Polarization Switch Operation Mode at ALBA

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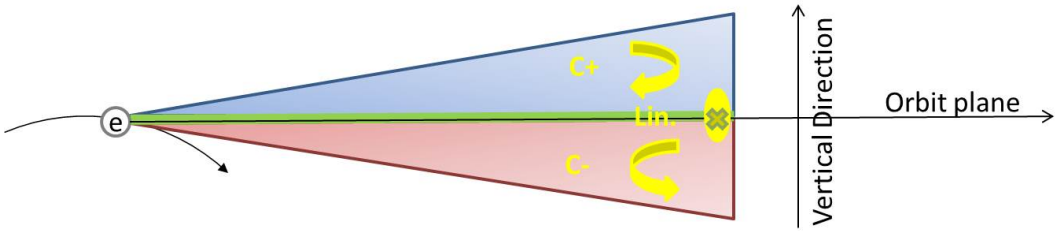
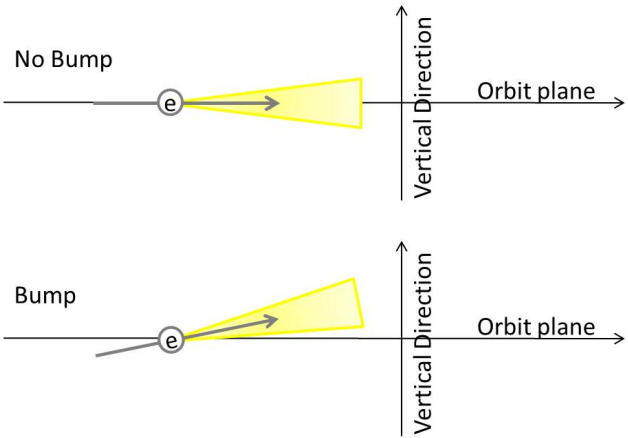
Synchrotron Radiation Polarization

Polarization of Synchrotron Radiation produced by a Bending Magnet depends on the emission angle



Selected by the beamline using movable masks $\Rightarrow$ Problems with heat load of optical components causing drifts

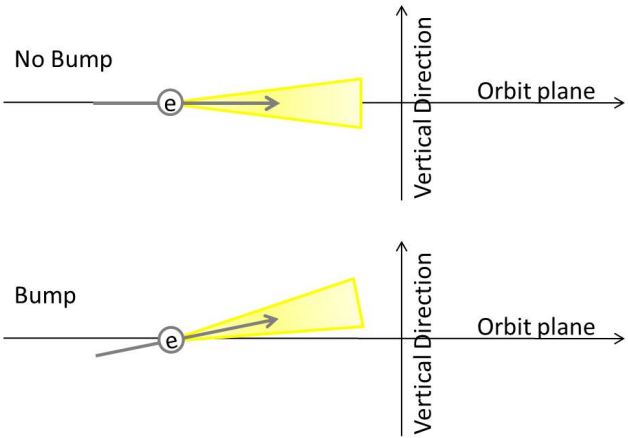
Polarization Selection via Electron Beam Bump



Synchrotron radiation is hitting optical components at the same location independently on the selected polarization

- M. Böge et al. "Fast Polarization Switching at the SLS Microspectroscopy Beamline POLLUX", EPAC 2006

Polarization Selection via Electron Beam Bump



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Electron beam bump generated online with a command from the beamline using the Fast Orbit FeedBack

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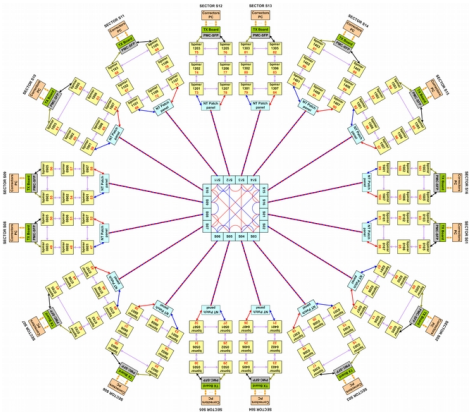
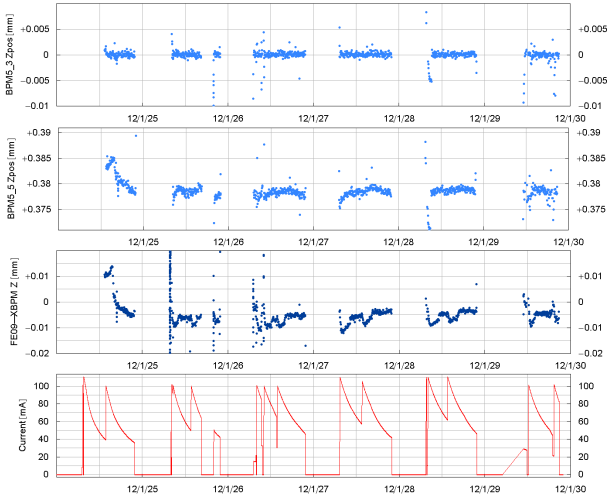
ALBA Fast Orbit FeedBack



- Distributed system @5 kHz damping up to 100 Hz
- Diamond CC + PSI protocol
- 16 FOFB processing nodes:
  - PMC FPGA sniffer board (Micro-Research EVR-230)
  - Correction Calculation CPU (4 Cores)
  - Optical Link Interface (to the correctors)
- Horizontal: 88 BPMs (Libera Brilliance)
- Vertical: 87 BPMs + **1 XBPM** (Libera Brilliance + Libera Photon)
- 88 Correctors (Hor. and Vert.) integrated in sextupoles

▸ A. Olmos et al. "Fast orbit feedback implementation at Alba synchrotron", IBIC 2013

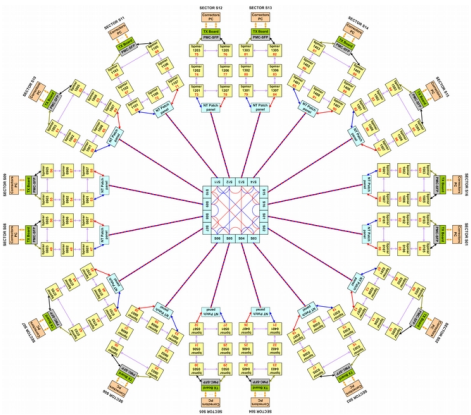
XBPM in FOFB for MISTRAL



Drift observed in XBPM and in not corrected BPM due to thermal stabilization after injection

$\Rightarrow$ Corrected adding XBPM in the loop

ALBA Fast Orbit FeedBack for Polarization Switch



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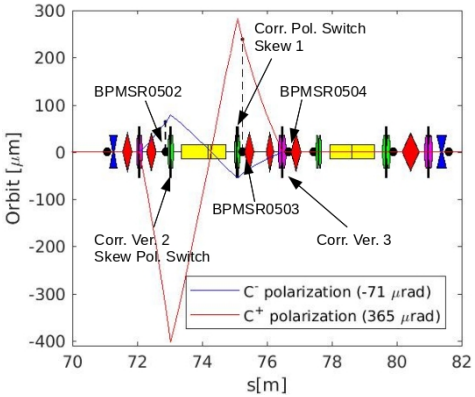
- + 1 Skew (No FOFB!)

Polarization Switch – Bump for MISTRAL beamline



- Skew Pol. Switch
- BPMSR0502 – Ver. Corr. 0502
- XBPM/BPMSR0503 – Ver. Corr. Pol. Switch
- BPMSR0504 – Ver. Corr. 0503 (Note: BPMSR0504 not in the FOFB loop before)
- Skew 1

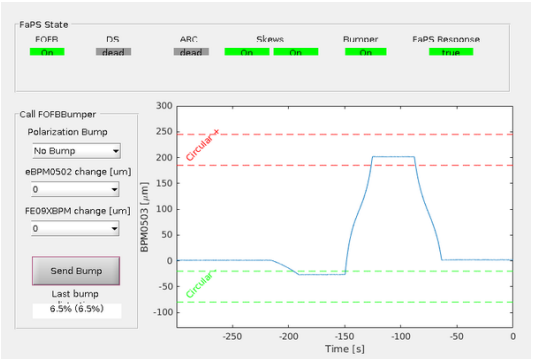
During operation we use the XBPM in the feedback and the BPMSR0503 to check the bump

XBPM had to be moved up by 1 mm to be in the linear region for all the scan range

Polarization Switch – Working Principle

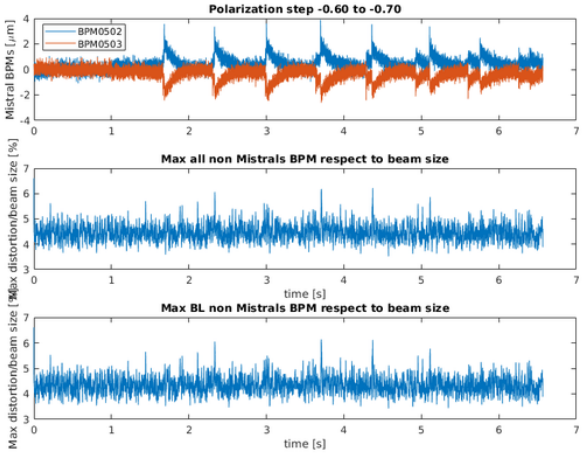
The idea is to create the bump by changing the BPMs offset ⇒ The FOFB will act to bring the orbit back to the golden orbit (0µm

- Device servers of BPMs involved have to be OFF to allow fast response of the Libera
- Must be done in small steps to avoid perturbation in other beamlines
- Regularization has to be reduced locally
- XBPM auto-range option has to be disabled
- Feed forward applied to skews to correct unwanted coupling



Libera Device Server Response

Command sent each 0.1 s

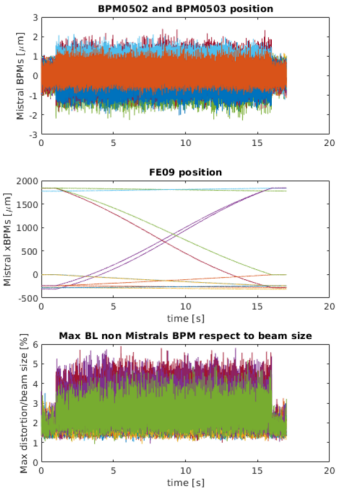


Change offset via Tango DS takes $\simeq$1 s!
Sometimes commands are not applied

Operational issues
$\rightarrow$ Not related with FOFB/Fast Archiver
$\rightarrow$ Issue with standard archiver, startup, operational GUIs...
Solved by taking data from Fast Archiver

Change the offset in small step

The goal is to keep the (Orbit Distortion)/(Beam size) lower than 5%*



The Polarization Switch takes ≃15 s with steps of 2 µm separated by 50 ms
⇒ not very fast but still faster than what can be done at the beamline

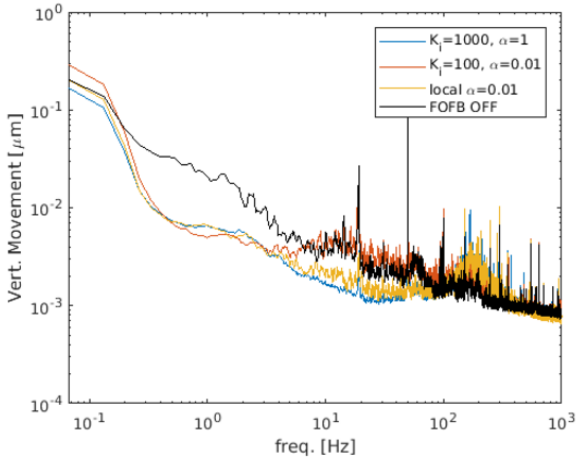
	C+	C-	0	Lin.
C+	–	5%	4.6%	4.3%
C-	5%	–	3.8%	3.8%
0	4.6%	3.8%	–	3.9%
Lin.	4.3%	4.6%	4.3%	–

*(Orbit distortion)/(Beam Size) during standard operation ≃2%

Local Regularization

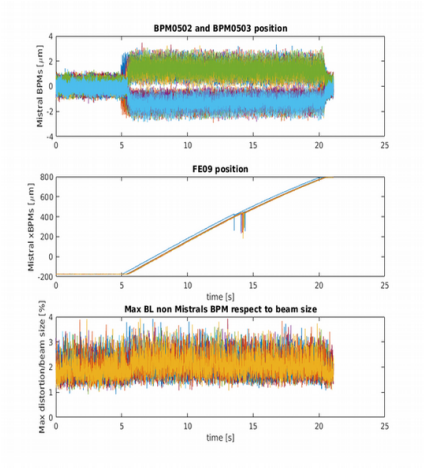
Regularization smooths the Inverse Response Matrix and distribute the correction
⇒ Noise is reduced but a high number is needed to perform the correction.

In order to go faster we had to reduce the regularization at the price of the noise.
⇒ If we reduce regularization only in the desired sector we get a good compromise!

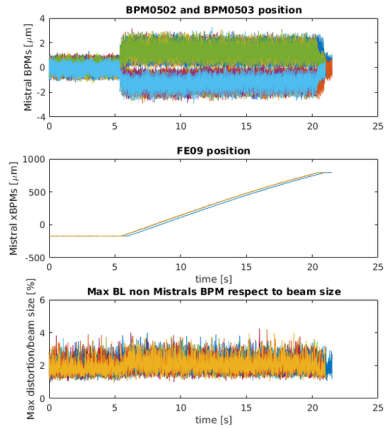


XBPM Auto-Range

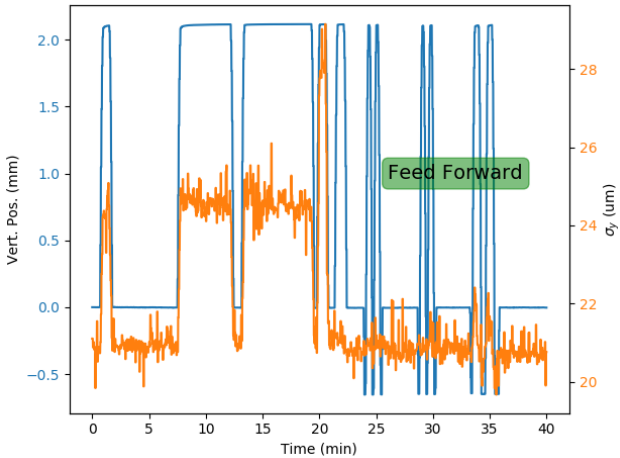
Auto-Range ON



Auto-Range OFF



Skew Feed Forward



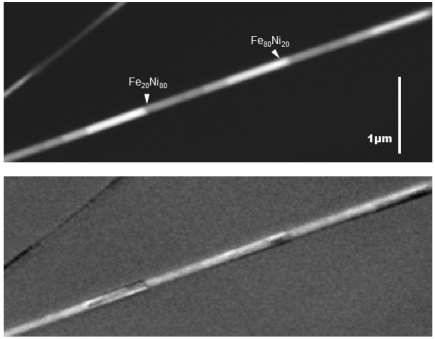
The bump modifies the orbit
⇒ the beam passes off-center in quadrupoles
⇒ Beam size is affected!

Skews changes linearly at each step when changing polarization

Only skews involved with Polarization Switch are involved in the feed forward

Summary

- Polarization Switch is operational since December 2021
- Users can select the polarization directly from the beamline thanks to Tango Gateway
- Some incidences related with the disabled Device Servers have been reported and action have been taken to ease the operation



Images of cylindrical magnetic nanowires with modulated composition, comparing the absorption (top) and magnetic (bottom) contrast. Subtle details of the magnetization configuration are revealed thanks to the use of the bump. Sample by C. Fernández-González et al., IMDEA Nanociencia, data taken at MISTRAL beamline.

Lesson Learned

Don't do like us!

We decided not touch the FOFB code and we ended up:

1. Adding correctors
2. Changing the FOFB code
3. Operating without Liberas Device Servers...

It would have been easier (*maybe*) to modify the FOFB code to vary the golden orbit maintaining the BPMs offset unchanged.

Next time, for ALBA II...

Discussion – XBPM in FOFB in general?