Schottky Diagnostics

- High Frequency Schottky
  - Enhanced LARP
- Low Frequency Schottky
  - Initial Instrumentation Suite
    ("almost free" with PLL Tune System)

Measurment Capabilities

- Tune
- Chromaticity
- Emittance
- dP/p
- Non Linear Tune Spread
- Ramp diagnostics

High Frequency Schottky

- Cavity and RF front-end built by LBNL

- Three cavity modes

  TM210 - Horizontal 2.067GHz

  TM120 - Vertical 2.071GHz

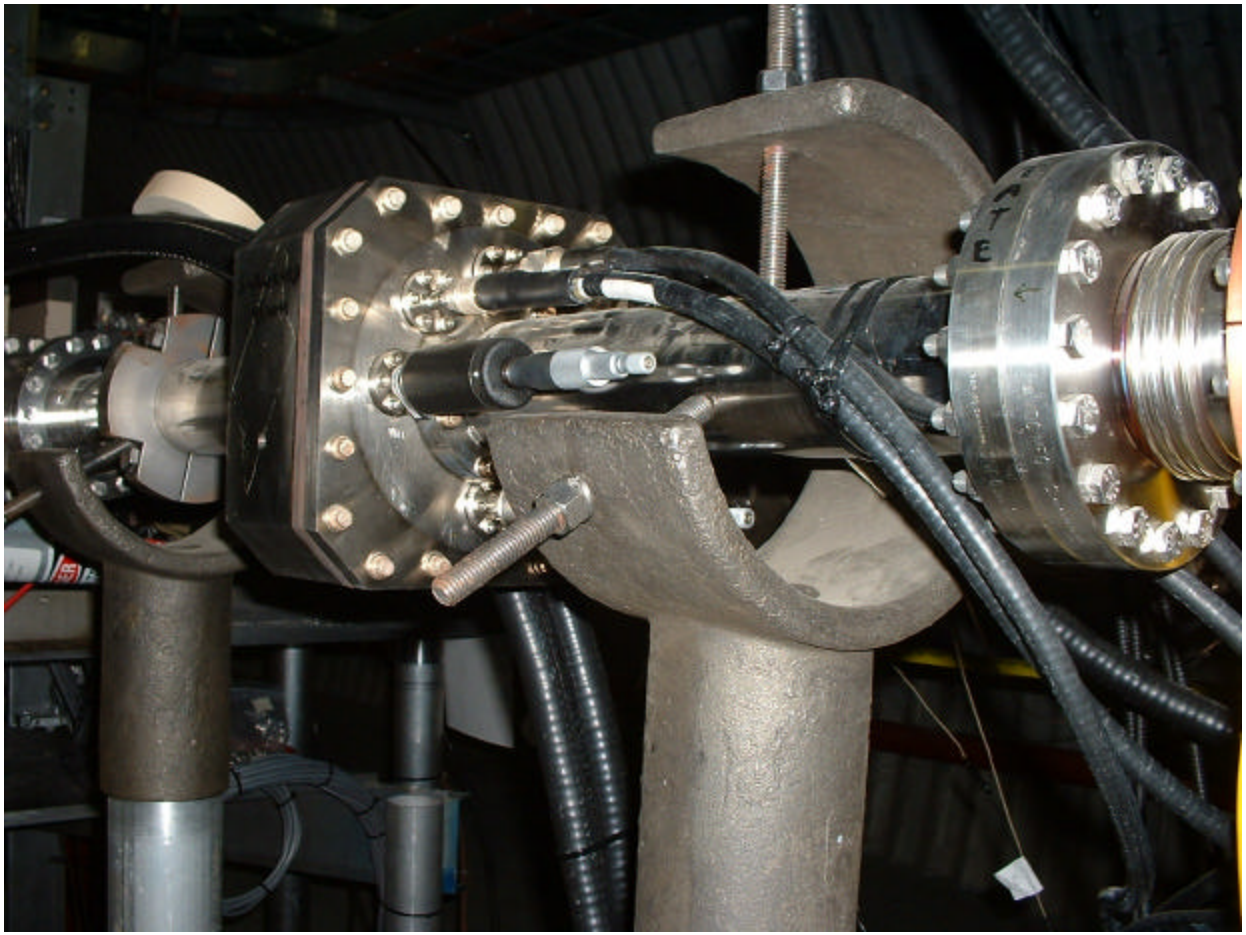
  TM111 - Longitudinal - 2.721GHz

- Cavity properties

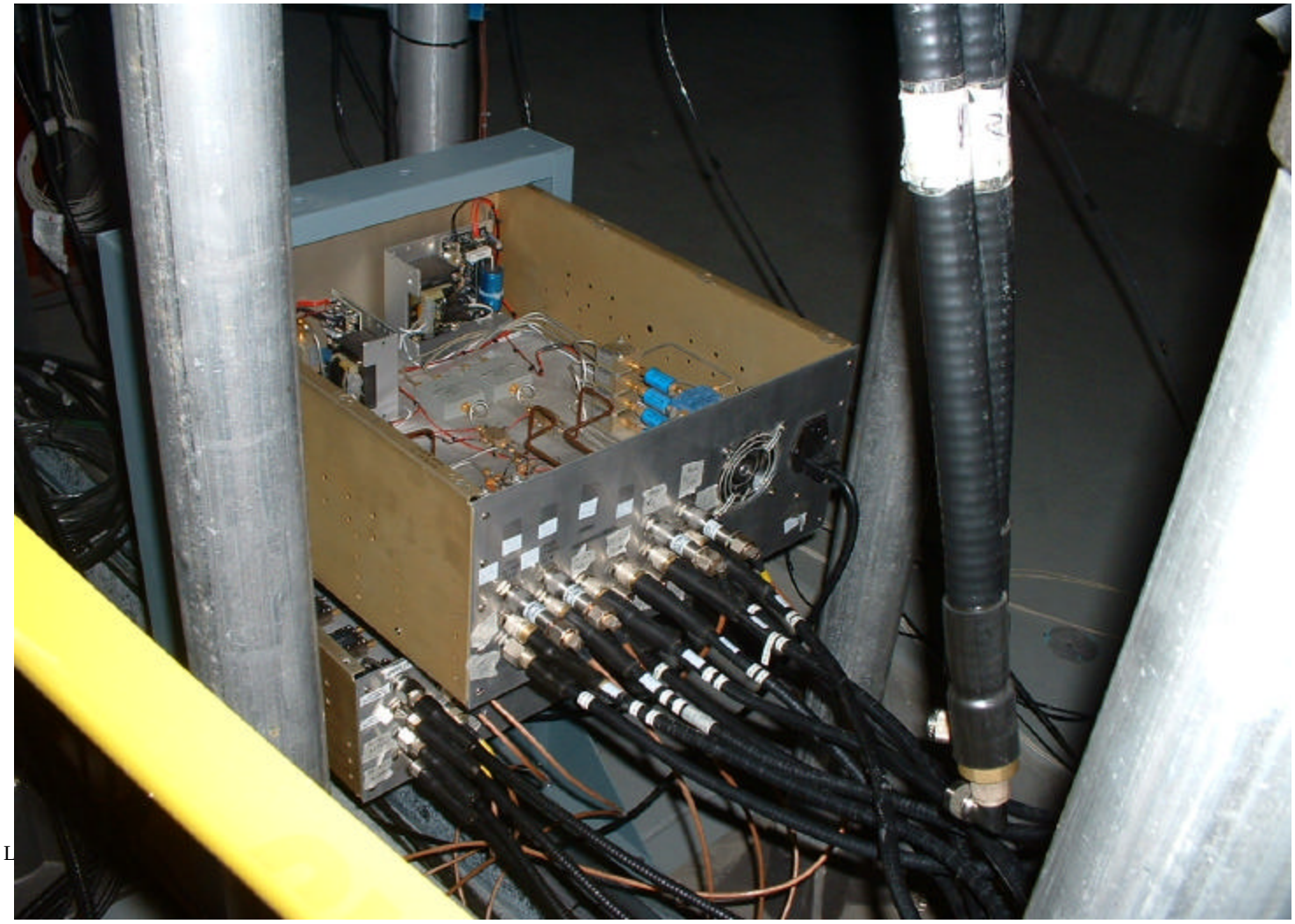
  Q_{loaded} ~ 5000, Transverse impedance ~ 9 MΩ/m

- DAQ – Direct Conversion Receiver, TI C6701 floating point DSP,
  LabView post-processing applications

HF Schottky Cavity



HF Schottky Receiver in Tunnel



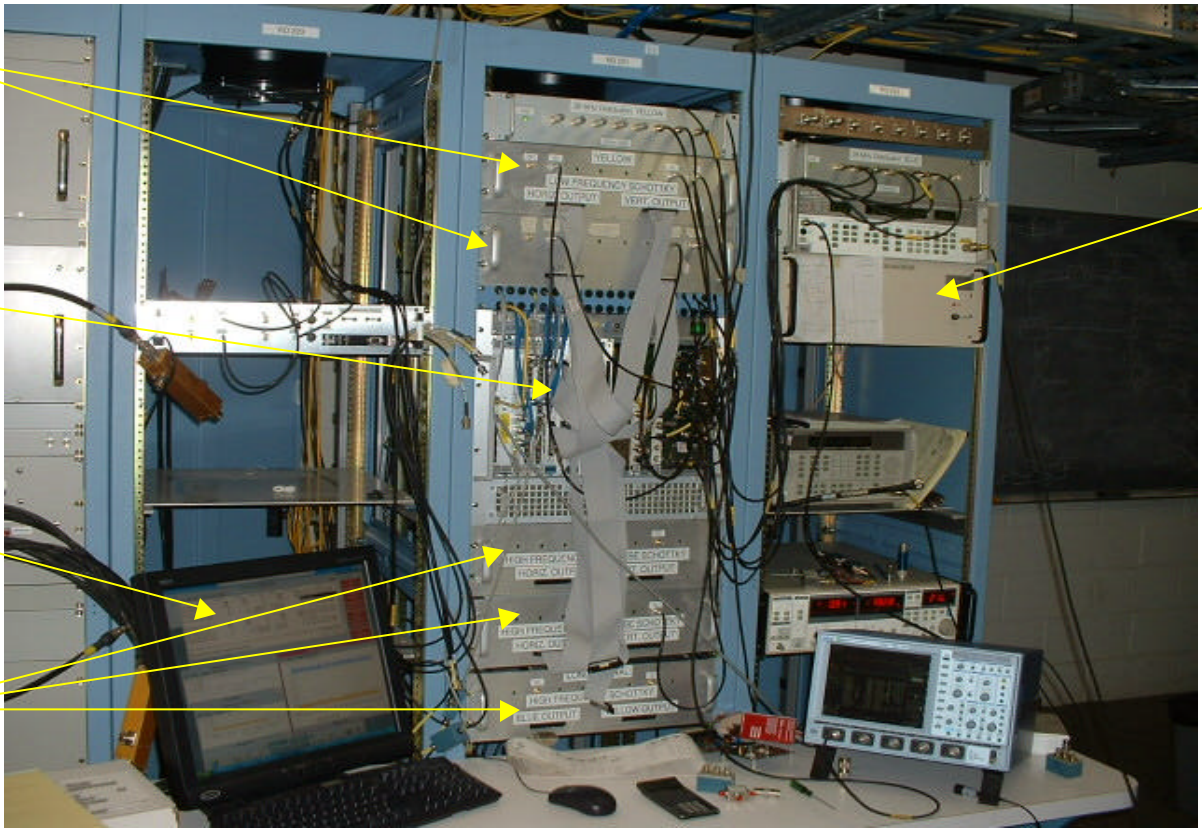
Schottky DAQ

LFS Receivers

Quad C6701 DSP VME boards

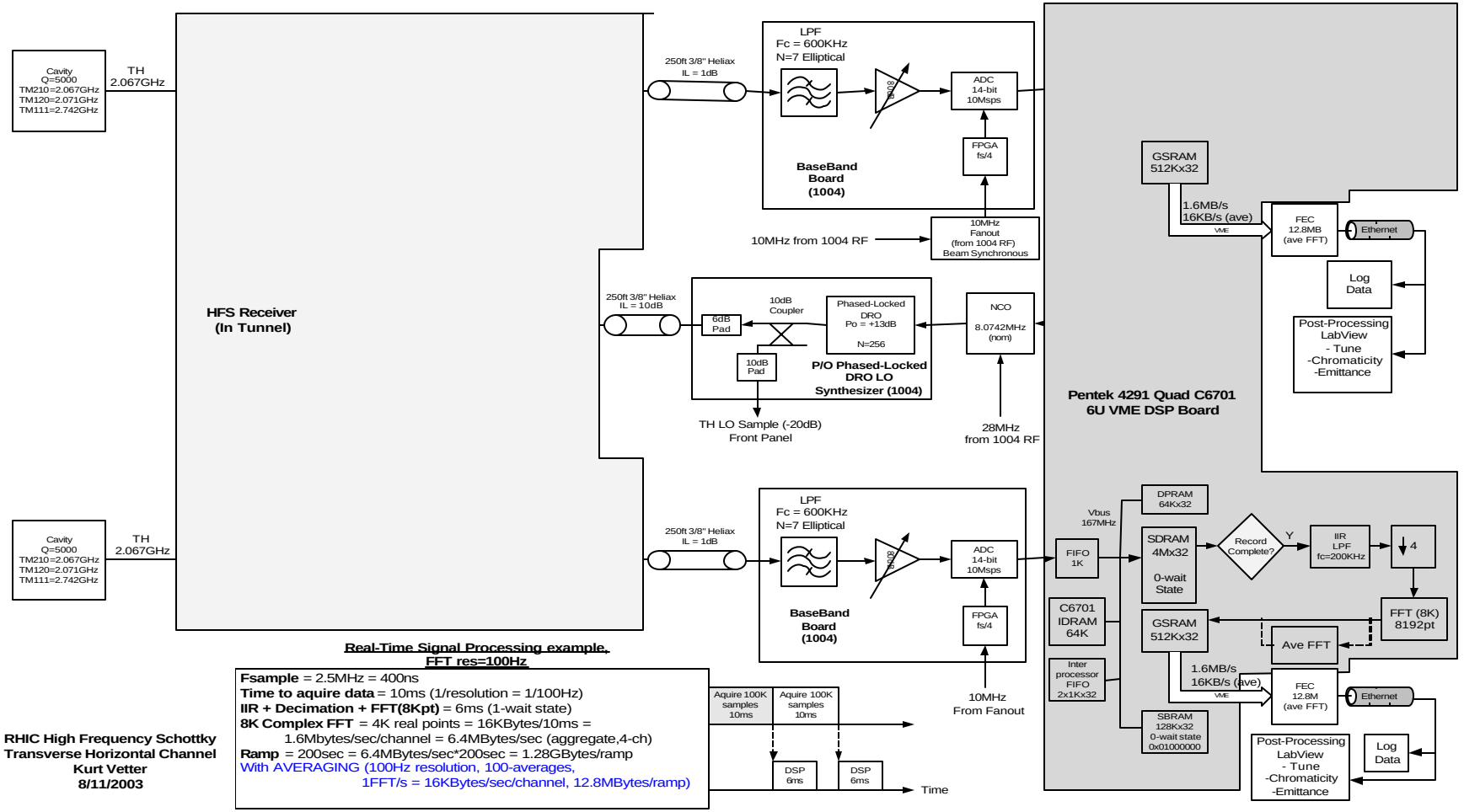
LabView on Linux

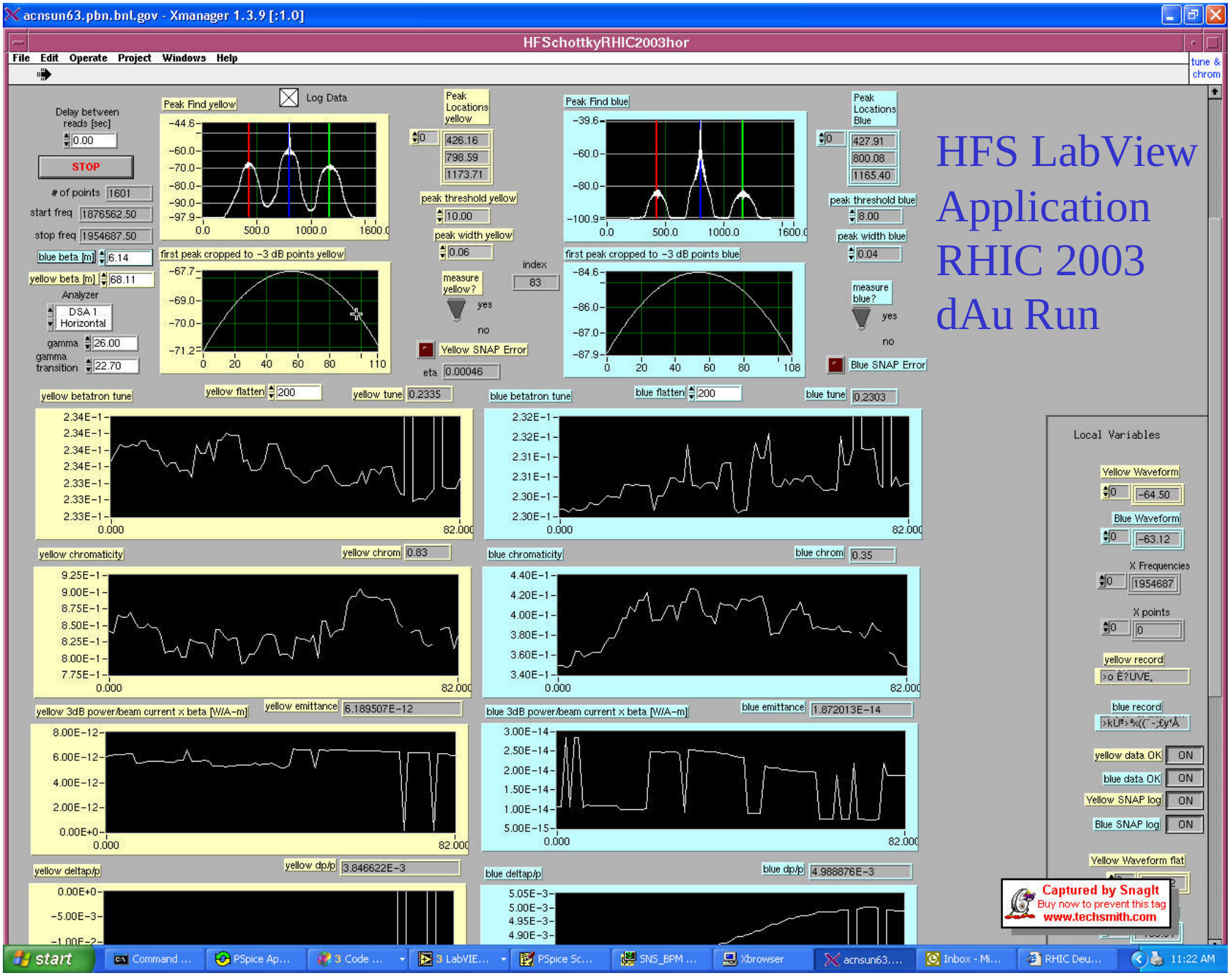
HFS Receivers



HFS Tracking DRO's

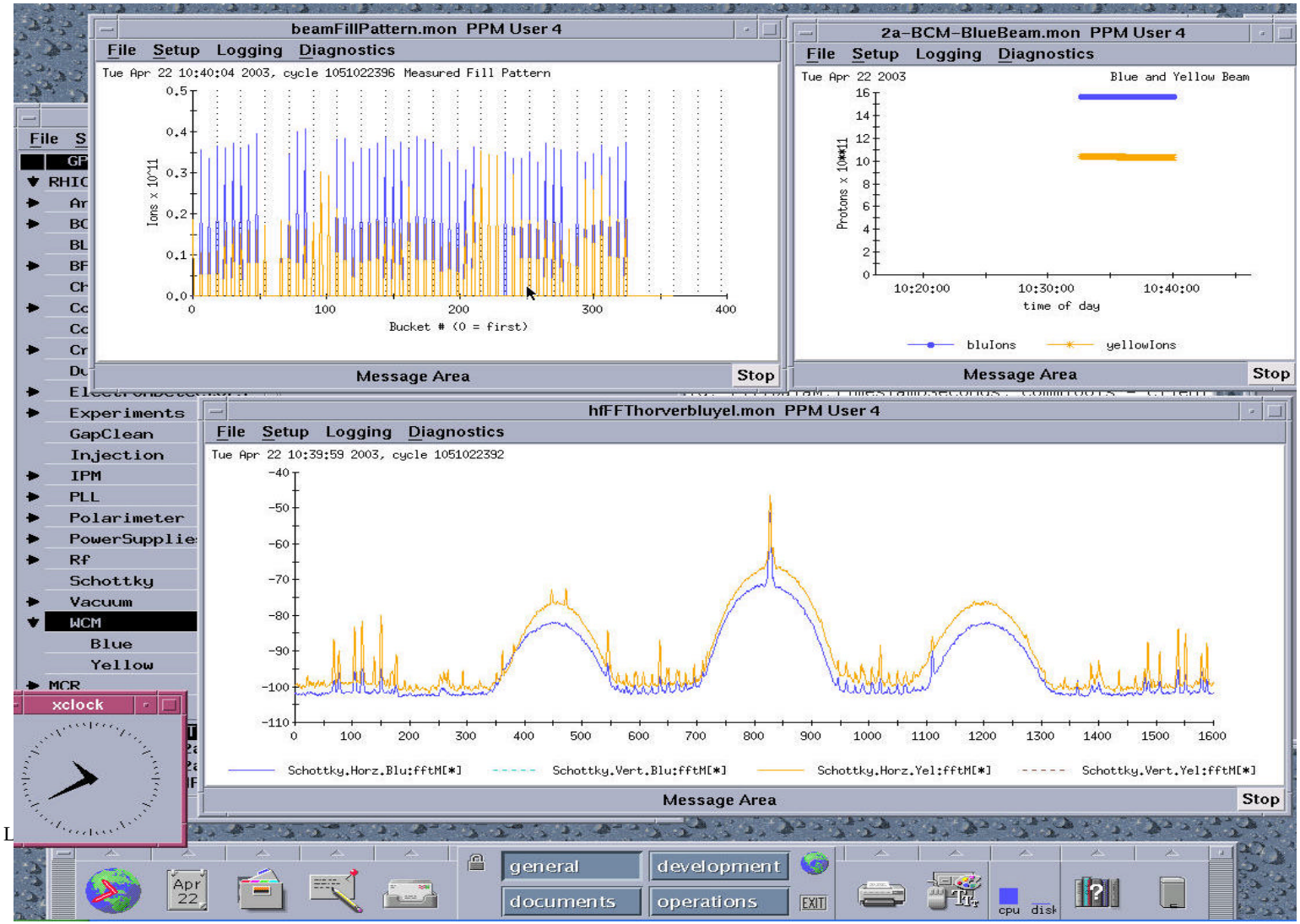
HFS/LFS Architecture RHIC 2004

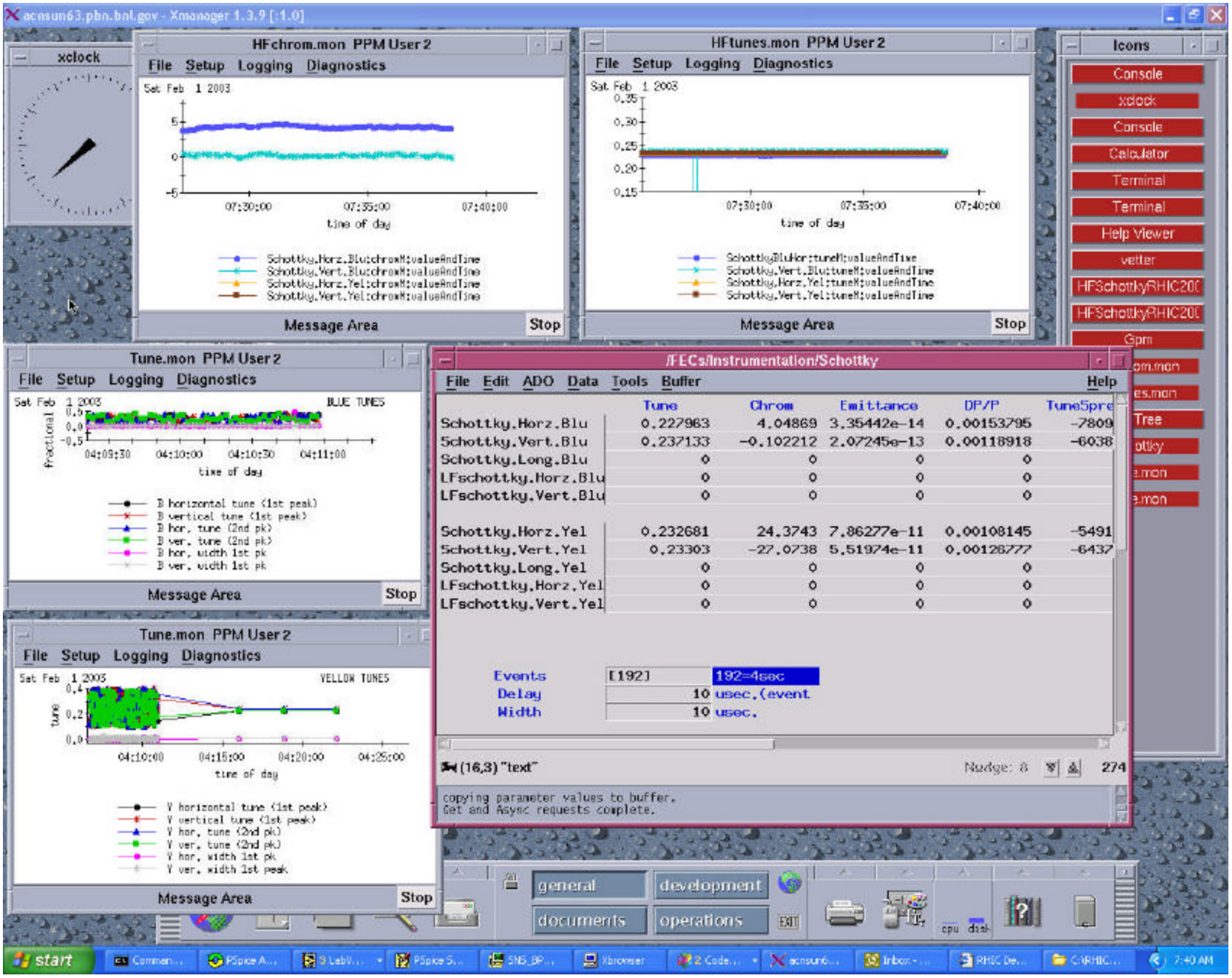




HFS LabView Application RHIC 2003 dAu Run

HFS Polarized Proton RHIC 2003



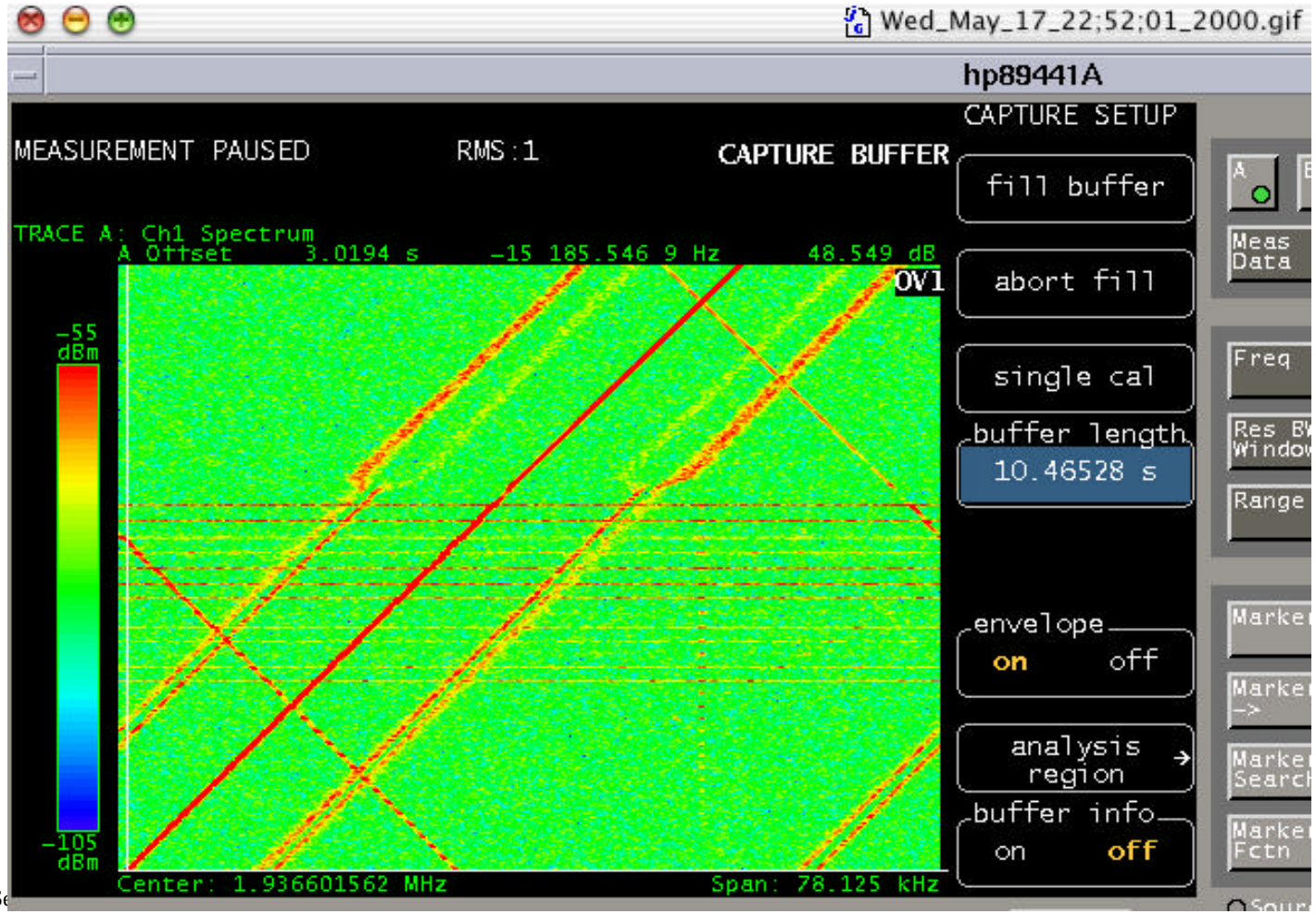

acnsun63.pbn.bnl.gov - Xmanager 1.3.9 [1.0]
xclock
HFchrom.mon PPM User 2
File Setup Logging Diagnostics
Sat Feb 1 2003
07:30:00
07:35:00
07:40:00
time of day
Message Area
Stop
HFtunes.mon PPM User 2
File Setup Logging Diagnostics
Sat Feb 1 2003
07:30:00
07:35:00
07:40:00
time of day
Message Area
Stop
Icons
Console
xclock
Console
Calculator
Terminal
Terminal
Help Viewer
vetter
Gpm
Tree
Tune.mon PPM User 2
File Setup Logging Diagnostics
Sat Feb 1 2003
BLUE TUNES
Fractional
04:09:30
04:10:00
04:10:30
04:11:00
time of day
B horizontal tune (1st peak)
B vertical tune (1st peak)
B hor. tune (2nd pk)
B ver. tune (2nd pk)
B hor. width 1st pk
B ver. width 1st pk
Message Area
Stop
/FECs/Instrumentation/Schottky
File Edit ADO Data Tools Buffer Help
Tune Chrom Emittance DP/P Tune5pre
Schottky.Horz.Blu 0.227963 4.04869 3.35442e-14 0.00153795 -7809
Schottky.Vert.Blu 0.237133 -0.102212 2.07245e-13 0.00118918 -6038
Schottky.Long.Blu 0 0 0 0
LFschottky.Horz.Blu 0 0 0 0
LFschottky.Vert.Blu 0 0 0 0
Schottky.Horz.Yel 0.232681 24.3743 7.86277e-11 0.00108145 -5491
Schottky.Vert.Yel 0.23303 -27.0738 5.51974e-11 0.00126777 -6437
Schottky.Long.Yel 0 0 0 0
LFschottky.Horz.Yel 0 0 0 0
LFschottky.Vert.Yel 0 0 0 0
Events [192] 192=4sec
Delay 10 usec.(event
Width 10 usec.
(16,3) "text"
Nudge: 0
274
copying parameter values to buffer.
Get and Async requests complete.
Tune.mon PPM User 2
File Setup Logging Diagnostics
Sat Feb 1 2003
YELLOW TUNES
tune
04:10:00
04:15:00
04:20:00
04:25:00
time of day
Y horizontal tune (1st peak)
Y vertical tune (1st peak)
Y hor. tune (2nd pk)
Y ver. tune (2nd pk)
Y hor. width 1st pk
Y ver. width 1st peak
Message Area
Stop
general
development
documents
operations
EXIT
cpu
disk
start
7:40 AM

First RHIC Transition Crossing

-1 sec

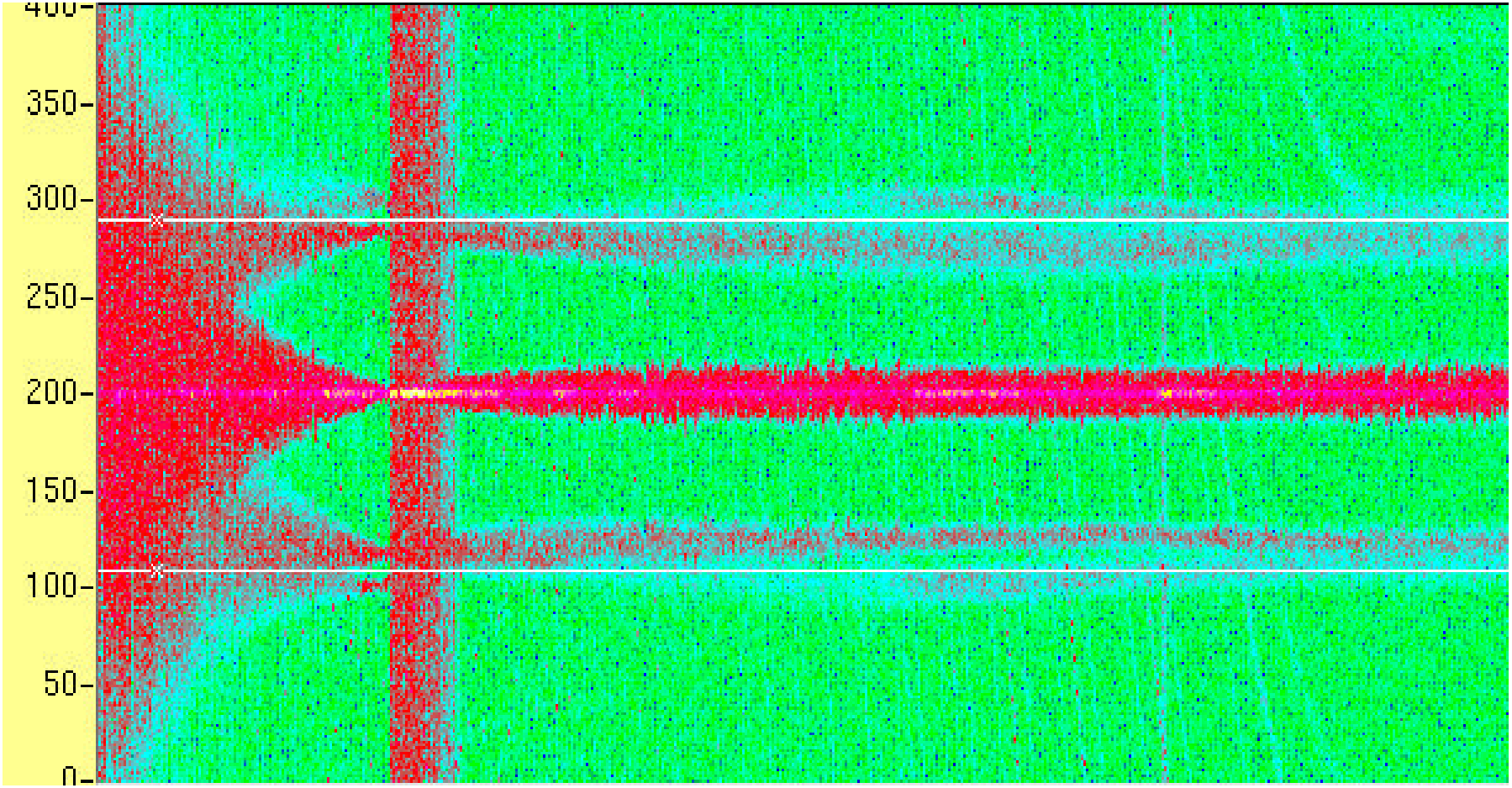
Transition

+2 sec



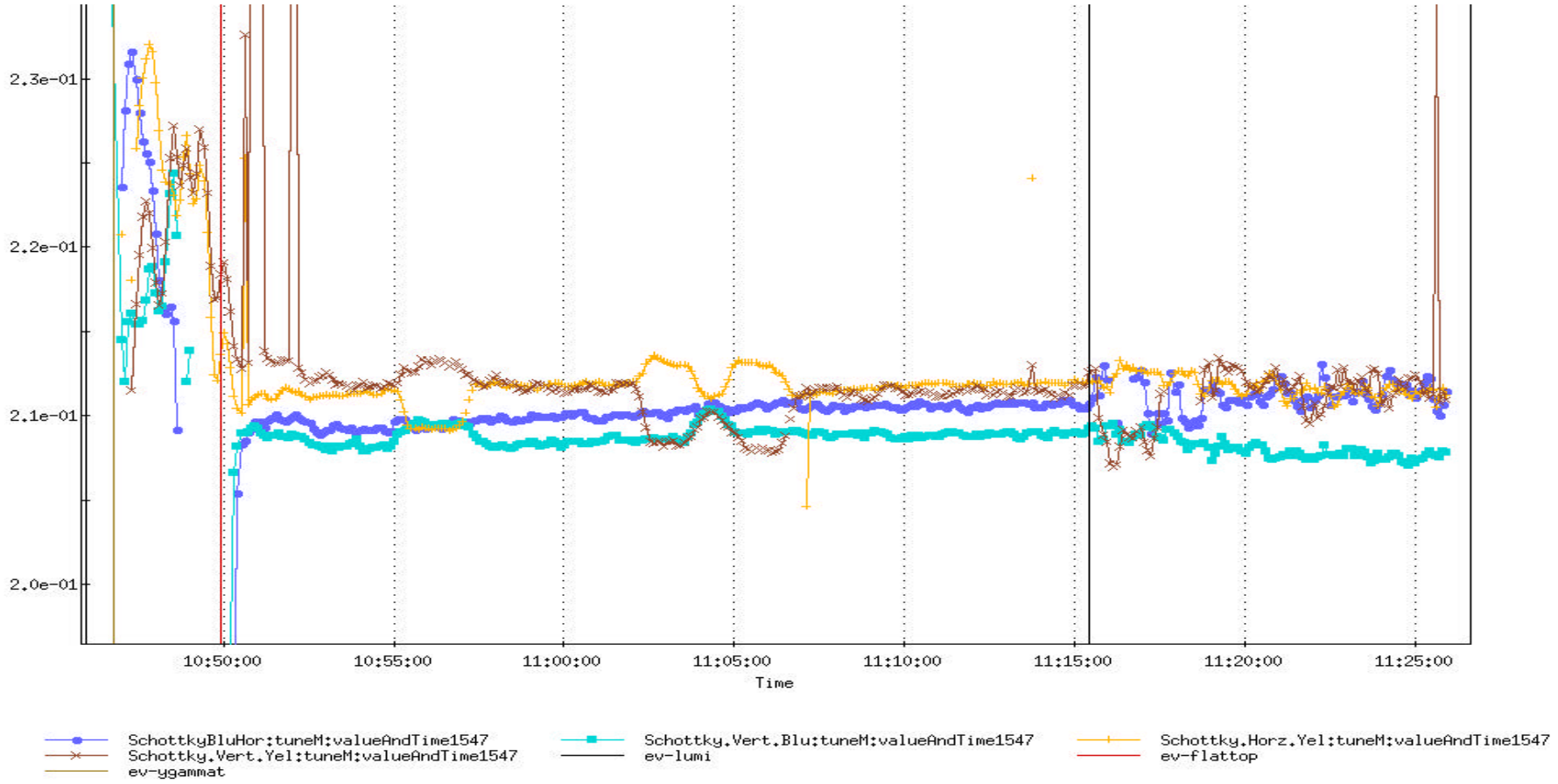
HF Schottky Tune up the Ramp

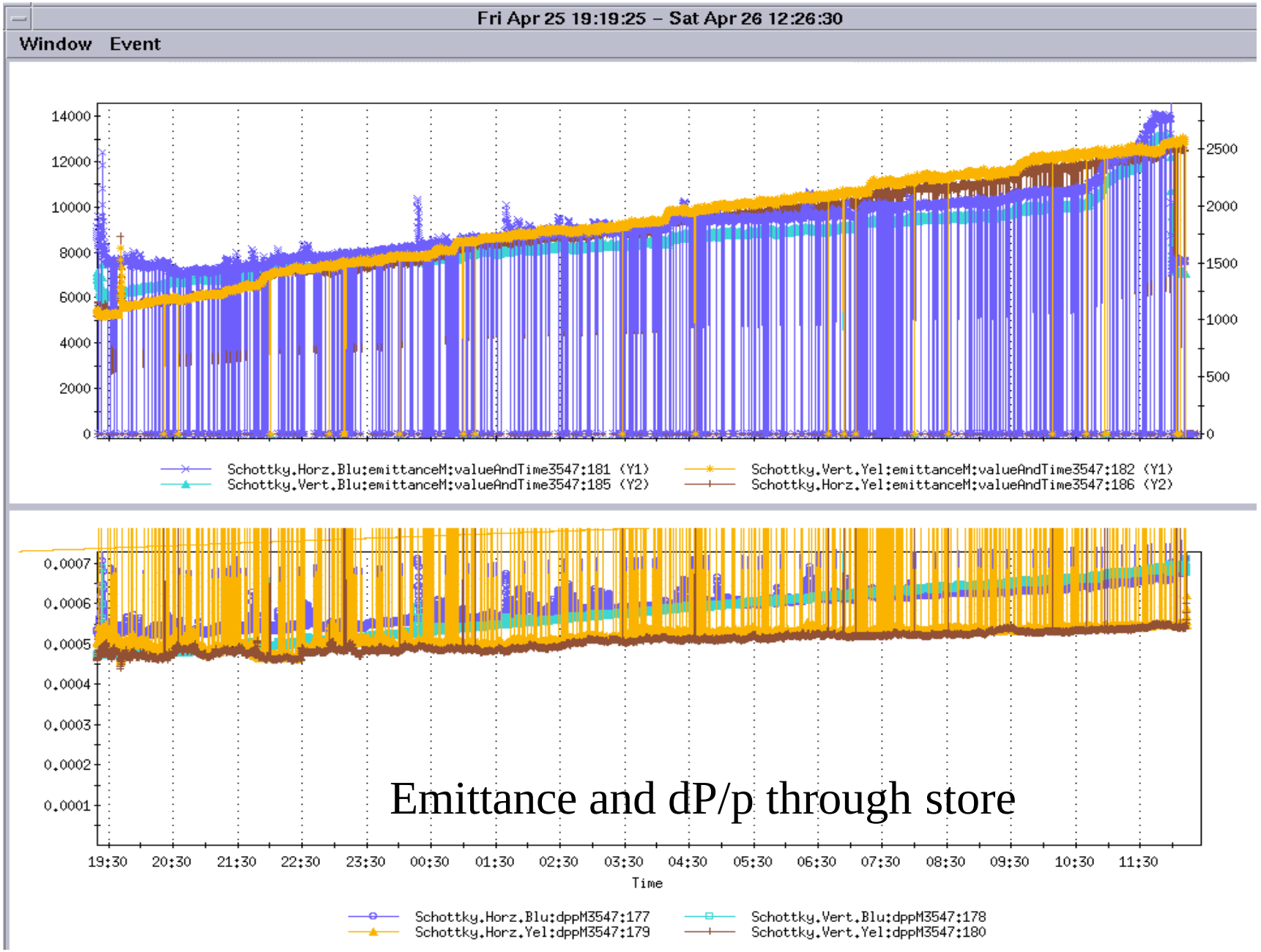
inj transition store



HF Schottky at Store - RHIC 2001

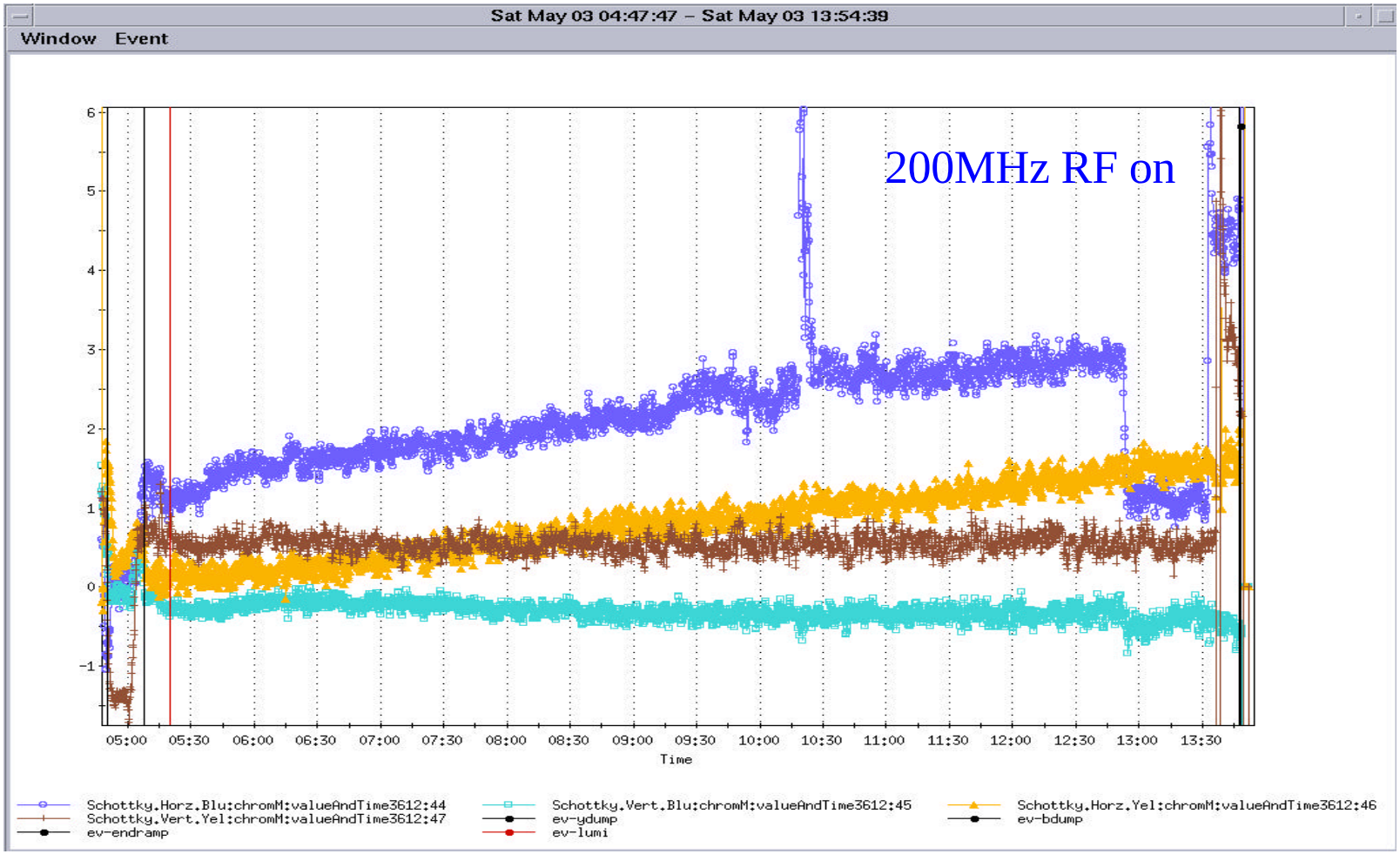
transition Flat top 200MHz on



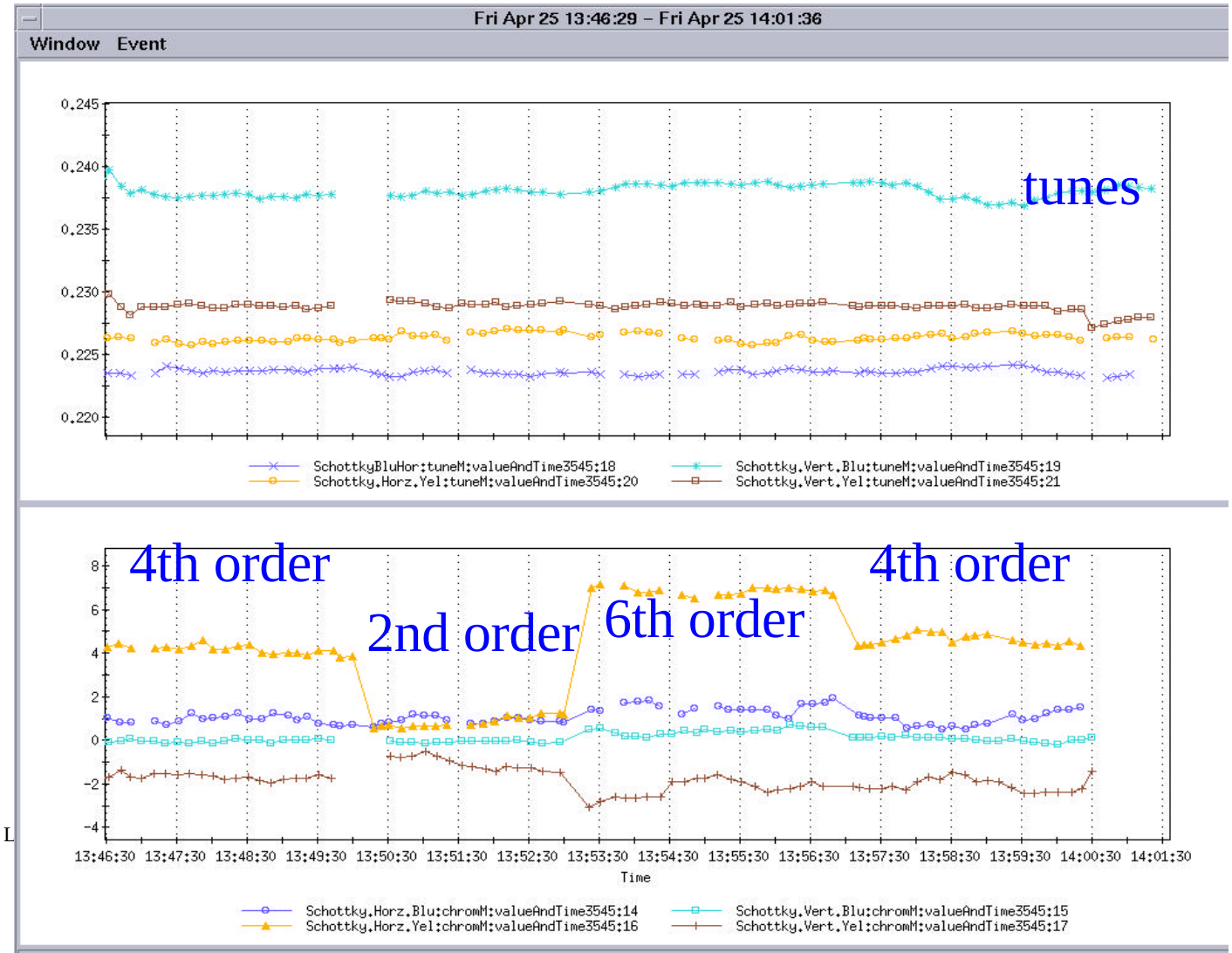


Emittance and dP/p through store

Chromaticity During Store (protons)



Fit Dependence of Chromaticity

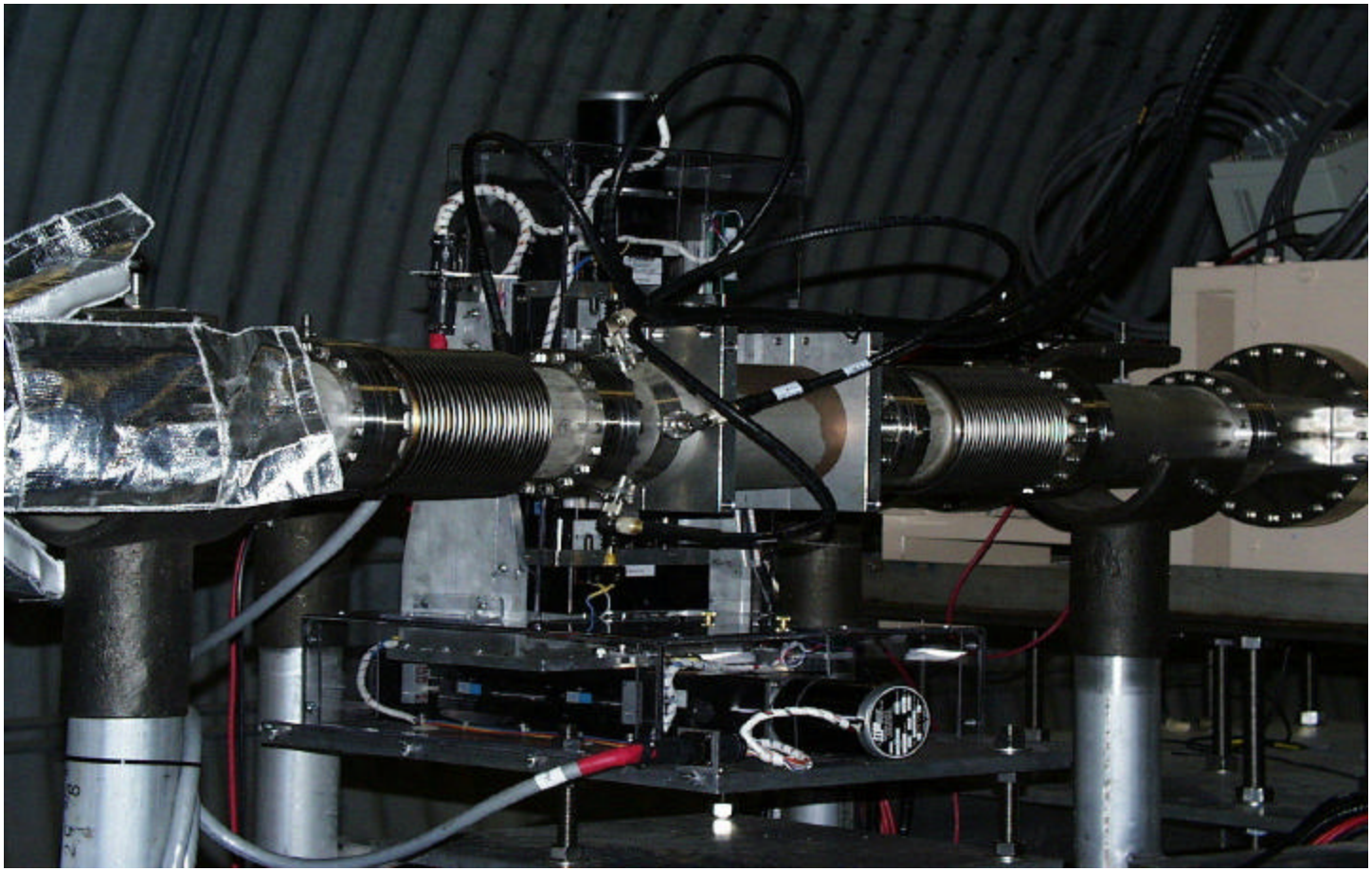


LF Schottky Resonant BPM

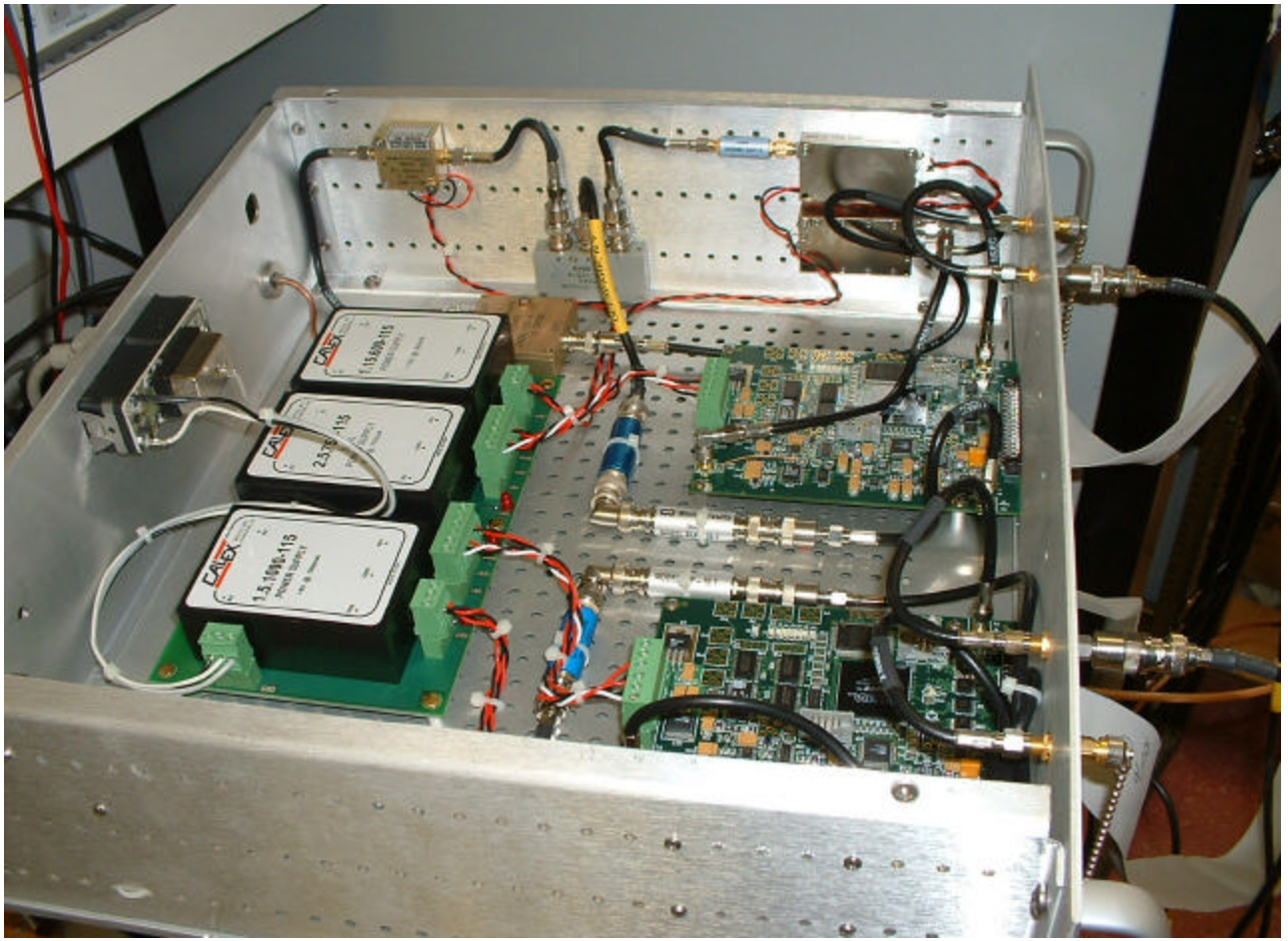
M. Kesselman et al - PAC 2001

- Stub-tuned 1/4 wave resonator
- Frequency ~ 240MHz (8.5xRF)
- Q_{loaded} ~ 100 optimal coupling
- Resonate difference mode
- Moveable - minimize difference mode signal at revolution line
- Resonate above coherent spectrum

Moveable Resonant BPM



Low Frequency Schottky Receiver



LF Schottky at Injection

Span 78KHz

5dB/div

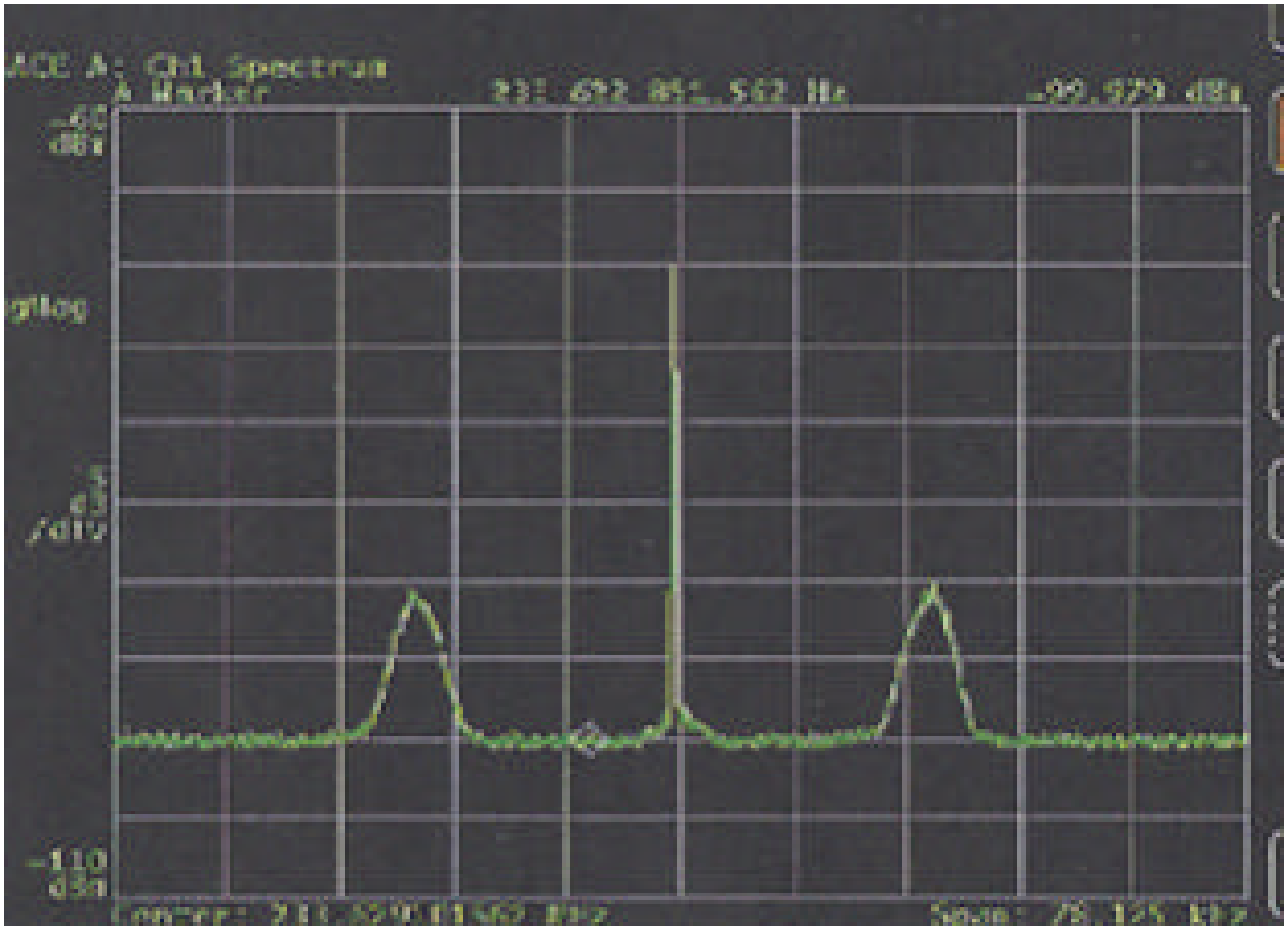
$\delta q = \eta N \delta p/p$

~ 2 KHz

$\eta \sim .007$

$N \sim 3060$

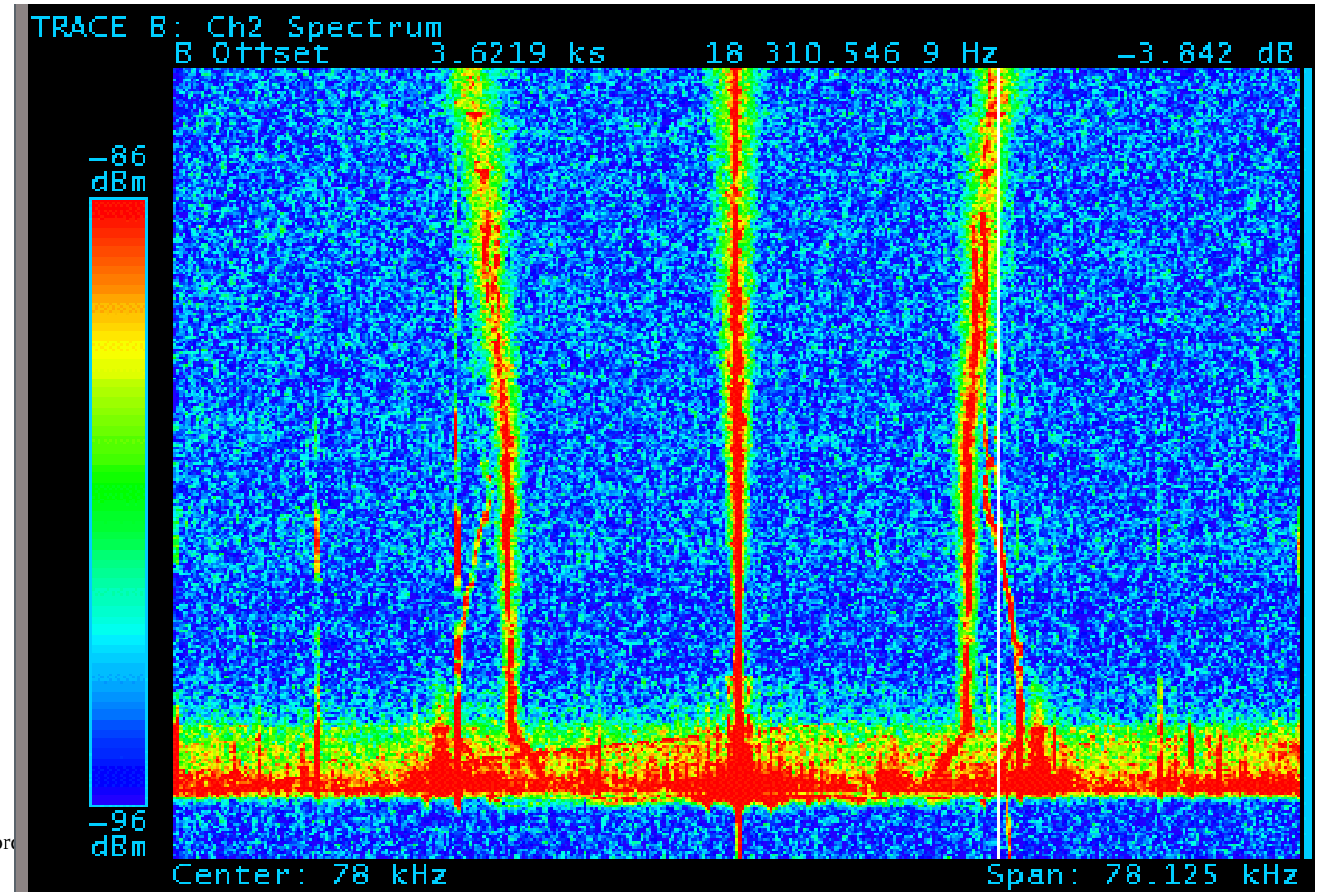
$\delta p/p \sim .001$



LF Schottky on the Ramp (Au, 6-bunches)

Injection

Transition



Conclusions

- Schottky is a useful **parasitic** diagnostic at RHIC for measuring *Tune*, *Chromaticity*, *Emittance*, *Tune Spread*, *momentum spread*
- Schottky can be used as **parasitic** ramp diagnostic tool
- Provides **correlation** with other diagnostic tools (when something is in question with active system, does it show up on Schottky?)
- RHIC provides a "**Live Beam**" developmental **platform**
  - Virtual extension of "Time on Beam", work at partner Lab developing system during shutdown at home Lab
    - **Example:** Head-Tail Monitor. LabView post-processing applications run from CERN

LARP Schottky Collaboration Proposal

- FY04
  - Perform LHC relevant beam studies in parallel with RHIC operations
  - Study and develop system architecture issues common to RHIC and LHC
- FY05
  - Develop optimized hardware of common interest
  - Develop LHC post-processing algorithms
  - Beam Studies