ICARUS T600 assembly in Hall B: status report

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Talk summary

• Description of the T600 plant
• Description of the recent events
• Present situation
• Next steps
• Conclusions
Definition of the overall ICARUS plant

- **T600 detector**
  - ICARUS Collaboration responsibility

- **T600 cryogenic plant**
  - AIR LIQUIDE contract

- **Nitrogen re-liquefaction system**
  - STIRLING contract (LNGS responsibility)

- **Lab and hall B infrastructures**
  - LNGS responsibility
T600 cryostat layout

- Pipe from safety magnetic disks
- Passive heaters
- LN2 Pumps
- LAr purification systems
- GAr purification systems
- Liquid storage exhaust connected to 50 kW electrical heater for safety
- Electronics
ICARUS overall plant layout

- 30 m$^3$ LAr Vessel
- 30 m$^3$ LN$_2$ Vessel
- N$_2$ Phase separator
- 3 STIRLING Skids (10 units)
Scheme of the overall cryogenic plant

- LN2 storage tank
- LN2
- GN2
- Cryocoolers (10x4 kW units)
- Intermediate LN2 vessels
- Transfer pumps
- 50 kW heater
- To LNGS ventilation
- STIRLING
- AIR LIQUIDE
- 4 kW cold power unit
- N2 phase separator (Testing vessel with heater)
- Circulators
- GAr & LAr recirculation & purification
- T600 cooling
- 50 kW heater
- Ventilation
- 4 kW cold power unit
T600 insulation mounting

Insulation reinforcing structure

Bottom and lateral insulation

Insulation pool and screens

T300 modules in position

June 2007
Activities on the T600 top (1st phase)

July-October 2007

- Straight chimneys mounting
- Extraction of cables/fibers
- Detector inspections (man-holes)
- Diffusion pipes for purified LAr
Activities on the inner detectors

- Wire chamber mechanics
- HV system
- PM light detection system
- Slow control system
- Purity monitors

July-October 2007
Insulation pool closure

Frontal cooling screens

Invar containment plate

Frontal insulation wall

External structure

September 2007
Top screen and insulation assembly

Top cooling screens

Top insulation mounting

Superinsulation layers

Top insulation external welding

October-December 2007
Top structure completion

January 2008

Insulation reinforcing structure completion and T600 top floor mounting

Insulation Bellow
Service structure completion

Begin of February 2008
STIRLING system construction

- Cryocoolers (10 units)
- LAr and LN2 storages
- Skid frames
- Pipes

November 2007
Cryogenic liquid storages

LAr and LN2 storages in the final position

February 2008
Compressor skids

February 2008
Activities on the T600 top (2nd phase)

“Cross” chimneys mounting

Signal feed-throughs in position

Feed-through internal cabling

Sensor mapping

January-February 2008
Electronics rack mounting

March 2008
Present state

- All the “crosses” and signal feed-throughs are mounted (except some “corners” for horizontal wires)
- All the internal auxiliary instrumentation is precisely mapped in the 80 chimneys (for some of them material has to be acquired)
- 88 racks in position on the T600 top
- 6 “trigger” racks on the service structure top
- 2 cabinets for power supply distribution to the racks on the service structure top
At the moment the activity of the collaboration on the T600 top is suspended in order to leave Air Liquide complete the installation of Ar and N2 lines on the top

Few weeks

- **Completion of the detector internal cabling and closure:** end of May 2008
  - Complete the mounting of signal, sensor, PM, monitor feed-throughs
  - Complete the closure of the blank flanges
  - Vacuum system mounting
  - Leak-checks
- **Detector external cabling and electronics test:** end of May 2008
  - External signals cabling for electronic racks and all the internal instrumentation
  - Electrical distribution cables, fibre connections installation
  - Power supply connections
  - Tests of the cabling, instrumentation and electronics
    - Temporary power supply in case of need (50 kW+50 kW)

In parallel:

- **Networking infrastructures preparation:** ongoing (not critical)
  - Racks (for computing and storage) completion in control room and ext. labs
  - Control room preparation and connection
  - Data acquisition, trigger system, data handling and storage system set-up
Air Liquide circuit mounting

Passive heaters

LN2 circulation pumps

LAr purification systems
Air Liquide plant completion

• Installation of the **Ar circuit**: *completion in first part of April 2008*
  – LAr re-circulation/purification system: almost complete
    • Cryostats for LAr pumps and LAr pumps: ok
    • Cryostat for LAr purification filters: ok
  – GAr collectors and recirculation/purification systems: April 2008
  – LAr lines: ongoing

• Installation of the external **N2 circuit**: *completion at begin of May 2008*
  – LN2 pumps and valve boxes: ok
  – LN2 piping mounting: ongoing
    • STIRLING interface (phase separator) just installed
    • Few interferences with STIRLING plant have just been solved

• Installation of **safety systems and devices**: *completion mid of May 2008*
  – Safety valves, magnetic safety disks: April - May 2008
  – Pre-assembly and installation of safety pipes to passive heaters and 50 kW electrical heater: ongoing, complete at begin of May 2008

• Installation of the **control instrumentation, electrical cabinets, cabling**: *completion in 2nd half of May 2008*
  – Materials: ok

• **Tests and commissioning**: *end of May 2008*
STIRLING circuit mounting

March 2008

Phase separator

Pumps and lines

LAr cryocooler
STIRLING plant completion

• Past delays due to mistakes and/or delays in the material delivery from subcontractors
  – Now all the materials have been delivered in Hall B
• **N2 Phase Separator/Testing vessel** installation (interface with Air Liquide): *just completed*
• **Piping** installation: *ongoing, end in April 2008*
  – Few interferences with Air Liquide plant have just been solved
• Installation of the **control instrumentation, electrical cabinets, cabling**:
  *ongoing, 3rd week of May 2008*
• Overall plant **commissioning**:
  • Filling of the storage tanks with LAr and LN2
    ➢ Unloading station
  • Test the overall cold power capacity (30 kW)
    ➢ Need of the new electrical power supply
  • Dedicated ventilation systems to collect the exhaust during tank cooling
  • Overall plant control and supervision commissioning
    ➢ **Not before June 2008 (see the next slides)**
LNGS Specific Technical Infrastructure (I)

• **Mains:**
  – Total power: 800-850 kW fully contemporary operational (400V/230V)
    – 600 kW for STIRLING plant
    – 100 kW for AIR LIQUIDE plant
    – 150 kW for ICARUS detector
  • *End of works:* May 10, 2008

• **Specific Ventilation in the ICARUS area:**
  – Emergency aspiration of areas where cold gas could be present
  – Continuous extraction of the output of electrical and passive heaters
    (necessary for the T600 start-up and emergency situation)
  • *End of works:* May 20, 2008

• **Safety & Control Supervision systems:**
  – Oxygen and Temperature sensors
  – Fire detection (T600 rack area and control room)
  – TVCC system and variable message panels
  – Slow Control for ICARUS and integration with lab supervision system
  – Normal and emergency lights
  • *End of works:* June 17, 2008

➢ *Fast administrative procedures*
LNGS Specific Technical Infrastructure (II)

- **ICARUS Control room**
  - With UPS and ethernet
    - *End of works:* Completed

- **Separation wall**
  - Wall to separate the ICARUS area from the rest of Hall B
    - *End of works:* April, 2008

- **Completion of the Service Structure**
  - Stairs and platforms
  - Crane for the re-liquefaction area
    - *End of works:* April, 2008

- **T600 top cooling system**
  - Heat produced by the racks (≈ 80 kW)
  - Aspiration and cooling of the warmed air by means of the Hall fan-coils
    - *End of works:* Design under discussion

- **Special power supply for the 50 kW electrical heater**
  - Diesel generator to guarantee uninterrupted power supply (black-out)
    - *End of works:* May, 2008
Commissioner Projects: completion by LNGS

- **“Double” Ventilation System**
  - Completion, commissioning and operation of the new LNGS ventilation system
  - **First step mandatory for ICARUS:**
    Air flow from Teramo side and extraction from L’Aquila side (necessary for the T600 start-up and emergency situation).
    Mechanical and control system to be upgraded:
    - Project and cost estimation: January 2008
    - Order by Commissioner: February 2008 (no tender!)
    - *End of works:* End of May 2008

- **Cooling System**
  - Primary cooling water flow rate has been increased and operation temperatures adjusted following regulations.
  - Improvement of the water quality to be done.
    - *End of works:* May 2008
Next steps towards the start-up

1. Agreement of the start-up procedures with LNGS, authorities and companies and logistic finalization (ongoing)
   - Safety (activation procedures, transports,…)
   - Logistics of the cryogenic liquids for the LN2 cooling and LAr filling phase (ADR transports, tunnel, impact on lab/hall transports and/or activities,…)
   - Cryogenic liquid delivery: tender adjudication (May 2008) + contract
     - LAr delivery
       1. 300000 l delivered by Air Liquide: 220000 l (recovered by T600 run in Pavia in 2001) + 80000 l to complete one T300 module
       2. 300000 l object of a new tender
          - Agreement between the 2 companies for the procedures, timetable, …
     - LN2 delivery
       195000 l object of the same tender
   - Delivery of the liquid unloading station, ICARUS responsibility (May 2008)
     - Executive project to be presented and discussed

2. LNGS Infrastructure commissioning
   - New power supply, Cooling system, Ventilation

3. Commissioning of the STIRLING plant
   - Cooling and filling of the storage tanks

4. T600 start-up
T600 Start-up

- Depending on the truck capacity (probably different for Ar e N2) and logistics
  - LAr &LN2 storages cooling/filling in advance (also for STIRLING commissioning)
    - \( \approx 2-3 \) LAr trucks + \( \approx 2-3 \) LN2 trucks
  - T600 cryostat activation:
    - Hypothesis:
      - Continuous procedures
      - Simultaneous fill of the 2 T300 modules (different solutions under evaluation)
      - Use of N2 from trucks only (no closed loop with STIRLING system active)
    1. Vacuum phase: \( \approx 10 \) days
    2. Vacuum stop and cryostat fill with GAr: LAr from the storage
    3. N2 “pre-cooling”: \( \approx 3 \) days LN2 from the storage
    4. N2 cooling: \( \approx 6-10 \) days \( \approx 1-2 \) LN2 truck/ day
    5. LAr filling (at 2000 l/h rate): \( \approx 10 \) days \( \approx 3-4 \) LAr trucks/ day + \( \approx 1 \) LN2 truck/ 3 days
    6. LAr fast purification
  - T600 normal operation: closed loop with STIRLING N2 re-condensation system
    - No other truck delivery is needed (only in case of emergency)
Conclusions

- Fast progresses in the T600 installation have been done in the last months.
- The T600 overall plant with all the required infrastructures (fully commissioned) is nearing its completion.
- In the next few months, in order to complete the overall plant on time, all the activities of the ICARUS Collaboration, AIR LIQUIDE, STIRLING and other companies installing the LNGS infrastructures will converge in the same time scale.
  - Logistics and safety problems cold affect the sequence/organization/time of the activities
  - Delays could cause serious domino effects
- For the T600 commissioning phase it is important to precisely define procedures, organize and control the sequence of the operations.
- The time-schedule of the T600 start-up will depend on the next progresses, different activities time matching, contracts, logistics and authorizations.
- The possibility to start-up one T300 per time is also under evaluation.