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are needed to see this picture.



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# ***Proposal for LHC Microwave Schottky Pickups***

***Ralph J. Pasquinelli***

***3/9/2005***

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are needed to see this picture.

# **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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# LHC Microwave Schottky Pickups



## ⌘ *Fermilab System Capabilities*

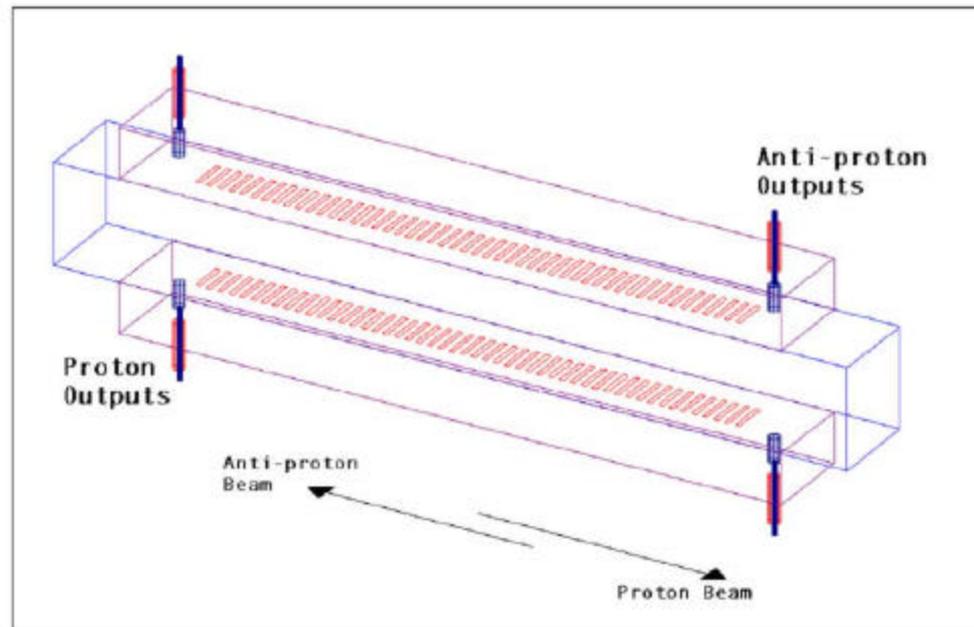
- ⌘ *Continuous on line emittance monitor both TeV and RR*
- ⌘ *Longitudinal emittance for RR*
- ⌘ *Ability to measure individual or multiple bunches in TeV*
- ⌘ *Ability to measure pbars in presence of protons in TeV*
- ⌘ *Ability to measure hot and cold pbars in RR*
- ⌘ *Down conversion utilizing RF source allows monitoring up the TeV Range*
- ⌘ *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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# LHC Microwave Schottky Pickups



Slotted Waveguide Pickup



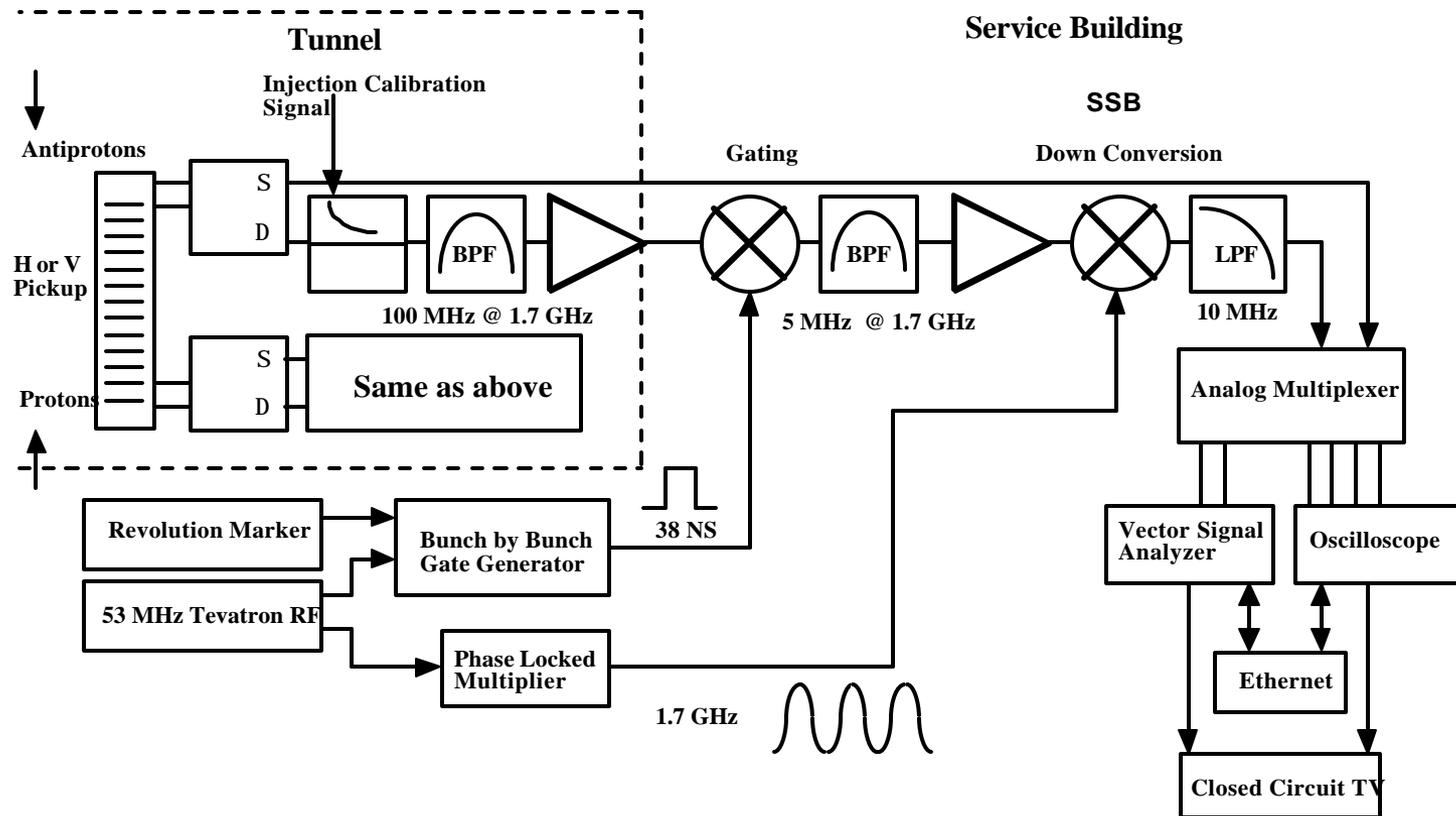
*1.7 GHz 109 x 75 mm aperture*

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TIFF (LZW) decompressor  
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# LHC Microwave Schottky Pickups



## Tevatron Schottky Signal Processing



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are needed to see this picture.

# ***LHC Microwave Schottky Pickups***



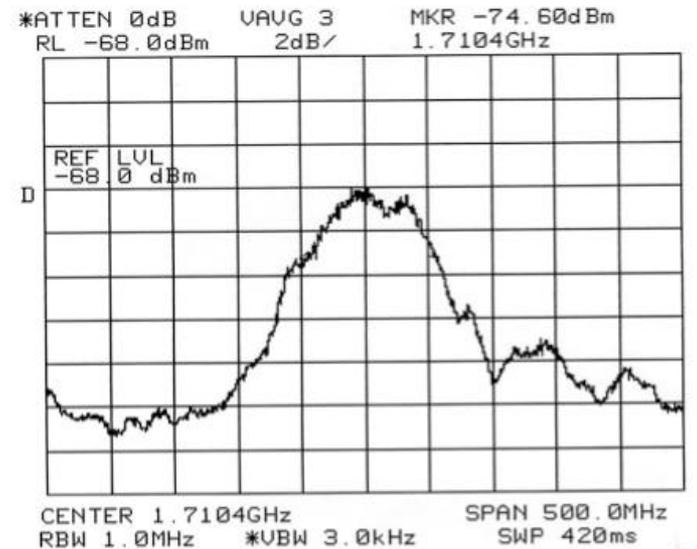
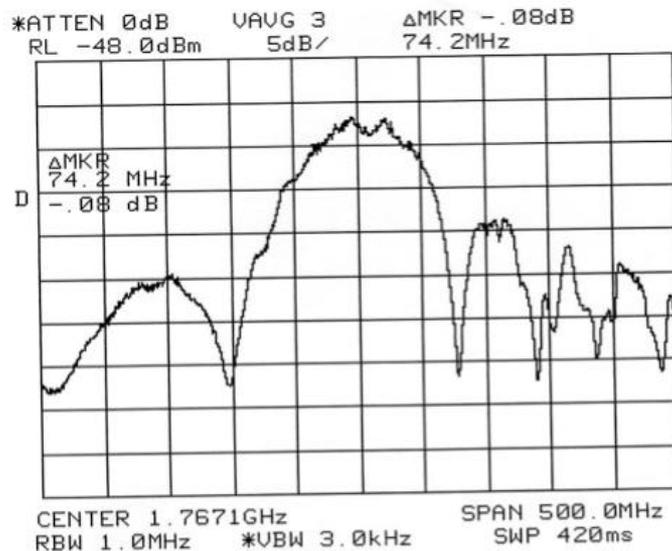
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TIFF (LZW) decompressor  
are needed to see this picture.

# LHC Microwave Schottky Pickups



## Measured Pickup Sensitivity in Recycler



*Sum Mode*

*Difference Mode*

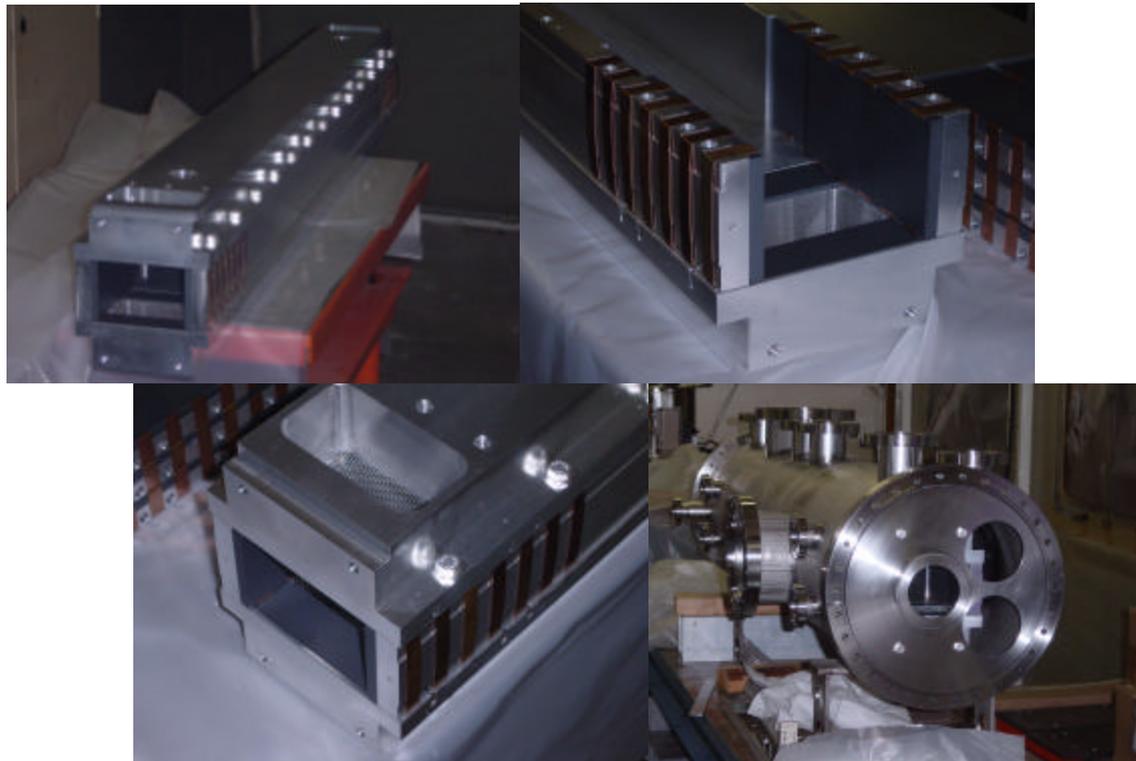
*Directivity Measured at 12-15 dB*

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are needed to see this picture.

# LHC Microwave Schottky Pickups



## Array Assembly

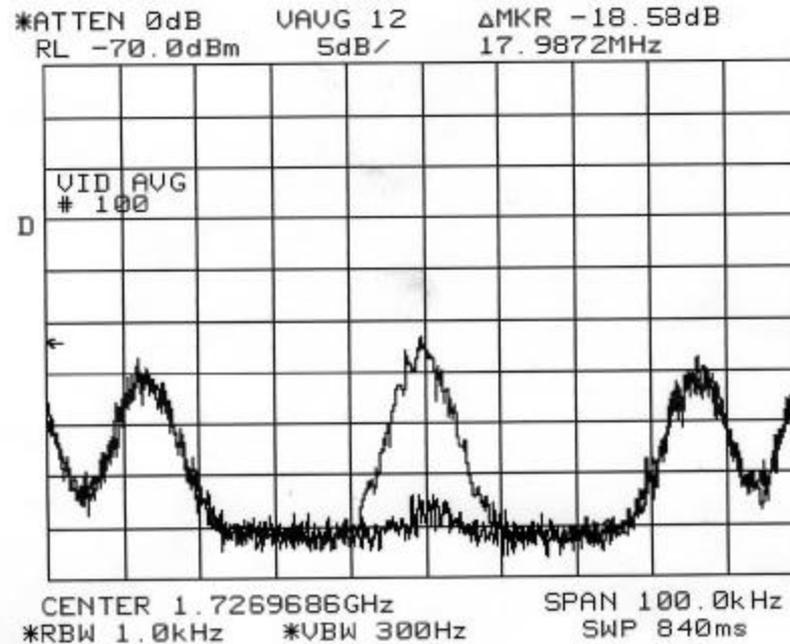


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# LHC Microwave Schottky Pickups



## Beam Centering Reduces Common Mode



## Recycler Horizontal Pickup $1 \times 10^{11}$ Protons

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# *LHC Microwave Schottky Pickups*



## *Recycler Automated Vector Signal Analyzer Program*

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TIFF (LZW) decompressor  
are needed to see this picture.

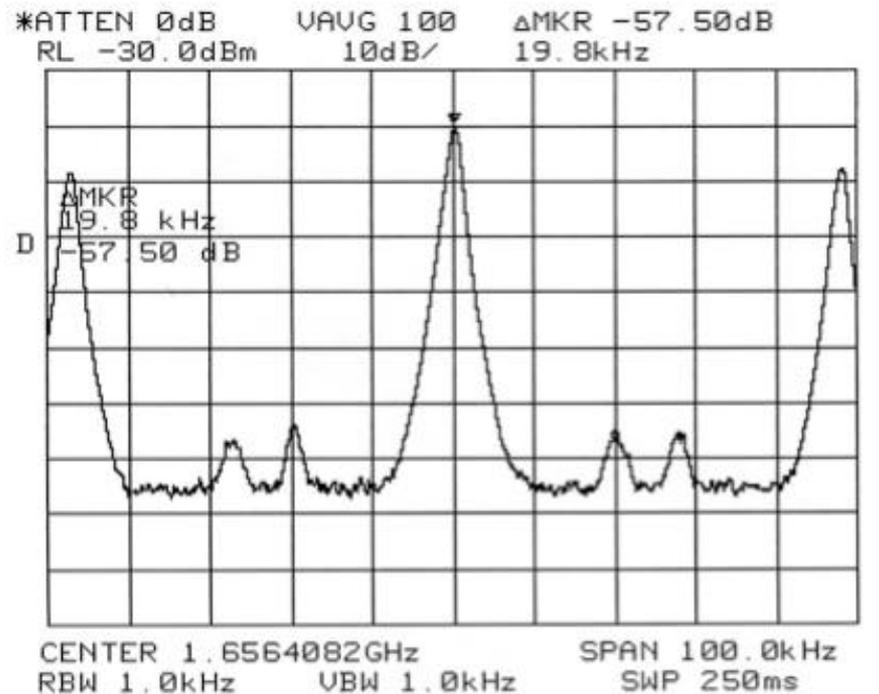
*Provides momentum spread, tune, revolution frequency, calculated emittance.*

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

# LHC Microwave Schottky Pickups



## Tevatron Schottky Signal Large Common Mode Signal Requires High Dynamic Range



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TIFF (LZW) decompressor  
are needed to see this picture.

# *LHC Microwave Schottky Pickups*



QuickTime™ and a  
YUV420 codec decompressor  
are needed to see this picture.

⌘ ***Time domain movie of Schottky signal during  
injection***

LARP-CP-00-000

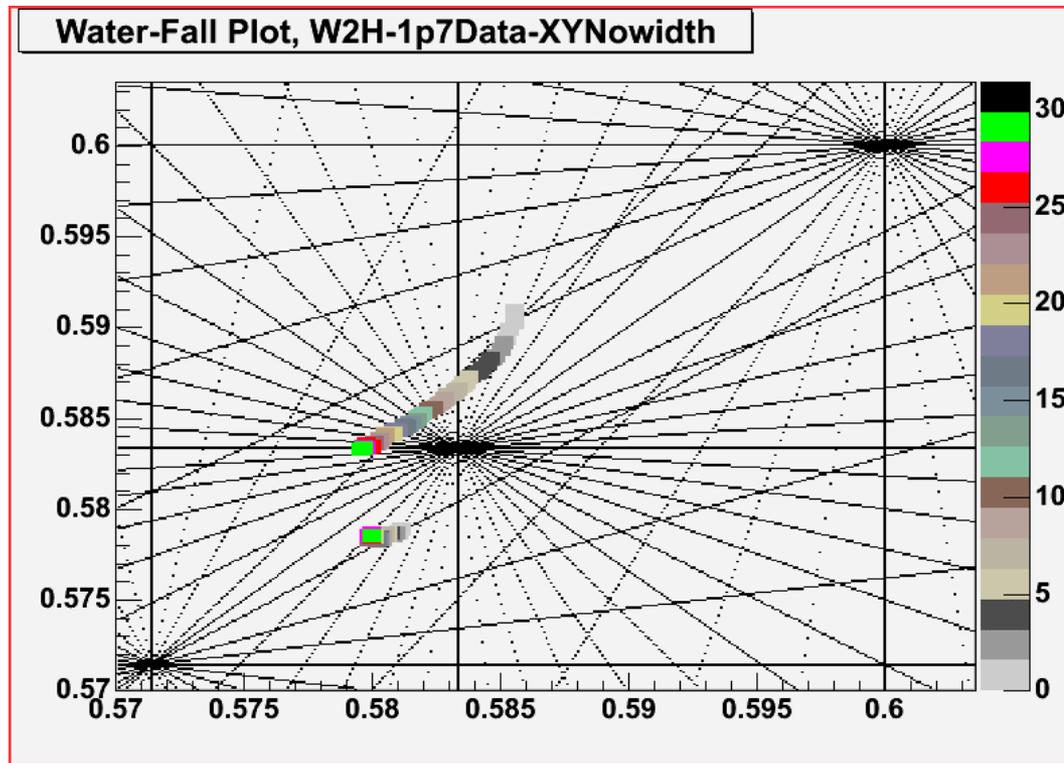
R. J. Pasquinelli

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TIFF (LZW) decompressor  
are needed to see this picture.

# LHC Microwave Schottky Pickups



*Pbar Tune variation through a Tevatron store*



*Hours*

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TIFF (LZW) decompressor  
are needed to see this picture.

# *LHC Microwave Schottky Pickups*



## *Proton Vertical Schottky up TeV Ramp*

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TIFF (LZW) decompressor  
are needed to see this picture.

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

# *LHC Microwave Schottky Pickups*



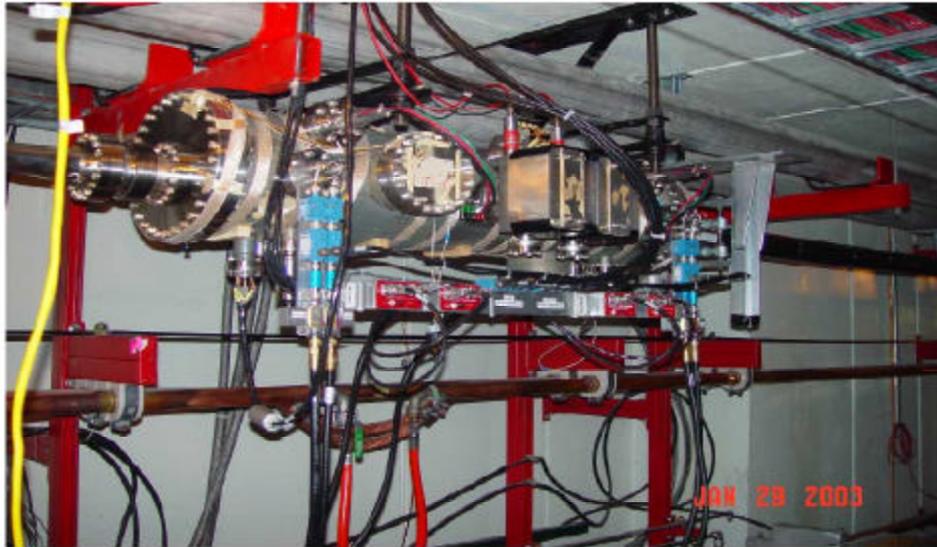
## *Tevatron Proton Schottky Signals*

*Horizontal*

*Vertical*

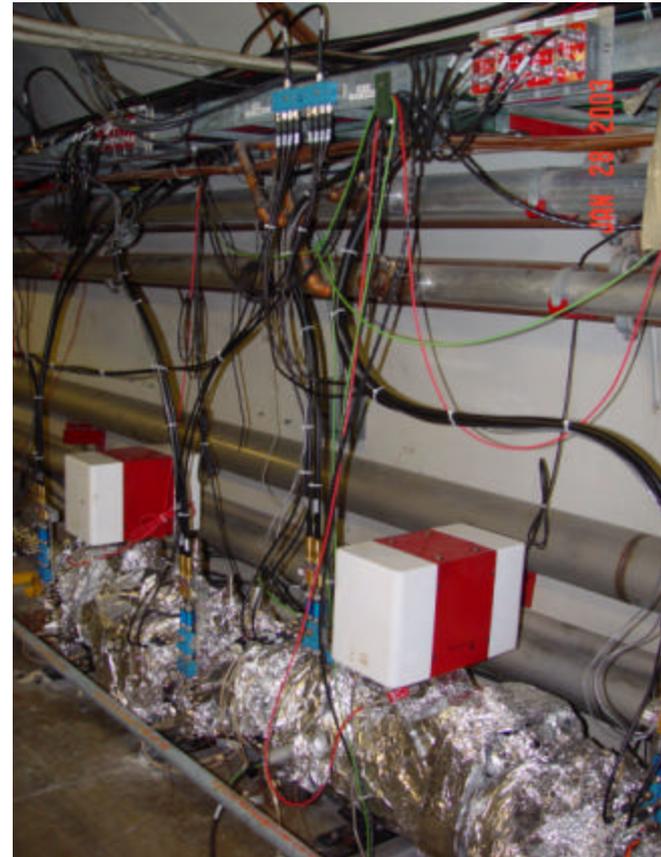
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# LHC Microwave Schottky Pickups



*Recycler Installation*

## *Tevatron Installation*



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# *LHC Microwave Schottky Pickups*



*Tevatron  
Signal Processing  
Hardware in  
E17 service building*

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TIFF (LZW) decompressor  
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QuickTime™ and a  
TIFF (LZW) decompressor  
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# **LHC Microwave Schottky Pickups**



## **⌘ 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**
- ⌘ Gating single or multiple bunch**

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

# **LHC Microwave Schottky Pickups**



## **⌘ 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 Ra**
- ⌘ 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**

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

# ***LHC Microwave Schottky Pickups***



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# ***LHC Microwave Schottky Pickups***



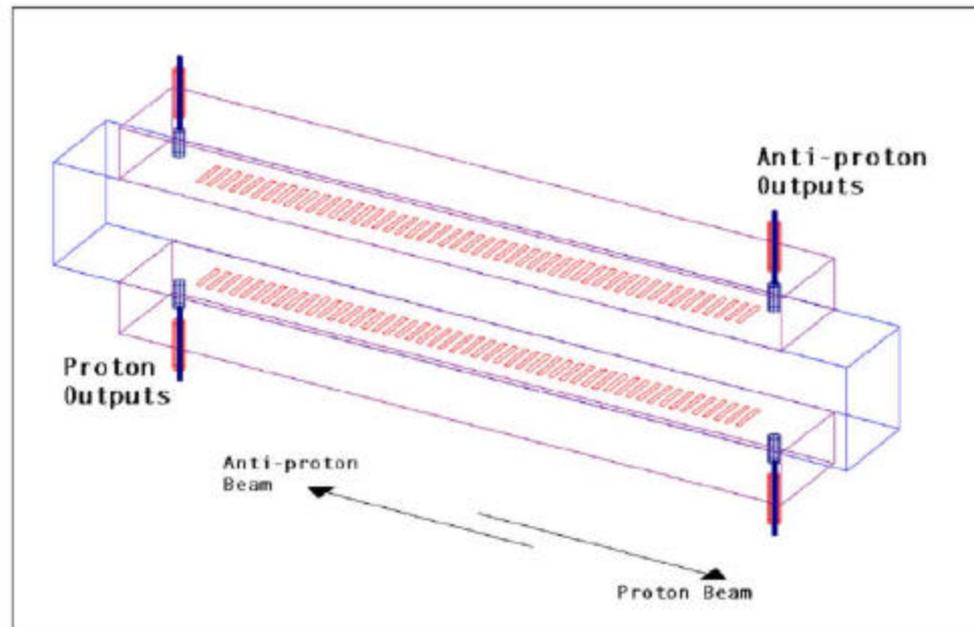
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# LHC Microwave Schottky Pickups



Slotted Waveguide Pickup



*4.7 GHz 60 x 60 mm aperture x 1.2 meter long*

QuickTime™ and a  
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# LHC Microwave Schottky Pickups



Revolution Marker  
Bunch by bunch gate generator  
Down converter Local Oscillator

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.

## Service Building

Vector Signal Analyzer  
Oscilloscope  
Multiplier  
Controls interface  
Closed Ckt TV

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# **LHC Microwave Schottky Pickups**



*Working on cost and labor estimate for the design  
Of the pickup, design and fabrication of the  
Processing electronics, travel and commissioning*