

NON-INTERCEPTING DIAGNOSTIC FOR HIGH BRIGHTNESS ELECTRON BEAMS USING OPTICAL DIFFRACTION RADIATION INTERFERENCE (ODRI)

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High Brightness Machines

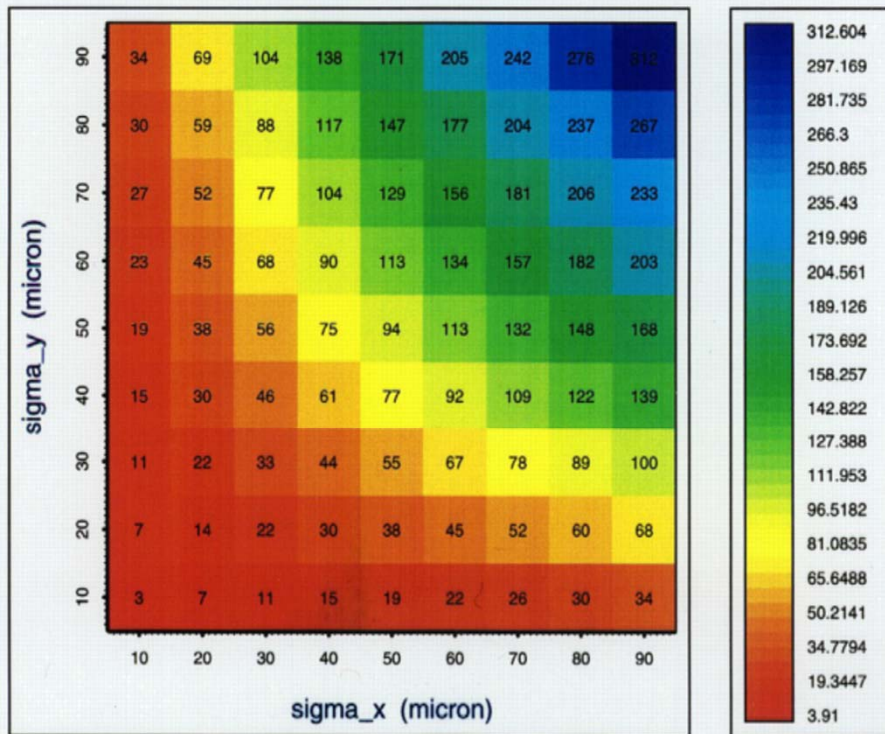


Figure 1: Number of bunches ($Q_b = 1 \text{ nC}$) at which Si foil (300 microns) is below the stress limit ($\Delta T = 1230^\circ$). The energy is 1 GeV.

$$\bar{B} = \frac{2I}{\pi^2 \varepsilon_x \varepsilon_y} [\text{A}/(\text{m-rad})^2]$$

High density power beam can substantially damage or destroy a foil or a wire scanner

Possible alternatives are multishots devices

—Wire scanner (intercepting)

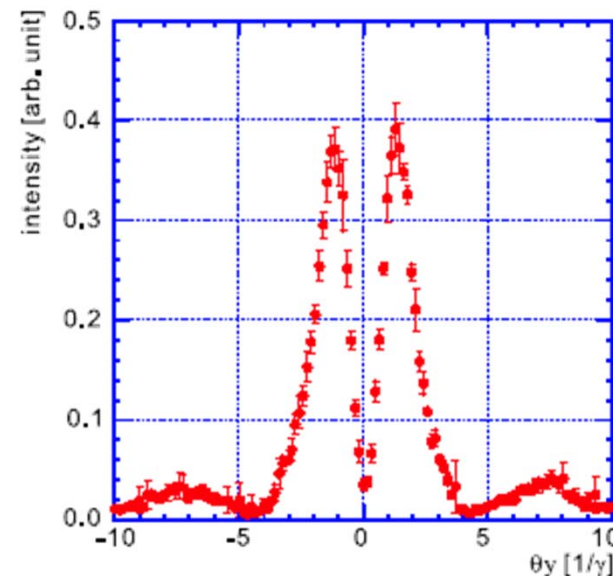
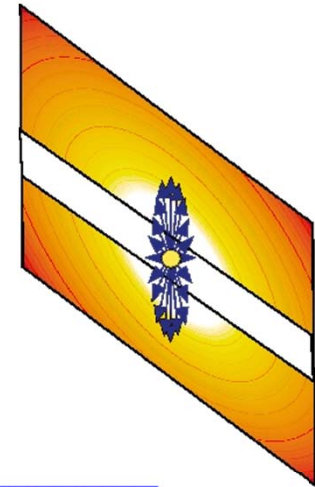
—Laser wire

Optical Diffraction Radiation (ODR)

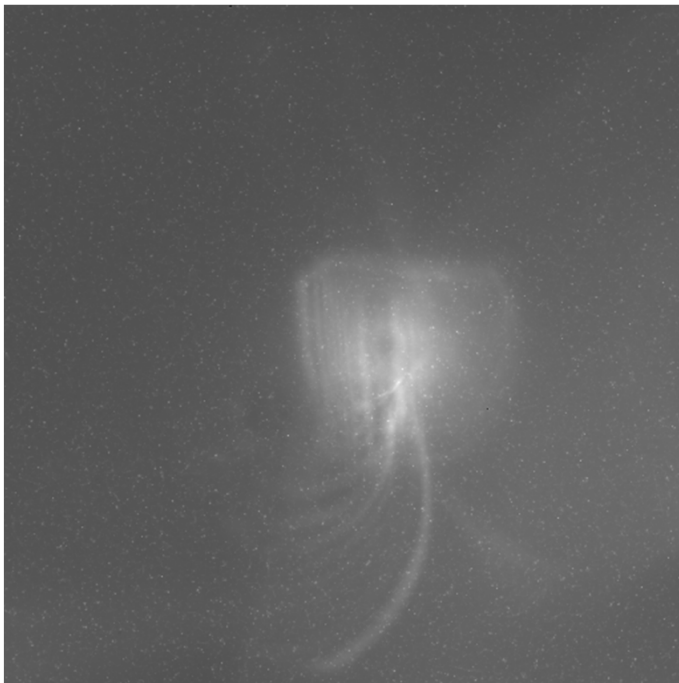
- The charge goes into the hole without touching the screen
- The electromagnetic field of the moving charge interacts with the metallic screen
- No power is deposited on the screen
- The angular distribution of the emerging radiation is affected by the beam transverse size, the angular spread and the position inside the slit
- Rectangular slit

P. Karataev et al., “Beam-Size Measurement with Optical Diffraction Radiation at KEK Accelerator Test Facility”, Phys. Rev. Lett. 93, 244802 (2004)

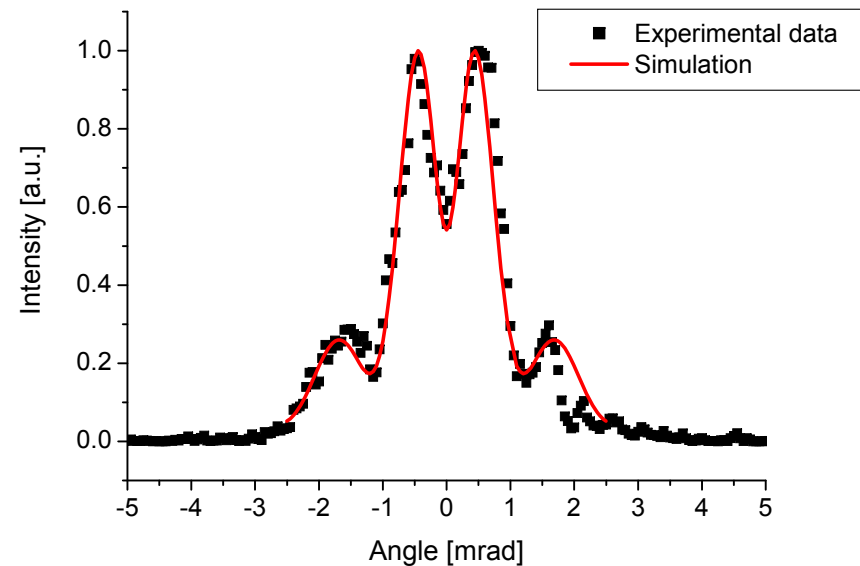
$$I \propto e^{-\frac{2\pi a}{\gamma\lambda}}$$



Background noise



Mainly Synchrotron radiation, both directly coming from bending magnets and reflected from the vacuum chamber walls

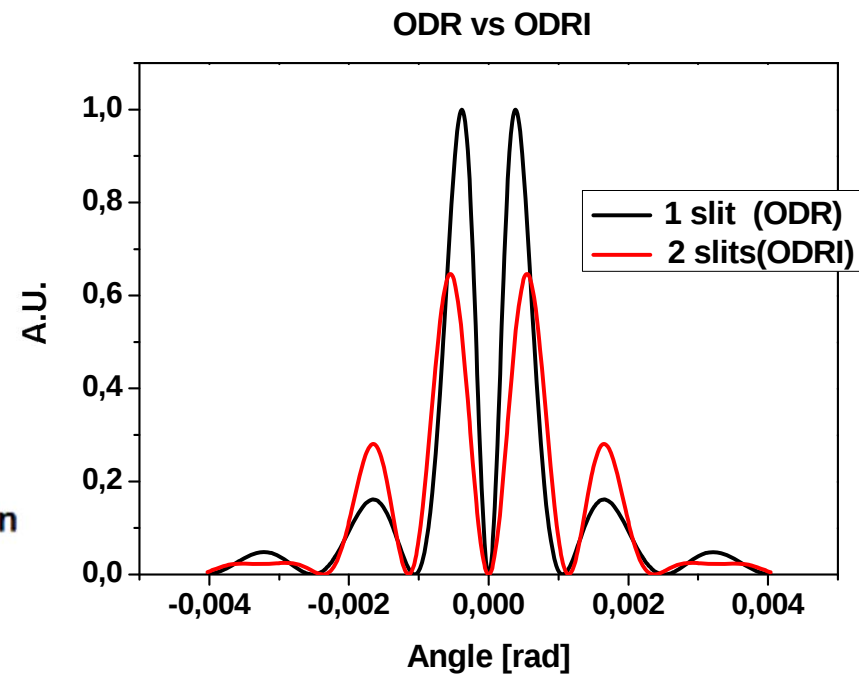
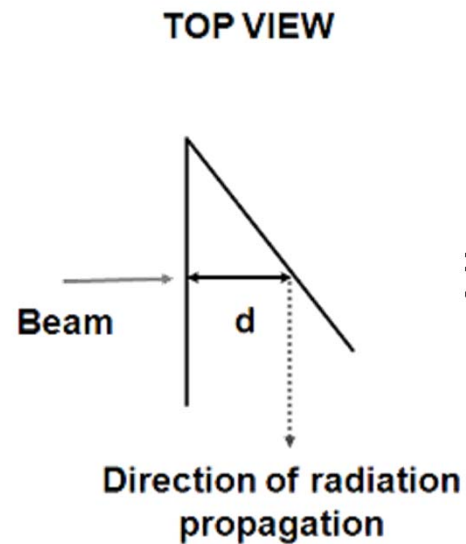
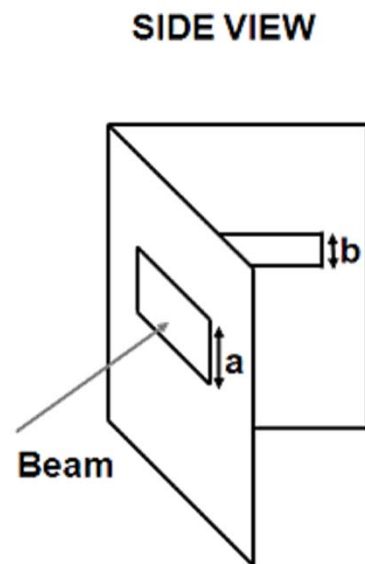


E. Chiadroni et al.,

Non-intercepting electron beam transverse diagnostics with optical diffraction radiation at the DESY FLASH facility

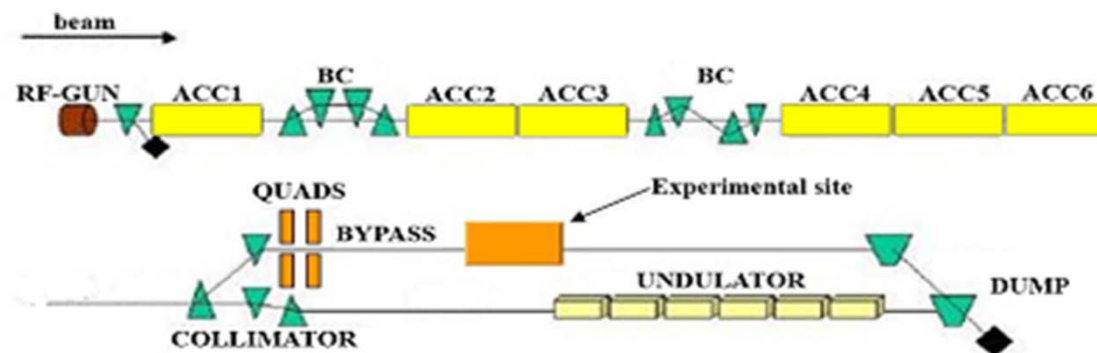
NIM B 266 (2008) 3789–3796

Two slits geometry (ODRI)



Optical Diffraction Radiation Interference (ODRI)

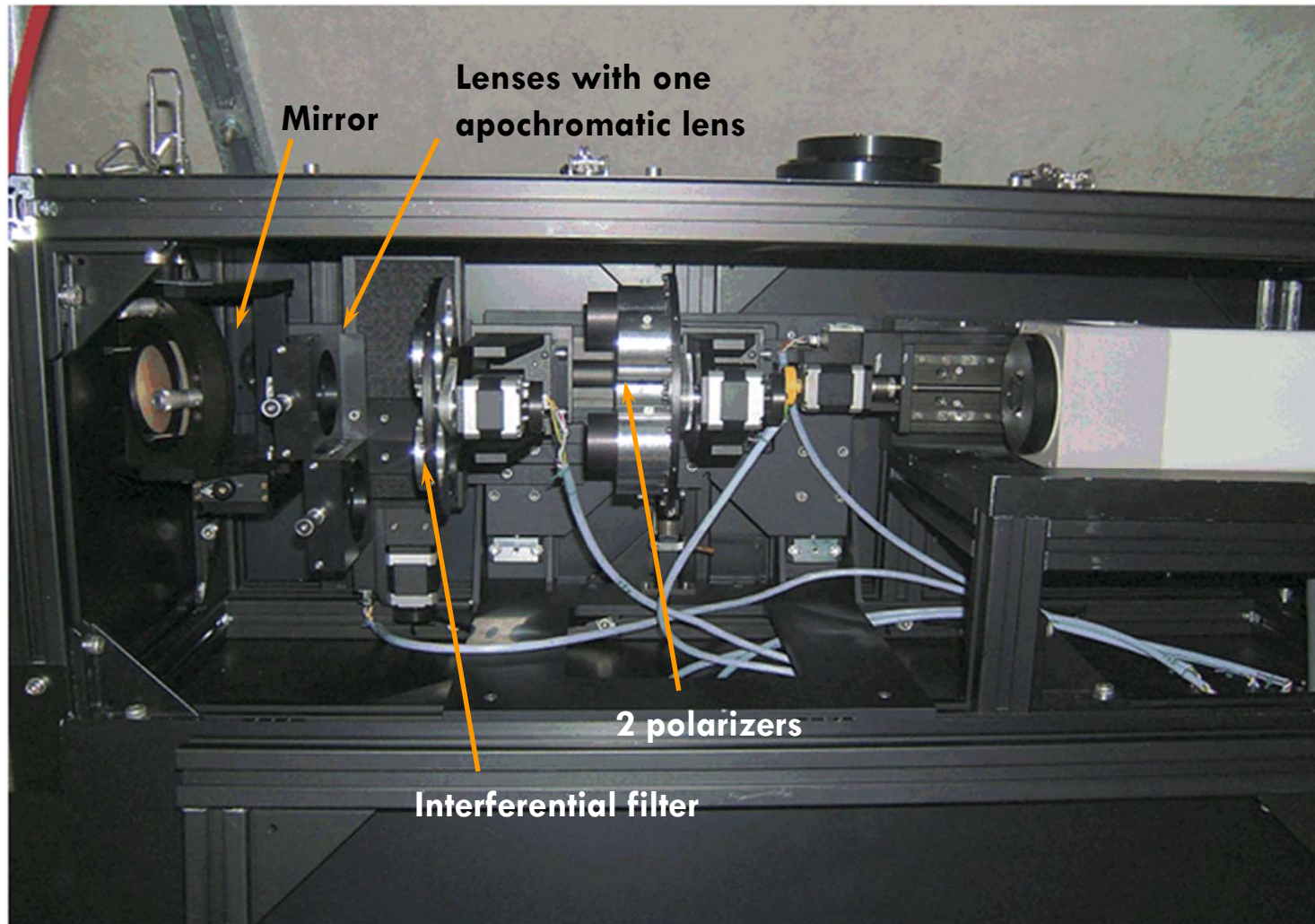
Experiment @ FLASH



FLASH is an excellent linac for this experiment:

- ❑ High energy up to 1 GeV
- ❑ Large number of bunches (up to 30) with high charge (up to 1 nC)
- ❑ Frequency repetition 5 Hz
- ❑ Long collaboration history

Experimental Setup (2)



Angular distribution

center

-25 μm

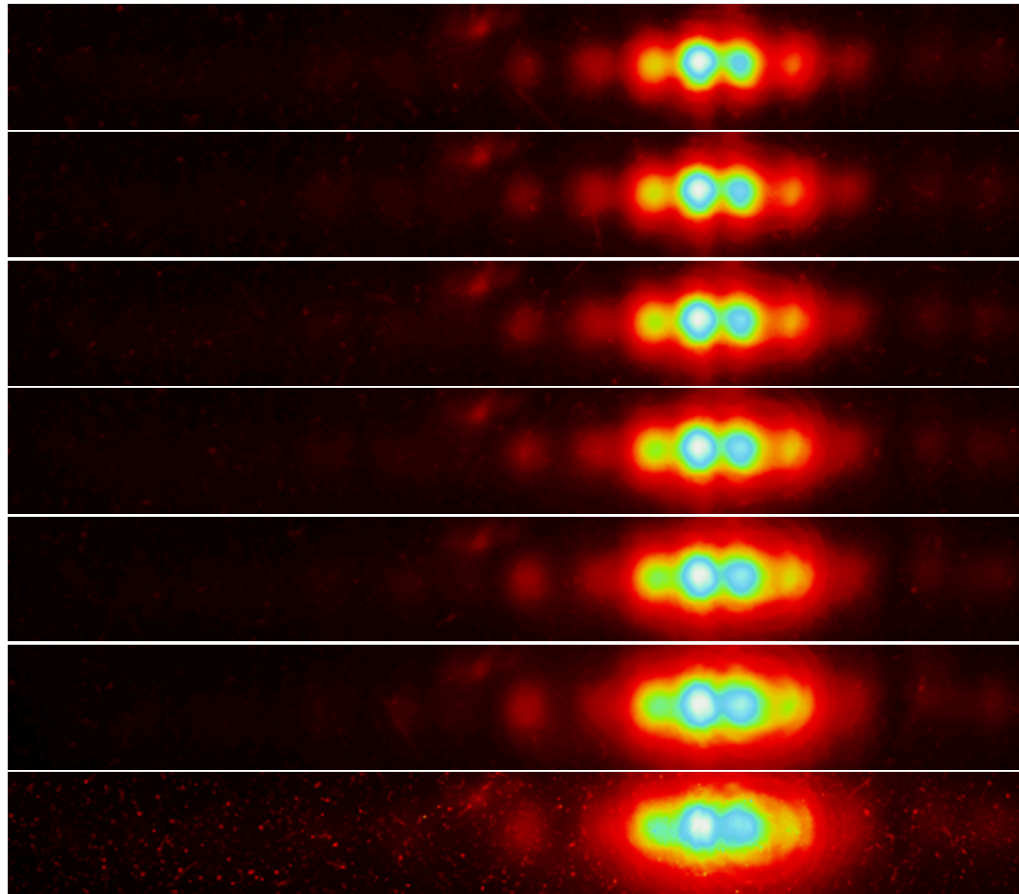
-50 μm

-75 μm

-100 μm

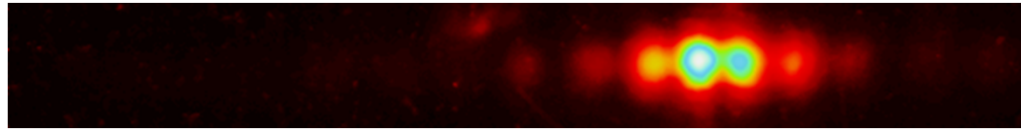
-125 μm

-150 μm

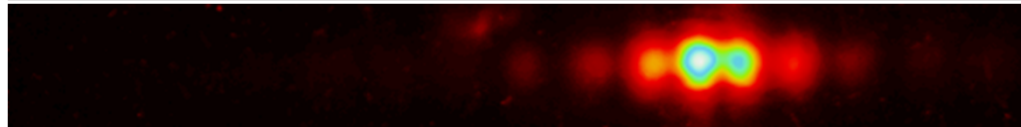


Angular distribution (2)

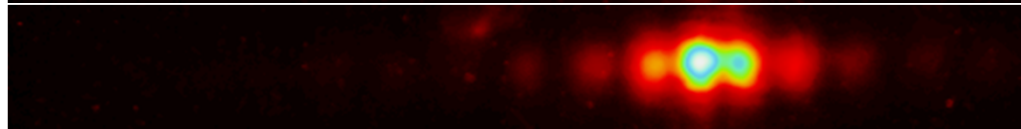
center



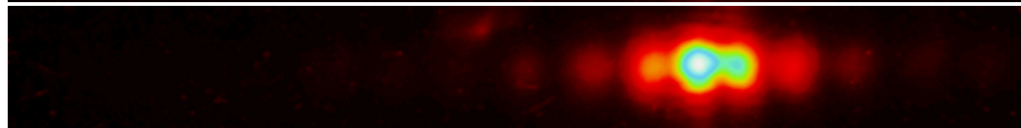
+25 μm



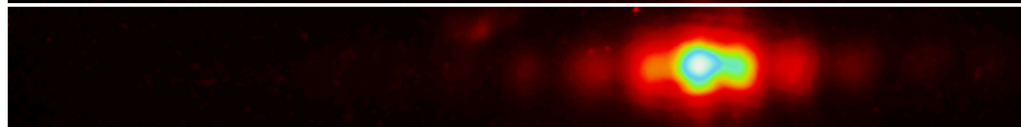
+50 μm



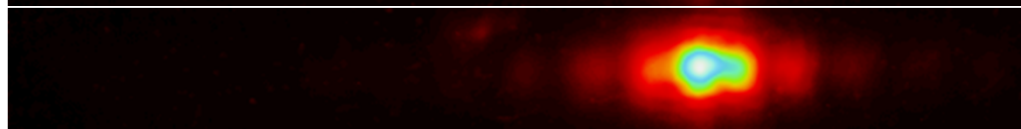
+75 μm



+100 μm

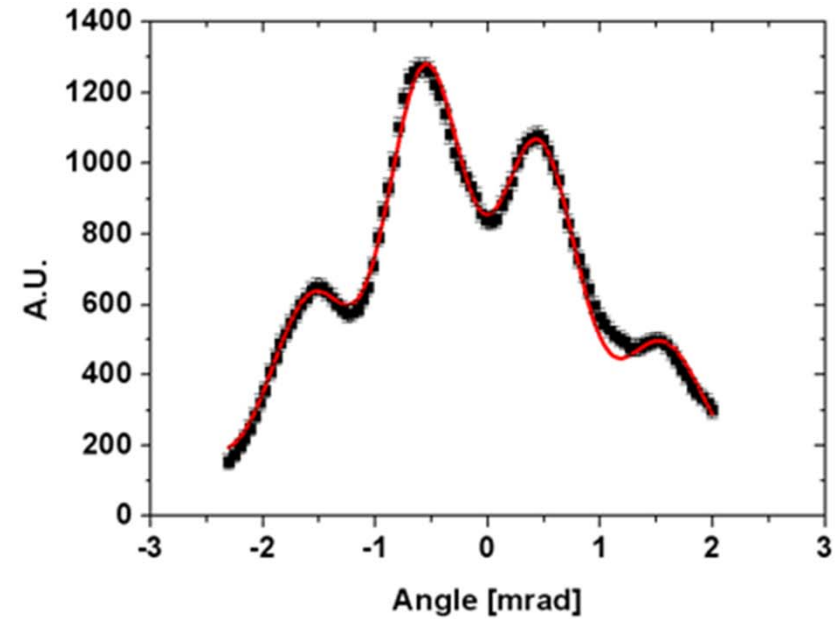
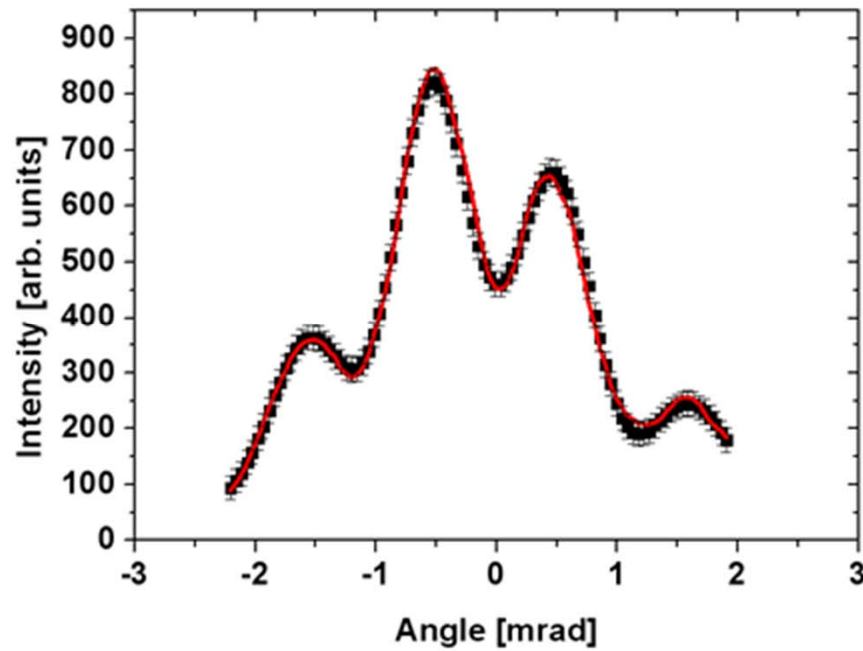


+125 μm



+175 μm



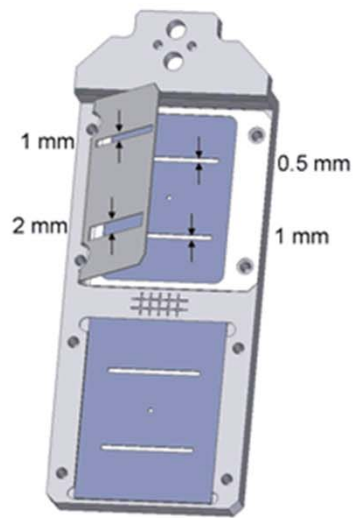


RMS Beam Size (μm)	82	78
RMS angular spread (μrad)	260	310
Displacement in respect to the second slit (μm)	-6	-55
Misalignment between two slits (μm)	110	113

A divergence of about $320 \mu\text{rad}$ can be estimated from a quadrupole-scan emittance measurement carried out under the same experimental conditions

Hardware evolution

- New design in the mover



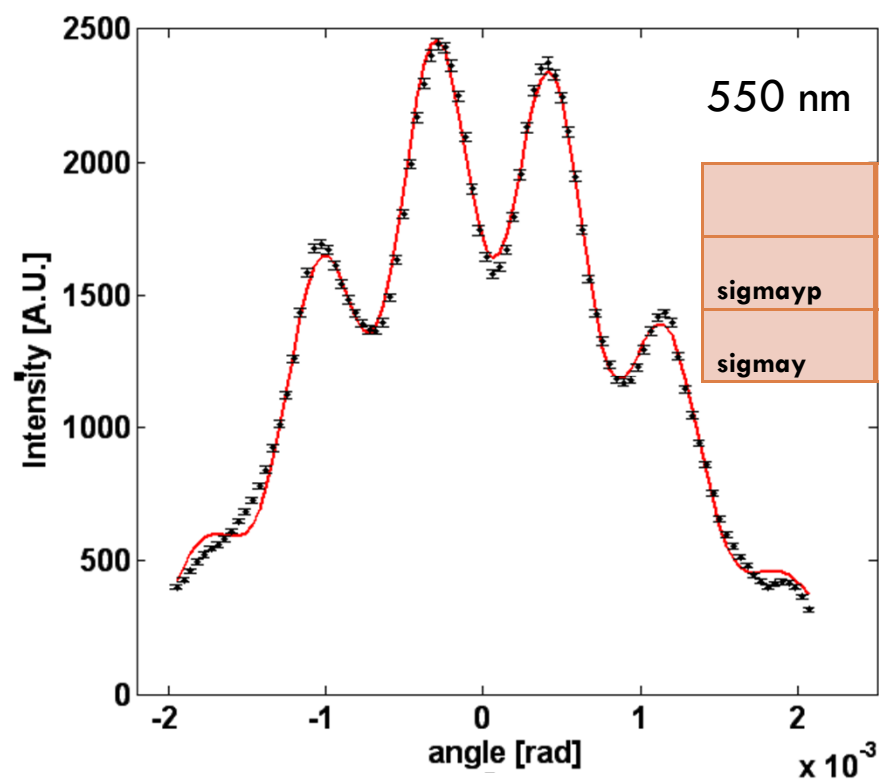
Old screen holder



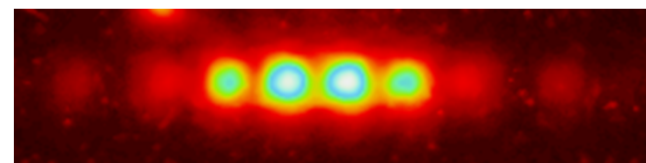
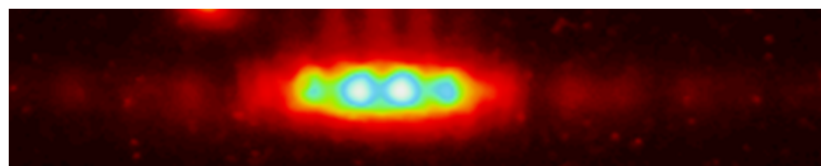
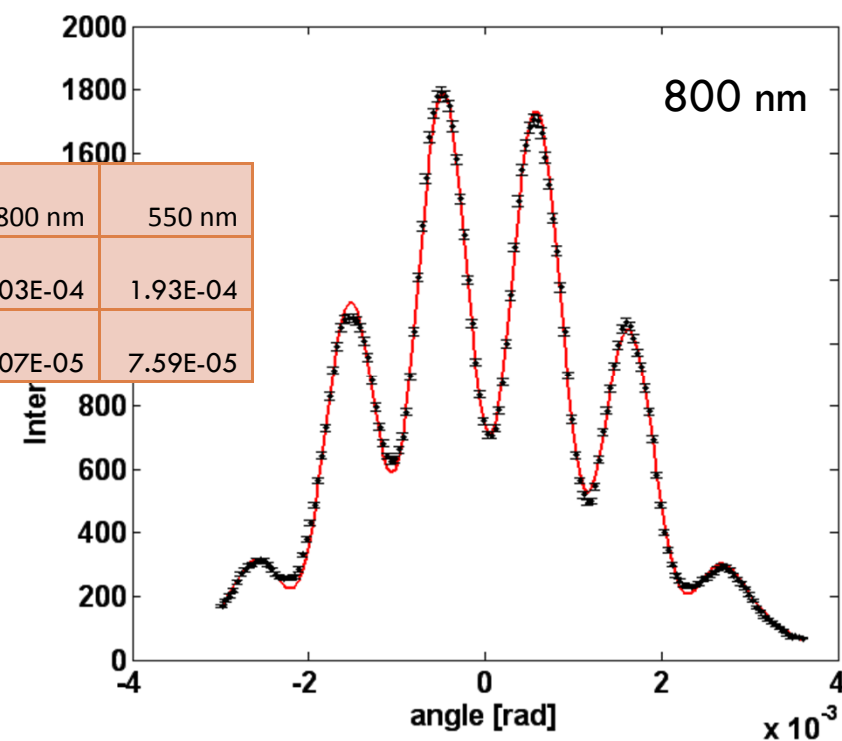
New screen holder

Different wavelength

Preliminary

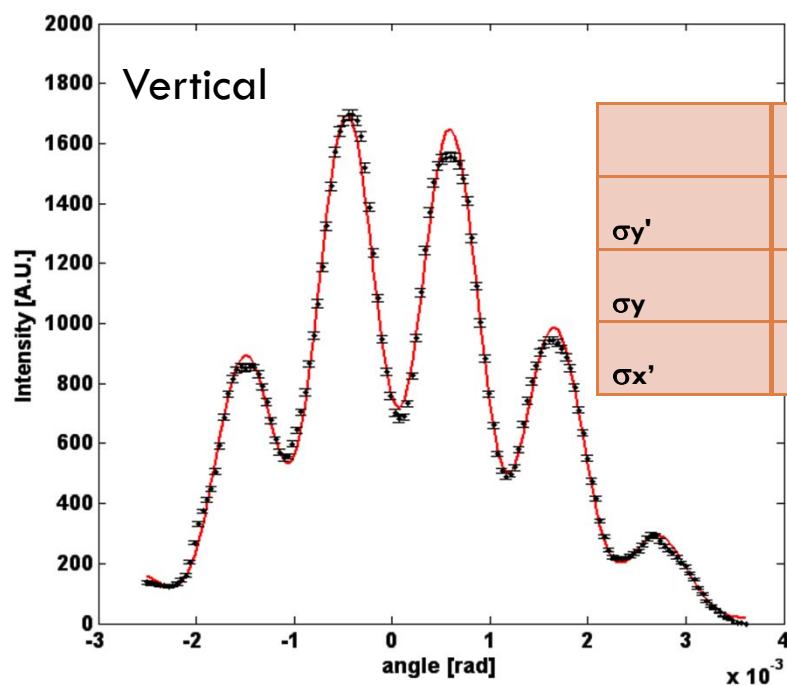


	800 nm	550 nm
sigmayp	2.03E-04	1.93E-04
sigmay	8.07E-05	7.59E-05

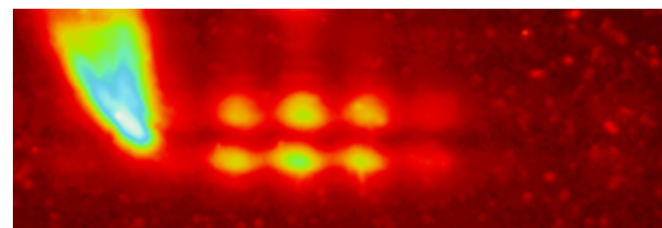
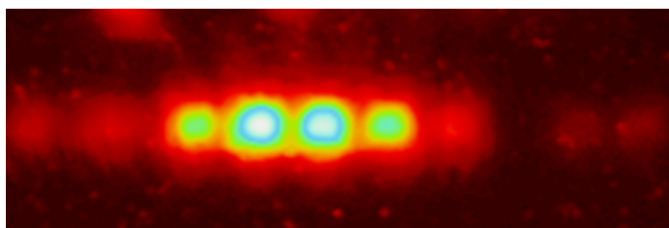
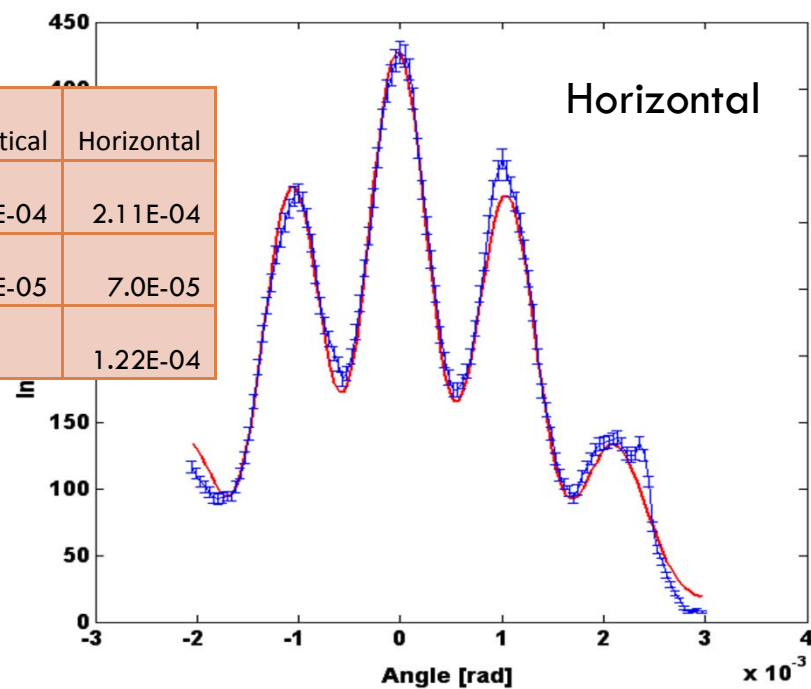


Horizontal polarization

Preliminary

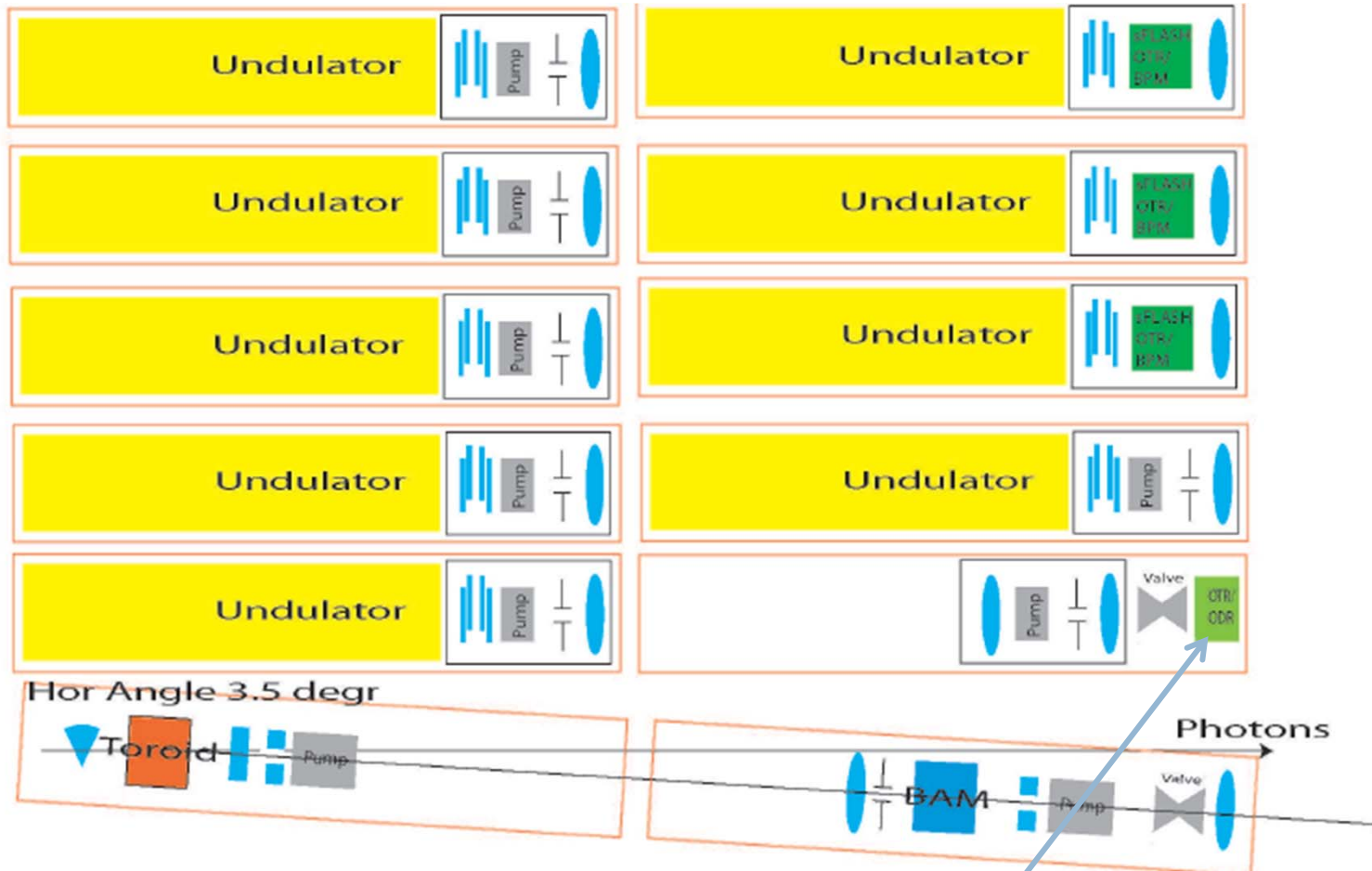


	Vertical	Horizontal
$\sigma y'$	2.03E-04	2.11E-04
σy	7.7E-05	7.0E-05
$\sigma x'$		1.22E-04



FLASH2 beamline

(part of SASE undulator section and section downstream)



230 mm reserved for the ODRI vacuum chamber presently mounted at OTR/57BYP

Status & Future plans



- ODRI is in developing
- ODRI dramatically reduce or eliminate the problem of background
- Asymmetric configuration resolves parameters ambiguities
- New measurements are foreseen to make a totally non intercepting emittance measurement

Short and long term



- Short term: improve the system, using two targets to measure both horizontal and vertical emittance
- Long term: use two stations to make the equivalent of 4 screens monitor in a totally not intercepting system



Thank you for your attention