ELETTRA S3HC installation and warm operation

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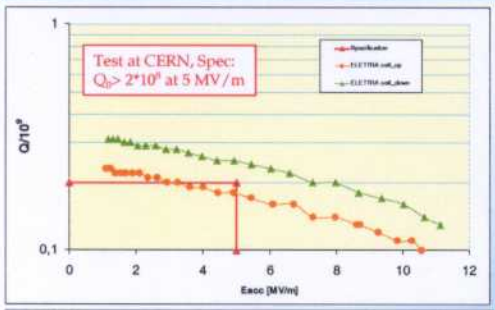
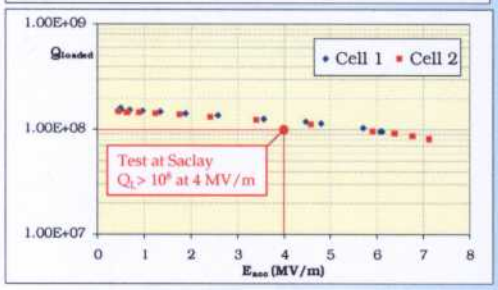
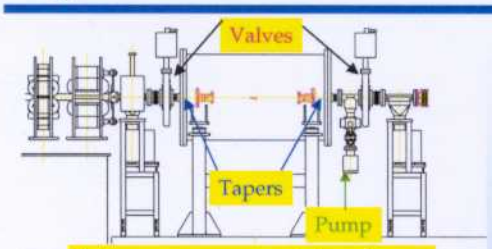
- The cavity and the components of the cryogenic plant were delivered on schedule.
- The installation was in August as scheduled, but we had two major problems, which prevented us to cool-down the cavity before the next machine operation period.
- Warm operation at the lower operation energy (2.0 GeV) is a problem.
- The second attempt to cool-down the cavity end of October failed as well, due to two more problems.
- This is affecting our operation schedule, Elettra is now running at 2.4 GeV until Christmas.

Cavity Performances



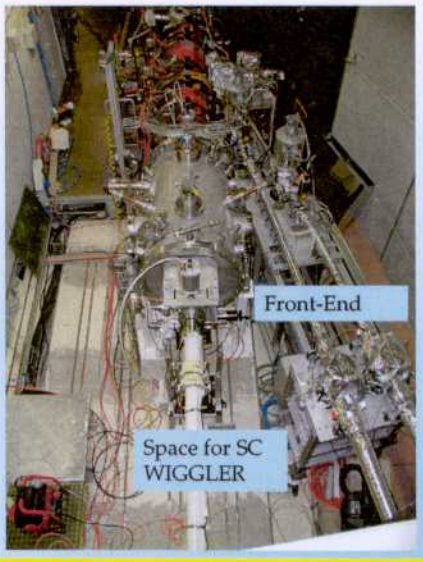


Cryomodule Installation



All vacuum components have been installed in the clean room at CERN

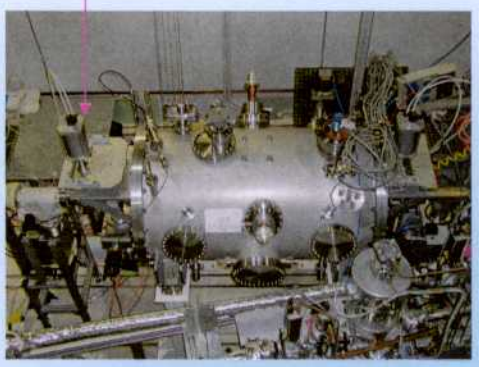
Vacuum tests on the cryomodule at ELETTRA, just before installation



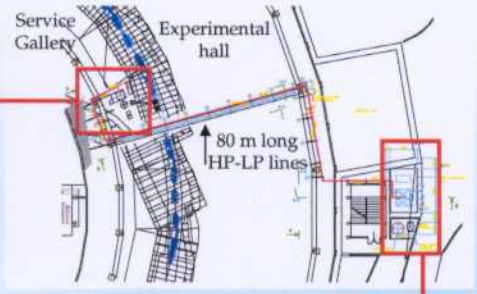
29.08.02 The cryomodule on the Storage Ring

Vacuum issues

After installation the pressure in the cavity at room temperature was about 10^{-8} mbar. With beam the pressure increased mainly due to the conditioning of the synchrotron radiation mask upstream. After some weeks of operation the pressure without beam is in the low 10^{-9} mbar range. **At 140 mA beam current intensity, at an energy of 2.4 GeV the pressure now attains 10^{-8} mbar.** During the installation of the **SC Wiggler**, in October, the **gate valve downstream** the cryomodule has been discovered to be no more perfectly tight. It seems that it has been damaged by the beam.

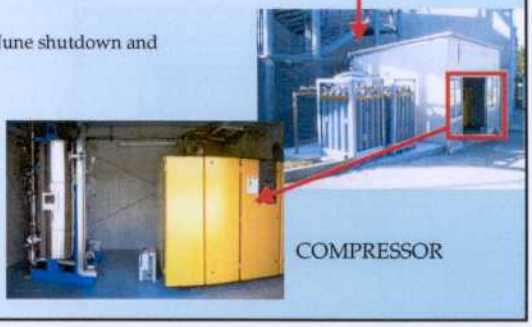


The cryogenic plant



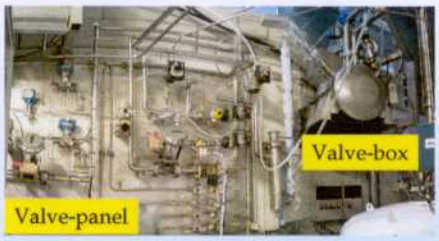
The cryogenic plant installation begun during the June shutdown and was completed in August.

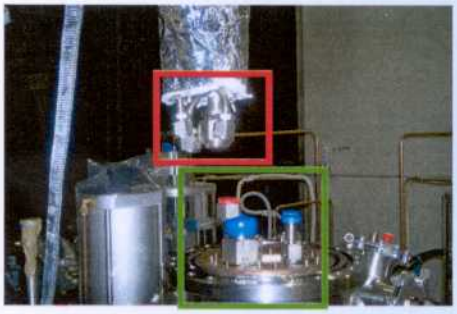
It includes:
- Helium gas buffer, 5 m³ at 16 bar
- Helium gas compressor, 16 bar
- Oil removal system
- HELIAL 1000 cold-box
- 500 l liquid He dewar



Helium distribution to/from the cryomodule

The cryomodule has one liquid Helium input and three Helium gas outputs. The corresponding lines are collected in a Multichannel Line. The interface between this line and the rest of the cryogenic plant is given by the valve -box and the valve panel.

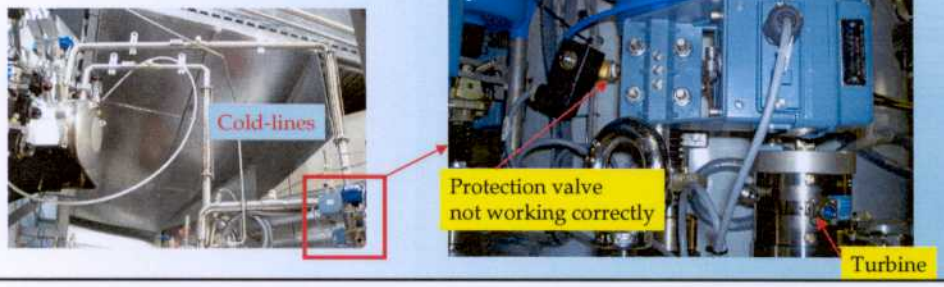




Due to a construction error, the lines in the multichannel line didn't fit to those on the cryomodule. This was discovered after installation, on the 30/08/02.
The modification caused a delay of two weeks in the cool down schedule.

First Cold-box Cool-down

- Elettra five weeks Summer shut-down ended on the 13th of September. 10 days of accelerator physics were scheduled afterwards. Due to the problem with the multichannel line, the run started with the warm cavity. First tests showed stability problems at 2.0 GeV, thus we decided to try to cool down the cryomodule in the machine physics period.
- On the 19th of September, during the first attempt to cool-down the cold-box, one of its expansion turbines crashed, due to a protection valve which didn't work correctly and allowed high speed helium gas to enter the turbine.
- This cancelled any possibility of cooling down the cryomodule, thus we had to face user's operation with the warm cavity.



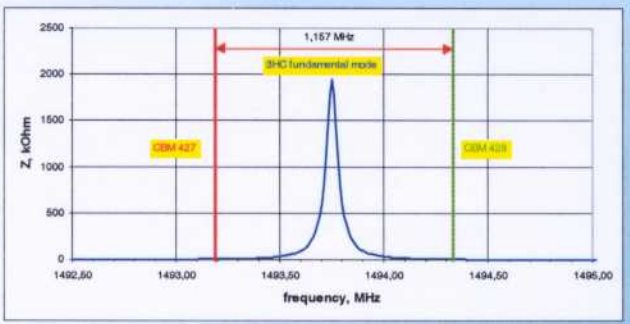
The Warm Parking Mode

In the warm parking mode the fundamental cavity mode is parked between two revolution frequencies.

The cavity is expected to be invisible to the beam in this operation mode, which is needed to operate the storage ring when the cryogenic plant is not available.

In the warm parking mode the cavity is cooled with air or with Helium gas in closed circuit, if the compressor station is working.

The picture shows the fundamental mode impedance of the warm cavity, when it is parked at 1493.75 MHz.



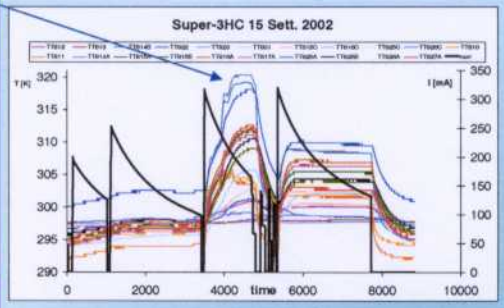
Warm Operation at ELETTRA

- In ELETTRA the warm cavity is not invisible to the beam at 2.0 GeV, 300 mA. CBM 427 is excited by the interaction with the fundamental cavity mode.
- At 2.4 GeV, 140 mA the beam is stable; user's operation in the first part of the run was as usual. 2.0 GeV operation was scheduled afterwards. After a period at 2.1 GeV, where the stability is better than at 2.0 GeV, eventually we went back to 2.4 GeV for the rest of the run.

When the fundamental mode excites the beam, the temperature of the cells increase is not negligible. For the example shown here 25 K increase on the tube (TT814) correspond to about 50 K increase on the cell. The corresponding frequency shift is of the order of the revolution frequency (1.157 MHz).

ELETTRA is unstable at low energies (instabilities are present for $I_{beam} < 1.0$ mA at 0.9 GeV). When the beam is at low energy during injection and ramping, the cavity, even if parked between two revolution frequencies, shifts to the lower one, due to the warming up.

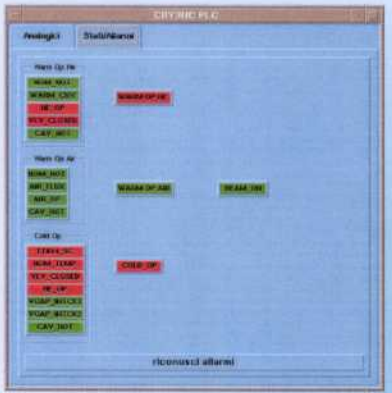
At 2.0 GeV the stability margin is not sufficient to deal with this shift, while at 2.4 GeV pre-tuning the 3HC cavity 100-200 kHz towards the higher harmonic allows to stabilise the process.



The Control and Interlock System

- **Two PLCs** control the whole system. One is installed in the Cold-box, the other is installed in the **3HC control rack**. Several information and interlock signals are exchanged between the two PLCs.
- These PLC create and exchange all the interlocks (vacuum, RF voltage too high, temperature alarm etc., for protecting the cryomodule).

The status of the different alarms is shown on a panel in the control room to allow fast troubleshooting. Three possible operation modes are identified: Warm Operation, Air Warm Operation, Helium Cold Operation.



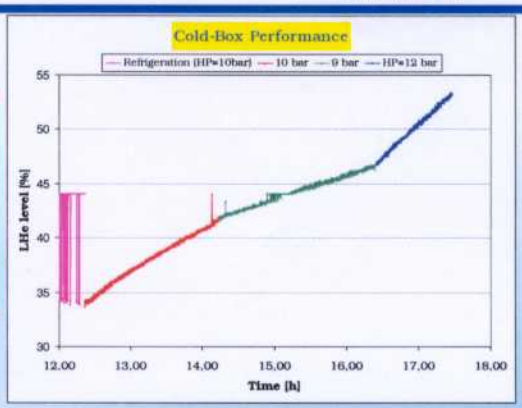
Trying to cool it down

- Beginning of October a new turbine was available and the cold-box was successfully cooled down. The measured performances of the cold-box 43 litre/hour at 13 bar at the high pressure side, were well beyond specification. Cool down of the cavity was then scheduled for the next machine shutdown, end of October.
- But the cool down of the cavity failed again, due to a failure of the electrical power supply to the cold-box, which caused a contamination of the first heat exchanger of the cold-box. We further had also unexpected problems with some valves on the helium gas lines to and from the cryomodule.

What's next?

Mid of November the cold-box has been set to work again.
Measured performances:
- REFRIGERATION 135 W at 10 bar
- LIQUEFACTION 36.5 litre/hour at 12 bar

(We need 45 W and 5.2 litre/hour)



- On the 2nd December we will test all the He gas lines to/from the cryomodule.
- The cool-down of the cavity is scheduled to start on the 7th of January 2003.