The Tenth Annual Large Hadron Collider Physics Conference(LHCP) May 16-20, 2022

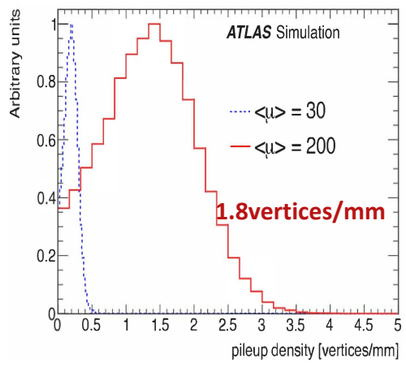
Developing a production database for the High Granularity Timing Detector for ATLAS Phase-II upgrade

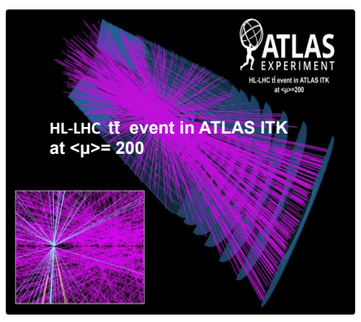
High Luminosity LHC (HL-LHC)

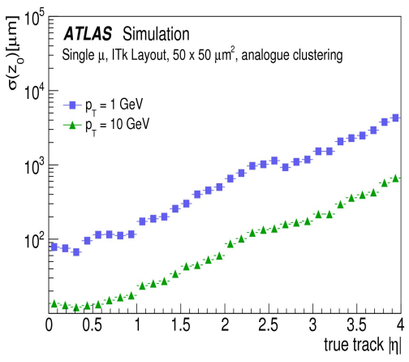
- HL-LHC is foreseen to start running in 2028.
- Instantaneous Luminosity: L ≈ 7.5 × $10^{34}$$cm^{-2}$ s^{-1}
- Integrated Luminosity (10 years): L ≈ 4000 fb^{-1}
- Up to 200 inelastic interactions ("pile-up") on average per bunch crossing .

➠ Driving motivation for HGTD

Reconstruction challenges at ⟨μ⟩ = 200



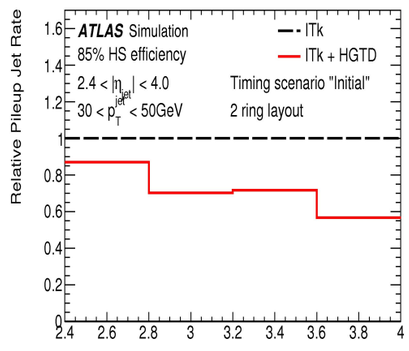


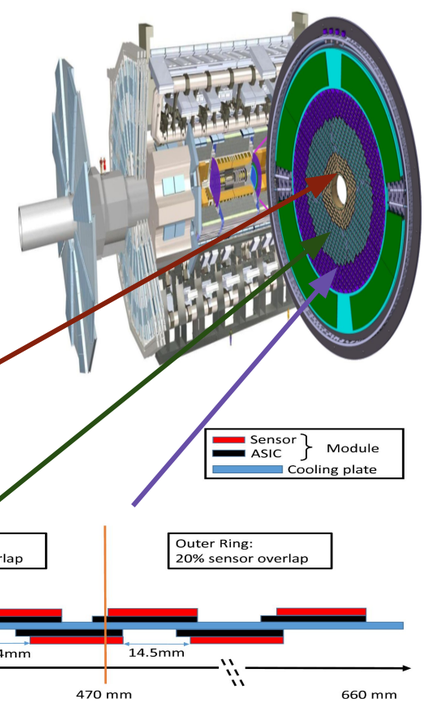


Increased residual pileup contamination when assigning reconstructed objects to the reconstructed vertex.

High Granularity Timing Detector(HGTD)

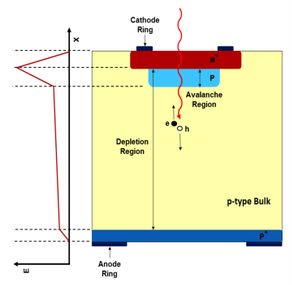
- **Main goal**: improve the ATLAS functionality in the high-pileup environment provided by the HL-LHC.
- Pseudo-rapidity coverage: 2.4< | η | < 4
- High-precision time measurement: 30-50 ps time resolution per track.
- Active area : 120mm< r <640mm
- End-caps: z = ± 3.5m
- Improve pileup rejection by a factor of 6 and correct track-to-vertex association.



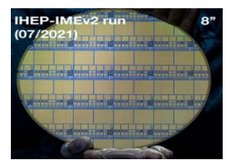


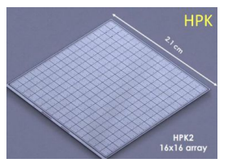
Low Gain Avalanche Diode LGAD

- Standard n-p Si detector with an additional p-type doped layer.
- Small rise time: ~0.5ns
- fast charge collection~1 ns
- 50 μm active thickness.



- Excellent time resolution: <30 ps before irradiation.

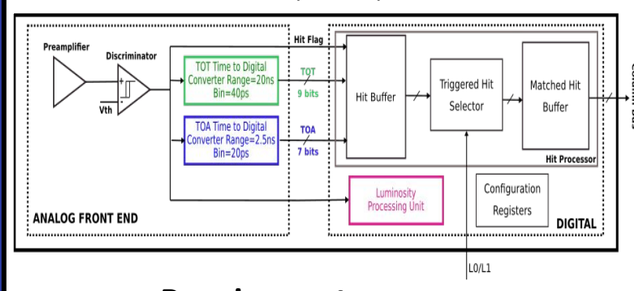




- HGTD prototypes are produced by CNM (Spain), HPK(Japan), FBK (Italy) and IME;NDL (China).

HGTD Front-End Electronics ASIC

- Signal from each LGAD sensor will be read out using the ALTIROC chip.
  - Pre-amplifier followed by TOA and TOT.
  - TSMC CMOS 130nm technology. Total of 225 readout channels (15x15).



Requirements

- σ_t < 25ps
- Total dose: 2MGy
- Discriminator threshold: 2fC
- Minimise noise and power consumption.

HGTD Production Database Setup and Structure

- A **production database(DB)** is an important tool for tracking the history and quality control (QC) performance of components in each HGTD module and detector unit.

❑ Production Database Content

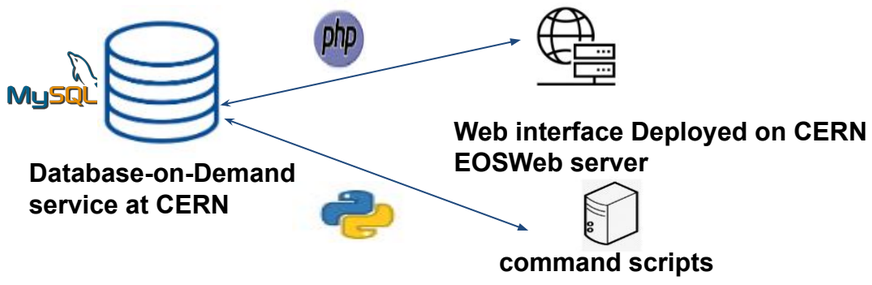
❖ **Detail information of the components used**

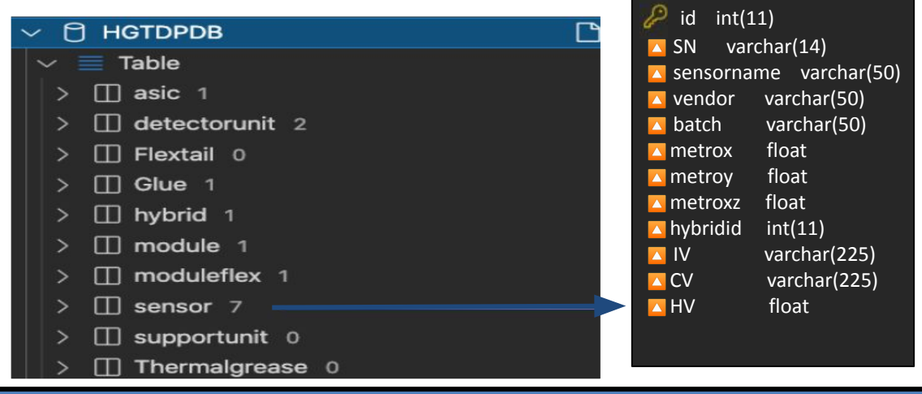
- Production: **vendor, batch,site**
- Metrology: **x,y,z**
- Operational properties:**IV,CV..**
- Link to next object
- Visual inspection: **pictures**
- Destructive tests: **shear of bumps**
- History and Quality Control

❖ **Location of where the modules are installed in the detector**

- The content of the production database has been implemented into the MYSQL database. Tables and columns were defined accordingly.
- Each table of the database contains a column that identifies each row of records(id column).
- The Serial Number(SN), a meaningful 14 digits pattern was used to identify components.
- Example **sensor table ->** IV varchar(255) variable: stores the .csv file of sensor IV measurements. The name of file can hold either numeric or character or both(varchar type) .

❑ Development Strategy





HGTD Production Database Web User Interface

- Web applications with many features for viewing ,uploding and retrieving information from the database.

Web page Interface

ATLAS-CERN, HGTD Production Database

You are not logged in to view this content. Please login or create an account.

Login

Are you new here?

Create account

❑ A query for selecting HGTD components, displaying the data from the database

- Add new data
- query Search for data using SN

Name of the .csv file in the database

❑ Displaying IV plot using a file of sensor IV measurements

❑ Store and show pictures for the components

Name of the picture in the database

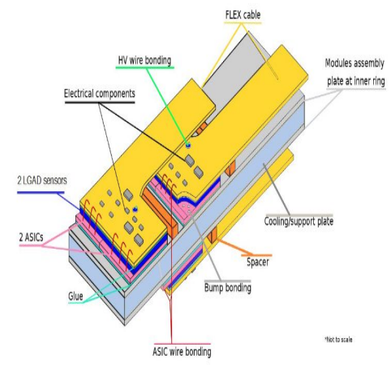
Microscope photo of an HPK-3.1 15×15 array sensor

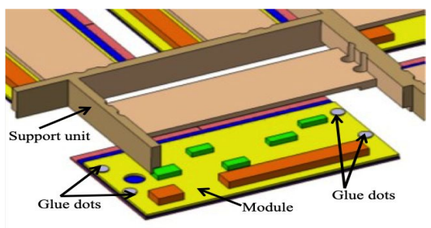
❑ Demos of some dummy data recorded in the database

HGTD Module and Detector Unit

Sensors bump-bonded to ALTIROC ASICs

- 8032 modules: 2 sensors + 2 asics + flex.
- Flex tails carrying HV, LV and signals to/from peripheral electronics boards (PEB).





Drawing of the module with glue dots for the fixation to the support unit

- Modules are installed and glued on plates (the support units) to be screwed on each side of one of the four cooling plates.

Conclusion

- The HGTD aims to improve pile-up rejection at the ATLAS experiment during the Large Hadron Collider (LHC) which is expected to start in 2028.
- The setup and the design of the HGTD production database were done using MYSQL technology.
- A web interface page with many features was developed and now is being tested by the HGTD community.
- Currently, many efforts are being made to continue the development of the HGTD production database.

Reference

ATLAS Collaboration.Technical design report:A high-granularity timing detector for the ATLAS phase-II upgrade. Technical report, 2020.https://cds.cern.ch/record/2719855

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