Difference in thickness of iron thin film

2021/07/13~17 BL05

Akatuka Hiroaki, HIguchi Takashi

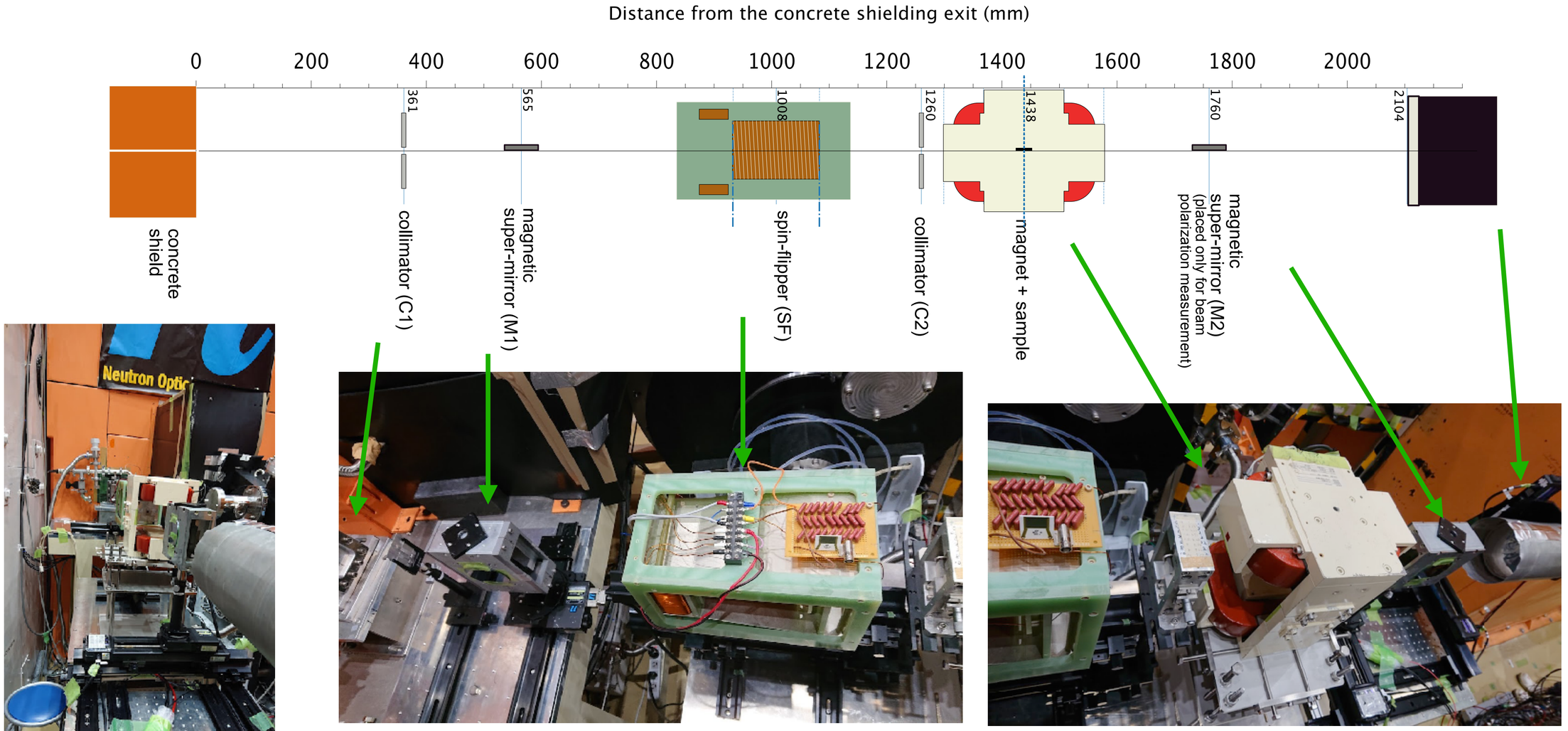
目次

- 目的
- 実験セットアップ
- 実験結果 (q vs R, B(mT) vs Pのグラフ)
-

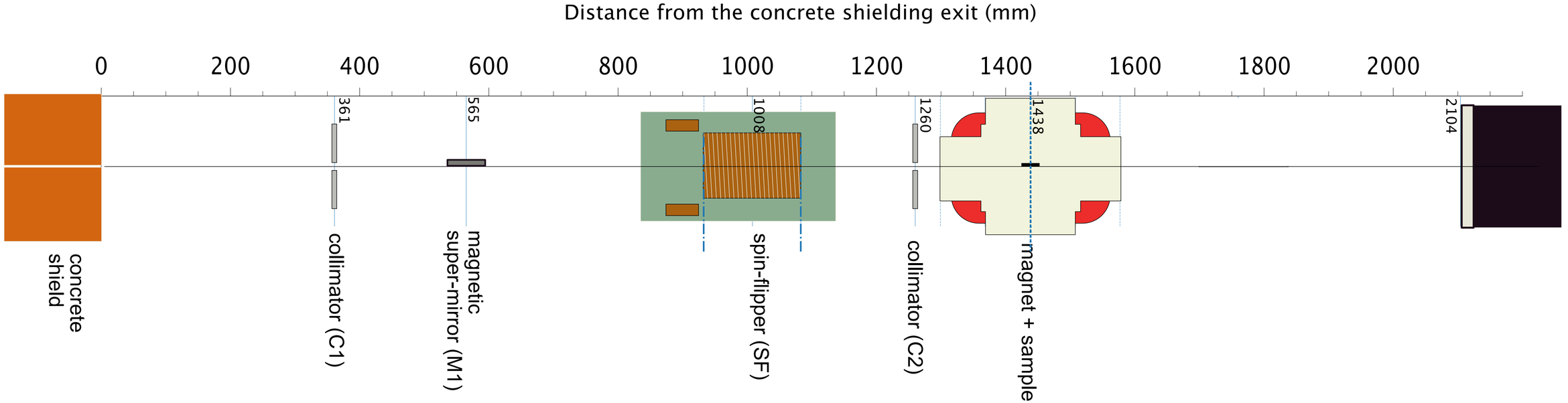
目的

- 鉄薄膜がどの程度の磁場によって磁化するかを測定

Setup 鉄薄膜の反射率測定



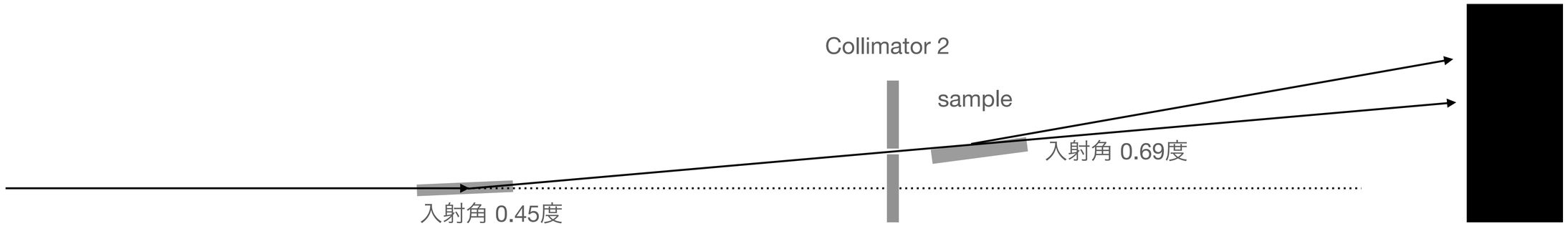
Setup 鉄薄膜の反射率測定



0.45度

~0.69度

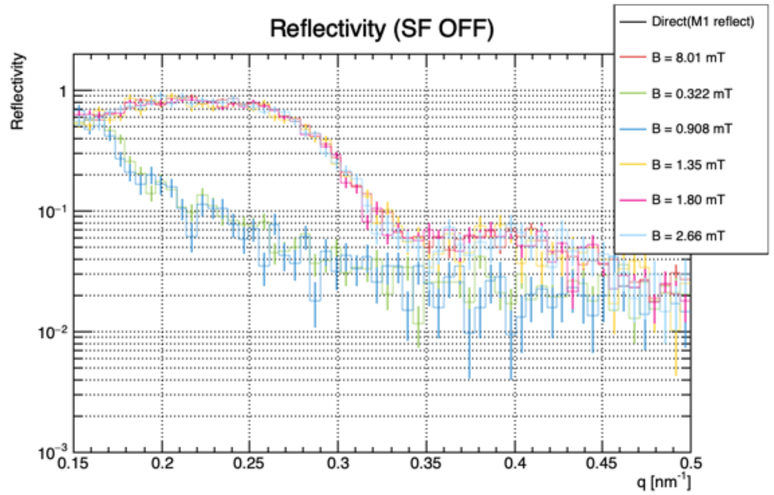
(Fe 30 nm, 50 nm, 90 nm)

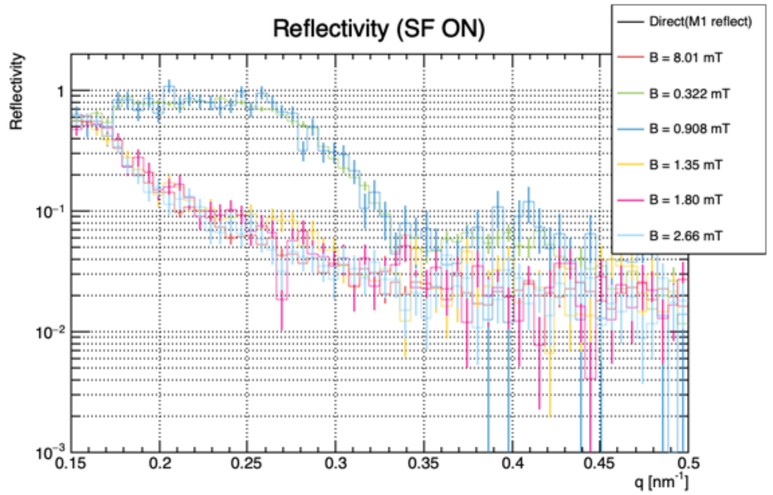


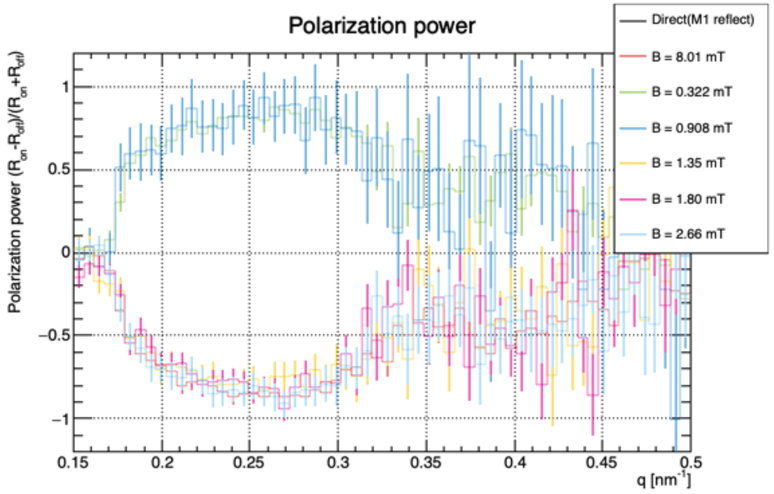
q-dependence of the polarization power (Fe 30nm)

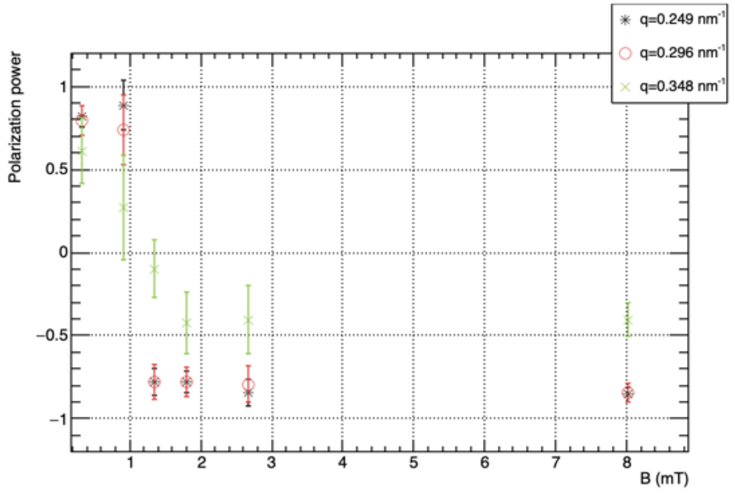
Color coding by the magnitude of the magnetic field applied to the sample

$$P = \frac{R_{\mathrm{on}} - R_{\mathrm{off}}}{R_{\mathrm{on}} + R_{\mathrm{off}}}$$



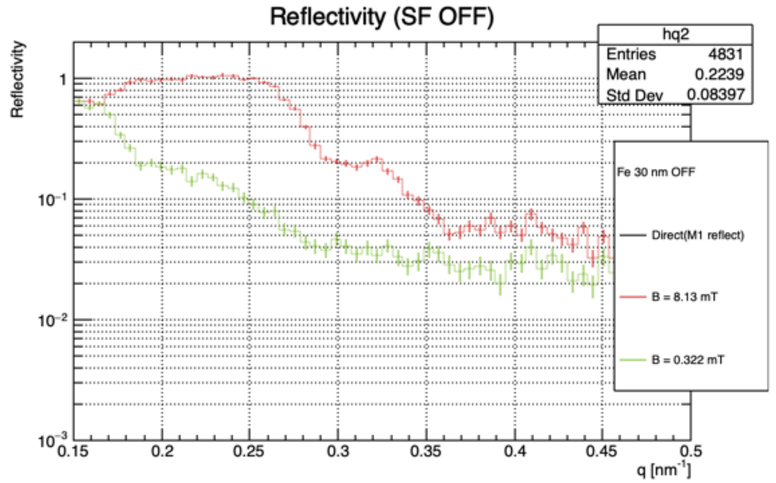


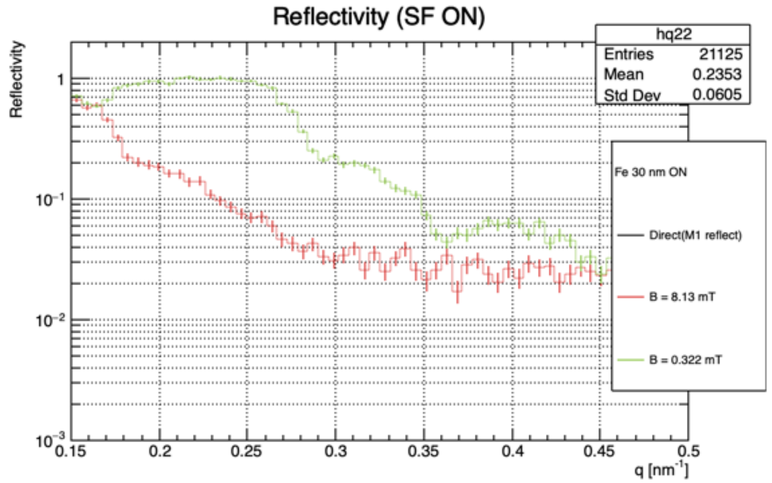


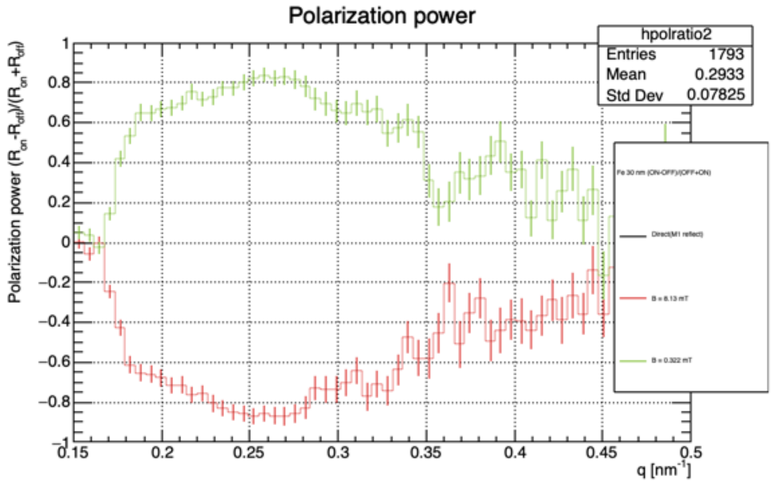


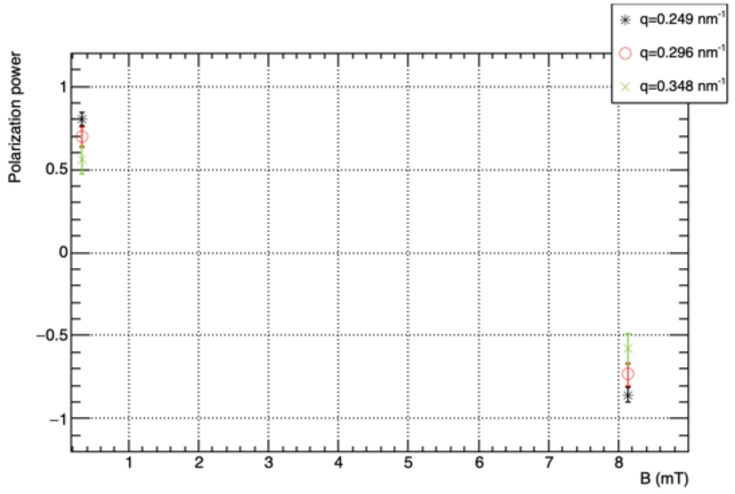
q-dependence of the polarization power (Fe 50nm)

Color coding by the magnitude of the magnetic field applied to the sample



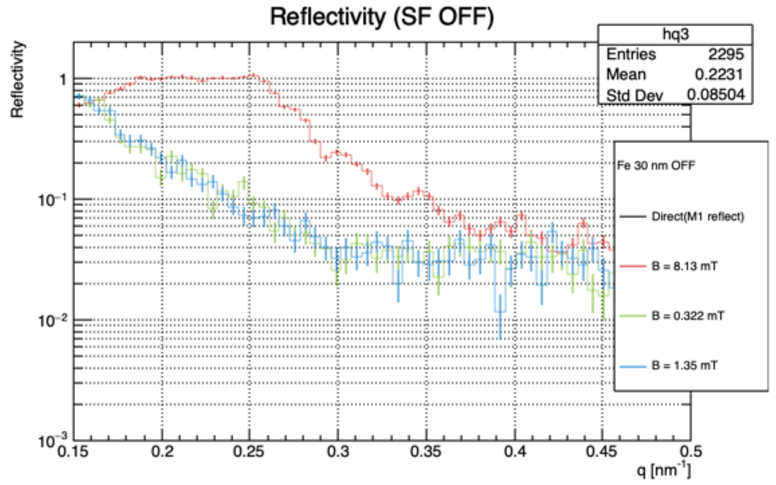


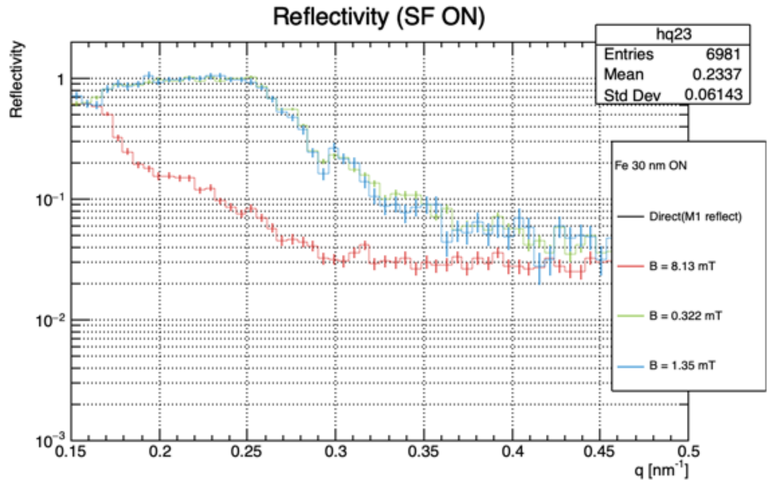


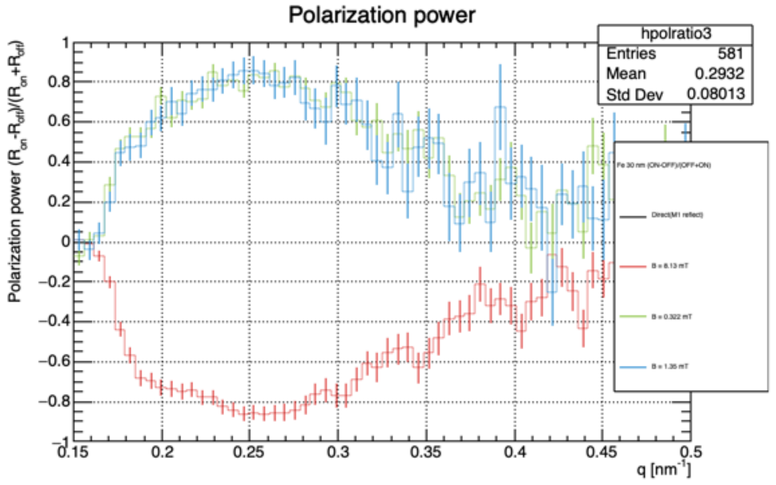


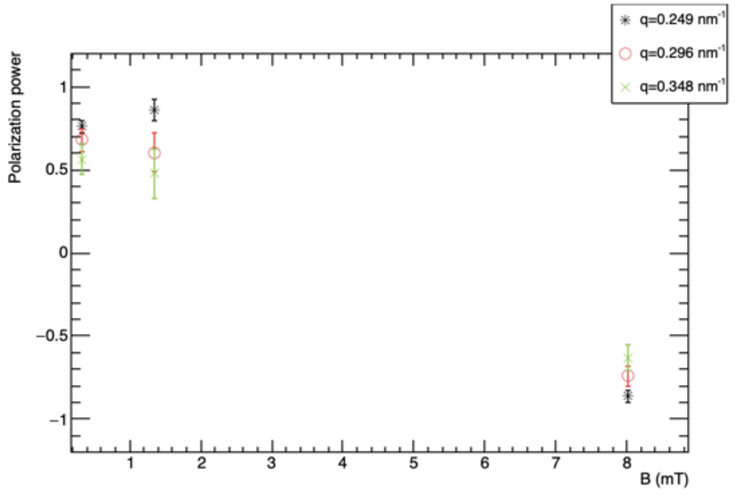
q-dependence of the polarization power (Fe 90nm)

Color coding by the magnitude of the magnetic field applied to the sample

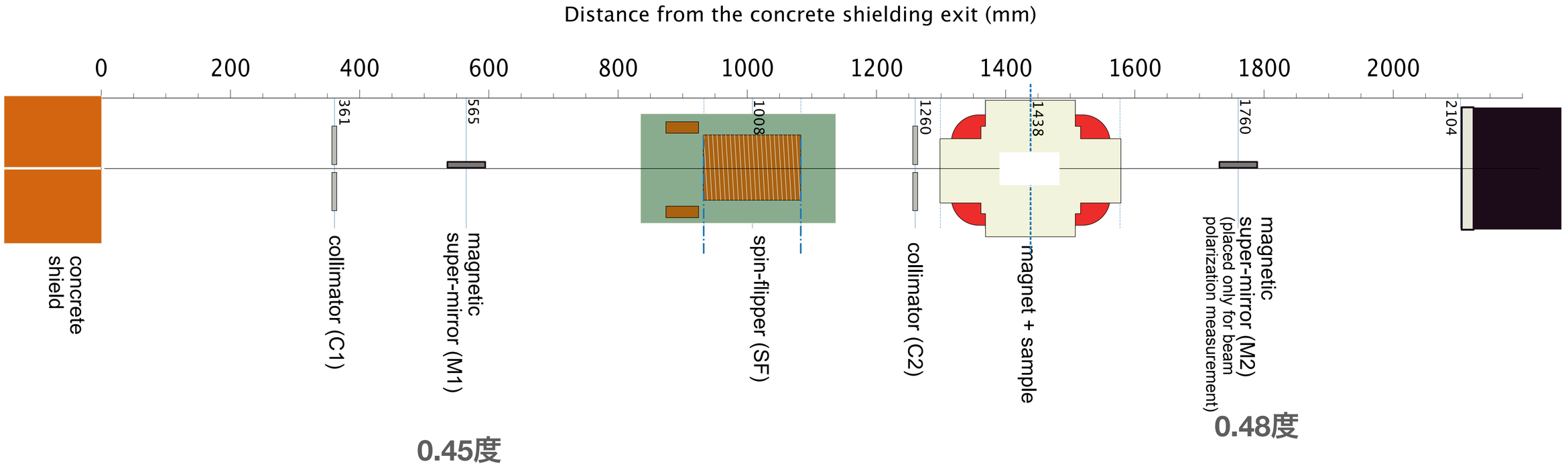






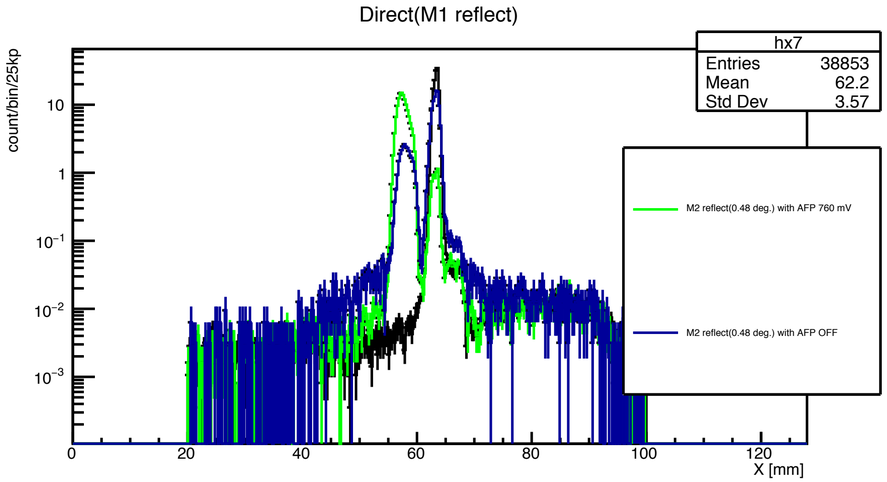


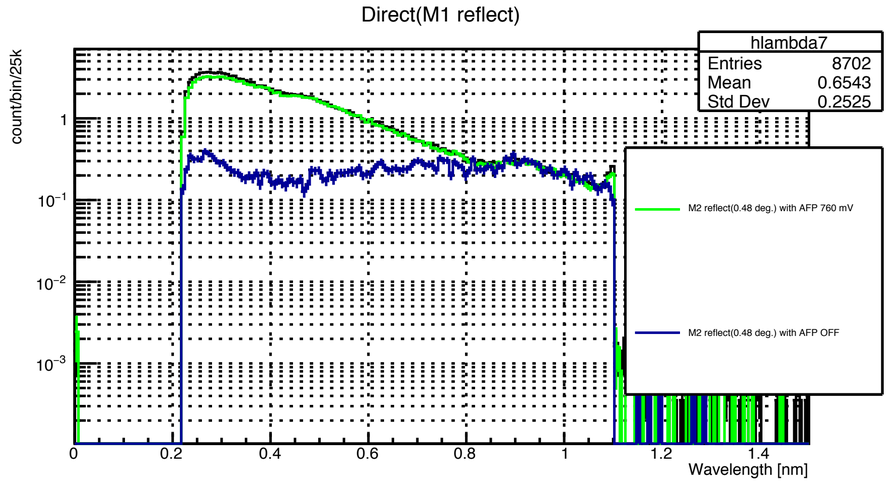
Setup M2による偏極率測定 (サンプルの代わりにM2を置いて測定)

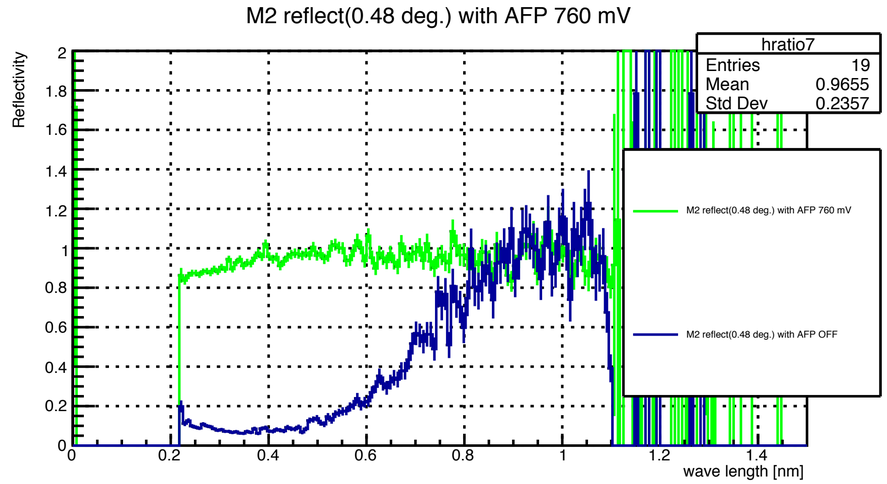


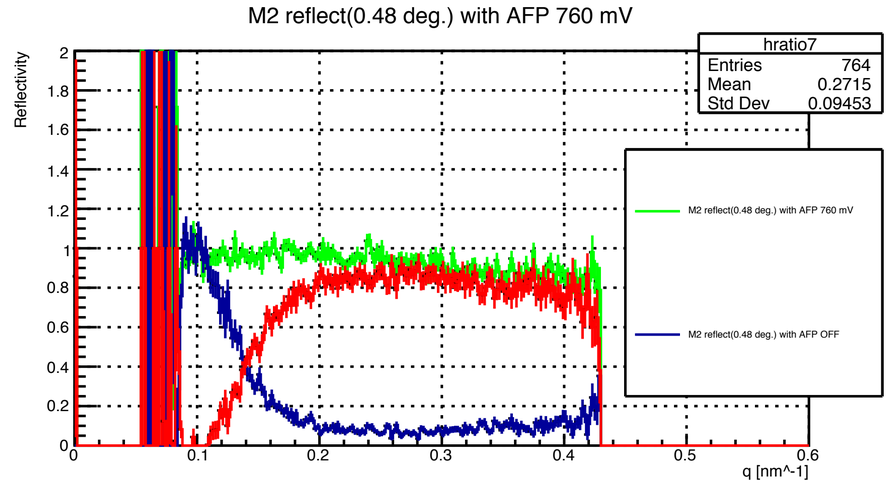
SF, M2の性能

Direct, SF OFF, SF ON, Polarization rate



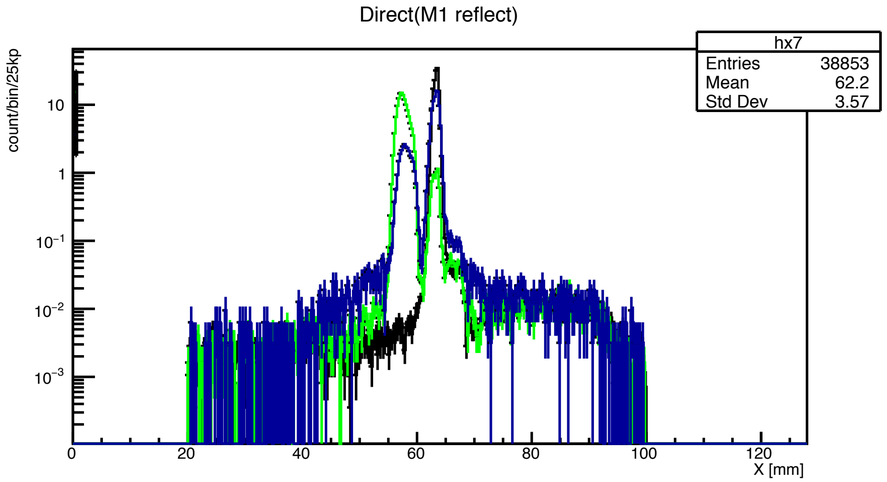


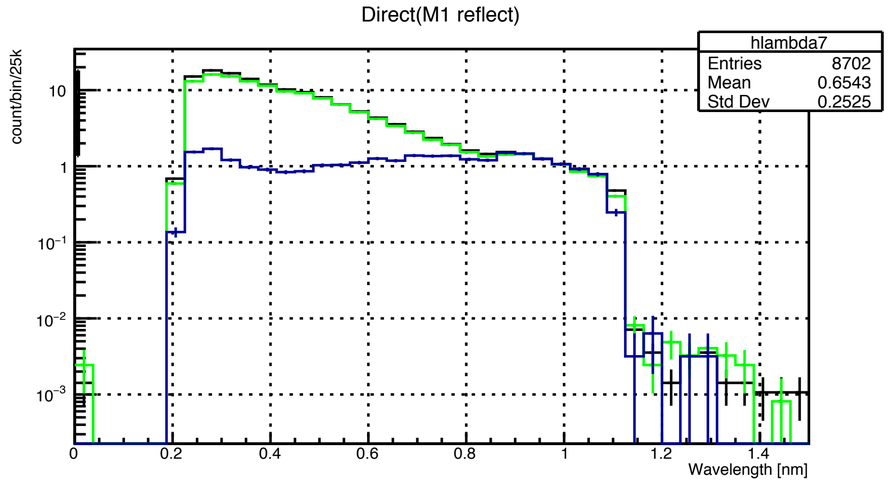


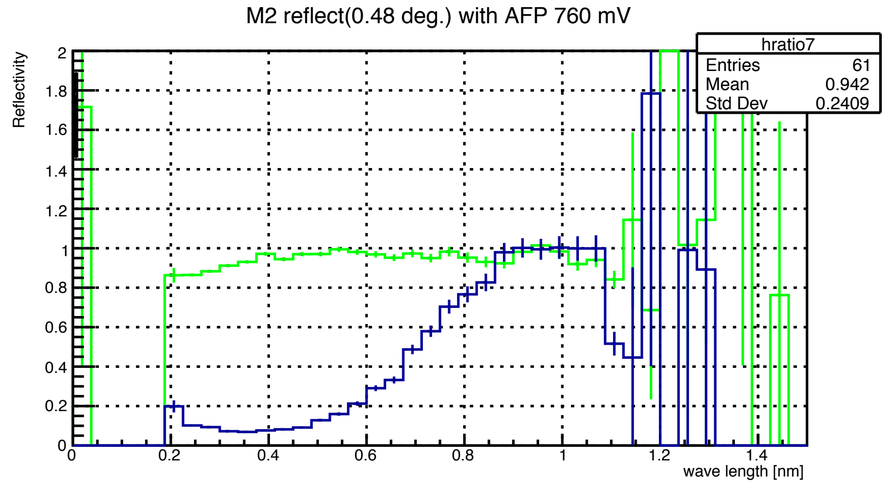


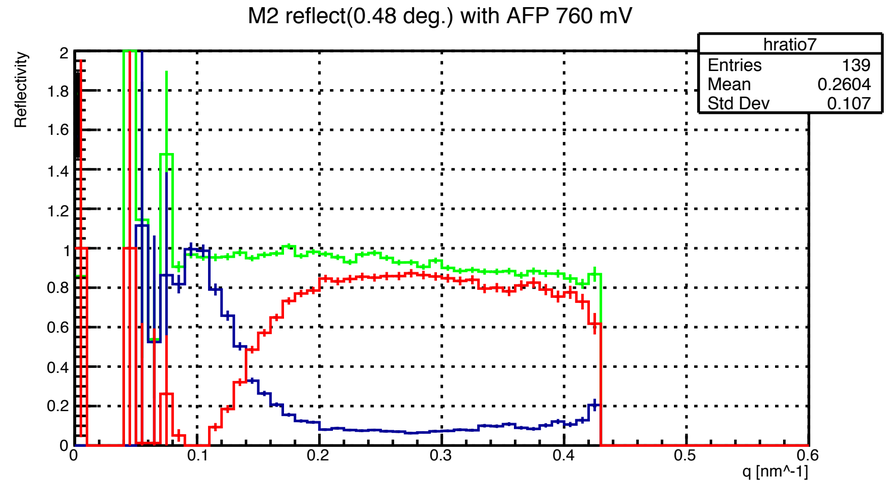
SF, M2の性能 [Rebin(5)]

Direct, SF OFF, SF ON, Polarization rate





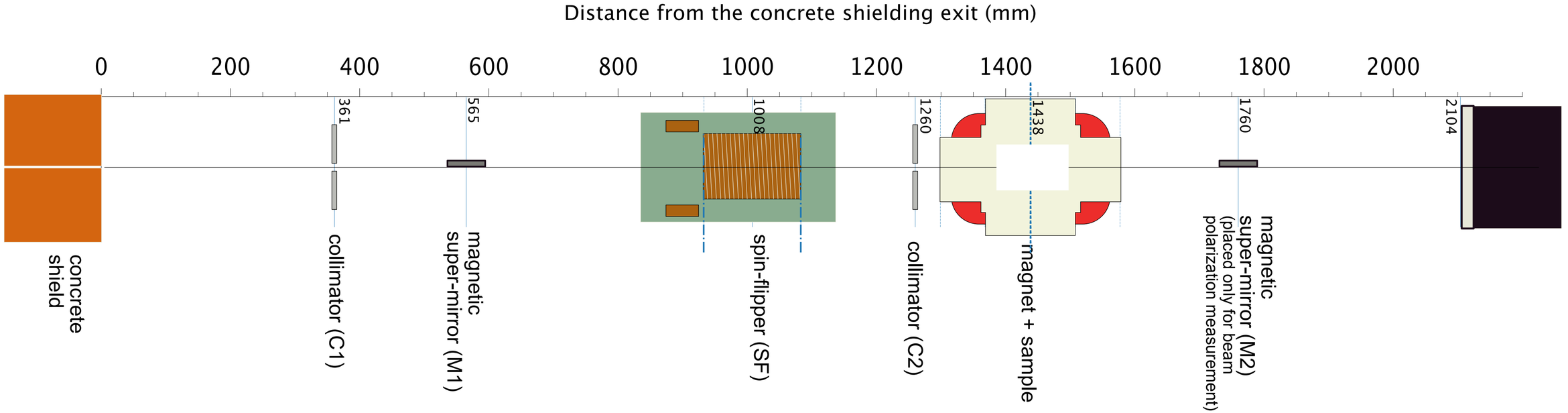




Back up

- セットアップ
- 何も置かないスペクトル
- m1のみ、m1,m2のみ、サンプル
- 1枚目に置いていないダイレクト？

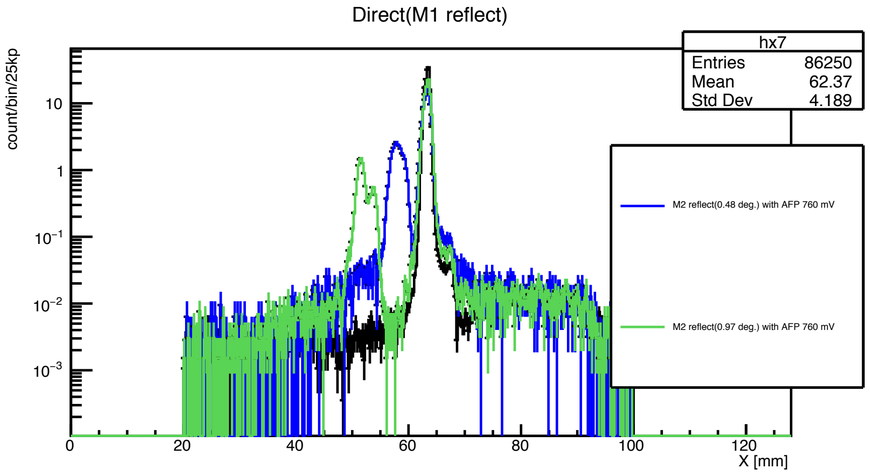
Setup (Comparison of incidence angles with different m2)

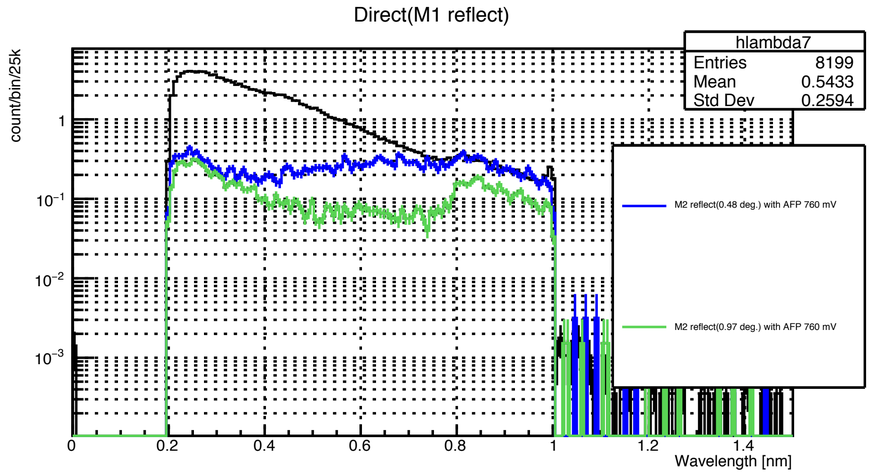


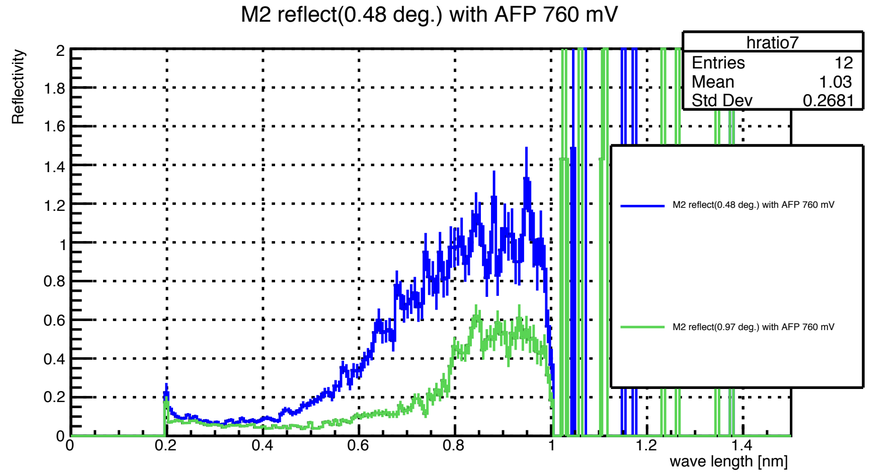
Comparison of incidence angles with different m2

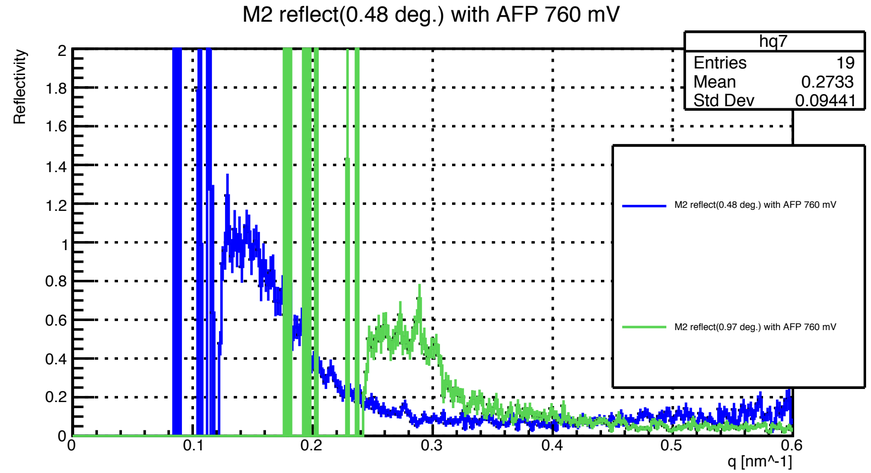
incidence angle m2 0.48deg vs 0.97deg (8.01mT, AFP ON)

上流のミラーの角度は？
二個の臨界角が求まる
・スピンupのみ全反射
updown両方全反射



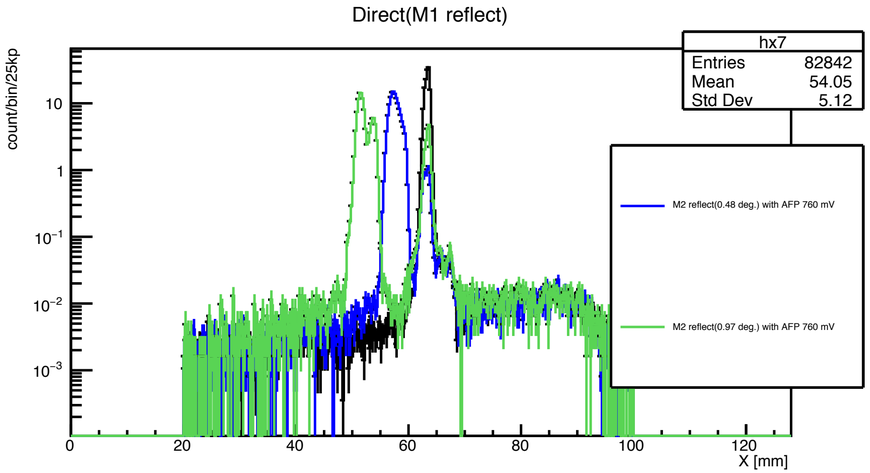


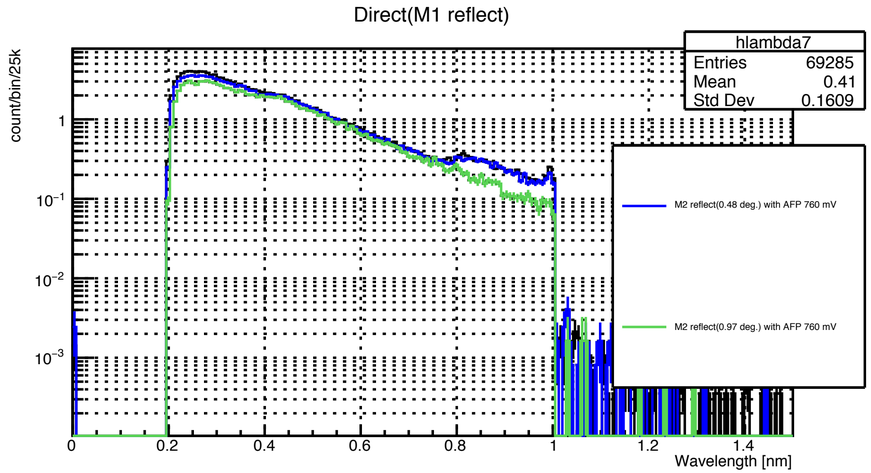


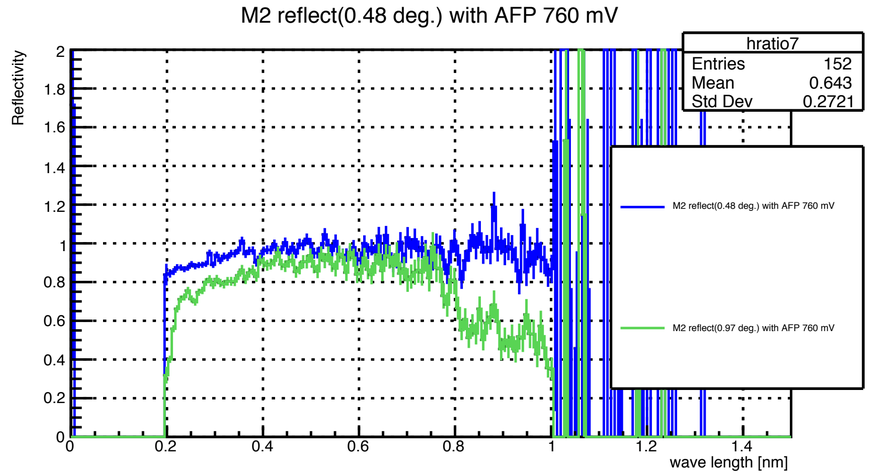


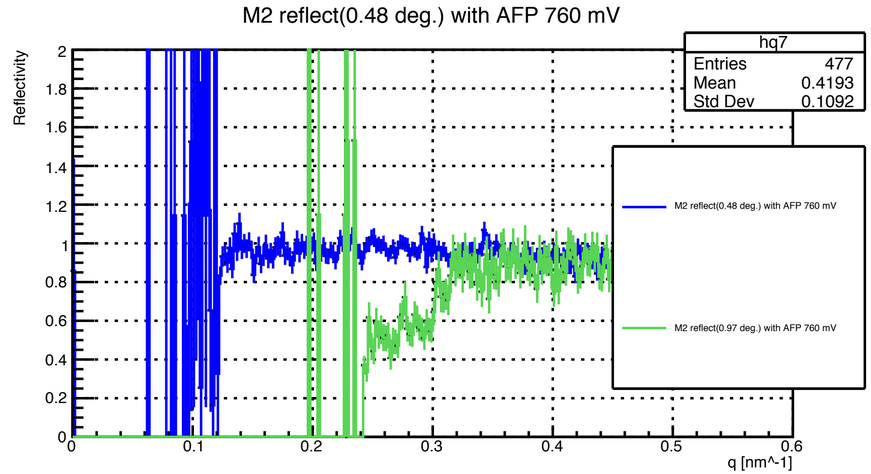
Comparison of incidence angles with different m2

incidence angle m2 0.48deg vs 0.97deg (8.01mT, AFP OFF)



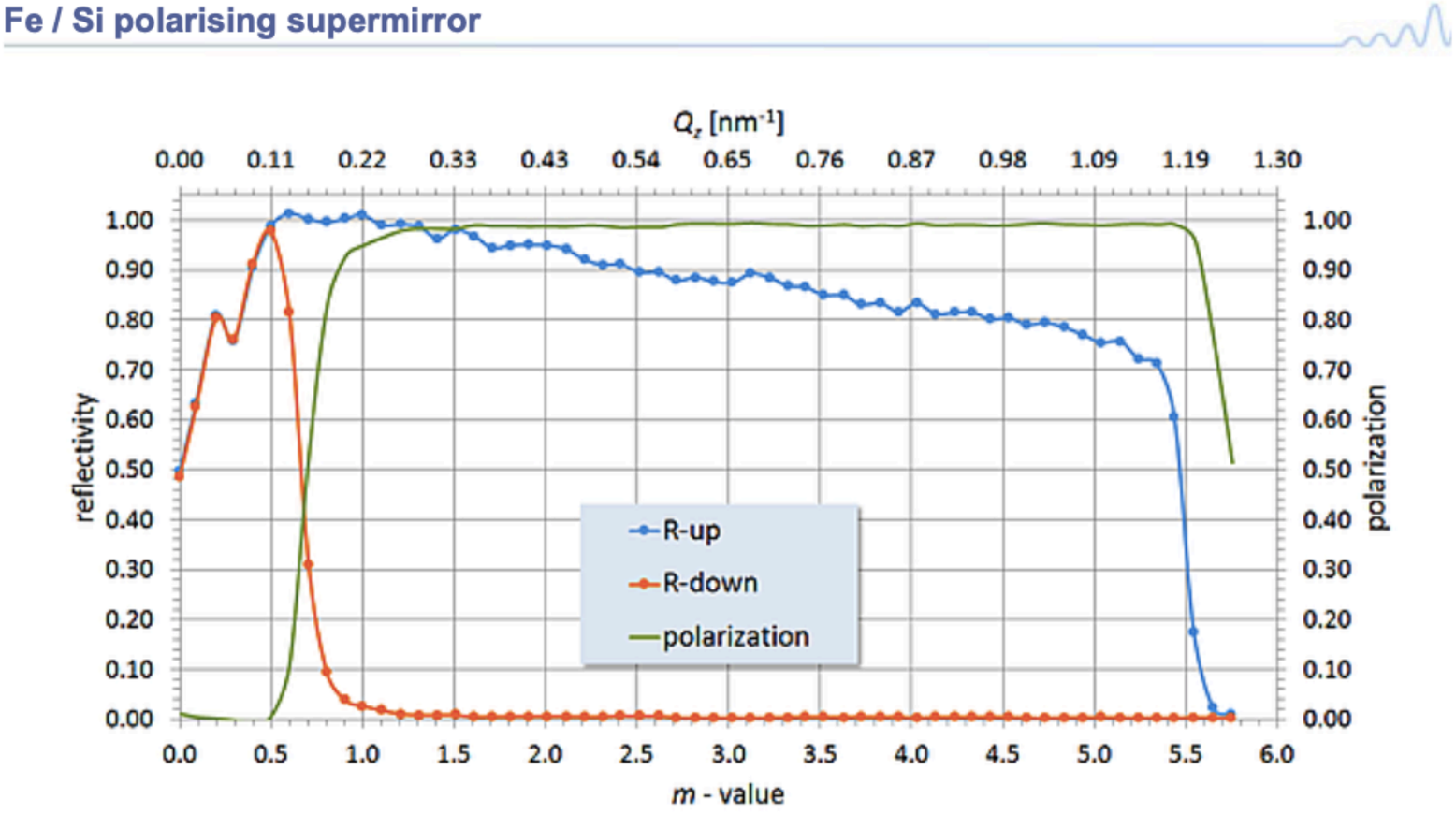






ミラーの性能

$0.3 < q < 1.1$であれば偏極率$P \sim 1$、 $q \sim 0.2$で$P > 0.9$



Spin dependent reflectivity and polarization of a Fe/Si polarizing supermirror m = 5.5

Determination of peak position

Determine the peak from the average of the histogram over the selected range

範囲の選択の仕方によって

± 1 mm程度ずれてくる(選択範囲を示す)

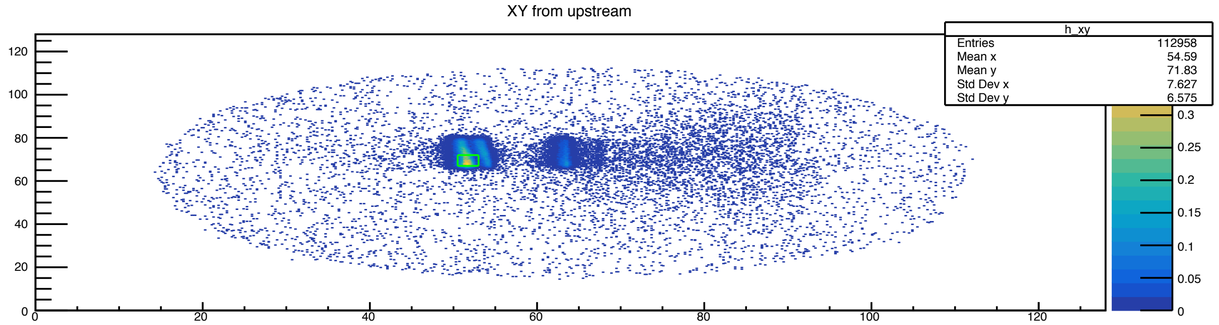
$$2\sin\theta_{m_2} \sim \frac{x_{\text{peak}} - x_{\text{direct}}}{x_{m_2 \sim \text{det}}}$$

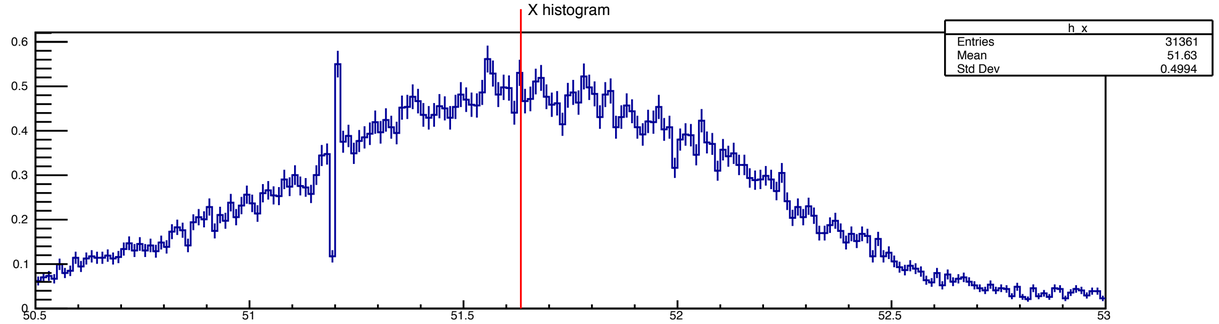
$$= \frac{\sqrt{1^2 + 1^2}}{344} = 0.0041$$

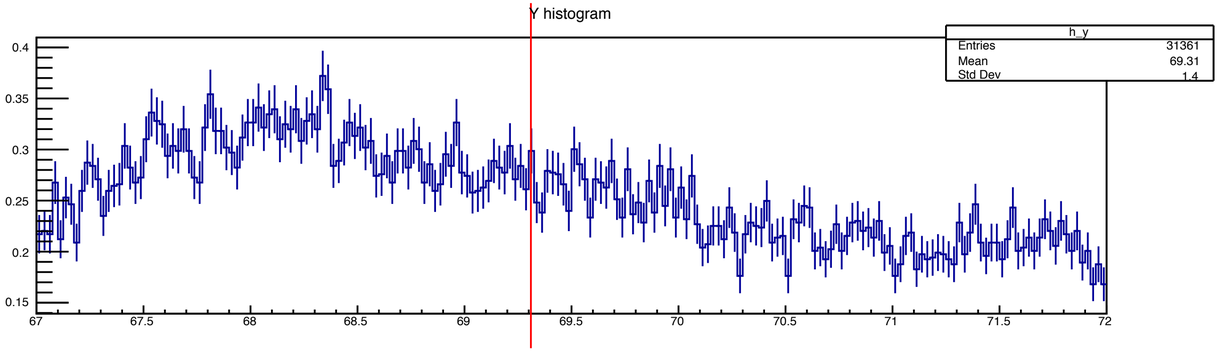
$$q_{\text{error}_{\max}} = \frac{2\pi}{0.2} \times 0.0041 \sim \pm 0.13$$

どのようにピークを決定すべきか？

サンプルを変えた時にqがずれてくる







$$q = \frac{4\pi \sin\theta}{\lambda}$$

$\lambda(0.2 \sim 1\,\text{nm})$

磁場測定と業者の測定と比較

妥当性を検証？　残差のプロット? 磁場を変える精度が3%ある？

- 業者の測定

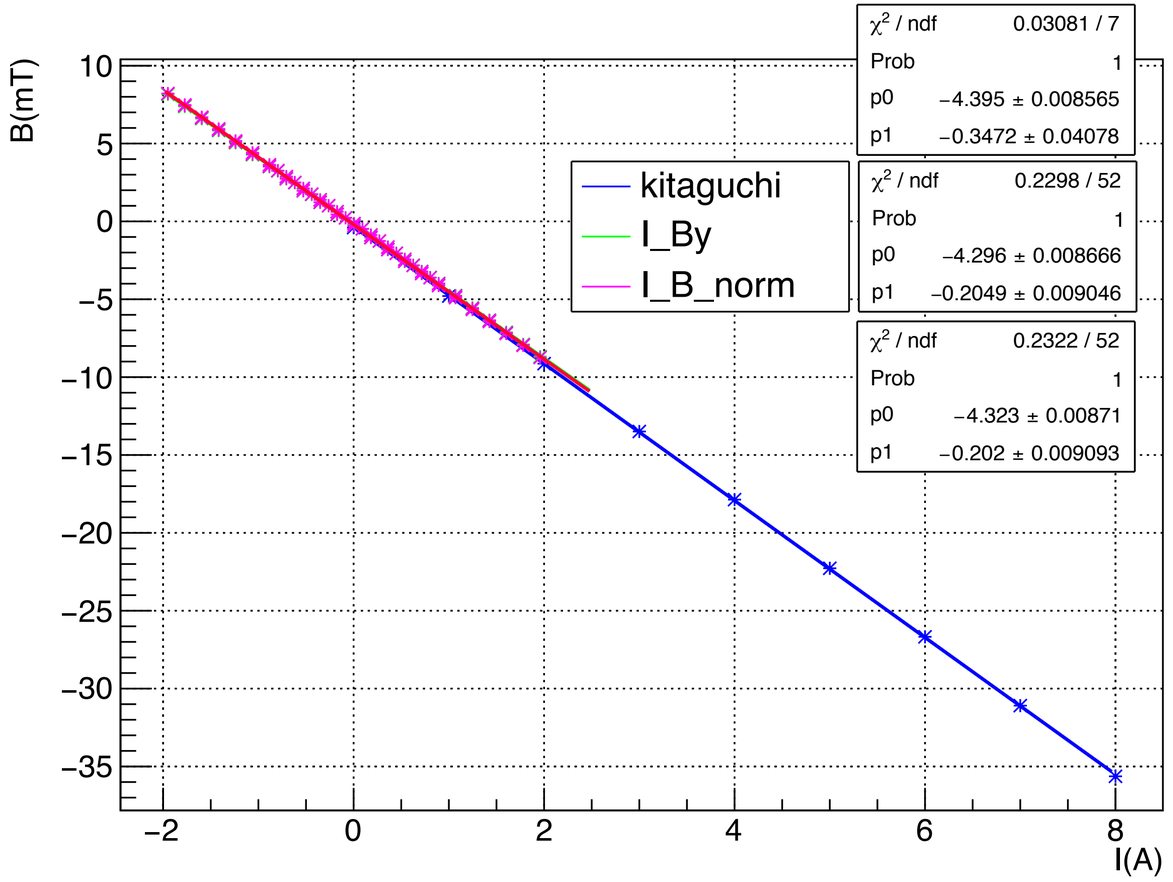
$$B_{\mathrm{kitaguchi}}(\mathrm{mT}) = -4.395(9)\frac{\mathrm{mT}}{A}I_{\mathrm{real}} - 0.34(4)$$

- 今回の測定(y方向)

$$B_{y}(\mathrm{mT}) = -4.296(9)\frac{\mathrm{mT}}{A}I_{\mathrm{real}} - 0.205(9)$$

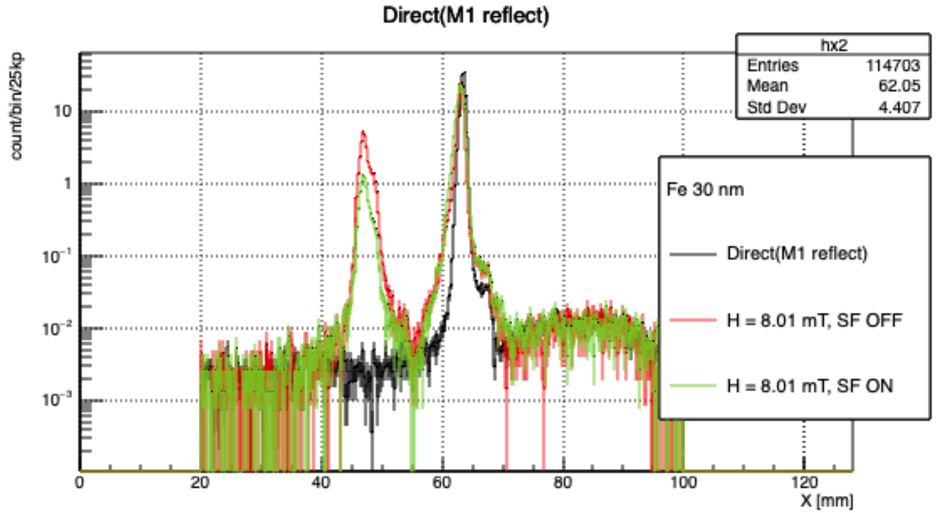
- 今回の測定(ノルム)

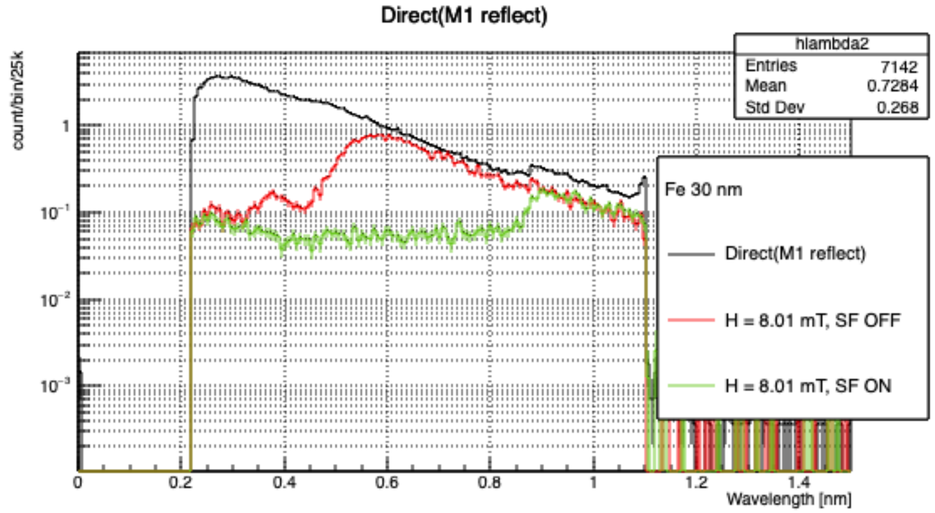
$$B_{\mathrm{norm}}(\mathrm{mT}) = -4.323(8)\frac{\mathrm{mT}}{A}I_{\mathrm{real}} - 0.202(9)$$

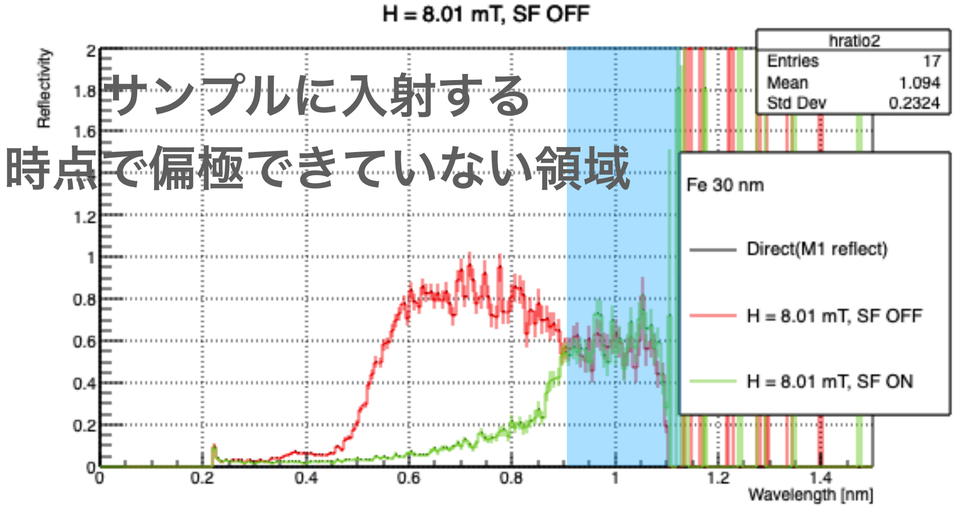


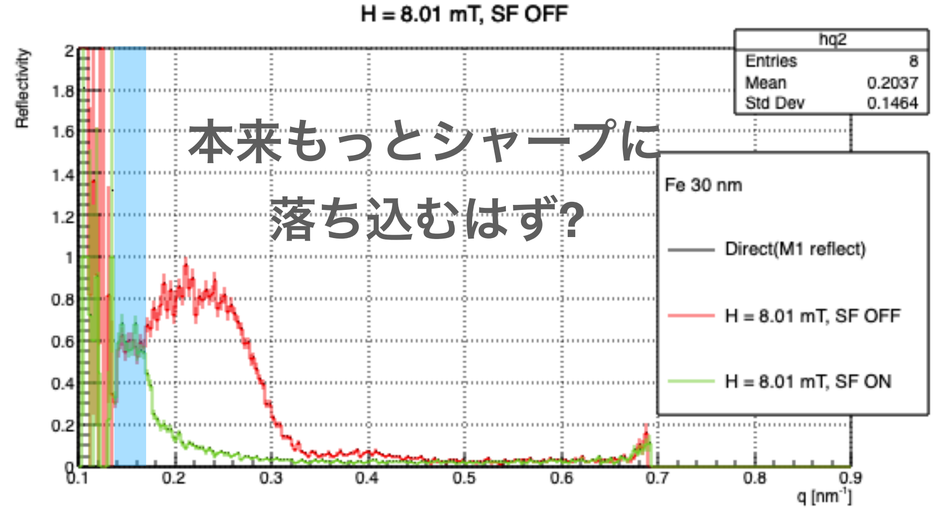
sample 30 nm 8.01 mT (saturated)

緑をとるには、上流ミラーの角度を深くする必要がある

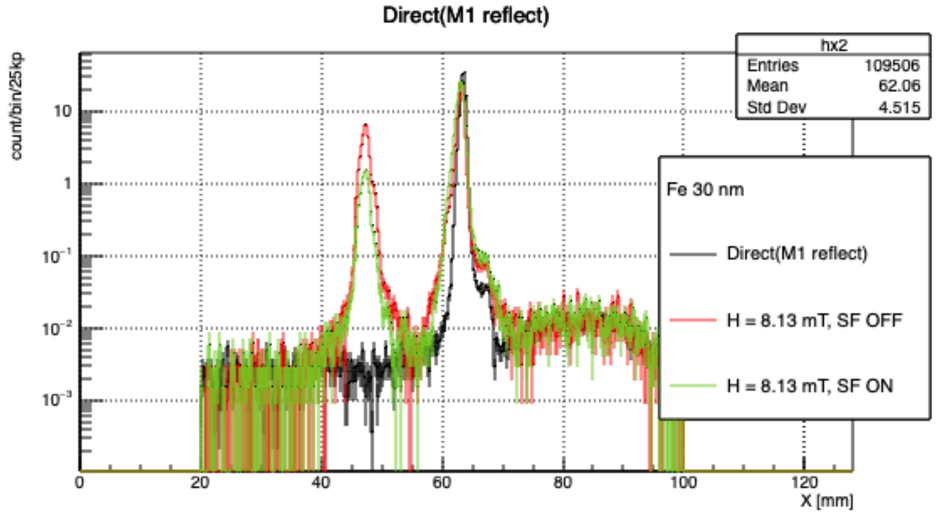


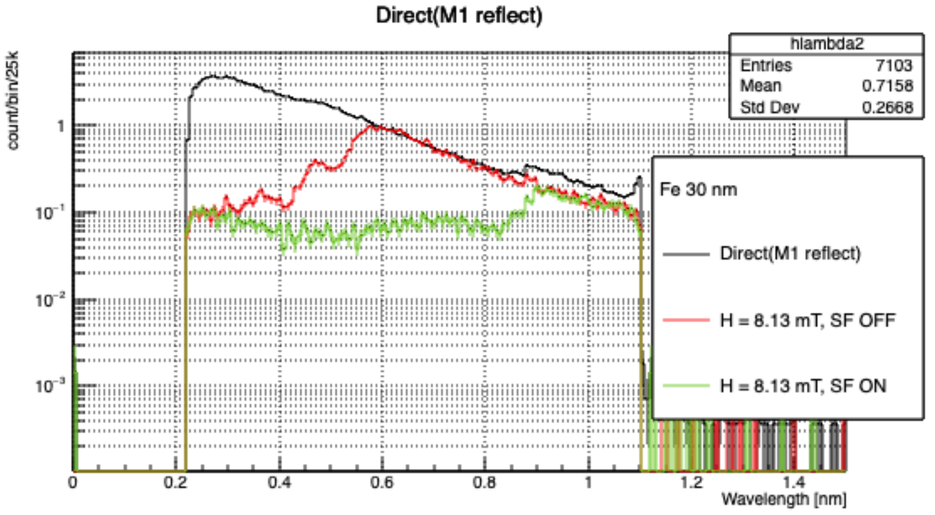


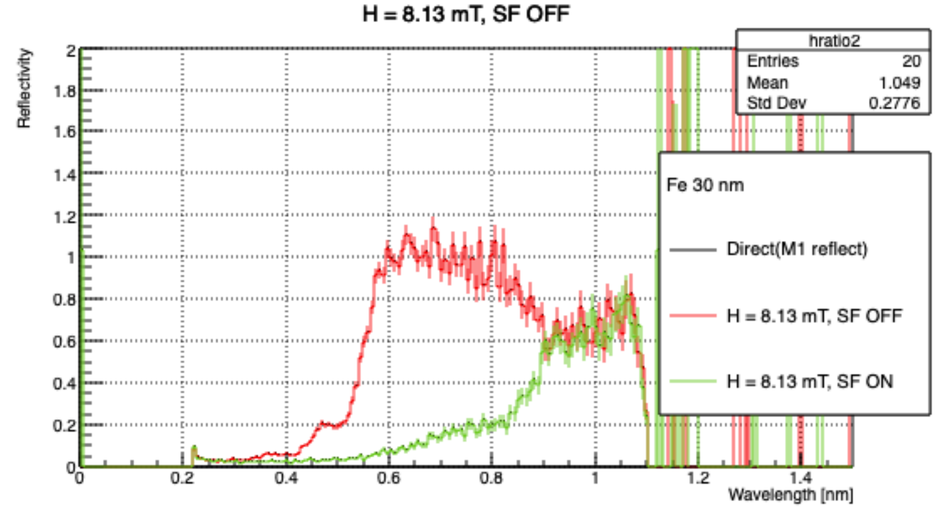


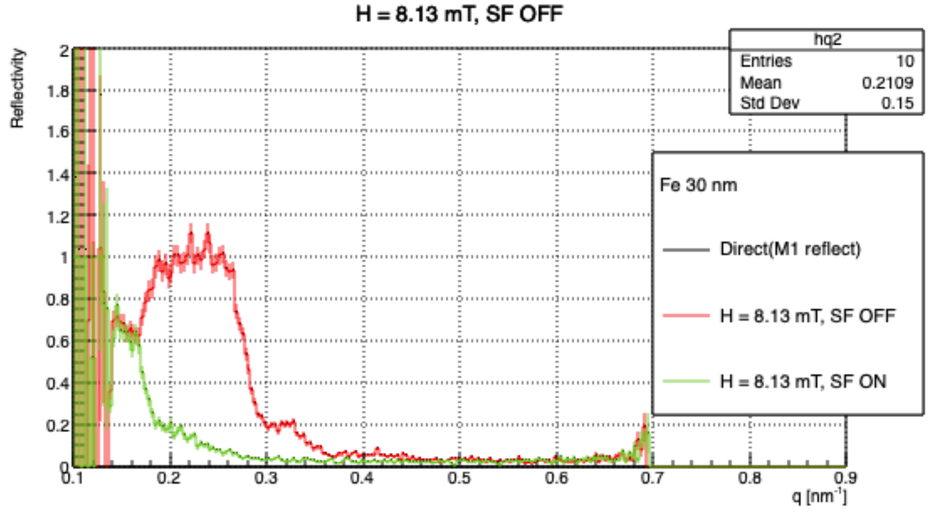


sample 50 nm 8.13 mT (saturated)

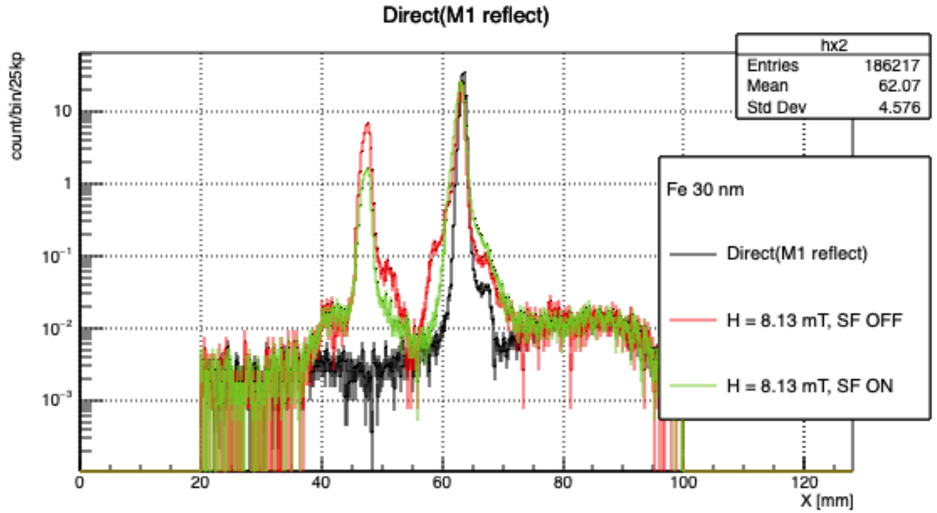


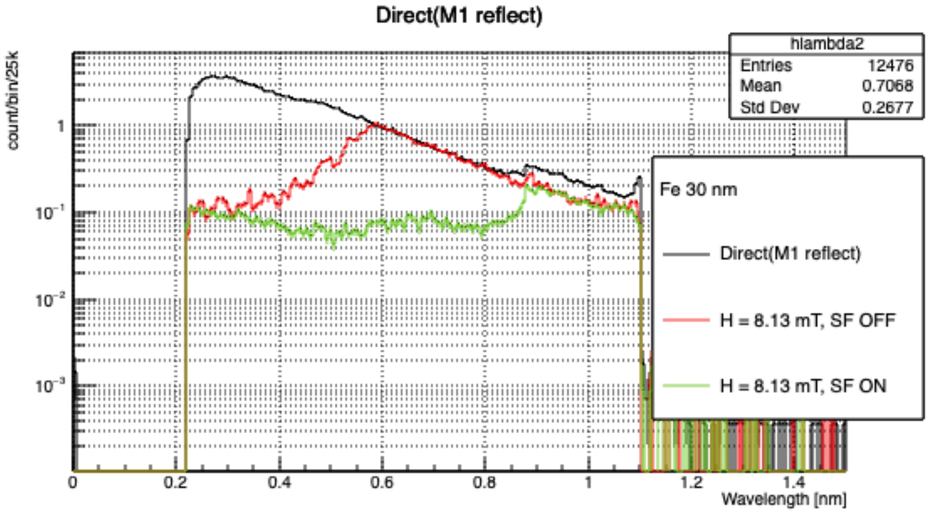


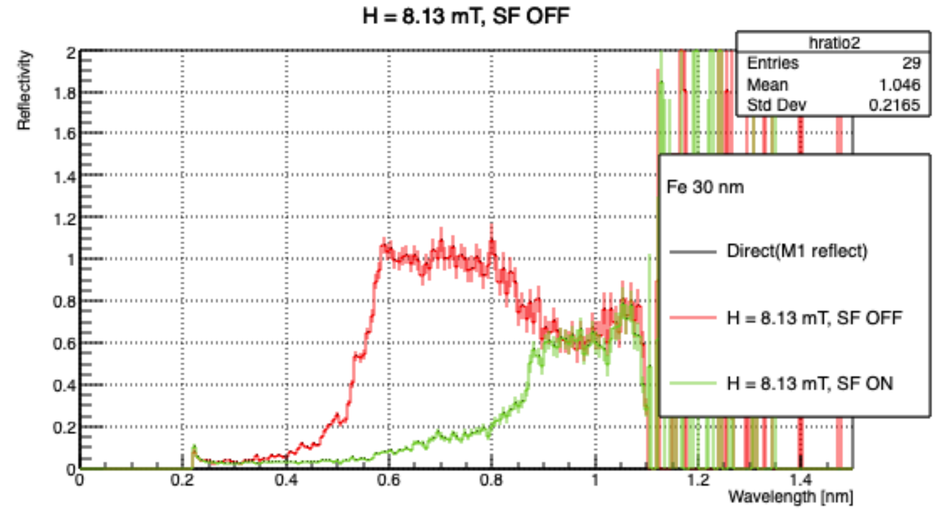


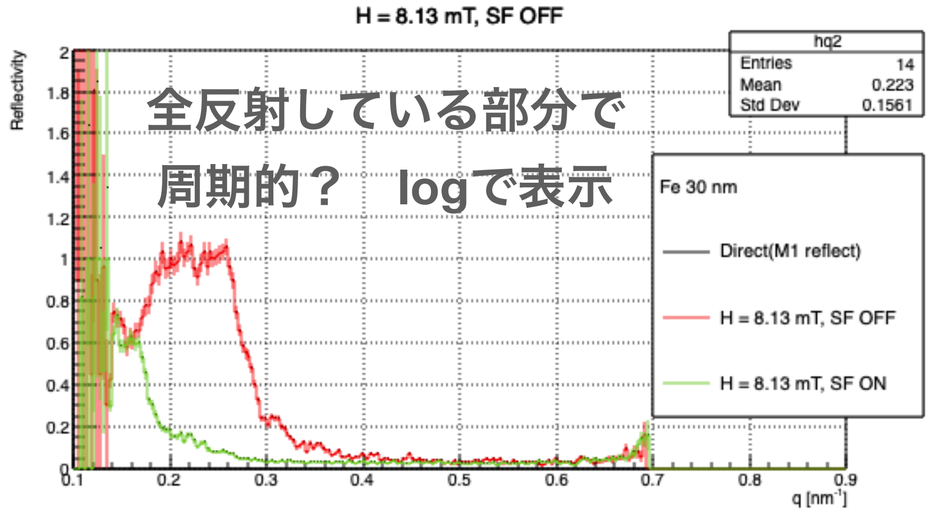


sample 90 nm 8.13 mT (saturated)

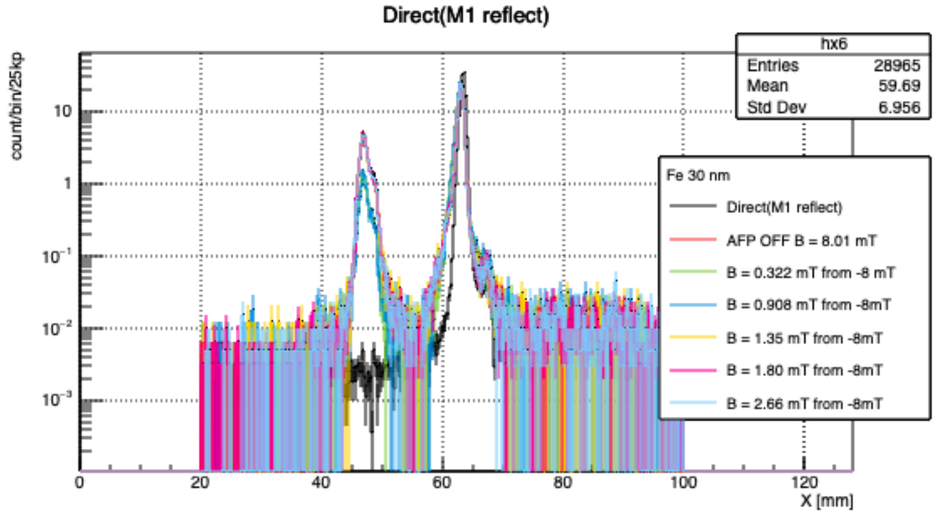


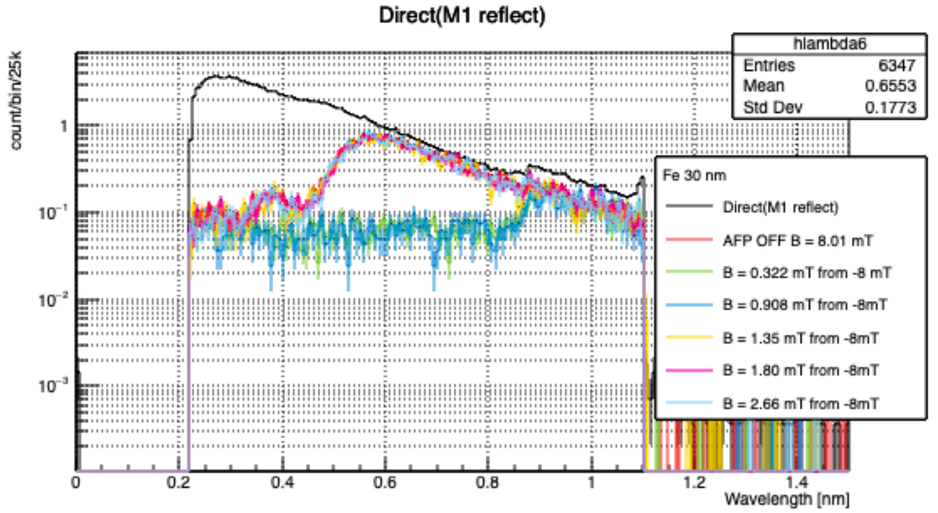


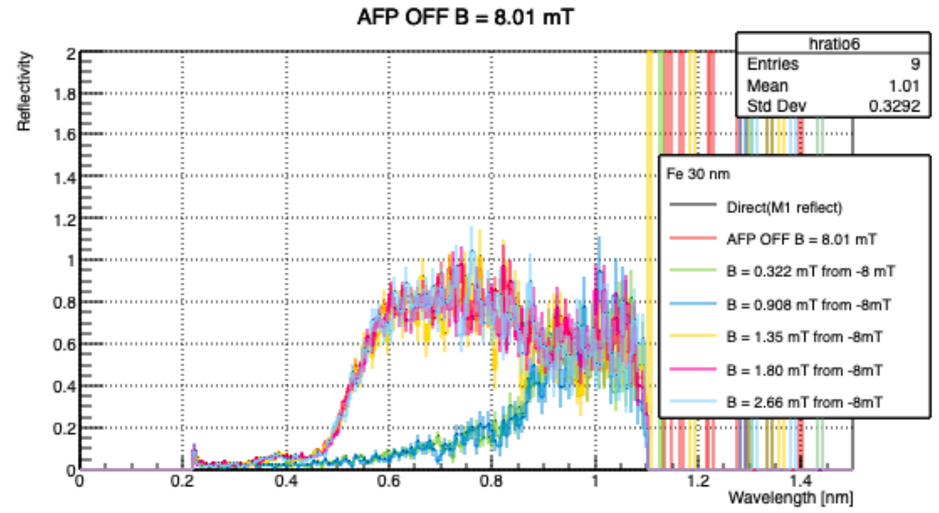


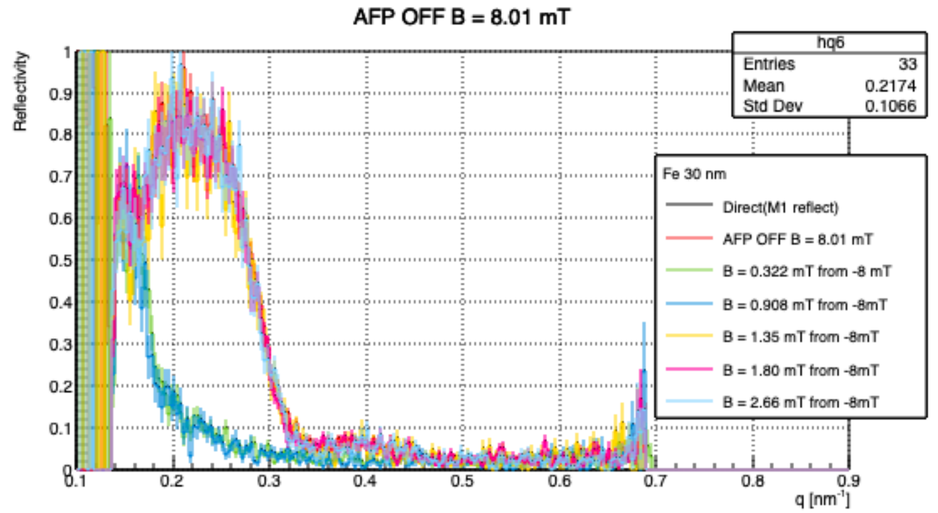


AFP OFF

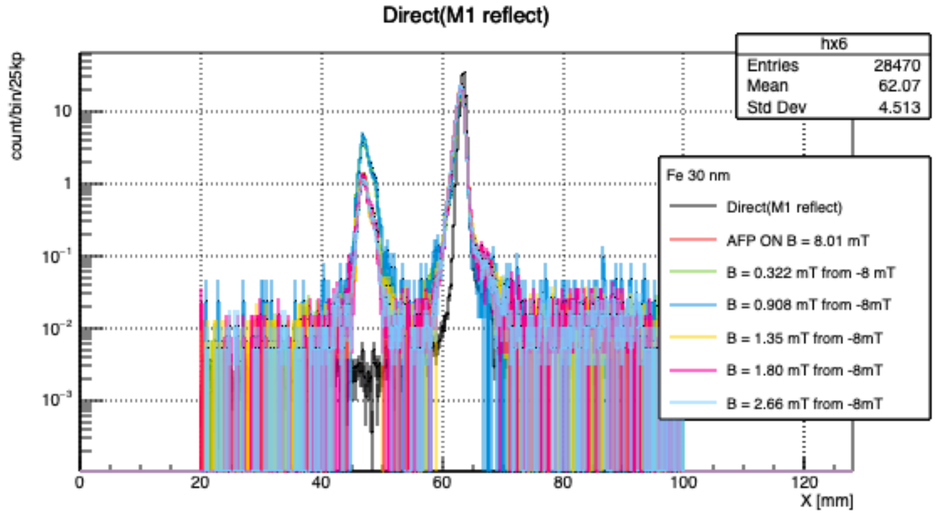

Direct(M1 reflect)
hx6
Entries 28965
Mean 59.69
Std Dev 6.956
count/bin/25kp
X [mm]
Fe 30 nm
Direct(M1 reflect)
AFP OFF B = 8.01 mT
B = 0.322 mT from -8 mT
B = 0.908 mT from -8mT
B = 1.35 mT from -8mT
B = 1.80 mT from -8mT
B = 2.66 mT from -8mT

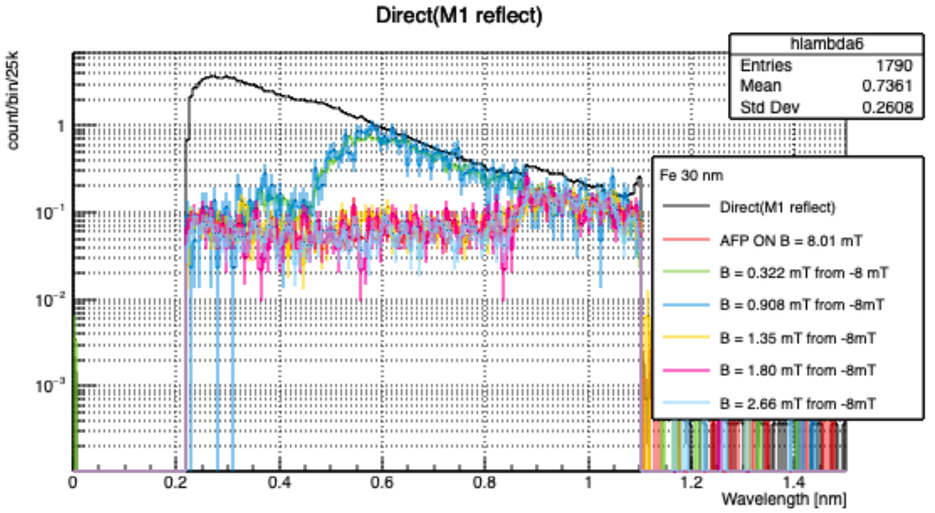

Direct(M1 reflect)
hlambda6
Entries 6347
Mean 0.6553
Std Dev 0.1773
count/bin/25k
Wavelength [nm]
Fe 30 nm
Direct(M1 reflect)
AFP OFF B = 8.01 mT
B = 0.322 mT from -8 mT
B = 0.908 mT from -8mT
B = 1.35 mT from -8mT
B = 1.80 mT from -8mT
B = 2.66 mT from -8mT

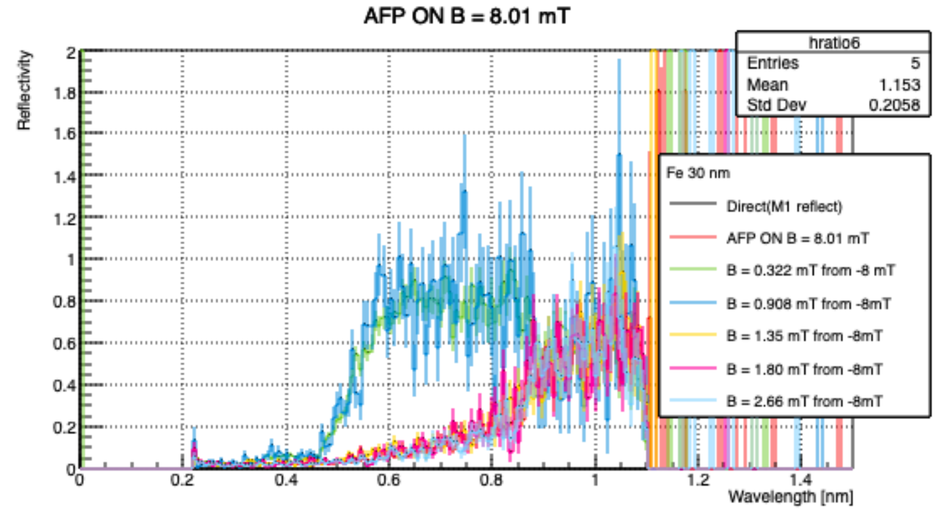

AFP OFF B = 8.01 mT
hratio6
Entries 9
Mean 1.01
Std Dev 0.3292
Reflectivity
Wavelength [nm]
Fe 30 nm
Direct(M1 reflect)
AFP OFF B = 8.01 mT
B = 0.322 mT from -8 mT
B = 0.908 mT from -8mT
B = 1.35 mT from -8mT
B = 1.80 mT from -8mT
B = 2.66 mT from -8mT

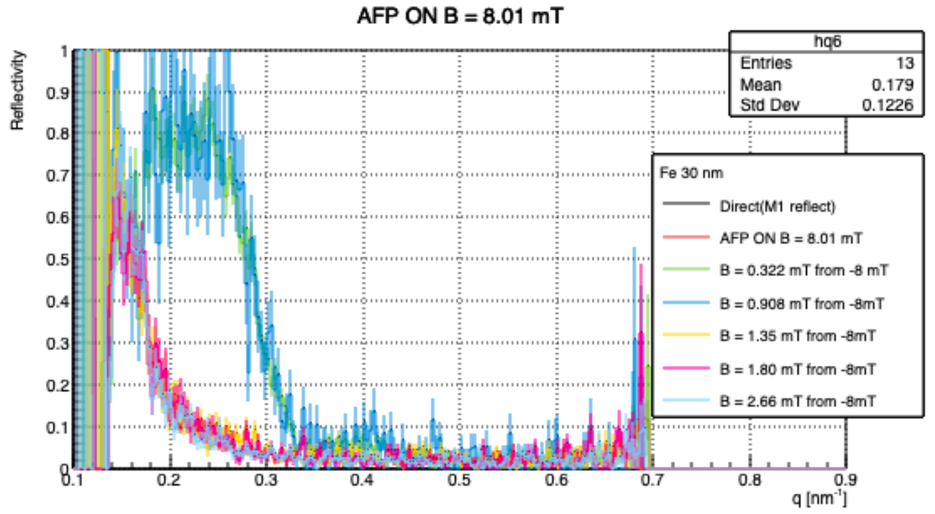

AFP OFF B = 8.01 mT
hq6
Entries 33
Mean 0.2174
Std Dev 0.1066
Reflectivity
q [nm^{-1}]
Fe 30 nm
Direct(M1 reflect)
AFP OFF B = 8.01 mT
B = 0.322 mT from -8 mT
B = 0.908 mT from -8mT
B = 1.35 mT from -8mT
B = 1.80 mT from -8mT
B = 2.66 mT from -8mT

AFP ON


Direct(M1 reflect)
hx6
Entries 28470
Mean 62.07
Std Dev 4.513
count/bin/25kp
X [mm]
Fe 30 nm
Direct(M1 reflect)
AFP ON B = 8.01 mT
B = 0.322 mT from -8 mT
B = 0.908 mT from -8mT
B = 1.35 mT from -8mT
B = 1.80 mT from -8mT
B = 2.66 mT from -8mT


Direct(M1 reflect)
hlambda6
Entries 1790
Mean 0.7361
Std Dev 0.2608
count/bin/25k
Wavelength [nm]
Fe 30 nm
Direct(M1 reflect)
AFP ON B = 8.01 mT
B = 0.322 mT from -8 mT
B = 0.908 mT from -8mT
B = 1.35 mT from -8mT
B = 1.80 mT from -8mT
B = 2.66 mT from -8mT


AFP ON B = 8.01 mT
hratio6
Entries 5
Mean 1.153
Std Dev 0.2058
Reflectivity
Wavelength [nm]
Fe 30 nm
Direct(M1 reflect)
AFP ON B = 8.01 mT
B = 0.322 mT from -8 mT
B = 0.908 mT from -8mT
B = 1.35 mT from -8mT
B = 1.80 mT from -8mT
B = 2.66 mT from -8mT


AFP ON B = 8.01 mT
hq6
Entries 13
Mean 0.179
Std Dev 0.1226
Reflectivity
q [nm^{-1}]
Fe 30 nm
Direct(M1 reflect)
AFP ON B = 8.01 mT
B = 0.322 mT from -8 mT
B = 0.908 mT from -8mT
B = 1.35 mT from -8mT
B = 1.80 mT from -8mT
B = 2.66 mT from -8mT

- Pol power の続き
- 上流ミラーのみをおいて測ったデータで何か言える？
-