A polarized solid state target for photon induced double polarization experiments at ELSA

Status of the project ‚Polarisierte Festkörpertargets' D.1 Bonn

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TR16 request 11/2003

D.1.3.5 Work Program (Goals, Methods, Timetable)

- ‚GDH – Frozen Spin Target' at Crystal Barrel
- ‚4π – continuous mode' polarized solid state target
- development of an internal superconducting solenoid

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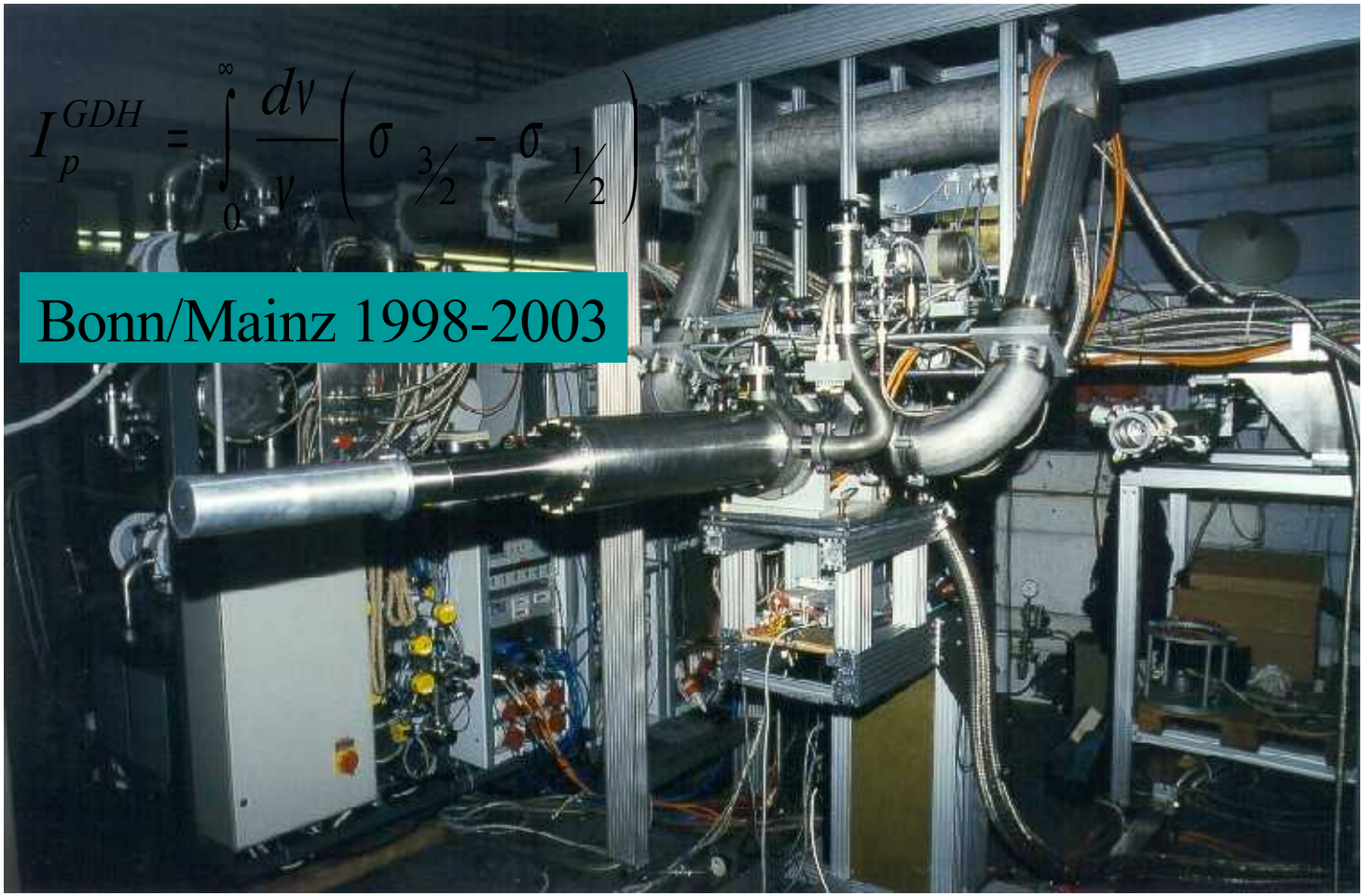
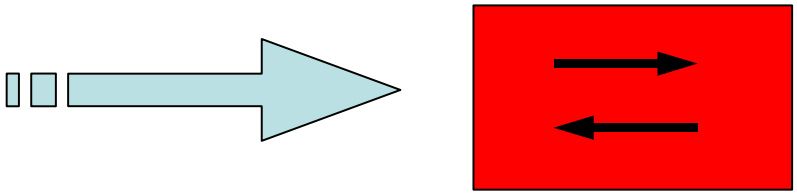
Horizontal frozen spin target ‚GDH – Frozen Spin Target‘

Specially designed for the GDH experiment @ MAMI and ELSA



Horizontal frozen spin target ‚GDH – Frozen Spin Target‘

Longitudinal polarized nucleons



Circular / linear polarized tagged photons (10^7 γ/s)

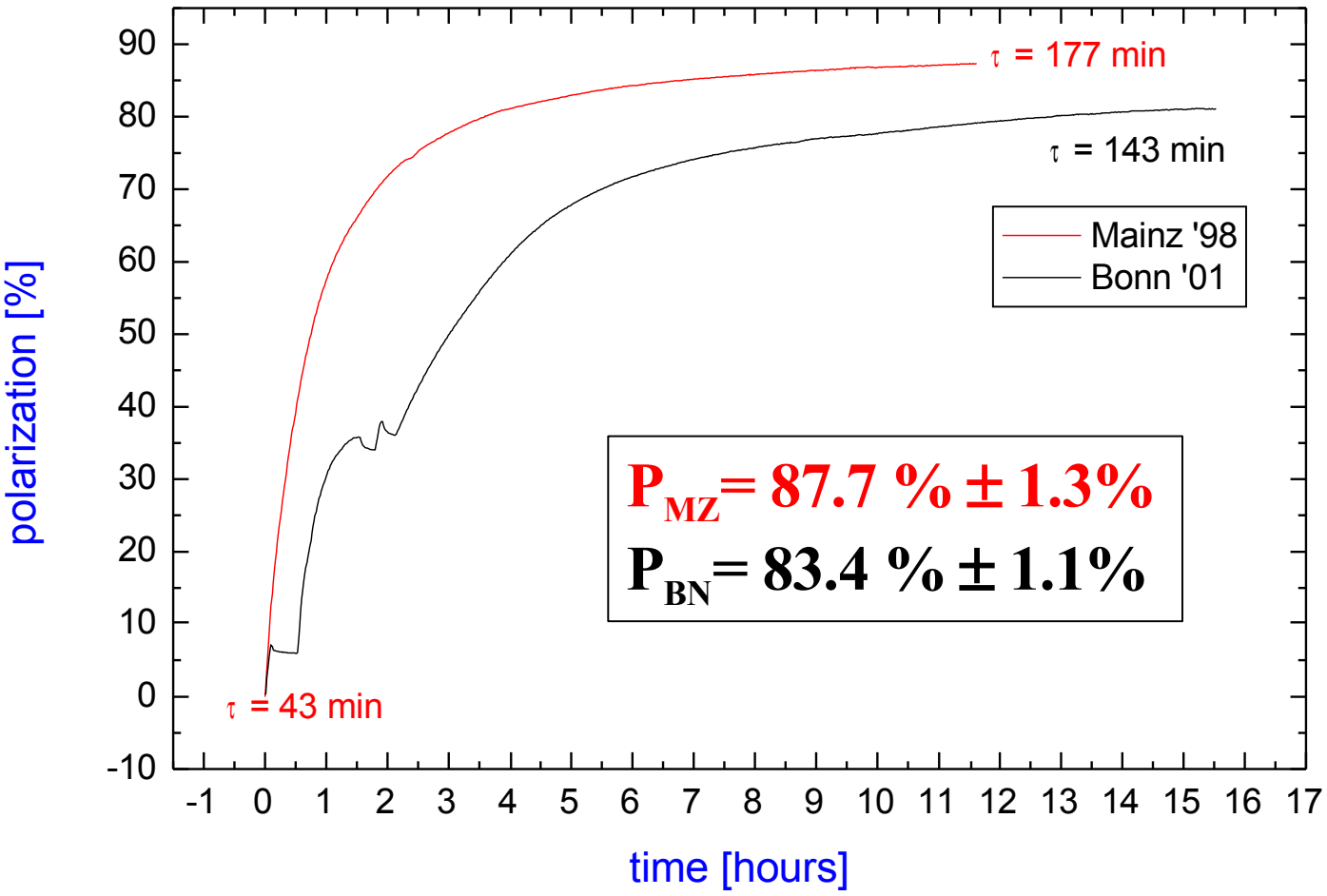
$$E, G \sim \frac{1}{P_z P_b f_t} \cdot \frac{N_{\uparrow\uparrow} - N_{\uparrow\downarrow}}{N_{\uparrow\uparrow} + N_{\uparrow\downarrow}}$$

CB-ELSA 2006 …

5 proposals using polarized protons (ELSA-1,2,4,6,7)
1 proposal using polarized deuterons (ELSA-3)

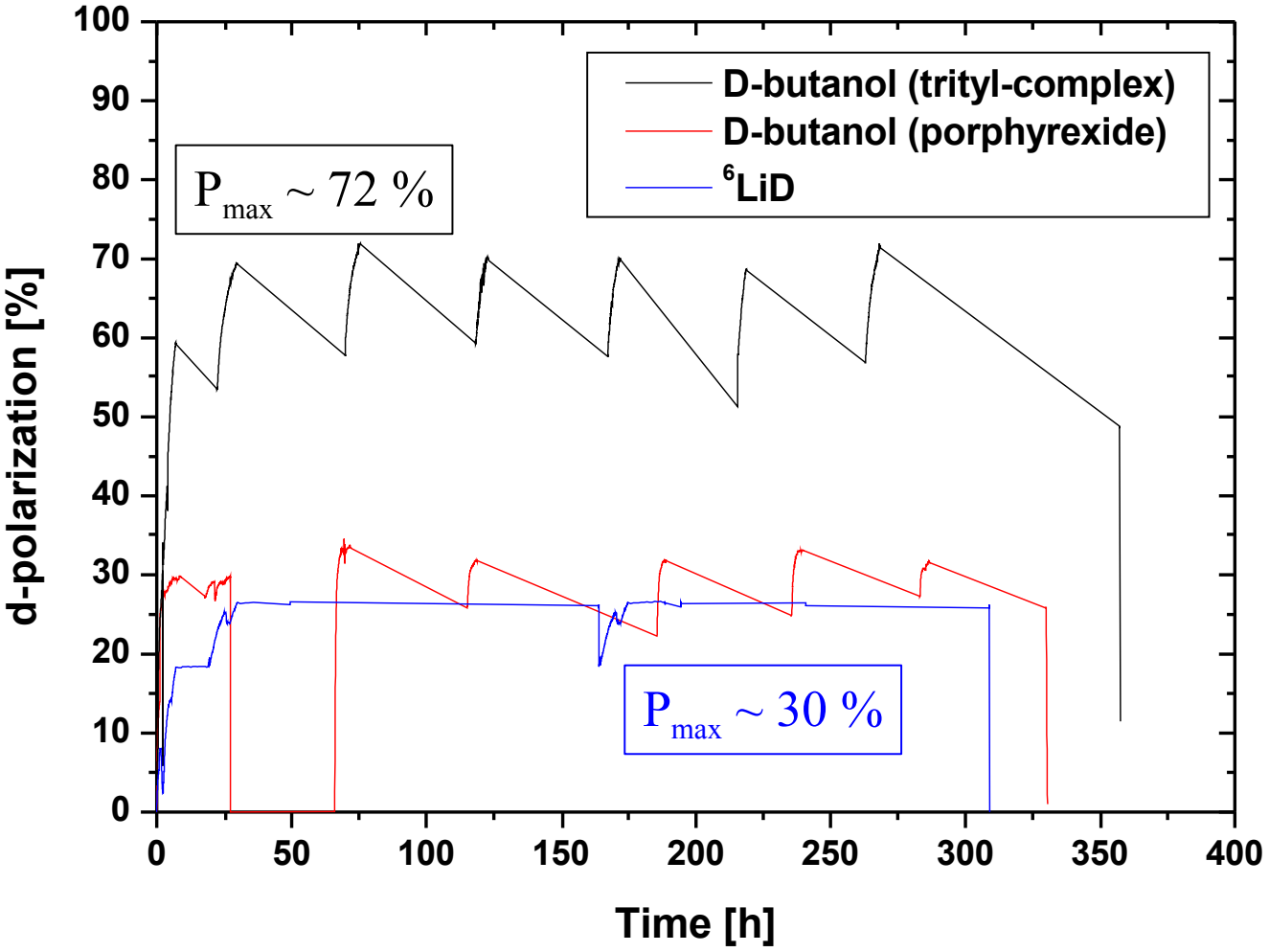
Horizontal frozen spin target ‚GDH – Frozen Spin Target'

Max. proton polarization @ 2.5 Tesla (butanol)



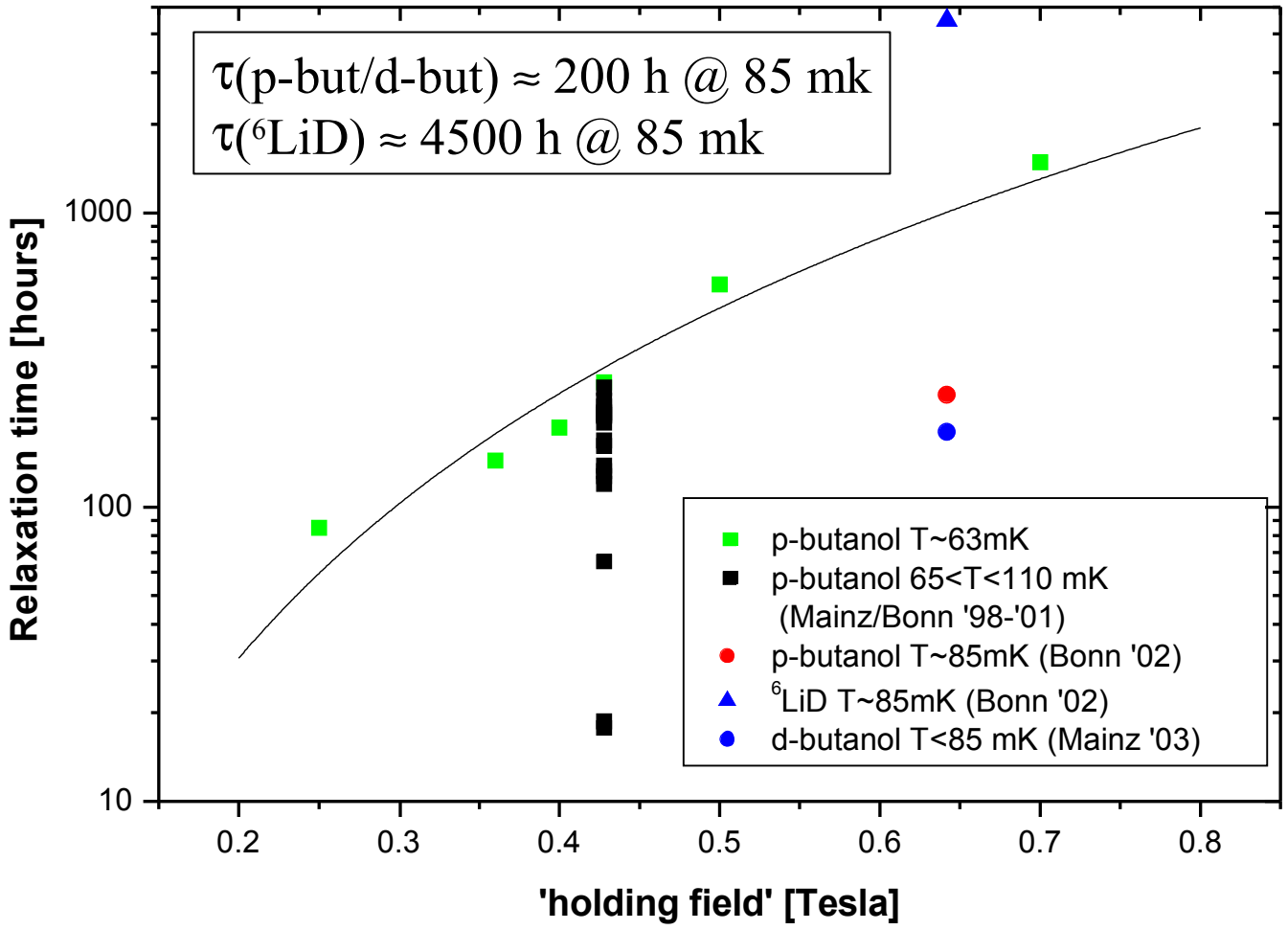
Horizontal frozen spin target ‚GDH – Frozen Spin Target'

Max. deuteron polarization @ 2.5 Tesla (butanol/^{6}LiD)



Horizontal frozen spin target ‚GDH – Frozen Spin Target'

Relaxation – times of various target materials



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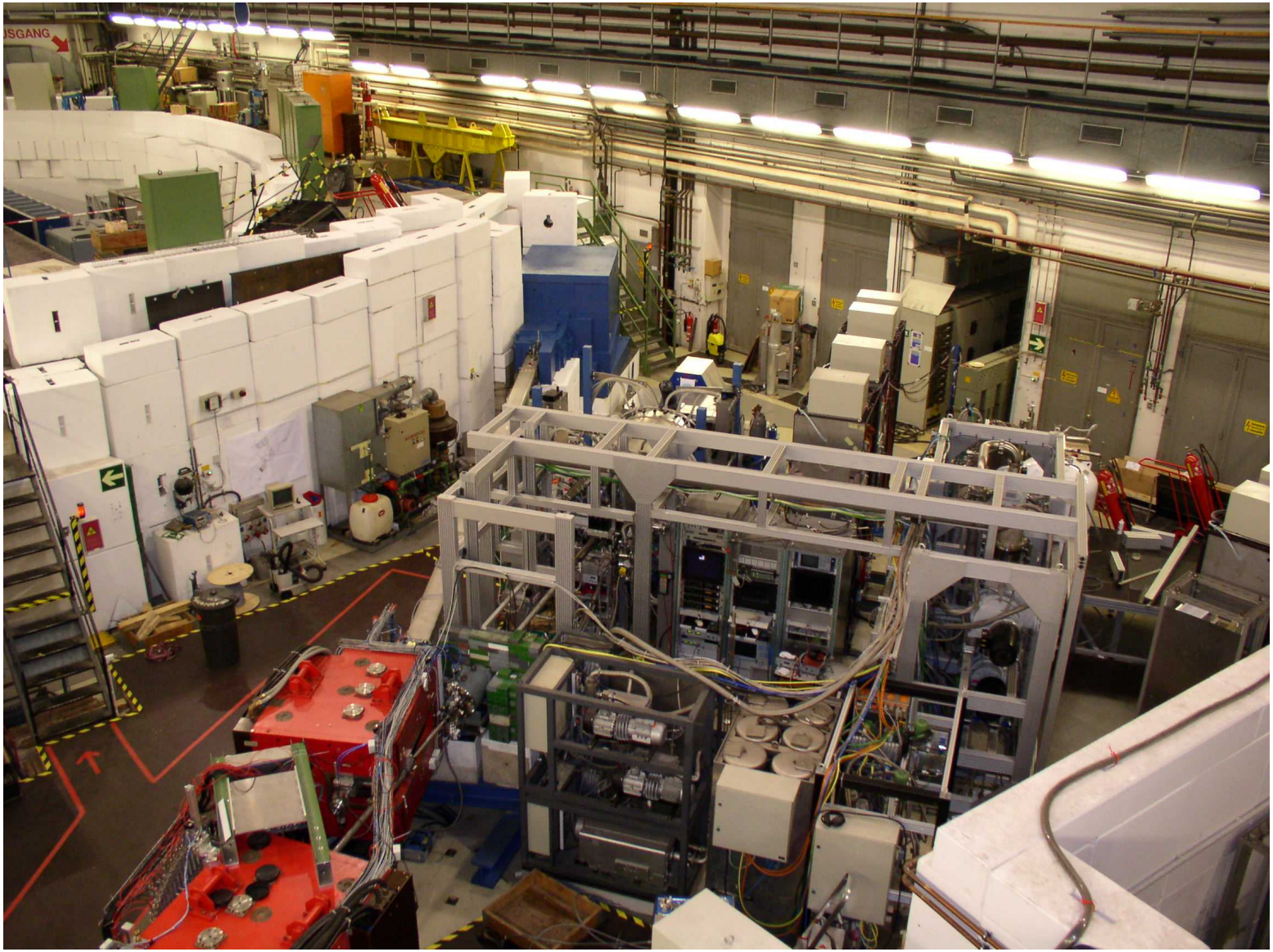
‚CB – Frozen Spin Target'
Set-up @ ELSA



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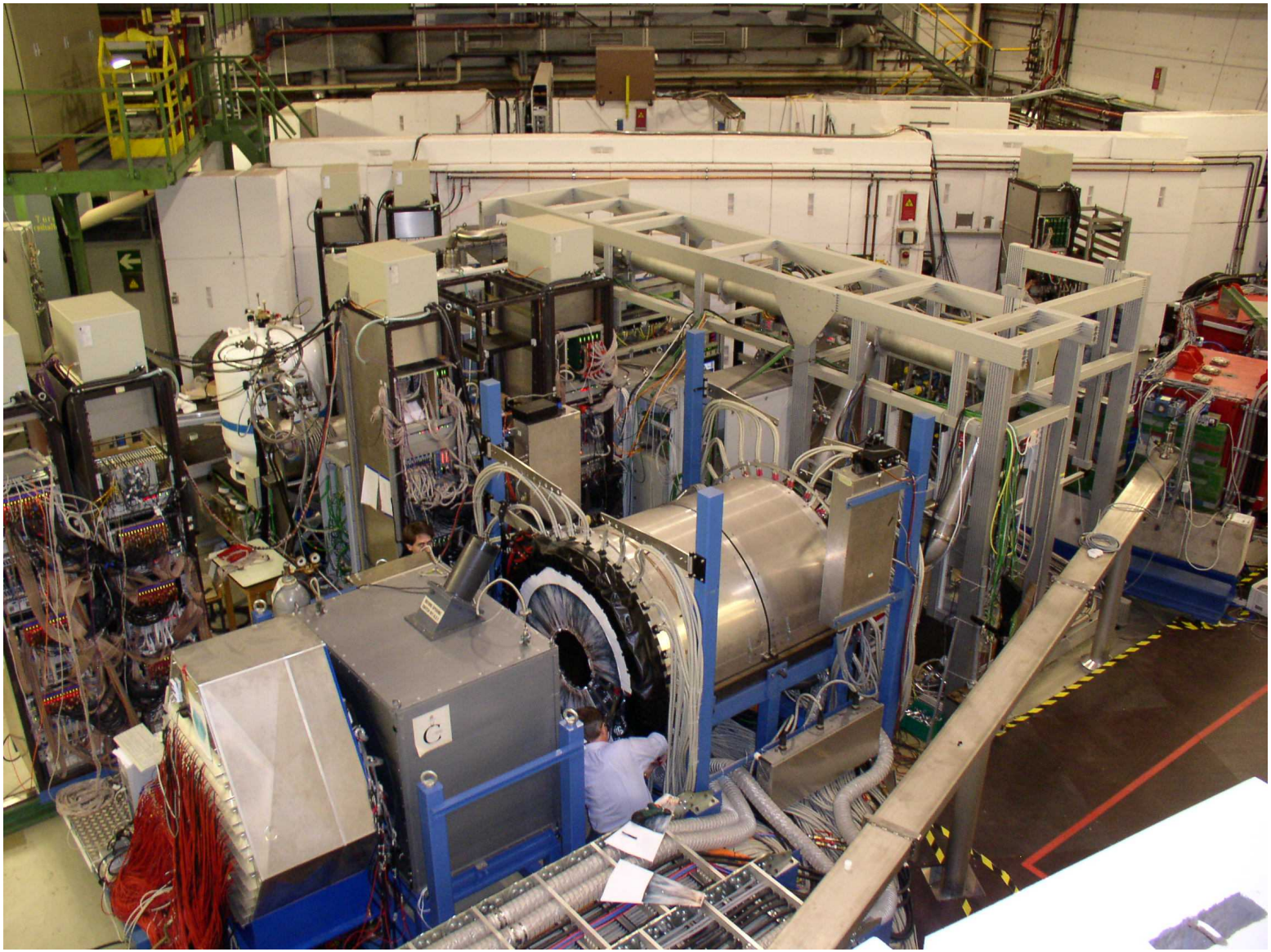
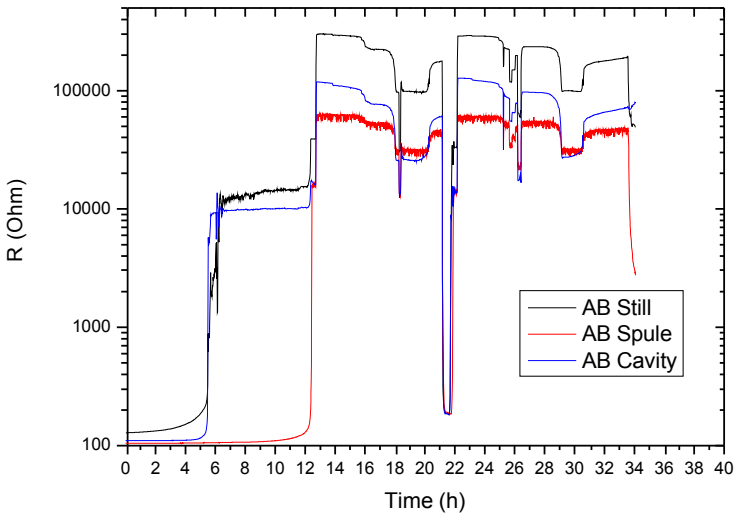


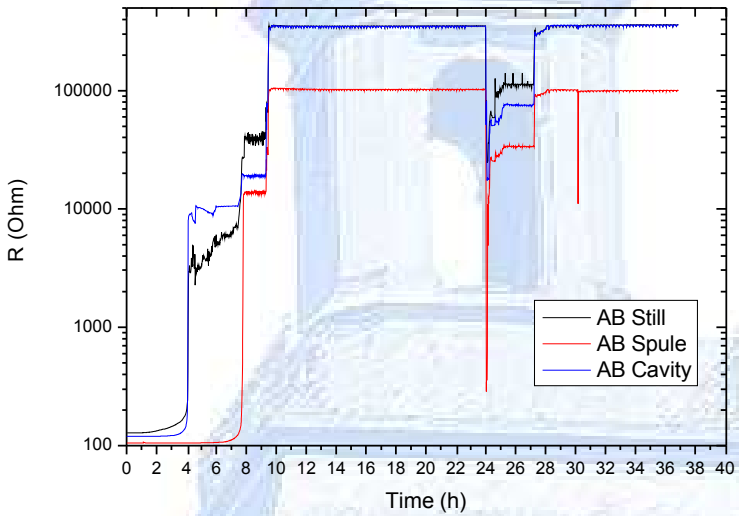
‚CB – Frozen Spin Target'
Status Set-up @ ELSA

Set-up completed → first cool down to 1 K in Oktober

26/27-10-06



22/23-04-02



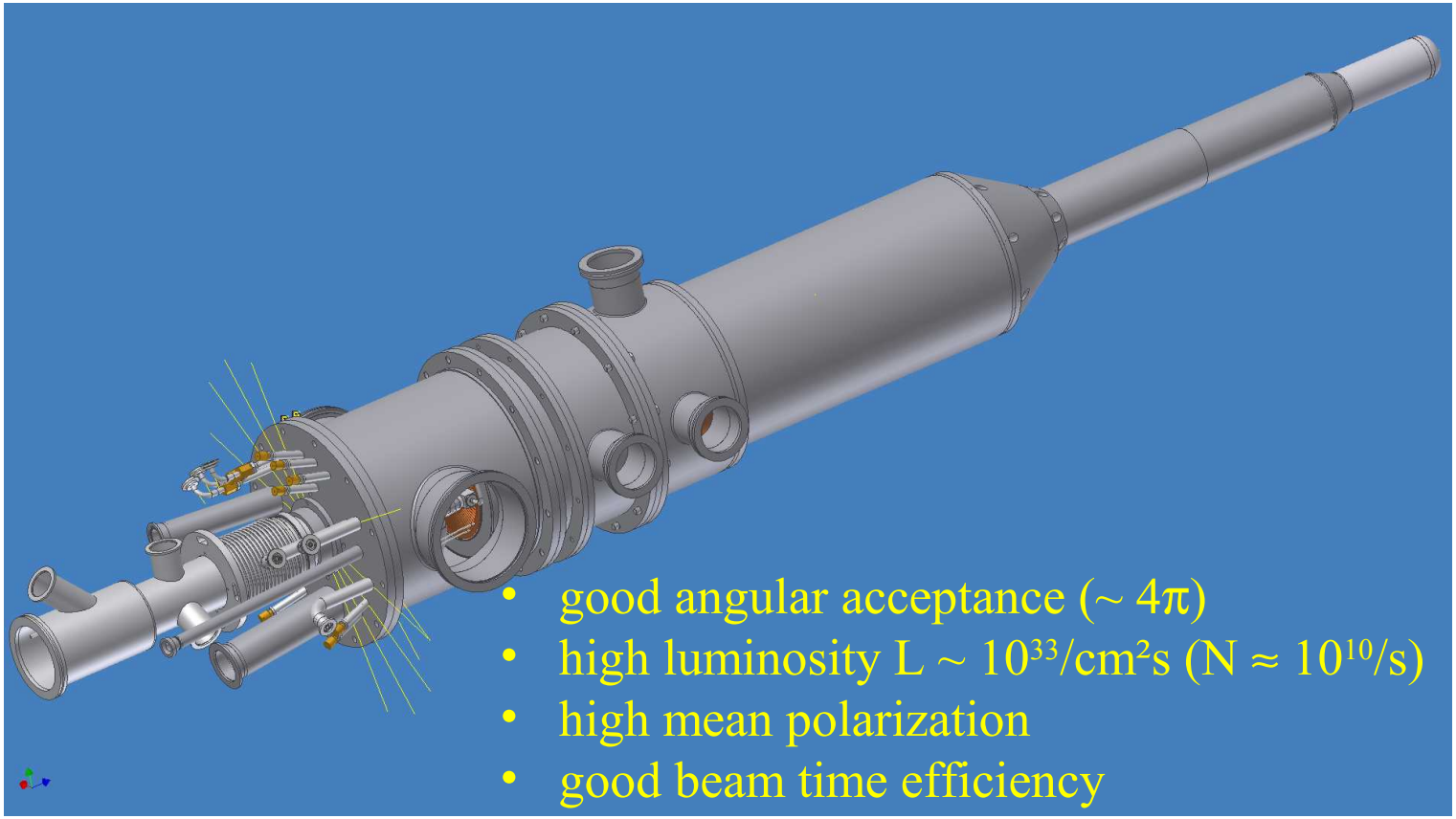
Thermal contact between internal .rad. shield and Still has been fixed

Next steps:

- cool down to 1K and into dilution mode
- activating NMR and microwaves
- polarizing Butanol and measure relaxation times

‚4π continuous mode target'

Horizontal dilution refrigerator incl. internal polarizing magnet for CB
Refrigerator in refrigerator system (^{4}He eva. - ^{3}He/^{4}He dil.)
high cooling power @ 300 mK
opt. run as ‚frozen spin target' Tmin ~ 50 mK



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‚4π continuous mode target'

Outer vacuum jacket

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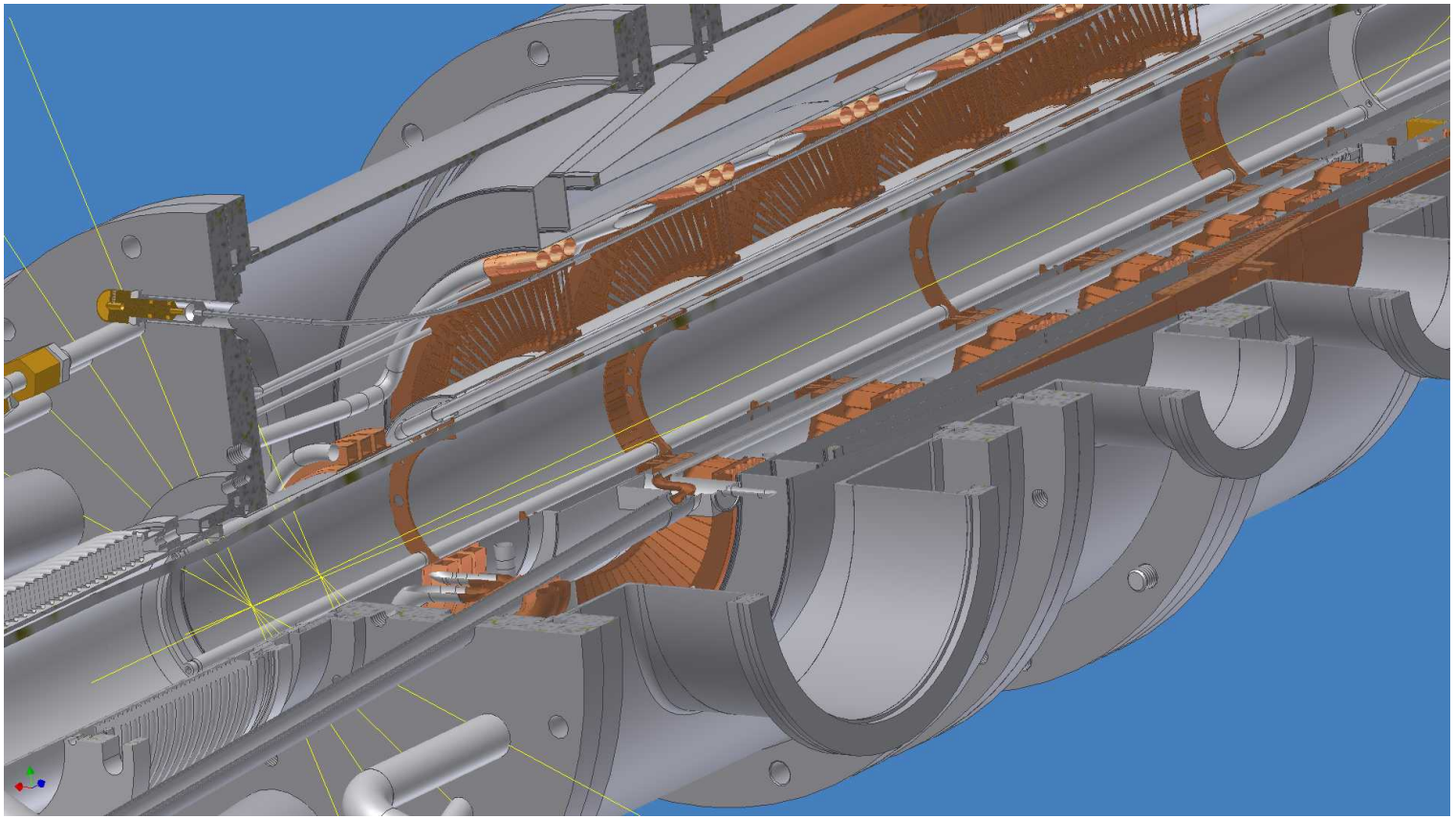
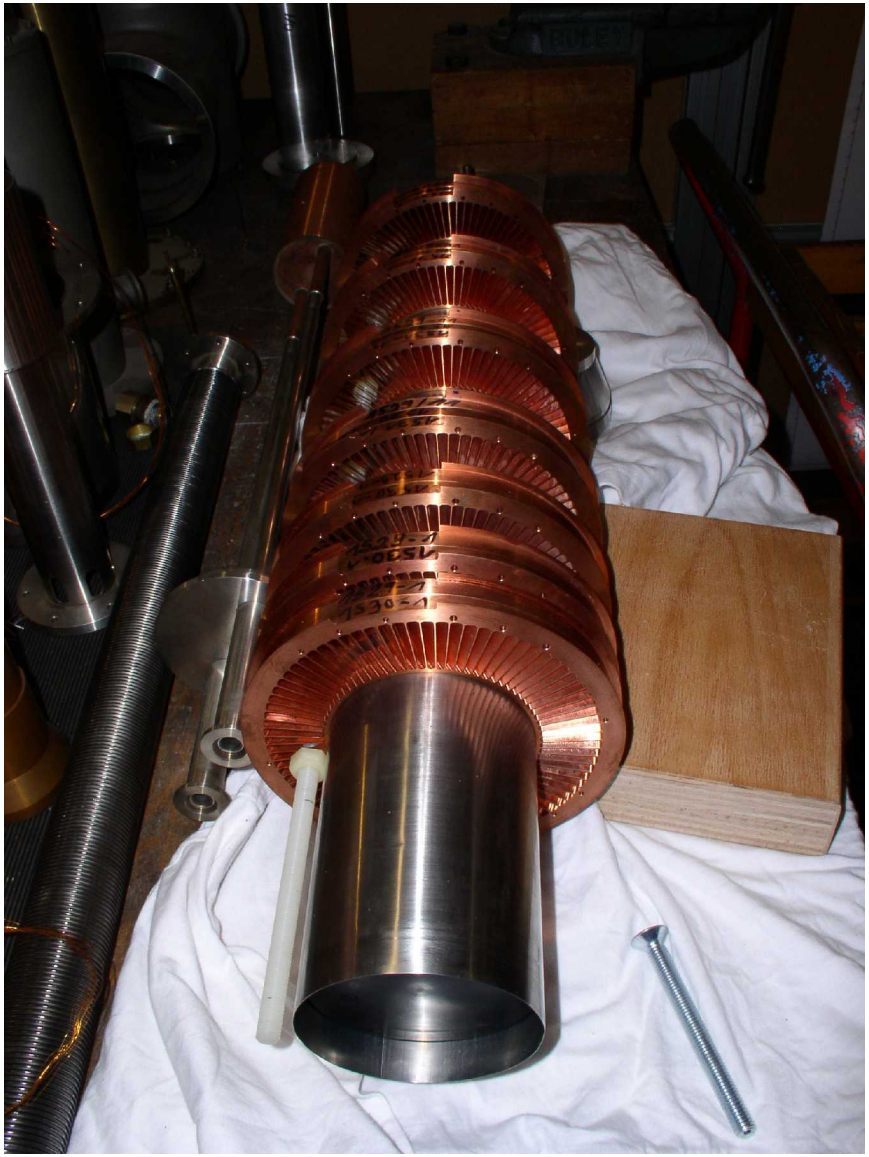
‚4π continuous mode target‘

Turbine like precooling stages



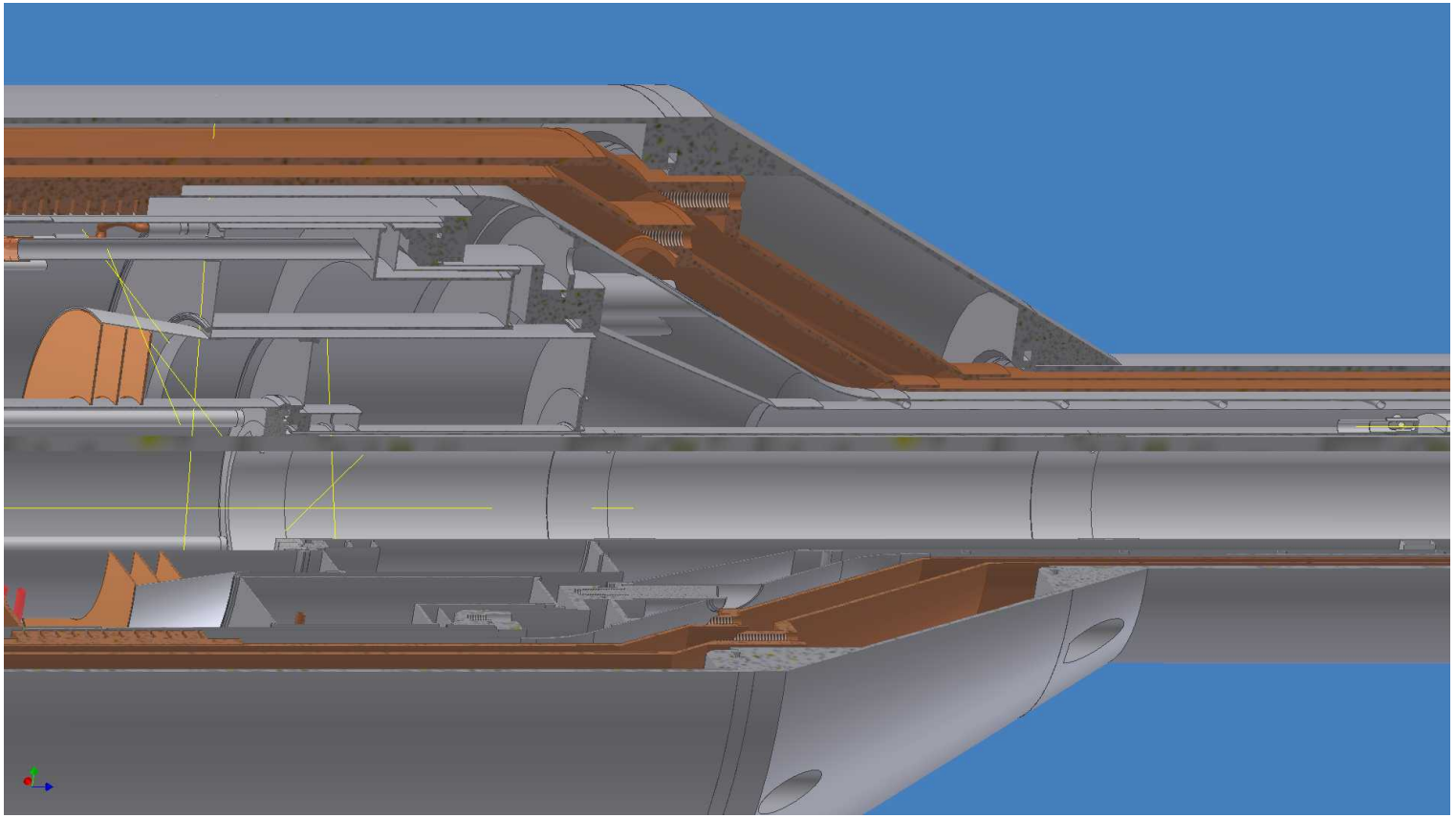
‚4π continuous mode target‘

Turbine like heat exchangers for the pre cooling stage



‚4π continuous mode target‘

Smooth transitions for HTSC – current leads
evaporator – still shielding
Self cooled Insert – sealing



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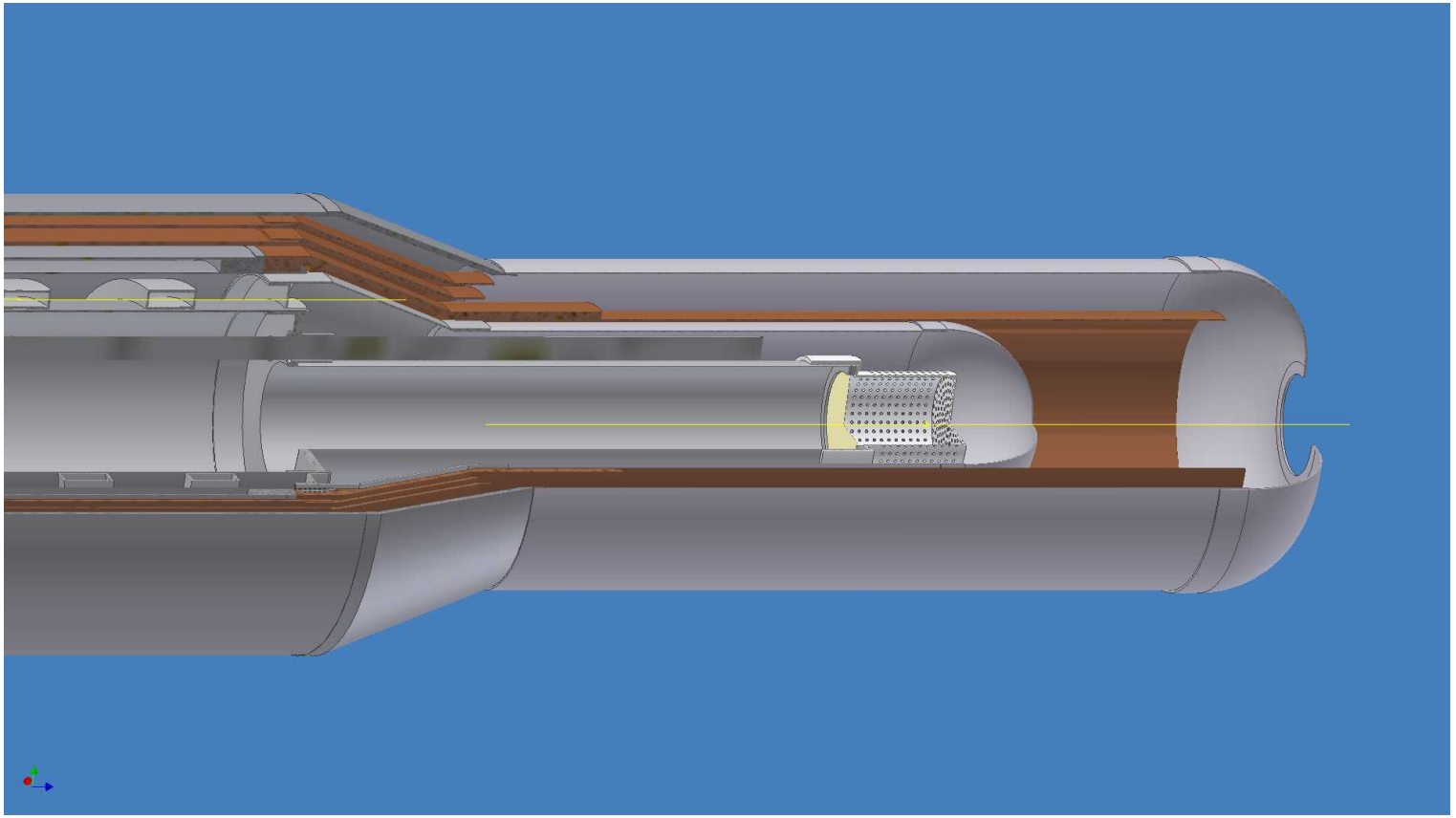
‚4π continuous mode target‘

Still cone for smooth HTSC bending

‚4π continuous mode target‘

Internal superconducting polarizing magnet
disc. final sintered heat exchanger



‚internal superconducting polarizing magnet'

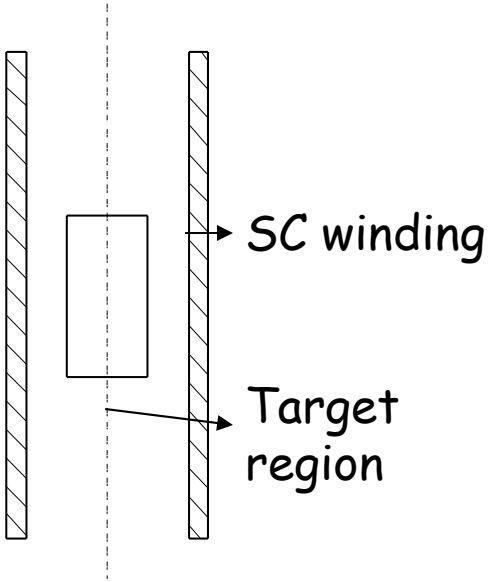
Requirements:

High field (~2.5 T)
+
High homogeneity ($\Delta B/B \sim 10^{-4}$) in the target region

Constraints on:

- Magnet thickness (particle absorption)
- Number of Bias Leads (heat load)
- Mechanical feasibility

Hom. volume ~ mag. volume



Any FEM – model on the market:

Requires a try and error (manual) approach and has a poor flexibility
old Feld.c – code failed

‚internal superconducting polarizing magnet'

A. Raccanelli, F. Zarife,

in collaboration with R. Krause, IAM-Bonn

A new code performing integration on the actual coils

Allows one to study the effect on the field homogeneity of:

- Limited accuracy in the winding
- Irregularities
  (random variations in the coil number in a layer)
- SC wire diameter

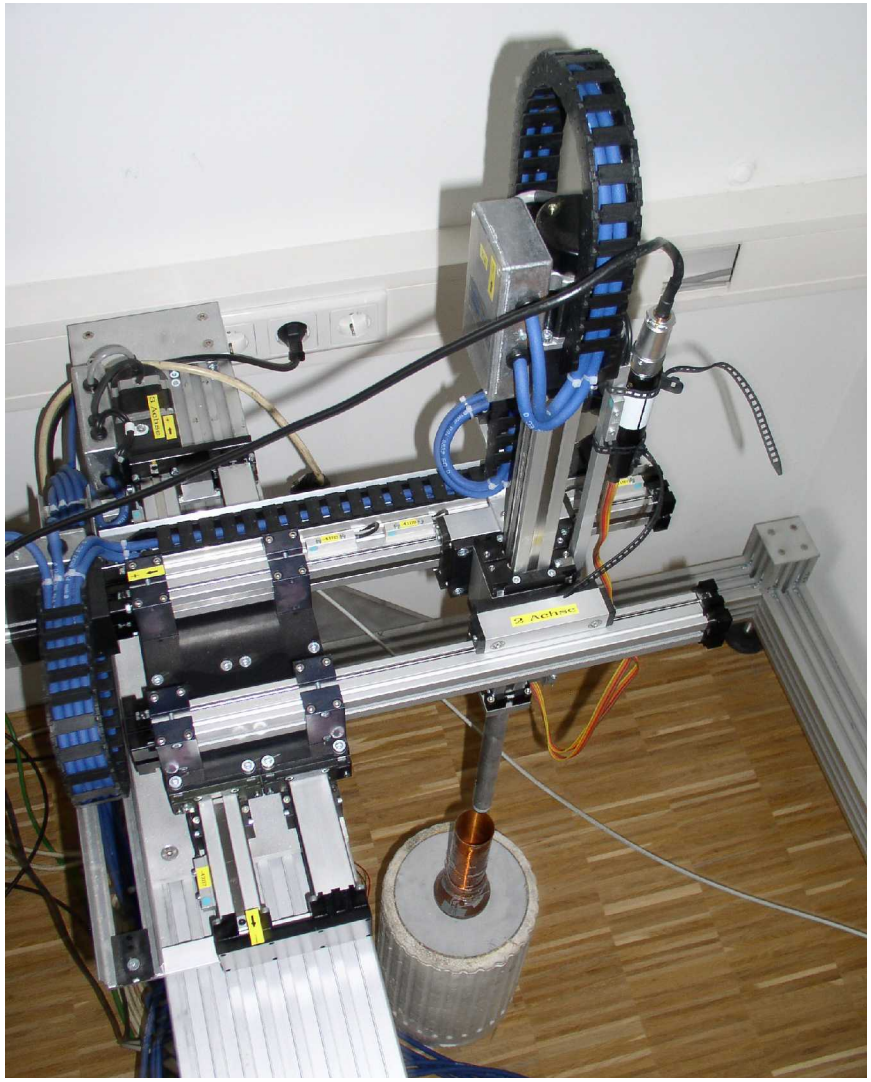
Allows the implementation of optimization algorithms

Calculations need to be tested / proofed

‚internal superconducting polarizing magnet‘ Status

High field holding coil:
1.8 T @ 4.2 K

Field mapping system, flux gate magnetometer



‚internal superconducting polarizing magnet'

Next Steps:

Horizontal polarizing coils: simulate, wind and test NC coils
transverse holding coil : saddle coils, racetrack type, field ~ 0.5 T
only in 'frozen spin mode'

JLAB transverse coil (failed 2006):

Holding Magnet, Transverse (Prototype)

Wire: Ø.1 mm multifilament NbTi, three layers
Dimensions: Ø 40 × 355 mm
Max. Field: 0.27 Tesla
Homogeneity: $\Delta B/B \sim 5\ 10^{-3}$

Conclusions / Outlook

‚CB – frozen spin target' has been proofed as a reliable tool to study double polarization experiments @ ELSA
ready for operation and data taking

4π – continuous mode' target:

'high luminosity, large acceptance' polarized solid state target
internal polarizing magnet
no railway system required
longitudinal polarization direction
transverse polarization as a frozen spin target
electron scattering experiments in a 4π detection system
mechanically completed 2008/2009

Transverse field magnet project needs further serious investigation and dipl. – PhD - students

Horizontal frozen spin target ‚CB – Frozen Spin Target'

ELSA/1-2005

Proposal to the PAC

Measurement of the G asymmetry in single π^0 and η meson production

ELSA/2-2005

Proposal to the PAC

Measurement of the helicity dependence of η and π^0 photoproduction

ELSA/4-2005

Proposal to the PAC

Search for Missing Resonances in Double–Polarised ω Photoproduction

ELSA/6-2005

Proposal to the PAC

Measurement of Double Polarisation Observables in $2\pi^0$-Photoproduction with the Crystal Barrel Detector at ELSA

ELSA/7-2005

Proposal to the PAC

Measurement of the Helicity Difference in $\pi^0\,\eta$-Photoproduction with the Crystal Barrel Detector at ELSA

ELSA/3-2005

Proposal for an experiment to the PAC

Photoproduction of η-mesons off the neutron
Part II: photon beam asymmetry and double polarization observable G

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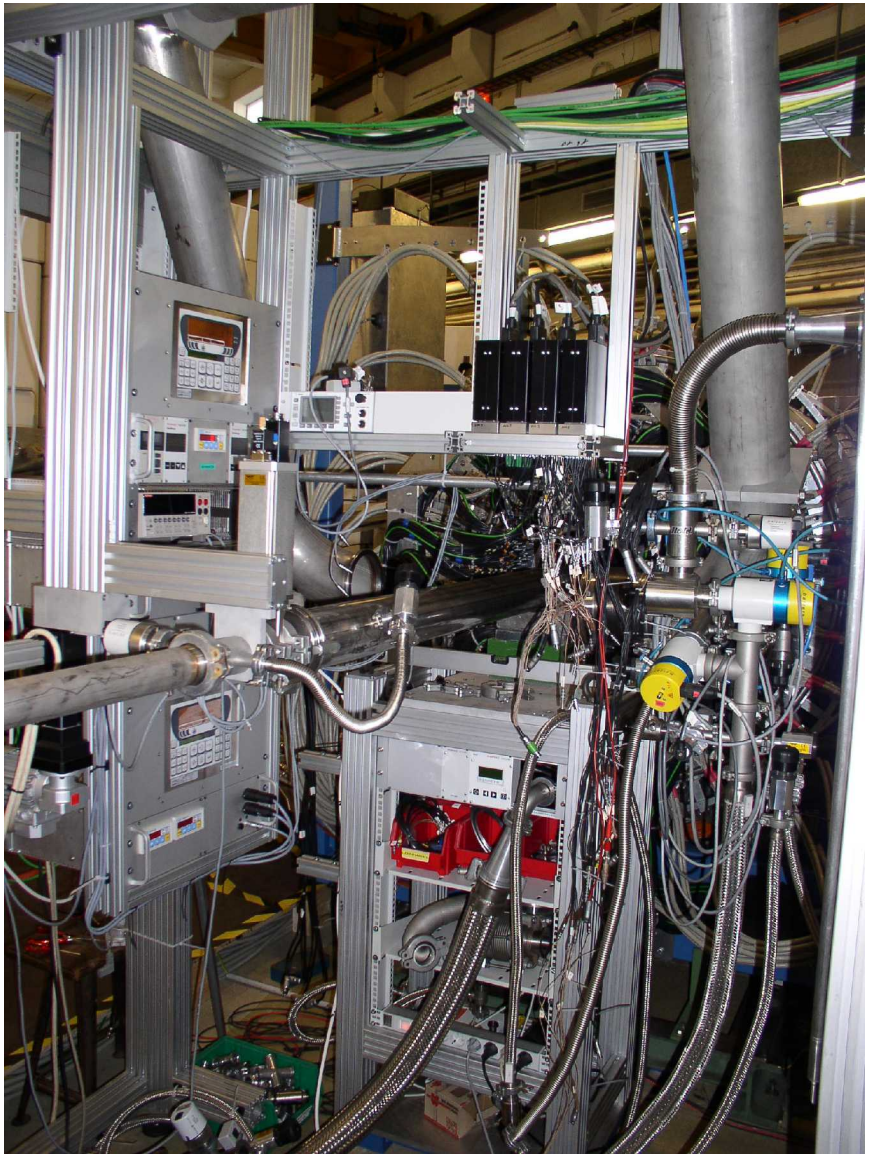

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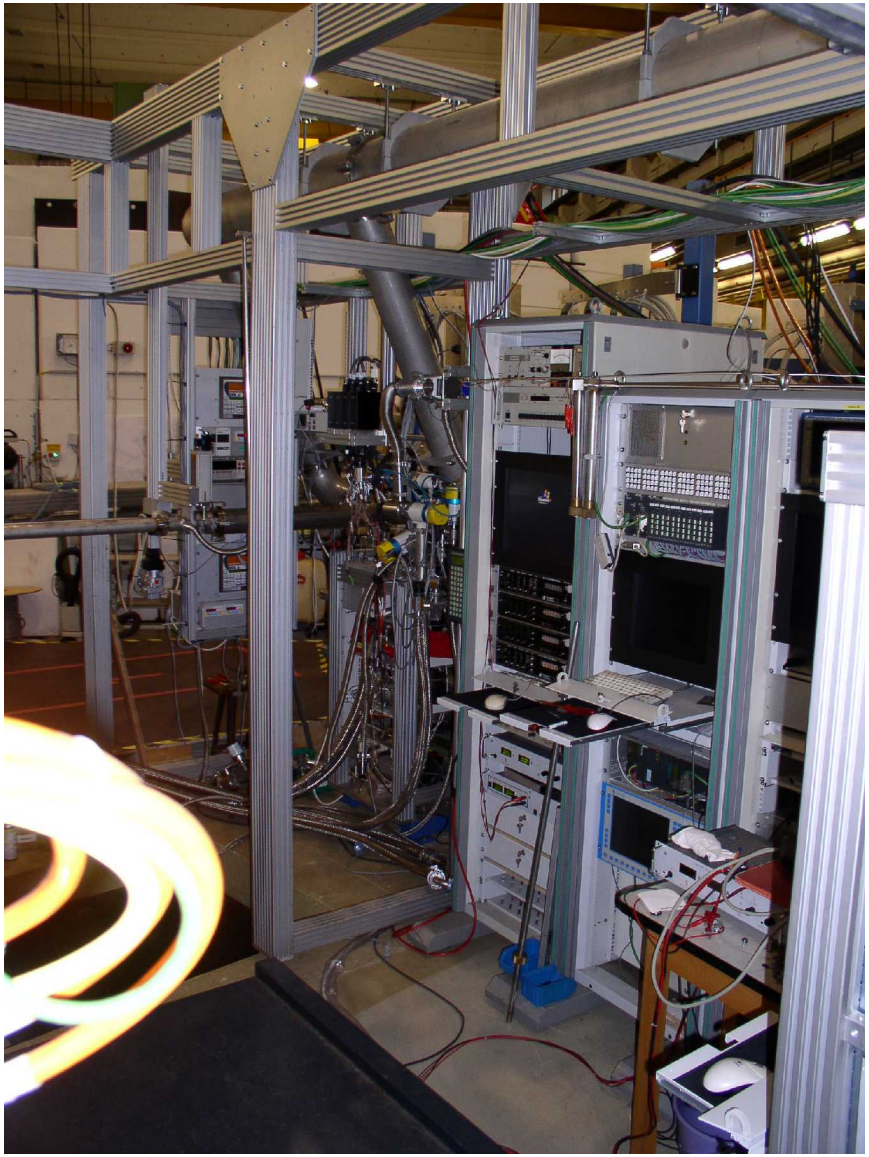

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‚CB – Frozen Spin Target'
Set-up @ ELSA

‚4π continuous mode target'
Status

Design of the horizontal dilution refrigerator nearly completed
Outer vacuum jacket is finished and vacuum tested
Thin wall stainless steel tubing delivered or machined
Turbine heat exchangers machined
Inner cone machined and soldered

Next Steps:

Design of the final heat exchanger has to be completed
Pre cooling stages (separator, evaporator)
Dilution unit incl. design of the mixing chamber
Assembling of the complete refrigerator
Internal superconducting polarizing magnet
Aim: mechanically completed 2008/2009