TÉCNICO LISBOA / DESY

Coherence measurements with double pinholes at FLASH2

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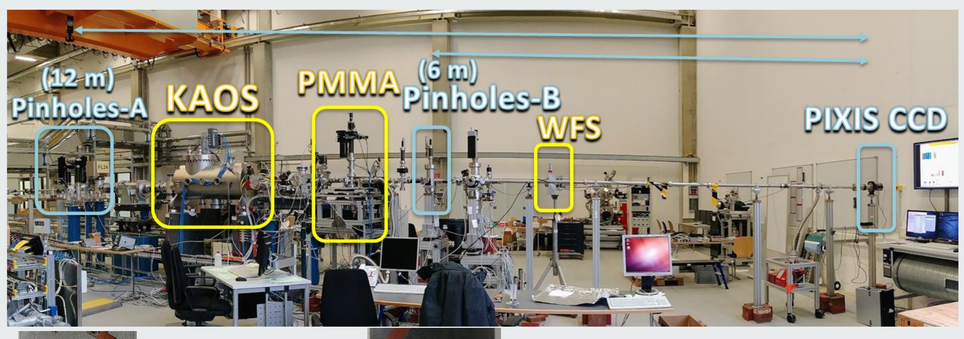
Beamtime in Nov/Dez 2017 at FL24

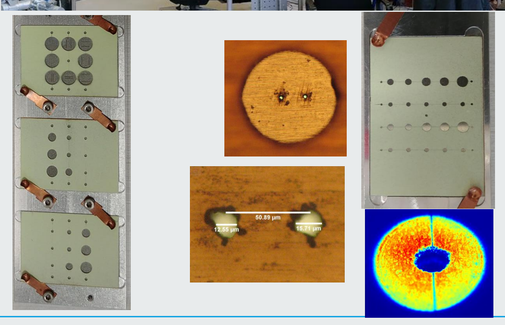
- Direct coherence measurements with double pinholes & slits
- Wave front measurements
- PMMA imprints (in collaboration with Chalupsky et al (FZU Prague) & Dziarzhytski (DESY)
- Wavelengths 8.0nm, 13.5nm and 18.0nm and different undulator settings

Double Pinholes

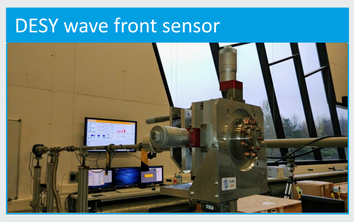
- Pinholes of **10 um diameter**
- **Pinholes-B**: Variable beam size with KAOS
  - 6 m from CCD
  - 107 um to 1570 um separations
- Measured beam position with **fluorescent coating**
- Measured pinhole diameters and separations under **microscope**

Experimental Setup





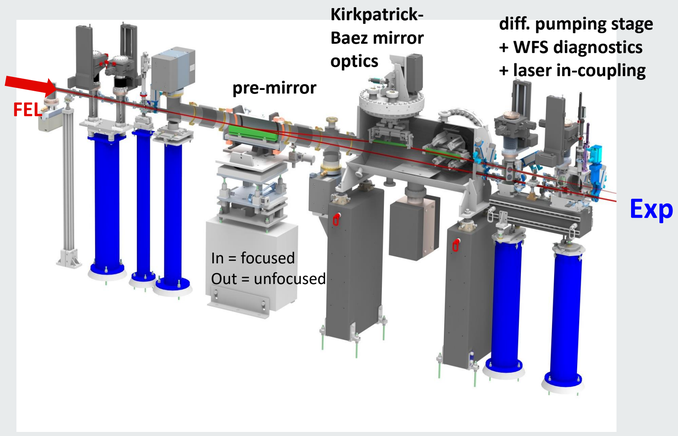
DESY wave front sensor



- Adjustable focus (nominal 2m behind first mirror)
- Online analysis with DESY WFS (Backpropagation, Zernike Aberrations)

KAOS: Variable micro-focus

KB focusing system using bendable mirrors



3.1 µm * 3.3 µm FWHM focus at 8 nm
→ up to 5*10[16] W/cm²

Collaboration of FLASH with **M. Zandrando, L. Raimondi** et al., Fermi@Elettra

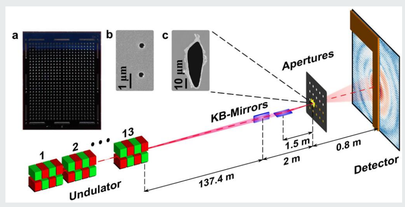
Bendable mirrors of 400 mm length with 2° grazing incidence

Blind-deconvolution method for an interference pattern in the intermediate zone

In a classical approach, the pinholes would be **destroyed** by being placed 1.5mm from the focussed beam (Singer 2013).

Here, the double-pinholes were positioned 1m behind the focus. This introduced a **curvature** to the beam, leading to a diffraction pattern in the intermediate zone instead of the far-field. Usually, one would determine the complex degree of coherence γ from the central visibility of the pattern.

The **blind-deconvolution** method (Clark 2012) can be used here to obtain the coherence length ξ.



Singer (2013)

The partially coherent interference pattern is the convolution of a fully coherent pattern with the Fourier-transform of the coherence function γ (Clark et al. 2012):

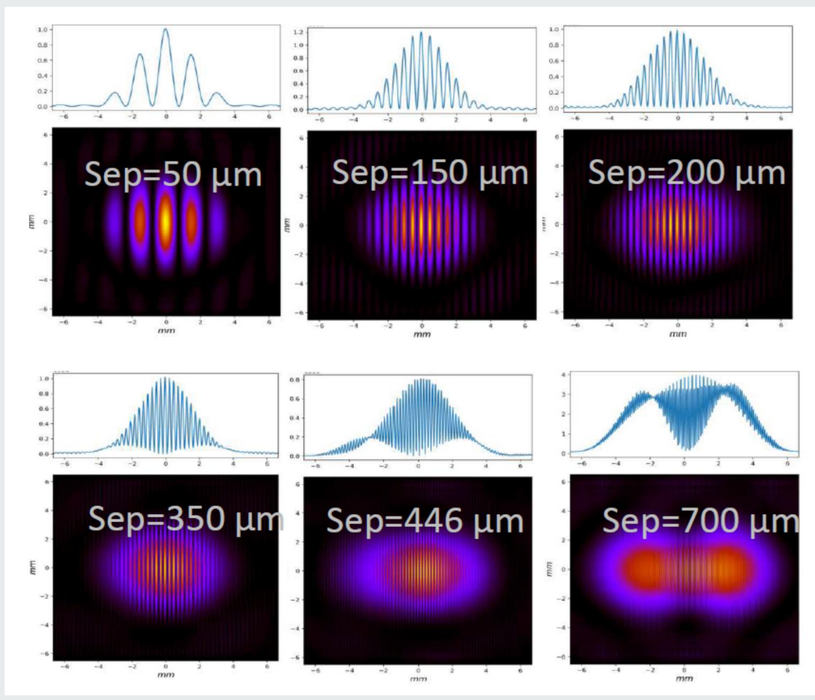
$$I_{pc} = I_{fc} * \mathcal{F}(\gamma)$$

blind-deconvolution → I_{fc}, $\mathcal{F}(\gamma)$

The **transverse coherence length** ξ is the rms width of the coherence function γ:

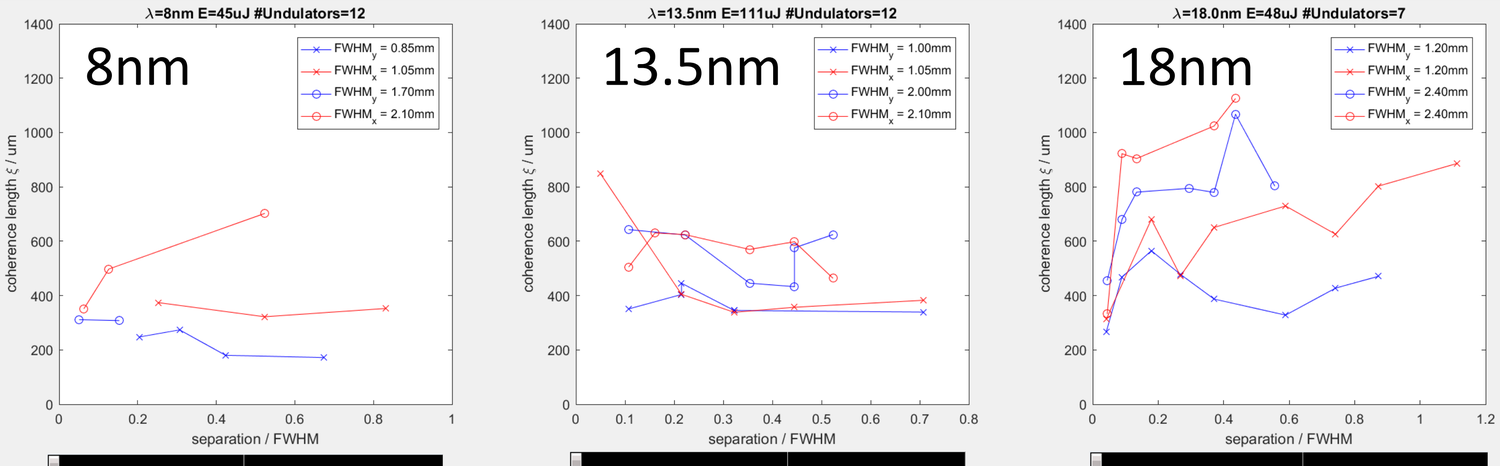
γ → rms width → ξ_T

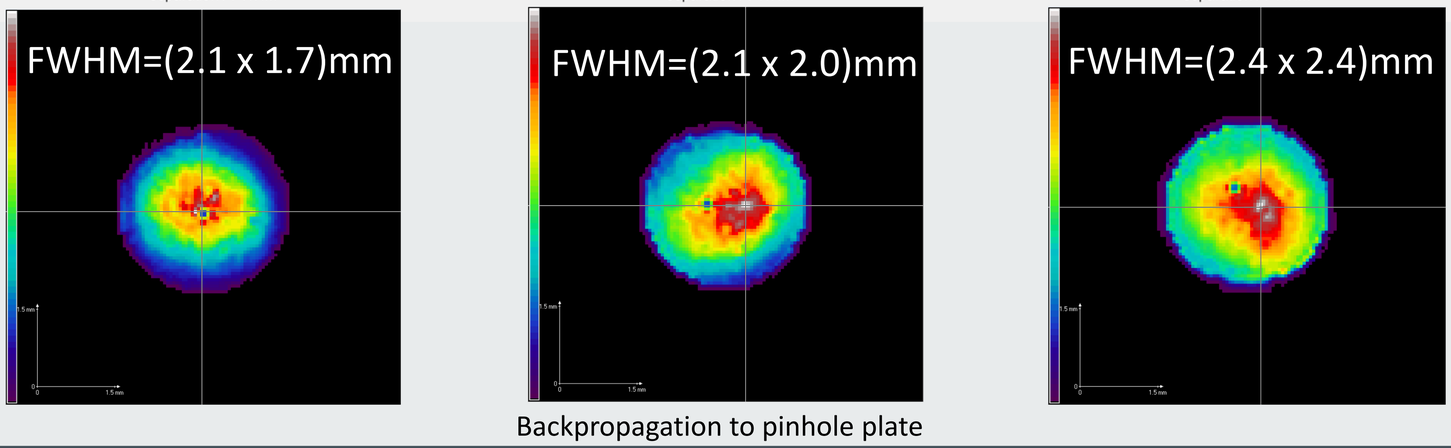
Simulation of interference in the intermediate zone



Simulated intensity distribution from a double-pinhole experiment for different pinhole separations. A divergent beam illuminates the pinholes and the diffracted light propagates in the intermediate zone.

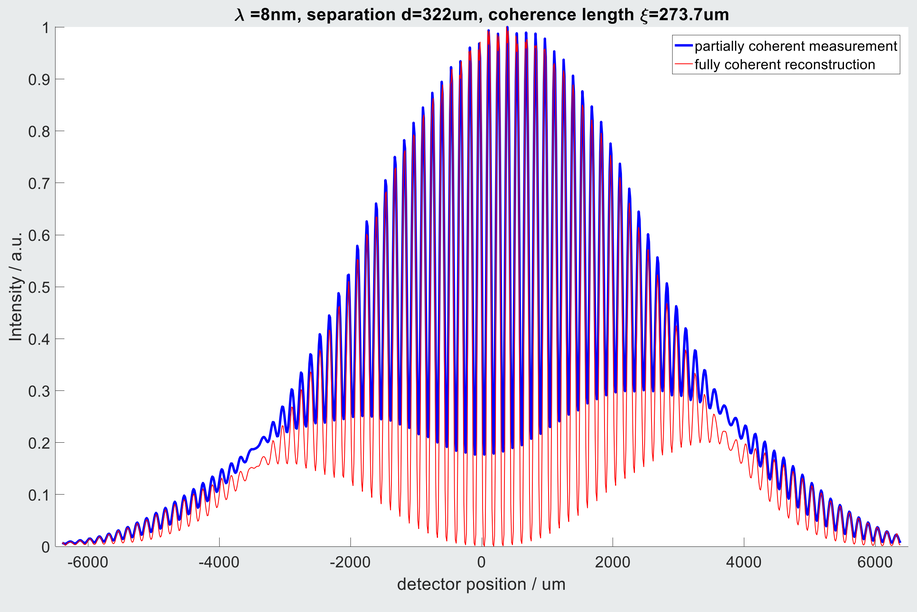
Coherence length vs. Pinhole Separation





Backpropagation to pinhole plate

Interference pattern example



Measured partially coherent interference pattern (blue) with the reconstructed fully coherent pattern (red) after applying a blind deconvolution algorithm

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