Upgrade of the mOTR System

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23^{rd} January, 2013
15^{th} ATF2 Project Meeting - Instrumentation

Acknowledgments to:
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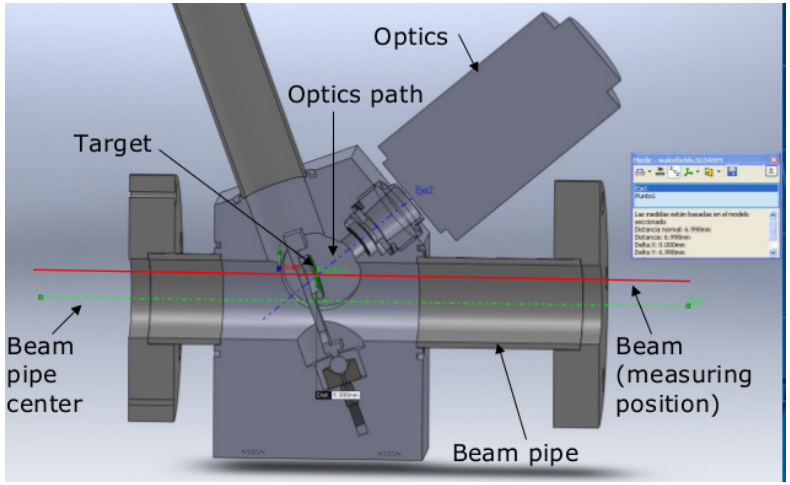
Motivation

For measuring the beam size the mOTR body is lowered about 7 mm for intercepting the beam (Beam pipe $\varnothing$=22 m)



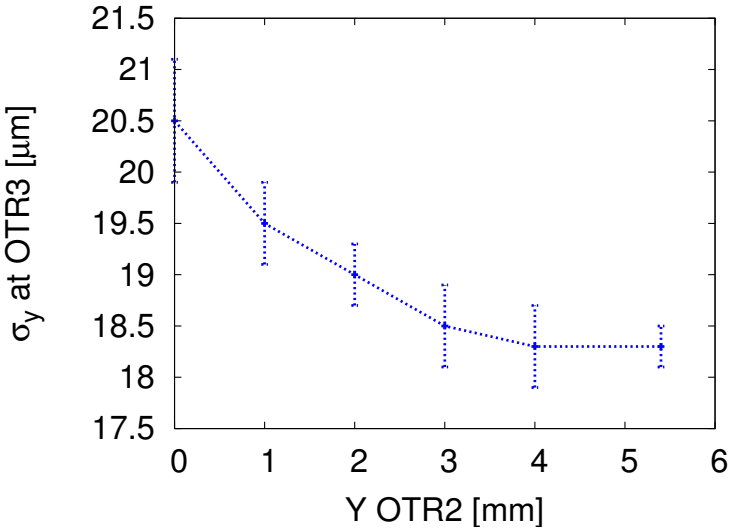
Wakefields are generated when lowering the OTRs

$$\Downarrow$$

10% $\Delta\sigma_{x,y}$

$$\Updownarrow$$

20%$\Delta\epsilon_{x,y}$ [a]



[a] OPTICS AND EMITTANCE STUDIES USING THE ATF2 MULTI-OTR SYSTEM, presented at IPAC 2012, *http://accelconf.web.cern.ch/AccelConf/IPAC2012/papers/MOPPR044.PDF*

Objectives

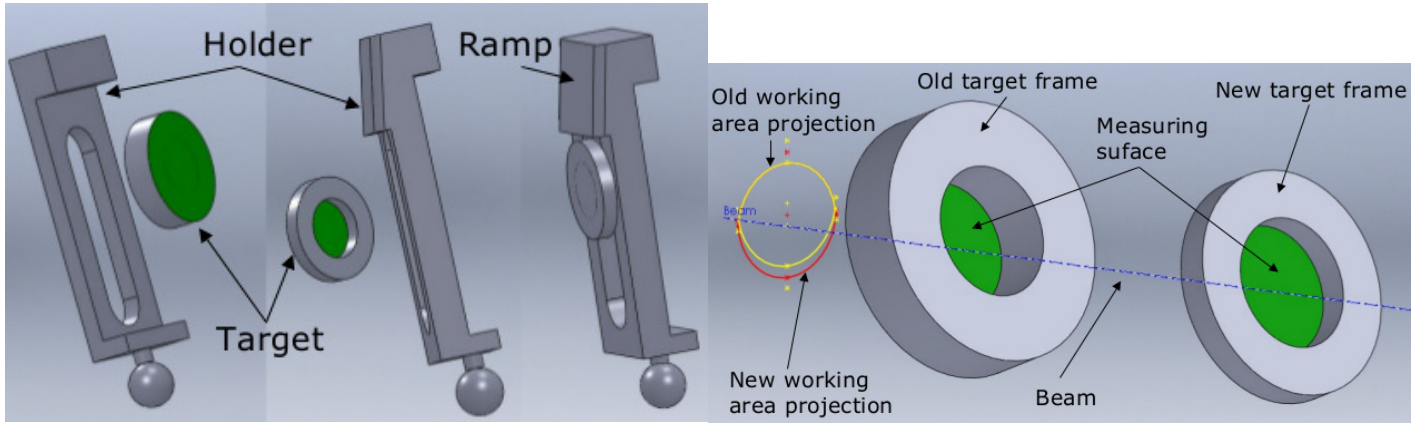
Our objectives are to design a new optical system that significantly reduces the distance to be lowered for measuring the beam sizes while preserving the required resolution

Modifications:

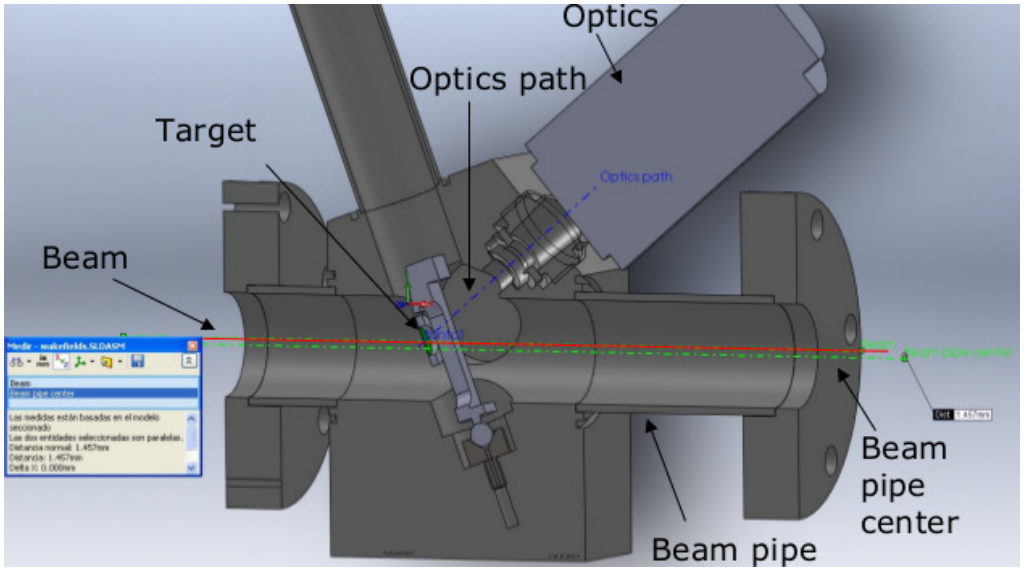
- design a new target frame that permits to place target downstream the holder
- design the target holder
- develop a new optics device which increases its working distance

New Target Holder and Frame

- Figures of the new target holder and frame designed by Cesar (IFIC)



- The required distance to be lowered for intercepting the beam is reduced from 7 mm down to 1.5 mm

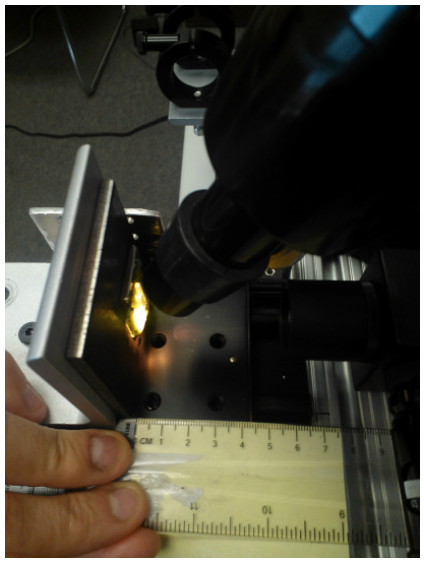


New Optical System

- The present optical device (Mitutoyo lens) implemented by the mOTR system features a working distance of 34 mm and provides a resolution of 10%
- We have designed a new optic device (Achromat) that features a working distance of about 55 mm
- To determine the resolution of the new optical system we use an optical bench that accommodates the CCD camera, a tube lens, zoom device, square box with a 45 deg mirror and the optical system that faces a test target

Mitutoyo device (Present lens)

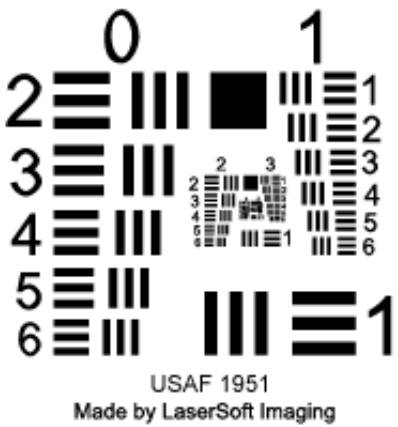
Achromat lens (New lens)



Test target

The test target is composed of square boxes, each of them is labelled by its group-element (G-E) The resolution of the new optical system is directly obtained from the resolved group/element of the test target

The used test target is:[1]:



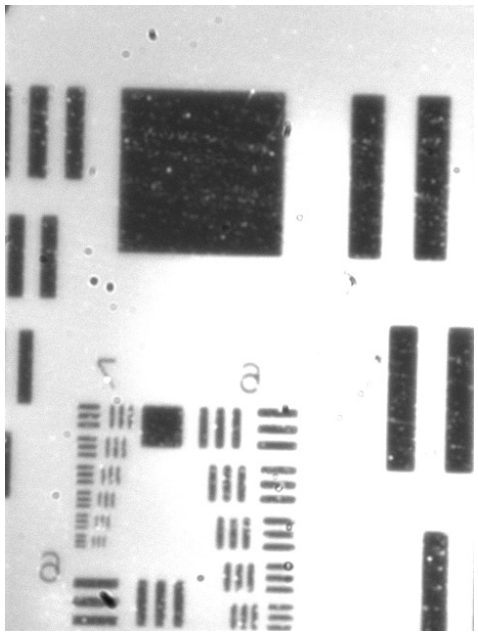
Number of Line Pairs / mm				
Element	Group Number			
	4	5	6	7
1	16.00	32.0	64.0	128.0
2	17.95	36.0	71.8	144.0
3	20.16	40.3	80.6	161.0
4	22.62	45.3	90.5	181.0
5	25.39	50.8	102.0	203.0
6	28.50	57.0	114.0	228.0

[1] http://www.edmundoptics.com/testing-targets/test-targets/resolution-test-targets/1951-usaf-glass-slide-resolution-targets/1790

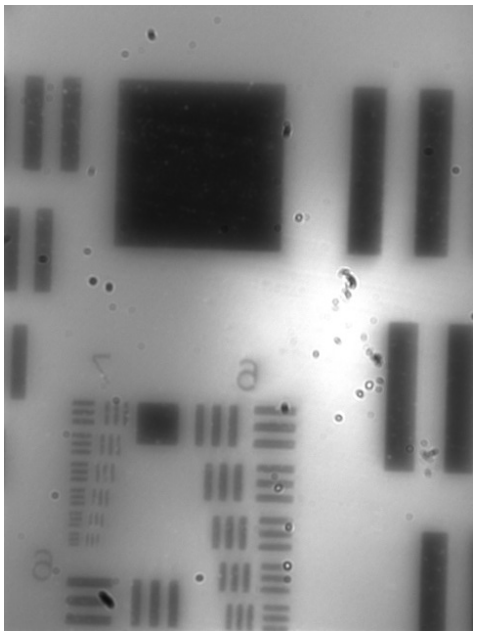
Images

Example of images taken by the CCD with both optical systems:

Mitutoyo device (Present lens)



Achromat lens (New lens)



Since the working distance of the Achromat lens is larger than the one of the Mitutoyo, a lower flux of light is collected, therefore there is a poor contrast when zooming in

Resolution Results

10 different images are taken for both lenses
Obtained resolution for the group-elements 6-5, 7-4 and 7-6

G - E	Size	Mitutoyo	Achromat
	[μm]	[a.u.]	[a.u.]
6-5	9.8	5.6 $\pm$ 0.11 (2%)	5.20$\pm$0.15 (3%)
7-4	5.5	2.84 $\pm$0.13 (5%)	2.67$\pm$0.15 (6%)
7-6	4.4	2.39 $\pm$0.17 (7%)	2.30$\pm$0.3 (13%)

Hardware Installation Plan

- Doug McCormick will install the new Achromatic lens and the target holder for OTR-0 during the 3^{rd} weekend of February
- In the following week observe their operation by the downstream OTRs
- If everything is ok:
  - Change the remaining OTRs-1,2,3 on the following weekend (22^{nd} and 23^{rd} of February)
  - Test the entire system by the following operation week

Conclusions

- Significant improvements of the mOTR hardware system have been made
- We expect that with the new holder target and the optics system will allow to measure the emittance within the required accuracy without increasing it
- We expect to conduct the first performance tests of the new OTR system by the end of February