

Phase contrast imaging at 100 keV

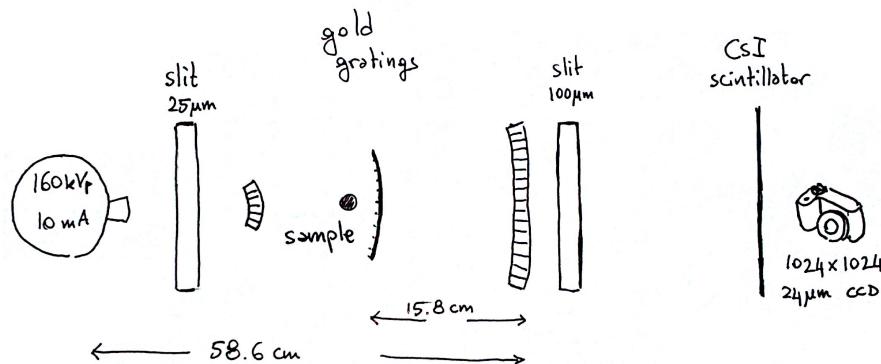
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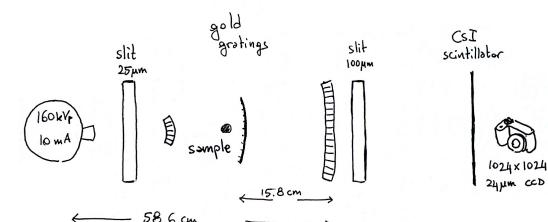


The one-dimensional setup at 100 keV

Top view



The one-dimensional setup at 100 keV



- pitch $2.8 \mu\text{m}$
- first Talbot ($p^2/8\lambda$)
- mean energy (SpekCalc): 50 keV
- maximum sample size 2 cm

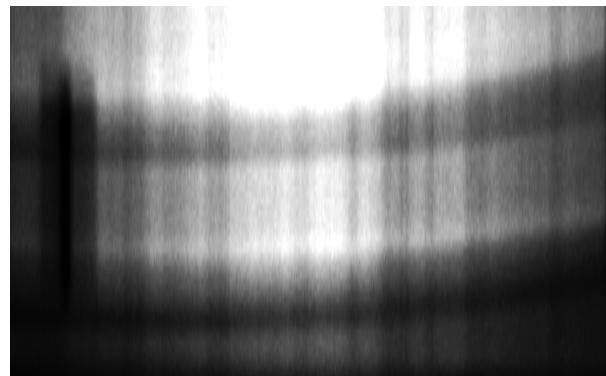
The alignment

motor	achieved	required
rotation x	0.05°	0.10°
rotation y	0.05°	0.10°
rotation z	0.003°	0.010°
translation x	5 mm	?
translation z	10 µm	50 µm

Alignment takes one week

An additional degree of freedom: curvature

The right end of G1 in the picture goes up by 50 µm on 3 cm



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Second progress report

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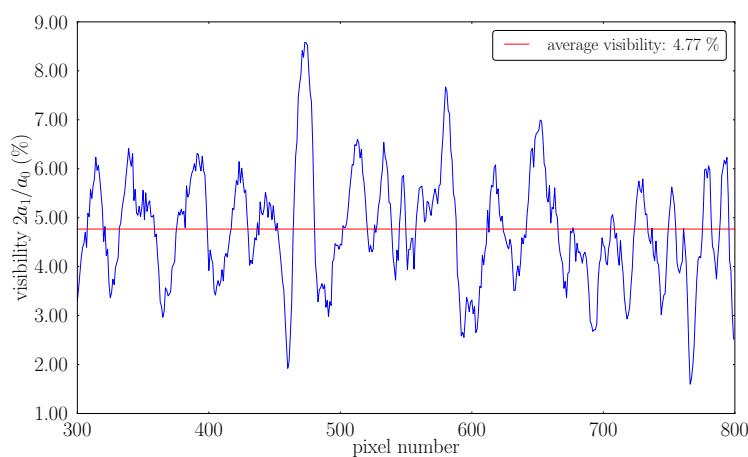
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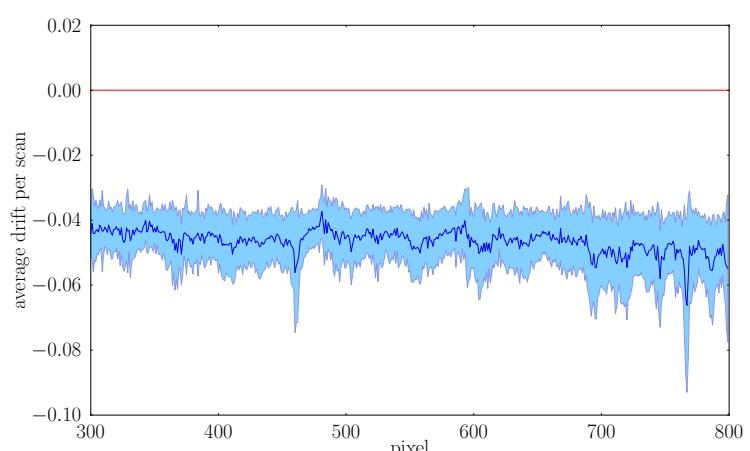
Visibility map

working now reliably at $5.0 \pm 0.2\%$



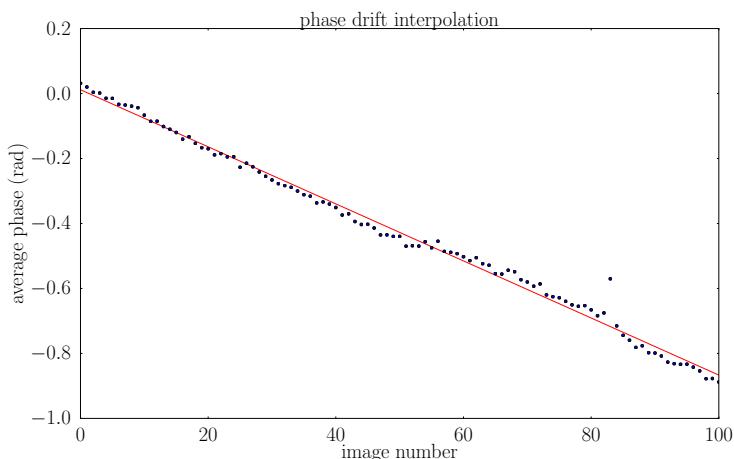
Strong drift

after twenty scans (~ 10 min)



Drift correction

linear fit → subtraction



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ETH

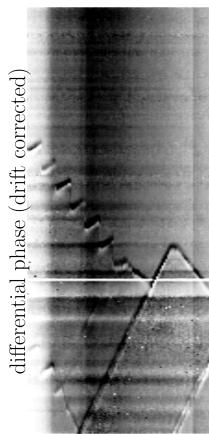
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Increasing the exposure time

14 h scan: 25 steps × 15 s × 100
field of view 2.5 × 1 cm



absorption image



differential phase (drift corrected)



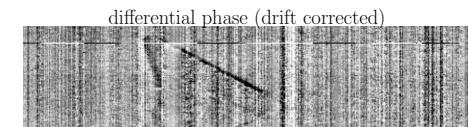
visibility reduction

The first noisy image

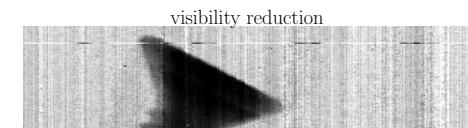
Head of a metal screw



absorption image



differential phase (drift corrected)



visibility reduction

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ETH

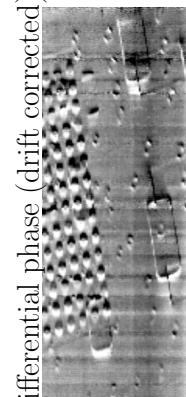
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Increasing the exposure time

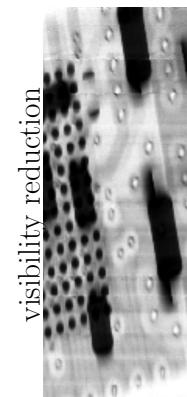
14 h scan: 25 steps × 15 s × 100
field of view 2.5 × 1 cm



absorption image



differential phase (drift corrected)



visibility reduction

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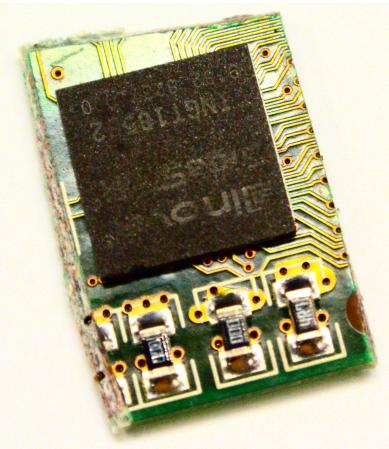
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Increasing the exposure time

14 h scan: 25 steps \times 15 s \times 100
field of view 2.5 \times 1 cm



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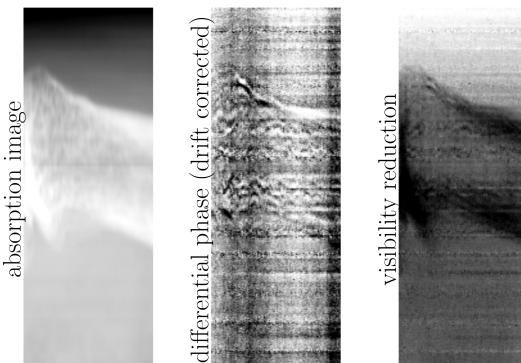
Second progress report

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Second progress report

A biological sample

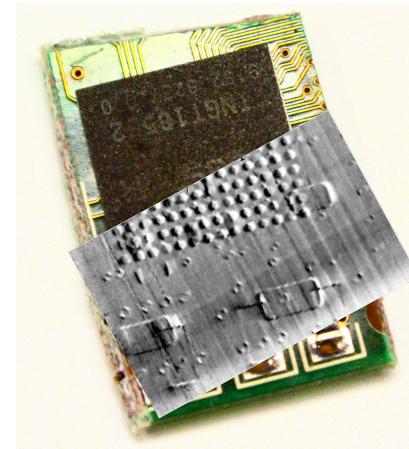
14 h scan: 25 steps \times 15 s \times 100
field of view 2.5 \times 1 cm



energy is too high

Increasing the exposure time

14 h scan: 25 steps \times 15 s \times 100
field of view 2.5 \times 1 cm



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Can high-energy phase contrast work?

Pushing grating interferometry towards its physical limits.

The signal becomes smaller

$$\varphi = \frac{\lambda d}{p_2} \frac{\partial \Phi}{\partial y} \propto \mathcal{E}^{-2}$$

Possible solutions:

- other samples
- larger distances
- smaller pitches

The signal becomes smaller

$$\varphi = \frac{\lambda d}{p_2} \frac{\partial \Phi}{\partial y} \propto \mathcal{E}^{-2}$$

Possible solutions:

- other samples → **is biological imaging possible?**
- larger distances → **polychromativity and flux**
- smaller pitches → **even more difficult fabrication**

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Second progress report

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Second progress report

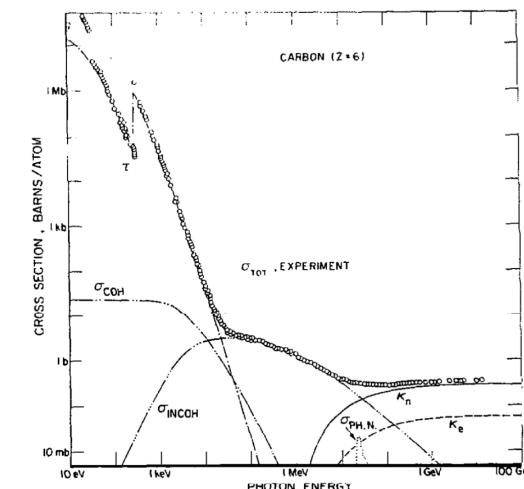
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The noise becomes larger

$$\sigma_\varphi \propto \frac{1}{\nu \sqrt{N}}$$

- difficult fabrication of the gratings → low visibility
- low detection efficiency
- little room for filtering

What is a high-energy absorption image?



Thanks!