Choice of Nickel Mesh thickness: COMSOL calculation of field Uniformity
(Draft2- Nov. 19, 2015)
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(the actual COMSOL calculation was done by Filippo)

We have constructed a model for the Hyperfast Silicon structure starting from a similar calculation Filippo did for the MicroMegas chamber to estimate the effect of Ni mesh thickness on field uniformity.
We start from the fact that the MicroMegas mesh we used in HFS up to now (see Fig. 1) with round wires yielded good time jitter when measured with 980 nm laser pulses.
Since we would like to move to a mesh of electroformed Ni sheet for ease of construction and since this naturally yields a mesh which has a height smaller than the conductor width we would like to know if a thin mesh degrades the field quality.

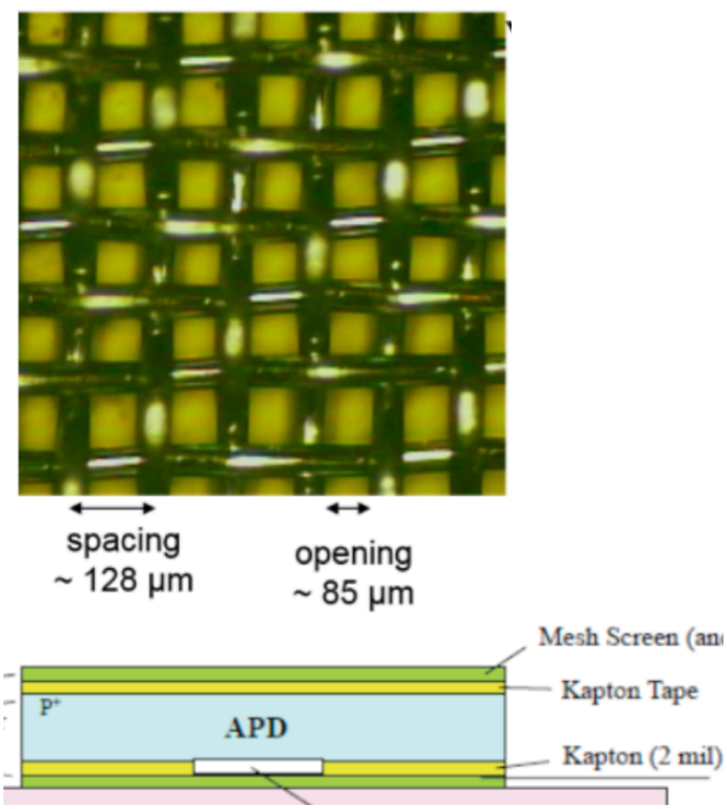


Fig.1 Mesh detail and elevation view of detector.

(note we recently learned that RMD actually produced detectors with 2 mesh types- one we supplied made with Al wires and the other with mesh obtained from McMaster Carr made from steel mesh and having finer pitch)
The model in COMSOL is shown in fig.2.

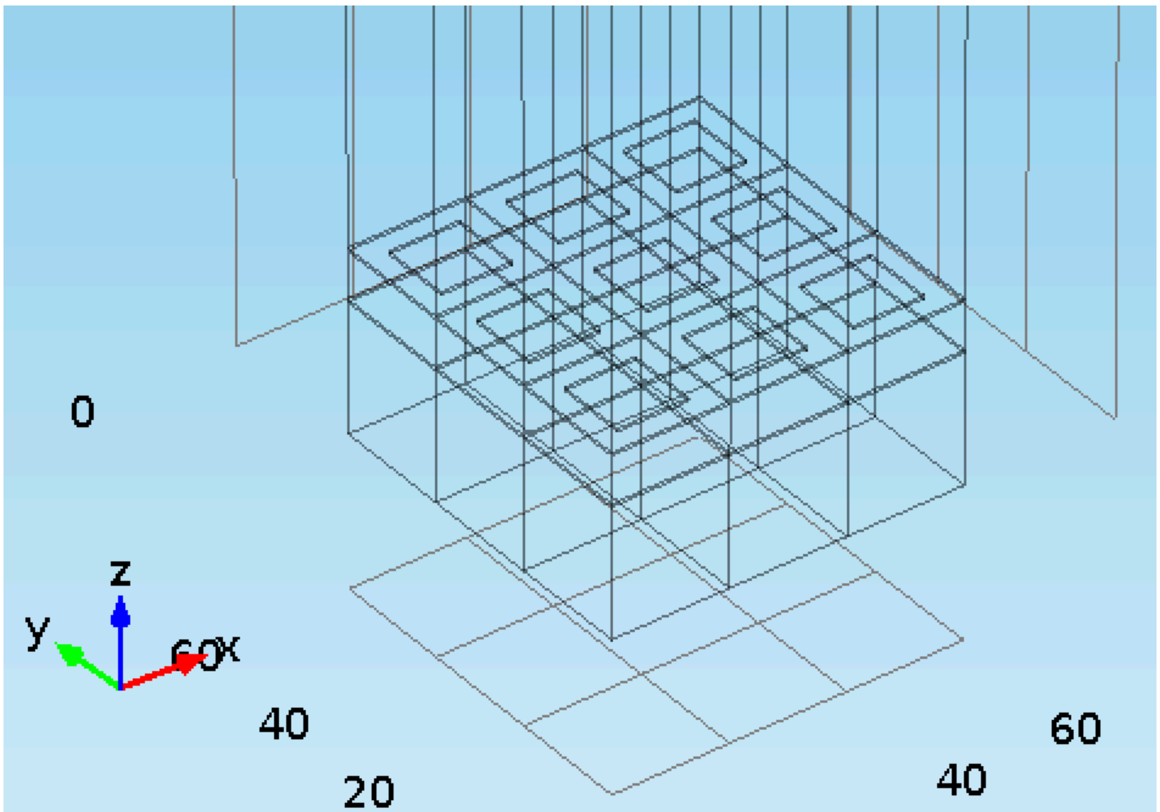


Fig. 2 COMSOL model used for these calculations.A (floating?) conducting sheet is placed 1cm above but the distance has negligible effect on the calculation. The mesh is separated by 80micron thick Kapton (slightly more than our nominal 2 mil).

Name	Expression	Value
t1	220[um]	2.2000E-4 m
t2	5[um]	5.0000E-6 m
t3	80[um]	8.0000E-5 m
t4	5[um]	5.0000E-6 m
t5	10[mm]	0.010000 m
e1	11	11.000
e2	3.5	3.5000
e3	3.5	3.5000
V0	50[V]	50.000 V
pp	200[um]	2.0000E-4 m
ll	80[um]	8.0000E-5 m

Table 1. The values for dimensions in the model. T1 is the assumed Si thickness. T2 is the mesh thickness (which we varied in this calculation from 5 micron to 80 micron.

It is not clear what is the appropriate depth at which to plot the field uniformity but a reasonable guess is 60 micron from the Si top surface. We also scan the top surface. In the plots below we see that in any case the E field variation is of order 1% and this variation is not strongly affected by the mesh thickness. Based on this we would recommend proceeding with a 5 micron thick mesh- if this is a thickness which Precision Eforming is comfortable with producing.
Some further comments: Mickel actually gives 270 micron for the Si thickness. The model uses 200 micron spacing and 80 micron wide conductor. I don't remember how I arrived at this coarser pitch but it is probably just one example we discussed. We could certainly go for a finer pitch without changing the conclusion of this calculation.
Please suggest other plots for discussion (Filippo produced a bunch of them).

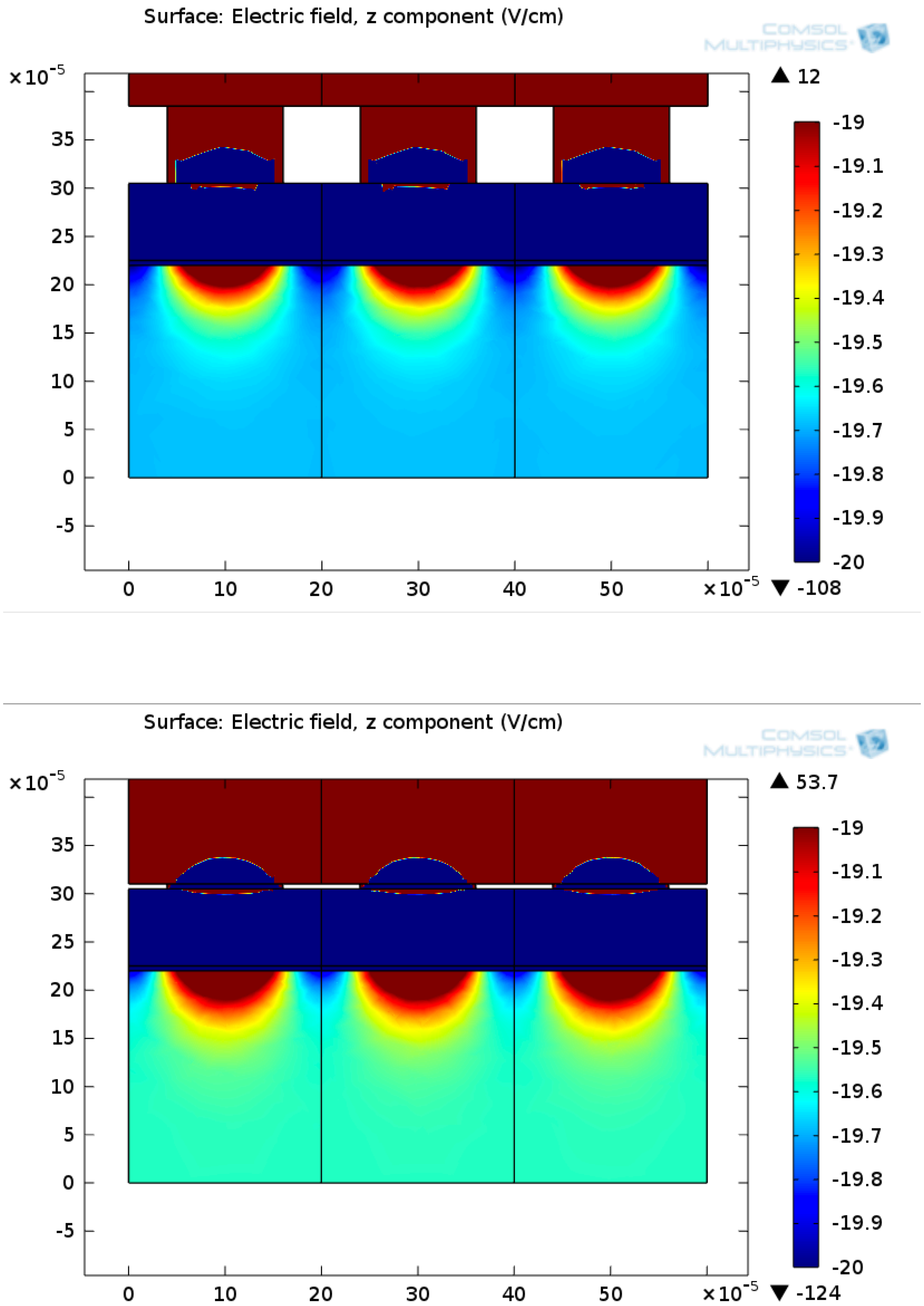


Figure 3. Field map for 80 micron thick Ni mesh (upper) and 5 micron mesh(lower). {It isn't clear why the average field seems slightly lower in the latter case.}

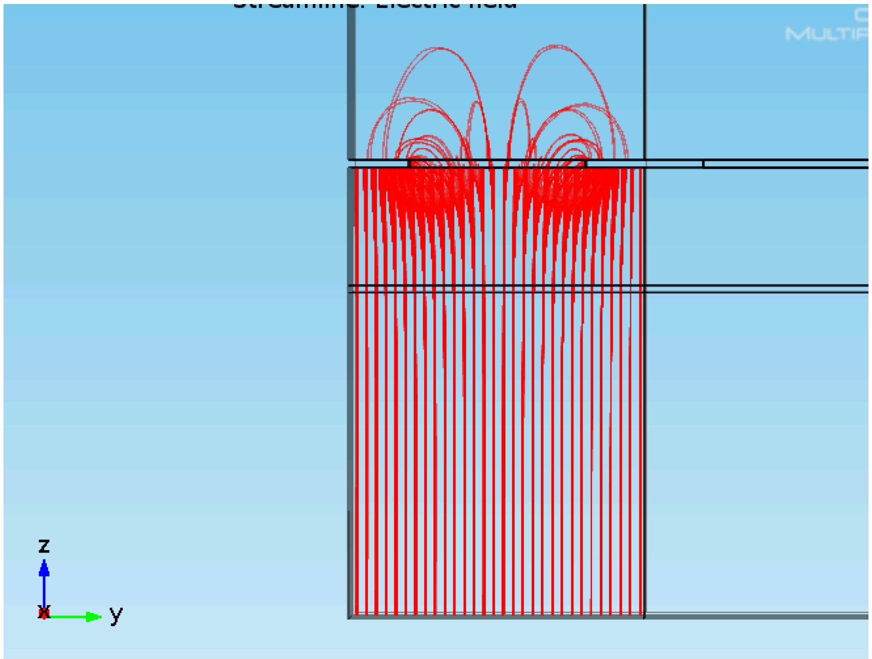
Addendum: Following Draft1 Filippo contributed a couple more plots which show the way the field lines terminate on the grid and address the coupling of the mesh to the signal source. He also clarified that the electrode at large distance is at ground potential- ie like the ground surface of our Silicon enclosure, whose distance has little effect on the conclusions about field uniformity.

Note also that, according to Filippo:

The capacitance with the 5um thick mesh is 19.05pF/cm^2

The capance with the 80um thick mesh is 19.17pF/cm^2

Below field lines for 5 micron (top) and 80 micron mesh(bottom).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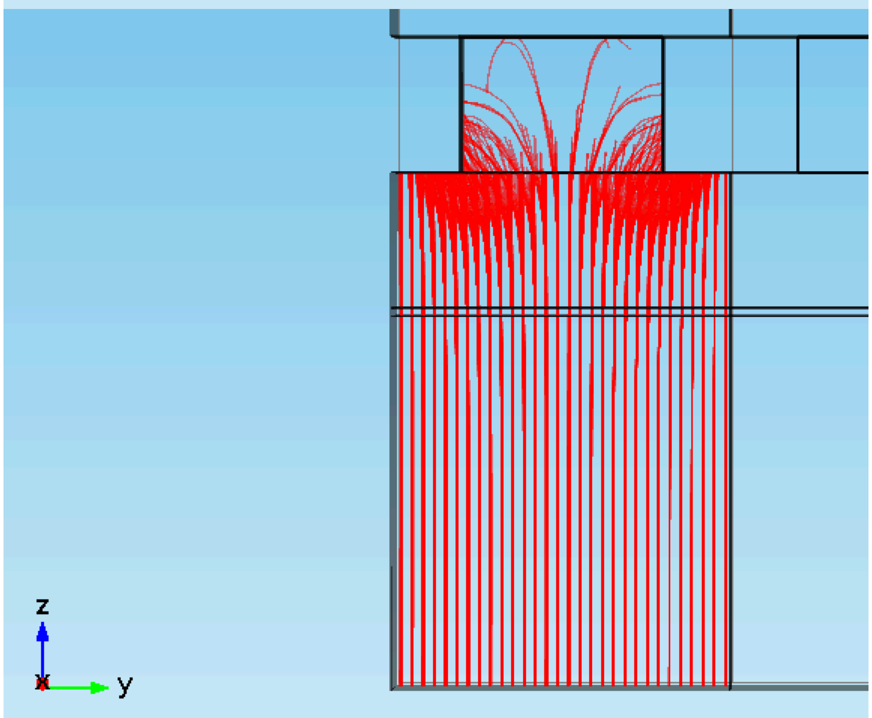
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