Development of Modulating Permanent Magnet Sextupole Lens for Focusing of Pulsed Cold Neutrons

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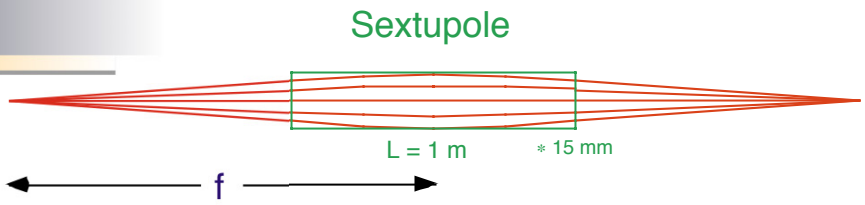
Introduction to PMSx

Principle of focusing

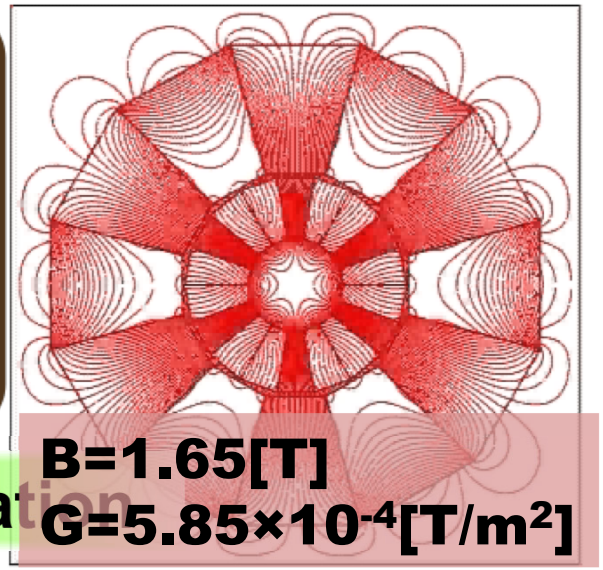


■ Sextupole : $|\mathbf{B}| = \frac{G}{2}(x^2 + y^2)$, G ; the strength (positive value)

■ The EOM : $\frac{d^2\mathbf{r}}{dt^2} = \mp\alpha\nabla|\mathbf{B}|$, (- : parallel spin, + : anti-parallel spin)

$\alpha = |\mu_n / m_n| = 5.77 m^2 s^{-2} T^{-1}$, μ_n, m_n ; magnetic dipole moment, mass of the neutron

■ focal length : $Z_f = Z_m + \frac{h}{\omega m_n \lambda}\cot(\frac{\omega m_n \lambda}{h} Z_m)$, $\omega^2 = G\alpha$,



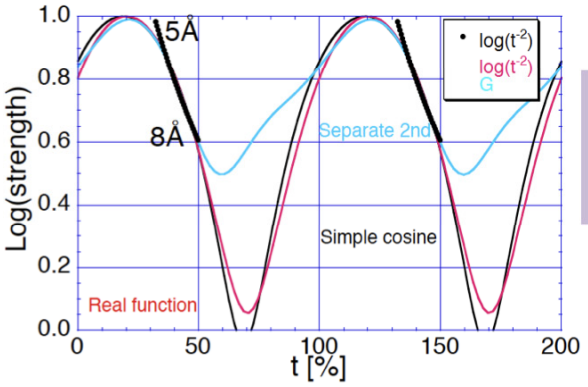
B=1.65[T]
G=5.85×10^{-4}[T/m^2]

Modulation for suppressing the chromatic aberration

■time dependence of wavelength : $\lambda = \frac{h}{mv} \propto t$

■modulation : $Z_f = const \Rightarrow G \propto \lambda^{-2} \propto t^{-2}$

PMSx located at the middle



Bore:15mm
Length:66mm

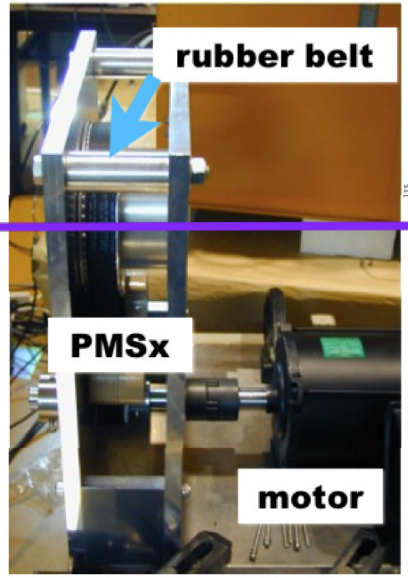


Fig6. Overview of the PMSx

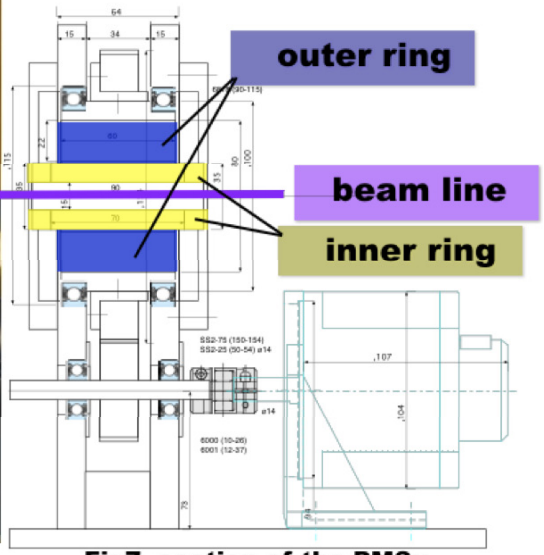
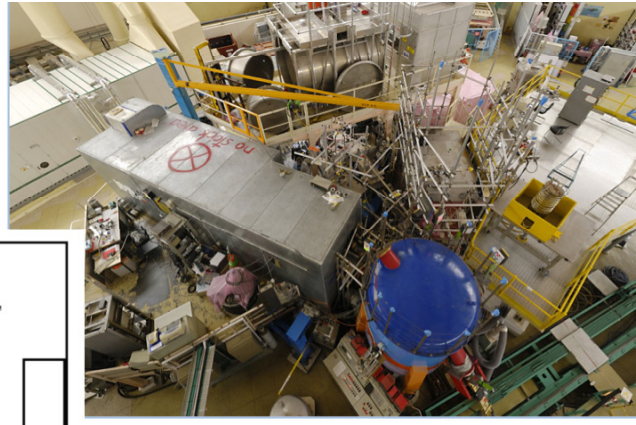


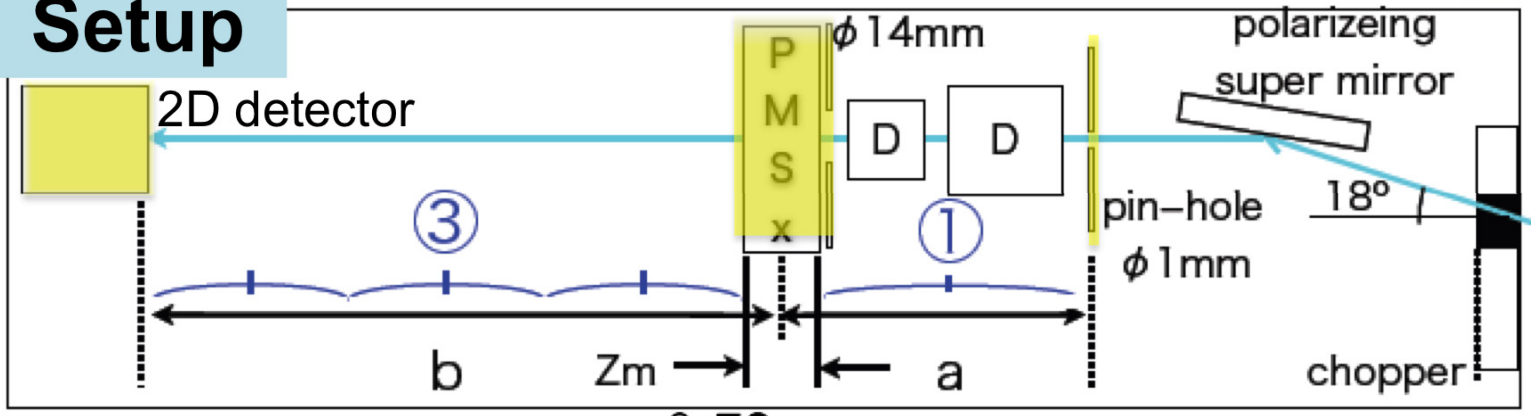
Fig7. section of the PMSx

Experiment – Focusing of VCN



PF2 VCN beam line at ILL

Setup



$$\begin{pmatrix} a=0.72\text{m} \\ b=2.14\text{m} \\ Z_f=0.54\text{m} \end{pmatrix} \Rightarrow \lambda\,(t, G)$$

Results

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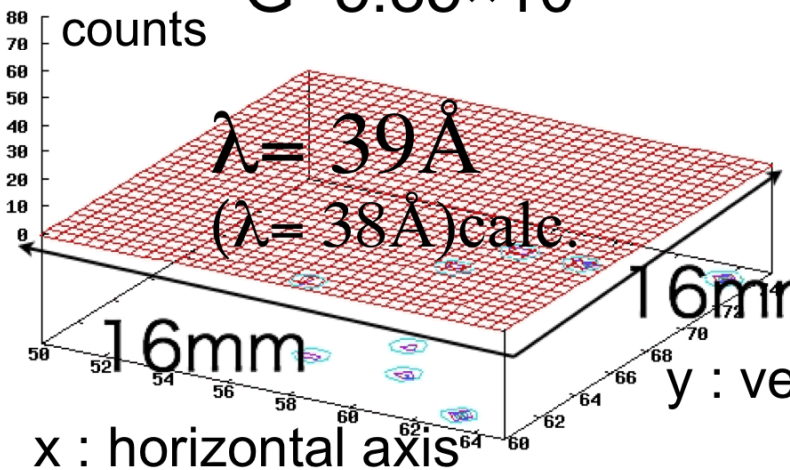
$G=5.85\times10^{-4}$



$G=3.51\times10^{-4}$