Diagnose of ATF2 Tuning Experiences

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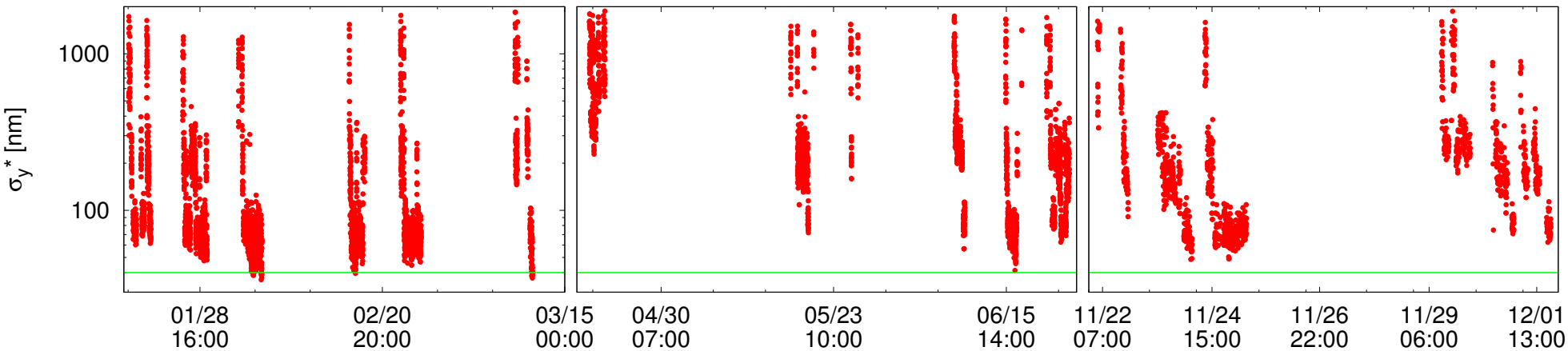
March 21st, 2018

20th ATF2 Project Meeting
LAL, Orsay (FRANCE)

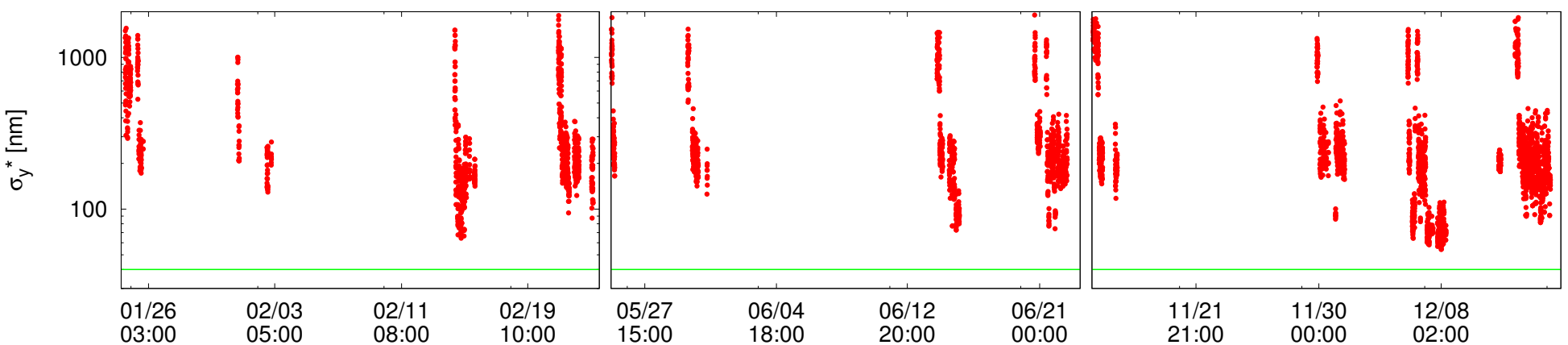
Outline

ATF2 Operation 2016-2017

- 2016



- 2017



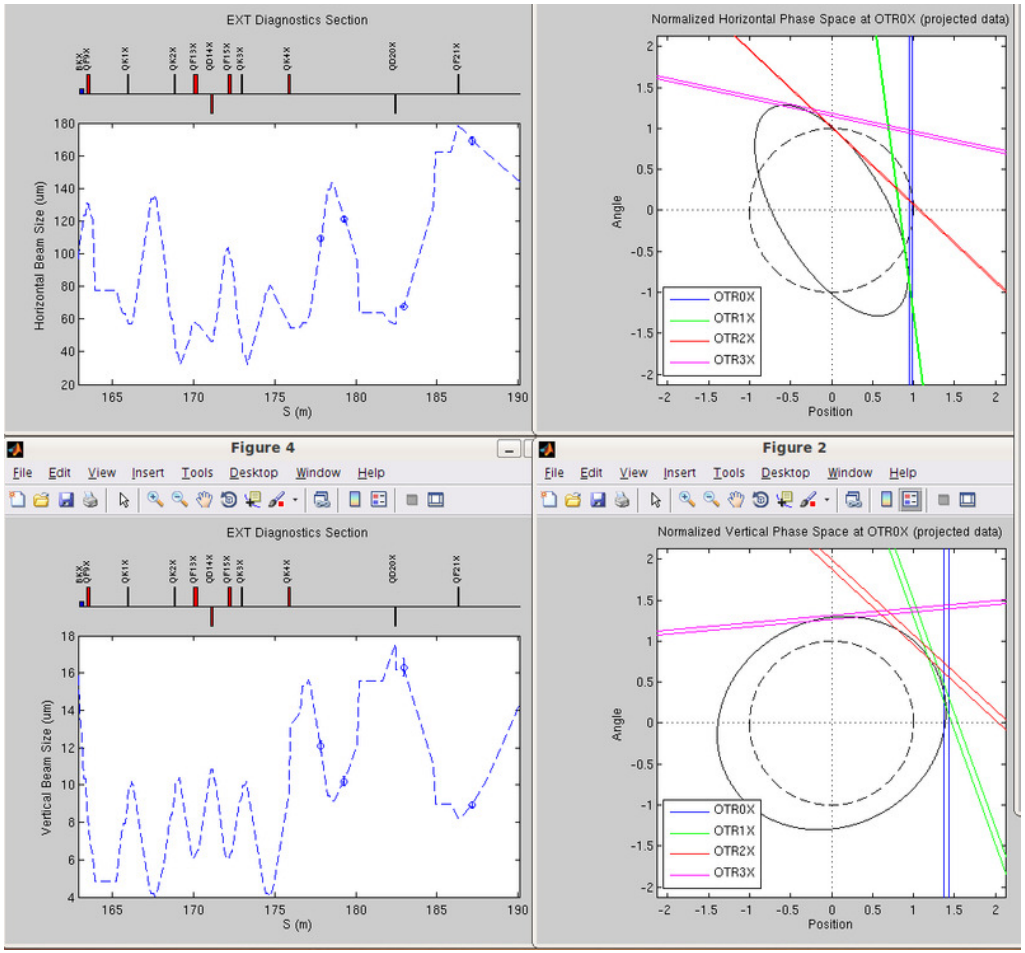
2016-2018 Run Operations under Study

Run	Tuning Procedure	Lattice β_x^*=4mm β_y^*=0.1mm	Minimum σ_y^* [nm]	Notes
16/02/05	Standard	$10\beta_x 1\beta_y$	47±6	
16/02/24	Standard	$10\beta_x 1\beta_y$	65±8	
16/03/10	Standard	$10\beta_x 1\beta_y$	41±2	2nd Bunch
16/05/20	Standard	$10\beta_x 1\beta_y$	75±10	
16/06/16	Standard	$10\beta_x 1\beta_y$	69±5	
16/11/24	Standard	$10\beta_x 1\beta_y$	60±5	
16/12/01	Standard	$10\beta_x 1\beta_y$	74±9	
17/02/15	Standard	$10\beta_x 1\beta_y$	82±14	
17/06/15 *	Standard	$10\beta_x 1\beta_y$	89±6	
17/12/08 *	Standard	$10\beta_x 1\beta_y$	63±4	Sext align.
17/12/14 *	Standard	$20\beta_x 0.25\beta_y$	97±6	not applied
18/02/22 *	Standard	$20\beta_x 0.25\beta_y$	70±6	w/o 2nd knobs

*mOTR non-operational

Emittance Measurement and Coupling Correction

- Coupling correction by optimization of skew quads



- Twiss measurement $\Rightarrow$ should be exploited for matching

Final Focus Matching

- m-OTR provides an intermediate Twiss measurement
- Quadrupoles QD18X, QF19X, QD20X, QF21X + QMFFs can be used to rematch to IP Twiss according to Twiss @ mOTR
- Preserving the following constraints

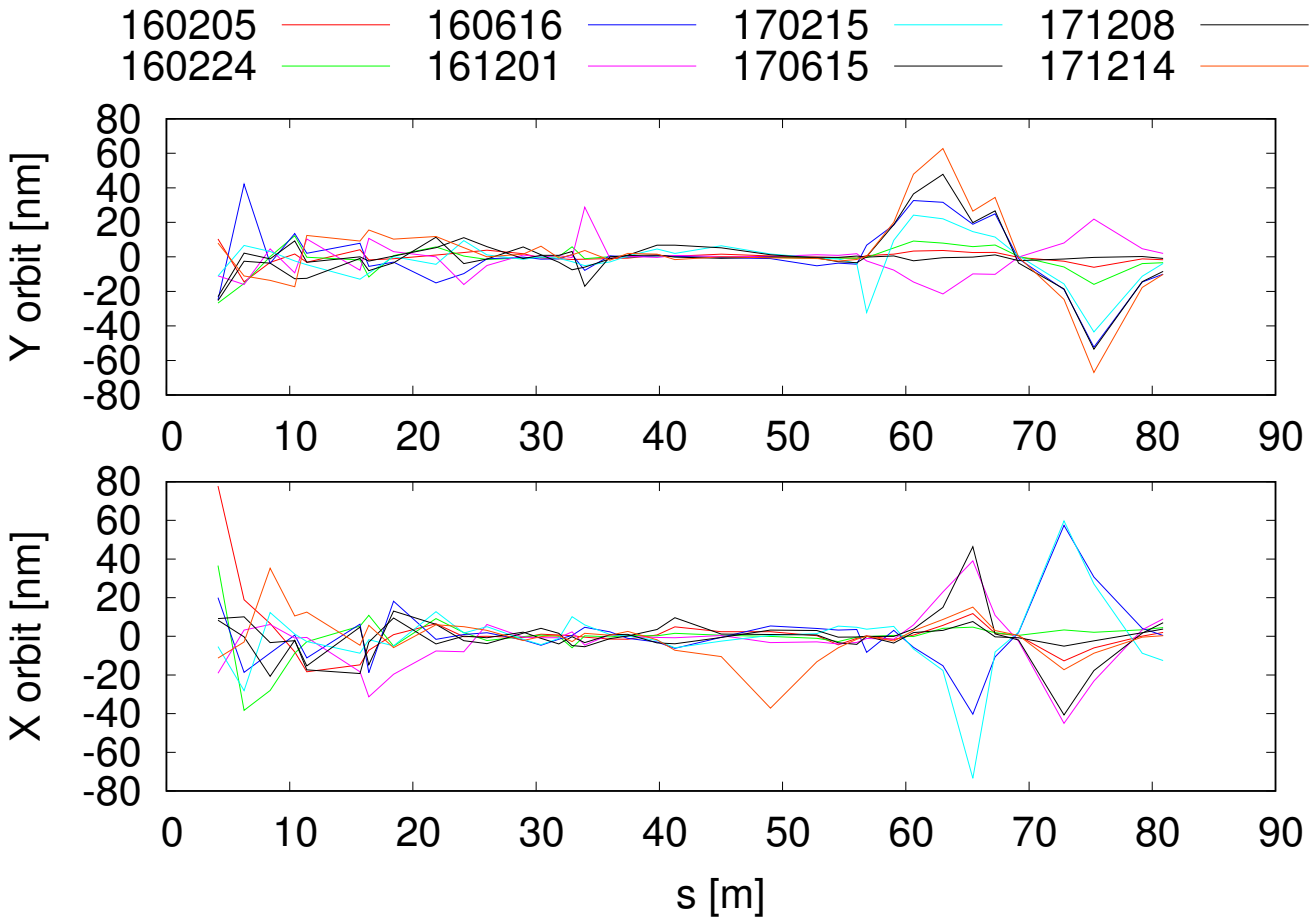
- $\beta^*_{x,y}$
- $\alpha^*_{x,y}$=0
- $\eta^*_{x,y}$=0
- $\alpha^{\mathrm{MFB1FF}}_{x,y}$=0
- $\alpha^{\mathrm{MFB2FF}}_{x,y}$=0

- $\Delta\phi_{MFB1FF\rightarrow IP} = n\frac{\pi}{2}$
- $\Delta\phi_{MFB2FF\rightarrow IP} = n\frac{\pi}{2}$
- $\Delta\phi_{ZH1FF\rightarrow IP} = n\frac{\pi}{2}$
- $\Delta\phi_{ZV1FF\rightarrow IP} = n\frac{\pi}{2}$

Successful attempt in Feb 2015 †

† https://agenda.linearcollider.org/event/6283/contributions/29303/attachments/24296/37607/Extraction_Status.pdf

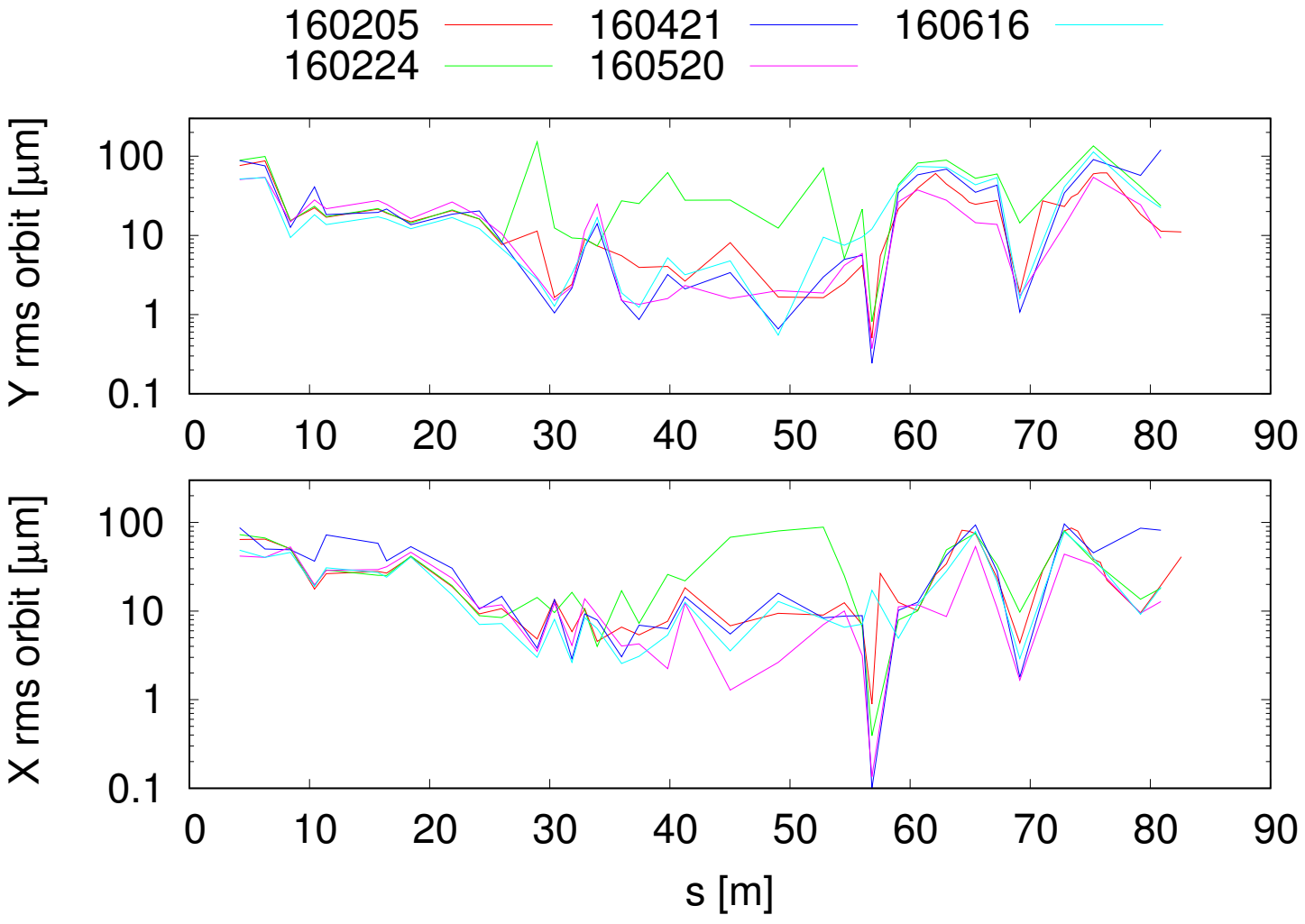
Orbit Conditions



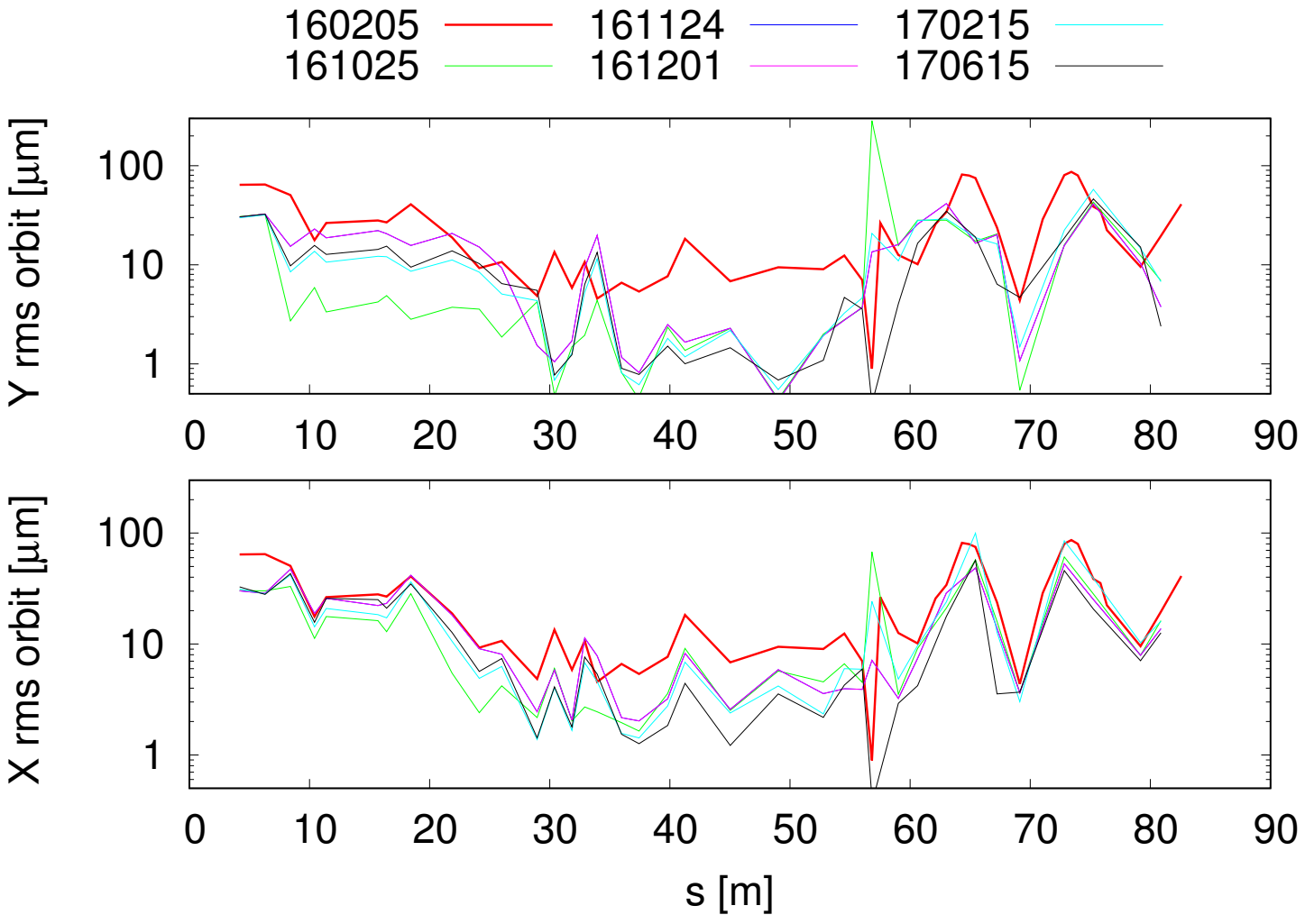
Y-orbit pattern is compatible with a non-corrected dispersion

Suggestion: Should we consider a feed-back on dispersion?

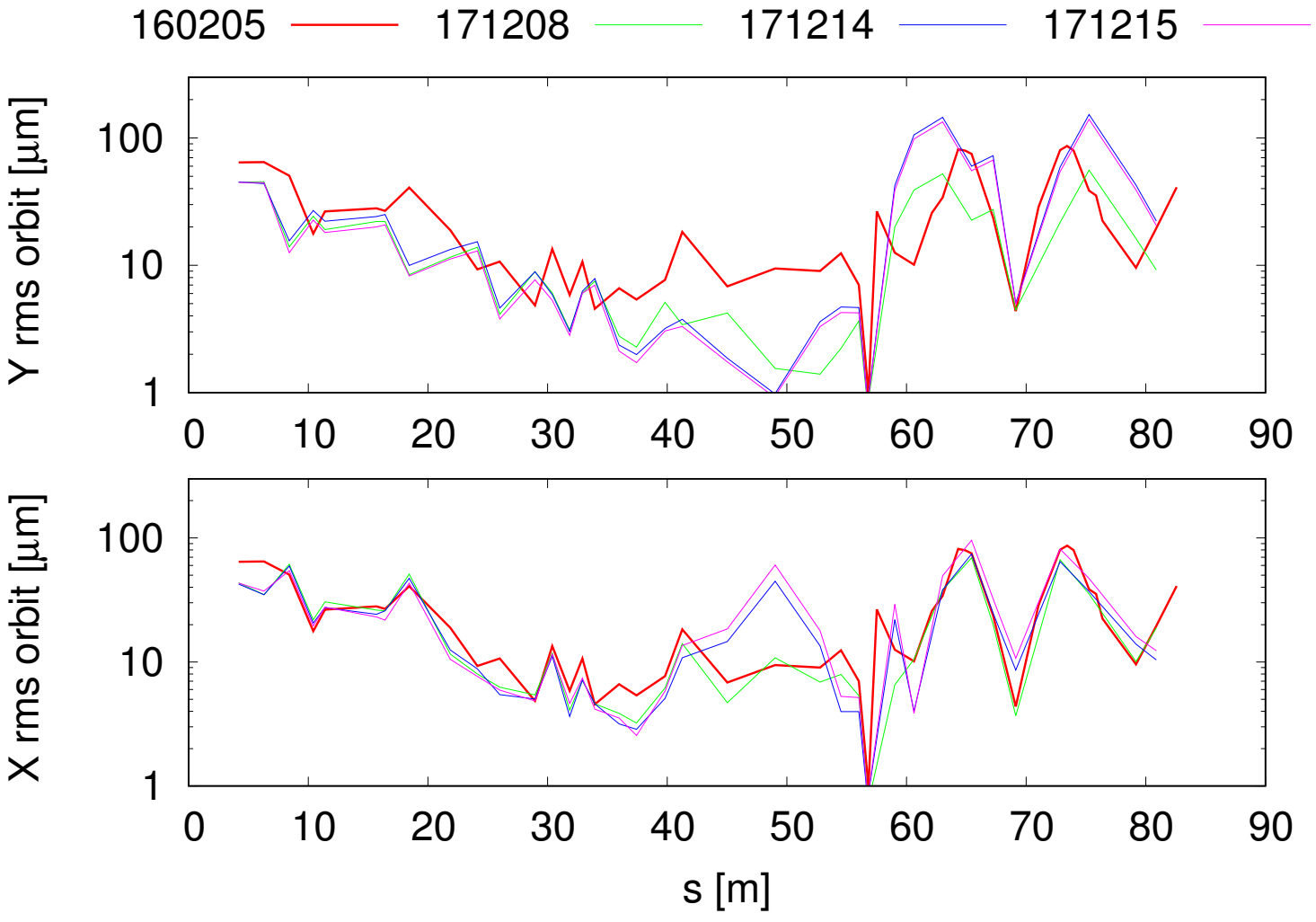
Jitter Conditions I



Jitter Conditions II



Jitter Conditions III

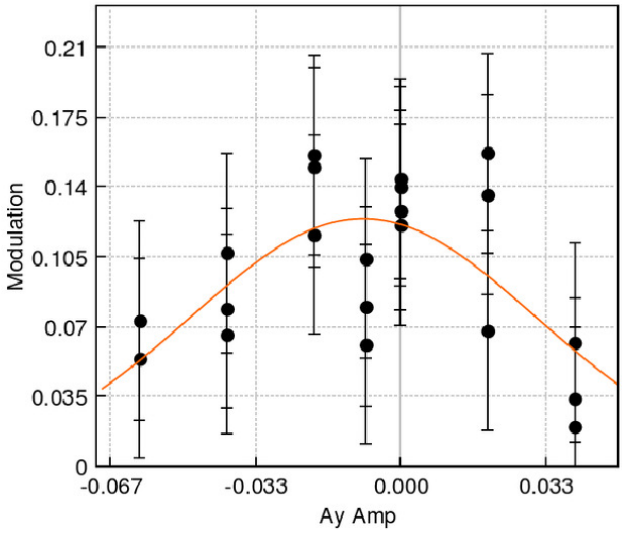


Data non-conclusive from orbit jitter conditions

IP Tuning

Complicated task as there are two systems to be tuned

- e^--beam
  - mixture of linear and non-linear aberrations
- Shintake Monitor
  - various modes, laser paths, timings, waist ....
- Time consuming process
  - critical for dynamic systems
- Measurement Error
  - Correction provided by knobs is comparable to Shintake measurement error



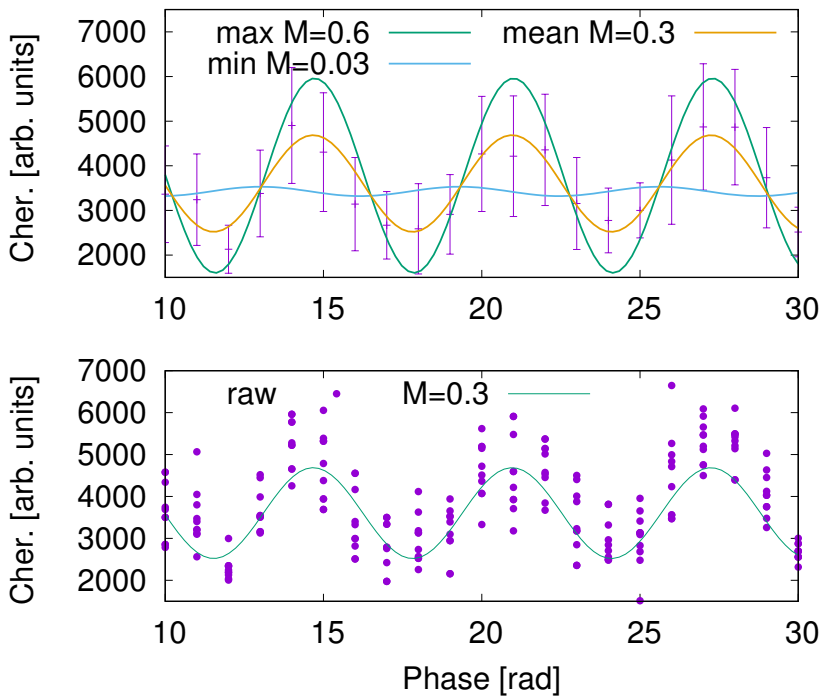
Similar error bars are obtained in other modes

Data taken 2017/12/14 - 174deg

mode - Day Shift

IPBSM Measurement Error

- IPBSM modulation errors larger than few percent impact the tuning dramatically
- $Av * (1.0 + M * cos(x + Phi))$ is fitted function on (raw or statistical data)



- It is crucial to minimize it as much as possible

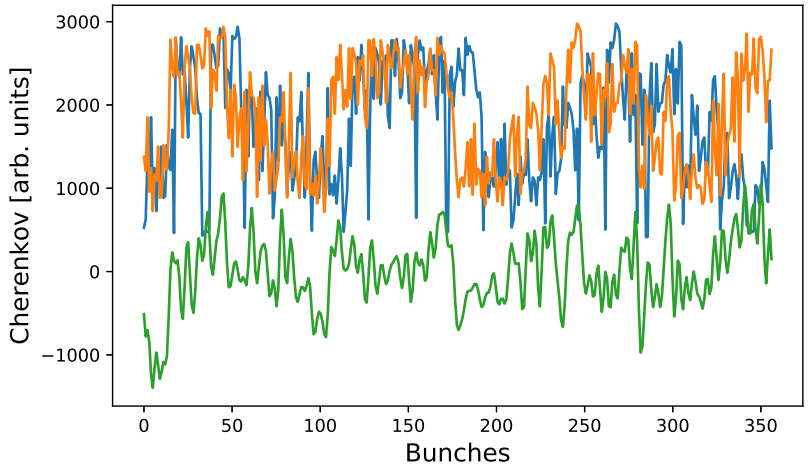
‡

‡Data taken 2017/12/14 - 174deg mode - Day Shift

Modulation Signal

Is the modulation obtained by Shintake monitor correlated with beam orbit?

- Low frequency removed by FFT from Cherenkov signal

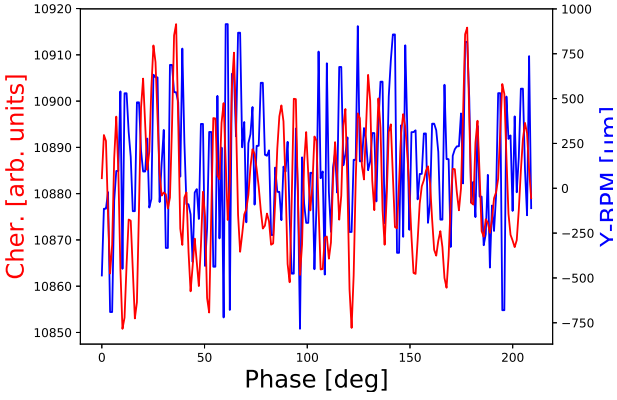


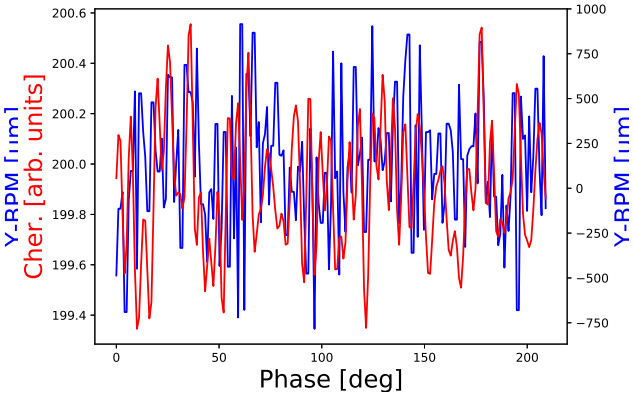
- Orbit data also treated by SVD

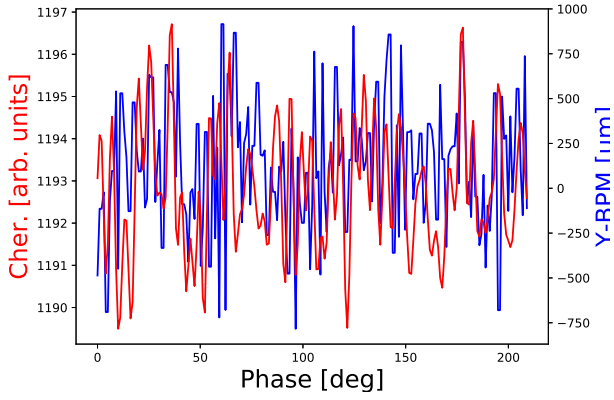
Modulation Signal vs Beam Jitter @ BPMs

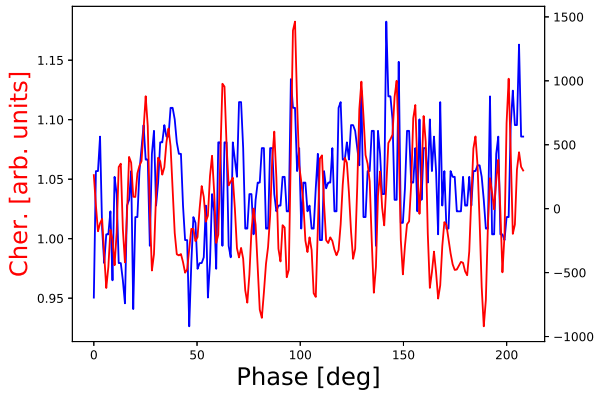
BPMs used in the study:

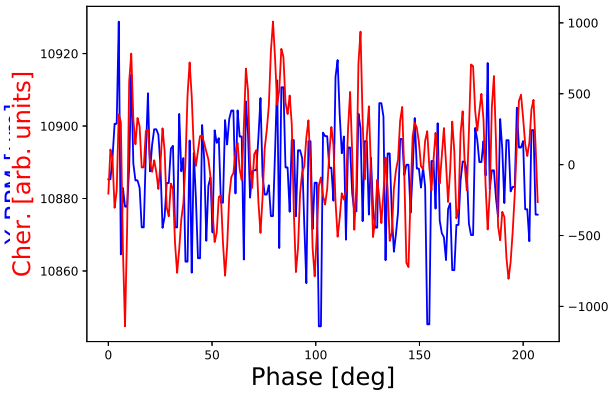
- MQM13FF
- MQM12FF
- MFB1FF
- MQF9AFF
- MQD8FF
- MQF7FF

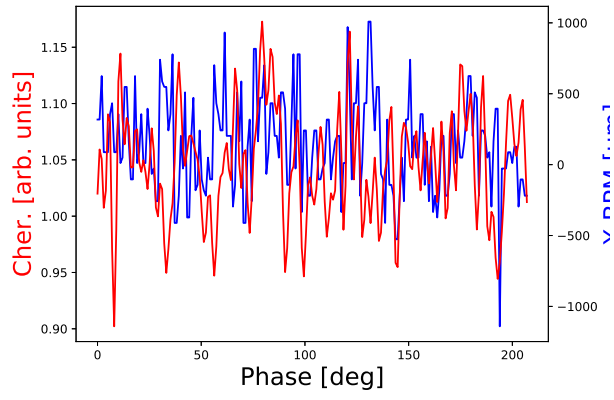






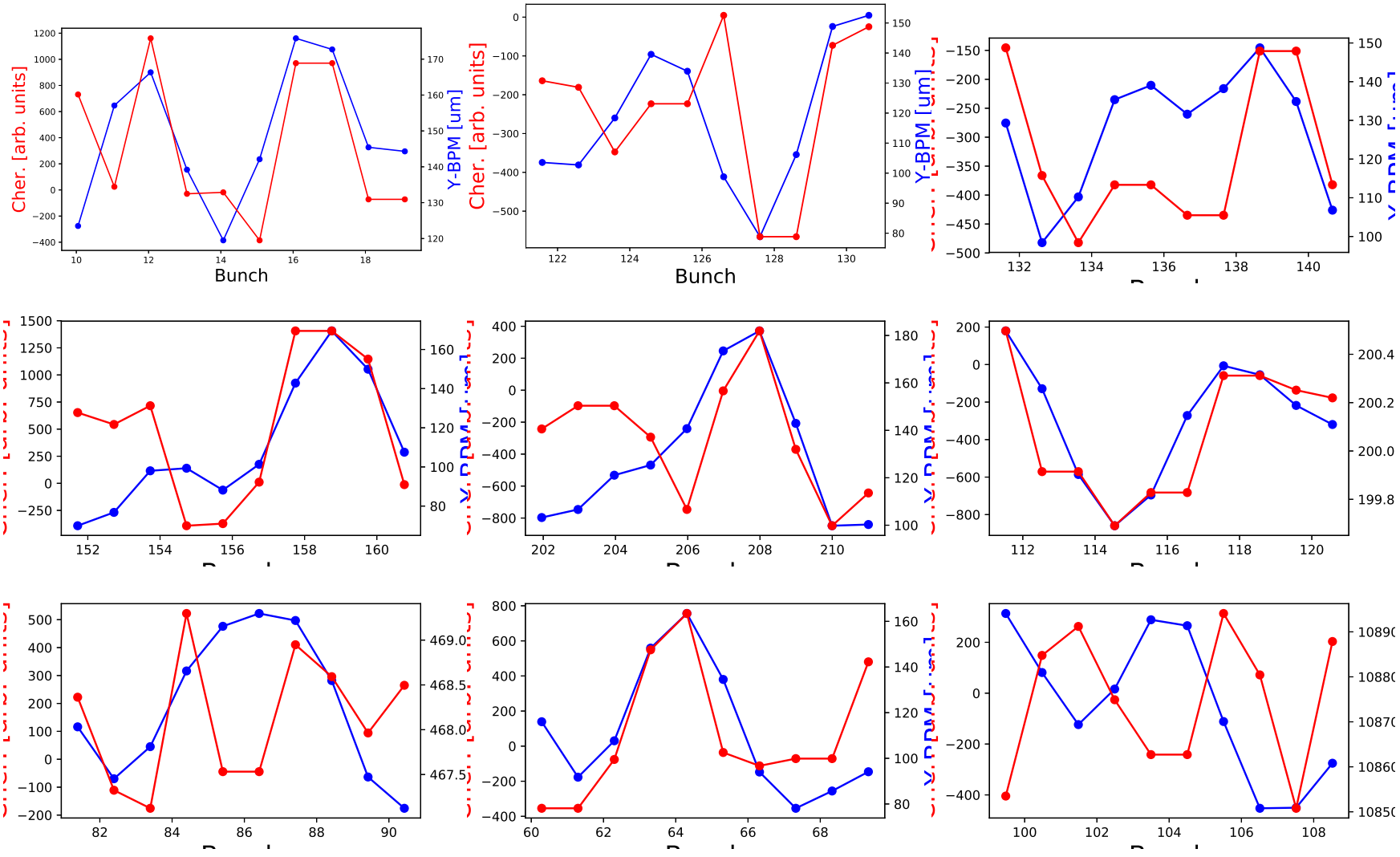






Shintake Modulation Fit

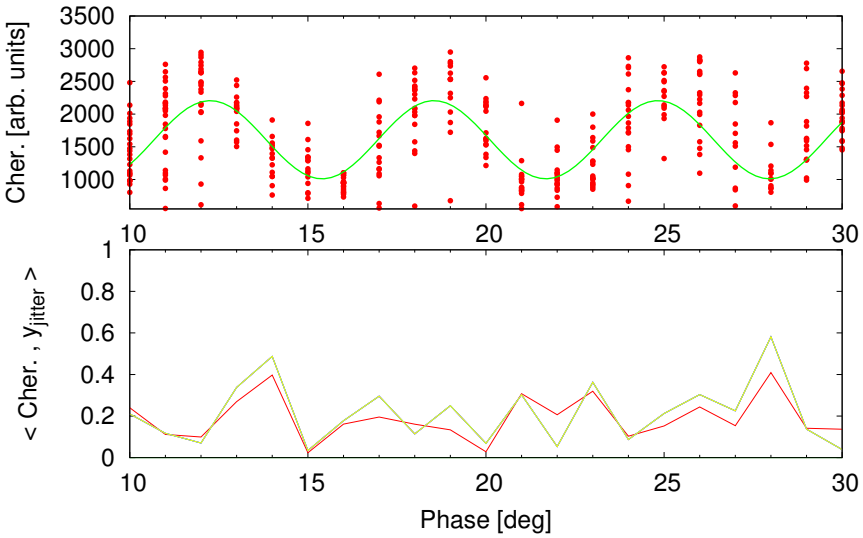
Modulation Error vs Beam Jitter @ single phase



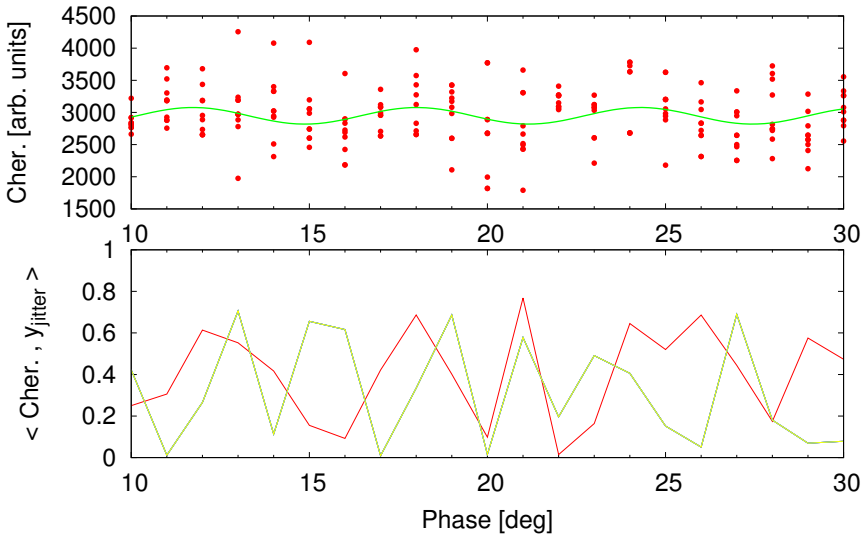
Correlation Coefficients

Correlation between orbit and the high frequency content of the modulation signal

- 2016/02/05



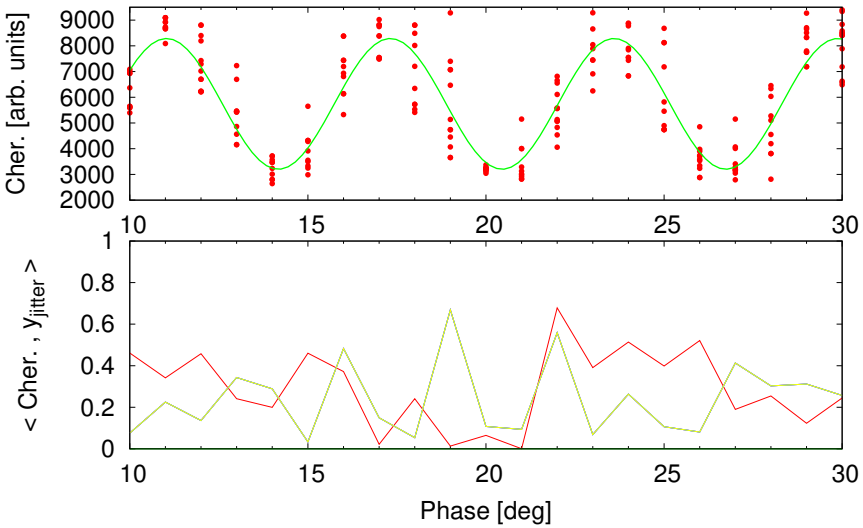
- 2017/12/14



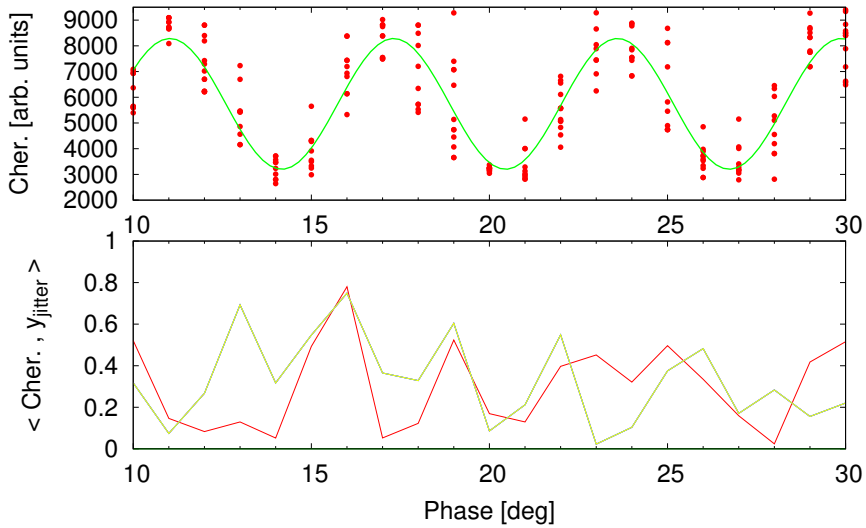
Much higher correlation observed in in Dec 2017 than Feb 2016

Correlation Coefficients-II

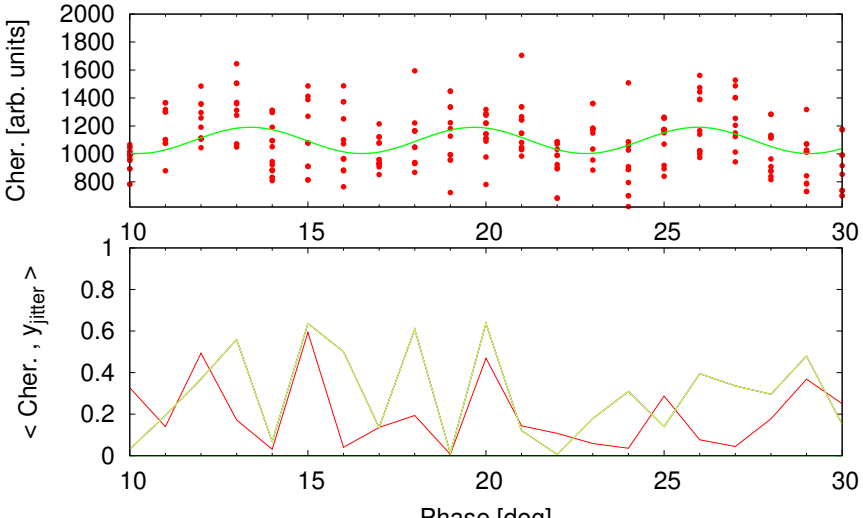
- 2016/10/25 (SVD)



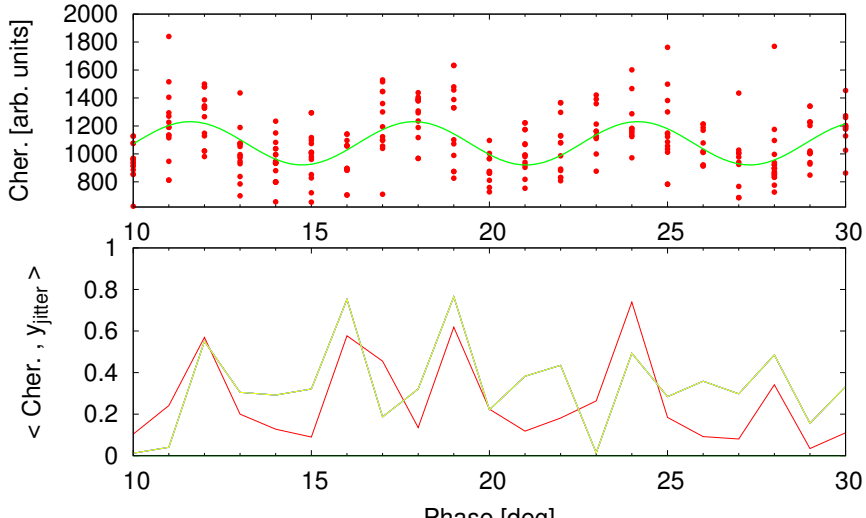
- 2016/10/25 (NO SVD)



- 2016/12/01 (SVD)

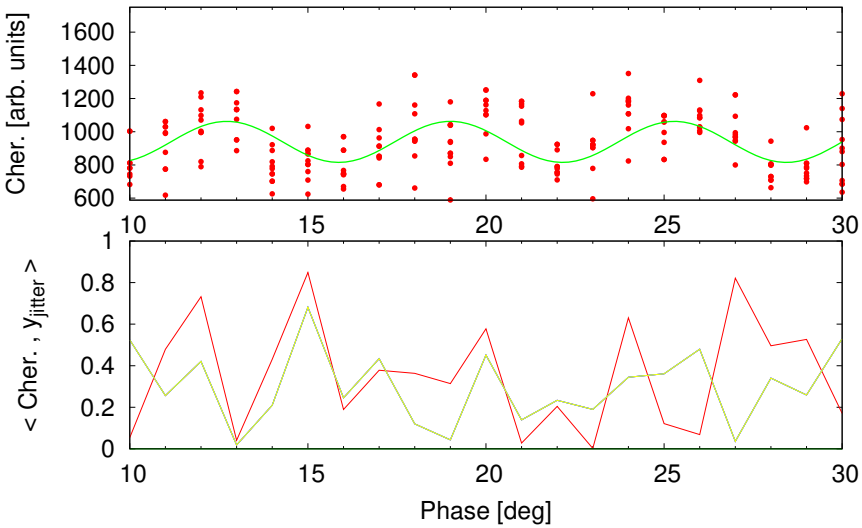


- 2016/12/01 (NOSVD)

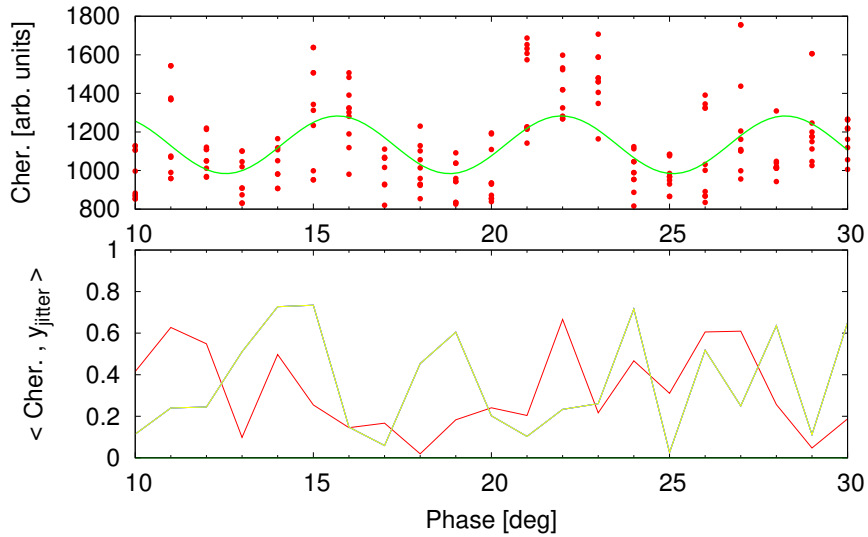


Correlation Coefficients-III

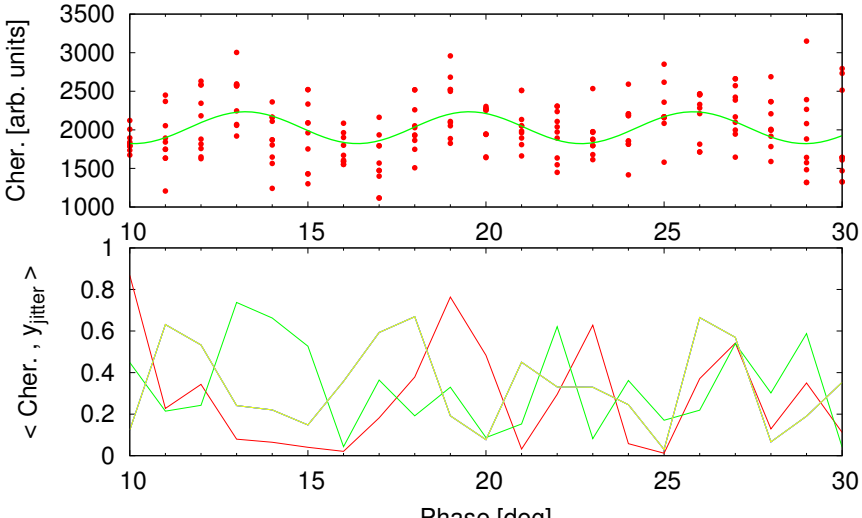
- 2016/11/24



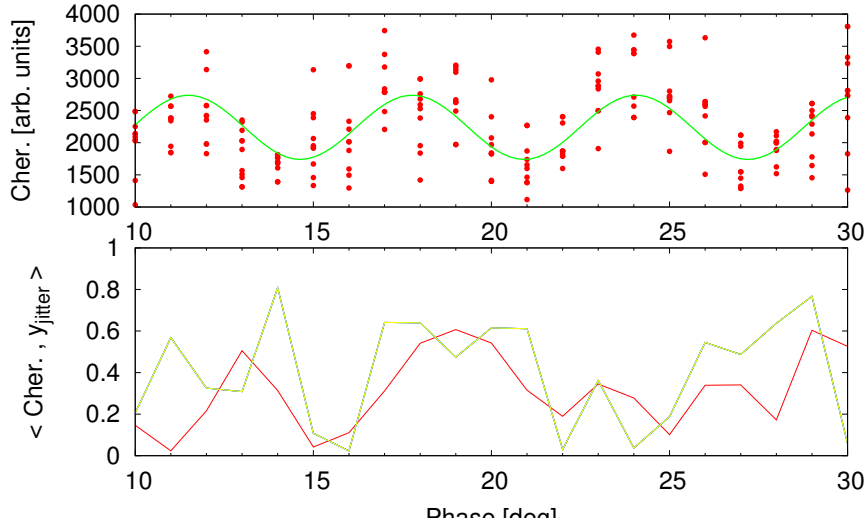
- 2017/02/15



- 2017/06/15

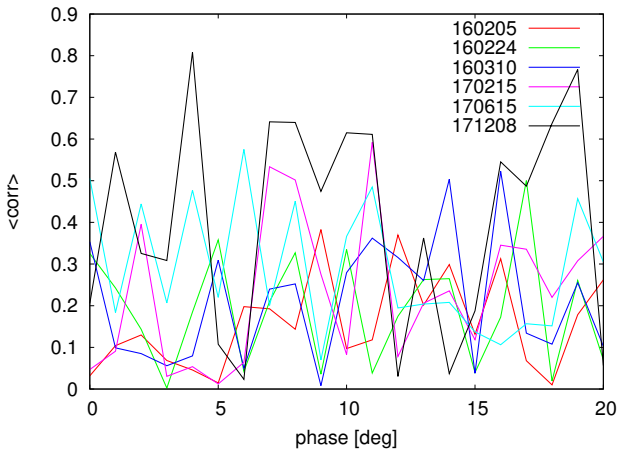


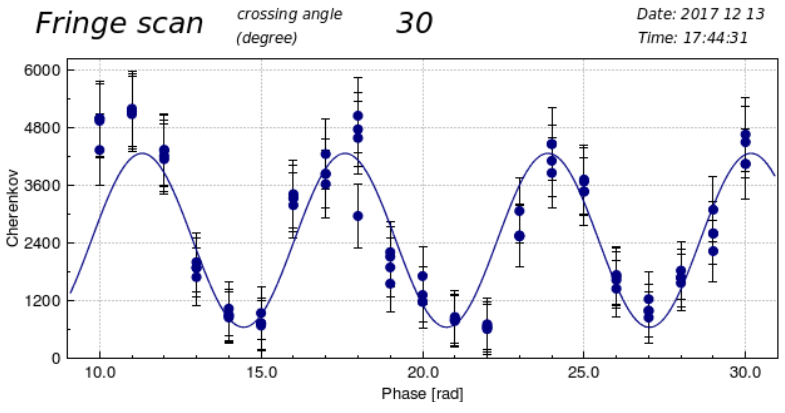
- 2017/12/08



Correlation Coefficients Summary

- Low correlations are observed for 2016/02 and 2016/03 runs
- Higher correlations are observed for 2017/02, 2017/06 and 2017/12 runs

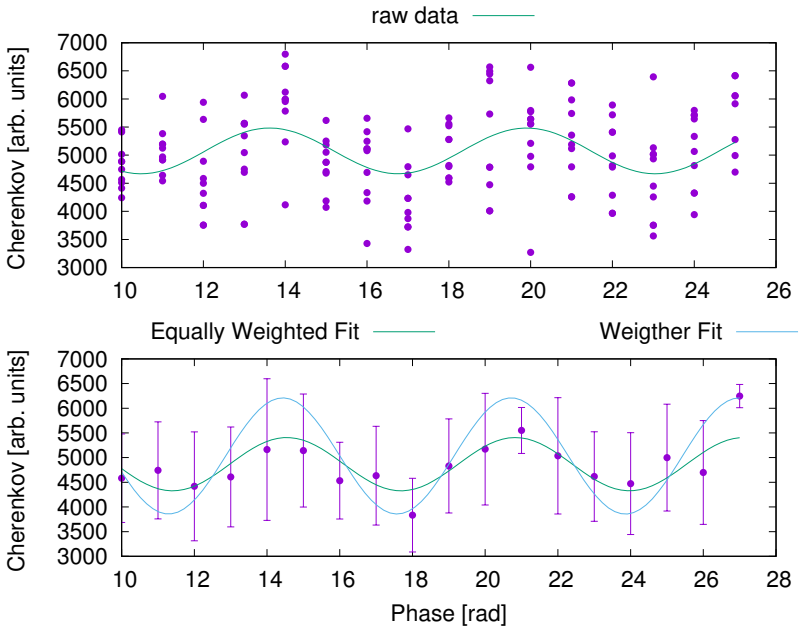


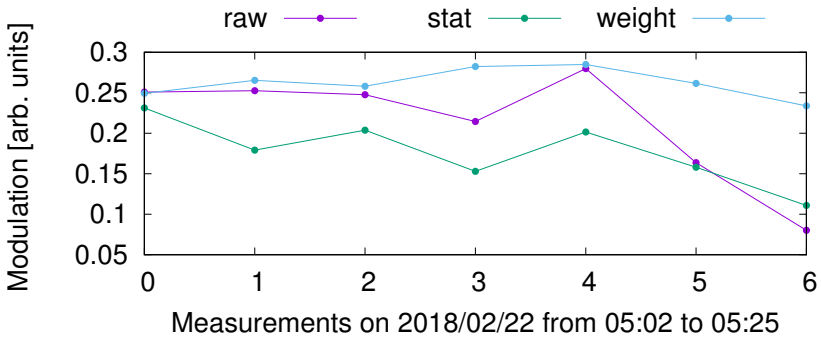


Modulation Fit Suggestion

Should we implement a 3rd kind of fit with larger weights on the peaks and valley

Attempt: Weight inversely proportional to the error



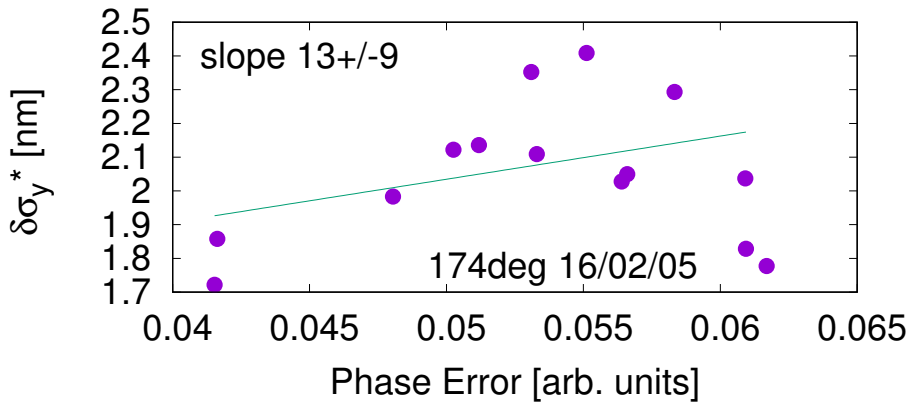


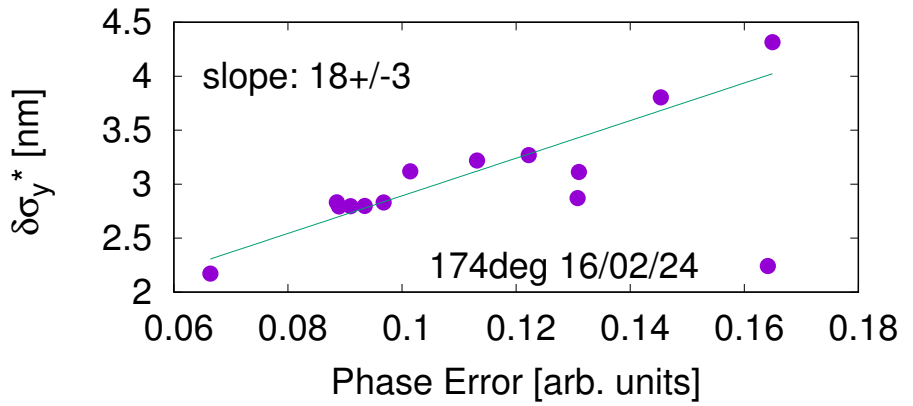
The implemented weighted method obtains larger modulation while keeping the slope

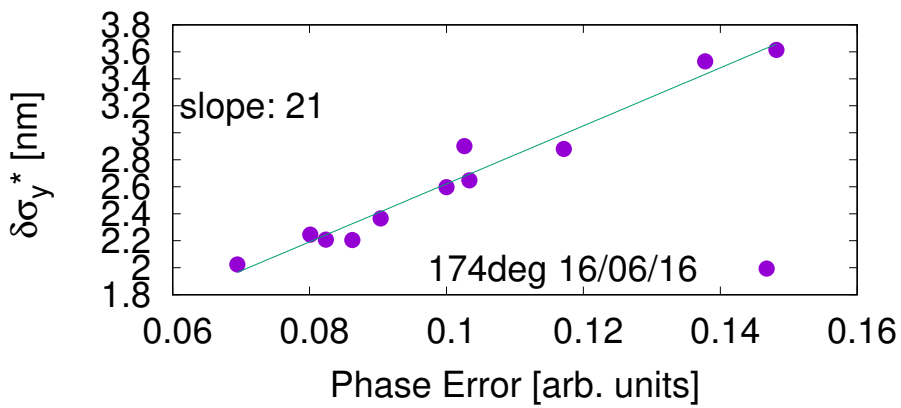
Beam Size Error vs Phase Error I

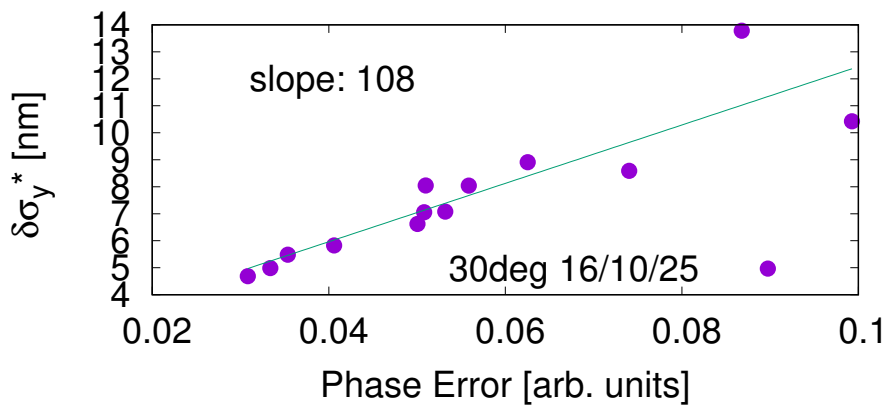
Goal: understand the contribution from phase error fit to beam size error

$$\sigma_y^* \approx M = Av * (1.0 + M * cos(x + Phi))$$



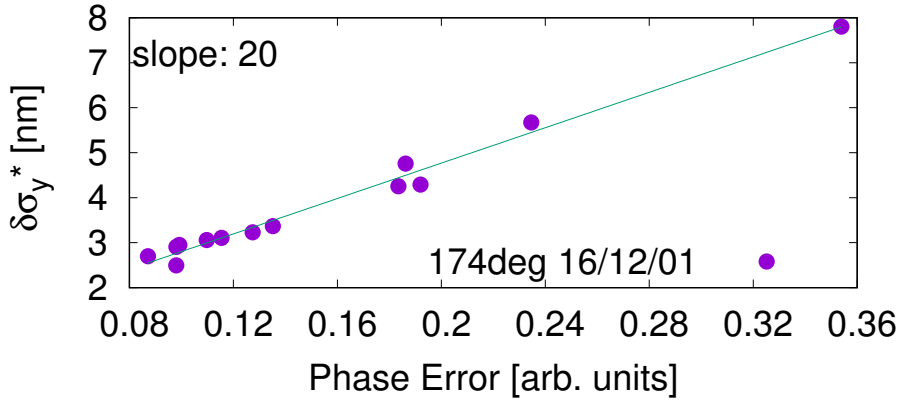


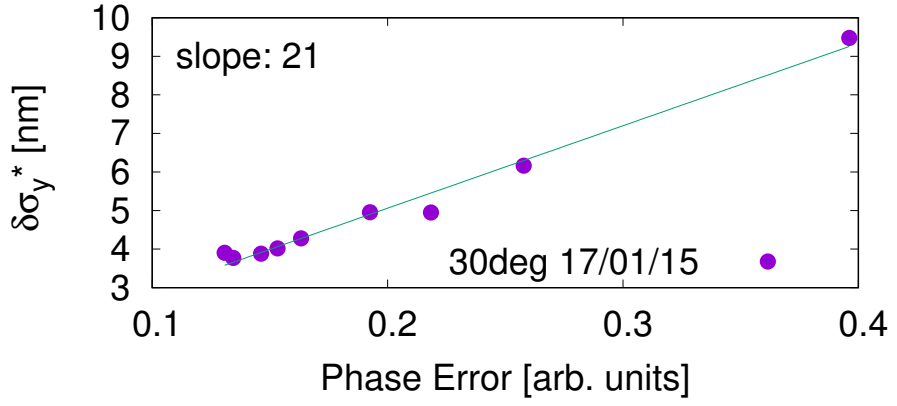


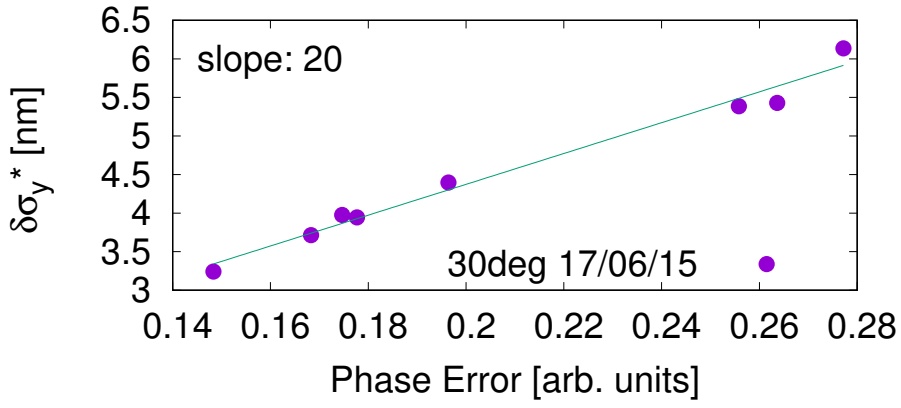


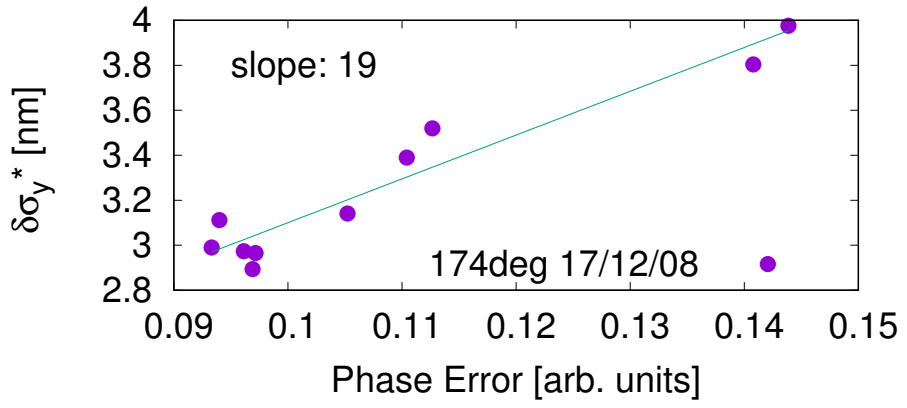
Shintake Modulation Fit

Beam Size Error vs Phase Error II

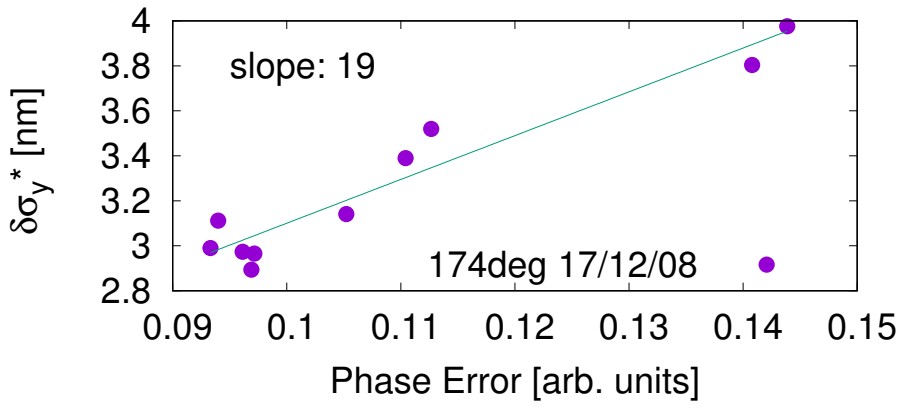


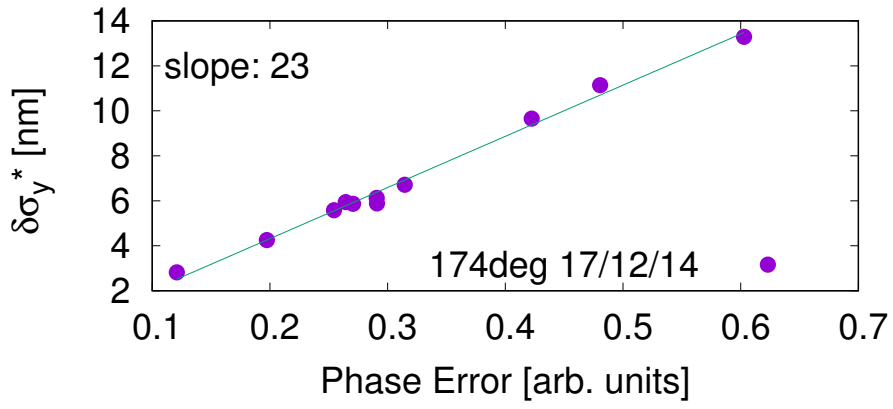


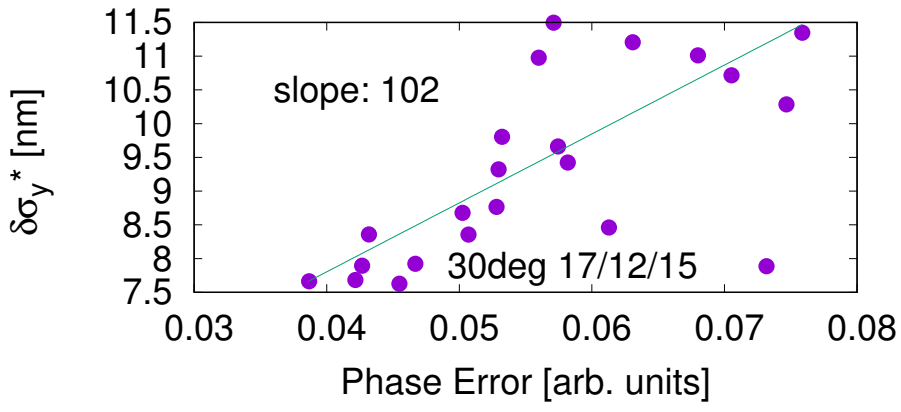




Beam Size Error vs Phase Error III







Data non-conclusive from Phase errors

Conclusions

- Standard tuning procedure has been proven to work (*Excel.lent results in earlier 2016 runs*)
  - mOTR (emittance, coupling, matching)
  - Sextupole alignment
- Other variables into play: jitter, orbit, Shintake, ...?
  - Jitter conditions seems to be equivalent
  - Orbit condition suggest a dispersion correction feed-back
- Beam size error should be reduced
  - Correlation coefficient explain modulation fluctuations intermittently and mostly between high and low modulation phases
    Other hidden variables?

Suggestions:

- m-OTR system key ingredient for matching and coupling correction
- Dispersion feed-back
- Weighted fit on peaks and valleys to determine modulation
- 2-Bunch operation mode?