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Linking 3-D Electrical Tomography Imaging to Fluid Flow Patterns in an Annular Fixed-Bed Reactor

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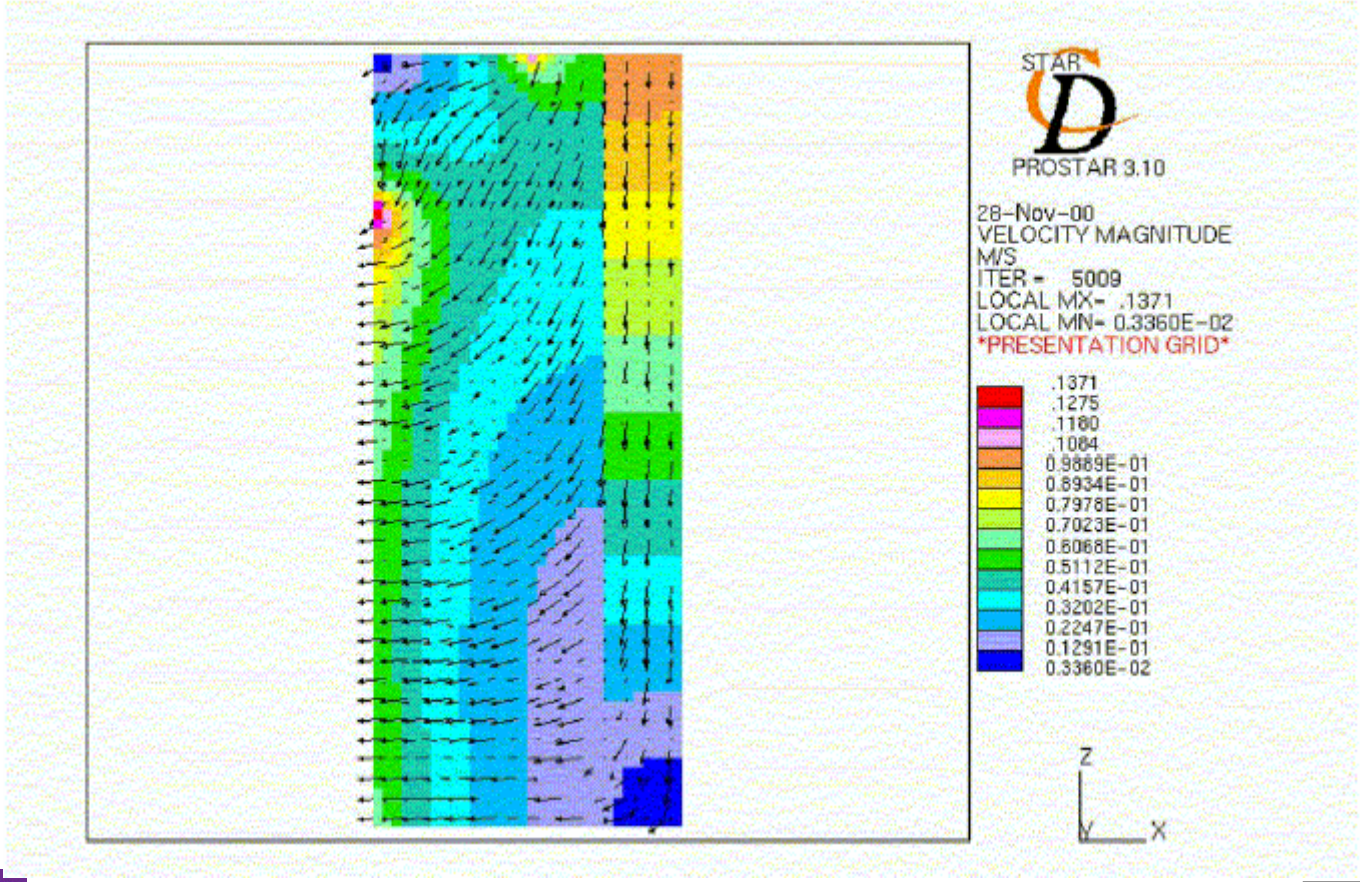
3-D Model for Annular Bed Catalytic Reactor

Contents

- Prior experimental work
- Creating a 3D model using networks-of-zones
- Some typical results
  - flow maps
  - RTD curves
  - theoretical 3D images
- Conclusions

CFD Analysis by Synetix



Flow field predicted for annular reactor

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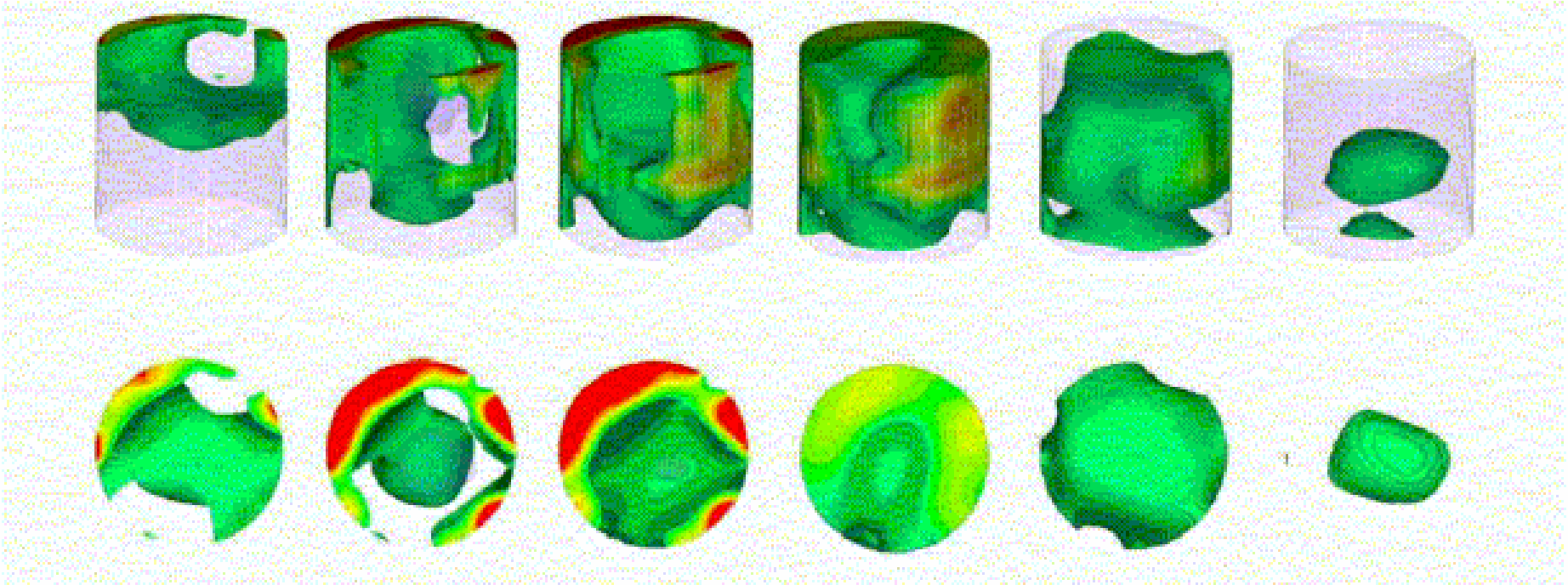
Experimental 3D tomographic images



Response to a pulse injection

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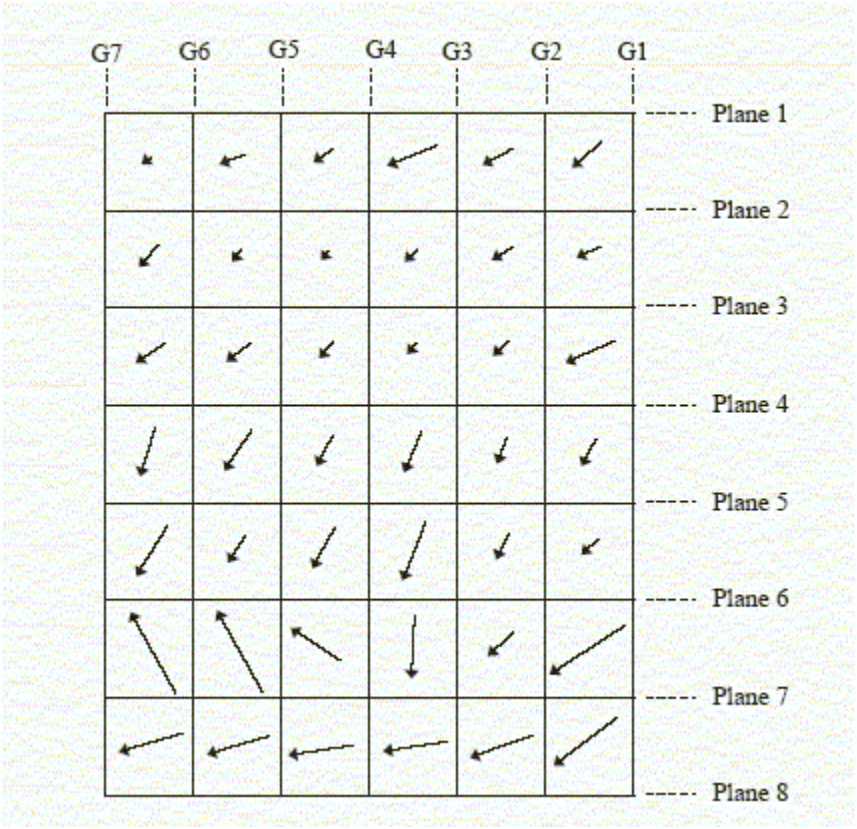
Flow map created from experimental images



Velocity vectors from differentiating tomographic fronts

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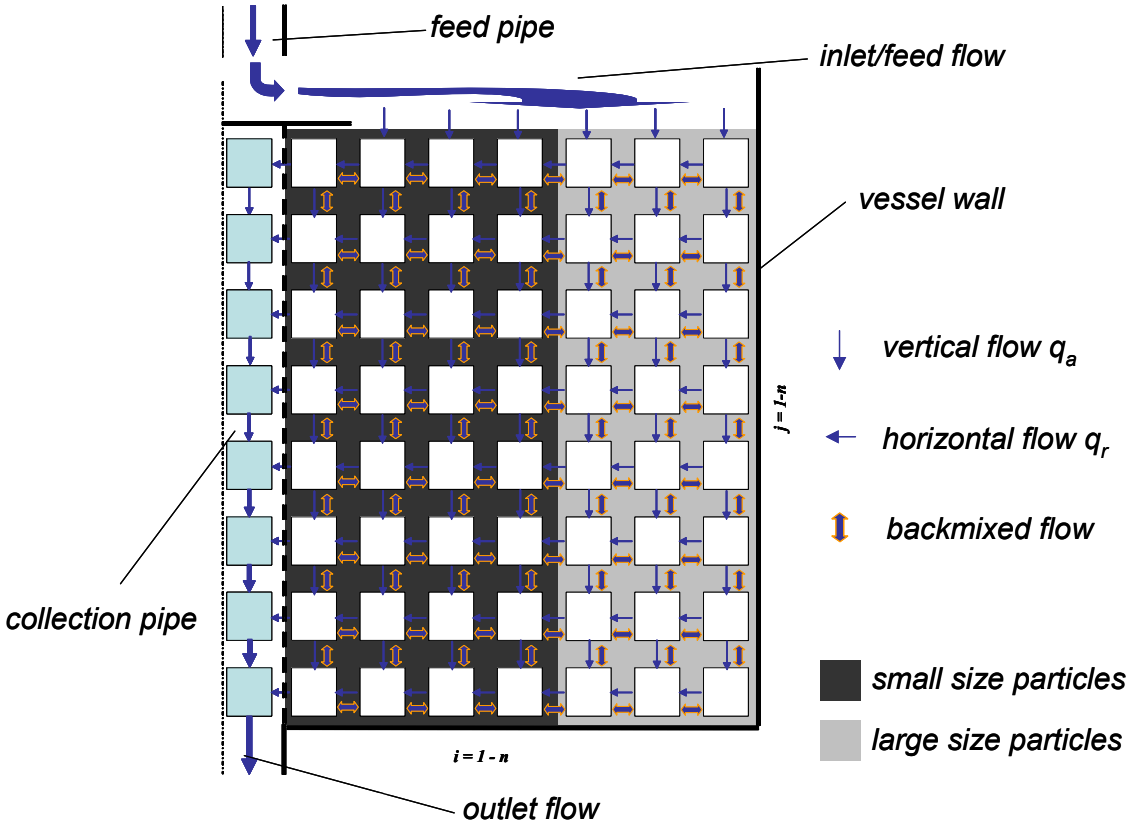
3D network of zones model



Networks-of-zones flow configuration for the annular fixed-bed reactor

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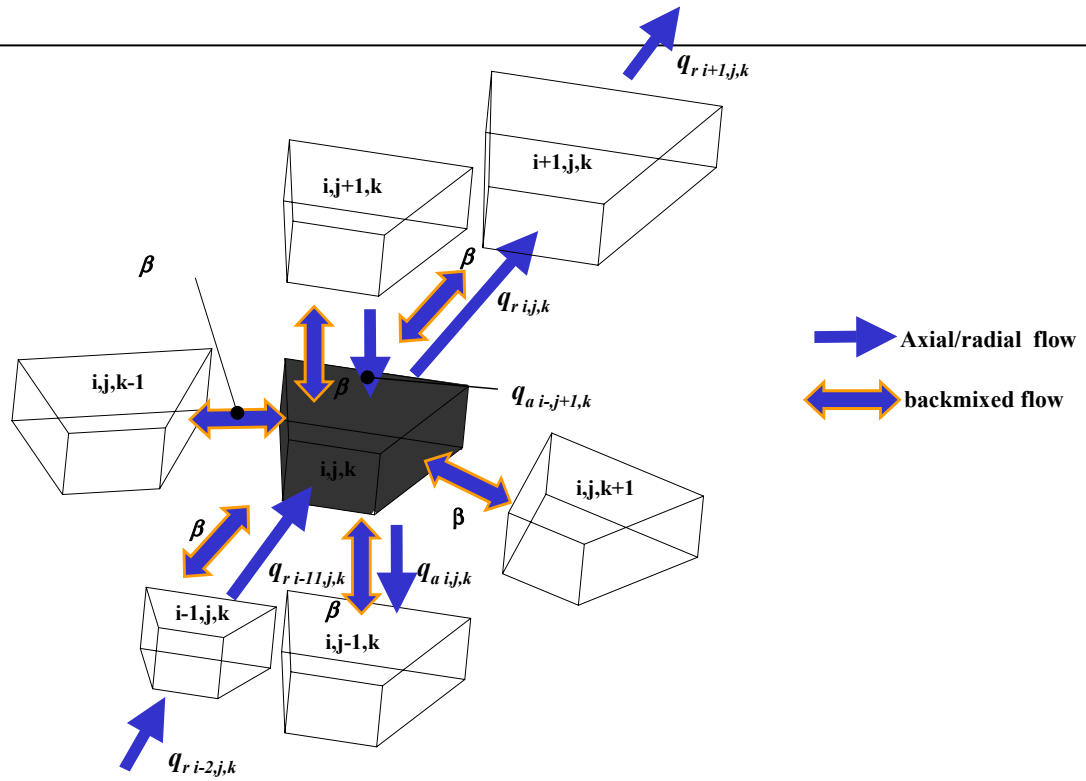
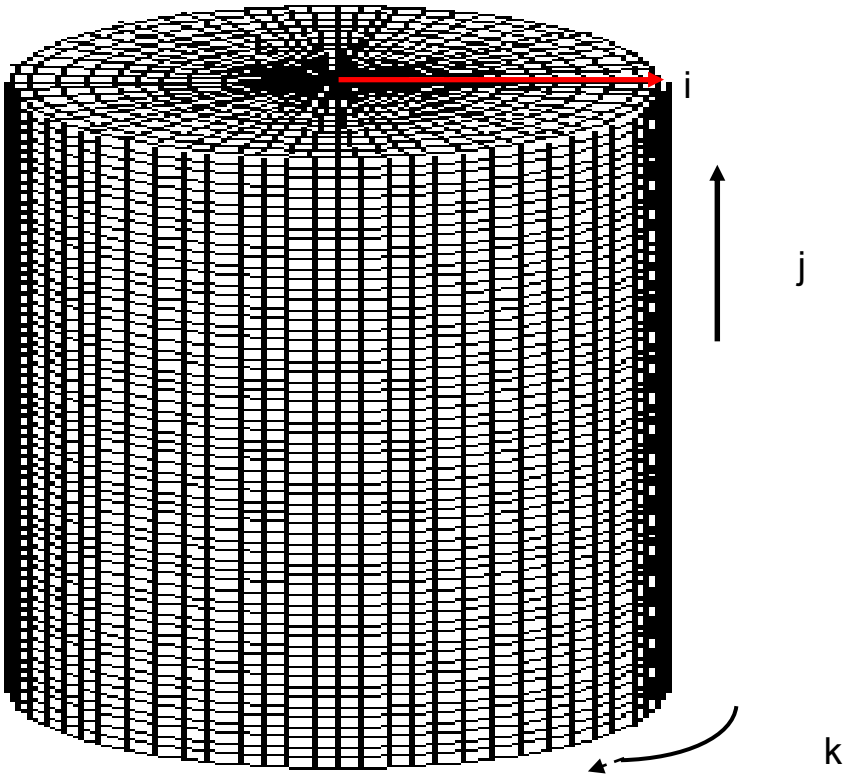
Flows around each zone



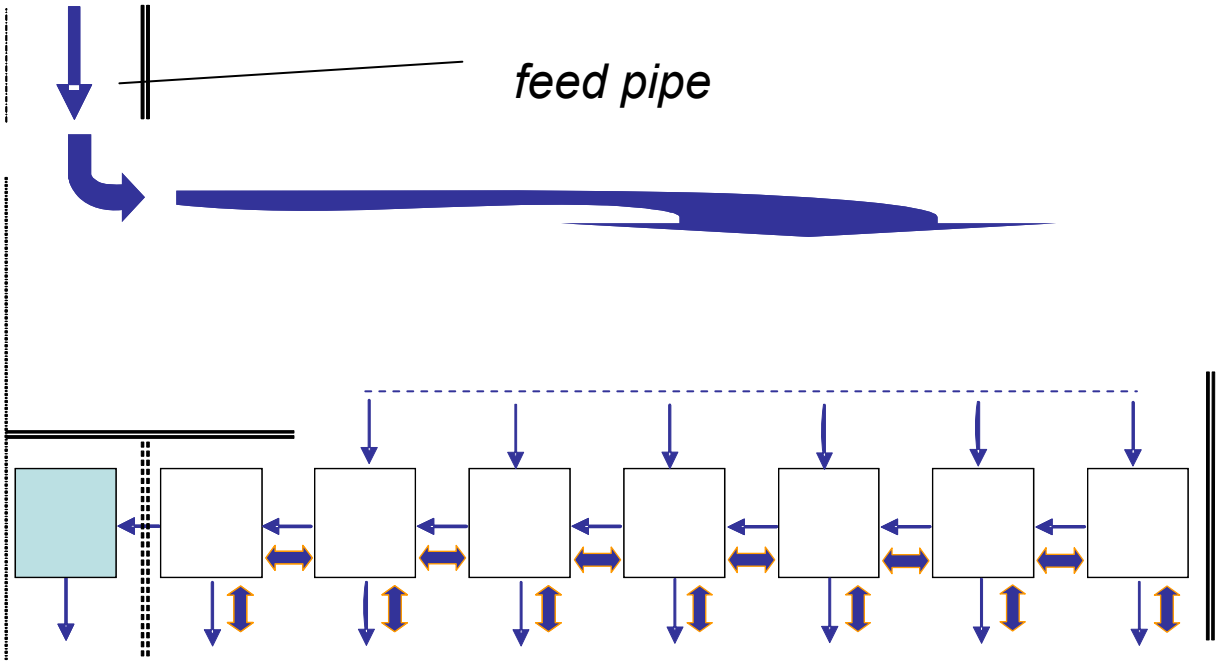
The general *i,j,k* zone showing flows and dispersive exchanges

Reactor as 3D network



3-D network-of-zones

Inlet flows?



Uniform input flow distribution

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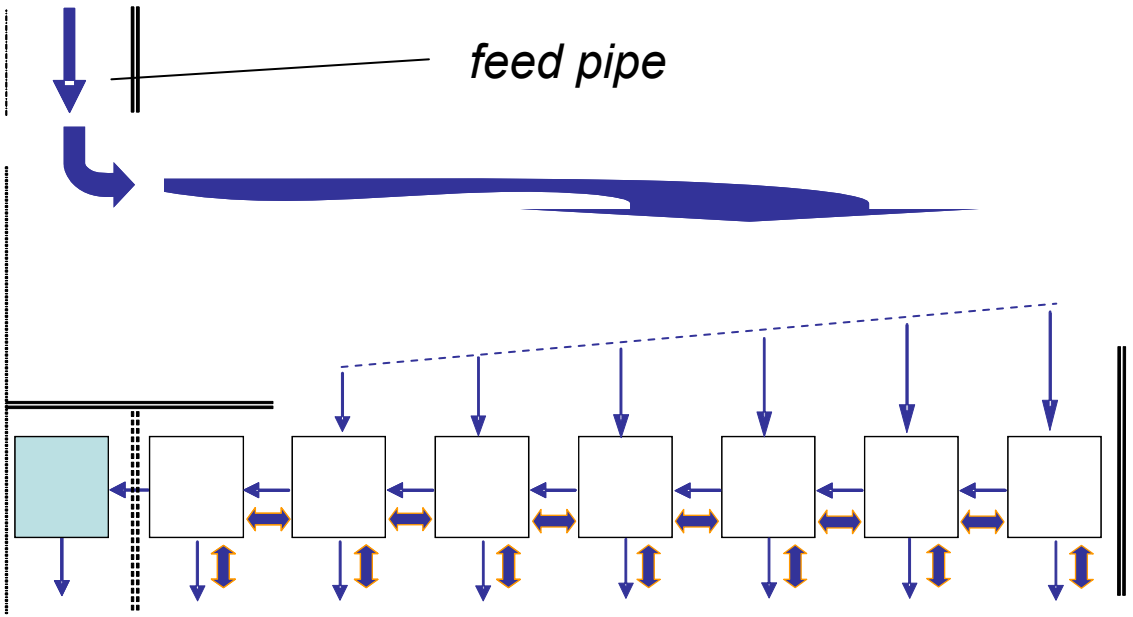
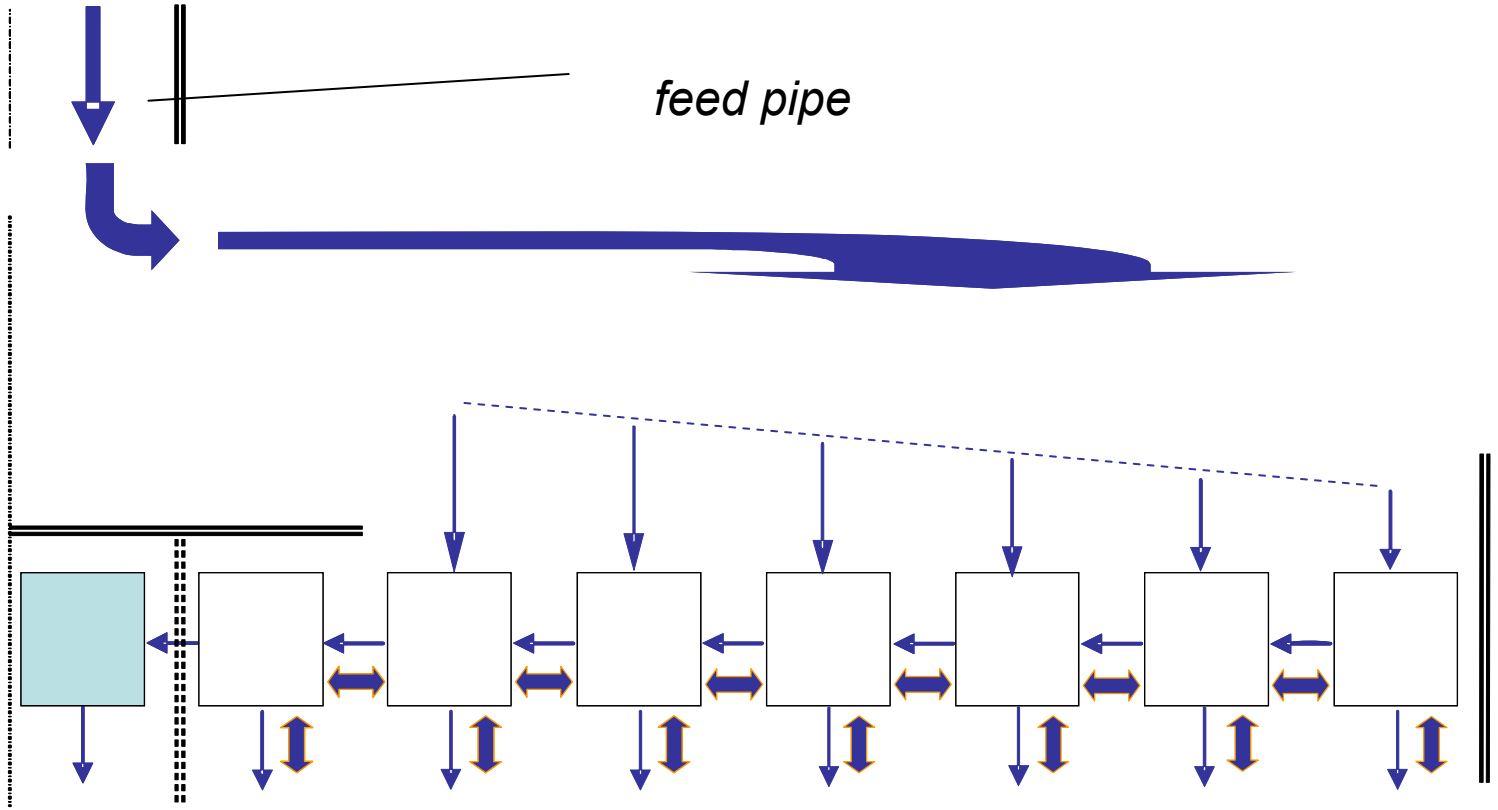
Inlet flows?



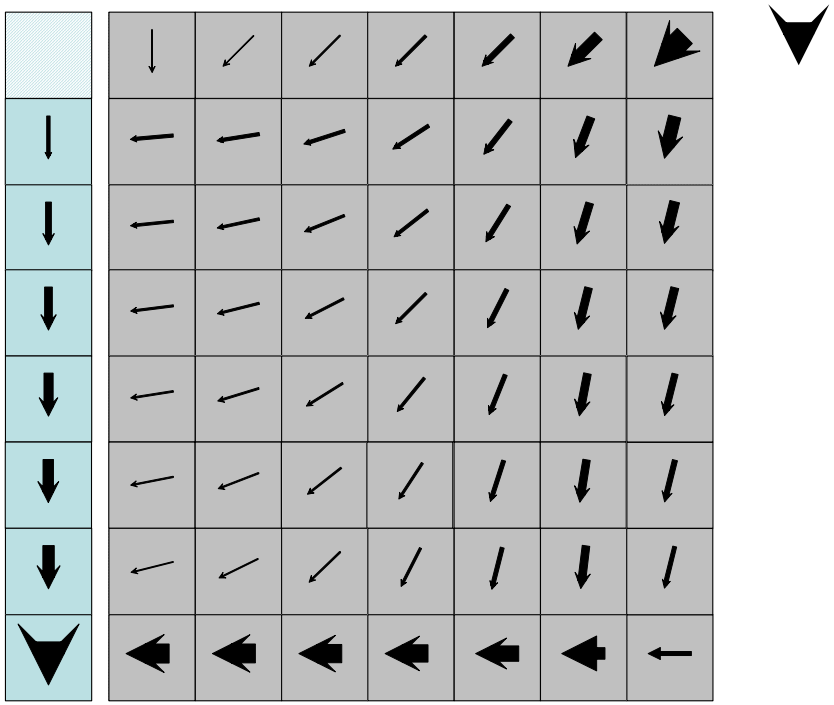
Inlet flow increases towards the outside

Inlet flows?



Inlet flow decreases towards the outside

Zonal flow maps



Inlet flow distribution and zonal flow redistribution rules determine the zonal flow pattern

Software is fully flexible allowing any possibility.

Slice flow map showing preferred flow towards the outside

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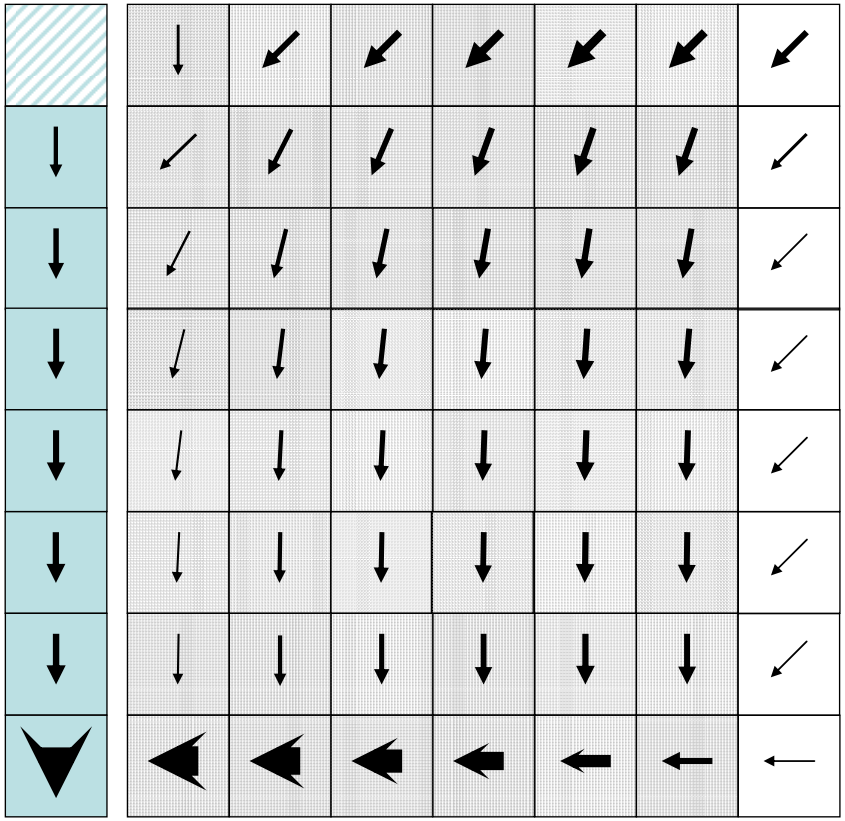
Zonal flow maps



Slice flow map showing more uniform flow

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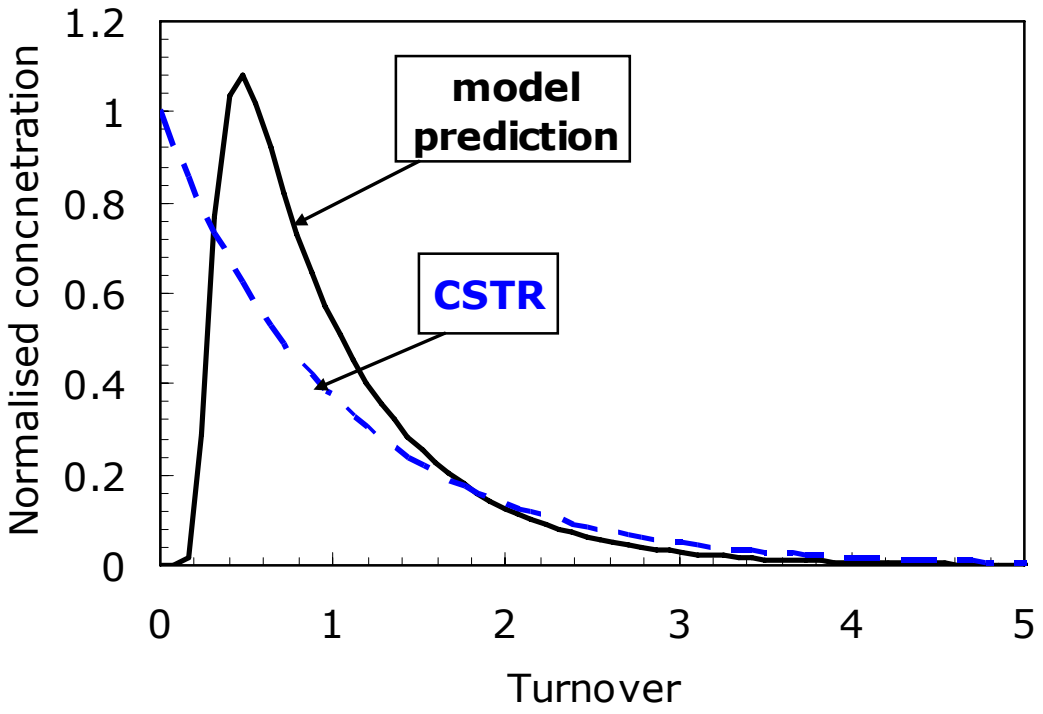
What do you see at the exit?



Residence time distribution!

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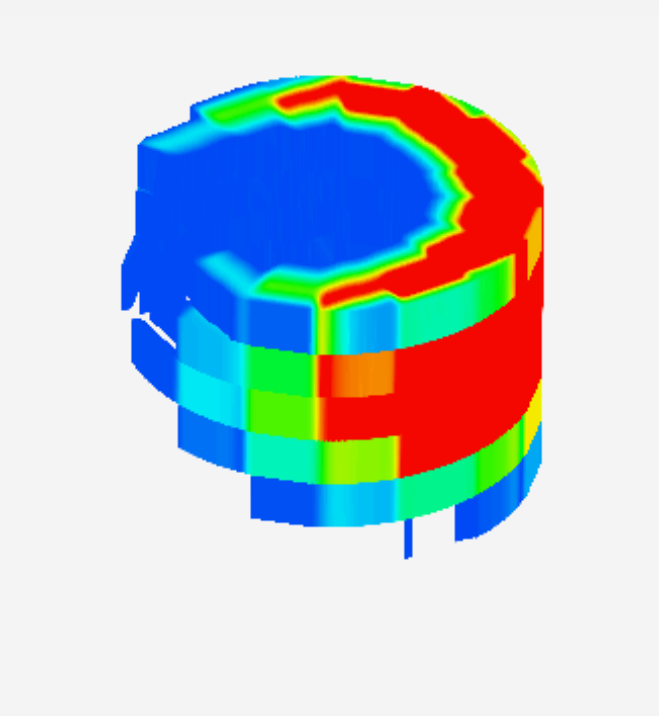
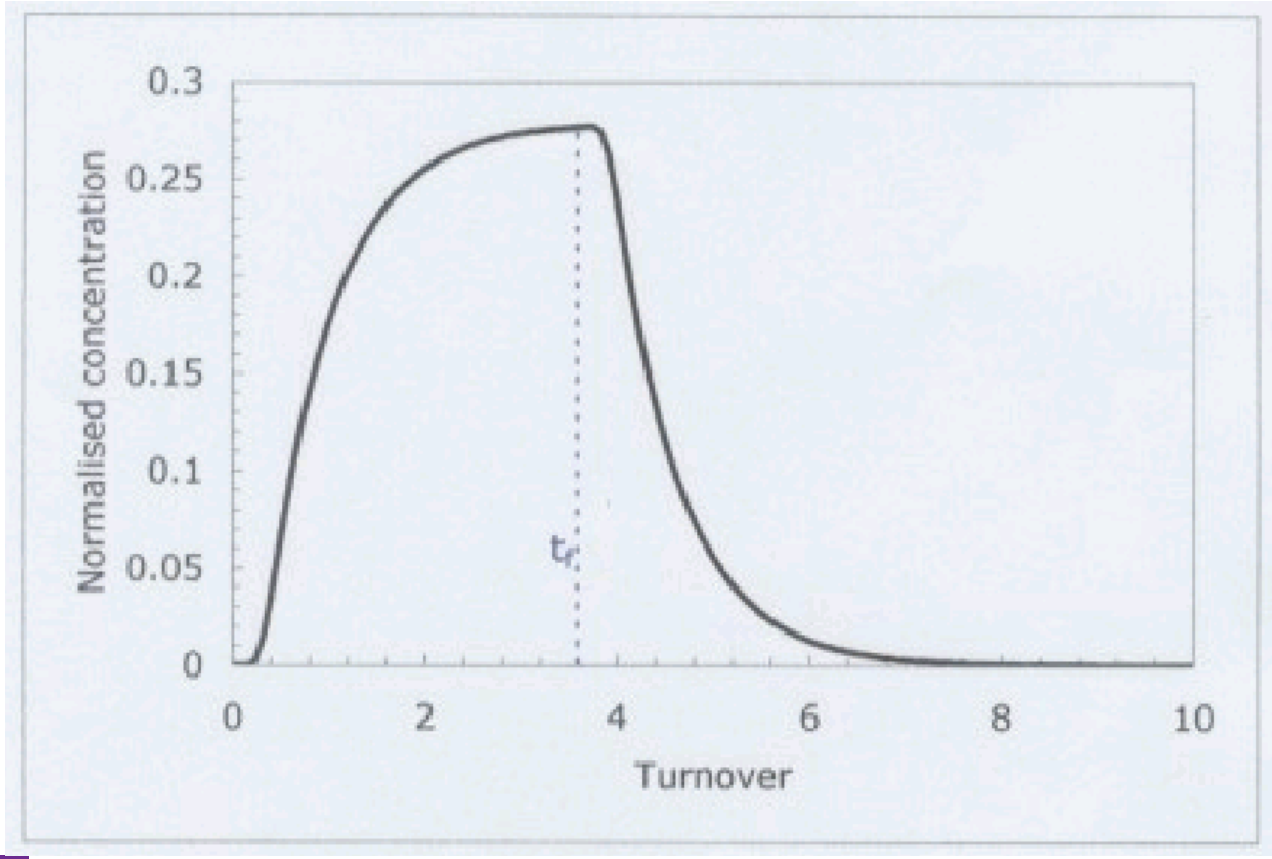
Pulse response predictions in 3D



Model predictions composed into tomographic format

Exit concentrations for semi-batch injection



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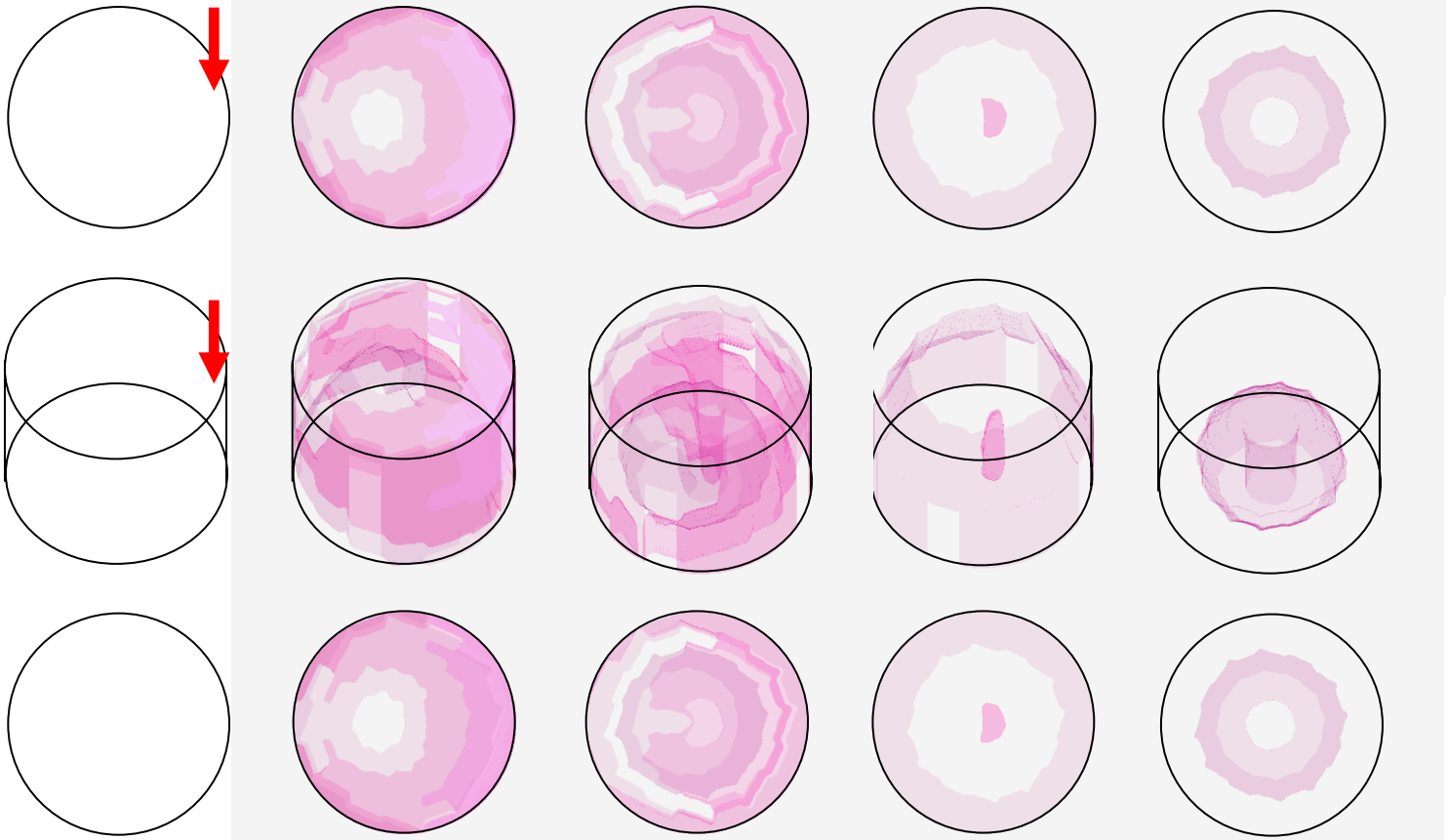
Semi-batch tracer injection for 45 seconds



0 2 4 6 12 min

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JM FEASIBILITY STUDY by VCIPT

CONCLUSIONS

- Generalised software has been written to analyse flows and mixing in an annual flow reactor
- The software has in-built flexibility making it useful for "deconstructing" the interior 3D patterns
- The capability has been demonstrated to predict
  - residence time distributions (at the exit)
  - interior concentration fields
- The predictions can be presented in equivalent tomographic 3D formats using see-through solid-body qraphics