Commissioning of the Upstream Tracker for the LHCb Upgrade I

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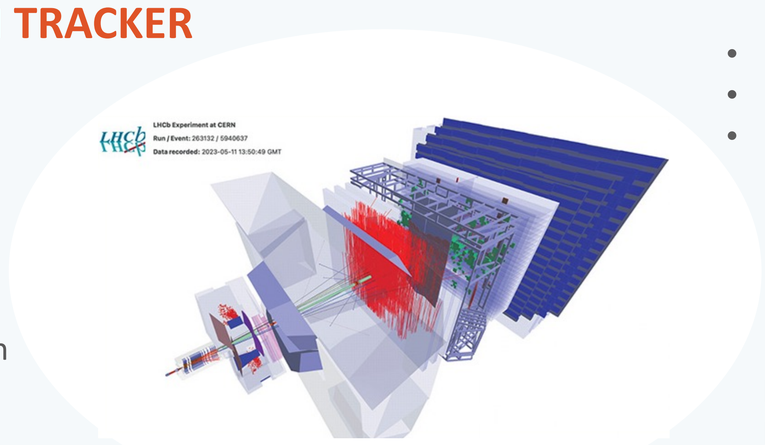
LHCb AND THE UPSTREAM TRACKER

- The LHCb experiment is a forward spectrometer located at the Large Hadron Collider (LHC).
- The Upstream Tracker (UT) is placed upstream of the bending magnet and is fundamental for:
  - software trigger implementation
  - reconstruction of K_S and Λ
  - reduction of the ghost rate

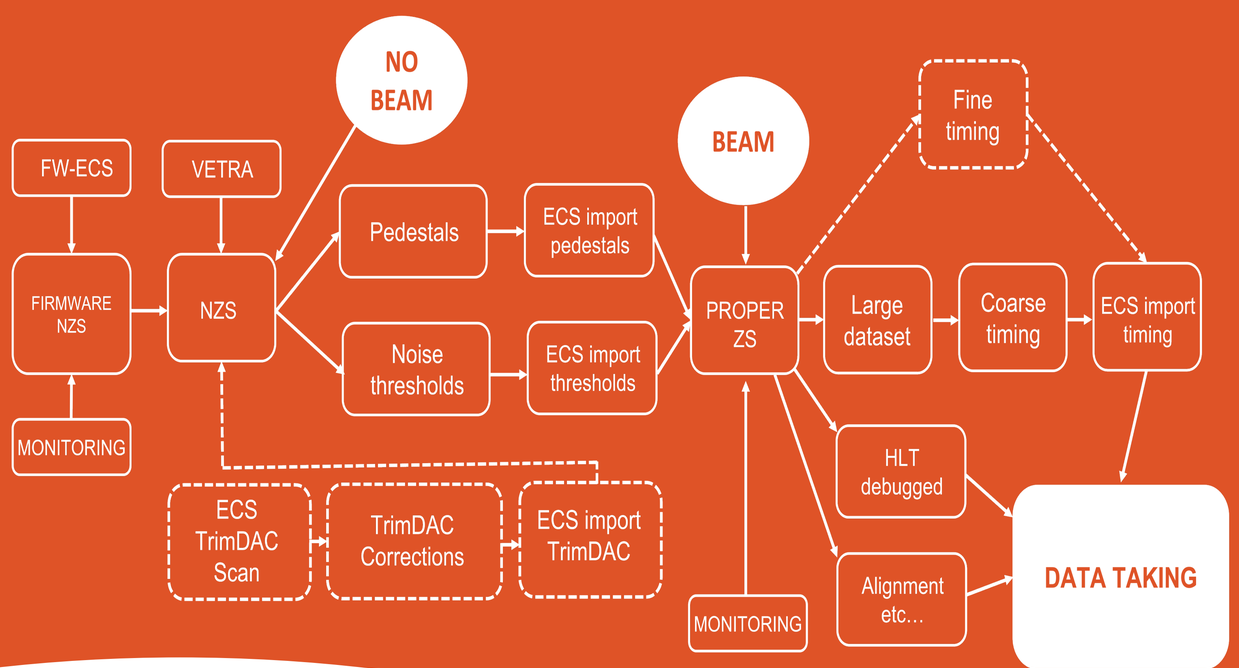


A SILICON STRIP DETECTOR

- Four planes of silicon microstrip sensors with vertical and stereo (+/- 5°) orientation
  - **A-Type:** p-in-n, 190 μm pitch, 320 μm thickness
  - **B- Type** n-in-p, ½ pitch, 320 μm thickness
  - **C-**, **D-**type: n-in-p, ½ pitch, 250 μm thickness
- Expected to operate at -5° C
- Hybrids: VERA (4 ASICs), SUSI (8 ASICs)
- Front-end ASIC (**SALT**):
  - **CMOS** 130 nm
  - **Peaking time** ~ 25 ns
  - **S/N** ~ 15
  - **Rad hard**: 30Mrad TID +TMR against SEE effects

Installation completed successfully in March 2023.

PATH TO DATA TAKING

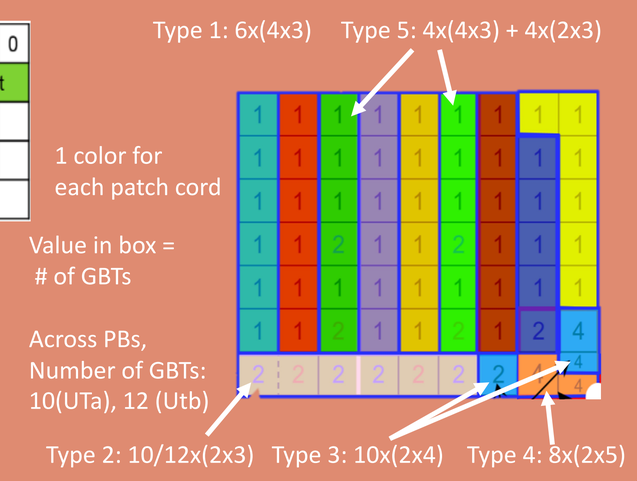


FIRMWARE

The readout of the detector is made with PCIe40 cards hosting Intel Arria 10 FPGA. UT firmware has 5 different flavours used for different detector regions having different occupancies.

GBT frame byte	13	12	11	10	9	8	7	6	5	4	3	2	1	0
4 x 3-eports			24-bit			24-bit			24-bit			24-bit		
2 x 3-eports			24-bit					24-bit						
2 x 4-eports			32-bit					32-bit						
2 x 5-eports			40-bit					40-bit						

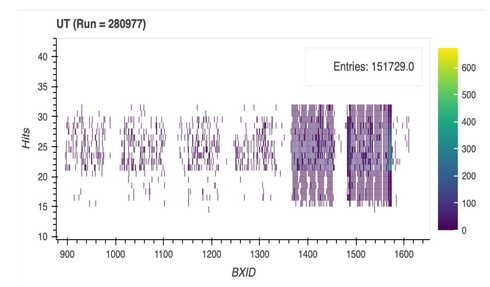
Implemented to work in Non-zero-suppressed (NZS) and in Zero-suppressed (ZS) mode

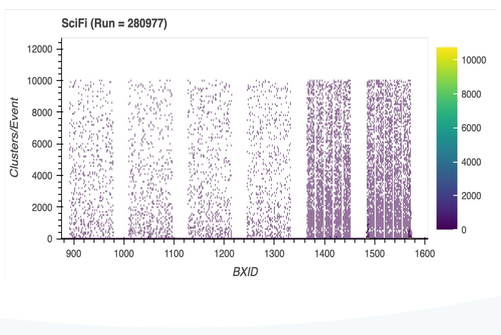


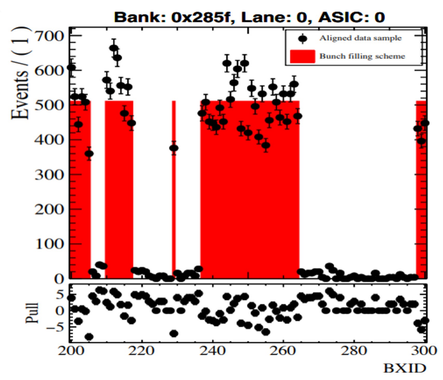
TIME ALIGNMENT

Need to align the UT hits with the bunch filling scheme of the LHC (BXID)

The ZS bank decoder provides the number of hits for each ASIC that are then fitted to the BXIDs histograms without the need of dedicated TAE runs.

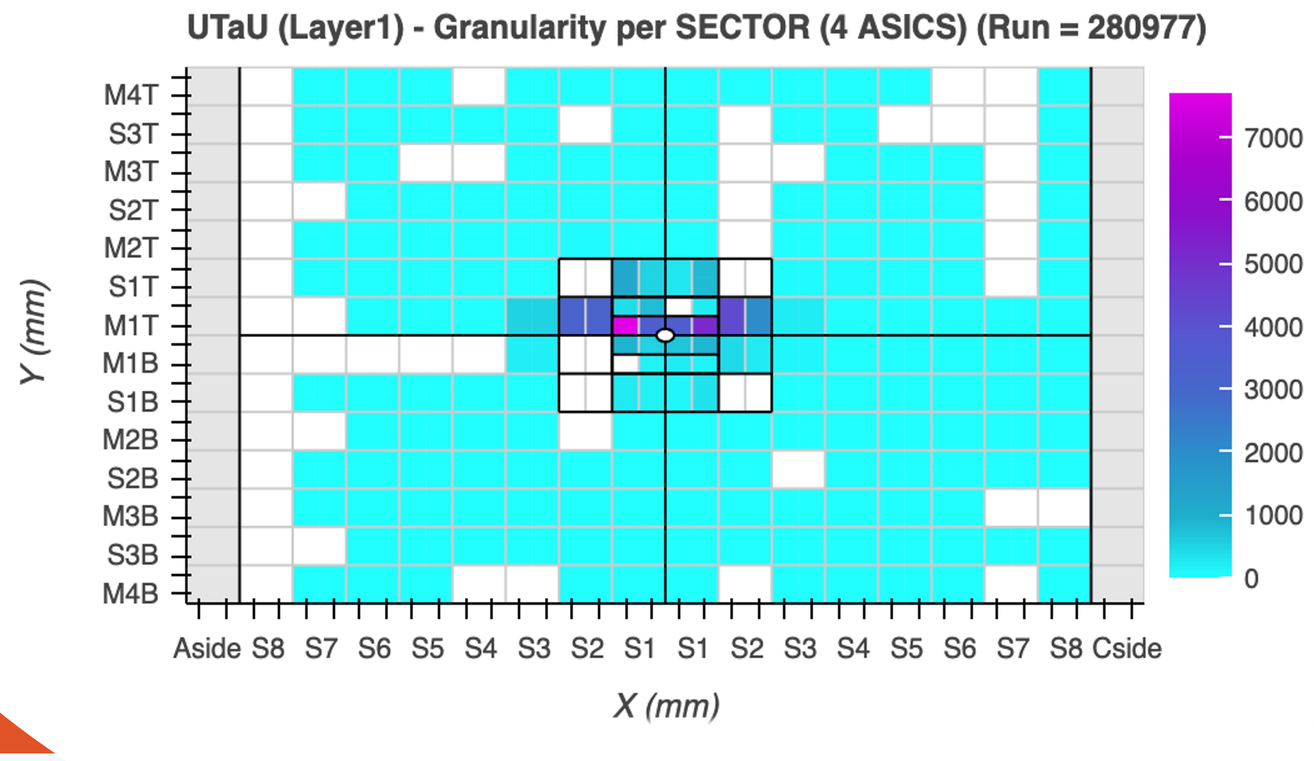






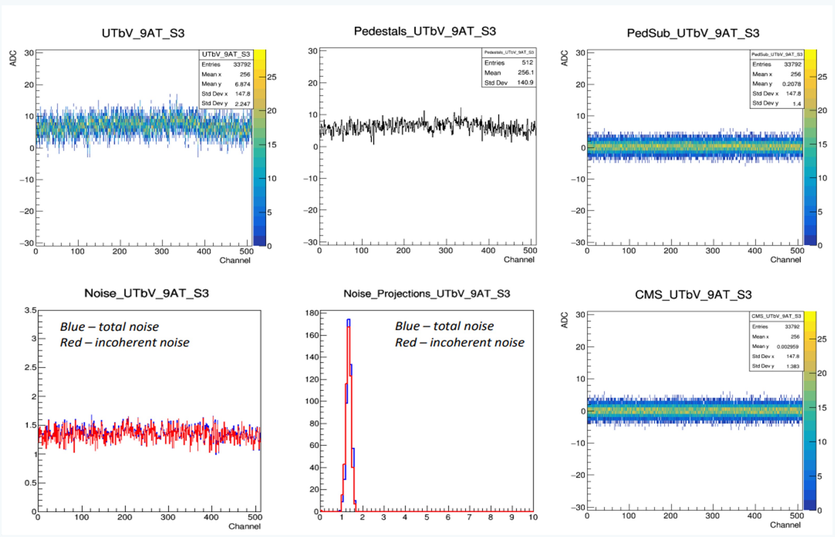
UT hits scheme matches the other sub-detectors.

First data collected in the **Global LHCb** data taking during the Ions run (Pb-Pb collisions) before the start of YETS 2023-2024, useful to develop offline software.



OFFLINE CALIBRATION

Dedicated software package (VETRA), part of the LHCb software project.



Preliminary results:

- uniform incoherent noise in the detector
- observed the variation of pedestals across the layer
- noise check after pedestal subtraction
- agreement with the early performance studies

CURRENT STATUS AND NEXT STEPS

- Detector performances measured in the commissioning phase are aligned with the ones measured in the laboratory.
- Ongoing analysing of the first commissioning data.
- First data acquisition in Global data taking of LHCb during the ion runs.
- Continuing working to guarantee stable data taking conditions.

ACKNOWLEDGMENTS

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