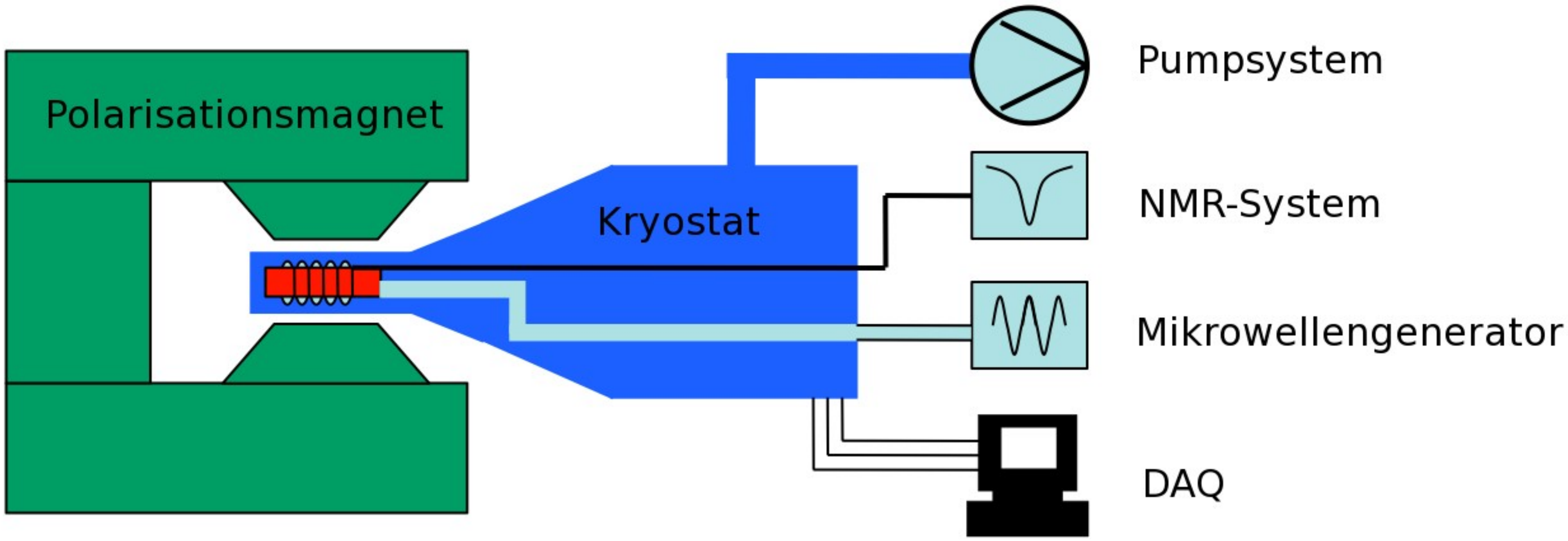
Transverse Polarized Target for Panda

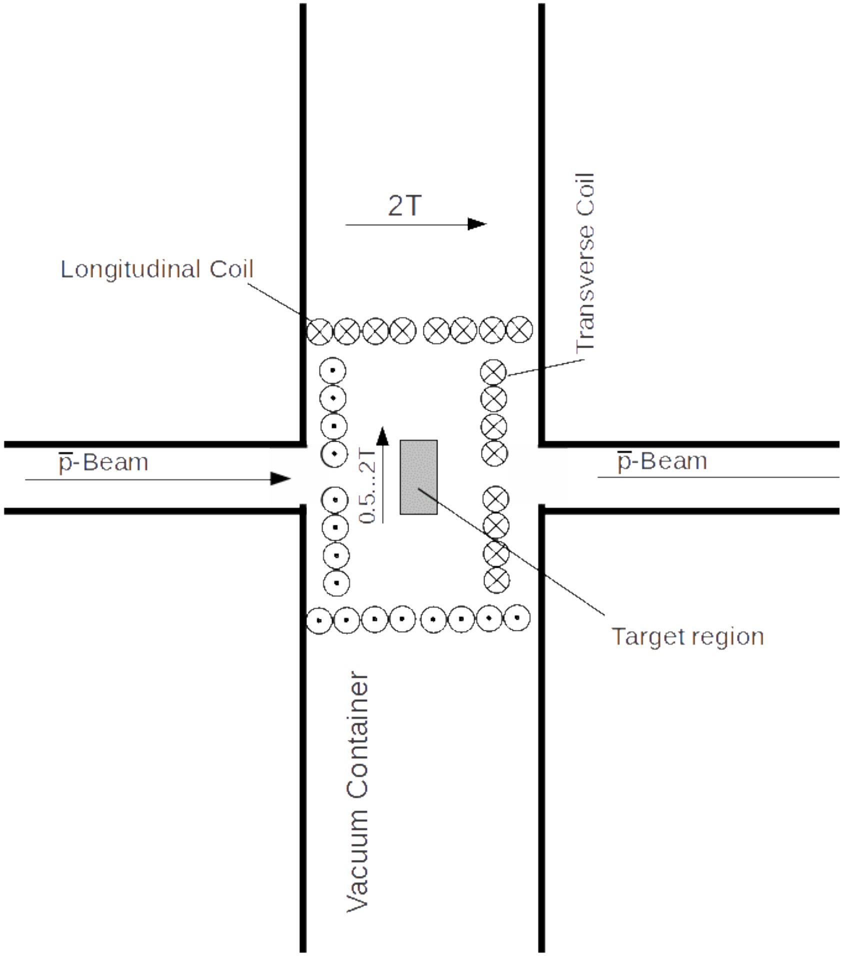
- Elements of a polarized Target
- Coil System
- Superconducting shielding
  - Transverse shield
  - Longitudinal shield
- CW HF-Polarization
- Outlook

Elements of the Polarized Target

- Targetmaterial
- Cryostat with pumping system 1K - 10 mK
- Magnet 1 - 7 T
- Mikrowave generator (Impatt-Diode) 50 - 200 GHz
- NMR (Nuclear Magnetic Resonance) 10 - 200 MHz
- DAQ



Transverse Polarisation with Coil System



- Torque can lead to missalignement or in the worste case quench

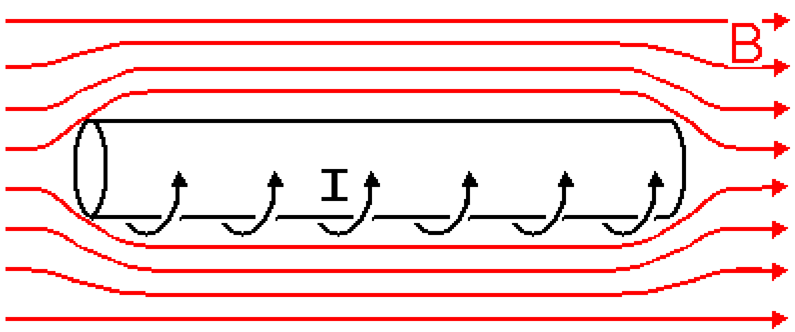
$$\vec{N} = \vec{m} \times \vec{B}$$

- High material budget (ca. 3mm thick coil with copper support)
- Power supply ?
- Cryogenics ?

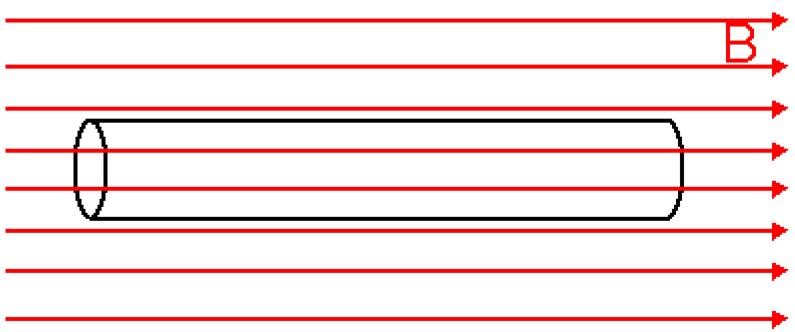
Shielding with a Superconductor

- Meissner-Ochsenfeld Effect

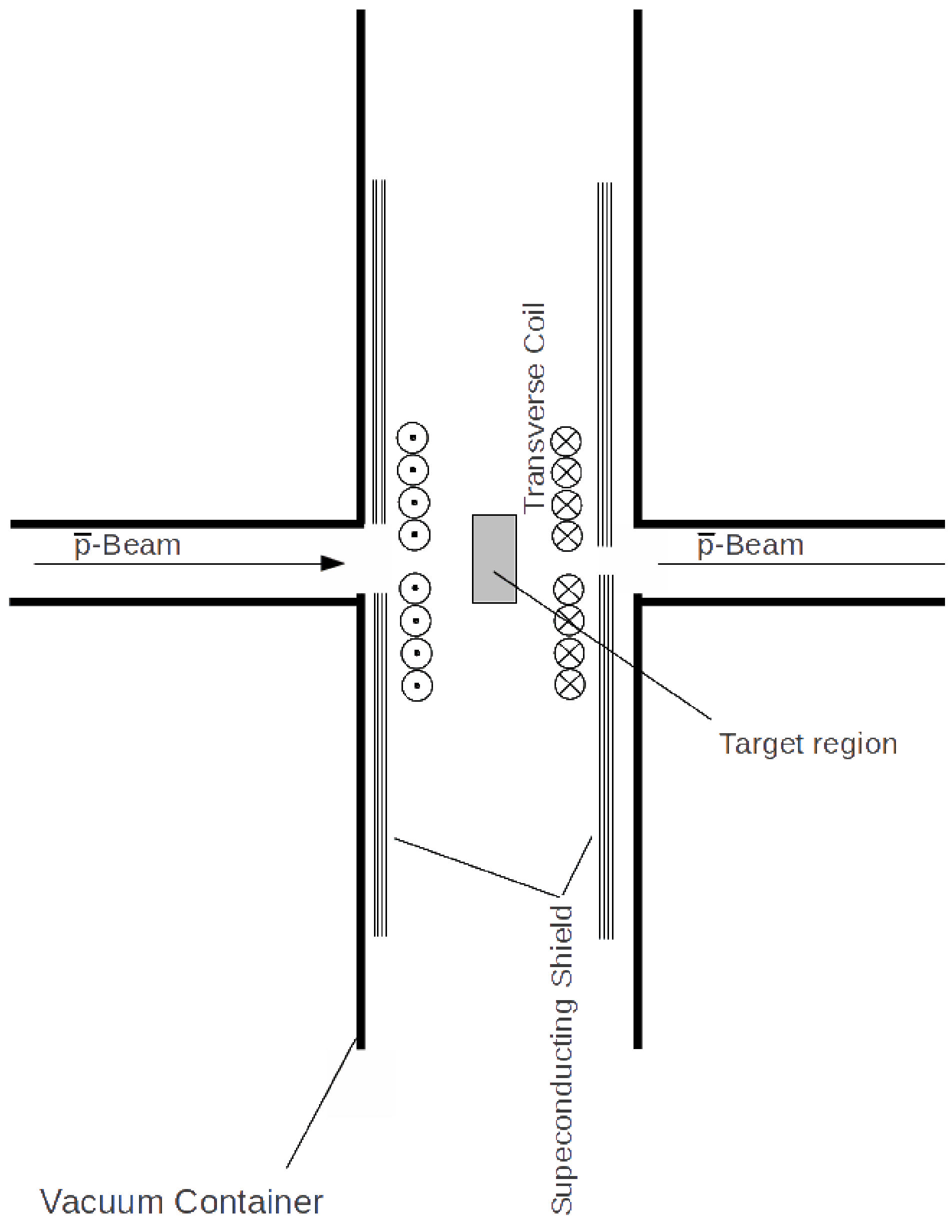
$$T < T_C$$



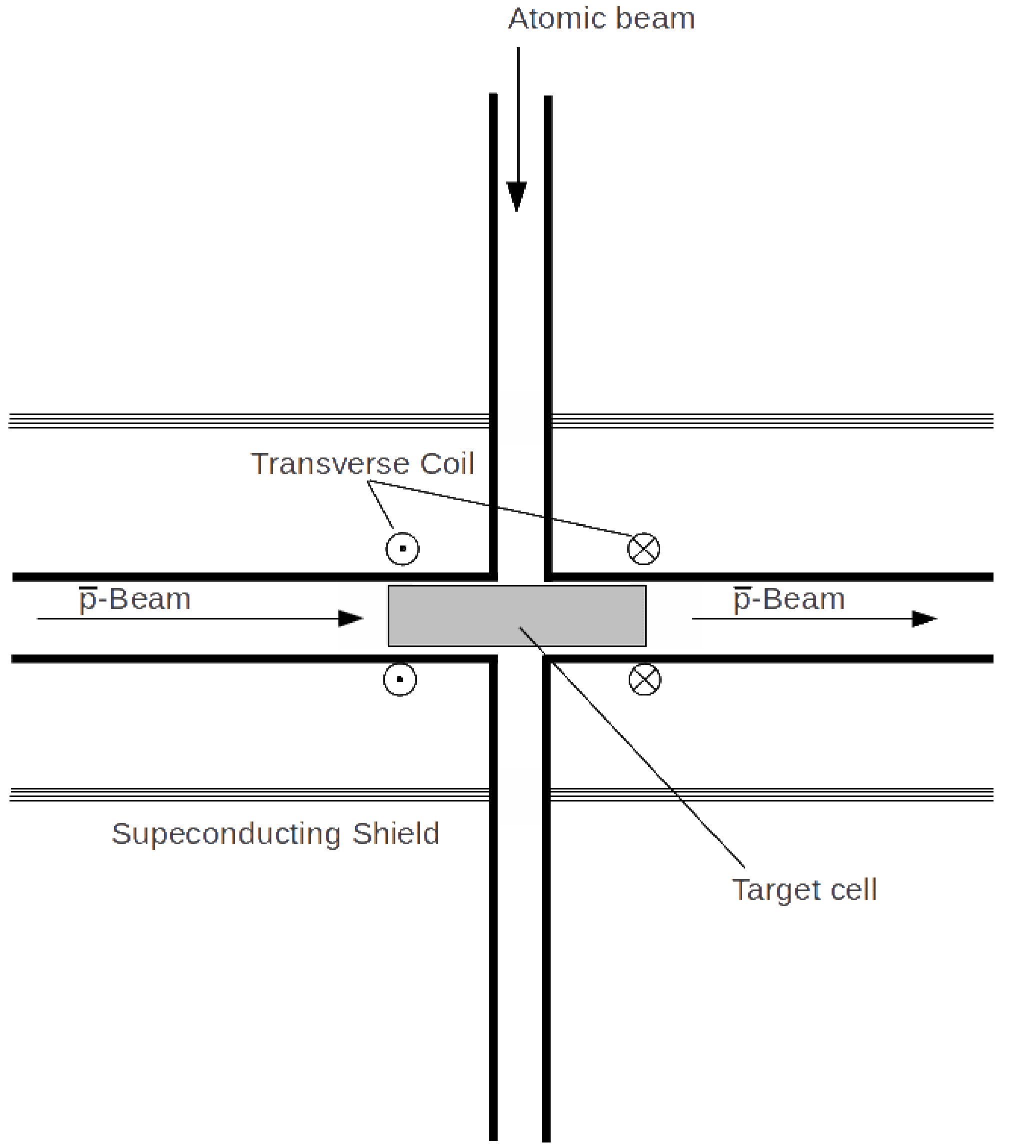
$$T > T_C$$



Transverse Cylinder



Longitudinal Cylinder



CW HF-Polarization (NMR-Effect)

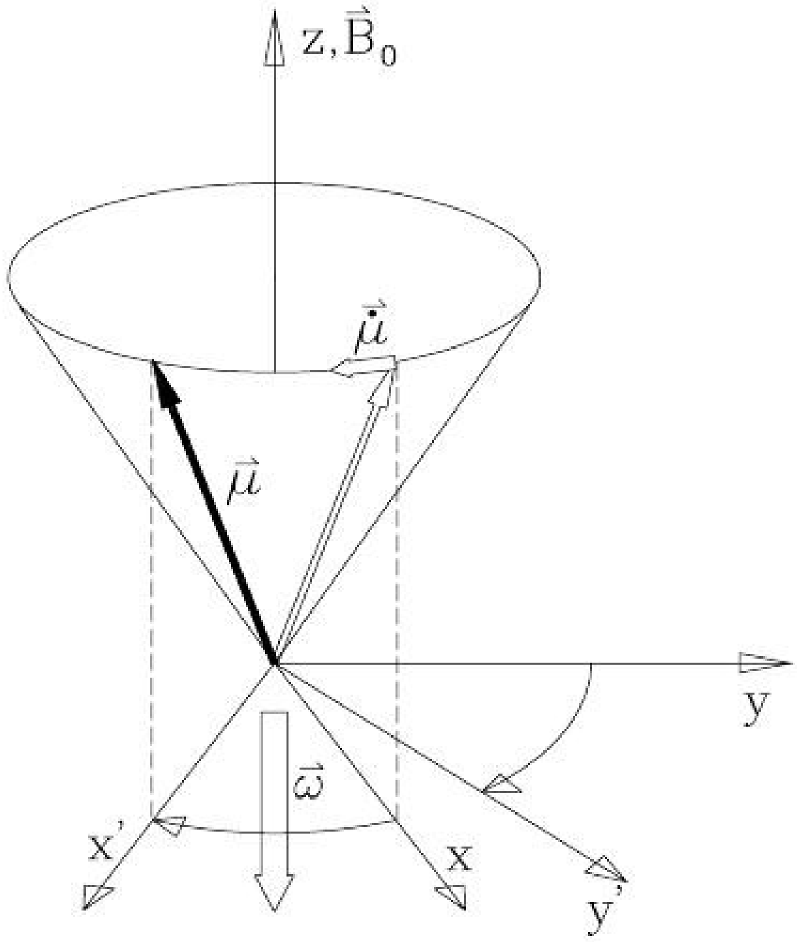
Proton magnetic moment $\vec{\mu} = \gamma \hbar \vec{S}$

With gyromagnetic ratio $\gamma = \frac{\omega}{B} = 42.58 \frac{MHz}{T}$

Torque $\vec{T} = \vec{\mu} \times \vec{B}_0$

$$\gamma \left(\vec{\mu} \times \vec{B}_0 \right) = \gamma \frac{d}{dt} \left(\hbar \vec{S} \right)$$

Rotational Frame



$$x, y, z \rightarrow x', y', z'$$

$$\left(\frac{d}{dt}\vec{\mu}\right)_{ROT} = \left(\frac{d}{dt}\vec{\mu}\right)_{LAB} - \vec{\omega} \times \vec{\mu} = \gamma \vec{\mu} \times \left(\vec{B}_0 + \frac{\vec{\omega}}{\gamma}\right)$$

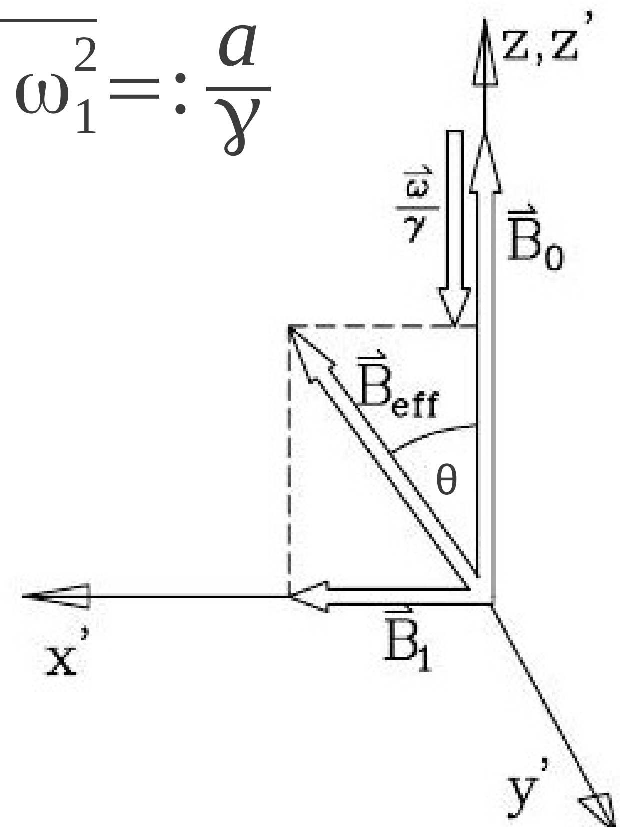
Effective Magnetic Field

$$\overrightarrow{B_{eff}} = \left(B_0 + \frac{\omega}{\gamma}\right)\vec{e}\,'_z + B_1 \vec{e}\,'_x$$

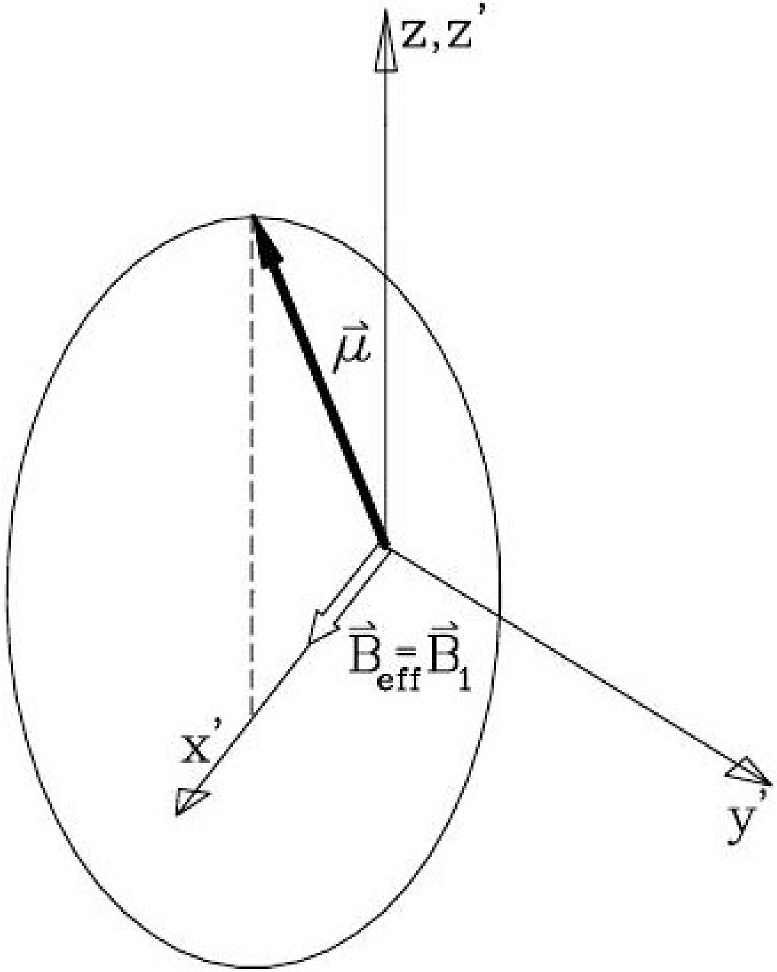
$$|\overrightarrow{B_{eff}}| = \sqrt{\left(\overrightarrow{B_0} + \frac{\vec{\omega}}{\gamma}\right)^2 + \overrightarrow{B_1}^2} = \frac{1}{\gamma}\sqrt{\left(\omega_0 + \omega\right)^2 + \omega_1^2} =: \frac{a}{\gamma}$$

$$\tan(\theta) = \frac{B_1}{B_0 - \frac{\omega}{\gamma}} = \frac{\omega_1}{\omega_0 - \omega}$$

$$|\omega_0 - \omega| \approx \omega_1$$



Resonance



- Ideal case $\overrightarrow{B_{eff}} = \overrightarrow{B_1}$
- Rotating frame: Precession along $\overrightarrow{B_{eff}}$ with a
- Lab frame: Additional fast precession along z
- Feasibility depends on physics case

Outlook

- First concentrate on finding a solution with superconducting shielding
  - Theoretical model and magnetic properties
  - Chose Material Type I, Type II
  - Numerical simulation with FEM, Mathematica, C++
    - Superconductor specimen in magnetic field
    - Cylindrical tube in magnetic field
    - Other shapes
  - Geometric effects
  - Peripheral components