Royal Holloway
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John Adams Institute
JAI
for Accelerator Science

ATF

Micron Size Laser-Wire System at the ATF-II Extraction Line

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Introduction

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

ATF Laser-wire summary

- Prediction for W_{in}=8.5mm is W_0=2sigma=3 micron
- Measured minimum size
  - 3.7 micron
- Laser properties
  - M^2 ~ 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 LW upgrade

- Interaction chamber relocation
- Alignment laser installation
- Transverse beam size cross-check OTR monitor
- New electron beam optics
- Detector relocation
- Laser Transport Line (LTL) simulation, design & installation
- Laser diagnostics upgrade
- DAQ upgrade
- Laser relocation and upgrade:

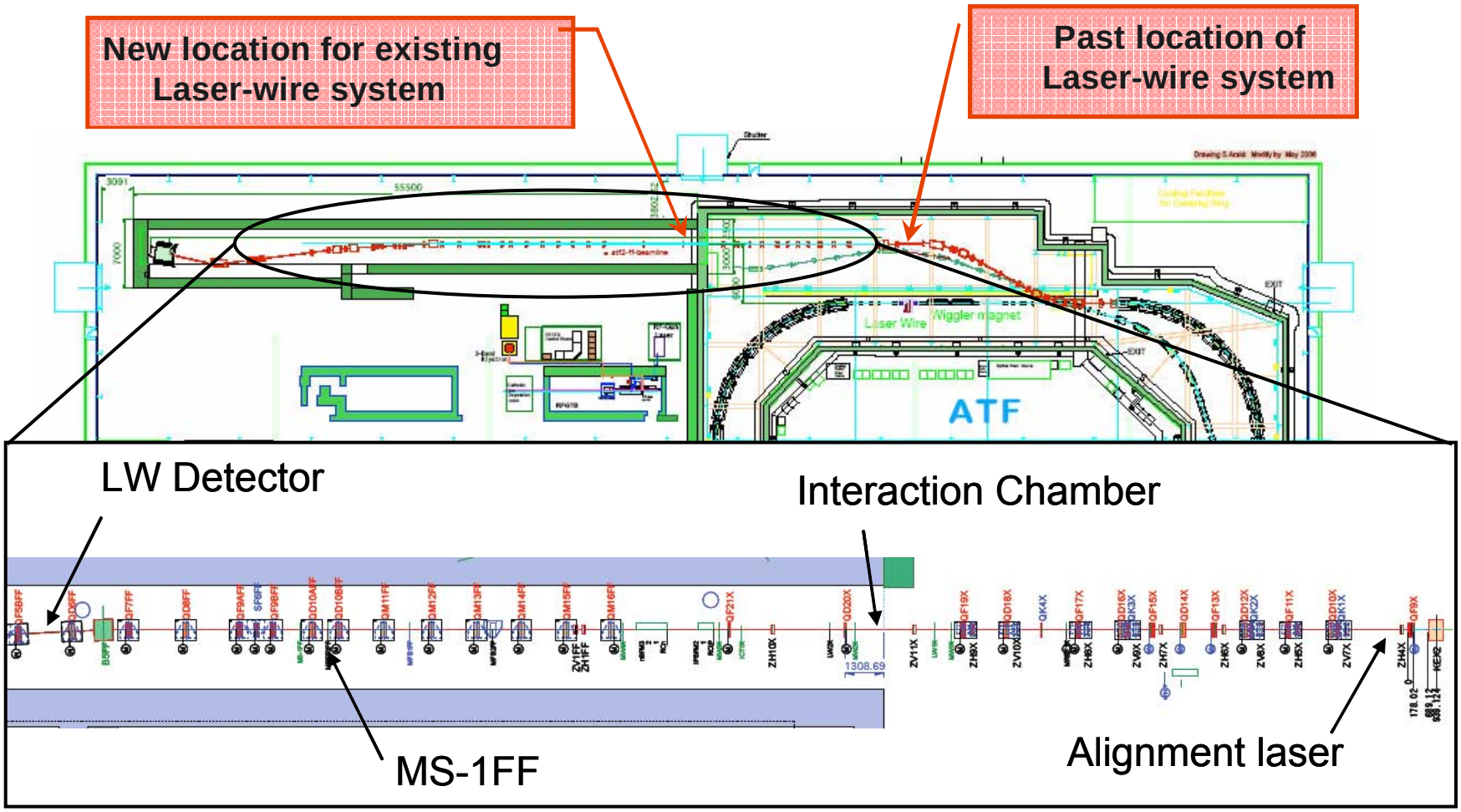
  mode quality improvement aiming to achieve 1 μm resolution.

General Aims:

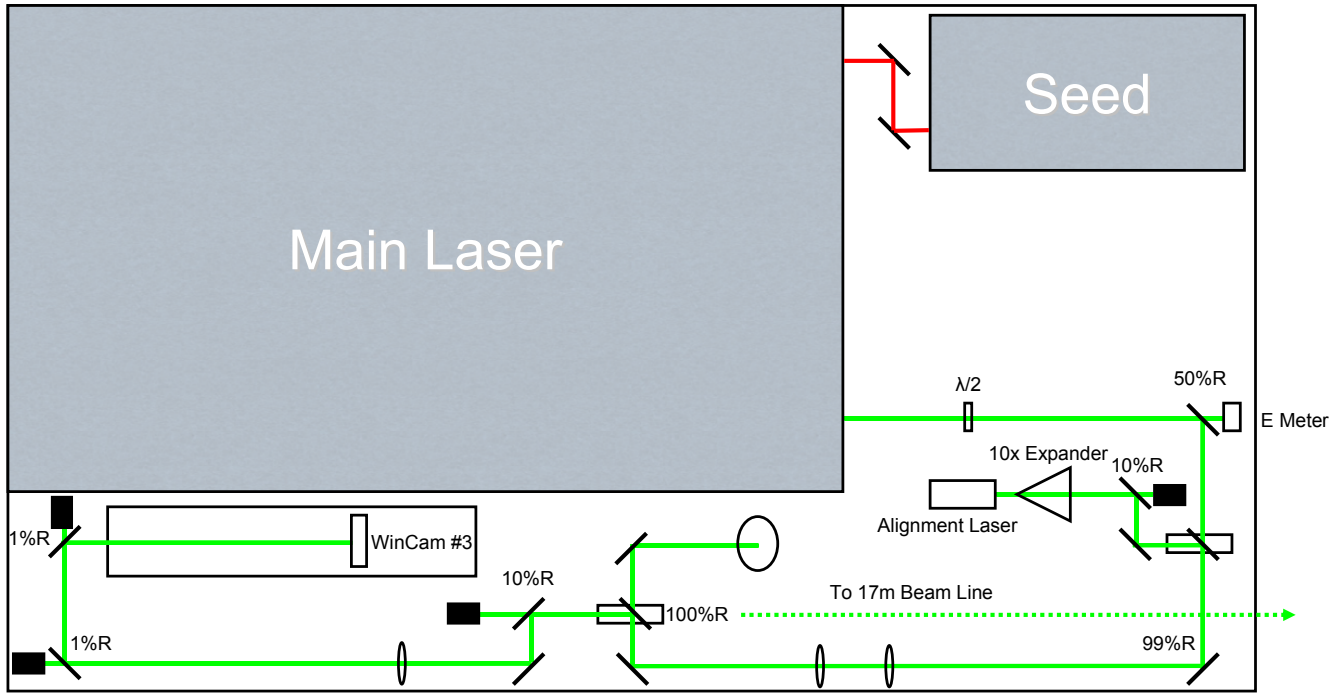
- Robust laser diagnostics

  (+ major laser diagnostics out of the tunnel)
- Upgradeability
- Automation

ATF-II Laser-wire system



High power Laser system



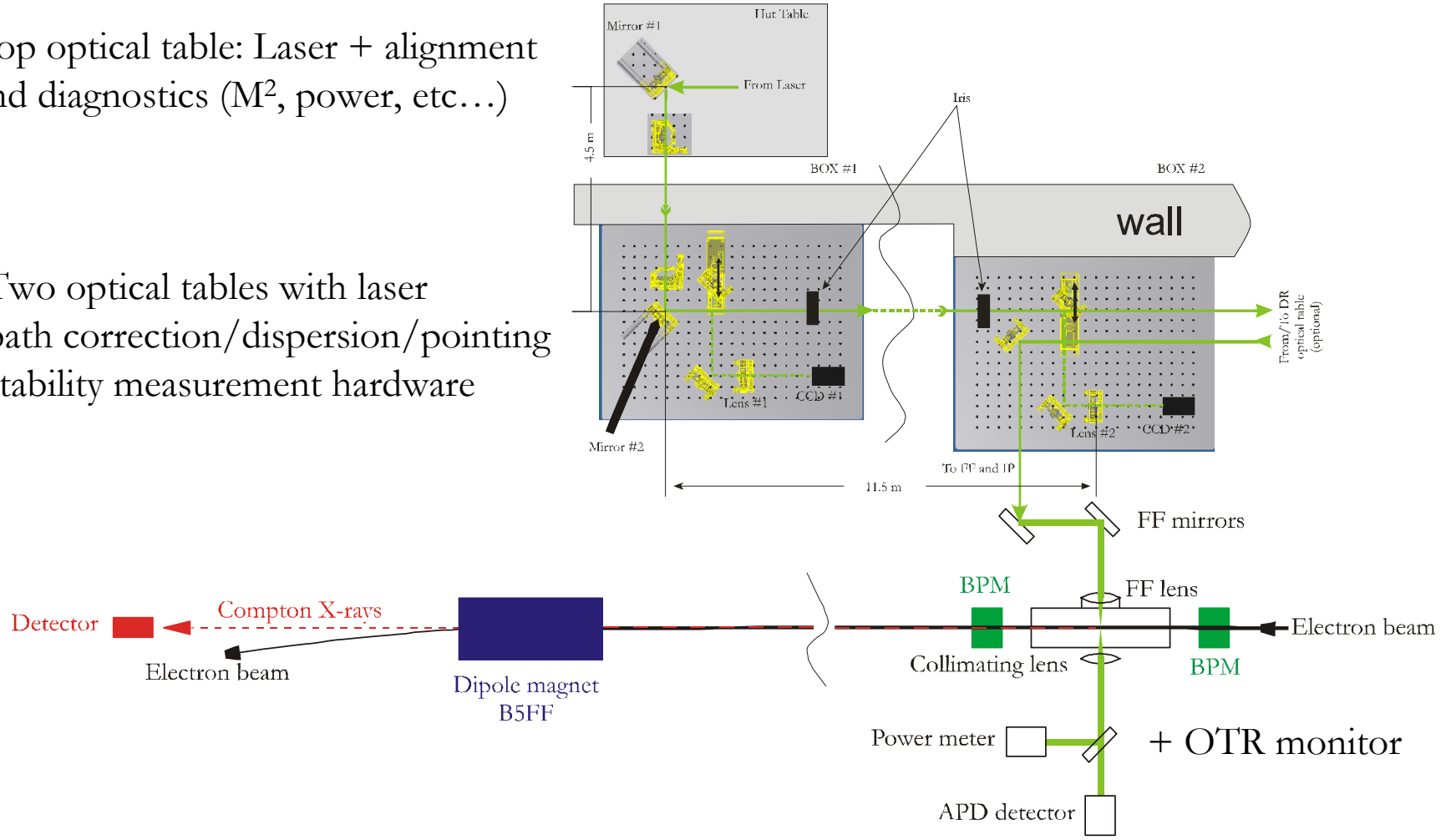
- 357MHz Mode locked seed laser
  pulse length 30ps, average power ~600 mW

- Nd:YAG regenerative amplifier and linear amplifier: pulse duration 300 ps
  max pulse energy ~400 mJ

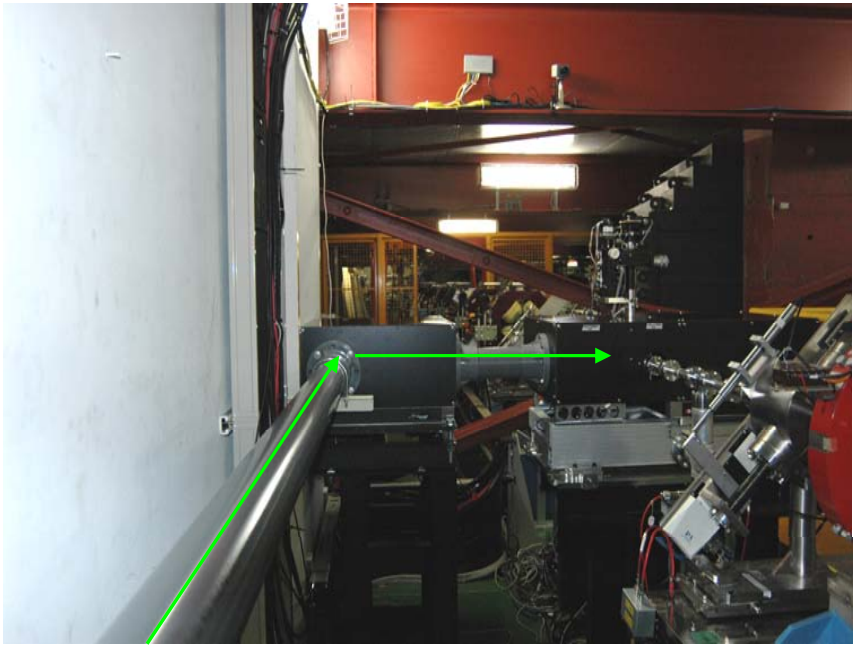
ATF-II Laser transport line and Interaction Point hardware

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

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

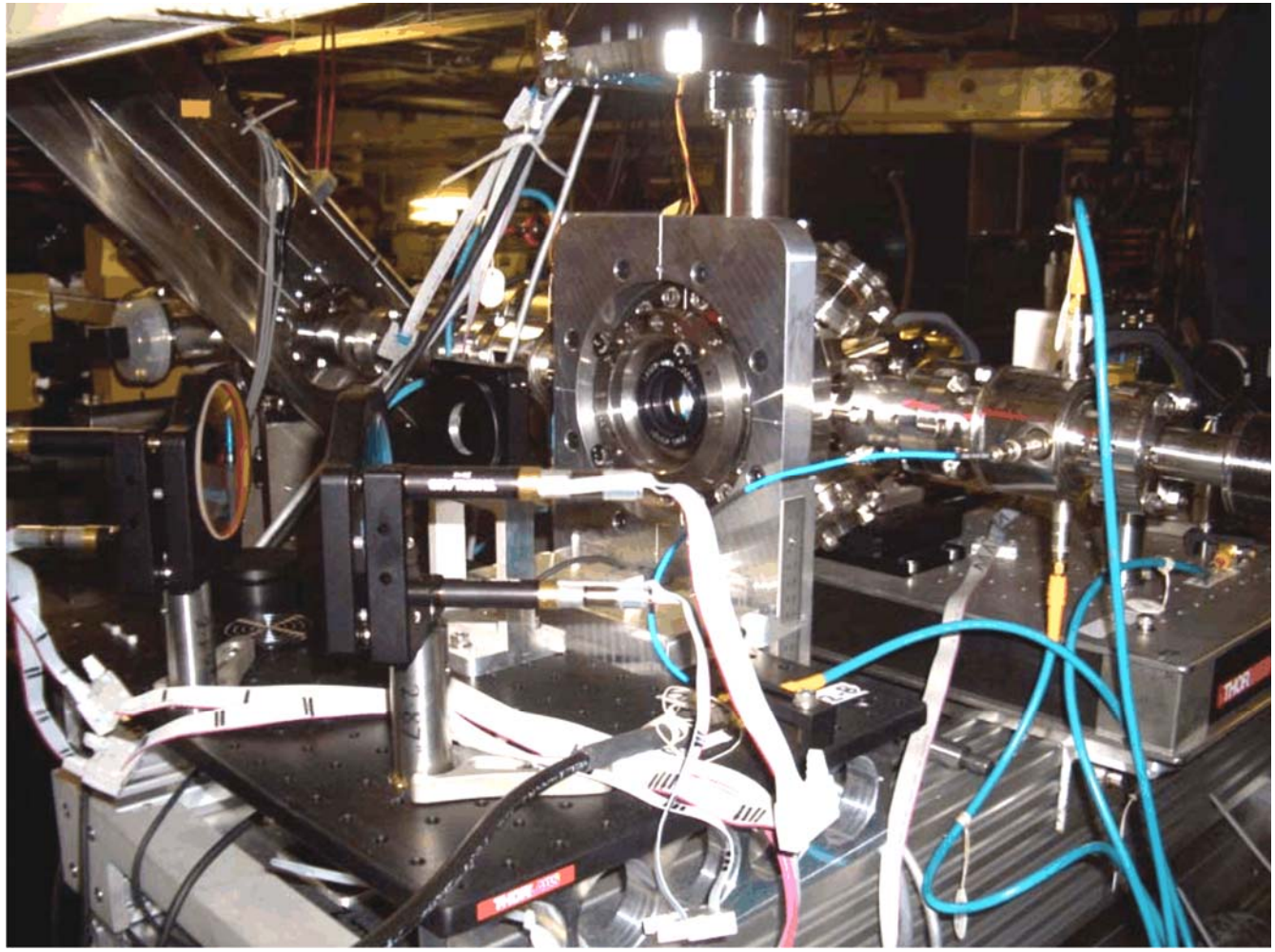


ATF-II Laser transport line

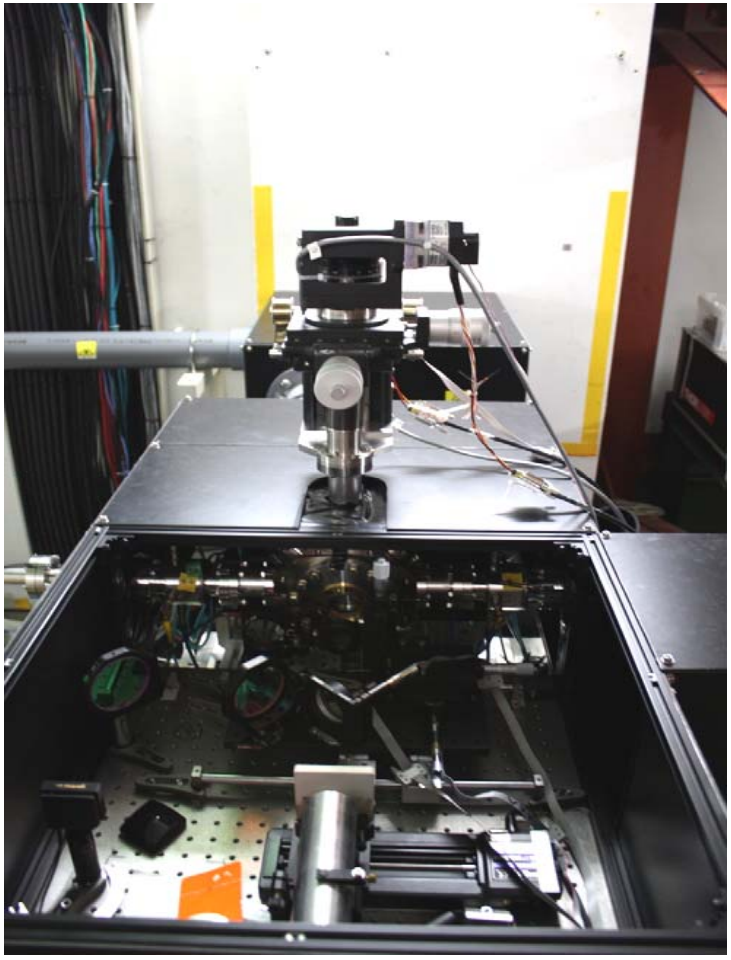


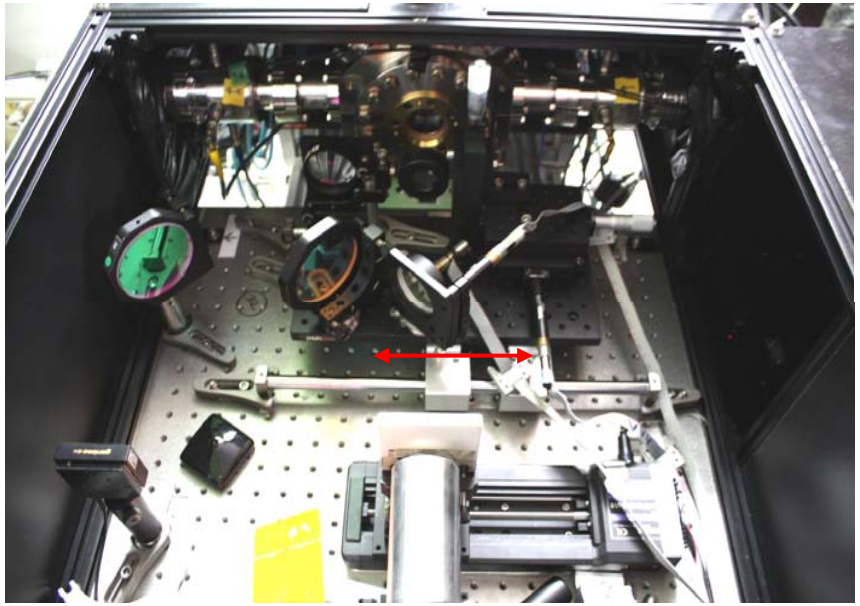
Left – first LTL optical table
Right – Second LTL optical table + IP

IP chamber with two final steering mirrors and FF lens.



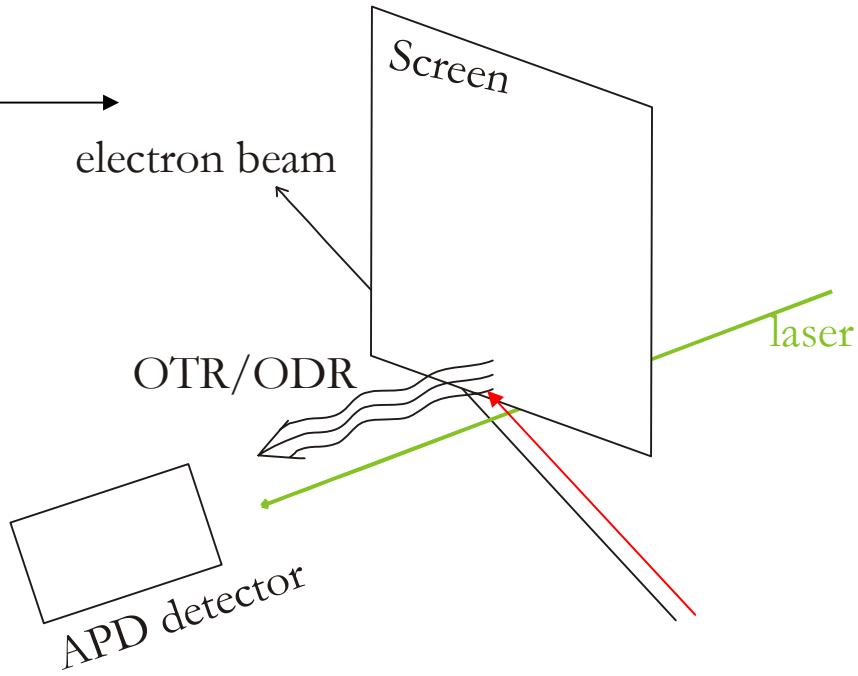
Interaction chamber, Post IP



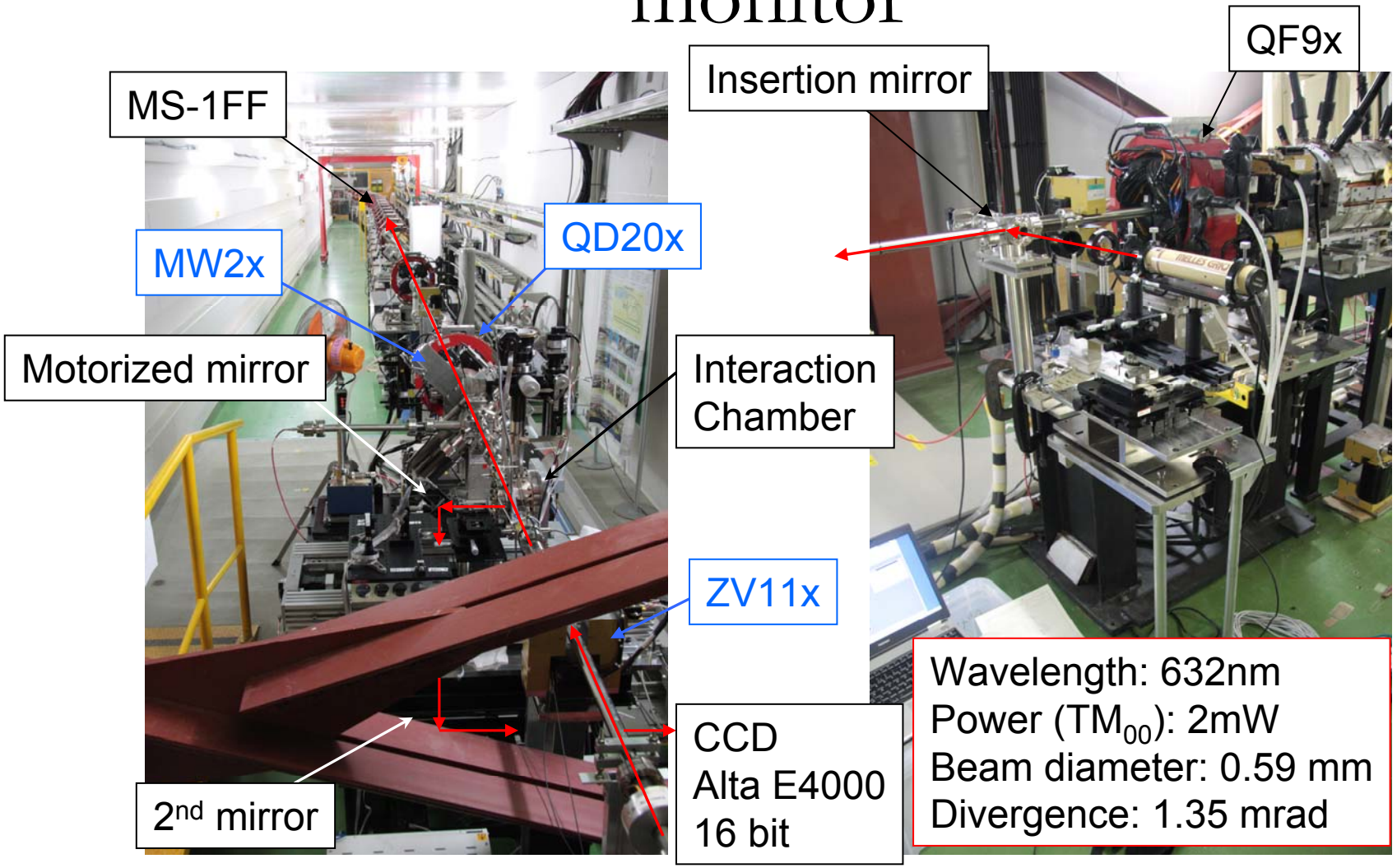


LTL and IP alignment

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

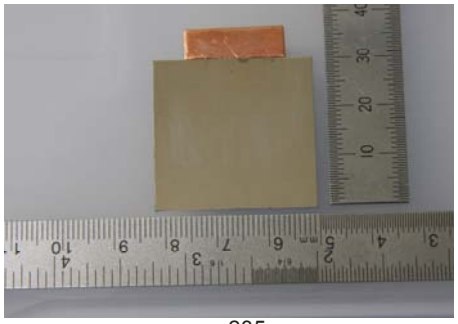


Beam line alignment laser and OTR monitor

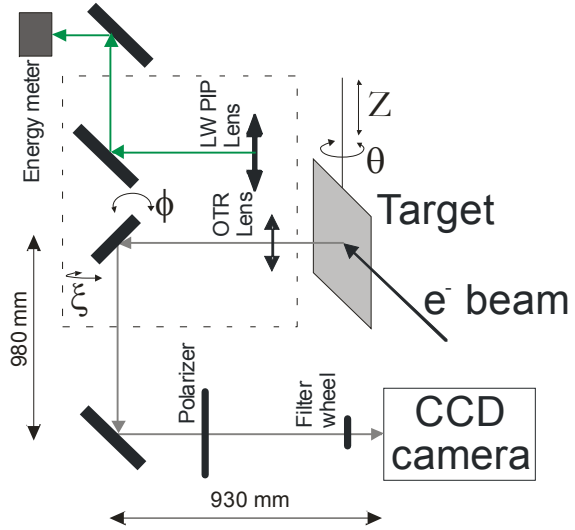


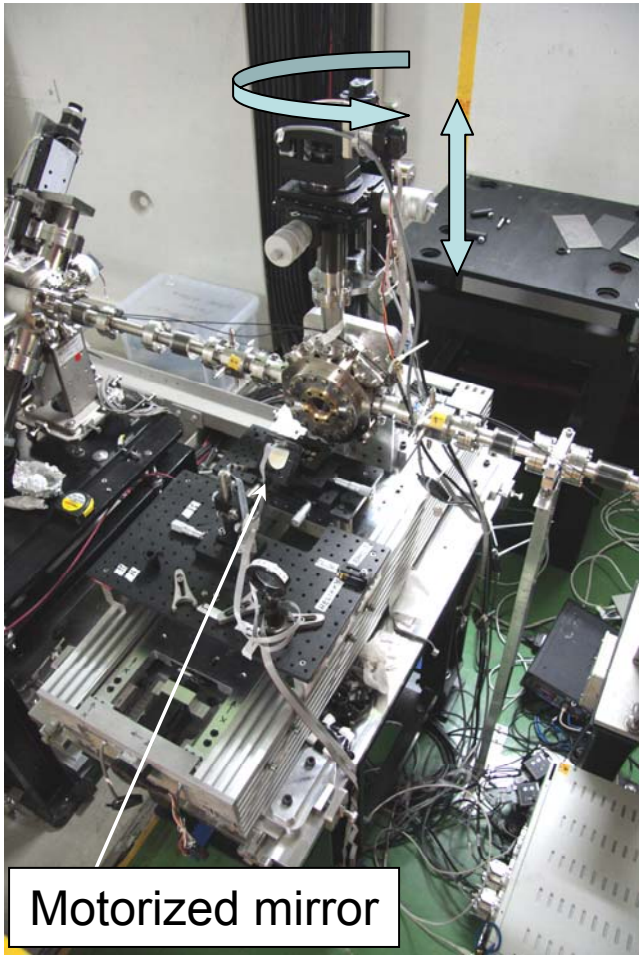
Interaction Chamber, OTR monitor test

Si substrate coated with Al
30x30x0.3 mm



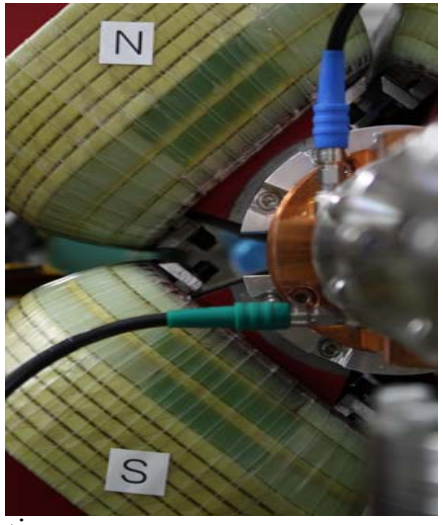
235 mm





Detector

QD6FF



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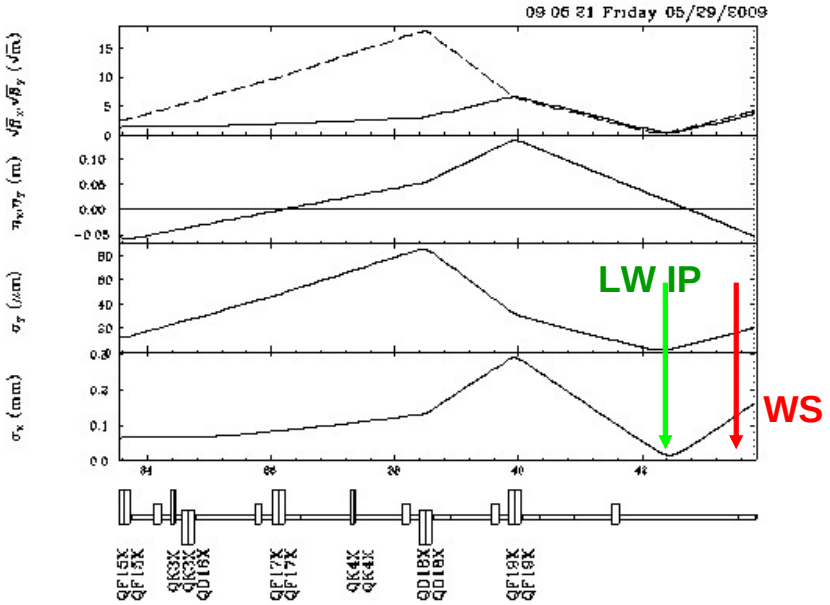
LW electron beam optics test



- Predictions:

	at LW IP	at MW2X
σ_x	20μm	20μm
σ_y	1.7μm	2.3μm

- Measurements at MW2X

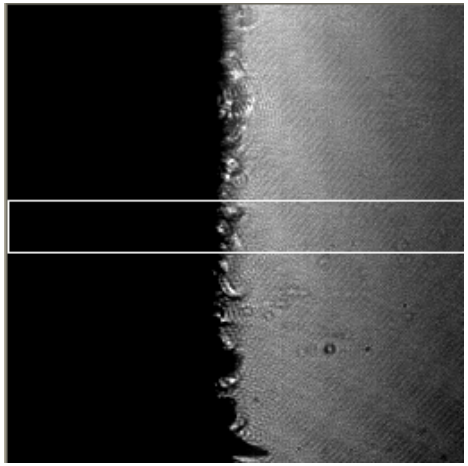
σ_x = 30μm

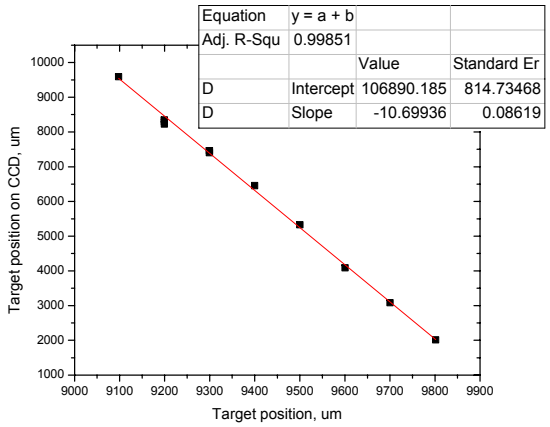
σ_y = 3.4μm

Magnets:
QD14x
QF15x
QD16x
QF17x
QD18x
QF19x
} magnets were used to tune the waist position

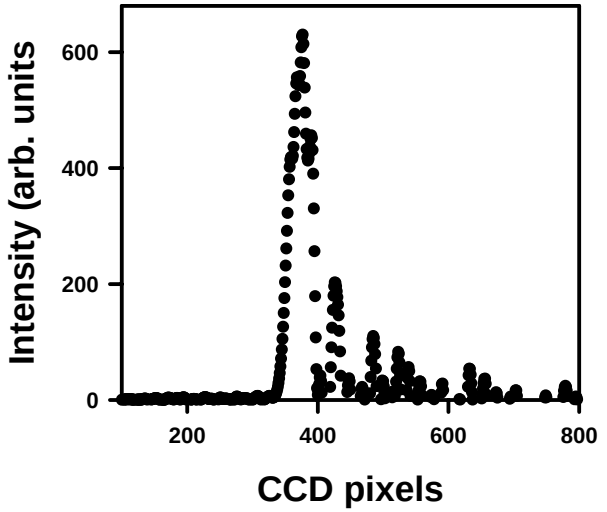
Calibration of the optical system

CCD Image of the target edge



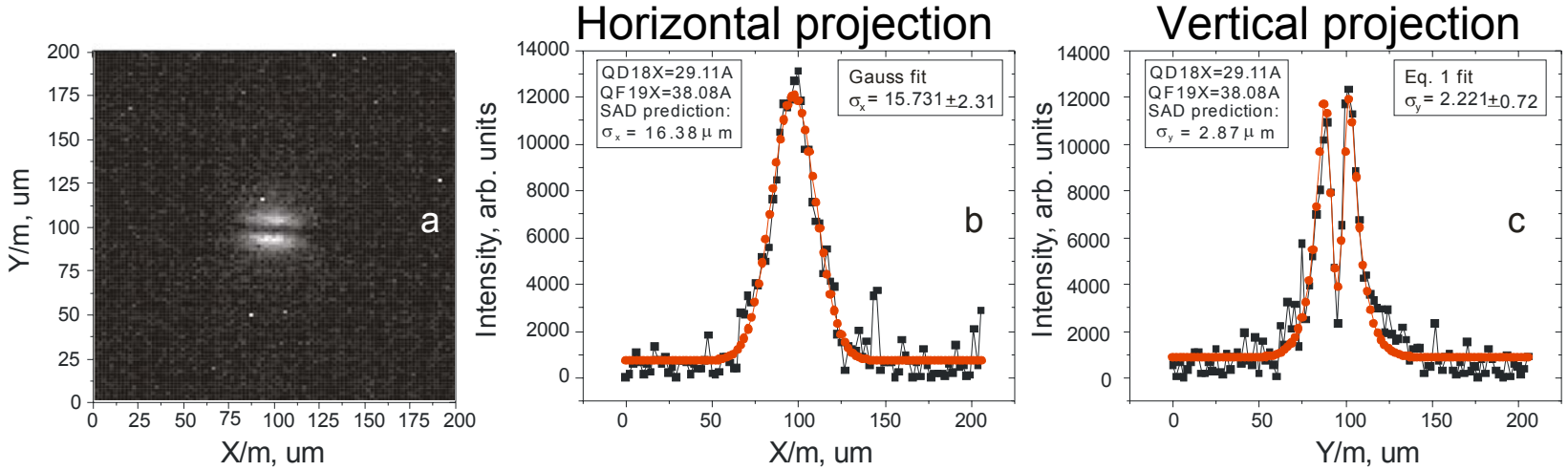


Differentiated slope



Magnification factor of an optical System 10.69

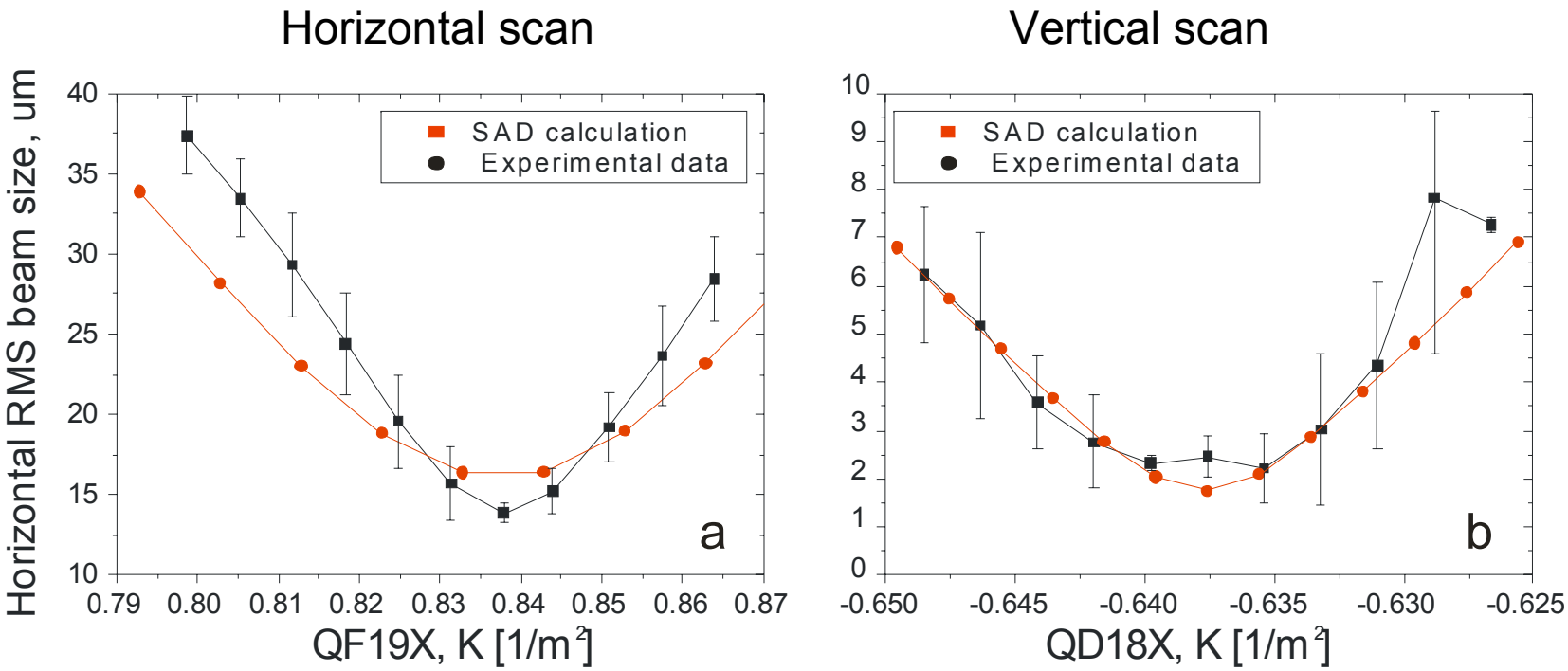
OTR image with a polarizer and optical filter



$$f(x) = a + \frac{b}{1+\left[c(x-\Delta x)\right]^4}\left\{1 - e^{-2c^2\sigma^2}\cos\left[c(x-\Delta x)\right]\right\}$$

Here *a*, *b*, c, σ, and Δx are free parameters of the fit function;
- *a* is the vertical offset of the distribution with respect to zero.
- *b* is responsible for the amplitude of the distribution;
- c is responsible for the distribution width;
- σ is the smoothing parameter dominantly defined by the beam size;
- Δx is the horizontal offset of the distribution with respect to zero.

OTR measurements



General plan for autumn run (November – December 2010)

- 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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