Micromegas Commissioning status report

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On behalf of the Micromegas Commissioning Team

Muon Week 02-05/02/2021
Micromegas overview before refurbishment

All small sectors on NSW-A apart from A14 were installed by September and were being commissioned.

In November it was decided that all sector would be brought down and refurbished.

**All sectors were commissioned** before dismounting to check for potential issues:

- Two central drift HV layers were short to GND in A14 MM
- LV MM white connectors overheating
- High elx noise w.r.t BB5 (details presented by Luigi)
  - Each sector showed each own noise behavior
  - A14 showed huge noise when sTGC went ON
- Other issues like an A12T MTP-36 fiber, broken C, faulty MMFE8 etc.
Micromegas overview after refurbishment

<table>
<thead>
<tr>
<th>Sector</th>
<th>PRE-INSTALLATION VALIDATION</th>
<th>CONNECTION ACTIVITIES &amp; VALIDATION</th>
<th>HV COMMISSIONING</th>
<th>ELX</th>
<th>TRIGGER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Installed</td>
<td>Ext. Cable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A14</td>
<td>11/Dec</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>A12</td>
<td>16/Dec</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>A10</td>
<td>17/Dec</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>A16</td>
<td>11/Jan</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>A08</td>
<td>18/Jan</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>A02</td>
<td>25/Jan</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>A06</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
</tbody>
</table>

News

☆ A12, A14 were tested on concrete blocks, and now A13 is being under tests
  ▶ The noise has very much improved (more later)!
☆ Improvements on DAQ system in order to resolve open parallelization issues (support from DAQ team)
☆ The commissioning has been ongoing but not without some hiccups
  ▶ When performing GND tests we found low resistance between MM and JD in various sectors (more later)
  ▶ The ICS have been modified -> Lower noise in some areas
    ▶ Re-tests
  ▶ The EN/EL has replaced the LV connectors on the detector side
    ▶ Re-do polarity tests on the wheel
☆ Migrated to new HV system (more later)
  ▶ Only 2 splitter boxes were available, so to protect
Gas leak tests & flushing

- One gas line is connected to two sector single wedges (e.g. A14/A16 IP)
  - Two lines is one complete sector
  - Use alla BB5 portable gas leak tester
- Gas leak tests have been ok up to now
  - All measurements are taken under stable $P_{\text{atm}}$
  - We are performing leak vs. $P_{\text{atm}}$ correlation investigation to apply as a future correction to gain time
- We can currently flush 40 L/h on two sectors
- We bought larger output bubblers to set the $P_{\text{out}}$ limit up to 7 mbar

<table>
<thead>
<tr>
<th>Sector</th>
<th>IP (mL/h)</th>
<th>HO (mL/h)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A14</td>
<td>70</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>A12</td>
<td>56</td>
<td>10</td>
<td>Underestimation on HO due to $P_{\text{atm}}$ variations</td>
</tr>
<tr>
<td>A16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A10</td>
<td>63</td>
<td>120</td>
<td>Overestimation on HO due to $P_{\text{atm}}$ variations</td>
</tr>
</tbody>
</table>
High Voltage Validation

- We migrated to the high granularity system in the beginning of January
  - We have a system with 2 splitter boxes, a 7038 AP power supply
  - We use extra DB 37 and coaxial cables to not stress the SB connectors
- DCS and analysis: We use the BB5 DCS and analysis code for now
  - We are working on updating our summary plots
- We compare our data to the BB5 sign-off documents
  - OK PCB:
    - max 6 s.p.m above 100 nA
    - Average current 40 nA

A14 has been validated and A12 is under validation

A14 differences w.r.t BB5:

<table>
<thead>
<tr>
<th>Qplet</th>
<th>Improvements</th>
<th>Deteriorations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM1 IP</td>
<td>L3P3: 530 (525)</td>
<td></td>
</tr>
<tr>
<td>SM1 HO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM2 IP</td>
<td>L3P7: 530 (520), L4P6: 525 (520)</td>
<td></td>
</tr>
<tr>
<td>SM2 HO</td>
<td></td>
<td>L1P6: 560 (570), L1P7: 545 (570), L2P7: 565 (570), L3P6: 555 (570), L4P7: 535 (560)</td>
</tr>
</tbody>
</table>

Note: SM2 IP and HO was not passivated
High Voltage Validation

Issues encountered:

- It can take a few days to reach nominal voltage due to high RH, increased the flow to reduce time
- Damaged REDEL connectors
  - Connectors missing alignment pin (A14)
    - EN/EL team came to fix them
  - Detracted pins (A14 and A12), some of them were visually ok before trying to connect them
    - Evidence of improper connectorization
  - Missing connector parts
  - Visually checked the connectors of all the other sectors
    - Another test to perform?
- REDEL connectors at brackets might need to be re-done due to potential bad crimping
  - Stelian will test them

These issues were discussed and the BB5 team now controls and protects the connectors before transportation
LV connections/fibers/T-sensors

- Test contact between sTGC/MM and MM/JD before and after services
  - Issues in next slide
- Perform polarity checks on all cables coming from the ICS
- Check cooling and surface temperatures, and keep an eye on elx T
- Issues encountered:
  - Branch controller flat cable shielding: Improved version
  - Short fibers
    - Re-routing needed
  - A bent ADDC fiber in A08
    - Unaccessible due to Faraday cage
    - Sector was brought down for replacement and re-installed again (thanks to Theo V. And the NSW TC team)
  - White connectors overheating
    - New 13 A connectors were installed on side A, to
  - Broken T-sensors
    - It is a usual issue even if BB5 protects them in transportation
    - Trained Panos how to remove the sensor and clean up the holes
    - Stelian replaces them and adds glue
Elx Commissioning - Low MM-JD Resistance

- Had noticed lower resistances (500-600Ω) before the refurbishment
  - Shorts due to gas-cooling pipes in contact on sectors close to brackets
  - In a couple of cases 500-600Ω but we were unable to find the source of it
- After the refurbishment the situation deteriorated (see table) and was not stable
  - In case of A12 we disconnected and un-routed all services but the problem remained
    - We disconnected the wedge GND in order to isolate the problem, no luck
    - We uninstalled the sector and that lead us to the conclusion that the problem
      were the kinematic supports (more from Partick)
    - In the meantime we connected A10 and took baselines/noise runs to test
      - The noise was acceptable

We decided to move on with the commissioning of the rest of the sectors

<table>
<thead>
<tr>
<th>Sector</th>
<th>Resistance between MM and JD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A14</td>
<td>600 Ω</td>
</tr>
<tr>
<td>A12</td>
<td>100 Ω</td>
</tr>
<tr>
<td>A10</td>
<td>180 Ω</td>
</tr>
<tr>
<td>A16</td>
<td>1 MΩ before services , 3 kΩ after</td>
</tr>
<tr>
<td>A08</td>
<td>73 kΩ</td>
</tr>
<tr>
<td>A02</td>
<td>3 kΩ after fixing shorts from pipes</td>
</tr>
</tbody>
</table>
Elx Commissioning

- Many DAQ improvements in order to facilitate sector parallelization
- New Felix PCs, fibers and ALTIs in order to completely separate the DAQ of two sectors
- Working on improving trimmers code and noise run post-processing
  - Masking noisy channels & removing disconnected strips from threshold calculation
- Trigger commissioning has been going smoothly on A12 and A14 (thanks A.Tuna)
- Tested A14, A12 and A10 on wheel and the noise is acceptable
- We are now testing A13 on the concrete blocks with a SS and LS ICS configuration

Thanks to: DAQ team, trigger team

Noise run results with improved post-processing

Sector occ. = 0.18 % (1.1% of channels above 3% occ.)

Sector occ. after masking = 0.053 %
Performed hundreds of tests in order to try to find the source of this noise

- Through all these tests at 191 and BB5 it was understood that the noise peaks in PCB 3 and 6 were due to the ADDC FEAST noise (support from E. Romano) -> Faraday cages
- The grounding was also improved by adding thicker GND cables
- A14 was also tested off-wheel but unfortunately after re-opening sTGC
  - Could not reproduce sTGC affecting MM (at least not to such extent)
  - After the refurbishment we were able to track that it was probably due to lack of ICS BC GND

We were able to reduce the general noise levels through improved GND (also thanks to BB5)
sTGC ON did not make any difference in noise
HV ON (new scheme) introduced a bit of noise, but non-significant
sTGC ON did not make any difference in noise
A13 summary plots on concrete blocks (sTGC OFF)

Noise reduced with modified ICS front panels (especially HO1)
Testing A13 with ICS large sector, to test with sTGC ON
## Personpower

<table>
<thead>
<tr>
<th>NAME</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henri Bachacou</td>
<td>Here until Summer, is becoming the 191 DAQ expert</td>
</tr>
<tr>
<td>Ottilia Ducu</td>
<td>20%, working on HV</td>
</tr>
<tr>
<td>Felix Klitzner</td>
<td>70%, here until Summer</td>
</tr>
<tr>
<td>Athina Kourkoumeli Charalampidi</td>
<td>Here at least until April/May</td>
</tr>
<tr>
<td>Peter Kramer</td>
<td>Qualification on noise run post-processing</td>
</tr>
<tr>
<td>Nikos Stouras</td>
<td>HV DCS support, general support (Here until March?)</td>
</tr>
<tr>
<td>Olivera Vujinovic</td>
<td>Online support, data analysis, documentation</td>
</tr>
<tr>
<td>Sahal Yacoob</td>
<td>Here until end of March or later</td>
</tr>
</tbody>
</table>

+ Support from Luigi Longo/Aimilianos Koulouris
+ Panos Paschalias: Technical support until April
+ Emanuele Romano: Support on electronics (when here)

We will need more person-power soon, working on that
Conclusions

The Micromegas Commissioning steadily progresses despite the issues

- The team has been going through a learning curve, becoming more efficient
  - Task responsibilities have been assigned, but people are being trained on various tasks
  - Some will leave shortly, need to be replaced

- The sector re-installment came (and comes) with some hiccups
  - LV and Elx: Low resistance issue, some noise peaks to debug, connector changing, ICS pin re-crimping, modified ICS to test on-wheel
  - HV: REDEL connector issues, new system to adapt to

- We are working on ensuring the “one week commissioning”
  - HV: New configuration allows for faster debugging
  - Elx and LV: Many noise issues resolved
  - DAQ: Significant improvements, new parallel system (to test), significantly reduced the time needed to take baselines
  - Data analysis: Improved post-processing (work ongoing)
  - Learn to quickly identify problems
  - Overall this is feasible and in various cases we have achieved this in the past
Gas connection scheme

IN: 16X

OD8

OD10

Wedge Manifold (1-to-4)

NSW MM Gas scheme

Interface = Patch Panel (part of bracket) @Sector 1

All pipes are Cu, except where noted otherwise

Wedge Manifold (1-to-4)

Impedance here (input only)

OD6

Plastic OD6

Total=32 pipes for MM

Pipes between tri-manifold and wedge are plastic

OD6

Cu

PU

External impedance

OD6

MM Trident Manifold (SUPPLY)

PU Internal impedance

Festo Conn On-det

OD6

No impedances @output

30/11/2017

Theo, Stavros, Armpins
LATEST NOISE RESULTS (NOISE RUNS)

Noise occupancy after masking < 2 hits/layer/event
 (~ 70 from cavern BG)

Max 1.5% masked channels/layer for all sectors !!!

Method developed by M. Perganti et al.
Threshold-to-efficiency dependence based on BB5 cosmics data