HGTD Production Database

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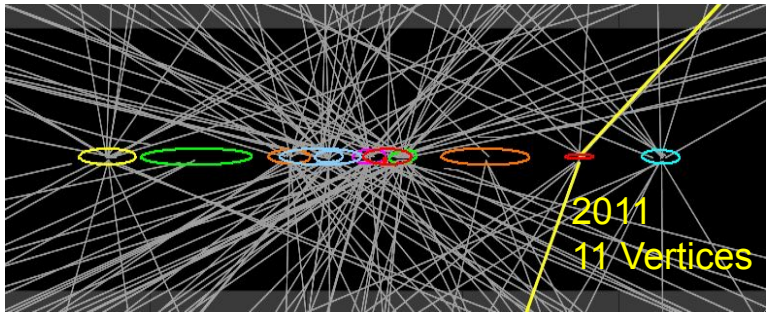
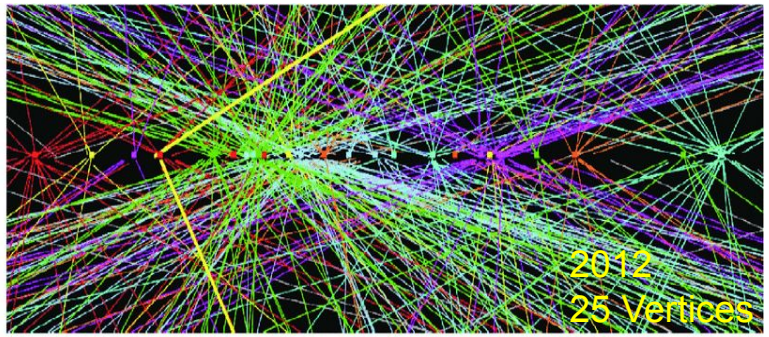
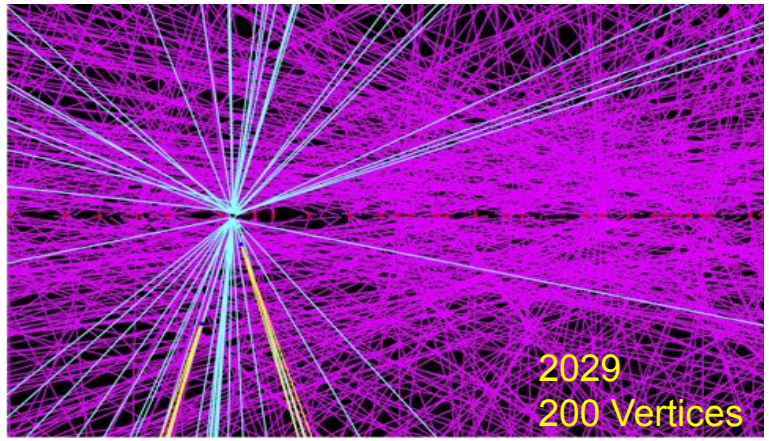
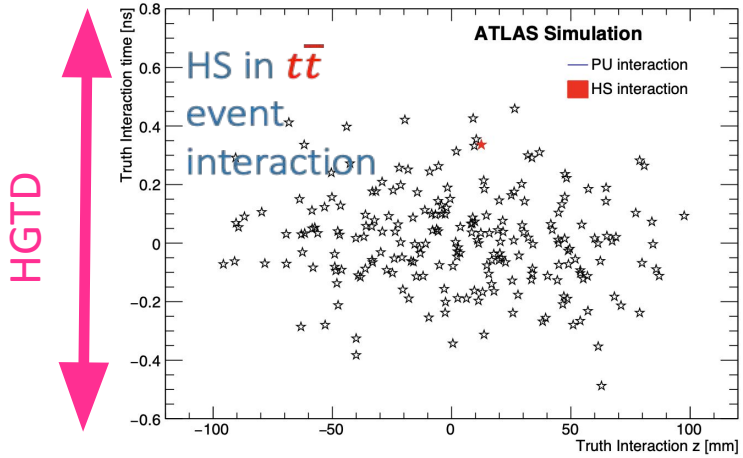
High Luminosity (HL)-LHC program

- Key numbers :
  - Instantaneous luminosity 7.5x1034 $cm^{-2}s^{-1}$ (~5 times Run 2)
  - Pile-up density (μ) 200 in bc of 25 ns
  - Interaction Density 1.8 vertices/mm
- Challenges
  - Primary vertex reconstruction
  - Detector radiation hardness
- High Granularity Timing Detector (HGTD) provides an extra dimension (time) to separate the individual interactions



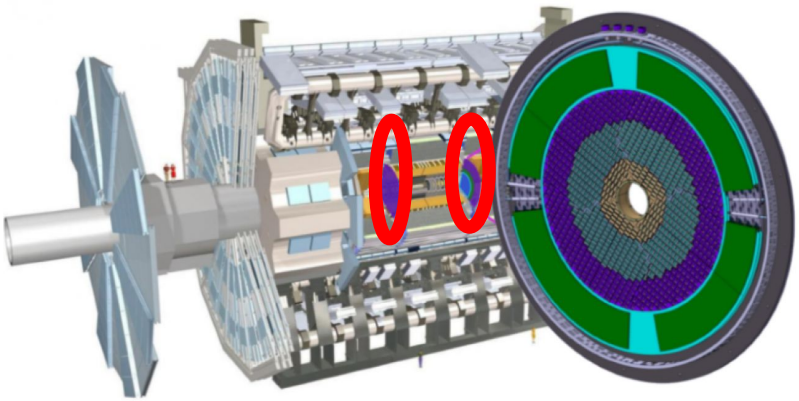


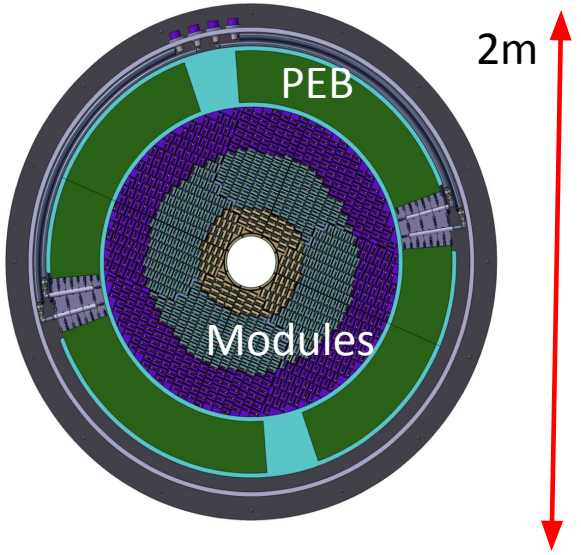




High Granularity Timing Detector(HGTD)

- HGTD is being designed for operation with average pile-up = 200 and a total integrated luminosity of 4000 fb^{-1}
- Consisted of Low Gain Avalanche Diode (LGAD) sensors
- Time resolution
  - 30-50 ps/per track
  - 35-70 ps/per hit
- Luminosity measurements
  - Goal for HL-LHC: 1% luminosity uncertainty



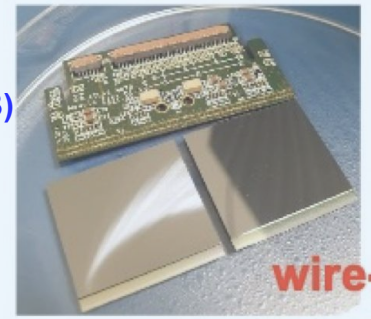


HGTD module assembly

1

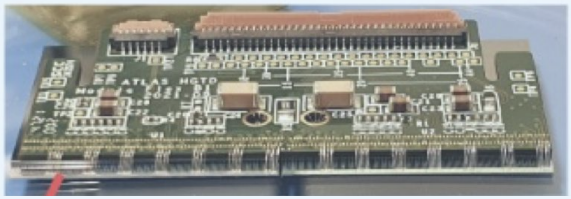
Module FLEX (flexible PCB)

2 Hybrid (LGAD + ASIC)



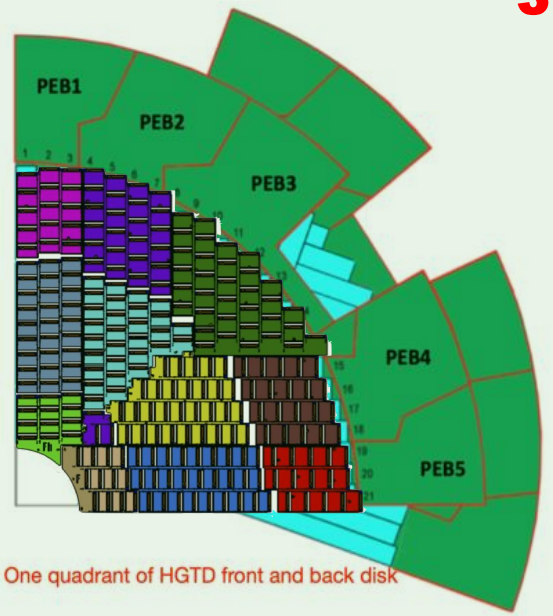
Module
(8034 modules per disc)

glue+
wire-bonds



Assembled module

3



One quadrant of HGTD front and back disk

2

PEB
(peripheral
electronics)

HGTD Production Database

- Production database to monitor and record HGTD construction
  - Large amount of different components
  - Production history and quality control
  - Measurements
  - Relationship of components(assembly)
- Characteristic of the database
  - A flexible and generic database design for components registration, attributes and module assembly.
  - Provision of shipment and handling
  - Custom tables for measurements and quality control data.

Measurements

- Leakage current, breakdown voltage of the LGAD sensors, timing calibration of the ASICs
- Component metrology (e.g. length, width, thickness…)
- Component images

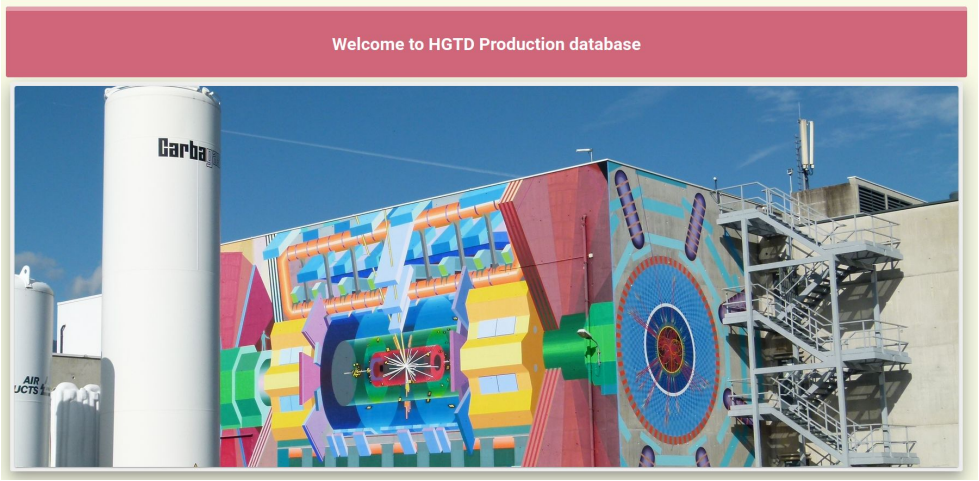
Components to be registered

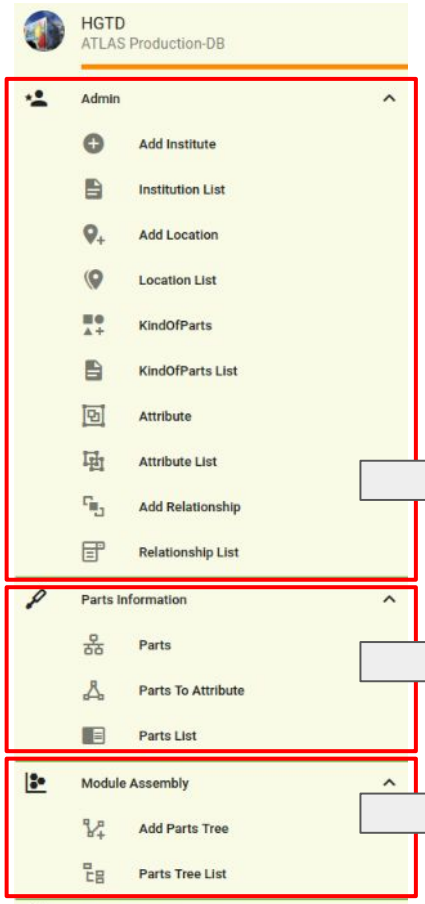
- sensor wafer, sensor
- ASIC (front end readout chip)
- Hybrid
- module flex
- Module
- flex tail
- support unit
- detector unit
- peripheral electrics board (PEB)

HGTD Production Database

- Oracle database hosted at CERN
- Web Applications
  - Frontend Application
    - VueJS based application that provides interface for the client to interact with the database.
    - Calls backend APIs provided by backend application.
    - Used for components registration, data uploading, module assembly and other relevant tasks.
  - Backend Application
    - Developed in Django REST Framework.
    - Provides APIs to frontend application and interacts directly with the database
    - Monitoring Application
    - Provides JSON endpoints to Grafana interface for data visualization.

Current Status





➢ Database is setup and applications are deployed

Completed:

- ➢ Admin Panel
  - Define HGTD institutes, Locations, Component Types, Component Attributes, Relationship
- ➢ Registration Panel
  - Registration of components and attributes
- ➢ Module Assembly
  - Define hierarchy of relationship between components

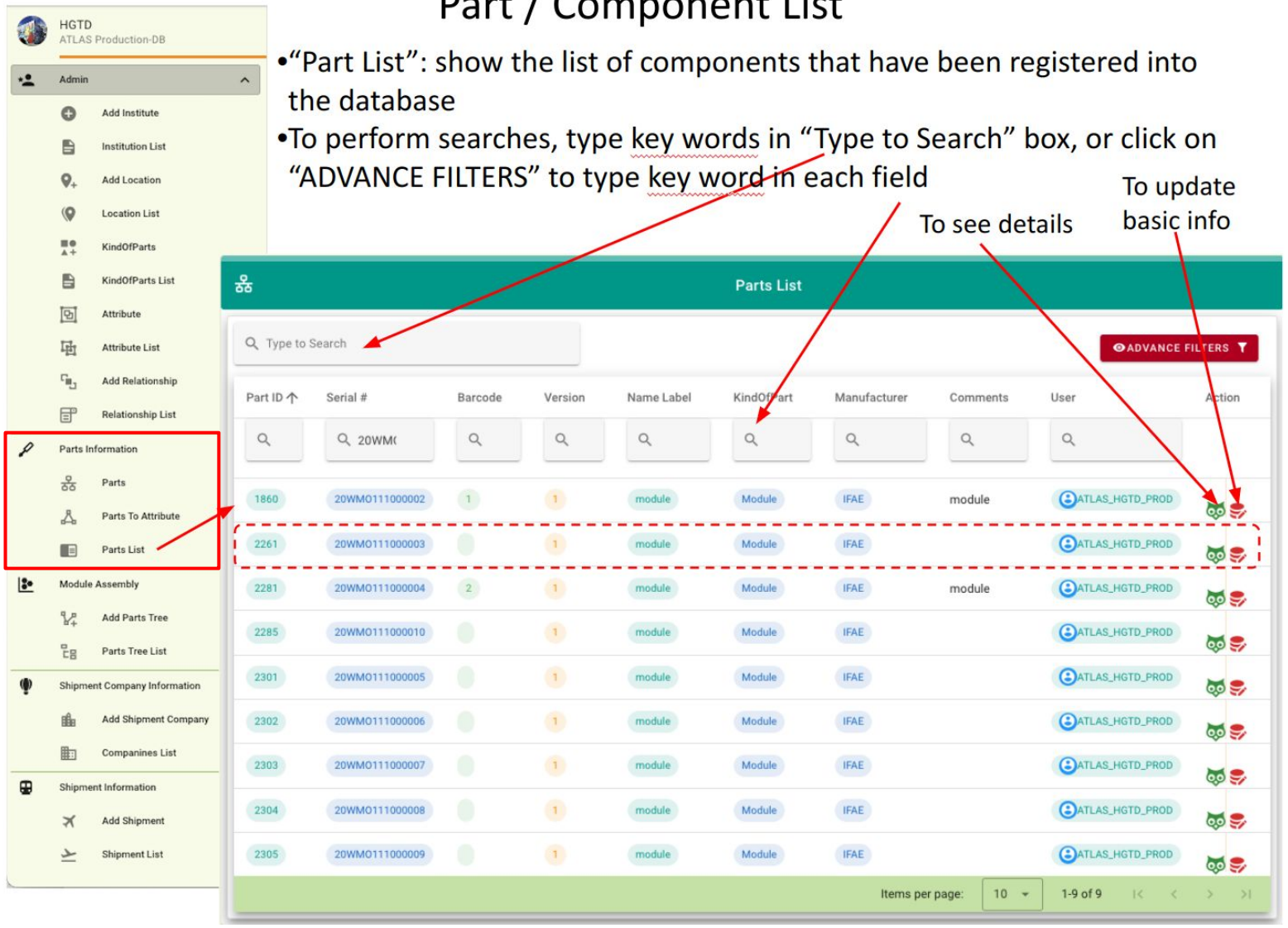
Part/Component List

Part / Component List

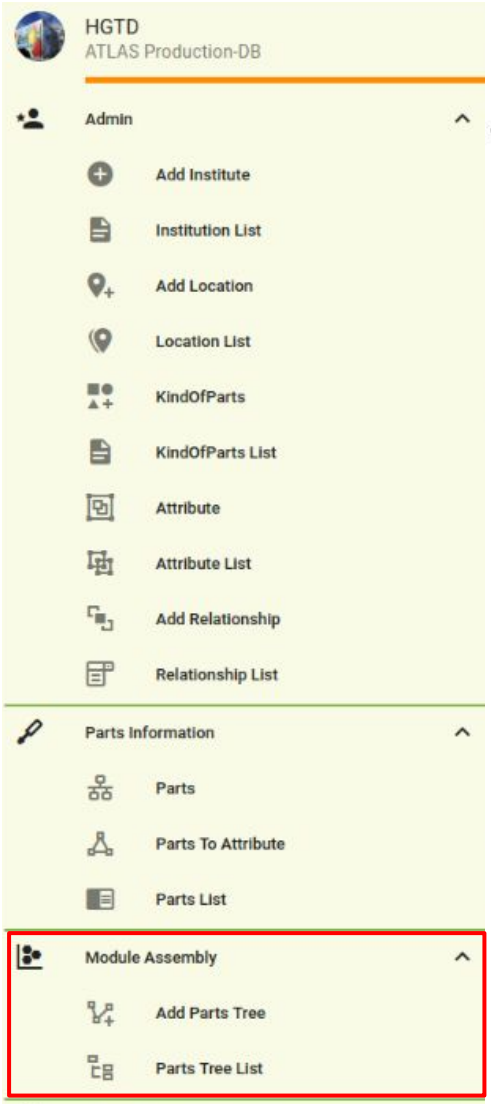
- "Part List": show the list of components that have been registered into the database
- To perform searches, type key words in "Type to Search" box, or click on "ADVANCE FILTERS" to type key word in each field

To see details

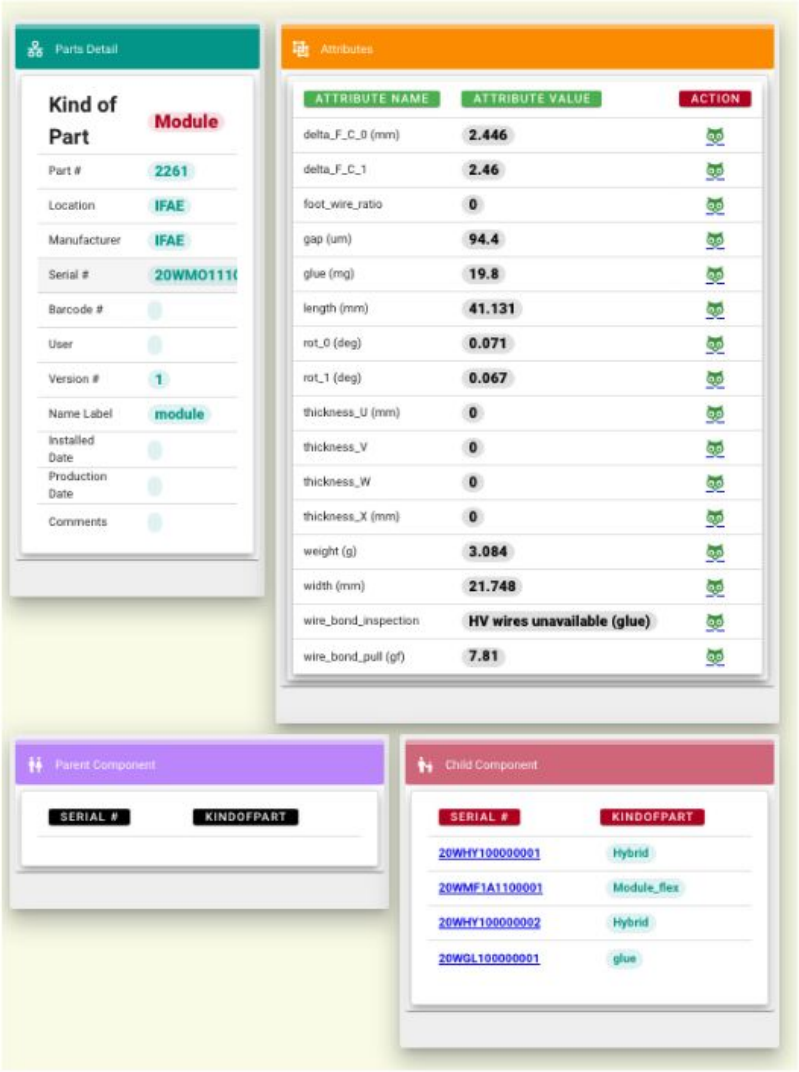
To update basic info



Registered modules

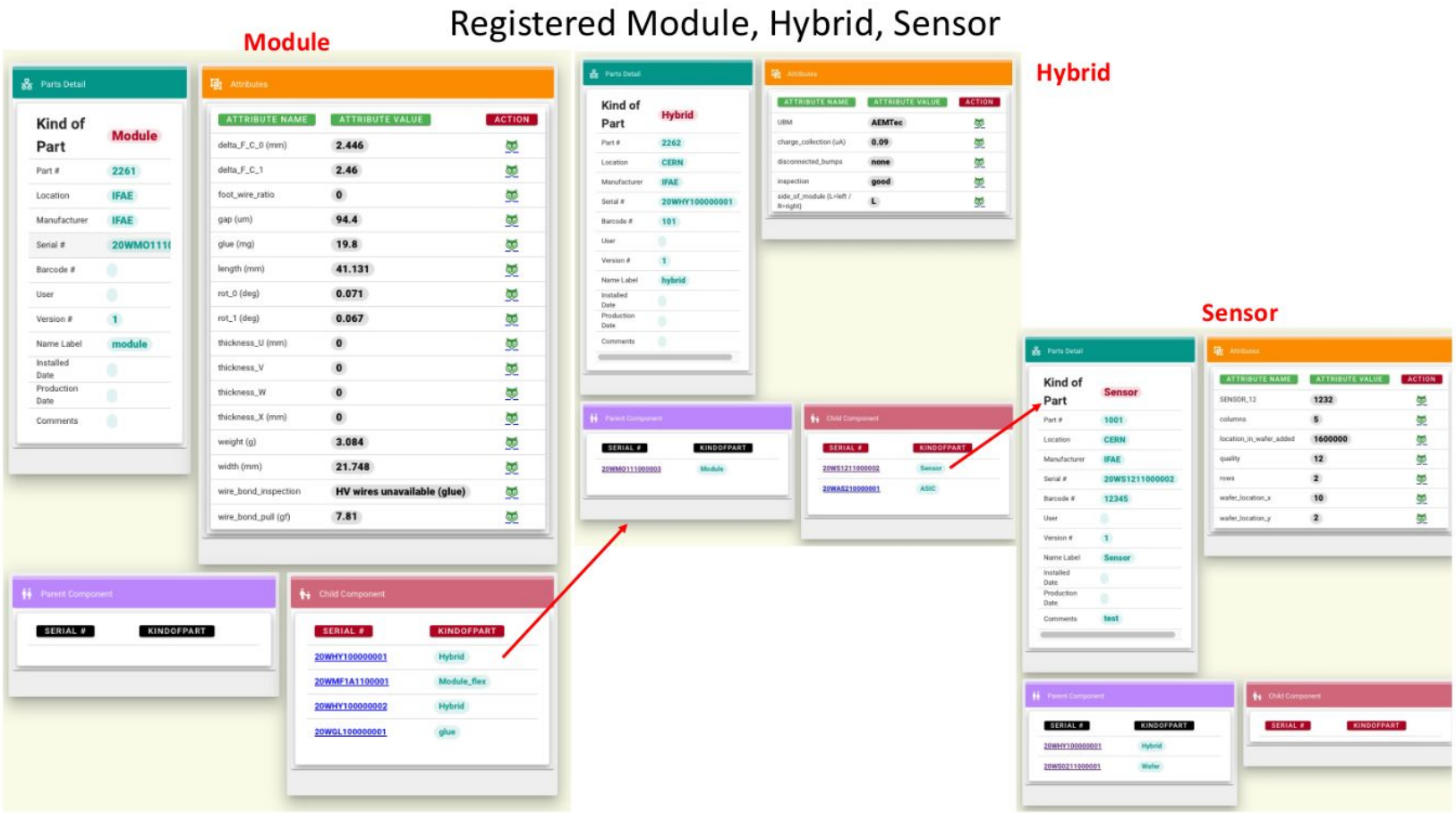


- Module basic information



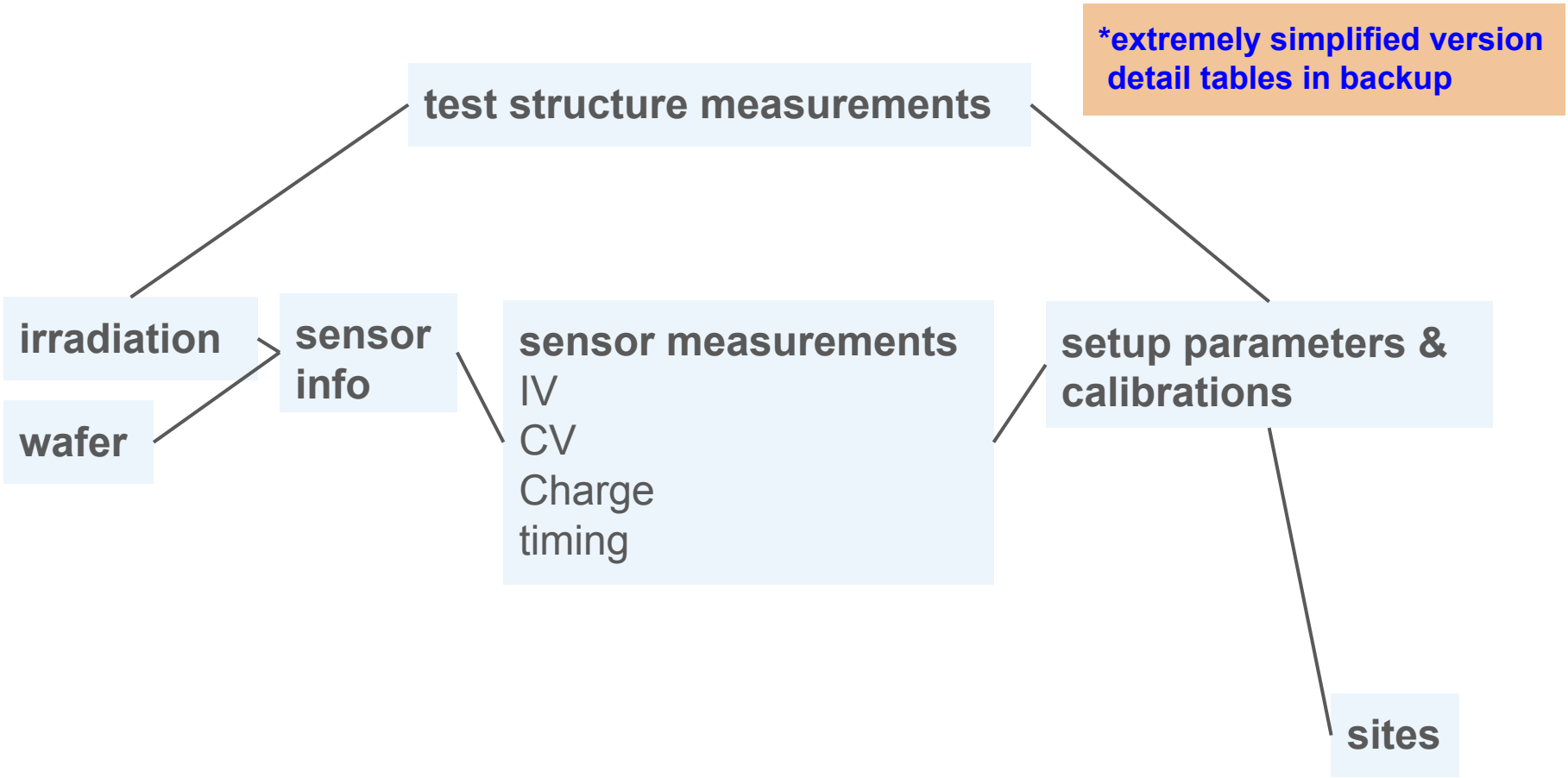
- Module attributes
- Children components of module

Relationship of components



In development

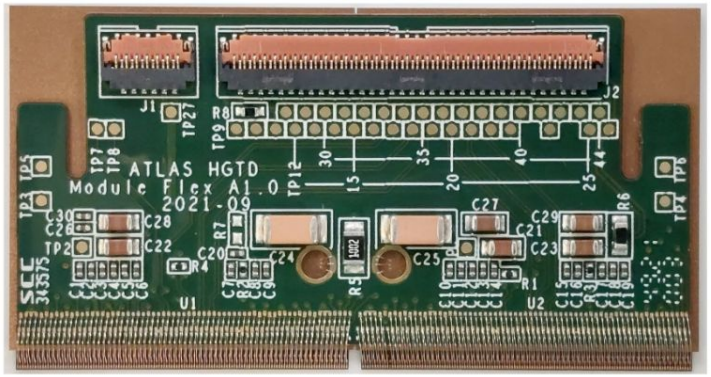
- Structure for tables for sensor measurements
  - Structure taken from “old MySQL database. to be updated
  - New database can provide better relationships of tables



In development

- Display uploaded component photographs

Assembled module



Flex tail

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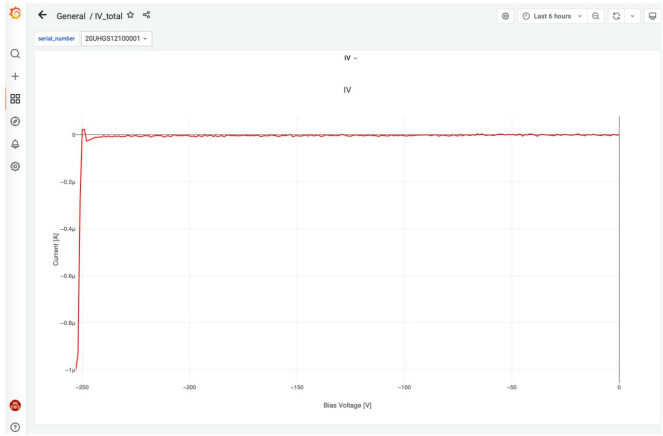
- JSON endpoints to link with Grafana
  - APIs to link data from database to view in Grafana web interface.
- Shipments
  - Register shipment, Add components in shipment, update shipment information.

Sensor leakage current IV curve



Summary

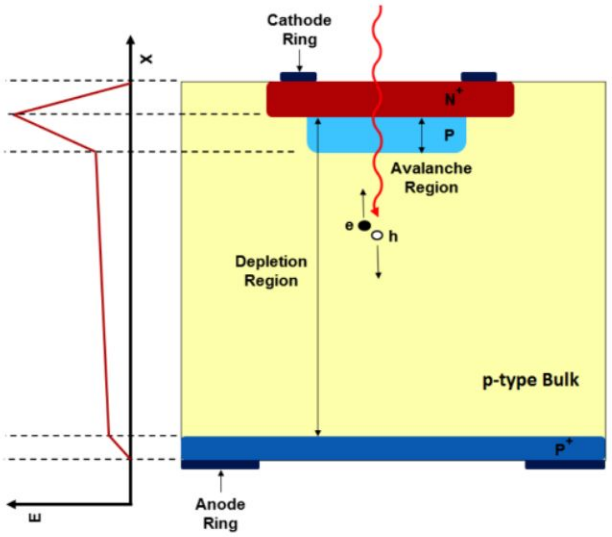
- HGTD Production Database is setup and hosted at CERN
- Has a flexible and generic database design for registering HGTD components
- Currently testing registration of components and making relationship links between the associated components
- Focusing on
  - Implementing functions to upload measurement data
  - Display the measurements
  - Display uploaded component photographs
  - Register component shipments
- Target to complete the production database development by spring 2024 before the start of main production of the HGTD

Thank you !

Back up

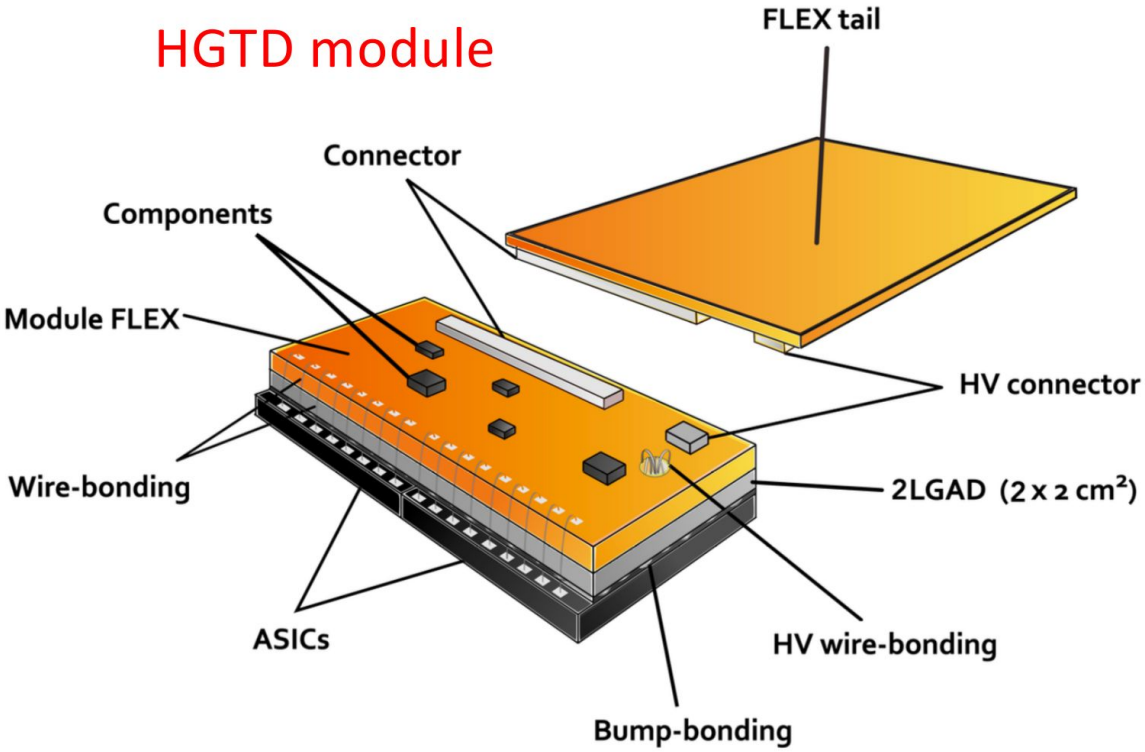
Low Gain Avalanche Diode: Sensors

- LGAD sensors are an advanced type of silicon photodetector that harness the avalanche multiplication effect to amplify signals
- LGAD sensors operate in a low gain mode, ensuring linearity and reducing excess noise
- LGAD specifics for HGTD
  - 50 µm thick
    - Compromise between Landau fluctuations contributing to the time resolution etc
  - Pad size1.3 ×1.3 mm^2
    - Compromise between rise time, capacitance, occupancy
  - Signal level: 10 fC (w/20 gain) before and 4 fC (w/8 gain) after irradiation

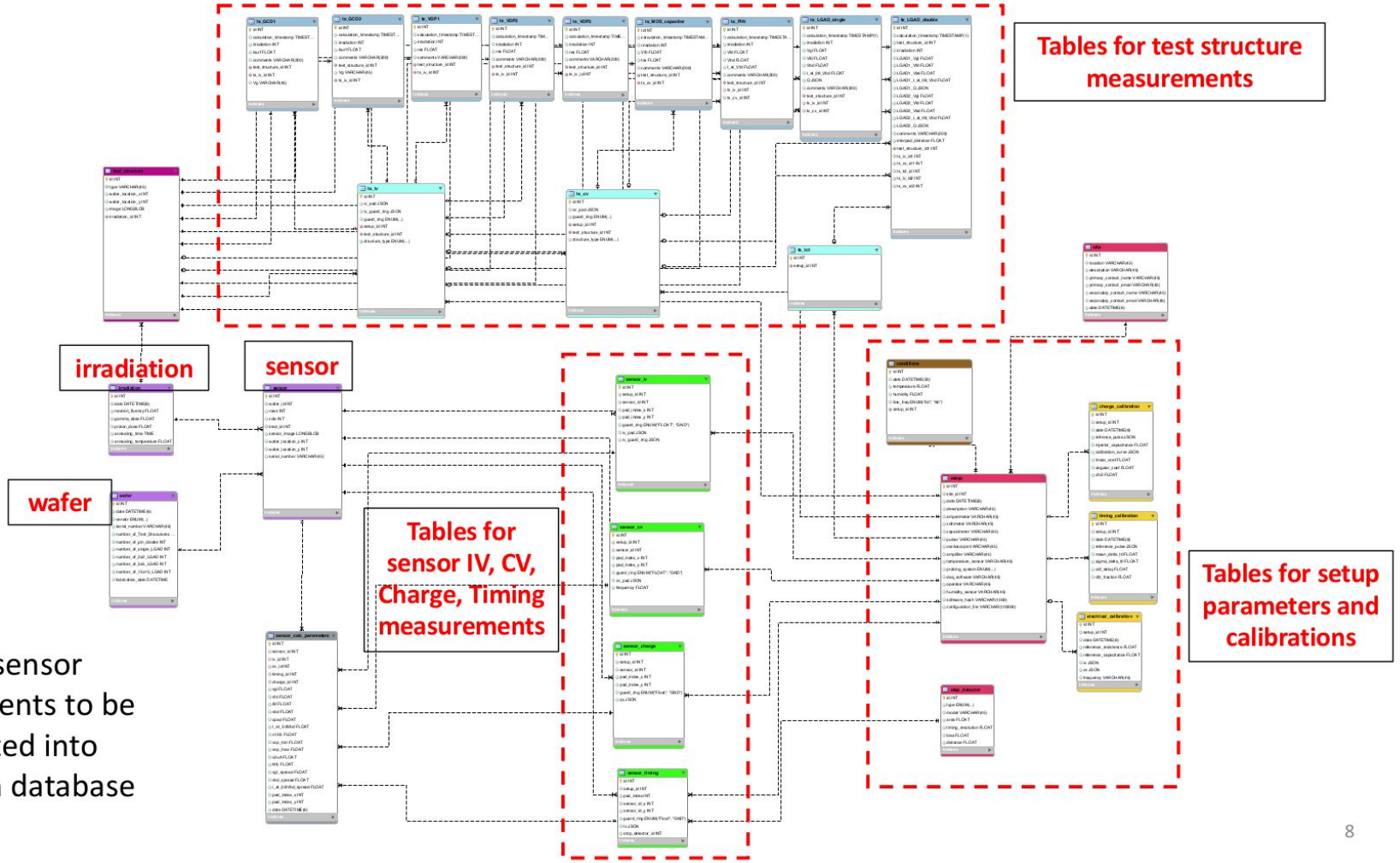


HDTD modules

- Each module consists of two bump-bonded LGAD sensor+ASIC readout chip combinations, glued and wire-bonded to a module flex
- Module = 2 Hybrid (LGAD + ASIC) + Module FLEX (flexible PCB)
- Flexible PCB connect to peripheral electronics(PEB) through FLEX tail



Tables for sensor measurements



- Tables for sensor measurements to be implemented into production database

ASIC test measurements