High Pressure Rinsing of Accelerator Cavities

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Final Presentation

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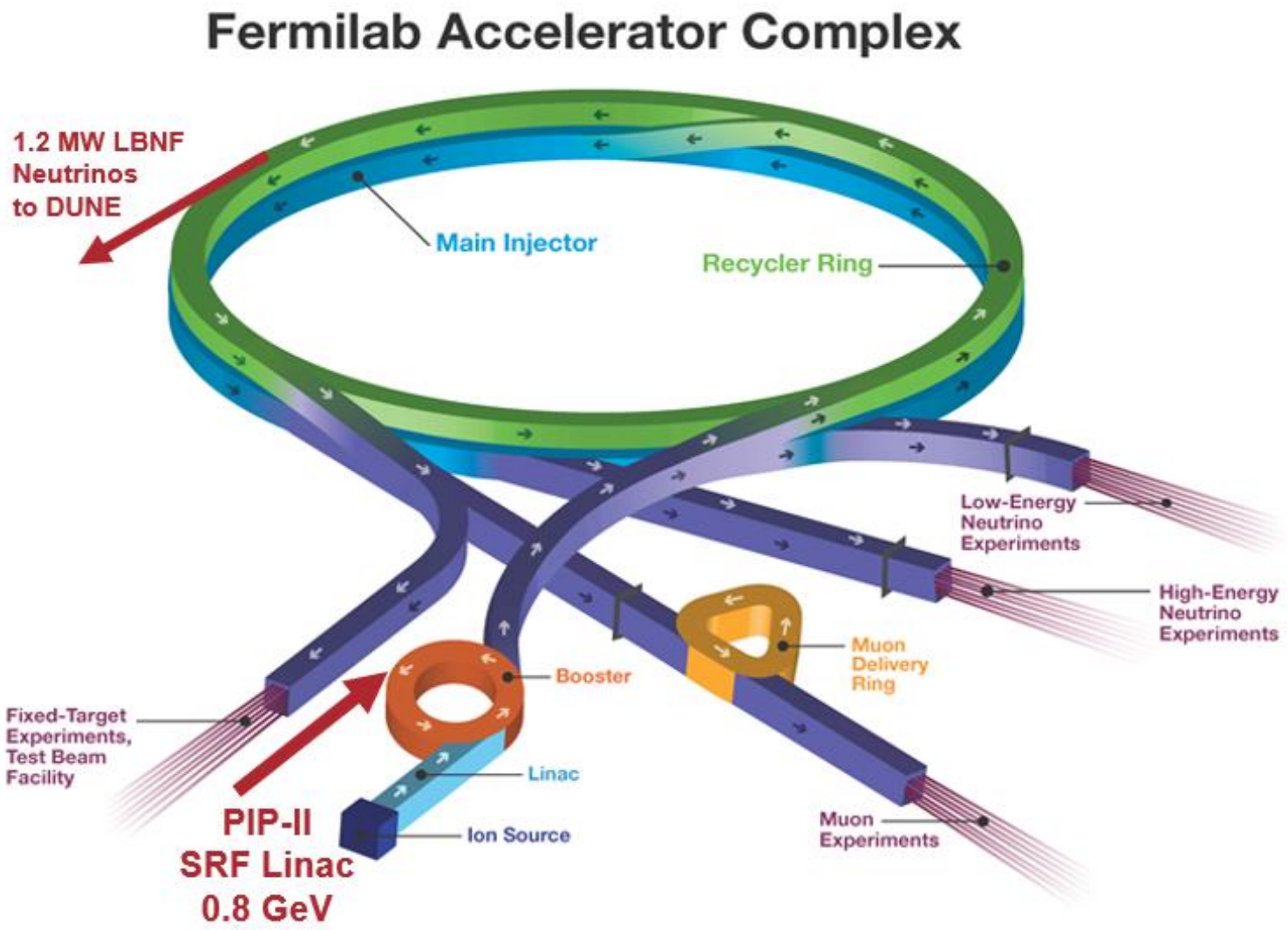
PIP-II is a partnership of:
- US/DOE
- India/DAE
- Italy/INFN
- UK/STFC-UKRI
- France/CEA, CNRS/IN2P3
- Poland/WUST

PIP-II



- Linac energy increased from 0.4 GeV to 0.8 GeV
- Energy of Neutrinos delivered to DUNE increased from 0.75 MW to 1.2 MW

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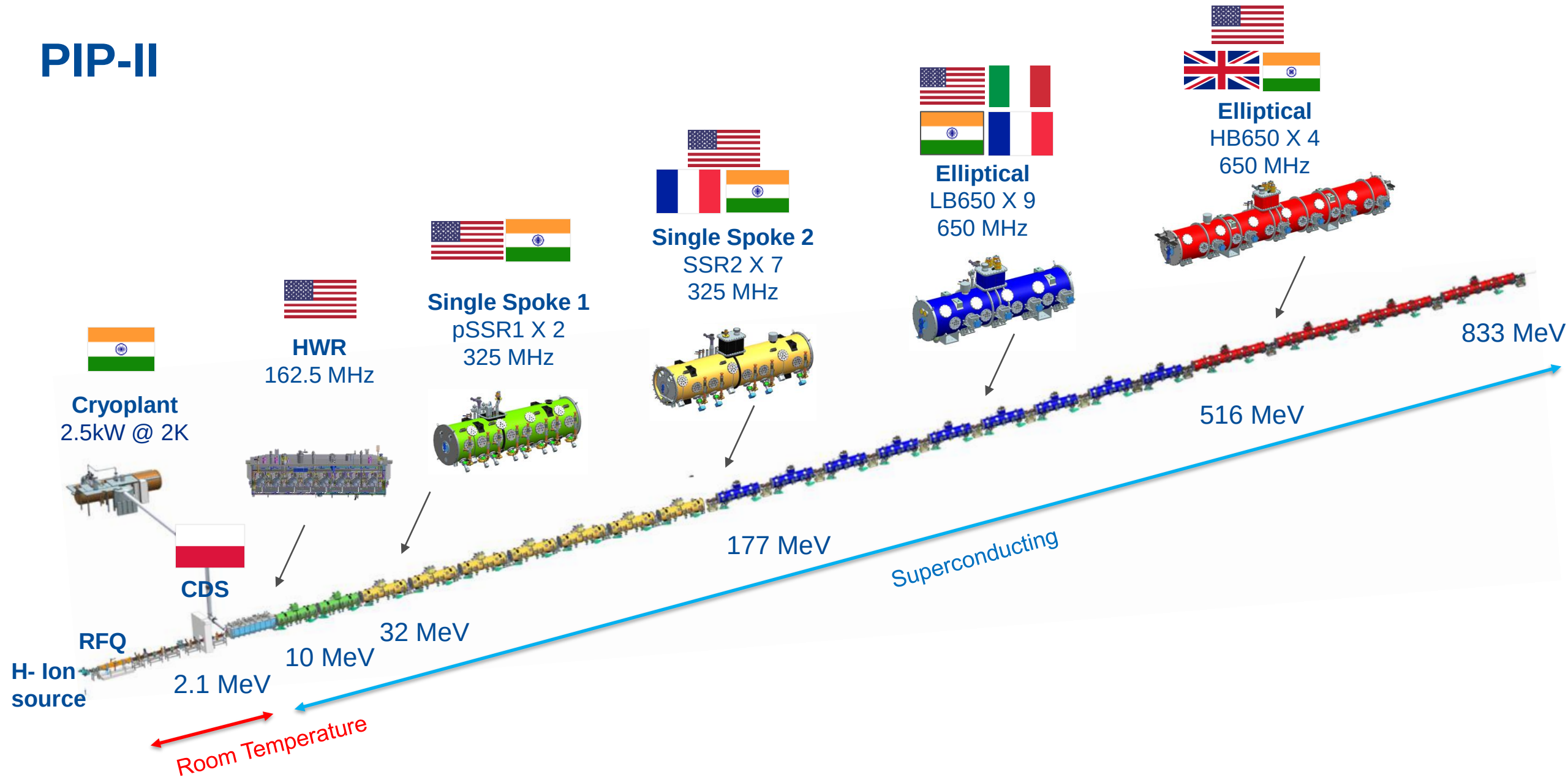

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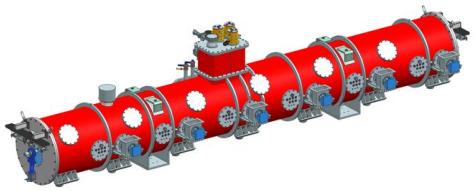
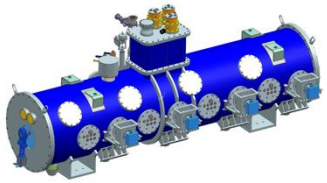
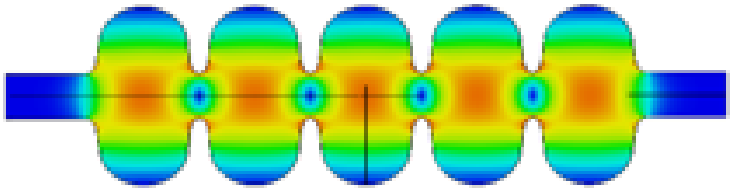
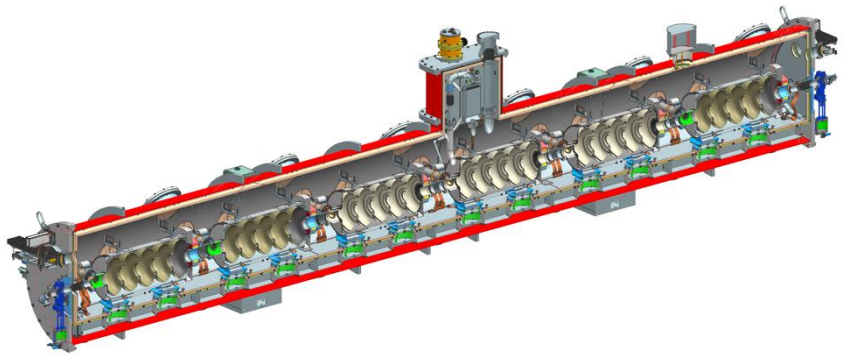
PIP-II

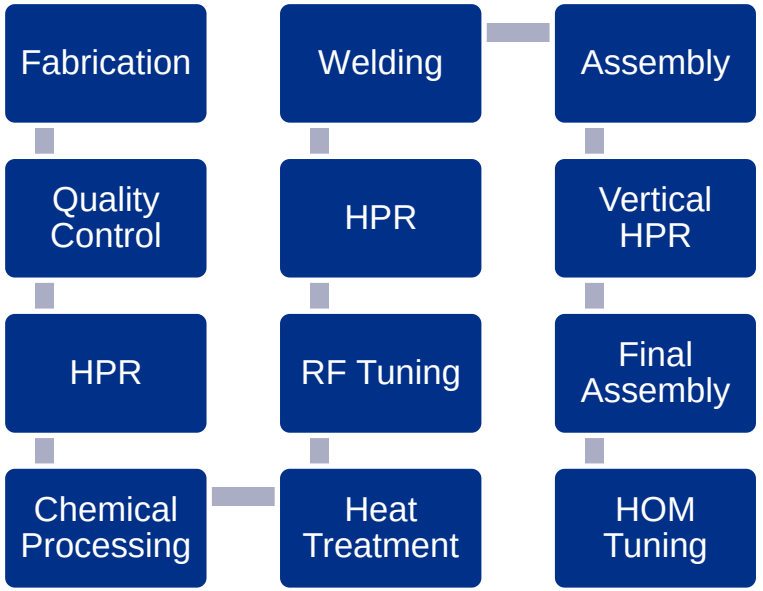








- Niobium chosen for its super conductive and mechanical properties
- HPR for elliptical cavities (low beta and high beta)



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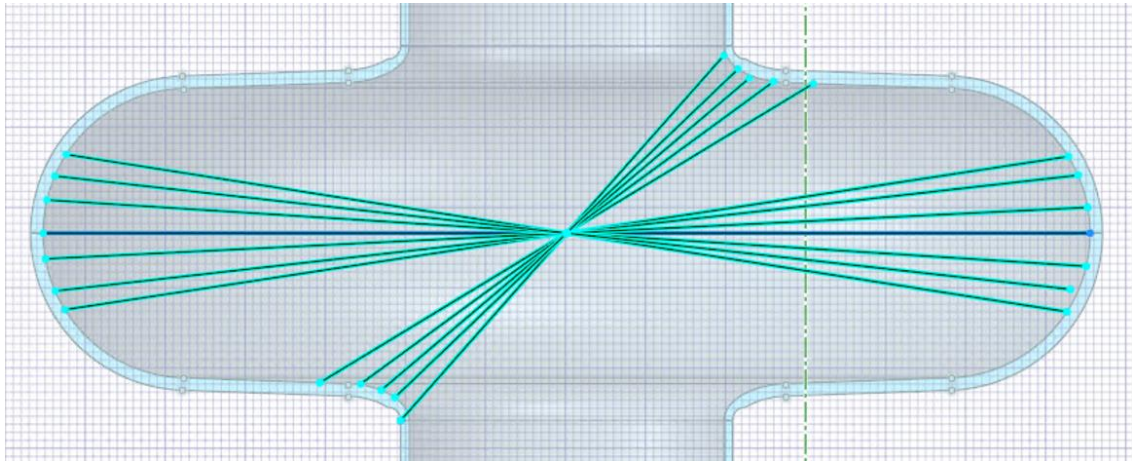
Motivation

- Particle contaminates act as electron field emitters, limiting performance
- High Pressure Rinse (HPR) used to remove particle contaminates



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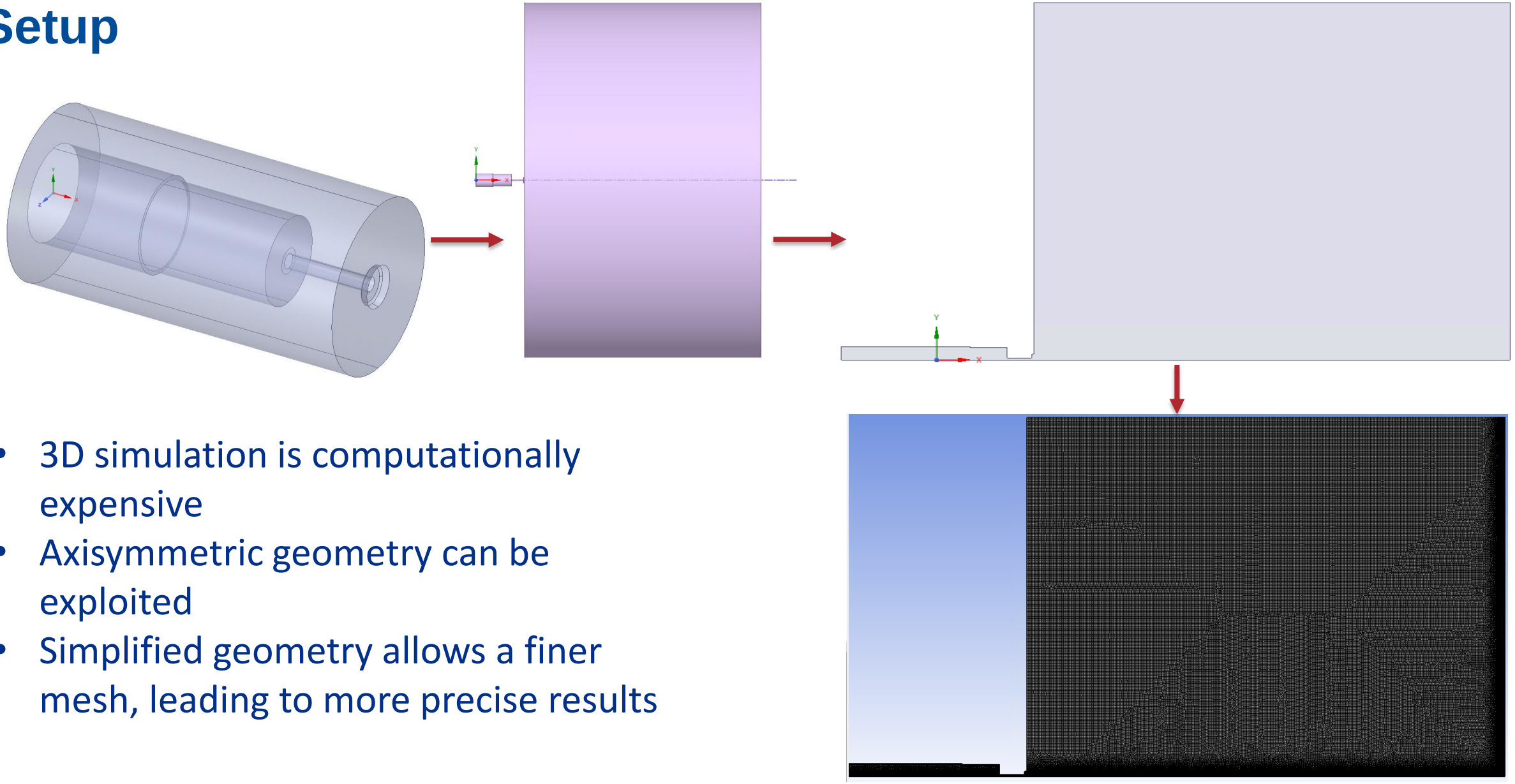
Setup



- 3D simulation is computationally expensive
- Axisymmetric geometry can be exploited
- Simplified geometry allows a finer mesh, leading to more precise results

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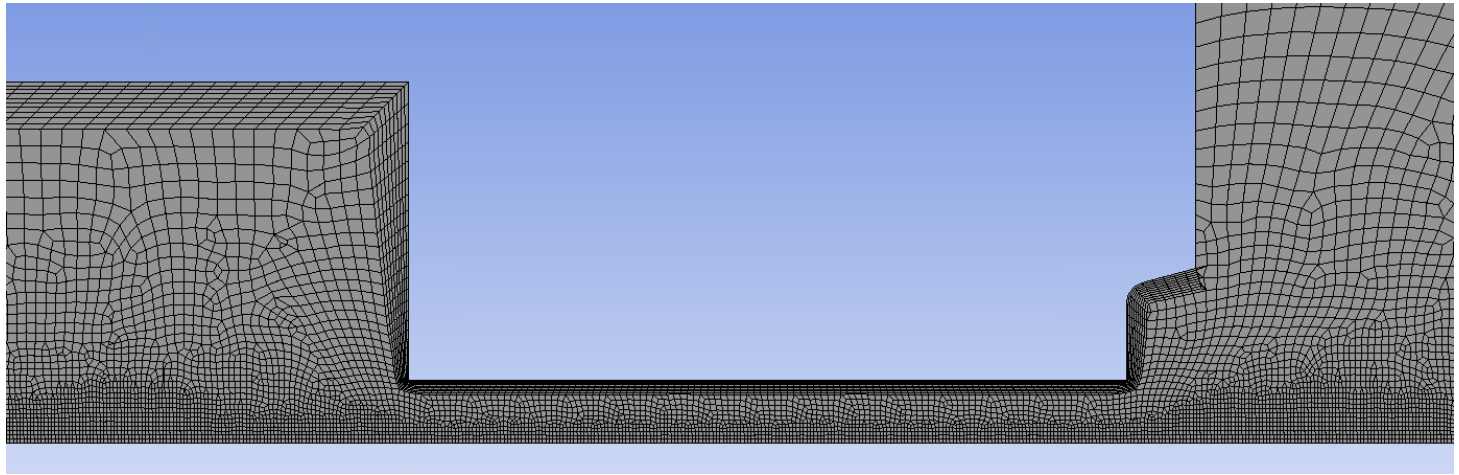
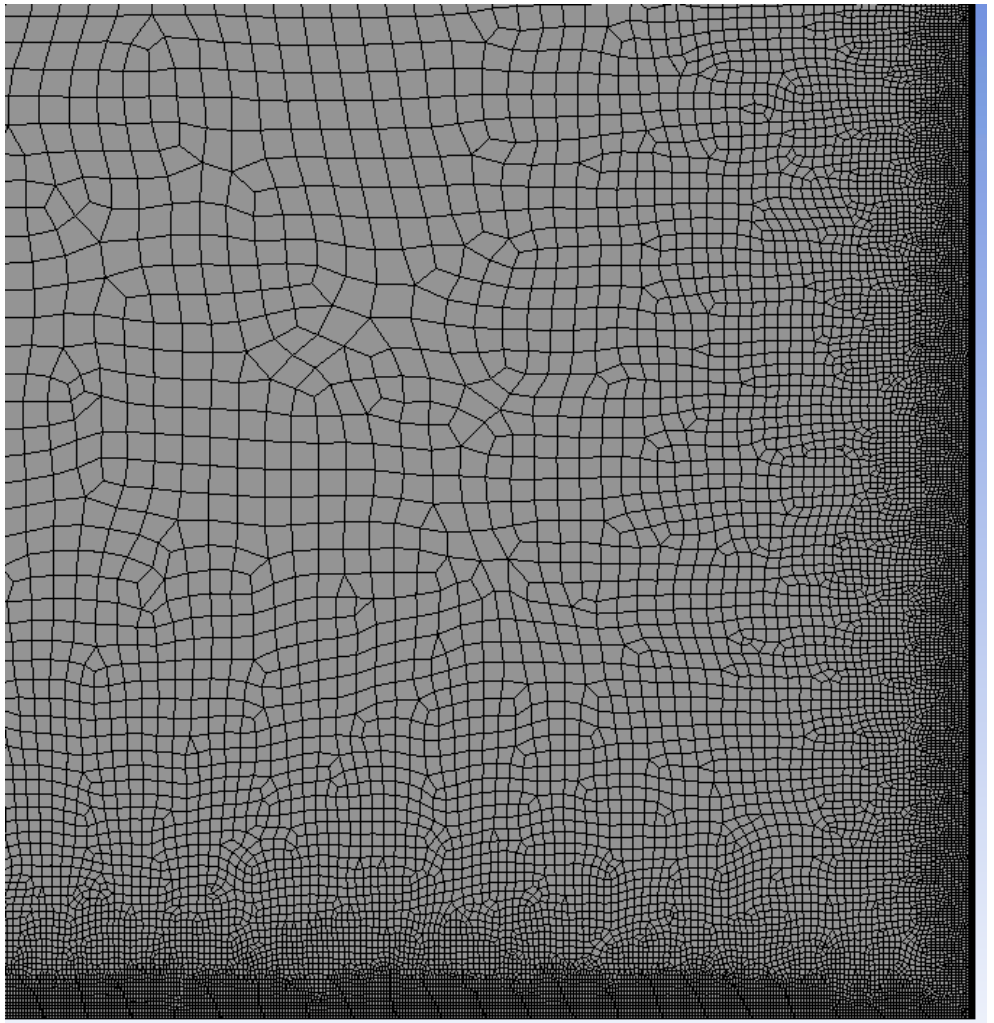
Setup

- Larger cells where flow is not expected improves computation time
- Adding inflation along critical boundaries improves precision
- Smooth transitions decrease mathematical errors





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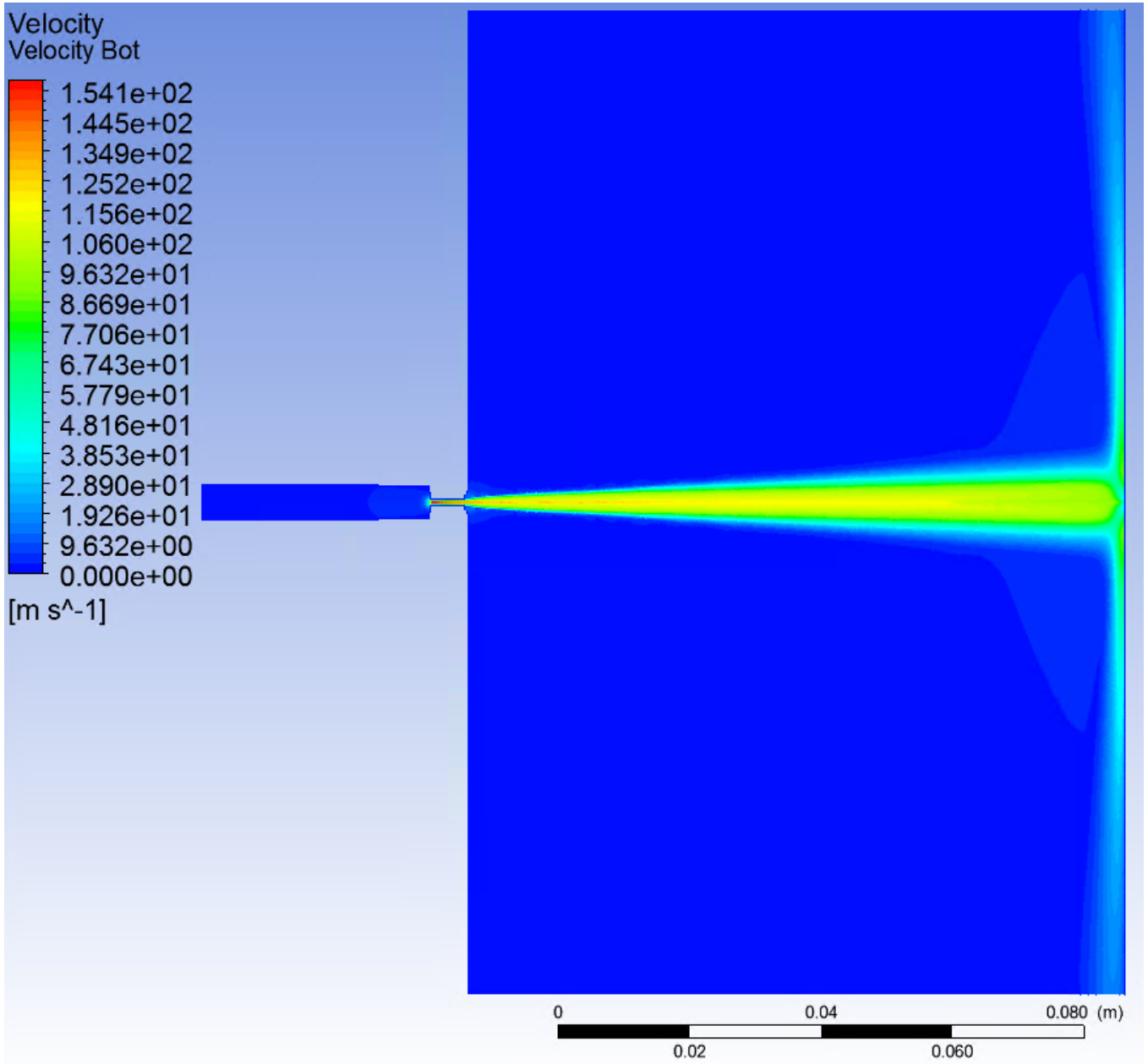
Results

- Results mirrored for visual
- Inlet velocity set

Parameter	Predicted	Results	% Dif
Inlet Velocity	2.8 m/s	2.8 m/s	N/a
Force on Wall	9 N	7.42 N	17.5%



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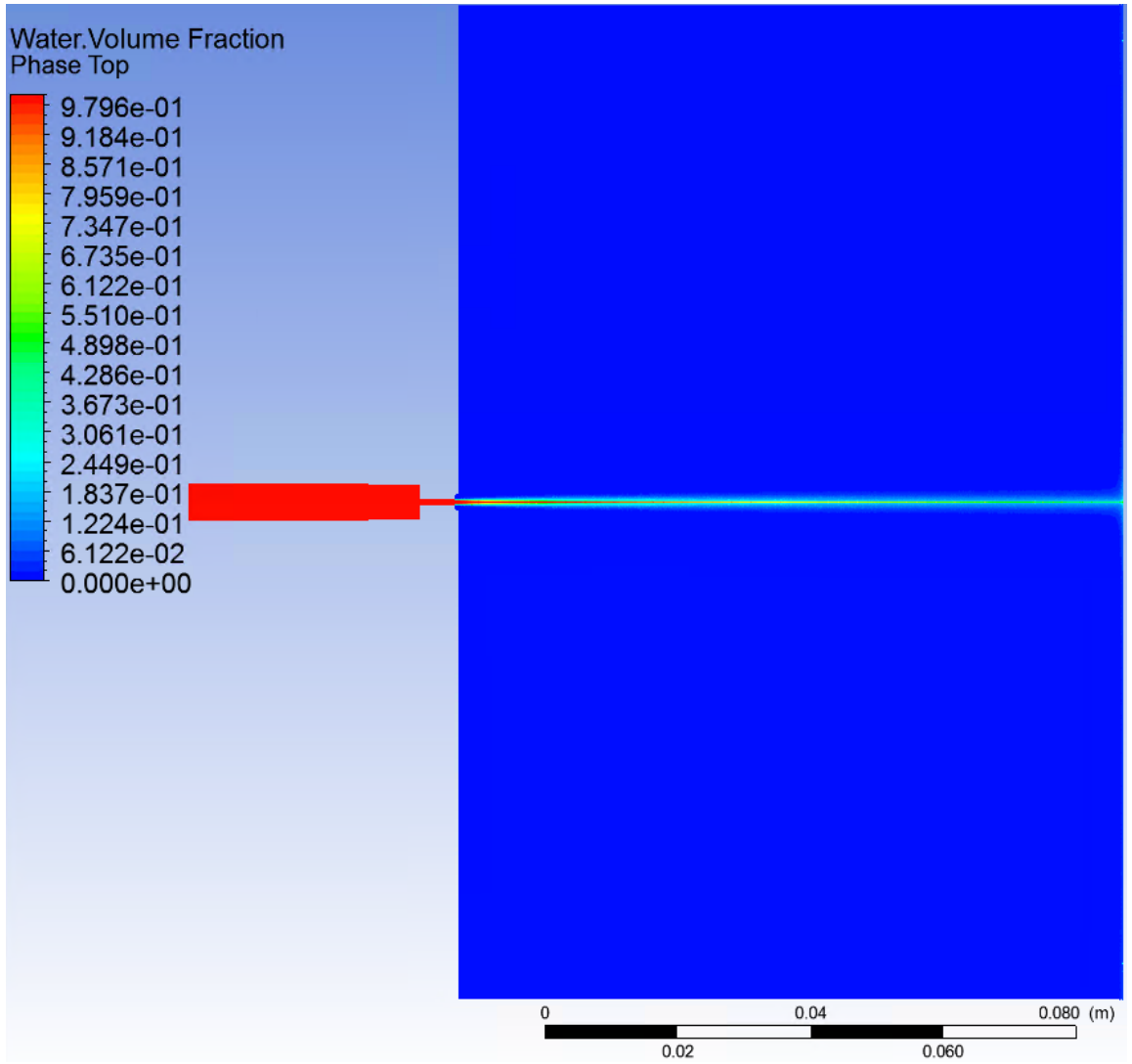
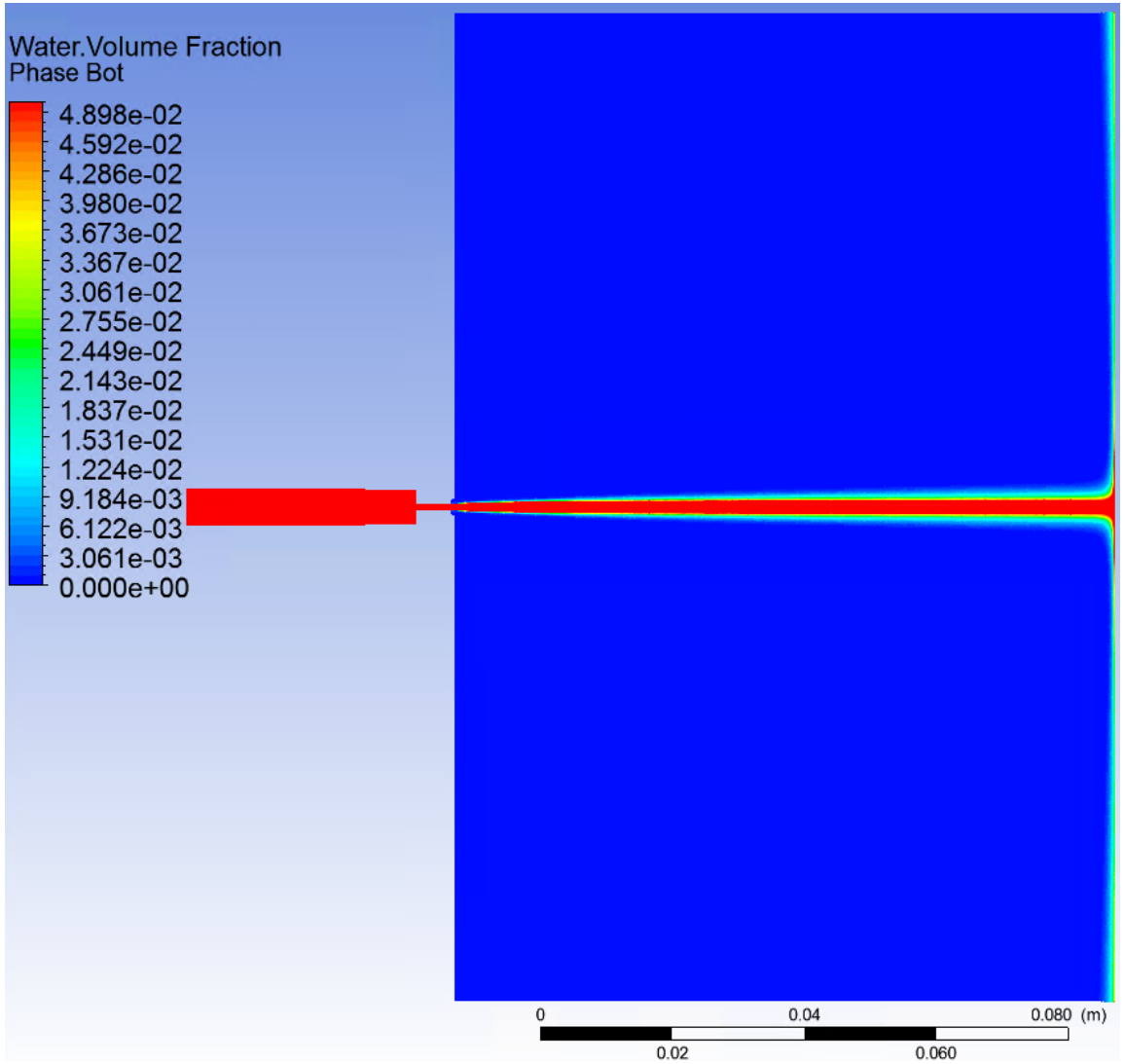
Results





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Results

- Y+ is a non dimensional parameter used in calculating shear force
- Smaller Y+ means the viscous sub layer in resolved well

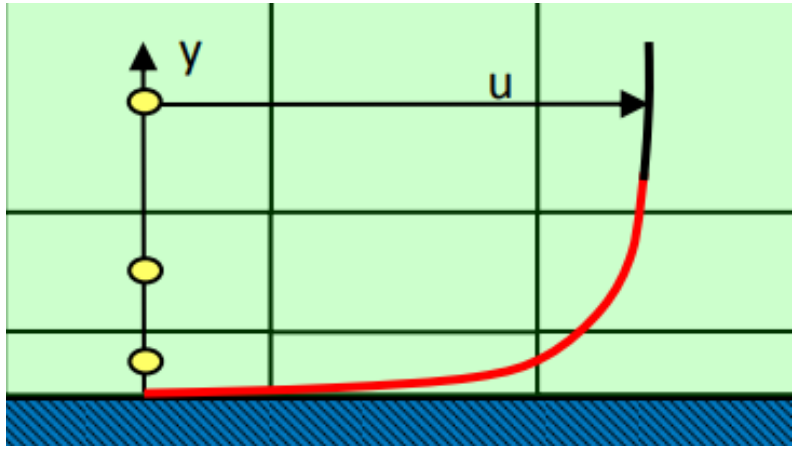
$$y^+ = \frac{u_\tau \rho y_P}{\mu} \quad [1]$$

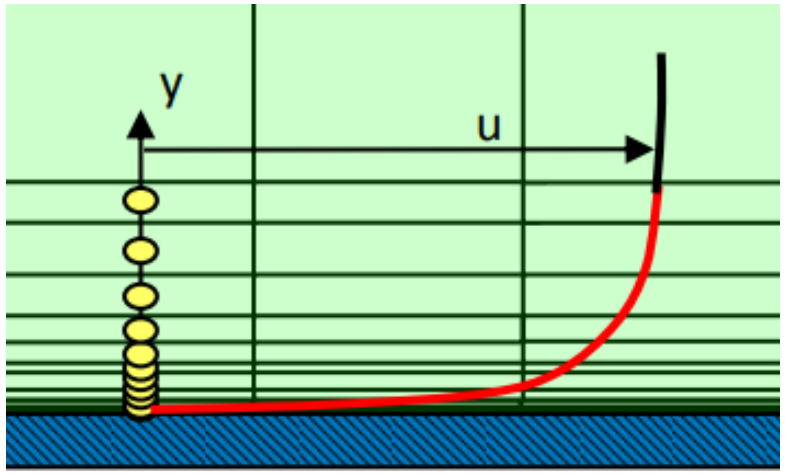
$u_\tau = \sqrt{\frac{\tau_w}{\rho_w}}$ the friction velocity

ρ the fluid density

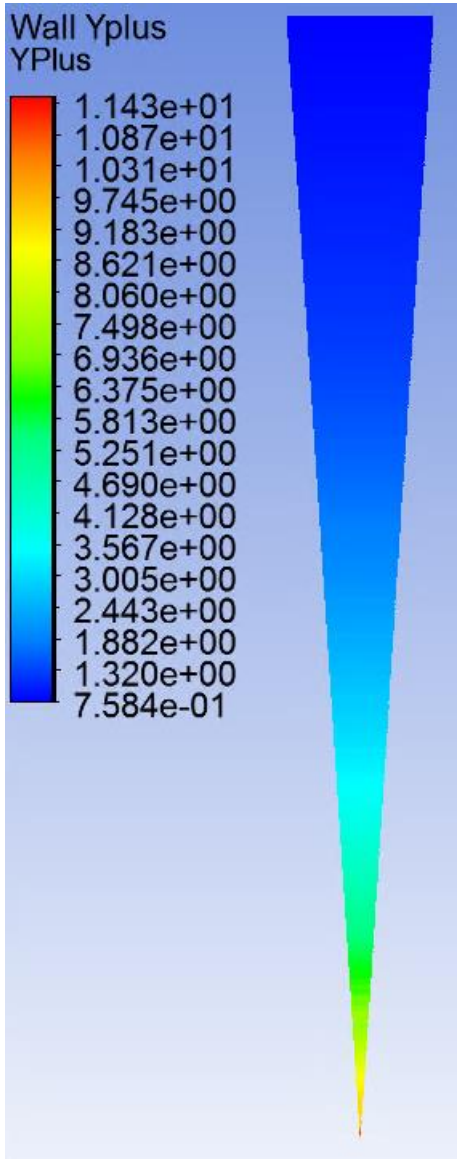
y_P the distance from point P to the wall

μ the fluid viscosity at point P





[2]



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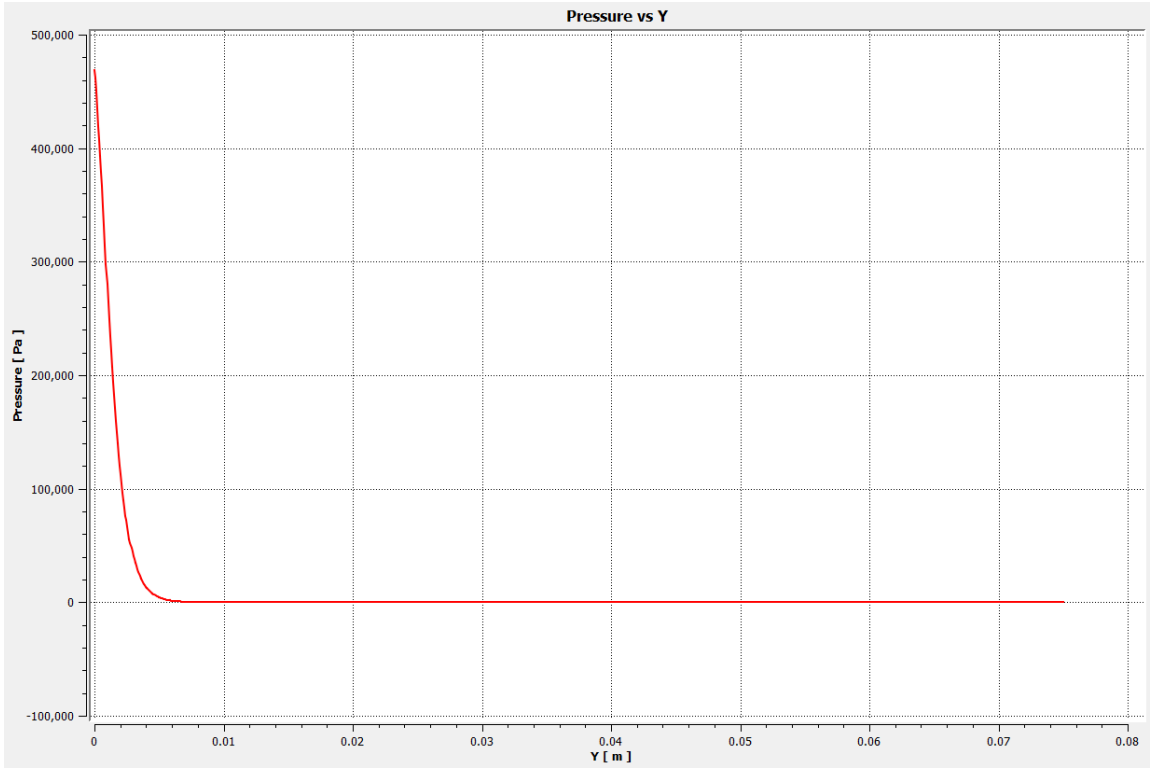
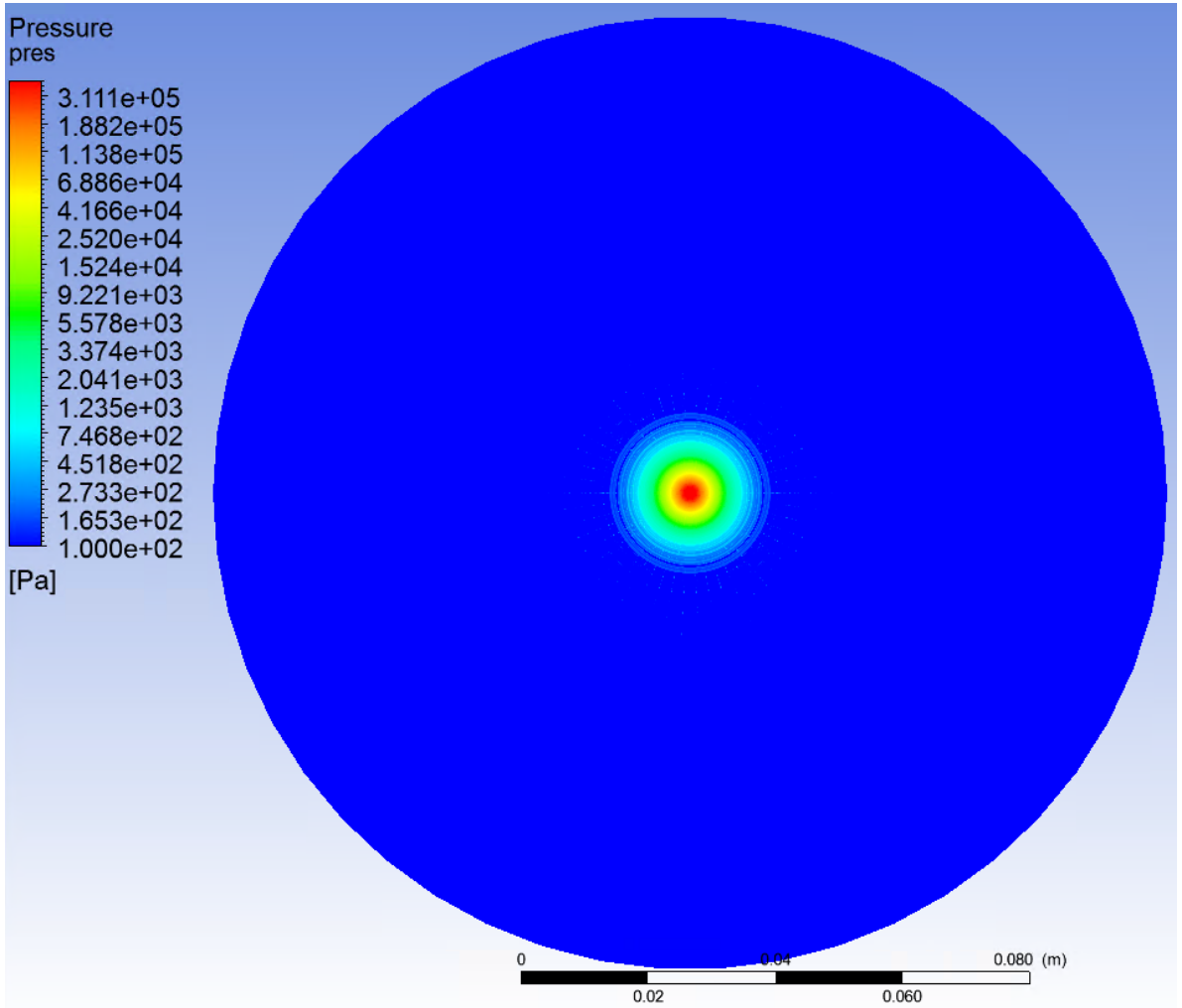
Results

- Full width at half maximum shows spot size is 1.2 mm





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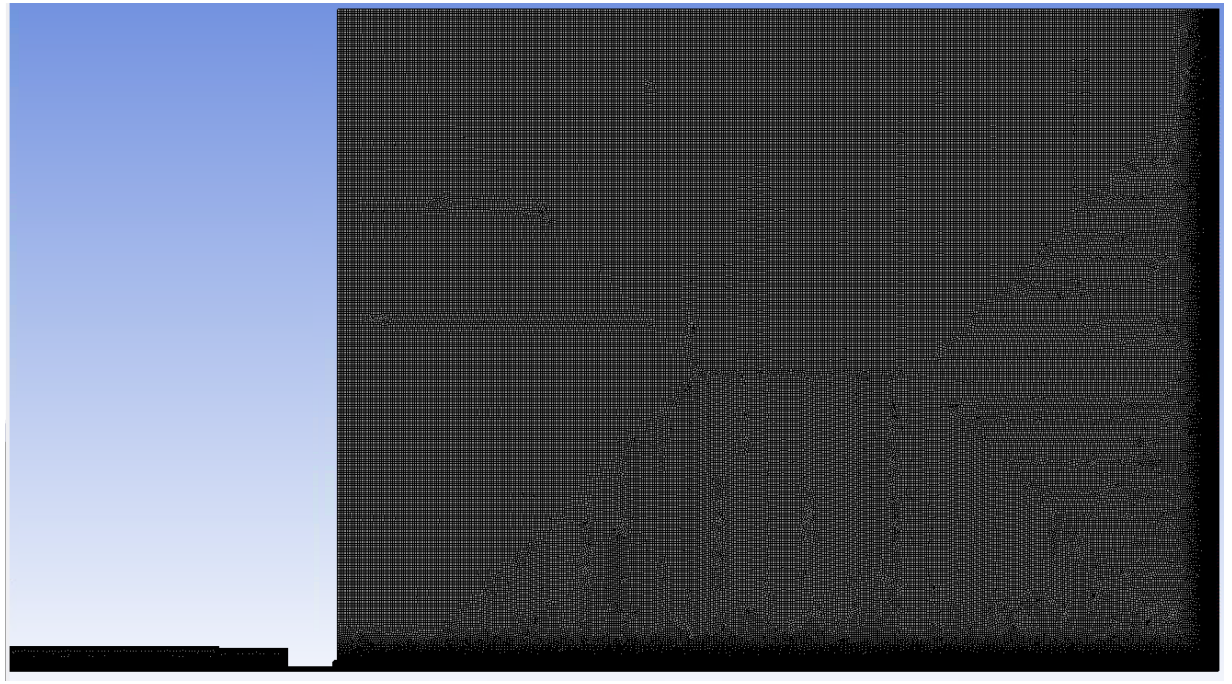
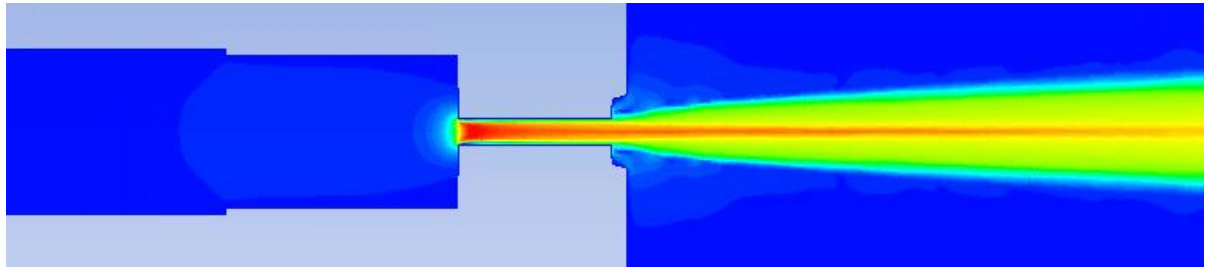
Conclusion

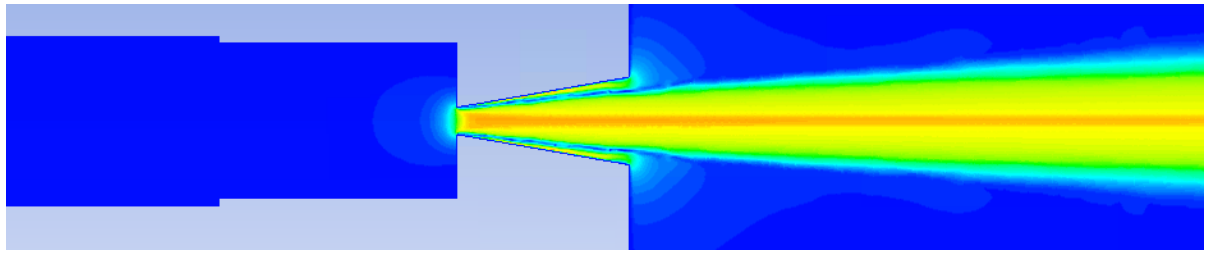
- Inflation layers in the inlet better capture the boundary layer and shape of the jet
- Inflation layers near the wall decreases Y+ and improves shear stress accuracy
- Axisymmetric geometries can be simplified to reduce calculation time

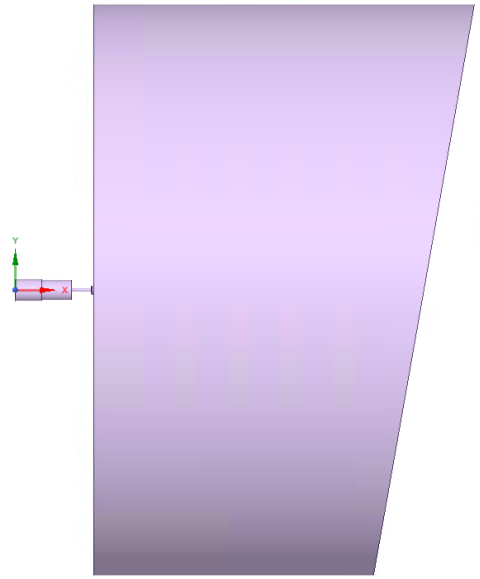


Next Steps:

- 2D simplification is limited to axisymmetric geometries
- Investigate 3D to understand wall shear
- Observe behavior of different nozzles
- Compare steady and transient results







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References

[1] SAS IP, Inc. (2013). Ansys Fluent User's Guide (15.0).

[2] Lecture 7: Turbulence Modeling. (2022, August). Introduction to ANSYS Fluent.

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Questions?

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