POLDI: a tof-diffractometer for residual stress investigations at SINQ

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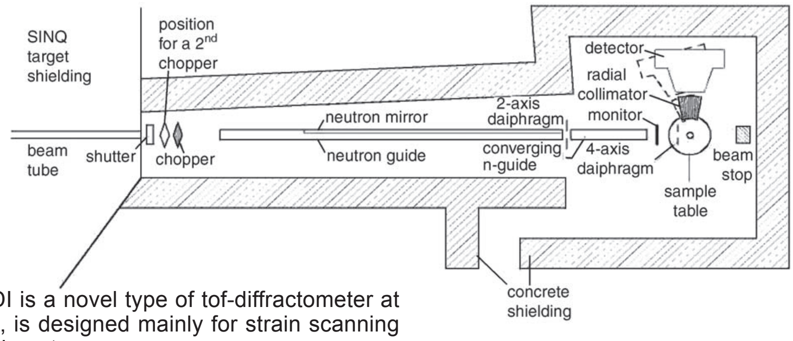
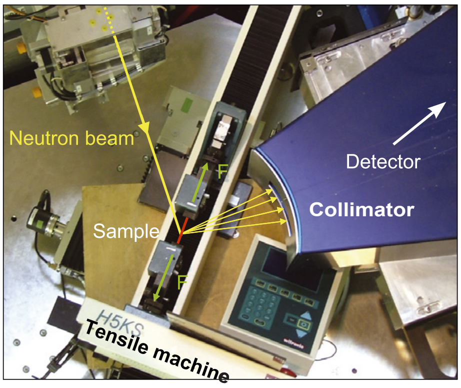
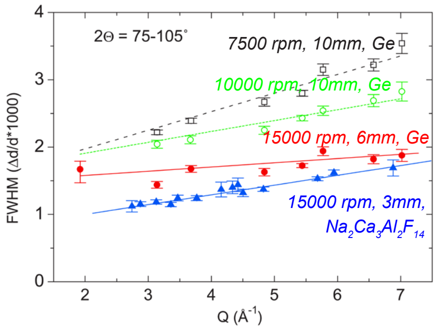
PULSE OVERLAP TIME OF FLIGHT DIFFRACTOMETER - Concept of the instrument



POLDI is a novel type of tof-diffractometer at SINQ, is designed mainly for strain scanning experiments.



Above: Set-up of an in-situ tensile experiment at POLDI.

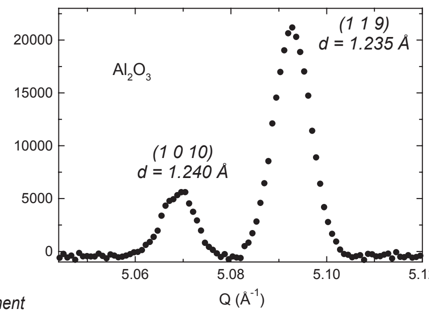


Above: The resolution of POLDI for selected instrument configurations (chopper speed and width of the 2-axis diaphragm). Data points are the result of the correlation method [1].

The concept of the instrument is based on multiple overlapping neutron pulses and allows tuning the resolution and the intensity independently. The dependence of the time-of-flight (typically 500 time channels are used) of the neutrons on the scattering angle (400 angle channels, 2Θ range of about 30°) is used as extra information in order to analyze the data [1].

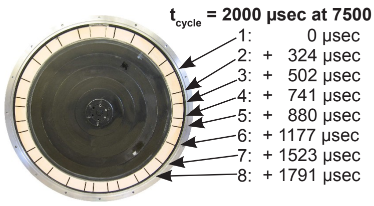
It was possible to build a tof-diffractometer at a continuous neutron source with short flight path, high resolution and high intensity.

The instrument is best suited for experiments with small samples or small gauge volumes within large samples where high resolution in a broad Q-range is required [2].

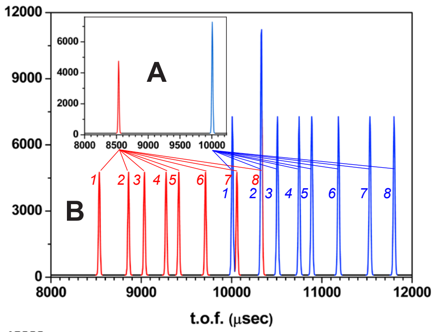


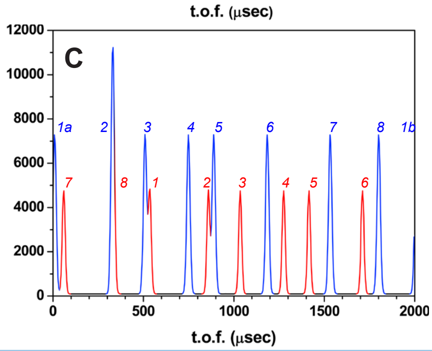
Above: Double peak of Al_2O_3. The peaks do not even overlap although they are separated by less than 0.5% [2].

Pulse overlap for two Ge reflections



Picture of the chopper disc. The 32 slits are arranged in four identical sequences with pseudo-random distribution.



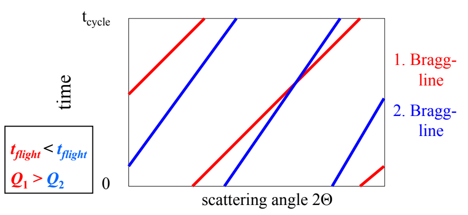


In order to carry out Rietveld refinement on POLDI data one has to start with the calculation of a theoretical t.o.f. powder pattern (consisting in our case of only two Ge reflections) for a given scattering angle and instrument parameter set (Fig. A).

Calculation 1 (A→B)
One chopper sequence (left top) leads to eight identical diffractograms, which are each time shifted by the time sequence given by the chopper layout and the used chopper speed (7500 rpm). As a result 16 instead of 2 Bragg reflections have to been taken into account for each angle channel (Fig. B).

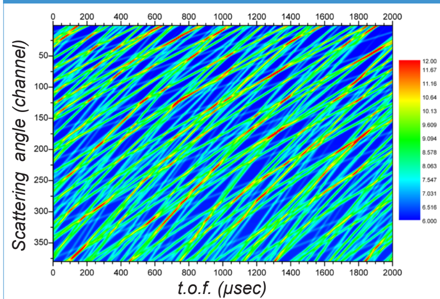
Calculation 2 (B→C)
The last step is to shift all reflections into the cycle time of one chopper sequence, in our case t_{cycle} = 2 ms (Fig. C).

These two calculations (A→B and B→C) have to be done for all 400 angle channels (each with 500 time channels).

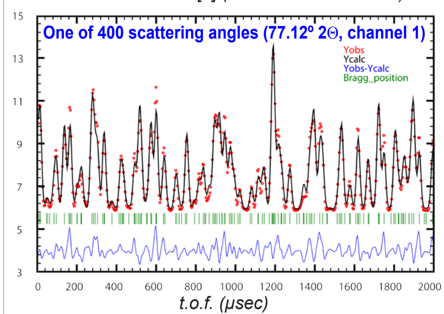


The slopes of the Bragg-lines roughly determine the time-of-flight and therefore also the slit of the chopper the neutrons passed

FullProf



Above: Theoretical Ge patterns for 400 scattering angles, calculated with FullProf [3] (with POLDI extension).



*Above: FullProf [3] (with POLDI extension) fit of powdered Ge sample, measured with POLDI, including total 18*8*380 = 54720 Ge reflections and 500*400 data points.*

References

[1] U. Stuhr, Nuclear Instruments and Methods in Physics Research A 545 (2005) 319-329.
[2] U. Stuhr, et al., Nuclear Instruments and Methods in Physics Research A 545 (2005) 330-338.
[3] J. Rodriguez-Carvajal, ILL (private communication).

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