

# FLASH Quadrupole (S-Band) Triplet

**A comparison between  
MAFIA simulations  
and  
magnet measurements**

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Triplet

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# Quadrupole Triplet: General Information

- Triplet was designed in 1993 for the S-Band Linear Collider Test Facility with a gradient of 17 T/m
- aperture radius = 17.5 mm
- total length: 300 mm, distance between the quadrupoles = 50 mm
  - inner quadrupole 100 mm,
  - two outer quads 50 mm each

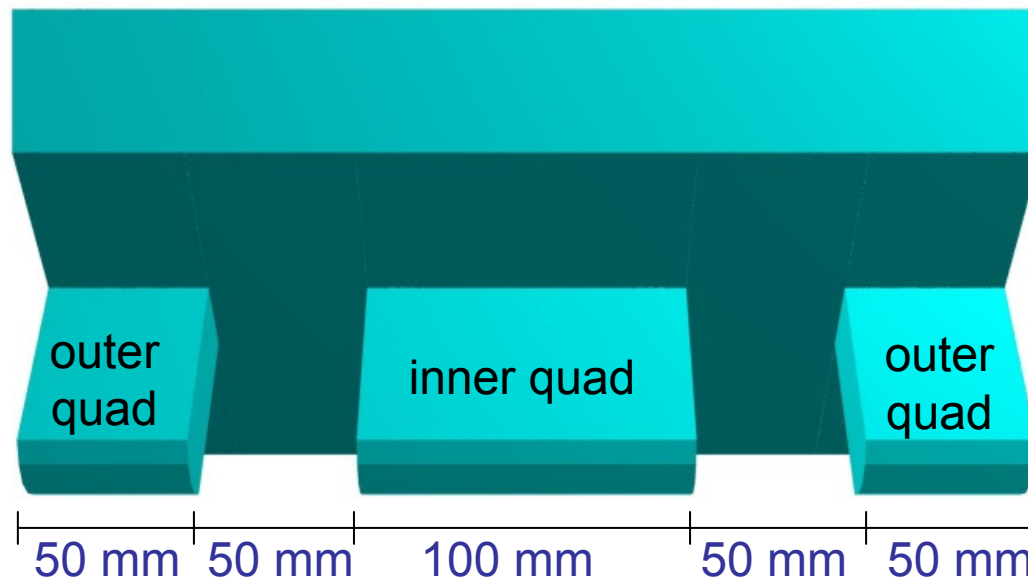
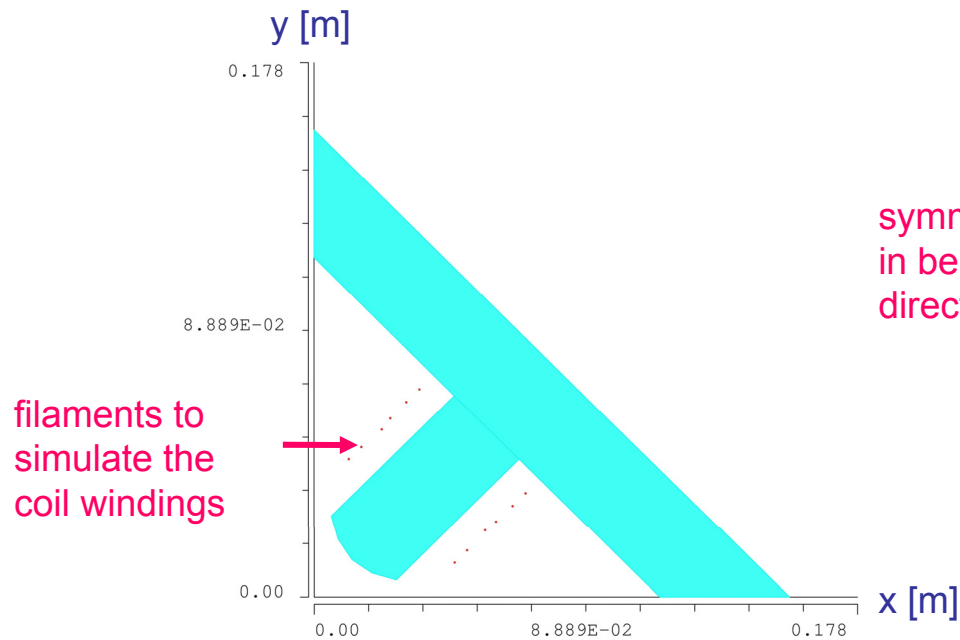


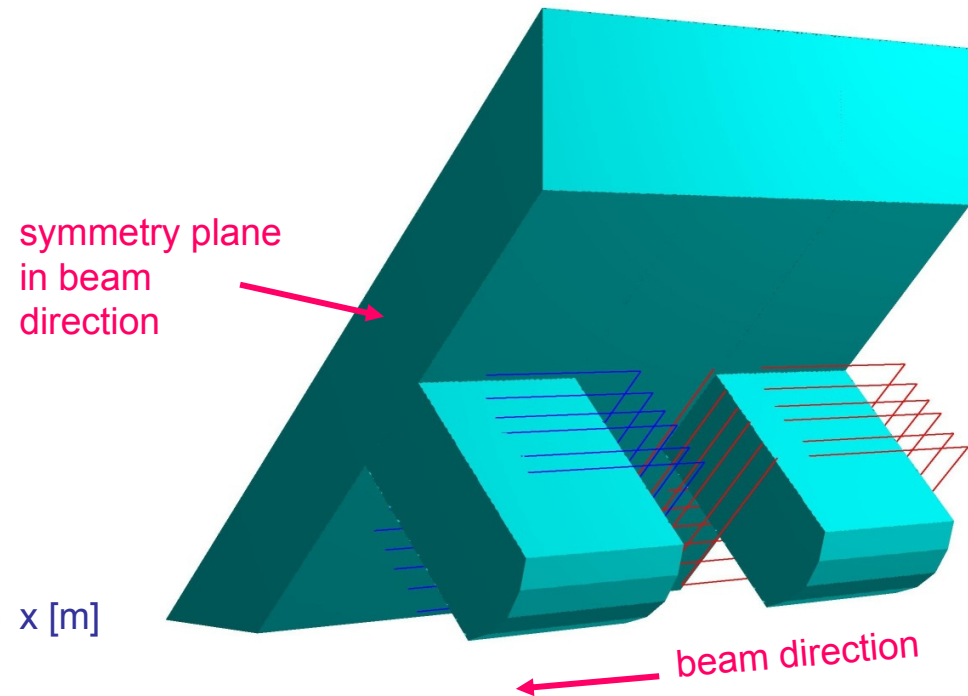
Figure shows the iron yoke –  
1/4 of the whole triplet

# The Simulation Model

- The triplet was simulated by using the magneto-static module of the program MAFIA
- Due to symmetry conditions **only one eighth** of the geometry has been taken into account for the calculation



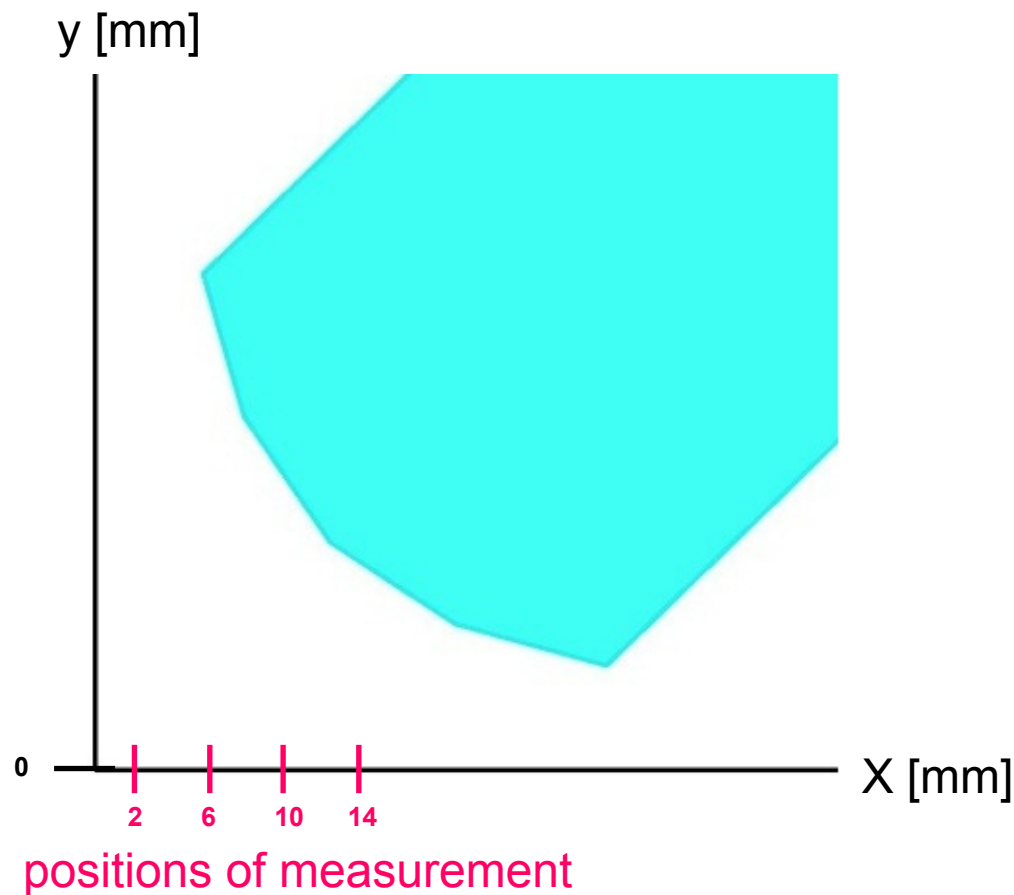
MAFIA model: Cross-section of the iron yoke with filaments, 2d view, xy plane.



MAFIA model: Iron yoke with filaments, 3d view.

# Measurements for the Quadrupole Triplet

- Various measurements have been done for the triplet by Y. Holler in 1996
- The field has been measured along the beam axis at different positions in the horizontal direction at  $x = 2, 6, 10$  and  $14$  mm;  $y = 0$  mm



## Settings for the current:

$$I_{\text{inner quad}} = 159.4 \text{ A} \quad \text{max. currents}$$

$$I_{\text{outer quad}} = -136.6 \text{ A}$$

$$I_{\text{inner quad}} = 79.7 \text{ A} \quad \text{half currents}$$

$$I_{\text{outer quad}} = -68.3 \text{ A}$$

Fields have been examined separately for the inner quad and for the outer quads:

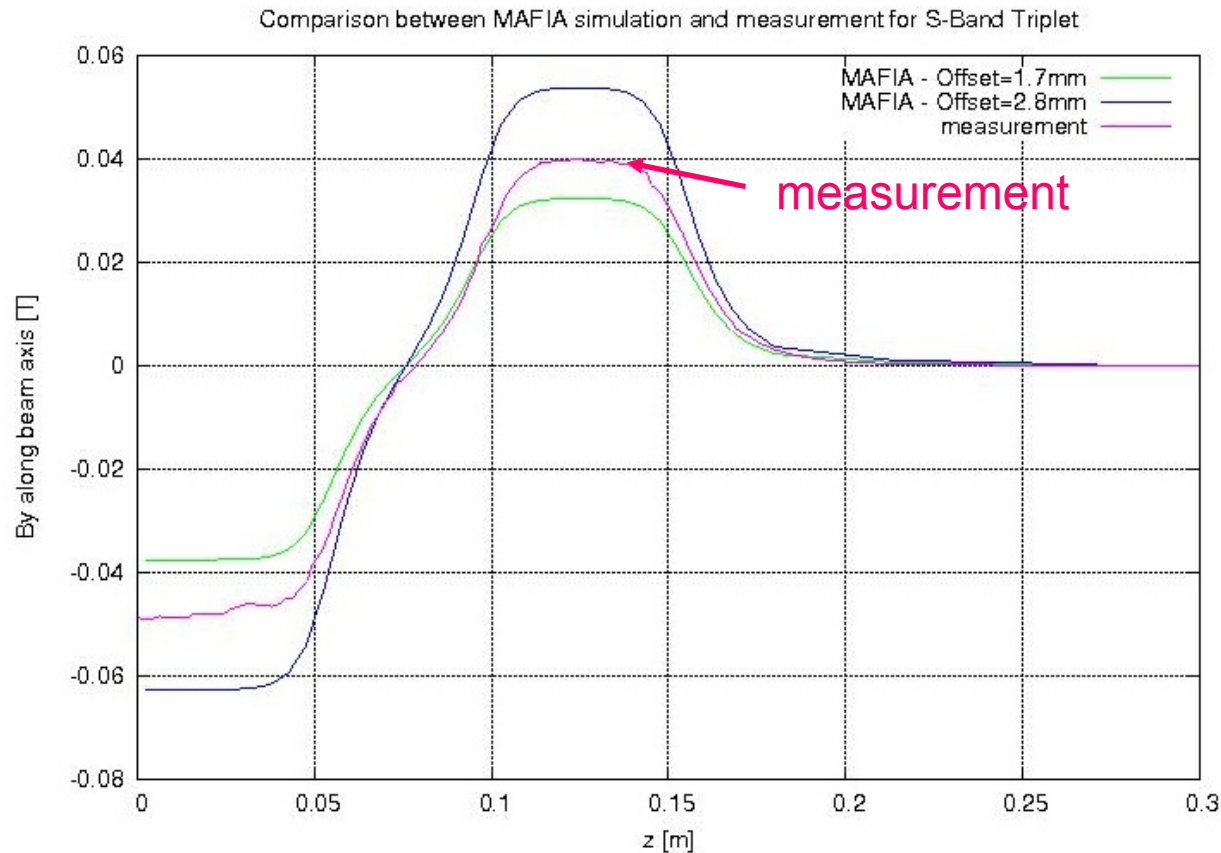
$$I_{\text{inner quad}} = 159.4 \text{ A}$$

$$I_{\text{outer quad}} = 0 \text{ A}$$

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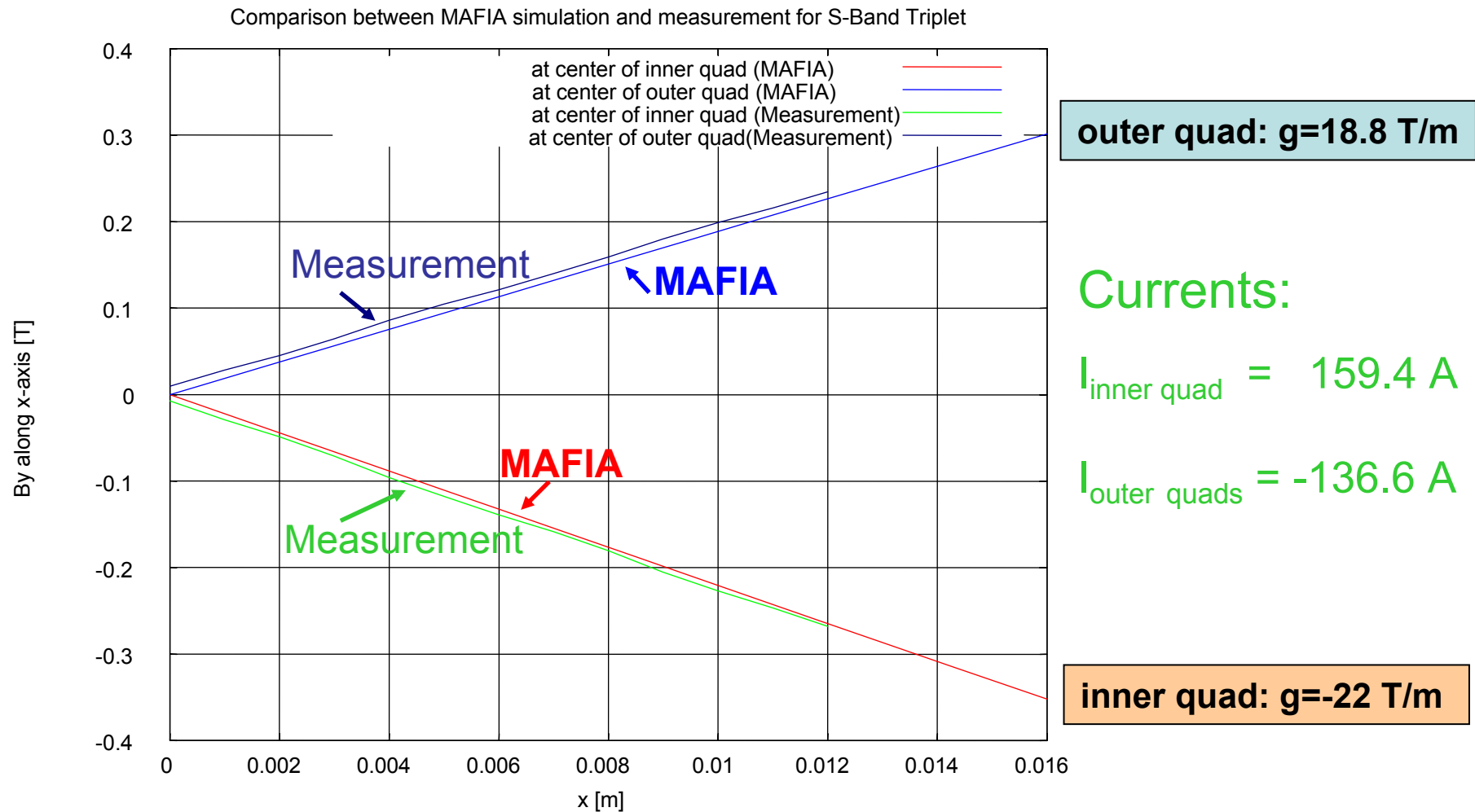
# Comparison between Measurement and MAFIA Simulation



Measurement has an estimated x-position offset of nearly 2 mm!

Figure shows the field  $B_y$  along the beam axis. The difference of the MAFIA simulation results from the mesh resolution in the simulation model. No mesh line is given at the position where the measurement has been done.

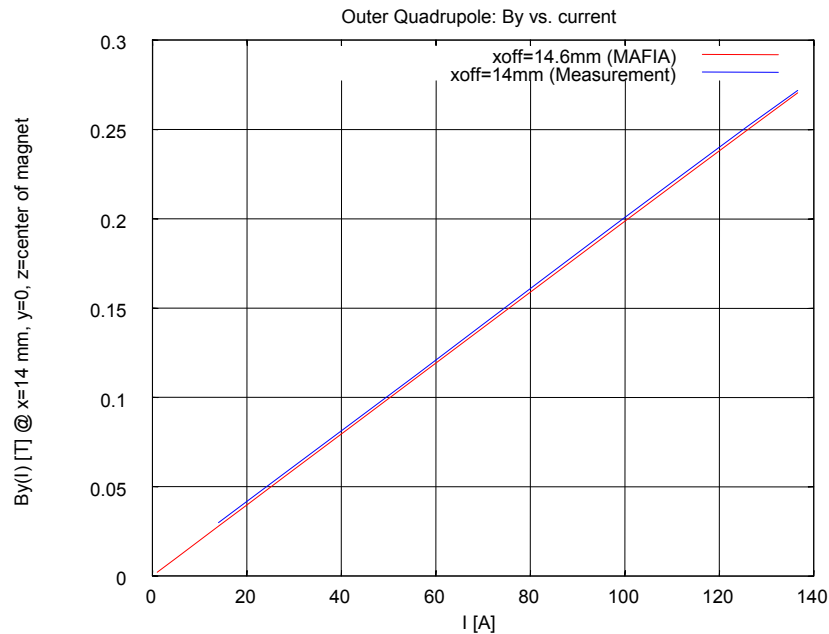
# Field Gradients



The field gradients are examined at the center of the inner quadrupole (lower curve) and at the center of the outer quadrupole (upper curve).

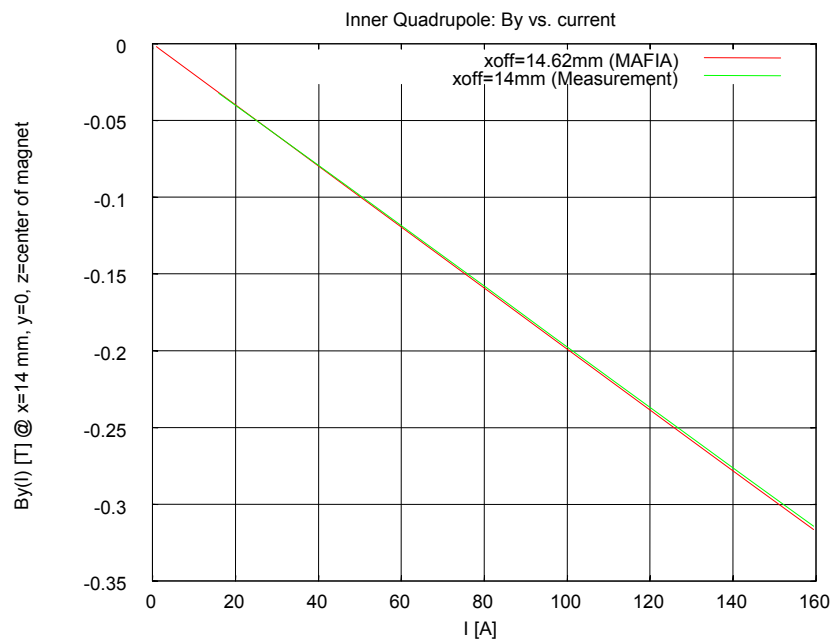
⇒ Good agreement between simulation and measurement!

# Field vs. Current



Field  $B_y$  vs. the current  $I$  for an **outer quadrupole** of the triplet.

⇒ very good agreement between measurement and simulation.

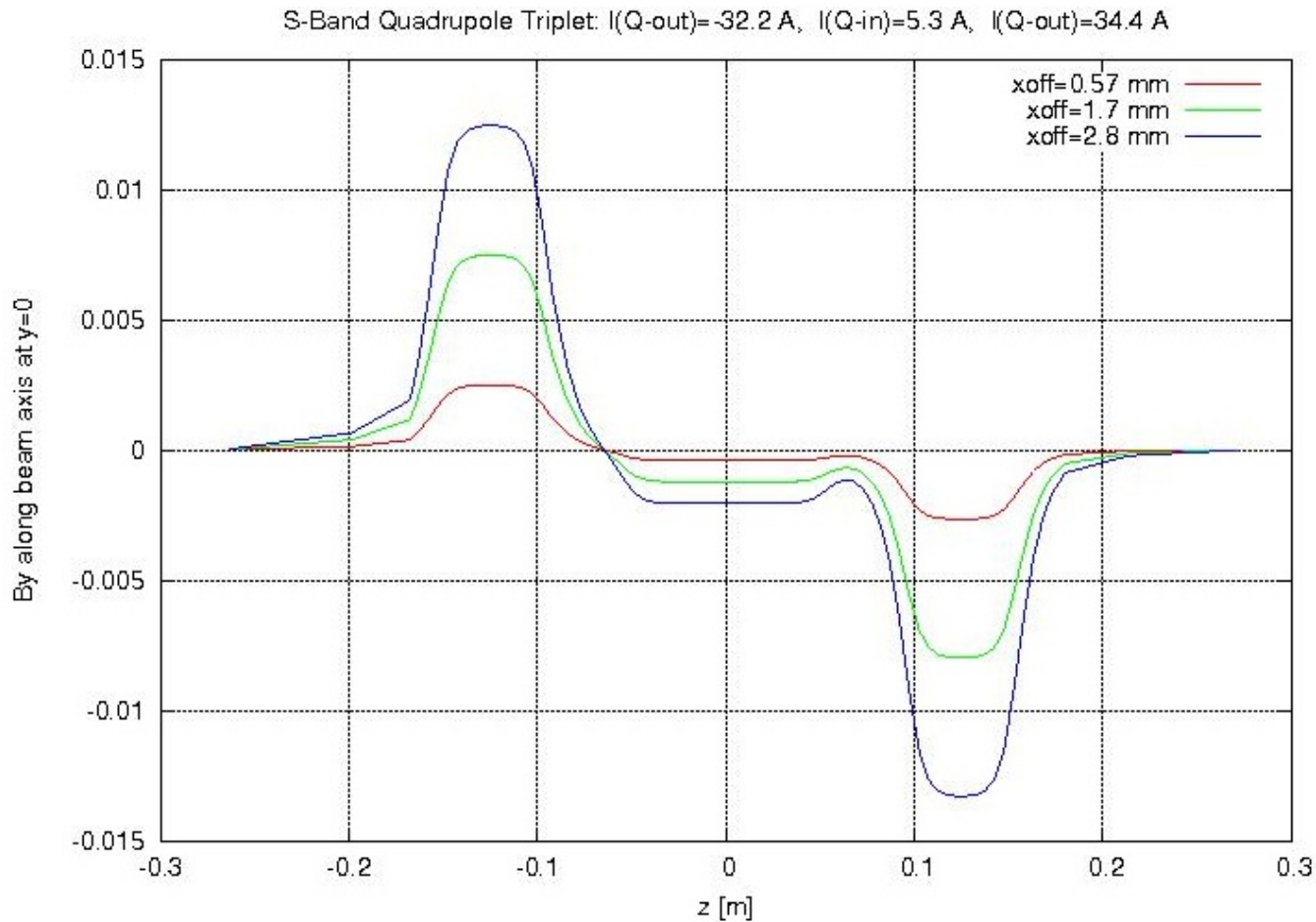


Field  $B_y$  vs. the current  $I$  for the **inner quadrupole** of the triplet.

⇒ very good agreement between measurement and simulation.

# The Quadrupole Triplet under current FLASH Conditions

Triplet is not used as a triplet, but as a doublet ...



$$I_{\text{outer quad}} = -32.2\text{ A}$$

$$I_{\text{inner quad}} = 5.3\text{ A}$$

$$I_{\text{outer quad}} = 34.4\text{ A}$$

Field  $B_y$  has been taken at different offset positions in x-direction:



## Conclusions

- Fields have been compared between Holler's measurements and a simulation with MAFIA
- Good agreement for the field gradient and for the excitation curves
- Problem: Absolute position of the HALL probe for the measurement is unknown. To compare the measurement with the MAFIA simulation the horizontal offset position was estimated from the measurements.