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Recycler BPM Proposal

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RECYCLER BPM – PRE-AMP

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- In the recycler the BPM and pre-amp form a resonant circuit
  1. Tuned at a single frequency (7.5 MHz)
  2. Coupling between BPM plates degrades the signal
- Digital BPM:
  1. No Need for resonant circuit due to down conversion
  2. Pre-amp and BPM form a Bandpass circuit
  3. Rshunt and Cplate+Ccable set the corner frequency
  4. Reduce coupling by –55 dB at 2.5 MHz and 7.5 MHz

Transition Module

- The performance of the digital receiver depends on how well the pre-amp, cables and input impedance to DDC are controlled.
- The differential signal can be processed with a transformer or a differential receiver before its digitized.

EXPECTED SIGNAL LEVELS

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- BPM Signal range from .3e10/bunch to 100e10/bunch
- For 1e10/bunch Gaussian bunch expected current
- $I(f) = N\ e\ f\ (\omega\ l/\ 2\ v\ )\ \exp{-1/2(f/1/2\pi\sigma)^2}$

	1e10		.3e10	
	2.5 MHz (μa peak)	7.5 MHz (μa peak)	2.5 MHz (μa peak)	7.5 MHz (μa peak)
I(f)/2	14.5	60.2	4.354	31.5

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PRE-AMP OUTPUT VOLTAGE

- Pre-amp gain is 40 dB for N=1e10/bunch Gaussian bunch
- The I(f)/2 and Rshunt produce V(f) into pre-amp

  Rshunt = 150 Ohms . The output voltage is V(f) * Gain

	1e10		.3e10	
	2.5MHz	7.5MHz	2.5MHz	7.5MHz
	(mV p)	(mV p)	(mV p)	(mV p)
V(f)	89.63	372.1	26.91	194.5

SIGNAL LEVELS @ DDC

- Cable attenuation is 1.2 dB/100 ft @ 2.5 MHz
- 2.1 dB/100 ft @ 7.5 MHz
- Short length = 150 ft, long length = 1300 ft
- The effect of cable atten. On the pre-amp signals

For 1e10/bunch Vin @ DDC expressed in mV peak

1e10				.3e10			
2.5 MHz		7.5 MHz		2.5 MHz		7.5 MHz	
Long	Short	Long	Short	Long	Short	Long	Short
14.87	72.85	16.06	258.9	4.47	21.87	8.39	135.3

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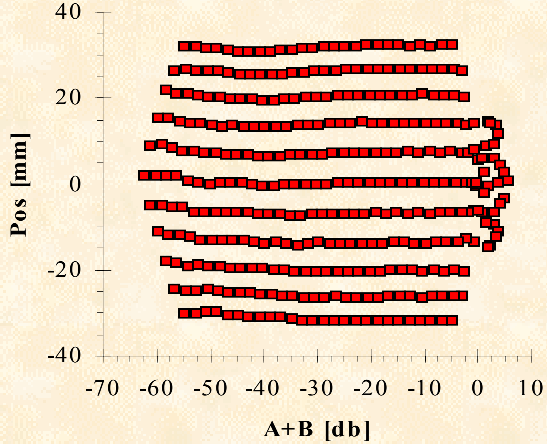
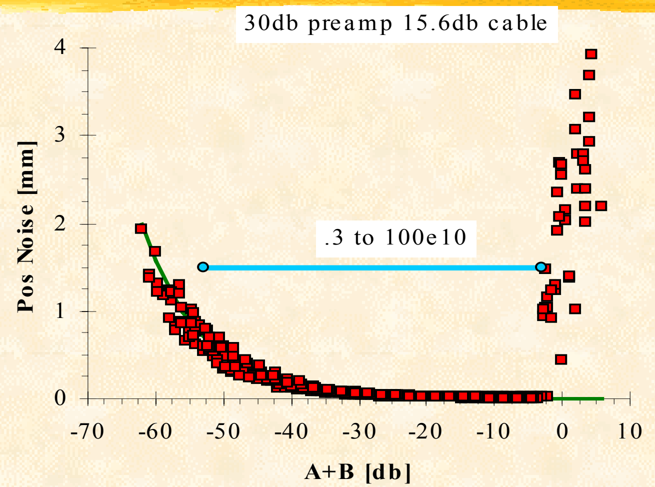
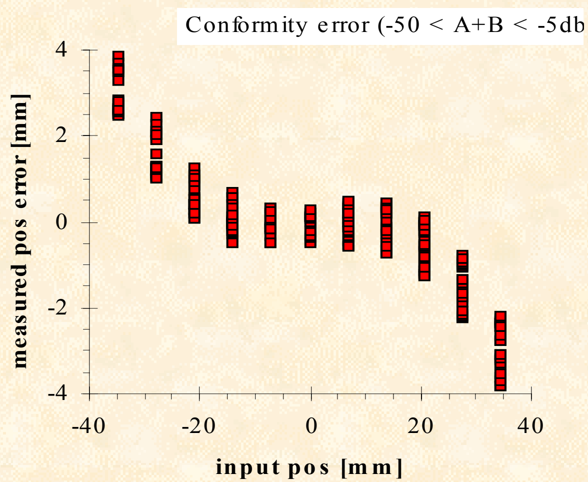
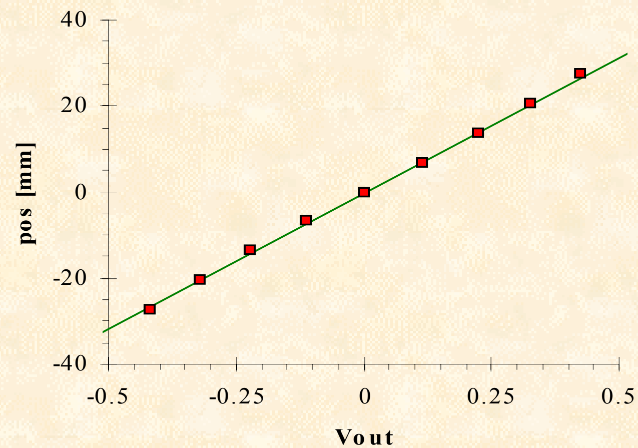
Digital Receiver Performance





-90.4 dbm equiv noise   15.0 bits   4-2.5MHz gaussian bunches   62.85 mm/Volt   0.29 bpm db/mm





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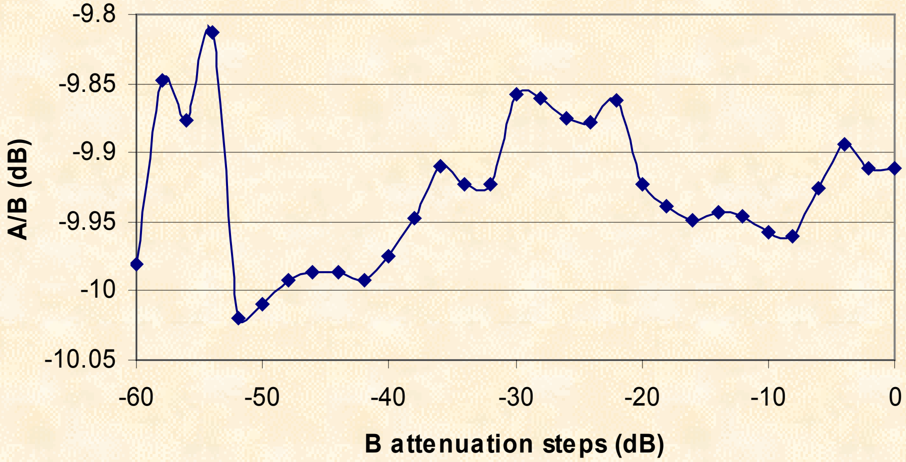
Test Accuracy

- Switchable attenuators contribute ±.1db error
  - ±.34mm Ver or ±.16mm Hor



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Optimum Preamp Gain

- AD6644 A/D converter
  - SNR=(power of true signal / power of noise) = 74.5db
  - ENOB=(SNR-1.763)/6.021=12.1 bits
- Measure 15 bits because of “processing gain”
  - M = Fs / 2 * BW where M = 2^2(2R-N)
- A/D input noise
  - 188uVrms
- Preamp noise at A/D input is not significant
  - 2nV/srHz, 50MHz, +30db gain, -15.6db longest cable
  - 74uVrms
- Total A/D input noise
  - 202uVrms

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Conclusion

- The digital receiver will do it
- We have to get the signals from the bpm to the receiver with minimum differences between channels
- Signal path must be controlled at every stage