Diagnostics results during the ALBA Storage Ring Commissioning

U. Iriso, M. Alvarez, F. Fernández, F. Pérez and A. Olmos
CELLS, Ctra BP-1413 km 3.3, Cerdanyola – 08290 (Barcelona)

Introduction

- ALBA SR Commissioning: **March – June 2011**
- ALBA BL Commissioning: **Oct. – Dec. 2011**
- ALBA Users Operation: **Spring 2012**

Diagnostics components were successfully commissioned during March – June 2011.
A general description and first results are presented in Ref. [1]. Here we report latest results and progress since then.

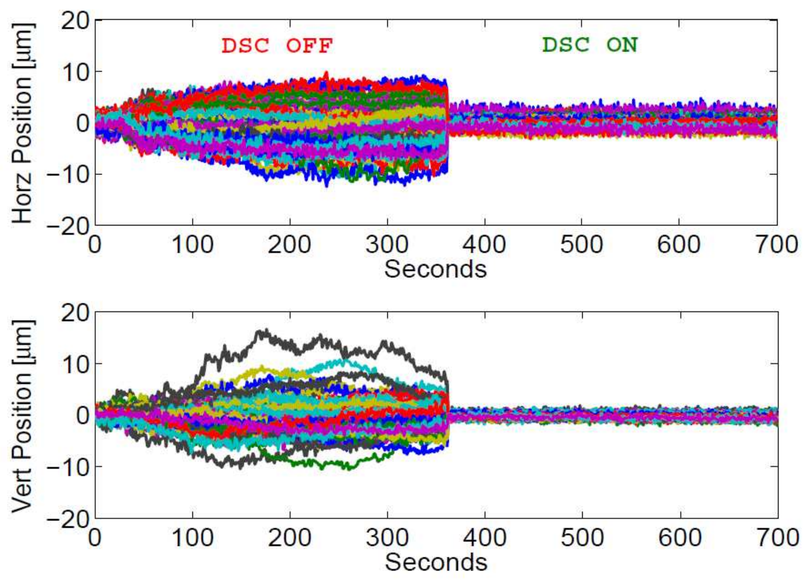
Table 1: Design beam parameters in the ALBA SR.

parameter	value
energy, GeV	3.0
circumference, m	268.8
max. current, mA	400
rf frequency, MHz	500
bunch length, ps	15
bunch size dipole (σ_x, σ_y), μm	61.3 , 32.8
bunch size med. str. (σ_x, σ_y), μm	134.5 , 8.2
rf frequency (MHz)	500
hor. emittance, nm·rad	4.3
coupling	1%
dipole field, T	1.42
tunes Qx, Qy	18.18, 8.37

BPM System:

With respect to [1], the main progress related with the BPM systems is related with its electronics.
Proper gain settings and activation of the Digital Signal Conditioning (DSC) allow us to reach sub-um resolution.

Slow Orbit Feedback (SOF) is already working at 0.3Hz.
Fast Orbit Feedback (FOF) hardware is implemented in 2/16 sectors and first tests will be carried out during the next weeks.



Beam size and emittance measurements:

Light extracted from a dipole is used to precisely analyze the transverse bunch size As opposed to VSR, in this case we use the xray part of the spectrum.
The xrays go through a pinhole system described at [3]. The image formed at the YAG screenis influenced by blurring and diffraction effects. Both of them are considered to perform the precise beam size measures:

Image at YAG screen: $\sigma_{YAG} = \sqrt{\left(\frac{L_2}{L_1}\sigma_b\right)^2 + \sigma_{blr}^2 + \sigma_{dffr}^2}$

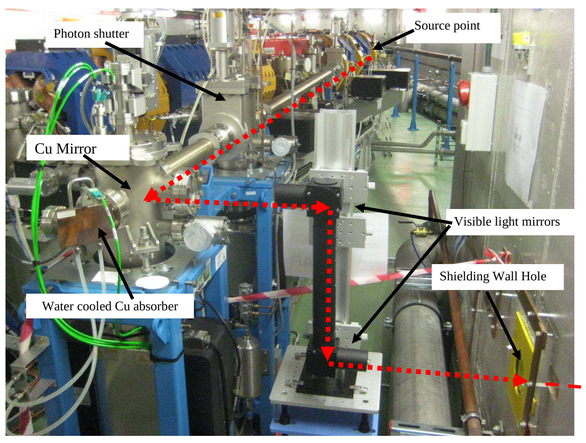
$\sigma_{dfr} = \int_0^\infty \frac{\sqrt{12}L_2}{4\pi w}\frac{hc}{E}P(E)dE$ Diffraction, which considers norm. photon flux:

$\sigma_{blr} = \frac{w(L_1+L_2)}{\sqrt{12}L_1}$ blurring

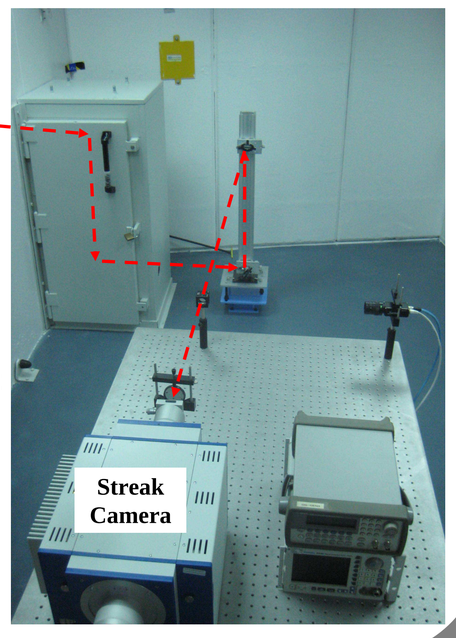
$P(E) = \frac{N_{ph}(E)X(E)}{\int_0^\infty N_{ph}(E)X(E)dE}$

Visible Synchrotron Radiation Monitor

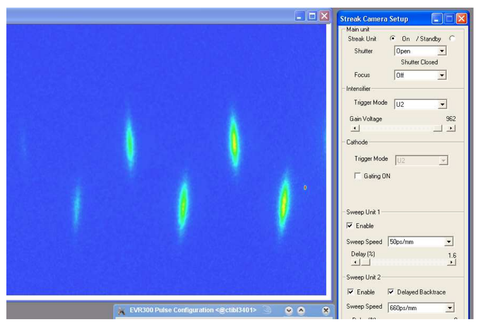
Light extracted from a dipole is used to precisely analyze the long. bunch structure.



In-vacuum mirror reflects just the visible part of the synchrotron radiation.
6 in-air commercial mirrors direct the light from the inside to outside the tunnel (Di. Hutch).



The VSR and Streak Camera are operational since ~May 2011 [7].

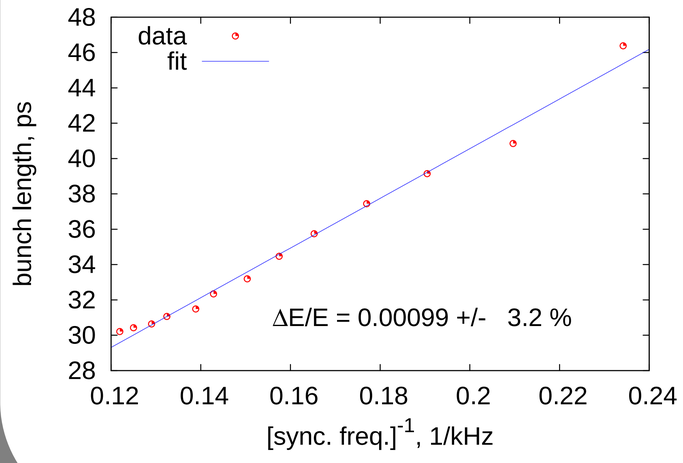


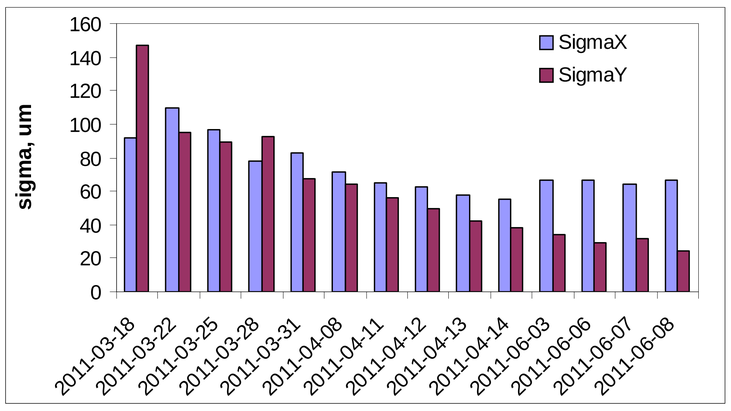
Example of an SC image analyzing 5 bunches.

FWHM=70.7ps

(larger than expected by the model, under investigation).

Its use allow to infer energy spread, which is found consistently with the ALBA model ($\Delta E/E$ = 1.05e-3).





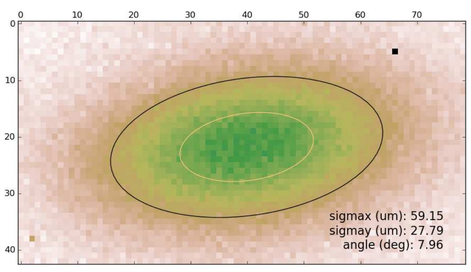
Beam size evolution from Marc – June 2011.
Note that the days are not equispaced.

The beam emittance is inferred by:

$$\epsilon = \left(\sigma^2 - (D\eta)^2\right)/\beta$$

We stress that the ε error bar is very influenced by the beam size.

Beam image (2011.10.13, 15mA):



The solid lines correspond to a 2-d Gaussian fit,.
Axis units are pixels.

The beam size is very sensible to image analysis (background substraction, ROI choice, etc).
Table below summaryzes the ε and its error bar.

	σ, μm	β, m	D, m	ϵ, **nmrad**
Hor Value	59.15	0.489	0.0355	**4.58**
Hor Error	3%	1%	1%	**10%**
Ver Value	27.79	24.465	0.0	**0.031**
Ver Error	3%	1%	0.0	**7%**

- **Emittance is in agreement with model (4.3nmrad).**
- **Coupling is estimated to 0.7%.**

References:

[1] U. Iriso et al, *Diagnostics during the ALBA Storage Ring Commissioning*, TUOA02, Proc. of DIPAC'11.

[2] D. Einfeld et al, *ALBA Synchrotron Light Source Commissioning*, MOXAA01, Proc. of IPAC'11.

[3] M. Munoz, et al, *Orbit studies during ALBA Commissioning*, THPC056, Proc of IPAC'11.

[4] K. Scheidt, *UV and Visible light diagnostics at the ESRF*, Proc. Of EPAC'96.

[5] F. Fernandez and U. Iriso, *VSRM Front End and BeamLine for Long. Diagnostics studies*, CELLS Internal Report, AAD-FE-DI-VMIR-01, Sept. 2011.

[6] P. Elleamue et al, *Meas. Beam sizes and ultra/small emittances using and xray pinhole*, J. Sync. Rad (1995), 2, 209-214.

[7] U. Iriso, *Beam size and emittance measurements in the ALBA pinhole*, CELLS Internal Report, AAD-SR-DI-PINH-001, June 2011.

Conclusions:

- The Diagnostics components are already commissioned and operational.
- The main progress since [1] is related to BPM electronics: the activation of DSC allow us to set/up the SOF to 0.5Hz.
- The two Diagnostics FE are fully operational, and their routine use allowed us to characterize the bunch longitudinally (with the Streak Camera) and transversally (with the pinhole).
- Related beam parameters are also inferred: both emittance and energy spread agree with the model.
- The emittance error bar is about 10%, although we stress that is very sensible to image analysis.
- Fast Orbit Feedback is ready to perform first tests