Performance Tests during the ATLAS Pixel
Insertable B-Layer Stave Integration
Malte Backhaus on behalf of the ATLAS collaboration

ATLAS Pixel Insertable B-Layer Upgrade
New Insertable B-Layer (IBL) Upgrade constructed and inserted:
- Recover from possible future failures in present pixel system, esp. B-Layer.
- Ensure and improve excellent tracking, vertexing and b-tagging performance during LHC phase I.
- Add to robustness of tracking with high luminosity pile-up.

IBL design values:
- Peak luminosity $2.3 \times 10^{34}$ cm$^{-2}$s$^{-1}$, integrated luminosity 700 fb$^{-1}$
- $5 \times 10^{15}$ n$_{eq}$cm$^{-2}$, 250 MRad.

Performance Tests during Integration
Fast characterization without recalibration (no cooling) at several integration steps:
- during stave integration on IBL Positioning Tube (IPT):
  - test of integrated stave + potential neighboring staves
  - each stave tested two to three times during integration.

Stave Selection and Integration Order
Full performance characterization on each stave before integration:
- Intense power-up, low voltage current and data transmission tests, IV-measurement.
- Individual pixel tuning (3000 $e^{-}$ threshold, 10 ToT @ 16 ke), full characterization and operation ($^{90}$Sr source scan) in warm environment (22°C).
- Pixel tuning in cold (-12°C) to target operation threshold of 1500 $e^{-}$.
- Stave performance ranking based on number of $\eta$-weighted faulty pixels (requirement: < 1 %).

Stave functionality verified after each work step:
- Cooling pipe extension.
- Integration on support ring (including neighboring staves).
- Finalization of complete package (see result box).
- Very delicate operation finished smoothly.

IBL in a nutshell:
- 14 staves:
  - 12 planar $n$-in-$n$ double chip modules (sensor fabricated by CiS).
  - 8 single chip 3D modules (sensor fabricated by CNM and FBK).
- 12,042,240 pixels, 250 x 50 µm$^2$.
- Radius: 3.27 cm

Installation and Commissioning
IBL installed in ATLAS on 7th of May 2014.
End of June: fully connected and first tests.
- All chips operational. Detector commissioning - including cooling – started.
- Final readout system in finalization phase and commissioning incl. cosmic and combined ATLAS runs started.
- Thanks to the IBL – which exceeds the requirements in terms of operational channels - ATLAS will profit from a unique 4-layer pixel tracker and benefit from the improved tracking performance.

Twenty modules loaded on carbon foam support build one "stave". Silicon 3D sensors for the first time used, loaded on extremities (~ 25% of area). CO$_2$ bi-phase cooling with Ti pipe.

IBL Staves and Integration Procedure
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Staves integrated around beam bipe with reduced radius on support ring around.

Service plug and cooling pipe extension using brazing technology.

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