



Micron Size Laser-Wire System at the ATF-II Extraction Line (status report)

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Introduction

- ATF Laser-wire summary
- Review of EXT-LW ATF-2 upgrade
 - Hardware
 - Laser Transport Line
 - Alignment
 - OTR monitor
 - DAQ
- Recent results
 - LW electron beam optics test + Background study
 - OTR monitor test
- Upgrade status and plans

ATF Laser-wire summary

- Prediction for $W_{in}=8.5\text{mm}$ is $W_0=2\sigma=3$ micron
- Measured minimum size
 - 3.7 micron
- Laser properties
 - $M^2 \sim 1.5$
- Astigmatism, 60 degrees
- So putting all together
 - 1.5 micron (lens) x 1.5 (M^2) x 1.5 (Astigmatism) = 3.4 micron
- Roughly consistent, need work on the laser!

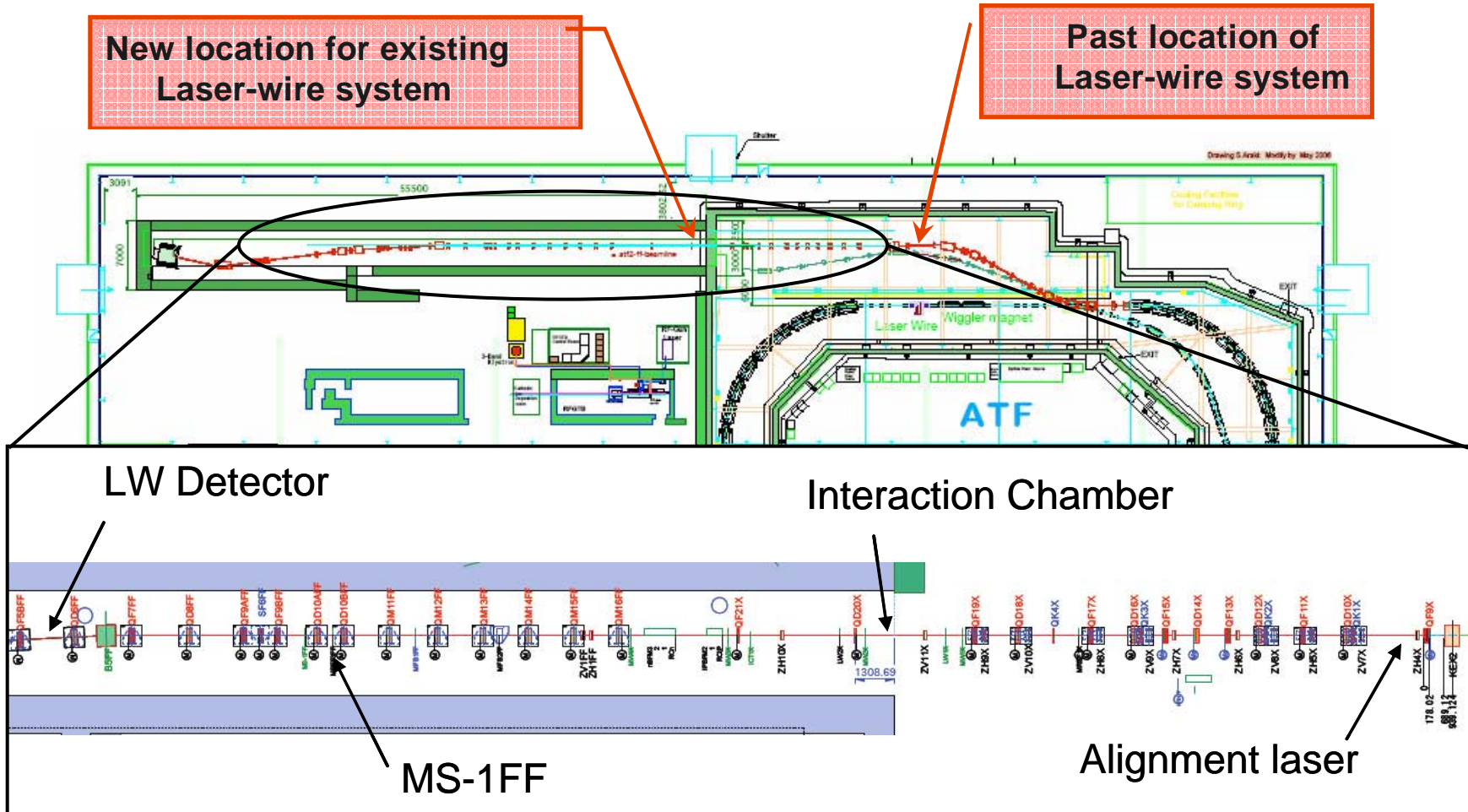
Review of ATF-II upgrade

- Interaction chamber relocation
- Alignment laser installation
- Transverse beam size cross-check OTR monitor
- Detector relocation
- Laser Transport Line (LTL) simulation & design
- Laser diagnostics upgrade
- DAQ upgrade
- Laser relocation and upgrade: mode quality improvement aiming to archive 1 μm resolution.

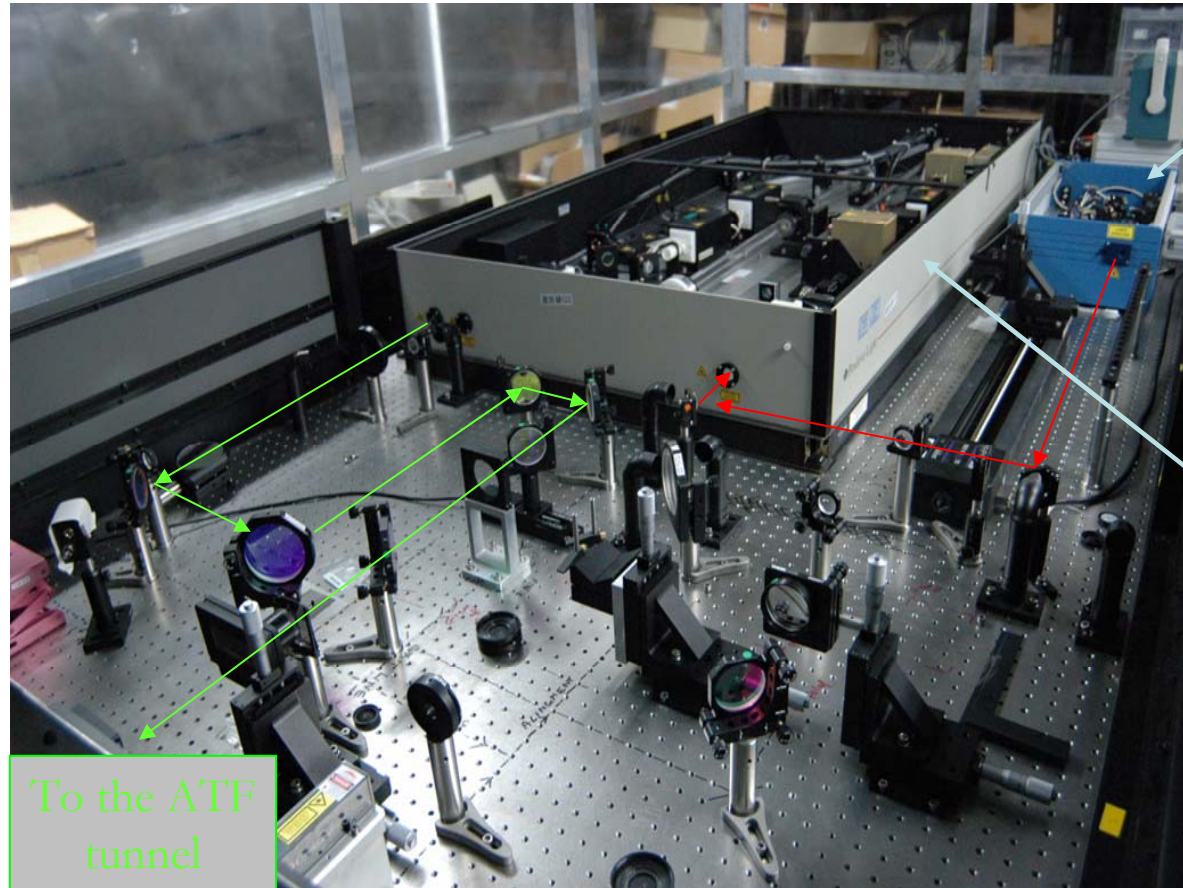
General Aims:

- Robust laser diagnostics (+ major laser diagnostics out of the tunnel)
- Upgradeability:
 - Second scanning axis or changing of scanning angle
 - Second IP
- Automation

ATF-II Laser-wire system

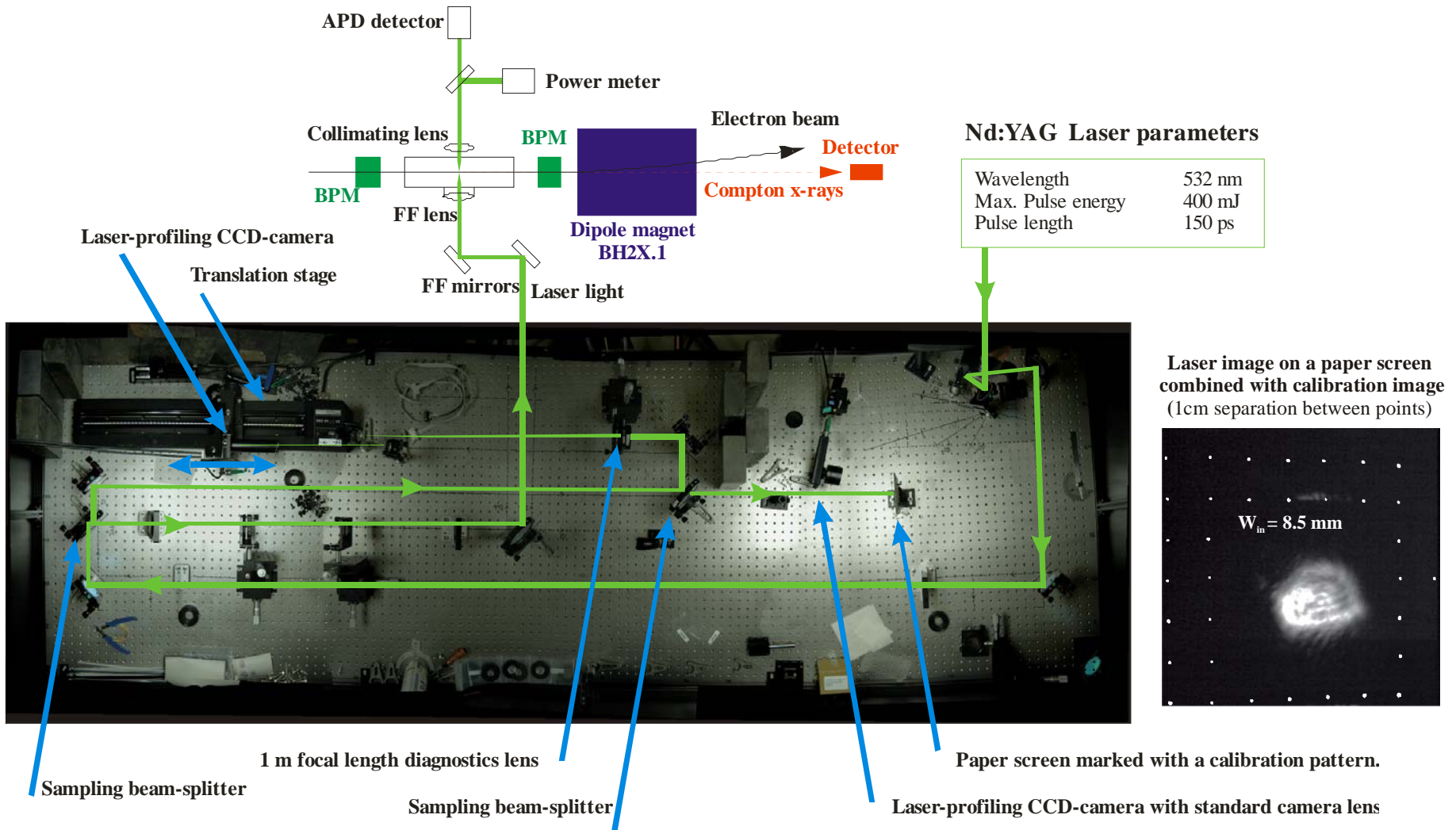


High power Laser system



- 357MHz Mode locked seed laser
pulse length 30ps,
average power
~600 mW
- Nd:YAG
regenerative
amplifier and
linear amplifier:
pulse duration
300 ps
max pulse energy
~400 mJ

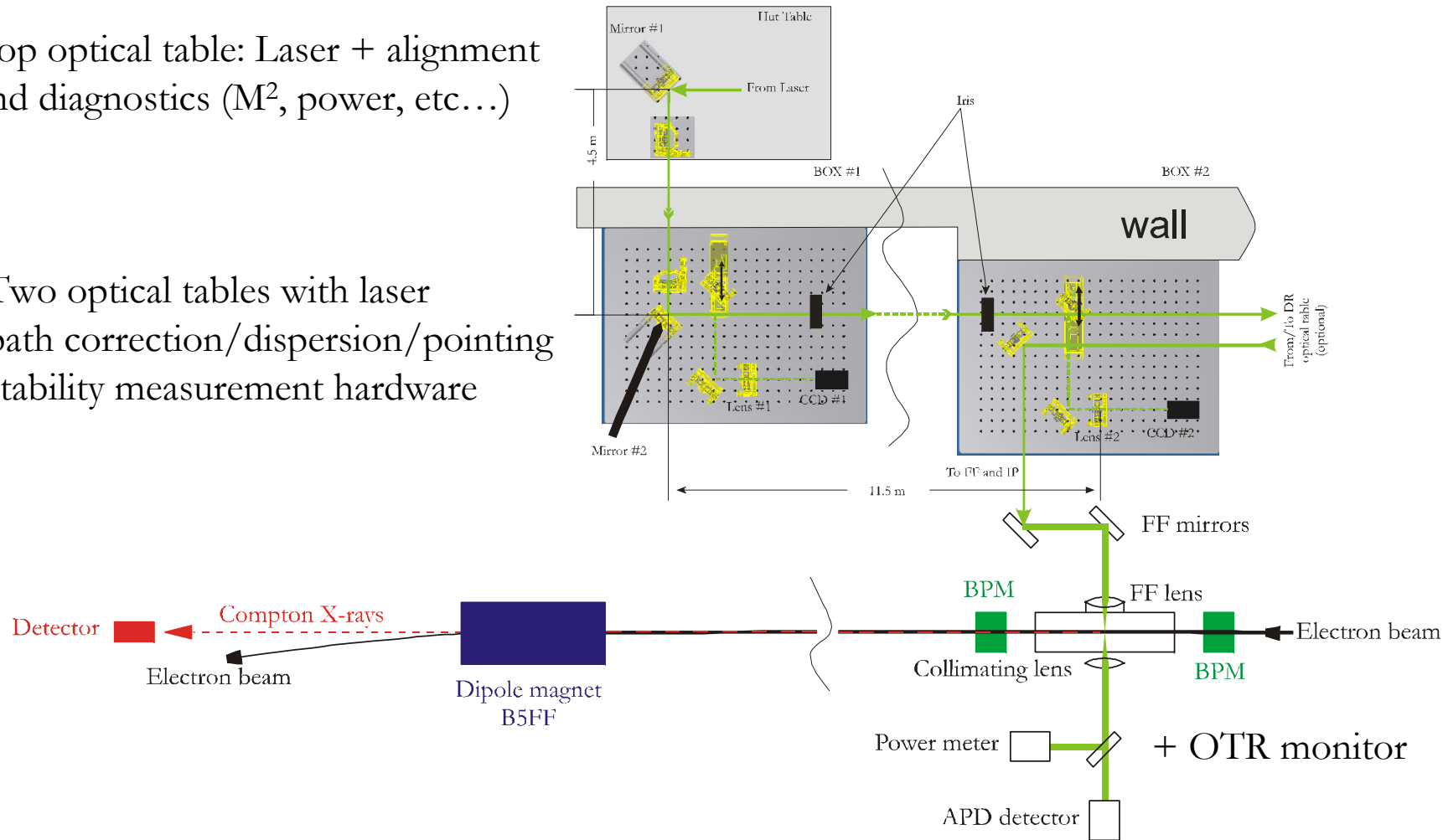
ATF Interaction Point hardware



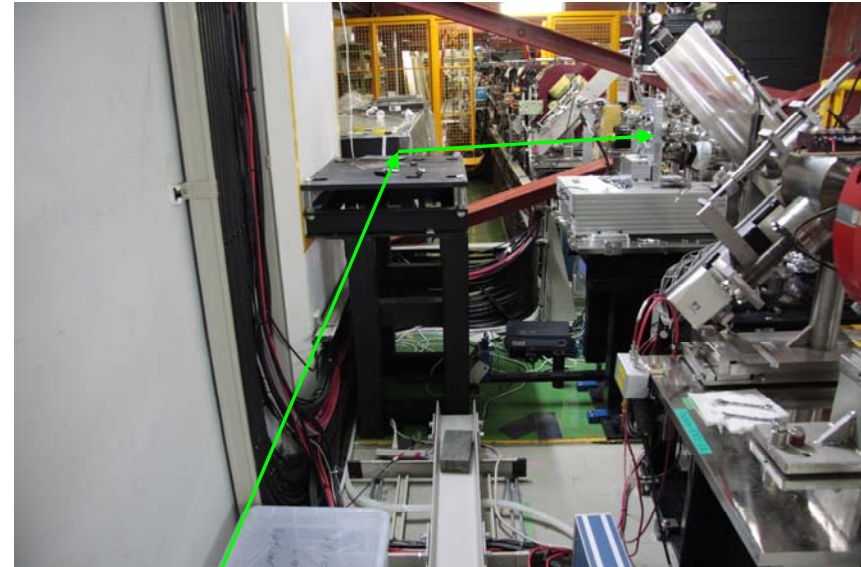
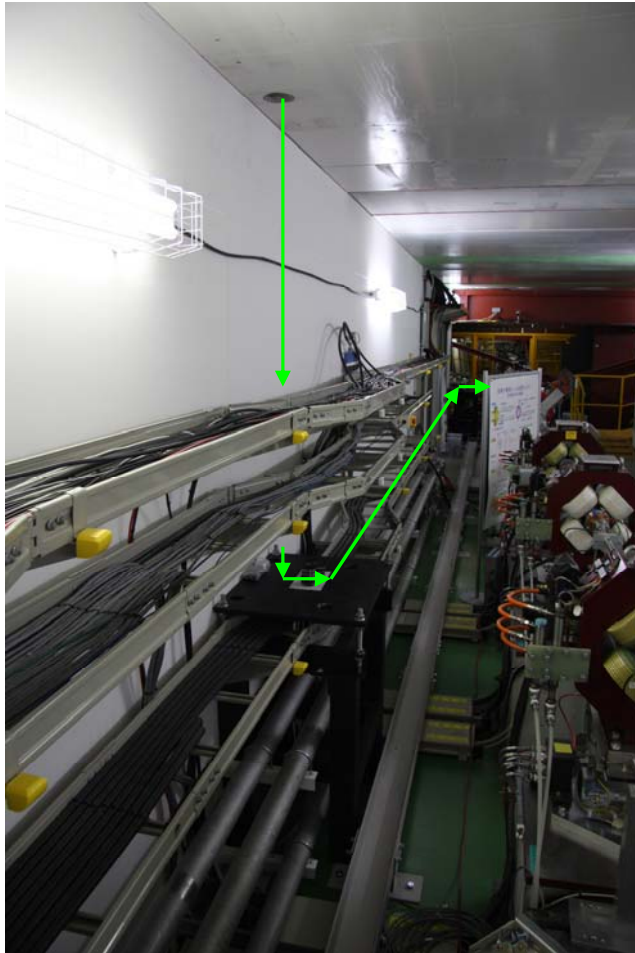
ATF-II Laser transport line and Interaction Point hardware

Top optical table: Laser + alignment and diagnostics (M^2 , power, etc...)

Two optical tables with laser path correction/dispersion/pointing stability measurement hardware



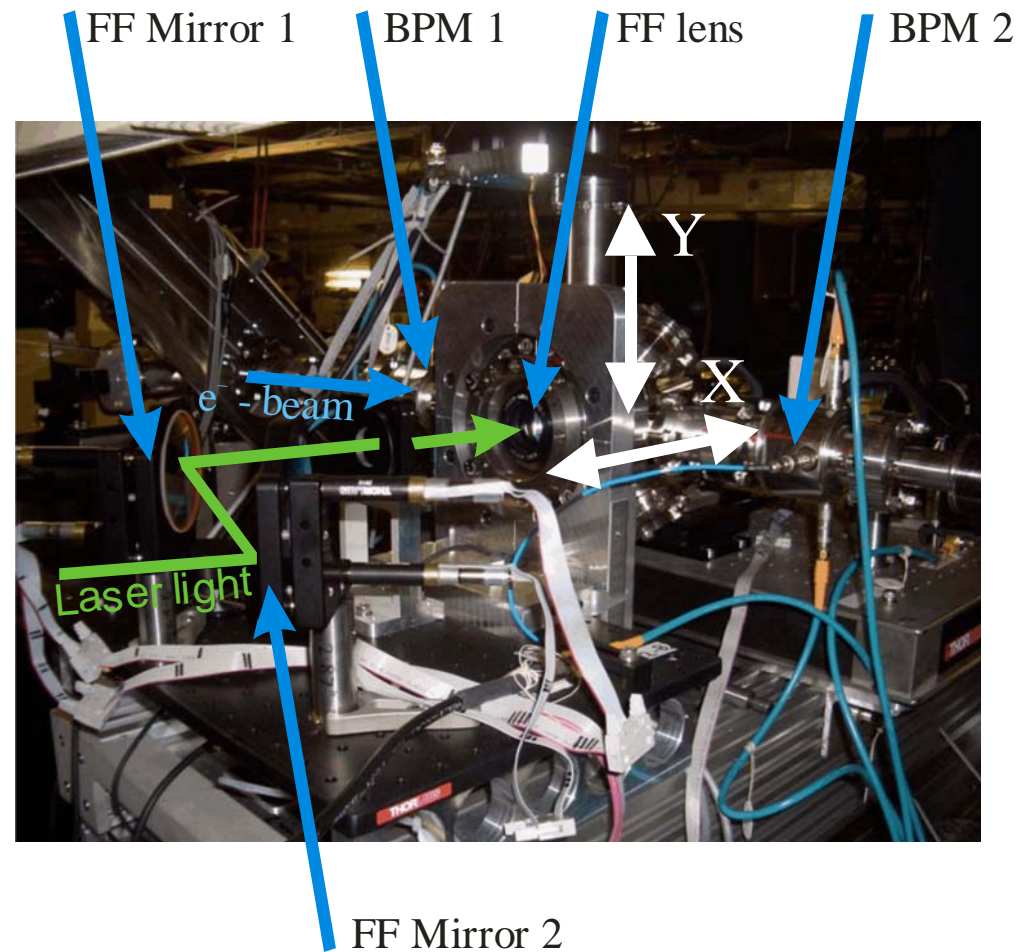
ATF-II Laser transport line



Left – first LTL optical table

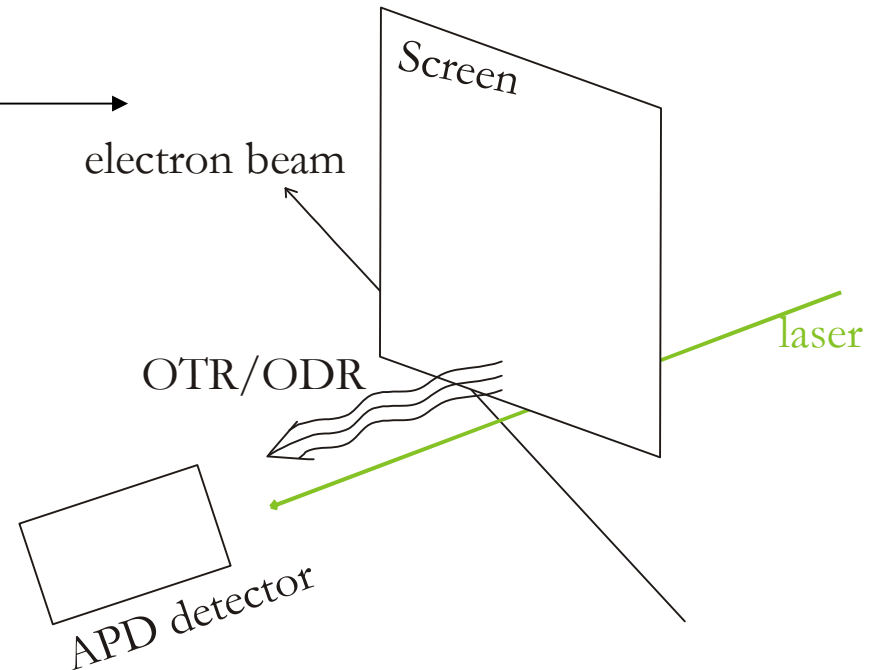
Top – Second LTL optical table + IP

IP chamber with two final steering mirrors and FF lens.

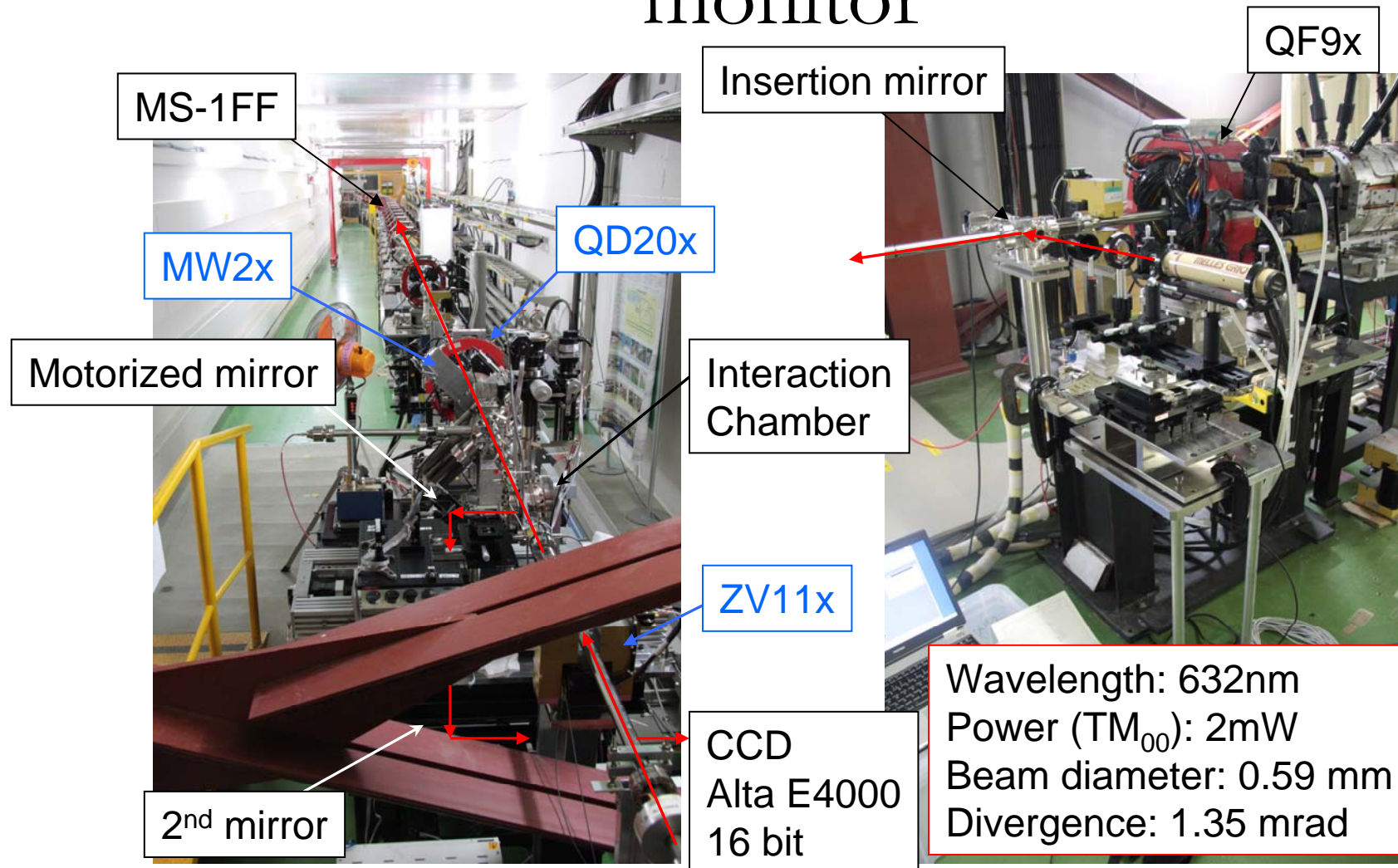


LTL and IP alignment

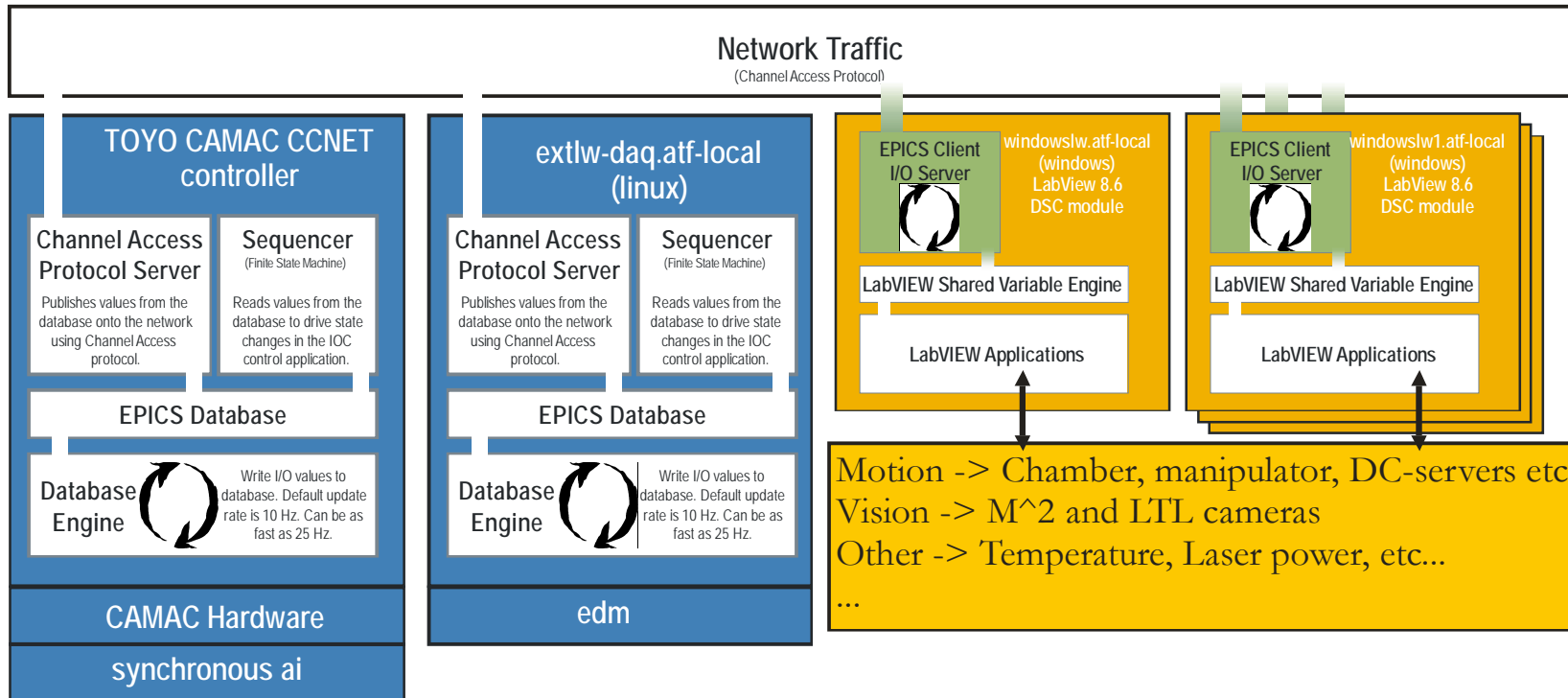
- Beam line alignment laser
 - OTR/timing screen
 - OTR path
- Laser line alignment laser
 - Primary laser path
 - Laser diagnostics path
 - FF optics
 - Post IP optics



Beam line alignment laser and OTR monitor



LW DAQ

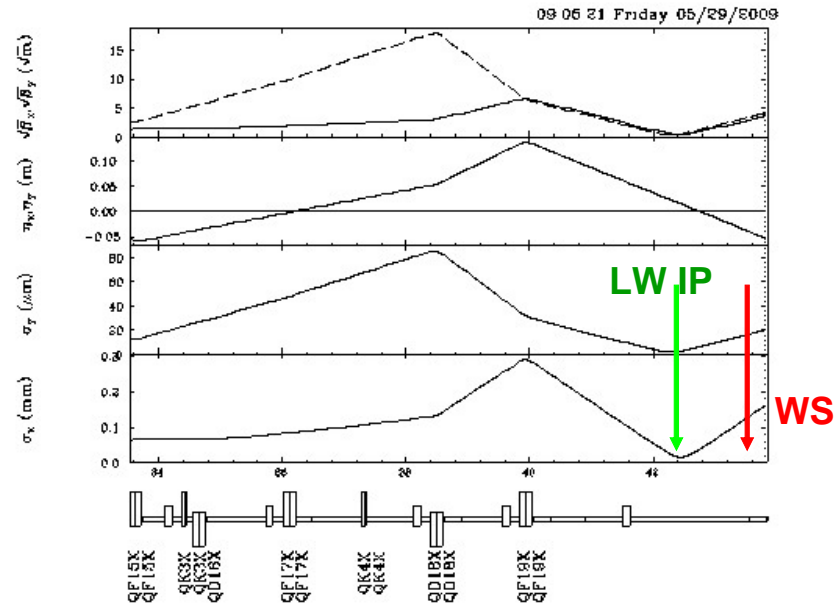


- Easy to extend (in principle we can add any number of PC's).
- All data is synchronous.
- All ATF-II extraction line parameters and controls are accessible.

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LW electron beam optics test



Magnets:

QD14x

QF15x

QD16x

QF17x

QD18x

QF19x

} magnets were used to tune the waist position

- Predictions:

at LW IP

at MW2X

$$\sigma_x = 20\mu\text{m}$$

$$20\mu\text{m}$$

$$\sigma_y = 1.7\mu\text{m}$$

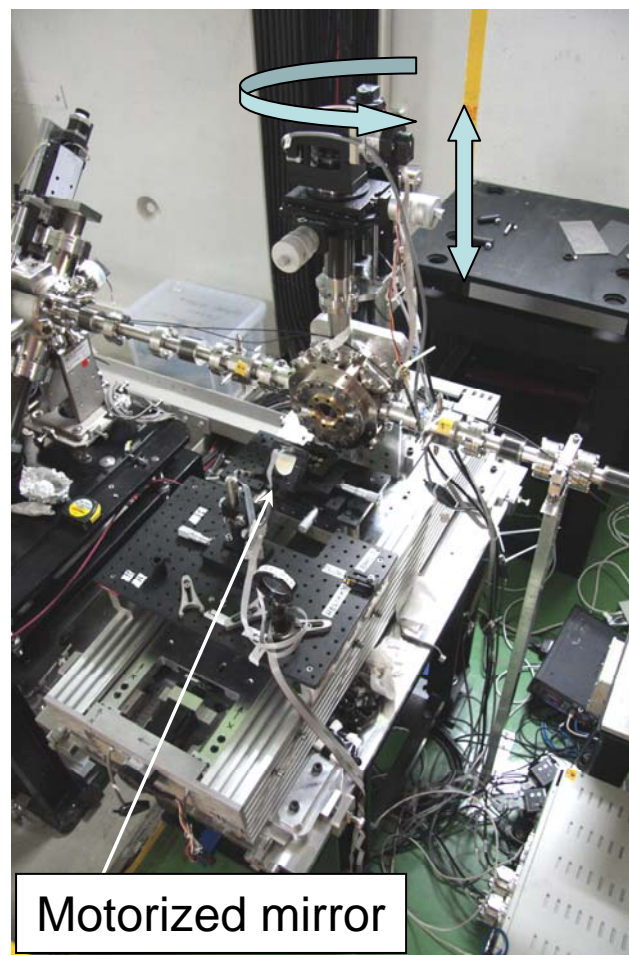
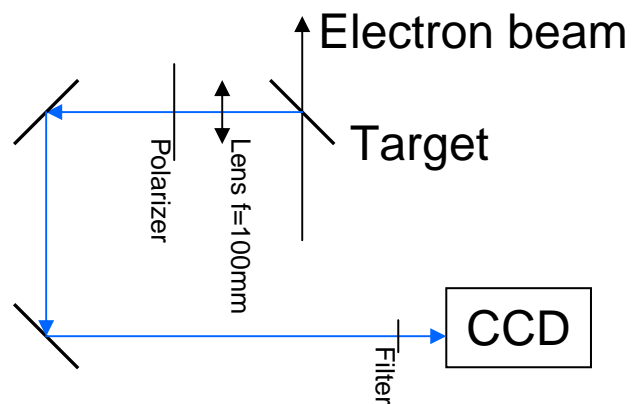
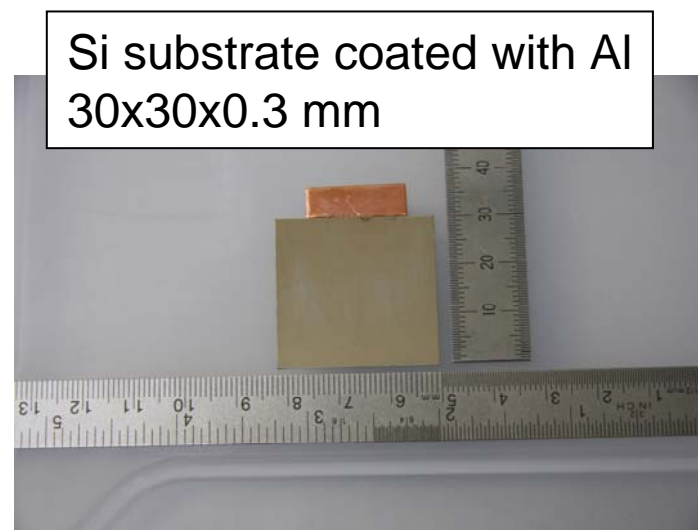
$$2.3\mu\text{m}$$

- Measurements at MW2X

$$\sigma_x = 30\mu\text{m}$$

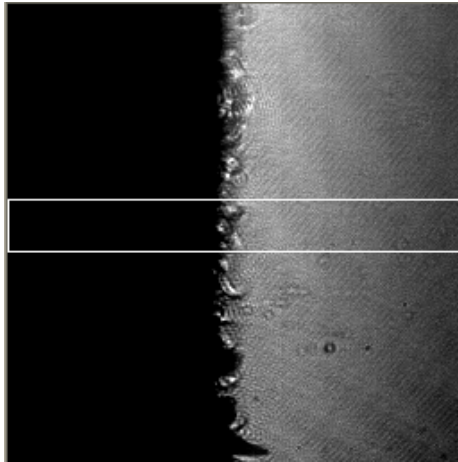
$$\sigma_y = 3.4\mu\text{m}$$

Interaction Chamber, OTR monitor test

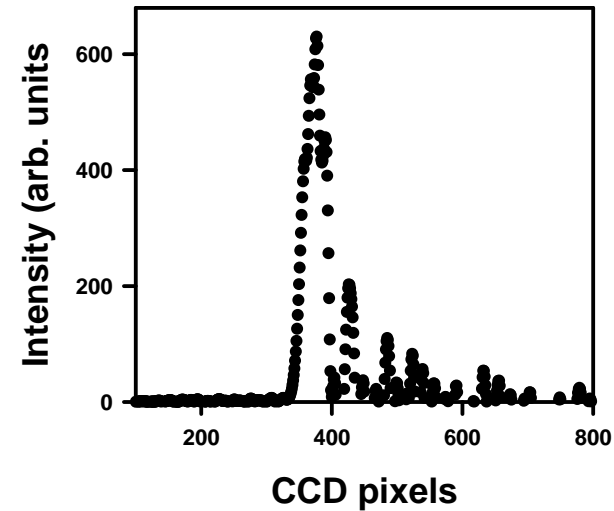


Calibration of the optical system

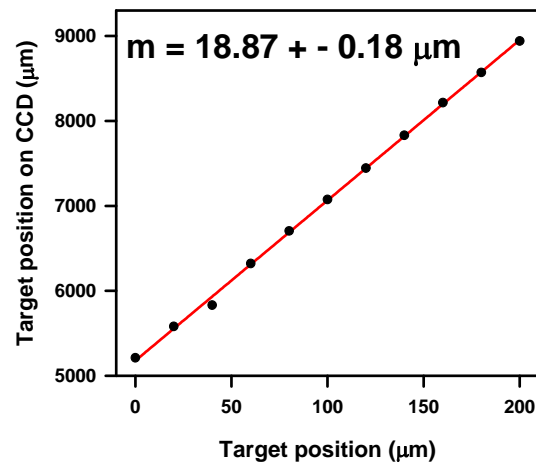
CCD Image of the target edge



Differentiated slope

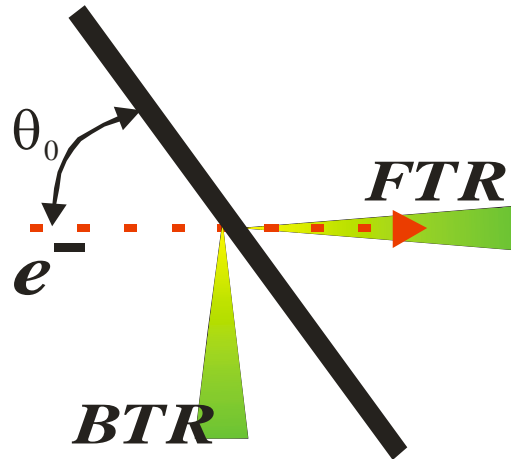


Calibration Curve



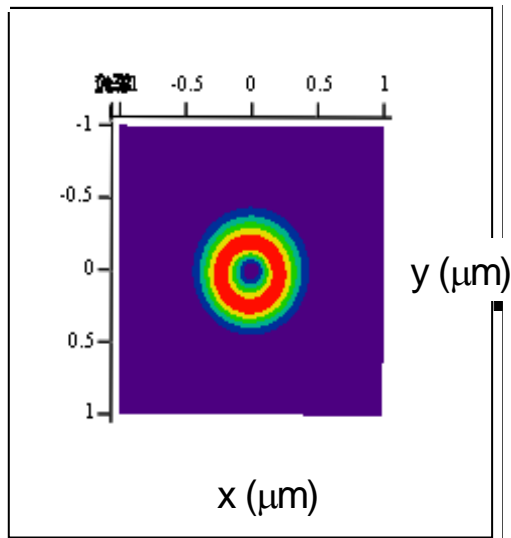
Magnification factor of an optical System 18.87

Optical Transition Radiation

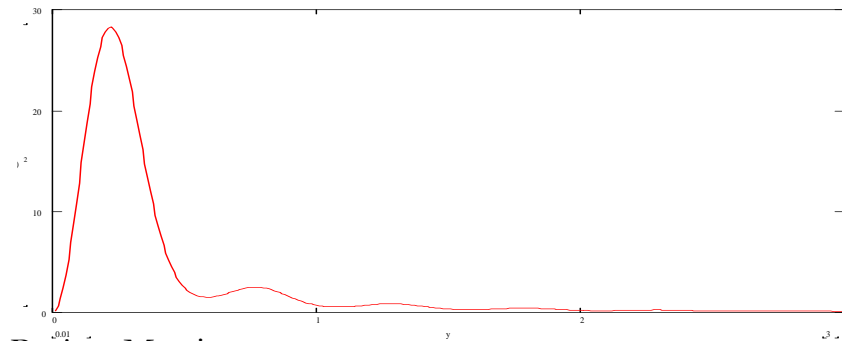


Transition radiation (TR) appears when a charged particle crosses a boundary between two media with different dielectric constants.

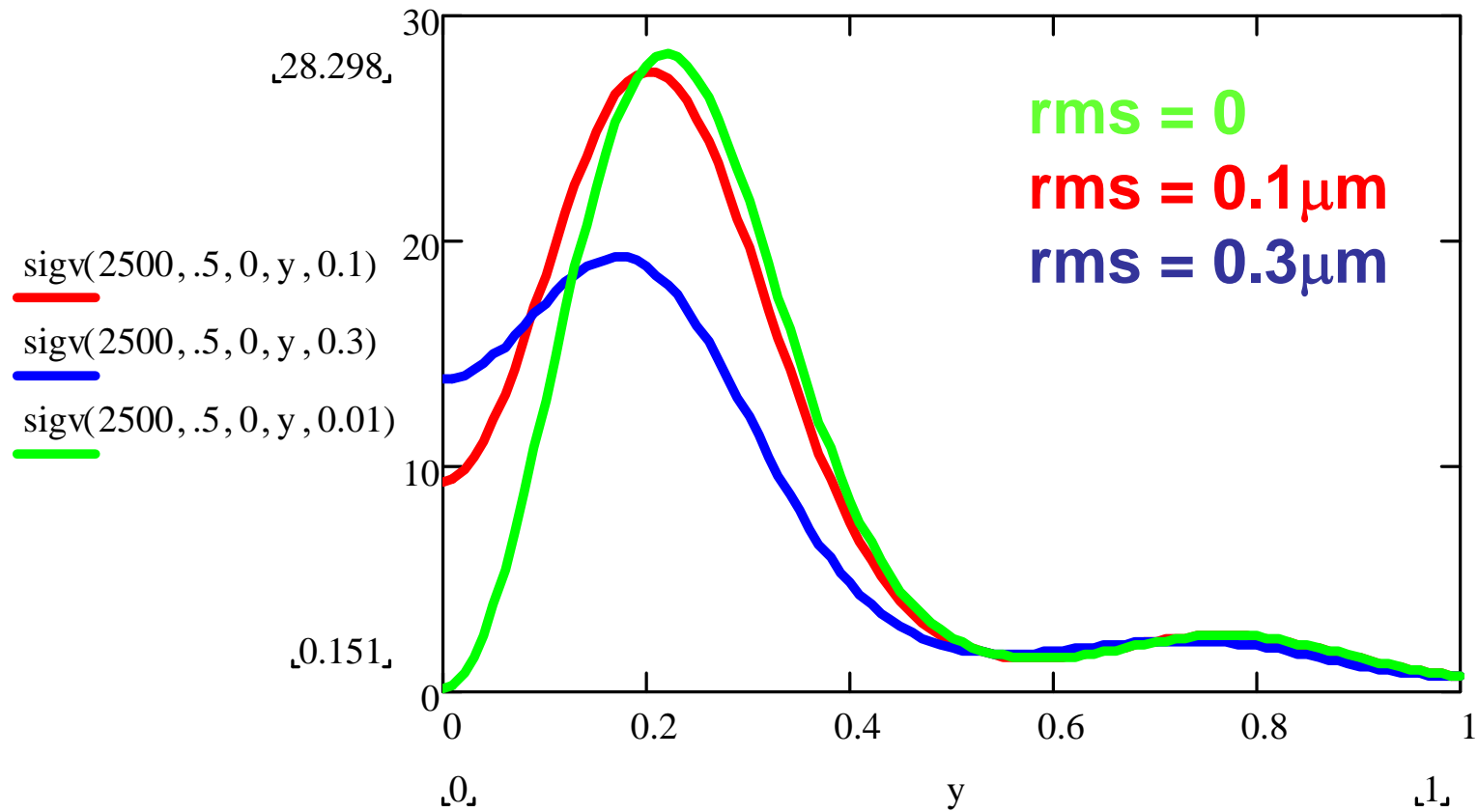
The resolution is determined by the source dimensions induced by a single particle plus distortion caused by the optical system (diffraction of OTR tails)



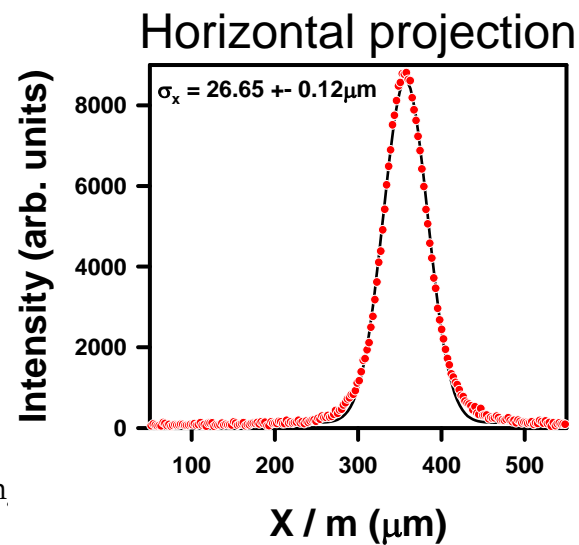
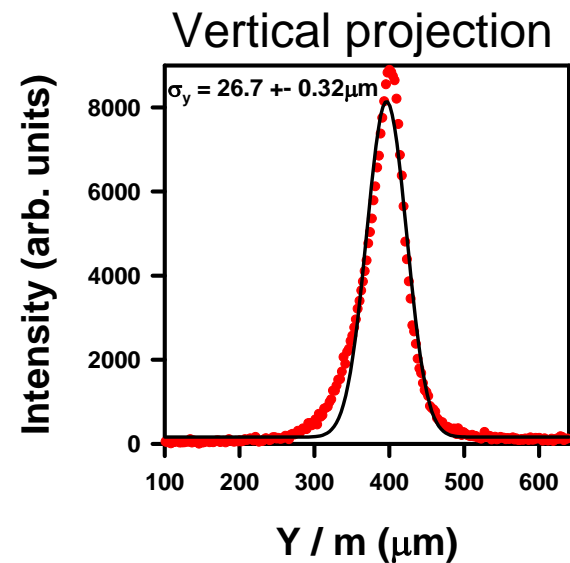
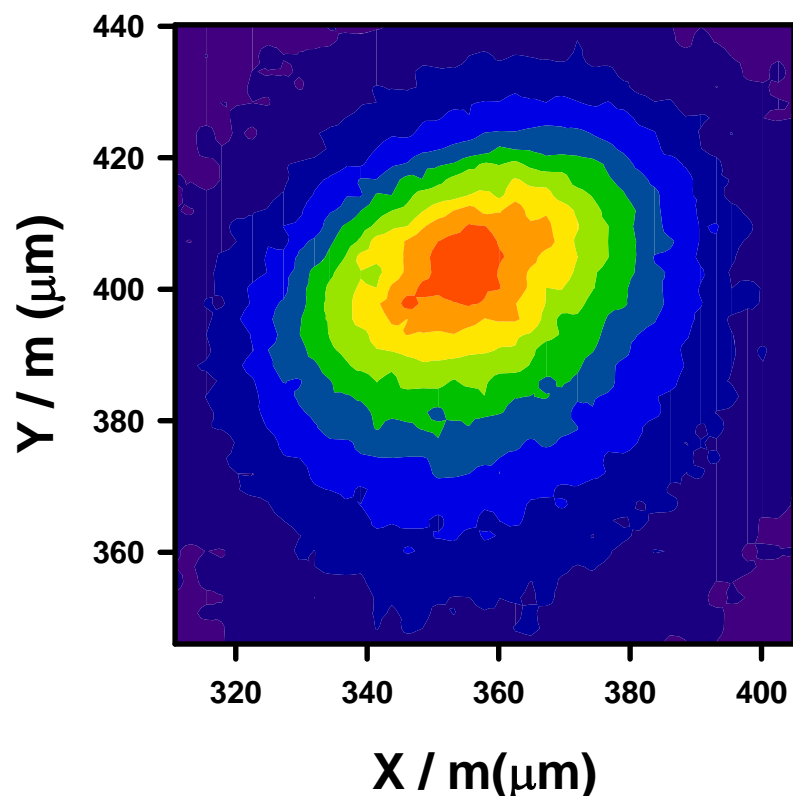
$$S = \text{const} \left| \frac{2\pi}{\gamma\lambda} K_1 \left(\frac{2\pi}{\gamma\lambda} \sqrt{x^2 + y^2} \right) - \frac{J_0 \left(\frac{2\pi}{\lambda} \sqrt{x^2 + y^2} \right)}{\sqrt{x^2 + y^2}} \right|^2$$



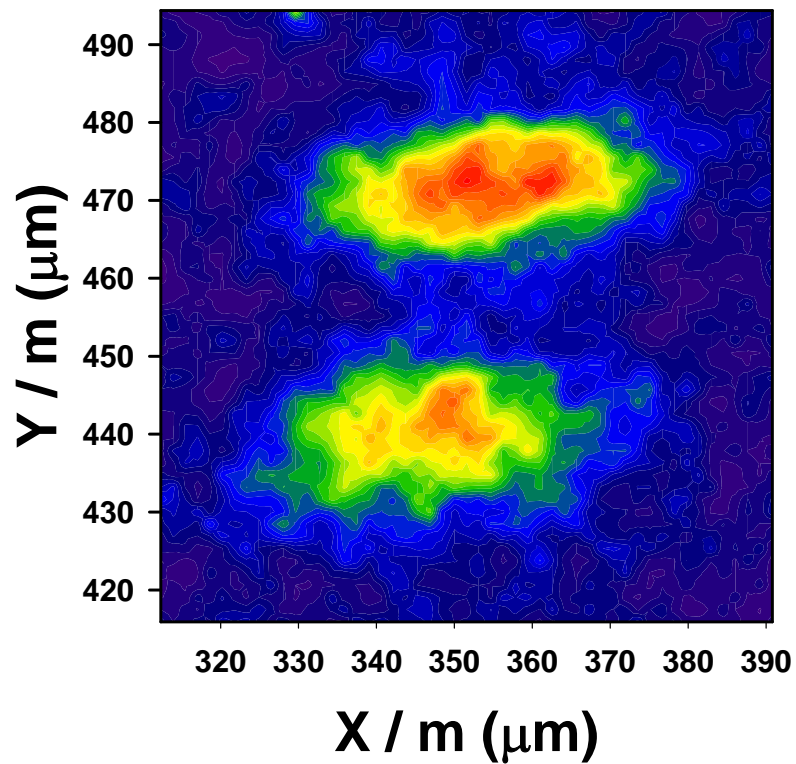
Beam size effect



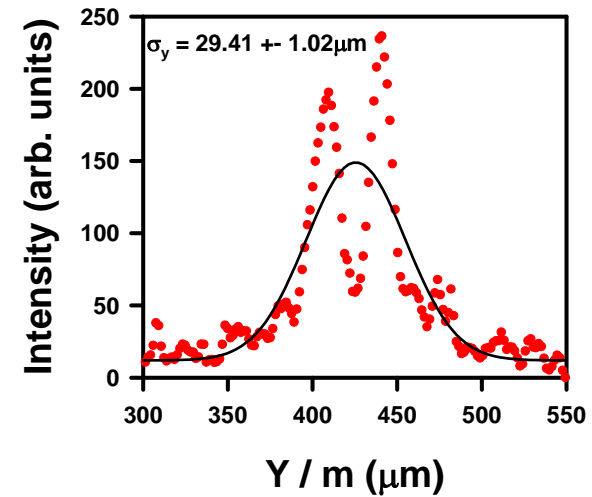
OTR image with NO filter and polarizer



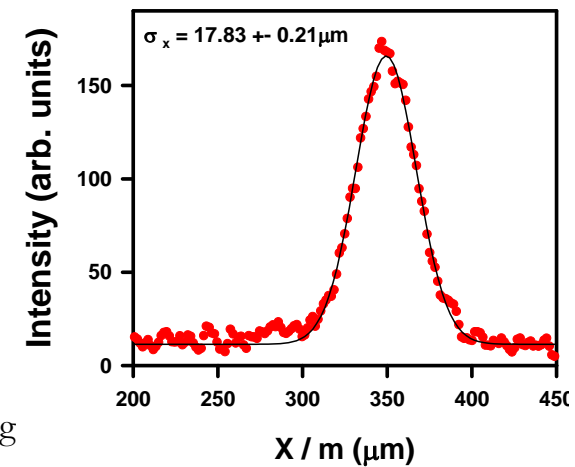
OTR image with a polarizer and optical filter



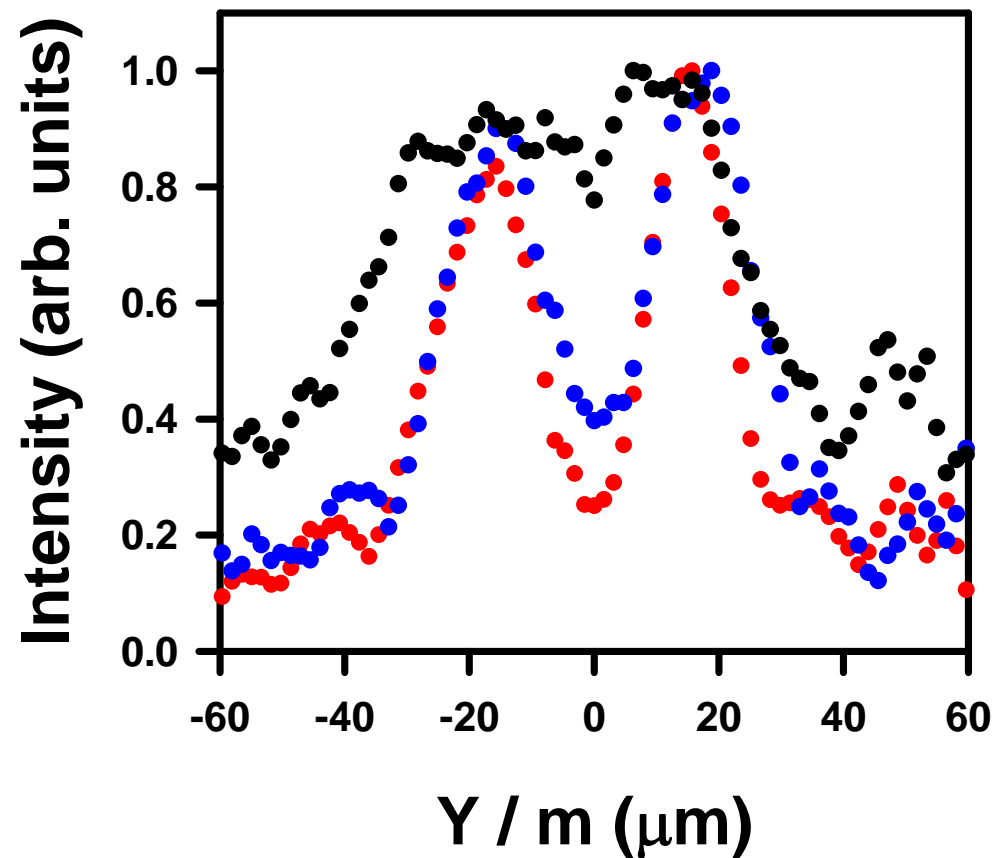
Vertical projection



Horizontal projection



Beam Size effect



QD18X = 29.56A

QD18X = 29.86A

QD18X = 30.16A

SAD predictions

$\sigma_y = 1.7\mu\text{m}$

$\sigma_y = 3.4\mu\text{m}$

$\sigma_y = 7.2\mu\text{m}$

Current state of EXT-LW ATF-II upgrade and plans

Done:

- Detector relocation – March 2009
- Interaction Chamber relocation – April 2009
- LTL hardware installation – March 2009
- LW optics test and background study – April 2009
- Beam line alignment laser installation – May 2009
- OTR monitor test – April, May 2009

During ATF summer shutdown:

- Installation of the new optical table, laser relocation and commissioning
- Improvement of the laser diagnostics
- Laser transport line optics – installation and alignment
- LW IP/post IP optics, including integration of the OTR monitor
- DAQ

General plan for autumn run (November – December 2009)

- LW optics and background study continue
- Laser diagnostics improvement continue
- Achieving of the stable electron beam transverse size measurements
- Further improvements towards automated scans

Thank you

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