CLAS12 Magnetology for Transversely Polarized Targets and Similarities with PANDA

Keith Griffioen
Helmholtz Institute Mainz
College of William & Mary

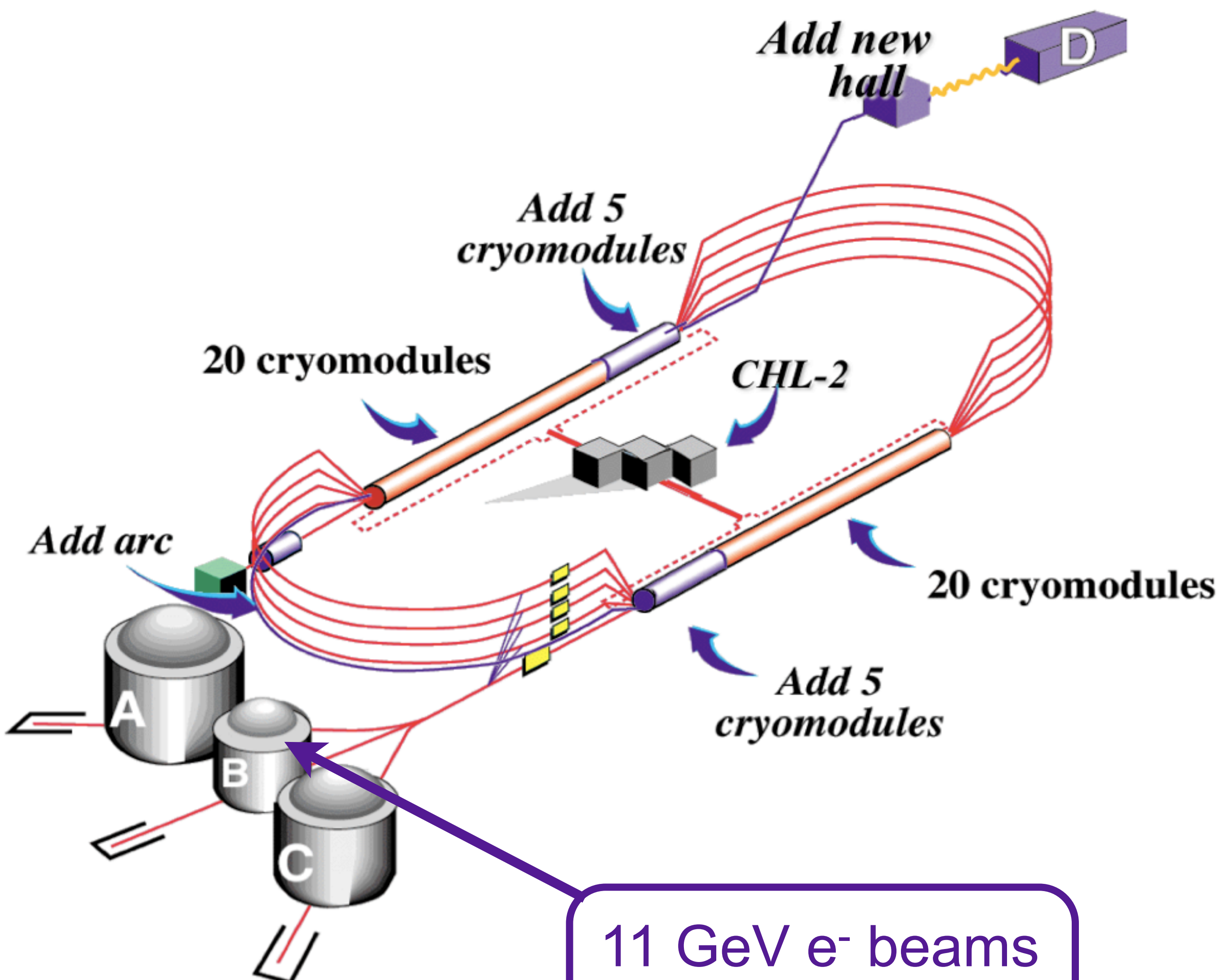
griff@physics.wm.edu

HIM 21 June 2012

Questions

- What is the current thinking for magnetic shielding of a transversely polarized target at CLAS12?
- What can we learn from this for PANDA's transversely polarized target?

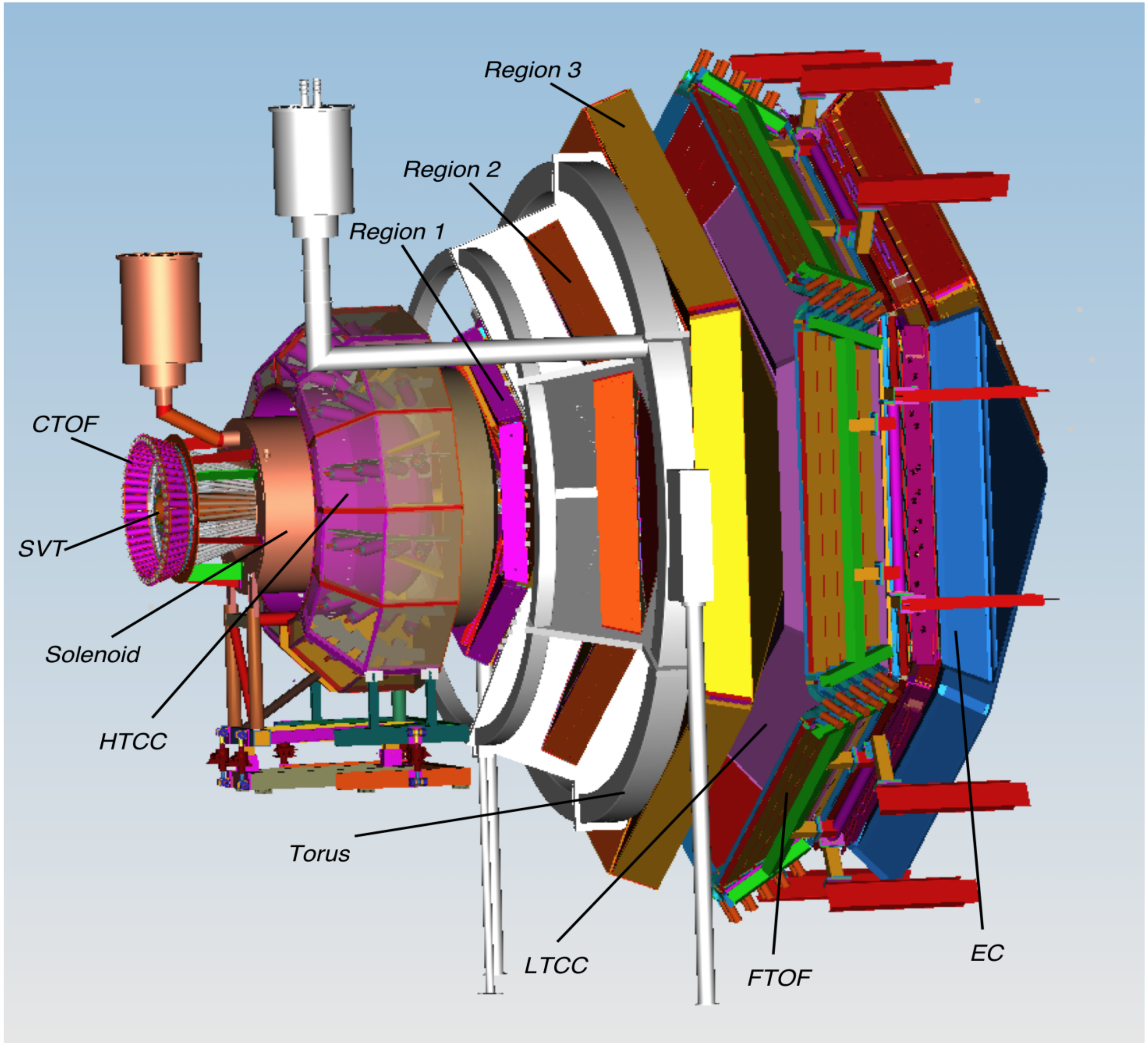
JLab 12 GeV Upgrade



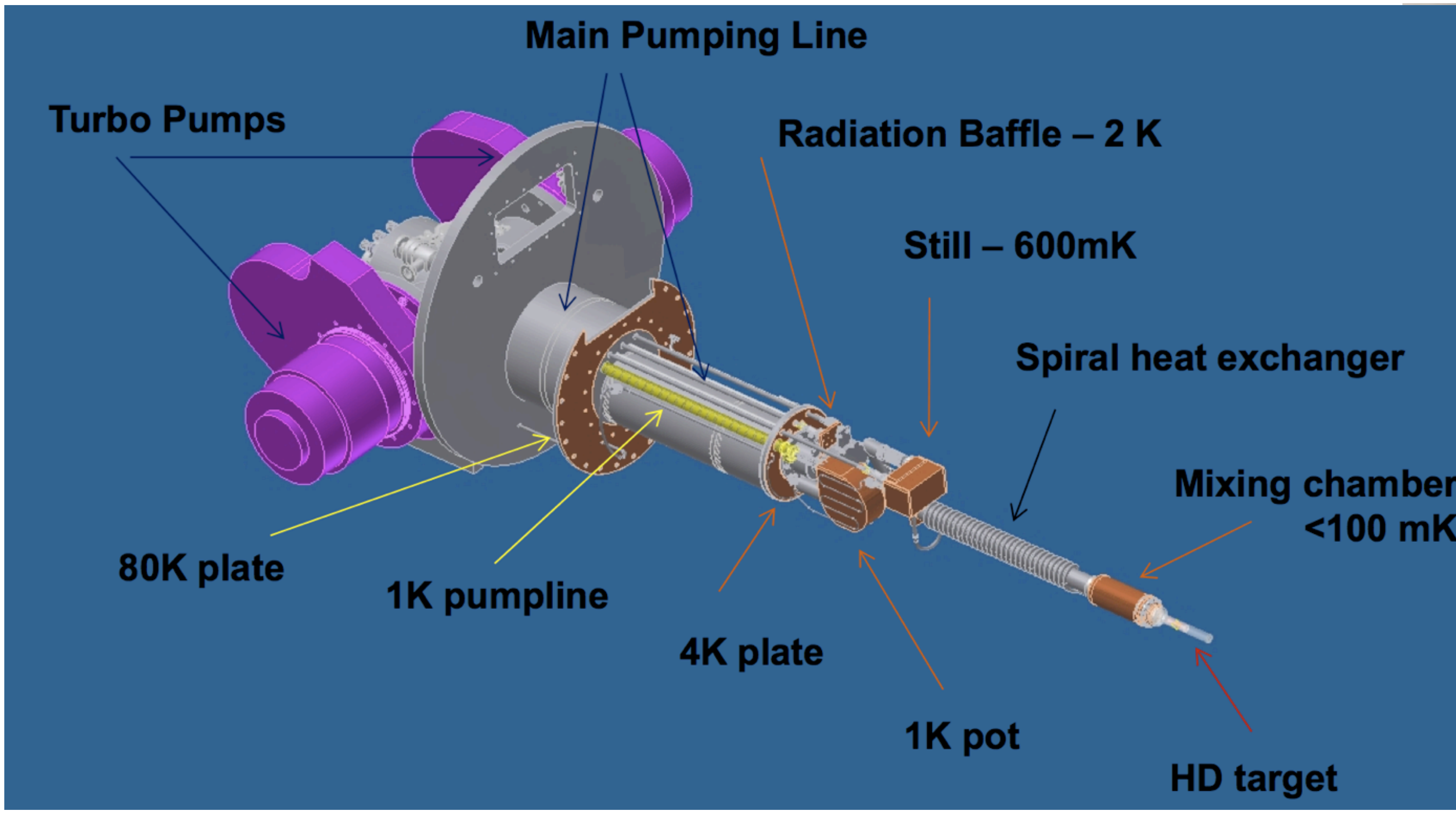
11 GeV e⁻ beams
85% polarization

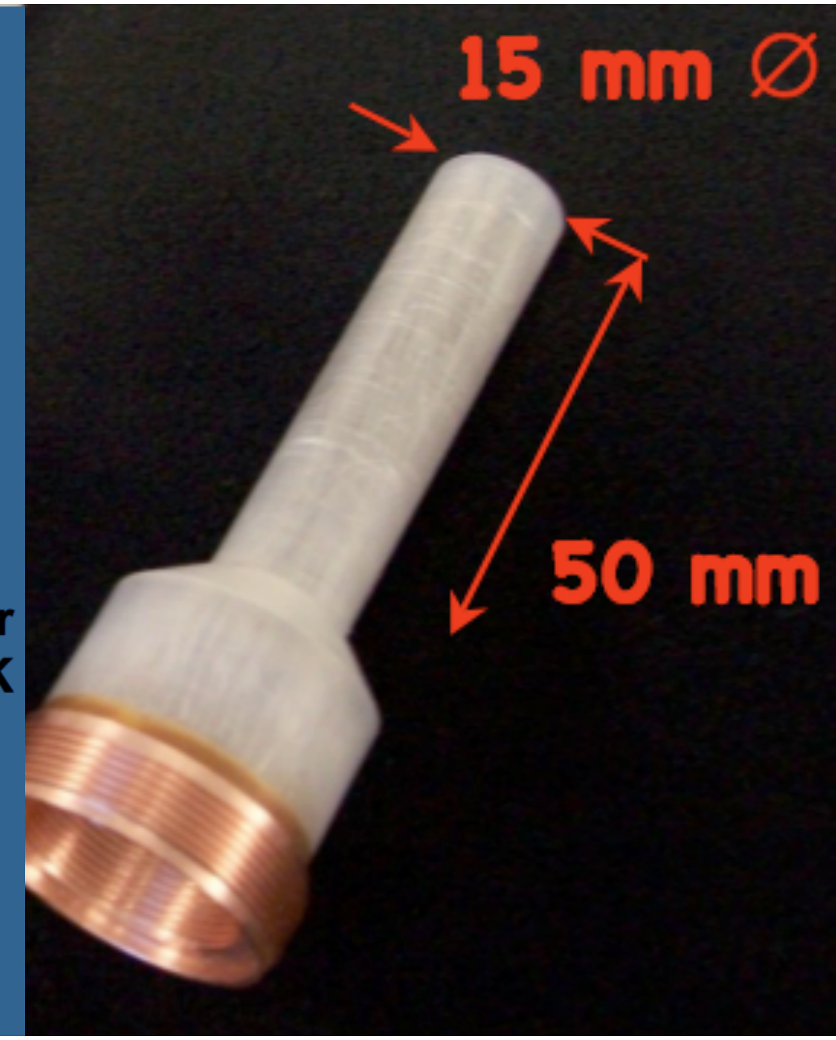
CLAS12 Detector

- Region 1,2,3 drift chambers
- **CTOF**: central time-of-flight
- **SVT**: silicon vertex tracker
- Superconductiong solenoid (5 T)
- **HTCC**: high threshold Cherenkov counter
- Superconductiong torus
- **LTCC**: low threshold Cherenkov counter
- **FTOF**: forward time-of-flight detector
- **EC**: electromagnetic calorimeter
- Upgrades: **RICH**, **CND**: central neutron detector, forward tagger, micromegas



Transversely Polarized Target





- HD Ice Target
- Polarize small amounts of H_2 and D_2
- o-H_2 and p-D_2 spin-exchange polarizes HD
- Frozen-spin achieved in a few months
- 0.05 K cryostat
- Low holding field (0.01-0.5 T)
- P_T = 75% for p and 40% for d
- Initial tests are promising for use with electron beam

JLab CLAS12 Proposal

Measurement of transversity with dihadron production in SIDIS with a transversely polarized target

H. Avakian, S. Anefalos Pereira, A. Courtroy, M. Radici, L. Pappalardo, K. Griffioen, co-spokespersons

A 12 GeV research proposal submitted to PAC39, June 2012

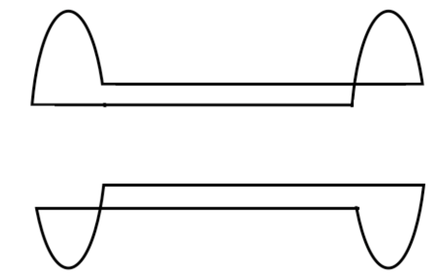
&

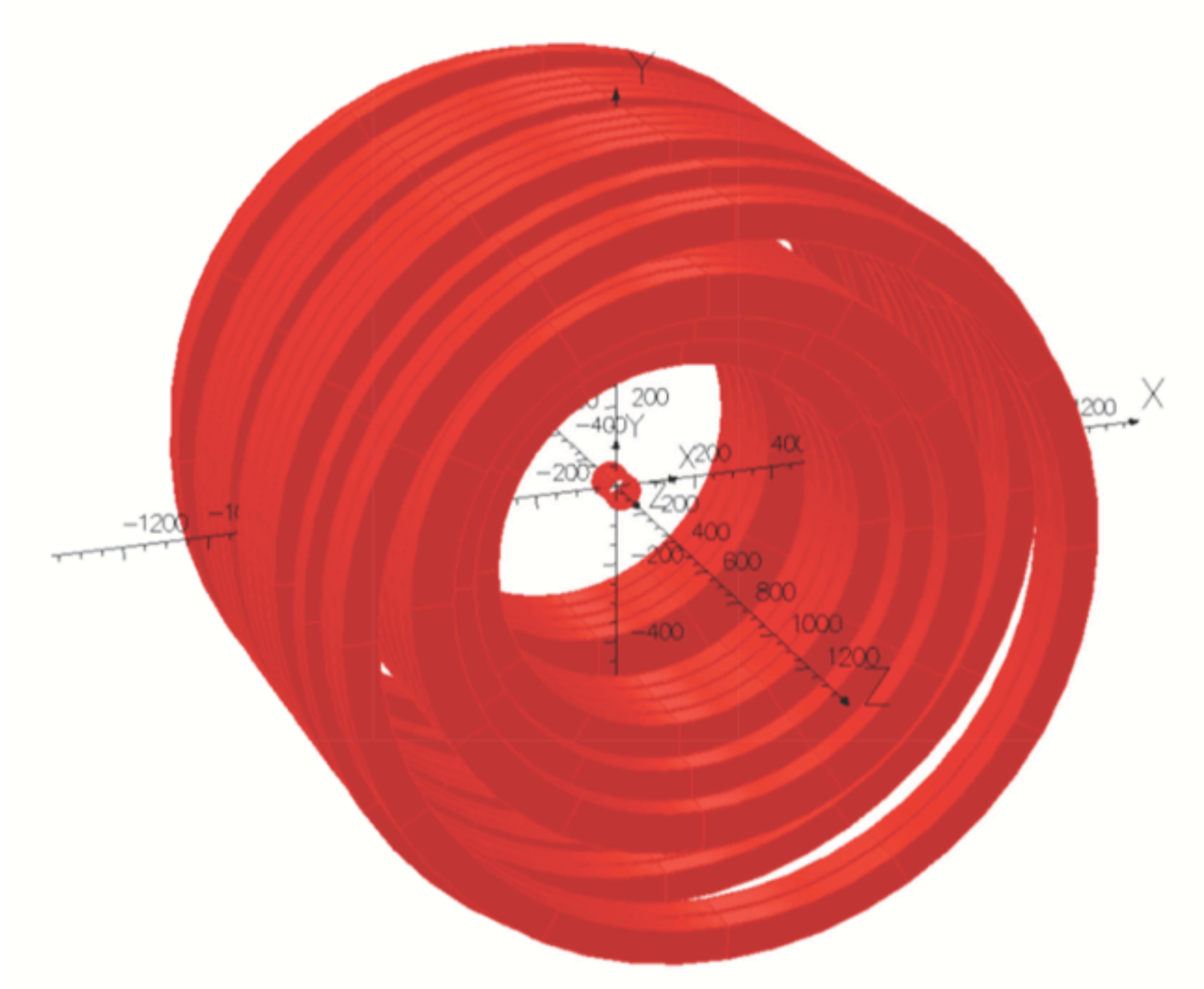
The Problem

- Like PANDA, the CLAS target is located in the middle of a large longitudinal magnetic field
- For CLAS the longitudinal field curls up Møller electrons and keeps them out of the detectors.
- A transverse target requires a transverse holding field.
- One needs to cancel the longitudinal field and add a transverse field at the target position

CLAS12 Longitudinal Magnets

Saddle coil





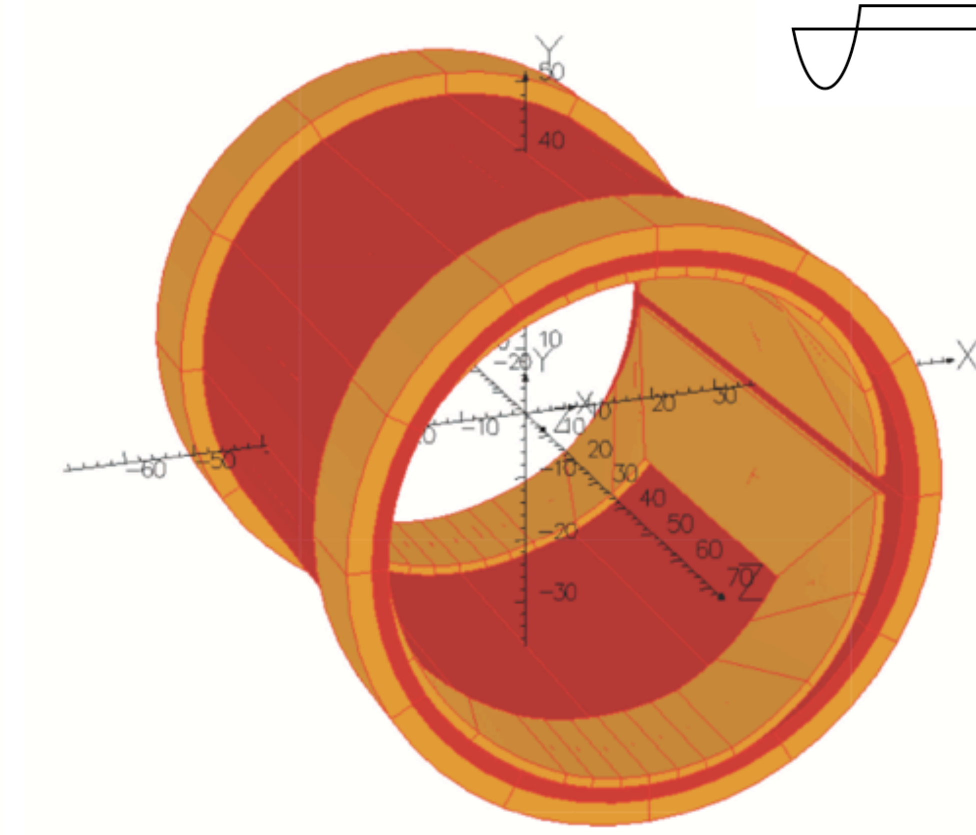


Figure 11: (Left) The HD-Ice superconducting magnetic system surrounds the target at the center of the CLAS12 central detector solenoid. (right) The HD-Ice magnetic system comprises, moving outward from the beam line, the HD-Ice holding field saddle coil (brown), the compensating solenoid (red), and the Helmholtz coil (brown).

Magnet Design

- Magnet simulations done by Marco Contalbrigo at Ferrara
- Considered a passive solution (3T field, 10^{34} /cm/s luminosity, 10cm long target), but discarded it because of the large material budget
- May reconsider a passive solution with a shorter target (5 cm), which requires a smaller longitudinal field (2T) for Møller scattering suppression.
- Magnet design is preliminary, but good enough for a PAC review.
- Helmholtz coils centered at ±42.5 mm
- Helmholtz and solenoid coils extend to ±50.0 mm.
- Saddle coil is 24 mm wide and provides up to 0.5T of transverse field
- Material concentrated at 40^{o} at the transition between forward and central detectors.
- All coils have 730 A/mm^2 current density, so they could be in series if necessary. Quench requirements may nix the serial connection.
- Wires could be NbTi (SUPERCON 0.229). Need ~0.3 mm diameter for the solenoid to reduce the inductance and allow standard quench protection. Current goes up, but it's still below 100A. Other coils can use SUPERCON
- On axis, the longitudinal component is reduced to 5 mT from 2 T over 5 cm.
- Transverse field varies by 10-20%, since the saddle is kept short.
- NMR measurements on the target need to be done in longitudinal mode where the field uniformity is good (10^{-4})

CLAS12 Longitudinal Fields

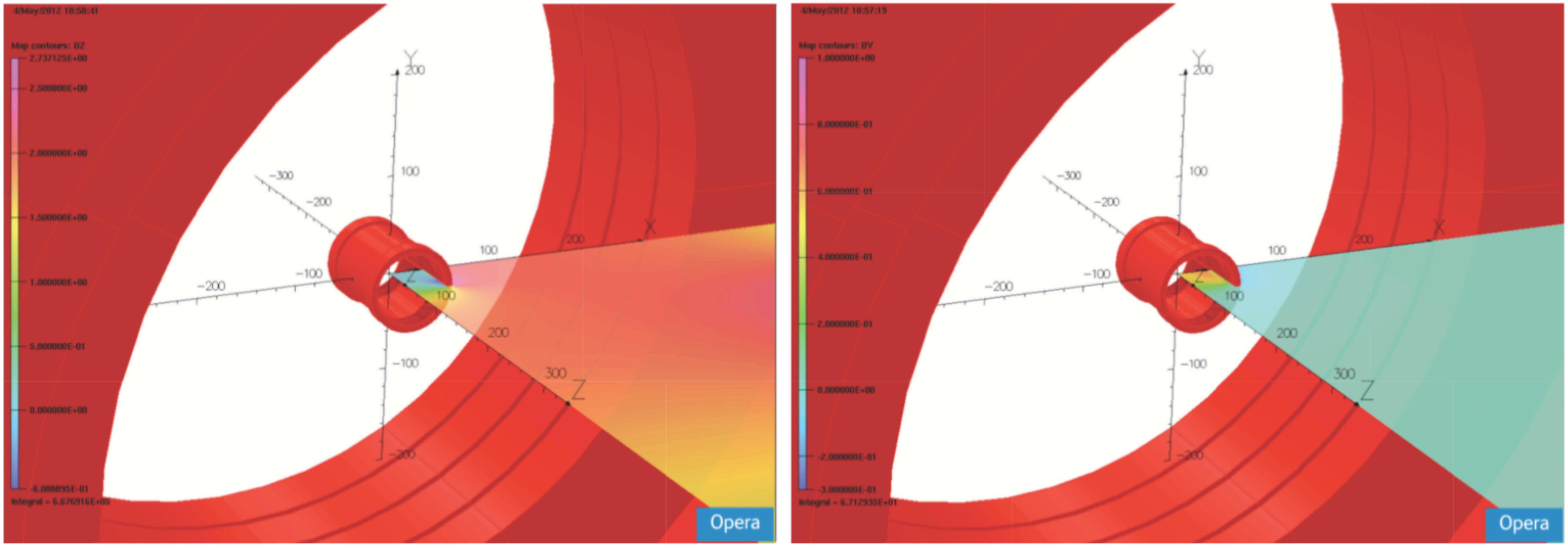
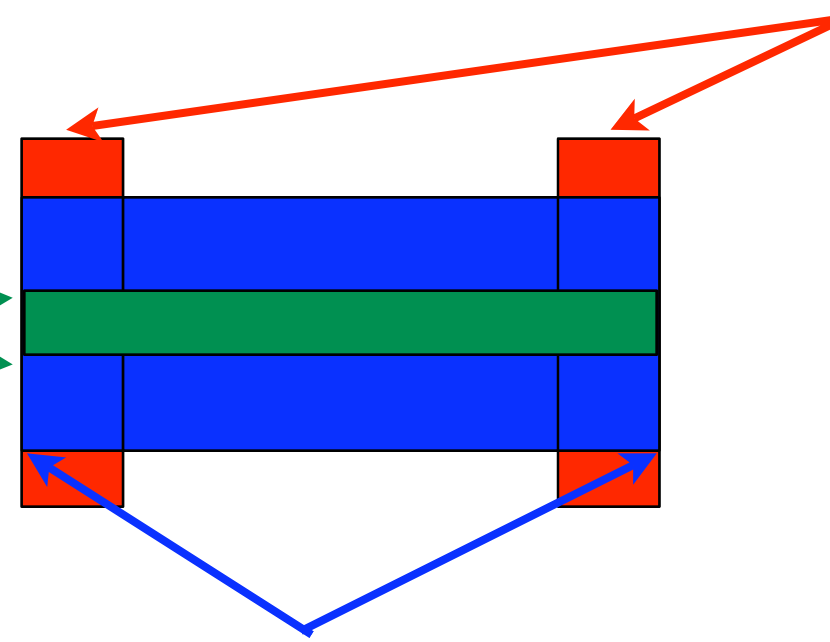


Figure 12: (Left) the 2 T longitudinal field component is almost compensated to zero internal to the HD-Ice magnetic system. (Right) The 0.5 T transverse target holding field is limited to a small volume around the HD-Ice target.

Design Parameters

Table 3: Main parameters of the magnet assembling.

parameter	Central detector solenoid (ideal)	Saddle coil	Compensat. solenoid	Compensat. Helmholtz
inner radius (mm)	471	35.8	37.4	38.4
outer radius (mm)	650	37.4	38.4	41.8
length (mm)	1225	100	100	15
current density (A/mm^2)		730	730	730



Magnet
Side View

These Magnets
are inside the HD-Ice
cryostat

Superconductor Load Lines

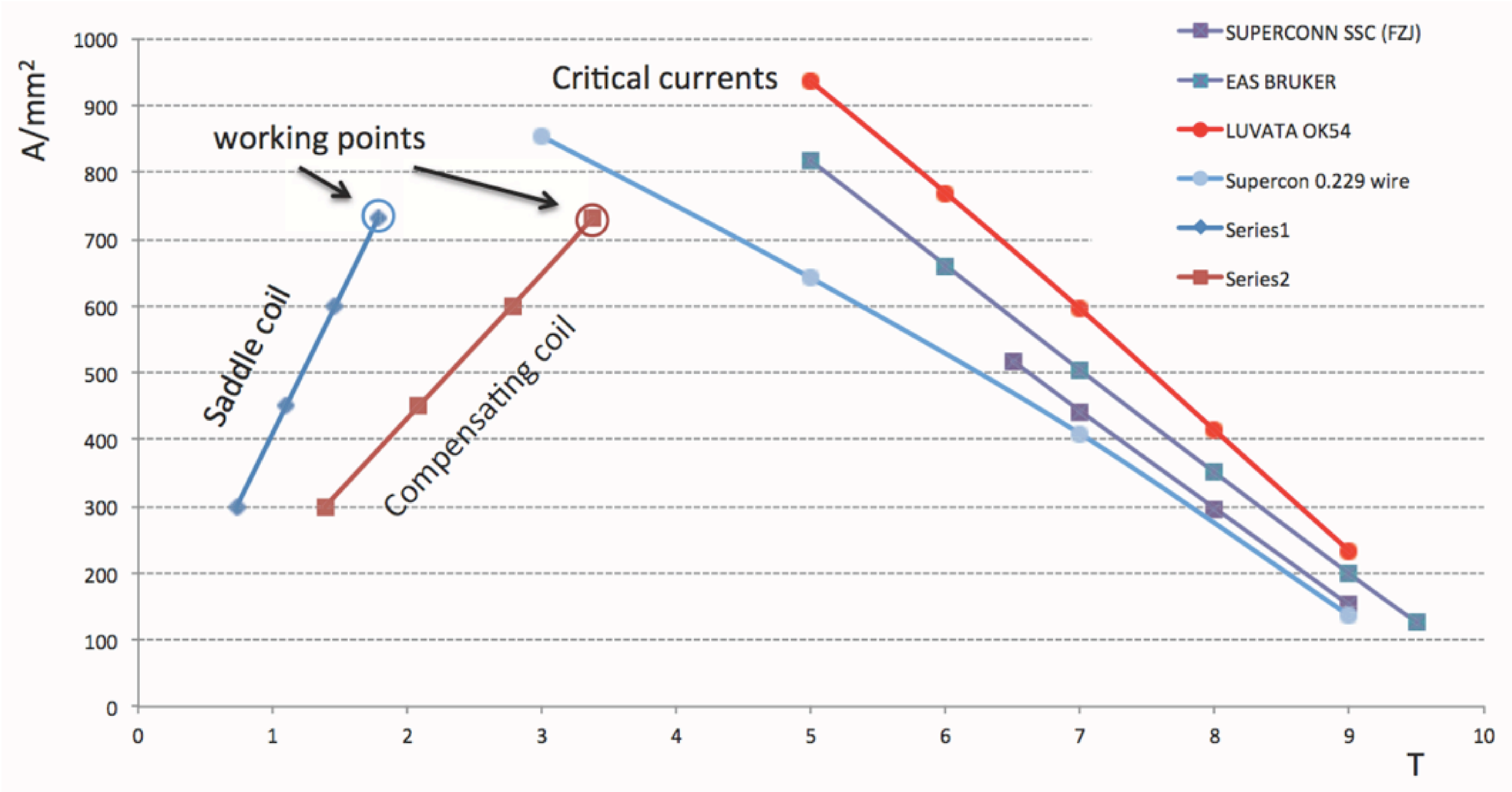


Figure 13: Load lines of the compensating (dark red) and saddle (dark blue) coils as compare to the critical current of the considered superconducting wires (see text). A realistic filling factor of 80% is considered for the superconducting coil wiring. The arrow indicates the working points.

Conclusions

- Passive magnetic shielding will be studied for the new CLAS12 configuration with a shorter target.
- A combined solenoid plus Helmholtz pair gives better uniformity of longitudinal field cancellation around the target than either one individually up to 3T.
- Most of the material is concentrated in a smaller range of angles between forward and central detector systems.