BLUE WATERS
SUSTAINED PETASCALE COMPUTING

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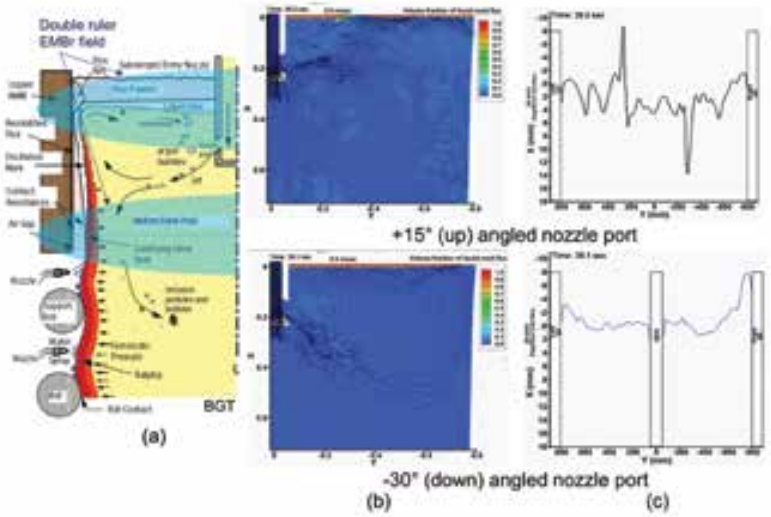
TRANSIENT MULTIPHASE FLOW PHENOMENA AND DEFECT FORMATION IN STEEL CONTINUOUS CASTING

Research Challenge

- Transient multiphase flow phenomena should be better understood in order to reduce the problems that introduce defects during continuous casting.
- The modeling results should be validated with plant measurements and applied to find optimal process conditions, including nozzle port angle, nozzle submergence depth and EMBr field strength.



(a) Schematic of multiphase flow phenomena in the steel continuous-casting mold and Effect of nozzle port angle on (b) mold flow patterns, including motion of the top liquid mold flux layer, and (c) level variations at the liquid mold flux/molten steel interface in the meniscus region.

Methods & Codes

- ANSYS Fluent is used to implement Large-Eddy Simulations (LES) coupled with Volume of Fluid (VOF) models.
- Use of GPU-based in-house code, CUFLOW, to create LES coupled with Lagrangian particle capture and MagnetoHydroDynamics models.

Results & Impact

- These studies have enabled better understanding of the complex multiphysics phenomena related to defect formation.
- This better understanding has led to suggestions of nozzle geometry/casting condition combinations that lead to fewer defects, and, consequently, to significant savings to the steel plants.

Acknowledgements

- Continuous Casting Consortium and NSF (Grant CMMI 15-63553) support

Why Blue Waters

- Blue Waters enabled high-resolution multiphase flow simulations of the continuous caster needed for accurate predictions.
- Blue Waters resources (both ANSYS Fluent HPC on XE nodes and our in-house multi-GPU code CUFLOW on XK nodes) showed speed-up breakthroughs (e.g., over 3000x with ANSYS Fluent HPC on BW) needed to provide this modeling capability for the steel continuous casting process.