

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

Marc Dupuis

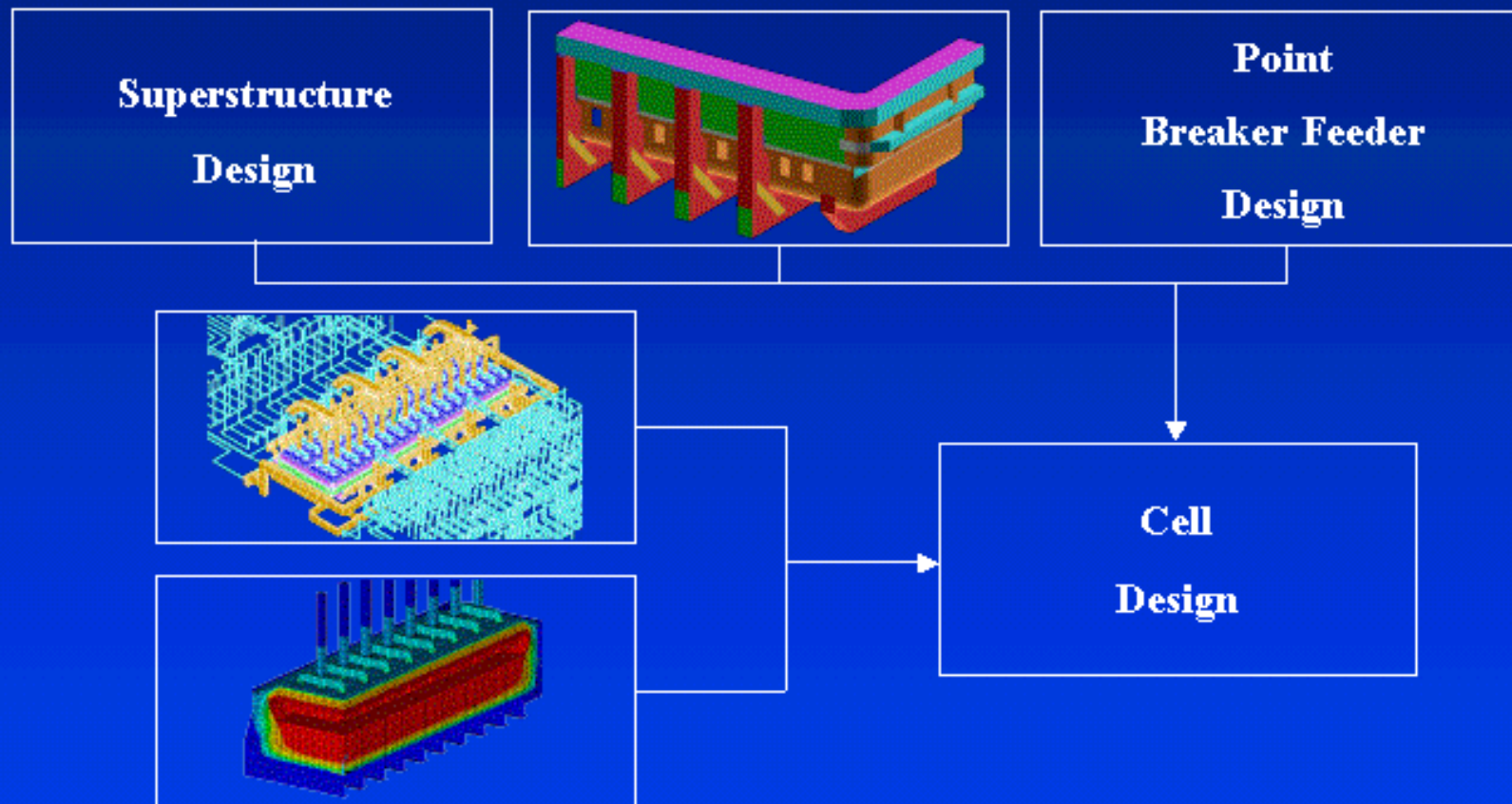
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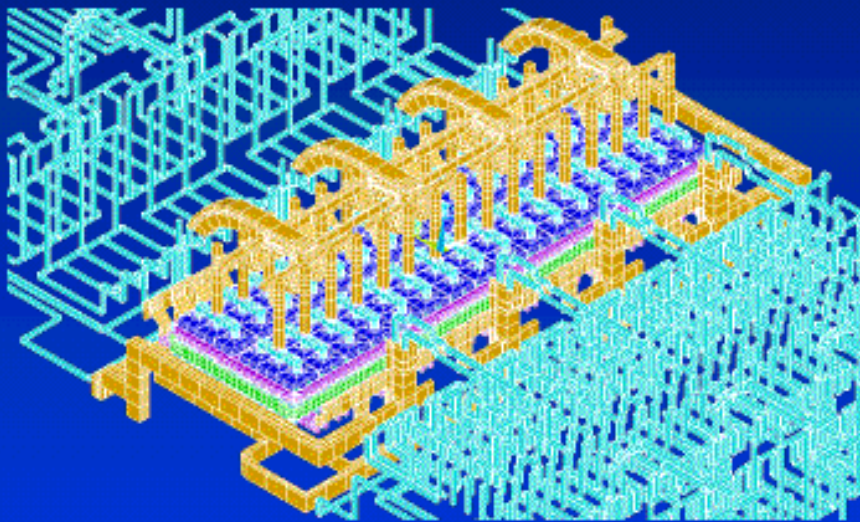
Plan of the Presentation

- 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

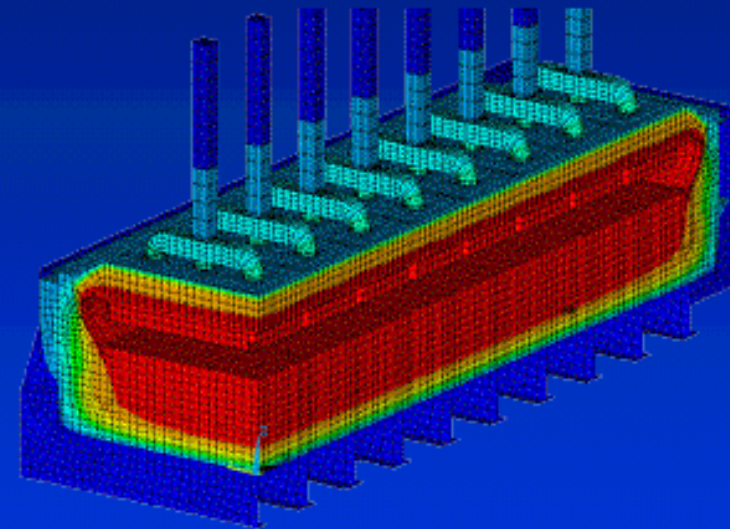
Modeling the Hall-Hérault Cell



Modeling the Hall-Héroult Cell

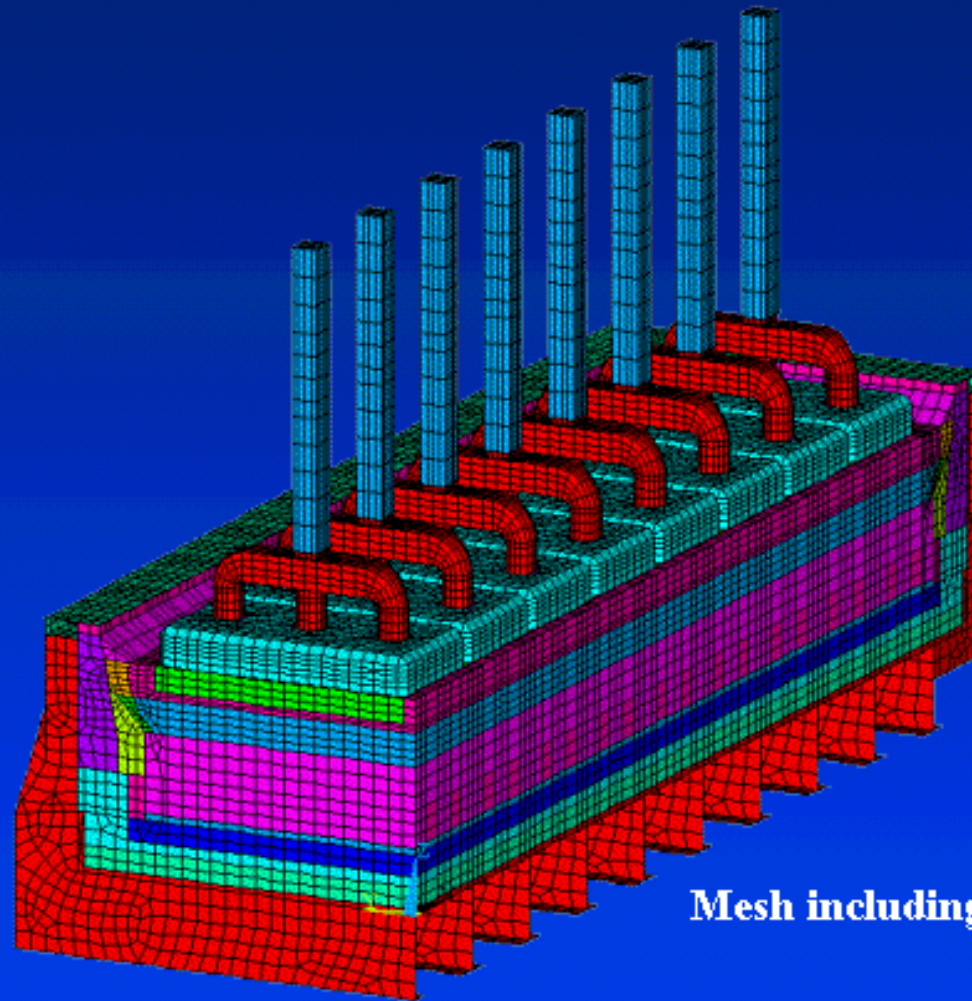


MHD model:
centered around the liquid zone



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

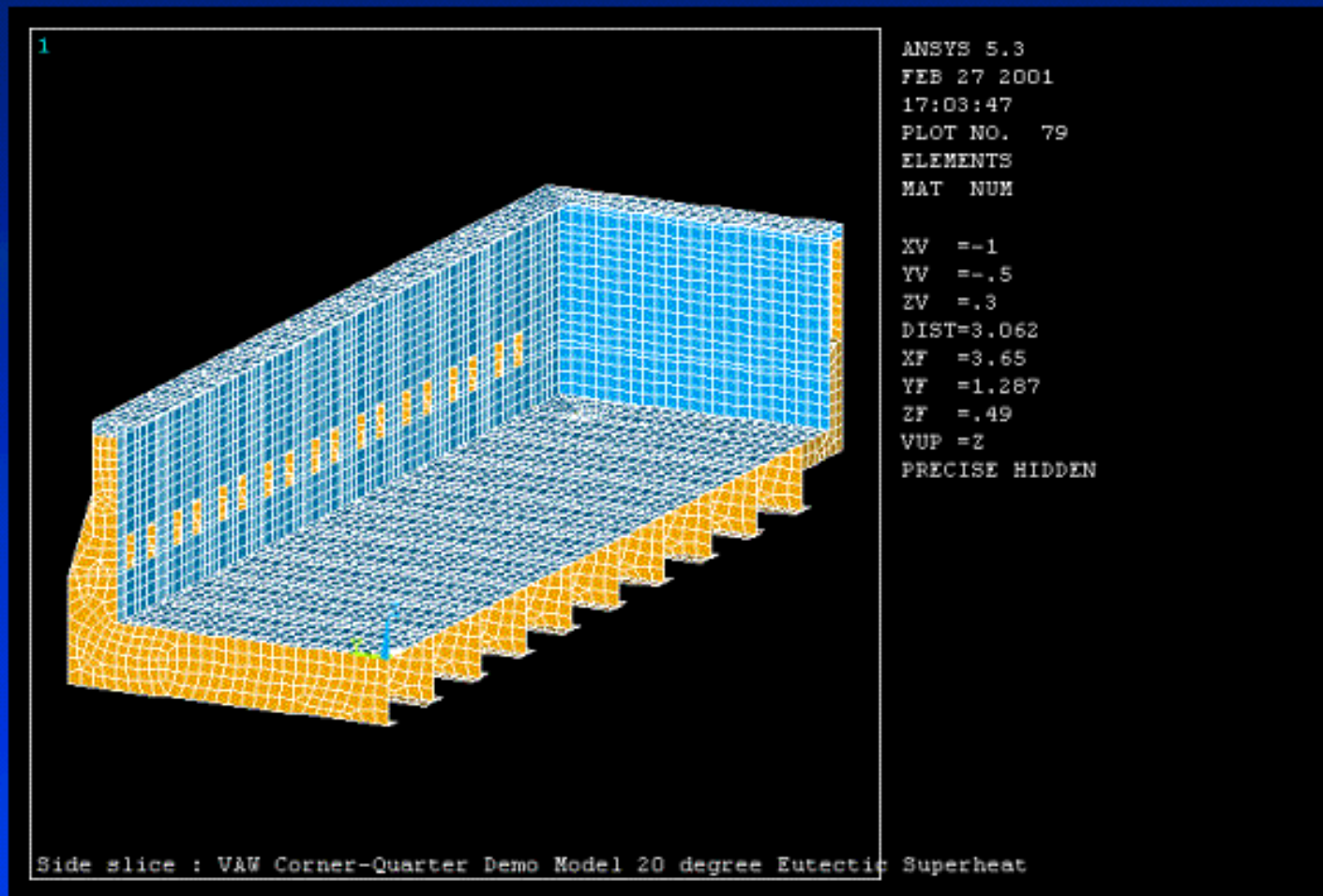
Full Cell Quarter Thermo-Electric Model



Mesh including the liquid zone

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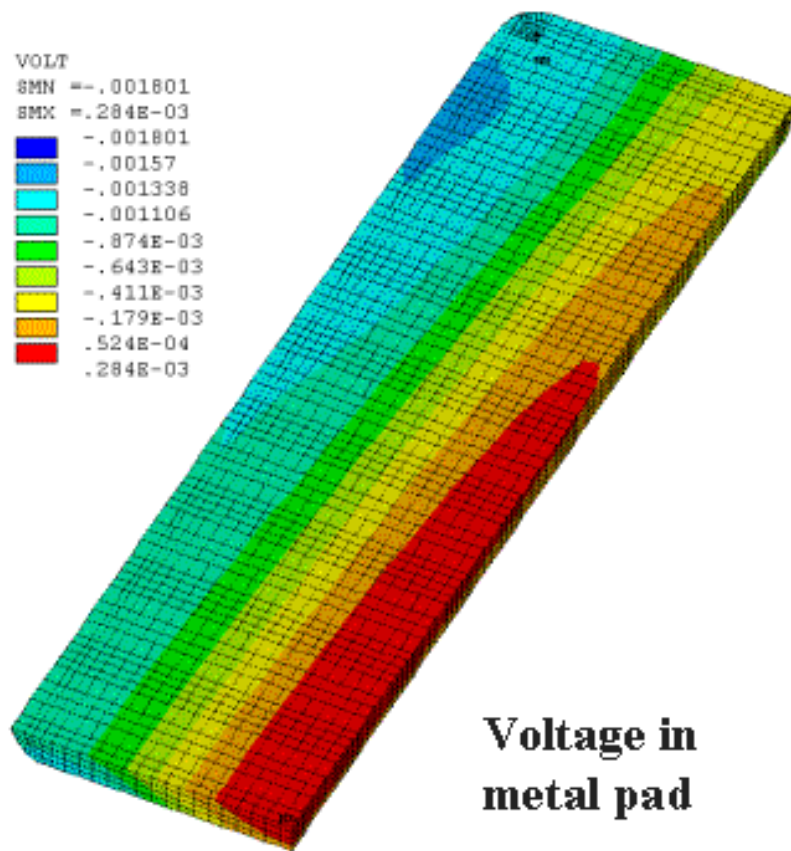
Full Cell Quarter Thermo-Electric Model



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Full Cell Quarter Thermo-Electric Model

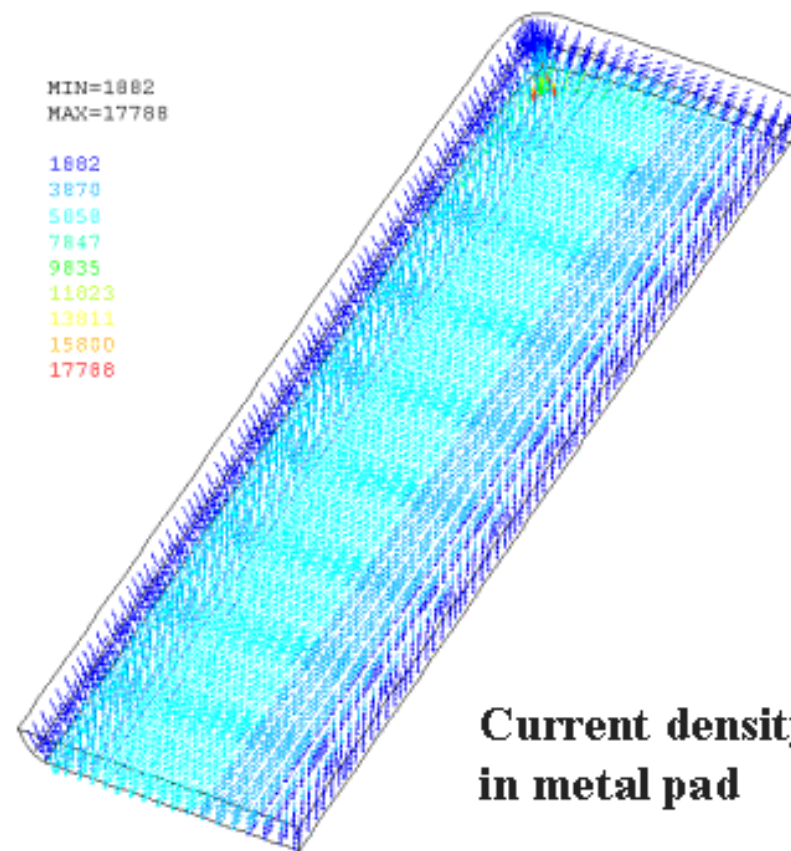
VOLT
SMN = -.001801
SMX = .284E-03
-.001801
-.00157
-.001338
-.001106
-.874E-03
-.643E-03
-.411E-03
-.179E-03
.524E-04
.284E-03



**Voltage in
metal pad**

MIN=1882
MAX=17788

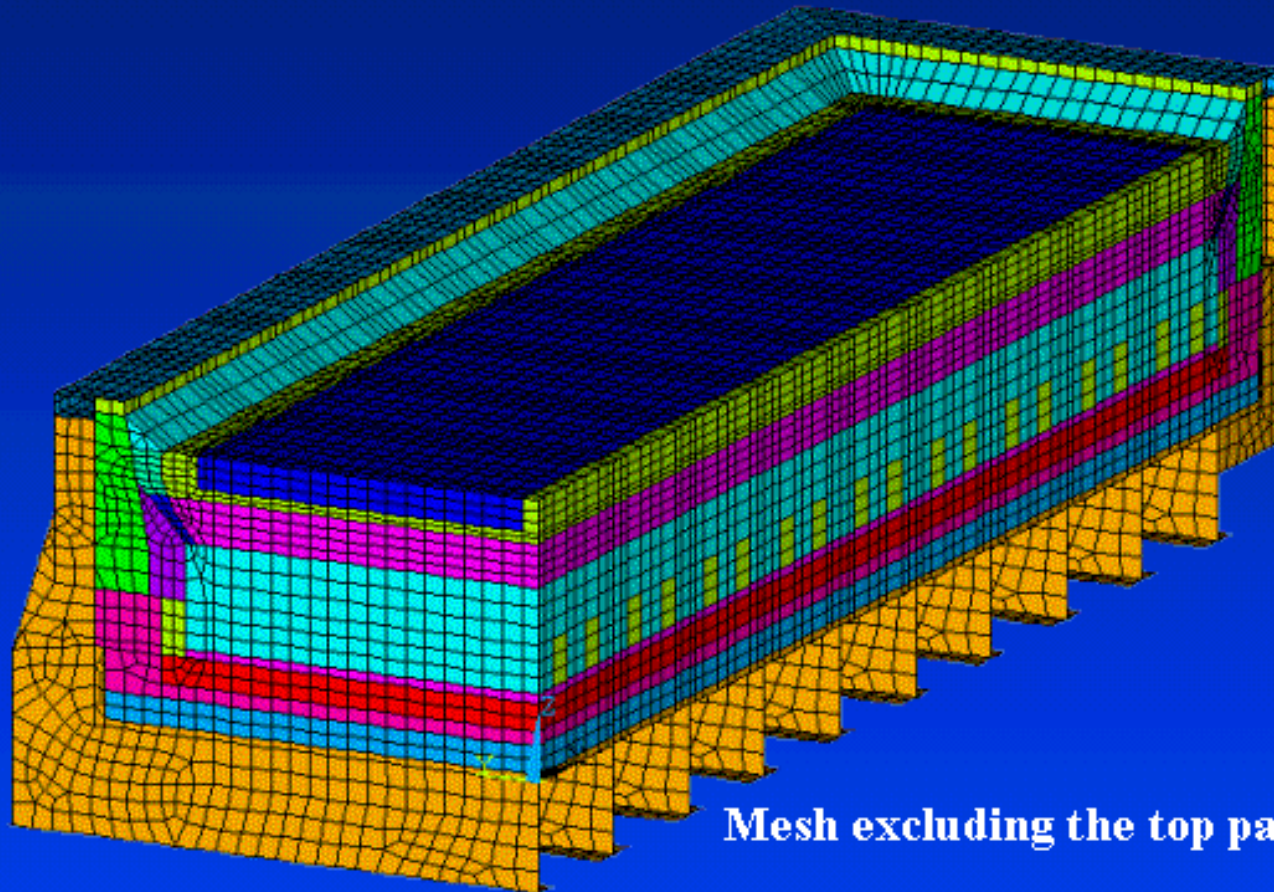
1882
3878
5858
7847
9835
11823
13811
15800
17788



**Current density
in metal pad**

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Cathode Quarter + Liquid Zone Thermo-Electric Model

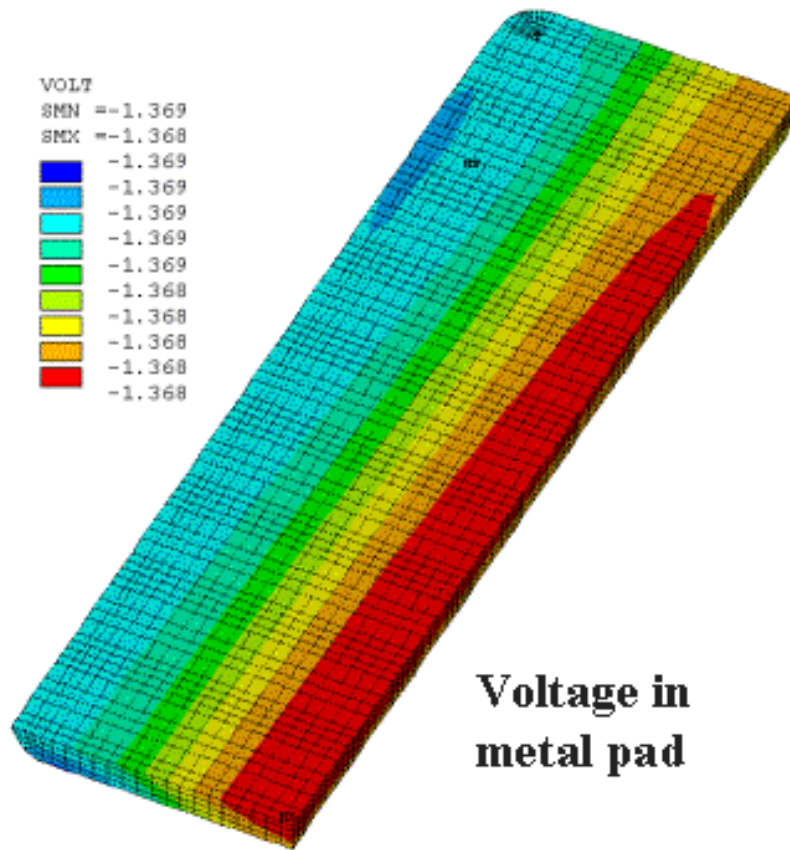


Mesh excluding the top part of anodes

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Cathode Quarter + Liquid Zone Thermo-Electric Model

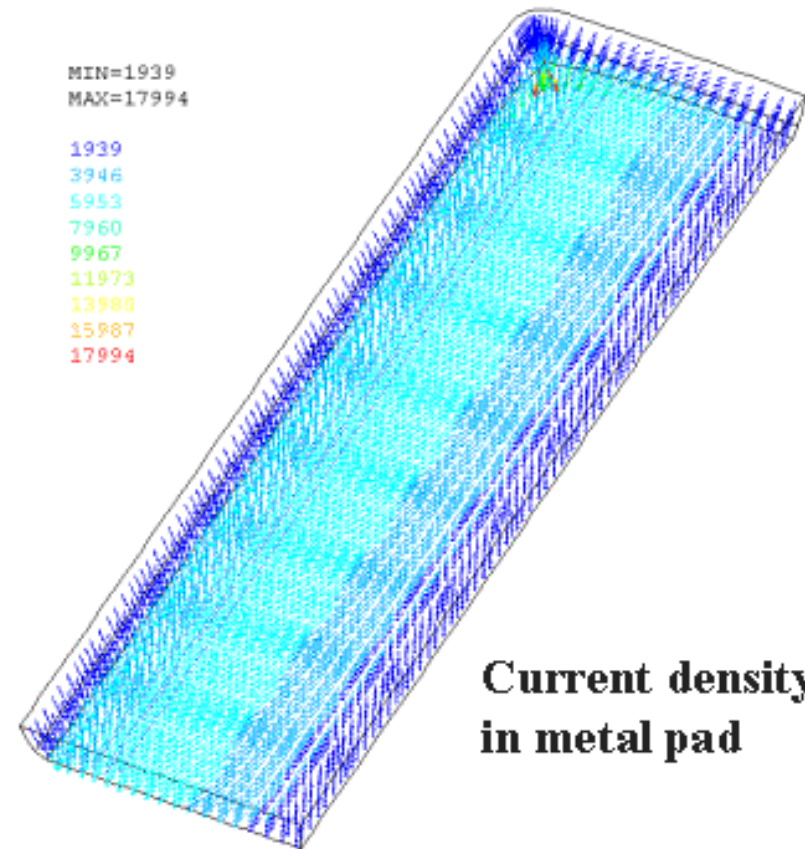
VOLT
SMN = -1.369
SMX = -1.368
-1.369
-1.369
-1.369
-1.369
-1.369
-1.368
-1.368
-1.368
-1.368
-1.368



**Voltage in
metal pad**

MIN=1939
MAX=17994

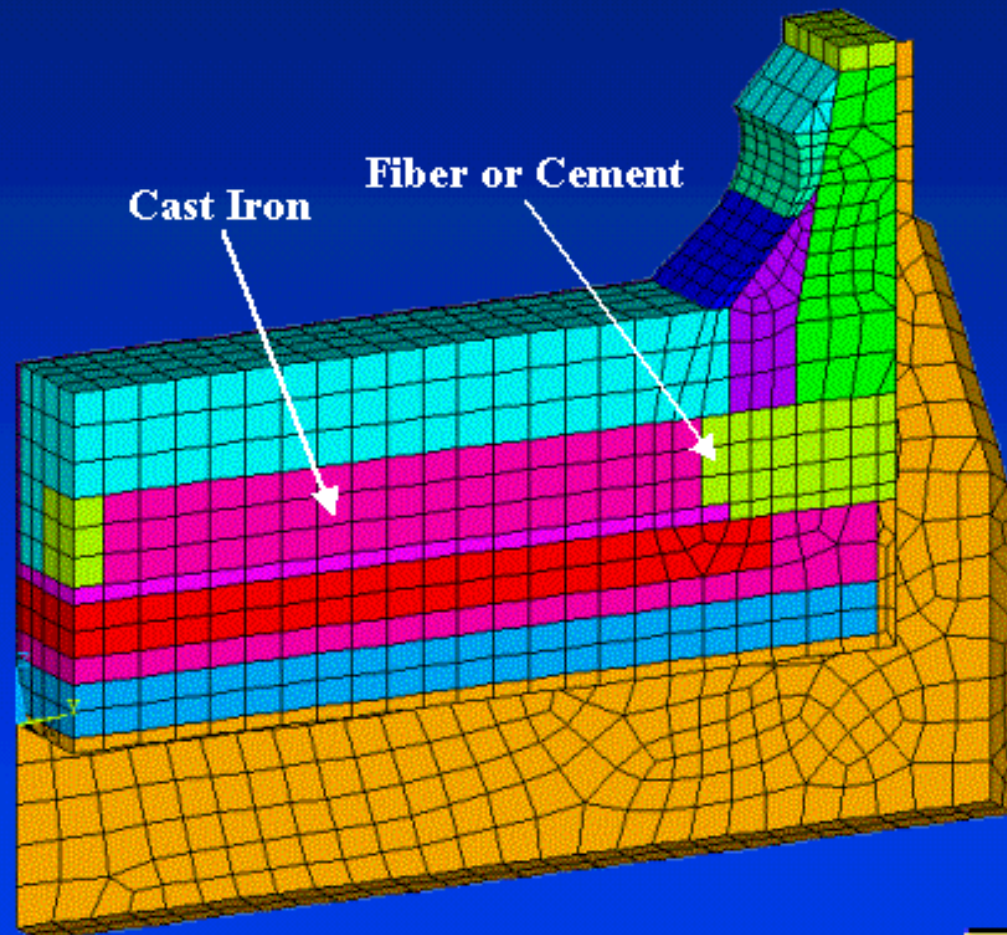
1939
3946
5953
7960
9967
11973
13980
15987
17994



**Current density
in metal pad**

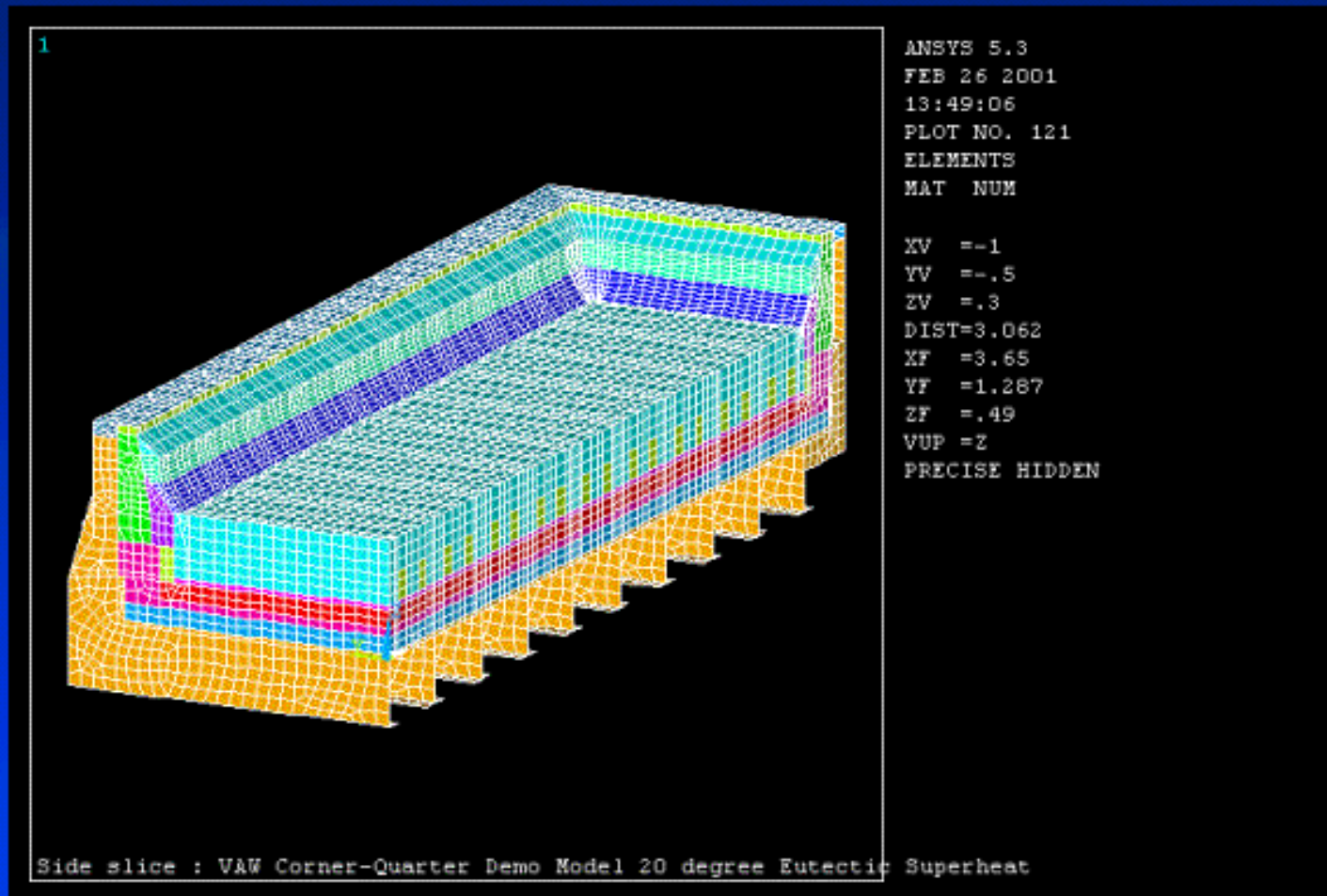
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Case Study 1: Rodding Collector Bars up to the Edge of the Blocks



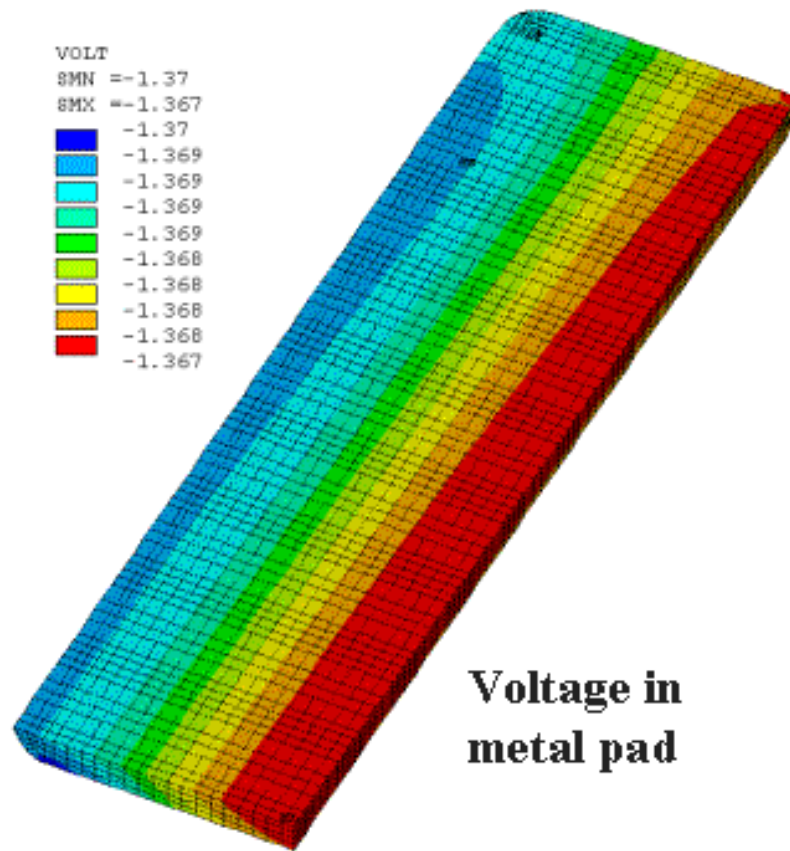
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Case Study 1: Rodding Collector Bars up to the Edge of the Blocks



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

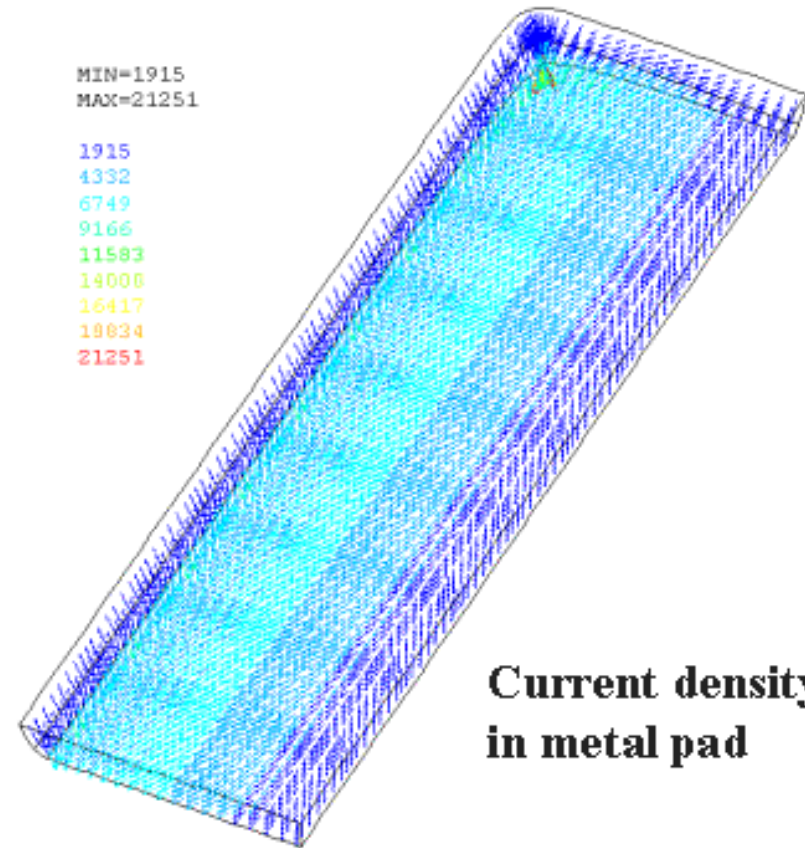
VOLT
SMN = -1.37
SMX = -1.367
-1.37
-1.369
-1.369
-1.369
-1.369
-1.368
-1.368
-1.368
-1.368
-1.367



**Voltage in
metal pad**

MIN=1915
MAX=21251

1915
4332
6749
9166
11583
14000
16417
18834
21251

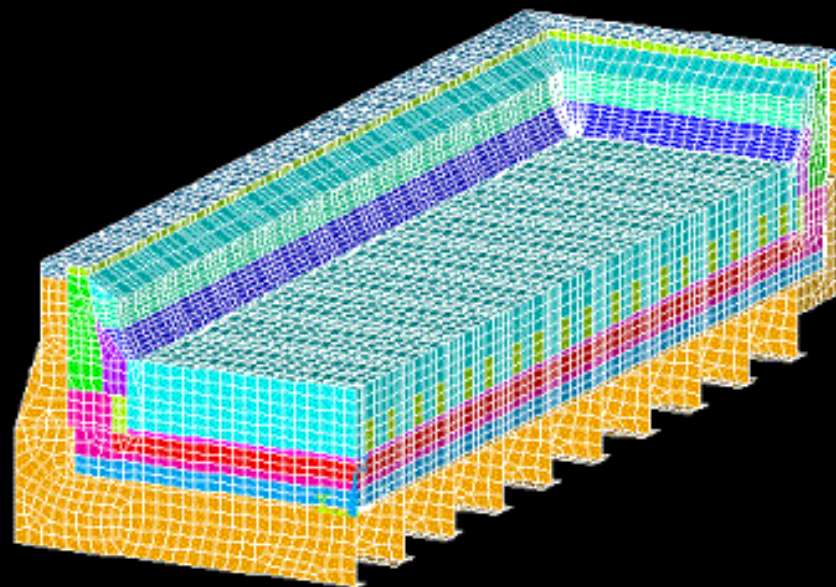


**Current density
in metal pad**

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Case Study 2: Decreasing the Liquidus Superheat by 25%

1



ANSYS 5.3
FEB 28 2001
20:49:09
PLOT NO. 121
ELEMENTS
MAT NUM

XV =-1
YV =-.5
ZV =.3
DIST=3.062
XF =3.65
YF =1.267
ZF =.49
VUP =Z
PRECISE HIDDEN

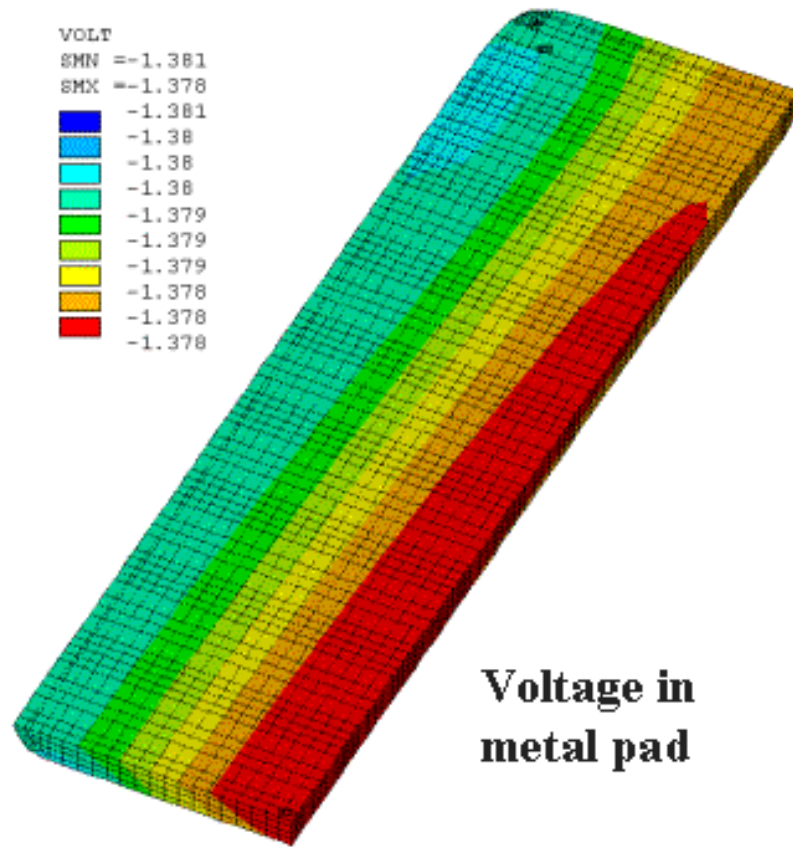
Side slice : VAW Corner-Quarter Demo Model 15 degree Eutectic Superheat

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Case Study 2: Decreasing the Liquidus Superheat by 25%

VOLT
SMN = -1.381
SMX = -1.378

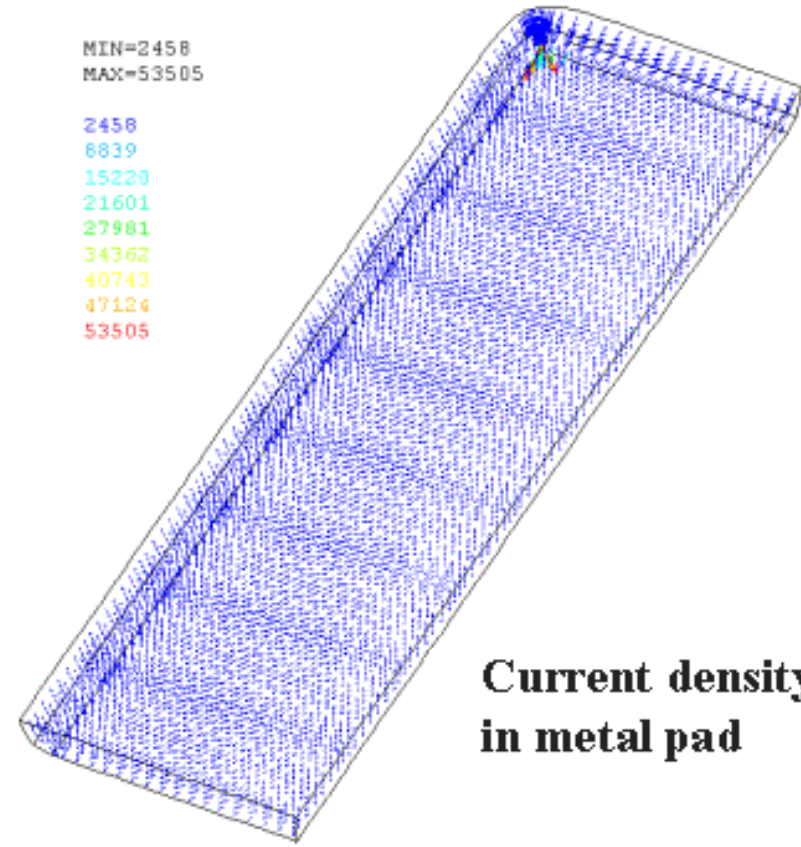
Blue	-1.381
Light Blue	-1.38
Cyan	-1.38
Green	-1.38
Light Green	-1.379
Yellow-Green	-1.379
Yellow	-1.379
Orange	-1.378
Red	-1.378
Dark Red	-1.378



**Voltage in
metal pad**

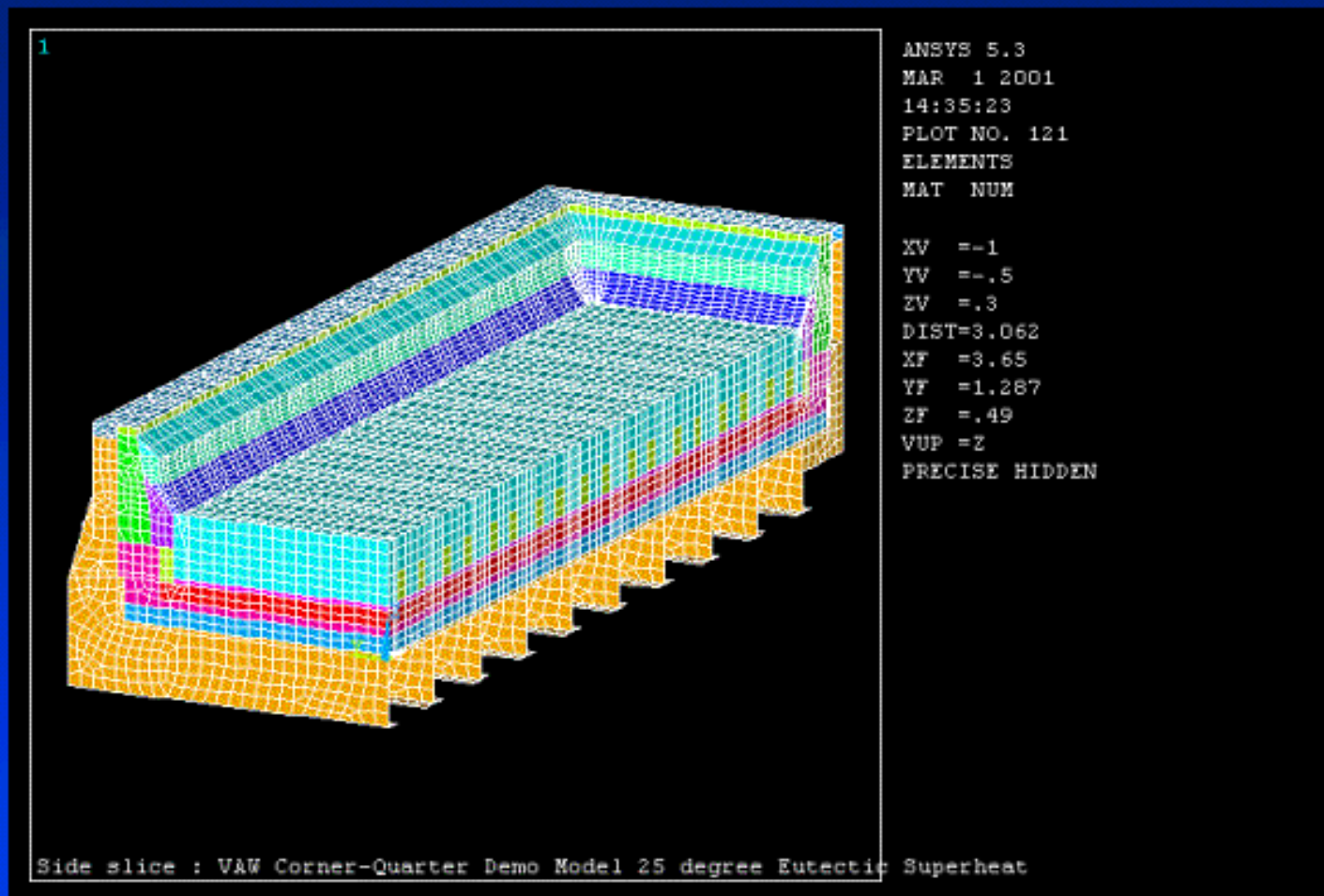
MIN=2458
MAX=53505

2458
8839
15220
21601
27981
34362
40743
47124
53505



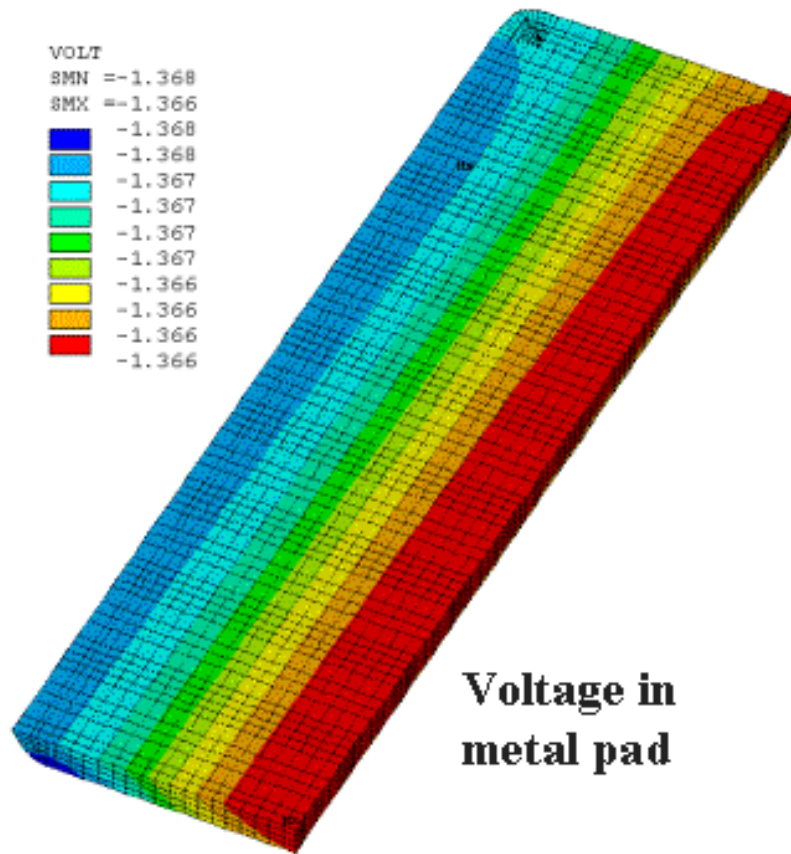
**Current density
in metal pad**

Case Study 3: Increasing the Liquidus Superheat by 25%



Case Study 3: Increasing the Liquidus Superheat by 25%

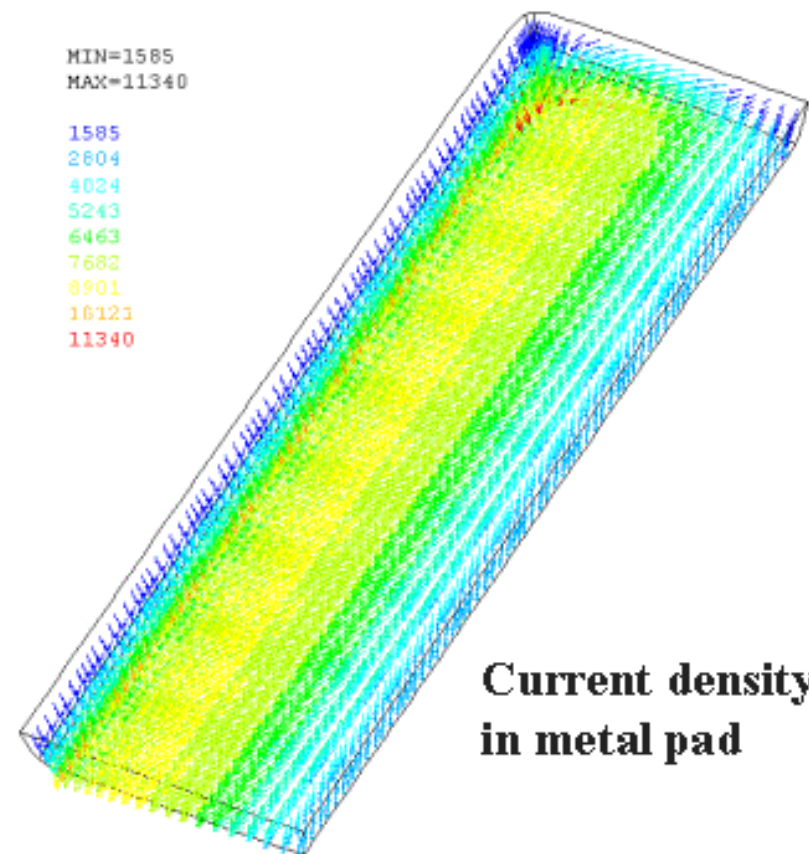
VOLT
SMN = -1.368
SMX = -1.366
-1.368
-1.368
-1.367
-1.367
-1.367
-1.367
-1.366
-1.366
-1.366
-1.366



**Voltage in
metal pad**

MIN=1585
MAX=11340

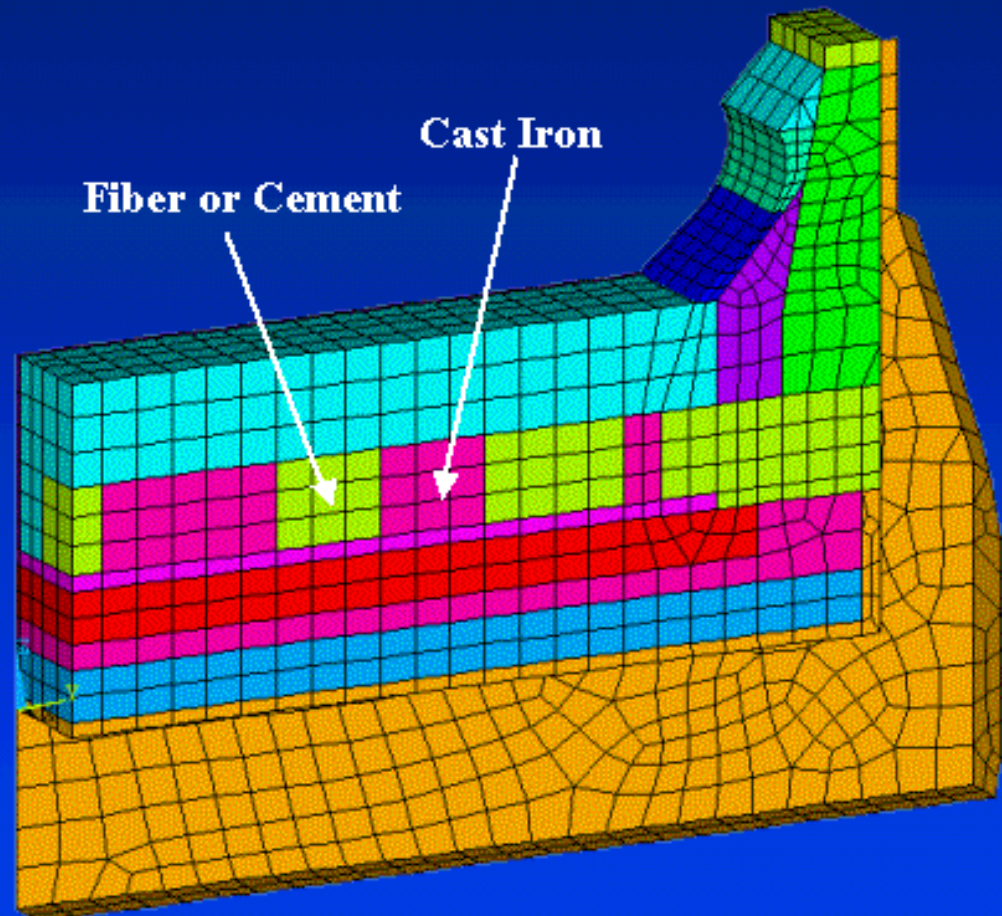
1585
2804
4024
5243
6463
7682
8901
10121
11340



**Current density
in metal pad**

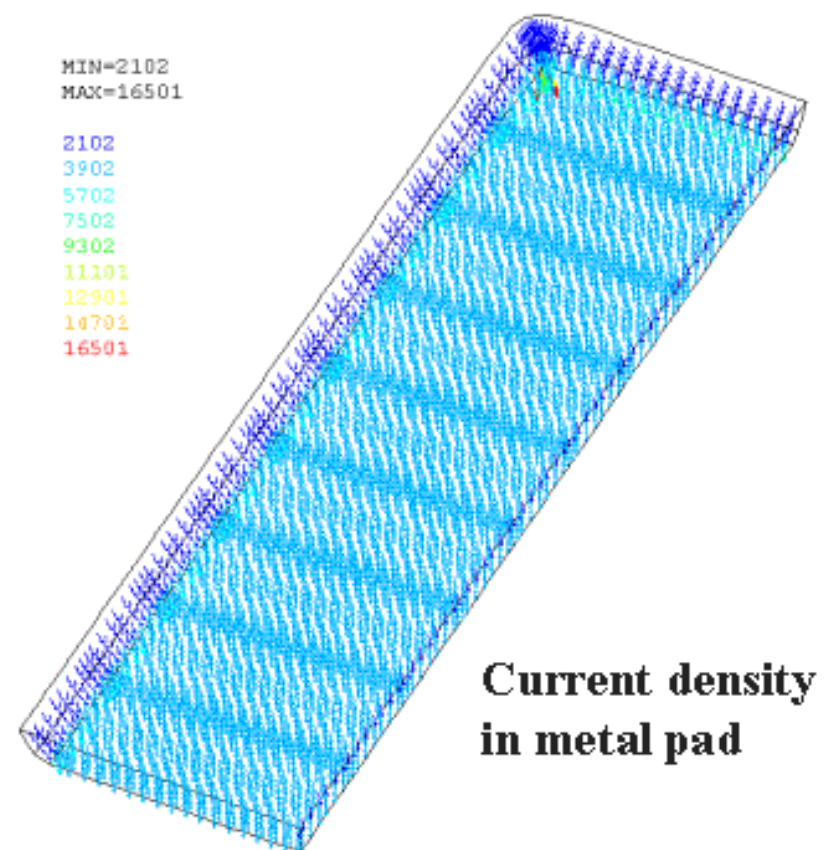
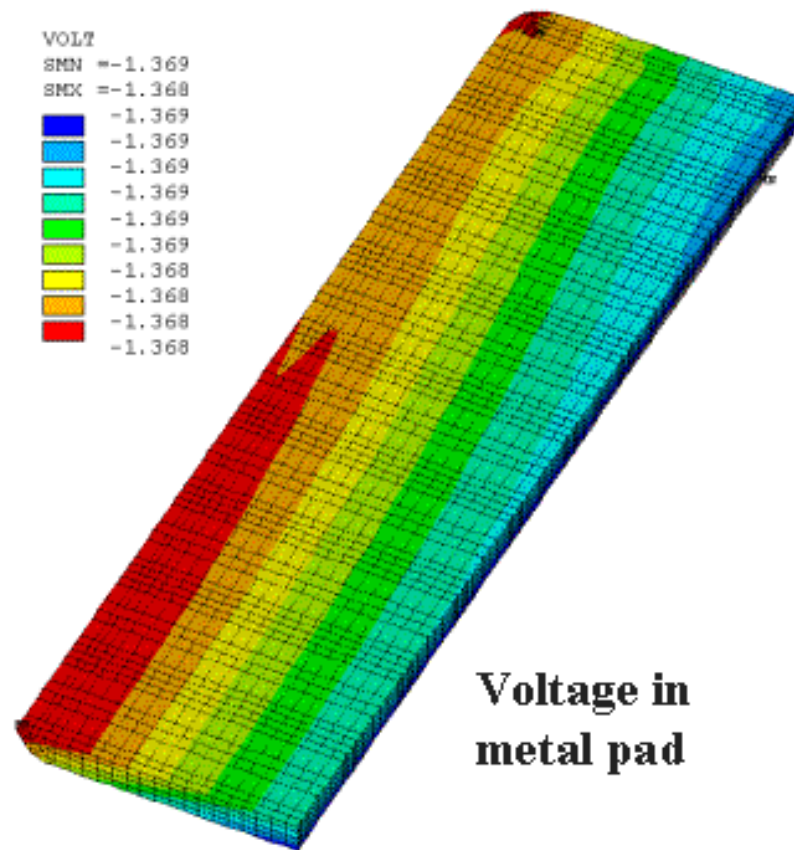
Low Cathode Block Erosion Design Proposal

- 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



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Case Study 4: Low Cathode Block Erosion Design Proposal



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.