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

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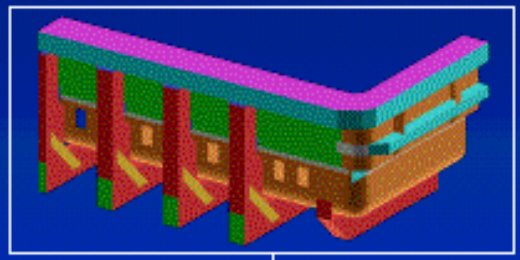
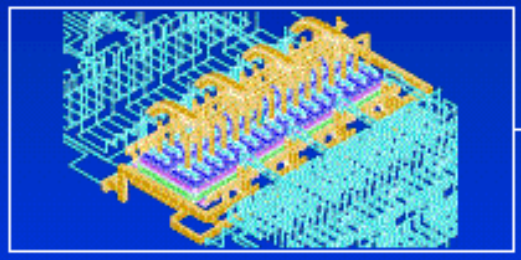
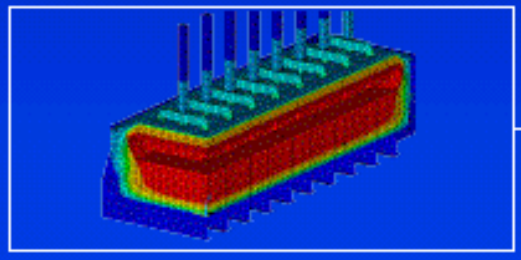
Modeling the Hall-Héroult Cell

Superstructure Design



Point Breaker Feeder Design





Cell Design

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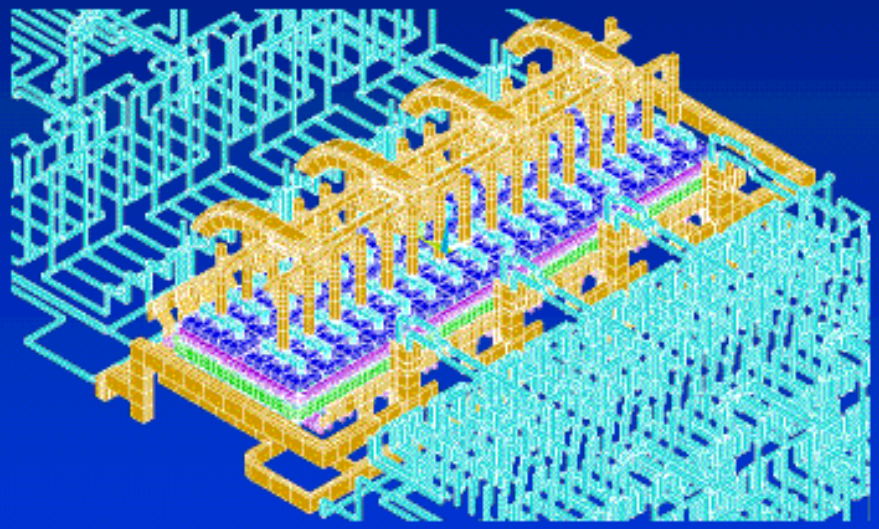
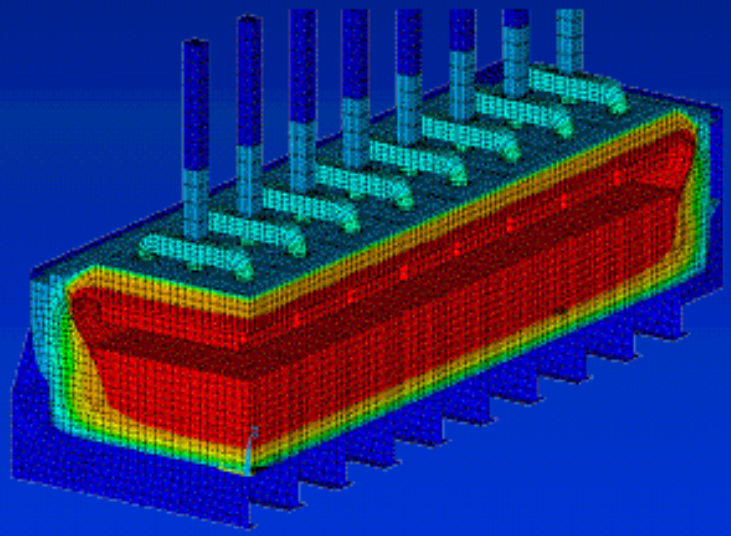
Modeling the Hall-Héroult Cell





MHD model:

centered around the liquid zone

Thermo-electric model:

no need to include the liquid zone

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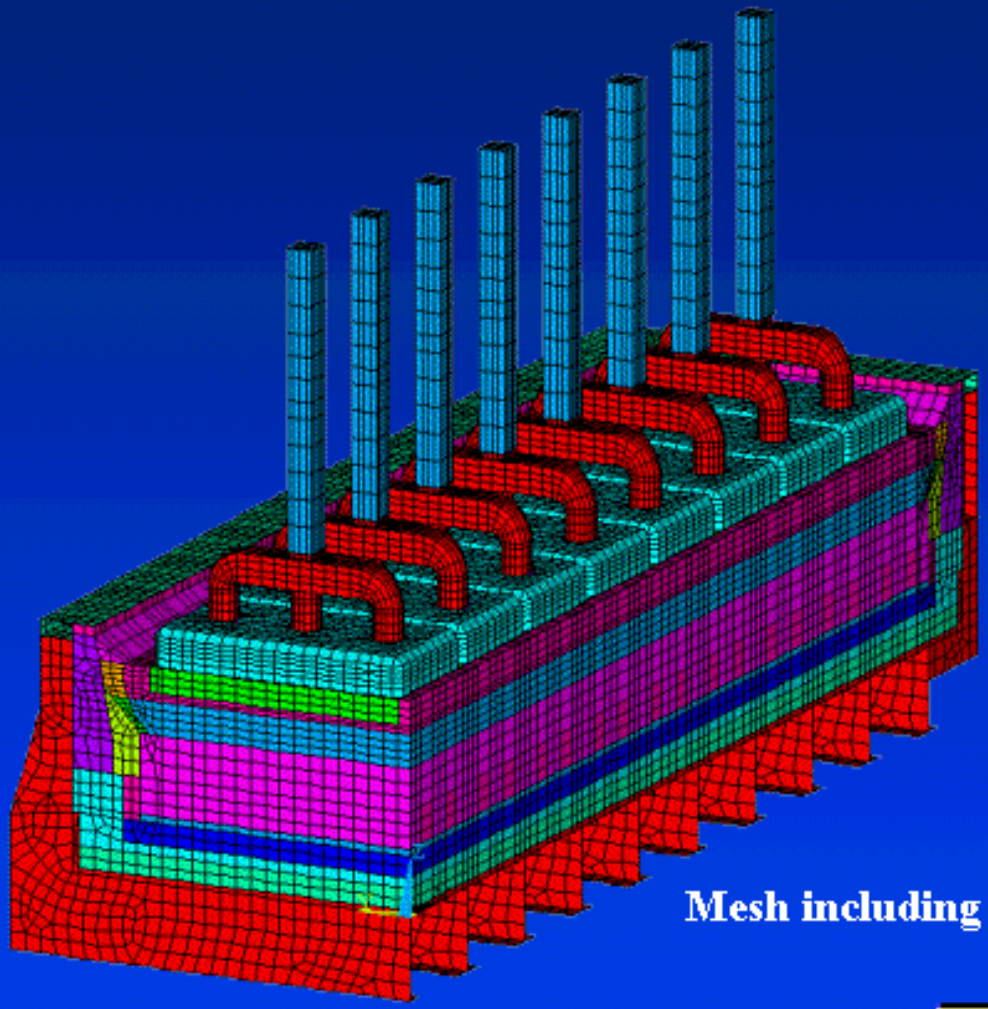
Full Cell Quarter Thermo-Electric Model



Mesh including the liquid zone

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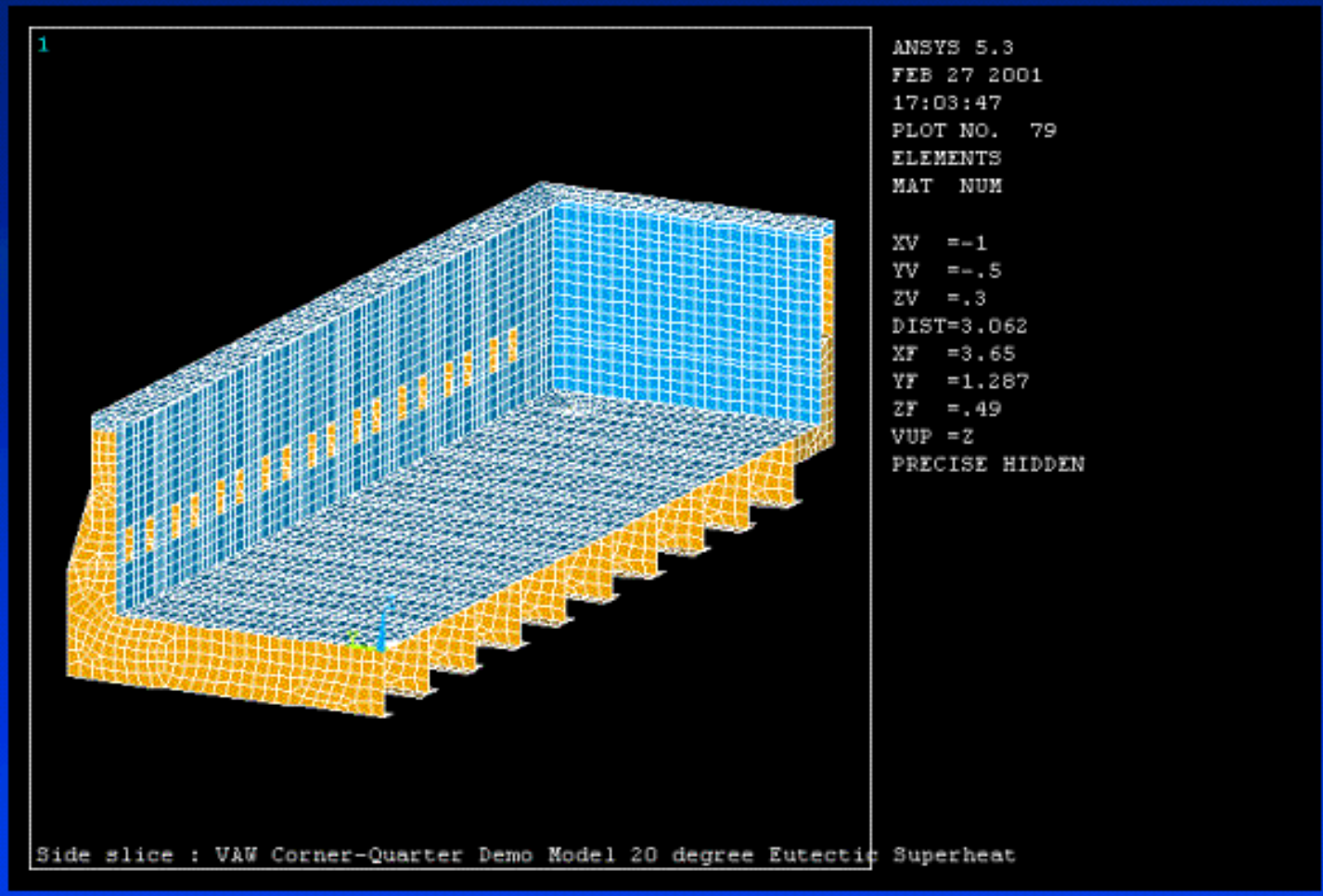
Full Cell Quarter Thermo-Electric Model



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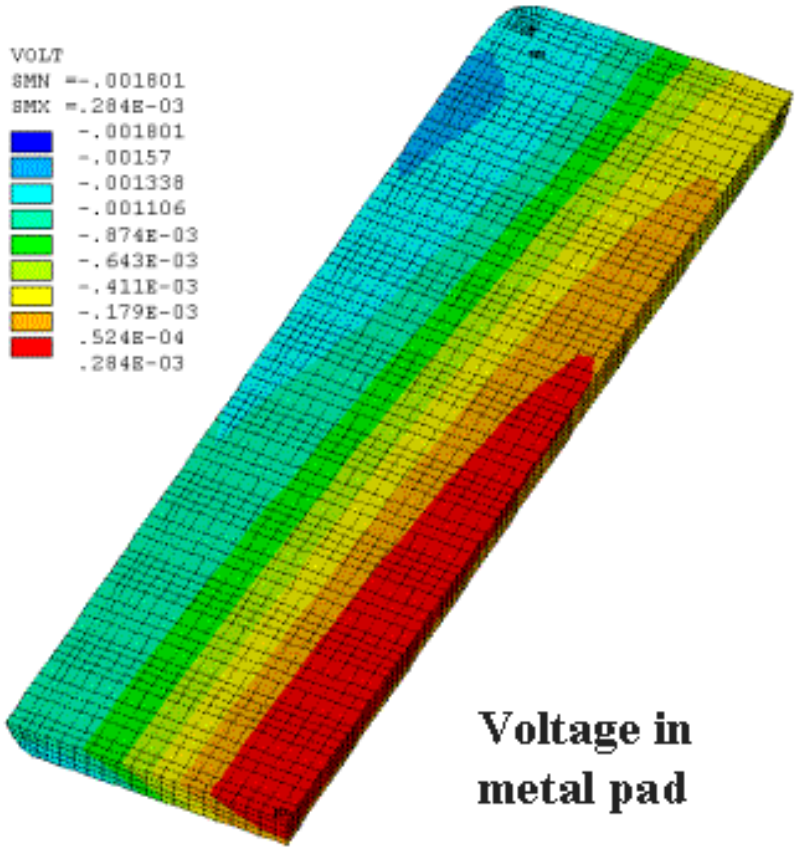
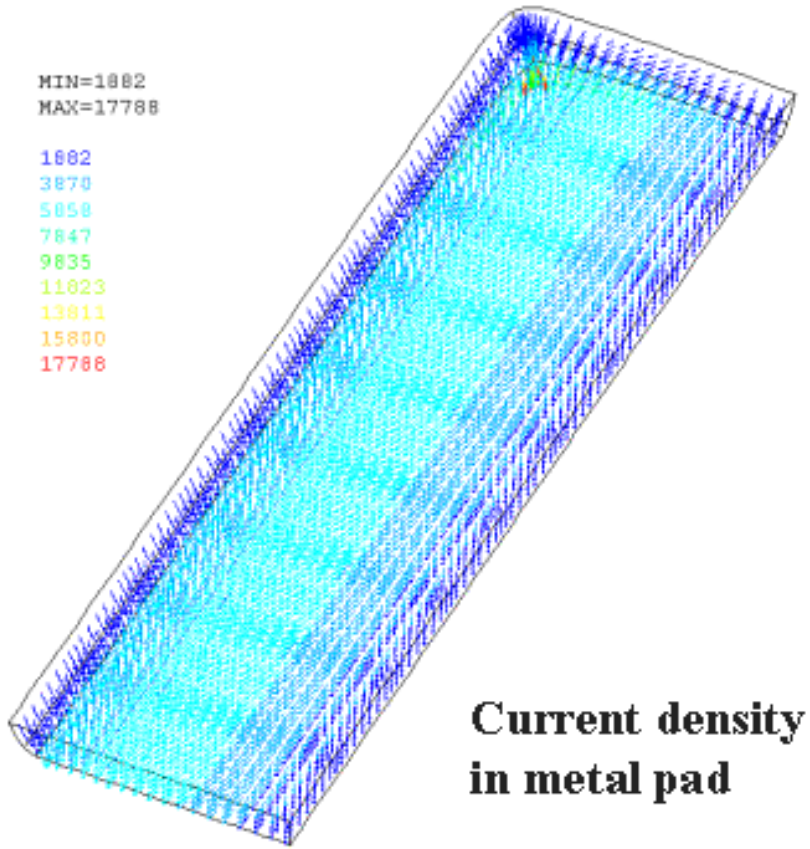
Full Cell Quarter Thermo-Electric Model



Voltage in metal pad



Current density in metal pad

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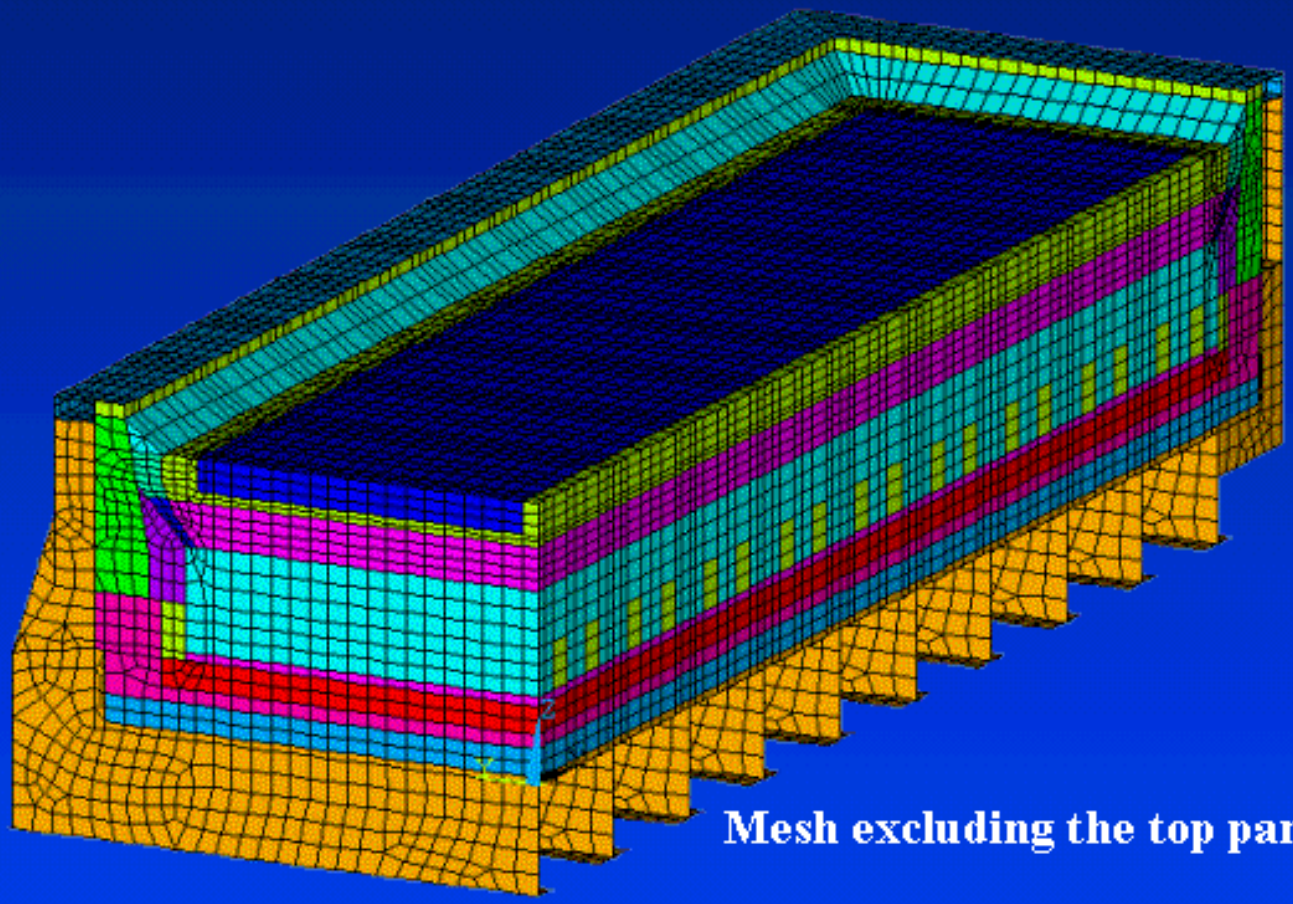
Cathode Quarter + Liquid Zone Thermo-Electric Model



Mesh excluding the top part of anodes

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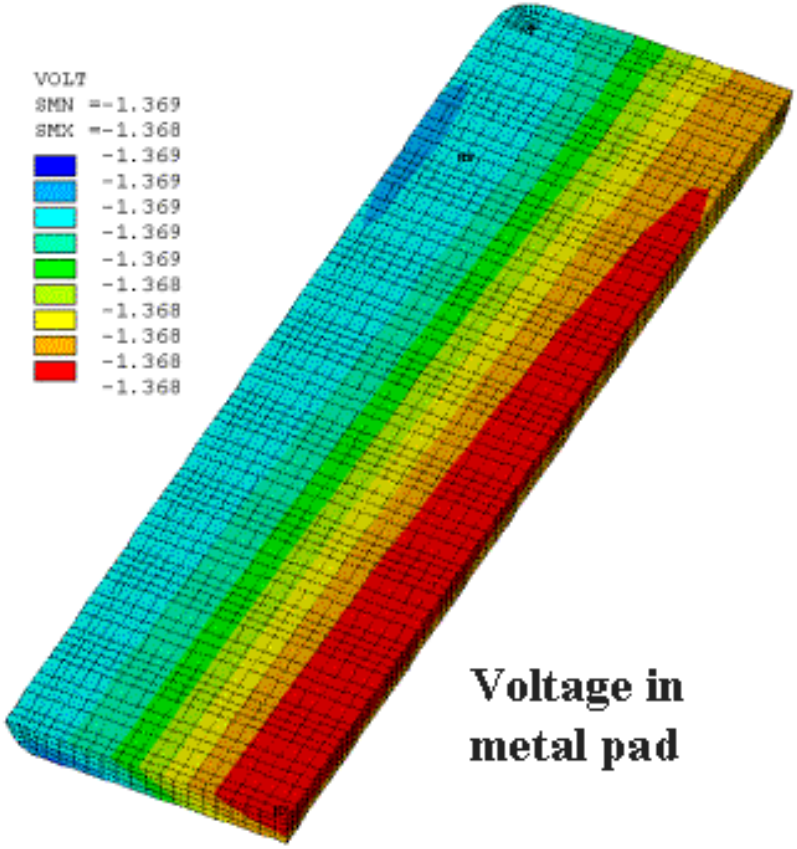
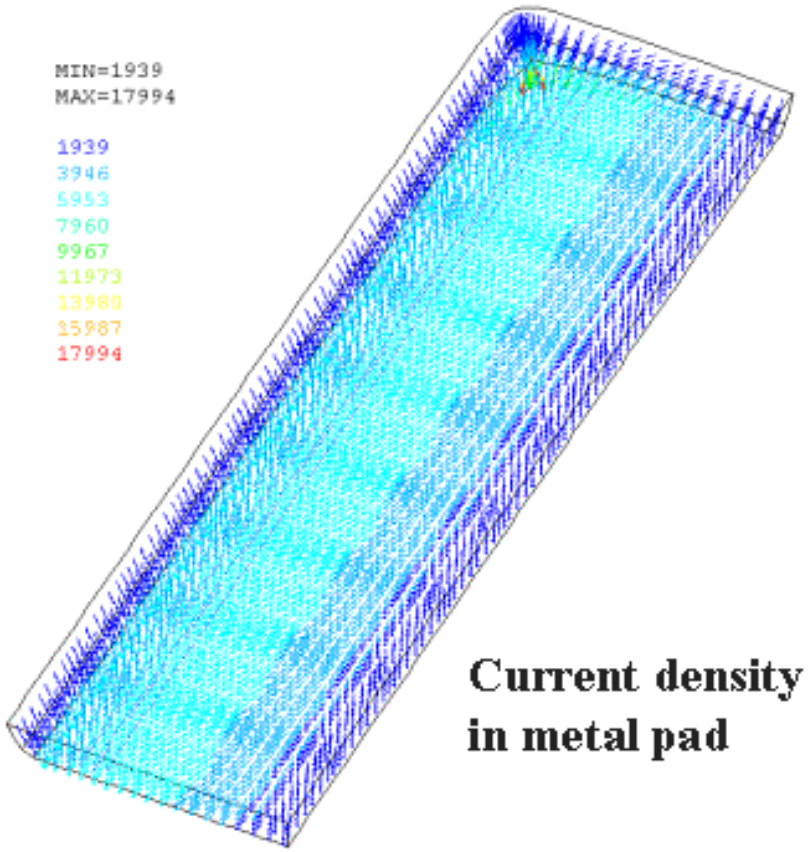
Cathode Quarter + Liquid Zone Thermo-Electric Model



Voltage in metal pad



Current density in metal pad

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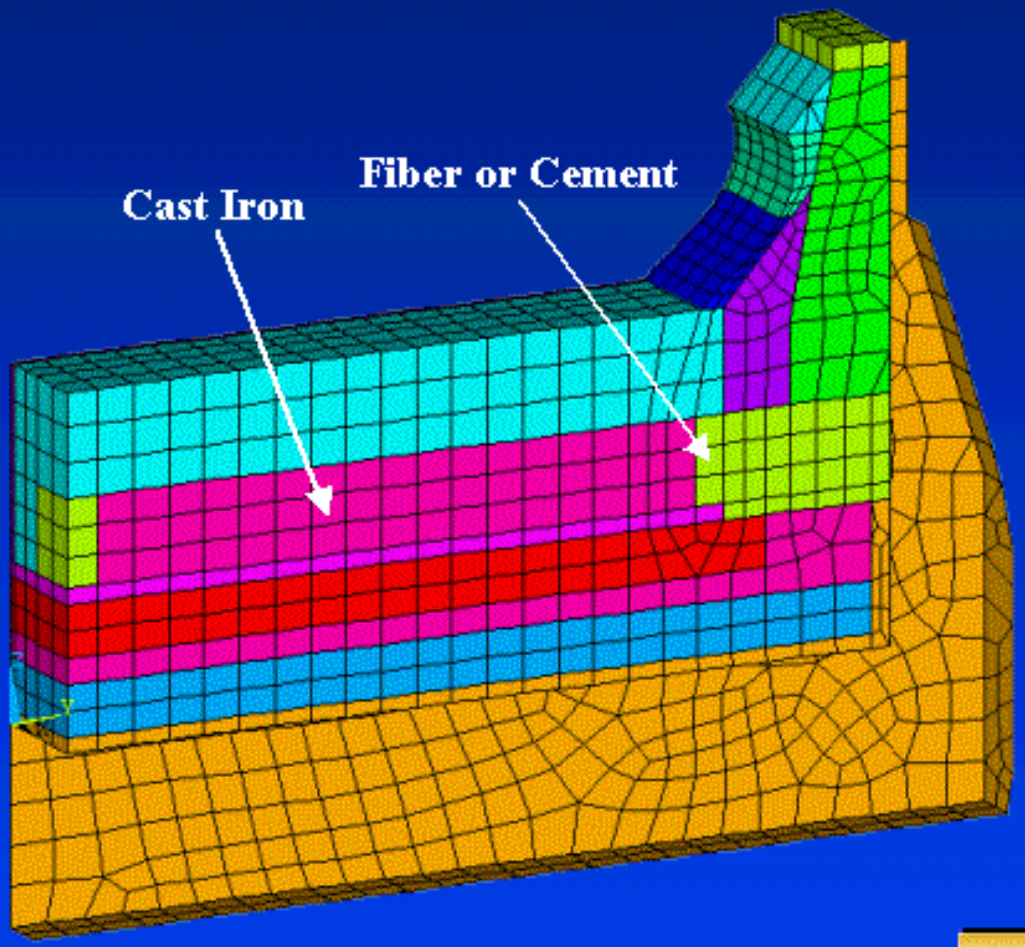
Case Study 1: Rodding Collector Bars up to the Edge of the Blocks



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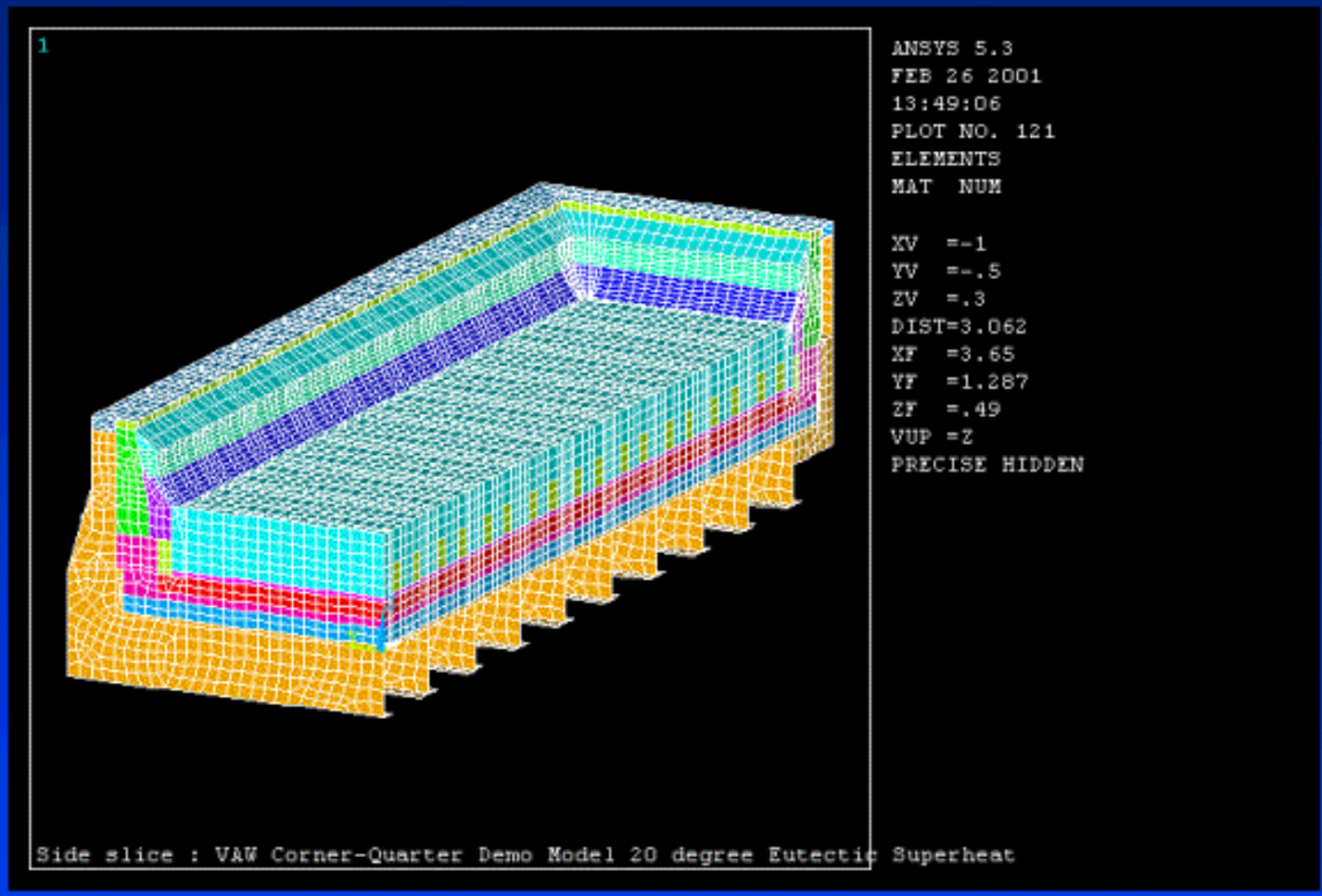

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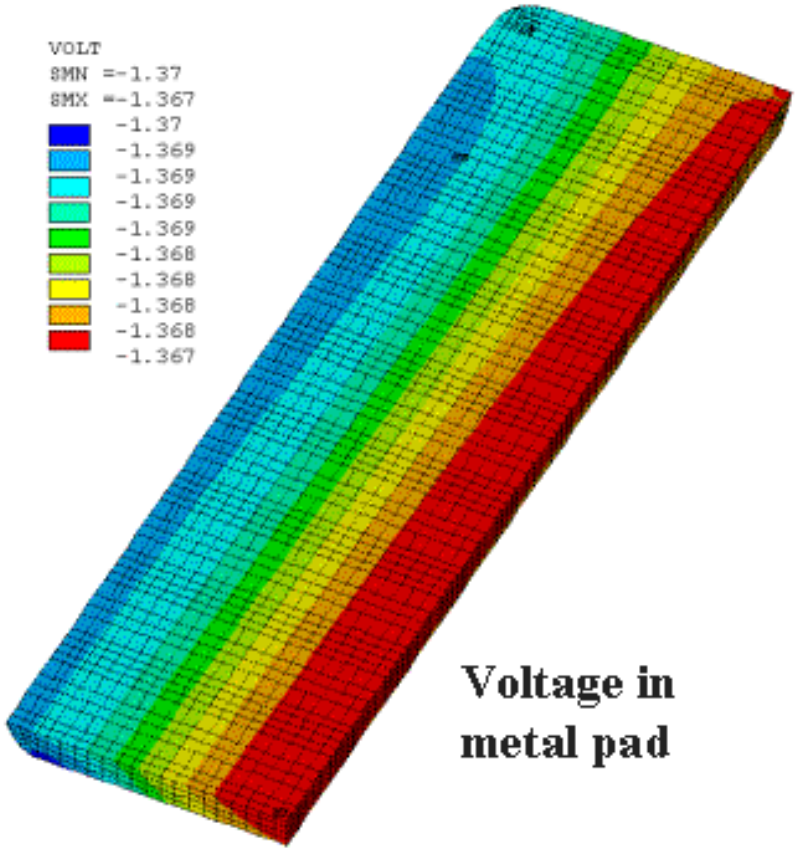
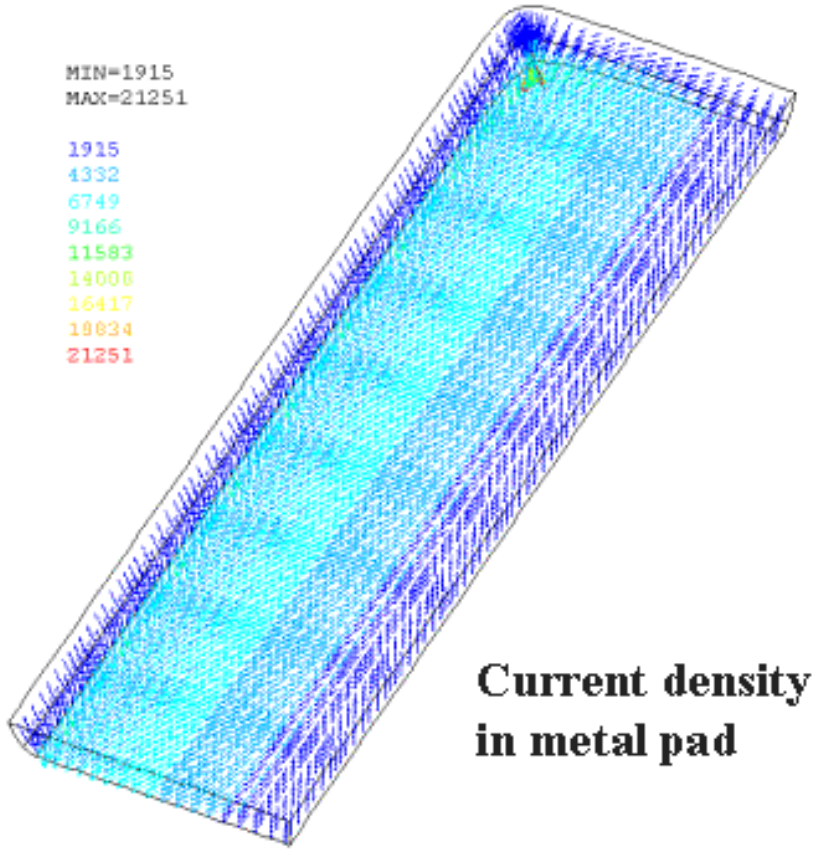


Voltage in metal pad



Current density in metal pad

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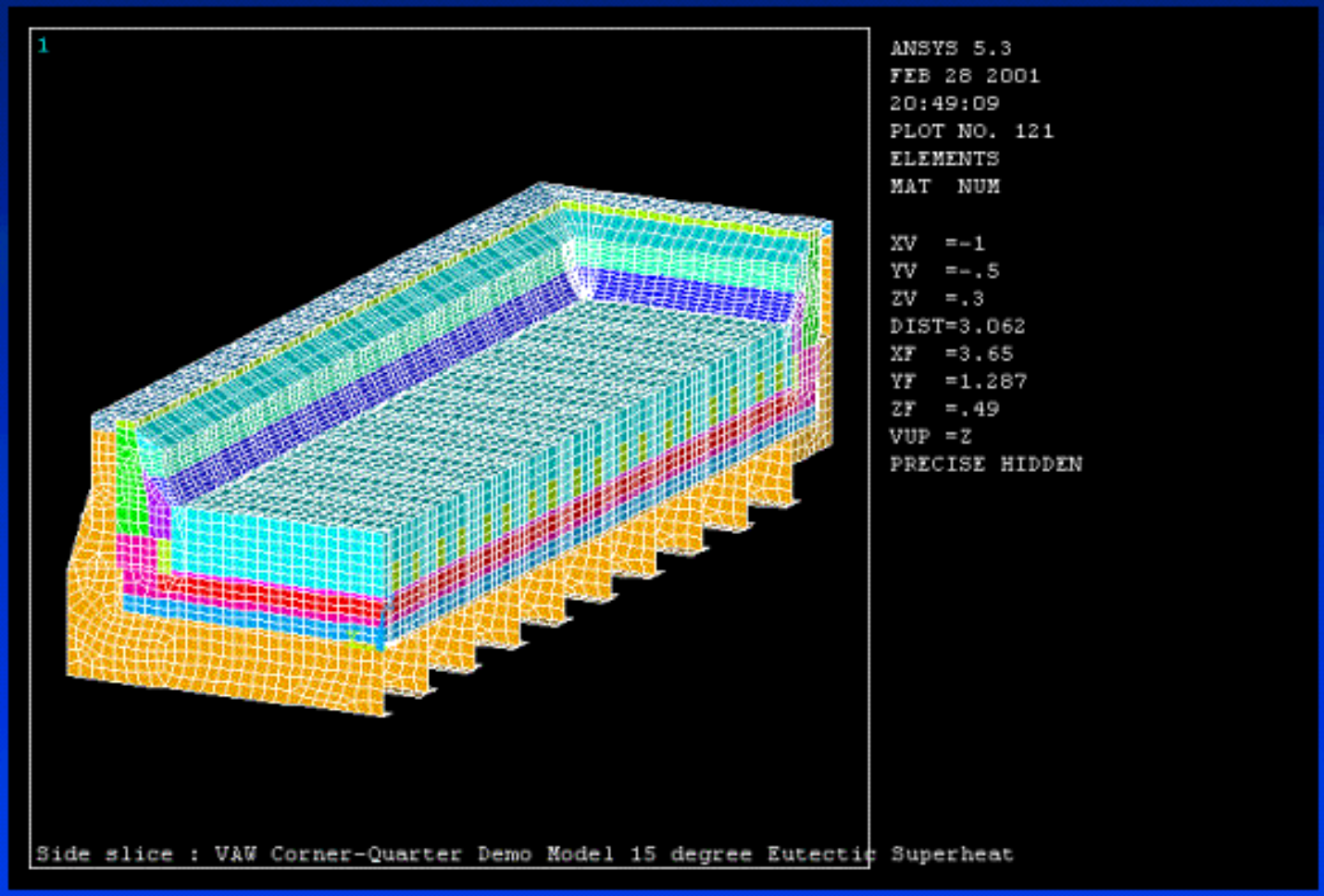
Case Study 2: Decreasing the Liquidus Superheat by 25%



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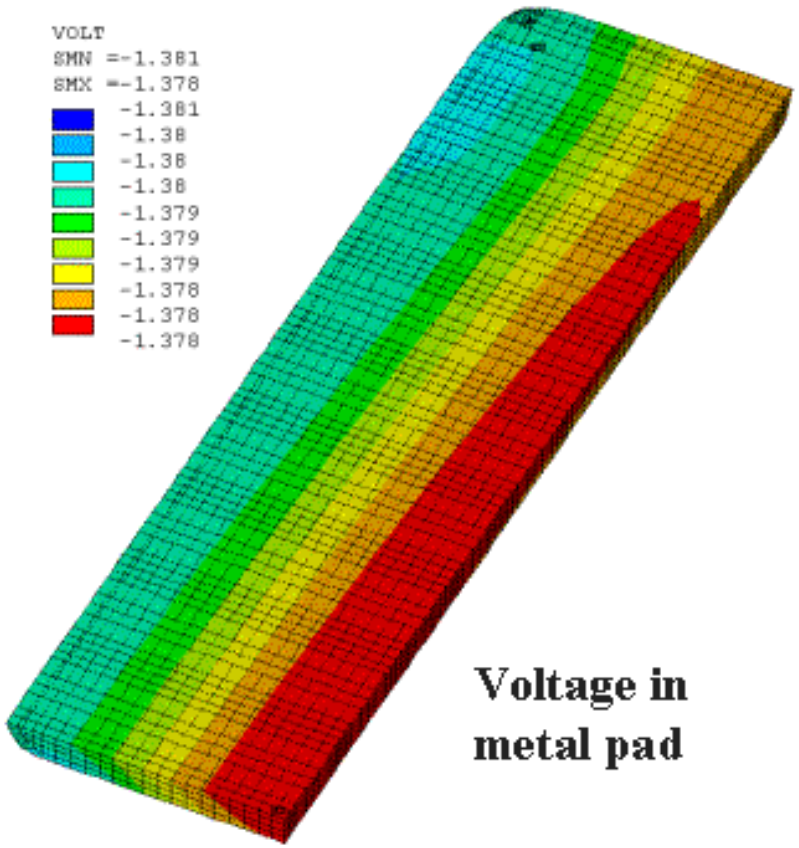
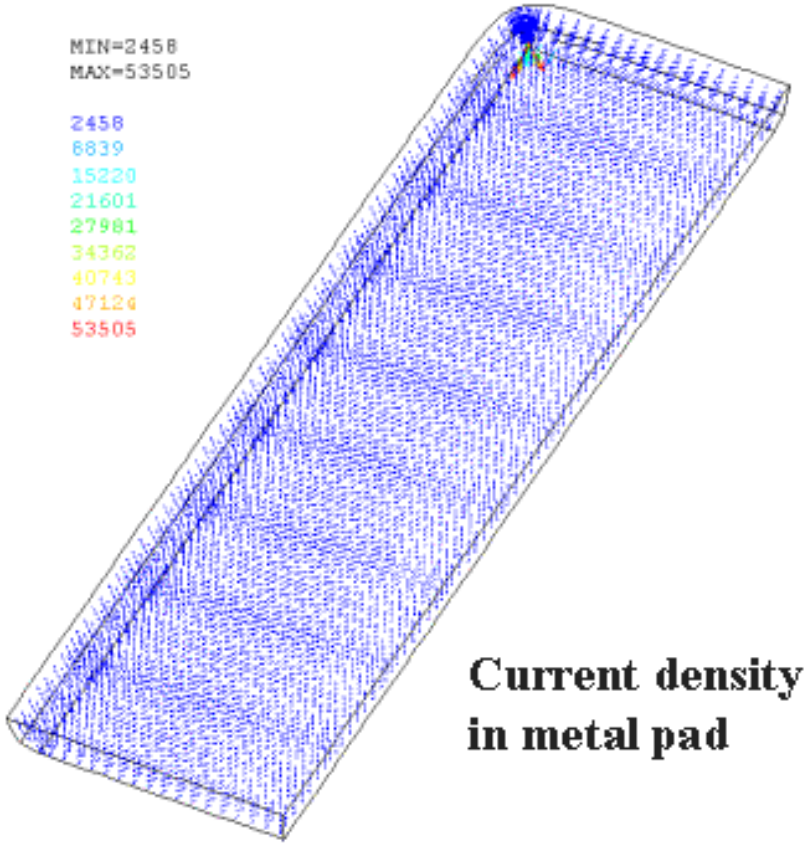
Case Study 2: Decreasing the Liquidus Superheat by 25%



Voltage in metal pad



Current density in metal pad

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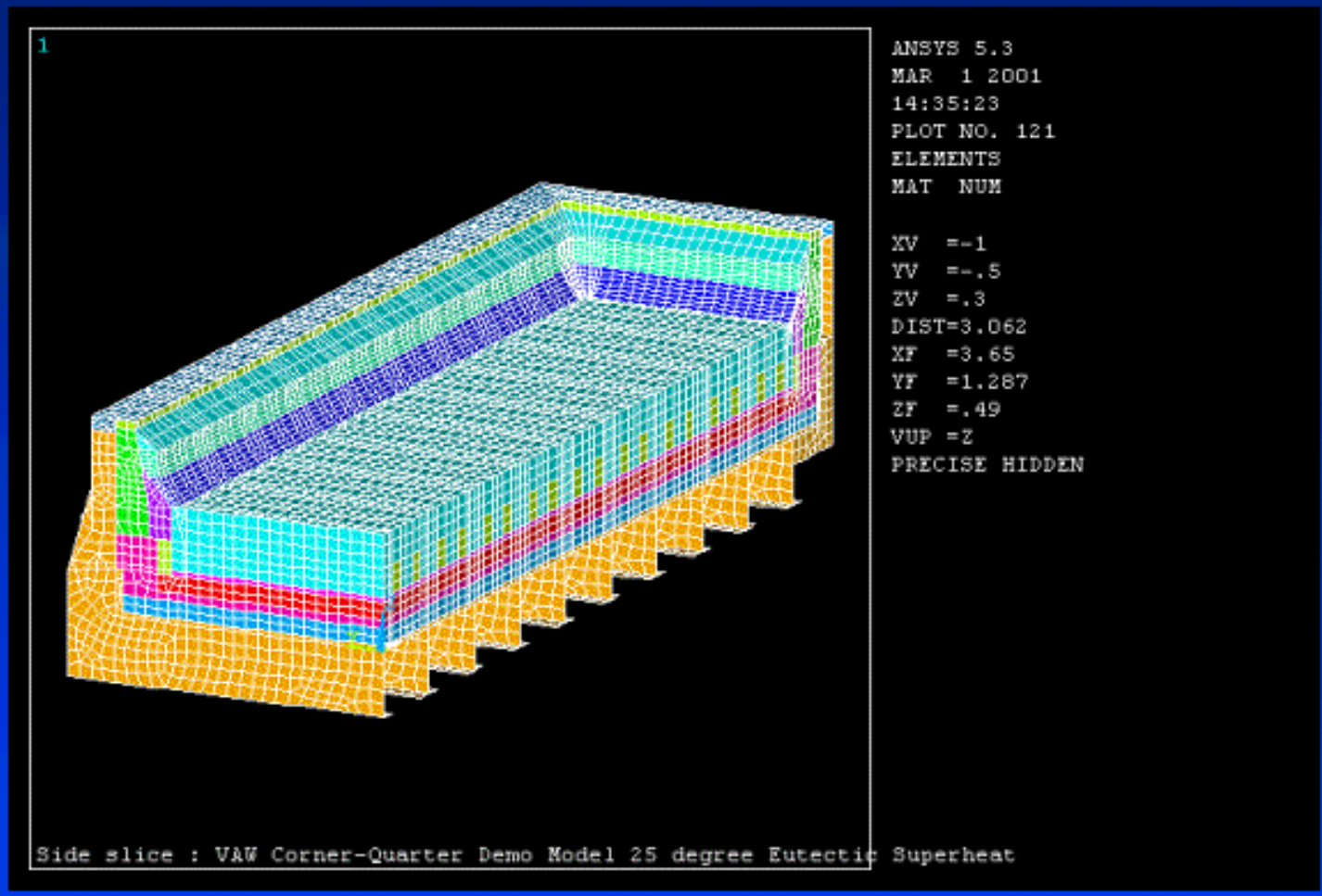
Case Study 3: Increasing the Liquidus Superheat by 25%



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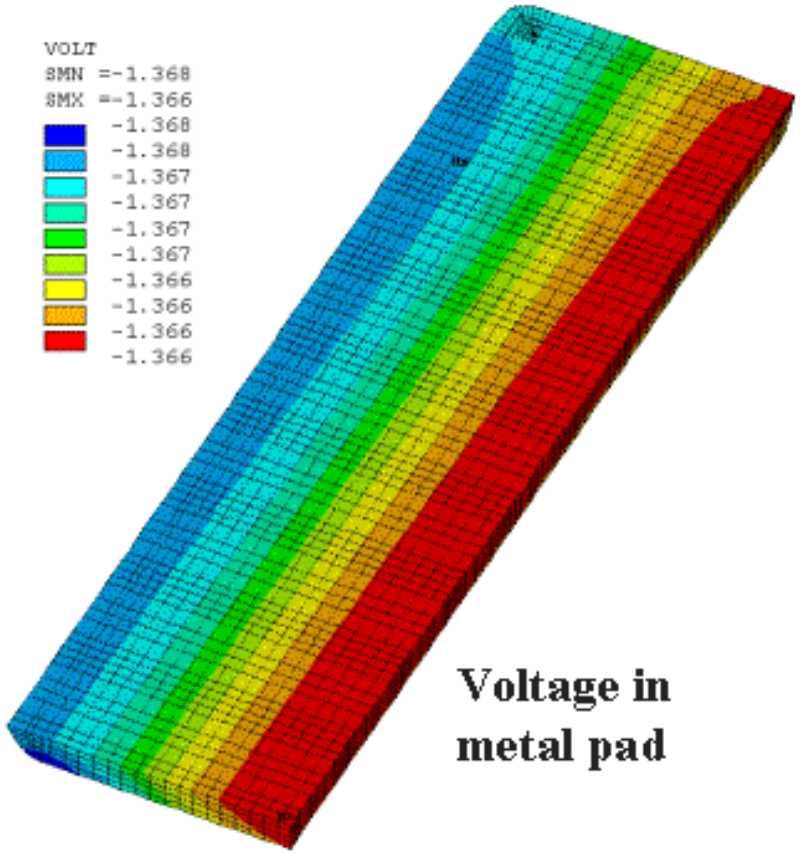
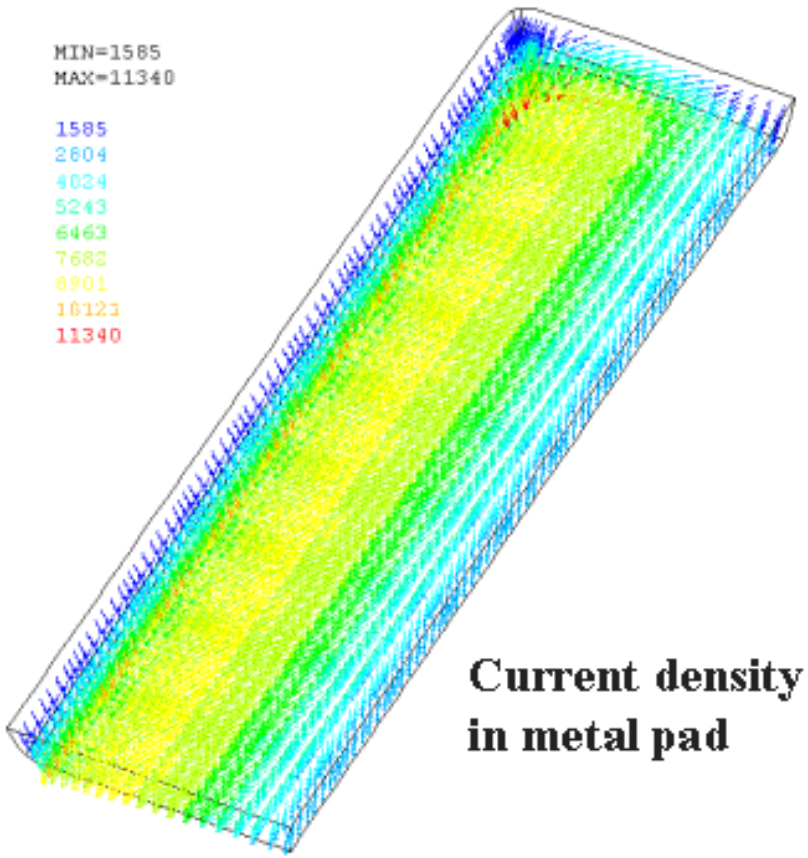
Case Study 3: Increasing the Liquidus Superheat by 25%



Voltage in metal pad



Current density in metal pad

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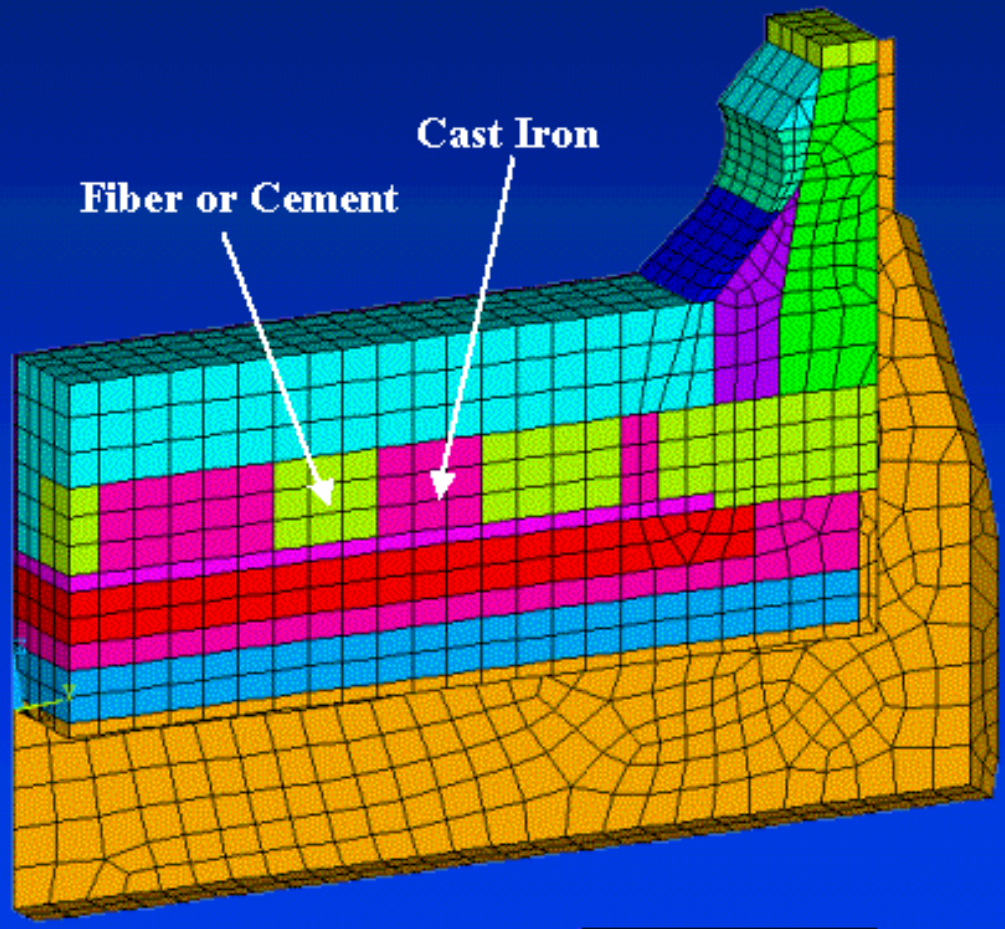
Low Cathode Block Erosion Design Proposal

- 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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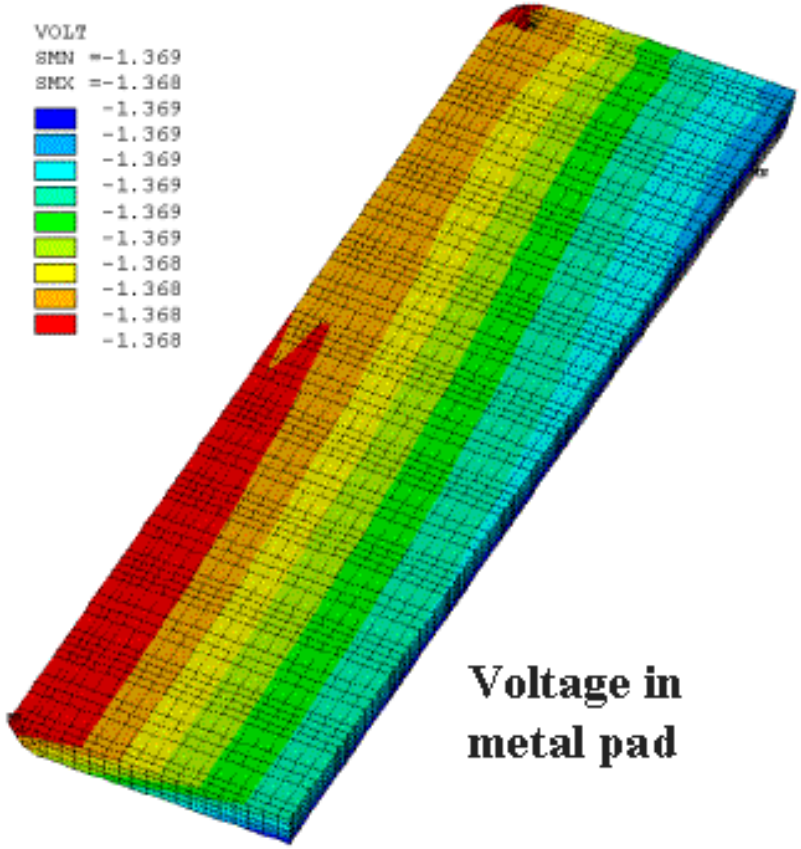
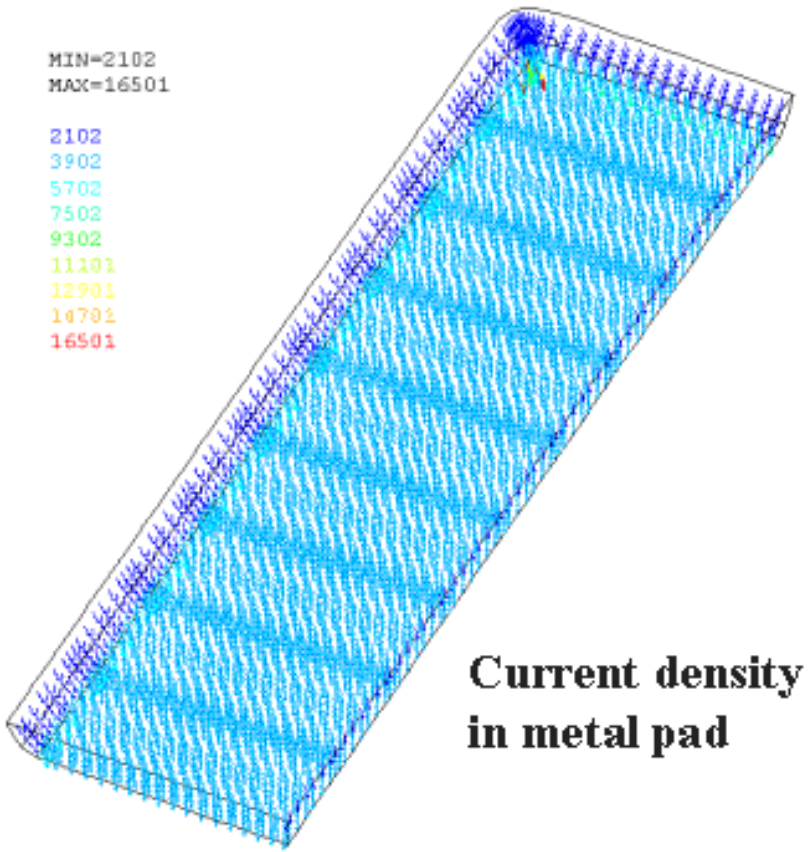
Case Study 4: Low Cathode Block Erosion Design Proposal



Voltage in metal pad



Current density in metal pad

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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.