Argonne NATIONAL LABORATORY

... for a brighter future

U.S. Department of Energy

UChicago ▶ Argonne LLC

Office of Science U.S. DEPARTMENT OF ENERGY

A U.S. Department of Energy laboratory managed by UChicago Argonne, LLC

AC Characterization of APS Storage Ring BPMs

Om Singh & Xiang Sun

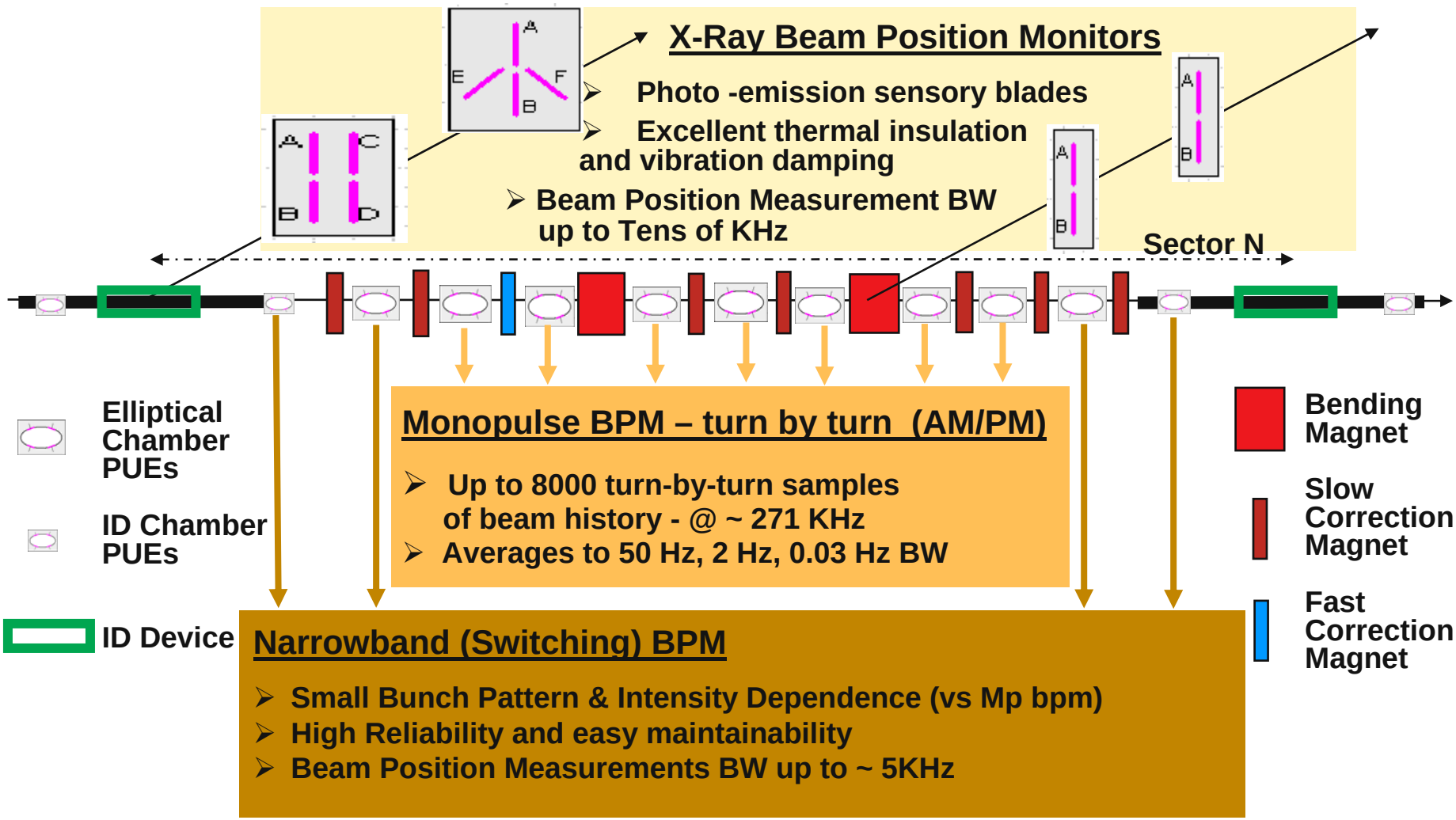
03/26/2007

Outline

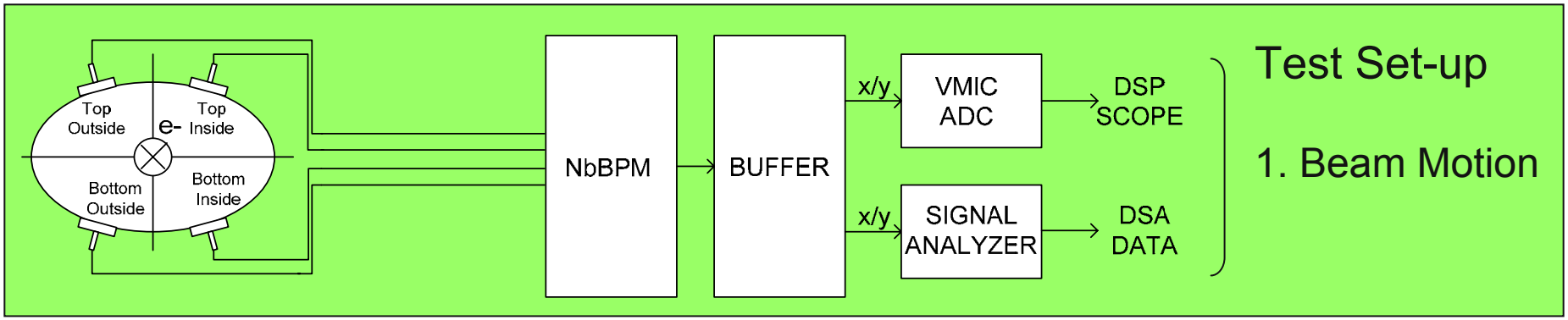
Title	Slide #
➢ One Sector BPM & Magnet Layout	3
➢ NbBpm	4-6
➢ MpBpm	7-8
➢ NbBpm vs MpBpm	9-10
➢ RMS Calculation	11
➢ Xbpms	12-18
➢ NbBpm, MpBpm and Xbpm	19

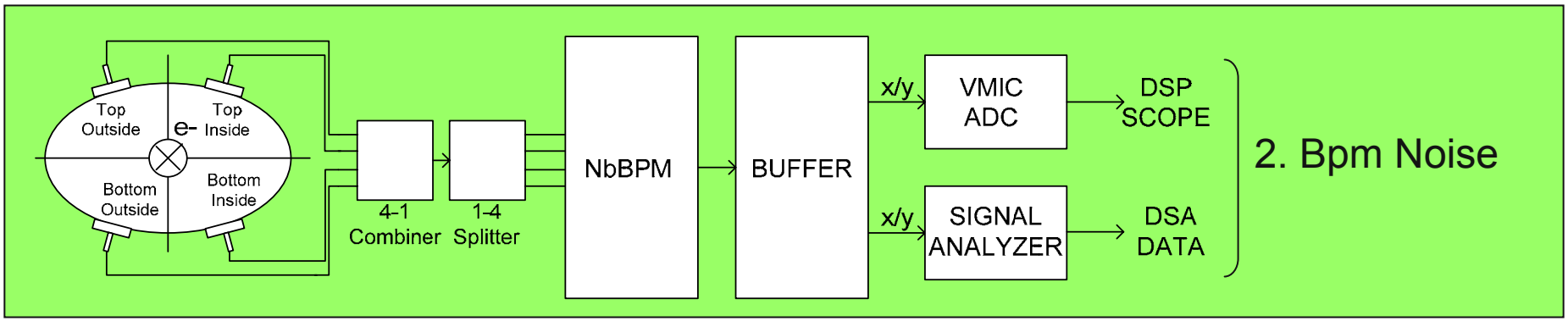
Beam Position Monitors and Dipole Magnets

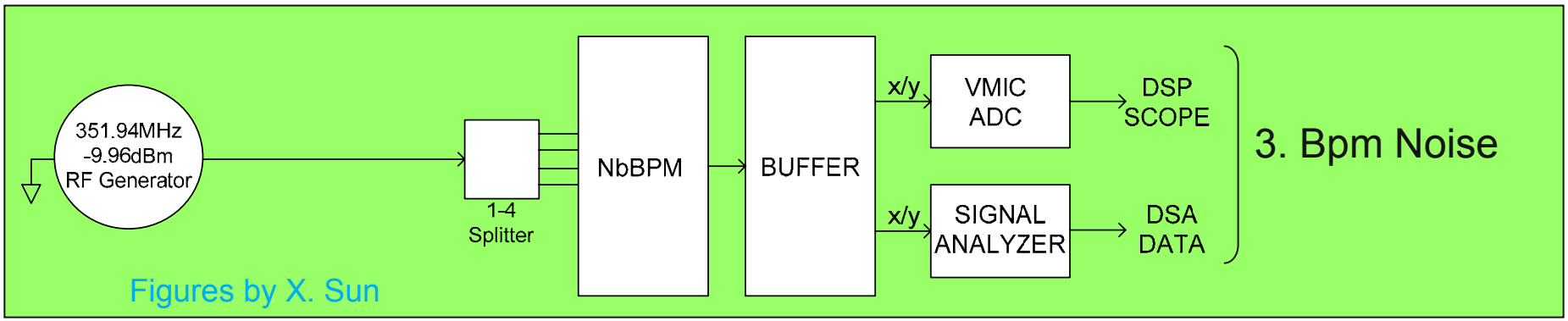
One Sector - Cartoon



NbBpm AC Data Measurement

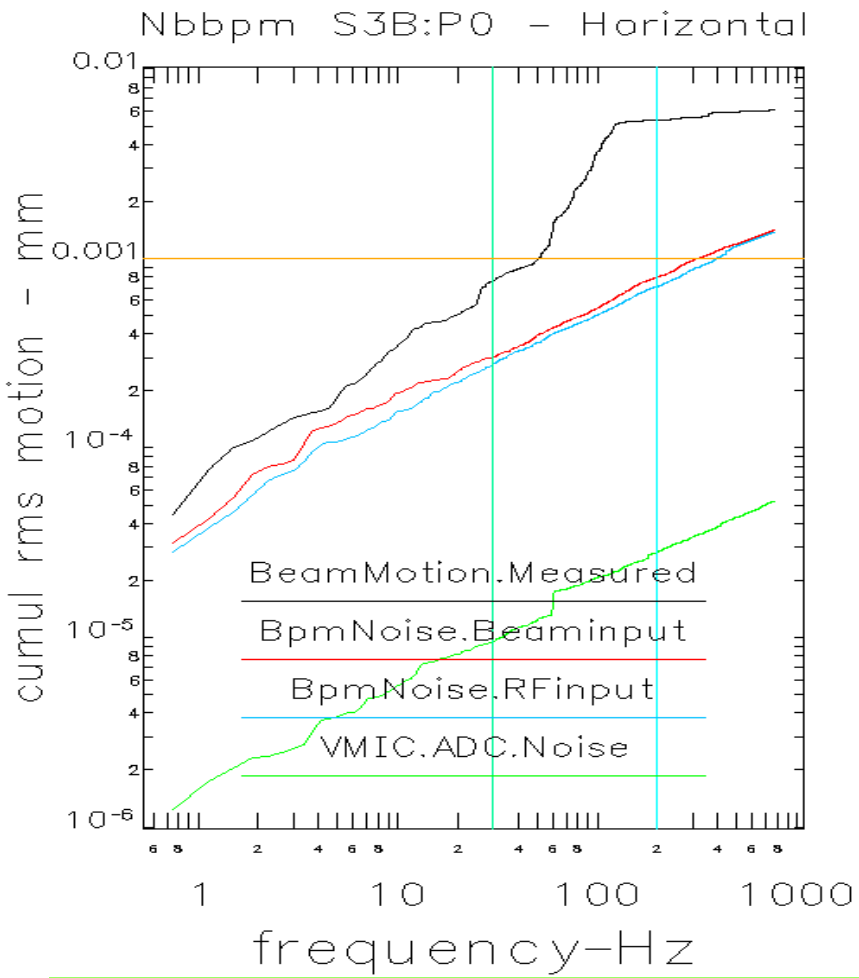


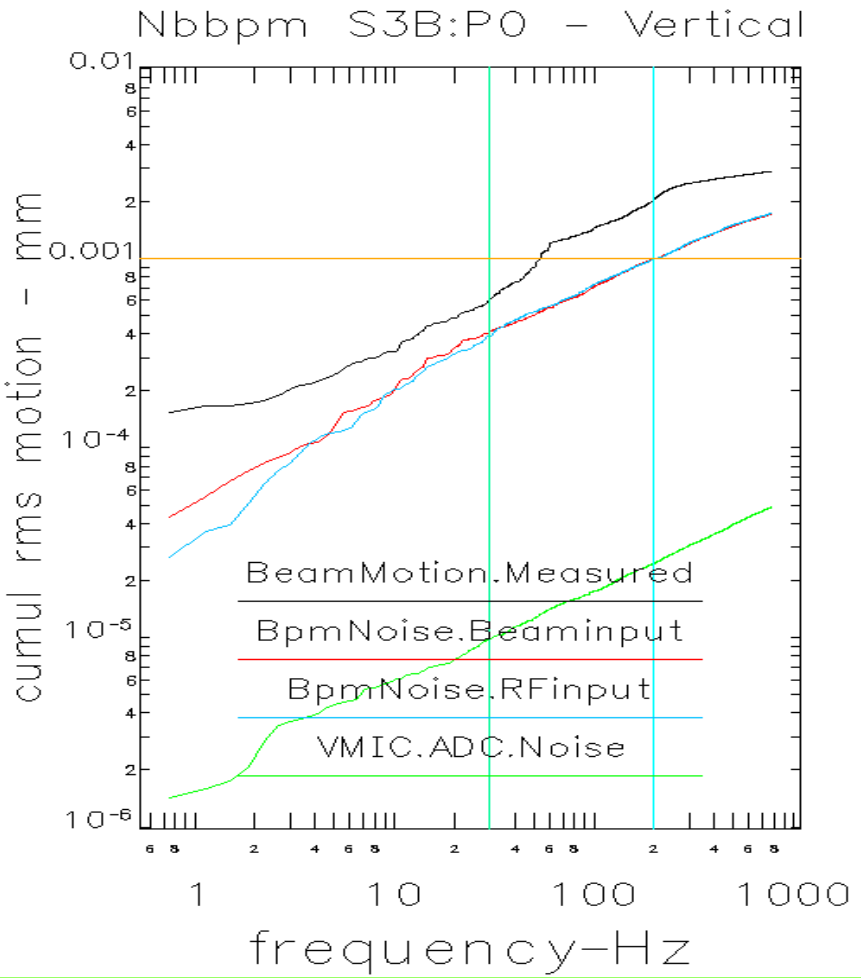




Figures by X. Sun

S3B:P0 NbBpm Data – 8 mm Rotated Button

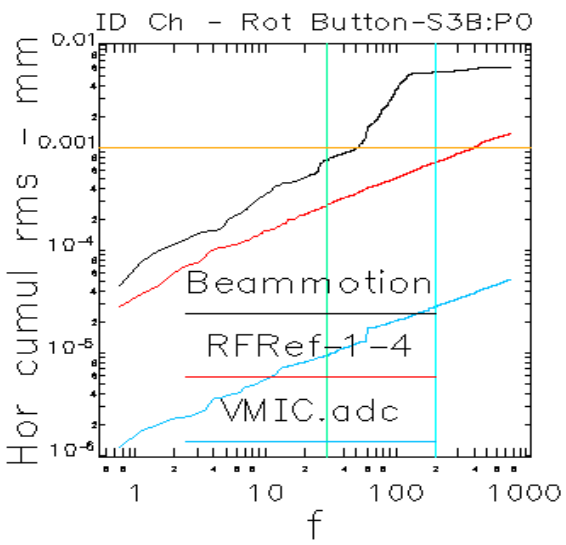


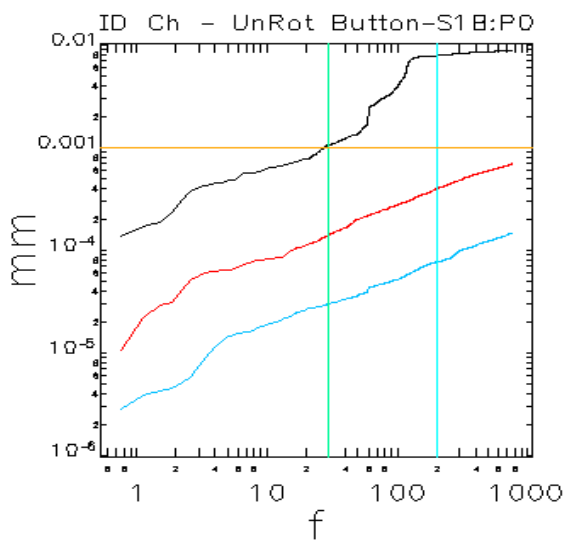


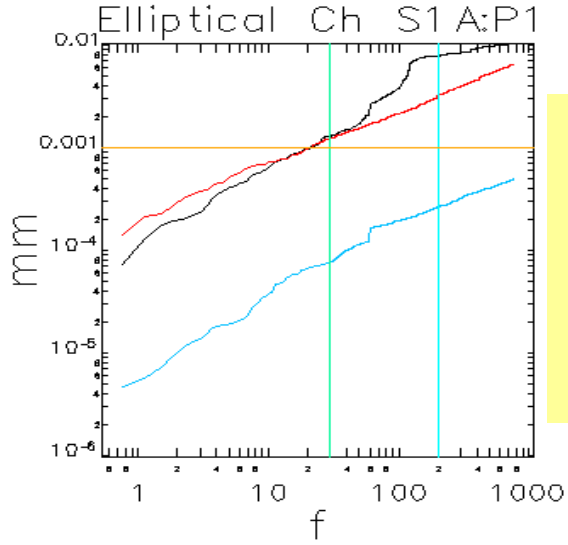
Cumul RMS 30 Hz band (H & V)

Beam Motion = 0.8 & 0.55 micron
Bpm Noise = 0.3 & 0.35 micron
VMIC ADC Noise = 0.01 & 0.01 micron

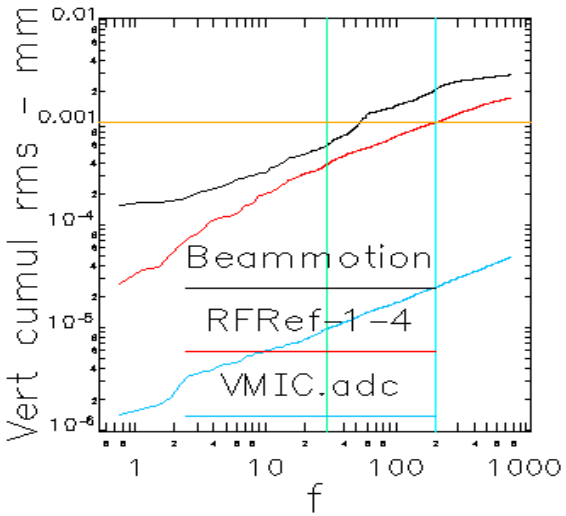
NbBpms Data for 3 Configurations

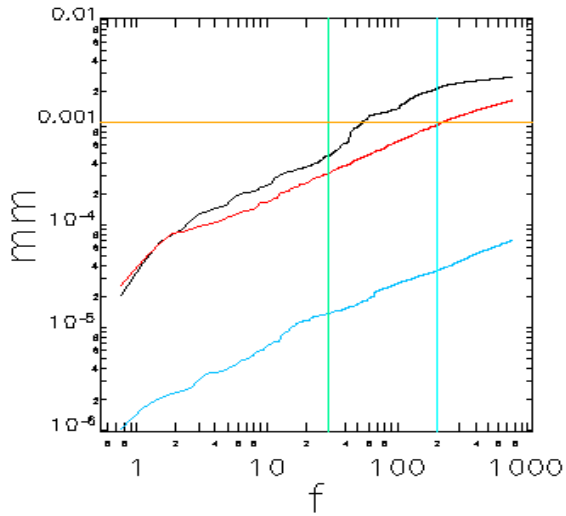


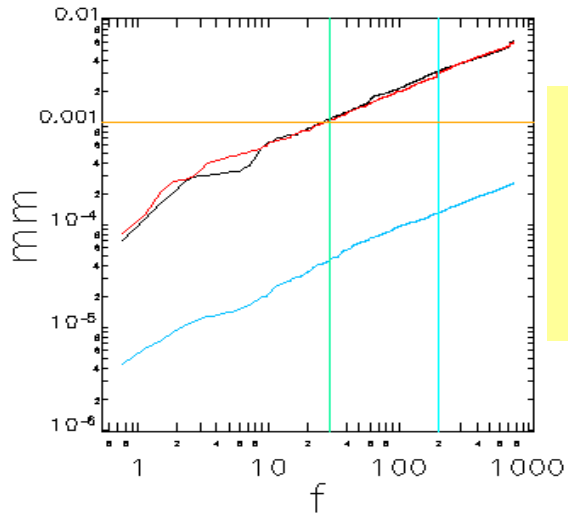




HORIZONTAL



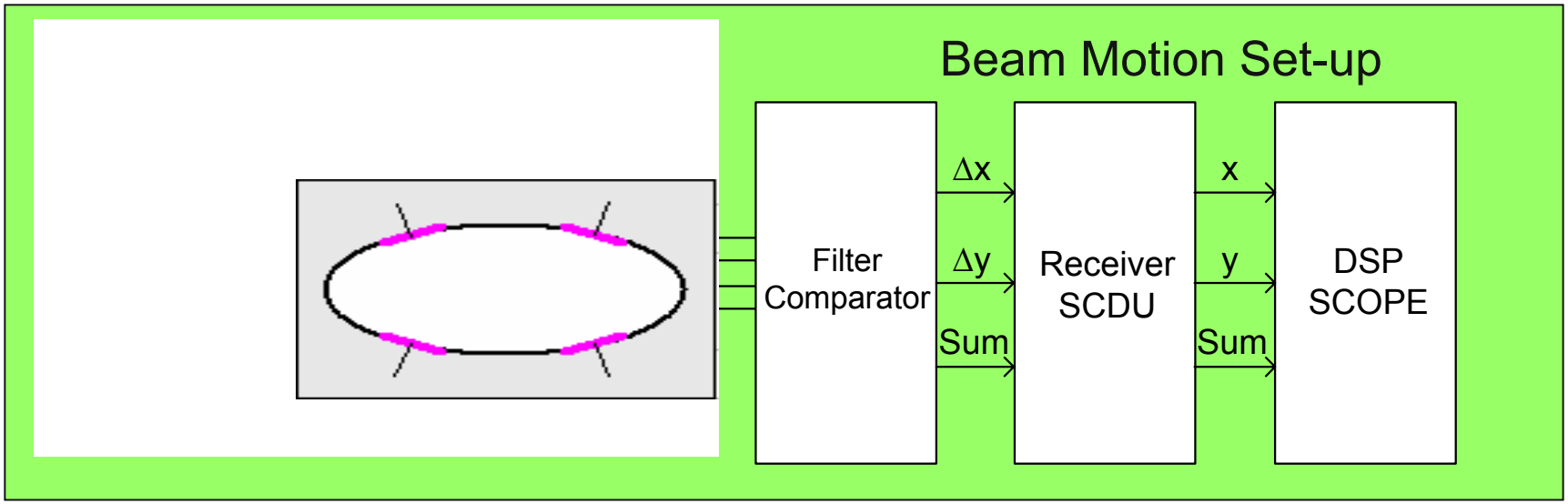


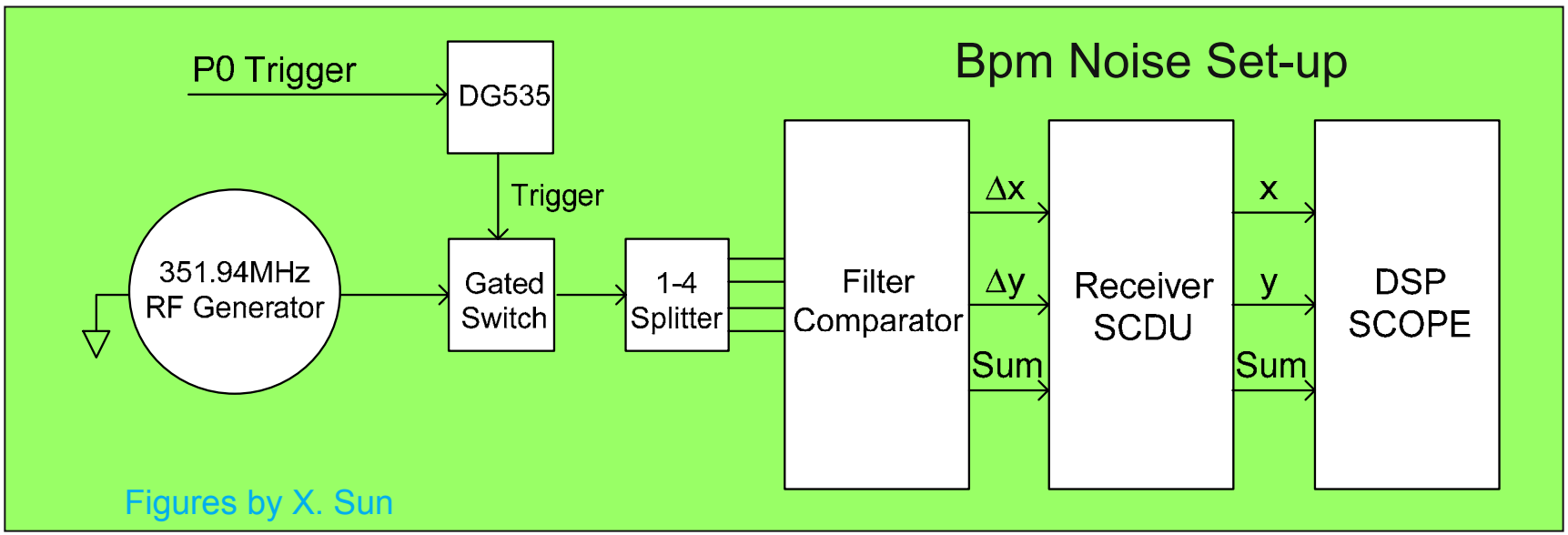


VERTICAL

Rotated Buttons | Un-rotated Buttons | Elliptic Ch Buttons

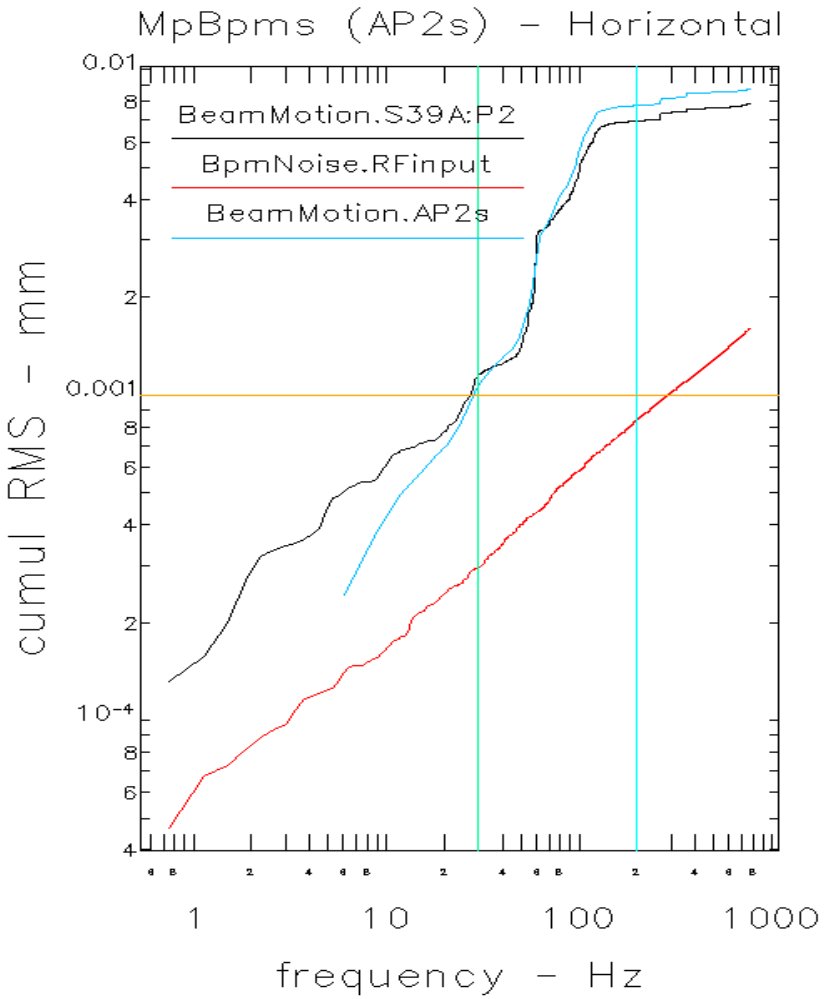
MpBpm AC Data Measurement

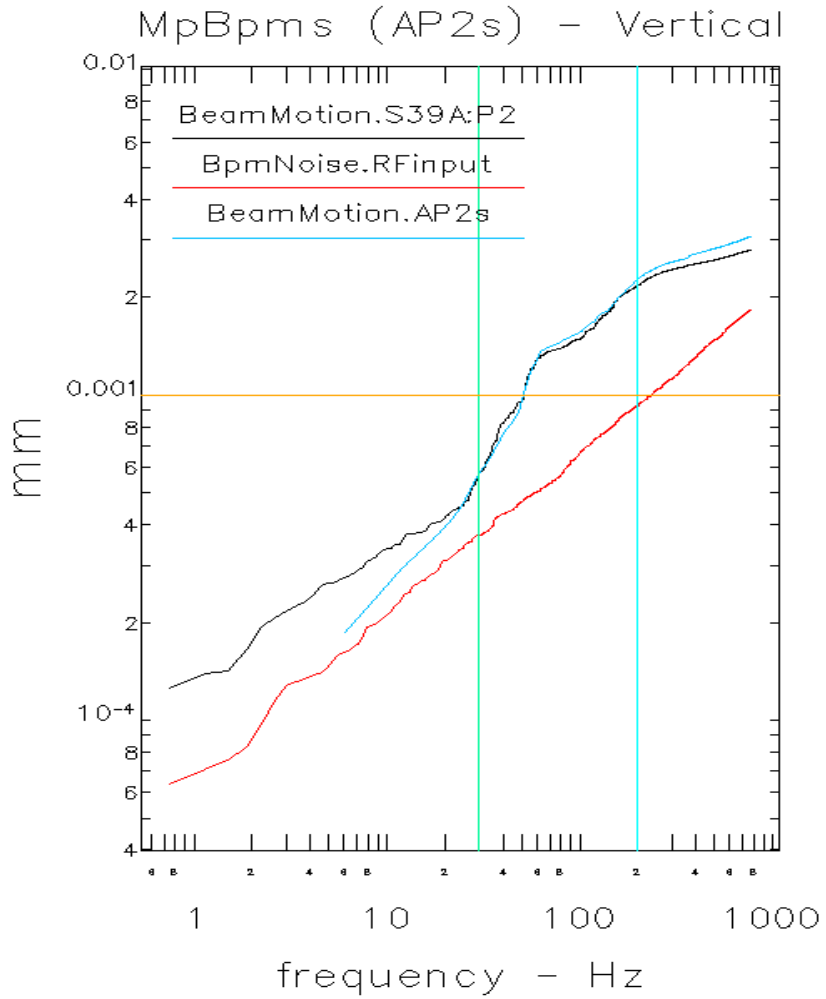




Figures by X. Sun

Mpbpms (AP2s) – Beam motion and Bpm noise data

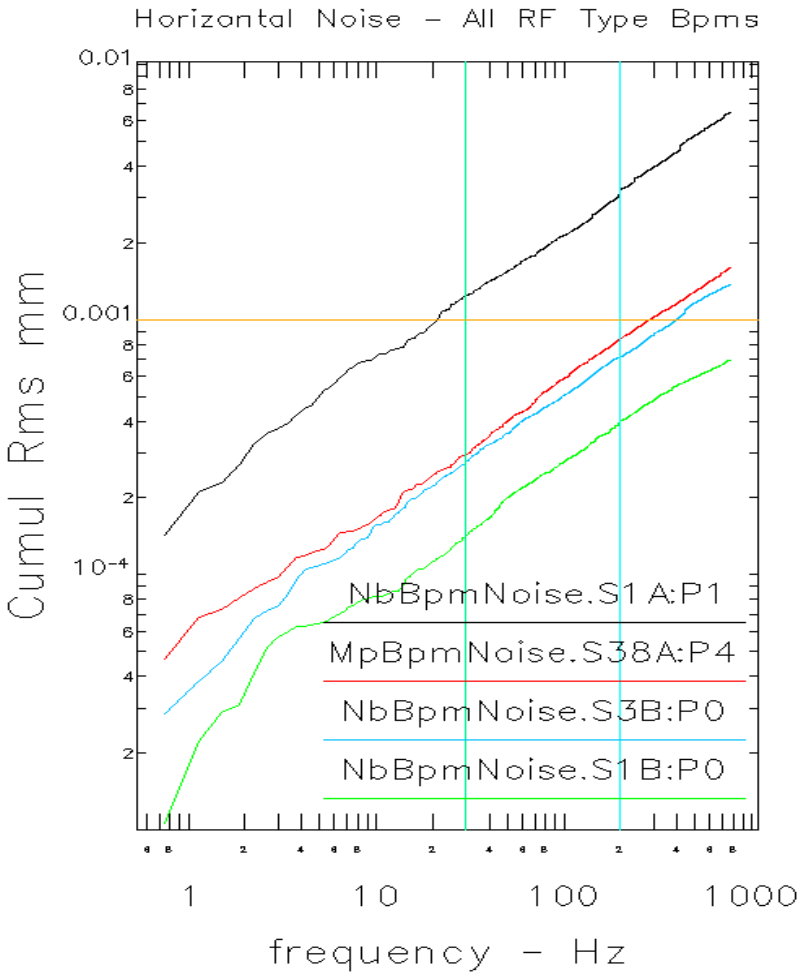


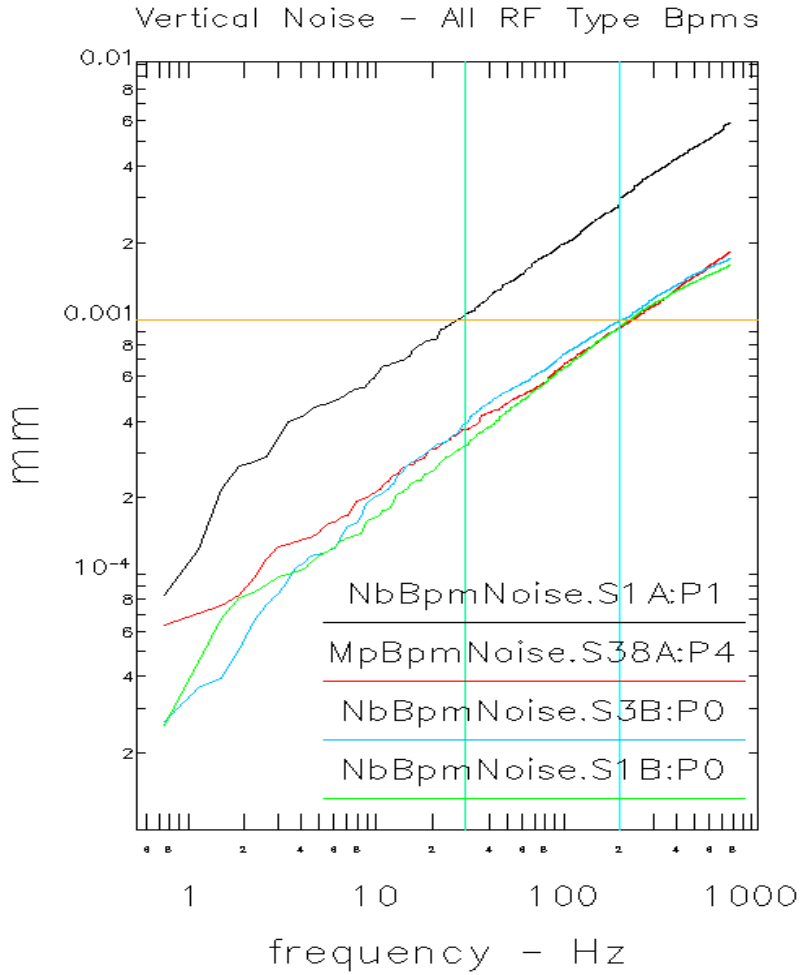


Cumul RMS 30 Hz band (H & V)

Beam Motion = 1.0 & 0.6 micron
Bpm Noise = 0.3 & 0.35 micron

RF Bpms Noise Baseline – NbBpm and MpBpm

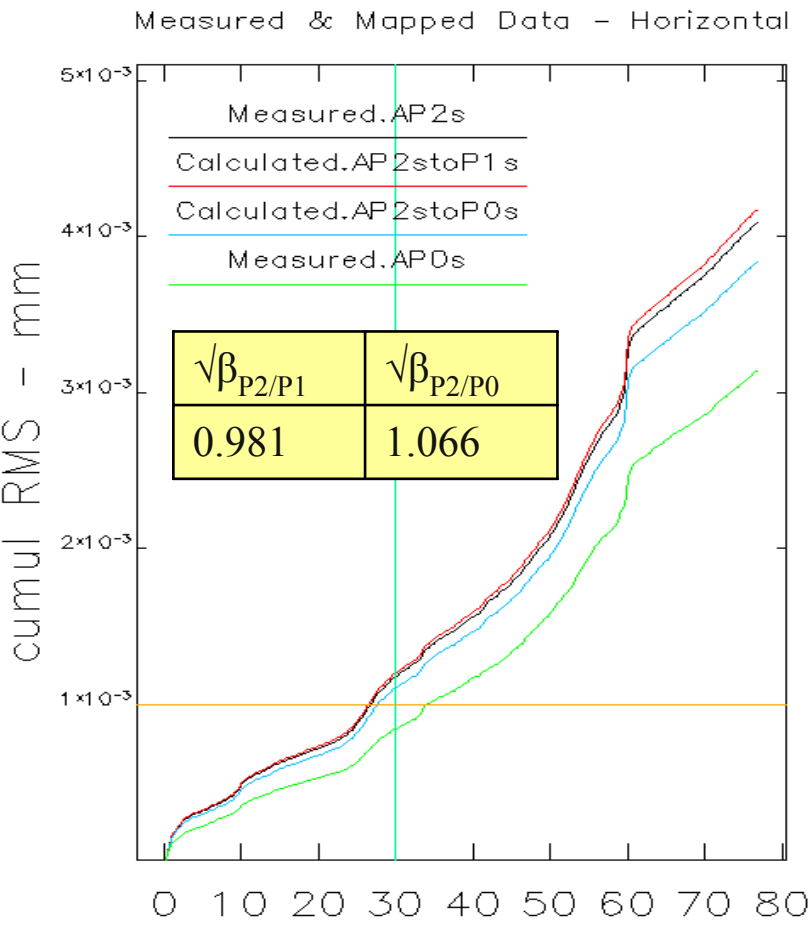


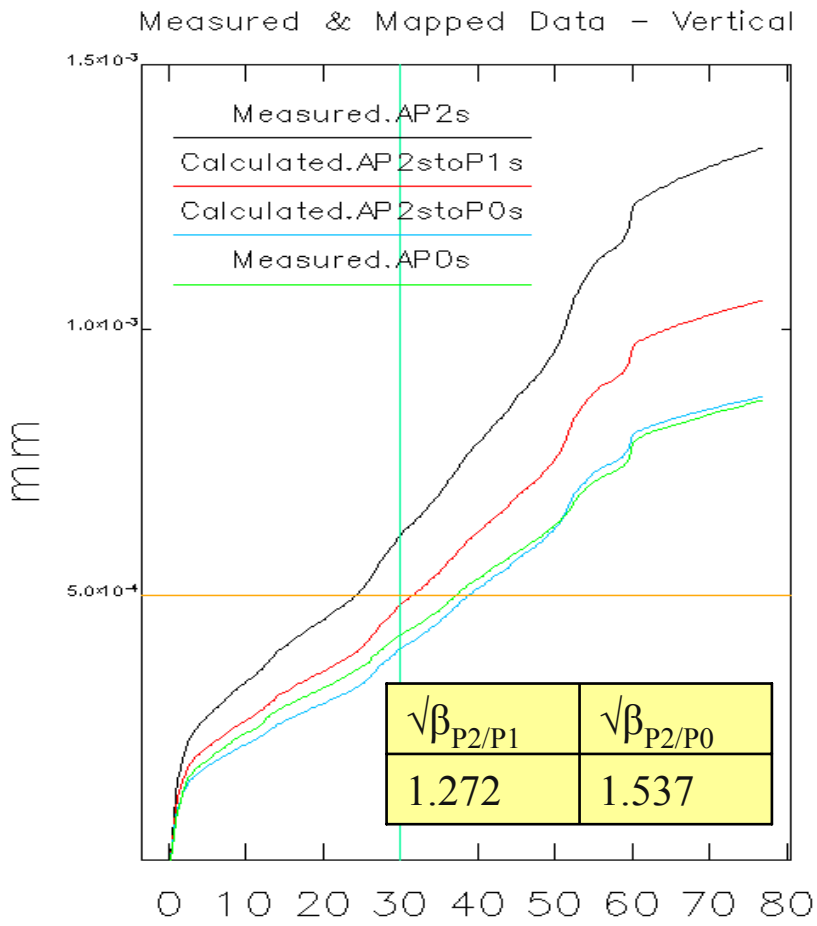


Cumul RMS 30 Hz band (H & V)

Mpbpm = 0.3 & 0.35 micron
NbBpm (Rot) = 0.3 & 0.35 micron
NbBpm (Unrot) = 0.15 & 0.3 micron

Measured & Mapped Data – P2, P1, P0 (0.6 Hz to 76 Hz)





Cumul RMS 30 Hz band (H & V)

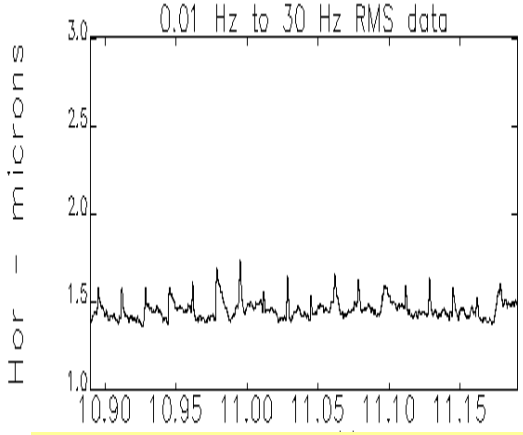
P2 measured ~= 1.2 & 0.6 micron

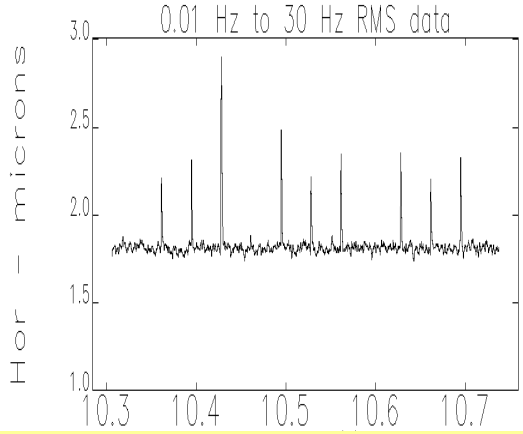
P2 to P1 mapped ~= 1.2 & 0.5 micron

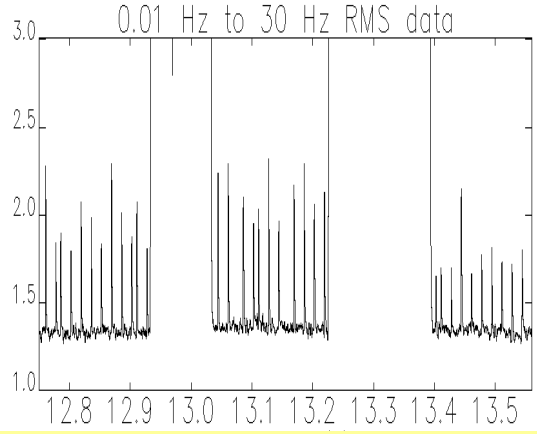
P0 measured ~= 0.8 & 0.4 micron

P2 to P0 mapped ~= 1.2 & 0.38 micron

RMS Data – 0.01 Hz to 30 Hz

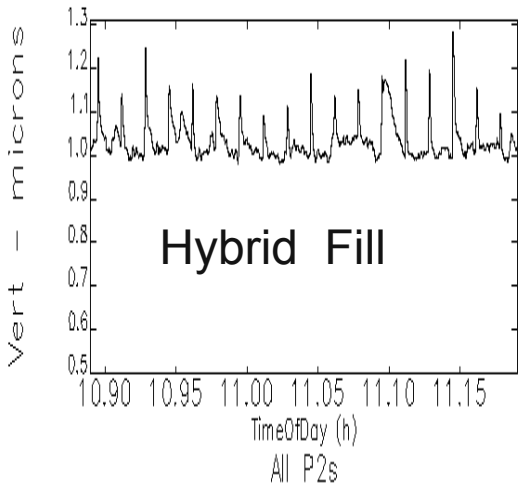


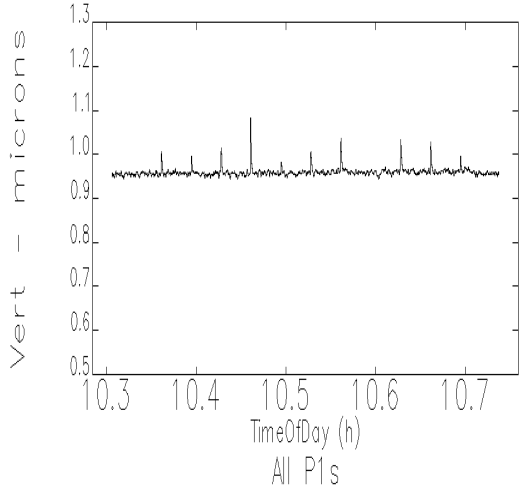


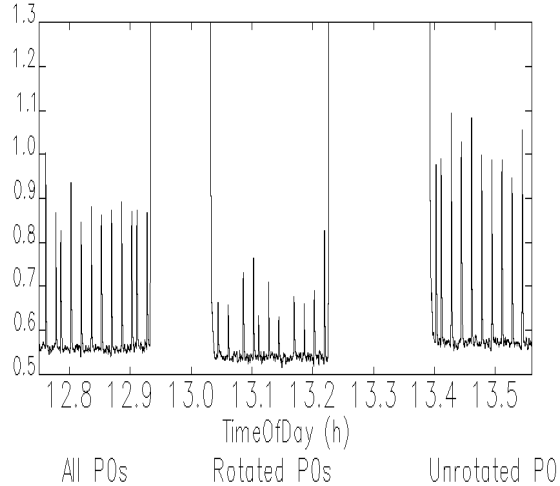


HORIZONTAL

------ P2s Based ------ -------P1s Based------ -------P0s Based ----------



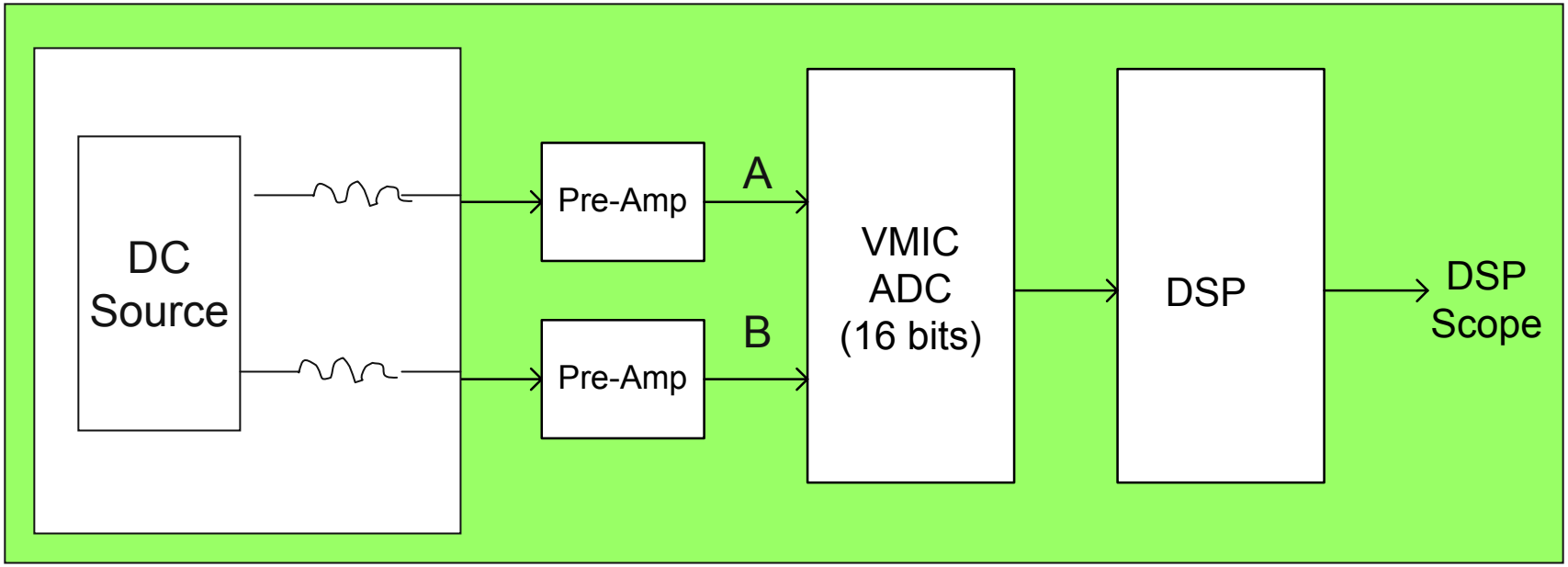




VERTICAL

Cumul RMS 30 Hz band (H & V) P1 measured ~= 1.80 & 0.95 micron
P0 measured ~= 1.3 & 0.55 micron P0 to P1 mapped ~= 1.41 & 0.66 micron
P2 measured ~= 1.4 & 1.05 micron P0 to P2 mapped ~= 1.38 & 0.85 micron
Increased level of top up Injection from baseline as observed is probably real !

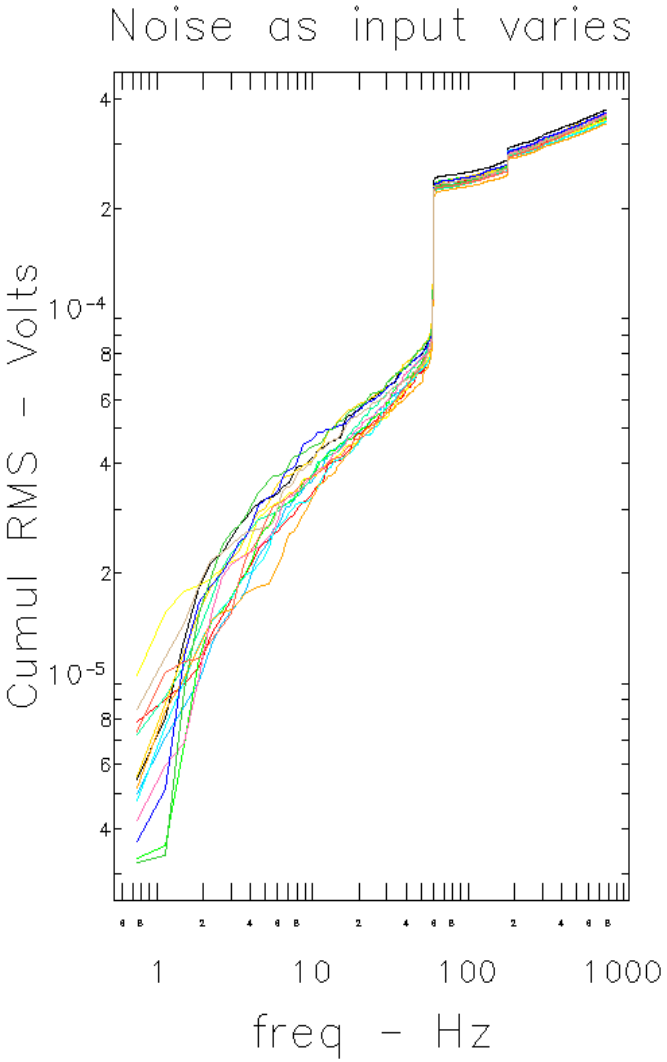
Xbpm AC Data Measurement

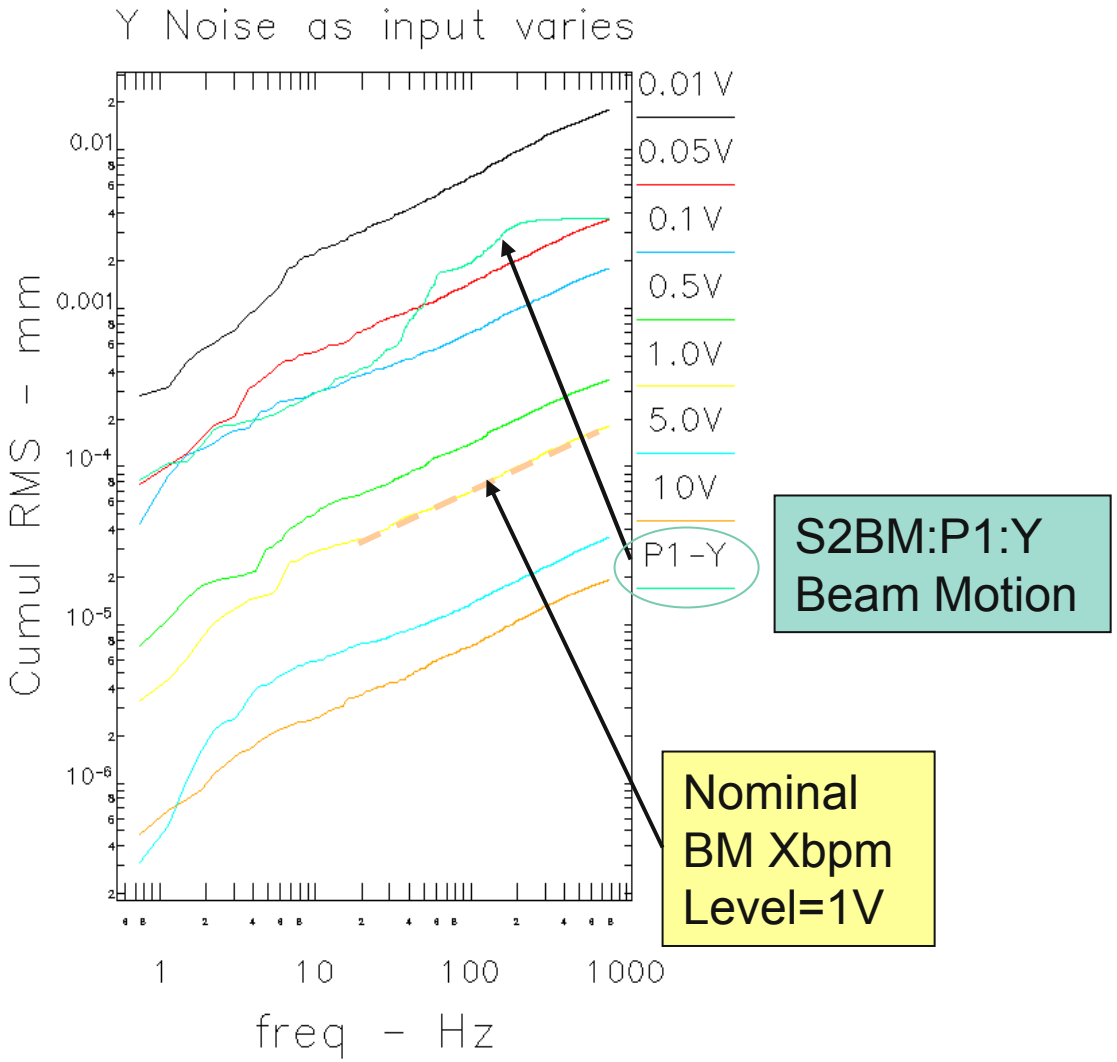


Position = Delta/sum = [(A-B) / (A+B)] mm

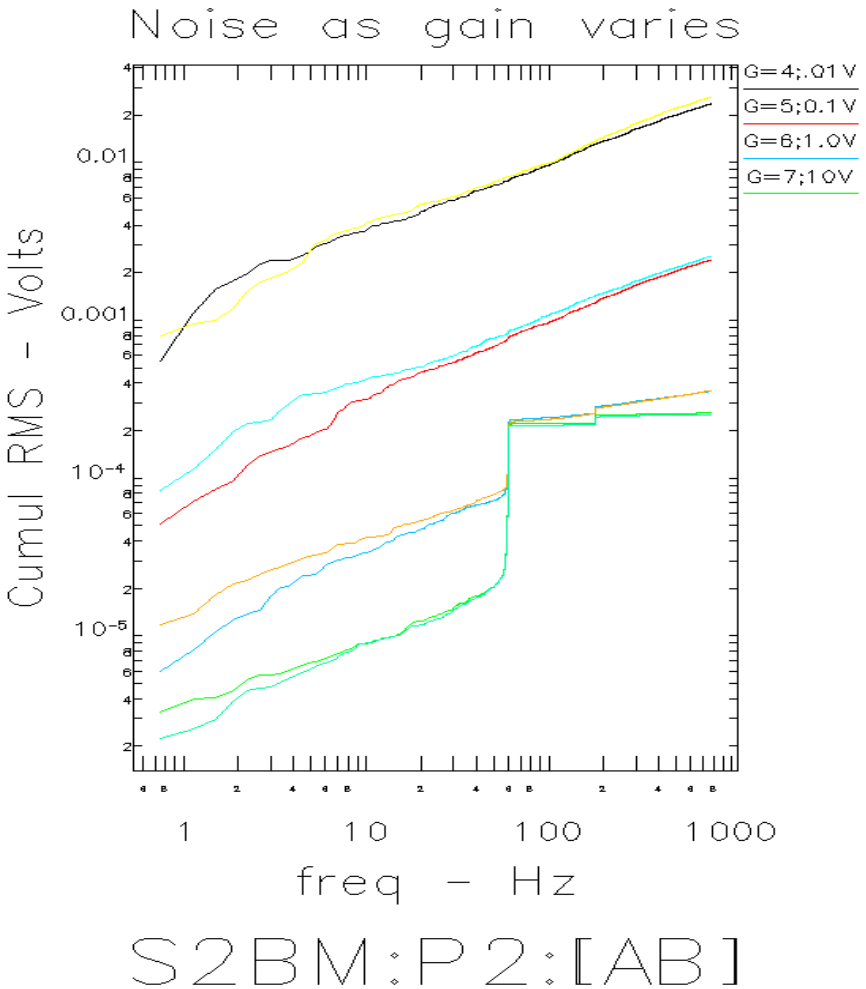
Digitization Noise (A~=B) = [0.3 mV (1 bit)] / [Blade Voltage V] microns

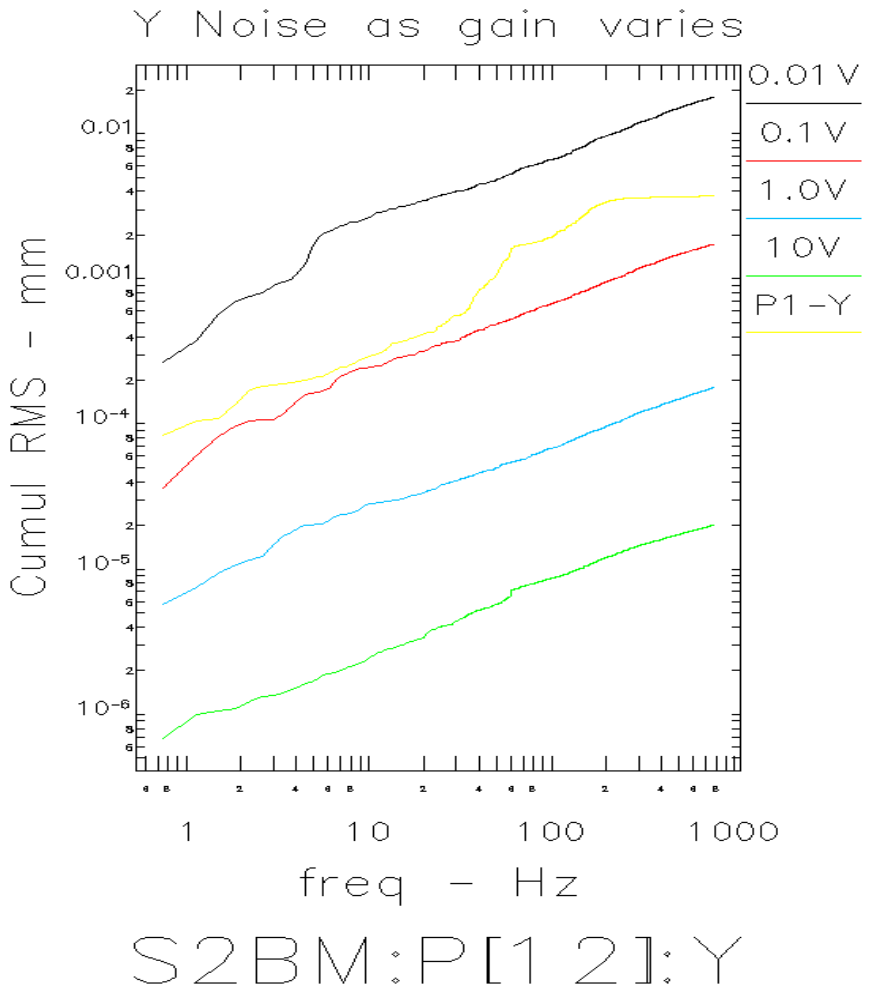
Xbpm digitization effect as input varies – fixed gain (6)





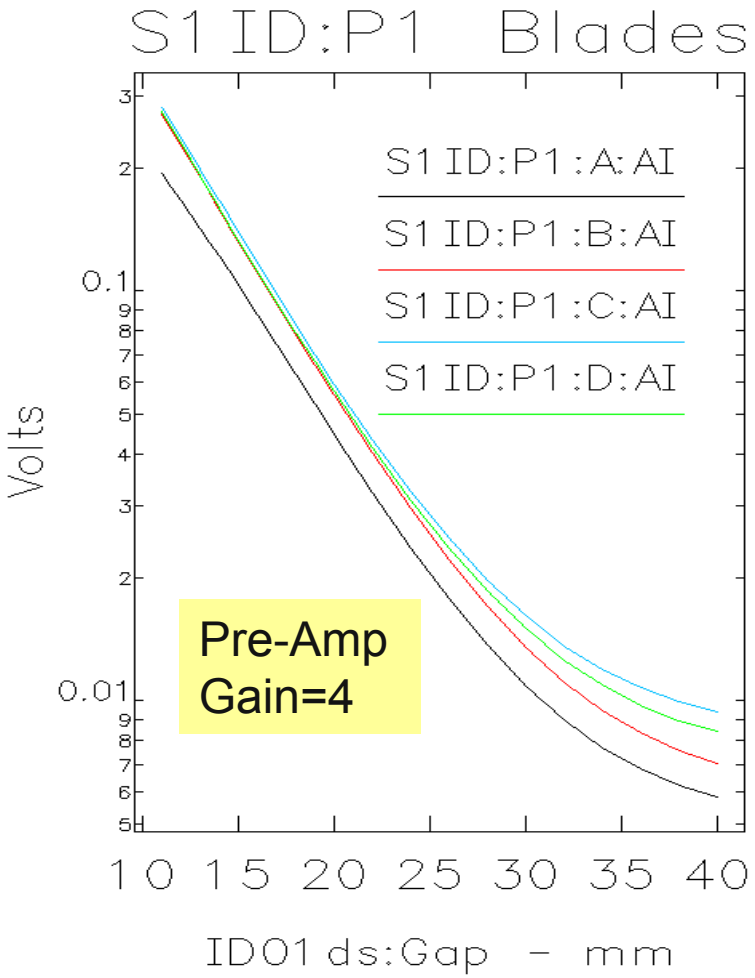
Bm xbpm noise – fixed source input (1 V); gain varies – 4,5,6,7

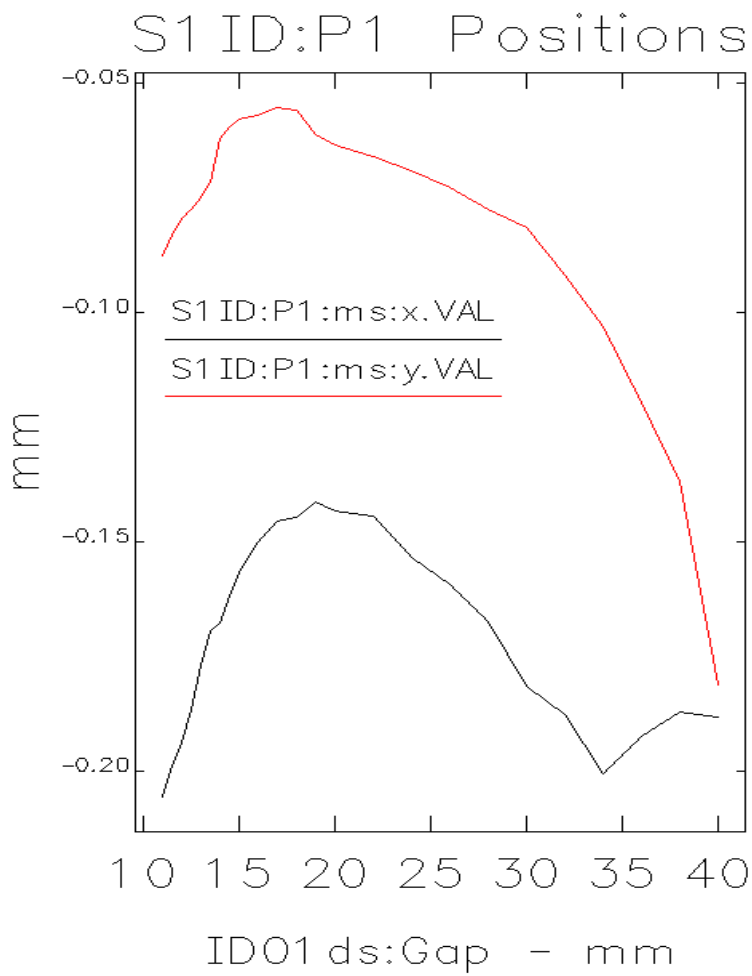




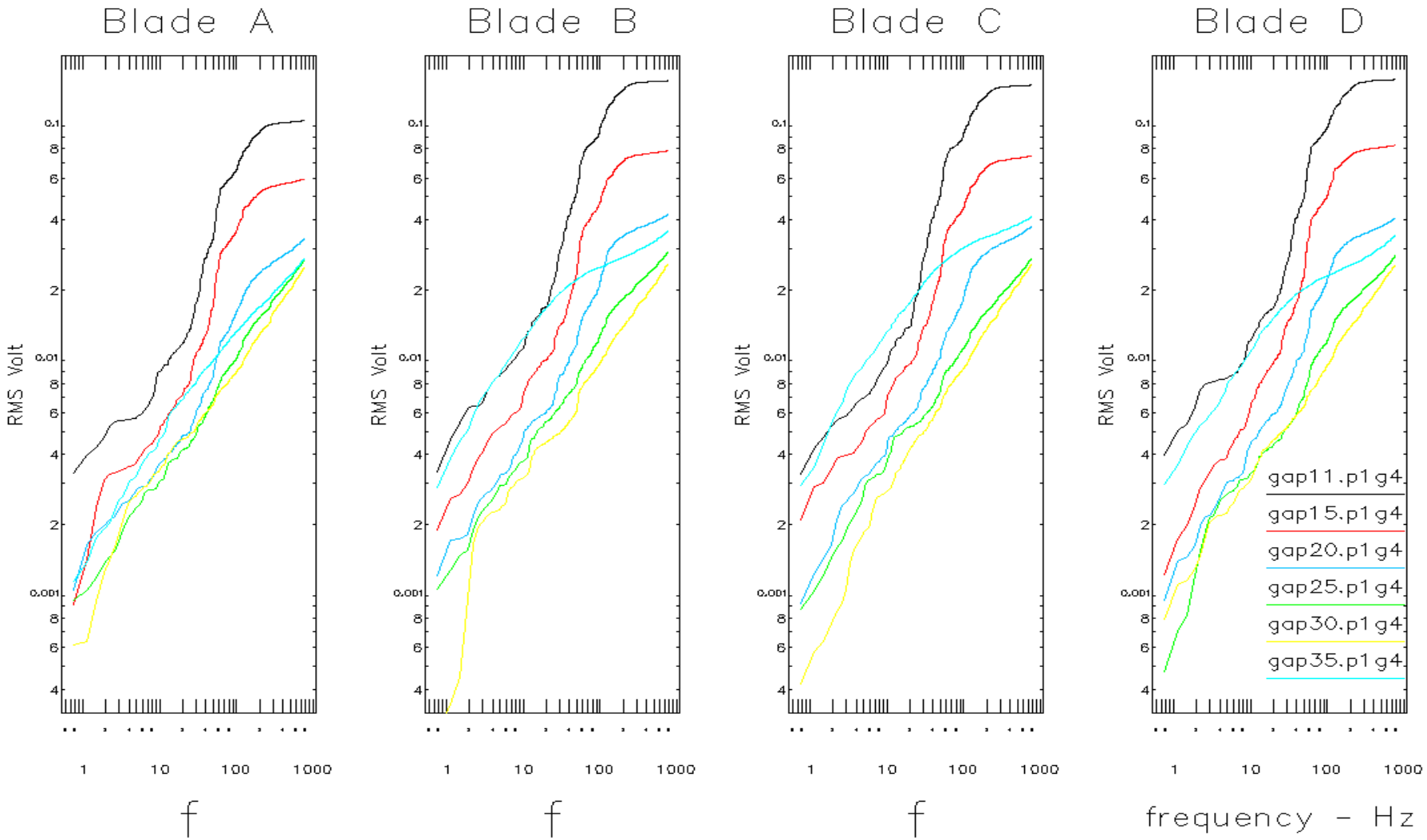
1. Digitization effect contributes significantly to Y Noise as gain varies
2. Pre-amp gain-change-effect is minimal

ID01 P1 Xbpm - Blades and Position as Gap varies



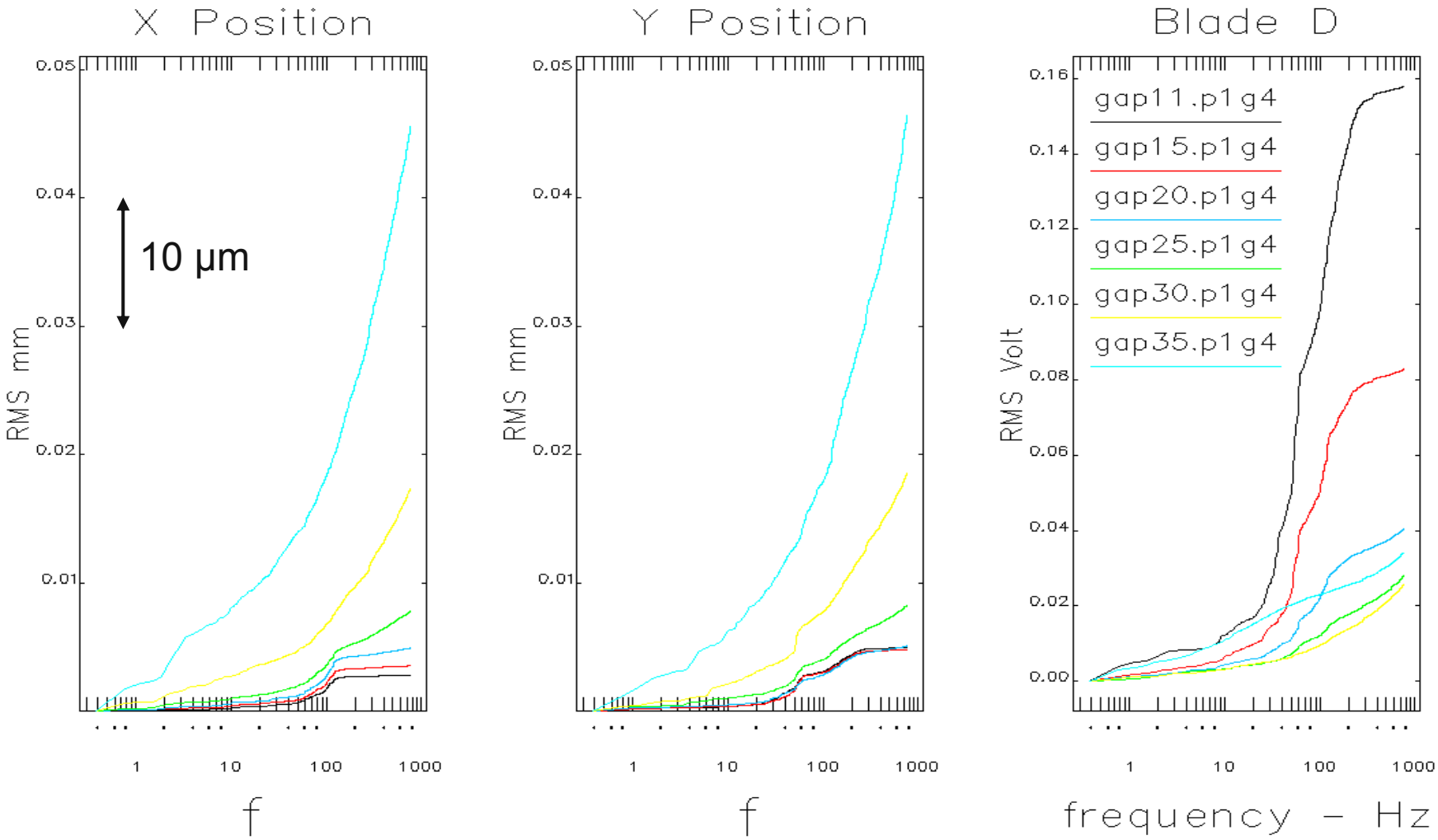


ID01 P1 Xbpm blades – as gap varies (fix blade gain=4)



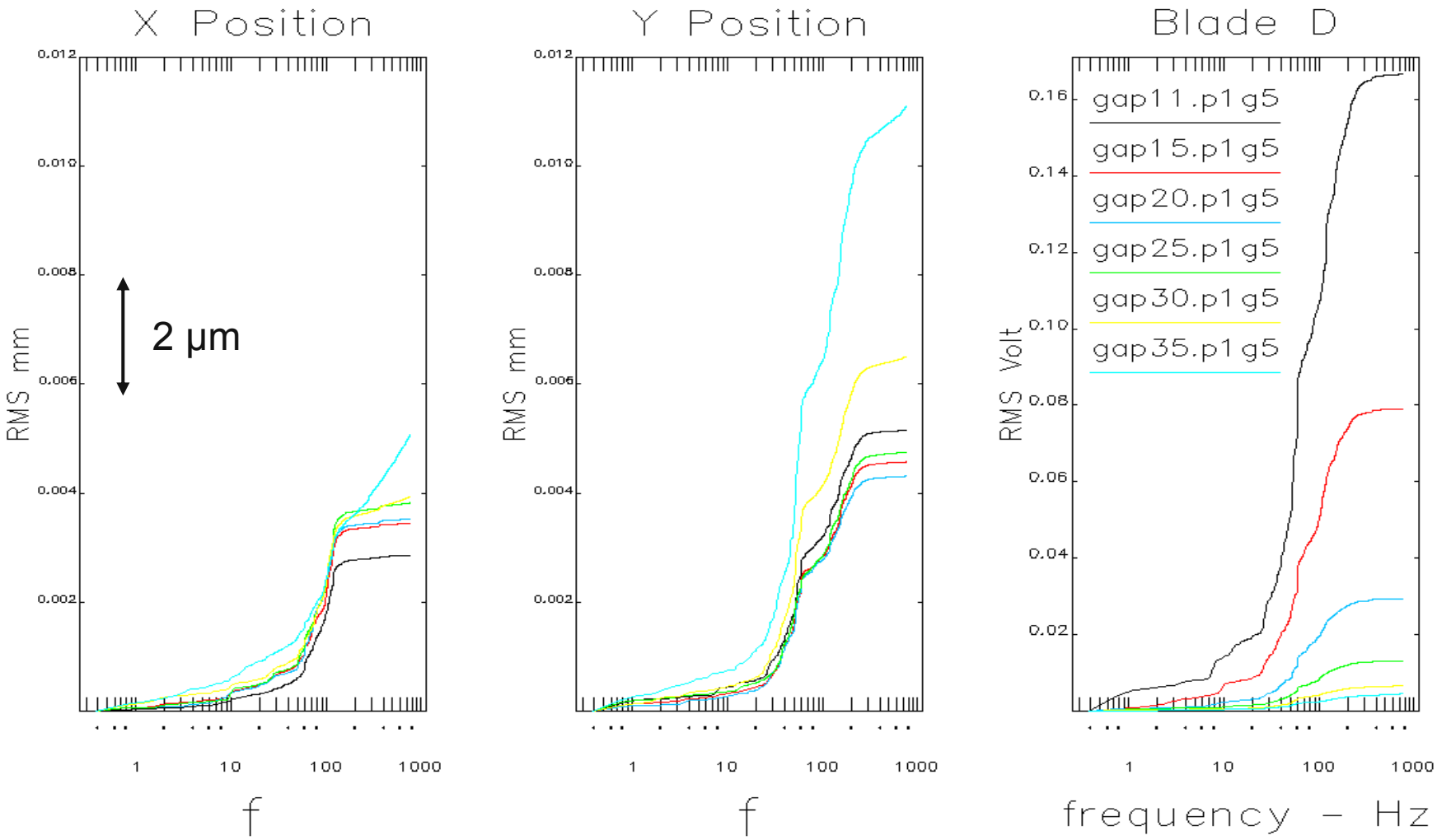
P1 Xbpm Blades AC data for ID01 gap's value to 11, 15, 20, 25, 30 , 35

ID01 P1 Xbpm Position AC Data (fix blade gain=4)



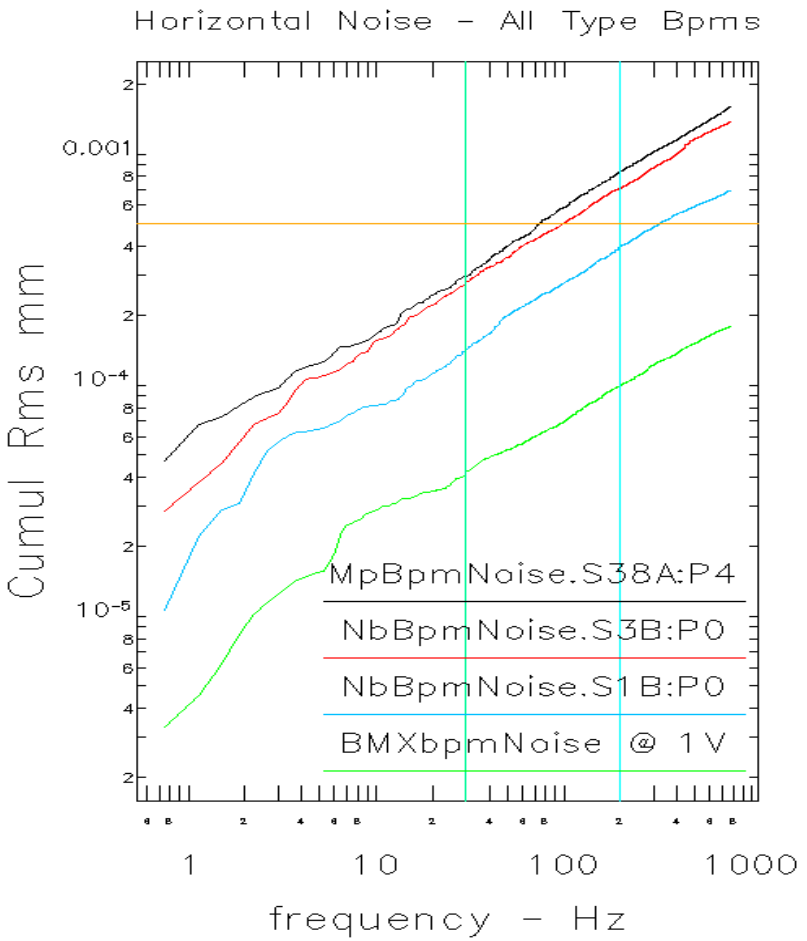
AC position data for gaps 11,15,20 mm – nominal levels
AC position data for gaps 25,30,35 mm – show higher level of noise

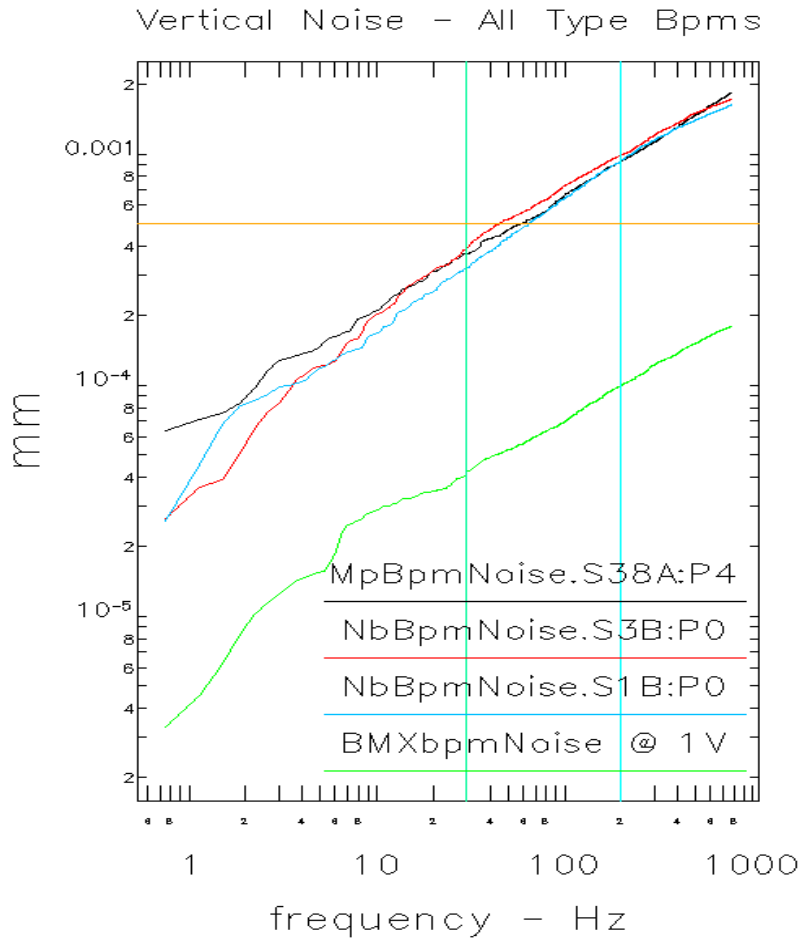
ID01 P1 Xbpm Position AC Data (fix blade gain=5)



AC position data for gaps 11,15,20,25,30 mm – nominal levels
AC position data for gaps 35 mm – show higher level of noise

All Bpms Noise Baseline – NbBpm, MpBpm, Xbpm





Cumul RMS 30 Hz band (H & V)

Mpbpm = 0.3 & 0.35 micron
NbBpm (Rot) = 0.3 & 0.35 micron
NbBpm (Unrot) = 0.15 & 0.3 micron
Xbpm = 0.04 & 0.04 micron

Acknowlegements

Xiang Sun - nbbpms

Michael Hahne - xbpms

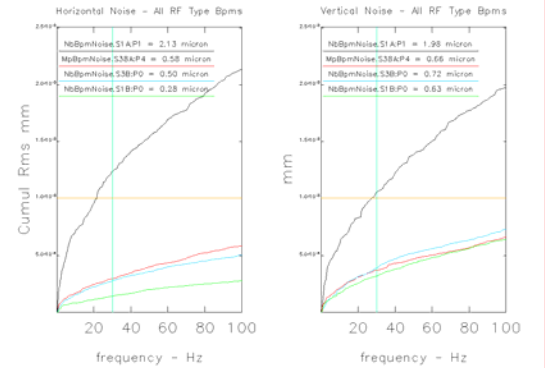
Robert Keane - mpbpms

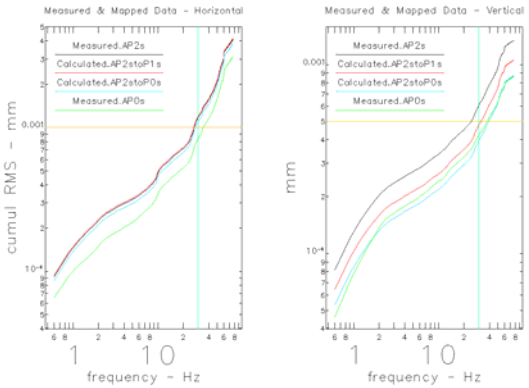
End

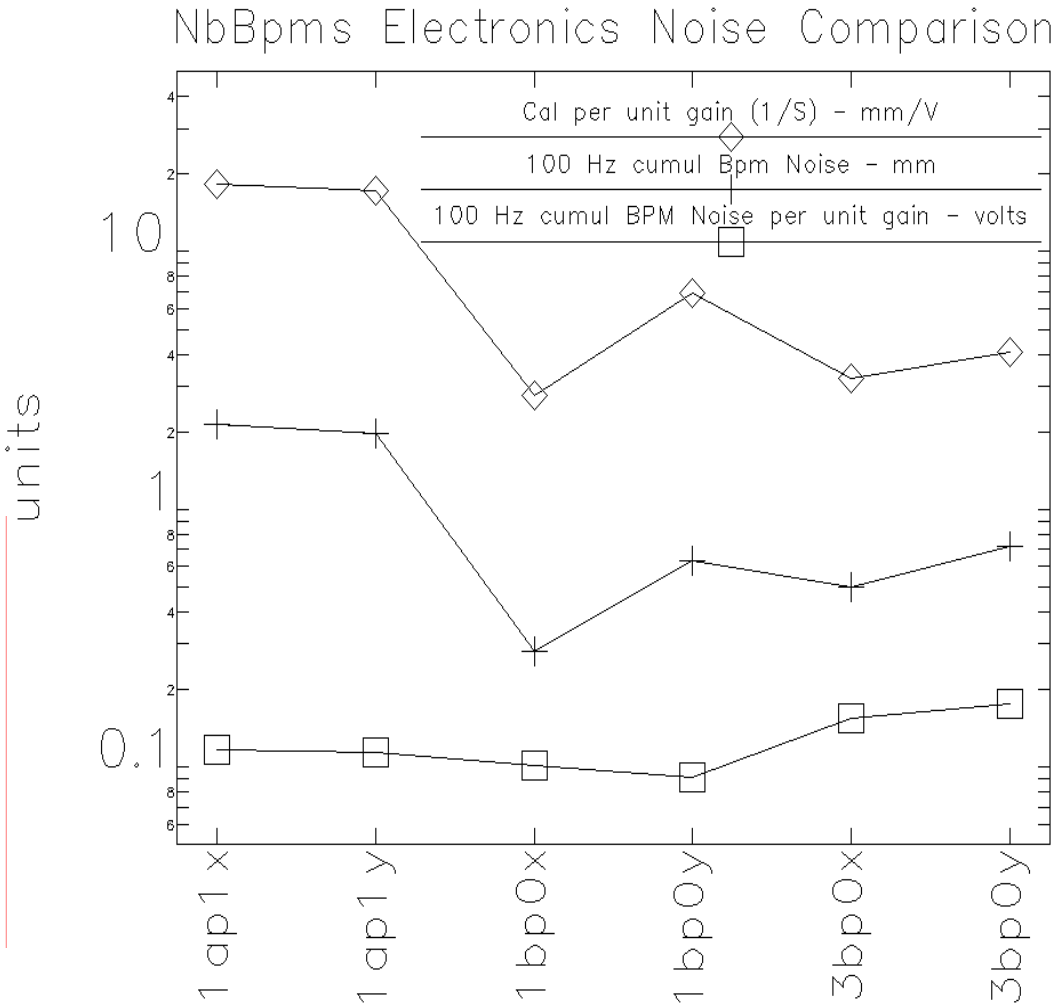
RF Buttons Sensitivities and BPM Electronic gains – APS SR

Buttons Type	Electronics Type		Sensitivity [S] / mm	Gain [G] V/100%	Calibration [1/(SG)] mm/V	Range +/- mm	Noise Factor (1/S) mm
Elliptical Chamber Buttons BPMs	1AP2 – E.Mp	X	0.055	4/π	14.28	14.28	-
		Y	0.058	4/π	13.54	13.54	-
	1AP1-E.Nb	X	0.055	14.8	1.228	12.28	18.18
		Y	0.058	16.1	1.072	10.72	17.24
8 mm ID chamber Buttons BPMs	1BP0-Unr.Nb	X	0.360	8.70	0.319	3.19	2.78
		Y	0.145	34.0	0.202	2.02	6.90
	3BP0-R.Nb	X	0.310	14.8	0.217	2.17	3.23
		Y	0.245	16.1	0.253	2.53	4.08

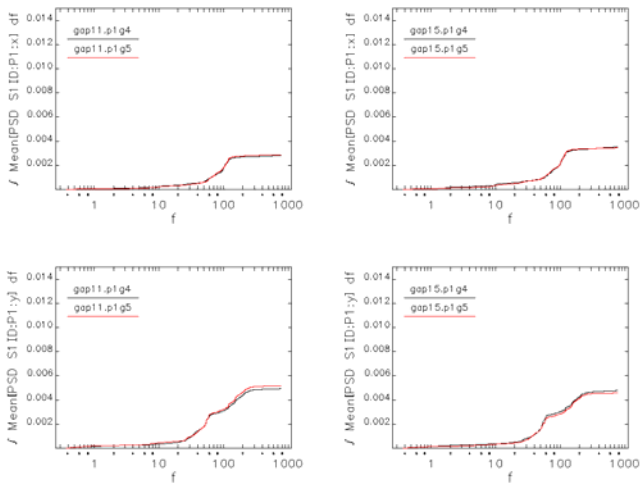
Back up slides

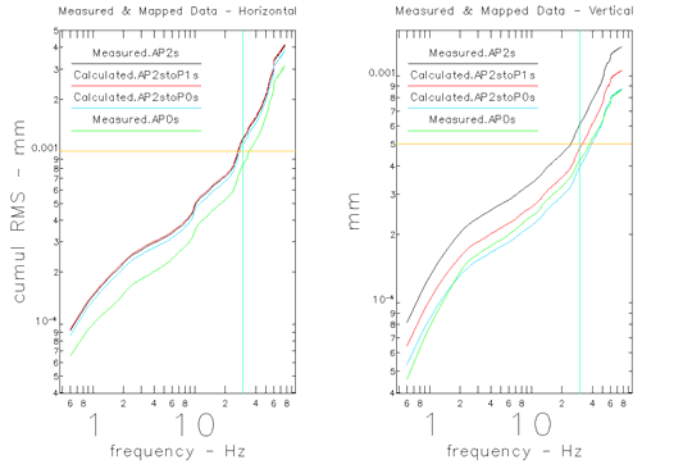


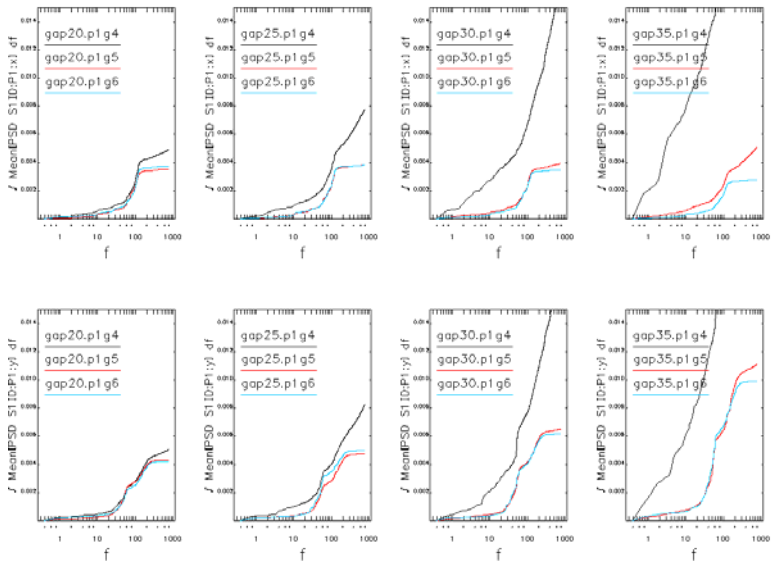


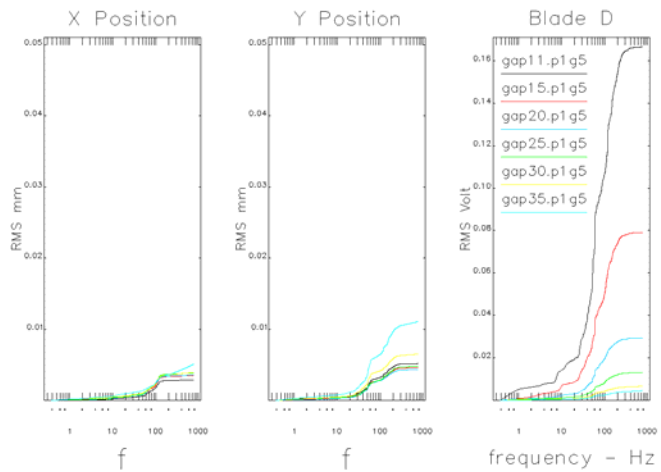


Back up slides









Back up slides

	P0	P1	P2	S8P0	S8P1	S8P2
βx	19.8	23.4	22.5	5.02	11.6	17.4
βy	4.95	7.23	11.7	6.15	6.69	7.17

	$\sqrt{\beta_{P2/P0}}$	$\sqrt{\beta_{P2/P1}}$	$\sqrt{\beta_{P1/P0}}$	$\sqrt{\beta_{P2/P0}}$	S8P1	S8P2
x	1.066	0.981	1.087			
y	1.537	1.272	1.209			

	P0 - β	P1- β	P2- β	$\sqrt{\beta_{P2/P1}}$	$\sqrt{\beta_{P2/P0}}$
x	19.8	23.4	22.5	0.981	1.066

	P0 - β	P1- β	P2- β	$\sqrt{\beta_{P2/P1}}$	$\sqrt{\beta_{P2/P0}}$
y	4.95	7.23	11.7	1.272	1.537