SOLEIL Libera Performance

Libera Workshop
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BPM system: MAC2 requirements, Feb. 2002

	closed orbit Correction	Global Feedback	First turns	turn-by-turn for machine studies
number of BPMs	120 instead of 112	48 instead of 32 (note 1)	120	120
single measurement resolution	< 0.2 μm	< 0.2 μm	< 0.5 mm	< 1 μm
absolute accuracy with respect to quad	< 0.2 mm	✕	< 0.5 mm	< 0.2 mm
measurement rate	> 1 per second	for 100 Hz feedback	1 per seconde	<1 μm in < 60 s
dynamic range	M: 200→600 mA T: 20→120 mA	M: 200→600 mA T: 20→120 mA	0.4 → 4 mA	4 → 100 mA
Current dependence within a 10 dB range	< 5 μm (note 2)	< 5 μm	< 0.5 mm	✕
8-h and 1-month drift at constant current	< 1 μm, < 3 μm	< 1 μm, < 3 μm	< 0.5 mm	✕
reproducibility versus bunch pattern	< 10 μm (note 2)	< 10 μm (note 2)	< 0.5 mm	< 0.5 mm

note 1: either part of the 120 closed-orbit-correction monitors or additional monitors

note 2: This value should be reduced to less than 1 μm after calibration

First Turns Mode Performance

	Feb. 2002 specs	Dec. 2006 performance
number of BPMs	120	OK
single measurement resolution	< 0.5 mm	OK
absolute accuracy with respect to quad	< 0.5 mm	OK
measurement rate	1 per seconde	OK
dynamic range	0.4 → 4 mA	≥0.1 mA @ resolution ≤ 0.5 mm
Current dependence within a 10 dB range	< 0.5 mm	OK
8-h and 1-month drift at constant current	< 0.5 mm	OK
reproducibility versus bunch pattern	< 0.5 mm	a few µm with simulated beams in lab

Turn-by-Turn Mode Performance

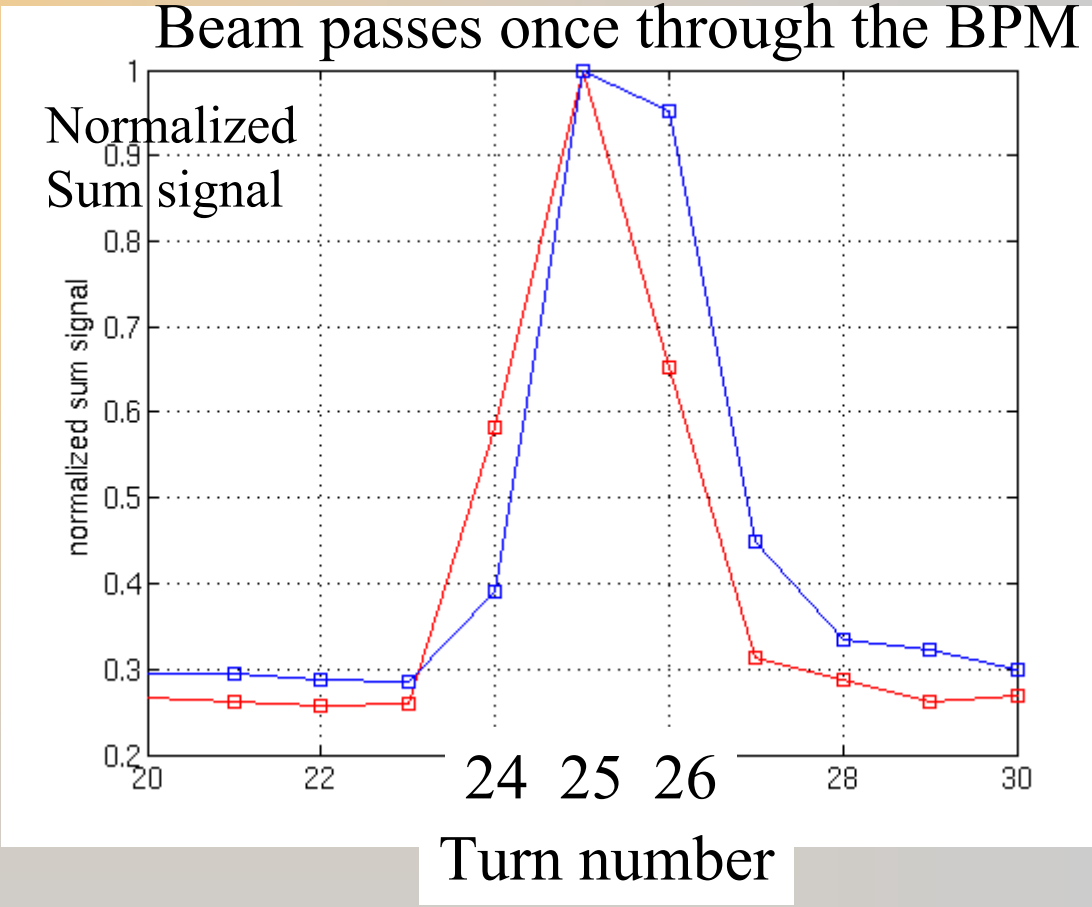
	Feb. 2002 specs	Dec. 2006 performance
number of BPMs	120	OK
single measurement resolution	< 1 µm (in less than 60 kicks at 1Hz)	$\sigma \leq$ 3,6 µm in one turn (should reach 1 µm in 13 kicks)
absolute accuracy with respect to quad	< 0.2 mm	OK
measurement rate	<1 µm in < 60 s (846 kHz)	OK
dynamic range	4 → 100 mA	4 mA → σ = 3,6 µm 100 mA → σ = 0,7 µm
Current dependence within a 10 dB range	×	×
8-h and 1-month drift at constant current	×	×
reproducibility versus bunch pattern	< 0.5 mm	OK

Turn-by-Turn mode

Timing

☼ BPM orbit needs data of the same turn: timing adjustment in Libera

☼ Turn-to-turn crosstalk: Beam is visible on 3 successive turns => <u>needs More work</u>

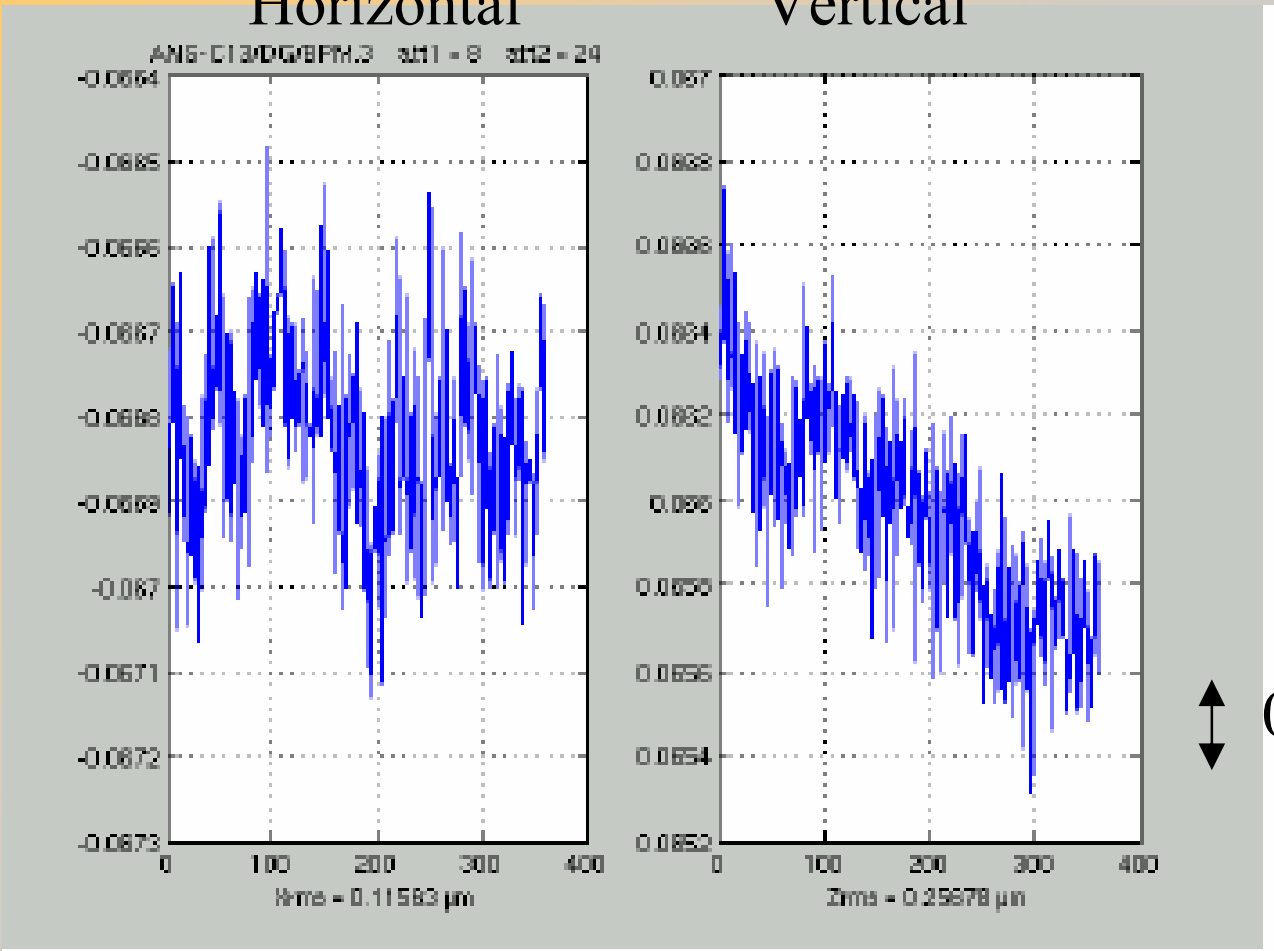


Orbit Correction (and Slow Orbit Feedback)

	Feb. 2002 specs	**Dec. 2006 performance**
number of BPMs	120	120
single measurement resolution	< 0.2 µm	≤ 0.2 µm (integrated BPM spectrum on the machine without beam)
absolute accuracy with respect to quad	< 0.2 mm	in 10 µm range (after BBA)
measurement rate	> 1 per second	≈ 10 per sec.
dynamic range	M: 200→600 mA T: 20→120 mA	OK
Current dependence within a 10 dB range	< 5 µm (note 2)	OK
8-h and 1-month drift at constant current	< 1 µm, < 3 µm	OK for 8h; 1 month not measured yet
reproducibility versus bunch pattern	< 10 µm (note 2)	OK
note 2: This value should be reduced to less than 1 µm after calibration		calibration table not yet implemented

Libera Noise in Slow Acquisition Mode

Horizontal Vertical



0.1 µm ↕

↕ 0.2 µm

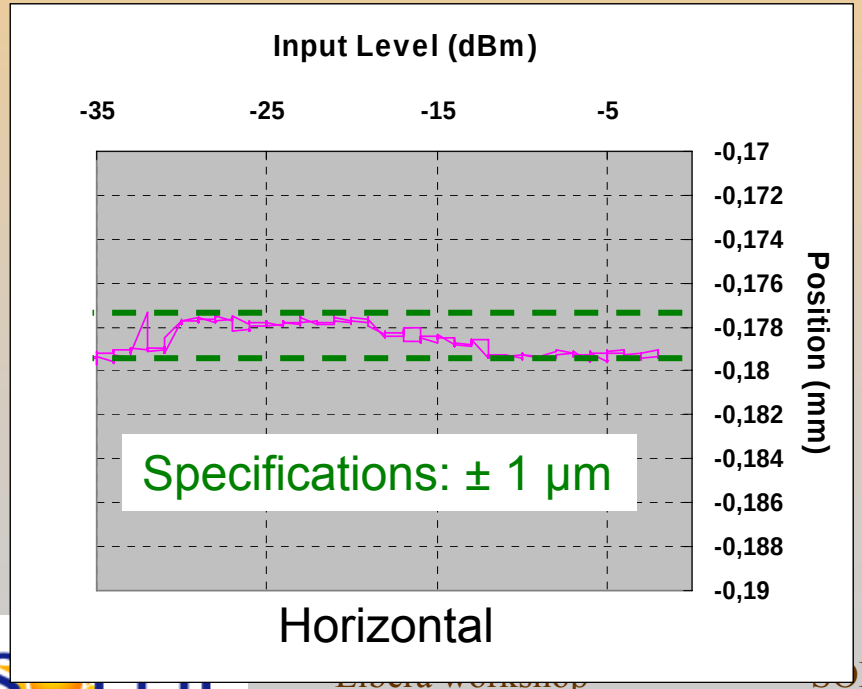
Figure 4: Libera noise in Slow Acquisition mode: Xrms = 0.11µm, Zrms = 0.25 µm (360 acquisitions in 180 s).

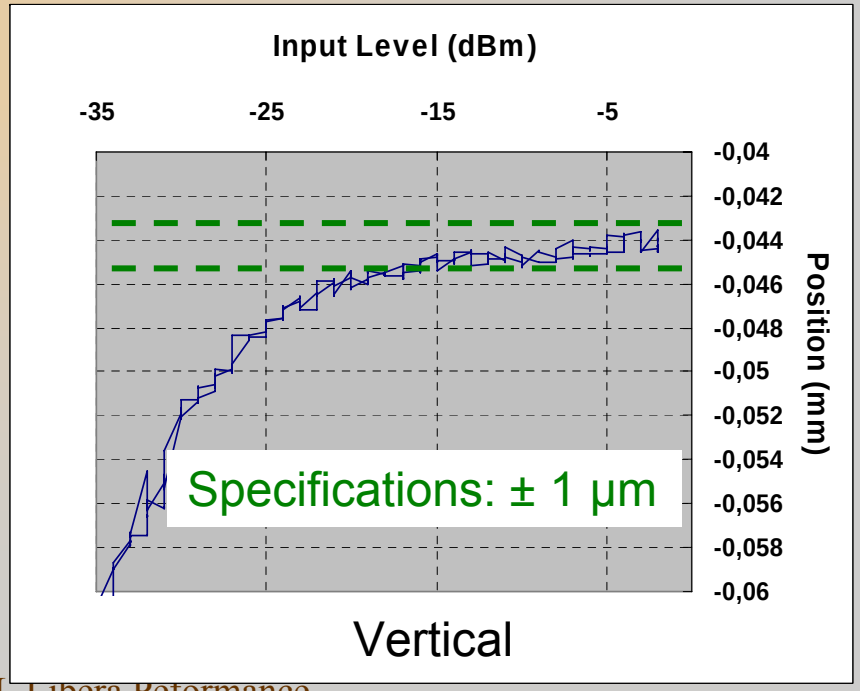
Slow Acquisition Mode

- Are the SA data obtained after averaging the FA data over 0.1 second?
- The Libera noise is within specs, however, an additional averaging would be beneficial to the slow orbit feedback performance.
- Bunch Pattern Dependence is 1 to 2 μm from multibunch Ring filling to 8-bunch pattern and 2 or 3 times more from 8-bunch to single-bunch pattern.
- Beam current dependence is about 10 μm from 500 to 20 mA. It is combined with bunch pattern dependence and it is too much.
- We think those two last characteristics are very important to Storage Ring operation.

Automatic Gain Control and beam current dependence

- Front-end attenuator values are automatically adjusted to input level
  - Steps <1 µm at each change of attenuators value
- Libera are able to follow injection from 0 mA to final current without triggering interlock (saturation of the ADCs).
- Beam current Dependence measured with a generator (AGC ON):





Fast Orbit Feedback Mode

	Feb. 2002 specs	Dec. 2006 performance
number of BPMs	48	120
single measurement resolution	< 0.2 μm	< 0.2 μm (0 to 500 Hz BW on ring and no beam)
absolute accuracy with respect to quad	✕	✕
measurement rate	for 100 Hz feedback	10 kHz
dynamic range	M: 200→600 mA T: 20→120 mA	OK
Current dependence within a 10 dB range	< 5 μm	OK
8-h and 1-month drift at constant current	< 1 μm, < 3 μm	OK for 8h; 1 month not measured yet
reproducibility versus bunch pattern	< 10 μm (note 2)	OK
note 2: This value should be reduced to less than 1 μm after calibration		calibration table not yet implemented

FOFB not yet implemented at SOLEIL

- Is the measurement rate OK?
- What about the fact that only 1/8 the rate is really a completely new measurement?

Position Interlock

- Has been slow and more difficult that anticipated to implement efficiently with the AGC. Several months while we had to work in manual instead of AGC mode.
- Safety is now 100%. We discovered it has not always been the case.
- From the start a specific diagnostic interlock system shows which BPM has triggered the interlock within a cell (7 to 8 BPMs). The global interlock system indicates which cell has triggered the interlock and whether it is beam position, or anything else (except RF failure, since it is not really an interlock).
- Specific injection procedure in manual gain (attenuation has to be set manually for the final beam current), then liberas are set to AGC mode. It would be more confortable to always stay in AGC, but it is a lower priority than fixing bunch pattern and current dependence issues.

"Postmortem" Data after Interlock

Vert. orbit problem

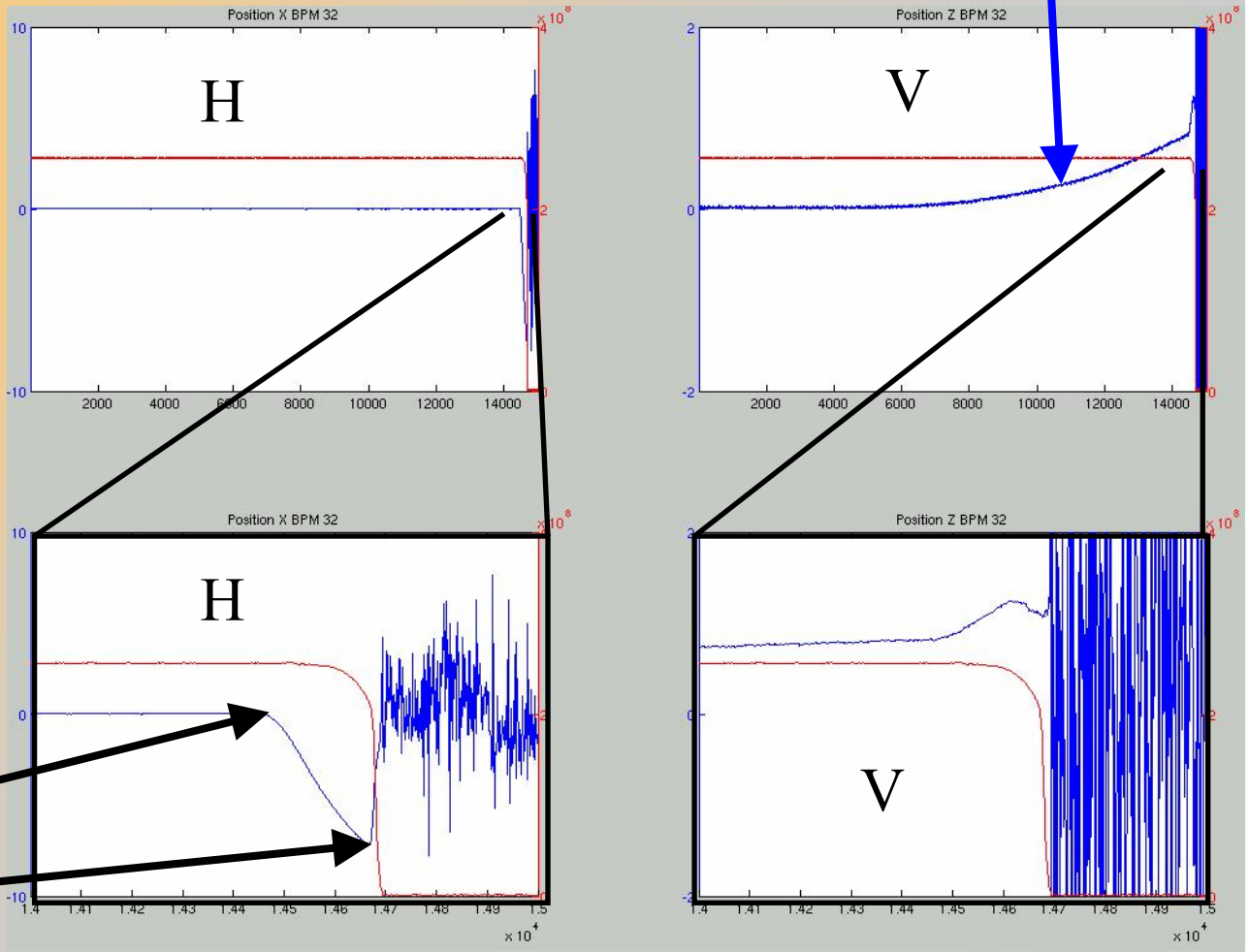
Full buffer

16 kSamples =>

Zoom on last Samples =>

RF is turned off

Beam killed



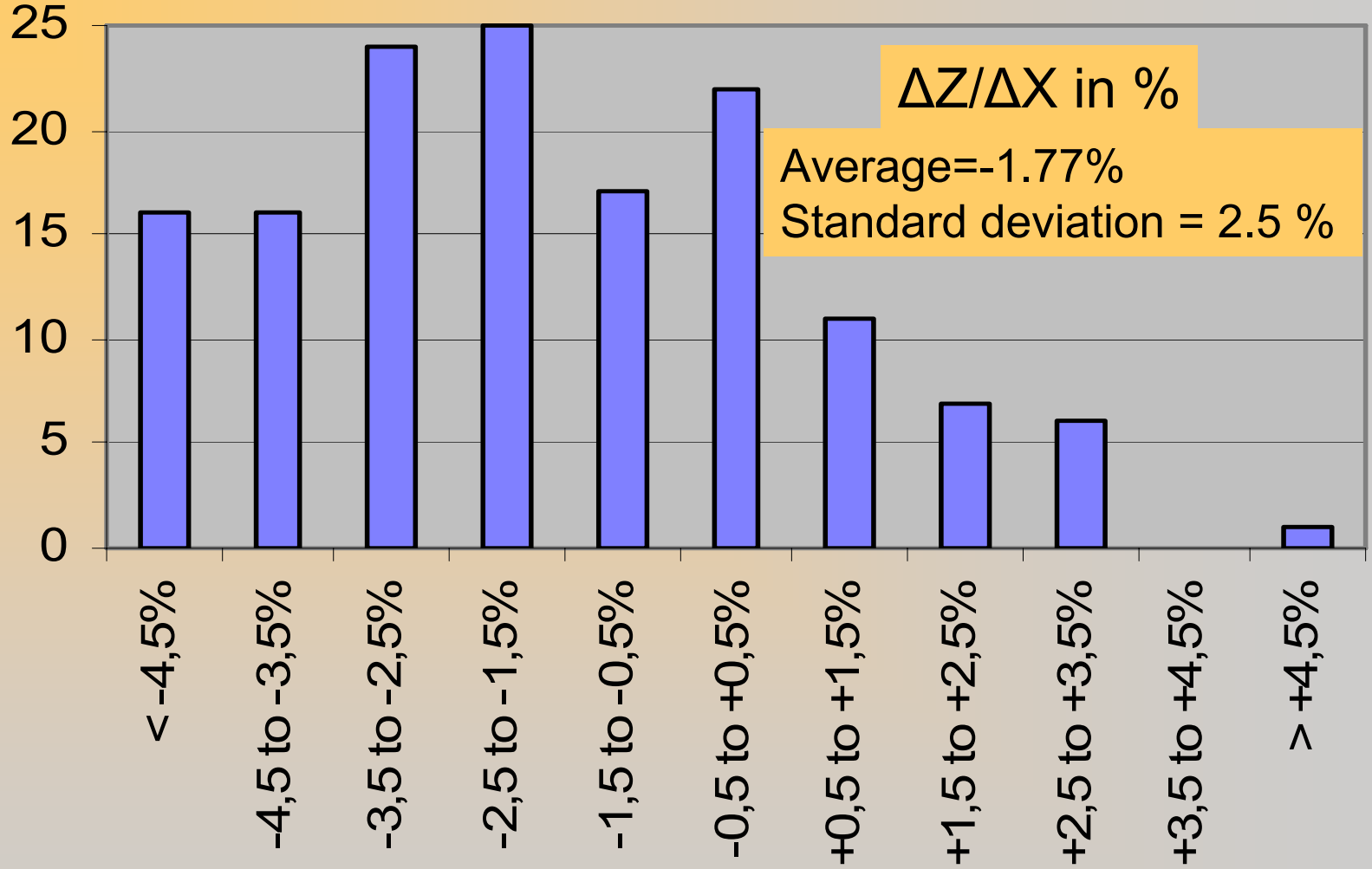
Post Mortem Data

- Is useful and works fine
- Is the 16 K buffer sufficient ?

Not Originally Specified

- Horizontal to Vertical Position Crosstalk
  - Does not really matter for the orbit feedback systems
  - It matters for measuring accurately the machine coupling.
  - Actually with LOCO, L.Nadolski was able to have a good idea of the BPM coupling and could reduce the coupling from 0.3 to 0.1 %.
  - We also measured all Libera crosstalks. Both sets of data match reasonably well.
  - How much do we want to pay for better crosstalk?
- Single Bunch maximum current
  - For the SOLEIL Libera, max peak input power is 33 dBm. With our cable attenuation and BPM geometry, it is 20 mA per bunch. We do not dare go to higher single bunch currents.
  - How much of a problem is that? How to fix it? At which cost?

RF Channels Crosstalk:



Effect in the vertical plane of an horizontal displacement measured with a generator on 145 Liberas

What are the most important items to ask to IT?