LIBERA EXPERIENCE AT SOLEIL

Nicolas HUBERT
Diagnostics Group, Synchrotron SOLEIL

Libera Workshop
Instrumentation Technologies
25/04/2013

SOLEIL SYNCHROTRON

- Synchrotron SOLEIL:
  - 3rd generation light source in Saint-Aubin , France
  - Delivering photons since 2007
  - 26 beamlines

- First Libera customer:
  - Call for tender based on Soleil specifications in 2003
  - Instrumentation Technologies selected with platform modification proposal to fit all users requirements
  - First delivery in December 2004 (25 units for Booster)

See J.C. DENARD presentation

OUTLINE

- Libera at SOLEIL
  - Status
  - Maintenance

- Typical examples of experiments that have been eased by Libera functionalities

  - Turn by turn measurements
  - Beam noise measurements

- Some recent improvements for beam stability

  - Band-pass filters to suppress beam current dependence in (few) single bunch operation
  - Bending magnet XBPMs in the Slow Orbit Feedback Loop during user operation

Libera status at SOLEIL

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  - BP filters for BCD
  - XBPMs in SOFB

- 161 Libera Electron
  - Storage Ring: 122 BPMs + 1 tune
  - Booster: 22 BPMs
  - Transfer lines: 4 BPMs
- 5 Libera Brilliance
  - for tests
  - To be installed on 2 BPMs in 2013 for slicing operation (beam laser alignment requires good beam current dependence)
- 7 Libera Photon
  - Bending Magnet beamline frontends: 4 XBPMs (blade type)

- Controlled by Tango devices running on external Linux servers.

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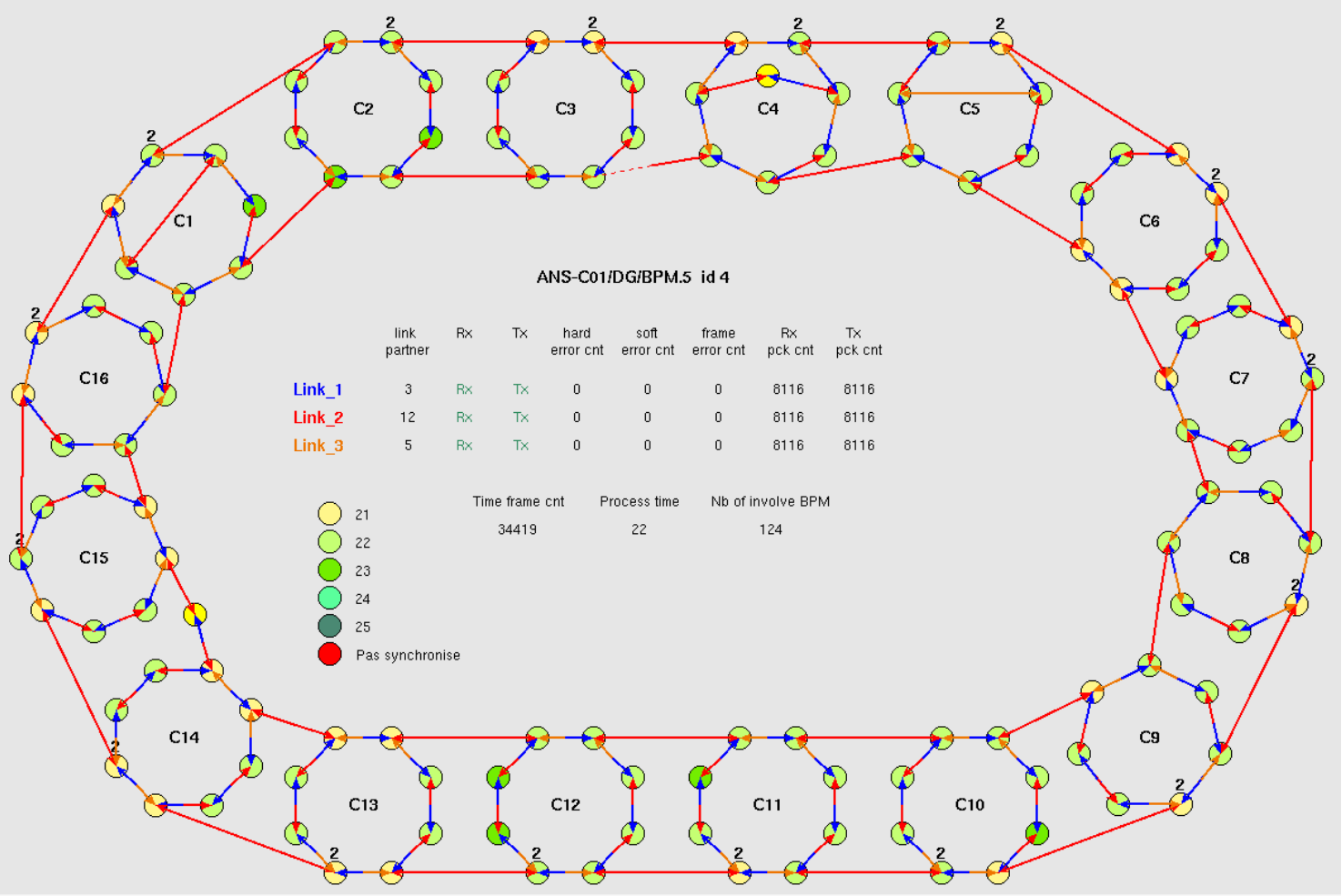
- **Fast Orbit Feedback (FOFB) architecture:**
  - **Fast Acquisition data are distributed over a dedicated network by the Diamond Communication Controller embedded on the Libera FPGA**



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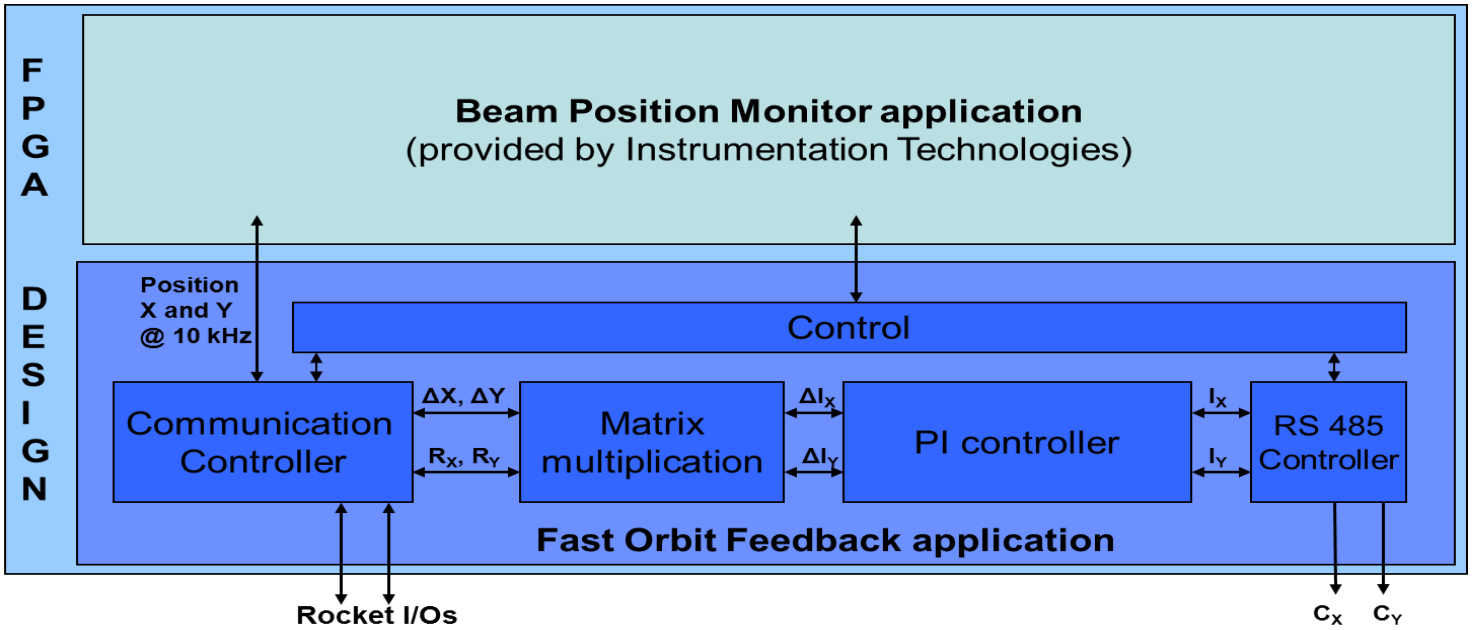
- Fast Orbit Feedback (FOFB) architecture:
  - Fast Acquisition data are distributed over a dedicated network by the Diamond Communication Controller embedded on the Libera FPGA
  - FOFB algorithm is embedded on the Libera FPGA
  - Fast corrector controller is embedded on the Libera FPGA



- FOFB in the Libera:
  - Cheap solution
  - Maintenance and upgrades are more demanding
    - Couldn't be done every year
    - SOLEIL Libera upgrades stopped at release 1,84

Maintenance

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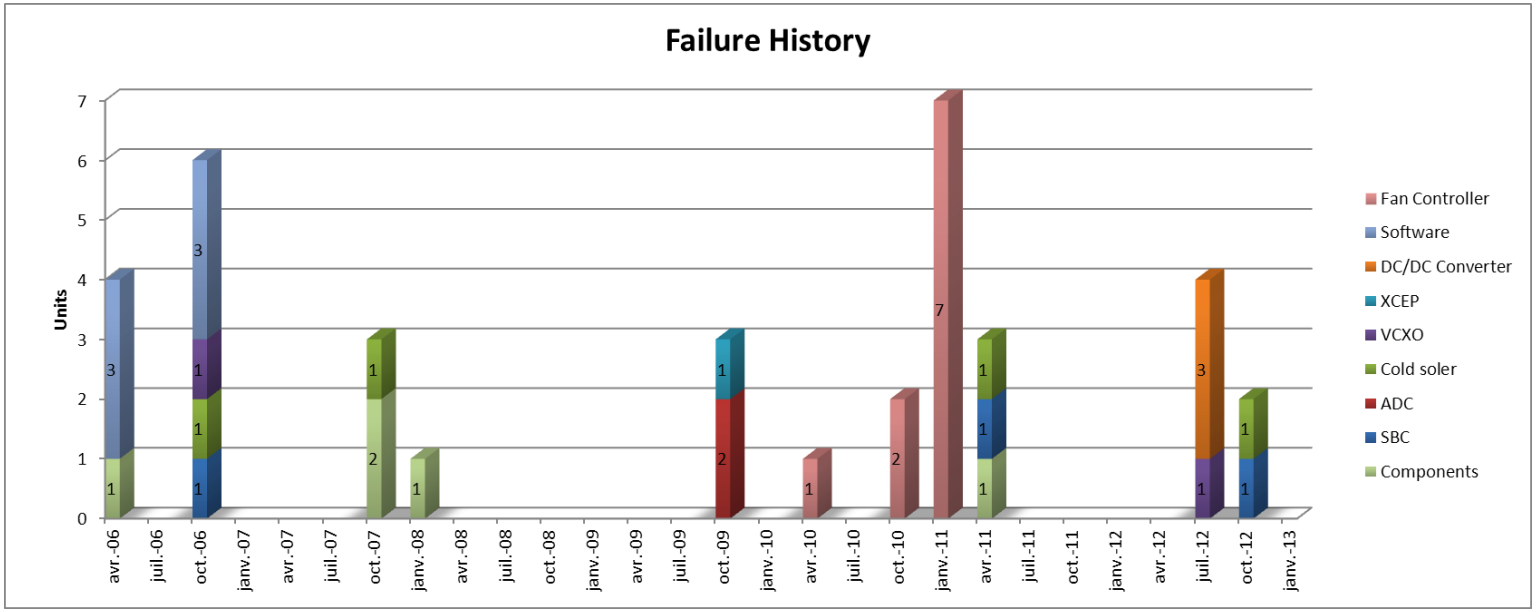
- Libera have been in operation for 7 years
  - 36 failures
  - 10 within 1 year (2010-2011) due to fan controller issue
    - Preventive maintenance on all units in may 2011
  - Rate of ~5 failures per year
  - MTBF of 2,3 months for 150 units in operation.



Maintenance

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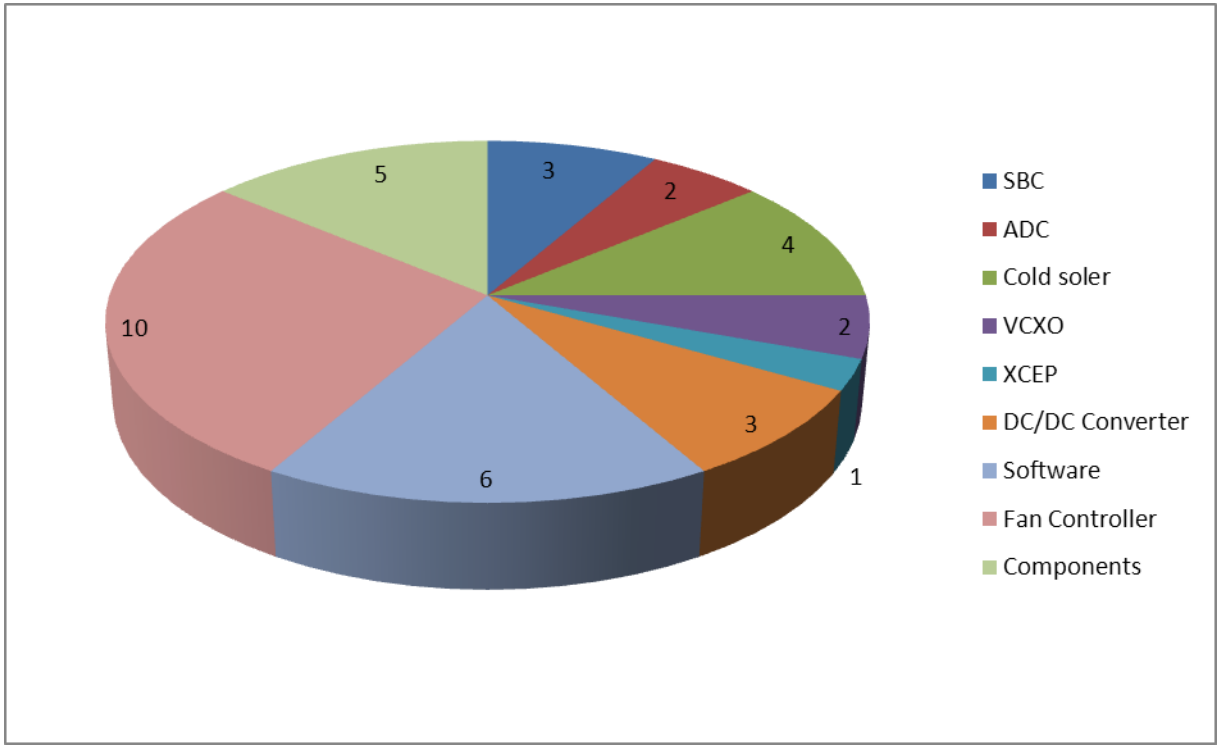
- Libera failures distribution



Libera advances

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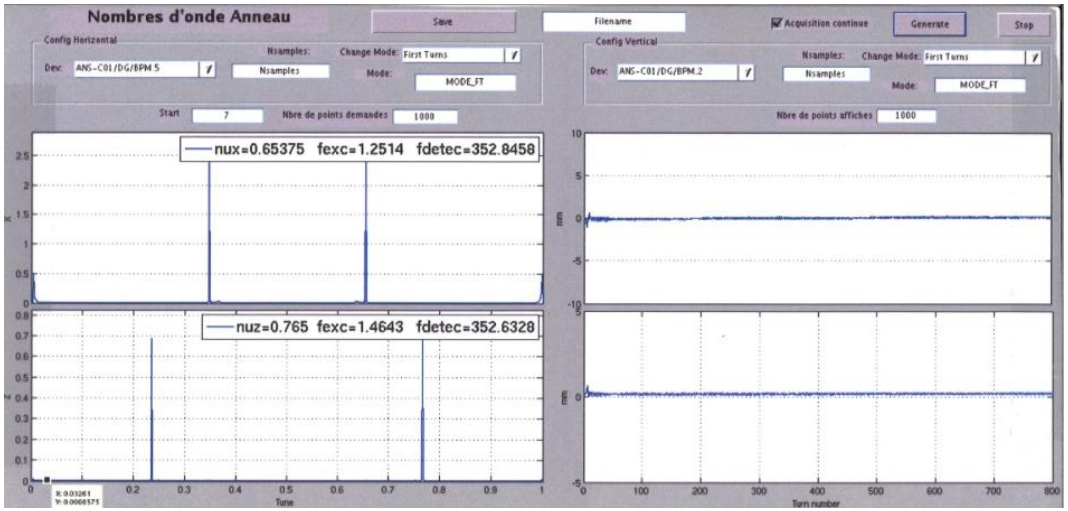
- The same electronics provides all data type (nearly) at the same time
  - Turn by turn (machine physic studies, tune measurement)
  - Fast Acquisition (Fast Orbit Feedback)
  - Slow Acquisition (Closed orbit correction)
- Easiest commissioning
- Make possible new machine physics and diagnostics studies



It has been faster to write a Matlab script to calculate the tune from TbT BPM data than looking after the signal on a spectrum analyzer....

Libera advances

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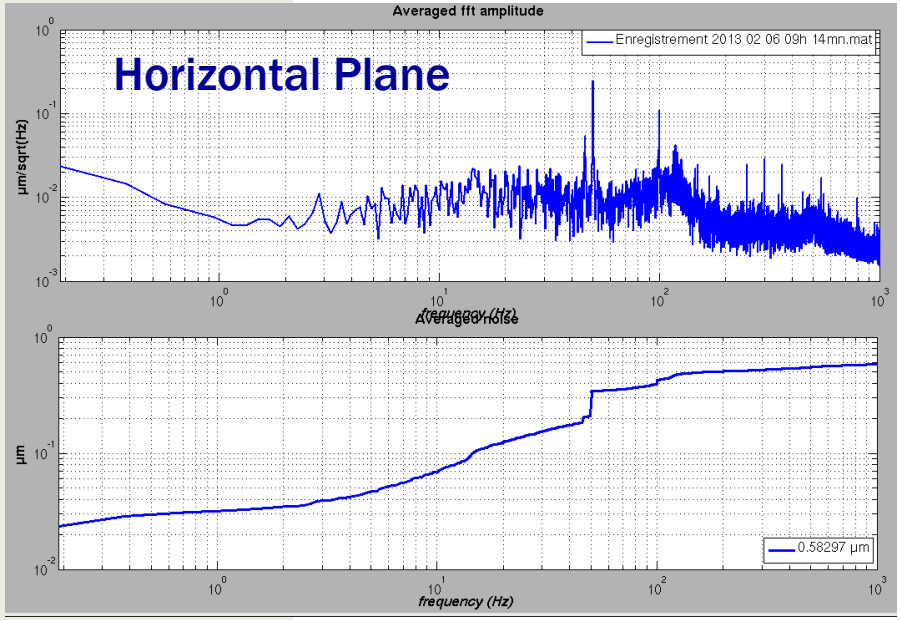
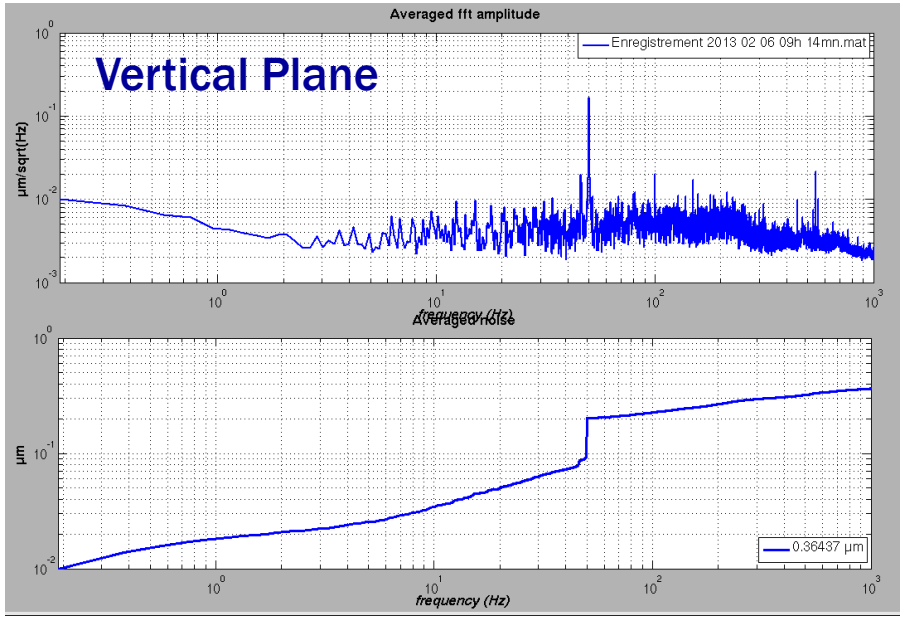
- Beam position noise measurements
  - From Fast Acquisition BPM data
    - Correlated with Libera synchronism mechanism
    - Retrieved in the control system by a sniffer connected to the dedicated network





Position Power Spectrum Density (PSD) averaged on all BPMs

Libera advances

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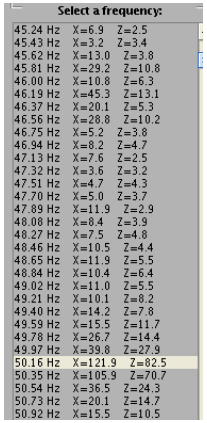
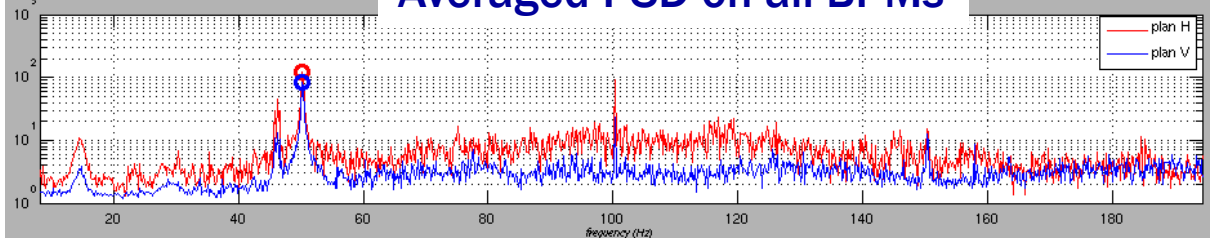
- **Noise source location**

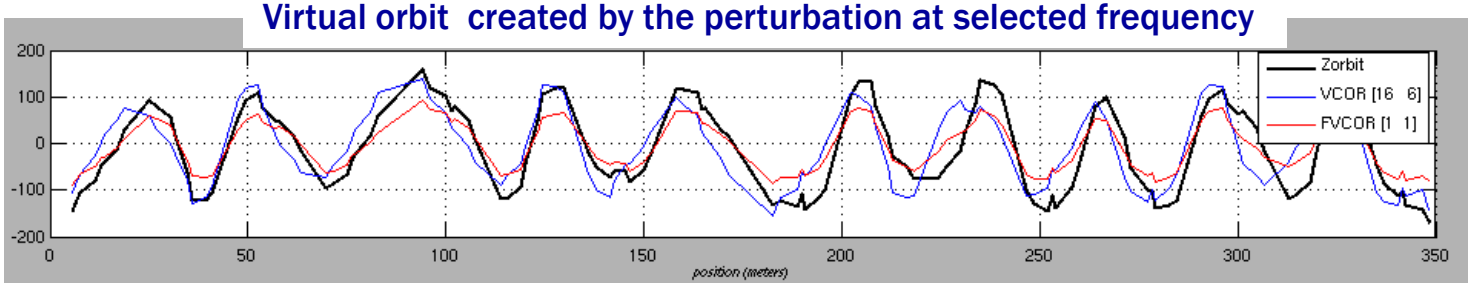
Frequency selection



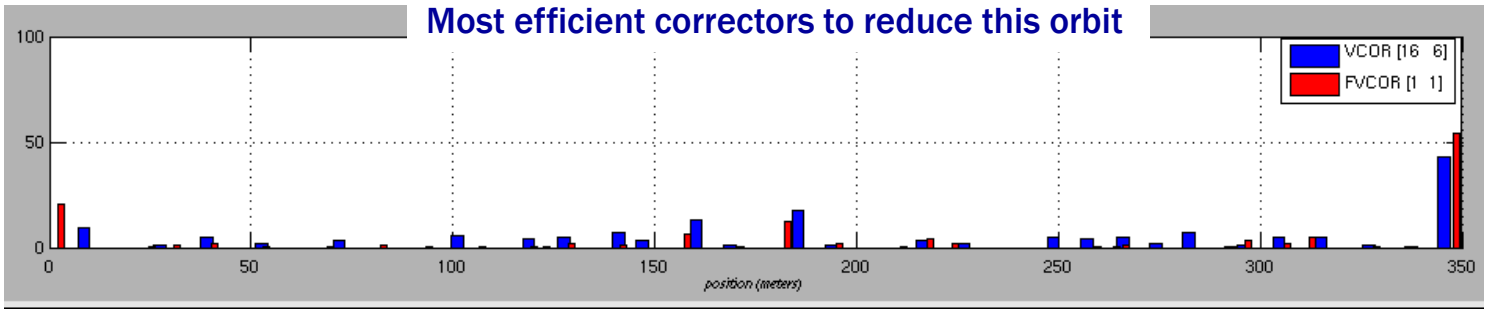
Averaged PSD on all BPMs



Virtual orbit created by the perturbation at selected frequency



Most efficient correctors to reduce this orbit



Libera advances

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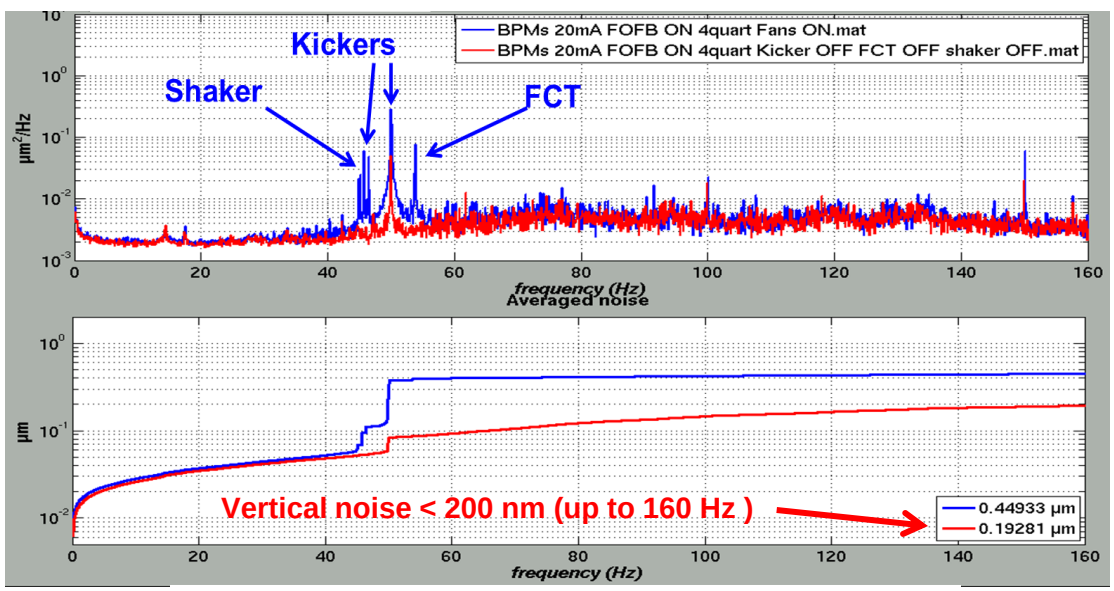
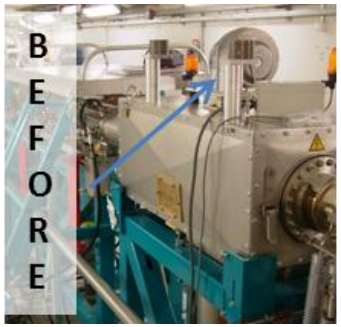
Noise source location

Fan Location	Kickers (injection, machine study H&V)	Shaker	FCT
Horizontal Plane	46Hz, 50 Hz	46Hz	54Hz, 108 Hz
Vertical Plane	46Hz, 50 Hz	46Hz	54Hz

VERTICAL PLANE





Fan perturbations seen on beam position PSD

BCD in single bunch

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  - Ma
- Libera advances
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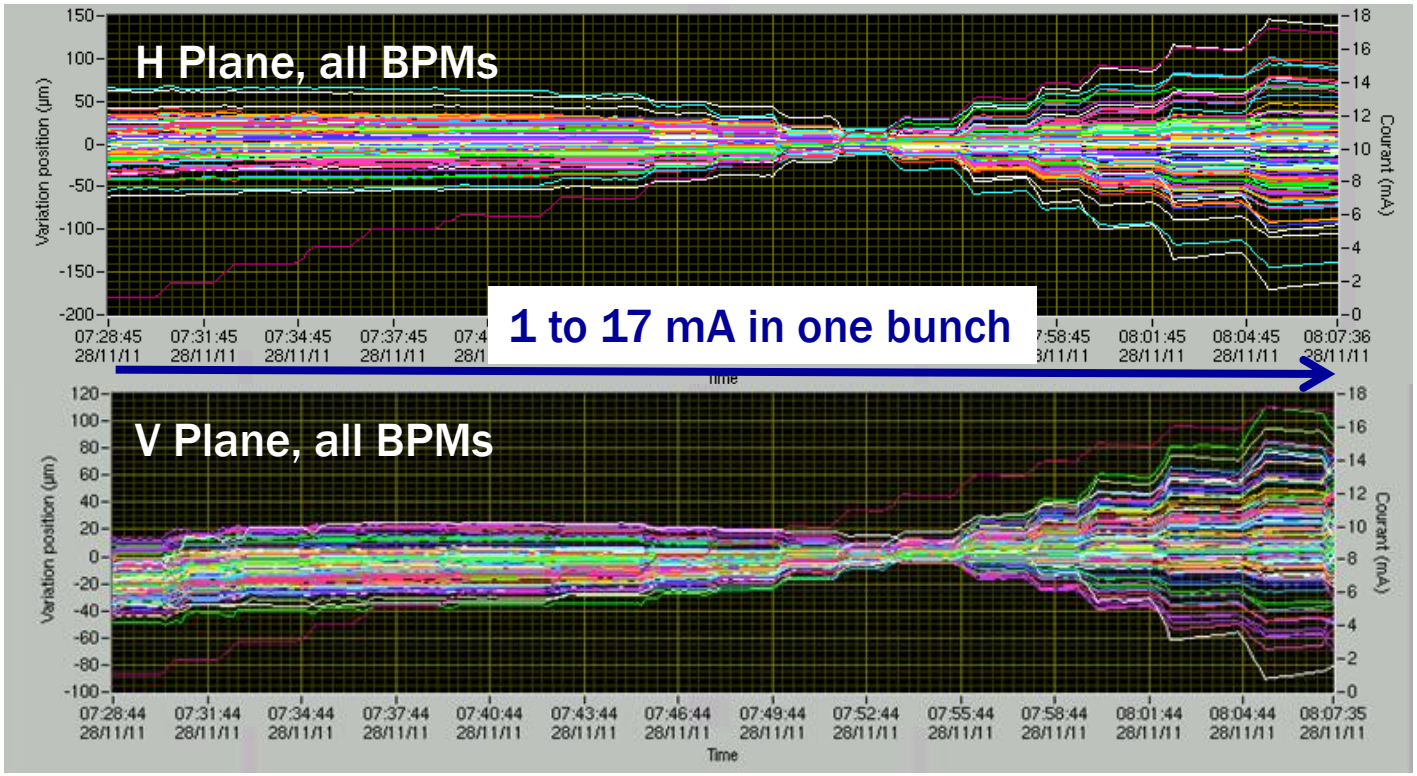
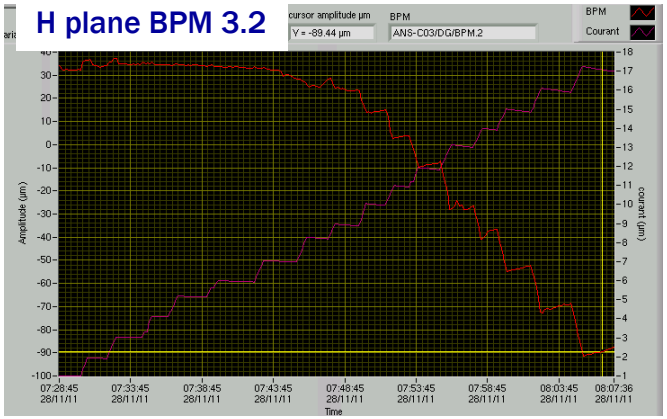
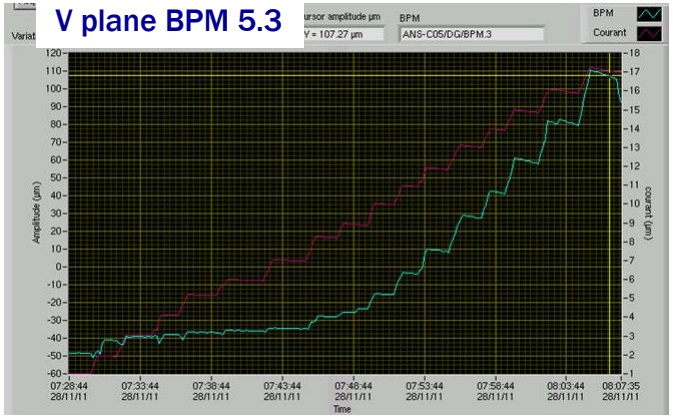
- What
  - BP BCD
  - XBPMs in SOFB

BCD up to 200 µm in H

BCD up to 160 µm in V







BCD in single bunch

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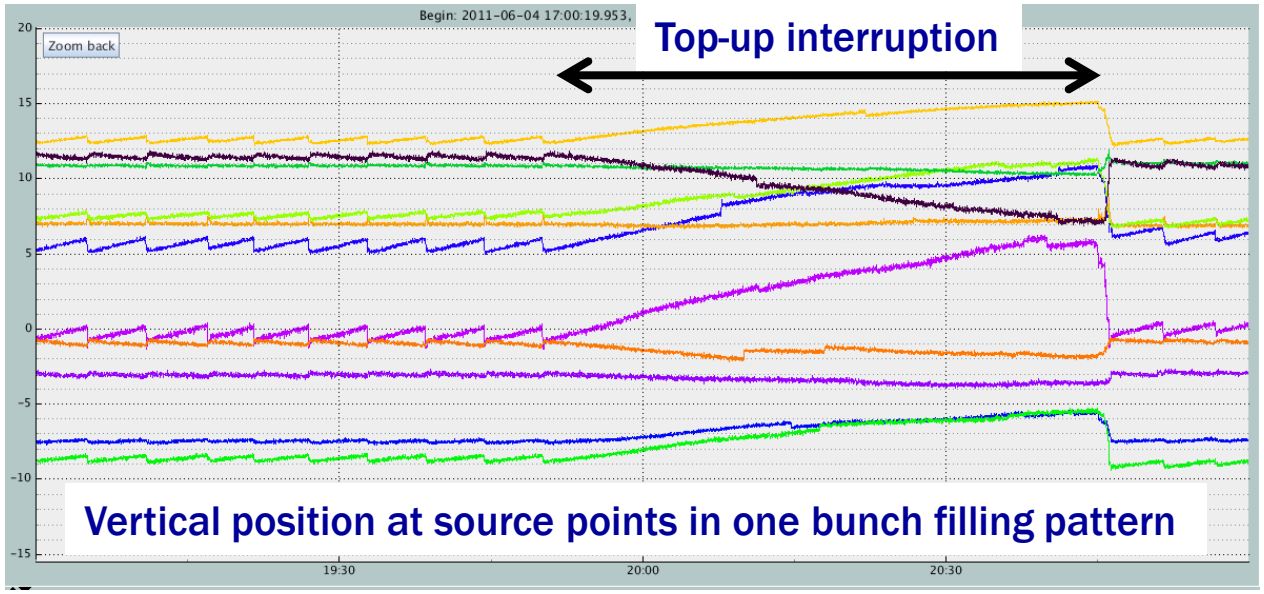
- Issue for the operation
  - In single bunch and 8 bunches filling pattern
  - Offsets measured and applied on all BPMs at the nominal current for operation. -> Do not work for another current in the machine



BCD in single bunch

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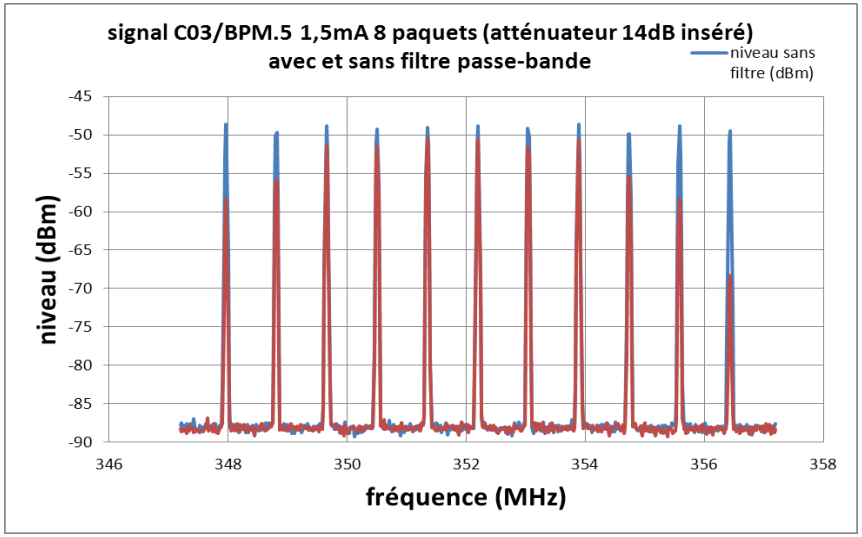
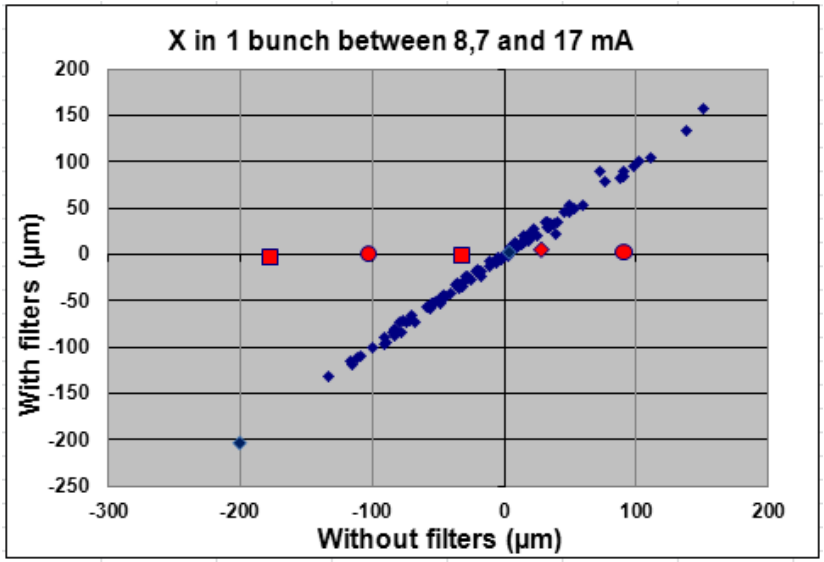
- **BPM frequency response in single bunch**



Low insertion loss 20 MHz bandpass filter at 352 MHz



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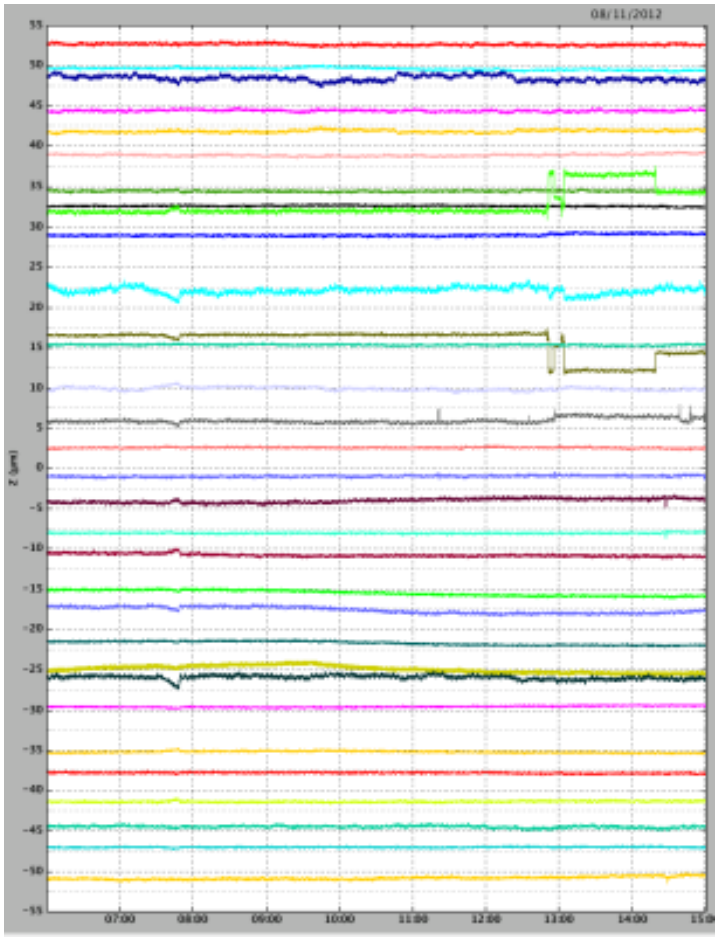
- 488 bandpass filters installed
  - Significant reduction of the beam current dependence at high current per bunch
  - No more offset tables specifics for operation current
  - No visible effect of the top-up injections on the position (as for the other filling patterns)



Vertical position at source points in one bunch filling pattern with filters

BCD in single bunch

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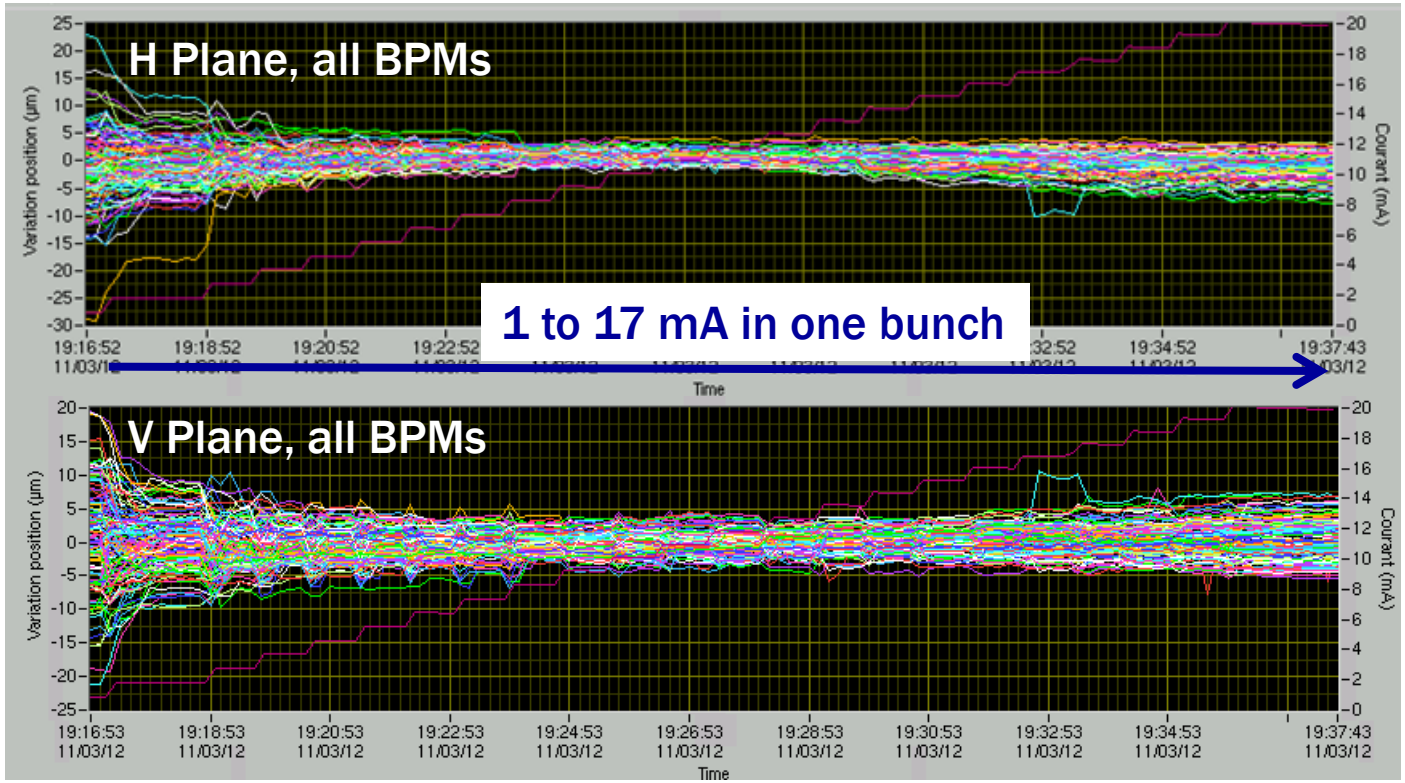
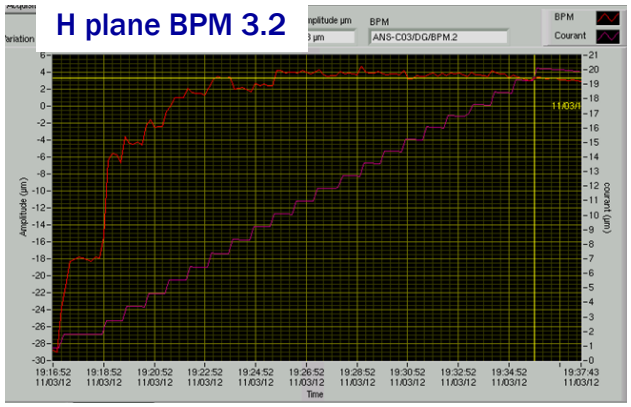
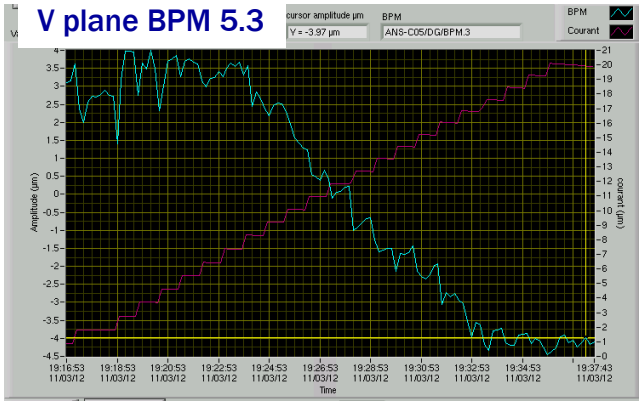
BCD up to 30 µm in H

BCD up to 20 µm in V







XBPM IN SLOW ORBIT FEEDBACKS

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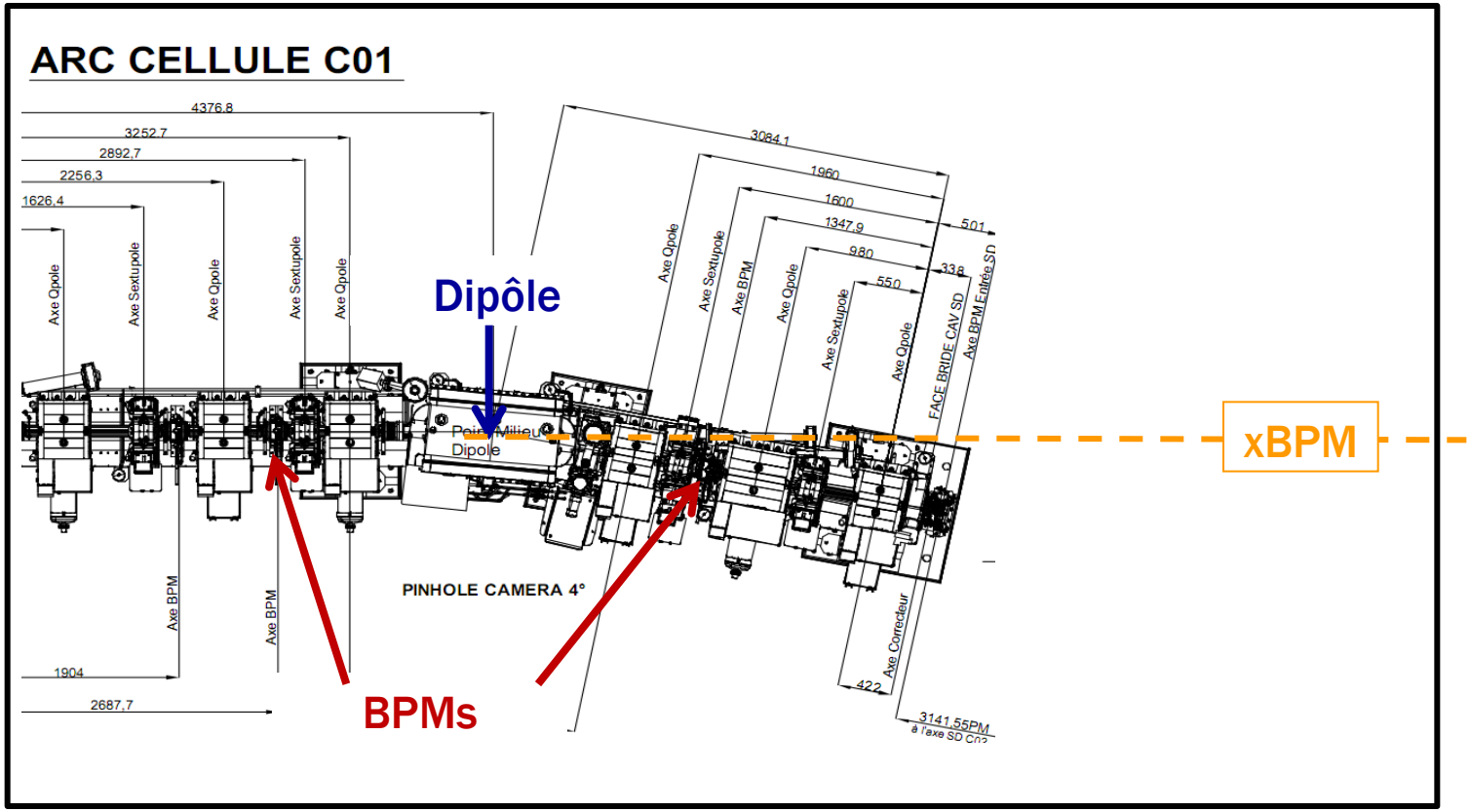

- Magnets (quadrupoles and sextupoles) between BPMs and bending magnets
  - -> No real position measurement at bending magnet source point
  - -> First XBPM could be used to improve photon beam stability by including it in orbit feedback loops

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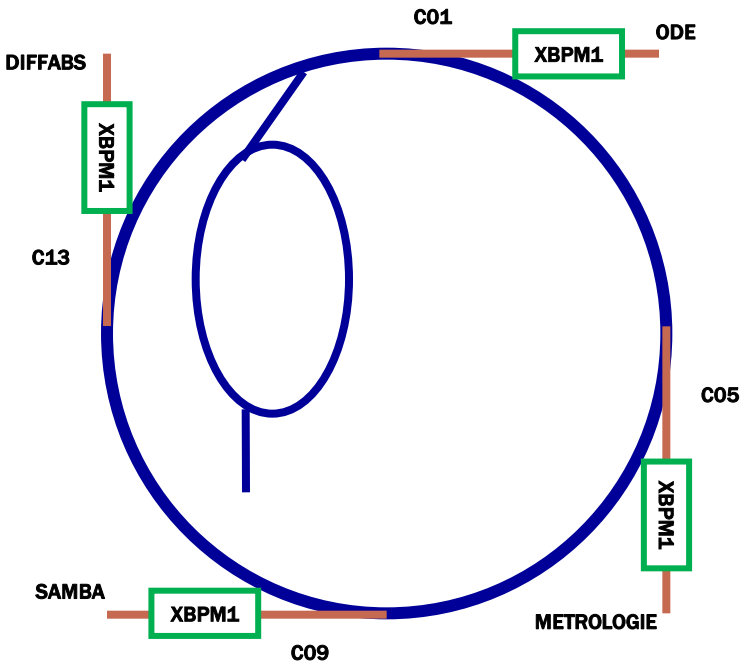
- Integration of 4 bending magnet beamlines first XBPM in global orbit feedback loops
- XBPMs are considered as additional BPMs in the SVD process to inverse the response matrix



- Use of Libera Photon to eventually be able to integrate XBPMs in FOFB as there is:
  - Same synchronization mechanism as Libera Electron
  - Same data rate
  - Communication Controller included
  - Same data latency between Photon and Electron

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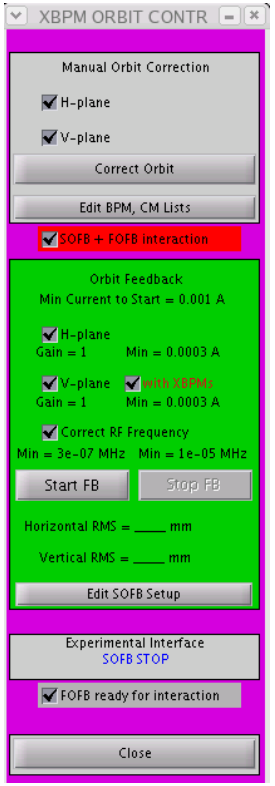
- Integration of 4 XBPM data in the Slow Orbit FeedBack (SOFB) loop
  - Use of Slow Acquisition data (10 Hz)
  - Correction rate: 10 seconds
  - Matlab process



- 27/09/11: XBPM in SOFB alone. Loop closed with theoretical response matrix. Correction converging

- 25/06/12: Loop closed with experimental response matrix

- July 2012 - Dec. 2012:
  - XBPMs in SOFB alone during Radio Protection dedicated shifts

- Jan. 2013 – March 2013:
  - Modification of SOLEIL Matlab MML
  - Modification of the SOFB-FOFB interaction

- 08/04/13: XBPM in SOFB with FOFB interaction. Loops closed

- 16-22/04/2013: XBPM in SOFB with FOFB interaction during user operation

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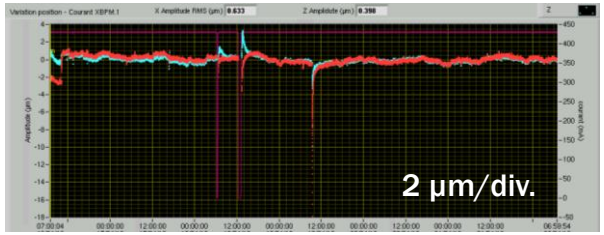
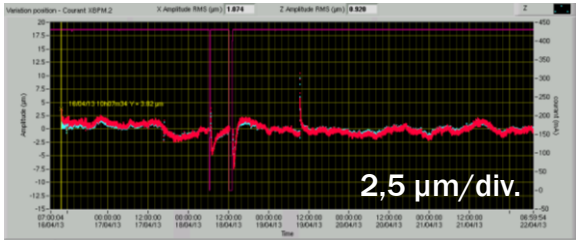
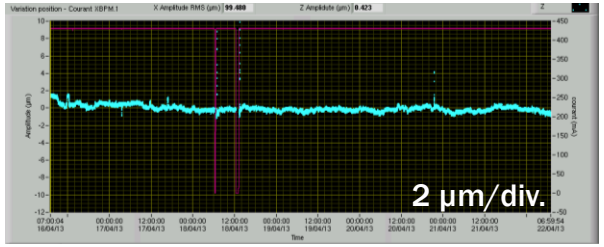
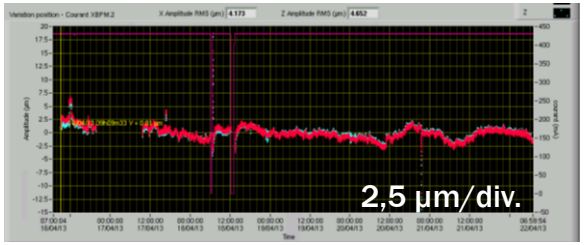
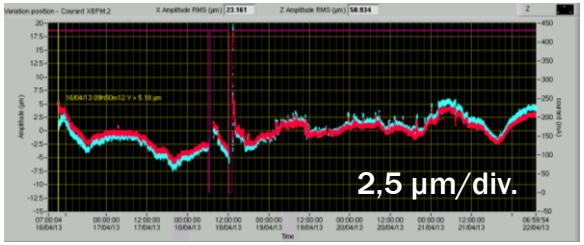
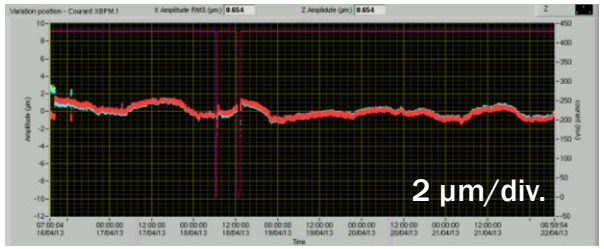
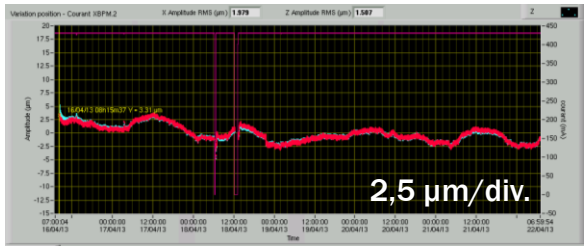
Week 16 2013

XBPM1 in SOFB		XBPM2 out SOFB
	**ODE**	
	**METRO**	
	SAMBA	
	**DIFFABS**	

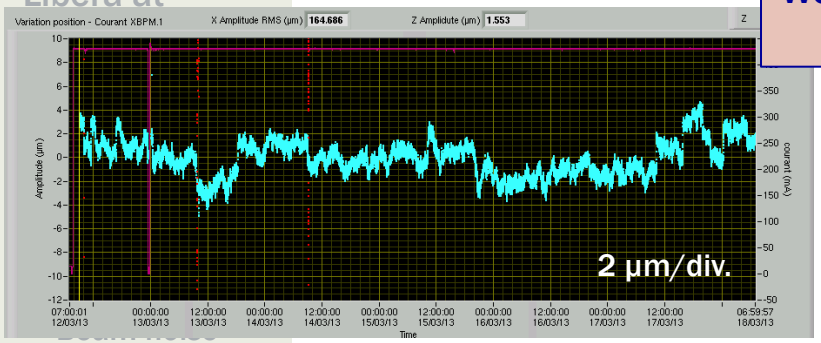
XBPM IN SLOW ORBIT FEEDBACKS

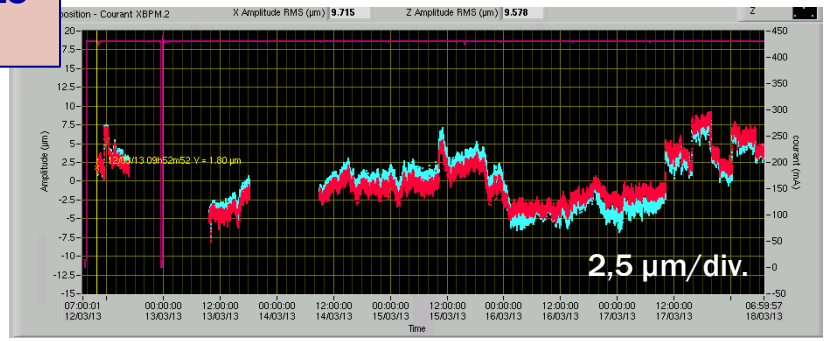
METRO Beamline

XBPM1 | XBPM2

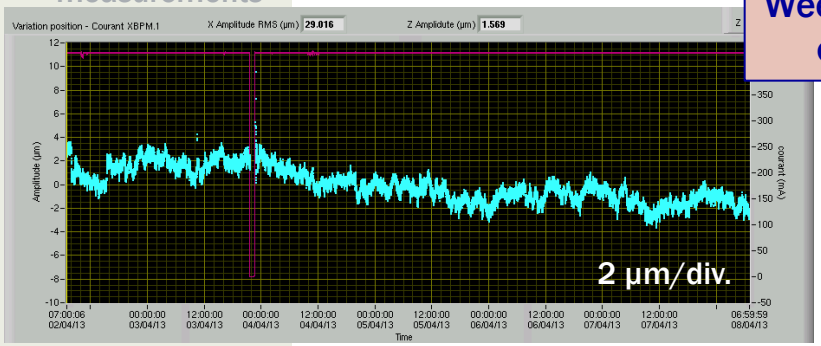
- Libera at
- measurements

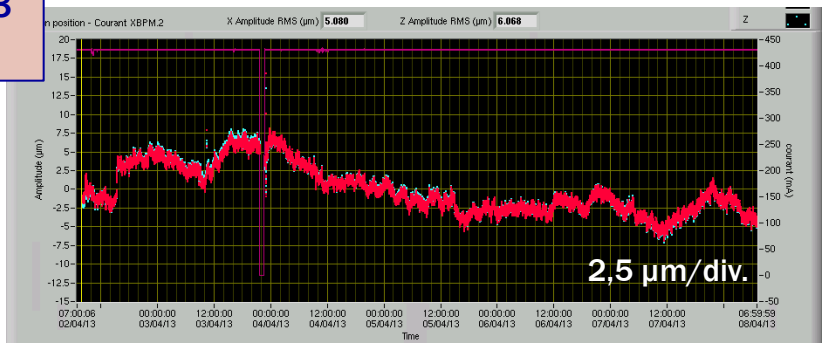
Week 11 2013 out SOFB



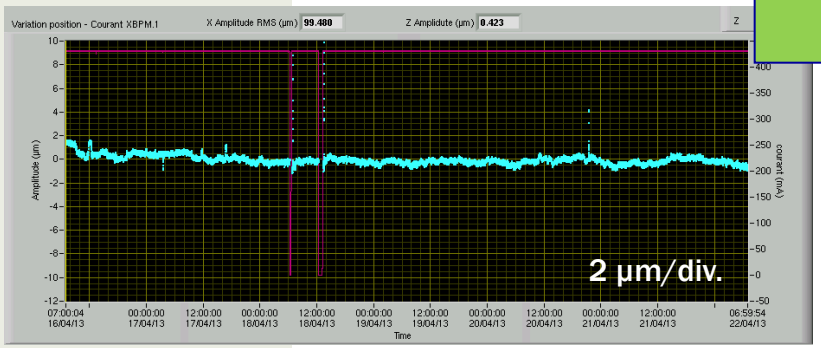


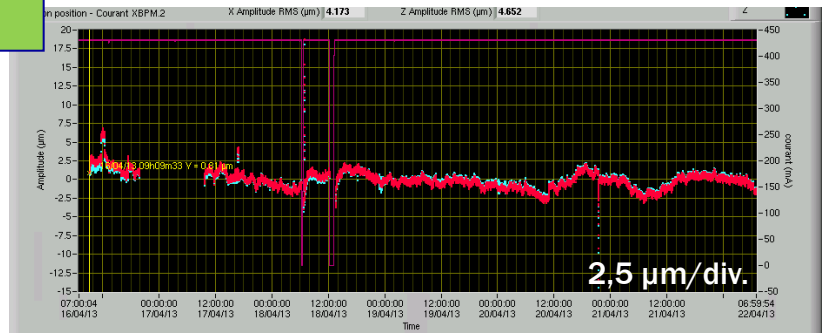
Week 14 2013 out SOFB





Week 16 2013 in SOFB



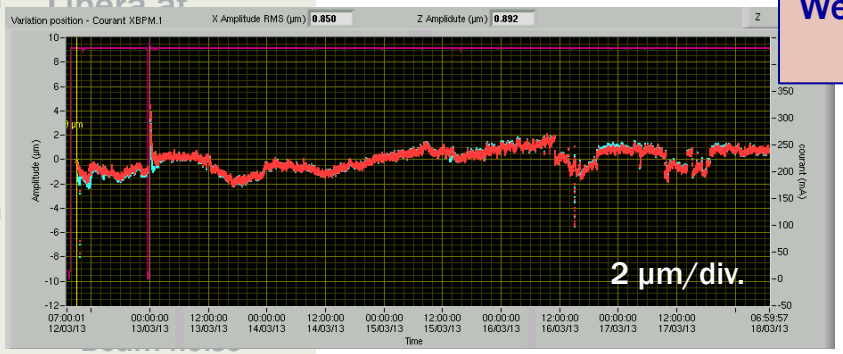


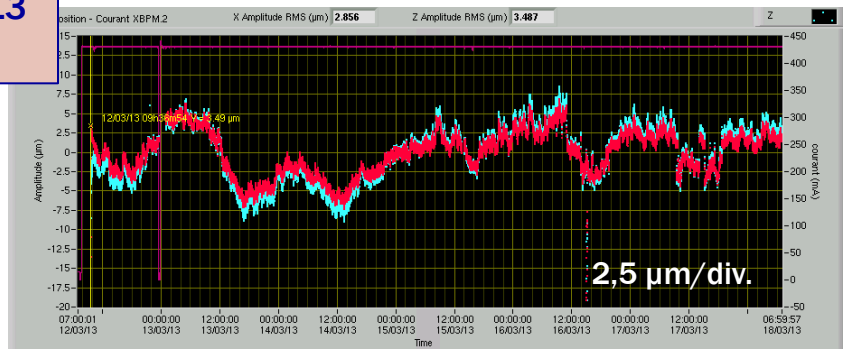
XBPM IN SLOW ORBIT FEEDBACKS

SAMBA Beamline

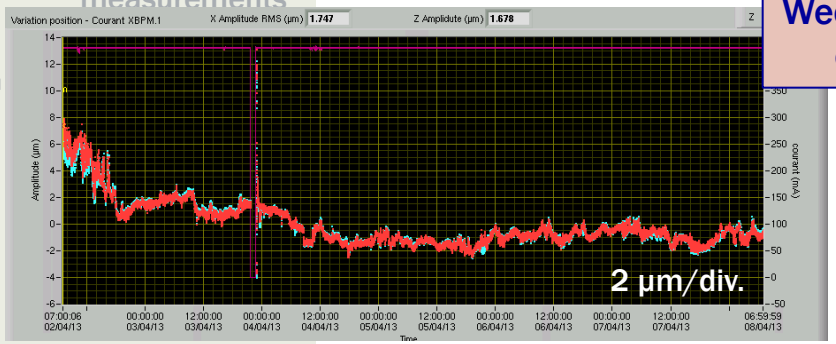
XBPM1 | XBPM2

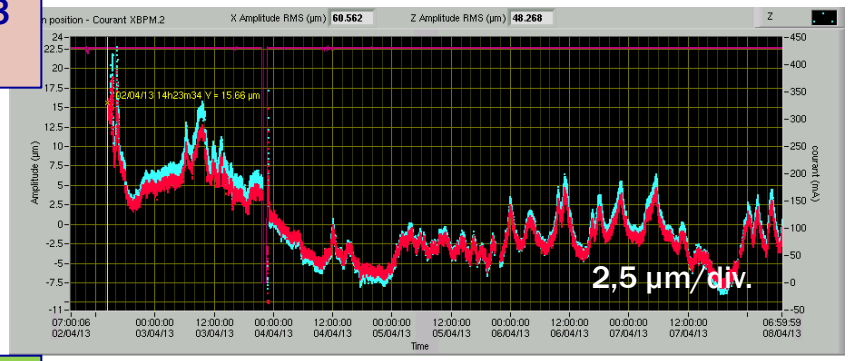
Week 11 2013 out SOFB



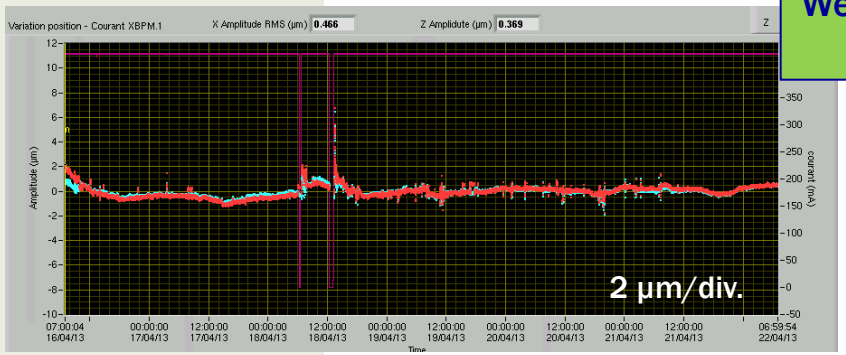


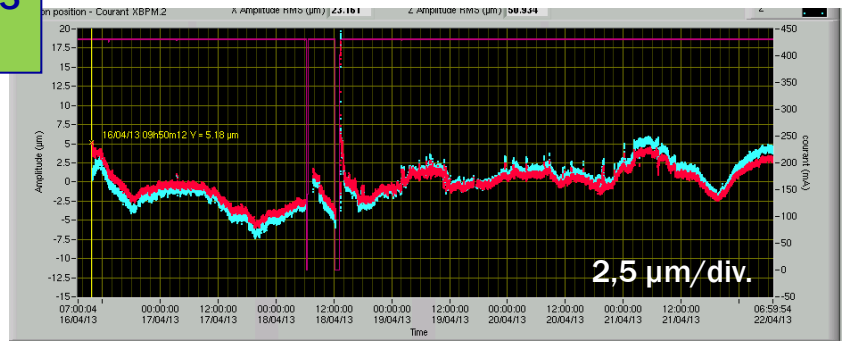
Week 14 2013 out SOFB





Week 16 2013 in SOFB





XBPM IN SLOW ORBIT FEEDBACKS

- Libera at SOLEIL
  - Status
  - Maintenance
- Libera advances
  - Data flows
  - Beam noise measurements
- What's new?
  - BP filters for BCD
  - XBPMs in SOFB

- Integration in fast orbit feedback:
  - Better stability with XBPMs in FOFB has to be proved
  - Technically ready to test it

CONCLUSION

- Libera at SOLEIL
  - Status
  - Maintenance
- Libera advances
  - Data flows
  - Beam noise measurements
- What's new?
  - BP filters for BCD
  - XBPMs in SOFB

- Libera Electronics:
  - Easy commissioning
  - Simplest hardware integrating several functionalities (Position data flows, interlock, post-mortem, FOFB) that were before separated in different boxes
  - Allowed new machine physics or diagnostics studies that were not (or hardly possible) before
- SOLEIL recent improvement
  - Better BCD at high current per bunch in single bunch filling pattern
  - Bending magnet XBPM in SOFB during user operation