

Flow quantification with MRI in the presence of flow diverter stents

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I. Purpose

Intracranial aneurysms can be treated with flow diverter (FD) stents. 4D Flow MRI measurements is able to evaluate the blood flow and success of the treatment after placing FD. Like other metal objects, stents induce artefacts on MRI. In this study, we investigate the influence of such artefacts on the measured flow.

II. Methods

- Flow measured with ultrasound flow meter at P1 and P2
- Flow setup used for MRI measurements
 - Control tube and test tube (with FD)
 - Three FD were used (FD1: Derivo, Acandis, FD2: P64, Phenox, FD3: Silk, Balt Extrusion).
- MRI measurements at 3T (Ingenia CX, Philips) and 7T (Biospec 70/30, Bruker)
 - T1-weighted
 - 2D Phase Contrast
 - 3D Phase Contrast

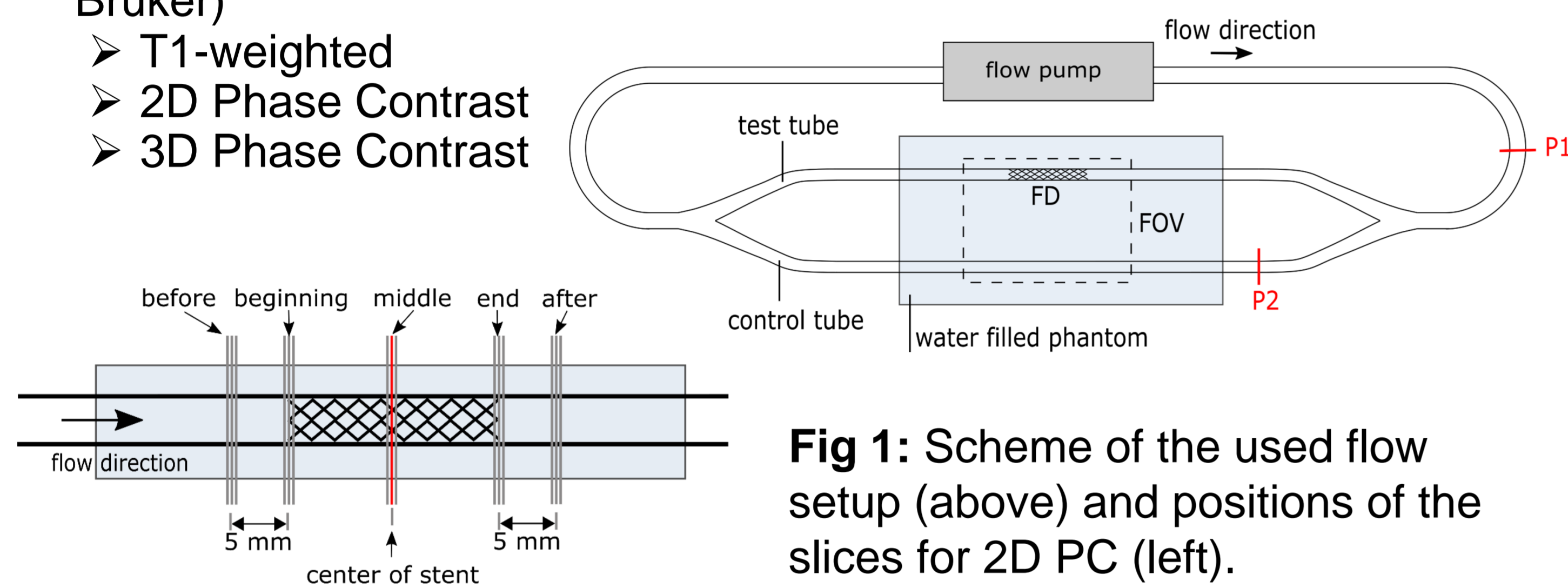


Fig 1: Scheme of the used flow setup (above) and positions of the slices for 2D PC (left).

III. Results

- All FDs induced artefacts on the T1w MRI for both field strength, although FD 3 produced least. (Fig. 2).

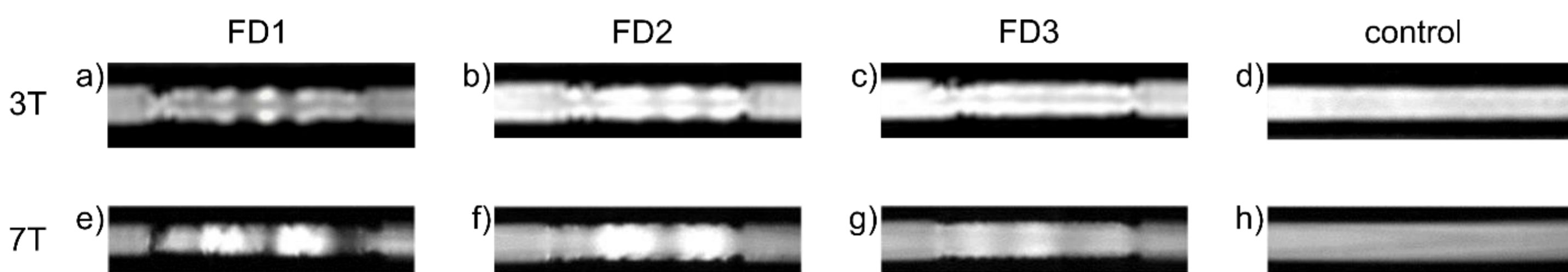


Fig 2: T1w MRI of the control and test tubes at 3 T (a-d) and 7 T (e-h)

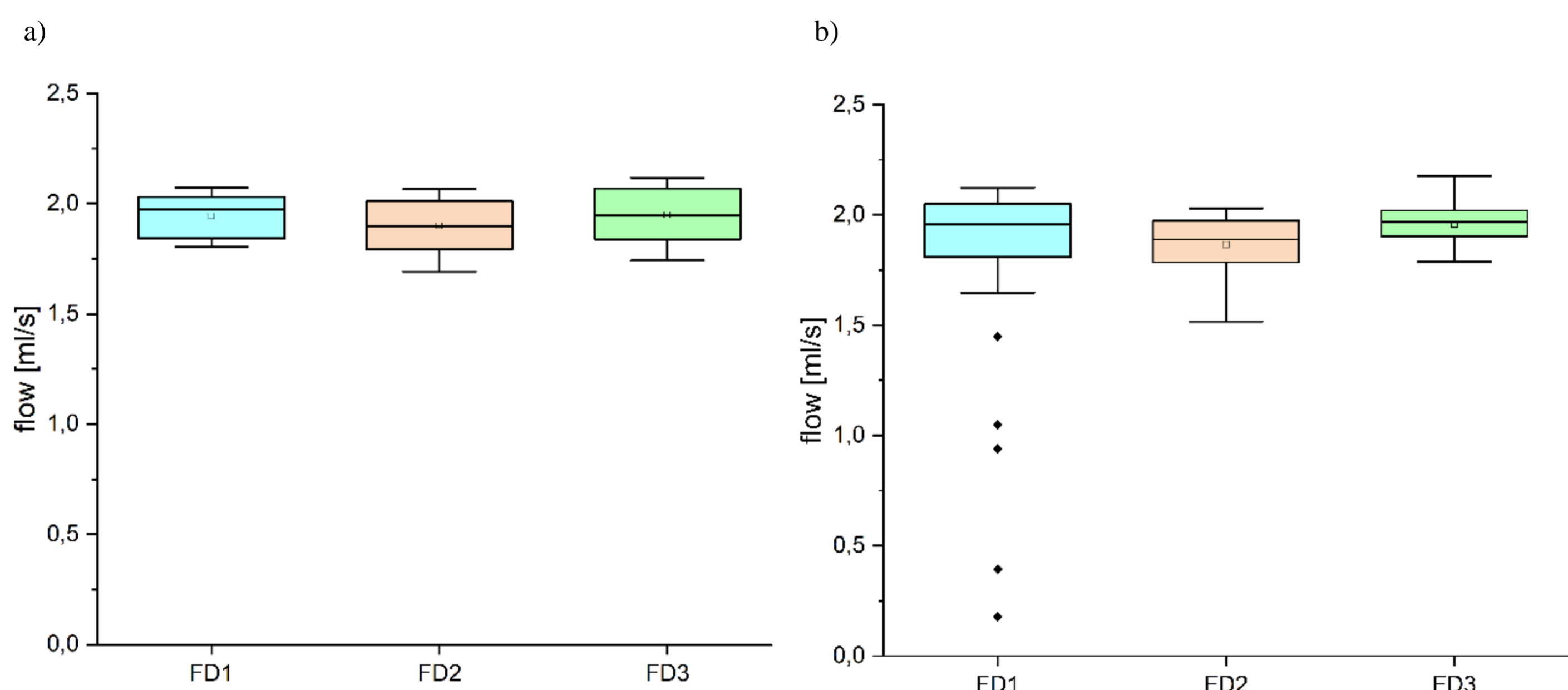


Fig 3: Flow measurements of the control tube at 7T for 2D (a) and 3D (b) PC-MRI to evaluate the reproducibility.

- For each field strength and sequence the measured mean was compared to the calibrated mean of the flow pump.
- The measurements can be performed reproducibly and are in a similar range to the calibrated value (1.77 ml/s).

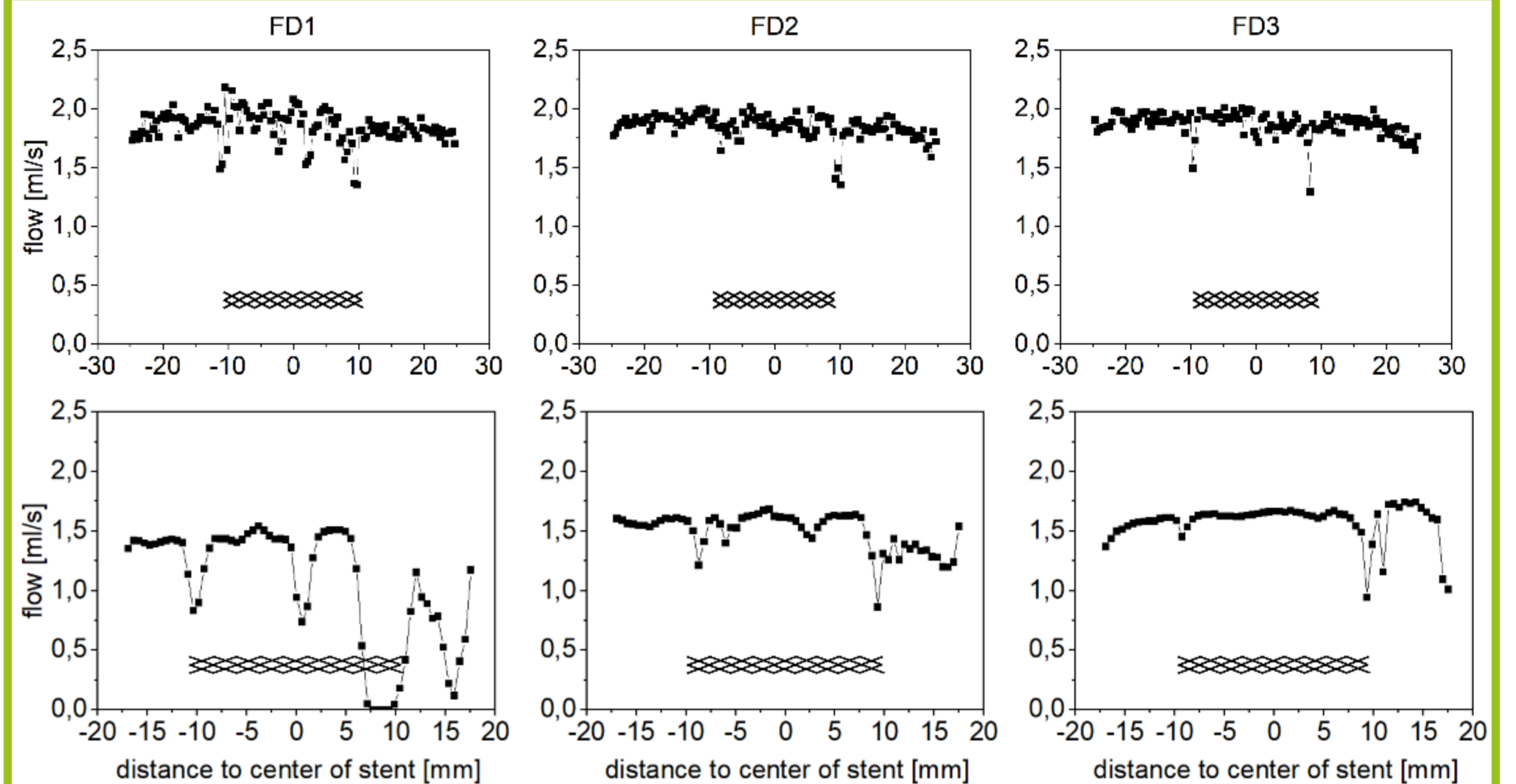


Fig 4: Flow profiles for 3T (upper row) and 7T (bottom row) for 3D PC for the test tube with different FD1-3.

- Flow and velocity were quantified at 5 positions perpendicular to the flow (2D) and over the whole length of the FDs (3D)

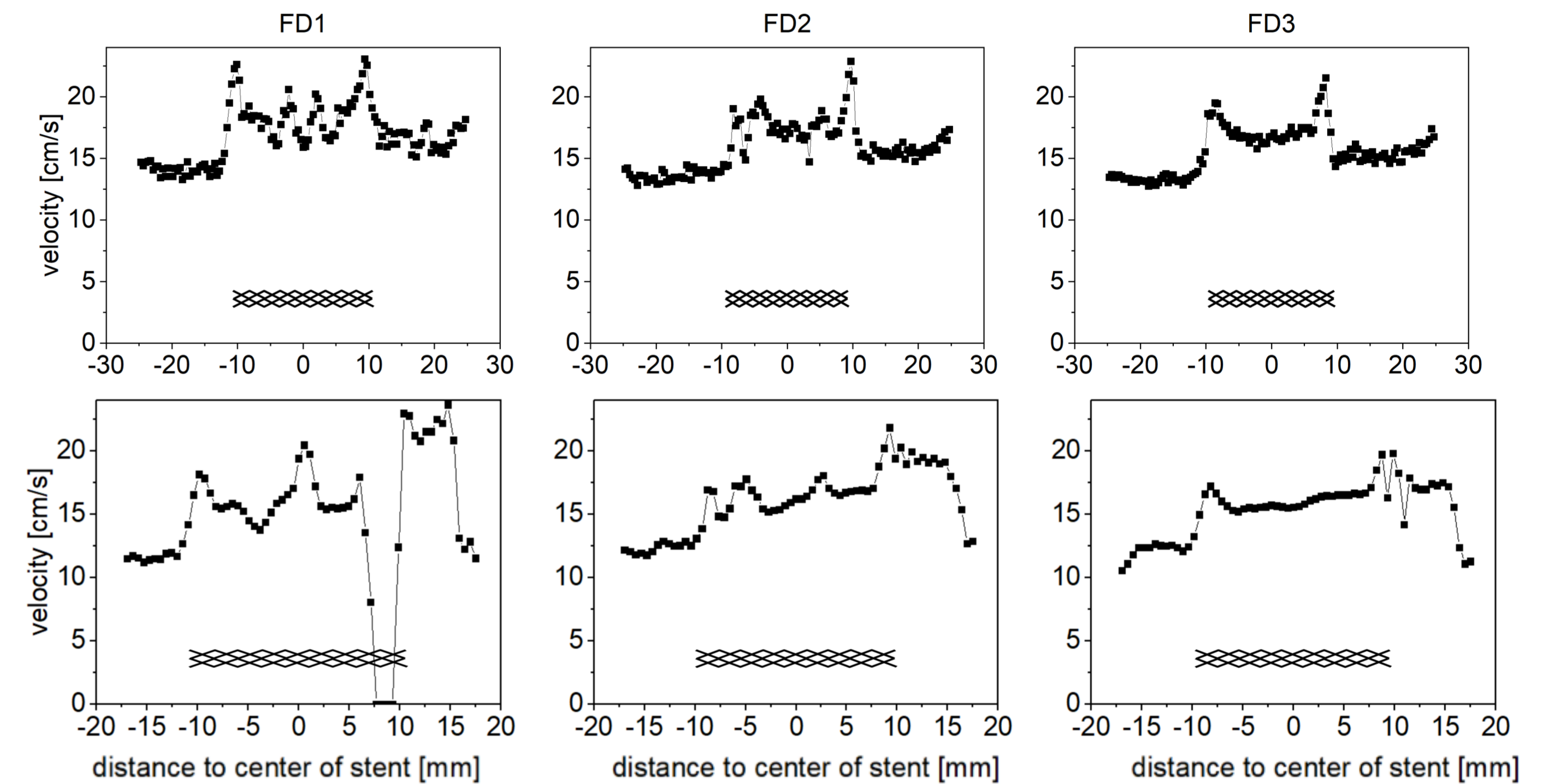


Fig 5: Velocity profiles for 3T (upper row) and 7T (bottom row) for 3D PC for the test tube with different FD1-3.

IV. Discussion

- FDs affect the GRE MRI
 - Similar effects were expected on PC MRI
- Distortions are caused by metallic artefacts
 - Visible by hypo- and hyperintensities
- Flow is less affected than the velocity
 - Area, where flow is detected, varies due to artefacts
- Artefacts are attributed by the composition of the stent
 - Artefacts are dependent on the x-ray markers due to their larger magnetic susceptibility

V. Conclusion

While flow diverter stents don't forbid MRI, the results have to be interpreted with care as artefacts are introduced. This holds especially for the velocity values. Still, flow MRI may be useful for evaluating treatment success, especially if FDs with little artefacts are chosen, or sequences are optimized to reduce the artefacts.