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Motivation

3D Micro-XANES scans enable **the uncovering of the topology** of samples with the same concentration of the element of interest in different layers but in a different chemical state of bonding (sample: **Figure 2**; topology: **Figure 6**). In that case 3D Micro-XRF scans can not uncover different layers (**Figure 3**).

In 3D Micro-XANES investigations for cultural heritage the main **field of application** is **corrosion processes**

Experimental setup

Experiment:

Setup at the mySpot beamline @ BESSY II; Depth resolution: **FWHM $\approx 28 \mu\text{m}$ (9 keV)**; Energy resolution: **$E/\Delta E \approx 25000$** ; Measurement time: **$t = 20 \text{ s}$ per point**; Step size for 3D Micro-XANES scan: **$\Delta y, \Delta z$ (parallel to surface) $\approx 50 \mu\text{m}$; Δx (normal to surface) $\approx 20 \mu\text{m}$** ; for depth scan: **Δx (normal to surface) $\approx 5 \mu\text{m}$**

Sample:

Stratified lacquer samples with different copper compounds as additives but with the same concentration of copper \rightarrow **Figure 2**

Layer thicknesses $\approx 60 \mu\text{m}$

Layer 1	lacquer with 5% Cu as Cu_2O
Layer 2	lacquer with 5% Cu as CuO
Layer 3	lacquer with 5% Cu as Cu_2O

Figure 2: Design sample

Summary / Conclusion

Depth scan at marker energies:

- layers visible \rightarrow **Figure 5**
- for certain **marker energies** some compounds are more sensible than others (e.g.: for **8.984 keV** Cu_2O is more sensible and for **8.9998 keV** CuO is more sensible \rightarrow **Figure 4**)

3D Micro-XANES scan:

- possible to uncover topology of samples \rightarrow **Figure 6**
- \rightarrow applicable e.g. to cultural heritage to uncover degree and area of corrosion processes

Outlook:

- reconstruct 3D geometry under consideration of absorption effects and extension of the probing volume

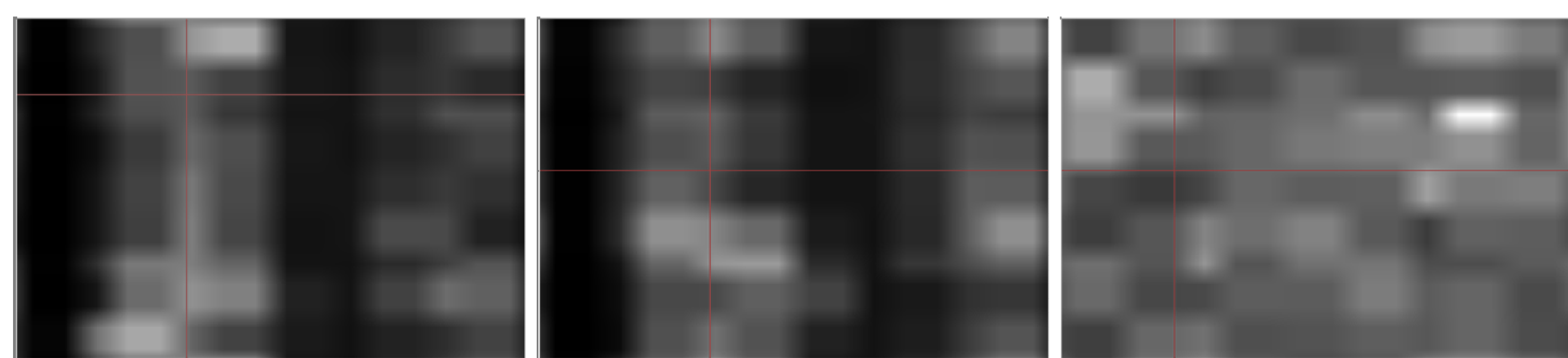
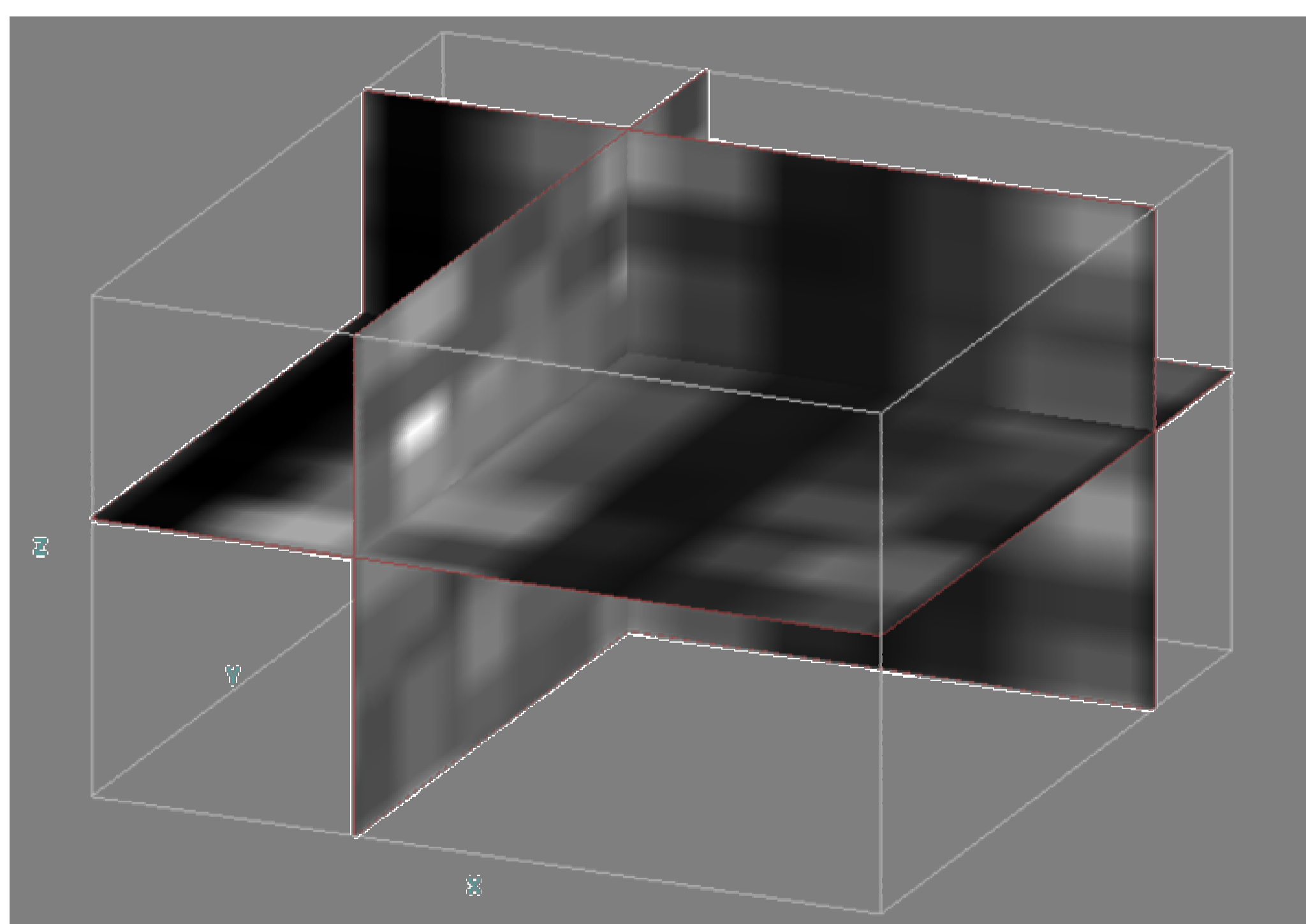


Figure 6: 3D Micro-XANES scan at 8.984 keV; top: crossing of horizontal (XY), vertical (XZ) and plane parallel to surface (YZ); bottom from left to right: horizontal (XY), vertical (XZ) and plane parallel to surface (YZ); drawn with the program MuxVis by Mielebacher Informatiksysteme

Method

3D Micro-XANES:

- **Setup:** 3D Micro-XRF \rightarrow **Figure 1** (detailed description see 3D Micro-XANES poster)

- **Measurement:** Excitation energy is varied in the area of an absorption edge while probing volume is placed in one layer of stratified samples

- **Challenges:** Upper layers distort the XANES spectra of deeper layers

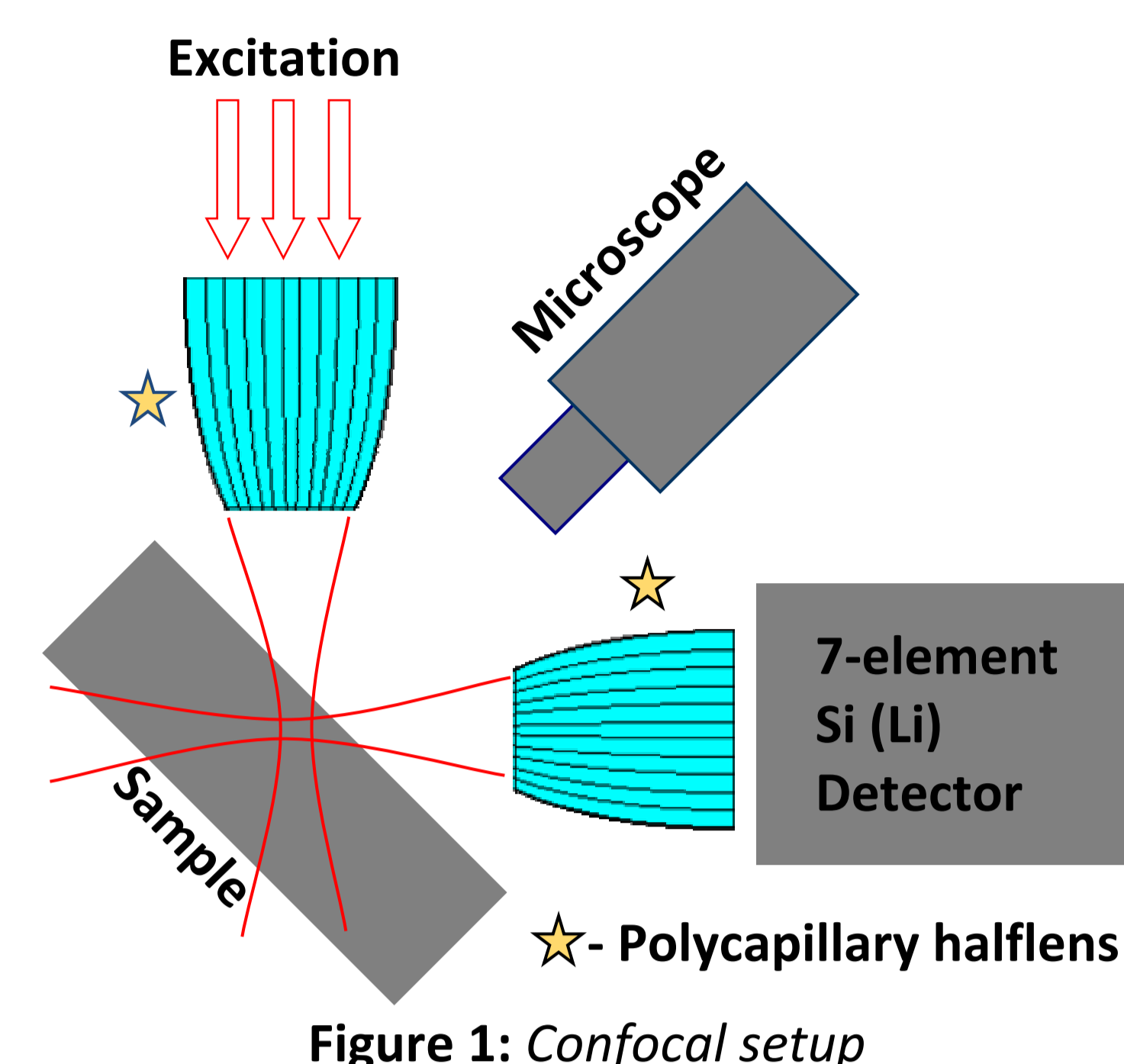


Figure 1: Confocal setup

Challenge of 3D Micro-XANES scan

- no layers detectable with 3D Micro-XRF at 9.6 keV \rightarrow **Figure 3**

- different XANES spectra for Cu_2O (layer 1 and 3) and CuO (layer 2) \rightarrow **Figure 4**

- find marker energies where absorption differs \rightarrow **Figure 4 vertical lines**

- depth scans at marker energies uncover layer structure

\rightarrow **Figure 5** (depth scans at two positions; at **8.984 keV** layers with Cu_2O show higher normalised fluorescence intensity than layers with CuO ; at **8.9998 keV** it is the **opposite way around**)

- uncover 3D topology of samples with different copper compounds

\rightarrow **Figure 6**

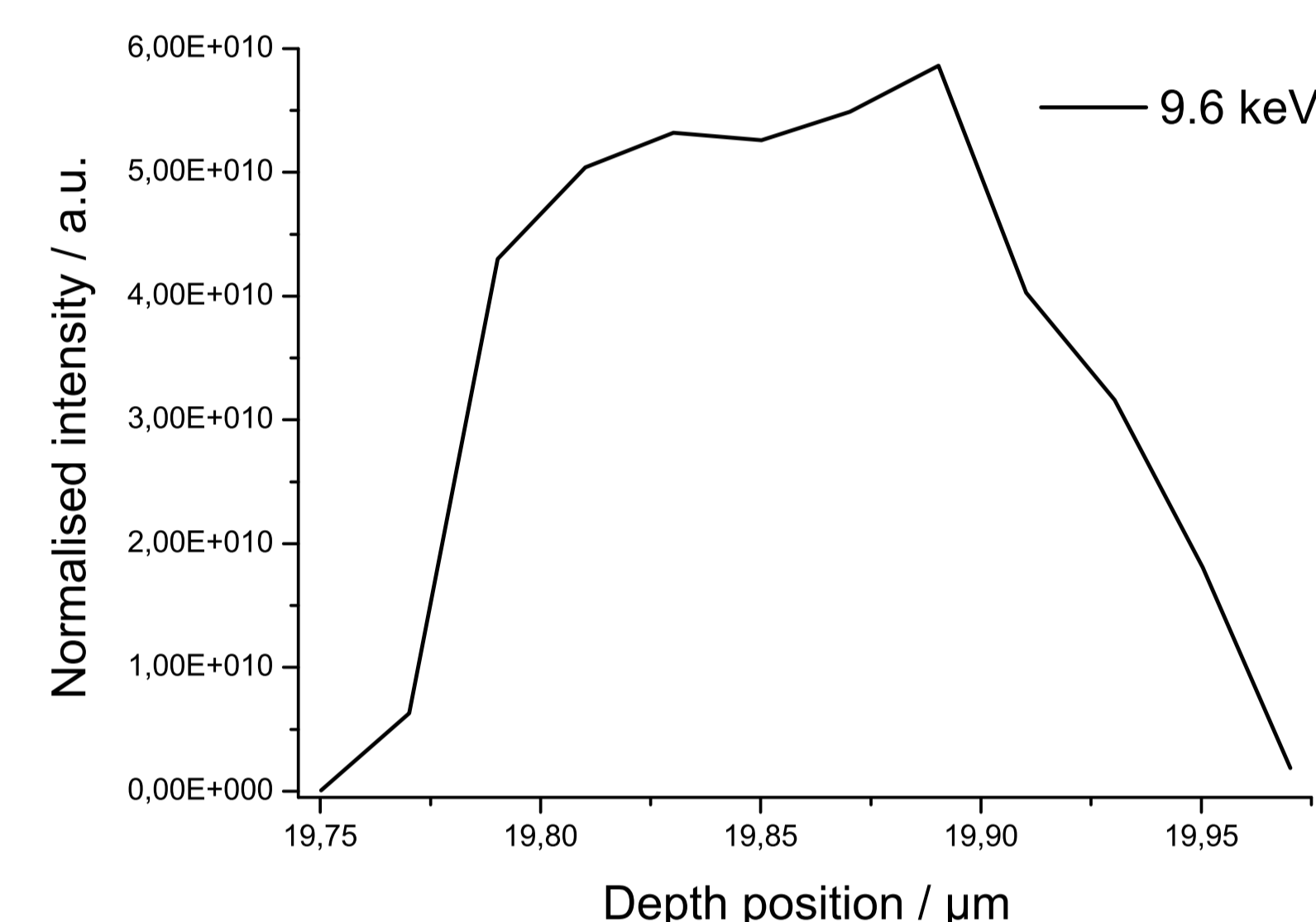


Figure 3: Rough depth scan of the sample at 9.6 keV

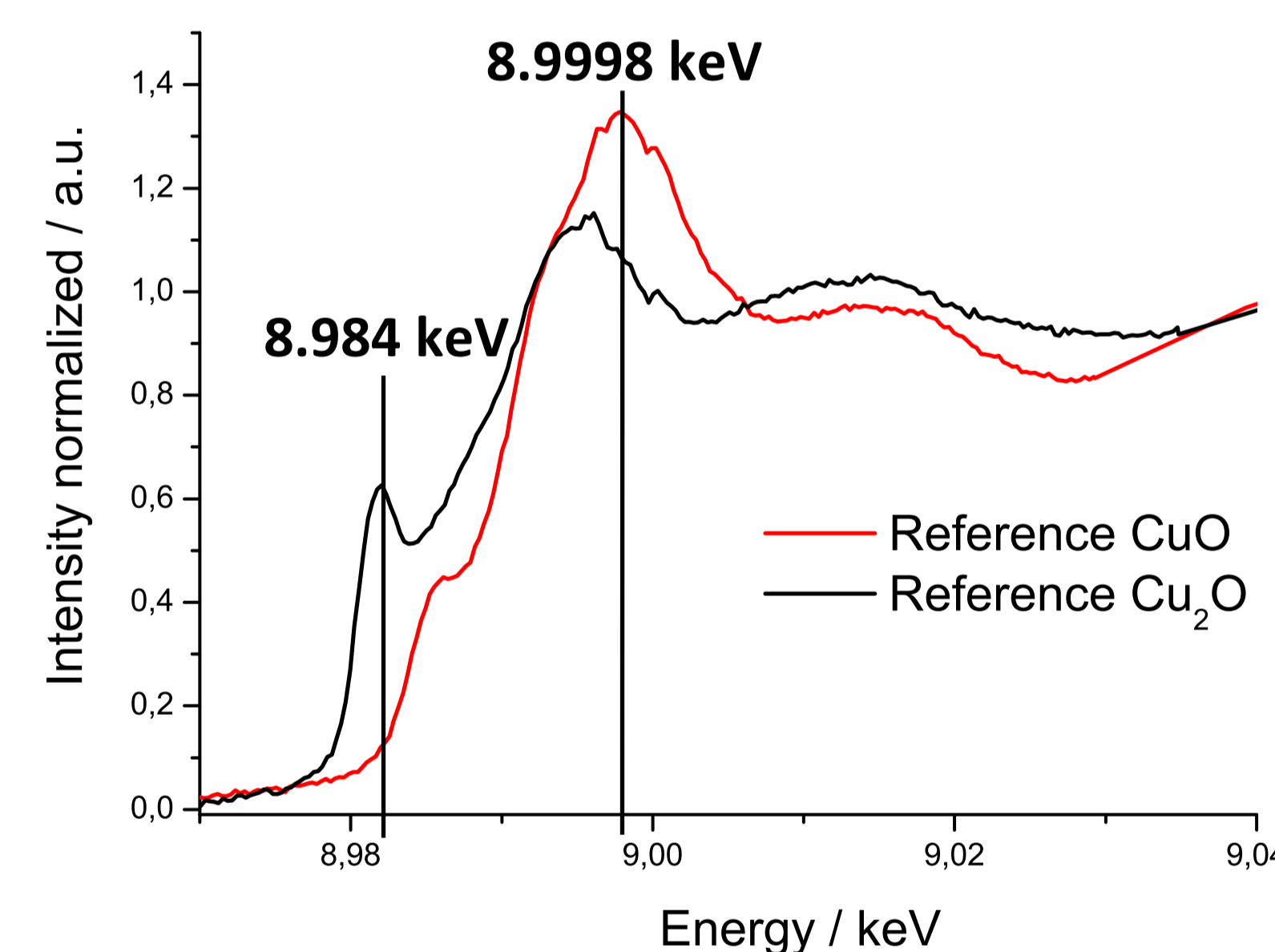


Figure 4: XANES spectra of Cu_2O and CuO

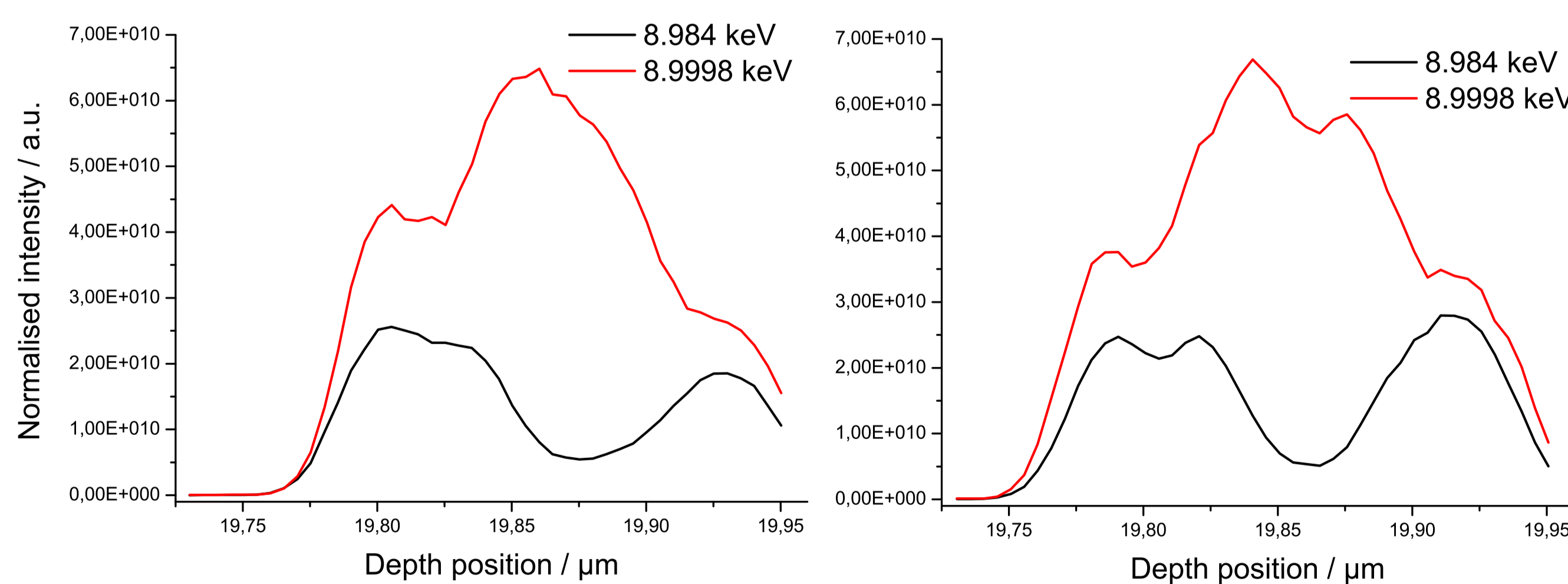


Figure 5: Depth scans at marker energies at two positions

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