3D Modeling of the Ventilation Pattern in an Aluminium Smelter "Potroom" Building using CFX-4

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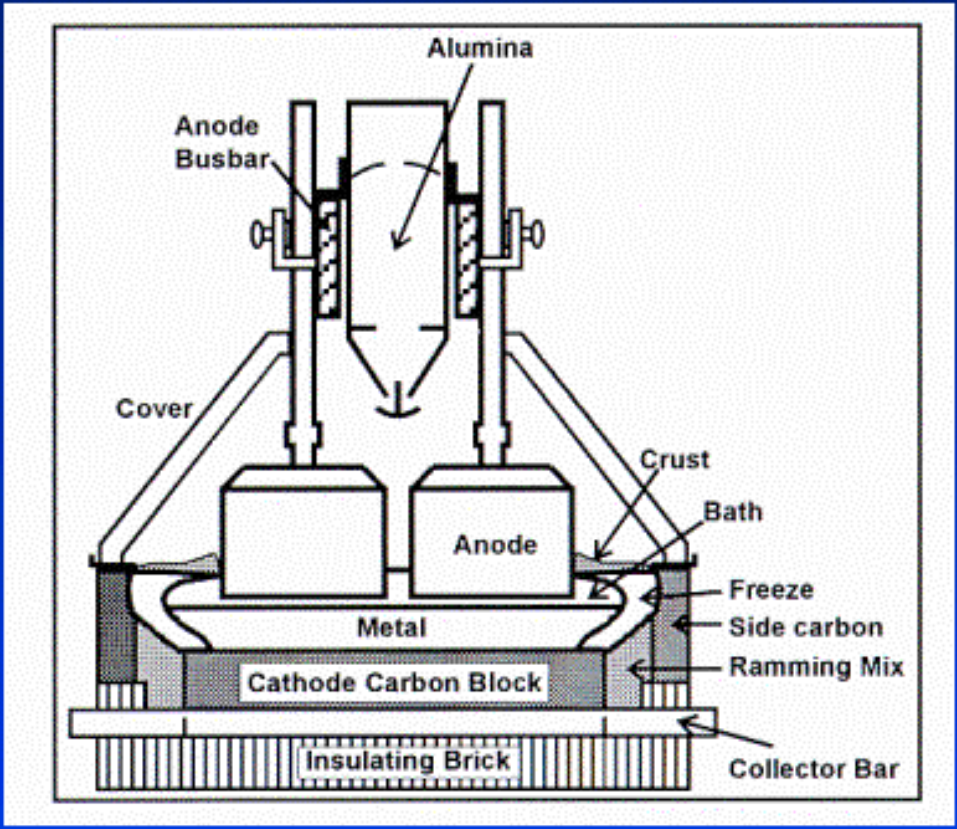
Plan of the Presentation

- Introduction
- Review of Previous Work
  - 2D model of an old smelter's physical model
  - 3D model of an old smelter's physical model
- Description of a Modern Smelter "Potroom" Building
- Description of the CFD Mathematical Model
- Results of the CFD Mathematical Model
- Conclusions

Introduction



- Aluminium reduction cells operate at 1000 °C and dissipate a lot of heat to their surrounding

Introduction

- The proper ventilation of aluminium smelter “potroom” buildings is important for two main reasons:

  as each pot dissipates a huge amount of heat, the potshell must be well ventilated to prevent it from becoming too hot

  as the temperature at the floor level is a key element of the working conditions, the potroom design must ensure that enough fresh air is circulating at that level

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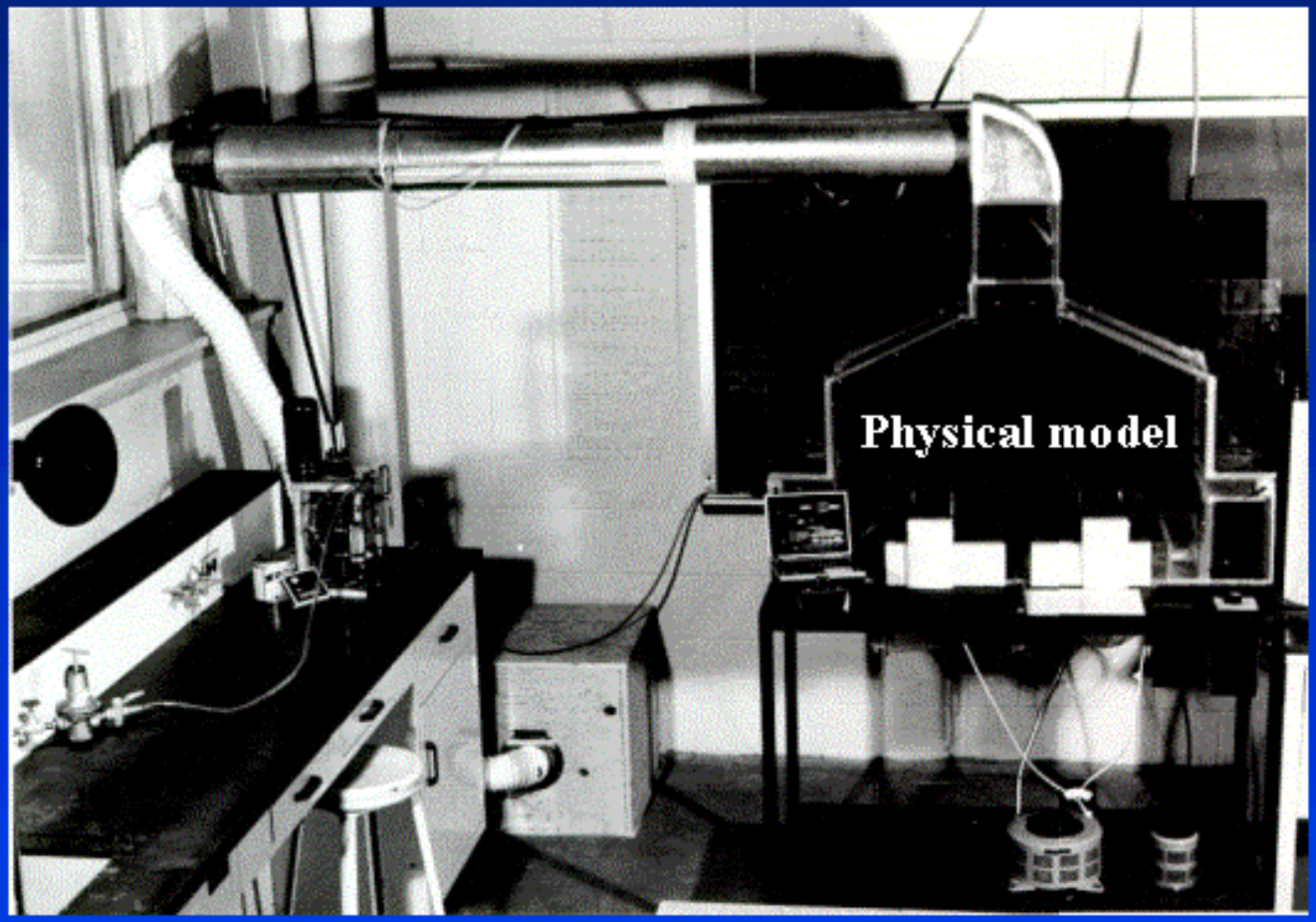
Review of the Previous Work



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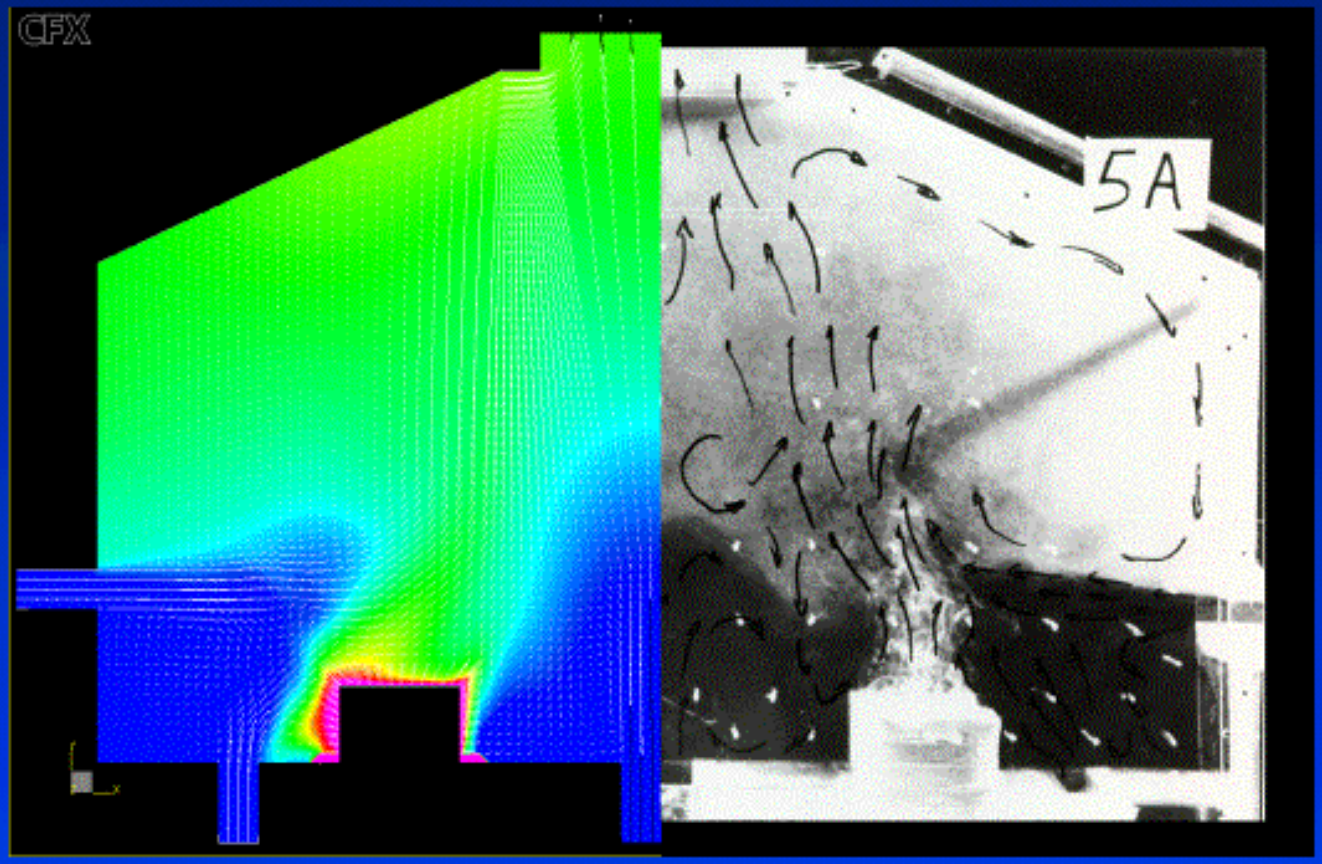

2D “Reynolds flux” model results vs. physical model results

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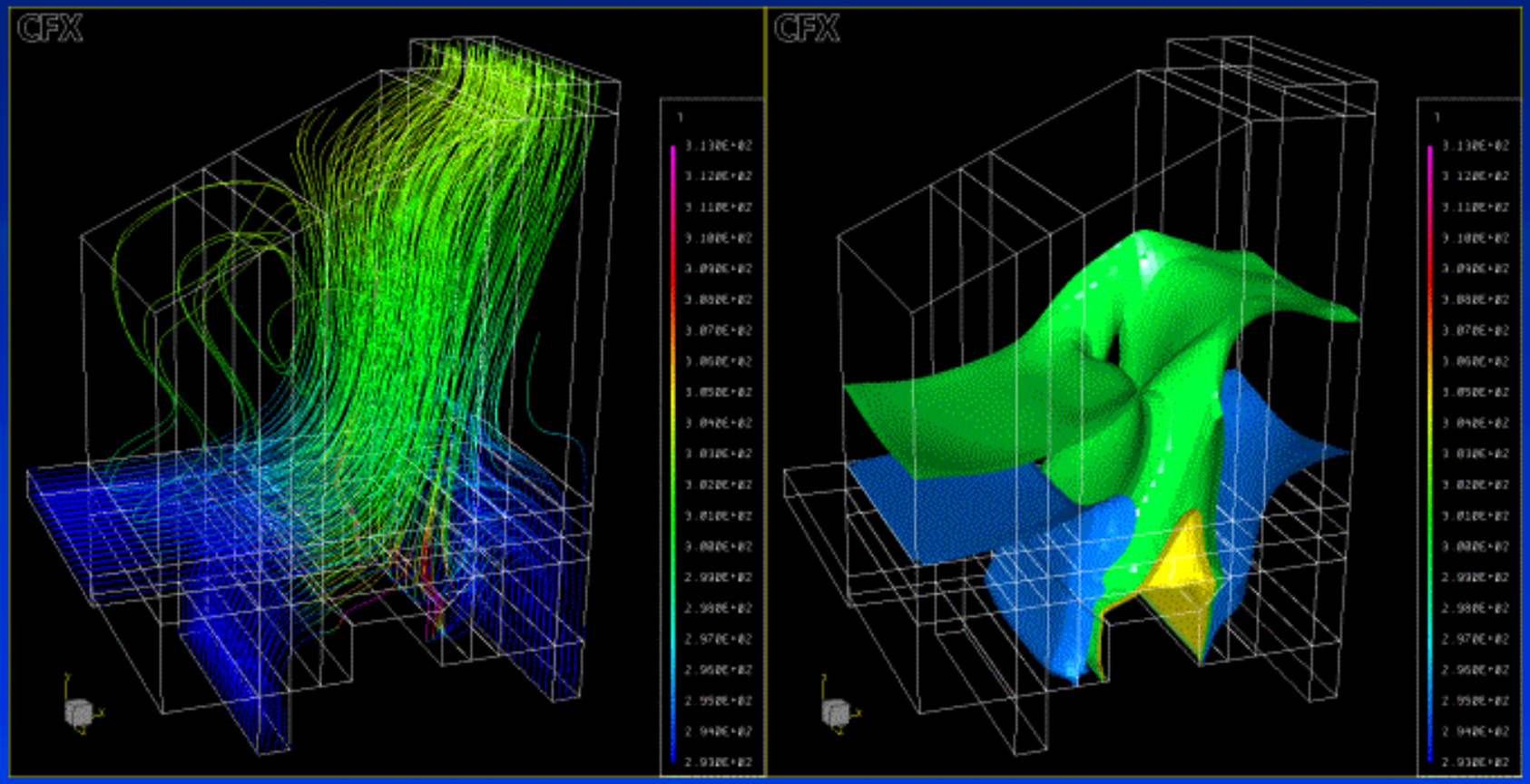
Review of the Previous Work



3D “Reynolds flux” model results of the exact physical model’s geometry

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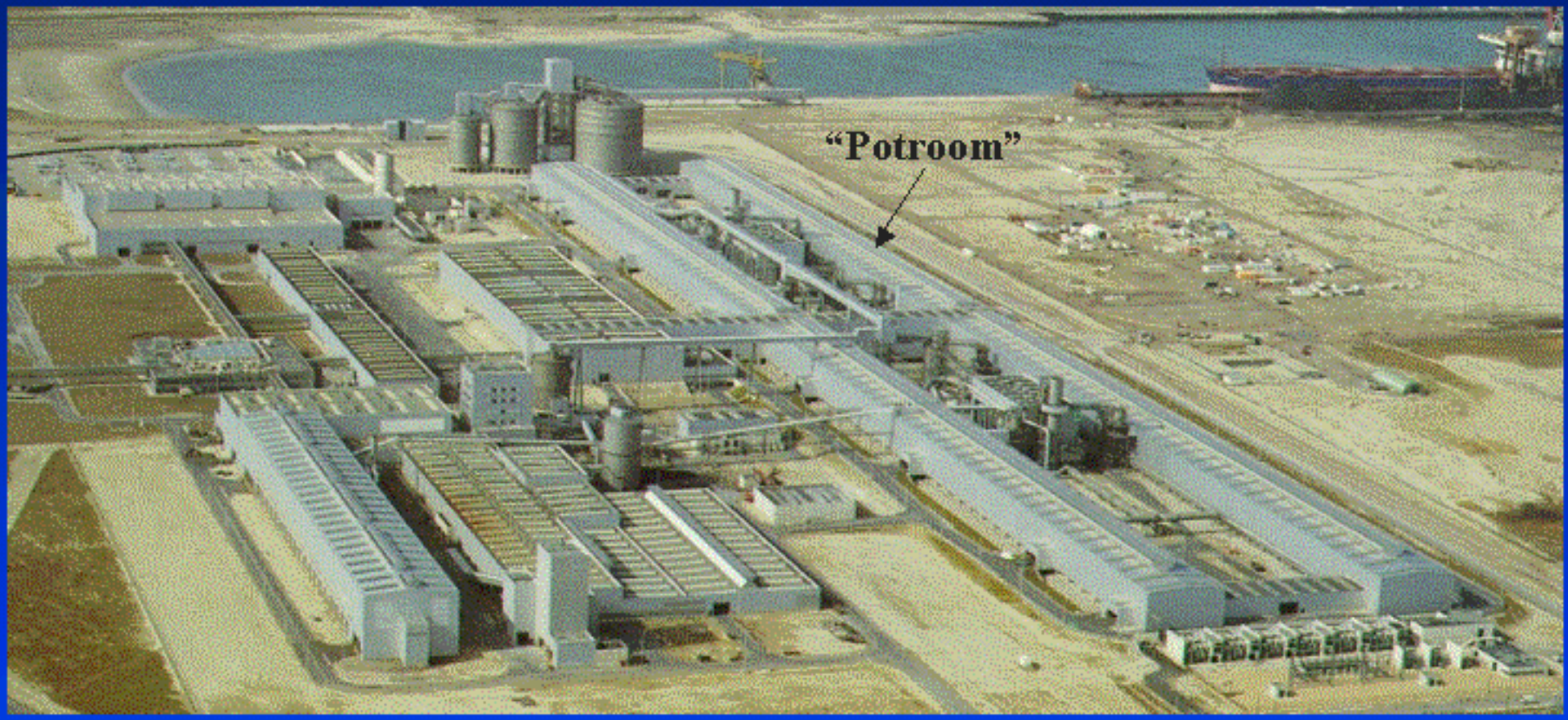
Description of a Modern "Potroom" Building



Modern "potroom" building can be up to 1 km long

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Description of a Modern "Potroom" Building

Side by side pot arrangement generates a truly 3D flow pattern

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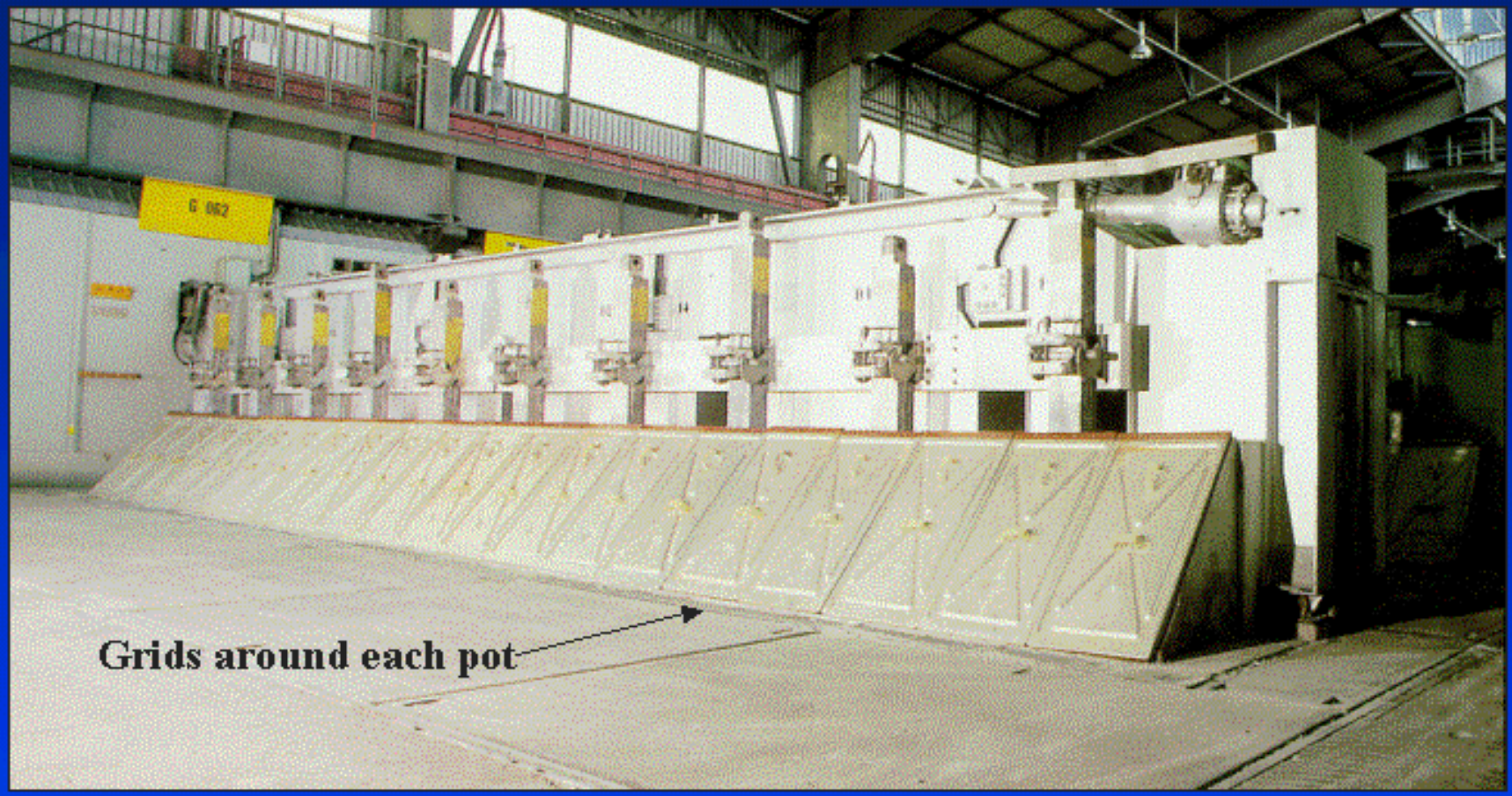
Description of a Modern "Potroom" Building



Fresh air from the basement is coming through grids around each pot

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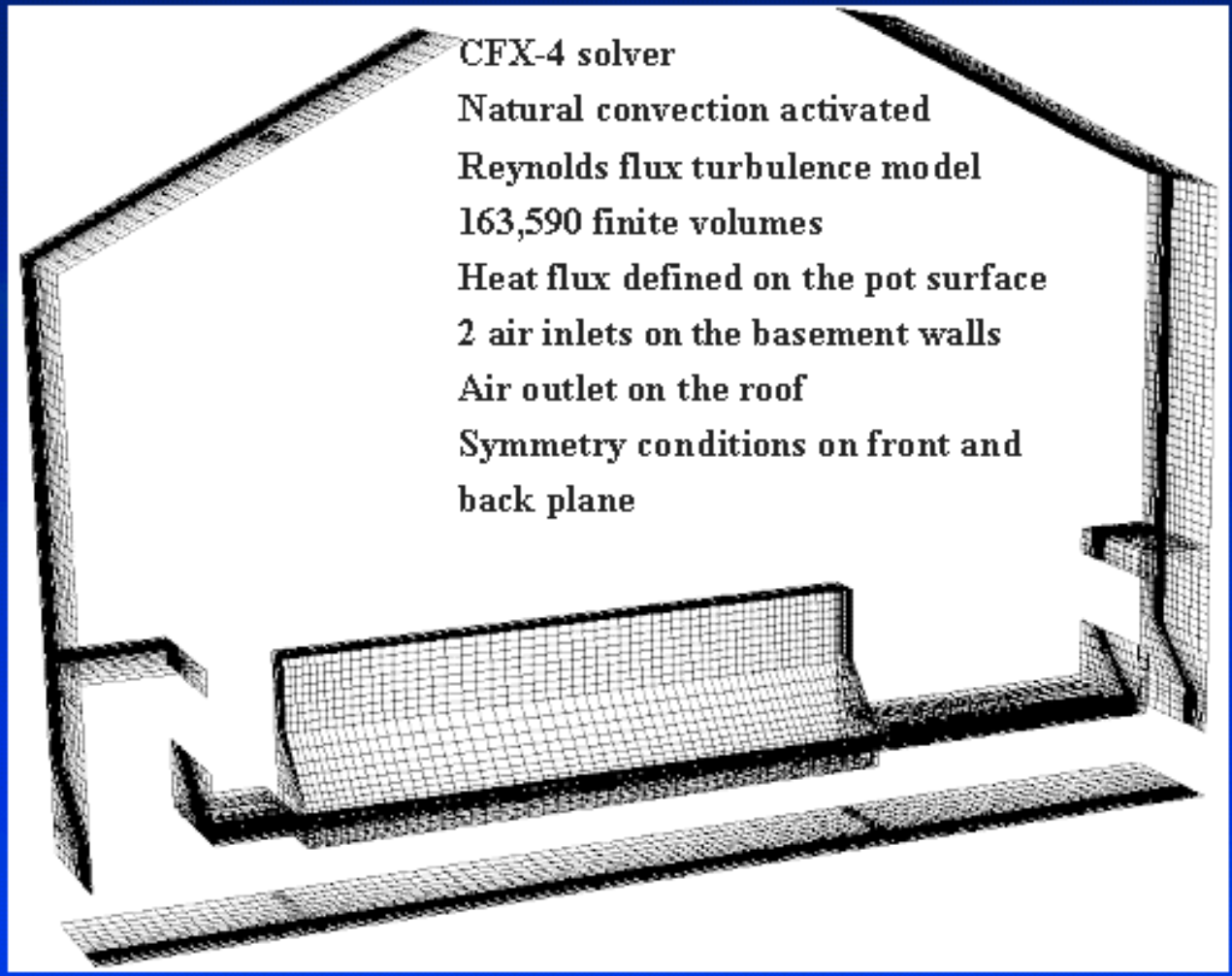
Description of the CFD Mathematical Model



CFX-4 solver

Natural convection activated

Reynolds flux turbulence model

163,590 finite volumes

Heat flux defined on the pot surface

2 air inlets on the basement walls

Air outlet on the roof

Symmetry conditions on front and back plane

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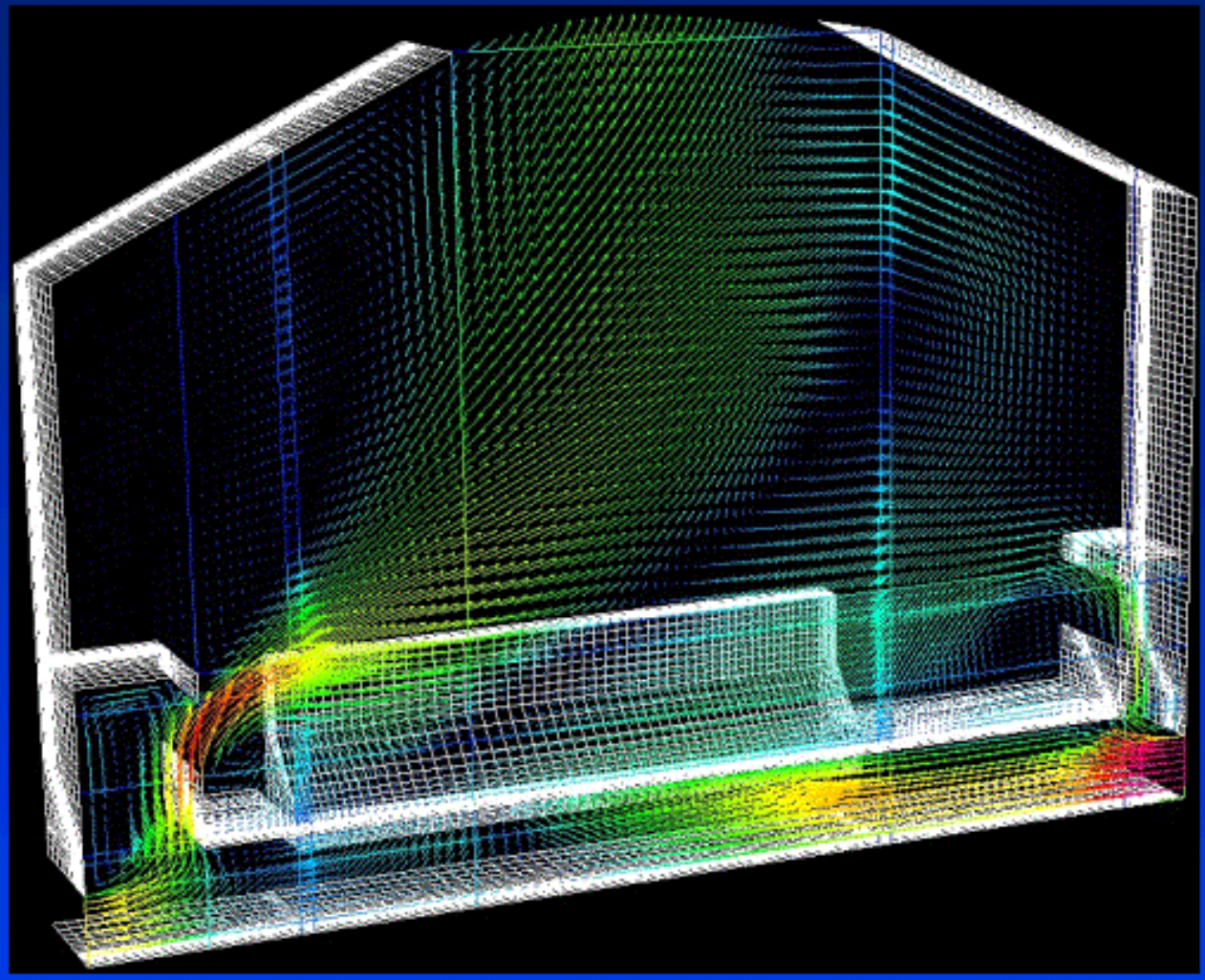
Results of the CFD Mathematical Model

Velocity vector plot, front plane



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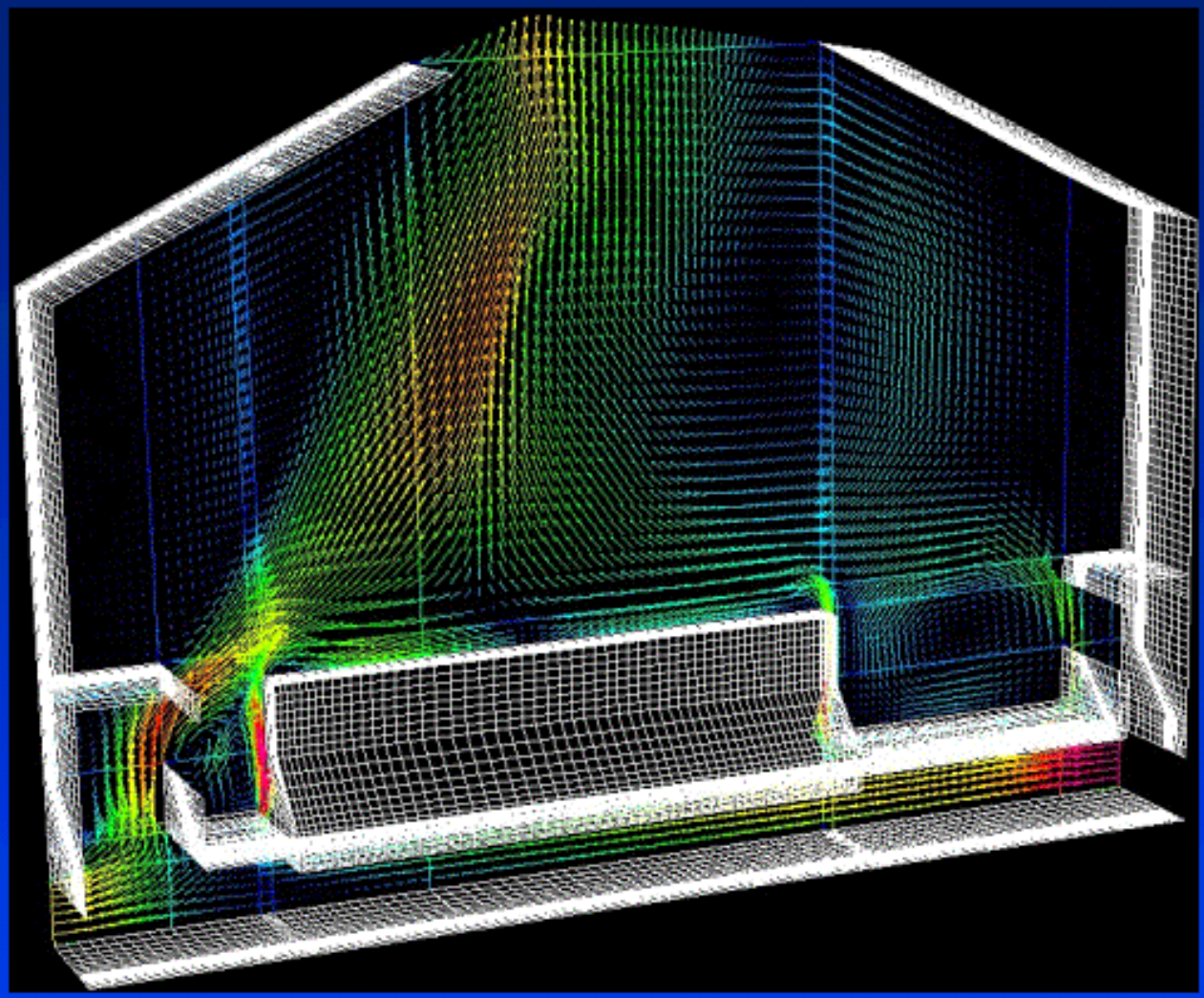
Results of the CFD Mathematical Model

Velocity vector plot, back plane



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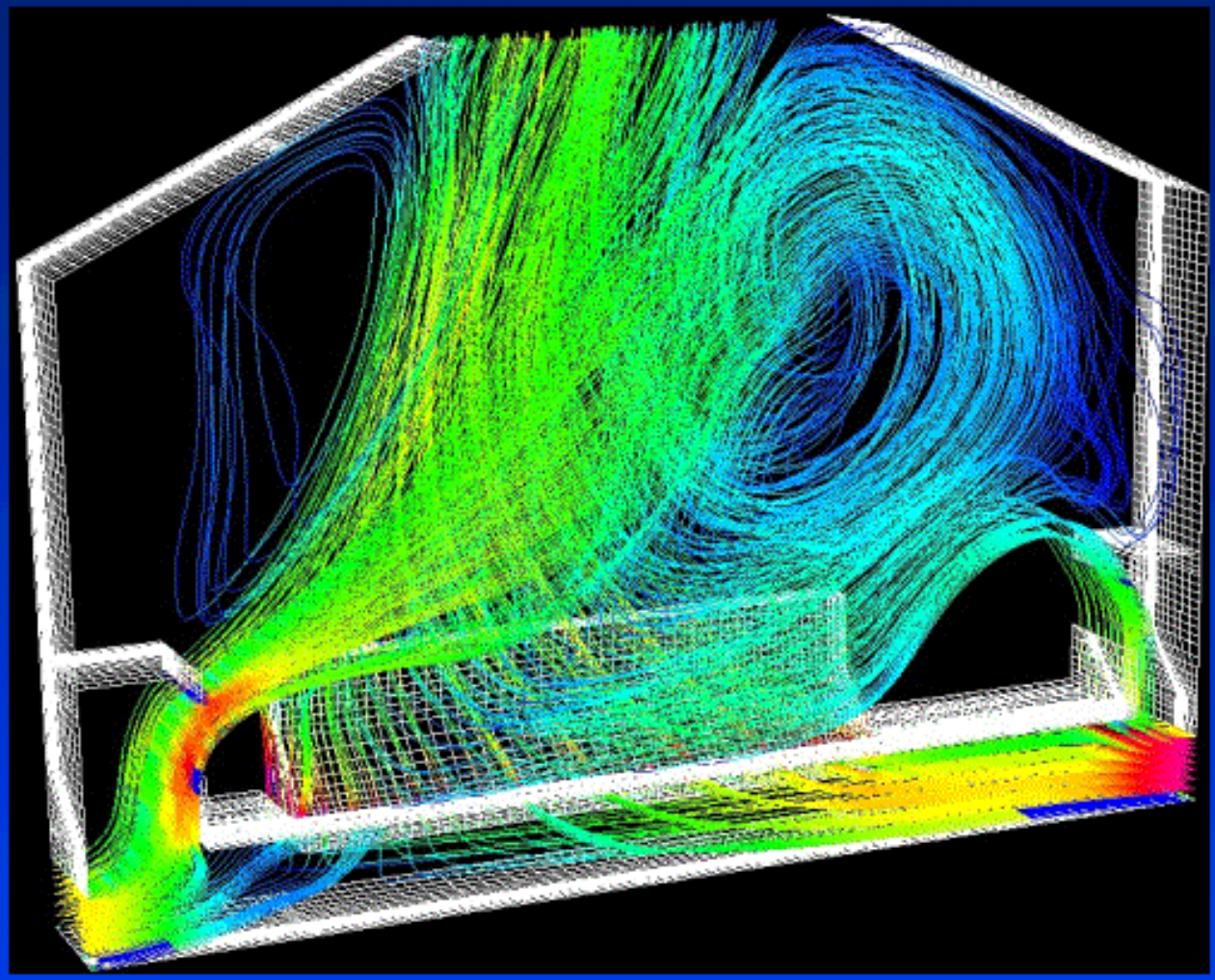
Results of the CFD Mathematical Model

Streak lines



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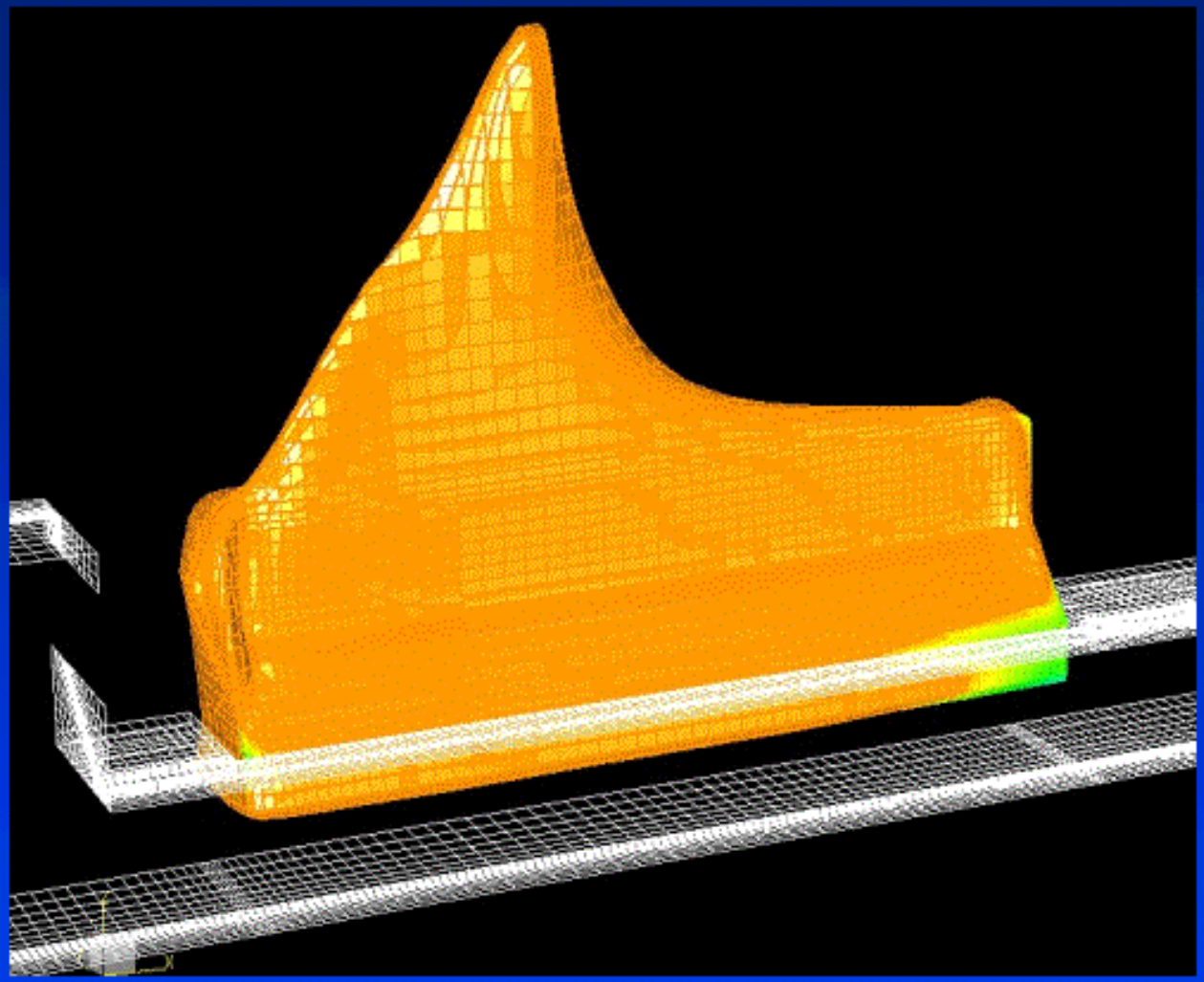
Results of the CFD Mathematical Model

Isosurface at constant temperature



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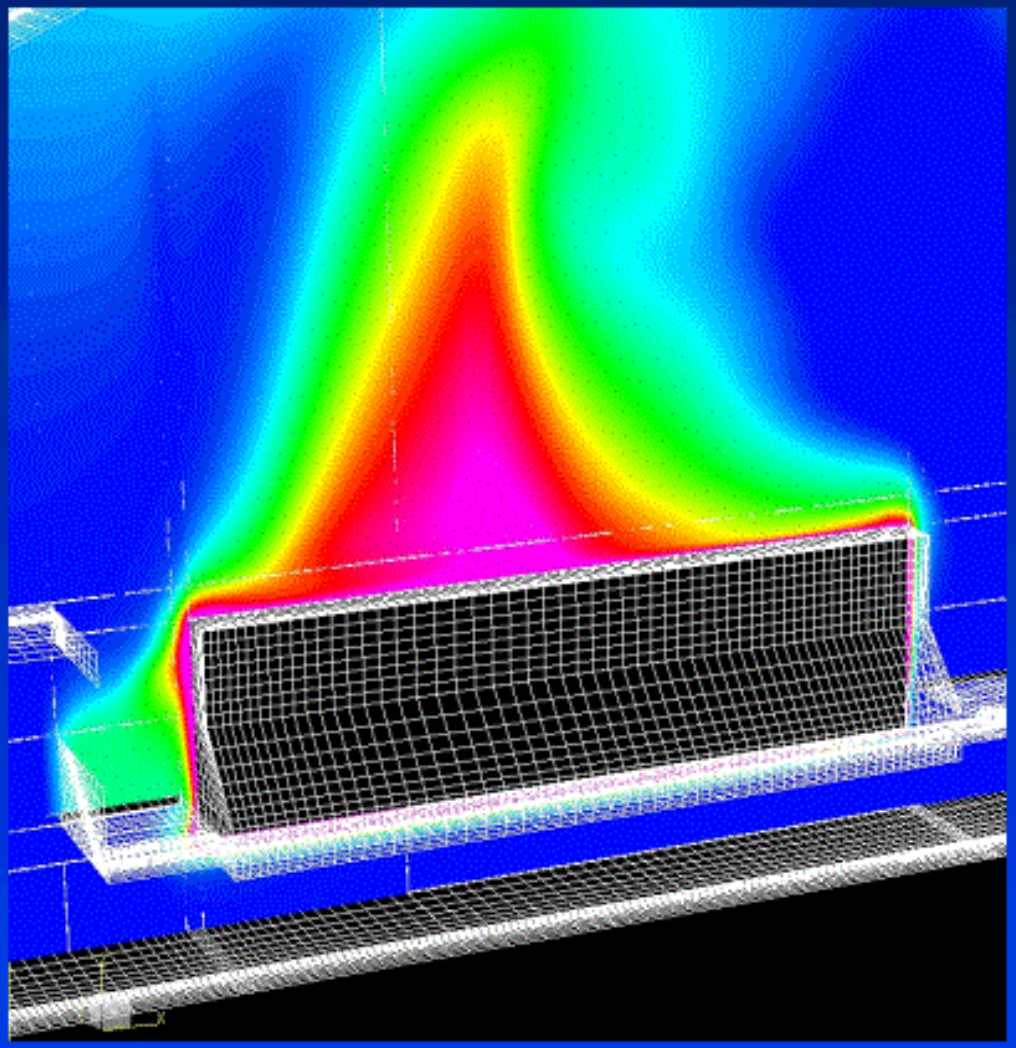
Results of the CFD Mathematical Model

Temperature fringe plot, back plane



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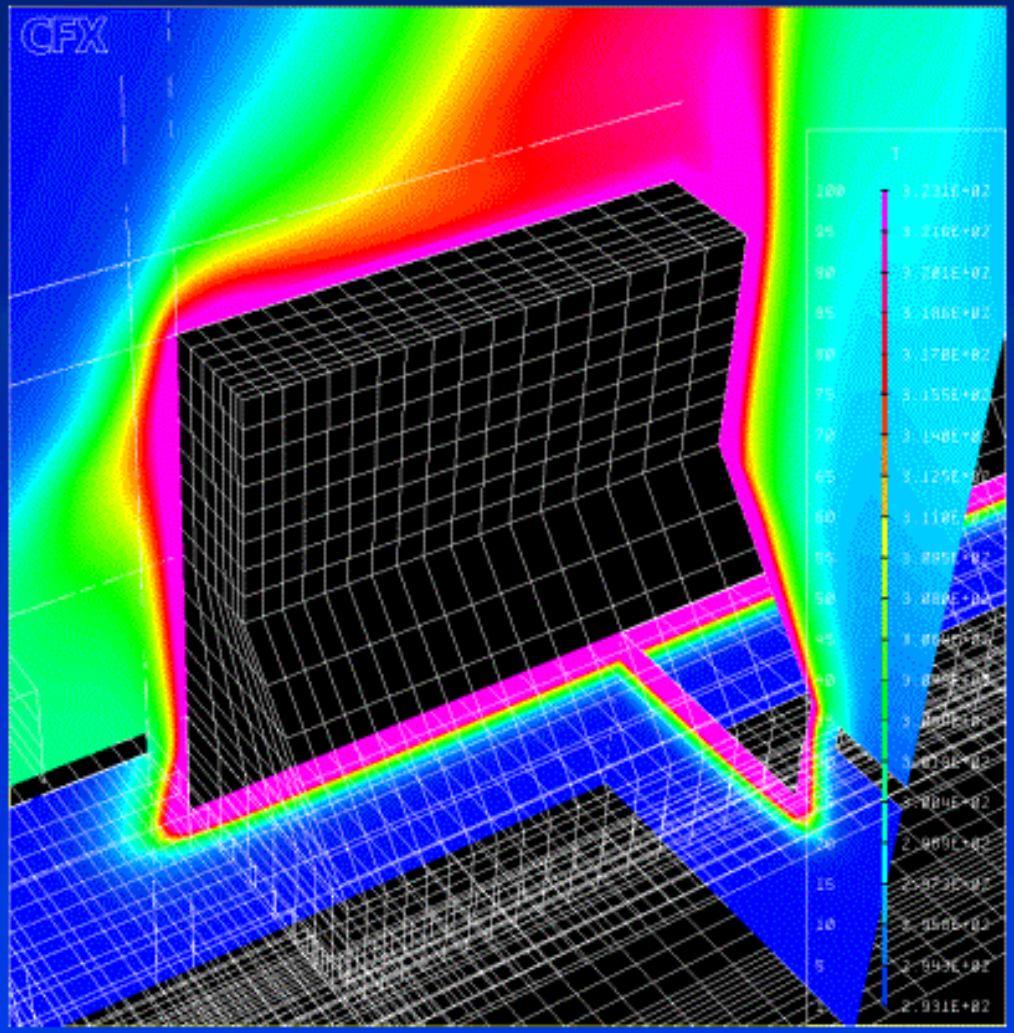
Results of the CFD Mathematical Model

Temperature fringe plot, back plane



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Conclusions

- A full 3D ventilation model of a modern potroom design has been successfully developed using the CFX-4 code from AEA.
- The model relies on the differential Reynolds flux turbulence model to be able to reproduce correctly the turbulent mix convection ventilation pattern.
- The model is converging to the steady state conditions in around 5 CPU hours on a 800 mHz PIII computer.
- Model results confirm the efficiency of the modern potroom design to maintain both the pots and the floor working area well ventilated.