PERFORMANCE OF IDs AT ALBA

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Abstract

The new synchrotron light source ALBA is currently being commissioned along with the first phase of beamlines. Up to 6 beamlines are using light produced by Insertion Devices (IDs). There are up to four types of IDs: 2 Apple-II undulators (EU62 and EU71) operating at low energies, one conventional wiggler (MPW80) operating in the range of 2 – 20 keV, two in-vacuum undulators (IVU21) operating in the range 5 – 30 keV and a superconducting wiggler (SCW30) operating in the range of 40 keV. Installation of the IDs has been done in two steps. First, the out-vacuum devices (EU62, EU71 and MPW80) have been mechanically installed. Initial commissioning of Storage Ring has been done with their gaps opened to maximum value. Then, their gap has been closed to study the effect in the beam dynamics. In the second step, the in-vacuum devices (both IVU21 and the SCW30) have been installed and tested.

In this paper we present the first results and performances of the IDs obtained both in Site Acceptance Test and during the first months of commissioning with beam.

INTRODUCTION

We described elsewhere [1] the Insertion Devices (IDs) installed al new ALBA synchrotron light source. They are summarized in Table 1.

Table 1: Insertion Devices Installed at ALBA.

Beamline	Spectral range	ID		B_{max}	λ_u	N
(name)	(keV)	(name)		(T)	(mm)	
BOREAS	0.08 - 3	EU71	H	0.93	71.36	22
			V	0.7		
			C	0.56		
CIRCE	0.1 - 2	EU62	H	0.87	62.36	27
			V	0.625		
			C	0.508		
CLAESS	2.0 – 20	MPW80		1.782	80.0	12.5
XALOC	5 – 21	IVU21		0.806	21.6	92
NCD	6.5 – 13	IVU21		0.806	21.6	92
MSPD	8 – 40	SCW30		2.15	30.15	58.5

The manufacturing of all IDs has been mainly outsourced. Elliptical undulators EU71 and EU62 Apple-II type have been built in collaboration with ELETTRA, [2,3]; superconducting wiggler SCW30 has been built in collaboration with BINP [4]; in-vacuum undulators IVU21 have been build by Bruker Advanced Supercon (former Accel) [5]; and multipole wiggler MPW80 has been built by ADC [6].

All six devices have been already inserted to ALBA Storage Ring. Installation has been done in two steps: first step lasts from January 10th to February 2nd of current year and was dedicated to install the out-vacuum devices, including the removal of dummy vacuum chamber at the straight sections and substitution by extruded aluminium NEG coated vacuum chamber with small vertical aperture (8 mm inside, 10 mm outside). These devices have been commissioned with beam between May 20th and June 8th.

Second step lasts from June 14th to August 5th. It has been dedicated to insert two in-vacuum undulators (including their bake-out) and the superconducting wiggler, along with the upstream and downstream vacuum chambers completing the straight section. In Figure 1 we present SCW30 inserted in the Storage Ring. It was the last ID installed. Commissioning with beam is expected to start on September 14th.

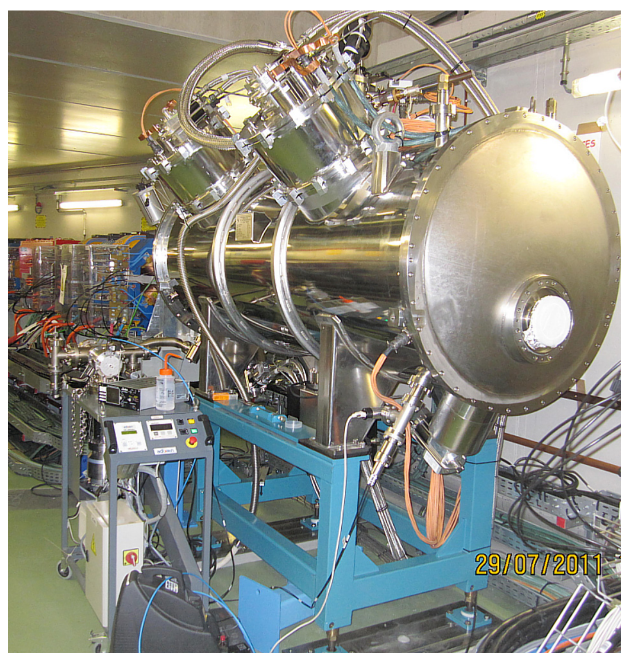

Figure 1: Superconducting wiggler installed in final position at ALBA Storage Ring is being pumped down.

SITE ACCEPTANCE TESTS

Prior to the installation, all IDs passed the Site Acceptance Tests (SAT). In the case of out-vacuum devices, they were remeasured at the ALBA magnetic and IDs measurement laboratory [7]. Magnetic field, phase error and field integrals were measured, finding a good agreement with manufacturer data acquired during Factory Acceptance Tests (FAT). Also fiducialization was successfully tested using SAT magnetic measurements. This fact is showing that transportation does not have a major impact in ID performances.

With respect to specifications, elliptical IDs were compliant, even producing specified peak field at higher gap values than expected. In the case of MPW80 wiggler, it presents higher sextupole component than specified, but this can be compensated by Storage Ring sextupoles. Also, the upper array was found to be longitudinally displaced 250 µm with respect to lower array, without consequences for its performance. Finally, also in this case, first and second integrals were higher than specified at one of the given working gaps. This lead us to build new correction coils, because those initially manufactured did not have compensation power enough.

Regarding in-vacuum undulators, SAT was only reduced to vacuum tests (leak and Residual Gas Analysis) because ALBA has not so far a magnetic measurement system to be used in "closed" IDs. Because of that, FAT follow up was stressed, especially regarding magnetic measurements. Both devices result to be compliant with specifications, presenting phase errors lower than 2.5º, first field integrals lower than 30 µT·m, and second field integrals lower than 55 $\mu T \cdot m^2$ (both without correction).

In order to account for the field degradation because of bake-out, the second device was disassembled after a first bake-out at 120ºC and was magnetically characterized again. Initially, at 6 mm gap, B_0=0.7571 T, phase error 2.4º, first field integral 25 µT·m and second integral 52 $\mu T \cdot m^2$. After bake-out, B_0 = 0.7533 T, phase error 2.6º, first integral 40 µT·m and second integral 70 $\mu T \cdot m^2$. Therefore, it was re-shimmed. New bake-outs made at ALBA before installation took place at lower temperatures (internal girders < 80º C).

Finally, SAT of superconducting wiggler SCW30 took place at ALBA and was carried out by BINP personnel assisted by ALBA staff. All specifications were fulfilled.

FIRST LIGHT

The first light from IDs at ALBA was obtained on May 20th and corresponds to the elliptical undulator EU62 operating in planar mode (horizontal polarization). Pictures of emitted light were obtained using a CCD camera installed in the Front End. As shown in Figure 2, cone of light is growing when closing the gap, as expected. Right and left signatures correspond to upstream and downstream bending magnets. Low current (2 mA) was maintained during experiment in order to avoid saturation in CCD. Same day, light from EU62 was detected at CIRCE beamline.

On June 3rd first light from EU71 was detected at BOREAS beamline. Circular polarized light was also captured in this beamline on June 7th (Figure 3).

Finally, light from MPW80 was captured on CLAESS beamline on June 9th (Figure 4) for a number of gaps.

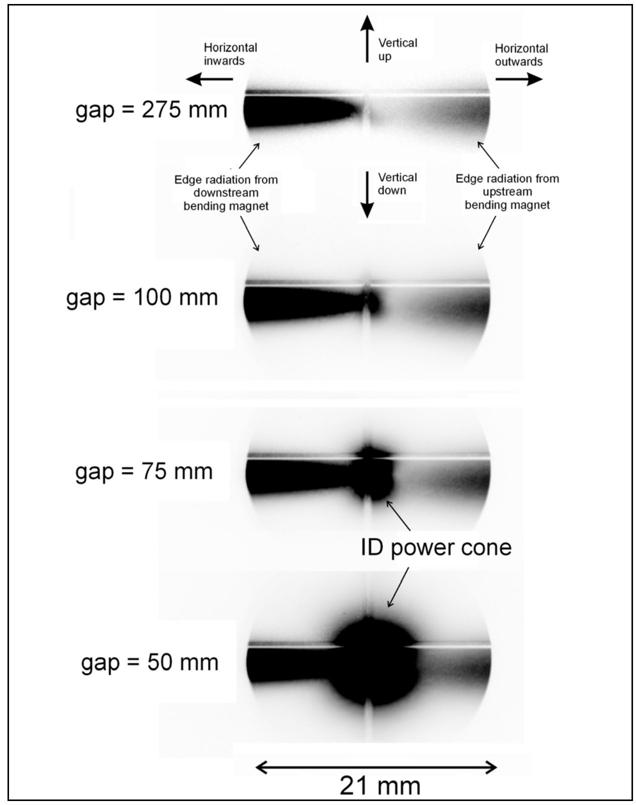

Figure 2: Image of EU62 emitted light captured at ALBA Front End 24 (CIRCE beamline) on May 20th.

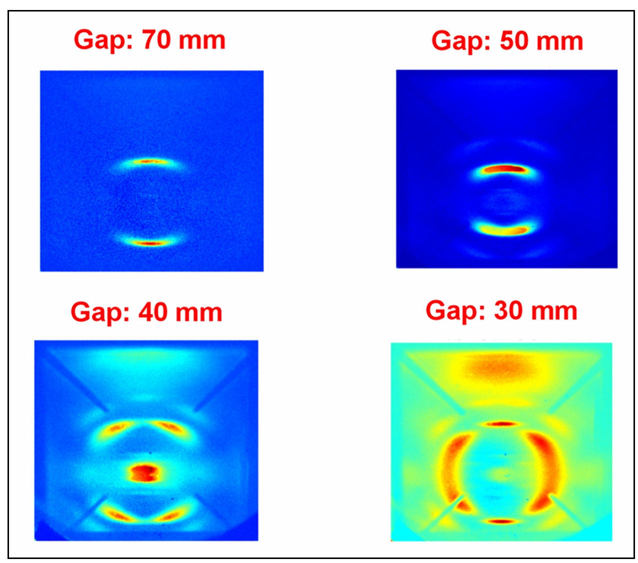

Figure 3: Image of EU71 circular polarized light captured at BOREAS beamline by DiagOn setup at 370 eV and at a number of gaps.

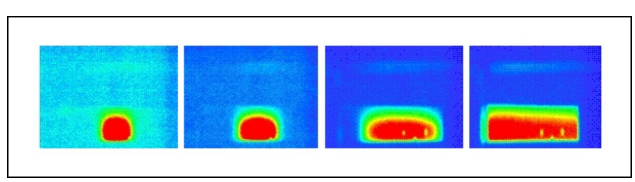

Figure 4: Image of MPW80 emitted light captured with a CCD at CLAESS beamline at a number of gaps between 60 mm (left) to 20 mm (right).

FIRST RESULTS WITH BEAM

During the commissioning of out-vacuum IDs with beam, they three were operated with correction coils activated. Circulating beam was maintained for any gap and phase of elliptical devices, showing small influence on ALBA performance.

A small increase of pressure was observed during the first moments of light generation, attributed to desorption in Front Ends. Original vacuum levels were recovered after some minutes.

In table 2, we show the rms closed orbit distortion and the change of tunes in the case of multipole wiggler MPW80.

Table 2: Influence of MPW80 on Orbit

Status	Gap	RMS orbit distortion		Tunes change	
	(mm)	(μm)		(10^{-3})	
		Horizontal	Vertical	H	V
Open	275	0	0	0	0
½ closed	50	11	57	-	-
Closed	12.7	13	9	0	2
Open	275	14	14	0	1

In table 3 we show the rms closed orbit distortion and the change of tunes in the case of elliptical undulator EU71.

Table 3: Influence of EU71 on Orbit

Gap	Phase	RMS orbit distortion		Tunes change	
(mm)	(°)	(μm)		(10^{-3})	
		Horizontal	Vertical	H	V
273	0	0	0	0	0
15.5	0	15	14	1	0
15.5	$\pi/2$	15	14	-1	1
15.5	π	16	15	-1	1
15.5	$-\pi/2$	15	15	-1	1
15.5	$-\pi$	16	15	-1	1
273	0	15	16	0	0

These measurements are very preliminary, but they show that the influence of out-vacuum IDs on the machine performance is small, and the vertical correction for MPW80 should be improved. To this end, new coils are fabricated at ALBA and will be implemented in next commissioning round. Also, in general, correction schemes should be refined for all IDs.

We observed also a decrease in the injection efficiency when the gaps of IDs were closed. This issue should be addressed and can be attributed to a change in the closed orbit affecting the injection section. Therefore, an improvement of correction schemes will lead to overcome this effect.

CONCLUSIONS

First round of Insertion Devices has been received and measured at ALBA. In general, Site Acceptance Tests confirm the characterization made in the factories, thus indicating that transport is not a big issue affecting the IDs performance.

All of the IDs have just been installed in the Storage Ring. Installation has been done in two campaigns, first one dedicated to out-vacuum devices, and a second one dedicated to in-vacuum devices (including superconducting wiggler).

First out vacuum IDs have already been tested with beam, and they deliver light to the beamlines from day one. The effect of such IDs on Storage Ring performance is small.

On October 2011 a new round of tests will start, involving new installed in-vacuum devices. Refinement of correction schemes is also foreseen for the next months.

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