

WP 7.3.2 Micro-focusing optics

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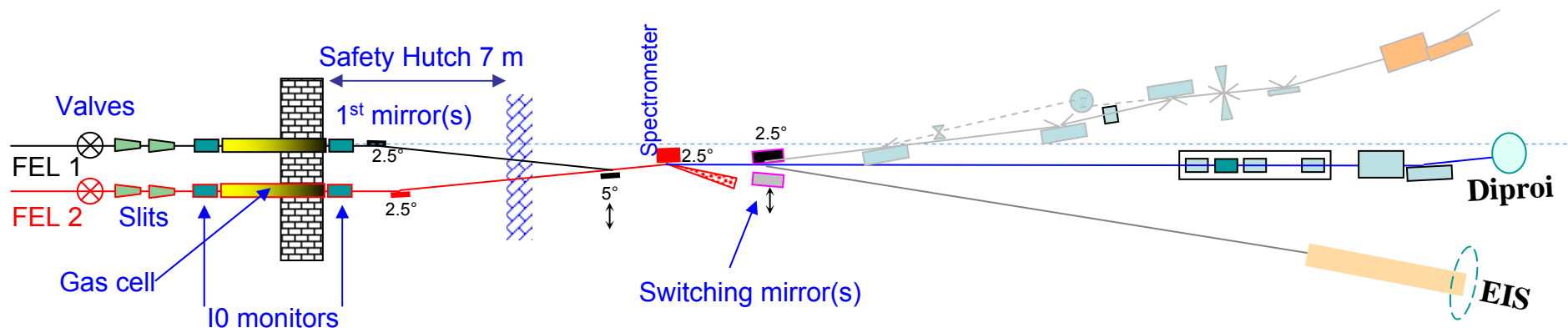
Luca Rumiz

.....

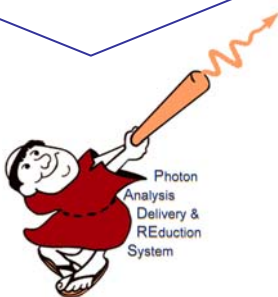
The Fermi@elettra project

Parameter	FEL-1	FEL-2
Wavelength range [nm]	100 to 40	40 to 10
Output pulse length [fs]	50	200
Bandwidth [meV]	17 (at 40 nm)	5 (at 10 nm)
Peak power [GW]	1 to >5	0.5 to 1
Harmonic peak power (% of fundamental)	~ 2	~ 0.2 (at 10 nm)
Photons per pulse	10^{14} (at 40 nm)	10^{12} (at 10 nm)
Virtual waist size [μm]	250 (at 40 nm)	120
Divergence (rms, intensity) [μrad]	50 (at 40 nm)	15 (at 10 nm)

Free Electron laser Radiation for Multidisciplinary Investigations at Elettra

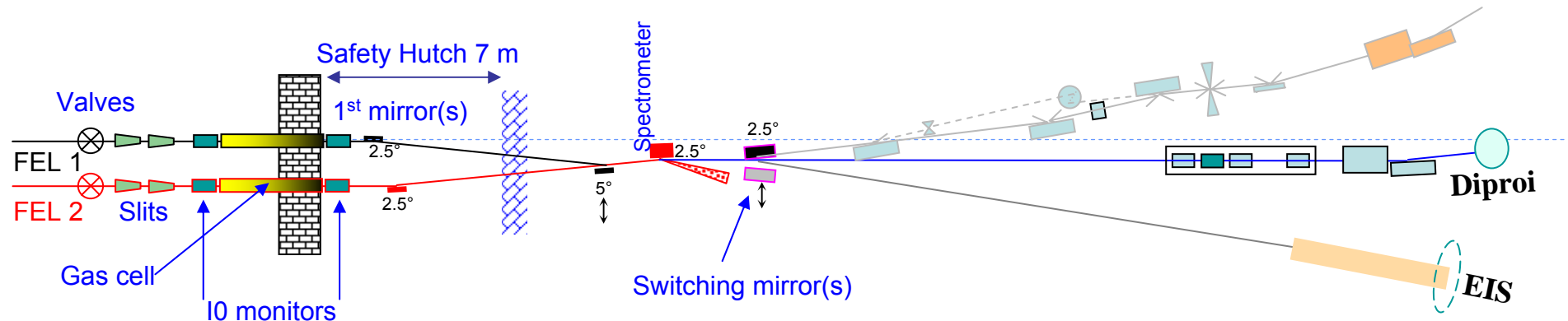


PADReS nov. 2009



DIPROI: dec. 2009

EIS: june 2010



Requests

Spot dimension

below $5 \mu\text{m}$ in standard operational mode

$0.2\text{-}0.3 \mu\text{m}$ in high spatial resolution mode (low divergence)

Maximum possible energy density

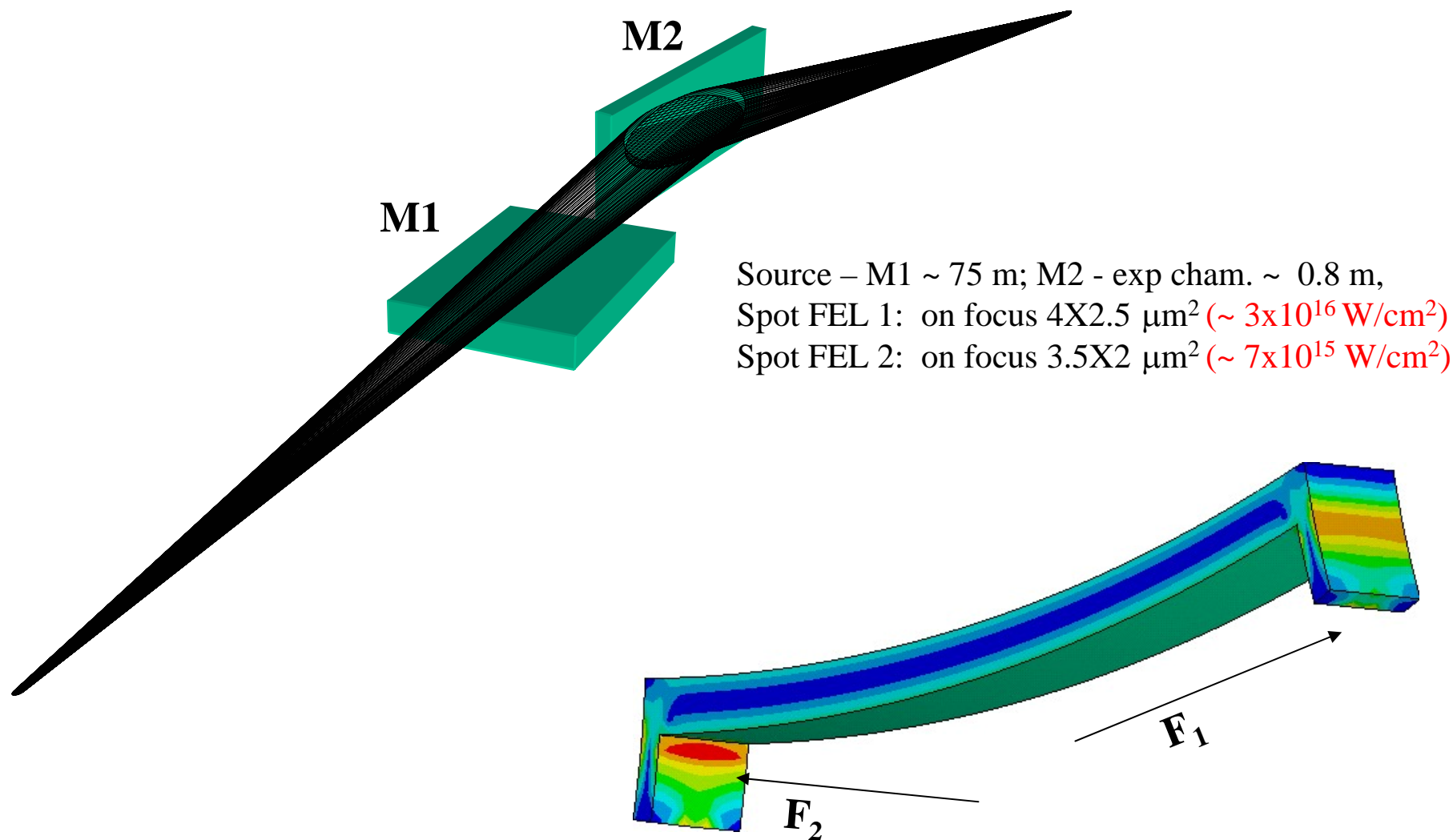
Target: 10^{17} W/cm^2

Variable spot size and variable focal distance

Wavefront preservation

$\lambda/4$ minimum (Rayleigh criteria), target $\lambda/10$

Compensate source distance variation $f(h\nu)$

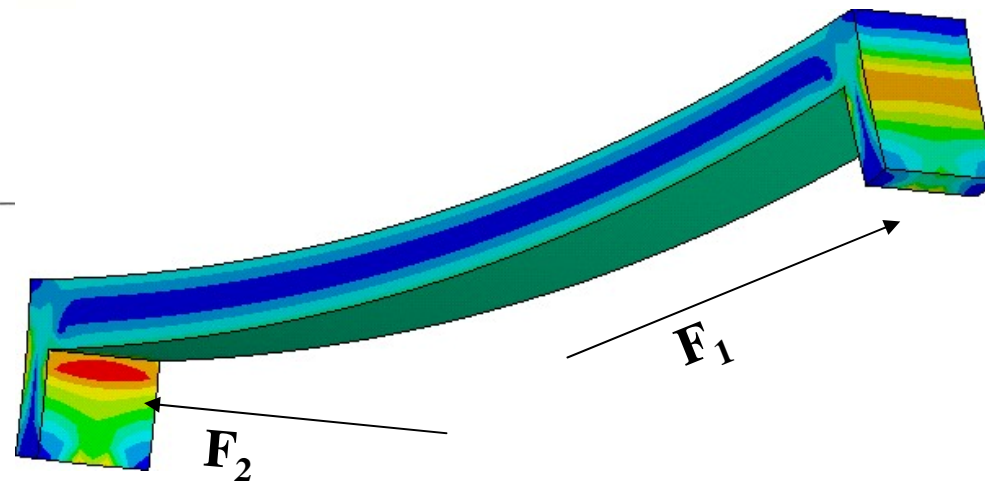
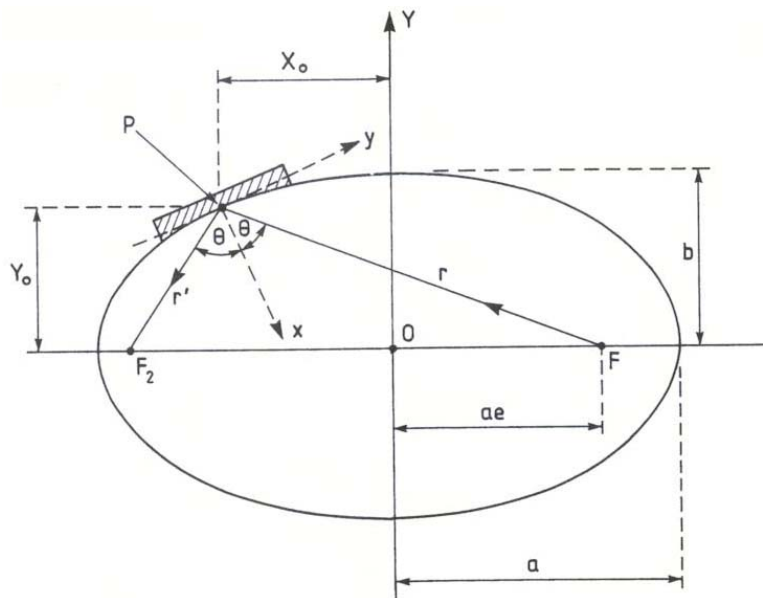


Two unequal moment applied at the edges

$$x^2 \left(\frac{\sin^2 \vartheta}{b^2} + \frac{1}{a^2} \right) + y^2 \left(\frac{\cos^2 \vartheta}{b^2} \right) - x \left(\frac{4f \cos \vartheta}{b^2} \right) - xy \left[\frac{2 \sin \vartheta \sqrt{e^2 - \sin^2 \vartheta}}{b^2} \right] = 0$$

where: $f = \left(\frac{1}{r} + \frac{1}{r'} \right)^{-1}$

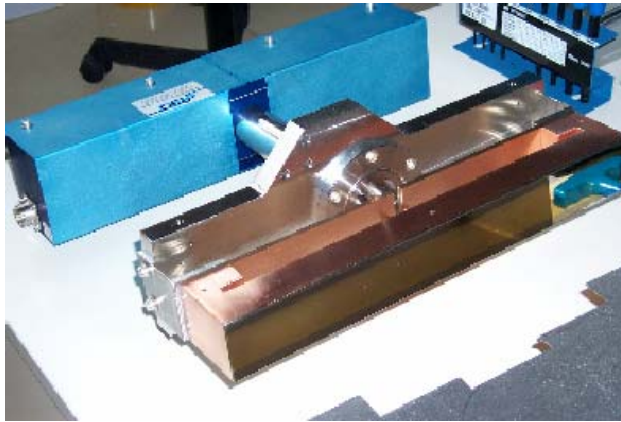
Needs a 3rd order approximation in shape



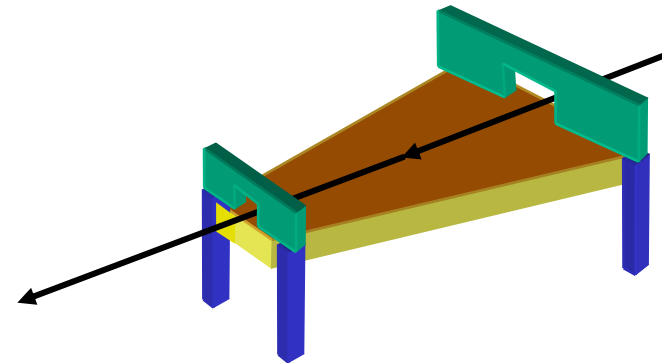
Two unequal moment applied at the edges

Higher order corrected by:

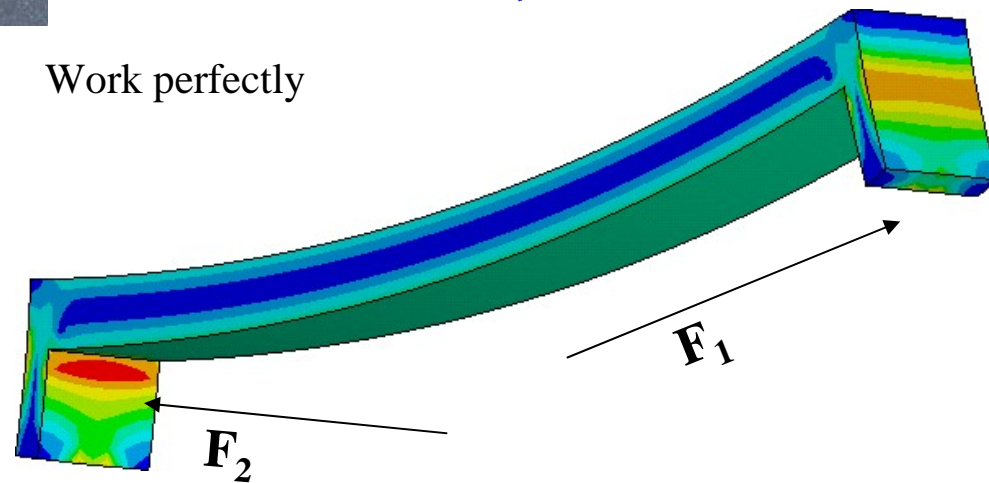
Polishing



Moment of Inertia variation

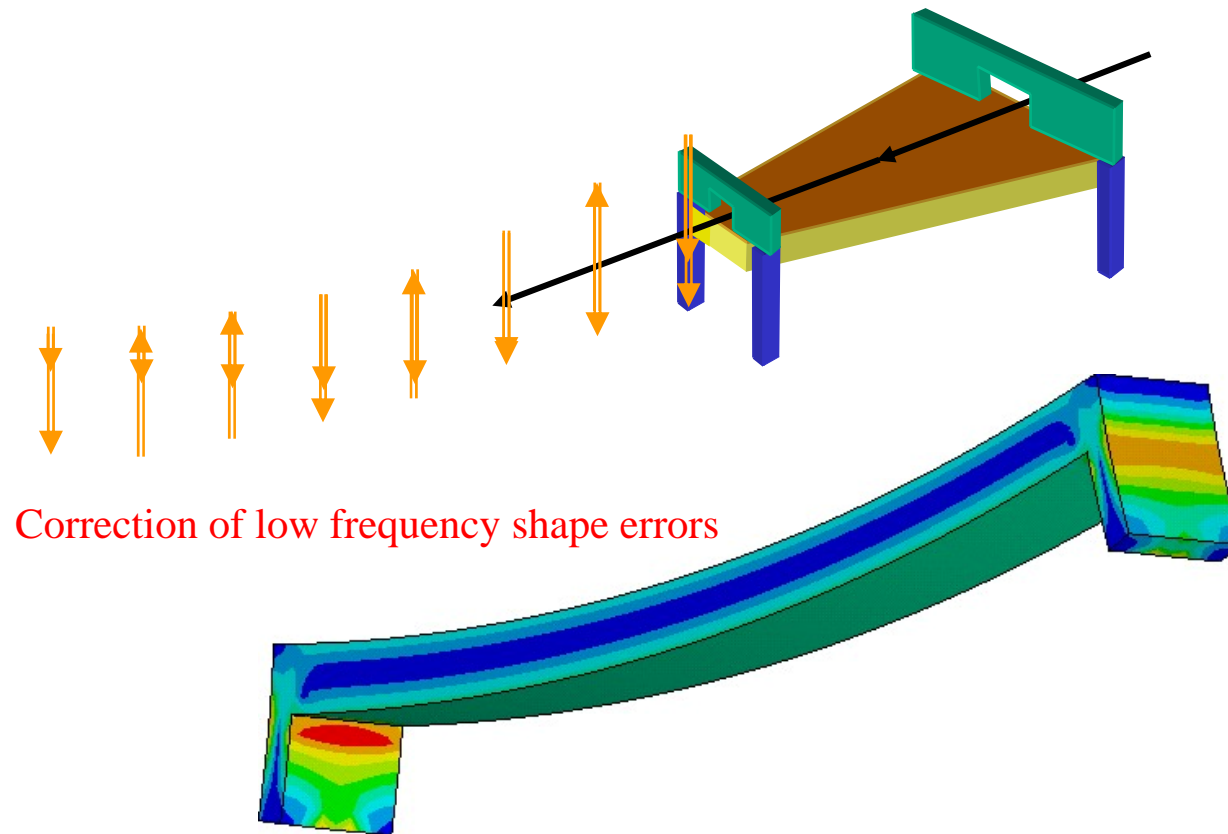


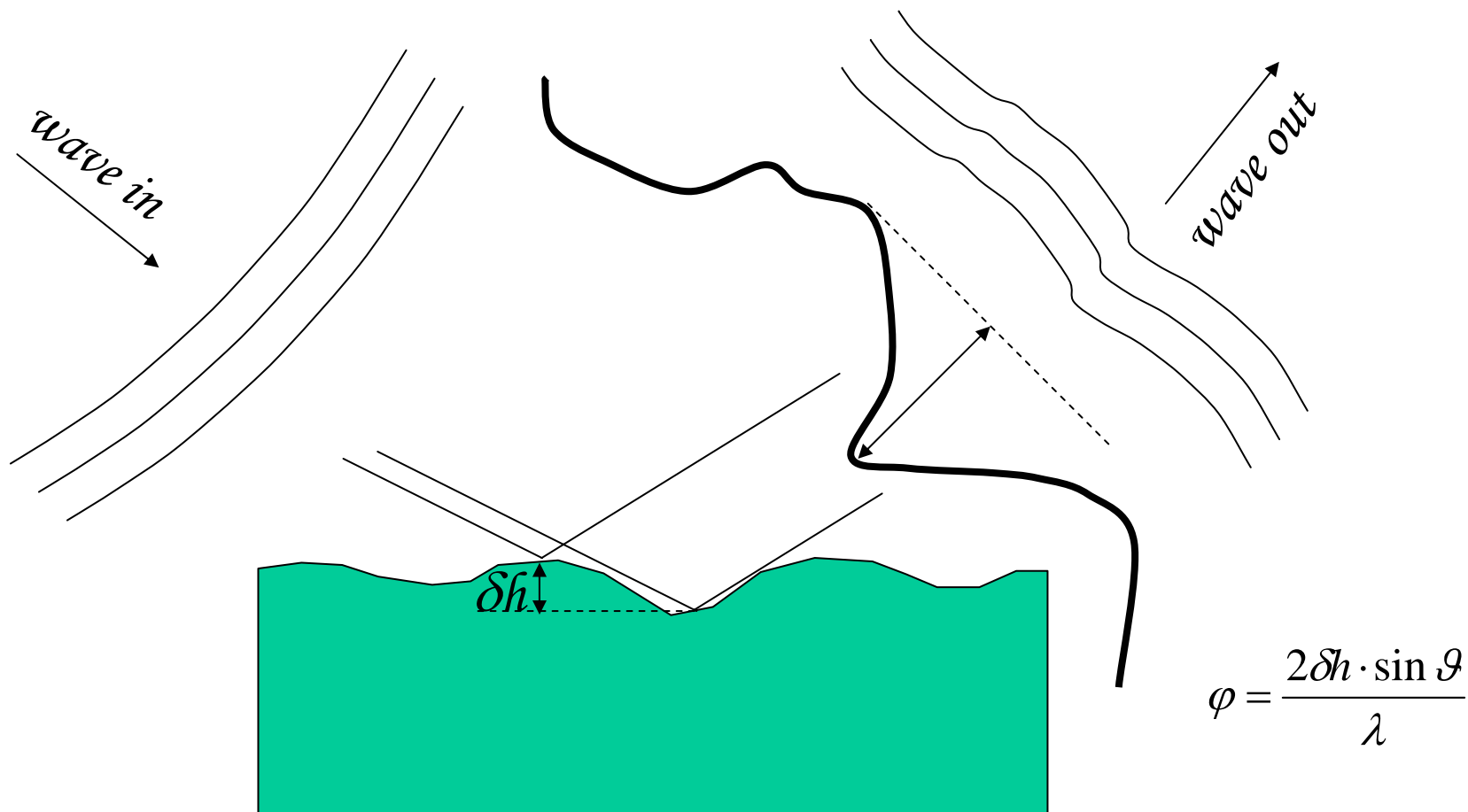
Work perfectly

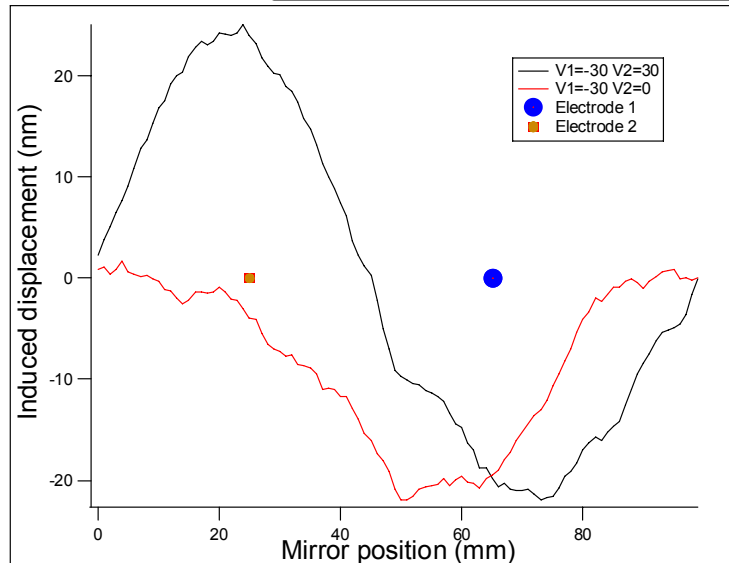


Two unequal moment applied at the edges

Higher order corrected by:
Dynamic variation of the moment of Inertia



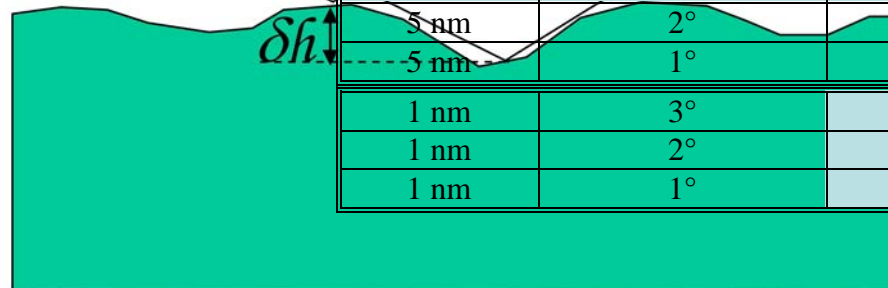




0.6 nm/V correction

1 nm stability over days

Our actual target



Fermi@elettra case

Wavelength	Angle of incidence	shape error p-v $\phi = 0.25$	shape error p-v $\phi = 0.1$
40 nm	6°	47	18
40 nm	3°	95	38
40 nm	1.5°	191	76
10 nm	3°	23	9
10 nm	2°	35	14
10 nm	1°	71	28
5 nm	3°	12	5
5 nm	2°	18	7.2
5 nm	1°	36	14
1 nm	3°	2.5	$2\delta h \cdot \sin \theta$
1 nm	2°	3.5	$\phi = 1.5$
1 nm	1°	7	3λ

Wave out

Survey of the existing polishing techniques

tests on samples (feedback from vendors and clients) (link to WP3)

Focusing tests at Fermi and other sites (if available)

Tests with SR and FEL (on January 2010)

Already UHV compatible, to be extend to cooling schemes

FEA and tests

Target Fermi

5-10 nm PV after best ellipse subtraction

Variable profile from flat to an ellipse of $p=80\text{m}$, $q=0.8\text{m}$

Target project

1 nm P-V ?? need better metrological instrument → link to WP3

Required (and really needed) ellipsoids → link to WP7.1



<http://www.elettra.trieste.it/Conferences/2008/ACTOP>

2nd Workshop on Active Optics 8-10 October 2008

- WP 7.1 *Design of beamline*
 - Deliverable 7.2 **2 months** 3 beamlines designed. Monochromator issue with energetically unstable beam
- WP 7.2 *Photon diagnostics*
 - Deliverable 7.2 **4 months** Based on DESY design, we are testing an I0 monitor and we are adapting the SR concept of BPM for the FEL. Study on the direct correlation energy-duration will be made. Autocorrelation set-up to study the temporal characteristic of the beam (available march 2010).
- WP 7.3.1 *Radiation damage optics*
 - Deliverable 7.5 **6 months** Tests on gratings was made at 800 nm. Test on the performance of Multilayer optics are needed. Samples can be provided for both, gratings and multilayers
- WP 7.3.2 *Microfocusing optics*
 - Deliverable 7.6 **20 months** Survey of the existing polishing techniques, Focusing tests at Fermi and other sites (if available), extend to cooling schemes, FEA and tests.
- WP 7.3.3 *Multiple use of FEL beam*
 - Deliverable 7.7 **4 months** Grating as beam splitter avoiding energy spatial dependence, “simple” mechanical system, realization of good half deflecting mirrors (standard production technique?)