Magnetic SANS Summer School 2020
(Held February 2021)

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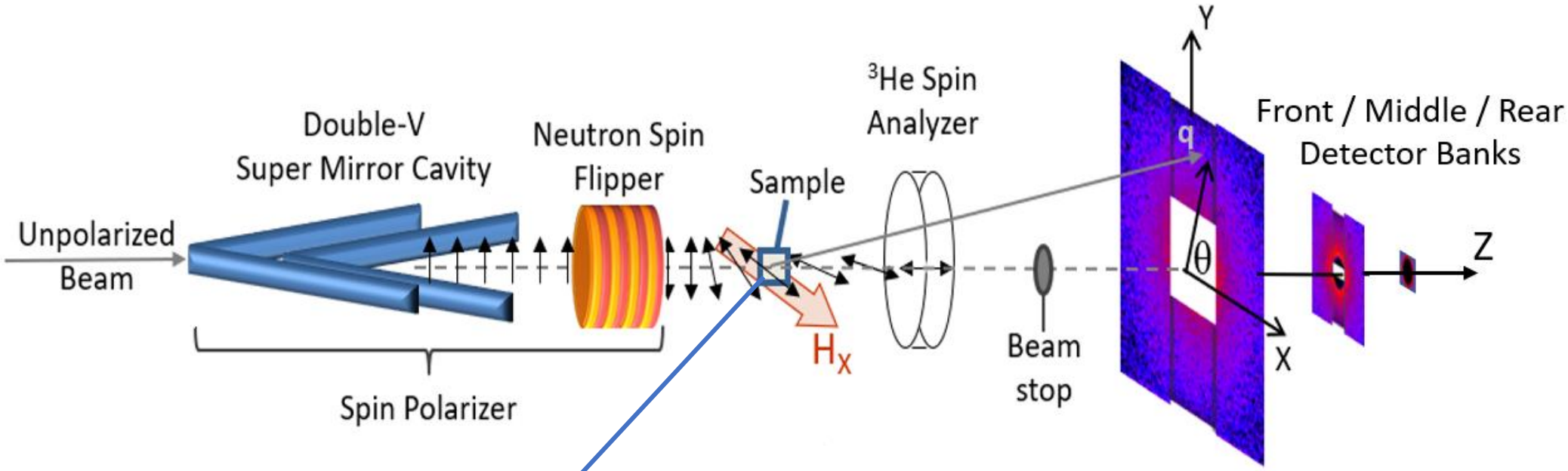
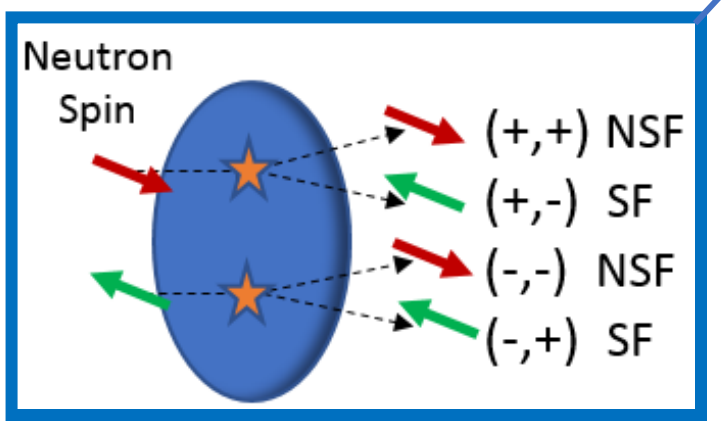
Polarization Analysis Cheat Sheet For Horizontal Magnetic Field





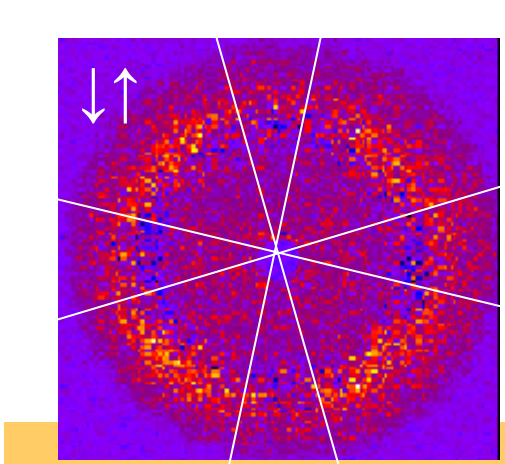
Non spin-flip (NSF) vs. Spin-flip (SF) scattering where can only measure magnetic moments, M, that are $\perp$ H

NSF → all structural scattering (N)
→ projection of (M $\perp$ Q) that is || H

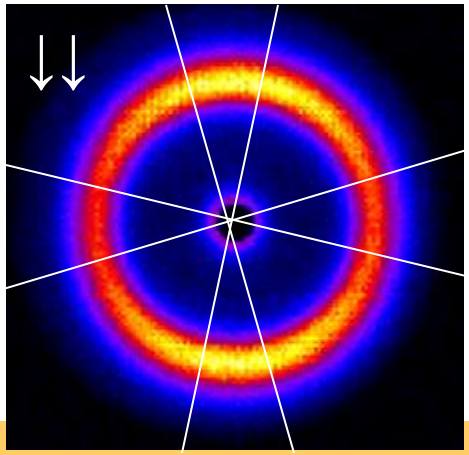
SF → the projection of (M $\perp$ Q) that is $\perp$ H

Thus, spin-flip is entirely magnetic!

Coordinate Axes Simplification (horizontal magnetic field)



$M^2_{Y \perp H} + M^2_{Z \perp H}$

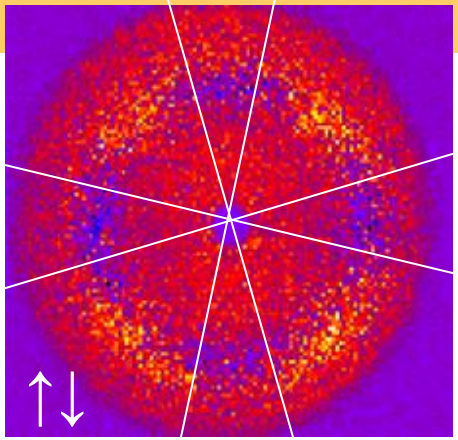


N^2

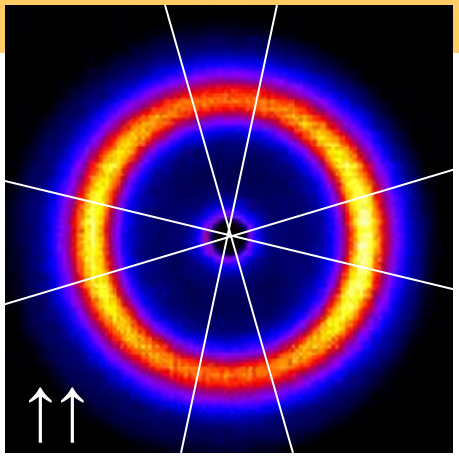
$M^2_{Z \perp H}$

$N^2 + M^2_{\parallel H} +/- 2NM_{\parallel H}$

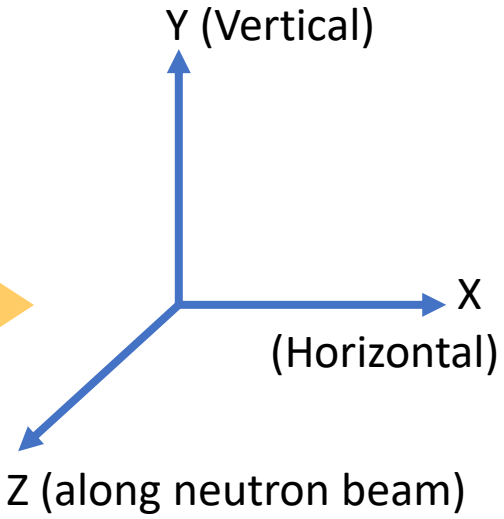
$\vec{H}$



$M^2_{Y \perp H} + M^2_{Z \perp H}$

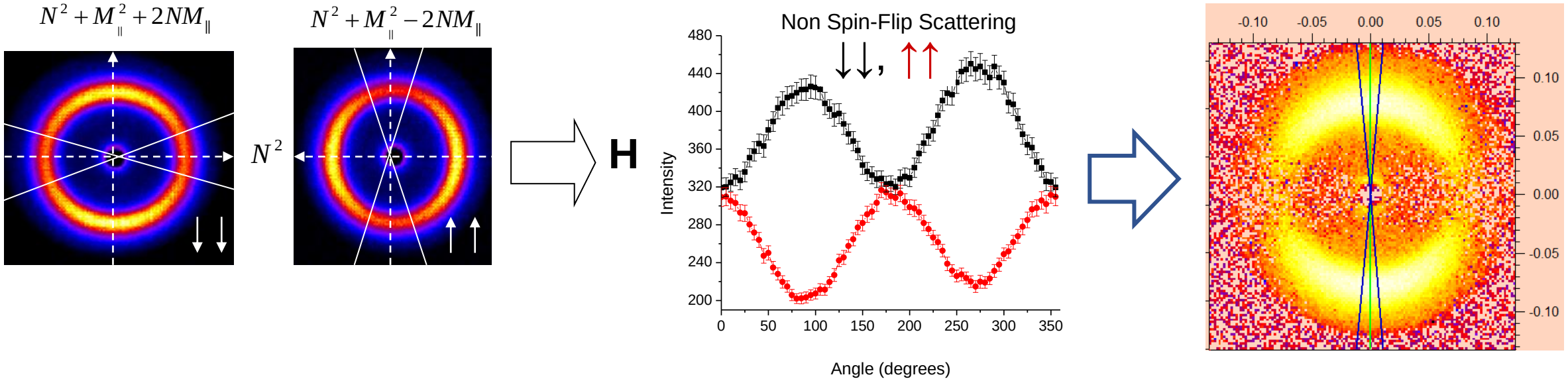


N^2



If sample is structurally isotropic, we can determine $M^2_{\parallel}$

Non Spin-Flip Scattering



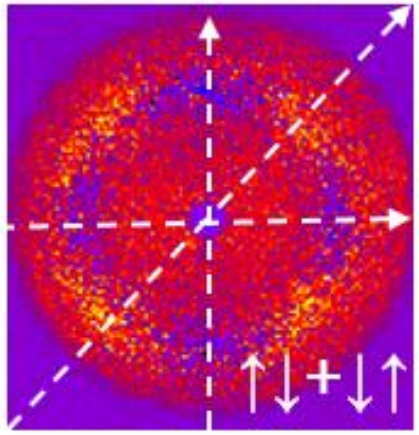
$$N^2 = (I_X^{\uparrow\uparrow} + I_X^{\downarrow\downarrow})$$

$$M_{||}^2 = (I_Y^{\uparrow\uparrow} + I_Y^{\downarrow\downarrow}) - (I_X^{\uparrow\uparrow} + I_X^{\downarrow\downarrow})$$

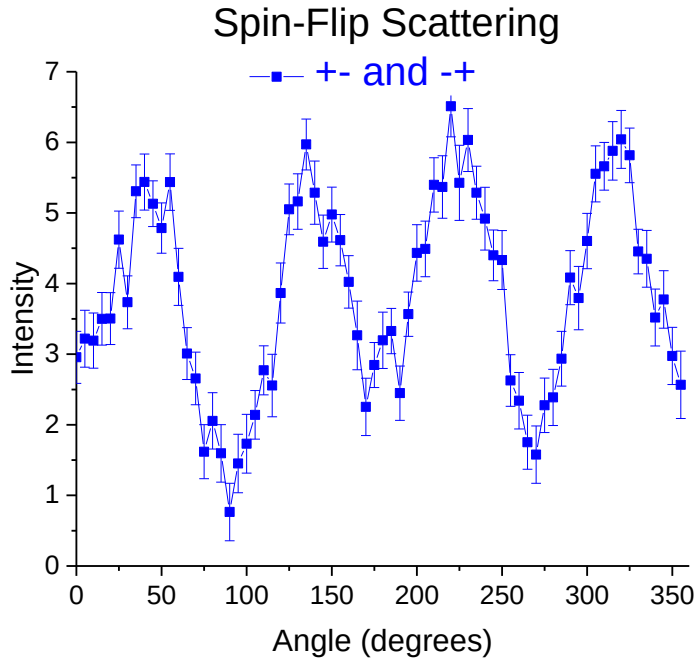
$$M_{||}^2\,(from\ NET\ moment\ parallel\ H) = (I_Y^{\downarrow\downarrow} - I_Y^{\uparrow\uparrow})^2/8N^2$$

Spin-Flip Scattering

$$M^2_{\perp OP} \quad M^2_{\parallel} + 1.25(M^2_{\perp IP} + M^2_{\perp OP})$$



$$M^2_{\perp IP} + M^2_{\perp OP}$$



Here ⊥OP (out-of-plane) means Z ⊥ H, and ⊥IP (in-plane) means Y ⊥ H.

$$M^2_{\perp H} = \left(I_X^{\uparrow\downarrow,\downarrow\uparrow}\right) = 2/3\left(I_X^{\uparrow\downarrow,\downarrow\uparrow} + I_Y^{\uparrow\downarrow,\downarrow\uparrow}\right)$$

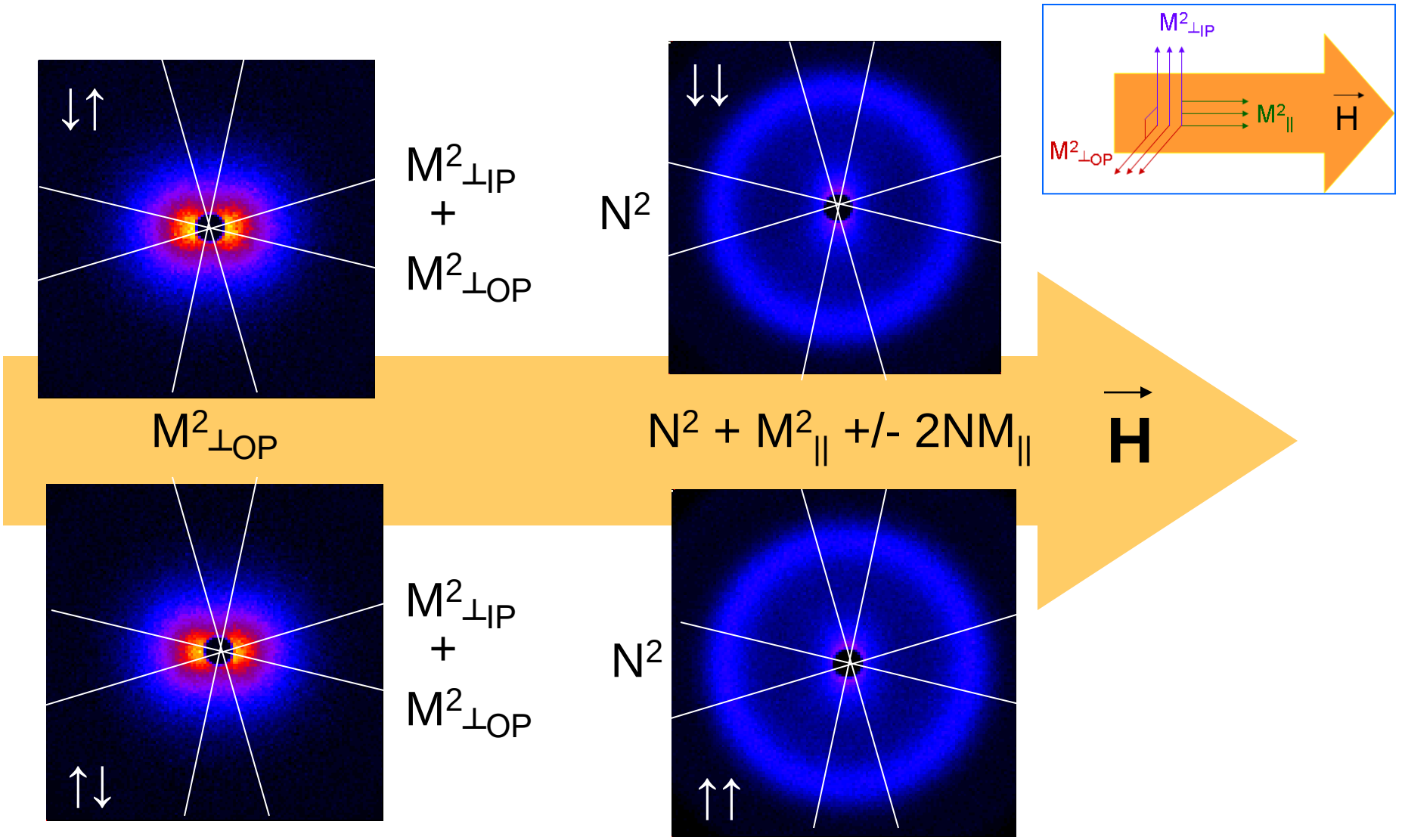
Calculation of SLD

- SLD stands for Scattering Length Density. SLD of $CoFe_2O_4$ = 6.07 x 10^{-6}Å^{-2}.
- SLD calculator: https://www.ncnr.nist.gov/resources/activation/ (to use for SLD purposes fill in Material and Absorption and Scattering sections).
- The precursor to the above link, https://www.ncnr.nist.gov/resources/sldcalc.html, gives some information on how SLD is derived if you're curious.
- magnetic SLD, ρ_m = M (in A/m) x 2.853 x 10^{-6} m/(A Å^2), where 1000 A/m = emu/cc.

Magnetic SLD of $CoFe_2O_4$ = 1.42 x 10^{-6}Å^{-2}.

- In a modeling program like SasView, the scale would be the volume fraction when the measured scattering is corrected to *intensity per cm thickness of sample*. In the case of a powder, for example, the true sample thickness is difficult to know and this becomes a simple scaling factor.

Coordinate Axes Simplification [cos(θ) and sin(θ) → 1 or 0]



1.2 Tesla $CoFe_2O4$: Log Scale