

Cornell University
Laboratory for Elementary-Particle Physics



CesrTA

Low Emittance Program

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Low Emittance Tuning

Objectives

- Develop strategies for systematically tuning vertical emittance
  - Rapid survey
  - Efficient beam based alignment algorithm
- Demonstrate ability to reproducibly achieve ultra-low emittance
  - In CesrTA this corresponds to a vertical beam size of about ~10-14 microns
- Enable measurement of instabilities and other current dependent effects in the ultra low emittance regime for both electrons and positrons

  For example - dependencies of
  - Vertical emittance and instability threshold on density of electron cloud
  - Cloud build up on bunch size
  - Emittance dilution on bunch charge (intrabeam scattering)

Alignment and Survey

Instrumentation - new equipment

Digital level and laser tracker

Network of survey monuments

→Complete survey in a couple of weeks

Magnet mounting fixtures that permit precision adjustment

- beam based alignment

Beam Position Monitor System

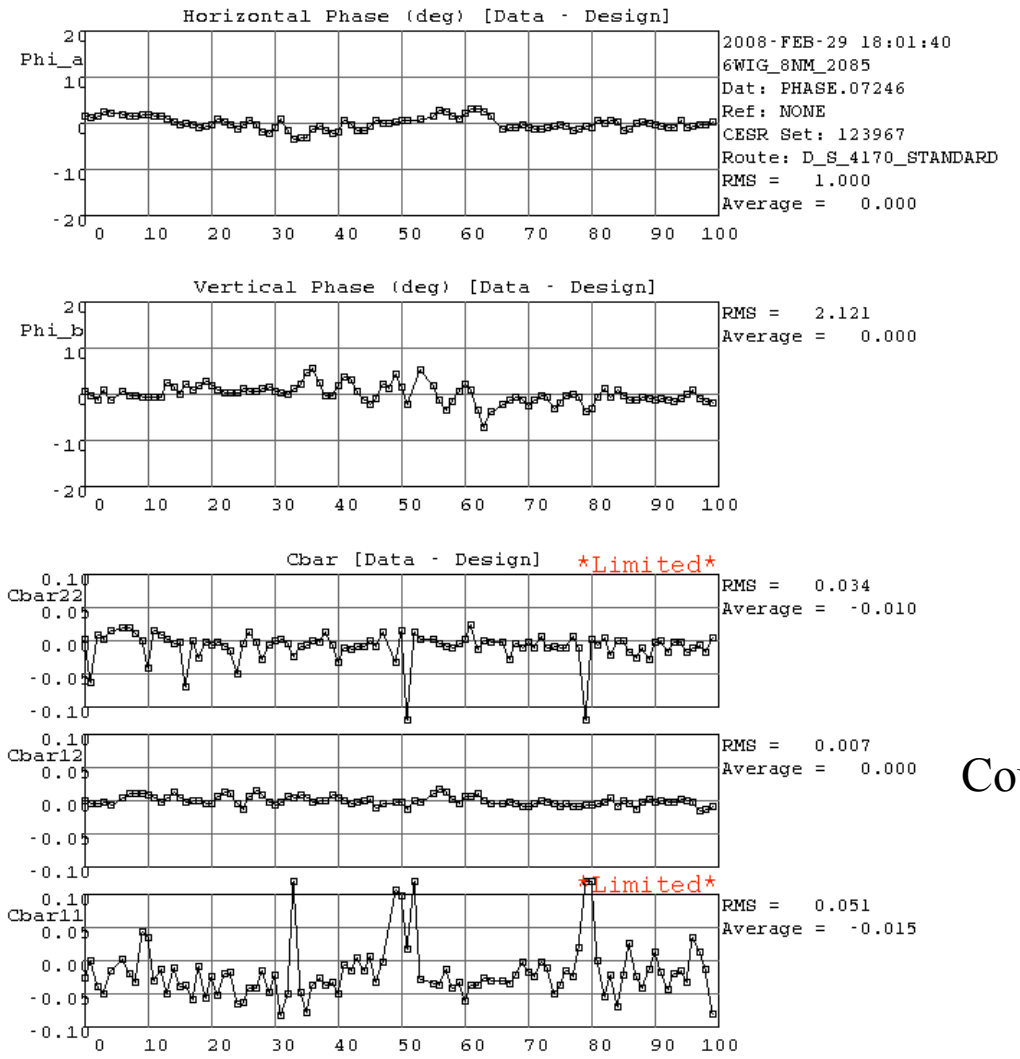
- Presently (and for June 08 run) have a mixed dedicated digital system with twelve stations and a coaxial relay switched analog to digital system with ninety stations.
  - Digital system stores up to 10 K turns of bunch by bunch positions with a typical single pass resolution of ~ 30 microns.
  - From the multi-turn data, individual bunch betatron tunes can be easily determined to < 10 Hz.
  - (Upgraded digital system will be fully implemented within the next year)

Meanwhile we work with digital/analog hybrid

Emittance tuning

- 6 wiggler optics
- ε_x~7.5nm

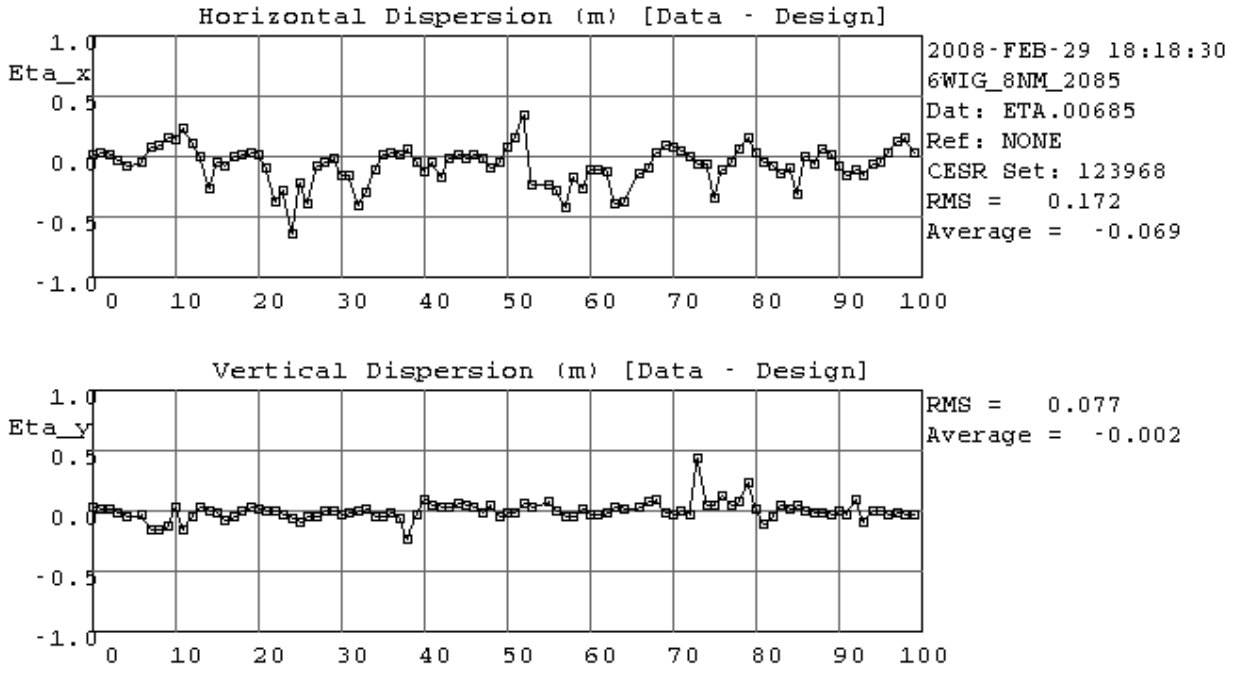
6 wiggler - low emittance optics



Coupling < 1%

Dispersion

6 wiggler, low emittance optics



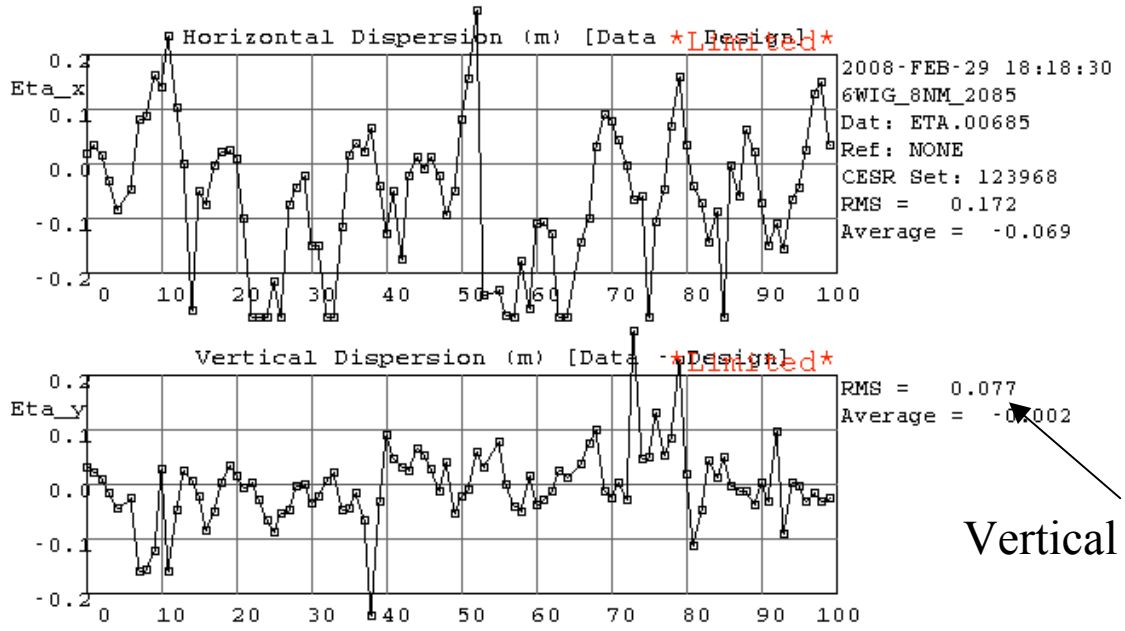
Wigglers are located between 18-19 and 80-81

Correction of horizontal dispersion is required

6 wiggler optics

- Dispersion

6 wiggler, low emittance optics



IR is primary source of vertical dispersion

Vertical dispersion

In order to achieve $\varepsilon_v < 5\text{pm}$, we require $\langle\sqrt{\eta^2}\rangle < 9\text{mm}$

AC Dispersion- simulation

- AC dispersion measurement - simulation

Dispersion is coupling of longitudinal and transverse motion

-Drive synchrotron oscillation by modulating RF at synch tune
-Measure vertical & horizontal amplitudes and phases of signal at synch tune at BPMs

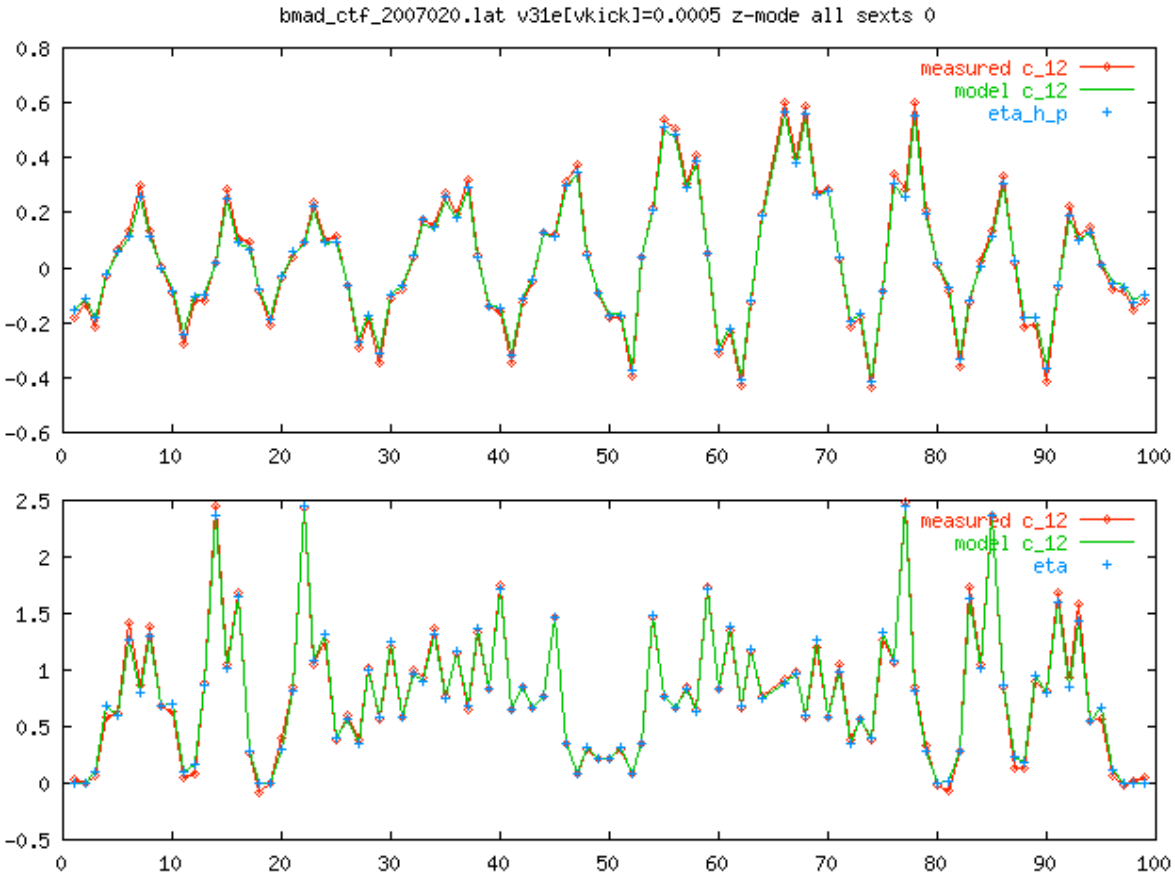
Then

$\{\eta_v/\beta_v\} = (y_{amp}/z_{amp}) \sin(\varphi_y - \varphi_z)$

$\{\eta_h/\beta_h\} = (x_{amp}/z_{amp}) \sin(\varphi_h - \varphi_z)$

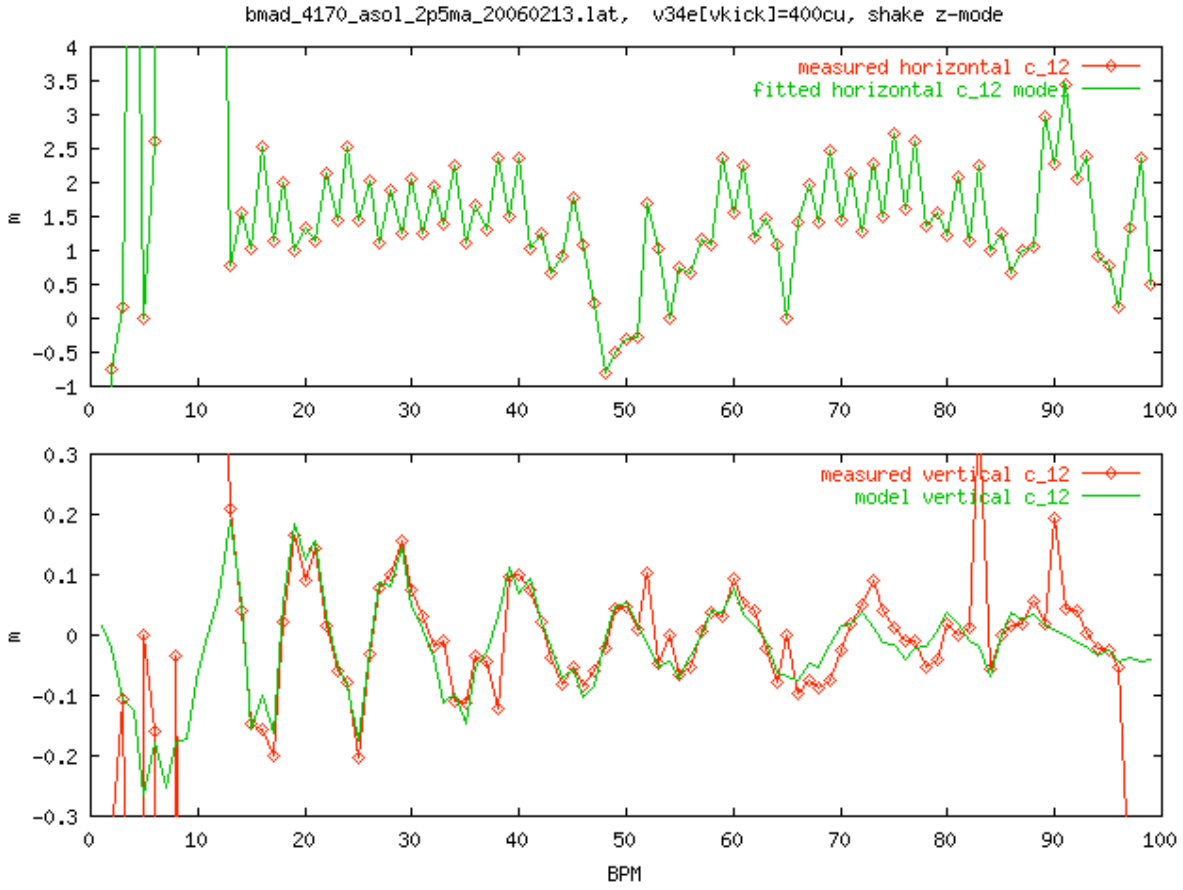
Advantages:

1. Faster (30k turns)
2. Better signal to noise - filter all but signal at synch tune



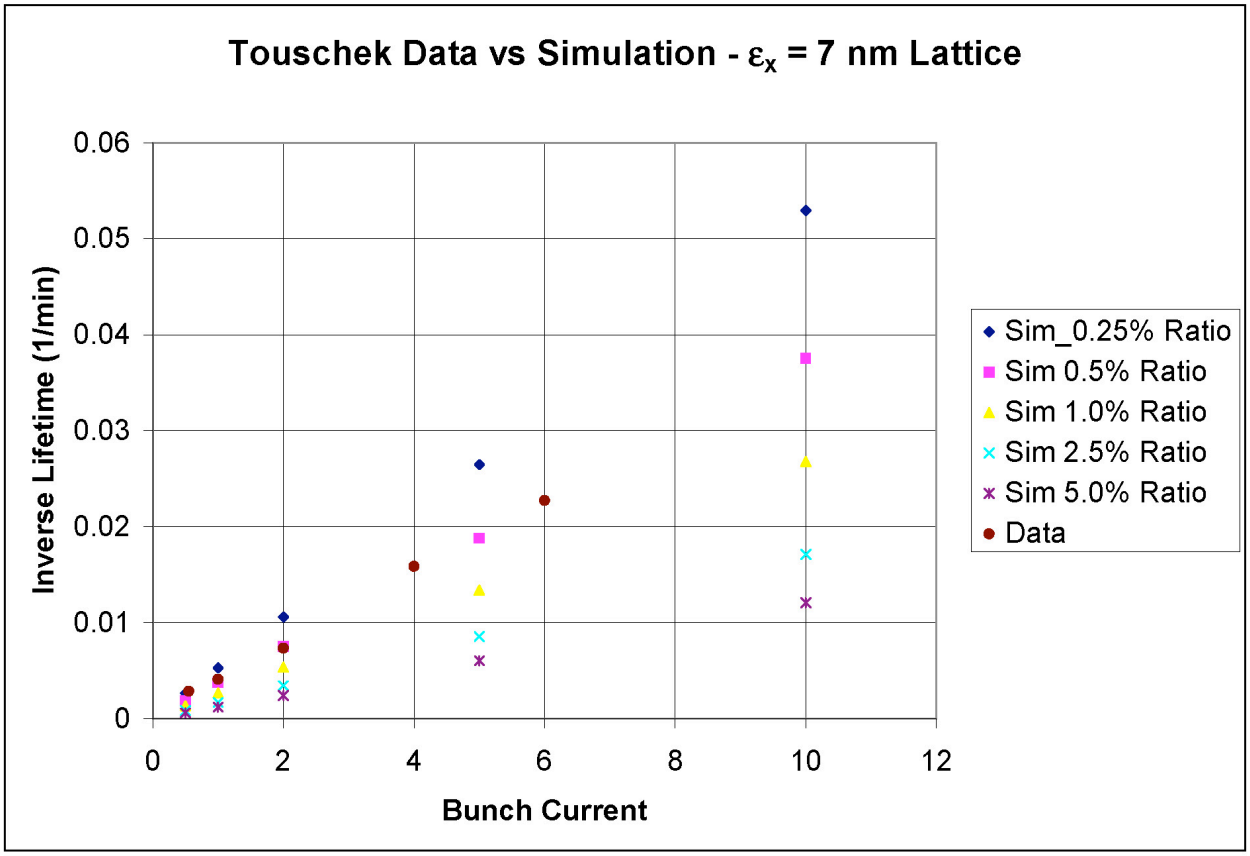
"measured c_12" - 30k turn simulation
"model c_12" - Model y-z and x-z coupling
"model eta" - Model dispersion

AC dispersion - measurement



Touschek Lifetime

6 wiggler, 1.89GeV optics



preliminary

11-September 2007

System status

- Status of beam based measurement/analysis
  - Instrumentation - existing BPM system is 90% analog with relays and 10% bunch by bunch, turn by turn digital
    - Turn by turn BPM -
      - A subset of digital system has been incorporated into standard orbit measuring machinery for several years
      - Remainder of the digital system will be installed during the next year
  - Software (CESRV) / control system interface has been a standard control room tool for beam based correction for over a decade
    - For measuring orbit, dispersion, betatron phase, coupling
    - With the flexibility to implement one or two corrector algorithm
    - To translate fitted corrector values to magnet currents
    - And to load changes into magnet power supplies
    - ~ 15 minutes/iteration