RPC Detector Control System

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http://www1.na.infn.it/wsubnucl/accel/cms/cms.html
• **What we want to monitor:**
  - HV and LV values $\rightarrow$ OPC server $\rightarrow$ 30 Kbytes;
  - FEB disc. Thresholds $\rightarrow$ I²C $\rightarrow$ 100 Kbytes;
  - FEB pulse width $\rightarrow$ I²C $\rightarrow$ 100 Kbytes;
  - FEB temperature $\rightarrow$ I²C $\rightarrow$ 25 Kbytes;
  - Single Counting Rate $\rightarrow$ I²C $\rightarrow$ to be calculated;
  - Cooling system $\rightarrow$ ? $\rightarrow$ ? ;
  - Gas system $\rightarrow$ ? $\rightarrow$ ? ;
  - Ambient parameters $\rightarrow$ ? $\rightarrow$ ? .

**All data have to be logged into the Databases**

**We can use different monitor rates to minimize the DB data rate**
Detector Control System II

- **What we want to control:**
  - HV and LV systems;
  - Cooling system;
  - Gas system;

- **What we want to load from the configuration DB:**
  - HV/LV setpoints
  - FEB disc. thresholds;
  - FEB pulse width;

<table>
<thead>
<tr>
<th>Status</th>
<th>ON/OFF…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>V0/V1set</td>
</tr>
<tr>
<td>Current</td>
<td>I0/I1set</td>
</tr>
<tr>
<td>Rump-up</td>
<td>Rup</td>
</tr>
<tr>
<td>Rump-down</td>
<td>Rdown</td>
</tr>
<tr>
<td>Trip time</td>
<td>Trip</td>
</tr>
</tbody>
</table>

How many subsets of HV setpoints do we need?
Two non adjacent gaps will be connected to the same HV channel in order to halve the # of HV channels “without” reducing the trigger efficiency.
SASY2000 project for RPC II

Electronic house

Branch controller #1

Branch controller #2

Branch controller #16

Detector region

256 Remote boards

Complex ch. 1

Complex ch. 512

HV #1
HV #2

LV #1
LV #6

HV #1023
HV #1024

LV #3071
LV #3072

What do we need??

26 ch * 12 sect * 5 wheels = 1560 LV
17 ch * 12 sect * 5 wheels = 1020 HV
One mainframe is enough for the barrel
HV-LV architecture for a barrel sector

26 LV channels

4 Remote Boards

17 HV channels

2 RB

1 cc ↔ 4 LV
1 RB

1 cc ↔ 4 LV
1 RB

1 cc ↔ 4 LV
1 RB

RB4

RB3

RB2

RB1

Total Number

1560 LV channel
1020 HV channel
480 complex ch.
240 remote boards

2 bigaps = 96 strips = 6 febs

LVA channel
LVD channel
HV channel
cc = complex channel
RB = remote board
Barrel HV-LV schema

26 LV ch/cable + 17 HV ch/cable per sector

Muon racks

LV

HV

Settore-4

Settore-5

Settore-6

LV-HV

26 LV ch/cable

17 HV ch/cable

17 HV

26 LV

48 remote boards/wheel → 240 Remote Board
1 crates/rack → 8 crates/wheel → 40 crates

26 ch * 12 sect * 5 wheels = 1560 LV
17 ch * 12 sect * 5 wheels = 1020 HV

Elect. house

2 RPC HV-LV crates

LV-HV

LV-HV

LV-HV

LV-HV
The barrel system consists of:

<table>
<thead>
<tr>
<th></th>
<th>wheel</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>gaps</td>
<td></td>
<td>408</td>
<td>408</td>
<td>408</td>
<td>408</td>
<td>408</td>
<td>2040</td>
</tr>
<tr>
<td>hv ch.</td>
<td></td>
<td>204</td>
<td>204</td>
<td>204</td>
<td>204</td>
<td>204</td>
<td>1020</td>
</tr>
<tr>
<td>remote board</td>
<td></td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>240</td>
</tr>
<tr>
<td>crates</td>
<td></td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>racks</td>
<td></td>
<td>4*1/2</td>
<td>4*1/2</td>
<td>4*1/2</td>
<td>4*1/2</td>
<td>4*1/2</td>
<td>20*1/2</td>
</tr>
</tbody>
</table>

1020 hv channels $\Rightarrow$ 1 SY1527
Each endcap system consists of:

<table>
<thead>
<tr>
<th>station</th>
<th>RE1</th>
<th>RE2</th>
<th>RE3</th>
<th>RE4</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td># chambers</td>
<td>108</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>468</td>
</tr>
<tr>
<td># hv ch.</td>
<td>216</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>756</td>
</tr>
<tr>
<td># RDB</td>
<td>54</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>189</td>
</tr>
<tr>
<td># crates</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td># racks</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

1512 gaps/hv ch. → 1 SY1527
**LV system description**

- **BARREL**
  
  26 ch/sector * 12 sectors * 5 wheels = **1560 LV ch.**
  
  3 RDBs/sector → 36 RDBs/wheel → **180 RDBs.**

- **ENDCAP**
  
  About **1200 LV ch** corresponding to **100 RDBs**

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**The LV system needs less Remote Board than the HV system → 1 SY1527 Mainframes is OK**
• We need different HV/LV setpoints loaded in the configuration database in order to have different configurations of the RPC system:
  – Different background conditions;
  – Efficiency vs. HV;
  – Electronic calibration (FEB and trigger) HV OFF.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>BRL ch.</th>
<th>EDC ch.</th>
<th>VALUES</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV</td>
<td>1020</td>
<td>1512</td>
<td>6</td>
<td>15192</td>
</tr>
<tr>
<td>LV</td>
<td>1560</td>
<td>1200</td>
<td>4</td>
<td>11040</td>
</tr>
</tbody>
</table>
What do we need to study the RPC efficiency versus the HV (plateau runs):

1. At least 6 runs with the RPC at different HV;
2. A trigger without RPCs (muon trig ?);
3. Load different HV setpoints for each run:
   - Build an automatic way to take these runs from the run control (state machine).
4. Write data and analysis results in the database:
   - Calculate the “new” working point for each RPC;
   - Write them in the configuration database;
   - Write the RPC efficiencies at the working point in the DB in order to use them in the simulation.
Electronic architecture for barrel sectors 4-10

5 MasterLinkBoards

10 SlaveLinkBoards

RB4

2 SLB

96+96 channels

1 MLB

RB3

96 channels

2 SLB

96+96 channels

1 MLB

RB2

1 SLB

96 channels + 96 channels + 96 channels

1 SLB

RB1

1 MLB

96 channels + 96 channels

1 MLB

bi-gap = 48 strips = 3 FEBs
96 channels = 6 FEBs

5 optical links
Electronic architecture for all the other barrel sectors

5 MasterLinkBoards

8 SlaveLinkBoards

<table>
<thead>
<tr>
<th>Box</th>
<th>MLB</th>
<th>SLB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec 4-10</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Other sec</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Wheel</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>Barrel</td>
<td>60</td>
<td>300</td>
</tr>
</tbody>
</table>

5 optical links/sectors
60 optical link/wheel
300 optical link barrel
FEB monitor/control data I

• **BARREL:**

  78 FEB/sector * 12 sectors * 5 wheels = 4680 FEBs

  9360 Threshold + 9360 width + 4680 temp.

  13 I²C lines/sector = 780 I²C lines

• **ENDCAP:**

  2544 FEBs (4 chips) → 336 I²C lines

  10176 Threshold + 10176 width + 2544 temp.

**TOTAL number of FEB variable to monitor:**

19536 Threshold + 19536 width + 7224 temp.
FEB monitor/control data II

• **Barrel FEBs** are equipped with 2 front-end chips (8 strips each) and 1 temperature sensor corresponding to the following parameters to monitor and control:
  • 2 threshold values (hardware defaults of 200 mV);
  • 2 width values (hardware defaults of 100 ns);
  • 1 temperature value.

■ **How many operations/bytes do we need to read/write this parameters ??**

1. Read width/thresh. → 2 write + 1 read → 5 bytes
2. Read temperature → 2 write + 1 read → 5 bytes
3. Write width/thresh. → 3 write → 5 bytes
To monitor all the barrel FEB parameters we need:
- 46800 bytes (width)
- 46800 bytes (thresh.)
- 23400 bytes (temp.)

To write a “new” width and/or threshold we need:
- 46800 bytes (width)
- 46800 bytes (thresh.);

How often do we need to monitor them?
- We are discussing about \[ 50 \text{ KB/h} \rightarrow 1.2 \text{ MB/day} \]

How often do we need to modify them?
- High background
- To reduce the dead time
More DCS items

- **Gas system:**
  - The Gas system group will provide us also the slow control system to integrate in our DCS.

- **Cooling:**
  - The slow control for the cooling will be developed with the DT people.

- **Ambient:**
  - The ambient temperature and pressure will be monitored using the DT system.
  - We are discussing about the humidity monitoring.

- **Single rate (under discussion):**
  - Measured by link board, can be monitored per chip (8 strips), per FEB (16/32 strips) per chamber (6/12 FEBs).
Strip and front-end board summary

Barrel Sectors

RB4 …… 120 chambers
RB3 …… 120 chambers
RB2 …… 120 chambers
RB1 …… 120 chambers

Total number of FE Channels:
180 x 192 = 34,560 (RB1_i, RB1_e, RB2)
60 x 288 = 17,280 (RB2-special)
240 x  96 = 23,040 (RB3, RB4)

Total = 74,880/16 Ch. = 4.680 FE boards x 1.2 (spare) ≈ 5,600 FEBs
Single Rate and strip occupancy

- **Strip occupancy:**
  - Monitor through histograms the **FEB/chip/strip** occupancies using the features provided by the LinkBoard.

- **Single rate:**
  - The LinkBoard will provide also a single rate monitor per **FEB/chip/strip**.
  - The histograms parameter and time window will be programmable thought the I2C line.

- **The total number of channels are:** 4.700/9.400/80.000

- **General questions:**
  - How many bytes ?
  - What is our monitor rate ?
  - What is our loading rate into the DB ?.
The monitored channels will be organized in “categories” following a “risk criteria”:

- High Risk  ➞ HV, LV and GAS
- Medium Risk  ➞ Cooling, FEB Temp and Single Rate
- Low Risk  ➞ Ambient param, width and thresh.

Every channel will have more warning/alarm levels:

… < LL < L < Imon (HV) < H < HH < …. (example)

A combination of the warning/alarm level and the “risk category” will generate a different operation to perform during the data tacking.
• **EXAMPLE I**
  
  – The **HV variables** belong to the High Risk category.
  
  – Suppose that the current drawn by a gap (Imon) will have 2 upper limits: **warning alarm**

    \[
    \text{Imon} < 10 \, \mu A < 15 \, \mu A
    \]

  – A single Imon alarm **do not have to stop the run** but it has to generate and **temporary voltage reduction**.

  – If we have \((# .gt. X)\) of Imon alarms we should stop it.

• **EXAMPLE II**

  – A LV trip will not stop the runs.

  – An HV/LV RDB crate trip will stop it.
• The HV/LV system prototype is under test in Bari and in Naples (May 2002).
• A PC running PVSS II is in Naples and we are waiting for a SY1527 mainframes to begin to develop some DCS code.
• Some items are still under discussion but I hope to freeze them for the september 2002.
• A collaboration with the DT and CSC group is now very important in order to define a uniform and consistent DCS muon system minimizing the effort of these groups.