CMS Week 050619-23
Barrel Muon DT Session

BMU Cooling Measurement, etc.

Hans Reithler / Aachen

Remarks CMS Week June 2005

- Piping on wheels is partly different from general drawing: each second wheel has inlet and outlet of subcircuit (feeds two BMU stations) swapped.

- As far as the flow limiters are installed in accordance, and the circuit within the BMU stations are symmetric, this swap would not jeopardize the utilization of the circuit.

- To avoid possible problems when opening the cooling circuit for e.g. chamber maintenance, the addition of colored labels to indicate SUPPLY and RETURN were proposed.

Possible additional labels on cooling pipes

- It appears that the cooling circuit within each pair of BMU stations has not been made symmetric, but has been optimized for minimum heat delivery to the chambers. To exploit this feature, the assignment of inlet and outlet should be brought to nominal. To be settled urgently.

Actions

- Check the status of piping and marking on the wheels.
  --> Subcircuits indeed with reversed flow on YB+2, correct on YB+1,...
  --> Aluminum labels corrected. Pairs of identical labels left at few places; should be corrected meanwhile.

- Check how an eventual correction of the piping could be done and the implications on work and cost.
  --> Done. Feasible but costs precious time and money.

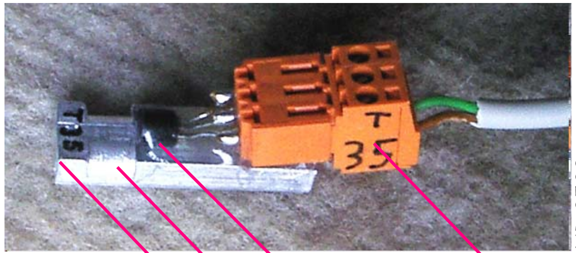
- Additional, colored labels to be implemented.
  --> Done, see example. Labels being mounted.

Example of actual labels being added: at left (blue) for supply, and at right (red) for return. In dark the position of the chamber directly connected; in grey the position of the second chamber of this subcircuit.

- Measure actual temperatures along the cooling subcircuit, to judge whether one can live with reversed flow direction.
  --> See next slides.

Temperature Sensors

Sensor unit to mount on a cooling pipe of 8 mm.
Attach with a cable ty.



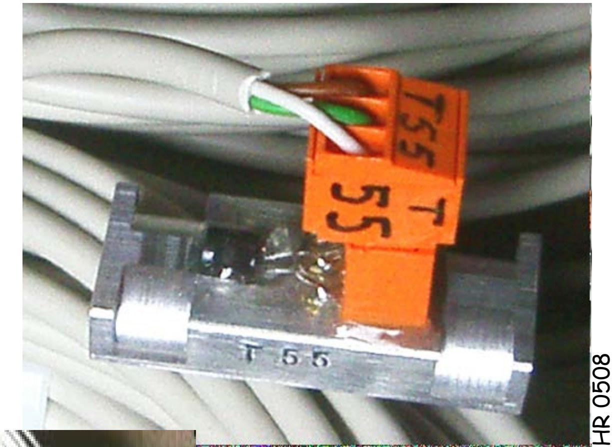
Sensor

Support

Label

Connector and cable (6 m)

Sensor unit to mount on a 13 mm hose



Components:
- Readout box for 25 sensors
- 6 m long cables
- Sensors with connectors, on support
- PC with LabVIEW readout program (not shown)

Serial link to PC

+5 V in

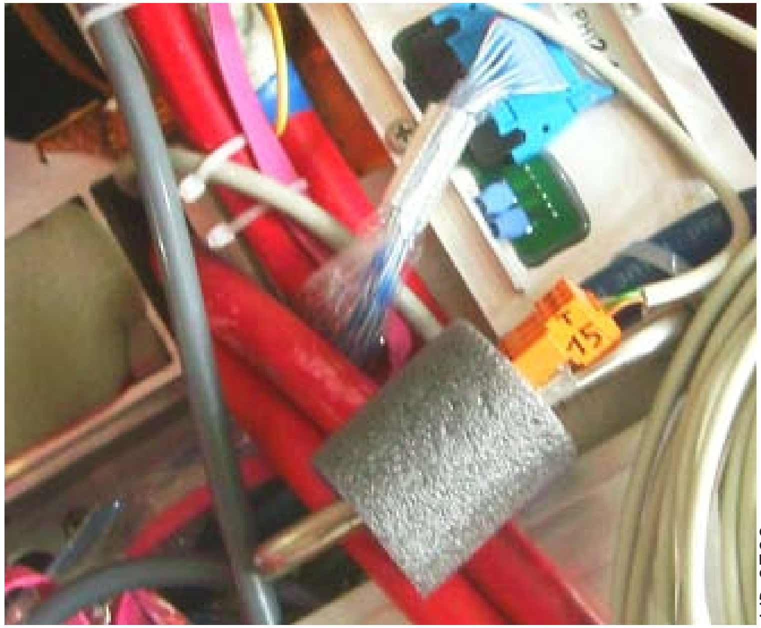
- In order to measure the temperature at several points along the cooling subcircuit, a setup for up to 25 sensors was made.
- Setup based on temperature sensors Dallas DS1820. Nominal steps 0.5 deg.
- Test runs: sensor works with actual steps of ~0.05 deg resolution and reproducibility. Differences sensor-to-sensor ~0.1 deg. Are thus suitable for check of cooling.

Installation In Situ

- Installed about 20 sensors along the cooling subcircuit.
- Available for measurement of subcircuit: Powering 1 (of the 2) DT being commissioned; powering 2 RPCs for few hours.
- Had occasion to make 3 runs.

Sensor at supply line of distributor.

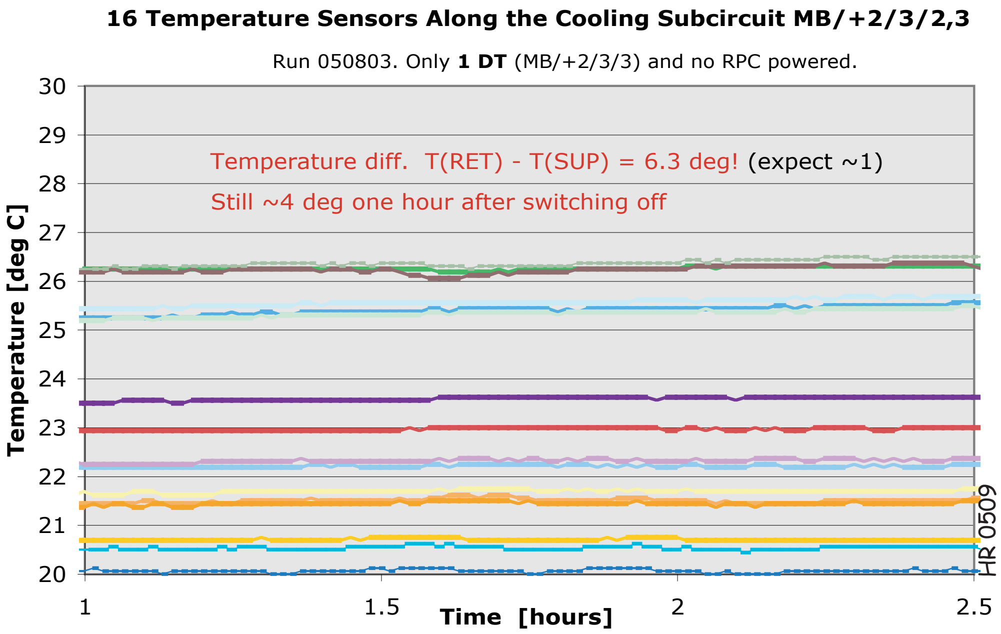
Distributor, with 4 sensors installed



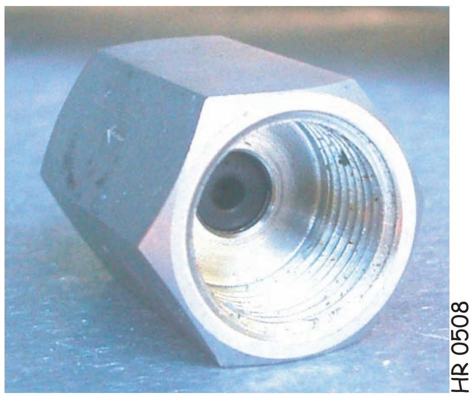
Sensor at DT chamber. Protect with insulating foam

First Surprise...

- Measurement 050803, only 1 MB3 powered (no RPC): cooling water warms up by >6 deg (instead of ~1.5 deg for 2 MB3+RPCs)!! ALARM! --> Check minicrate and cooling.



DT commissioning of MB3_02_03, 050803. Reach > 26 deg on cooling water. Temperature on minicrate PCBs reaches ~42 deg (expect ~34 deg from former data; info from M. Zanetti).



Flow limiter used. Is for 1.5 l/min and was designed to tolerate operation in magnetic field. (By Profi-Mess in Bremerhaven. Info from L. Isaksen)

- Minicrate: internal measurement also shows similar increase (reach 42 instead of ~34 deg) on PCBs, but current remains normal.
  --> Problem originates elsewhere.
- Cooling circuit: find that this subcircuit has only 0.9 l/min (instead of 1.5; in open circuit).
  -->Bingo! ...but on 050805 the flow and the temperatures were closer to normal. Substituted the flow limiter.

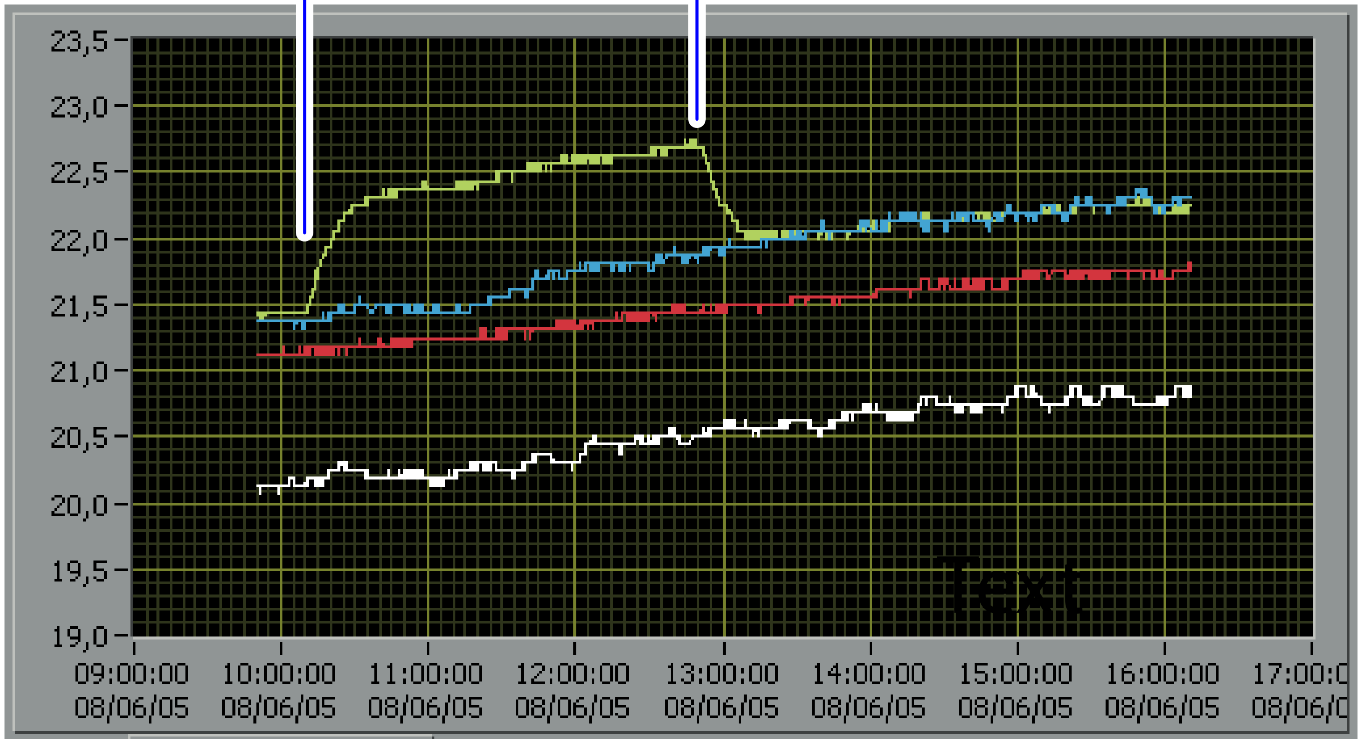
Conclude:

- May encounter water flow problem(s).
- Need tool to measure water flow without opening the circuit. An ultrasonic flowmeter has been ordered by CERN.
- The built-in temperature measurement of the minicrate PCBs can warn about cooling problems. Use empirical reference values for this.
- The external temperature measurement was useful to discover and clarify the problem.

RWTH AACHEN
Phys. Inst. III A

Cooling One Minicrate

● One MB2 powered; no HV, no RPC:



A cooling subcircuit with 2 MB2, but only ONE MB2 powered with LV; no HV. White: hose at supply patch panel; red: hose between both MB2; blue: hose from RPC to minicrate at second MB2 (input to the minicrate powered); yellow: hose from this minicrate to SLphi1 (output from minicrate). Run 050806, powering MB/+2/2/3; no RPC. 23 A on +5 V (compare with 28 A for an MB3)

Observe:

- Temperature of supplied coolant not very constant; ~0.8 deg increase in ~6 h, following ambient temp.
- Powering LV of **ONE MB2 DT** warms coolant by **~0.9 deg.**
- Current on +5 V: 23 A for MB2, 28 A for MB3 --> MB3 warms up coolant more.
- Temperature of coolant is settled within ~0.5 h.
- From "distributor" panel to chamber patch panel SUP see 1 deg temperature increase (ambient temp. 24.3 deg). Environment has thus quite an impact on temperatures.

Cooling One MB3 + 2 RB3

- Measuring cooling pipe temperature along cooling subcircuit of MB/+2/3/2,3. Powered one DT and both RPCs - Thanks to A. Colaleo, M. Maggi, M. Zanetti.
- Waited ~1.2 h for settling ON and OFF.
- Observe temperature increase **RET - SUP** of ~ **2.5 to 3 deg**, but **ON - OFF** of **~1 deg.**

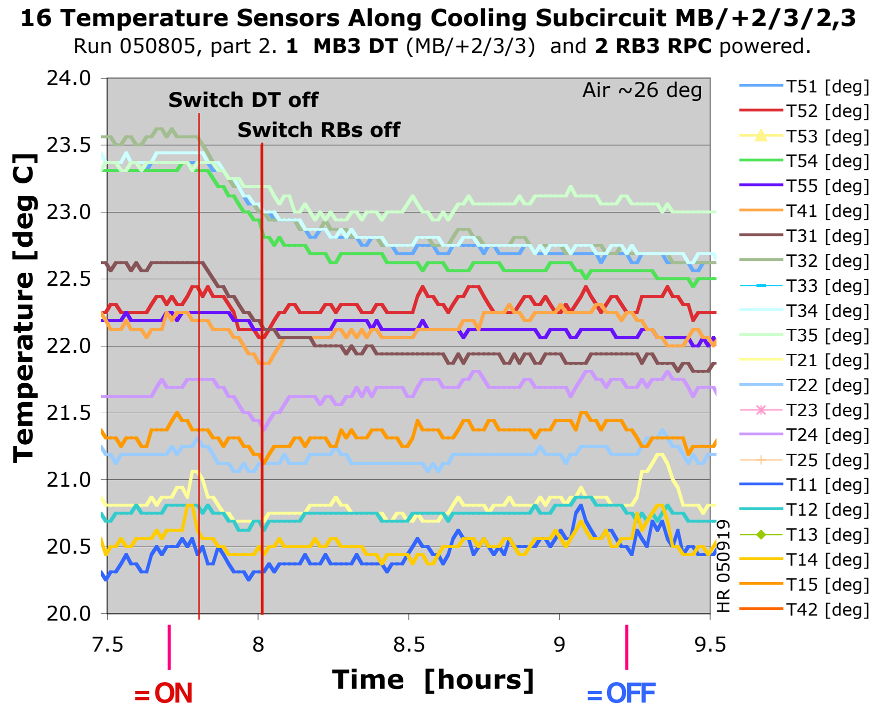


Fig. 1: Temperatures vs. time

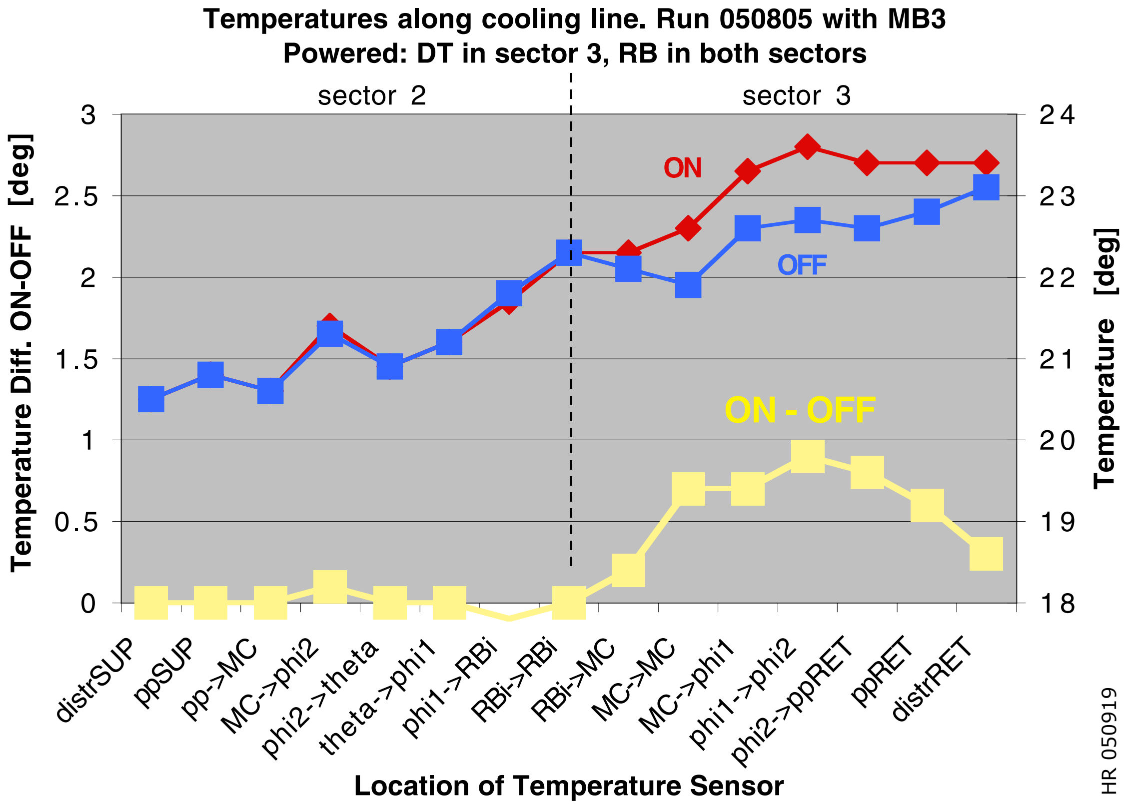
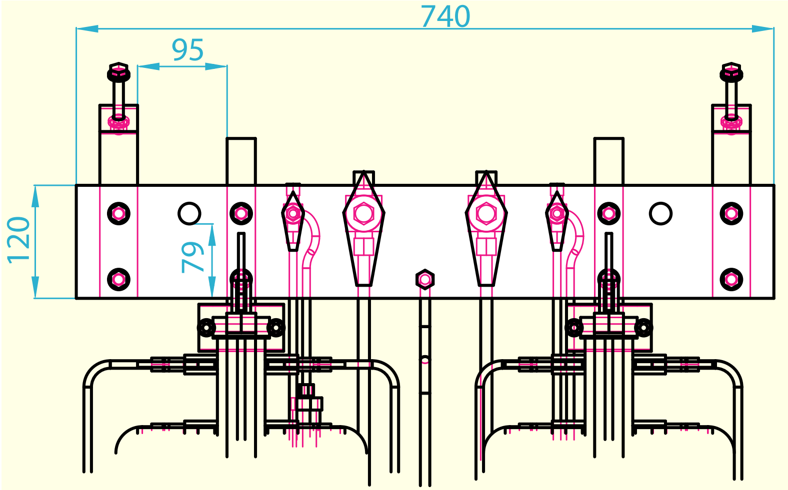


Fig. 2: Temperature vs. sensor, for power ON and OFF.

Conclude:

- 1 DT heats coolant ~ **1 deg**. Fine; about as predicted by ILK.
- RB heats very **little**, fine. Same heating at high data rates?
- Watch additional **~2.5 deg** heating! Environment? Check.

Labeling, Naming ...



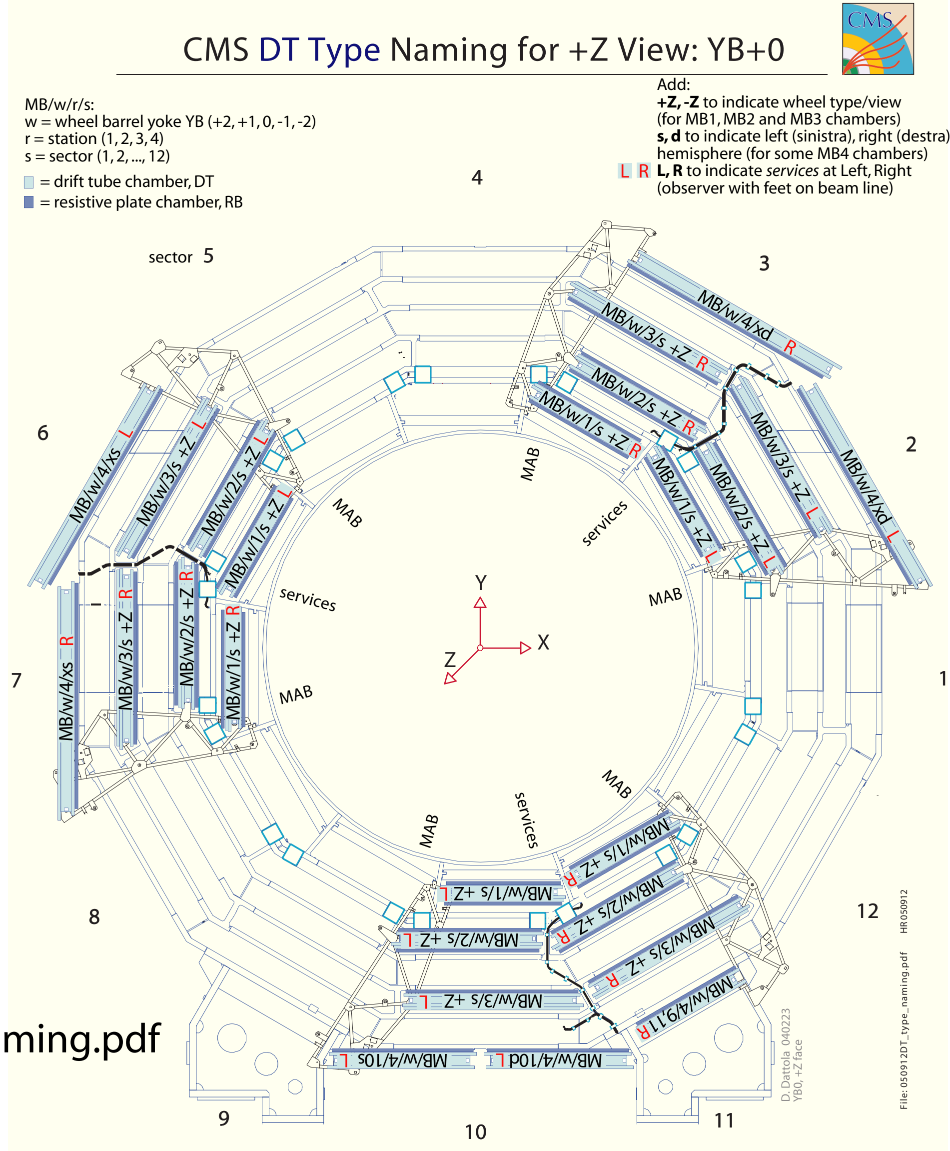
Panel at cooling distributor: several components but no marking available yet on the 30 panels.

- 30 large panels need to be marked; are mainly for HO & YB cooling... Who does it?

- The list of chamber types and their location, as seen when looking at the BMU Fron-End side, is shown graphically on the document at

http://www.physik.rwth-aachen.de/~reithler/050912DT_type_naming.pdf

for all wheels. The schematic sketch on its last page summarizes an overview of services.



Naming of CMS DT chamber type: The convention is to look at the FrontEnd side of the chambers, having the feet on the beam axis and to name the chamber TYPE according to its construction. Services (HV, gas, cooling) add an asymmetry to the chambers, and to reflect whether services are at the left or right side the (reserved) letters L or R are added to the name.
Some chambers are of same type on all wheels: MB/4/4, MB/4/9,11.
The majority of chambers are different for +Z and -Z wheels: MB/w/1/s, MB/w/2/s, MB/w/3/s; quote +Z or -Z.
Some chambers are different for left and right hemisphere (w.r.t. a vertical line!) of the wheel: MB/w/4/s; quote s or d.
Although the twin chambers MB/w/4/4 are of identical *type*, their *positions* should be given appending an s and d, respectively, to distinguish them.

Summary

- At about 60 of the 130 DT+RPC cooling subcircuits the direction of flow is presently reversed. One subcircuit cools 2 adjacent stations.The effort to correct it has been assessed.
- To understand whether a correction is necessary, a measurement of coolant temperature was along the cooling circuit was performed.
- The measured temperatures show, for a subcircuit, a contribution of
  ~ 2 deg from the DTs
  ~ negligible from the RPCs
  ~ 2.5 deg from the "surrounding".
  These face values seem to indicate that the reversed flow can be tolerated.
- BUT note that with the very short operation time available the observed temperature increase might an underestimation.
- Fluctuations in the coolant flow rate may cause huge temperature changes; be prepared to check the flow rates and do maintenance.
- "Simple" labeling of cooling pipes being done; "simple" infos on naming etc. available on web; further labeling to be done.