MOPP44

ANALYSIS OF MULTI-BUNCH INSTABILITIES AT ALBA WITH THE TRANSVERSE FEEDBACK SYSTEM

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Abstract

Since 2015 Alba is equipped with a transverse bunch by bunch feedback system, which not only damps the transverse coupled bunch instabilities in the machine, but also allows the impedance characterization of the storage ring. This characterization is produced by an internal sequence, which is programmed to excite and measure the growth and damping rates of each of the multi-bunch modes. This paper describes the measurement technique, presents the studies carried out to characterize the machine and different movable systems like the scrapers or in-vacuum undulators. Results are compared with the transverse impedance spectra obtained from computer simulations.

Set-Up and Procedure

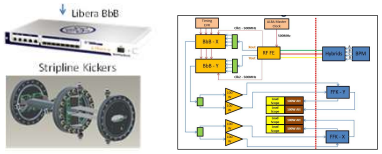
ALBA Parameters in Operation:

energy, E	GeV	2.98
beam current	mA	250
harmonic number, h	...	448
emittance, ϵ	nm-rad	4.6
coupling, κ	%	0.6
hor tune, Q_h	...	0.155
ver tune, Q_v	...	0.365
hor chrom, ξ_h	...	1
ver chrom, ξ_v	...	3

Bunch-by-Bunch System:

The Bunch-by-Bunch (BBB) feedback (commissioned in 2015) efficiently damps instabilities in operation.

Nevertheless, it can be used for machine experiments.



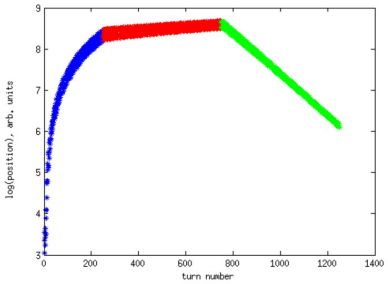
Grow/Damp Sequence using BBB

We program the BBB such that is able to produce a super-sequence which, for every possible mode ***m***, it does:

- Beam **Excitation:** 250 turns
- Beam Free Oscillations: 500 turns
- Beam Damping: 500 turns

The growth rate (or damping time) of each mode is found from a fit of the amplitude signal when the beam freely oscillates (red points).

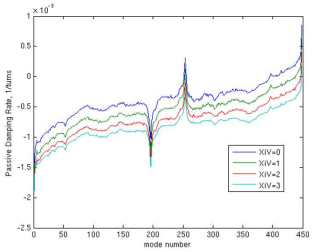
The loop over the 448 modes takes few seconds.



Influence of Chromaticity

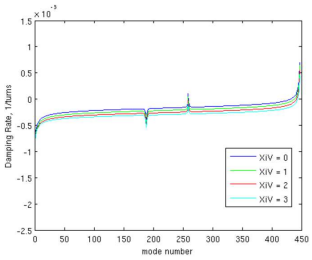
Mode spectrum for different chromaticities as obtained from the BBB.

Data with a 90% filling.

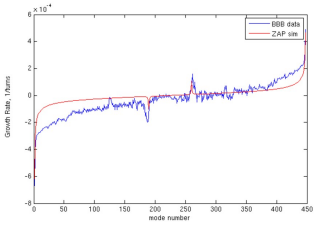


Mode spectrum for different chromaticities using ZAP code (Zotter formalism).

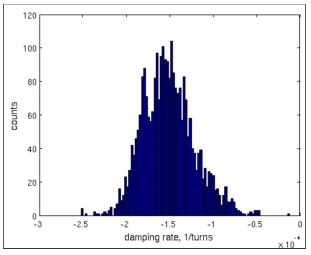
Simulations assuming full filling pattern at 250mA.



Comparison for ChromV = 0

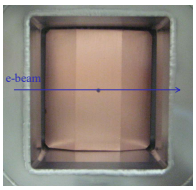


The modelled spectrum using ZAP fits the experimental data if we consider an effective radius 25% larger. We are still investigating where this difference come from.

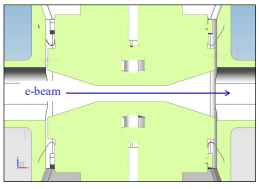


Histogram of damping rates differences for each one-unit step of chromaticity, resulting on a **(1.5 +- 0.3)·10^{-4}** 1/turn.

Vertical Scraper



Bottom view of vertical scraper, before its installation, showing the upper jaw in a fully retracted position.

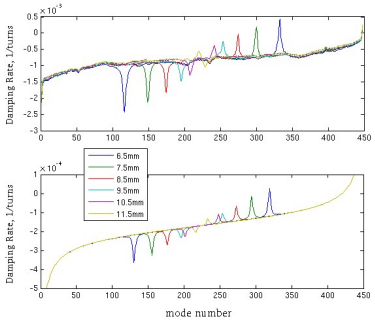


Sketch of vertical scraper (lateral view).

The mode scans allow to identify the position of the mode produced by the scraper.

As we close the gap from 11.5mm to 5.5mm, the peak drifts towards higher frequencies. The peak moves from:

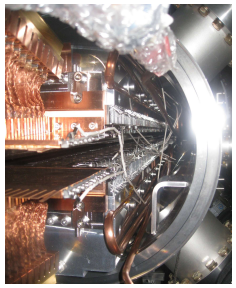
- m=378; gap=5.5mm
- m=253; gap=9.5mm
- m=221; gap=11.5mm



The qualitatively agreement with ZAP simulations is very good: for each scraper gap aperture, the peak position is reproduced very well: ~14 MHz of difference, or ~14modes of difference.

On the other hand, the slope in the growth rate variation is more pronounced in the experimental data.

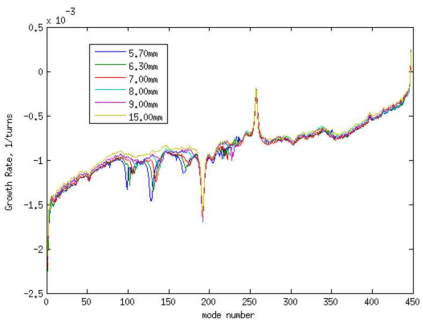
Characterization of In-Vacuum Undulators



The In-Vacuum Undulators (IVUs) at NCD and Xaloc are exactly the same.

Similarly to what the technique shown with the scraper, we close both gaps and perform BBB mode scans to identify these modes.

The (negative) peaks are clearly indentified for m=100, 130, and 170. Surprisingly, there are no symmetric peaks above 224 (h/2). This behaviour is similar to what is shown in Diamond [2].



Conclusions

The BBB system is programmed to excite and measure the growth rate of each of the multi-bunch modes at ALBA.

This has been used to crosscheck the ALBA impedance model, which is dominated by resistive wall impedance (if we assume the effective vertical aperture is increased by 25%), plus the effect of few narrow-band resonators.

These narrow-band resonators have been identified as the vertical scraper and the in-vacuum undulators. While the peaks of the first one have been very well reproduced with ZAP simulations, the peaks of the IVUs are not well reproduced due to their non-symmetric behavior.