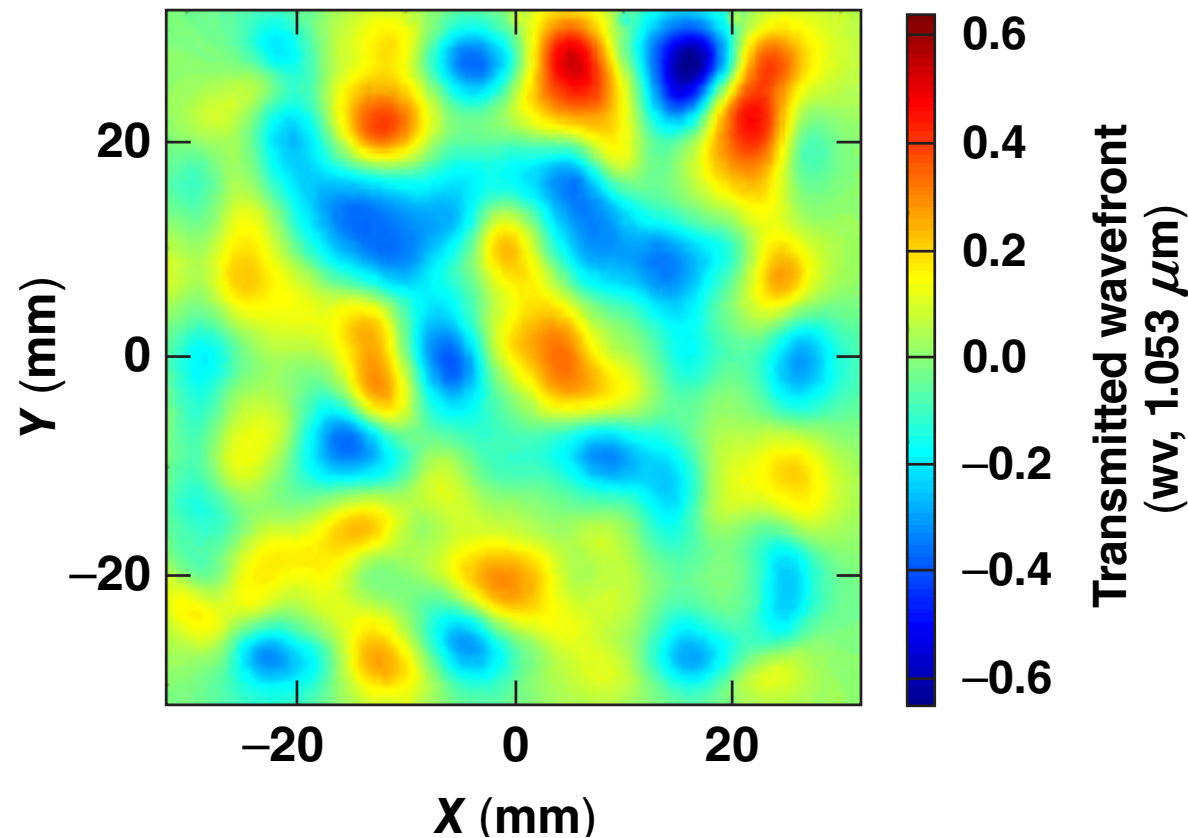


Static Wavefront Correction on OMEGA EP



Beam 2 static corrector wavefront specification



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Summary

A static wavefront corrector (SWC) will be implemented in the OMEGA EP beamlines to improve wavefront correction



- **Static, high-order wavefront in the OMEGA EP beamlines uncorrectable by existing deformable mirrors will be statically corrected**
- **A prototype static corrector was successfully tested on Beamline 2**
 - **~2× improvement in the focal spot radius at the output of the beamline was achieved**
 - **peak intensity was improved by 2 to 3×**
- **The static wavefront corrector will be installed first on Beamline 2 in Q4 2011, with other beamlines to follow as wavefront data becomes available**

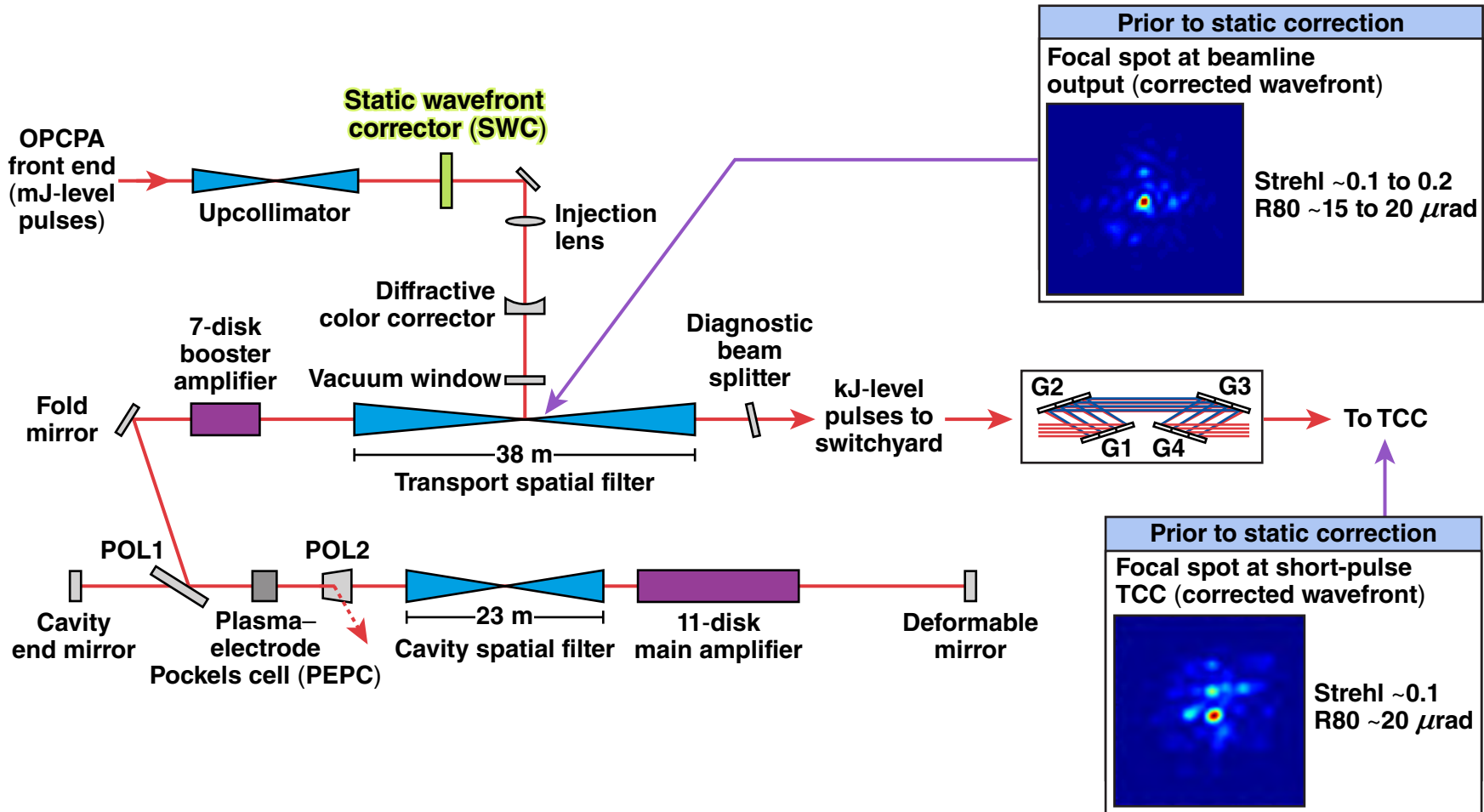
There are three major limitations to wavefront correction in the OMEGA EP beamlines



- **Sub-optical wavefront control system setup, calibration, or referencing**
 - mitigated procedurally
- **Wavefront drift during the delay between stopping DM correction and shot**
 - being mitigated by Late-Cycle Correction improvement to WCS
- **Limitations imposed by spatial-frequency response of the deformable mirror (“fitting error”, or “DM-limited wavefront correction”)**
 - being mitigated by static wavefront correction

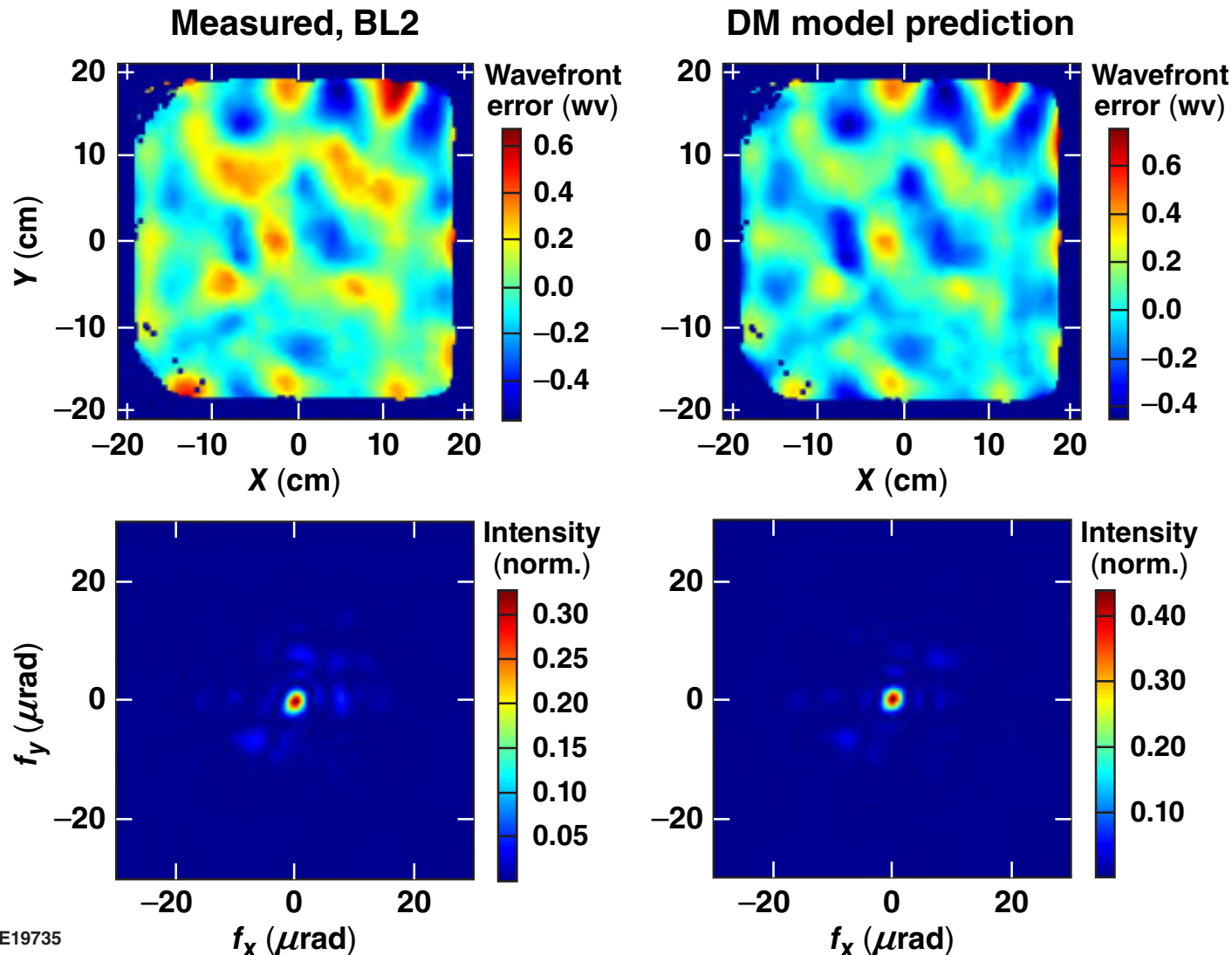
Static wavefront correction is one component of the overall plan to improve the wavefront quality achievable by our existing wavefront control system.

Static wavefront correction will be used to optimize wavefront performance of the IR beamlines



The static wavefront corrector will compensate wavefront errors only in the IR beamlines (not compressor or UV sections).

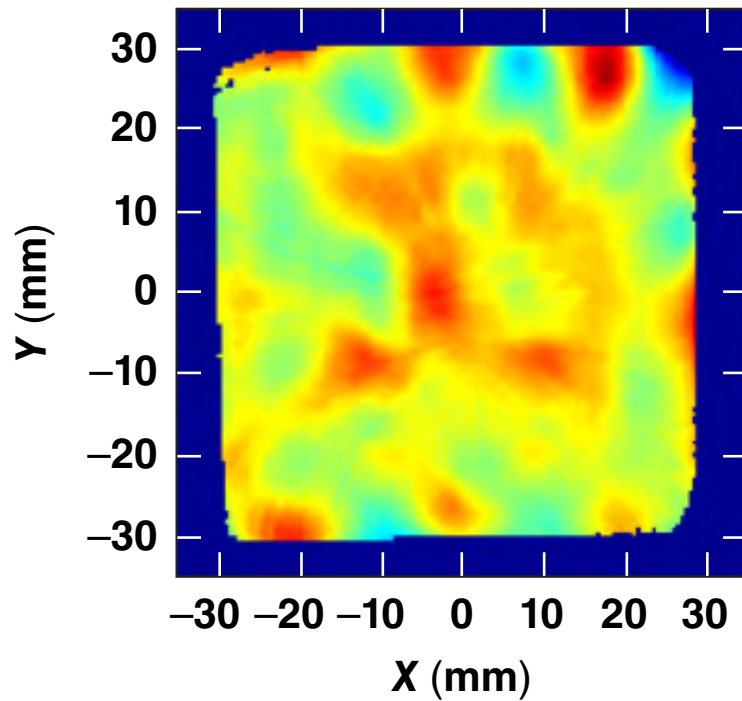
When the wavefront control system is optimized and actively correcting, wavefront performance is nominally limited by the DM



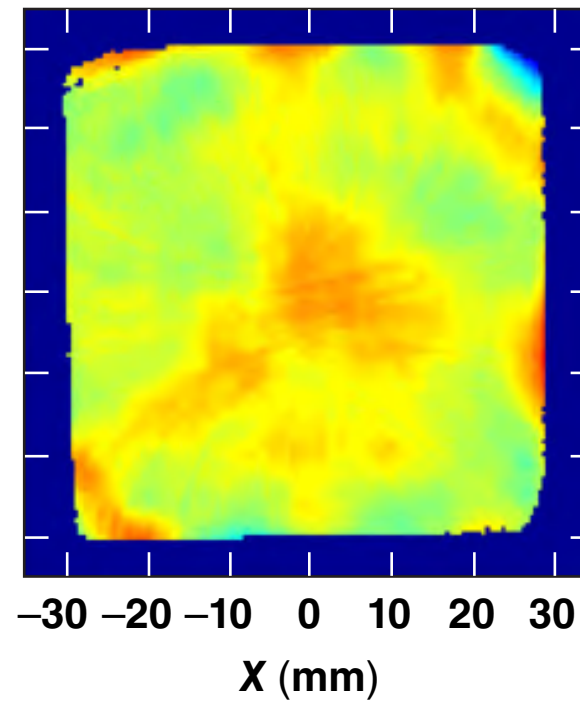
Modeling confirms that the DM simply cannot “make” the shape required to correct this component of the wavefront error.

The uncorrectable residual wavefront has been stable for over one year

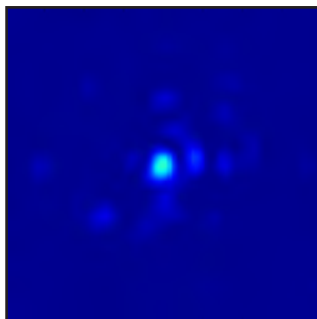
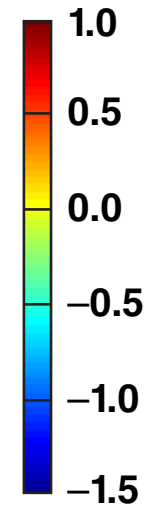
Measured wavefront (6/17/09)



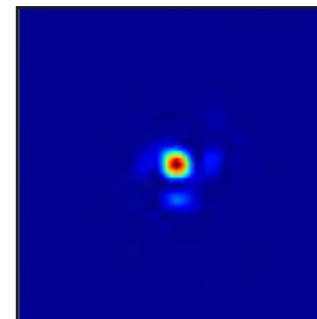
Static corrector applied



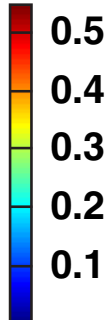
Wavefront error (wv)



Simulated focal-spot intensities, 40- μ rad field-of-view, identical color scales



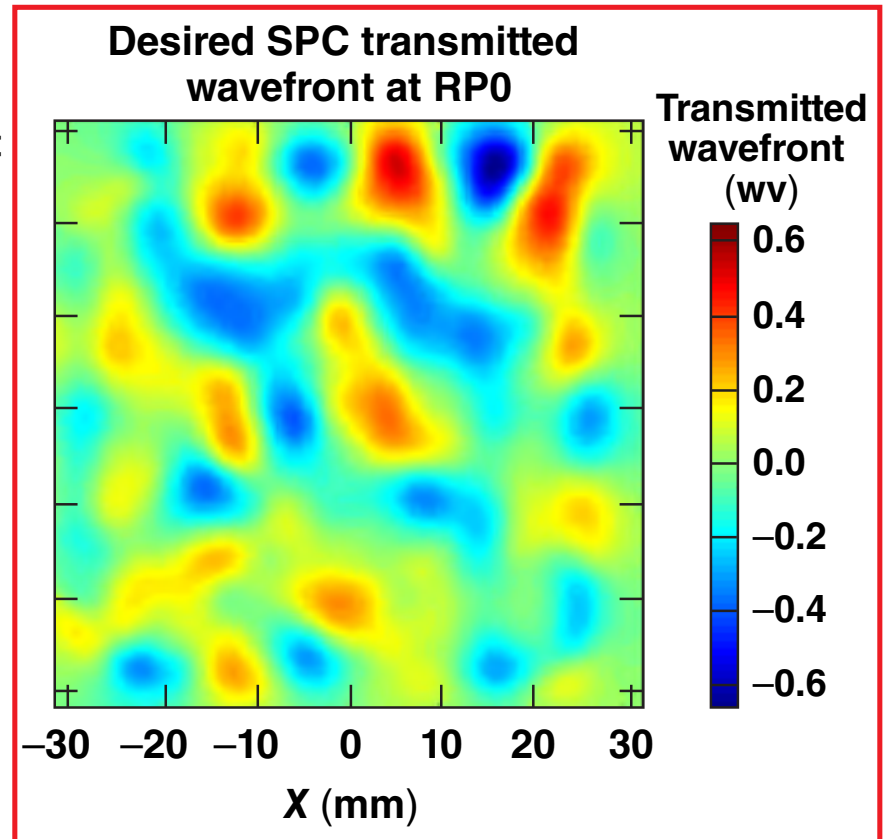
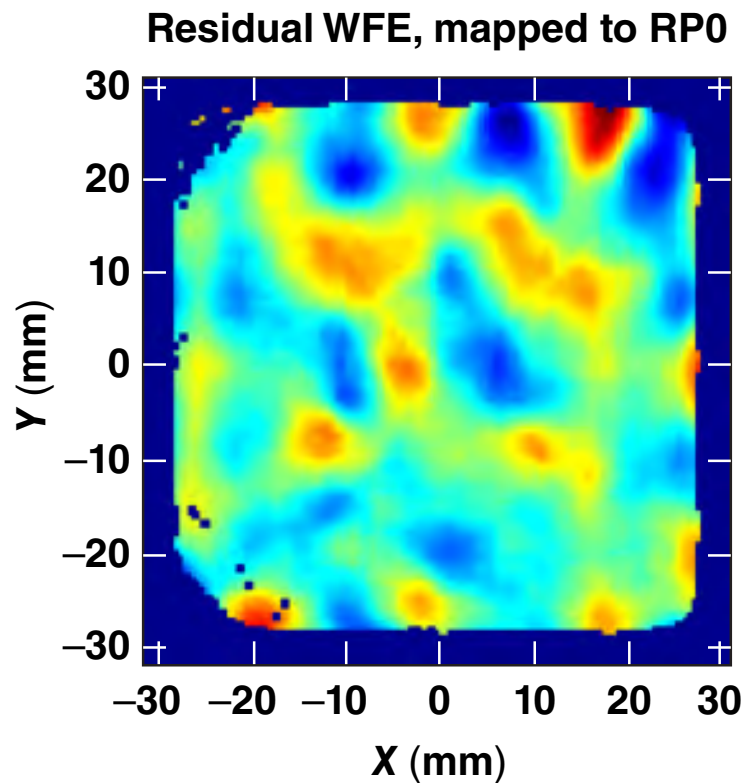
Focal spot intensity (norm. by peak diffraction-limited)



0.5
0.4
0.3
0.2
0.1

This vertical color scale maps normalized focal spot intensity from 0.1 to 0.5. The colors transition from dark blue at 0.1, through cyan, green, yellow, and orange to dark red at 0.5.

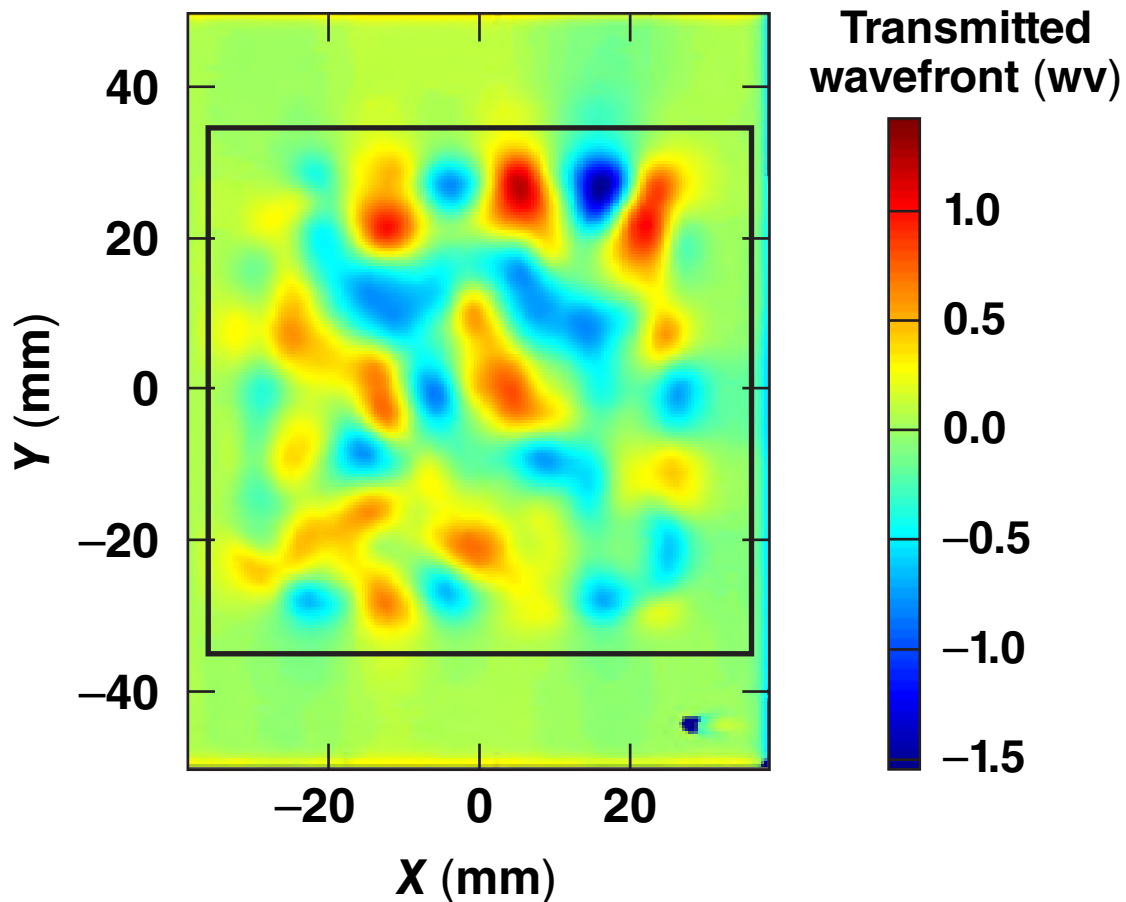
The designed correction phase is the inverse of the measured DM-limited residual wavefront error



Note that these have been oriented and scaled to the RP0 plane, looking from the incident side of the optic.

A prototype static wavefront corrector was designed, procured, and tested on Beamline 2

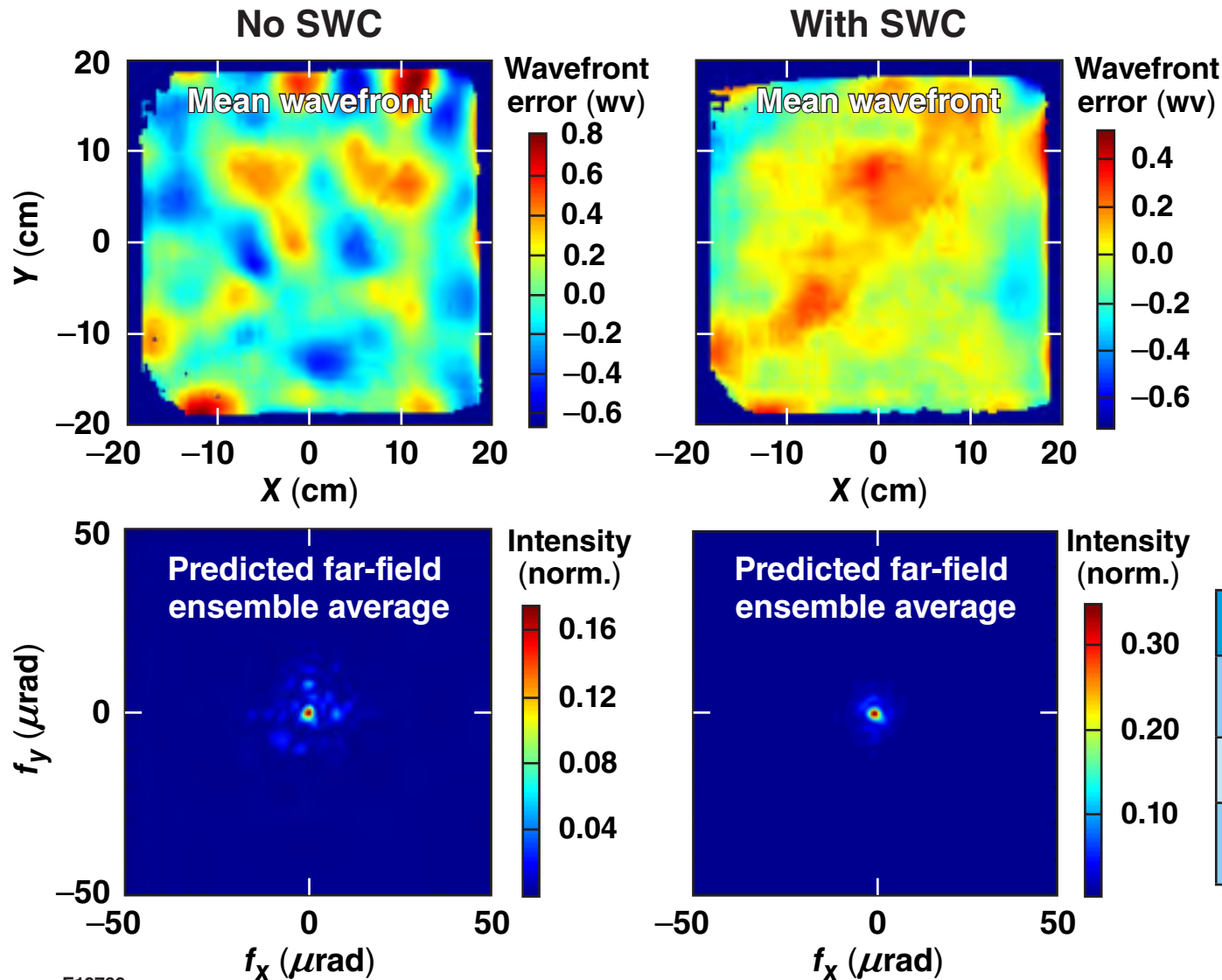
Interferometry provided by QED



Part was fabricated by
QED Technologies, Inc.
using MRF polishing

Sol-gel coating and
mounting provided
by OMAN

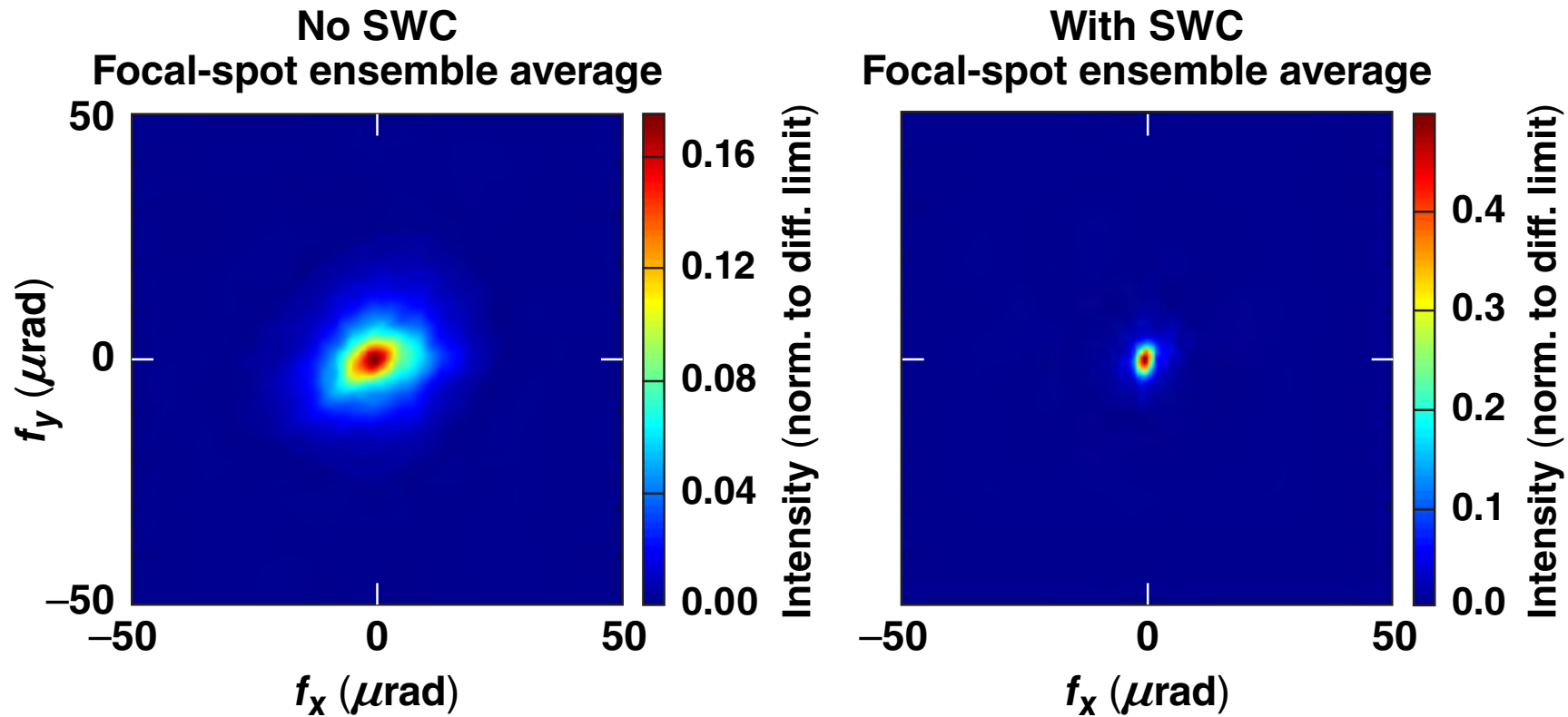
An $\sim 2\times$ improvement in R80 and Strehl ratio was observed using the prototype corrector



Results from a series of 50 measurements acquired while wavefront was actively corrected

	Before	After
WFE	0.213 wv	0.123 wv
<Strehl>	0.17	0.35
<R80>	16.8 μ rad	9.2 μ rad

The results were confirmed with direct measurements using the beamline output far-field CCD on the IRDP table



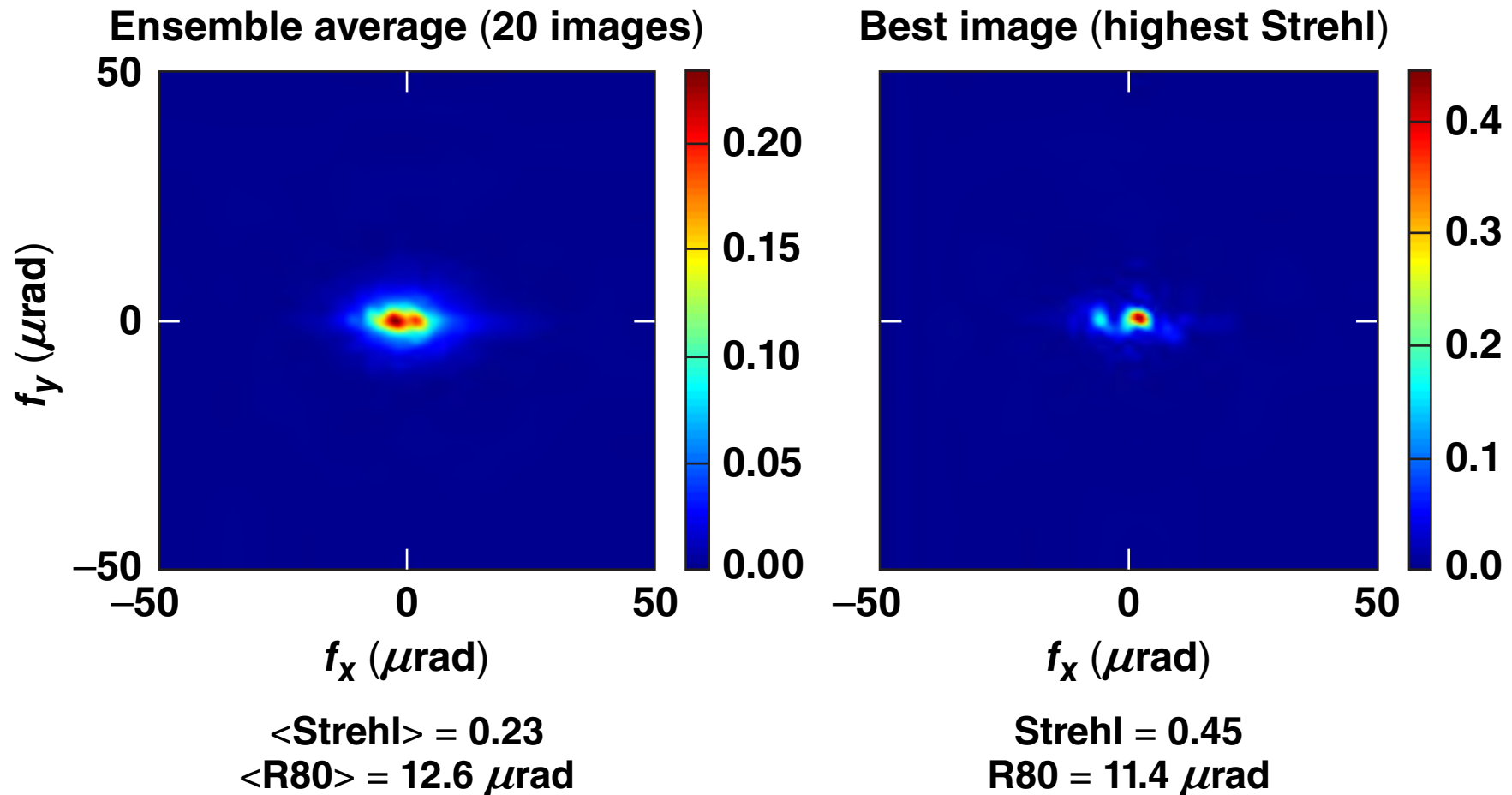
Ensemble averages of ten images. Pointing variation was removed before ensemble averaging.

Note that a direct comparison with the same source was not possible due to source availability.

	Before	After
<Strehl>	0.17	0.50
<R80>	16.6 μrad	8.7 μrad

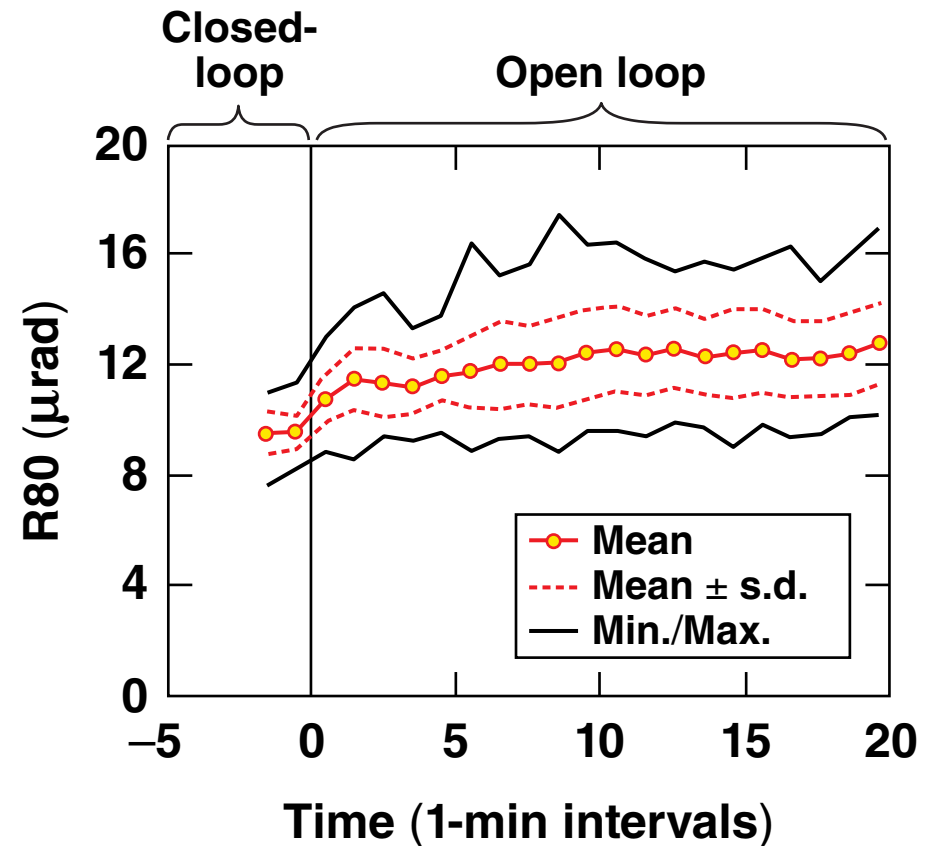
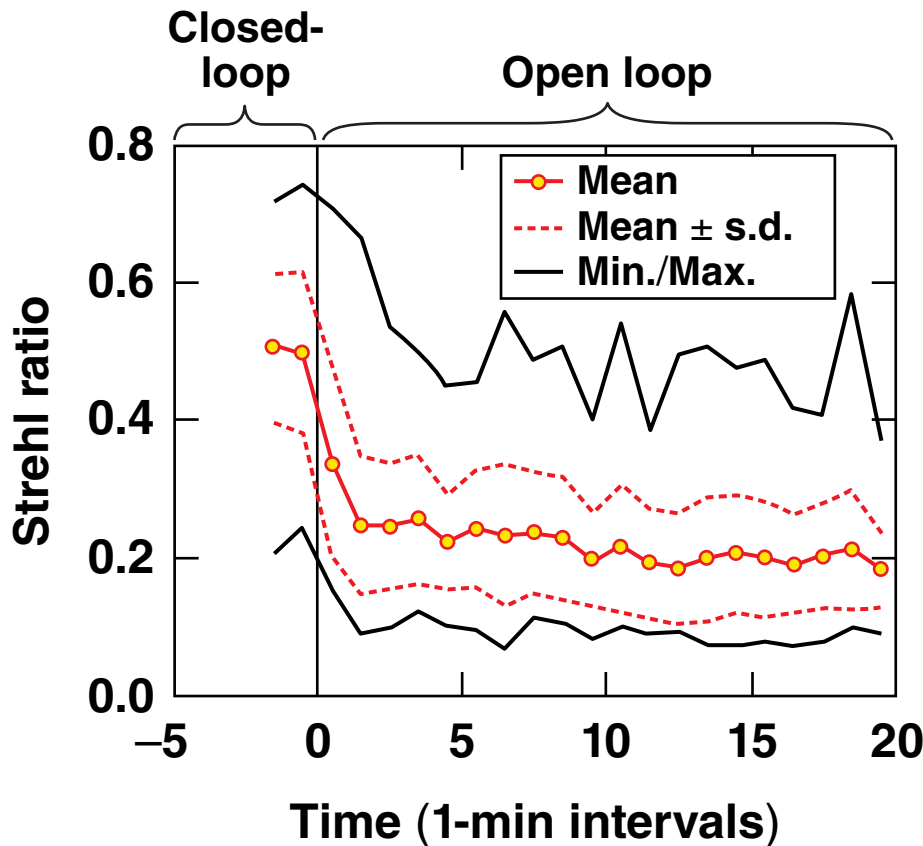
Improved focal spots were observed at the output of the compressor with the prototype SWC installed

Upper compressor far-field CCD data



Focal spot repeatability will be characterized as part of system testing.

Focal-spot improvements were only modestly maintained after WCS correction was stopped



Repeatable improvements in on-target intensity will also require correction nearer to shot time (“Late-Cycle Correction”).

Static wavefront correctors will be deployed starting in Q4 2011



- **Beamline 2: static wavefront corrector to be deployed in Q4 2011**
 - final design review completed in April 2011
 - procurement of Beam 2 corrector optic is underway
 - installation requires an appropriate window in the Facility schedule
- **Beamlines 1, 3, and 4: static wavefront correctors will be deployed in FY12**
 - high-resolution wavefront sensors must be deployed on these beamlines to acquire data needed for SWC specification
- **Late-cycle correction is progressing in parallel, with activation expected in FY12**

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