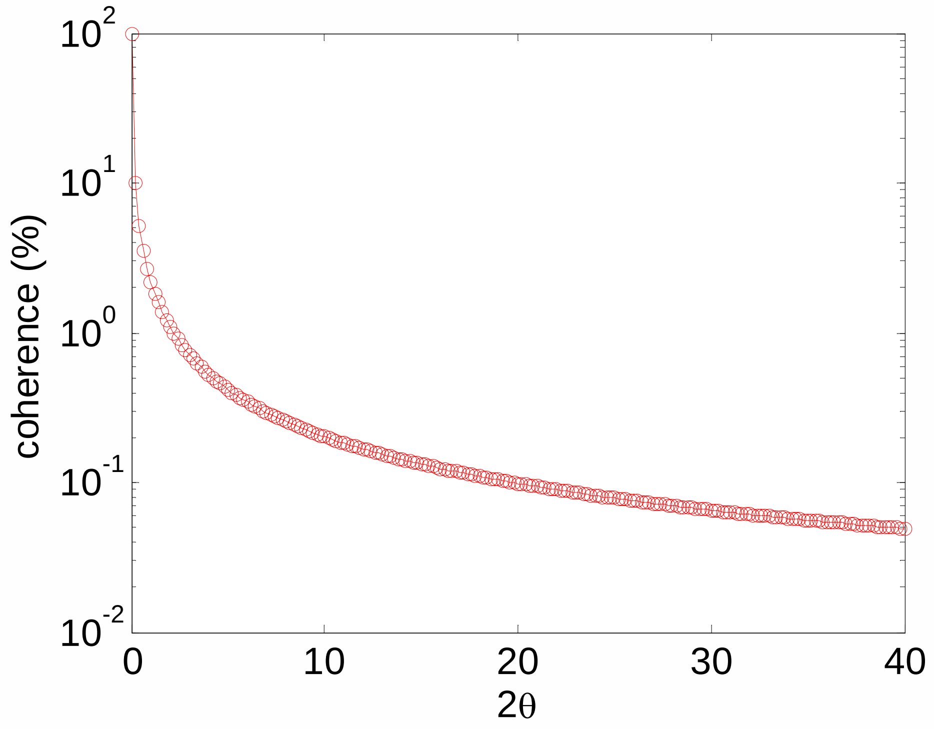
Speckle contrast (assuming a perfectly disordered sample)

XFEL (no optics config.): coherence length $\xi_h = \xi_v \approx 0.7$ mm,
beamsize on sample 0.1 mm (slit defined), λ = 1Å, $\Delta\lambda/\lambda$ = 8e-4

2D Coherence factor, transmission geometry, sample thickness 0.1 mm:

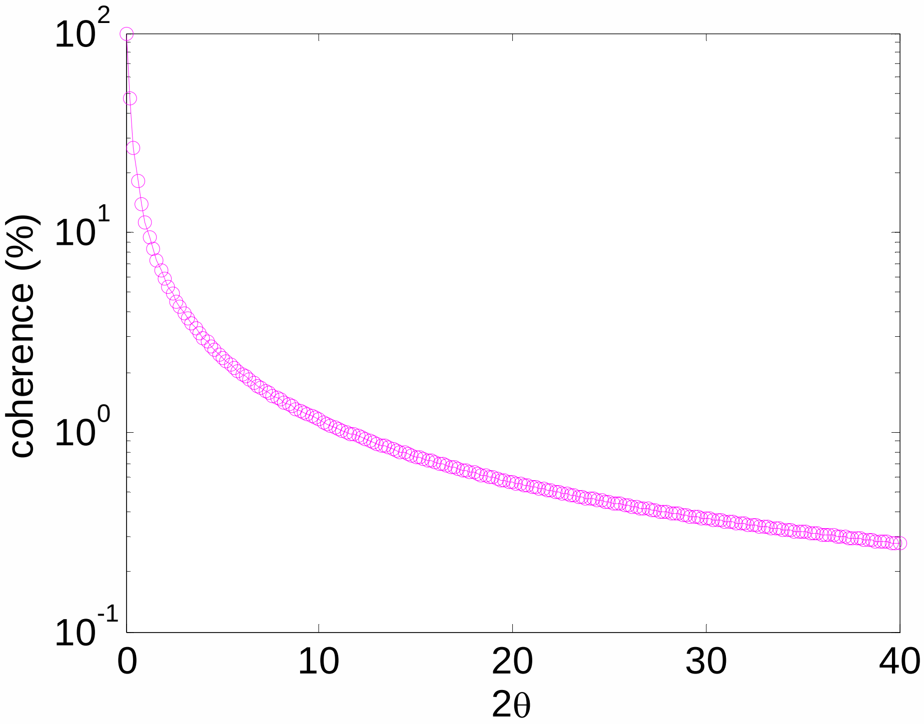


$\beta(2\theta=1^o)=2.2\%$
$\beta(2\theta=10^o)=0.2\%$

Speckle contrast (assuming a perfectly disordered sample)

XFEL (with Si(111) mono): coherence length $\xi_h = \xi_v \approx 0.7$ mm, beamsize on sample 0.1 mm (slit defined), λ = 1Å, $\Delta\lambda/\lambda$ = 1.4e-4

2D Coherence factor, transmission geometry, sample thickness 0.1 mm:



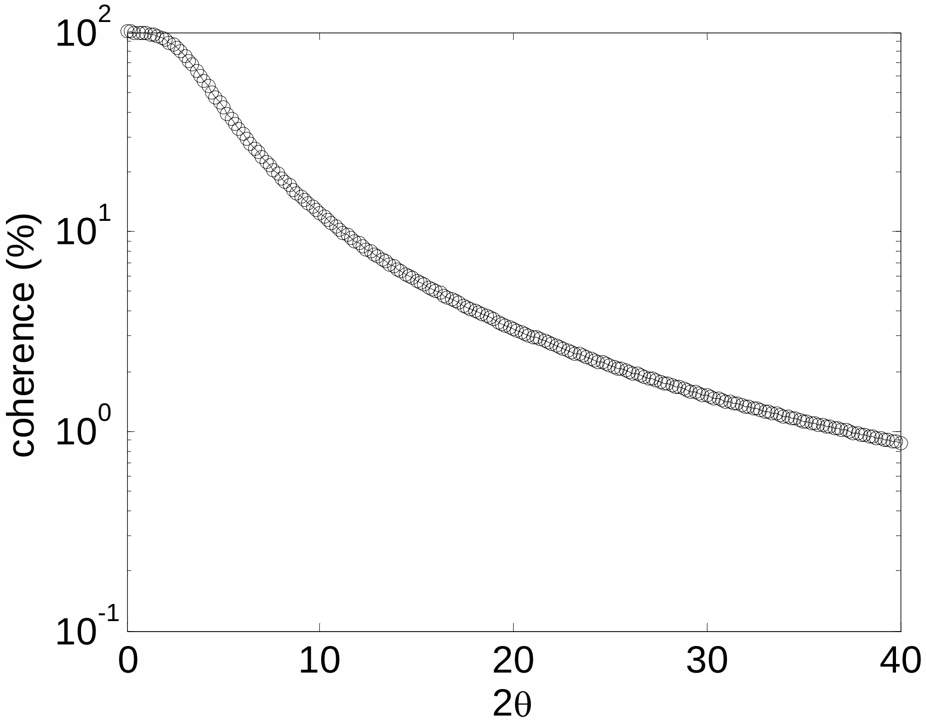
$\beta(2\theta=1°)$=11.3%
$\beta(2\theta=10°)$=1.2%

Speckle contrast (assuming a perfectly disordered sample)

XFEL (with focusing f=25m and Si (111) mono):

Beamsize on sample: 2x2 μm^2

2D Coherence factor, transmission geometry, sample thickness 0.1 mm:

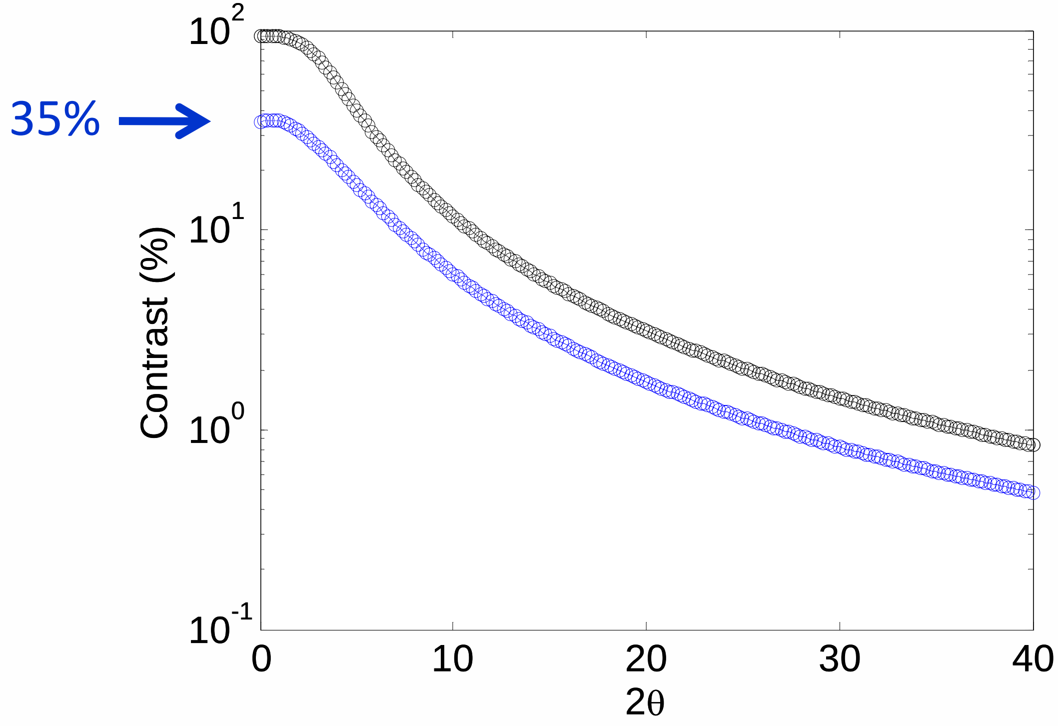


$\beta(2\theta=1^o)$=98.5%
$\beta(2\theta=10^o)$=12.3%

Convolution between speckle width and pixel size will decrease the measured contrast:

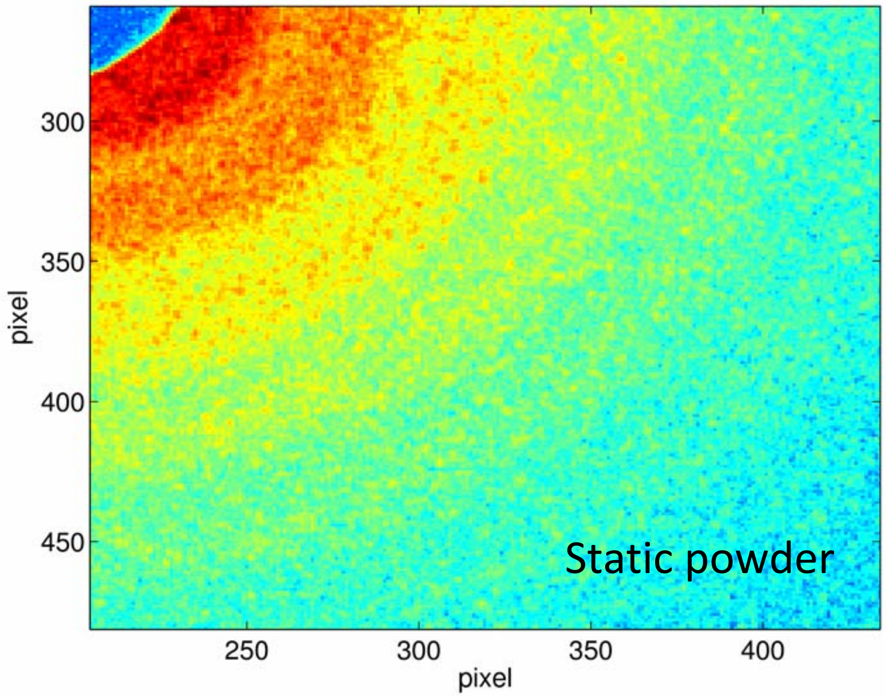
2D Gaussian model (P.N. Pusey, Abernathy *et al*, M. Sutton)

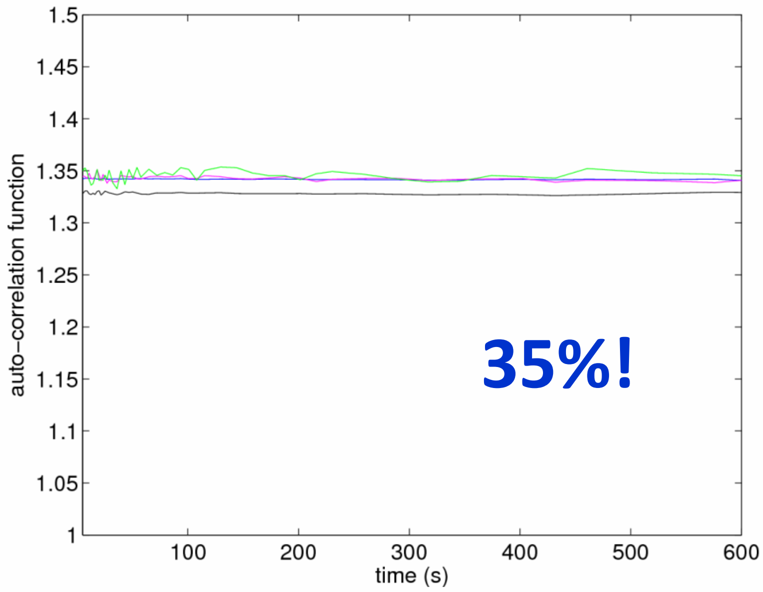
XFEL: λ=1Å, focusing, mono and 10μrad pixel opening angle

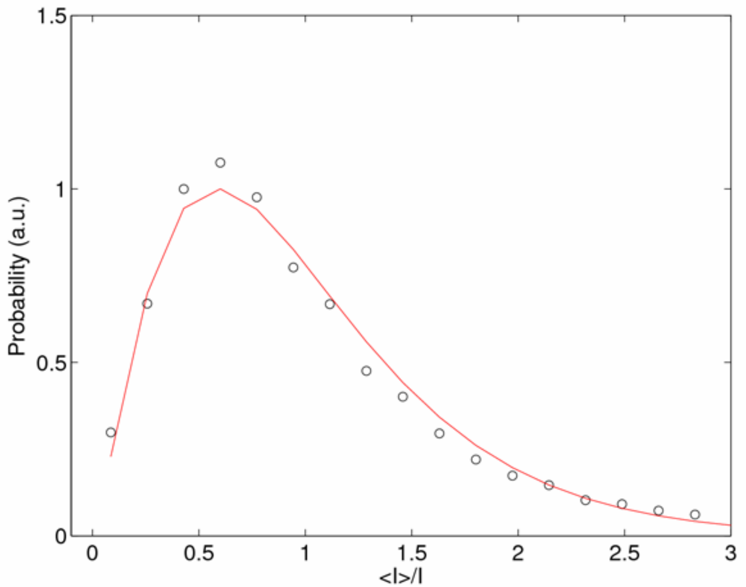


C(2θ=1°)=93.3%
C(2θ=10°)=11.7%

Troika: 10mu beam, 8keV
Si(111), 22micron pixels
2.3m sample-CCD dist.
0.1mm sample thickness





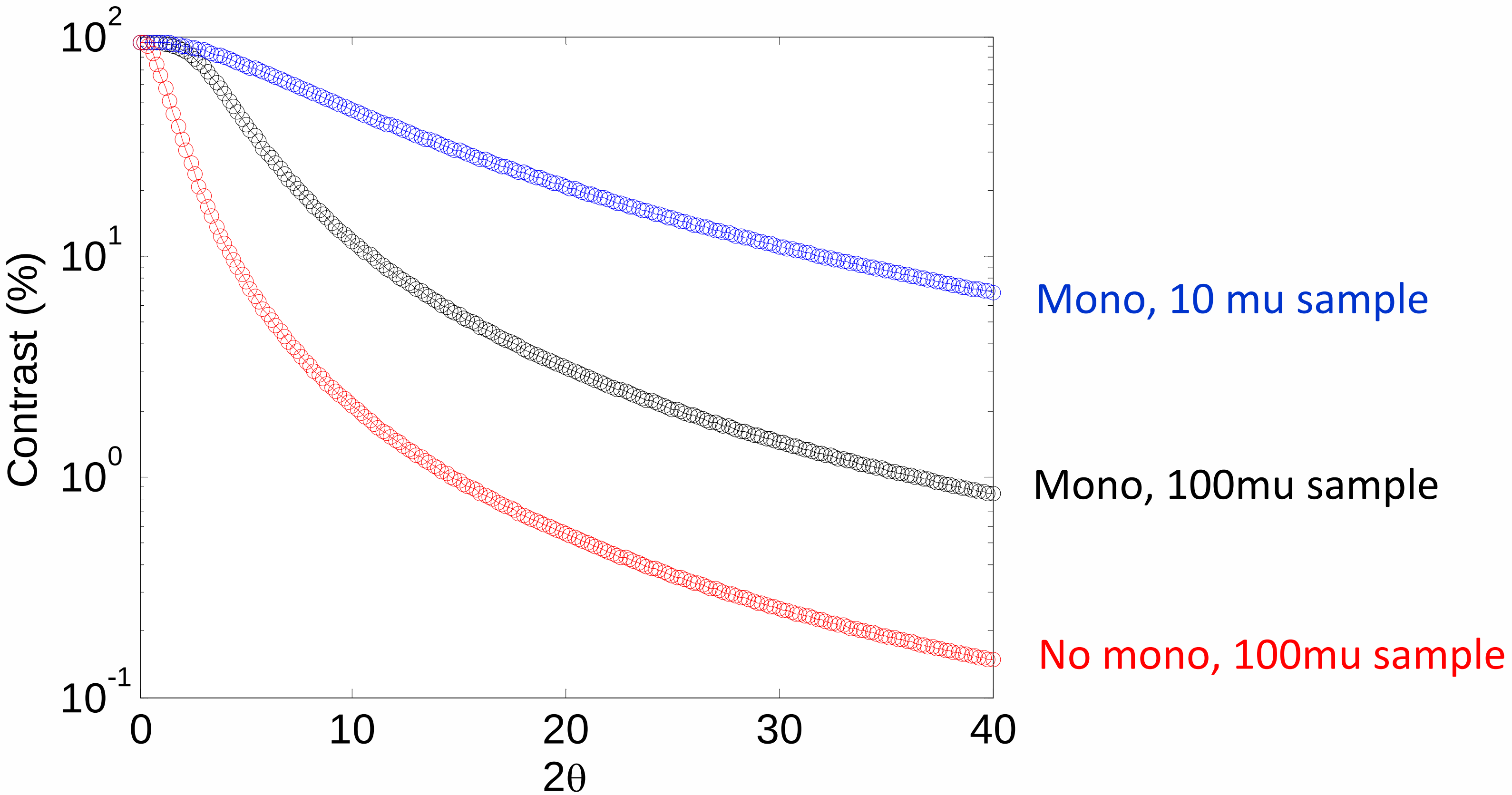


Speckle intensity histogram:

Gamma-Poisson distribution

Variance=$\langle I \rangle^2$/M and M=35%

Contrast with focusing: effect of sample thickness and mono



Remember: s/n-ratio in XPCS is prop. to Contrast*I. Today many experiments are s/n or radiation damage limited

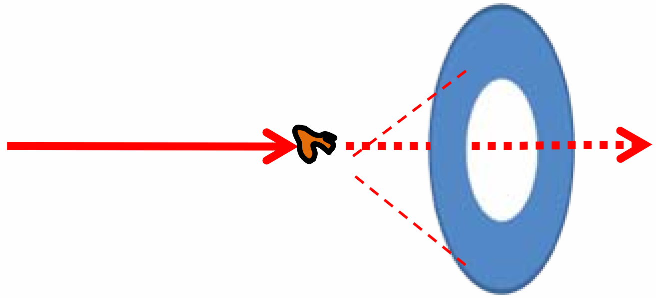
Conclusion:

Focusing is needed (too penalizing in β not to do it)

SAXS: Mono is not required
Use as thick samples as required to optimize the scattering (1/e)

WAXS: Contrast scales approximately with 1/thickness
Mono is optional but contrast can become too low at large Q………
Transmission geometry is better than reflection geometry (not discussed)

Need to deal with beam damage!



Dynamics of liquids, polymers and macromolecules.

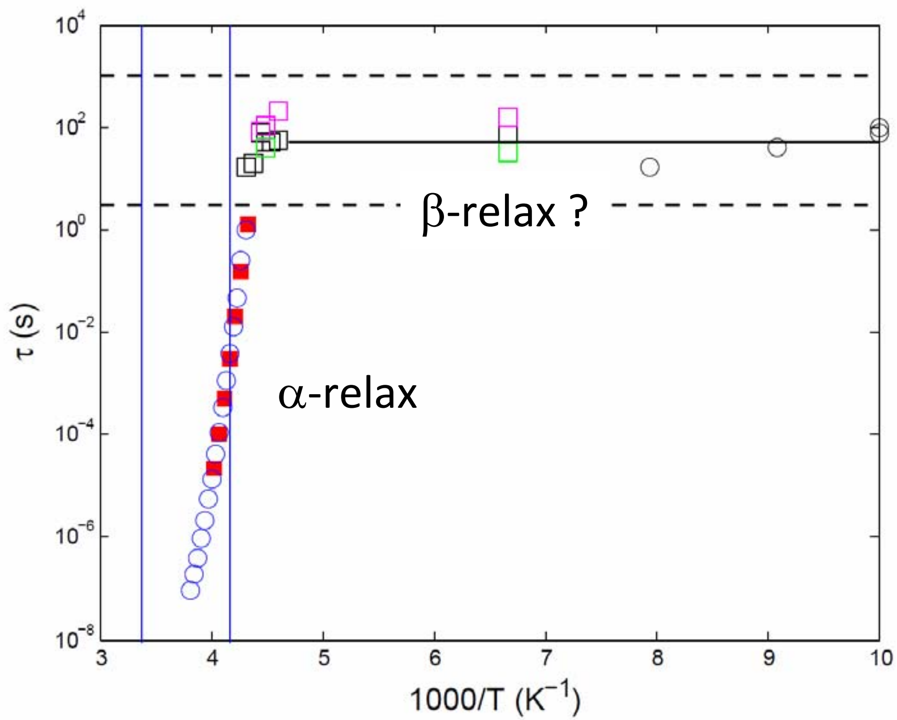
Ring shaped detector to be efficient at large Q

SAXS detector could be separate (and different?)

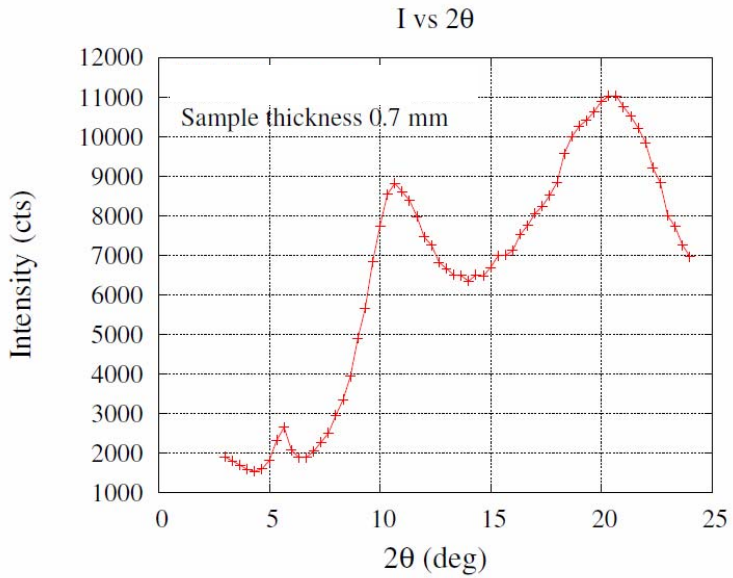
XPCS on a molecular liquid: Primary and secondary relaxations in a Silicon oil

XPCS provides access to a combination of length- and timescales not accessible by any other techniques.

Very challenging at 3rd generation sources (small contrast at $Q=0.85Å^{-1}$, low count rates)



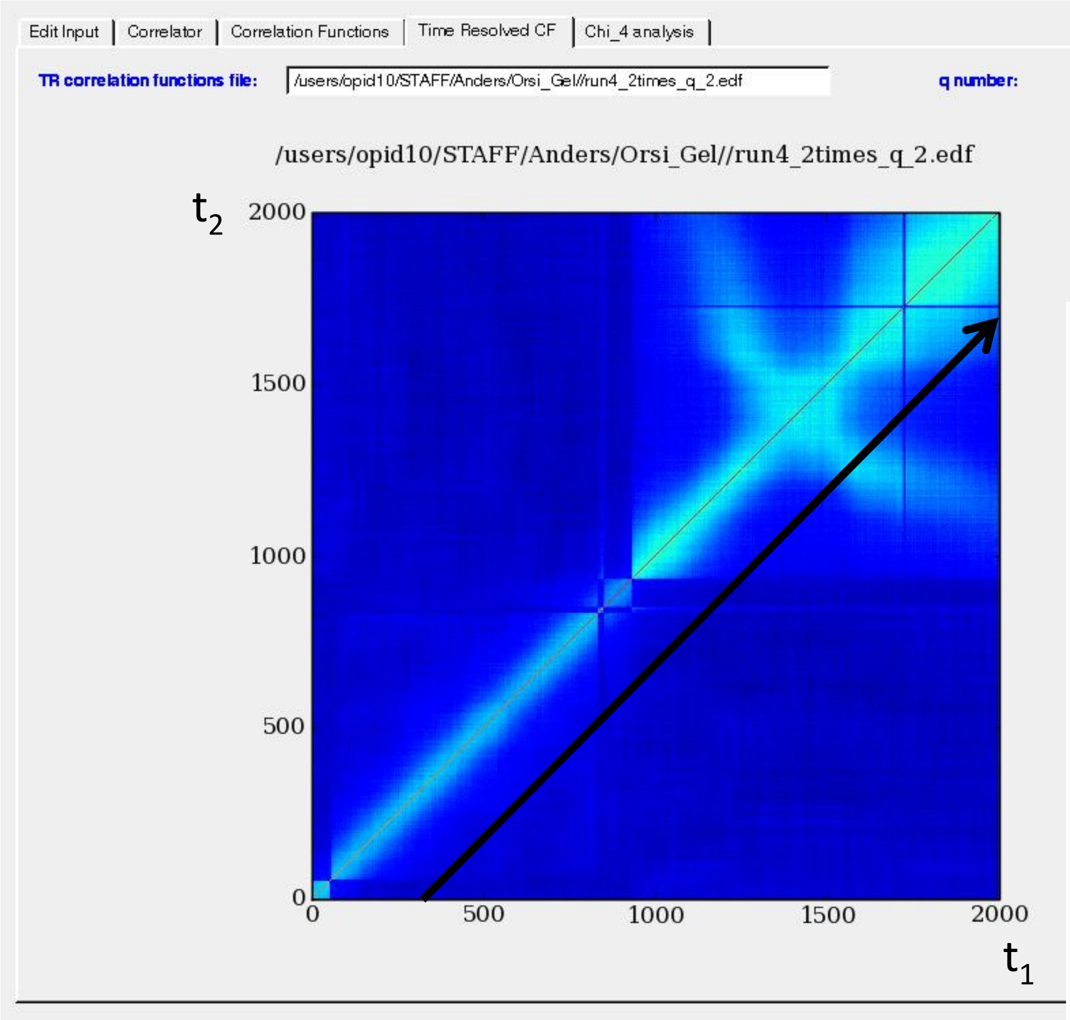
Chushkin, Caronna, Madsen, Mattson & Matic



XPCS data compared with dielectric spectroscopy and mechanical relaxations

Maybe a secondary relaxation process in the glassy state….

Working in the time-domain: Fast, non-equilibrium dynamics with the XFEL



$G(t_a, \Delta t = \tau_0)$

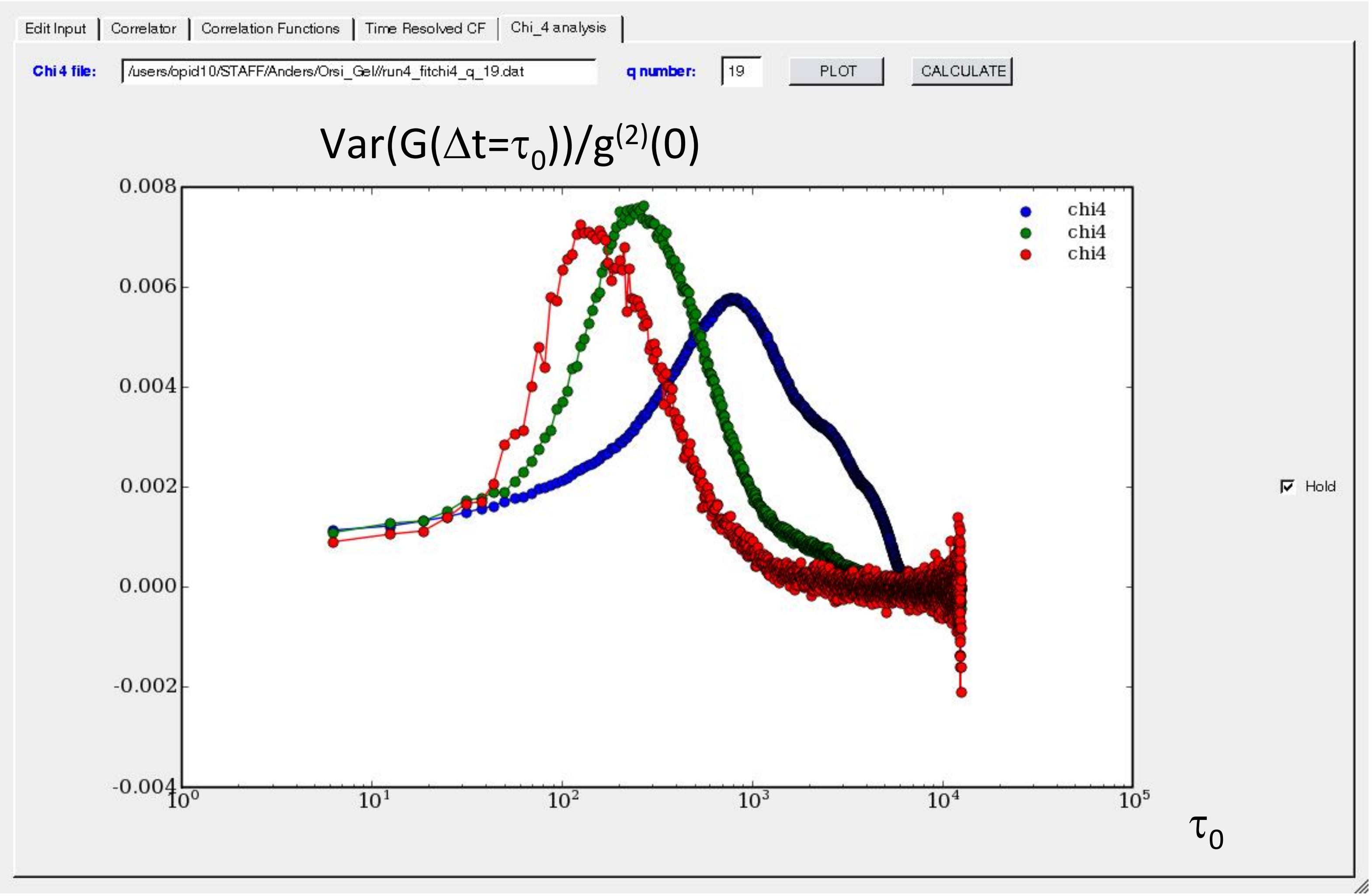
$$G(Q,t_1,t_2) = \frac{\langle I(Q,t_1) I(Q,t_2) \rangle_\phi}{\langle I(Q,t_1) \rangle_\phi \langle I(Q,t_2) \rangle_\phi}$$

$\Delta t = t_1 - t_2$
$t_a = (t_1 + t_2)/2$

Fast, non-equilibrium dynamics targeted by the split-delay technique

Examples: RF aerogel, O. Czakkel *et al*, ESRF

Dynamical susceptibility analysis



Examples: RF aerogel, O. Czakkel *et al*, ESRF

Need to deal with beam damage

- Detune the mono (effects on the coherence?)
- Move sample out of focus (effects on the coherence?)
- Working at higher energies (?)
- Absorbers (effects on coherence)
- Heterodyning
- Flowing the sample (microfluidics)
  - flowing without shear (plug flow)
  - diffusion time<transient time (i.e. small Deborah number)
  - transient time<damage time (?)
- Is there a way to vary the flux of a SASE beamline without touching the photon beam ?

…………….

Discussion…………..