COMSOL CONFERENCE EUROPE 2012

Turbulent Bounded Flows for Oil & Gas Industry CFD Module

Excerpt from the Proceedings of the 2012 COMSOL Conference in Milan

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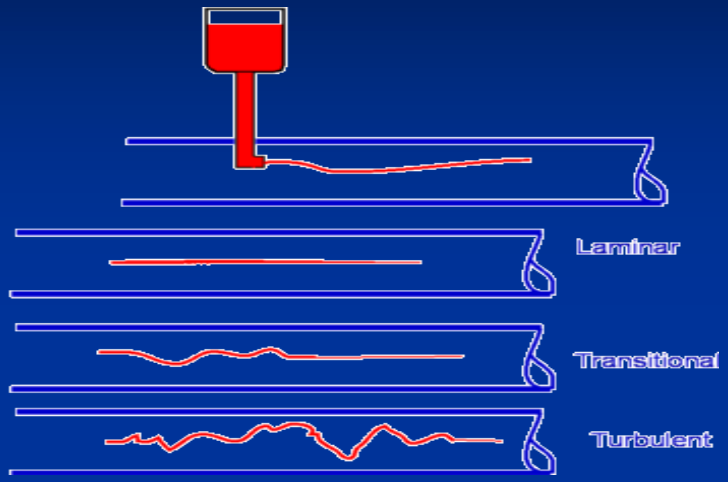
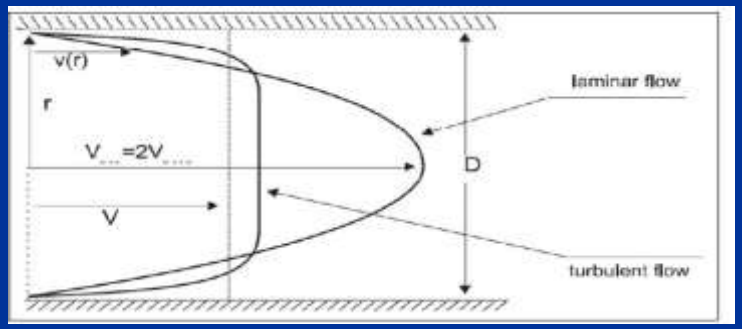
Introduction

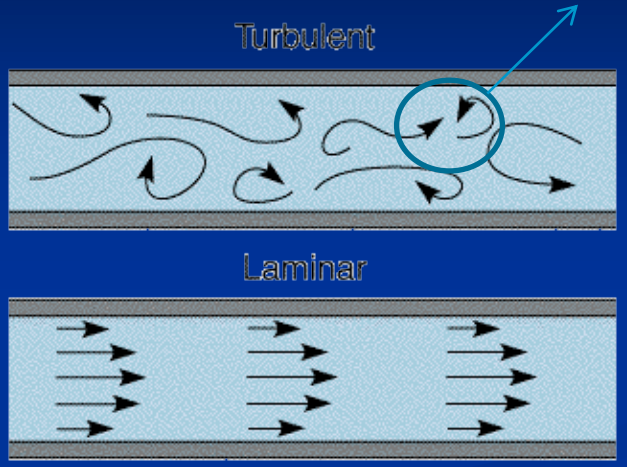
Reynolds' Experiment:



Transition: Re=2.200



Eddies
Turbulent Vsicosity



Re from 200 to 600.000

Bounded Flows:

- Streamlines
- Head Loss
- Time of Residence

Customer -oriented

Pressure Equipment Directive
Organisation Internationale de Métrologie Légale

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CFD with COMSOL

- Modeling means approximation:
  - Spalart - Almaras
  - k-ε
  - k-ω (Bounded Flows)
- Almost automatic meshing:
  - Size –Bulk
  - Size – Boundary
  - Manual Boundary Layer Mesh, 1st Layer Thickness
- Solvers:
  - Iterative
  - Direct - PARDISO

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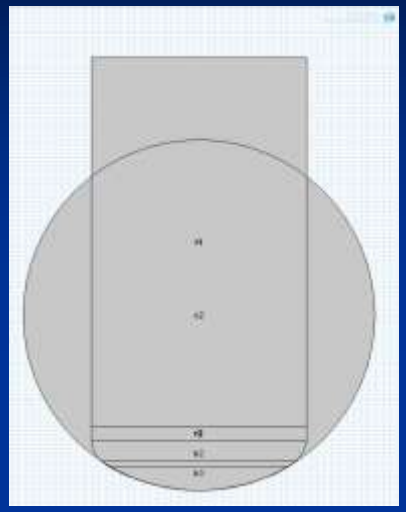
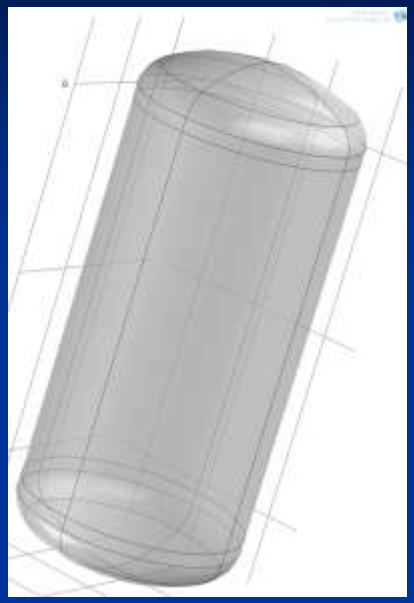
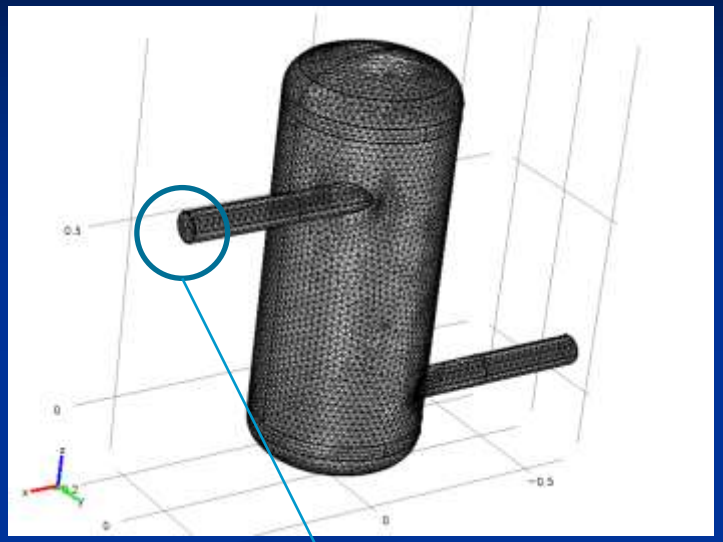
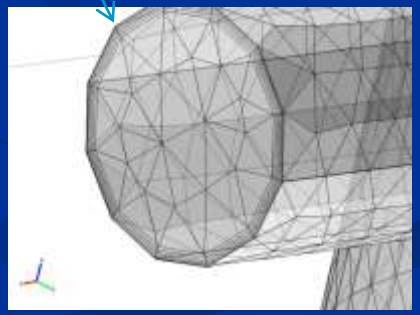
Air Separator DV

CAD & Mesh









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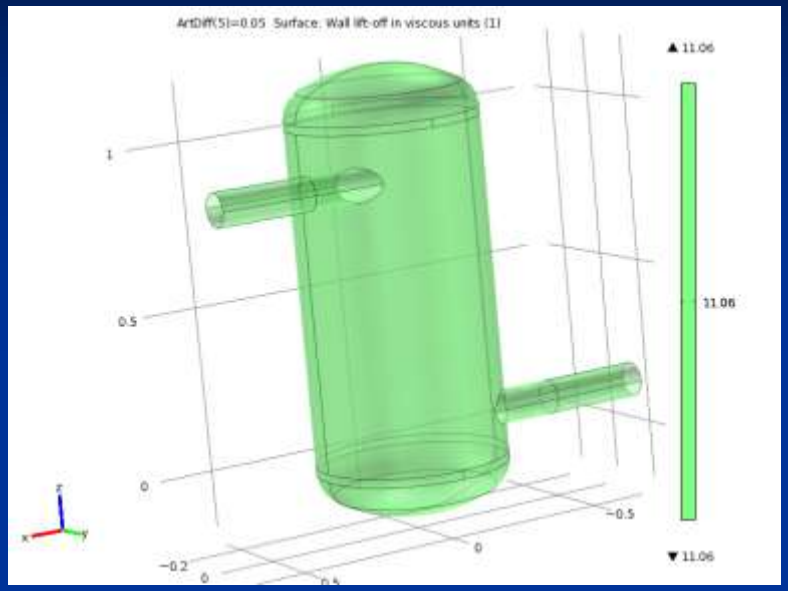
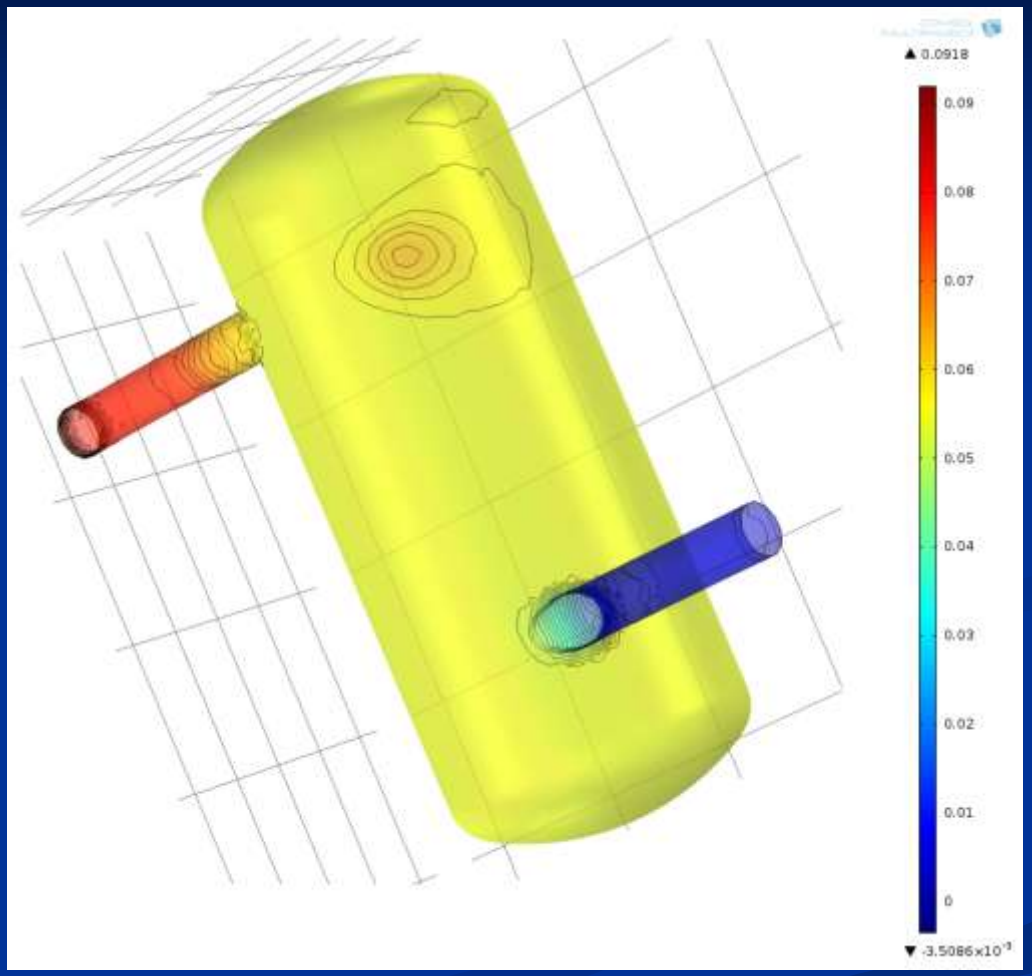
DV – Results (1)





Check Dimensionless Wall Distance for consistency

Data can be extracted through 3D/2D plot and specific operations (model couplings)

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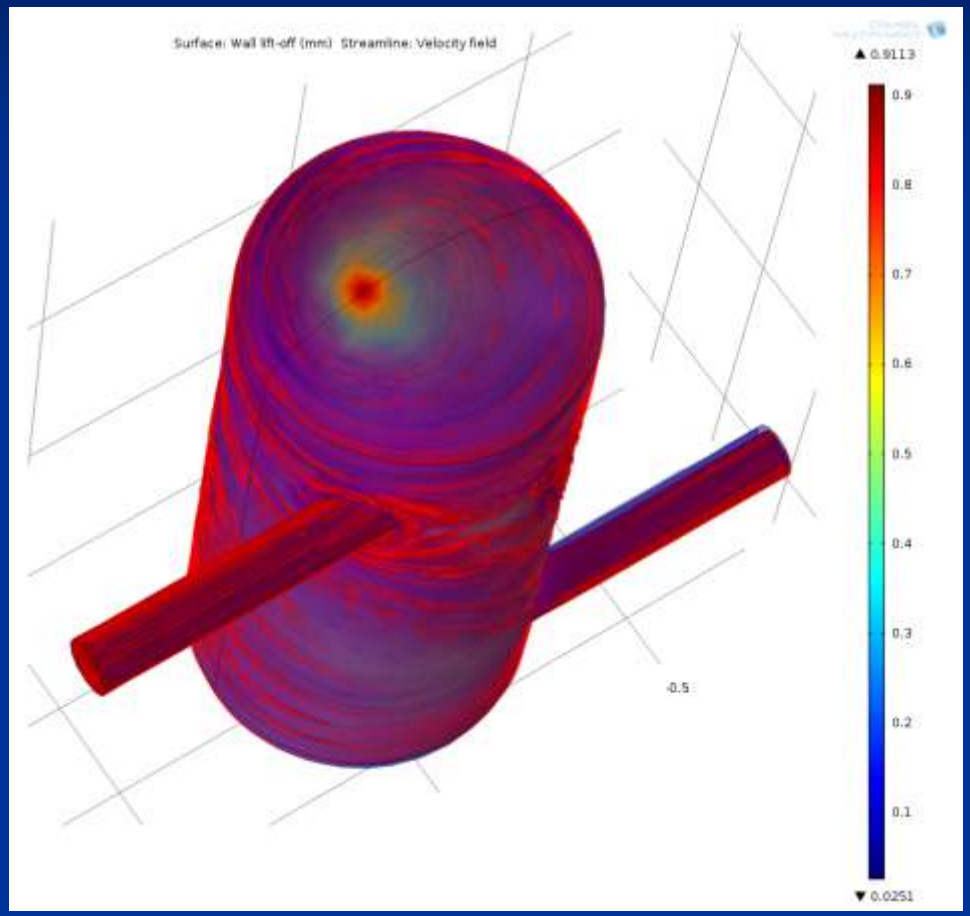
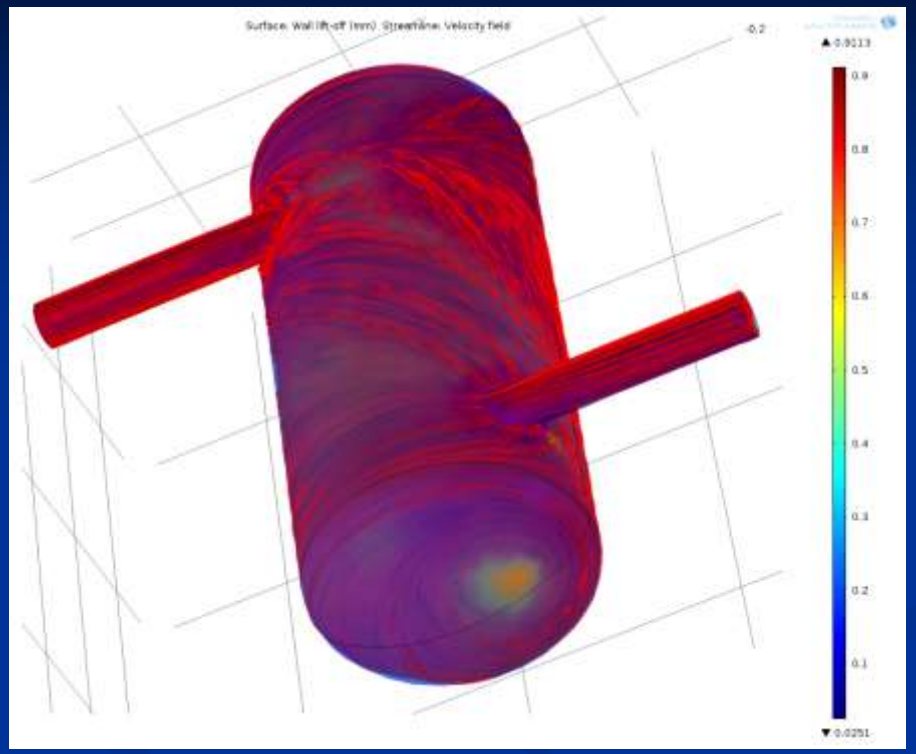
DV – Results (2)





Streamlines highlight vortex formation

Upper and lower vertices of vortex coincide with local maxima for dimensional wall distance

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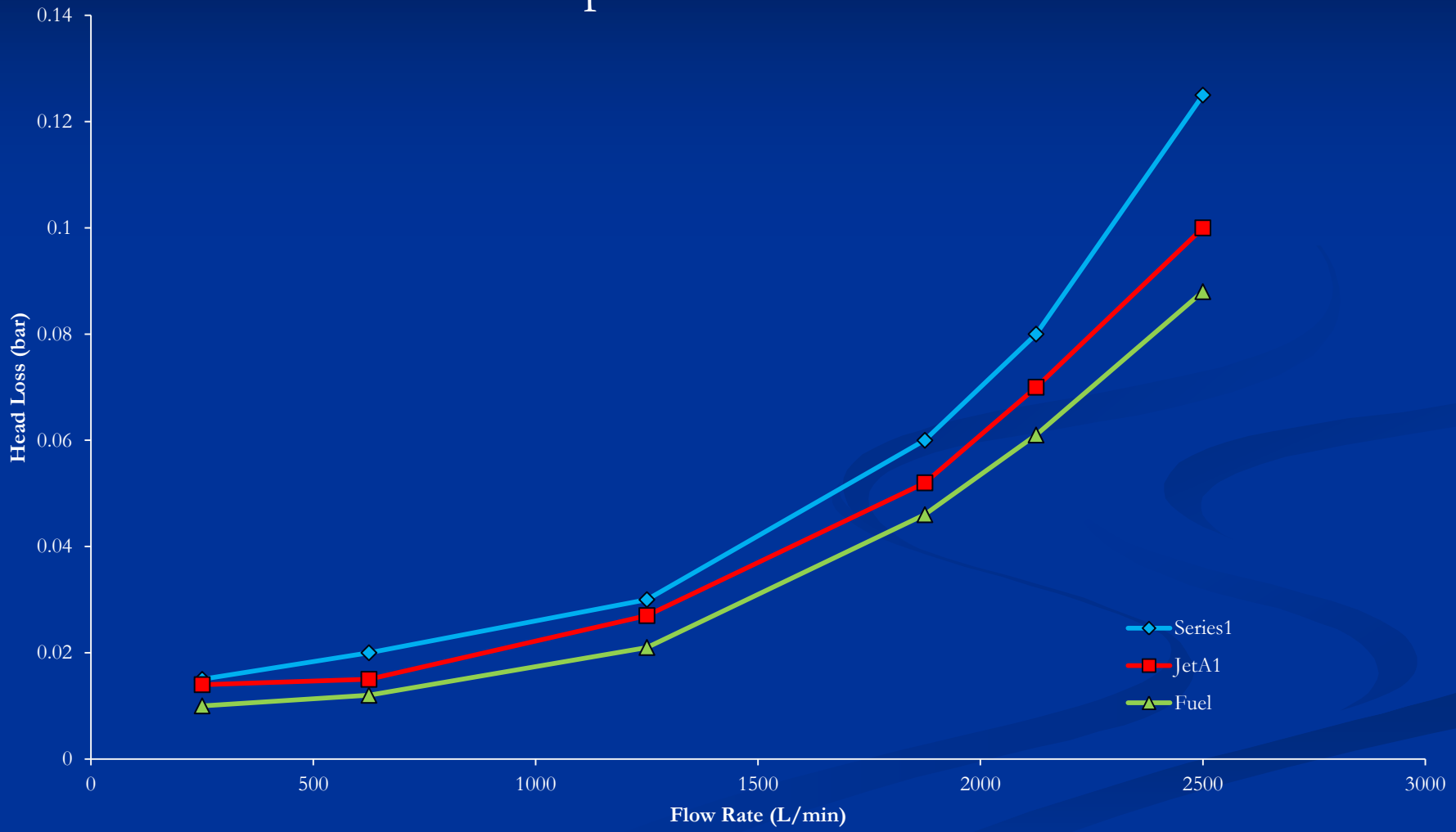
DV – Results (3)

Pressure Drop as a Function of Flow Rate



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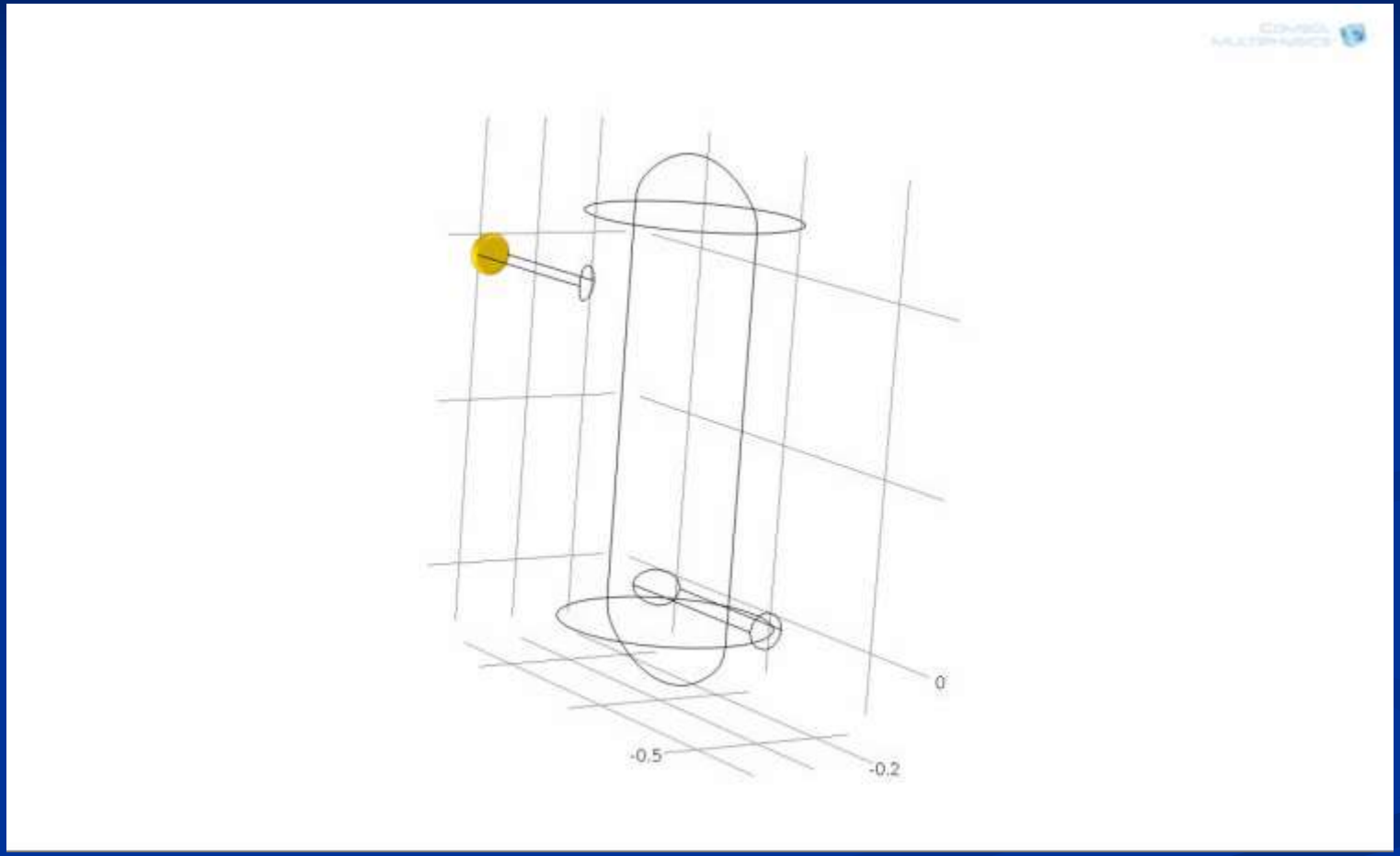
DV – Results (4)



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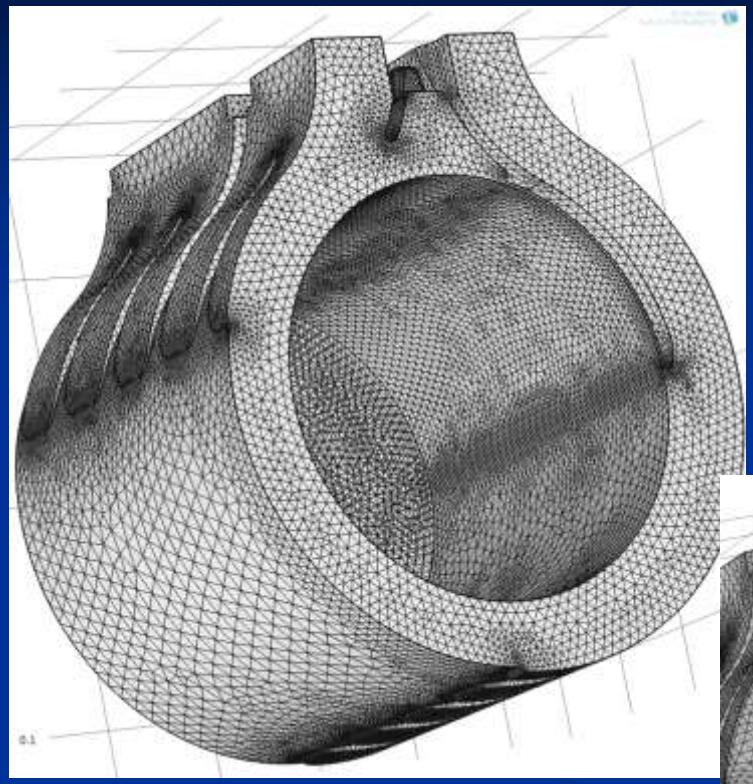
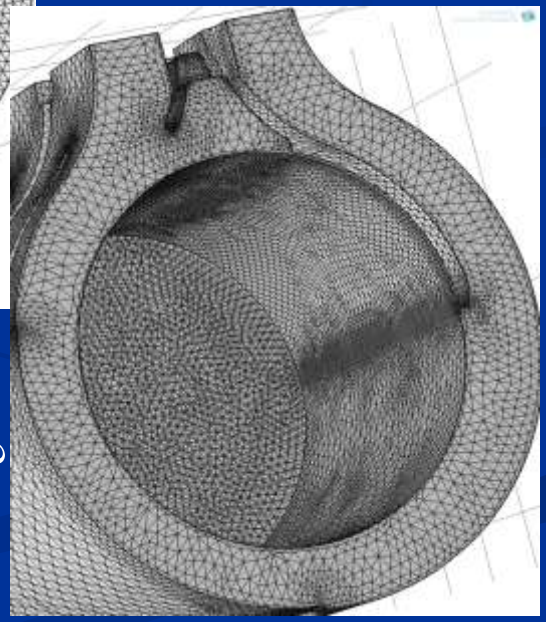
Flow Meter BM - Model



D.O.F. up to 1.7e6



- Irregular Geometry:
  - Aspect Ratio ≈1.500
- Moving Walls Functions:
  - Thickness 1° Layer B.L.M.
  - Dimensionless Wall Distance
  - Dimensional Wall Distance

Transition???

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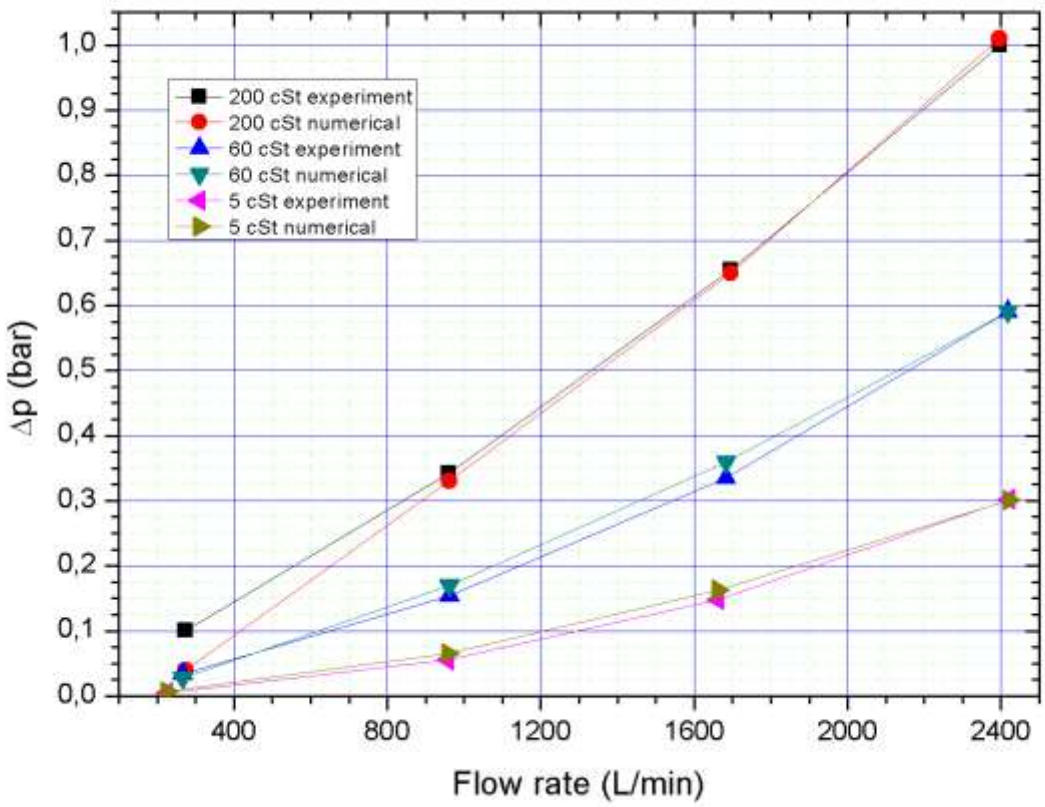
Flow Meter BM

Validation



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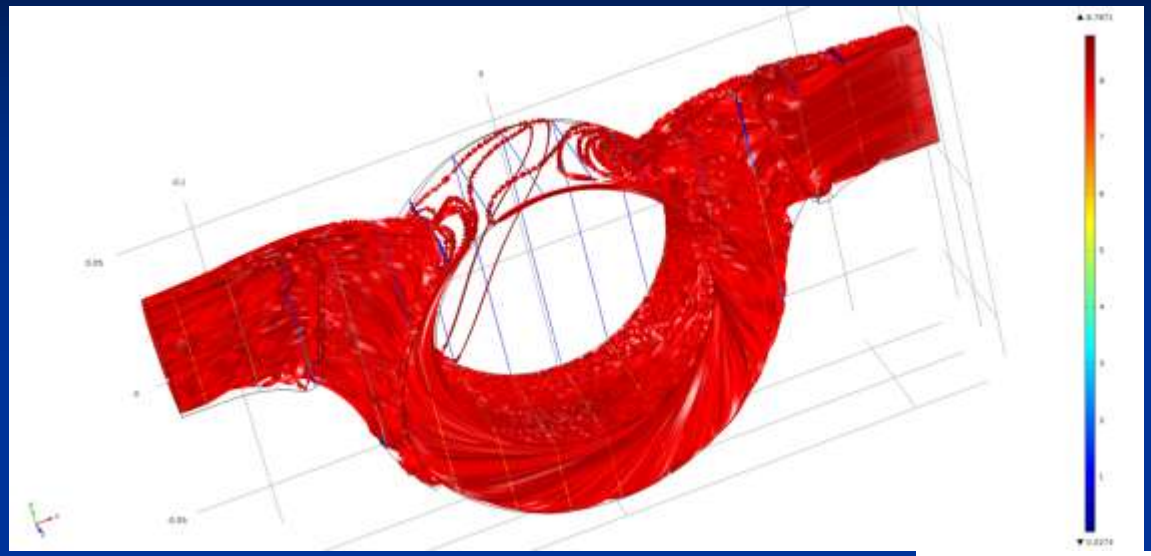
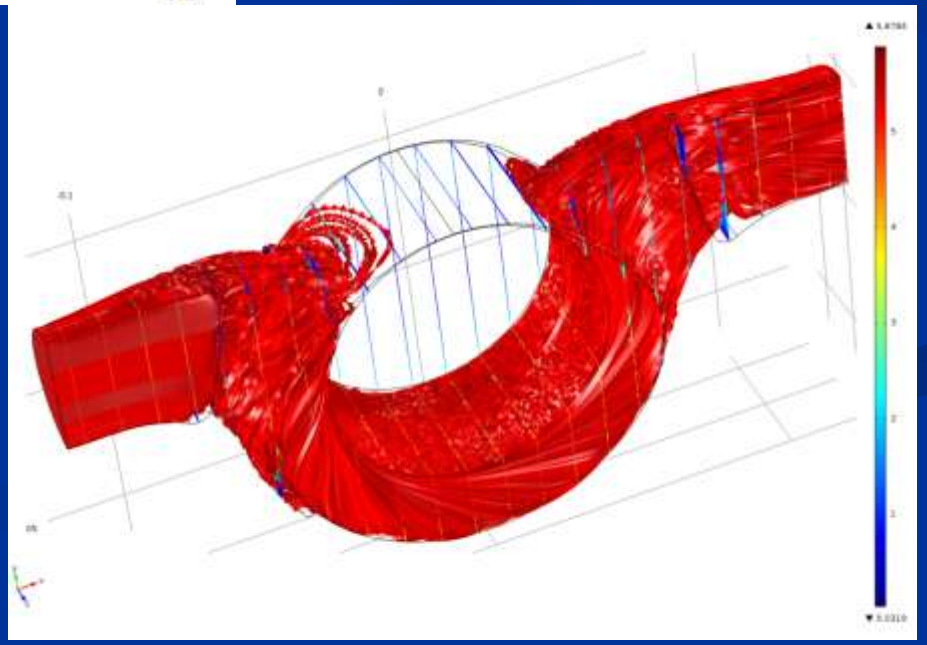
New BM

Influence of Geometry





- Small Changes in Geometry:
  - Reduce re-circulation
  - Avoid negative effects on head loss

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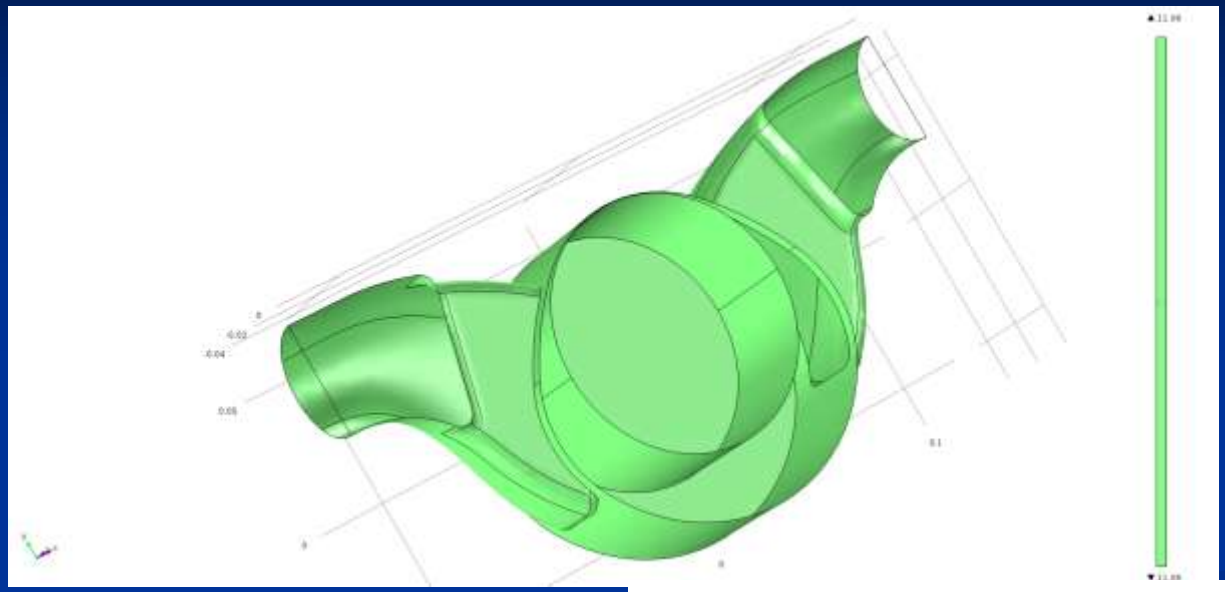
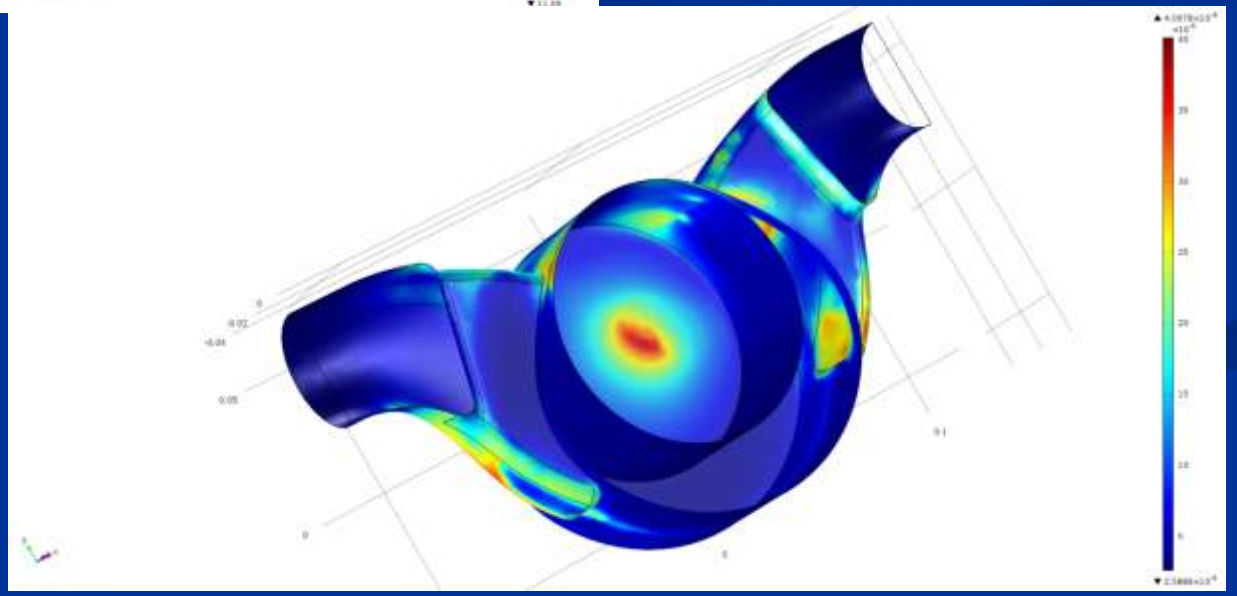
New BM

Consistency



Dimenionless Wall Distance must always equal 11.06

Dimensional Wall Distance must always be less than local characteristic lengths



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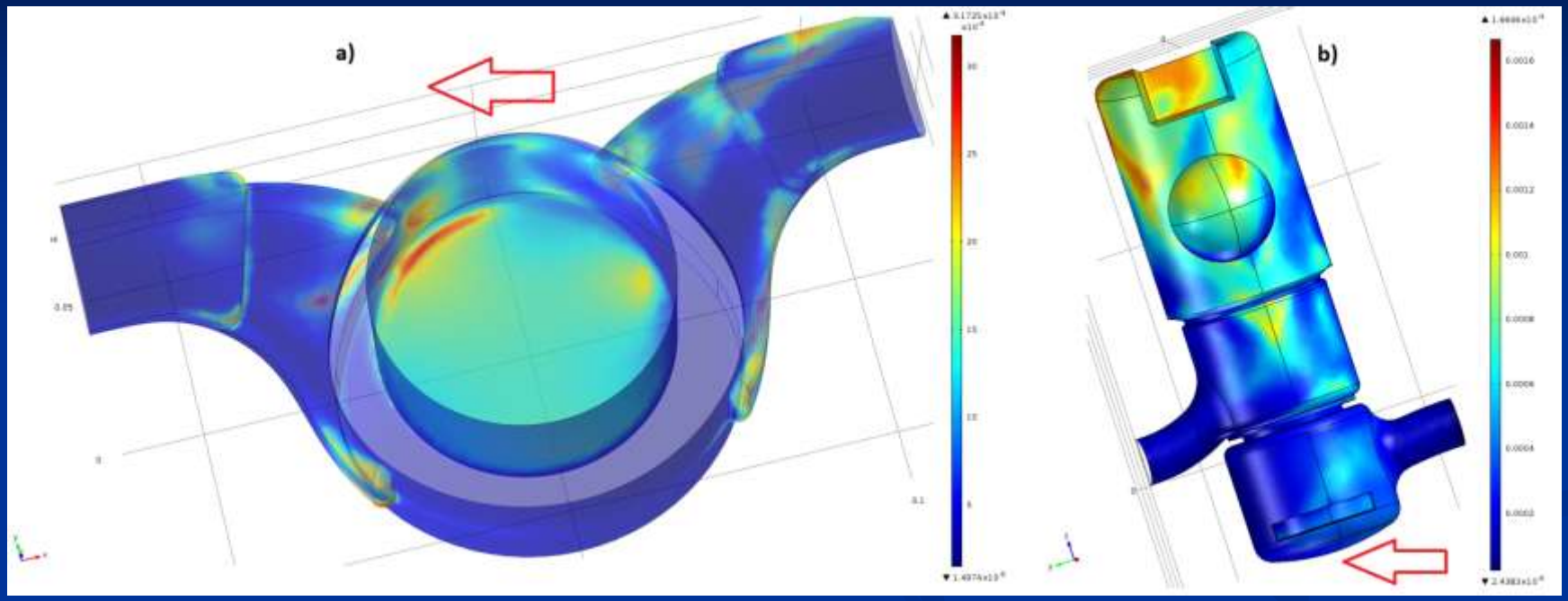
New BM

Coupling



Build different geometries and couple them together

- Good: one model then another
- Bad: same file (300MB on average)

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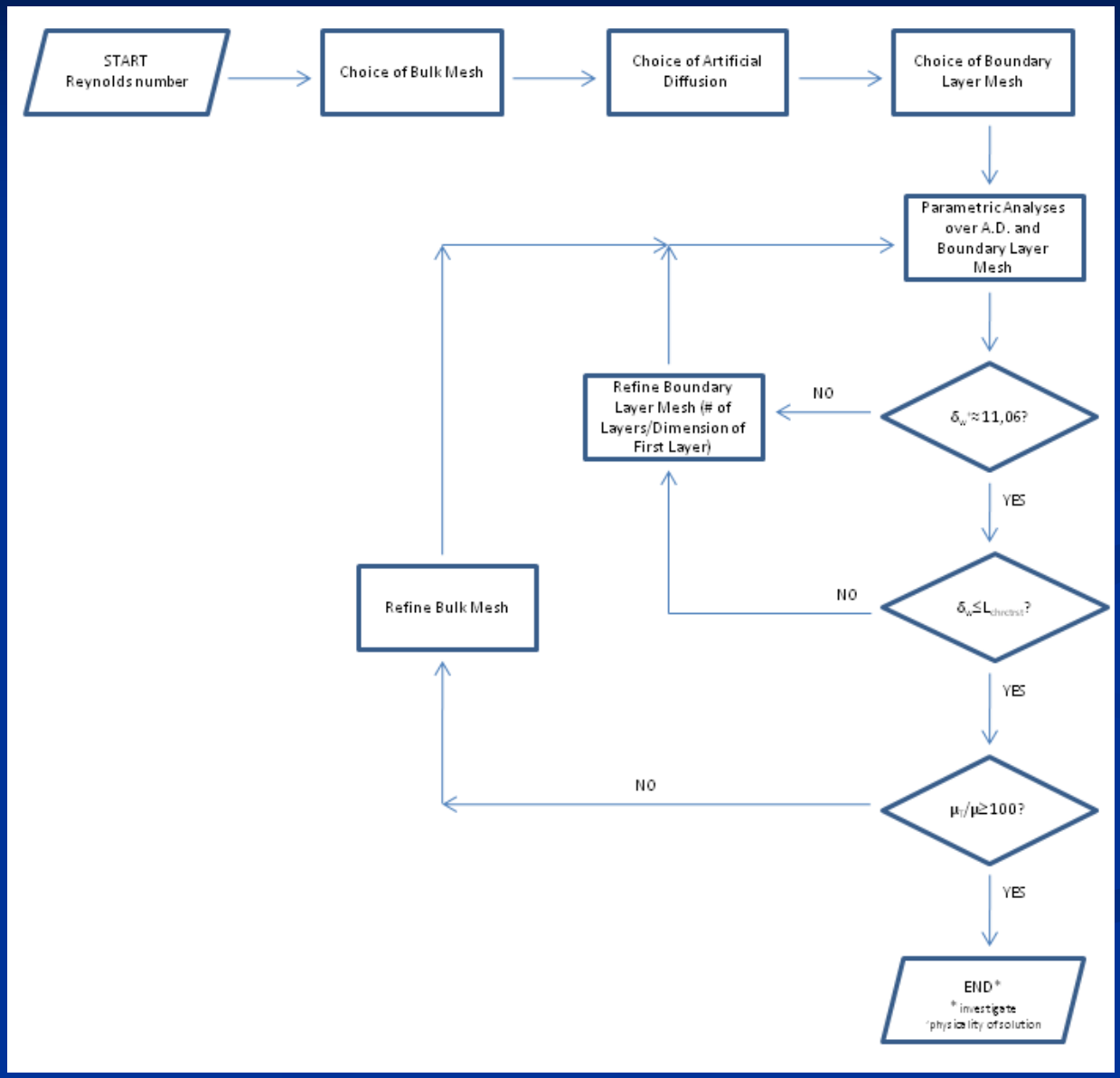
Check for Consistency



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Conclusion

Good & Bad

Sweet:	Bitter:
CAD – parametric design, import	Impinging Flows
Almost Automatic Meshing	Iterative Control for Consistency
Almost Automatic Solver	Monolithic Files

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