Lt setup in Torino using Vienna Box

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- Module plates
- Test with 2 modules
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General considerations

The Lt setup is needed for a module test priori to the mounting on the mechanical structures.

The Lt set-up has to make thermal cycles from 25C to –25C of up to 10 modules, for 2-3 days in an automatic way. It has:

- to be stable and safe also during nights ➔ needs to have software SC and hardware interlocks to prevents damages from accidents
- to be robust in order to work for a long period (up to 2 years for 24 hours/day);
- to be installable in all labs
- to be as cheap as possible

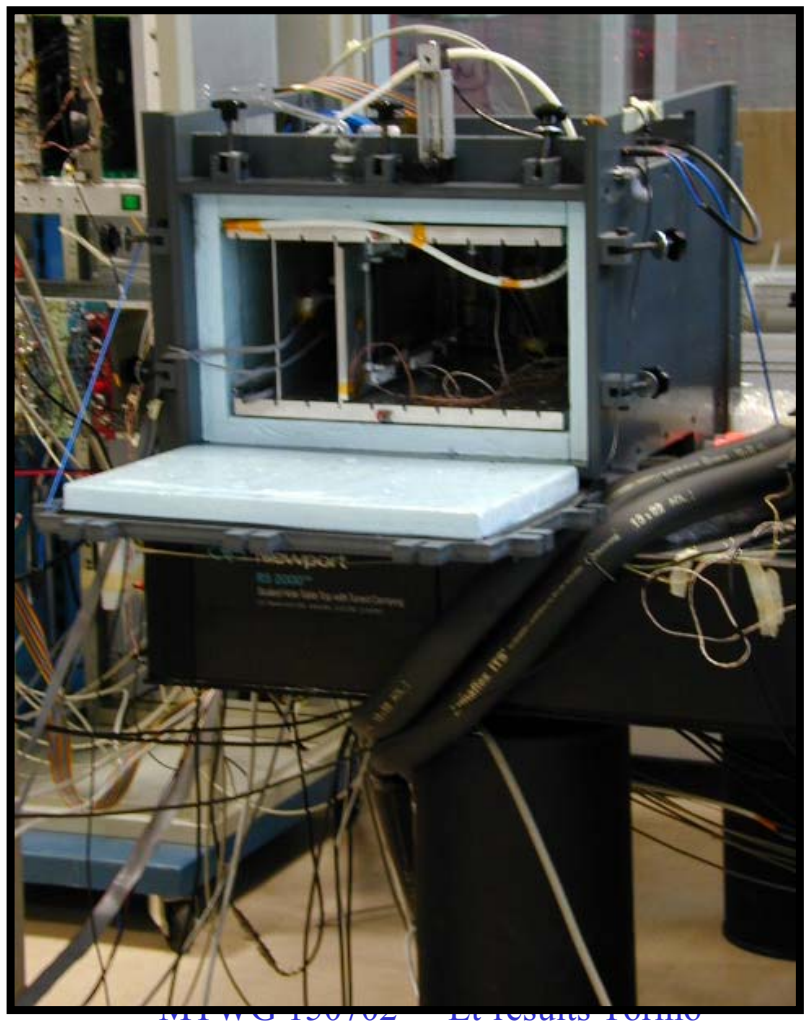
This is far more than dealing with cooling down 1 module for only few hours while physicists are around looking after the tests…

Wien has built the cold box and SC readout. In **Torino** we have worked as pilot lab to build up the full setup, and to put under stress the set-up looking to potential problems…

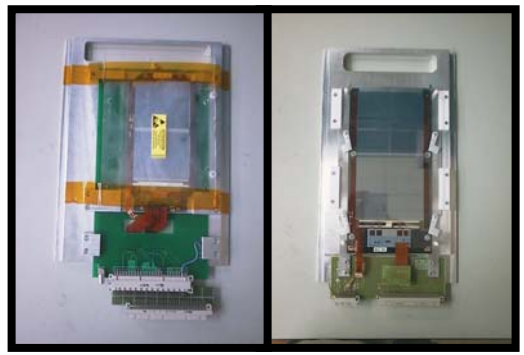
Lt setup overview

Dry air

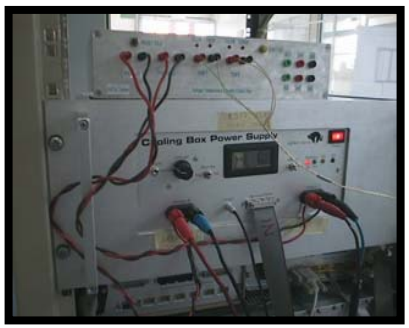
Wien Box



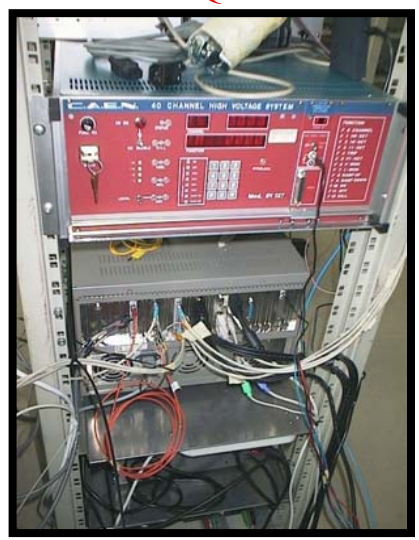
Module and plates



Wien Peltier PS &
Torino Interlock box



DAQ and HV



Chiller

Humidity

Inside box the relative humidity has to be well below 100% at low temperature. Dry atmosphere has to be injected with dew point below –25C. Two choices:

- nitrogen (safety problems, many bottles)
- dry air

Essicator

Dry air was chosen: big quantity and safe

Essicator: filters at high pressure (8-10 bar)
Dew point @ -40C with regenerator

This means ~0.5% RH@25C

Cooling

Box cooling is done via 2 Peltier elements, max: 25V, I=13A allows to reach a ΔT=50C between warm and cold surfaces. Warm surface has to be kept cool. We implemented a water recirculation system using a small chiller of 1.5kW cooling power, 15l tank.

This is ideal in a lab:

1) avoid water consumption (7000 l/day),

2) gives stable temperature among seasons,

3) minimizes risks in case of leaks;

4) allows to use antifreeze liquid therefore avoid damages of the Peltier elements in case they stops when the box is well below 0C

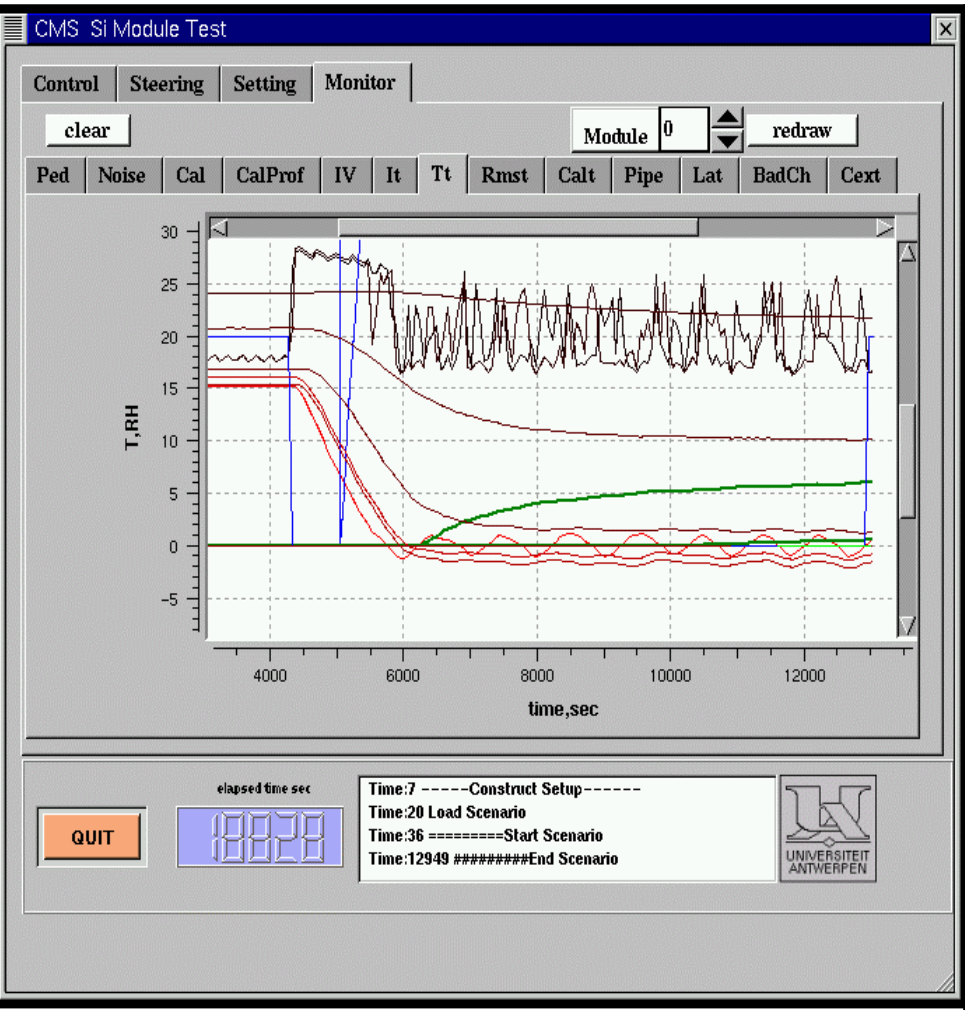
Chiller

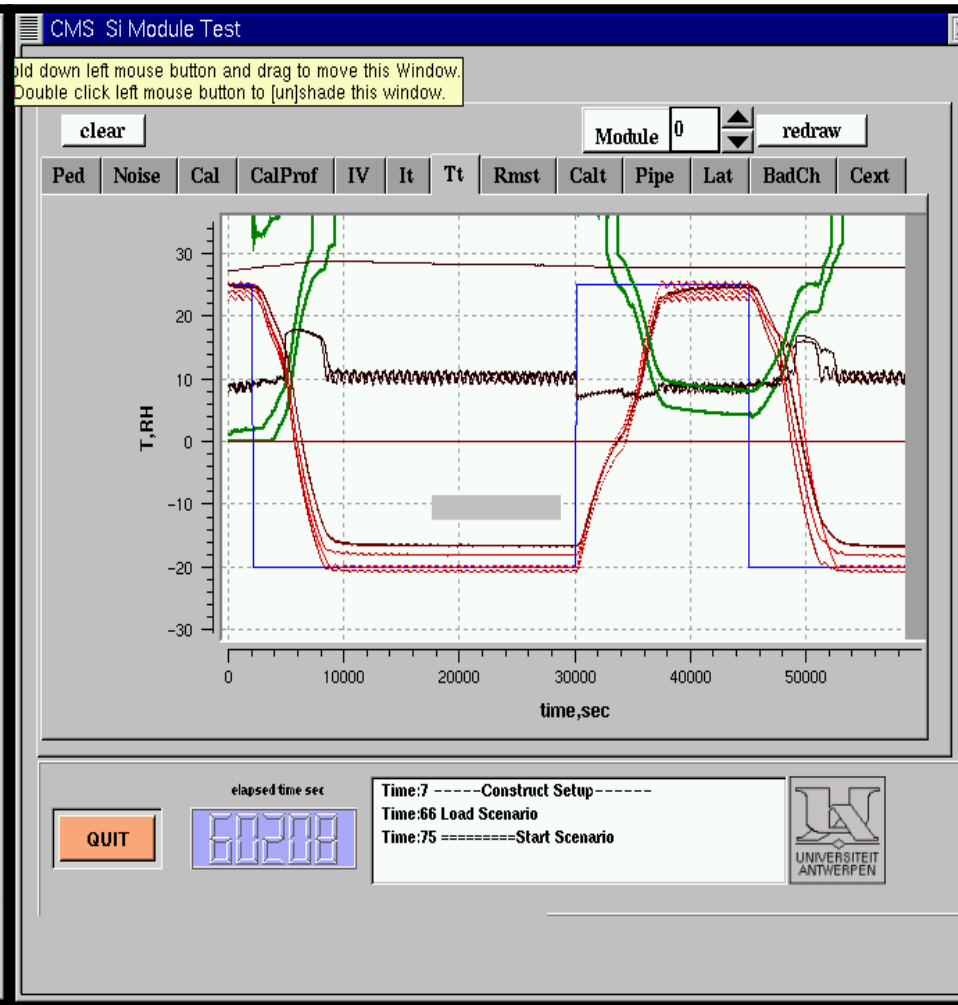
We set the water temperature to 8C in order to use the Peltier at a better efficiency and to avoid to have the PS always at maximum power when at low temperature

SOFTWARE: we optimized the software managing the Peltier control in order to have a better temperature stability and to provide also a little warm up to be able to have the box at 25C.

OLD Lt Softw.& 18C water

Modified Lt Softw.& 8C water





Safety aspects on cooling and humidity

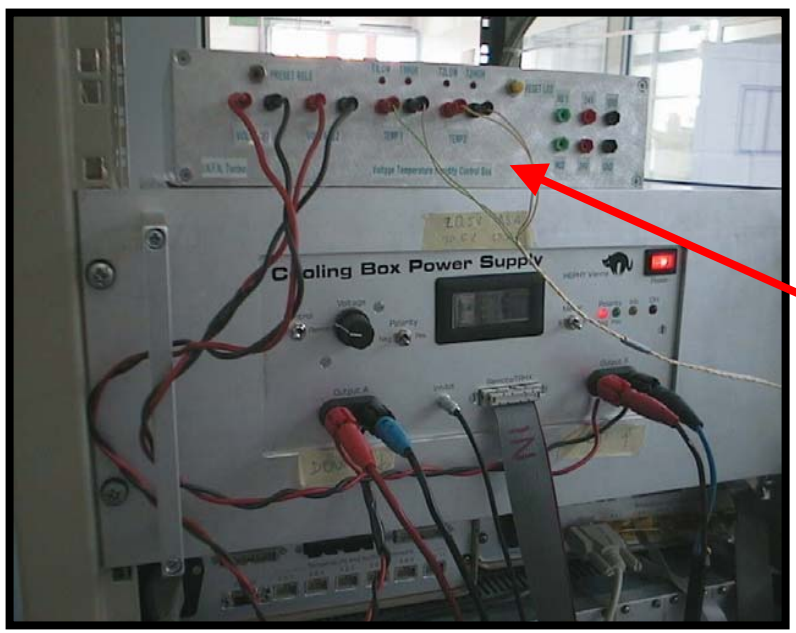
Peltiers : the power supply transistors can break. This means the PS channel goes to maximum power. This is dangerous and can happen both when the peltier is in cooling or in warming state. The PS is no more controllable and can only be switched off and repaired.

Humidity: if dry air is used the quality of the essicator has to be controlled. If filters become dirty, the regenerator circuit fails or other problems occour, the dew point of the air can increase and go beyond the working cold temperature of the module. This has to be understood immediatelly, it is useless to monitor the RH inside the box ➔ ice is formed on the cold surfaces and during the warming cycle the RH can go above 80% !!!
Monitor of RH at the input of the box is mandatory

Torino
Interlock Box

To prevent the damage of the modules during Lt test, because of failure of the cooling system or of the RH, we developed an interlock Box that checks CONTINUOUSLY:

- temperature of the upper and lower surfaces of cold box (-30C < T < 35C, tunable)
- voltage outputs of Peltier PS (<25V, tunable)
- humidity of dry air (RH<1% @25C, tunable from 0.5 to 2%)



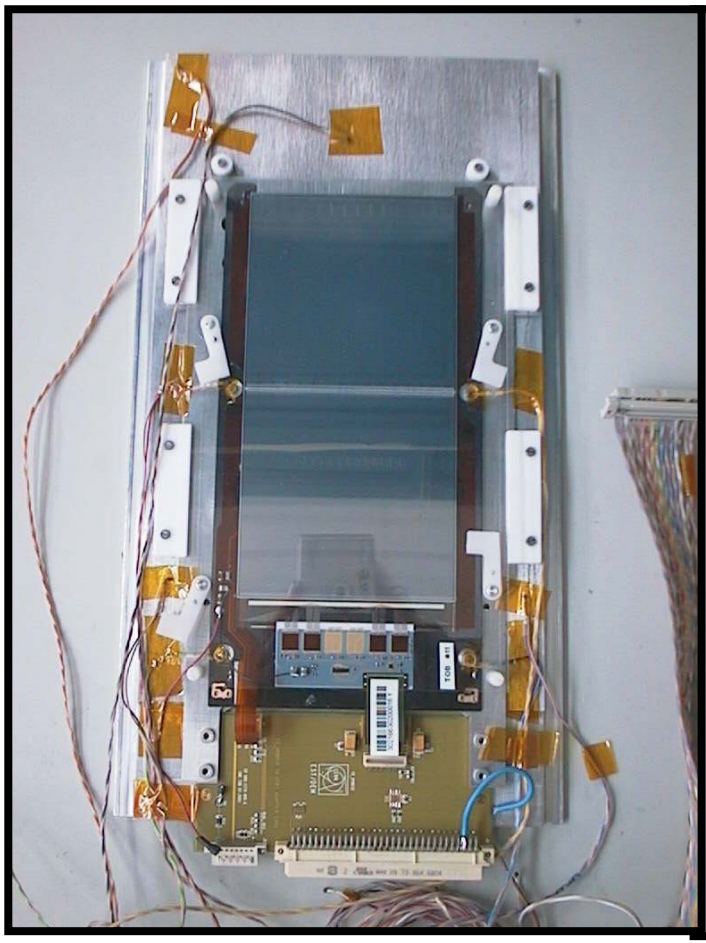
Interlock box

If any threshold is passed the peltier PS is switched off, causing the temperature of the box to go to about 10C.

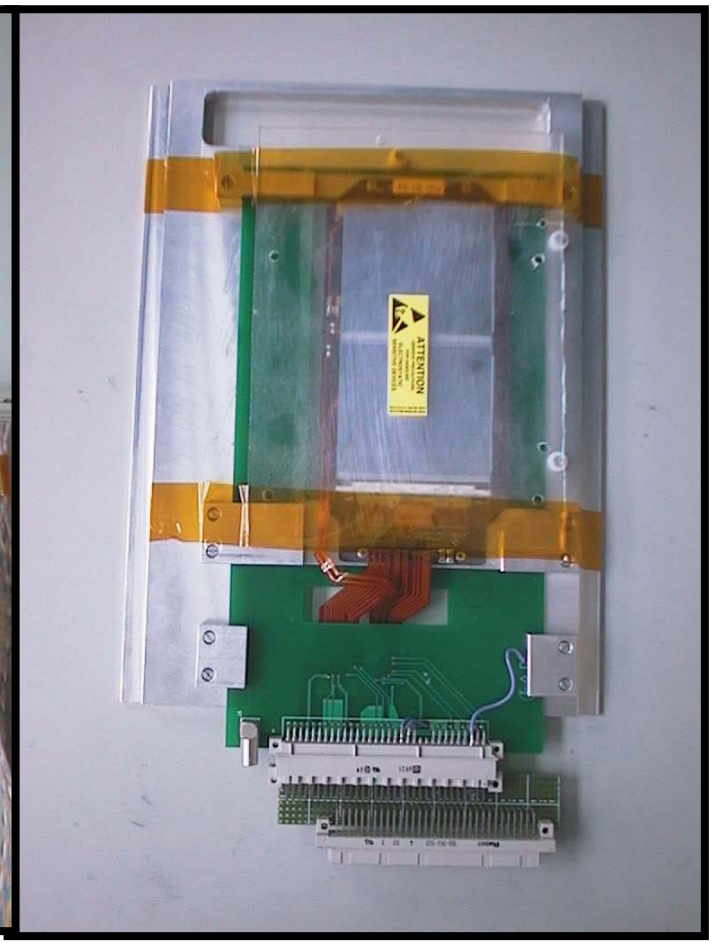
RH probe

Module Plates

TOB



TIB



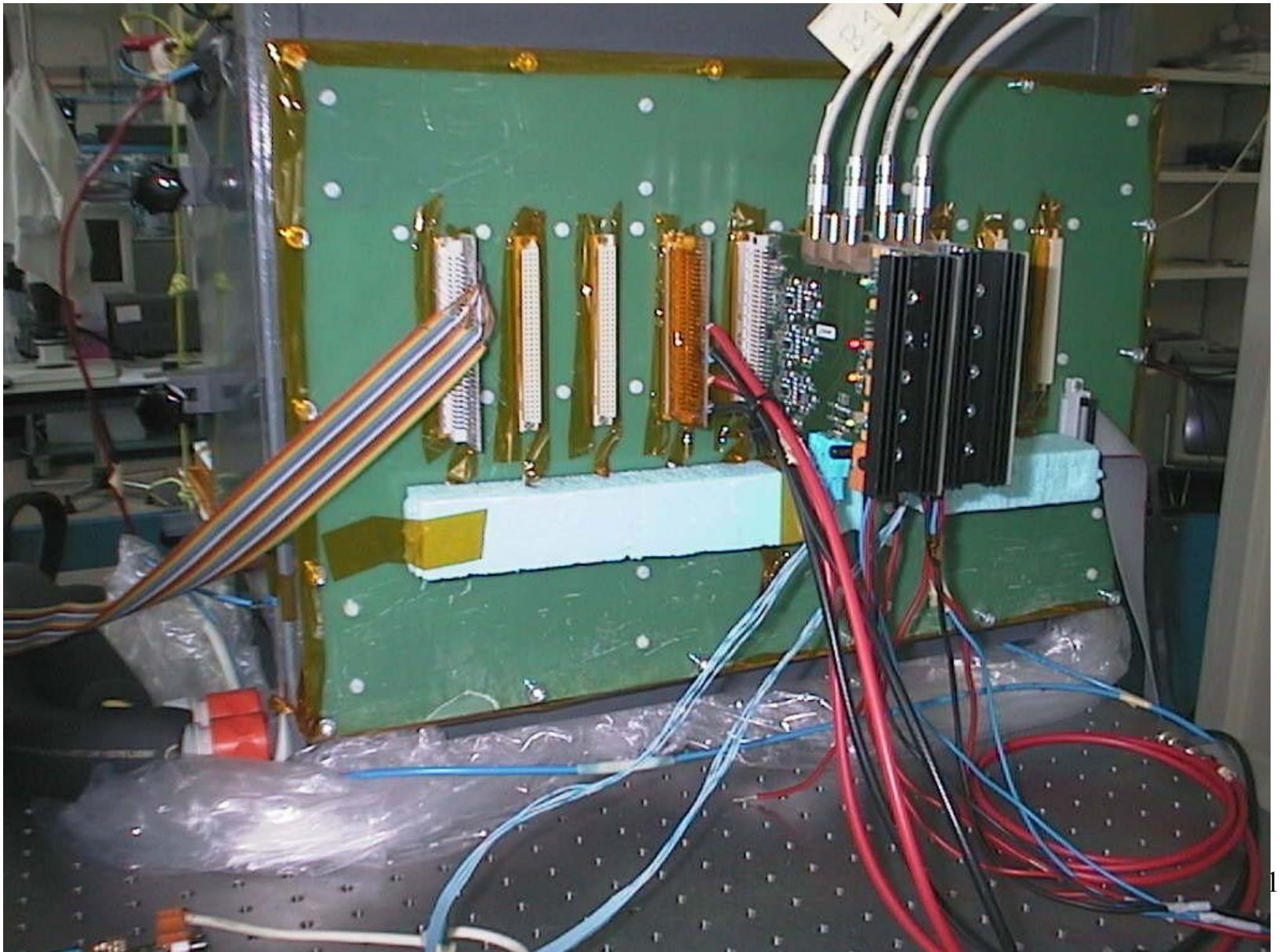
The module plates should provide good thermal contact of module with the cold box

Plates design and realization at Torino INFN

Fully tested on TOB module

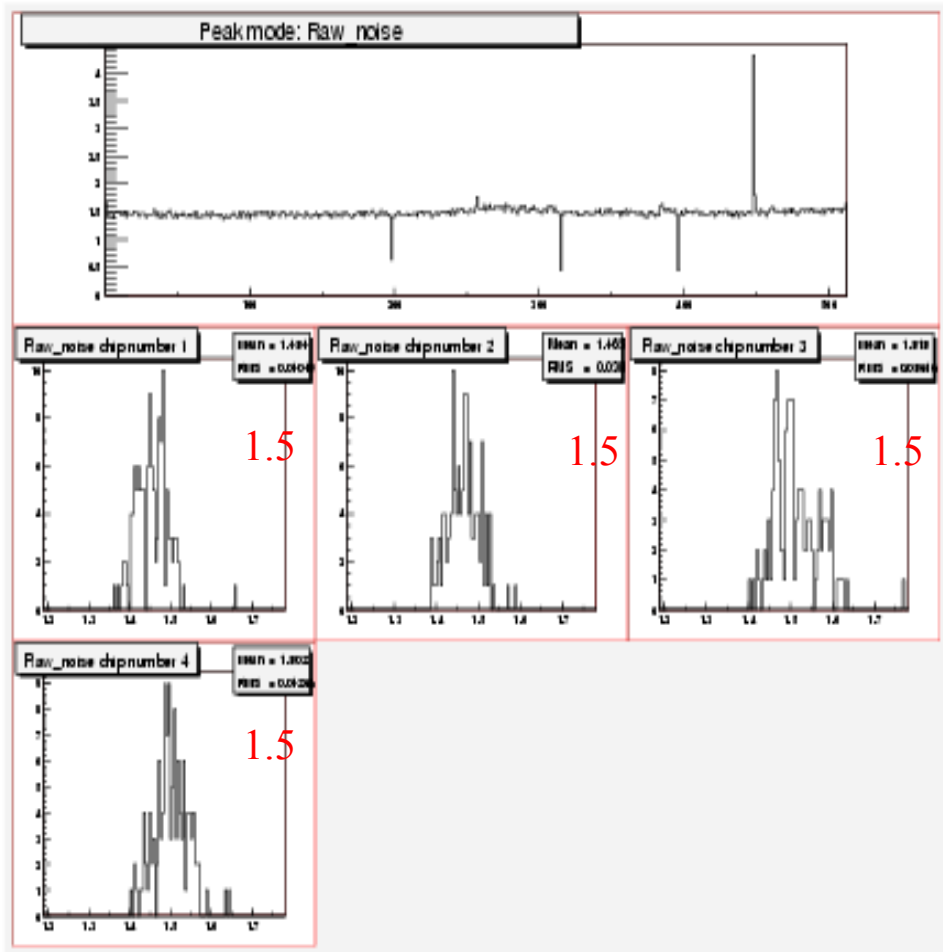
Test with 2 Modules

Box back conn.

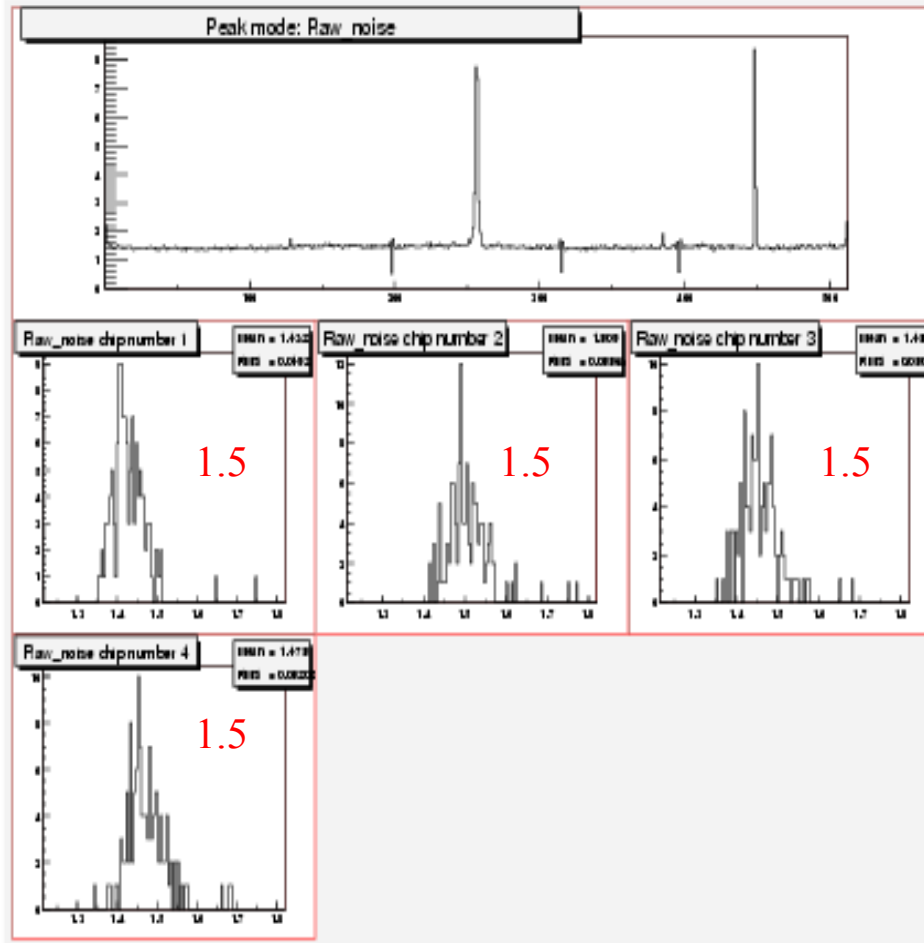


Noise figures
TOB#11 – peak mode

Cold box



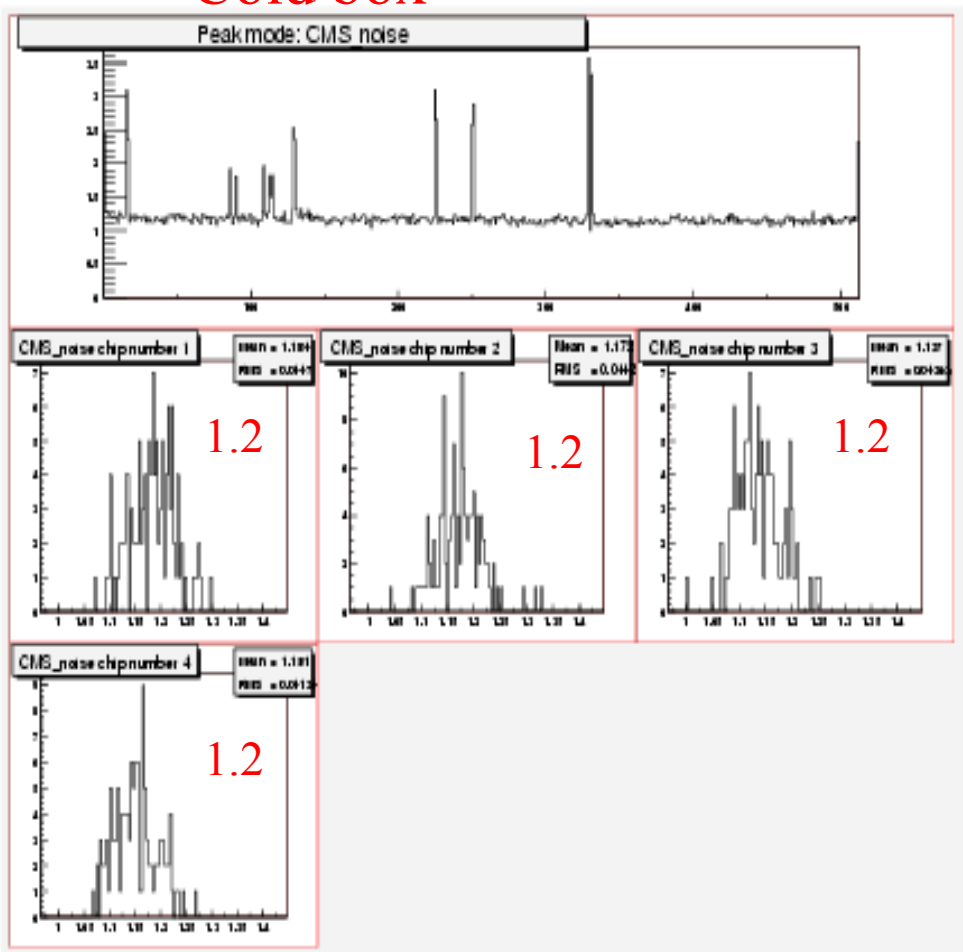
Not in Cold box



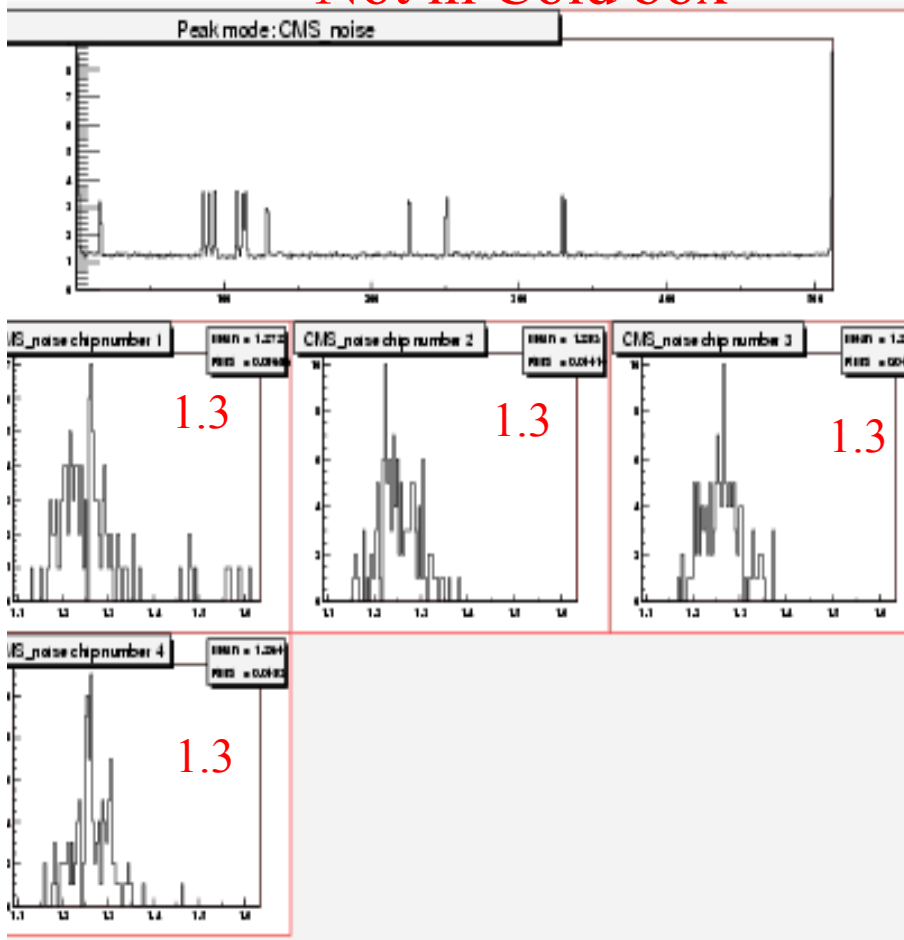
Noise Figures

TIB#12 – peak mode

Cold box



Not in Cold box



Set-up performances and desiderata

-Box Tightness: we experience a leak of ~100 l/h ➔ fixed in new boxes

- Cooling : ok for 10 modules if chiller is used. About 2h to make 45C step (cooling or warming).

-Peltier PS: the switch among warming and cooling is delicate.It increases the failure rate of the PS transistor. Some more study on PS is urgent (Wien).

- Mechanics: support for the 10 VUTRIs and 30 cables needed ?

Conclusions

- Lt test can be performed using Wien system (cold box +Trhx+PeltierPS) with the addition of a chiller, the Torino interlock box, or an equivalent system, and an appropriate dry atmosphere line with dew point well below –25C

- In Torino we will now concentrate on doing Lt tests for several days on TOB and TIB modules and we would like to fully equip the set-up to be able to understand the full potentiality of the setup (multiplexer, VUTRIs, CCU, modules…)

- Equipment of other Lt testing centers is advisable to have further feedbacks (Antwerpen,…)