Transverse spin effects in SIDIS at 11 GeV with transversely polarized target using the CLAS12 detector

(A CLAS12 experiment proposal for PAC38)

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JLab PAC 38 – Open session
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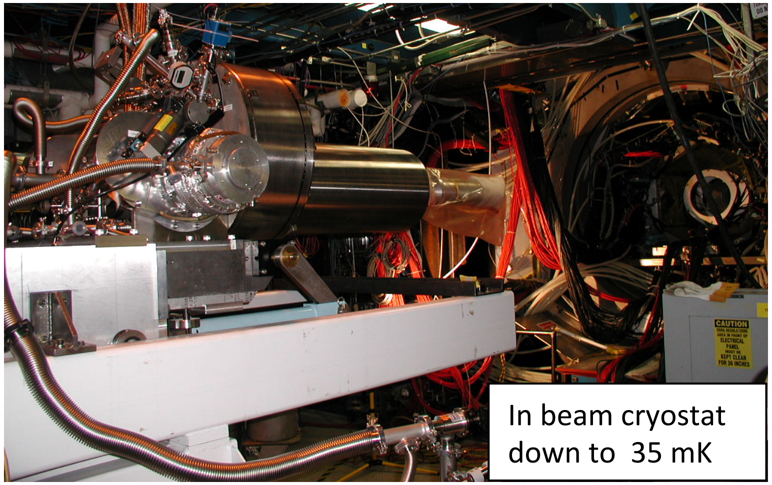
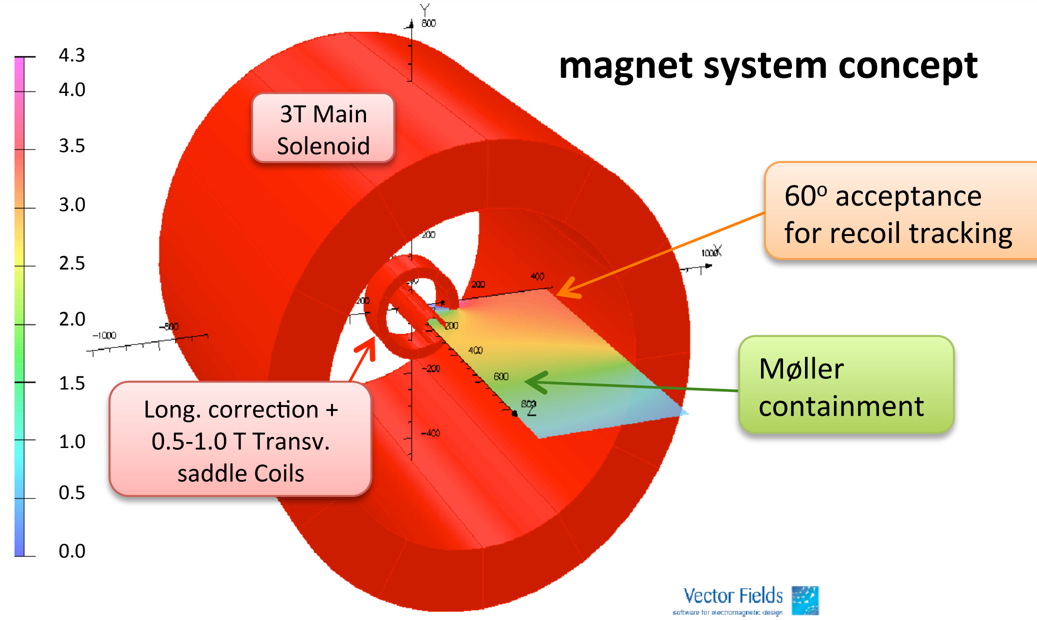
Transversely Polarized HD-Ice Target

Up to 75% H and 40 % D polarization independently controlled

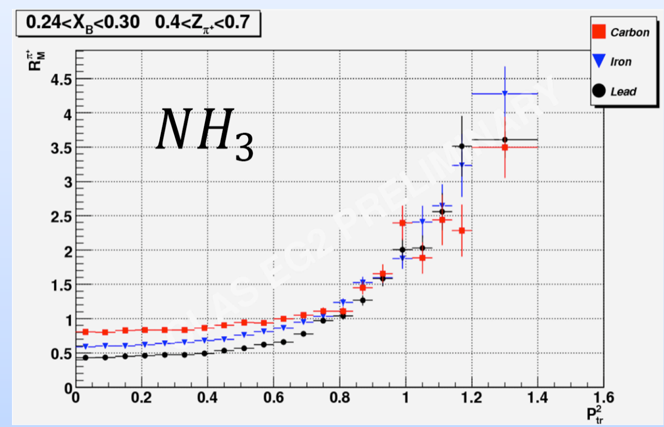




HD-Ice target vs standard nuclear targets

Advantages:

- Minimize nuclear background
  small dilution and nuclear effets at large p_T
- Weak holding field (BdL ≤ 0.1 Tm)
  wide acceptance, negligible beam deflection,
  viable field inversion



Disadvantages:

- Very long polarizing times (months)
- Need to demonstrate that can remain polarized for long periods with an electron beam: as consevative approach we consider 1/10 of full luminosity (compensated by better dilution)

PAC38 requirements

Measurement and Feasibility: Using CLAS12 with a transversely polarized HD-Ice target and a longitudinally polarized 11 GeV electron beam, data for pions and kaons will be taken simultaneously in a 4-dimensional scan, aiming at a substantially improved statistical precision compared to previous HERMES and COMPASS data. The proposed 100 days include 80 days of data taking and 20 days for calibration, test and set-up. For part of the program flavor tagging is required. The low-threshold Cherenkov detector has to be replaced by a RICH. Tests of the target in a high-intensity electron beam are planned in early 2012. The impact of Moeller scattering on the detector performance has to be well controlled. A combined analysis of unpolarized and longitudinally polarized data will constrain different TMDs and will provide an important contribution to nucleon tomography.

Issues: The measurement requires incorporation of the transversely polarized HD-Ice target into the 3-5 Tesla field of the CLAS12 solenoid. The transverse holding field is applied in the region where the longitudinal field of the main solenoid has to be compensated by an additional small solenoid leaving 60^0 acceptance and requiring some central trackers to be removed. In such a difficult configuration one needs to be sure about the proper magnetic and mechanical design and a sufficiently precise track reconstruction in the complicated field arrangement.

Conditions: The operation of the HD-Ice target in an electron beam with the requested beam current has to be proven. The magnetic field and detector configuration has to be optimized and the track reconstruction code has to be developed including the final configuration.

Plan

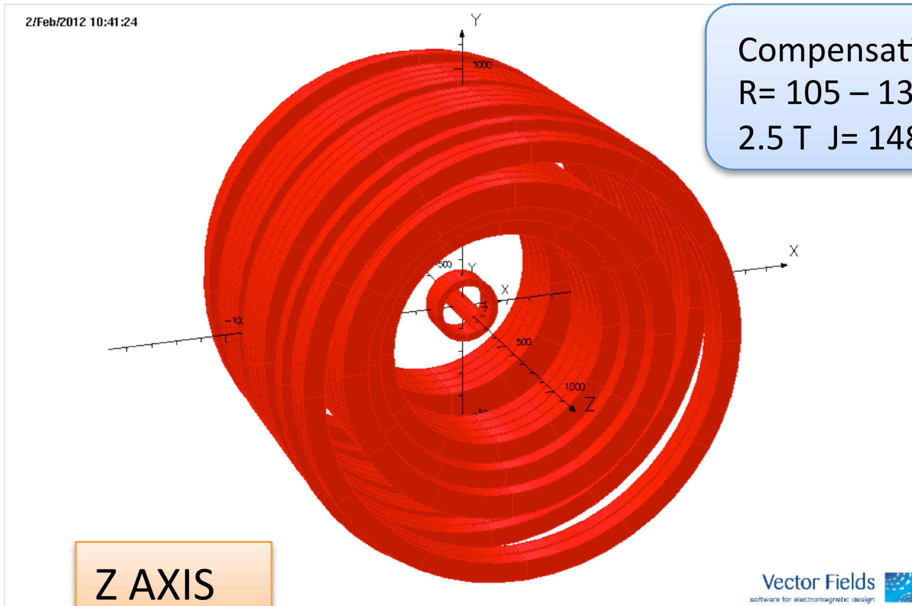
Identify best configuration + alternative

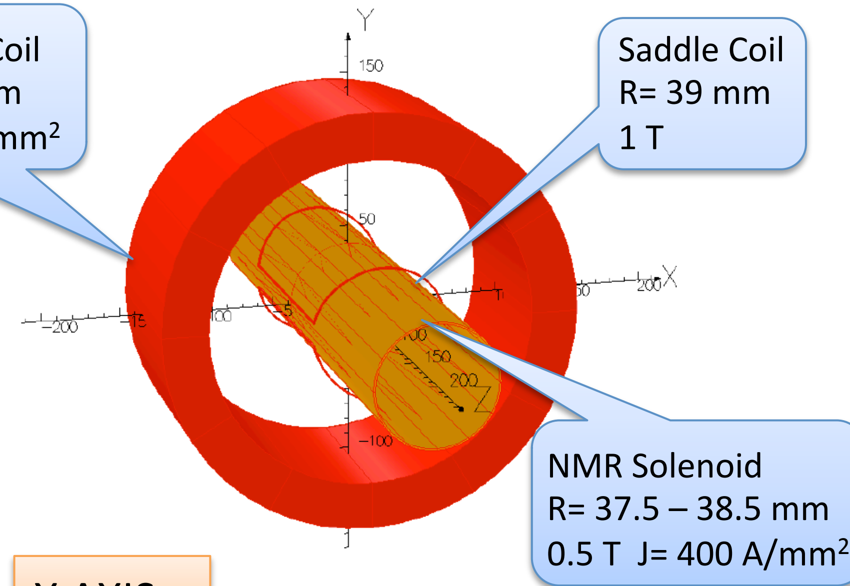
- **Characterize each magnet configuration as**

- **MAGNETIC SYSTEM :**
  - ✔ *Realistic geometry*
  - ✔ *Field map*
  - ✔ *Critical current*
  - ✔ *Quench protection*
  - * *Tolerances (static force)*
  - * *Quench simulation*

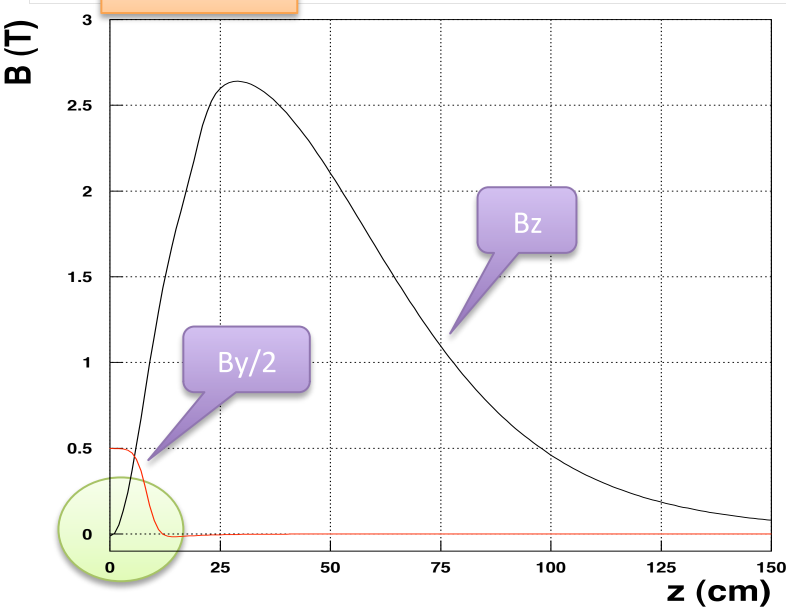
- **TRACKING :**
  - ✔ *Acceptance*
  - ✔ *Moeller background*
  - * *Resolution*

TT magnet N80

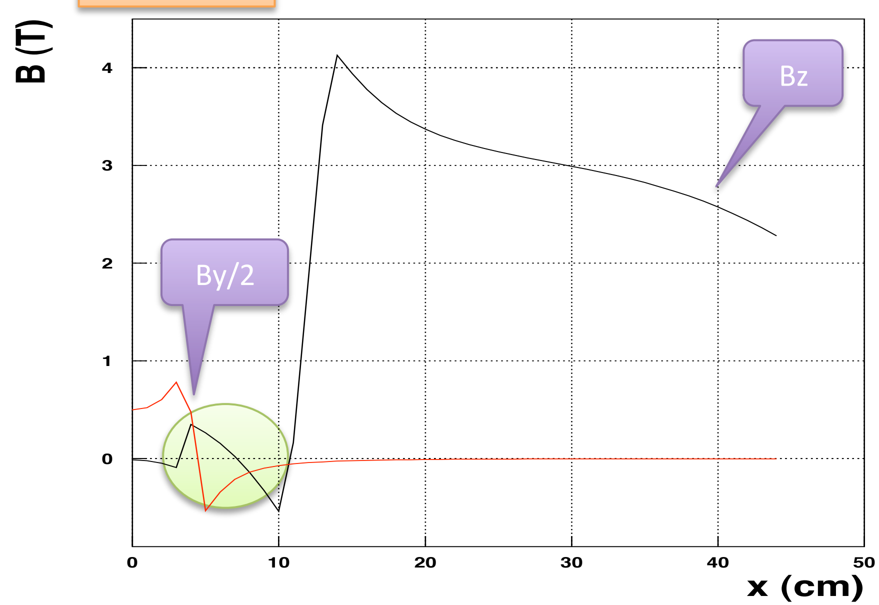




Z AXIS

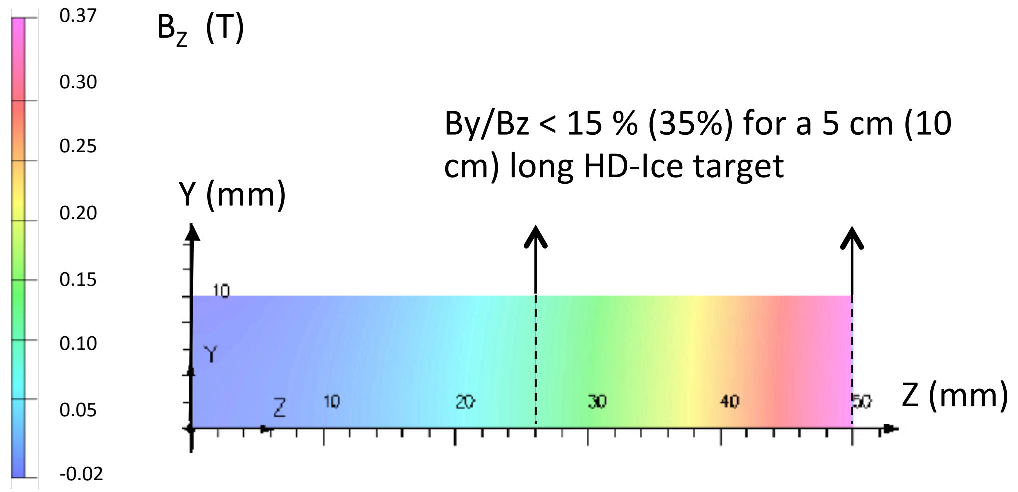


X AXIS

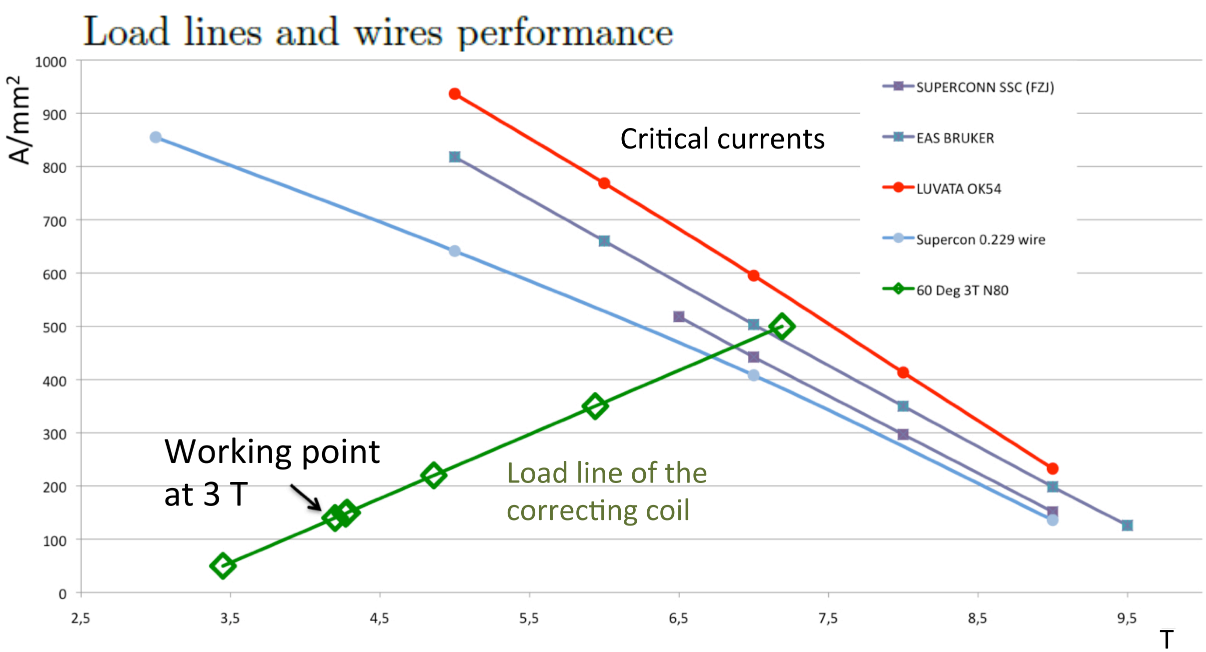


TT-N80 Working Point

- Comparable with mixing due to polarization transverse to beam
- Compromise with
  - target dimensions
  - acceptance requirements
  - beam induced depolarization ?

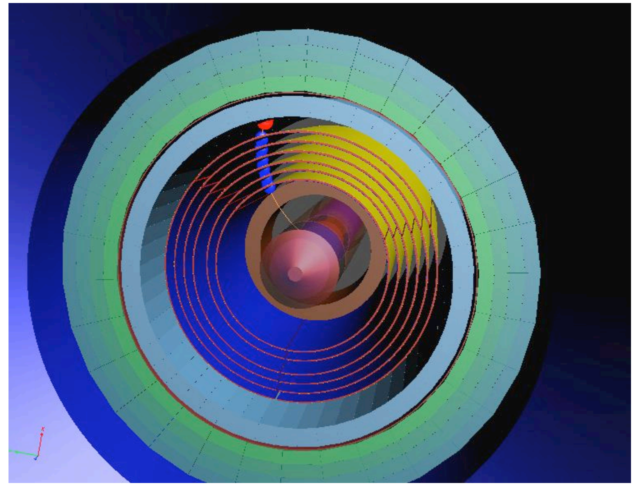


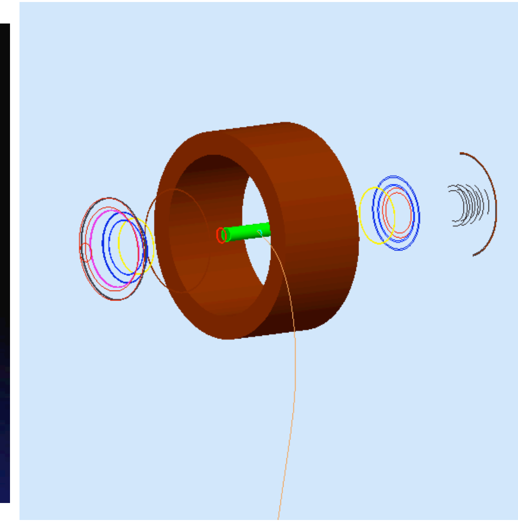
- Close to safety margin for standard SC wires
- Quenching (T < 160 K):
  - 1.25 wire
  - L = 1.02 H
  - dump resistance 4 Ohm
  - current 245 A



TT-N80 Performances

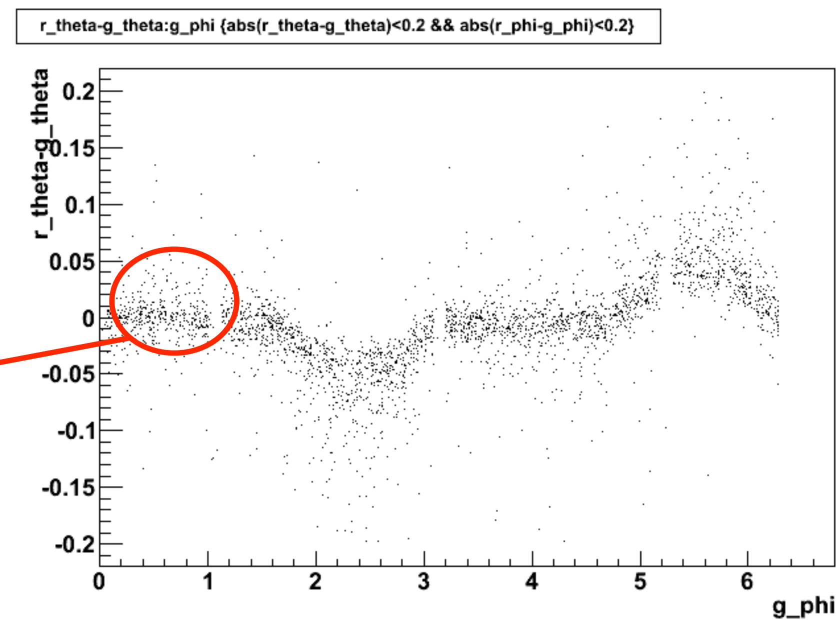
- Massive coil
- 60° acceptance from cell center
- Untouched forward acceptance



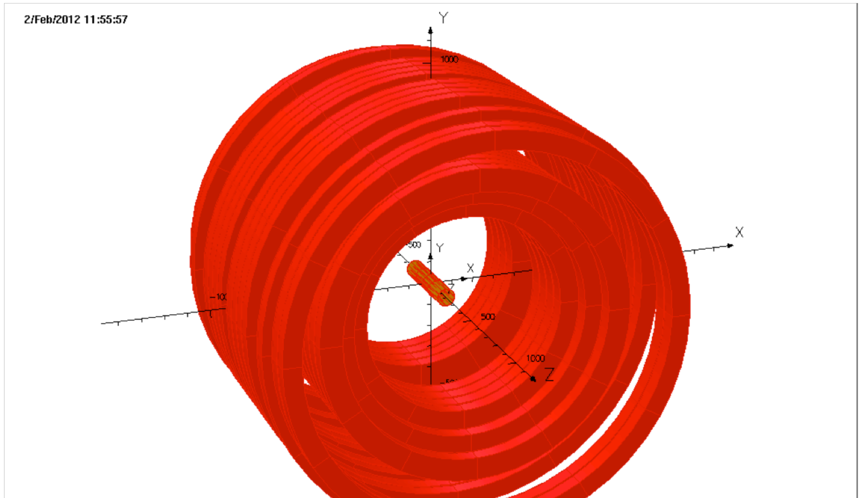


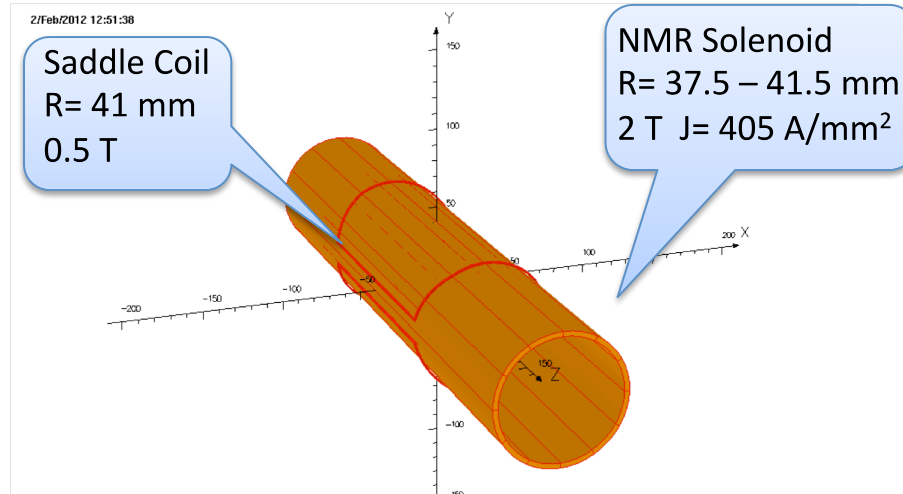
Thanks to Sebastien Procureur

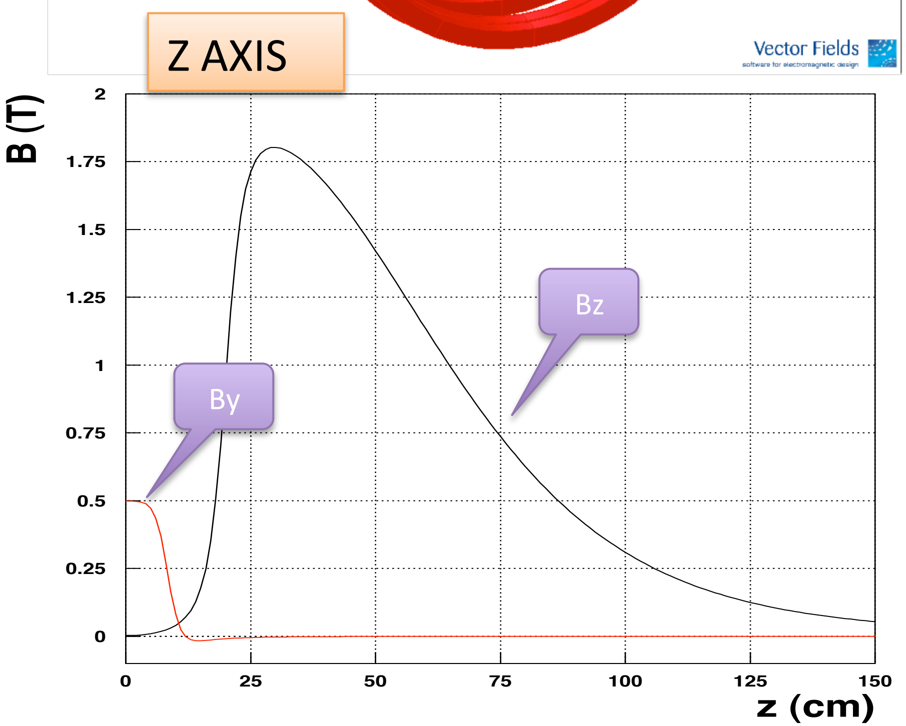
- Momentum resolution ~ 10% versus 6 % with standard setup
- Theta resoultion ~ 8 mrad versus ~ 7 mrad with standard setup

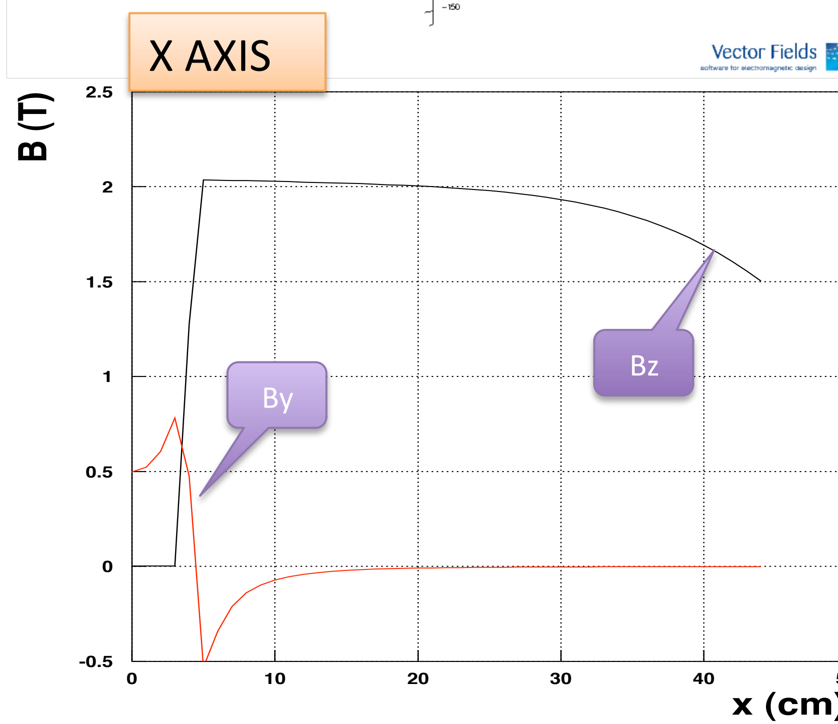


TT magnet N95



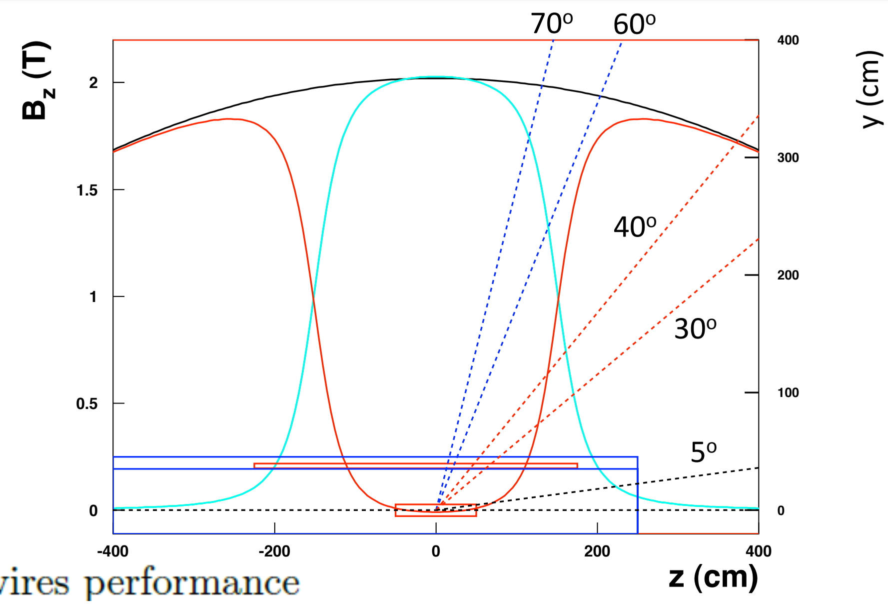




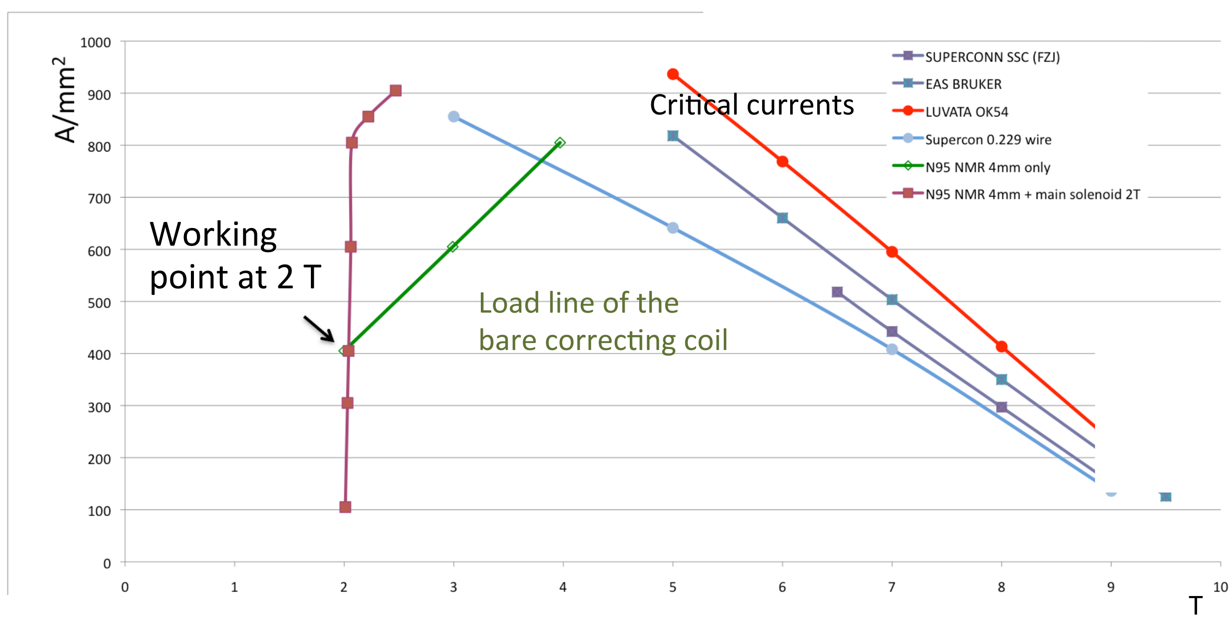


TT-N95 Case

- Excellent compensation (homogeneity)
- Critical material budget in forward acceptance
  - thickness x 6 at 10 degrees

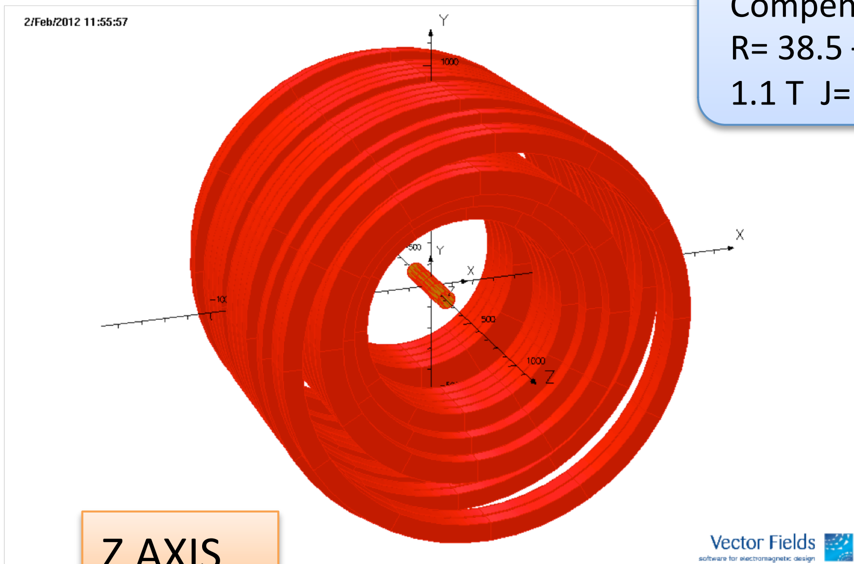


Load lines and wires performance

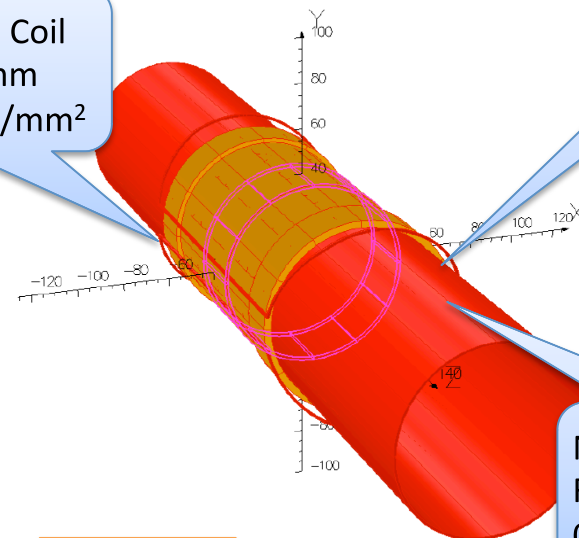


- Close to safety margin for standard SC wires
- Quenching (T < 160 K):
  - 0.7 wire
  - L = 0.11 H
  - dump resistance 4 Ohm
  - current 225 A

TT magnet N101



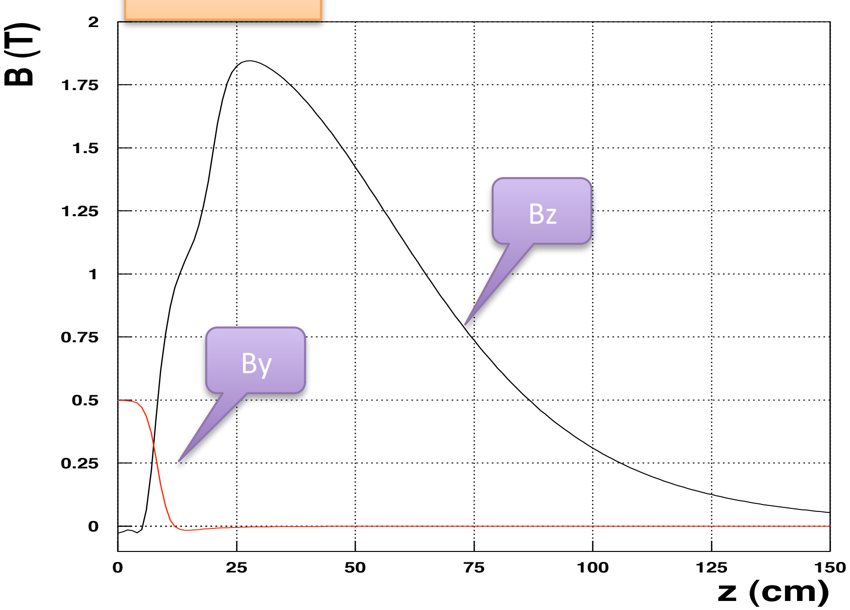
Compensating Coil
R= 38.5 – 40 mm
1.1 T J= 730 A/mm^2



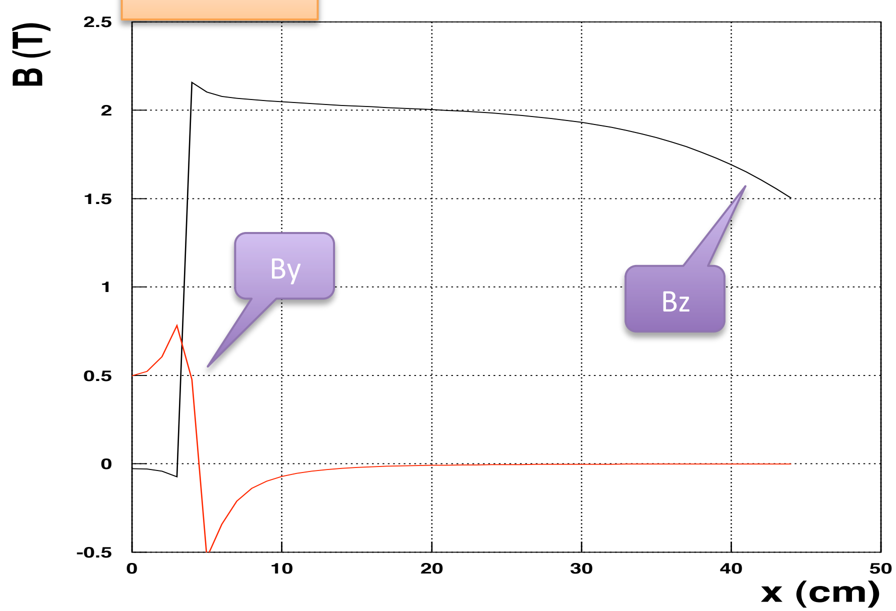
Saddle Coil
R= 39 mm
0.5 T

NMR Solenoid
R= 37.5 – 38.5 mm
0.9 T J= 730 A/mm^2

Z AXIS

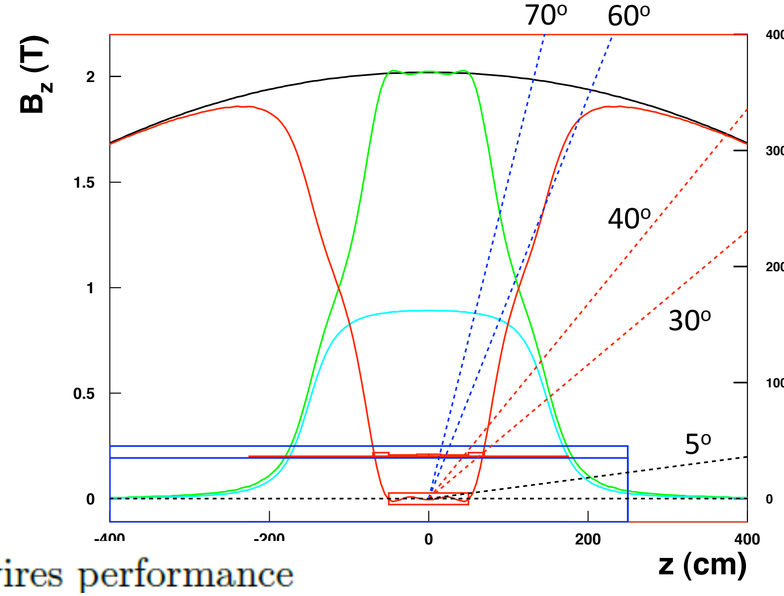


X AXIS

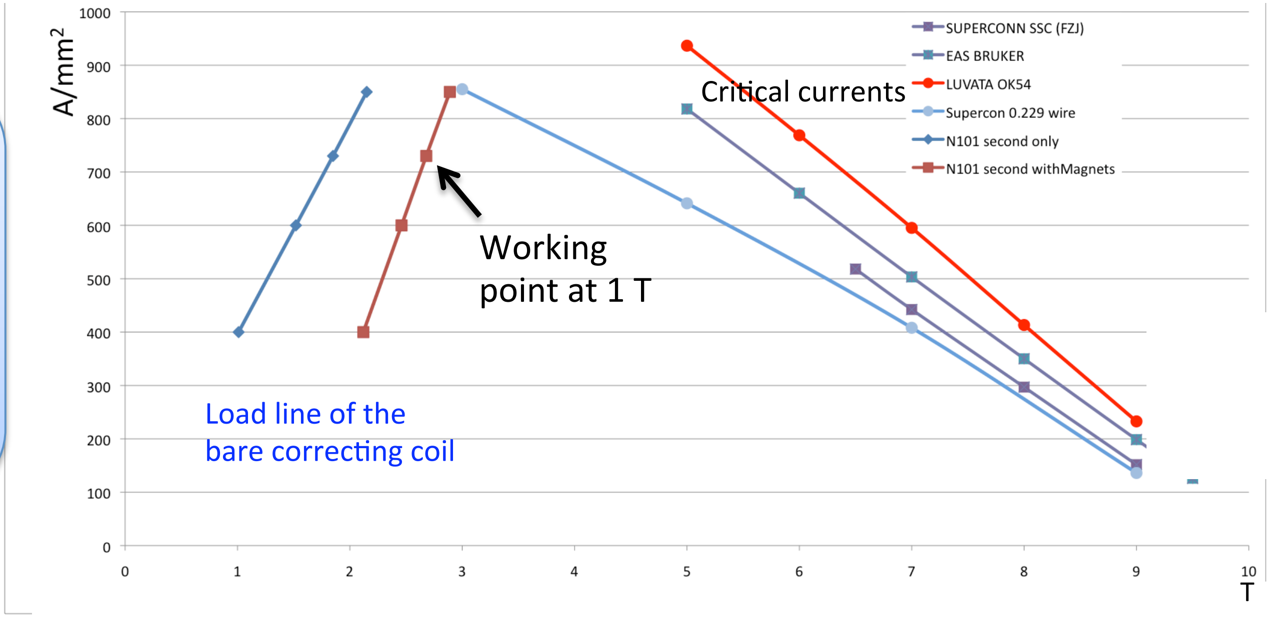


TT-N95 Case

- ❖ Good compensation (homogeneity)
- ❖ Untouched forward acceptance
- ❖ Material budget at large angles
  - ~ 4 mm from 30 to 40 degrees
  - ~ 2 mm above 40 degrees

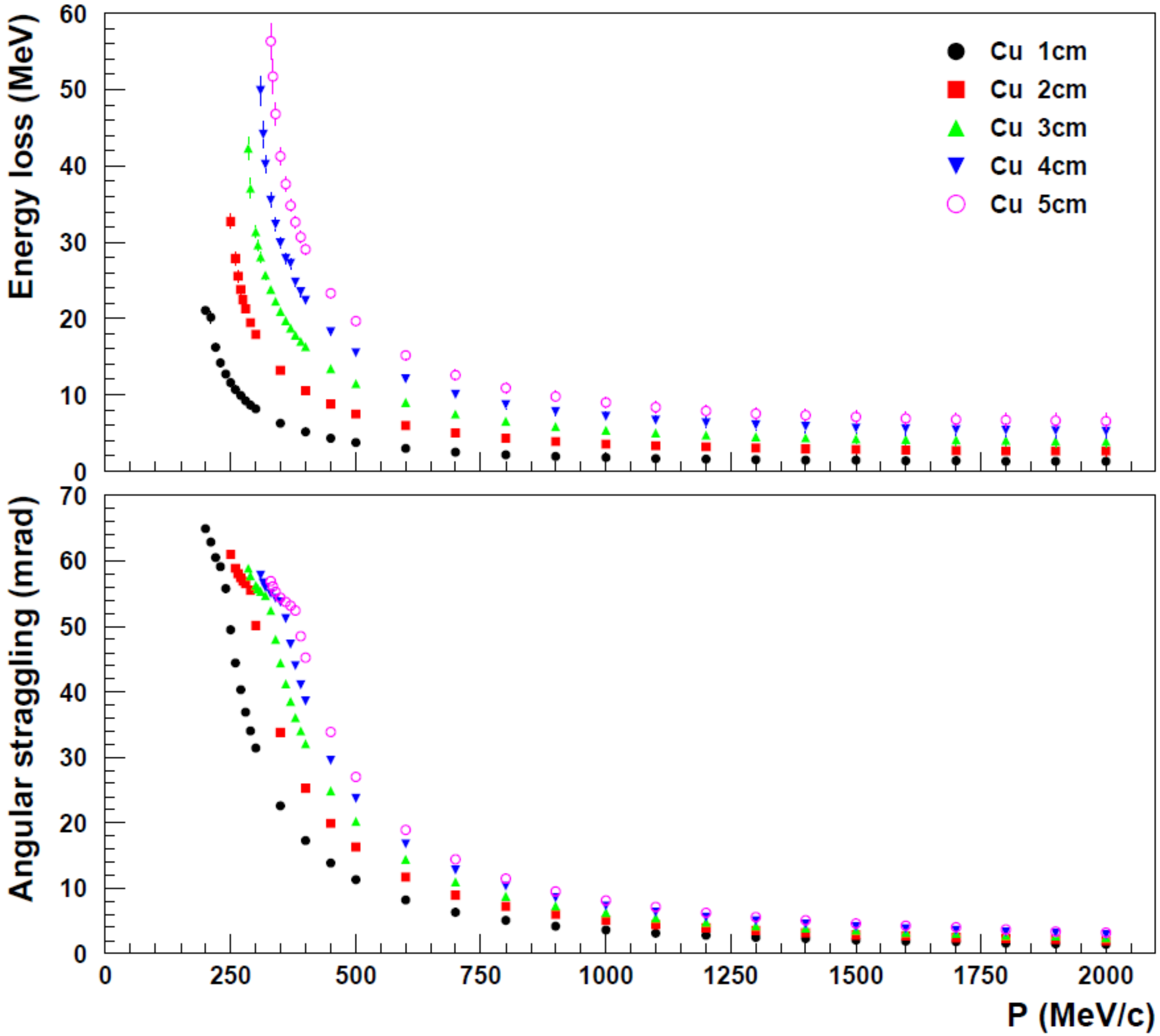


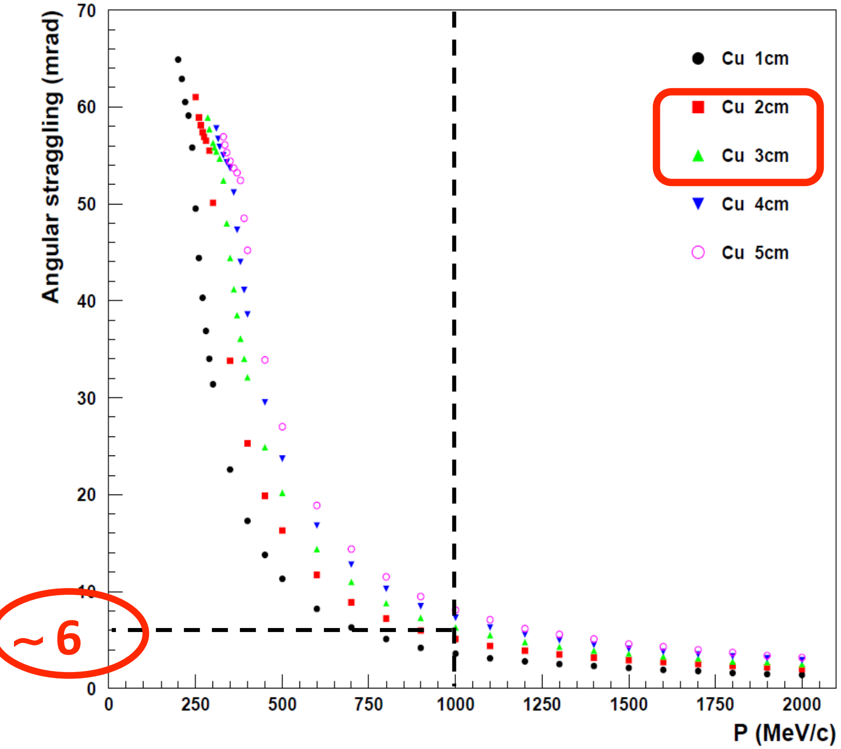
Load lines and wires performance

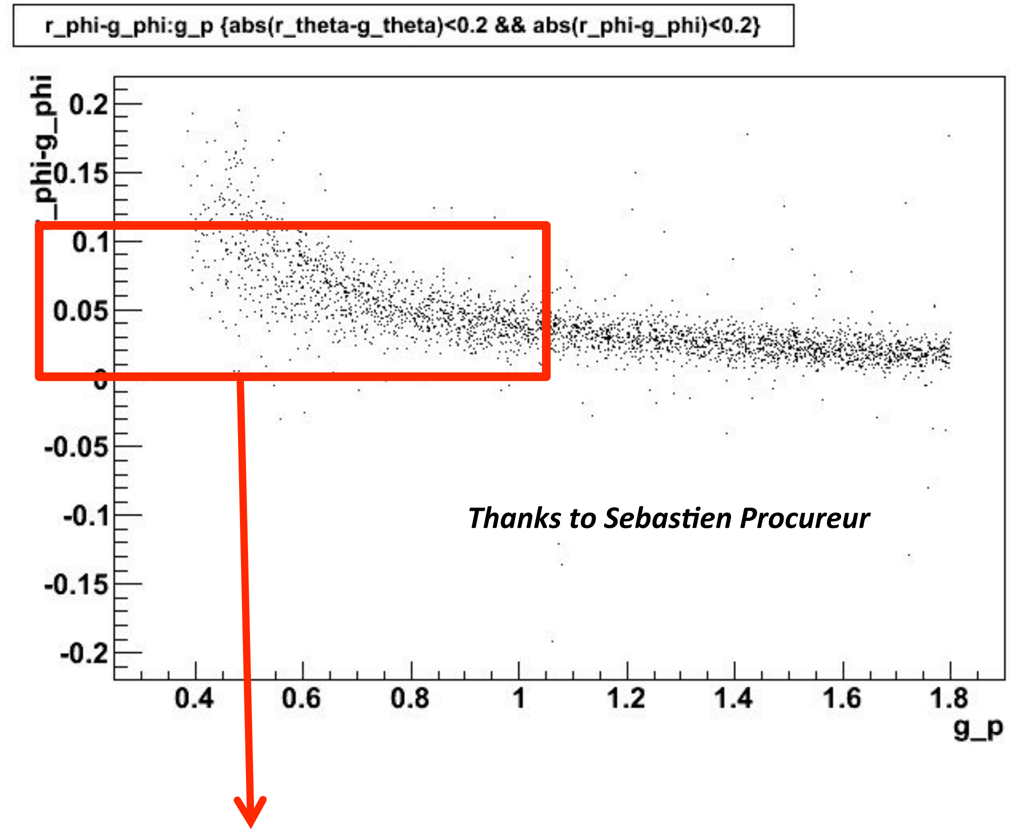


- ❖ Close to safety margin for standard SC wires
- ❖ Quenching (T < 160 K):
  - 0.3-0.35 wire
  - L = 0.12 H
  - dump resistance 12 Ohm
  - current 82 A

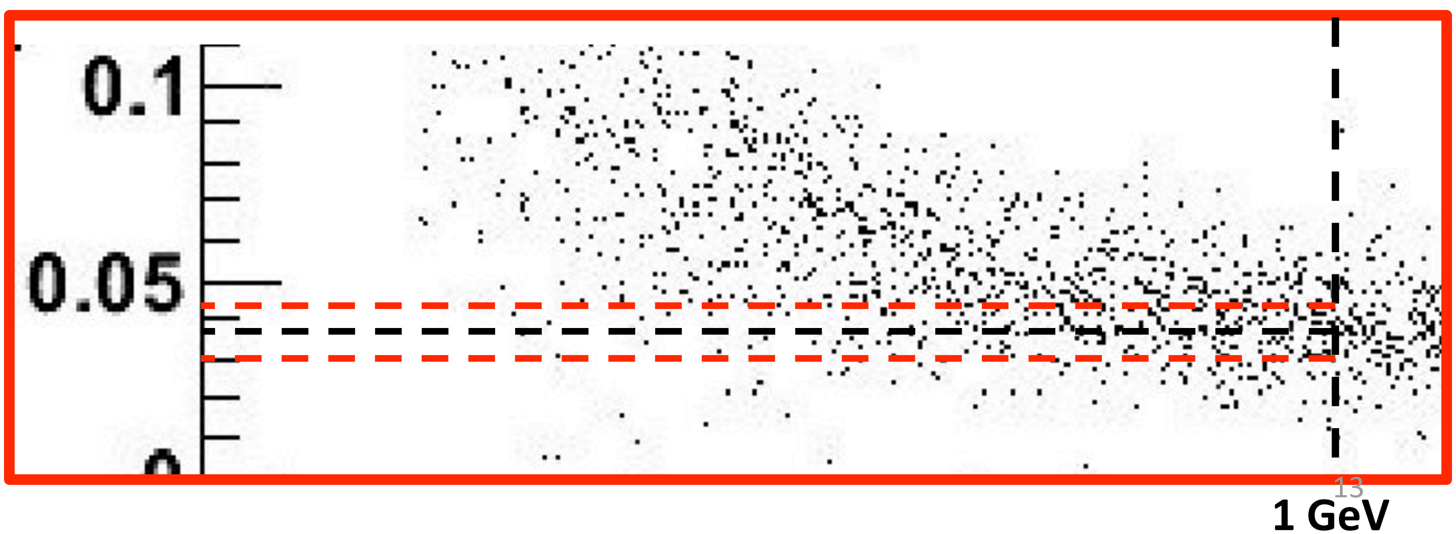
Material budget





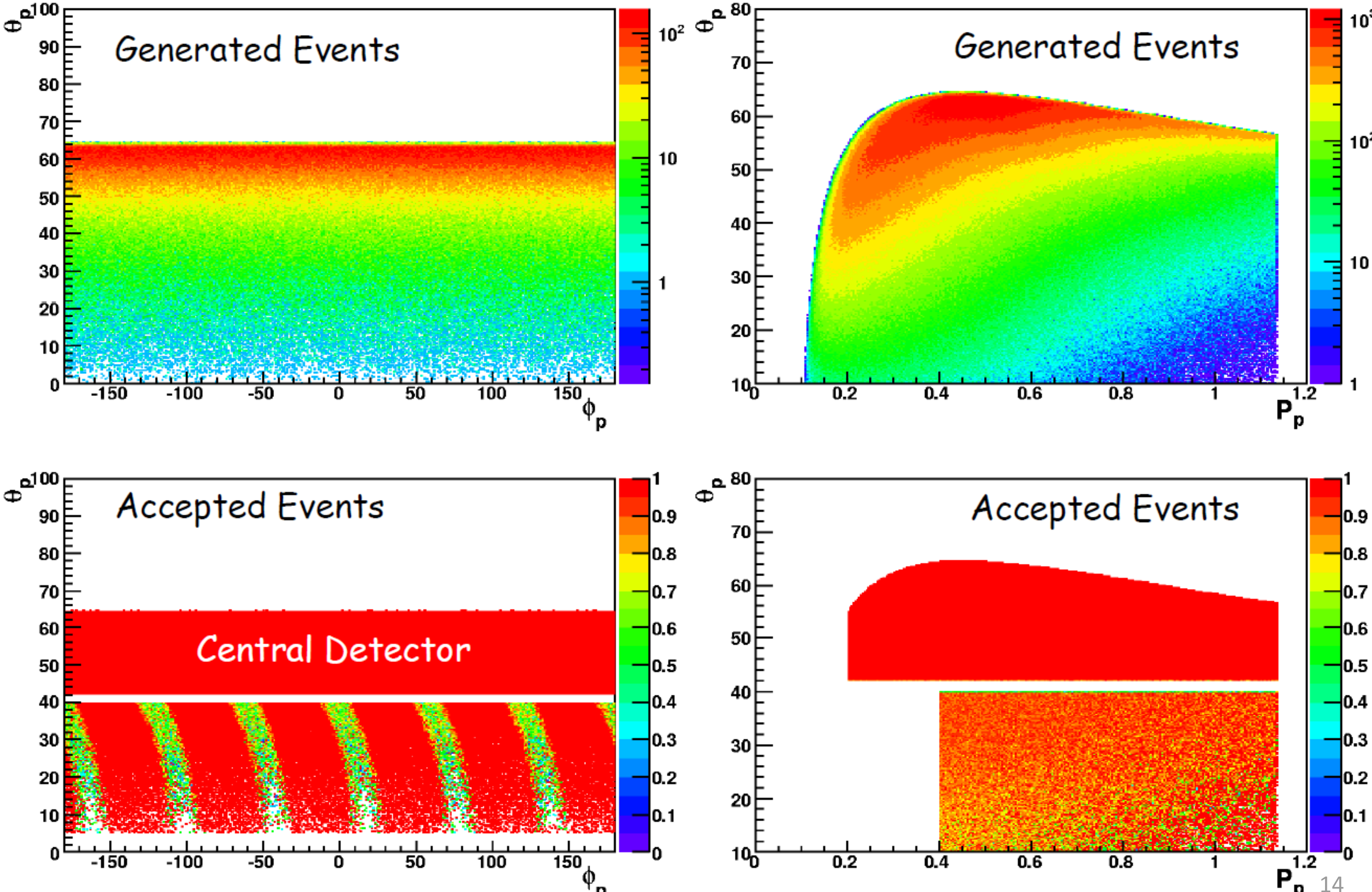


$\pm 1\sigma \approx 14$
$\rightarrow \sigma \approx 7$



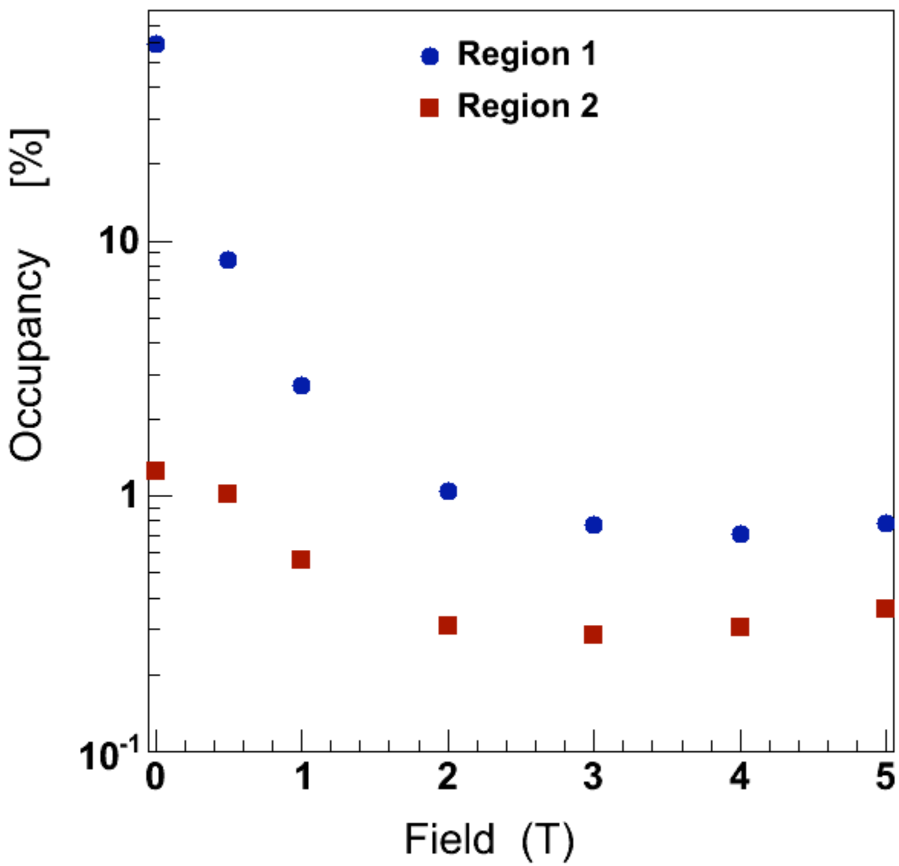
Franck Sabatié
Saclay

Proton acceptance for DVCS

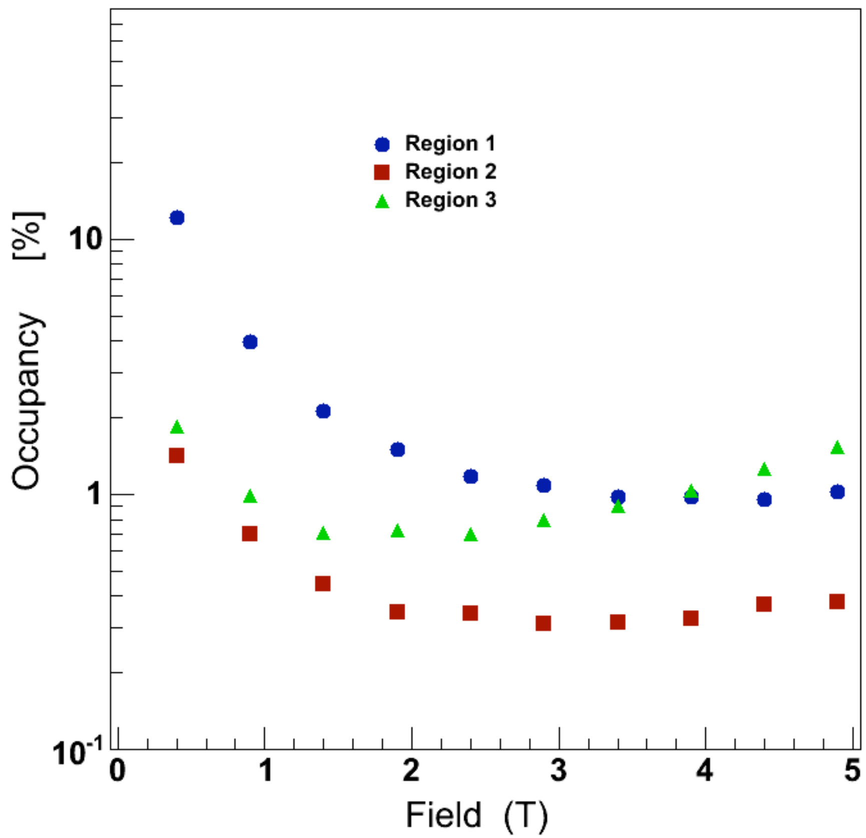


Moeller background

Drift Chamber Occupancy

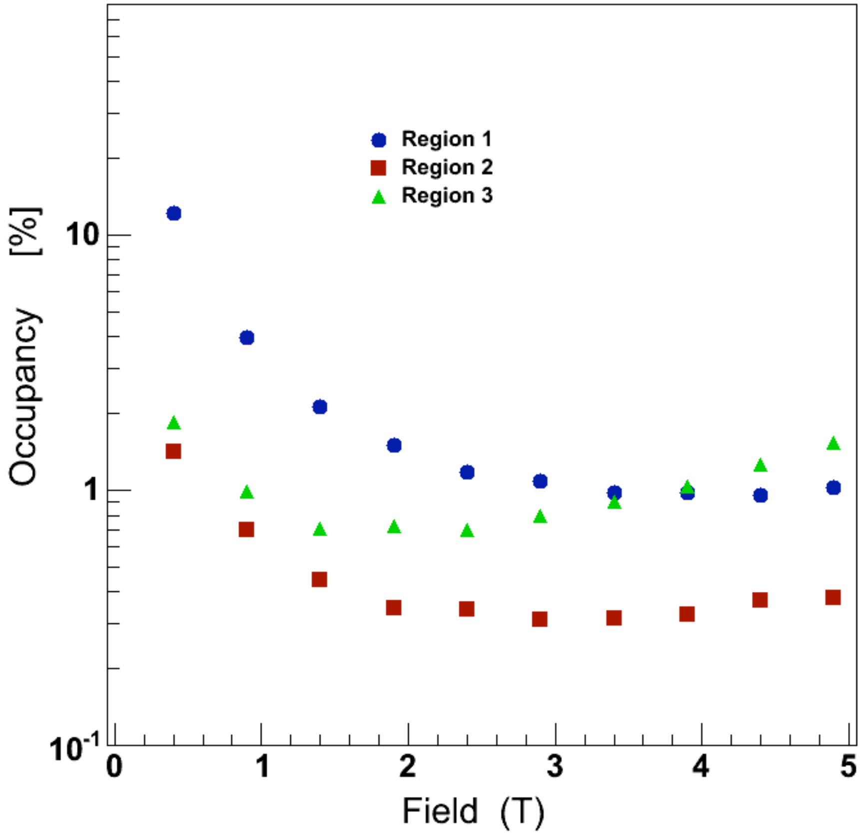


HD N80

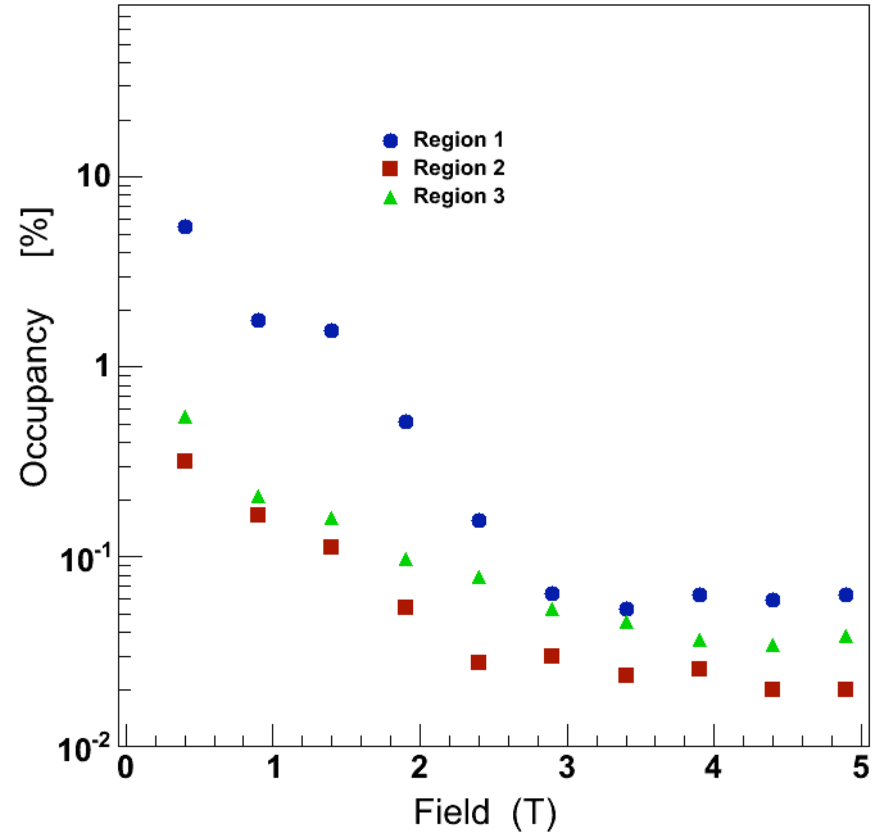


Moeller background

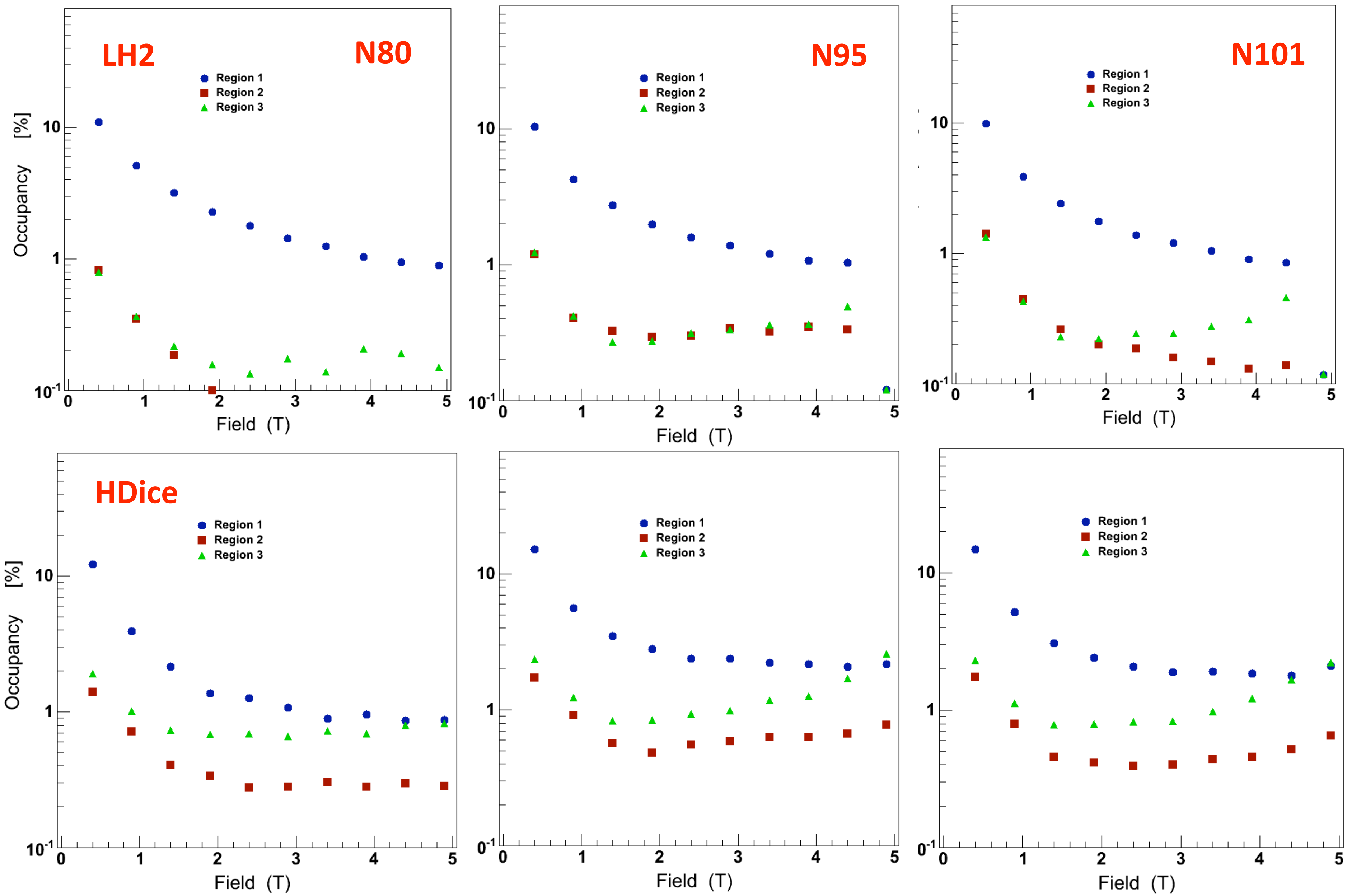
HD N80



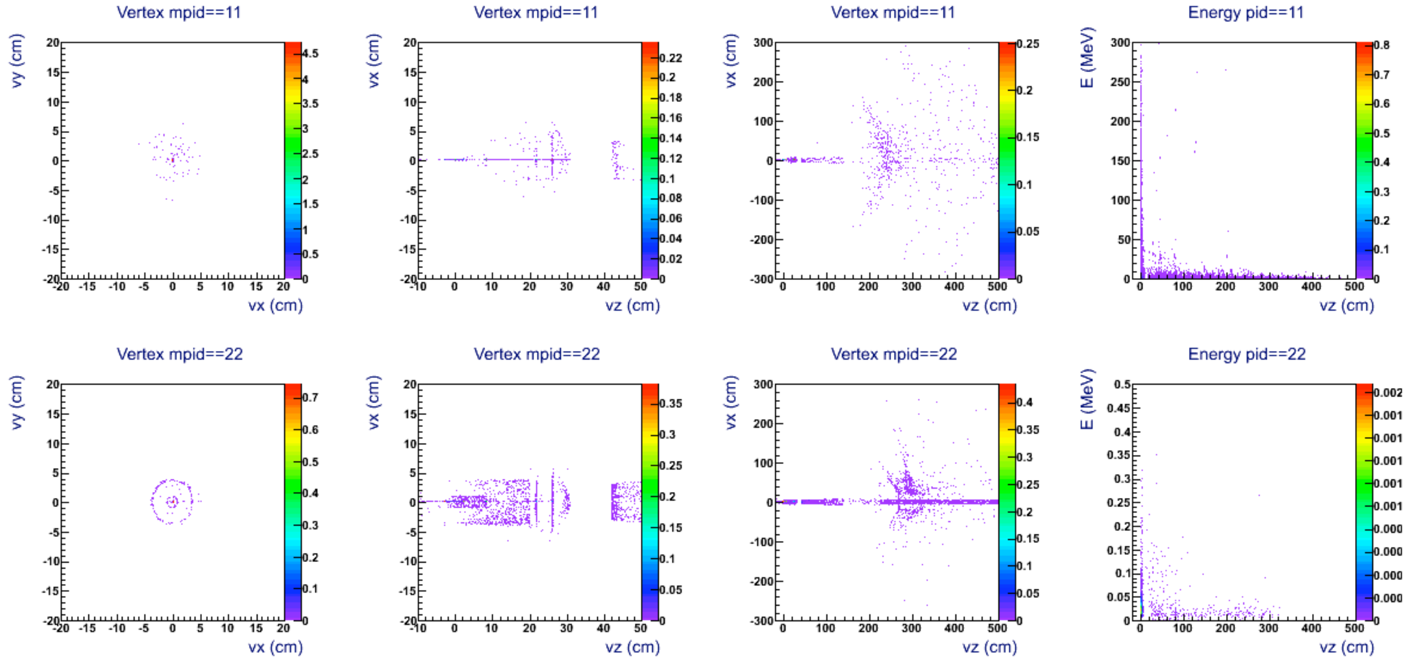
LH2 SRR



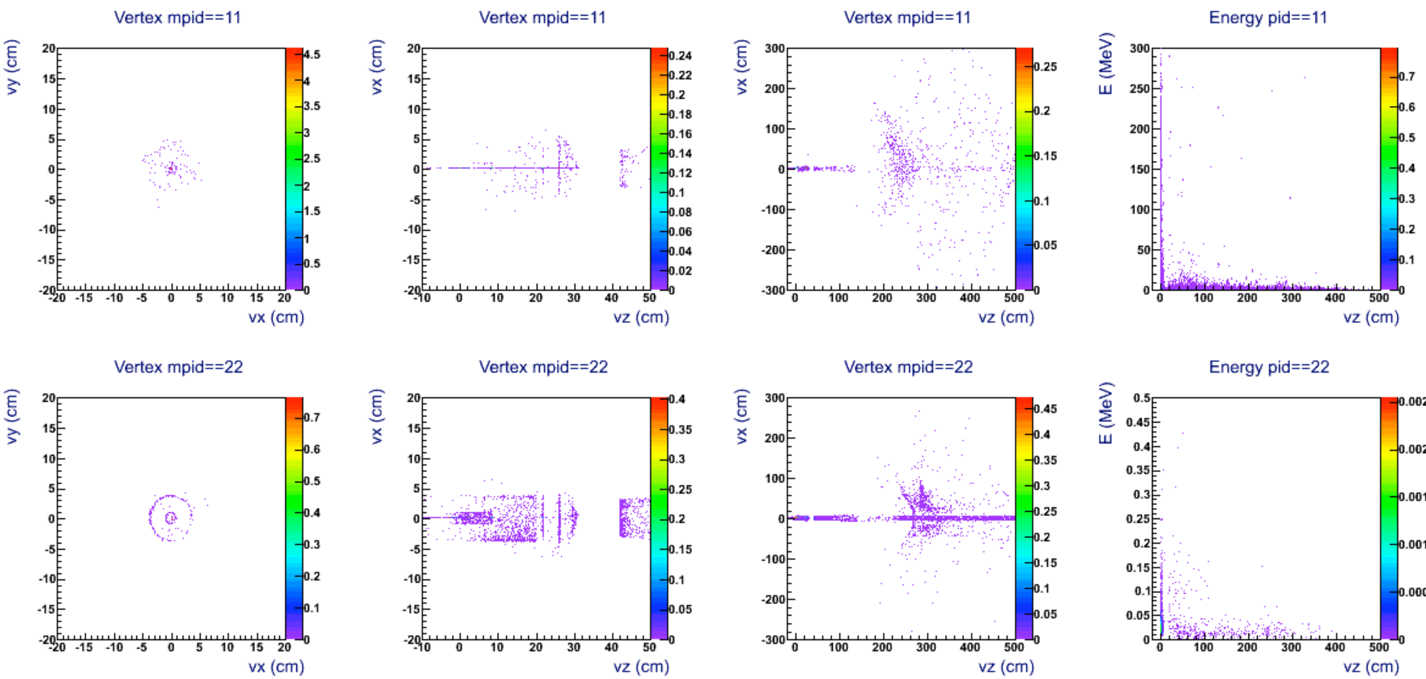
Moeller background



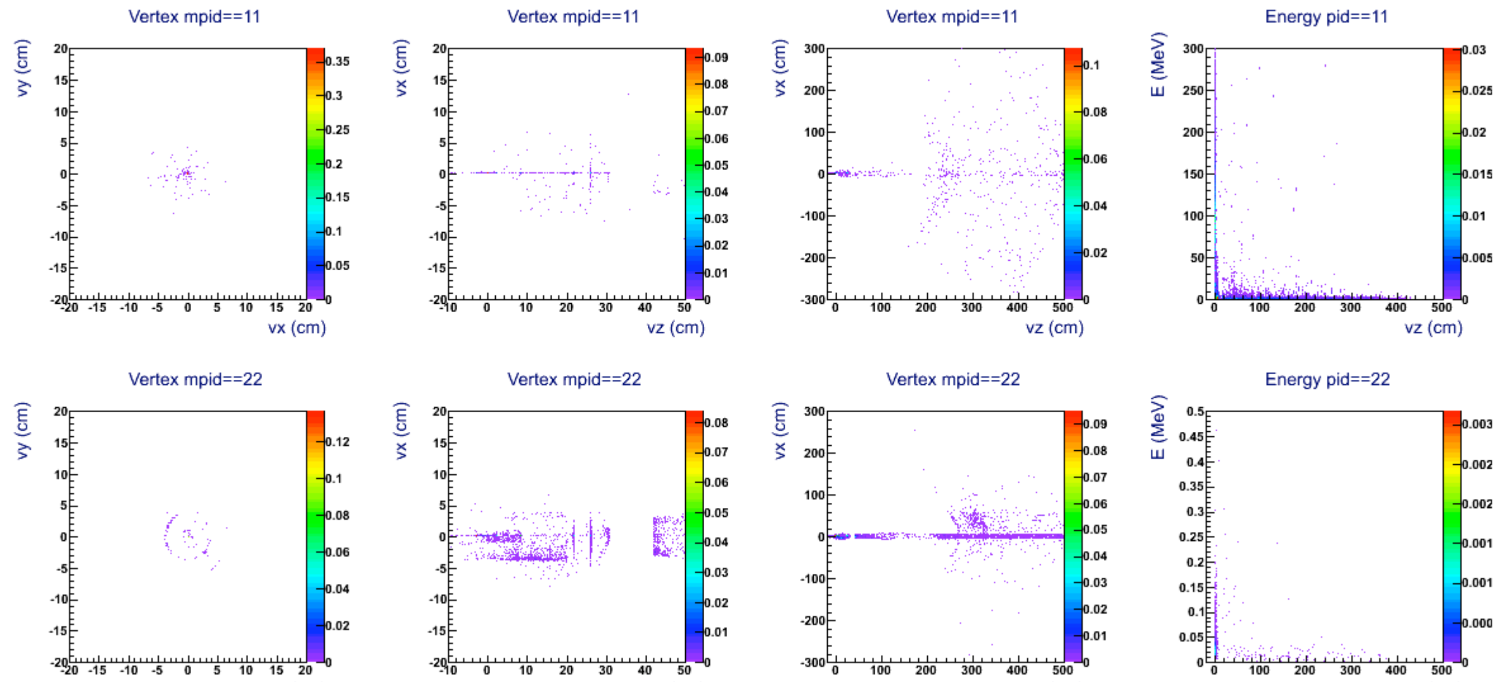
N80 0.5T



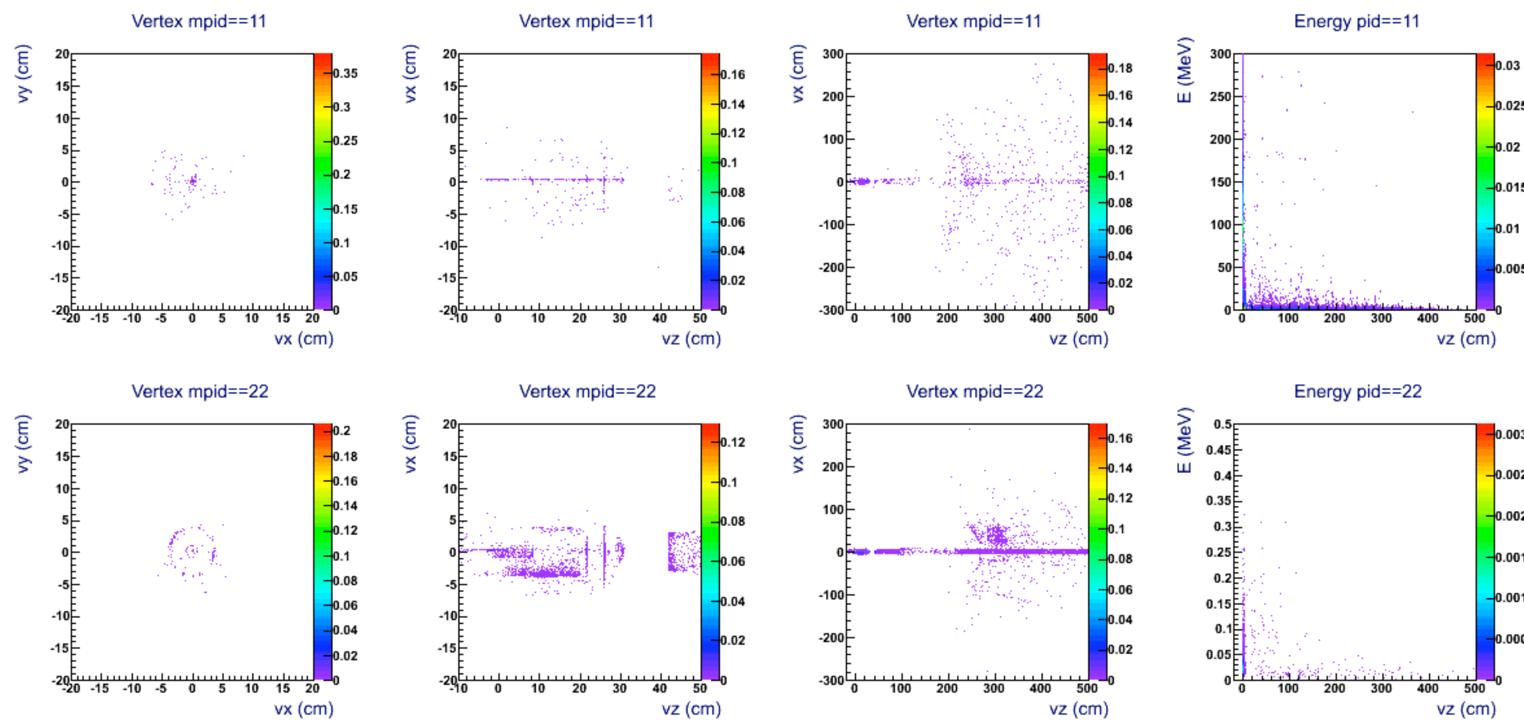
N101 0.5T



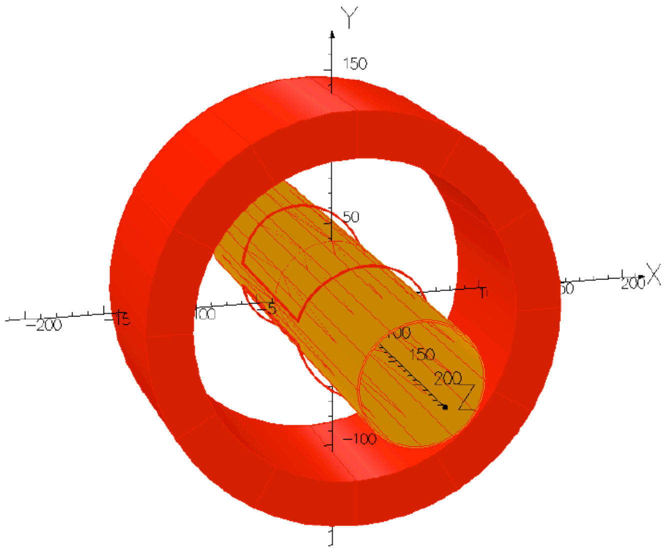
N80 2.0T

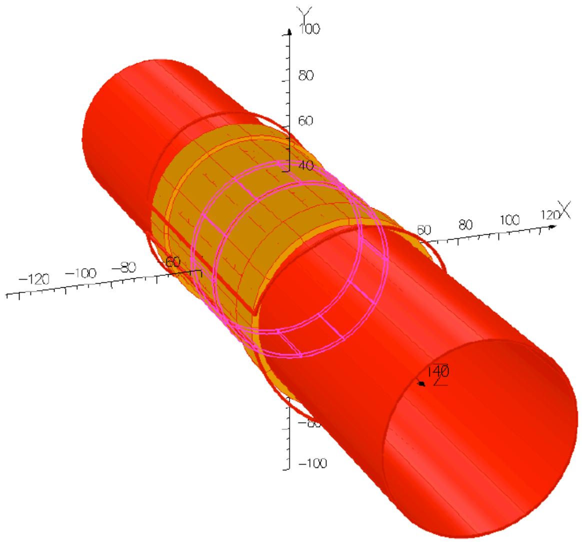


N101 2.0T



Phylosopy





- **N80:**
  - ✔ *High Field for high Lumi*
  - ✔ *Decouple from Hdice cryo*
  - ✔ *Short target*

- **N101:**
  - ✔ *Mild Field for low Lumi*
  - ✔ *Light structure*
  - ✔ *Long target*