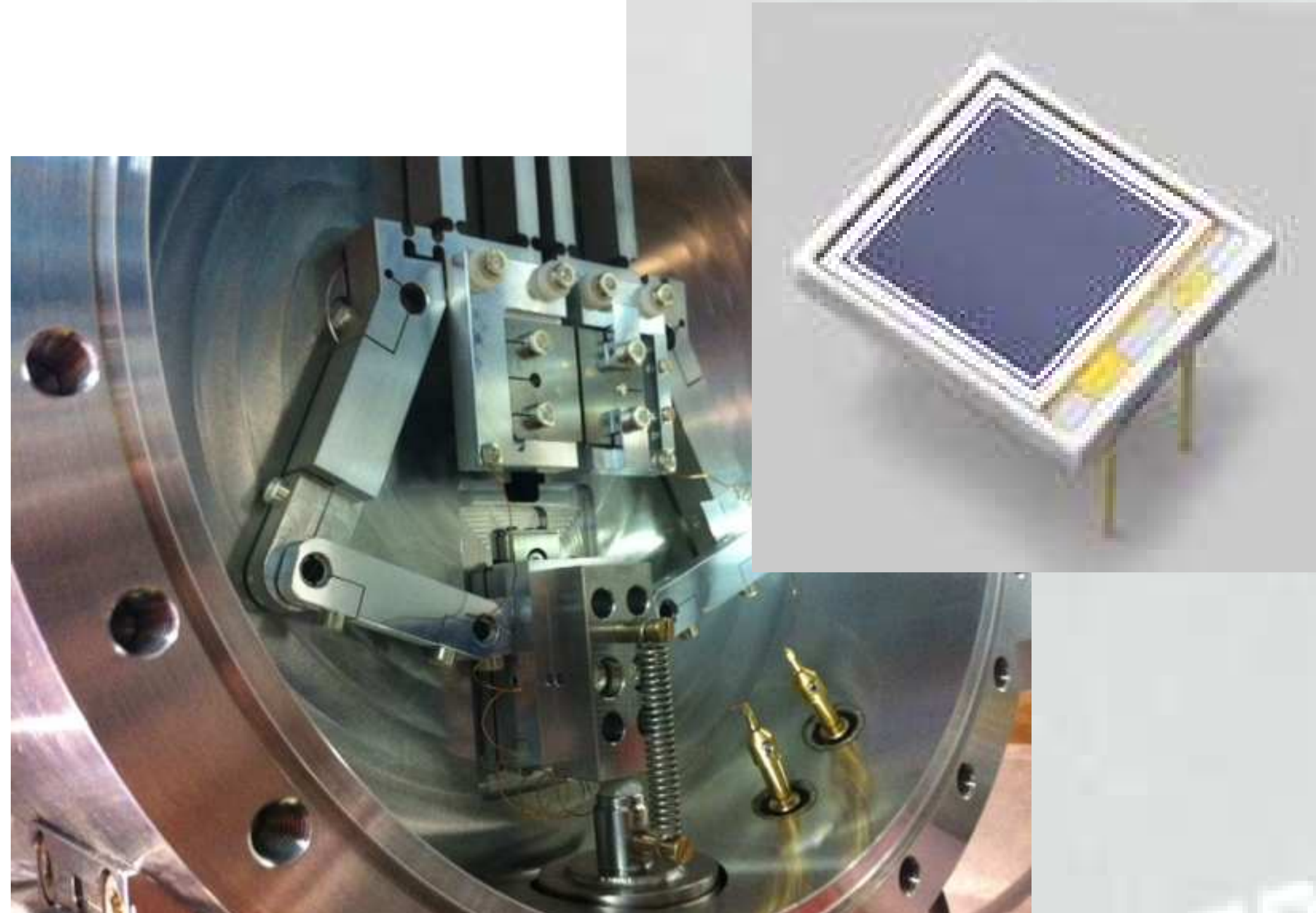# LOW CURRENT MEASUREMENTS AT ALBA

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High accuracy low current readout is an extensively demanded technique in 3rd generation synchrotrons. Whether reading from scintillation excited large-area photodiodes for beam position measurement or out of gold meshes or isolated metallic coated surfaces in drain-current based intensity monitors, low current measurement devices comprise an ubiquitous need both for diagnostics and data acquisition in today's photon labs.

In order to tackle the problem of measuring from various sources of different nature and magnitude synchronously, while remaining flexible at the same time, ALBA has started a project to develop a 4 independent channel electrometer. It is based on transimpedance amplifiers and integrates high resolution ADC converters and an Ethernet communication port. Each channel has independently configurable range, offset and low pass filter cut-off frequency settings and the main unit has external I/O to synchronize the data acquisition with the rest of the control system.

Electrometer architecture

-Up to 4 transimpedance amplifiers:
 Ranges from 1mA to 100pA on +/- 10V output
 Analog low pass filter (100Hz, 10Hz, 1Hz)
 Polarity inversion
 Input offset correction down to 1uV
 Double output
-Main board hosting
 Rabbit 6700 Minicore(200MHz CISC, 1Mb RAM, 1Mb Flash, Ethernet port
 Quad-channel, 200kHz, 18bit, bipolar ADC
 I/O circuitry for synchronization and regulation
- Front panel board with LCD and buttons

First project results

- Transimpedance amplifier with very good noise figures.
- 25 units of a low-end model with 12bits, 1kHz ADC for readout of diagnostic elements during October 2011 beamline commissioning. Fully compatible with final version.

ALBA Electrometer Block Diagram

Range	No filter		10Hz		1Hz	
	RMS	SNR(dB)	RMS	SNR(dB)	RMS	SNR(dB)
1mA	7nA	103	7nA	103	7nA	103
100μA	700pA	103	700pA	103	700pA	103
10μA	300pA	90	70pA	103	70pA	103
1μA	50pA	86	7pA	103	7pA	103
100nA	4pA	88	800fA	102	700fA	103
10nA	700fA	83	150fA	96	80fA	102
1nA	500fA	66	100fA	80	20fA	94
100pA	500fA	46	100fA	60	20fA	74
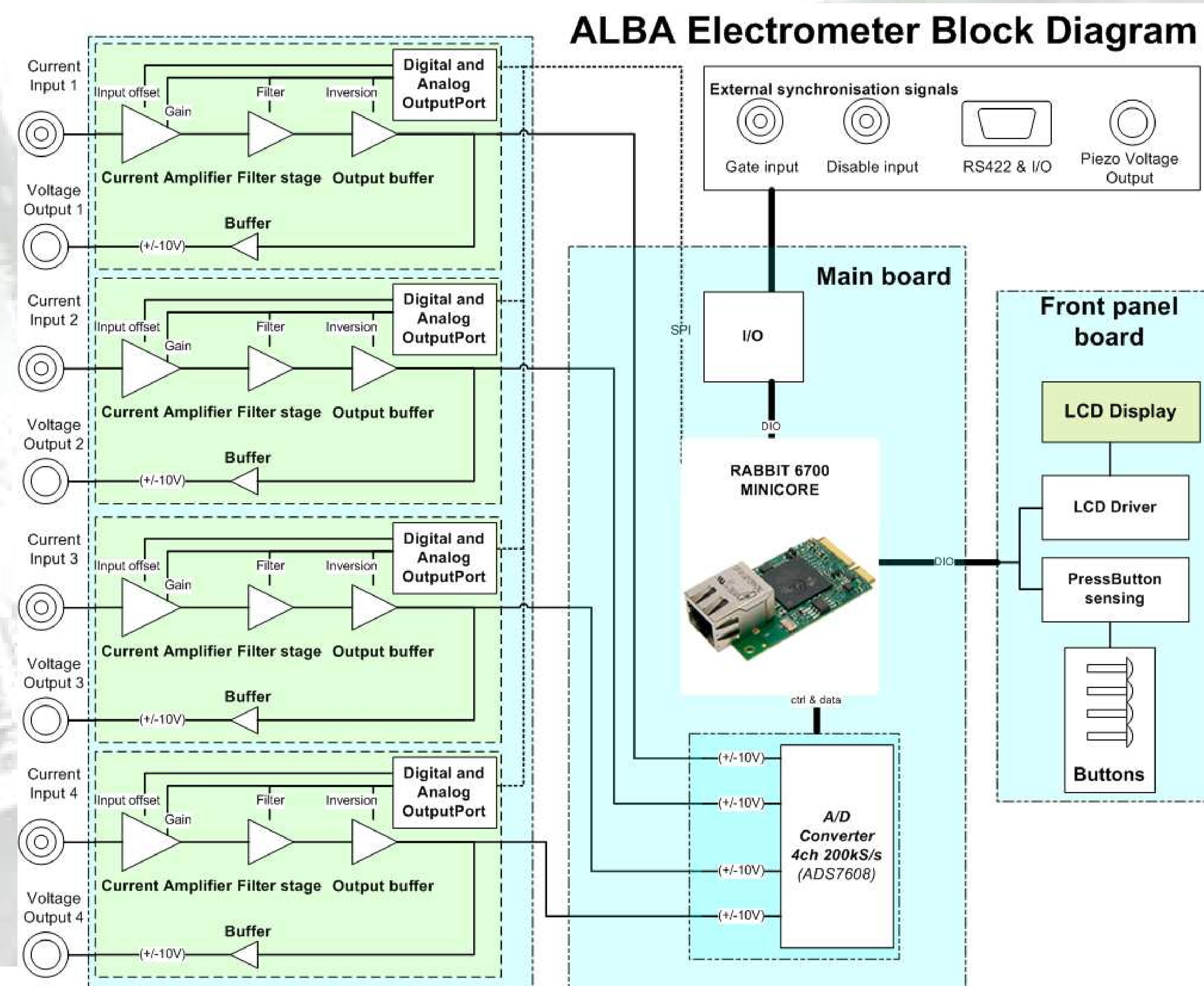
Integration in beamline control system

- Low level python library
- Sardana pool controller
- Tango device server for GUIs

Implemented functionality

-Digital input filtering (moving average).
- Input and offset corrections.
- Buffered measurements.
- Measurements synchronised with software or hardware triggered
- Gated measurements
- Events
- Remote firmware updates

CONCLUSIONS

- AlbaEm is a living project. With very good results in the analog part of the design and an already mature functionality, it can fullfil the scientist requirements for the October 2011 commissioning at the Alba beamlines.
- The amplifier is considered to be the final one for general purposes, though other versions could be built in case more specific applications arise.
- An acquisition system based in a 12bit ADC used in a previous inhouse project has been designed, implemented and tested. The units are prepared to be updated with just one part replacement wherever extra resolution is necessary. A fast 18bit ADC is expected to be ready the first quarter next year.
- In less than one year, the team has been able to put together 25 units of a robust system that fulfills the basic needs for current based diagnostics. Currently, these 25 units are already installed in the 7 beamlines and ready for the first photon beams.
- Moreover the high potential of the new updates should convert AlbaEm in a platform that will allow us to tackle all the future needs of the scientists at Alba beamlines.