

Time-of-Arrival filtering in x-ray imaging using a novel compact ICS source

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Smart*Light 2.0

Smart*Light: tunable x-rays from a lab-scale setup

At Eindhoven University of Technology a lab-based tabletop x-ray source is being commissioned based on inverse Compton scattering (ICS). Here, relativistic electrons collide with a laser pulse producing monochromatic x-rays. This compact and tunable source will bridge the gap between conventional lab sources and synchrotrons, making high quality and tunable x-rays better accessible for a wide range of applications.

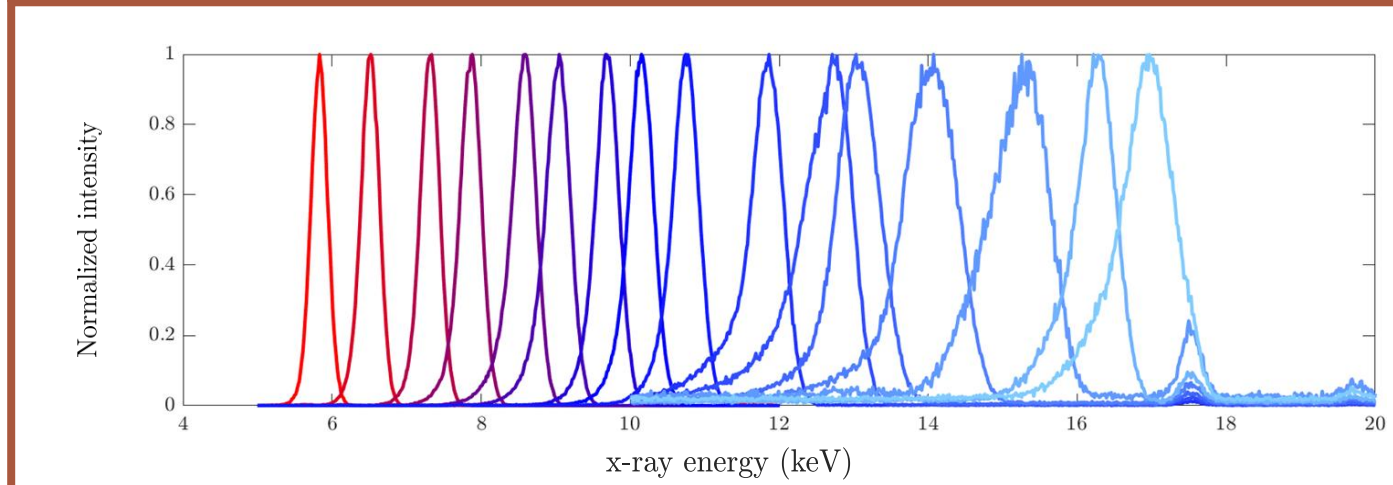
Electron beam

Beam energy	10-25 MeV
Bunch charge	10 pC
Repetition rate	500 Hz

x-rays targets

Energy	5 – 40 keV
Photons/sec	6×10^7
Divergence	1 mrad
Source size	5 μm
Energy spread	1%

Measured tunability

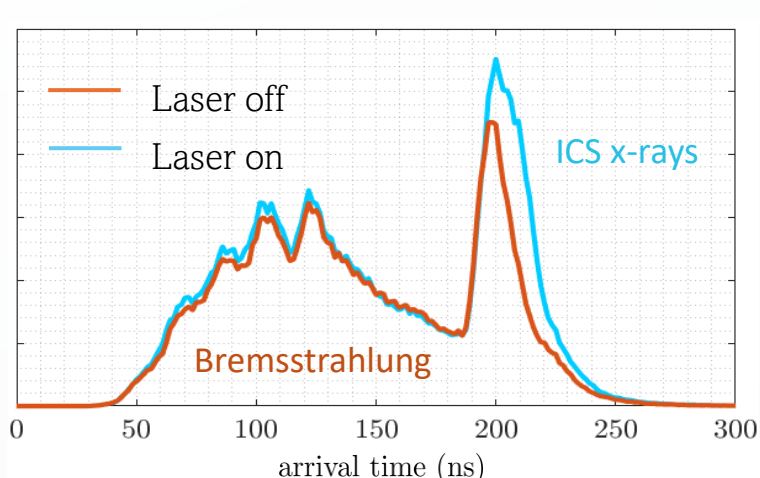


A main challenge at the moment is bremsstrahlung created by the dark current of the accelerator. The bremsstrahlung arrives in pulses with a time duration of 200 ns, while the x-ray pulse length is on the order of picoseconds. We use the temporal resolution of the TimePix3 to filter the bremsstrahlung, improving the signal-to noise ratio in K-edge subtraction imaging experiments.

Temporal filtering with TimePix3

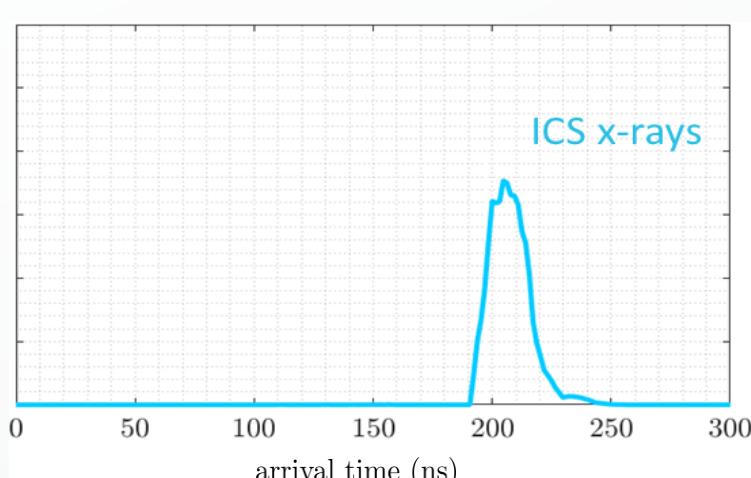
Bremsstrahlung pulse length: 200 ns
x-ray pulse length: 1 ps
Time resolution TimePix3 camera: 1.5 ns

unfiltered

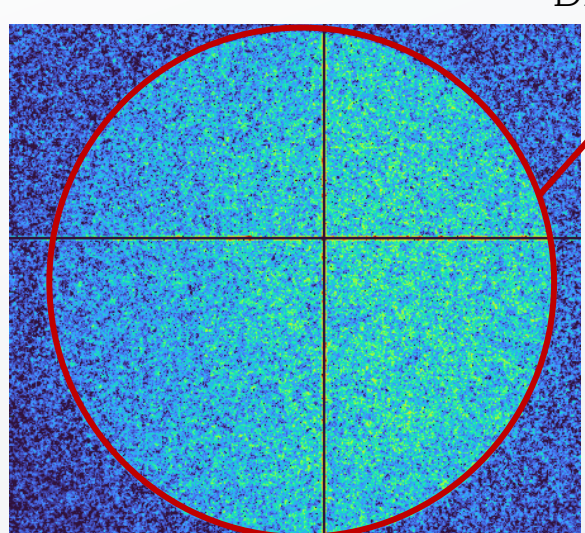


SNR 0.9:1

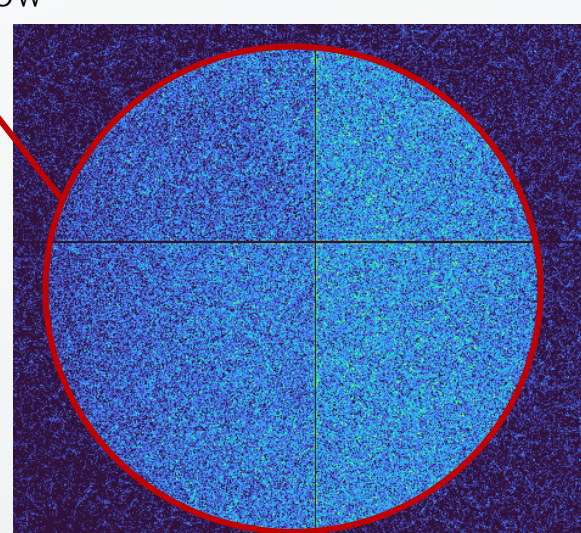
filtered



SNR 5:1



Diamond window



inverse Compton scattering

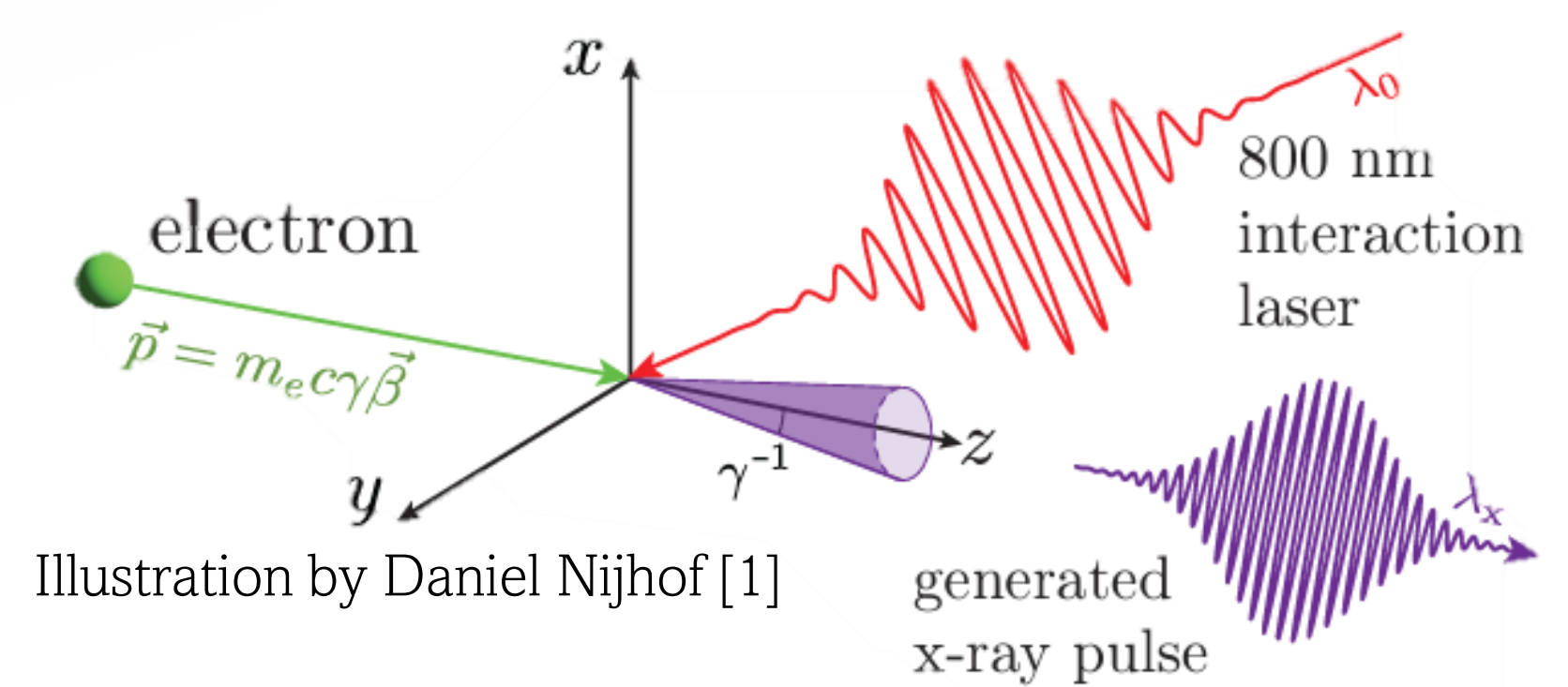
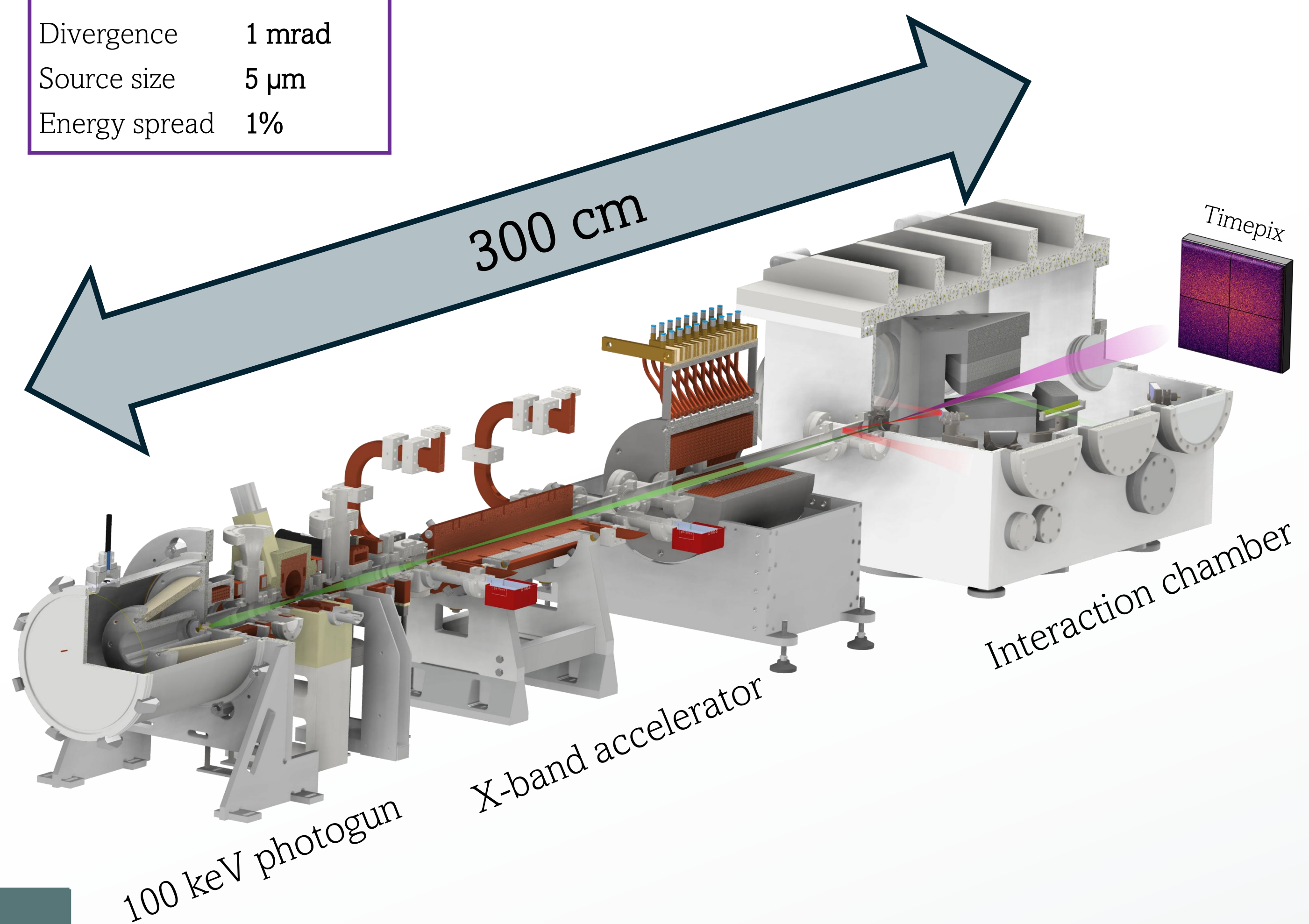
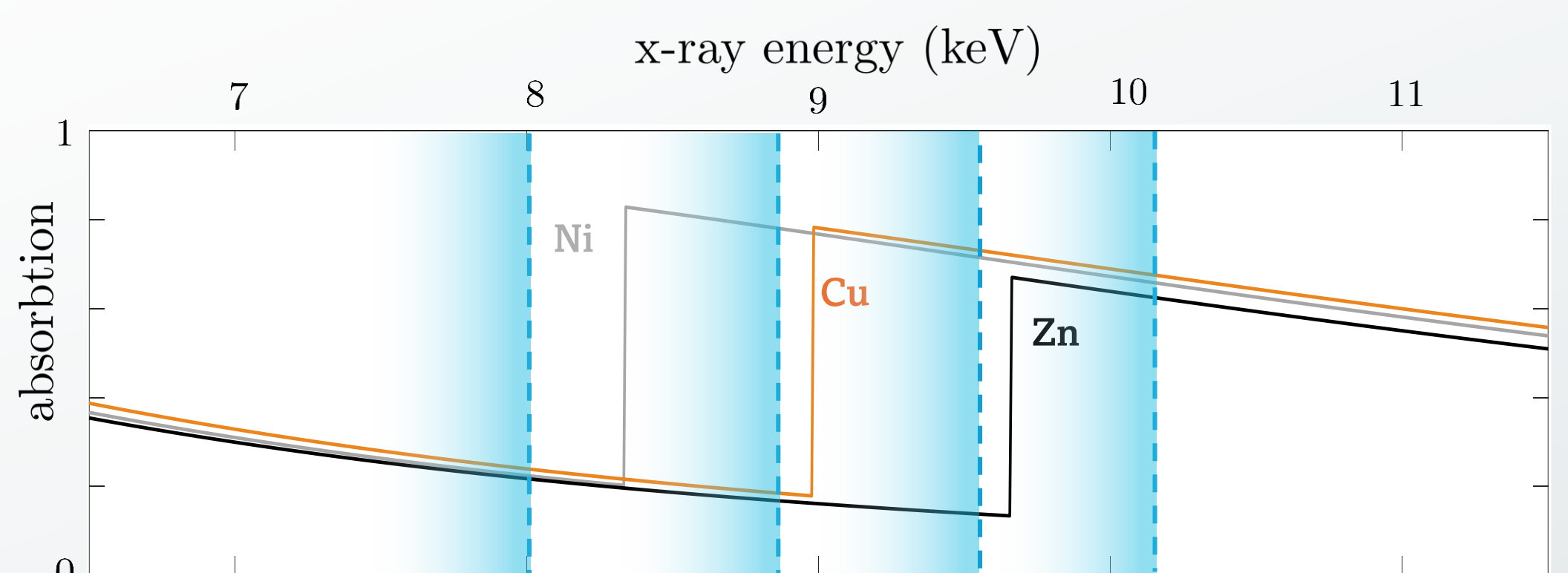


Illustration by Daniel Nijhof [1]



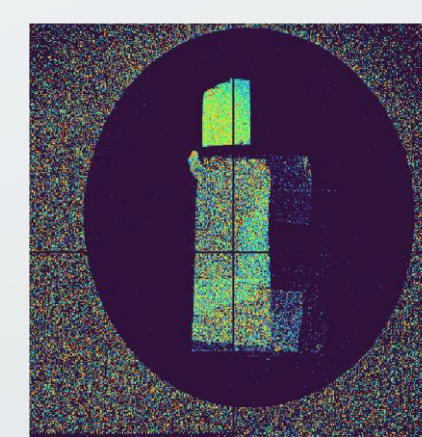
K-edge subtraction imaging



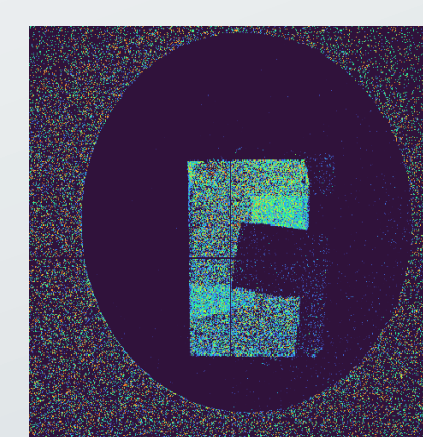
Sample



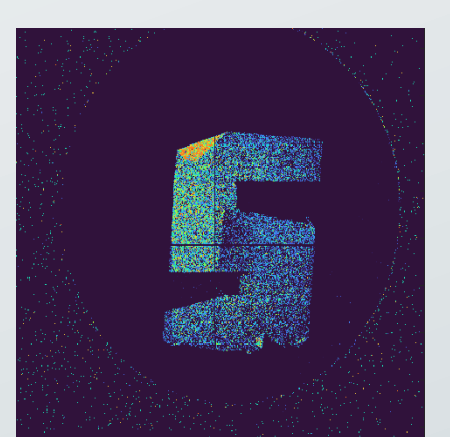
Zn



Cu



Ni



References

[1] Nijhof, D. F. J. (2024). "Ultracold electron source development and X-band acceleration for a compact ICS-based x-ray source."