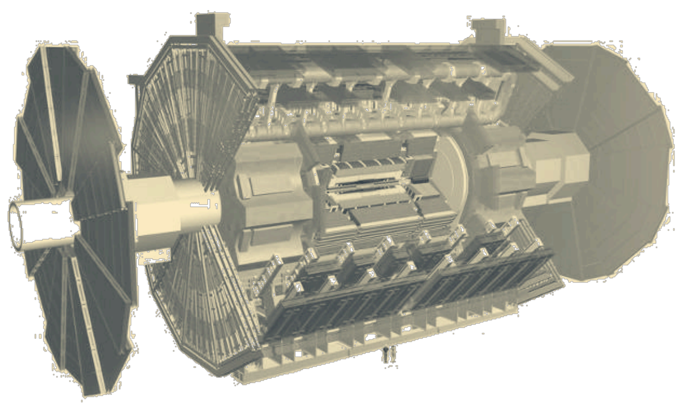

A Calibration Data Stream for the ATLAS Inner Detector Alignment

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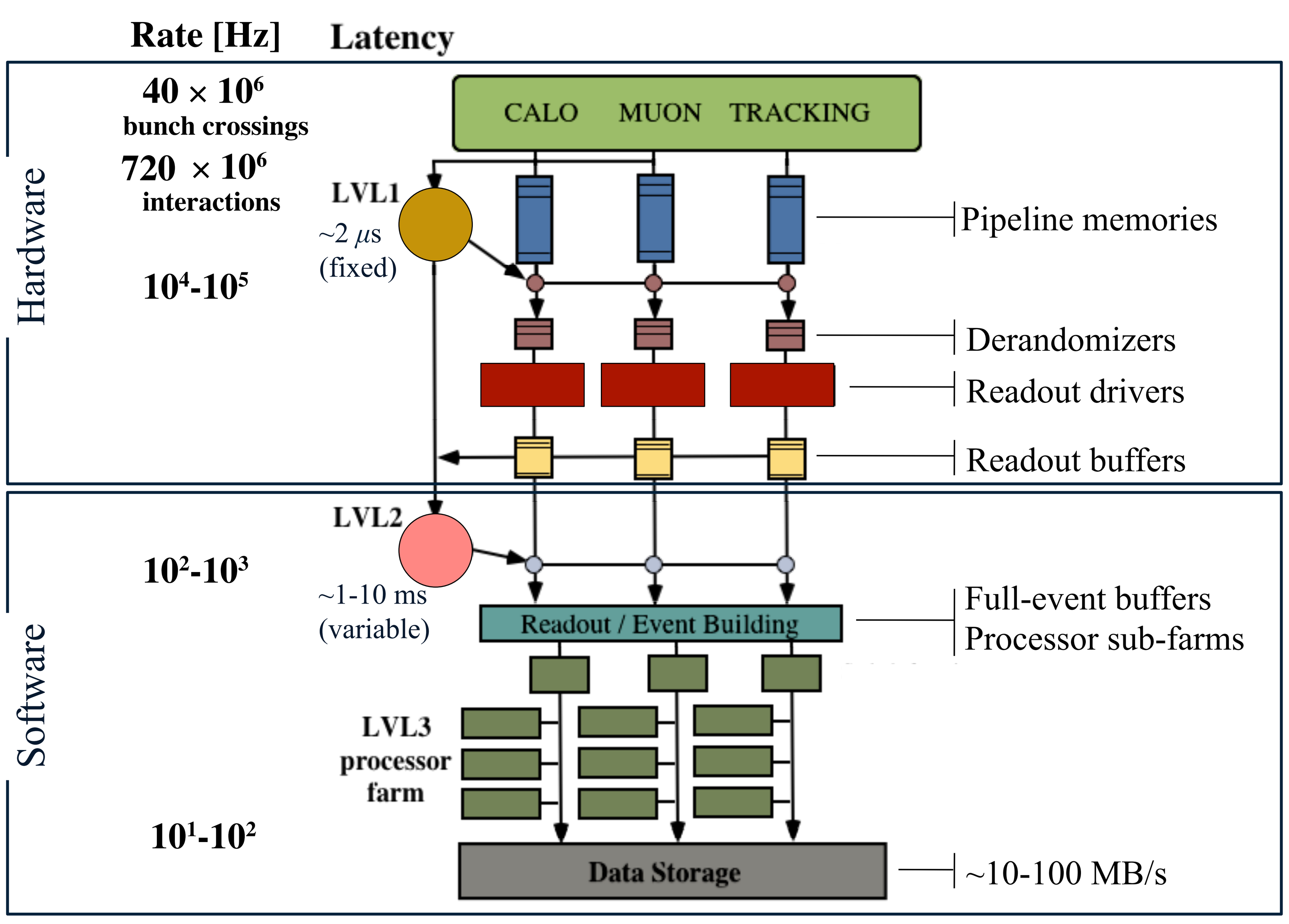
For the ATLAS TDAQ and Inner Detector Alignment Groups

The ATLAS Trigger System



Data Streaming

Debug Streams
events for which a trigger decision has not been made, because of failures in parts of the online system

Physics Streams
data for physics analyses

Express Stream
full events for fast reconstruction

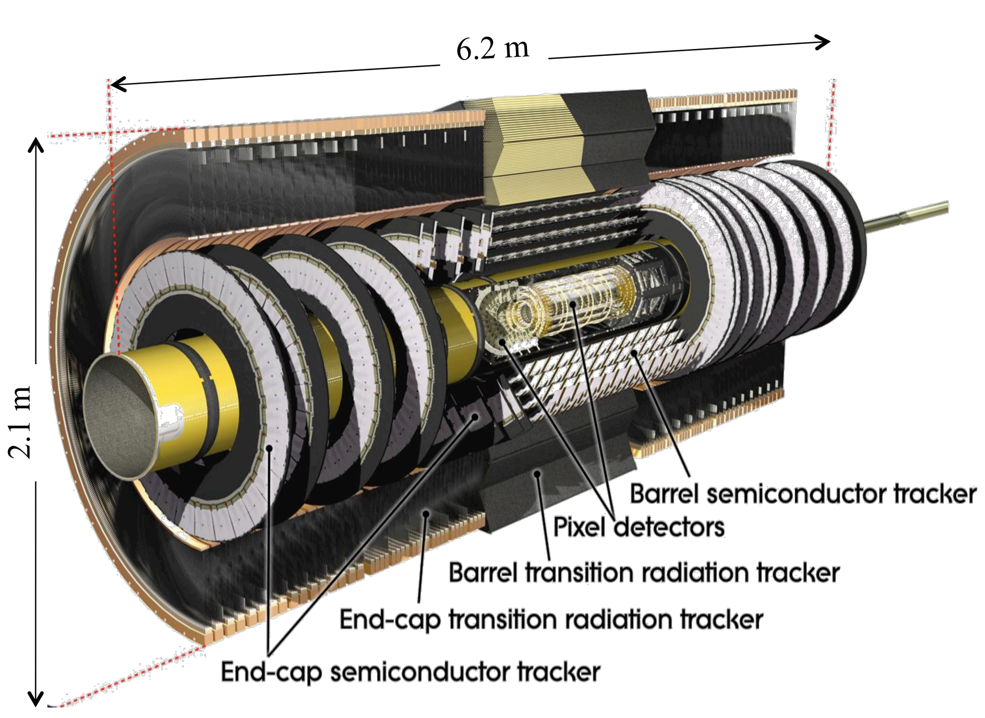
Calibration Streams
events delivering the minimum amount of information for detector calibrations at high rate

Partial Event Building

Unlike physics events, calibration events for specific sub-detectors of the ATLAS experiment do not require the full event information, but only part of it. The **Partial Event Building (PEB)**, a TDAQ system design feature developed specifically for detector calibrations, provides partial events based on a list of selected read-out channel identifiers, which are filled by calibration algorithms in the HLT.

Being based on a pull protocol, the Event Builder can assemble partial calibration events, following the HLT result. The size of calibration streams is reduced, allowing higher calibration rates and efficient use of the allocated bandwidth. The PEB is now used for calibrations by various ATLAS sub-detectors, e.g. the calorimeters, and the Inner Detector for alignment purposes.

The ATLAS Inner Detector (ID)

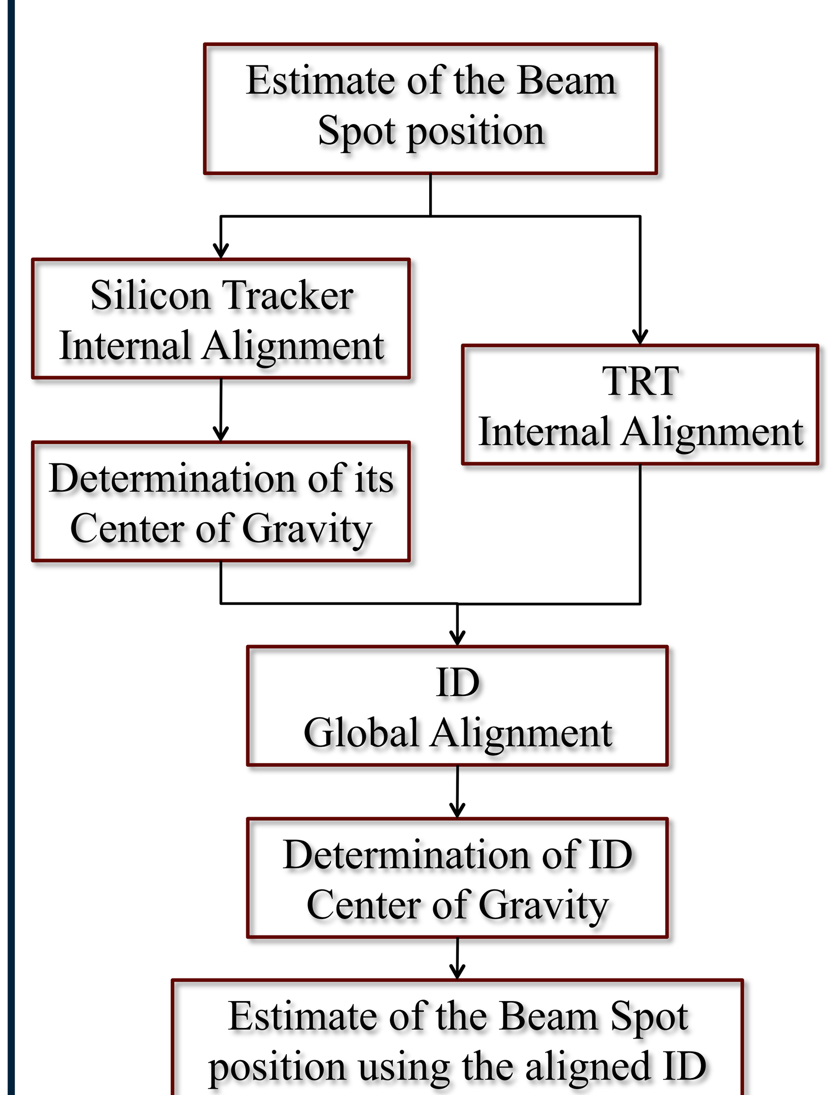


The ATLAS ID is a large and complicated system that consists of ~5,800 silicon pixel and strip detectors, and ~1000 modules of straw drift-tubes. If each silicon module is assumed to be a rigid body, three translational and three rotational degrees of freedom (DoF) should be considered. This means that alignment algorithms have to deal with ~40,000 DoF, what makes the ID alignment particularly challenging.

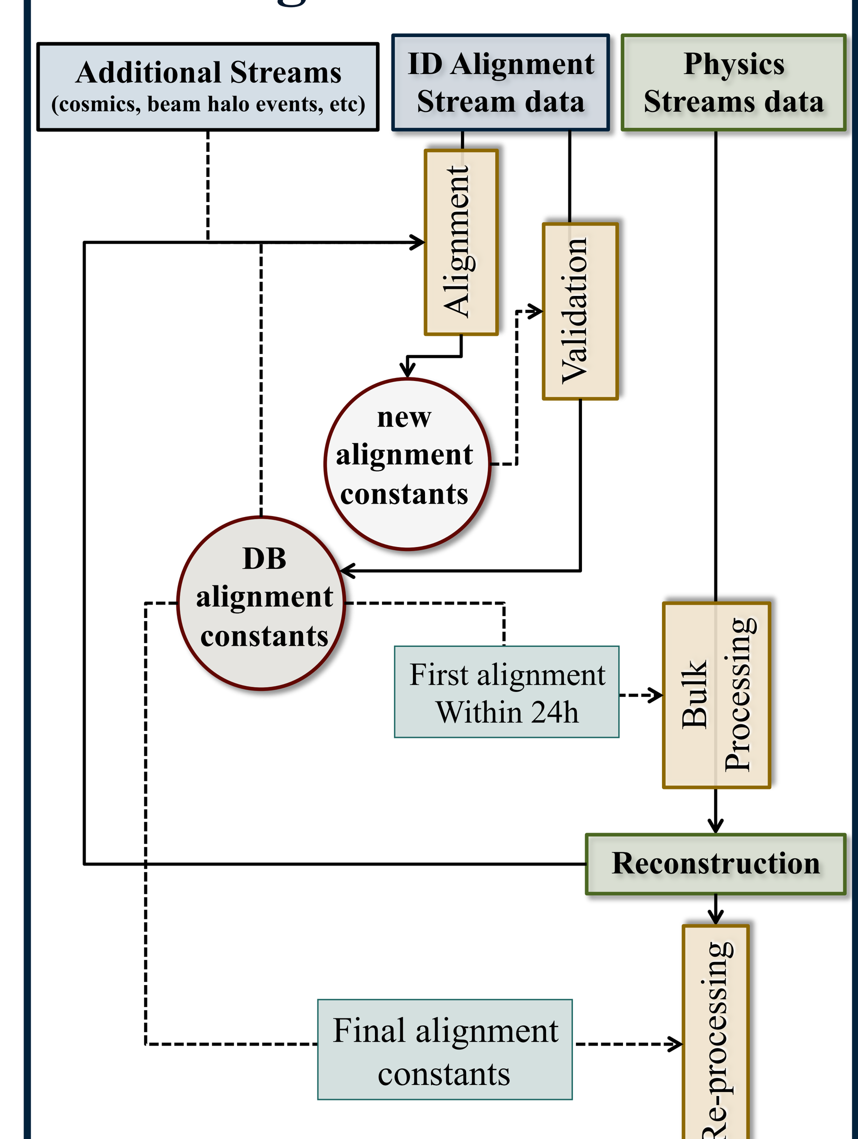
Sub-detector	Pixels	SCT	TRT
Type	Silicon pixels	Silicon micro-strips	Gaseous drift tubes
# Modules	1744	4088	992
# Readout Channels	80.4M	6.3M	350K
Resolutions	10 μm ($r\varphi$)	17 μm ($r\varphi$)	130 μm ($r\varphi$)
	115 μm (rz)	580 μm (rz)	

Inner Detector elements and intrinsic resolutions

Track Based Alignment



Alignment Chain



The ID Alignment Calibration Stream

A dedicated ID Alignment calibration stream is crucial in order to acquire enough statistics of tracks for fast deriving alignment constants, during collision data. That way, the alignment constants are updated before the full reconstruction takes place.

The stream provides a high rate of isolated tracks that cover a wide momentum range. Such track candidates can originate from hadrons that traverse the ID.

The stream collects tracks at O(50Hz). The size of each event is approximately 50 times smaller as compared to a fully built event.

This calibration stream, as an input to the alignment chain, has been successfully tested in a TDAQ technical run where Minimum Bias Monte Carlo simulated data mimics the LVL1 decision.

The ID Alignment trigger chains

LVL1
Hadronic Signatures with energy thresholds at 6GeV or 9GeV

LVL2
Isolated tracks with momentum thresholds at 9GeV or 16GeV inside the η-φ region defined by the LVL1 hadronic signatures

PEB
The information from the ID and for the η-φ region defined by the LVL1 hadronic signatures is stored

Testing with Cosmic Data

The algorithms developed for collision data conditions can not be used during cosmic data taking because they trigger on tracks coming from the interaction point. Two dedicated cosmics trigger chains were developed and tested:

- Used cosmic chains that selected silicon tracks at cosmic data runs (Test chains w/o PEB); and
- Applied PEB in the detector region around the track in the Test chains w/o PEB raw data and generated new raw data (Test chains w/ PEB).

The trigger selection was softer and the η-φ region used for the PEB was bigger than what is planned for collision data conditions. The generated raw data in the PEB case was ~10 times smaller compared to the raw data, and processing it though the alignment full chain was 60% faster. The track fit quality was found to be comparable.