Upgrading the Inner Tracking System of ALICE

HEP Xmas Meeting

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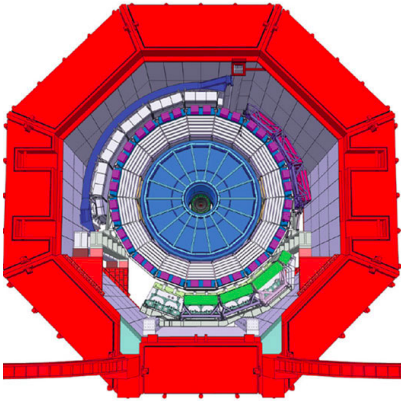
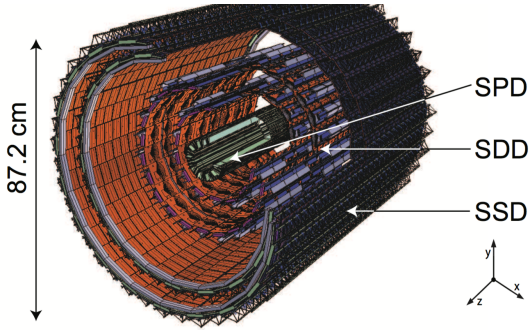
ALICE



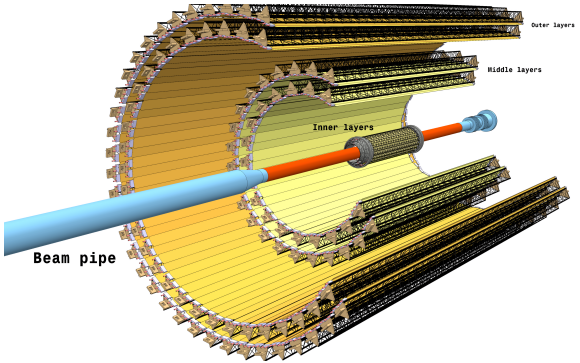
- The main goal of ALICE is to better understand the quark gluon plasma
- ALICE differs from other experiments at the LHC in that it runs a lower luminosity and is interested in low momentum events
- A thin tracking system is necessary for low momentum probes

ALICE Inner Tracking System

Currently the ITS is made of 6 layers: 2 of Silicon Drift Detectors (SDD), 2 of Silicon Pixel Detectors (SPD) and 2 of Silicon Strip Detectors (SSD)



To be completely replaced with:



The replacement of the current ITS will...

- reduce the material budget of the ITS by a factor of ≈ 3 per layer
- increase the readout rate to 100kHz
- reduce pixel size to $27\mu m \times 29\mu m$
- reduce the radius of the innermost layer from 39mm to 23mm
- first tracking detector based entirely on Complementary Metal Oxide Semiconductor (CMOS) Monolithic Active Pixel Sensors (MAPS)

ITS upgrade: 7 layer barrel geometry, UK involved in Outer Barrel

- 12.5G pixel camera
- takes 50,000 pictures per second
- $\approx 10m^2$ of silicon

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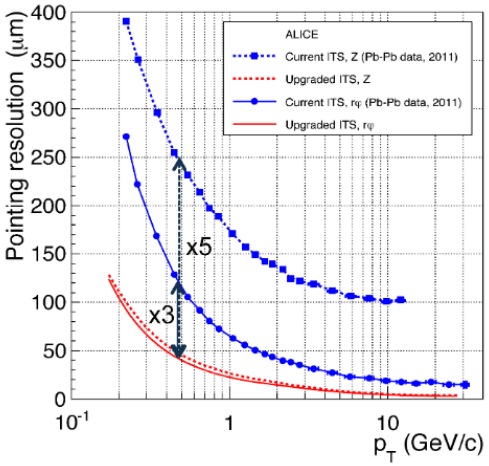
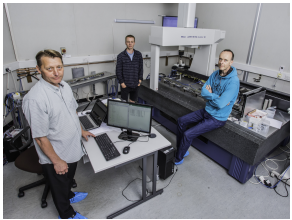
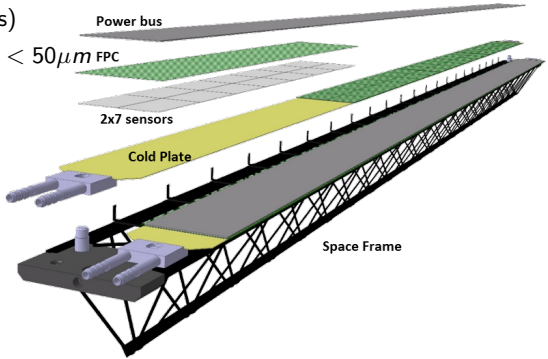


$\approx 40\mu m$ at 500MeV/c (low p_T)

Outer Barrel Stave Construction

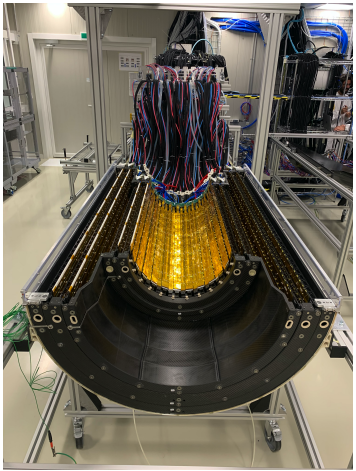
- staves contain spatial structure, cooling and powering
- 25 were constructed and tested in the Engineering Technology Centre (ETC) at Daresbury (UK) and the remaining 65 in Torino and Frascati (IT), NIKHEF (NL), Berkeley (USA)
- 1.5m long (for the two Outer layers), $\approx$ 0.9m long (for two Middle layers)
- 50M pixels in each half stave (outer layers)
- mechanical module alignment with CMM $< 50\mu m$





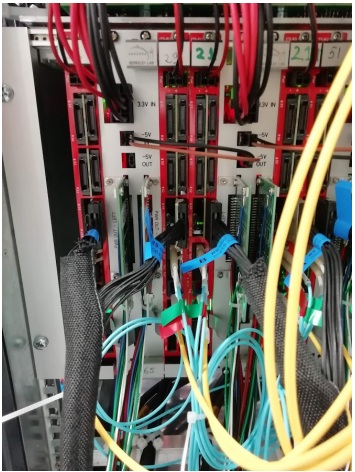
Assembly of Staves into Half Barrels

- All staves are now assembled into the intended barrel geometry of the ITS
- The power and data cables of each stave was verified by emitting PRBS data from the chips and reading it out
- The stability of the staves was tested by monitoring the currents and temperatures for at least 48 hours



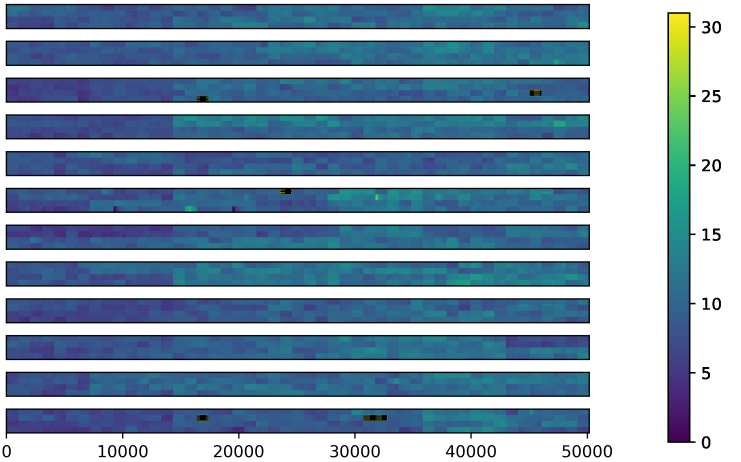
Development of the Production Readout System

- The readout units used to test modules and staves throughout the construction process are not radiation hard
- The software for the production readout units is nearing the end of development
- My current role is to develop the readout software such that cosmic muon data can be gathered



Threshold scan on multiple staves

- Charge of increasing amplitude is injected and the amount of charge needed to register a hit is recorded - this is the threshold value
- This scan was performed simultaneously on all 12 staves connected to a central readout unit
- The next steps are to tune the chip thresholds for uniformity



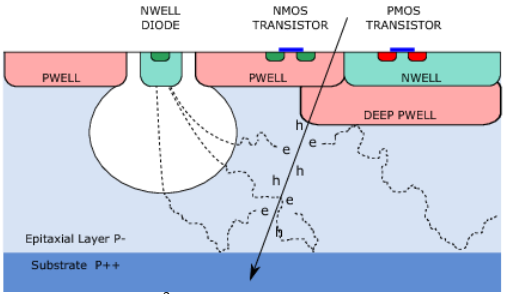
Outlook

- The ITS is fully constructed and connected to the readout system
- The readout software is nearing the end of development
- Threshold scans have been run simultaneously on all staves connected to one central readout unit, an essential step towards to gathering of cosmic muon data
- After the CERN Christmas break, cosmic muon data taking for the outer barrel will begin

Thanks for listening

Back-up

ALice PIxel DEtector

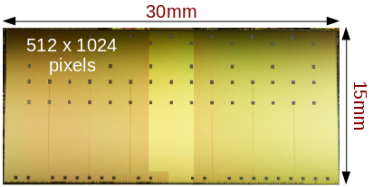


- 130,000 pixels / cm^2
- spatial resolution: $\approx 5\mu m$
- power: $\approx$ 300nW / pixel
- fake hit rate: $\approx 10^{-10}$

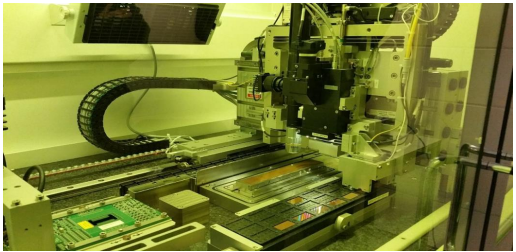
ALPIDE has the following in pixel:

- discriminator
- amplifier
- signal shaper
- multiple event buffers

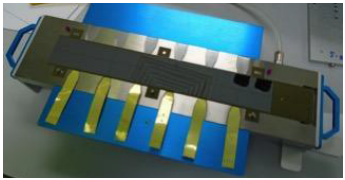
Module Assembly



100μm thick (Outer barrel)



Over the last two years, Liverpool constucted and tested over 500 outer barrel modules in the Liverpool Semiconductor Detector Centre (LSDC).
The rest were constructed in Strasbourg (FR), Pusan (SKR), Wuhan (CN) and Bari (IT).



- class 100 clean room
- automated chip placement
- accuracy of 5μm
- $\approx$ 7M pixels per module