

Jürgen Sotke

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## Volume Flow Rate Determination in the Cranial Vessel Tree Based on Quantitative Magnetic Resonance Data

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Supervisor (TUM): Andreas Keil

Supervisors (BrainLAB): Thomas Seiler,  
Fritz Vollmer

# Agenda

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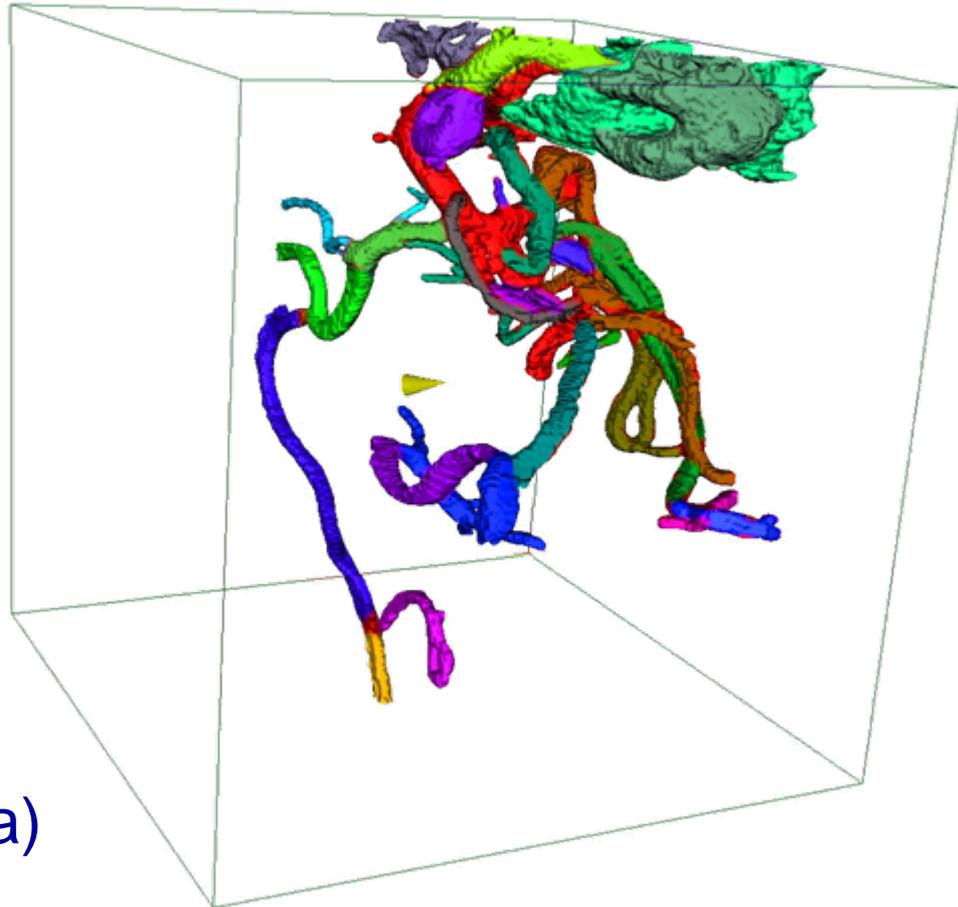
- Goal
- State of the Art
- New Approach
  - Vessel Segmentation
  - Abstract Vessel Representation
  - Gathering Flow Information
  - „Filling the Gaps“
  - Visual Presentation
- Appendix: Phase-Contrast-MR

# Goal

Quantitative  
information about  
volume flow rates  
(either abstract or  
graphicaly)

Purposes:

- Diagnosis  
(stenosis, ischemia)
- Checking of  
operation results

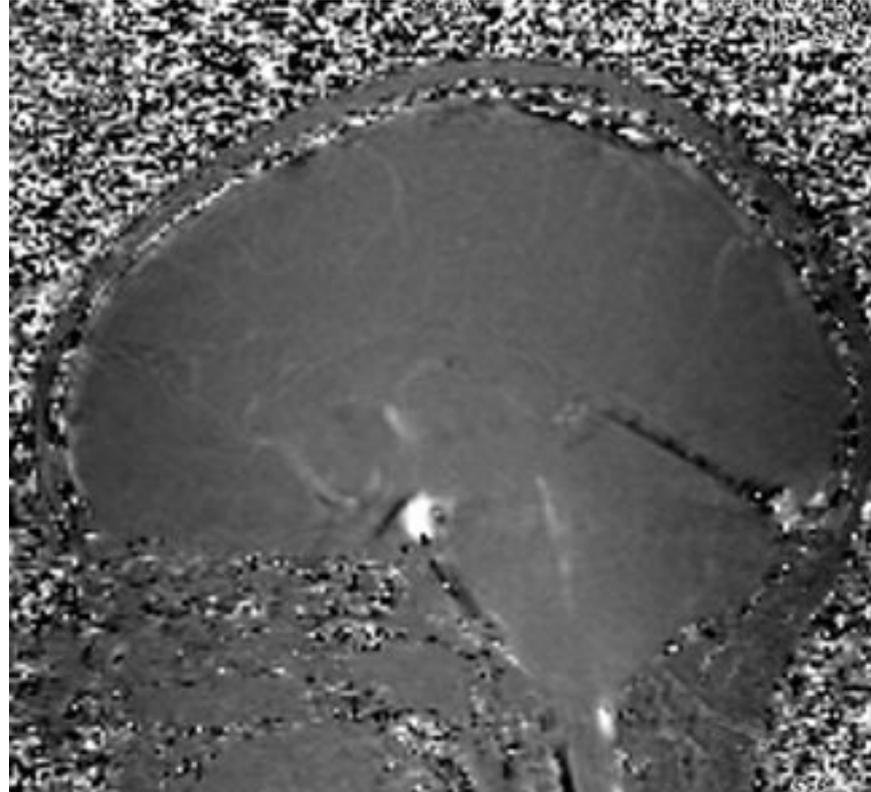


Selecting slices for PC-imaging based on a previously recorded anatomical scan



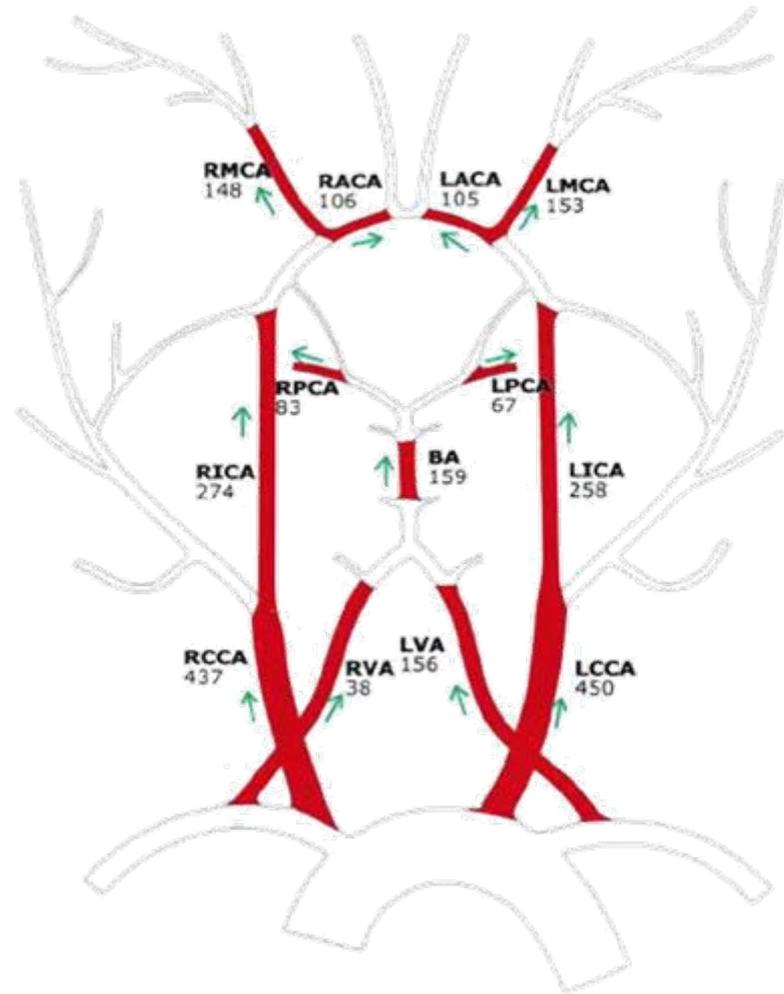
# Quantization of the Flow Velocity by Phase-Contrast Imaging

The brighter, the higher the flow velocities.



# Model Based Approach<sup>2</sup>

Results can be matched with a standardized model of the major cranial vessels.



# New Approach

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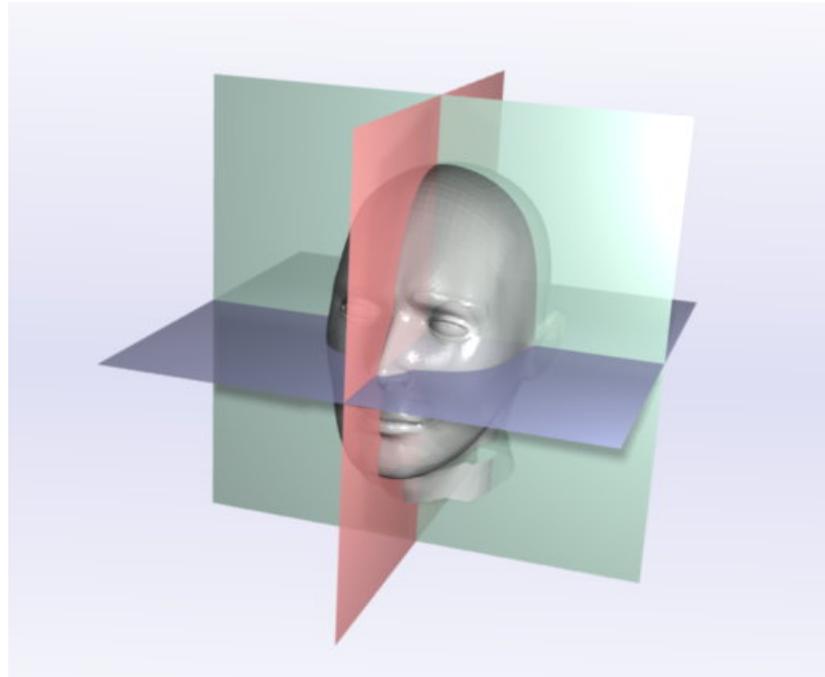
- one session



# New Approach

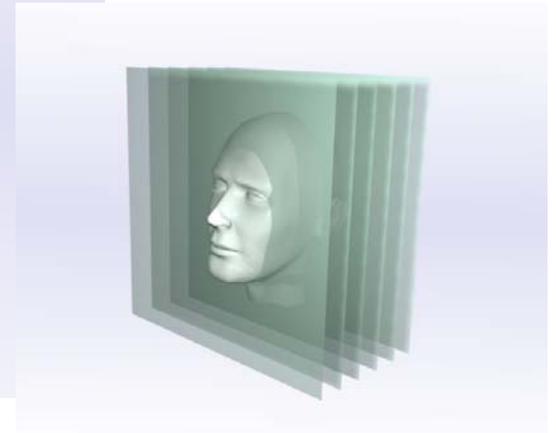
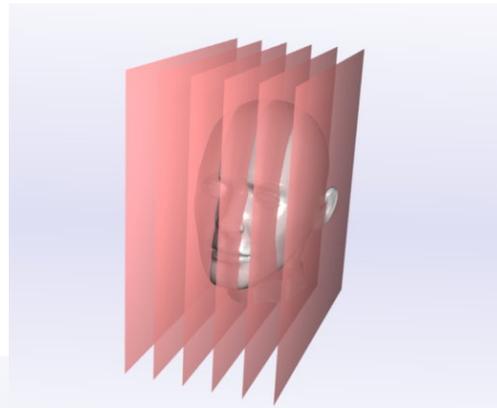
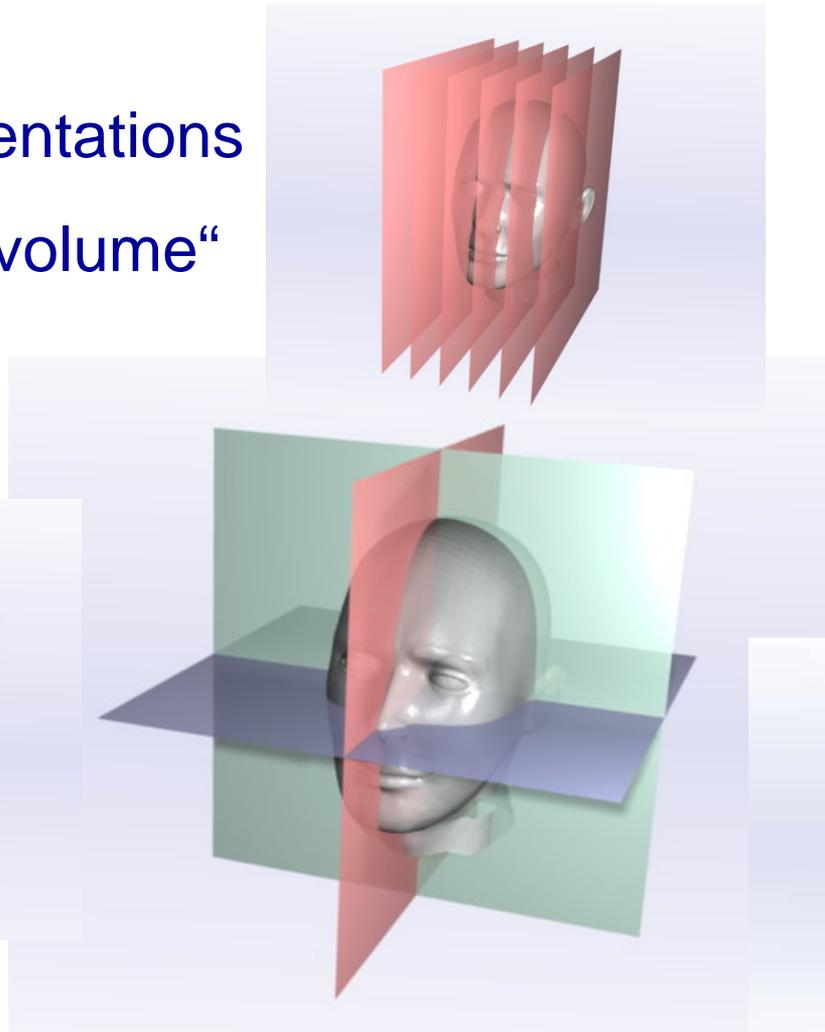
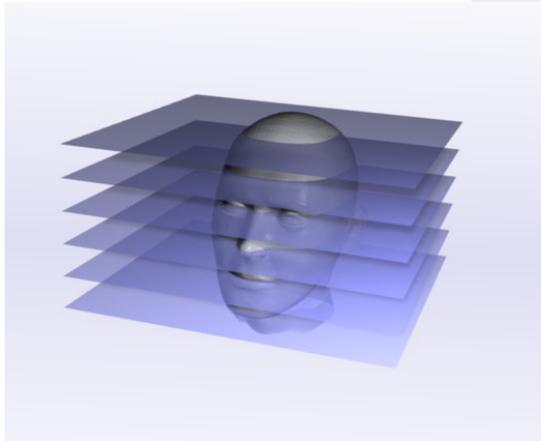
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- one session
- at least three orientations



# New Approach

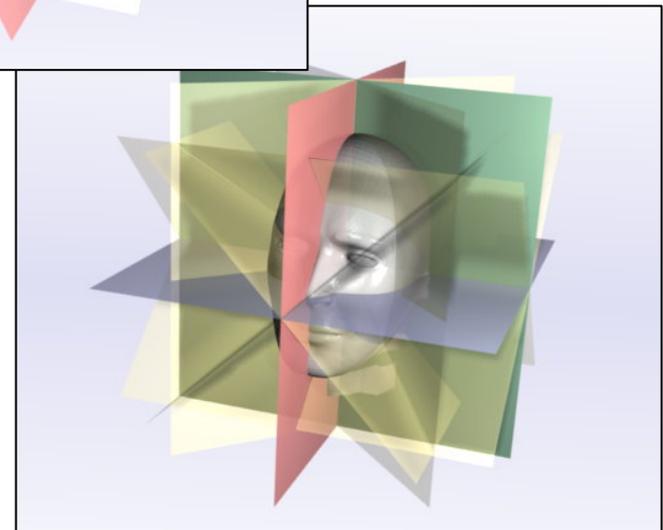
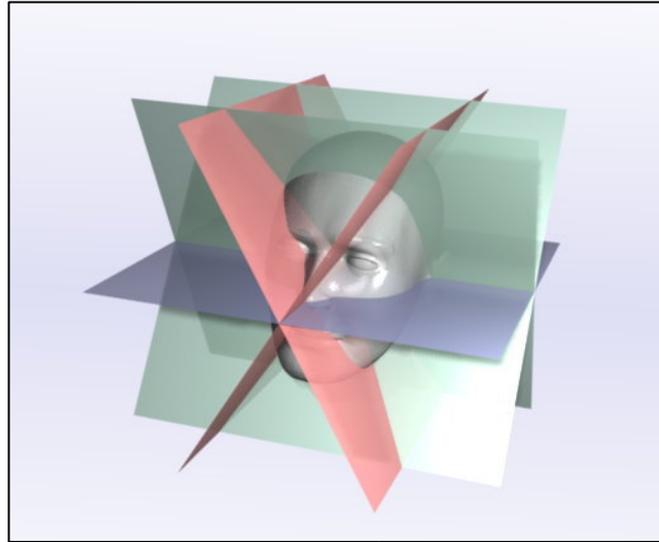
- one session
- at least three orientations
- phase-contrast-„volume“



# New Approach

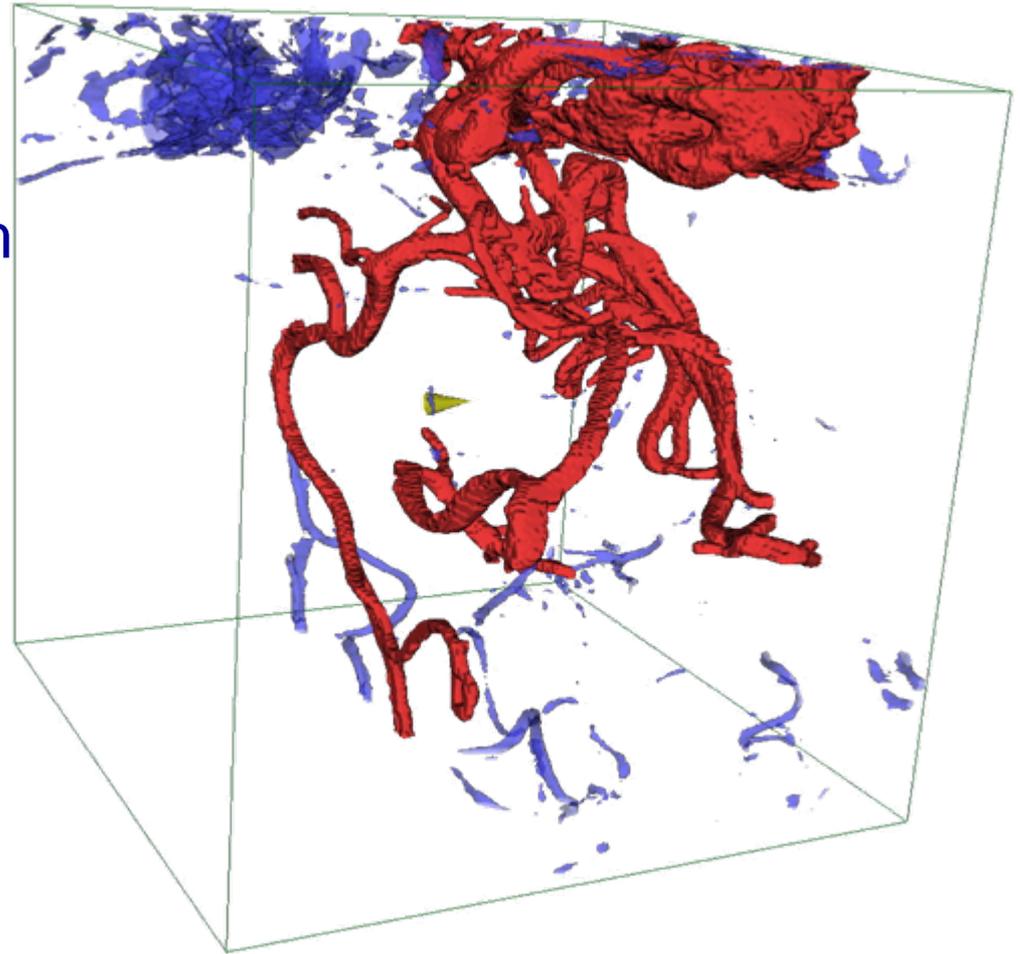
Phase contrast  
imaging sensitive to  
angular  
misregistrations

→ Desirable to get  
PC-volumes in as  
many different  
orientations as  
possible



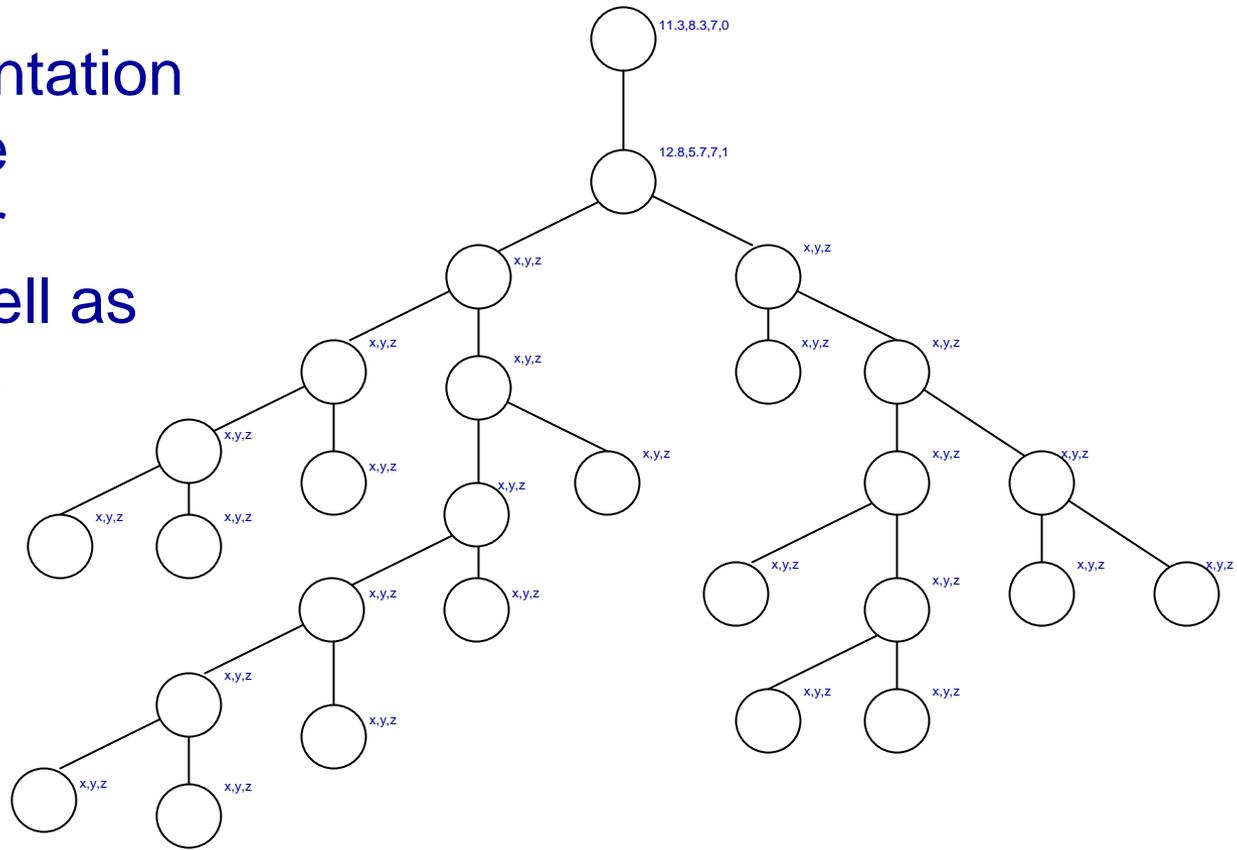
# Segmentation of the Vessel Tree

Vessel tree  
segmentation  
(from PC-scans or from  
an additional  
anatomical scan taken  
in the same session)



# Abstract Representation of the Vessel Tree

After centerline  
extraction:  
Abstract representation  
of the vessel tree  
including angular  
information as well as  
vessel diameters



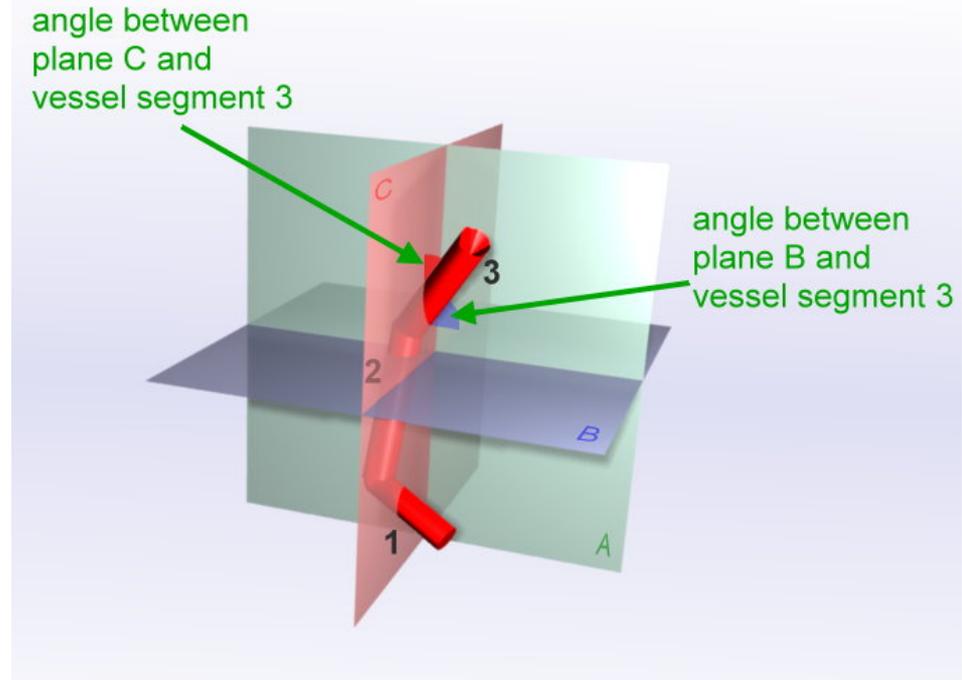
# Angular Considerations

Angular information allows

selecting the most suitable PC-slice,

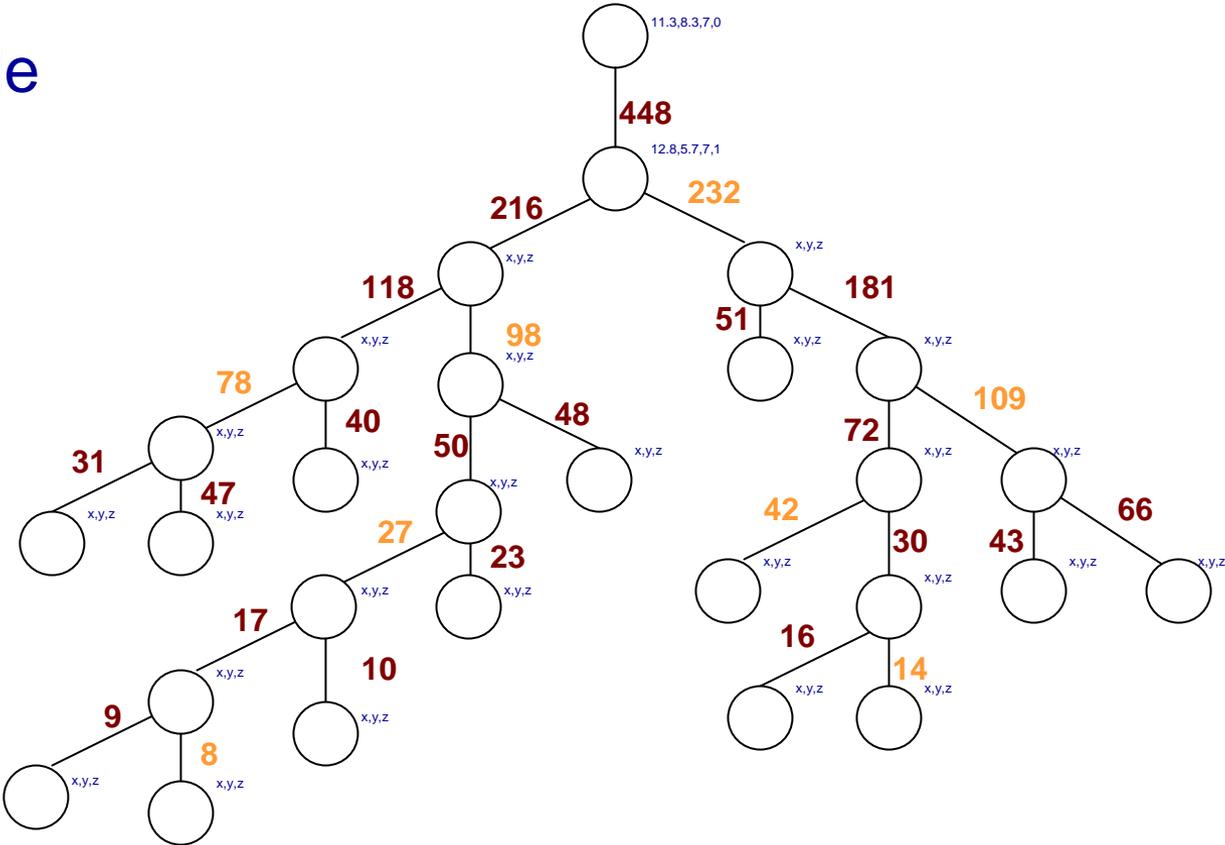
or generating an intelligently weighted combination of the data from different slices

in order to gain flow information



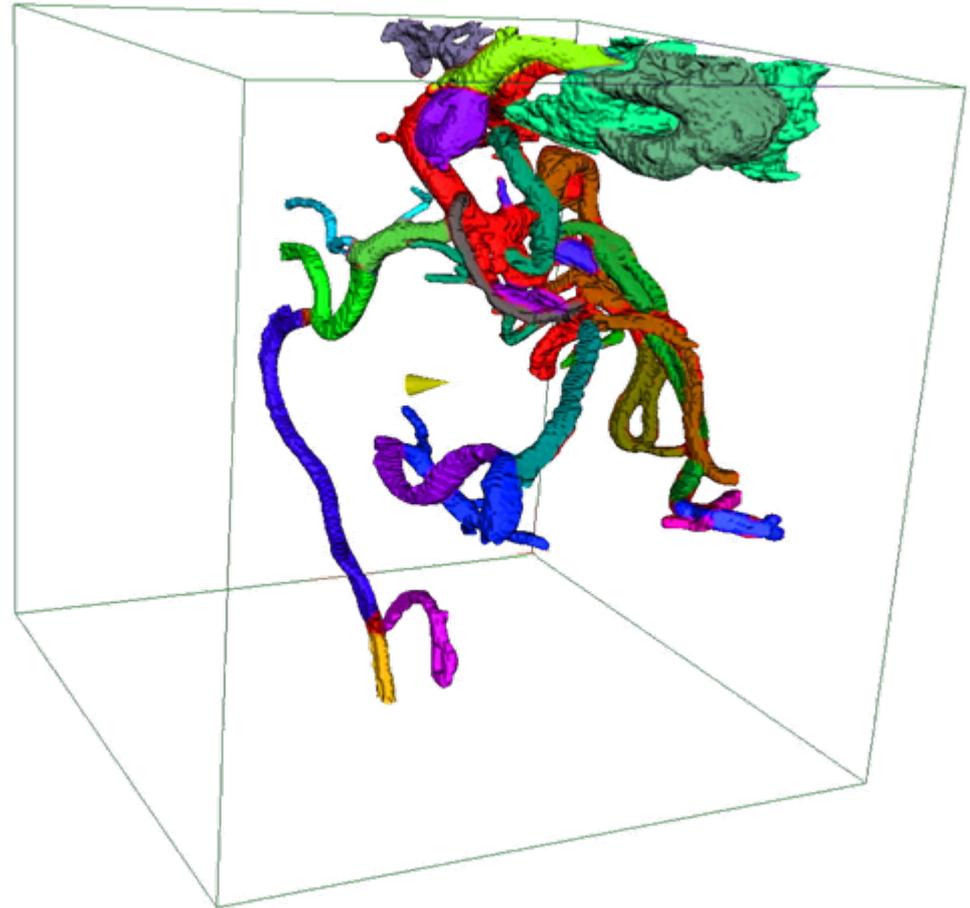
# Abstract Representation of the Vessel Tree

Completion / validation of flow rates for the whole vessel tree using known rates at bifurcations



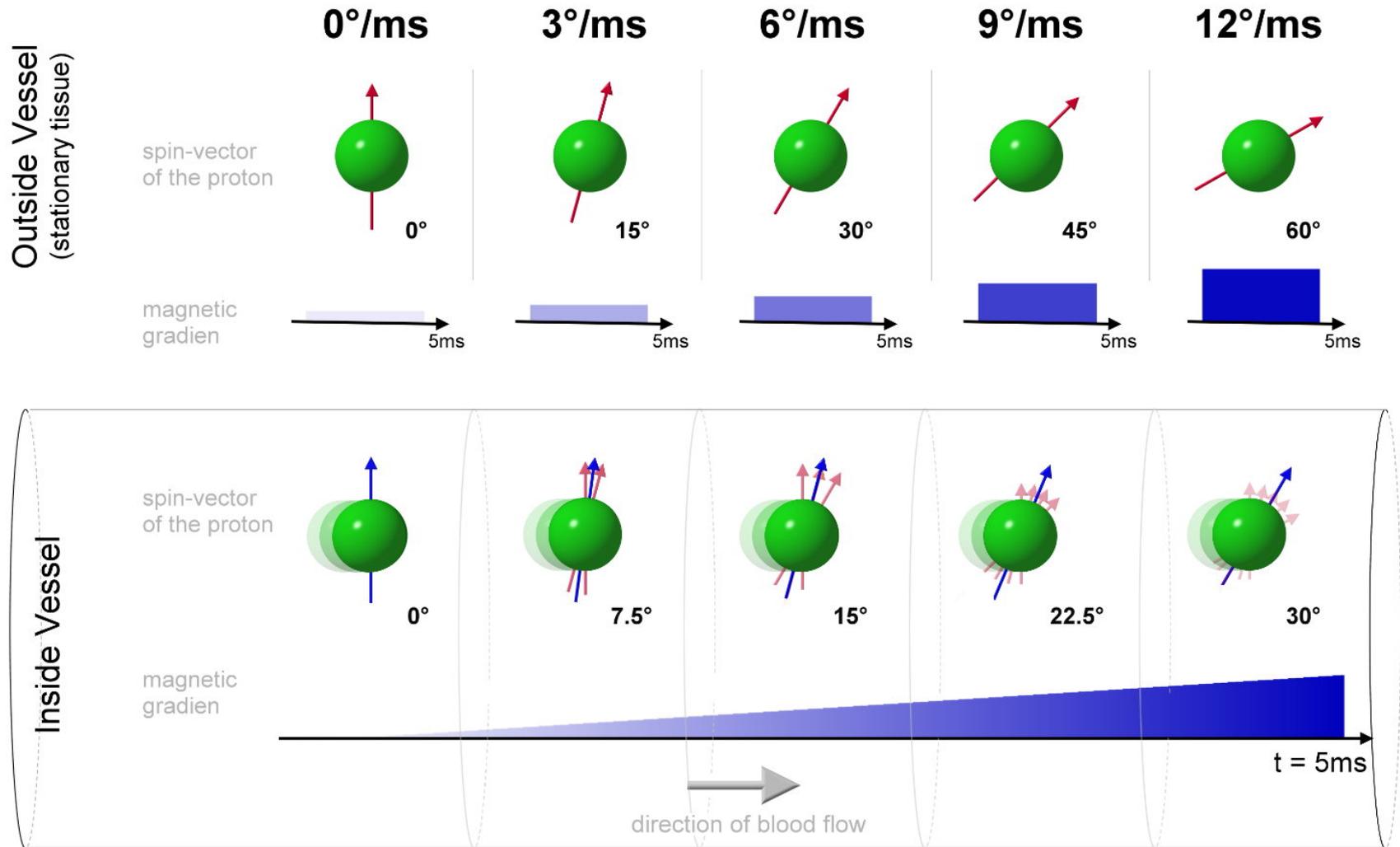
# Visualized Blood Flow

Visualization of  
computed flow rates



# Phase-Contrast-MR<sup>1</sup>

Moving through a magnetic gradient field causes protons to gain a shift in phase different to that of the surrounding stationary tissue:



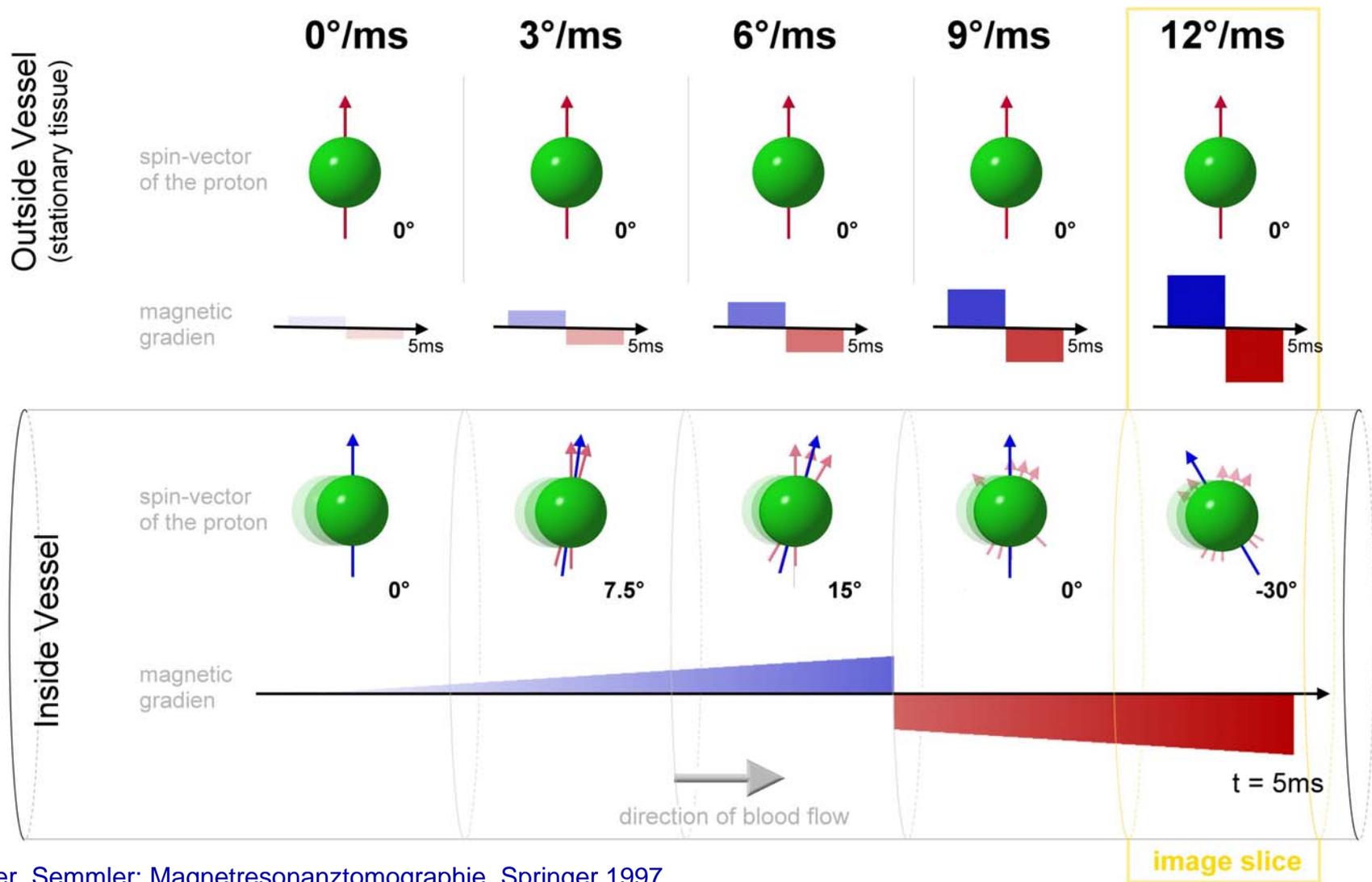
<sup>1</sup>Reiser, Semmler: Magnetresonanztomographie, Springer 1997

Such a phase shift would be already enough to determine flow, but by simply applying an inverted gradient half of the time, a kind of „background suppression“ can be easily achieved...

<sup>1</sup>Reiser, Semmler: Magnetresonanztomographie, Springer 1997

# Phase-Contrast-MR<sup>1</sup>

Since the moving protons are exposed to a different field strength during positive and negative lobe, the negative gradient does not exactly annihilate the phase-shift:



<sup>1</sup>Reiser, Semmler: Magnetresonanztomographie, Springer 1997

This way, only protons in motion generate a signal, which is proportional in strength to their velocity.

<sup>1</sup>Reiser, Semmler: Magnetresonanztomographie, Springer 1997