WEPP02

CIEL : Current Injection Efficiency and Lifetime

Triggered Beam current monitoring and lifetime computation.

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Abstract
We will introduce a new acquisition system for storage ring beam current monitor. It is based on the co-developed PandABox electronics, associated with a 24 bits 128kS/s ADC. It offers the possibility of fast, triggered captures to measure injected current even during bursted injections. We'll show the results of the first tests and the integration of this new measure.

Introduction

Beam Current Monitoring on the storage ring at Soleil was performed with a digital multimeter board, providing high resolution (26 bits) but at low frequency (1Hz).

This rate made it impossible to measure burst injections in the storage ring, performed at 3Hz. Furthermore, injections were detected with a rising threshold on the current, making either false detection or missing low charge injections.

This multimeter board is now replaced by a generic platform already used at SOLEILand Diamond LS : the PandABox. Custom-equiped with a higher frequency ADC, it allows systematic capture of the injected current.

The wanted features are

1. a current measure at a 12 Hz rate and a lifetime processing not disturbed by injections.
2. Measure injected current for each injection.
3. Compute lifetime as with different dynamics (fast losses or precise lifetime).
4. Burst captures at the full sampling frequency.

Beam Current Monitoring – System Overview

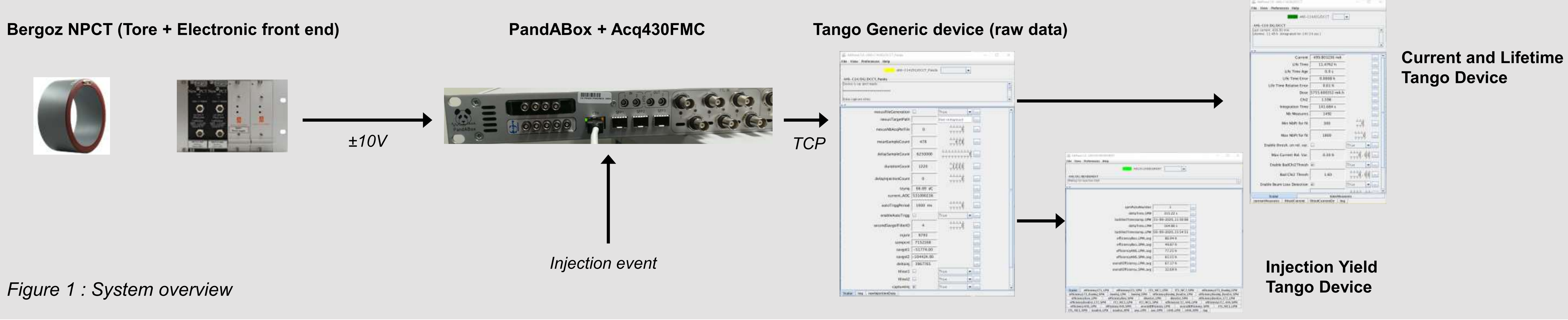

Figure 1 : System overview

Slow current measure

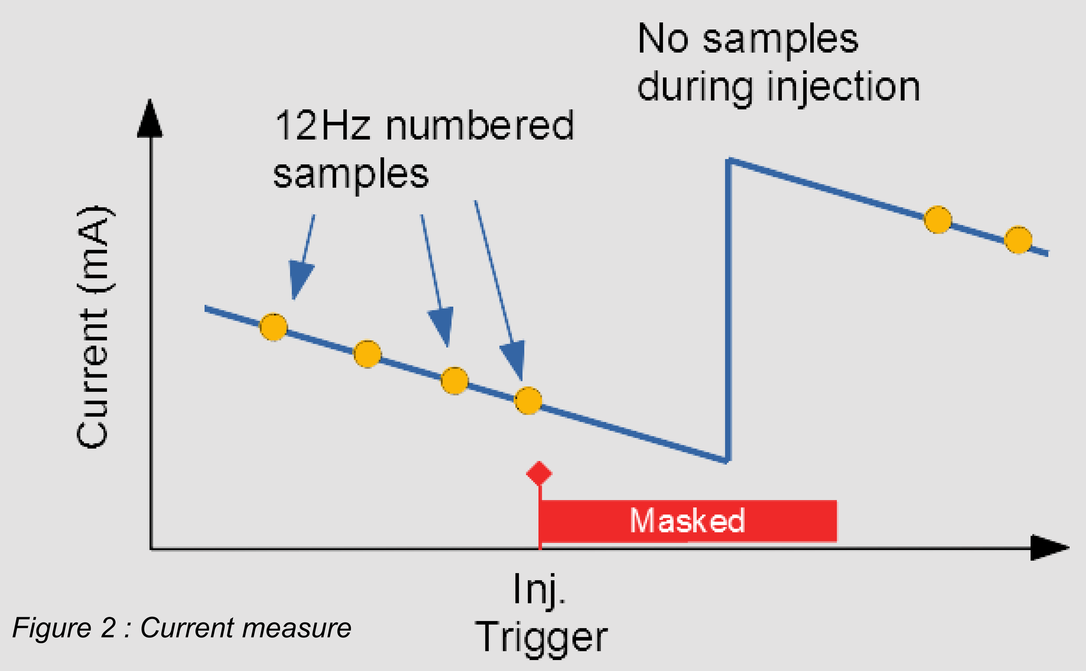

Figure 2 : Current measure

Data are filtered with rectangular window, decimate to 12Hz samples from the 48kHz initial data. These samples are provided in a register.

Every sample is numbered to facilitate fitting with missing data.

Data are masked around the injection event. All filters are reset to avoid filtered transient response. The duration is set by the user.

PandABox Acquisition System

PandABox is a open hardware project, initially created to provide motion encoder processing for continuous scans triggering, from a collaboration between SOLEIL and Diamond LS.
It is based on a PicoZed board, offering a Zynq 7030 device as the centerpiece. The PandABox offers multiple interfaces : TTL, LVDS, SFP, Ethernet, FMC, USB and Motion Encoder IOs.
This solution was selected because of its adaptability. By using this platform, we aim to converge to a unified and versatile platform for multiple applications.

The PandABox is equipped with a ADC on a FMC board for this application**.** The ACQ430FMC was selected for its 24 bits resolution at 48 kSps. It offers 8 channels, but we only use one for this application.
It accepts voltage signal of ± 10V, compatible with the electronic front-end from Bergoz.

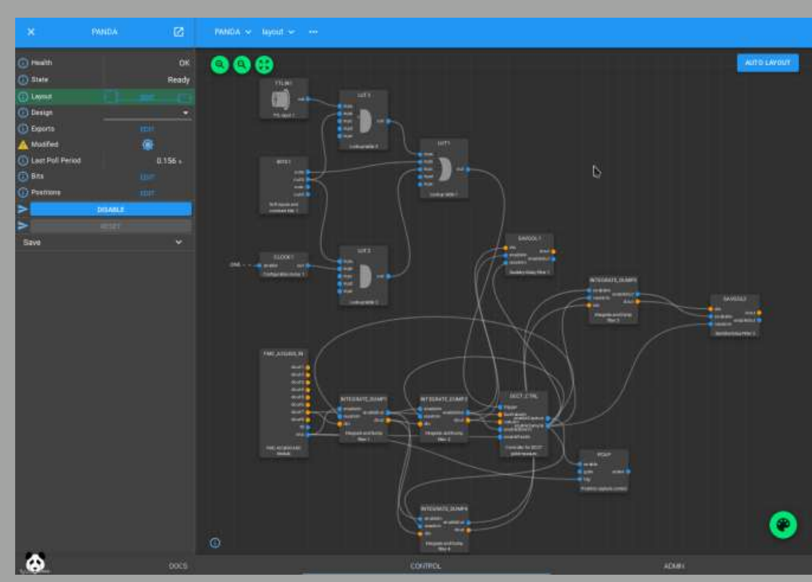

Figure 4 : PandABox web interface

Figure 3 : PandABox Hardware, and ACQ430 FMC

PandABox offers a full framework, that allows quick binding between developed FPGA blocks and an embedded TCP server for control/command and data captures. FPGA registers and platform IO are easily accessed from the software stack.
A series of scripts are used to generate VHDL wrappers, facilitating the integration of new processing blocks.
The framework offers the possibility of quickly chaining processing blocks at run-time, by a complete set of muxes. Spying of signals is also easily performed.
An embedded web interface is also available to run these functionalities.

A generic Tango device was developed, allowing quick connection with SOLEIL control system.
Customized attributes are declared in the device properties, with the register path specified. One does not need to recompile the device when changing the FPGA firmware, or to add monitoring/controls of more parameters.

For more information. PandABox HW : S. Zhang, ICALEPS'17 ; Firmware : G. B. Christian ICALEPS'19

Injected current measure

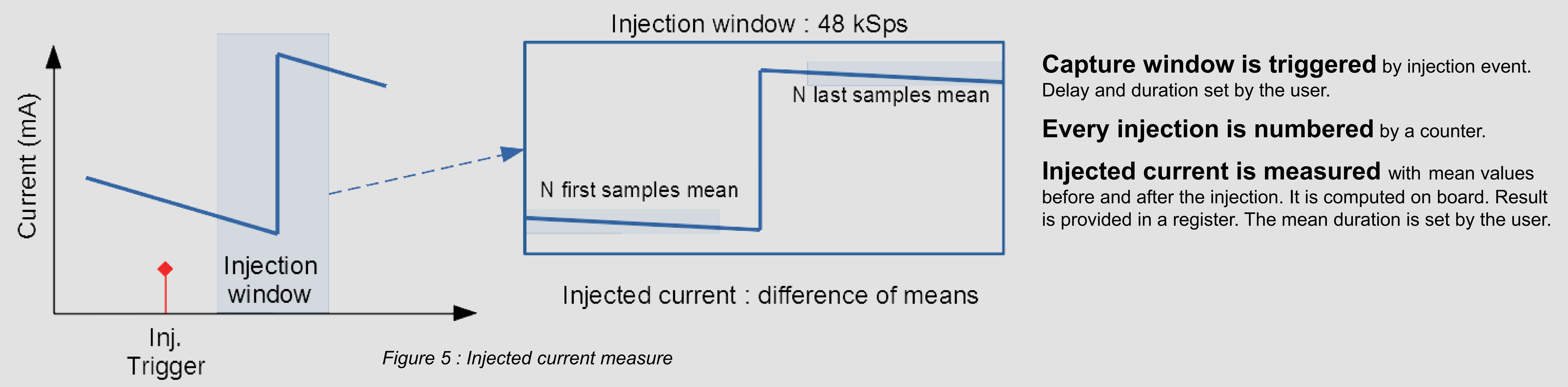

Figure 5 : Injected current measure

Capture window is triggered by injection event. Delay and duration set by the user.

Every injection is numbered by a counter.

Injected current is measured with mean values before and after the injection. It is computed on board. Result is provided in a register. The mean duration is set by the user.

Lifetime estimation

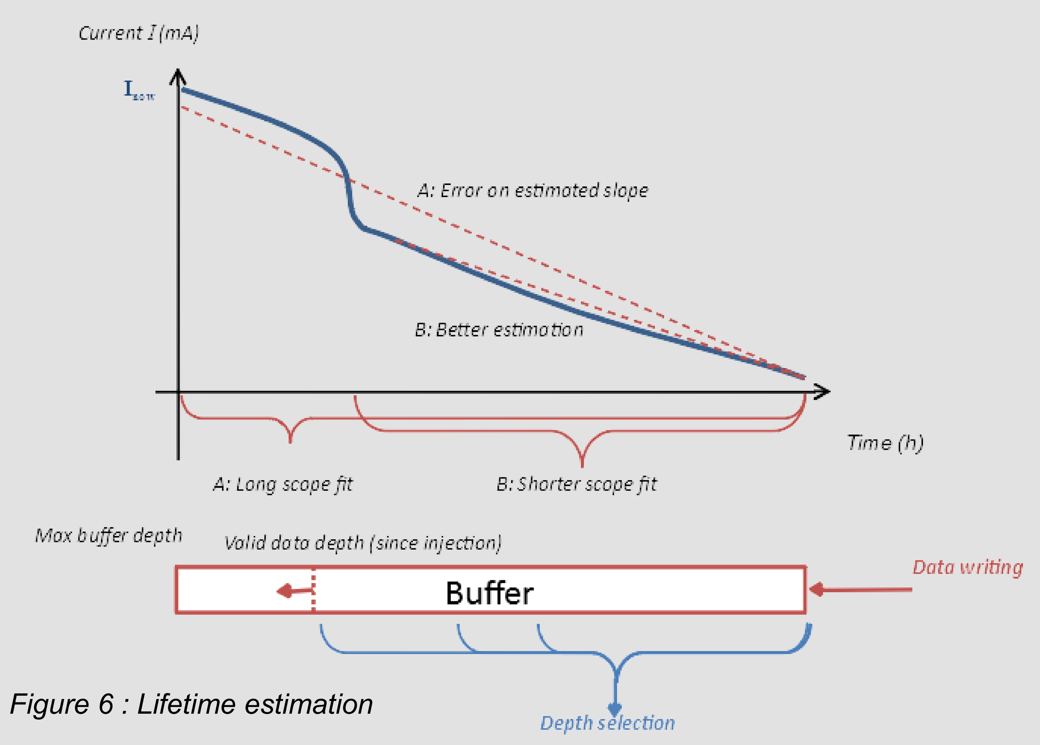

Figure 6 : Lifetime estimation

The scope of the fit if adapted automatically to follow current variation. Minimum and maximum scope are provided by the user. Oldest samples are removed first.

Fit score is computed with a Chi Square distance and compared to a threshold to shorten the scope.

Points are removed until the score is under the threshold. The data removal rate can be adjust, to avoid dropping too much points instantaneously.

Multiple device instances can be started. They share a common buffer to avoid overloading the Panda Device. Each one can process the lifetime with its own parameters.

CONCLUSION

Two systems deployed: One of which has been the main measure for some weeks. When kept the old measure for comparison.

Measure precision: 1,4 µA STD after fit slope removed, ±4 µA PTP. That is the electronic front-end level.

Lifetime Estimation: Equals actual estimation, is not fouled by small injections. Makes it possible to have quicker dynamic.

Injection observation: Can now tell exact current injected and thus yield for each fire. We observe cooldown effects of pulsed elements.

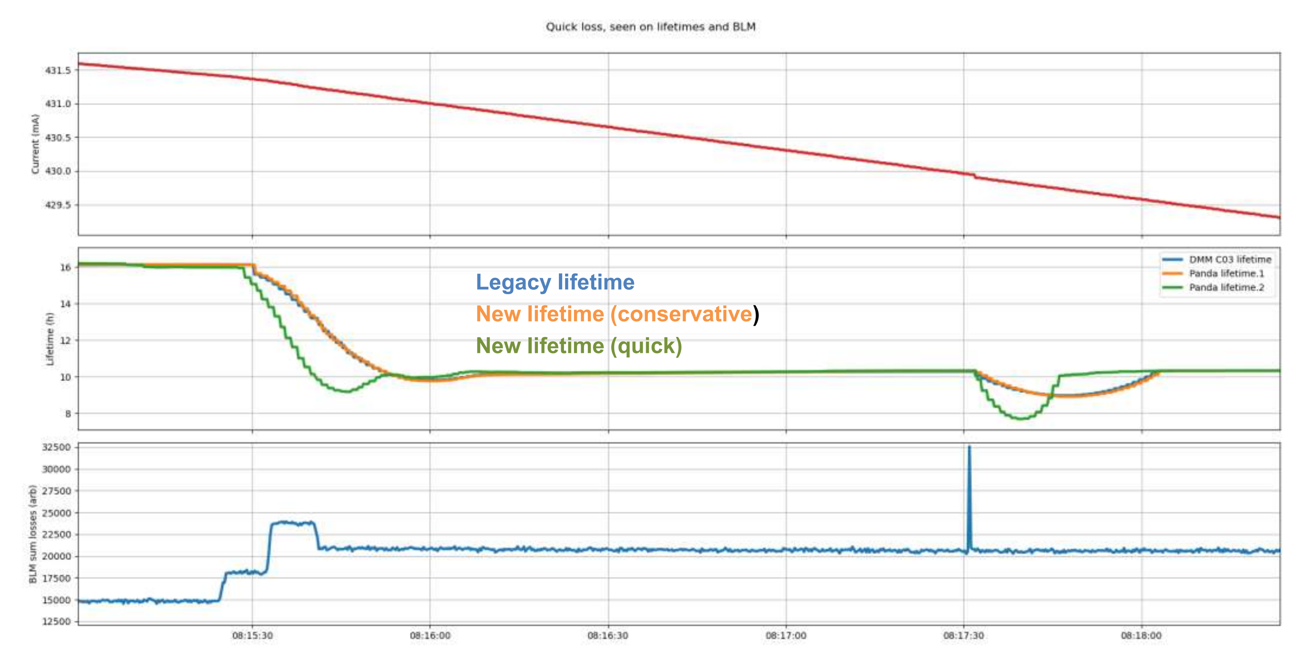

Figure 7 : Lifetimes and current . We have good correlation with BLM readout on a small loss (~50µA).

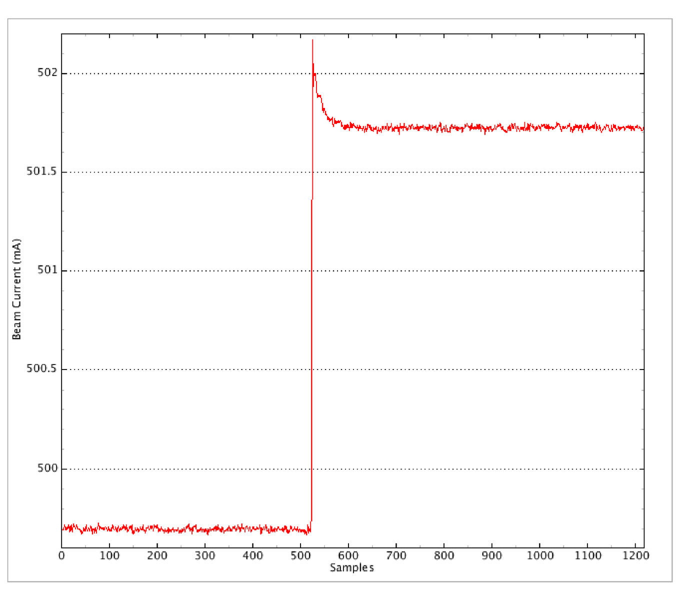

Figure 8 : Injection capture

Acknowledgement

Many thanks to Shu ZHANG (SOLEIL), Gwenäelle ABEILLE (SOLEIL), Guillaume Renaud (SOLEIL) and Gauthier THIBAUX (SOLEIL), for all the information they provided, leading to these results.