Update of the SoLID Cerenkov detector for PVDIS: CSI coated GEM option

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Outline

- Update of the detector layout

- Update of the simulation details

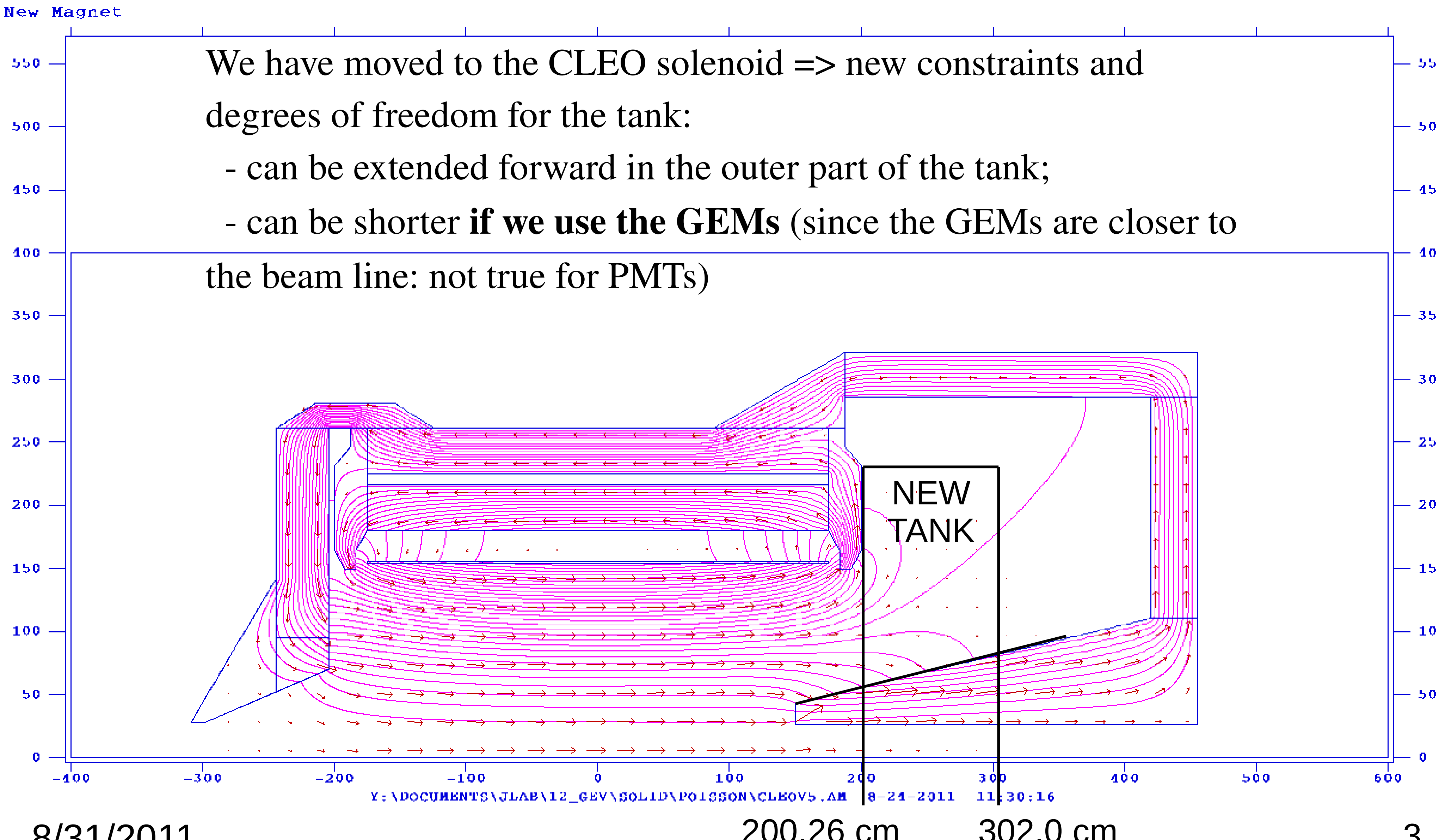
- Results

- Summary, prospectives

Update of the detector layout

We have moved to the CLEO solenoid => new constraints and degrees of freedom for the tank:

- can be extended forward in the outer part of the tank;
- can be shorter **if we use the GEMs** (since the GEMs are closer to the beam line: not true for PMTs)

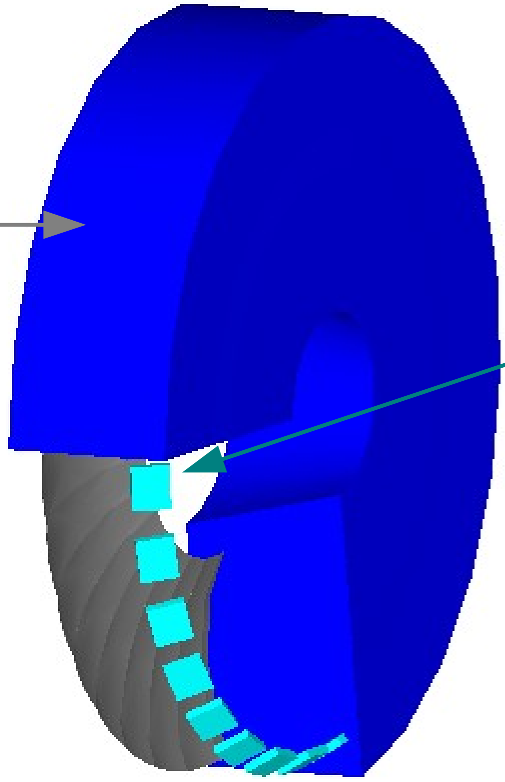


BTW is 302 cm OK ?

Update of the detector layout

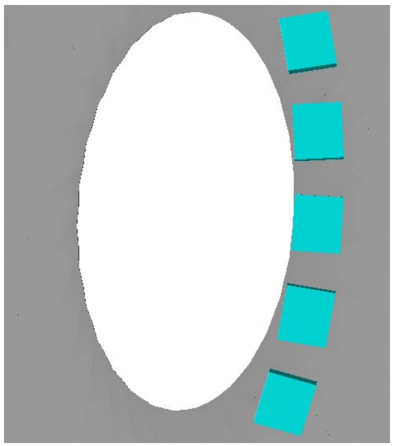
Observer position:
210 cm away from beamline
220 cm downstream the center of the hall

Mirrors:
“Coverage” from 19 to **38** degrees (relative to the center of the hall)
Note: there curvature radius is different from the mirrors in the PMT option



CSI coated GEM from PHENIX:
$23 \times 27\ cm^2$
“long” dimension along **phi**
“short” along **z**

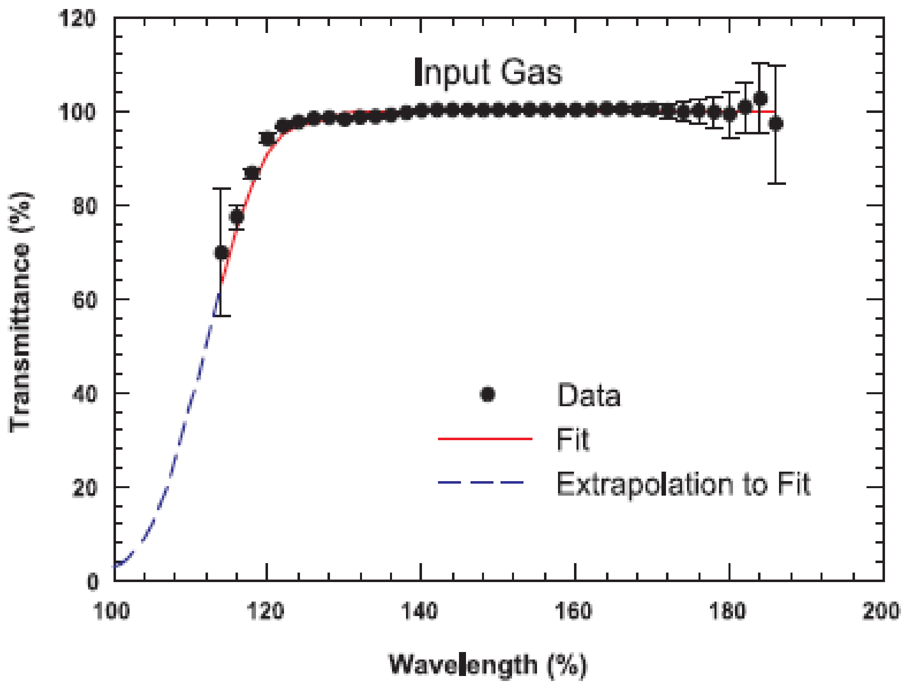
No Winston cones



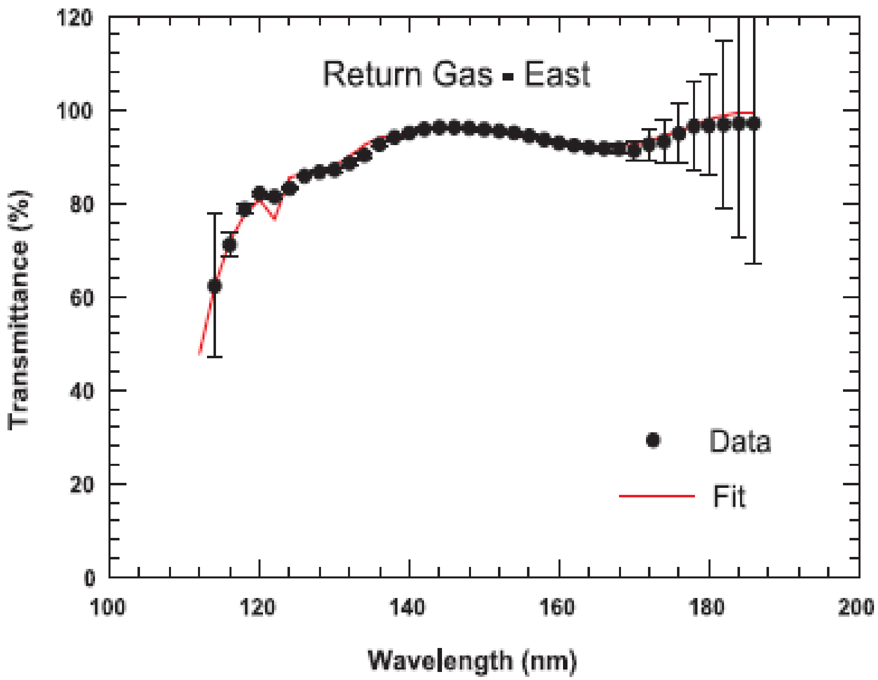
Note: use of CF_4 is mandatory
(C_4F_{10} is a quencher for GEMs)

Update of the simulation details

Absorption length set for CF4:



H_2O, O_2 < 2ppm
("pure" gas)

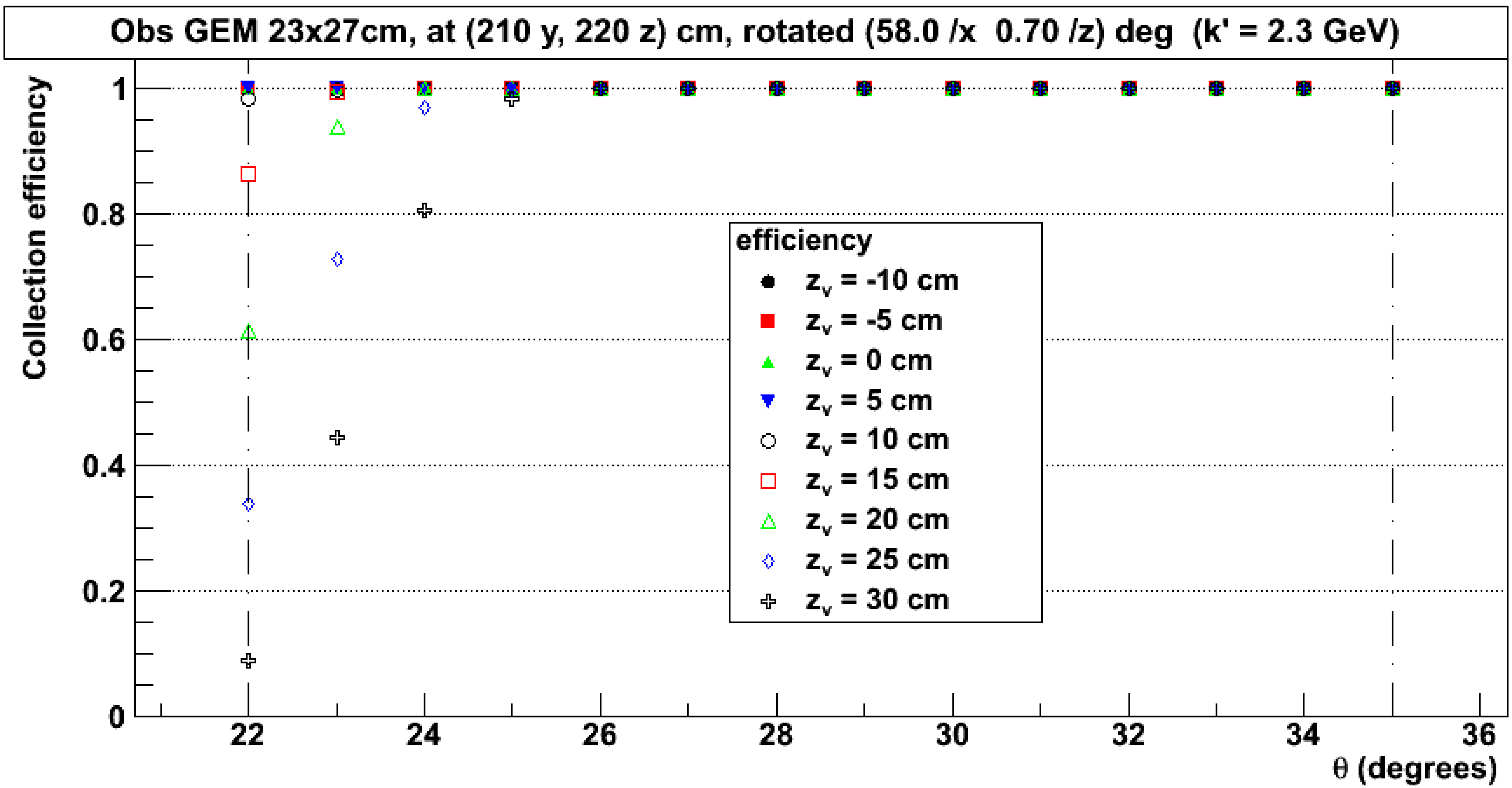


H_2O ~ 20-30 ppm
O_2 ~ 2-3 ppm

[W. Anderson et al, arXiv 1103.4277v1 physics.ins-det]

Results

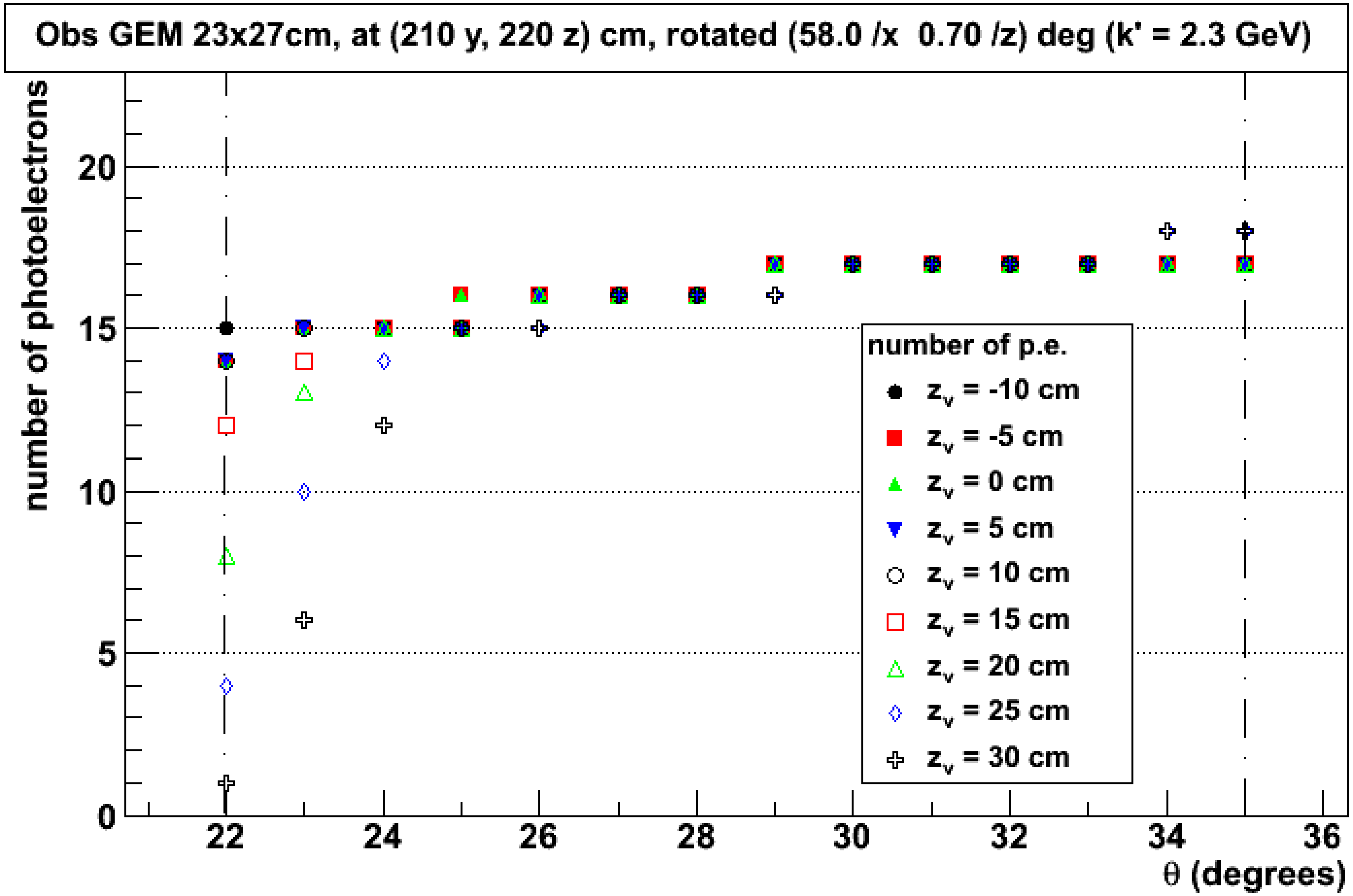
Efficiency (with perfect surfaces at 100 % reflectivity for mirrors, and 100% efficiency for GEMs). Optimized at $k' = 2.3$ GeV.



Results

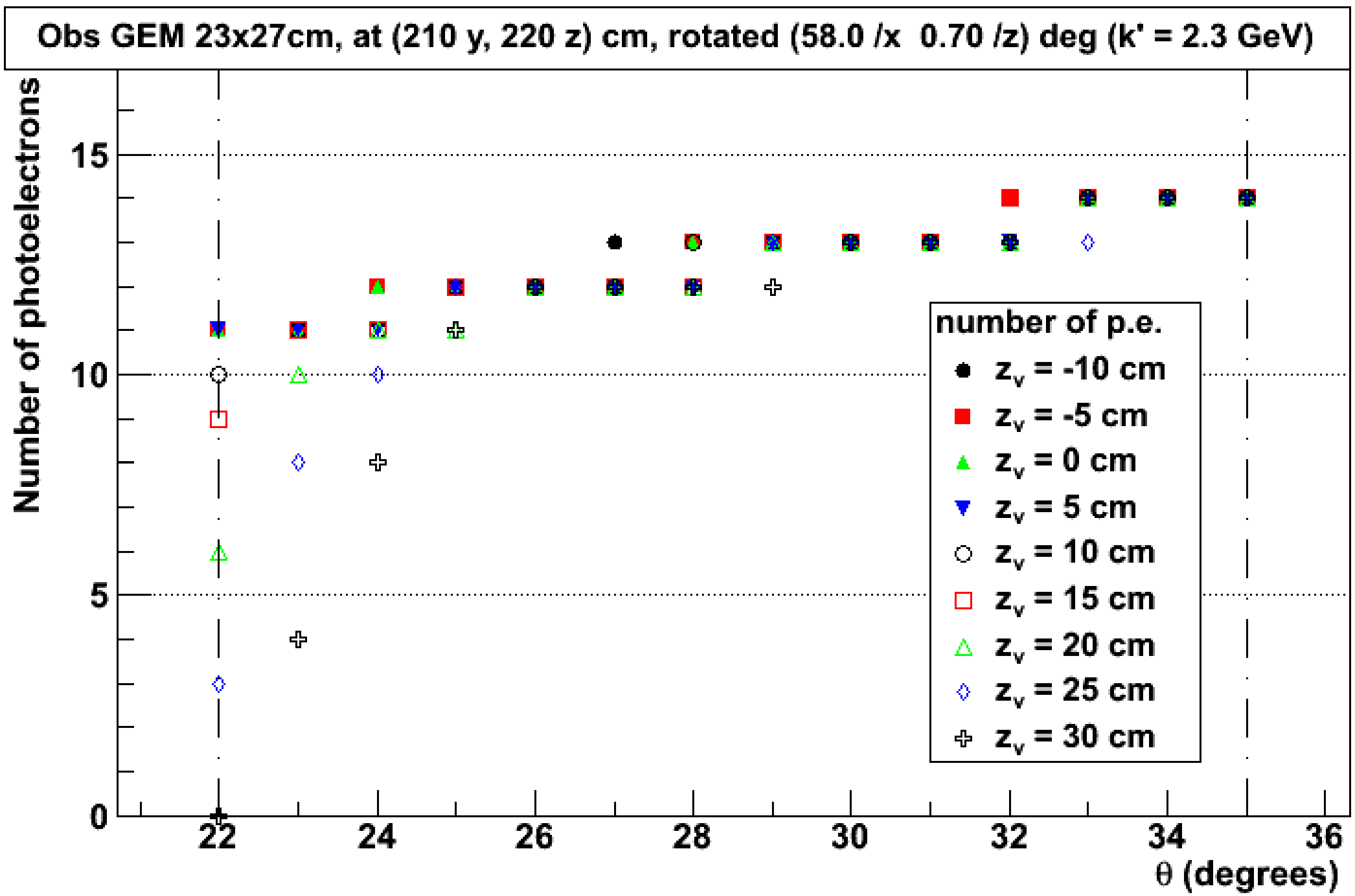
Number of photoelectrons with “pure” CF_4 at $k' = 2.3$ GeV

(Mesh transparency, dead GEM area, gas transparency, p.e. transport efficiency corrected by a global factor of 0.54)



Results

<u>Robustness test</u>: Number of photoelectrons with **20-30 ppm H_2O / 2-3 ppm O_2 contaminated** CF_4 => still functional.



Summary

- The cerenkov detector has been reoptimized with the new solenoid, at least for the CsI coated GEM option (optimization for the PMT option is underway);

- the number of photons is sufficient, while the simulation tends to be as realistic as it could be: the cerenkov detector with its new design is functional, and it even seems robust to a reasonable level of contamination.

Prospectives

TO DO:

- Introduce this design in GEMC;

- get the GEM prototype and its DAQ from Stony Brook (during september probably) and test it;

BACK UP

Results

As a cross check to those numbers of photoelectron, we compared the yield of raw number of photons produced on the path length of the electron in the gas given by GEANT 4 to the number of photons given by the integral of Frank-Tamm equation over the path computed by Mathematica (courtesy of Brad Sawatzky):

=> estimation better than 8 %

GEM option (CF4, n = 1.00046, 133 photons/m):

z = 0

theta(deg)	L_Gas(cm)	N_th	N_G4	|N_G4-N_th|/N (%)
22.0	90.1	120	128	6.7
35.0	115.0	152	164	7.9

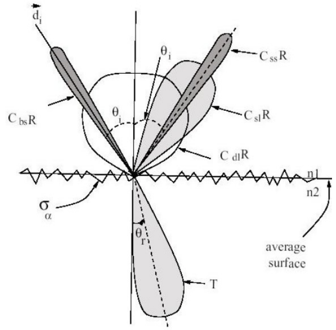
PMT option (C4F10, n = 1.0015, 454 photons/m):

z = 0

theta(deg)	L_Gas(cm)	N_th	N_G4	|N_G4-N_th|/N (%)
22.0	65.7	298	307	3.0
35.0	112.3	510	481	5.7

Update of the simulation details

Started to set up realistic surfaces in the GEANT 4 simulation: Mirrors surfaces include reflectivities, various types of reflections, and the layer of MgF_2 coating, necessary to preserve reflectivities at short wavelengths



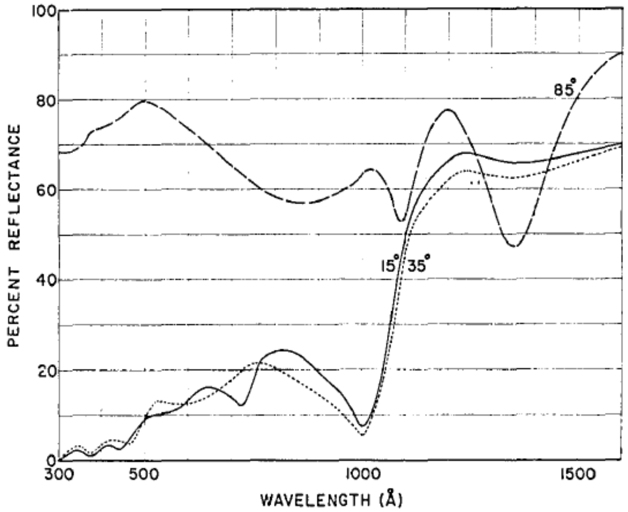
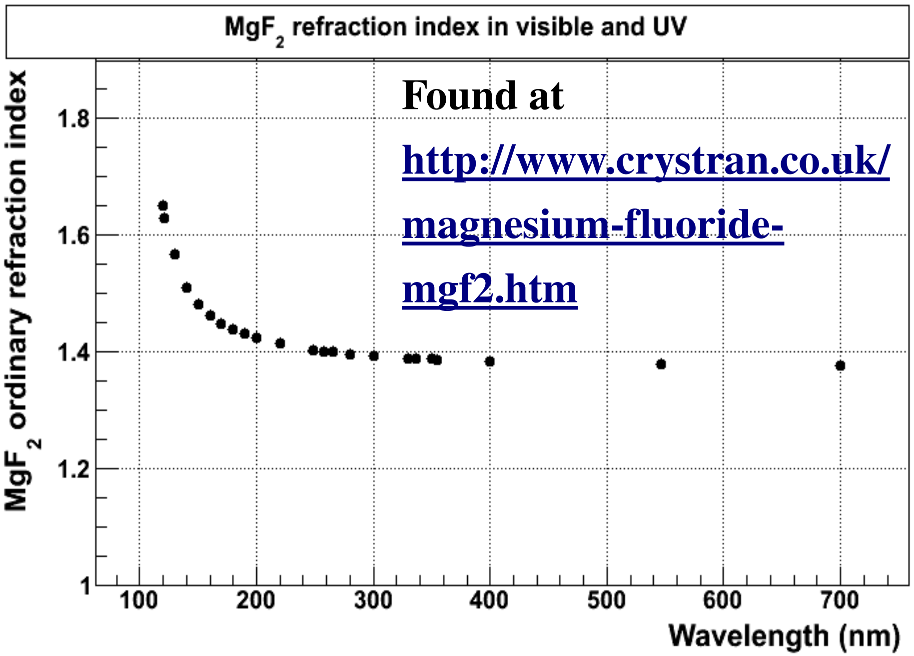


Fig. 1. Measured reflectance of an Al + MgF_2 mirror from 300 Å to 1500 Å. The MgF_2 thickness is 150 Å.

[W. R. Hunter *et al.*, Applied Optics Vol. 10, No. 3 (1971), pp 540-544]



Found at http://www.crystran.co.uk/magnesium-fluoride-mgf2.htm

Update of the simulation details

Not really figured out how to treat GEM surfaces properly:
GEM surfaces still only include efficiencies

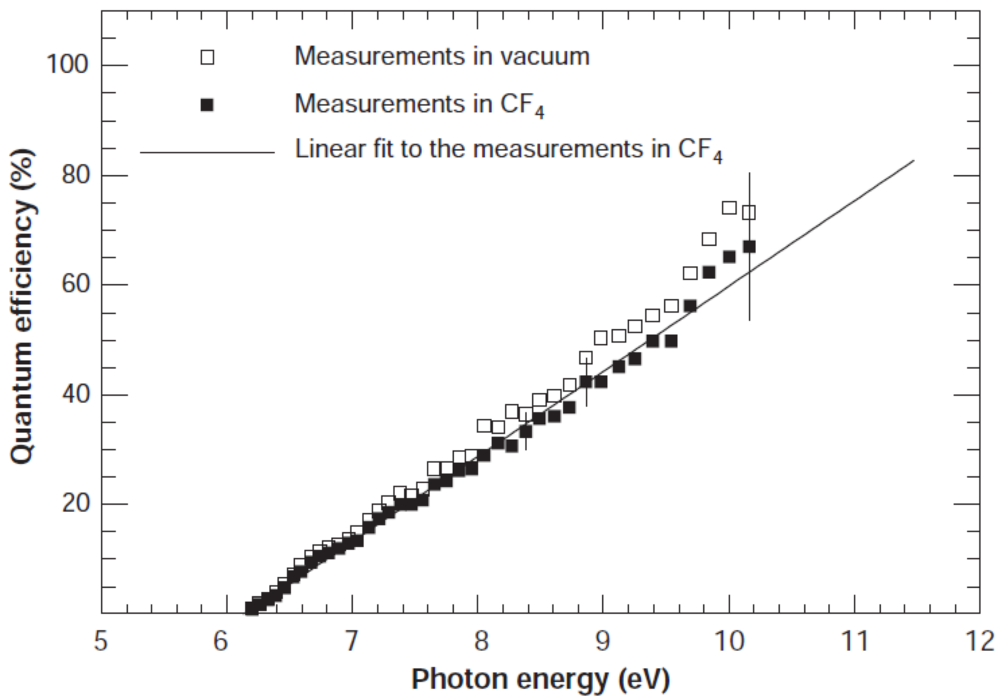


Fig. 9. Absolute quantum efficiency of CsI in vacuum and CF_4 over the bandwidth 6.2–10.3 eV.

[Z. Fraenkel *et al.*, "A Hadron Blind Detector for PHENIX experiment at RHIC", NIM A546 (2005), pp 466-480]

Results

Number of photoelectrons with CF_4 (dead GEM area - holes - taken into account by a coefficient 0.54) at $k' = 4.4$ GeV (detection threshold for pions).