Installation and further use of a CAN-bus/ LMB based Measurement System at the ATLAS ID cooling laboratory.

By

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The European Laboratory for Particle Physics
in Geneva, Switzerland.
01.04.99-01.10.99
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• Presentation of the test done at the ATLAS ID cooling laboratory.
  Cooling rig
  Example of tests

• Why we need the CAN bus-LMB system.

• Realization of the first data acquisition system based on CAN-LMB.
  Presentation of the different sensors
  CAN bus
  Data acquisition program

• Tests of this first DA-system
  Presentation of the structure to be tested
  Results

• Future development of the DA-system
  Structures to be tested (Phase 2)
  Number and types of sensors
  Other aspects
Why do we need a CAN-bus/LMB based measurement system

- *Cheap solution needed*
  - Large number of sensors
  - Two wire read out possible for temperature sensors

- *High reliability*

- *Robust concerning*
  - Magnetic fields
  - Radiation

- *Noisy environment*

- *Real time*
**CAN-bus & LMB based measurement system**

**LMB 64 ch:** Temperature
Pt-100, 4 wire read out

**LMB ADC:**
Pressure (0-10V)
Mass flow (0-10V)
Valve Status
Heater status
(Sonar Gas analyzer) etc..

**WAGO:**
Valve control
Heater control
# Measurement System

<table>
<thead>
<tr>
<th>Sensor type</th>
<th>No</th>
<th>Type</th>
<th>Name</th>
<th>LMB</th>
<th>V range (V)</th>
<th>I (A)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>64</td>
<td>AI</td>
<td>Pt-100</td>
<td>PT-100</td>
<td>+/-0.1</td>
<td>100p</td>
<td>4 wire read out</td>
</tr>
<tr>
<td>Pressure</td>
<td>0-8</td>
<td>AI</td>
<td>RS</td>
<td>ADC+</td>
<td>0-10</td>
<td>100i</td>
<td>Max current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AI</td>
<td>ST</td>
<td>ADC+</td>
<td>0-10</td>
<td>100i</td>
<td>Max current</td>
</tr>
<tr>
<td>Mass flow</td>
<td>0-8</td>
<td>AI</td>
<td>BH</td>
<td>ADC+</td>
<td>0-10</td>
<td></td>
<td>For big rig</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AI</td>
<td>S</td>
<td>ADC</td>
<td>0-5</td>
<td></td>
<td>For little rig</td>
</tr>
<tr>
<td>Isolation valve control</td>
<td>4</td>
<td>DO</td>
<td>HW</td>
<td>WAGO</td>
<td>5 (TTL)</td>
<td>5m</td>
<td>Controlling pressurised air</td>
</tr>
<tr>
<td>Heater Control</td>
<td>4</td>
<td>DO</td>
<td>Custom (TTL)</td>
<td>WAGO</td>
<td>5 (TTL)</td>
<td>5m</td>
<td>Turns heaters On/off</td>
</tr>
<tr>
<td>Isolation valve status</td>
<td>8</td>
<td>DI</td>
<td>Custom (TTL)</td>
<td>ADC</td>
<td>0-5 (TTL)</td>
<td>5m</td>
<td>Using AI</td>
</tr>
<tr>
<td>Heater status</td>
<td>0</td>
<td>DI</td>
<td>Custom (TTL)</td>
<td>ADC</td>
<td>0-5 (TTL)</td>
<td>5m</td>
<td>Using AI</td>
</tr>
</tbody>
</table>
Data Acquisition program

CAN-bus & LMB based measurement system

13.09.99
Other aspects

* Tests
Table of sensors:

<table>
<thead>
<tr>
<th>Sensor type</th>
<th>No</th>
<th>Type</th>
<th>Name</th>
<th>LMB</th>
<th>V range (V)</th>
<th>I (A)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>384</td>
<td>AI</td>
<td>Pt-1000 ADC+termin.</td>
<td>+/-0.1</td>
<td>100p</td>
<td></td>
<td>2 wire read out</td>
</tr>
<tr>
<td>Pressure</td>
<td>32+</td>
<td>AI</td>
<td>?</td>
<td>ADC</td>
<td>0-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure control</td>
<td>16</td>
<td>AO</td>
<td>H</td>
<td>WAGO</td>
<td>0-10</td>
<td>100i</td>
<td>Via analog compressed air</td>
</tr>
<tr>
<td>Mass flow metering</td>
<td>1</td>
<td>AI</td>
<td>?</td>
<td>ADC</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Mass flow control</td>
<td>16</td>
<td>AO</td>
<td>H</td>
<td>WAGO</td>
<td>0-10</td>
<td>100i</td>
<td>Via analog compressed air</td>
</tr>
<tr>
<td>Isolation valve control</td>
<td>32</td>
<td>DO</td>
<td>HW</td>
<td>WAGO</td>
<td>5 (TTL)</td>
<td>5m</td>
<td>Controlling pressurised air</td>
</tr>
<tr>
<td>Heater Control</td>
<td>44</td>
<td>DO</td>
<td>Custom (TTL)</td>
<td>WAGO</td>
<td>5 (TTL)</td>
<td>5m</td>
<td>Turns heaters On/off</td>
</tr>
<tr>
<td>Isolation valve status</td>
<td>32</td>
<td>DI</td>
<td>Custom (TTL)</td>
<td>ADC</td>
<td>0-5 (TTL)</td>
<td>5m</td>
<td>Using AI LMB</td>
</tr>
<tr>
<td>Heater status</td>
<td>44</td>
<td>DI</td>
<td>Custom (TTL)</td>
<td>ADC</td>
<td>0-5 (TTL)</td>
<td>5m</td>
<td>Using AI LMB</td>
</tr>
</tbody>
</table>
CAN-bus & LMB based measurement system 13.09.99
Examples of tests made at the cooling laboratory 13.09.99

Schematics of the Small Evaporative Circuit

Vacuum Pump

Coolant

Compressor

Chilled liquid condenser

Counter-current Heat Exchanger

Needle valve

or Capillary

Drier

Chiller

Mass flow meters

Needle valve

or Capillary

Filter

Position of the sensors attached to the single-tube for heat transfer coefficient measurements

HT (1,2) - coil heater-thermometers
PT (0..3) - PT100 sensors on the pipe [total number of sensors on the pipe = 13]
H (1..12) - heaters on blocks
BT (1..12) - PT100 sensor on the blocks [total number of sensors on the blocks = 12]
Examples of tests made at the cooling laboratory

Big rig

Temperature controlled cold box

DAQ System either Lab View or Testpoint based (mobile)

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ATLAS
Placement of the sensors in ATLAS
## Structure to be tested

<table>
<thead>
<tr>
<th>Layer</th>
<th>R (cm)</th>
<th>No. Elements</th>
<th>Power /element</th>
<th>Manifold Factor</th>
<th>Elements /group</th>
<th>Power /group</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCT No.4</td>
<td>54</td>
<td>56 (staves)</td>
<td>120 W</td>
<td>2 series/2 parallel (4 staves)</td>
<td>8 (2 mflds)</td>
<td>480 W x 2</td>
</tr>
<tr>
<td>SCT No.3</td>
<td>46</td>
<td>48 (staves)</td>
<td>120 W</td>
<td>2S+2P (4 staves)</td>
<td>8 (2 mflds)</td>
<td>480 W x 2</td>
</tr>
<tr>
<td>SCT No.2</td>
<td>38</td>
<td>40 (staves)</td>
<td>120 W</td>
<td>2S+2P (4 staves)</td>
<td>4 (1 mfld)</td>
<td>480 W x 1</td>
</tr>
<tr>
<td>SCT No.1</td>
<td>30</td>
<td>32 (staves)</td>
<td>120 W</td>
<td>2S+2P (4 staves)</td>
<td>4 (1 mfld)</td>
<td>480 W x 1</td>
</tr>
<tr>
<td>SCT Disk</td>
<td>-</td>
<td>4 (Quadrants)</td>
<td>330 W</td>
<td>Quadrant</td>
<td>1</td>
<td>330 W x 1</td>
</tr>
<tr>
<td>Pixel No. 2</td>
<td>14</td>
<td>56 (staves)</td>
<td>101 W</td>
<td>2</td>
<td>7 (4pairs)</td>
<td>202 W x 4</td>
</tr>
<tr>
<td>Pixel No. 1</td>
<td>11</td>
<td>44 (staves)</td>
<td>101 W</td>
<td>2</td>
<td>6 (3pairs)</td>
<td>202 W x 3</td>
</tr>
<tr>
<td>Pixel B Layer</td>
<td>4.5</td>
<td>18 (staves)</td>
<td>143 W</td>
<td>1</td>
<td>2 (indiv.)</td>
<td>143 W x 2</td>
</tr>
<tr>
<td>Pixel Disk</td>
<td>-</td>
<td>12 (sectors)</td>
<td>55 W</td>
<td>2</td>
<td>2 (1 pair)</td>
<td>110 W x 1</td>
</tr>
</tbody>
</table>

**TOTAL POWER (EXC. SCREENS, LOW MASS POWER RIBBONS)**: 5 kW

### Phase 2:

1/8 of SCT and Pixel layers
Example of small rig measurements

HTC in the tube of ID=3.6mm

Power = 8 W; MF ~ 1.5 g/s; \( t_0 \sim -15 \) to \(-25 \) °C

Examples of tests made at the cooling laboratory

\[ \text{HTC [W/m}^2{\text{K}]} \]

Distance along the tube [mm]

- C3F8
- C4F10
- Mix_50/50
- CF3I

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Test of ADC module:

- Observed error of 18% of the values read by an LMB ADC. This number is independent of ADC range chosen.

- All the channels on one board have the same error, but it varies from board to board. (Each 16 channels).
First test

Temperature distribution at room temperature of the new RAL structure. No calibration.
The first test: 13.09.99