Goals for RHIC 2003

- Tune Feedback day one
- Chromaticity feedforward day one
- Supporting diagnostics (tune, chromaticity, coupling) in good order
- Operation from MCR via control system

Definitions

1. • Tune Feedback
   - Ramp development tool
   - Normal operations?
2. • 'Day One' - see commissioning plan
3. • Operational - 'it works'
   - The Specialist's definition - works when the specialist is present
   - The Physicist's definition - works when the physicist is present
   - The Operator's definition - When it breaks you call the physicist/specialist

Responsibilities

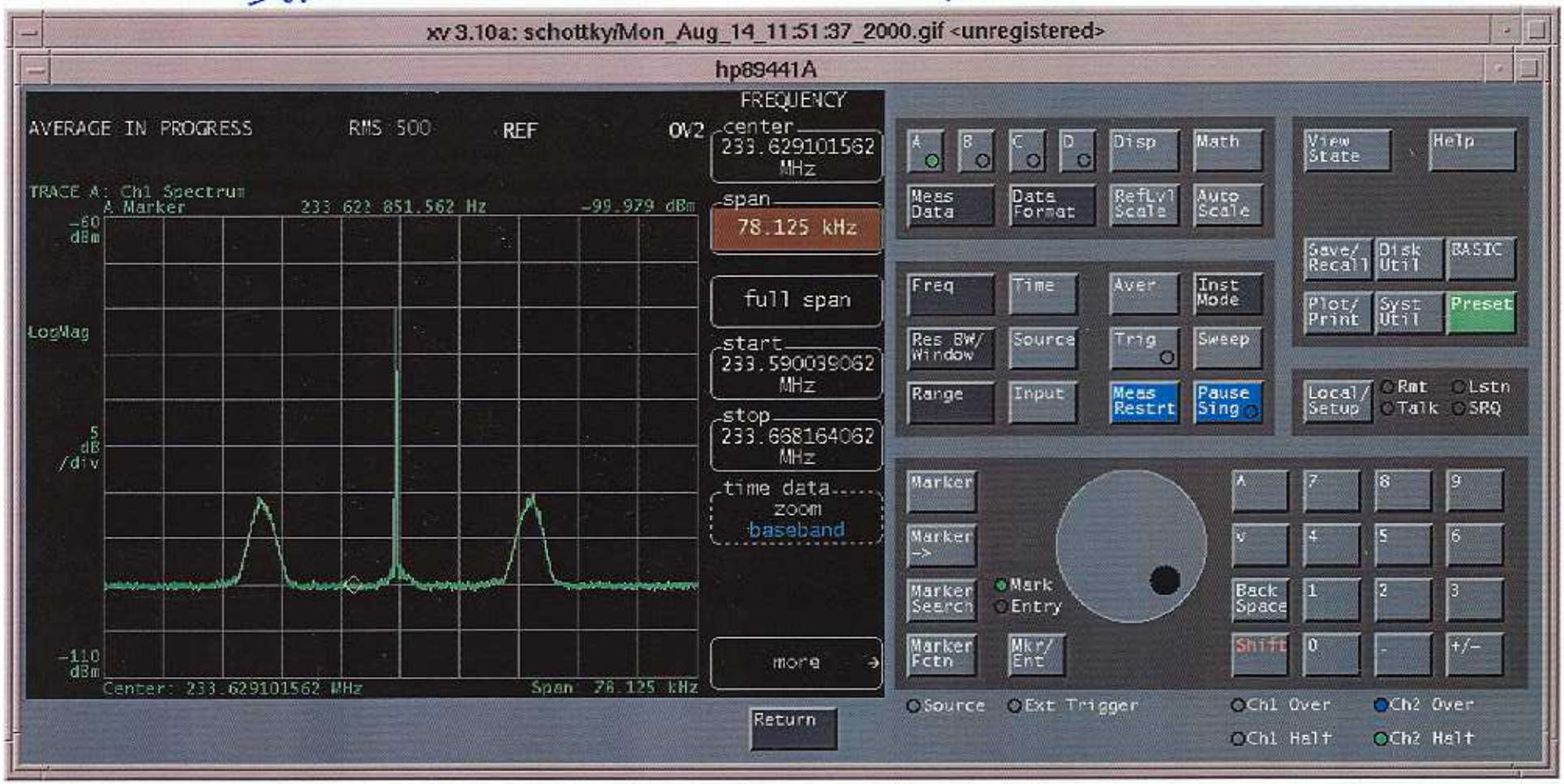
- Definition of System Requirements
  - Accelerator Physics - Drees, Pilat, Peggs,…
  - Power Supplies - Schultheiss
  - Instrumentation - Cameron
- PLL - Cameron
- Magnet Control - Schultheiss
- Simulation - Schultheiss, Peggs, Pilat, Malitsky,..
- Controls - Marusic, van Zeijts, Tepikian,…

Resonant BPM

- M. Kesselman et al - PAC 2001
- Stub-tuned 1/4 wave resonator
- Simulated in Spice
- frequency ~ 240MHz (8.5xRF)
- Q_{loaded} ~ 100 optimal coupling
- In-tunnel hybrid for Σ and Δ
- Resonate difference mode - not sum mode signal at revolution line
- Moveable - minimize difference mode signal at revolution line
- Resonate above coherent spectrum

AT INJECTION

SPAN 78 KHz 5 dB/div



$\Delta q = \eta N \frac{\Delta P}{P} = 237 \times 10^6 \times 7 \times 10^{-3} \times 10^{-3}$ FWHM

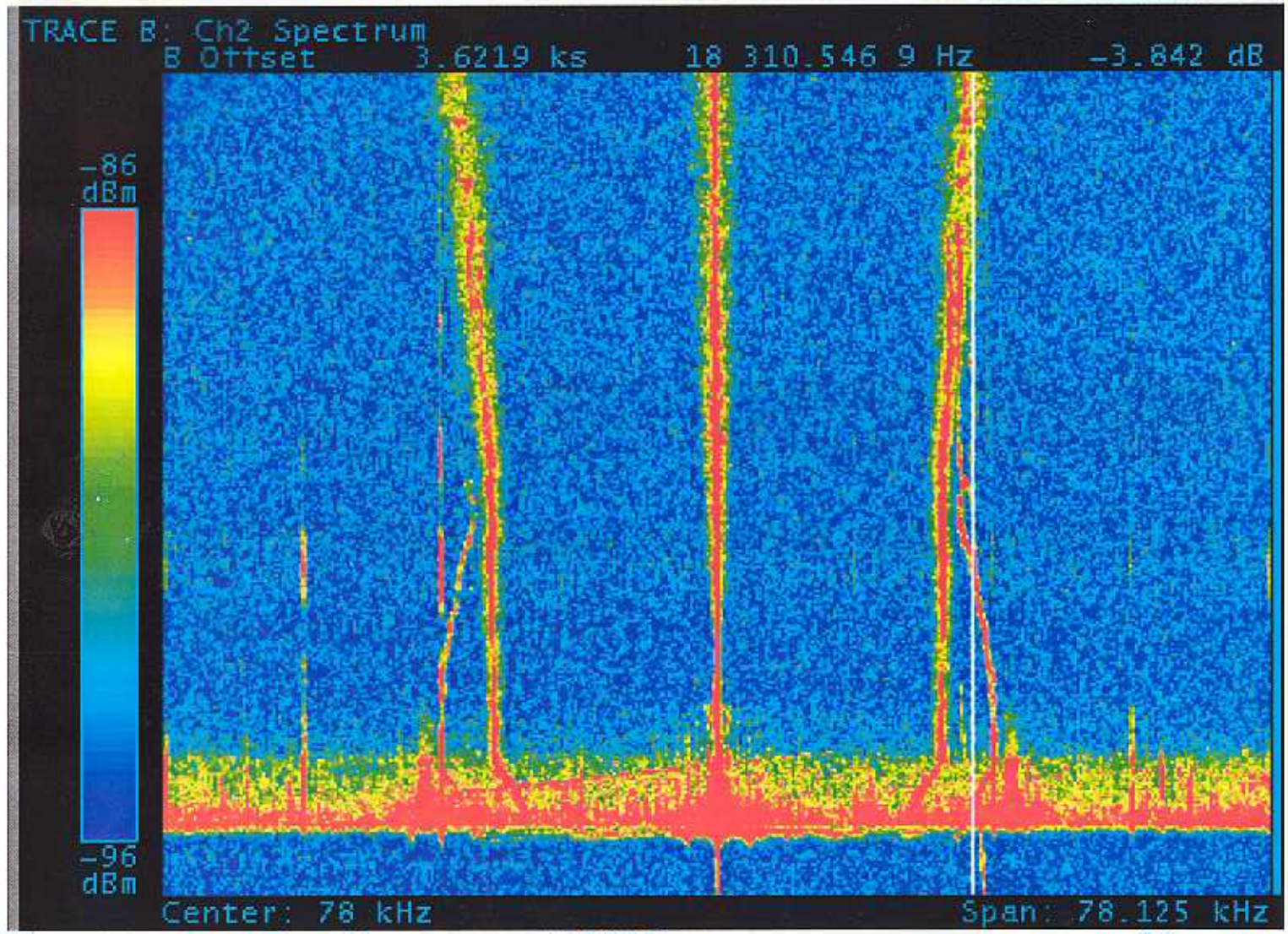
$\sim$ 1-2 KHz FWHM

$\sim$ 4 KHz MEASURED

LF Schottky on the Ramp

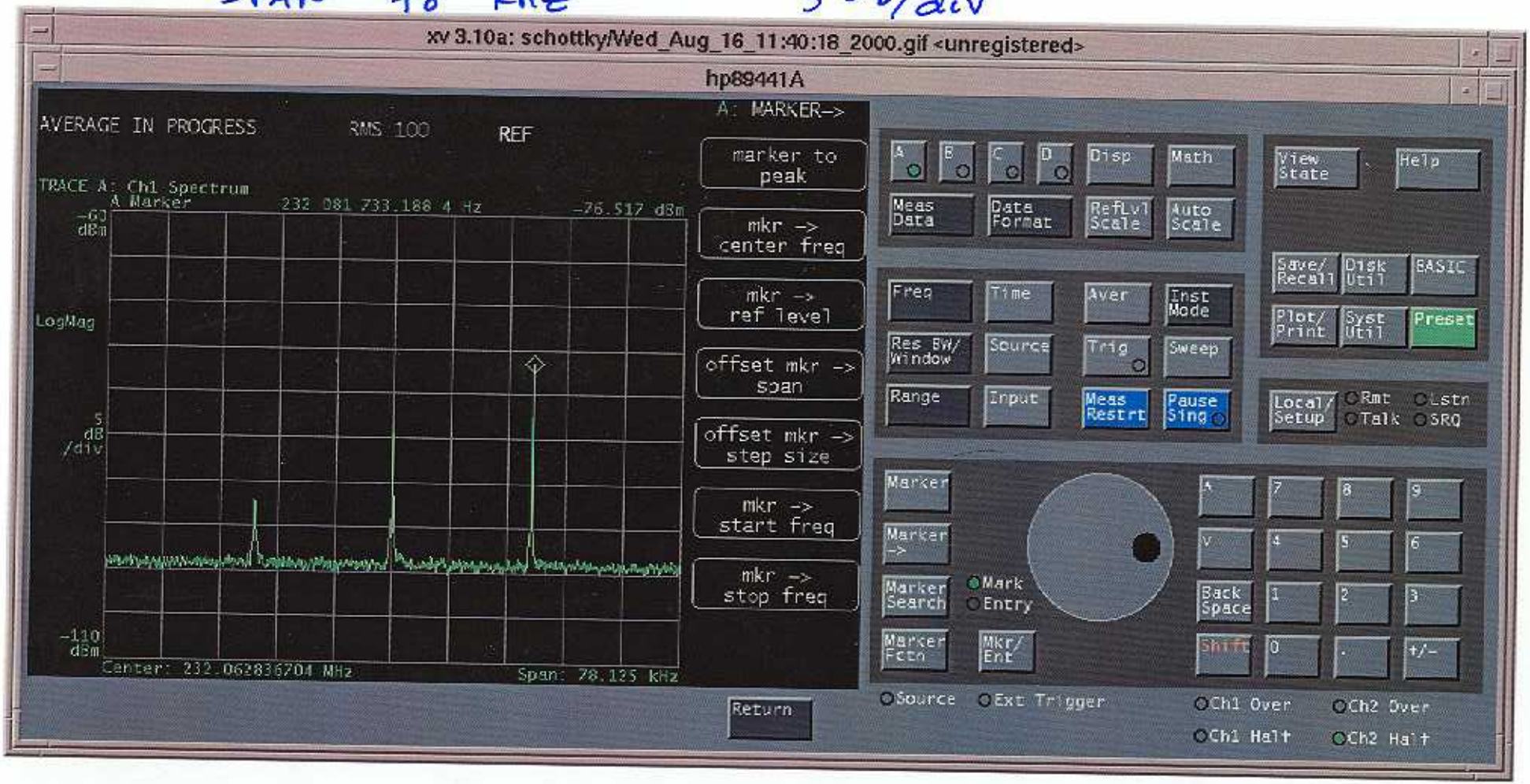
Injection

Transition



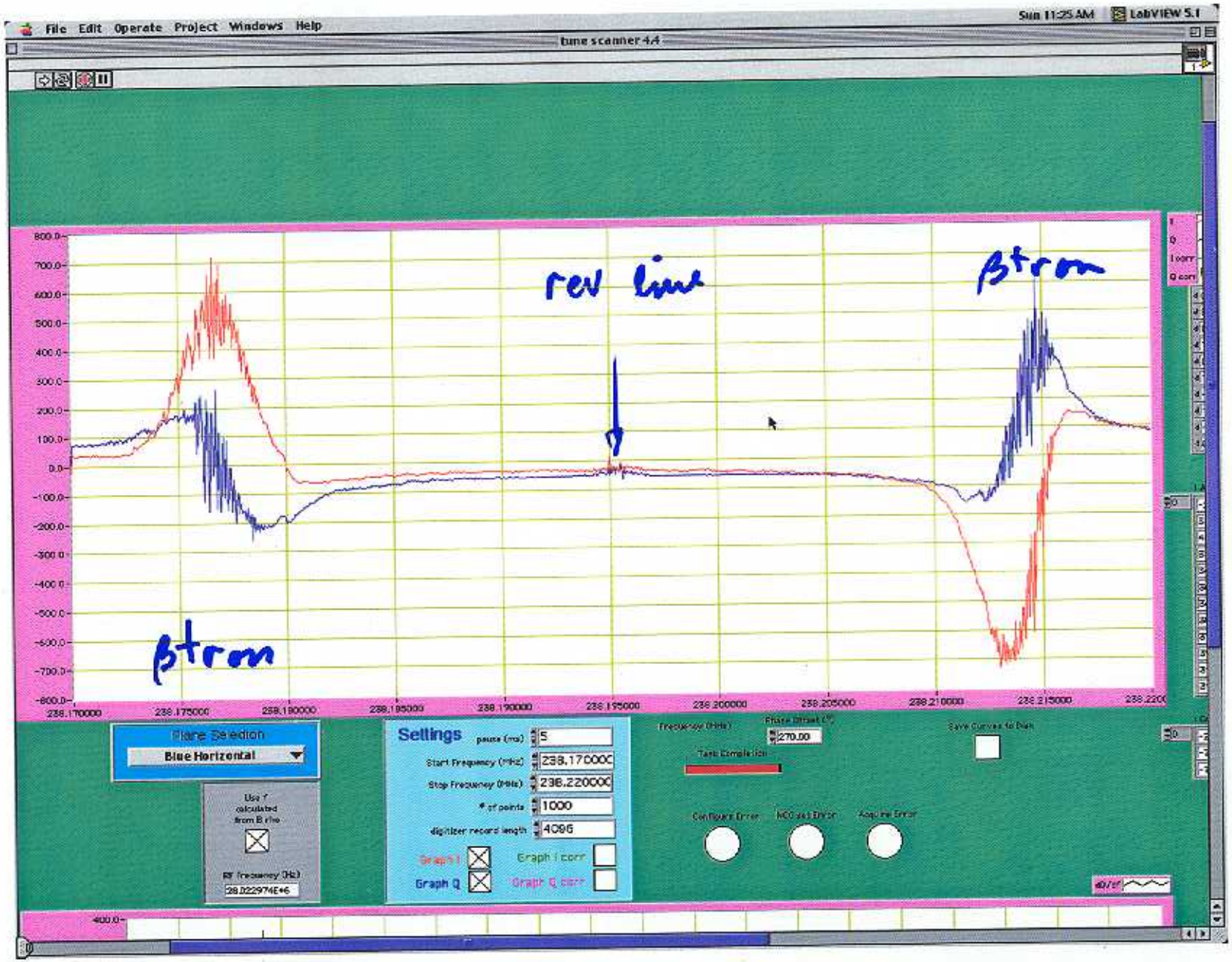
STORE

SPAN 78 KHZ 5 dB/div

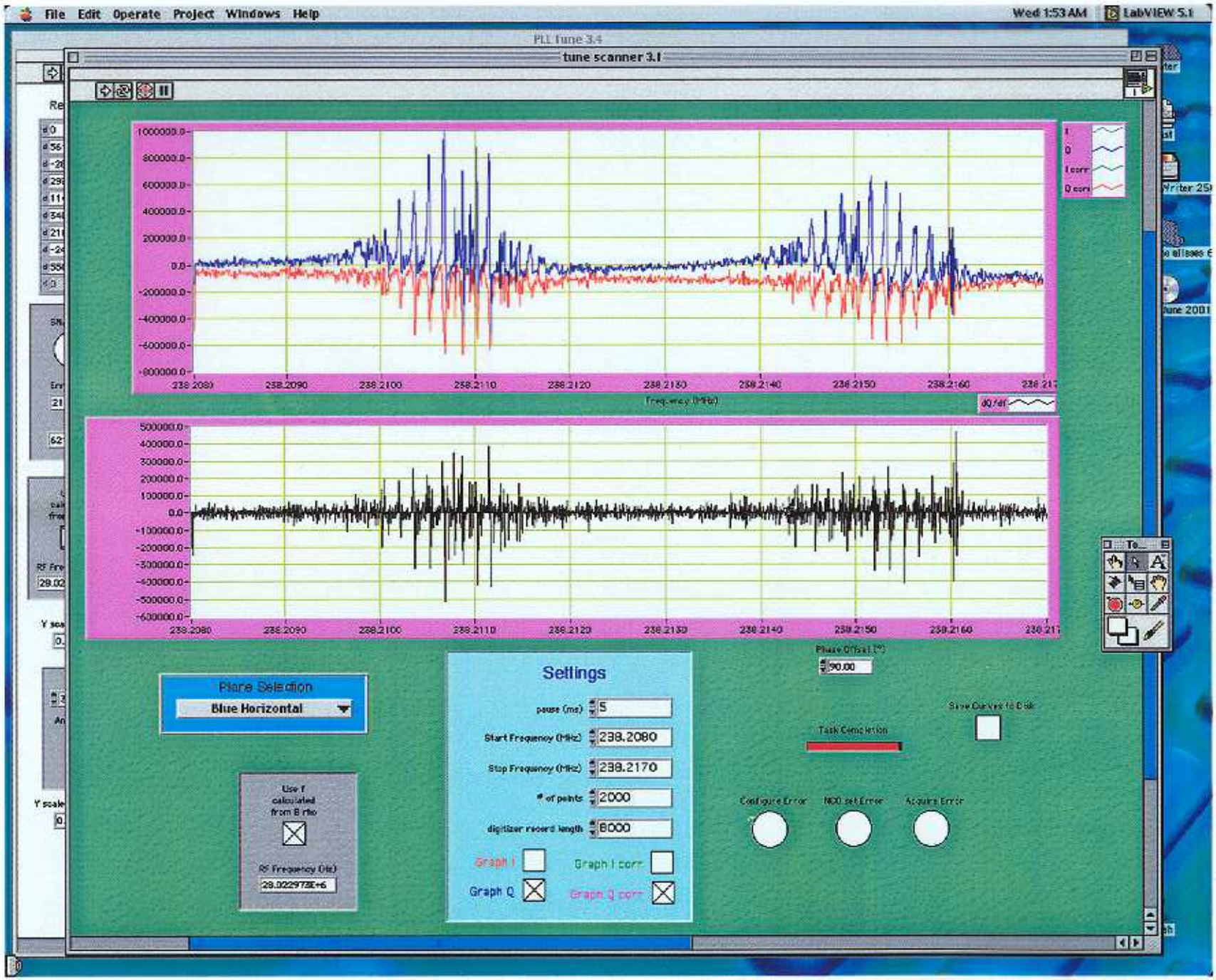


SIGNAL +15 dB

S/N + 25 dB

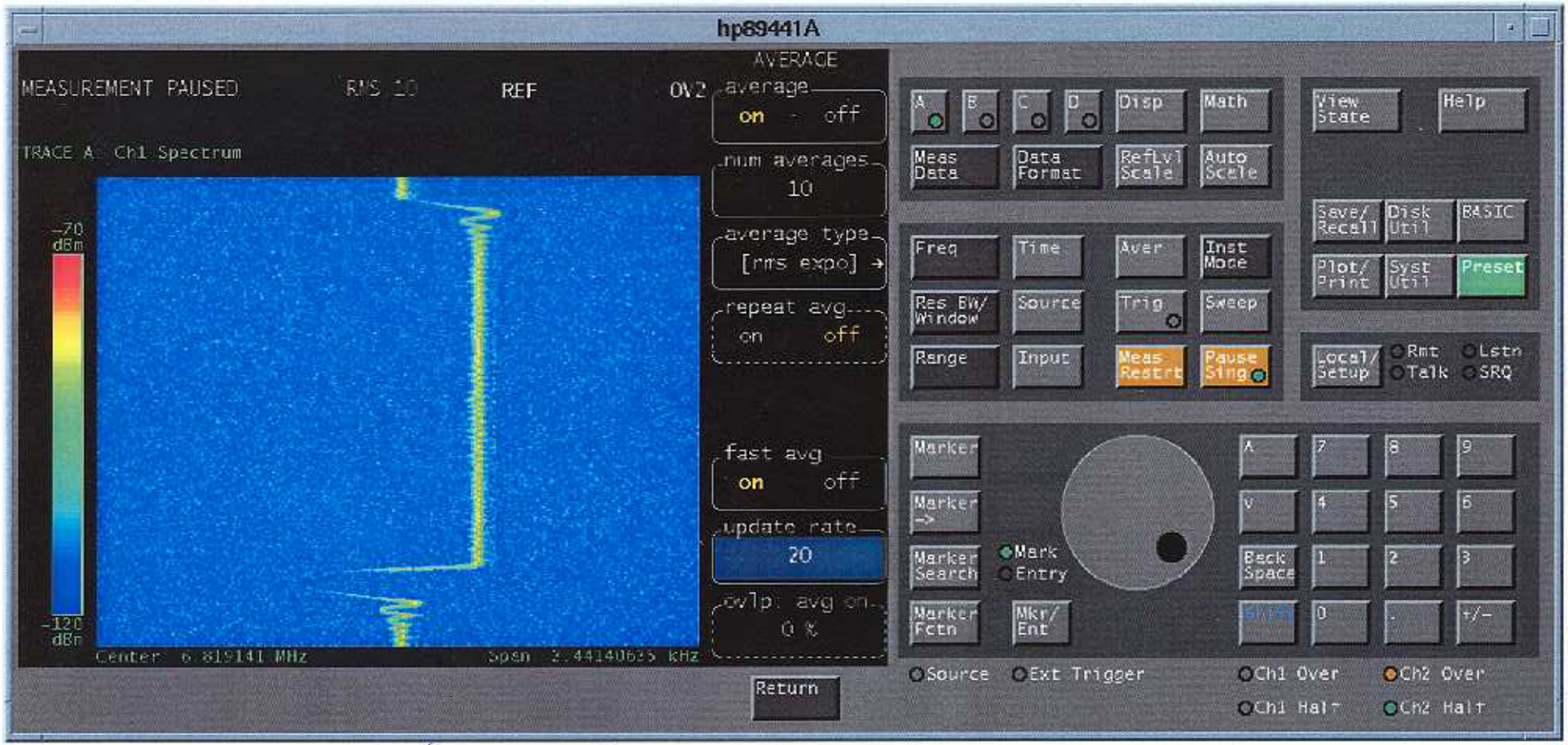

File Edit Operate Project Windows Help
Sun 11:25 AM
LabVIEW 5.1
tune scanner 4.4
rev line
Btron
Btron
Plane Selection
Blue Horizontal
Use Y calculated from B rho
RF frequency (Hz)
Settings
pause (ms)
5
Start Frequency (MHz)
238.17000
Stop Frequency (MHz)
238.22000
# of points
1000
digitizer record length
4096
Graph I
Graph Q
Graph I corr
Graph Q corr
Phase Offset (°)
270.00
Save Curves to Disk
Configure Error
NCO set Error
Acquire Error

w/ LOW LOOP GAIN YOU LOCK ON SATELLITE → PRECISION



SPAN = 2.4 KHZ

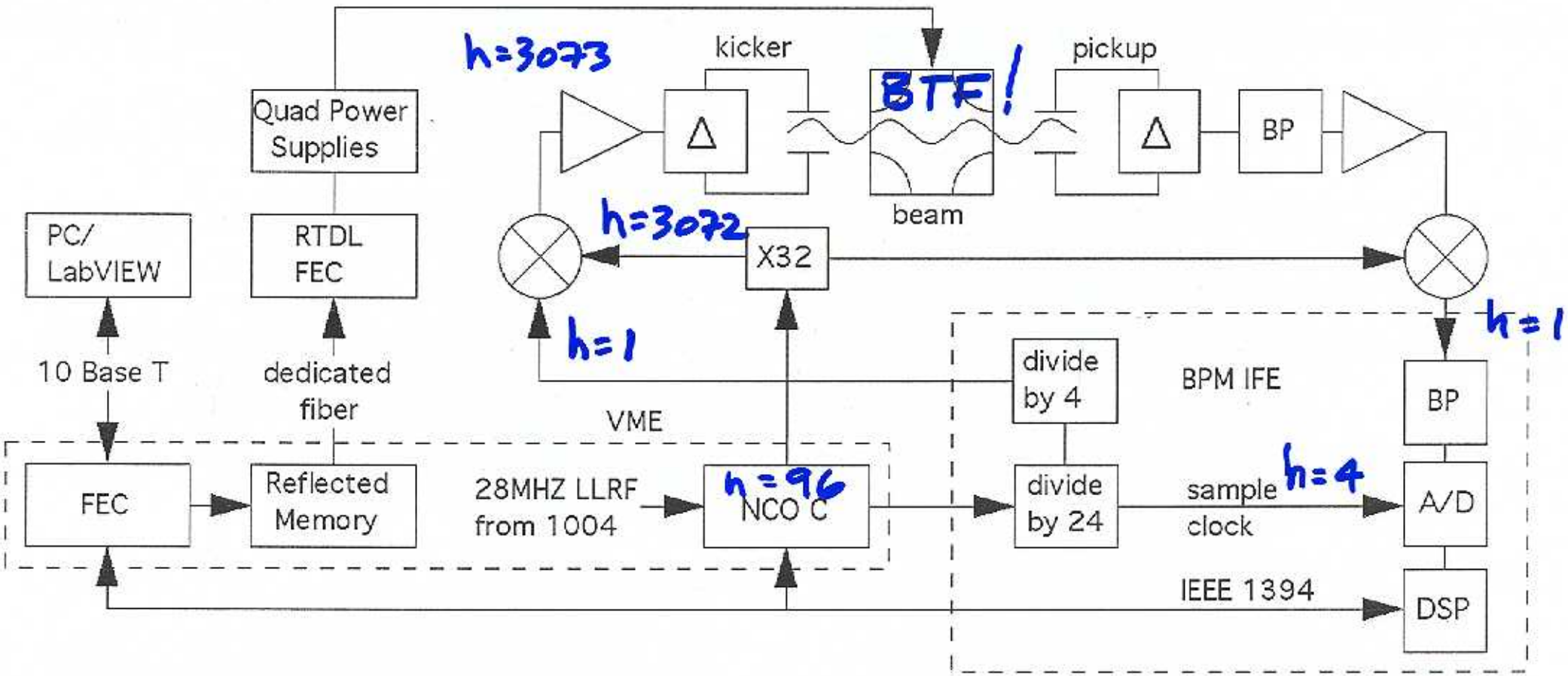
~~60 Hz artifact?~~

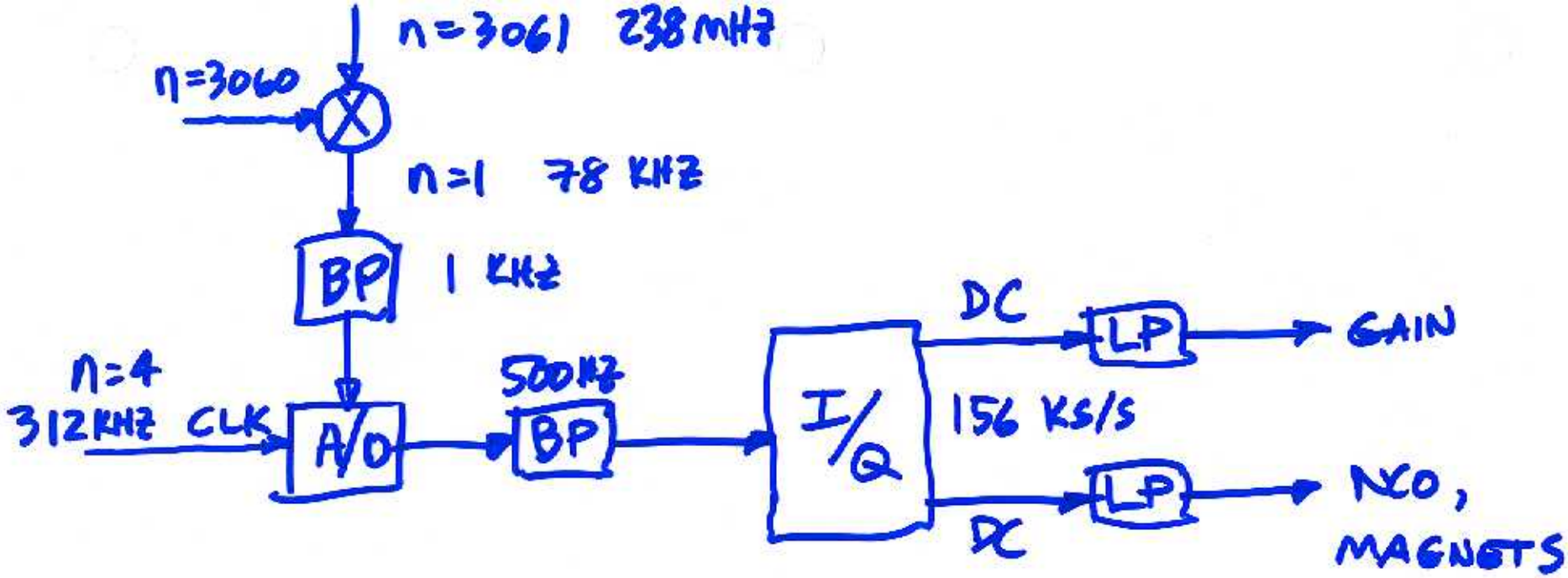


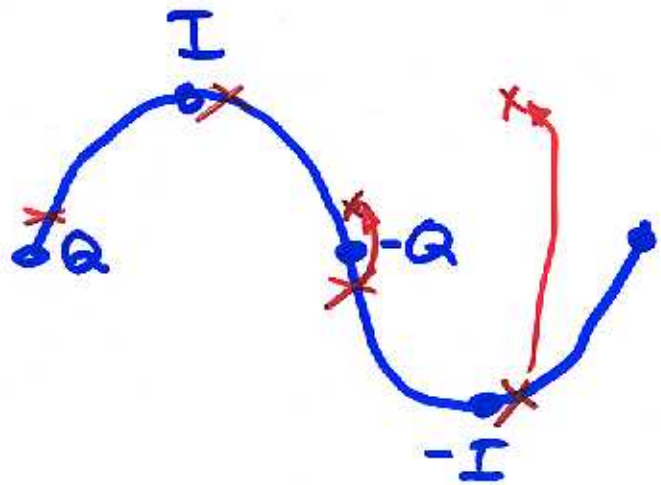
$\Delta f \sim 300$ Hz $\Rightarrow \Delta q \sim .004$

measurement accuracy - a few 10^{-4}

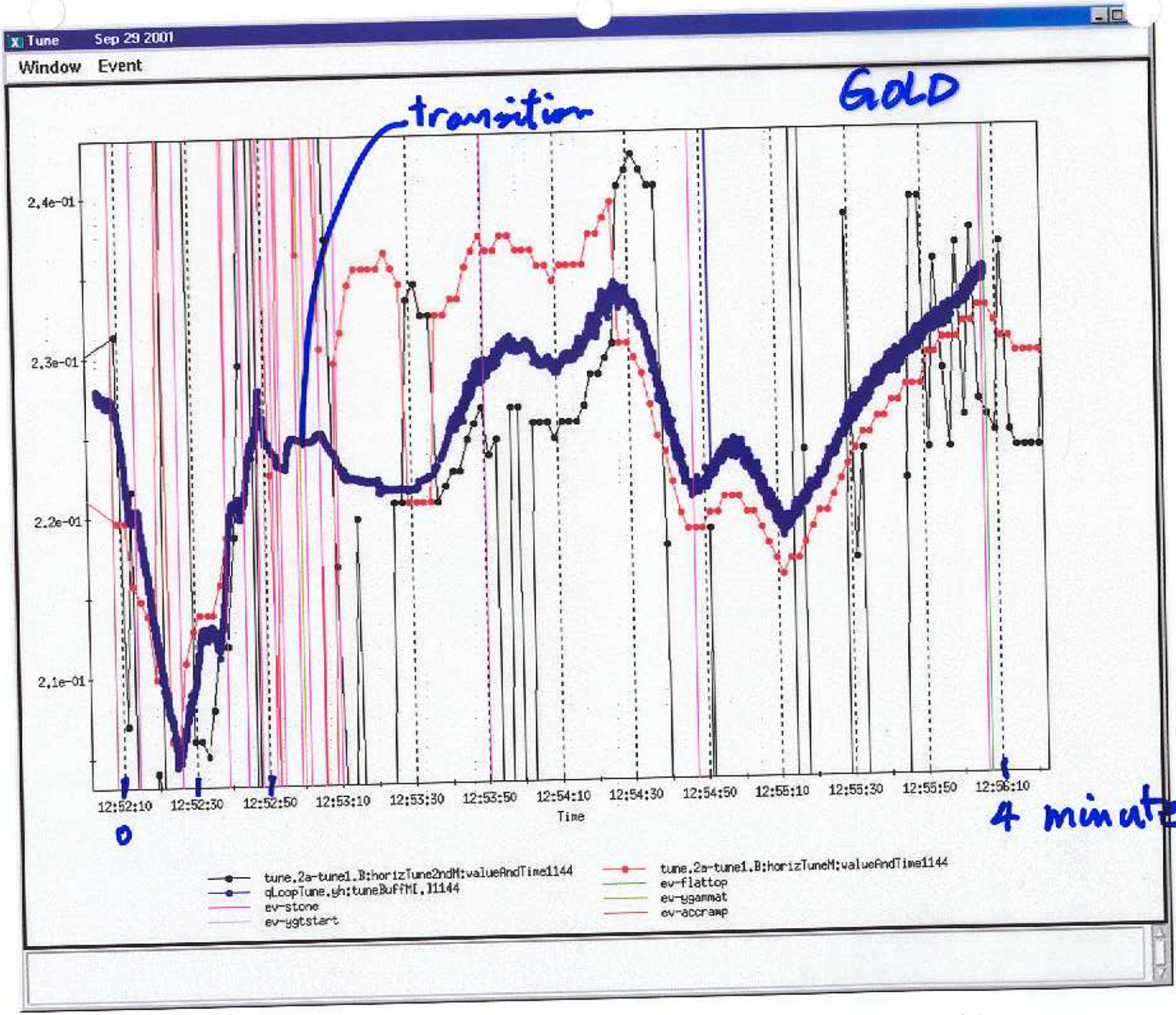
SRI lockin HP DC FM sig. gen. kick ~ 1 mW

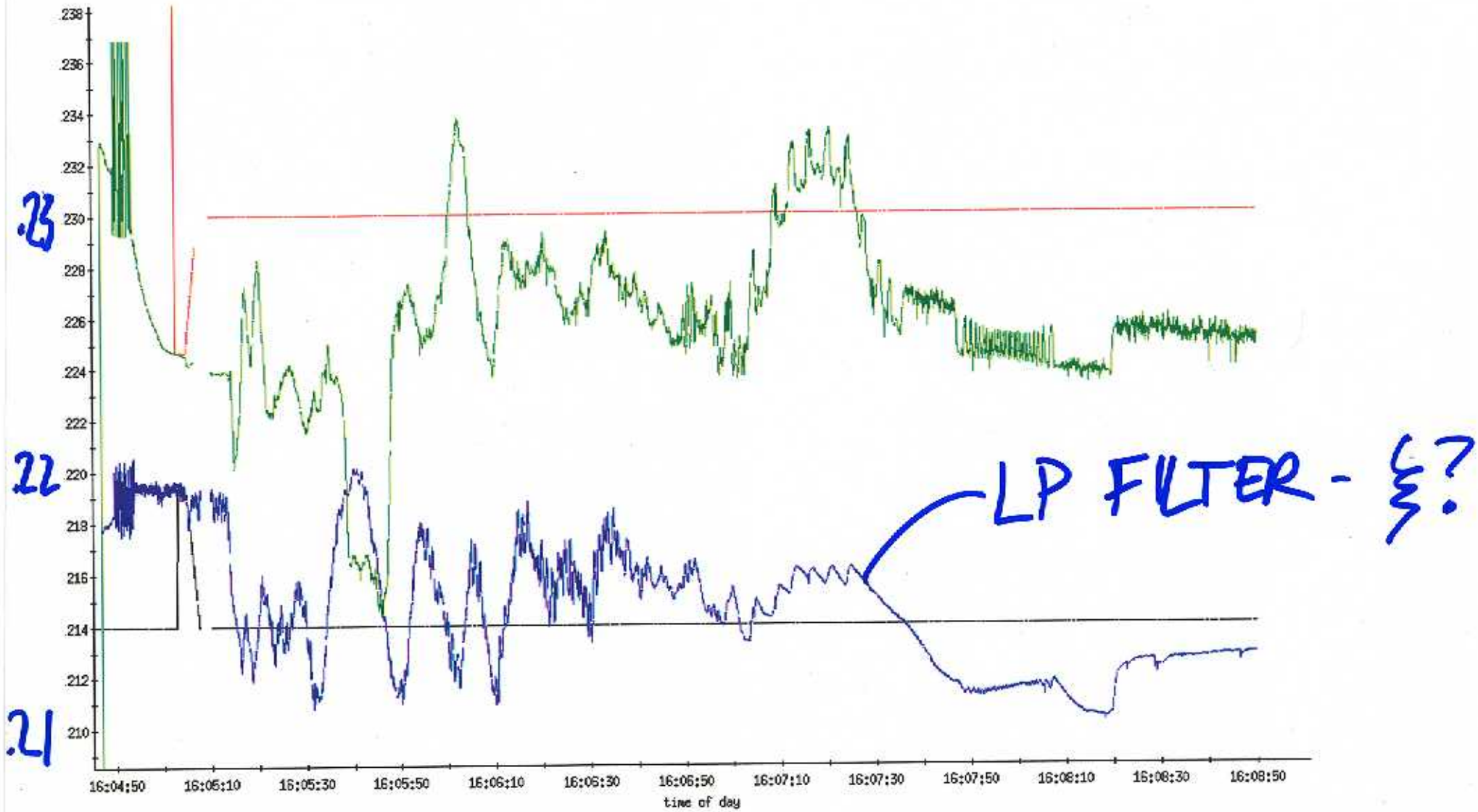

h=3073
kicker
BTF!
pickup
Quad Power Supplies
Δ
Δ
BP
beam
h=3072
X32
PC/ LabVIEW
RTDL FEC
h=1
h=1
10 Base T
dedicated fiber
VME
divide by 4
BPM IFE
BP
FEC
Reflected Memory
28MHZ LLRF from 1004
h=96
NCO C
divide by 24
sample clock
h=4
A/D
IEEE 1394
DSP





I/Q DEMODULATION (RECTIFICATION)


Tune Sep 29 2001
Window Event
transition
GOLD
.24
.23
.22
.21
2.4e-01
2.3e-01
2.2e-01
2.1e-01
12:52:10
12:52:30
12:52:50
12:53:10
12:53:30
12:53:50
12:54:10
12:54:30
12:54:50
12:55:10
12:55:30
12:55:50
12:56:10
Time
0
4 minutes
tune.2a-tune1.B:horizTune2ndM:valueAndTime1144
qLoopTune.yh:tuneBuffM[.]1144
ev-stone
ev-ygtstart
tune.2a-tune1.B:horizTuneM:valueAndTime1144
ev-flattop
ev-ygammat
ev-accramp


.23
.22
.21
LP FILTER - ξ?
238
236
234
232
230
228
226
224
222
220
218
216
214
212
210
16:04:50
16:05:10
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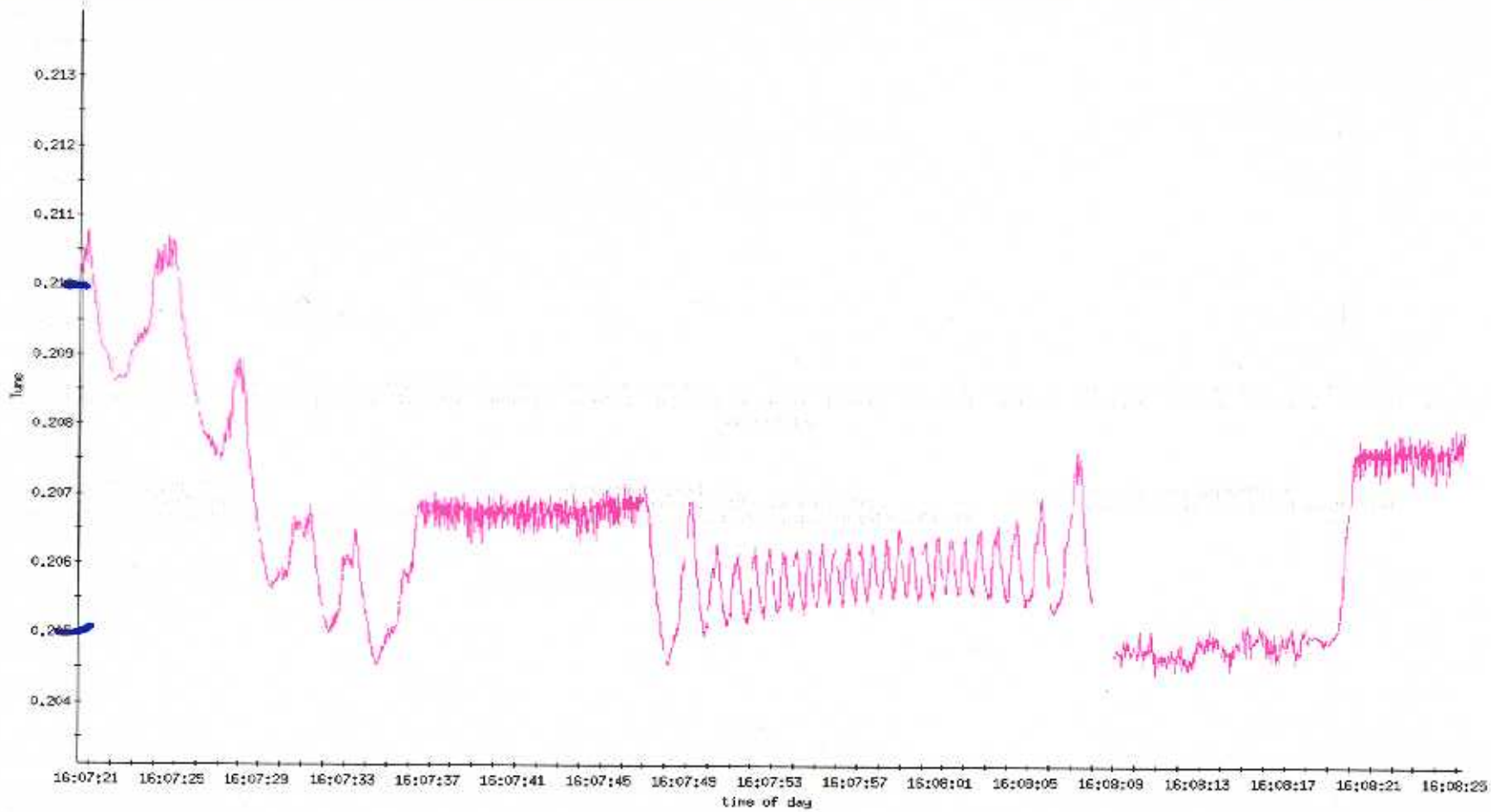
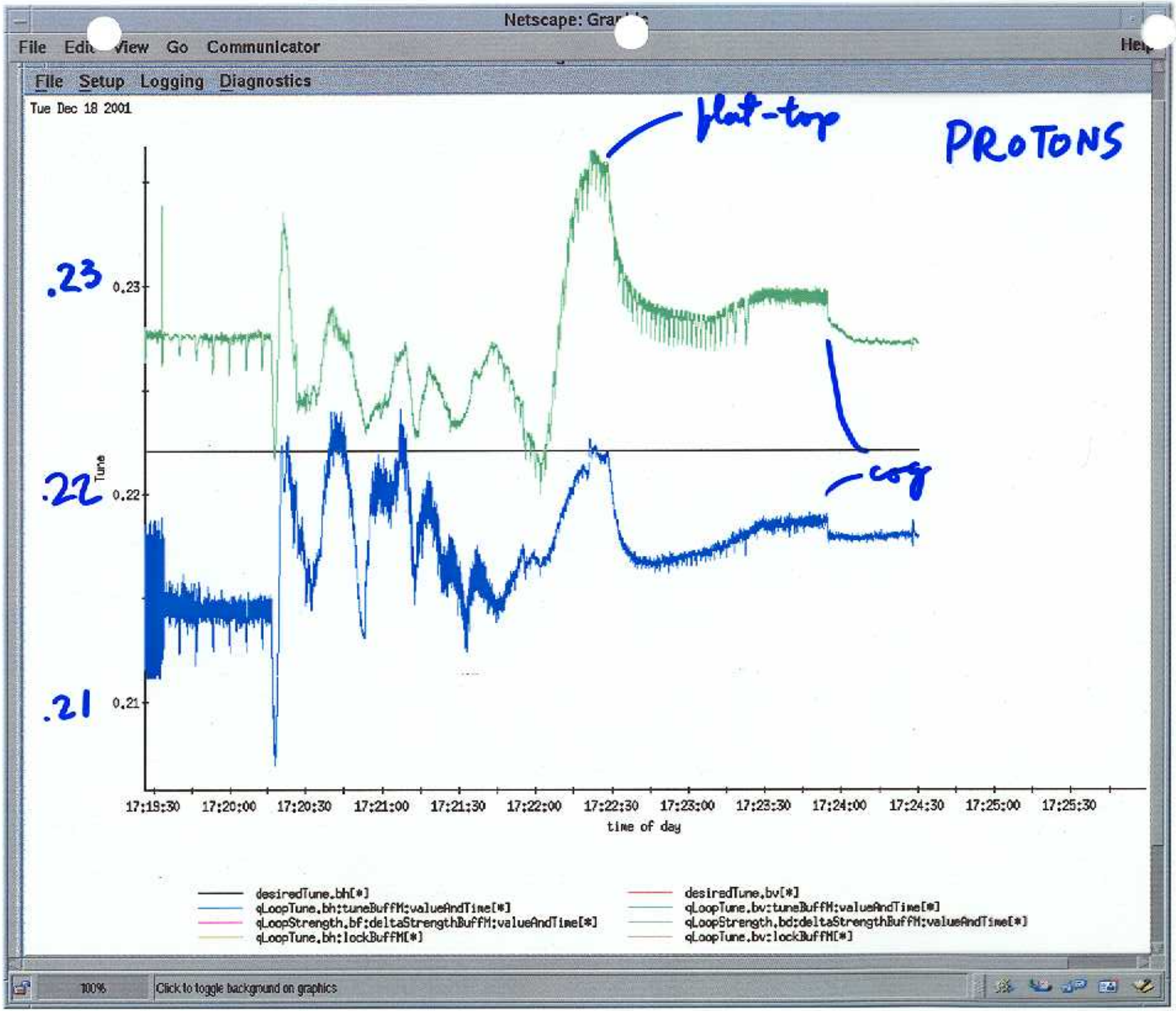
16:05:50
16:06:10
16:06:30
16:06:50
16:07:10
16:07:30
16:07:50
16:08:10
16:08:30
16:08:50
time of day
desiredTune.bh[*]
qLoopTune.bv:tuneBuffM:valueAndTime[*]
qLoopTune.bh:lockBuffM[*]
desiredTune.bv[*]
qLoopStrength.bf:deltaStrengthBuffM:valuesAndTime[*]
qLoopTune.bv:lockBuffM[*]
qLoopTune.bh:tuneBuffM:valuesAndTime[*]
qLoopStrength.bd:deltaStrengthBuffM:valueAndTime[*]

~.002 Beam-Beam Tune Shift Yellow

.21

.205




Netscape: Gra
File Edit View Go Communicator Help
File Setup Logging Diagnostics
Tue Dec 18 2001
flat-top
PROTONS
.23
.22
.21
0.23
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Tune
17:19:30
17:20:00
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17:21:30
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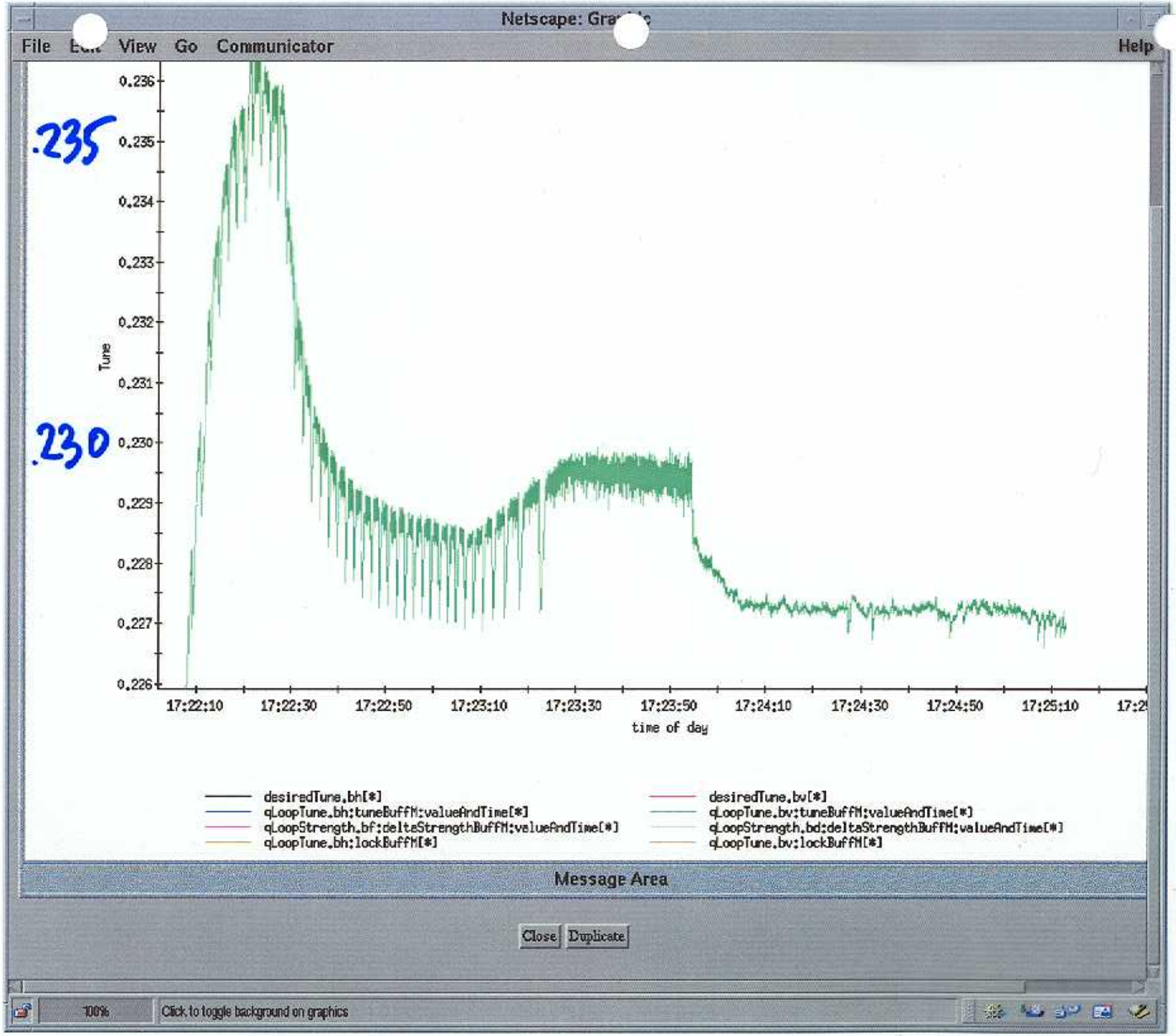
17:23:30
17:24:00
17:24:30
17:25:00
17:25:30
time of day
desiredTune.bh[*]
qLoopTune.bh:tuneBuffM:valueAndTime[*]
qLoopStrength.bf:deltaStrengthBuffM:valueAndTime[*]
qLoopTune.bh:lockBuffM[*]
desiredTune.bv[*]
qLoopTune.bv:tuneBuffM:valueAndTime[*]
qLoopStrength.bd:deltaStrengthBuffM:valueAndTime[*]
qLoopTune.bv:lockBuffM[*]
100%
Click to toggle background on graphics


Netscape: Gra
File Edit View Go Communicator Help
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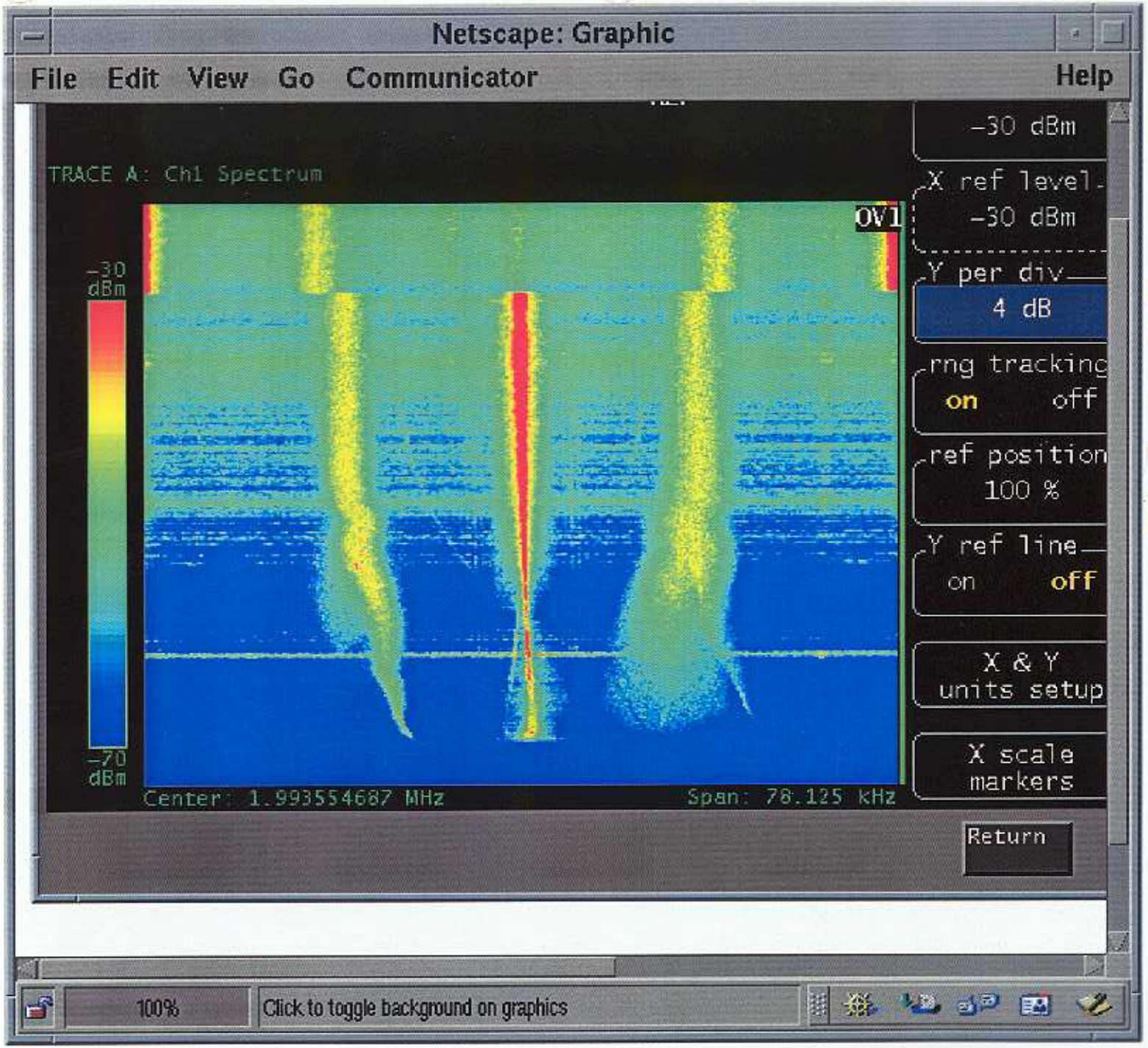
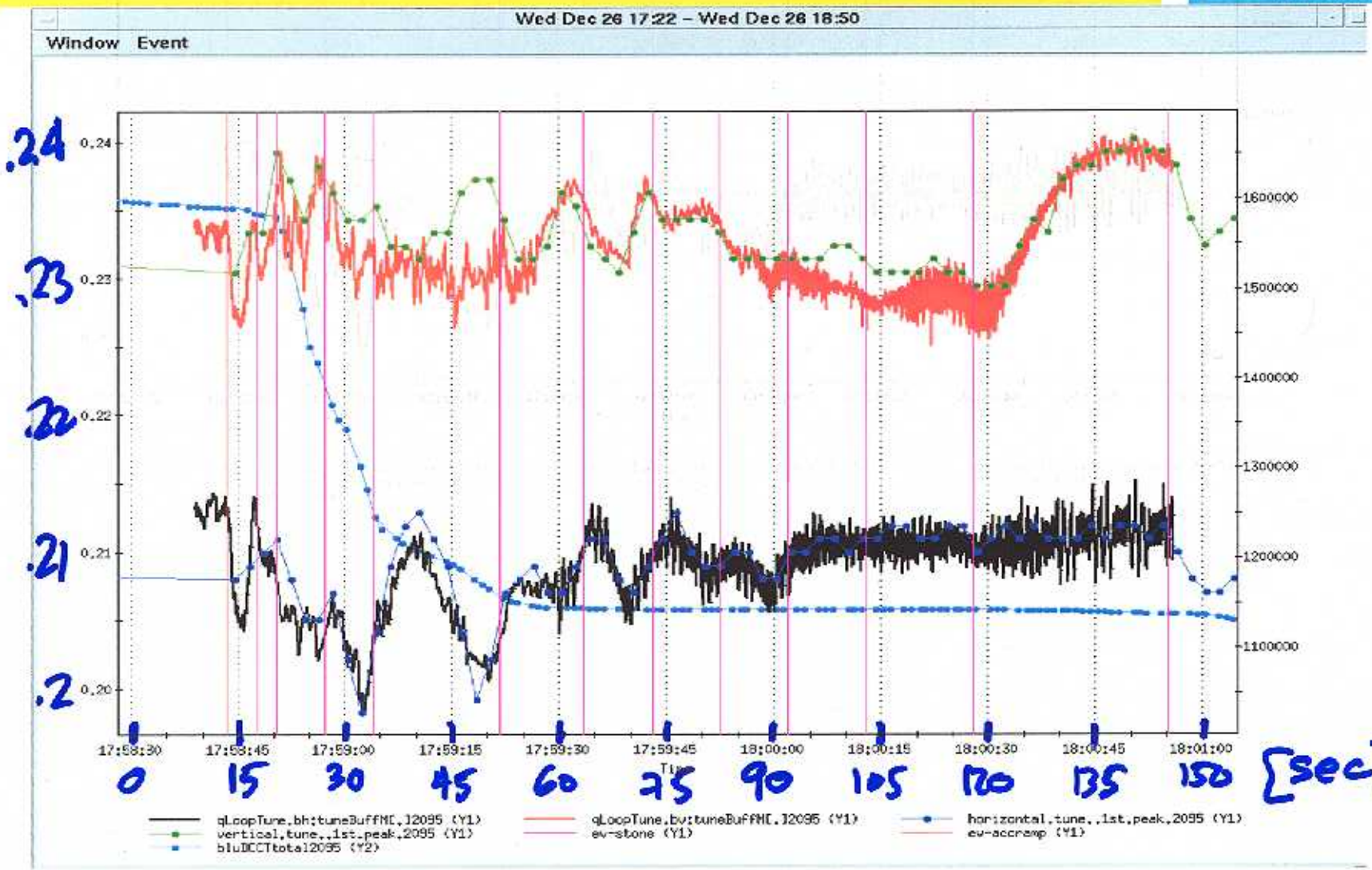
0.232
0.231
0.230
0.229
0.228
0.227
0.226
Tune
17:22:10
17:22:30
17:22:50
17:23:10
17:23:30
17:23:50
17:24:10
17:24:30
17:24:50
17:25:10
time of day
desiredTune.bh[*]
qLoopTune.bh:tuneBuffM:valueAndTime[*]
qLoopStrength.bf:deltaStrengthBuffM:valueAndTime[*]
qLoopTune.bh:lockBuffM[*]
desiredTune.bv[*]
qLoopTune.bv:tuneBuffM:valueAndTime[*]
qLoopStrength.bd:deltaStrengthBuffM:valueAndTime[*]
qLoopTune.bv:lockBuffM[*]
Message Area
Close
Duplicate
100%
Click to toggle background on graphics

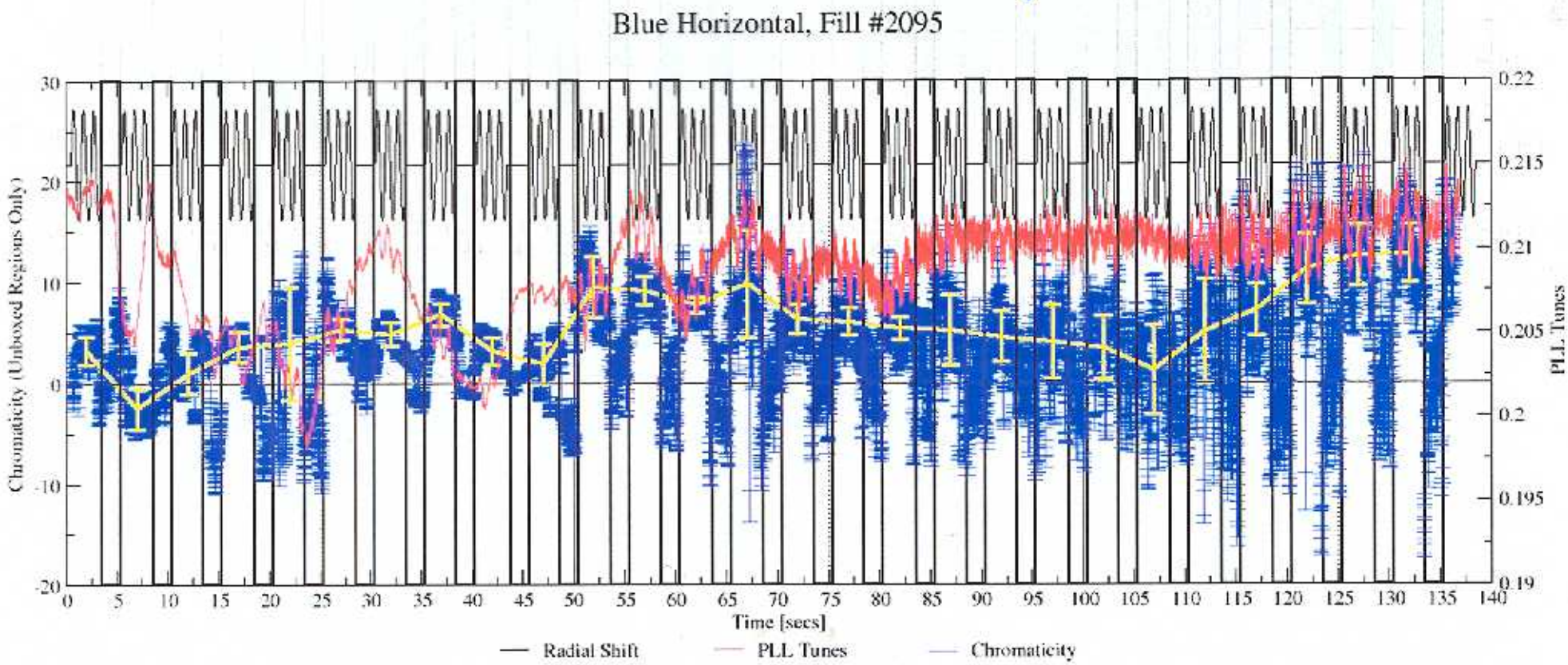


HF SCHOTTKY DOWN RAMP

Radial Modulation on the Ramp



$\Delta R = 200\mu$ $\Delta p/p \sim 1.8 \times 10^{-4}$



Lessons Learned about PLL/TF

- Good approach
  - resonant pickup give sensitivity
  - above coherent spectrum gives clean spectrum, small kick OK
  - Mix to harmonic 1 permits effective analog filtering (revolution lines!)
  - Synchronous x4 digitizer clock for I/Q demodulation - simple
- Landau damping effective except near transition (protons)
- RF Leakage requires careful attention - 1/4 heliax connectors, resonant BPM capacitive trimmers,...
- Ramp phase compensation (cables give >3pi) not a problem
- Reliable autolock at constant phase is essential
- Filter, filter, filter,…
- Chromaticity control (feedforward? feedback?) is ESSENTIAL
- Coupling correction is highly desirable

Where We Stand with PLL/TF

- We could run TF with present system during RHIC 2003
- State of the art in accuracy ($<10^{-5}$) and resolution (a few 10^{-6})
- Autolock in good shape – ran unattended for last month of run
- Up Ramps after 'lessons learned' - 4 of 5, failure due to chrom
- Down Ramps - Four attempted, none successful due to chrom
- By end of run system was stable, repeatable, reliable specialist tool
- Qloop stable with ARTUS kicking, agreement is generally good, understood in terms of chromaticity and coupling when it is not
- Results with radial modulation for chromaticity are encouraging, but not convincing.

PLL Status - Goals

- PLL is not a Diagnostic, but rather a system needed to commission an operating mode (ie d-Au, Au-Au, p-p, downramp,…
- Goal is fast and efficient ramp development
- Improve the S/N
  - Signals are ~ 10^{-15} watt!
  - Vertical plane was problematic - β functions
  - DSP limitations - filtering, communications,…
- Reduce 'expert' dependency
  - Not so far from this last run

PLL Status - Methods

- Move Pickups and kickers to larger β
- Move processing from BPM IFE to VME DSP
  - Better communications (no more ethernet/1394/sederta/VME)
  - Faster - improved digital filtering, processing gain
- Move Control from LabVIEW/Mac to LabVIEW/Sun
  - System will be run from MCR, familiarity will propagate quickly

Improvements from last run

- Common Mode rejection - MBPM position control, better preamps, h=3060 to h=3148/49, fix obstruction,… - 5dB?
- Oversampling processing gain - 455KHz - 7dB?
- Improved analog and digital filtering - 5dB? More?
- PUEs at larger beta, 3/8 heliax - 2dB?
- For ramp development don't care about emittance growth - 10dB?
- Operation from MCR
- Improved phase compensation
- Matrix Inversion, PLL/Beam Model
- Improved Diagnostics - ARTUS, Schottky's, Coupling,…

Status of Improvements

- Common Mode rejection
  - MBPM position control - Angelika
  - better preamps - done
  - h=3060 to h=3148/49 - done
  - fix obstruction - not yet
- DSP Improvements
  - Pentek DSPs in house, running in VXWorks, interfaced to digitizer
  - DSP code from IFE ported to Pentek DSP - debugging
- Improved analog filtering - 455KHz ceramic filters
- PUEs at larger beta - in progress
- Operation from MCR - LabVIEW running on Sun, new ADO parameters,…
- Matrix Inversion, PLL/Beam Model - in progress
- Improved Diagnostics - ARTUS, Schottky's, Coupling - in progress

Commissioning Plan

- Single plane running on resonator - early to mid-August
- First dry run - Single plane system integration from MCR
- Second dry run - All planes,…
- With beam single bunch - concurrent w/ BPM timing, RF,…
  - PLL/Diagnostics/Applications Commissioning - dedicated time
  - Phase zero, Phase compensation, Autolock
  - Comparison with ARTUS, Schottky,…
  - Loop gain, filter BW, AGC,…
  - Coupling, Chromaticity - how to measure, effect on PLL,…
  - Magnet transfer function
  - Close magnet loop, ramp?
- Six bunches