

# Emittance from RHIC HF Schottky

## Hardware

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## Software

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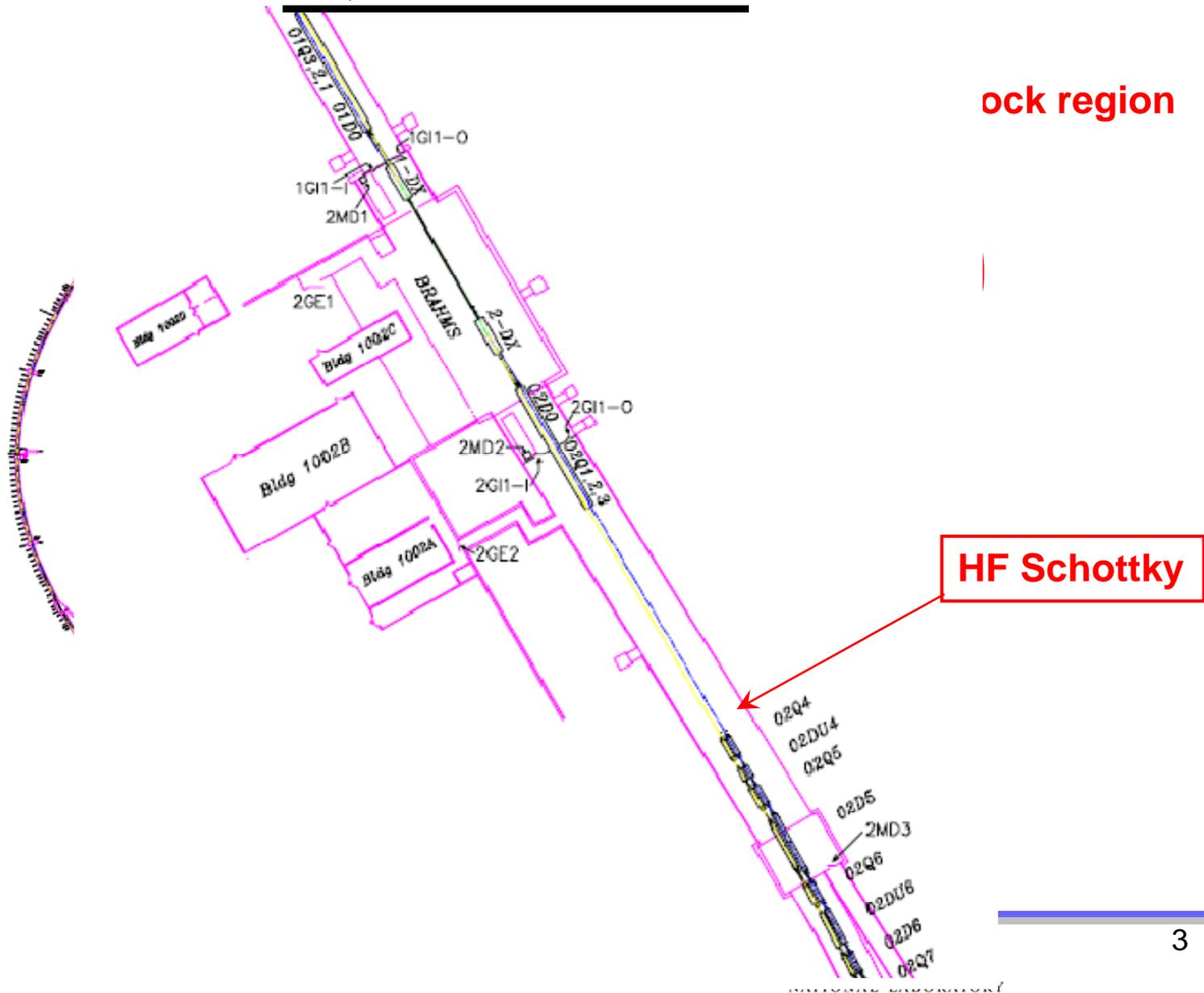
## Physics

*M. Blaskiewicz, K.A. Brown*

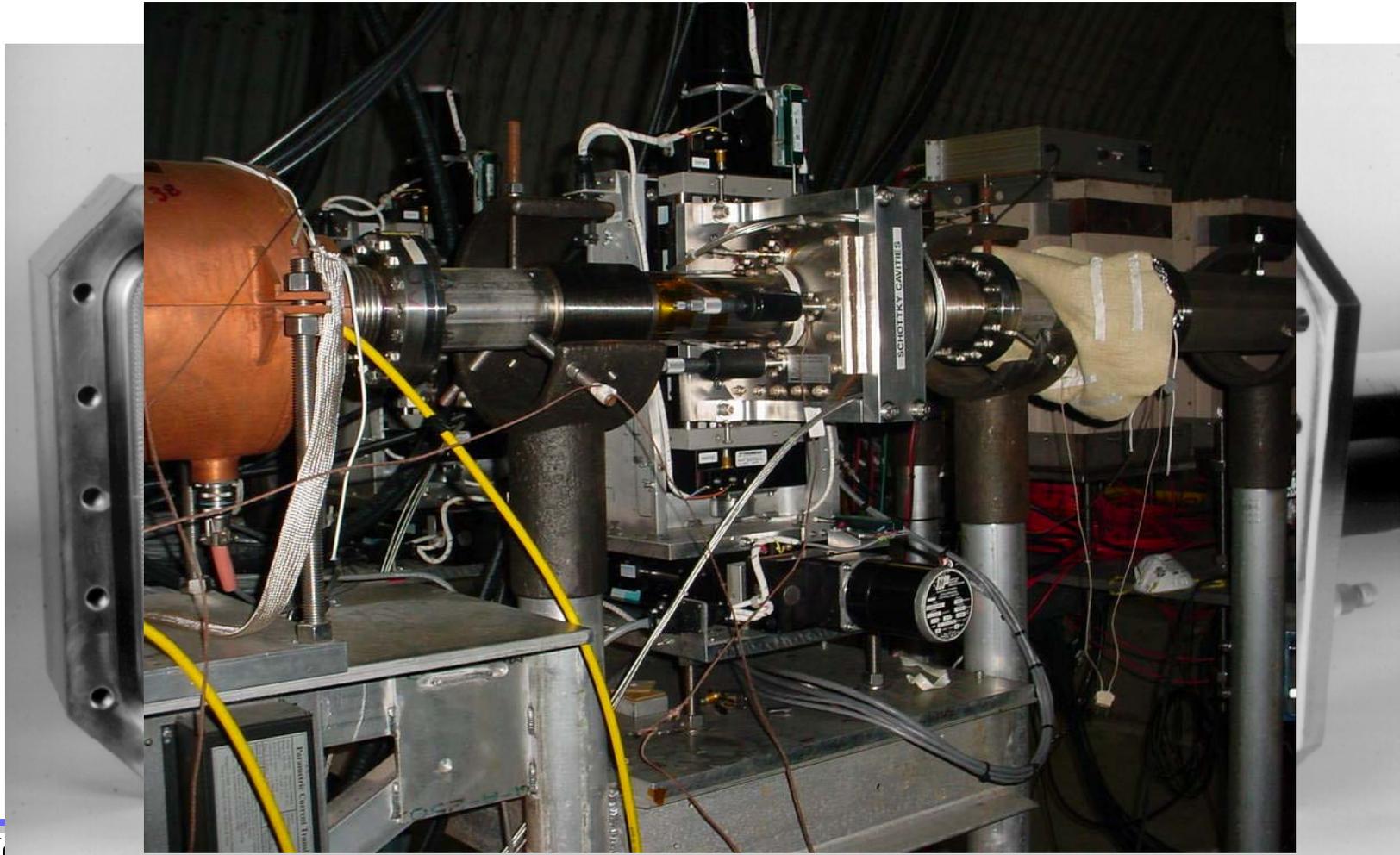
# Contents

- RHIC HF Schottky System
- Using Schottky power to measure beam size.
- Results from Run8 studies.
- Plans for Run9

# Quick Tour

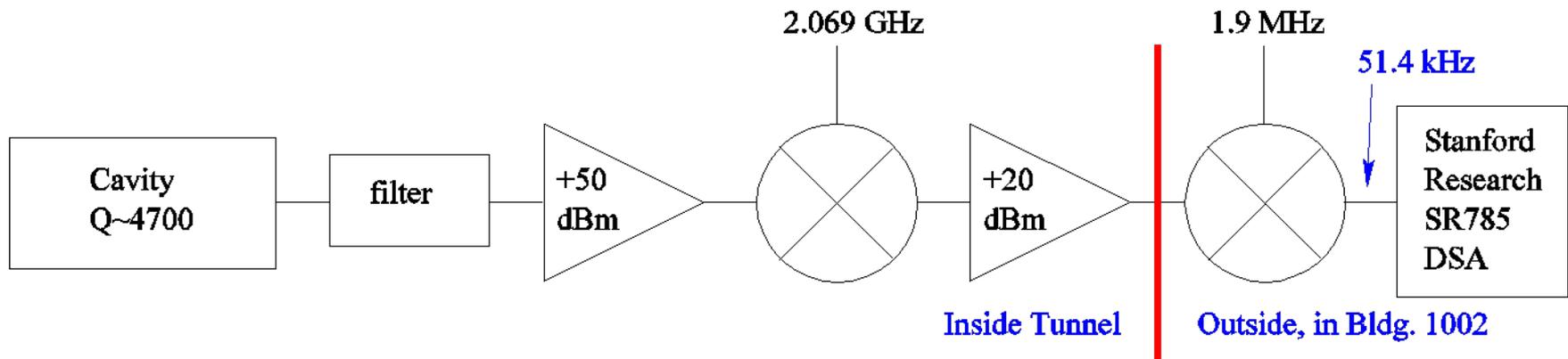


# HF Cavities in RHIC

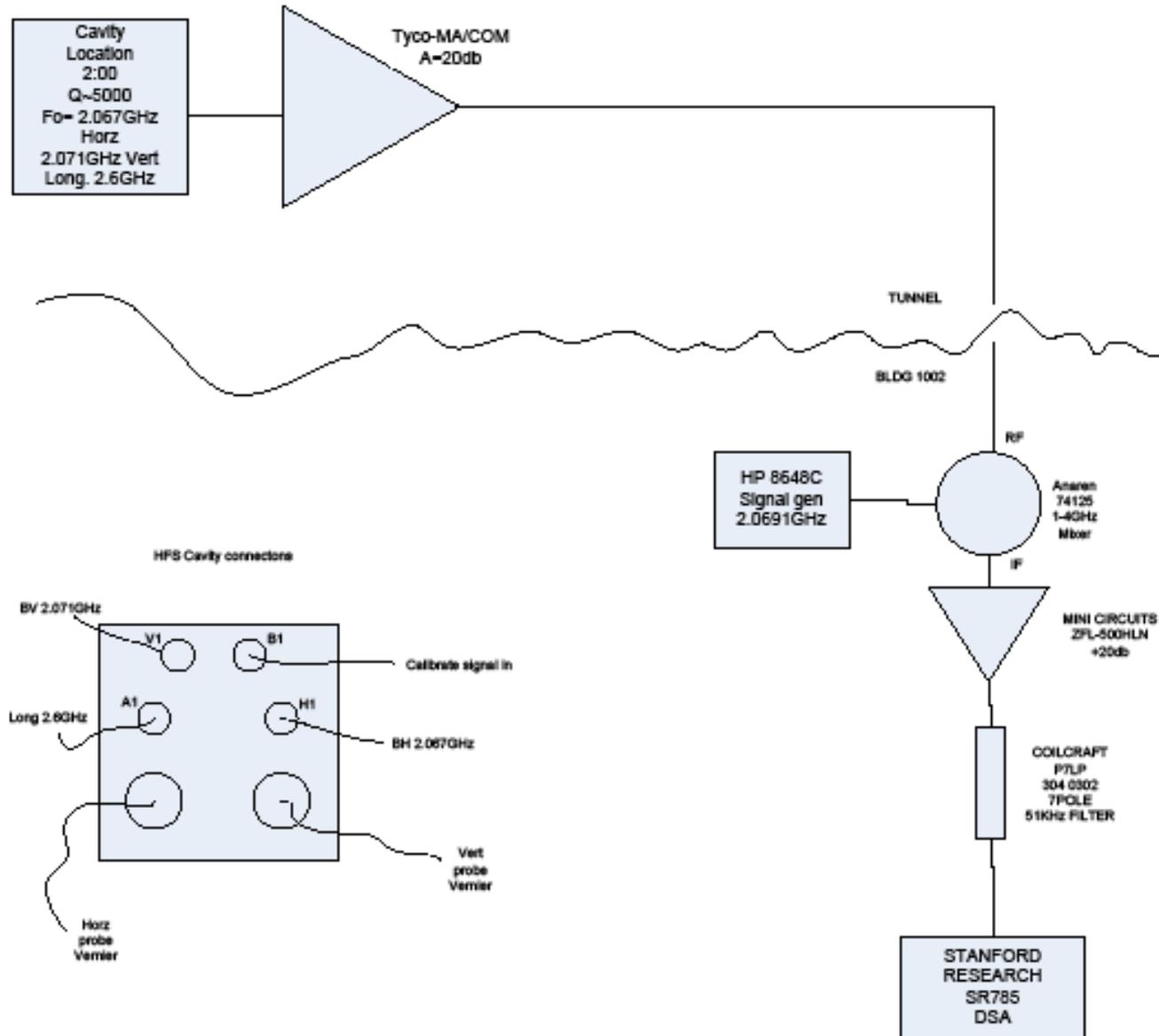


K  
5, 2008

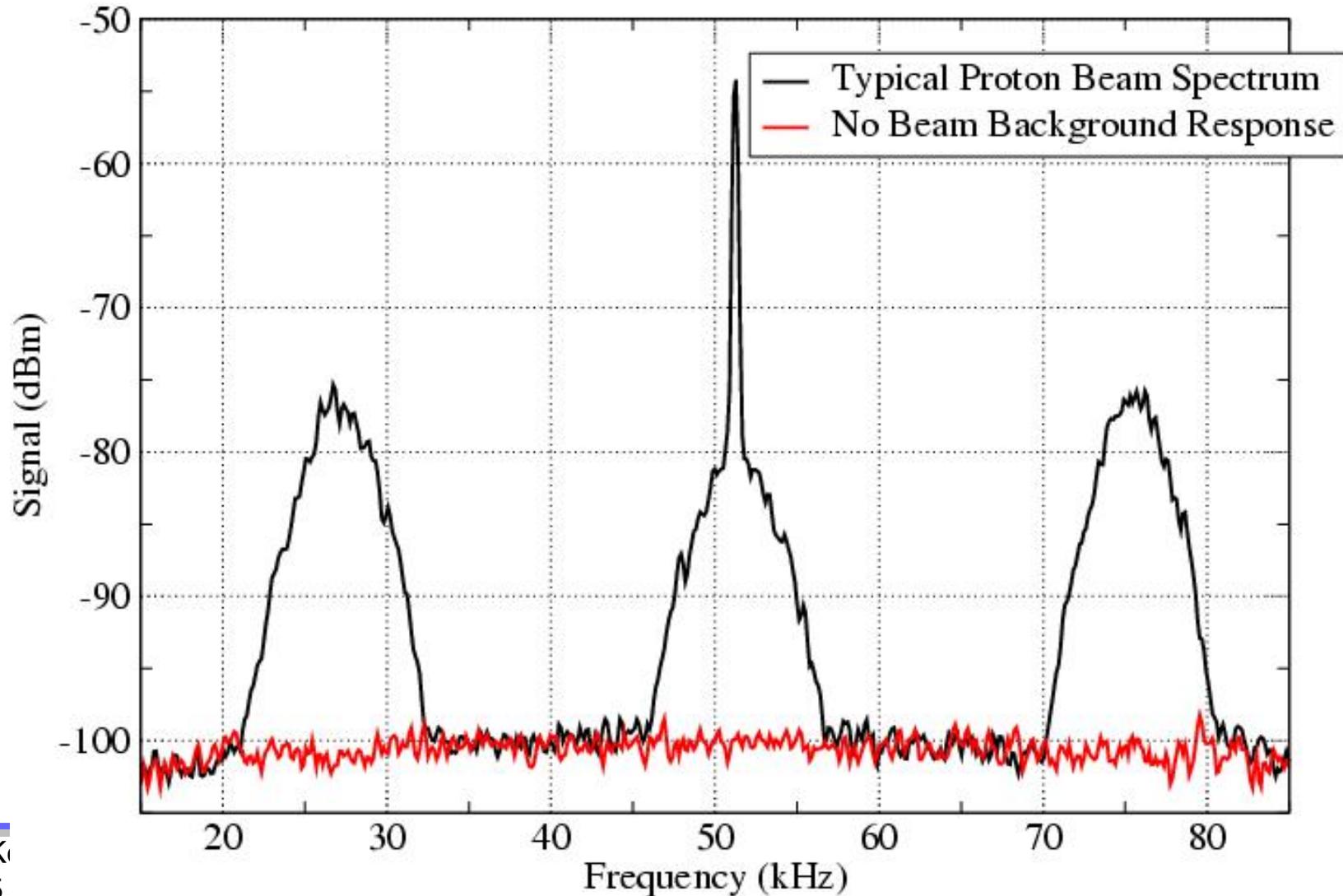
# Signal Processing



# System for FY09



# Typical HF Transverse Spectrum



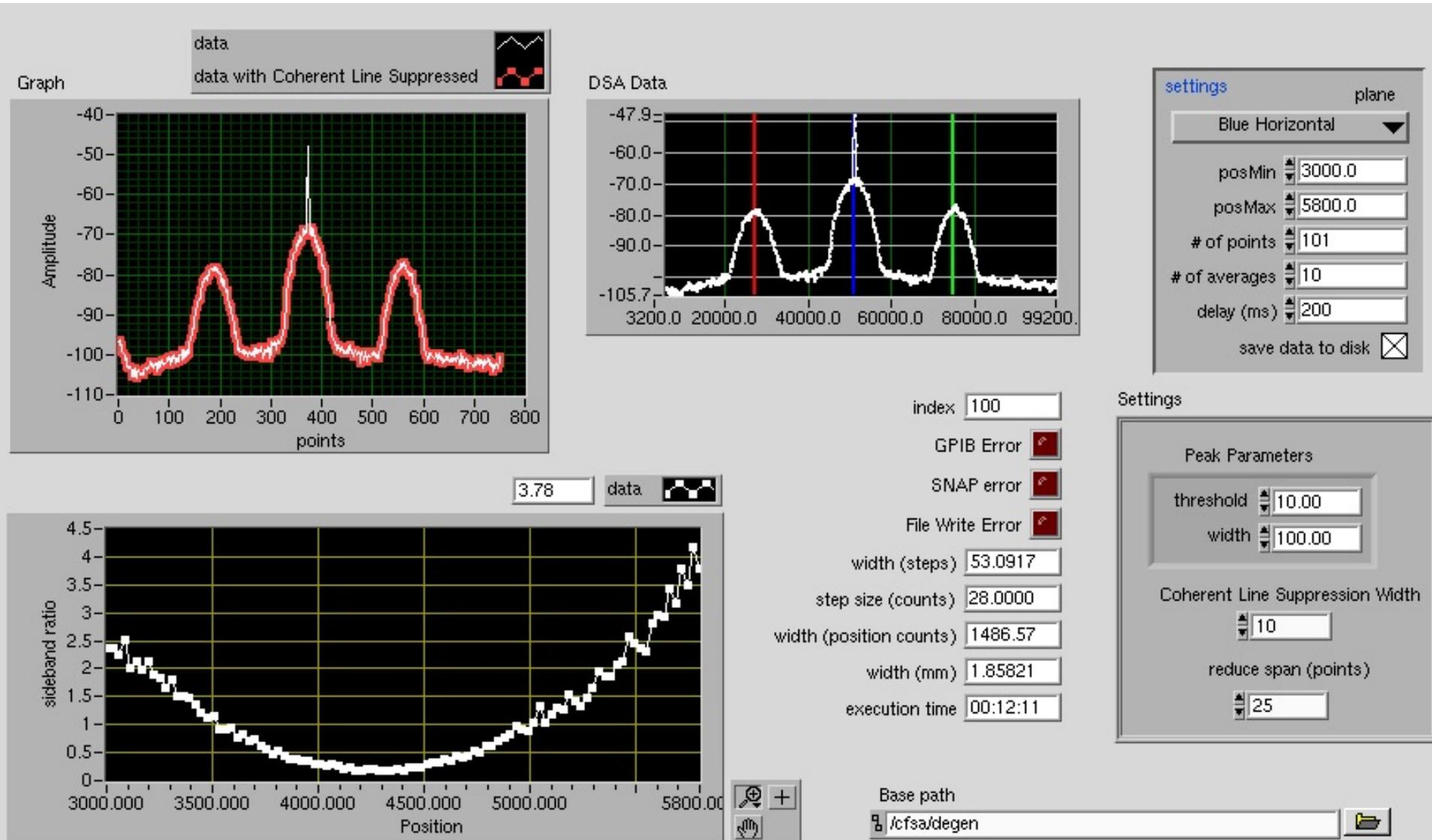
# HF Schottky Emittance Measurement

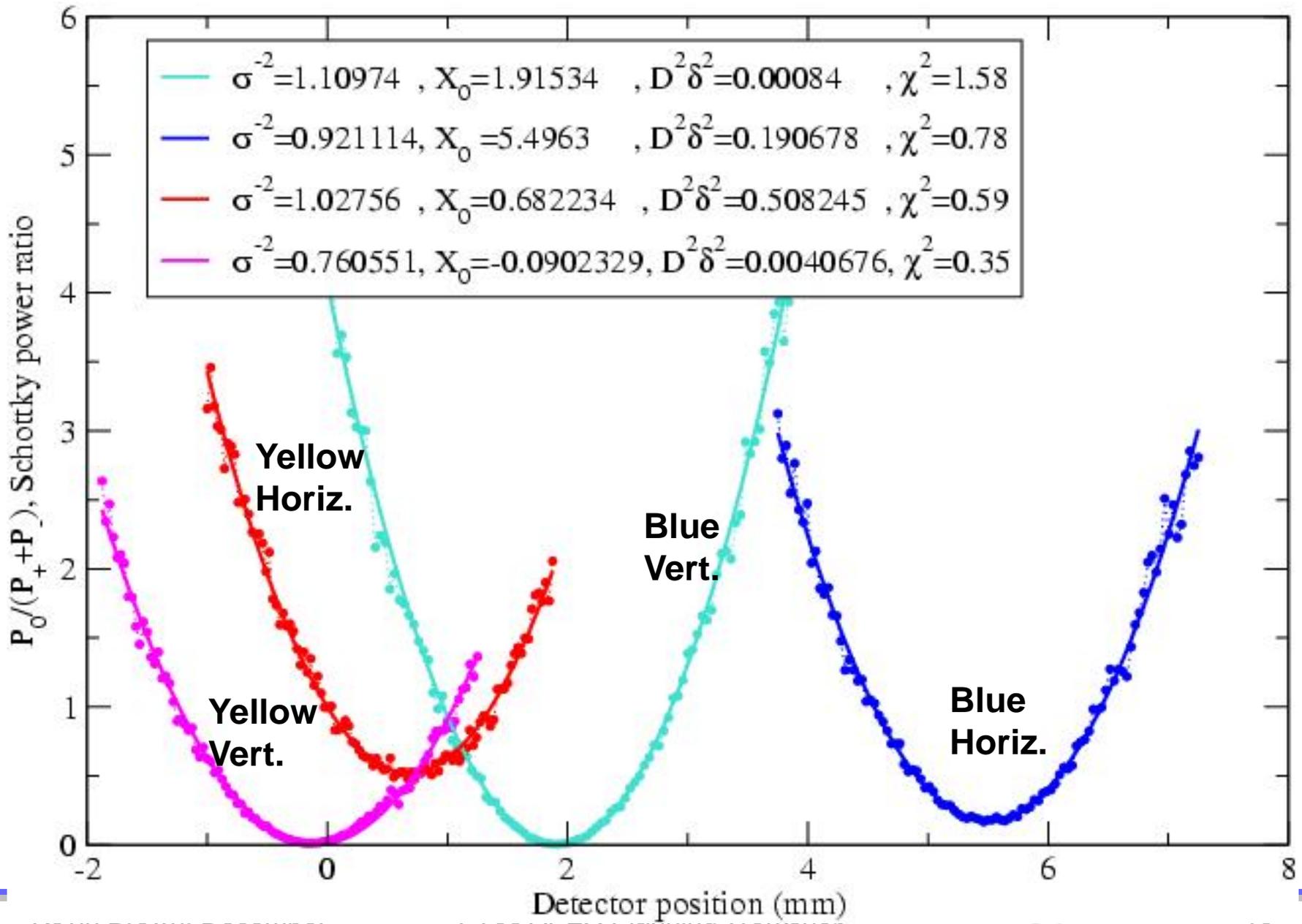
- rms beam size,  $\sigma$ , is derived by taking the ratio of the power in the revolution line to the betatron lines.

$$\frac{P_0}{P_u + P_l} = \frac{(X - X_0)^2}{\sigma^2} + \frac{D^2 \delta^2}{\sigma^2}$$

- To measure, scan  $X$  and fit the resulting parabola to find  $\sigma$ ,  $X_0$ , and the offset. {i.e.,  $y=a(x-x_0)^2 +ab$  }.
- Note that the offset contains the dispersion.

# A typical scan and FY08 interface





# New Interface in pet (work in progress)

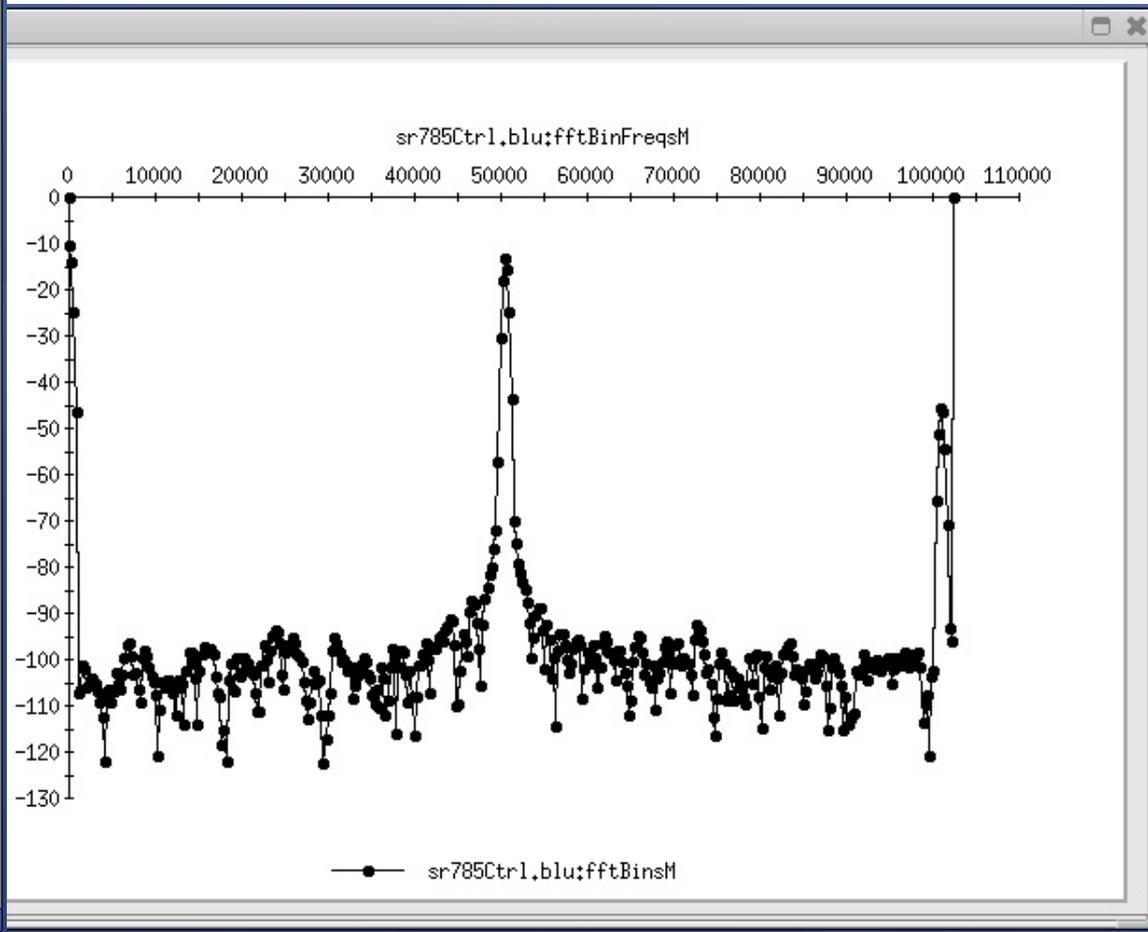
Temp ADO Page 2

Page PPM Device Data Tools Buffer Help

sr785Ctrl1.blu	fecName	acnlin86.pbn.bnl
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sr785Ctrl1.blu	constructTime	1227294008
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sr785Ctrl1.blu	className	sr785Ctrl
sr785Ctrl1.blu	commandBuffer	%
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sr785Ctrl1.blu	scanDelayS	1
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sr785Ctrl1.blu	debugS	0
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sr785Ctrl1.blu	responseM	
sr785Ctrl1.blu	sendCmdS	SEND
sr785Ctrl1.blu	freqSpanS	102400.000
sr785Ctrl1.blu	freqCenterS	51200.000
sr785Ctrl1.blu	traceLengthM	401
sr785Ctrl1.blu	startFrequencyM	0.000
sr785Ctrl1.blu	stopFrequencyM	102400.000
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sr785Ctrl1.blu	traceReadCountM	1005
sr785Ctrl1.blu	scratchM	0
sr785Ctrl1.blu	fftBinsM	[-10.587 -13.931
sr785Ctrl1.blu	fftBinFreqsM	[0.000 256.000..
sr785Ctrl1.blu	instrumentIdentityM	Stanford_Research
sr785Ctrl1.blu	testParm2M	Stanford_Research
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sr785Ctrl1.blu	readDisplayBTraceA	Read Trace
sr785Ctrl1.blu	readStuffA	Read Stuff
sr785Ctrl1.blu	doStuffA	Do Stuff
sr785Ctrl1.blu	readBinFreqsA	Read Bin Freqs
sr785Ctrl1.blu	readIdentityA	Read Identity
sr785Ctrl1.blu	myDebugS	Off

(27,3) sr785Ctrl1.blu:readTraceA Nudge: 0 149

Wed Dec 3 14:51:07 2008: Value sent for (27,3)  
Wed Dec 3 14:51:07 2008: Value sent for (27,3)



# Plans for FY09

- Analysis will be pulled up into a new manager with ADO and pet interfaces.
- The new manager will:
  - scan the position of the detector during stores (every 10 to 20 minutes, frequency & start event yet to be determined)
  - Amount of motion will be small, ~ 2 mm
  - generate the parabola's and fit them
  - use the on-line model  $\beta$ -functions and publish the answers to be logged.
- Signal processing will be modified to avoid saturation (overdriving amplifiers, etc.).
  - Minimal signal gain in the tunnel = just enough to compensate for cable losses.
  - Mixing and further gain, if needed, will be done in 1002.

# Studies?

- All studies efforts will be parasitic
- Main focus will be
  - Comparison to IPM's (and other instruments)
  - Scalability with intensity (compared to others)
  - Stability and variations
    - pulse to pulse
    - Long term
  - Improving precision (power measurement and fittings)

# Backup

# HF Cavity Parameters

Table 1: Cavity parameters.

Mode	Parameter	Value
TM <sub>120</sub>	Frequency	2.071 GHz
	$Q_{\text{unloaded}}$	10,000
	$R_{\perp} T^2 / Q$	900 $\Omega$
	$R_{\perp} T^2$	9 M $\Omega$ /m
TM <sub>210</sub>	Frequency	2.067 GHz
	$Q_{\text{unloaded}}$	10,000
	$R_{\perp} T^2 / Q$	900
	$R_{\perp} T^2$	9 M $\Omega$ /m

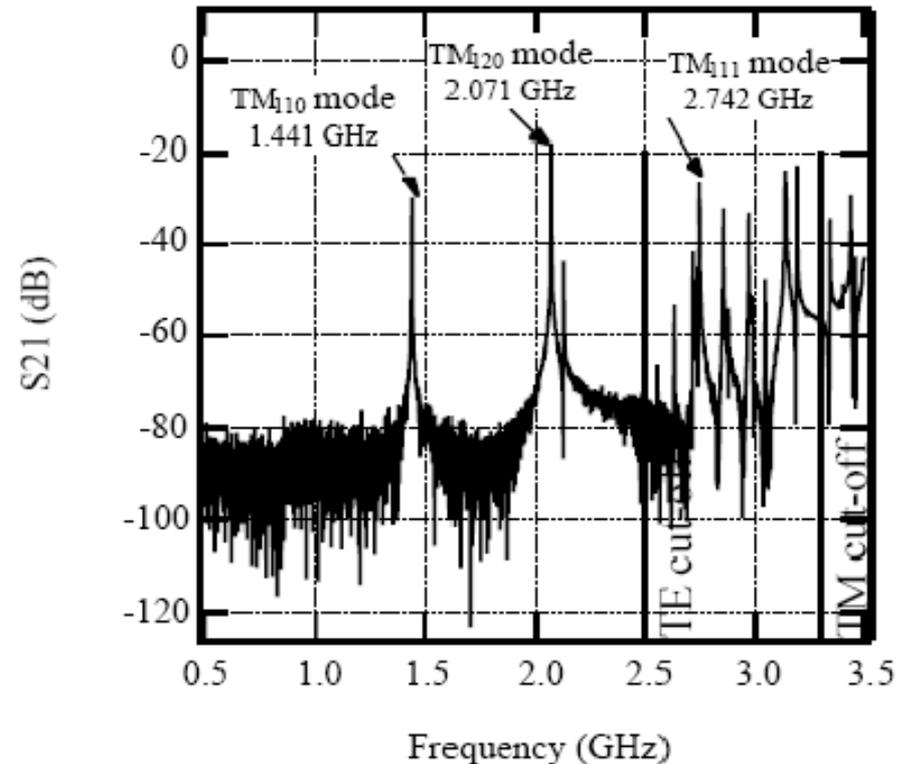


Figure 2: S21 spectrum measured from the vertical coupling probe to a 45° probe.

Proceedings of the 1998 European Particle Accelerator Conference (EPAC 98), Stockholm, pp.1514-1516, (1998)

Kevin Brown, December 5, 2008  
 W. Barry, J. N. Corlett, D. A. Goldberg, D. Li, LBNL Center for Beam Physics  
 FY09 APEX Planning Workshop

# Schottky Signal Power: Transverse Mode

1. signal in the revolution line of transverse mode

$$S_{0,m}(t) = \sum_{k=1}^N f_k Q e^{im(\omega_k t + \phi_k(t))} \left( X + \frac{(E_k - E_0)D}{\beta^2 E_0} \right)$$

*where the power in the revolution line is,*

$$P_0 = \left\langle |S_{0,m}(t)|^2 \right\rangle = f_0^2 Q^2 N \left( X^2 + \frac{\langle (E_k - E_0)^2 \rangle D^2}{(\beta^2 E_0)^2} \right)$$

2. The power in the betatron sidebands is:

$$P_u = P_l = f_0^2 Q^2 N \frac{\sigma^2}{2}$$

# Results from this scan.

BH emittance = 23 , IPM emittance = 23.5  
BV emittance = 20 , IPM emittance = 22.5  
YH emittance = 22 , IPM emittance = 19.0  
YV emittance = 26 , IPM emittance = 28.0  
(95 % normalized,  $\pi \mu\text{m}$  values)

{note: uncertainties on the order of 15%, all cases}

$\beta$ -functions used are (from On-line model) :

BH = 28 m

BV = 27 m

YH = 27 m

YV = 30 m