Status of APEX studies for CeC PoP

I. Pinayev, V. N. Litvinenko, M. Minty, A. Marusic, V. Ptitsyn, D. Trbojevic, G. Wang

APEX workshop, Nov. 20th, 2012

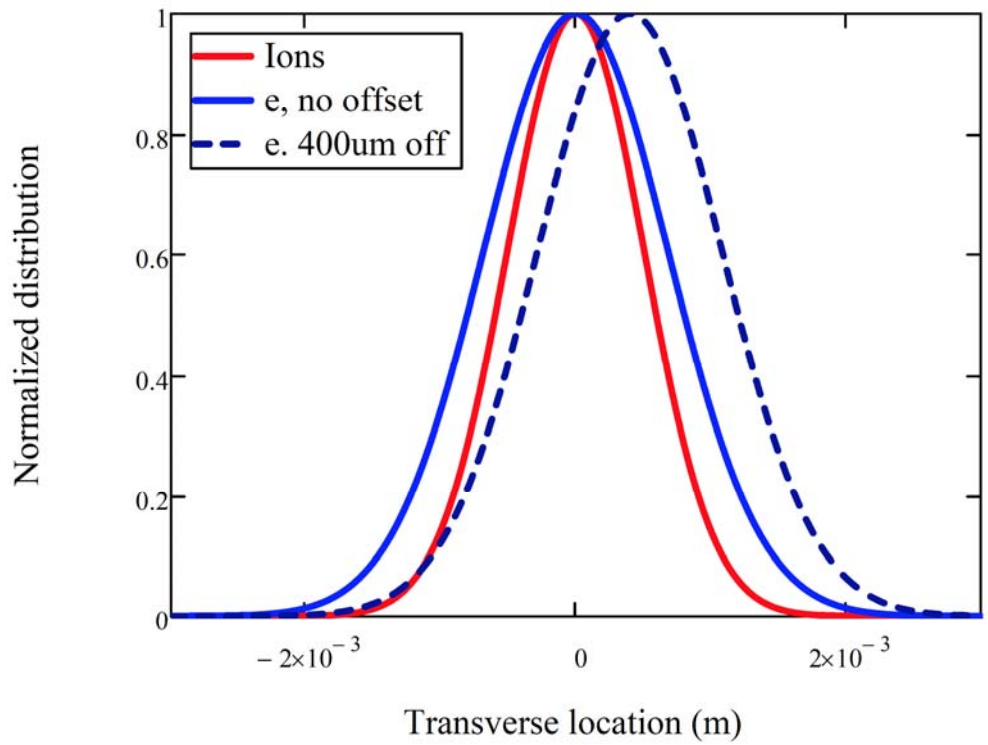
Goals of CeC APEX in run 12

- Measure beam parameters critical for CEC POP:
  - Orbit stability

  e rms size: 682 um

  Ion rms size: 506 um

Unstabe orbit introduce transverse offsets between electron beam and ion beam, which reduces cooling force seen by the ions.



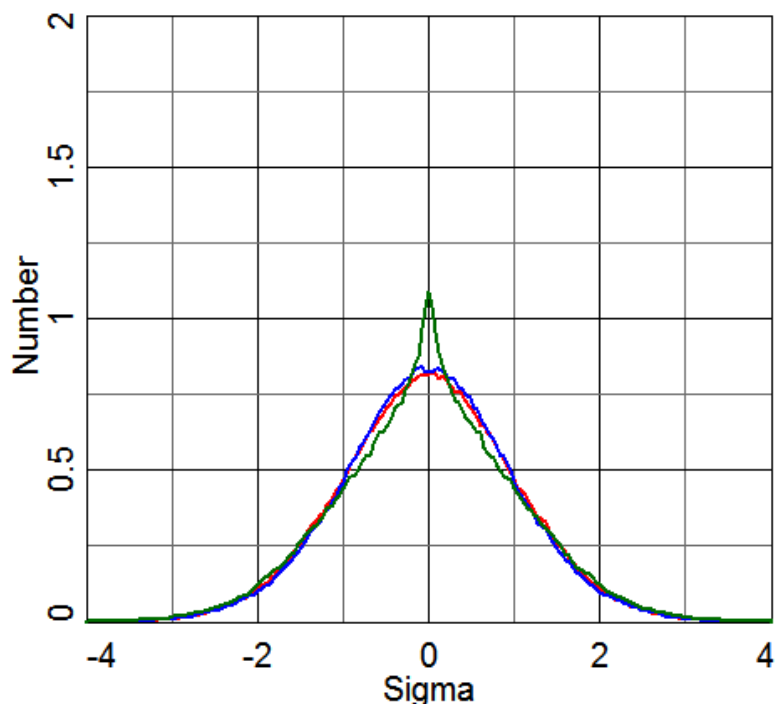
Goals of CeC APEX in run 12 con. 1

– longitudinal arriving time jitter of ion bunches

$$\sigma_{i,\tau} = 5ns$$

$$\sigma_{e,\tau} = 5ps$$

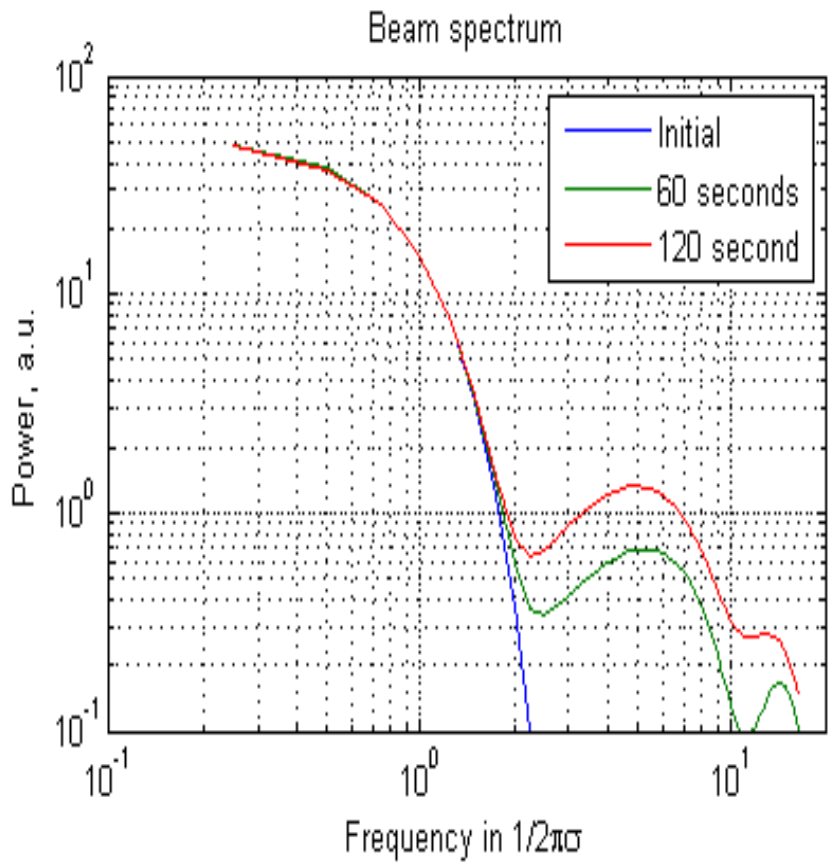
- ✓ Observation of local cooling could be an effective way for cooling diagnostics.
- ✓ Longitudinal jitter can reduce effective local cooling rate and hence affect the efficiency of cooling diagnostics.



Goals of CeC APEX in run 12 con. 2

– Ion bunch spectrum

- ✓ The longitudinal size of the 'bump' due to local cooling is determined by electron bunch size.
- ✓ Betacool simulation suggests that an increase of the spectrum power in the range from 200 MHz to 800 MHz should be observed after 60 seconds of effective cooling, if the noise level allow.
- ✓ Thus, it is essential to measure the ion beam spectrum and noise level in the relevant frequency range.

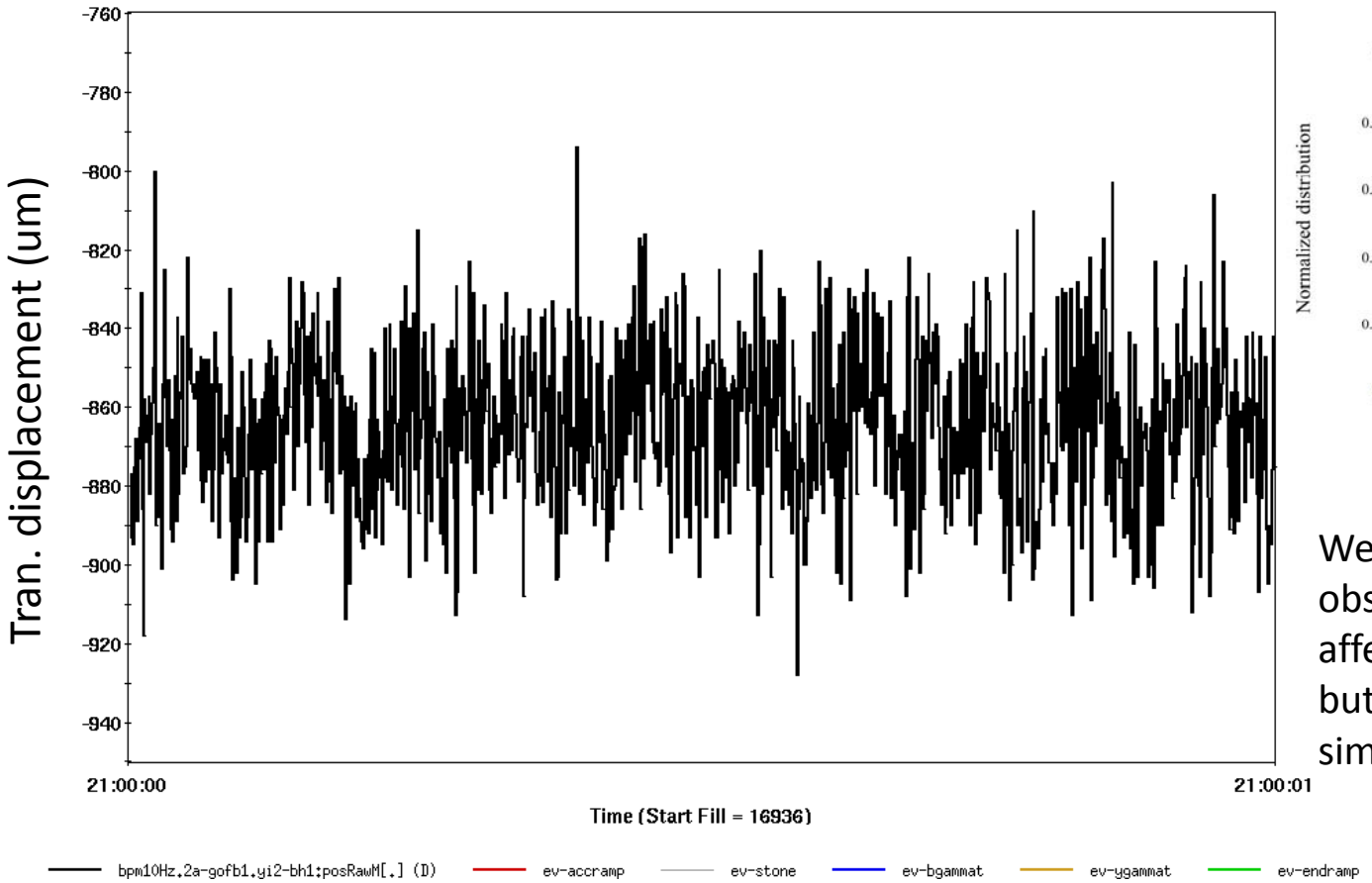


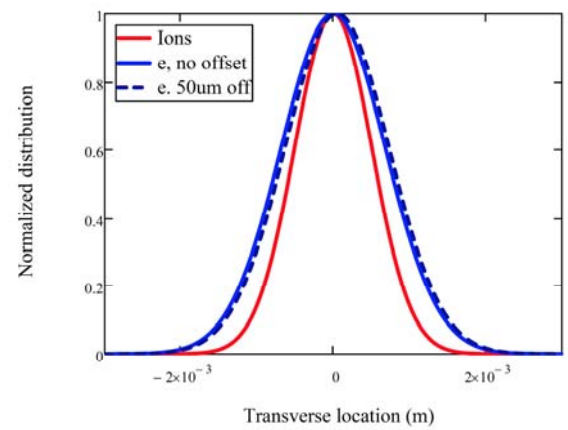
Machine setup during CeC APEX session on May 30th

- Yellow, fill 16936, Au at 100 GeV/u:
  - took beam from the previous APEX session (we dumped blue while keeping yellow);
  - no re-bucketing, Landau cavities off, stochastic cooling off, 10 Hz orbit feedback on;
  - connecting WCM output in I004a (used for cogging monitor) with *LeCroy WaveRunner 640Zi digital oscilloscope* (with jitter analysis package).

Measurements on May, 30th

- Orbit stability: ~100 um (peak to peak)

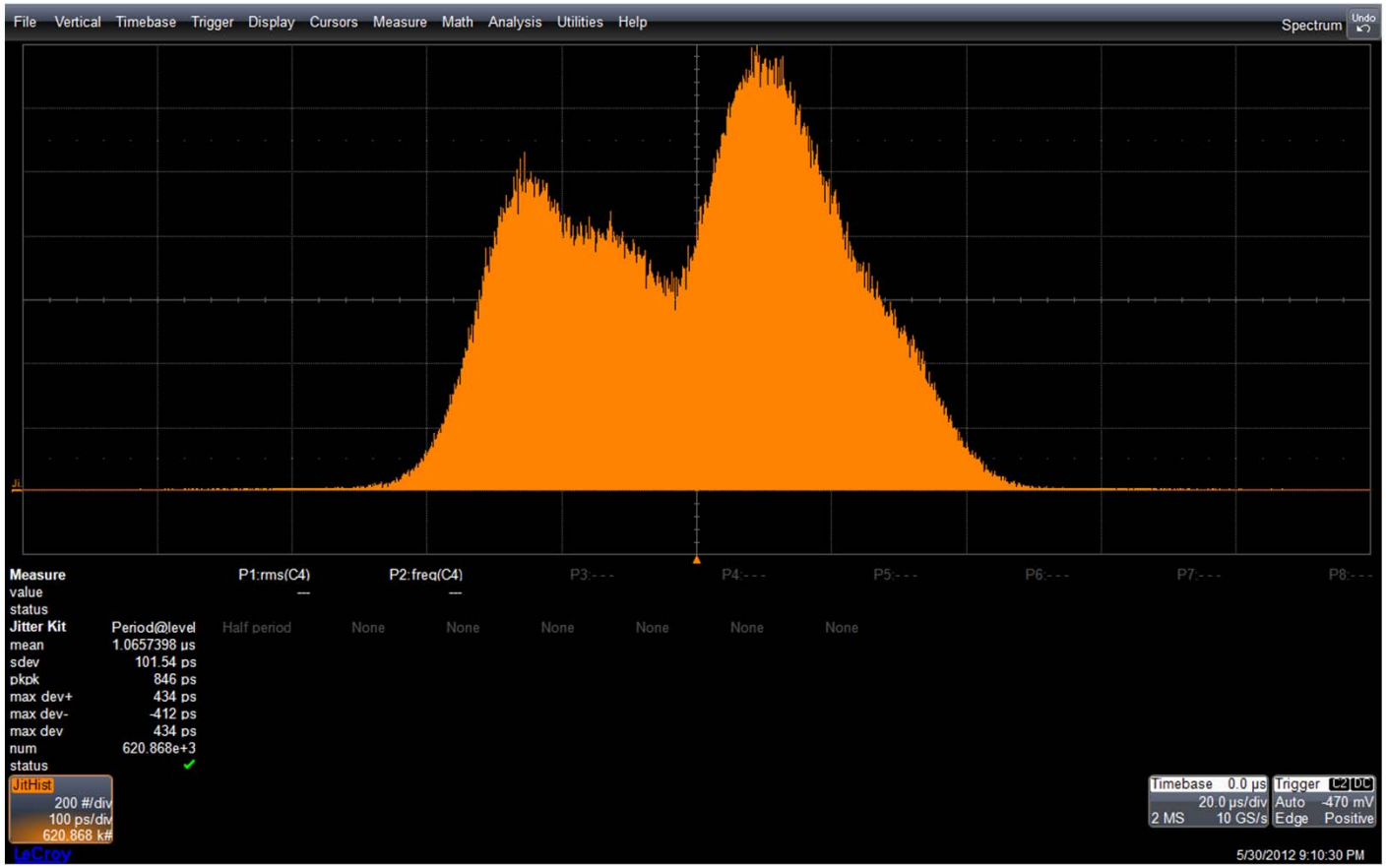




We do not expect that the observed beam motion will affect CEC POP experiment, but real data will be used for simulations.

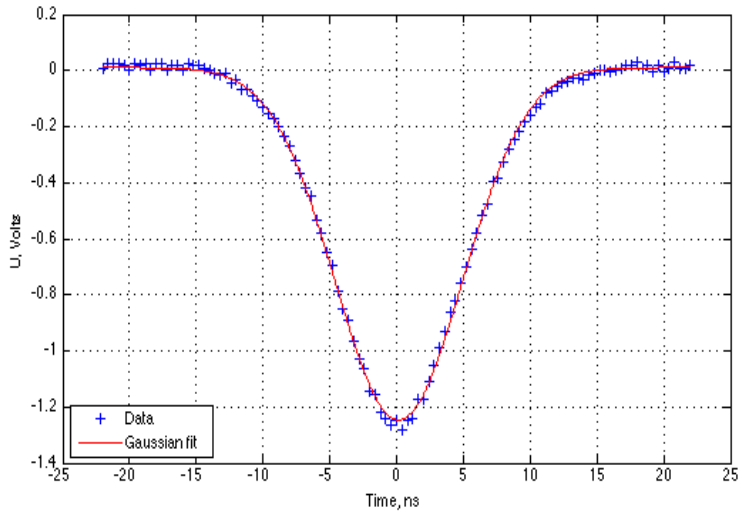
Measurements on May, 30th continue 1

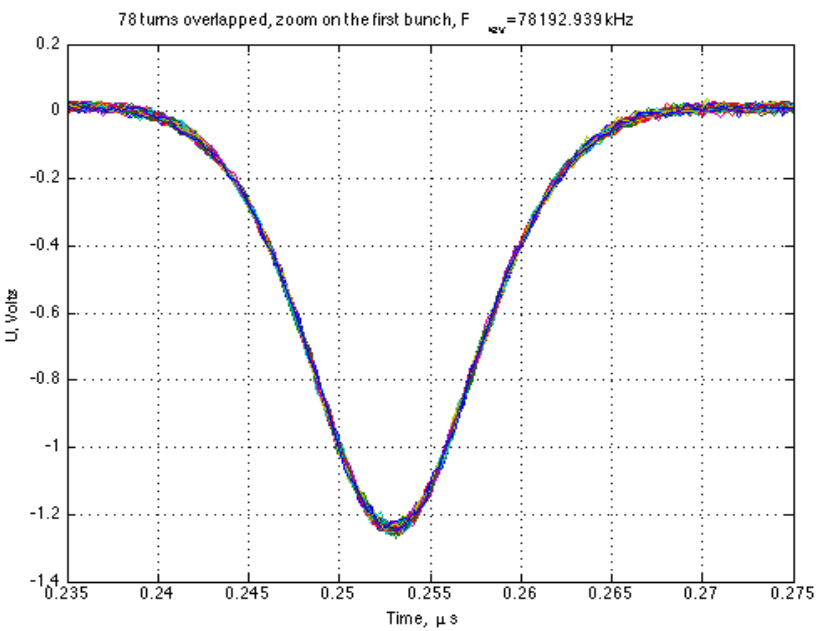
- Longitudinal jitter:
  - the rms jitter level as measured by the oscilloscope for 12 bunches is ~50 ps. (The deviation from Gaussian is possibly due to the charge variation from bunch to bunch.)

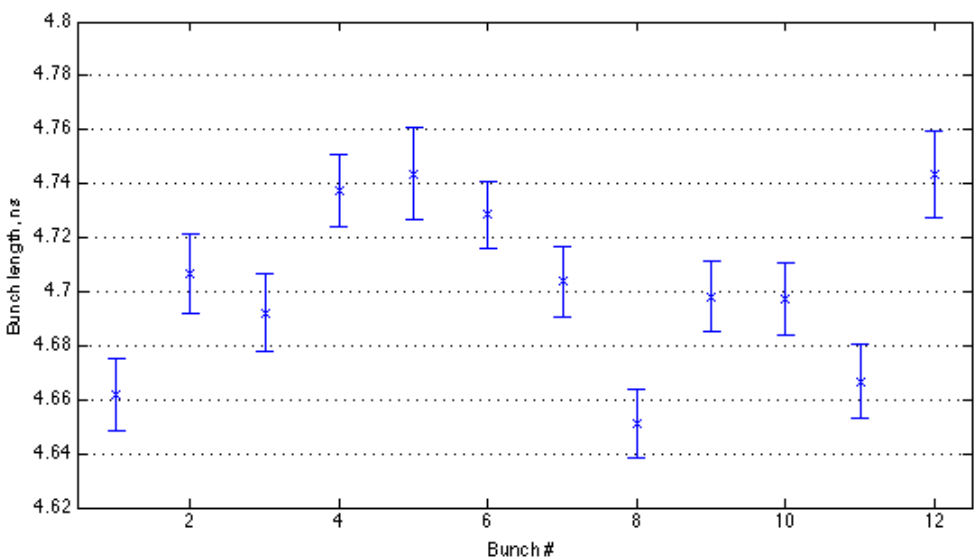


Measurements on May, 30th continue 2

- The jitter level as measured for a specific bunch is around 15ps, which is in the same level of the tbt variations of the bunch length measurements.
- As the measurement is probably limited by the WCM precision, the real beam jitter can be even smaller.
- Since the jitter level is much smaller than the size of the 'bump' due to local cooling, we don't expect that the PoP experiment will be effected.



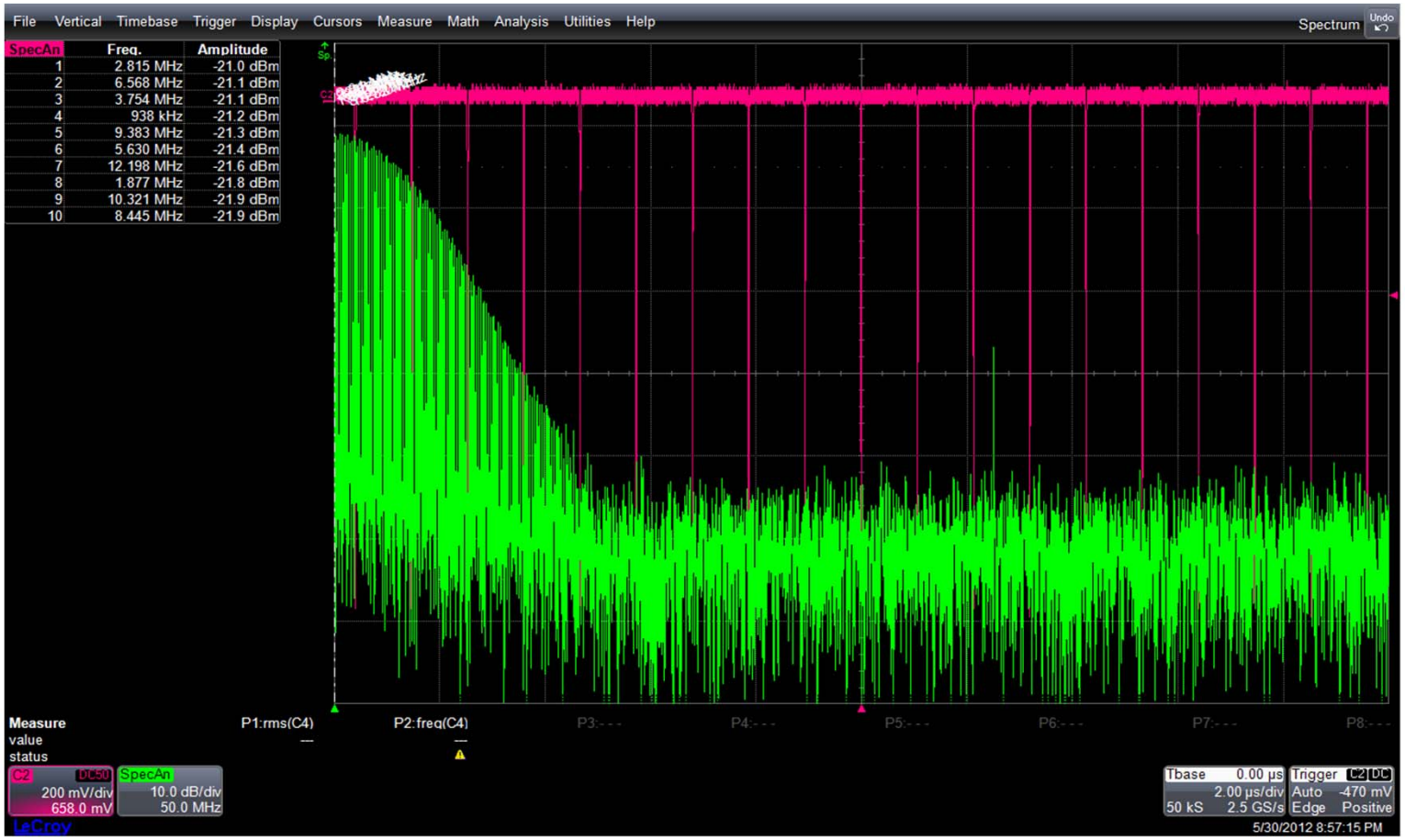




Measurements on May, 30th continue 3

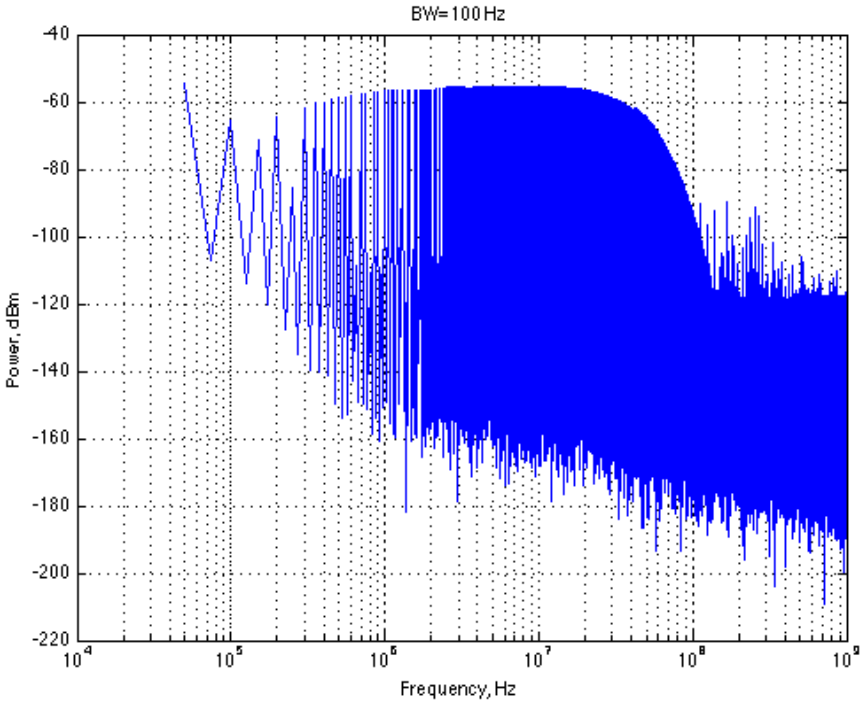
Beam Spectrum (500 MHz span, 28 MHz, 150KV):

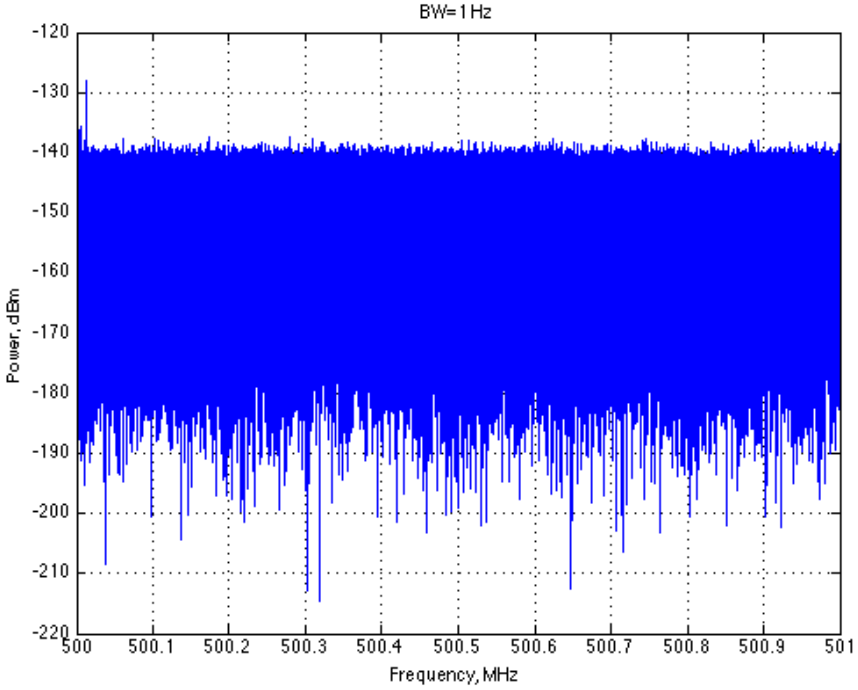
The noise level is ~40 dB down the beam signal and we need to reduce the noise level in order to observe spectrum change due to local cooling.



Measurement on June, 22nd

We took 20 minutes measurement at injection in yellow ring on June 22nd with Agilent N9010A signal analyzer.





Noise level is 80 dB below the level at revolution frequency. Small acquisition time (4 seconds) allows in real time monitor the cooling process.

Summary

- The measured orbit stability is 100 um (peak to peak), which is not expected to affect CeC PoP experiment.
- The measured arriving time jitter is 15 ps, which is not expected to affect CeC PoP experiment.
- The noise level can be reduced to 80 dB below the beam signal at the range of 500 MHz, which should allow observation of local cooling.
- These measured values will be put into simulation for realistic cooling estimation.
- We currently do not have requests for beam time in run 13.

Backup Slides

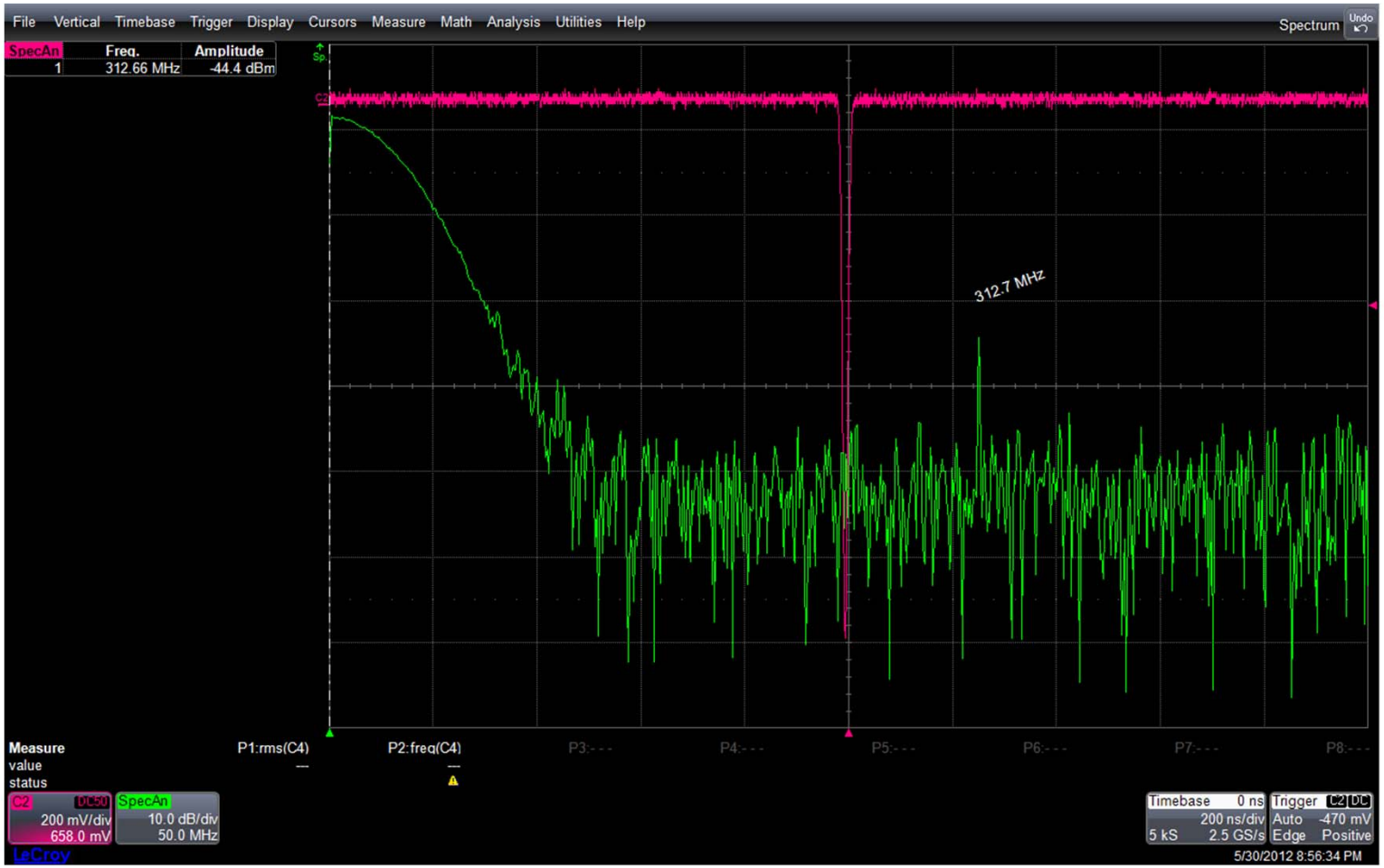
Things to prepare

- Summary of run 11 data
  - Beta star measurement

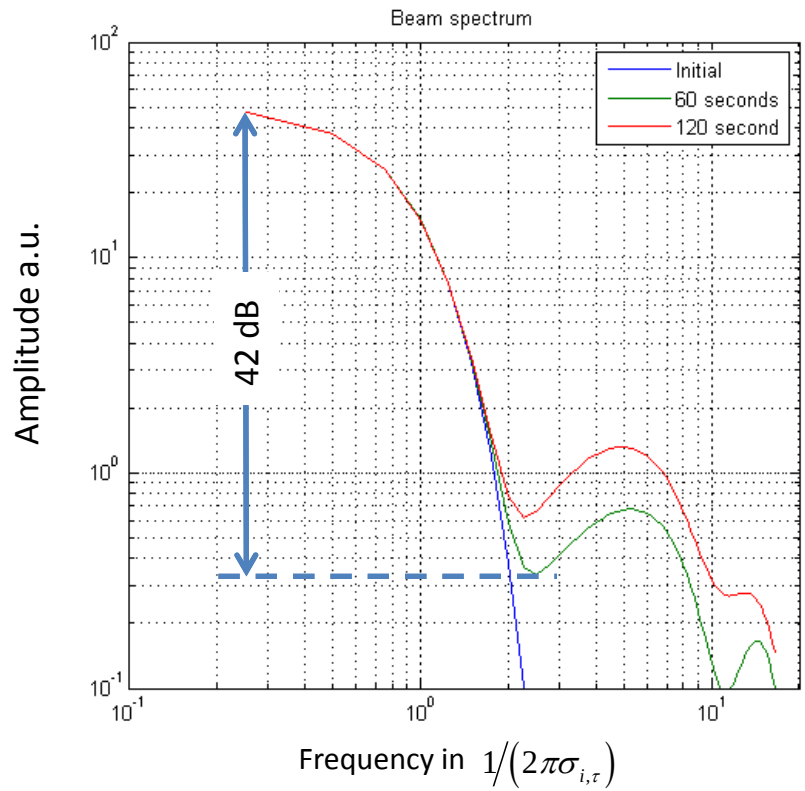
    IR2 optics measurements for Blue
    horizontal plane: beta* = 4.92 m, s* = -0.89 m
    vertical plane: beta* = 5.30 m, s* = 0.24 m

Measurements on May, 30th continue 3

- Spectrum:



Goals of CeC APEX in run 12 con. 2

– Ion bunch spectrum

- ✓ The longitudinal size of the 'bump' due to local cooling is determined by electron bunch size.
- ✓ Betacool simulation suggests that an increase of the spectrum power in the range from 200 MHz to 800 MHz should be observable after 60 seconds of effective cooling, if the noise to signal ratio (power) is below 40dB.
- ✓ Thus, it is essential to measure the ion beam spectrum and noise level in the relevant frequency range.