ICARUS T600 (CNGS2) Status Report

(ICARUS COLLABORATION)

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CERN-SPSC-2009-023 / SPSC-SR-049
07/07/2009

Since the last presentation to the SPSC committee, the ICARUS T600 detector assembly has progressed up to its completion. The cryogenic plant, the liquefier system, the read-out, the Laboratory infrastructure and the safety facilities have been installed.

However the Collaboration had to face some problems that have delayed the start-up of the commissioning of the apparatus. Besides the one-month suspension of the activities in the Laboratory, following the seismic event in the l'Aquila region, delays have emerged due to the commissioning of the liquefier system, to the pressure/vacuum leaking of some wire signal feed-through flanges and to the deformation of a panel of the external thermal insulation.

1. The L'Aquila seismic event.

On April 6th the L'Aquila zone was hit by a 6.3 Richter magnitude earthquake, following a seismic shower present in the region since January 2009.

The earthquake hit the Laboratory area. A maximum acceleration of the order of 0.03 g was recorded in the underground halls and 0.15 g in the external structures. These have to be compared to the 0.64 g value measured in the L'Aquila city.

The seismic event affected marginally the experimental plants inside the underground halls. Nevertheless the access was limited from April 6th to April 29th to allow the laboratory inspection by LNGS staff, by civil protection engineers and by the experts on structures, geology and hydrogeology. This caused one month of general delay to the experimental activities. On May 4th the laboratory restarted the normal access and activity.

A first survey was carried out on May 12th and 13th by the ICARUS collaboration and Air Liquide in order to verify the integrity of the ICARUS T600 apparatus after the seismic event. The result was positive: the ICARUS apparatus was able to get over the seismic event, still keeping the intrinsic safety of its different parts.

2. The ICARUS cryogenic plant.

The Air Liquide cryogenic plant was completed in summer 2008 with the activation of the vacuum pumping for the insulation panels. The unloading station was also completed and already used (September 2008 and February 2009) to unload the liquid Nitrogen needed to the liquefier system commissioning.

The tender for the cryogenic liquids is accomplished. In addition, a large range of spare parts has been ordered; these will be delivered before the start-up.

The ICARUS Control System has been cabled and almost tested. The interface with the Control System of the Laboratory is almost completed. Final tests will be carried out at the commissioning level.

The slow control system has been implemented and installed, allowing the measurement and monitoring of the pressure inside the cryostats, the liquid Argon level, the temperature and the inner wall displacement. The system has been tested and used during the pressure/vacuum leaking tests. These tests are in progress since December 2008. Presently the cryostats are set in overpressure by using Argon gas; later, the Helium leak detection under vacuum will conclude the test.

3. The liquefier plant.

The liquefier plant (Stirling) has been completed and the commissioning started on September 20th. One of the two cryogenic tanks (30 m^3) has been filled with LN_2, using the unloading station, under the management of the ICARUS Control System.

All the 10 units have been switched-on: it is certified that the liquid Nitrogen is produced at the required rate.

A major problem concerning the capability of the system to transfer the liquid Nitrogen from the ground level to the stocking tanks at the top of the plant (difference of 10 meters in height) was found. The layout, previously realized by Stirling, did not get rid of the gas development in the transit pipes, which prevent the pump operation. A new layout has been designed. The implementation of the new solution ended in February 2009.

A 6 weeks test period, up to April 2009, has been spent to demonstrate the stability and the efficiency of the system, which is now in continuous operation (test mode).

4. The ICARUS read out.

The installation of the readout electronics racks on the T600 top has been completed, together with the cabling of clock & trigger distribution. Each rack has been commissioned with test pulse data taking in order to identify any broken/malfunctioning boards. A suitable number of spare DAQ boards have been ordered.

The event builder architecture has been deployed including DAQ computers (10 server), storage (160 TB on disk and 100 TB on tape), networking (cabling, switches and fibres to control room & to external labs). The set up has been tested in summer 2008.

5. The Laboratory infrastructures.

The general power supply for ICARUS plant has been delivered in October 2008. The UPS (the emergency power supply to feed the control system, the valves and the 50 kW heater) is fed now by a Diesel motor generator placed underground. From a more general point of view, a different layout of the power supply plant is foreseen by the Labs. in order to gain a higher level of redundancy.

The ICARUS exhaust ventilation system has been completed. The new “double” ventilation system for the underground Labs has been successfully tested at the beginning of October. It was required for the ICARUS operation.

The water-cooling circuit in Hall B has been upgraded, to obtain the needed cooling power for Stirling system (10 liquefier, 45 kW each) and to keep the thermal fluctuations within 3 °C.

The safety facilities have been completed and partially tested. The wall to separate the ICARUS area in Hall B has been assembled.

The T600 start-up procedures, logistics and authorizations have been almost defined.

6. The flanges.

The detector pressure/vacuum leaking tests are in progress since December 2008. These tests showed that some of the flanges mounted on the cryostats, housing the wire signal feed-throughs, were leaking in a sensitive way.

Already in 2001, during the test in Pavia, this problem was observed. For this reason, all flanges were reworked at CERN to add a layer of Araldite with the consultancy of TS/MME department. These flanges were tested under vacuum after the reworking and the problem seemed solved. The common assumption is that the aging and the mechanical stress could induce the loss of the tight performance. It is widely accepted that the architecture of the original wire signal flanges has major flaws, and because of this the collaboration, soon after the 2001 surface test in Pavia, developed a new flat flange that showed higher reliability.

A set of 28 new flanges was available in late 2008 (96 is the total number of wire signal flanges in T600). These have been used to substitute all the bad flanges: this is enough to allow the detector vacuuming. The collaboration is operating to get enough flanges of the new type in order to substitute all the old flanges, to prevent possible future problems.

7. External insulation panel.

A deformation in the lower side of the welded panel of the external thermal insulation was recently noticed.

This deformation, which has probably nothing to do with the seismic event occurred in the L'Aquila region in April 2009, is confined to the lower side of the insulation panel of the rear external wall. It consists of a unique deformation - others were not found - and did not lead to vacuum losses in the panel itself or to damages in the internal cryostats. It manifests itself as a reduction of the panel thickness, whose nominal value is 400 mm, giving rise to the contained honeycomb insulator (Nomex) collapse.

The deformation is presently subject to a technical analysis by Air Liquide, and an official report showing the intervention strategy will be issued. The Air Liquide position, stated firstly on May 22th and then in a report on June 15th, is that "a preliminary evaluation, not binding at all, indicates a timing of intervention of the order of two months".

8. **Conclusions.**

The installation of ICARUS T600 has progressed in 2008/2009 up to its completion. The detector, the cryogenic plant and the data acquisition are now essentially ready.

The Laboratory infrastructures, required for the detector filling, have been completed and the T600 start-up procedures, logistics and authorizations have been almost defined.

The actual time-schedule of the T600 operation is now mainly dependent on the panel insulation repair by Air Liquide. The intervention should take about 2 months.

The commissioning of the detector should be scheduled just after the recovery of the panel conformity. The filling of the detector with 600 tons of liquid Argon should last 2-3 weeks.

Finally, provided that the timing of intervention on the panel is confirmed, the detector will operate both with cosmic neutrinos and with a fraction of the CNGS neutrino beam scheduled for 2009.