Magnetism Diffractometer at ESS

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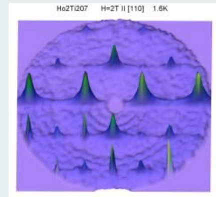
McStas

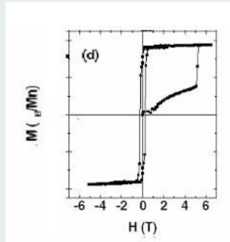
• Typical SC magn. experiments

- Collection of many Bragg reflections for structure solution or refinement

- Volumetric mapping of reciprocal space; diffuse scattering and super structure, 1D and 2D cuts



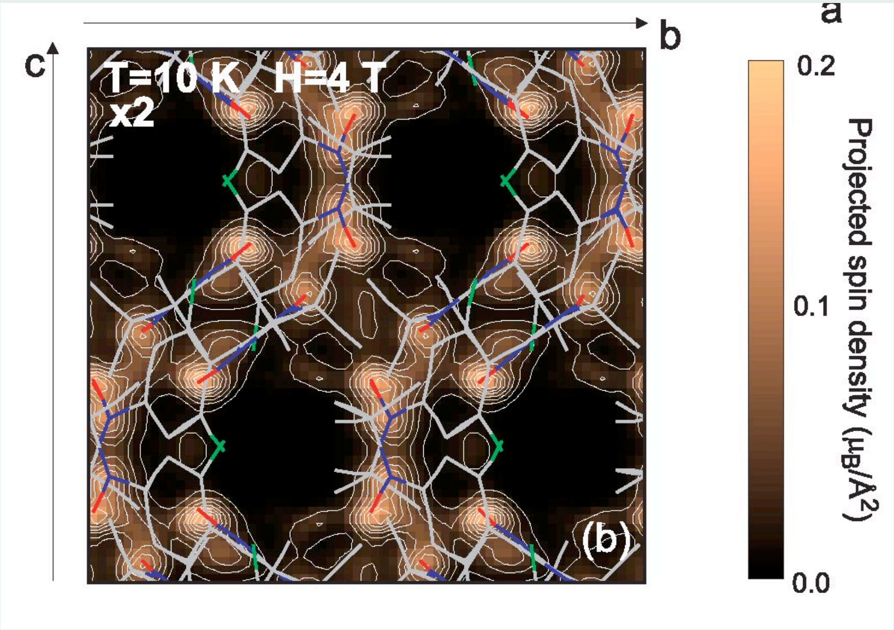
- Study of individual reflection in phase transitions

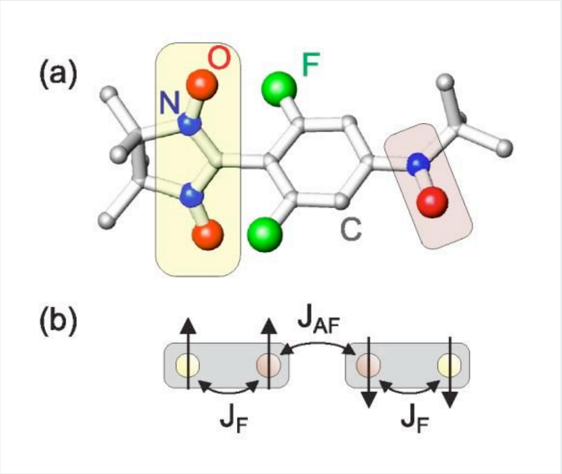


SPIN DENSITY IN THE PARTIALLY MAGNETIZED ORGANIC QUANTUM MAGNET F_2PNNNO

A. Zheludev, V. Garlea, S. Nishihara, Y. Hosokoshi, A. Cousson and A. Gukasov.
Phys Rev B75,104427, 2007

- 6T2 HII[001] , [110] 1 day





Field induced Double Layered Monopole Structure in TbTi2O7

SAZONOV, GUKASOV, MIREBEAU, AND BONVILLE PHYSICAL REVIEW B 85, 214420 (2012)

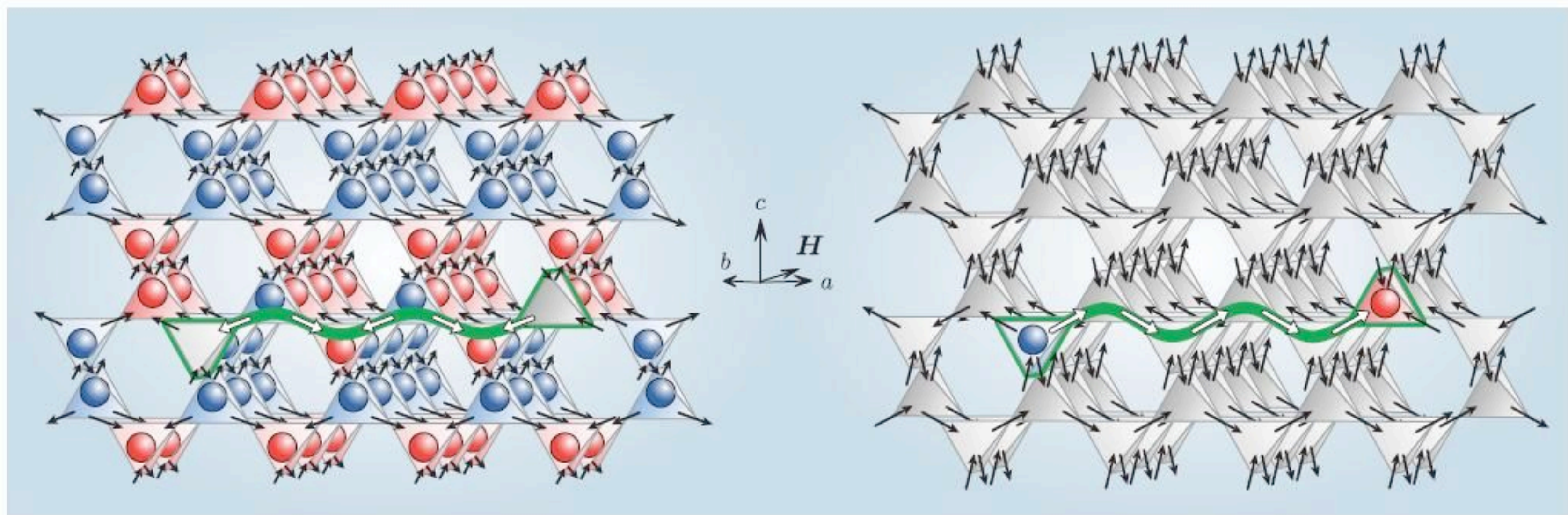
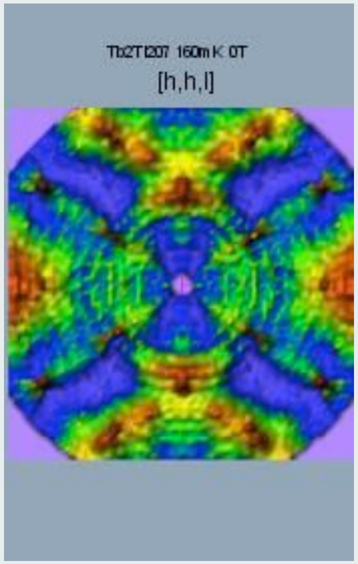
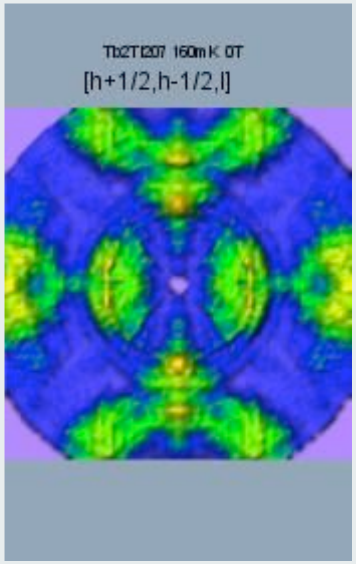
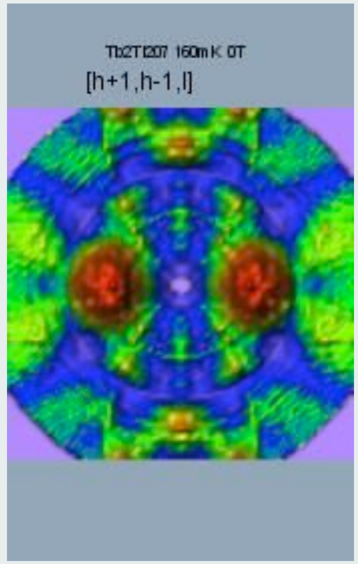


FIG. 5. (Color online) Left panel: Double-layered monopolar structure of $Tb_2Ti_2O_7$ with vacuum pair excitations. Right panel: Magnetically vacuum state of $Ho_2Ti_2O_7$ with monopole pair excitation.

Diffuse scattering in $Tb_2Ti_2O_7$ at 160mK, H=0T

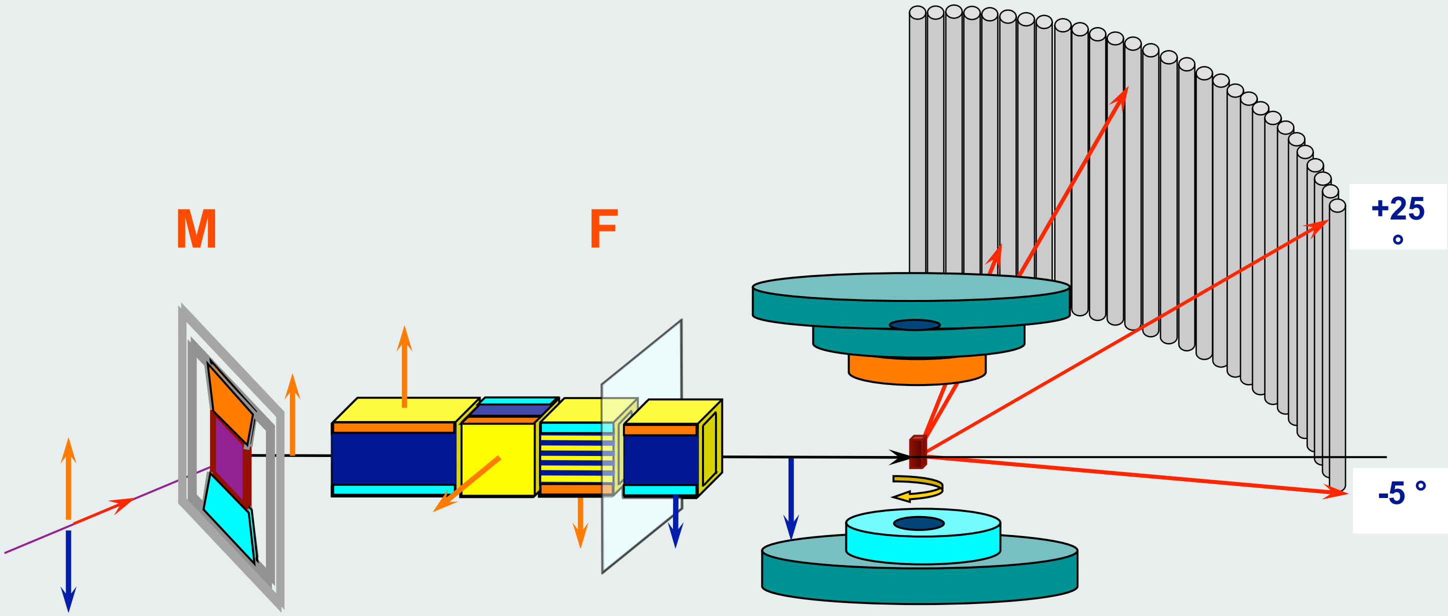






Cap2010

Very Intense Polarized Neutron DIFFRACTOMETER (5C1) at LLB

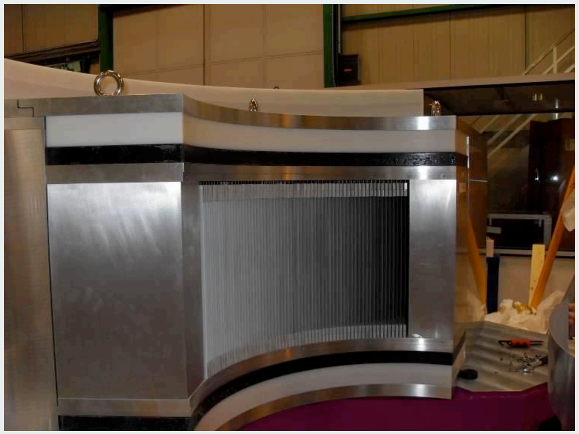


25°x80°

Cap2010

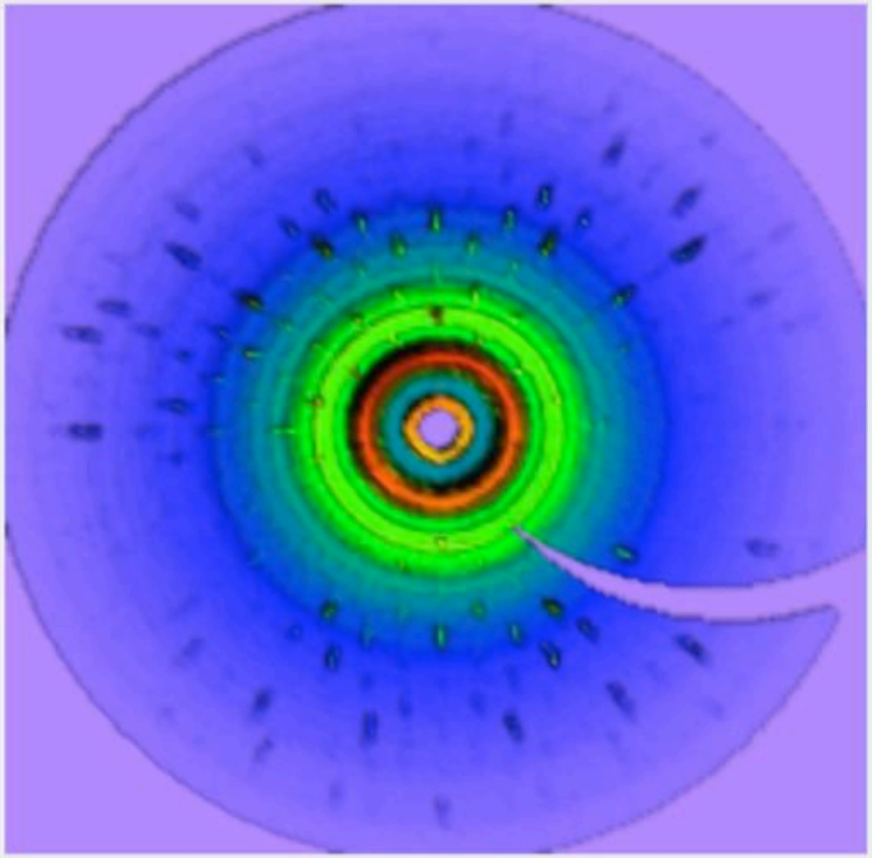
VIP Neutron DIFFRACTOMETER (5C1)

delivered in 2010



64 PS He3 detectors spaced at 1.2

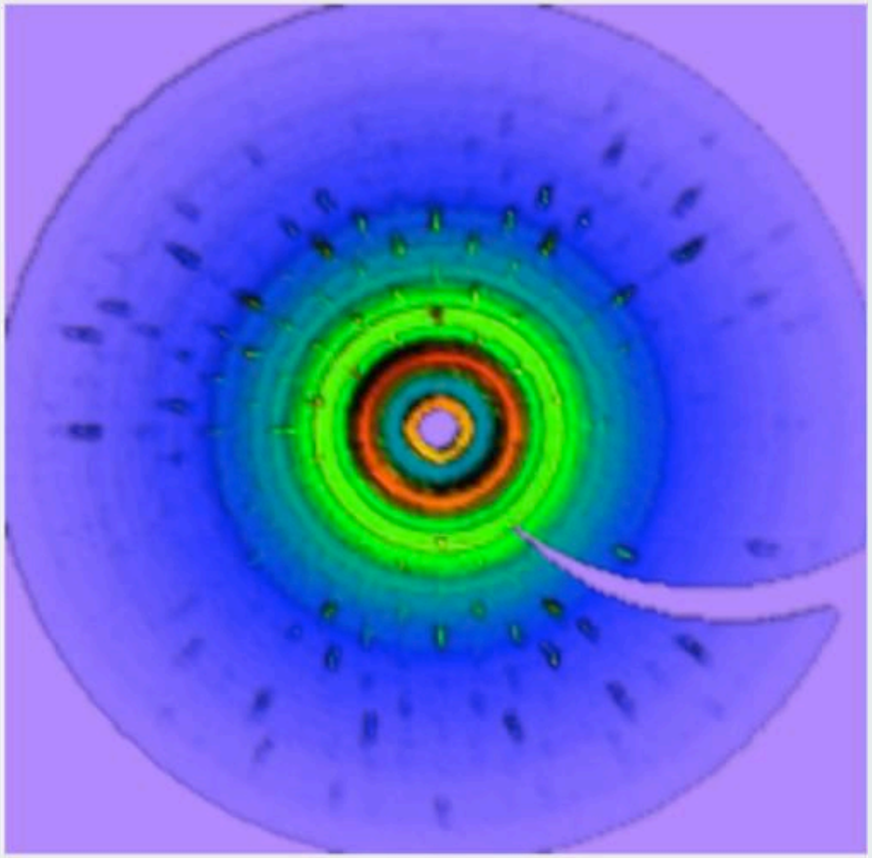
VIP Neutron DIFFRACTOMETER (5C1) LLB



Tb2Ti207 2 K, 1T
A=10.12 Å Fd3m
V~60mm3

3500 steps of 0.1
Exposition 4 sec/frame

VIP Neutron DIFFRACTOMETER (5C1) LLB



$Tb_2Ti_2O_7$ 2 K, 1T
A=10.12 Å Fd3m
V~60mm3

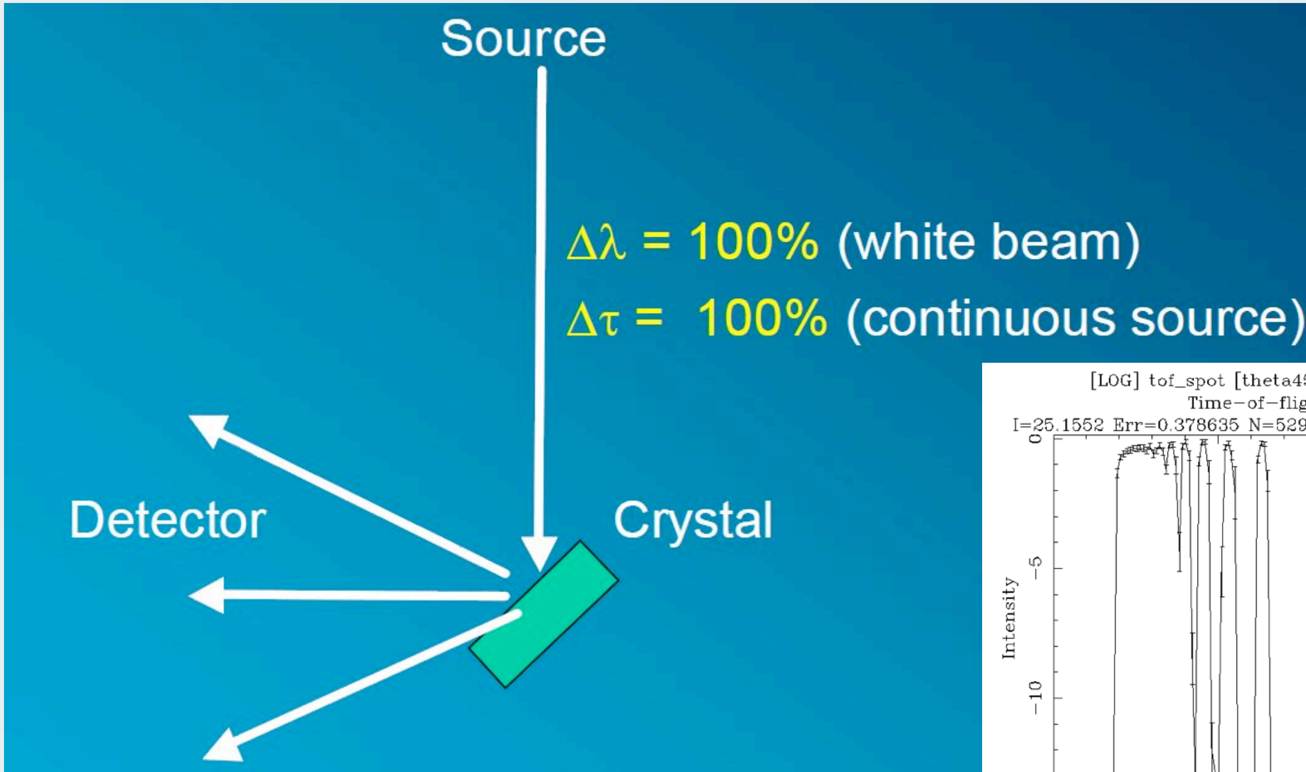
3500 steps of 0.1
Exposition 4 sec/frame

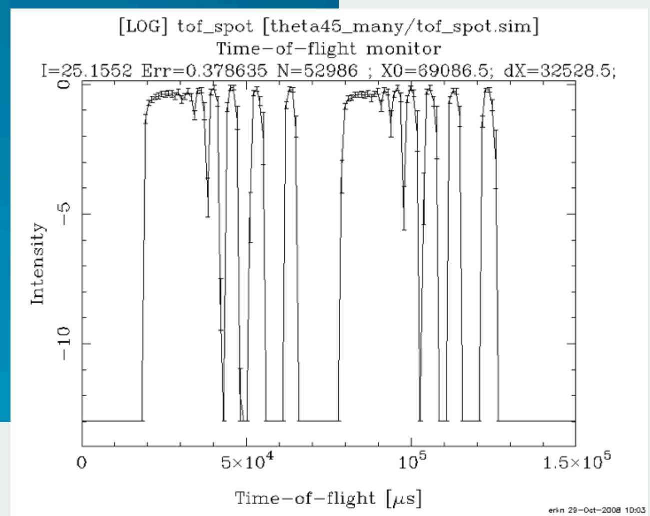
951 reflections observed

726 FR> 3σ i.e. magnetic

White Beam (Laue) Neutron Diffraction from a single crystal

Multiple reflections sorted by the Crystal itself





ESS simulation meeting on diffraction, Oct 24th 2012

SCD on ESS

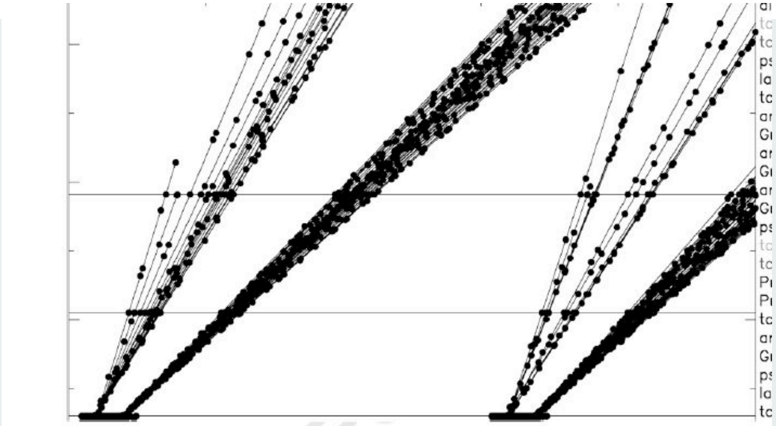


Fig. 5. Neutrons traveling down the flight path length.

- $t = L/4000 * \lambda$
- For L=40 m, λ =1Å t=10ms (λ =7Å t=70ms)
- Pulse width Δt~2ms Period T~70ms
- Δt/t ~ 20-3 %

SCD on ESS , Ven workshop 2008

XESS – Extreme environment single crystal diffractometer for the ESS-LP (ESS workshop October, 2008, Ven, Sueden)

A. Gukasov, P Willendrup, E. Knudsen and F. K. Larsen

Abstract

A single crystal diffractometer for extreme environments was designed during the ESS Ven workshop. We show using Monte-Carlo simulations that the exceptional qualities of the long-pulse spallation source translate into strongly enhanced performance of single crystal diffractometer. This is due to the fact that the ESS duty cycle matches perfectly well the wavelength resolution required for single crystal diffraction. We show as well that very significant additional gain of the instrument luminosity can be achieved by exploiting modern focusing neutron optics.

Background

The XESS diffractometer described below can be considered as a general purpose crystal and magnetic structure instrument optimized for crystals with unit cell from 15x15x15 Å to 25x25x25 Å. It uses the time-of-flight (TOF) Laue

Moderator and guide section

The proposed solution is a Laue TOF instrument with normal beam geometry, utilizing the wavelength band $0.8 < \lambda < 8$ Å and a total instrument length of 30 m. The preliminary studies were done assuming a thermal moderator, but results can be generalized to a mixed moderator setup.

McStas simulations of XESS

of diffraction patterns usually allows eliminating the correlations in the structural parameters during due to overlapping reflections. Second consists in

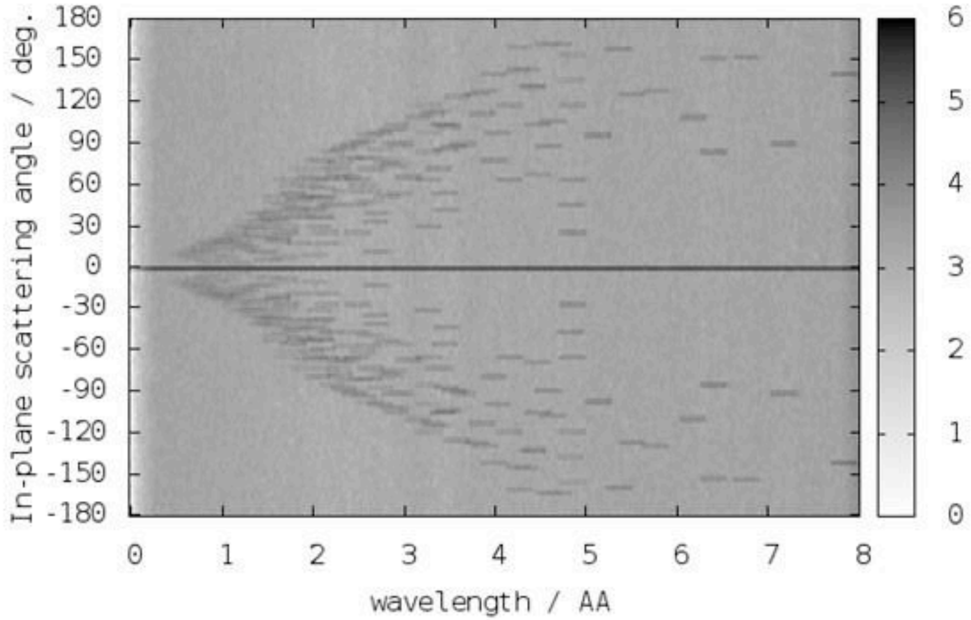


Figure 5: In-plane scattering angle and time-of-flight diagram for full 2ms pulse. Color scale is logarithmic, in a.u.

improving the spatial resolution.

Moderator and guide section

The proposed solution is a Laue TOF instrument with normal beam geometry, utilizing the wavelength band 0.8< λ < 8 Å and a total instrument length of 30 m. The preliminary studies were done assuming a thermal moderator, but results can be generalized to a mixed moderator setup.

McStas simulations of XESS

- **Pulse tailoring by chopper (intensity losses)**

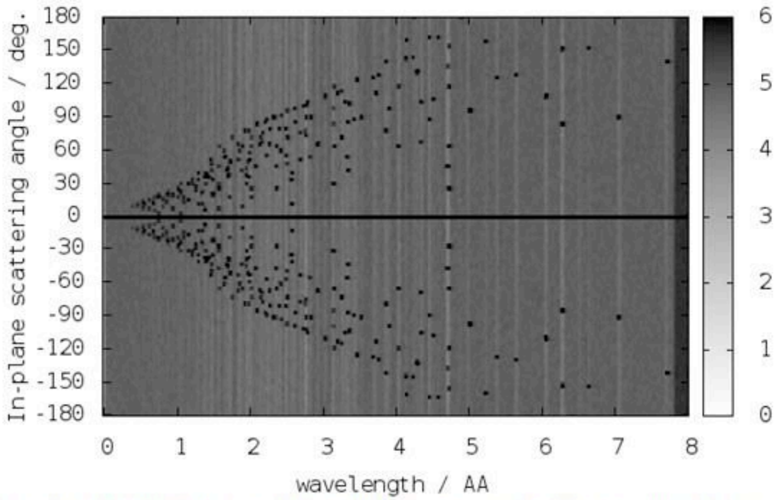


Figure 6: In plane scattering angle and time-of-flight diagram for a 0.25 ms pulse. Color scale is logarithmic, in a.u.

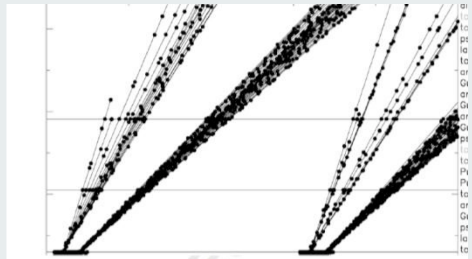
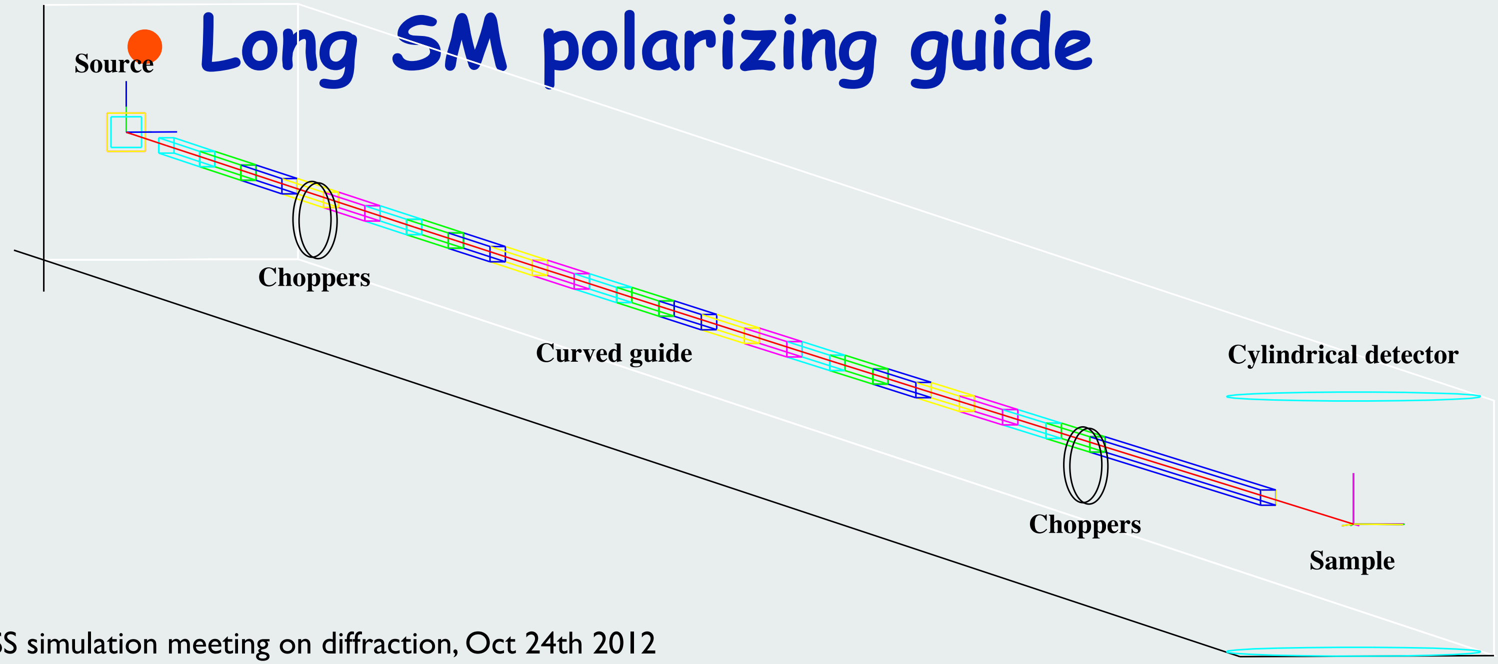


Fig. 5. Neutrons traveling down the flight path length.

- **Correlation methods, Fourier, PR choppers to be reconsidered**

Design elements

- ESS Long pulse favorable for SC (XESS)
- Short wavelength (0.8 A) are desirable
- Area Detectors, arranged cylindrically for good sample env access
- Long SM polarizing guide



• Polarized neutrons optic

- Ni mirror 0.002rad/Å (~7' for 1Å)
- SM m=2.5 0.005rad/Å (20' for 1 Å)

- Guide width a= L/4* 0.005= 50mm
- Advantages :

White spctrum, Transmission ~100%,
Polarization 95-99%, known technology

1- Single curved Polarizing neutron guide (reference option)

beam size 20x20 mm2.

minimum length L=33m for λ*=0.4 Å

SM FeCo/TiN m=2.5 0.8-4.5 Å.

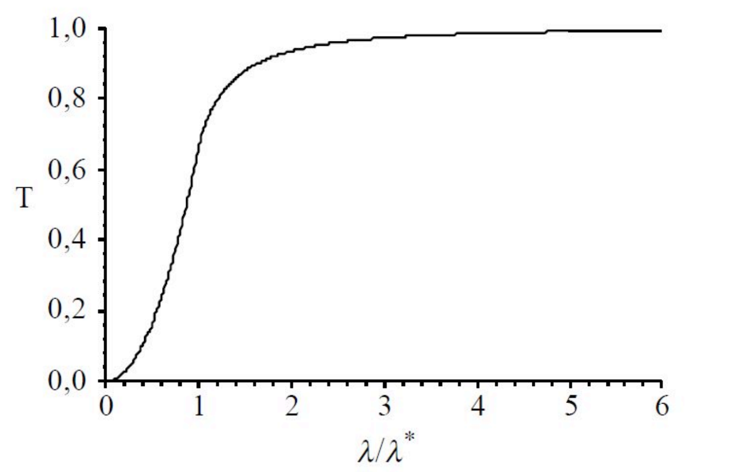


Fig. 3 The transmittance T of a perfect neutron guide for an incident neutron beam with the divergence *D=2θ* λ/ λ**as a function of *λ/ λ**

A.F. Schebetov et al. / Phys.

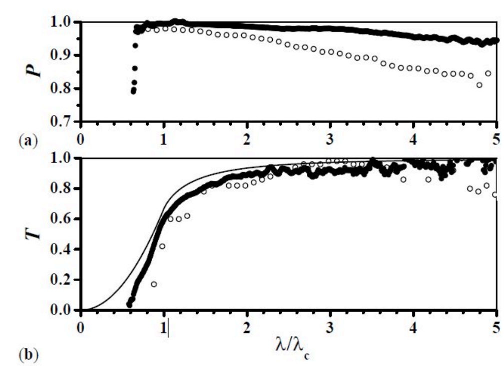


Fig. 2. (a): The polarizing efficiency of the old (open symbols) and the new (solid symbols) polarizers. (b) The transmittance of the old (open symbols) and the new (solid symbols) polarizers and according to theory [4] (line) as a function of the reduced wavelength λ/λ_c. The transmittances are divided by the respective geometrical factors $w/(w+g)$, where w and g are the thickness of channel gaps and glass substrates, respectively.

2- Ballistic (elliptic, parabolic) Polarizing neutron guide

Cross-section 50x50 mm2.

minimum length L=80 m for λ*=0.4 Å

FeCo m=1 0.8-4.5 Å.

3- Ballistic (elliptic, parabolic) Unpolarized neutron guide + cavity?

Add-on options?

Asymmetric SC Magnet

Guide fields

Microfocusing optics

Post Doc to be hired @ LLB

Post Doc position open at LLB from January 2013 devoted to the Project Magnetism Diffractometer at ESS