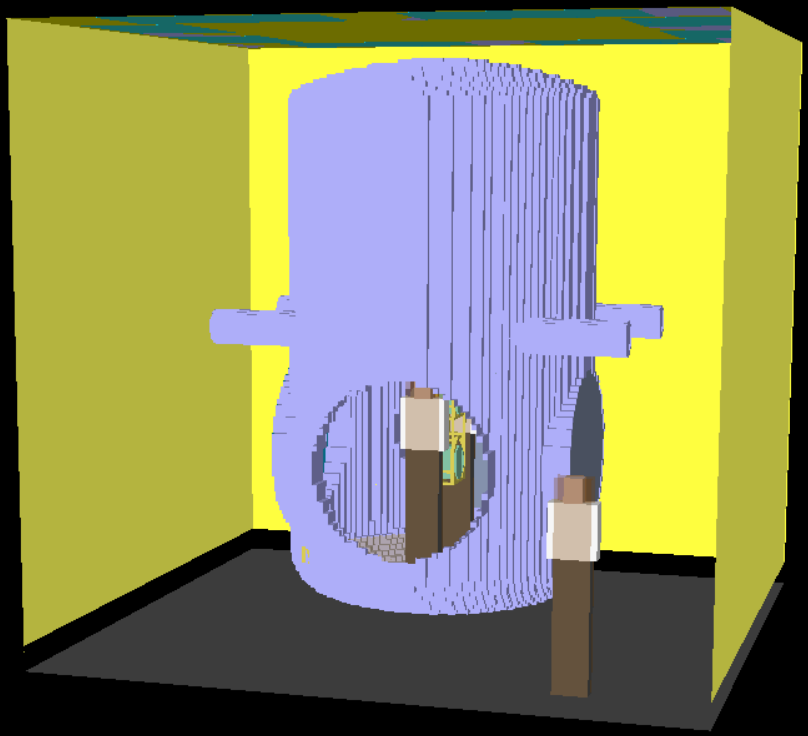
Contamination Control Study: BSC Chamber

LIGO Observatory



Project Number: FVMS0506-01

Parametric-1 Results

August 14, 2006

LIGO-T060205-00-D

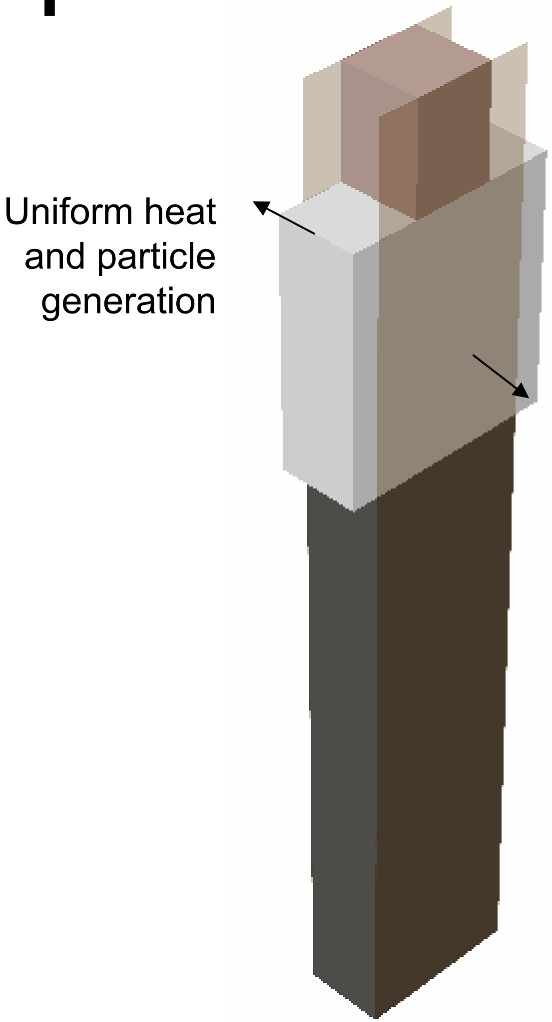
Objectives

- Modify the thermal/airflow FLOVENT model of the BSC Chamber such that the airflow speed from the core area matches that of the annular area:
  - Baseline Scenario 2:
    - Core Flow: 1.0 m^3/sec; ~0.4 m/sec
    - Annular Flow: 2.0 m^3/sec; ~2.0 m/sec
    - Extract duct size;QTY: 6”x6”;1
  - Parametric-1:
    - Core Flow: 5.5 m^3/sec; ~2.0 m/sec
    - Annular Flow: 2.0 m^3/sec; ~2.0 m/sec
    - Extract duct size;QTY: 12”x12”;4

The speeds stated above are for comparison purposes and are based on the flow surface area of the particular device and does not include the acceleration of the flow through the perforation

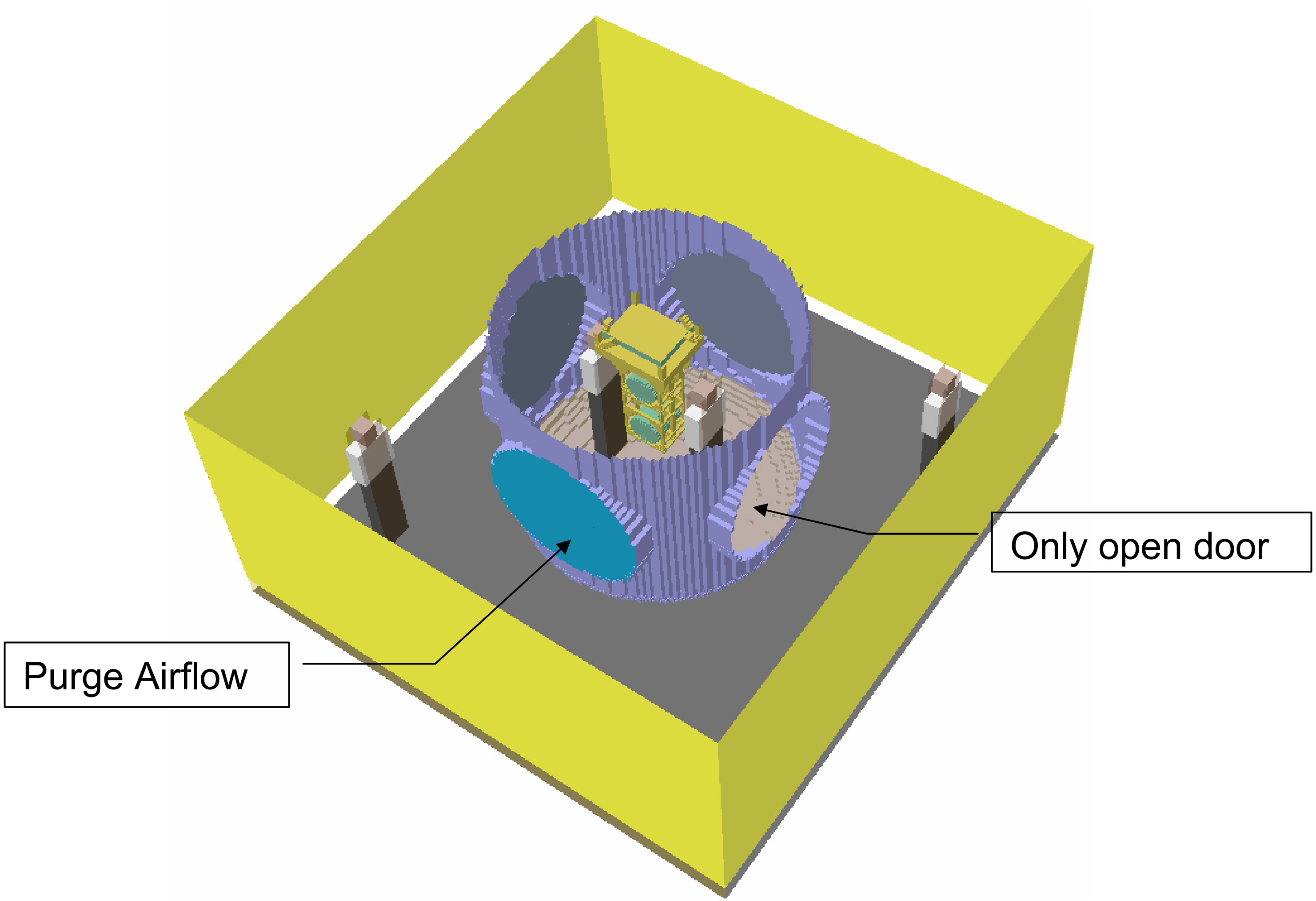
Personnel Assumptions

- Personnel:
  - 4 personnel: 2 in BSC Chamber, 2 in surrounding cleanroom
  - Contamination Generation rate: 3950 particles/sec (≥ 0.5um)
  - Heat Generation rate: 85 W sensible heat

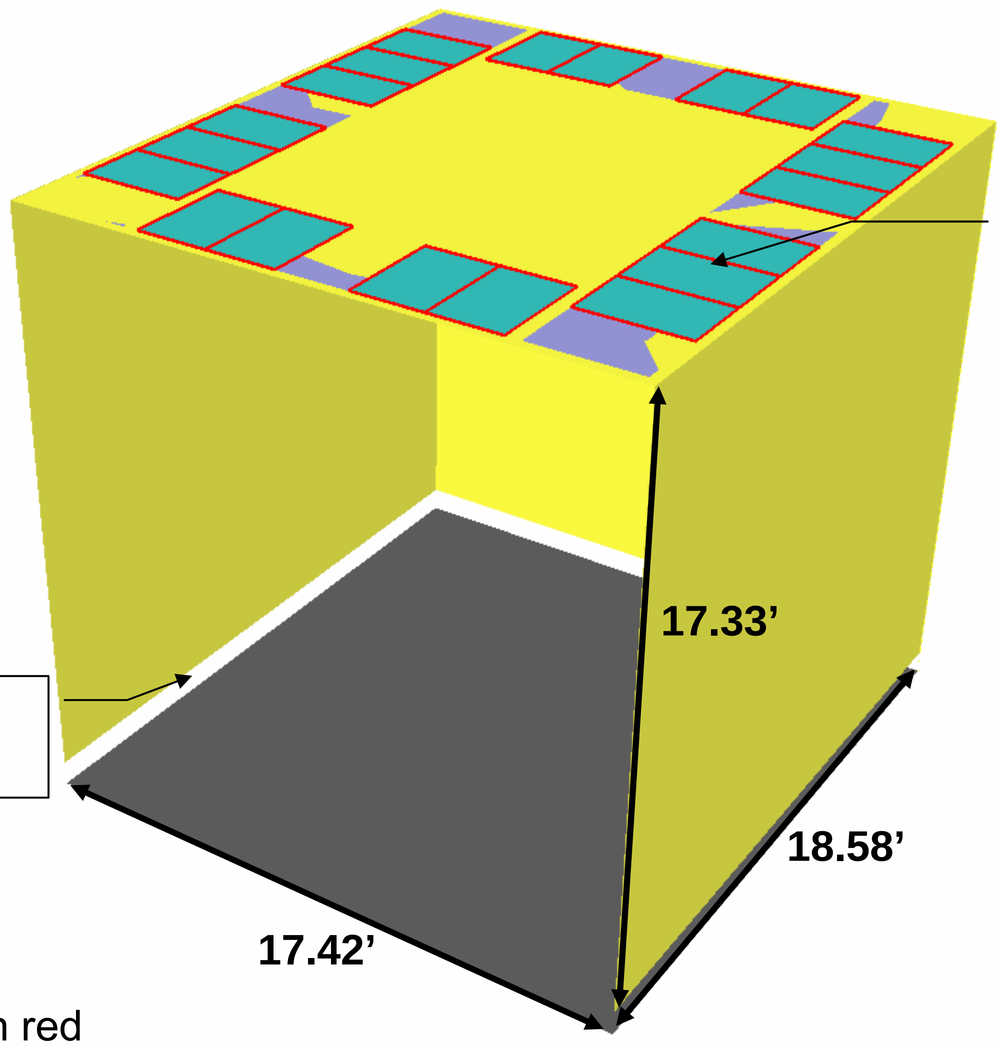


Contamination rate based on: high quality cleanroom clothing systems at 25 washes and moderate personnel activity (Cleanroom Clothing Systems: People as a Contamination Source, Ljungqvist and Reinmuller)

Personnel Locations



Cleanroom Overview

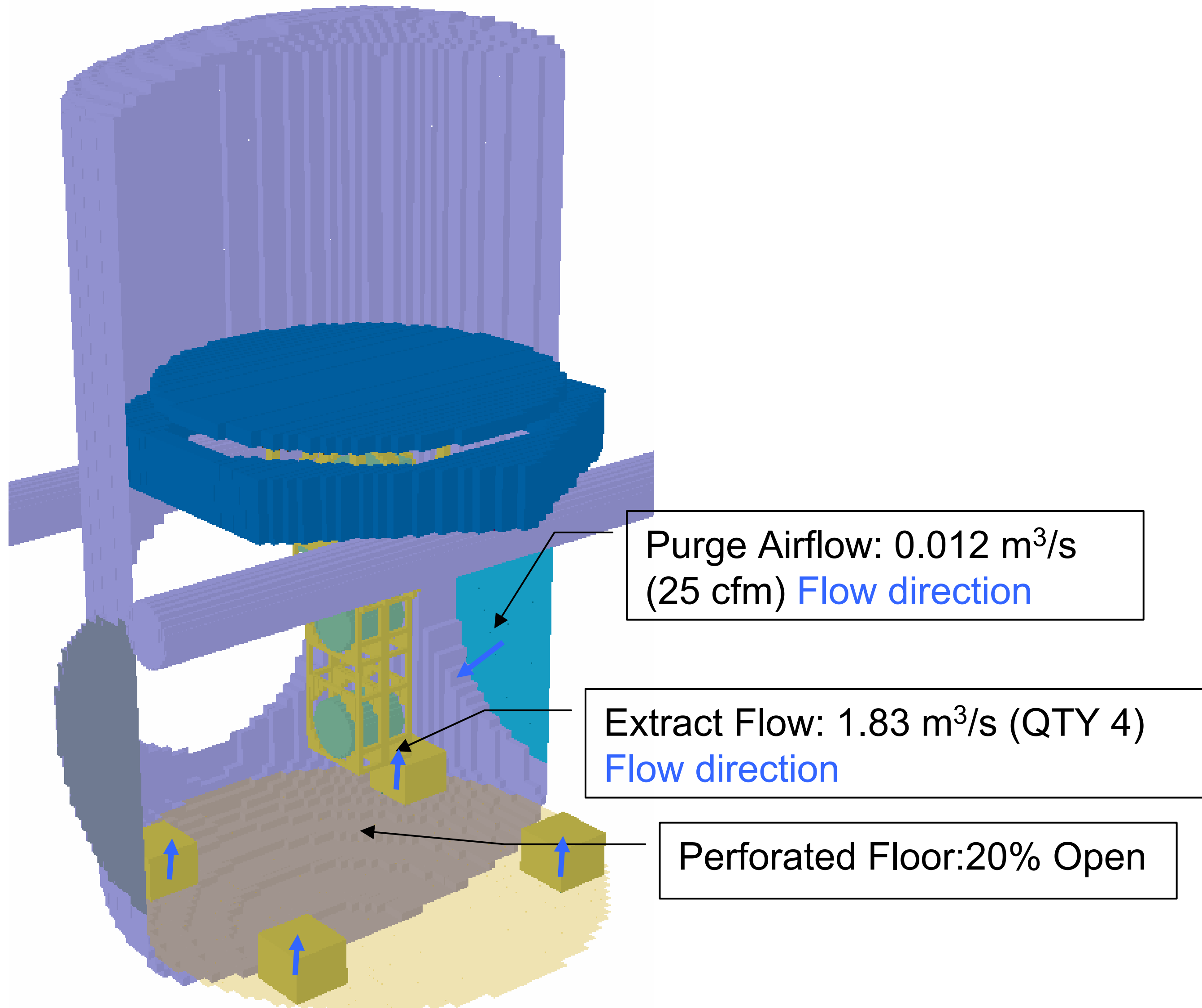


HEPA Filters: 400 cfm (0.188 m^3/s) each, QTY: 20

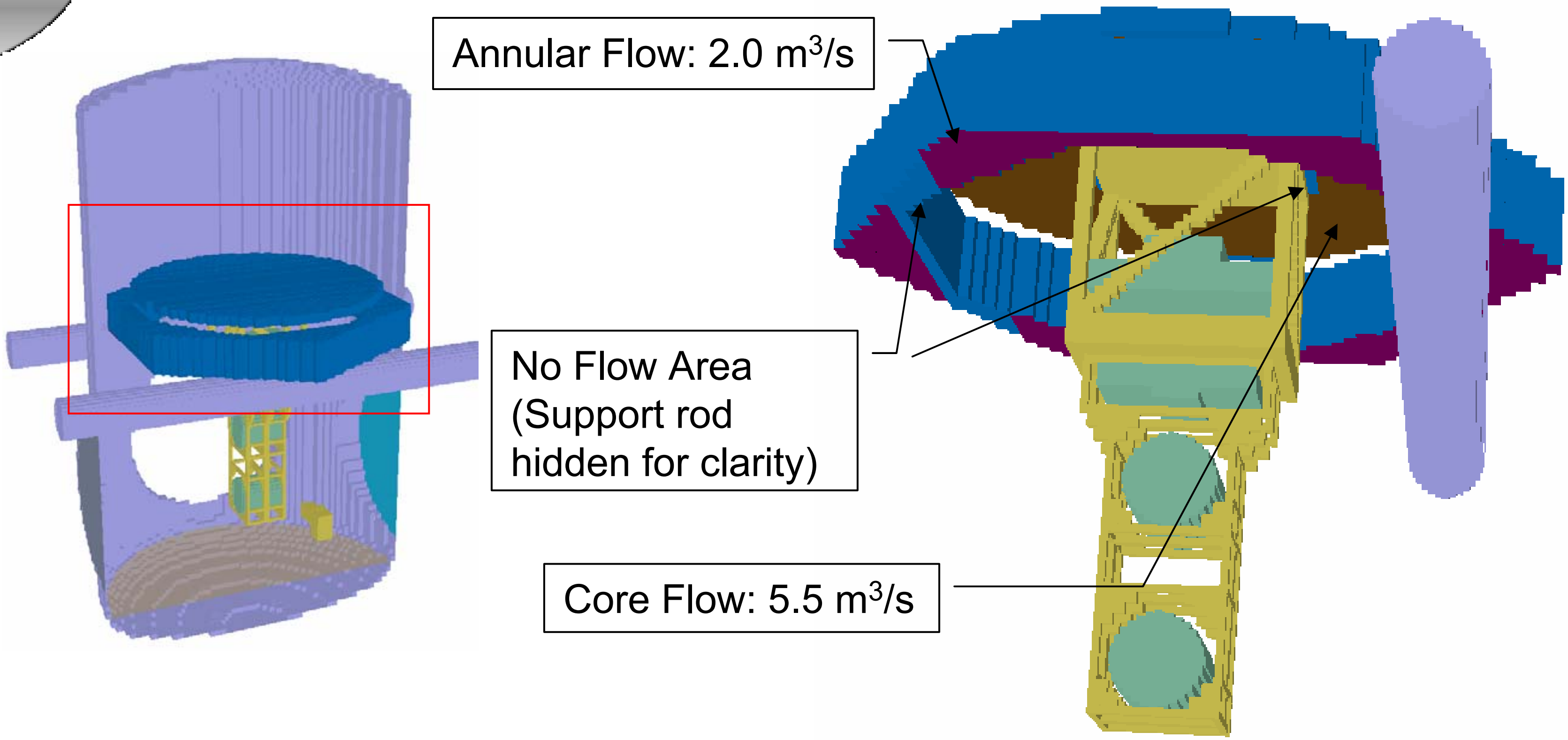
Curtain opening: 8.5" height

HEPA Filters outlined in red

BSC Airflow Overview



Air Shower Overview

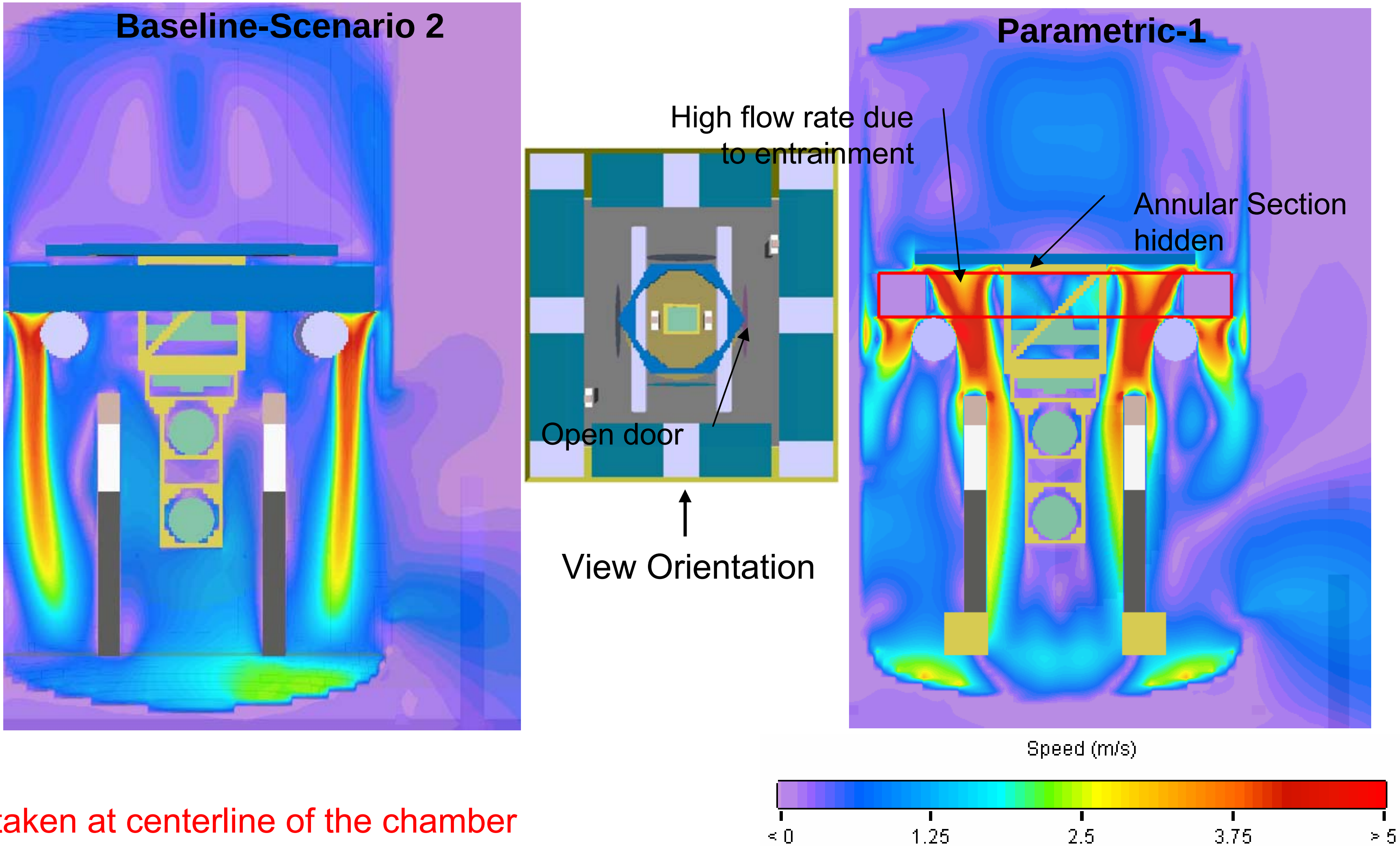


Core Flow and Annular Flow approximated with flow accelerated through 3/8” holes on 1” pitch (11% Open)

Simulation Results

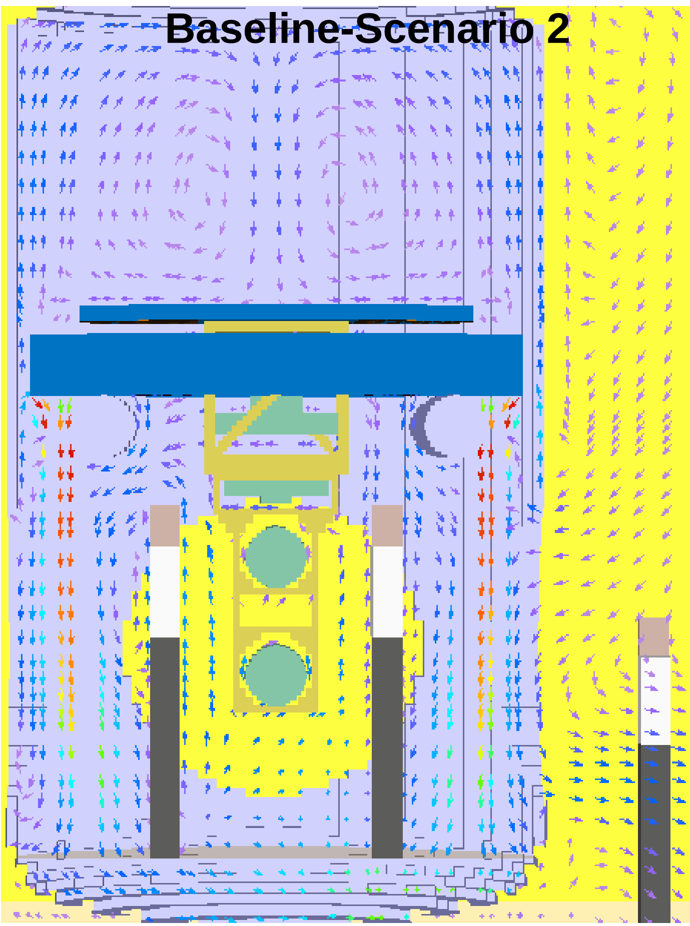
Parametric-1

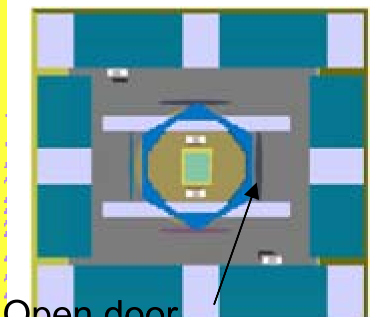
Design Comparison-Speed

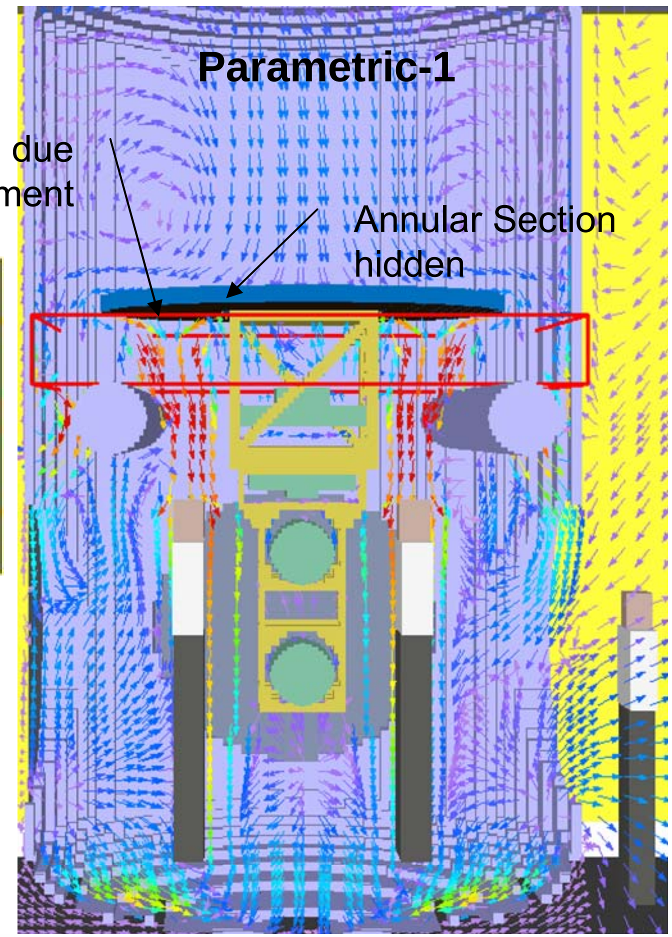


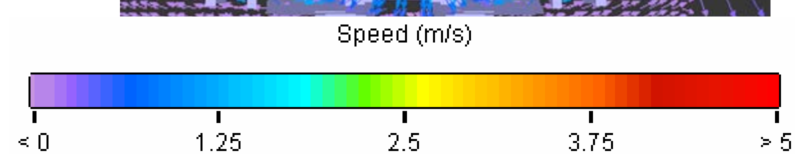
Plane taken at centerline of the chamber

Design Comparison-Velocity



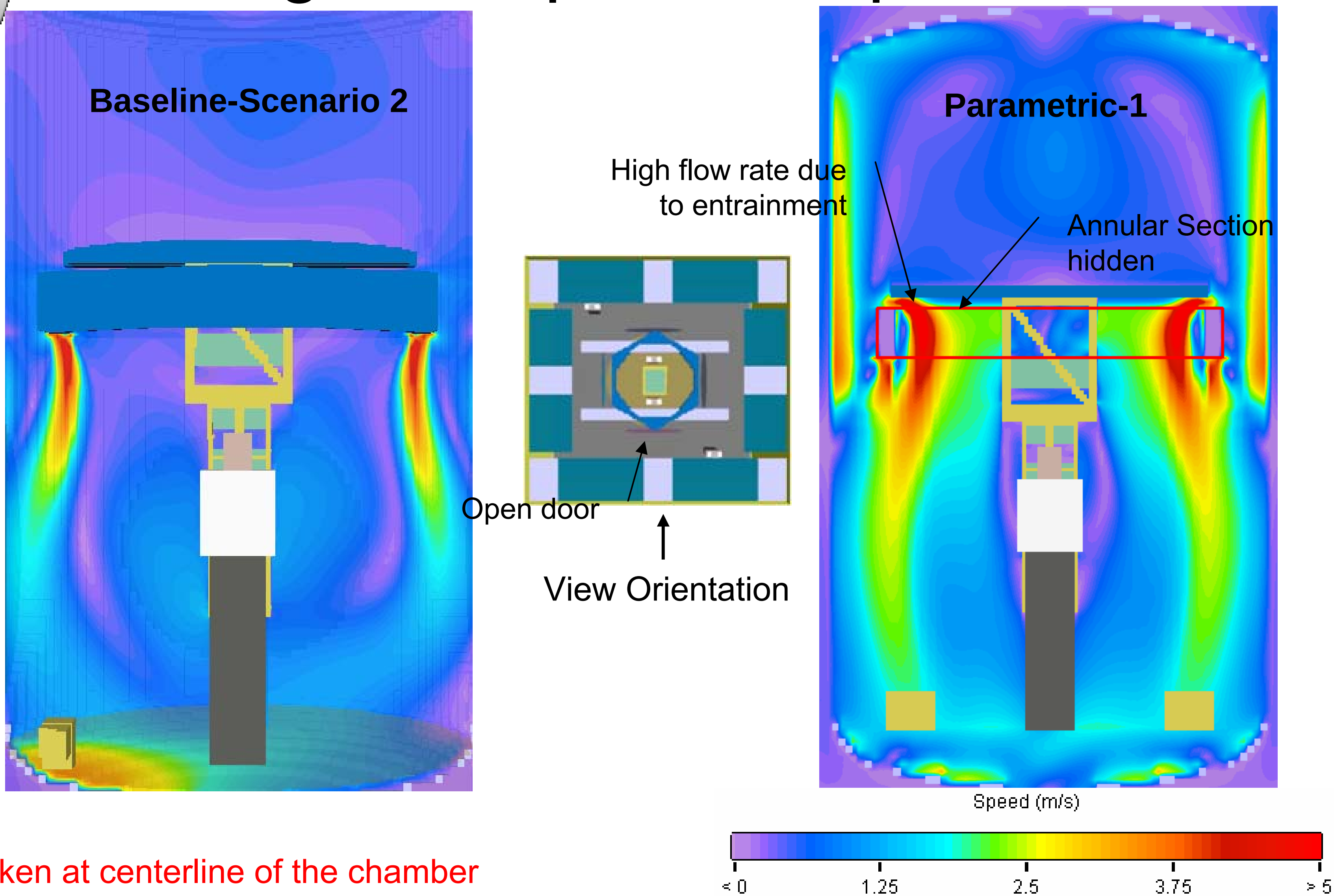






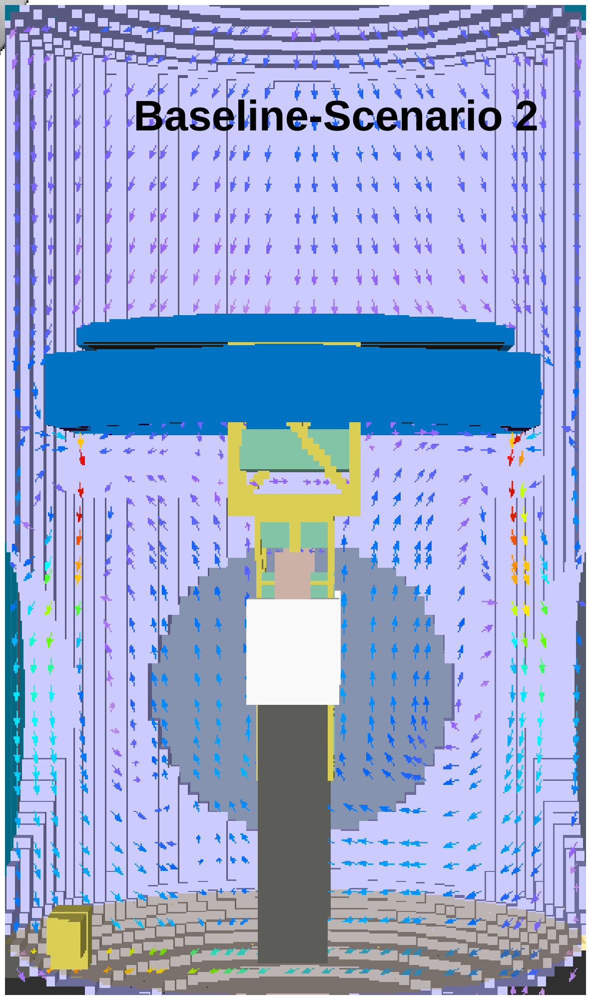
Plane taken at centerline of the chamber

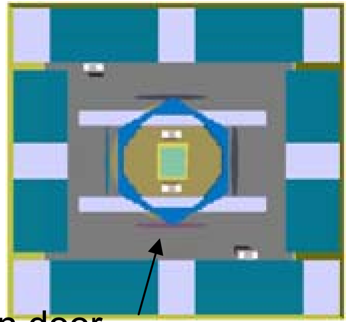
Design Comparison-Speed-2

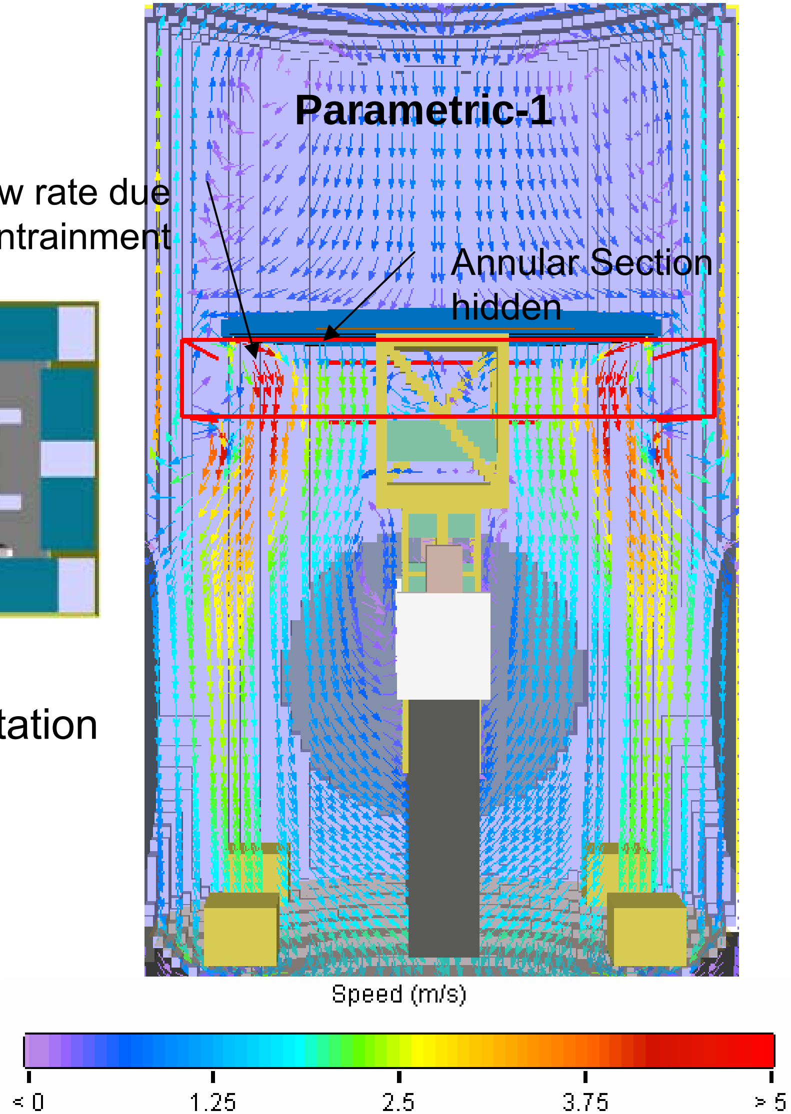


Plane taken at centerline of the chamber

Design Comparison-Velocity-2

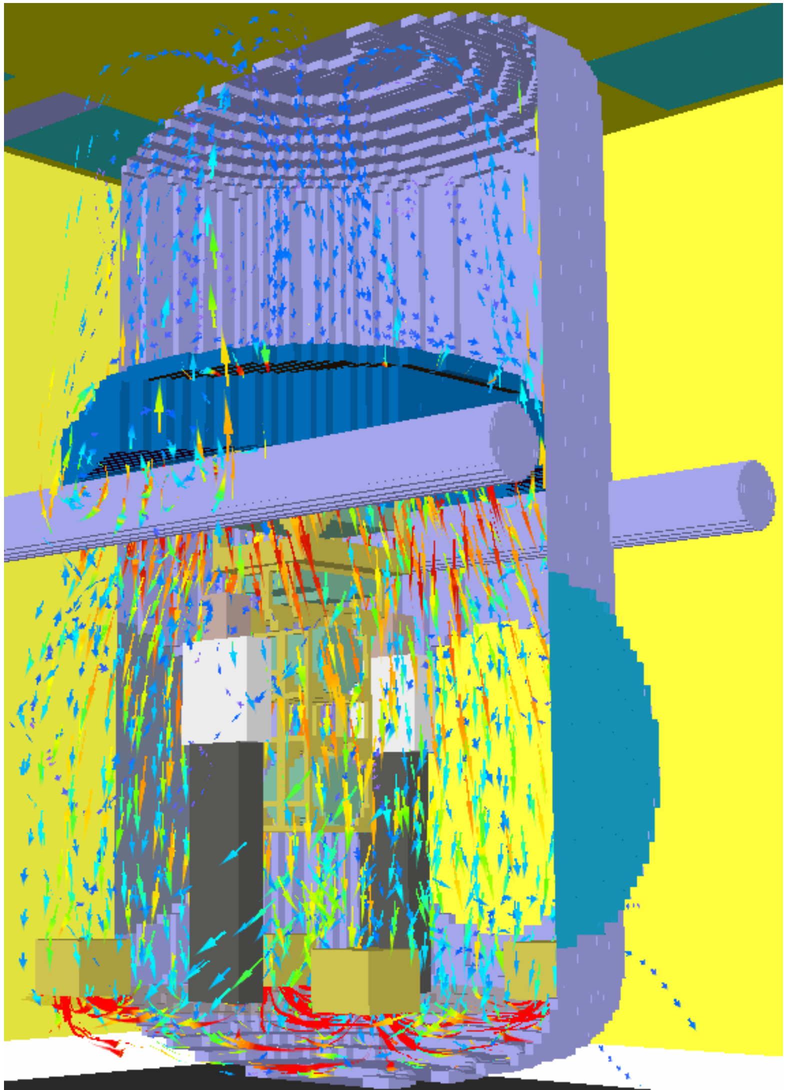


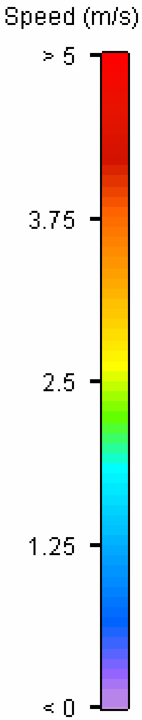




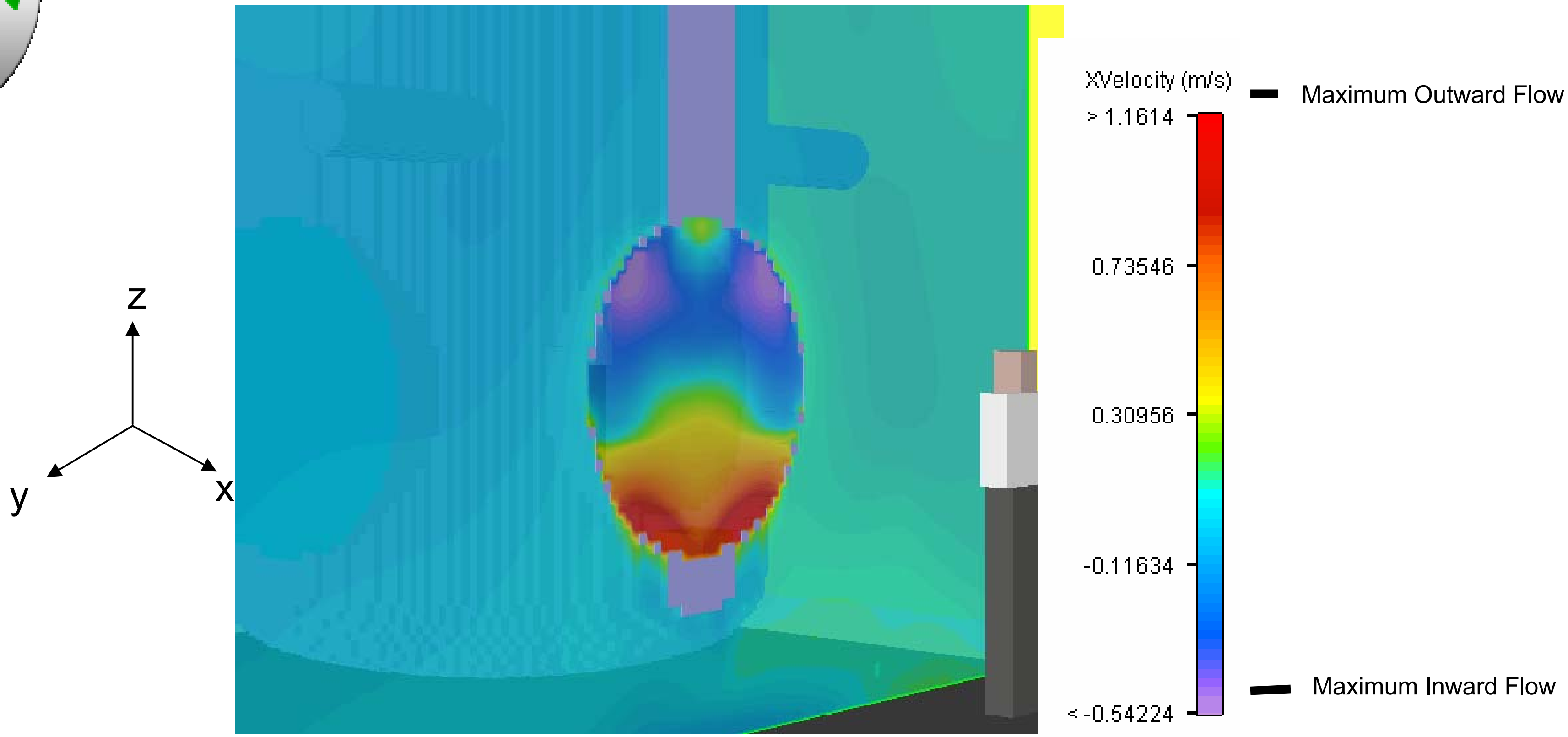
Plane taken at centerline of the chamber

Air Shower Flow Paths





Speed Profile through the Chamber Door

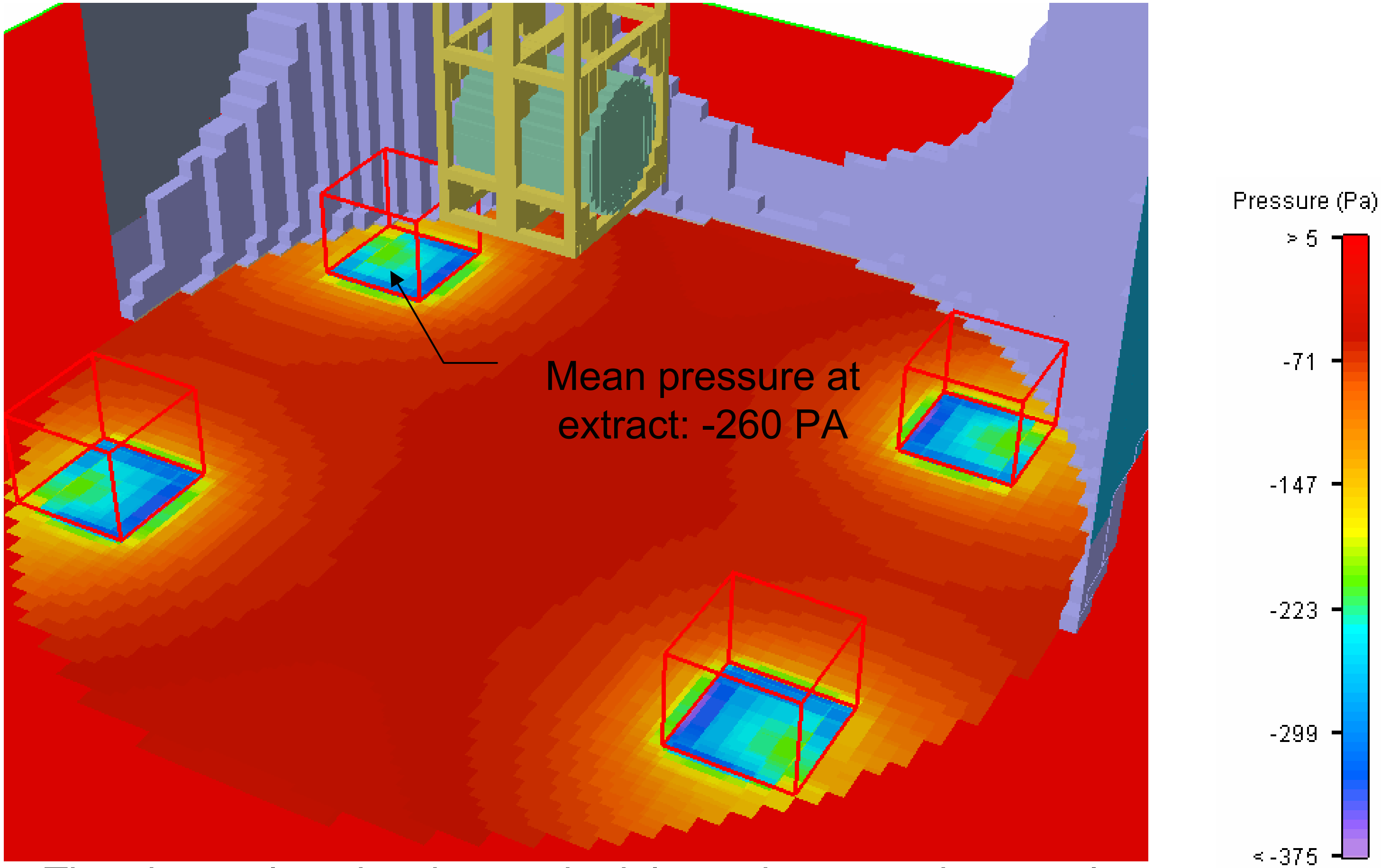


Flow Rates Through Chamber Door

Volume Flow Out (m^3/sec)	Volume Flow In (m^3/sec)	Volume Flow Net (m^3/sec)
0.4604	0.2607	0.1997

Plane taken at the cross-section of the chamber door

Extraction Pressure



The above plane is taken at the inlet to the extraction nozzle, and illustrates the pressure required to achieve a flow of 1.83 m^3/sec and assumes the nozzle is venting to atmosphere

ISO Class Specifications

	Particle Density (particles/m^3)
ISO-5	3,250
ISO-6	32,500
ISO-7	325,000
ISO-8	3,250,000

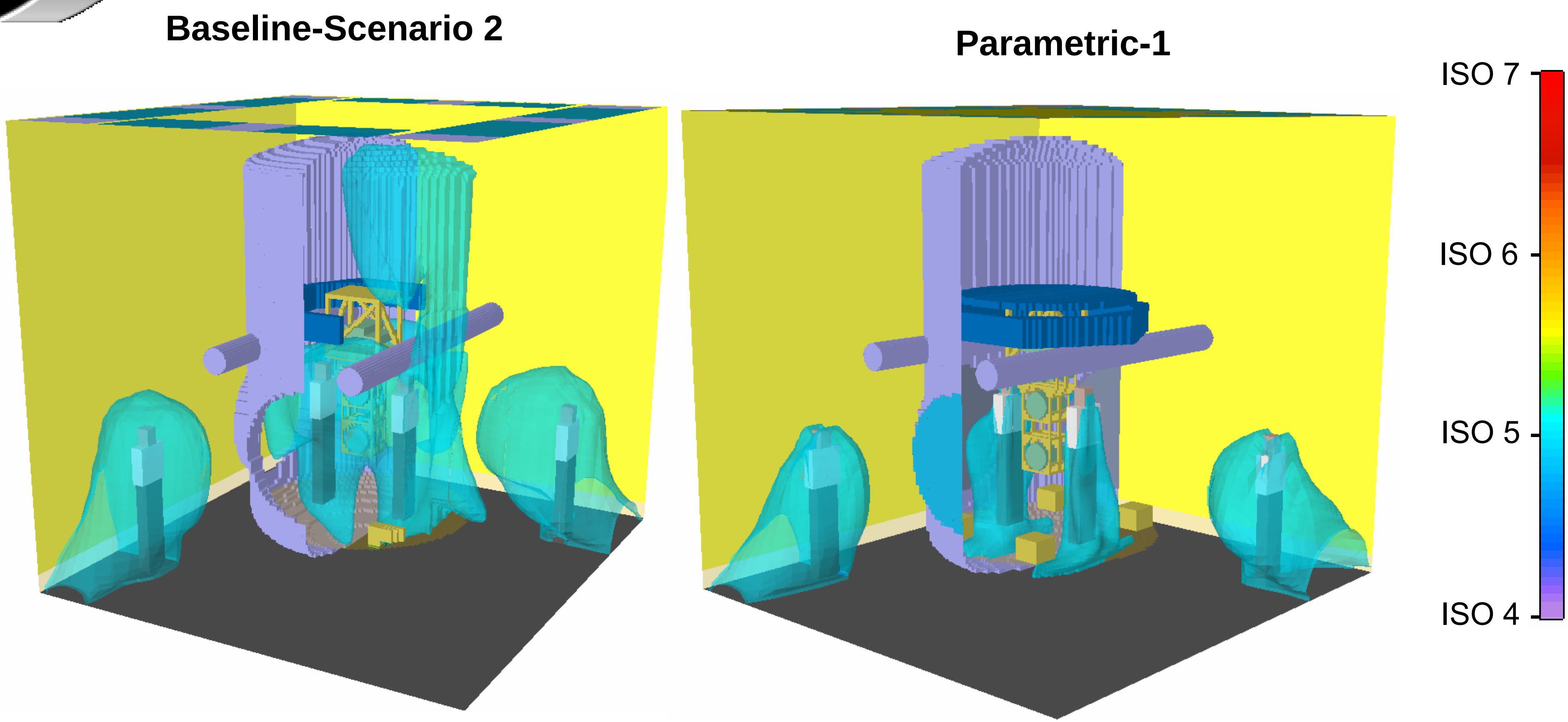
0.5 um diameter particles

Maximum concentration: 184,928 Particles/m^3 (ISO 7)

The following slides show the areas of the space at various uniform concentration levels.

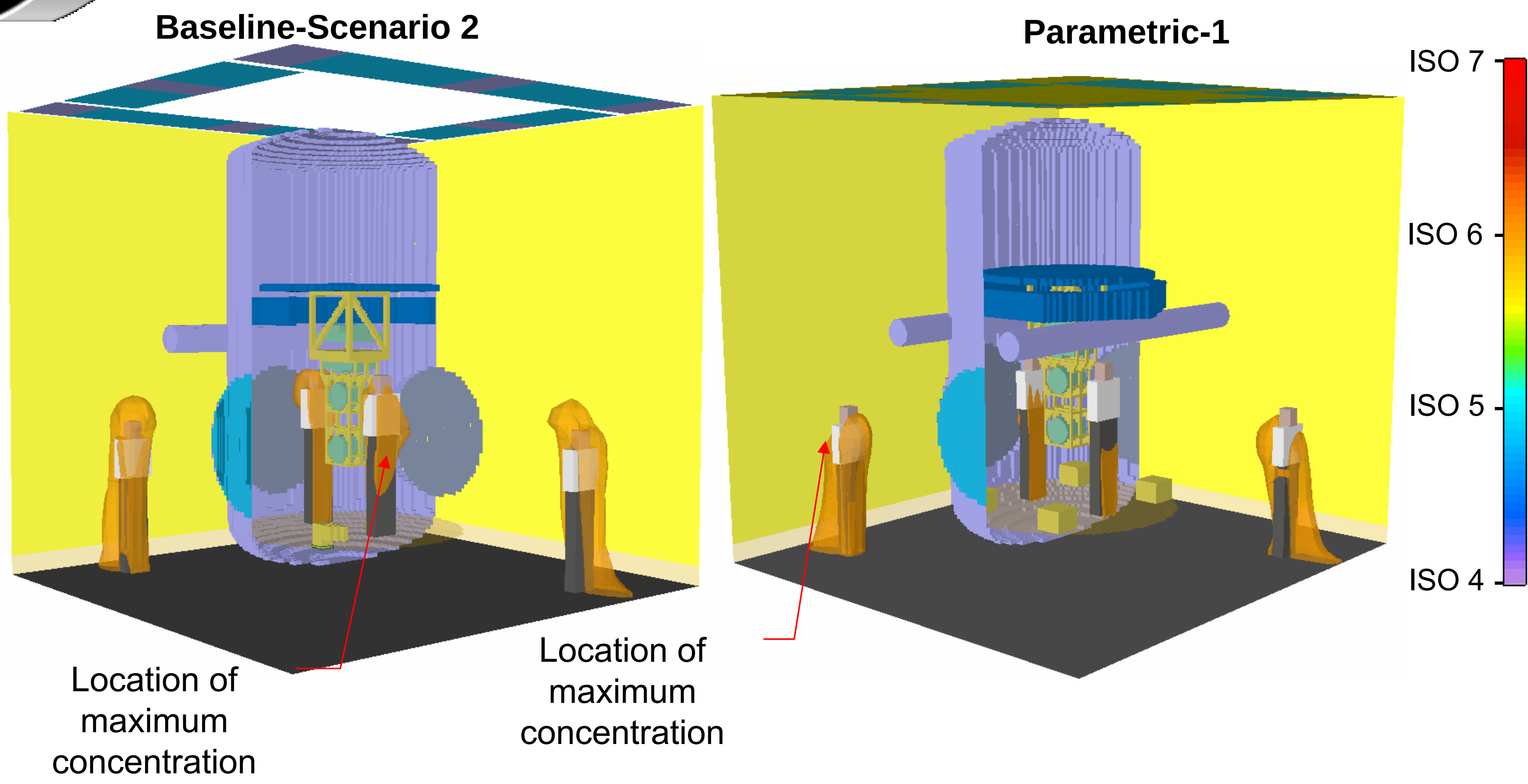
FLOMERICS

Design Comparison-ISO Class 5



Chamber doors hidden for visualization purposes

Design Comparison-ISO Class 6



Summary

- The thermal/airflow FLOVENT model of the BSC Chamber has been modified such that the airflow speed from the core area matches that of the annular area. A comparison between the Baseline-Scenario 2 and Parametric-1 simulations has been shown. Some conclusions are drawn below:
  - The increase in air flow resulted in a slight decrease in maximum particle concentration and the location of the maximum has moved outside the BSC Chamber.
  - Extracting flow through 4 -12” exhaust ducts has decreased the required work to move the air flow.
  - A more uniform airflow was obtained when increasing the core flow to match the speeds exiting the annular ring area. Any reduction/increase in overall airflow should maintain a consistent air speed from each delivery point.