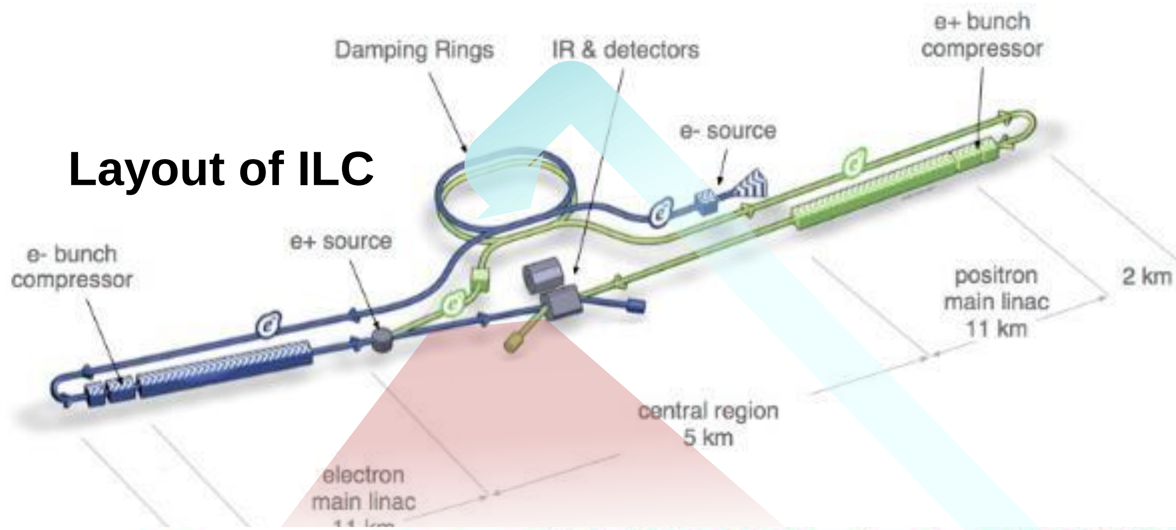
CLIC Project Meeting #25
28 June 2016
CERN

ATF Report

Douglas BETT

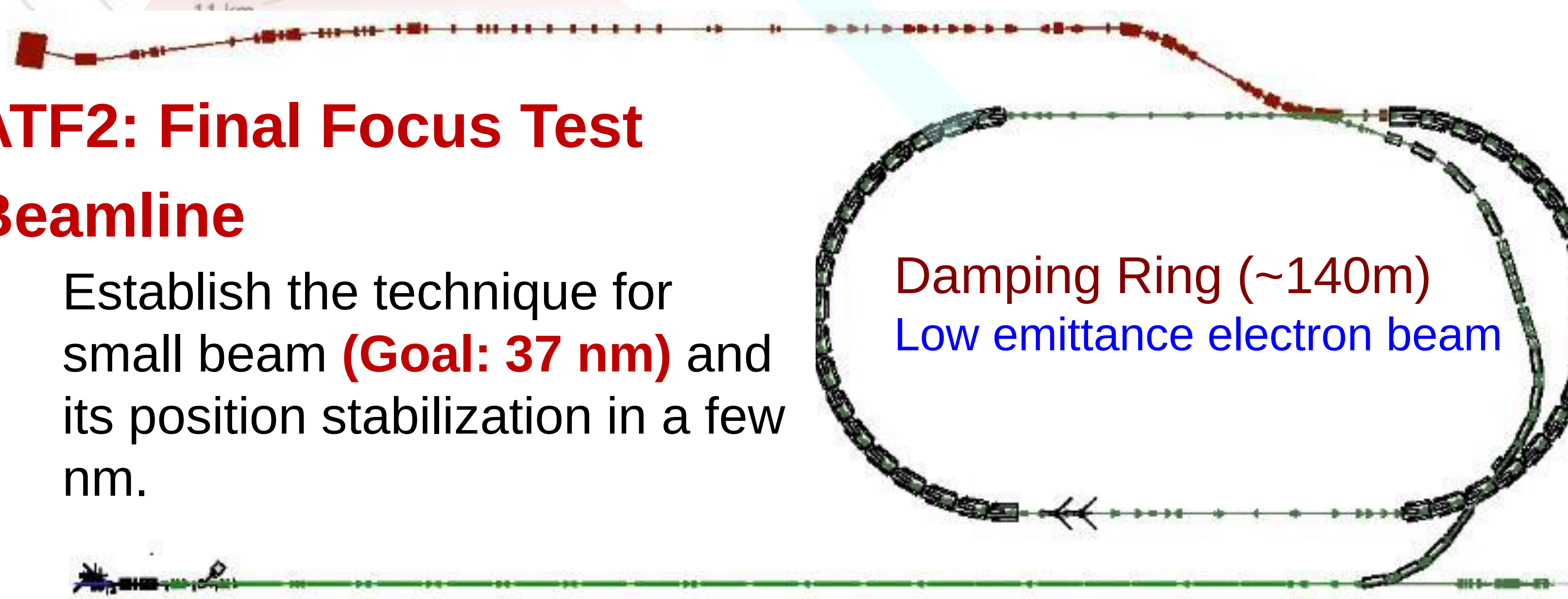
ATF/ATF2: Accelerator Test Facility

Layout of ILC



Develop the nanometer beam technologies for ILC

- Key of the luminosity maintenance
- 6 nm beam at IP (ILC)



ATF2: Final Focus Test Beamline

Establish the technique for small beam **(Goal: 37 nm)** and its position stabilization in a few nm.

1.3 GeV S-band Electron LINAC (~70m)

Slide courtesy of Nobuhiro Terunuma

ATF2 Status

Goal 1	Goal 2
Achieve 37 nm beam size	Achieve beam position stabilization at the nm level

Goal 1

Achieve 37 nm beam size

- Achieved 44 nm (2014)
- Obtained good reproducibility

OUTLOOK

- Understand impact of wakefields to achieve small beam sizes for high intensities

Goal 2

Achieve beam position stabilization at the nm level

- Effectively achieved for ILC
- Demonstration at ATF requires BPM with nm resolution

OUTLOOK

- Improve BPM resolution

CLIC Plans

Slides from:

Fabien Plassard

- Ultra-low β* (including octupoles)
- Energy acceptance measurement

Michele Bergamaschi

- OTR/ODR
- Ground motion feed-forward

In discussions to host ATF2 Project Meeting at CERN (early 2017)

Ultra-low β*

- ATF2 ultra-low β_y^* project aims to test a Final Focus System (FFS) with chromaticity (ξ_y) similar to that of CLIC
  - ATF2 with nominal optics has chromaticity comparable to ILC
  - Larger chromaticity makes the FFS more difficult to operate
- Ultra-low β_y^* optics reduces vertical beam size at IP down to 20 nm
- Octupole magnets are required to combat higher order aberration

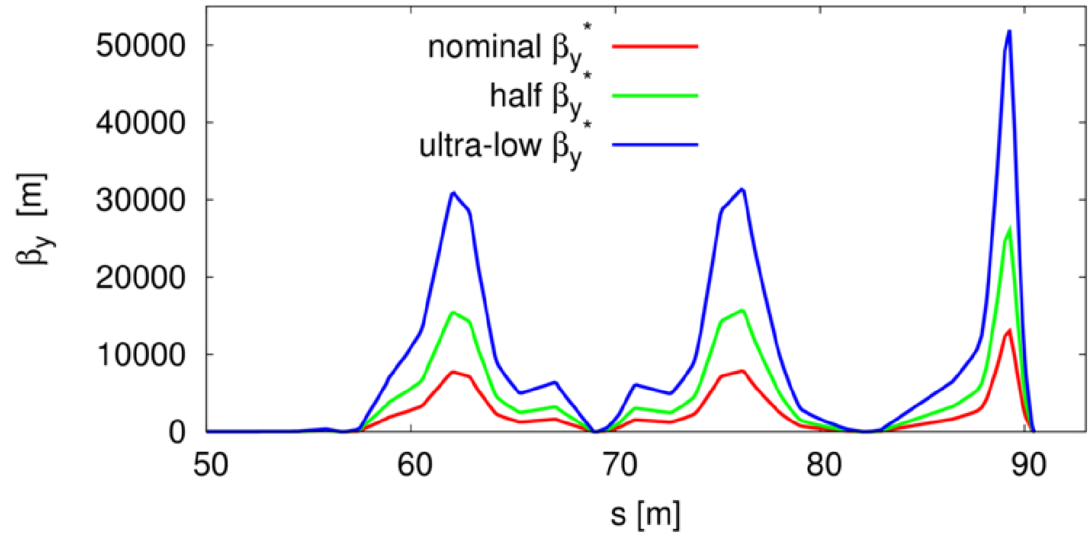
	β_y^* [µm]	σ_y^* [nm]	L^* [m]	ξ_y (L^*/β_y^*)
ILC	480	5.9	3.5 / 4.5	7300 / 9400
CLIC	70	1	3.5	50000
ATF2 nominal	100	37 (44[a])	1	10000
ATF2 half β_y^*	50	25[b]	1	20000
ATF2 ultra-low β_y^*	25	20[b]	1	40000

[a] measured June 2014 [b] using octupoles

Decreasing β_y^* makes the FFS more sensitive to imperfections. Simulations suggest that:

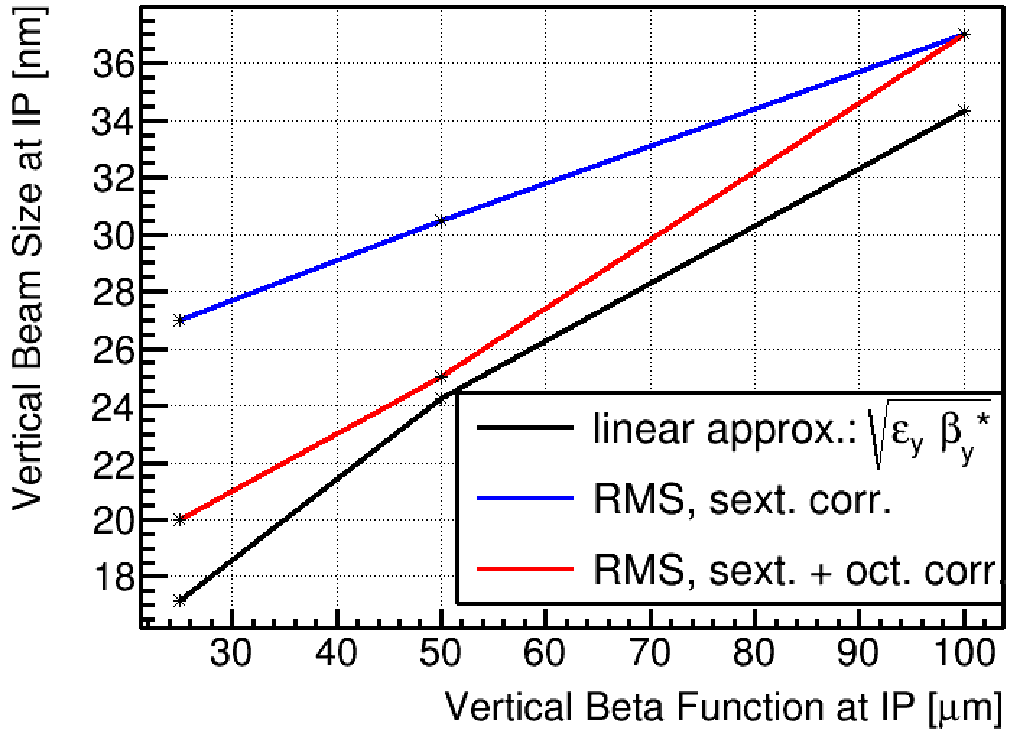
- Magnetic multipole fields
- Fringe fields

are **limiting factors for the IP beam size**



Proposed mitigation method:

- Installation of two octupoles magnets
  - Corrects both multipole fields and fringe fields
  - Makes correction with sextupoles easier
  - **Reduces the IP beam size from 27 nm to 20 nm**



Latest results

- In February 2016 tuning was performed for two sets of optics by applying several iterations of linear and non-linear knobs in order to reach a target beam size of 30 nm

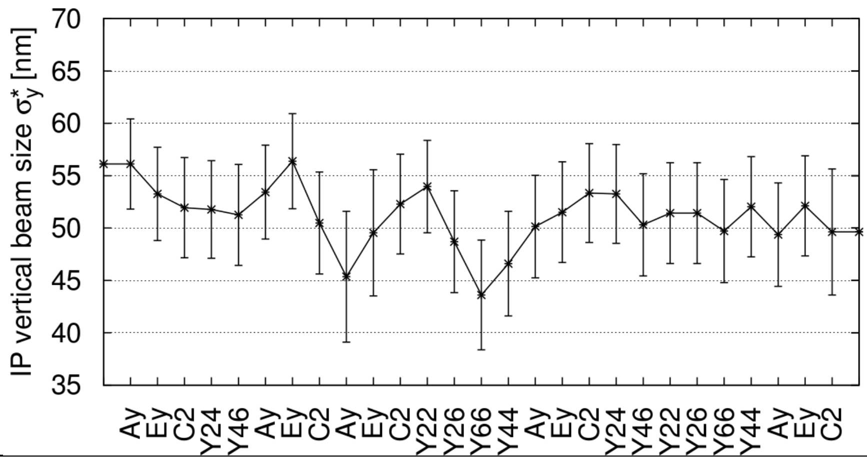
$10\beta_x^* \times 0.5\beta_y^*$

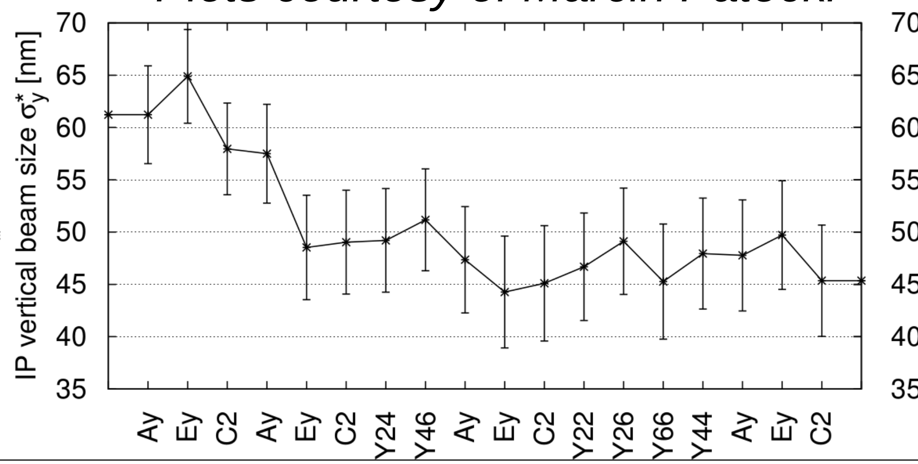
- Achieved beam size of 50 nm
- Tuning efficiency could be spoiled by orbit jitter, wakefields, intensity fluctuation and Shintake monitor stability

$25\beta_x^* \times 0.5\beta_y^*$

- Improved tuning efficiency resulted in beam size of 45 nm
- Larger β_x^* tends to reduce the effect of the multipole field errors

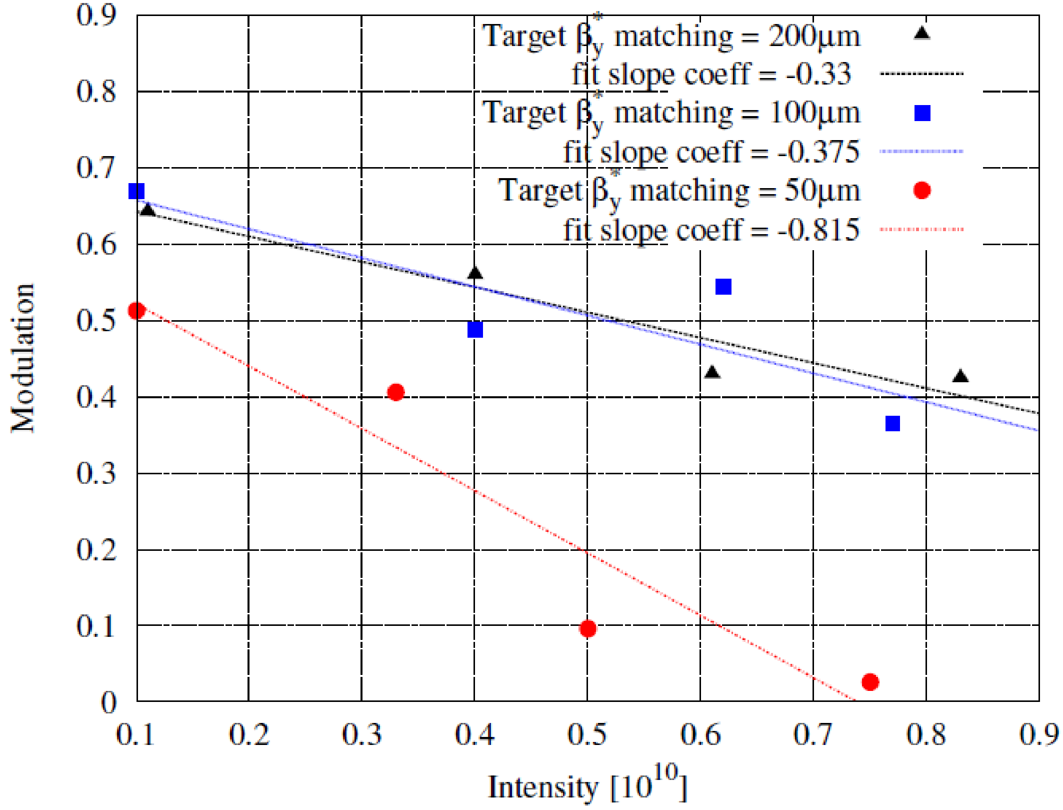
Plots courtesy of Marcin Patecki





Intensity dependence measurement

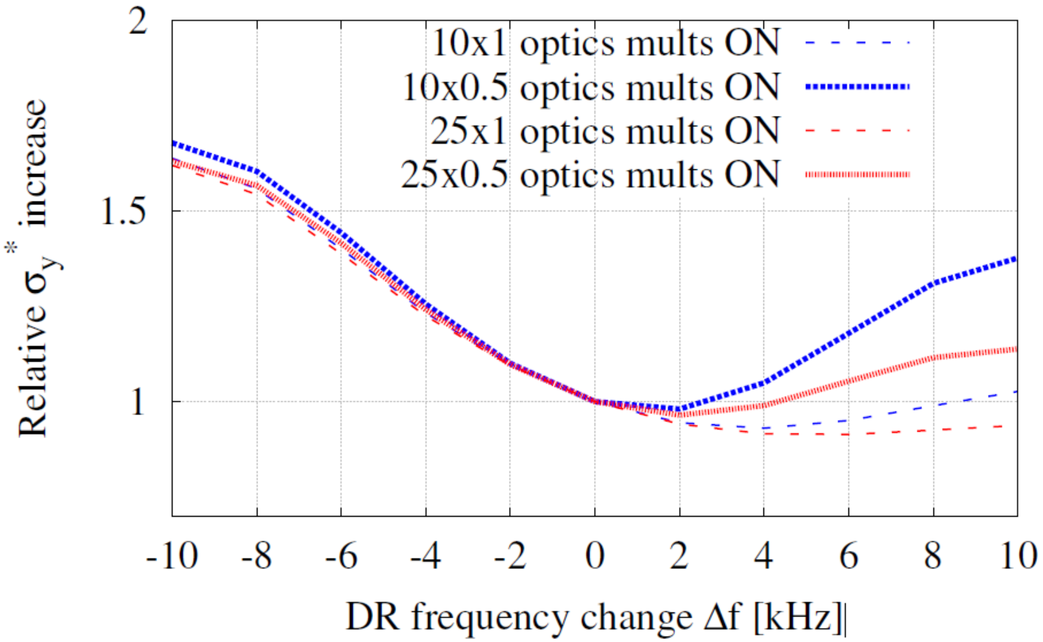
- Effect of beam intensity on beam size studied for several values of β_y^*



- Very strong intensity dependence observed for half β_y^* optics
- Wakefields, multipolar errors and angular jitter possibly limiting beam size at high intensity

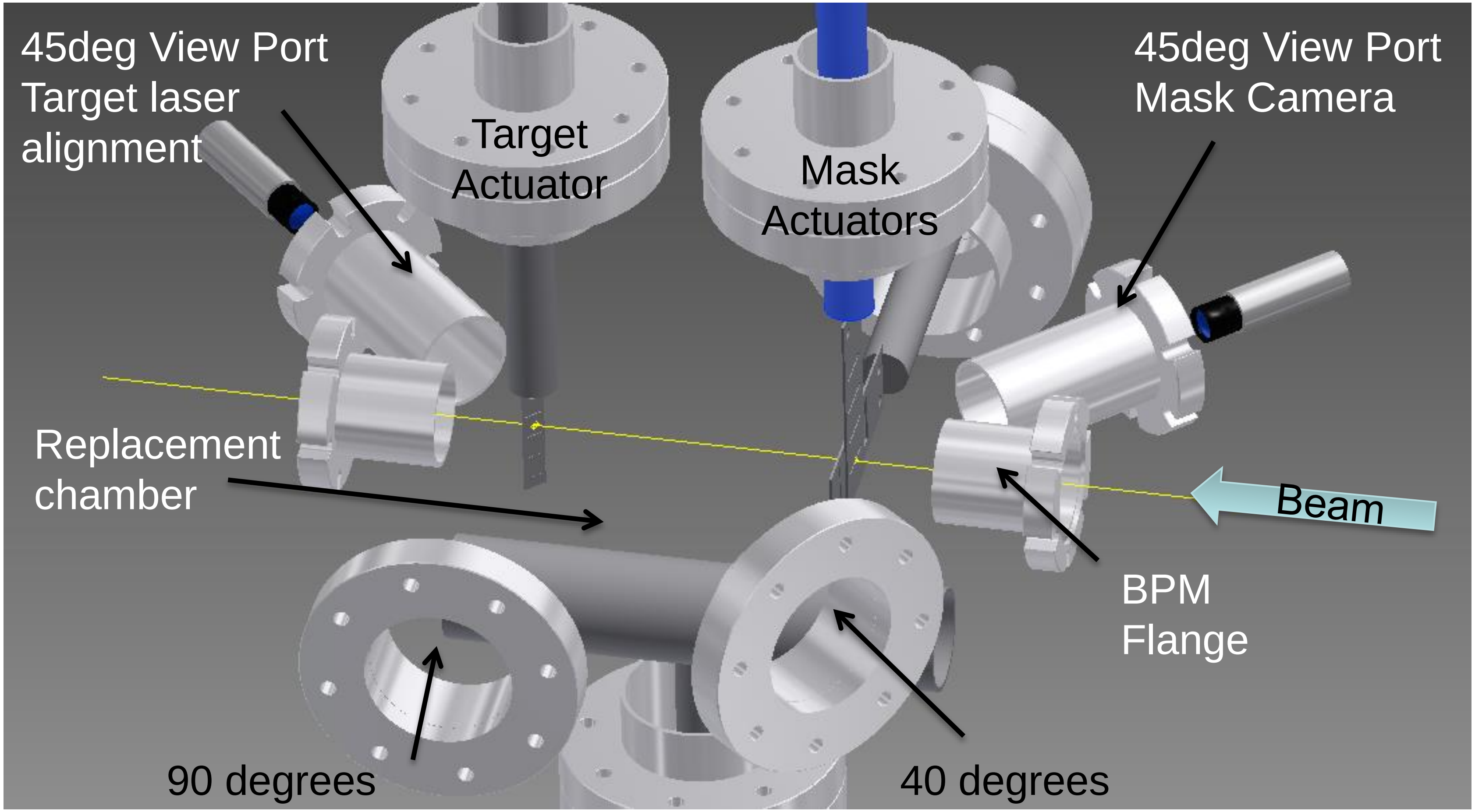
Energy acceptance measurement

- Perform an energy scan by changing the linac frequency and observing the effect on the beam size
- Compare measurement with simulation to determine the chromatic behaviour of the beam and the impact of non-linear fields



- Beam size monitor optimized for normal operation not for energy ramp
- New hardware needed to perform measurement

ODR/OTR emittance station

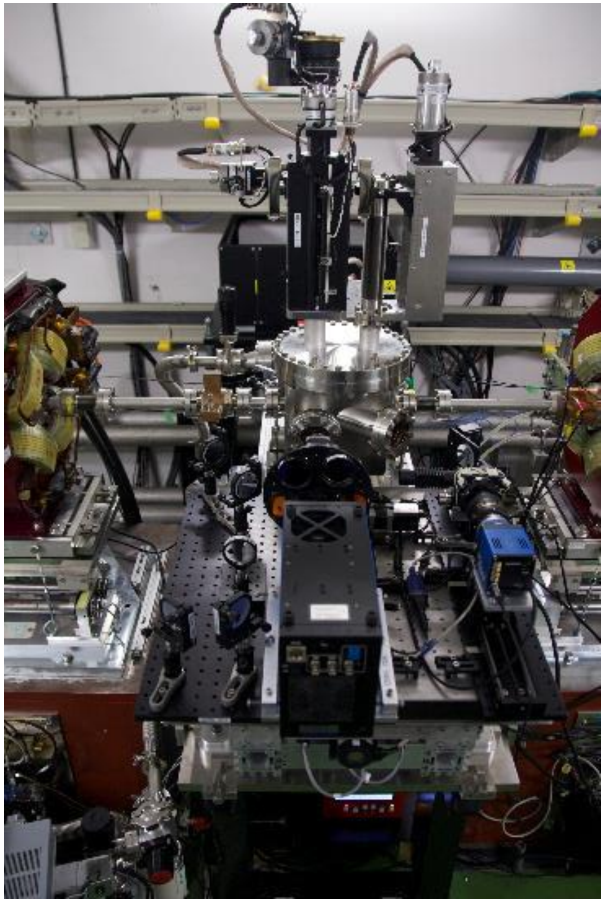


90 degrees
View Port on target
(ODR imaging and far-field)

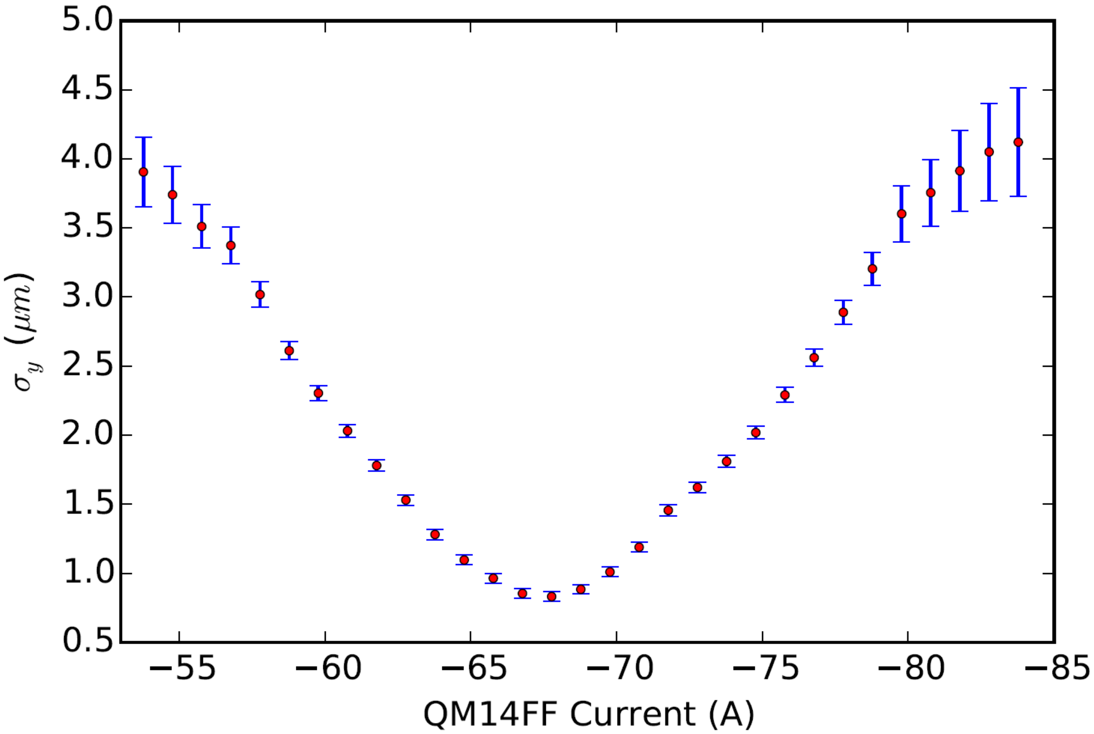
40 degrees
View Port on target
(OTR imaging)

OTR sub-micron measurement

February 2016



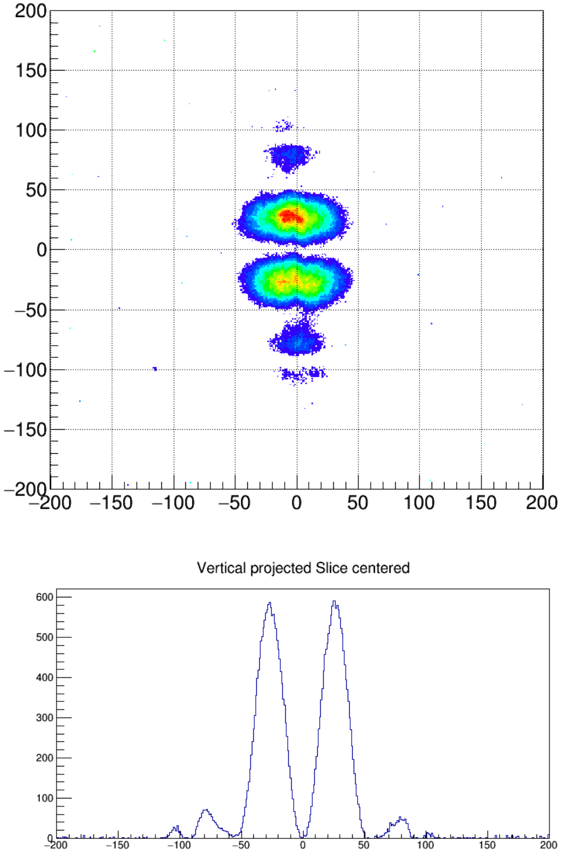
Sub-micron beam size data obtained through measurement of visibility of vertically polarized OTR signal: minimum vertical size **800nm**



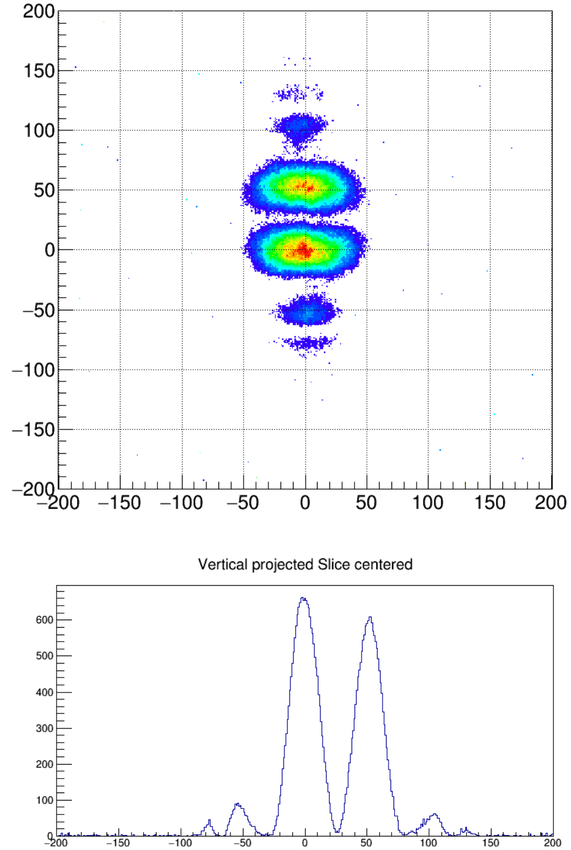
ODR measurement

June 2016

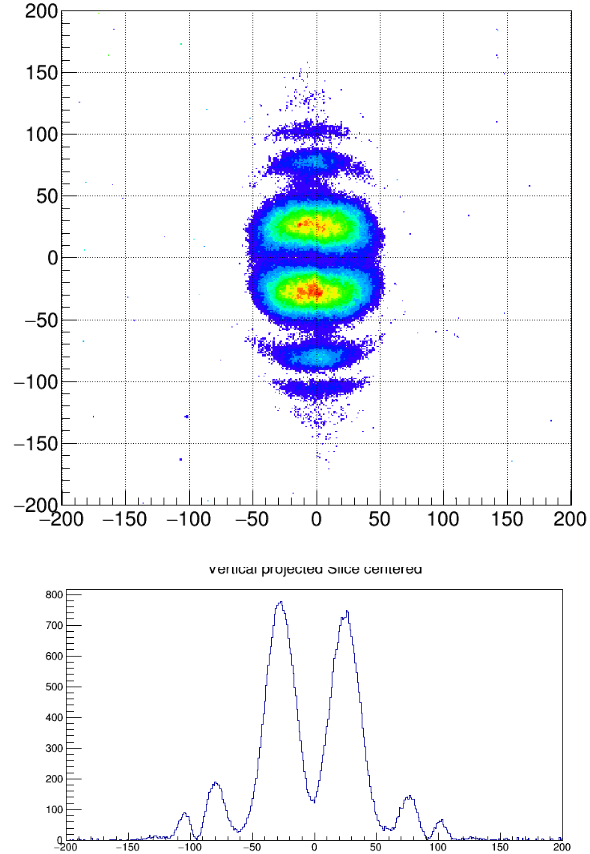
Beam 1um



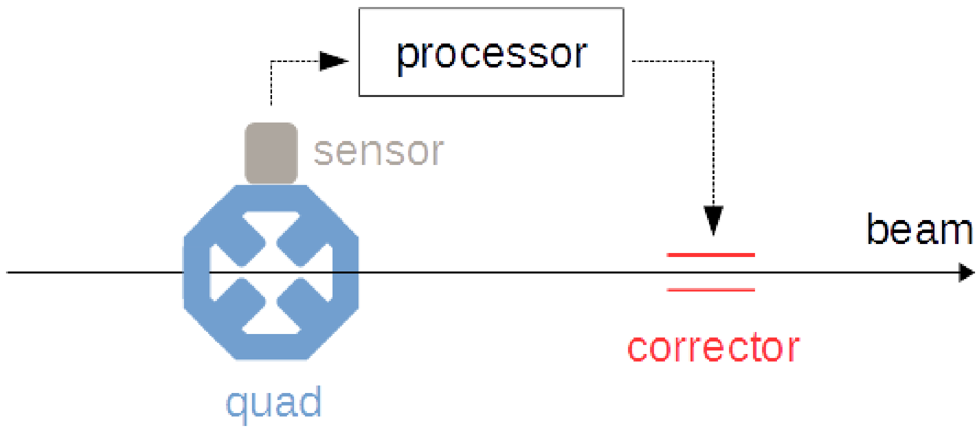
Beam 18 um



Beam 30 um



Ground motion feed-forward



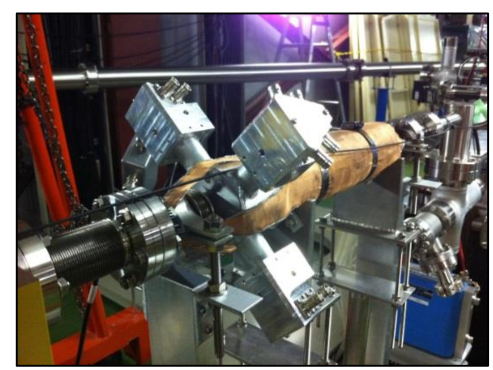
Similar concept to orbit feedback but uses **seismometers** instead of BPMs to drive the correction

- Cheaper than active stabilization systems.
- Correct frequencies out of limits for orbit feedback systems.

seismometers

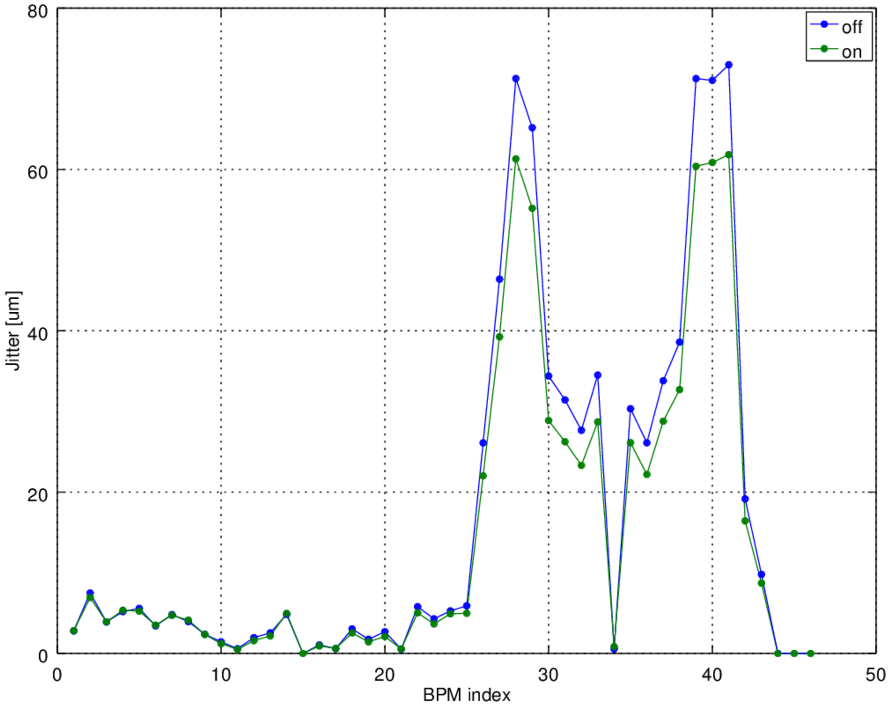
feed-forward processor

stripline kicker



Latest results

First demonstration of ground motion feed-forward: achieved to date a **15%** reduction in beam jitter acting on slow drifts

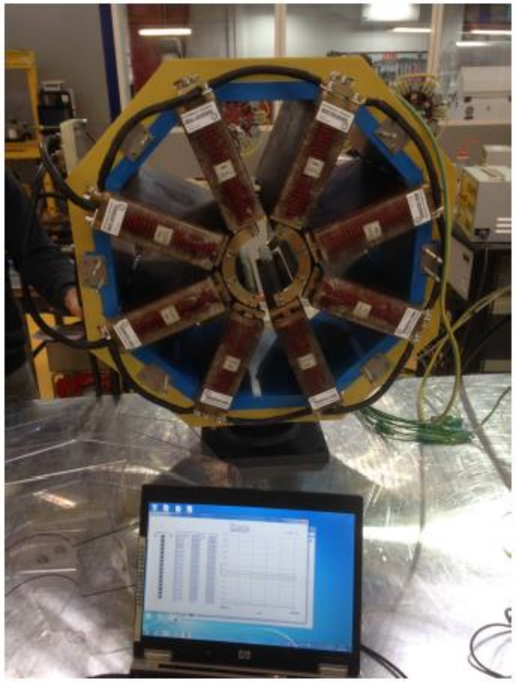


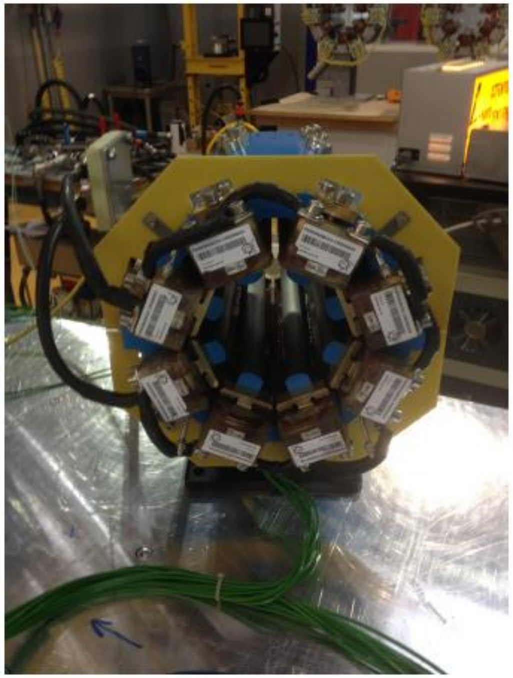
June 2016

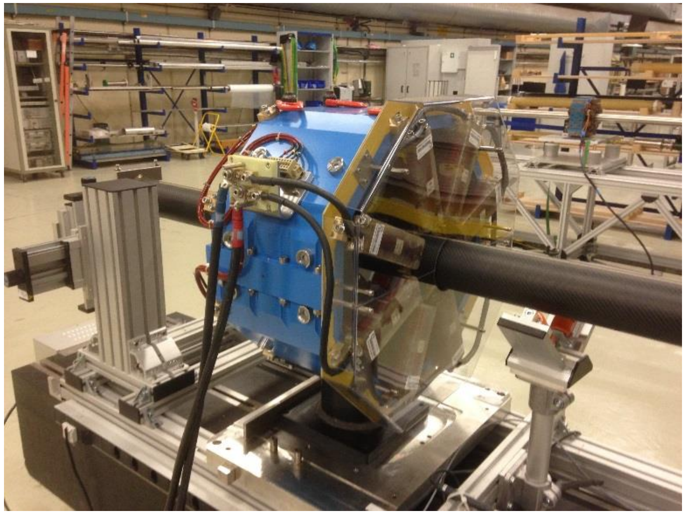
- Demonstrated minimal latency solution of direct communication with FONT5 board allowing for correction of higher frequency vibrations in future
- Latest measurements from ground motion sensors suggest increased noise below 0.8 Hz so the high-pass filter on the feed-forward processor should be updated to reflect this

ATF2 octupoles status

Thanks to Michele Modena







OCTFF2 mounted on Magnetic Measurements bench

- Octupoles assembled and measurements of multipolar field components started this week
- OCTFF1 and OCTFF2 should be installed in ATF2 and ready for operation by October

Conclusion

- ATF2 collaboration continues to work towards the goal of 37 nm beam size
- CERN work progresses in several areas:
  - Ultra-low β* (including octupoles)
  - Energy acceptance measurement
  - OTR/ODR
  - Ground motion feed-forward
- In discussions to host ATF2 Project Meeting at CERN in Early 2017