Fermilab

LHC 4.8 GHz Schottky Commissioning

Ralph J. Pasquinelli
Andreas Jansson
April 8-15, 2010

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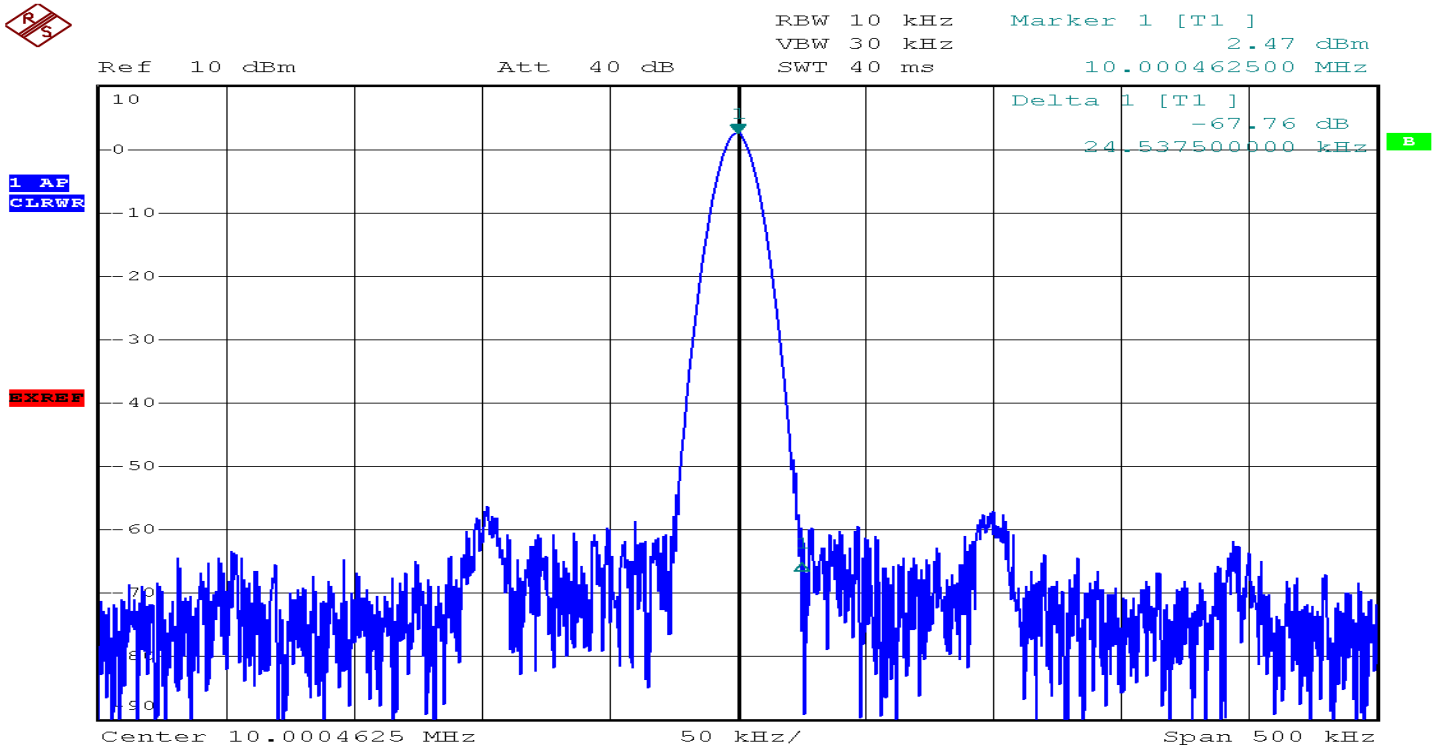
Amplified 10 MHz derived from RF Beam 1
Used for ext reference on cal signal gen



10mhzB1

Date: 9.APR.2010 10:20:57

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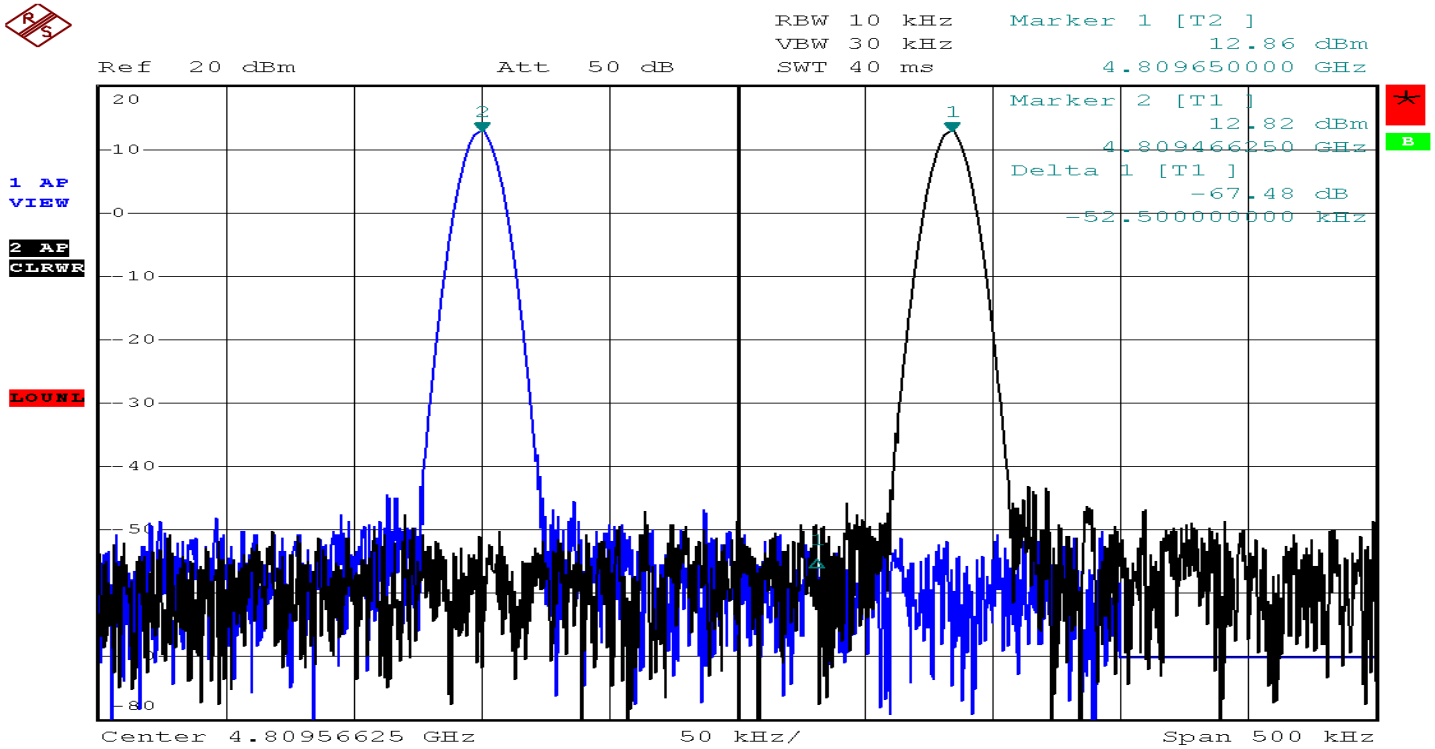
Calibration signal generator with 10 MHz ext ref from Beam 1 Tracking RF frequency change



10mhzB1

Date: 9.APR.2010 11:49:10

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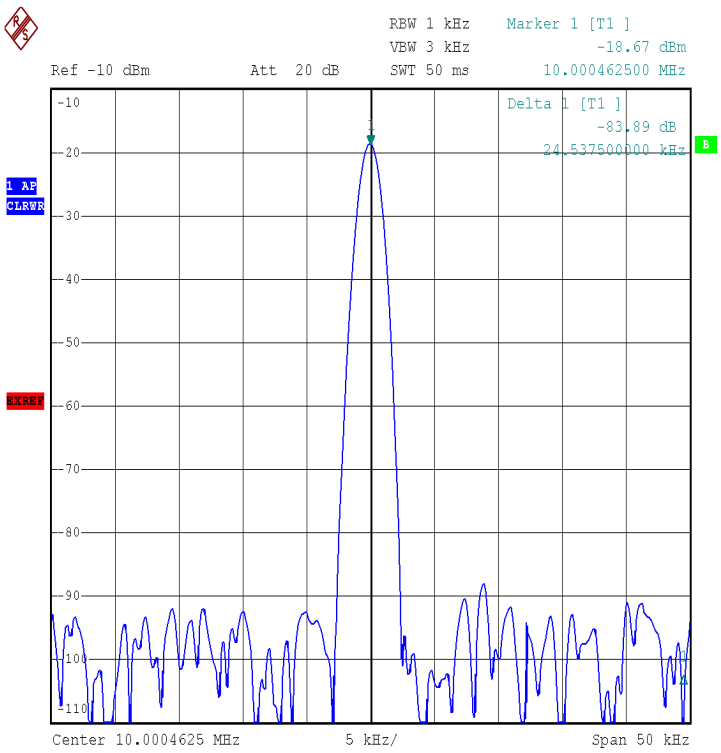
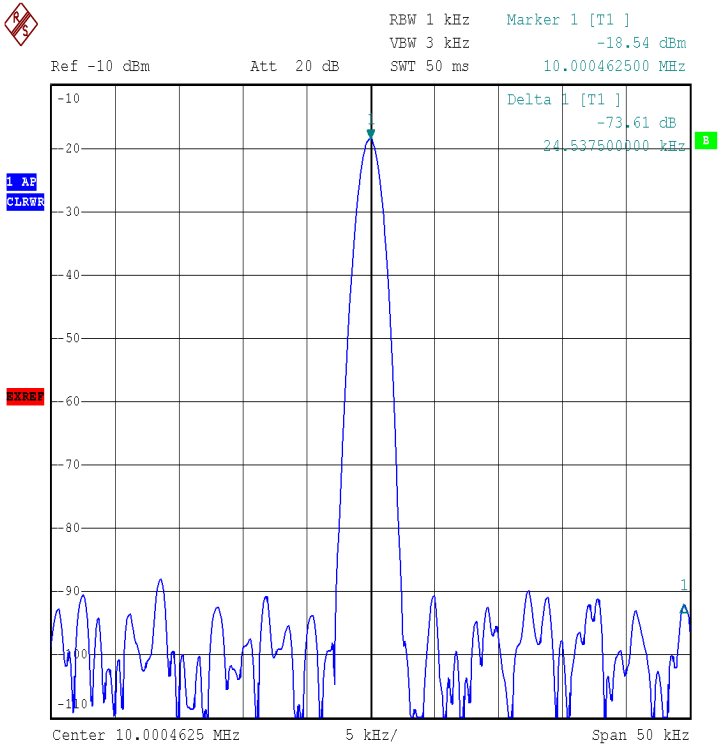
Beam 1 Beam 2: 10 MHz samples
In service building



10mhzB1

Date: 9.APR.2010 10:07:43



10mhzB1

Date: 9.APR.2010 10:09:52

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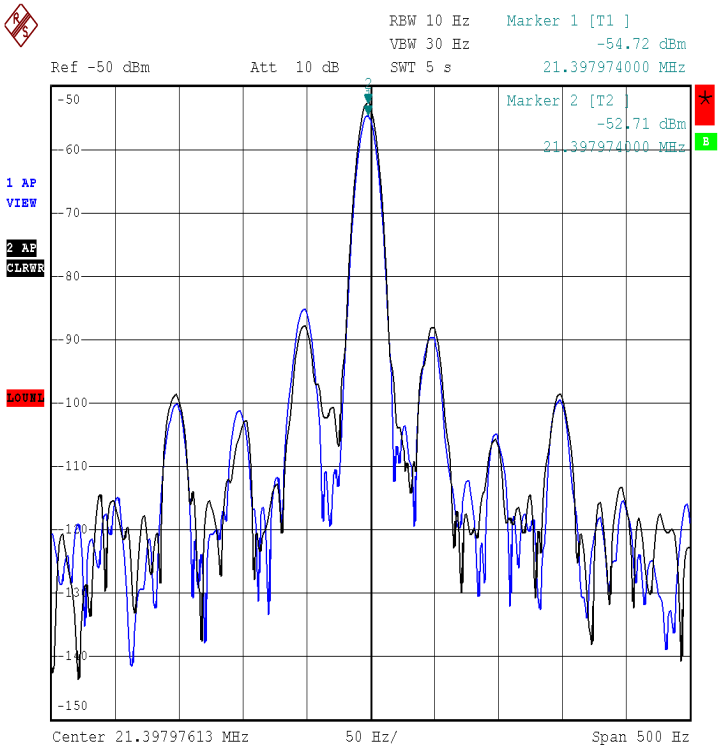
Beam 1 cal signals to 21.4 MHz IF
Sidebands are line harmonics on sig gen
Vertical higher IL due to 7/8" cable plant

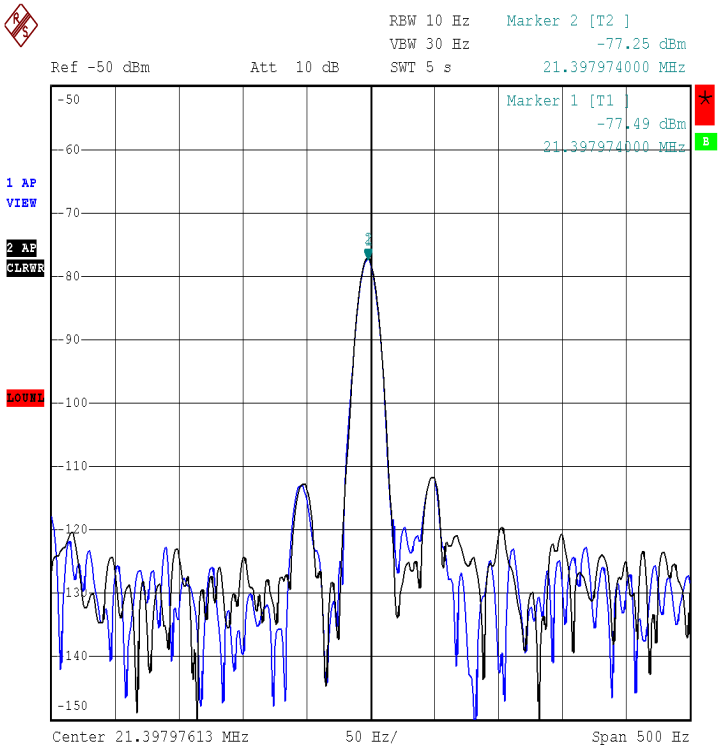
Horizontal



10mhzB1

Date: 9.APR.2010 12:34:54

Vertical



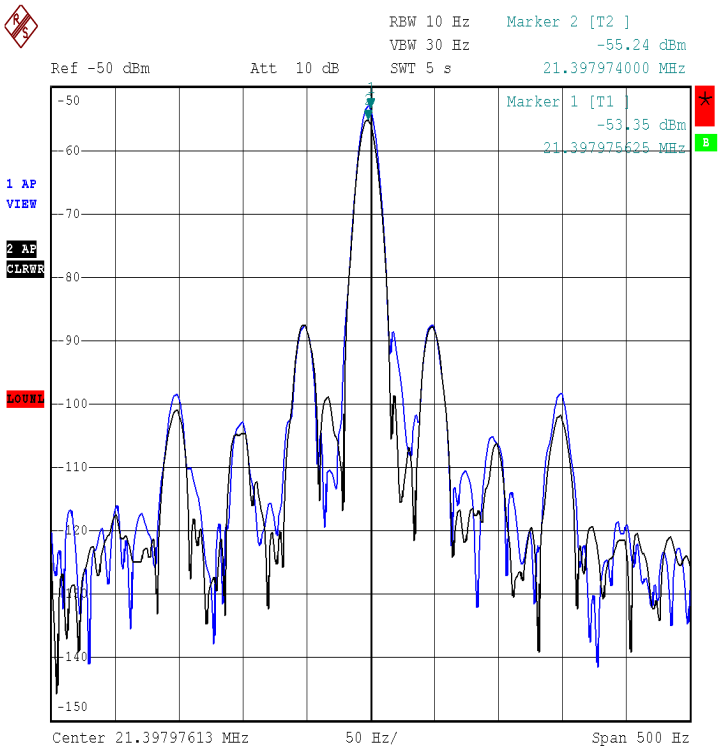
10mhzB1

Date: 9.APR.2010 12:36:48

Fermilab

Beam 2 cal signals to 21.4 MHz IF
Sidebands are line harmonics on sig gen
Vertical higher IL due to 7/8" cable plant

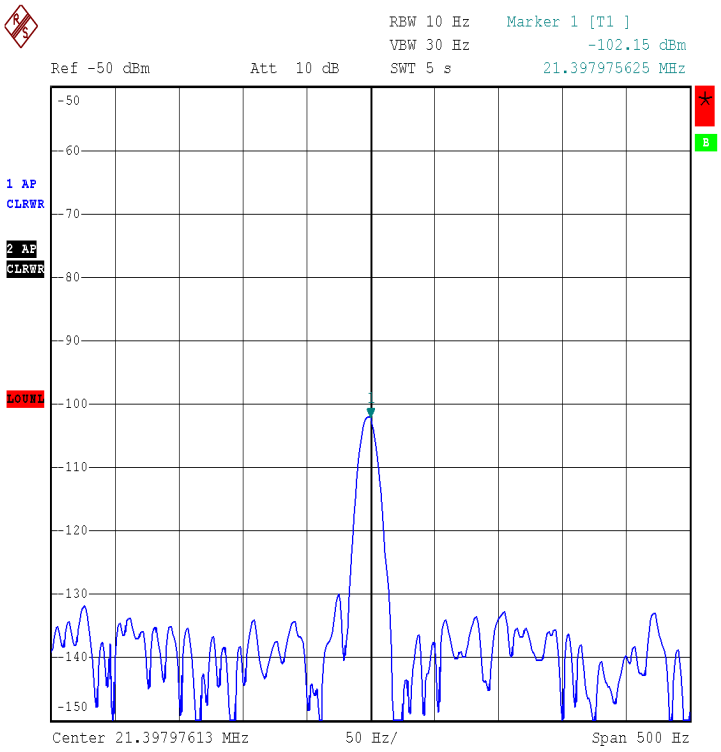
Horizontal



10mhzB1

Date: 9.APR.2010 12:32:00

Vertical



10mhzB1

Date: 9.APR.2010 12:29:17

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Typical GUI Hardware Page

cwe-ccr-vmw2 Options Connect USB Device

Schottky Monitor Application (BEAM2)

RBA: andja Exit Text/Icons

Device Selection

BEAM2-H

Selected: BEAM2-H

Running & Setting Mode

Read Only

Read and Set

Authorized User:

andja/CWE-CCR-VMW214

Time left: 27670 sec.

Default

Manually Change Settings

StandBy/Pause

Beam Mode

Beam Mode: INJDUMP

Monitor Idle: 1 sec.

Subscriptions

Rec'd: BEAM2/LHC.BQBBQ.UA47.BQS...

Time: Wed Apr 14 17:11:15 CDT 2010

Show History

Beam Conditions: Now

Flags:

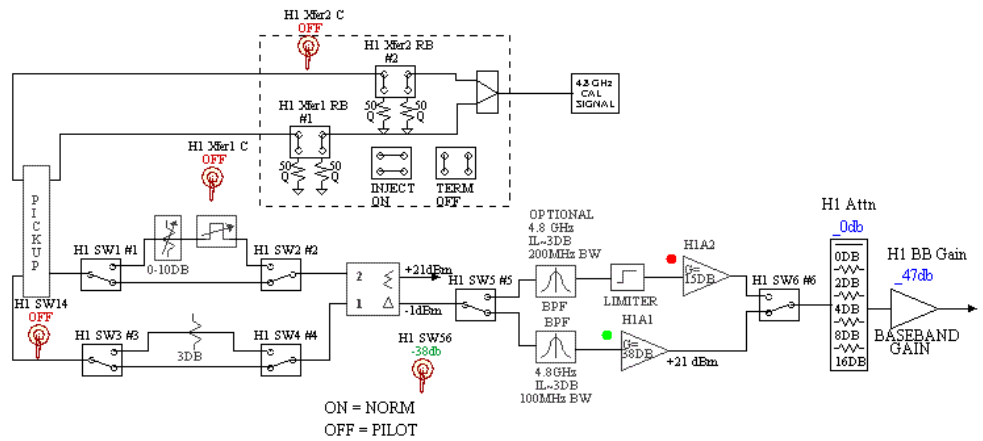
B1 Intensity: 0.00E00

B2 Intensity: 9.00E10

Energy: 450.24 @ Wed 17:11:16

Data Display | Time Plots | Circuit Diagram | Read/Set | Gates | Scope | Tune Diagram | Configuration | SYS setting | FFT Info

Circuit Diagram for BEAM2-H, RUN_AND_SET



Local Oscillators

Output_B2_21MHz:	ON	Output_B2_400MHz:	ON
Frequency_B2_21MHz:	21.38884925842285	Frequency_B2_400MHz:	378.50048828125
Power_B2_21MHz:	0.0	Power_B2_400MHz:	0.0
Ref_Oscillator_B2_21M...	EXT	Ref_Oscillator_B2_400M...	EXT
Last Update:	Wed Apr 14 17:11:15 CDT 2010	Device Name:	BEAM2-H

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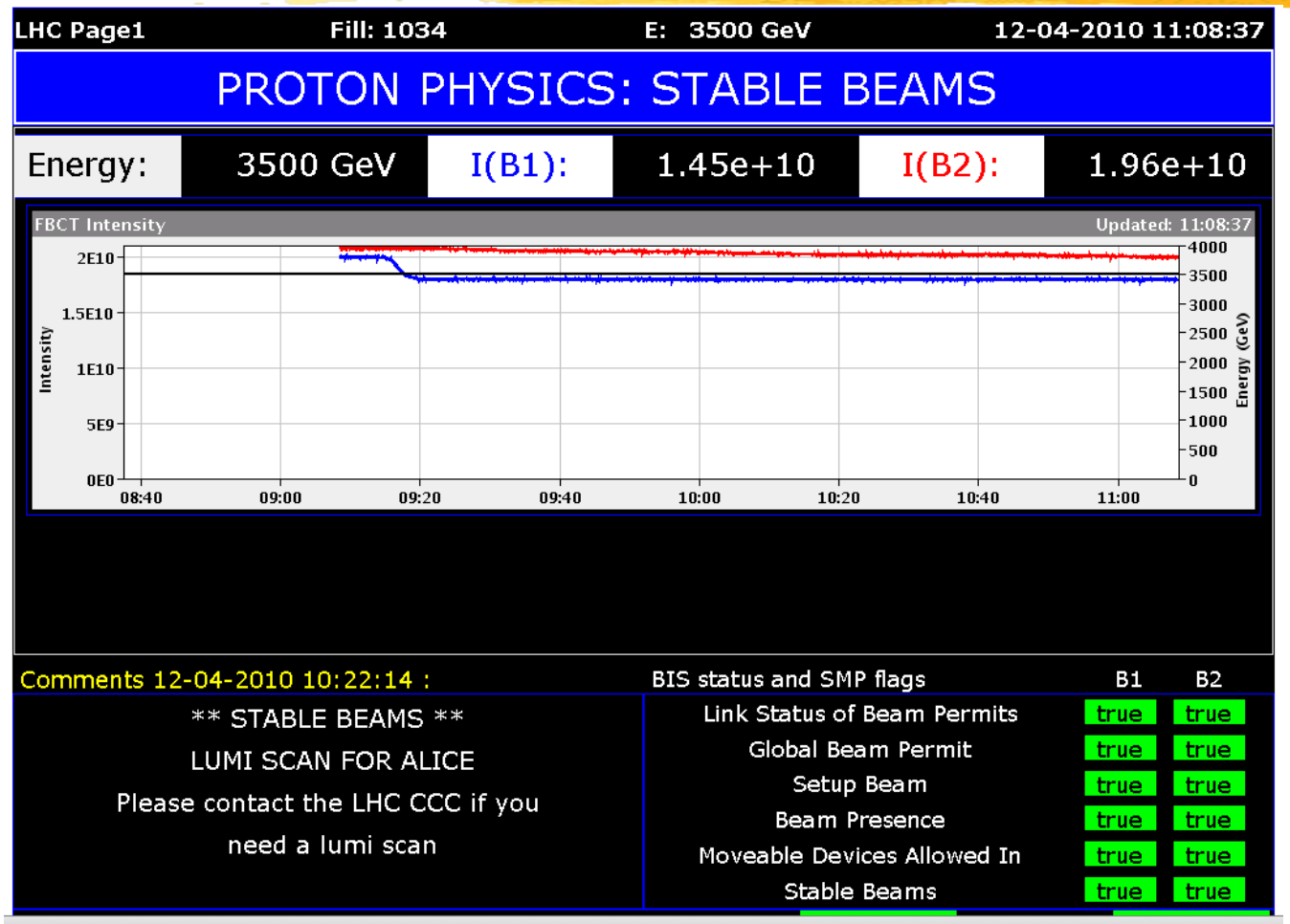
2x2 store 3.5 TeV



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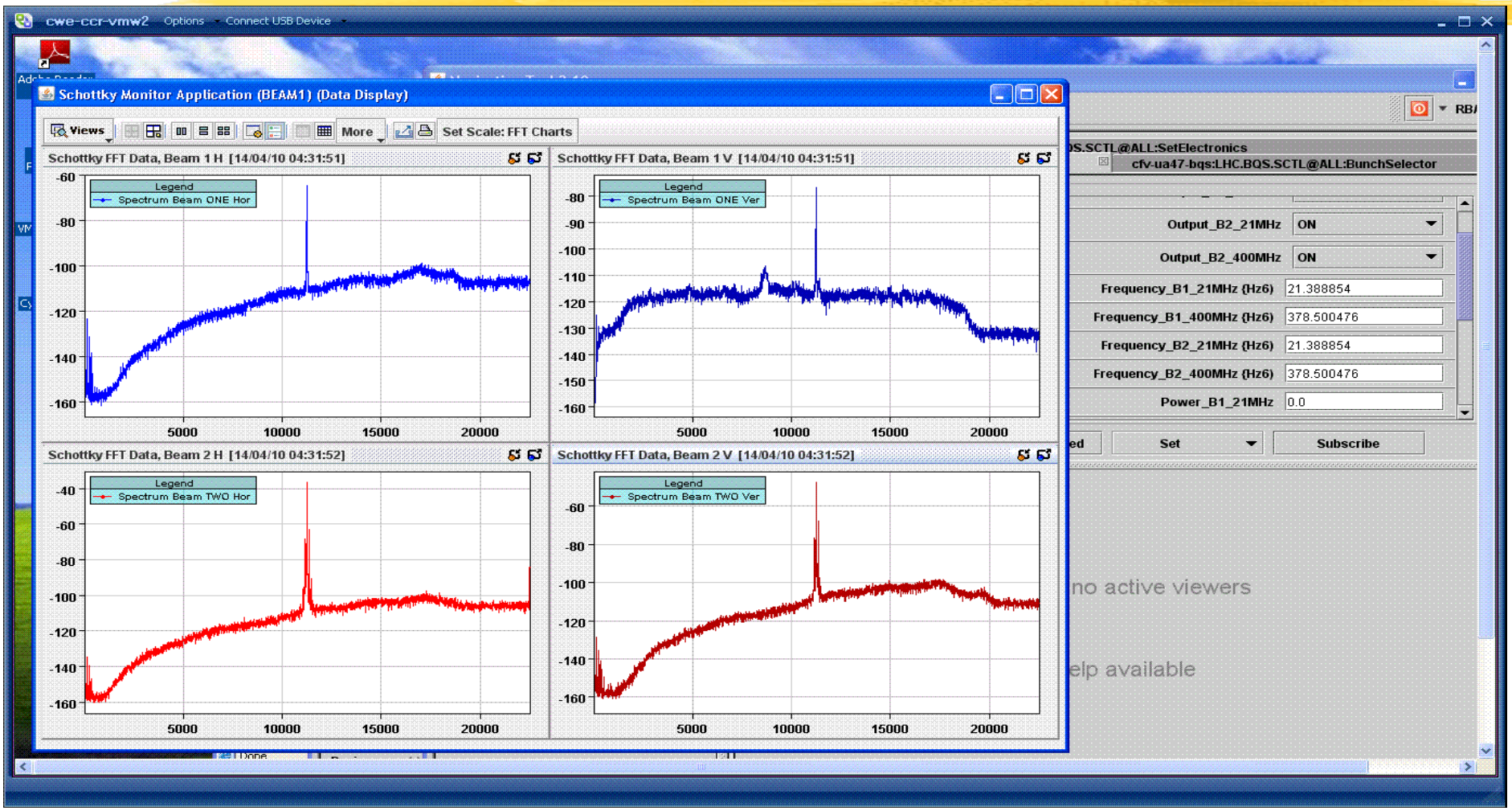
Un-gated base band signals 2x2 store
NOTE LO frequencies set for revolution
Frequency of 11245 Hz



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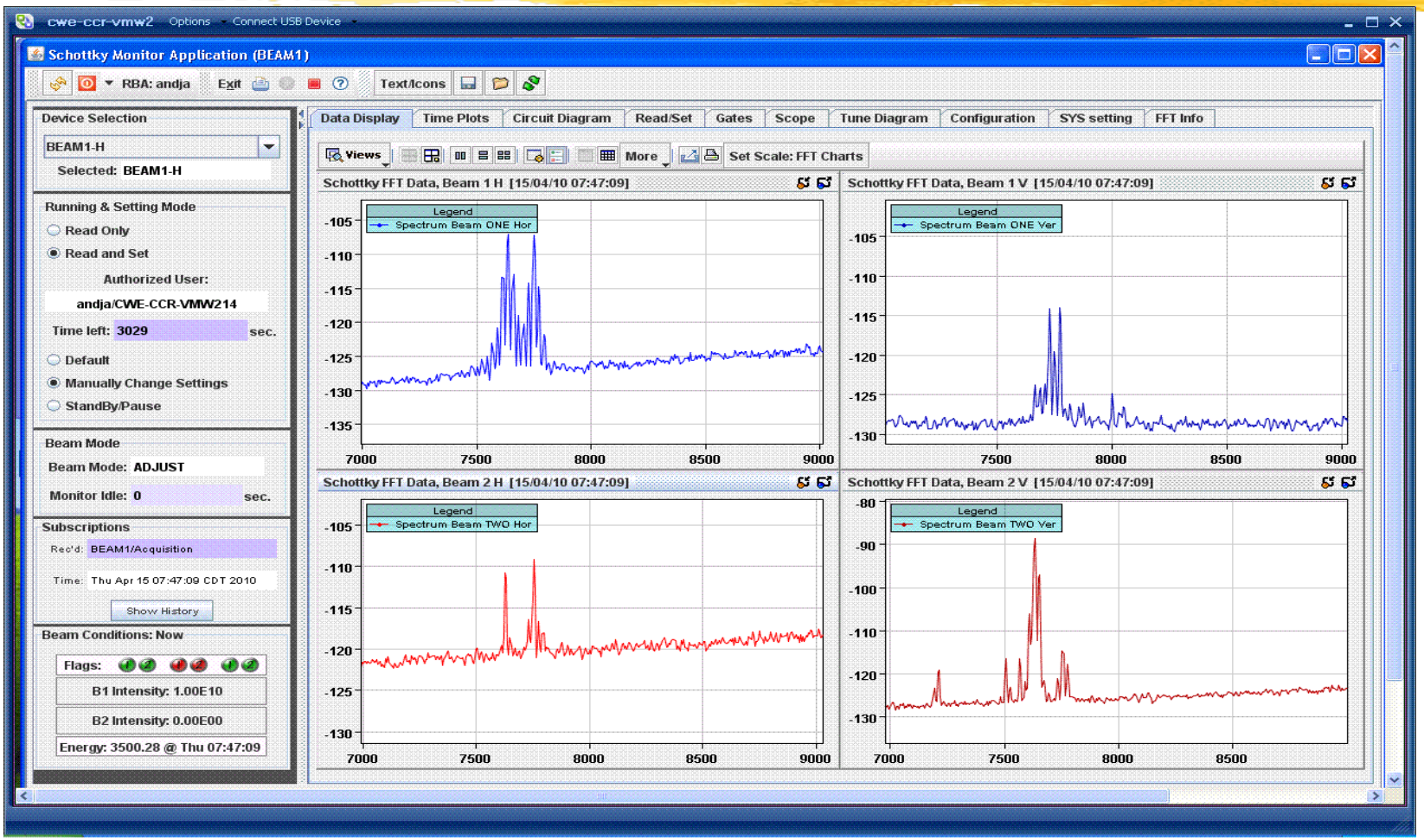
Zoom in on sideband with FNAL GUI



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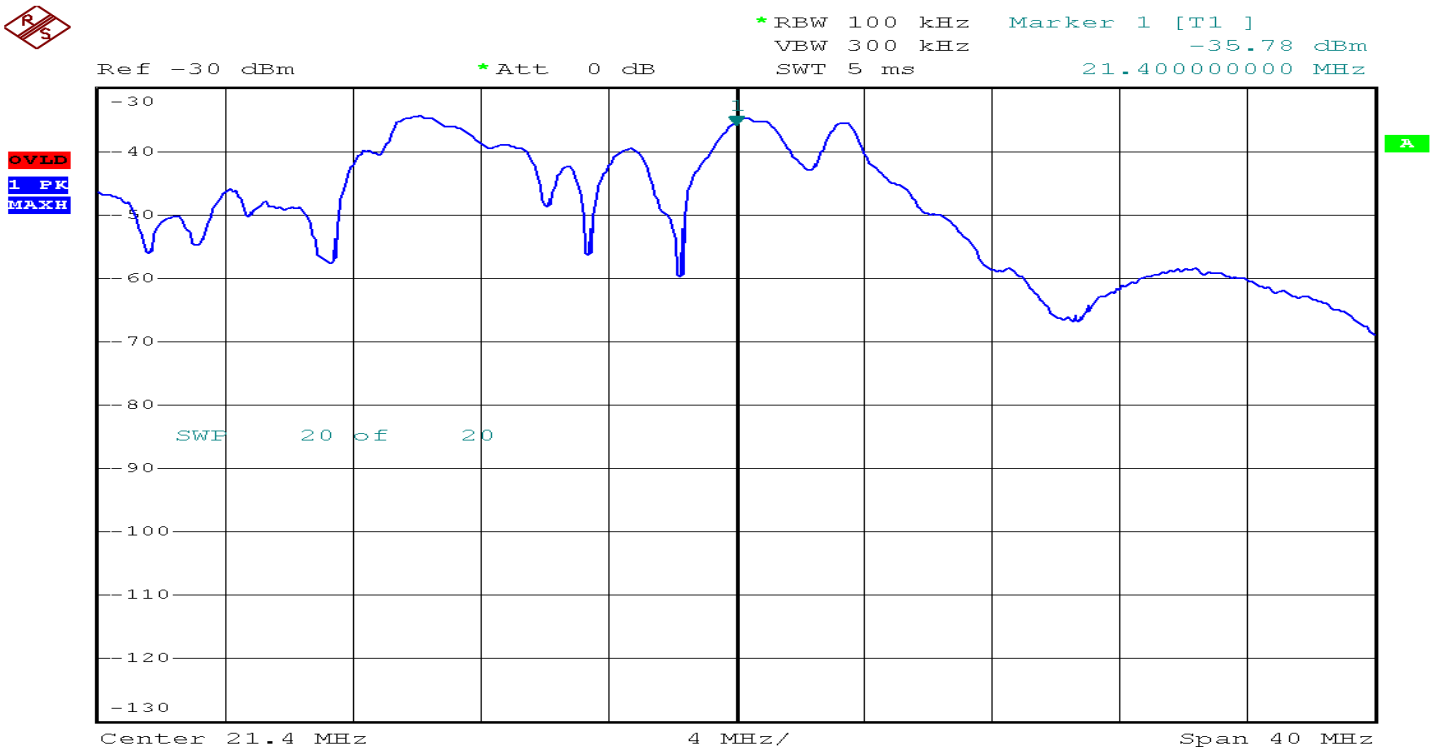
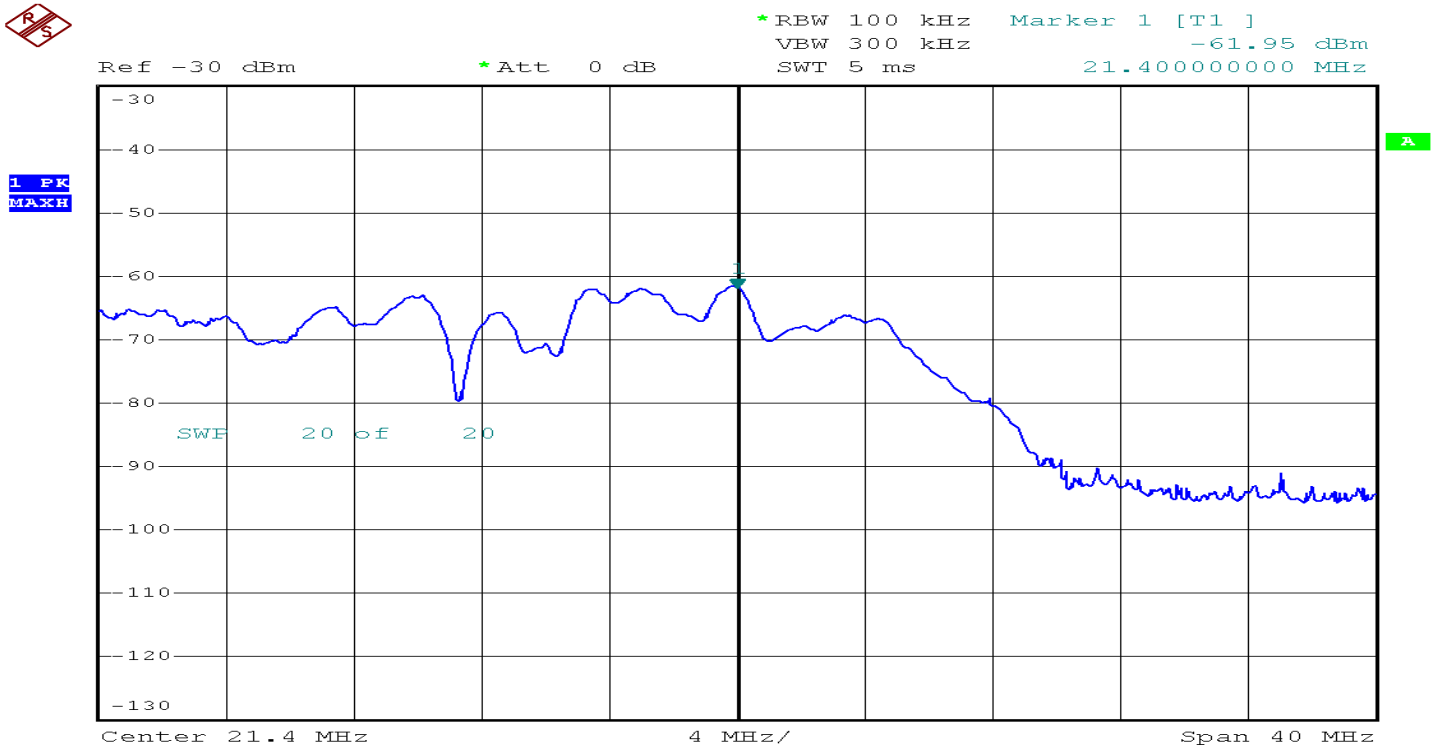
HB1 21.4 MHz IF with arbitrary 378 MHz LO: Ripple observed in Electronics/pickup



10mhzB1

Date: 12.APR.2010 11:07:48

VB1 21.4 MHz IF with arbitrary 378 MHz LO small signal due to 7/8" cable plant



10mhzB1

Date: 12.APR.2010 11:07:06

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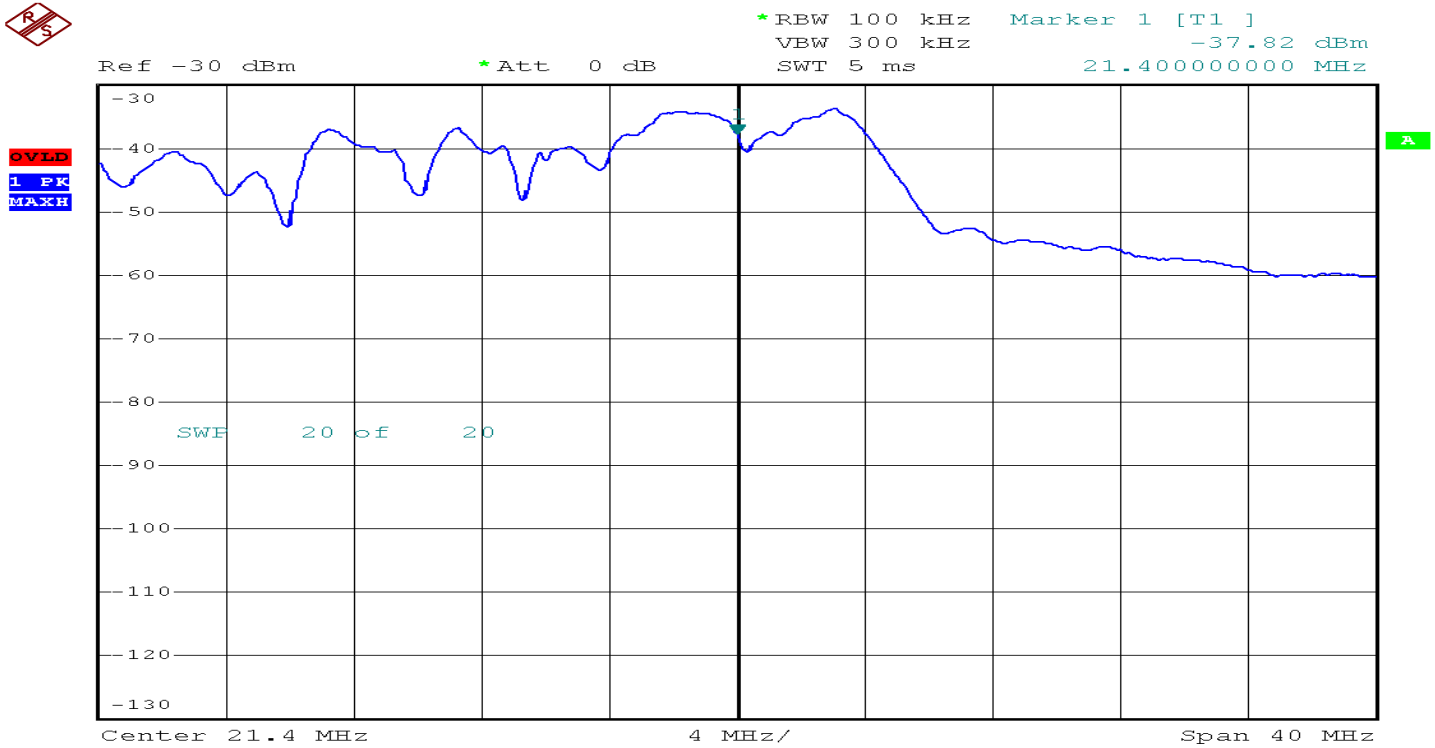
HB2 21.4 MHz IF with arbitrary 378 MHz LO



10mhzB1

Date: 12.APR.2010 11:10:30

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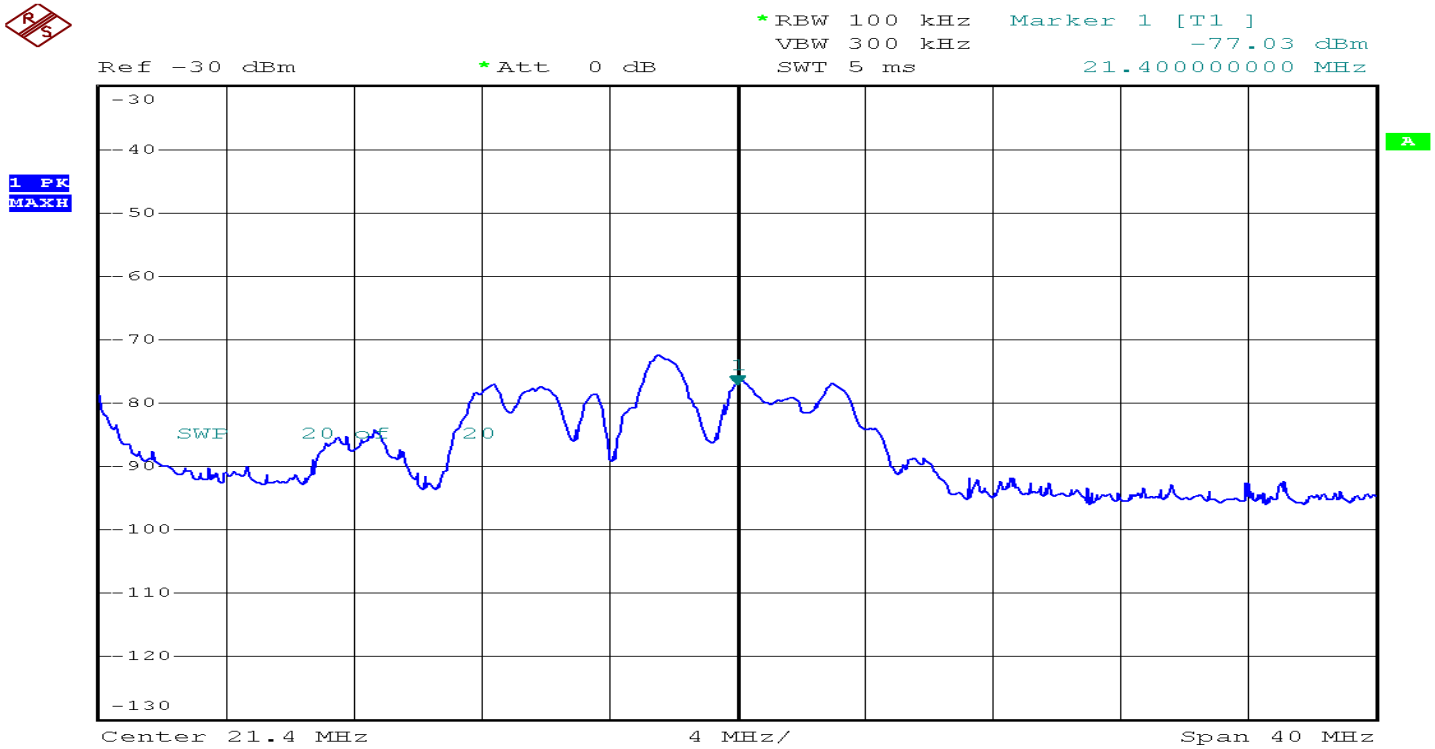
VB2 21.4 MHz IF with arbitrary 378 MHz LO small signal due to 7/8" cable plant



10mhzB1

Date: 12.APR.2010 11:09:40

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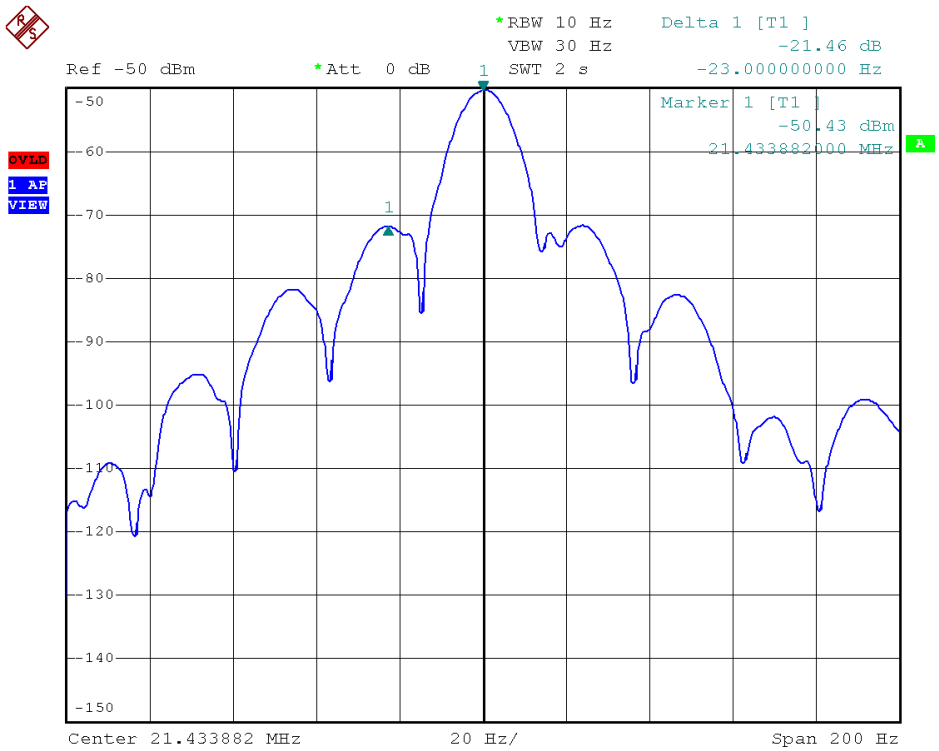
HB1 21.4 MHz IF



Synchrotron f @ 3.5 TeV
Freq=23 Hz

10mhzB1

Date: 12.APR.2010 16:13:25

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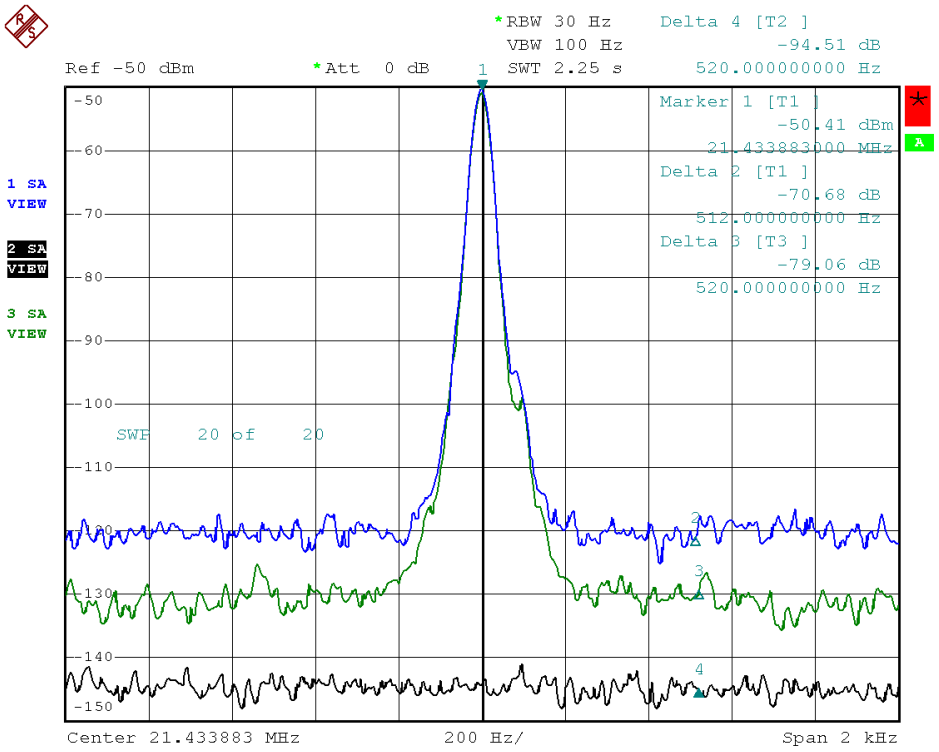
HB1 21.4 MHz IF



Gate on full time blue

Gate Table green

SA noise floor black

Max noise reduction with gating observed to be approximately 10 dB

10mhzB1

Date: 12.APR.2010 15:30:02

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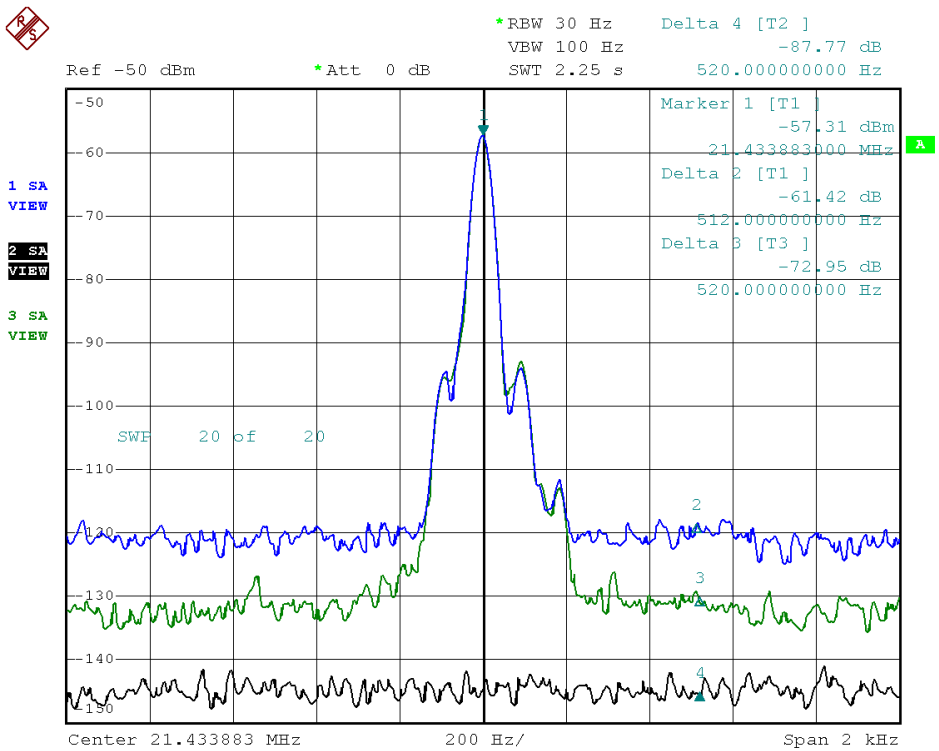
HB2 21.4 MHz IF



Gate on full time blue
Gate Table green
SA noise floor black

10mhzB1

Date: 12.APR.2010 15:34:12

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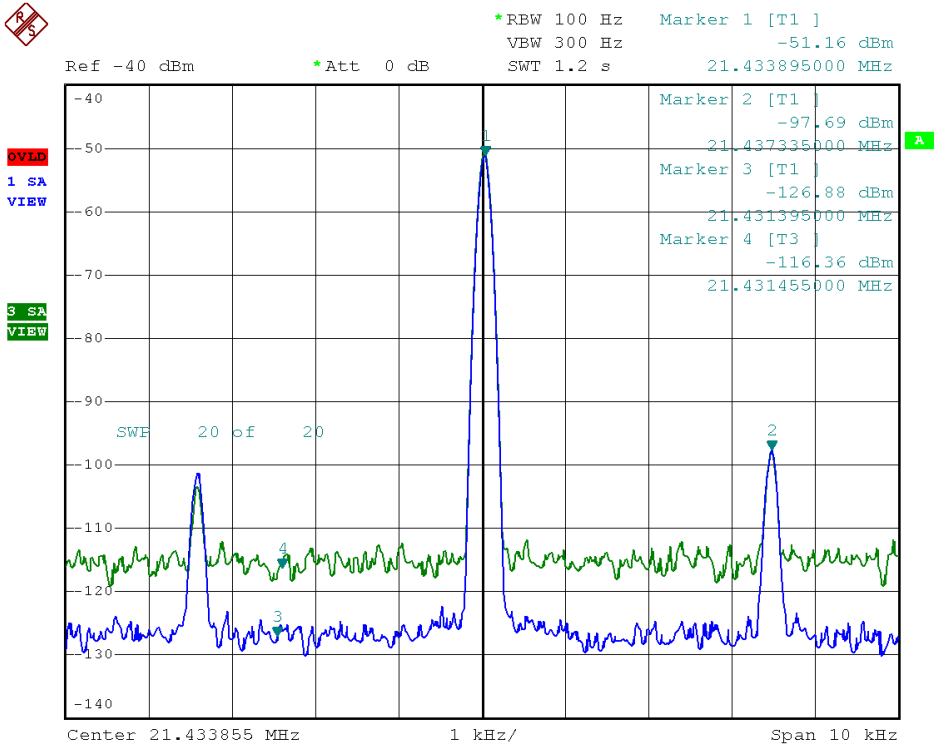
HB1 21.4 MHz IF
Coherent sidebands



Gate on full time green
Gate Table blue

10mhzB1

Date: 12.APR.2010 13:01:22

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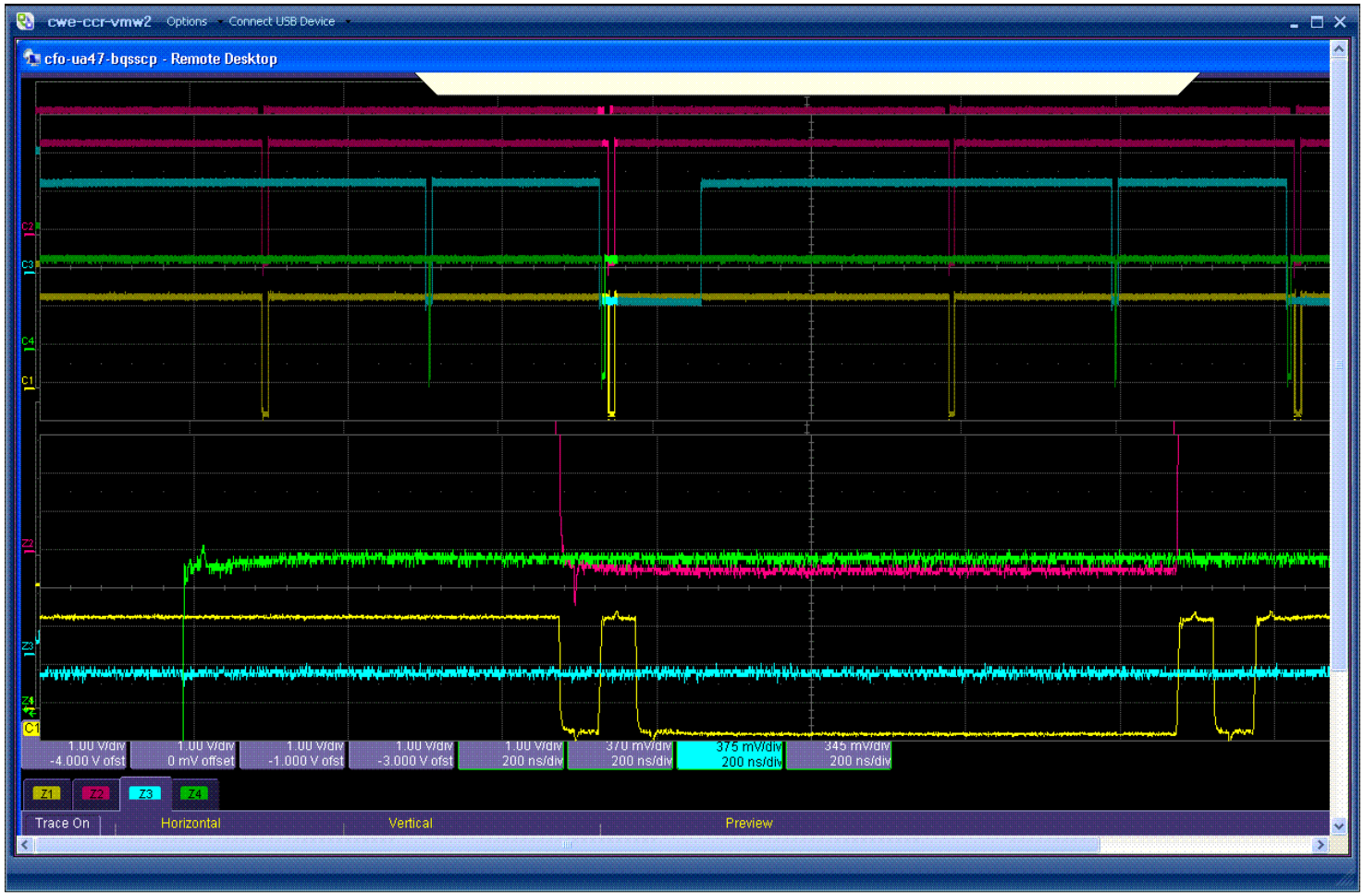
Debugging Gates using Tunnel Scope
Bouncing (yellow) was a software error
Scope is essential for gating studies



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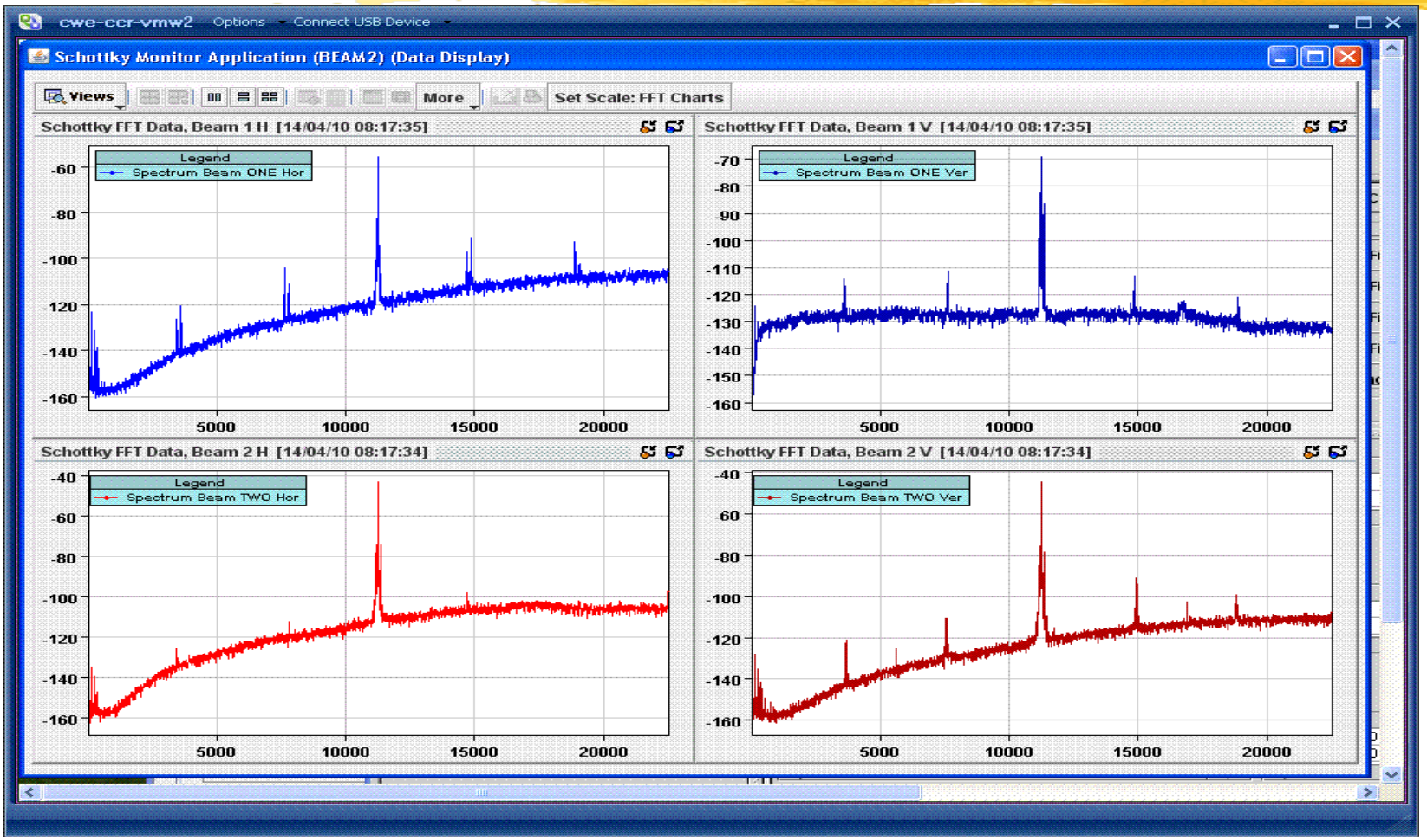
Baseband 2x 2 store 3.5 TeV with gating. Vertical Band 1 has modified daughter card which looks good. Need to modify others.



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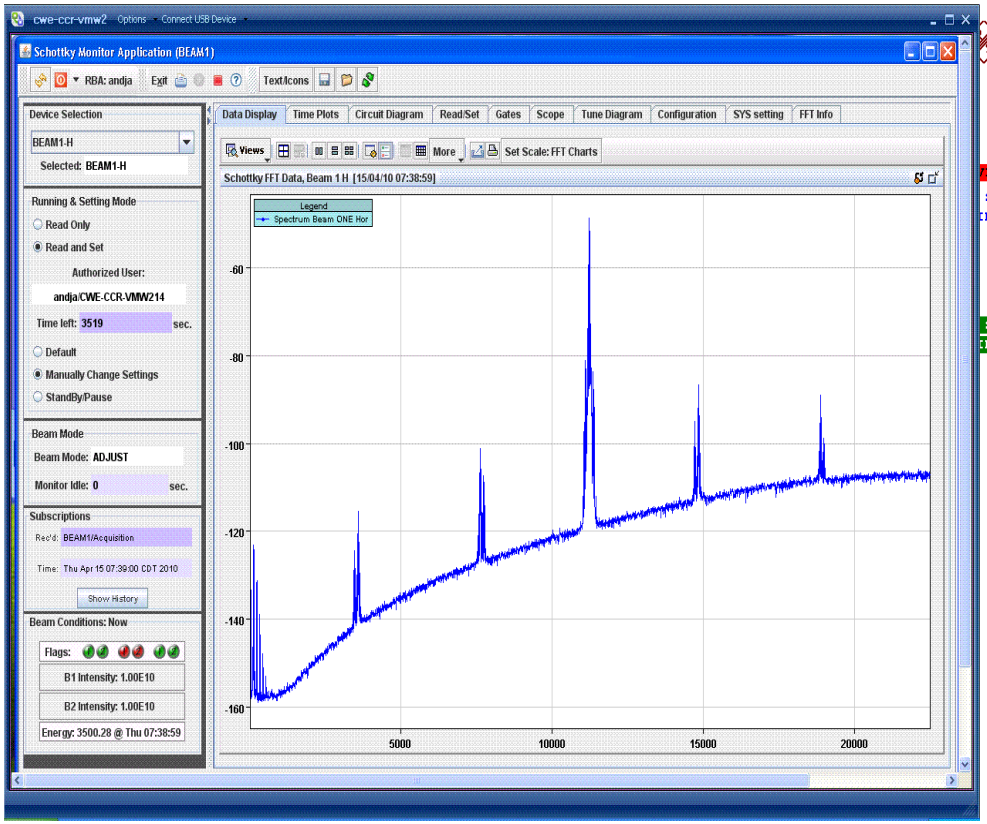
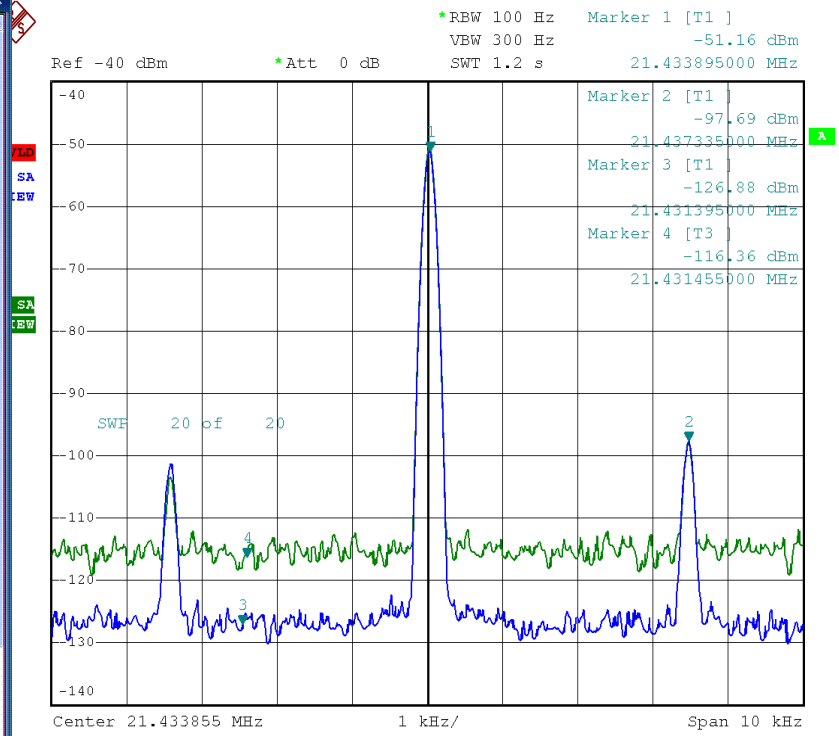
Fermilab HB1 Comparison of 21.4 MHz to Baseband

Signal to Noise Limitations with Gating





10mhzB1

Date: 12.APR.2010 13:01:22

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Bunch loading table for 2x2 store

```
Scheme 2x2_a, december 2009, 1 colliding pair in all IPs:

     (NB: maximum acceptable now: B1 30986, B2: 30950)

*****************************************************************
*  NOTE: to get the same scheme without overinjection:          *
*   - just add +1000 to all RF bucket numbers                   *
*   - in addition there will be a pilot bunch (5e9 p/bch)       *
*     in RF bucket 1 for each beam                              *
*****************************************************************

                              RF Bucket
 inj 1      1     ring_1            1          25       1
 inj 1      2     ring_2            1          25       1
 inj 2      3     ring_1        17851          25       1
 inj 2      4     ring_2         8911          25       1

Bunch crossings:

d = displacement relative to IP in meters
    (negative is anticlockwise)

                                     d     Beam1            Beam2

  good collision in IR1:             0 m   bucket      1 and bucket    1
  good collision in IR2:             0 m   bucket      1 and bucket 8911
  good collision in IR8:             0 m   bucket 17851 and bucket 8911
```

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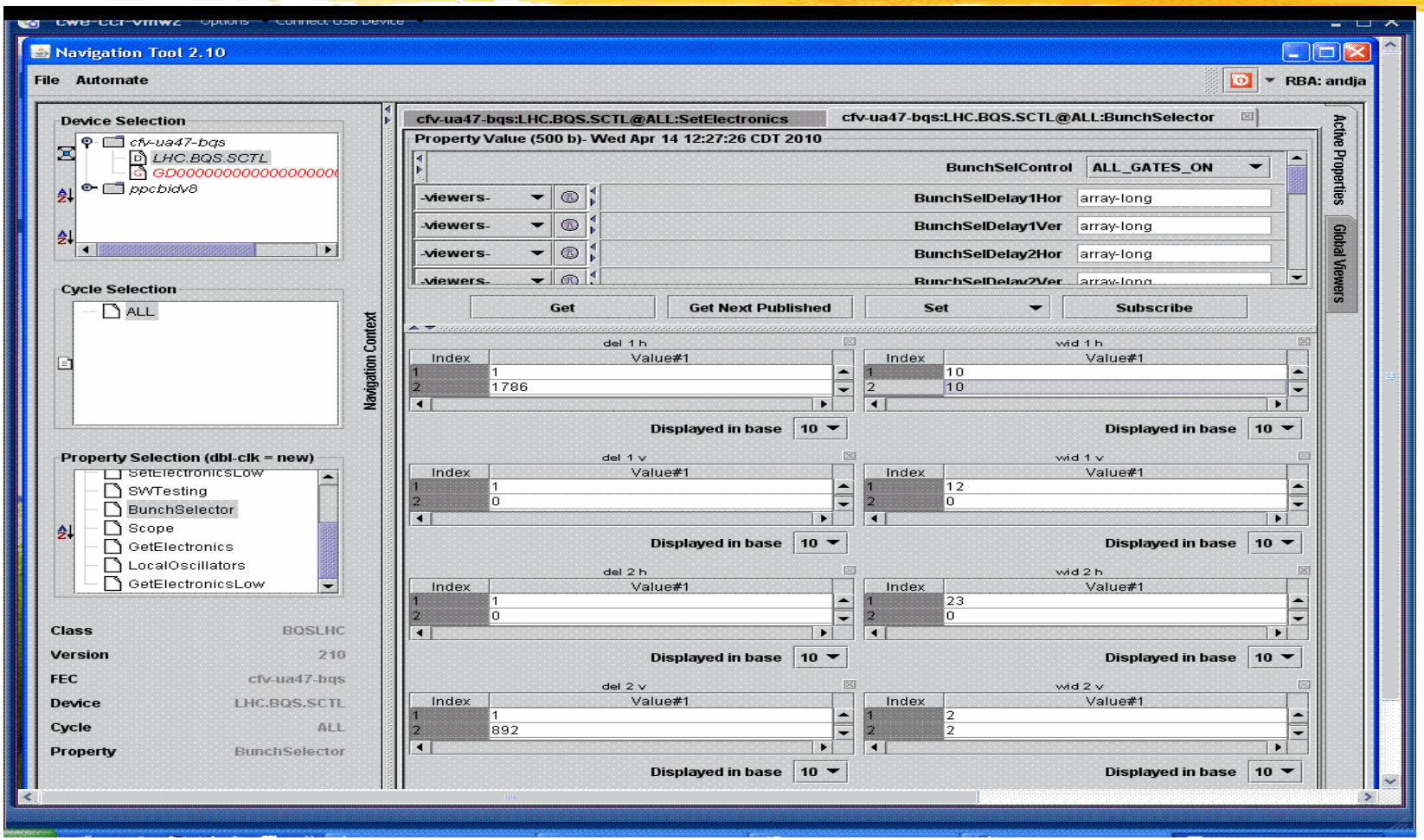
Sample Gate tables 2x2 store
Using navigator tool



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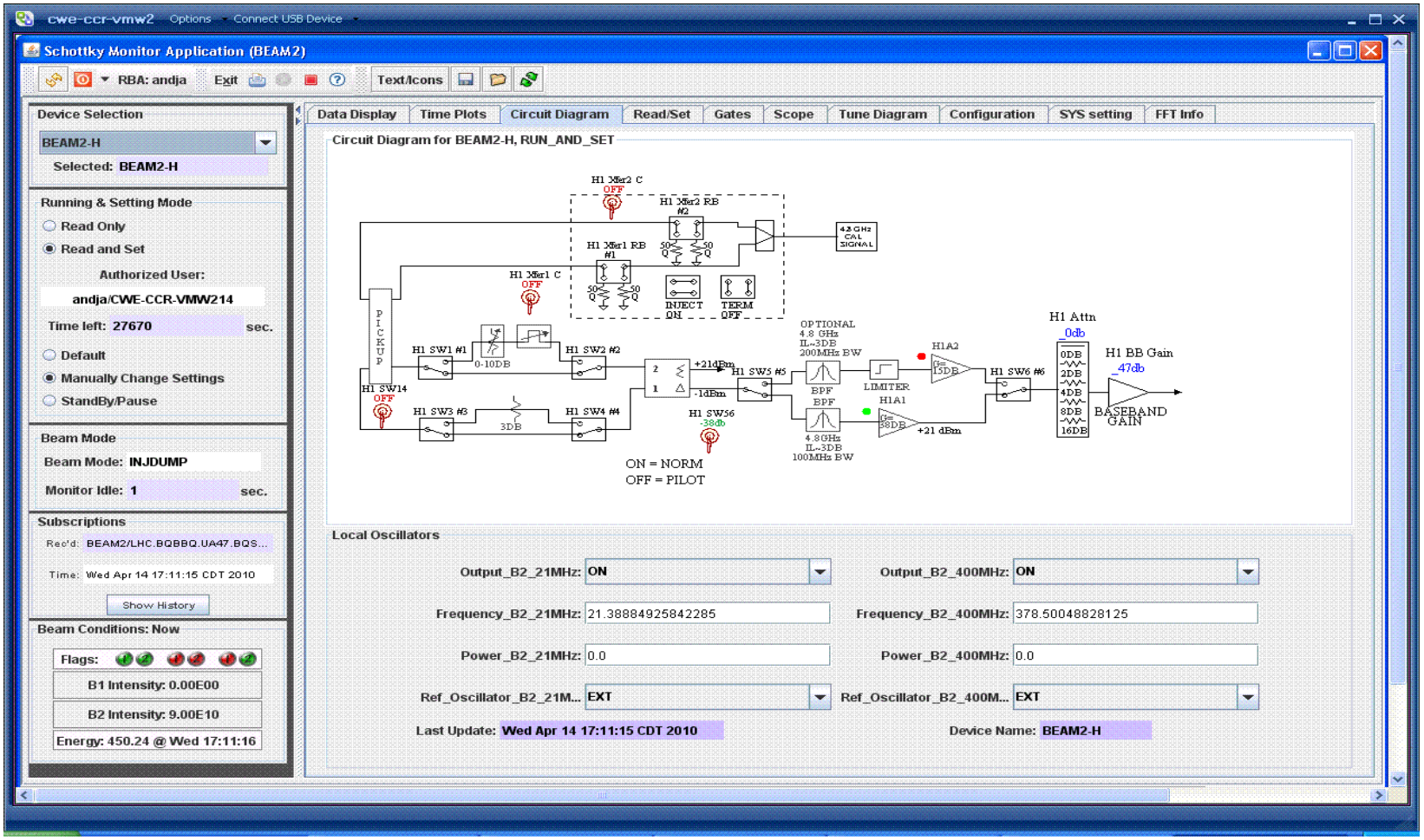
Set up for 10 bunch 450 GeV store



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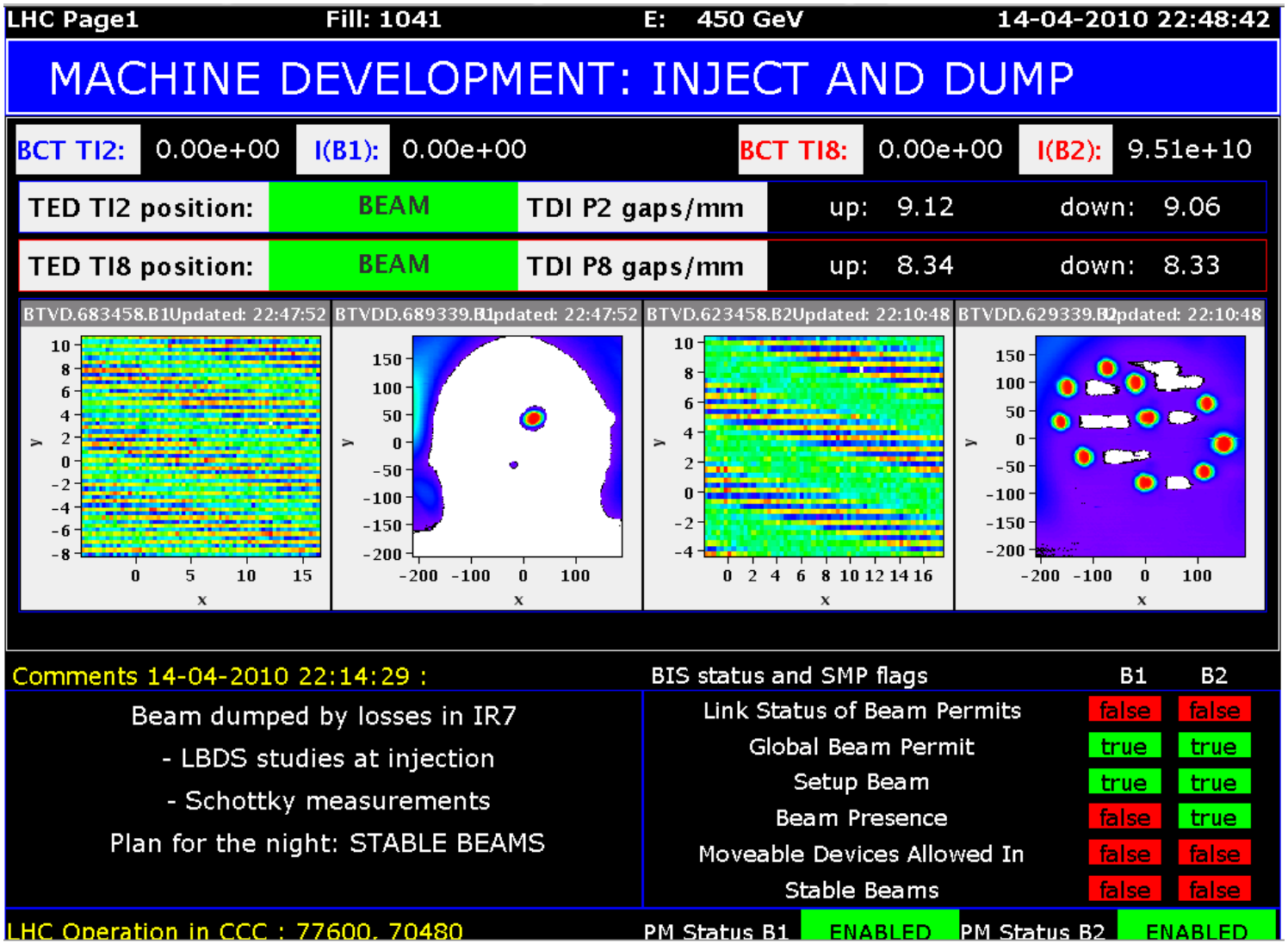
Dedicated 10 bunch store 450 GeV



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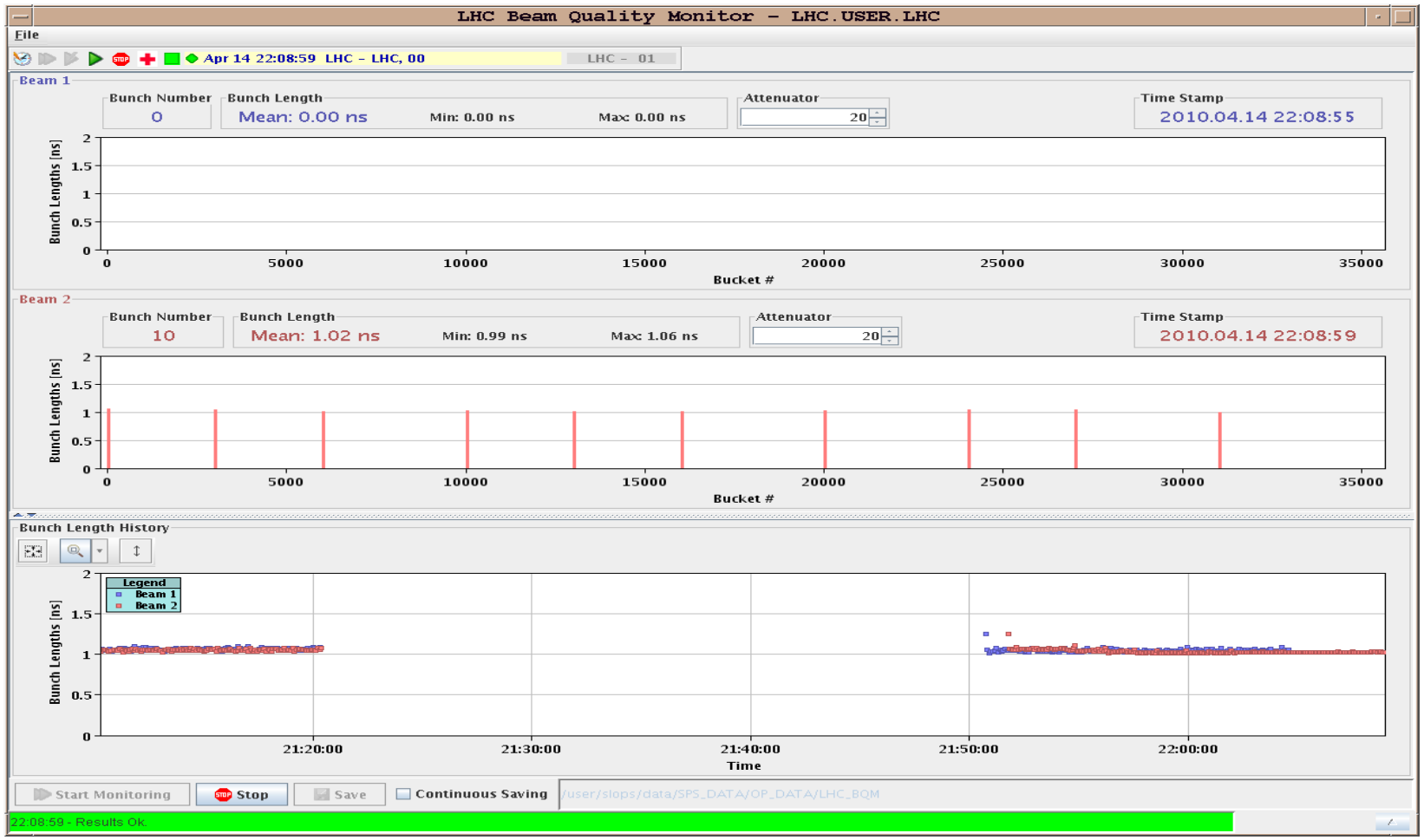
10 bunches approximately 10^{11} total



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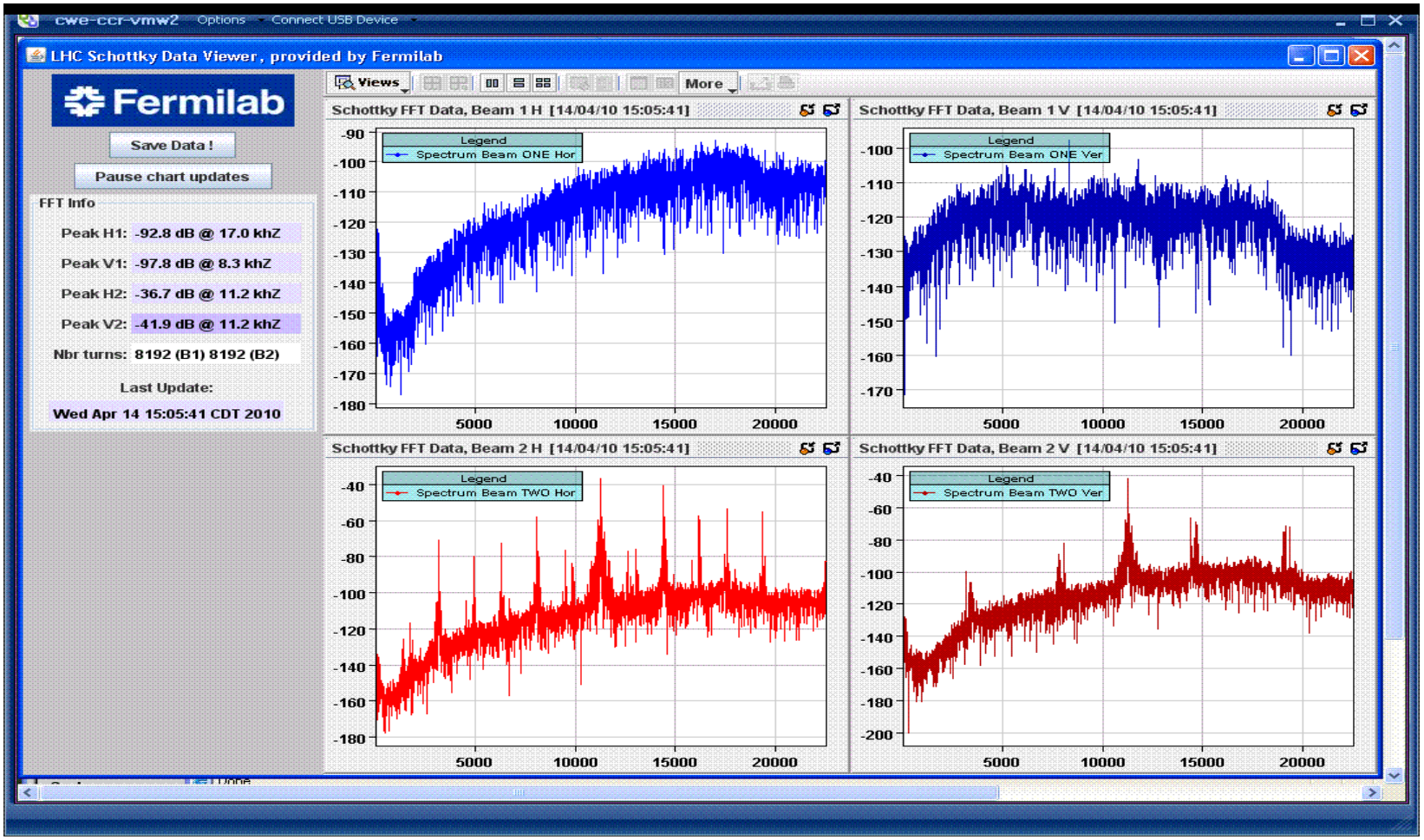
First Schottky Signals FNAL GUI app
10 Bunches Beam 2: 450 GeV



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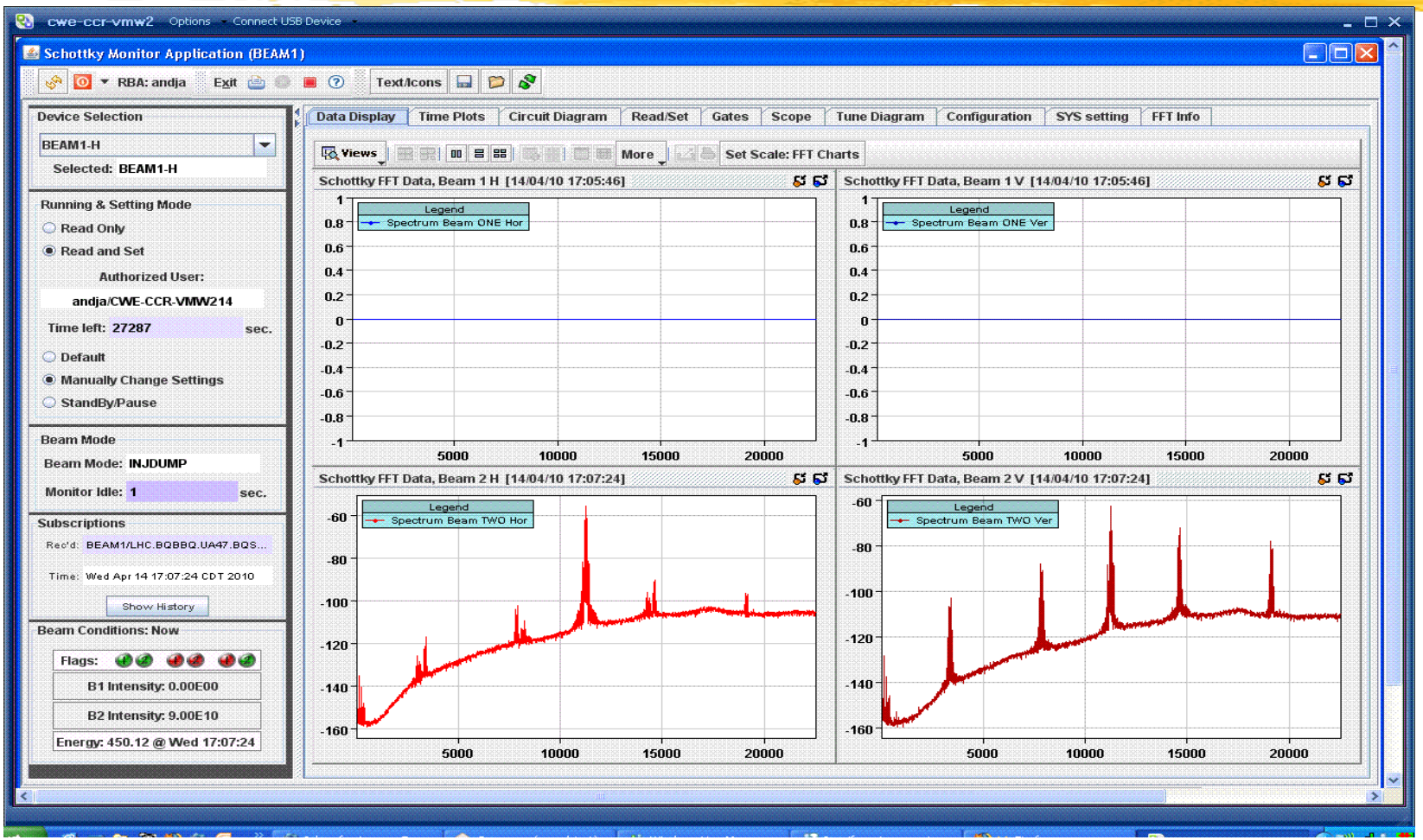
First Schottky Signals 10 Bunches Beam 2: 450 GeV with averaging Measured Accurate Tunes



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Beam 2: 10 Bunch store 450 GeV Vertical gate settings

cwe-ccr-vmw2 Options Connect USB Device

Schottky Monitor Application (BEAM2)

RBA: andja Exit Text/Icons

Device Selection

BEAM2-V

Selected: BEAM2-V

Running & Setting Mode

- Read Only
- Read and Set

Authorized User:

andja/CWE-CCR-VMW214

Time left: 27600 sec.

- Default
- Manually Change Settings
- StandBy/Pause

Beam Mode

Beam Mode: INJDUMP

Monitor Idle: 0 sec.

Subscriptions

Rec'd: BEAM2/Acquisition

Time: Wed Apr 14 17:12:22 CDT 2010

Show History

Beam Conditions: Now

Flags:

B1 Intensity: 0.00E00

B2 Intensity: 9.00E10

Energy: 450.12 @ Wed 17:12:22

Data Display | Time Plots | Circuit Diagram | Read/Set | Gates | Scope | Tune Diagram | Configuration | SYS setting | FFT Info

Type of bunch selection: TABLES_VER_HOR

Last updated: Wed Apr 14 17:11:24 CDT 2010

Gate Width: 10

Expert

Data

0	301, 40	601, 40	1001, 40	1301, 40	1601, 40	2001, 40	2401, 40	2701, 40	3101, 40

Transfer Readings for TWO V to This Panel

Send Selection for TWO V to Front End

0 -- Starting Bunch nbr:	1	Width:	40
1 -- Starting Bunch nbr:	301	Width:	40
2 -- Starting Bunch nbr:	601	Width:	40
3 -- Starting Bunch nbr:	1001	Width:	40
4 -- Starting Bunch nbr:	1301	Width:	40
5 -- Starting Bunch nbr:	1601	Width:	40
6 -- Starting Bunch nbr:	2001	Width:	40
7 -- Starting Bunch nbr:	2401	Width:	40
8 -- Starting Bunch nbr:	2701	Width:	40
9 -- Starting Bunch nbr:	3101	Width:	40

Fermilab

Beam 2: 10 Bunch store 450 GeV Horizontal gate settings

cwe-ccr-vmw2 Options Connect USB Device

Schottky Monitor Application (BEAM2)

RBA: andja Exit Text/Icons

Device Selection

BEAM2-H

Selected: BEAM2-H

Running & Setting Mode

- Read Only
- Read and Set

Authorized User:

andja/CWE-CCR-VMW214

Time left: 27646 sec.

- Default
- Manually Change Settings
- StandBy/Pause

Beam Mode

Beam Mode: INJDUMP

Monitor Idle: 0 sec.

Subscriptions

Rec'd: BEAM2/Acquisition

Time: Wed Apr 14 17:11:38 CDT 2010

Show History

Beam Conditions: Now

Flags:

B1 Intensity: 0.00E00

B2 Intensity: 9.00E10

Energy: 450.12 @ Wed 17:11:38

Data Display | Time Plots | Circuit Diagram | Read/Set | Gates | Scope | Tune Diagram | Configuration | SYS setting | FFT Info

Type of bunch selection: TABLES_VER_HOR

Last updated: Wed Apr 14 17:11:24 CDT 2010

Gate Width: 10

Expert

Live Data

1, 200	301, 200	601, 200	1001, 200	1301, 200	1601, 200	2001, 200	2401, 200	2701, 200	3101, 200

Transfer Readings for TWO H to This Panel

Send Selection for TWO H to Front End

TWO H Manual | TWO H GUI

0 -- Starting Bunch nbr:	1	Width:	200
1 -- Starting Bunch nbr:	301	Width:	200
2 -- Starting Bunch nbr:	601	Width:	200
3 -- Starting Bunch nbr:	1001	Width:	200
4 -- Starting Bunch nbr:	1301	Width:	200
5 -- Starting Bunch nbr:	1601	Width:	200
6 -- Starting Bunch nbr:	2001	Width:	200
7 -- Starting Bunch nbr:	2401	Width:	200
8 -- Starting Bunch nbr:	2701	Width:	200
9 -- Starting Bunch nbr:	3101	Width:	200