Electric field study of screened PMT photocathode, D. Shuman, 8/16/12

Cross - Section
Detail through PMT
axis

14.55

13

7

4.1

70

64

MESH

SAPPHIRE

SILICONE

SUPRASIL

PHOTOCATHODE

PMT window thickness calc from Arisaka/
Hamamatsu paper showing a 35 gm window
weight

based on FILENAME

finite element unit cell model (1/2 mesh spacing), in POISSON/SUPERFISH

7400 V = equipotential @y=2 cm (for 95 kV over 7cm gap)

Neumann boundaries (field parallel) @ x=0, x=.025 cm (except at wire)

wire dia = .0012" (r=0.015mm), V= 0V, location at x=.025cm y=1.455cm

ε_r=1.0

axisymmetric model (ring mesh electrode) more closely approximates the square wire mesh (gives ~2x lower field below mesh than 2D wire plane (same model in cartesian geometry)

sapphire, ε_r=9.0

Suprasil, silicone, ε_r=3.7

wire spacing = 0.5mm (x= 0.25mm)

V=0 @ y=0 cm (photocathode)

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turn off line width in Adobe Reader and
zoom in to see mesh

"air"

sapphire

it appears that the sapphire works to "expel" the
remaining field below the mesh

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Electric field data from file MESH_DIEL.AM
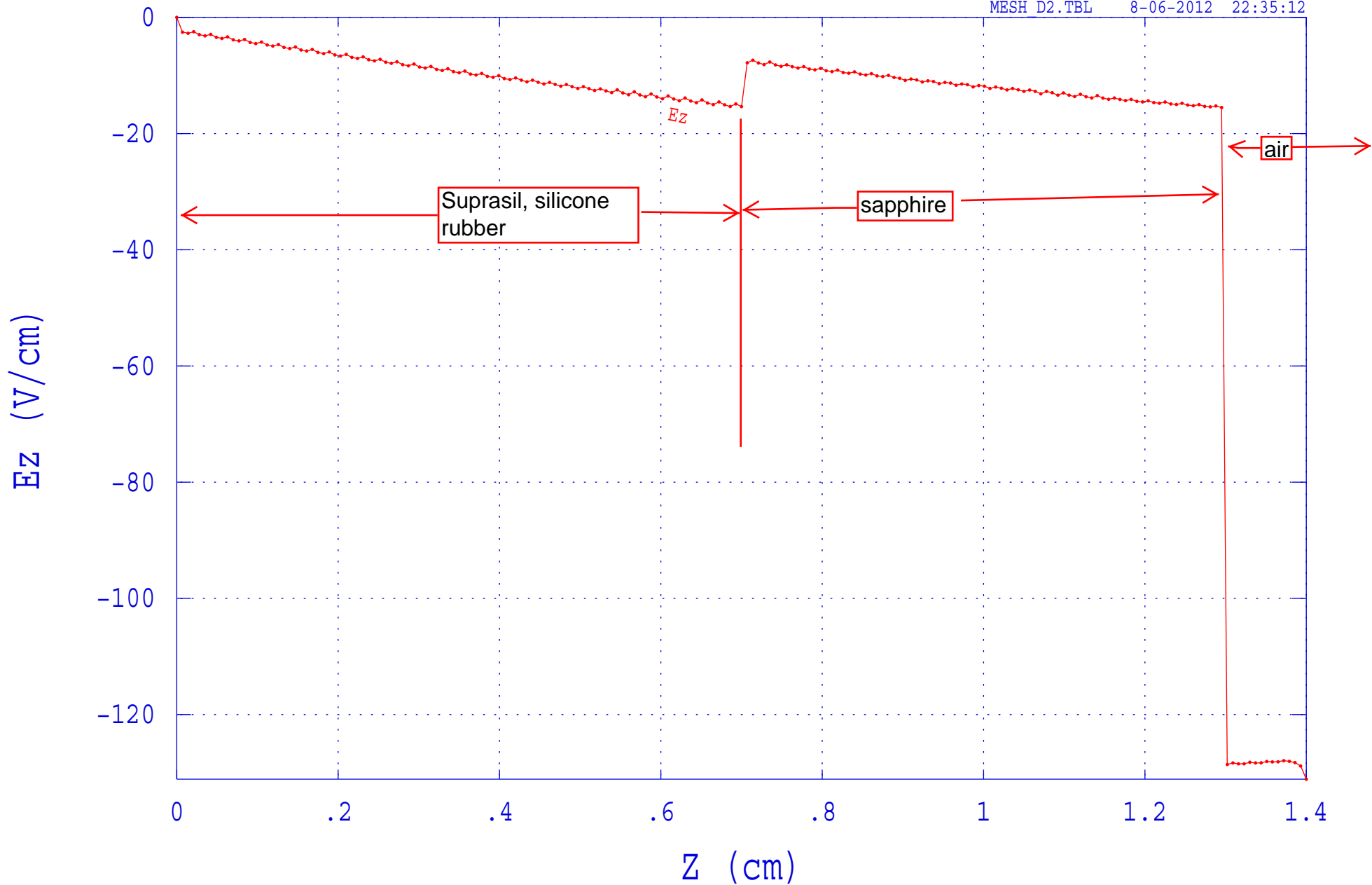## Problem title line 1: based on FILENAME

MESH D4.TBL   8-06-2012   22:38:08

Ez

Electric field along
unit cell axis (x=0)

sapphire

photocathode

mesh wire location

Ez (V/cm)

Z (cm)
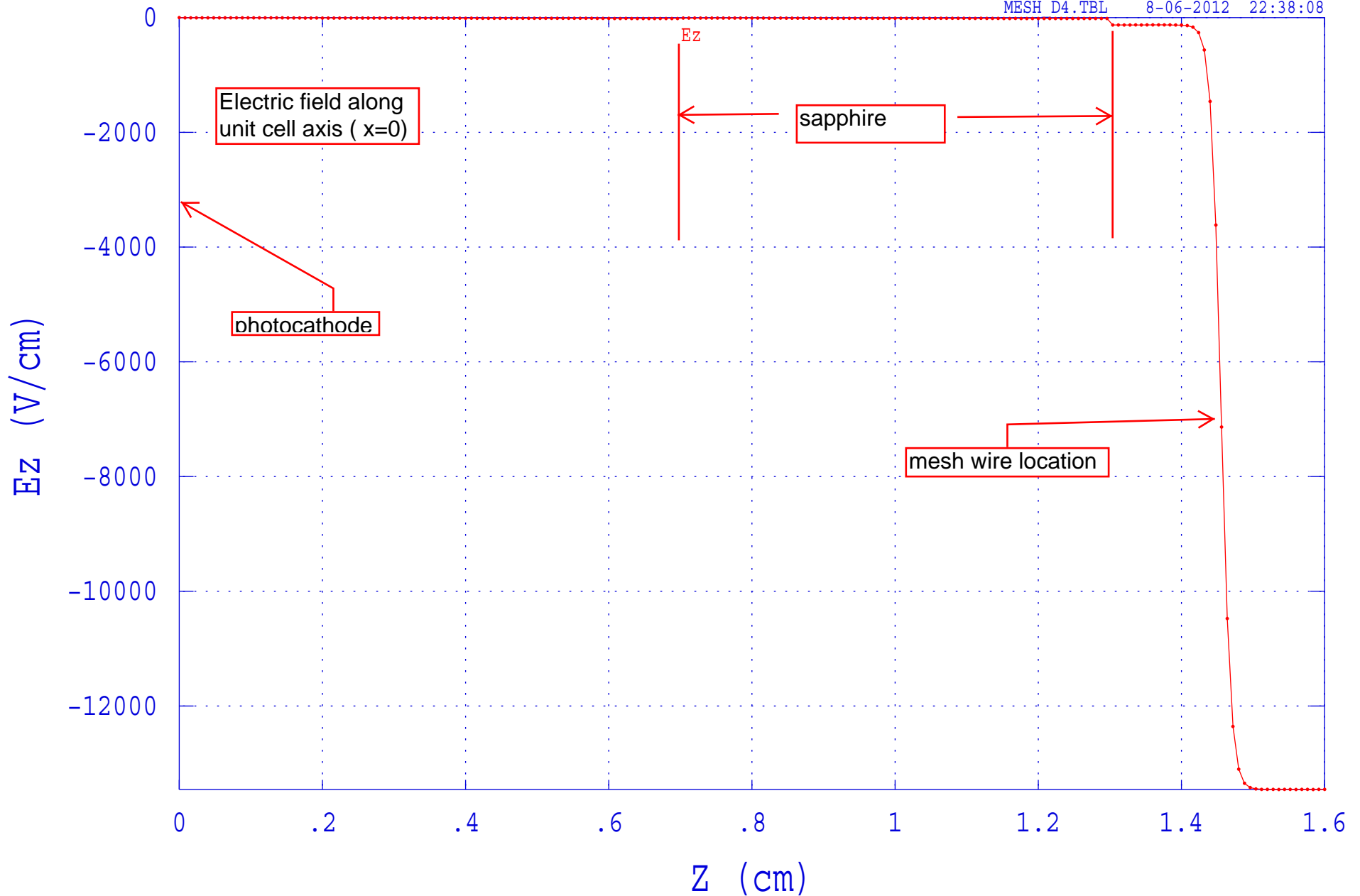
Electric field data from file MESH_DIEL.AM
Problem title line 1: based on FILENAME

MESH_D2.TBL   8-06-2012   22:35:12

Ez

Suprasil, silicone rubber

sapphire

air

Ez (V/cm)

Z (cm)

Electric field data from file MESH_NO_DIEL.AM
Problem title line 1: based on FILENAME

MESH_N2.TBL   8-16-2012 14:00:30

Same (axisymmetric) geometry, but with
all materials set to $\varepsilon_r=1.0$
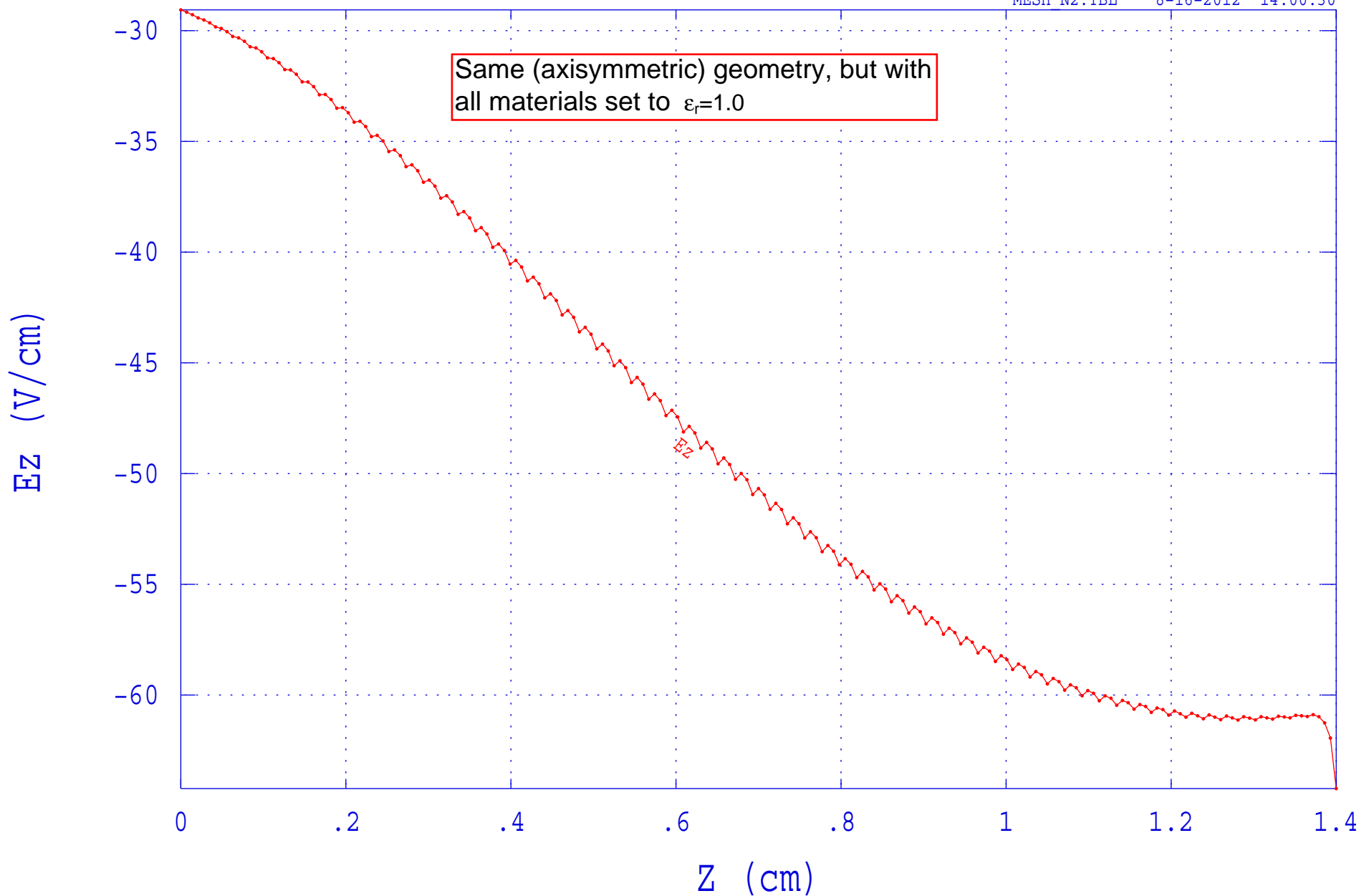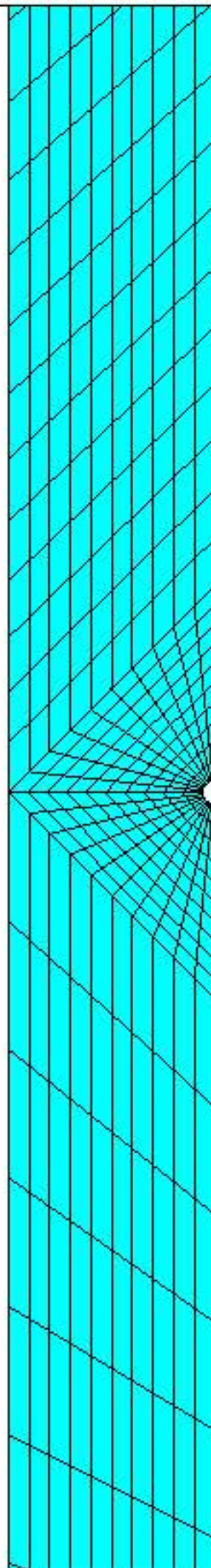
same geometry using coarser ANSYS finite element model for a check
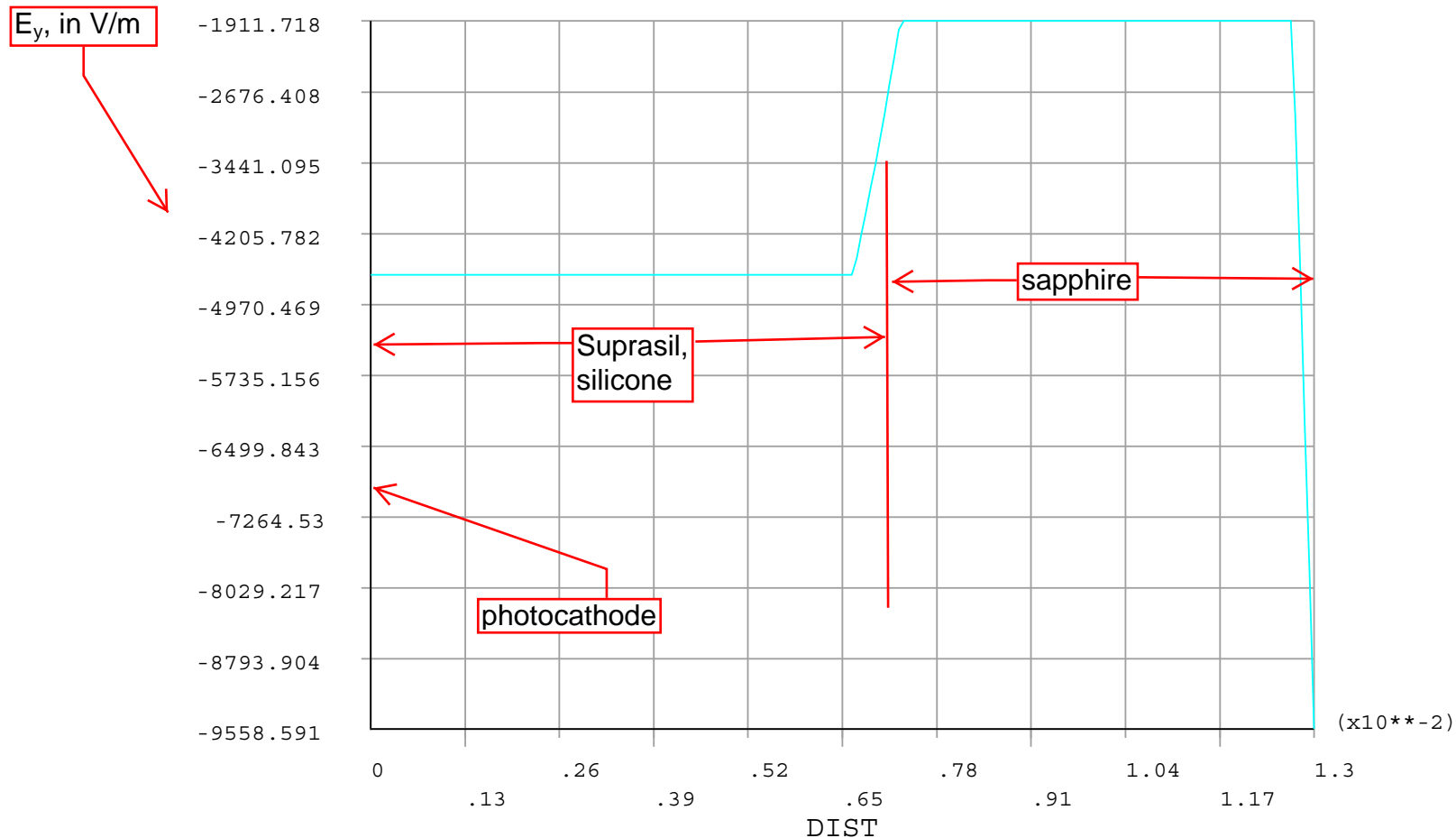
Conclusion: A fine mesh screen mounted over the sapphire windows, held at ground potential, results in electric fields that are sufficiently low enough across the PMT (Suprasil) window to avoid electrolysis of the photocathode. There is no need to isolate these mesh screens and run them at some other voltage (to further reduce the field)