### Purpose
Module tests for CMS Tracker and other accelerated ageing tests

### Features
- Holds up to 10 modules
- Temperature range -30…+70°C (cooling or heating operation)
- TRHX monitoring and control
- Water cooled Peltier elements
- Linear power supply
- Remote control and monitoring
- Nitrogen flushing to reduce humidity

### Web
[http://cern.ch/friedl](http://cern.ch/friedl) → Cooling Box
Photos

Full system:
Cooling Box (right)
TRHX (center)
Power Supply (left)
PC control (back)
Cooling Box internals

Two temperature sensors can be placed by the user (attached to inserts here)
Backplane for VUTRI and auxiliary modules
Extra connector (bottom right) is for internal temperature and humidity sensors
Performance - no load

Cooling box performance - no load

Cooling and heating cycle, full power

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cooling water</td>
</tr>
<tr>
<td></td>
<td>Volume air</td>
</tr>
<tr>
<td></td>
<td>Modules</td>
</tr>
<tr>
<td></td>
<td>Plates</td>
</tr>
</tbody>
</table>

Full power, no load

Room → -30°C: ≈ 1.5hrs

-30°C → +70°C: ≈ 40min

Water flow ≈ 5l/min

Legend:

Plates: cold side of Peltier elements

Modules: Inserted module transportation plates
Cooling - no load

Full power, no load

First-order system

Time constant: 44.5 min

\( T_\infty = -33^\circ C \) (depending on water temperature)
Full power, no load

First-order system

Time constant: 42.2 min

\( T_\infty = 124^\circ C \) (depending on water temperature) - extrapolation

We do not recommend operation above +70\(^\circ\)C
Performance - 50W load

Cooling box performance - 50W load
Cooling and heating cycle, full power

Full power, 50W load
10 modules with 6 APVs each dissipate ≈25W at nominal settings

Room → -20°C: ≈1.5hrs
-20°C → +70°C: ≈40min
Cooling - no load

50W load - cooling
Module temperature, full power

- Data

Fit: $T[^{°C}]=-22.6+37.1\exp(-t[^{min}]/45.4)$

Full power, 50W load
First-order system
Time constant: 45.4 min

$T_{\infty}=-23^{°C}$ (depending on water temperature)
**Heating - no load**

50W load - heating
Module temperature, full power

Note: We do not recommend operation above +70°C

Full power, 50W load
First-order system
Time constant: 42.6 min

$T_\infty = 123°C$ (depending on water temperature)
- extrapolation

We do not recommend operation above +70°C

Data

Fit: $T[°C] = 122.9 - 142.1 \times \exp(-t[min]/42.6)$
Module transportation plate

Provided by Paolo Tempesta (Paolo.Tempesta@ba.infn.it)

Tested with connectors: fits perfectly

Cooling test

Two temperature probes attached to transportation plate and to APV25 location
Full power, quick test
(cooling stopped before reaching saturation)

Both transportation plate and APV25 hybrid closely follow plate temperature

Transportation plate responds a bit faster than plates because plate sensors are located on the outside edge (i.e. thermal delay line)
## Technical data

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peltier</td>
<td>2 elements with 350W max. each</td>
</tr>
<tr>
<td>Power supply</td>
<td>Dual channel linear power supply</td>
</tr>
<tr>
<td></td>
<td>Each channel individually adjustable between 0...25V</td>
</tr>
<tr>
<td>TRHX</td>
<td>Temperature and humidity monitoring</td>
</tr>
<tr>
<td></td>
<td>Remote control and monitoring of power supply</td>
</tr>
<tr>
<td>Temp. range</td>
<td>-25°C...+70°C (with 10 modules installed ≈ 25W)</td>
</tr>
<tr>
<td>Time constant</td>
<td>≈44min (first order system)</td>
</tr>
<tr>
<td>Cooling speed</td>
<td>Room temperature → -25°C: ≈1.5hrs</td>
</tr>
<tr>
<td>Heating speed</td>
<td>-20°C → +70°C: ≈40min</td>
</tr>
</tbody>
</table>
## Price list

<table>
<thead>
<tr>
<th>Components</th>
<th>Description</th>
<th>Price (CHF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cooling Box mechanics (including 2 Peltier elements, gas flow meter and bubbler)</td>
<td>3000</td>
</tr>
<tr>
<td></td>
<td>Cooling Box power supply (dual linear 0…25V 15A)</td>
<td>1800</td>
</tr>
<tr>
<td></td>
<td>TRHX_base + 3 combined sensors + 3 dual temperature sensors</td>
<td>1440</td>
</tr>
<tr>
<td></td>
<td>Shipping</td>
<td>100</td>
</tr>
</tbody>
</table>

**Payment**

TID is preferred method

**Contact**

Manfred Pernicka <pernicka@hephy.oeaw.ac.at> (Cooling box)
Markus Friedl <markus.friedl@cern.ch> (Power supply, TRHX)