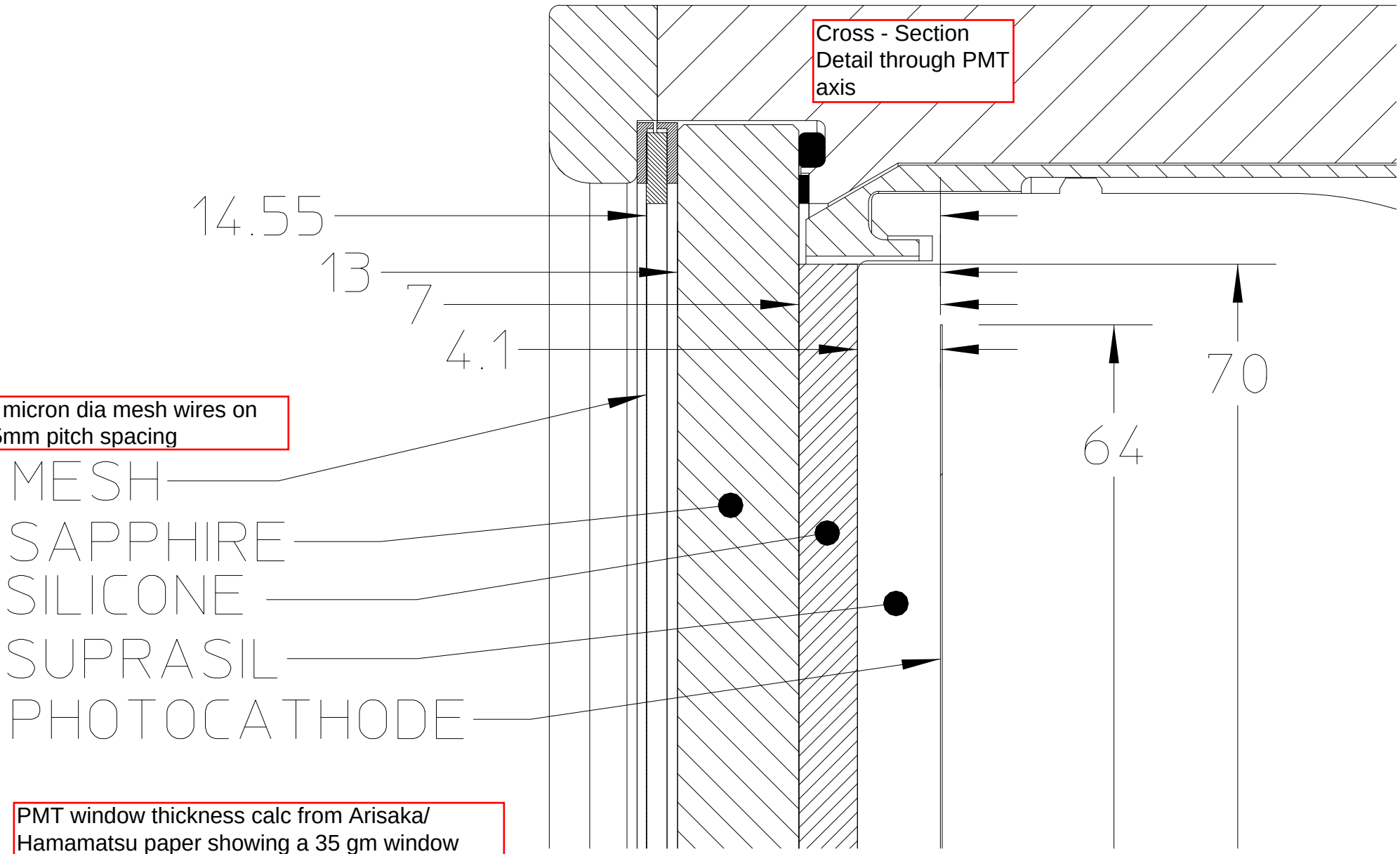
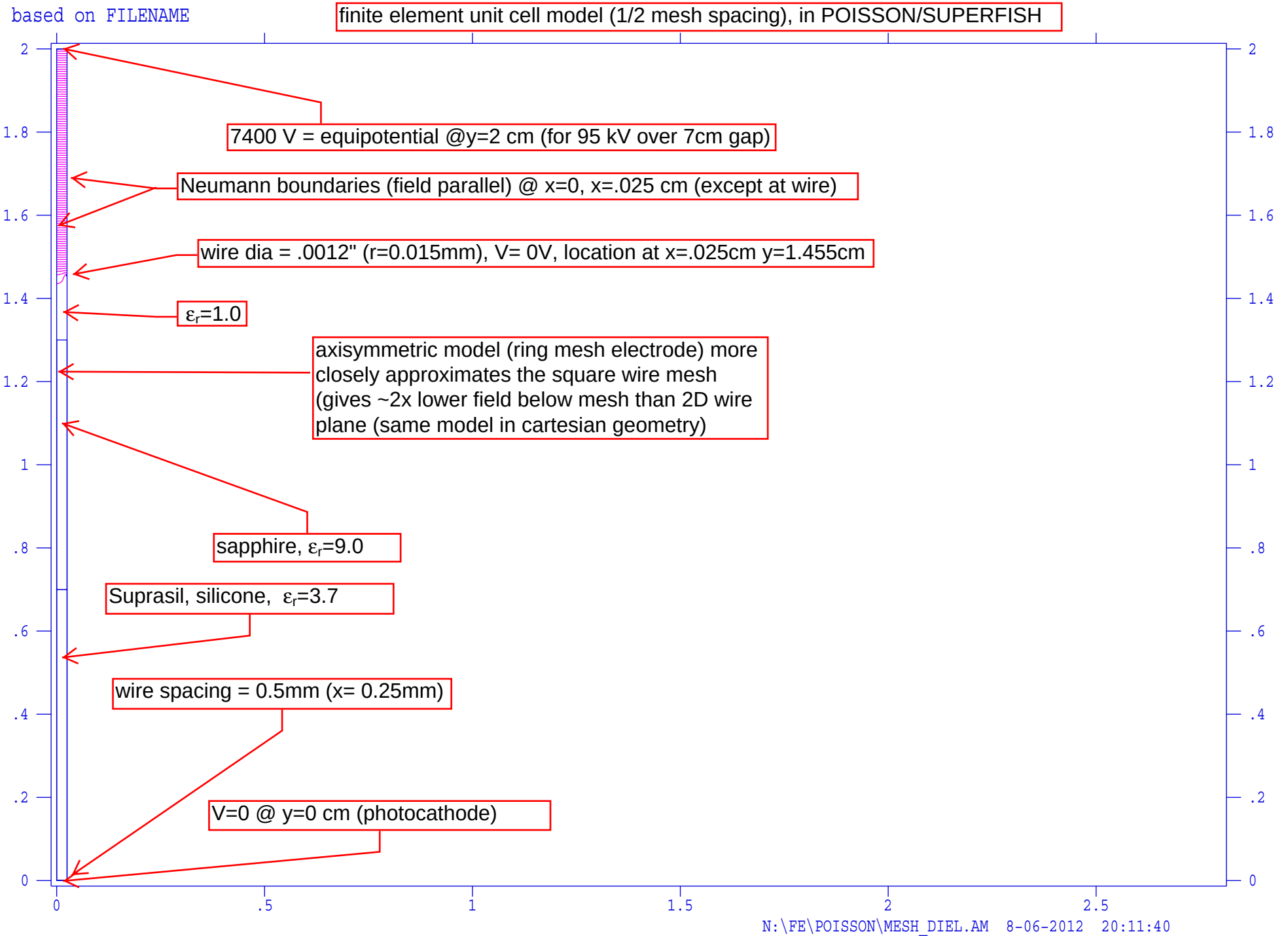
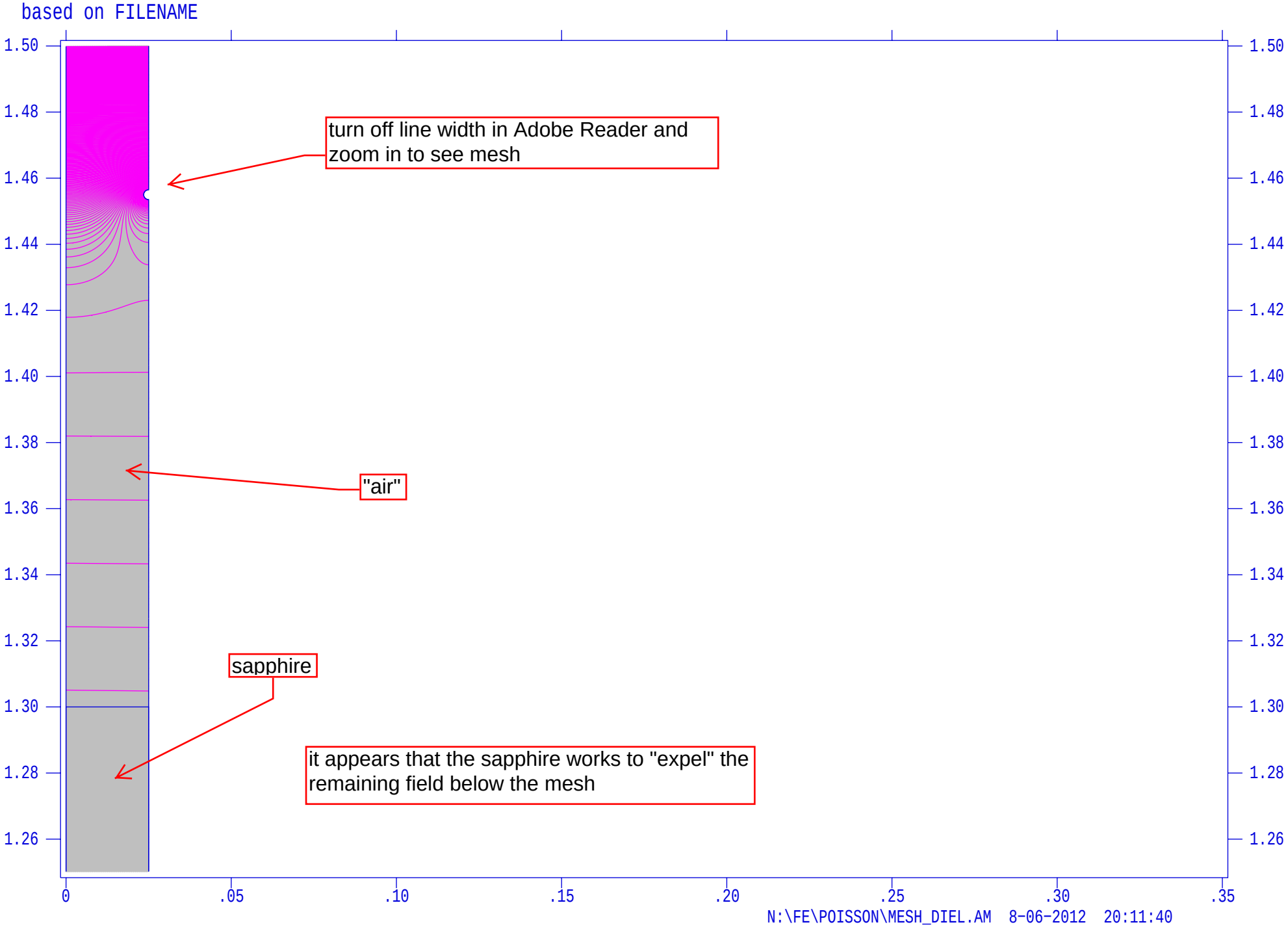
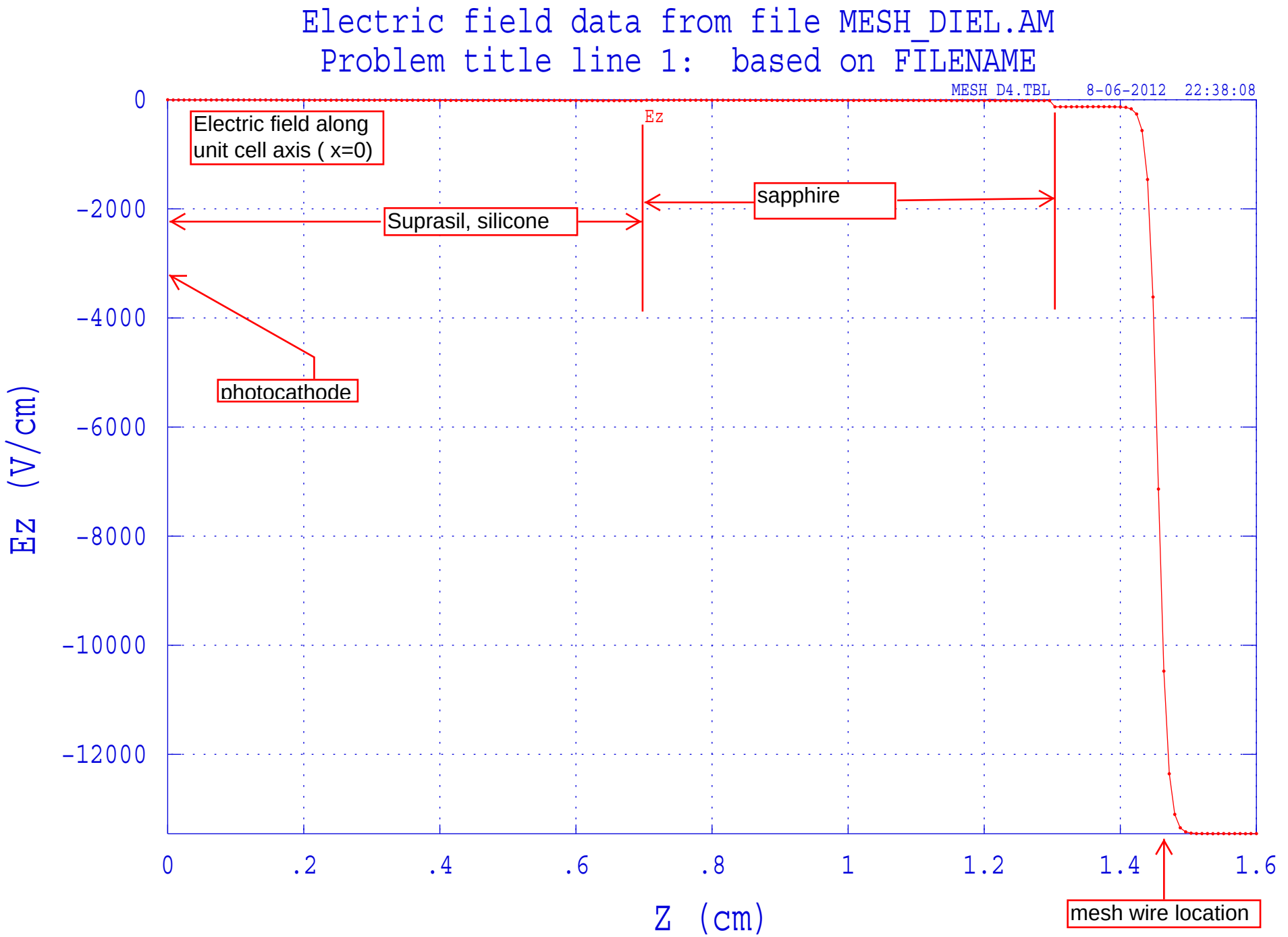
Electric field study of screened PMT photocathode, D. Shuman, 8/16/12

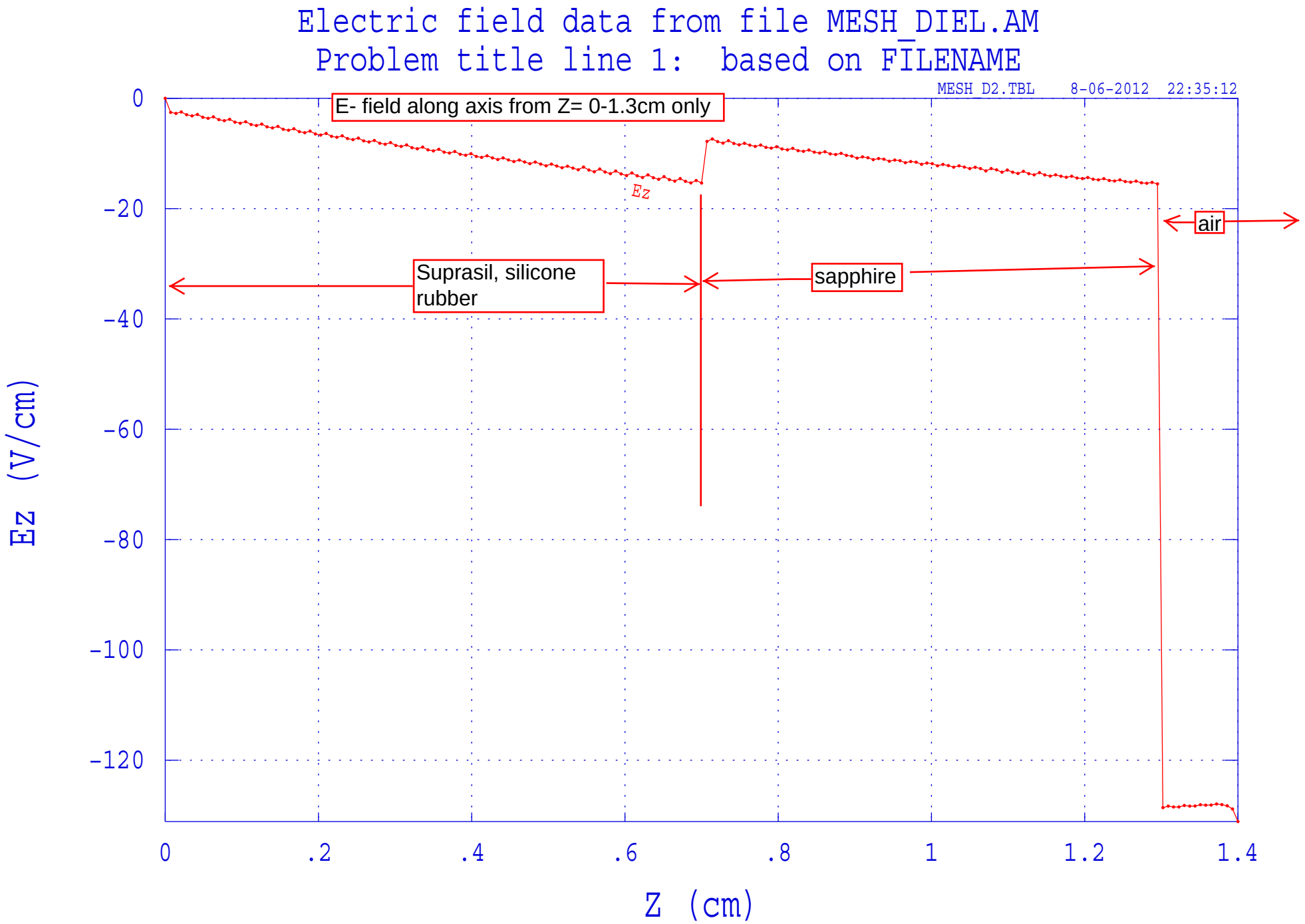


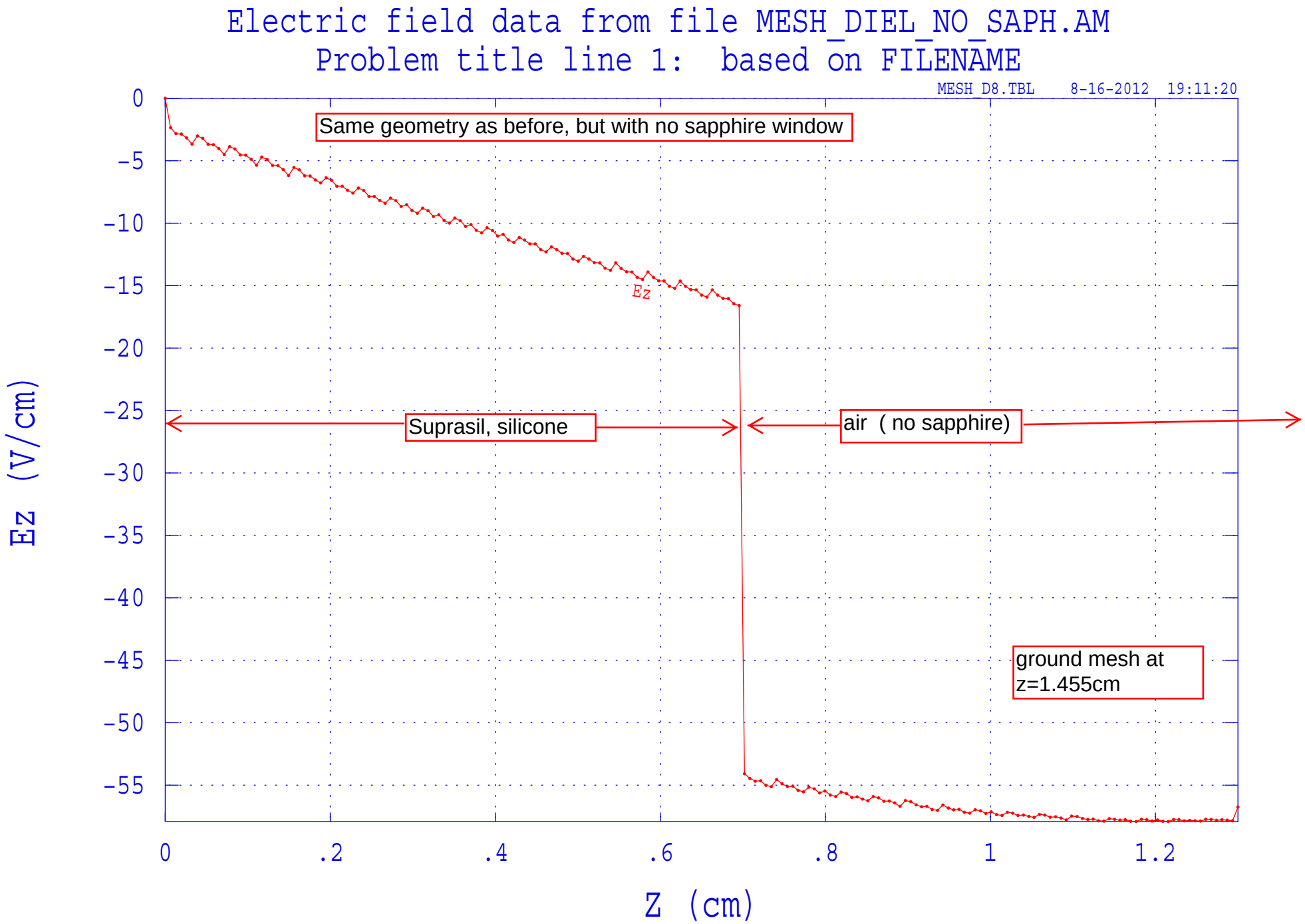
PMT window thickness calc from Arisaka/
Hamamatsu paper showing a 35 gm window
weight

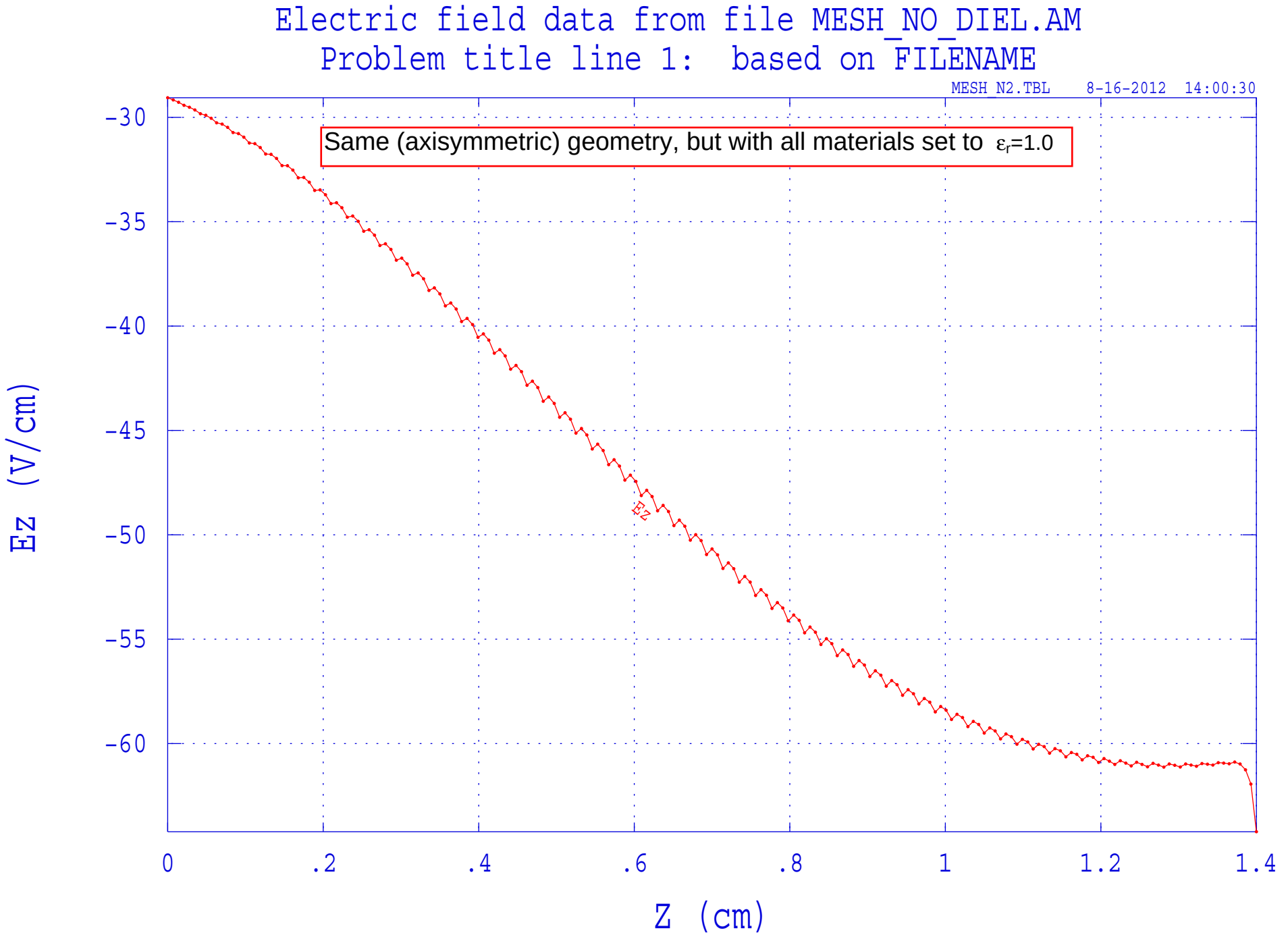

based on FILENAME
finite element unit cell model (1/2 mesh spacing), in POISSON/SUPERFISH
7400 V = equipotential @y=2 cm (for 95 kV over 7cm gap)
Neumann boundaries (field parallel) @ x=0, x=.025 cm (except at wire)
wire dia = .0012" (r=0.015mm), V= 0V, location at x=.025cm y=1.455cm
εr=1.0
axisymmetric 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, εr=9.0
Suprasil, silicone, εr=3.7
wire spacing = 0.5mm (x= 0.25mm)
V=0 @ y=0 cm (photocathode)
N:\FE\POISSON\MESH_DIEL.AM 8-06-2012 20:11:40

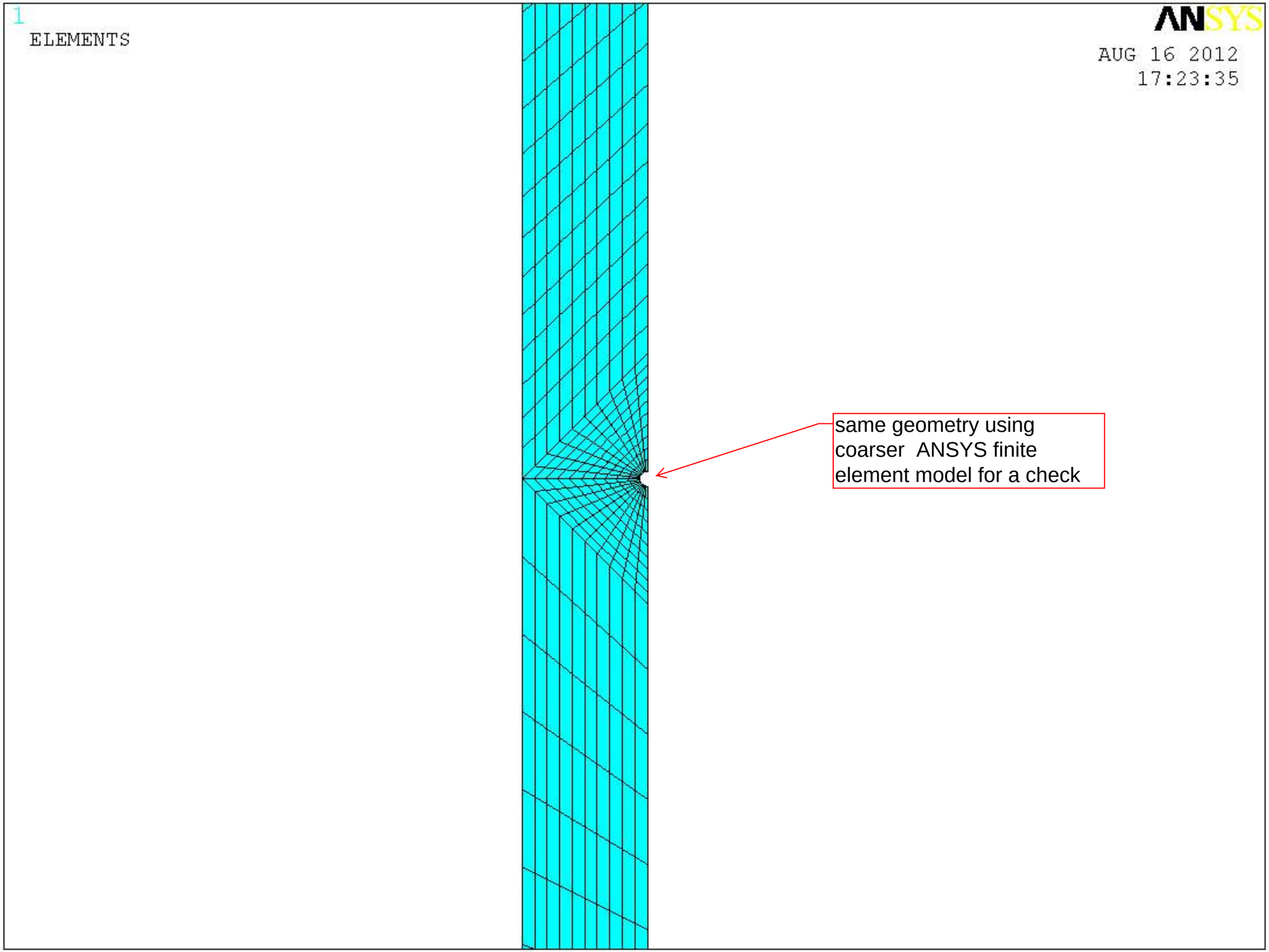

based on FILENAME
1.50
1.48
1.46
1.44
1.42
1.40
1.38
1.36
1.34
1.32
1.30
1.28
1.26
0
.05
.10
.15
.20
.25
.30
.35
turn off line width in Adobe Reader and zoom in to see mesh
"air"
sapphire
it appears that the sapphire works to "expel" the remaining field below the mesh
N:\FE\POISSON\MESH_DIEL.AM 8-06-2012 20:11:40


Electric field data from file MESH_DIEL.AM
Problem title line 1: based on FILENAME
MESH D4.TBL 8-06-2012 22:38:08
Electric field along
unit cell axis (x=0)
Ez
sapphire
Suprasil, silicone
photocathode
mesh wire location
Ez (V/cm)
Z (cm)
0
-2000
-4000
-6000
-8000
-10000
-12000
0
.2
.4
.6
.8
1
1.2
1.4
1.6


Electric field data from file MESH_DIEL.AM
Problem title line 1: based on FILENAME
MESH_D2.TBL 8-06-2012 22:35:12
E- field along axis from Z= 0-1.3cm only
Ez
Suprasil, silicone rubber
sapphire
air
0
-20
-40
-60
-80
-100
-120
Ez (V/cm)
0
.2
.4
.6
.8
1
1.2
1.4
Z (cm)


Electric field data from file MESH_DIEL_NO_SAPH.AM
Problem title line 1: based on FILENAME
MESH_D8.TBL 8-16-2012 19:11:20
Same geometry as before, but with no sapphire window
Ez
Suprasil, silicone
air (no sapphire)
ground mesh at z=1.455cm
Ez (V/cm)
Z (cm)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0
.2
.4
.6
.8
1
1.2

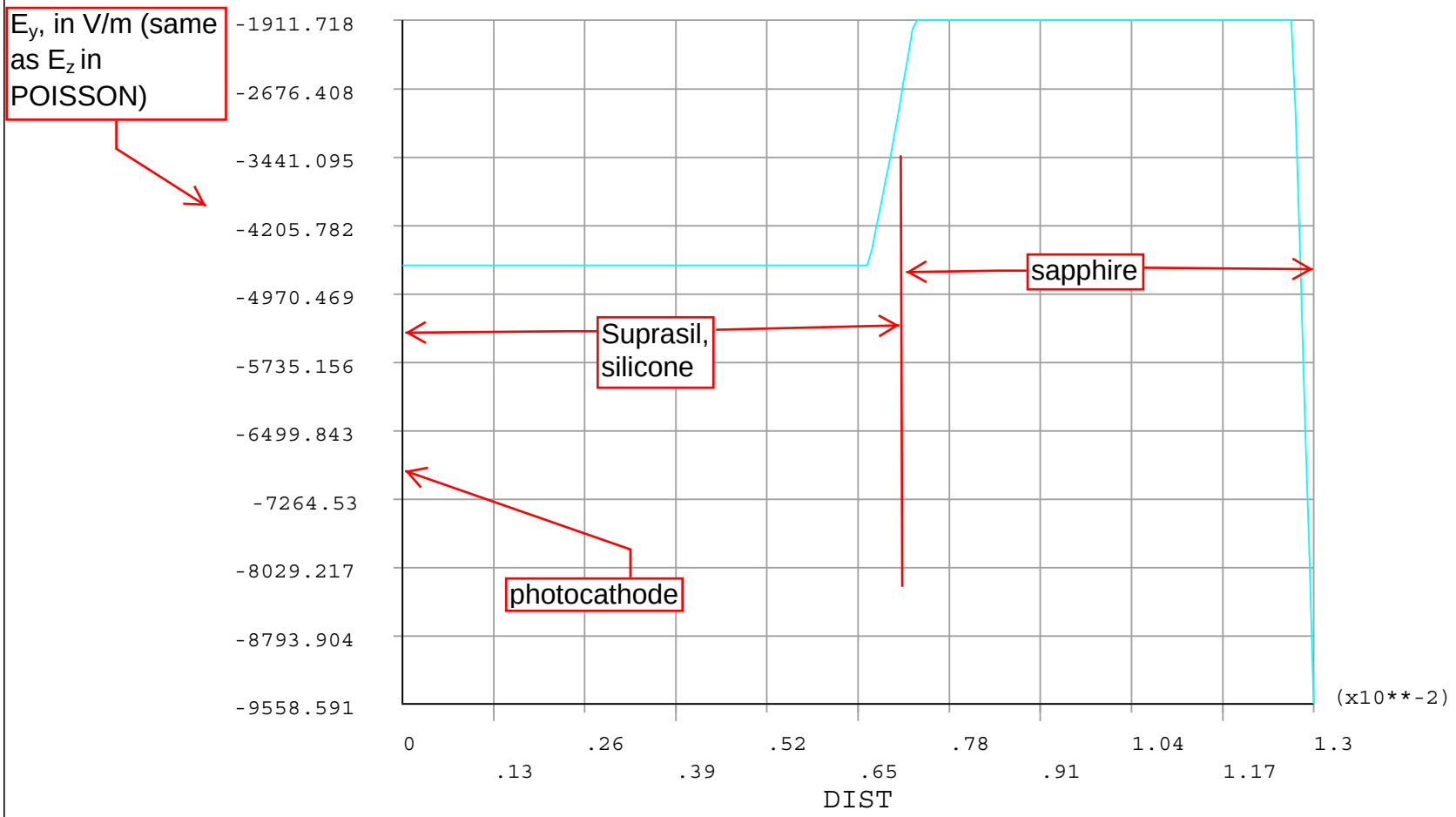

Electric field data from file MESH_NO_DIEL.AM
Problem title line 1: based on FILENAME
MESH_N2.TBL 8-16-2012 14:00:30
Same (axisymmetric) geometry, but with all materials set to εr=1.0
Ez
-30
-35
-40
-45
-50
-55
-60
Ez (V/cm)
0
.2
.4
.6
.8
1
1.2
1.4
Z (cm)


1
ELEMENTS
ANSYS
AUG 16 2012
17:23:35
same geometry using
coarser ANSYS finite
element model for a check

1
POST1
STEP=1
SUB =1
TIME=1
PATH PLOT
EY

ANSYS gives somewhat different results for field in low field region, (much coarser mesh)

ANSYS
AUG 16 2012
17:19:33
PLOT NO. 1



Conclusion: A fine mesh screen (88% open area, 0.03mm dia.wires on 0.5mm wire pitch) mounted over the sapphire windows, held at ground potential, results in electric fields that are estimated to be 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)