Structures RF Meeting - 6/29/04

- 1) Overview of meeting at SLAC (Harry and other travelers)
- 2) Agreed revised plans and schedules (Harry)
- 3) Comments on technical issues (Timer and other travelers)
- 4) FXE Input-Output coupler design studies (Timer)
- 5) Structure cooling issues (Cristian)
- 6) FXD disk sets QC [including HOM measurements] (Gennady)
- 7) AOB

Agenda item #1, 2, 3

- Overview of meeting at SLAC
- Agreed revised plans and schedules
- Comments on technical issues

Items We Agree On (1)

- FNAL will send a sample of cells to Kirby that have small grains after heat treatment (Kirby should already have FXB6 and FXB7 coupons). Will look at SLAC cells also.
- There is no immediate need for FNAL to produce more strongbacks for tests at NLCTA.
- FNAL will decide within a week if they will build a strongback for the ASSET test.
- Cristian's analysis of the proposed NLC structure cooling system shows a high copper temperature (~70 degC). SLAC will check this and specify a working temp and allowable copper temp rise.

Items We Agree On (2)

- The remaining FXD structures (2-6) will be built as planned, although with variations in the preparation techniques:
  - Changes to 2 will be finalized next week
  - Changes to 3-6 will be finalized during the 3rd week of July
- Both SLAC and FNAL will develop the following for a next generation design by next Summer.
  - Compact coupler (Fat lip style if possible to maintain gradient)
  - Compact HOM load (SLAC external, FNAL internal)
    - Both coupler and HOM loads consistent with superstructure layout
  - Rounded cell design
  - Methods for characterizing dipole properties of single cells or stacks
  - Methods for evaluating dipole characteristics of complete structures

Items We Agree On (3)

- To this end
  - SLAC will measure the dipole properties of the KEK SLA and SLB cells before the ASSET test to verify the KEK fabrication procedure.
  - FNAL will measure the dipole properties of FXD/E cells to verify that the fab methods used by Lavezzi will meet the 3 MHz rms frequency requirement.
  - Both SLAC and FNAL will evaluate the trapped modes their proposed couplers.
  - The FXE cells will be used to test new coupler and HOM load designs (1-2 structures each with SLAC and FNAL designs).
  - SLAC will provide a single rounded cell drawing now and a full rounded-cell structure design by end of September - need to decide on VG3 or VG4 design
  - FNAL will decide in the few months if they can tune the rounded cells and whether their current brazing method can be used with the rounded-cell design.
  - FNAL will build a rounded cell structure without HOM ports and with standard couplers to test high gradient performance (FXF1)

Milestones and cavity production until 2005

July, 2004

Aug-Nov, 2004: FXD-production, FXD-2-6 with HOM to replace current 8-pack, prep variations ?

Oct, 2004: Drawings for rounded cell

Nov, 2004: Drawings for compact coupler

Dec, 2004: Drawings for HOM

Jan, 2005: Drawings of new waveguide distribution
Fix number of structures on a girder !

Jan-Mar, 2005: FXE-production to test different coupler concepts

Jun, 2005: Test one new structure, rounded, compact coupler, inline HOM, FXF's ?
High power test of new waveguide distribution system

Oct, 2005: Test a superstructure in NLCTA

CDR, End of 2005

Session 3 – Girders and Strongbacks

- Cristian presented vibration data on a three-structure girder including a magnet and water mounted on the floor of MP8. The results agree with ANSYS.
- Cristian proposes to do initial alignment with a hydrostatic leveling system (HLS).
- The current facilities model for the cooling of Main Linac structures was shown by Javier Sevilla. To reduce the amount of water pumped it assumes a water flow of nine feet/second and a 12 °F delta T in the water at the structures to take up 3,600 W of dissipated power per structure.
- With these assumptions Cristian calculates a copper temperature of 70 °C (because the water flow becomes laminar). This temperature rise is too high.

Session 3 – Girders and Strongbacks

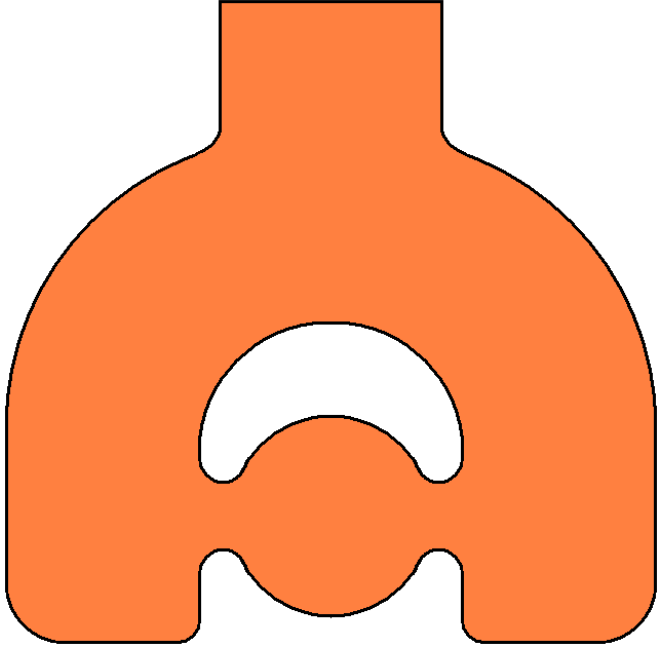
- Chris Adolphsen displayed the Main Linac cooling system information presented at the Cornell meeting for the USLCSG. This material needs a wider dissemination. Cristian will model these assumptions and report on the results.
- We agreed on the need for a document defining the specifications on a structure. This will be maintained on the Fermilab LC website and amended as appropriate.
- Gordon Bowden showed a series of sketches outlining a method for supporting four 60 cm structures on a combination girder/strongback with insulation. It has the pumps at the ends of the loads underneath the structures.
- Several alternative methods for making the phase adjustments in the RF lines were discussed.

Session 3 – Girders and Strongbacks

- Chris A. described the ASSET configuration – 76.76” between beamline flanges with four threaded rods to bolt to. The strongback used for RDDS1 remains in Room 150. Chris A. proposed that Fermilab produce the strongback for the ASSET test in October, 2004 of the two KEK structures. Fermilab will study this based on the requirements and accept or decline. If they accept it may require SLAC to return a long Fermilab strongback.

Agenda item #4

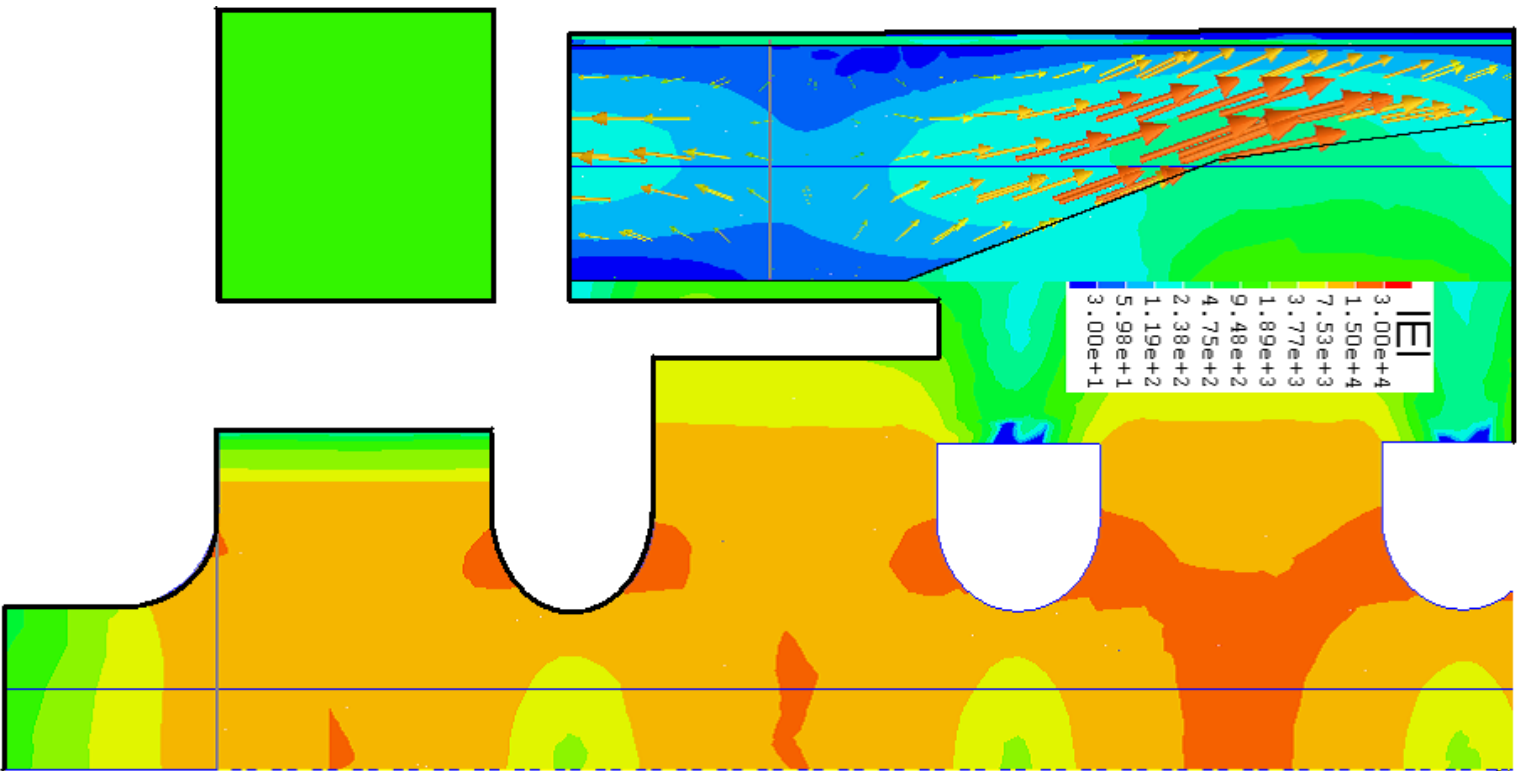
- FXE Input-Output coupler design
  - 1 Flange, output coupler



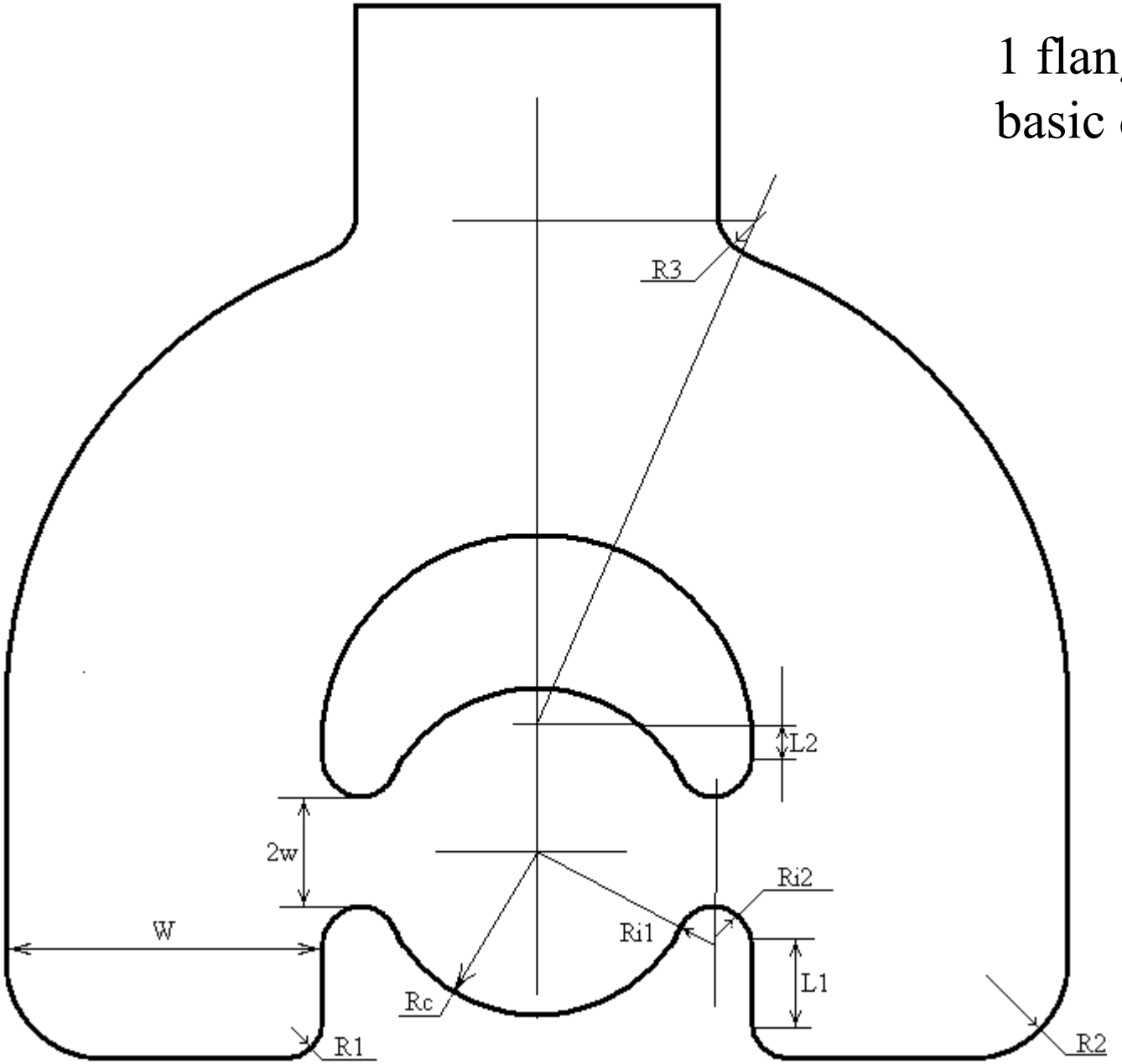
1 flange Output coupler.

Reduced or no HOM coupling for cell 53.

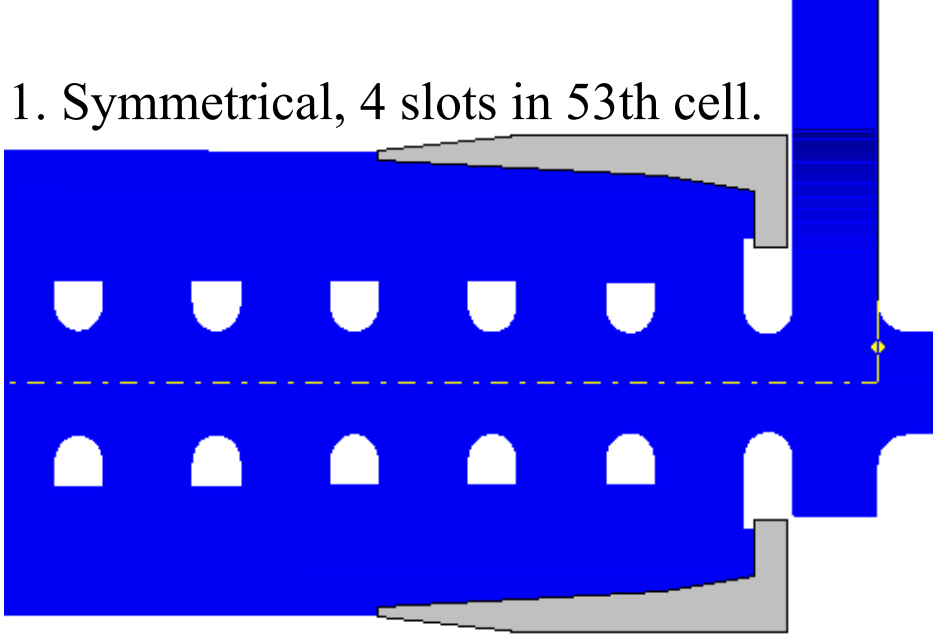
Move absorber by 15mm to structure.



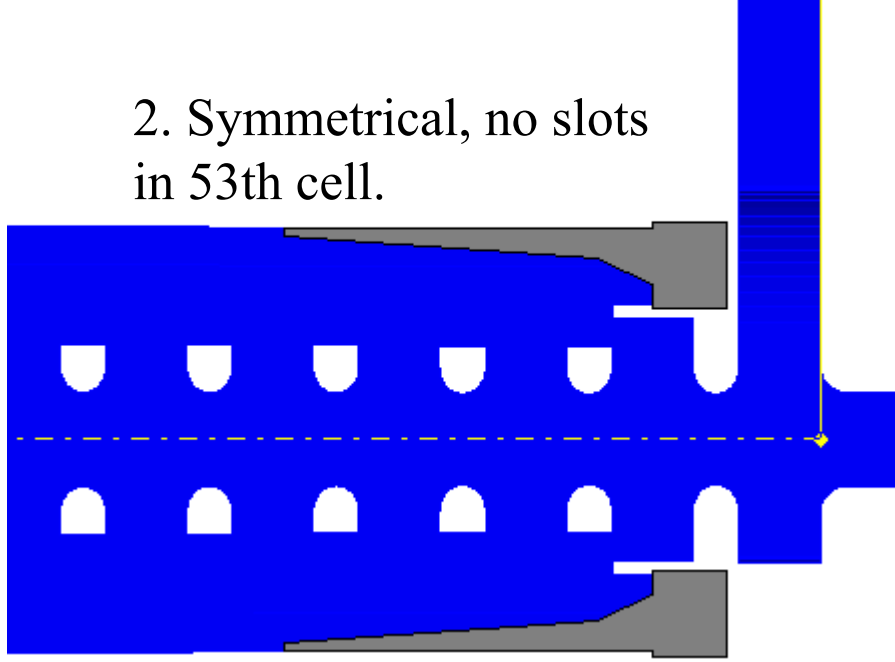
1 flange coupler
basic dimensions.

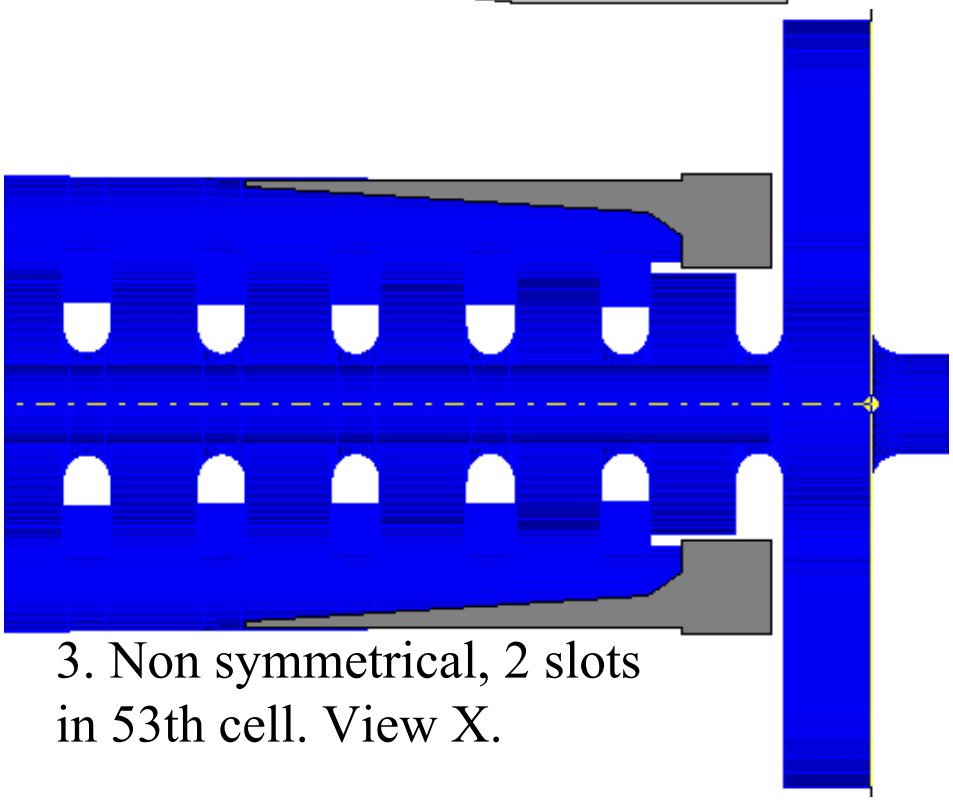


1. Symmetrical, 4 slots in 53th cell.



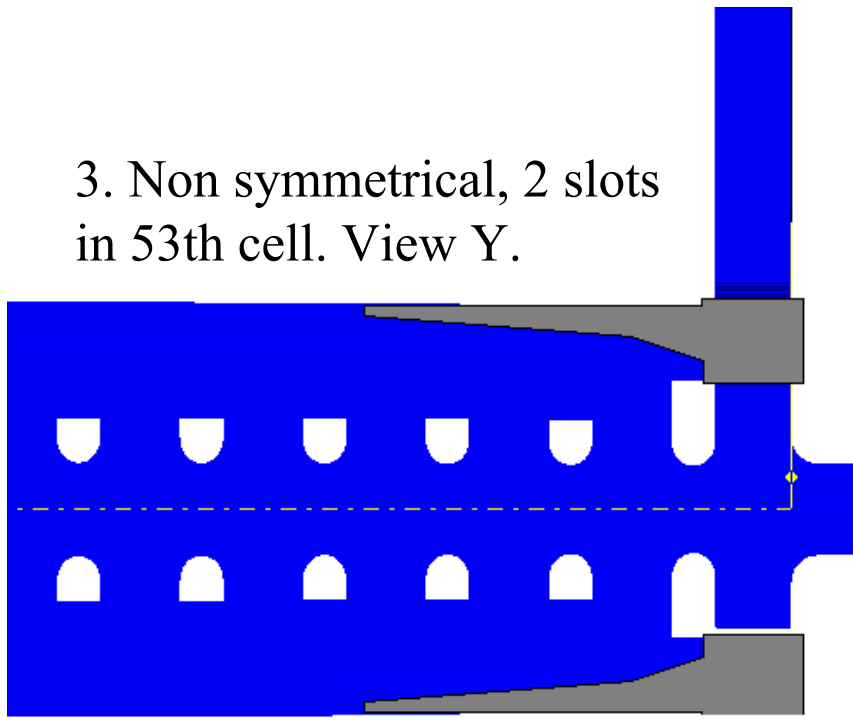
2. Symmetrical, no slots in 53th cell.

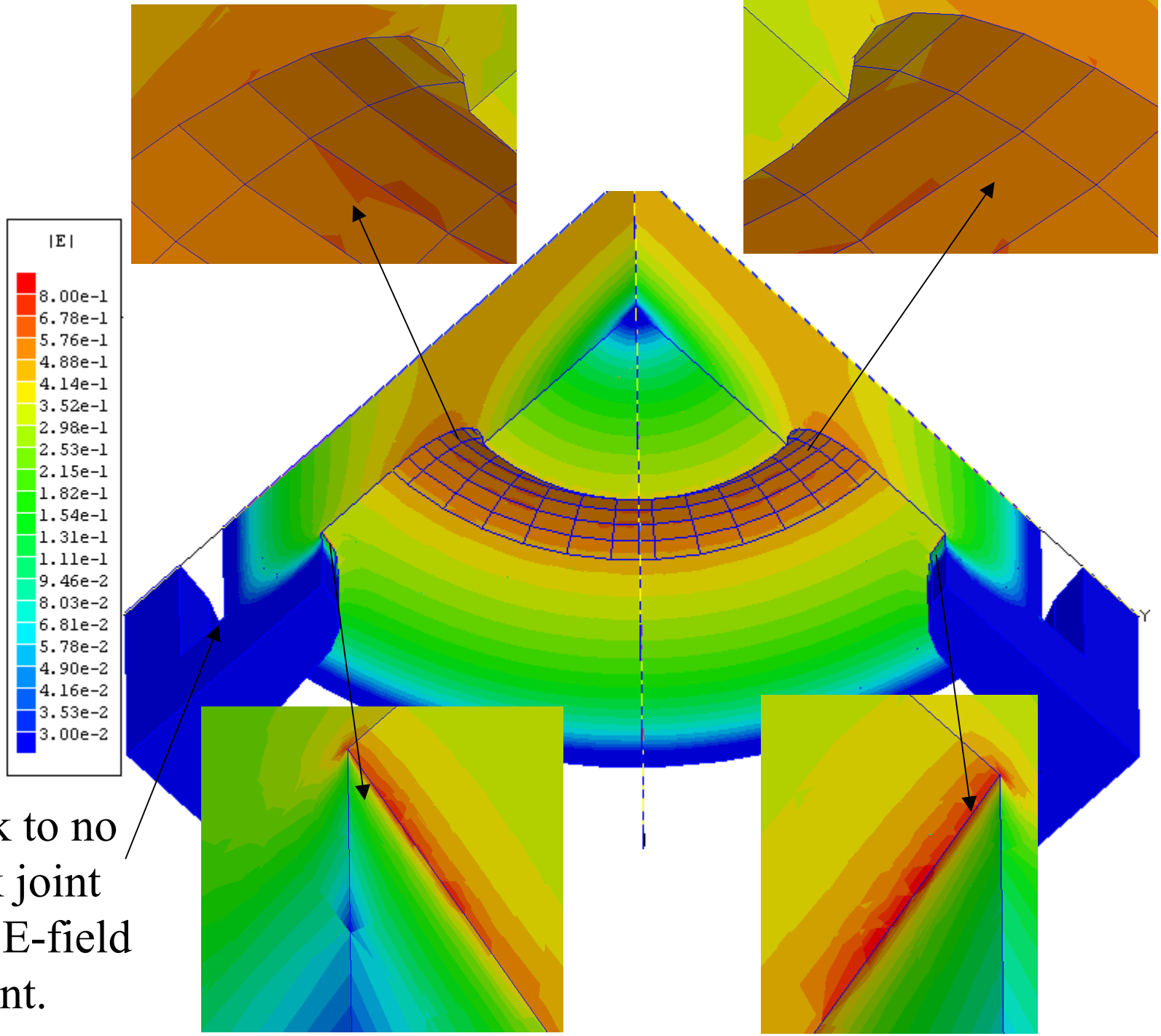




3. Non symmetrical, 2 slots in 53th cell. View X.

3. Non symmetrical, 2 slots in 53th cell. View Y.

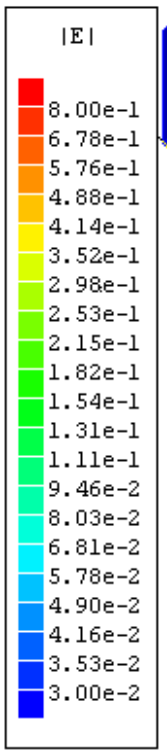


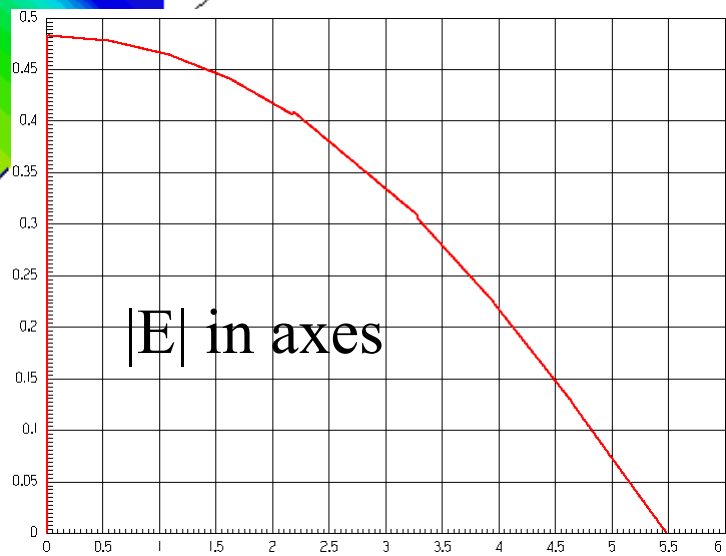


Slotted disk to no slotted disk joint sharp edge E-field enhancement.

For R=0.02 mm rounding E<20mV/m.

Slotted disk to no slotted disk joint sharp edge E-field enhancement.



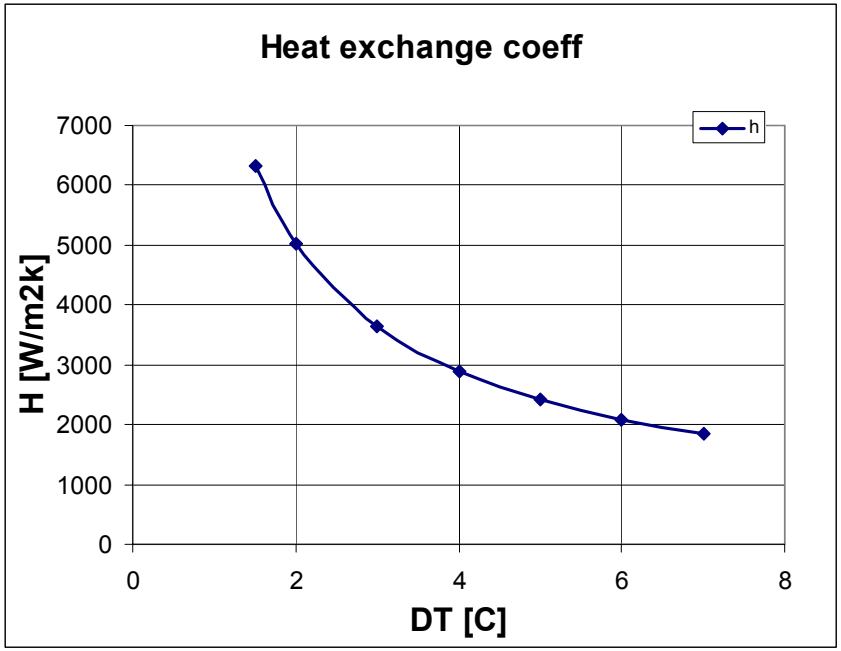


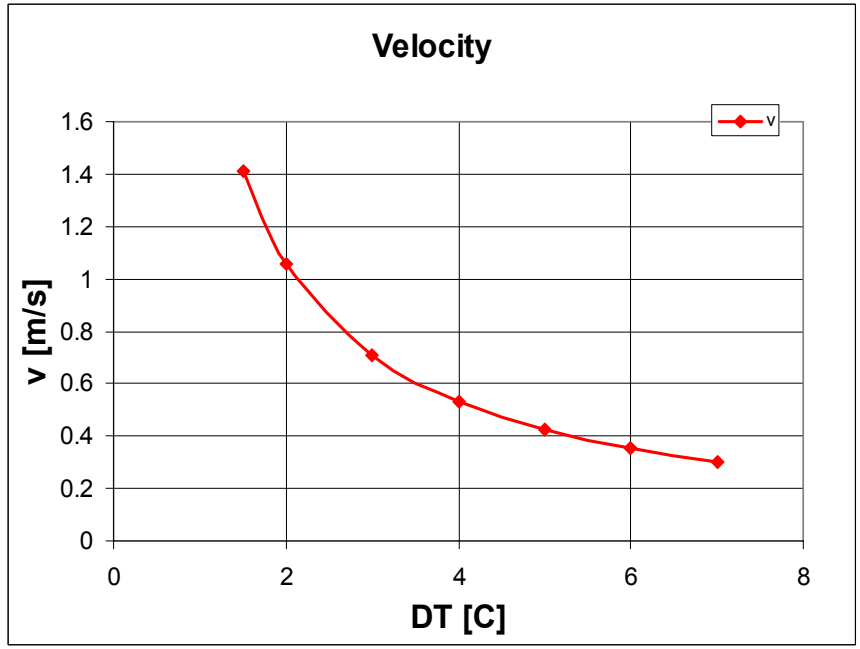
Agenda item #5

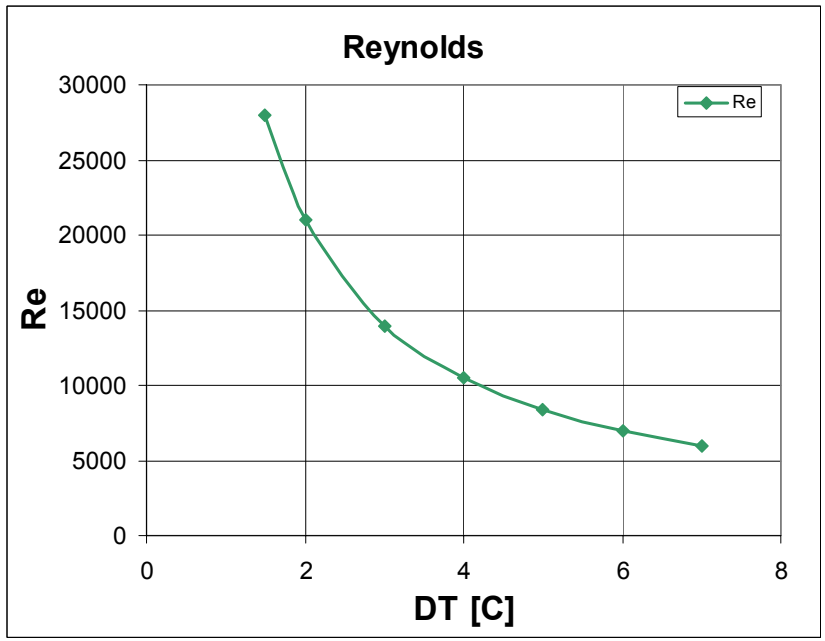
- Structure cooling issues

NLC COOLING WATER PARAMETERS

P	W	3500	3500	3500	3500	3500	3500	3500
T average	C	30	30	30	30	30	30	30
d	m	0.01587	0.01587	0.01587	0.01587	0.01587	0.01587	0.01587
a	m^2	0.000198	0.000198	0.000198	0.000198	0.000198	0.000198	0.000198
DT	C	1.5	2	3	4	5	6	7
flow total 2 pipes	Kg/s	0.5584	0.4188	0.2792	0.2094	0.1675	0.1396	0.1197
GPM total 2 pipes	GPM	8.8639	6.6479	4.432	3.324	2.659	2.216	1.899
v	m/s	1.4118	1.0589	0.7059	0.5294	0.4236	0.353	0.3025
Re	-	27965	20974	13980	10487	8389	6991	5992
Pr	-	5.4162	5.4162	5.4162	5.4162	5.4162	5.4162	5.4162
h	W/m2K	6325	5025	3633	2886	2414	2087	1845


Heat exchange coeff
H [W/m2k]
7000
6000
5000
4000
3000
2000
1000
0
0
2
4
6
8
DT [C]
h


Velocity
v [m/s]
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
DT [C]
v


Reynolds
Re
30000
25000
20000
15000
10000
5000
0
0
2
4
6
8
DT [C]
Re

		NLCTA? High FLOW	NLC
Tin	C	28	27.8
Tout	C	29.5	34.4
DT	C	1.5	6.7
Flow	Kg/s	0.558	0.126
v	m/s	1.417	0.318
Re	-	27615	6830
Pr	-	5.493	4.926
h	W/m^2K	6289	1993

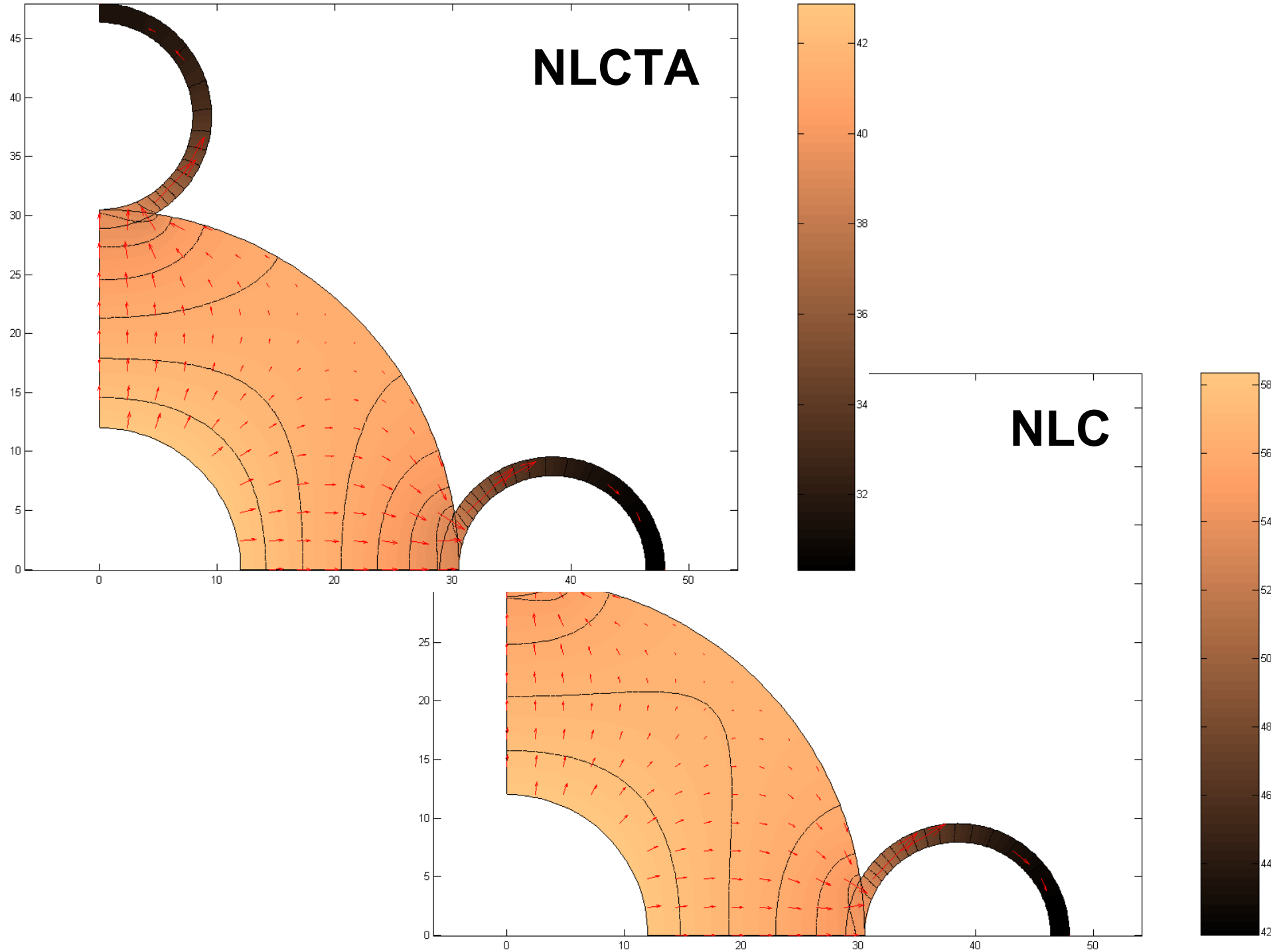
Beside secondary effects of the different temperatures, and assuming the same area of contact between water and copper, since the heat transfer coeff is 3 times smaller in the first case, it means that the difference in temperature between Cu and water should be roughly 3 times higher in order to let the heat exchange process happen…so:

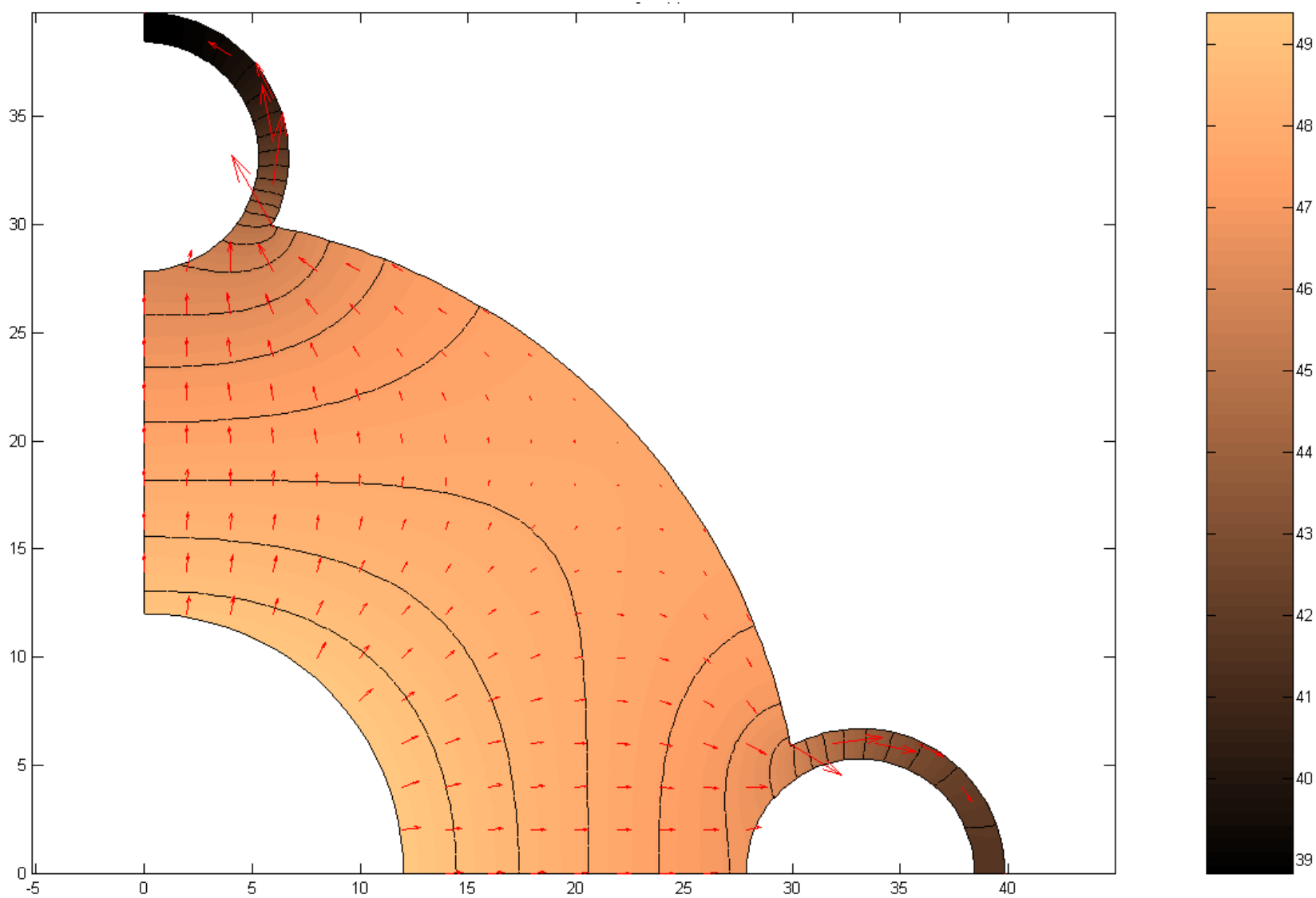
NLCTA my assumption:
Water T ~30 C
Copper T **~40 C**
DT ~10 C
NLC one can extrapolate:
Water T ~30 C
Copper T 10 (NLCTA DT) * 3 (heat transfer coeff.) + 30 (water) = **~60**

BUT IN NLCTA THEY USE:

Tin 45 C
Tout 46.67 C

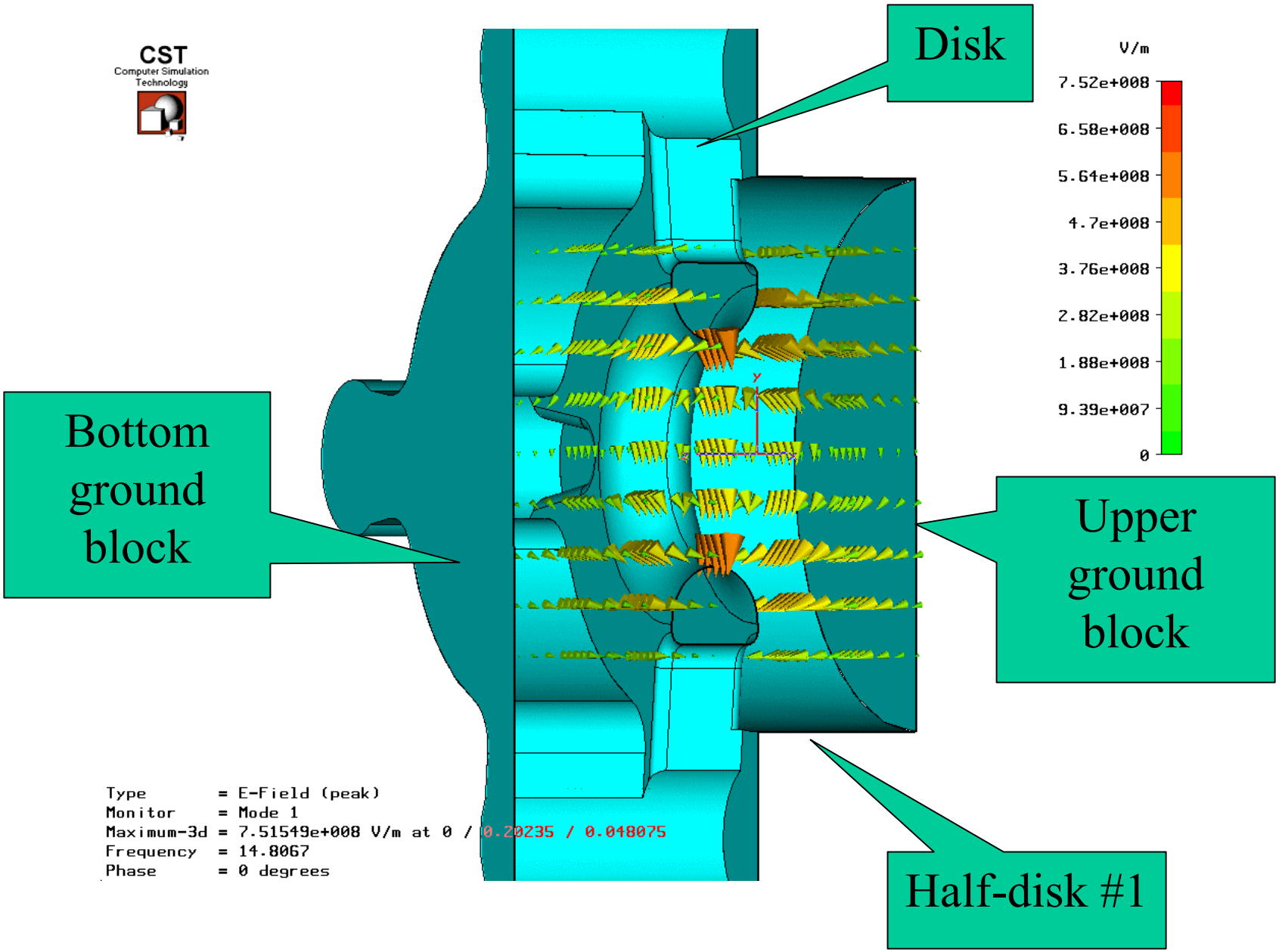
HOW CAN THE STRUCTUTRE BE AT 45 C ?


NLCTA
NLC

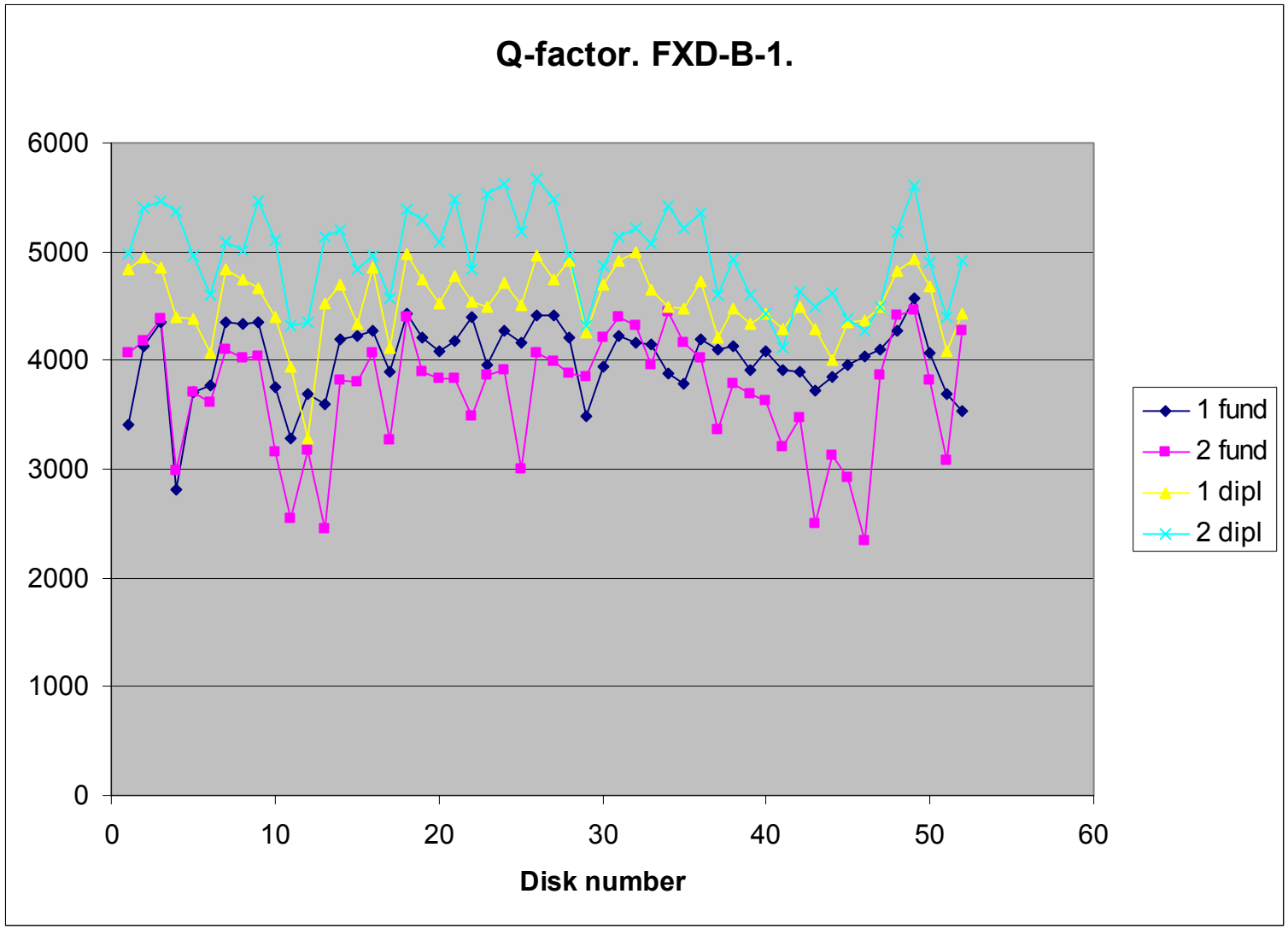

35
30
25
20
15
10
5
0
-5
0
5
10
15
20
25
30
35
40
49
48
47
46
45
44
43
42
41
40
39

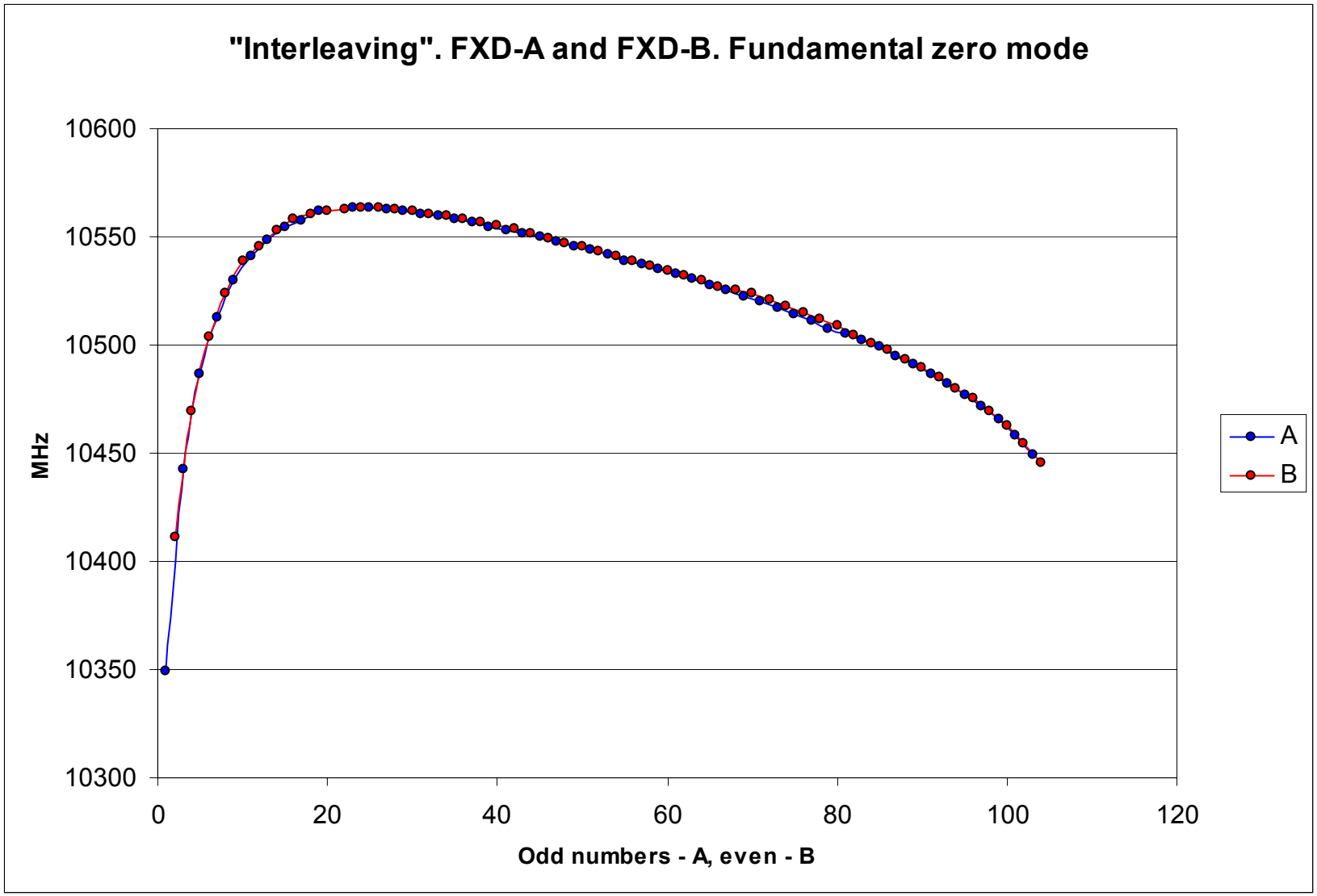
Agenda item #6

- FXD disk sets QC (including HOM measurements)
  - FXD-A & FXD-B disks are machined by LaVezzi
  - Disks are hand deburred before single disk RF QC


CST
Computer Simulation Technology
Disk
V/m
7.52e+008
6.58e+008
5.64e+008
4.7e+008
3.76e+008
2.82e+008
1.88e+008
9.39e+007
0
Bottom ground block
Upper ground block
Half-disk #1
Type = E-Field (peak)
Monitor = Mode 1
Maximum-3d = 7.51549e+008 V/m at 0 / 0.20235 / 0.048075
Frequency = 14.8067
Phase = 0 degrees

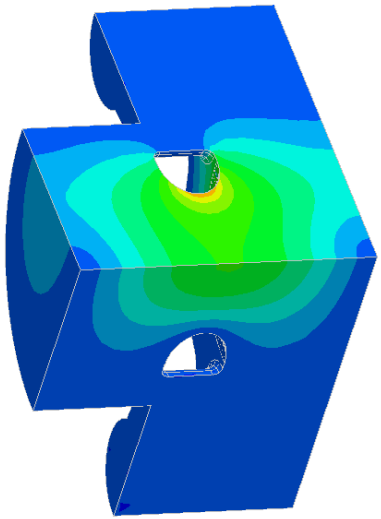
Force: 300 ± 5 lb




"Interleaving". FXD-A and FXD-B. Fundamental zero mode
10600
10550
10500
10450
10400
10350
10300
MHz
0
20
40
60
80
100
120
Odd numbers - A, even - B
A
B

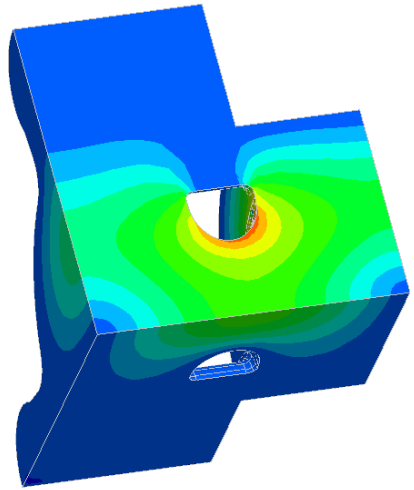
FXD-A. Simulated by Ivan

#1



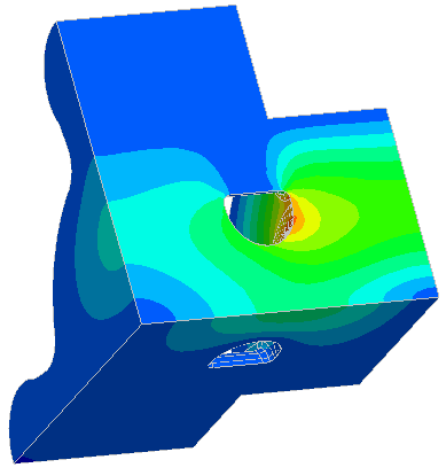
13663.4 **(-6 MHz, QC)**

#25

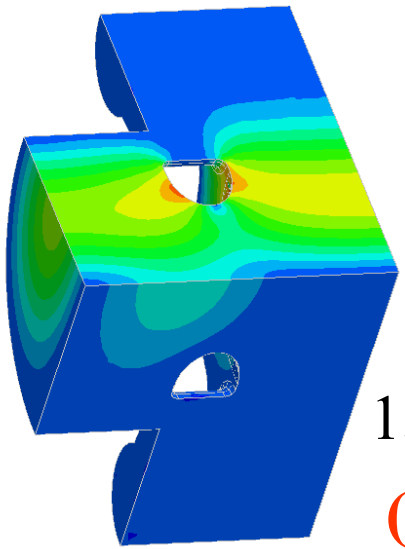


14863.7 **(-7)**

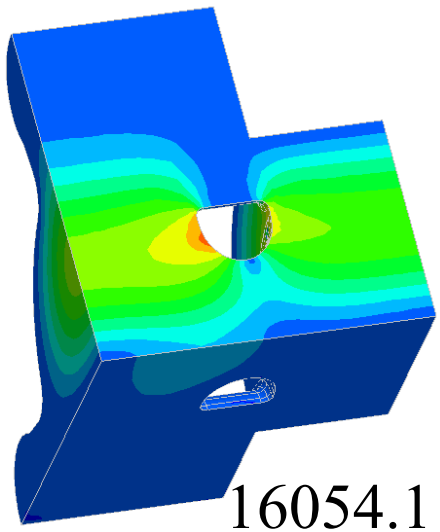
#52



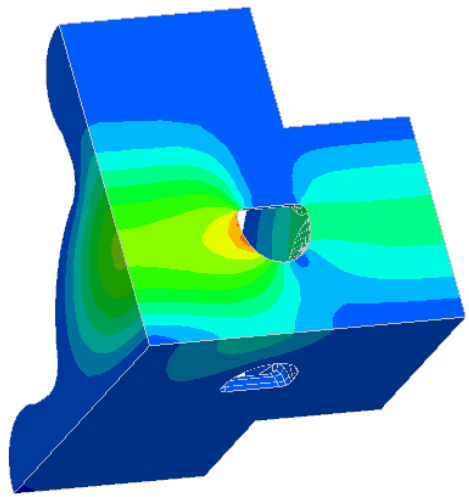
15440.0 **(-9)**



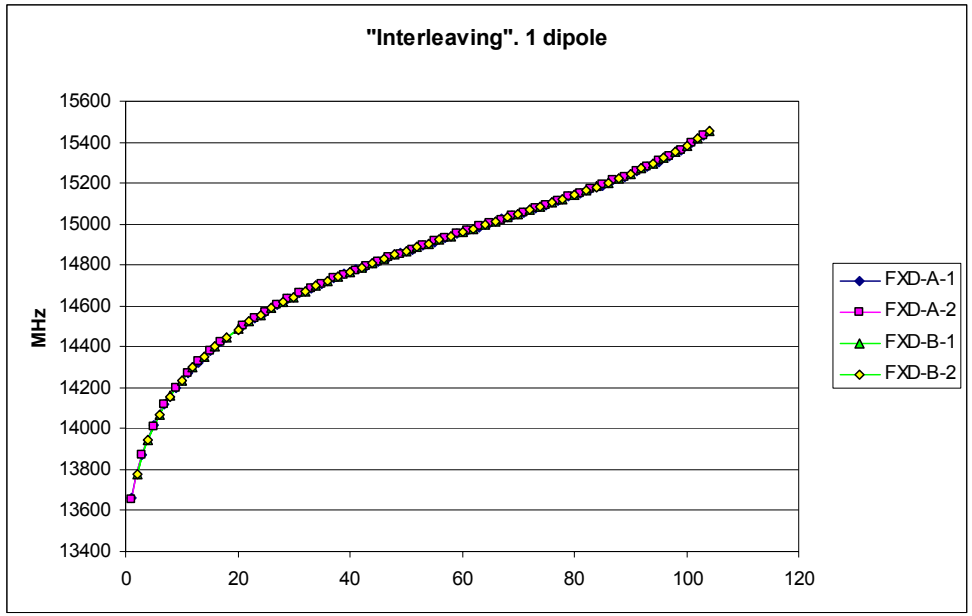
15768.4 **(-10)**

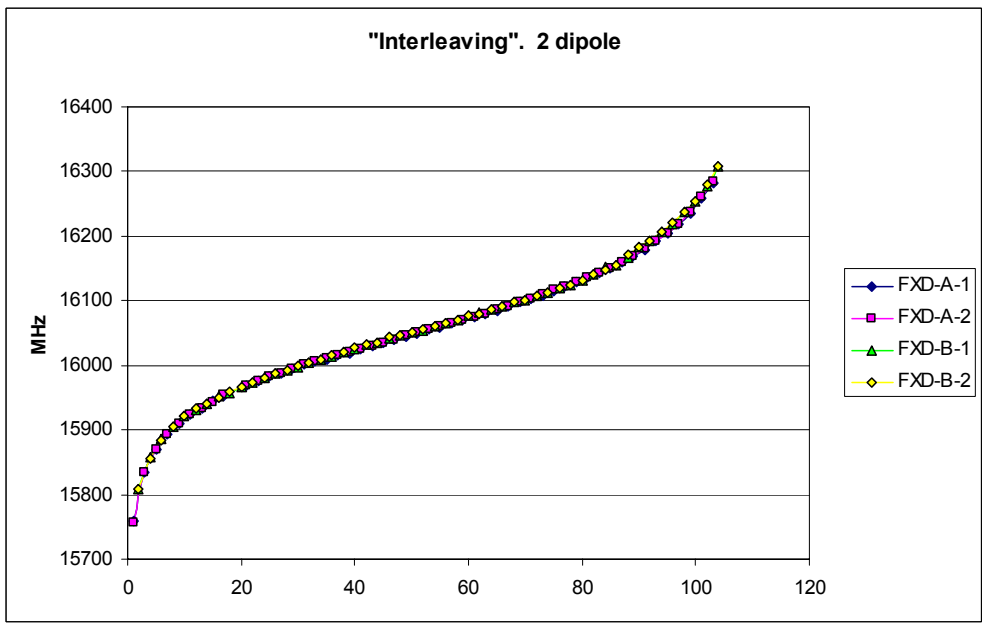


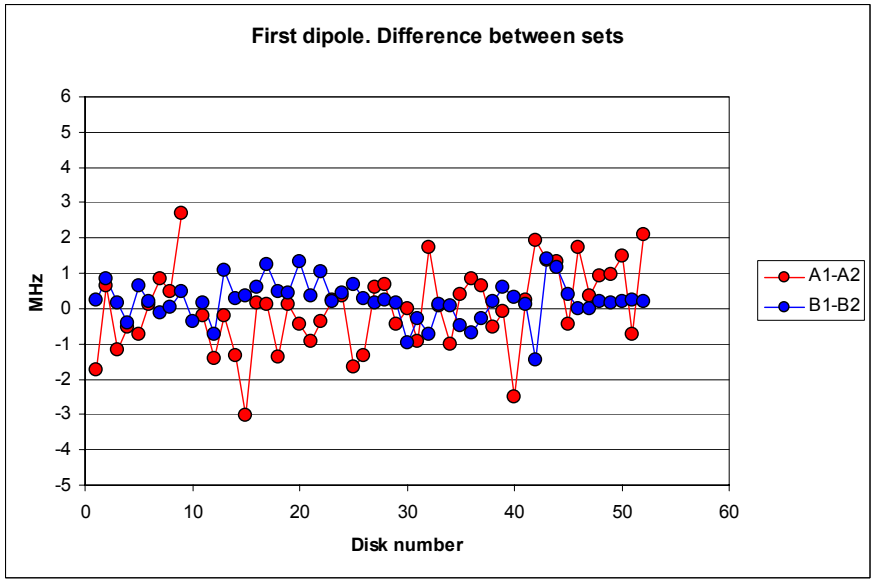
16054.1 **(-10)**

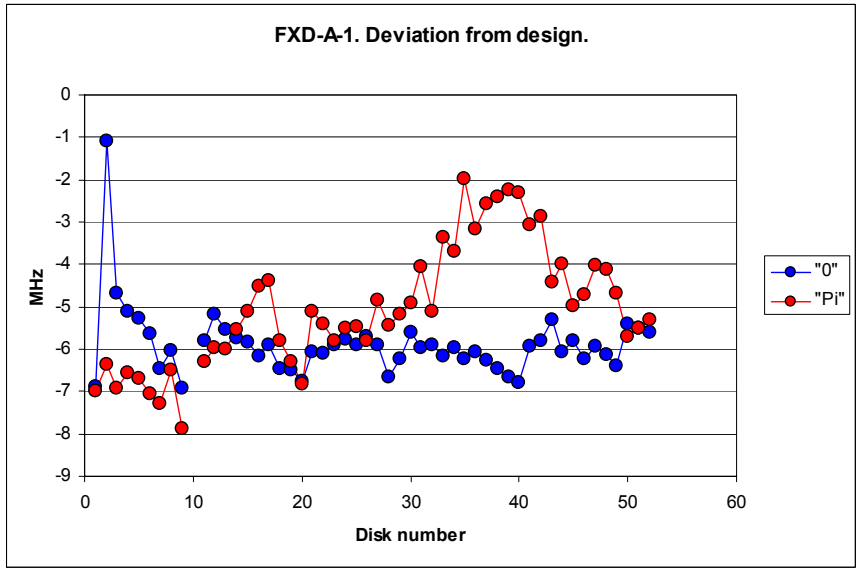


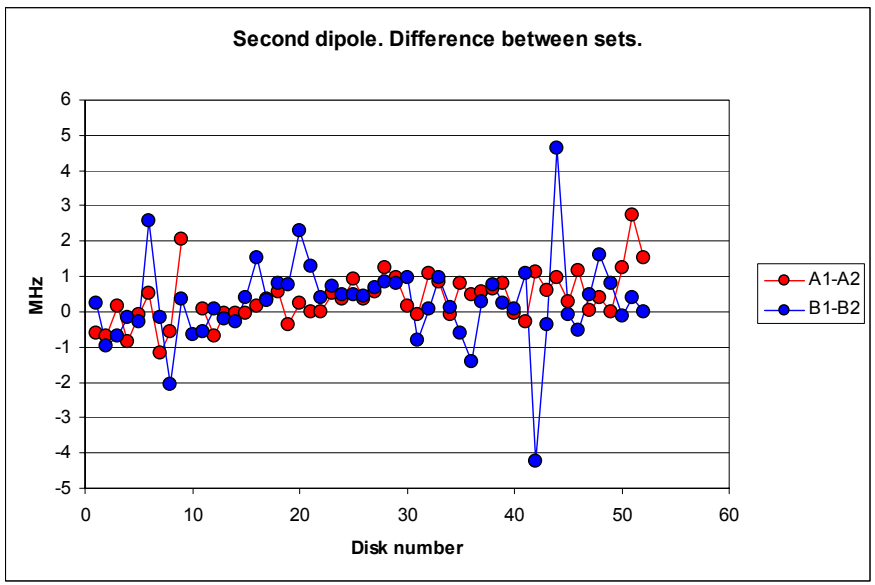
16290.6 **(-9)**

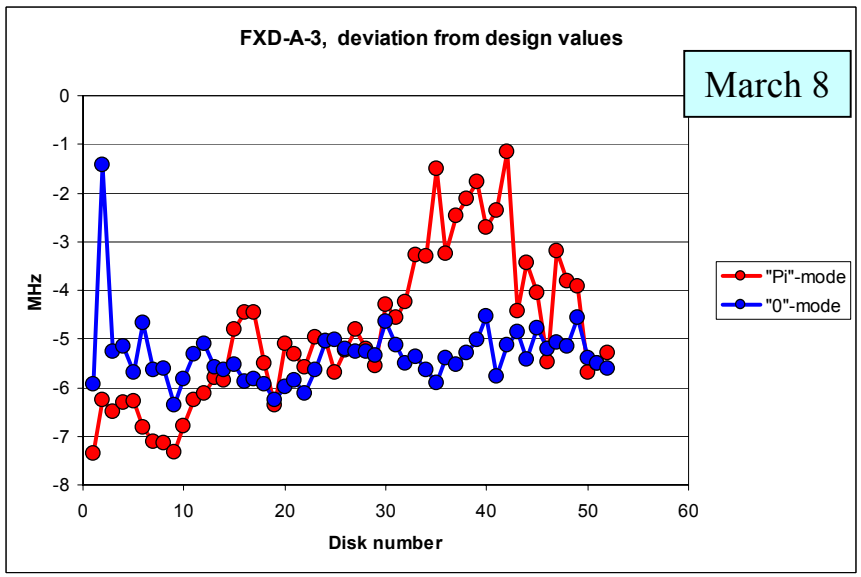

"Interleaving". 1 dipole
MHz
15600
15400
15200
15000
14800
14600
14400
14200
14000
13800
13600
13400
0
20
40
60
80
100
120
FXD-A-1
FXD-A-2
FXD-B-1
FXD-B-2


"Interleaving". 2 dipole
MHz
16400
16300
16200
16100
16000
15900
15800
15700
0
20
40
60
80
100
120
FXD-A-1
FXD-A-2
FXD-B-1
FXD-B-2


First dipole. Difference between sets
MHz
Disk number
A1-A2
B1-B2


FXD-A-1. Deviation from design.
MHz
Disk number
"0"
"Pi"


Second dipole. Difference between sets.
MHz
Disk number
A1-A2
B1-B2


FXD-A-3, deviation from design values
March 8
MHz
Disk number
"Pi"-mode
"0"-mode