Using Optical Flow Tracing of MRI Flow Artifacts to Validate CFD Findings

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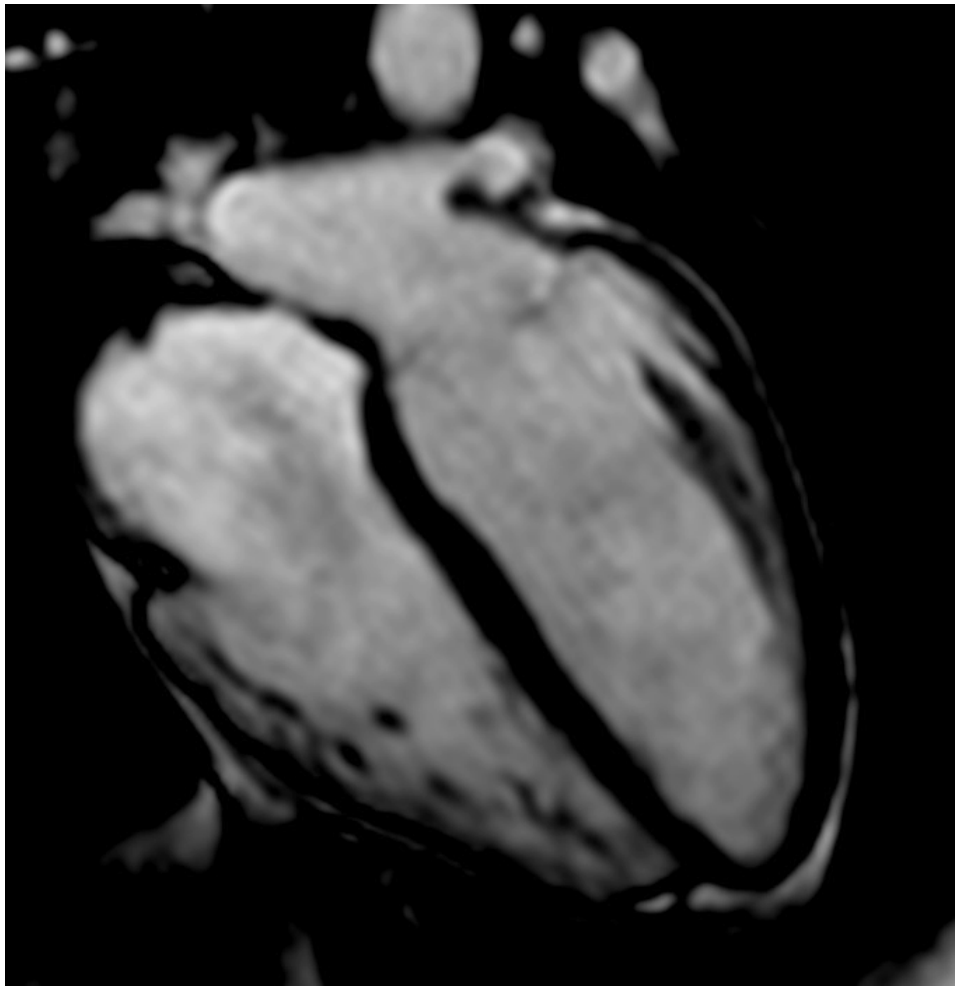
Excerpt from the Proceedings of the 2011 COMSOL Conference in Stuttgart



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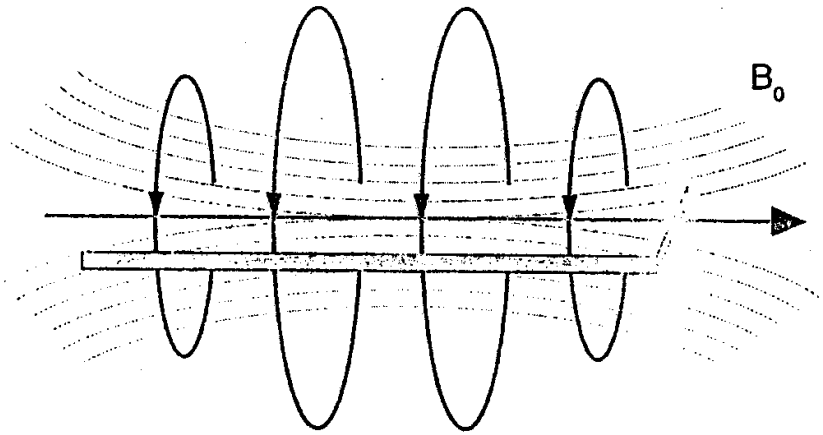
MRI

Magnetic Resonance Imaging



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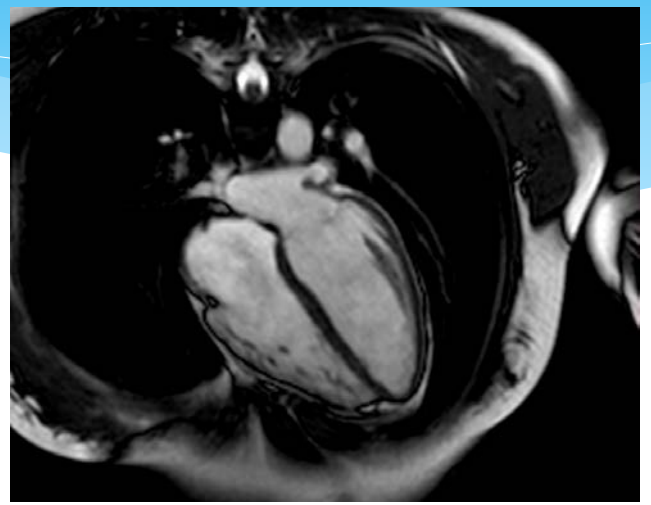
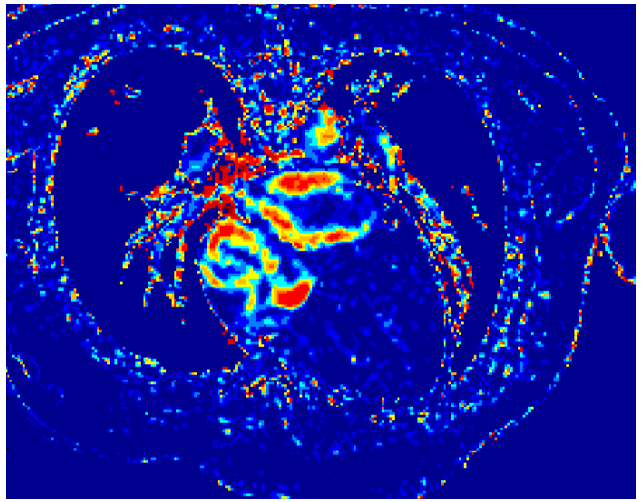
MRI

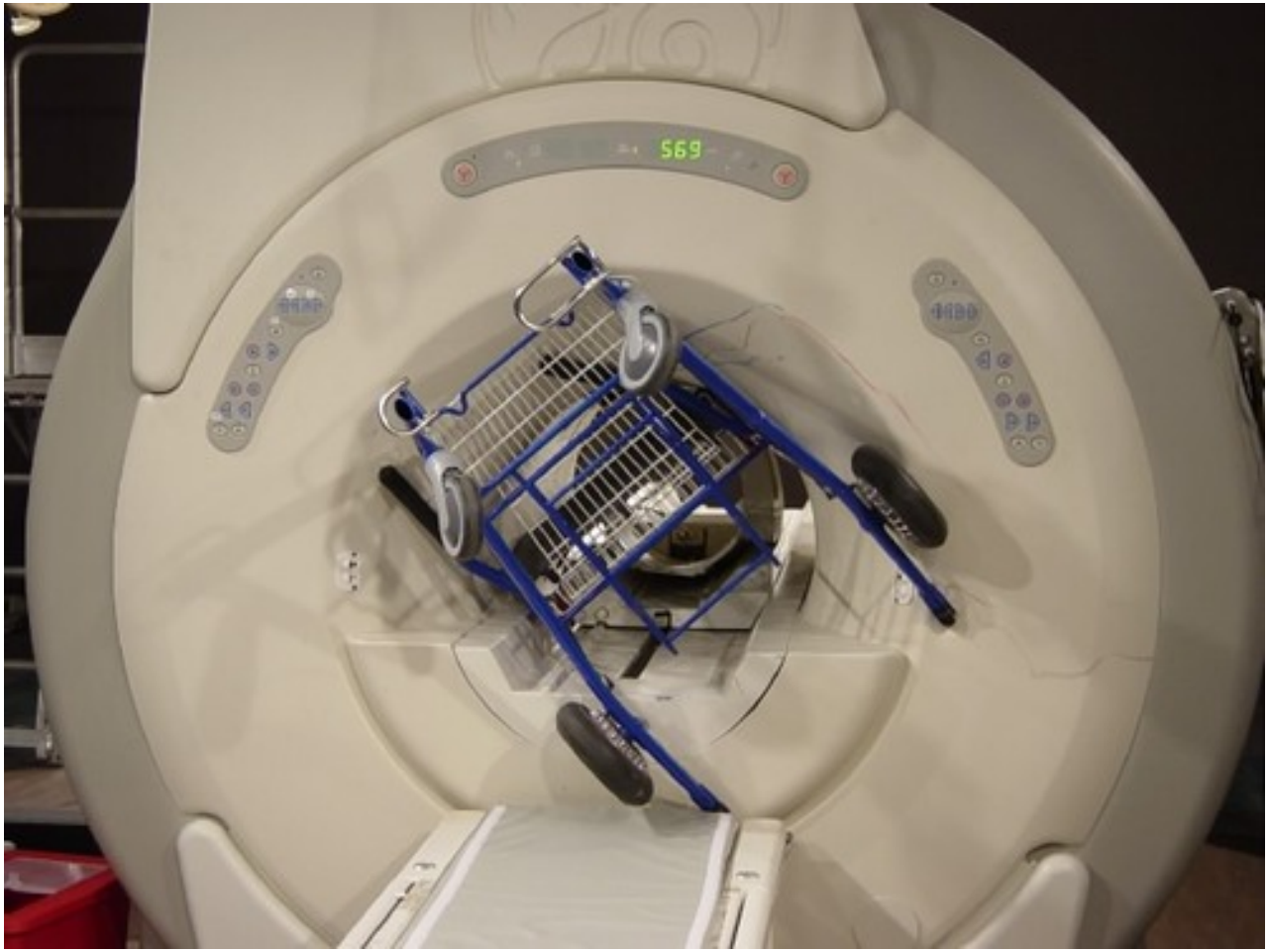
Techniques

- Balanced Steady State Free Precession (b-SSFP)



- Phase Contrast (PC)

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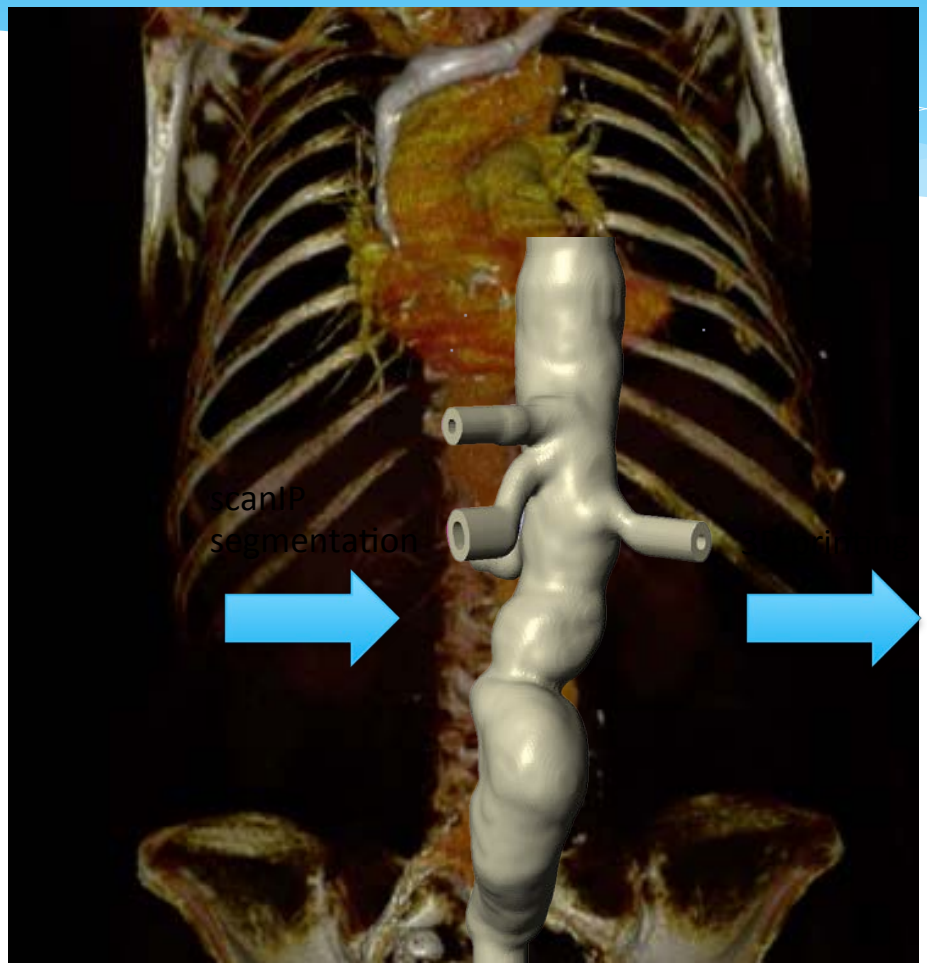
Phantom



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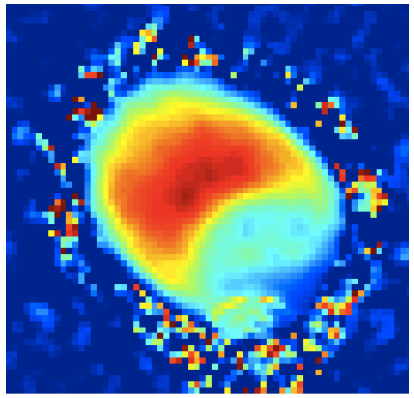
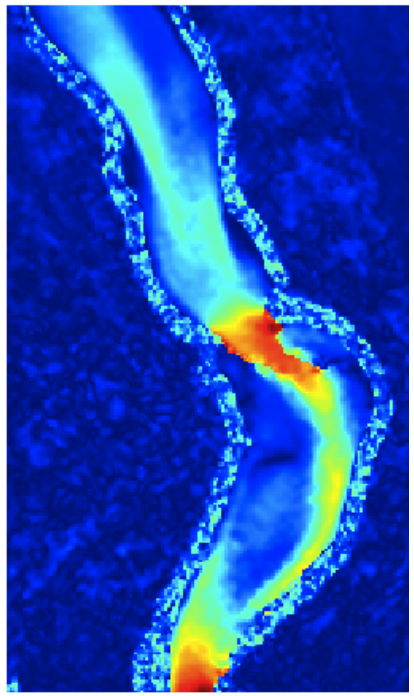
Setup

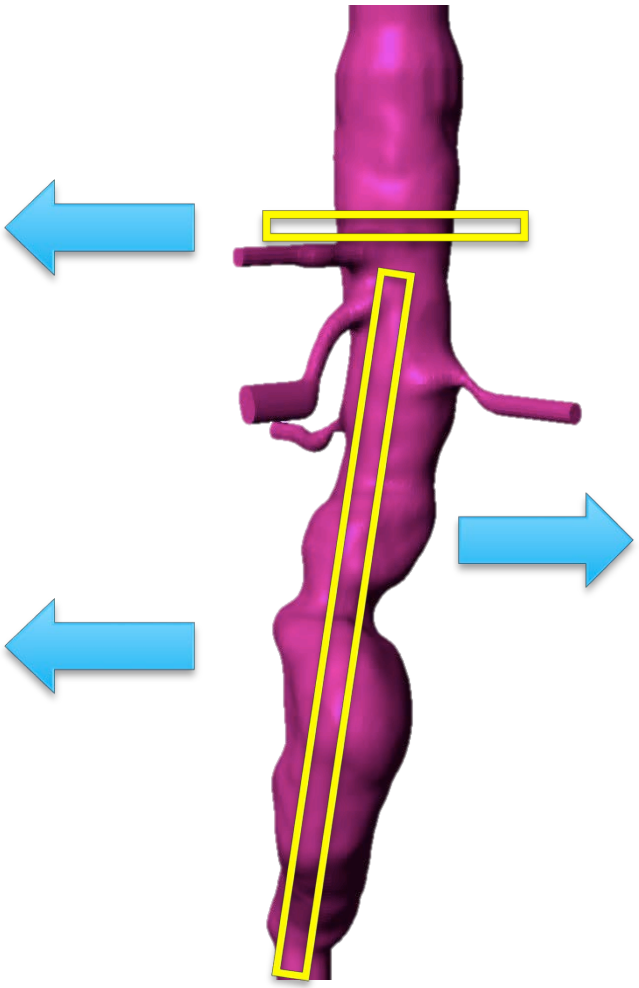
Setup in MRI Scanner

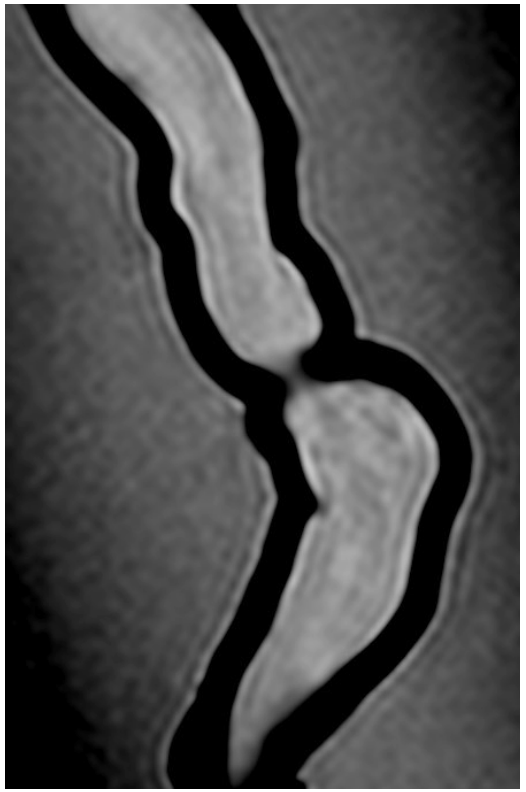
Control Room

Continuous flow









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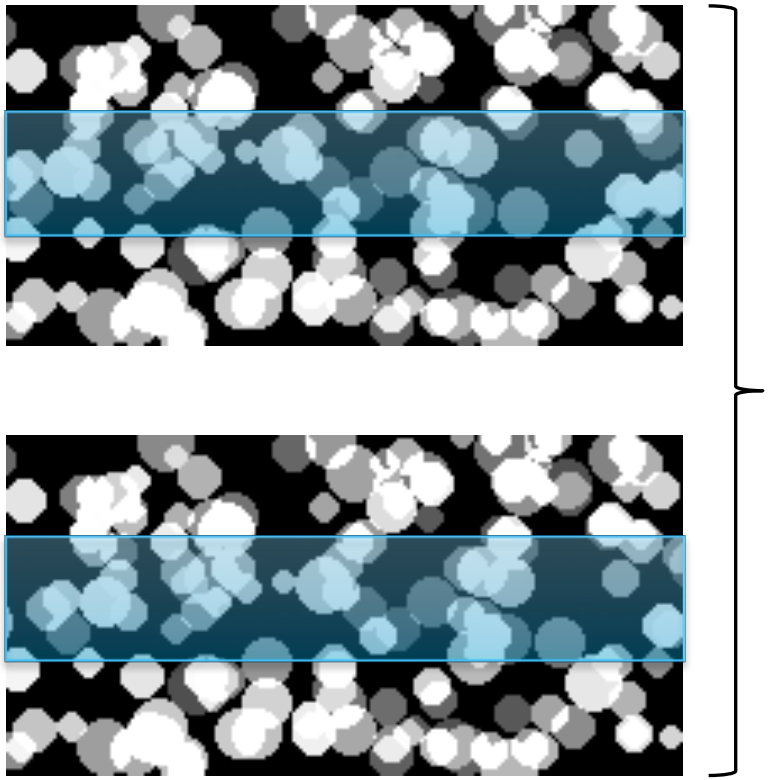
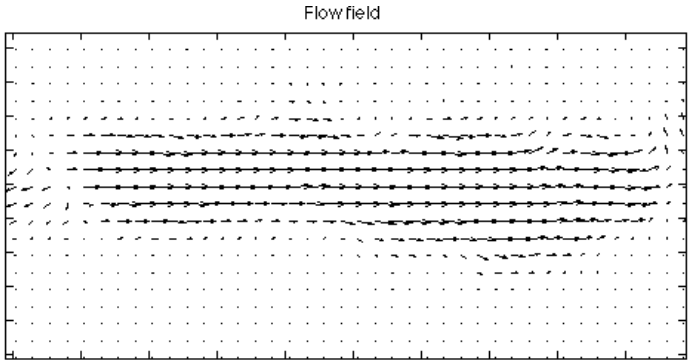
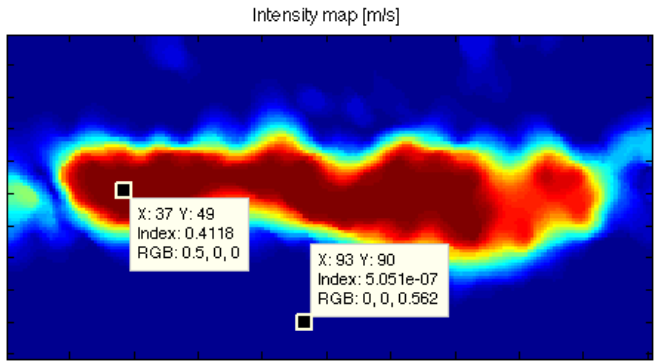
Optical Flow

- Tracking of brightness gradients







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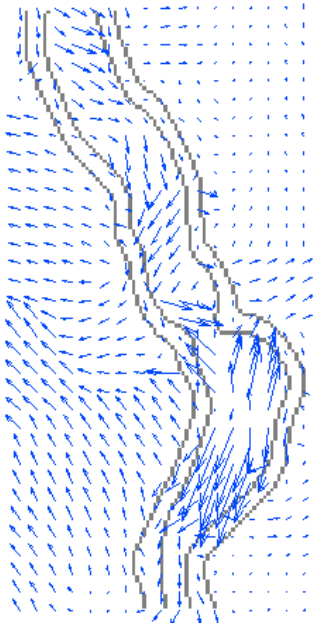
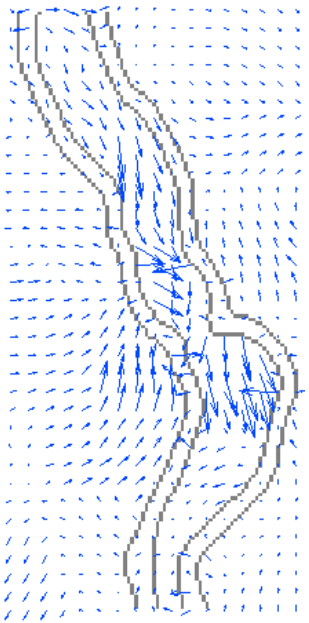
Optical Flow

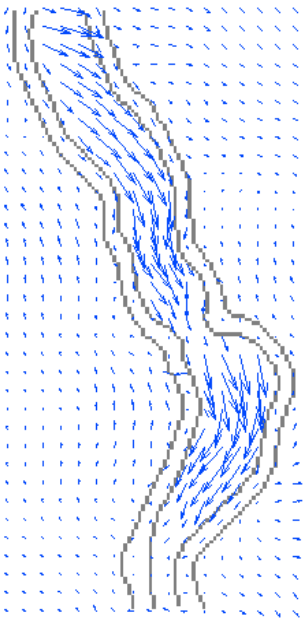
Flow field 1

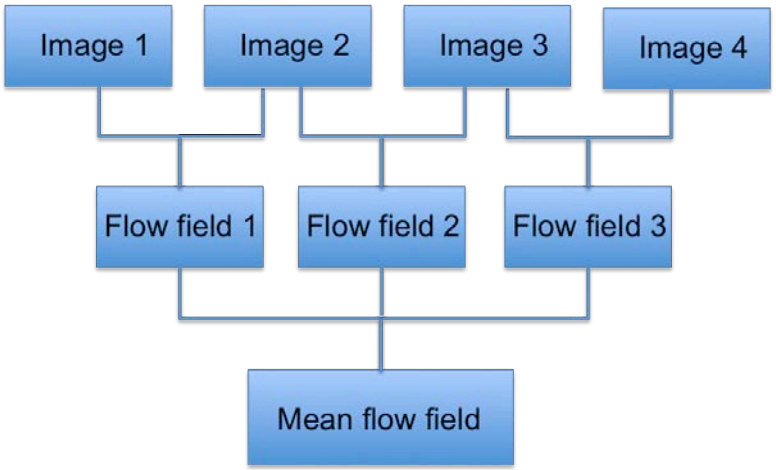


Flow field 2



Mean





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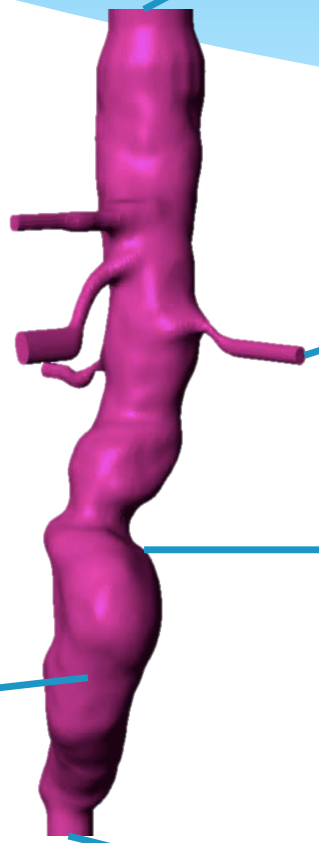
CFD

- Boundary conditions:
  - Stationary Study
  - Laminar solver
  - Isodiffusion: 0.01



Inflow (from PC)

Small arteries
(closed off)

Wall interaction
(no slip)

Viscosity
(water)

Outflow (zero pressure)

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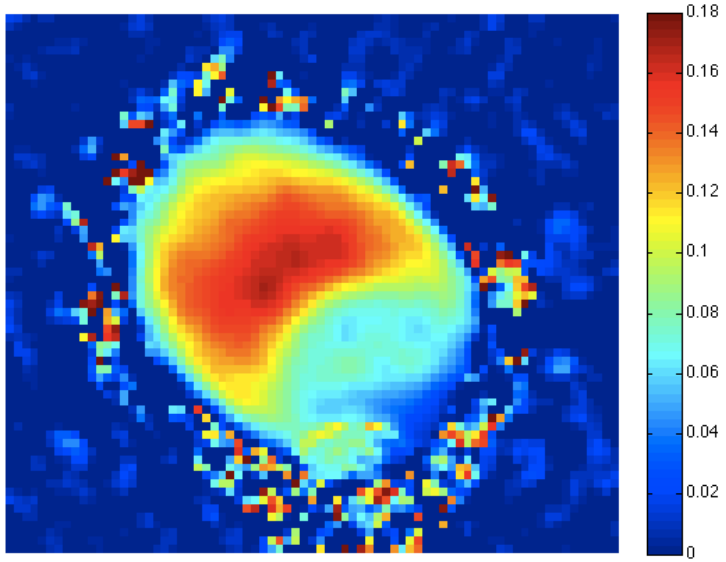
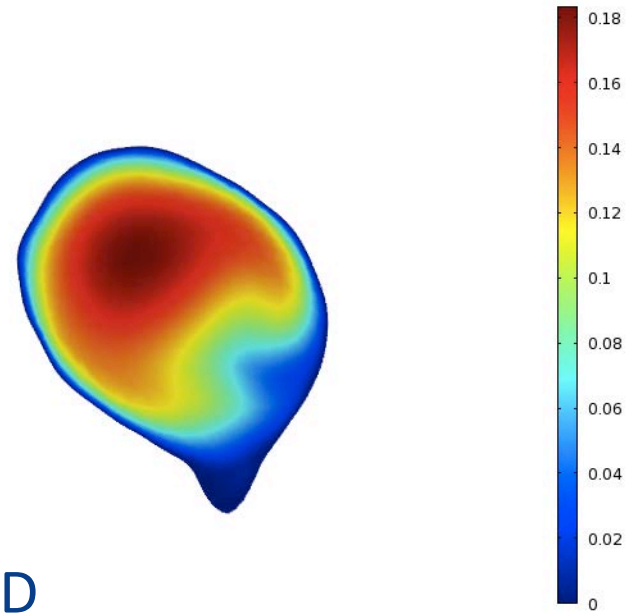
Results



PC



CFD

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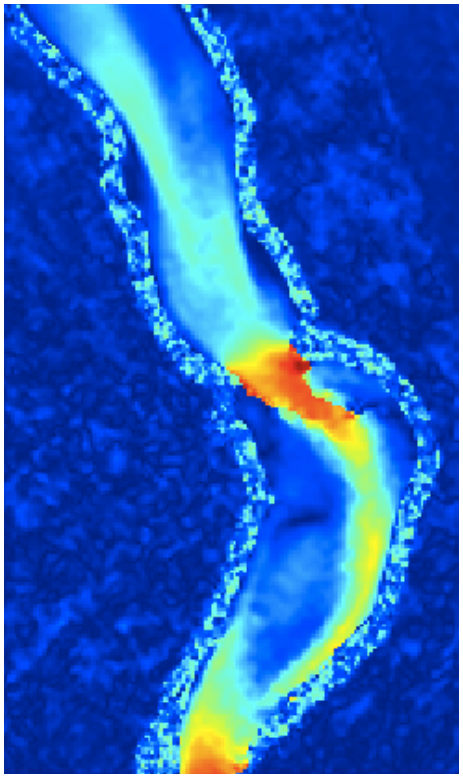
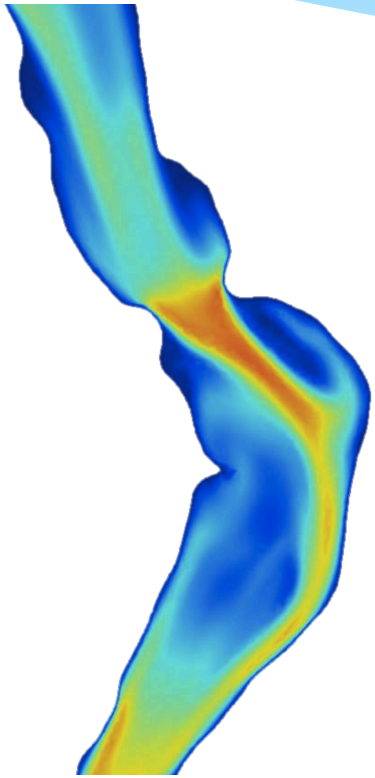
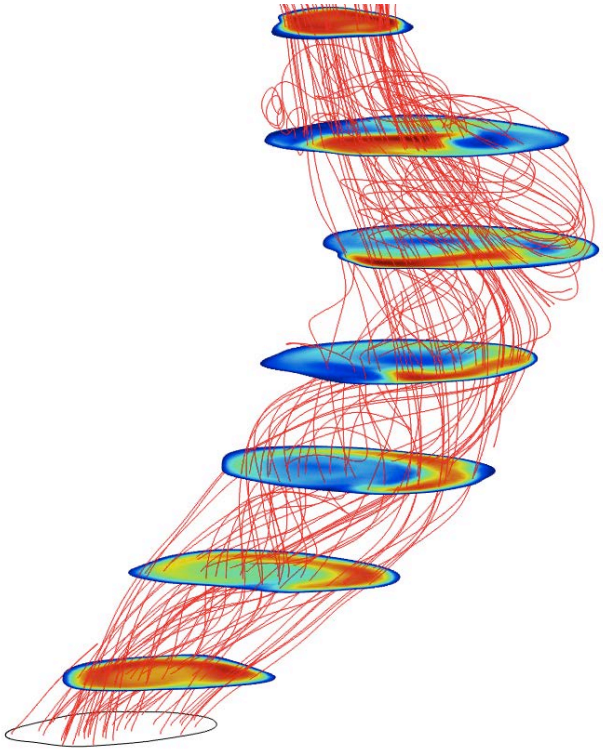
Results



PC





CFD

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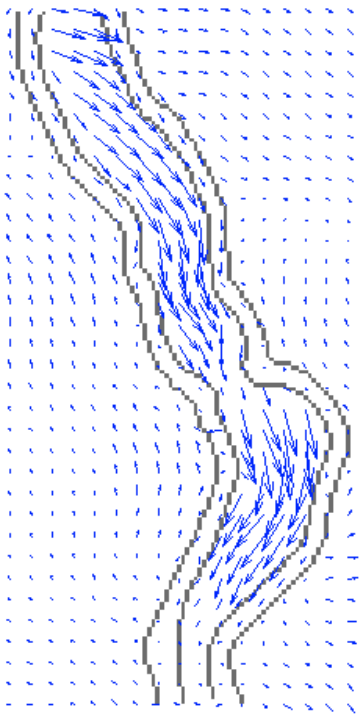
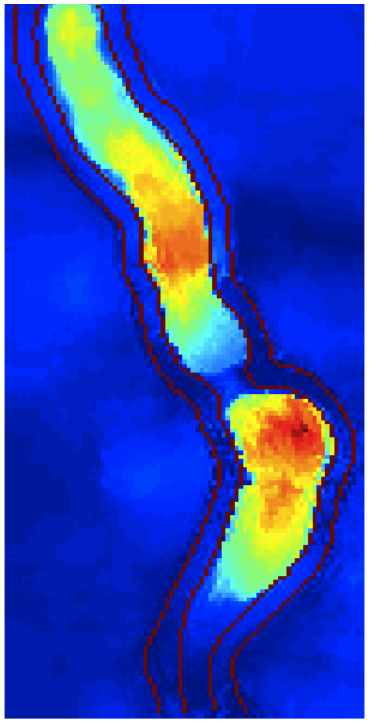
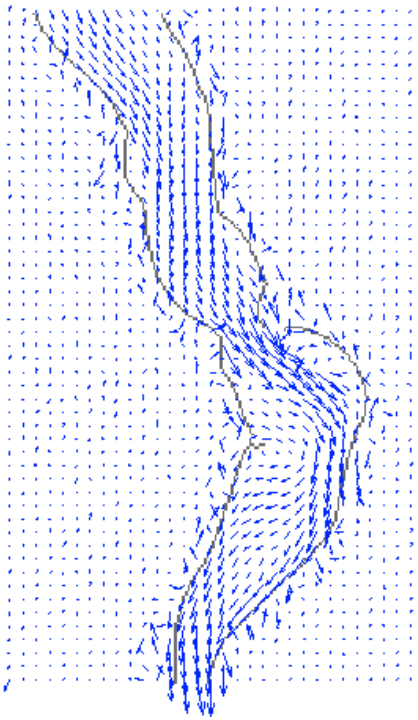
Results

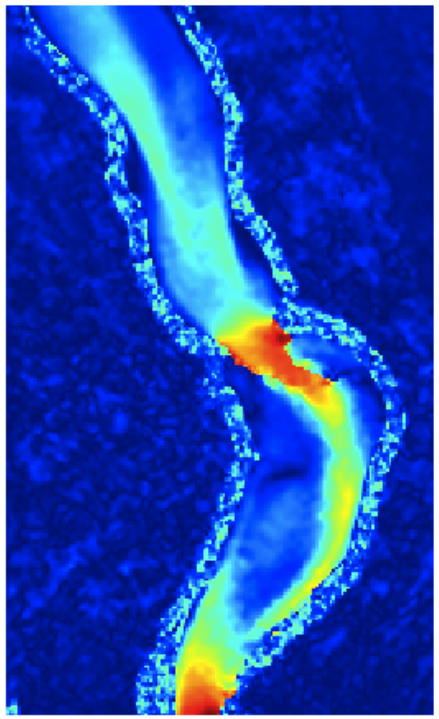
Velocities underestimated by a factor of 10





Optical Flow





PC (from last page)

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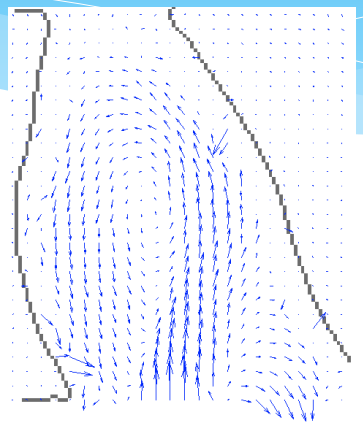
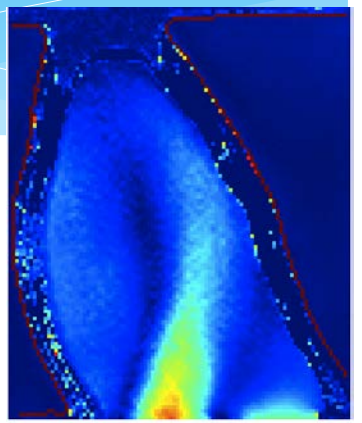
Heart Phantom

PC



(a)



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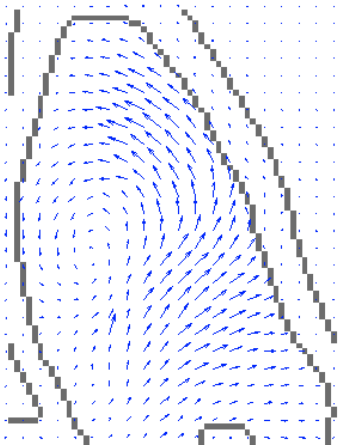

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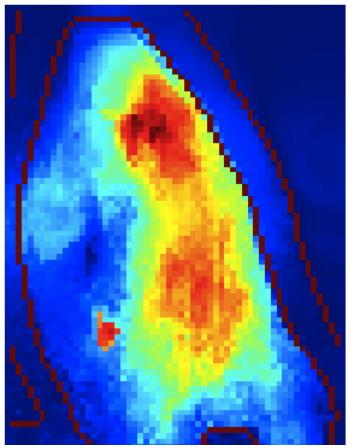

(d)

Optical Flow

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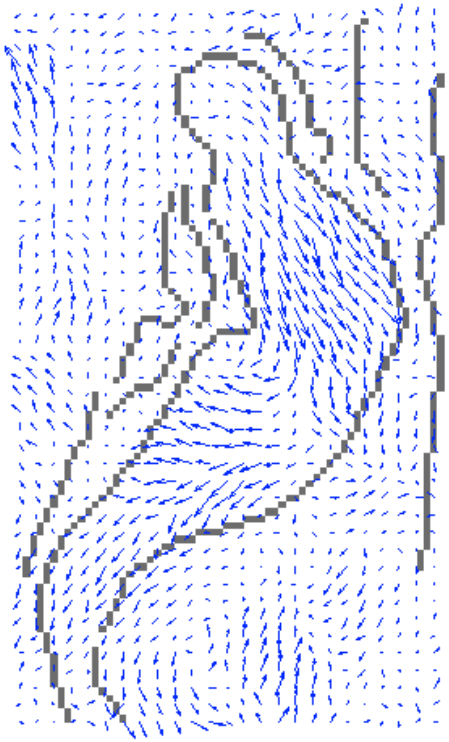
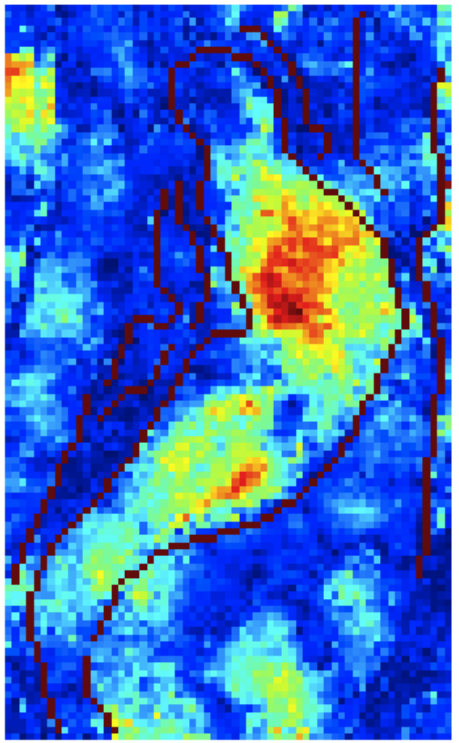
In Vivo

Mean flow field



Intensity map of mean flow



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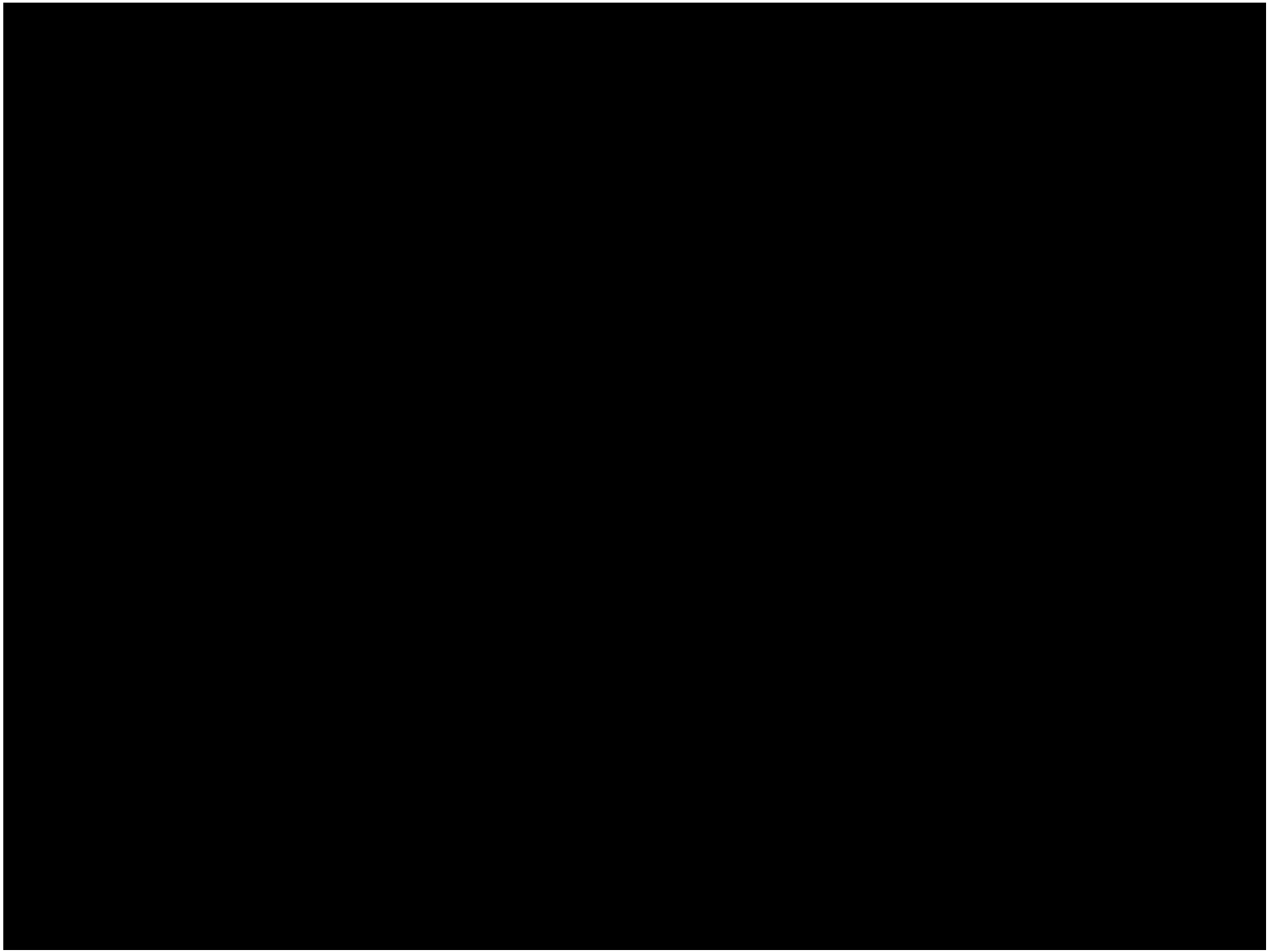
Conclusion

- PC vs. CFD
  - Rapid prototyping
  - Good agreement
- Optical Flow
  - Qualitatively: Good agreement with CFD/PC
  - Quantitatively: Underestimation (10%)
  - Solutions