Some Beam Test Results for a Single Bunch Dif-Sum BPM with Beam-Signal-Based Clock

(part 1)

A. Kalinin

Accelerator Science and Technology Centre,

Daresbury Laboratory, UK

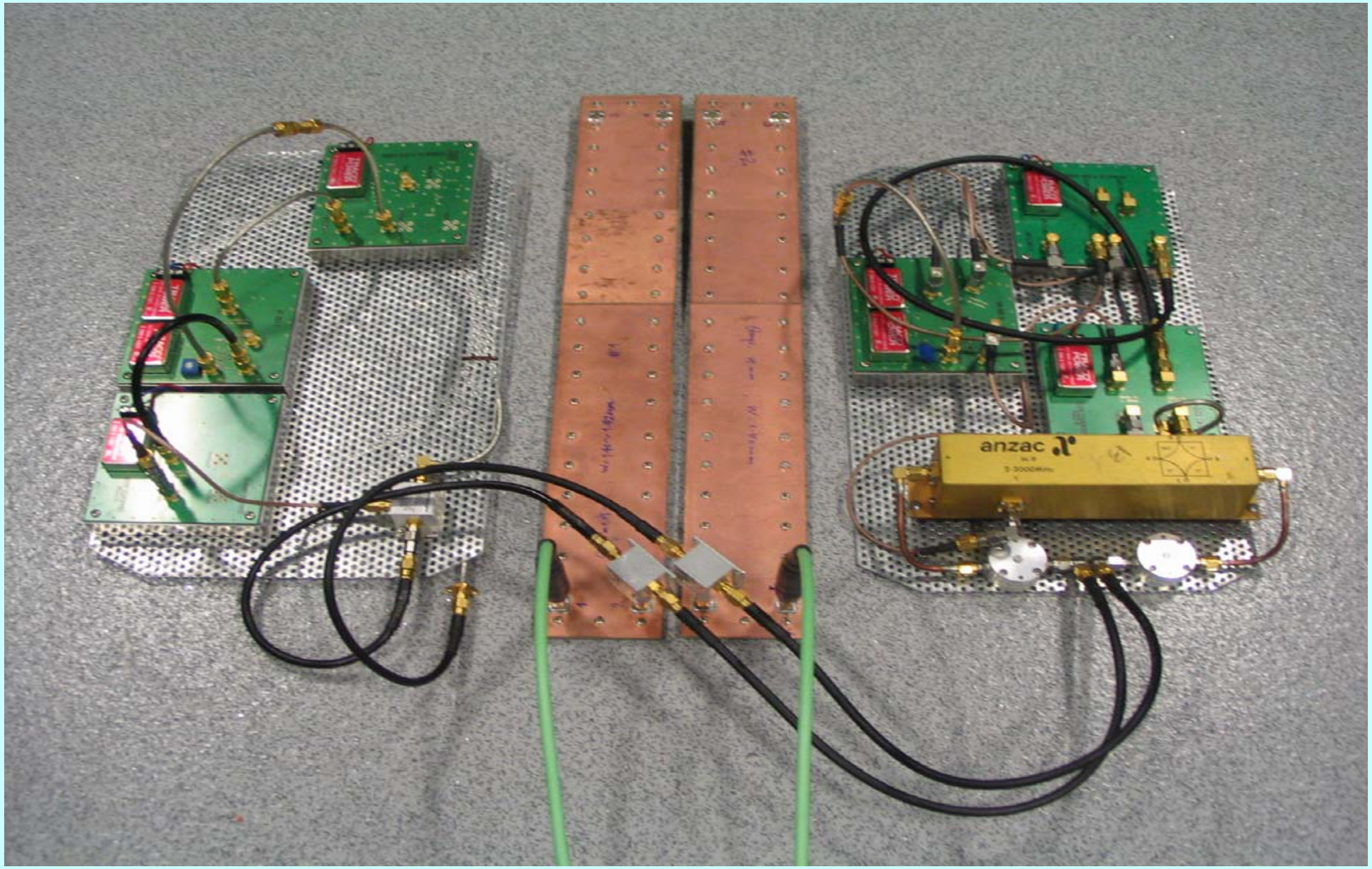
The FONT Meeting

Oxford, January 11, 2008

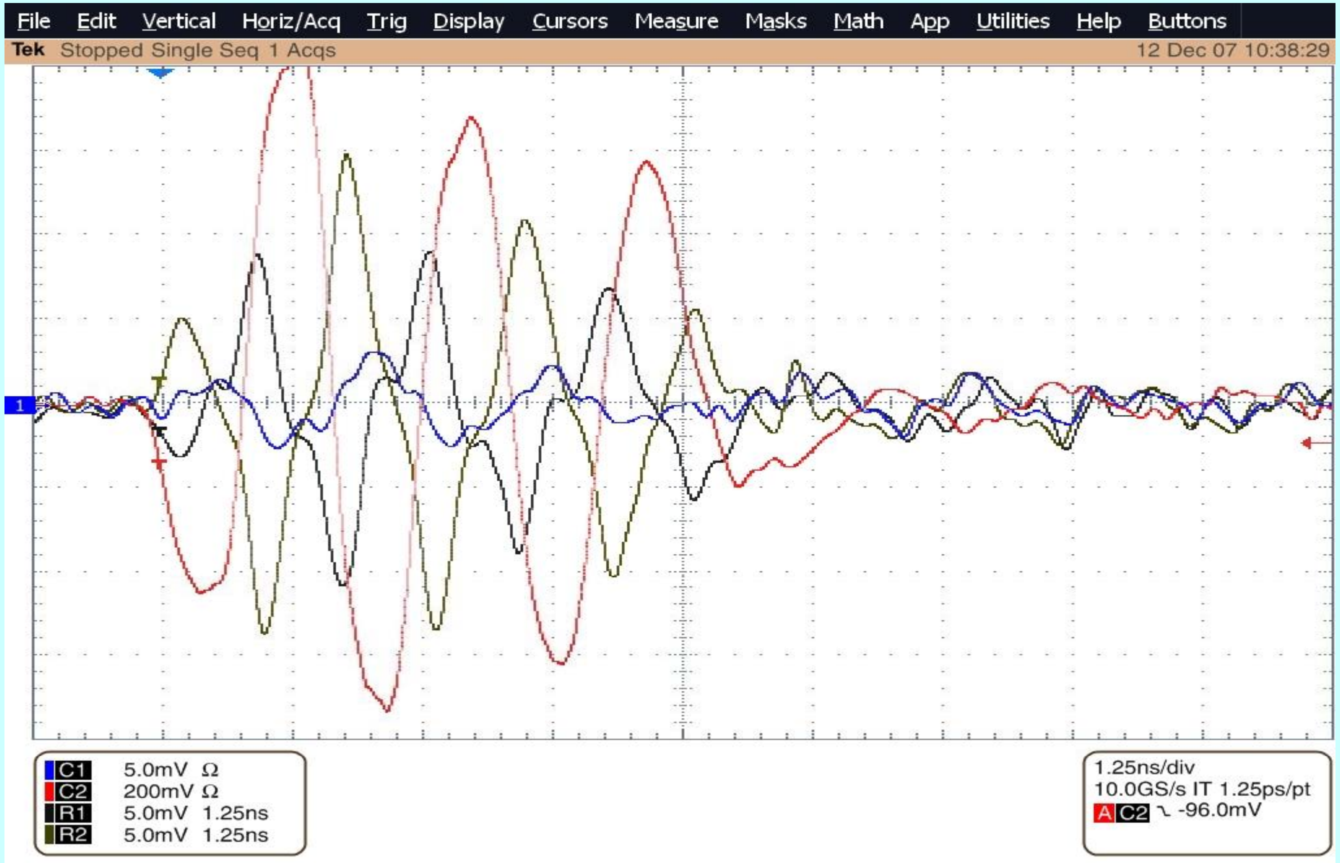
Test Block Diagram

Calibration: two BPMs are connected in parallel to the strip line pickup #10 (as shown).

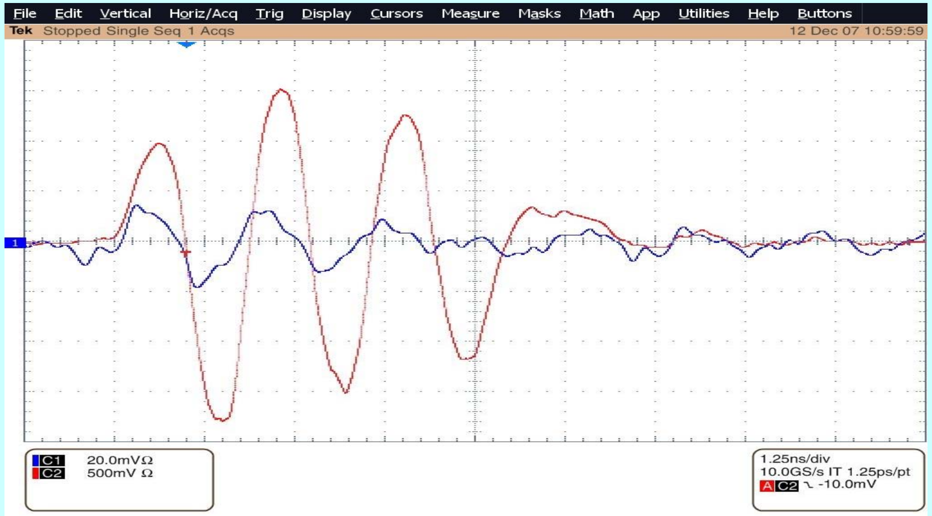
Characterisation and Resolution measurement: a signal of one strip line is split into two BPM inputs.



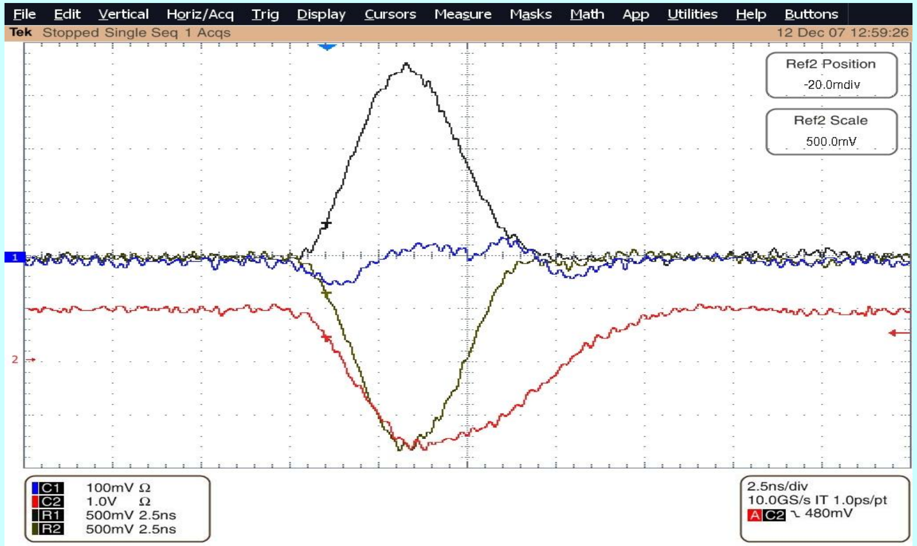
Characterisation & Calibration:
oscilloscope TDS7154B 1.5GHz
Resolution measurement:
ADC GFT6003 14bit 2Gsamples/s



1. Balancing of the Dif-Sum BPM inputs. The Hybrid Junction outputs. Red: the sum signal (=1); black: the signals for intentionally unbalanced inputs; blue: a residue of balancing (~1/200).



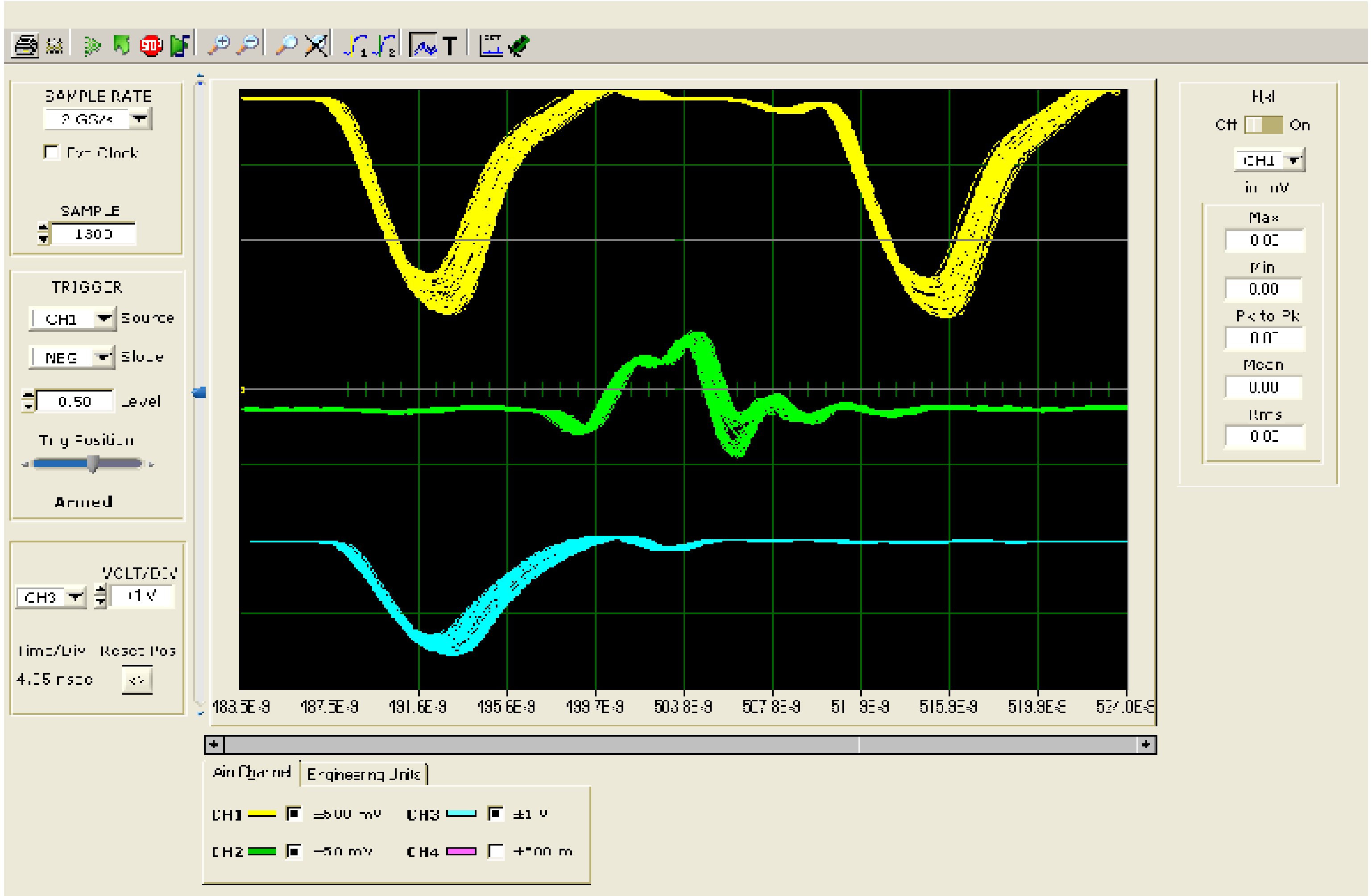
The Amplifiers outputs. An attenuator 6dB at the sum input.



The Dif-Sum BPM outputs.

Red: the sum signal; black, blue, brown: the signals for 'displacement' +5dB, 0 and –5dB. The dif gain is about 10dB higher than the sum gain.

The BPM signals at GFT6004



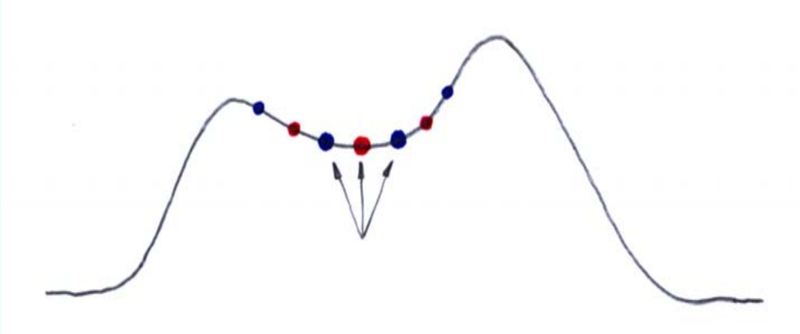
The resolution data recorded:

- The 071808 Shift: three arrays 40 to 60 shots for threshold 60mV and Dif gain 10dB.
- The 071218 Shift: total nine arrays 60 to 120 shots for threshold 300mV, including six arrays for Dif Gain 10dB (one of them for ghost bunch) and three arrays for Dif Gain 14dB.

The resolution data processed:

- The 071808 Shift: one array (Raw 100). Resolution was calculated for the three cases: the upstream max, the saddle and the downstream max of the Dif Out pulses.
- The 071218 Shift: five arrays. Resolution was calculated for the saddles. Two arrays (1 and 5), and one array (3) for ghost bunch as well are for Dif Gain 10dB, two arrays (7 and 9) are for Dif Gain 14dB.
- From each array, thirty samples (1 to 30) are used.
- Fliers if any, are not removed.

- **Bunch intensity is ≥5·10^9e.**
- **The pickup signal is deliberately attenuated 7dB. So, the resolution obtained is for ≥2·10^9e, or 0.3nC.**
- **x[mm]=(Dif/Sum)·M[mm]**
- **The scale coefficient M measured with ZH4X and ATF BPM10 is about 2.6mm. A coefficient estimated from Jitter BPM (0.85mm for Dif Gain 20dB) is 2.7mm (Dif Gain 10dB). For the resolution calculation here the coefficient is taken M1=3mm for Dif Gain 10dB and M2=0.63·3mm for Dif Gain 14dB.**
- **No interpolation is used. For saddle the minimal reading is taken, for upstream/ downstream maximums the max is taken. For synchronous sampling this would be equivalent to ADC clock jitter within ±1/4ns.**



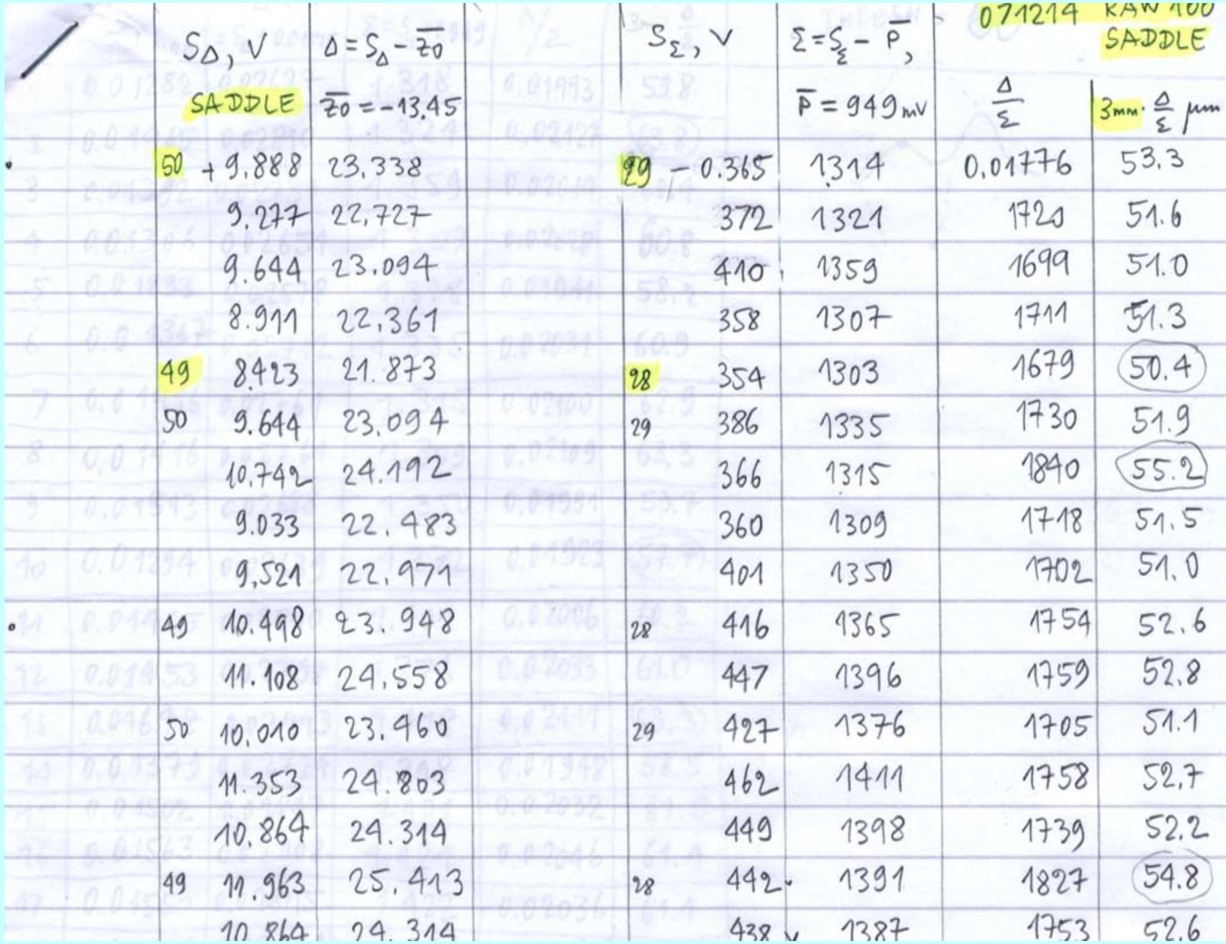
The data sheet

An ASCII array:

Date: 18/12/2007 at 14:18:24
Sampling rate: 2000000000 Hz
Total Number of Samples: 100

6.500000e-09	-0.013916
7.000000e-09	-0.014771
7.500000e-09	-0.016846
8.000000e-09	-0.020630
8.500000e-09	-0.025269
9.000000e-09	-0.031616
9.500000e-09	-0.032227
1.000000e-08	-0.023071
1.050000e-08	-0.005371
1.100000e-08	0.012817
1.150000e-08	0.023560
1.200000e-08	0.022095
1.250000e-08	0.013916
1.300000e-08	0.009521
1.350000e-08	0.015015
1.400000e-08	0.024658
1.450000e-08	0.025024
1.500000e-08	0.007568
1.550000e-08-	0.018066
1.600000e-08	-0.034790
1.650000e-08	-0.034424
1.700000e-08	-0.02246
1.750000e-08	-0.011963
1.800000e-08	-0.008301
1.850000e-08	-0.007690
1.900000e-08	-0.013672

The data sheet for 30 arrays:



071214 RAW 100 SADDLE

	S_Δ, V	$\Delta = S_\Delta - \bar{z}_0$		S_Σ, V	$\Sigma = S_\Sigma - \bar{P}$	Δ/Σ	$3mm \cdot \Delta/\Sigma$ μm
	SADDLE	$\bar{z}_0 = -13.45$			$\bar{P} = 949$ mV		
50	+9.888	23.338	29	−0.365	1314	0.01776	53.3
	9.277	22.727		372	1321	1720	51.6
	9.644	23.094		410	1359	1699	51.0
	8.911	22.361		358	1307	1711	51.3
49	8.423	21.873	28	354	1303	1679	50.4
50	9.644	23.094	29	386	1335	1730	51.9
	10.742	24.192		366	1315	1840	55.2
	9.033	22.483		360	1309	1718	51.5
	9.521	22.971		401	1350	1702	51.0
49	10.498	23.948	28	416	1365	1754	52.6
	11.108	24.558		447	1396	1759	52.8
50	10.010	23.460	29	427	1376	1705	51.1
	11.353	24.803		462	1411	1758	52.7
	10.864	24.314		449	1398	1739	52.2
49	11.963	25.413	28	442	1391	1827	54.8
	10.864	24.314		438	1387	1753	52.6

The shift 071208. The threshold is 60mV.		
upstream maximum	saddle	downstream maximum
1.60μm (published)	1.34μm	2.60μm

The 071218 shift. The threshold is 300mV. Saddle.					
Dif Gain	10dB			14dB	
array	1	3	5	7	9
	1.86μm		1.83μm	1.12μm	1.05μm
ghost bunch		1.55μm			

Conclusions:

1. As it was expected for the intensity given, the BPM resolution is decided by the (SD + ADC Driver + ADC) noise. So, increase of the Dif Gain proportionally improves the resolution.
2. The threshold value looks to be not critical.
3. A ghost bunch does not affect the resolution (provided the beam is near the pickup center).

Nearest tasks:

1. Complete processing. Use Fourier Interpolation to exclude the ±1/4ns jitter.
2. See a 'position' mean drift along the array and its correlation with the bunch intensity, a ghost bunch, etc.
3. Process the Multiplex BPM data.
4. Using a signal imitating the pickup signal, measure the resolution by a single sample ADC CS328A.