

Preliminary GOTHIC Results

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Outline

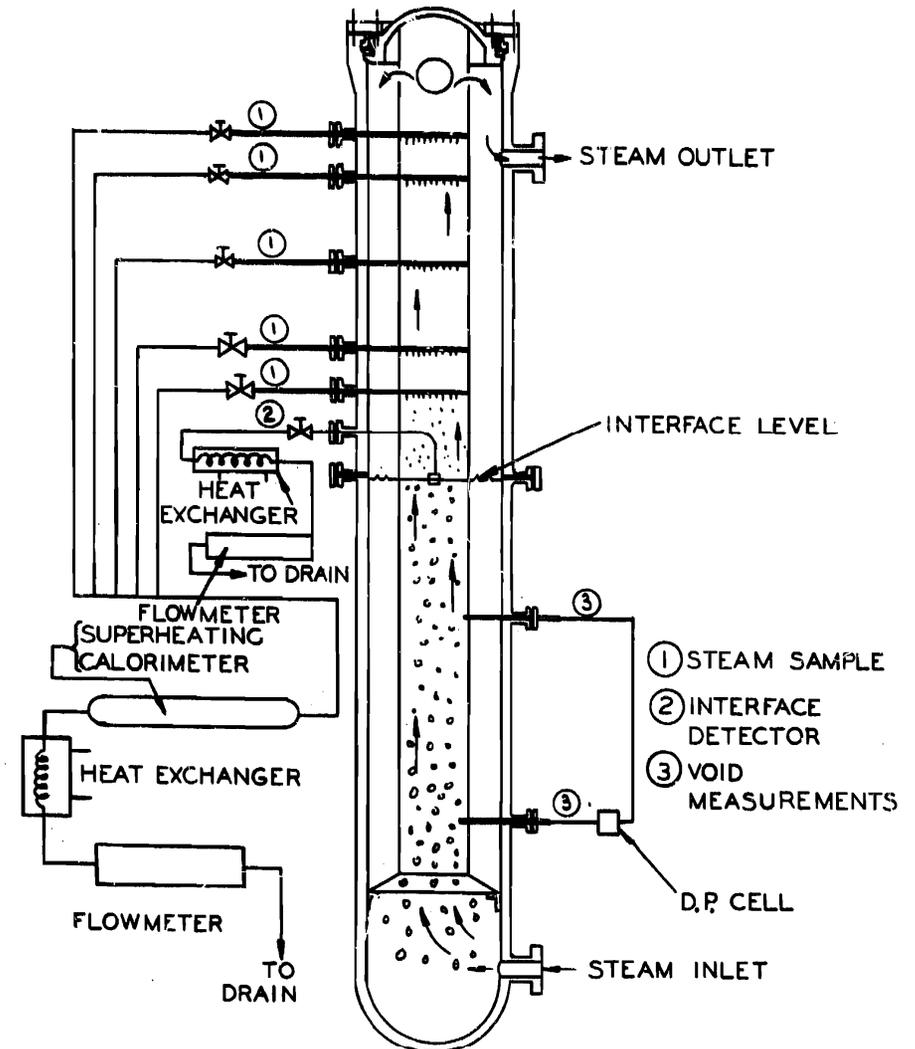
- Example Assessment: hot leg riser void fraction
 - Large diameter experiment over a variety of pressures and steam flow rates
 - Comparison to RELAP5 and an appropriate correlation
 - A look at the “3D” processes occurring as a fundamental check
- Example Calculation SBLOCA
 - Brief view of GOTHIC model
 - Some key initial results
 - A look at the transient

Example Assessment

- Large diameter, quiescent voiding may become important during SBLOCA if primary natural circulation is broken
- Most steam/water experimental data are at much smaller diameter's than the NuScale riser
- Search for large diameter data yielded an interesting experiment

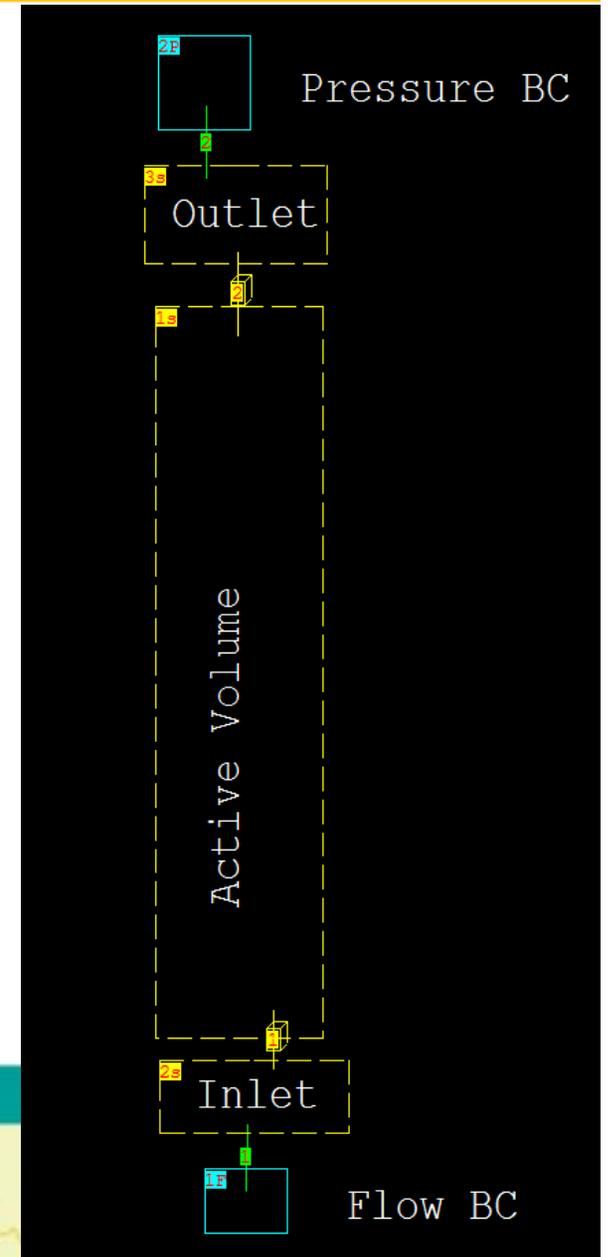
Void Fraction Experimental Facility

- 36" steady state void fraction data* is available which will be part of our code assessment
 - Variety of pressures
 - Variety of steam mass flow rates
 - Void fractions measured based upon dP's at three radial locations (measured radial profile)



GOTHIC Model

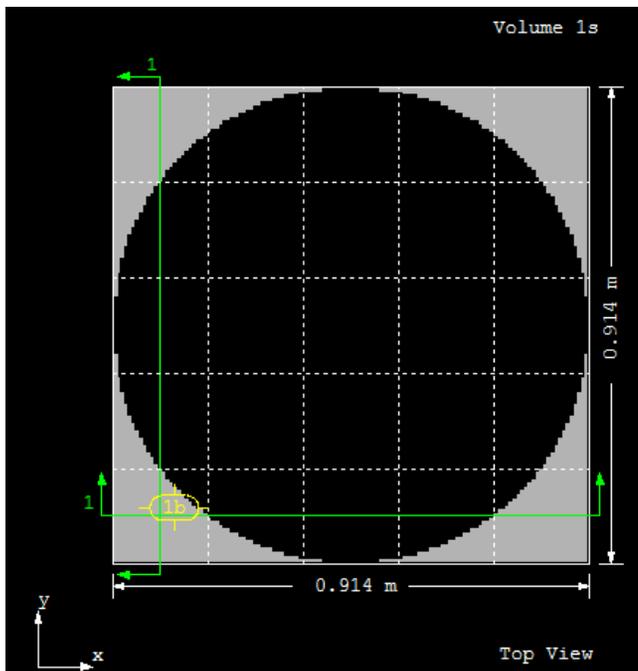
- Match experimental flow areas and approximate L/D measurement location
- Modeling options are set to defaults – no tuning
- Results shown are time and axially averaged



GOTHIC Model Continued

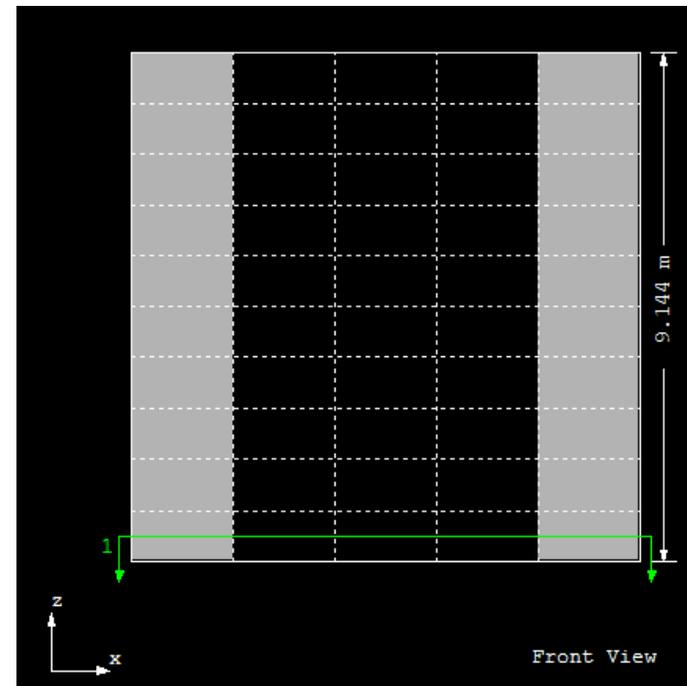
Top View:

- 36" round tube
- 5x5 Cartesian grid



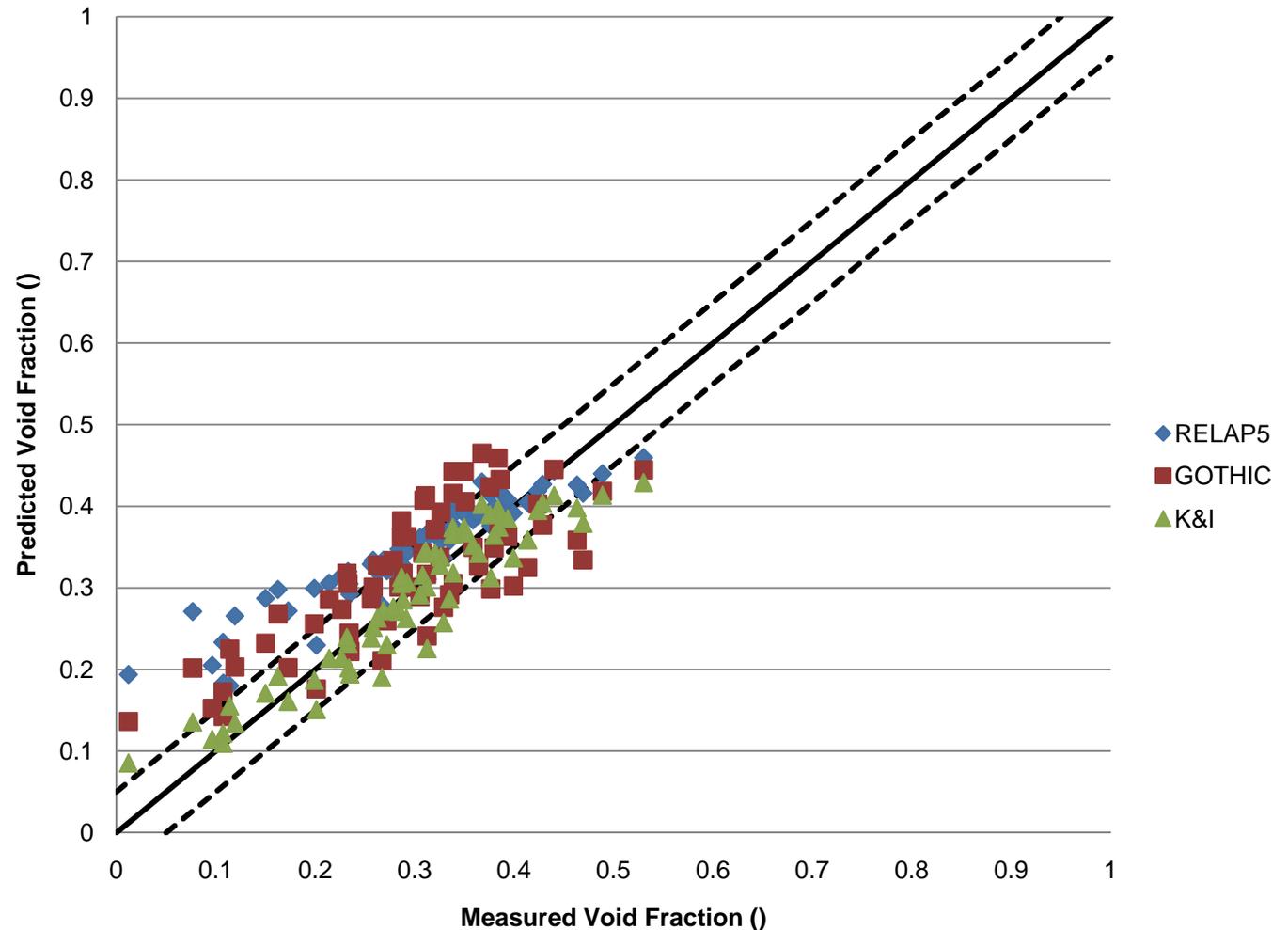
Side View:

- 10 L/D tube
- 10 axial levels – 4 to 6 averaged



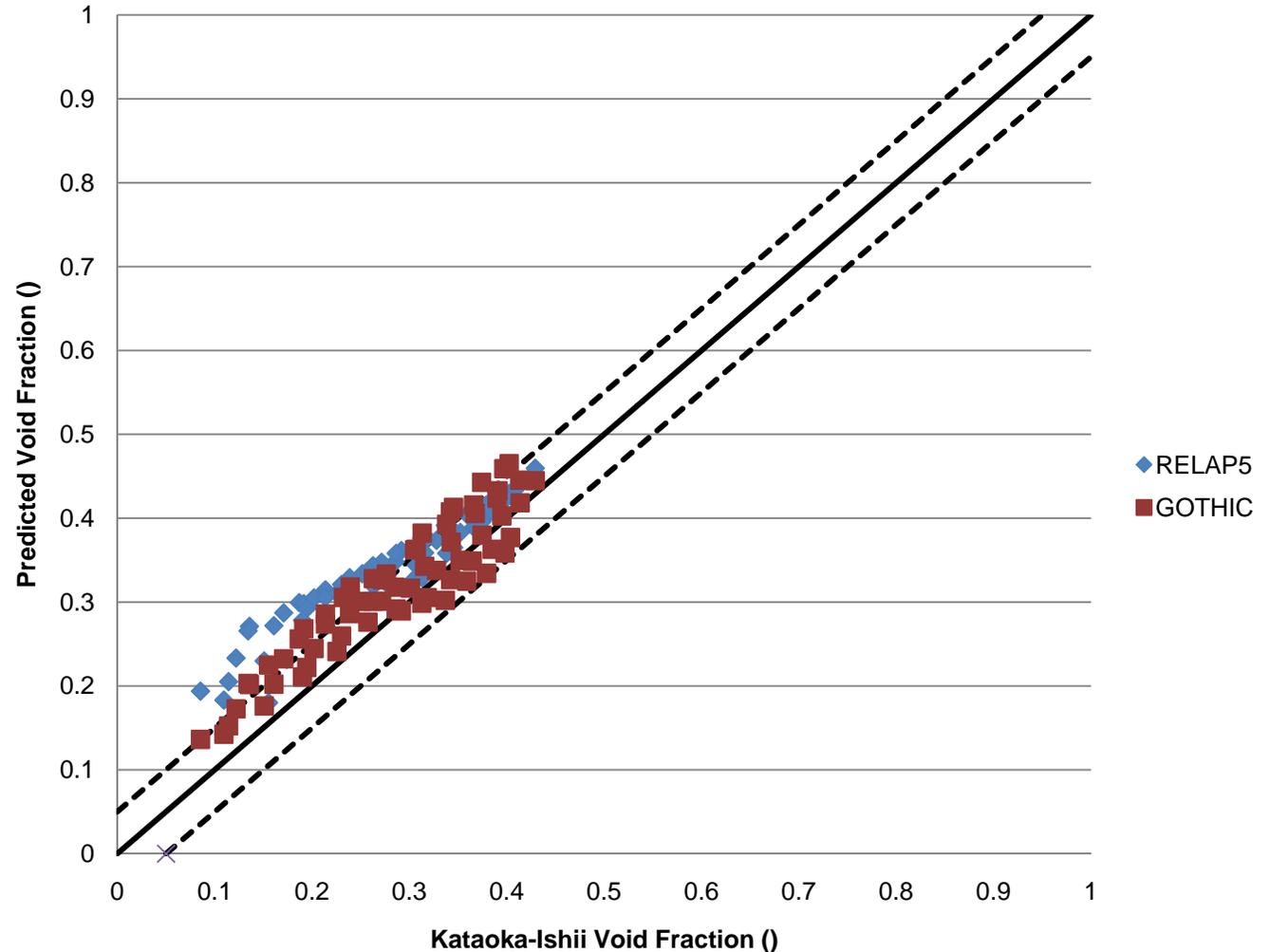
P vs. M Void Fraction 36" Experiments

- Data is not qualified
- Kataoka-Ishii* correlation similar to code results
- Similar trend for all three predictions



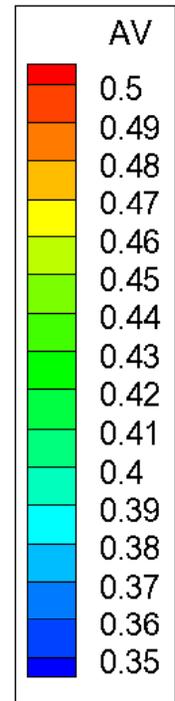
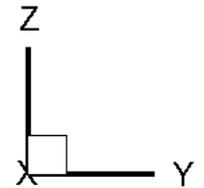
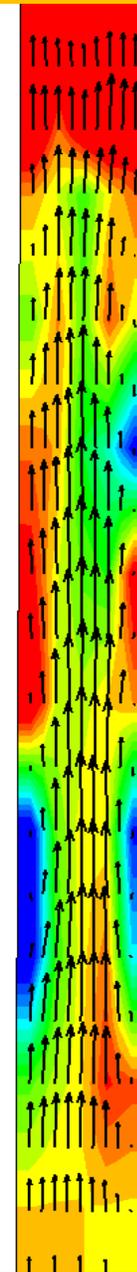
P vs. Kataoka-Ishii Void Fraction 36"

- Good agreement for RELAP5 and especially GOTHIC
- Compared to raw data:
 - Less scatter
 - Better trending



Void Velocity View; Center Slice

- Conditions:
 - 600 psig
 - 35,000 lb/hr steam
 - $G=6.73$ kg/m²-s
 - $J_v=0.32$ m/s
- Observations:
 - Central stream
 - Flat inlet profile
 - Void at top of tube

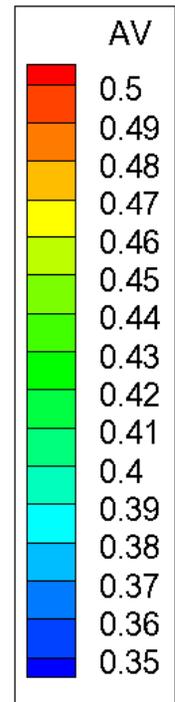
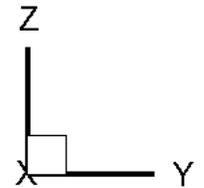
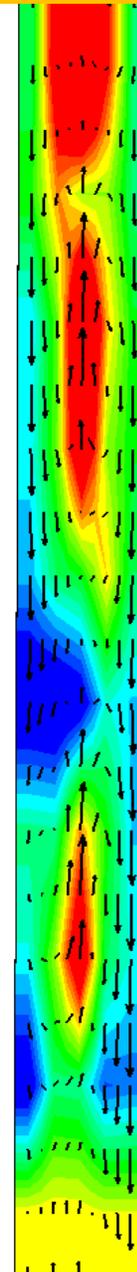


Time = 150 sec

Void Velocity View: Edge Slice

- Observations:

- Edge has entrained vapor flowing down
- Void at top of tube



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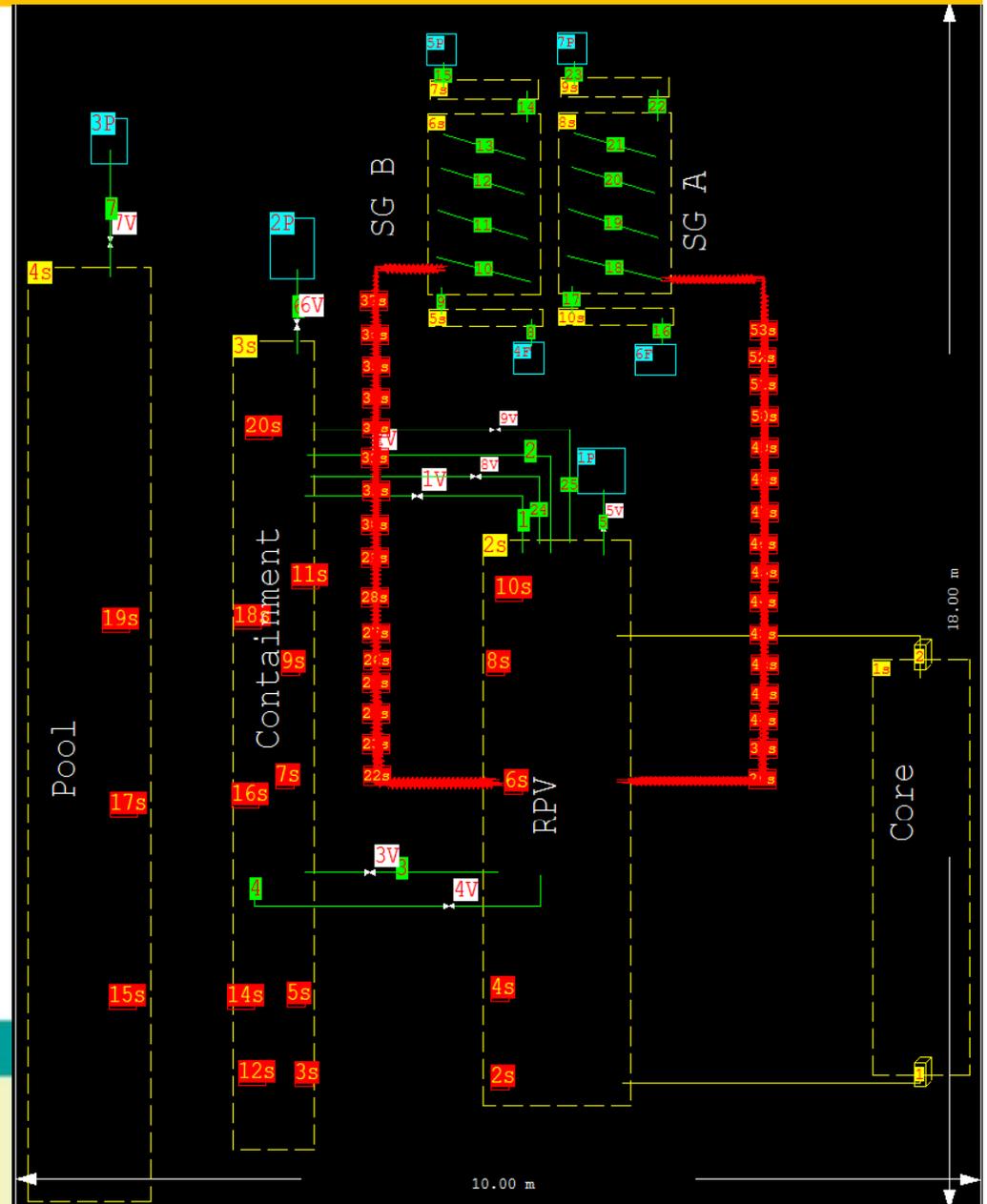
Time = 150 sec

Example SBLOCA Application

- A preliminary GOTHIC model of the NuScale module has been constructed
 - Used to evaluate and test the code features and performance for SBLOCA, leading to selection of GOTHIC
 - Results will be compared to RELAP5/MOD3.3 for a check of “reasonableness”
 - Model is now being expanded to incorporate detailed modeling of all important systems such as steam generator, pressurizer heaters/sprays, etc.

Whole Model

- Major volumes:
 - 1 = Core
 - 2 = RPV
 - 3 = Containment
 - 4 = Pool
 - 6,8 = Steam Generator
- Red Lines = Conductors
- Green Lines = Flow Paths:
 - 1,2,24,25 = RVV's
 - 3,4 = RRV's

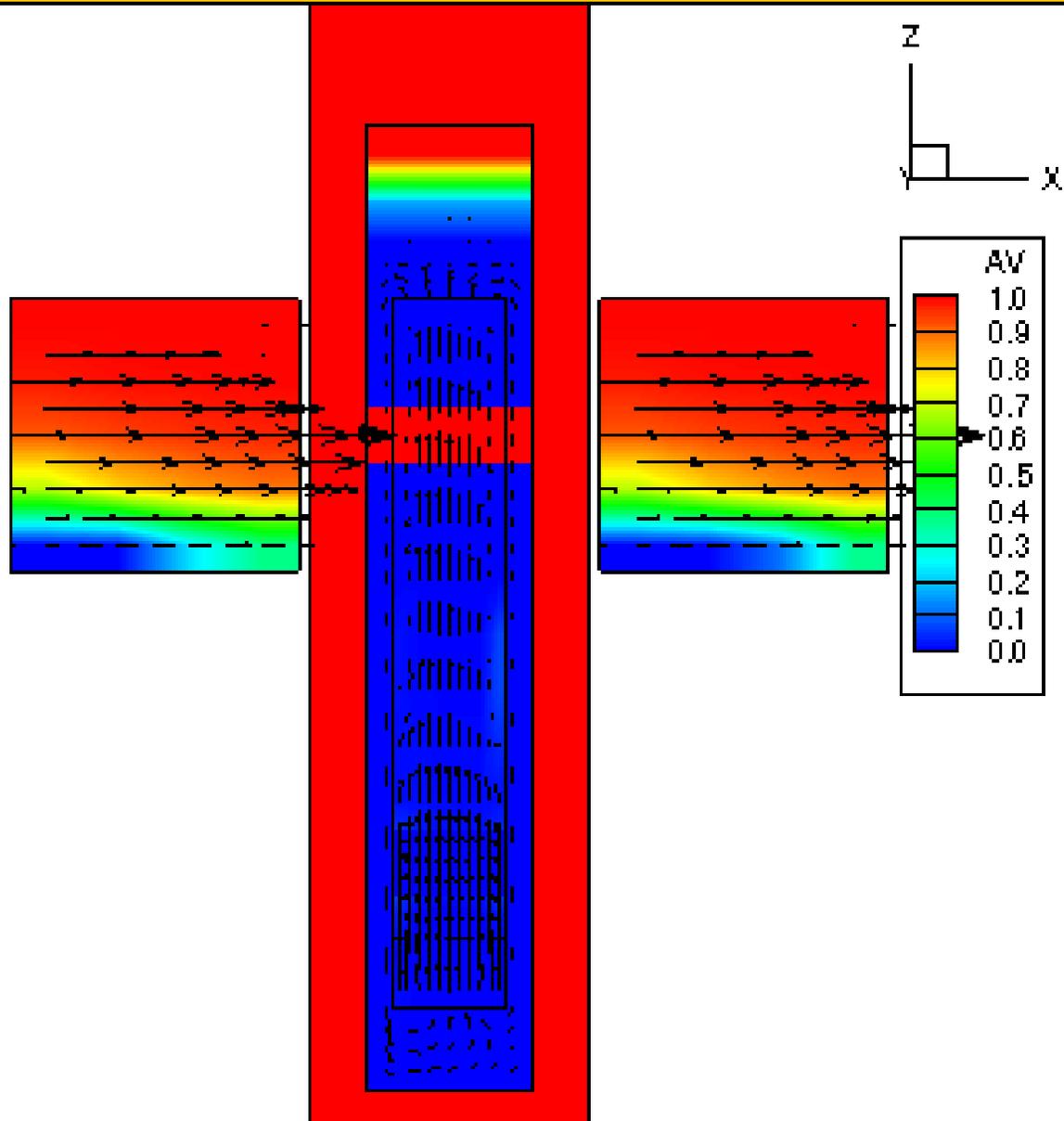


SBLOCA Preliminary Results

- Sample SBLOCA results show fairly consistent system trends as compared to RELAP5/MOD3.3
 - Peak containment pressure and RPV level are equivalent, no major surprises elsewhere in the system response
 - GOTHIC illustrates strong 3D flow behavior in the RPV once primary natural circulation ends; churning and tumbling of the flow is not observable in 1D codes such as RELAP5/MOD3.3
 - 3D flow behavior does not seem to have a large effect on highly-ranked phenomena or figures of merit
 - Churning and tumbling flow behavior can be important to other aspects such as boron precipitation, boron dilution, thermal gradients

RRV Inadvertent Opening

- GOTHIC demonstrates gross SBLOCA system behavior
- Additional work is being done to confirm code applicability



Time = 90 sec

Conclusions

- Large diameter quiescent boiling may become important during SBLOCA
 - Most data/correlations focus on smaller diameters
 - ACNP 36” data tested against RELAP5, GOTHIC, and correlation
 - RELAP5 and GOTHIC perform well
 - “3D” effects are being investigated
- SBLOCA model is being developed
 - Major systems/components in place
 - Initial results are consistent with RELAP5
 - System trends show expected behavior



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