Status of FL24 (focused):

Report on current commissioning results.

Marion Kuhlmann
Hamburg, 2017-06-06

HELMHOLTZ
ASSOCIATION

DESY

Co-Operation Fermi@Elettra and FLASH@DESY

Memorandum of Understanding between DESY and Elettra:
"Future developments, realizations and commissioning of specialized K-B (Kirkpatrick-Baez) bending mirror systems for Fermi and FLASH".

KAOS [Kirkpatrick-Baez Adaptive Optical System]

Direct co-operation of PADREeS:
(**PADReS**, which stands for **P**hoton **A**nalysis **D**elivery and **RE**duction **S**ystem.)

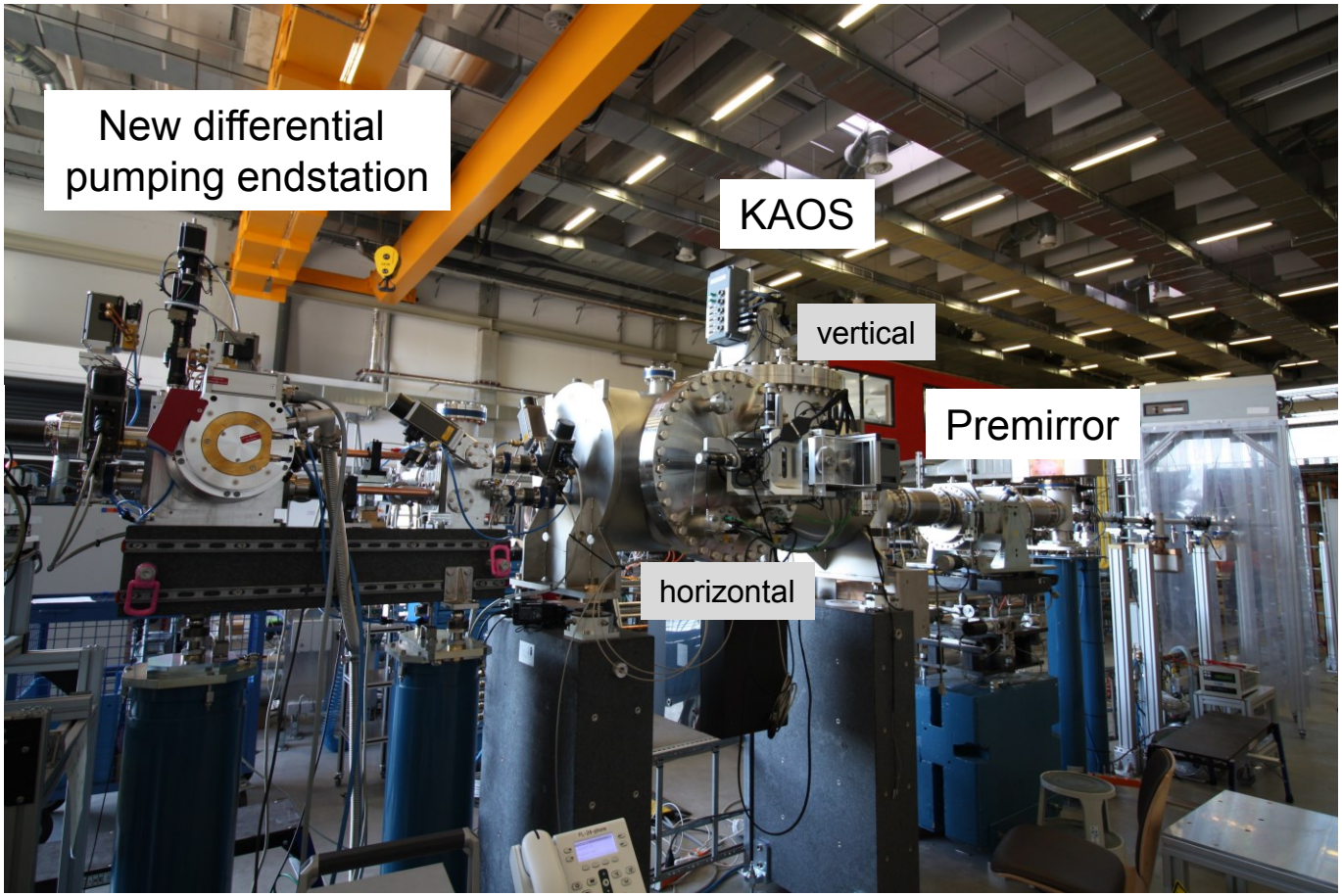
Marco Zangrando, Nicola Mahne, Lorenzo Raimondi, Michele Manfredda, Furio Zudini, Riccardo Gobessi, Claudio Fava, Simone Gerusina, Luca Rumiz, Luka Novinec

and part of FLASH-B:

Elke Plönjes-Palm, Barbara Keitel, Günter Brenner, Maciej Brachmanski, Mabel Ruiz-Lopez, Thomas Wodzinski,

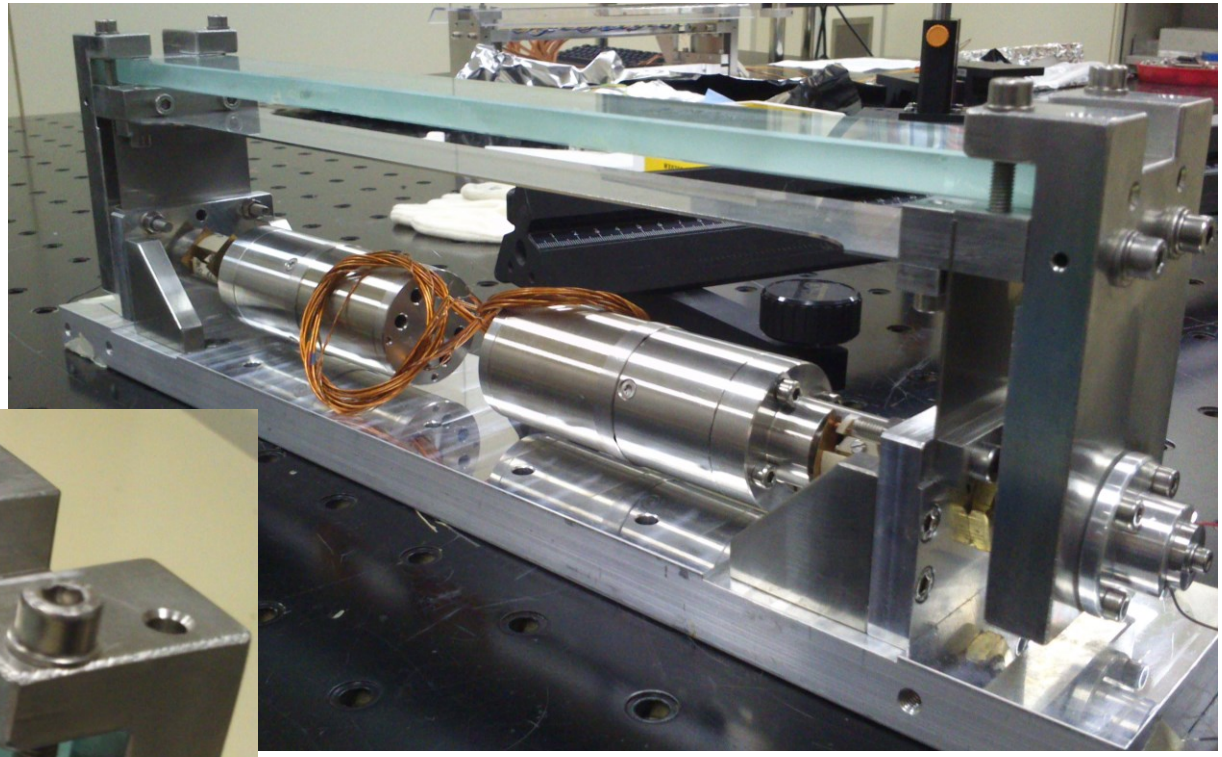
FL24 focusing optics: KAOS

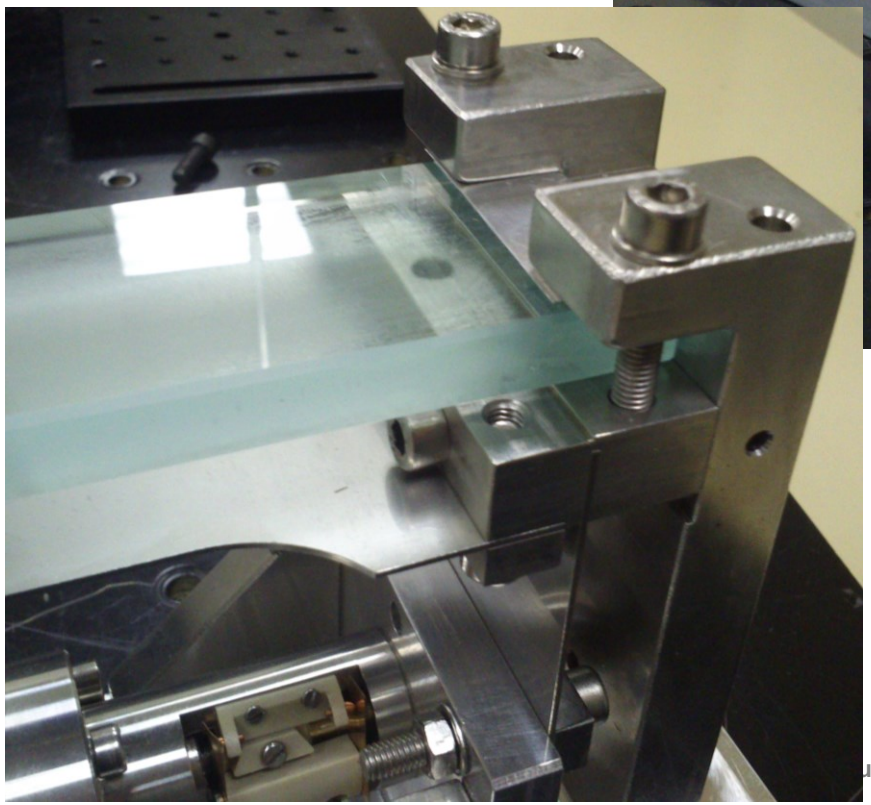
Experiment



Bending

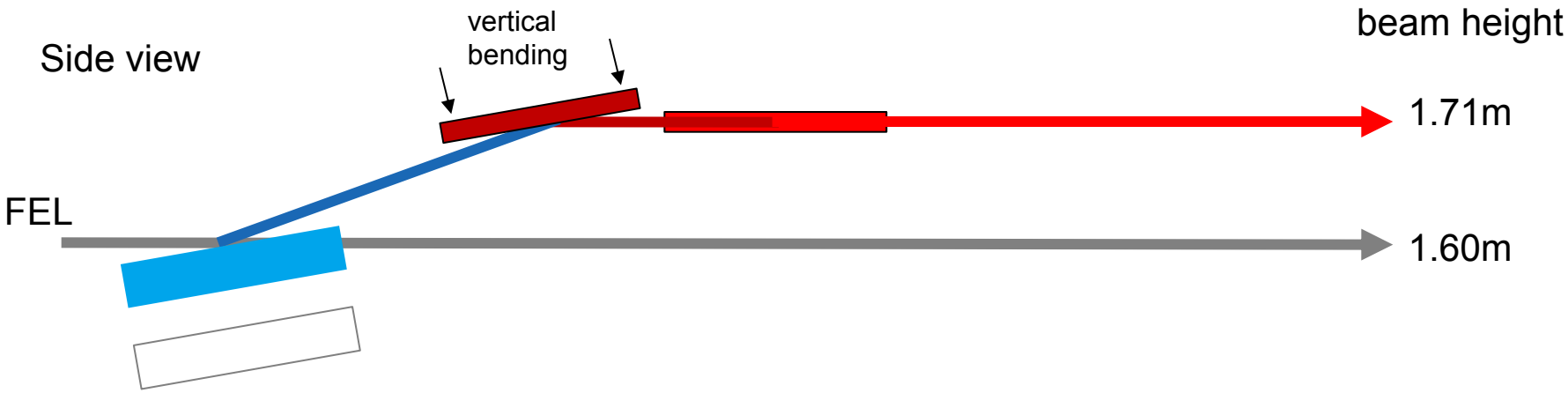
Optical surface
380mm x 14mm

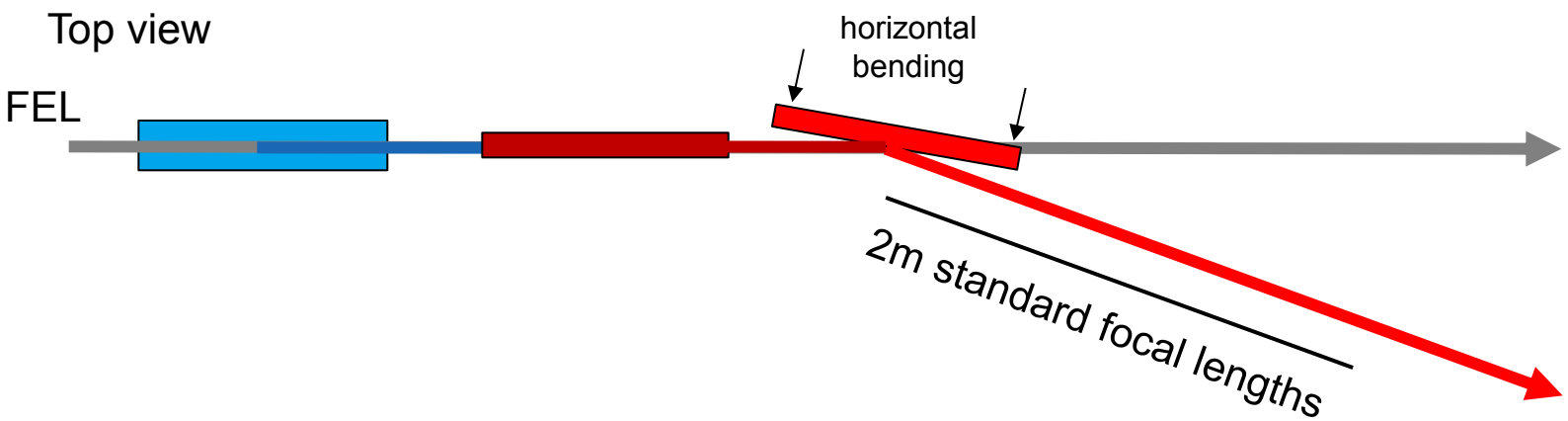




Bending from flat (>100km) to radius of 60m.

Geometry



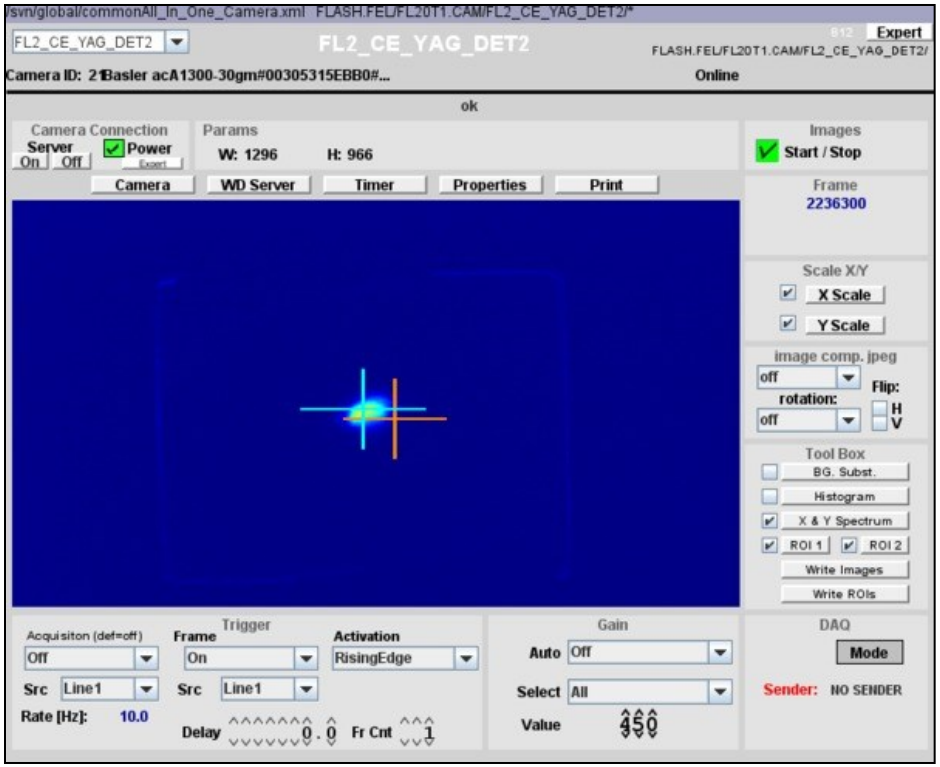


(not to scale)

‘Operator View’

7.68

FL2 running with single bunch at 8nm => checked with OPIS



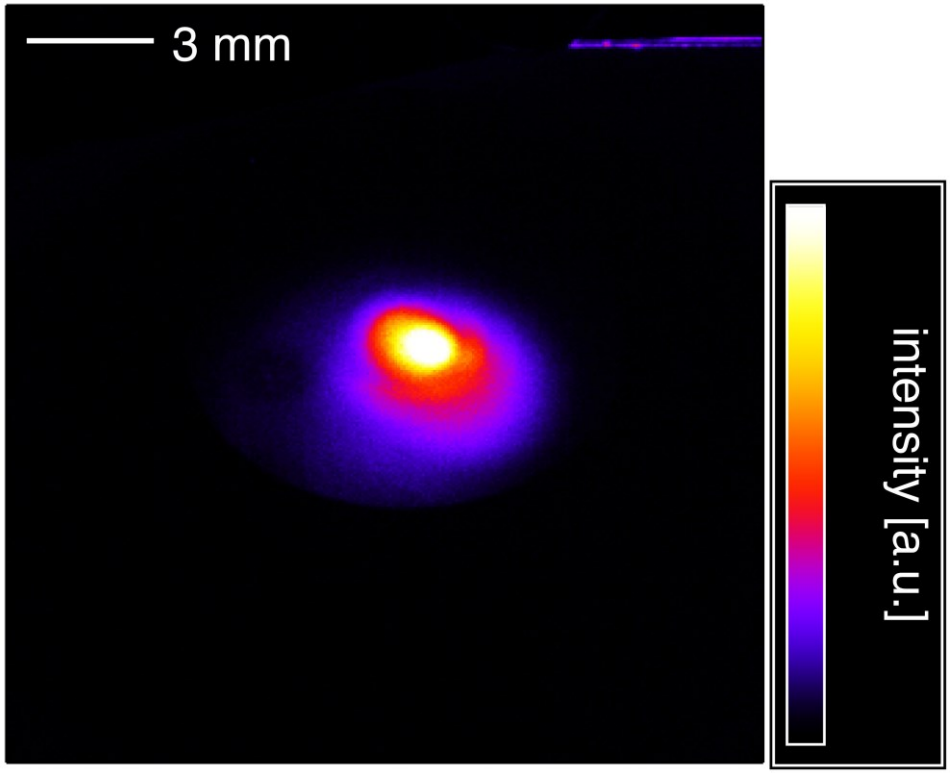
SASE6 to 14 are closed

0.00

No Taper

Det2
[19.5m downstream from center SASE14]

21.04.17
8nm

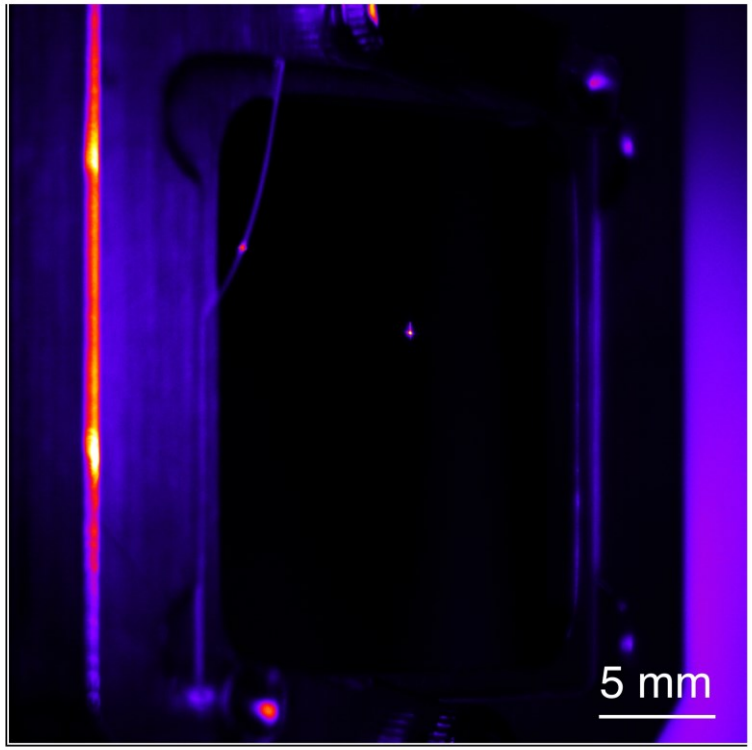


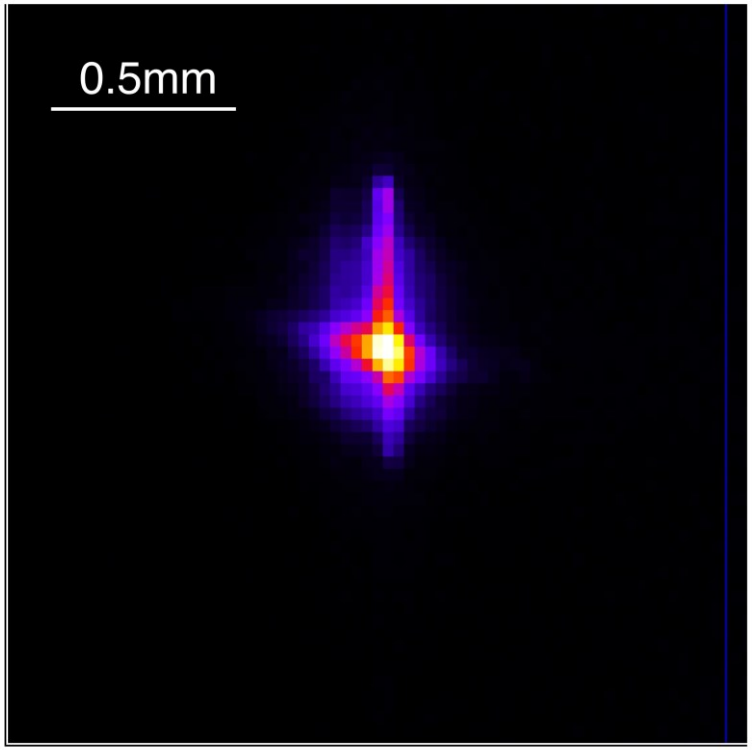
divergence
hori: 5.66e-05 avg / rad,
vert: 7.83e-05 avg / rad

beam size
hori: 1.0792 avg / mm,
Vert: 1.1977 avg / mm

[fwhm]

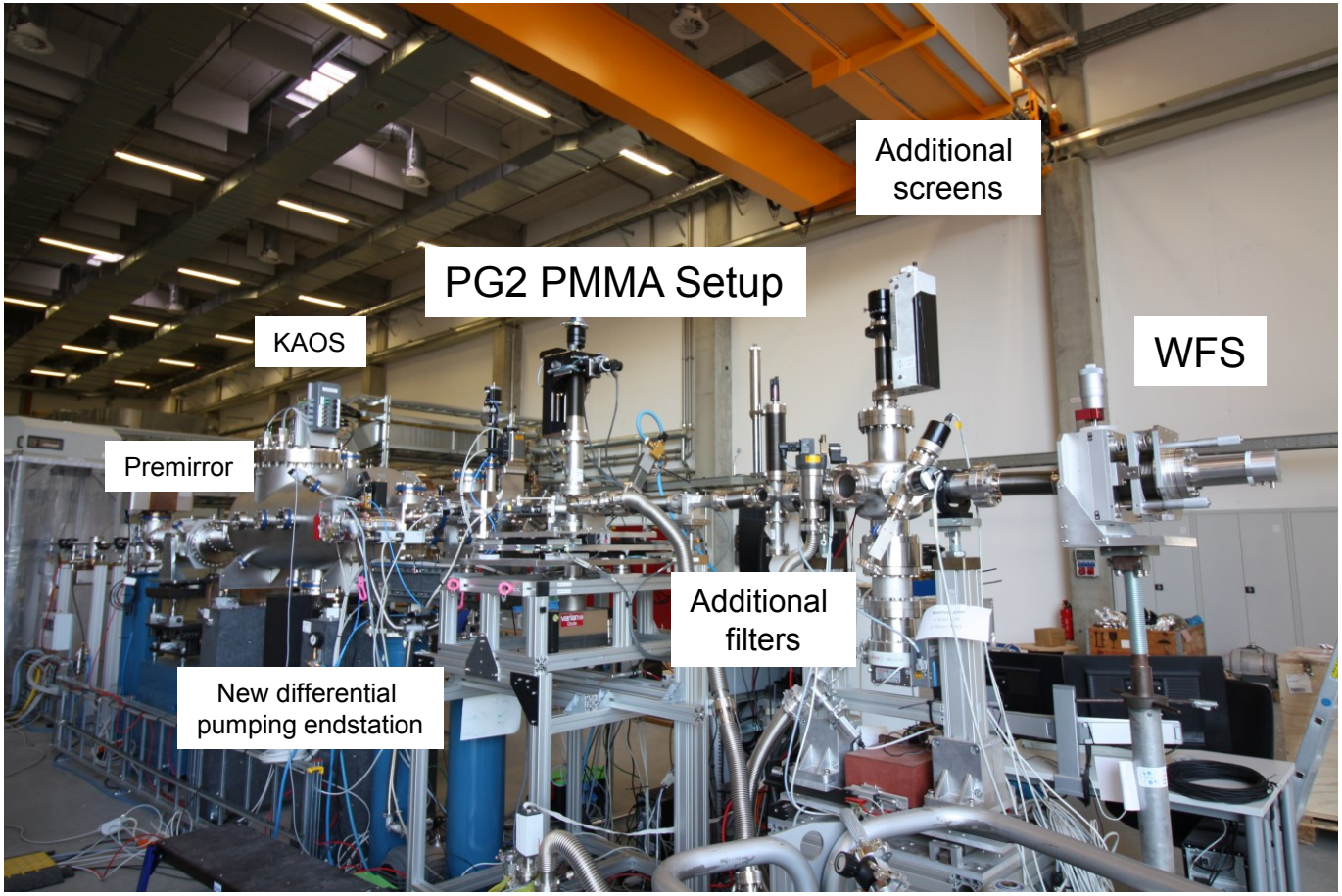
FL24_Exp1
[90m downstream from center SASE14]



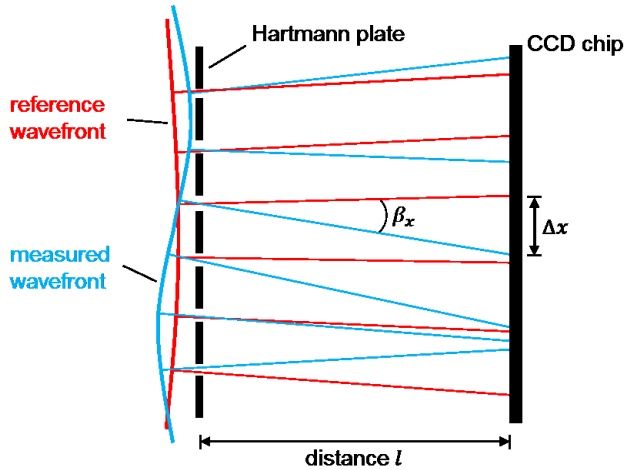


0.029mm / pixel

Commissioning

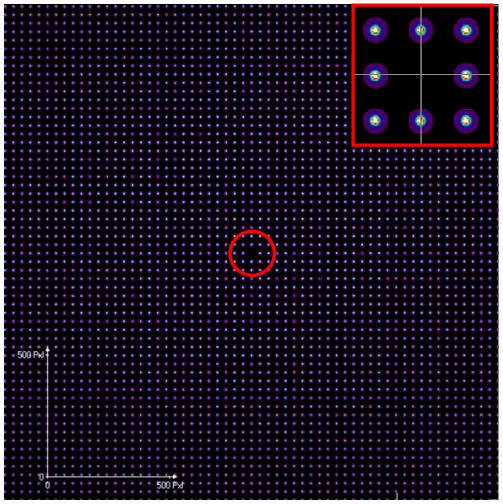


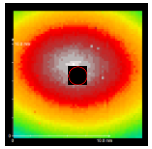
Wavefront Measurement



The actual beam is compared to a reference wave (spherical wave).

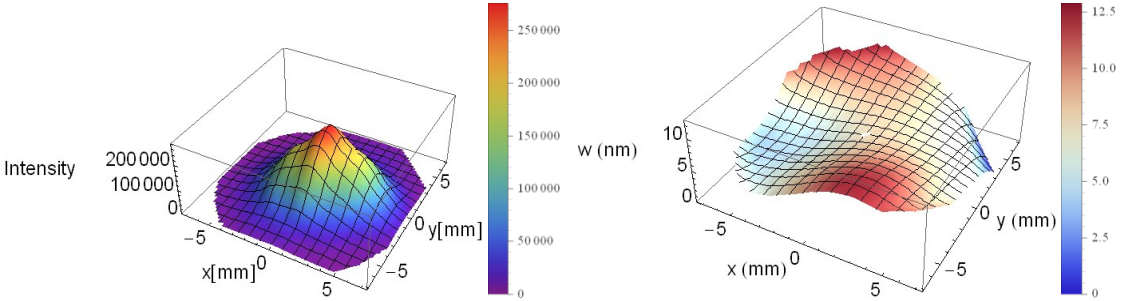
Spot pattern of reference wave



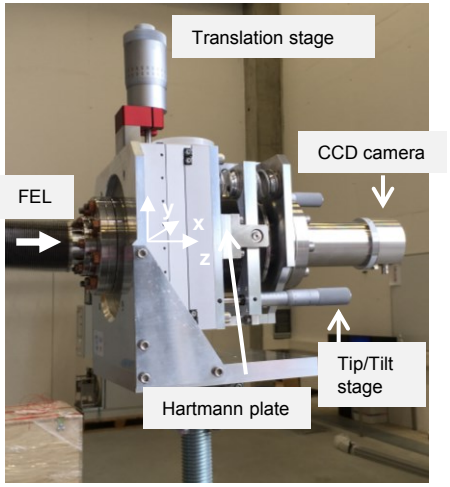


Longterm collaboration of DESY with Laser-Lab Göttingen e.V. (LLG)

FLASH2 at 13.5nm

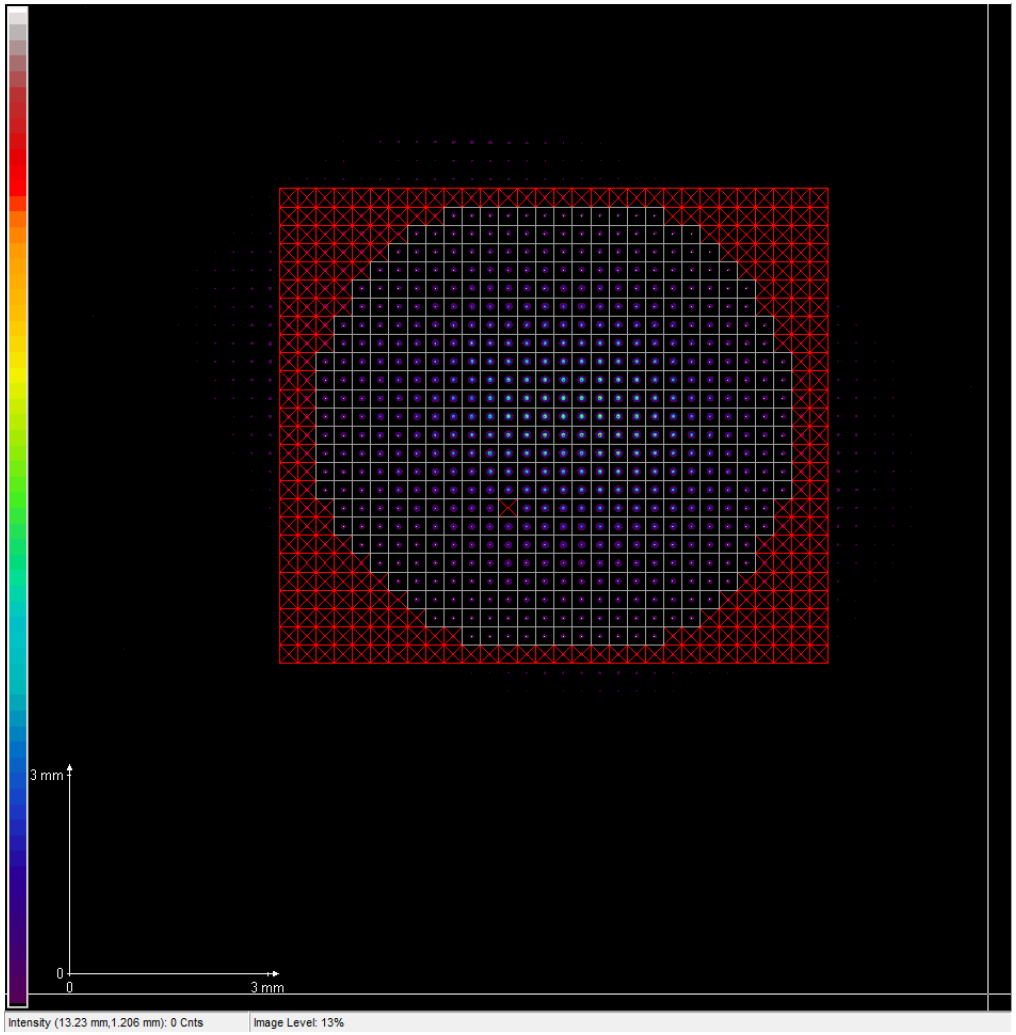


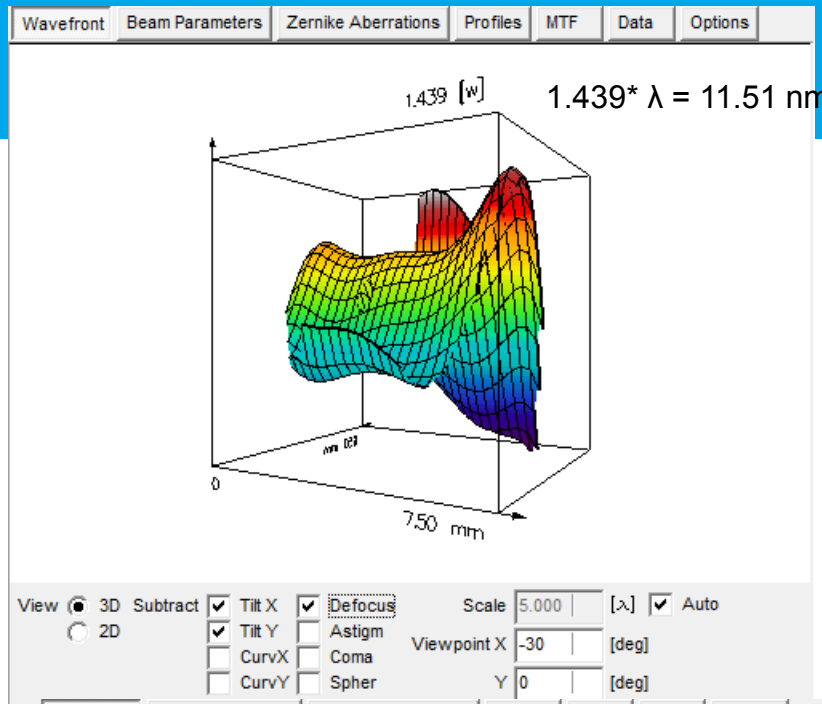
Wavefront sensor

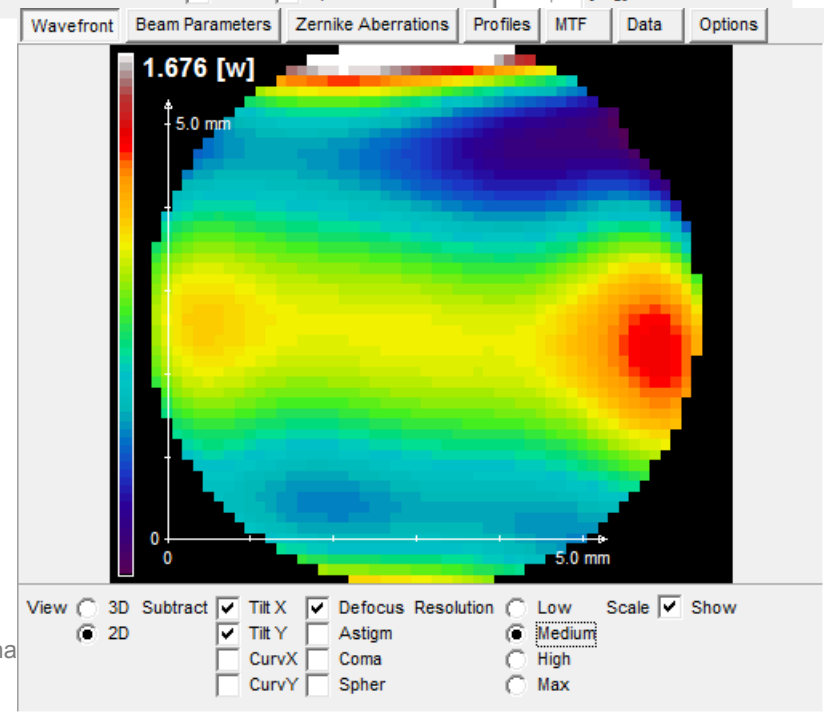


Keitel, B., Plönjes, E., Kreis, S., Kuhlmann, M., Tiedtke, K., Mey, T., Schäfer, B., and Mann, K., "Hartmann wavefront Sensors and their application at FLASH," Special Issue (PhotonDiag2015),J. Synchrotron Rad. **23**, 43-49 (2016).

FL24 22.04.17







File: av30_zu_sequence4.tif32

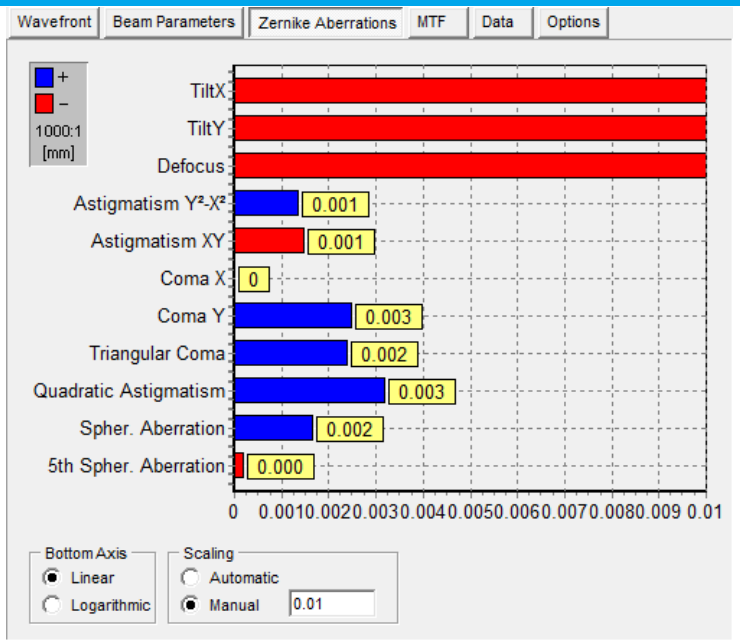
File: av30_zu_sequence4.tif32

Wavefront | Beam Parameters | Zernike Aberrations | MTF | Data | Options

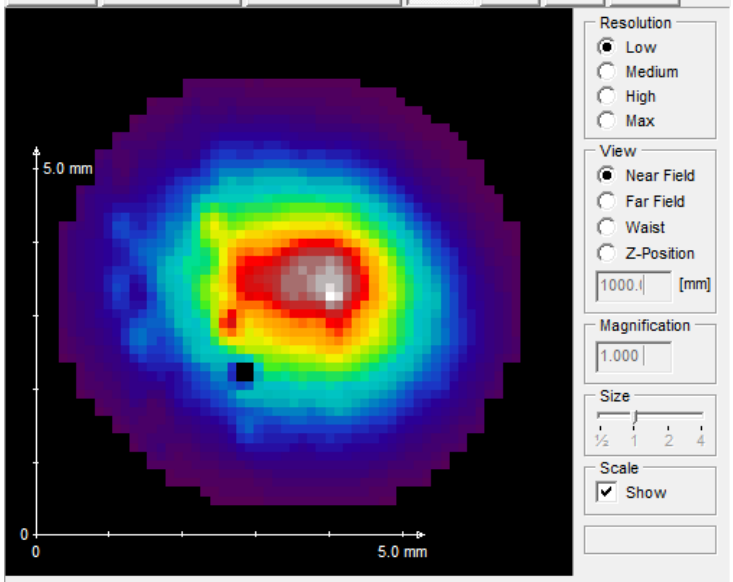
rms Deformation	[mm]	1.747562E-6	RayleighLengthX	[mm]	3.1609
pv Irregularity	[mm]	1.157172E-5	RayleighLengthY	[mm]	9.9363
Defocus	[mm]	1983.041	Slope rms	[mrad]	0.8145
General Astigm.		3.371437	Slope max	[mrad]	1.0000
Strehl		0.1033	Beam Ellipticity		0.83
$M^{2\,2}$		7.8511			

Angle / MainAxis		0°	45°	-17.84°
M^2 X		1.8865	4.0632	2.3699
M^2 Y		4.4242	3.7814	4.1635
DivergenceX	[mrad]	2.4656	2.4224	2.5023
DivergenceY	[mrad]	2.1296	2.1786	2.0864
BeamWidthX	[mm]	4.8939	4.8038	4.9665
BeamWidthY	[mm]	4.2134	4.3158	4.1275
WaistPositionX	[mm]	-1984.8612	-1983.0521	-1984.7941
WaistPositionY	[mm]	-1978.4265	-1980.9493	-1978.2538
WaistDifference	[RL]	-0.9826	-0.2772723	-0.9620
WaistDiameterX	[mm]	0.0077934	0.0170853	0.0096471
WaistDiameterY	[mm]	0.0211608	0.0176792	0.0203263

Wavefront | Beam Parameters | Zernike Aberrations | MTF | Data | Options



Wavefront | Beam Parameters | Zernike Aberrations | Profiles | MTF | Data | Options

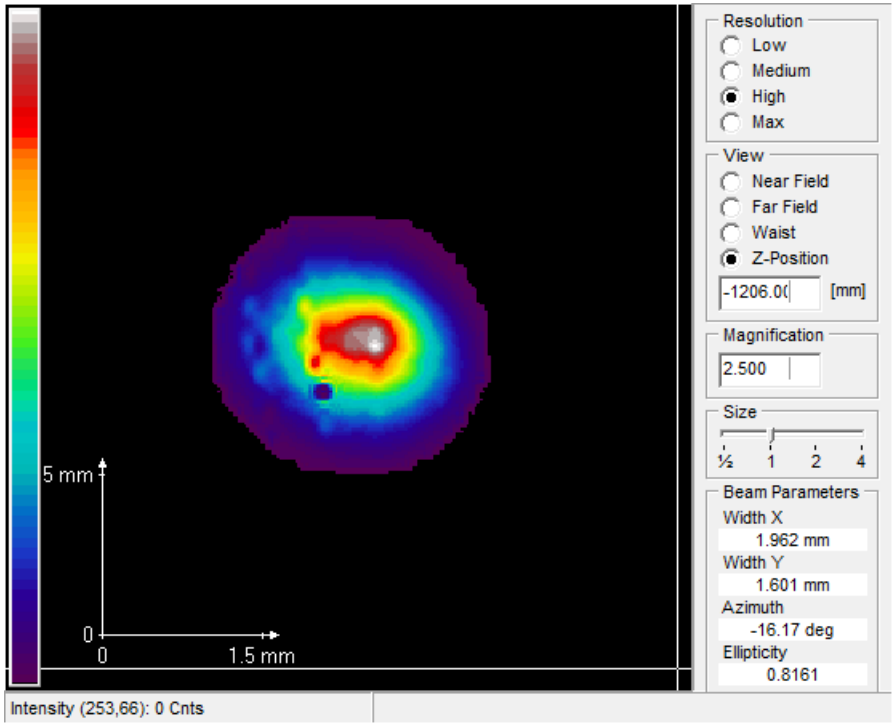


Beam parameter (see tab above) calculated from second order moments, coordinate system of the CCD camera (lab coordinate system):

Fwhm waist diameter X: 4.58 µm
Fwhm waist diameter Y: 12.46 µm

File: av30_zu_sequence4.tif32

Fresnel Propagation using FFT and beam transformation with Born-Wolf expansion 6.

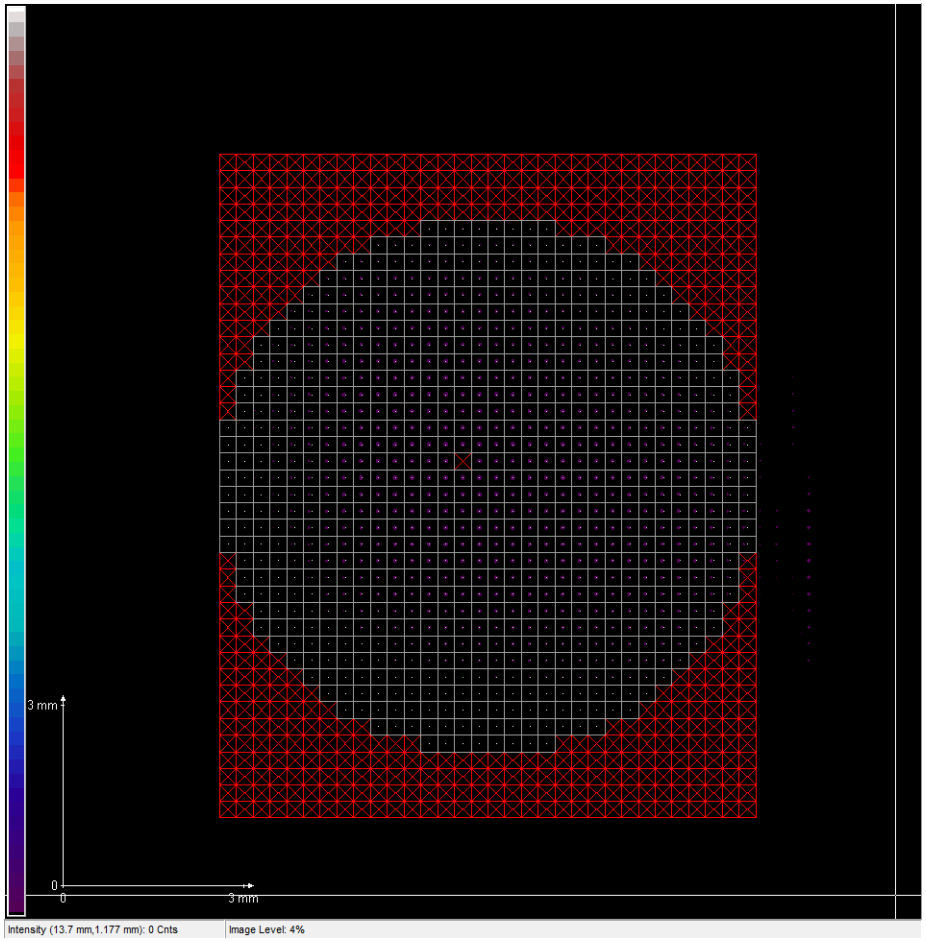


Focus positions from propagation:

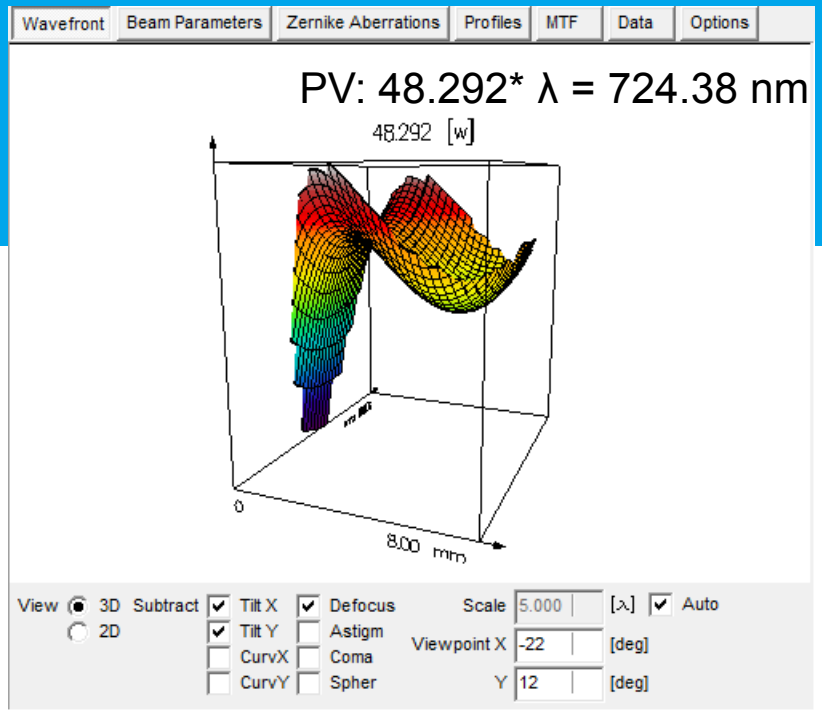
For these beam parameters a coordinate system of the principal axis of the propagated beam at position z is used (different at each z-position because it rotates with the beam).

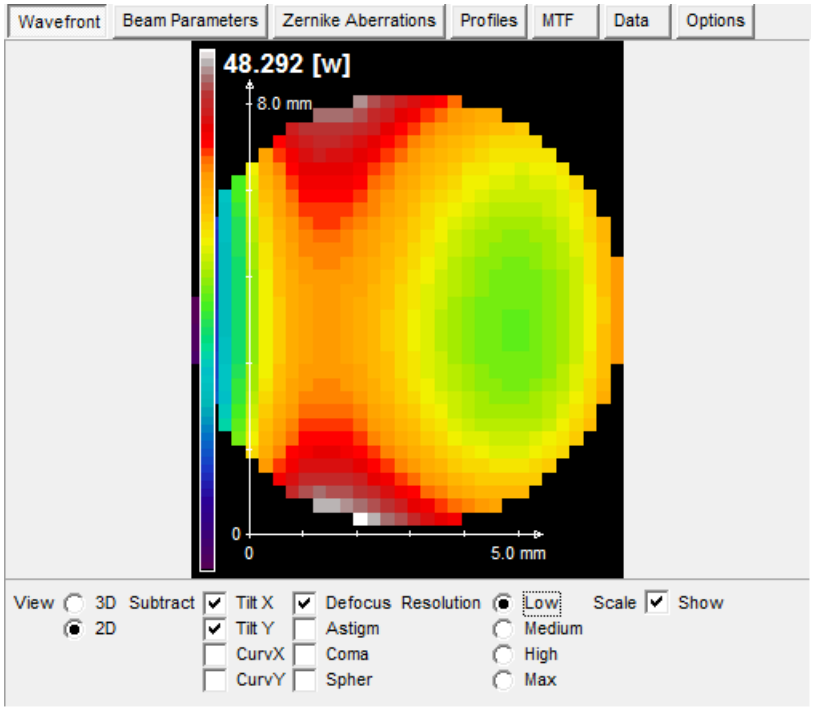
At 800 mm after the focus:
Waist X (fwhm): 1.16 mm at z = -1206 mm
Waist Y (fwhm): 0.94 mm at z = -1206mm

FL24 18.05.17



File: av_zu_sequence3.tif32





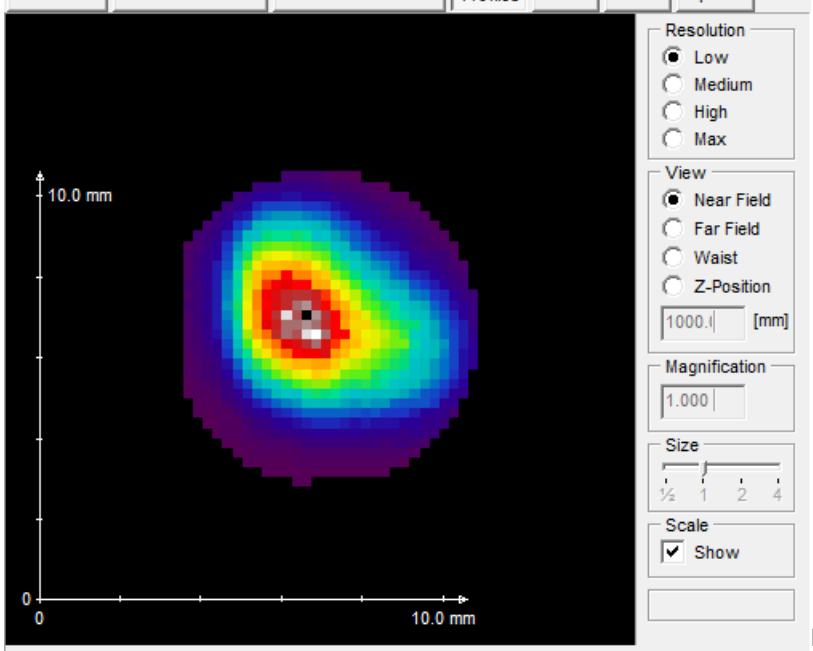
HELMHOLTZ ASSOCIATION

Wavefront | Beam Parameters | Zernike Aberrations | Profiles | MTF | Data | Options

rms Deformation	[mm]	0	RayleighLengthX	[mm]	169.8308
pv Irregularity	[mm]	0.0007202442	RayleighLengthY	[mm]	16.1092
Defocus	[mm]	1905.455	Slope rms	[mrad]	1.0661
General Astigm.		3649.383	Slope max	[mrad]	0.9997
Strehl		0.0000	Beam Ellipticity		0.80
$M^{2\,2}$		580.5896			

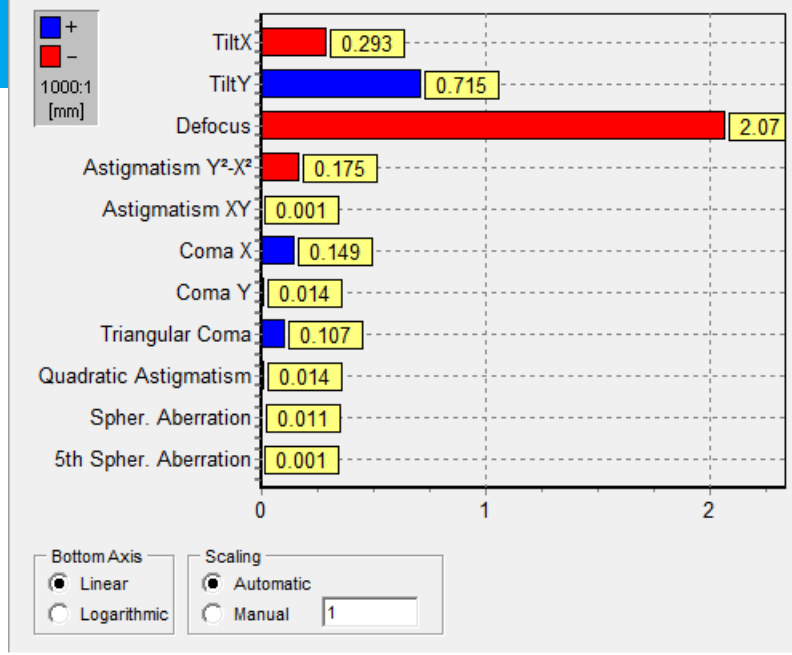
Angle / MainAxis		0°	45°	-33.66°
M^2 X		91.4757	72.8280	84.2999
M^2 Y		6.6275	58.5664	46.5612
DivergenceX	[mrad]	3.2073	3.2926	3.3426
DivergenceY	[mrad]	2.8031	2.7025	2.6404
BeamWidthX	[mm]	6.0897	6.4073	6.4517
BeamWidthY	[mm]	5.6024	5.2362	5.1814
WaistPositionX	[mm]	-1891.0747	-1941.7502	-1924.7919
WaistPositionY	[mm]	-1998.5715	-1931.5038	-1958.1931
WaistDifference	[RL]	1.1563	-0.0728107	0.2459
WaistDiameterX	[mm]	0.5447055	0.4224395	0.4816700
WaistDiameterY	[mm]	0.0451557	0.4138927	0.3367864

Wavefront | Beam Parameters | Zernike Aberrations | Profiles | MTF | Data | Options



File: av_zu_sequence3.tif32

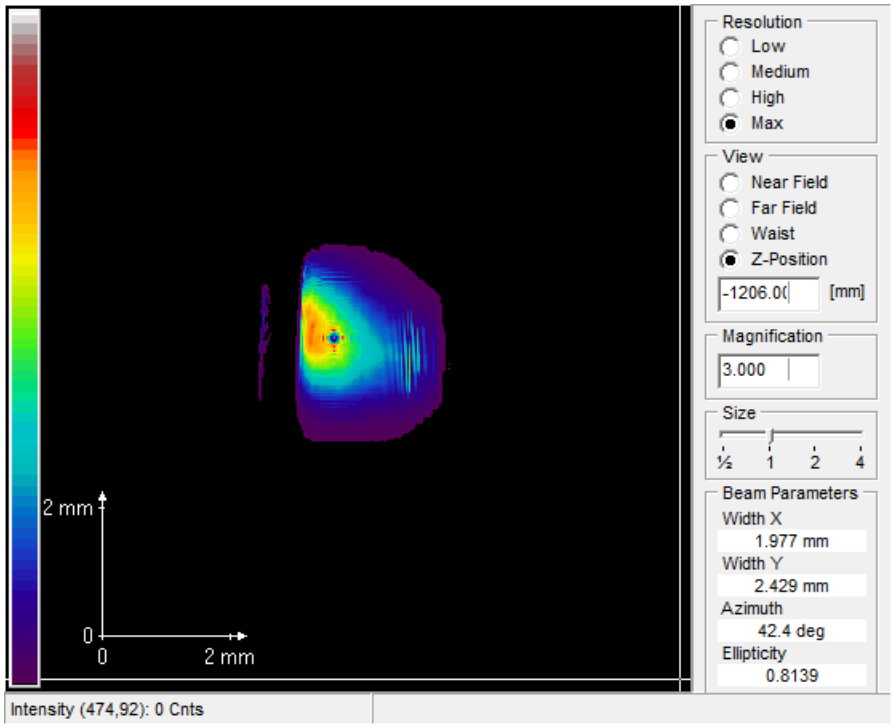
Wavefront | Beam Parameters | Zernike Aberrations | Profiles | MTF | Data | Options



Beam parameters (see tab above) calculated from second order moments in the coordinate system of the CCD camera (lab coordinate system):

Fwhm waist diameter X: 320.7 µm
Fwhm waist diameter Y: 26.58 µm

Fresnel Propagation using FFT and beam transformation with Born-Wolf expansion 6.



Focus positions from propagation:

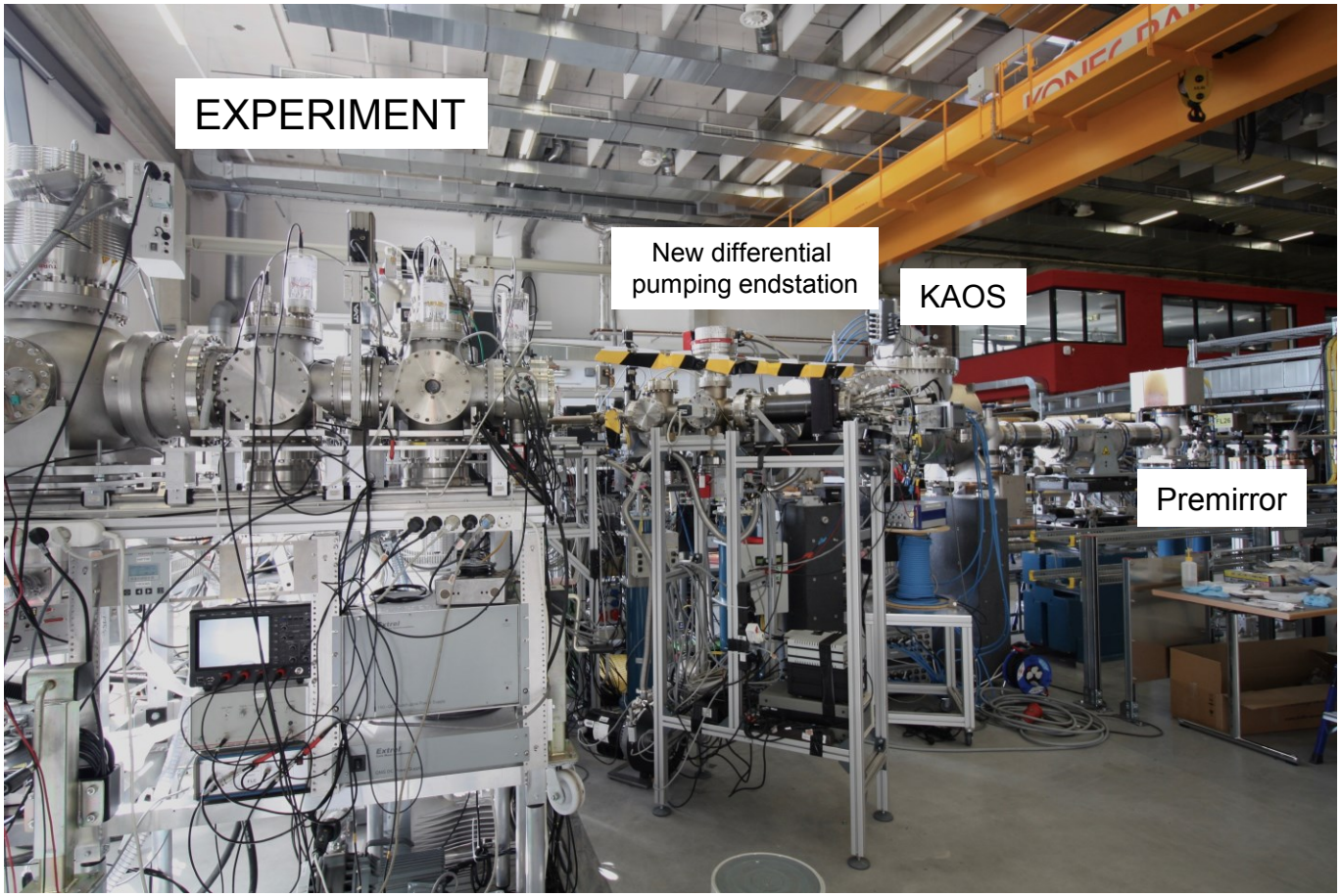
For these beam parameters a coordinate system of the principal axis of the propagated beam at position z is used (different at each z-position because it rotates with the beam).

At 800 mm after the focus:
Waist X (fwhm): 1.16 mm at z = -1206 mm
Waist Y (fwhm): 1.43 mm at z = -1206 mm

Current User Experiment at FL24

University of Rostock Meiweis-Broer / Martinez:

'XUV-induced multiple core ionissation of size selcted metalic clusters'

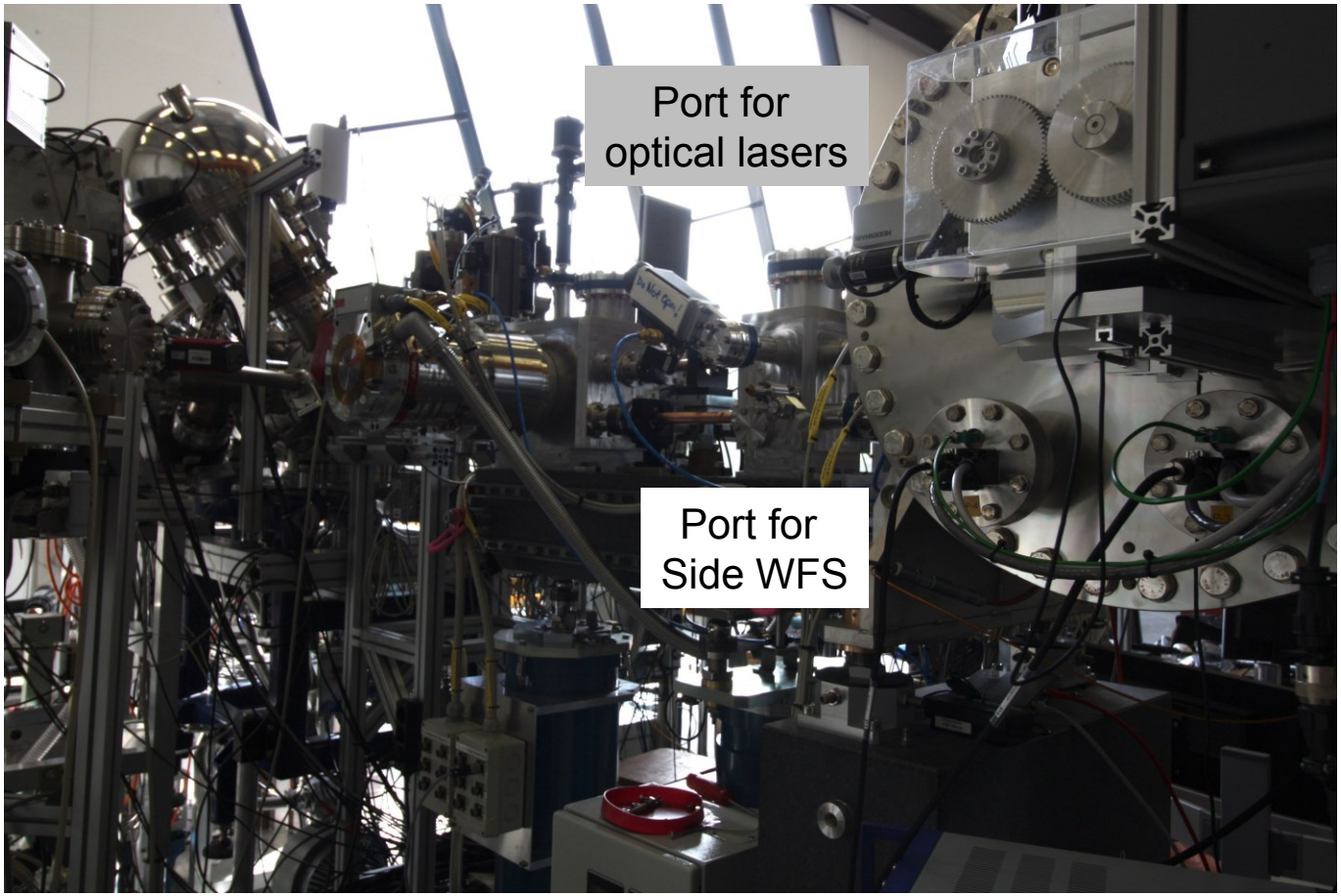


FEL parameters:

300 bunches,
26nm at FL2
(FL1=13.5nm),
12 undulators,
maximal taper
[last 5 with 1.5%]

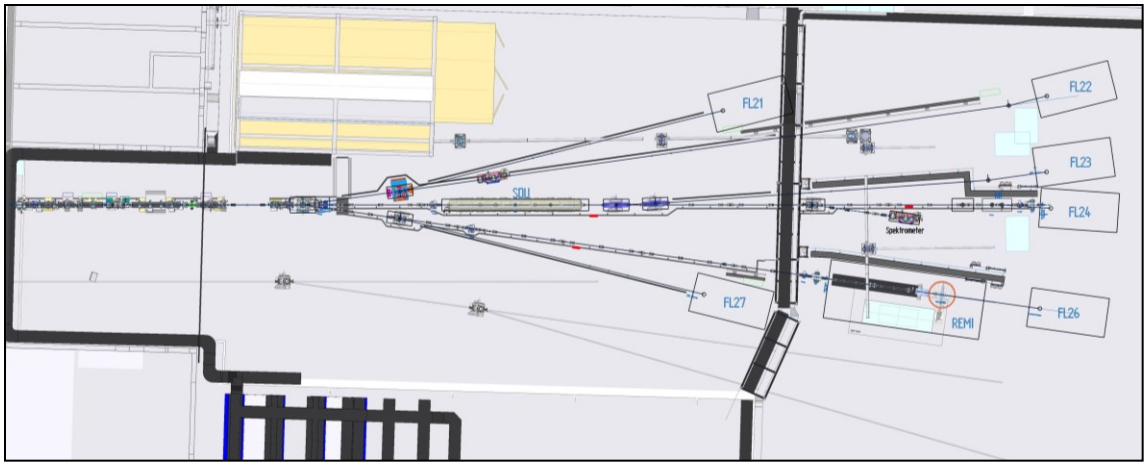
=> 350µJ GMDT

FL24 next Steps



FL24 up-coming Steps

University of Münster: Split and Delay Unit



To be continued…