ATLAS ITk Strip Module Production

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On behalf of the IHEP/THU ATLAS ITk Group

23 December 2017
The Large Hadron Collider at CERN
LHC Point 1: The ATLAS Experiment

The ATLAS Collaboration
3000 Members
177 Institutes
38 Countries
ATLAS ITk Upgrade

- ATLAS Detector upgrade for the LHC high luminosity upgrade, all silicon tracking device

<table>
<thead>
<tr>
<th>Layer</th>
<th>Radius [mm]</th>
<th>Maximal Fluence [n_{eq/cm^2}]</th>
<th>Maximal Dose [MRad]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strips</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Strips</td>
<td>762</td>
<td>(4.2 \times 10^{14})</td>
<td>10.7</td>
</tr>
<tr>
<td>Short Strips</td>
<td>405</td>
<td>(8.1 \times 10^{14})</td>
<td>35.7</td>
</tr>
<tr>
<td>End-cap</td>
<td>385</td>
<td>(1.2 \times 10^{15})</td>
<td>50.4</td>
</tr>
<tr>
<td>Pixels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layer 0</td>
<td>39</td>
<td>(2.25 \times 10^{16})</td>
<td>1710</td>
</tr>
<tr>
<td>Layer 1</td>
<td>75</td>
<td>(0.82 \times 10^{16})</td>
<td>715</td>
</tr>
<tr>
<td>Layer 2</td>
<td>155</td>
<td>(0.25 \times 10^{16})</td>
<td>148</td>
</tr>
<tr>
<td>Layer 3</td>
<td>213</td>
<td>(0.12 \times 10^{15})</td>
<td>96</td>
</tr>
<tr>
<td>Layer 4</td>
<td>271</td>
<td>(0.12 \times 10^{16})</td>
<td>61</td>
</tr>
<tr>
<td>End-cap</td>
<td>80</td>
<td>(0.67 \times 10^{16})</td>
<td>687</td>
</tr>
</tbody>
</table>
ITk Silicon Strip Detector Concept

- Stave/Petal + Mechanics Supported Silicon Modules
ITk Upgrade Project Timeline

2017: ITk-STRIP TDR

Mid-2018: Pre-Production

2019: Production Readiness Reviews

2024: Detector Install
The Team

8 Staff Members (7 IHEP + 1 THU)

Xinchou Lou  Joao da Costa  Hongbo Zhu  Weiguo Lu

Xin Shi  Zhijun Liang  Yiming Li  Xin Chen
Assembly and tests of barrel modules

- Produce 50 working modules during pre-production

- Tooling for module handling
Silicon Strip Detector Module

- Silicon Sensor + Hybrid PCB (with Readout ASICs and control chips) + Power board + Glue and Wire-bonds
Quality Control

- Based on the prototype study, along with the current ATLAS SCT detector experience, improve the quality control (QC) of module production process.

Control board QC

Detector Module QC
Module QC Task: Evaluate max no. of modules in a bonder – by IHEP

• Design and fabricated at IHEP, Polished at RAL
• Placed under BondJet820: dimensions fit, bonding head can reach to the four corners.
• Next: to evaluate with modules on jig

Drawing: Yuzhen Yang
Production: Fang Chen
IHEP Lab for ITk Upgrade

• An existing class 1000 Cleanroom with 150m²

• OGP Flash CNC 300 already purchased

• Hesse BondJet820 received
Cleanroom for mass production

A new cleanroom is proposed for the strip production

- Reinforcement of the floor has been completed
Radiation-hard ASICs Import Issue

• **Rad-hard ASICs under export control** → obstacle for our direct involvement in some high-tech detector projects

• **Main driving factors**: China’s deeper involvements in detector operation, software development, and physics analyses, and continuous investment into various detector upgrade projects (Phase 0/I/II) → increased contributions, higher visibility (across all LHC experiments!)

• Discussion over years and official requests to the ATLAS upgrade management, which were escalated to the CERN management → started coordinating between ATLAS/CMS experiments and obtained export license from US DoC
  - Overall package (valid for process and ATLAS/CMS projects), valid for seven years
  - Much less difficult to apply for SECO (Swiss export license)

• Received the first **ABC130 (strip readout ASIC)** which allows setting up the local module test system

**Milestone of the project**
Collaboration with RAL

- RAL in UK is the leading institution on ATLAS ITk upgrade.
- MoU to be signed with RAL
- Staff rotation plan to maintain 2 FTE’s at RAL for the coming years.
- Invited RAL collaborators to China.
  - Giulio Villani visited IHEP in Dec 2017
  - Craig Sawyer will visit IHEP in Jan 2018

IHEP Team visited RAL on September 19, 2016
Module Production at RAL

- Glued three modules (two thermal mechanical and one electrical)
- Passed electrical test after wire bonding.
Sensor Electrical test at RAL

- ATLAS 07 Mini Sensor + ABC130, Learn basic silicon strip sensor test, measure I-V and Equivalent Input Noise

![Image of equipment setup]

<table>
<thead>
<tr>
<th>偏置电压</th>
<th>-10 V</th>
<th>-100 V</th>
<th>-300 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor + ASIC</td>
<td>597.9e</td>
<td>565.9e</td>
<td>563.5e</td>
</tr>
<tr>
<td>ASIC</td>
<td>450.5e</td>
<td>449.5e</td>
<td>448.4e</td>
</tr>
</tbody>
</table>
Participation of Module Testbeam at DESY

- ATLAS R0 module and SS module test at E-lab in DESY May 2017
- Xiaocong Ai, Liejian Chen and Yi Liu
Summary

• The HL-LHC upgrade requires ATLAS ITk upgrade to meet the challenge

• IHEP/THU ATLAS ITk team is making steady progress on barrel module assembly and tests

• More experience will be brought back to China