

Instability Studies at the MLS

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October 27, 2011



Outline

- 1 Setup
 - System Updates
- 2 Beam Studies
 - Calibration
 - Longitudinal Grow/Damp Measurements
 - Vertical Grow/Damp Measurements



Work Summary

- Updated all 4 iGp12 units to a new gateway/software release:
 - 3 tap bunch shaper FIR for improved back-end bunch-to-bunch isolation;
 - Dual independent acquisition engines with 192k/12M memories;
 - Pre-trigger acquisition capability;
 - User interface improvements.
- Swapped front/back-end module (from FBELT_0001 to FBELT_0004) to help troubleshoot intermittent communication loss problem.

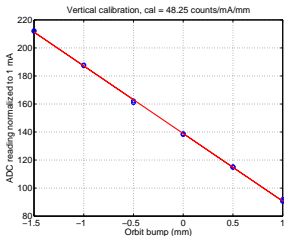
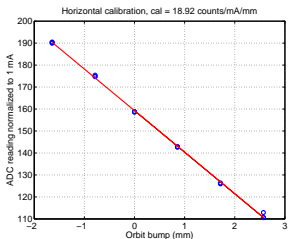


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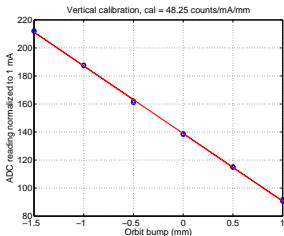
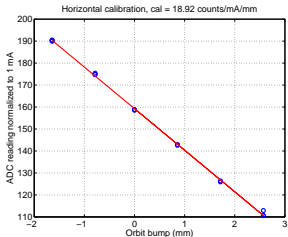
Front-end Calibration: Transverse Plane



- Set up controlled orbit bumps in X and Y;
- Measure bunch signal displacement in ADC counts;
- At 2 mA per bunch ADC LSB corresponds to 26 and 10 μm in X and Y respectively;
- Calibrations from 2011-11-17: 58.4 and 64.8 in X and Y.



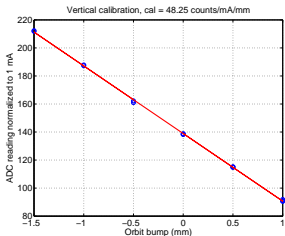
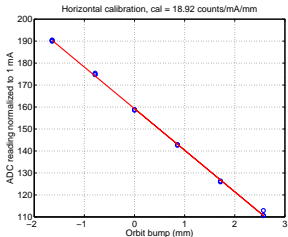
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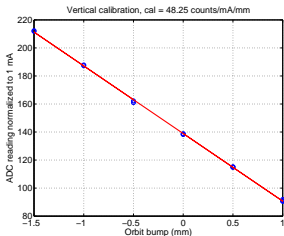
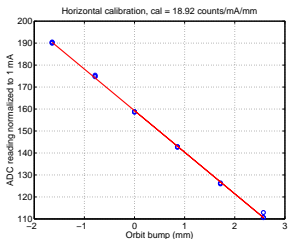
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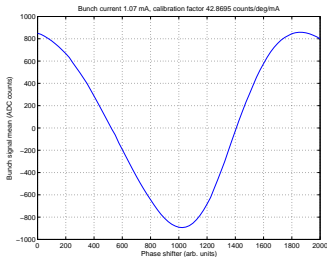
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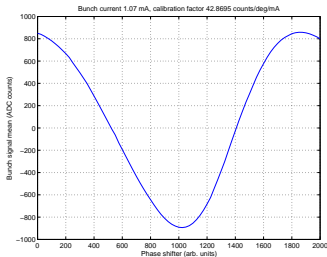
Longitudinal Calibration



- Sweep phase shifter over 360° ;
- Record bunch signal (average);
- Calibration factor of 42.9 counts/mA/degree;
- At 2 mA per bunch ADC LSB is 12 milli-degrees (67 fs).

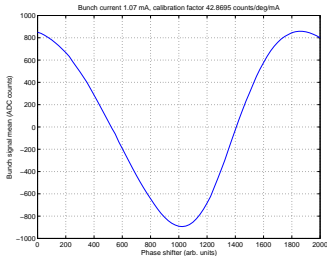


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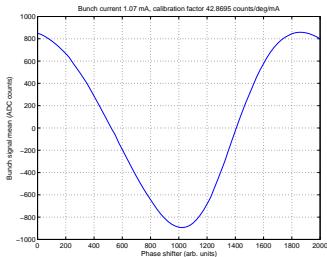
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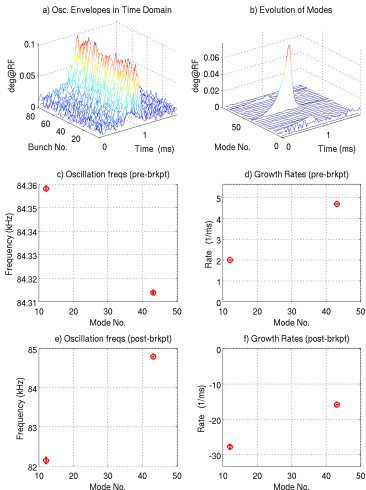
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Longitudinal Grow/Damp Measurement

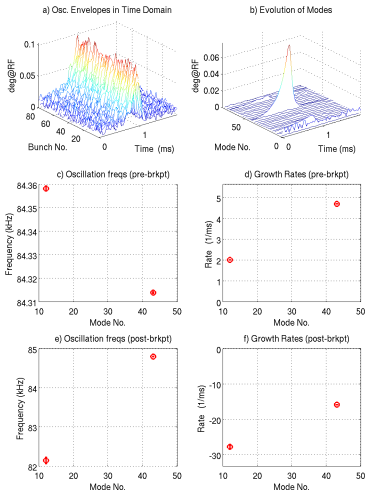


- Open-loop growth at 141 mA shows modes 43, 71, and 12;
- Very fast feedback damping.

MLS-Z:134749; I= 140.9472mA, Dsamp= 1, ShiftGain= 3, Nburn= 80,
 At Fs: G1= 16.6099, G2= 0, Ph1= -117.4263, Ph2= 0, Brkpt= 6400, Calib= 42.9.



Longitudinal Grow/Damp Measurement



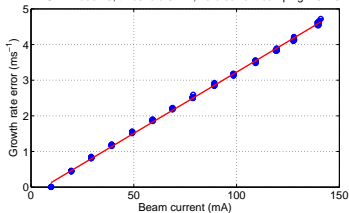
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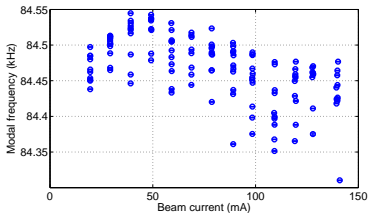


Longitudinal Growth Rates vs. Beam Current (1/3)

MLS Z: Mode 43, threshold 6 mA, zero current damping 4.8 ms

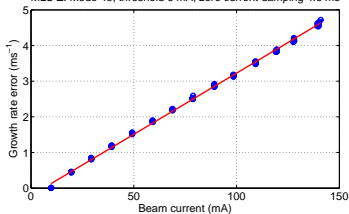


- Mode 43 open-loop eigenvalues vs. beam current;
- Threshold of 6 mA, zero current damping of 4.8 ms;
- Effective impedance of 39.2 k Ω at $nf_{rf} + 268.6$ MHz;
- Some impedance variation with current.

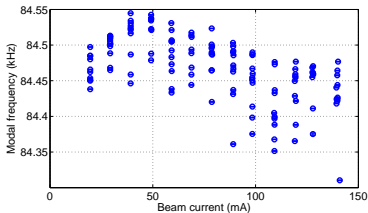


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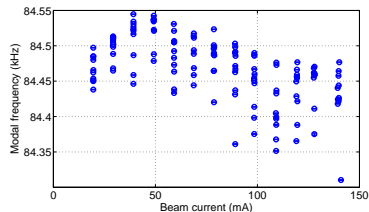
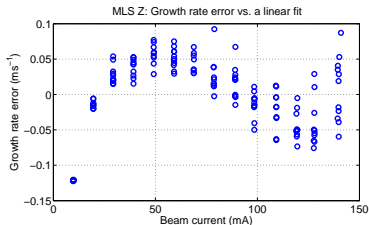
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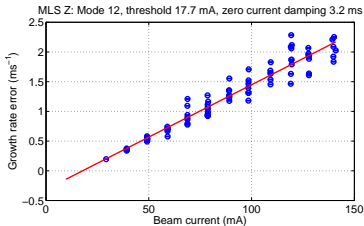
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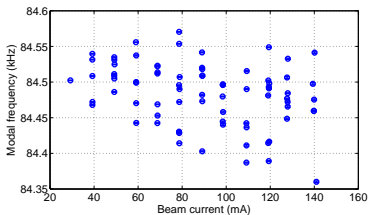
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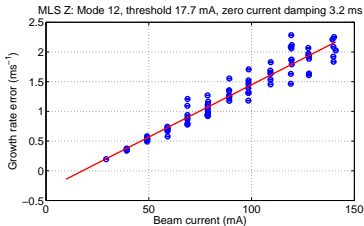
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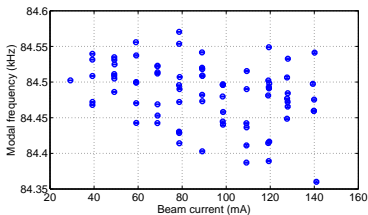
- Mode 12 open-loop eigenvalues vs. beam current;
- Threshold of 17.7 mA, zero current damping of 3.2 ms;
- Effective impedance of $20 \text{ k}\Omega$ at $n f_{\text{rf}} + 75 \text{ MHz}$.



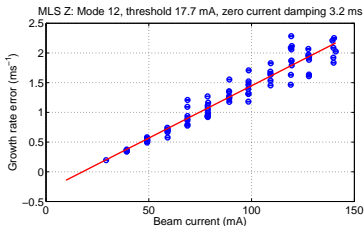
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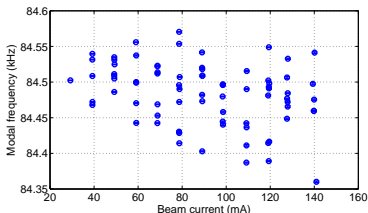
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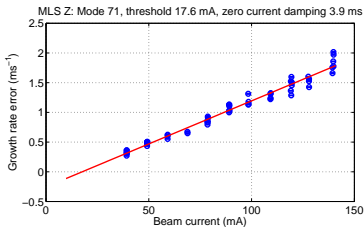
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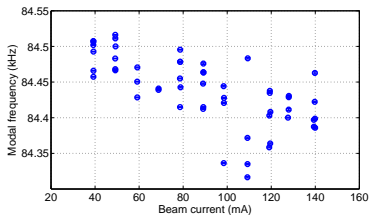
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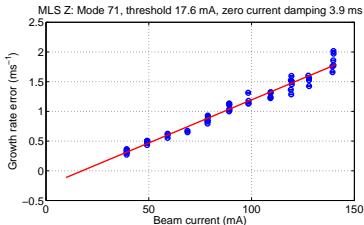
Longitudinal Growth Rates vs. Beam Current (3/3)



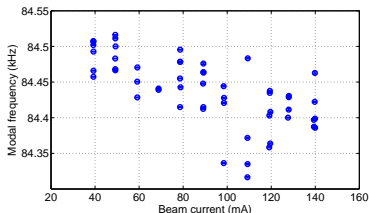
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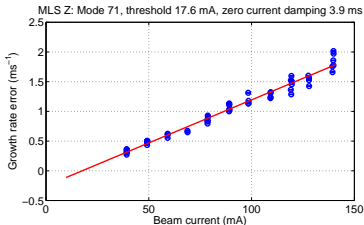
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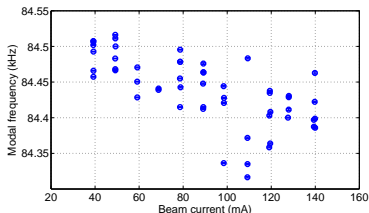
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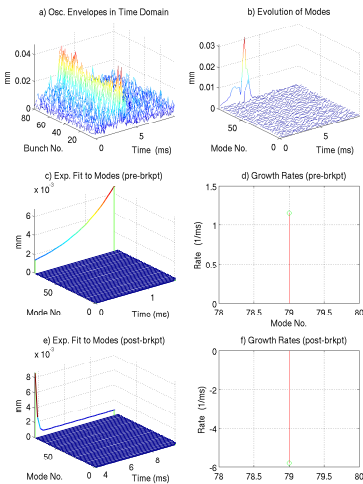


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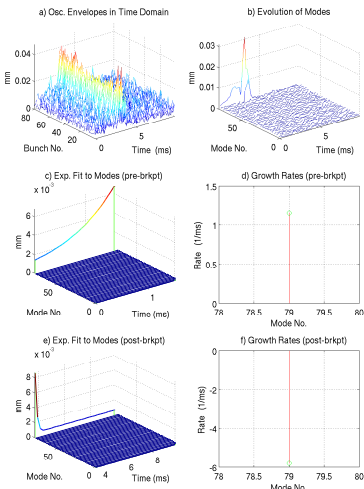


- Open-loop growth at 127 mA shows modes -1 and -2;
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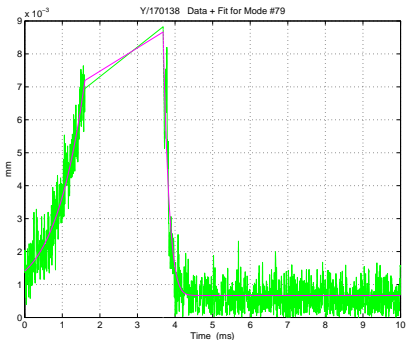


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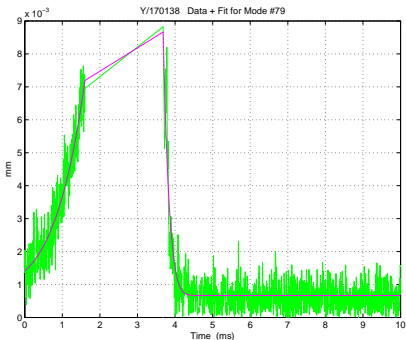


A Transient in Detail



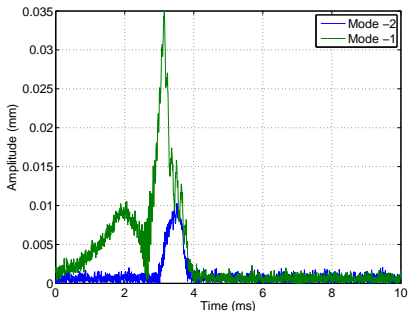
- Feedback on at 2 ms;
- Amplitude fitting produces reasonably clean fits;
- Strange behavior in between;
- Large tune shifts of ≈ 0.05 .

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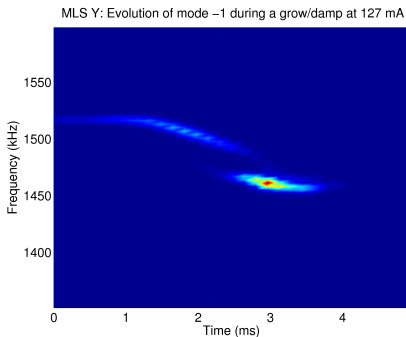
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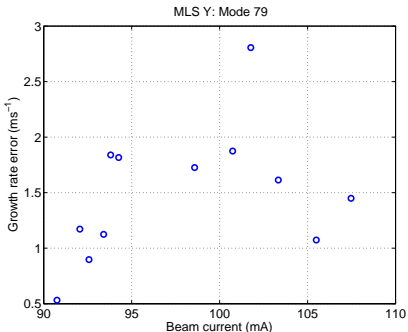
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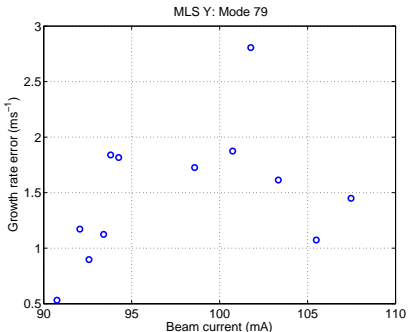
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- Needs more attention to perform fit checking;
- Interesting to measure a wider current range.

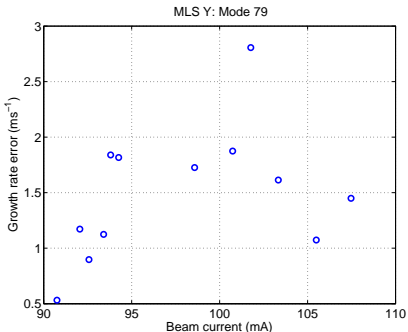
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- Feedback control of ion-driven transverse instabilities requires additional work to achieve robustness;
- Expect the operating regimes and configurations to evolve with experience and machine requirements.



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