Modeling and simulation of laboratory scale dense-phase solids transport systems

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Outline

- Introduction: Dense-Phase Modeling Simulation
- Topic 1: Simulation of the MTF
- Topic 2: Modeling and simulation of Cold Flow
- Future Plans and validation needs

Multi-use Test Facility: (MTF)

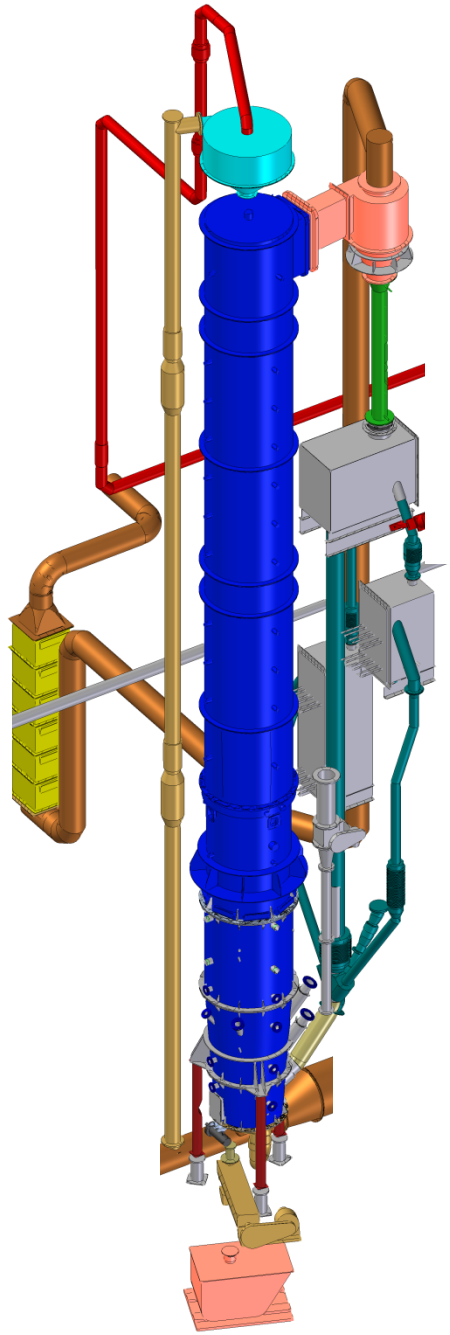
Alstom Pilot Plant CFB at Windsor, CT

Platform for process development and testing

Experimental Measurements

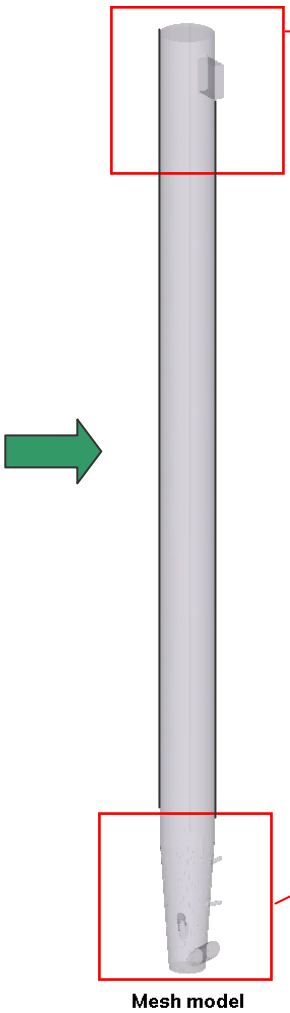
Basis for several dense-phase CFD efforts

Used to evaluate Barracuda®



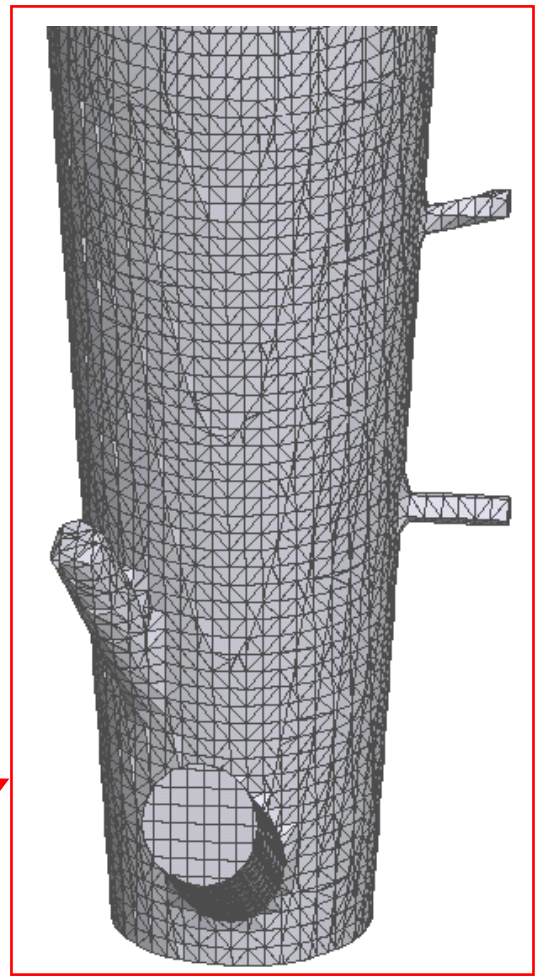
Modeling of the MTF: Barracuda Tests

Riser



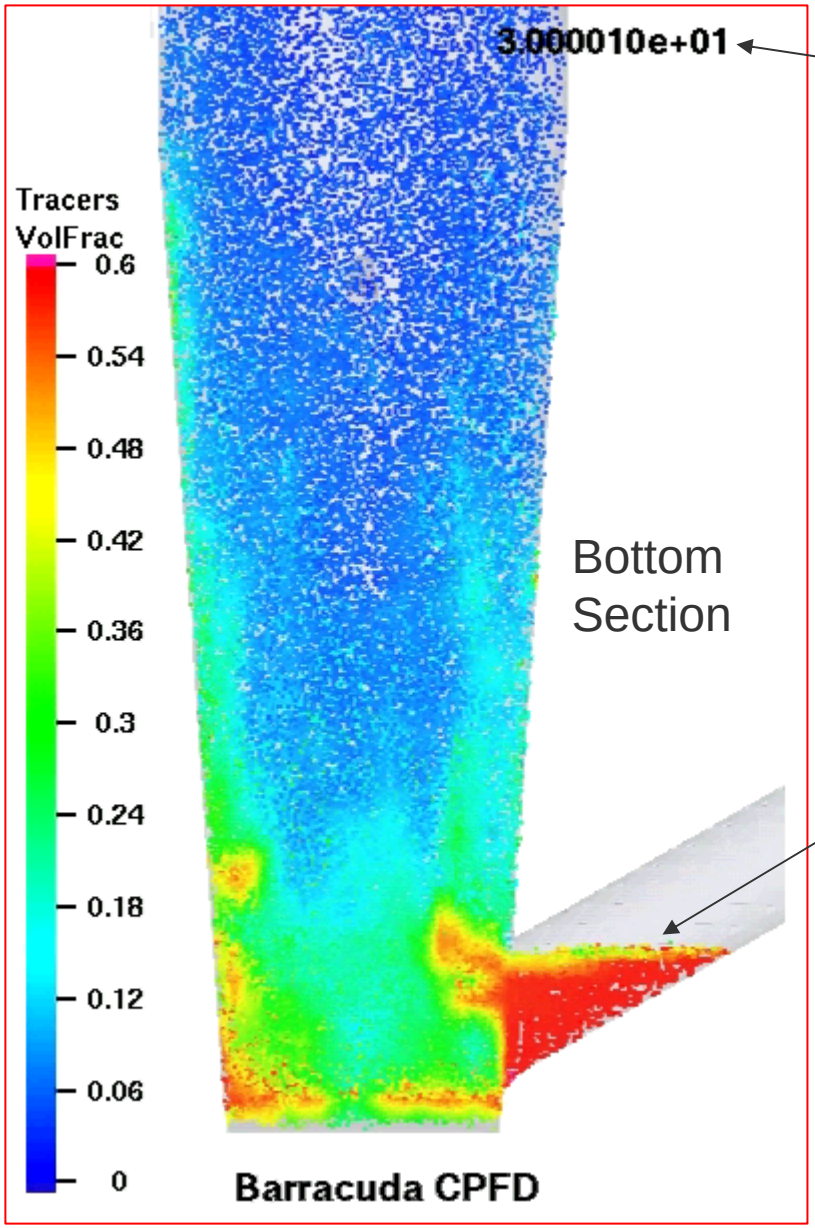
Mesh model

Top – Cyclone inlet



Bottom

MTF Predictions: Animation of Solids



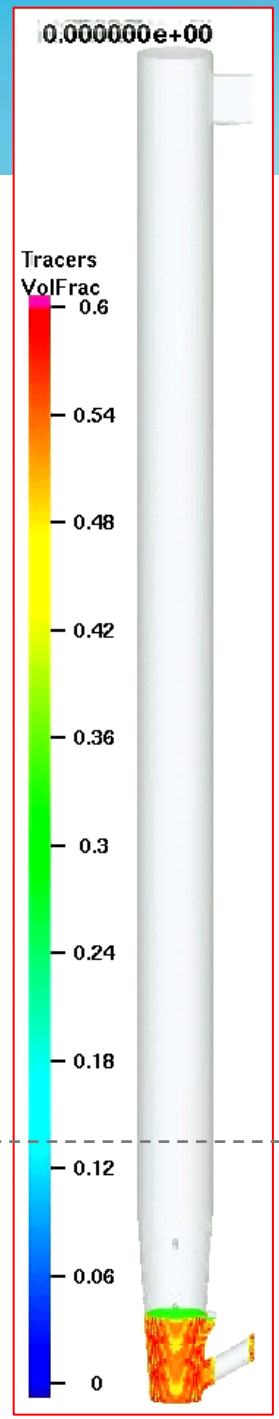
Run Time
30-50s

Bottom
Section

Cyclone
Return:
Solids flow
(Turn On @ 40s)

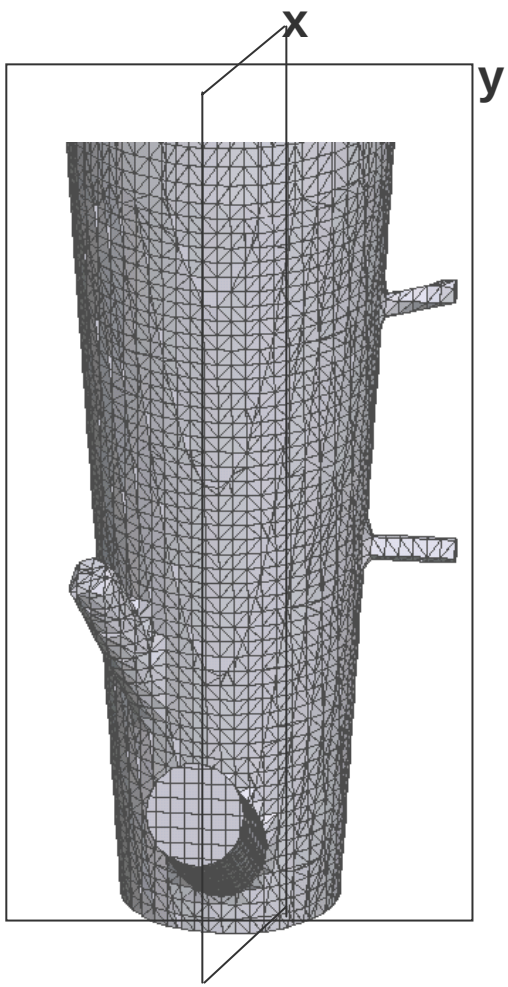
Full
Height

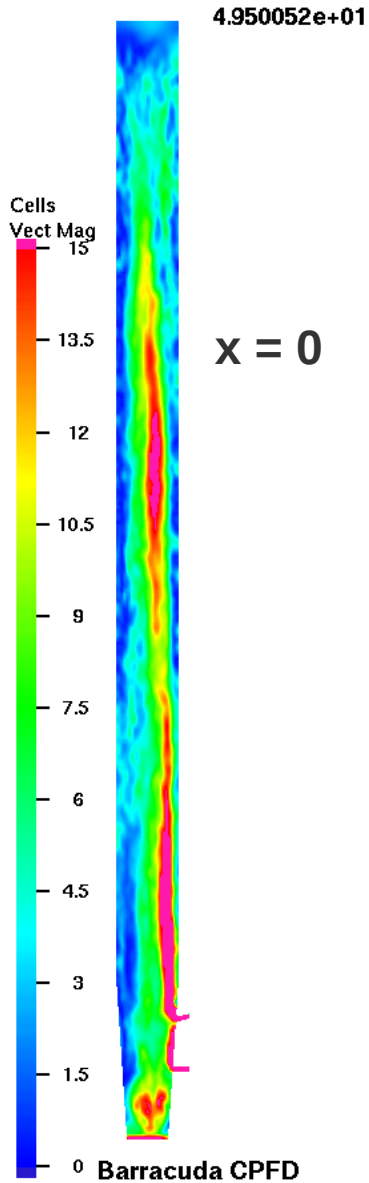
T= 0-40s

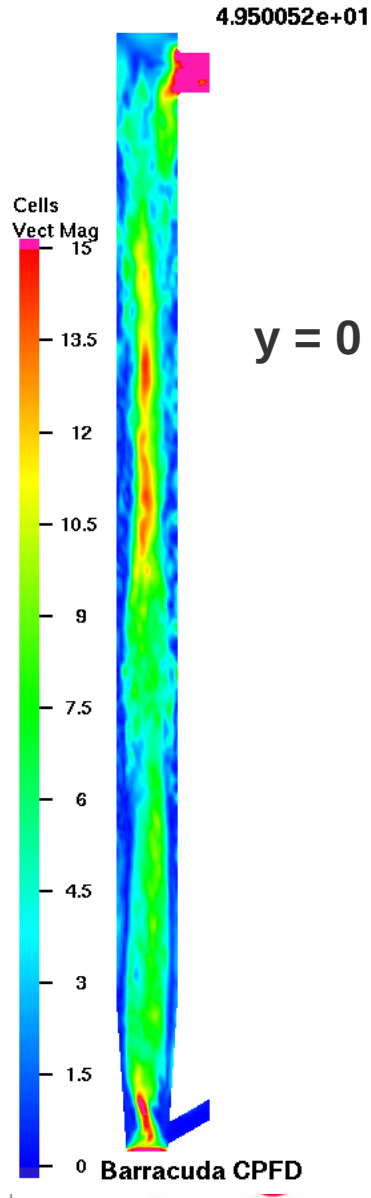


MTF Predictions: Time Averaged Velocities

Asymmetrical Pattern Indicated
Expected due to geometry…

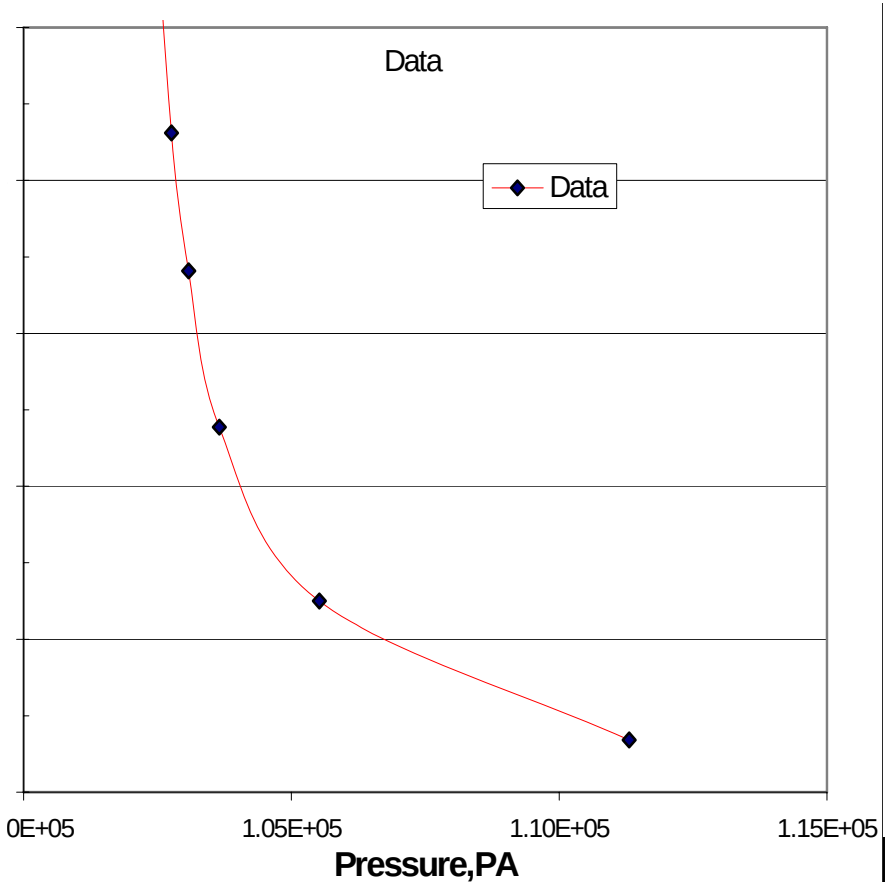




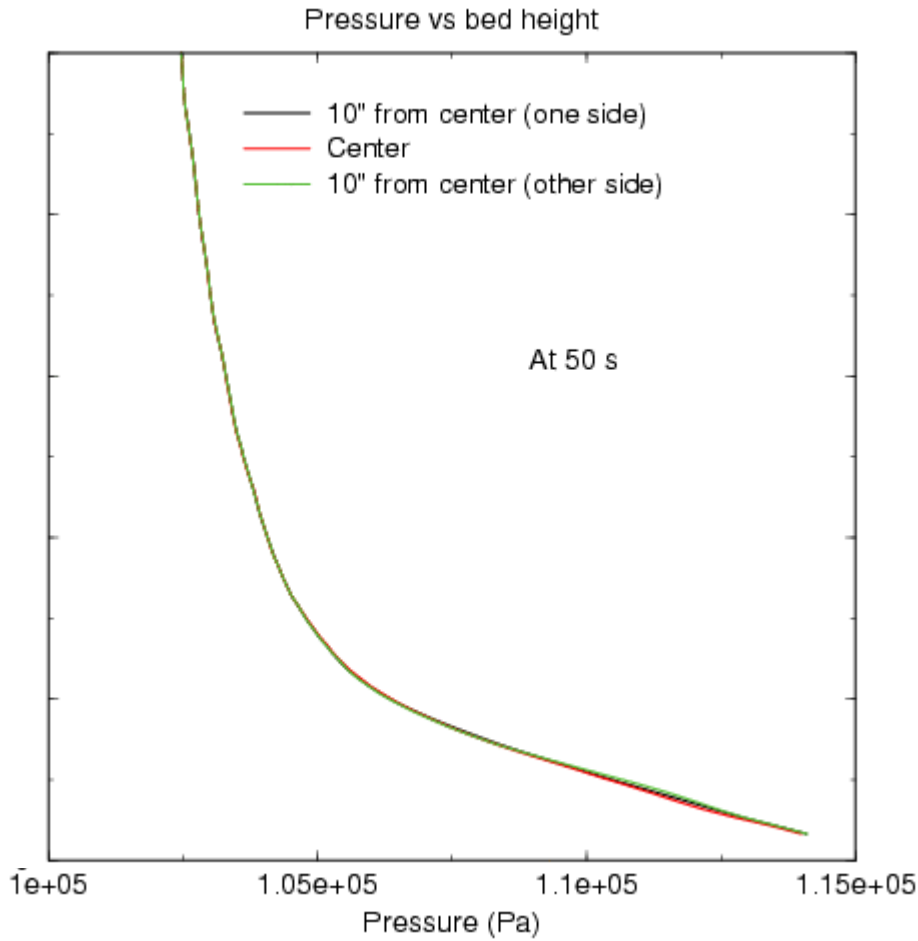


Multi-use Test Facility: (MTF)

Measured Pressure Profile along riser



Predicted Pressure Profile within riser



Barracuda CPFD

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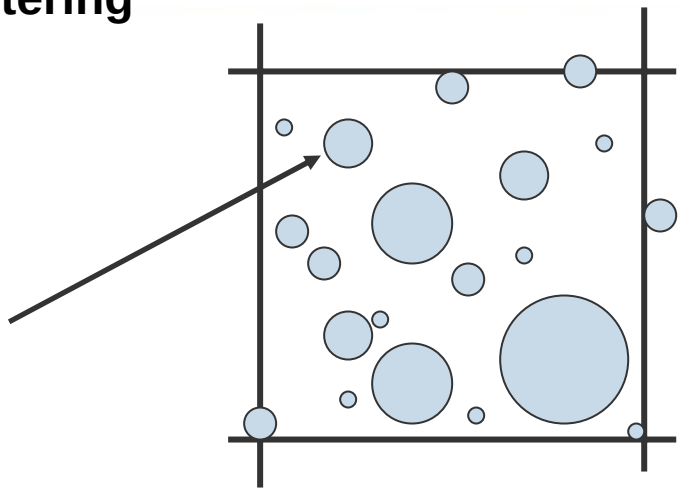
CPFD® Sub-Grid Properties

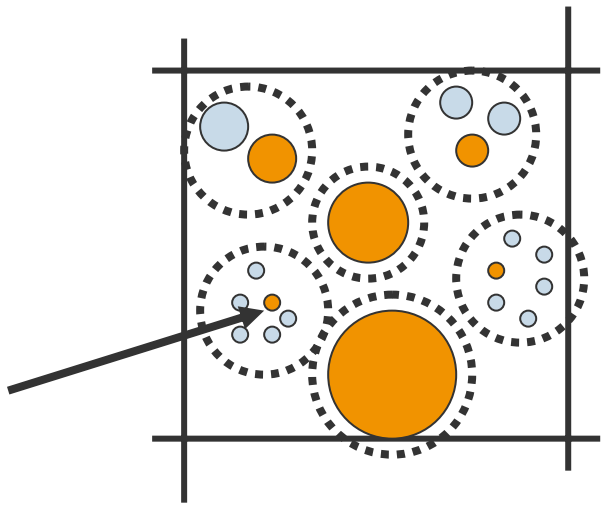
Automatic selection of particle clustering

For small calculations, every particle is modeled directly

Each computational particle represents one actual particle



For most calculations, not every particle is modeled individually (each computational particle represents many actual particles)



MTF Predictions: Conclusions

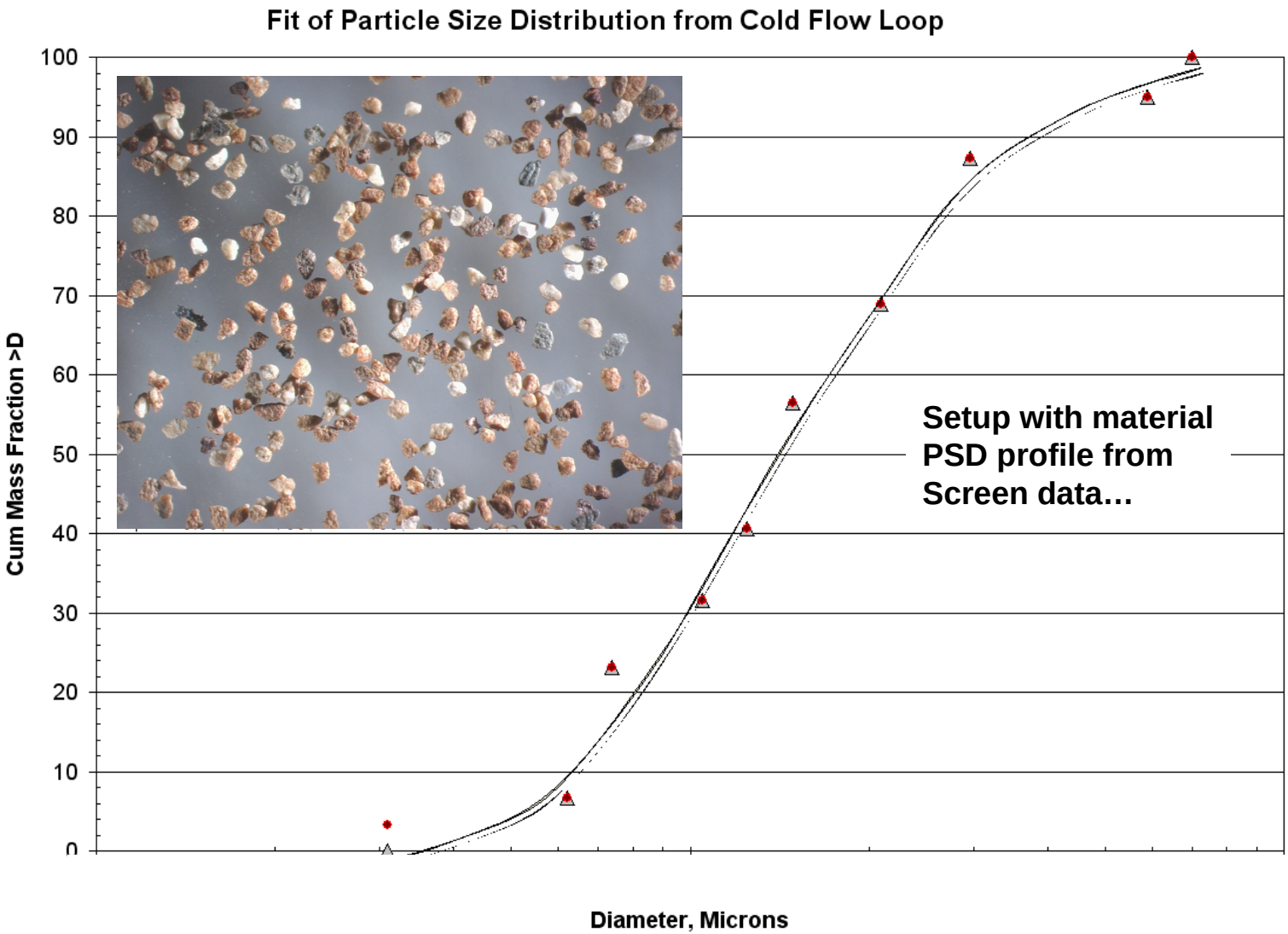
- Run times significantly faster than previous attempts.
- Cursory checks indicate reasonable correlation.
- Approach using coarse grid somewhat unusual.
- Refinement of the OFA zone needed.
- Supported decision to continue Barracuda® application.

Riser cold flow model: Isothermal Flow Loop

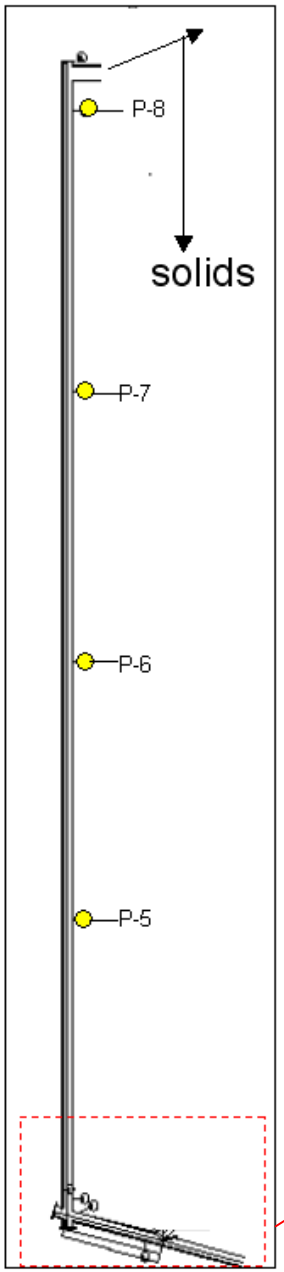
OBJECTIVES:

- Model Lower Portion of Flow Loop
- Examine Details of Lower Elbow, Riser
- Compare Pressure Drops
- Compare to observations
- Determine subsequent tasks

Riser cold flow model: Solids Description

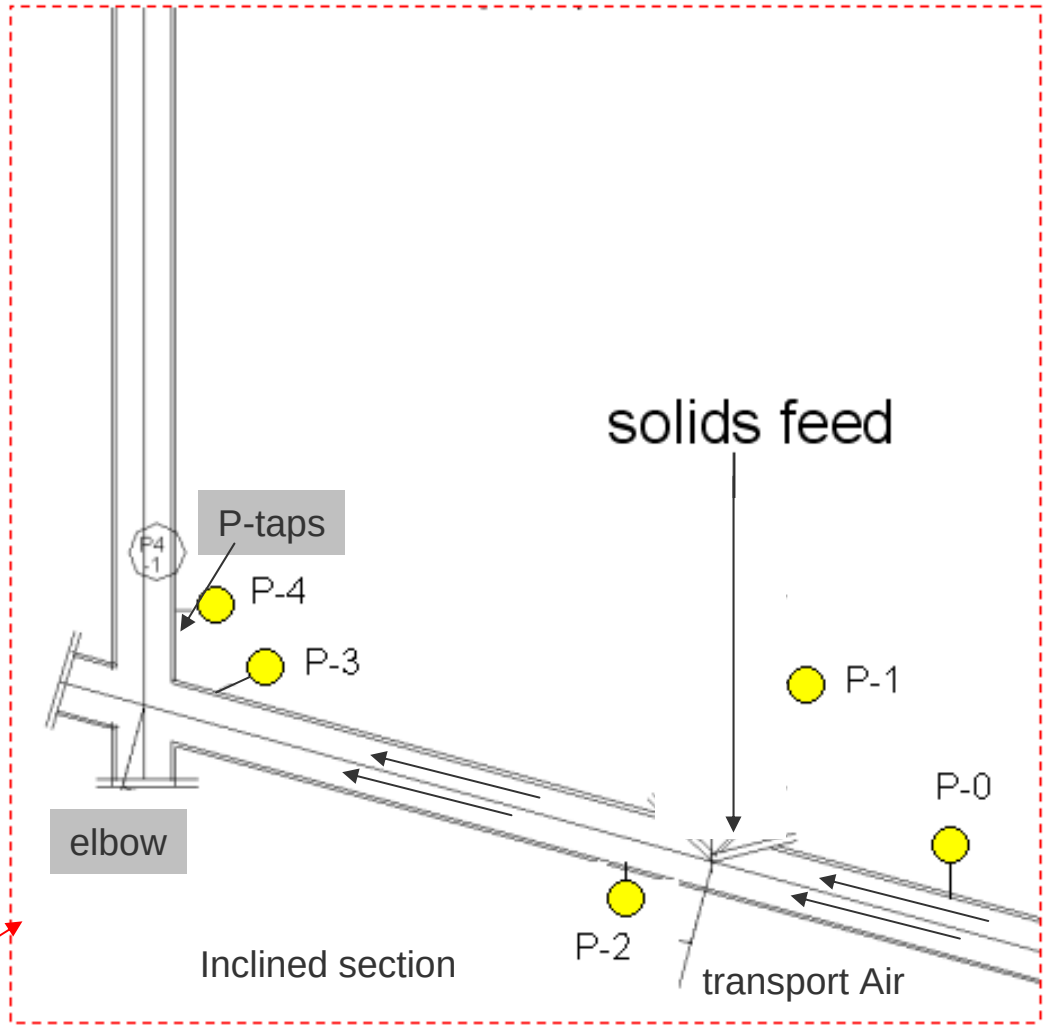


Riser cold flow model: Geometry

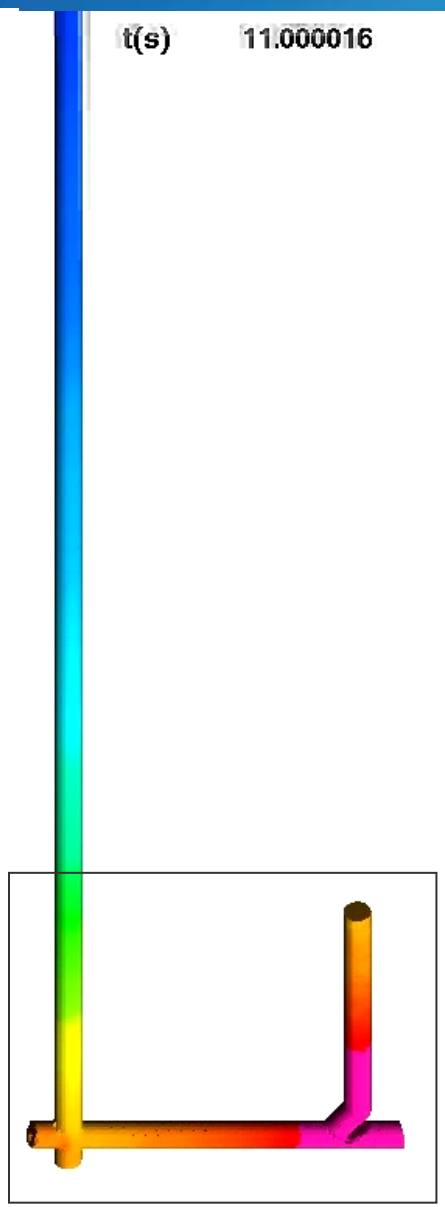


Full Elevation

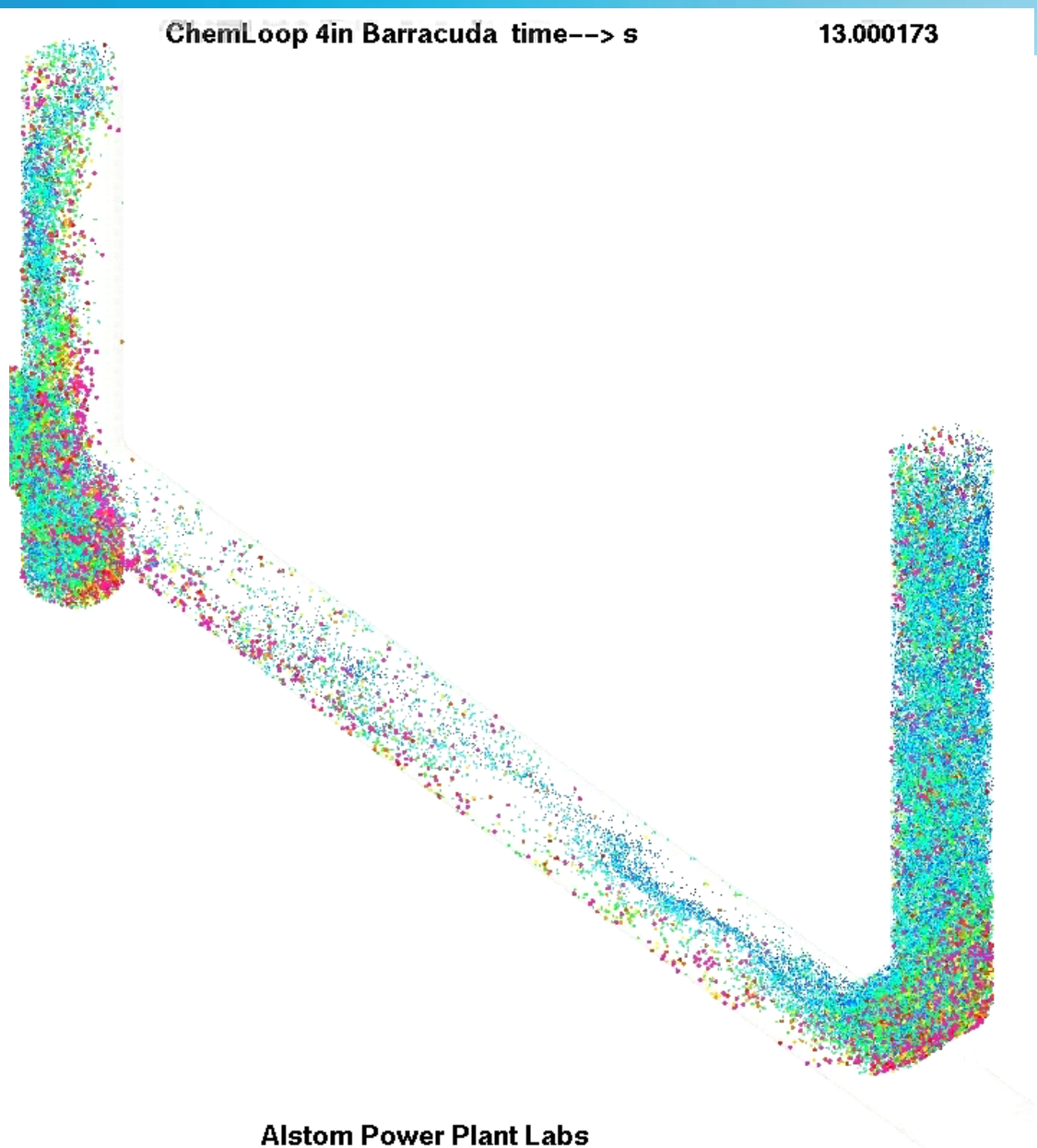
Modeled Zone



Riser cold flow model: pressure and particle flows



Pressures



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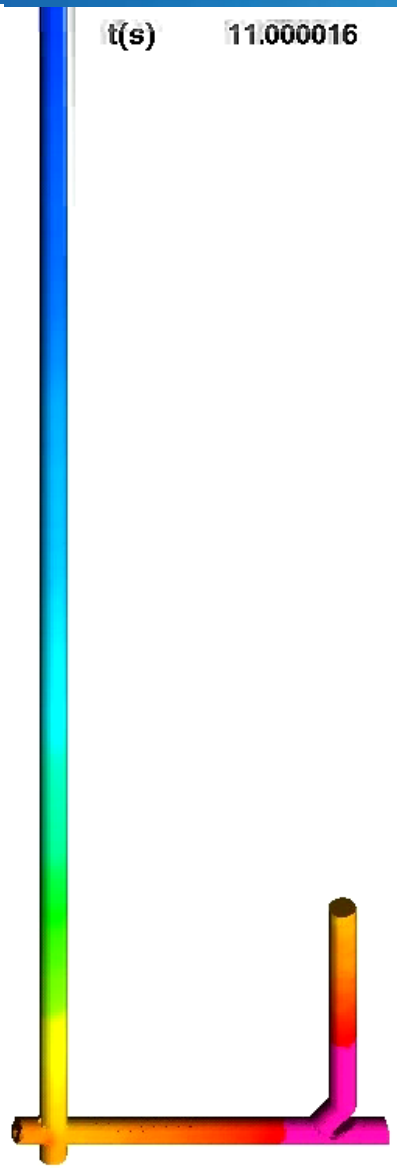
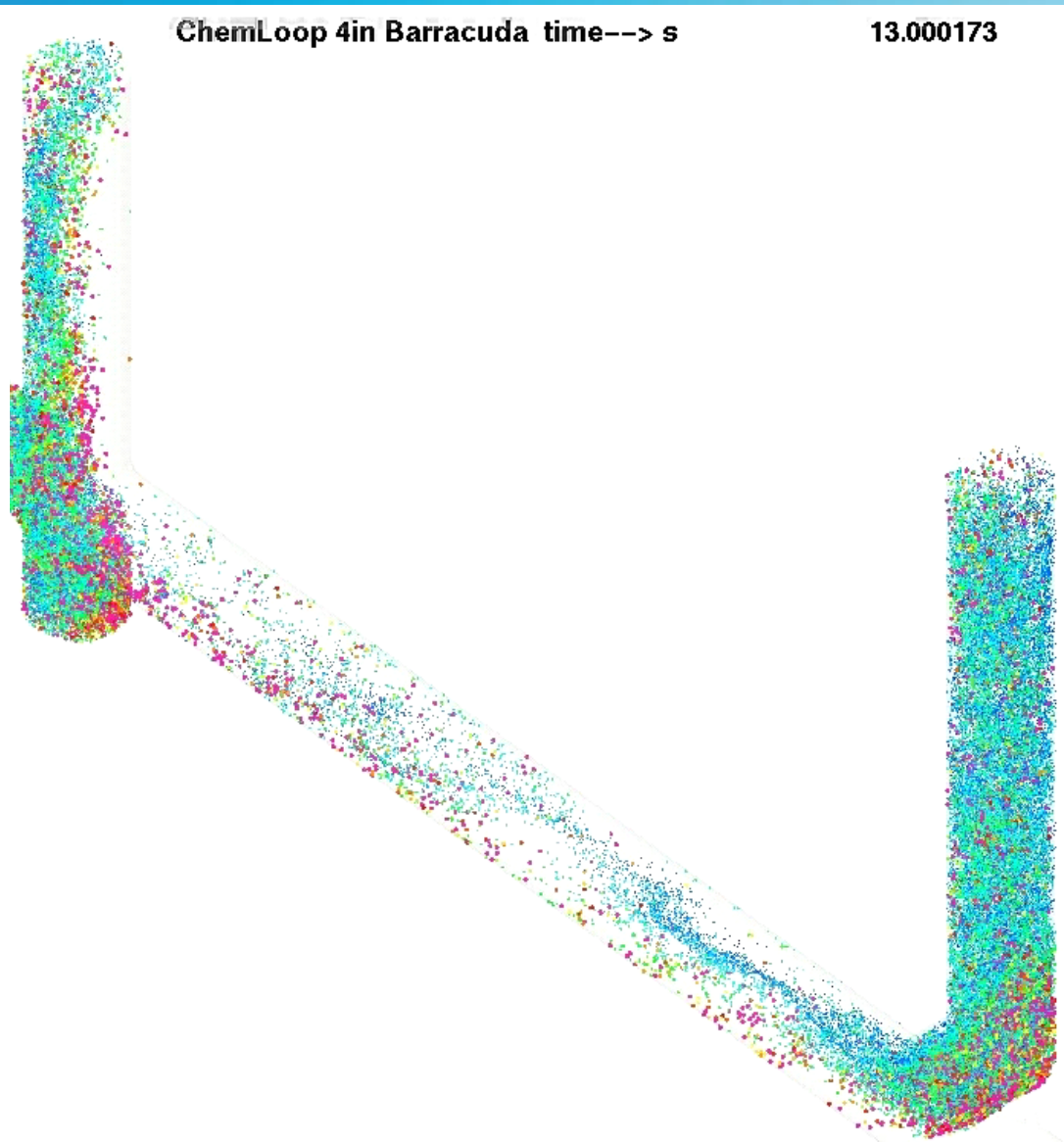
Riser cold flow model: pressure and particle flows



Pressures



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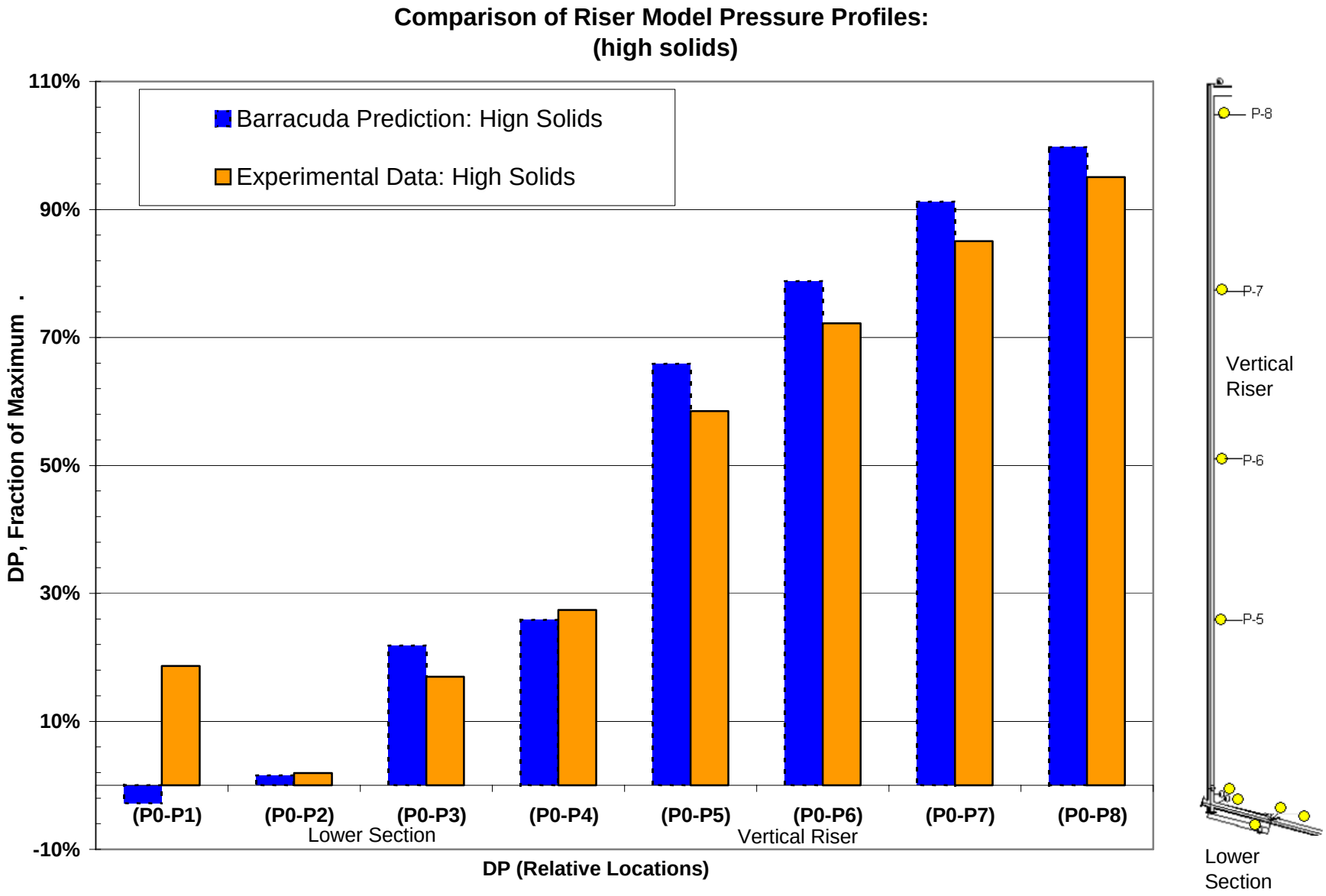
Riser cold flow model: DP Prediction Comparison



Riser cold flow model : Observations

- Pressure drop predictions quite good.
- Flow patterns appear reasonable.
- Additional studies planned.

Future Testing and Validation of Simulations:

Perform a set of cold flow experiments with companion CFD

Study impact of geometry, solids loading, and PSD,

- velocity distribution & pressure drop
- solids residence time & hold-up

Develop confidence before more complex geometry or physics

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