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PSI

Phase contrast imaging at 100 keV

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Phase contrast imaging at 100 keV

The edge-on setup

Alignment

Visibility

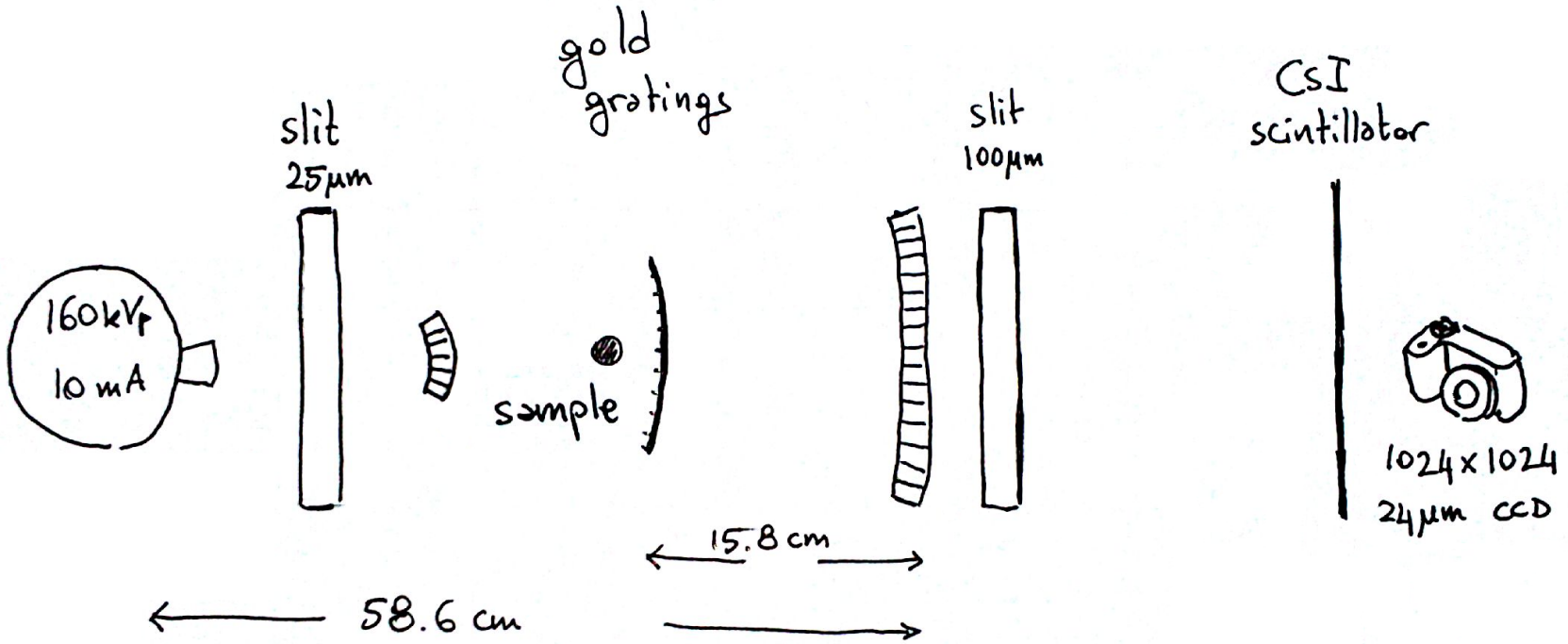
Phase drift

The first images

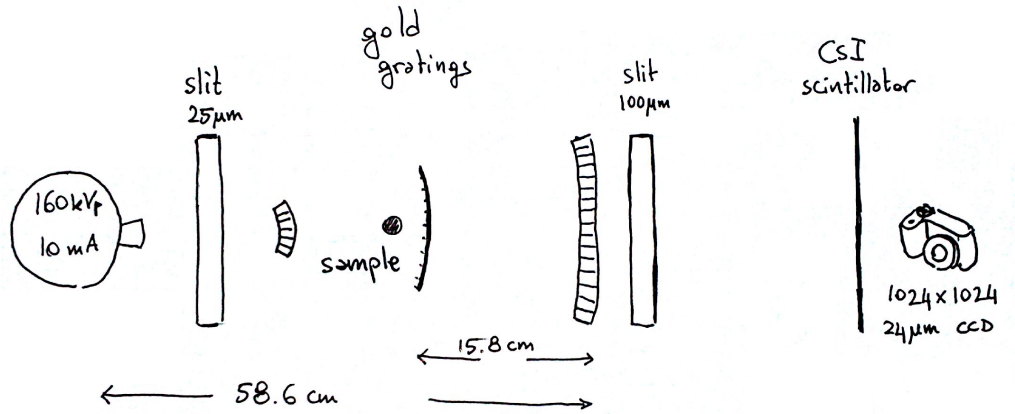
Deep questions ahead

The one-dimensional setup at 100 keV

Top view



The one-dimensional setup at 100 keV



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

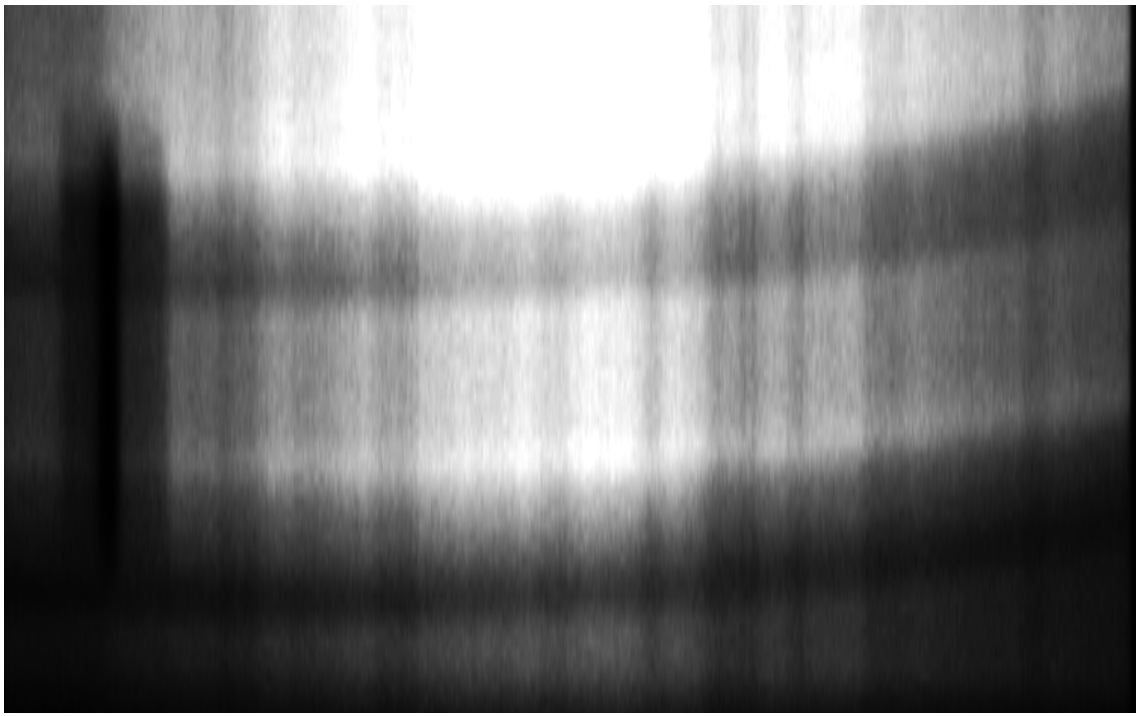
The alignment

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

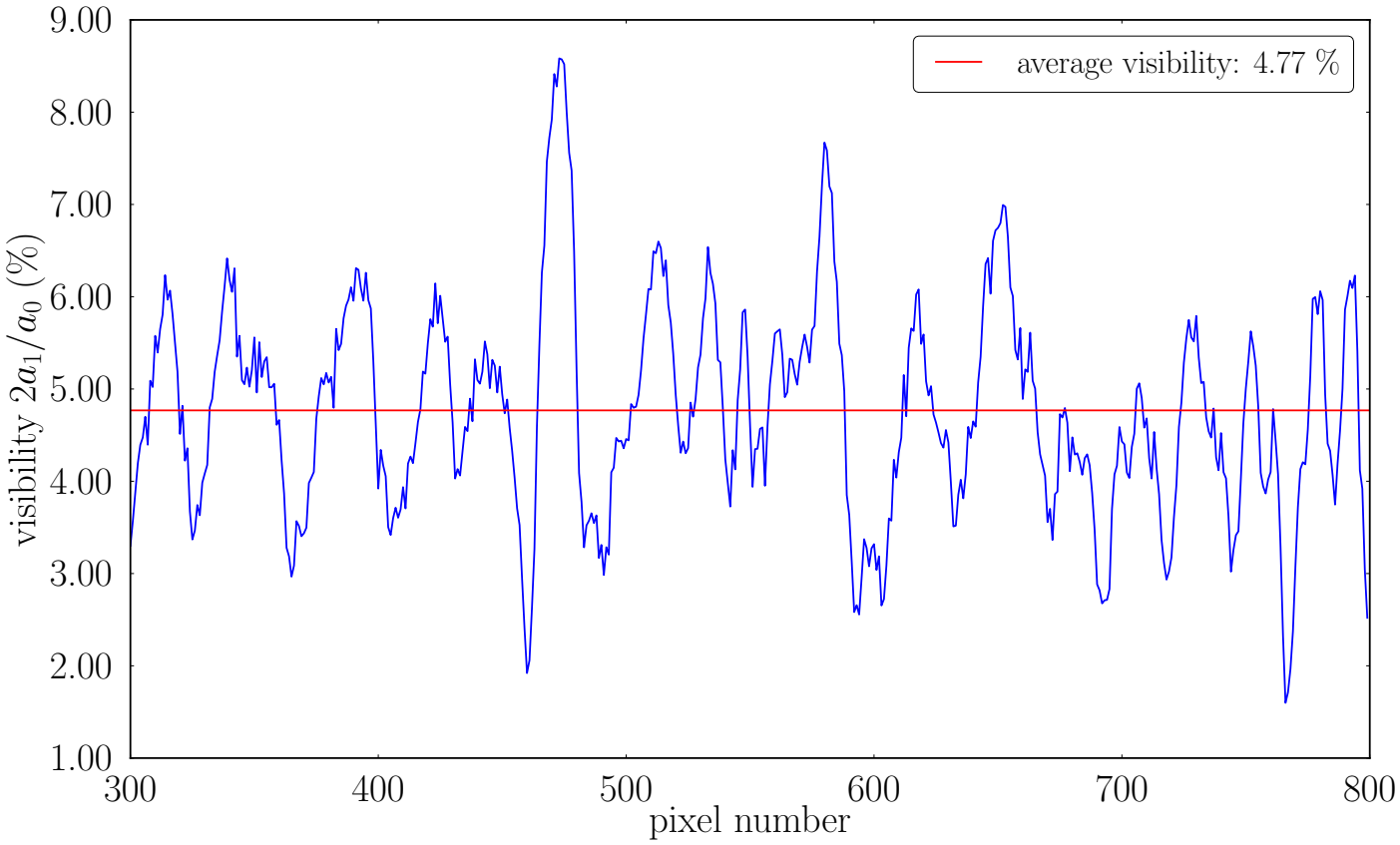
The right end of G1 in the picture goes up by 50 µm on 3 cm



New holders from Gordan keep the gratings flat

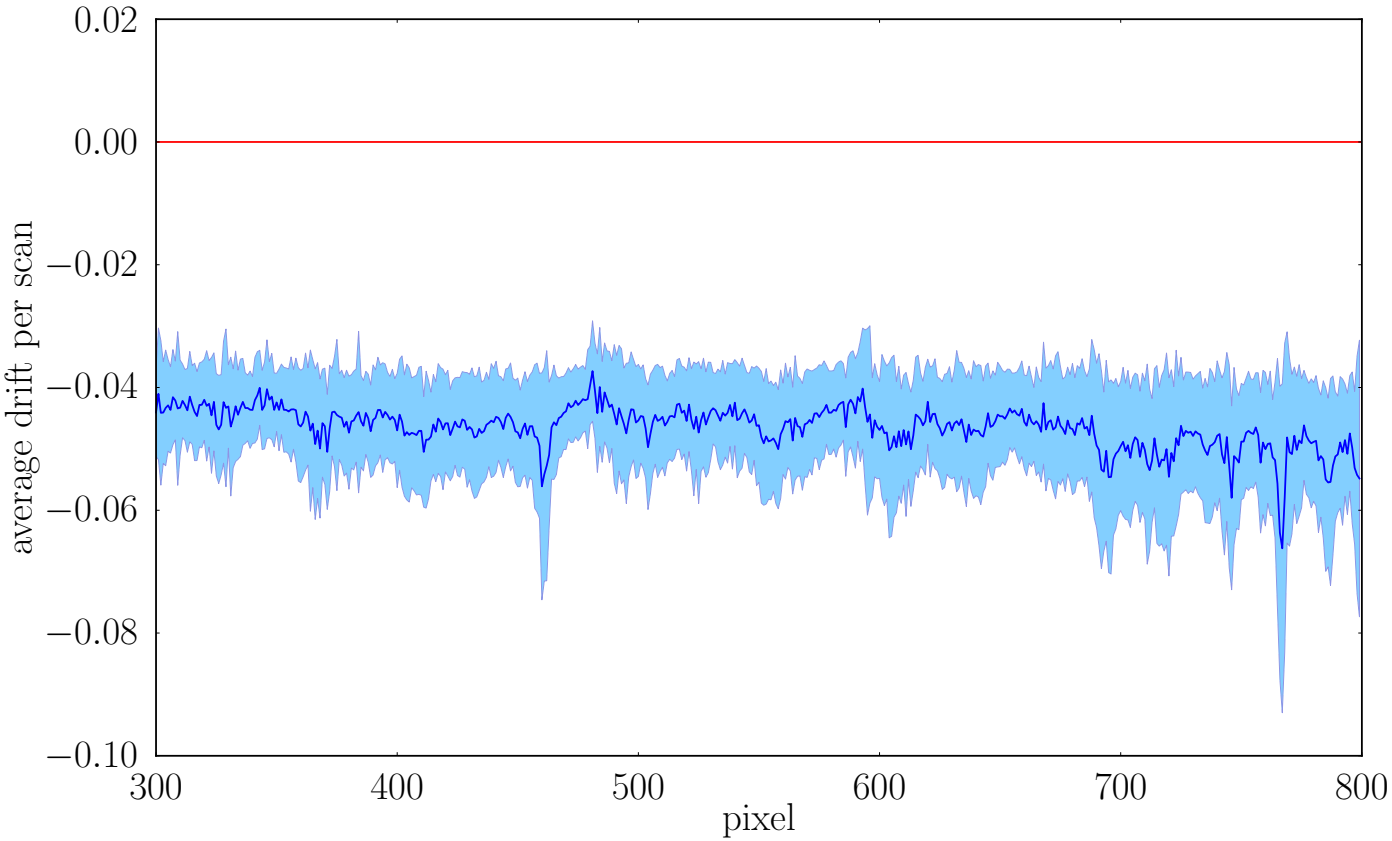
Visibility map

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



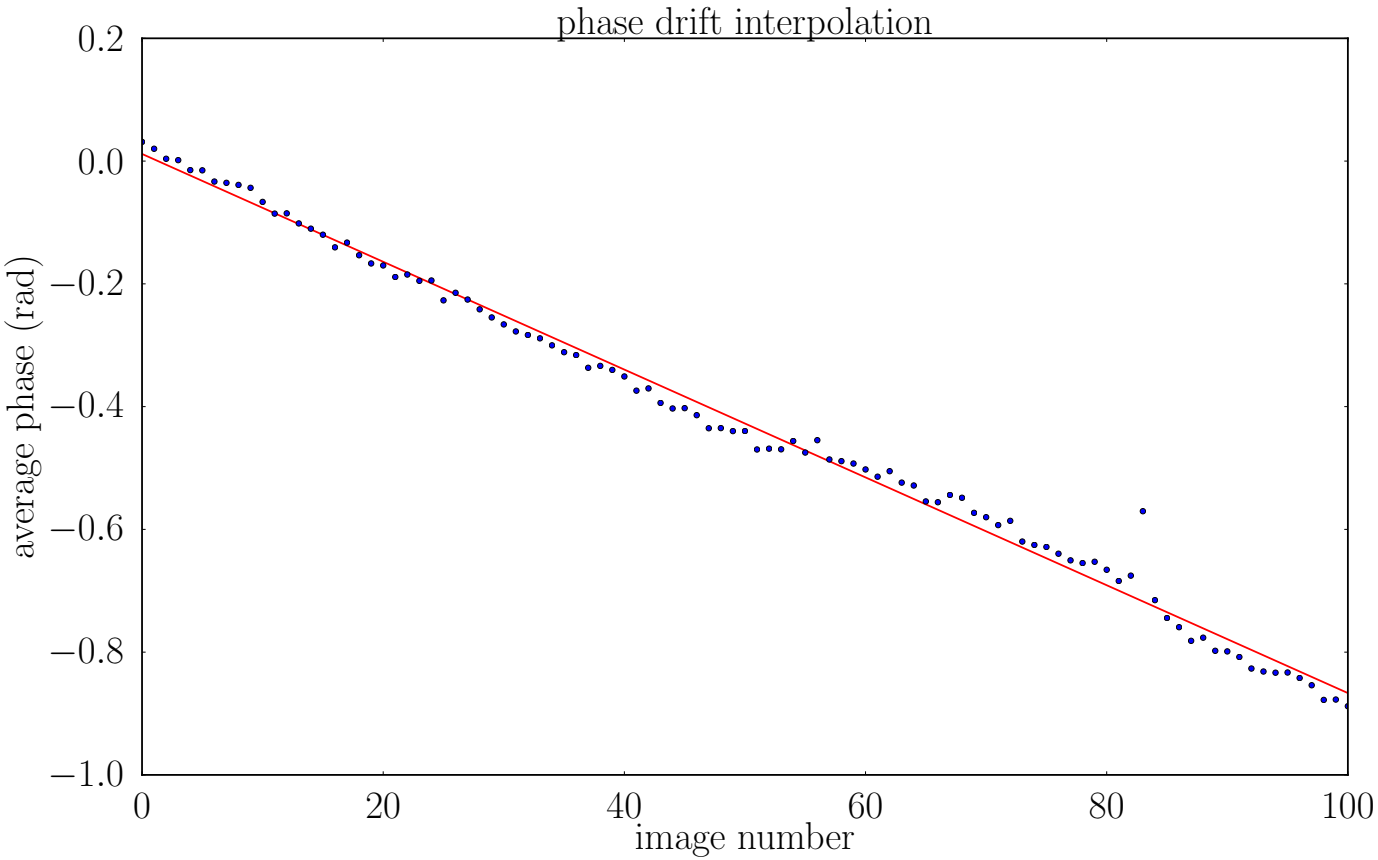
Strong drift

after twenty scans ($\sim$ 10 min)



Drift correction

linear fit $\rightarrow$ subtraction

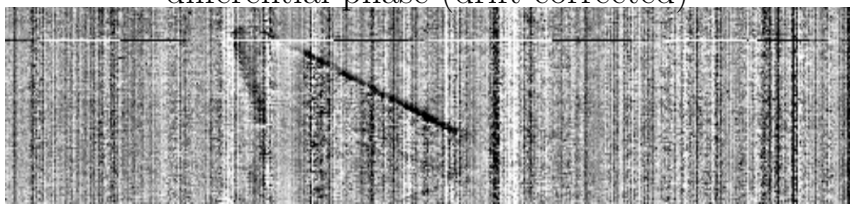


The first noisy image

Head of a metal screw

absorption image

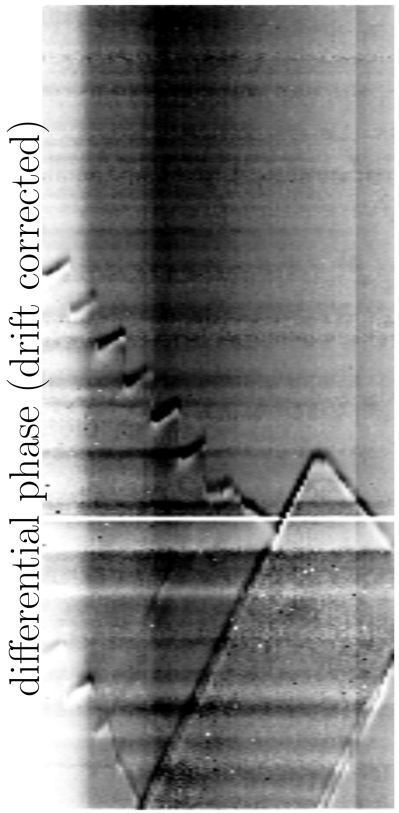
differential phase (drift corrected)

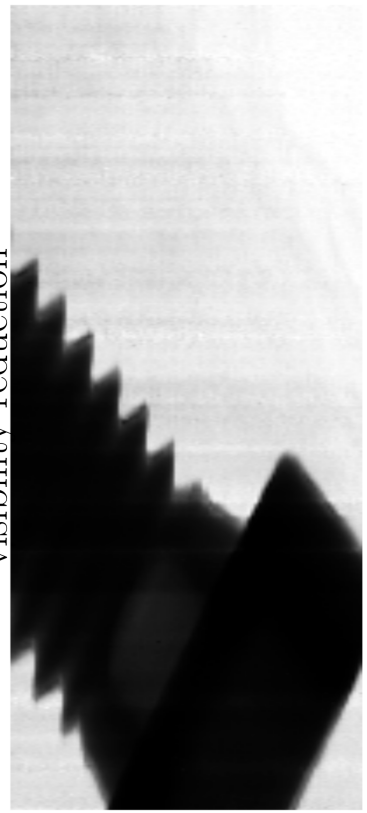


visibility reduction

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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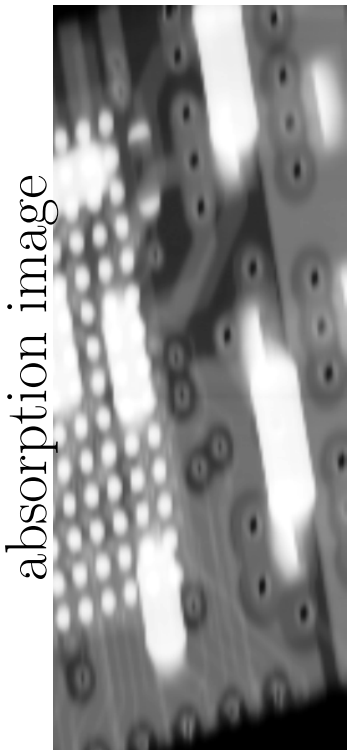

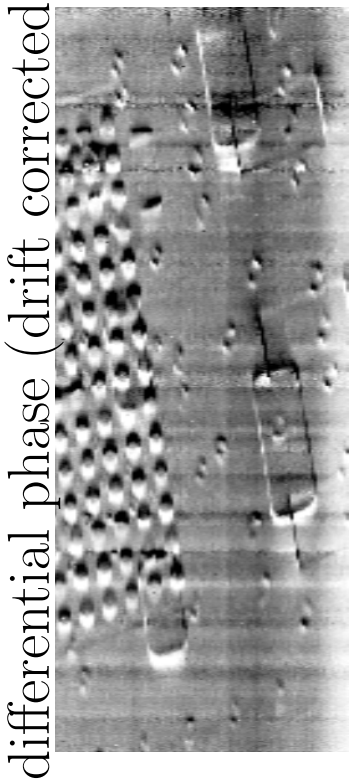

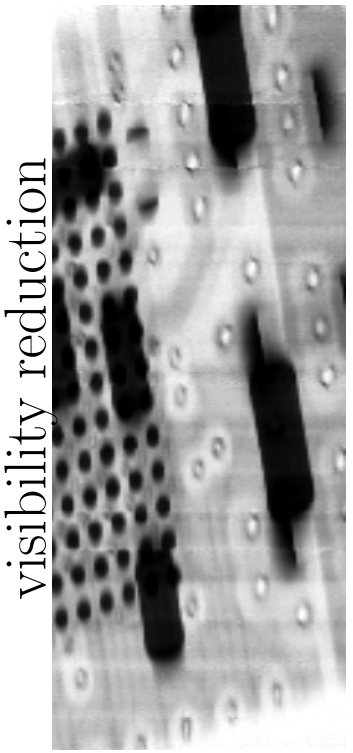

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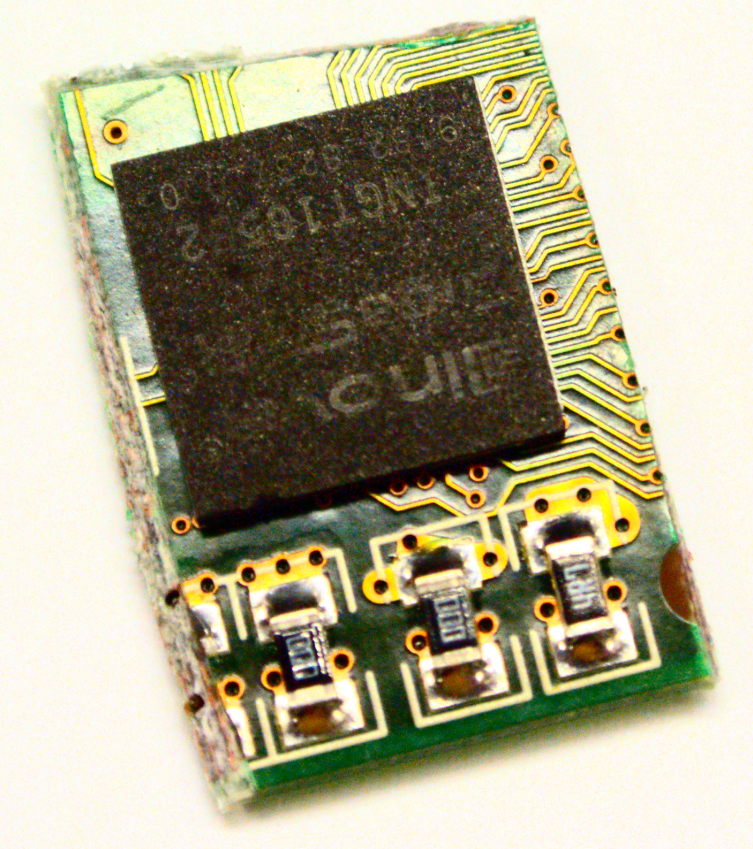

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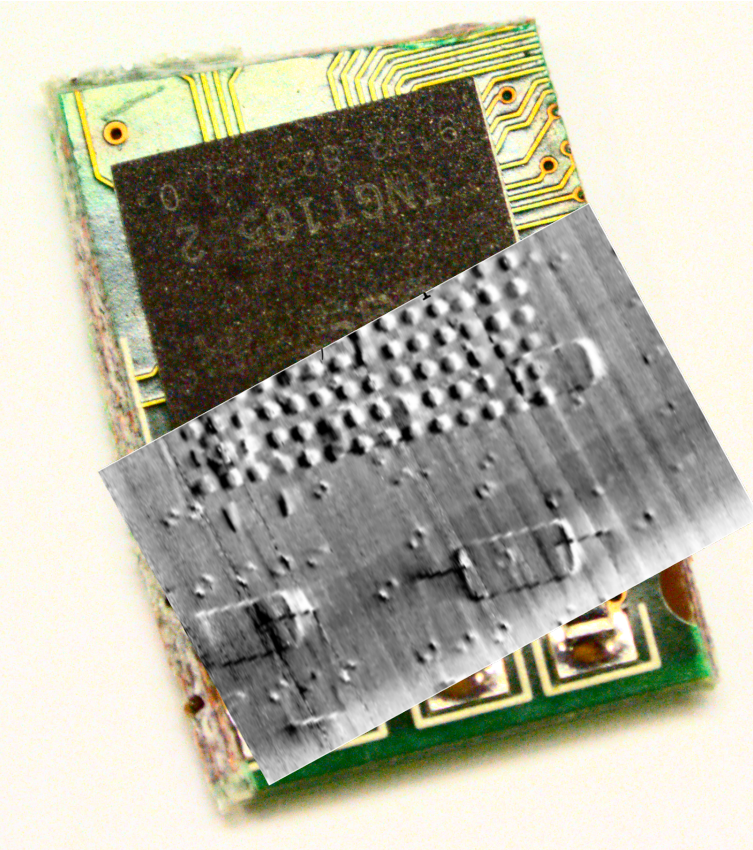
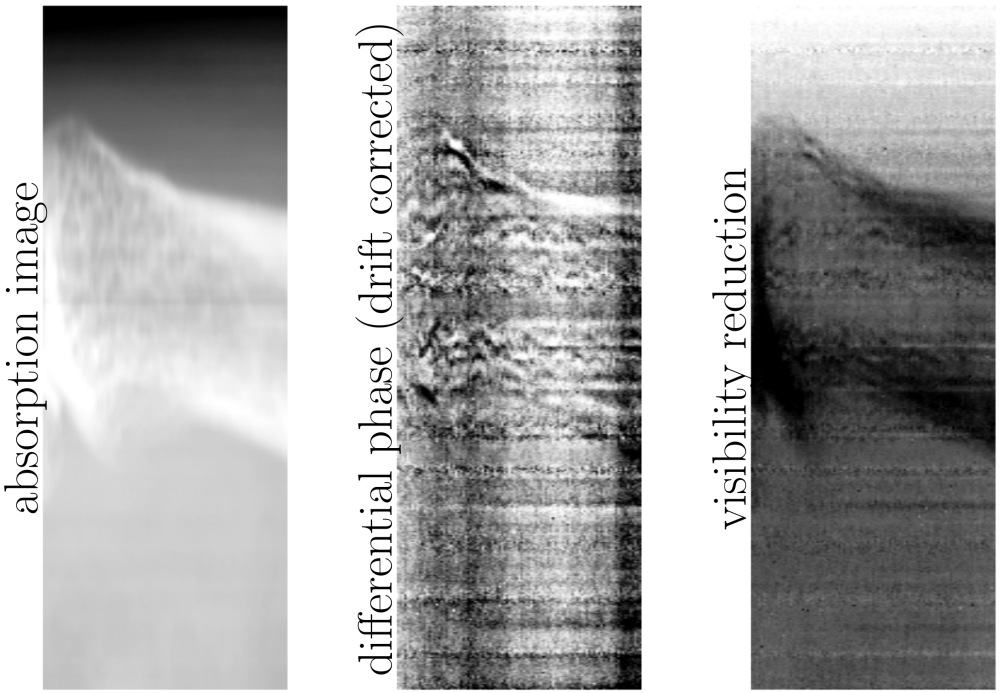


A biological sample

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



energy is too high

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:

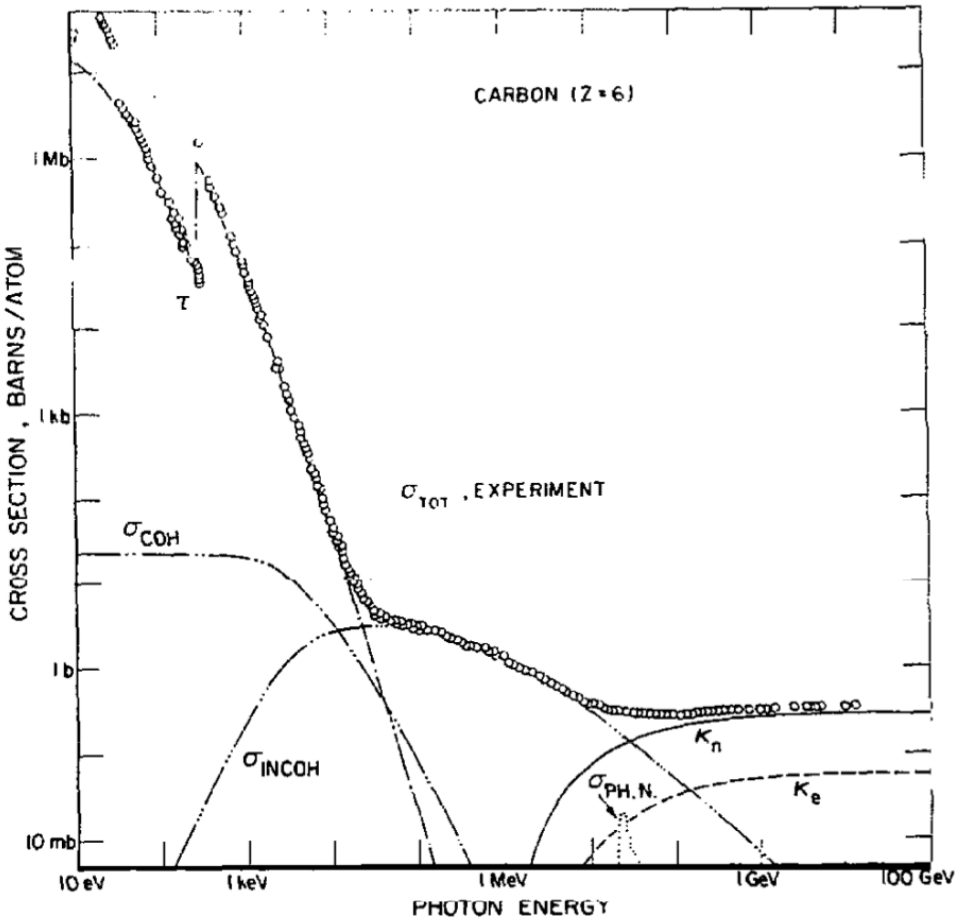
- other samples $\longrightarrow$ is biological imaging possible?
- larger distances $\longrightarrow$ polychromaticity and flux
- smaller pitches $\longrightarrow$ even more difficult fabrication

The noise becomes larger

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

- difficult fabrication of the gratings $\rightarrow$ low visibility
- low detection efficiency
- little room for filtering

What is a high-energy absorption image?



Thanks!