EXPERT PORTRAIT

JEAN-PAUL RICAUD, ELECTRICAL ENGINEER

Coming from industry, a specialist in electronic development, Jean-Paul Ricaud joined the Control and Acquisition Electronics group in SOLEIL's Computing Division in 2004.

In what context did you start working at SOLEIL?

When I was recruited, Alexandre Loulergue, Head of the "synchronization machine" project, had just finished writing all the specifications for this system. My mission was to develop the technical side and to establish the specifications necessary to order from outside sources, the different elements involved. Once this "machine" component was in operation - this was in 2006 - I was put in charge of its monitoring and maintenance, as is still the case.
And, in parallel, I was assigned to the beamline synchronization system, available now on six beamlines that carry out time-resolved experiments: DESIRS, DISCO, LUCIA, METROLOGIE, PLEIADES and TEMPO. This system is up and running.

What is the "synchronization machine" system?

Electrons are generated by the electron gun, accelerated in the LINAC and then injected into the Booster where their acceleration continues until their extraction and injection into the storage ring. This trajectory requires the perfectly synchronized triggering of a variety of instruments: the electron gun, magnets and diagnostic devices of the beam. Hence the need to set up "clocks" and trigger signals to temporally link the various devices to each other.
In addition, we must manage the various ways of filling the Ring (ring "full" with 416 bunches, or 8 bunches, a single bunch, or even a hybrid mode), and the top-up operation (filling of about 2 mA every 2-6 minutes).

What does it consist of?

Once the role and characteristics of the system were specified, developing the appropriate electronics was entrusted to the French company Greenfield Technologie, which had already supplied similar equipment to the CEA.
A real mini network of optical fibers was installed to dispatch the synchronization messages from the «central brain» - a computer located in the control room - towards local boards situated throughout the machine.
Each board can then generate trigger signals through eight outputs. The mainframe itself is synchronized with the clock of the very accurate radio-frequency system (352.196 MHz) that sends their power to accelerator cavities.
To compensate for the time it takes for the signal to travel the length of cable between devices, and also compensate for the latency of the equipment, the system includes time delays that the user can specify. Thus, in the control room, operators can program into the mainframe computer - using a LabVIEW application - preset delays in order to trigger the series of events that will get the desired filling mode of the storage ring.
The triggering accuracy is 5.7 ns for all equipment, and even up to 80 ps in the case of the electron gun.

And what about the beamlines?

The machine synchronization system already provided beamlines with the storage ring master clock (846 kHz, the frequency of revolution of an electron bunch), as well as the warning signals at the beginning and end of each injection during the top-up operation.
For most beamlines this information is sufficient, but not for those who perform time-resolved experiments, the principle of which is to synchronize the acquisition of their detector to the photons emitted by the passage of one or more electron bunches.
When a bunch passes in front of the beamline, it causes a extremely short flash of synchrotron radiation: 20 to 50 ps (time related to the length of the bunch).
The flash occurs at a very stable and high frequency (846 kHz in single bunch mode, 6.77 MHz in 8-bunch mode) and its very short duration can freeze the exact condition of the sample studied. Successive flashes during the following passages will then "photograph" the sample during its evolution over time.
The challenge is to trigger the analysis just as flashes occur. As electrons turn at more or less the speed of light, accuracy is required!
This is why we set up a complementary synchronization system adapted to the specific needs of these beamlines: their measuring instruments are triggered during the passage of the electron bunch.
This system is very flexible and versatile. It can accommodate a maximum of different instruments, a vital quality in a research center such as SOLEIL, where each beamline has its specific equipment.

This diversity can also be found in the people that I have the opportunity to encounter in the course of my work, since it has led me to interact with most beamline teams and SOLEIL sources, but also with some external users.
It is a very enriching human environment, which contributes to making my work at SOLEIL interesting.

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