Modeling magnetic field of PS main unit

Mariusz Juchno

AB-ABP-LII section meeting
29th of January 2007

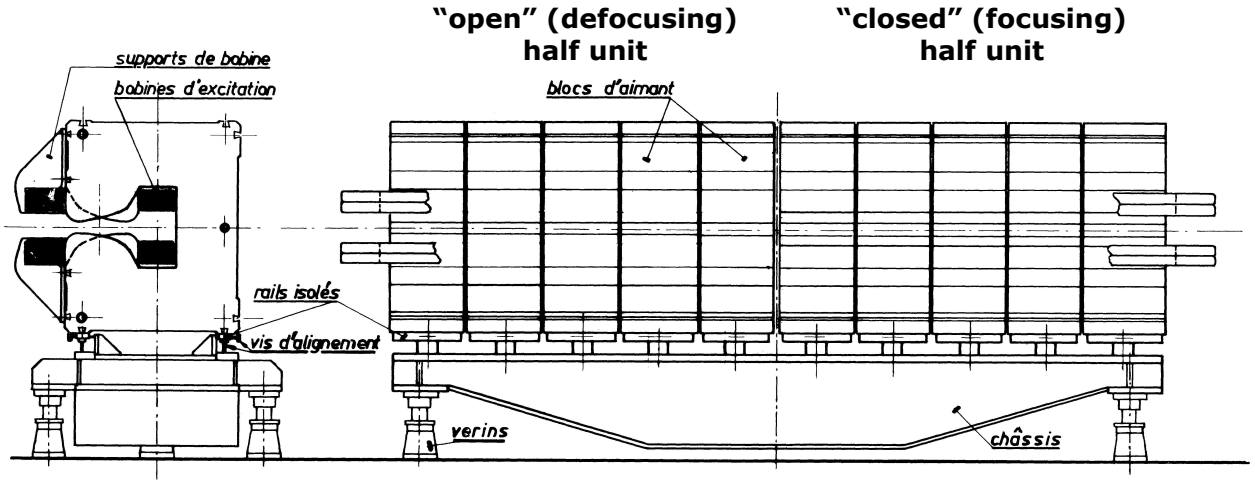
Thanks to: Simone Gilardoni, Bernhard Auchmann,
Didier Cornuet, Thomas Zickler, Alexander Asklov

CONTENTS

- Goal
  - Modeling 3D magnetic field
    - Pole-face windings power converter modification to get better control over optical parameters: Q_x, Q_y, ξ_x, ξ_y
      - Today: 3 currents for 4 parameters
      - Future (2007): 5 currents for 4 parameters
    - BPMs influence on magnetic field
- PS main magnet unit
- ANSYS vs ROXIE (2D simulation)
- SIMULATION (ANSYS) vs MEASUREMENTS
- Conclusions
- Forthcoming work

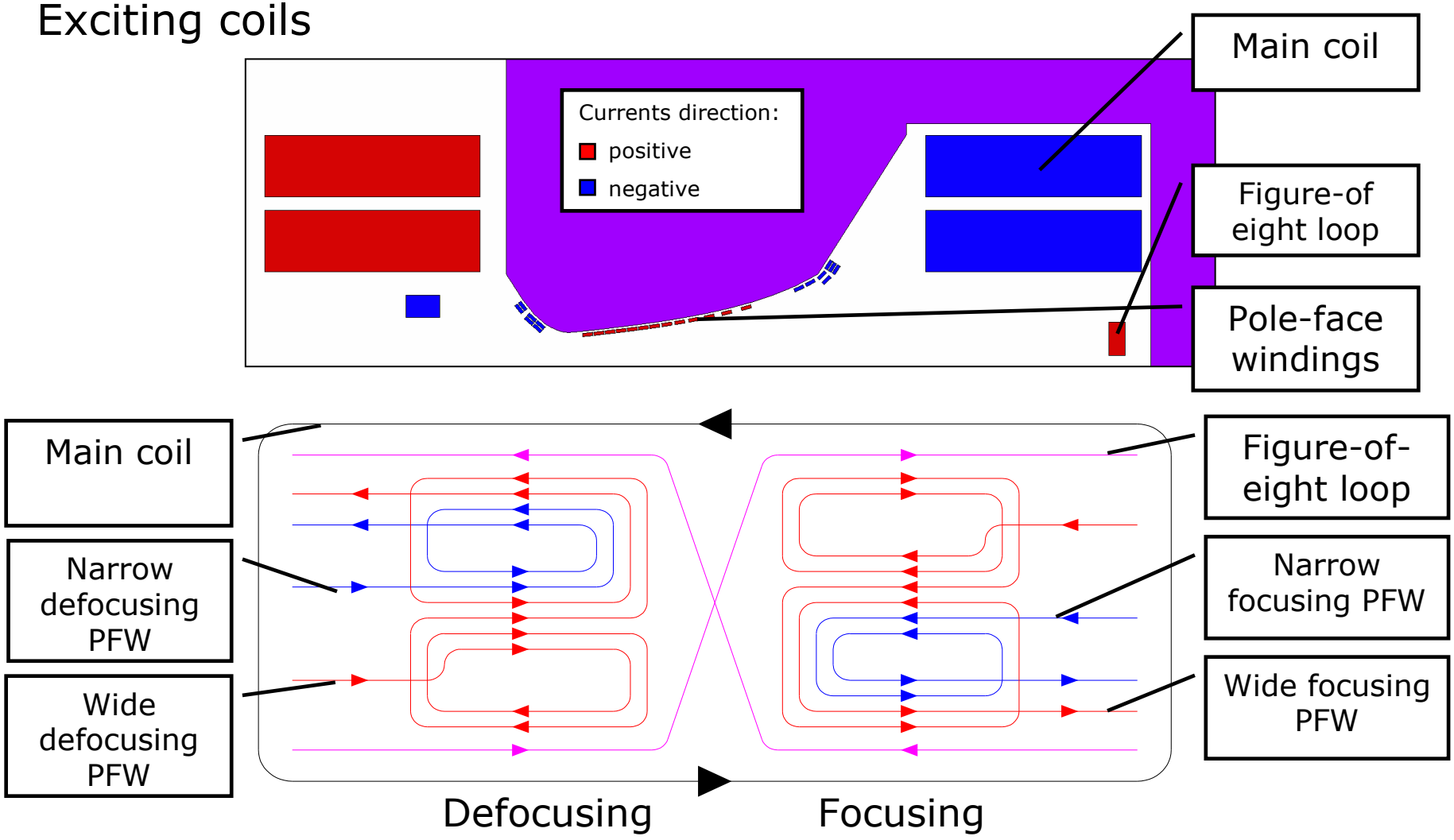
PS main magnet unit

Spare main magnet unit U17



PS main magnet unit

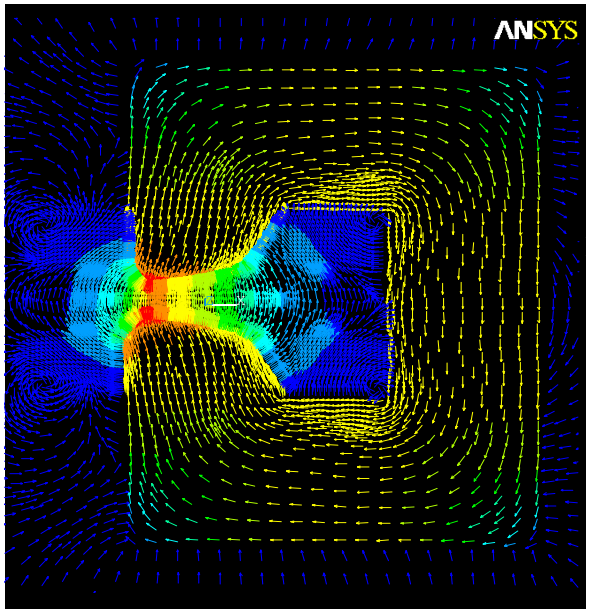
Exciting coils

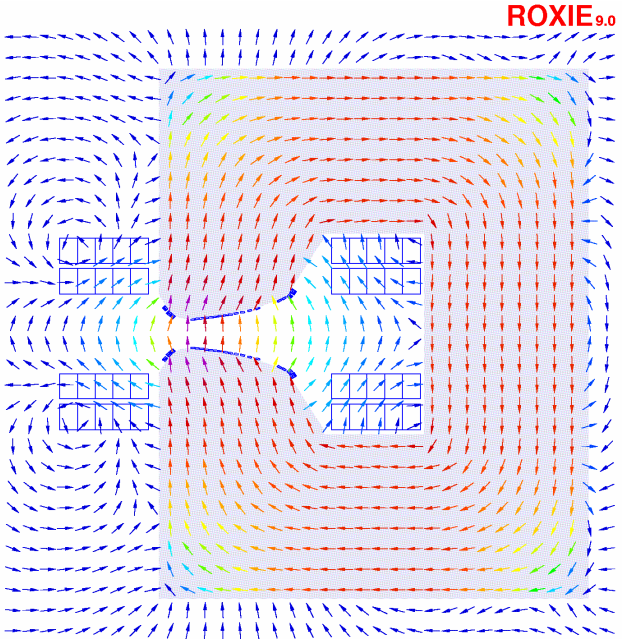


ANSYS vs ROXIE

- Modeled focusing block contains:
  - Iron yoke (non-linear B-H curve)
  - Main excitation coil (I_p=5400.56 A – 26GeV)
  - Pole-face windings (I_{pfwF}=206.7 A)
  - No figure-of-eight loop
  - Air region

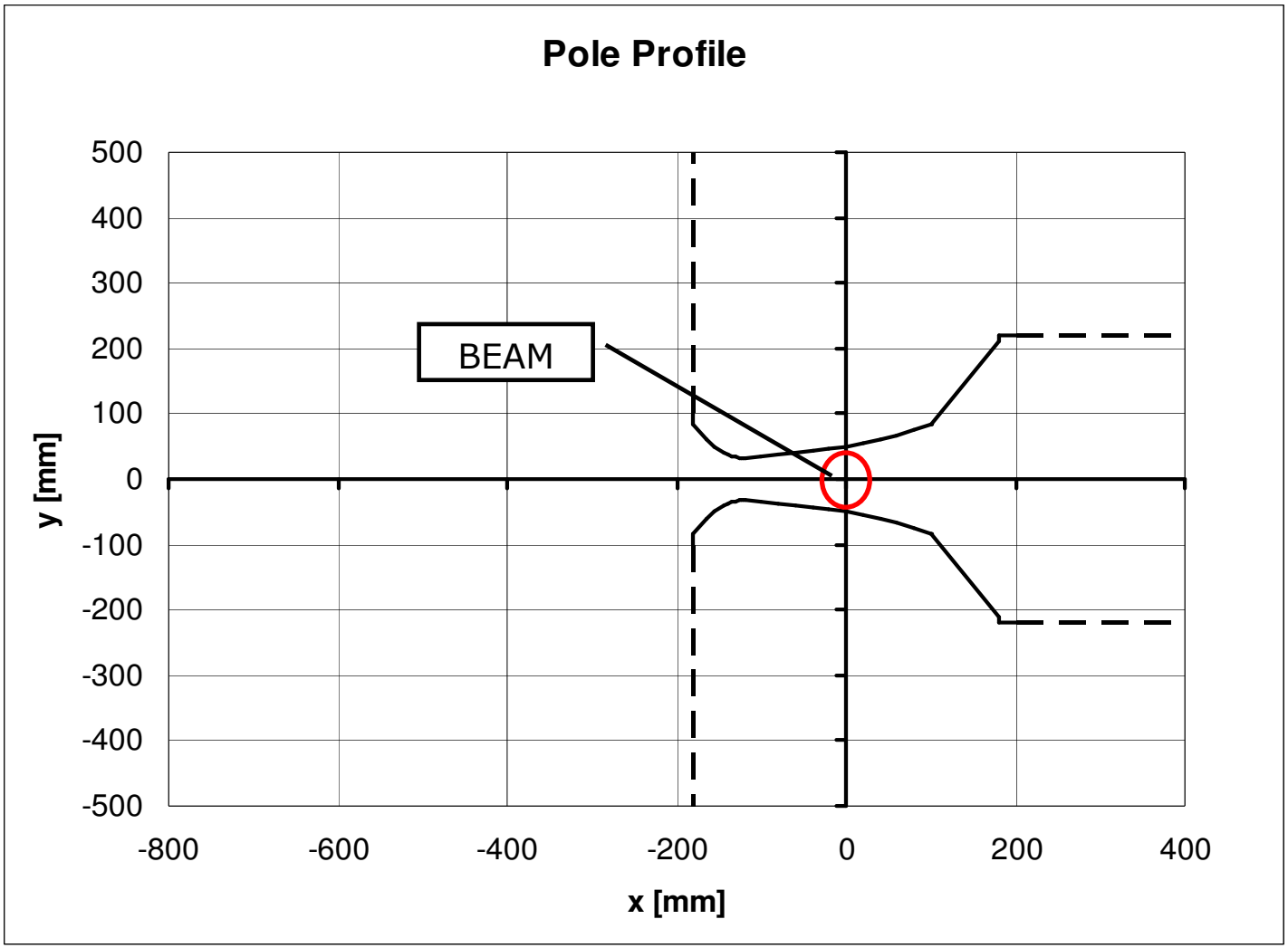
ANSYS vs ROXIE



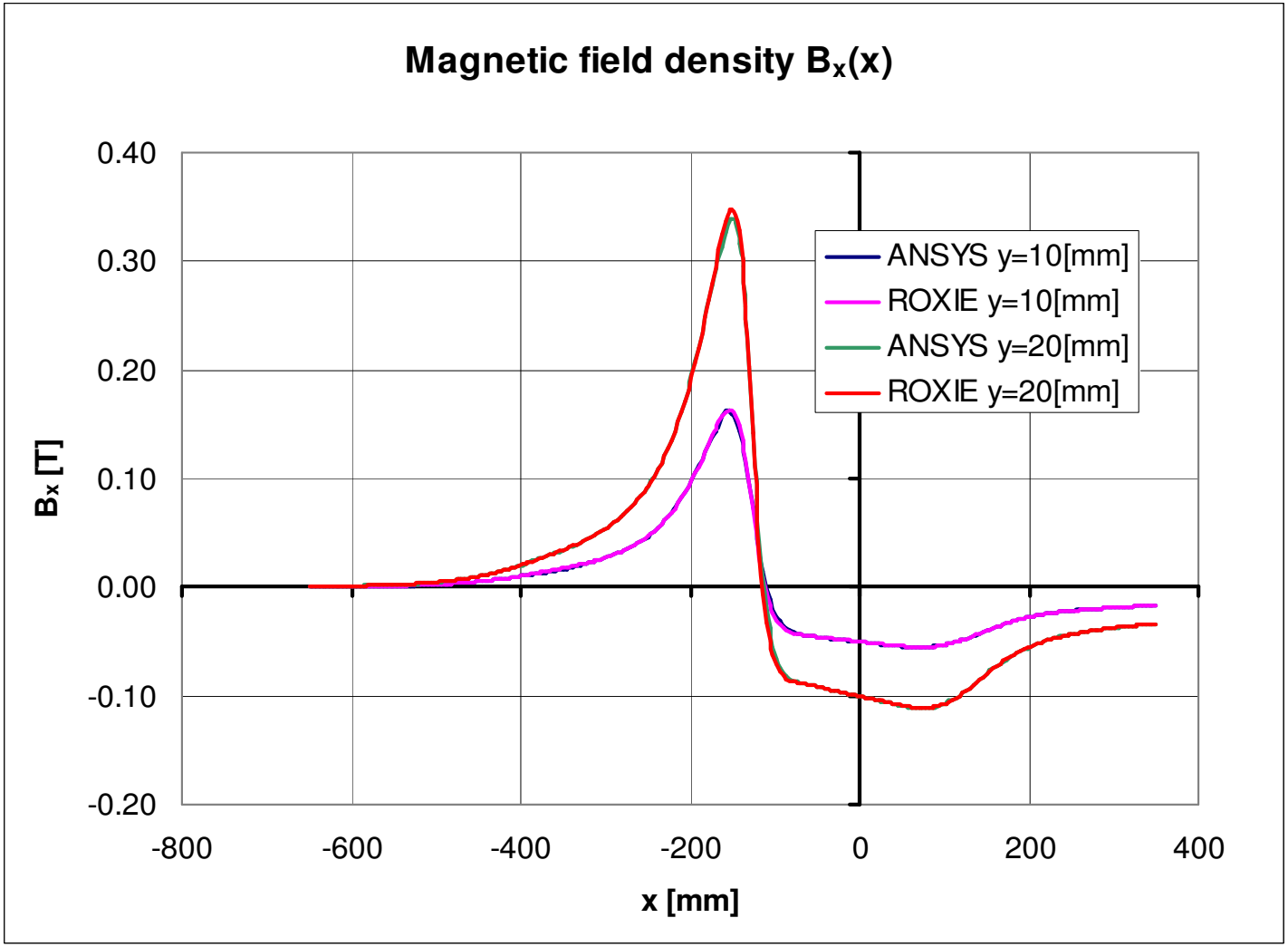


- ANSYS (FEM)
  - FEM
    - whole model
- ROXIE (BEM-FEM)
  - BEM:
    - air region
    - coil currents
  - FEM
    - iron yoke

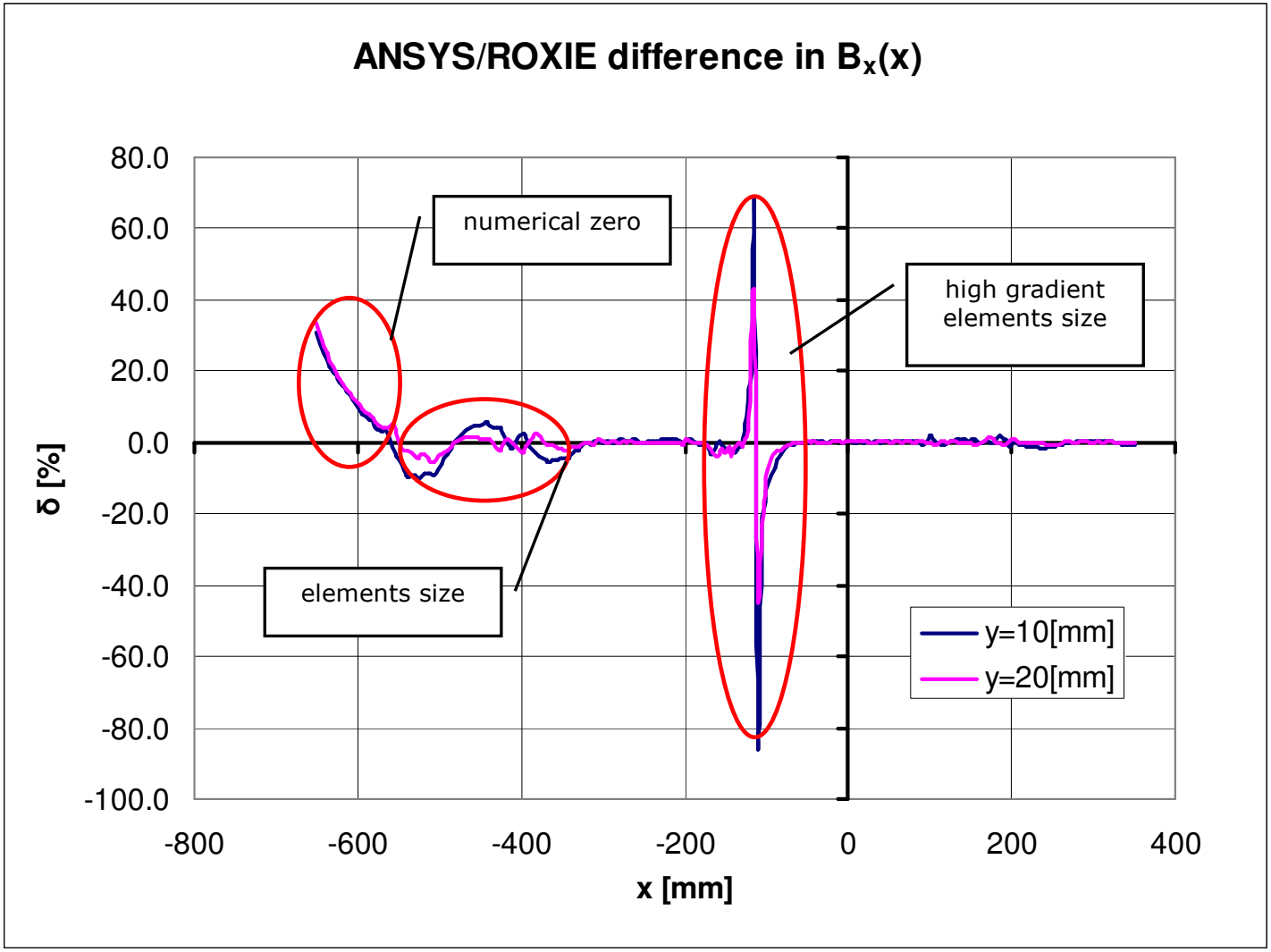
ANSYS vs ROXIE



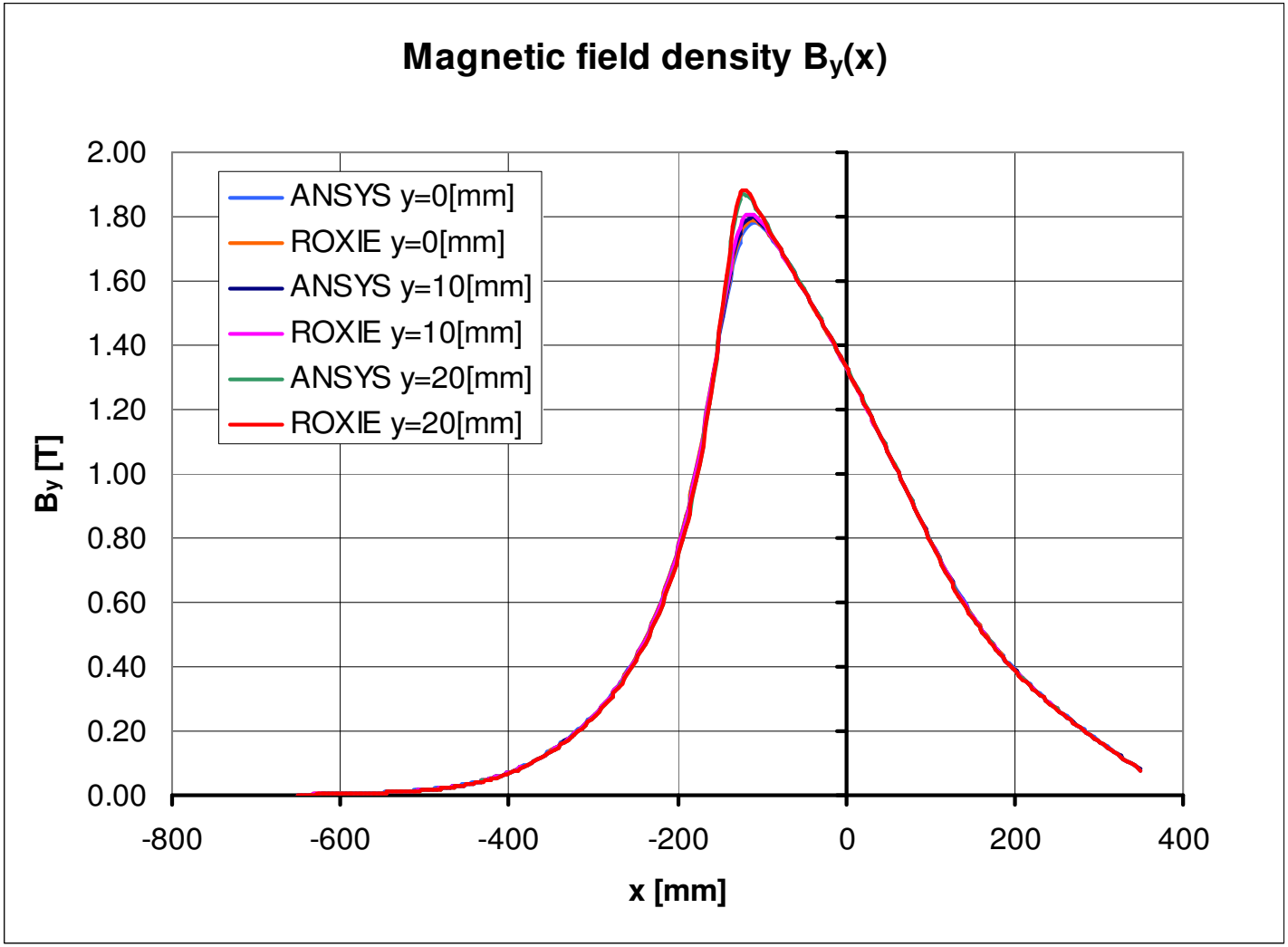
ANSYS vs ROXIE



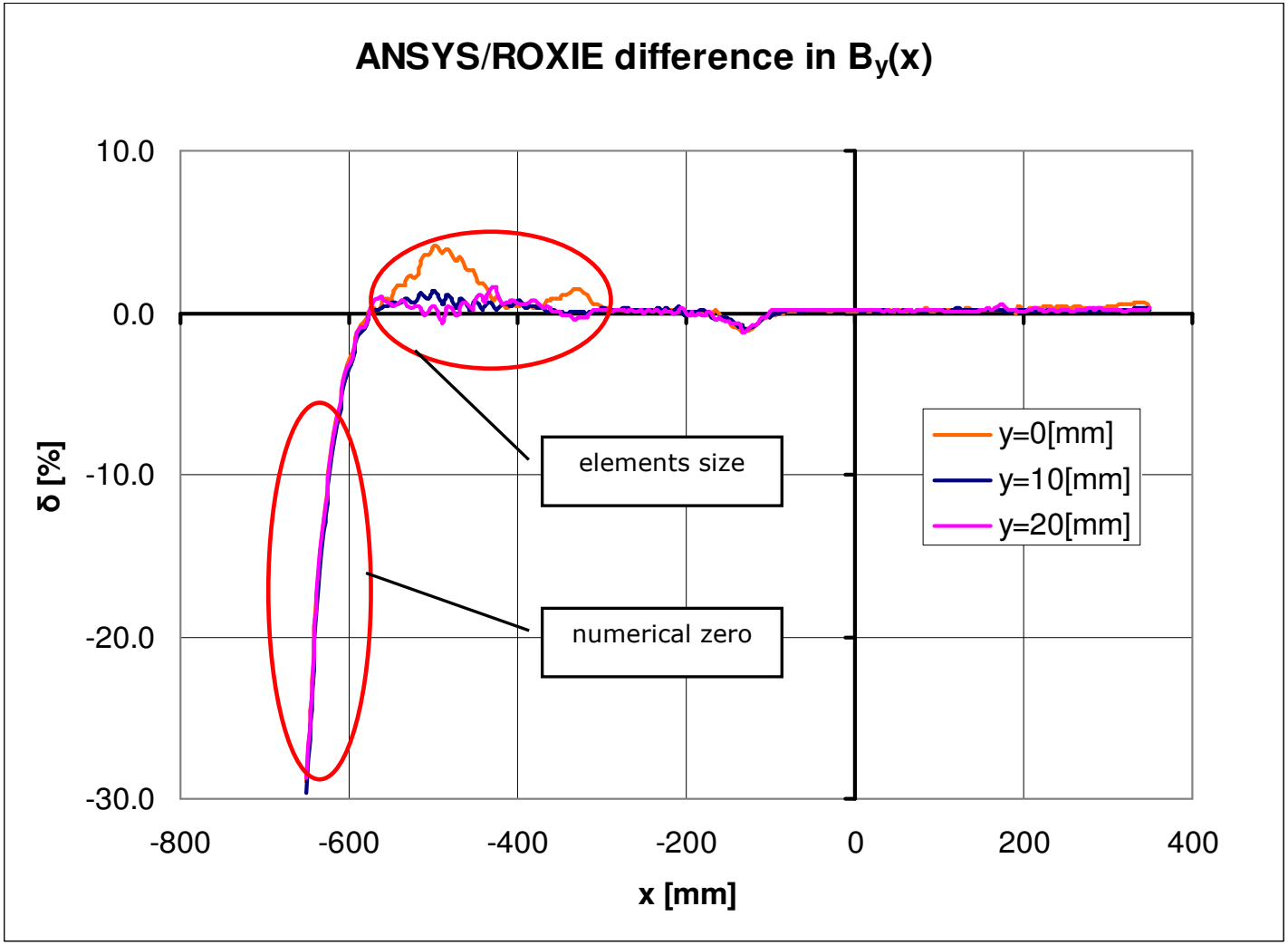
ANSYS vs ROXIE



ANSYS vs ROXIE



ANSYS vs ROXIE



SIMULATION vs MEASUREMENTS

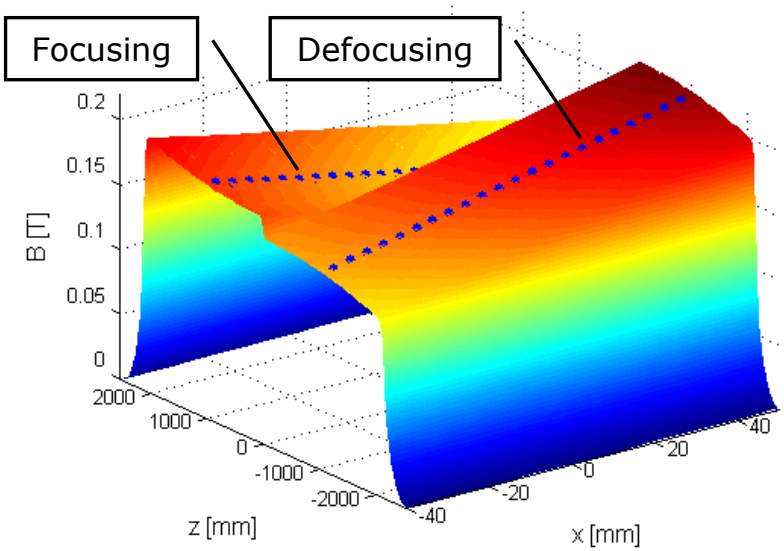
- Geometry contains
  - Iron yoke
  - Main excitation coil
  - Figure-of-eight loop (only in LHC cycle)
  - Pole-face windings (only in LHC cycle)
- Current configuration

	I_p	I_8	I_{pfwF}	I_{pfwD}
Cycle E	669.2 A	-	-	-
Cycle LHC (26GeV)	5400.56 A	1452.8 A	206.7 A	86.9 A

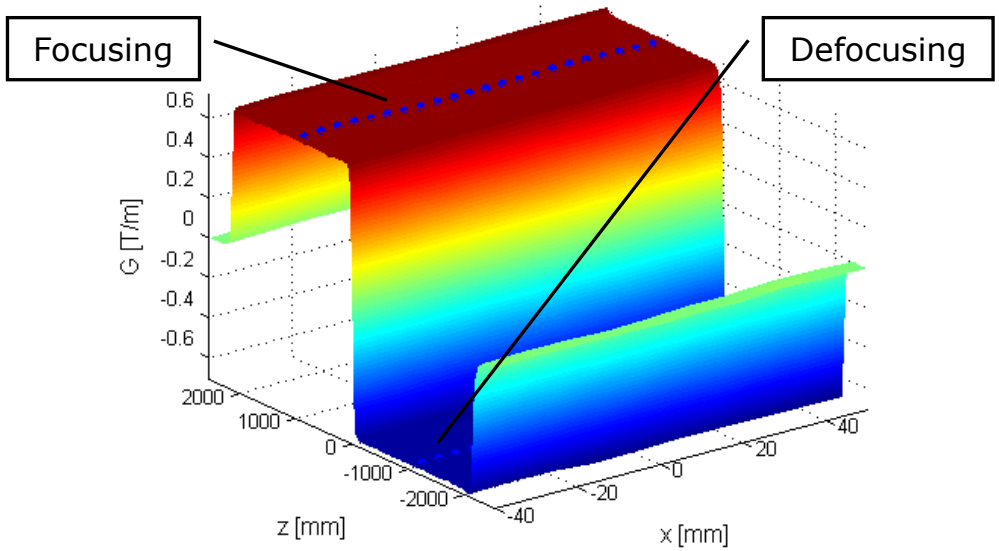
- Measurements made by A. Asklov and D. Cornuet
  "Magnetic measurement on the CERN proton synchrotron" (LITH-IFM-EX-05/1463-SE)

SIMULATION vs MEASUREMENTS

Cycle E dipole field component B(x,z)

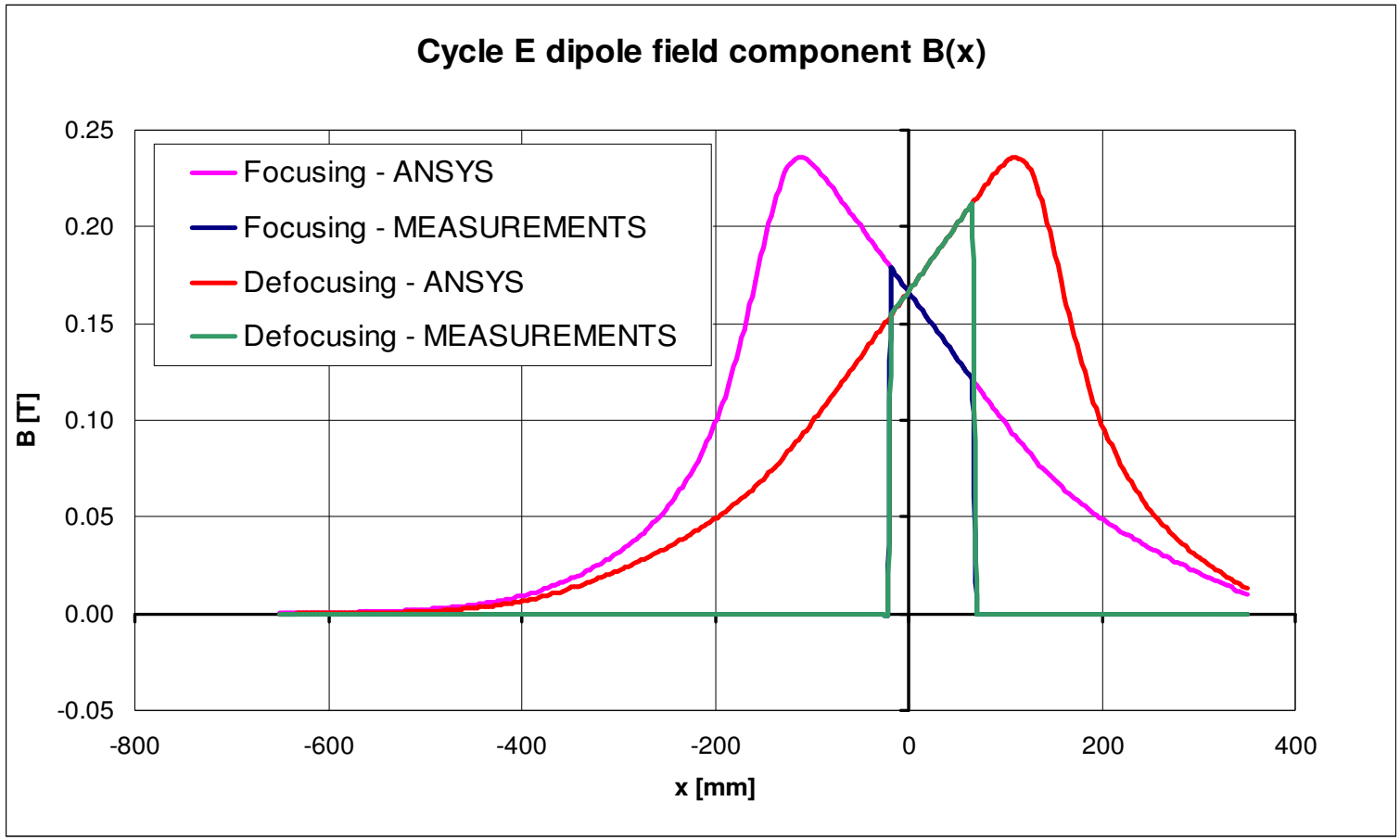


Cycle E quadrupolar field component G(x,z)



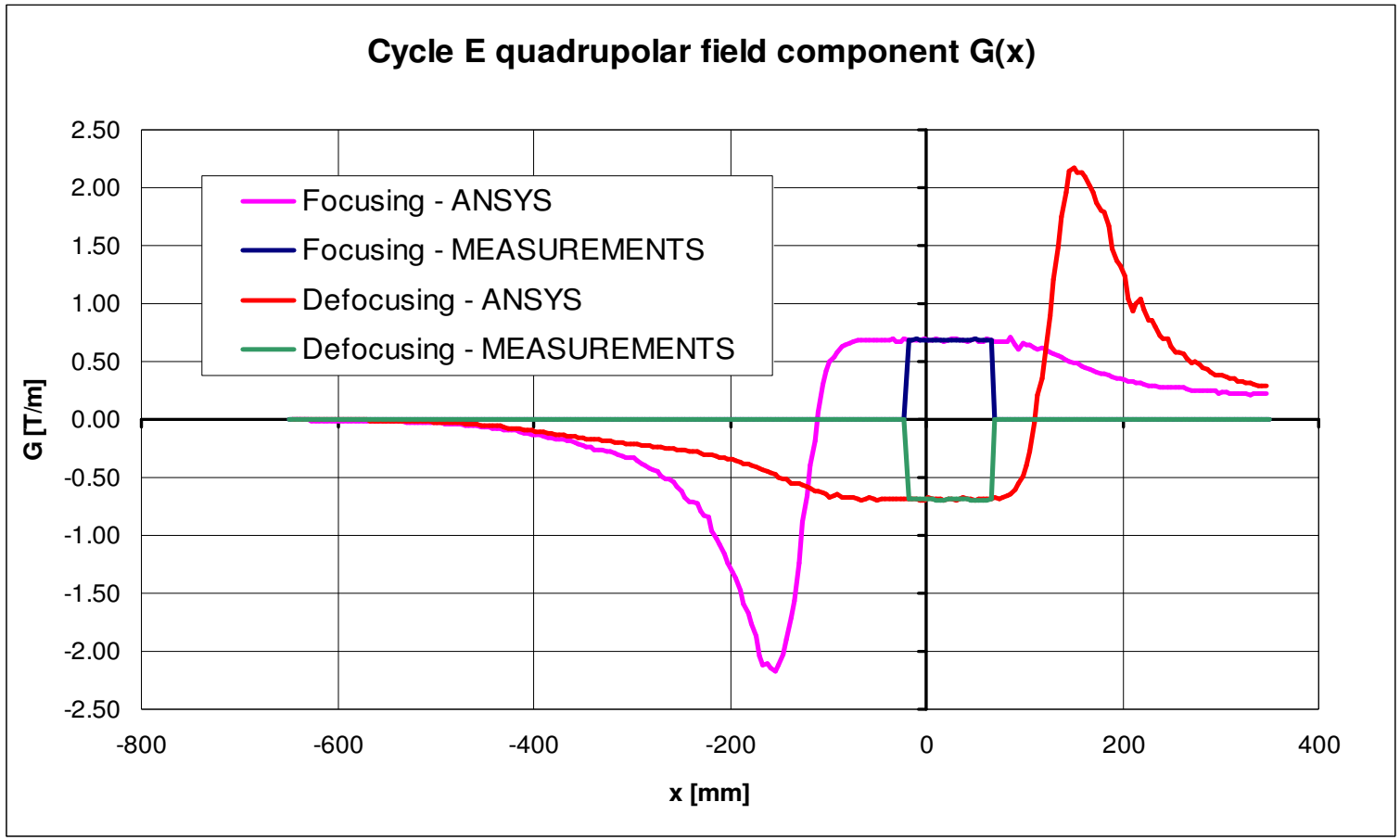
data compared with the simulation

SIMULATION vs MEASUREMENTS



Difference $|\delta_B|<0.2\%$

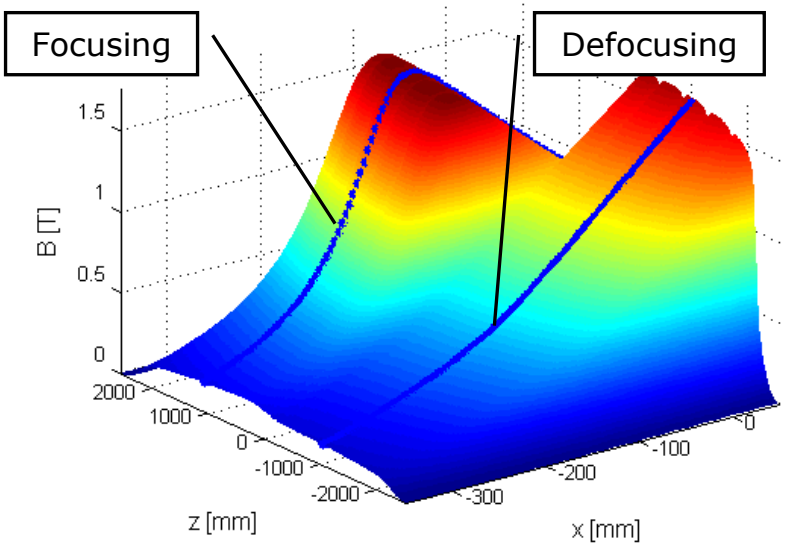
SIMULATION vs MEASUREMENTS



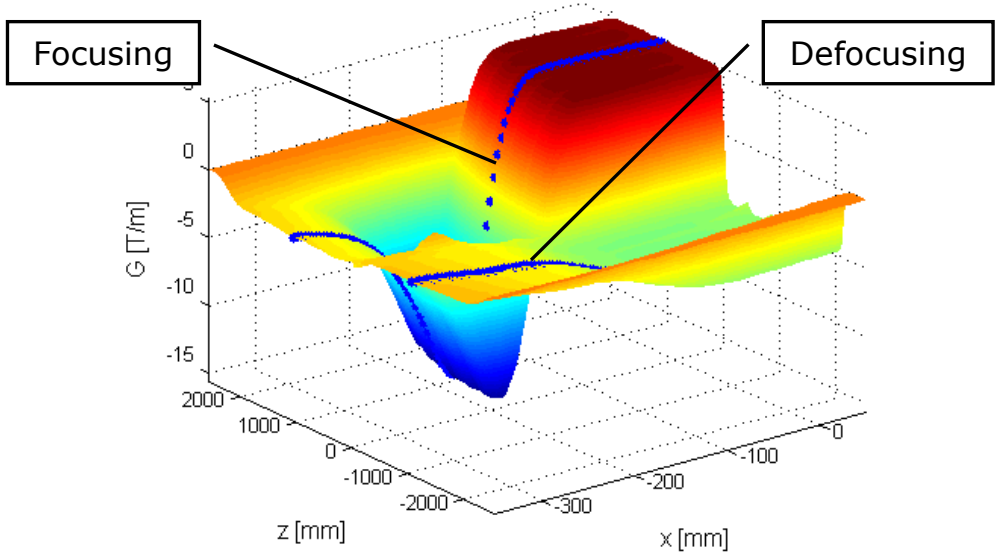
Difference $|\delta_G| < 2.5\%$

SIMULATION vs MEASUREMENTS

Cycle LHC dipole field component B(x,z)

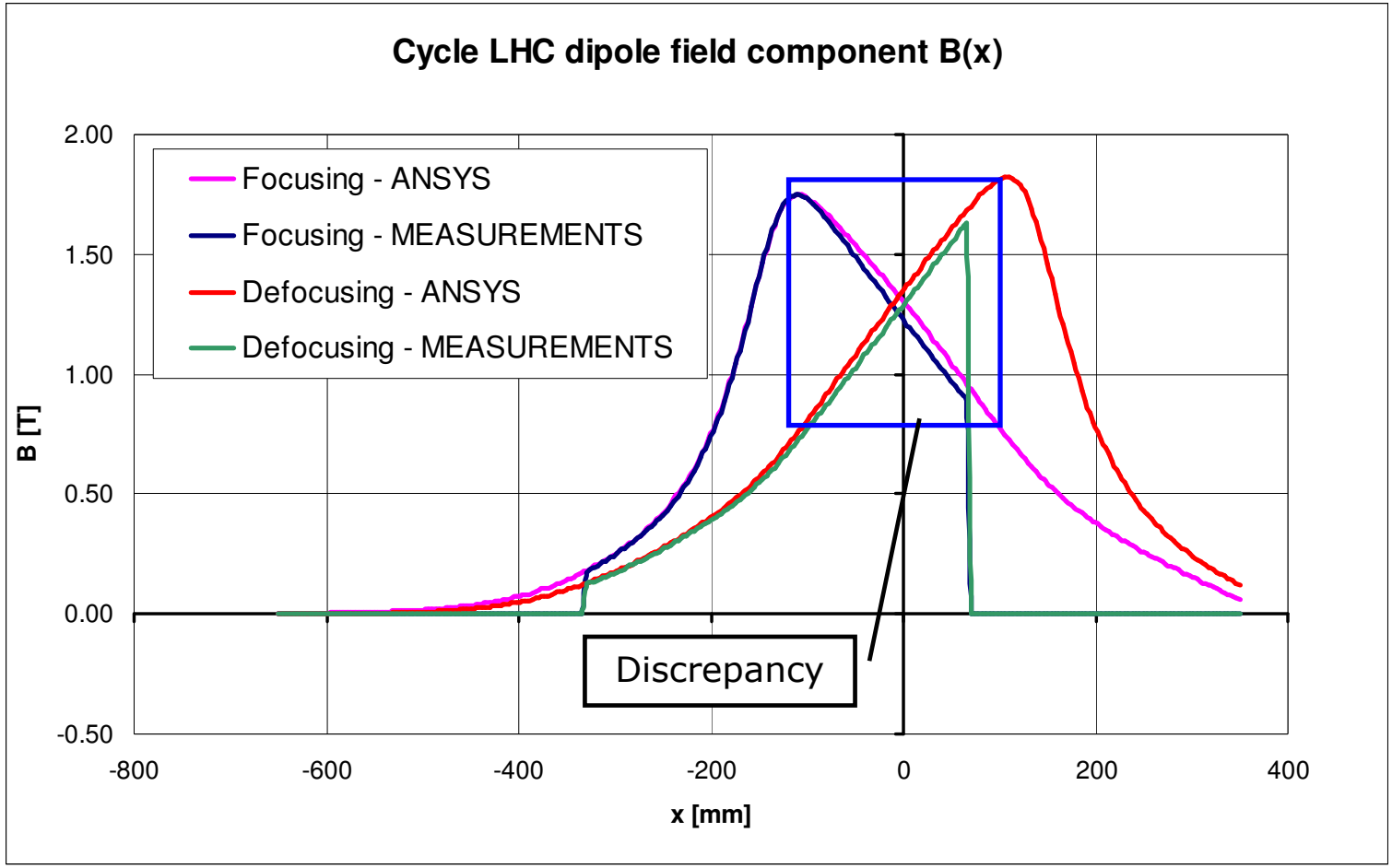


Cycle LHC quadrupolar field component G(x,z)

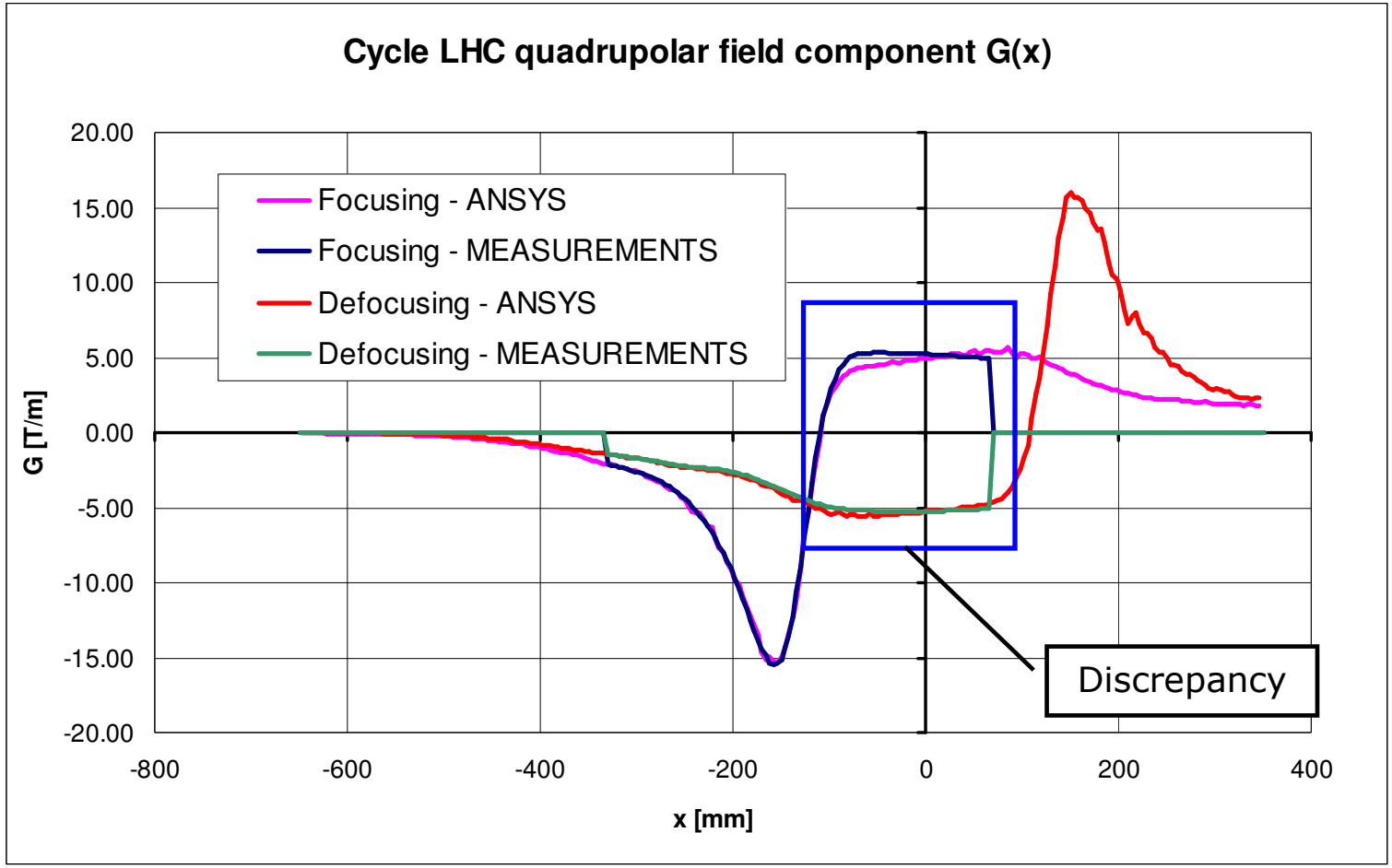


data compared with the simulation

SIMULATION vs MEASUREMENTS

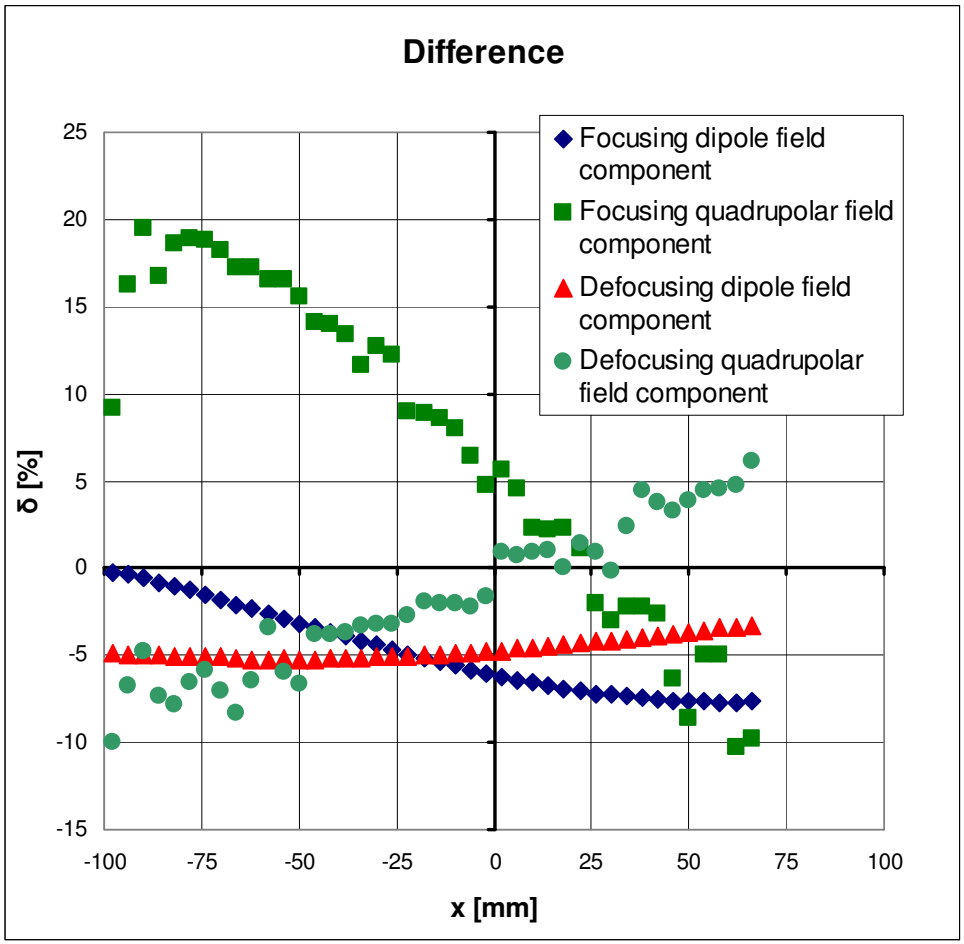


SIMULATION vs MEASUREMENTS



SIMULATION vs MEASUREMENTS

- Possible discrepancy reasons
  - Wrong figure-of-eight loop geometry
    - No CAD drawings
    - Many upgrades in the past
  - Wrong pole-face windings current direction
    - Misinterpretation of drawings
    - Non-standard currents direction used in past measurements



Conclusions

- 2D simulation results of both ANSYS and ROXIE are comparable to a high degree of accuracy
- Software choice for 3D analysis will depend on resource consumption, personal preferences and other factors not known today
- Discrepancies still need to be investigated

Forthcoming work

- Investigating discrepancy reasons
  - Currents direction measurement
  - Checking past measurements documentation
- Creating 3D model
  - Model development already started with simplified geometry
  - Possibility to interface CAD software with ANSYS