Operation, Maintenance and Developments of LNL Heavy Ion Accelerator Complex


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OPERATION FACTS

The TAP (Tandem-ALPI-PIAVE) accelerator complex provided around 3400 beam-on-target hours, including accelerator tests, during 2014, close to the average of the last 9 years (~ 3500 hours), as reported in fig.1.

The partition of beam-on-target hours among the three different combinations (Tandem, Tandem-ALPI and PIAVE-ALPI) for the same period is shown in fig. 2.

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MAINTENANCE AND DEVELOPMENTS OF THE XTU-TANDEM AND BEAM LINES

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The reason why the beam line to GARFIELD had to be modified is that, in the previous configuration, it would have partially overlapped with the SPES transport line from the Charge
Breeder to the injection of the SPES RFQ. While for the GALILEO beam-line the support of the Accelerator Division was limited to laser tracking (LT) alignment of the beam line, the new GARFIELD beam line had to be completely designed and rebuilt, starting from beam dynamics calculations. We largely reused machine components of the previous beam lines (magnetic lenses and steerers, diagnostics stations, vacuum equipment [1], beam tubes). The Technical Division supported us for both infrastructural work (cabling and piping, new distribution of the electrical power, etc.) and mechanical work, in particular for the delicate issue of mechanically matching the waveguides of the two magnetic dipoles (45° in opposite directions) just upstream the experimental apparatus. This beam line was LT-aligned as well.

The beam line (fig.3) was commissioned in December, when the beam was successfully transported to the experiment. However, a residual leak in the vacuum chamber between the dipoles, together with an insufficient number of diagnostics stations and poor beam steering capability in Experimental Hall III, suggested to fix such flaws and to complete the commissioning in early 2015.

MAINTENANCE AND DEVELOPMENTS OF ALPI AND PIAVE

On ALPI, the thorough commission of the cryogenic plant with the 3rd turbine was completed in Spring.

The upgrade of the lower section of ALPI (consisting in liquid N cooling of cavity couplers so as to increase their power management capability and, consequently improving cavity stabilization vs. ponderomotive instabilities) had been completed in 2013. However, 2 resonators in cryostat CR04 and 3 resonators in cryostat CR06 had flaws on the RF input lines, preventing their operation at 4K: on cryostat CR04, such flaws remained when the resonators were brought back to 300K; on CR06, on the other hand, heated RF lines went back to regular behavior (a short due to differential cooling between the inner and the outer conductor of the RF lines can be speculated). Maintenance on such cryostats could be planned in 2015, with priority on CR04 where the failure can be diagnosed more easily.

In Fall 2014, a further fault on the largely obsolete supervision of the ALPI cryostat control system sounded as an alarm bell, which made us to decide to anticipate the completion of the refurbishment of the entire cryostat control system with respect to the original plan (in which the work had to be split between Fall 2015 and Fall 2016). The whole activity was anticipated to the period November 2014 – April 2015, which unavoidably impacted on the PIAVE-ALPI calendar. Consequently, it was decided to continue experiments with Tandem only until summer 2015 and switch on the cryogenic plant in September 2015, so that the next semester with all accelerators available will be Fall-Winter 2015-2016.

A further issue, which arose in September 2014, was a leak towards the isolation vacuum on 9 out of the 21 cryogenic valves which regulate the liquid He level in ALPI cryostats. Mechanical fatigue after more than 20 years of operation was the reported cause. The time window left by the extended maintenance on the cryostat control system will be used to replace them all.

On PIAVE, we report that – after the successful replacement of RF antennas in 2013 – we had to recalibrate the SRFQs accelerating field with the beam. Indeed, the electronic calibration was insufficiency accurate. Without such calibration, we ended up in a reduction of the beam transmission of around a factor 2. The transmission was then lower in ALPI too, due to the fewer lower beta cavities available (see above). It was hence decided to set aside 3 full days for such recalibration (July 2-4). Eventually, in the 20Ne PIAVE-ALPI shift on July 9-16 (channel -40°, LIRAS), the transmission went back to approximately the original values.

In late Fall 2014 the special maintenance of the SRFQ cryomodule started. It regards both the resonators themselves (surface treatments to make conditioning quicker and hence increase the achievable accelerating field), their ancillaries (new slow+fast tuners, repaired electromagnetic fast tuners) and cryostat components and functionality (resonator LT alignment, more reliable positioning system, increase of drainage capability of the gaseous He from the cavity inferior electrode, renewing of heating system and thermometry on both the resonators and the thermal shields). We foresee to carry out and complete the maintenance during 2015, to make PIAVE available at the beginning of 2016 at the latest.

We mention eventually a few developments, which were carried out mostly in the more general framework of ALPI refurbishment within the SPES project, concerning control systems. In 2014 the new beam diagnostics control was implemented and successfully tested, first of all on PIAVE then on ALPI, and is now operational; a new access control system, fully developed in house, was also realized and tested in 2014 (fig.4). Finally, the work on the refurbishment of the magnet control system started, and a preliminary version was tested on the new transport line from the end of ALPI to the GARFIELD experimental station: after a few improvements and further tests on such line, it will be tested on both PIAVE and ALPI in 2015.

Fig.4 Photo of one page of the new access control system supervision (internal developments), operational since Dec 2014

[1] M. De Lazzari¹, A. Conte¹, C. Roncolato¹, M. Rossignoli¹, Installation and Commissioning of the New Vacuum System for the ALPI HEBT Line to the III Experimental Hall