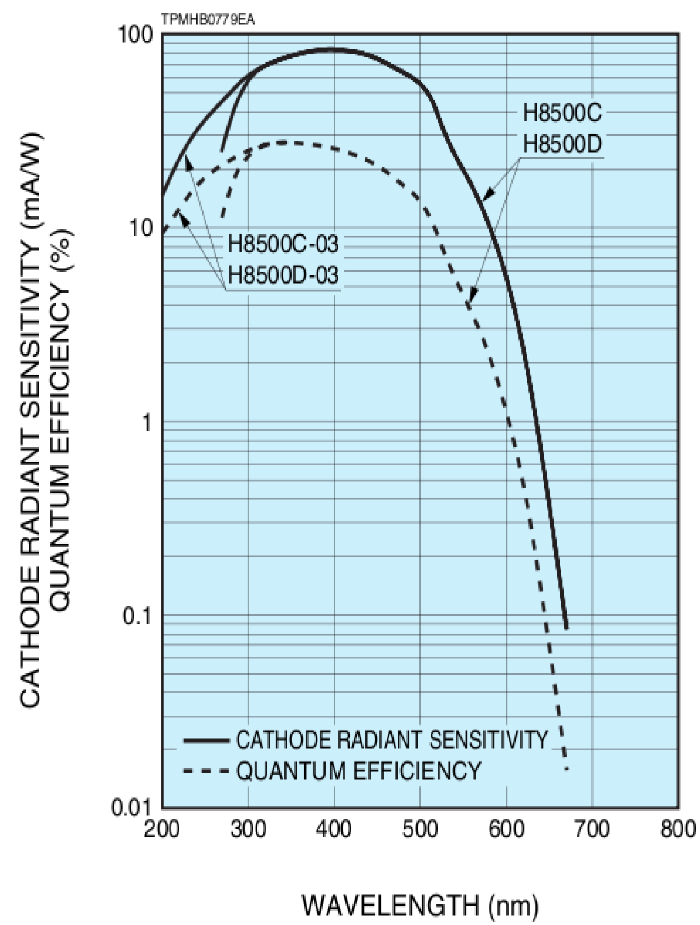


Fig. 36. Measured reflectance for a typical mirror piece. The measurements have been performed shortly after production, 1 and 2 years later.

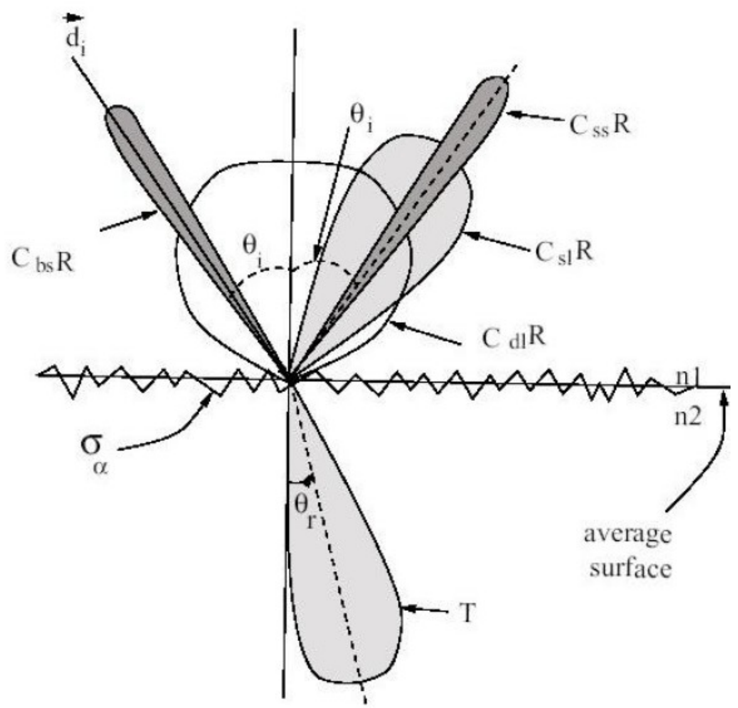
[P. Abbon *et al.*, "the COMPASS experiement at CERN",
NIM A577 (2007), pp 455-518]



Hamamatsu

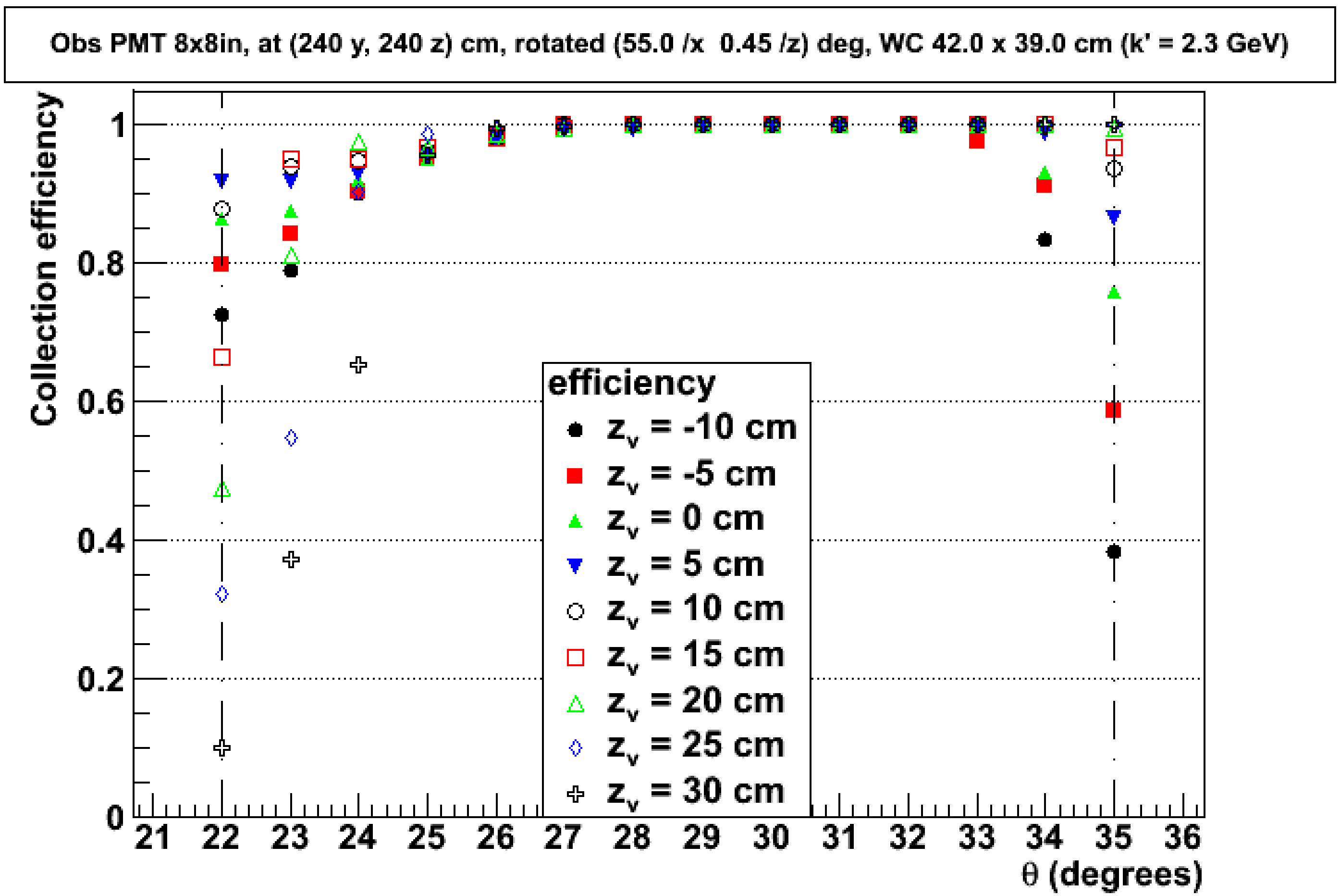
Update of the simulation details

Started to set up realistic surfaces in the GEANT 4 simulation;
Need better understanding of the surfaces in GEANT 4
(may somebody be able to help ?) in order to include all possible
kinds of reflection, plus the effect of the coating on the mirrors, plus
the effect of the dielectric interface gas/PMT window.



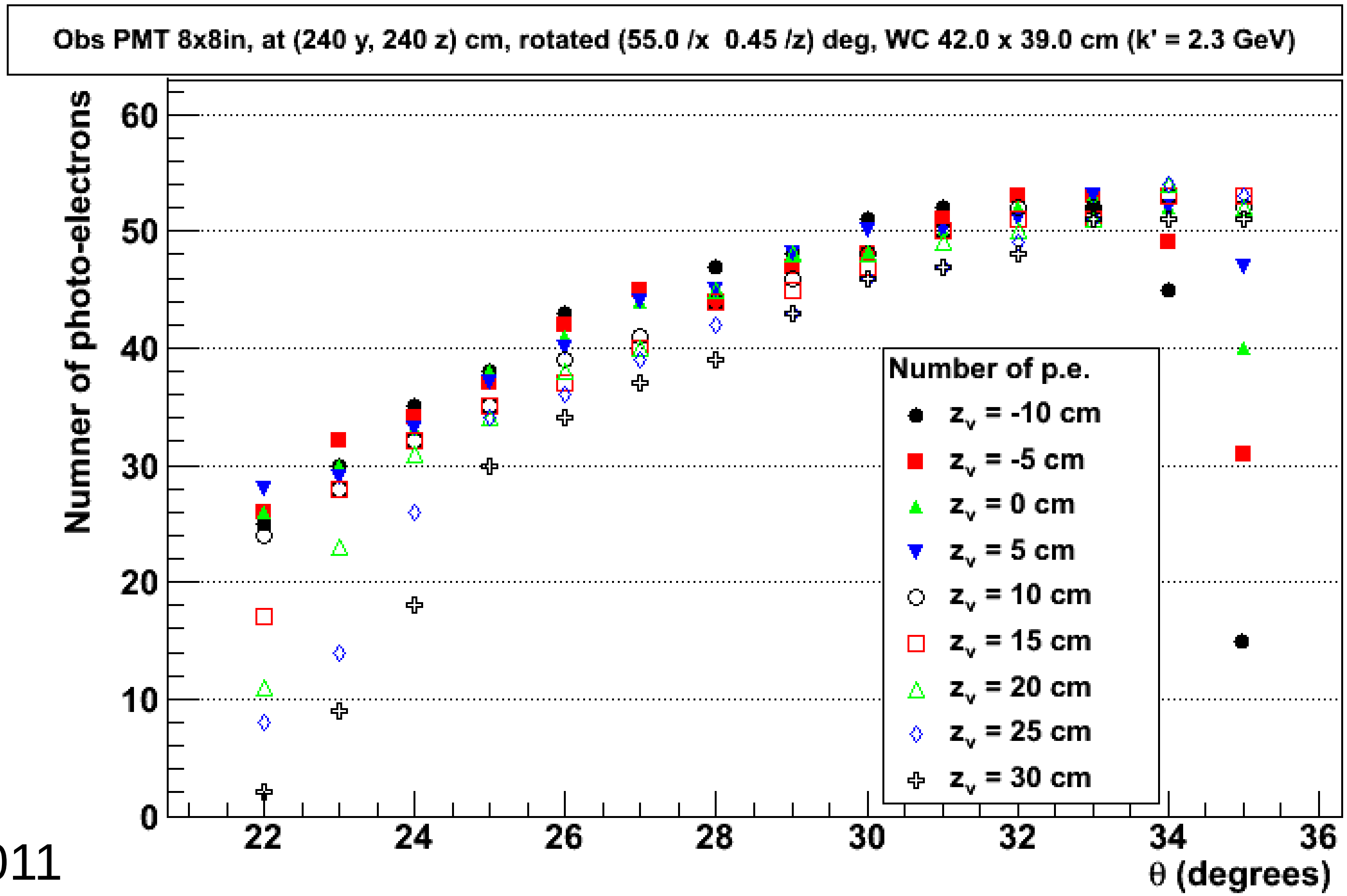
Results

Efficiency (with perfect surfaces at 100 % reflectivity for mirrors, and 100% efficiency for PMTs). Optimized at $k' = 2.3$ GeV.



Results

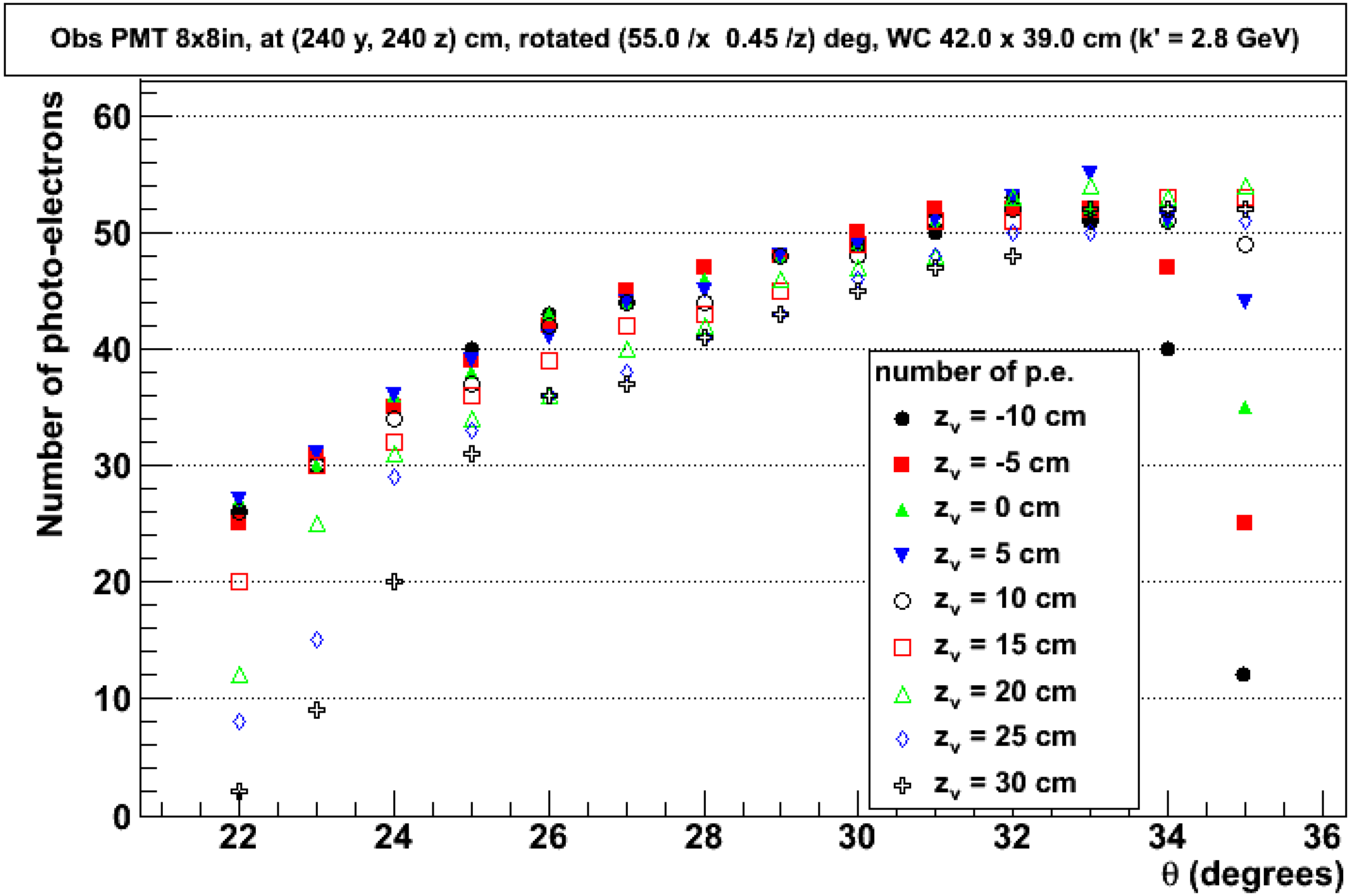
Number of photoelectrons with C4F10 (absorption length included, perfect surfaces at reflectivities and efficiencies shown above, dead PMT area taken into account by a coefficient) at $k' = 2.3$ GeV.



CF4: <20 p.e. @ $z = +10$ cm, $\theta = 33$ deg, at same energy, within same hypothesis.

Results

Number of photoelectrons with C4F10 (absorption length included, perfect surfaces at reflectivities and efficiencies shown above, dead PMT area taken into account by a coefficient) at $k' = 2.8$ GeV (detection threshold for pions).



Summary

- Progress has been made, for the PMT option mainly, to improve the collection efficiency of the detector;

- So far, the number of photoelectrons for C_4F_{10} is large enough over most of the acceptance, except at the edges of the target. BUT pure C_4F_{10} has a limited energy range, and pure CF_4 wouldn't do the job.
  => would consider a mix of CF_4 and C_4F_{10} to extend the detector momentum range.

Prospectives

TO DO

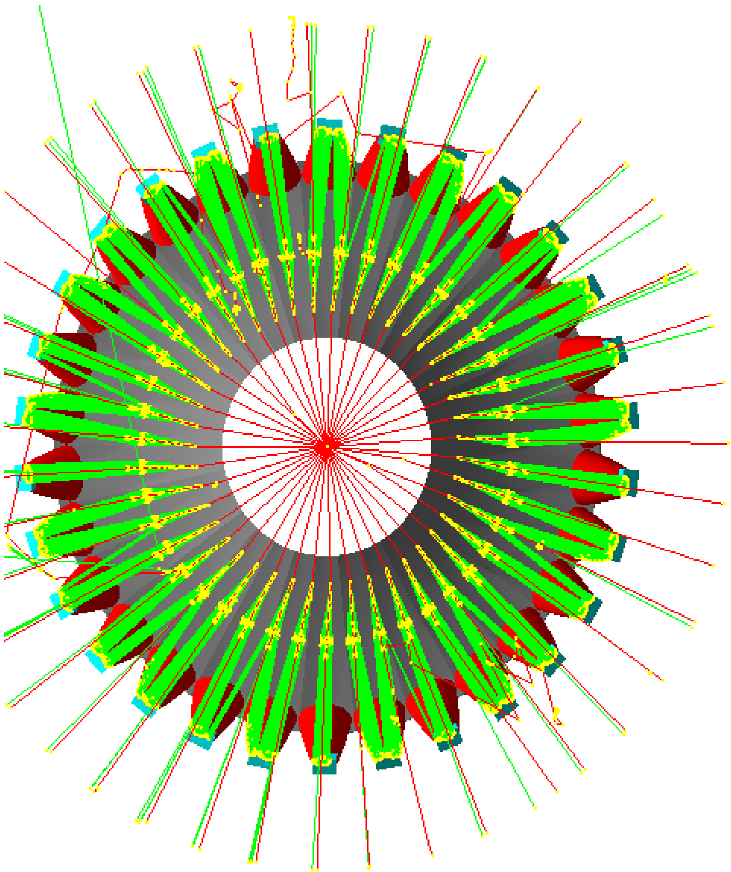
- For PMT option:
  * Add more realistic surfaces => started, work in progress (i.e. need better understanding of how surfaces work in G4);
  * If still “satisfying” efficiencywise, try to achieve similar performances with 6x6 inches PMT arrays (for cost saving);
  * Try to consider a mix of Cerenkov gases to extend energy range.

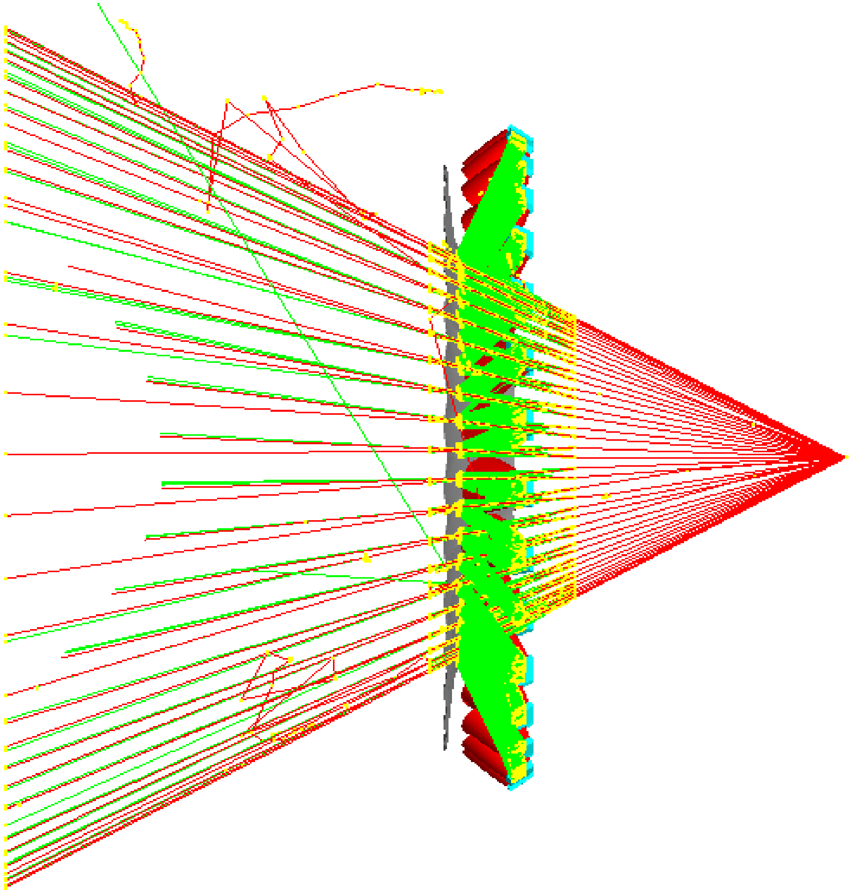
- For GEM option:
  * Try to optimize the Cerenkov detector with PHENIX GEMs (since apparently there would be an opportunity to get them)

BACK UP

Collection efficiencies

In the middle of the acceptance (z = +10 cm, θ = 29 deg)

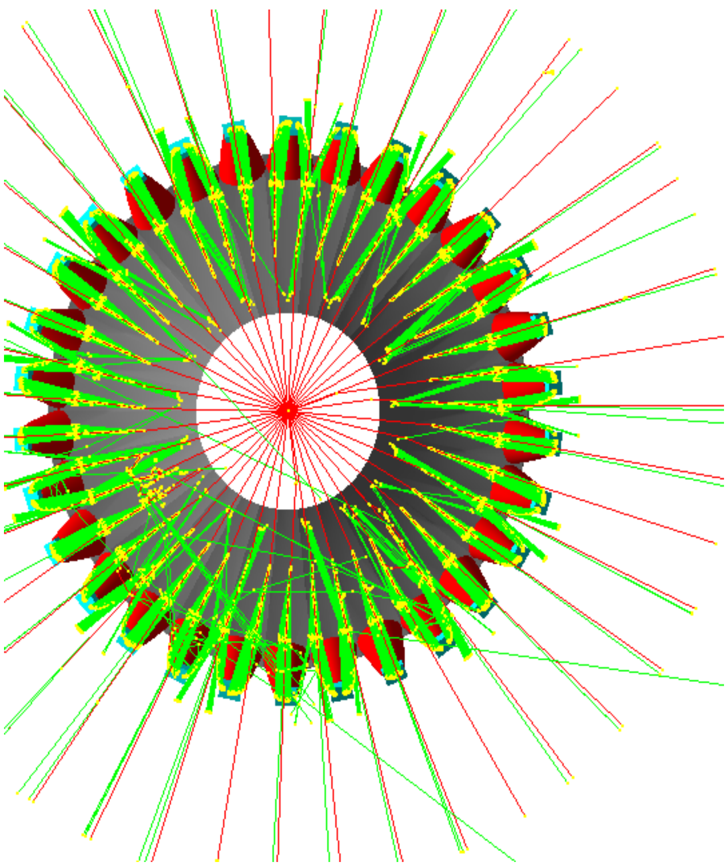




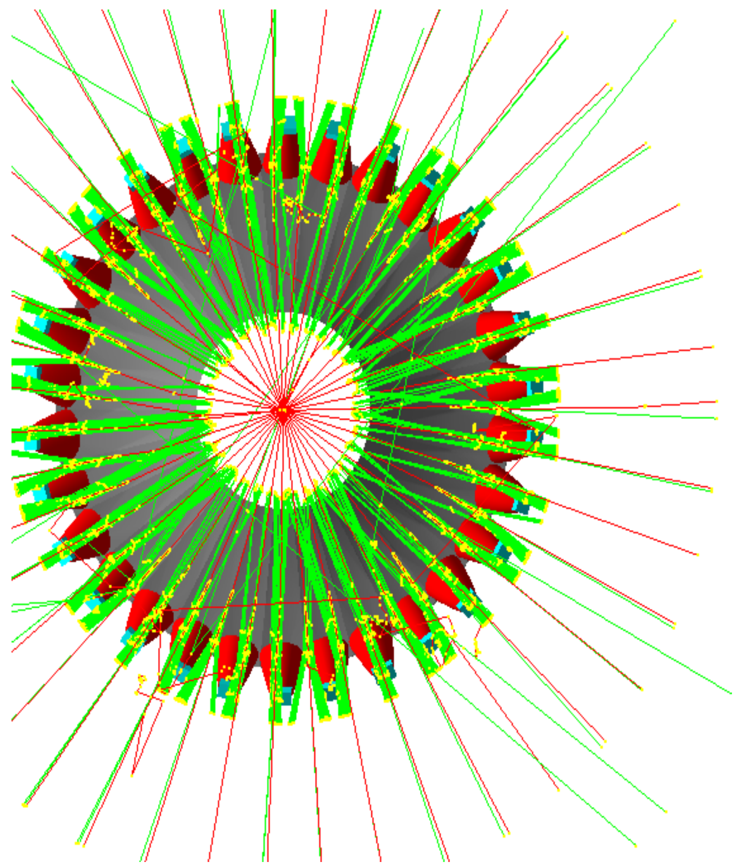
Collection efficiencies

At the higher edges of the acceptance ($\theta = 35$ deg)

$z = +10$ cm



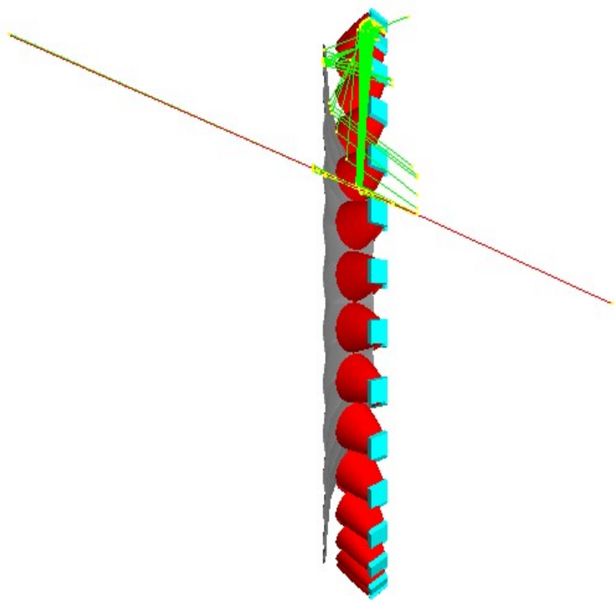
$z = +30$ cm



Collection efficiencies

At the lower edges of the acceptance (θ = 22 deg)

z = +10 cm



z = -10 cm