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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

Cécile Daversin, Francois Debray, Jean Dumas, Romain Hild, Philippe Sala,  
Christophe Trophime

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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

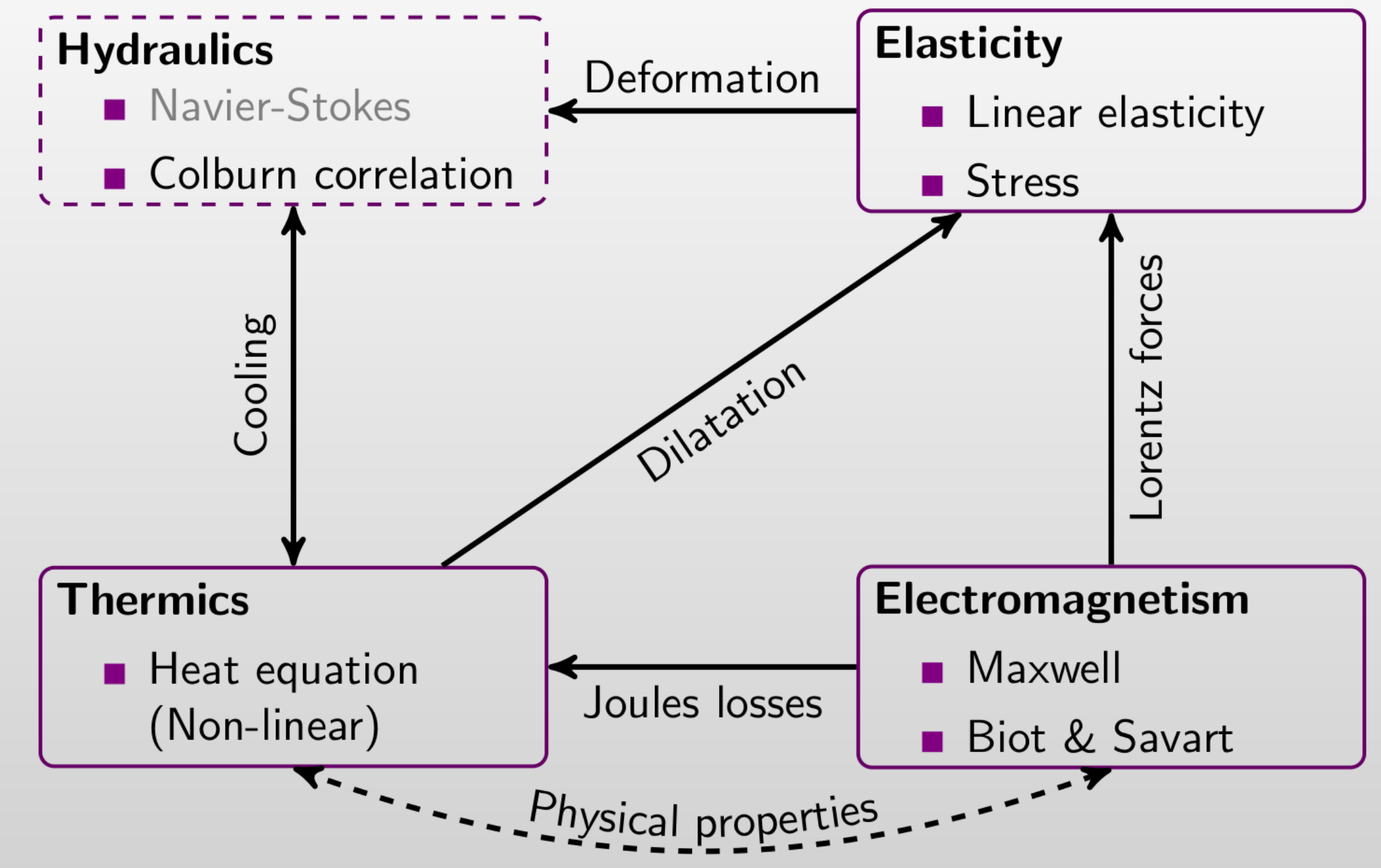
Cécile Daversin<sup>1,3</sup>, Francois Debray<sup>2</sup>, Jean Dumas<sup>2</sup>, Romain Hild<sup>1</sup>, Philippe Sala<sup>2</sup>, Christophe Trophime<sup>2</sup>

1. IRMA, University of Strasbourg, F-67000 Strasbourg, France
2. LNCMI, CNRS UGA INSA EMFL, F-38000 Grenoble, France
3. Formerly at IRMA now at Simula Research Laboratory, P.O. Box 134, 1325 Lysaker, Norway



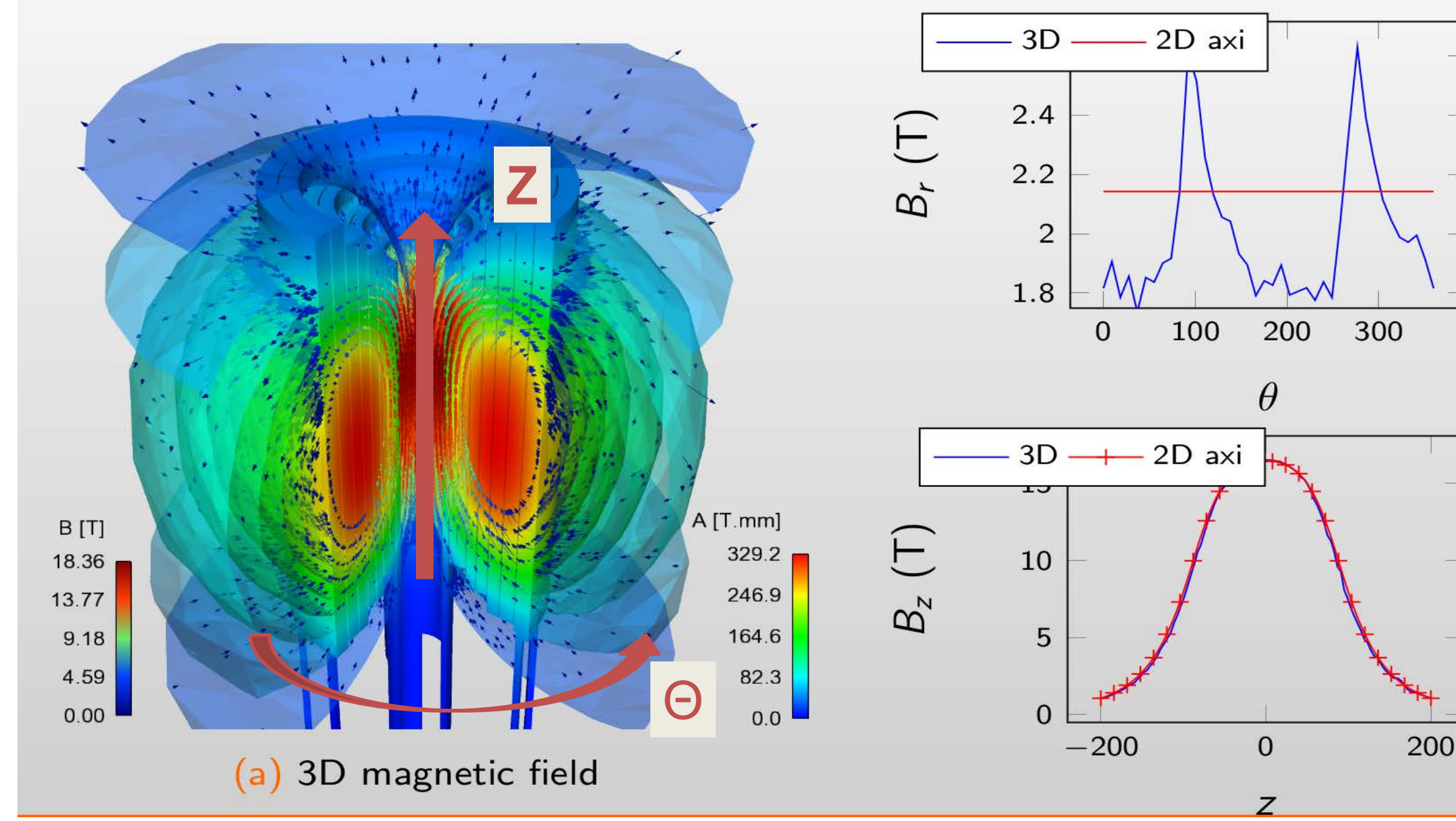
Tue-Af-Po2 [169]

## 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 10<sup>6</sup> elts

Full 3D multi-physics model on polyhelix magnet



**Unexpected 3D B Field profile observed in calculation**

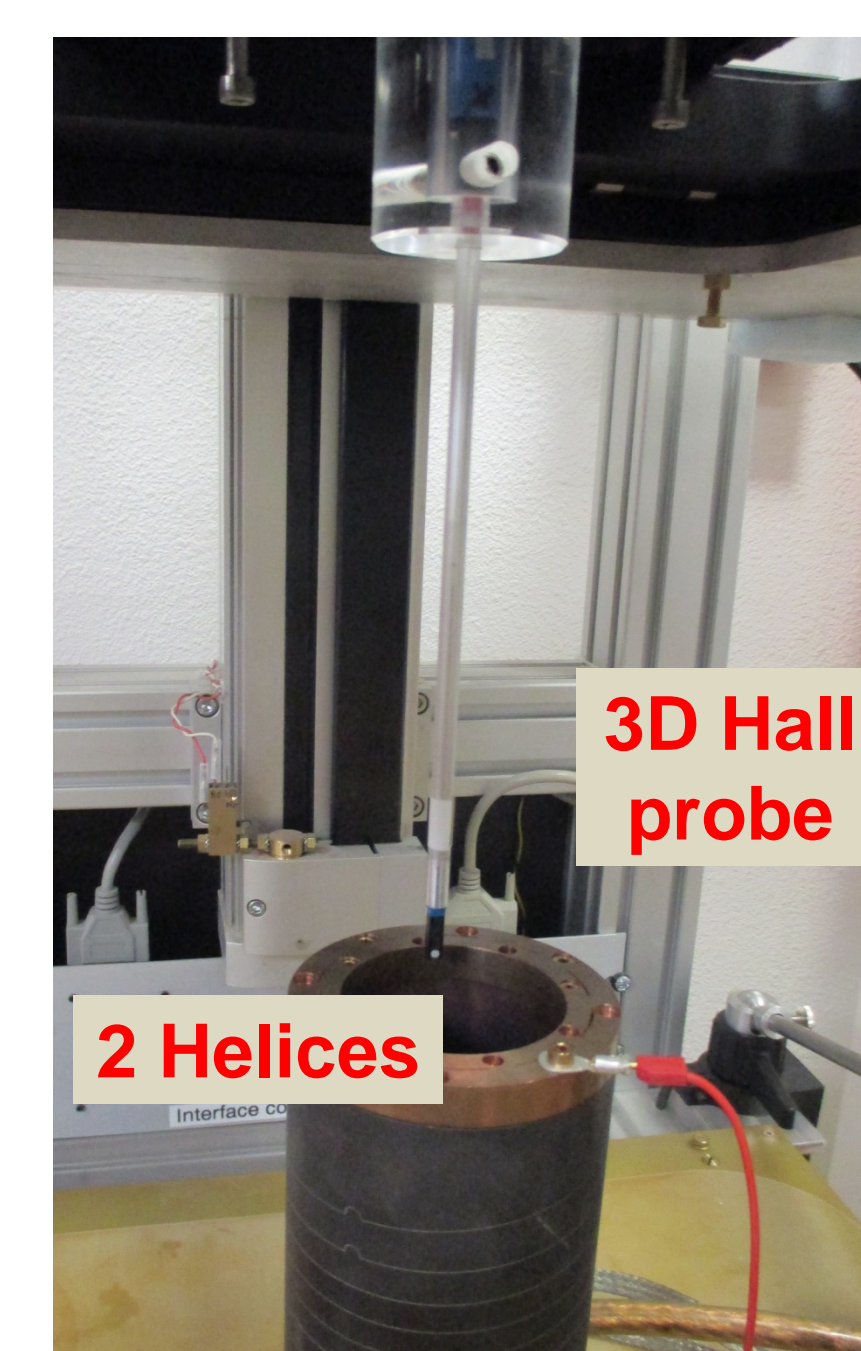
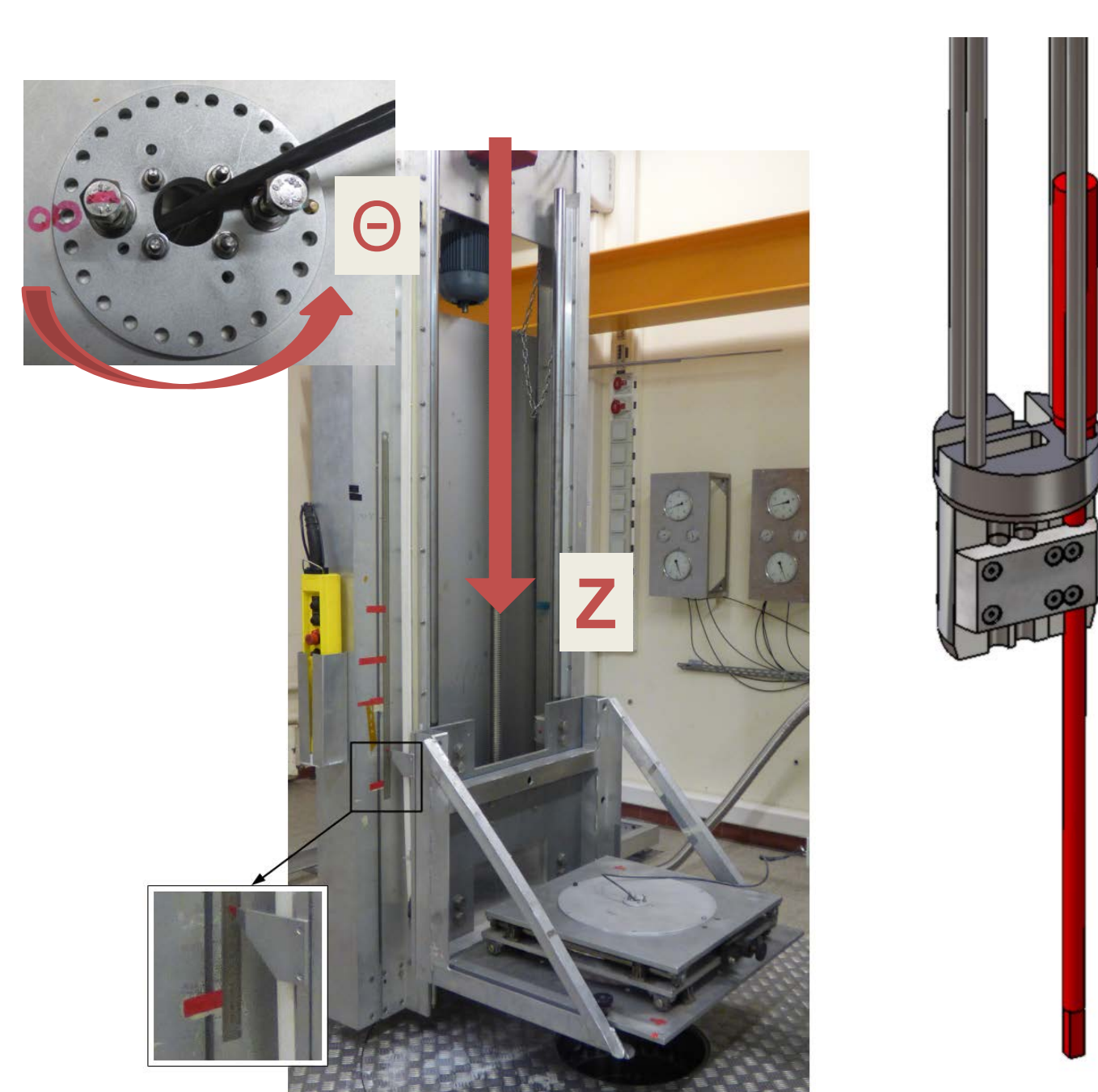
Elements: 27 10<sup>6</sup>  
Cpus: 48 procs  
Time: 1640s  
Mem: 785 Gb

## Objectives

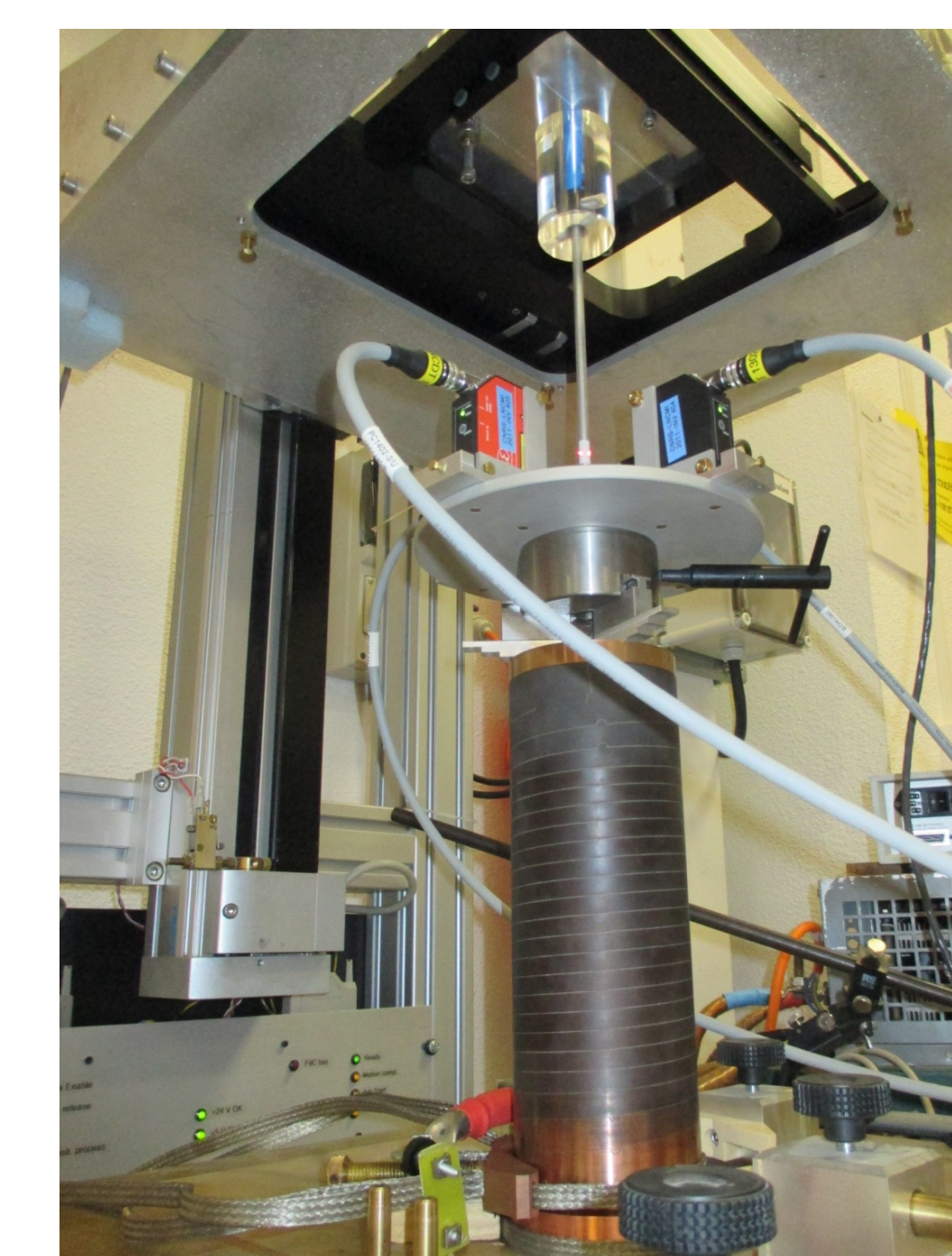
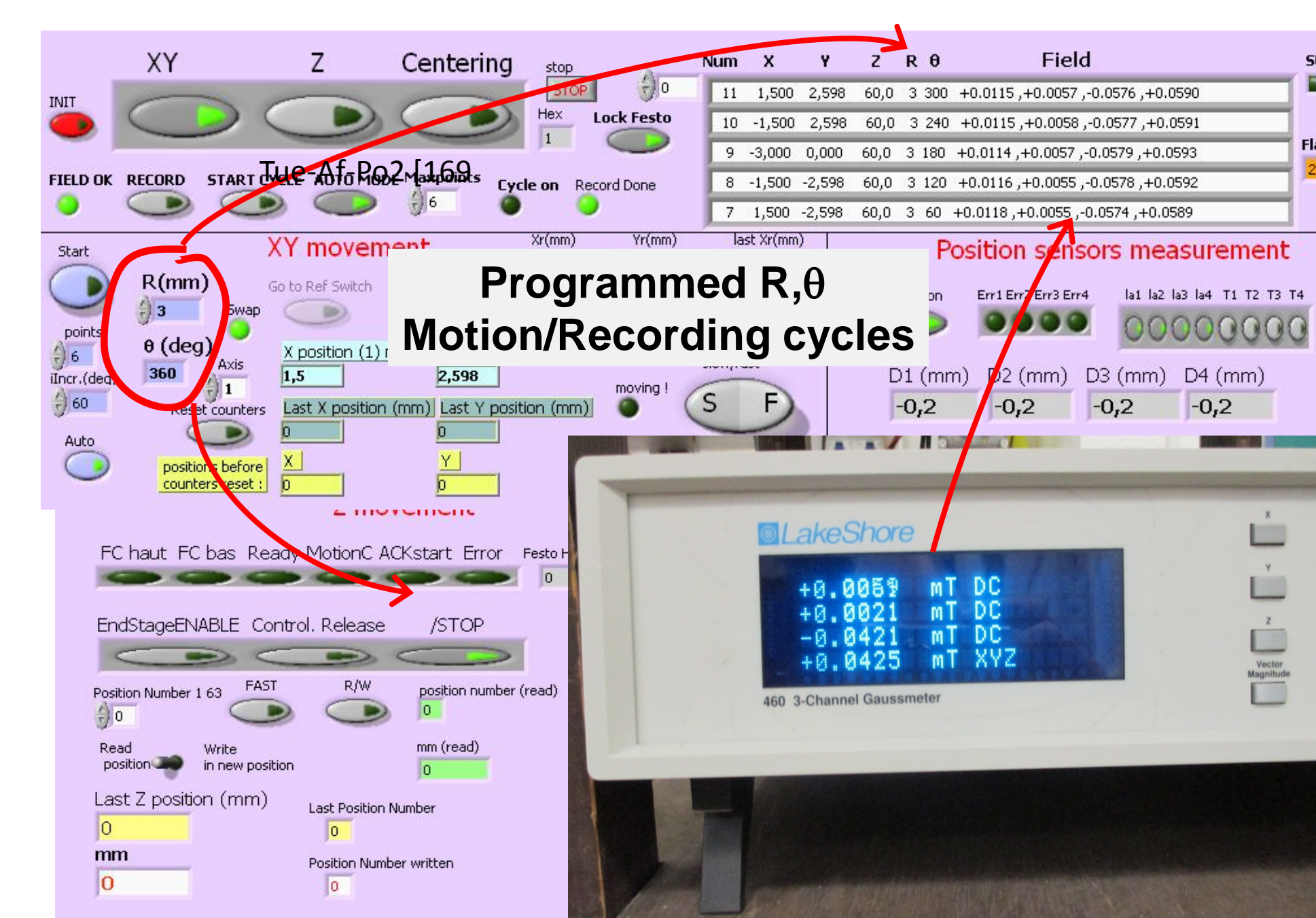
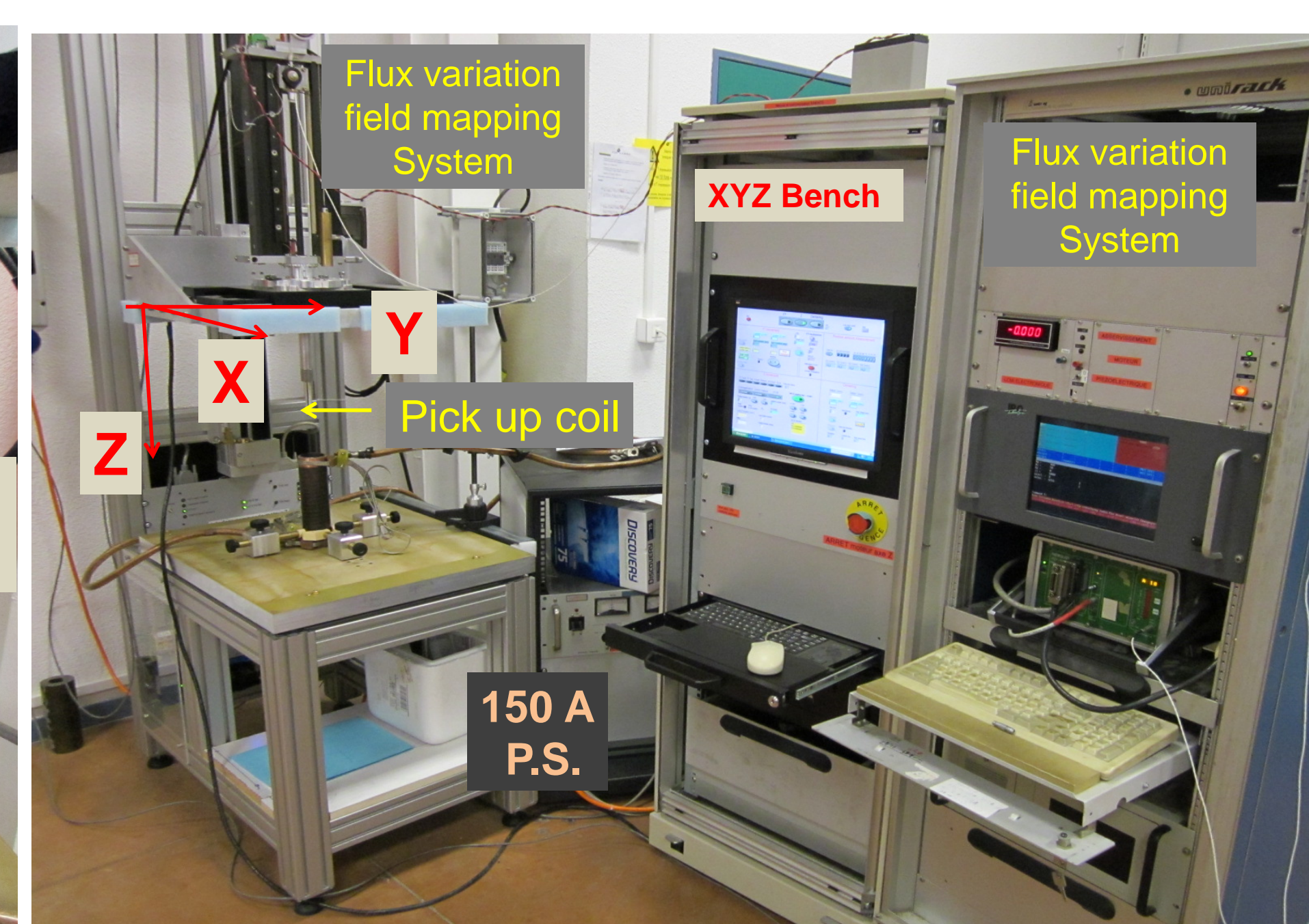
- Confirm the 3D effects predicted**
- Validate Numerical Model(s)
- Existing Mag. Field profile : only available**
- on Oz axis
  - in a small sphere of 1 cm<sup>3</sup>
- Need for Dedicated experimental setup**
- On Magnet Site setup
  - Low Field TestBench

## Experimental Setups

### On Magnet Site



### Low Field TestBench



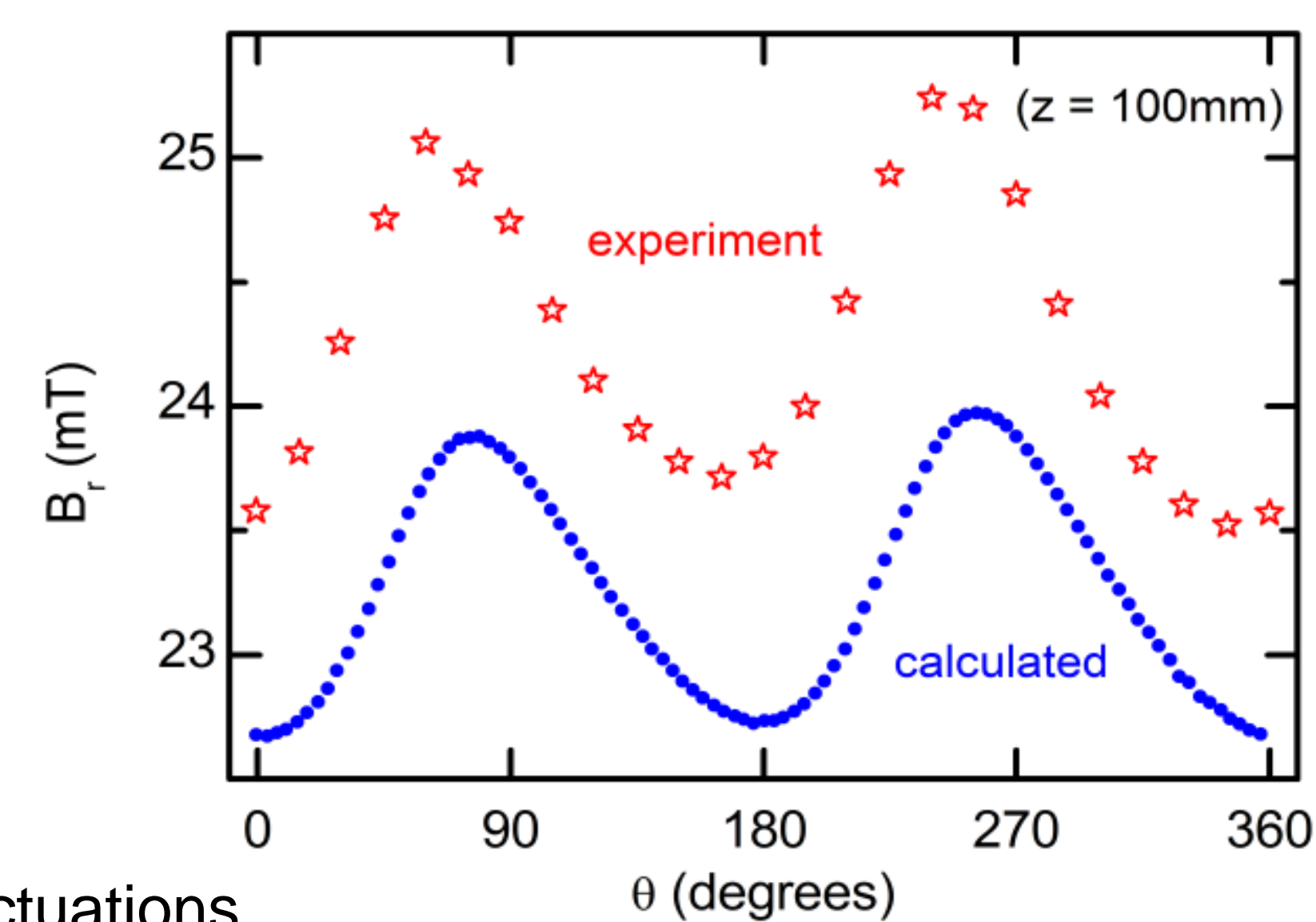
### 3D Hall probe (limited to 3 T)



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

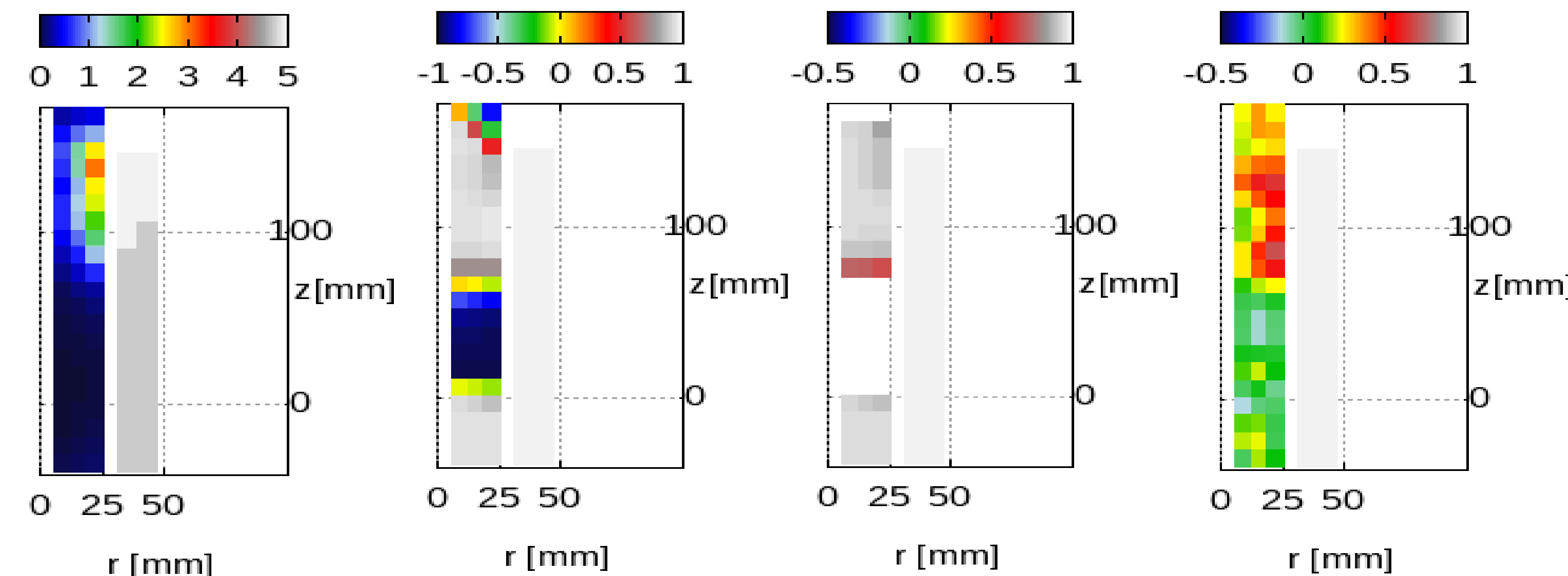
## Results

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

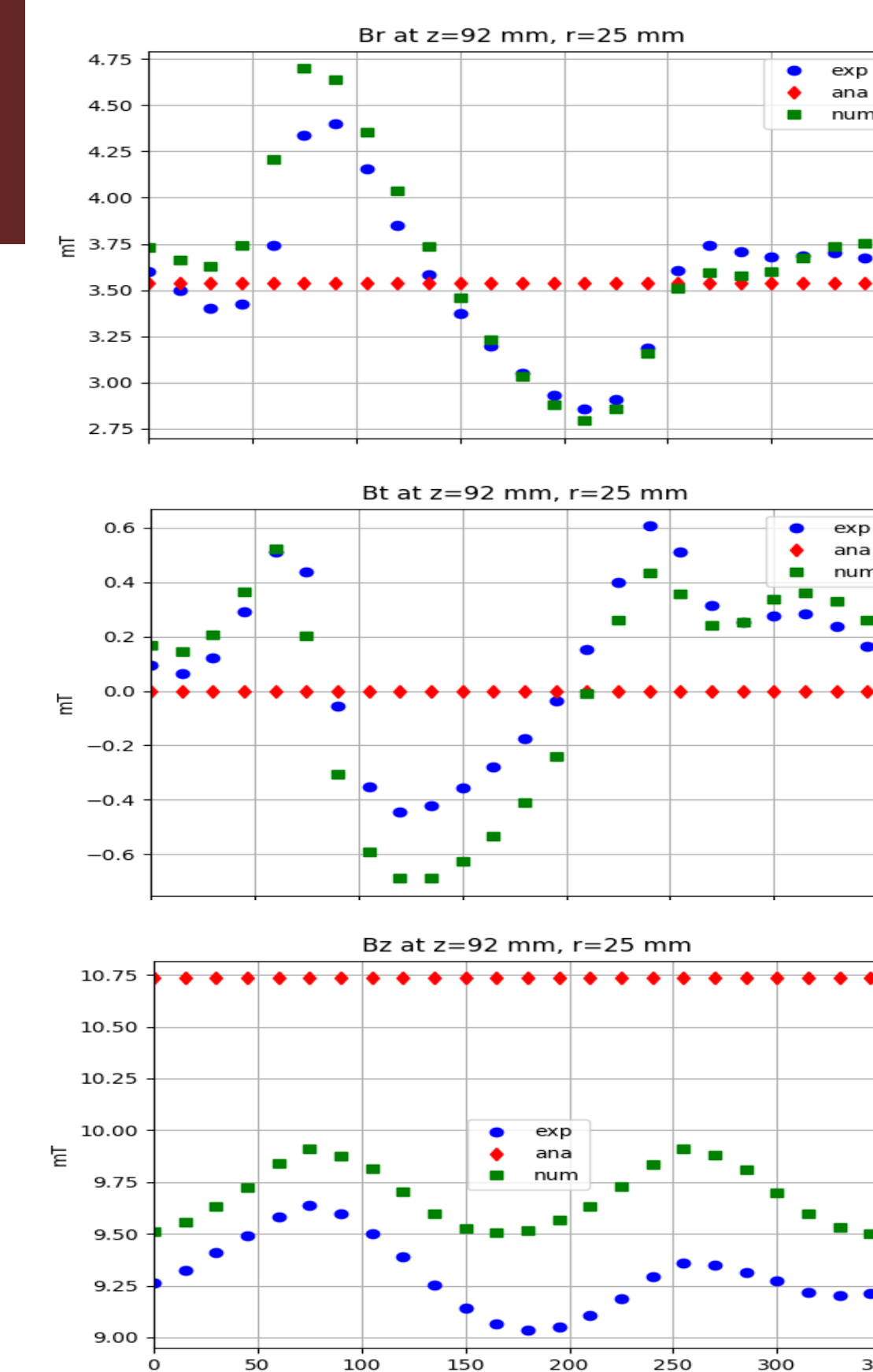


- Low resolution:
- input current fluctuations
  - Weak precision of probe
  - Poor mechanical structure

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