

Longitudinal Instabilities in CESR-TA

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January 26, 2009



Outline

iGp

Single Bunch
Setup

Bunch Train
Measure-
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Even Fill Mea-
surements

Model
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Transverse
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Summary

- 1 Single Bunch Setup
- 2 Bunch Train Measurements
- 3 Even Fill Measurements
- 4 Model Comparison
- 5 Transverse Measurements



Front-end Calibration

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Single Bunch Setup

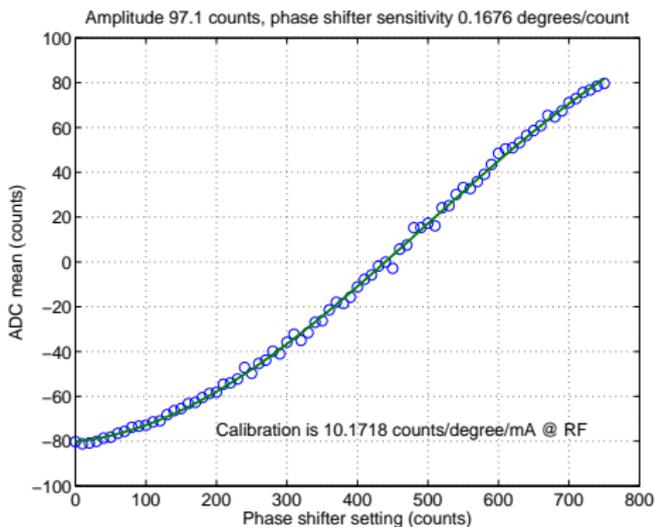
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Summary



- Move front-end phase shifter;
- Record average of the filled bunch;
- Performed automatically using "sweep" script;
- Slope around zero crossing is the calibration factor.



Front-end Calibration

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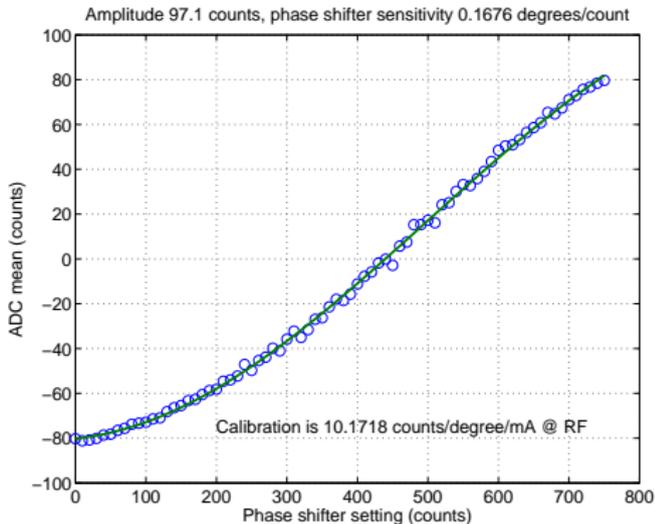
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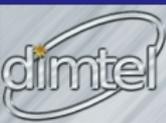
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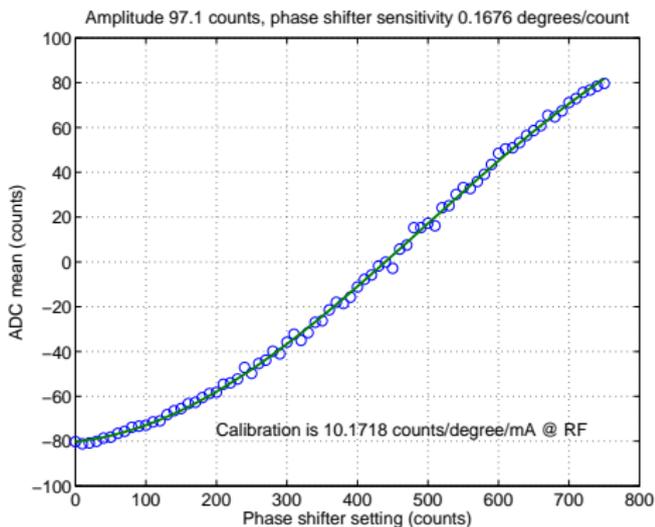
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Radiation Damping Measurement

iGp

Single Bunch Setup

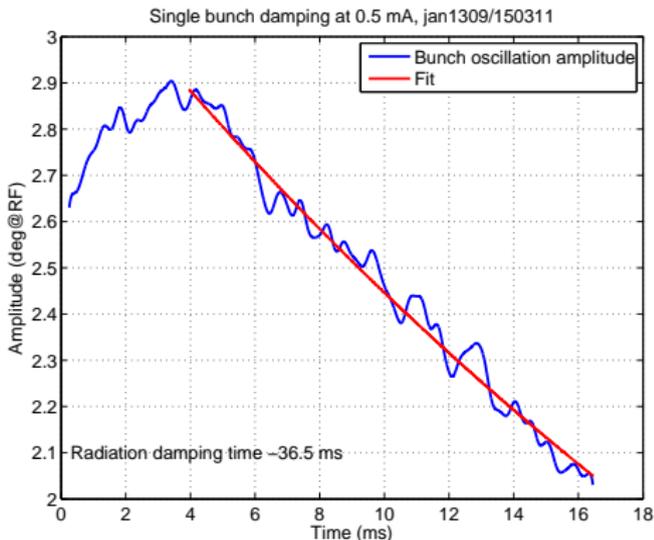
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Summary



- Use positive feedback to excite the beam;
- Feedback goes to open loop at 4 ms;
- Estimated radiation damping time is 36.5 ms;
- Computed value is 28.2 ms.



Radiation Damping Measurement

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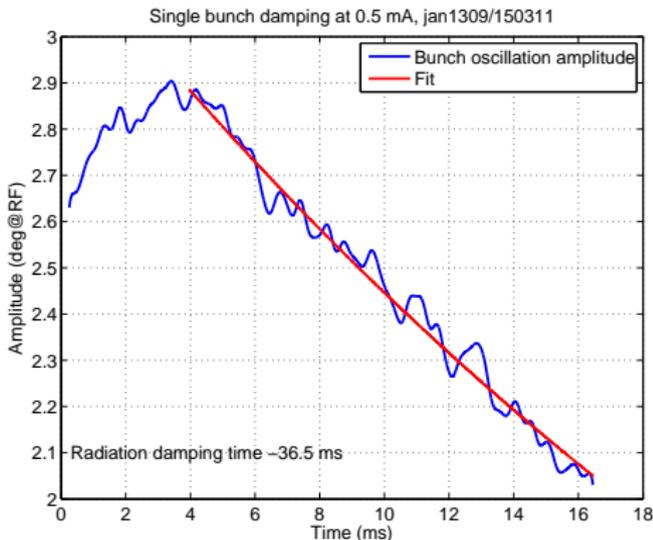
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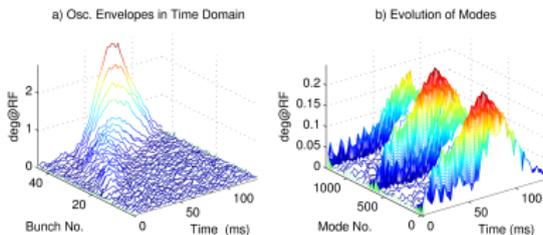
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- Feedback goes to open loop at 4 ms;
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CESR TA:jan1409/140044: Io= 28.5mA, Dsamp= 8, ShiftGain= 4, Nbun= 45, At Fs: G1= 5.1618, G2= 0, Ph1= 105.3491, Ph2= 0, Brkpt= 711, Calib= 8.2572.

- Open-loop growth - first 14 ms;
- Spectrum is dominated by a band of modes around 49;
- Feedback turns on too late:
 - growth continues after 14 ms;
- Damping in the end;
- Growth rate of 0.23 ms^{-1} ;
- Damping of 0.12 ms^{-1} .



Grow/Damp Measurements

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Single Bunch Setup

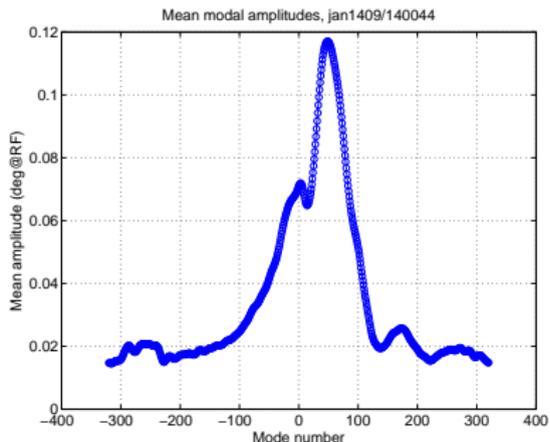
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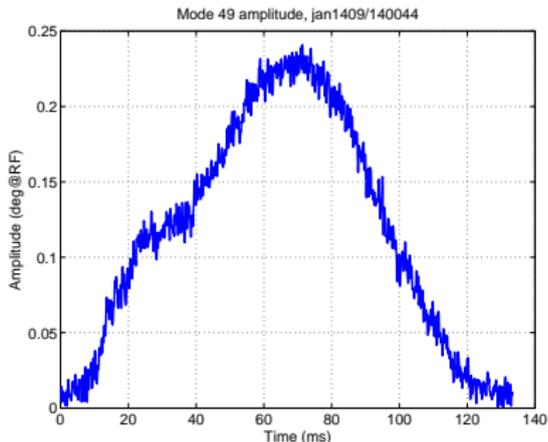
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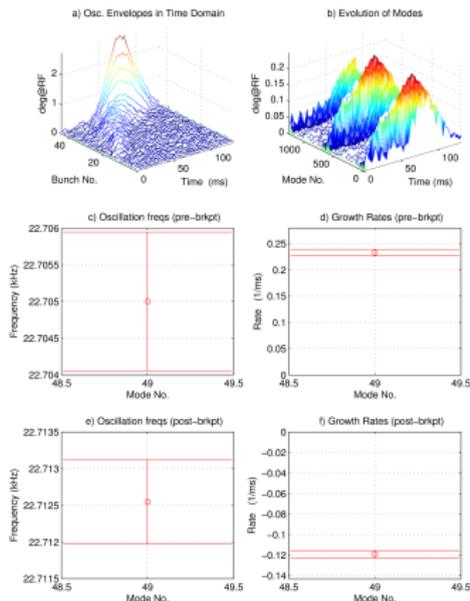
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CESR TA: jani1423@140044; Iov= 28.5mA, Dsamps= 8, ShiftGain= 4, Nbu= 45,
AI F#: G1= 5.1610, G2= 0, Ph1= 105.3491, Ph2= 0, Brkpt= 5500, Coll= 0.2572.

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Open-loop Damping

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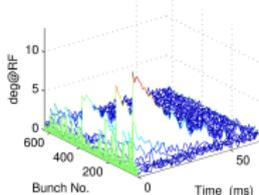
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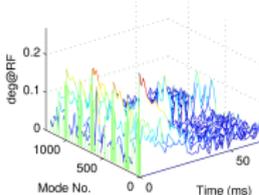
Transverse
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Summary

a) Osc. Envelopes in Time Domain



b) Evolution of Modes



CESR TA:jan1509/140929: Io= 46mA, Dsamp= 8, ShfGain= 5, Nbun= 641,
At Fs: G1= 0, G2= 10.3235, Ph1= 0, Ph2= 105.3491, Brkpt= 1, Callb= 8.2572.

- Roughly uniform filling in 599 RF buckets;
- Use positive feedback to excite the motion;
- Modal spectrum is relatively narrow
- 1–3 mode bands;
- Fit the open-loop damping;
- A puzzle - damping rates are faster than radiation damping (0.029 ms^{-1} measured, 0.036 ms^{-1} computed).

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Single Bunch
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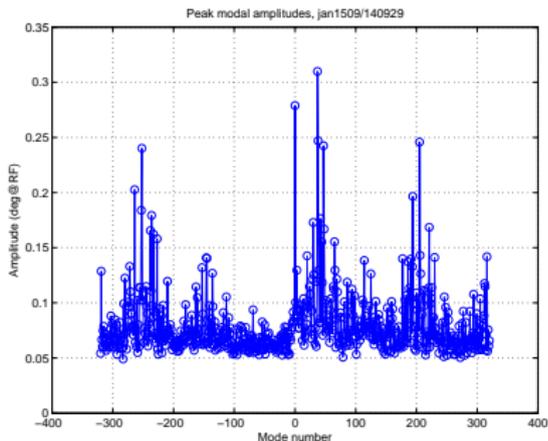
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Open-loop Damping

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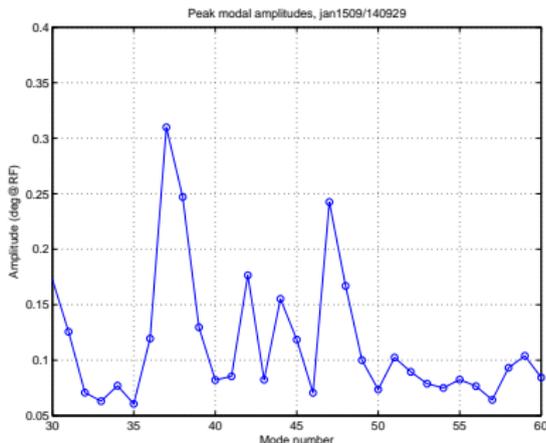
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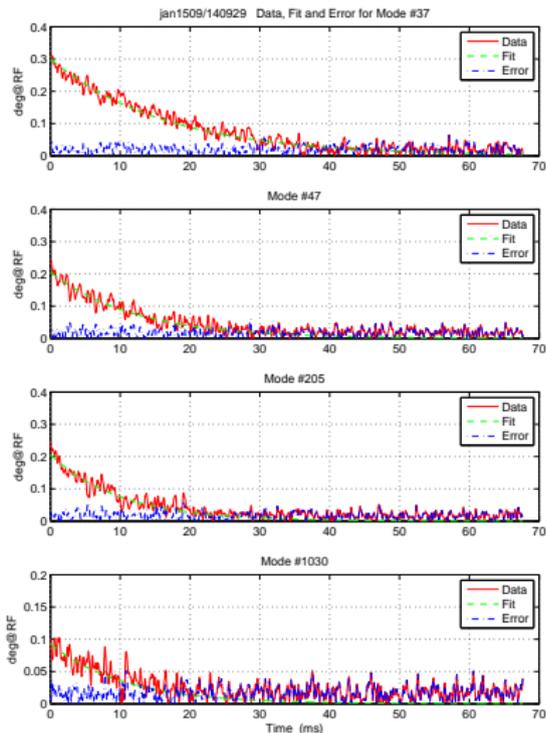
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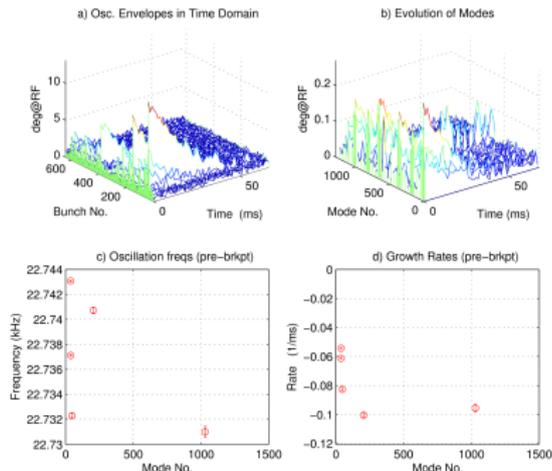
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At Fs: G1= 0, G2= 10.3235, Ph1= 0, Ph2= 105.3491, Brkpt= 3300, Callb= 8.2572.

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Simulated grow/damp transient

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Single Bunch Setup

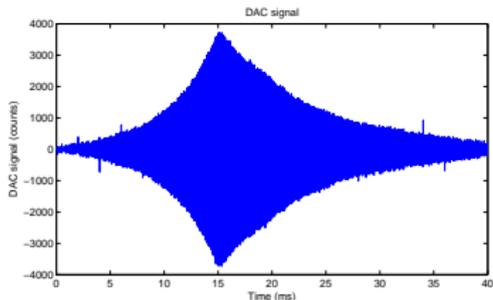
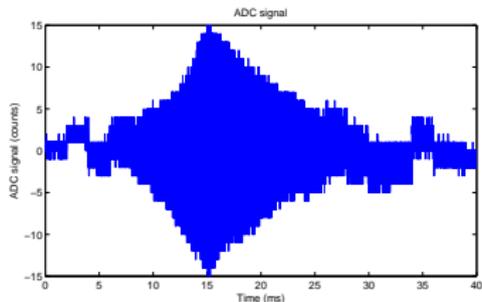
Bunch Train Measurements

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Summary



- Estimate kicker voltage based on known quantities;
- For clean grow/damp data remove back-end saturation;
- Fit growth and damping transients;
- Damping is also compared to the analytical formula
$$\lambda_{fb} = \frac{\alpha e f_{ri}^2}{2 E f_s h} G_{fb};$$
- Estimated kicker voltage is 42 V (expect 178 V).

Simulated grow/damp transient

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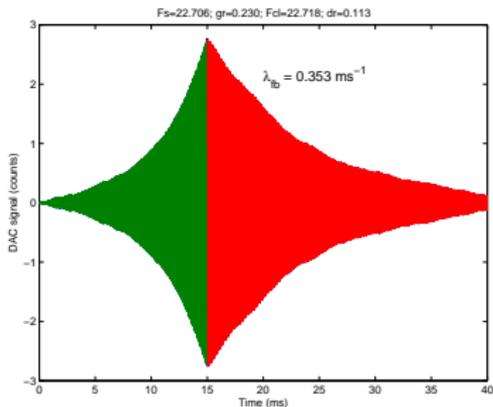
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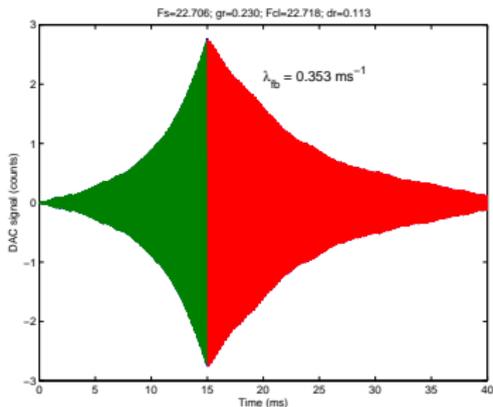
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Kicker Voltage Discrepancy

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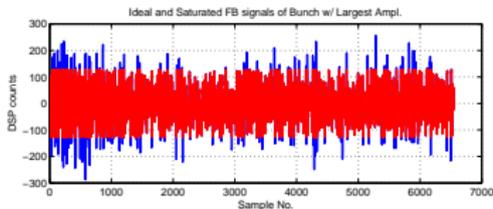
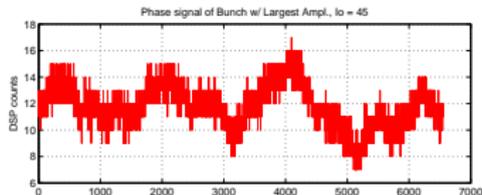
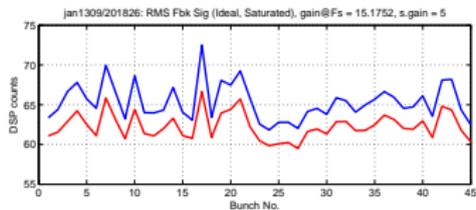
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- Feedback is running partially saturated;
- Low-frequency mode at 1.014 GHz - TWT amplifier gain drop around 1 GHz;
- Feedback setup optimization?



Kicker Voltage Discrepancy

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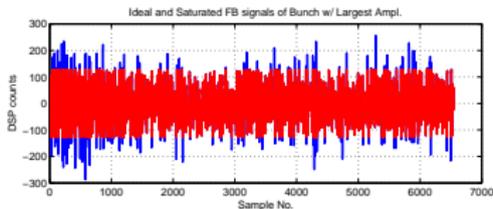
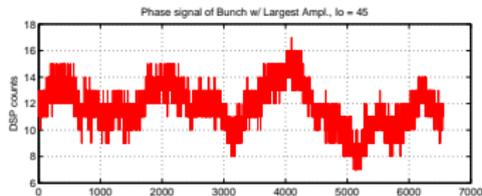
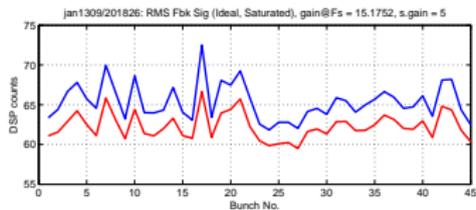
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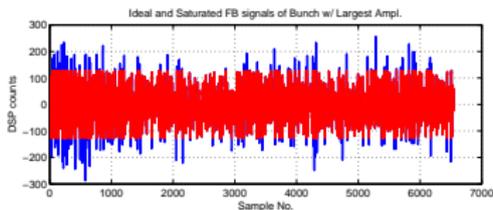
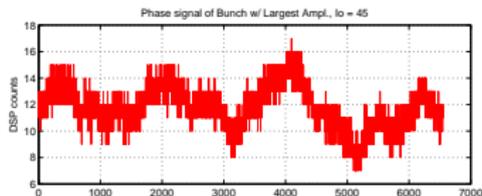
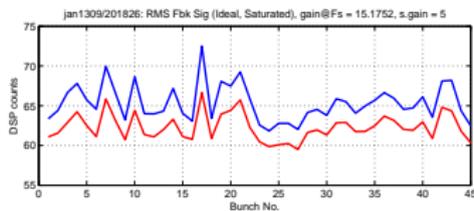
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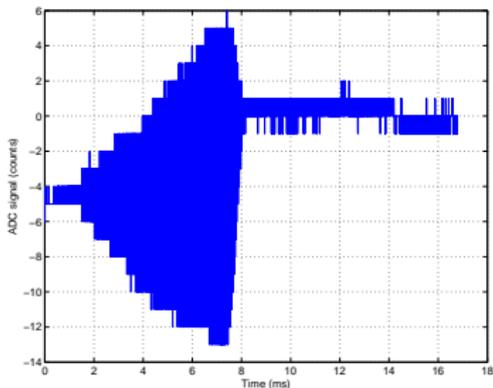
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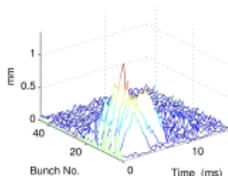
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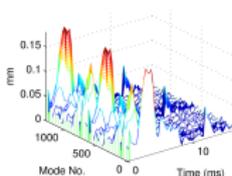


- Single-bunch positive feedback - beam lost;
- Multibunch drive/damp;
- Mean mode amplitudes during growth transient;
- Not the lowest frequency, expected from resistive wall.

a) Osc. Envelopes in Time Domain



b) Evolution of Modes



CESR TA:jan1609/161748: Io= 17mA, Dsamp= 1, ShiftGain= 5, Nbun= 45,
At Fs: G1= 161.5358, G2= 161.5358, Ph1= -118.7965, Ph2= 61.2035, Brkpt= 817, Callib= 8.2572.

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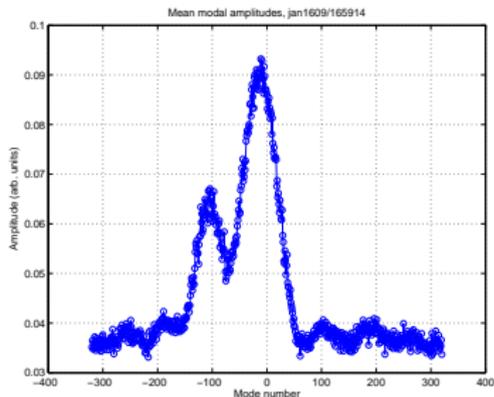
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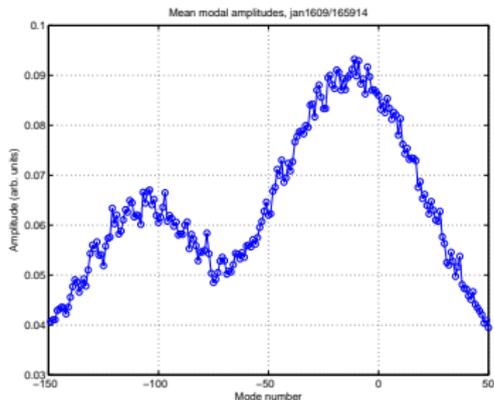
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- We have demonstrated longitudinal feedback with both electron and positron beams;
- Multiple impedances are at play longitudinally;
- Estimated kicker voltage is low, even fill puzzle;
- Still, for current operating conditions the setup is sufficient;
- Successfully demonstrated feedback operation in the vertical plane.



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