

# Monopulse BPM System Overview

Glenn Decker

April 24, 1998



# **APS RF BPM System Upgrade (monopulse)**

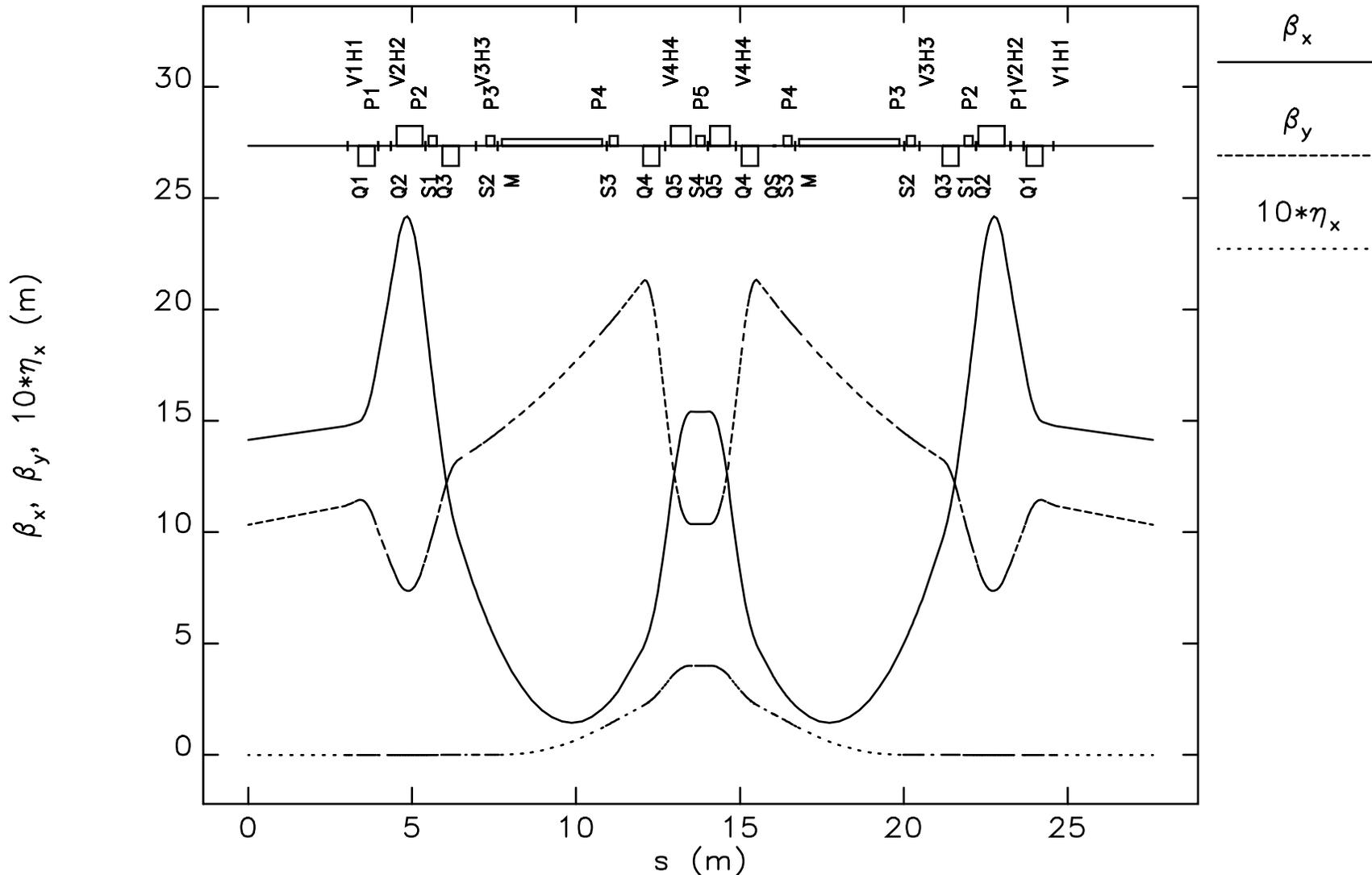
- **BPM System Overview / Scope of Upgrade**
- **Present specifications**
- **Performance to date / performance limitations**
- **Desired specifications**

# APS Storage Ring

## Operational Parameters

- RF Frequency 351.93 MHz nominal
- Circumference 1104 meters
- Harmonic number  $1296 = 2^4 * 3^4$
- Revolution period 3.6826 microseconds
- Revolution frequency 271.55 kHz
- Max. average current 100 mA (now) - 300 mA(future)
- Max. single bunch current 20 mA
- Typical single bunch current 1 to 3 mA
- Bunch length 17 to 60 psec rms
- "Standard" fill pattern 6 + 25 triplets or singlets  
w/ 400 to 1000 ns dead time
- "Desired" fill pattern 36 singlets or triplets  
equally spaced @ 100 ns
- Four-Button pickup types 4 pF, 1 cm & 4 mm diameters
- Number of sectors 40
- BPM stations per sector 9 now, 11 w/ Bergoz upgrade
- BPM cabling 2" SiO2 @ button; 0.25" Heliax  
Andrews FSJ1-50 -->upstairs

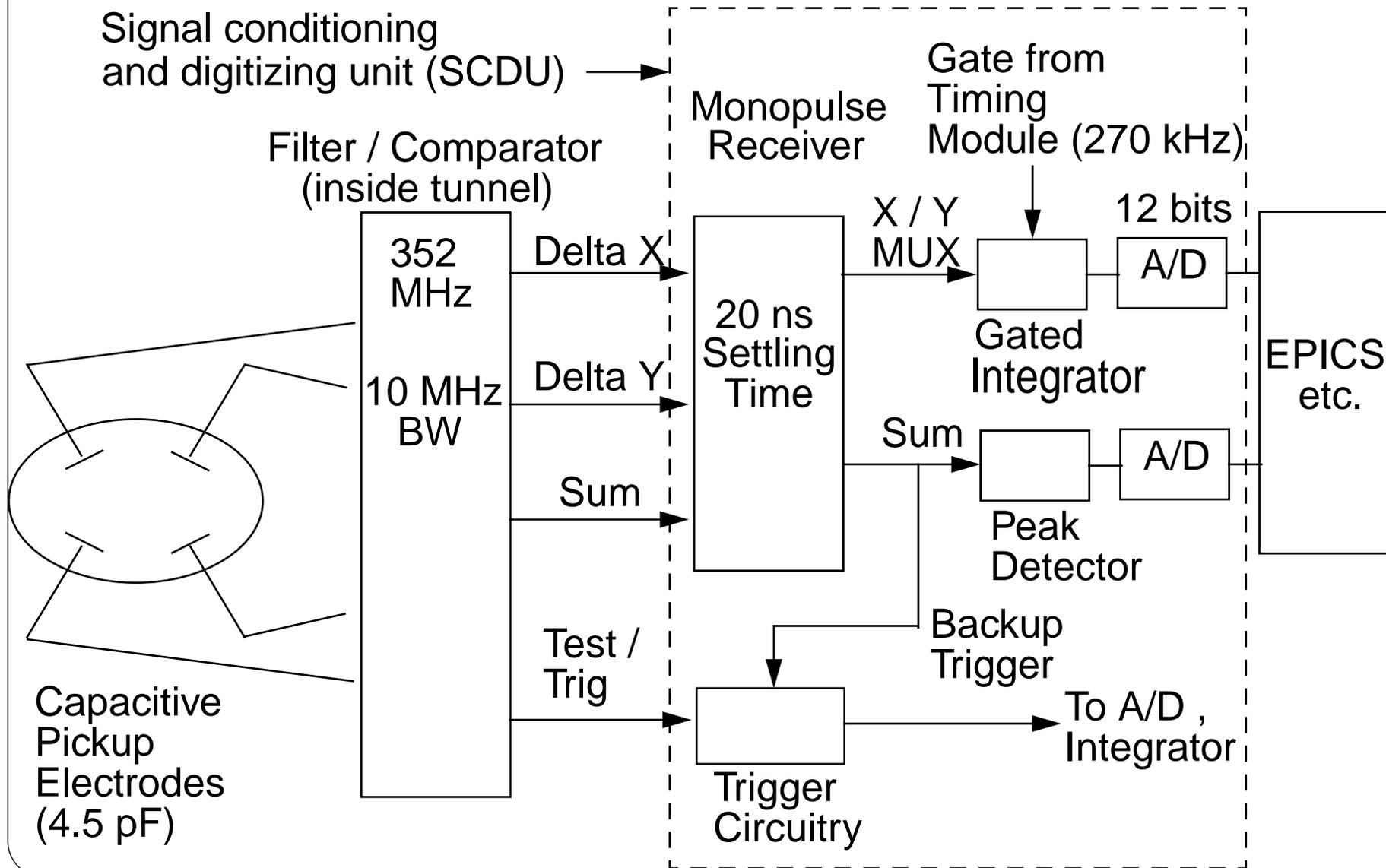




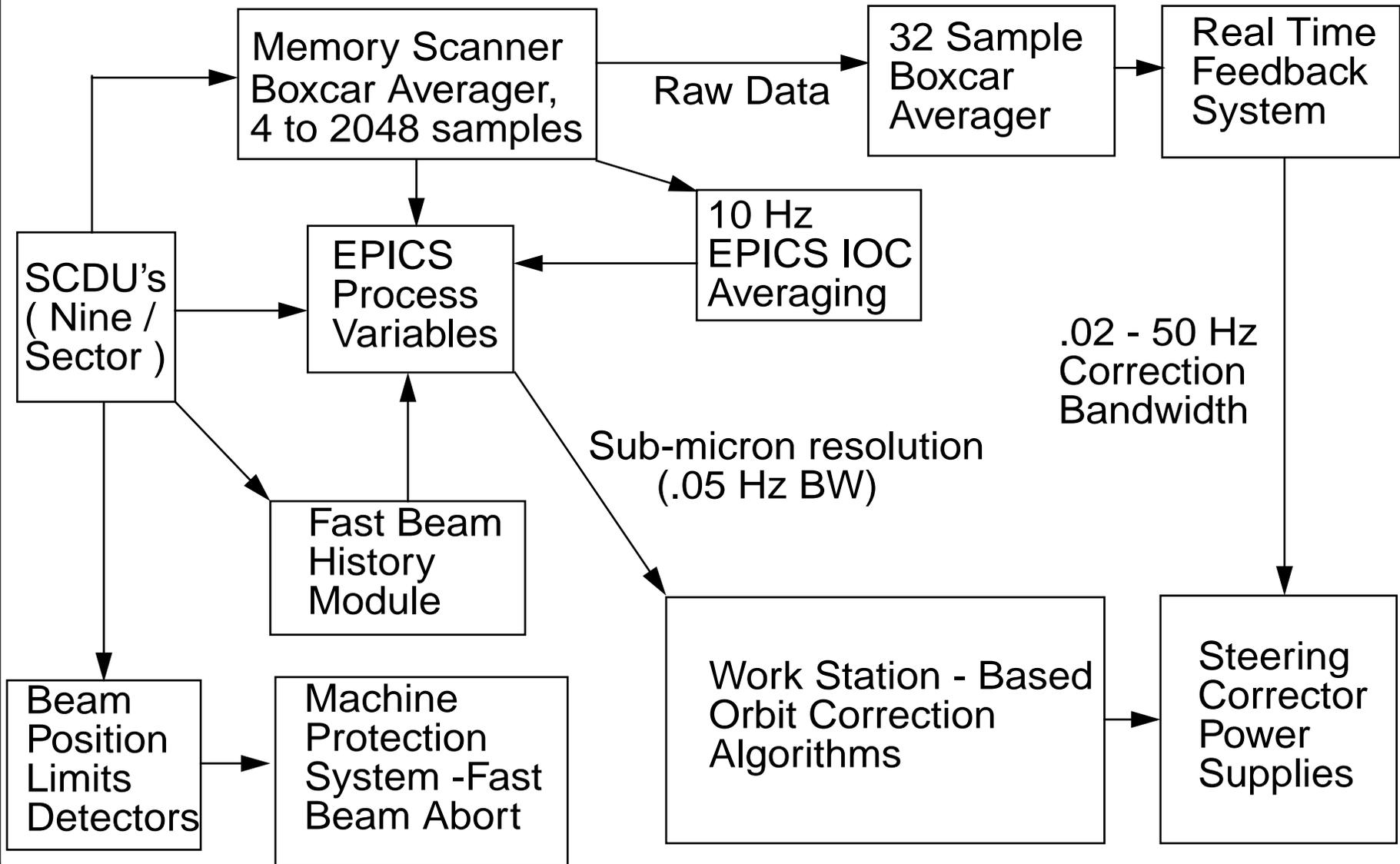
Twiss parameters--input: apsSector1.ele lattice: apsSector1.lte



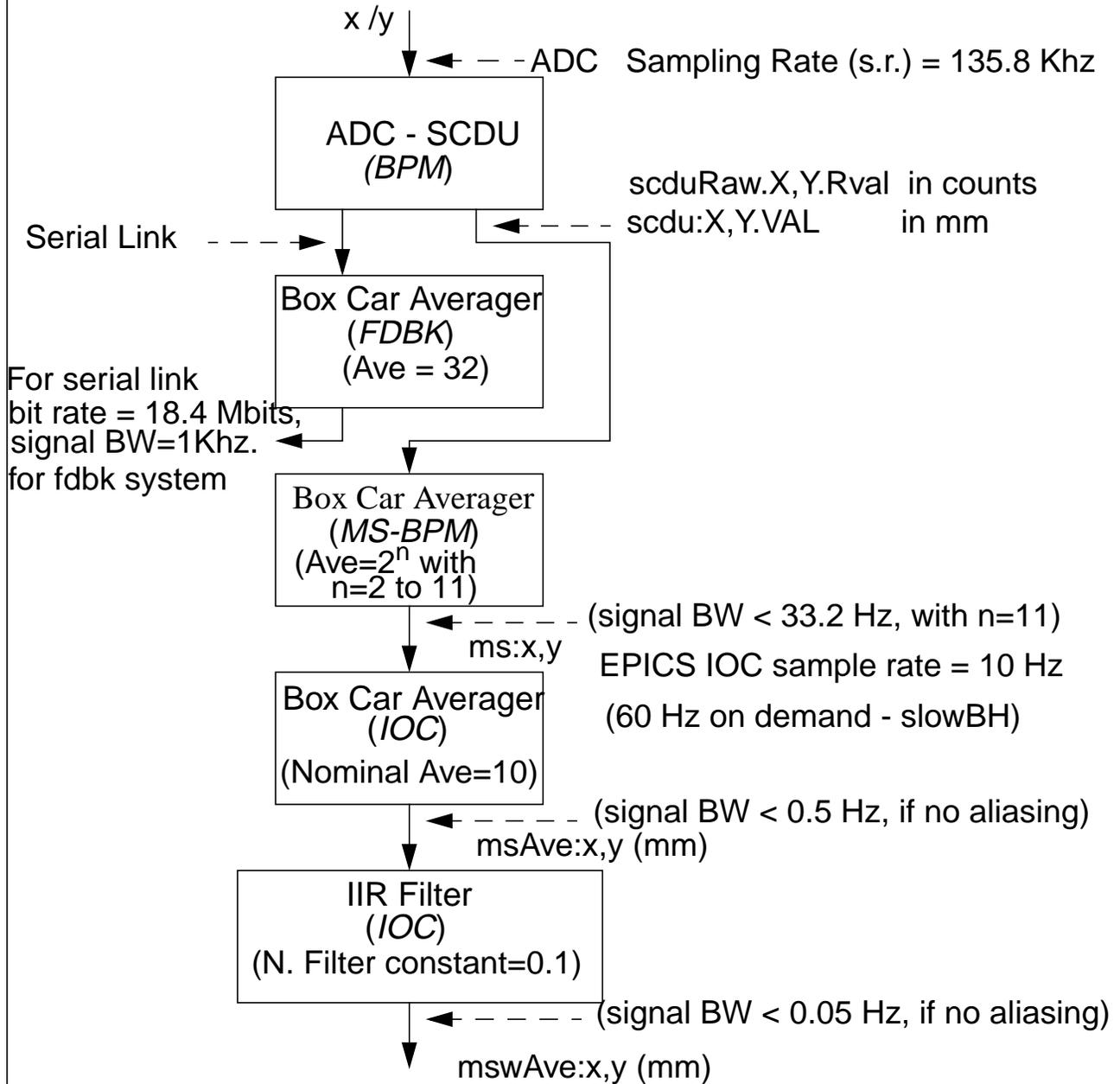
# APS RF Beam Position Monitor Block Diagram



# BPM / Orbit Correction Data Flow



## RF BPM Averaging (os,fl,jc -3/12/98)



# Specifications

## Present Filter / Comparator Front End

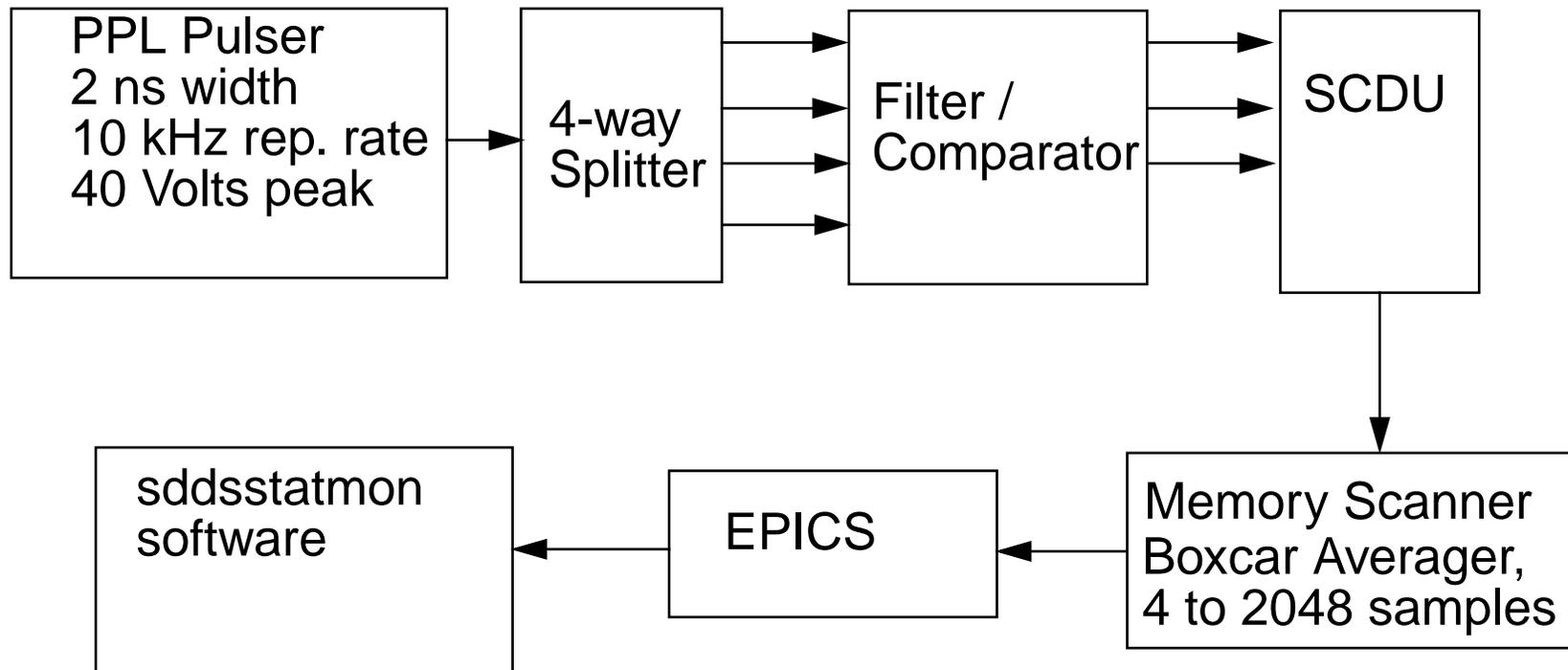
- **Input pulse amplitude** 0.2 to 200 Volts
- **Input pulse width** 30 to 60 picoseconds
- **Input power** 5 W avg, 1 kW peak
- **Output center frequency** 351.93 MHz
- **Output bandwidth (3 dB)** 10 MHz nominal
- **Output envelope pulse width** 100 ns @ 1/2 amplitude
- **D/S time domain cancellation ratio** -45 dB min., for Dx & Dy, for equal input amplitudes
- **D/S linearity** +/- 0.5% for D/S from -1 to 1, for the input pulse dynamic range
- **Time domain spurs and sidelobes rejection** 60 dB min
- **Total insertion loss** 14 dB max @ 351.93 MHz
- **Output phase Sum vs. Delta** 0 or 180 deg., +/- 2 deg.



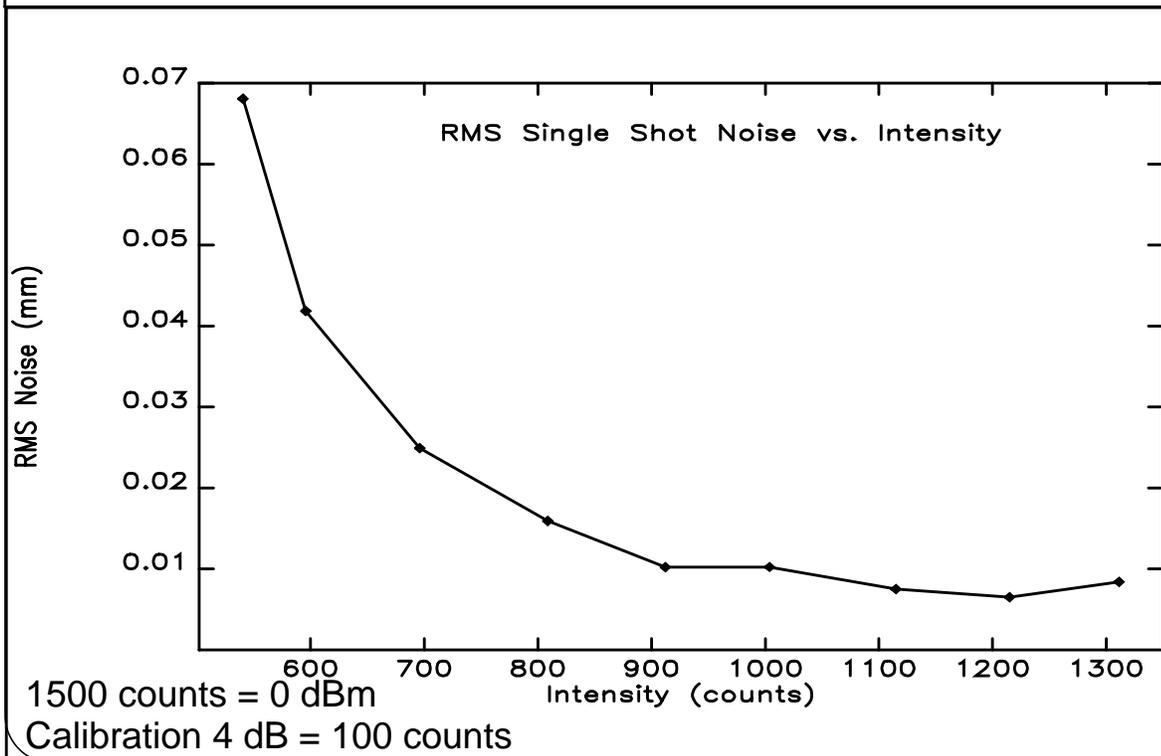
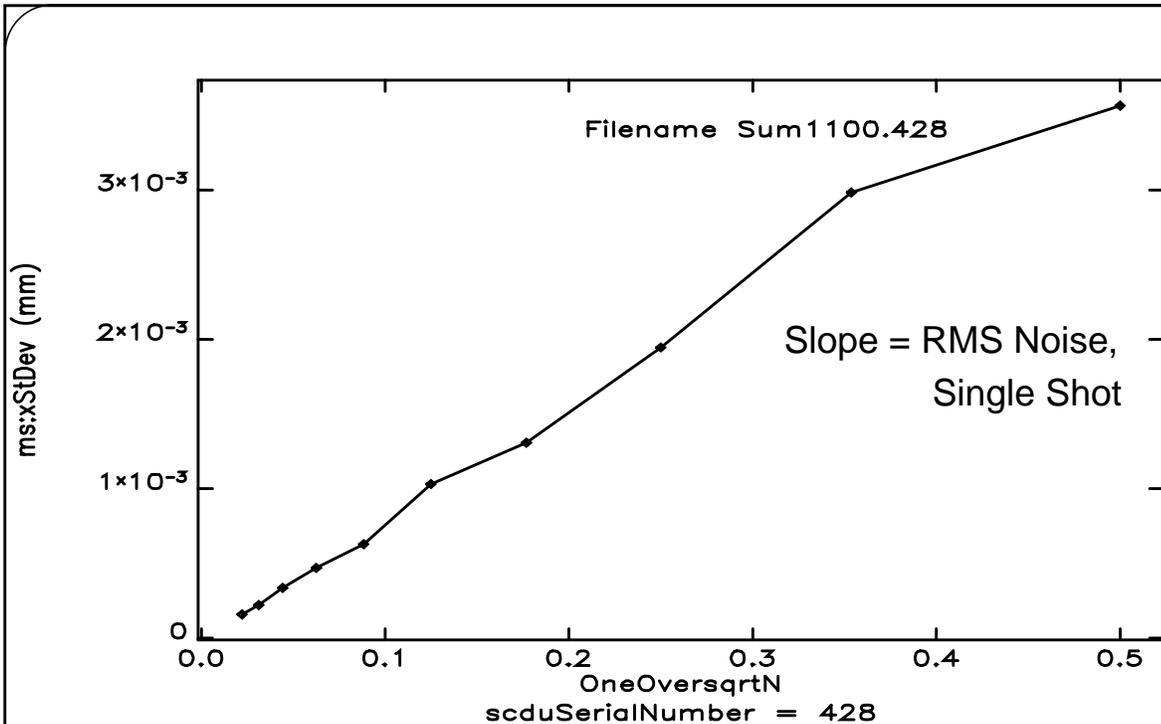
## **System Performance / Limitations**

- **Experimental determination of noise floor vs. intensity**
- **Experimental determination of long-term drift**
- **Measurement / correction of intensity dependent offset**
- **Measurement of offset relative to quad centers vs. time**
- **Bunch pattern dependence**
- **Comparison of monopulse and switched receiver systems**
- **Comparison of monopulse and x-ray bpm**

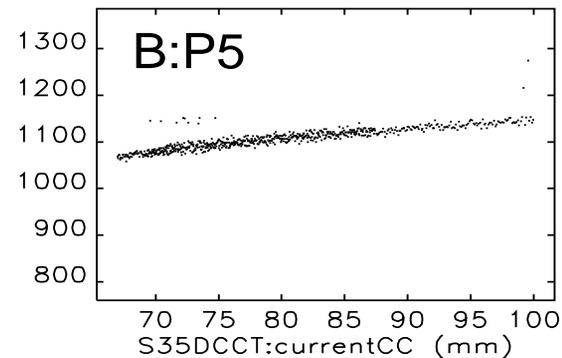
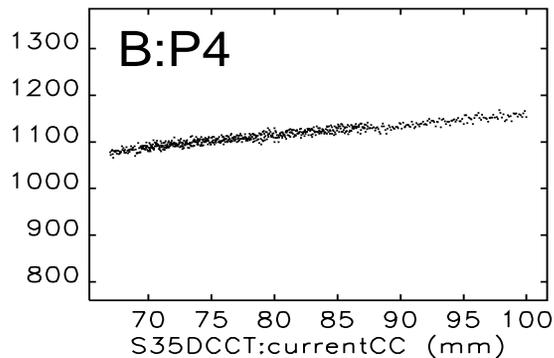
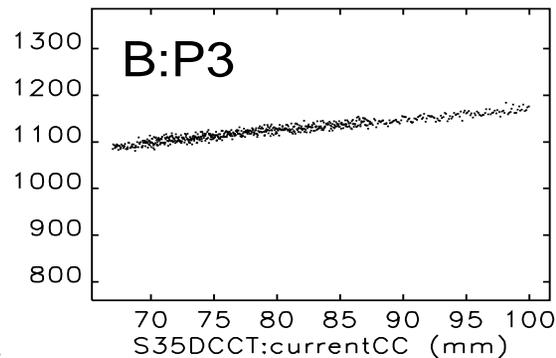
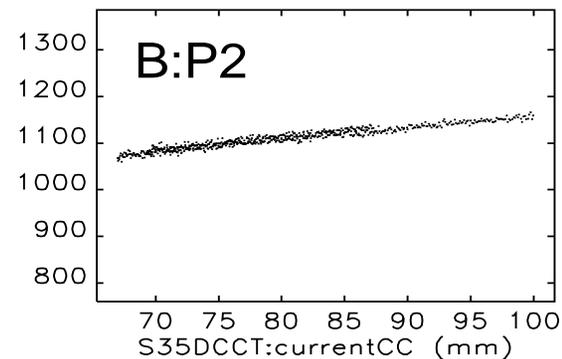
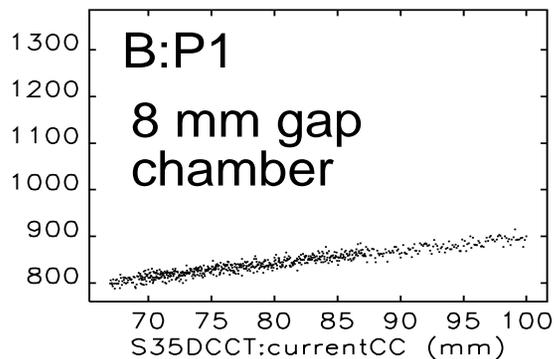
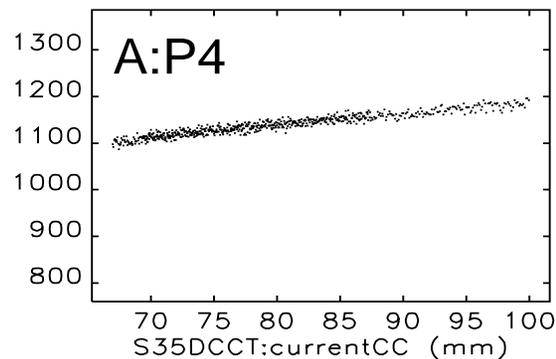
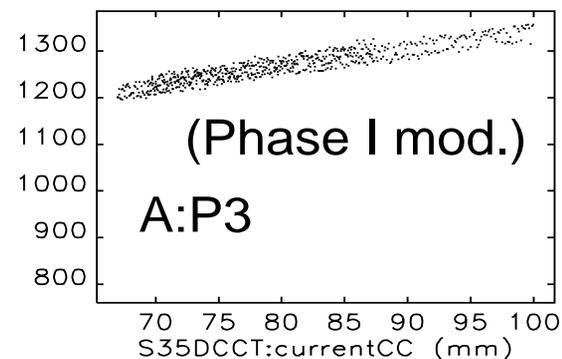
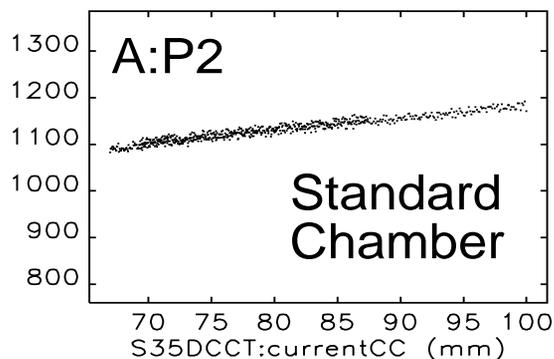
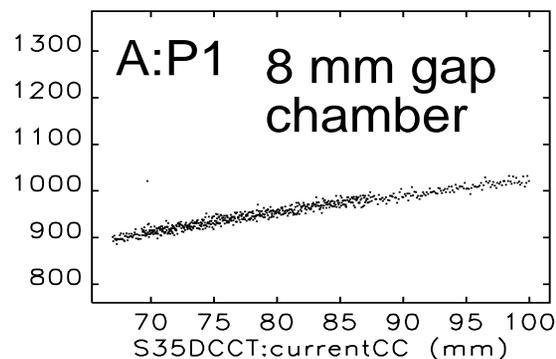
## Experimental Arrangement for Determination of Receiver Noise Floor



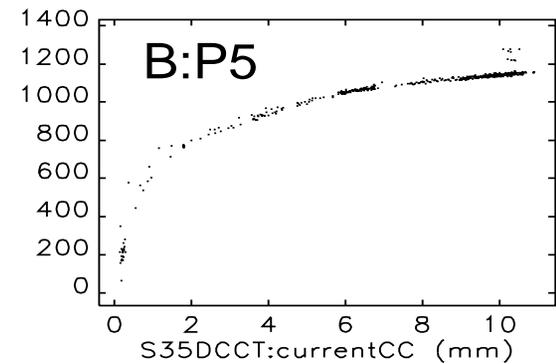
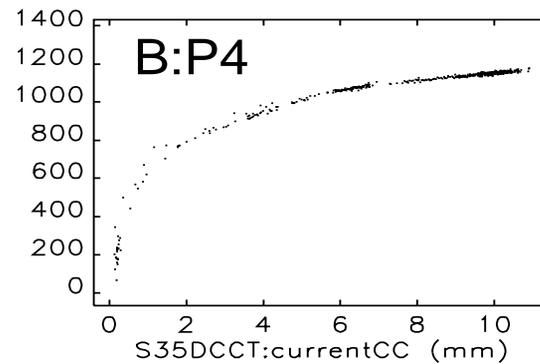
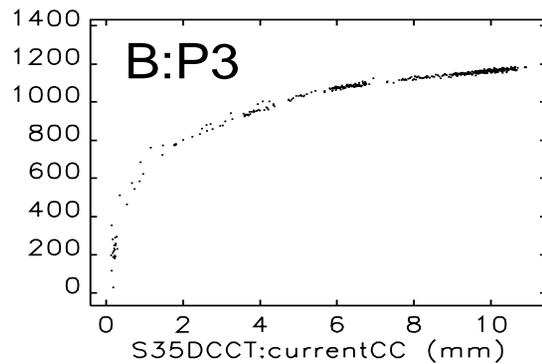
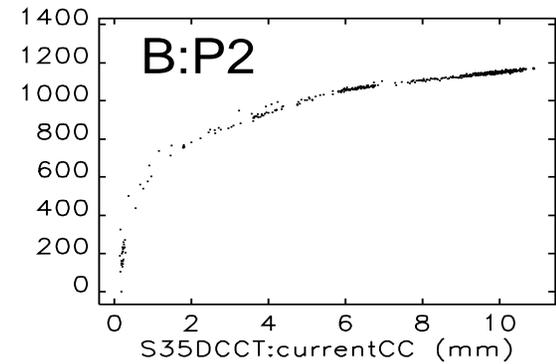
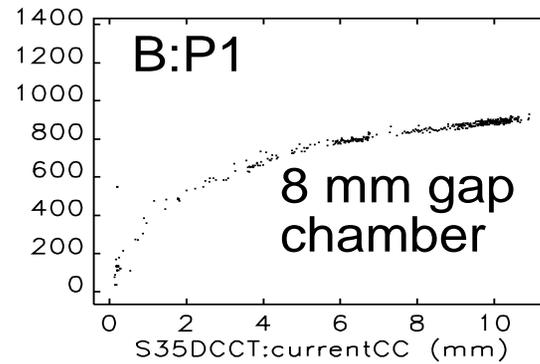
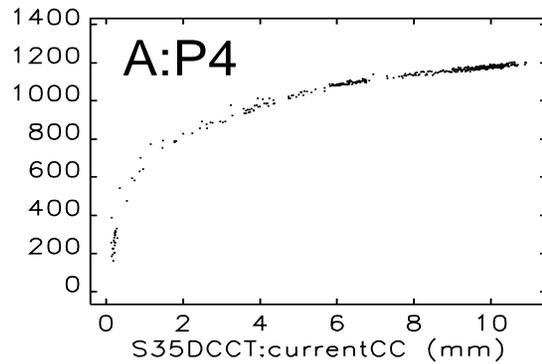
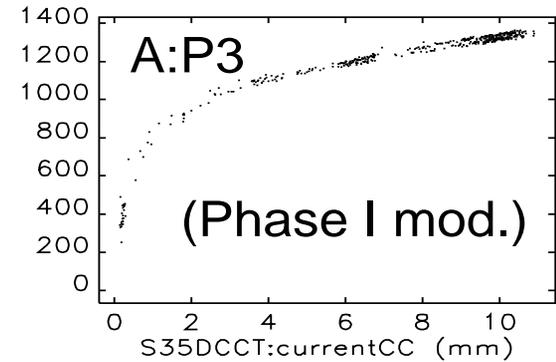
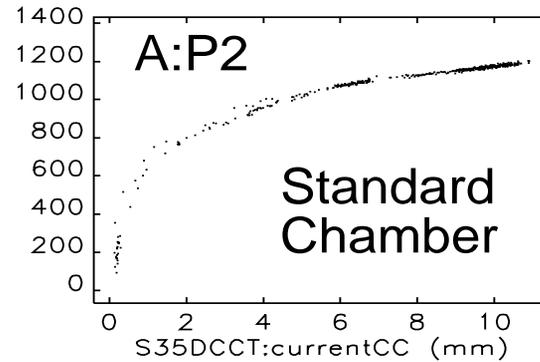
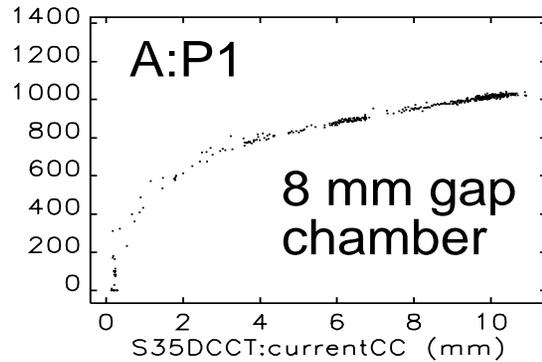
# SCDU Noise Floor Results



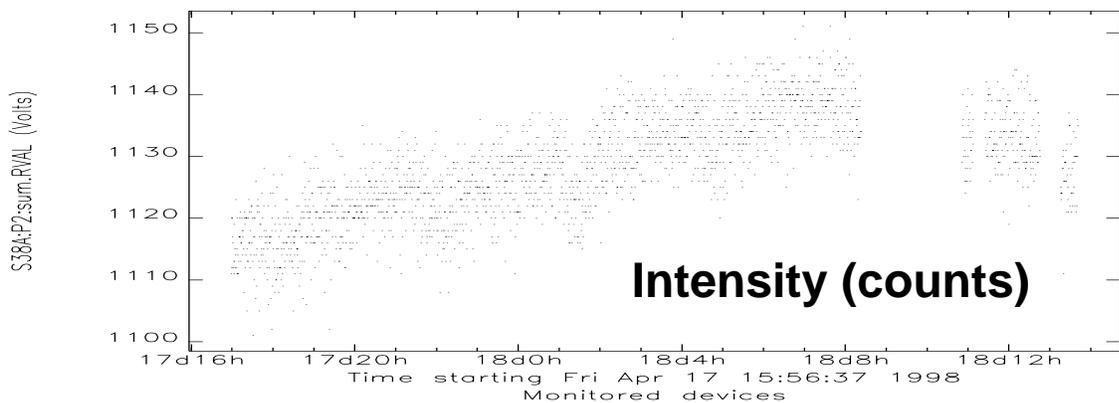
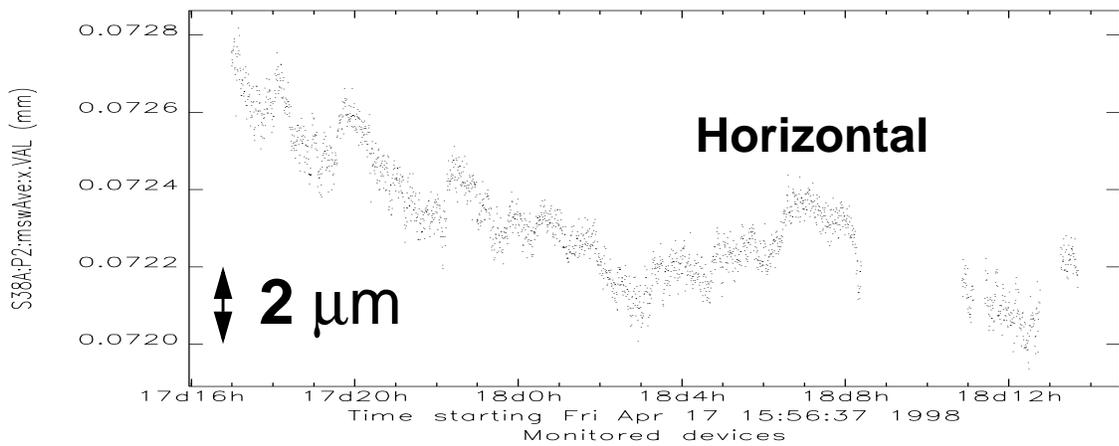
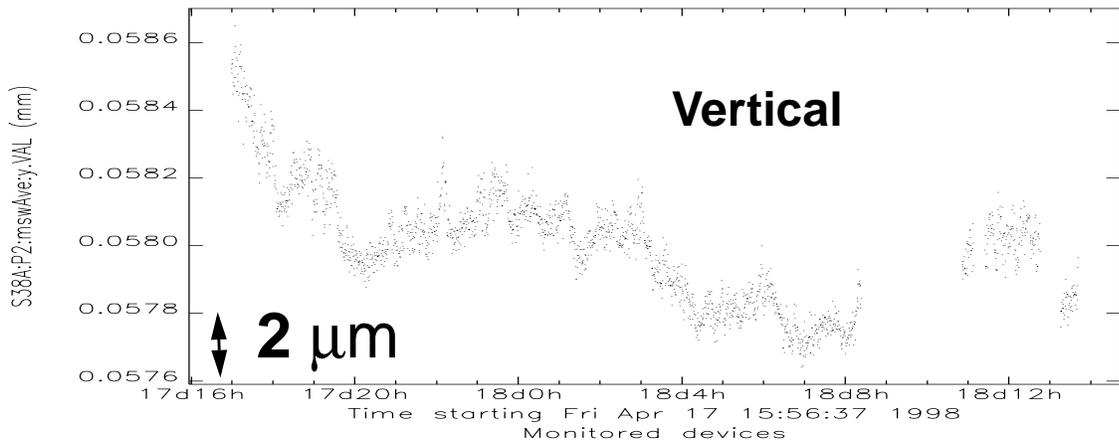
# Scaling of BPM Sum Channel with Total Beam Current - Sector 2



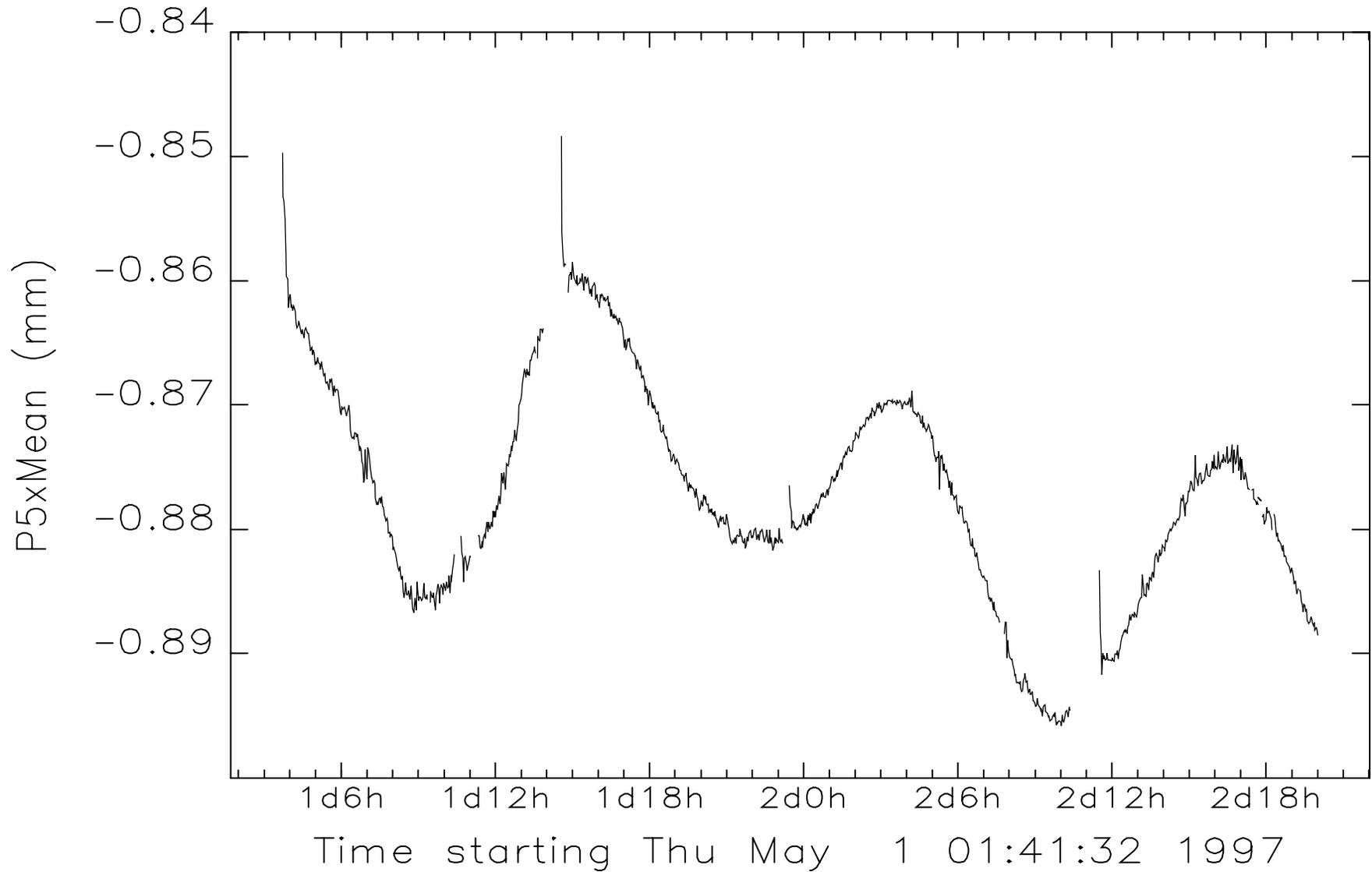
# BPM Sum Output vs. Single Bunch /Cluster Current - Sector 2 - 3/2/98



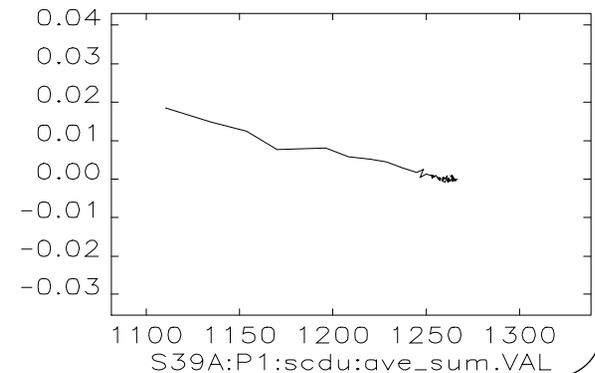
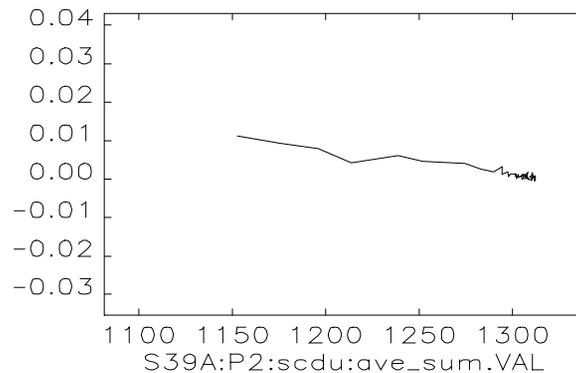
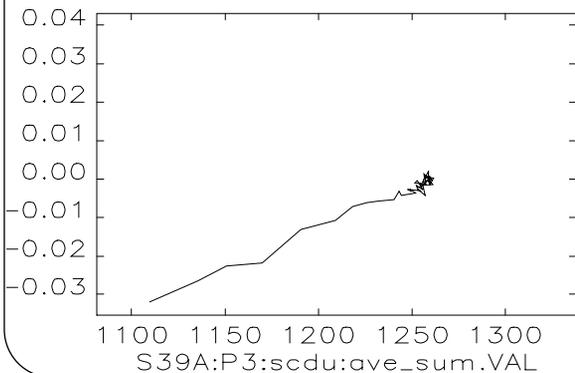
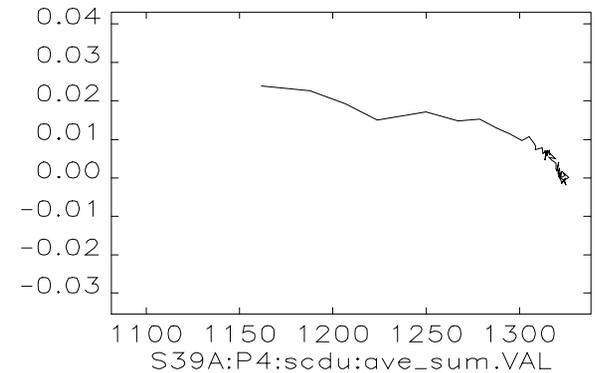
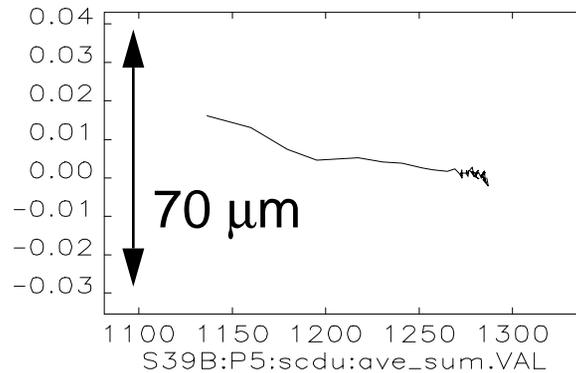
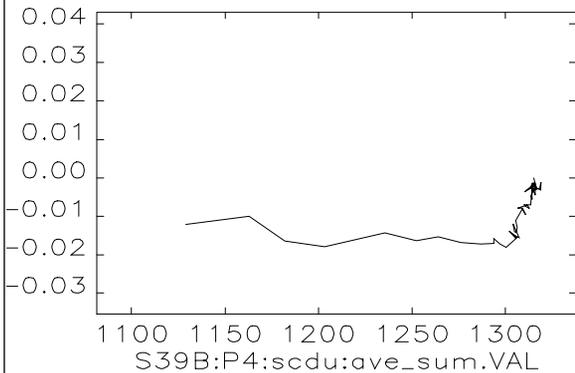
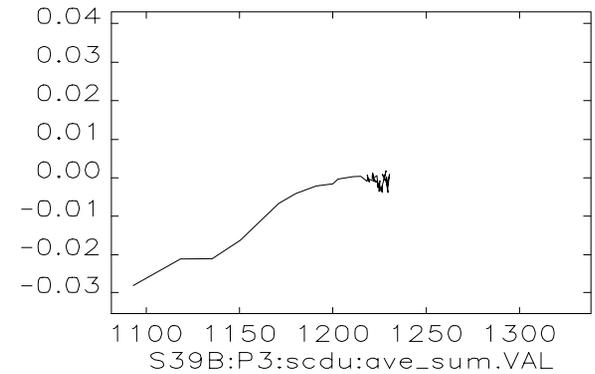
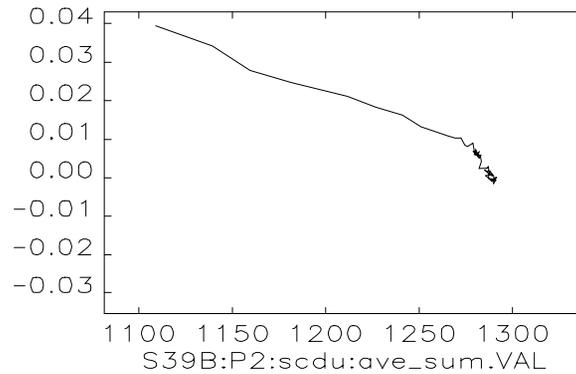
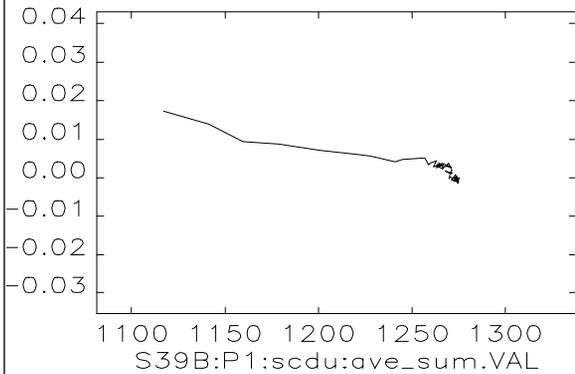
# Long Term Drift Data

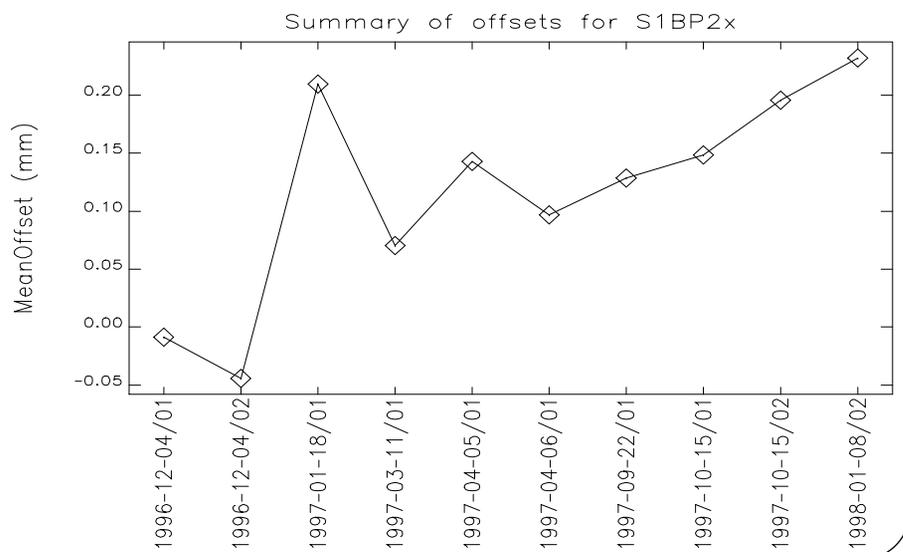
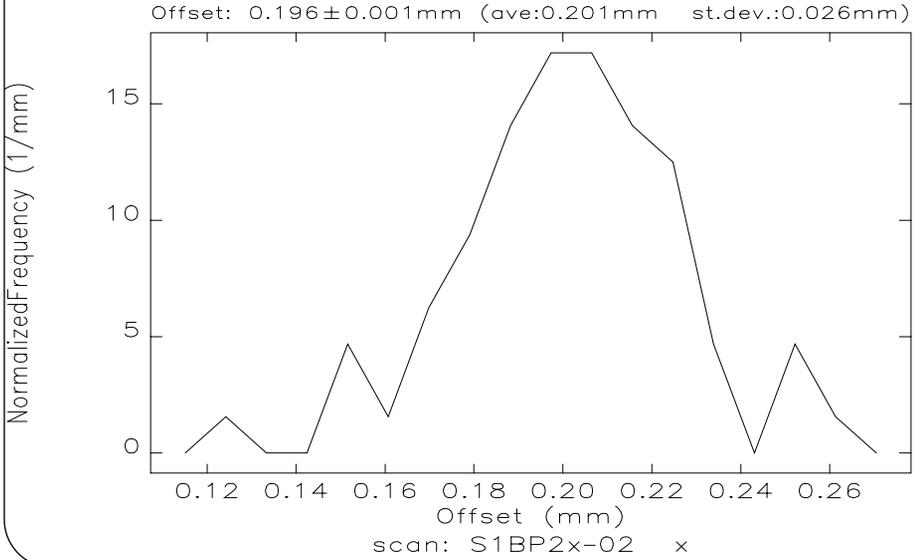
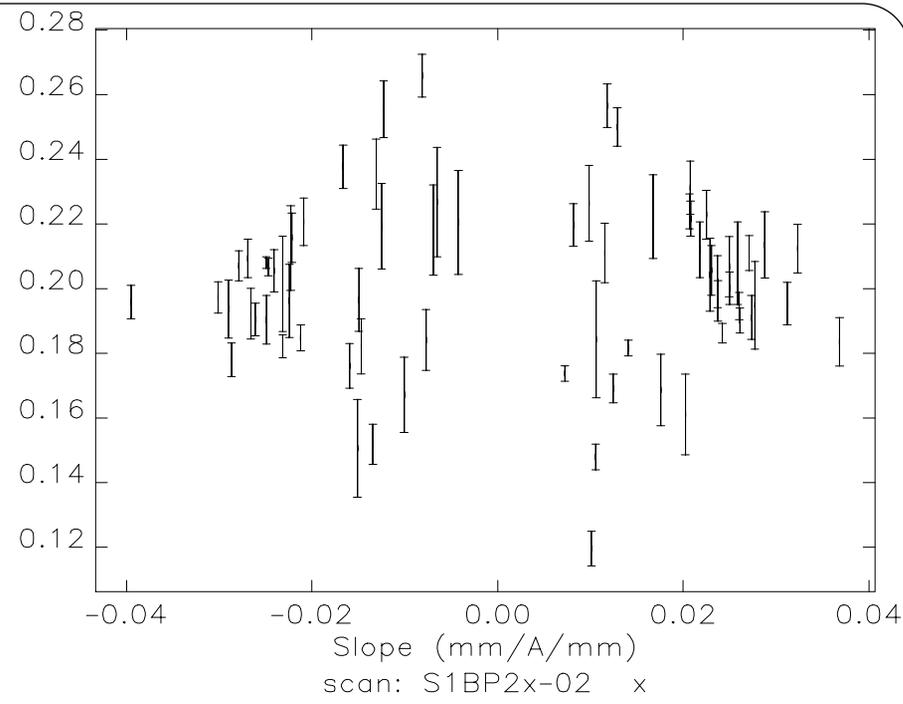
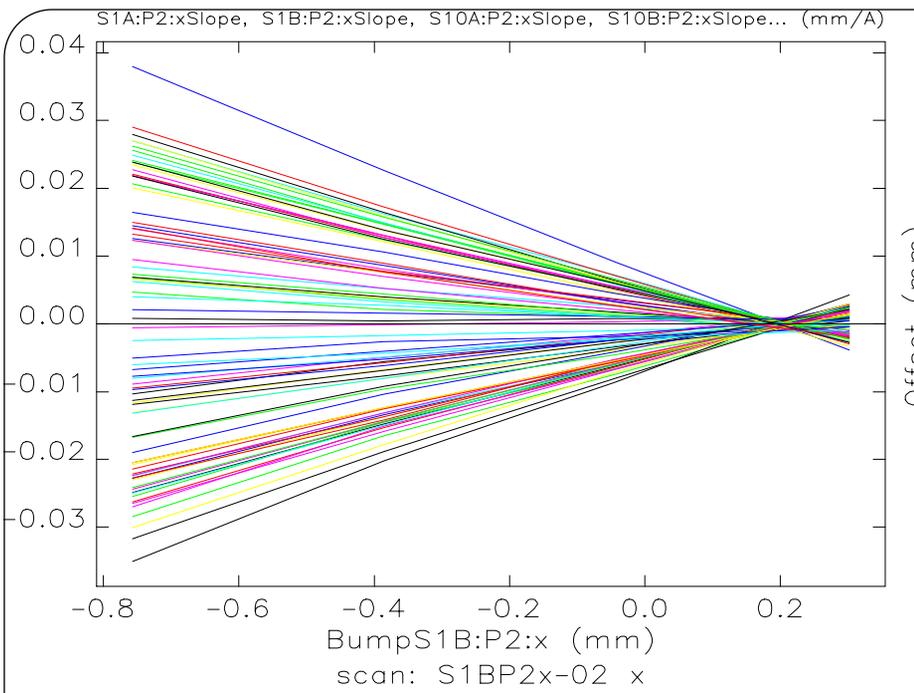


Horizontal Position Averaged at High Dispersion Locations

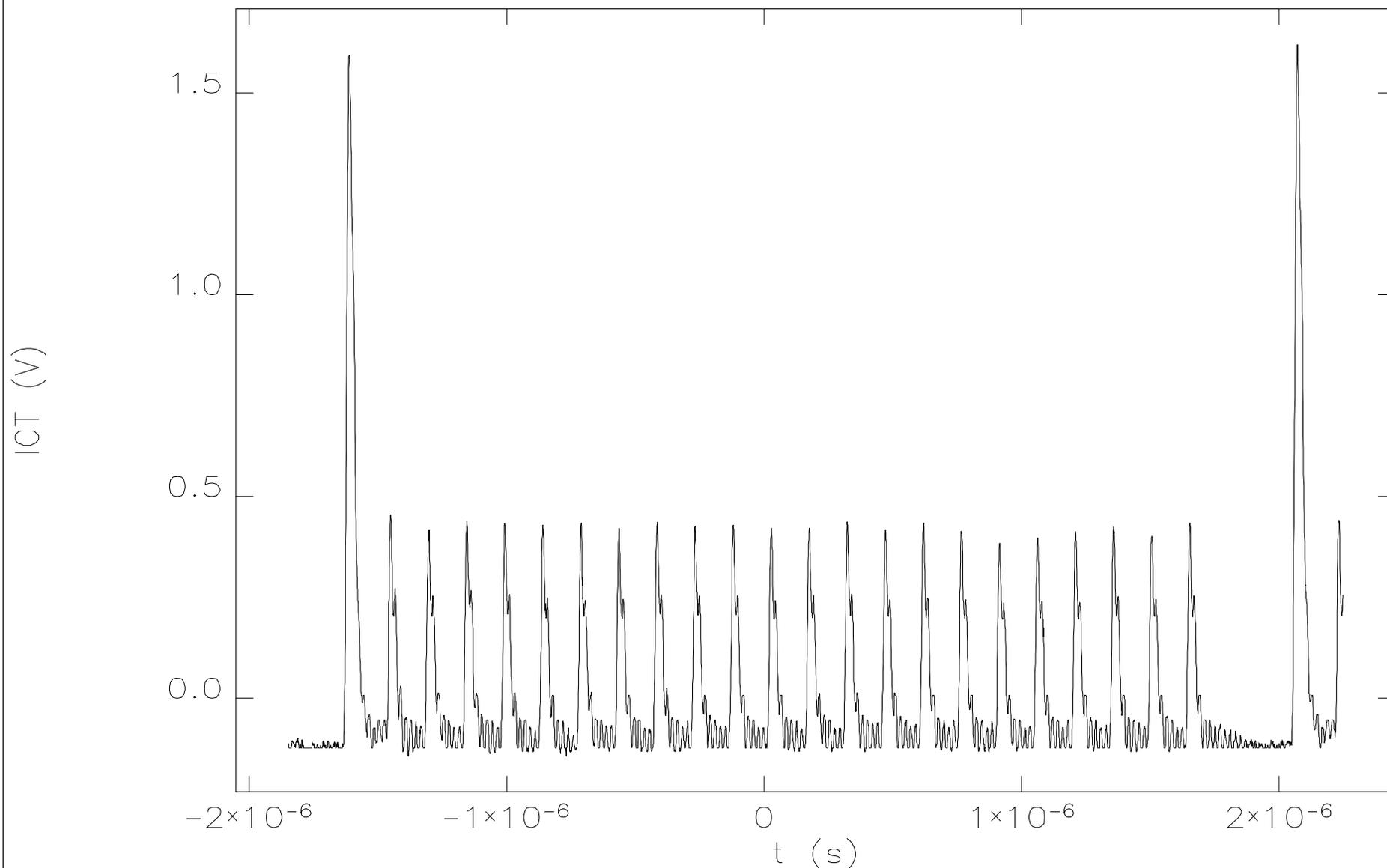


# Vertical Position ( in microns) vs. Intensity During Beam Scrapedown





Fill #70 fill pattern 6+22 Singlets



Sun Apr 12 08:03:14 1998

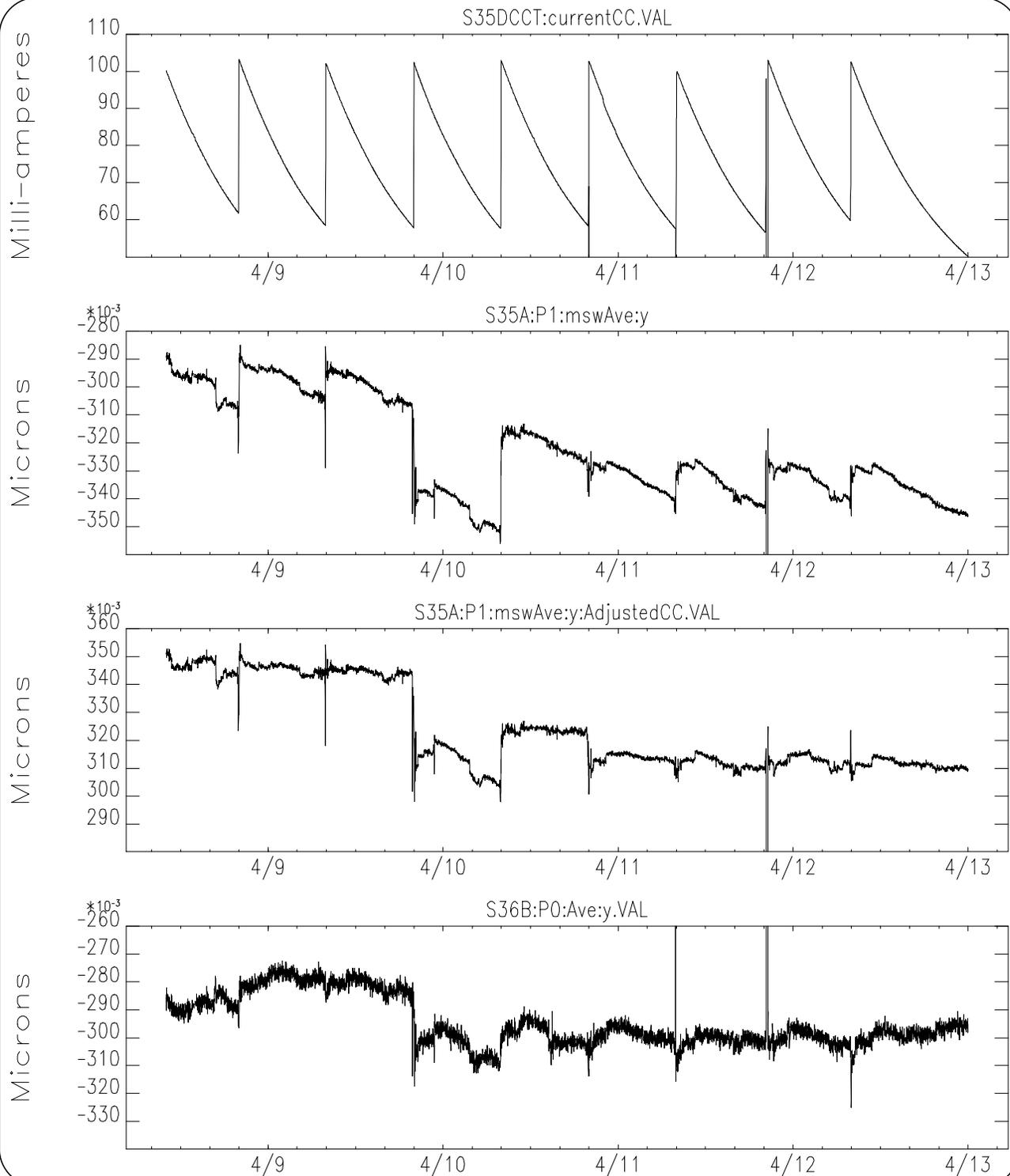
Argonne National Laboratory  
Advanced Photon Source  
ASD Diagnostics



BPM Review  
Glenn Decker  
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# Monopulse vs. Switched Receiver Comparison

(Vertical)

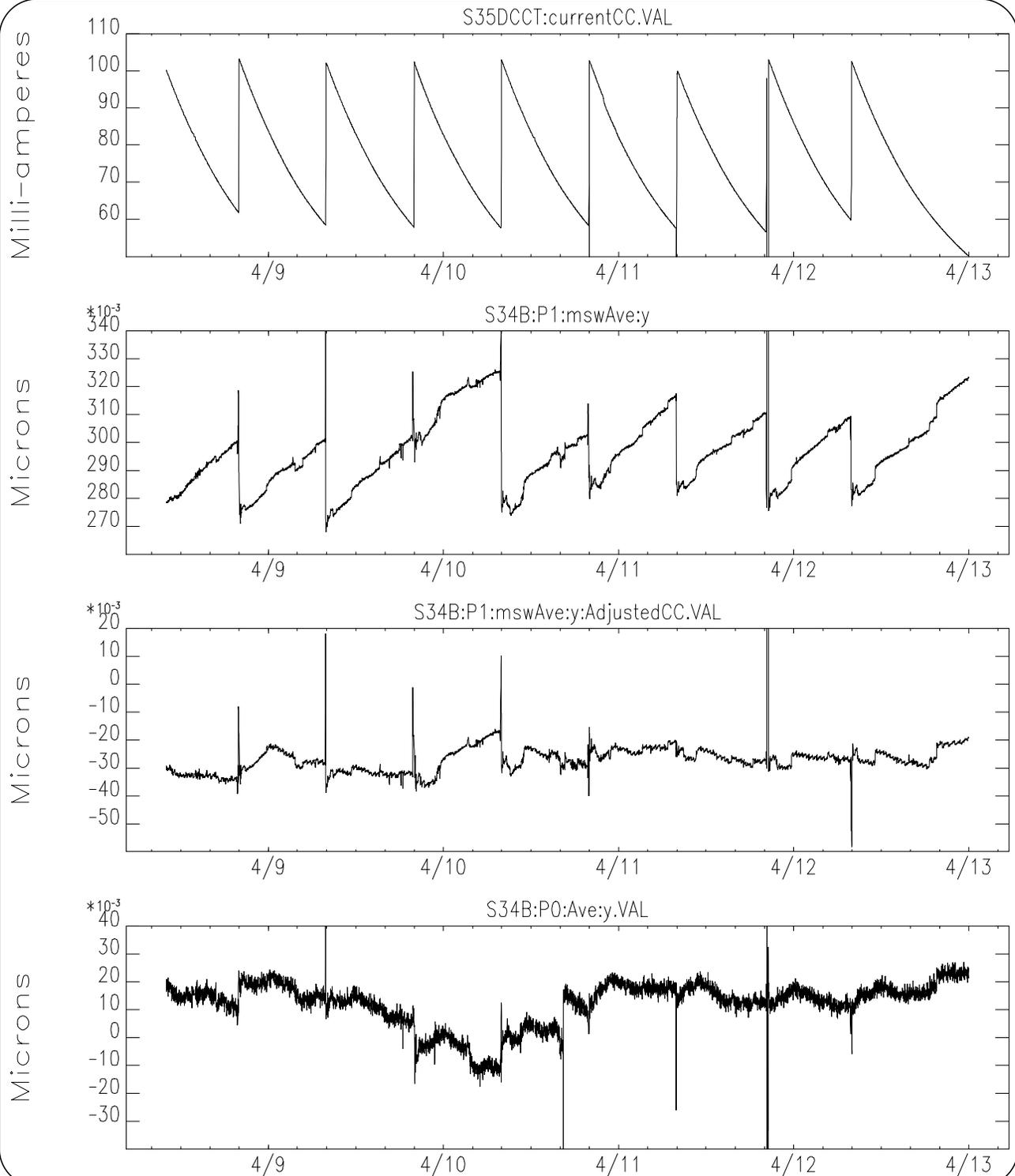


Courtesy of O. Singh, ANL



# Monopulse vs. Switched Receiver Comparison

(Vertical cont'd)

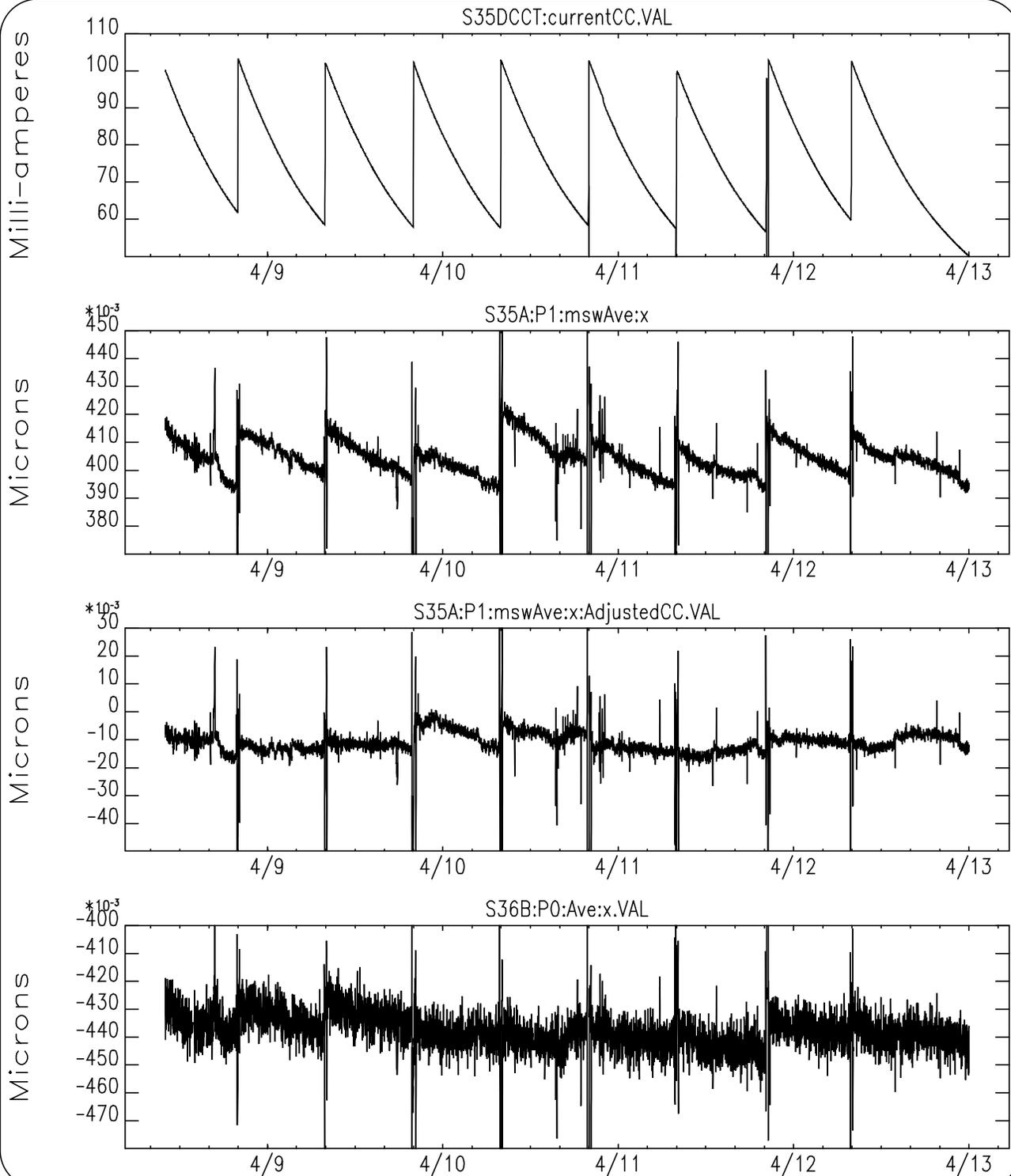


Courtesy of O. Singh, ANL



# Monopulse vs. Switched Receiver Comparison

(Horizontal)

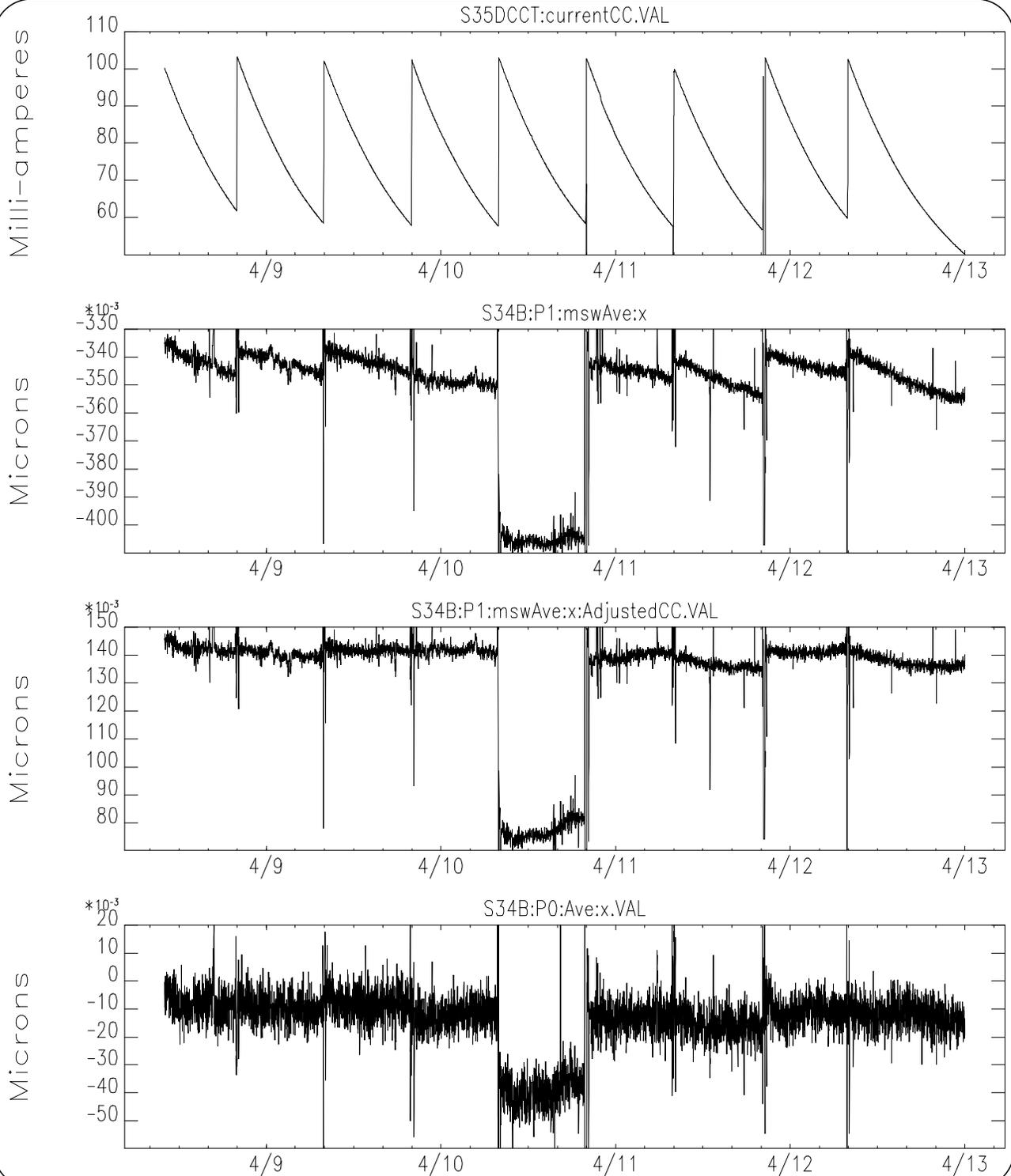


Courtesy of O. Singh, ANL



# Monopulse vs. Switched Receiver Comparison

(Horizontal cont'd)

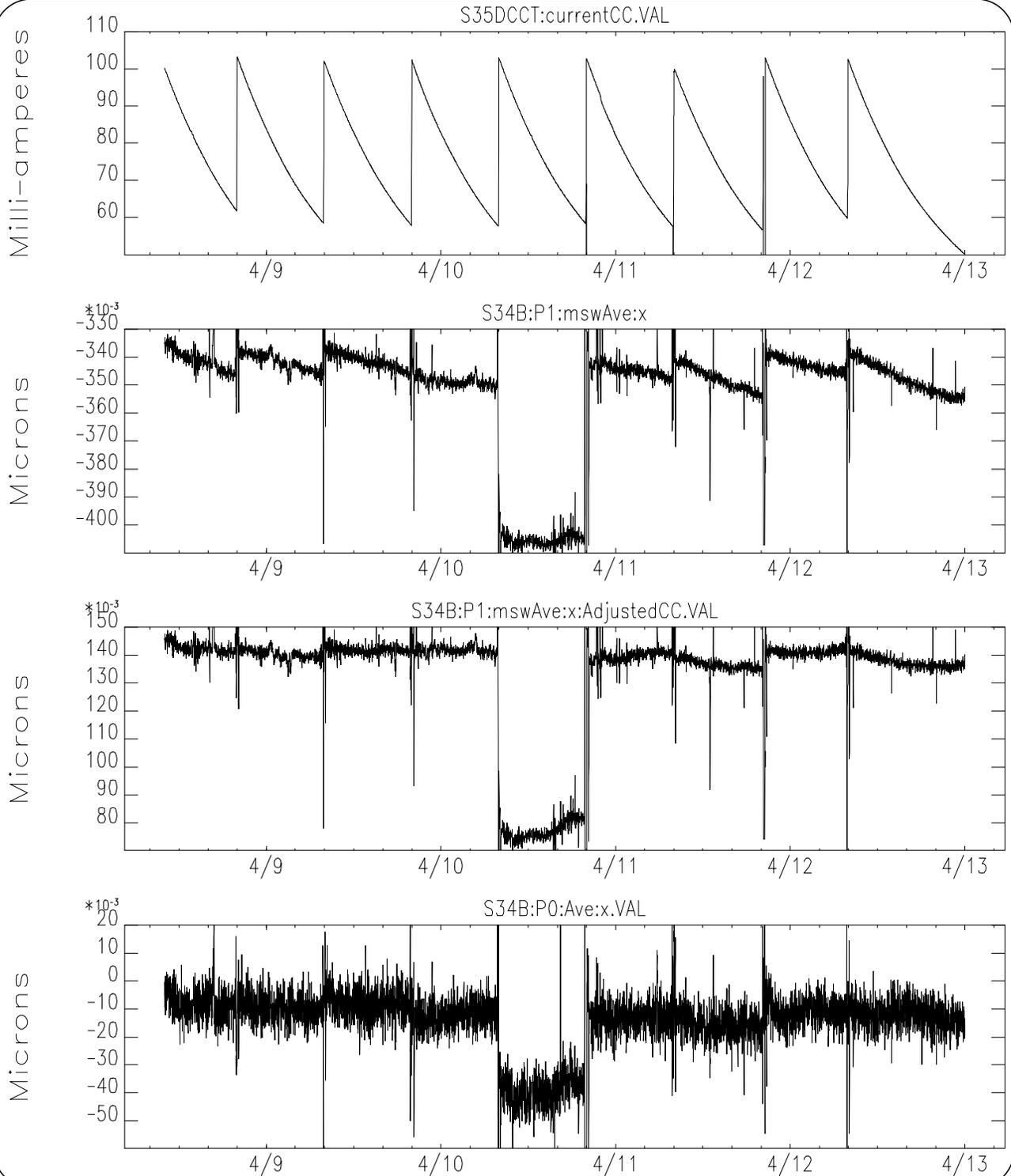


Courtesy of O. Singh, ANL



# Monopulse vs. Switched Receiver Comparison

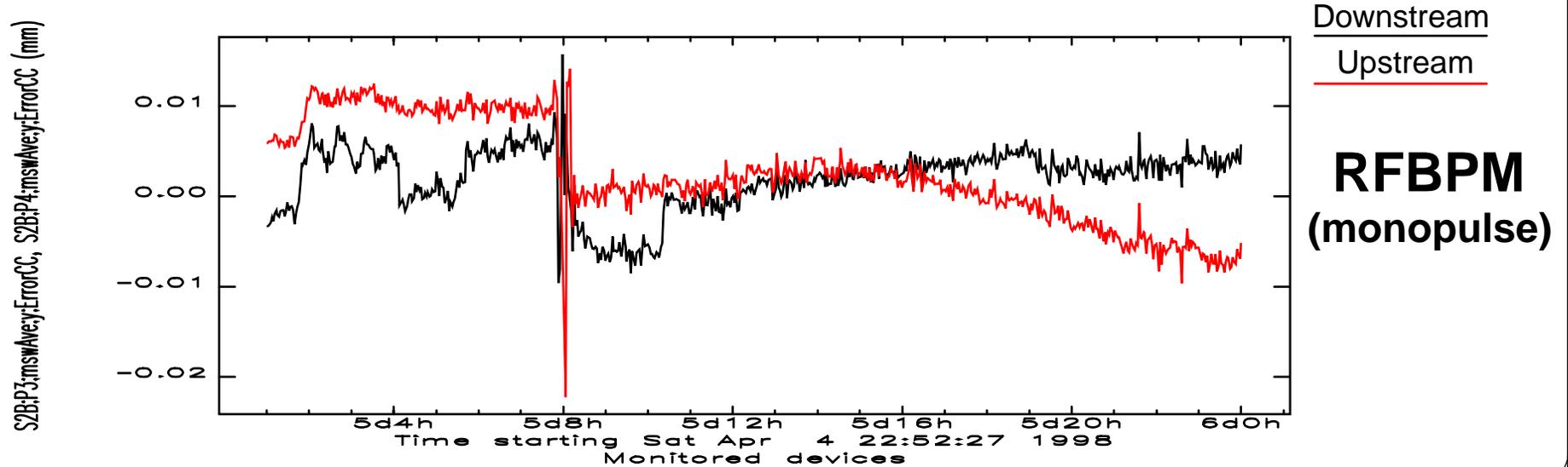
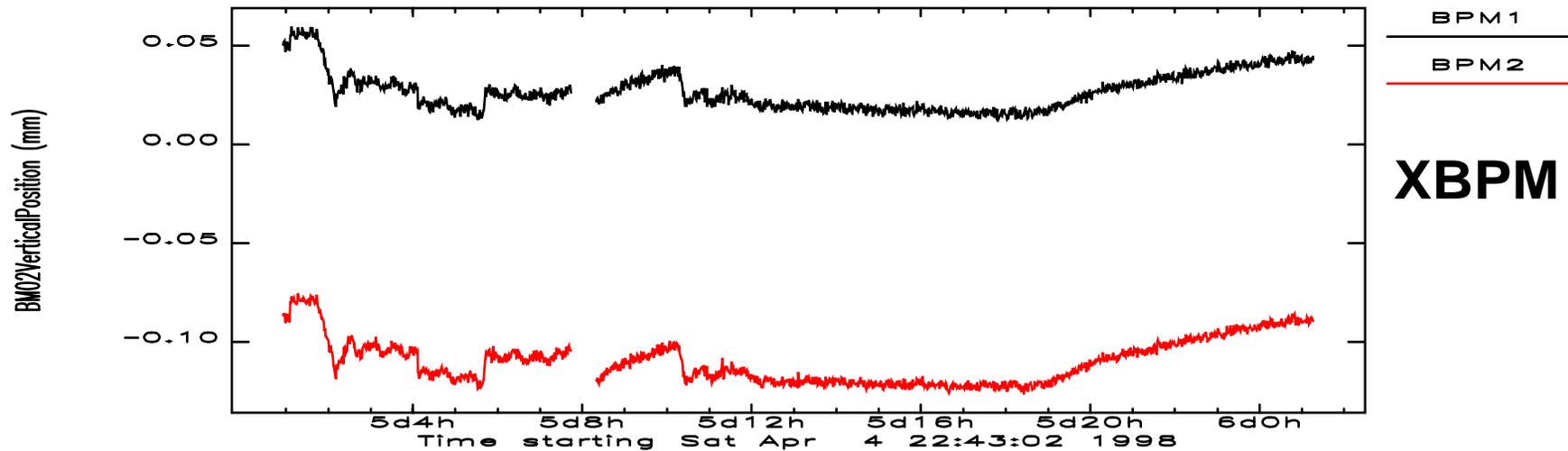
(Horizontal cont'd)



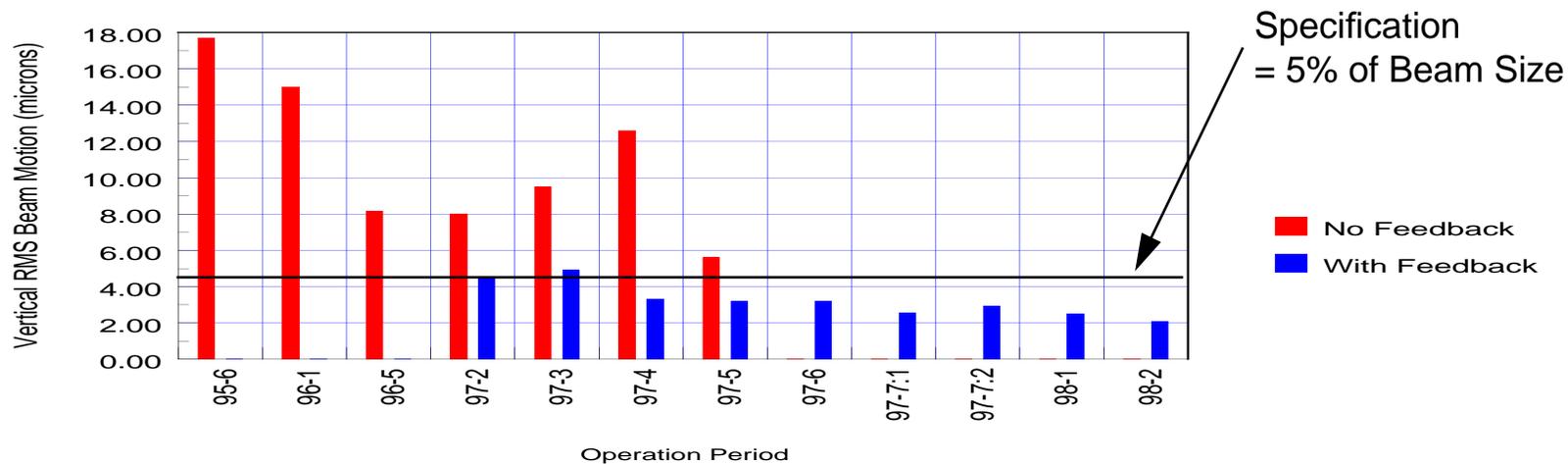
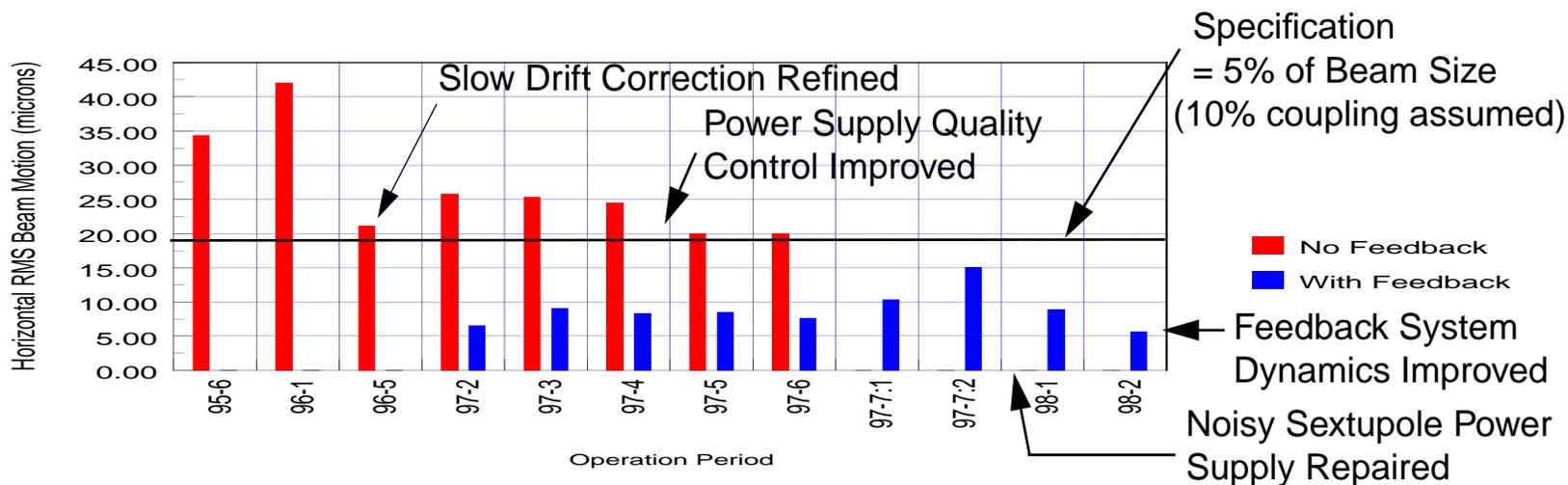
Courtesy of O. Singh, ANL



# Comparison of X-ray BPM and RF BPM Data, Beamline 2-BM



## APS Horizontal and Vertical Beam Position Stability History (DC - 30 Hz)

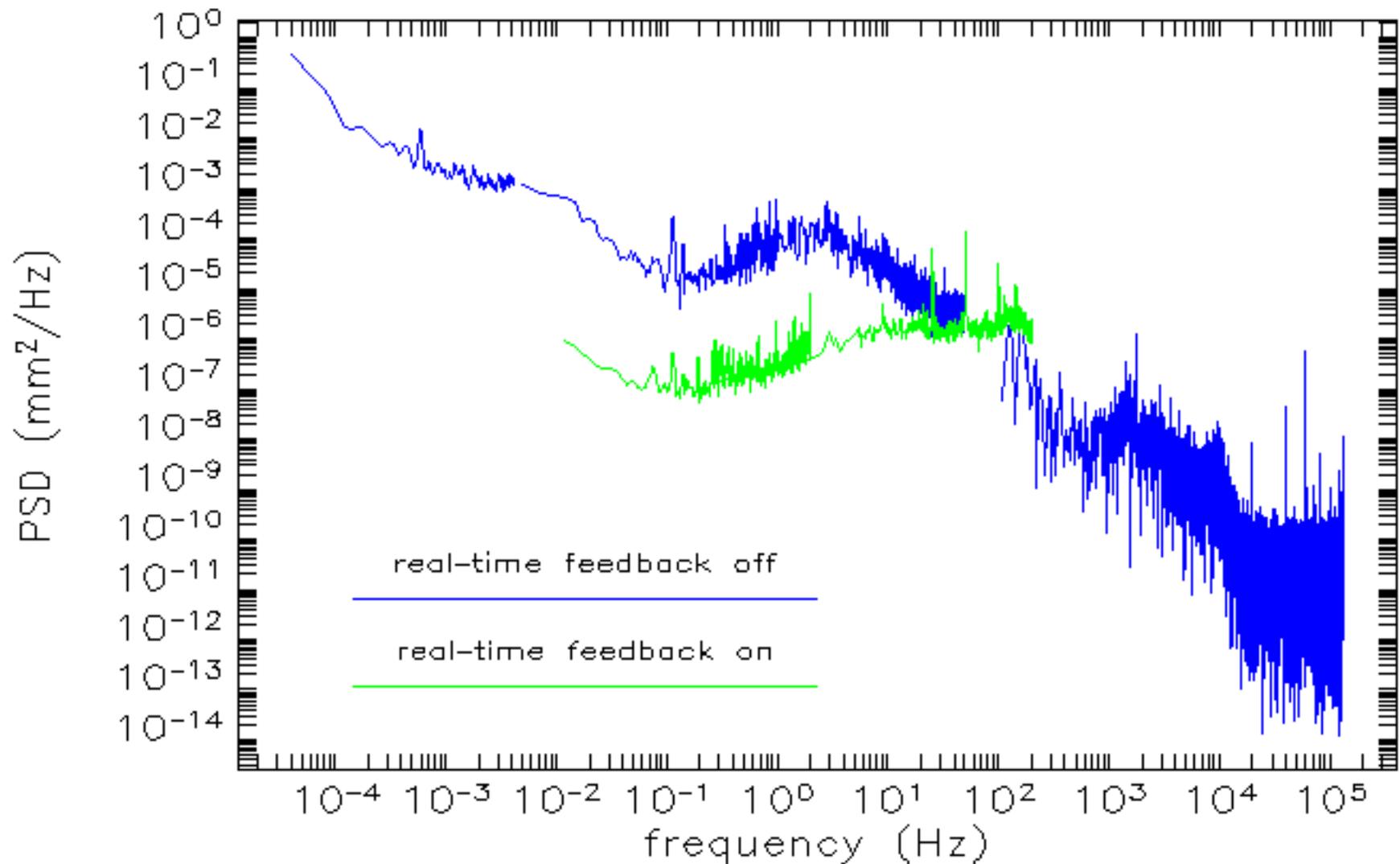


# Specifications

## Front End Upgrade - System

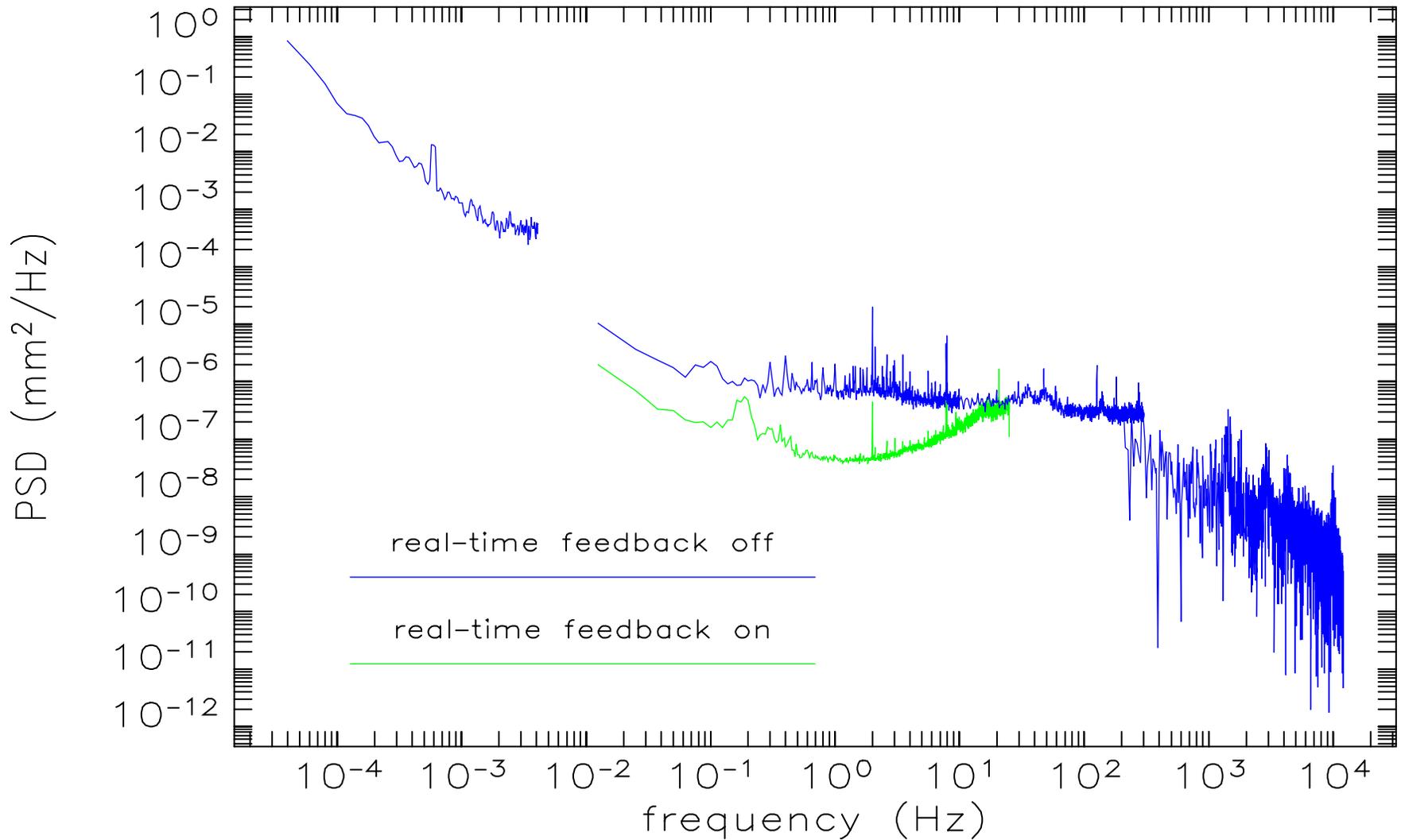
- **Center Frequency** 351.927 MHz
- **Button interface output power** 0.5 W avg, 800 W peak
- **Matching network impedance** 50 Ohms
- **Return loss into network** 25 dB (30 dB design goal)
- **Return loss into BPF** 25 dB (30 dB design goal)
- **Insertion loss** ALARA
- **Standard bunch pattern** 352 MHz tone burst < 20 ns evenly spaced 102 ns apart
- **Max. single bunch current** 20 mA
- **Min. single bunch current** 0.2 mA (normal operation)  
0.05 mA (derated operation)
- **--> Dynamic Range (Intensity)** 40 dB
- **BPF Time Domain Side Lobe Rejection** -50 dBc @101 ns
- **BPF Amplitude Match (4 units)** +- 0.2 dB across pass band
- **BPF Phase Match** +- 5 deg. across pass band
- **BPF Ring Down Time** -50 dB in 100 ns
- **Cancellation Ratio (Boresight Null)** 40 dB ( 200 microns offset)

# Horizontal Mean PSD at Insertion Device Source Points



data from 10/21/96 1/11/97 1/25/97 5/4/97

# Vertical Mean PSD at Insertion Device Source Points



data from 1/11/97 3/04/97 5/4/97