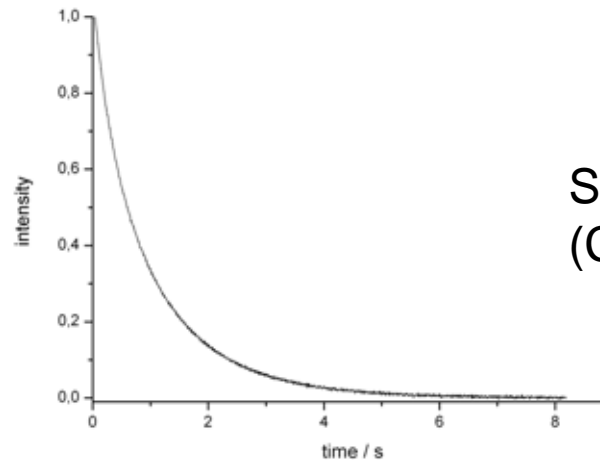


Permanent Magnet Arrangements for Low-Field NMR

Carsten Horch
University of Leipzig

NMR Principles

- Alignment of nuclear spins in static magnetic field
- Excitation of nuclear spin by rf-pulse
- Rotation of nuclear spins
- Measurement of induced voltage



Spin-spin decay of water
(CPMG pulse sequence)



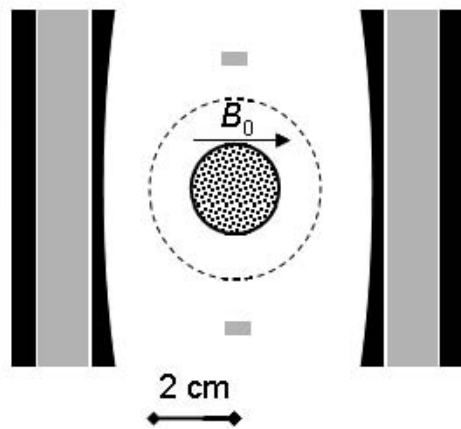
Sketches of Arrangements

Parallel arrangement:

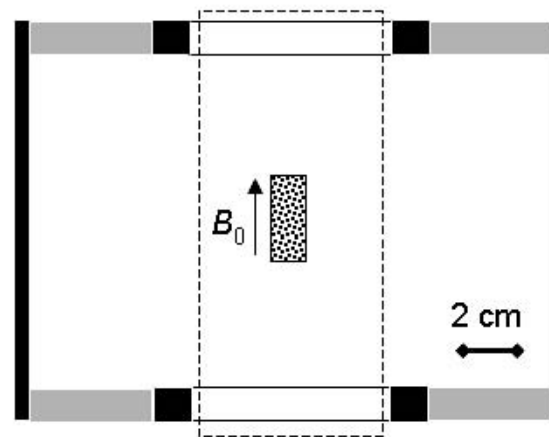
- 100 x 100 x 15 mm³ blocks of NdFeB magnets
- Iron yokes (shaped & flat)
- Shim magnets

Circular arrangement:

- 10 x 10 x 40 mm³ blocks of NdFeB magnets
- Iron ring yoke mount 16 blocks
- Iron bars at back side



a

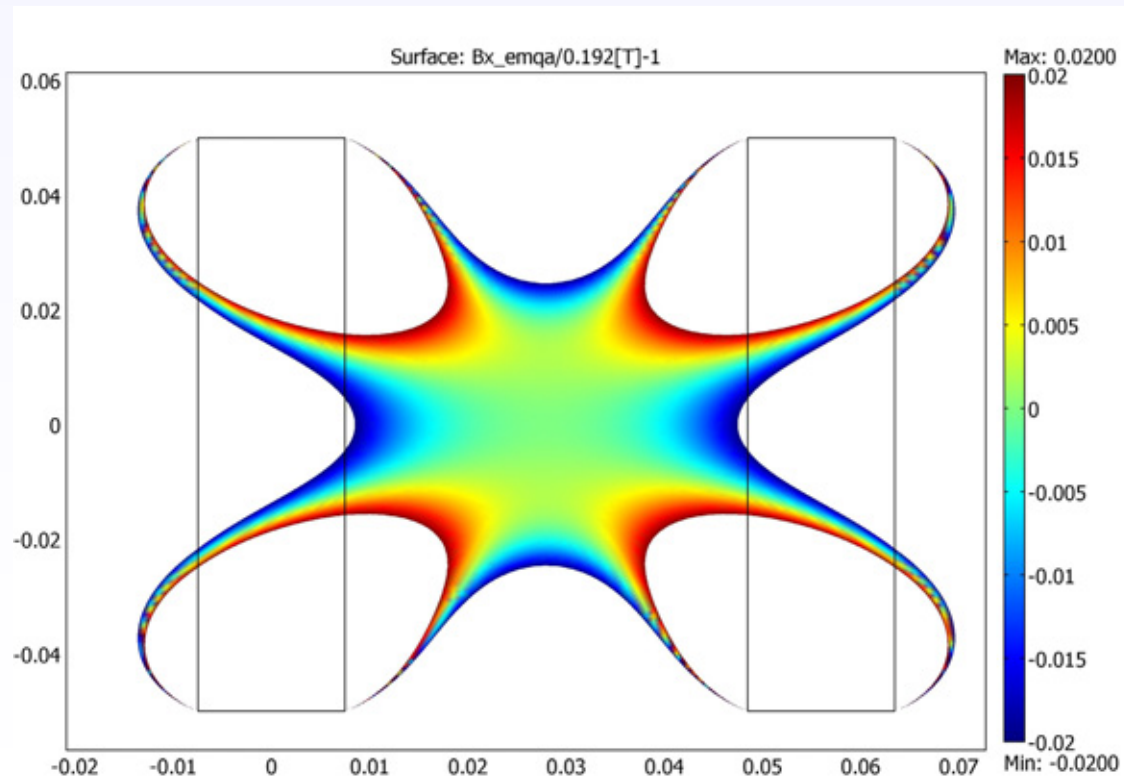


b

Parallel Magnet Arrangement

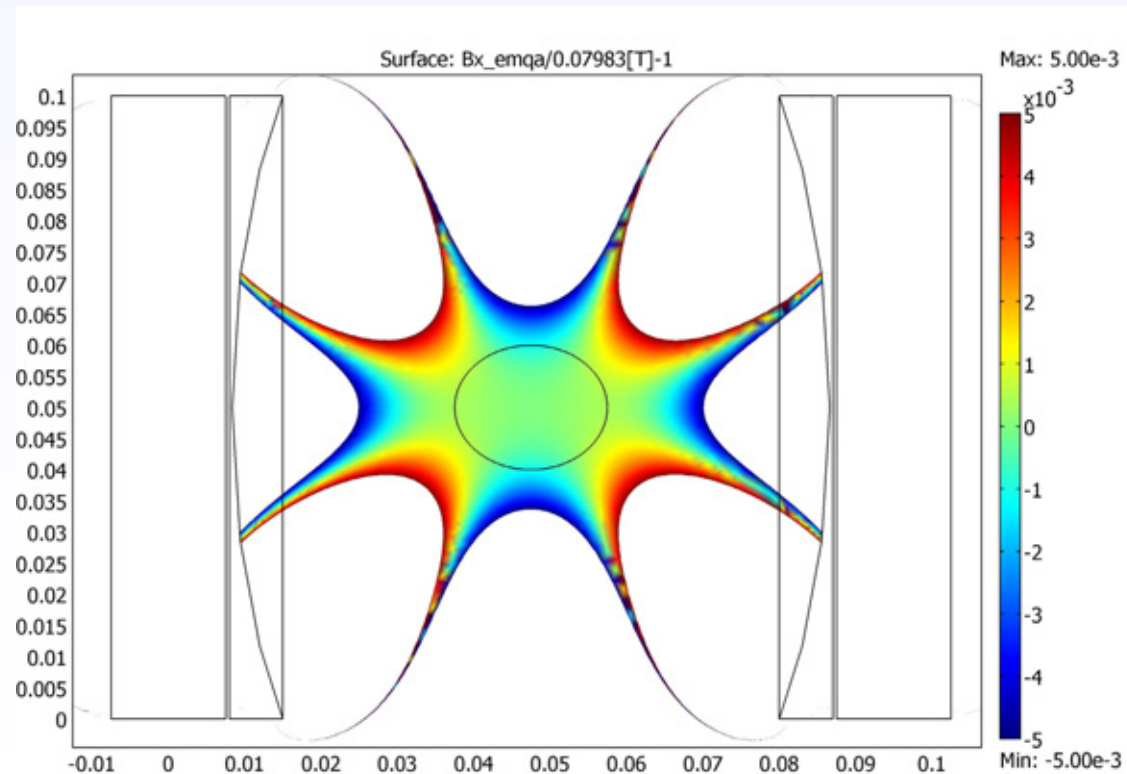
Two magnet single blocks, distance 51 mm

1. Insufficient magnetic field homogeneity
2. Too less space in between



Parallel Magnet Arrangement

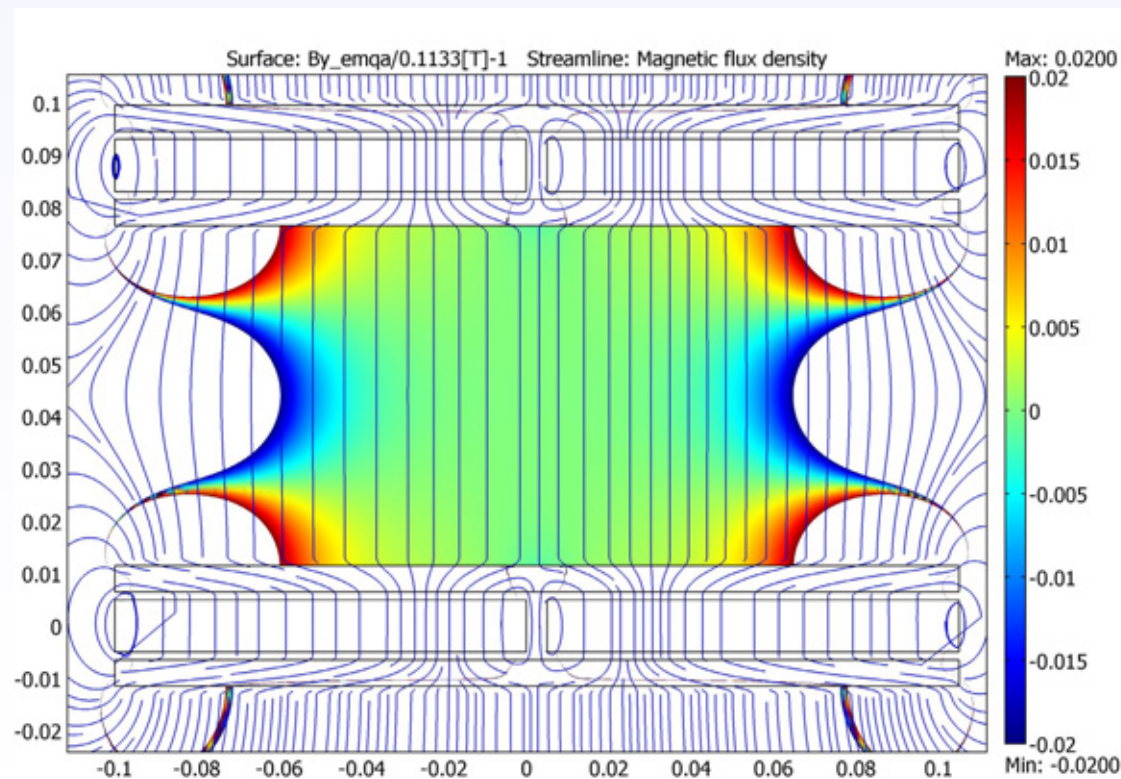
Two magnet blocks, shaped iron yokes added
Useable magnetic field homogeneity



Parallel Magnet Arrangement

Perpendicular slice: 2 magnet blocks on each side

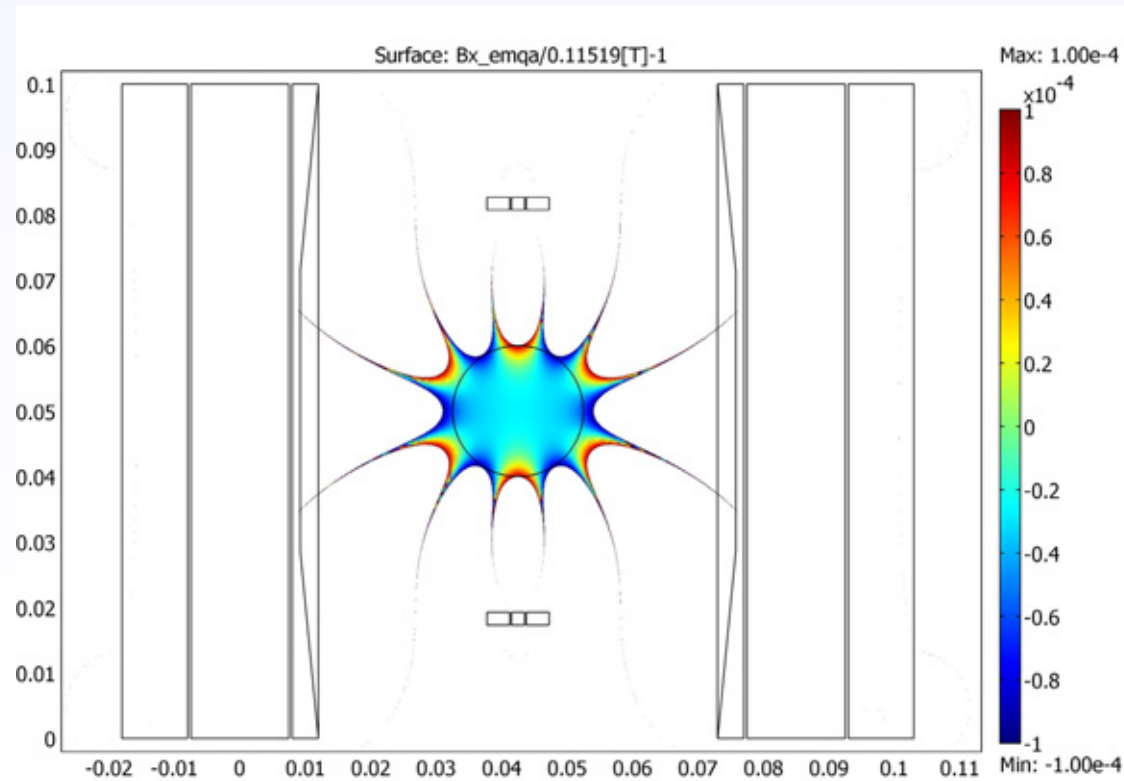
1. Enlarge useable volume
2. Bridge gap between magnet blocks



Parallel Magnet Arrangement

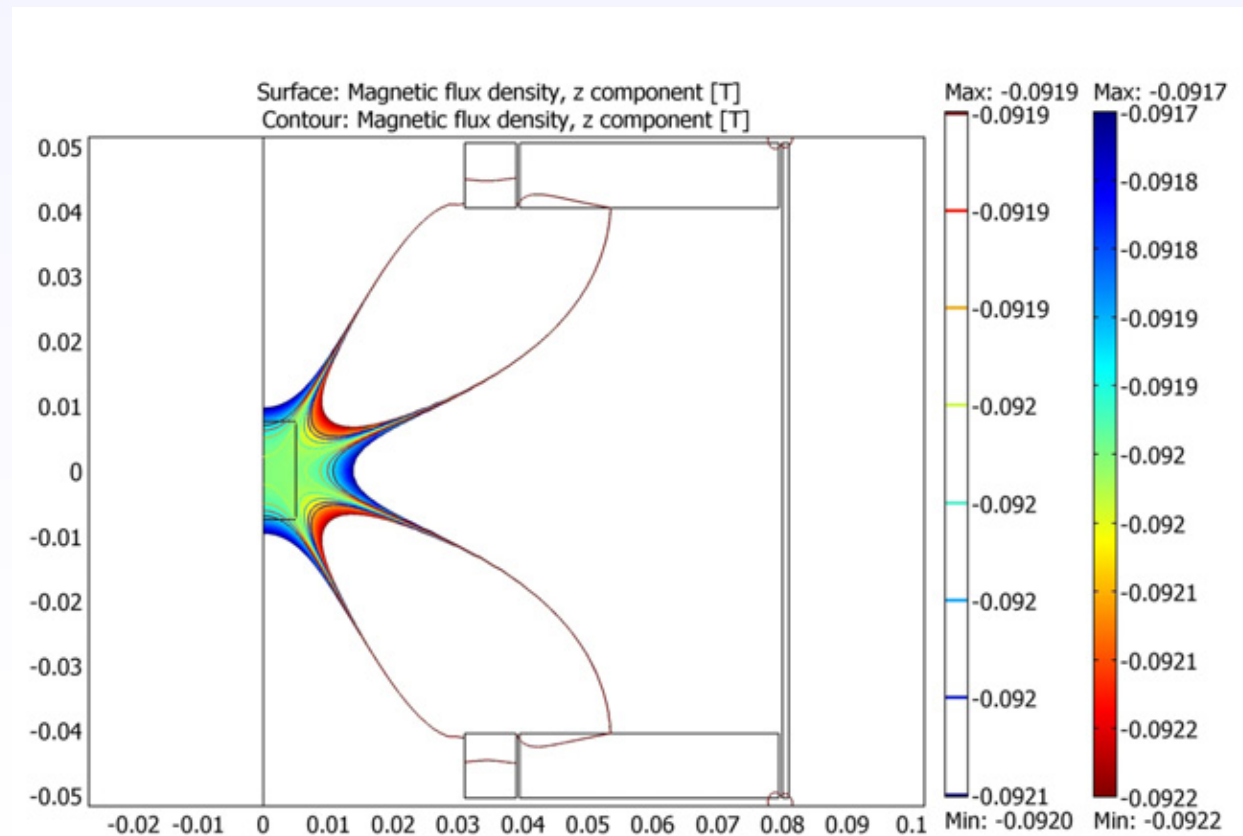
Final result:

- Shaped iron yokes inside, flat iron yokes outside
- Shim magnets composed of iron bars & NdFeB cubes
- Optimized to needed space & best field homogeneity
- Dimensions for manufacturing



Circular Magnet Arrangement

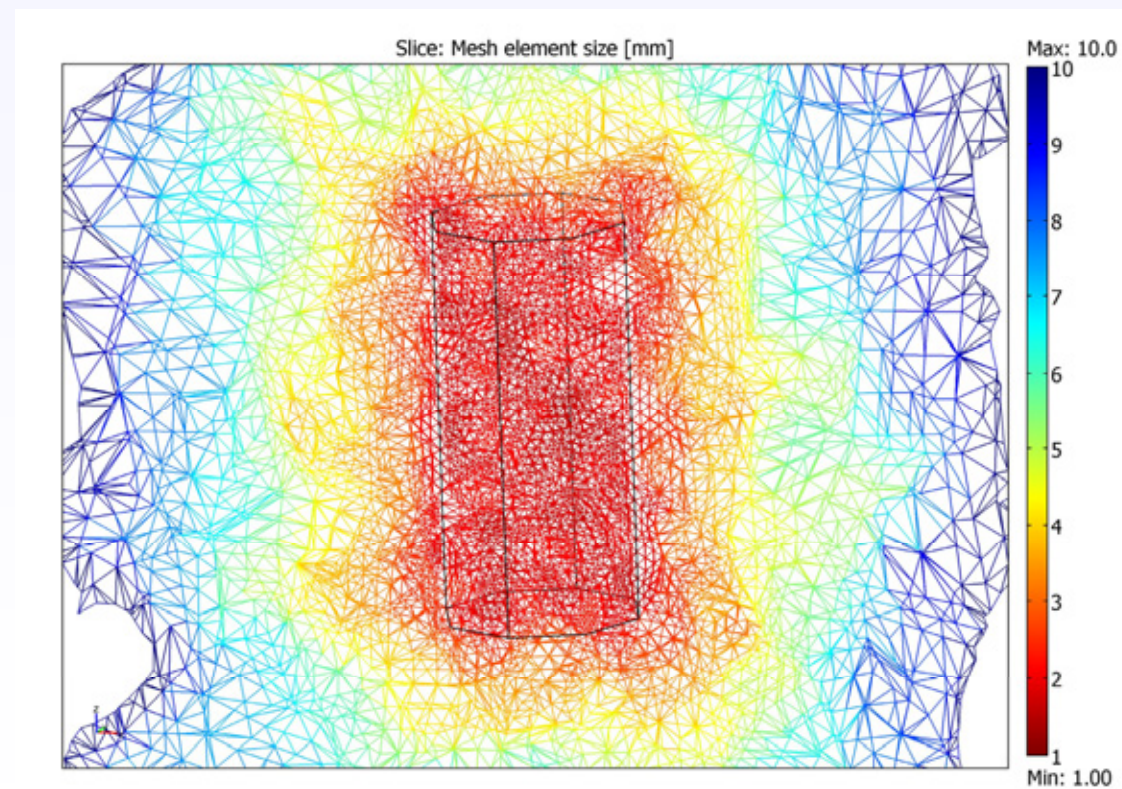
2D axial symmetry for good approximation
for disances, sizes & positions of magnets and yokes



Circular Magnet Arrangement

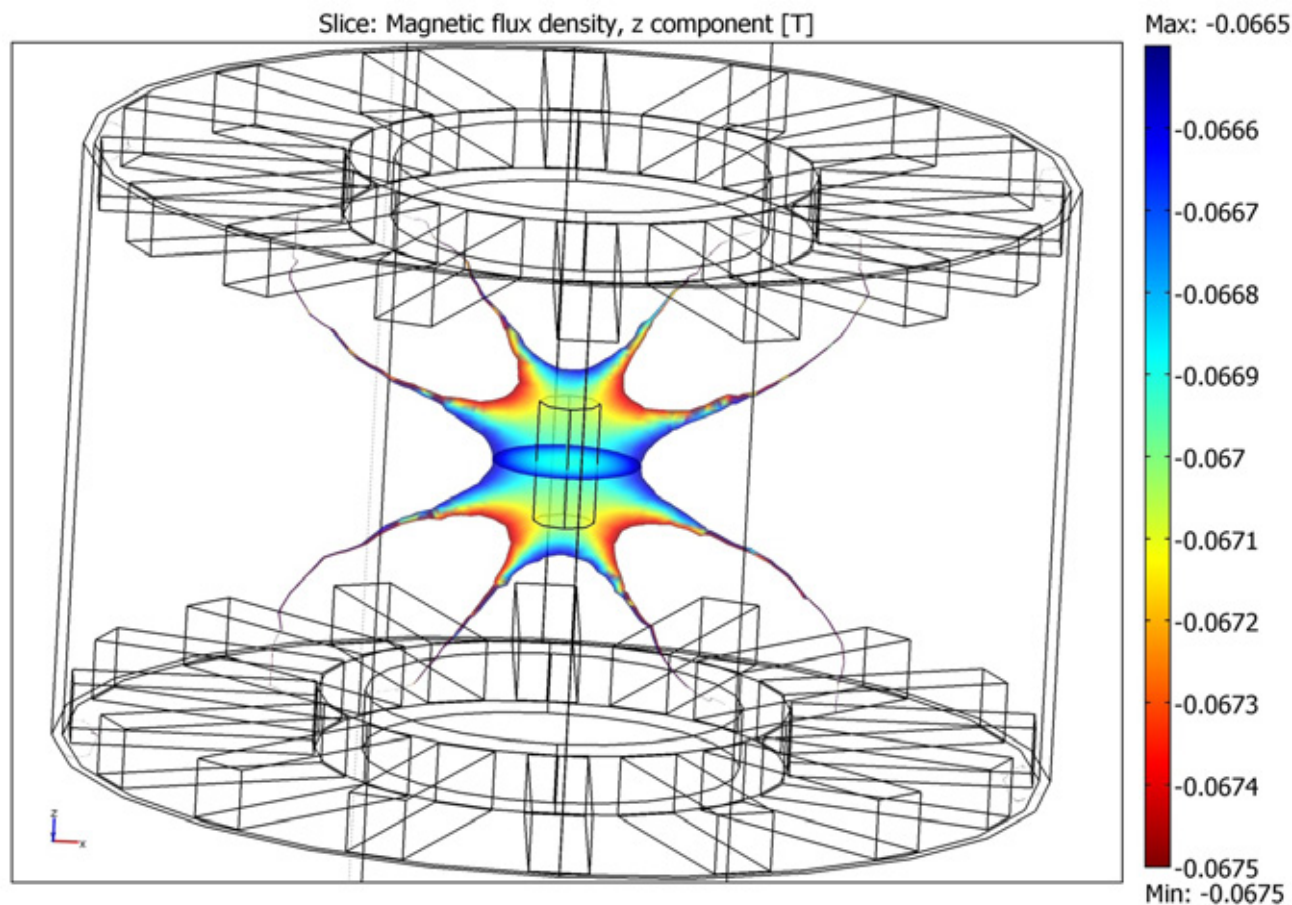
Refined mesh at sample position

- Element growth rate: 1.5
- Maximum element size: 0.002 m

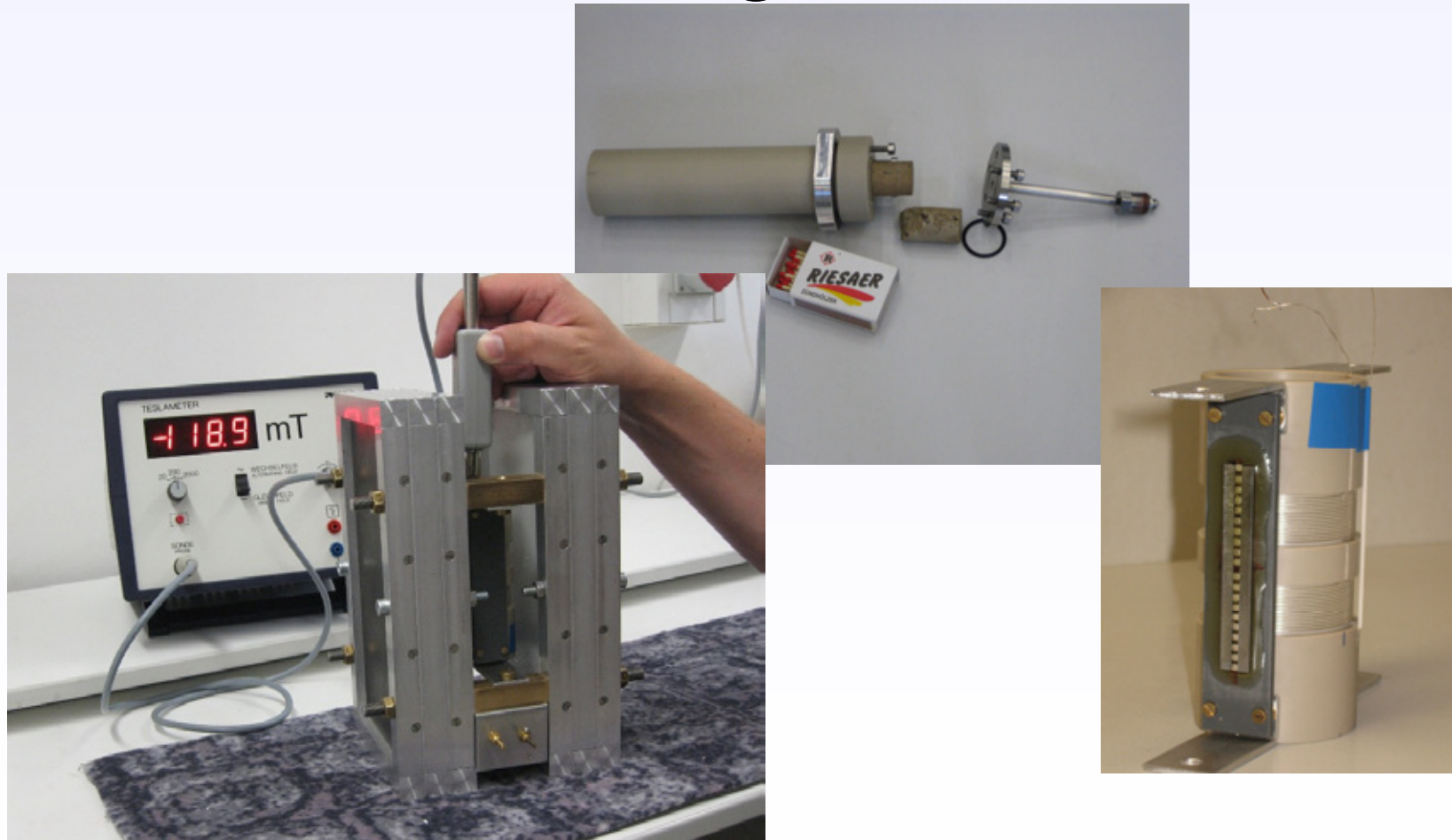


Circular Magnet Arrangement

Final 3D result: good agreement with manufactured arrangement



Photos of Parallel Magnet Arrangement

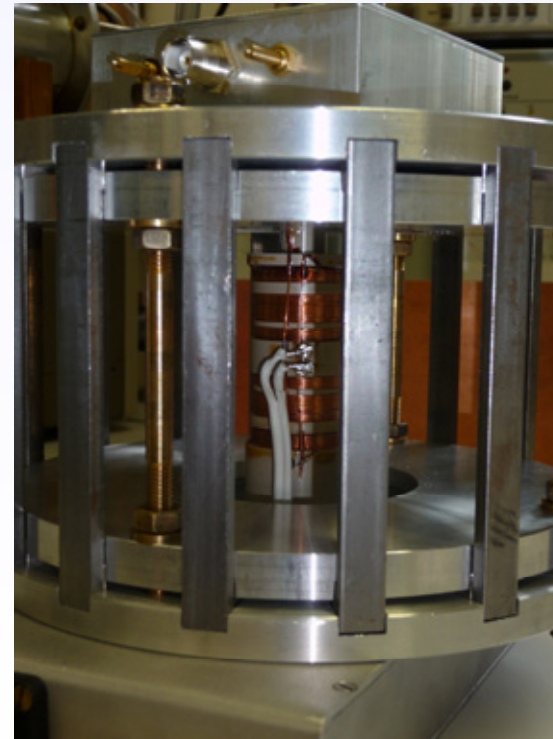
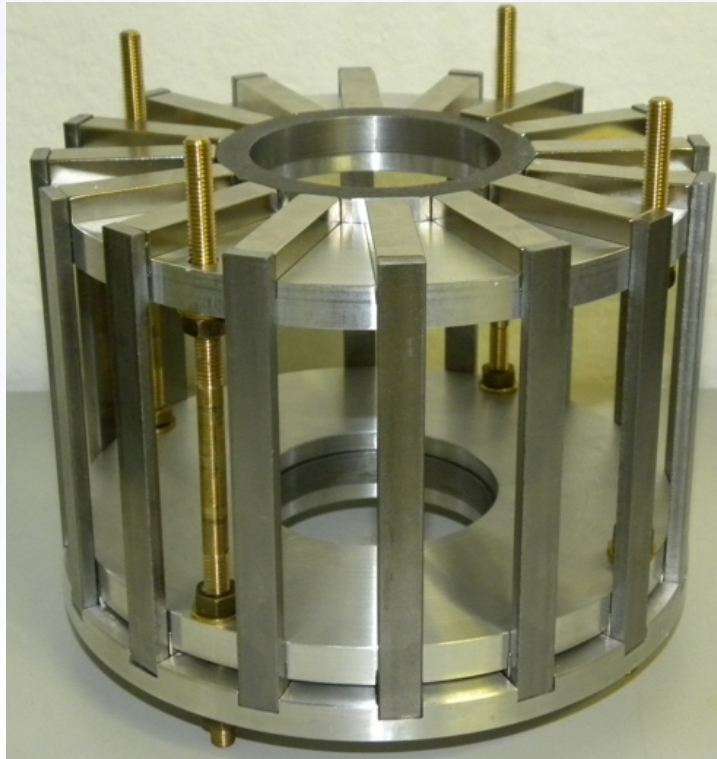


Carsten Horch
University of Leipzig

Permanent Magnet Arrangements
for Low-Field NMR

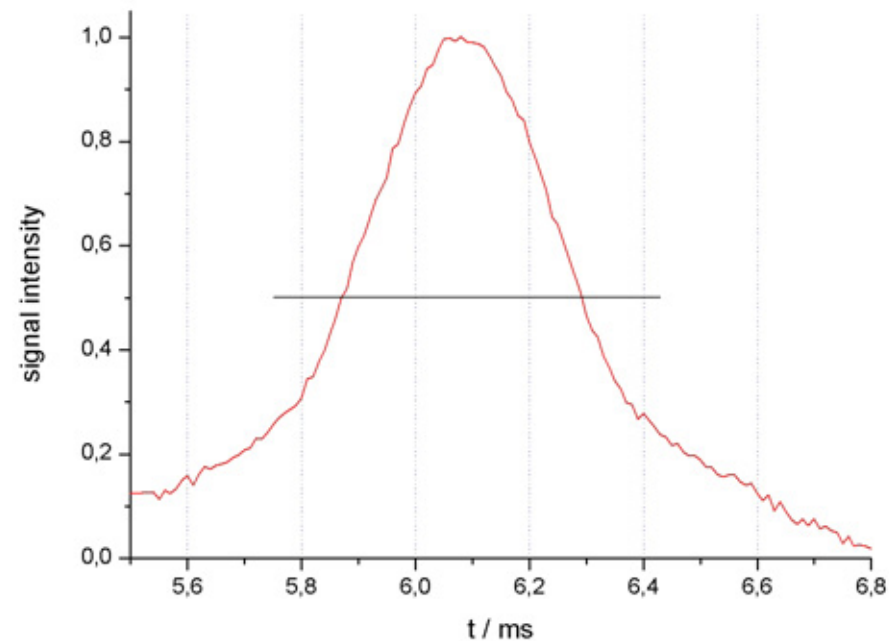


Photos of Circular Magnet Arrangement



Experimental Result

Spin echo received with parallel arrangement: desired size
→ same homogeneity of magnetic field



Thank you for your attention!