Orbit analysis

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FONT group

Motivation

- Relationship between IP and MFB2FF
- Effect of bunch length and charge on orbit
- Orbit data
  - BPM position x and y (Stripline + cavity) + reference cavities + DR BPMs
- MFB2FF
  - Cavity BPM + SLAC electronics
  - Resolution
  - Correlation with IP
- Jitter/beam size (wake or jitter source? Can we measure?)

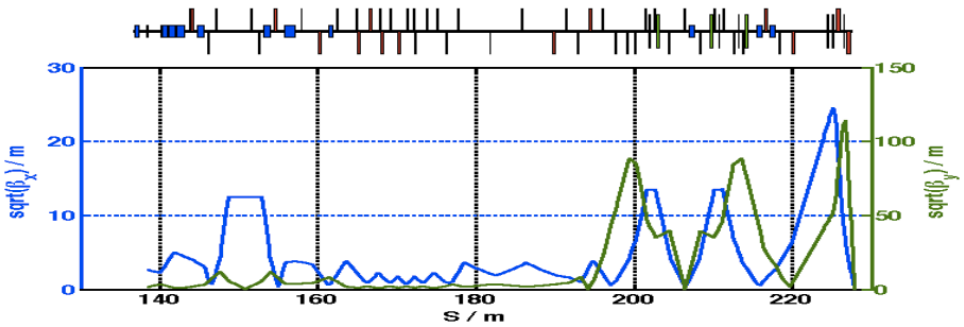
Orbit data

- Type of data
  - Stripline BPM + Cavity BPM (C/S-band) + IPBPM
  - Reference cavities (C/S-band)
  - DR BPMs (NEW)
- Data for this talk :
  - Bunch length and charge scan : 300 pulses
  - Normally 200 pulses (almost same length of IPBSM one scan)
- Calibrations (MFB2FF)
  - ± 50 um, 5 steps

MFB2FF

- MFB2FF cavity BPM
  - Used in Nano BPM project
  - Electronics : Heterodyne down-mixer (SLAC)
  - X : position + energy jitter
  - Y : position jitter

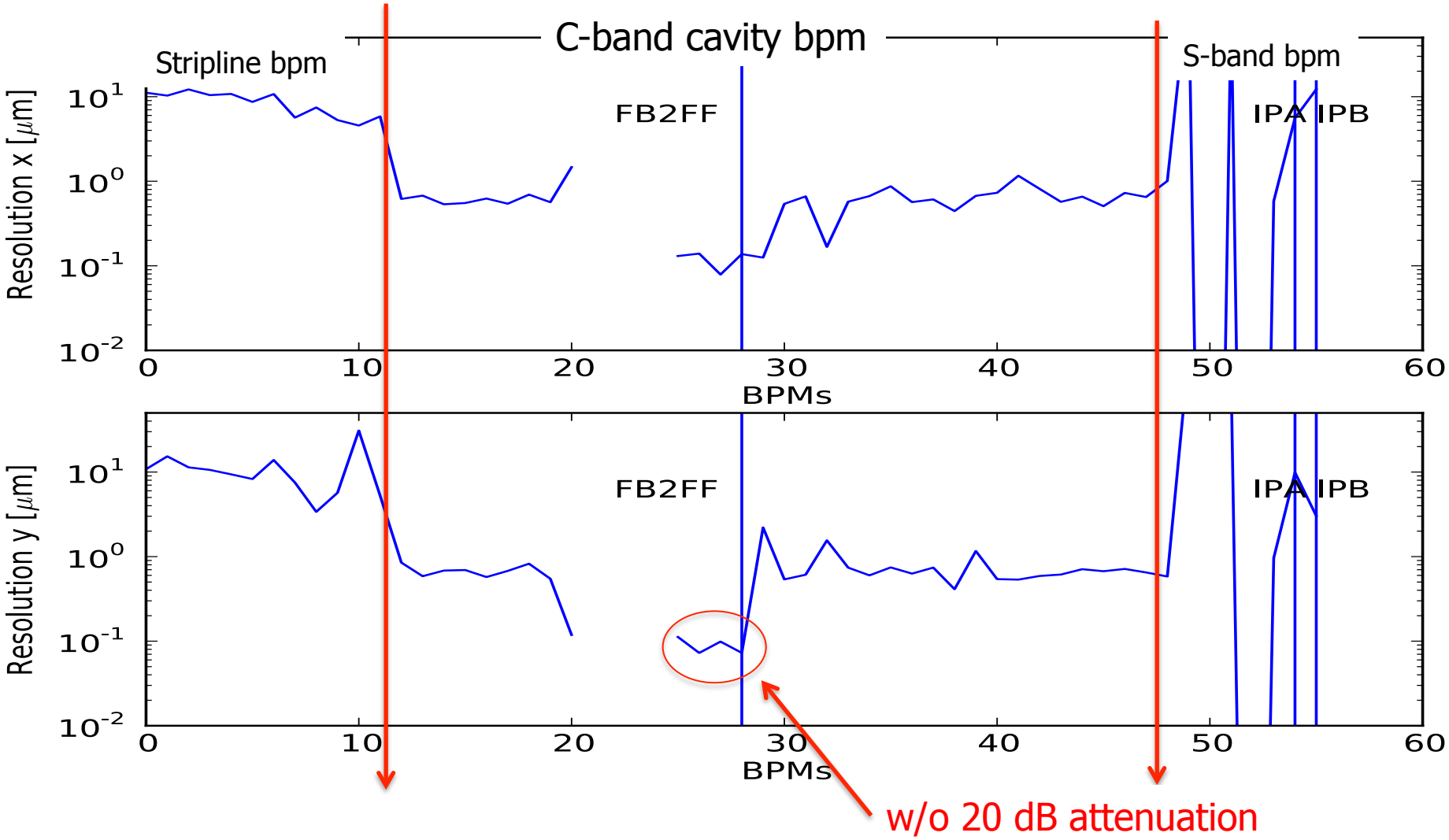
V 5.0 Optics Matching and Tracking



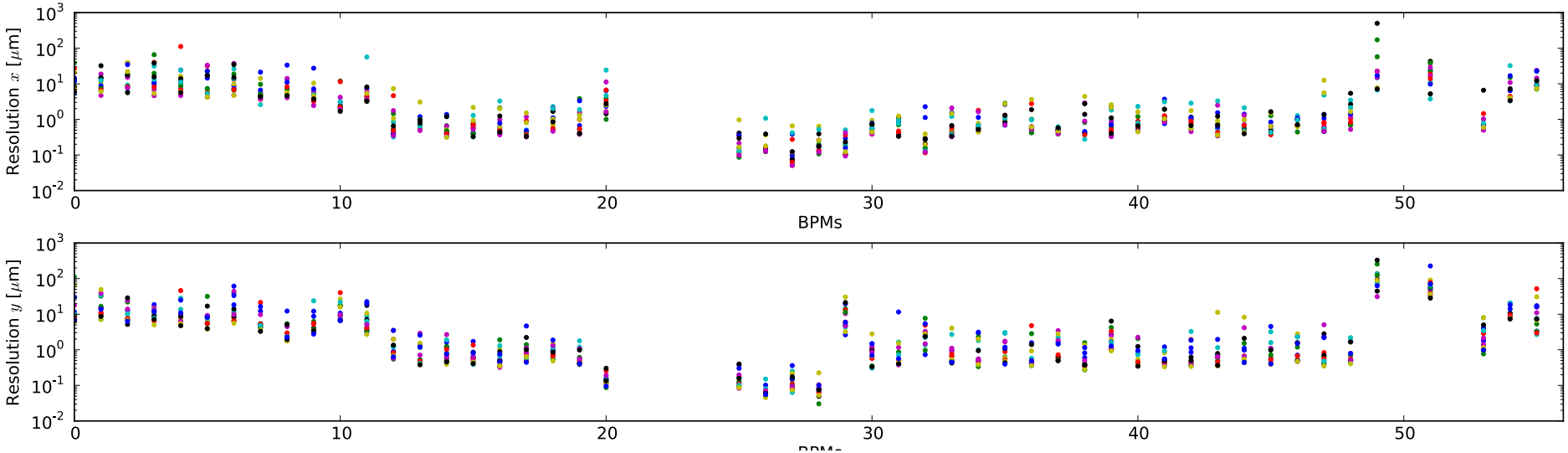
- Matched with waists at MFB1FF (horizontal) and MFB2FF (vertical) in MAD using QD21X, QM(16:12)FF.
  - QF21X was found to be necessary to keep FB waists
- Tracked IP beam sizes (Lucretia)
  - 10 um x 35 nm (no multipoles)
  - 10 um x 40 nm (all multipoles)

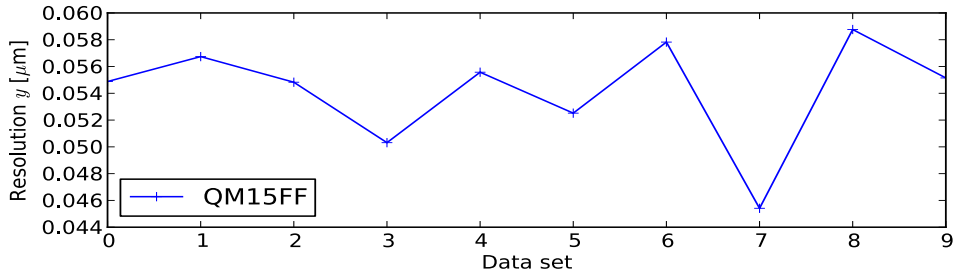
ATF2 tuning update – G. White (2012/09/20)

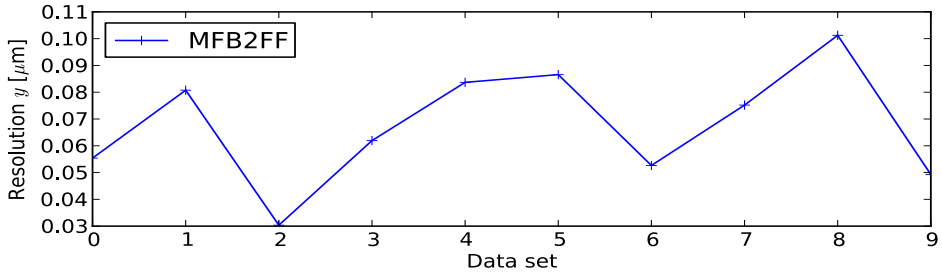
BPM Resolution (stripline + cavity)



Resolution (2012/12/21)



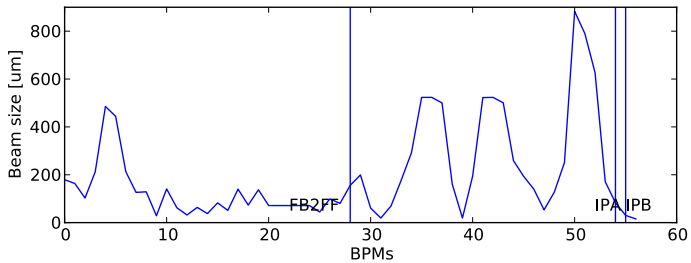


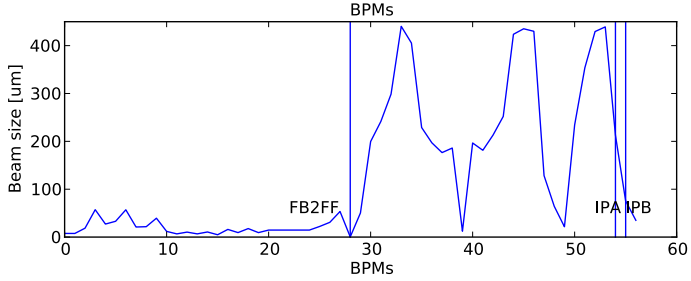


The best resolution of CBPM system : 27 nm
PRSTAB 15, 042801 (2012)

Normal operation
Order 10s of nm w/o 20 dB attenuation
Order 100s of nm w/ 20 dB attenuation

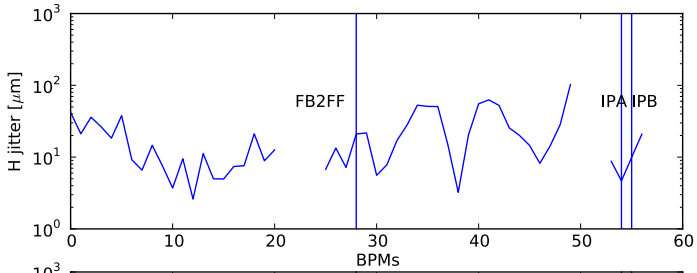
Jitter and beam size

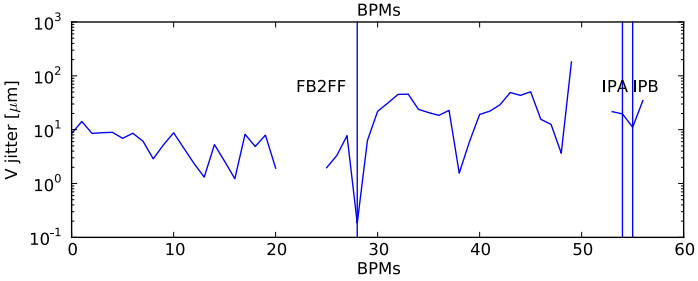


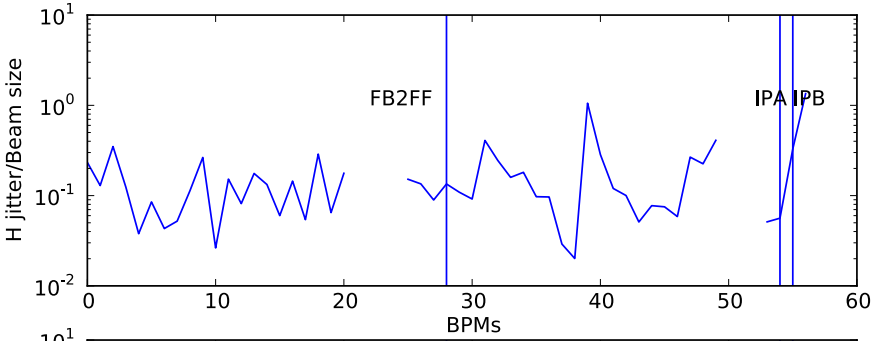


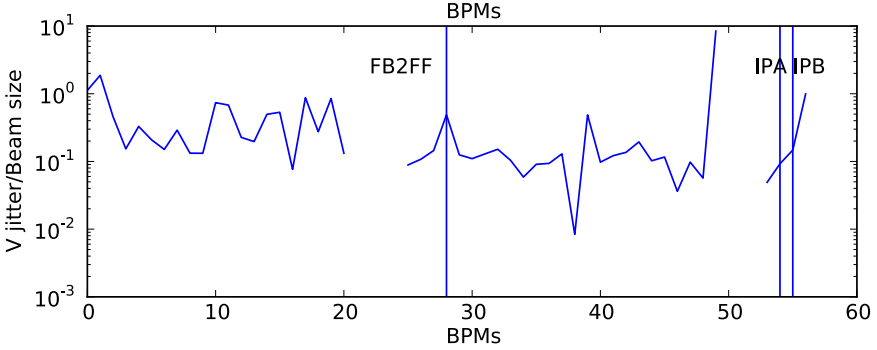
Beam size : from Flight Simulator

Jitter ~ 10 – 20% of beam size







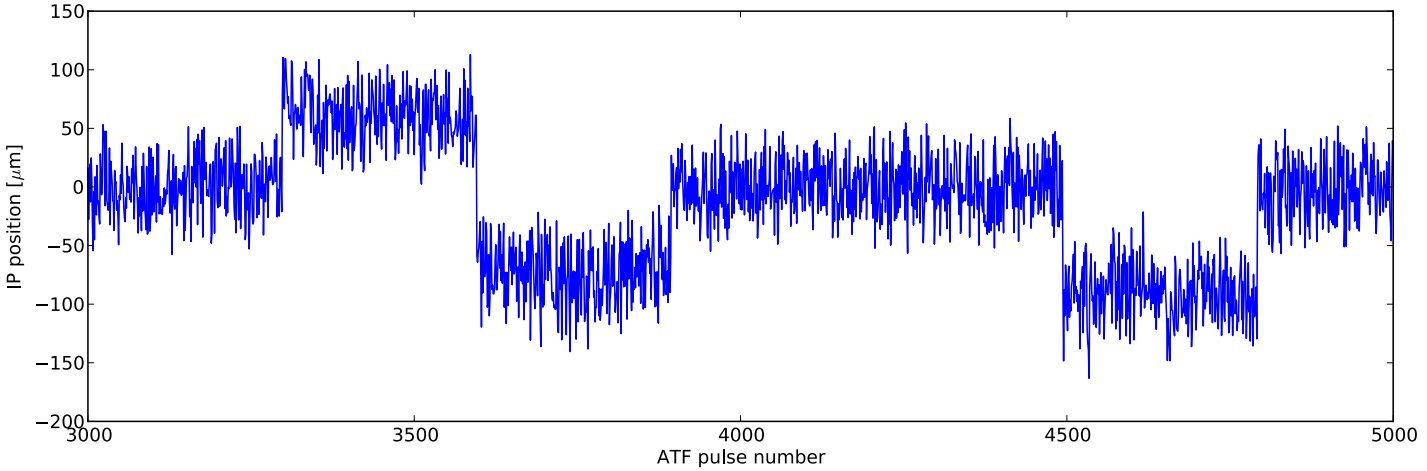


IP : calculate IPA and IPB

- Calculate IP position

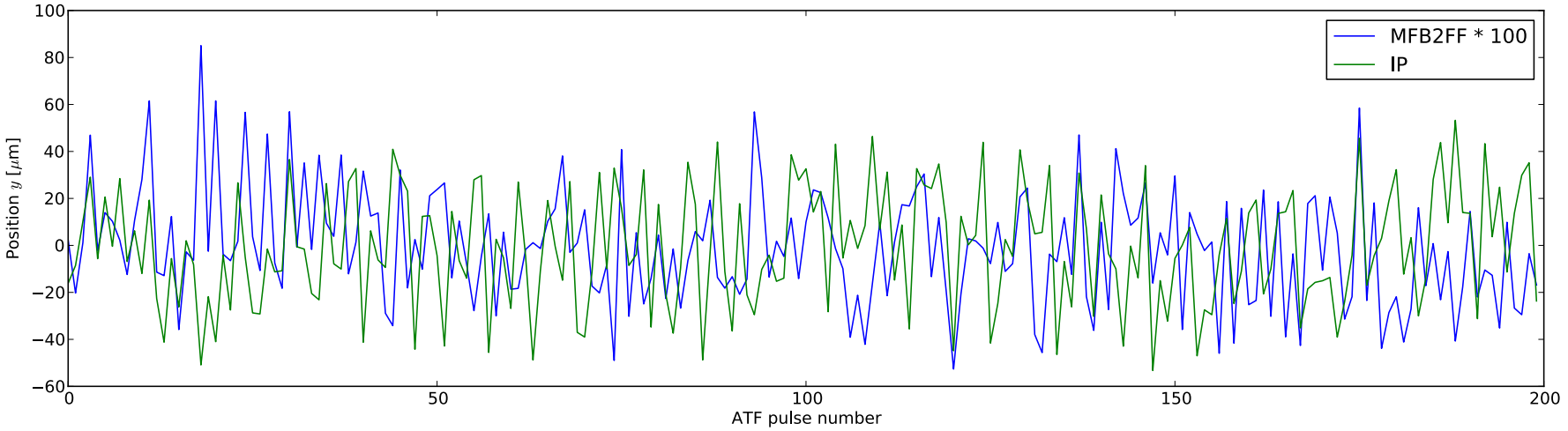
$$y_{IP} = y_{IPA} + \frac{L}{L\_bpm}(y_{IPB} - y_{IPA})$$

- No calibration after change the attenuation (2012/12/03)
  - IP position scale is not correct
  - Available to monitor beam
- Steps in reconstructed IP position
  - MREF3 scan data
  - IP was moved? This is why modulation was changed?



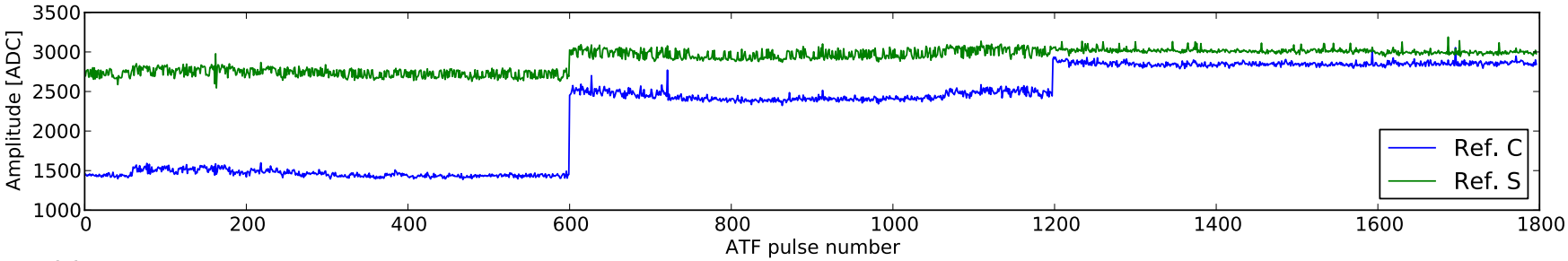
IP vs. MFB2FF

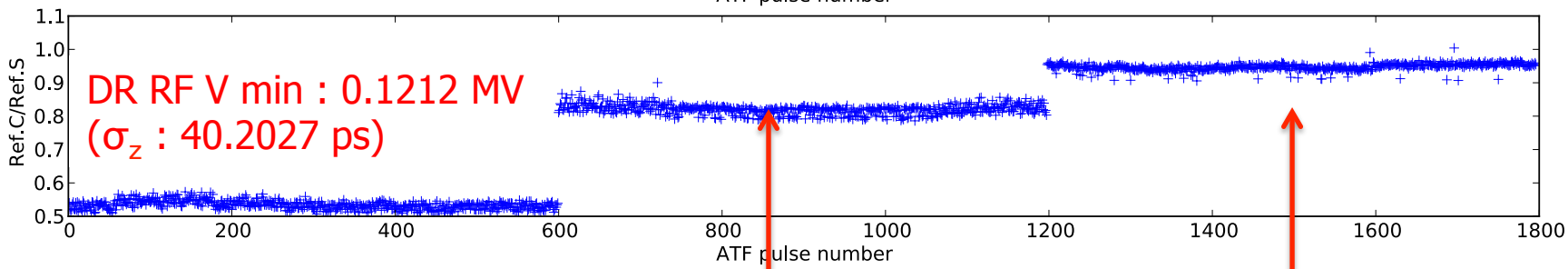
- 100 y(MFB2FF) : Blue
- y(IP) : Green
  - No good correlation observed (correlation coeff. 0.65)
  - Need to carefully check processing



Bunch length scan (2011/11/16)

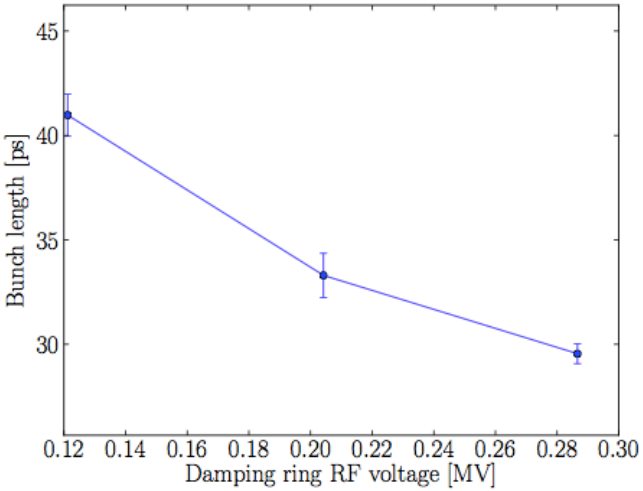
To check the effect of bunch length on Cavity BPM resolution





DR RF V nom : 0.2042 MV
(σ_z : 32.189 ps)

DR RF V max : 0.2866 MV
(σ_z : 29.071 ps)



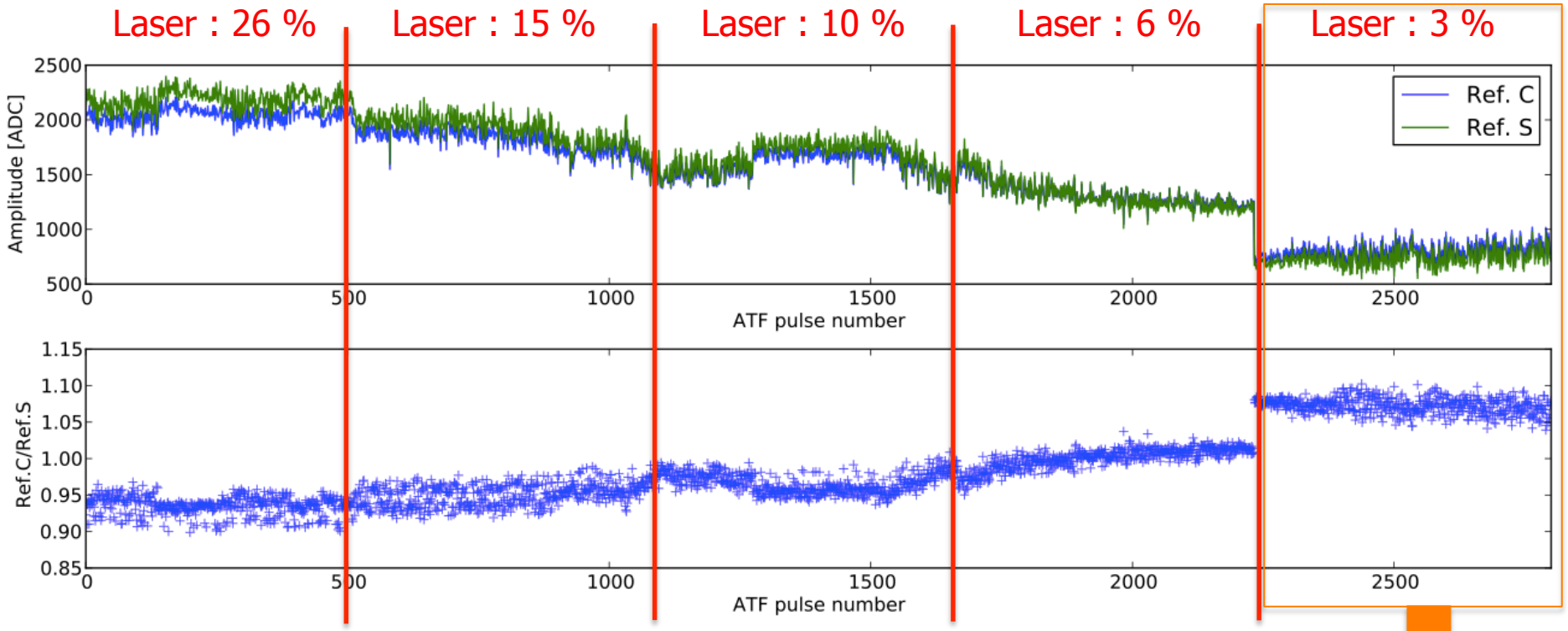
Bunch length was measured by streak camera

There was no enough time, this is why there are only three points.
We thought that three points were enough for the calibration.

JJAP Vol. 43, No. 11A (2004), pp. 7747-7752
Bunch length monitor using two-frequency analysis

$$\sigma_z \propto \sqrt{\ln\left(\alpha\frac{V_1}{V_2}\right)},$$

Charge scan (2011/11/16)



The ratio of two reference cavities was expected to be flat.
Orbit is important as function of charge and bunch length!

From the reference amplitude ADC counts
this is similar condition as 2012/12/21

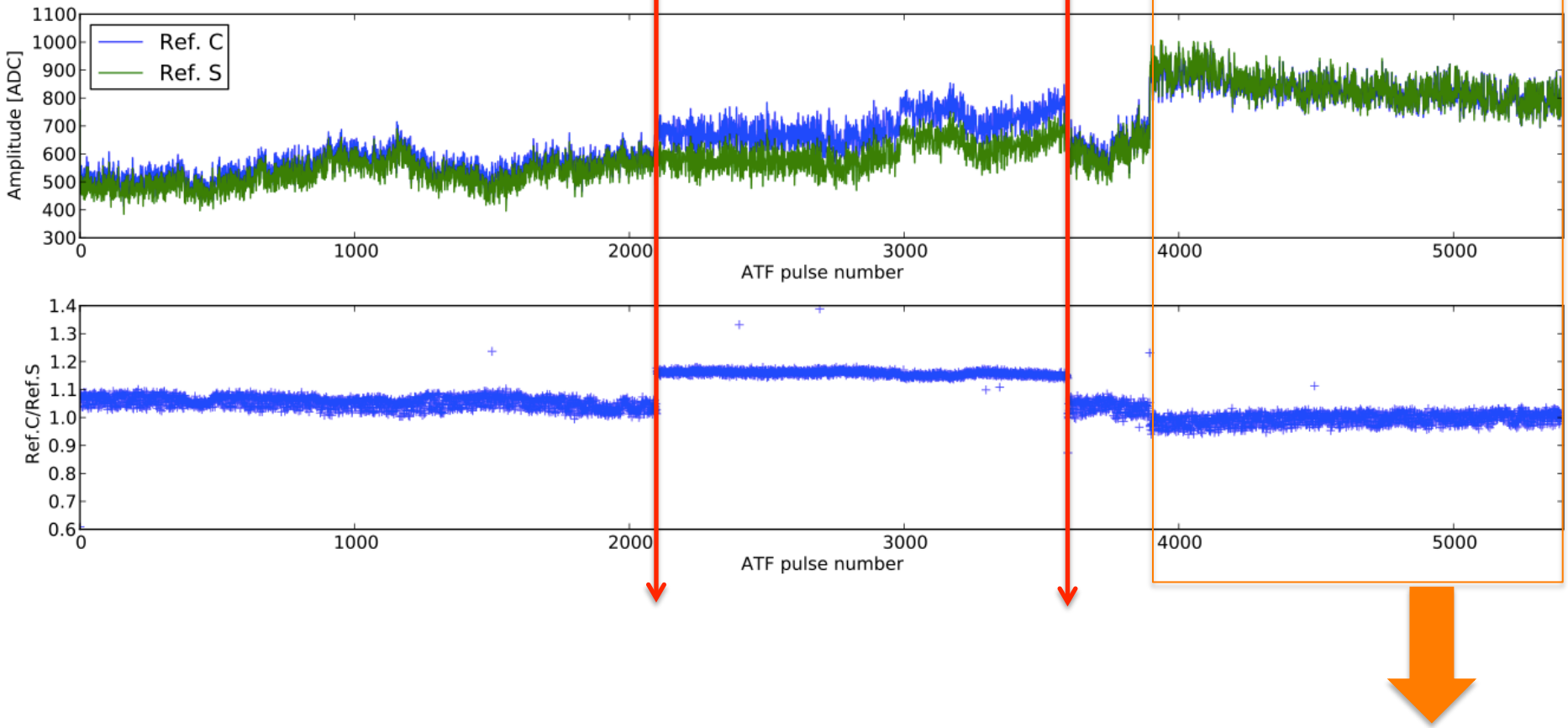
Nominal bunch length : DR RF Voltage : 0.2042 MV, changed laser power

Bunch length/Charge (2012/12/21)

DR RF V nom : 0.2 MV
Intensity : 2e9

DR RF V : 0.29 MV
Intensity : 2e9

DR RF V nom : 0.2 MV
Intensity : 3-3.5e9



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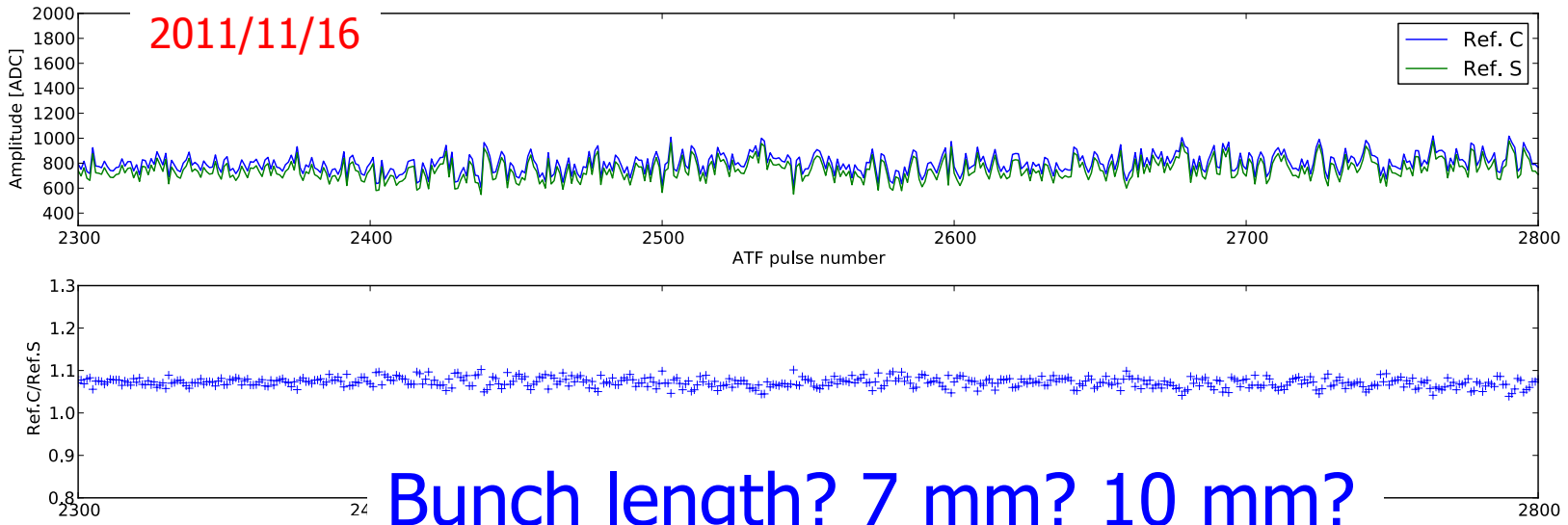
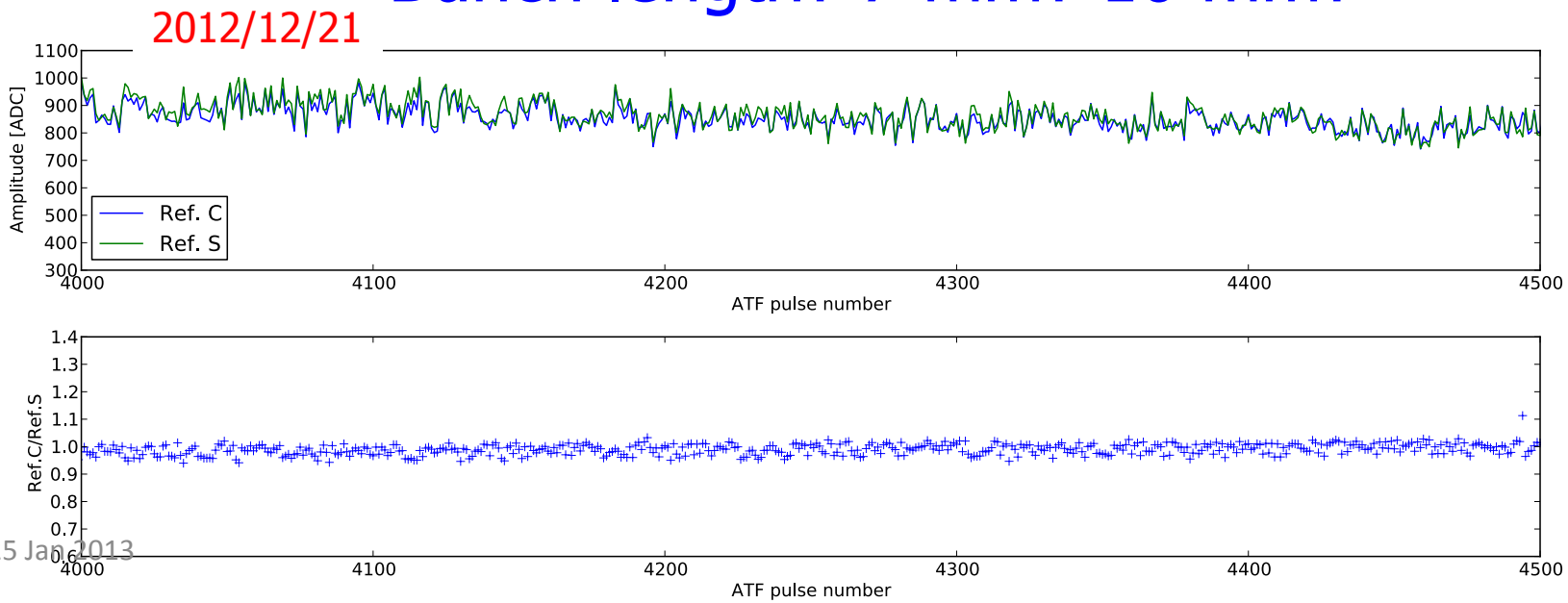
Bunch length @ low charge



Bunch length? 7 mm? 10 mm?



Summary

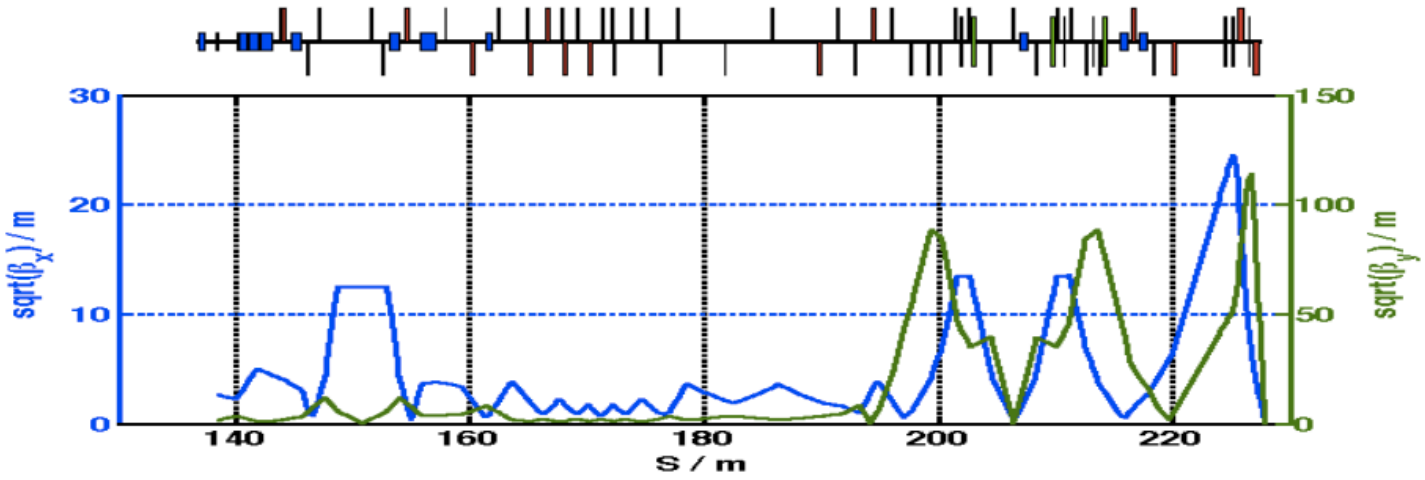
- Took a lot of orbit data (Dec. 2012)
- Check EXT beam line BPM resolution
  - Nominal < 50 nm (w/o 20 dB attenuation)
- MFB2FF resolution < 50 nm (w/o 20 dB attenuation)
  - Best : 29 nm, Jitter at MFB2FF monitor : < 200 nm
- Jitter (both horizontal and vertical) 0.1-0.2 of beam size
- Bunch length and charge scan
- A new simple method to determine the bunch length was shown
  - C/S-band reference cavity

- Sync problem (3Hz operation)
  - Between C-band and S-band

MFB2FF

ATF2 tuning update – G. White (2012/09/20)

V 5.0 Optics Matching and Tracking



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  - QF21X was found to be necessary to keep FB waists
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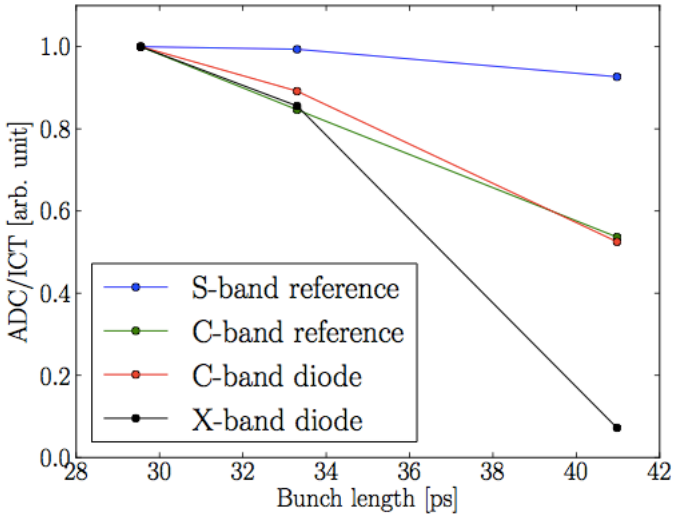
Bunch length change



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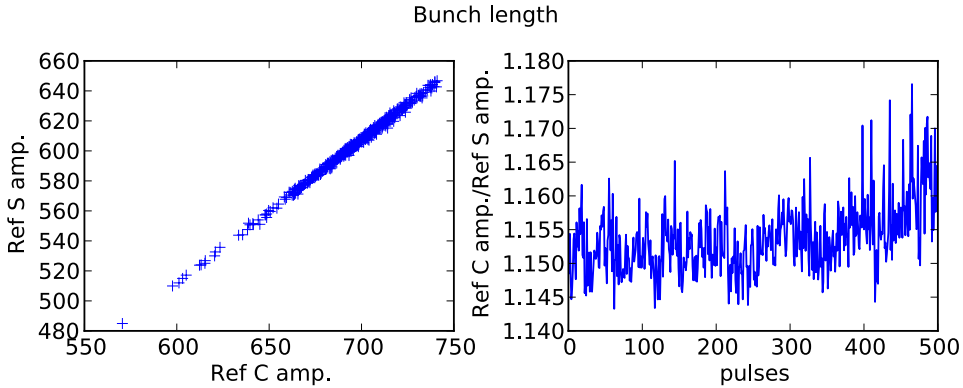

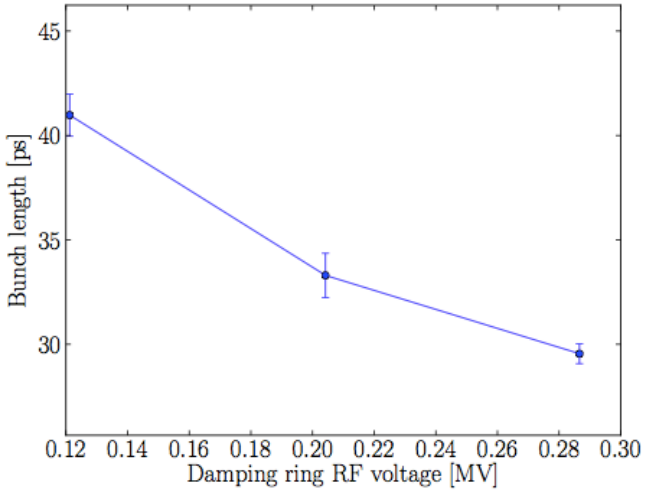

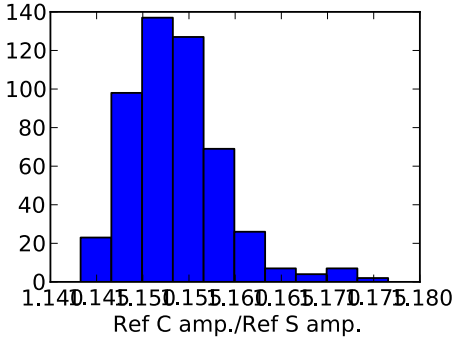

Effect of bunch length on cavity resolution

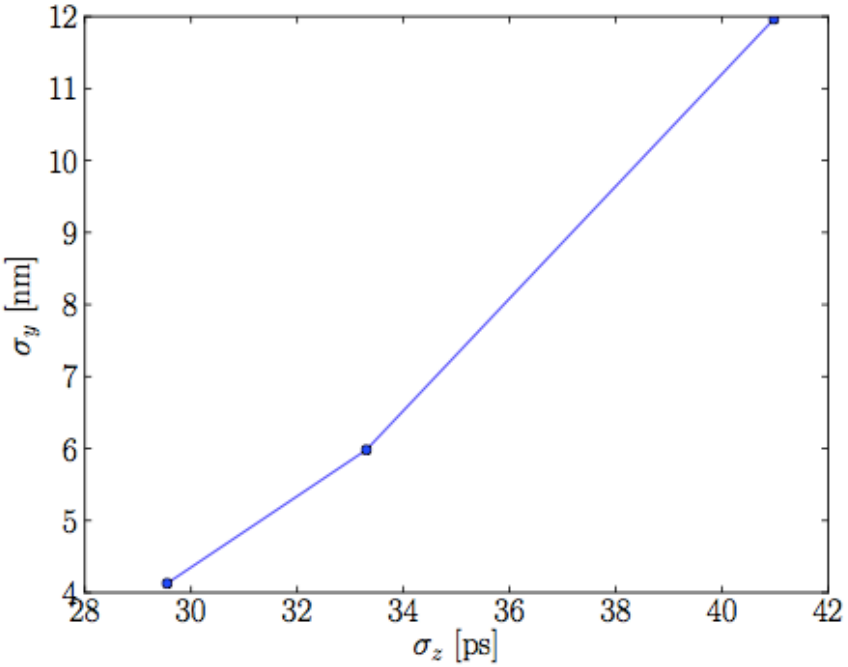

Figure 4.36: Vertical position residual σ_y as a function of the bunch length. This data was taken homodyne processing and single point method is used for analysis, labelled W1-HO-20-0-B file was used.