Magnetic environments for polarised ^{3}He cells on neutron instruments

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Shielded solenoid

- Initially designed for the CRISP neutron reflectometer.
- Based on work of Hanson and Pipkin[1].
- Magnetically shielded solenoid and three correction coils.
- By changing the currents it is possible to optimise the device to reduce the magnetic field gradient and correct for the effects of external magnetic fields.

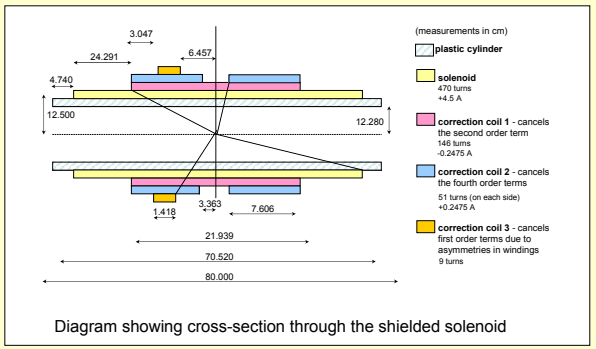


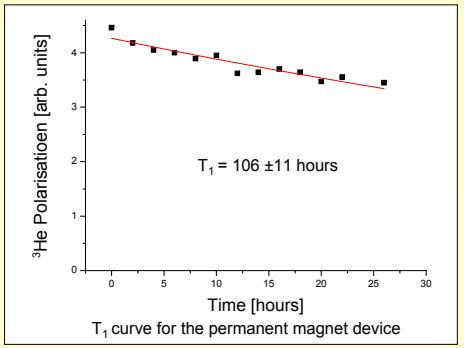
Diagram showing cross-section through the shielded solenoid

$T_1 \approx 80$ hours

[1] Hanson, R J, and Pipkin, F J, 1965, Magnetically Shielded Solenoid with Field of High Homogeneity, Review of Scientific Instruments, vol. 36, no.2

Permanent magnet device

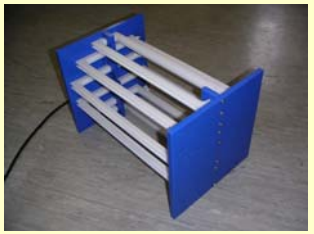
- Is a design from the ILL, Grenoble.
- Uses a series of permanent magnets and mu-metal panels to create a large homogeneous region of magnetic field.
- Ideal for transporting polarised helium-3 cells.
- Compact design allows it to be used on neutron instruments where space is limited.
- Low maintenance as requires no power source.



T_1 curve for the permanent magnet device

$T_1 \approx 100$ hours

Sinθ Coil



- Under development to produce compact field for optical pumping on a neuron beam.
- Development of work by Katabuchi et al [2].
- Original version used separate power supplies to power each coil.
- ISIS version uses a different number of turns on each pair of coils to produce the same effect.

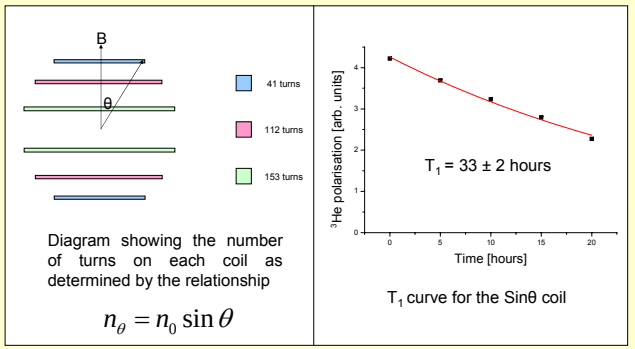


Diagram showing the number of turns on each coil as determined by the relationship

$$n_\theta = n_0 \sin\theta$$

T_1 curve for the Sinθ coil

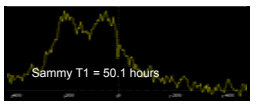
$T_1 \approx 30$ hours

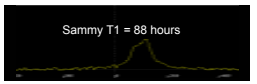
[2] T. Katabuchi, S. Buscemi, J. M. Cesaratto, T. B. Clegg, T. V. Daniels, M. Fassler, R. B. Neufeld and S. Kadlecek, 2005, Spin-exchange optically pumped polarized 3He target for low-energy charged particle scattering experiments, Review of Scientific Instruments, vol. 76, no.3.

Measurement

The ^{3}He cells relaxation time constant, T_1, is used as the main parameter for assessment of the homogeneity of the magnetic environment (see equation below).

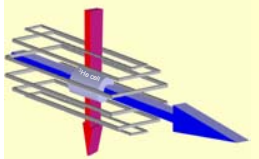
$$\frac{1}{T_1} = 1.7 \times 10^4 \left(\frac{\frac{\partial B}{\partial r}}{B_0} \right)^2 \frac{1}{p}$$





Measurement of T_1 are made in the laboratory with NMR techniques and directly with neutrons on the test beamline. Initial optimisation is carried out by minimising the linewidth of the NMR signal (see figure).

On beam pumping



- Compact coil design that avoids placement of optics components in neutron beam preferred.
- The Sinθ coil allows easy access for both laser (red) and neutron (blue) beams simultaneously, making it ideal.

CCLRC

ISIS