Design of a compact cryo-flipper using a YBCO film

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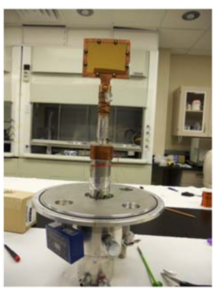
Abstract

Method- Superconducting screens provide a sharp transition between two magnetic field regions. This can be used to create a non-adiabatic transition and hence provide efficient spin reversal (π flip).[1]

Motivation -. High temperature superconducting screens (YBCO) eliminate the need for cryogens. This allows the creation of a turn key device [2]. Our aim is to create a low maintenance and cost effective compact spin flipper for use in a variety of applications including large beams.

Preliminary measurements using permanent magnets



350nm thick YBCO film capped with 100nm of gold on a 78 x 100 x 0.5mm sapphire substrate (Theva, Germany) mounted in an oxygen free copper high conductivity frame

Test measurement on SESAME beamline at LENS- simple guide field using permanent magnets – orientation swapped for flipping/ non flipping

Permanent magnets before/after YBCO film

Magnetic field at YBCO film ~12 G
Temperature ~8.5K (measured on copper frame)

Flipping ratios ~16 at 5.5 angstroms
Beam diameter 40mm
Corresponds to ~95% efficiency
– works despite crude guide field (and with large `beam)

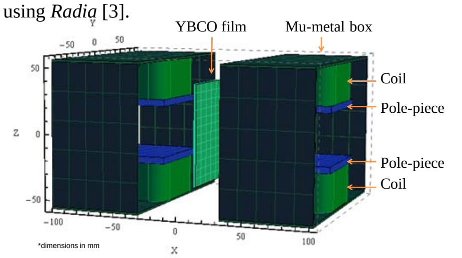
Neutron spin manipulation project

This device is part of an NSF program to develop a series of spin manipulation devices to be utilized at national facilities.

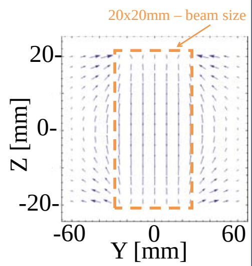
The device plans and documentation will be made broadly available.

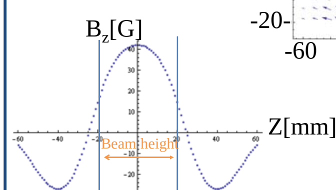
Guide field electromagnet design

Finite element simulation of air cooled guide field electro-magnet and super conducting film was produced using *Radia* [3].



Vector plot of field profile to the superconductor - shows uniformity over large region – for efficient spin transport (high flipping efficiency)





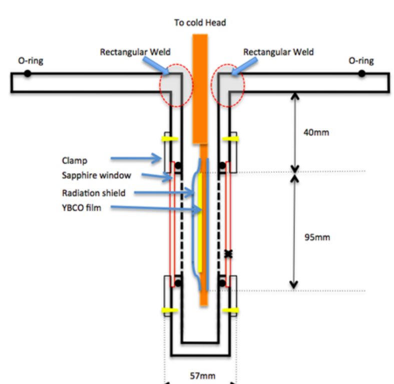
Vertical magnetic field (Z on diagram above, Y=0, X= 5mm) component showing guide field across ~40mm B_z>12G

Cold finger and heat shield detail

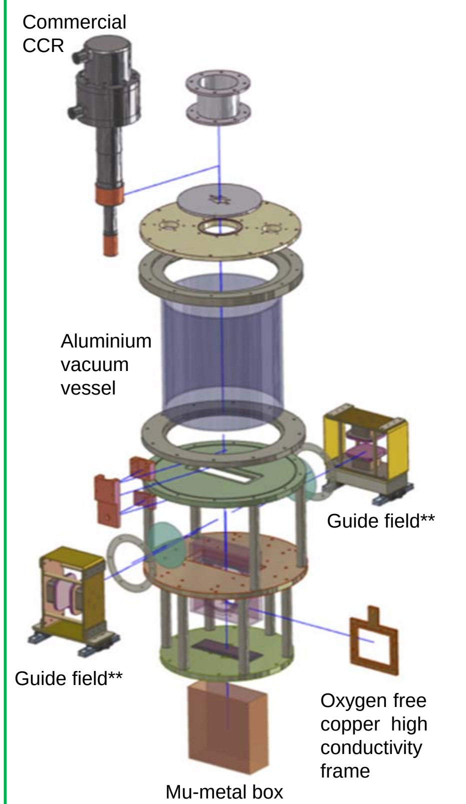
Low cross section (57mm) allows for close placement of electromagnets

Sapphire windows for high transmission

All aluminium construction of vacuum vessel to limit magnetic contamination.



Exploded view of design



**Mu-metal box is placed around film during cooling to prevent flux trapping*
***Guide field can be mounted either vertically or horizontally*

Summary

Preliminary measurements show suitability of chosen film

Small device footprint along beamline ~20cm

Will be tested on SEAME beamline at LENS

References

1. J.B.Forsyth, At Energy Rev. 17 (1979) 345

2. M.R. Fitzsimmons *et al*. NIM A 411 (1998) 401

3. P. Elleaume, *et al*. Proc. of the PAC97 (1997), 3509

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