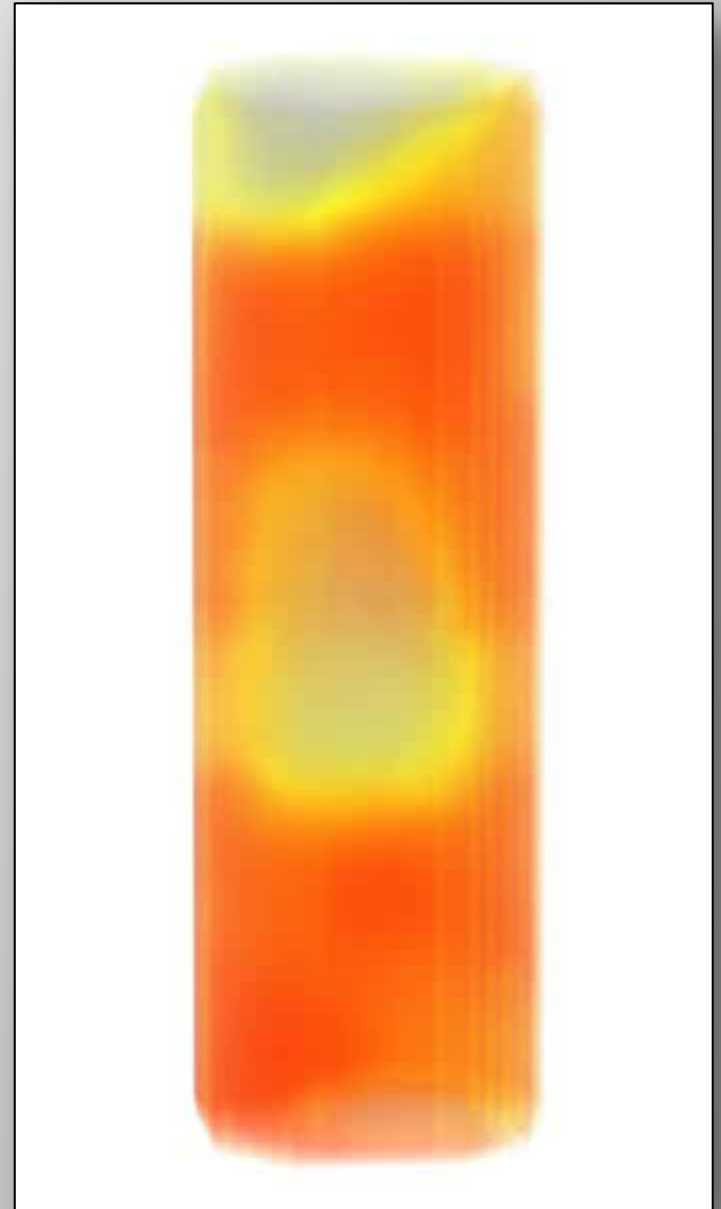




Distributor Plate Modeling with CPFD's Barracuda, Compared to ECVT

**Justin Weber, Ky Layfield,
Dirk Van Essendelft, Joseph Mei**

August 7, 2013



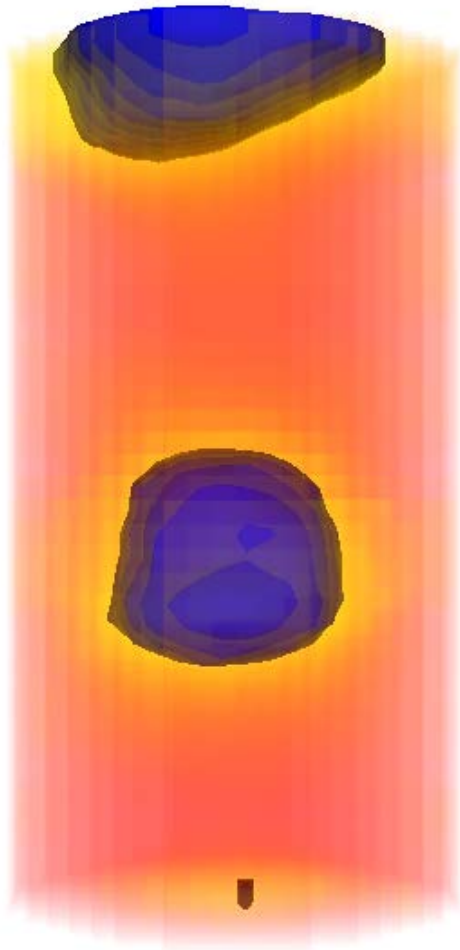
U.S. DEPARTMENT OF

ENERGY

**National Energy
Technology Laboratory**

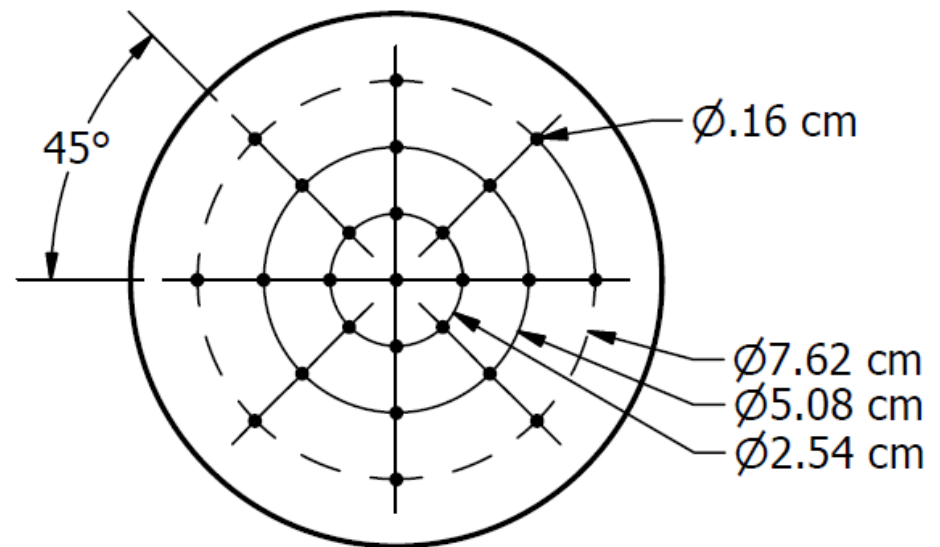
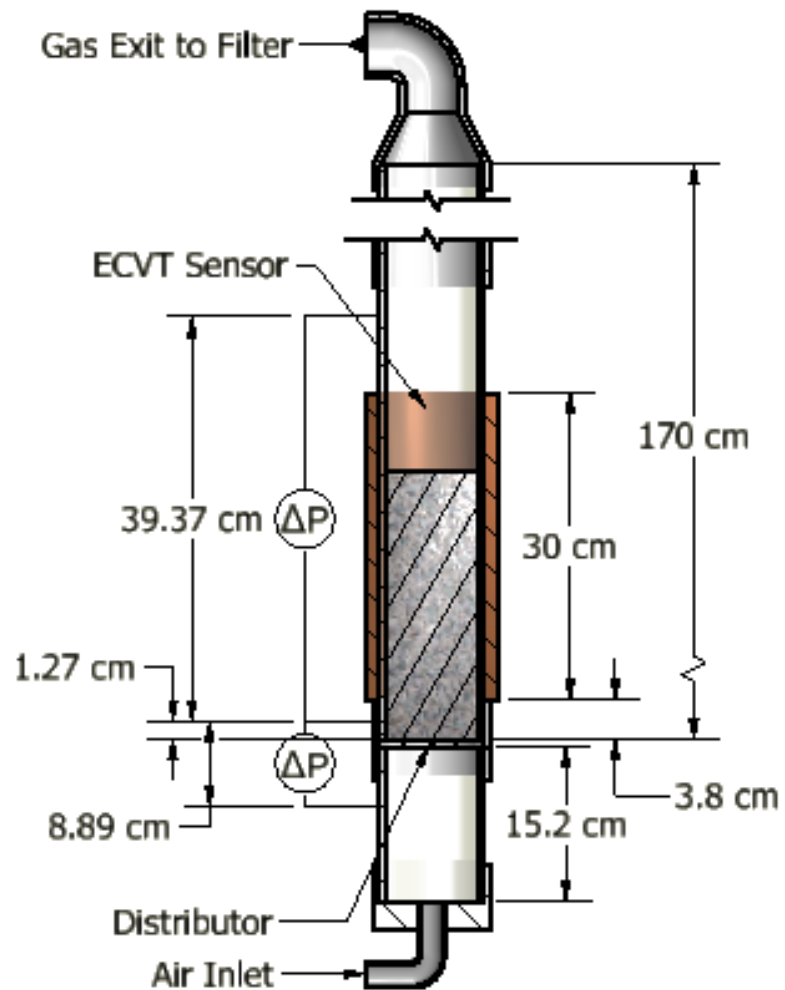
the ENERGY lab

Outline

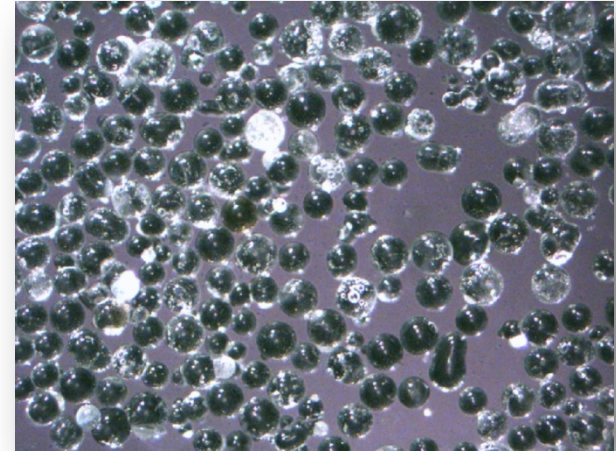
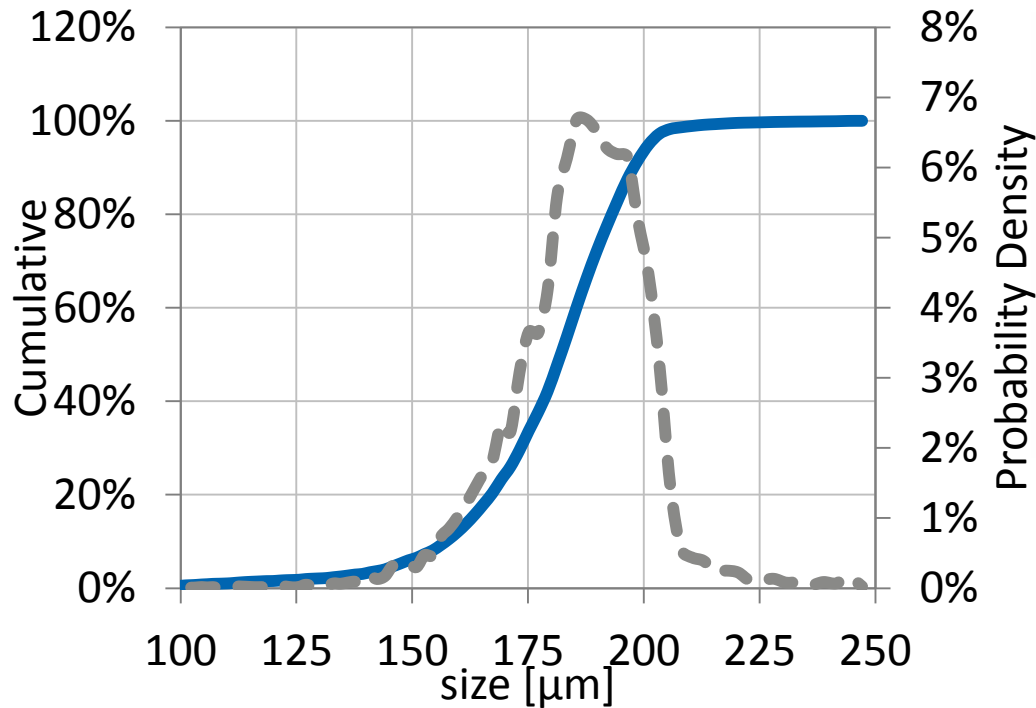


- **Experiment**
- **Electrical Capacitance Volume Tomography**
- **Computational Models**
- **Comparison**

Experiment: Geometry



Experiment: Particles



- Density: 2.48 g/cm^3
- Mean: 185 μm
- Sphericity: 0.98
- U_{mf} : 3.18 cm/s

Static Bed Height: 26.2cm

$U_g/U_{mf}=4$, or specifically 12.68 cm/s

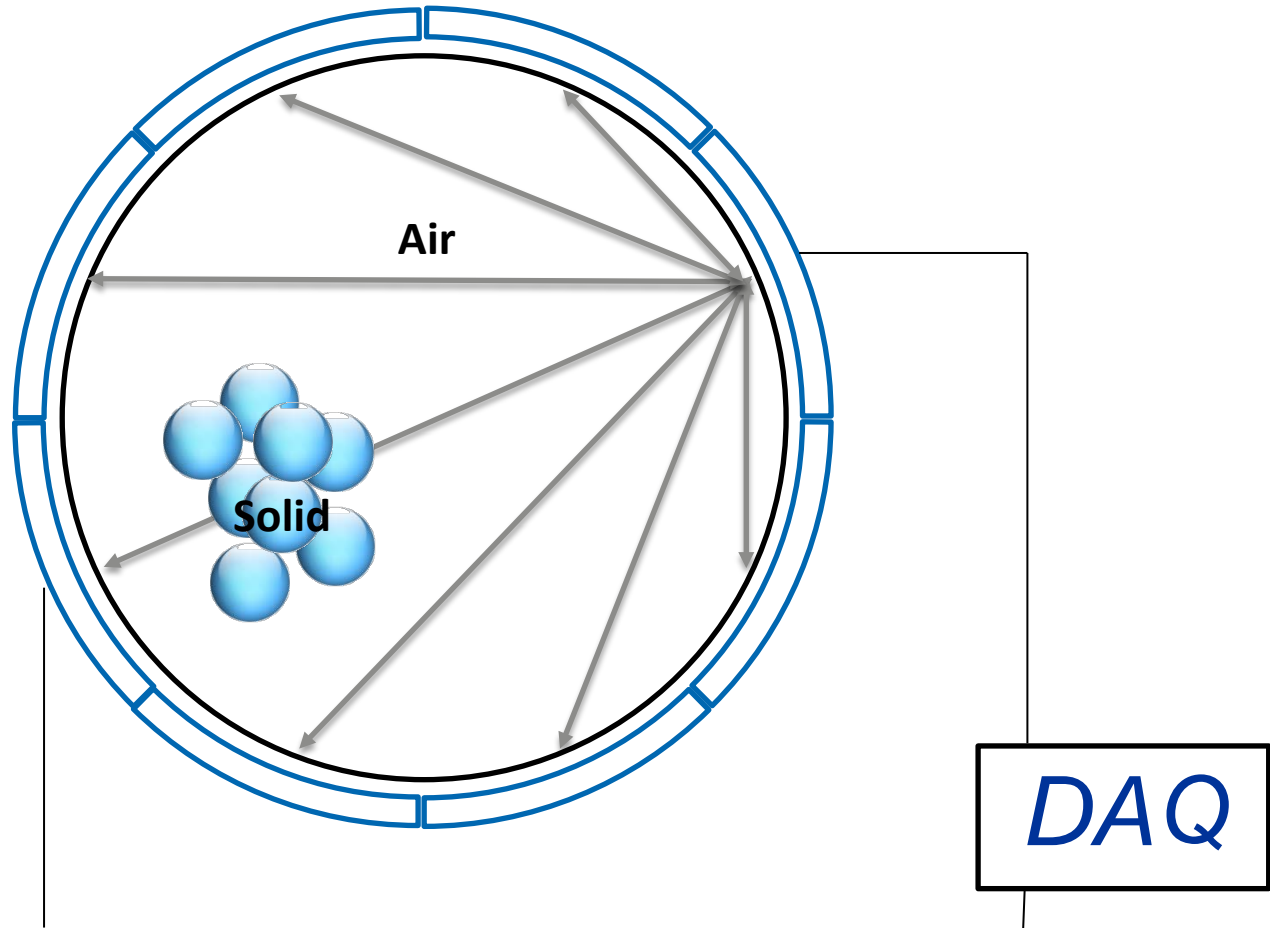
Electrical Capacitance Tomography [ECT]

Relative permittivity

Air ≈ 1

Polyethylene ≈ 2.25

Glass ≈ 4.7



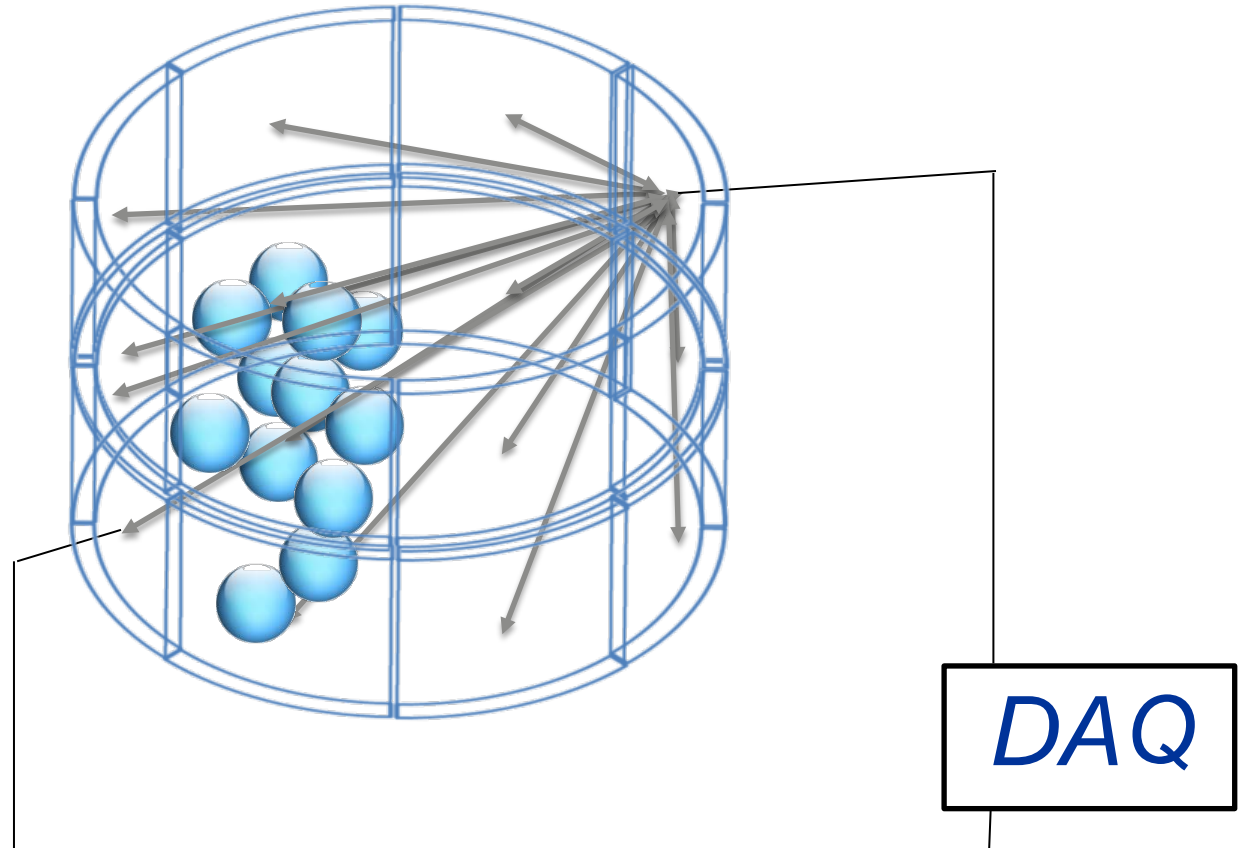
Electrical Capacitance Volume Tomography [ECVT]

Relative permittivity

Air ≈ 1

Polyethylene ≈ 2.25

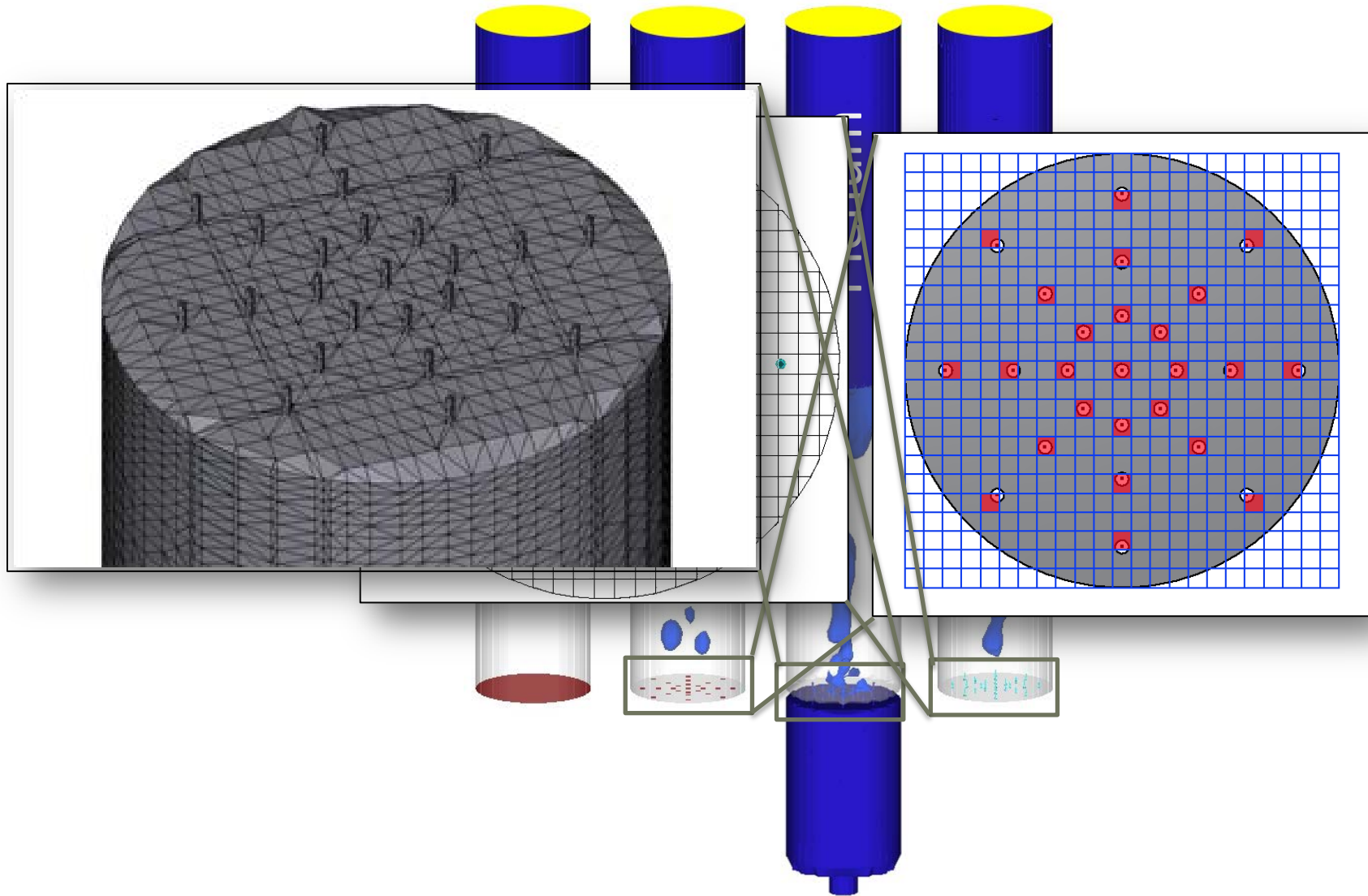
Glass ≈ 4.7



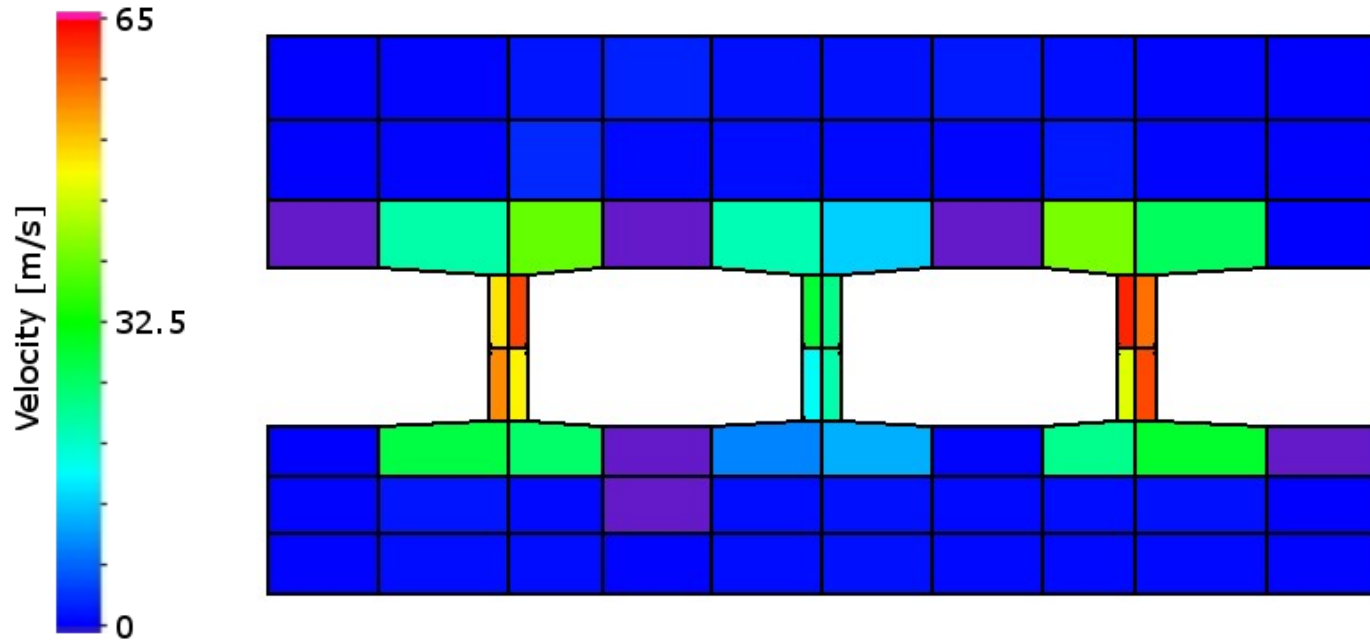
Electrical Capacitance Volume Tomography



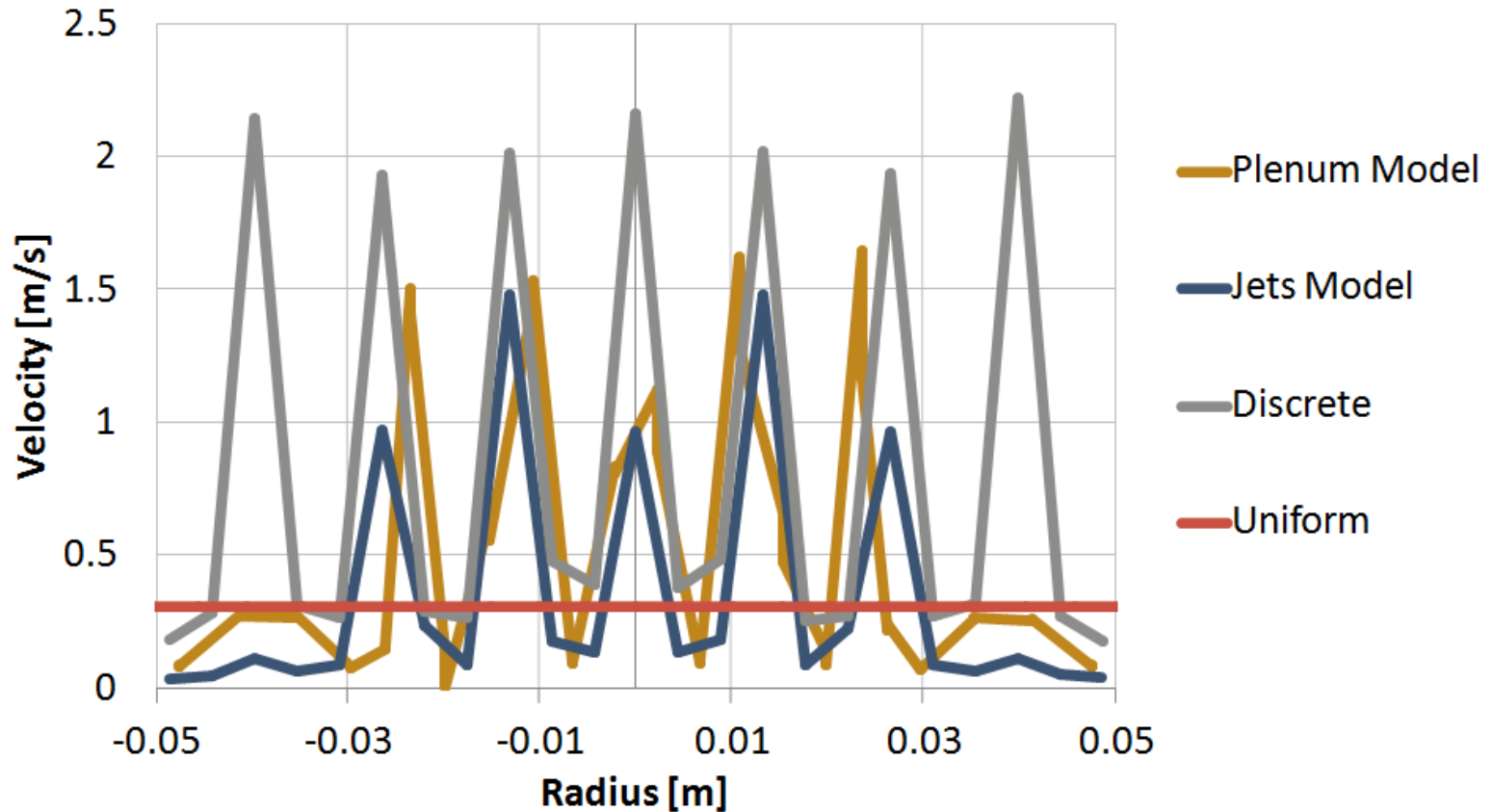
Computational Models



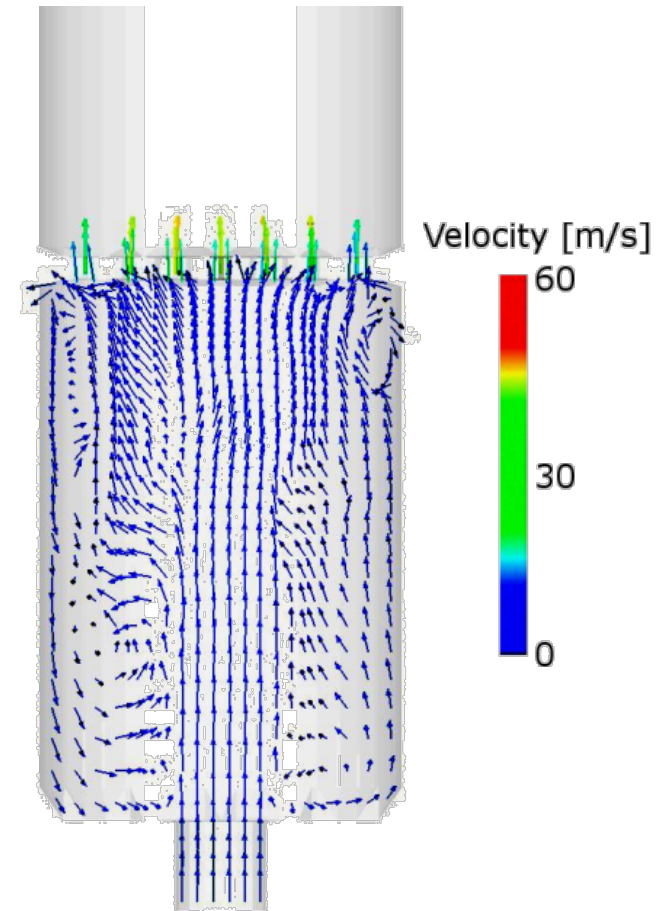
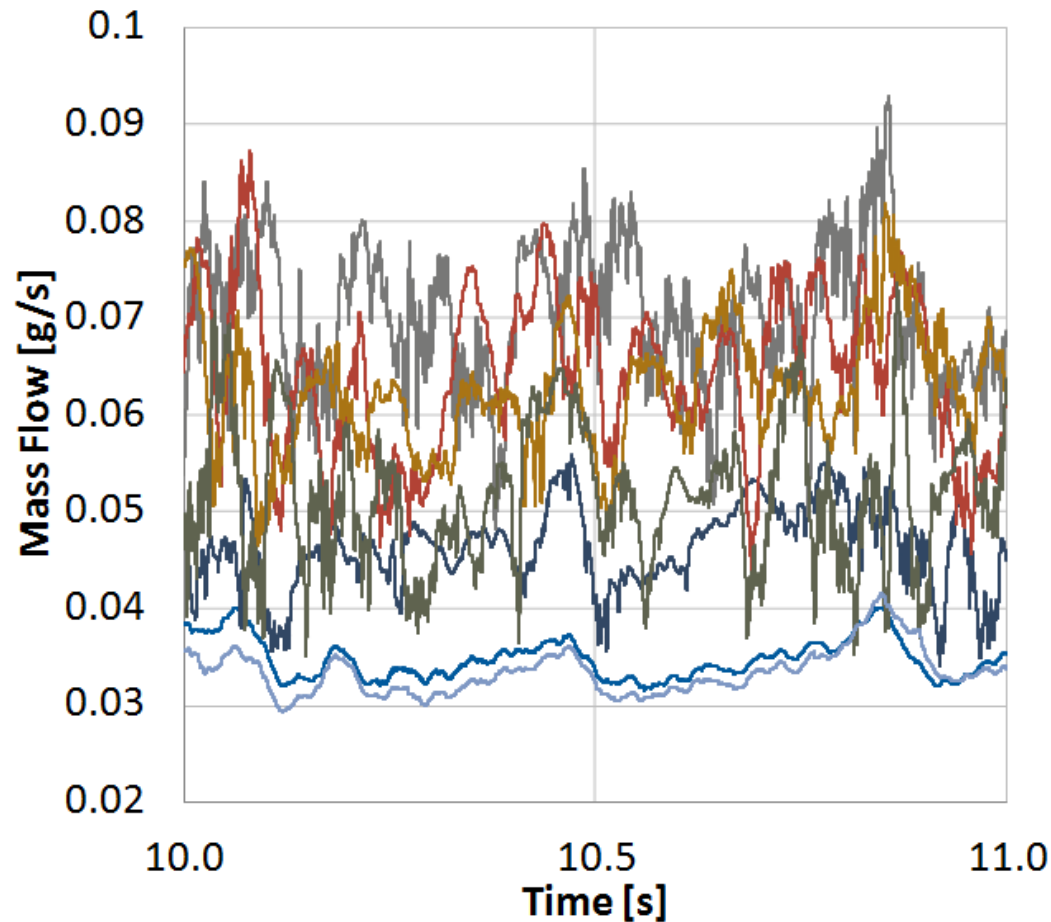
Computational Models



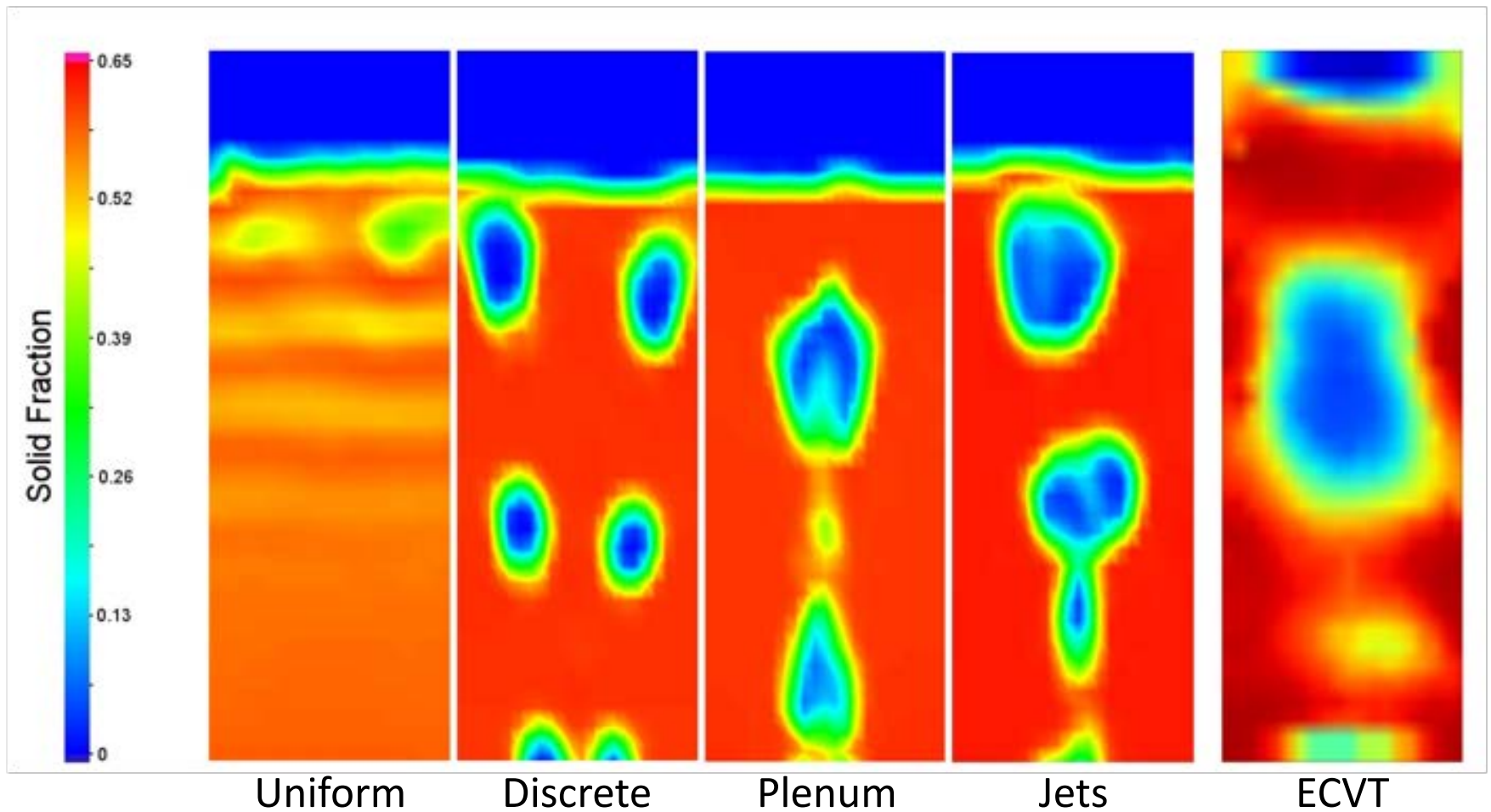
Results: Velocity Distribution



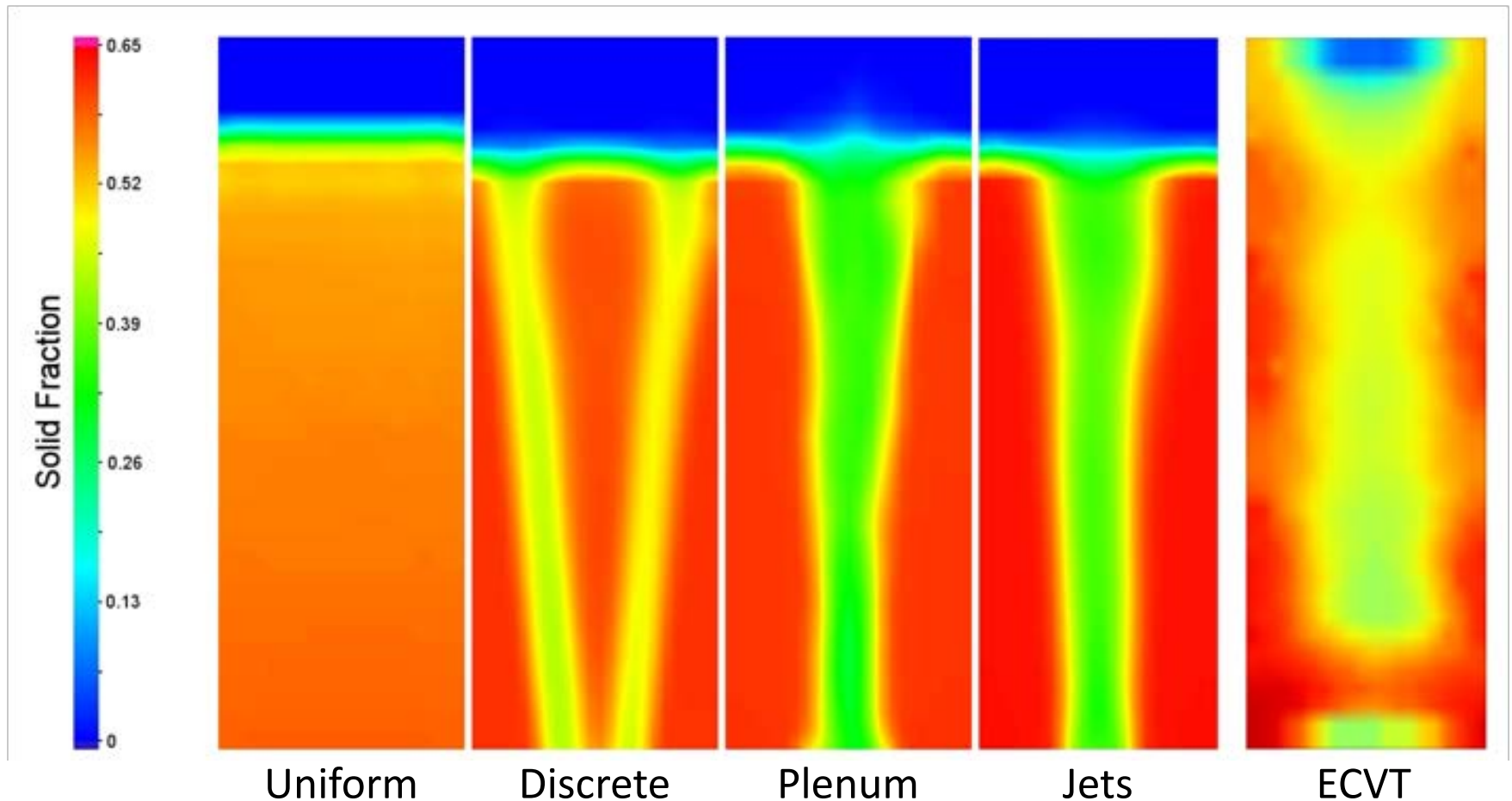
Results: Plenum Mass Flow



Results Solid Fraction

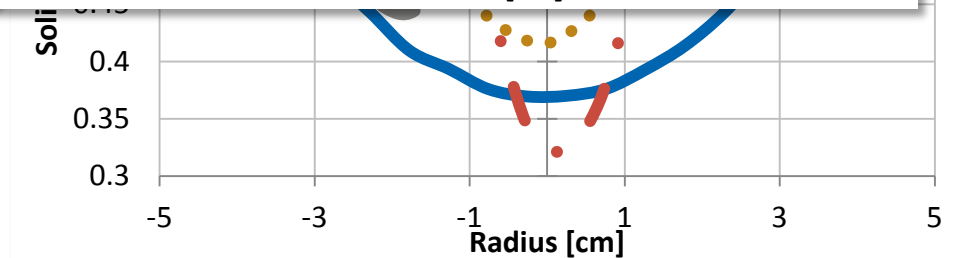
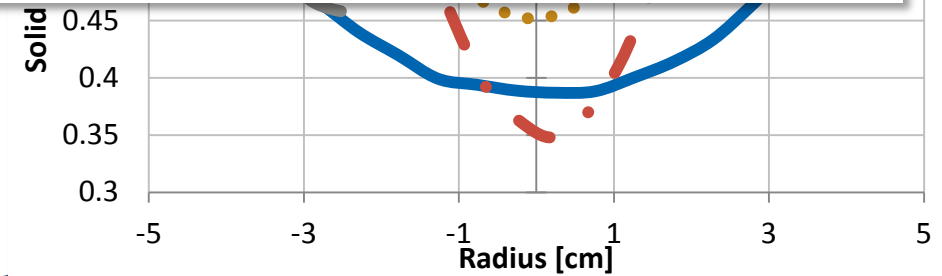
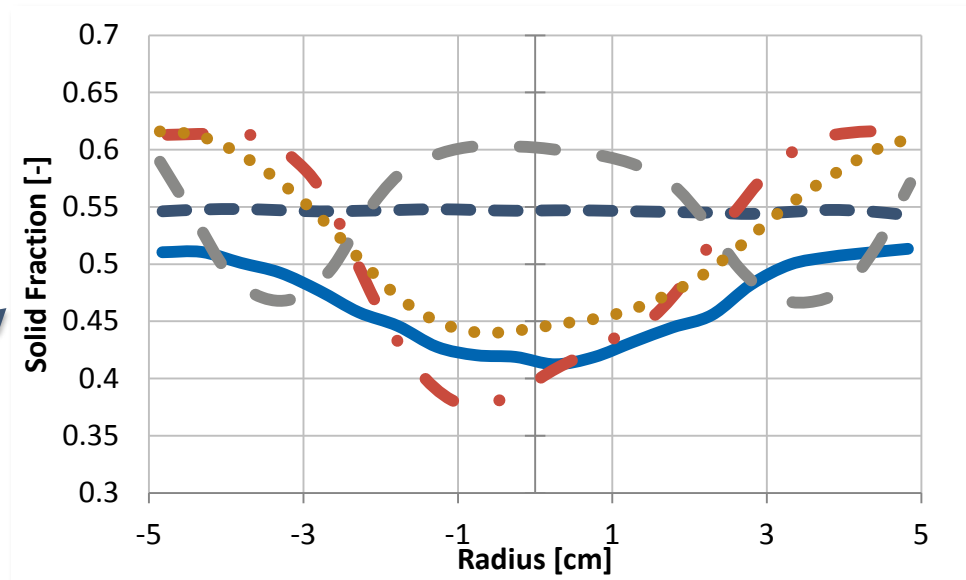
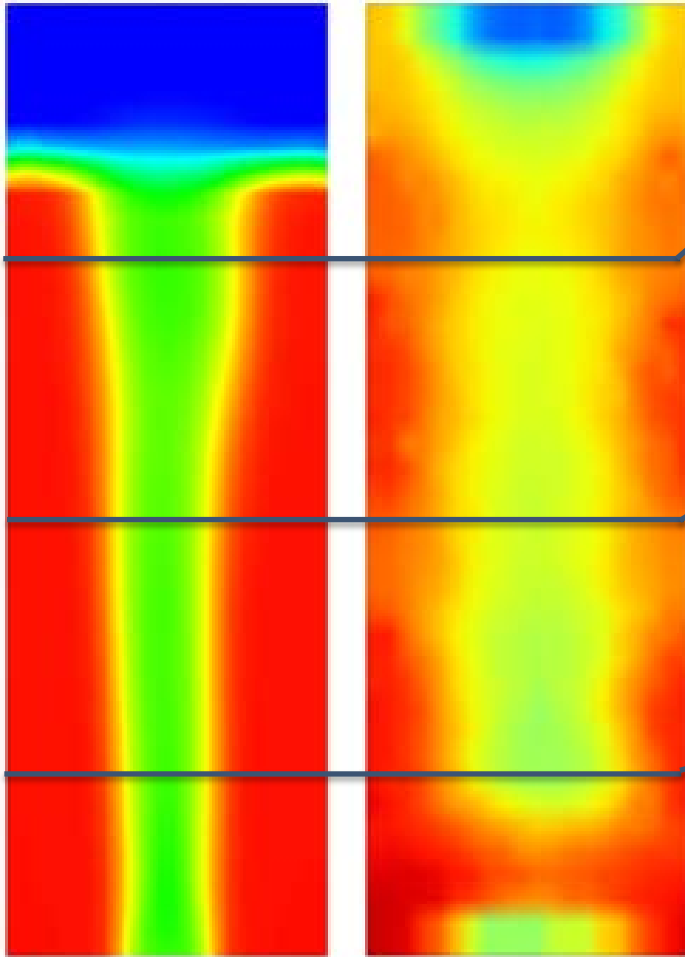


Results: Time Average Solid Fraction



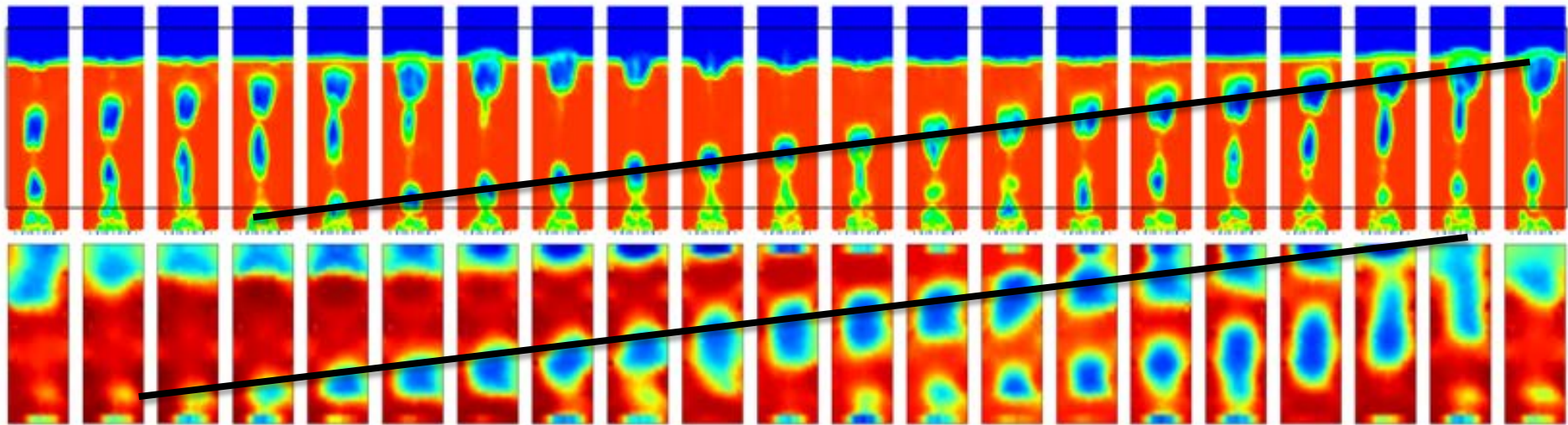
Results: Time Average Solid Fraction

ECVT Uniform Discrete
Plenum Jets



Results: Dynamics

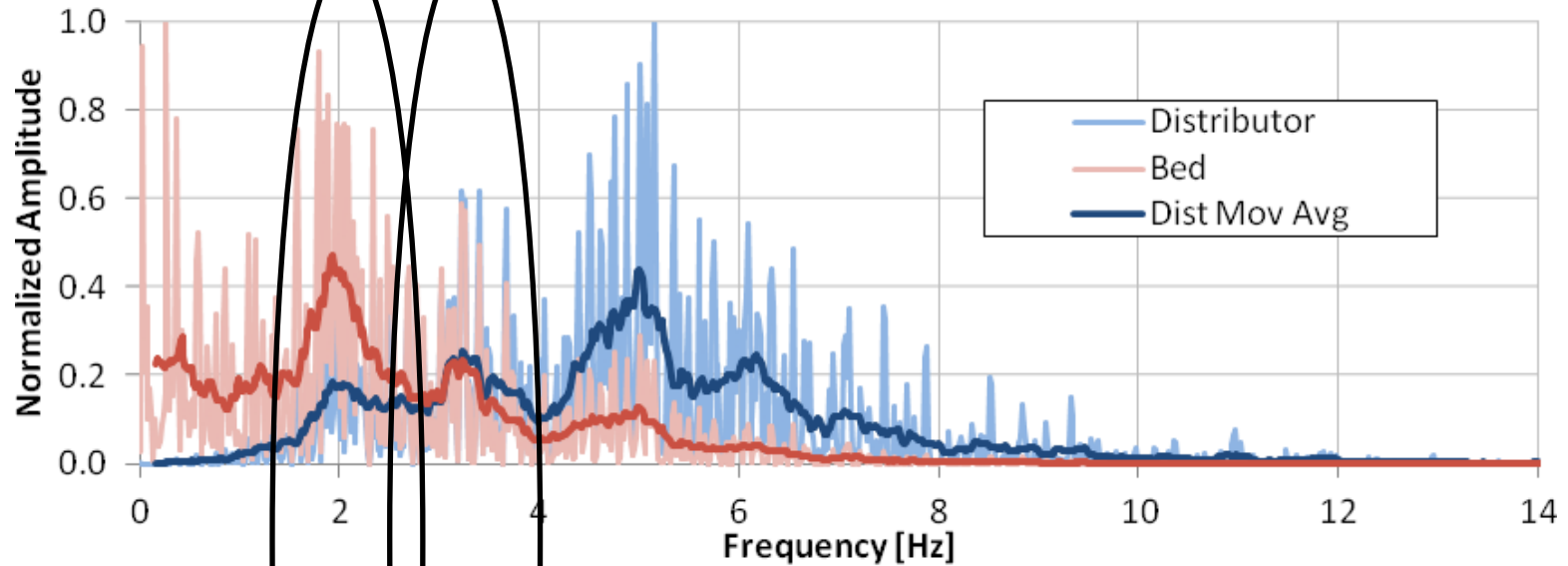
Plenum Model



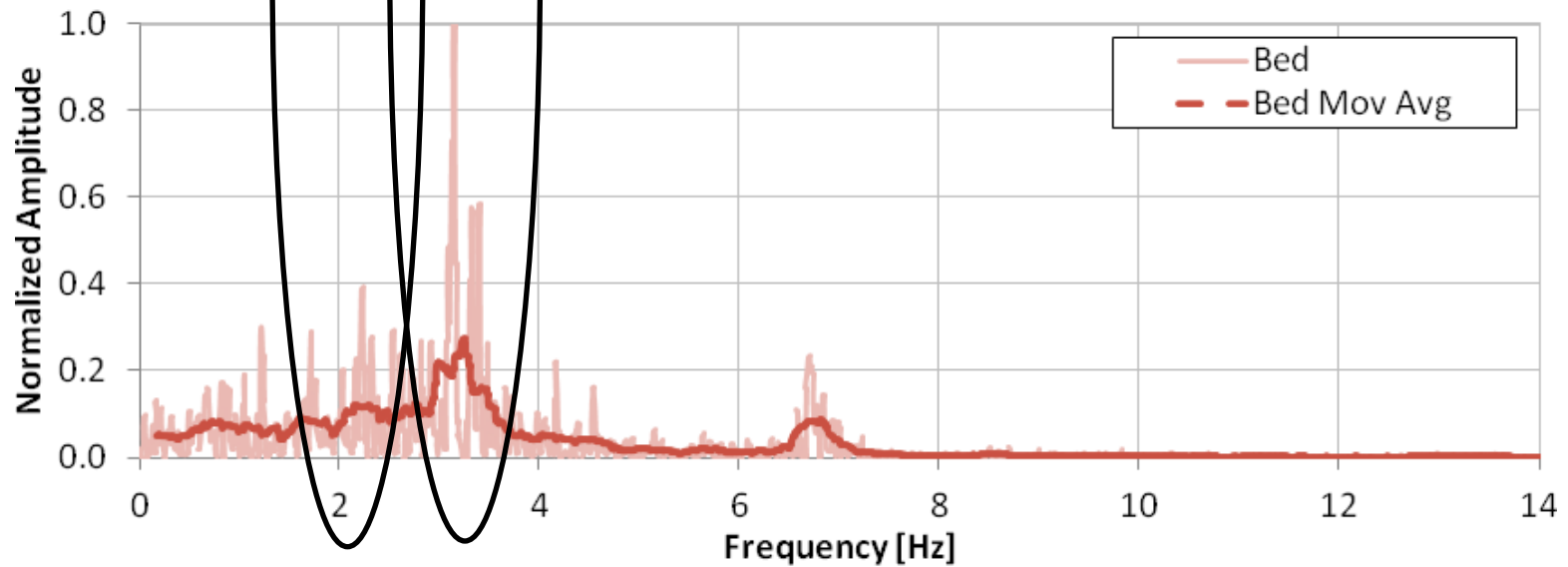
ECVT

Results: Dynamics

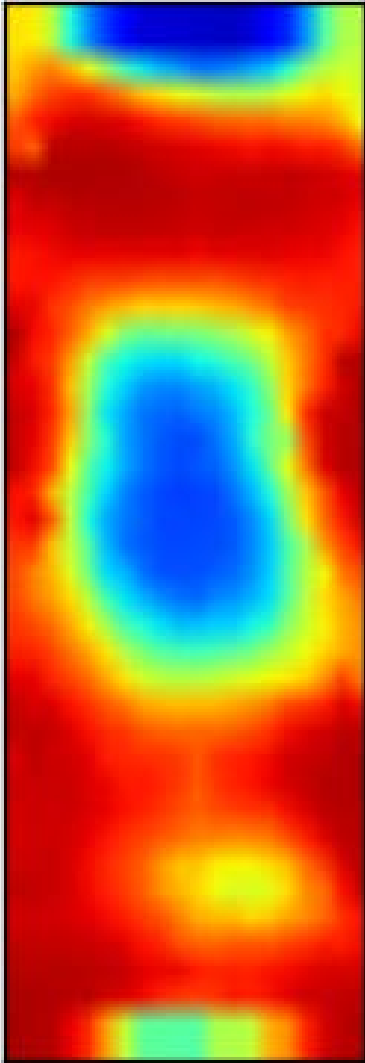
Experiment



Model



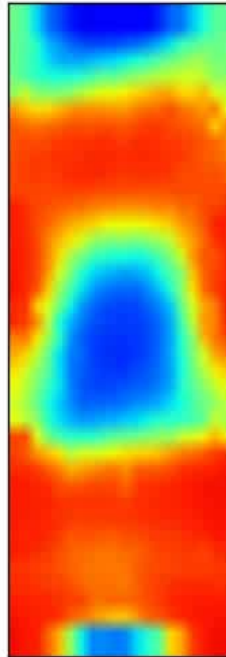
Summary



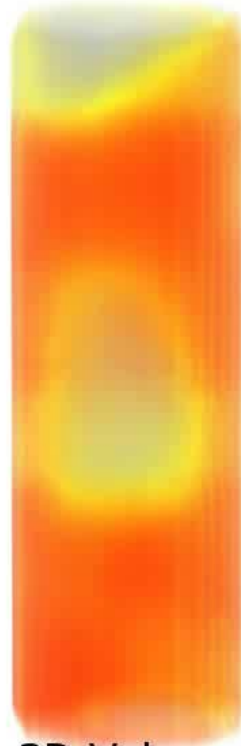
- Four CPFD Barracuda models were compared to ECVT and high speed pressure transducers.
- The plenum model compared best with the experimental data, however the slowest [1s/day].
- The jets model compared reasonably well, and was significantly faster [30s/day].
- The typical uniform distribution did not perform well at all.

Questions?

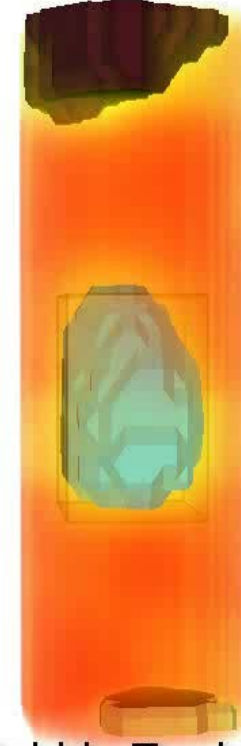
ECVT, 10cm Fluidized Bed



2D Slice



3D Volume



Bubble Tracking

Weber, J., Mei, J., “Bubbling fluidized bed characterization using Electrical Capacitance Volume Tomography (ECVT)”, Powder Technology, Volume 242, July 2013, Pages 40-50.

Weber, J., Layfield, K., VanEssendelft, D., Mei, J., “Fluid Bed Characterization Using Electrical Capacitance Volume Tomography (ECVT), Compared to Computational Particle Fluid Dynamics’s (CPFD) Barracuda”, Powder Technology. - **Submitted**

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Backup Slides

Model	Grid	Cells (Fluid)	Particles (Clouds)	Computation Time	Average Time Step
Uniform	20x20x65	26k (22k)	61M (0.5M)	63.5s/day	$2.98 \times 10^{-3}s$
Discrete	23x23x65	34k (28k)	62M (0.6M)	21.7s/day	$2.24 \times 10^{-3}s$
Plenum	22x22x107	52k (45k)	62M (0.8M)	0.98s/day	$4.01 \times 10^{-5}s$
Jets	23x23x64	33K (30k)	62M (0.6M)	29.9s/day	$2.80 \times 10^{-3}s$

	Experi ment	Models			
		Uniform	Discrete	Plenum	Jets
Distribu tor Bed	931	NA	NA	1115	NA
	3880	3982	3963	3652	3996