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Comparative study between in-situ measurements and a 3D efficient model for the computation of magnetic fields in High Field Polyhelix magnets

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Comparative study between in-situ measurements and a 3D efficient model for the computation of magnetic fields in High Field Polyhelix magnets

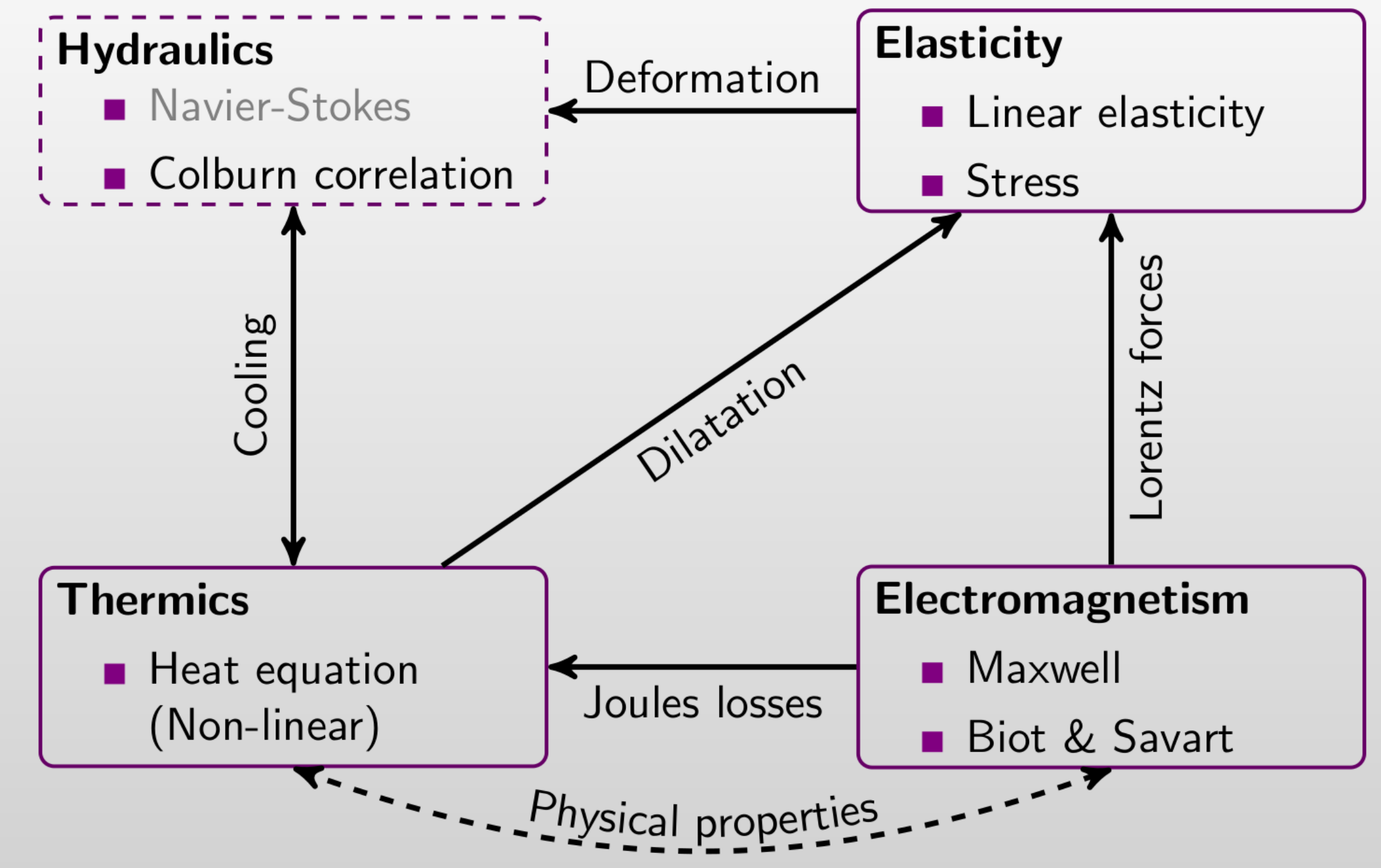
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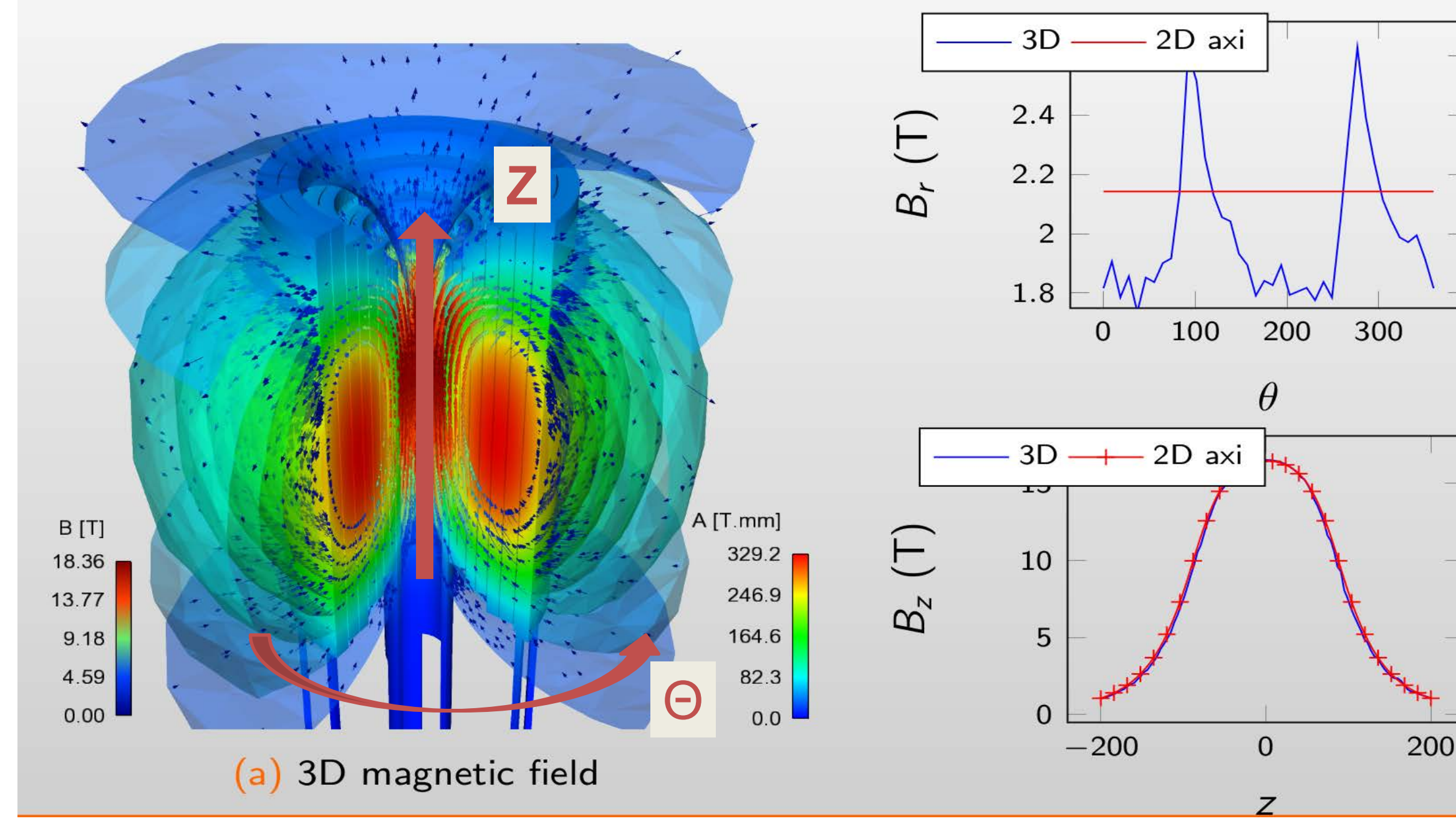
Tue-Af-Po2 [169]

PolyHelix Magnet Modeling



- Full 3D NL Multi-Physics model**
- Use **Feel++ C++-14** FEM library
 - ThermoHydraulics: 0D
 - **Parallel Biot-Savart** Magnetic Field
 - Automatic CAD and Meshing (**Salome**)
- Up to 1024 procs
• Up to 70 10⁶ elts

Full 3D multi-physics model on polyhelix magnet



Unexpected 3D B Field profile observed in calculation

Elements: 27 10⁶
Cpus: 48 procs
Time: 1640s
Mem: 785 Gb

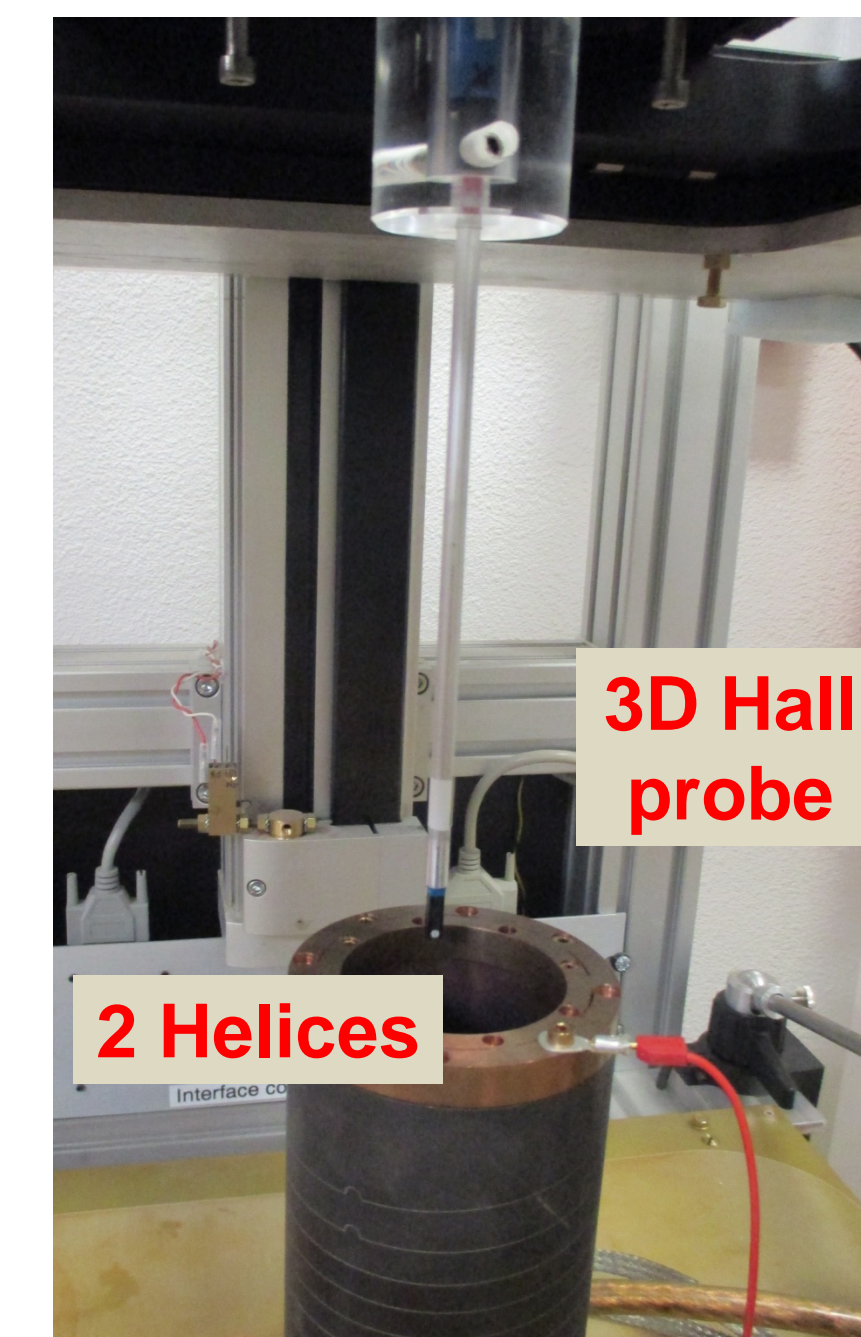
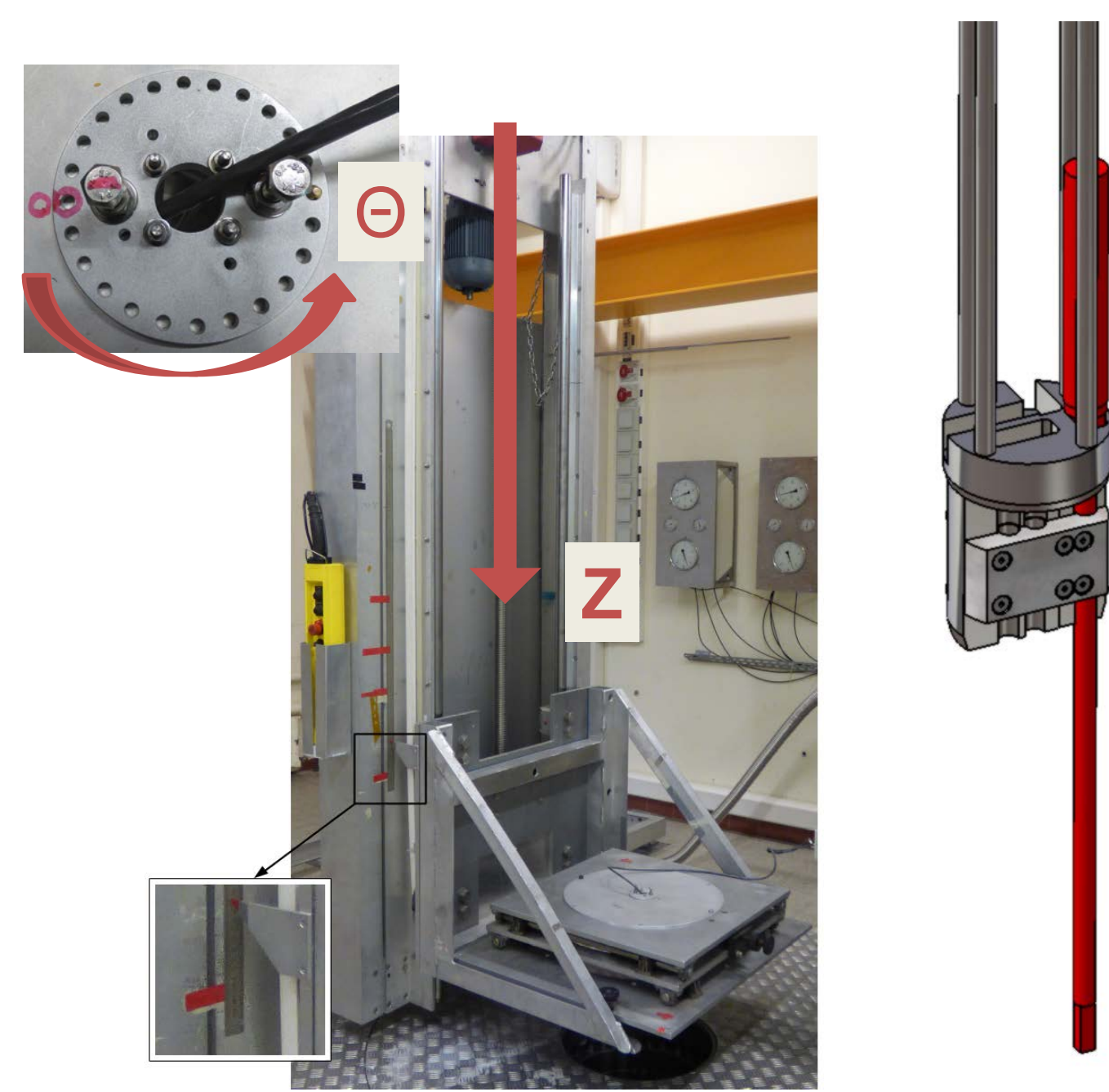
Objectives

Confirm the 3D effects predicted

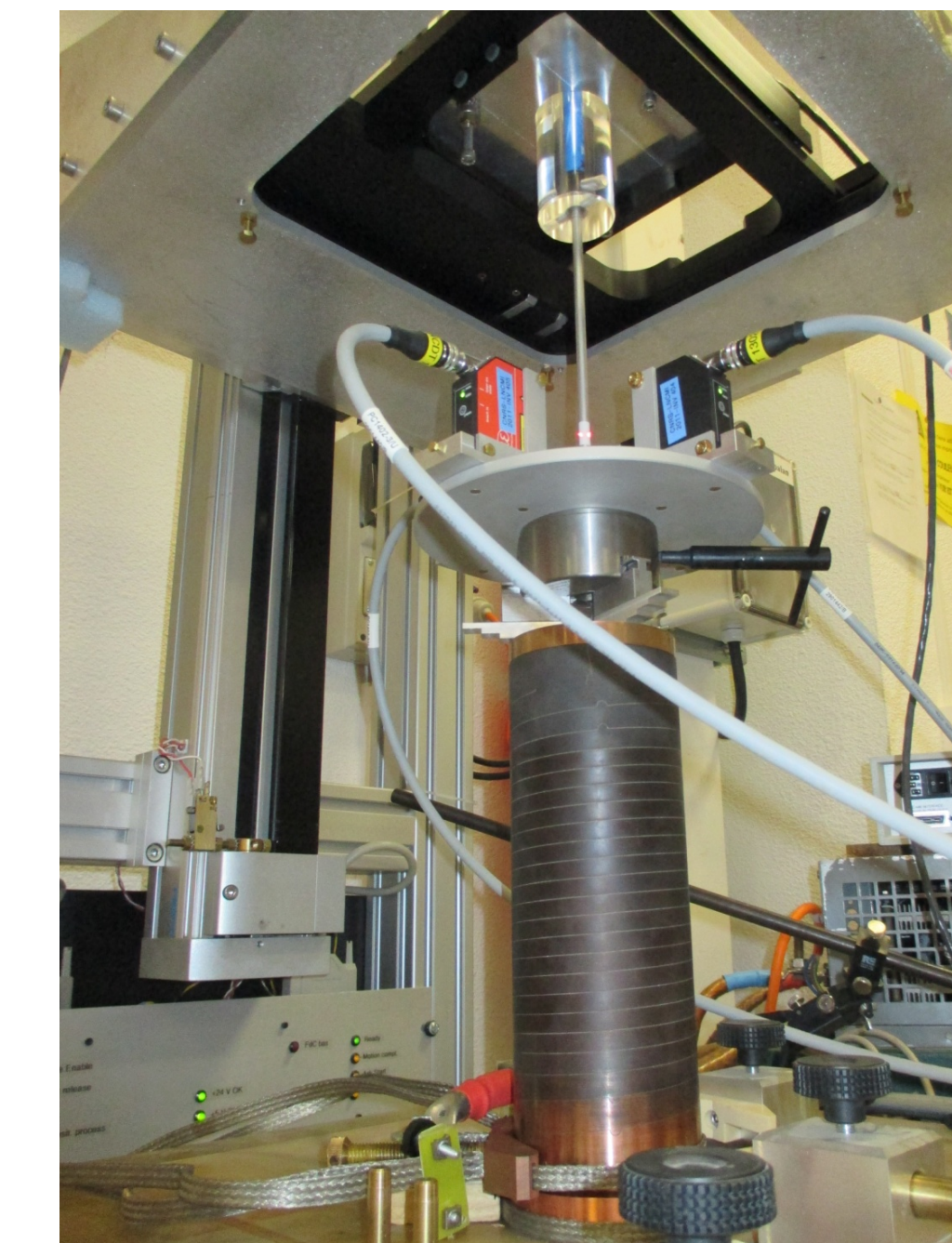
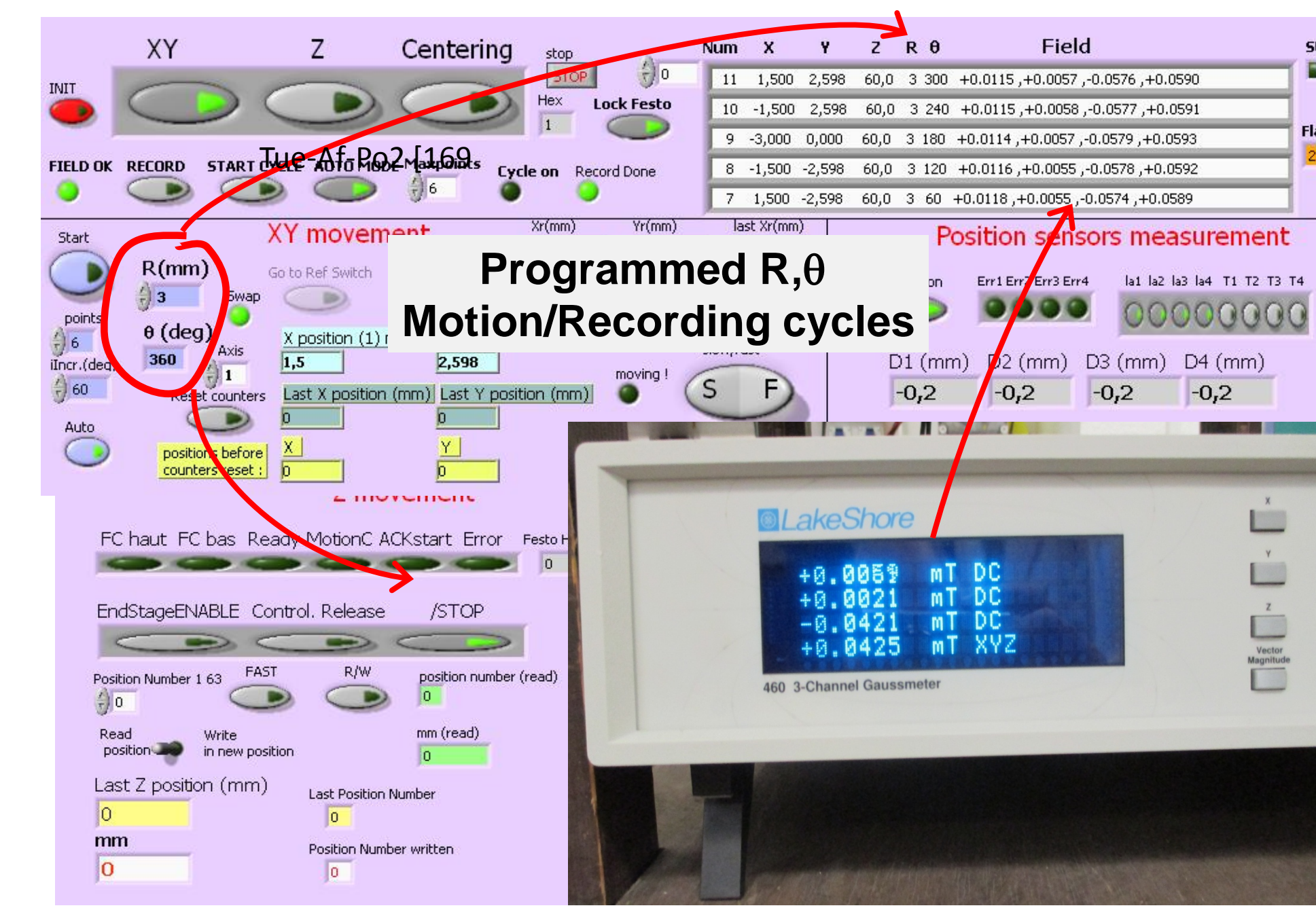
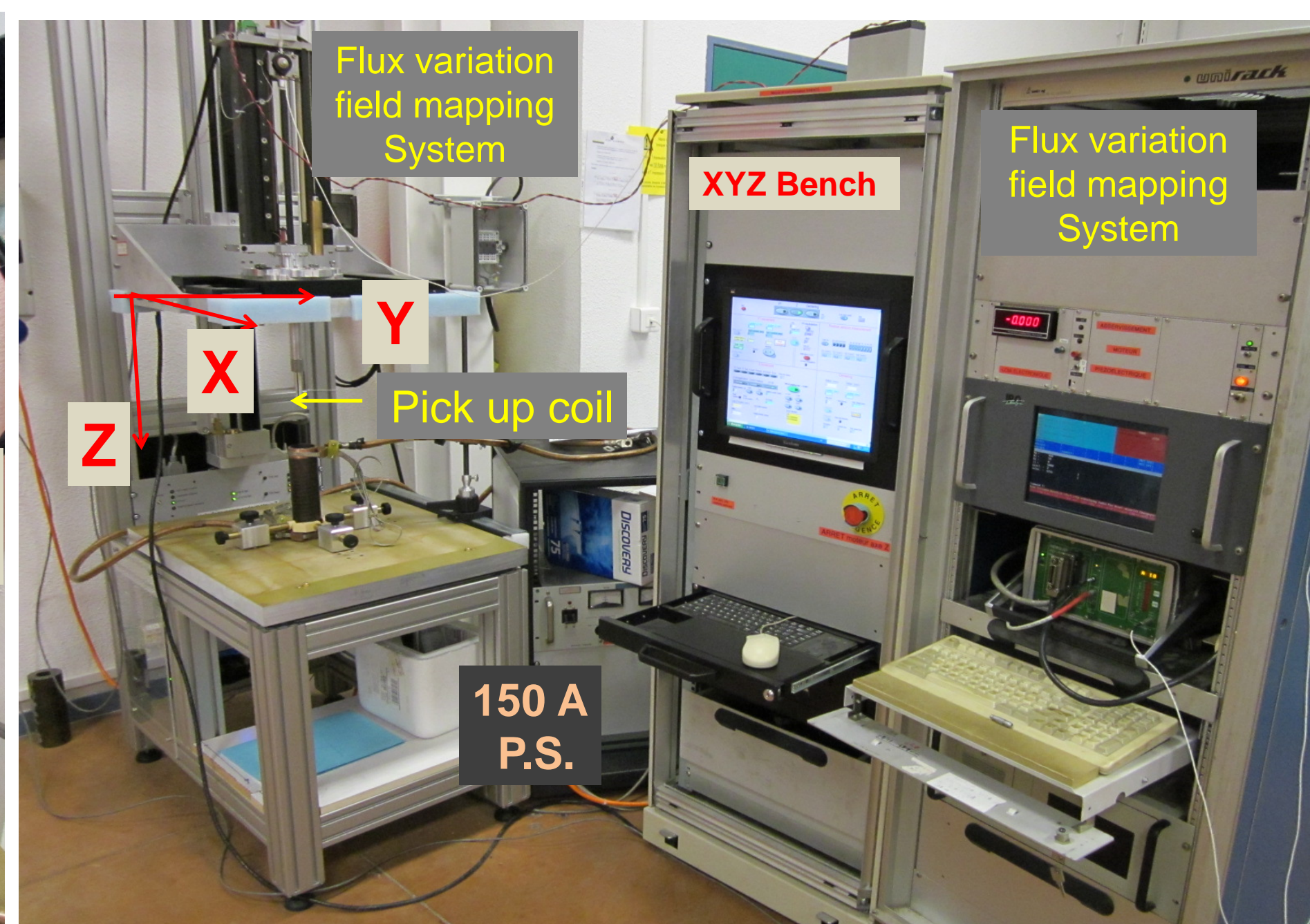
- Validate Numerical Model(s)
- Existing Mag. Field profile : only available**
 - on Oz axis
 - in a small sphere of 1 cm³
- Need for Dedicated experimental setup**
 - On Magnet Site setup
 - Low Field TestBench

Experimental Setups

On Magnet Site



Low Field TestBench



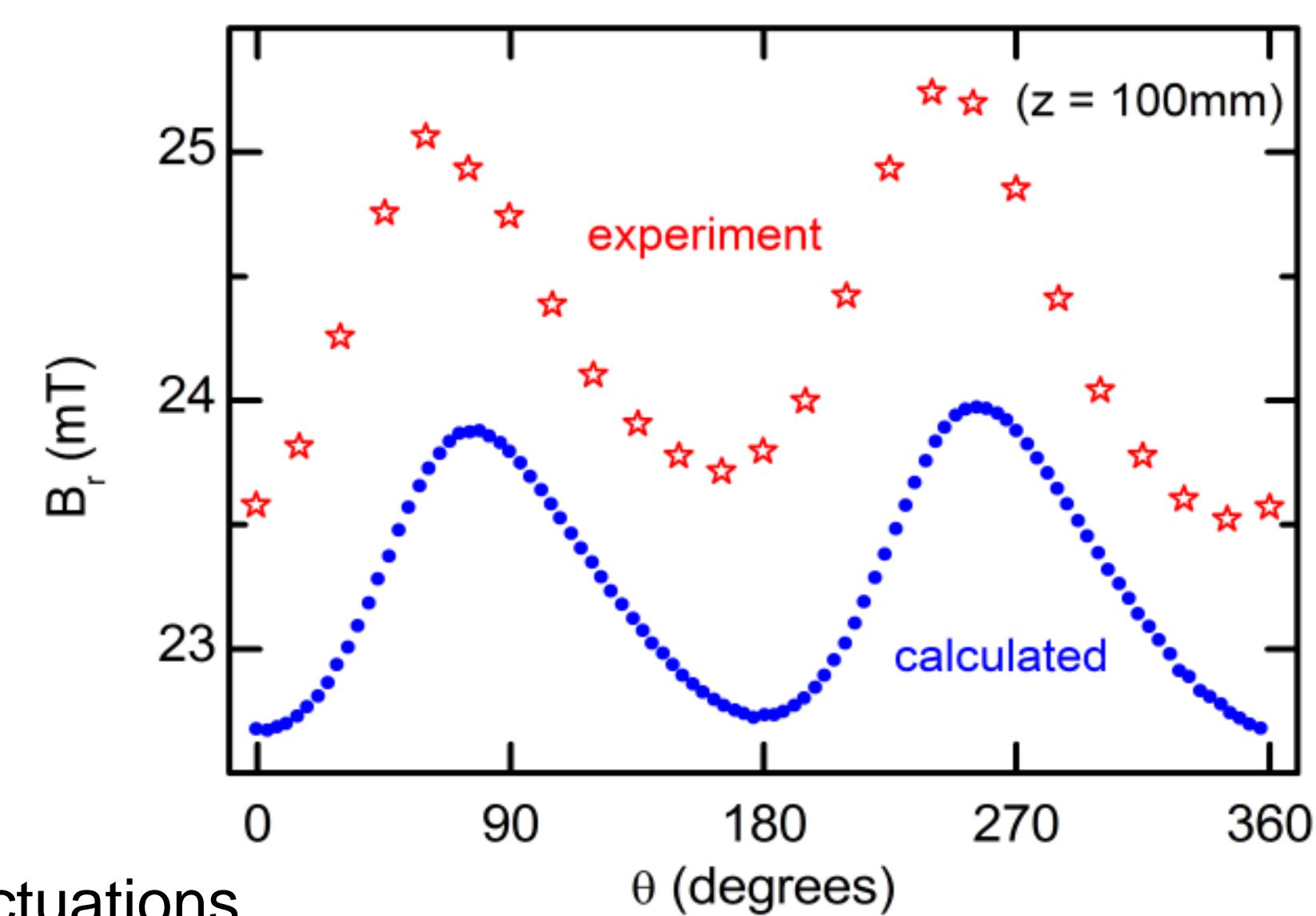
3D Hall probe (limited to 3 T)



	On Site	Test Bench
Displ.	Translation Z + Rotation t	Translation X, Y, Z
Automated	No	Partly
Precision	-	++
Alimentation	500 A	150 A (stabilized)

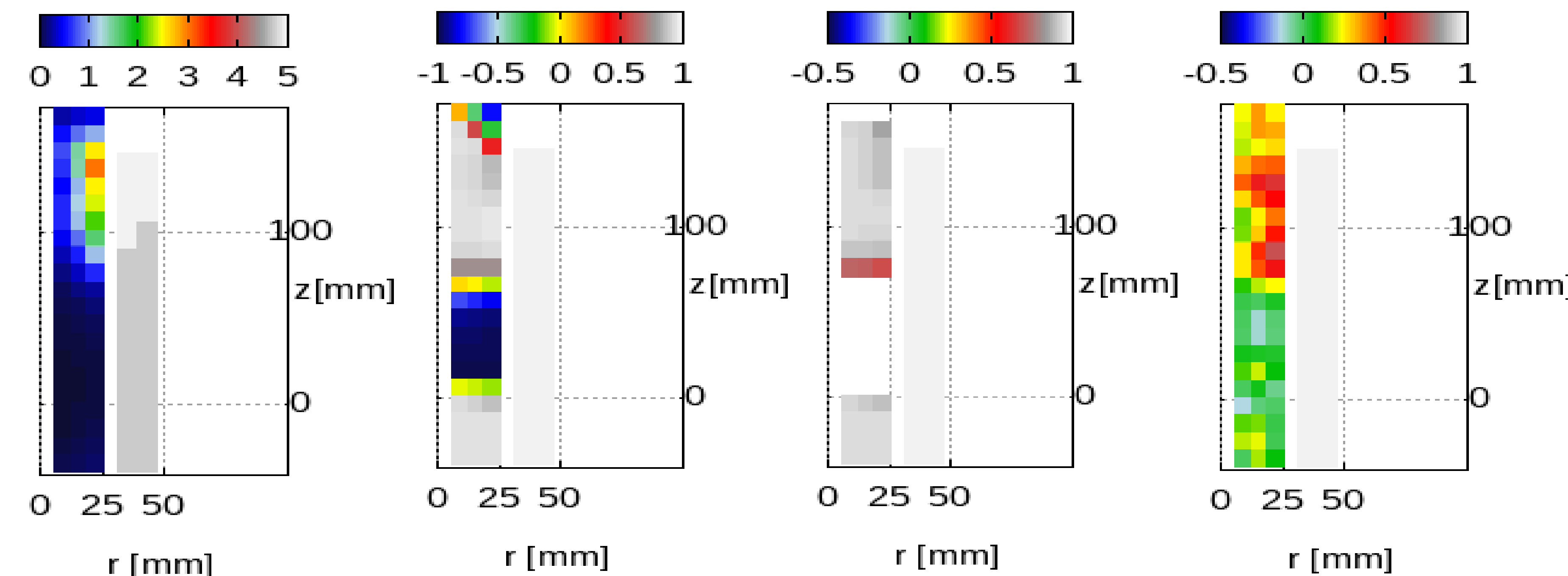
Results

Best fit for $r = 20$ mm and $z = 100$ mm

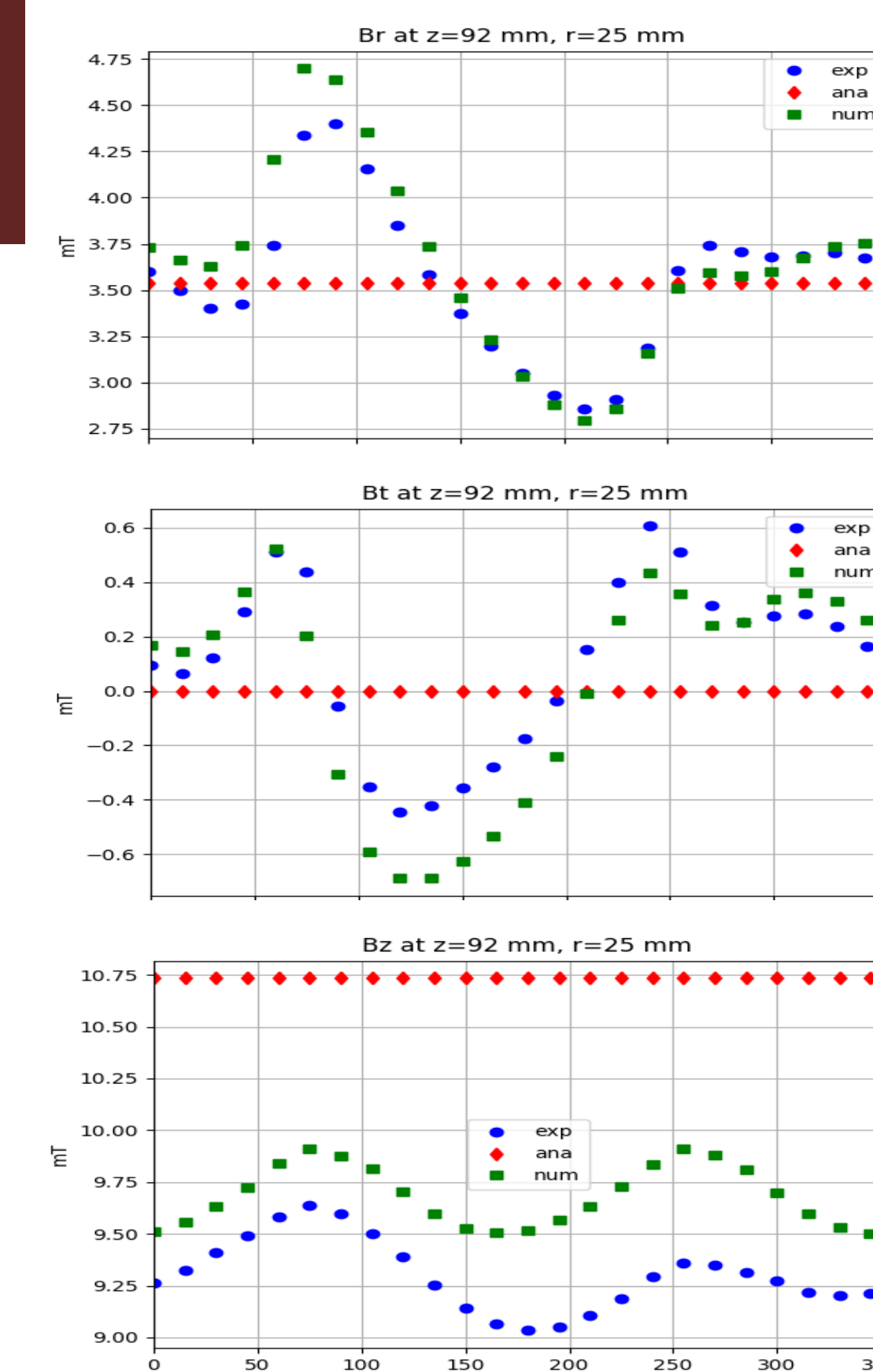


- Low resolution:
- input current fluctuations
 - Weak precision of probe
 - Poor mechanical structure

3D Exp Indicator:
 $100 \cdot \text{std}(B_r) / \text{mean}(B_r)$



Num/Exp Correlation Index



Conclusions

Experiments

- 3D Magnetic Field B profile
- Work needed to improve setups
- Improve Precision of On Magnet Site setup

Full 3D multi-physics model

- Validation
- Add RB feature to investigate UQ on B
- In progress Consequence on Mechanical Efforts

Perspectives

- 3D effects in Bitter? (expected to be less import.)
- PolyHelix Magnet design
- Address Users demand for specific B profile: eg, NMR, Levitation, Ions sources