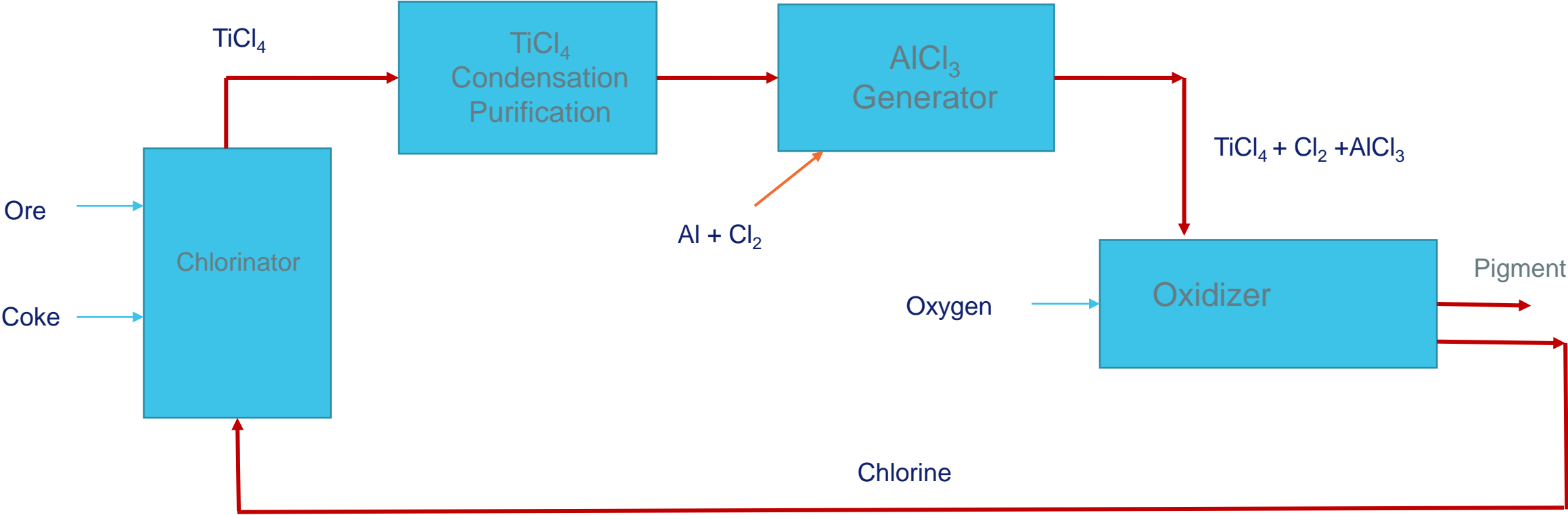


# Entrainment Reduction: Modeling & Plant Data

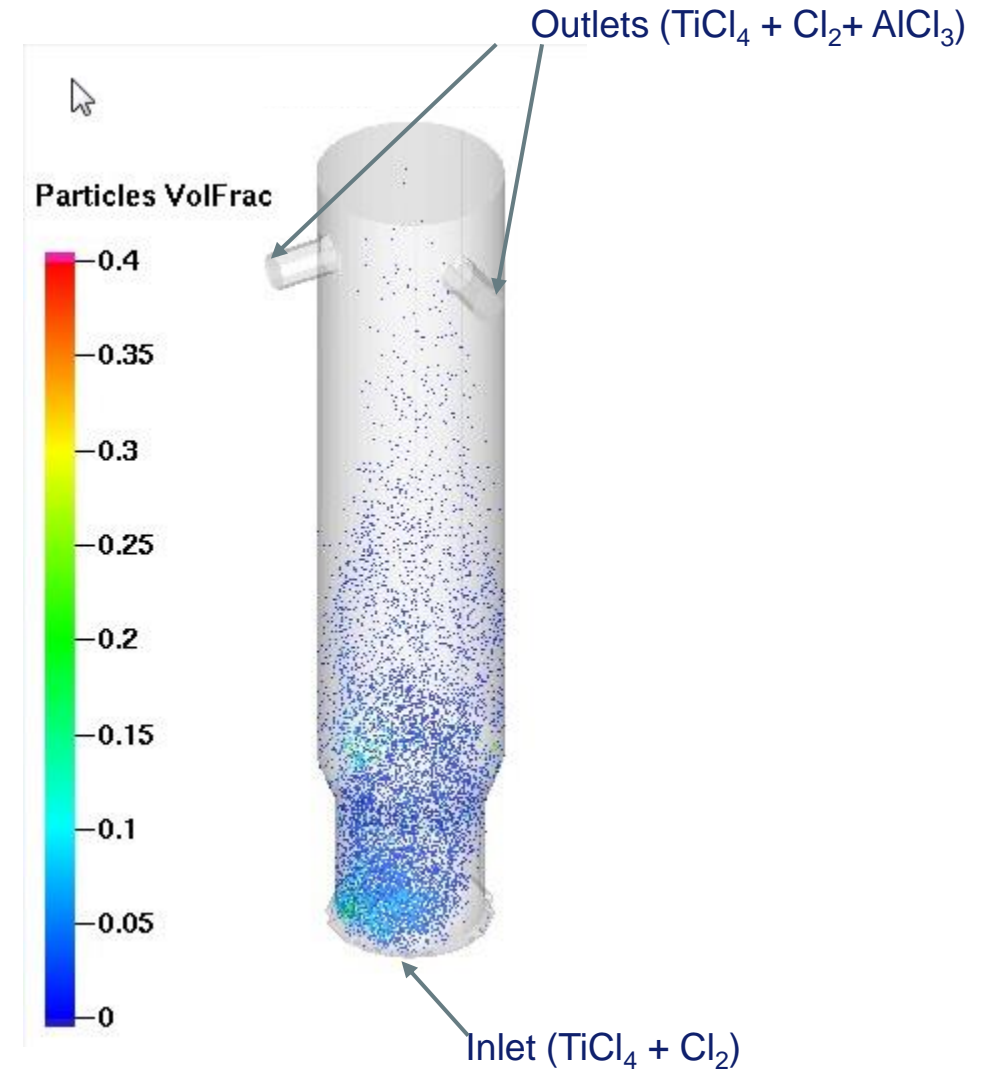
*S. Banerjee / R. Massey*

# Process Schematic

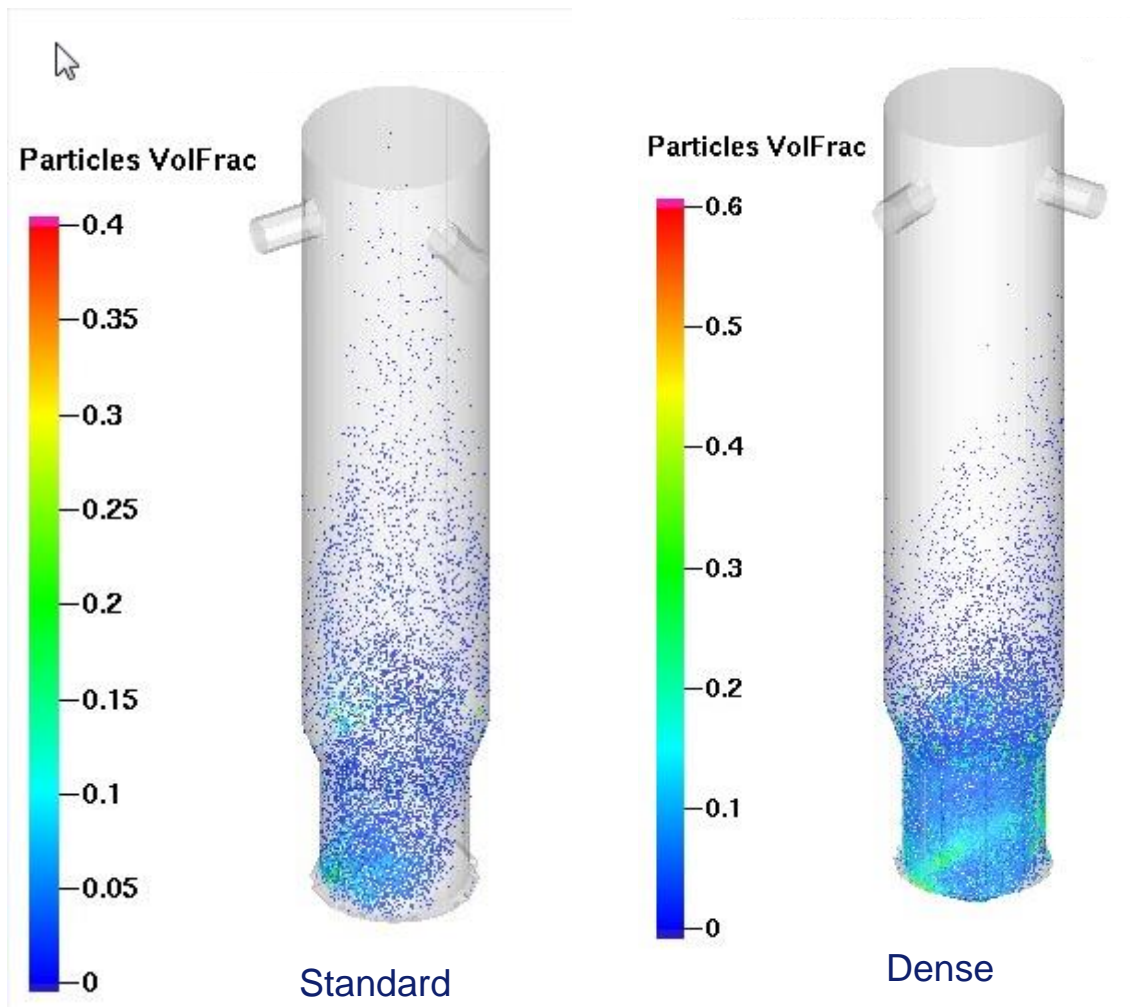


# Problem Description - Generator

- “Fluidized bed” with bed media & aluminum pellets
- Bottom inlet with discrete entry points
- Excessive media entrainment
  - Pluggages & downtime in oxidizer
  - Bed sintering when sat down
- Superficial velocity < terminal velocity
- Sufficient disengagement height



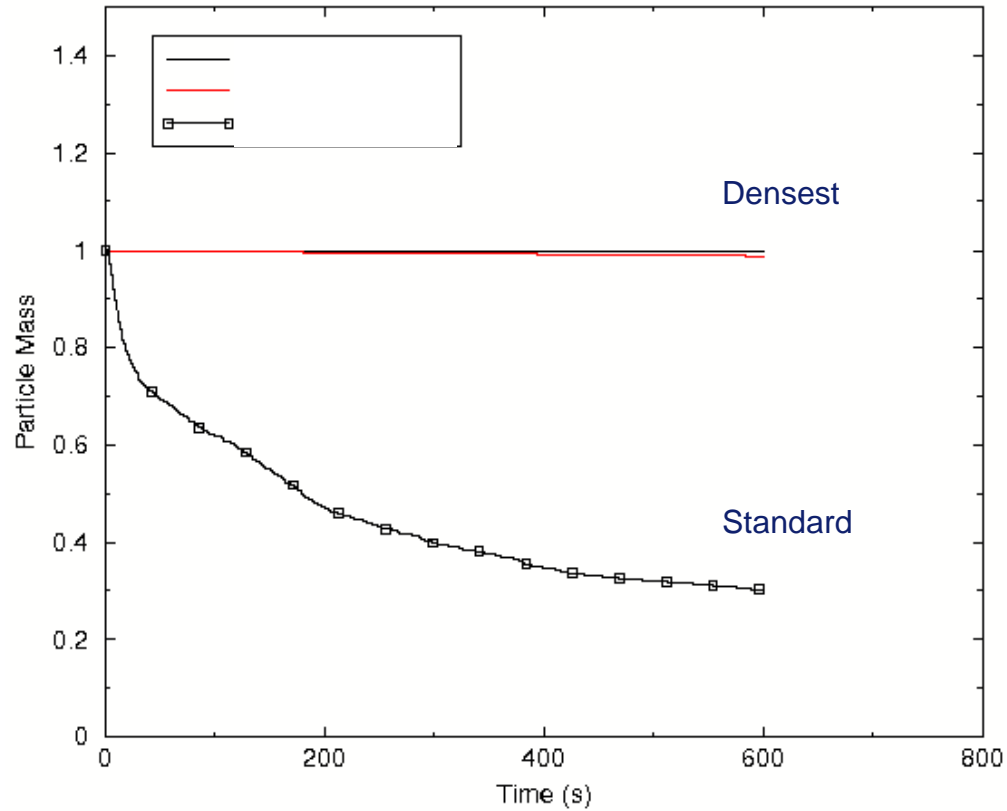
# Proposal #1: Change Media



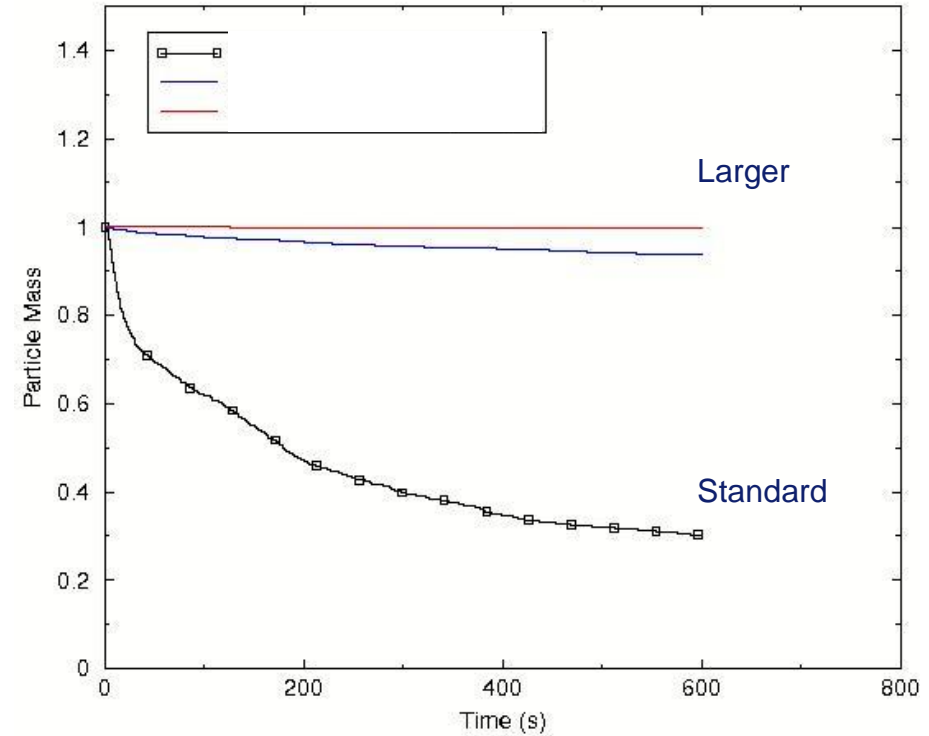
- Alternative media
  - Dense media
  - Larger media
- Issues
  - Cost
  - Media chlorination

# Proposal #1: Change Media

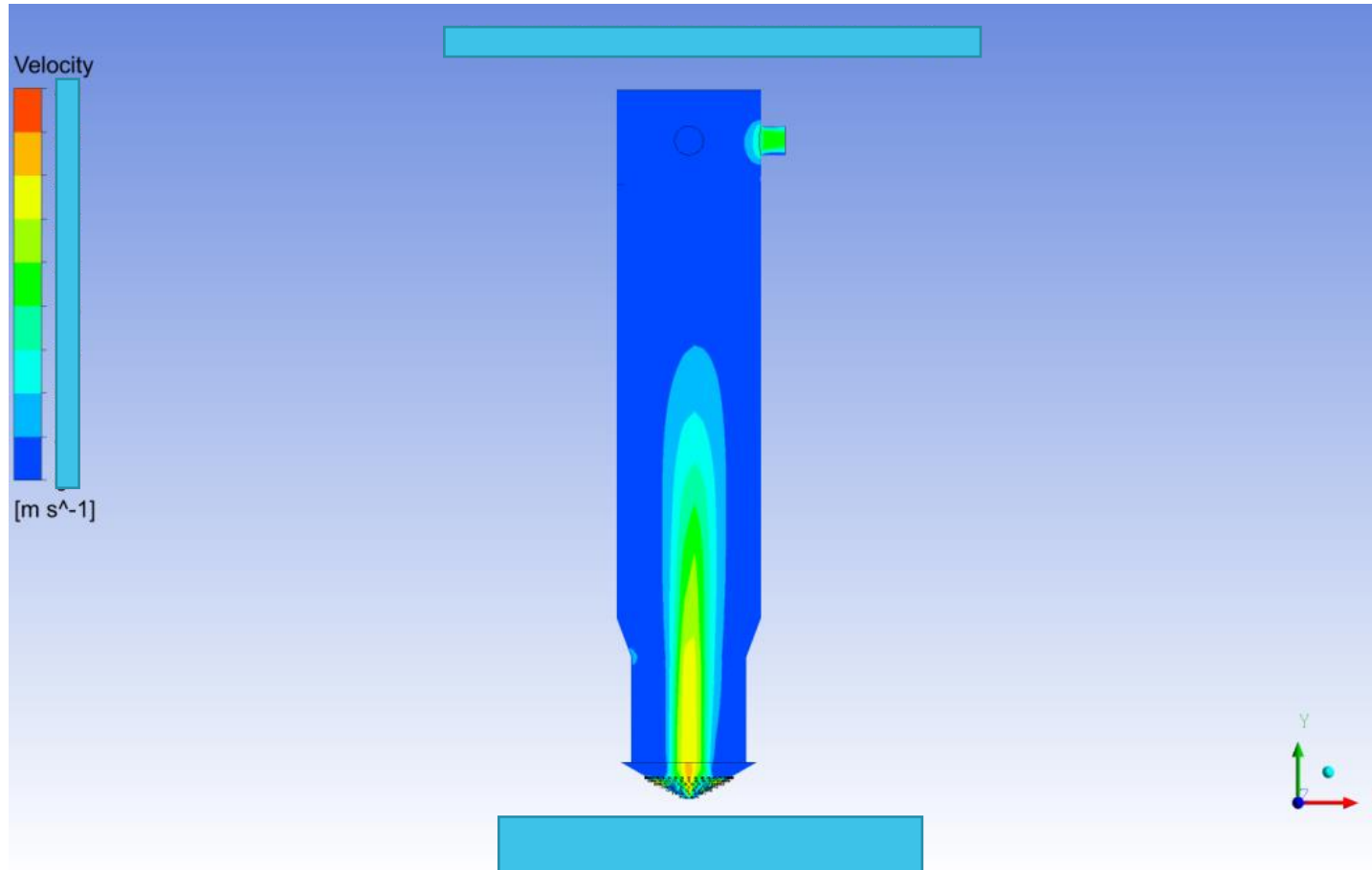
Normalized Mass in Bed



Normalized Mass in Bed

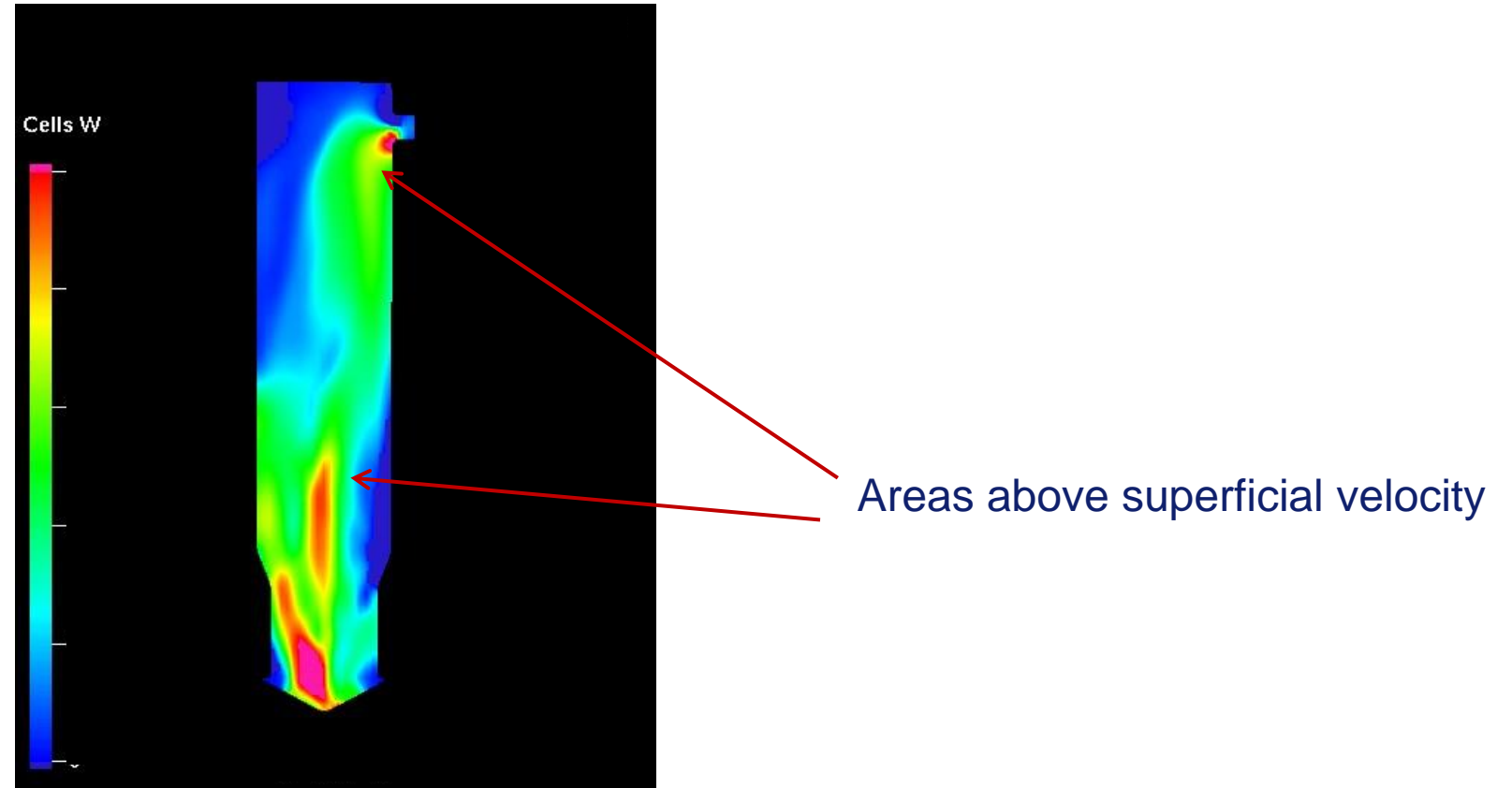


# Proposal #2: Look at Design



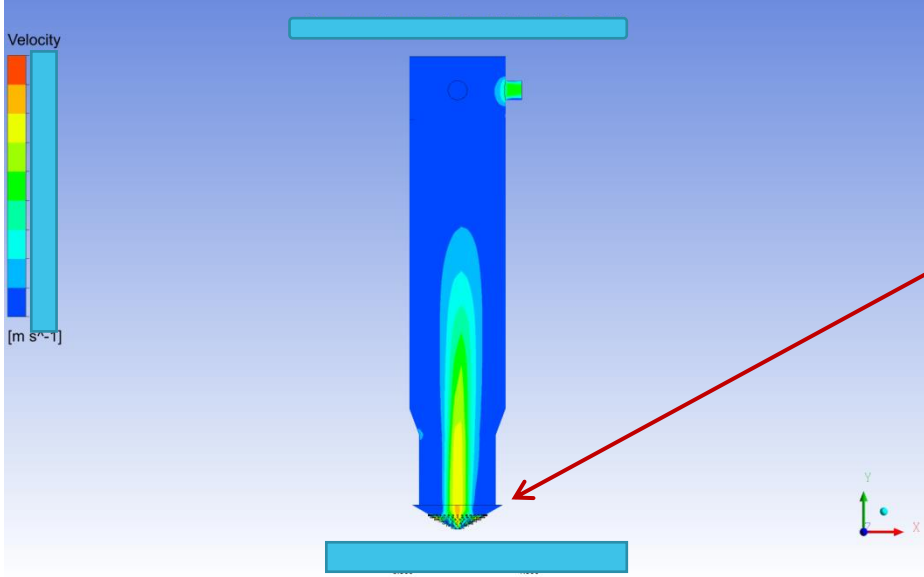
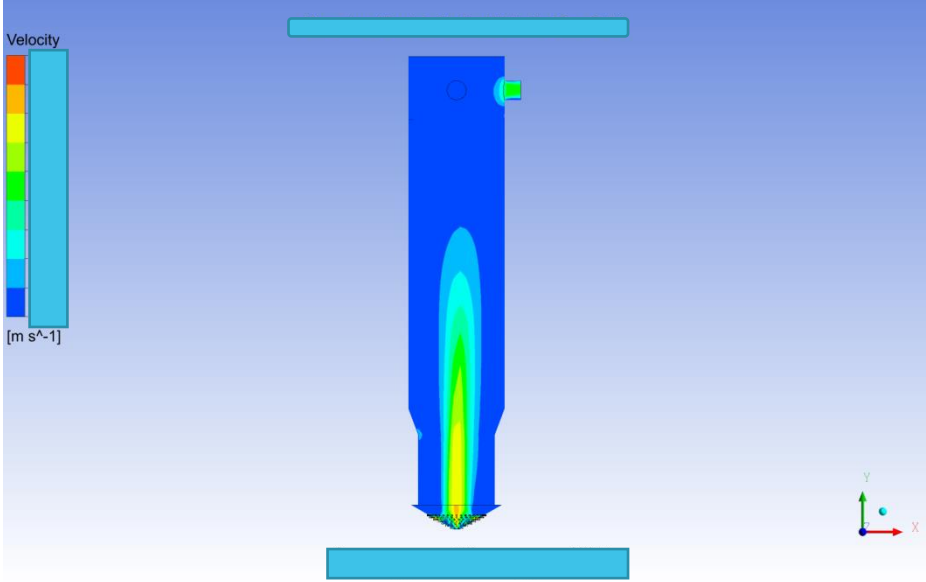
Gas only flow with Fluent: Large central plume, velocity above terminal velocity

# Proposal #2: Look at Design



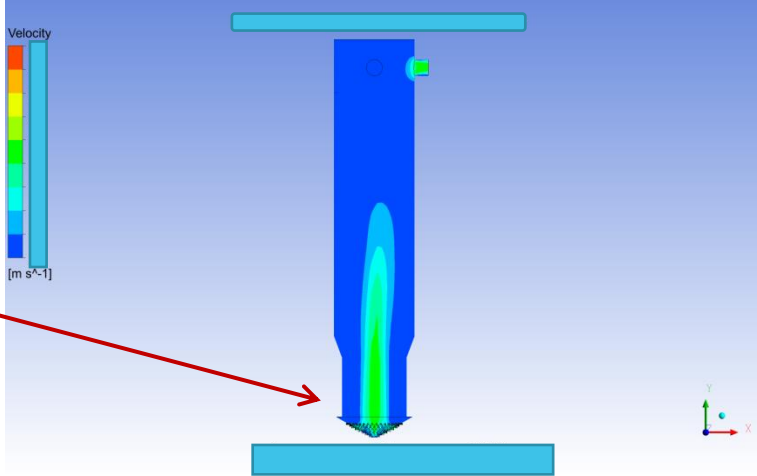
Task: Reduce the height and intensity of central plume, while retaining bottom design

# Alternate Designs



Increased hole diameter

Increased hole diameter + added rows



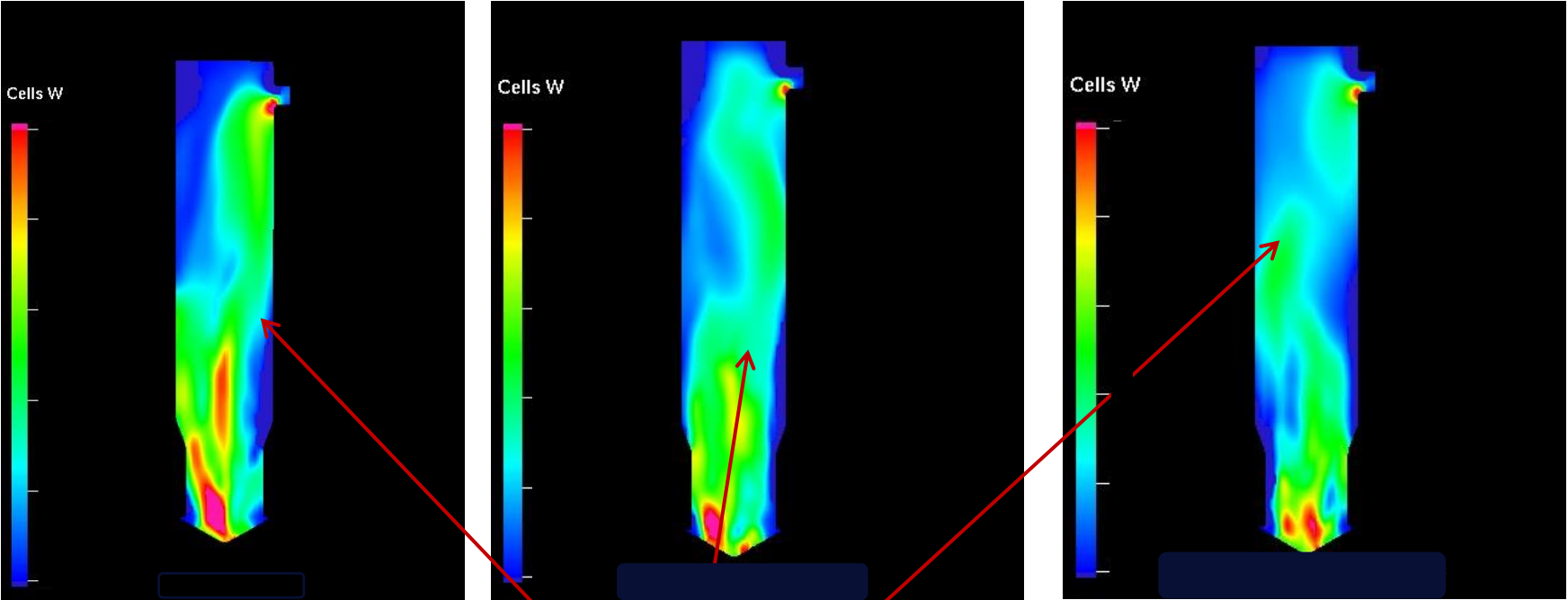


# Alternate Designs

Existing

Larger Holes (LH)

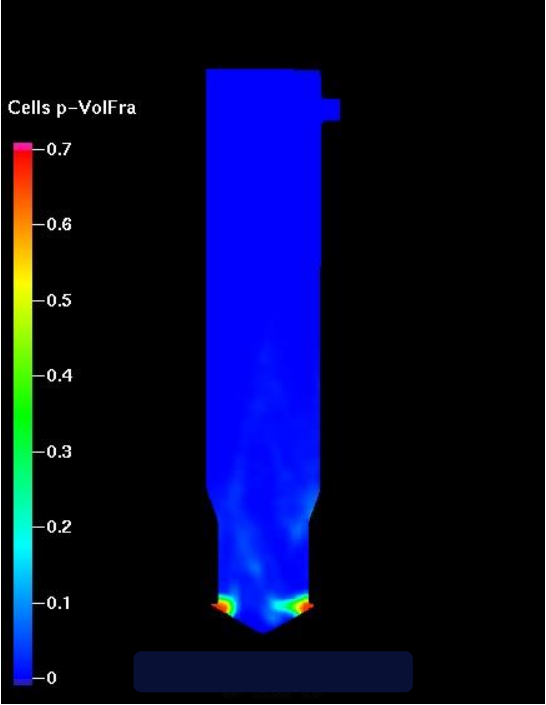
Larger Holes + Additional Row (LH+NR)



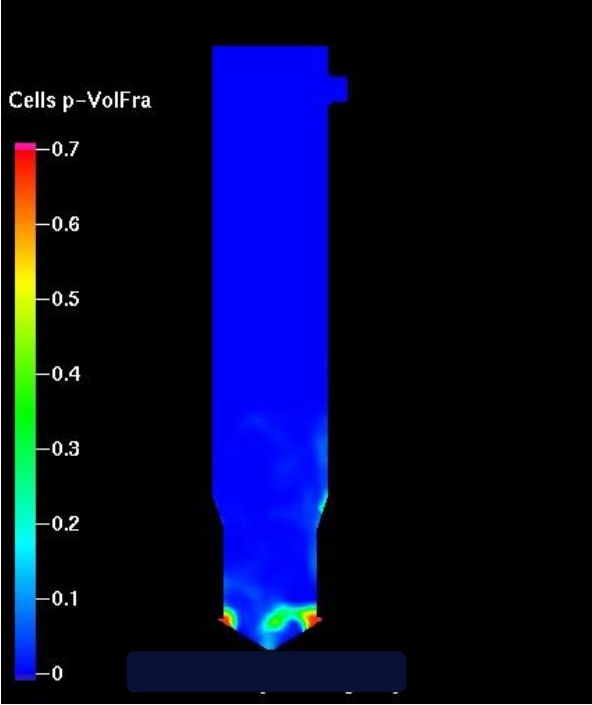
Areas above superficial velocity

# Alternate Designs – Volume Fractions

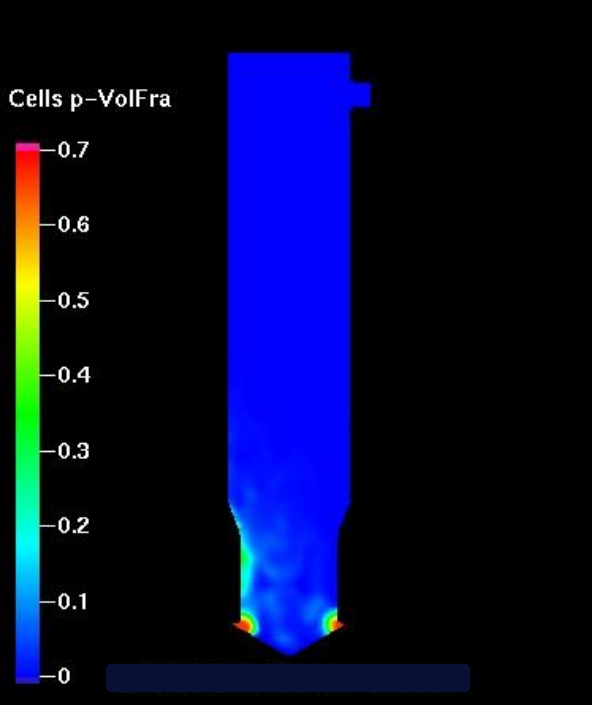
Existing



Larger Holes

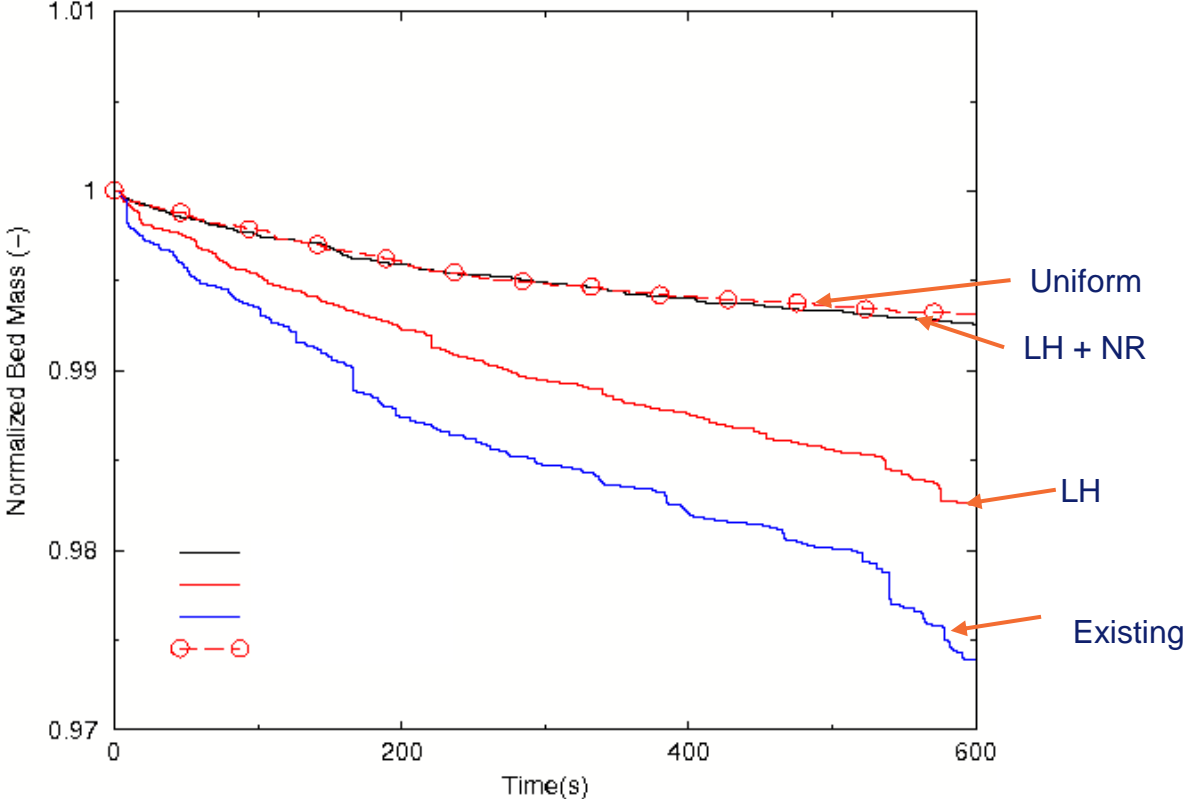


Larger Holes + Additional Row



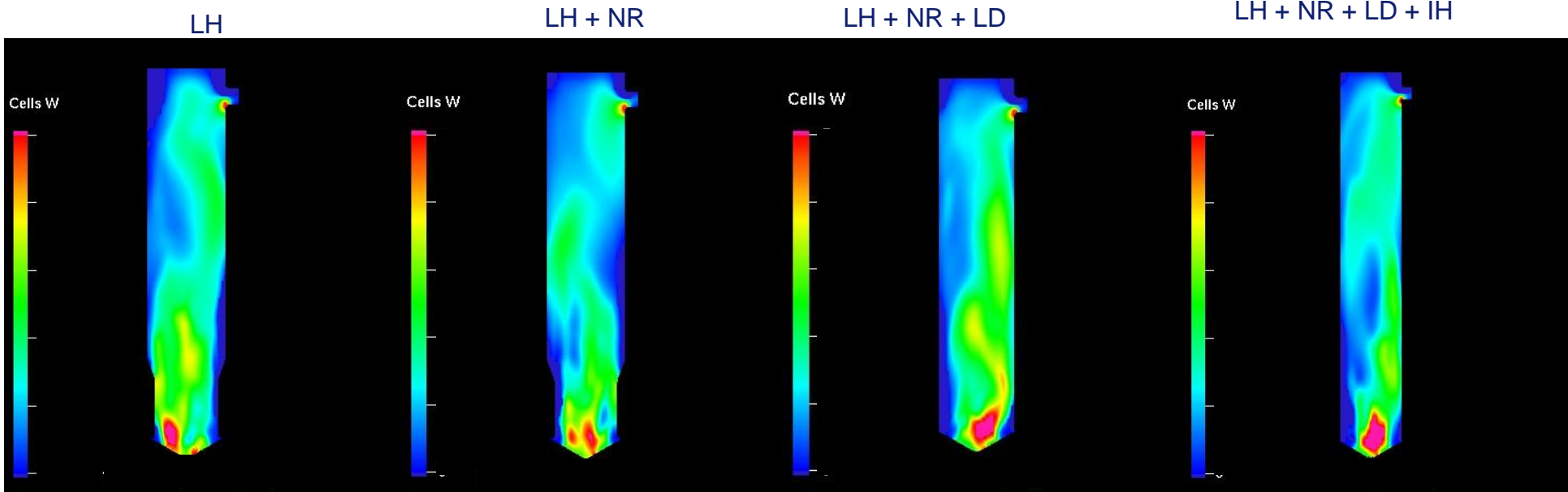
# Alternate Designs – Entrainment Comparison

Normalized Bed Mass vs Time

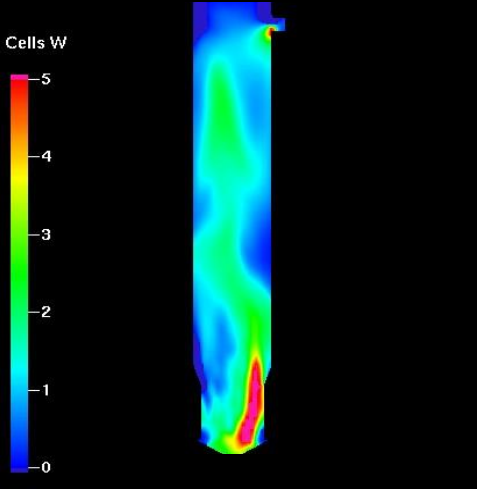


Key:  
LH: larger holes  
NR: new row

# Additional Designs



Key:  
LH: larger holes  
NR: new row  
LD: larger diameter  
IH: increased height



LH + NR + IH

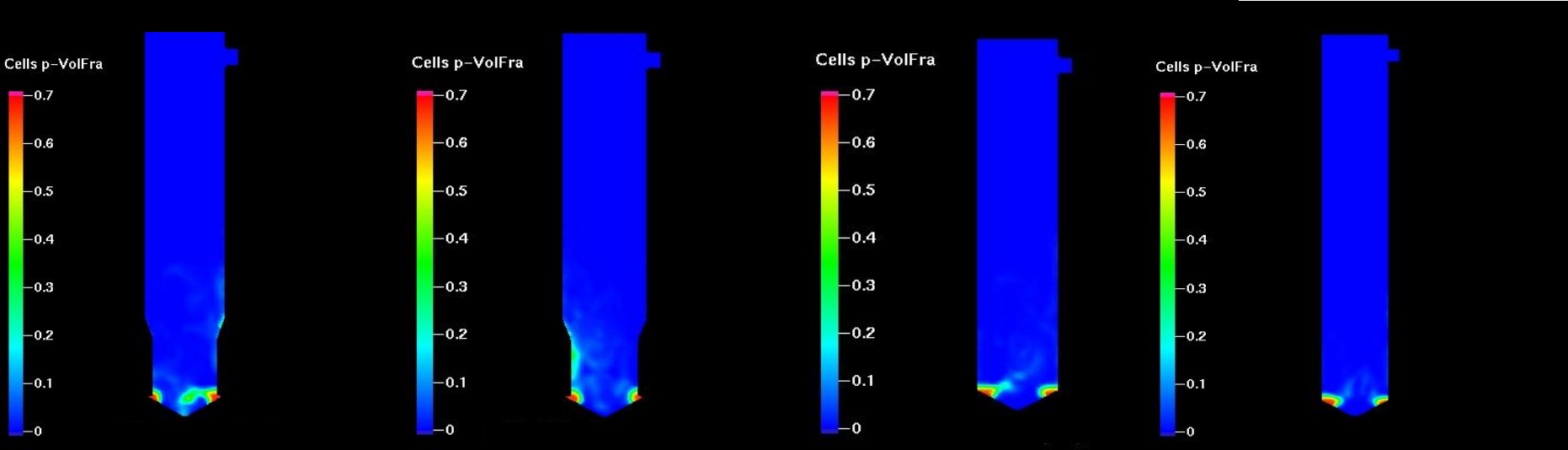
# Additional Designs

LH

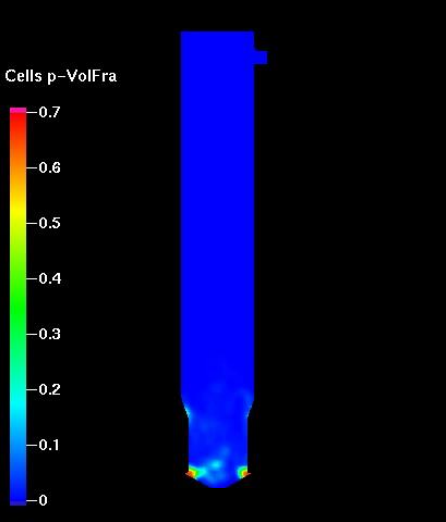
LH + NR

LH + NR + LD

LH + NR + LD + IH

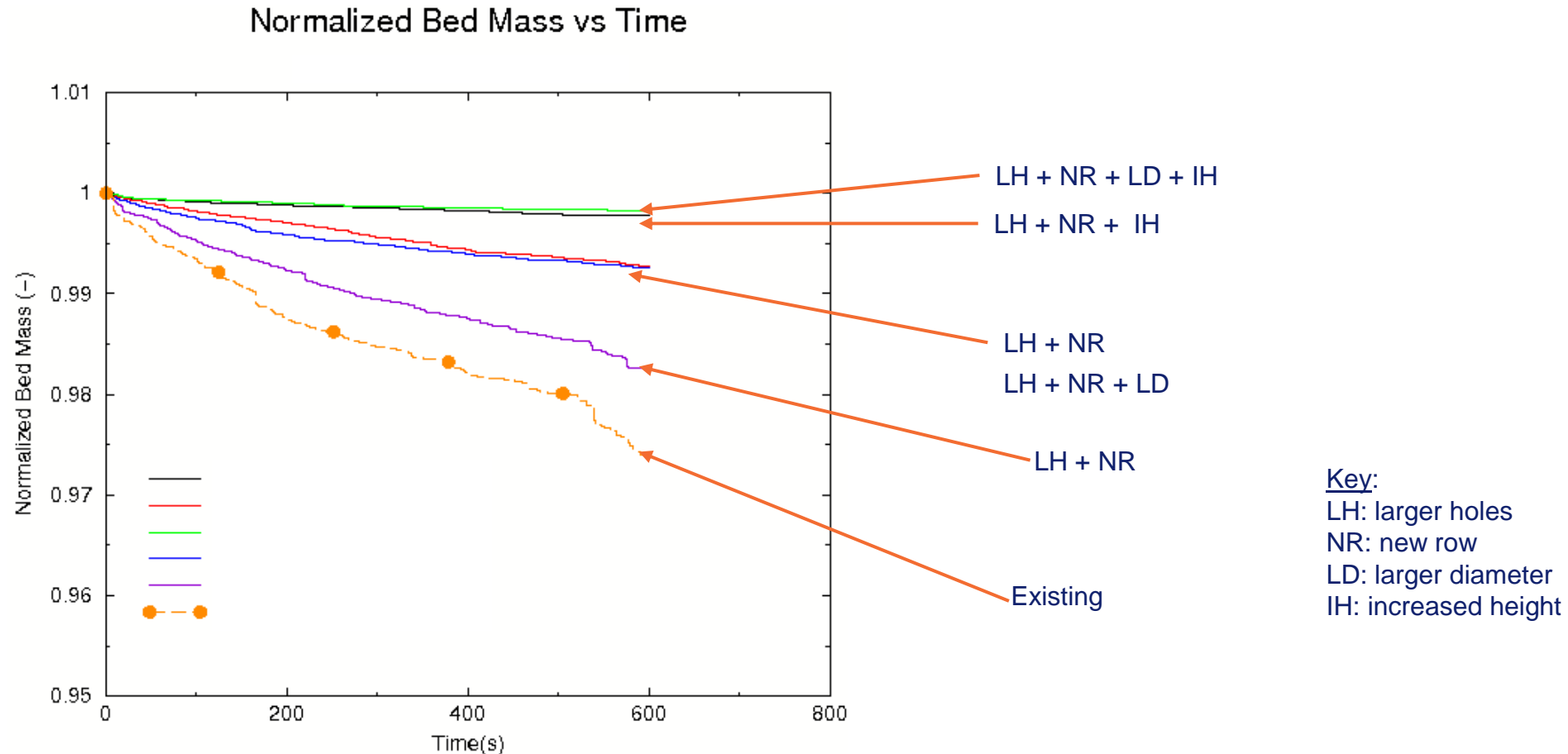


Key:  
LH: larger holes  
NR: new row  
LD: larger diameter  
IH: increased height



LH + NR + IH

# Additional Designs – Entrainment Comparison

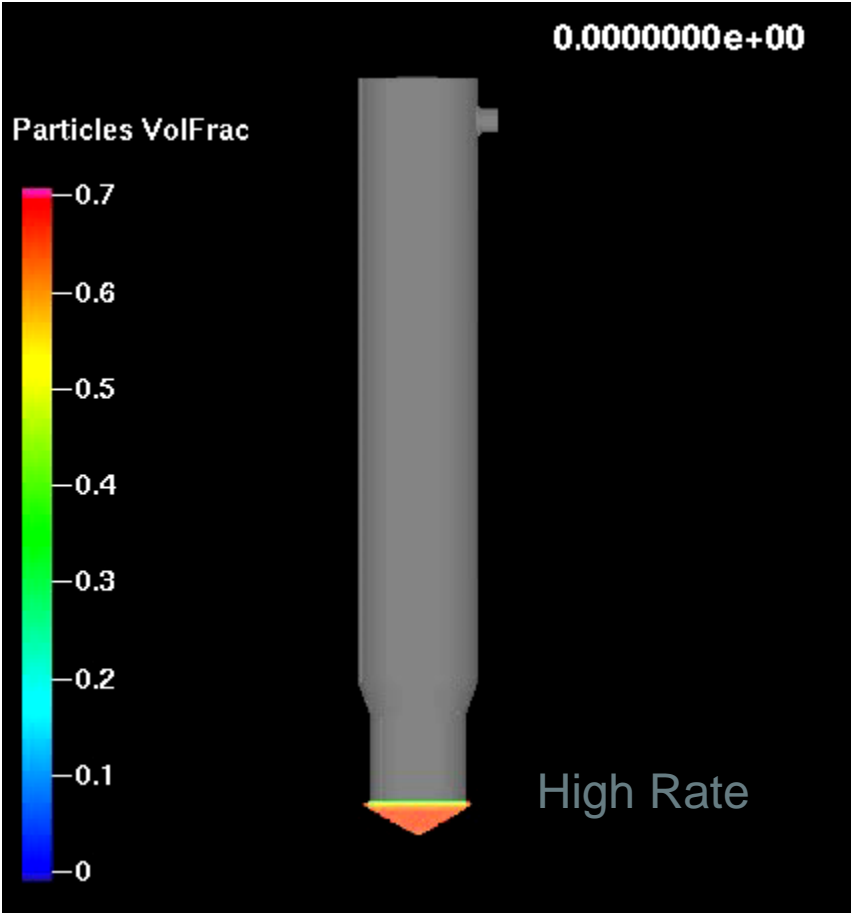
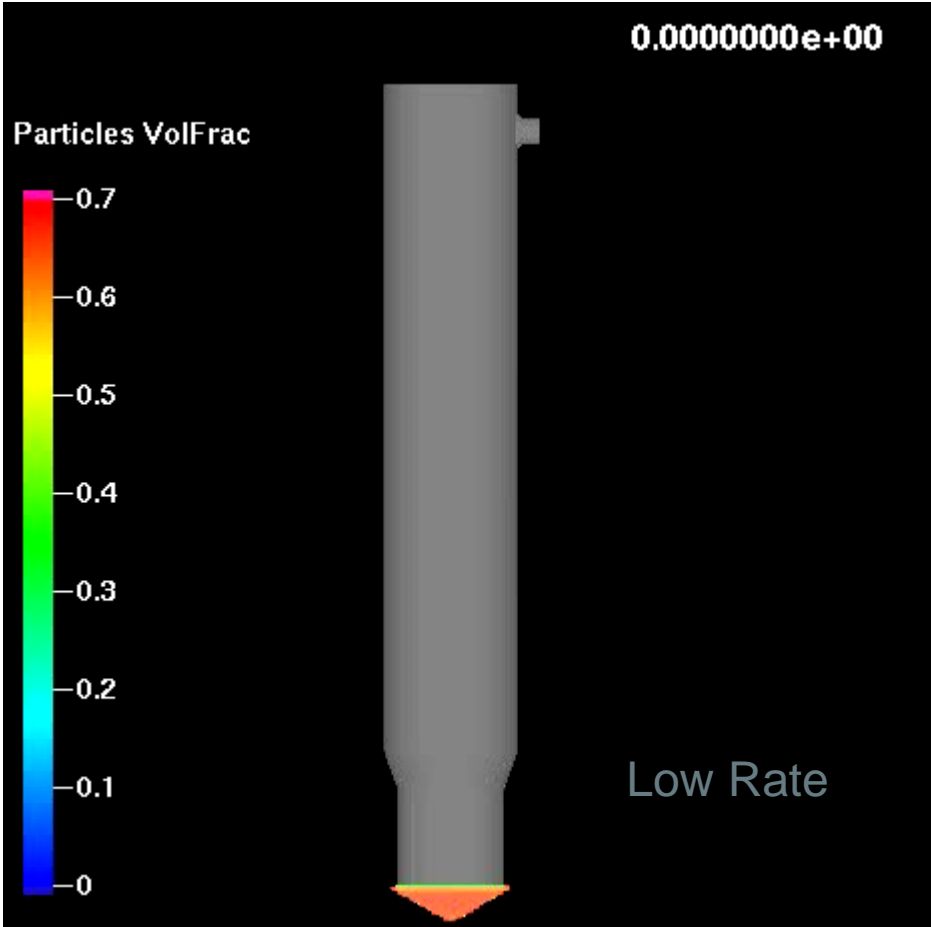


Increased diameter has less effect than increased height

# Recommendations & Outcome

- Distributor design contributes to increased entrainment
- Denser/larger media is better than standard media
- Larger holes + extra row reduces entrainment by reducing height of central plume
- Increasing hearth diameter has same effect as increasing hole size
- Increasing the height provides lowest entrainment rate
- Implemented in plant: larger holes + additional row + increased height
- Reduction of entrainment > 80%
- Substantial reduction in oxidizer downtime

# Recommendations & Outcome





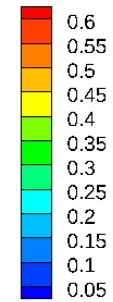
# Observations

- Project took ~ 2 months
- GPU capability of CPFDF allowed for rapid iteration of designs
- Injection BC capability provides for more realistic boundary conditions
- Request:
  - Ability to see injection points after grid is generated & .csv file read in
  - No need to run a single time-step first

# Chlorinator Entrainment

- Changes:
  - Geometry
  - Ore & coke feed
  - Distributor design
  - Start-up procedures
  - Effect of PSD
- Resulted > 1% reduction in losses

Particle Volume Fraction



999.80 s

