

Day 1:
2021-04-28

Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

DAΦNE Instability Studies

D. Teytelman

Dimtel, Inc., San Jose, CA, USA

May 5, 2021

Work Summary

Day 1:
2021-04-28

Day 2:
2021-04-29

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Day 4:
2021-05-04

Summary

- ▶ **Started in the vertical plane;**
- ▶ High gain needed, unusual behavior at high currents;
- ▶ In single bunch mode checked timing in all planes (X, Y, and Z);
- ▶ Found a qualitative change in behavior in the vertical plane between 170 and 320 mA.

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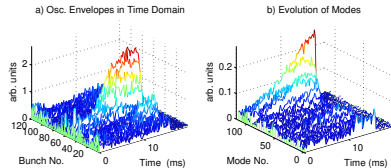
Day 3:
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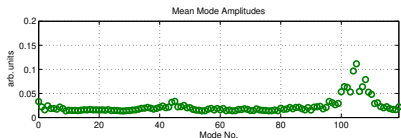
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Low Current



DAFNE E+ (IGp):apr2821/205956: Io= 173mA, Dsamp= 1, ShiftGain= 7, Nbnun= 120,
At v: G1= 137.0528, G2= 0, Ph1= 22.1899, Ph2= 0, Brkpt= 48995, Calib= 1.



- ▶ A vertical grow/damp at 173 mA;
- ▶ A band of unstable modes around 105;
- ▶ Envelope fitting works well;
- ▶ A horizontal grow/damp at 159 mA;
- ▶ Unstable modes center around 97;
- ▶ Growth rates similar to those in the vertical plane.

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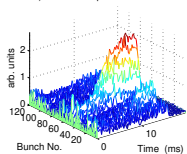
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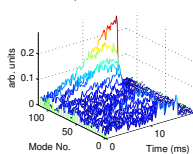
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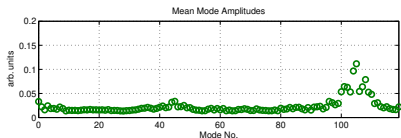
a) Osc. Envelopes in Time Domain



b) Evolution of Modes



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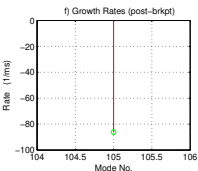
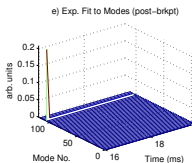
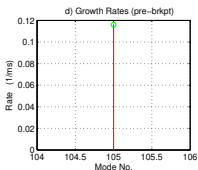
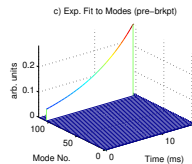
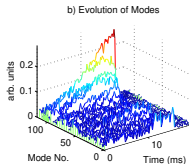
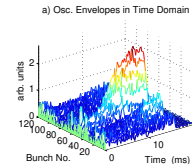
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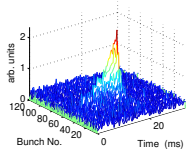


DAFNE E+ (IGp):apr2821/205956: I₀= 173mA, D_{samp}= 1, ShifGain= 7, Nbun= 120,
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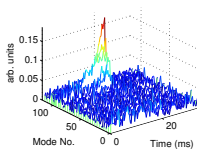
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Low Current

a) Osc. Envelopes in Time Domain

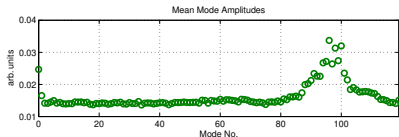


b) Evolution of Modes



DAFNE E+ (IGp): apr2821/210519: Io= 159mA, Dsamp= 1, ShiftGain= 1, Nbnun= 120,
At v: G1= 8.7625, G2= 0, Ph1= -128.9749, Ph2= 0, Brkpt= 61262, Calib= 1.

- ▶ A vertical grow/damp at 173 mA;
- ▶ A band of unstable modes around 105;
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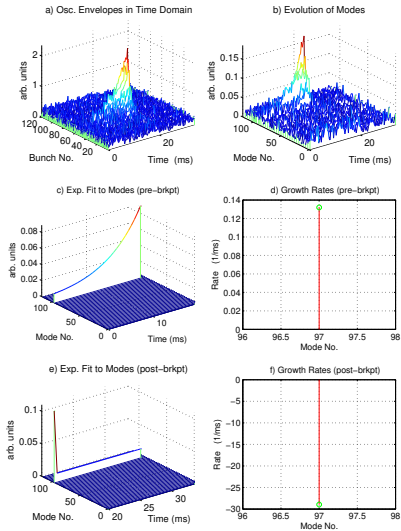
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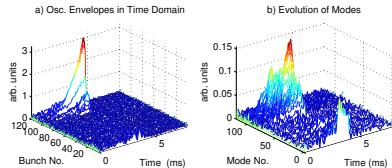
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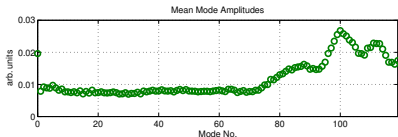
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DAFNE Ex (iGp): apr2821/210519: I₀= 159mA, D_{samp}= 1, ShiftGain= 1, N_{bun}= 120,
At v: G1= 8.7625, G2= 0, Ph1= -128.9749, Ph2= 0, Brkpt= 61262, Calib= 1.

Medium Current



DAFNE E+ (IGp): apr2821/211821: Io= 303mA, Dsamp= 1, ShifGain= 1, Nbun= 120,
At v: G1= 8.7524, G2= 0, Ph1= -132.3128, Ph2= 0, Brkpt= 12195, Calib= 1.



- ▶ A horizontal grow/damp at 303 mA;
- ▶ Wider modal pattern;
- ▶ Growth rates increase from 0.14 to 1 ms^{-1} ;
- ▶ A completely different picture in the vertical plane;
- ▶ No clear modal structure in the transient;
- ▶ A mix of single- and coupled-bunch instabilities?
- ▶ Growth rates go from 0.12 to 8 ms^{-1} .

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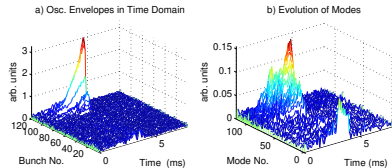
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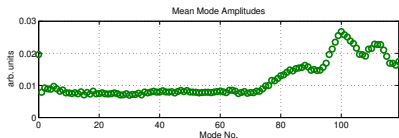
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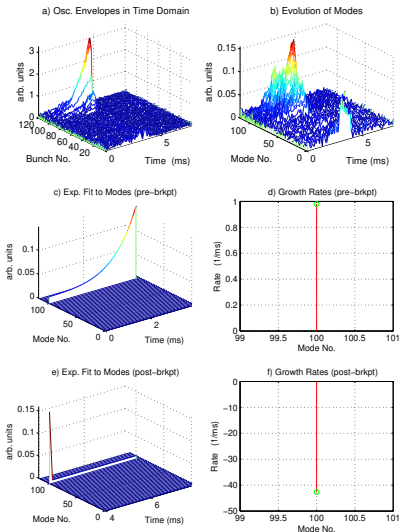
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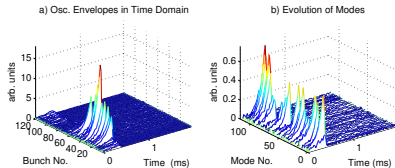
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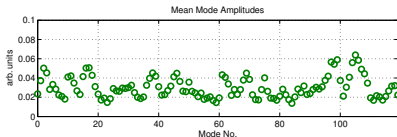
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Medium Current



DAFNE E+ (IGp): apr2821/211522: Io= 326mA, Dsamp= 1, ShiftGain= 7, Nbun= 120,
At v: G1= 137.6872, G2= 0, Ph1= 21.7329, Ph2= 0, Brkpt= 1204, Calib= 1.



- ▶ A horizontal grow/damp at 303 mA;
- ▶ Wider modal pattern;
- ▶ Growth rates increase from 0.14 to 1 ms⁻¹;
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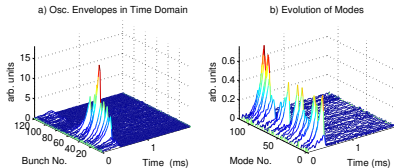
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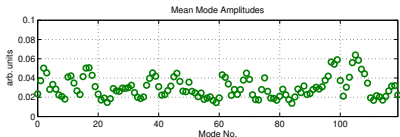
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Medium Current



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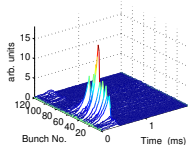
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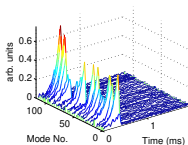
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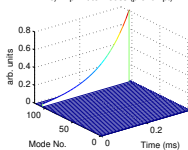
a) Osc. Envelopes in Time Domain



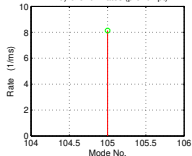
b) Evolution of Modes



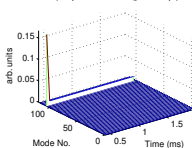
c) Exp. Fit to Modes (pre-brkpt)



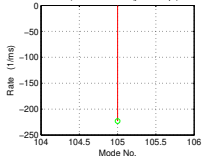
d) Growth Rates (pre-brkpt)



e) Exp. Fit to Modes (post-brkpt)



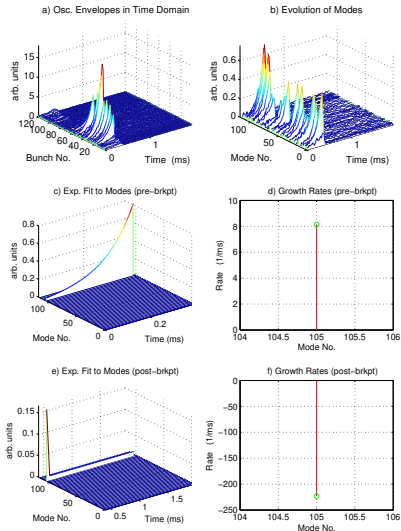
f) Growth Rates (post-brkpt)



DAFNE E+ (IGp): apr2821/211522: I₀= 326mA, D_{samp}= 1, ShifGain= 7, Nbuns= 120,
At v: G1= 137.6872, G2= 0, Ph1= 21.7329, Ph2= 0, Brkpt= 1250, Callb= 1.

- ▶ A horizontal grow/damp at 303 mA;
- ▶ Wider modal pattern;
- ▶ Growth rates increase from 0.14 to 1 ms⁻¹;
- ▶ A completely different picture in the vertical plane;
- ▶ No clear modal structure in the transient;
- ▶ A mix of single- and coupled-bunch instabilities?
- ▶ Growth rates go from 0.12 to 8 ms⁻¹.

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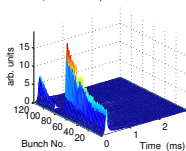
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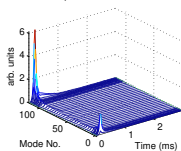
Summary

High Current

a) Osc. Envelopes in Time Domain

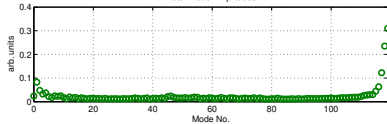


b) Evolution of Modes



DAFNE E+ (IGP): apr2821/213536: Io= 545mA, Dsamp= 1, ShifGain= 1, Nbun= 120,
At v: G1= 8.617, G2= 0, Ph1= -148.3432, Ph2= 0, Brkpt= 591, Calib= 1.

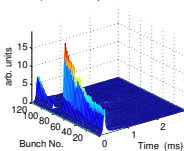
Mean Mode Amplitudes



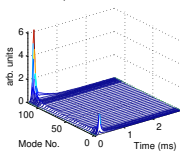
- ▶ A horizontal grow/damp at 545 mA;
- ▶ Dominated by modes -1 and -2 (AKA 119 and 118);
- ▶ Very fast growth, unusual long damping tails;
- ▶ Vertical plane at 582 mA is very similar to medium current case;
- ▶ Growth rates go from 24 ms^{-1} .

High Current

a) Osc. Envelopes in Time Domain

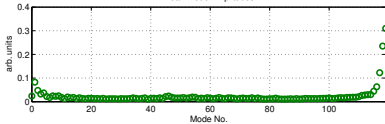


b) Evolution of Modes



DAFNE E+ (IGp): apr2821/213536: Io= 545mA, Dsamp= 1, ShifGain= 1, Nbun= 120,
At v: G1= 8.617, G2= 0, Ph1= -148.3432, Ph2= 0, Brkpt= 591, Calib= 1.

Mean Mode Amplitudes



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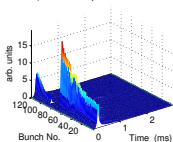
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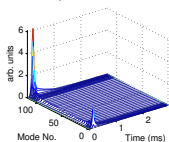
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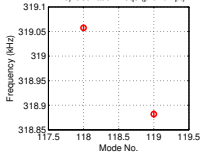
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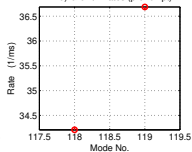
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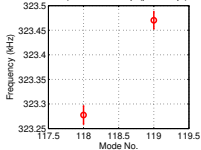
c) Oscillation freqs (pre-brkpt)



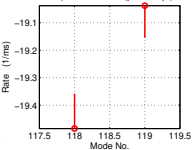
d) Growth Rates (pre-brkpt)



e) Oscillation freqs (post-brkpt)



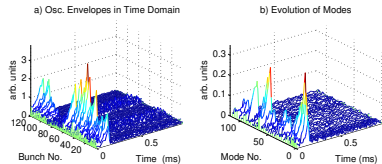
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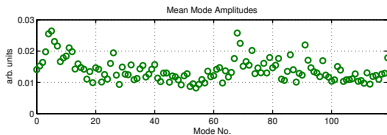
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- ▶ A horizontal grow/damp at 545 mA;
- ▶ Dominated by modes -1 and -2 (AKA 119 and 118);
- ▶ Very fast growth, unusual long damping tails;
- ▶ Vertical plane at 582 mA is very similar to medium current case;
- ▶ Growth rates go from 24 ms^{-1} .

High Current



DAFNE E+ (IGp): apr2821/213401: Io= 582mA, Dsamp= 1, ShifGain= 7, Nibun= 120,
At v: G1= 139.0955, G2= 0, Ph1= 20.7041, Ph2= 0, Brkpt= 438, Calib= 1.



- ▶ A horizontal grow/damp at 545 mA;
- ▶ Dominated by modes -1 and -2 (AKA 119 and 118);
- ▶ Very fast growth, unusual long damping tails;
- ▶ Vertical plane at 582 mA is very similar to medium current case;
- ▶ Growth rates go from 24 ms^{-1} .

Day 1:
2021-04-28

Day 2:
2021-04-29

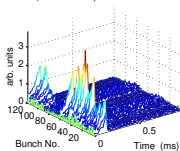
Day 3:
2021-04-30

Day 4:
2021-05-04

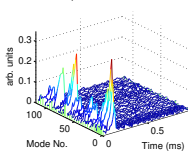
Summary

High Current

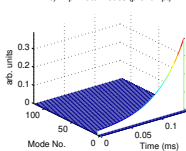
a) Osc. Envelopes in Time Domain



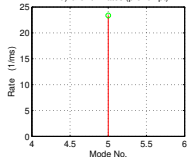
b) Evolution of Modes



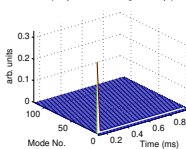
c) Exp. Fit to Modes (pre-brkpt)



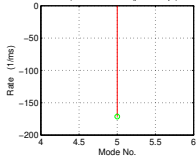
d) Growth Rates (pre-brkpt)



e) Exp. Fit to Modes (post-brkpt)



f) Growth Rates (post-brkpt)



DAΦNE E+ (IGP):spr2821/213401: Io= 582mA, Dsamp= 1, ShifGain= 7, Nbum= 120,
At v: G1= 139.0955, G2= 0, Ph1= 20.7041, Ph2= 0, Brkpt= 438, Calib= 1.

- ▶ A horizontal grow/damp at 545 mA;
- ▶ Dominated by modes -1 and -2 (AKA 119 and 118);
- ▶ Very fast growth, unusual long damping tails;
- ▶ Vertical plane at 582 mA is very similar to medium current case;
- ▶ Growth rates go from 24 ms^{-1} .

Day 1:
2021-04-28

Day 2:
2021-04-29

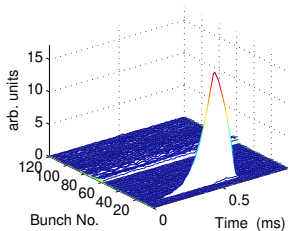
Day 3:
2021-04-30

Day 4:
2021-05-04

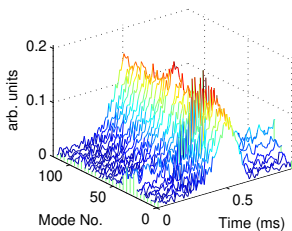
Summary

Single Bunch Grow/Damp

a) Osc. Envelopes in Time Domain



b) Evolution of Modes



DAFNE E+ (iGp):apr2821/170601: $I_0=700\text{mA}$, $D_{\text{samp}}=1$, $\text{ShifGain}=5$, $N_{\text{bun}}=120$,
 At v: $G1=101.1803$, $G2=101.1803$, $Ph1=-158.8413$, $Ph2=-158.8413$, $Brkpt=2996$, $Calib=1$.

- ▶ A single bunch grow/damp;
- ▶ Feedback turned off for bunch 10, all other bunches under normal feedback action;
- ▶ Fast exponential growth, not expected with coupled-bunch instabilities;
- ▶ Another measurement at 670 mA, bunch 60.

Day 1:
2021-04-28

Day 2:
2021-04-29

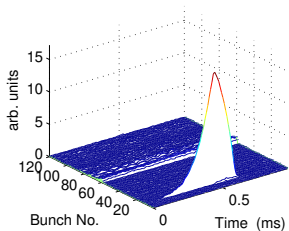
Day 3:
2021-04-30

Day 4:
2021-05-04

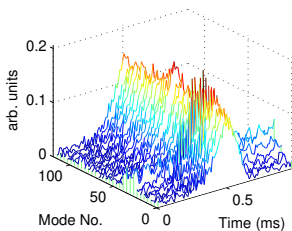
Summary

Single Bunch Grow/Damp

a) Osc. Envelopes in Time Domain



b) Evolution of Modes



DAΦNE E+ (iGp):apr2821/170601: $I_0=700\text{mA}$, $D_{\text{samp}}=1$, $\text{ShifGain}=5$, $N_{\text{bun}}=120$,
 At v: $G_1=101.1803$, $G_2=101.1803$, $\text{Ph}_1=-158.8413$, $\text{Ph}_2=-158.8413$, $\text{Brkpt}=2996$, $\text{Calib}=1$.

- ▶ A single bunch grow/damp;
- ▶ Feedback turned off for bunch 10, all other bunches under normal feedback action;
- ▶ Fast exponential growth, not expected with coupled-bunch instabilities;
- ▶ Another measurement at 670 mA, bunch 60.

Day 1:
2021-04-28

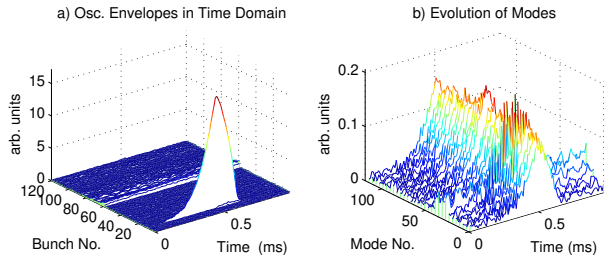
Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

Single Bunch Grow/Damp



DAΦNE E+ (iGp):apr2821/170601: $I_0=700\text{mA}$, $D_{\text{samp}}=1$, $\text{ShifGain}=5$, $N_{\text{bun}}=120$,
 At v: $G_1=101.1803$, $G_2=101.1803$, $\text{Ph}_1=-158.8413$, $\text{Ph}_2=-158.8413$, $\text{Brkpt}=2996$, $\text{Calib}=1$.

- ▶ A single bunch grow/damp;
- ▶ Feedback turned off for bunch 10, all other bunches under normal feedback action;
- ▶ Fast exponential growth, not expected with coupled-bunch instabilities;
- ▶ Another measurement at 670 mA, bunch 60.

Day 1:
2021-04-28

Day 2:
2021-04-29

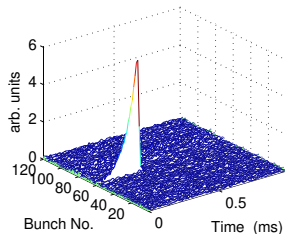
Day 3:
2021-04-30

Day 4:
2021-05-04

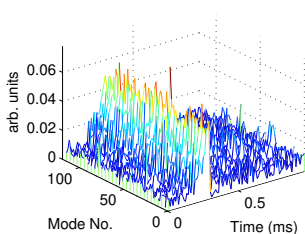
Summary

Single Bunch Grow/Damp

a) Osc. Envelopes in Time Domain



b) Evolution of Modes



DAΦNE E+ (IGp): apr2821/171056: Io= 670mA, Dsamp= 1, ShifGain= 5, Nbun= 120,
At v: G1= 101.1803, G2= 101.1803, Ph1= -158.8413, Ph2= -158.8413, Brkpt= 2996, Calib= 1.

- ▶ A single bunch grow/damp;
- ▶ Feedback turned off for bunch 10, all other bunches under normal feedback action;
- ▶ Fast exponential growth, not expected with coupled-bunch instabilities;
- ▶ Another measurement at 670 mA, bunch 60.

Day 1:
2021-04-28

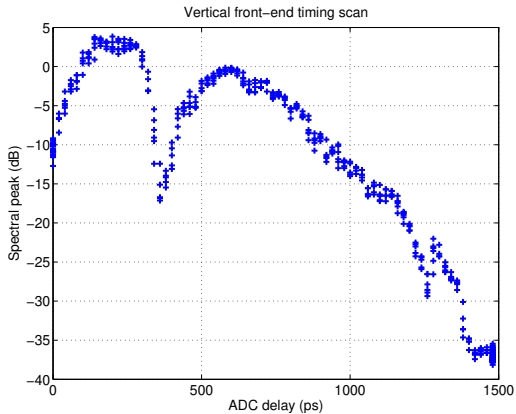
Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

ADC Timing



- ▶ **Single bunch in the ring;**
- ▶ Exciting at a low amplitude at the betatron tune;
- ▶ Measuring betatron peak amplitude;
- ▶ Started at 750 ps, moved to 180 ps;
- ▶ A similar scan in the horizontal plane.

Day 1:
2021-04-28

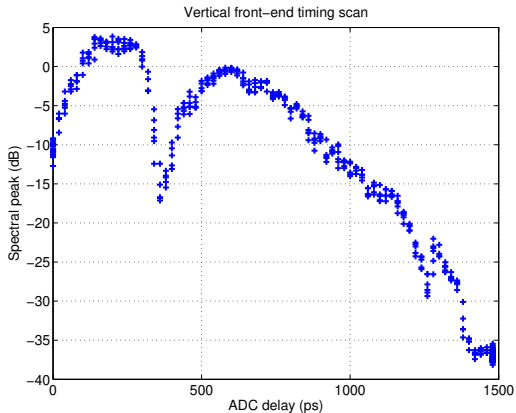
Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

ADC Timing



- ▶ Single bunch in the ring;
- ▶ Exciting at a low amplitude at the betatron tune;
- ▶ Measuring betatron peak amplitude;
- ▶ Started at 750 ps, moved to 180 ps;
- ▶ A similar scan in the horizontal plane.

Day 1:
2021-04-28

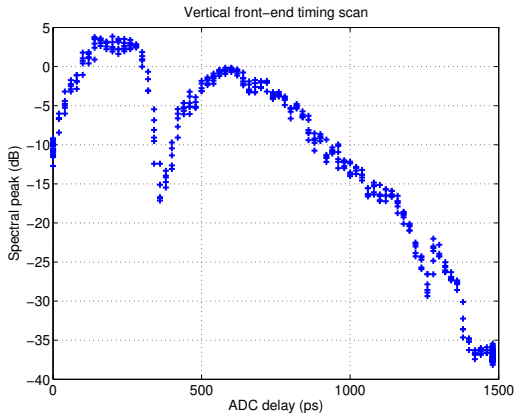
Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

ADC Timing



- ▶ Single bunch in the ring;
- ▶ Exciting at a low amplitude at the betatron tune;
- ▶ Measuring betatron peak amplitude;
- ▶ Started at 750 ps, moved to 180 ps;
- ▶ A similar scan in the horizontal plane.

Day 1:
2021-04-28

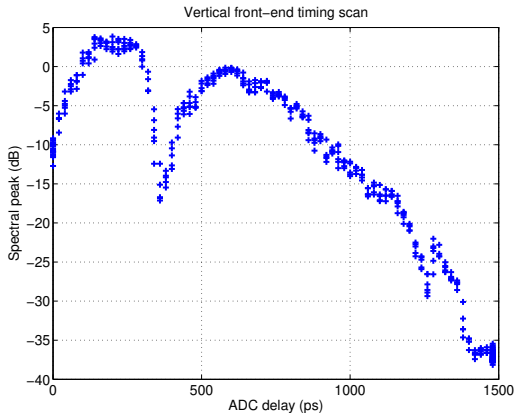
Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

ADC Timing



- ▶ Single bunch in the ring;
- ▶ Exciting at a low amplitude at the betatron tune;
- ▶ Measuring betatron peak amplitude;
- ▶ Started at 750 ps, moved to 180 ps;
- ▶ A similar scan in the horizontal plane.

Day 1:
2021-04-28

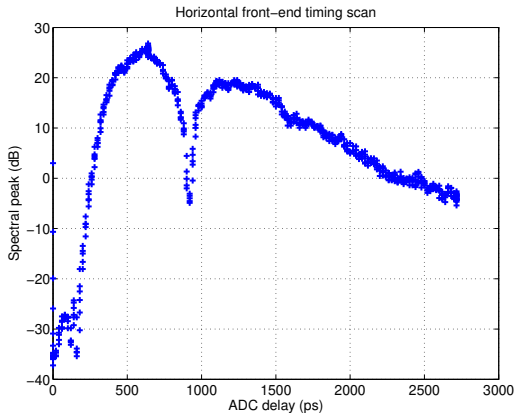
Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

ADC Timing



- ▶ Single bunch in the ring;
- ▶ Exciting at a low amplitude at the betatron tune;
- ▶ Measuring betatron peak amplitude;
- ▶ Started at 750 ps, moved to 180 ps;
- ▶ A similar scan in the horizontal plane.

Day 1:
2021-04-28

Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

Work Summary

Day 1:
2021-04-28

Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

- ▶ Chromaticity has been raised in X and Y;
- ▶ Better behaved vertical plane, less feedback gain needed to suppress the instabilities;
- ▶ Next limit — longitudinal plane;
- ▶ Found unstable mode 0 — low-level RF feedback loops are responsible.

Work Summary

Day 1:
2021-04-28

Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

- ▶ Chromaticity has been raised in X and Y;
- ▶ Better behaved vertical plane, less feedback gain needed to suppress the instabilities;
- ▶ Next limit — longitudinal plane;
- ▶ Found unstable mode 0 — low-level RF feedback loops are responsible.

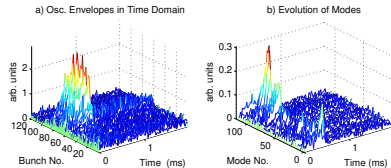
Work Summary

- ▶ Chromaticity has been raised in X and Y;
- ▶ Better behaved vertical plane, less feedback gain needed to suppress the instabilities;
- ▶ Next limit — longitudinal plane;
- ▶ Found unstable mode 0 — low-level RF feedback loops are responsible.

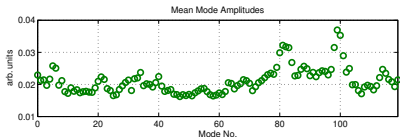
Work Summary

- ▶ Chromaticity has been raised in X and Y;
- ▶ Better behaved vertical plane, less feedback gain needed to suppress the instabilities;
- ▶ Next limit — longitudinal plane;
- ▶ Found unstable mode 0 — low-level RF feedback loops are responsible.

Vertical Grow/Damp



DAFNE E+ (IGp):apr2921/205200: Io= 506mA, Dsamp= 1, ShifGain= 4, Nbun= 120,
At v: G1= 0, G2= 50.158, Ph1= 0, Ph2= -160.4922, Brkpt= 1511, Calib= 1.



- ▶ A vertical grow/damp at 506 mA;
- ▶ More consistent with coupled-bunch motion, showing several groups of modes;
- ▶ Growth rates reduced from 24 ms^{-1} at 582 mA to 8 ms^{-1} at 506 mA.

Day 1:
2021-04-28

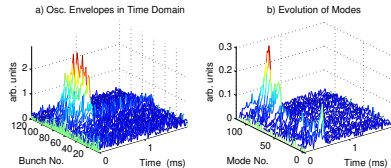
Day 2:
2021-04-29

Day 3:
2021-04-30

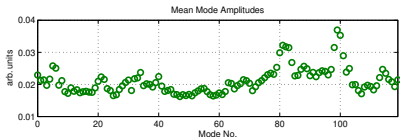
Day 4:
2021-05-04

Summary

Vertical Grow/Damp



DAFNE E+ (IGp):apr2921/205200: Io= 506mA, Dsamp= 1, ShifGain= 4, Nbun= 120,
At v: G1= 0, G2= 50.158, Ph1= 0, Ph2= -160.4922, Brkpts= 1511, Calib= 1.



- ▶ A vertical grow/damp at 506 mA;
- ▶ More consistent with coupled-bunch motion, showing several groups of modes;
- ▶ Growth rates reduced from 24 ms^{-1} at 582 mA to 8 ms^{-1} at 506 mA.

Day 1:
2021-04-28

Day 2:
2021-04-29

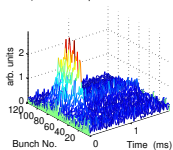
Day 3:
2021-04-30

Day 4:
2021-05-04

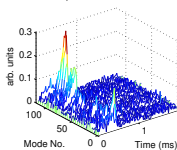
Summary

Vertical Grow/Damp

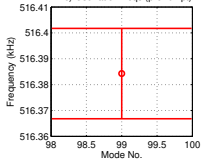
a) Osc. Envelopes in Time Domain



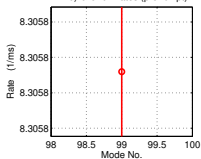
b) Evolution of Modes



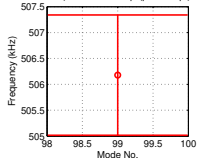
c) Oscillation freqs (pre-brkpt)



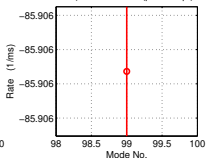
d) Growth Rates (pre-brkpt)



e) Oscillation freqs (post-brkpt)



f) Growth Rates (post-brkpt)



DAFNE Ex (IGp): apr2921/205200: I0= 506mA, Dsamp= 1, ShfGain= 4, Nbuns= 120,
At v: G1= 0, G2= 50.158, Ph1= 0, Ph2= -160.4922, Brkpt= 1511, Callib= 1.

- ▶ A vertical grow/damp at 506 mA;
- ▶ More consistent with coupled-bunch motion, showing several groups of modes;
- ▶ Growth rates reduced from 24 ms^{-1} at 582 mA to 8 ms^{-1} at 506 mA.

Day 1:
2021-04-28

Day 2:
2021-04-29

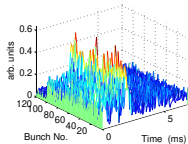
Day 3:
2021-04-30

Day 4:
2021-05-04

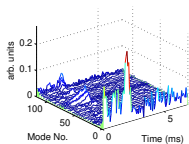
Summary

Longitudinal Grow/Damps

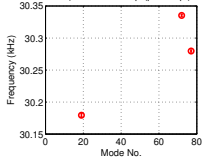
a) Osc. Envelopes in Time Domain



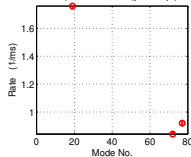
b) Evolution of Modes



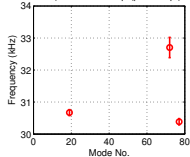
c) Oscillation freqs (pre-brkpt)



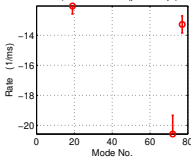
d) Growth Rates (pre-brkpt)



e) Oscillation freqs (post-brkpt)



f) Growth Rates (post-brkpt)



DAΦNE E⁺ (IGP): apr2921/214352: Io= 666mA, Dsamps= 5, ShiftGain= 3, Nbun= 120,
At v: G1= 0, G2= 63.9064, Ph1= 0, Ph2= -94.0647, Brkpts= 1290, Calib= 0.6241.

- ▶ Intermittent mode 0 instabilities;
- ▶ A “normal” grow/damp at 666 mA;
- ▶ Higher order modes grow and damp in a 2 ms transient;
- ▶ Another measurement, taken a minute later, at 632 mA;
- ▶ Mode 0 grows to very large amplitudes;
- ▶ Growth rate is not constant.

Day 1:
2021-04-28

Day 2:
2021-04-29

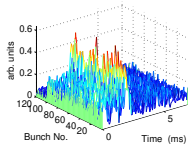
Day 3:
2021-04-30

Day 4:
2021-05-04

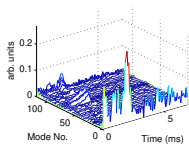
Summary

Longitudinal Grow/Damps

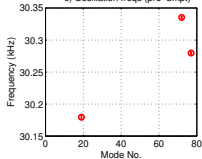
a) Osc. Envelopes in Time Domain



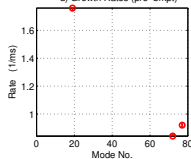
b) Evolution of Modes



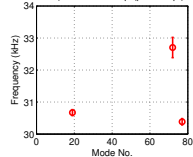
c) Oscillation freqs (pre-brkpt)



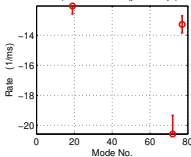
d) Growth Rates (pre-brkpt)



e) Oscillation freqs (post-brkpt)



f) Growth Rates (post-brkpt)



DAΦNE E+ (IGP): apr2921/214352: Io= 666mA, Dsamps= 5, ShiftGain= 3, Nbun= 120,
At v: G1= 0, G2= 63.9064, Ph1= 0, Ph2= -94.0647, Brkpts= 1290, Calib= 0.6241.

- ▶ Intermittent mode 0 instabilities;
- ▶ A “normal” grow/damp at 666 mA;
- ▶ Higher order modes grow and damp in a 2 ms transient;
- ▶ Another measurement, taken a minute later, at 632 mA;
- ▶ Mode 0 grows to very large amplitudes;
- ▶ Growth rate is not constant.

Day 1:
2021-04-28

Day 2:
2021-04-29

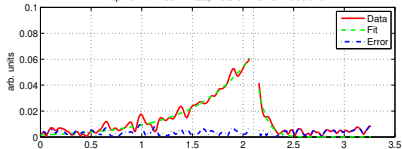
Day 3:
2021-04-30

Day 4:
2021-05-04

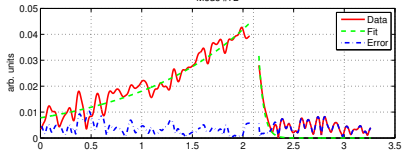
Summary

Longitudinal Grow/Damps

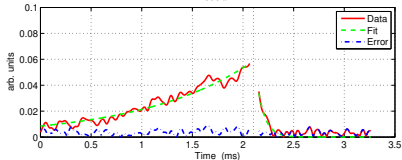
apr2921/214352 Data, Fit and Error for Mode #19



Mode #72



Mode #77



- ▶ Intermittent mode 0 instabilities;
- ▶ A “normal” grow/damp at 666 mA;
- ▶ Higher order modes grow and damp in a 2 ms transient;
- ▶ Another measurement, taken a minute later, at 632 mA;
- ▶ Mode 0 grows to very large amplitudes;
- ▶ Growth rate is not constant.

Day 1:
2021-04-28

Day 2:
2021-04-29

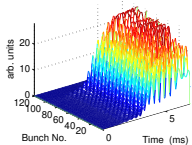
Day 3:
2021-04-30

Day 4:
2021-05-04

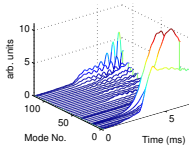
Summary

Longitudinal Grow/Damps

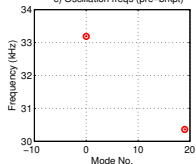
a) Osc. Envelopes in Time Domain



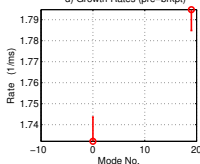
b) Evolution of Modes



c) Oscillation freqs (pre-brkpt)



d) Growth Rates (pre-brkpt)



DAΦNE E+ (IGp):apr2921/214446: I₀= 632mA, D_{samp}= 5, ShiftGain= 3, Nbun= 120,
At v: G1= 0, G2= 63.1281, Ph1= 0, Ph2= -78.8721, Brkpt= 2464, Calib= 0.6241.

- ▶ Intermittent mode 0 instabilities;
- ▶ A “normal” grow/damp at 666 mA;
- ▶ Higher order modes grow and damp in a 2 ms transient;
- ▶ Another measurement, taken a minute later, at 632 mA;
 - ▶ Mode 0 grows to very large amplitudes;
 - ▶ Growth rate is not constant.

Day 1:
2021-04-28

Day 2:
2021-04-29

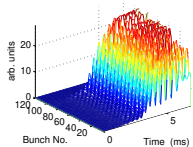
Day 3:
2021-04-30

Day 4:
2021-05-04

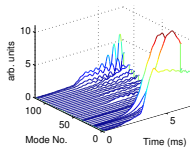
Summary

Longitudinal Grow/Damps

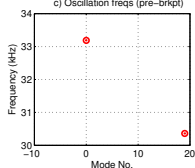
a) Osc. Envelopes in Time Domain



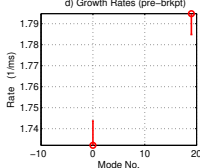
b) Evolution of Modes



c) Oscillation freqs (pre-brkpt)



d) Growth Rates (pre-brkpt)



DAΦNE E+ (IGp):apr2921/214446: I₀= 632mA, D_{samp}= 5, ShiftGain= 3, Nbun= 120,
At v: G1= 0, G2= 63.1281, Ph1= 0, Ph2= -78.8721, Brkpt= 2464, Calib= 0.6241.

- ▶ Intermittent mode 0 instabilities;
- ▶ A “normal” grow/damp at 666 mA;
- ▶ Higher order modes grow and damp in a 2 ms transient;
- ▶ Another measurement, taken a minute later, at 632 mA;
- ▶ Mode 0 grows to very large amplitudes;
- ▶ Growth rate is not constant.

Day 1:
2021-04-28

Day 2:
2021-04-29

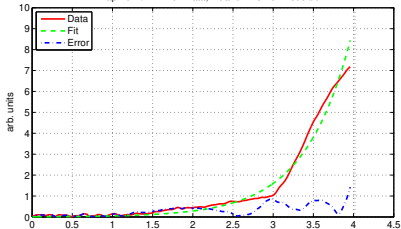
Day 3:
2021-04-30

Day 4:
2021-05-04

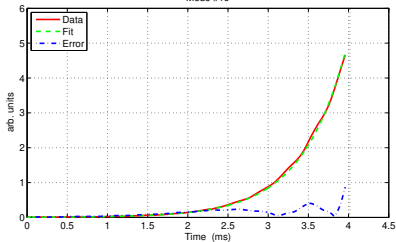
Summary

Longitudinal Grow/Damps

apr2921/214446 Data, Fit and Error for Mode #0



Mode #19



- ▶ Intermittent mode 0 instabilities;
- ▶ A “normal” grow/damp at 666 mA;
- ▶ Higher order modes grow and damp in a 2 ms transient;
- ▶ Another measurement, taken a minute later, at 632 mA;
- ▶ Mode 0 grows to very large amplitudes;
- ▶ Growth rate is not constant.

Day 1:
2021-04-28

Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

Work Summary

- ▶ **Worked on optimizing low-level RF loops;**
- ▶ Achieved a better configuration for mode 0 stability by tilting the direct loop response and reducing mode 0 feedback gain;
- ▶ In the process of injection to higher currents, observed quadrupole instabilities (at 750 mA and above);
- ▶ In the limited time available, tried to configure the LFB for dual band dipole and quadrupole control;
- ▶ Ultimately, needed more time to make this work.

Work Summary

- ▶ Worked on optimizing low-level RF loops;
- ▶ Achieved a better configuration for mode 0 stability by tilting the direct loop response and reducing mode 0 feedback gain;
- ▶ In the process of injection to higher currents, observed quadrupole instabilities (at 750 mA and above);
- ▶ In the limited time available, tried to configure the LFB for dual band dipole and quadrupole control;
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Work Summary

- ▶ Worked on optimizing low-level RF loops;
- ▶ Achieved a better configuration for mode 0 stability by tilting the direct loop response and reducing mode 0 feedback gain;
- ▶ In the process of injection to higher currents, observed quadrupole instabilities (at 750 mA and above);
- ▶ In the limited time available, tried to configure the LFB for dual band dipole and quadrupole control;
- ▶ Ultimately, needed more time to make this work.

Work Summary

- ▶ Worked on optimizing low-level RF loops;
- ▶ Achieved a better configuration for mode 0 stability by tilting the direct loop response and reducing mode 0 feedback gain;
- ▶ In the process of injection to higher currents, observed quadrupole instabilities (at 750 mA and above);
- ▶ In the limited time available, tried to configure the LFB for dual band dipole and quadrupole control;
- ▶ Ultimately, needed more time to make this work.

Work Summary

- ▶ Worked on optimizing low-level RF loops;
- ▶ Achieved a better configuration for mode 0 stability by tilting the direct loop response and reducing mode 0 feedback gain;
- ▶ In the process of injection to higher currents, observed quadrupole instabilities (at 750 mA and above);
- ▶ In the limited time available, tried to configure the LFB for dual band dipole and quadrupole control;
- ▶ Ultimately, needed more time to make this work.

Longitudinal Grow/Damp

Day 1:
2021-04-28

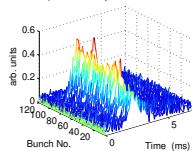
Day 2:
2021-04-29

Day 3:
2021-04-30

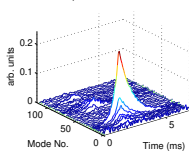
Day 4:
2021-05-04

Summary

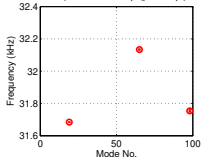
a) Osc. Envelopes in Time Domain



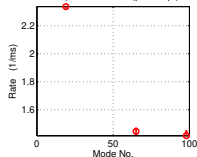
b) Evolution of Modes



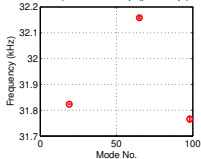
c) Oscillation freqs (pre-brkpt)



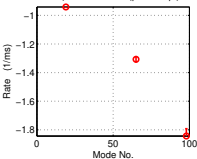
d) Growth Rates (pre-brkpt)



e) Oscillation freqs (post-brkpt)



f) Growth Rates (post-brkpt)



- ▶ At 729 mA;
- ▶ Mode 0 well suppressed;
- ▶ Modes 19, 65, and 98 are active.

DAFNE E+ (IGp): apr3021/175251: I₀= 729mA, D_{samp}= 5, ShfGain= 2, Nbun= 120,
At v: G1= 31.8171, G2= 0, Ph1= -86.2692, Ph2= 0, Brkpt= 1299, Calib= 0.6241.

Longitudinal Grow/Damp

Day 1:
2021-04-28

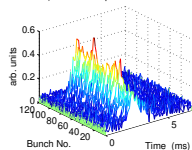
Day 2:
2021-04-29

Day 3:
2021-04-30

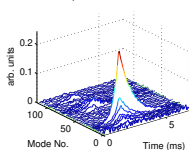
Day 4:
2021-05-04

Summary

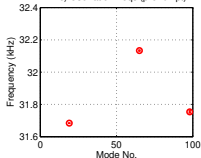
a) Osc. Envelopes in Time Domain



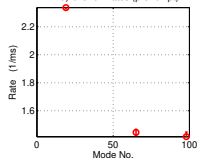
b) Evolution of Modes



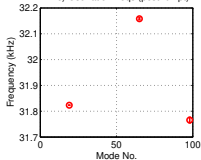
c) Oscillation freqs (pre-brkpt)



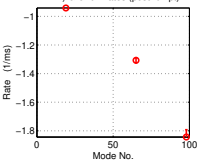
d) Growth Rates (pre-brkpt)



e) Oscillation freqs (post-brkpt)



f) Growth Rates (post-brkpt)



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Longitudinal Grow/Damp

Day 1:
2021-04-28

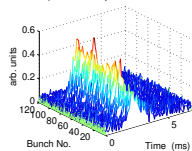
Day 2:
2021-04-29

Day 3:
2021-04-30

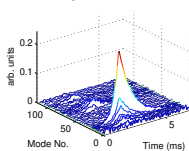
Day 4:
2021-05-04

Summary

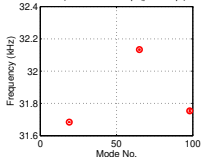
a) Osc. Envelopes in Time Domain



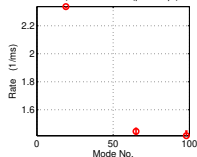
b) Evolution of Modes



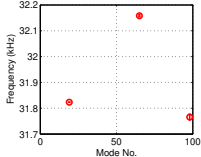
c) Oscillation freqs (pre-brkpt)



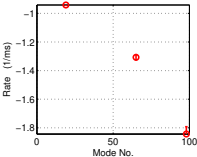
d) Growth Rates (pre-brkpt)



e) Oscillation freqs (post-brkpt)



f) Growth Rates (post-brkpt)



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At v: G1= 31.8171, G2= 0, Ph1= -86.2692, Ph2= 0, Brkpt= 1299, Calib= 0.6241.

Work Summary

- ▶ **Trying to establish quadrupole and dipole feedback;**
- ▶ Observed some regression in the vertical plane, needed more gain to suppress the motion;
- ▶ Had a hard time producing enough gain for dipole and quadrupole control;
- ▶ Obtained some quadrupole grow/damps.

Work Summary

- ▶ Trying to establish quadrupole and dipole feedback;
- ▶ Observed some regression in the vertical plane, needed more gain to suppress the motion;
- ▶ Had a hard time producing enough gain for dipole and quadrupole control;
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Work Summary

- ▶ Trying to establish quadrupole and dipole feedback;
- ▶ Observed some regression in the vertical plane, needed more gain to suppress the motion;
- ▶ Had a hard time producing enough gain for dipole and quadrupole control;
- ▶ Obtained some quadrupole grow/damps.

Work Summary

Day 1:
2021-04-28

Day 2:
2021-04-29

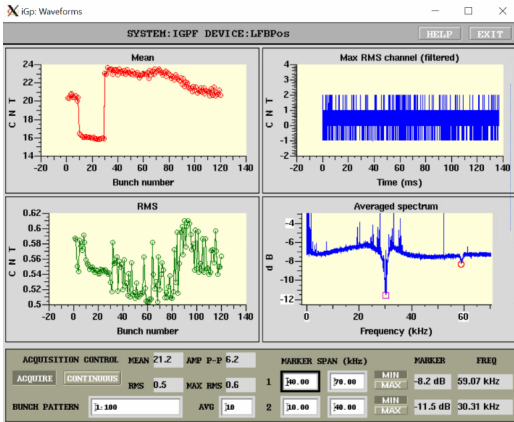
Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

- ▶ Trying to establish quadrupole and dipole feedback;
- ▶ Observed some regression in the vertical plane, needed more gain to suppress the motion;
- ▶ Had a hard time producing enough gain for dipole and quadrupole control;
- ▶ Obtained some quadrupole grow/damps.

Dual Band Feedback



- ▶ At 430 mA;
- ▶ Two notches at synchrotron and quadrupole frequencies.

Day 1:
2021-04-28

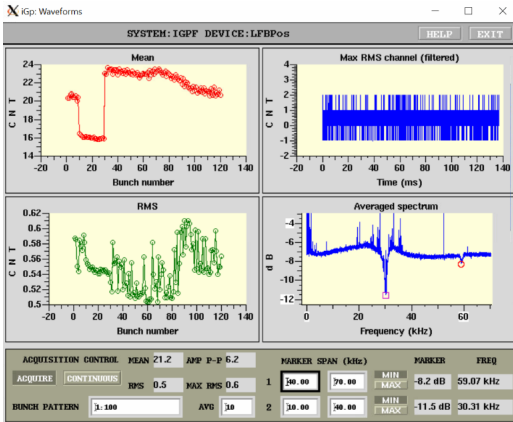
Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

Dual Band Feedback



- ▶ At 430 mA;
- ▶ Two notches at synchrotron and quadrupole frequencies.

Day 1:
2021-04-28

Day 2:
2021-04-29

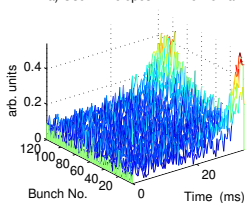
Day 3:
2021-04-30

Day 4:
2021-05-04

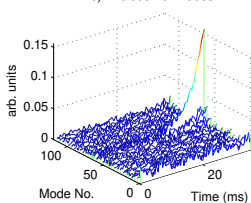
Summary

Quadrupole Growth Transient

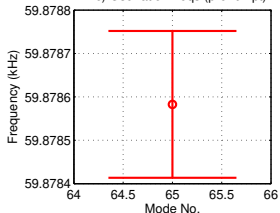
a) Osc. Envelopes in Time Domain



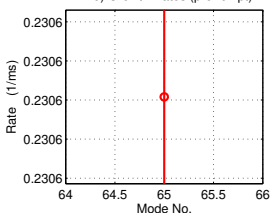
b) Evolution of Modes



c) Oscillation freqs (pre-brkpt)



d) Growth Rates (pre-brkpt)



DAΦNE E+ (iGp):may0421/200046: Io= 750mA, Dsamp= 6, ShifGain= 7, Nbun= 120,

At v: G1= 720.2595, G2= 29.5368, Ph1= -93.458, Ph2= 108.4599, Brkpt= 17000, Calib= 0.6241.

- ▶ At 750 mA we transition from a dual band filter to dipole only one, with a notch at the quadrupole frequency;
- ▶ Clean growth of a single mode;
- ▶ Mode 65, also see in the dipole measurements;
- ▶ Analyzing the same dataset around the synchrotron frequency — no activity apart from driven mode 0 motion.

Day 1:
2021-04-28

Day 2:
2021-04-29

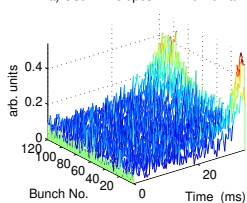
Day 3:
2021-04-30

Day 4:
2021-05-04

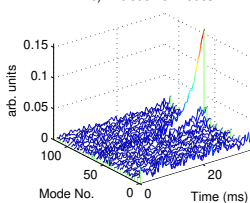
Summary

Quadrupole Growth Transient

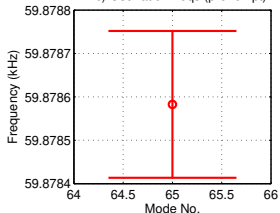
a) Osc. Envelopes in Time Domain



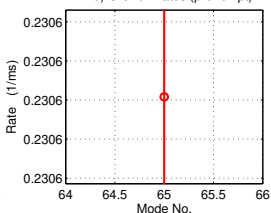
b) Evolution of Modes



c) Oscillation freqs (pre-brkpt)



d) Growth Rates (pre-brkpt)



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- ▶ Analyzing the same dataset around the synchrotron frequency — no activity apart from driven mode 0 motion.

Day 1:
2021-04-28

Day 2:
2021-04-29

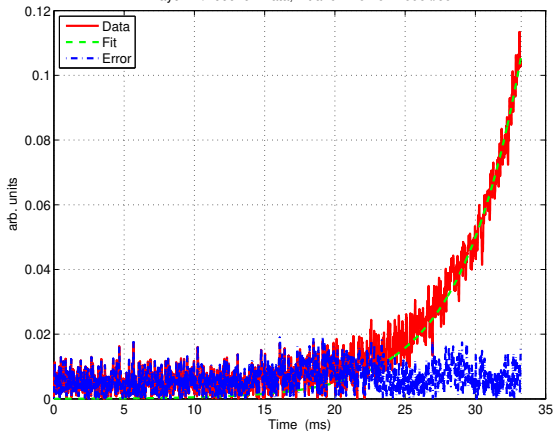
Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

Quadrupole Growth Transient

may0421/200046 Data, Fit and Error for Mode #65



- ▶ At 750 mA we transition from a dual band filter to dipole only one, with a notch at the quadrupole frequency;
- ▶ Clean growth of a single mode;
- ▶ Mode 65, also see in the dipole measurements;
- ▶ Analyzing the same dataset around the synchrotron frequency — no activity apart from driven mode 0 motion.

Day 1:
2021-04-28

Day 2:
2021-04-29

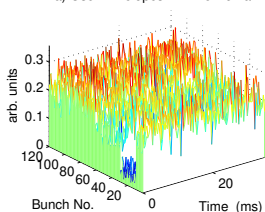
Day 3:
2021-04-30

Day 4:
2021-05-04

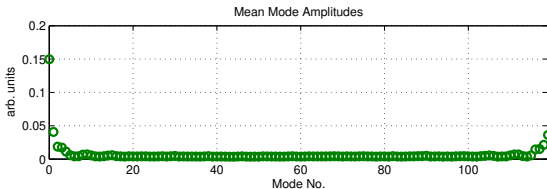
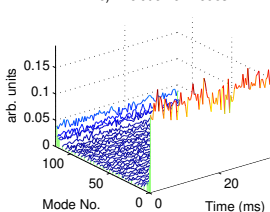
Summary

Quadrupole Growth Transient

a) Osc. Envelopes in Time Domain



b) Evolution of Modes



- ▶ At 750 mA we transition from a dual band filter to dipole only one, with a notch at the quadrupole frequency;
- ▶ Clean growth of a single mode;
- ▶ Mode 65, also see in the dipole measurements;
- ▶ Analyzing the same dataset around the synchrotron frequency — no activity apart from driven mode 0 motion.

Day 1:
2021-04-28

Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

Summary

Day 1:
2021-04-28

Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

- ▶ **Many issues seen in vertical and longitudinal planes;**
- ▶ Wide variety of causes;
- ▶ Machine is changing, not steady state;
- ▶ Investigate the source of quadrupole instabilities, possibly cavity temperatures can be optimized;
- ▶ Vertical plane is still marginal, need to check optics;
- ▶ Scrubbing?

Summary

Day 1:
2021-04-28

Day 2:
2021-04-29

Day 3:
2021-04-30

Day 4:
2021-05-04

Summary

- ▶ Many issues seen in vertical and longitudinal planes;
- ▶ Wide variety of causes;
 - ▶ Machine is changing, not steady state;
 - ▶ Investigate the source of quadrupole instabilities, possibly cavity temperatures can be optimized;
 - ▶ Vertical plane is still marginal, need to check optics;
 - ▶ Scrubbing?

Summary

- ▶ Many issues seen in vertical and longitudinal planes;
- ▶ Wide variety of causes;
- ▶ Machine is changing, not steady state;
- ▶ Investigate the source of quadrupole instabilities, possibly cavity temperatures can be optimized;
- ▶ Vertical plane is still marginal, need to check optics;
- ▶ Scrubbing?

Summary

- ▶ Many issues seen in vertical and longitudinal planes;
- ▶ Wide variety of causes;
- ▶ Machine is changing, not steady state;
- ▶ Investigate the source of quadrupole instabilities, possibly cavity temperatures can be optimized;
- ▶ Vertical plane is still marginal, need to check optics;
- ▶ Scrubbing?

Summary

- ▶ Many issues seen in vertical and longitudinal planes;
- ▶ Wide variety of causes;
- ▶ Machine is changing, not steady state;
- ▶ Investigate the source of quadrupole instabilities, possibly cavity temperatures can be optimized;
- ▶ Vertical plane is still marginal, need to check optics;
- ▶ Scrubbing?

Summary

- ▶ Many issues seen in vertical and longitudinal planes;
- ▶ Wide variety of causes;
- ▶ Machine is changing, not steady state;
- ▶ Investigate the source of quadrupole instabilities, possibly cavity temperatures can be optimized;
- ▶ Vertical plane is still marginal, need to check optics;
- ▶ Scrubbing?