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Combined x-ray reflectivity and grazing incidence x-ray fluorescence analysis of a Ta/Cr/Pt trilayer stack



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X-ray planar waveguide

Samples prepared by magnetron sputtering

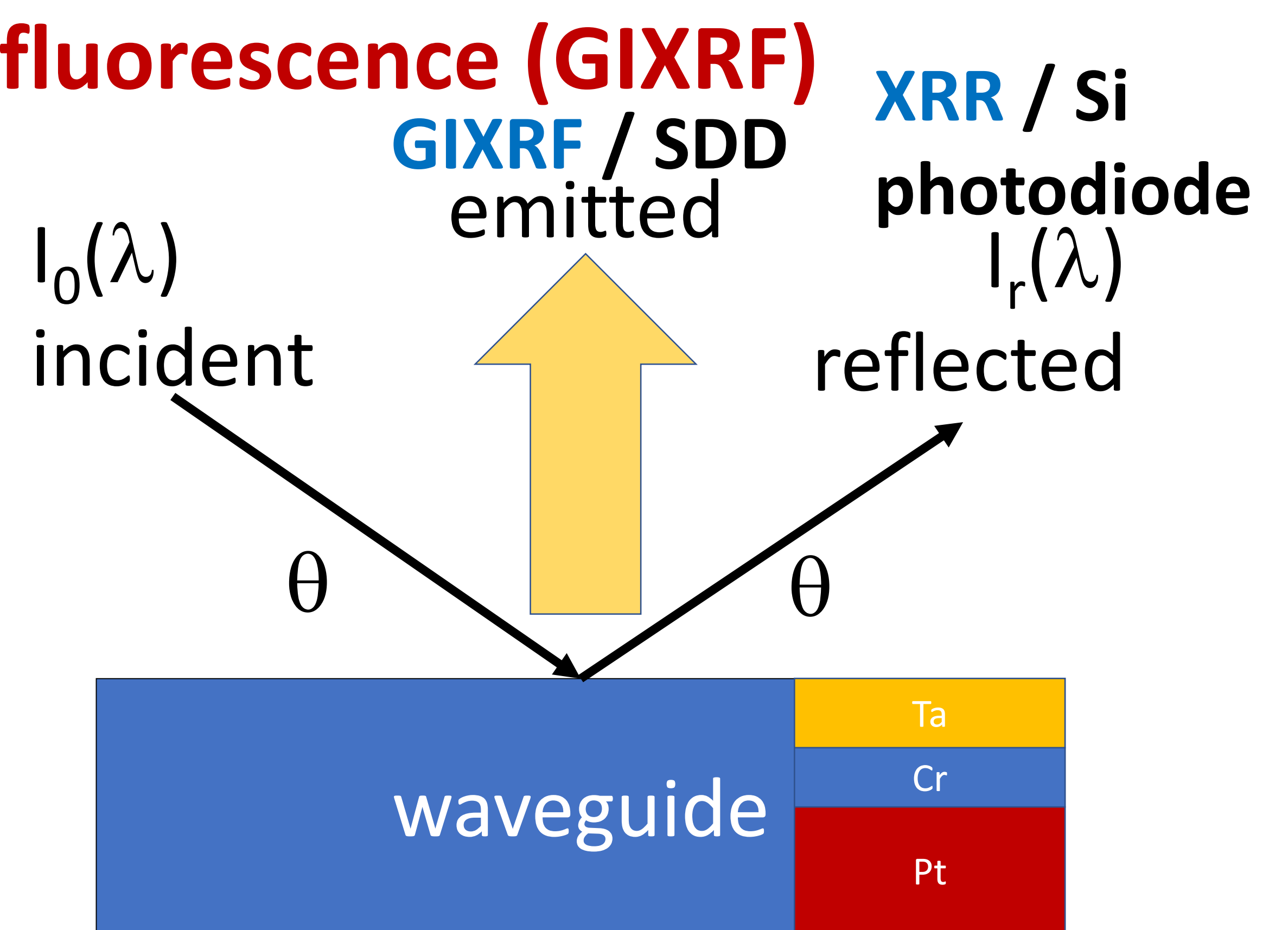
A “light” guiding layer, Cr, inserted between two “heavy” cladding layers, Ta and Pt
Ta (8 nm) / Cr (5, 10 and 15 nm) / Pt (14 nm) / Si substrate

When x-rays impinge the samples under a critical “guiding” angle, defined from the optical indices of the layers, then the radiation is guided inside the light layer.

X-ray reflectivity (XRR) and Grazing incidence x-ray fluorescence (GIXRF)

XRR, measurement of the reflected incident radiation of a given energy (or wavelength) as a function of the glancing angle

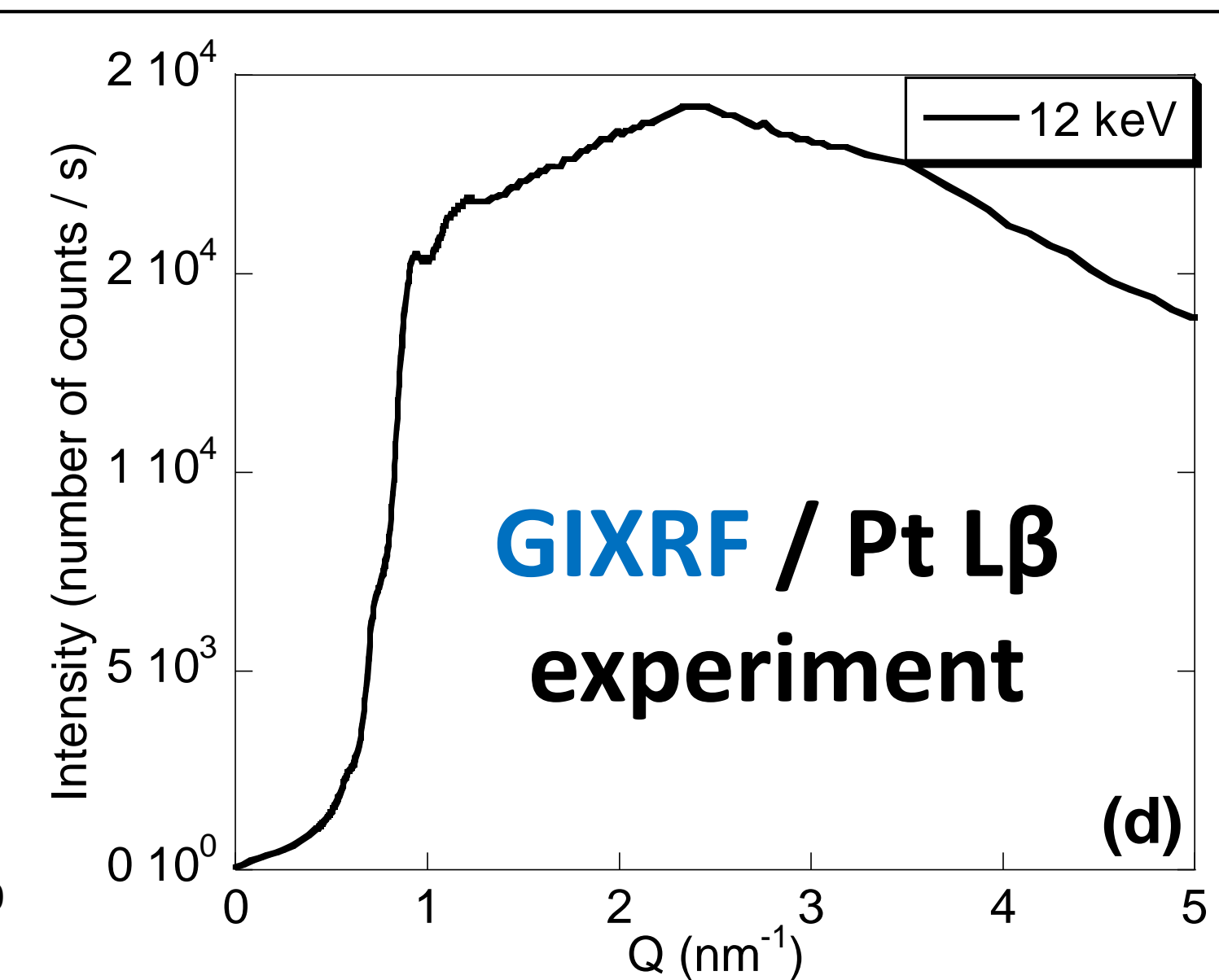
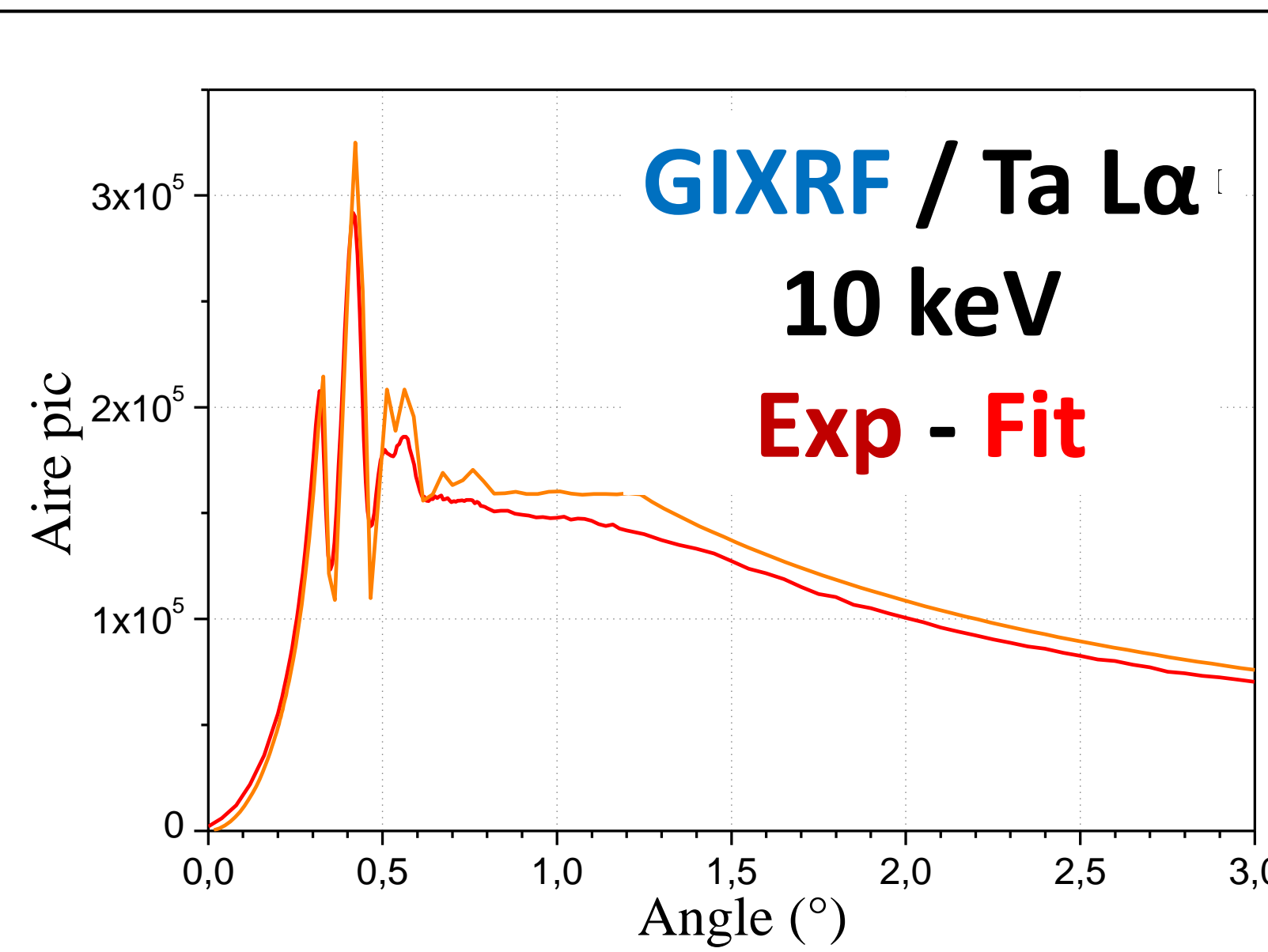
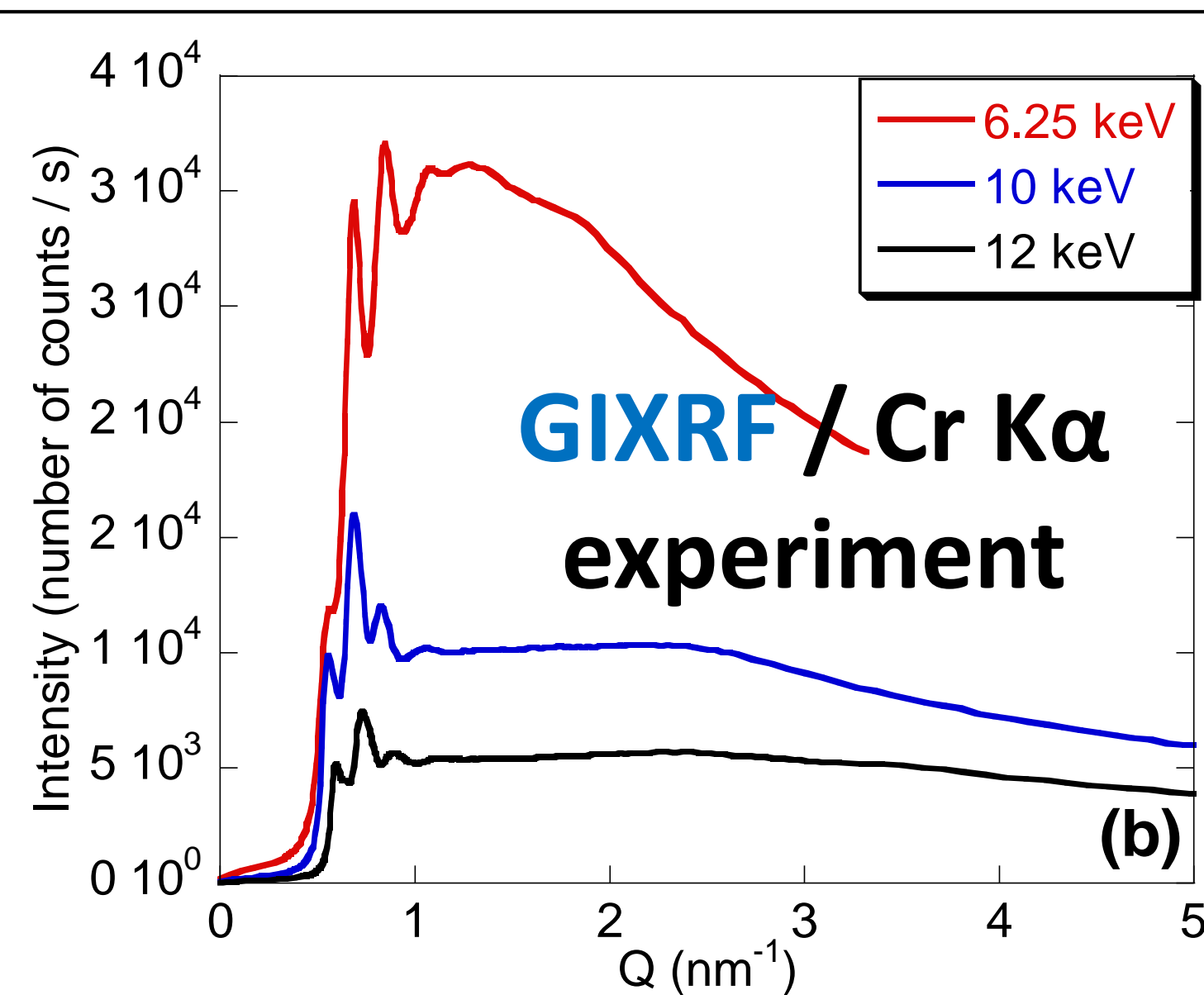
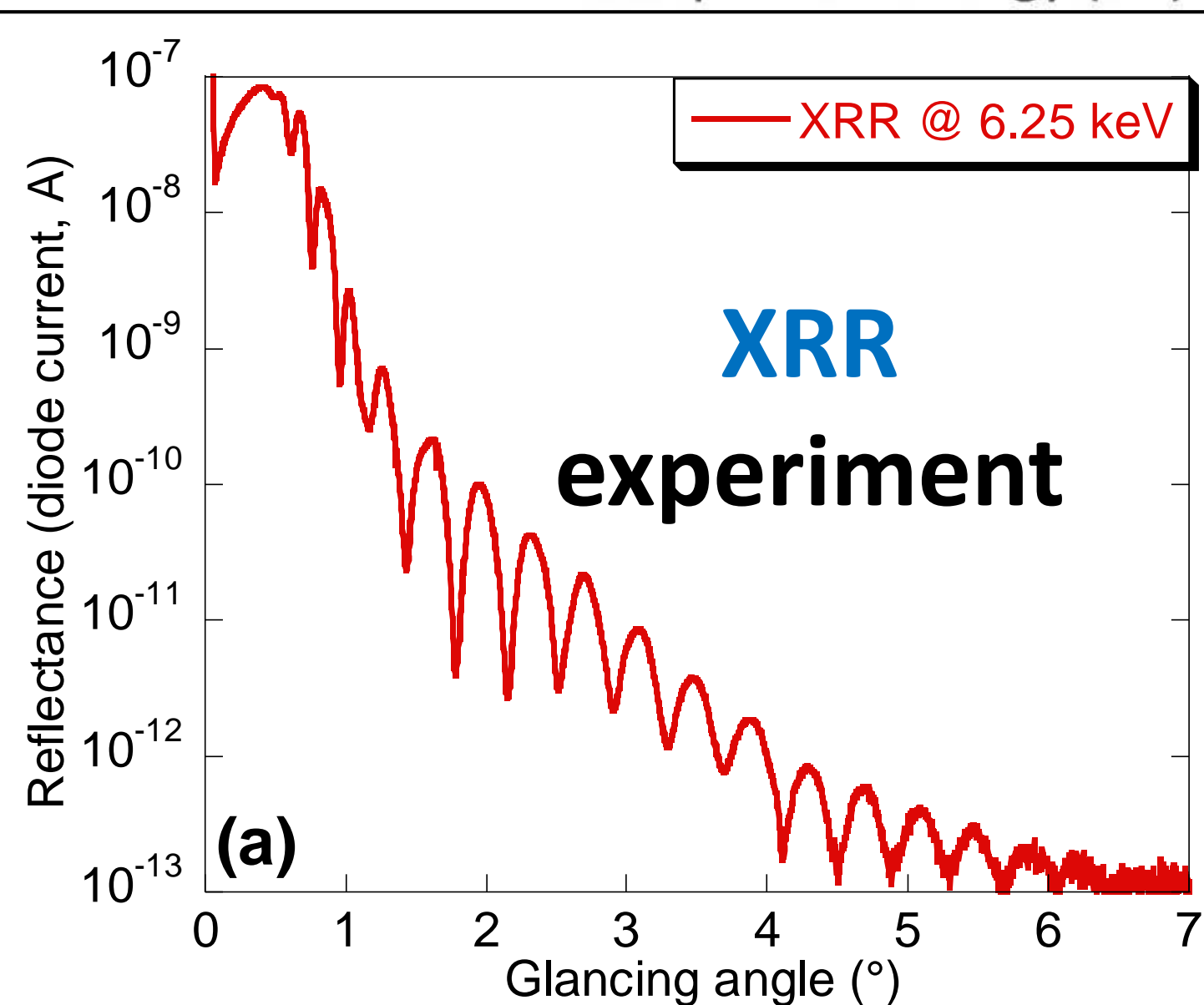
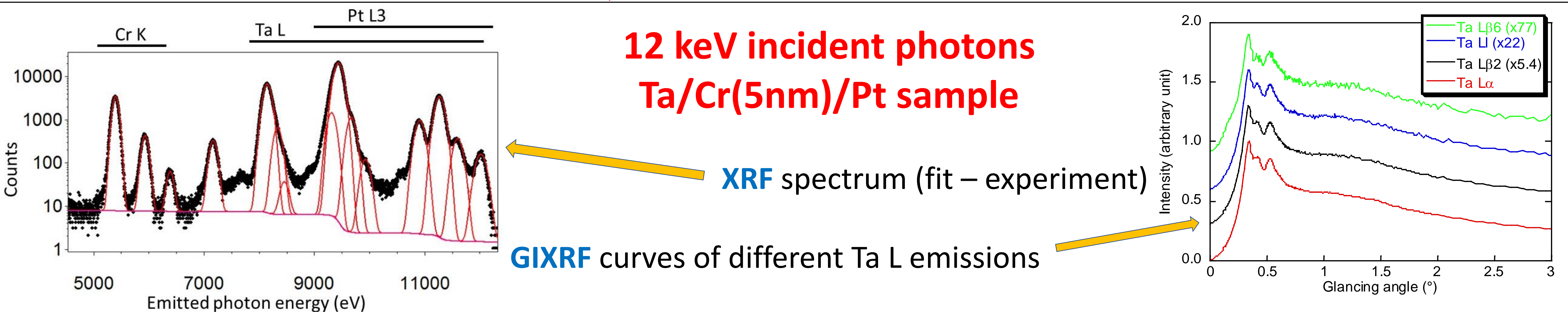
GIXRF, measurement of the characteristics x-ray emission of the atoms present in the sample, generated by the incident beam, as a function of the glancing angle of the incident radiation



Measurements at the Métrologie beamline of SOLEIL synchrotron with the CASTOR setup

XRR curves obtained with 6.25 keV incident photons

GIXRF Ta L α (8145eV), Cr K α (5411eV), Pt L $\beta_{2,15}$ (9650eV) lines obtained with 6.25, 10 and 12 keV incident photons



Ta/Cr(15nm)/Pt sample

The same kind of curves are obtained for Ta/Cr(5nm)/Pt and Ta/Cr(10nm)/Pt samples
 XRR and GIXRF curves fitted at the same time to determine the structure of the stacks

Fitted parameters	"5 nm Cr"	"10 nm Cr"	"15 nm Cr"
d Ta ₂ O ₅ (nm)	1.9	2.0	2.0
d Ta (nm)	3.9	4.1	4.1
d Cr (nm)	6.8	14.3	20.0
d Pt (nm)	13.8	13.8	13.8
d Pt _{0.88} Si _{0.12} (nm)	0.7	0.2	0.6
Rho Ta ₂ O ₅ (g/cm ³)	5.9	5.9	5.9
Rho Ta (g/cm ³)	16.3	16.4	16.4
Rho Cr (g/cm ³)	7.15	7.15	7.15
Rho Pt (g/cm ³)	21.3	21.2	21.2
Rho PtSi (g/cm ³)	15.7	15.7	15.7
Cr (at/cm ²)	5.63 10 ¹⁶	11.84 10 ¹⁶	16.56 10 ¹⁶
Ta (at/cm ²)	2.43 10 ¹⁶	2.57 10 ¹⁶	2.57 10 ¹⁶
Pt (at/cm ²)	9.38 10 ¹⁶	9.12 10 ¹⁶	9.12 10 ¹⁶

Description of the stack identical for the three samples
 with an oxide (Ta₂O₅) superficial contamination layer
 with a silicide (PtSi) interfacial layer close to substrate
 Cr layers 30% thicker than expected

Densities of the layers close to their bulk values

Number of atoms close to the one from RBS

except for Pt
 percentage = deviation from the Rutherford backscattering value