Polarized ^{3}He targets at MAMI-C

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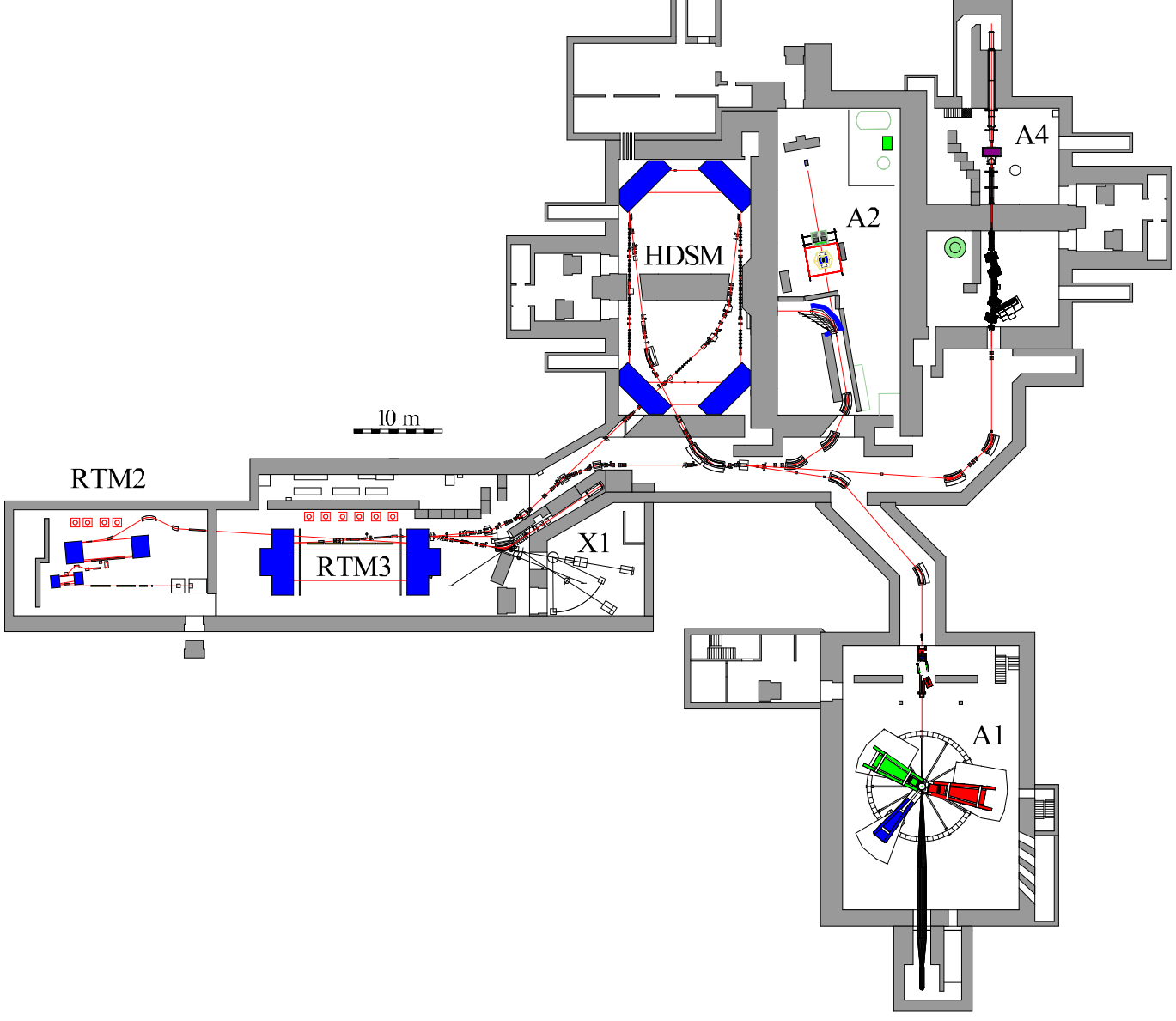
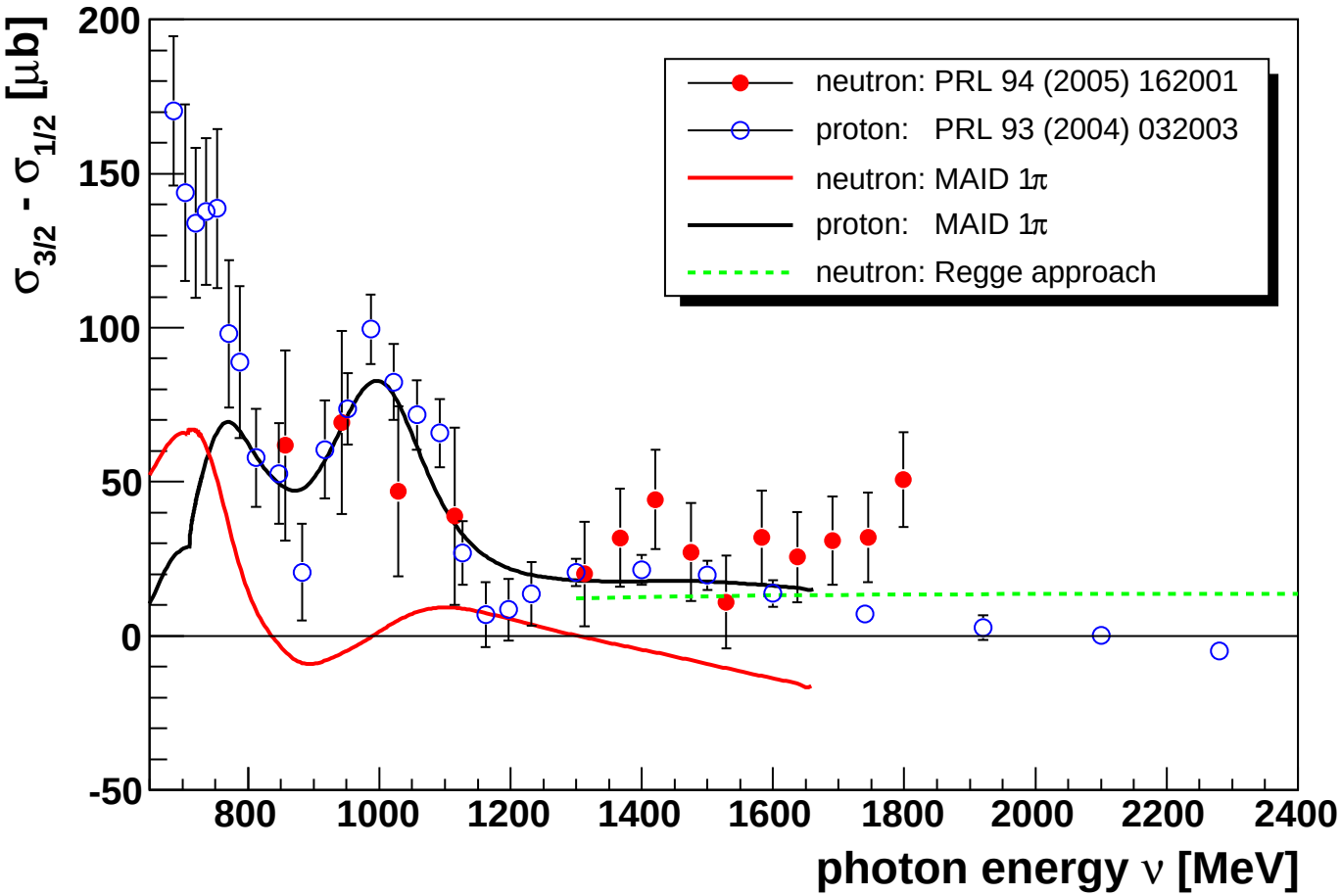
Outline



- MAMI-C: Maximum electron energy: 1.5 GeV
- Start of operation beginning 2006

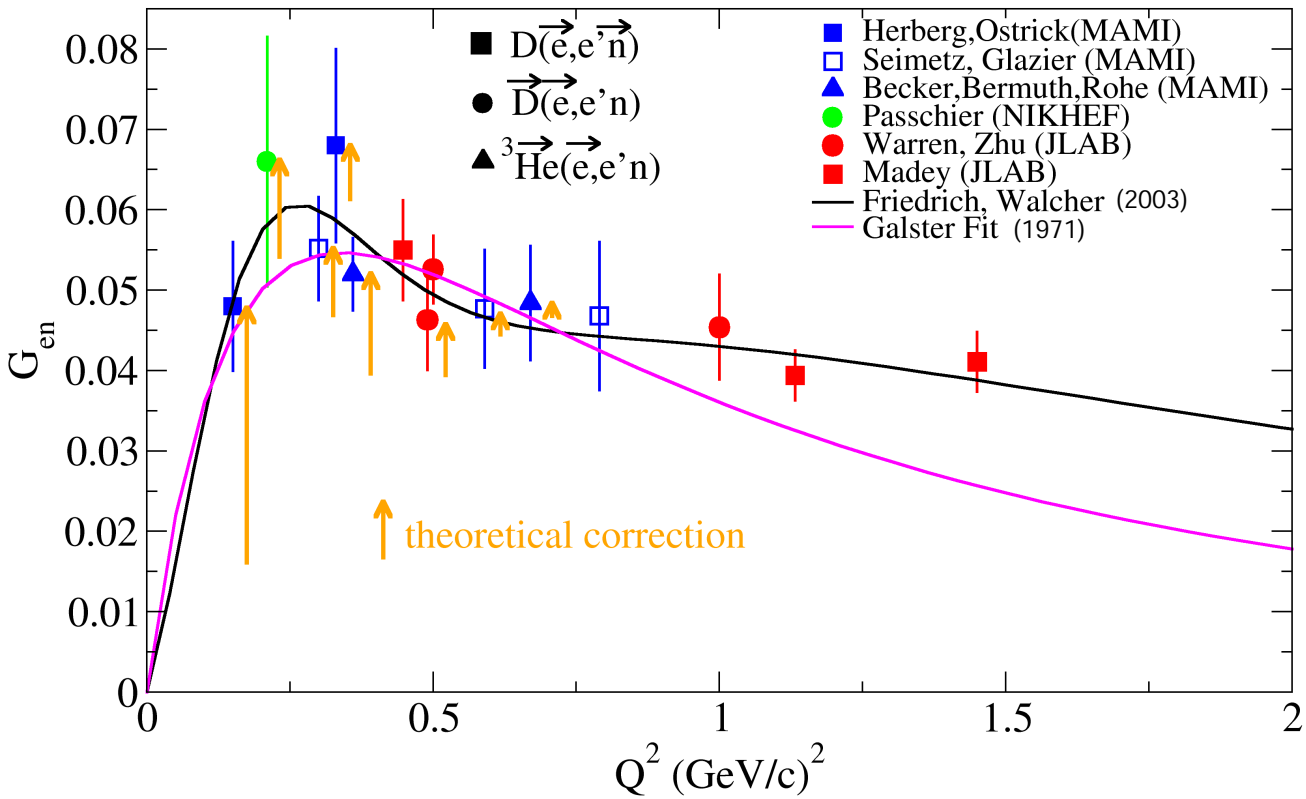
Real Photons



- Neutron: Significant contribution in the 3rd resonance region
  - Modification of the helicity amplitudes ?
  - Double pion contribution ?
  - $\Rightarrow$ Crystal Ball detector at MAMI-C

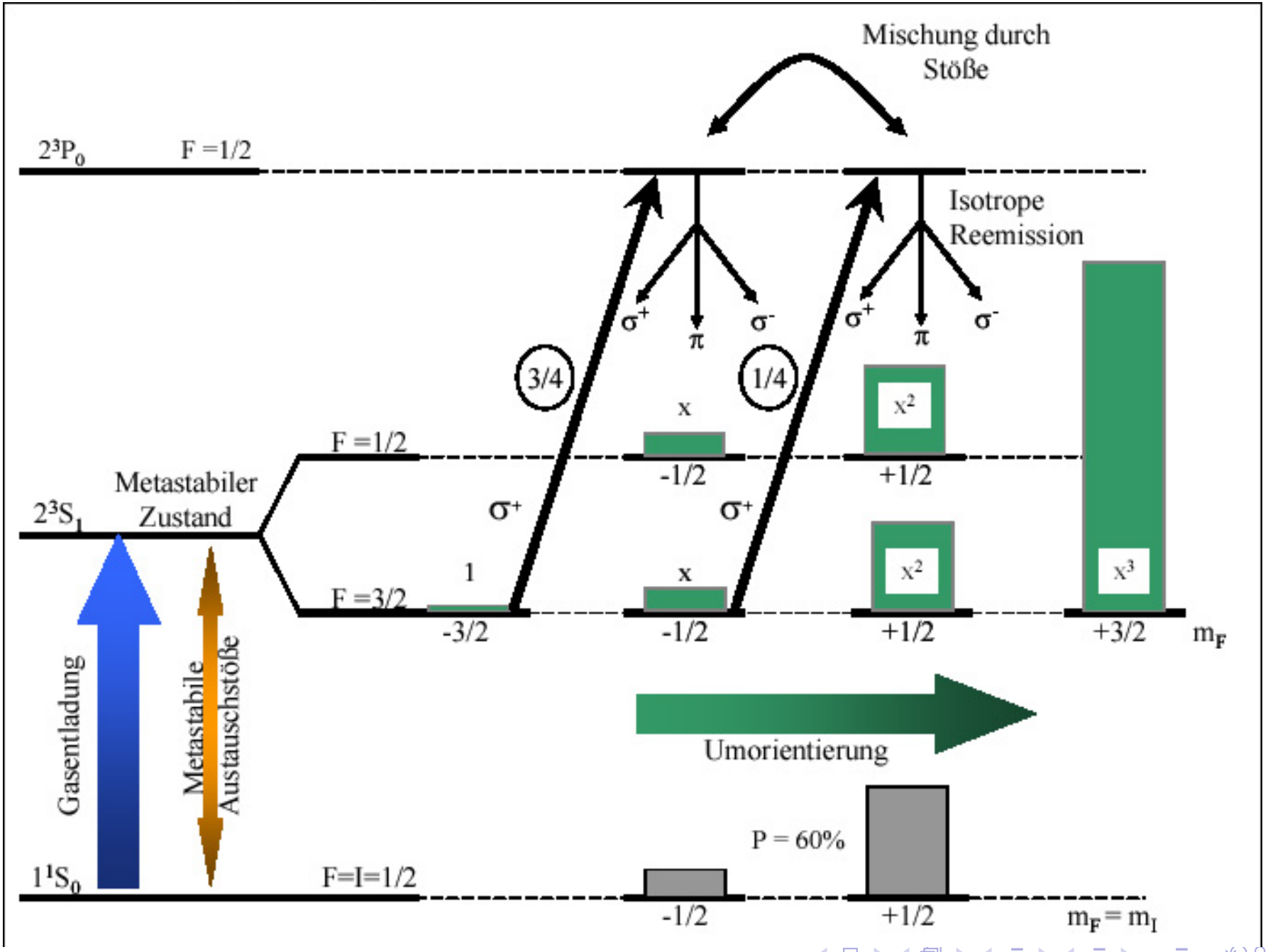
Virtual photons

G_{en} from polarization experiments

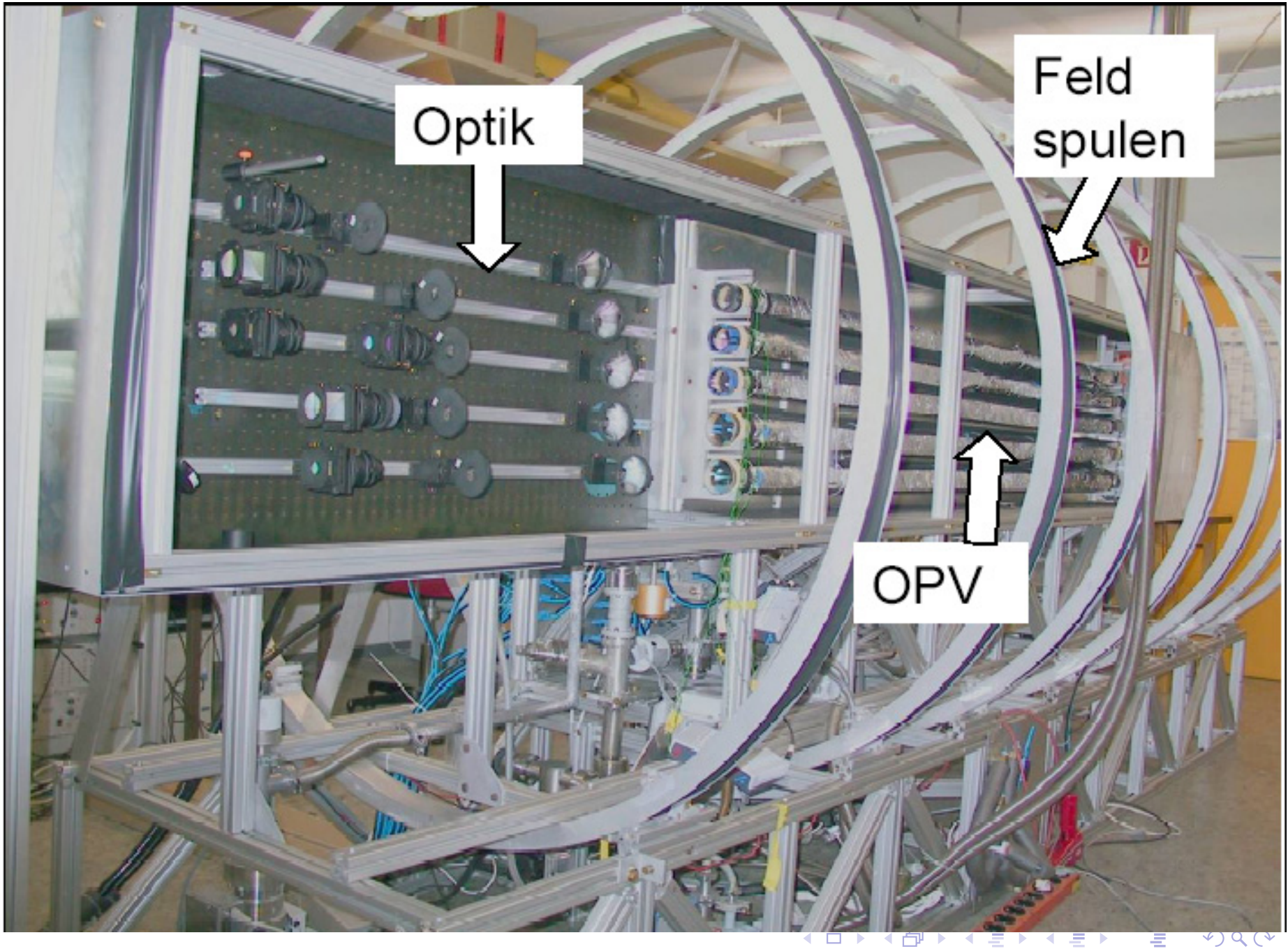


- Approved proposal to measure G_{en} with polarized ^{3}He at $Q^2 = 1.5$ (GeV/c)^2.

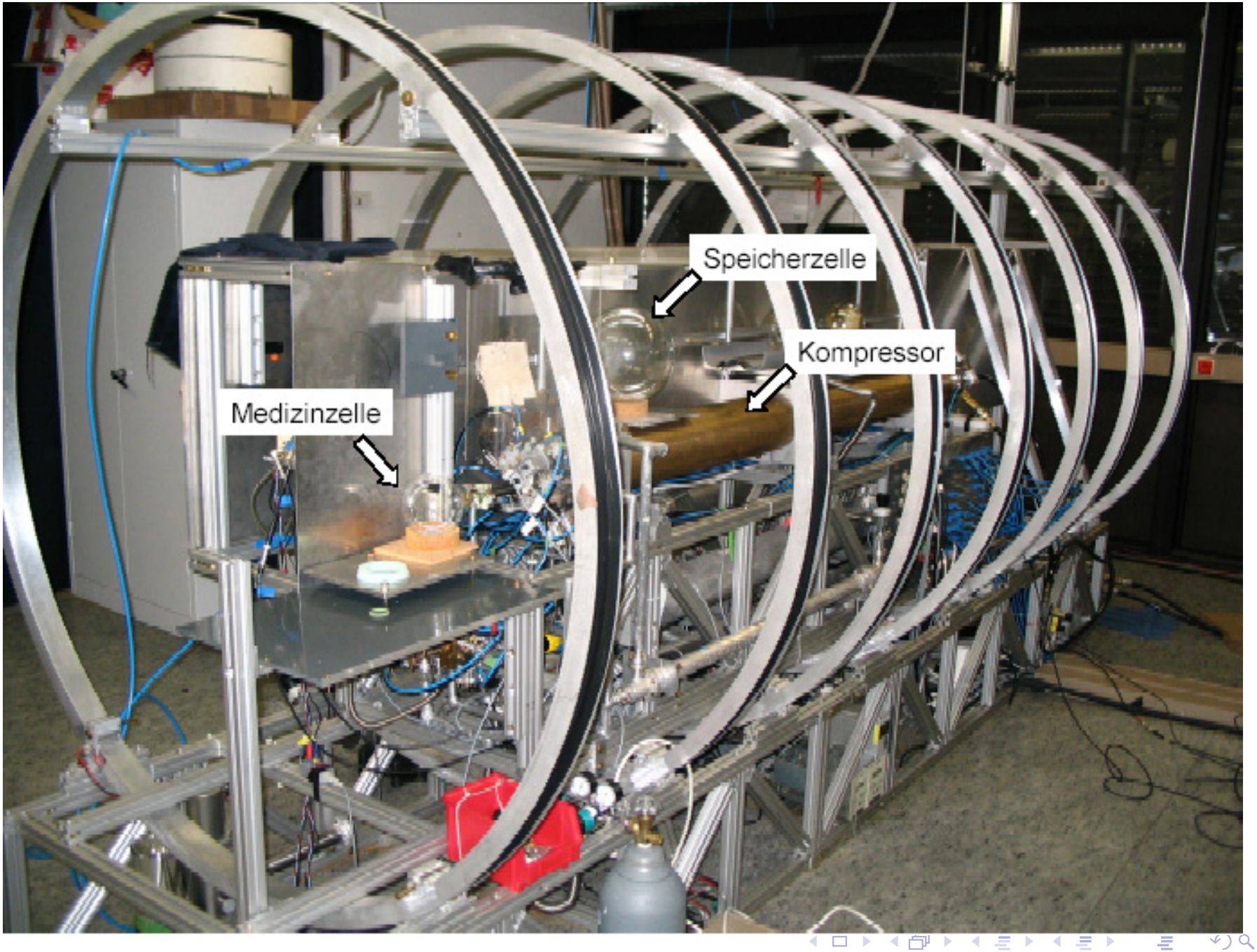
Polarization principle (MEOP)



The Polarizer

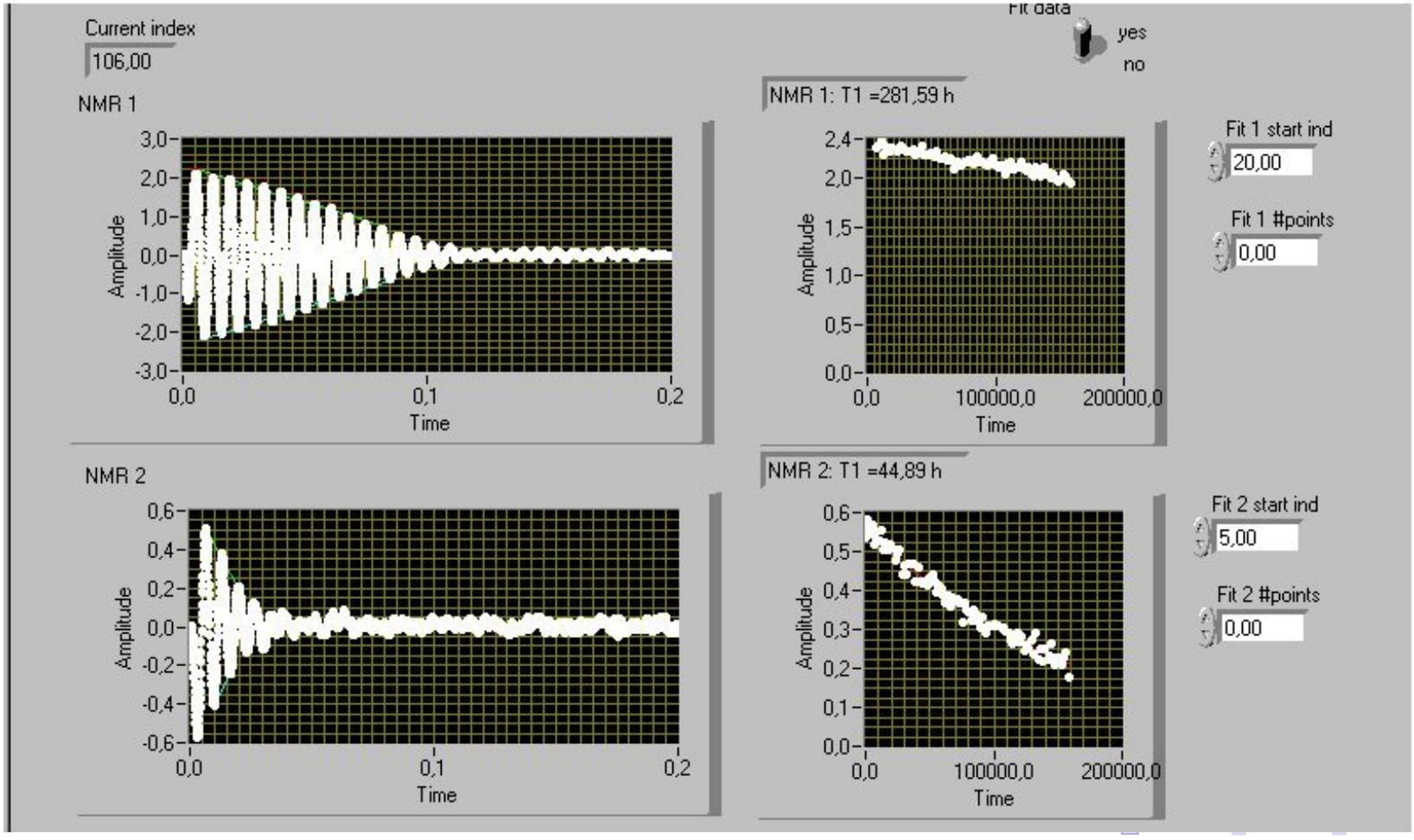


The Polarizer



T_1 measurement

- NMR: use additional static field for flipping the magnetization, $\Rightarrow$ measure induced voltage
- Flipping angle $< 2°$
- Polarization loss per measurement $\approx 0.02\%$



Relaxation mechanisms

- Field gradients
  - $$\frac{1}{T_1^{grad}} \sim \left(\frac{dB/dr}{B_0}\right)^2 \cdot \frac{1}{p}$$
  - $T_1^{grad} > 300$h at p=4bar $\Rightarrow$ gradient $< 9 \cdot 10^{-4}\text{cm}^{-1}$
- Beam relaxation
  - Production of $^3He_2^+$ molecules $\Rightarrow$ use N_2 as quenching gas
  - Production of $^3He^+$ ions

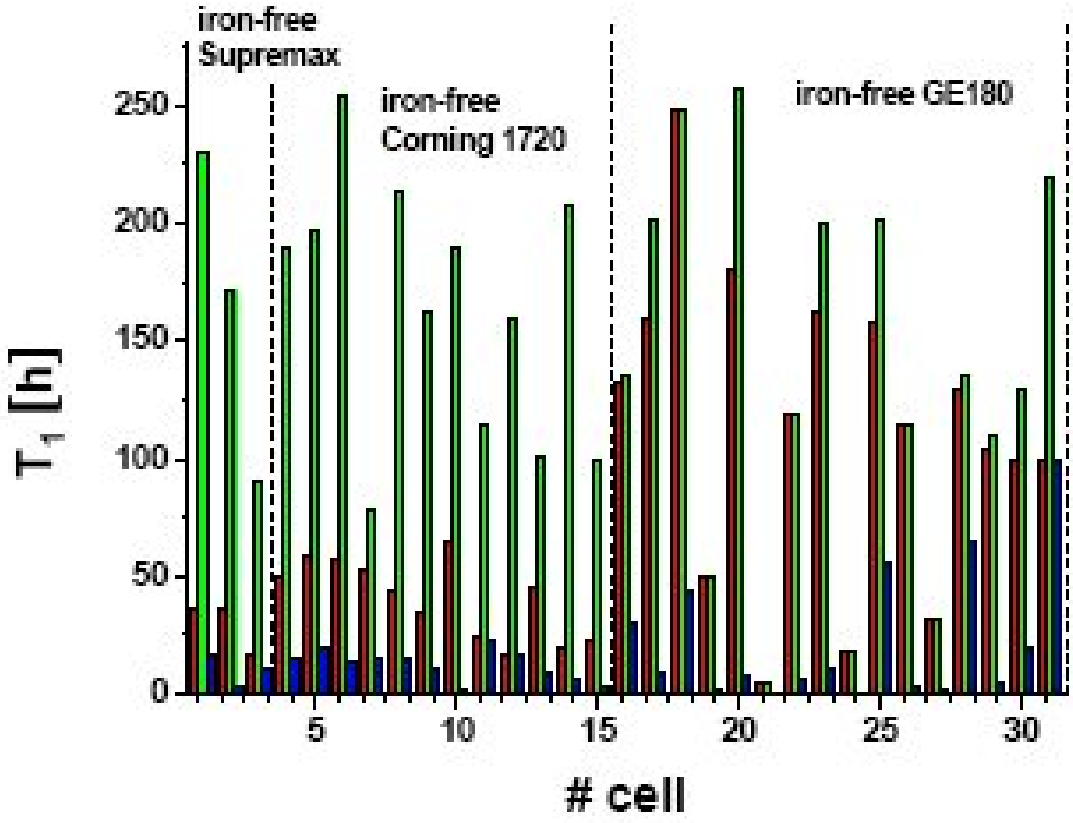
$$\frac{1}{T_1^{beam}} = \frac{\frac{dE}{dx} \cdot z_T}{E_{ion} \cdot V_T} \cdot \frac{I}{e} \cdot P_T$$

z_T = Target length, I = electron current
$\Rightarrow T_1^{beam} \approx 150$h at 10 μA

- Dipol-dipol interaction
  - $$T_1^{dipol} \approx \frac{817\text{h} \cdot \text{bar}}{p[\text{bar}]}$$
  - p=4bar $\Rightarrow T_1^{dipol} = 204$h

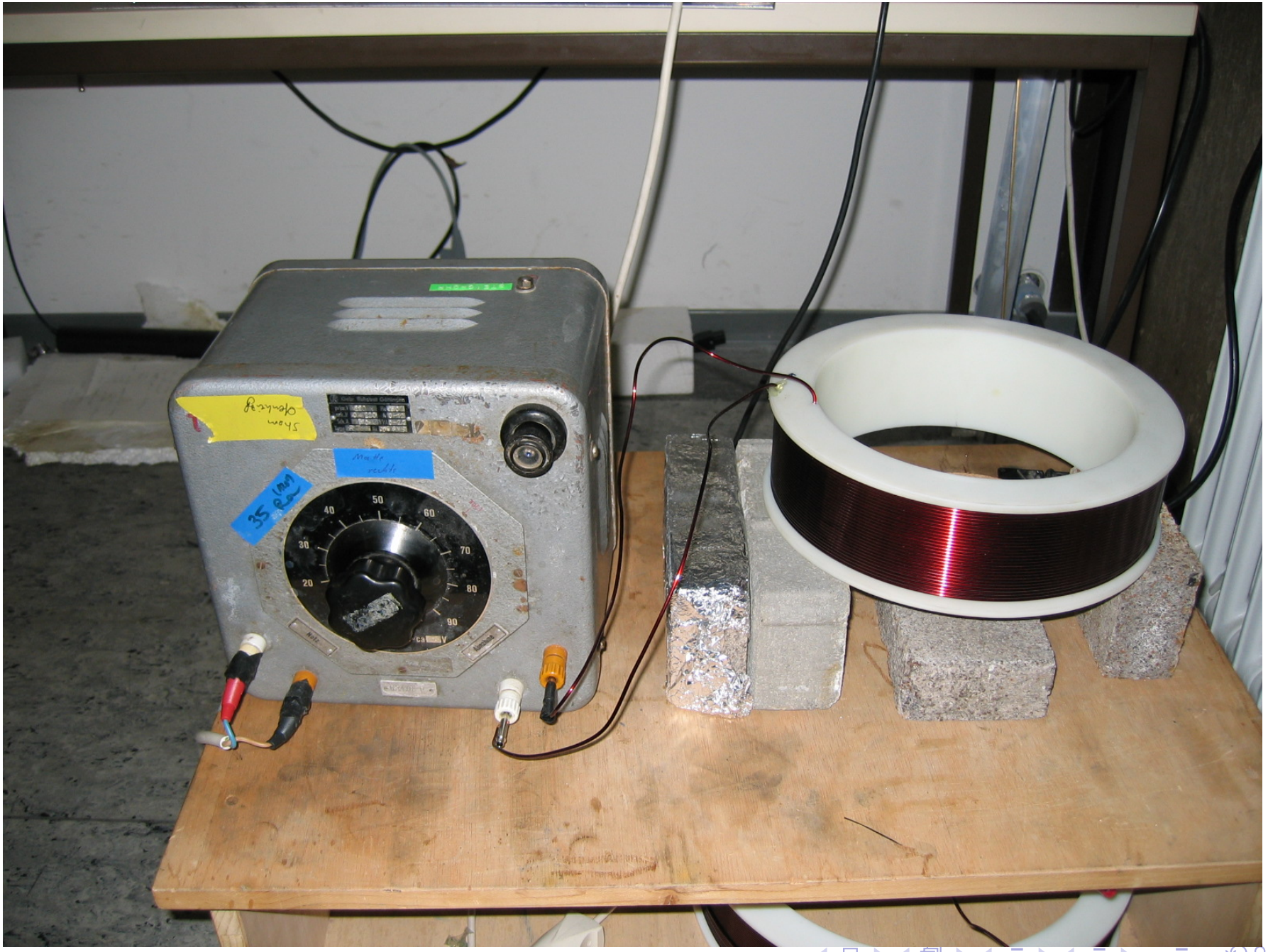
Wall relaxation

- Ferromagnetic impurities
  ⇒ proper de-magnetization

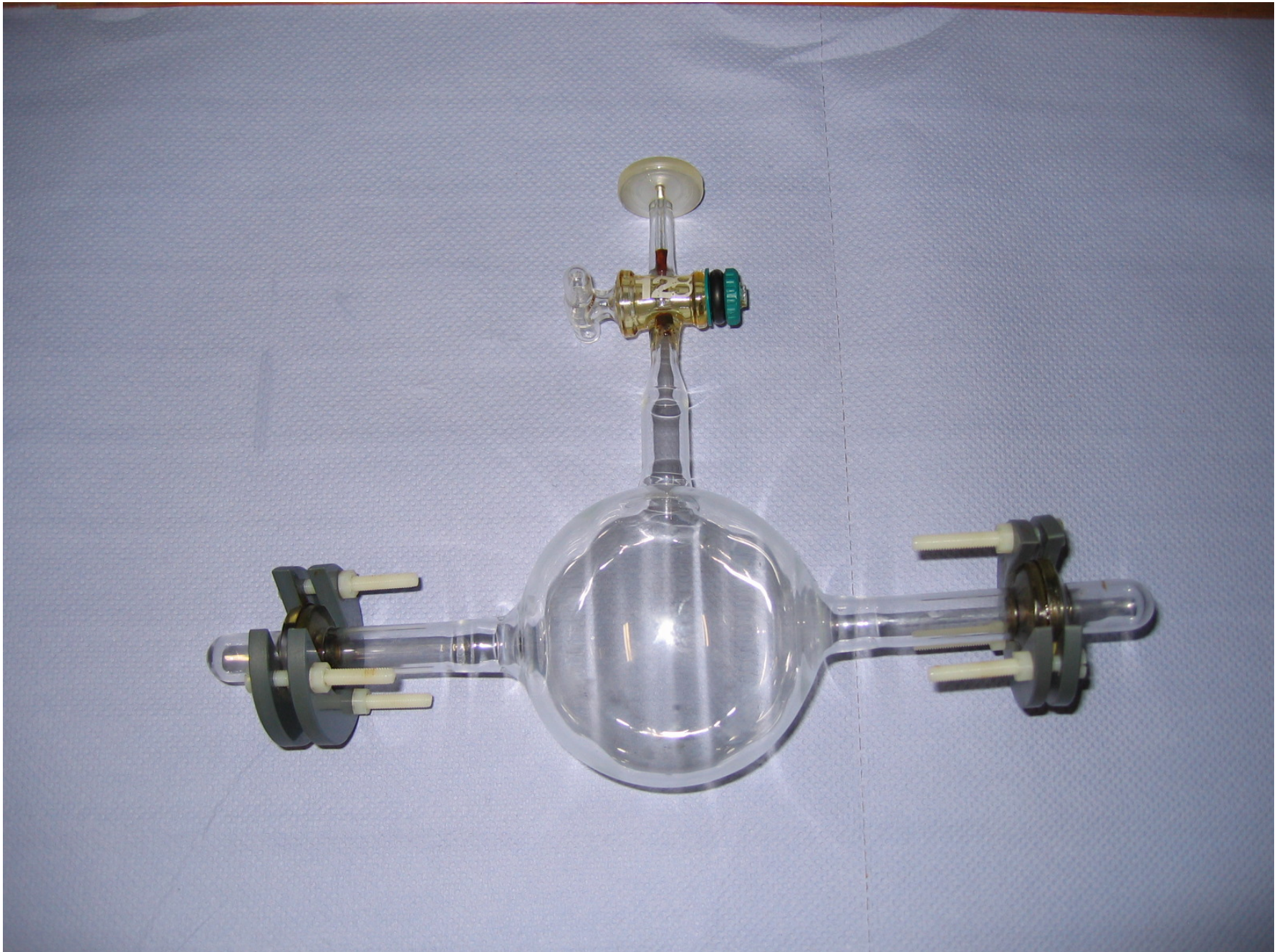


- Adsorption
  ⇒ coating e.g. with Cs to reduce sticking time
- Dissolution
  ⇒ use of dense glasses (aluminosilicates)
  ⇒ pores closed by Cs coating

Demagnetization device



Target cell



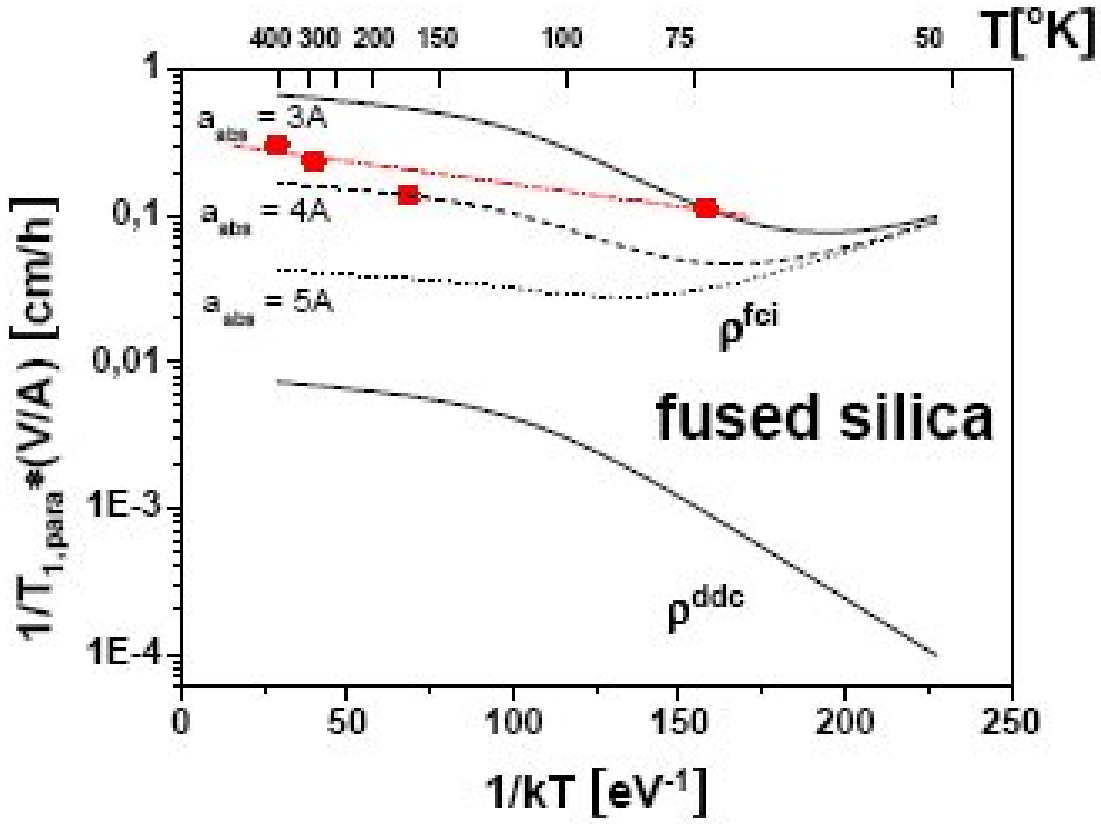
T_1 measurements

- Test of different entry windows

material	T_1
blind flange	50 h
Copper (25 μm)	50 h
Diamond (30 μm)	70 h
Titan (25 μm)	70 h
Beryllium (50 μm)	20 h
Beryllium (50 μm) + Al (10 μm)	50 h
Beryllium (50 μm) + Ti (25 μm)	70 h
Kapton (50 μm)	35 h
Mylar (50 μm)	45 h

Understanding Wall Relaxation

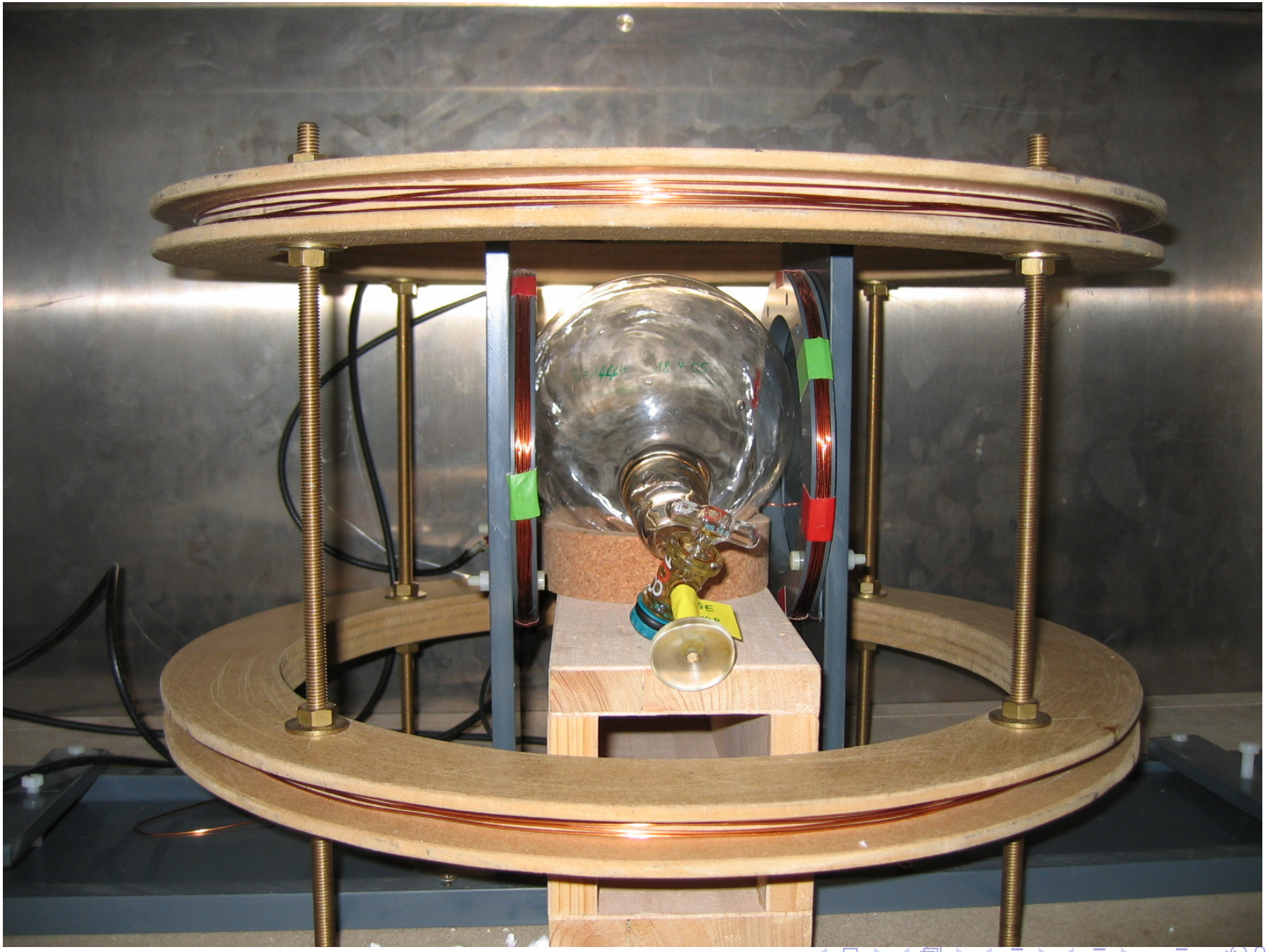
- “Historical” model:
  Dipolar coupling to paramagnetic impurities, e.g. iron
- Experimental observation:
  “Iron-free” and normal Supremax cells have similar T_1 times
- New model:
  Including Fermi-contact interaction with dangling bonds.



Summary

- Polarizer
  - Polarization 70-75 %
  - Flux: 2 bar·l/h
- Target cells
  - Test of different window materials
    Pressure tests
  - Demand: Wall relaxation time > 100 h
    $\Rightarrow$ Cs coated quartz cells
- Improved understanding of wall relaxation

T_1 measurement



The Box

- Provide homogenous holding field
- Shield and compensate for fields in A1-Hall
- Possibility for polarisation measurement