

Computation of Accurate Horizontal Current Density in Metal Pad using a Full Quarter Cell Thermo-Electric Model

Marc Dupuis

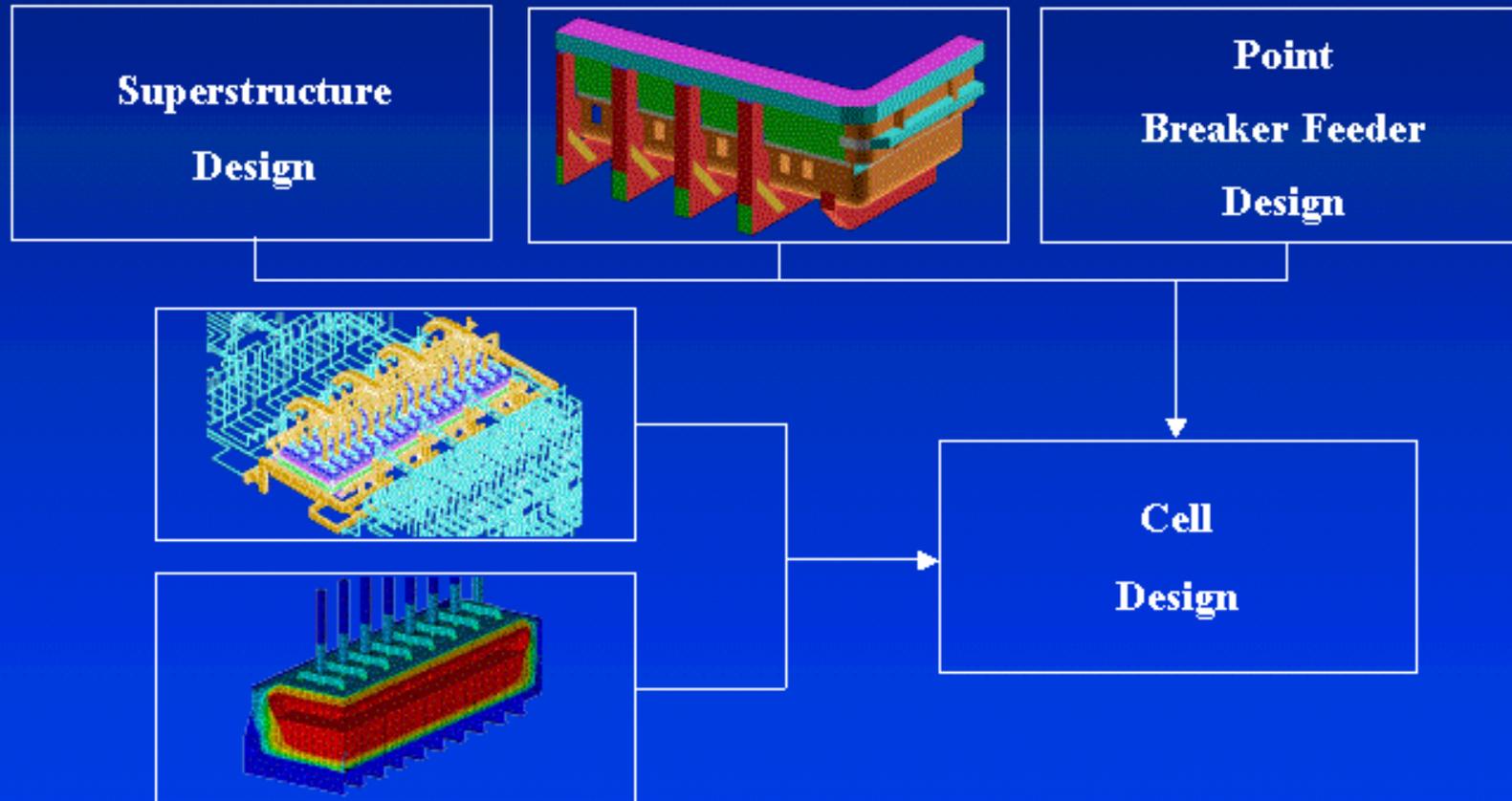
GENISIM

GENISIM

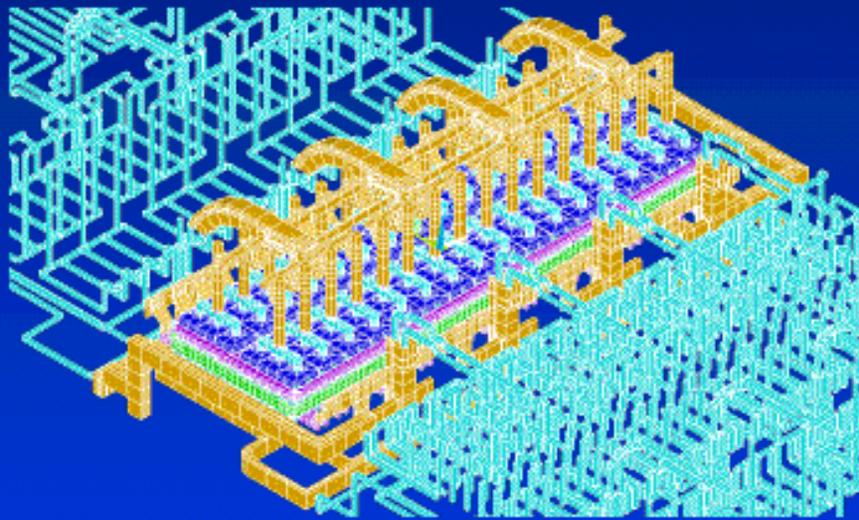
Plan of the Presentation

- Introduction
- Full Cell Quarter Thermo-Electric Model
- Cathode Quarter + Liquid Zone Thermo-Electric Model
- Case Studies
 - Rodding collector bars up to the edge of the blocks
 - Decreasing the liquidus superheat by 25%
 - Increasing the liquidus superheat by 25%
 - Low cathode block erosion design proposal
- Conclusions

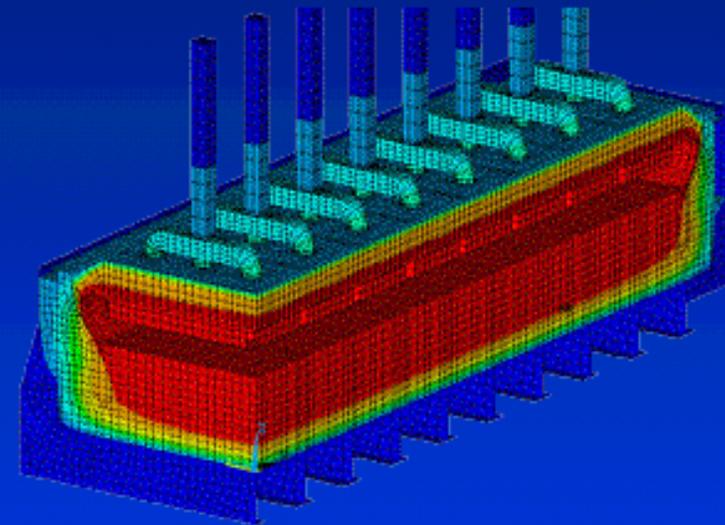
Modeling the Hall-Hérout Cell



Modeling the Hall-Héroult Cell

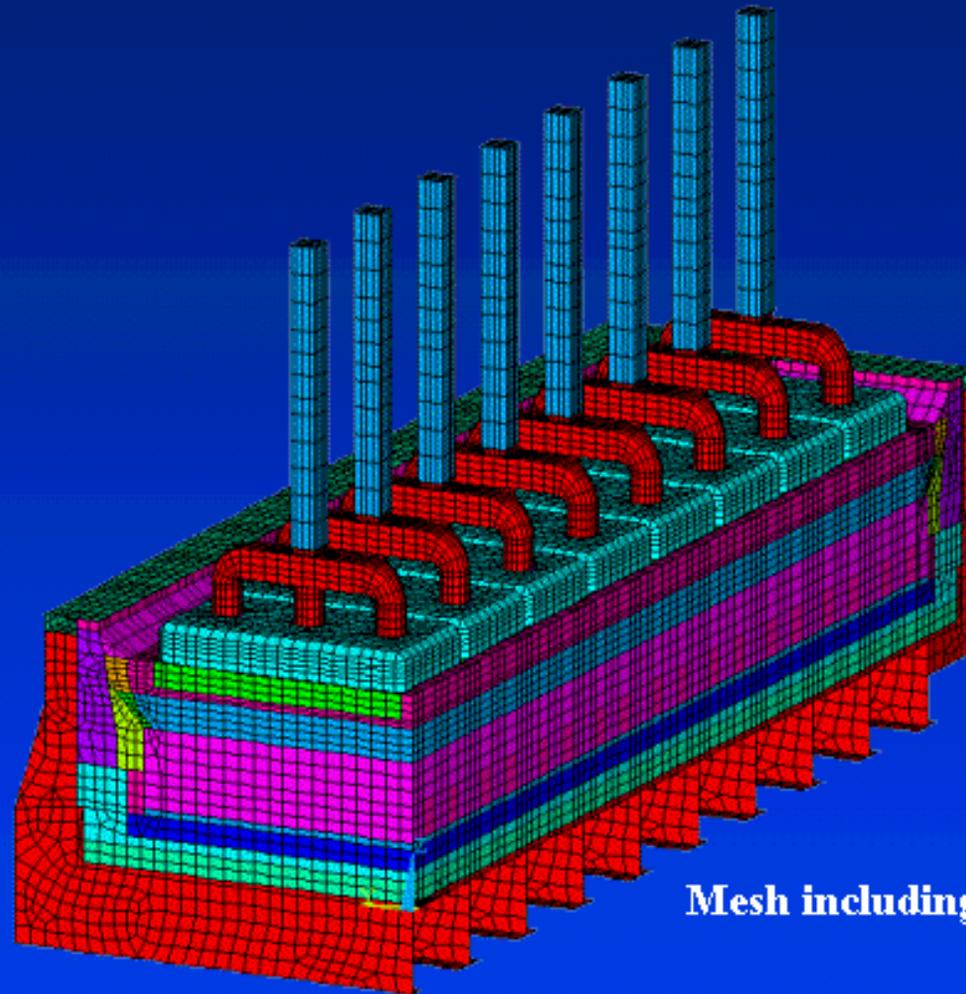


MHD model:
centered around the liquid zone



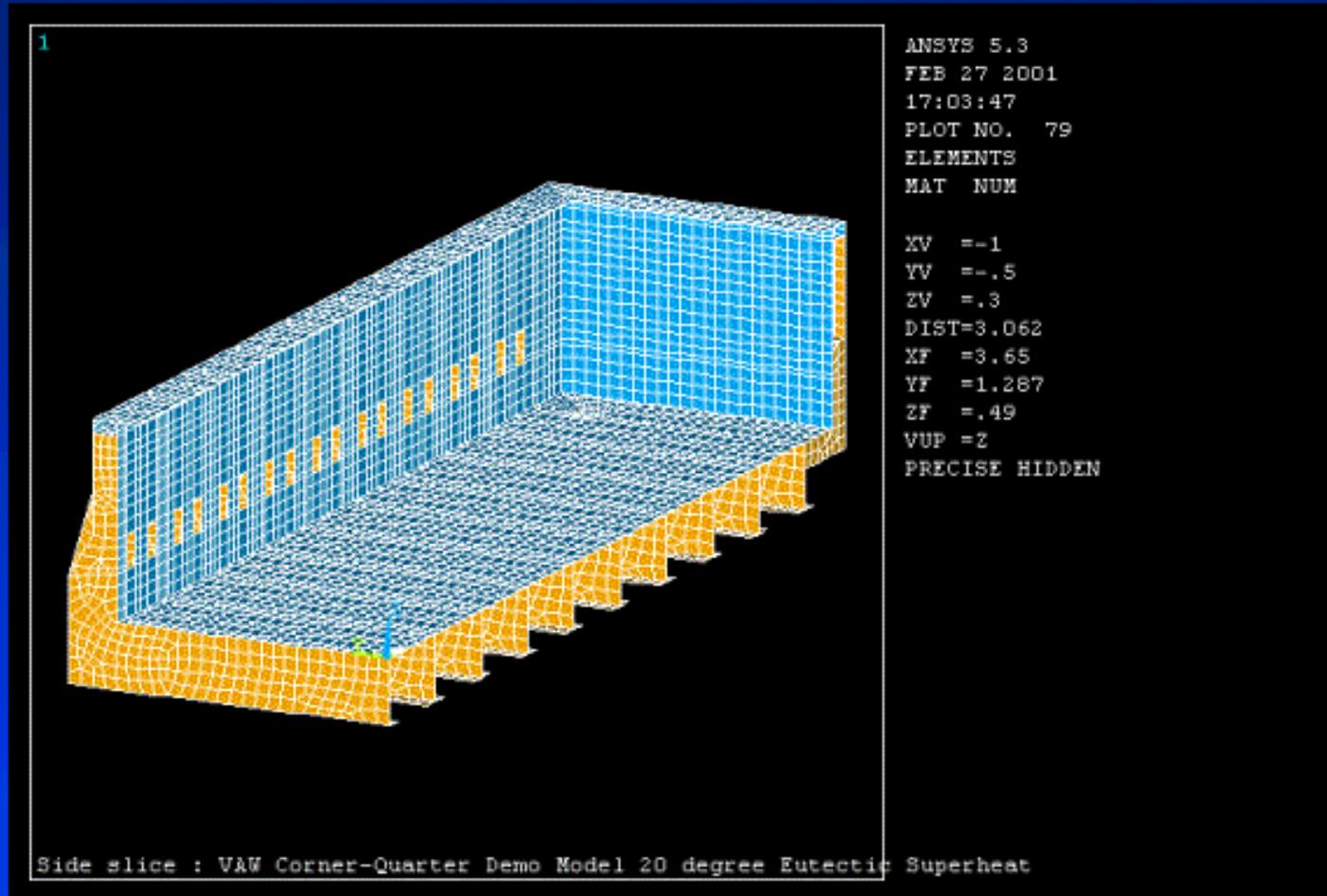
Thermo-electric model:
no need to include the liquid zone

Full Cell Quarter Thermo-Electric Model



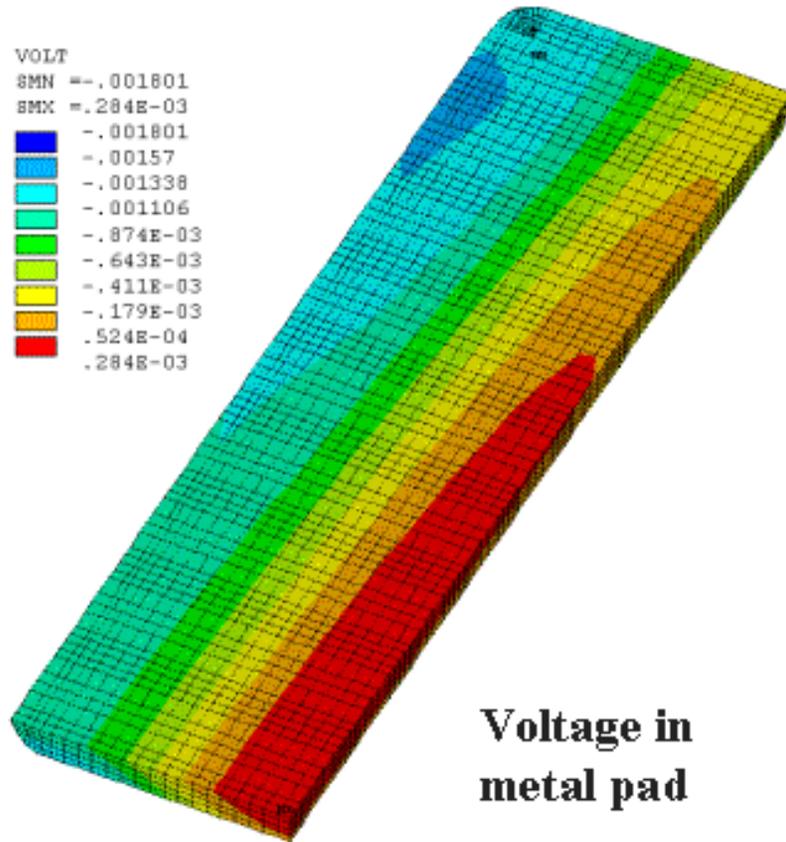
Mesh including the liquid zone

Full Cell Quarter Thermo-Electric Model



Full Cell Quarter Thermo-Electric Model

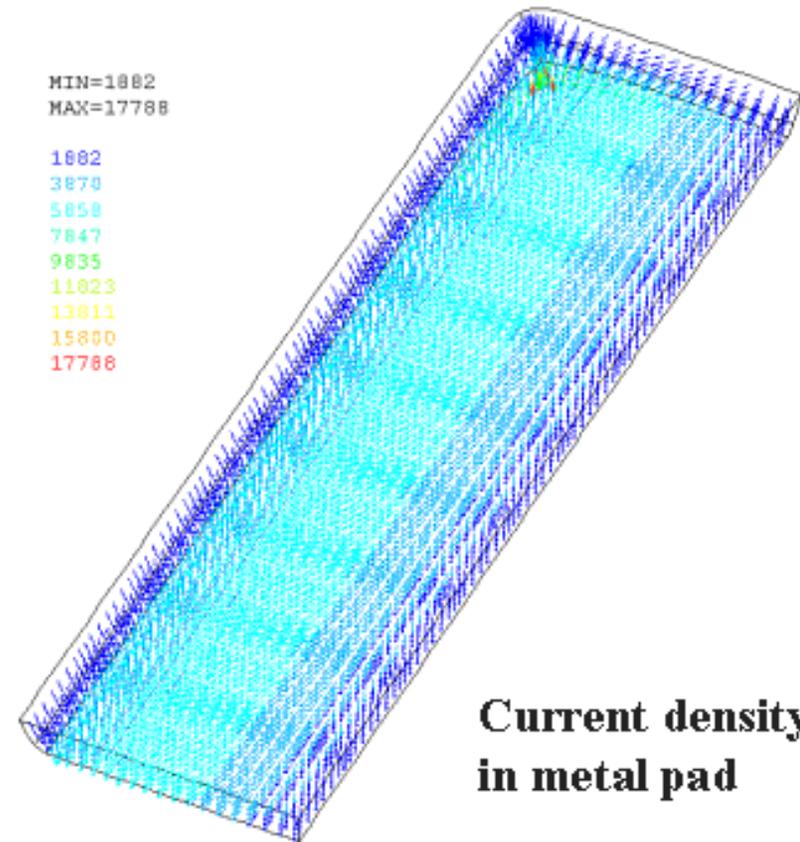
VOLT
SMN = -.001801
SMX = .284E-03
-.001801
-.00157
-.001338
-.001106
-.874E-03
-.643E-03
-.411E-03
-.179E-03
-.524E-04
.284E-03



**Voltage in
metal pad**

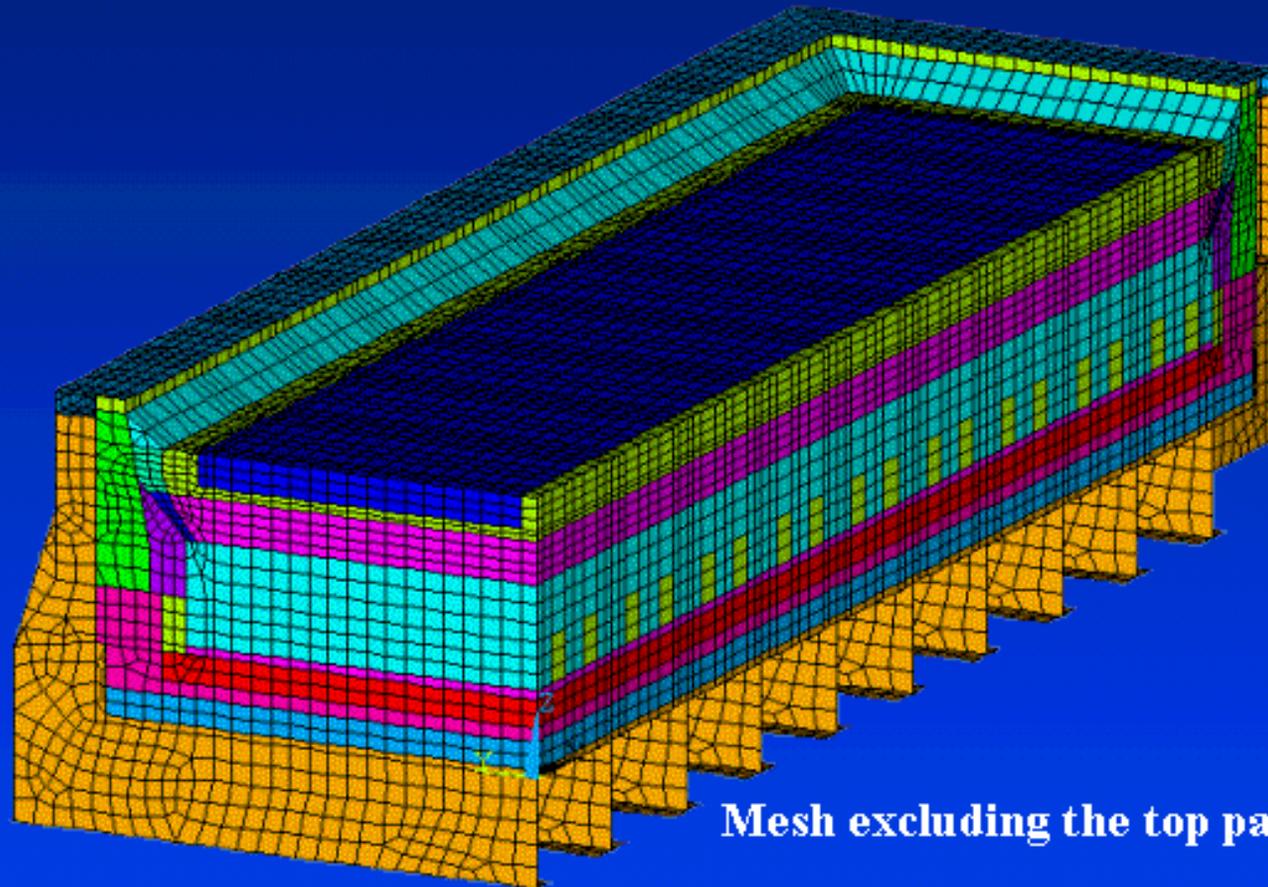
MIN=1882
MAX=17788

1882
3870
5858
7847
9835
11823
13811
15800
17788



**Current density
in metal pad**

Cathode Quarter + Liquid Zone Thermo-Electric Model

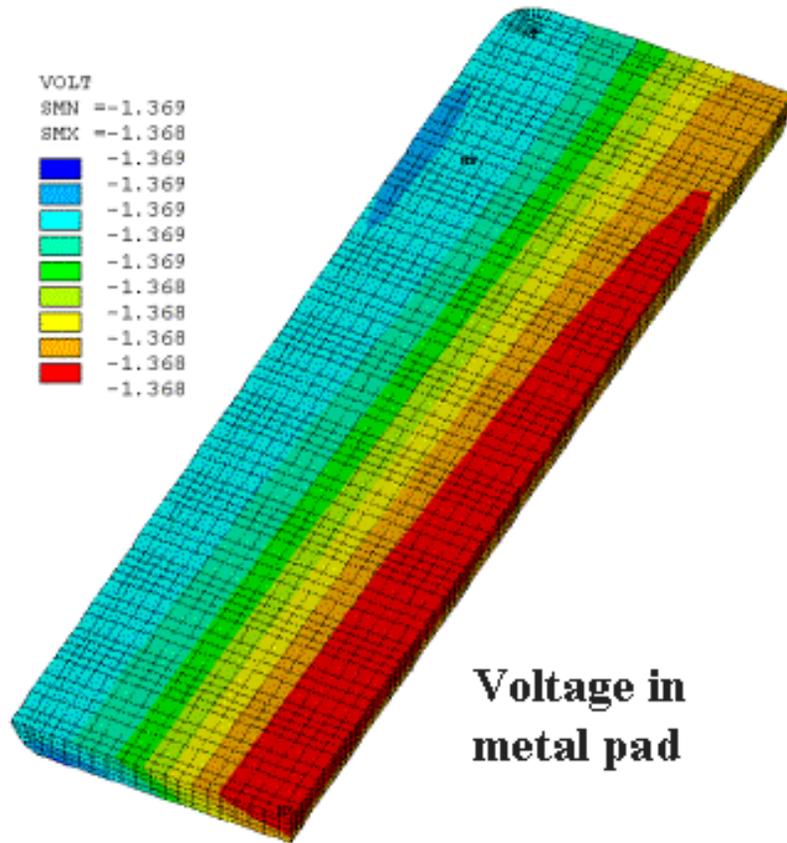


Mesh excluding the top part of anodes

Cathode Quarter + Liquid Zone Thermo-Electric Model

VOLT
SMN =-1.369
SMX =-1.368

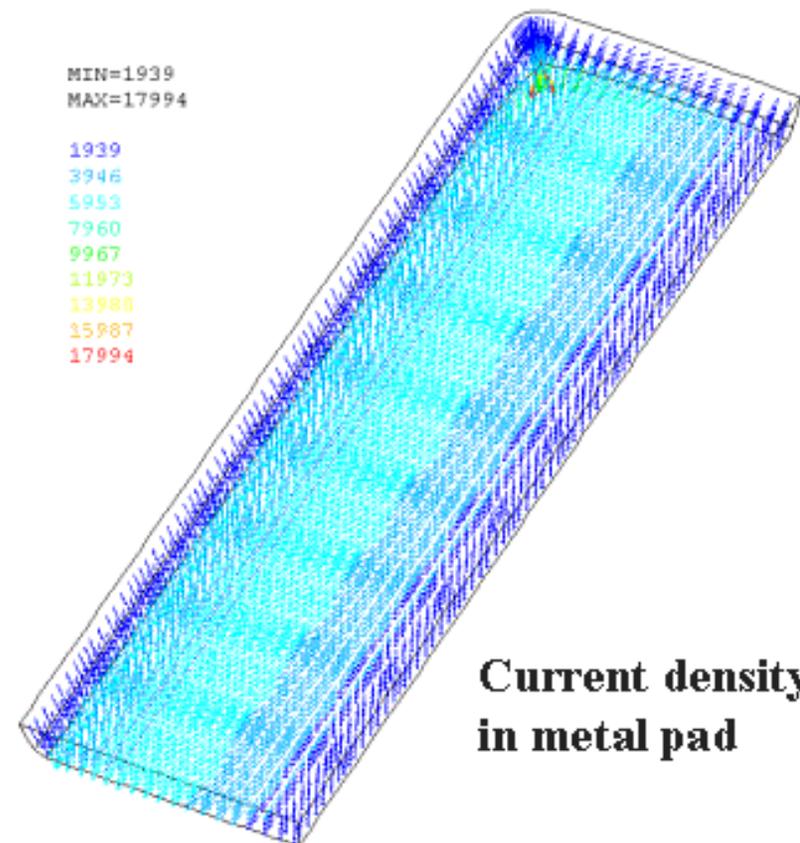
Blue	-1.369
Light Blue	-1.369
Cyan	-1.369
Green	-1.369
Light Green	-1.368
Yellow	-1.368
Orange	-1.368
Red	-1.368



**Voltage in
metal pad**

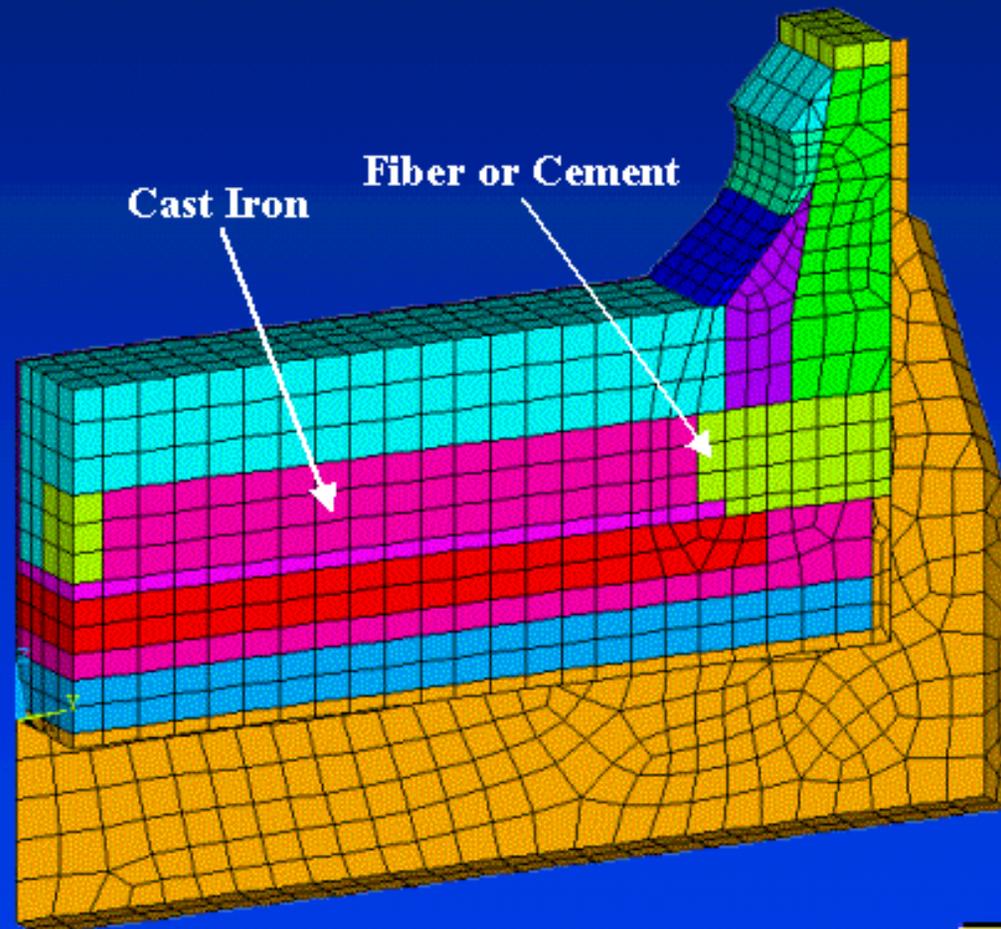
MIN=1939
MAX=17994

1939
3946
5953
7960
9967
11973
13980
15987
17994

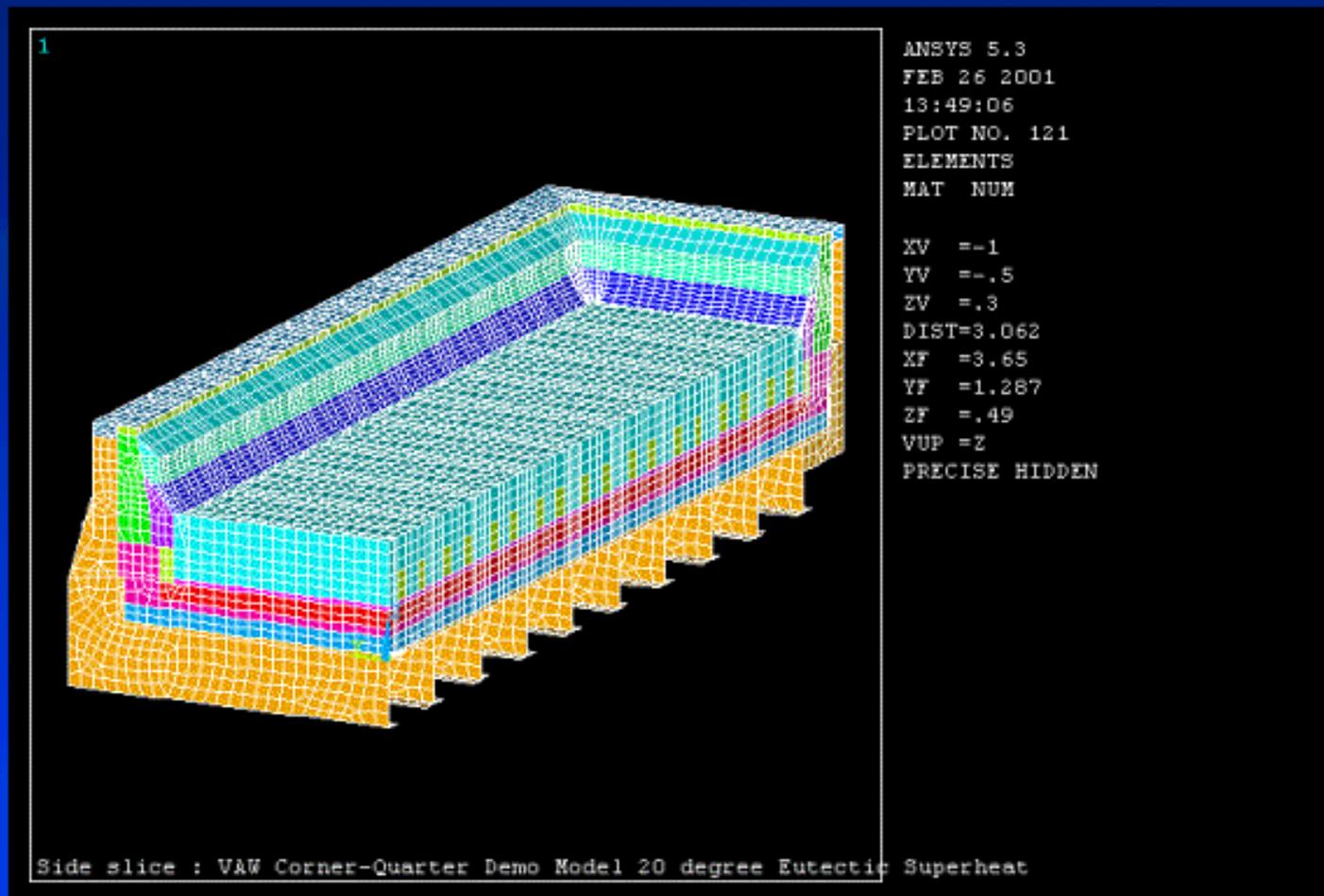


**Current density
in metal pad**

Case Study 1: Rodding Collector Bars up to the Edge of the Blocks



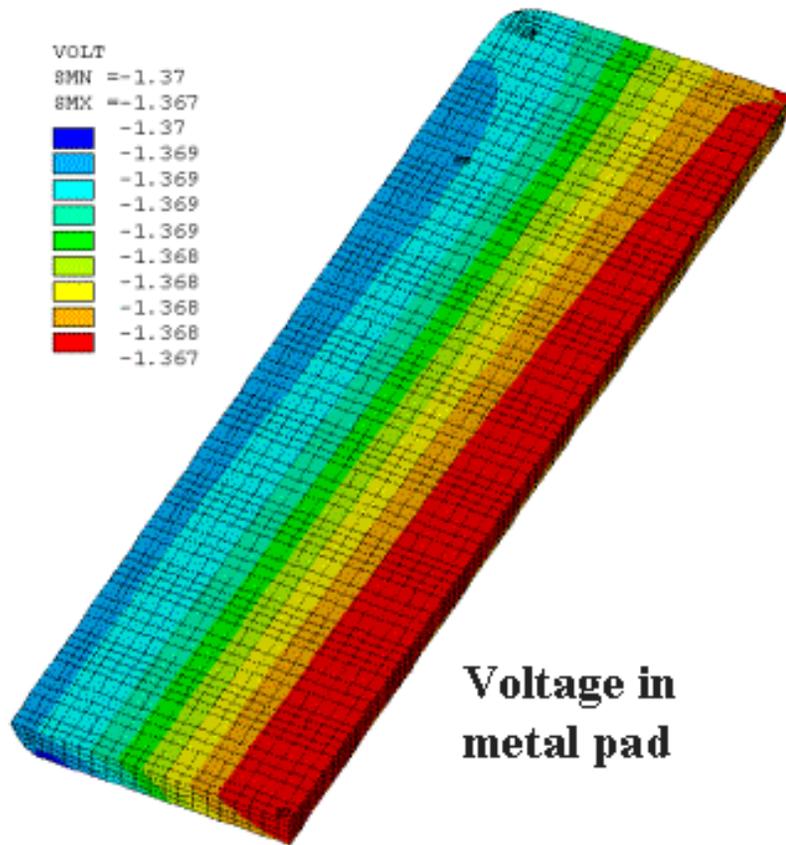
Case Study 1: Rodding Collector Bars up to the Edge of the Blocks



Case Study 1: Rodding Collector Bars up to the Edge of the Blocks

VOLT
SMN = -1.37
SMX = -1.367

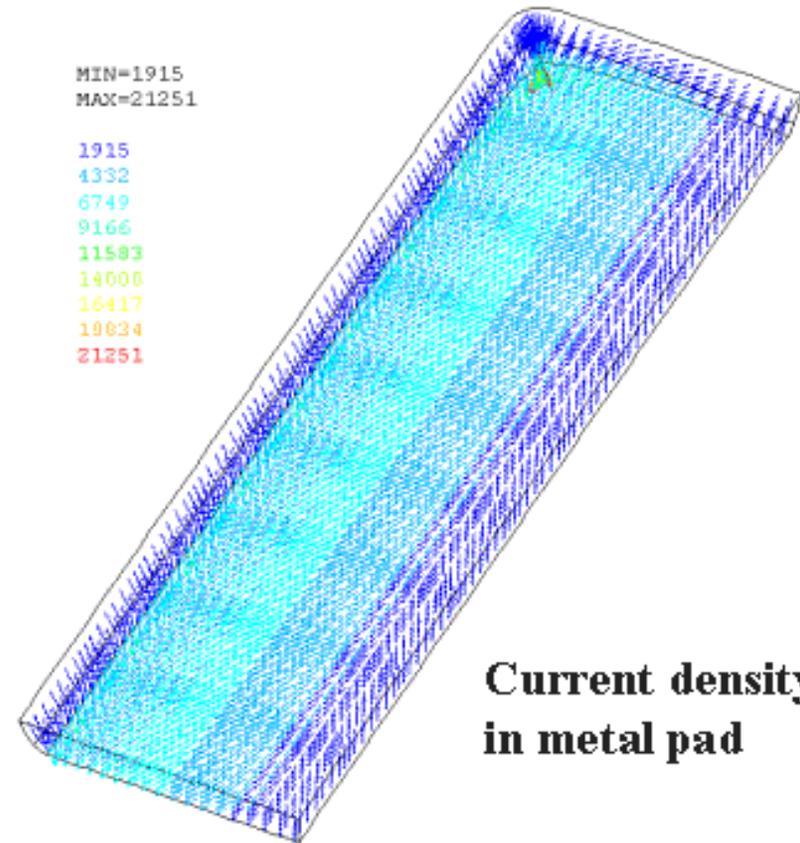
Blue	-1.37
Light Blue	-1.369
Cyan	-1.369
Green	-1.369
Yellow-Green	-1.368
Yellow	-1.368
Orange	-1.368
Red	-1.368
Dark Red	-1.367



**Voltage in
metal pad**

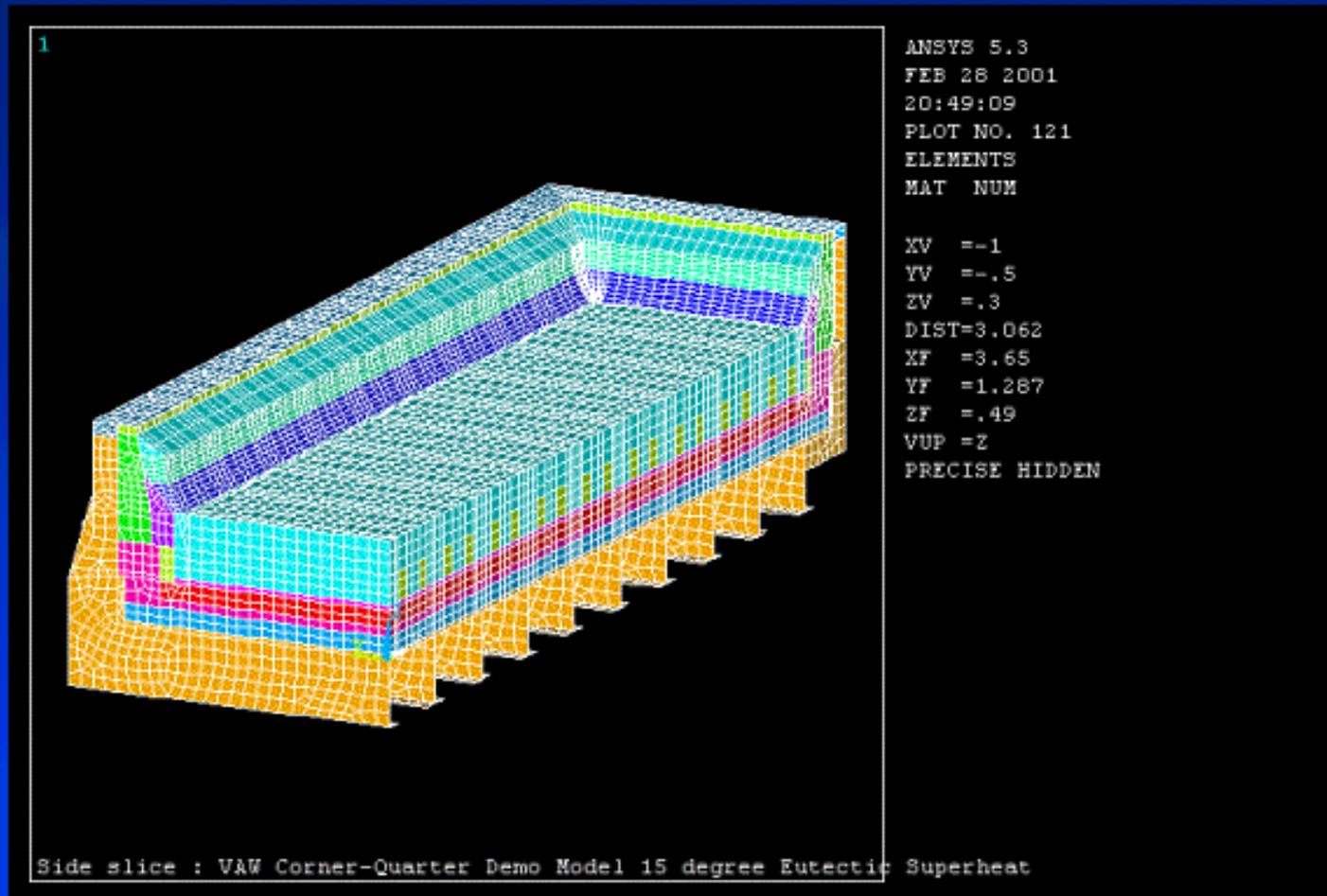
MIN=1915
MAX=21251

1915
4332
6749
9166
11583
14000
16417
18834
21251



**Current density
in metal pad**

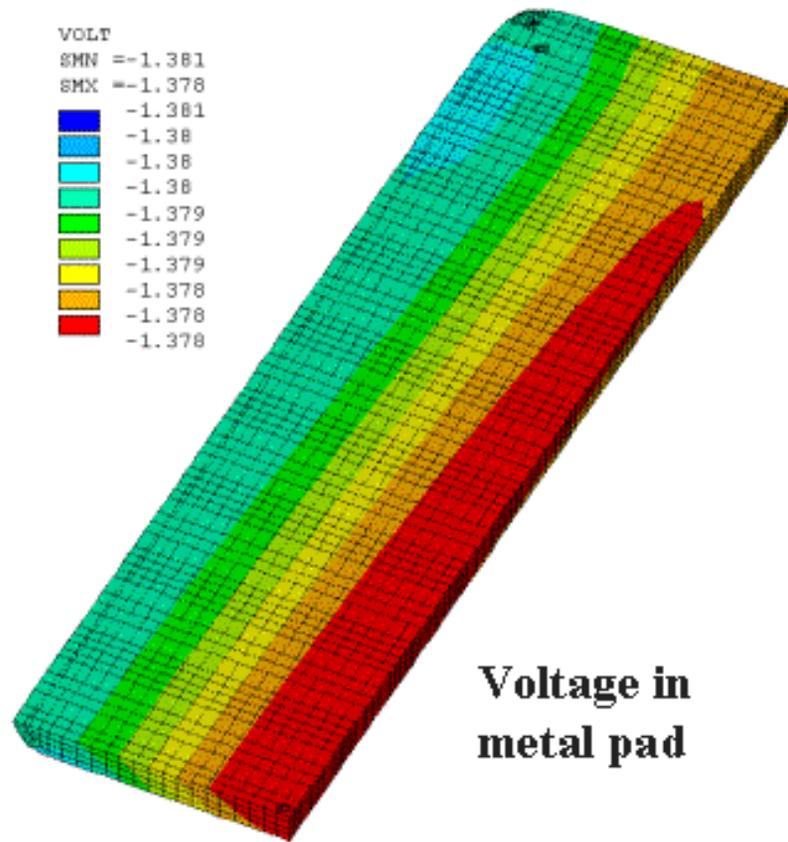
Case Study 2: Decreasing the Liquidus Superheat by 25%



Case Study 2: Decreasing the Liquidus Superheat by 25%

VOLT
SMN =-1.381
SMX =-1.378

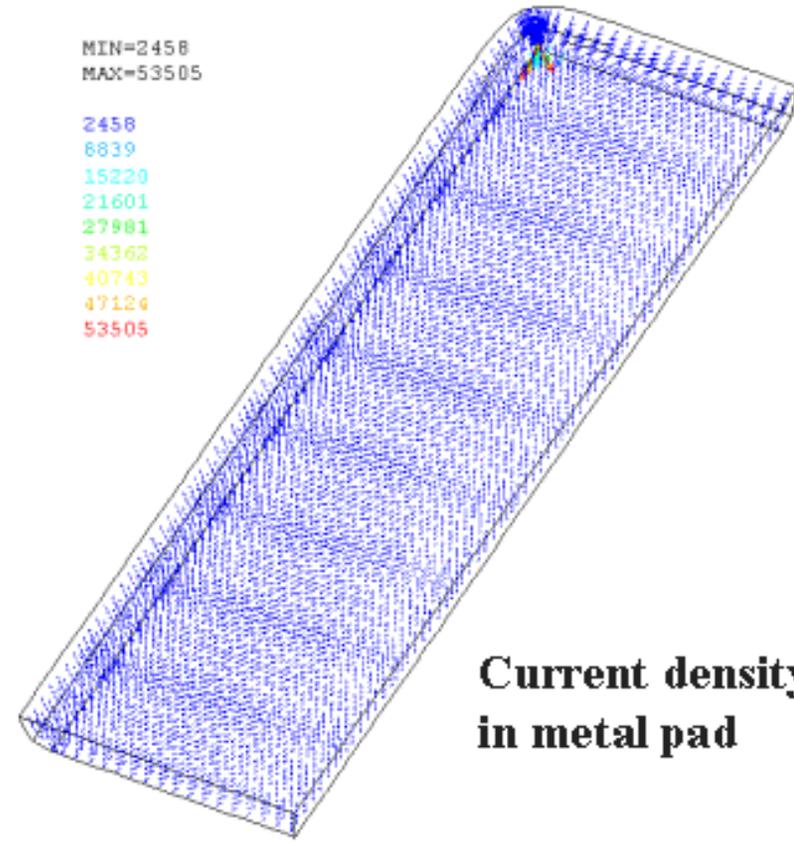
■	-1.381
■	-1.38
■	-1.38
■	-1.38
■	-1.379
■	-1.379
■	-1.379
■	-1.378
■	-1.378
■	-1.378



**Voltage in
metal pad**

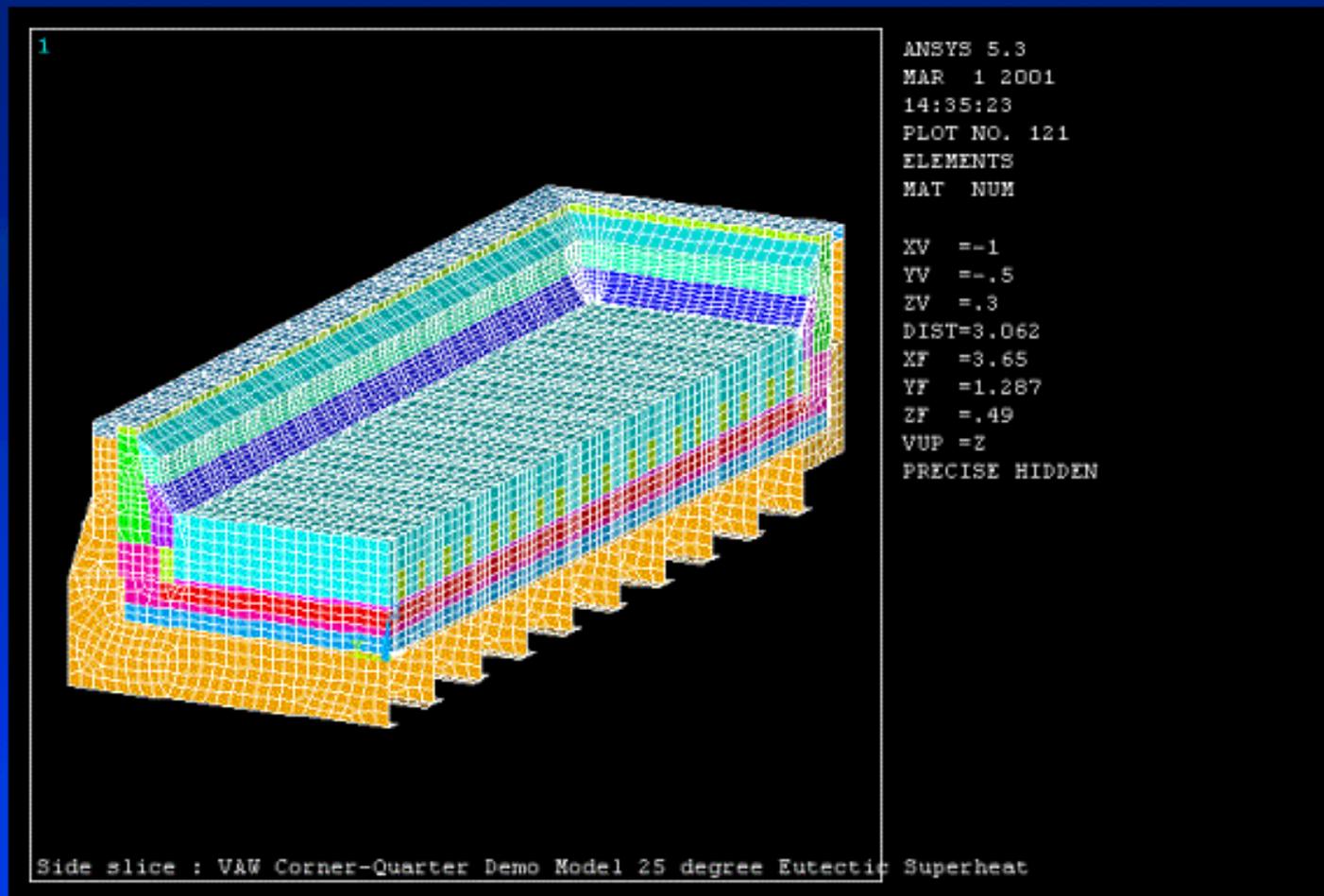
MIN=2458
MAX=53505

2458
8839
15220
21601
27981
34362
40743
47124
53505



**Current density
in metal pad**

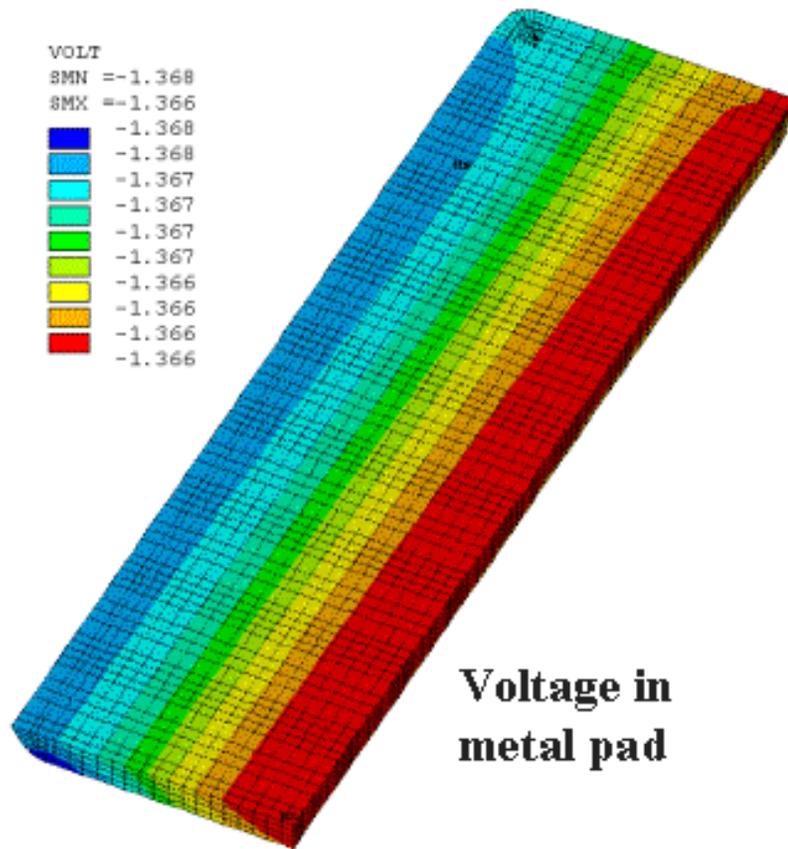
Case Study 3: Increasing the Liquidus Superheat by 25%



Case Study 3: Increasing the Liquidus Superheat by 25%

VOLT
SMN = -1.368
SMX = -1.366

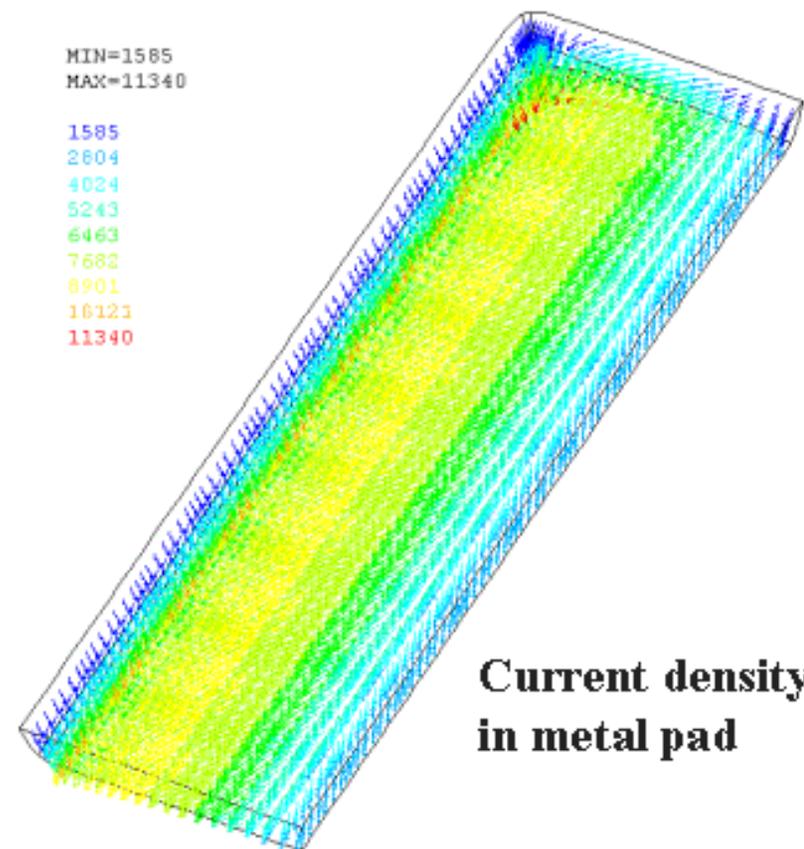
Blue	-1.368
Light Blue	-1.368
Light Green	-1.367
Green	-1.367
Yellow-Green	-1.367
Yellow	-1.366
Orange	-1.366
Red	-1.366
Dark Red	-1.366



**Voltage in
metal pad**

MIN=1585
MAX=11340

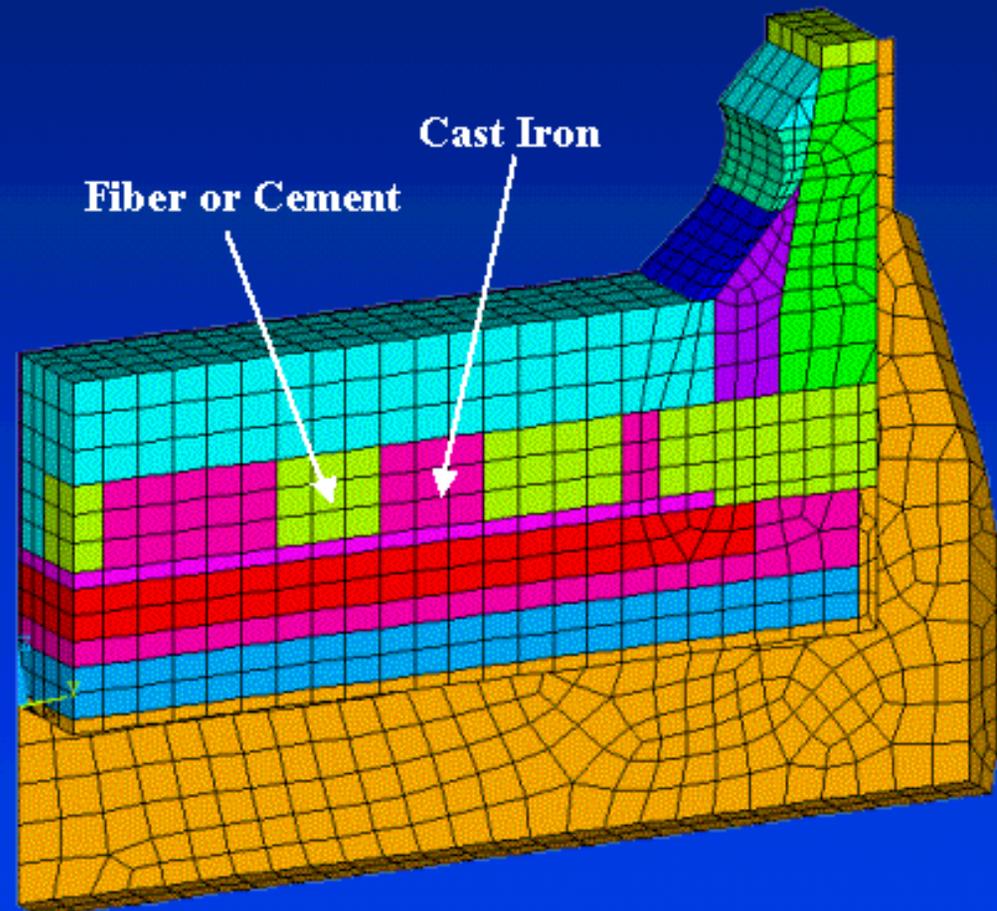
1585
2804
4024
5243
6463
7682
8901
10121
11340



**Current density
in metal pad**

Low Cathode Block Erosion Design Proposal

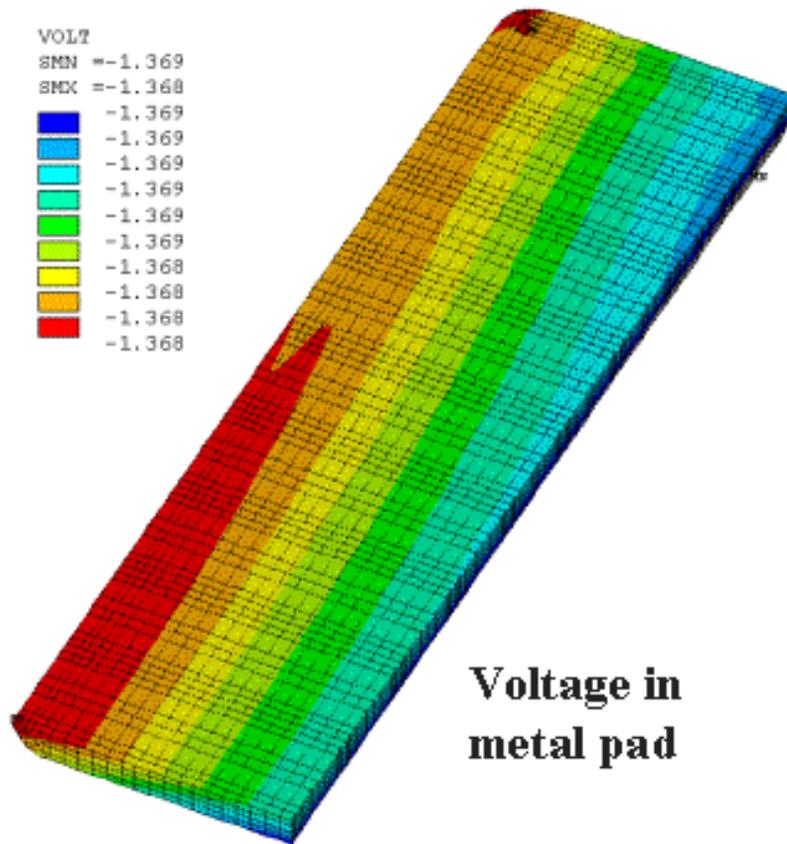
- Partial cast iron rodding in order to promote a uniform current density at the surface of the cathode block
- Increase of 20% of the collector bar width and height
- Increase of 10 cm of the block height
- Decrease by 10 cm the height of the horizontal cradles web under the pot shell floor



Case Study 4: Low Cathode Block Erosion Design Proposal

VOLT
SMN = -1.369
SMX = -1.368

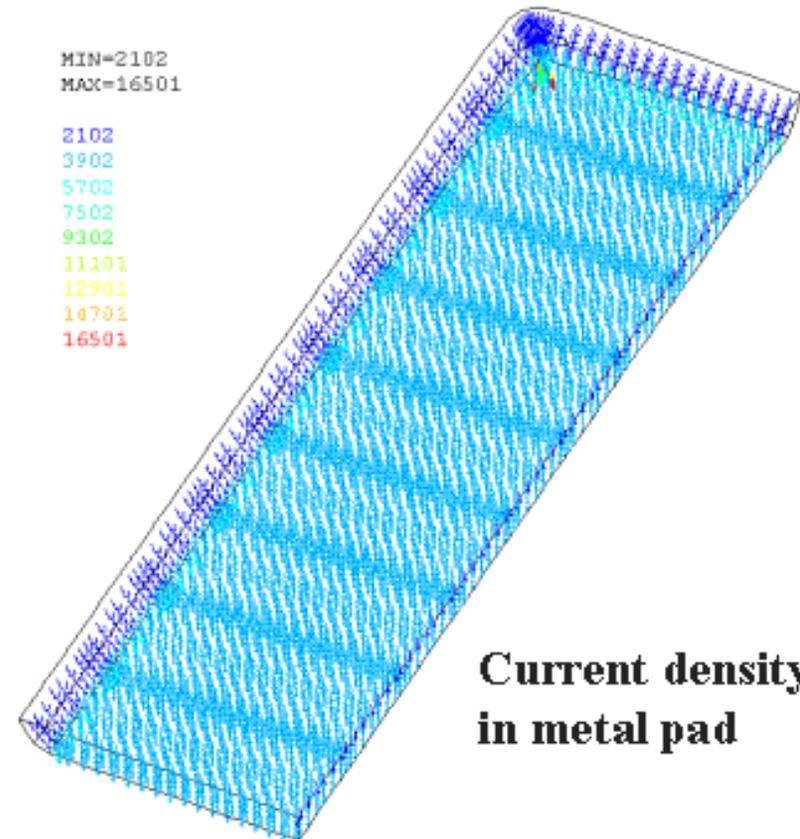
■	-1.369
■	-1.369
■	-1.369
■	-1.369
■	-1.369
■	-1.369
■	-1.368
■	-1.368
■	-1.368
■	-1.368



**Voltage in
metal pad**

MIN=2102
MAX=16501

■	2102
■	3902
■	5702
■	7502
■	9302
■	11101
■	12901
■	14701
■	16501



**Current density
in metal pad**

Conclusions

- A typical quarter cell thermo-electric model has been successfully extended to study the impact of the cell lining design and the cell operating conditions on the horizontal current in the metal pad.
- The results clearly demonstrate that the maximum value of the horizontal current in the metal pad is strongly affected by the cell lining design and the cell operating conditions.
- Considering the above, it is hard to believe that the cell stability problem is not significantly affected by the cell lining design and the cell operating conditions and that it can only be reduced to a busbar network design issue.