STS-XYTERv2 AND PROTOTYPE FEB-B TESTS FOR THE CBM SILICON TRACKING SYSTEM

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**CBM Experiment**

**What will be obtained**
Exploration of the QCD phase diagram in the region of very high baryon densities

**Aim**
High-precision measurements of hadrons including multistrange hyperons and dileptons for different beam energies.
- Most of these particles will be studied for the first time in the FAIR energy range.

**Requirements**
- High event rates: up to 10 MHz Au+Au reactions/seconds
- Self-triggering front-end electronic
- High-speed data processing
- Radiation hard detectors and front-end Electronics
• **Dipol Magnet:** bending charged particles trajectories
• **Silicon Tracking System:** charged particle tracking
• **Micro-Vertex Detector:** secondary vertex reconstruction
• **Ring Imaging Cherenkov:** pion identification
• **Transition Radiation Detector:** electron identification
• **Time of Flight Detector:** hadron identification
• **MUon Chambers:** muon identification
• **Electromagnetic CALorimeter:** electron/photon identification
• **Projectile Spectator Detector:** collision centrality and reaction plane determination
Silicon Tracking System

- 8 tracking stations between the angle $2.5^\circ \leq \Theta \leq 25^\circ$
- Self-triggering electronics
- Double-sided silicon microstrip sensors
- Hit spatial resolution $\approx 25 \, \mu m$
- $\Delta p/p \approx 1.8\%$
- Inside 1 Tm dipole magnet
- Hit reconstruction efficiency $> 98\%$
mCBM and mSTS

- The CBM experiment is planning to be carried out in 2024. However, in 2018 the mini CBM experiment is planned as a preliminary stage. It will allow to test the detector and electronics components developed for the CBM experiment.
- The installation of the mCBM detector system is being completed with detector and front-end electronic tests as well as the installation of test modules.
- mSTS includes 2 ladders and 2 station
- ASIC basic test & calibration
- ASIC + Microcable Test
- ASIC + Microcable + Sensor Test

Prototype FEB Test → FEB Test

Fully Assembled Module test

Test Experiment for CBM

CBM

mCBM

ASIC Test
-ASIC basic test&calibration
-ASIC+Microcable Test
-ASIC+Microcable+Sensor Test
STS-XYTERv2

- dedicated electronic for the STS and MUCH detectors read out.
- 128 channels that comprise a charge sensitive amplifier (CSA), SLOW and FAST shapers and a flash ADC.
- ASIC optimized for energy and time measurements.

**MOTIVATION:**
Test and QA of STS-XYTER v2 for module production and FEB assembly
POGO PIN TEST STATION

A first level test where basic functionalities are checked.

Hardware:
- Pogo pin station designed at GSI with close collaboration from Cracow team.
- The pogo-socket has 53 pogo needles, each one has a diameter of ~100 µm.
- Basic experimental set up similar to the one used for FEB test in the LAB:
  - Pogo station
  - AFCK board with STS-XYTER tester firmware.
  - gDPB_FMC interface card.

Software:
- Consist (at the moment) of a Python script that runs automatically after placing the ASIC into the pogo-pin test socket
Basic protocol for ASIC testing

TIMELINE

1 min

- Power_ON (2.7 V)
- Measure current

5 sec

- Faulty ASIC
  - NOT_OK
  - OK
  - x 3 times full_sync

5 sec

- ASIC configuration
  - NO Errors
  - Errors
  - Measure current (~0.6 A)

10 sec

- Check analog response for ev_i
  - Inject pulses in test channel
  - Hits are generated
  - Hits are not generated
  - Other test_ch

3 min

- Check ADC and FAST shaper
  - Channel by channel study for ev_i
  - Channels (broken or problems)
  - Check Hits generation readout via IPBus

Summary written in output file: “config_date_box_nr_asic_id.txt”

- Test date
- ASIC ID
- Config registers
- Register with problems
- Currents (bel Sync/after Config)

- ADC and FAST shaper (disc/counters) read back.
- Analog response information
- List of broken channels
- Sample of data readout from FIFO
Some statistics on the ASIC tests

- Quality assurance tests were done for 162 individual ASICs.
- The one specifically chosen channel number 64 under test (one out of 128 channels).
- Current values, reference voltages values, analog responses, the dynamic range of the ADC for electrons and holes for and the following generated hit information were obtained.
- 156 out of a total of 162 ASICs showed good quality and passed the test.

<table>
<thead>
<tr>
<th></th>
<th>Electrons</th>
<th>Holes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADC Ranges (Register Value Units)</strong></td>
<td>185</td>
<td>169</td>
</tr>
<tr>
<td><strong>ADC Range (mV)</strong></td>
<td>92.5</td>
<td>84.5</td>
</tr>
<tr>
<td><strong>Amplifier Gain (ADC units/mV)</strong></td>
<td>0.33</td>
<td>0.37</td>
</tr>
<tr>
<td><strong>σ</strong></td>
<td>12.2</td>
<td>8.4</td>
</tr>
</tbody>
</table>
• ASICs that have shown good quality were wire bonded to the prototype FEBs-B.
• ASICs on FEBs were protected using glob-top (Polytec UV 2237&UV 2257)
• FEBs were also tested with the same protocol.
• In total 138 FEBs out of 146 have passed the tests.
• 10 ASICs provided to Test Module.

• Findings during FEBs tests (main issues):

<table>
<thead>
<tr>
<th>Total Number of Tested FEBs</th>
<th>146</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of FEB with problematic performance</td>
<td>8</td>
</tr>
<tr>
<td>- very high current</td>
<td>2</td>
</tr>
<tr>
<td>- no analog response</td>
<td>1</td>
</tr>
<tr>
<td>- no fast discriminator response</td>
<td>1</td>
</tr>
<tr>
<td>- one or more individual broken channel</td>
<td>4</td>
</tr>
</tbody>
</table>
ASIC Test

- ASIC basic test & calibration
- ASIC + Microcable Test
- ASIC + Microcable + Sensor Test
@GSI Clean Room

Top socket with latches and knob

Bottom socket with cavity for the ASIC and vacuum fixation
Second stage for the ASIC test procedure
The goal is to check electrical connectivity between microcable and ASIC (tab-bonding quality)
Measure the noise level and see the connection of channels
Possible to rebond and bond again on ASIC side!
- ASIC basic test & calibration
- ASIC + Microcable Test
- ASIC + Microcable + Sensor Test
TEST: ASIC+Microcable+Sensor  @GSI Clean Room

- Third stage for the ASIC test procedure
- The goal is to check electrical connectivity between microcable, Sensor and ASIC (tab-bonding quality)
- Measure the noise level and see the connection of channels
- Possible to rebond and bond again on the sensor side!
i. Histograms in root
ii. Read noise hits
iii. Data stored in .txt format

Unconnected channel
**Looking forward to mCBM**

mSTS
- Number of ASICs: 208 (this will required to test ~250 ASICs)
- Time per ASIC: ~ 12 min (subject to optimization)

<table>
<thead>
<tr>
<th>ASSEMBLY STAGE</th>
<th>SETUP REQUIREMENT</th>
<th>TEST PURPOSE</th>
<th>TIME</th>
<th>QA level</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIC test</td>
<td>Pogo pin station</td>
<td>Fully calibration &amp; test</td>
<td>12 min</td>
<td></td>
</tr>
<tr>
<td>ASIC bonded to microcable</td>
<td>Pogo pin station</td>
<td>Check electrical connections</td>
<td>5 min</td>
<td></td>
</tr>
<tr>
<td>ASIC+ microcable bonded to SENSOR</td>
<td>Pogo pin station</td>
<td>Check electrical connections</td>
<td>5 min</td>
<td></td>
</tr>
<tr>
<td>FEB-8 Test</td>
<td>DAQ System</td>
<td>Check electrical connections</td>
<td>~1/2 Day</td>
<td>&lt; %1 Dead channels</td>
</tr>
<tr>
<td>Full module</td>
<td>Module testing setup(box)</td>
<td>Check electrical connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check electrical connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Signal readout. Noise measurements</td>
<td></td>
<td></td>
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The compressed baryonic matter experiment (CBM) at FAIR and the construction of the silicon tracking system

Christian J. Schmidt - Saturday, 8 September
Many thanks to my colleagues....