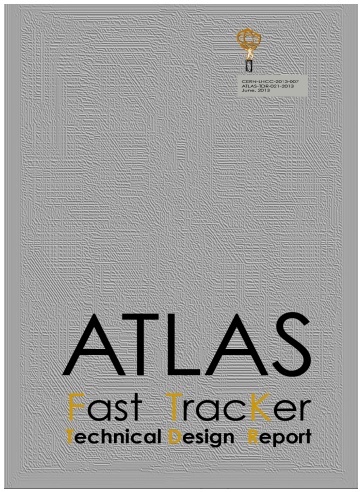
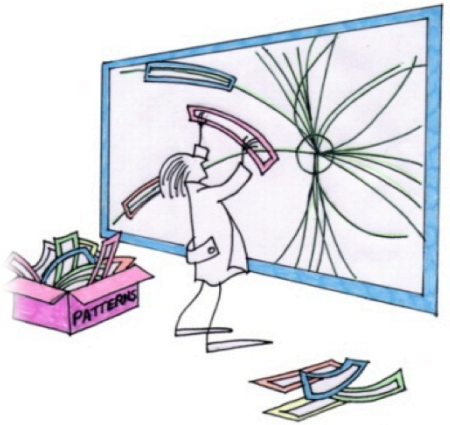




Overview of the ATLAS **F**ast **T**rac**K**er Project

Lucian-Stefan Ancu - Université de Genève
on behalf of the ATLAS Collaboration

38th International Conference on High Energy Physics

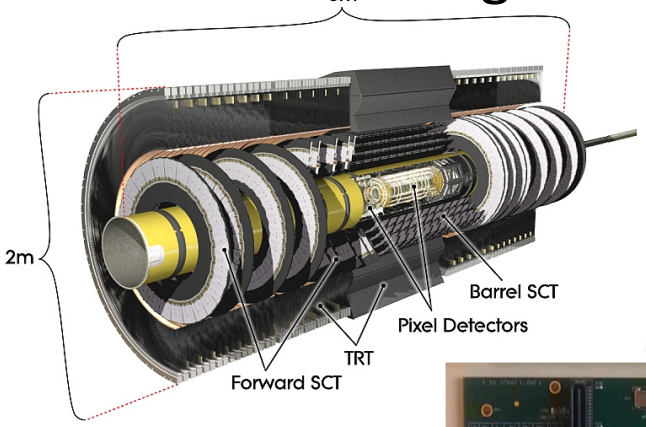
UNIVERSITÉ DE GENÈVE

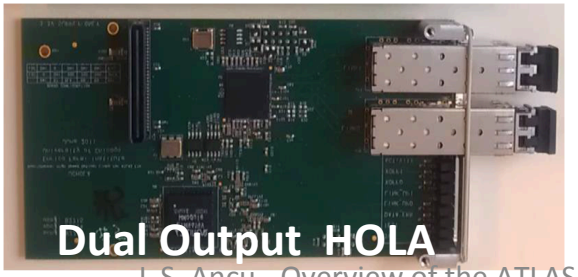
The **F**ast **T**rac**K**er

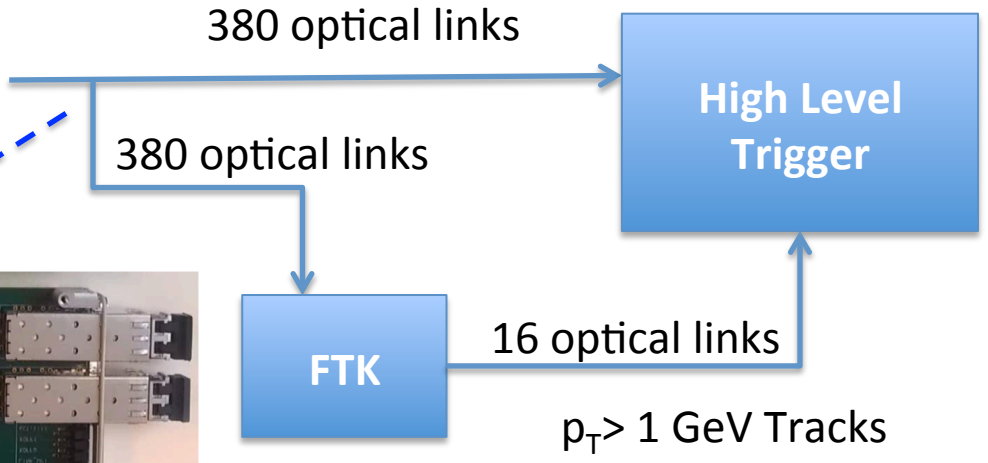
ATLAS has a two layer trigger system : 1st- hardware, 2nd -software

For every Level 1 trigger accept (**100 kHz**) the **FTK**:

- Reads the output of the ATLAS silicon Inner Detector(ID)
  - **100 M** channels, 4 Pixel Layers, 4 Strip double-layers
- Carries out full scan for tracks with $\mathbf{p_T > 1\ GeV}$ and delivers them to High Level Trigger with **100 μs** latency

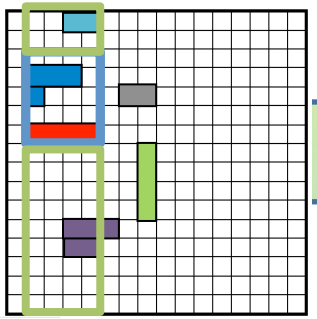




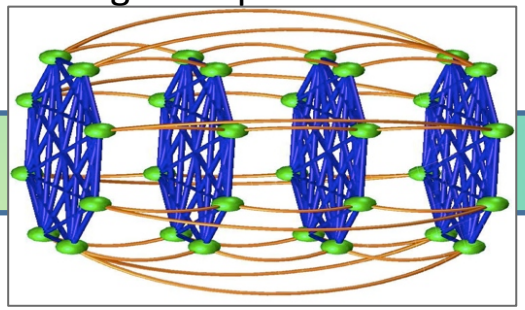


Functional Overview

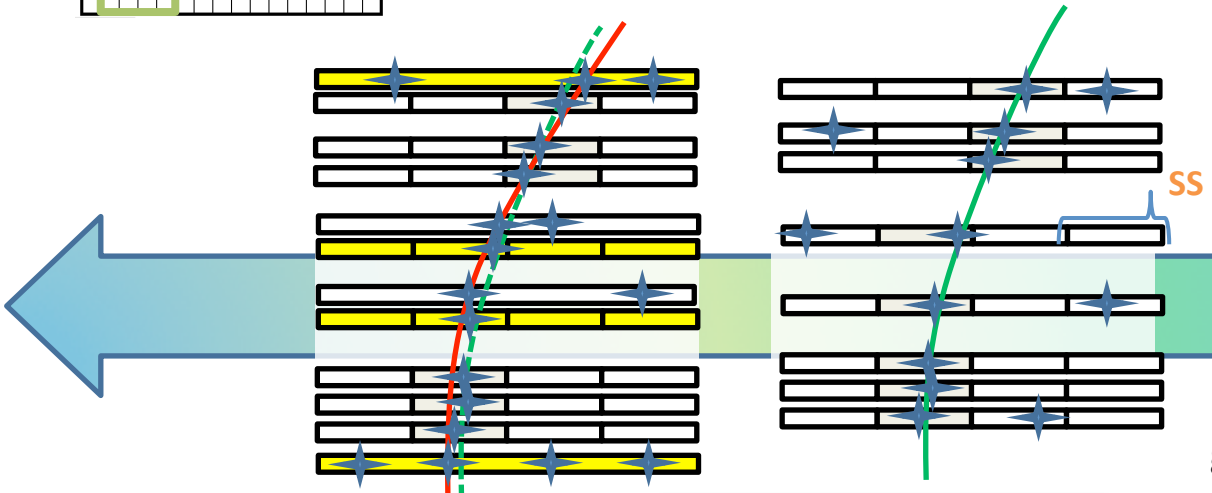
2D pixel clustering



The data are geometrically distributed to the processing units and compared to existing track patterns.



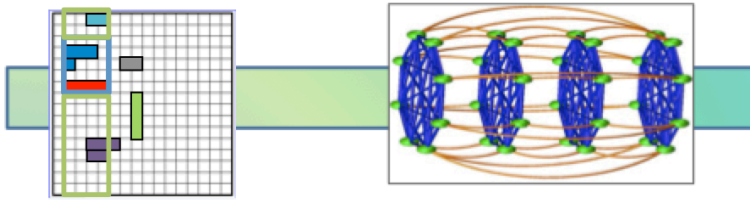
Pattern matching limited to 8 layers: 3 pixels + 5 SCTs.
Hits compared at reduced resolution.



Good 8-layer tracks are extrapolated to additional layers, improving the fit

$$p_i = \sum_j C_{ij} \cdot x_j + q_i$$

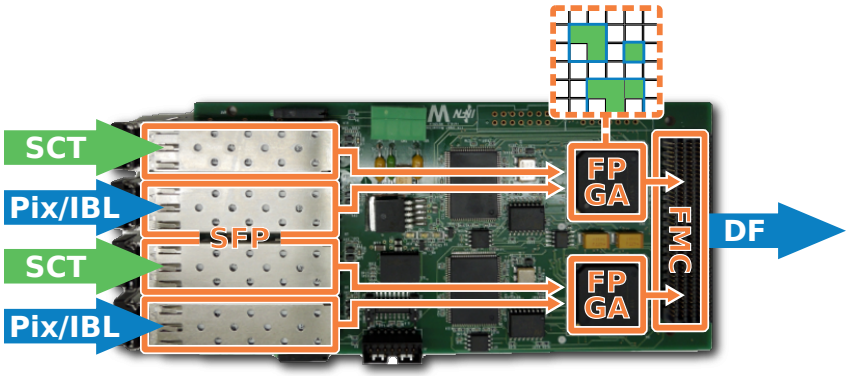
Full hit precision restored in good roads.
Fits reduced to scalar products.



Input processing

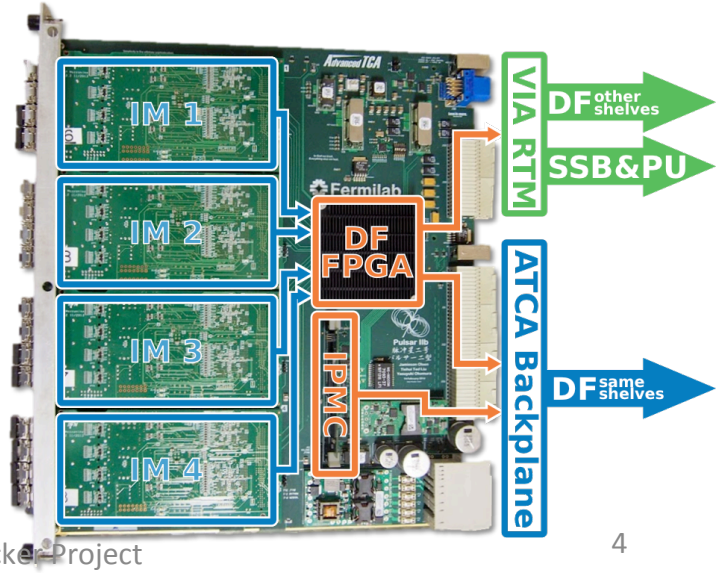
Input Mezzanine (128/128)

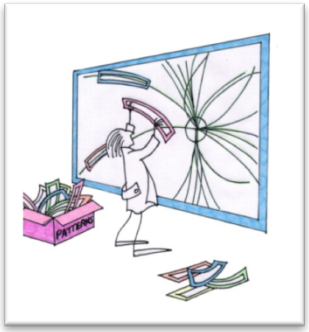
- Dual output HOLA's allow a copy of the ID data to be sent to the FTK Input Mezzanine (IM).
- IMs perform clustering of the ID hits – important for data reduction and resolution
- These are are passed on to the Data Formatter



Data Formatter (32/32)

- Redistributing the clusters into 64 eta-phi towers
- Using ATCA backplane communication and inter-shelf fibers for the distributing the hits into eta-phi towers
- Commissioned 1 out of 4 shelves

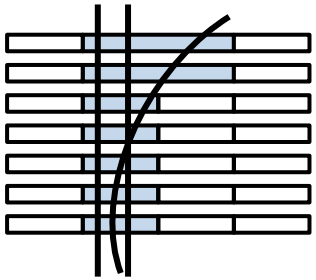


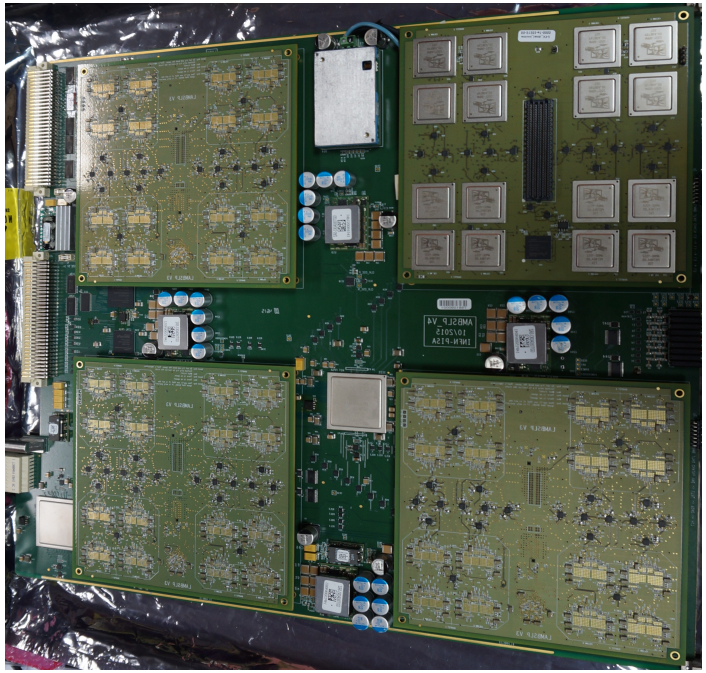


Processing Unit

Associative Memory Board (AMB) & Little AMB (16/124)

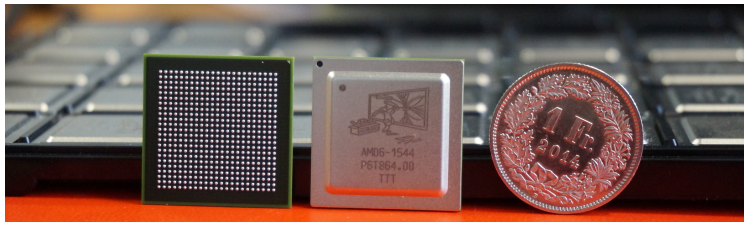
- SuperStrips are defined as a collection of pixels/strips
- If a cluster is present in a SuperStrip it is considered as fired
- The AM chip matching 7 out 8 streams (8 layers) of incoming SuperStrips with the stored patterns
- 64 AM Chips are housed on a single board AMB on 4 LAMBs
- Over 700 high speed lines



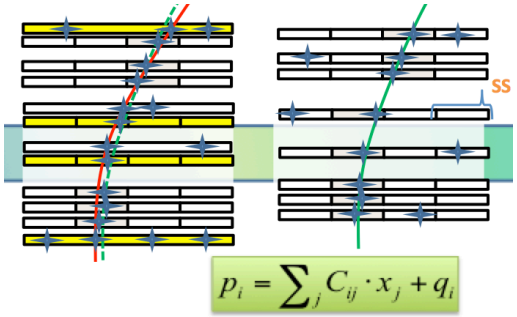


Associative Memory Chip 06 (AM06)

- ASIC built in 65 nm
- Stores 128k patterns (18 words of 18 bits each)
- Performs 10^{14} word comparisons per second
- Allows for patterns with width varying layer by layer (using ternary CAM cells)



Track fitting

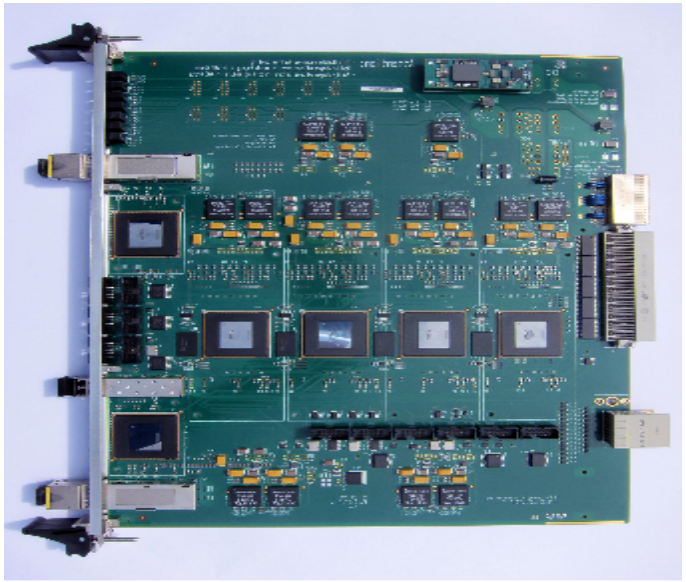


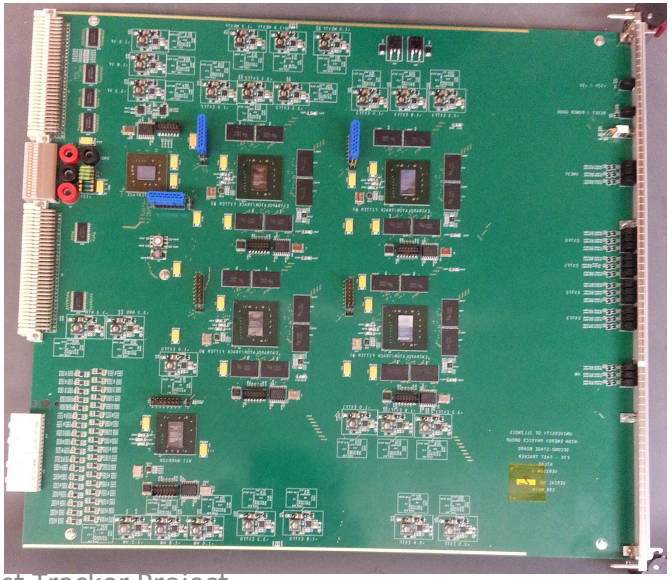
AUX (16/128)

- Full resolution hits in the 8 layers corresponding to the fired pattern are retrieved
- Tracks are fitted using stored constants (linear approximation); retained if they are below a specific χ^2
- Performs local duplicate track removal based on shared hits

Second Stage Board - SSB (8/32)

- Scope – reducing fakes, using all layers for best resolution
- Hits in 4 extra layers are added to the tracks delivered by the AUX
- Linear fits to the hits are performed
- Performs track overlap removal from different towers

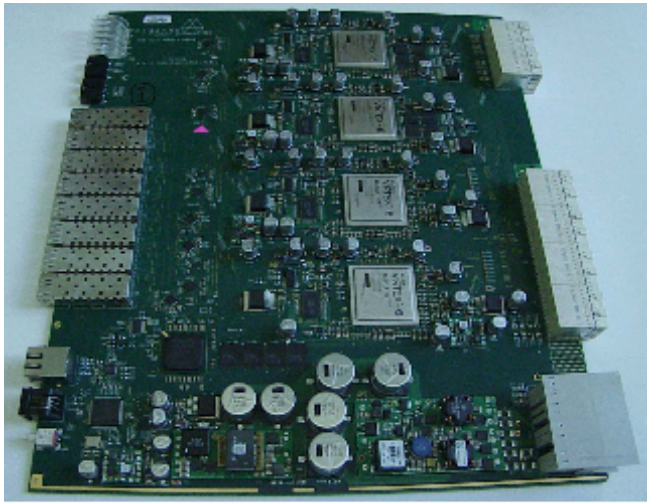


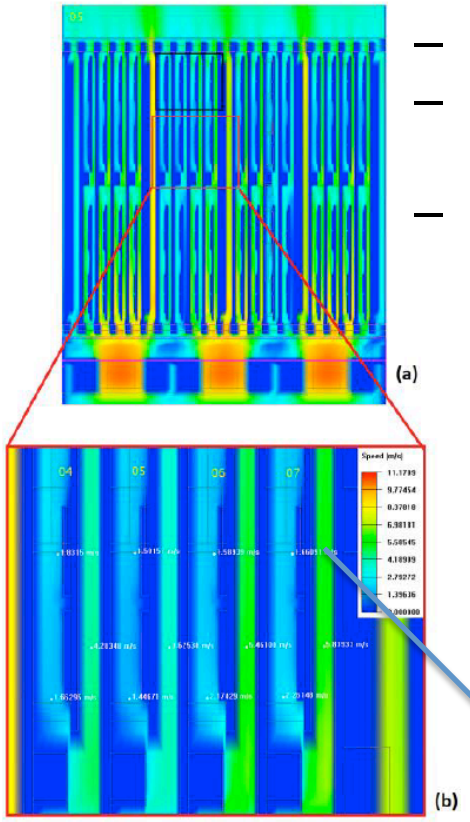


FLIC and Infrastructure

HLT Interface - FLIC (2/2)

- Translates the SSB tracks into ATLAS HLT format





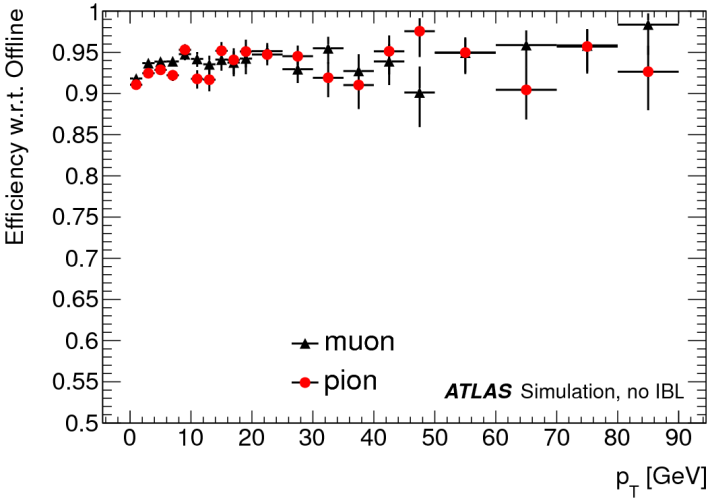
VME – crate airflow simulation

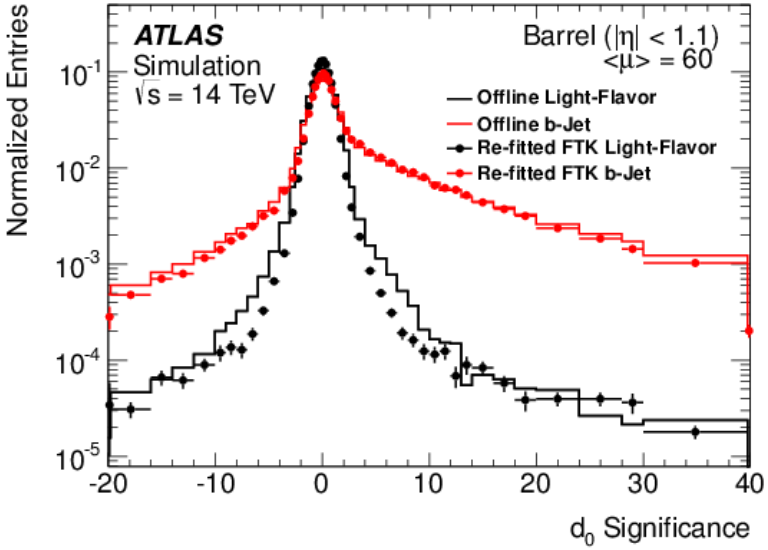
Location of fan

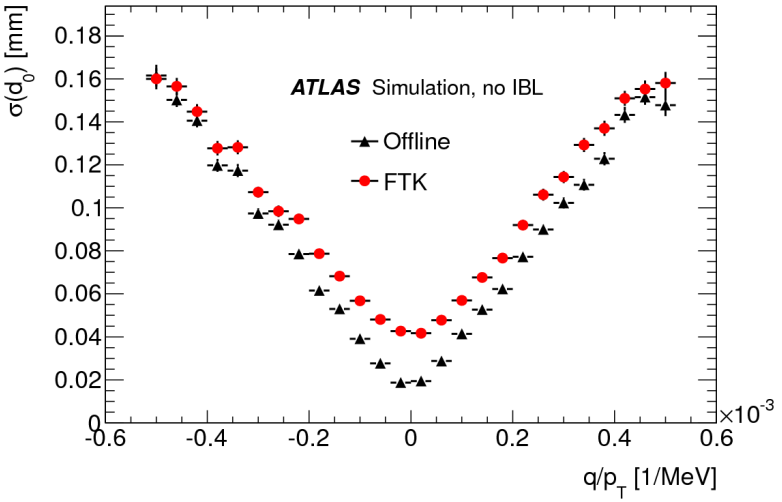
- **Infrastructure**
  - 2.5 racks ATCA – Data Formatter, FLIC
  - 4 racks VME – AUX, AMB, SSB
  - Custom CAEN PS – powering 2 VME crates in a single rack
  - Extensive power/cooling studies for VME racks were performed with mock up boards and simulation.

Expected performance

- FTK is more that 90% efficient with respect to offline reconstruction
- Differences come from:
  - Targeting only tracks above 1 GeV
  - Use of simplified clustering, track fitting
  - Using only the Silicon Detectors

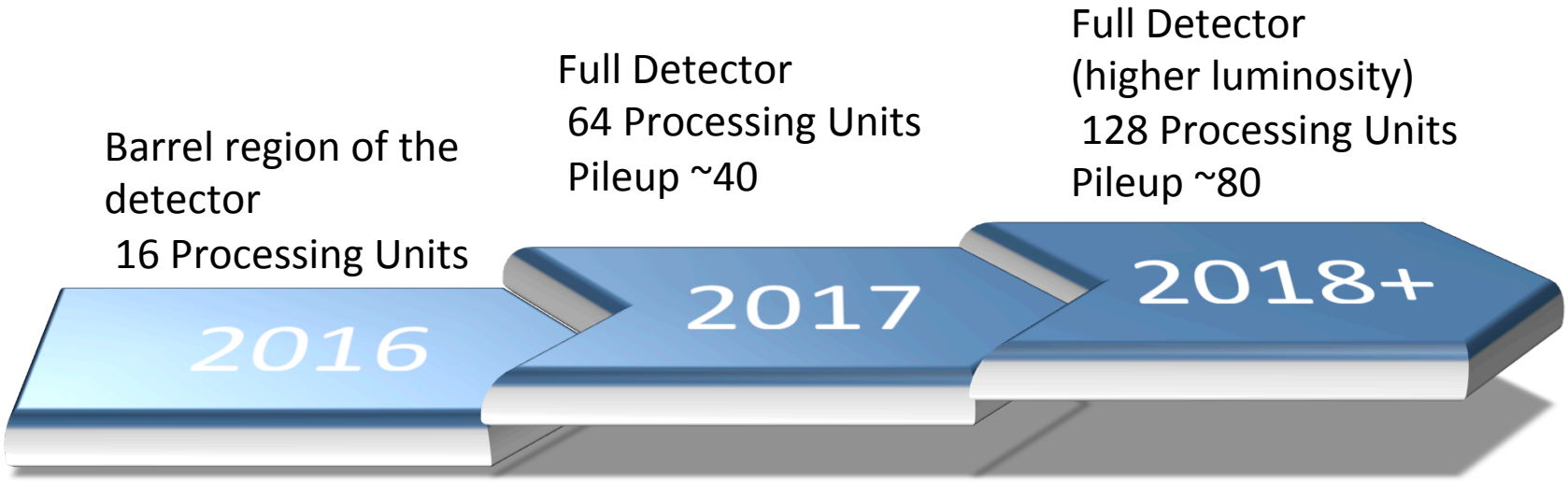






Conclusions and timeline

- FTK will provide **full scan** tracks with **p_T > 1 GeV** to HLT at **100 kHz**
- Board development is complete
- HW production is being completed
- Installation of hardware and commissioning of FW is underway
- Expected to provide tracks to HLT in barrel limited coverage |η|<1.1 in late 2016



FTK TDR: https://cds.cern.ch/record/1552953/
FTK Public results: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/FTKPublicResults