Bulk copper sizes....

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From: Simon

Subject: Bulk copper sizes....

Sent: Tue 01/02/2011 14:17

To: Pete, Juergen, Scott, Alan

Hi Scott,

You can find the SAT files for the complete 4m FETS RFQ vane modulations in the following directory:

<http://www.hep.ph.ic.ac.uk/~jolly/cad/3-099_rho_fixed_r0_01-02-11/>

I had a quick check in Comsol and they all seem to be loading in without trouble, so you should be good to go. They are oriented correctly - at least according to the axes in Inventor and Comsol - so the vanes are all aligned along the Z-axis.

I've also included an Excel file that includes Alan's parameters for the vane modulations along with one slight modification: I've adjusted m(2) = 1 so that the matching section meets up correctly. You're right that m(2) = 1.0001 is far too tiny to be machinable, but it has the knock on effect of making a(2) and ma(2) different by a micron if you round up to the nearest micron, since a(2) = 3.06464 and ma(2) = 3.06468. This was the root of my question about setting the tolerances, since we'd need to set them in such a way as to make the numbers come out right.

Ideally, what I want is to have a method that I can use for any parameters. So all I have to do is dump them into a spreadsheet and update the model, which is pretty much how it is now. What I don't want to have to do is go through each parameter set with a fine tooth comb to make sure they all come out correctly.

For now, I think Pete is also going to use the ultra high precision values until we need to decide on the tolerance. So Pete, the numbers you need are:

r0 = 3.6464 mm

rho = 3.0996 mm

Then our models should match!

Cheers,

Simon.

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From: Scott

Subject: Bulk copper sizes....

Sent: Tue 25/01/2011 09:36

To: Pete, Juergen, Simon, Alan

Dear Simon,

I picked 3.100mm for rho since if you look at every cell other than the matching section, the maximum rho = 3.1003 and the minimum rho = 3.0971... a spread of less than 3 microns. The matching section is the one exception to this rule so it seemed reasonable to fix the rho to what would suit every other cell. Additionally, since the matching section in reality varies in 'rho' because it extends quite a way up the tapering vane, it seems silly to base the rest of the modulations on the dimensions of the matcher.

The first cell absolutely cannot be made to the precision to have m = 1.0001. Why not just set it to 1.0000 in your spreadsheet/simulation? Then the matcher will definitely join up to it.

Regarding the accuracy of all the other cells, I think this a question for Pete: what do you imagine will be the transverse positional accuracy of the cutter as it moves along the vane cutting the modulations?

The value of r0 doesn't actually exist in any real sense because there will always be modulations (not a plain, modulation-less vane) and so all you will see is the a and ma of each cell. I'm guessing that Pete will make it so the cutter will try to form your four-decimal-place a and ma values as best it can; as long as the datum is fixed to the beam axis. Therefore I don't think you should round up any of the r0, a or ma in your simulations: only the rho. I originally picked r0 = 3.650mm since it was a nice round number that could be machined (but see preceding sentences explaining why that isn't strictly necessary) and because it closely matches the r0 values of the cells at the end of the gentle buncher (about cell 220) which is quite a critical area.

If by cutting the a and ma nice and accurately we end up with the r0 we expect, and that r0 is slightly smaller than 3.650mm, then that means the capacitance there will be slightly higher. This will ever so slightly lower the frequency which is no bad thing. I've started looking at how the modulations affect the frequency because other labs (FNAL and JPARC) have seen that the modulations do affect field flatness. Taking the modulation with the largest deviation from a plain vane - i.e. the final cell - its capacitance is 1.22% lower than the plain vane, resulting in a 0.62% higher frequency (i.e. 323.4MHz --> 325.4MHz). This is a potential problem as it will affect the field flatness (specifically, the volts will be lower toward the end of the RFQ unless we do something about it now), but the first few cells will have a much smaller effect so it's not worth worrying about the r0 there.

In summary, Simon, I suggest fixing rho to what we'll use (3.100mm), but leaving the rest of your simulation un-touched. Then you can tell us what effect the fixed rho has on the beam. Later, when we've CMM'd the RFQ and have the manufactured cell parameters, you can tell us how the as-manufactured RFQ should perform relative to your ideal one, and we can then compare that to the measured beam.

Cheers,

Scott

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From: Simon

Subject: Bulk copper sizes....

Sent: Mon 24/01/2011 18:01

To: Pete, Juergen, Scott, Alan

To add to what Pete said, I had a quick check of some of the older vane modulation parameter sets to see how much variation there was. For example, the 325-cell design Alan produced late last year, with the 2.9mm rho and fixed r0, is 3.5m long and gave a final tank length of ~540mm. On the other hand, the set of parameters going back to IPAC'10 have a total length of 4063mm and a 4th tank of 1060, hence my request for the final tank to be slightly longer.

What I do in my Excel code is try and get the first 3 tanks as close to 1m as possible, assuming that you have to cut the vanes in between cells and not in the middle of one, then let the 4th tank take up the slack. Sometimes it ends up being slightly shorter, but by and large it tends to be slightly longer. At the moment the vane lengths are as follows:

Tank 1: 1009.6718mm

Tank 2: 1010.2570mm

Tank 3: 1038.5534mm

Tank 4: 994.8244mm

...so the 4th tank is actually slightly shorter. Note, however, that the length for the 1st Tank includes the 21.77mm matching section while the length of the 4th Tank DOES NOT include any matching out section. At the moment the matching out section is assumed to be the same as the matching in section - but slightly closer to or further away from the beam axis, depending on the modulation depth of the last cell - but this hasn't been decided upon, nor is it included in my simulations or my vane models. This was the reason I thought about holding off the order for the last section, since we've sort of mentioned these ideas in FETS meetings past but no decision has ever been made.

Something else that needs fixing is the accuracy of the numbers I've got from Alan and the tolerances required for machining. Since Scott asked for a fixed rho and r0, it's been assumed that rho = 3.1mm and r0=3.65. However, the numbers I have from Alan are very slightly different. For example, for the first 10 cells the parameters are:

N a(mm) m (ul) rho(mm) L(mm) ma(mm)

1 3.646 1.000 3.1078 21.7698 3.6460

2 3.6464 1.0001 3.0996 5.4424 3.6468

3 3.643 1.0015 3.0988 5.4447 3.6485

4 3.6401 1.0031 3.0988 5.4445 3.6514

5 3.6375 1.0045 3.0988 5.4443 3.6539

6 3.6329 1.0077 3.0998 5.4441 3.6609

7 3.6303 1.0091 3.0998 5.444 3.6633

8 3.6274 1.0107 3.0998 5.4438 3.6662

9 3.6249 1.0121 3.0998 5.4437 3.6688

10 3.6211 1.0138 3.0991 5.4436 3.6711

...where cell 1 is the matching section. Now, cell 1 in the x-vane starts a distance a = 3.6464mm away from the beam axis, whereas in the y-vane it starts a distance 3.6468mm from the beam axis. You might say "this is virtually identical", but using these strict numbers Inventor would see a difference and therefore a discontinuity with the matching section, since Pete is using the aforementioned numbers. It is possible to get the numbers to round to a tolerance in Excel by dividing by that tolerance, rounding to the nearest whole number, then multiplying by that tolerance again, but if so what is the required tolerance. If I go to the nearest micron, the first cells in the X and Y vane will be different, since m(2) is not 1: it's very close, but not close enough, so a(2) = 3.646mm and ma(2) = 3.647mm, giving a discontinuity. This will also show up in my field map. Rounding to the nearest 10 microns would fix the problem, but is this too coarse? This won't effect the shape of the cell, since it will still vary smoothly between a(2) and ma(3), just the start and end points.

On a related note, I also need to fix which values to use for rho and r0, since these hold for the entire vane. Strictly speaking I don't need to fix r0, but Pete uses it in his models and I need to make sure it matches my values of a and ma so that the matching section meets the second cell. Rho, on the other hand, has to be fixed. Previously I'd been selecting the values for the matching section, since every cell was different, but doing so will give different values to those Scott and Pete has been using: even rounding to the nearest 10 microns would give rho = 3.11mm. It looks to me like choosing the second cell and round to the nearest 10 microns would give the best results, matching those Pete has got in his model, but that comes back to the question of what tolerance I should be using.

This is the last thing I can think of that prevents me from matching the vane tips to Pete's model.

Cheers,

Simon.

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From: Alan

Subject: Bulk copper sizes....

Sent: Mon 24/01/2011 10:39

To: Pete, Juergen, Scott, Simon

The lengths all look consistent with my modulation design and by ordering copper for 4 x 1050mm long sections it looks like we should be safe on material. Will the transverse size also be specified as -0mm +3mm?

Good work Pete. It will be great to have this order in the pipeline and feel like the RFQ manufacture is finally underway.

Alan

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From: Pete

Subject: Bulk copper sizes....

Sent: Fri 21/01/2011 17:04

To: 'Pozimski, Jürgen K'; A.P.Letchford@rl.ac.uk; 'Jolly, Simon'; scott.lawrie@stfc.ac.uk

Attached: RFQ\_Drawings\_v13.pdf

 RFQVaneParamsMaster.xls

Dear all,

I would appreciate it if you would spend 15 minutes checking the sizes on the attached drawing. If I have made a mistake and the copper ordered is the wrong size it will be expensive. I need to get the request for a quote in to the supplier ASAP to be sure of using this year’s budget. I plan to send the request in on Monday.

**FIRSTLY: THE LENGTHS**

For the first time ever I have put together 4 major vanes with their final lengths. They are shown in the attached PDF.

The major vanes have had their respective vane tips grafted onto them. The vane tip lengths come from Simon’s spreadsheet and they are:

|  |  |  |
| --- | --- | --- |
| TankLen1 | 987.902 | mm |
| TankLen2 | 1010.257 | mm |
| TankLen3 | 1038.5534 | mm |
| TankLen4 | 994.8244 | mm |

These values are taken from Sheet 1 of the attached spreadsheet.

RFQ sections 2 and 3 are simple because the total section length is equal to the vane tip length.

Section 1 has a matching section radius of 21.8mm + a small (<2mm) offset to the end face.

Section 4 (in the CAD model) has an identical ‘matching section’ to Section 1. It is understood that this feature is unnecessary at the output end. However, for the purpose of ordering material I need information. The safe approach is to over-order in length.

So, the total lengths of each RFQ section become:

TOTAL LENGTH SECTION 1 = 1011,4mm

TOTAL LENGTH SECTION 2= 1010,257mm

TOTAL LENGTH SECTION 3= 1038,553mm

TOTAL LENGTH SECTION 4= 1018,3mm

Then I have added 5mm at either end and then rounded up to the next whole mm. This gives bulk material lengths of:

BULK MATERIAL LENGTH 1 = 1022mm [10,6mm OVERSIZE]

BULK MATERIAL LENGTH 2 = 1022mm [11,7mm OVERSIZE]

BULK MATERIAL LENGTH 3 = 1050mm [11,4mm OVERSIZE]

BULK MATERIAL LENGTH 4 = 1030mm [11,7mm OVERSIZE]

NOTE that these sizes will be the minimum requested size. I will request the above lengths with a tolerance of -0mm +3mm (on recommendation from the suppliers).

**SECONDLY: THE TRANSVERSE DIMENSIONS**

The assembled RFQ will have outer transverse dimensions of 260mm x 260mm (in the present ‘O’ ring + finger strip design).

The major vanes will have transverse outer dimensions of 260mm x 126,4mm

The minor vanes will have transverse outer dimensions of 126,4mm x 102,5mm

Again I have added 5mm either side and rounded up to the nearest whole mm to give bulk material transverse dimensions of:

MAJOR VANE = 270mm x 137mm

MINOR VANE = 113mm x 137mm

**FINALLY: WHAT ARE WE ORDERING?**

[4 PIECES PER RFQ SECTION, 4 RFQ SECTIONS, 16 PIECES IN TOTAL]

4 OFF: 1022mm x 270mm x 137mm   [MATERIAL FOR SECTIONS 1 & 2]

4 OFF: 1022mm x 113mm x 137mm

2 OFF: 1050mm x 270mm x 137mm   [MATERIAL FOR SECTION 3]

2 OFF: 1050mm x 113mm x 137mm

2 OFF: 1030mm x 270mm x 137mm   [MATERIAL FOR SECTION 4]

2 OFF: 1030mm x 113mm x 137mm

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Thanks for your help,

Pete