Transition Instability Studies

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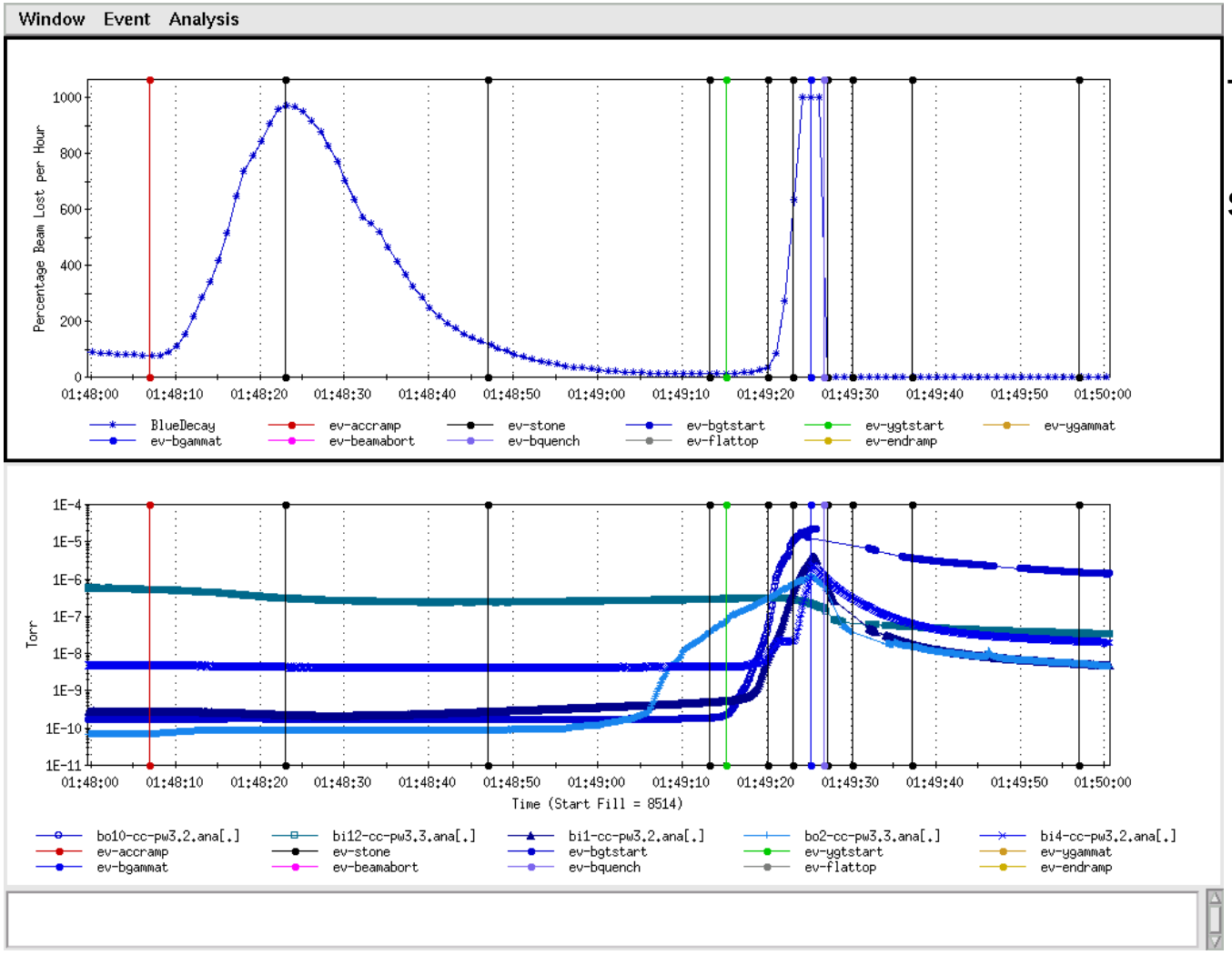
High intenisty studies on April 11
3 high intensity ramps

- Blue beam only
- Continuous bunch train (in 120 bunch mode spacing)
- Ramp 1: 93 bunches, 1.45e9/bunch
- Ramp 2: 50 bunches, 1.5e9/bunch (WCM: all bunches)
- Ramp 3: 50 bunches, 1.35e9/bunch (no Landau cavity)
- Instrumentation:
  - WCM (end-of-train bunch)
  - Button BPM (0.4ns/100ms, start right before the transition)
  - Transition monitor
  - Quadrupole pickup
  - IPM (10 bunches along the train)
  - E-detectors
  - 100ms vacuum logging

Beam intensity was limited by pressure rise



Transition Losses: IR10, IR2, some arcs

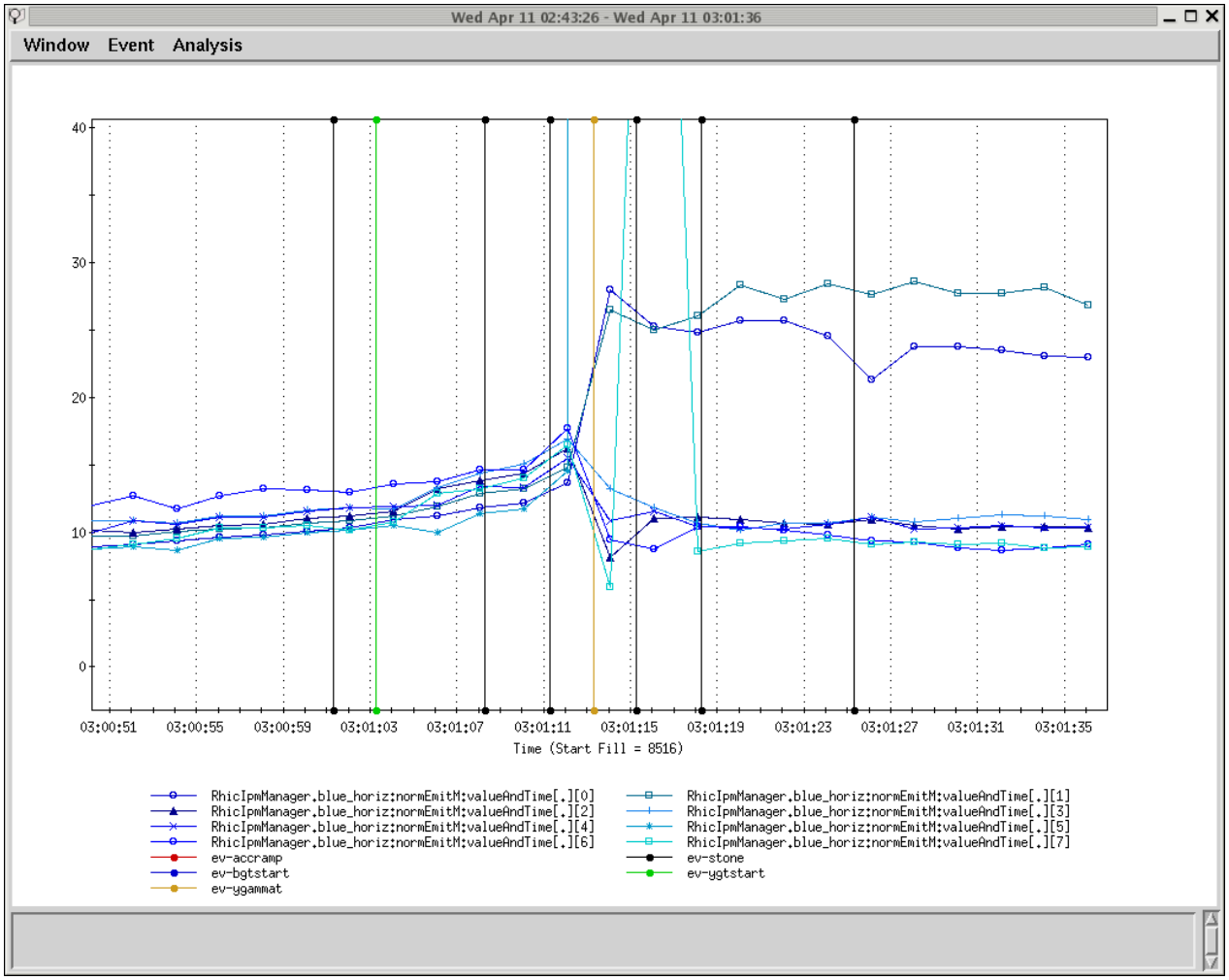
Magnet quench: B1Q2

No signs of e-cloud related instability observed on April 11

- No dependence of loss and emittance along the bunch train.
- No obvious instability signs on Button BPM, WCM, transition monitor.
- No good indication of e-cloud signal on e-detectors
- No distortion of the bunch tail is seen on WCM

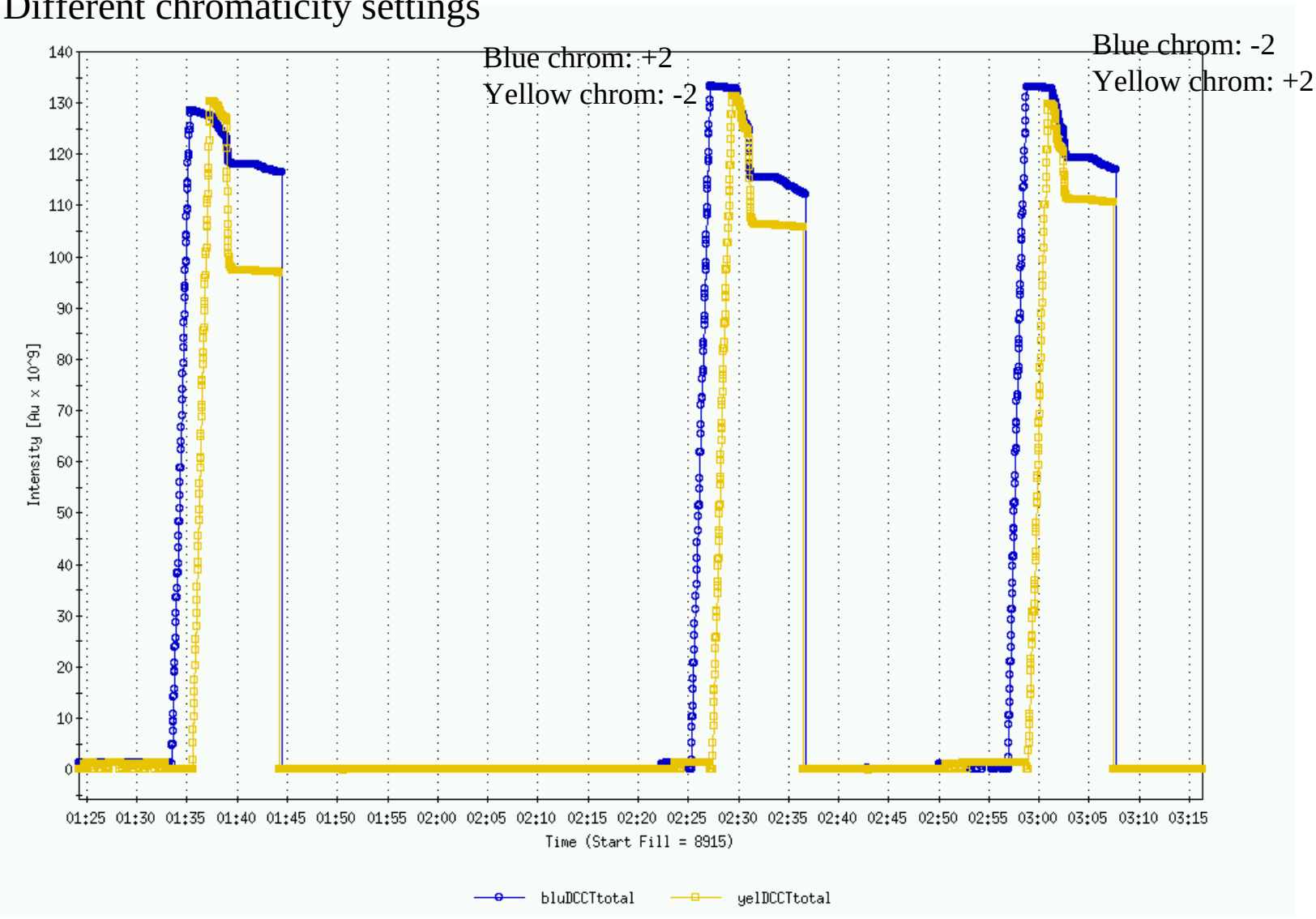
Indications: Unequal intensity losses for different bunches
Emittance blowup for some of the bunches

Possible instability in the individual bunches

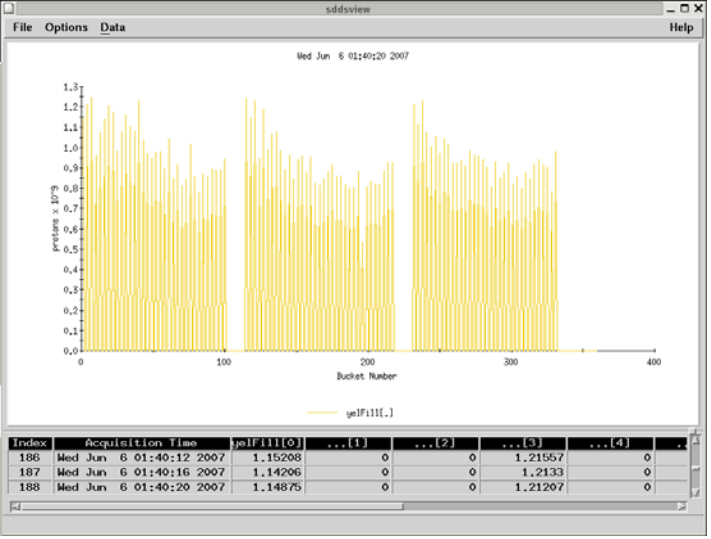


Studies on June 8, which followed observations of beam loss dependence along the train in the RHIC operation

Ramps with ~1.3e9/bunch, 103 bunches (fancy gap)
Different chromaticity settings

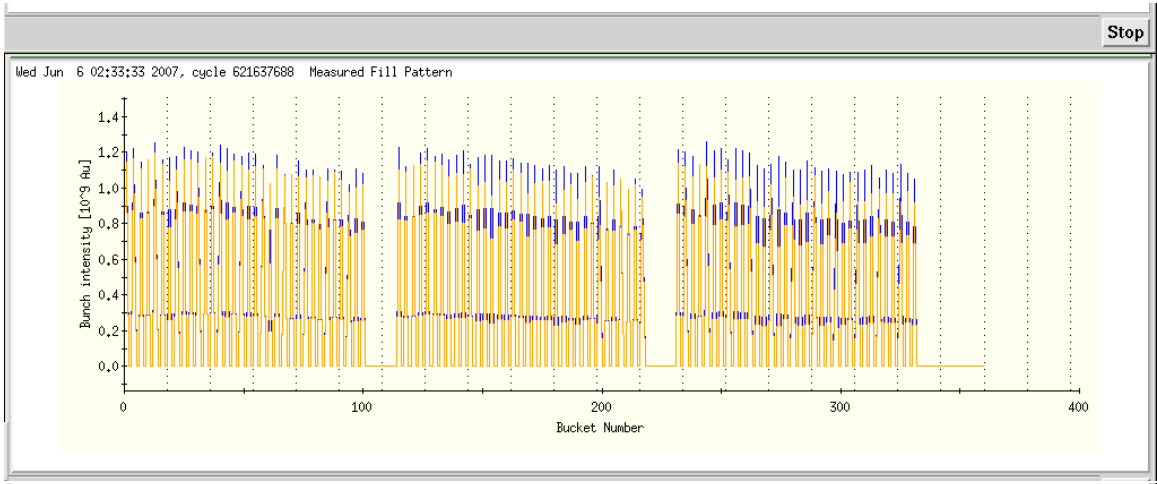


Bunch pattern after the transition crossing

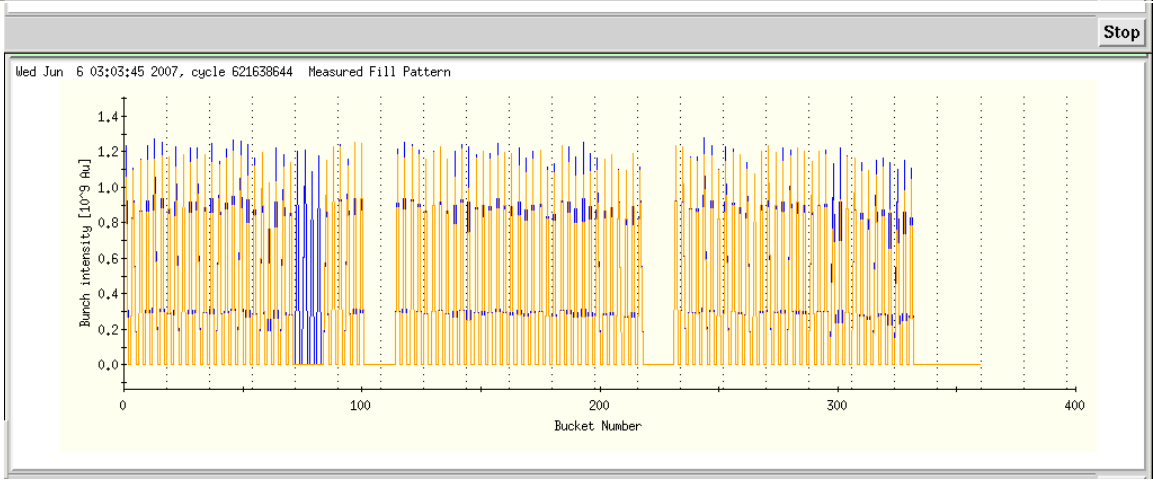


ramp 8915

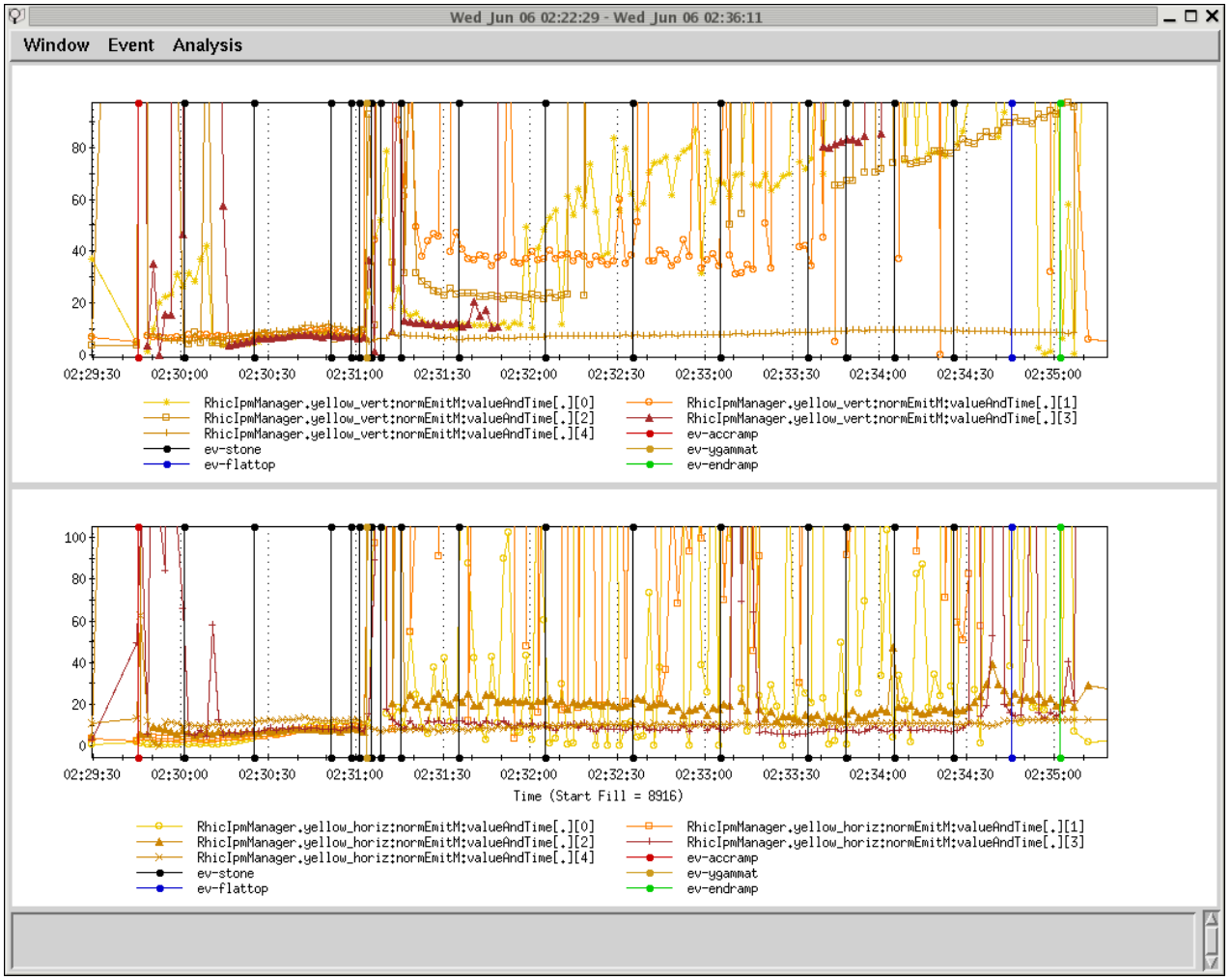
ramp 8916



ramp 8917



Emittance data have been collected for different bunches along the mini-train



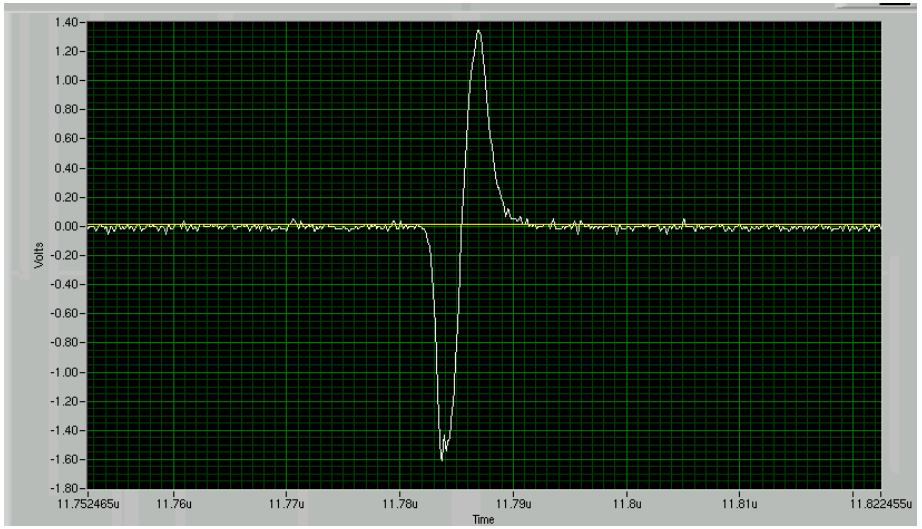
The emittance data show dependence on the position in the train in both horizontal and vertical planes

Button BPM data

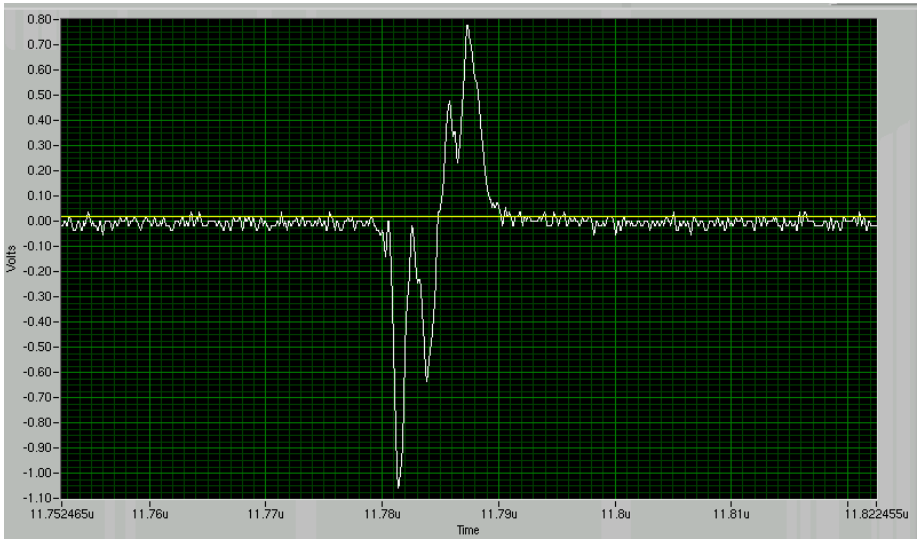
- Good quality data were obtained during June 8 studies.
- The data were collected only for Yellow ring but both difference and sum signals for both transverse planes were recorded. It allowed to distinguish more clearly between longitudinal and transverse effects.
- Button BPM setup:

➢ 0.1ns per point
➢ 2 ms between the acquisition sequences
➢ 245 sequences acquired (~490ms)
➢ Acquisition started at or 50ms before the transition

Button BPM. Sum signal observations

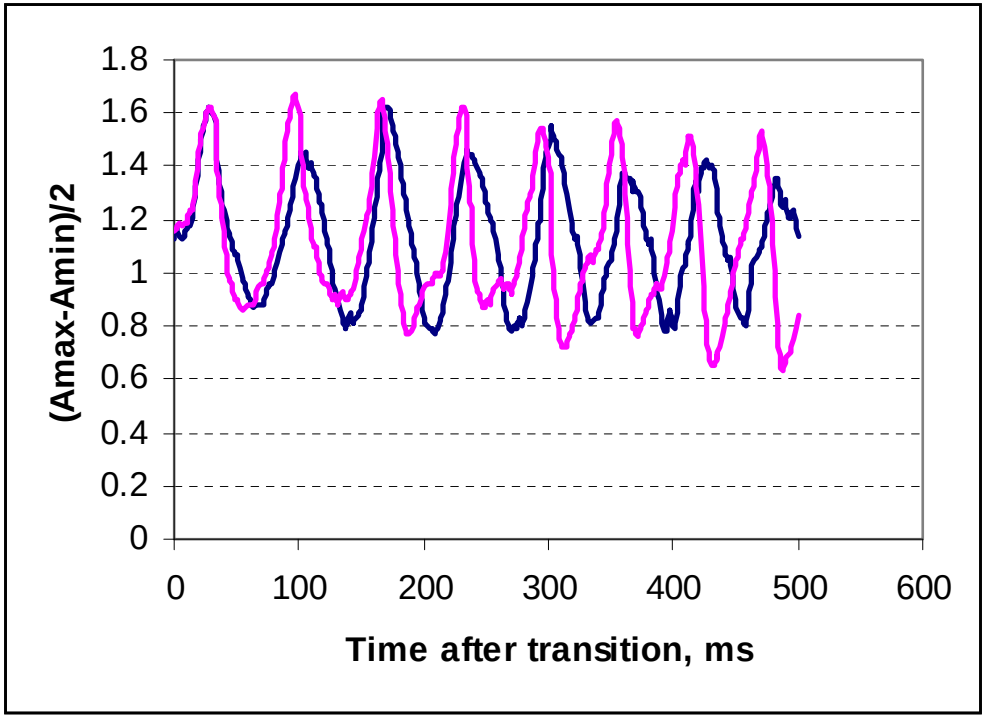


Clean signal most of the time



Sometimes simple deformations of longitudinal distribution are seen

Peak-to-peak height versus time

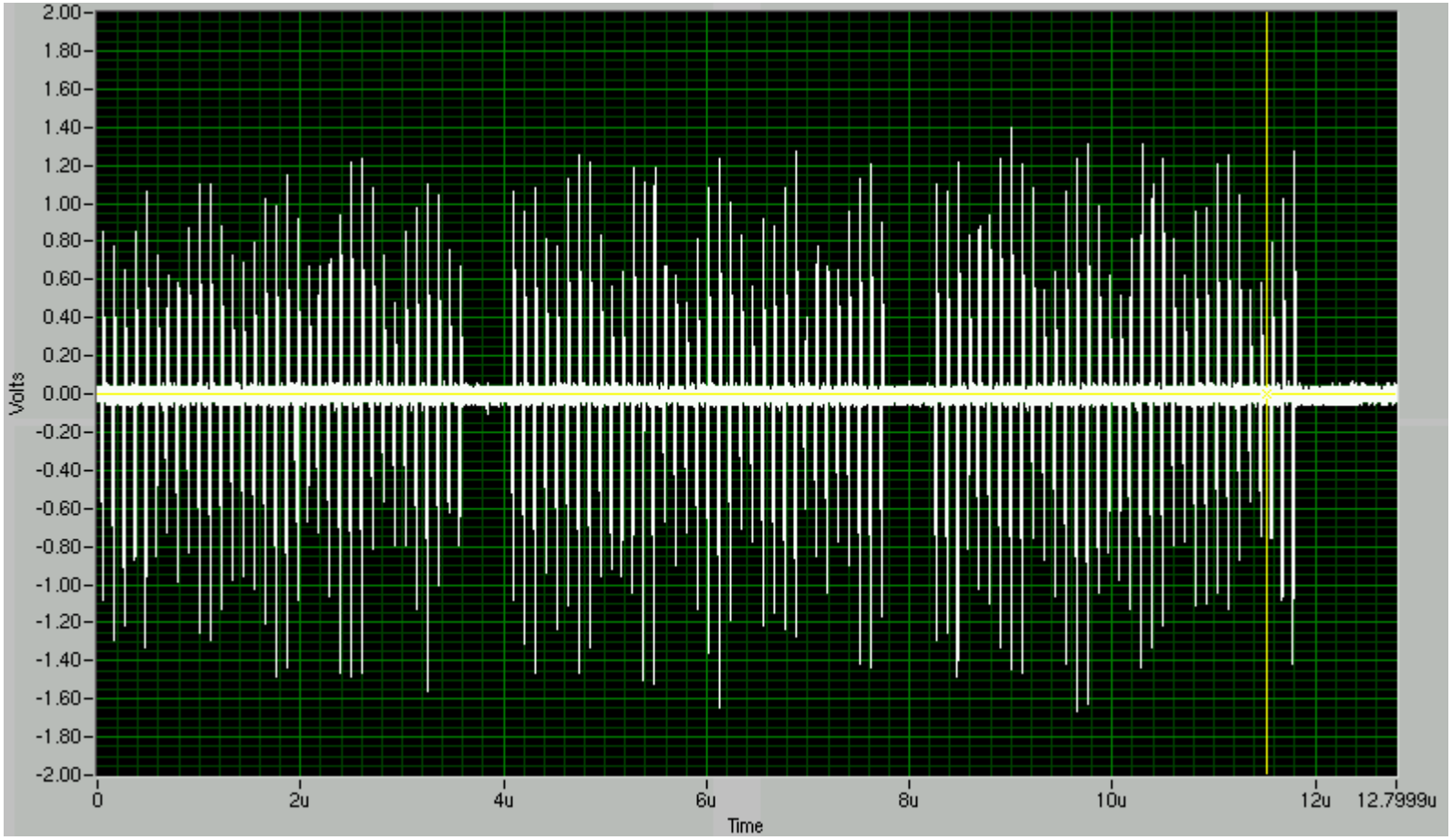


Characterizes longitudinal quadrupole oscillations

Shown for bunches 5 and 8 on ramp 8915.
Different oscillation frequency is observed.

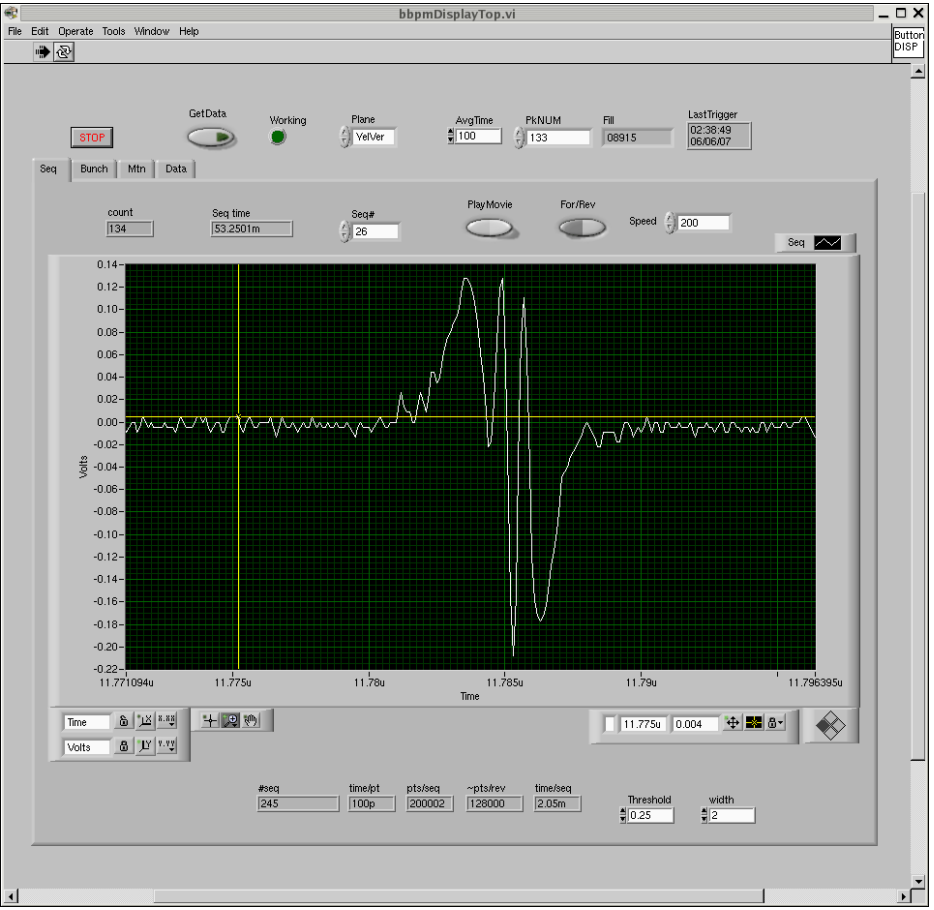
Sum signal.

Longitudinal quadrupole oscillations are modulated by bunch position in the train.

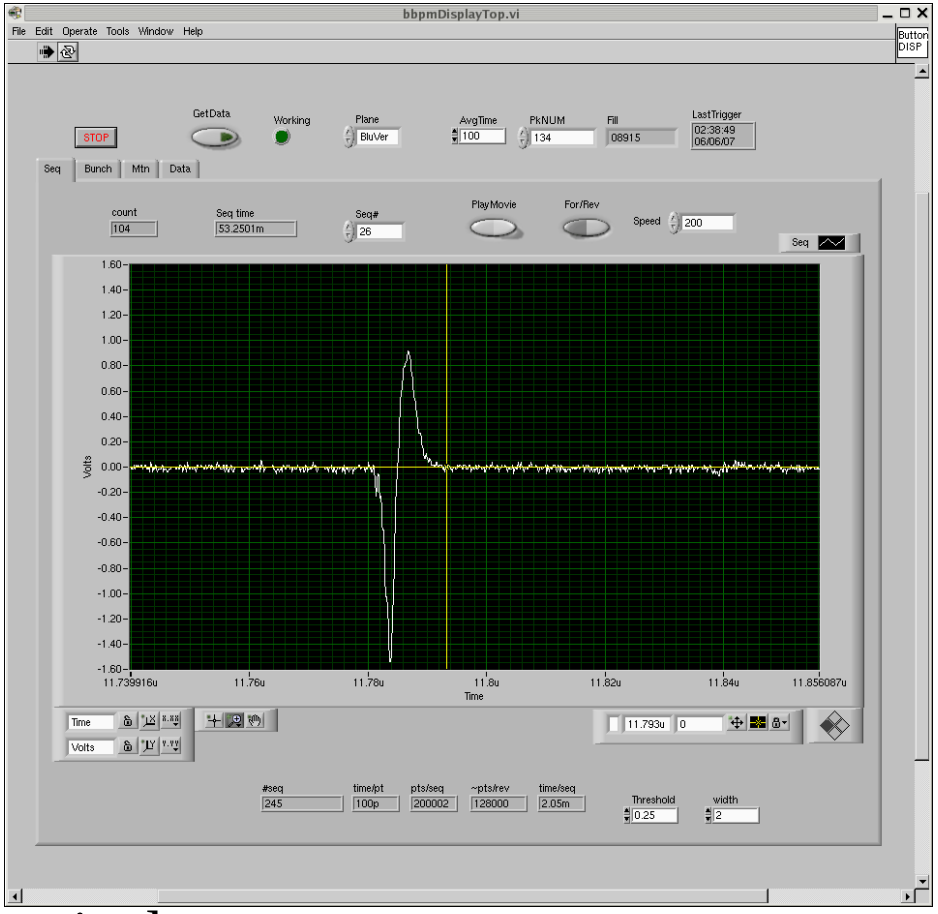


The instability caught by Button BPM in vertical plane

Difference signal



Sum signal

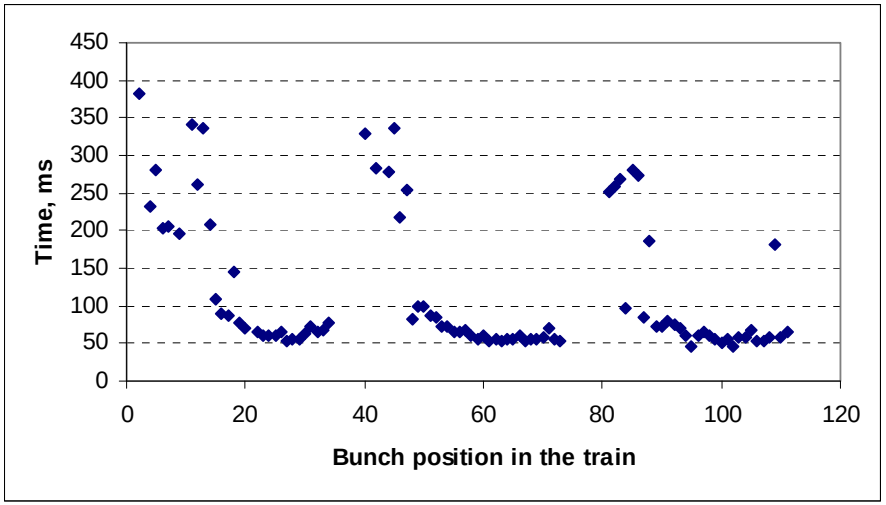


Yellow vertical

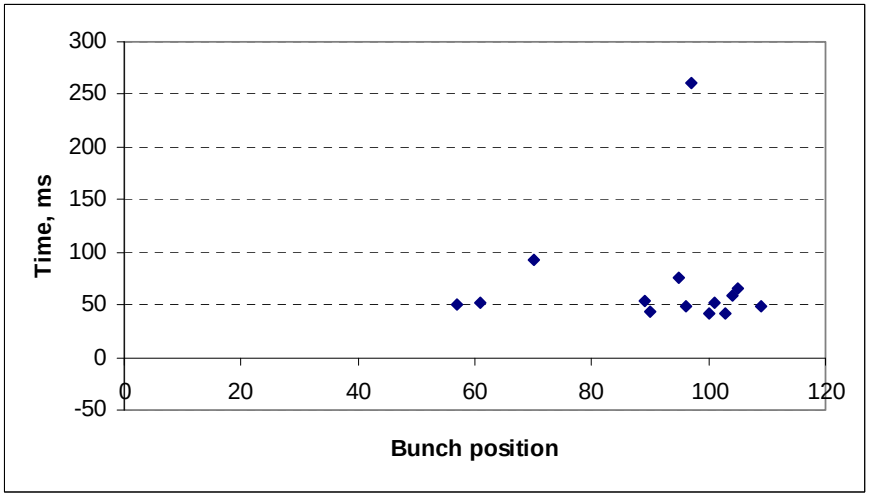
Instability continued for ~50ms

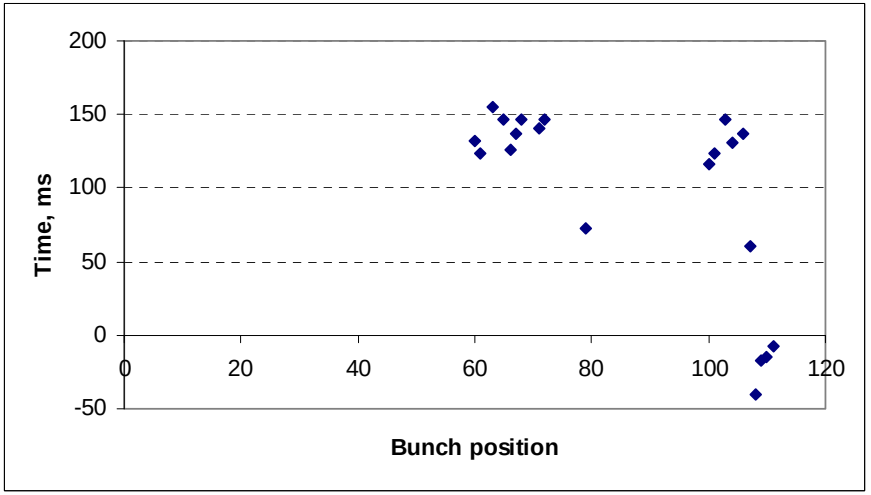
Time of the transverse instability from difference signal deformation analysis. Zero time corresponds to the transition.

Ramp 8915 (chromY:-7.7 -> -1.5)



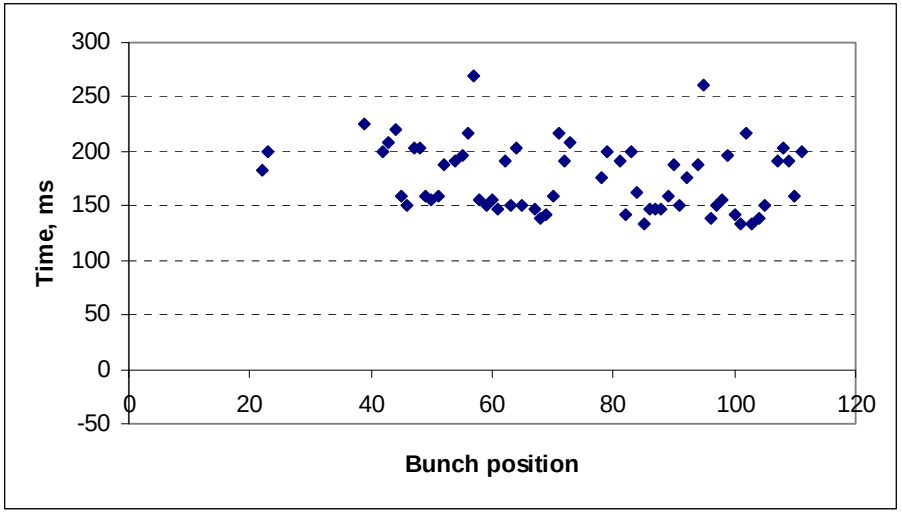
Ramp 8916 (chromY: -9.7->-3.5)



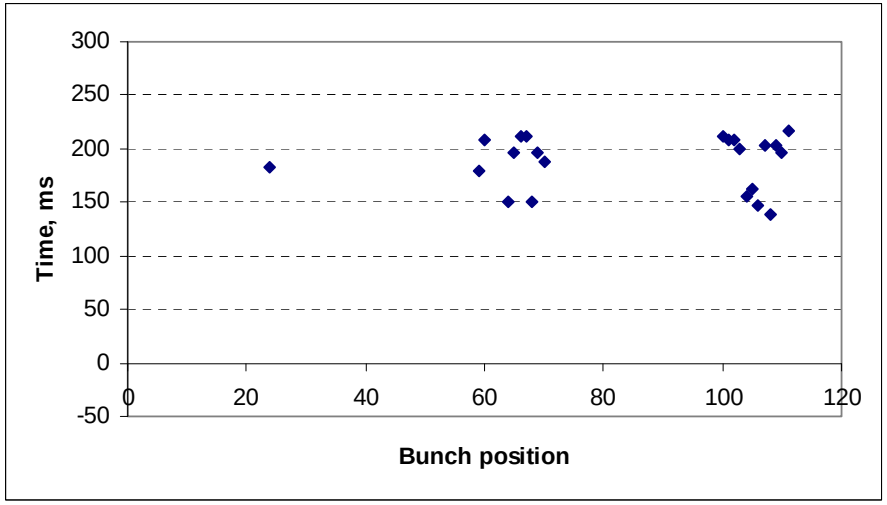


Ramp 8917
(chromY: -5.7->0.5)

Time of the instability for ramps with different bunch pattern



Ramp 8936; no fancy gaps

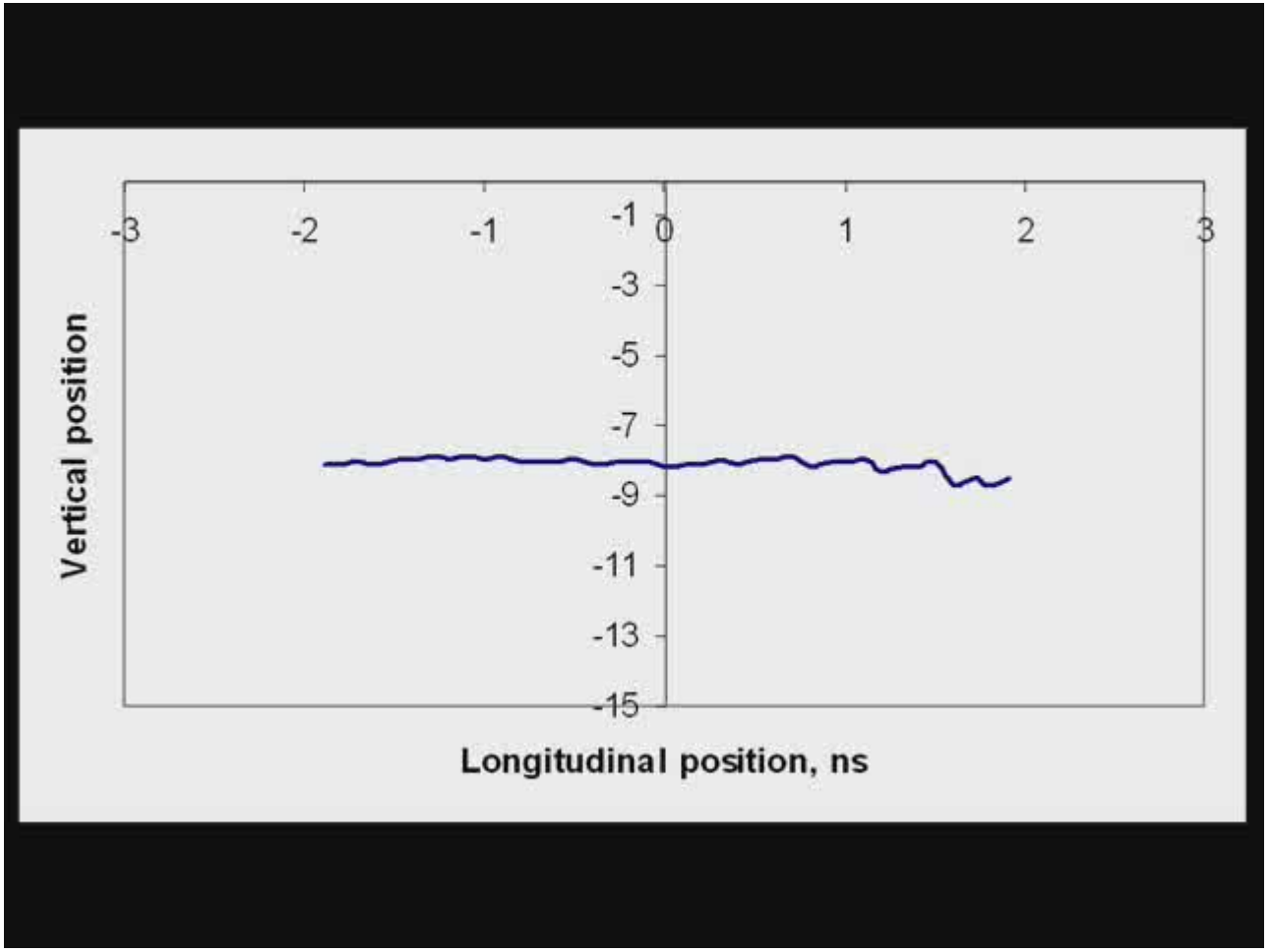


Ramp 8937; fancy gap pattern

chromY: -7.7 -> -0.5

Vertical instability

$$y(\tau) = \frac{\int_{-\infty}^{\tau} S_d \, dt}{\int_{-\infty}^{\tau} S_s \, dt}$$



Bunch 111; 4ms between traces

Further plans

- Complete analysis of existing data:

✓ comparison of instability development for different bunches along the train

✓ the role of the electron cloud

- Make some of developed analysis tools available for on-line analysis of button BPM data.

- Continuous data showing the dynamic of the instability on the shorter time scale (tens of turns) will be useful to uncover the mode frequencies and the influence of EC.