Emittance from RHIC HF Schottky

Hardware

J. Cupolo, C. Dawson, R. Schroeder, M. Wilinski

Software

C. Degen, R. Lee

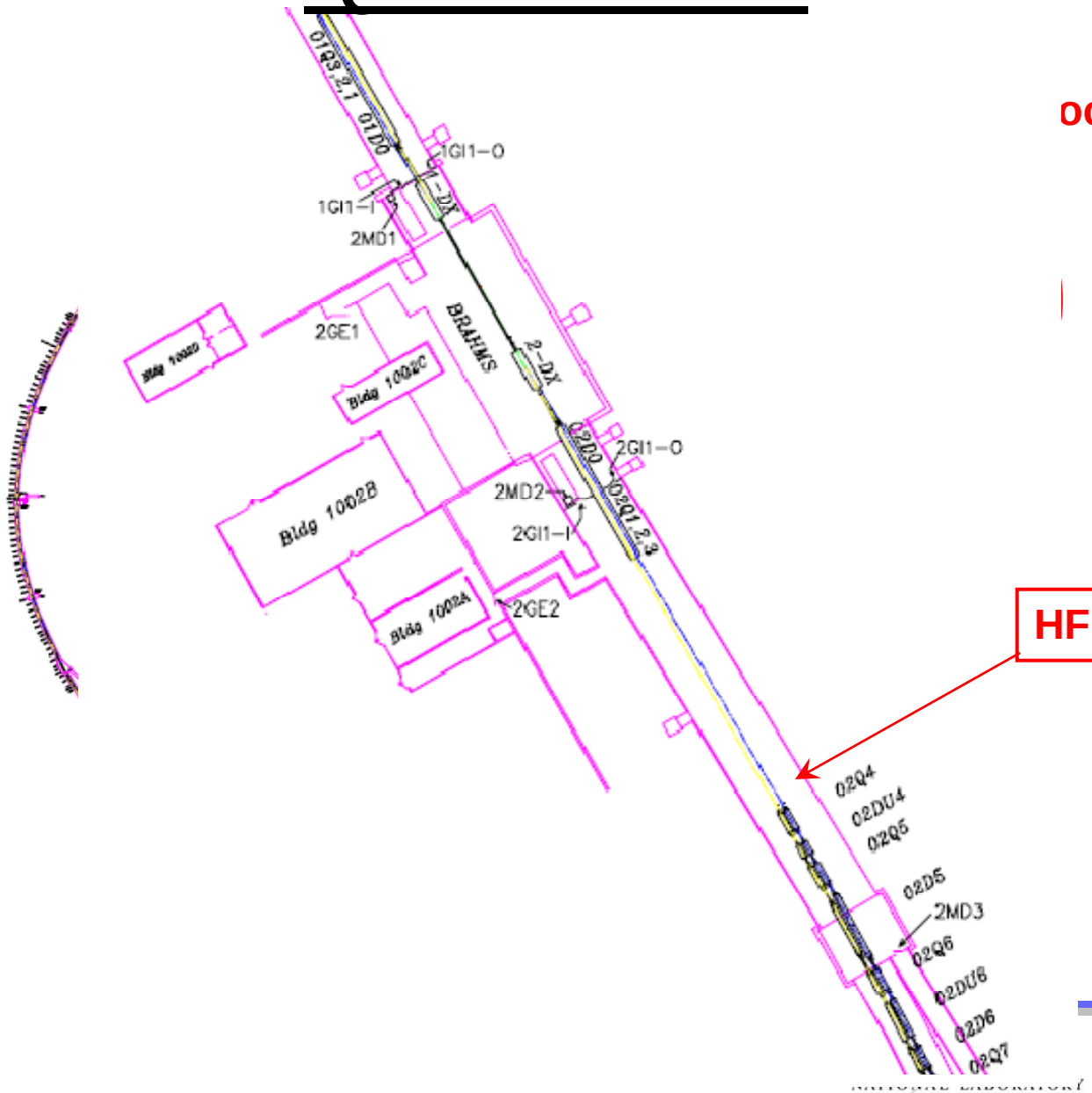
Physics

M. Blaskiewicz, K.A. Brown

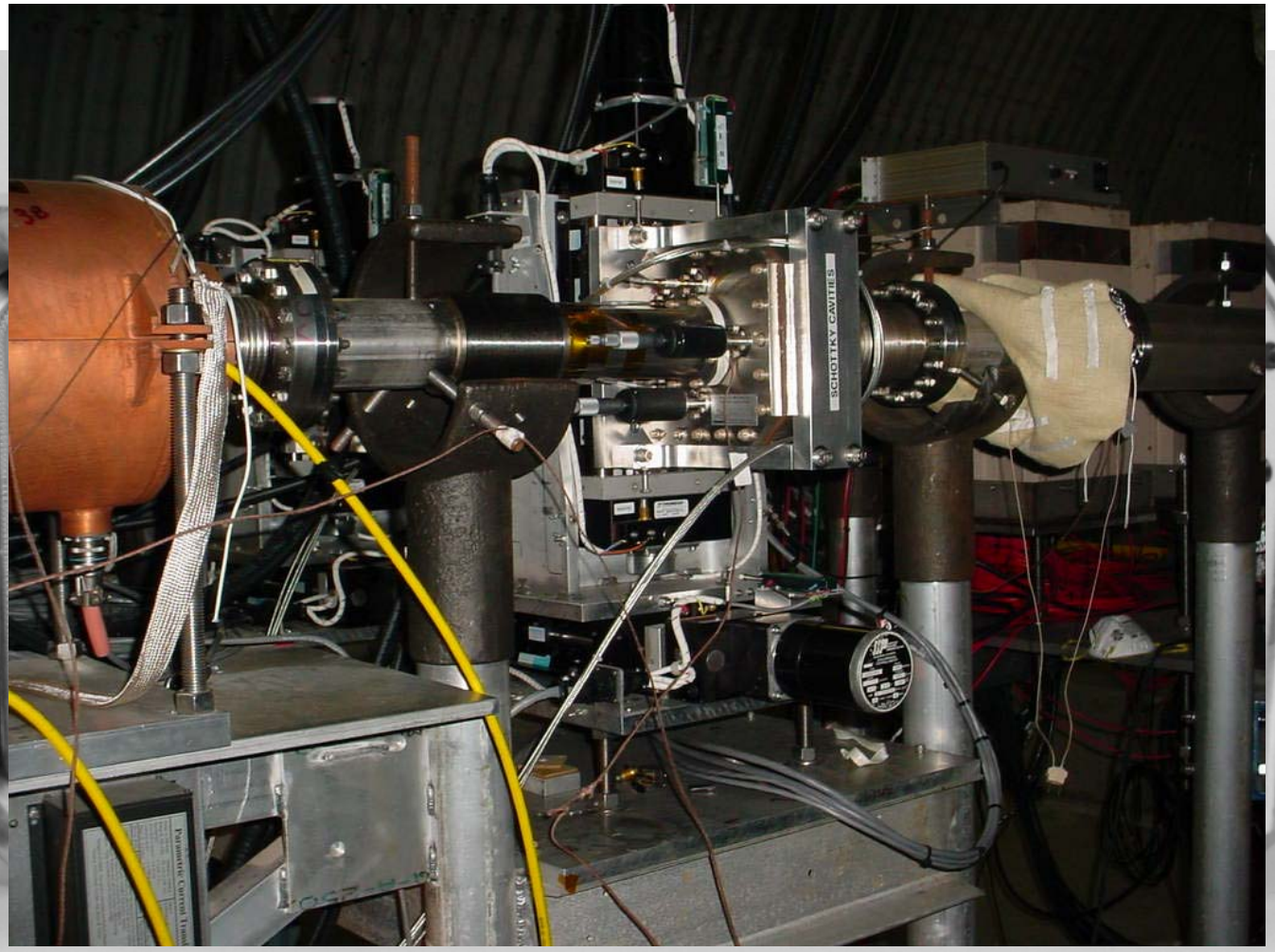
Contents

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

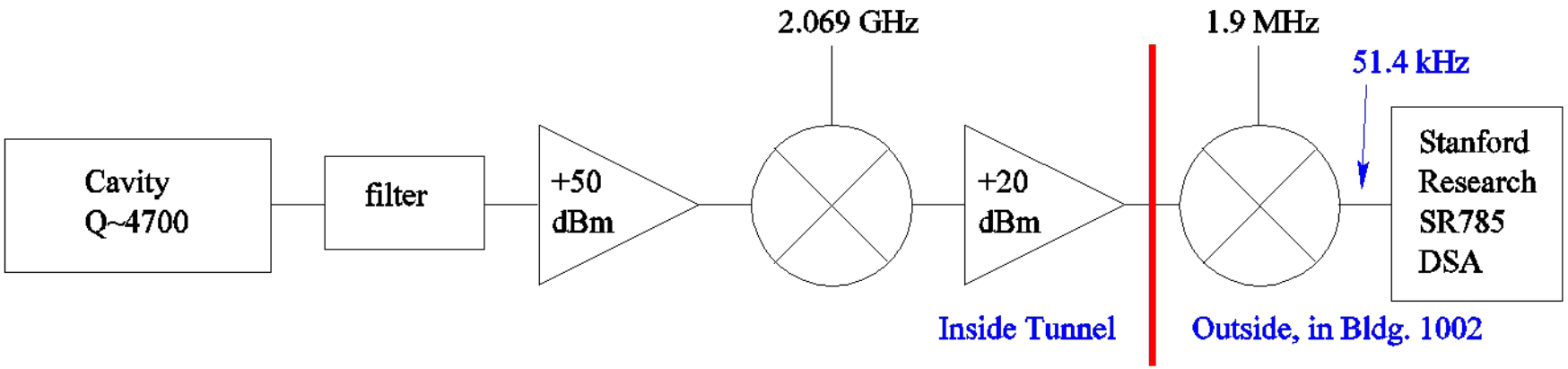
Quick Tour


ock region
HF Schottky
1GI1–O
1GI1–I
2MD1
2GE1
BRAHMS
2–DX
2GI1–O
2MD2
2GI1–I
2GE2
Bldg 1002B
Bldg 1002C
Bldg 1002A
02Q4
02DU4
02Q5
02D5
2MD3
02Q6
02DU6
02D6
02Q7

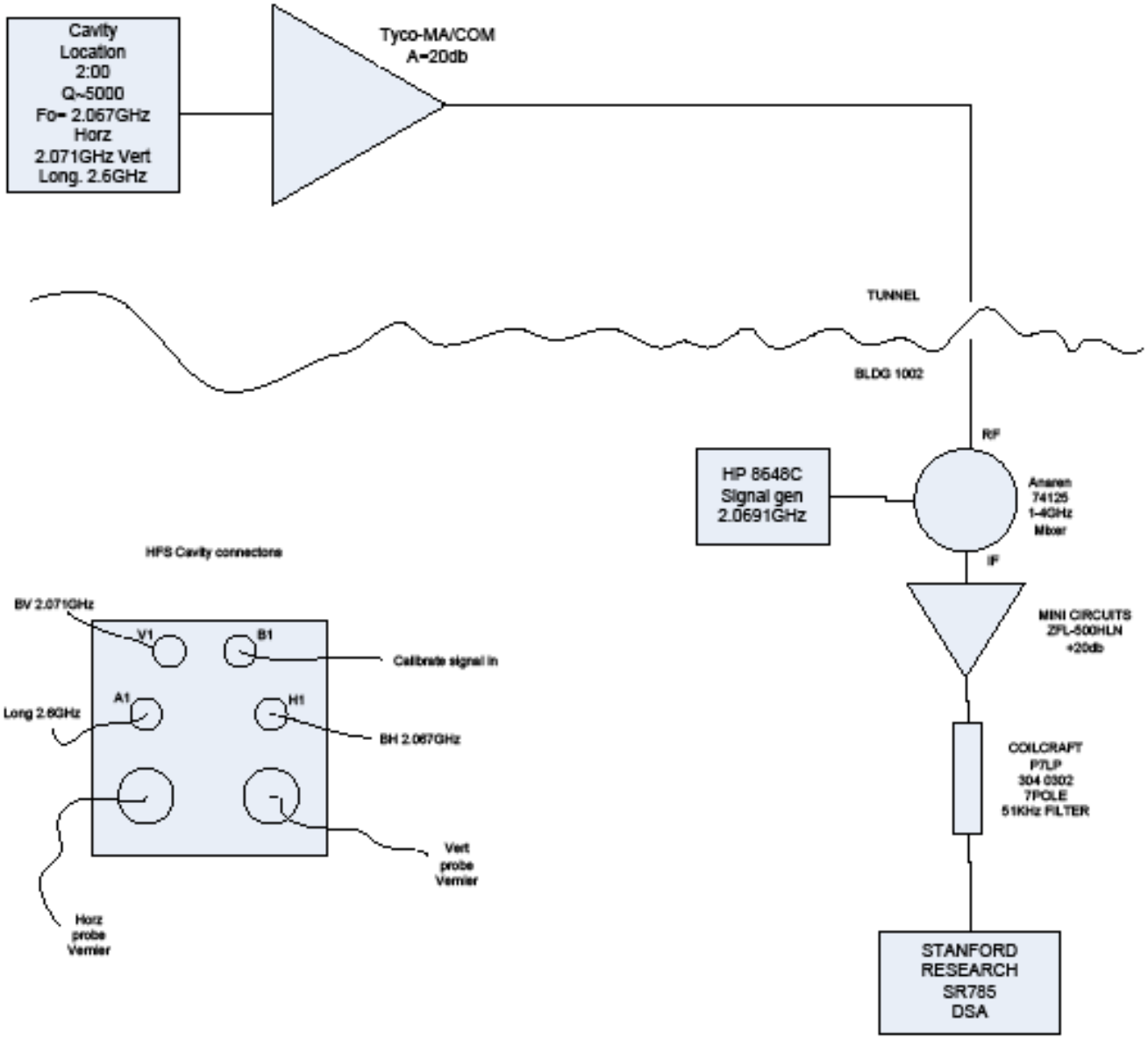
HF Cavities in RHIC



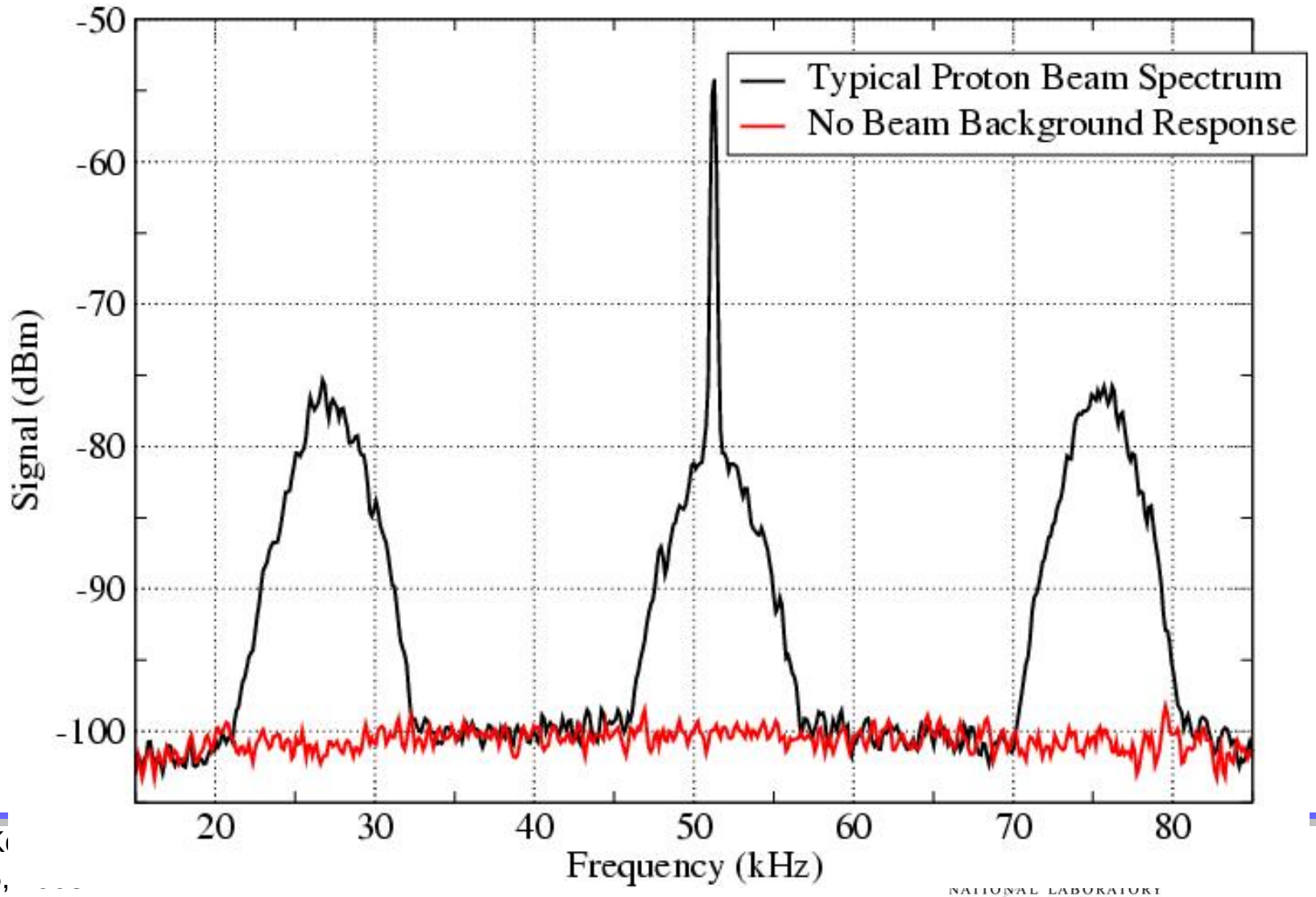
Signal Processing



System for FY09



Typical HF Transverse Spectrum



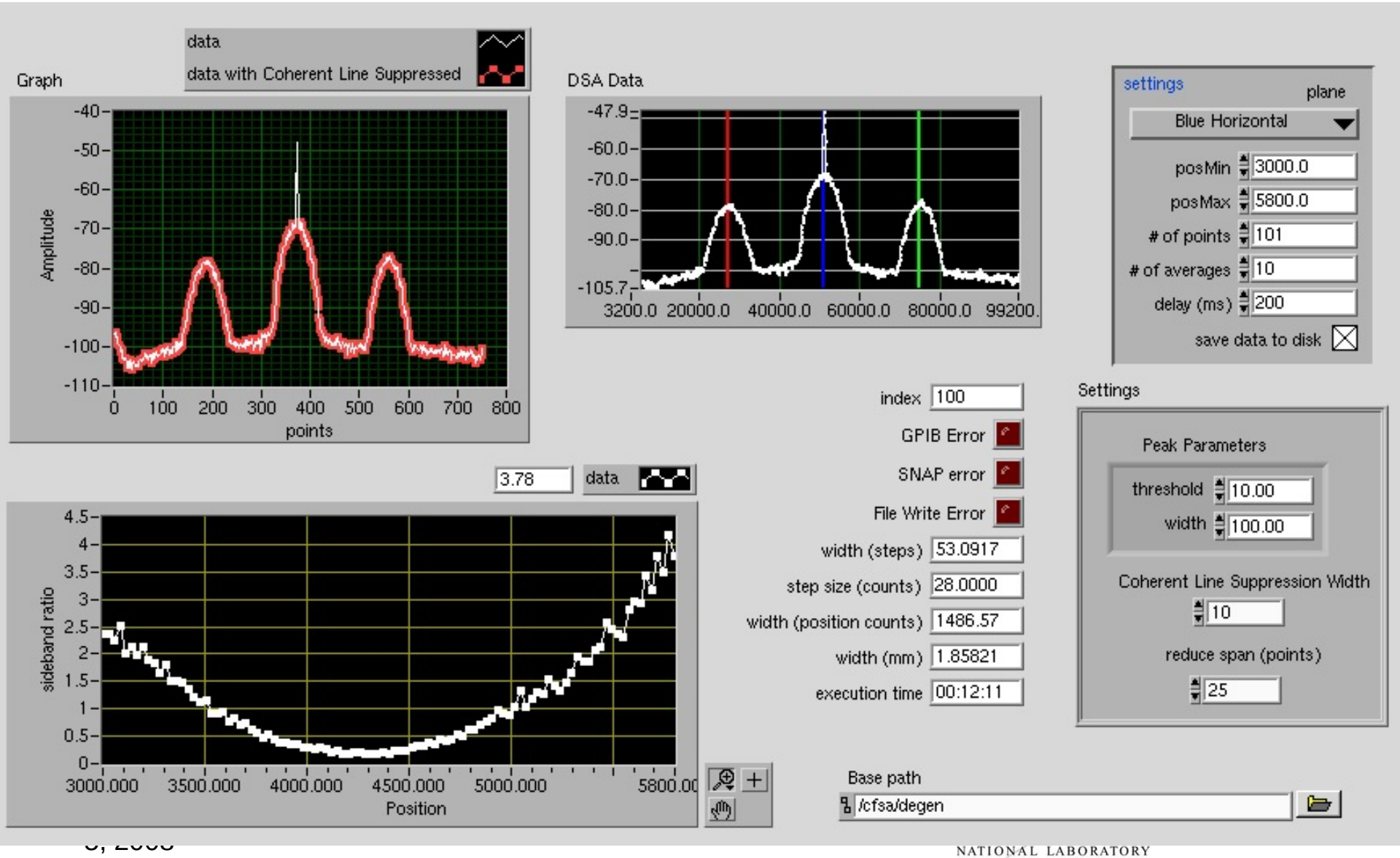
HF Schottky Emittance Measurement

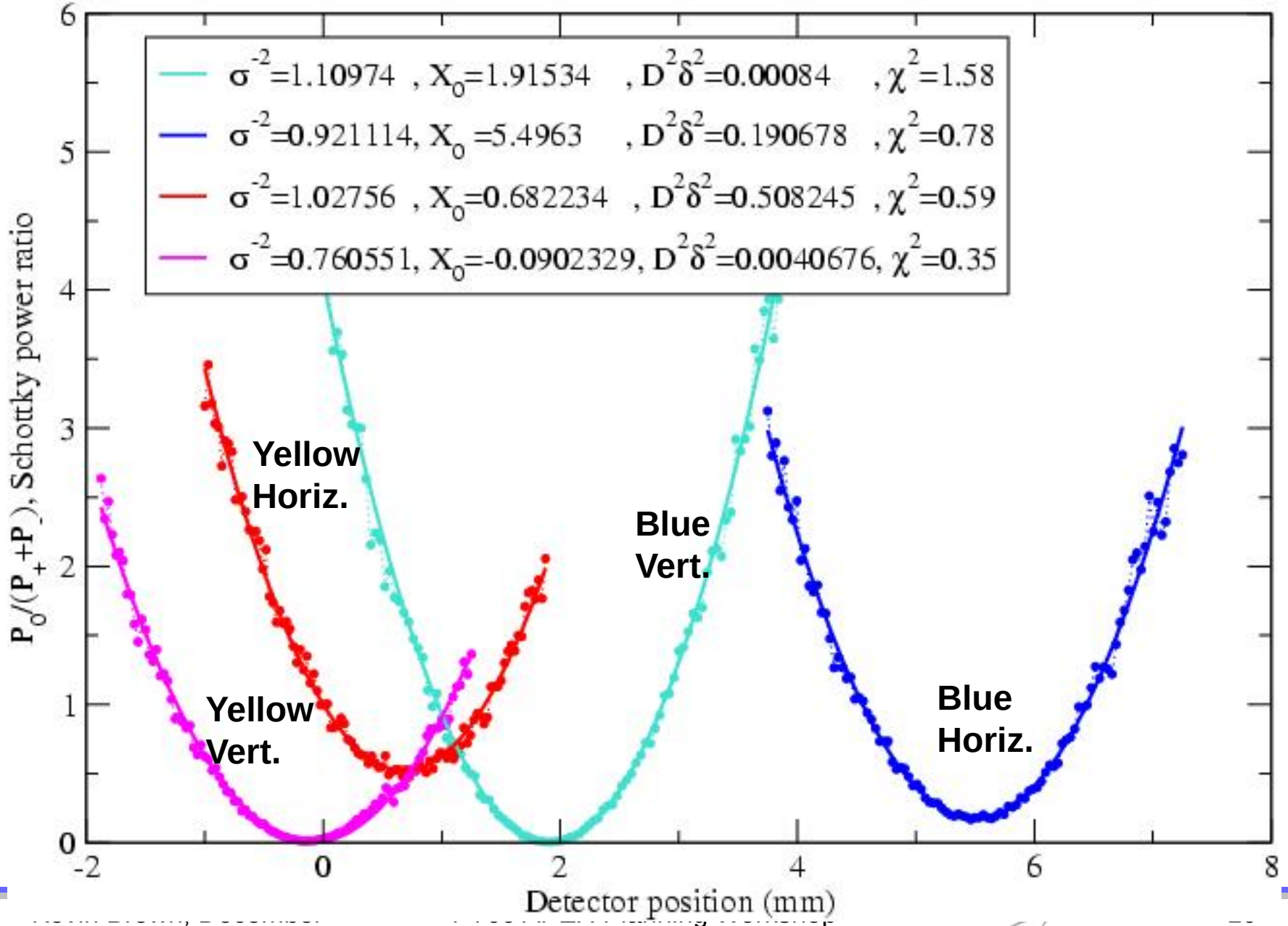
- rms beam size, σ, is derived by taking the ratio of the power in the revolution line to the betatron lines.

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

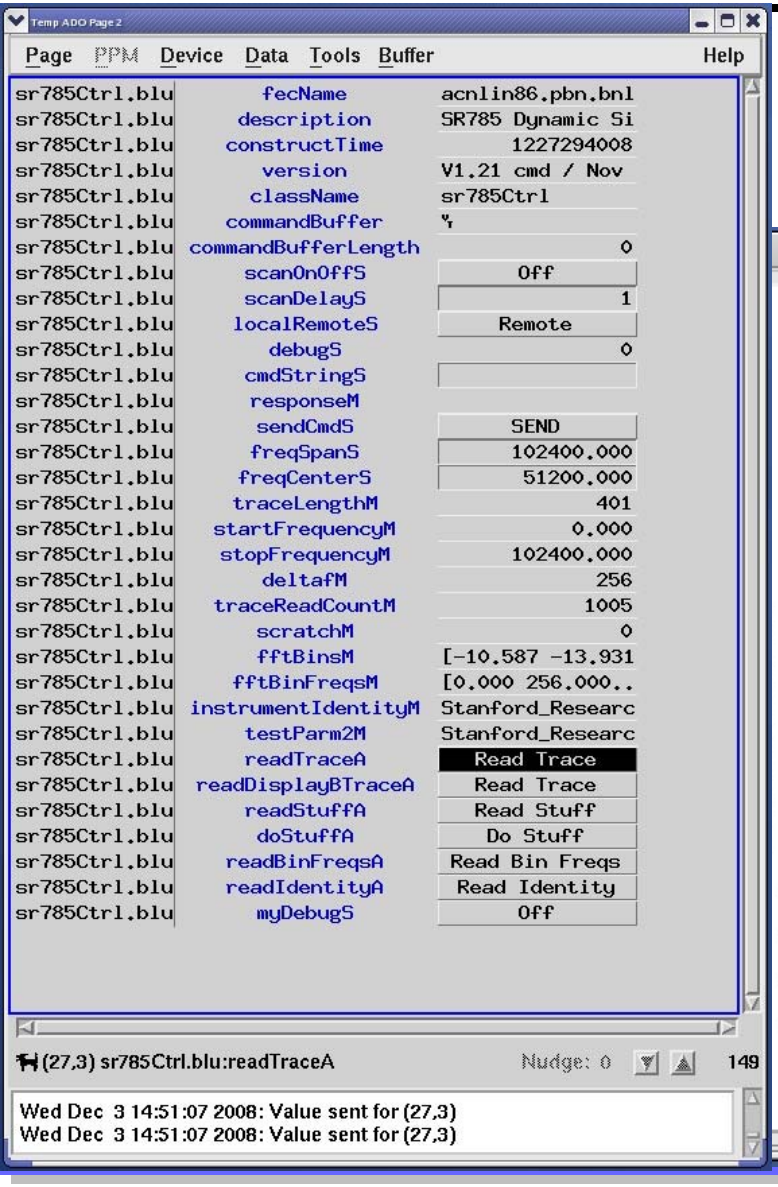
- To measure, scan X and fit the resulting parabola to find σ, X_0, and the offset. {i.e., $y=a(x-x_0)^2 + ab$ }.
- Note that the offset contains the dispersion.

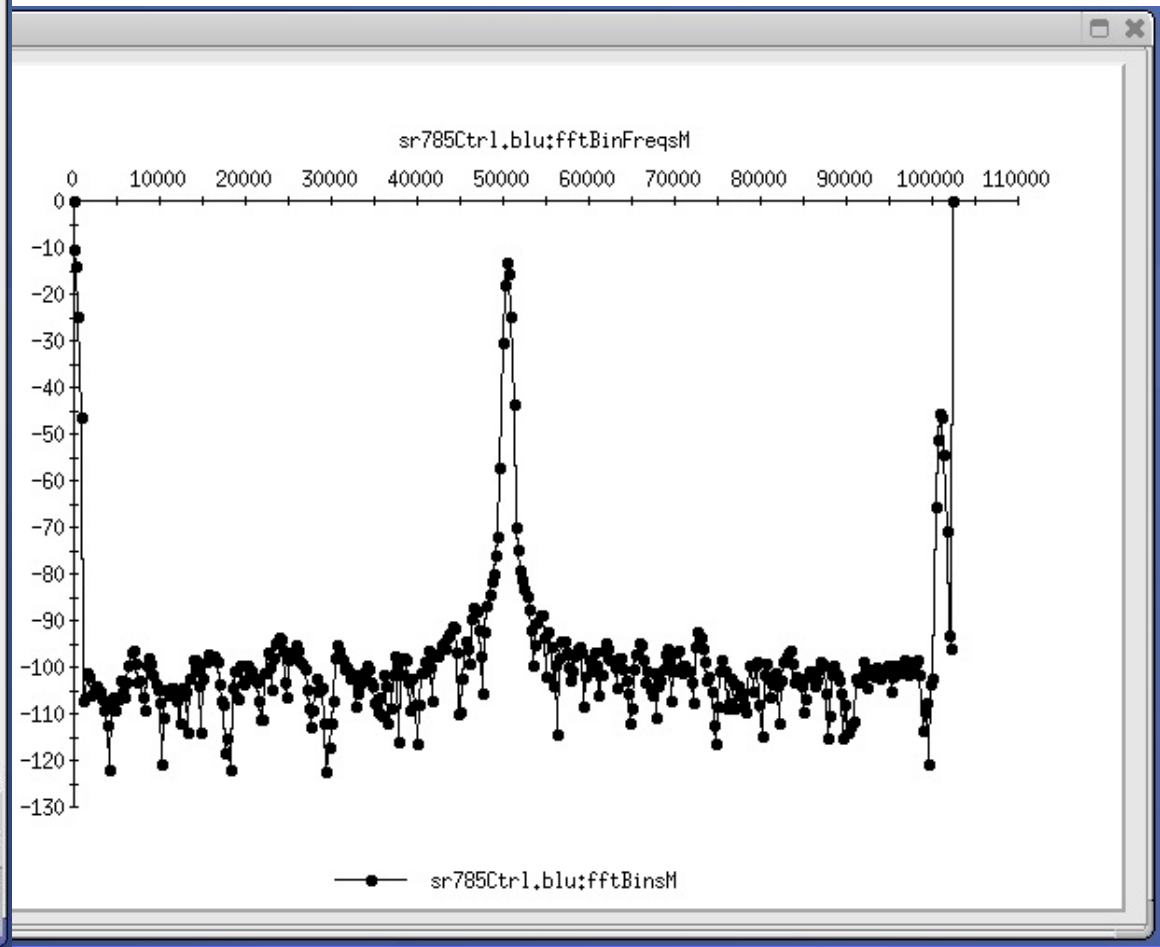
A typical scan and FY08 interface




σ^-2=1.10974 , X0=1.91534 , D^2δ^2=0.00084 , χ^2=1.58
σ^-2=0.921114, X0 =5.4963 , D^2δ^2=0.190678 , χ^2=0.78
σ^-2=1.02756 , X0=0.682234 , D^2δ^2=0.508245 , χ^2=0.59
σ^-2=0.760551, X0=-0.0902329, D^2δ^2=0.0040676, χ^2=0.35
Yellow Horiz.
Yellow Vert.
Blue Vert.
Blue Horiz.
P0/(P+ +P-), Schottky power ratio
Detector position (mm)
0
1
2
3
4
5
6
-2
0
2
4
6
8

New Interface in pet (work in progress)





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 β-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_{120}	Frequency	2.071 GHz
	$Q_{unloaded}$	10,000
	$R_\perp T^2/Q$	900 Ω
	$R_\perp T^2$	9 MΩ/m
TM_{210}	Frequency	2.067 GHz
	$Q_{unloaded}$	10,000
	$R_\perp T^2/Q$	900
	$R_\perp T^2$	9 MΩ/m

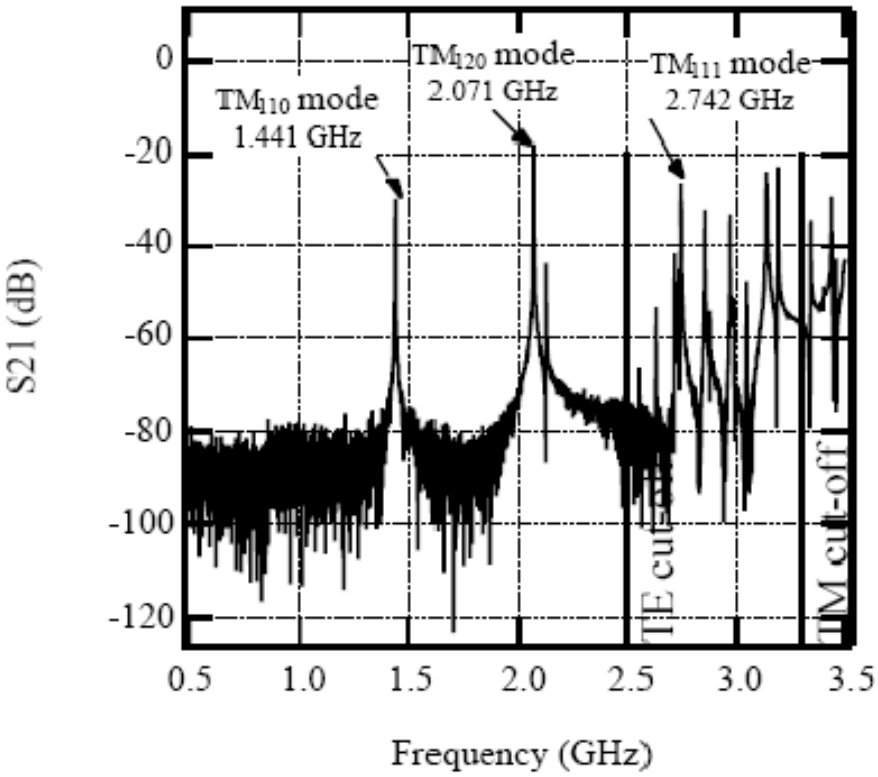


Figure 2: S21 spectrum measured from the vertical coupling probe to a 45° probe.

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

W. Barry , J. N. Corlett, D. A. Goldberg, D. Li, LBNL Center for Beam Physics

Schottky Signal Power: Tranverse 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,

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

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, π μm values)

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

β-functions used are (from On-line model) :
BH = 28 m
BV = 27 m
YH = 27 m
YV = 30 m