# Simulation for the ATLAS Upgrade Strip Tracker

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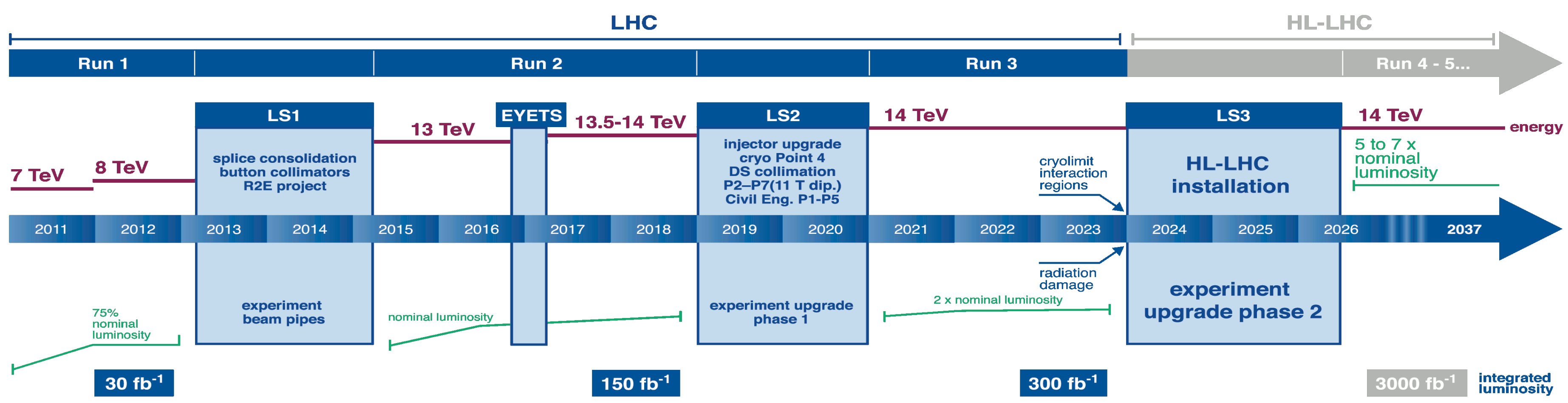
## Studies for a next generation tracking detector

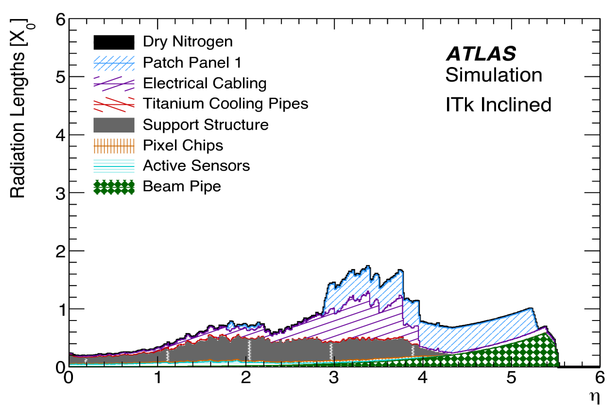
An upgrade of the LHC is planned for ~2024 which will provide very high collision rates, enhancing the possibilities for new physics measurements, but also posing very significant experimental challenges. The current ATLAS Inner Detector (ID) will not be suitable for operation in such an environment, and so must be replaced; an **all-silicon tracker** is considered to be the best solution for such conditions. To arrive at the optimum design, detailed simulation studies are needed to predict the tracking performance of candidate layouts.



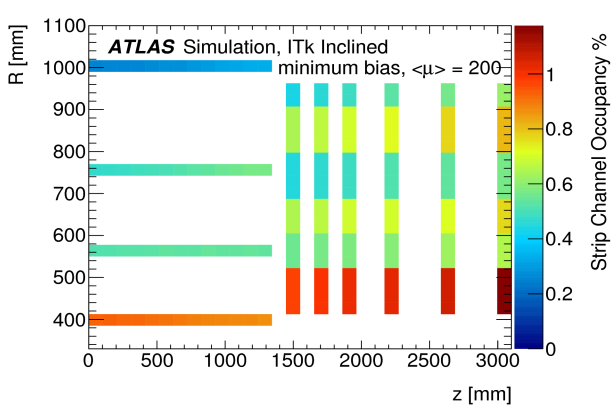

## Design Considerations

The following factors are amongst those taken into account when designing a detector for HL-LHC conditions:

- Granularity should be sufficient to provide the necessary impact parameter resolution and allow good separation of tracks and vertices
- Material within the tracking acceptance should be kept to a minimum in order to reduce loss of resolution and efficiency through multiple-scattering and brems-strahlung
- Occupancy should be kept down to an acceptable level – this drives decisions such as the length of the strips in the microstrip detector
- The number of hit points must be sufficient to discriminate against fake tracks from combinatorics while maintaining a high tracking efficiency



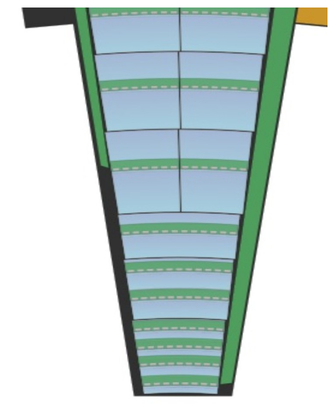

( Material radiation length X0 versus η )

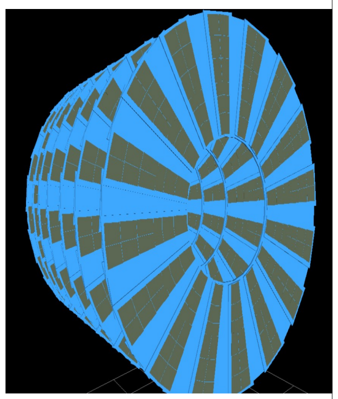


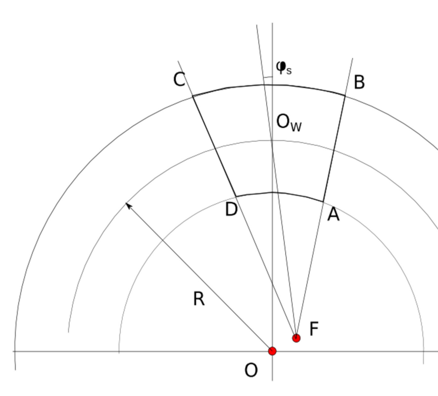

( The average channel occupancy calculated with pileup =200 in the Strip Tracker )

## The new Strip detector structures

The implementation of the new detector structures into the ATLAS detector simulation framework, such as the Strip endcap petals and the endcap sensors (shown below).







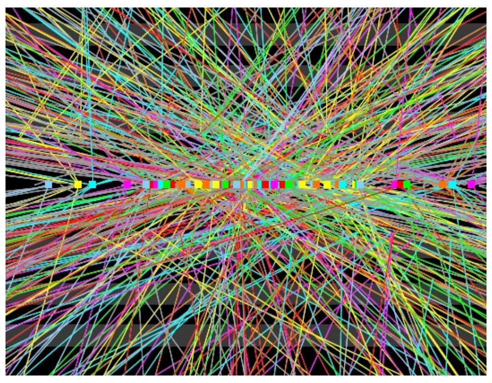

## High-Luminosity LHC

The High-Luminosity LHC (HL-LHC) will operate with the following conditions:

- A proton-proton centre-of-mass energy √s=14 TeV
- A luminosity of *L*=5x10^34 cm-2s-1.

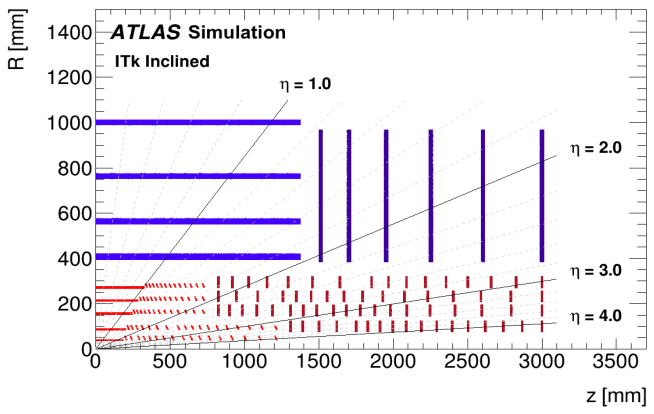
Assuming luminosity leveling, this corres-ponds to 140-200 pile-up collisions per bunch crossing.

Such high pile-up will pose significant challenges to the detector, and to data analysis.



An event display of one event with mu = 140. The colored lines are the charged tracks in the ITk; the points are the vertices. Very busy situation.

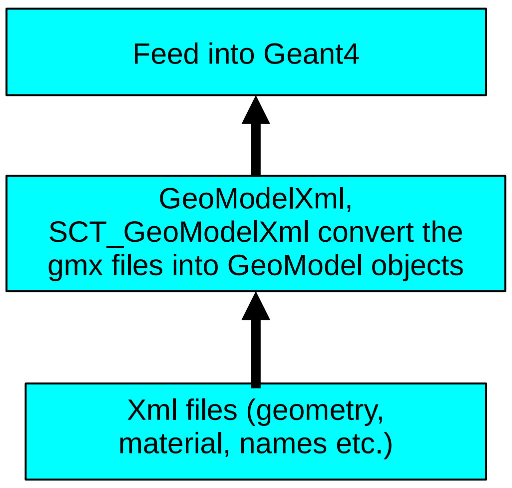
**The plot is produced using the Atlantis software**



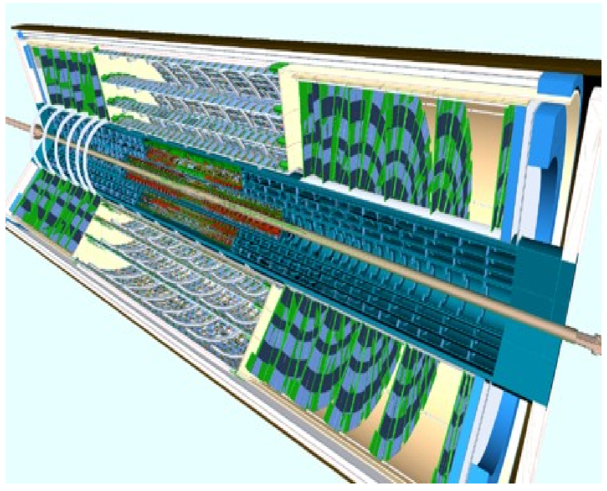

Schematic layout of the ITk for the HL-LHC. Here only one quadrant and only active detector elements are shown. The horizontal axis is the axis along the beam line with zero being the interaction point. The vertical axis is the radius measured from the interaction point. The outer radius is set by the bore of the solenoid. The outer blue color structure is the Strip tracker.

## Building the Strip Tracker using Xml

- For the current ATLAS Inner Detector, the geometry is defined directly in C++ code, with the dimensions and quantities stored in the text files. This way is very difficult to maintain and very hard to extend to new layouts.
- For the upgrade Strip Tracker design, the Xml language is used. Xml is very well suited to geometry description: can store numbers, such as dimensions, as well as their meaning; can also handle hierarchical structure.
- The Pixel Tracker is using Xml as well




The flow chart of building the Strip Tracker



A visualization of the ITk as implemented in the simulation framework. From inner to outer, are the Pixel and Strip Tracker respectively

## Tracking performance

Nice tracking performance achieved for the future ITk. From left to right, the plots are the mean number of hits per track as a function of η, the track reconstruction efficiency for particles as function of η, the resolutions on track parameters z0, q/pT as a function of true track η.