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*Proposal for LHC
Microwave Schottky Pickups*

Ralph J. Pasquinelli

4/7/2005



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*LHC Microwave
Schottky Pickups*



■ *Fermilab System Specifications*

- *1.75 GHz center frequency*
- *100 MHz bandwidth*
- *One Horizontal and Vertical tank each for RR and TeV*
- *Single Sideband Down Conversion preserves chromaticity information*
- *Both transverse and longitudinal signals from same pickup*
- *Bi-directional for both protons and pbars from same pickup*
- *Gating (single or multiple bunch) for proton or pbar signals for TeV*
- *Gating for hot or cold pbars in RR*



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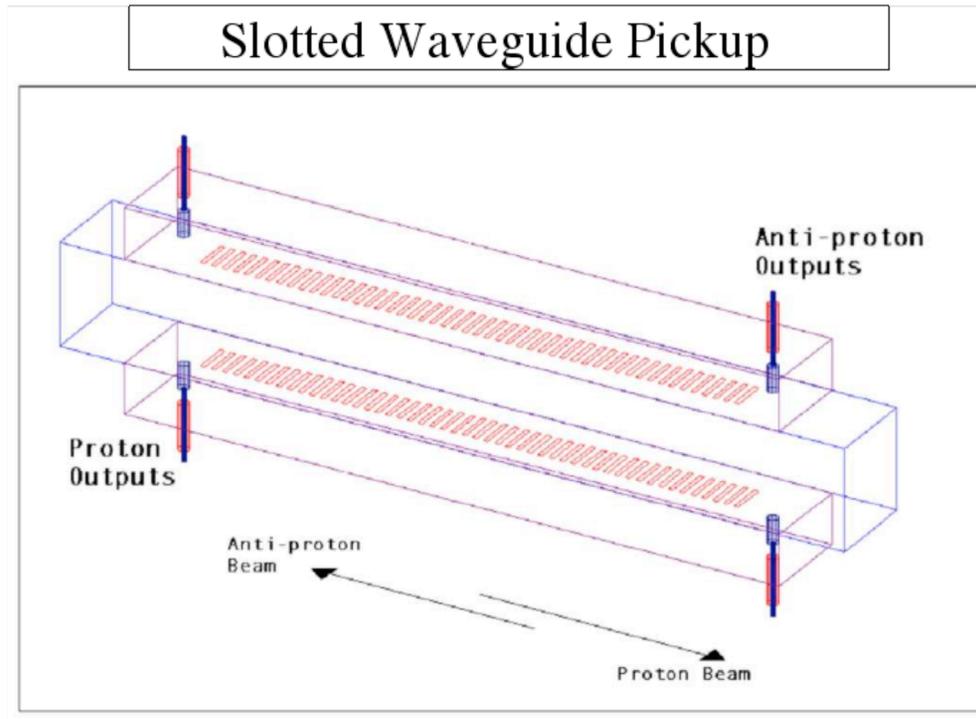
■ *Fermilab System Capabilities*

- *Continuous on line emittance monitor both TeV and RR*
- *Measures momentum spread*
- *Ability to measure individual or multiple bunches in TeV*
- *Ability to measure pbars in presence of protons in TeV*
- *Ability to measure warm and cold pbars in RR*
- *Down conversion utilizing RF source allows monitoring up the TeV Ramp*
- *Single sideband down conversion allows measuring of chromaticity*
- *Tune measurement for the TeV & RR*
- *Built in calibration system to monitor gain variation with time*



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1.7 GHz 109 x 75 mm aperture

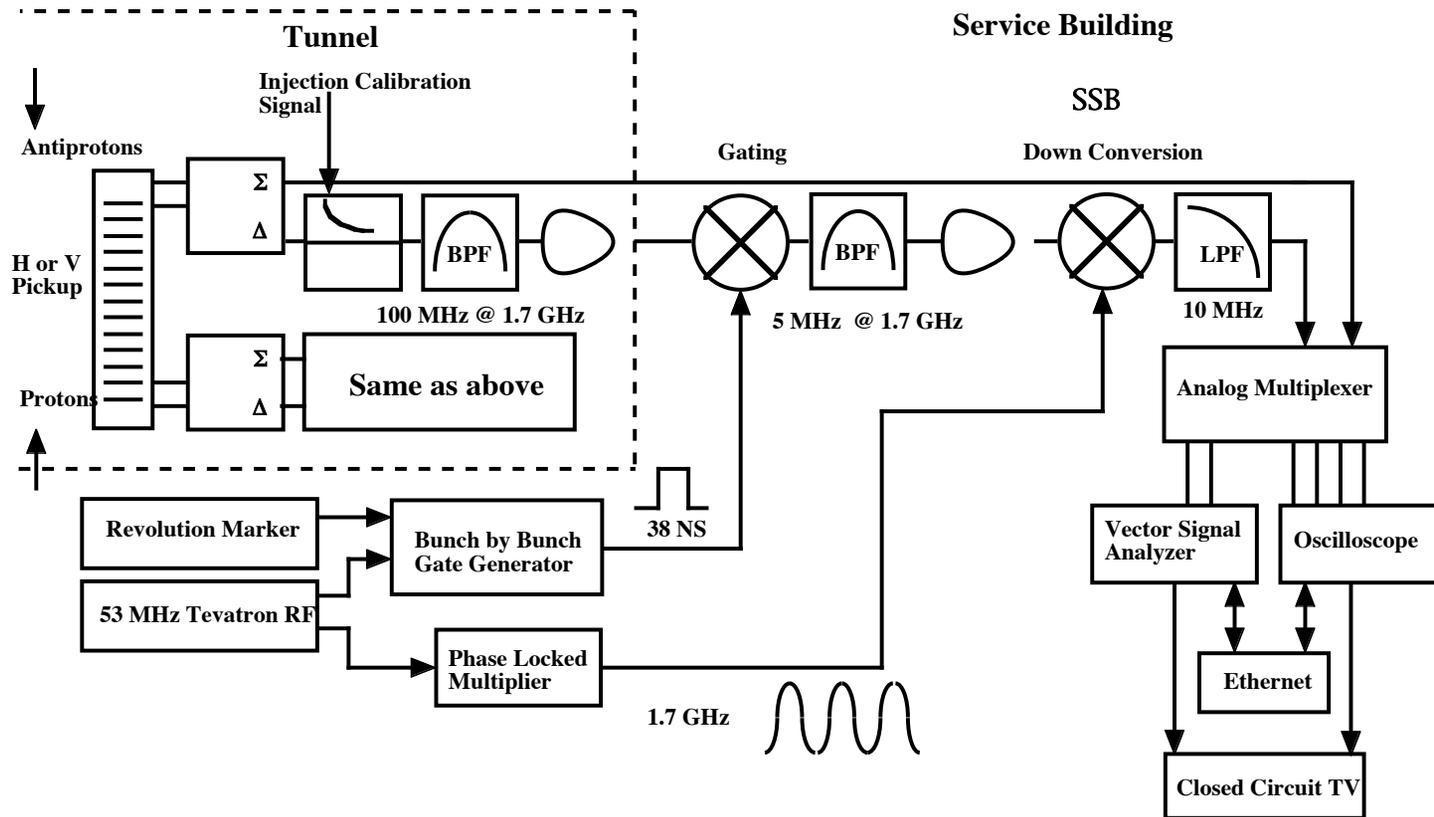


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Tevatron Schottky Signal Processing



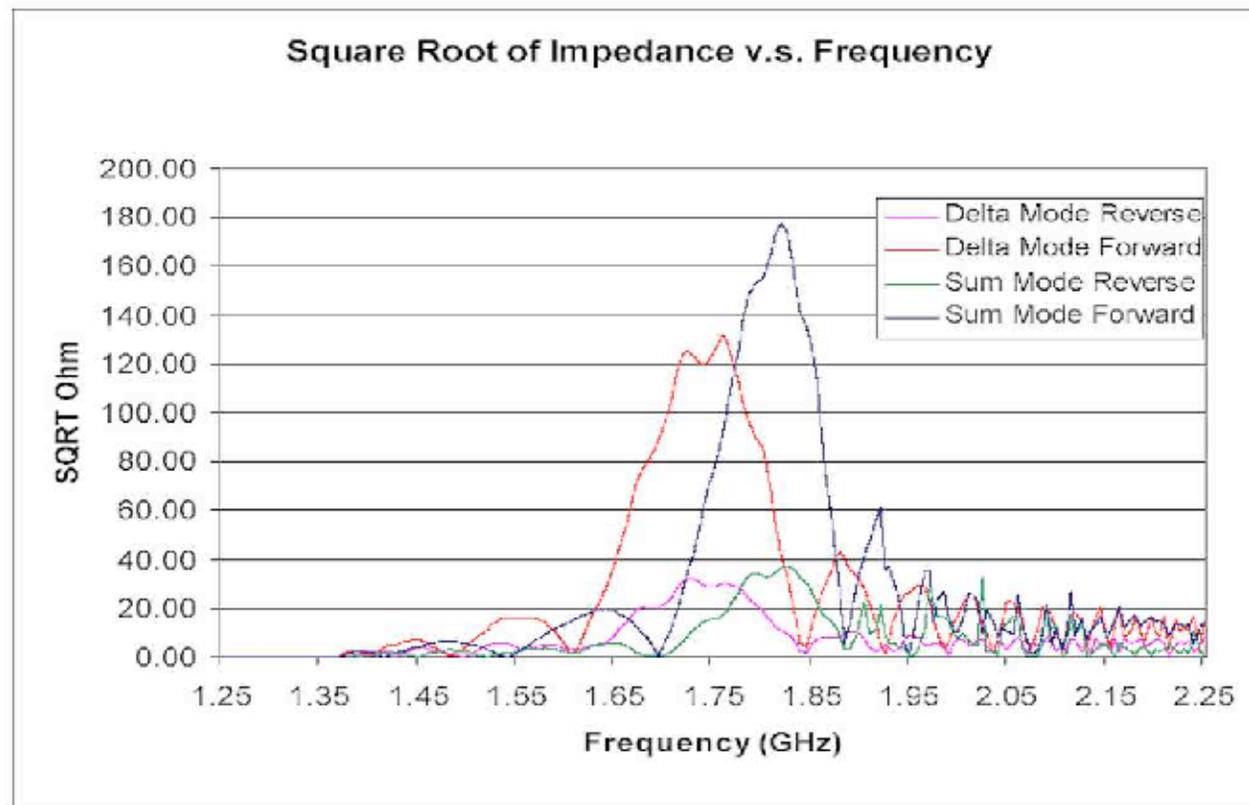


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Schottky Pickup Frequency Response



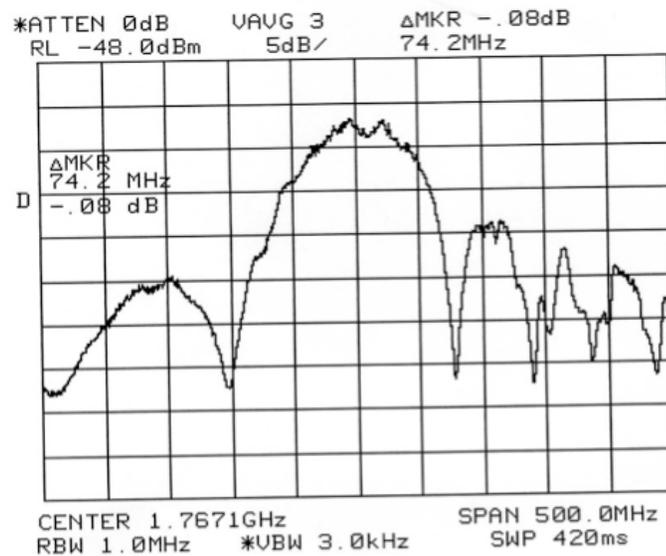


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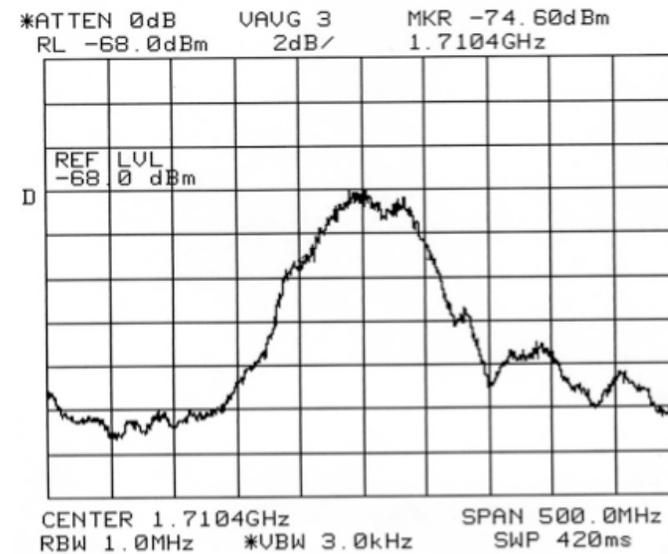
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Measured Pickup Sensitivity in Recycler



Sum Mode



Difference Mode

Directivity Measured at 12-15 dB

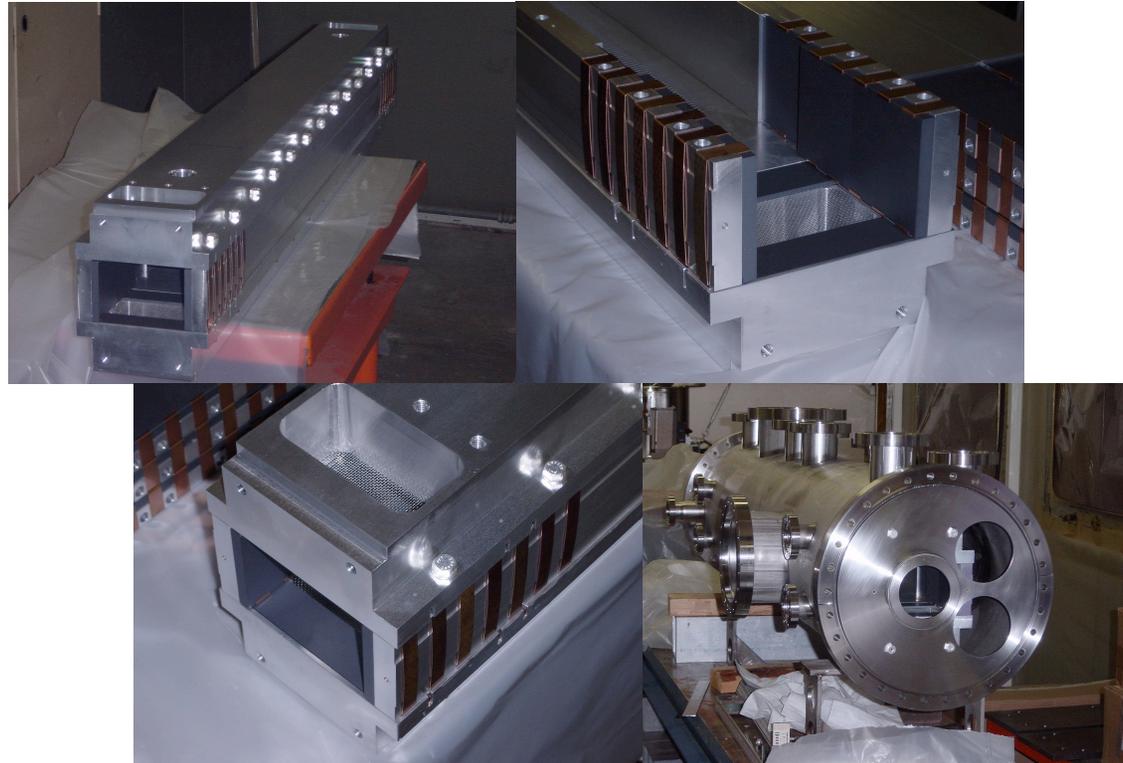


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Array Assembly



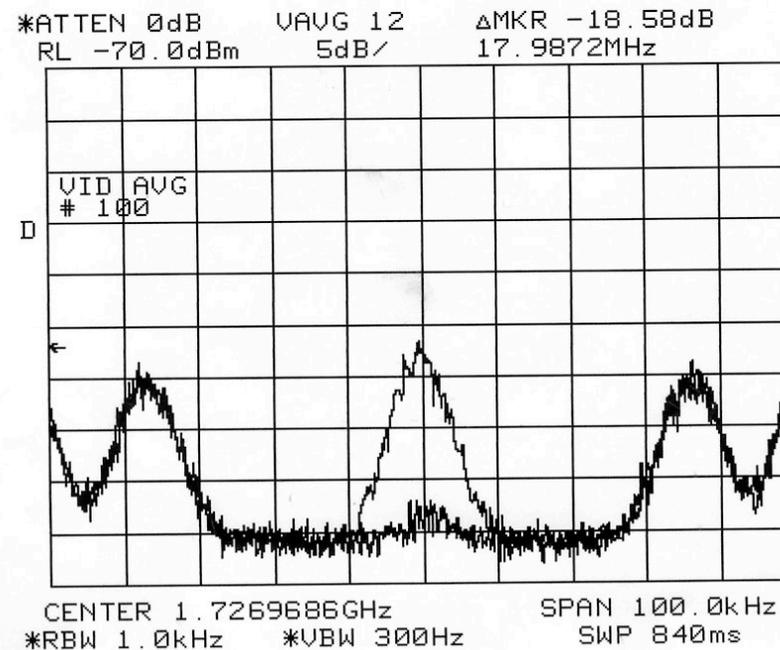


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Beam Centering Reduces Common Mode



Recycler Horizontal Pickup 1×10^{11} Protons

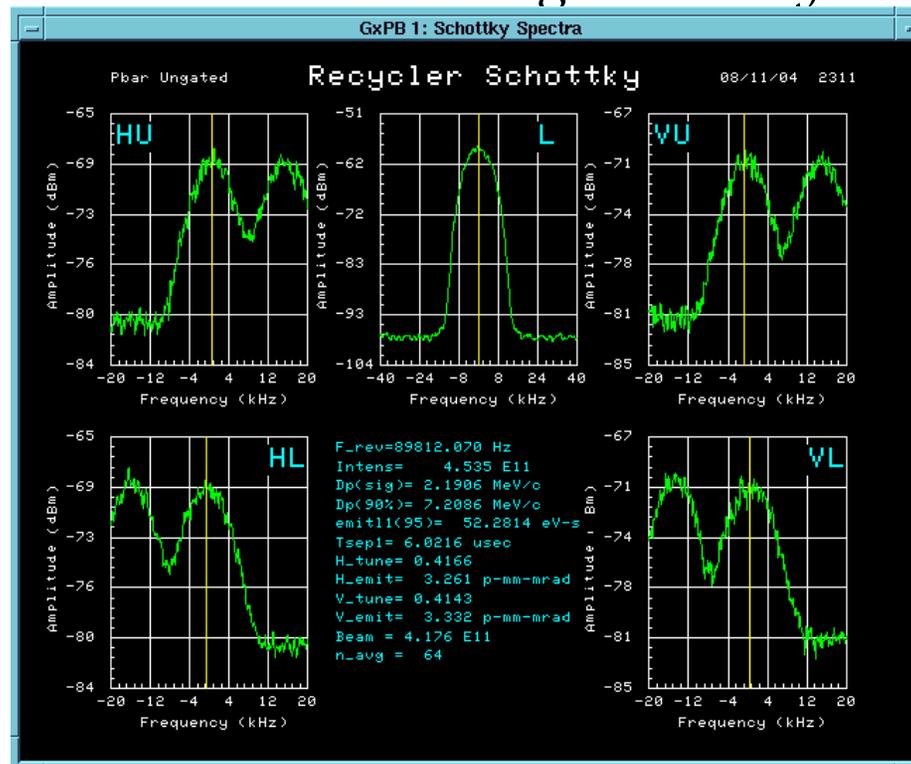


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Recycler Automated Vector Signal Analyzer Program



Provides momentum spread, tune, revolution frequency, calculated emittance.

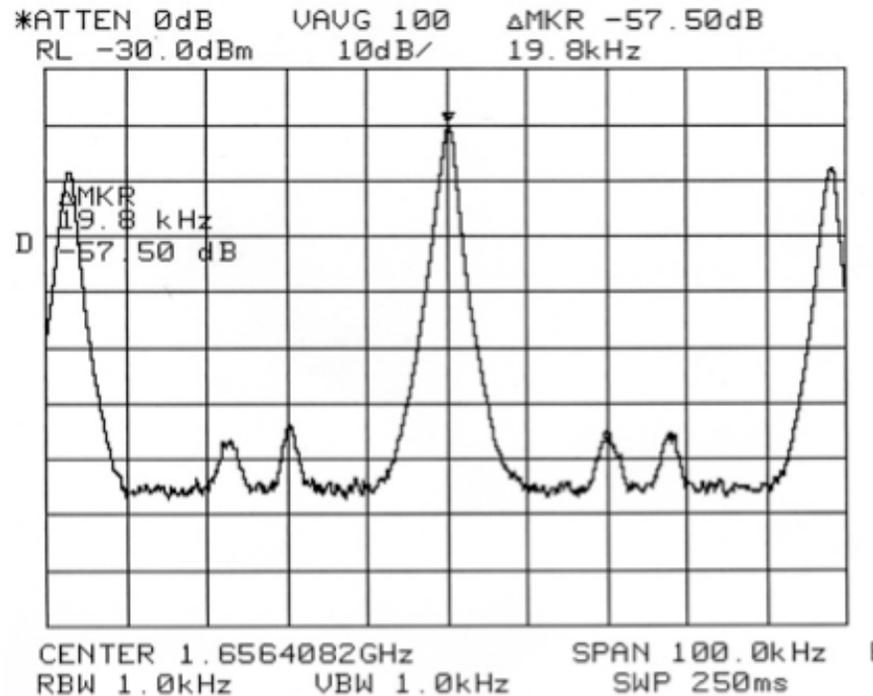


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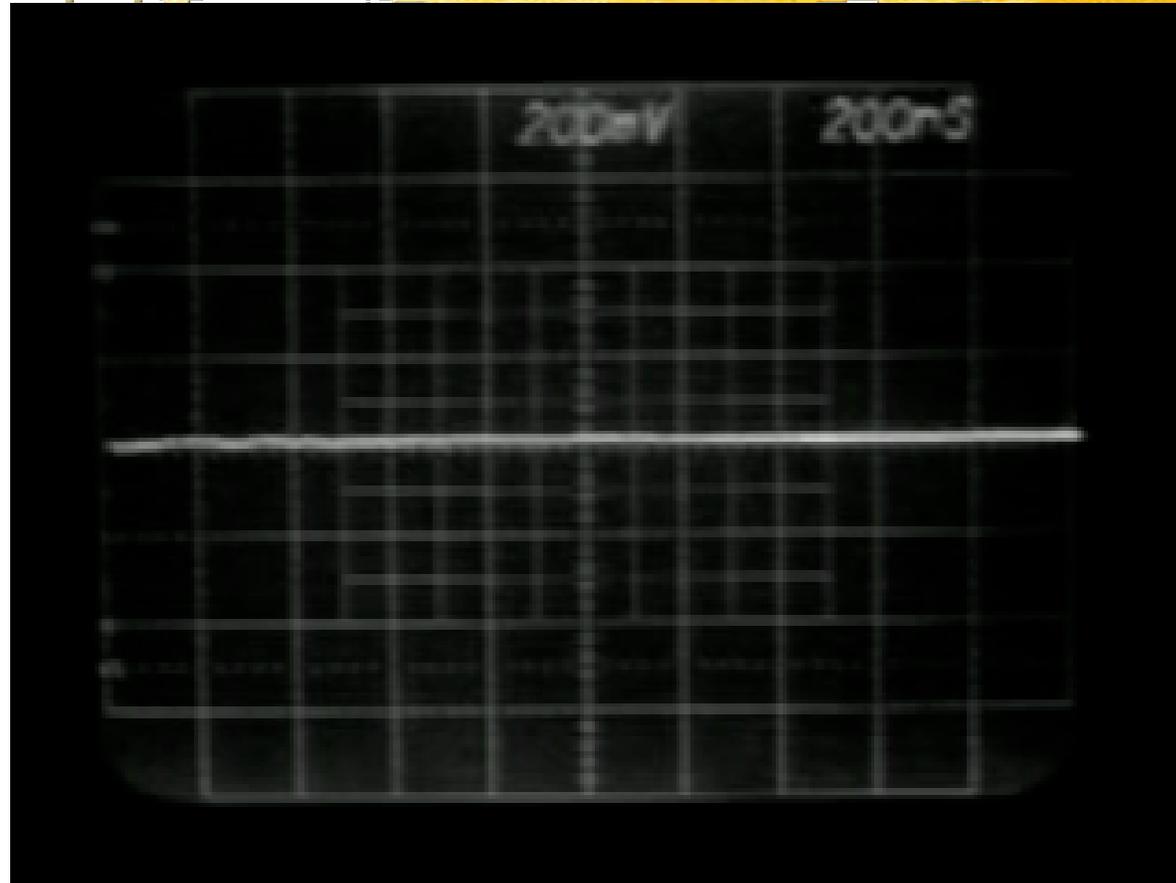
Tevatron Schottky Signal Large Common Mode Signal Requires High Dynamic Range





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■ *Time domain movie of Schottky signal during injection*

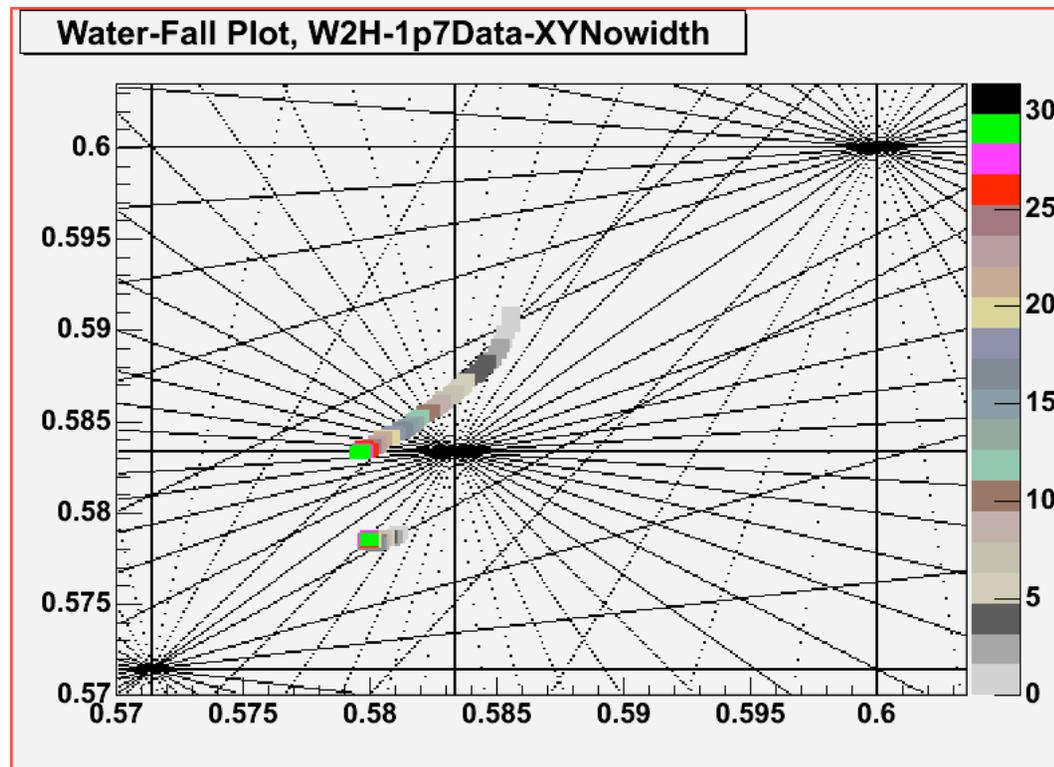


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Pbar Tune variation through a Tevatron store



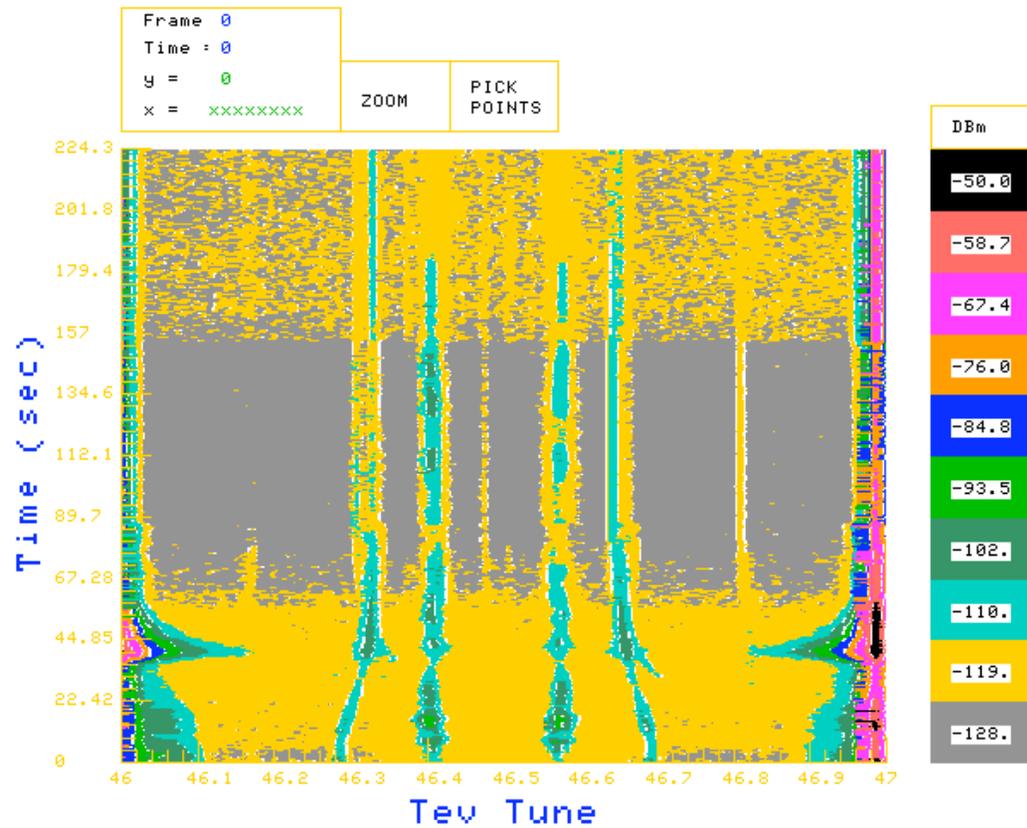


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Proton Vertical Schottky up TeV Ramp



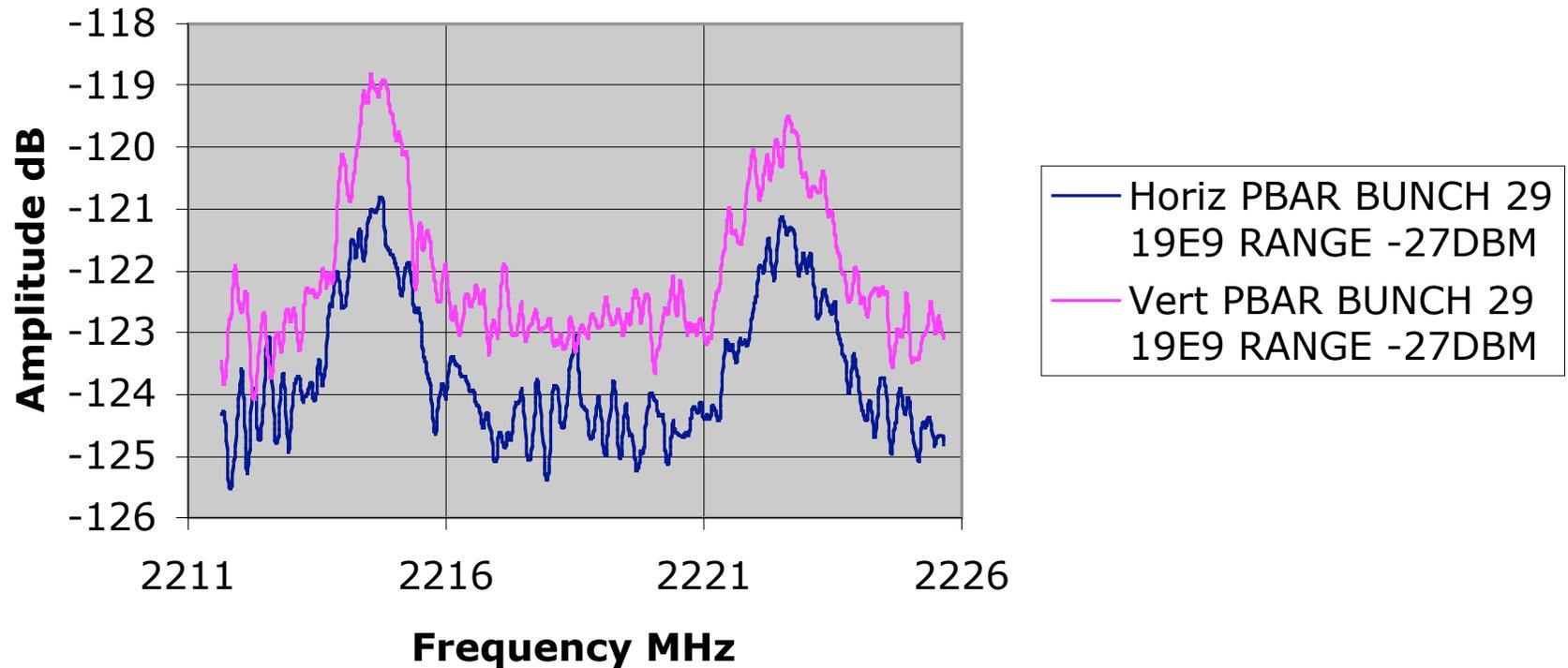


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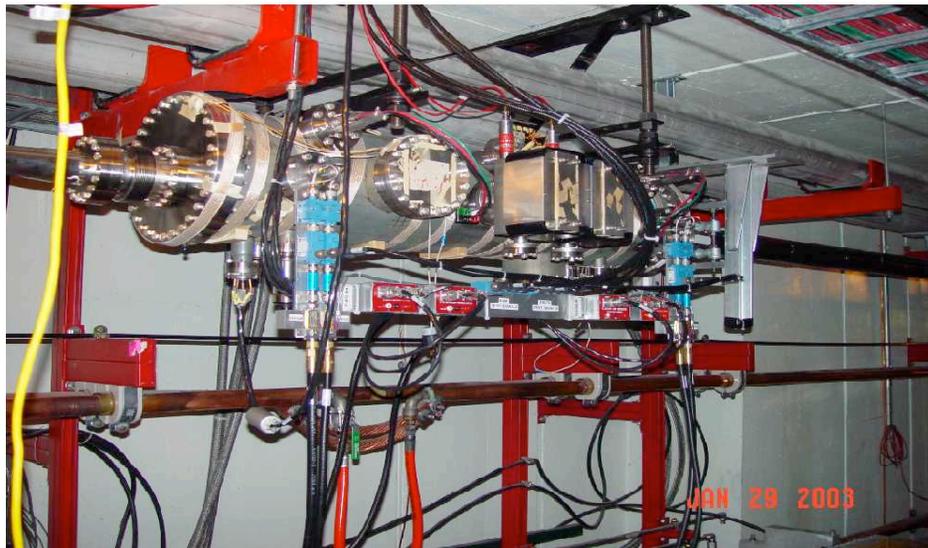
E17 Schottky single bunch 19e9 pbars





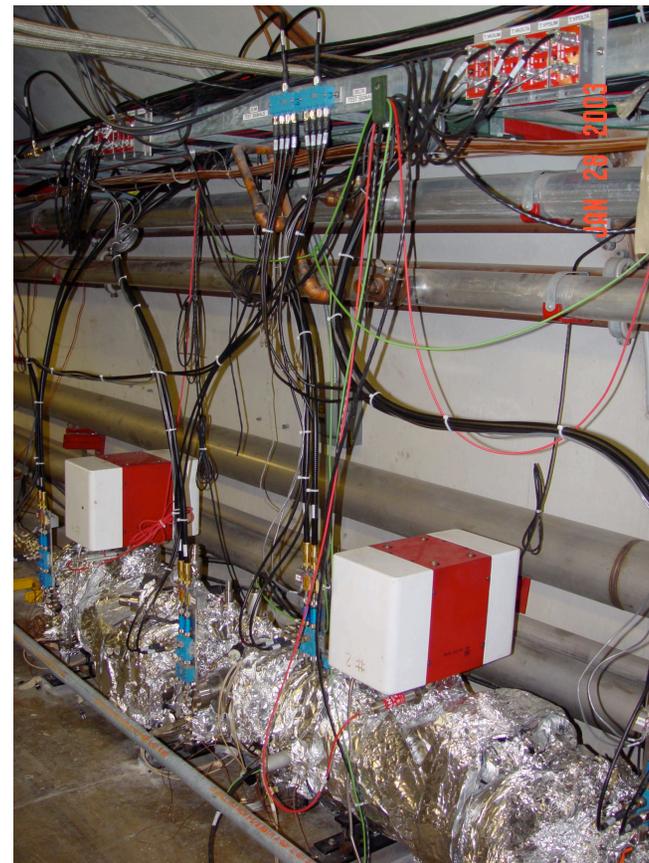
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Recycler Installation

Tevatron Installation





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*Tevatron
Signal Processing
Hardware in
E17 service building*





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■ *Proposed LHC System Specifications*

- *4.7 GHz center frequency*
- *100 MHz bandwidth minimum allows bunch by bunch gating*
- *One Horizontal and Vertical tank each LHC ring*
- *Single Sideband Down Conversion preserves chromaticity information*
- *Movable tank for common mode suppression does not need motorization*
- *Gating single or multiple bunch*



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■ *Proposed LHC System Capabilities*

- *Continuous on line emittance monitor*
- *Ability to measure individual or multiple bunches*
- *Down conversion utilizing RF source allows monitoring up the LHC Ramp*
- *Noninvasive Chromaticity measurements*
- *Noninvasive Tune measurement for each ring*
- *Measurement of beam beam tune shift*
- *Measurement of momentum spread*
- *Built in calibration system to monitor gain variation with time*

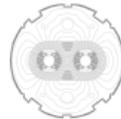


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CERN
CH-1211 Geneva 23
Switzerland



the
Large
Hadron
Collider
project

LHC Project Document No
LHC-BQS-ES-0001 draft
CERN Div /Group or Supplier/Contractor Document No
AB/BDI
EDMS Document No
Date: 2005-03-01

Engineering Specification

THE LHC MICROWAVE SCHOTTKY DETECTOR SYSTEM (BQS)

Abstract

The measurement of the incoherent tunes in the LHC without external excitation of the beam will be performed using a microwave Schottky detector system. This system will be used to monitor the stability of the beam tunes during coast, and identify any drifts of beam parameters which could affect the luminosity. This specification describes the functional requirements of Schottky detectors based on forward travelling wave couplers. One monitor per plane and per beam will be installed in Point 4 of the LHC. The design and implementation of these monitors and related signal treatment electronics can be part of the US LHC Accelerator Research Programme (LARP).

Prepared by :

Fritz Caspers
[AB-RF/CERN]
fritz.caspers@CERN.CH
Rhodri Jones
[AB-BDI/CERN]
rhodri.jones@CERN.CH

Checked by :

Approval Leader:

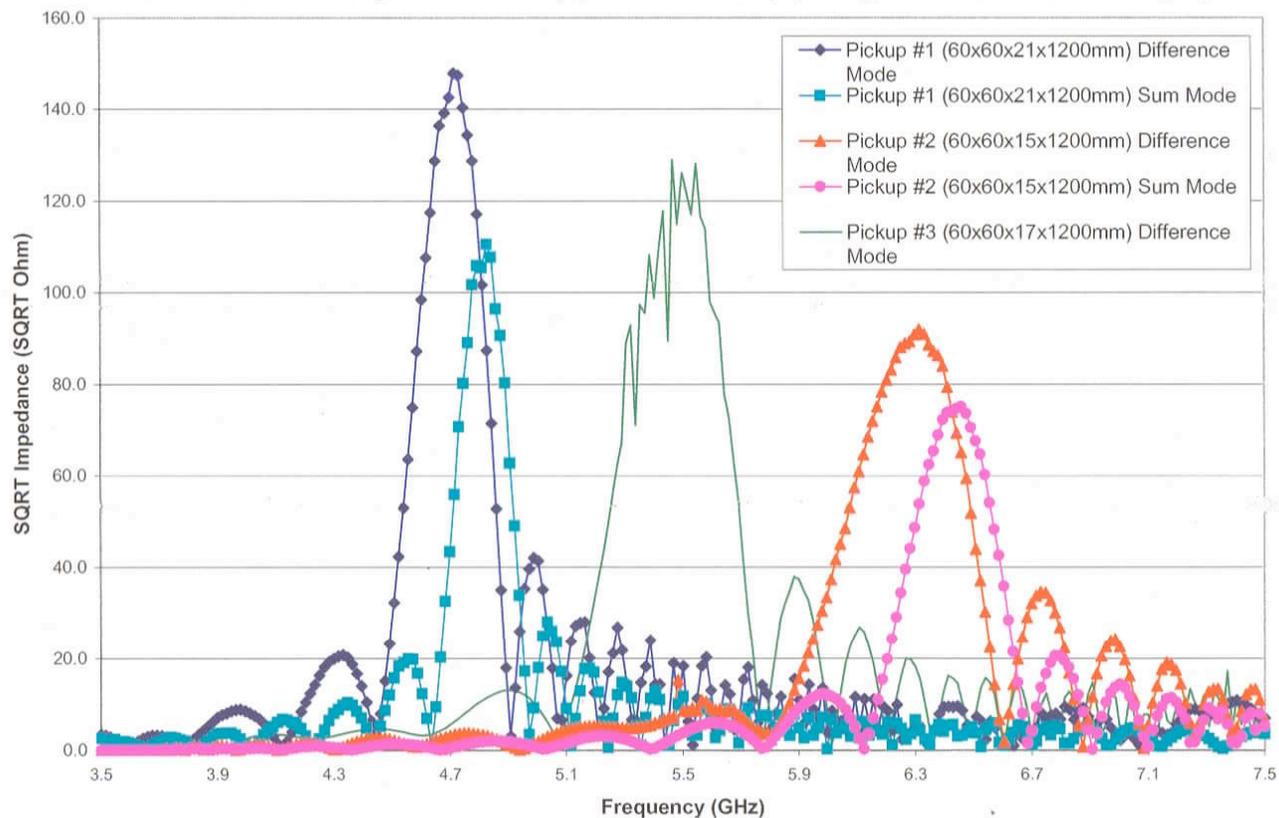


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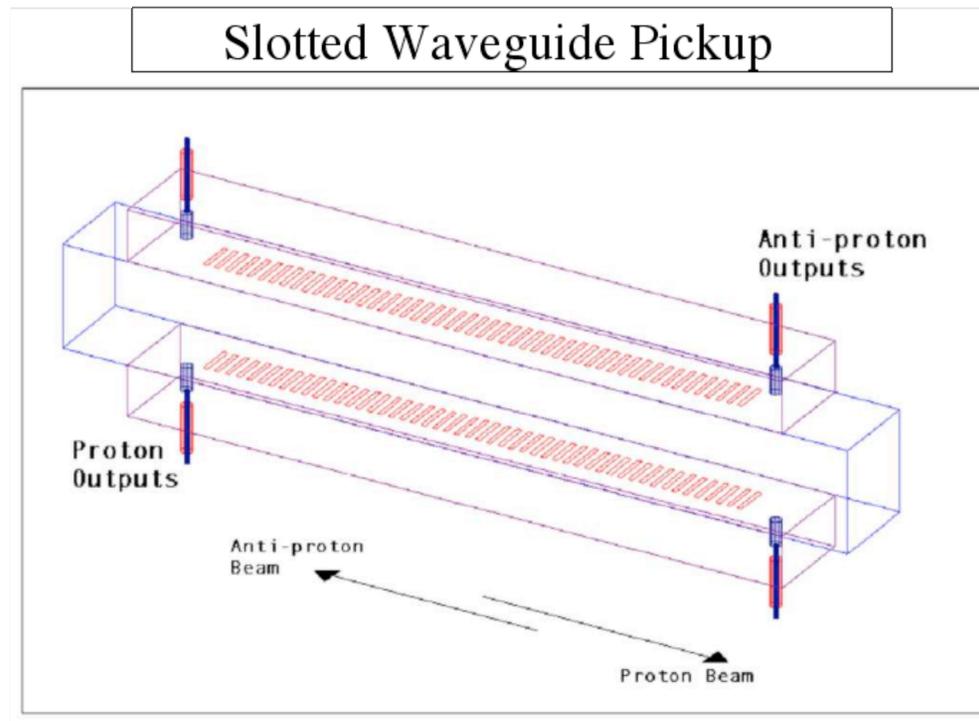
02/02/2005 Schottky Pickups for LHC (Note1: Pickup #3 shows resonance region --- not usable.
Note2: numbers in legend are: beam pipe width x beam pipe height x slot width x total length)





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4.7 GHz 60 x 60 mm aperture x 1.2 meter long



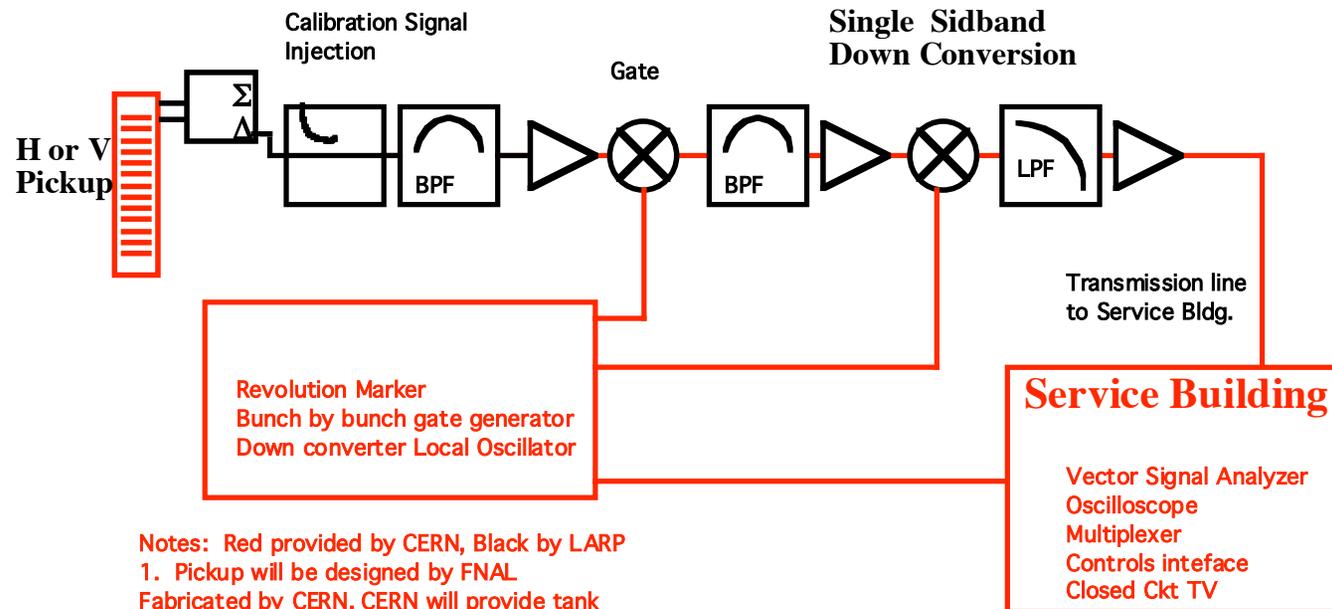
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LHC Schottky Proposal

Tunnel



Notes: Red provided by CERN, Black by LARP

1. Pickup will be designed by FNAL
Fabricated by CERN. CERN will provide tank stand, motion controls, bake out hardware.
2. Fermilab has developed software for measuring beam parameters. This software can be made available to CERN. Fermilab does not intend to port software to CERN control system.



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effort/cost estimate for LHC 4.7 GHz Schottky				
R.J. Pasquinelli				3/18/05
Item	man power type	man months		
pickup microwave design	microwave engineer	1		
pickup mechanical design	mechanical engineer	2		
pickup mechanical drafting	mechanical designer	2		
signal processing design	microwave engineer	2		
signal processing prototype	electrical technician	1		
collaboration/travel	two trips to CERN for 2 people			
installation	2 weeks at CERN 2 people			
commissioning	3-4 weeks at CERN 2 people			
signal processing M&S	\$25K			