



*Fermilab*



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*LARP LHC 4.8 GHz Schottky  
System Initial commissioning  
with Beam*

*Ralph J. Pasquinelli  
Fermilab*



*Fermilab* **LARP LHC Schottky**



*Tevatron Schottky System  
Operational 2003*

*LHC Schottky System  
Approved by LARP 2004*

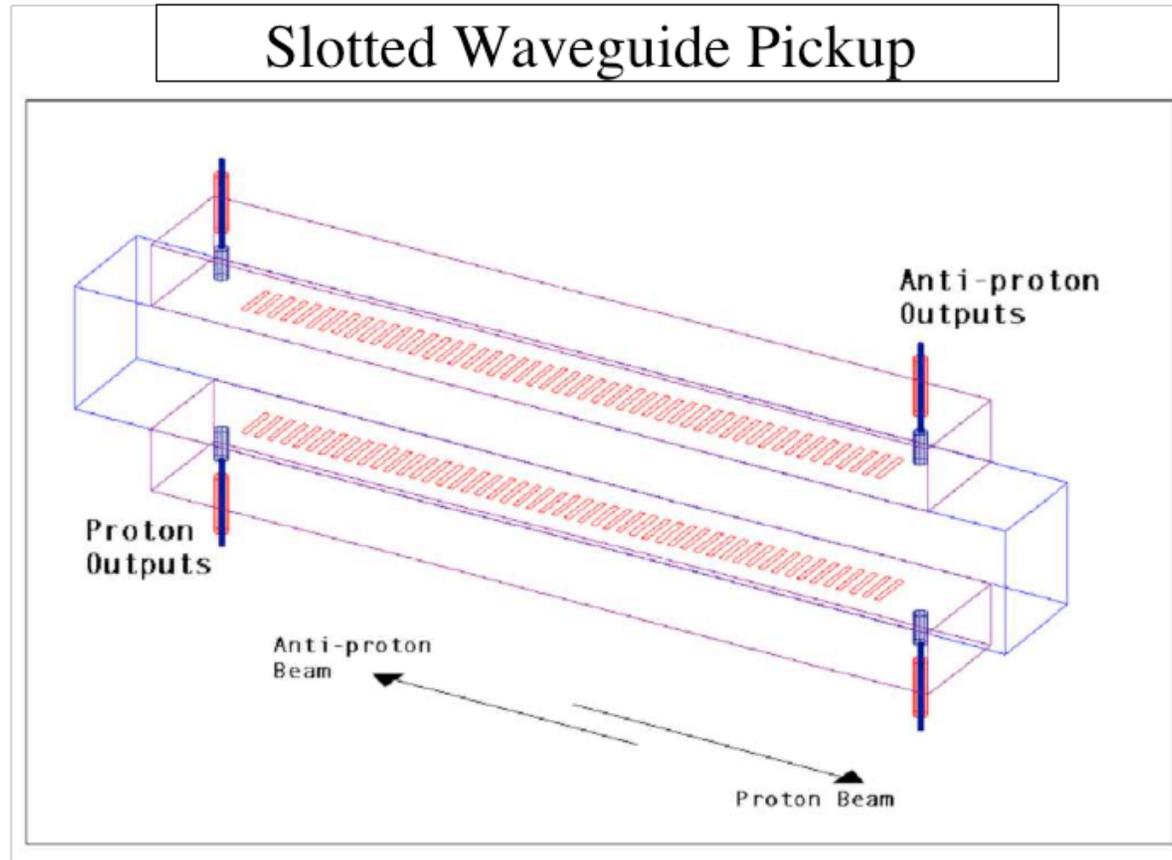
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*Pickup Designed @ Fermilab in 2005*

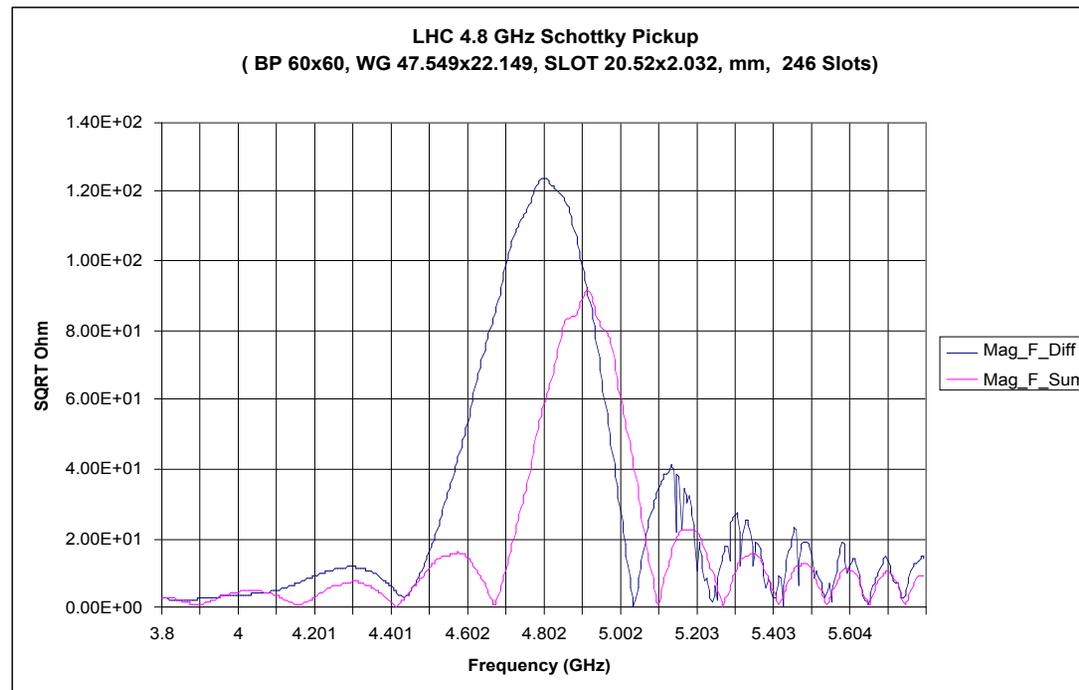
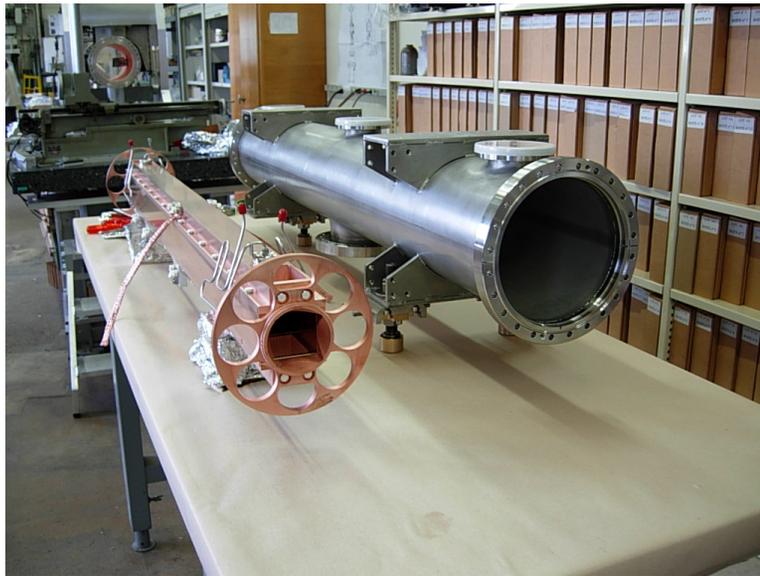


Figure 2. Impedance of LHC Schottky pickup



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*Pickups Fabricated  
at CERN Autumn 2006*



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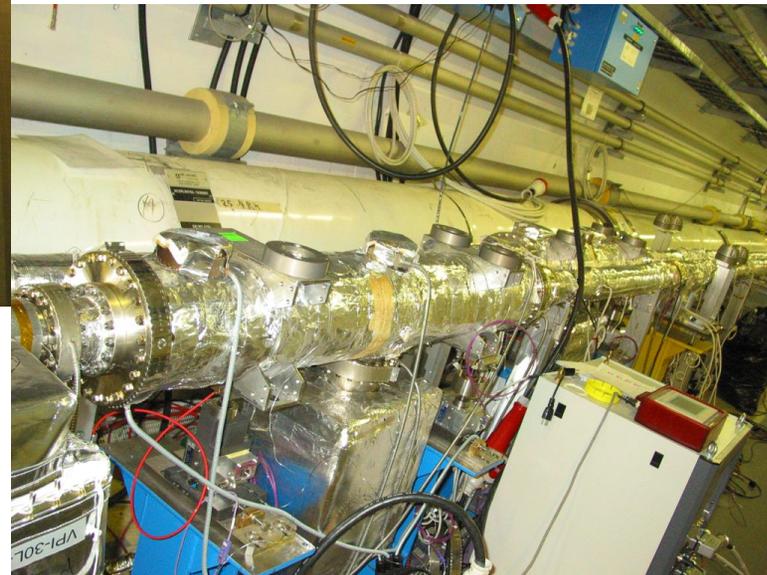
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*Pickup tanks installed  
at LHC Point 4, Spring 2007*



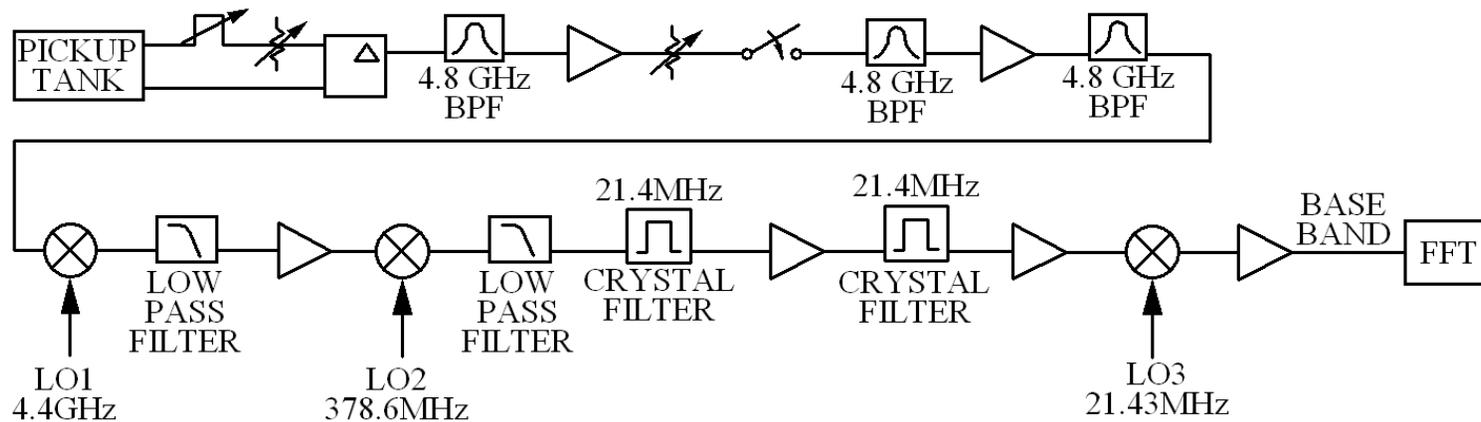
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### LHC Schottky Triple Heterodyne Block Diagram

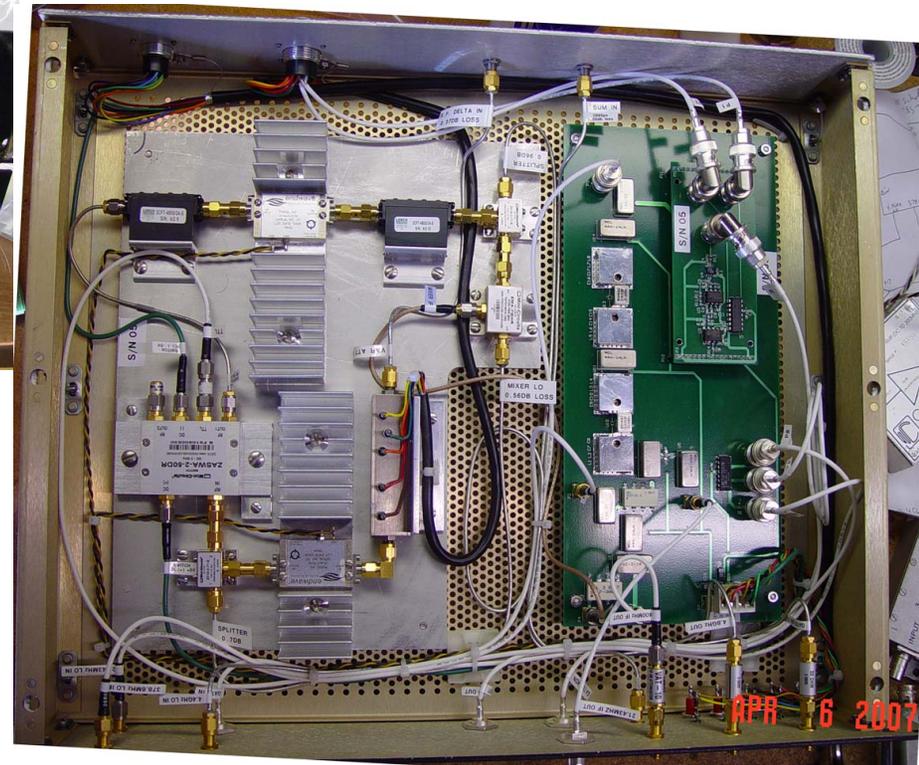
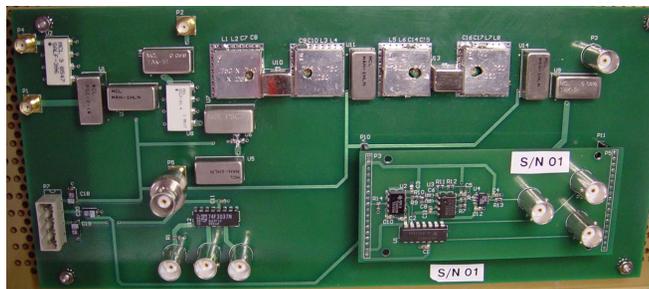




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## Signal Processing Chassis Spring 2007



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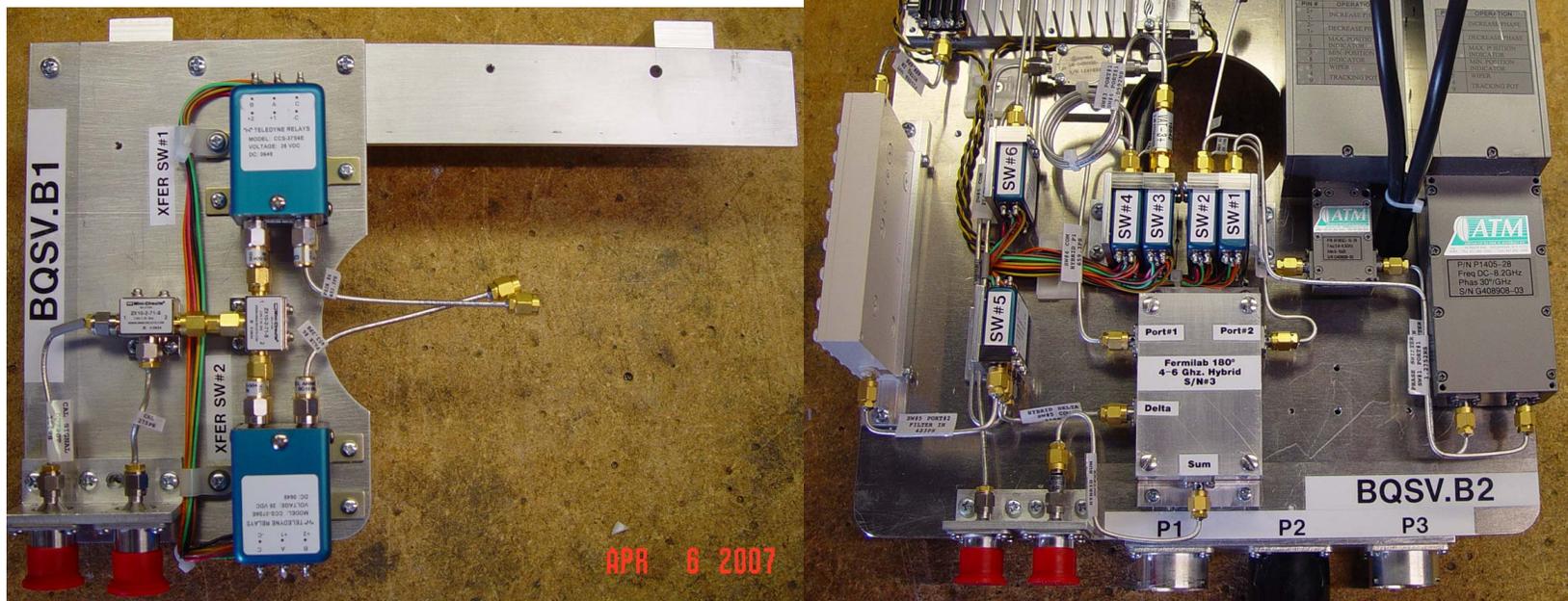
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## Pickup Plate Hardware



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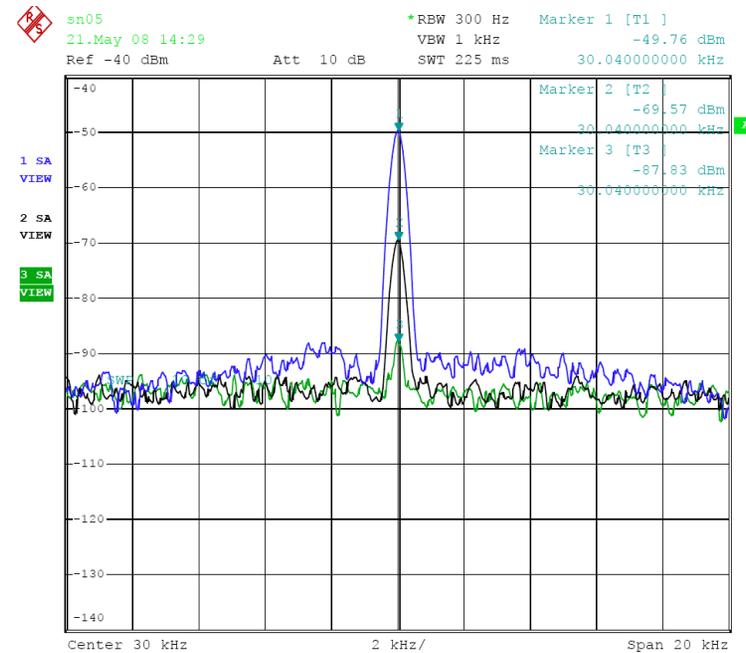
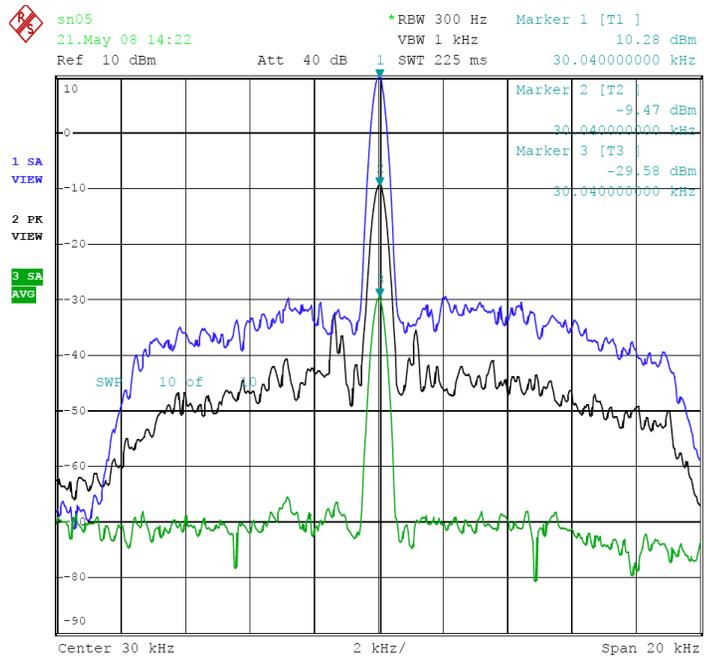
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*Measured 100 dB instantaneous dynamic range in  
Signal processing, +10 dBm to -90 dBm input*



*10 dB per division*

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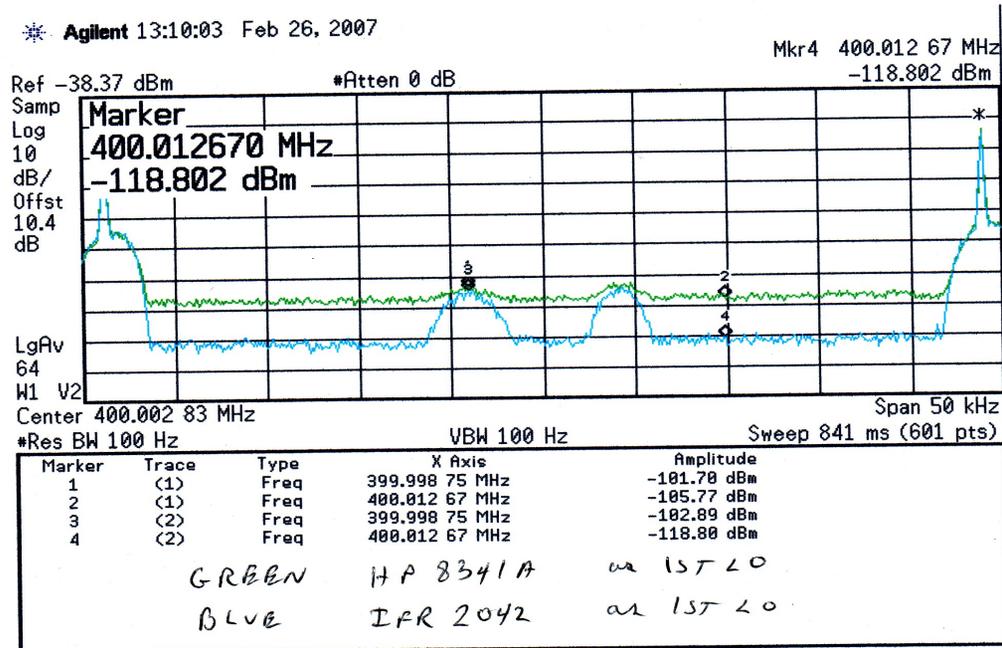
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## Importance of low phase noise in local oscillators



400 MHz IF FRONT PANEL



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*Crated up and on its way to CERN April 2007!*



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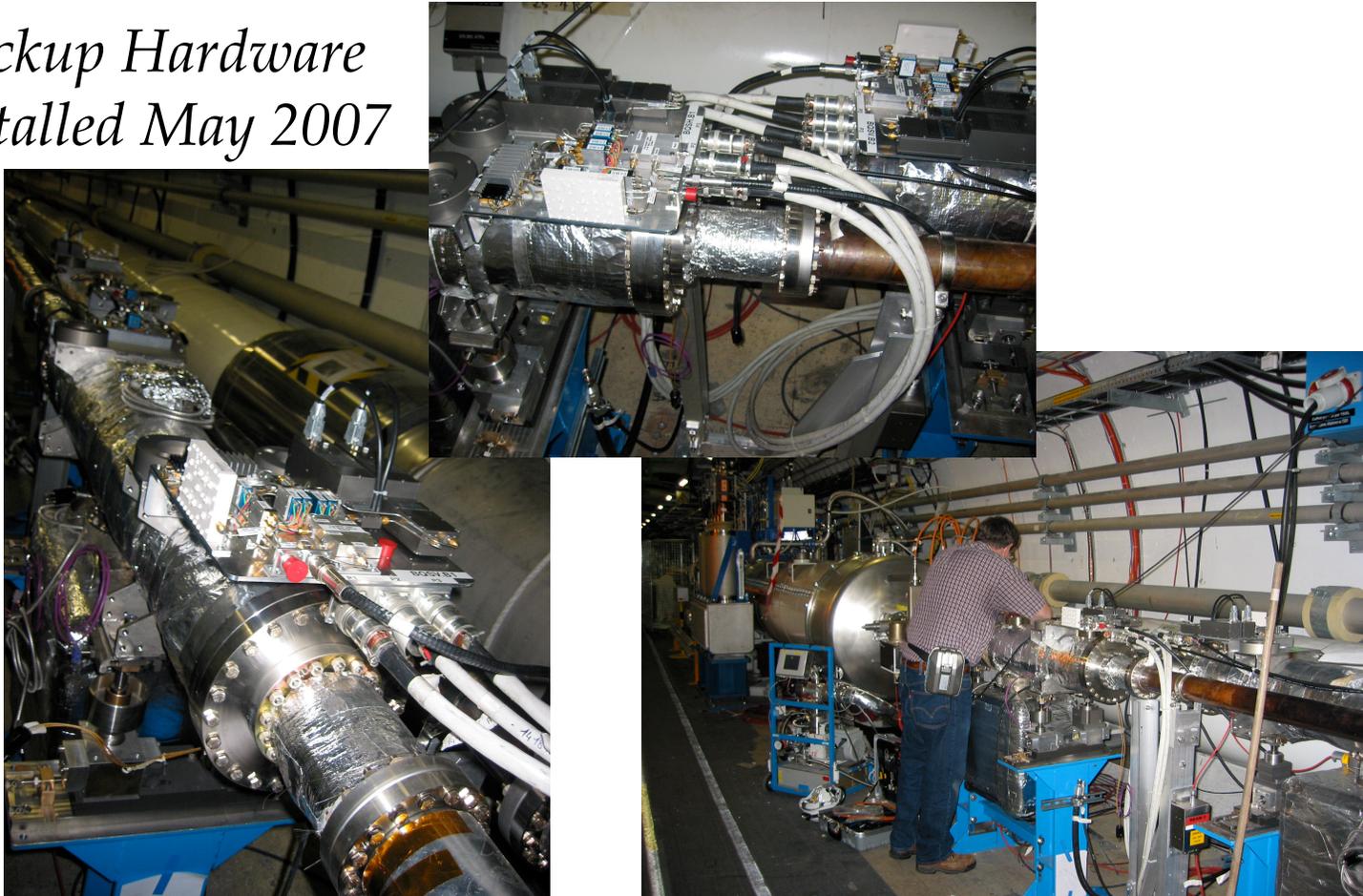
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*Pickup Hardware  
Installed May 2007*



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*Point 4  
Alcove  
Hardware  
May 2007*



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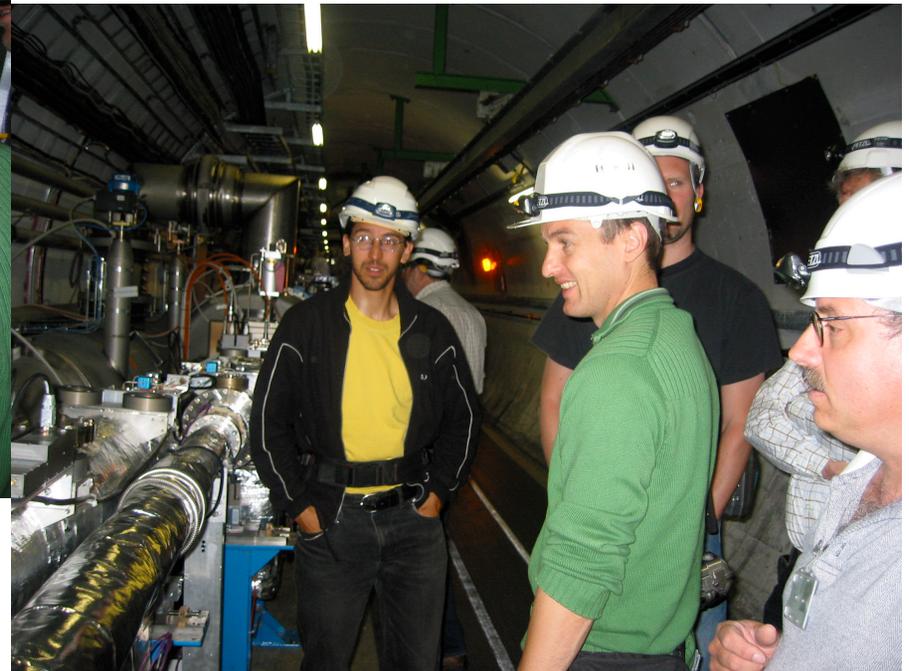
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*Touring Hardware Installation  
May 2007*



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*Installation of controls interface*



*May 2008*

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*Fermilab LARP LHC Schottky*



*Two Beam  
Commissioning Trips  
to  
CERN*

*April 2010  
October 2010*

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# Fermilab LARP LHC Schottky



## Interactive Graphics Control of Hardware

The screenshot displays the Schottky Monitor Application interface. The main window is titled "Schottky Monitor Application" and shows a "Circuit Diagram for Beam ONE, H (READONLY)". The diagram includes components such as switches (SW1-M6), attenuators (Attu), amplifiers (A1, A2), and filters (BPF, LIMITER). The interface also features a "Local Oscillators" section with controls for Output, Frequency, Power, and Reference Oscillators for both 21MHz and 400MHz bands. The status of each oscillator is shown as ON or INT. The interface includes a menu bar with options like "Data Display", "Time Plots", "Circuit Diagram", "Read/Set", "Gates", "Scope", "Tune Diagram", "SYS Setting", "Status", "Logging", and "Fit Info". The status bar at the bottom indicates "09:13:52 - READONLY and AUTO".

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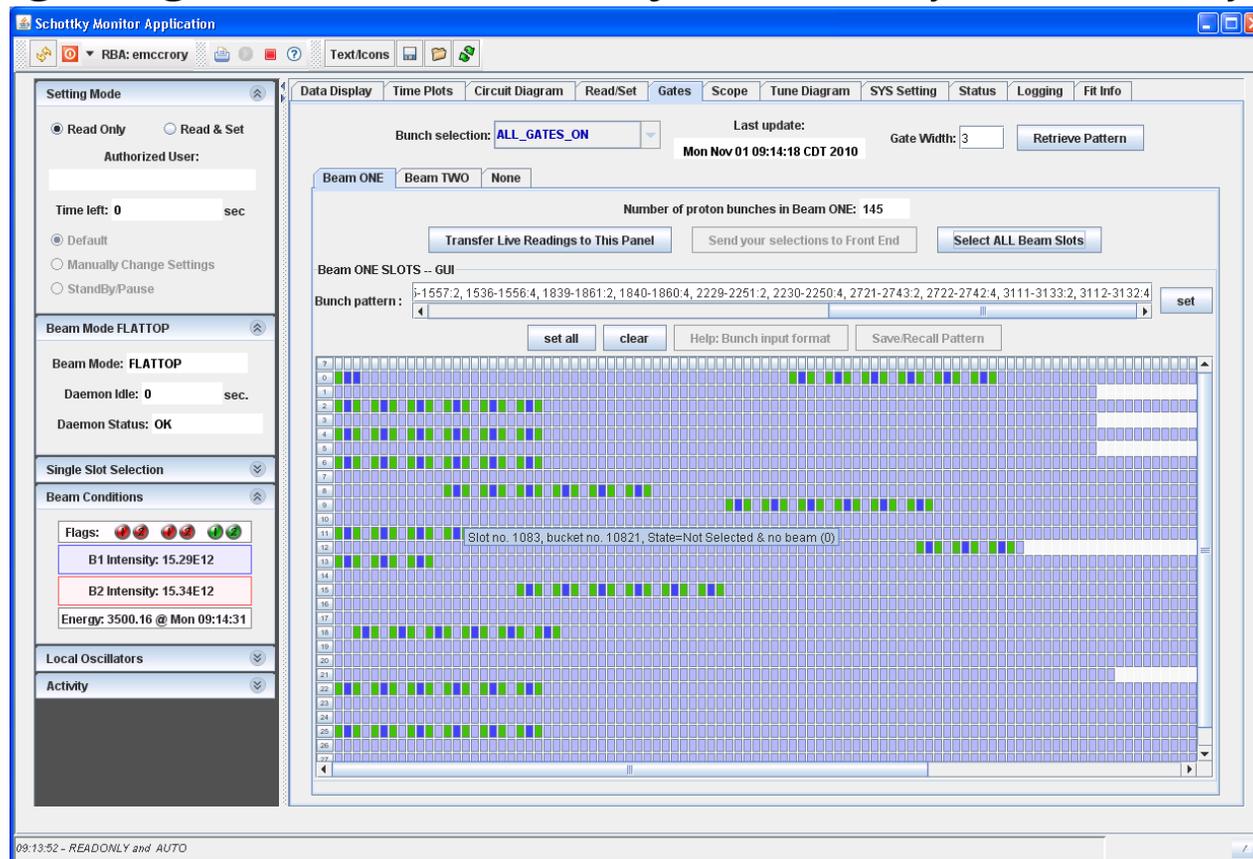
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*Automated gating control allows any number of bunch configurations*



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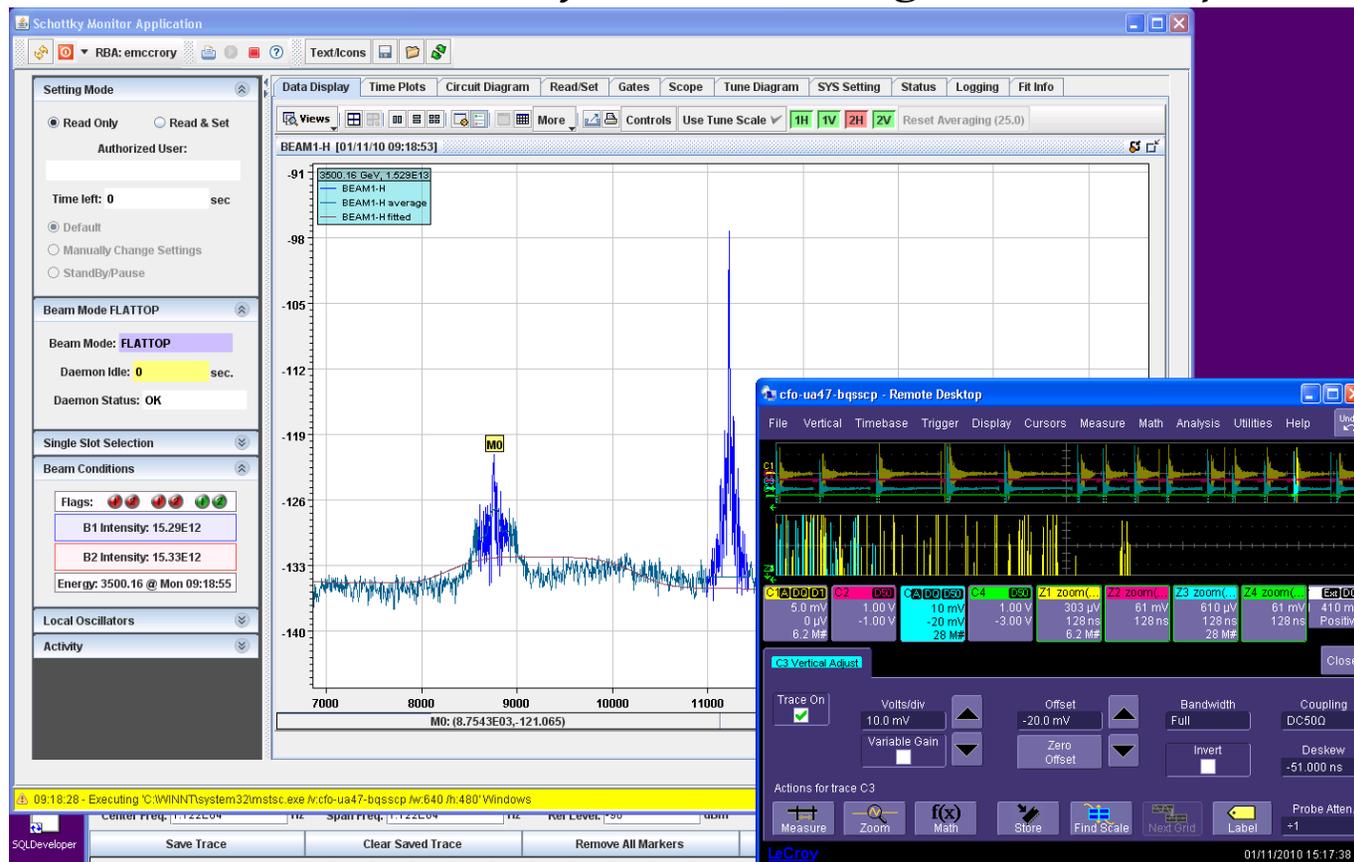
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## Remote Control of Gate Timing Oscilloscope



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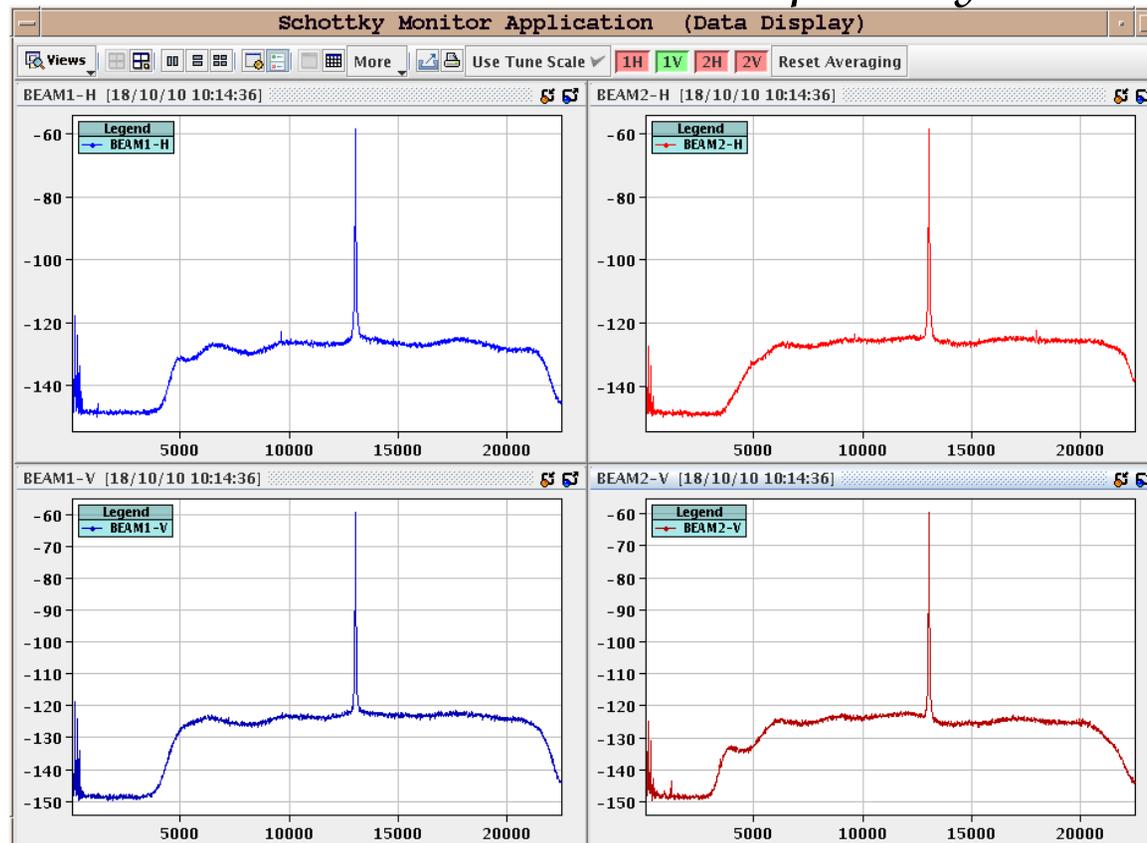
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## Built In Calibration Capability



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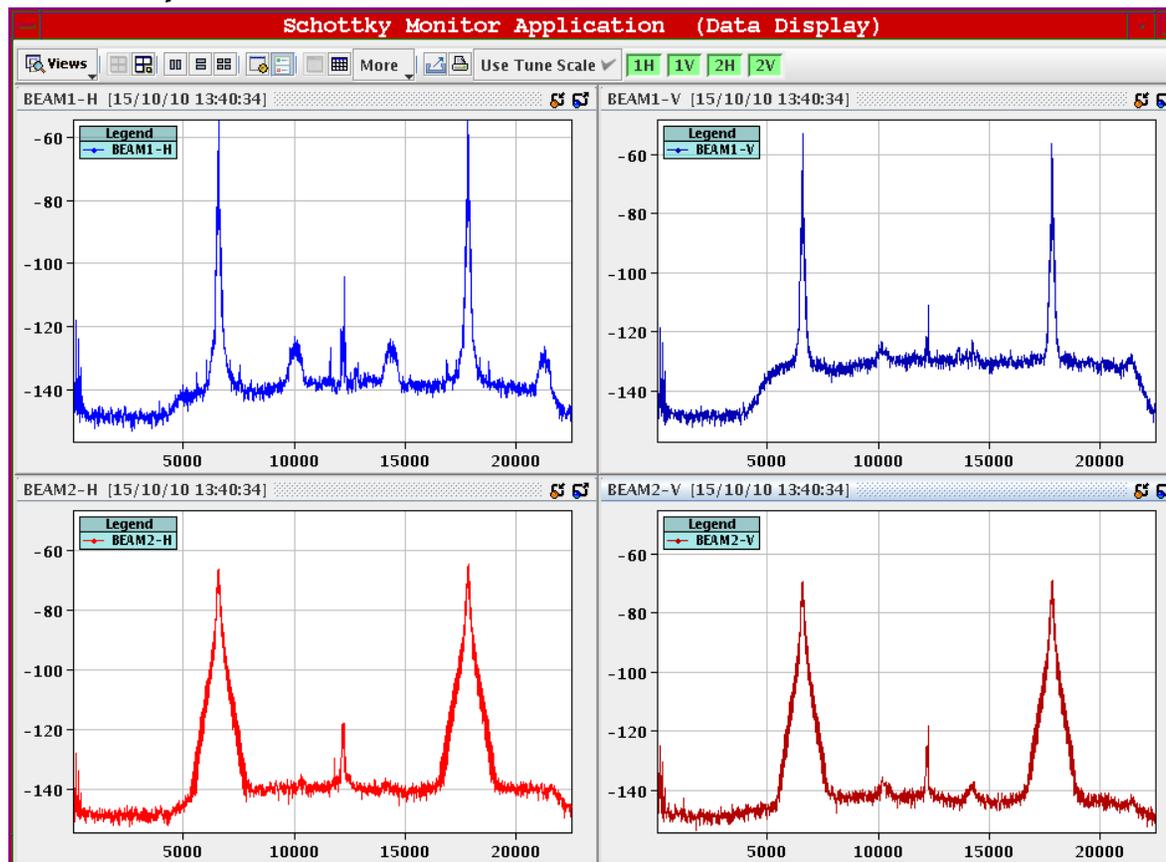
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## *Spectra Reveal Coherent Phenomena*



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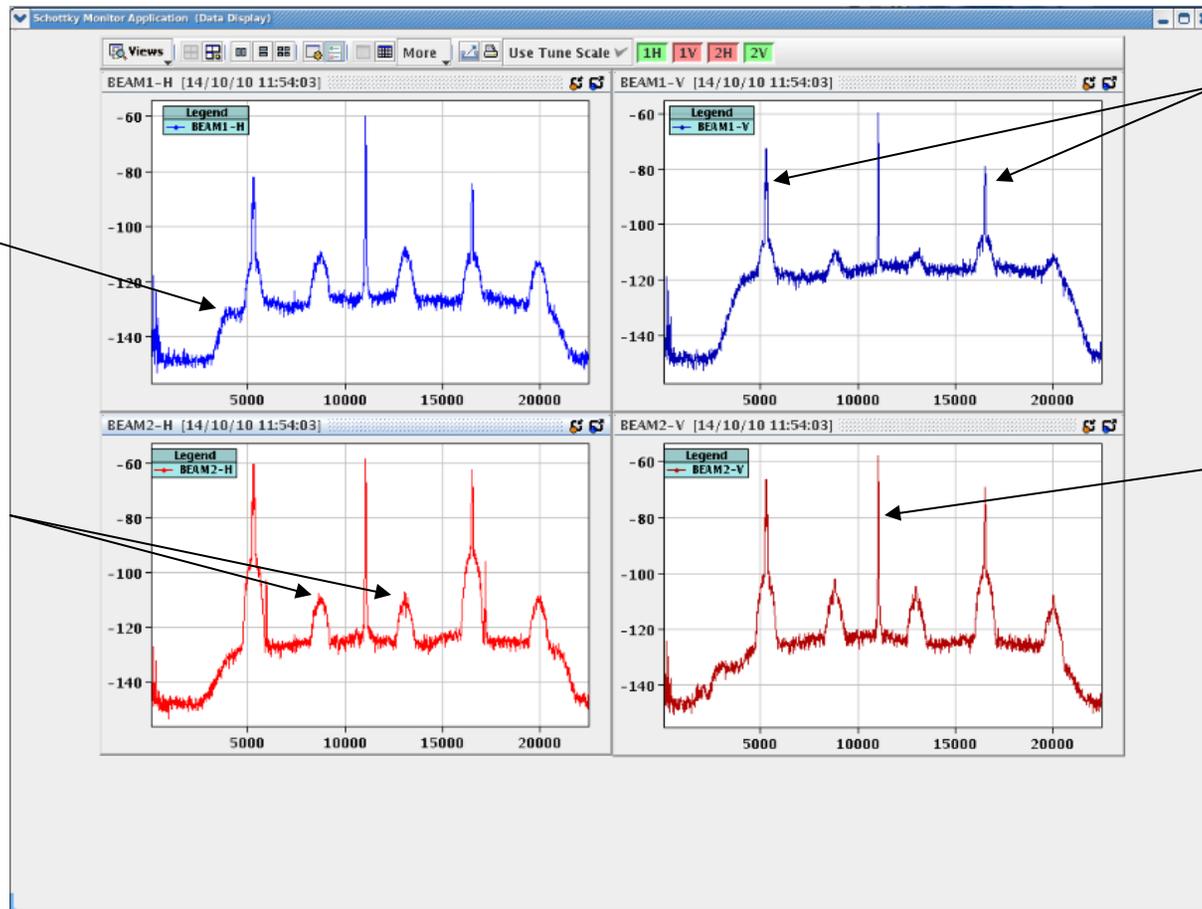


Noise Floor

Tune Sidebands

Revolution Lines

Calibration Signal

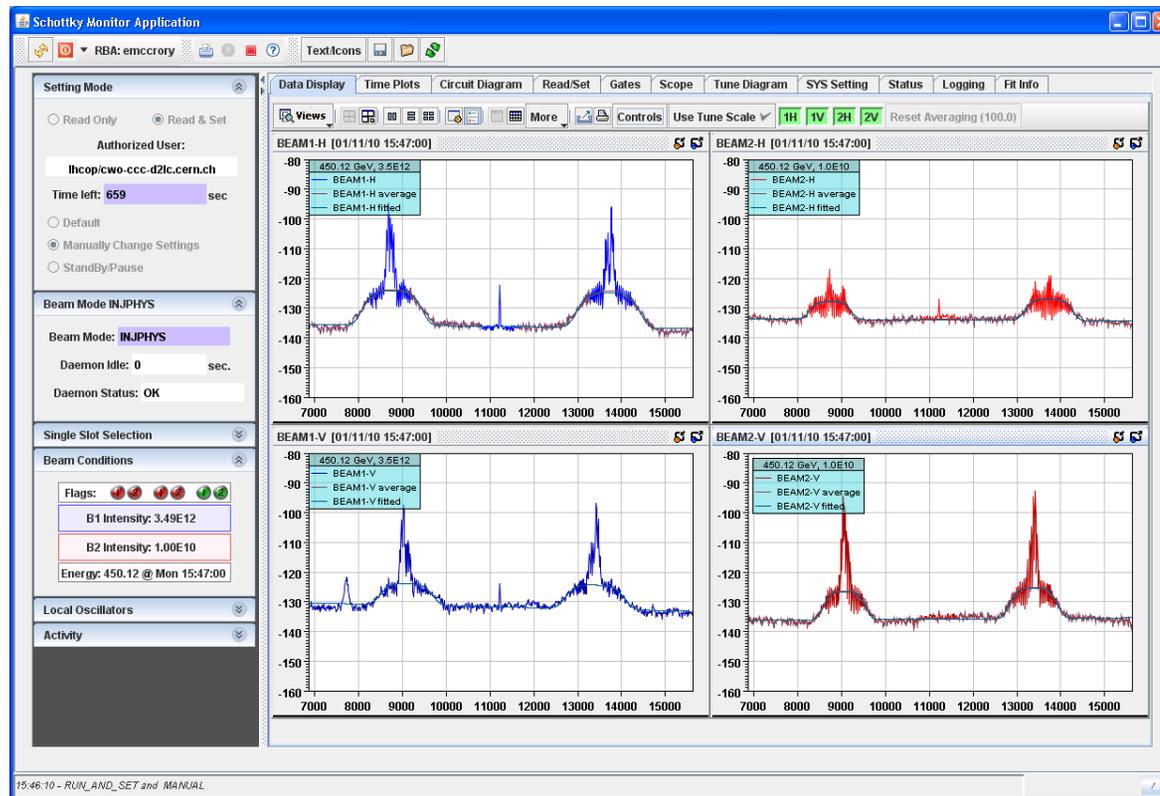




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$3.4 \times 10^{12}$  Protons 450 GeV  
Fit eliminates coherence



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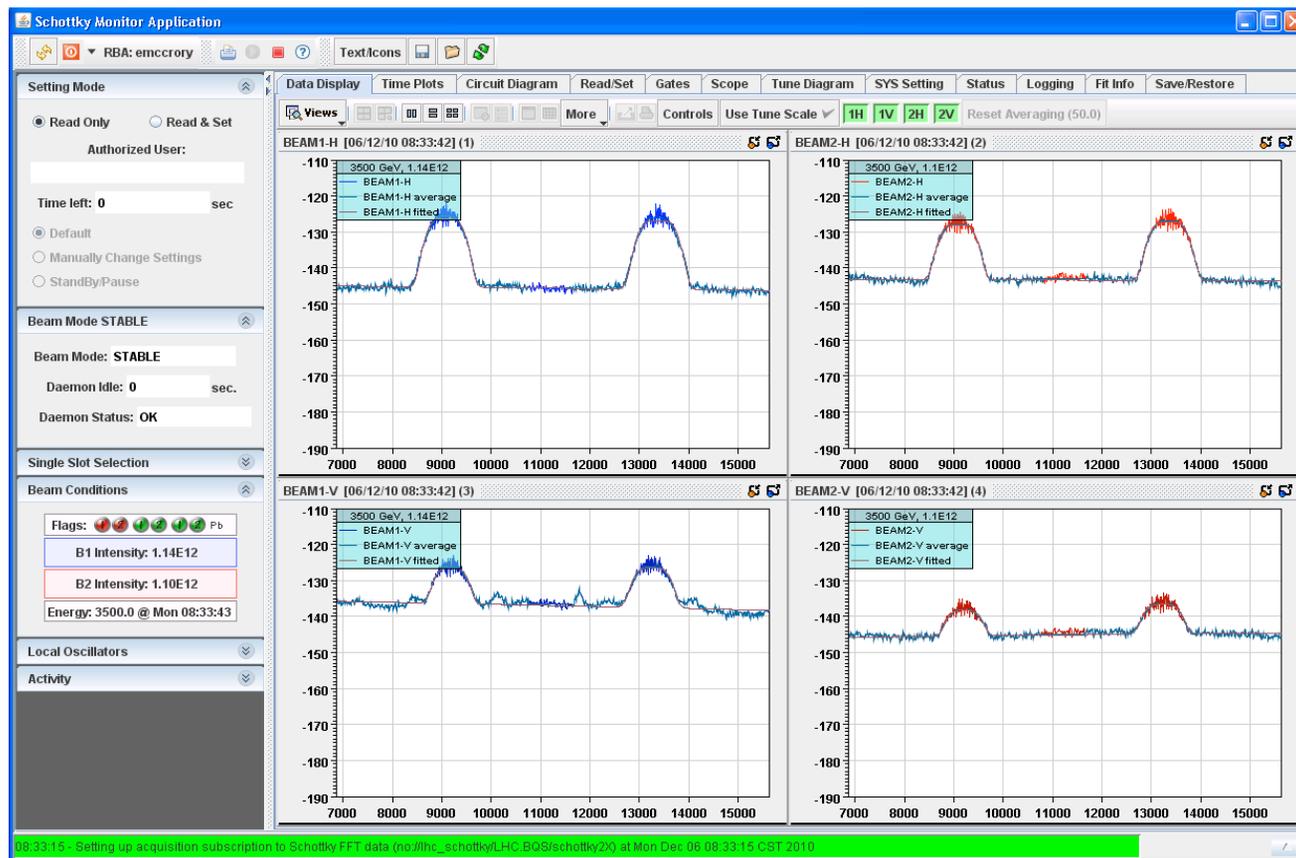
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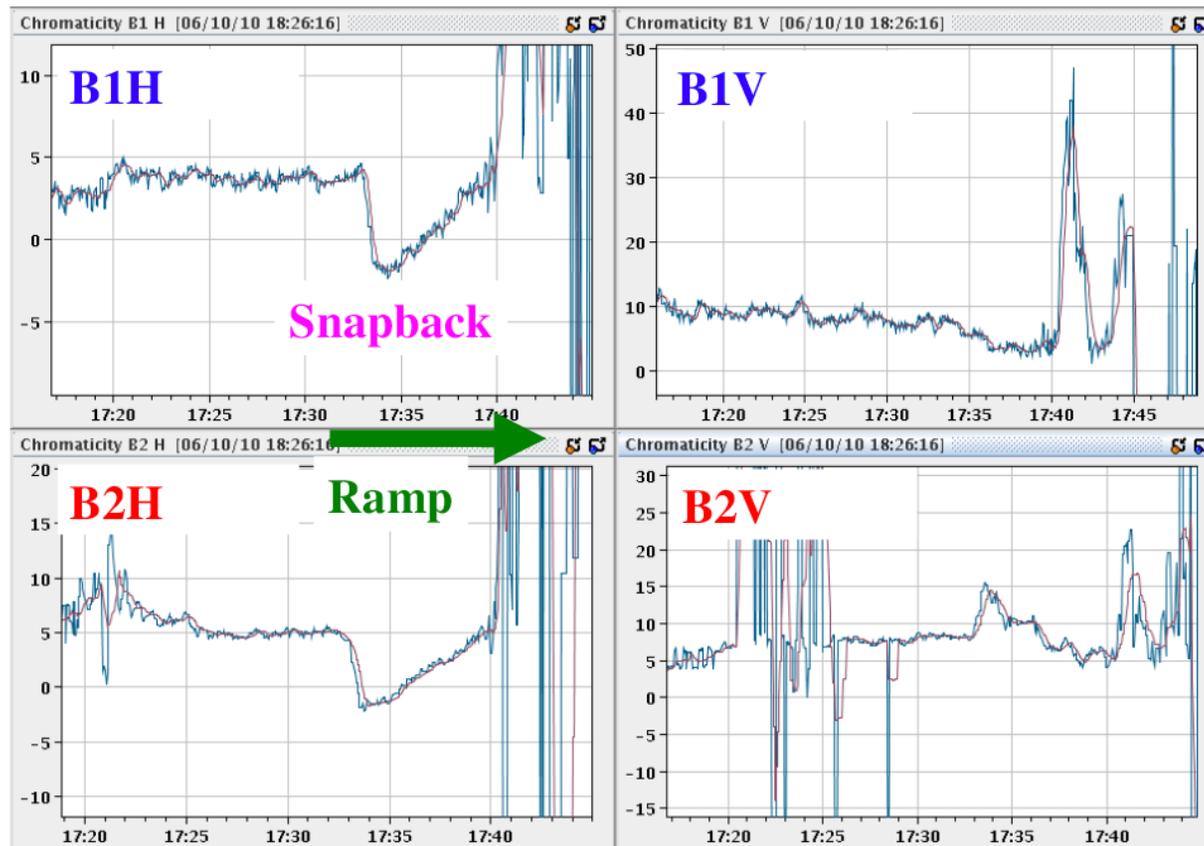


Lead Ions  $1.1 \times 10^{12}$  at 3.5 TeV





## Chromaticity Measurements Protons during Energy Ramp





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## Data Logged Tunes

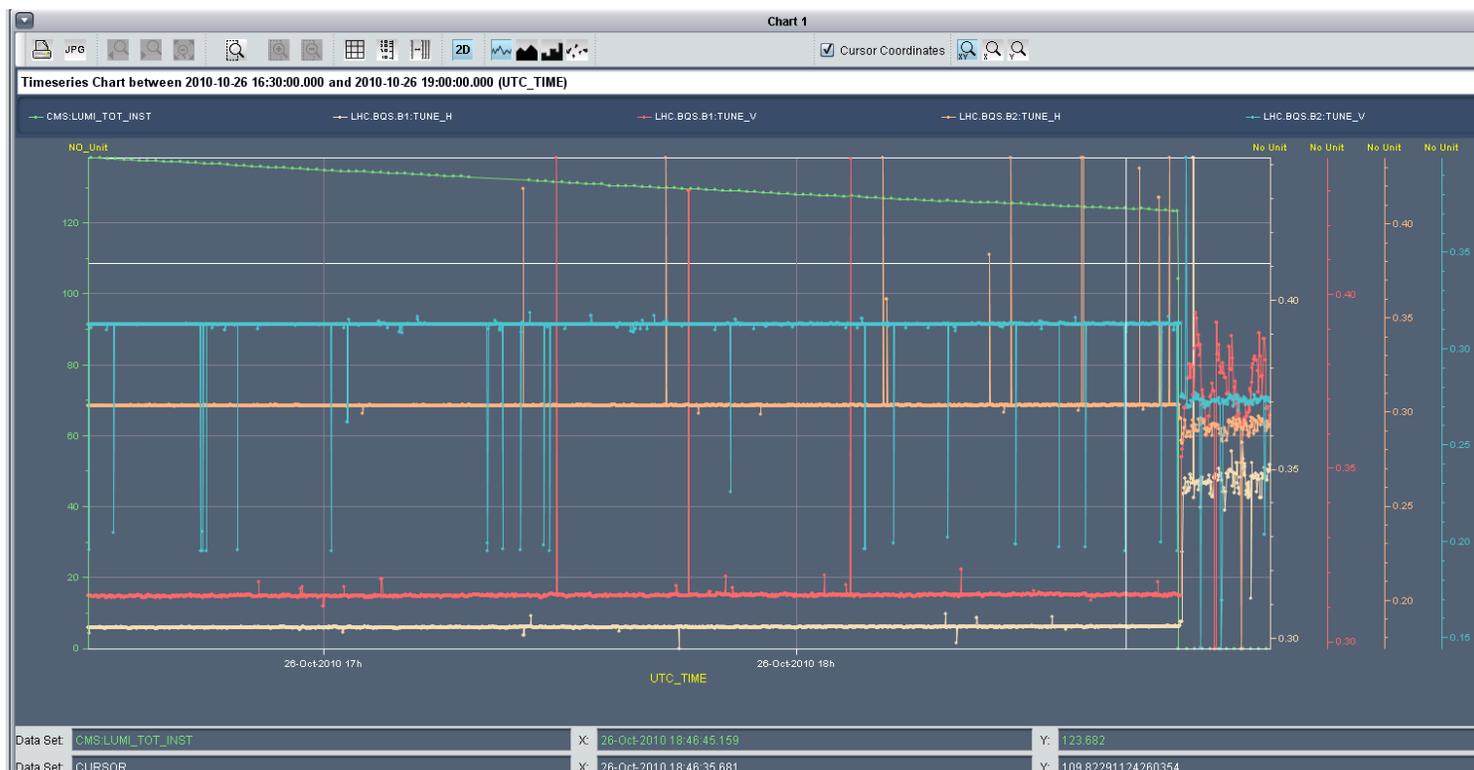
*Luminosity*

*Beam 2V*

*Beam 2H*

*Beam 1V*

*Beam 1H*



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## ■ *Capabilities and Commissioning*

- *Non invasive measurements*
- *Bunch by bunch transverse measurements*
- *Measures single bunch with  $10^{11}$  protons/bunch*
- *Verified tunes track with other tune measurements*
- *Chromaticities and Momentum spread measured*
- *Signal tracking for ramped beam measurements*



*Fermilab LARP LHC Schottky*



*October 2010*



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