Large beam XPCS

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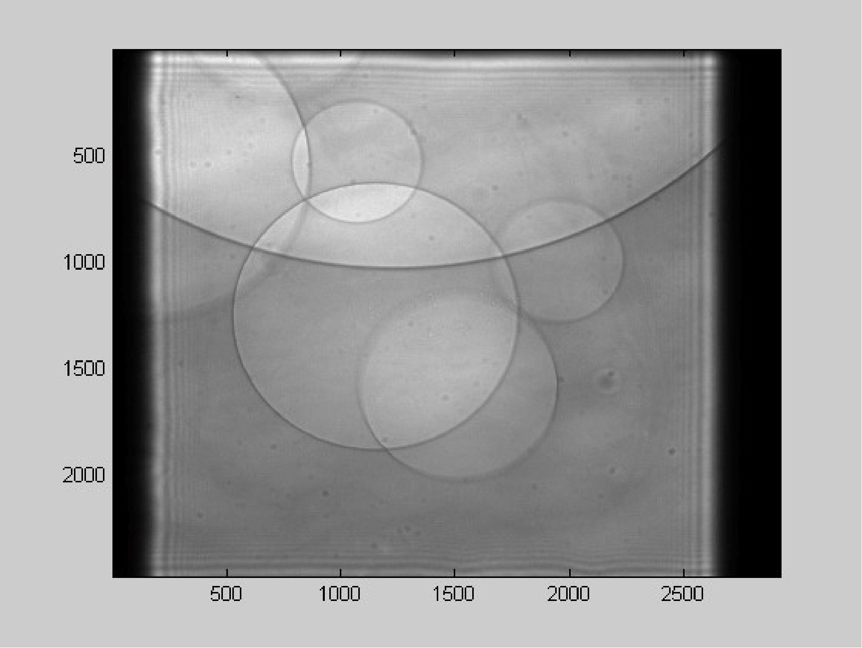
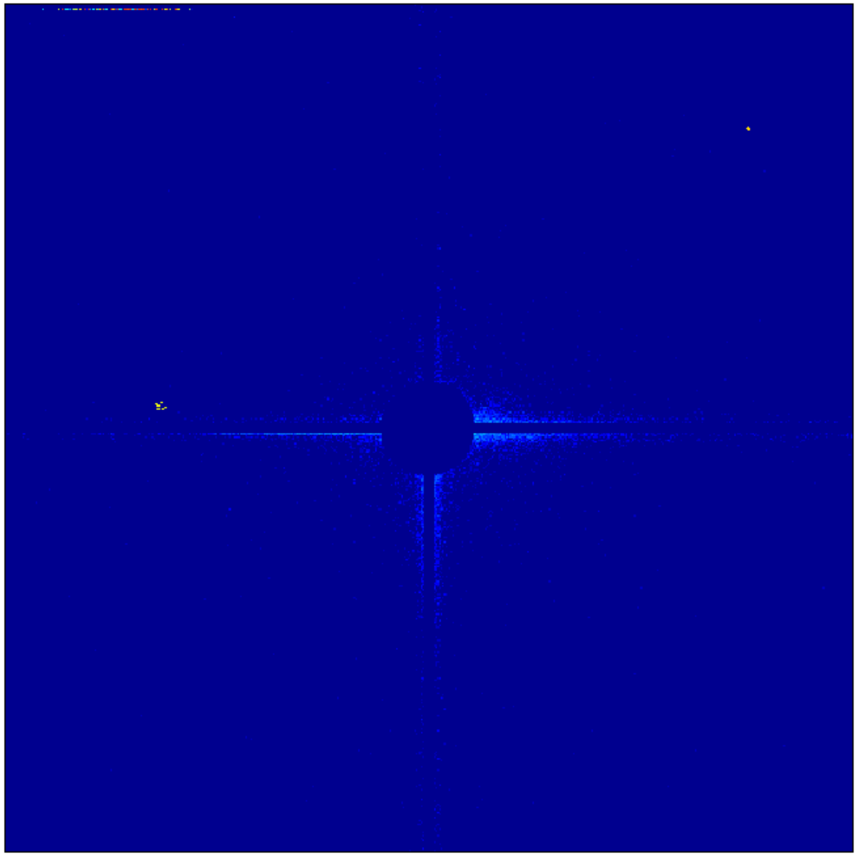
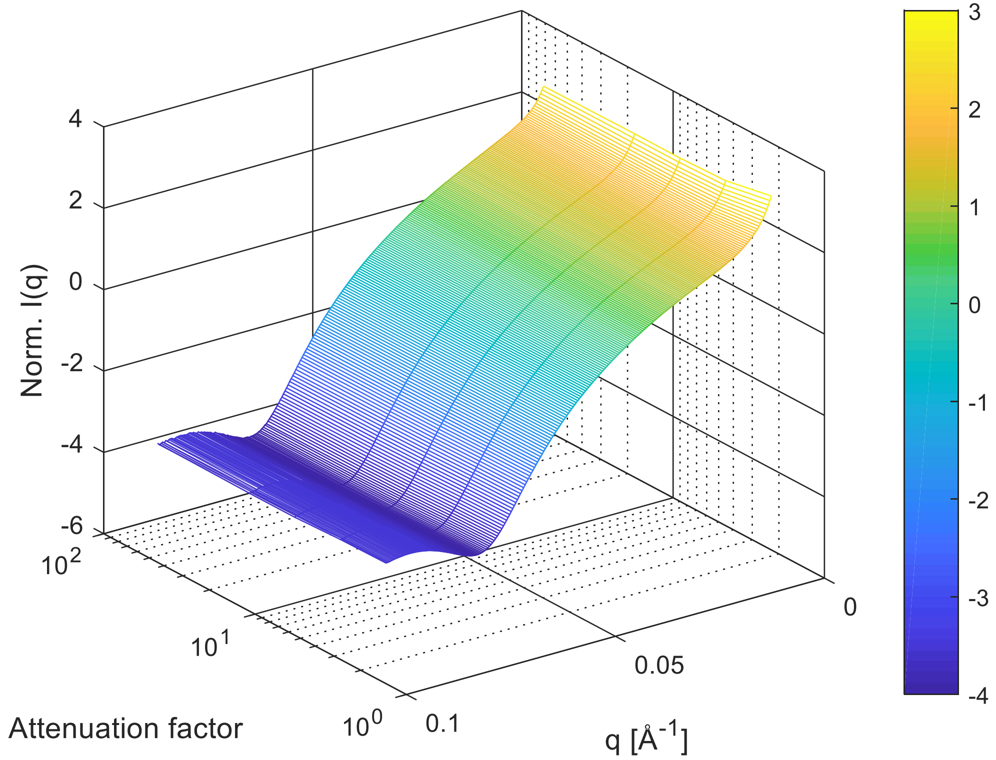
Motivation





Motivation: Beam damage

- In many systems, X-rays change the sample (or at least the sample dynamics)
  - Usually a function of dose
  - $D = {}^{absorbed\ radiation}/_{mass}$

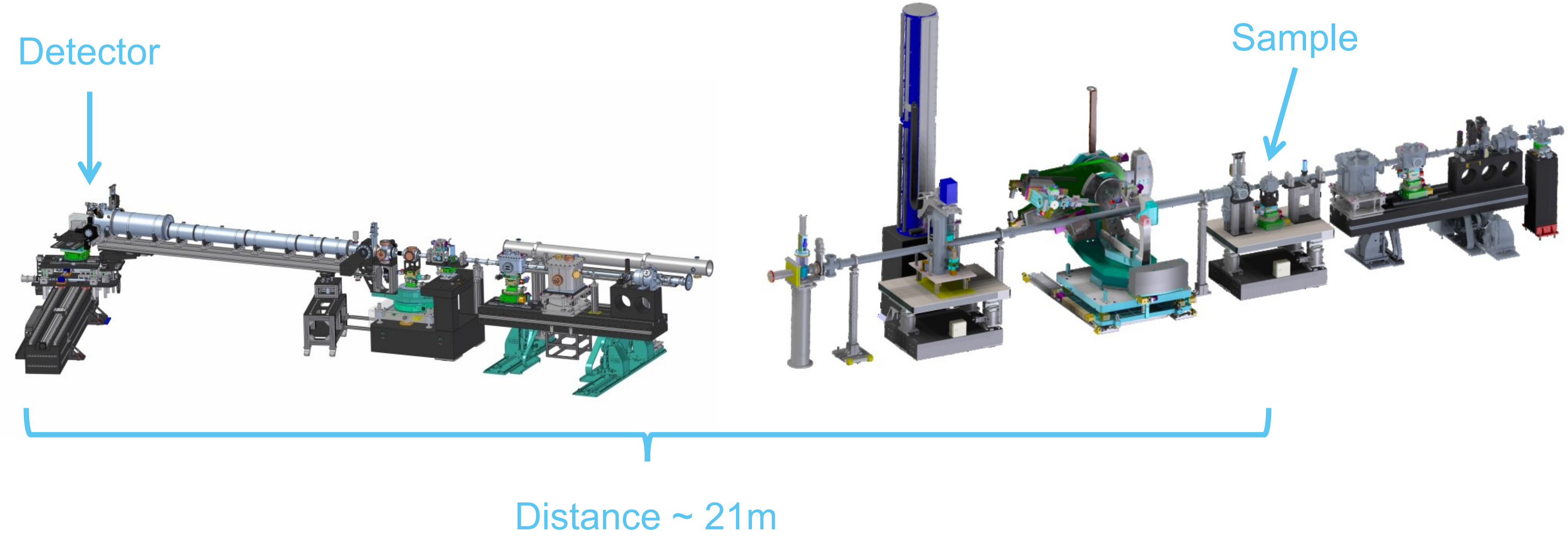


Motivation: Beam damage

- In many systems, X-rays change the sample (or at least the sample dynamics)
  - Usually a function of dose
  - $D = {}^{absorbed\ radiation}/_{mass}$
  - By using a large beam, we increase the mass…
    - Limitations:
      - Restricted to *large* uniform sample systems
        - Heterogeneous sample systems: Mean of dynamics (advantage/disadvantage)
- Coherent flux at P10-EH1: ~ 10^{11} ph/s
    - Flux density: ~ 10^{7} ph/s/µm^{2}

Realization

- Our problem: The bigger the beam, the smaller the speckles…
- Solution: Increase distance between sample & detector



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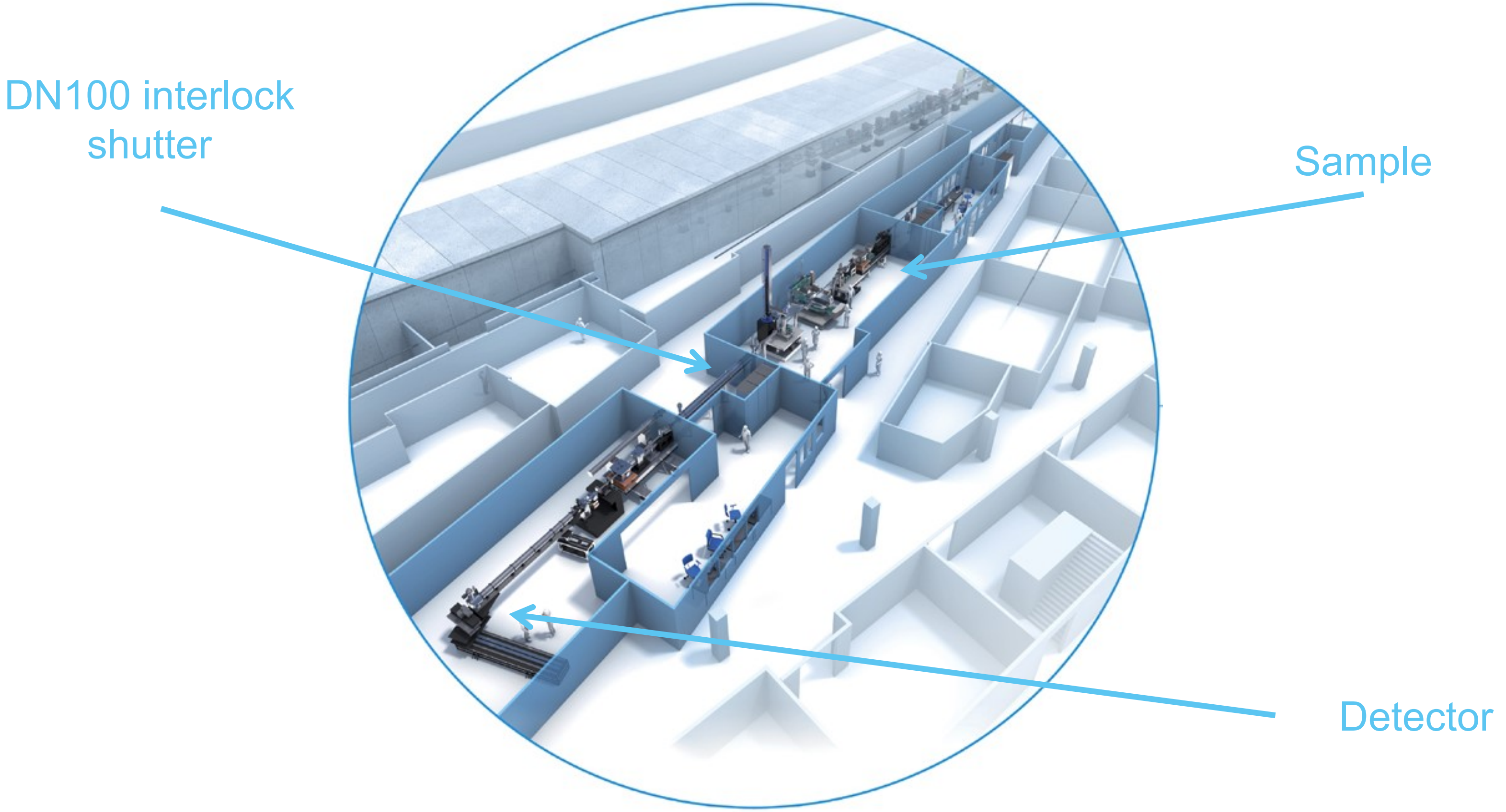
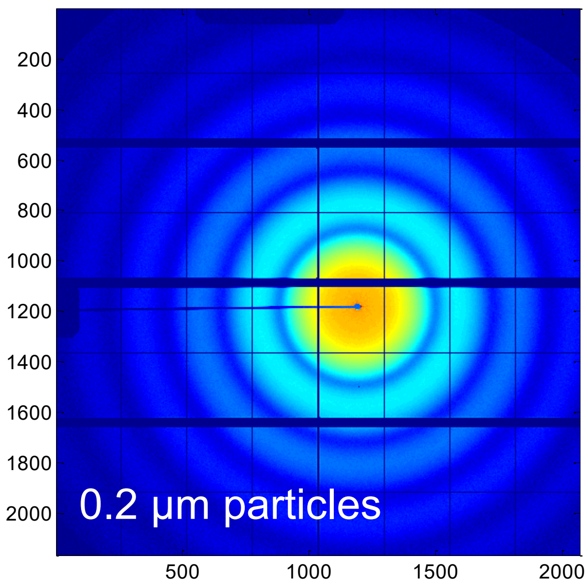
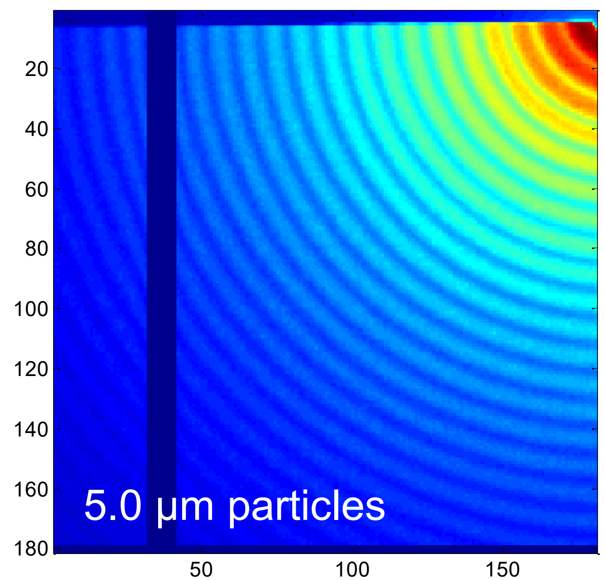


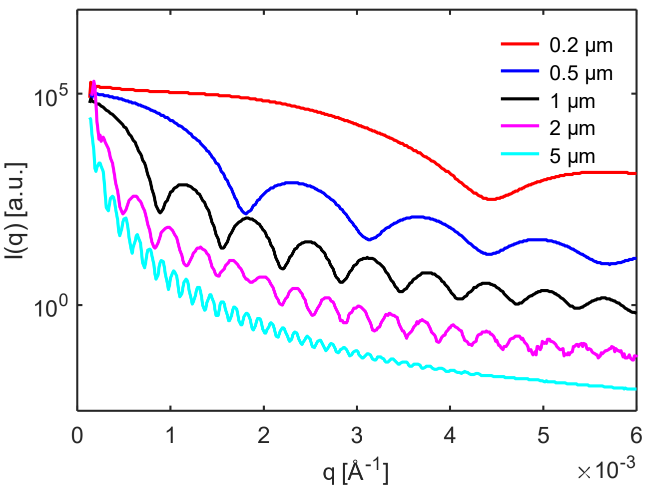
Some images…

Approx. 2000x2000 pixel



ROI, approx 200 x 200 pixel

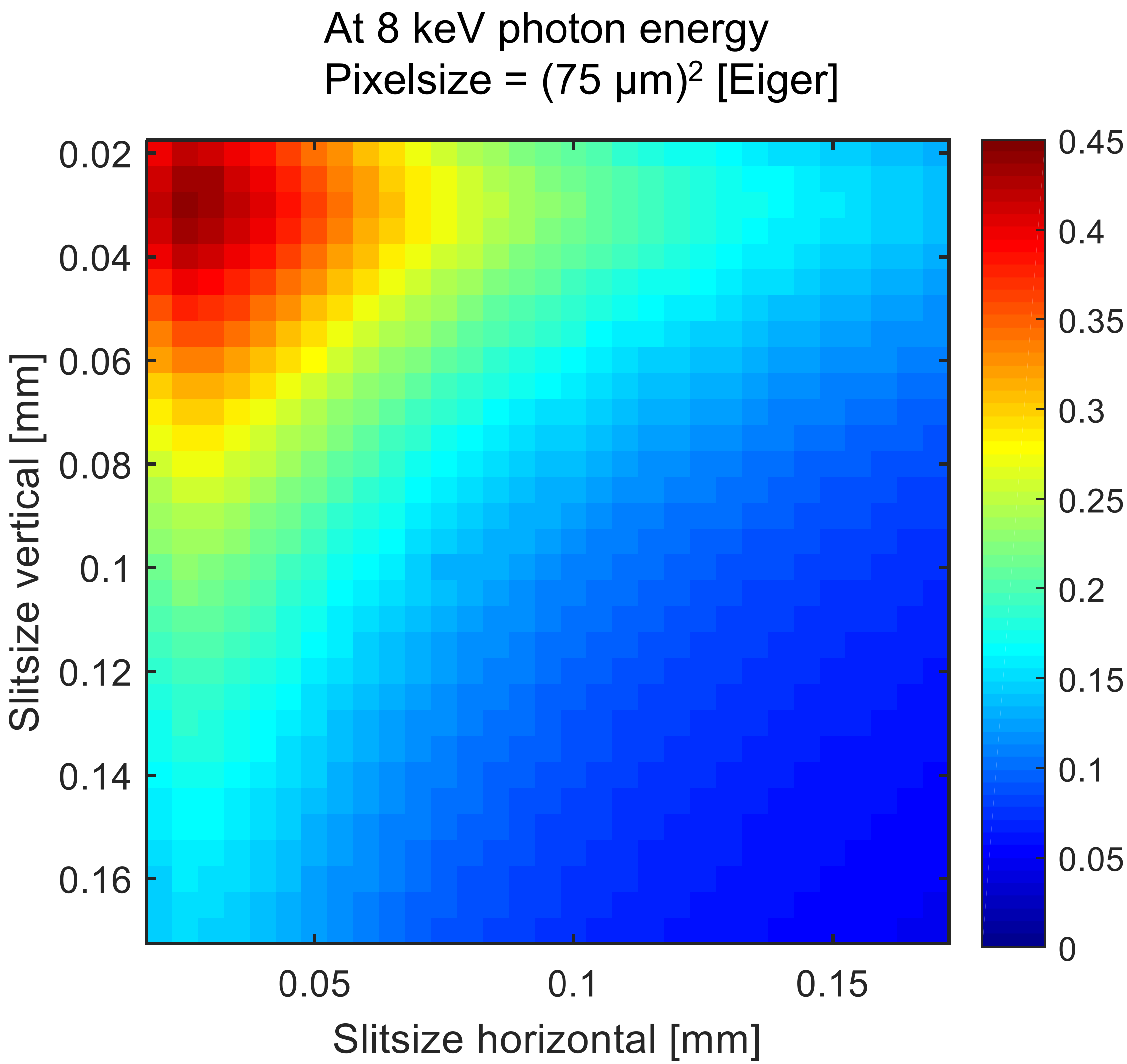




Setup characteristics

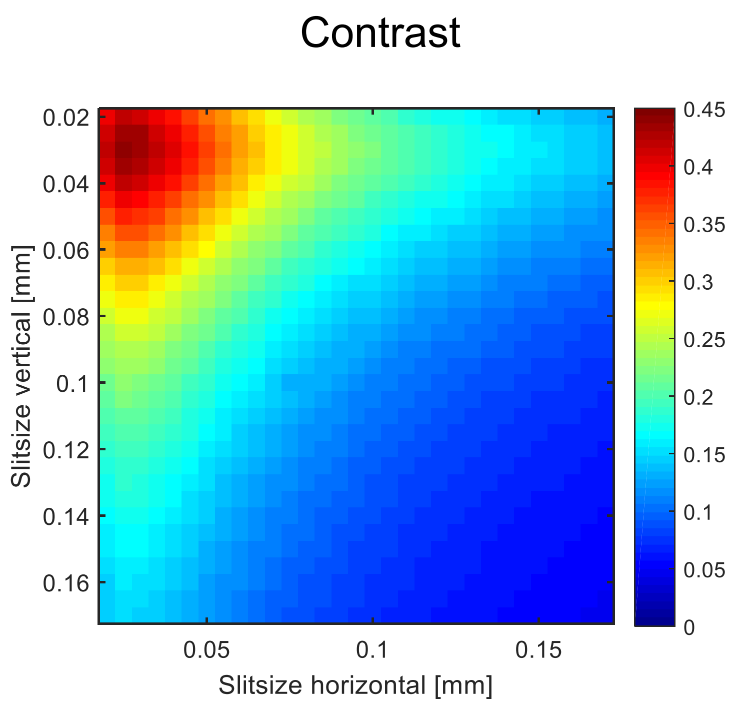
- Sample-detector distance of 21.0 m
- Accessible q-range at 8 keV photon energy: 2×10^{-4} – 2×10^{-2} Å^{-1}
- Low-beta source: Approx. 7x40 µm (sigma source size)
- Large sample area: Approx. 600 mm along beam & wide open across beam
  - Maximum load: 150 kg
- Standard sample environment:
  - Samples are placed in a DN100 cube which is fully vacuum integrated
    - Transmission & reflectivity inserts, temperature-range: -150 to 400°C
    - Nano-positioning setup based on piezo stages
  - Custom user setups:
    - Linkam temperature stage
    - High-pressure cell (University of Dortmund)

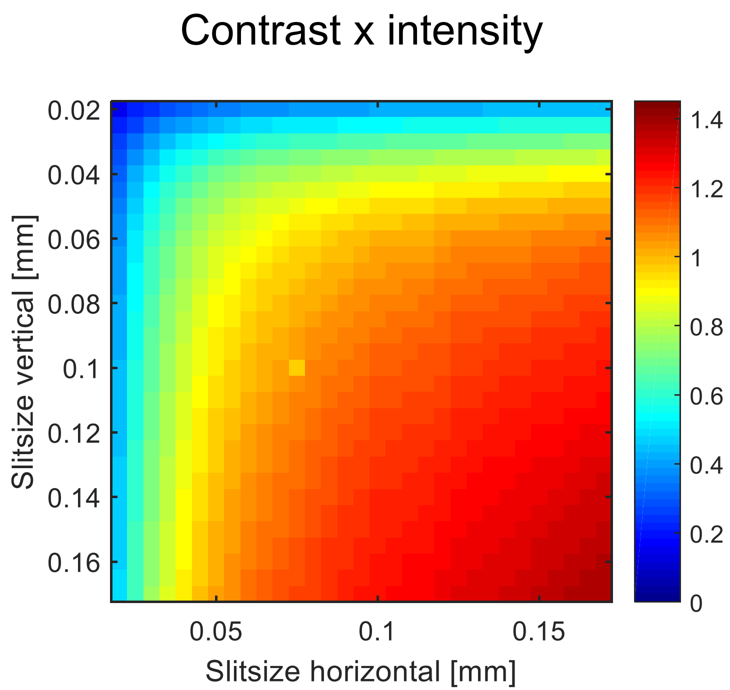
How about the contrast



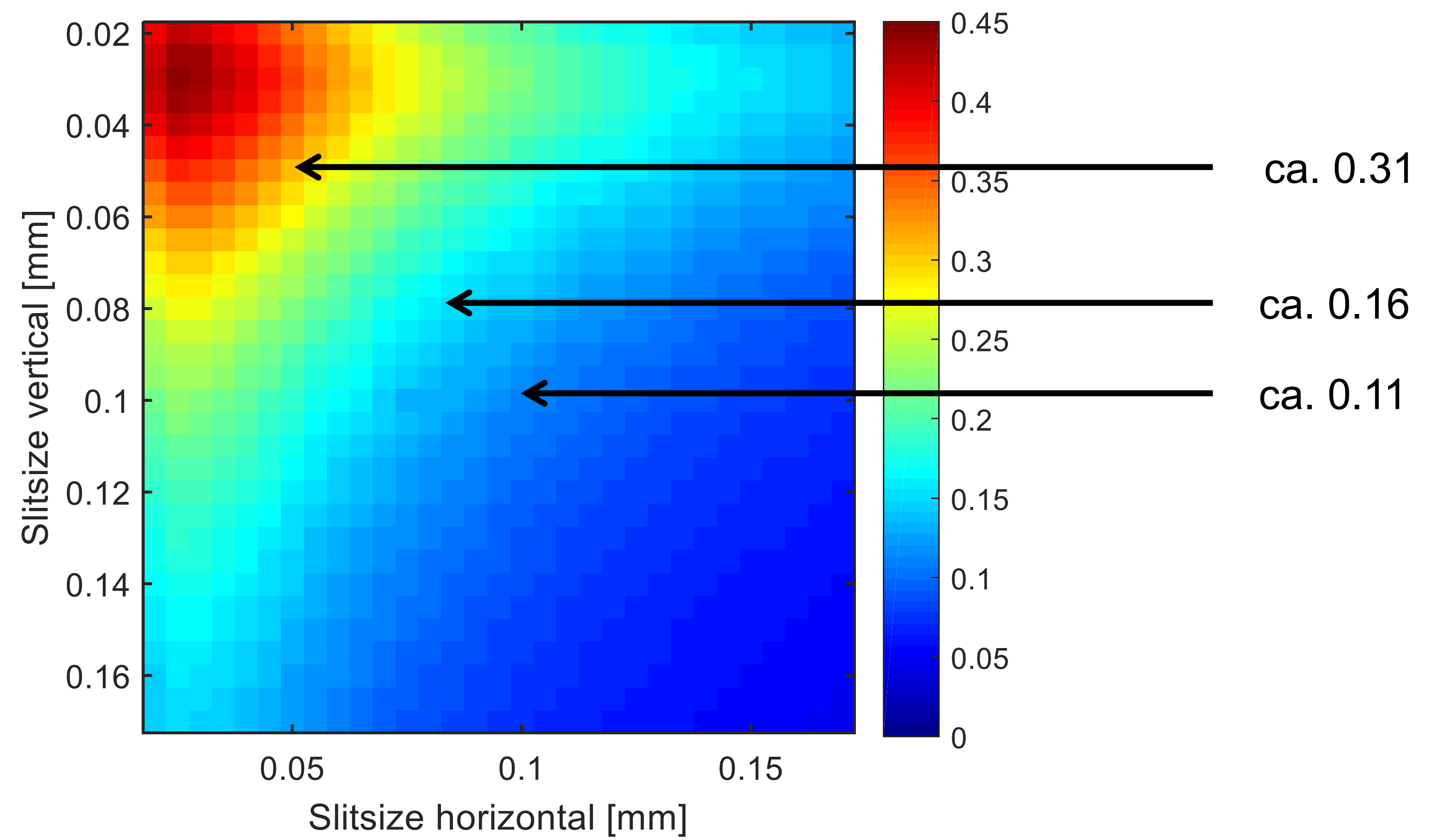
How about the contrast

In XPCS, SNR is proportional to $\beta \cdot I$



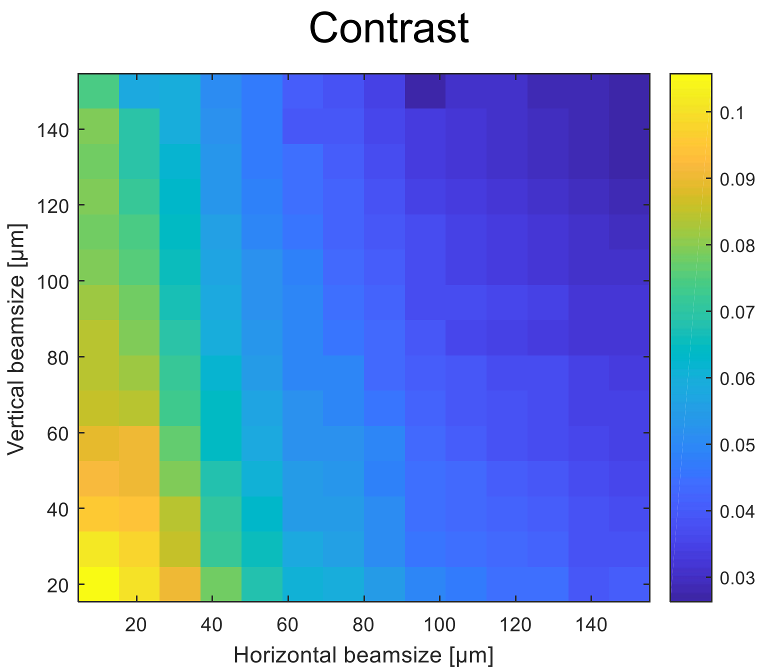


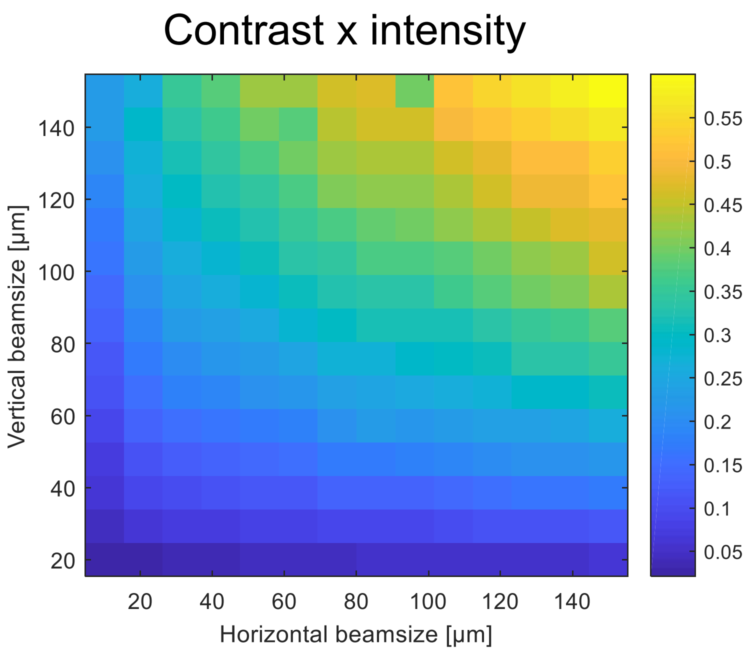
How about the contrast



How about the contrast

At 13 keV photon energy
Pixelsize = $(75\ \mu m)^2$ [Eiger]





Some suggestions for low-dose XPCS

- Flux matters – no virtual source
- Flux matters – try to optimize $\beta \cdot I$
- For fast (kHz) detectors:
  - Detector pixel size will most probable stay in the range of (50-200 μm)^2

  → Maximize sample to detector distance

	ESRF high	ESRF low	ESRF-EBS
H β [m]	37.6	0.35	6.90
H η [mm]	134	31	1.73
H beam size [μm]	387.8	37.4	30.2
H beam divergence [μrad]	10.3	106.9	4.37
V β [m]	3	3	2.645
V beam size [μm]	3.46	3.46	3.64
V beam divergence [μrad]	1.15	1.15	1.37

plus less divergence…

Thanks

- to the P10 team
    - Michael Sprung
    - Sergej Lazarev
    - Dmitry Dzhigaev
    - Daniel Weschke
- and all P10 users