

HGTD Production Database

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On behalf of TW ATLAS team

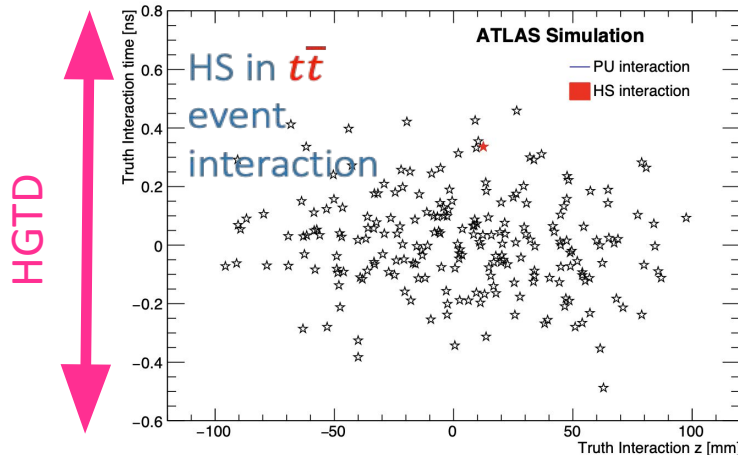
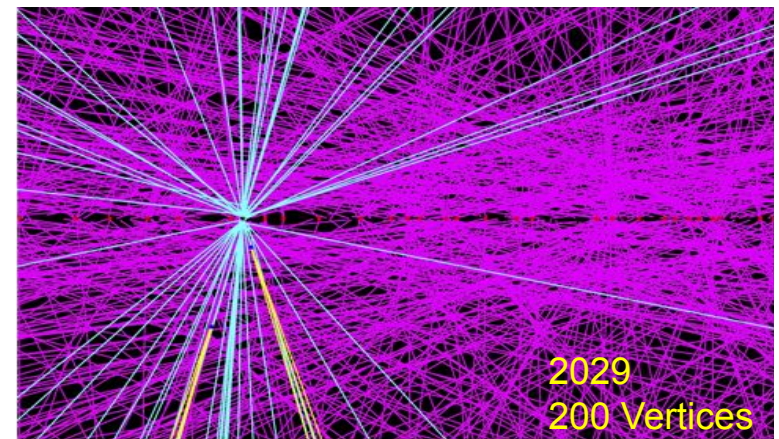
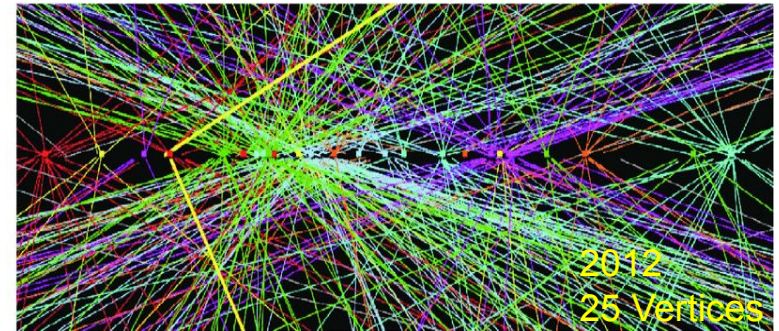
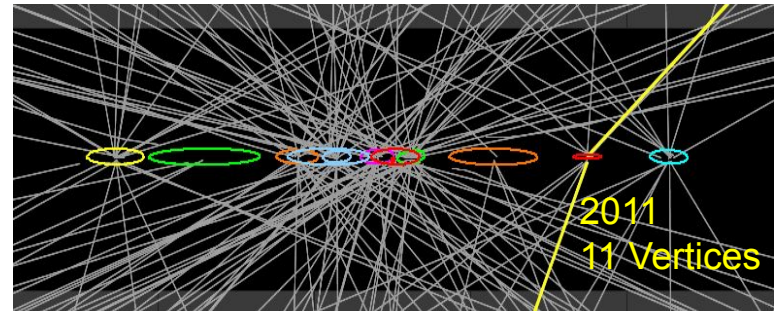
25th Nov, 2023

2023 TIDC



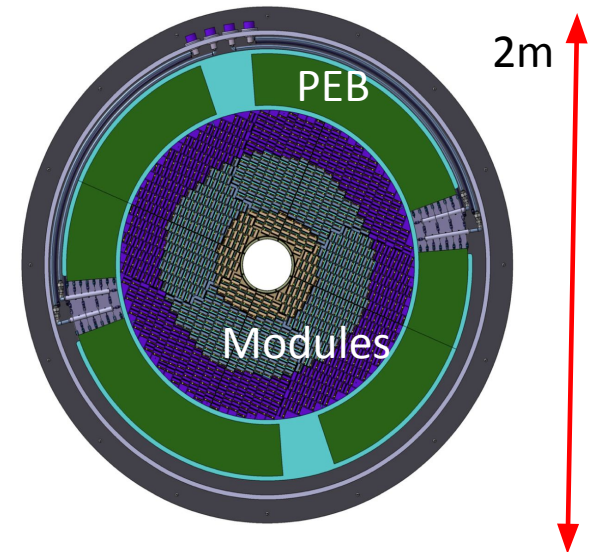
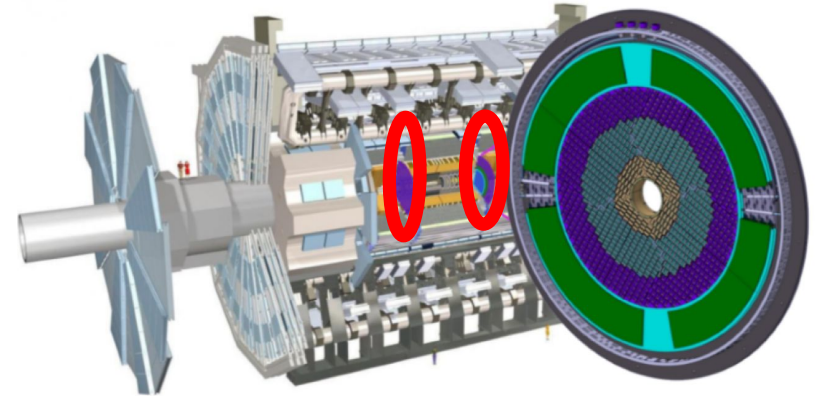
High Luminosity (HL)-LHC program

- Key numbers :
 - Instantaneous luminosity $7.5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ (~ 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

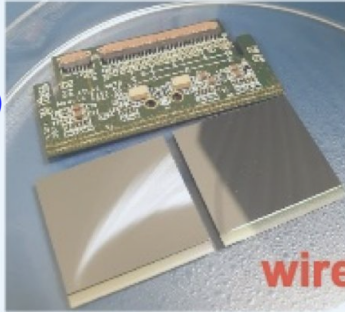


HGTD module assembly

1

Module FLEX (flexible PCB)

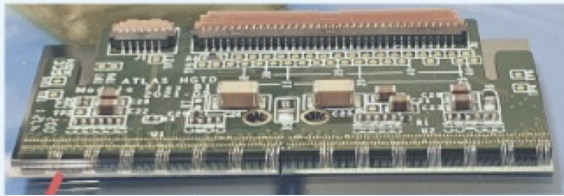
2 Hybrid (LGAD + ASIC)



Module

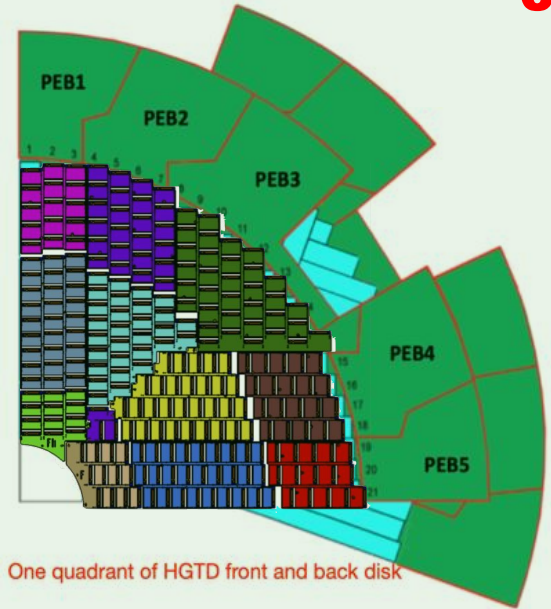
(8034 modules per disc)

glue+
wire-bonds



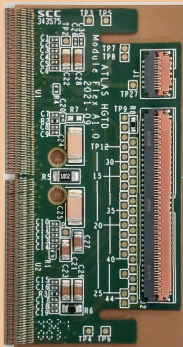
Assembled module

3



One quadrant of HGTD front and back disk

2



Flex tails

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

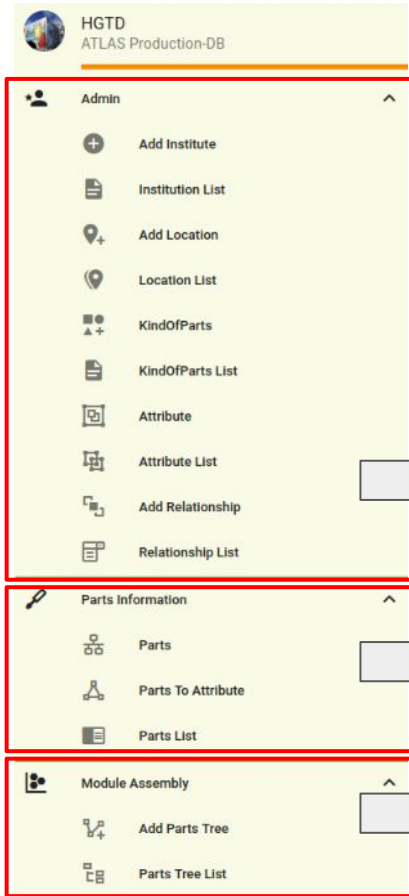
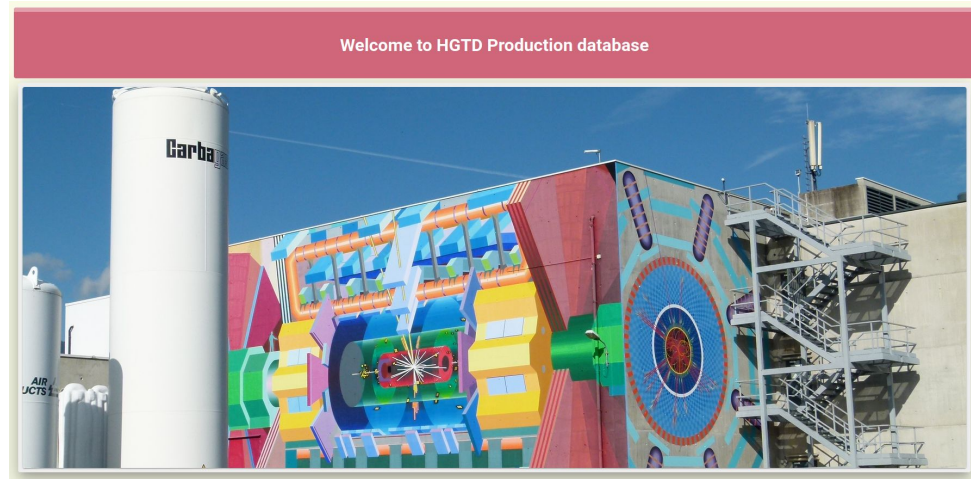
- sensor wafer, sensor
- ASIC (front end readout chip)
- Hybrid
- module flex
- Module
- flex tail
- support unit
- detector unit
- peripheral electrics board (PEB)

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

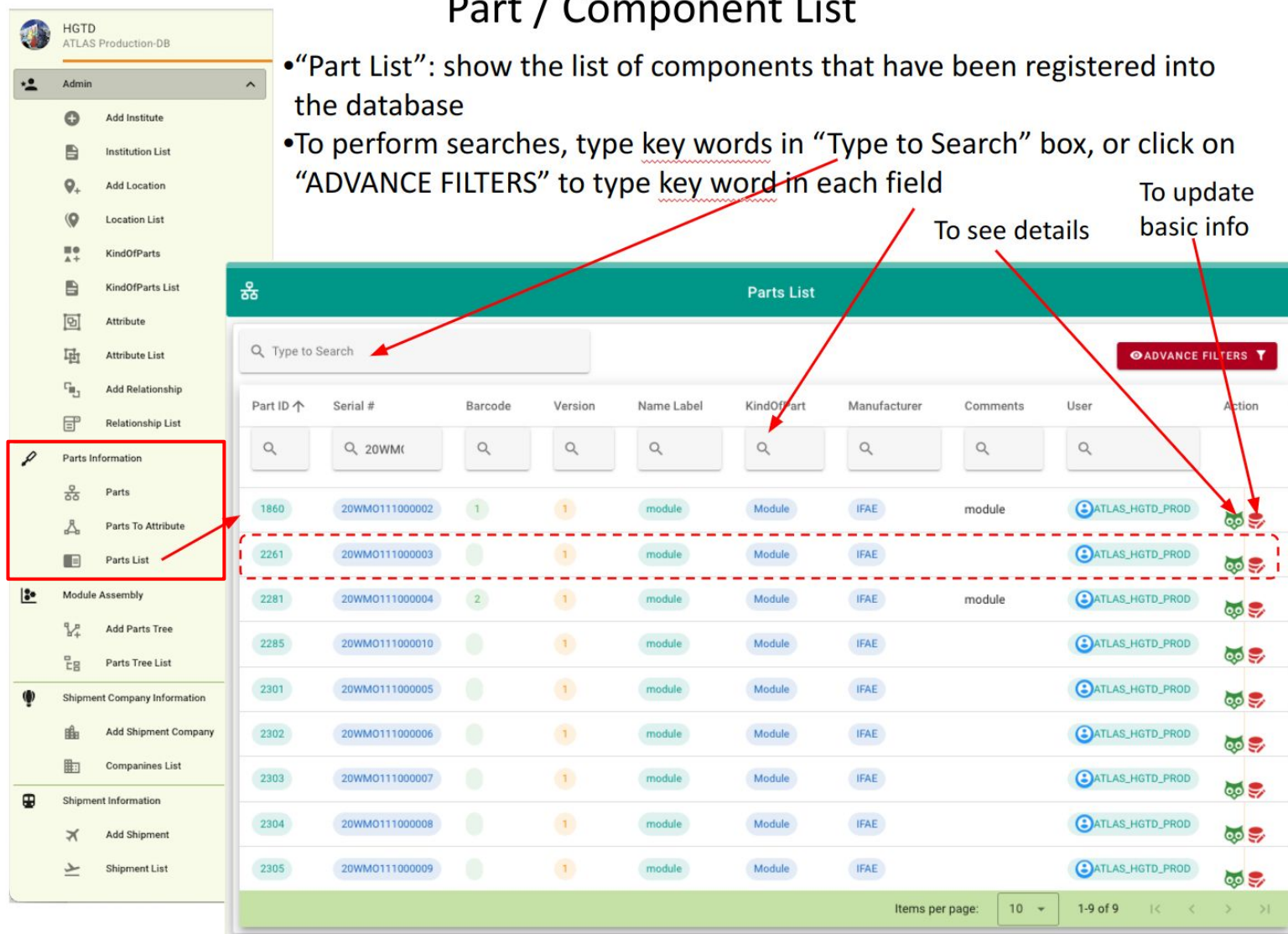
➤ Module Assembly

- 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



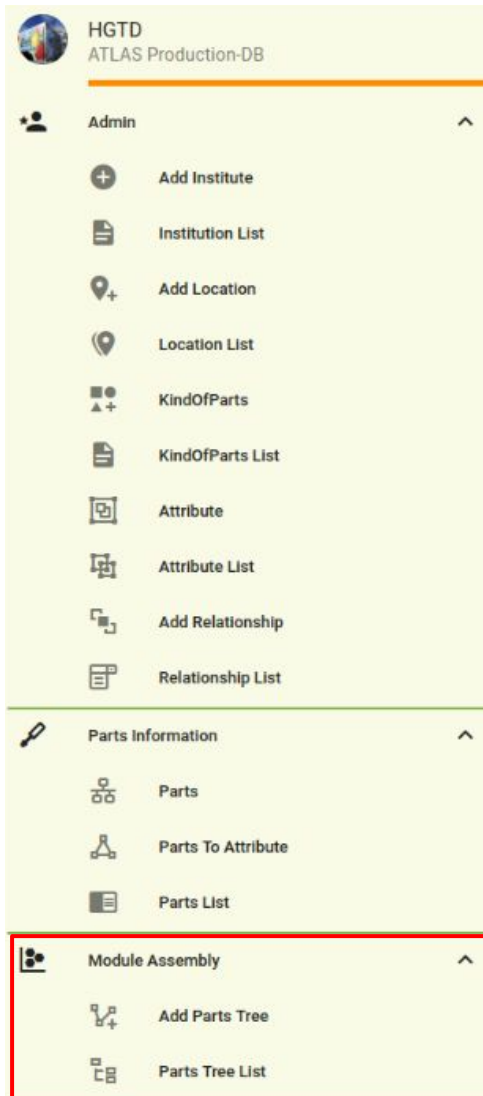
The screenshot displays the ATLAS Production-DB interface. The sidebar on the left contains navigation options, with 'Parts List' highlighted in a red box. The main content area shows a table titled 'Parts List' with columns: Part ID, Serial #, Barcode, Version, Name Label, KindOfPart, Manufacturer, Comments, User, and Action. A search bar at the top left is labeled 'Type to Search'. A red arrow points to the search bar. Another red arrow points to the 'Parts List' menu item in the sidebar. A third red arrow points to the 'ADVANCE FILTERS' button. A red dashed box highlights the second row of the table, which has Part ID 2261 and Serial # 20WMO111000003.

Part ID ↑	Serial #	Barcode	Version	Name Label	KindOfPart	Manufacturer	Comments	User	Action
1860	20WMO111000002	1	1	module	Module	IFAE	module	ATLAS_HGTD_PROD	
2261	20WMO111000003		1	module	Module	IFAE		ATLAS_HGTD_PROD	
2281	20WMO111000004	2	1	module	Module	IFAE	module	ATLAS_HGTD_PROD	
2285	20WMO111000010		1	module	Module	IFAE		ATLAS_HGTD_PROD	
2301	20WMO111000005		1	module	Module	IFAE		ATLAS_HGTD_PROD	
2302	20WMO111000006		1	module	Module	IFAE		ATLAS_HGTD_PROD	
2303	20WMO111000007		1	module	Module	IFAE		ATLAS_HGTD_PROD	
2304	20WMO111000008		1	module	Module	IFAE		ATLAS_HGTD_PROD	
2305	20WMO111000009		1	module	Module	IFAE		ATLAS_HGTD_PROD	

To see details

To update basic info

Registered modules



HGTD
ATLAS Production-DB

Admin

- Add Institute
- Institution List
- Add Location
- Location List
- KindOfParts
- KindOfParts List
- Attribute
- Attribute List
- Add Relationship
- Relationship List

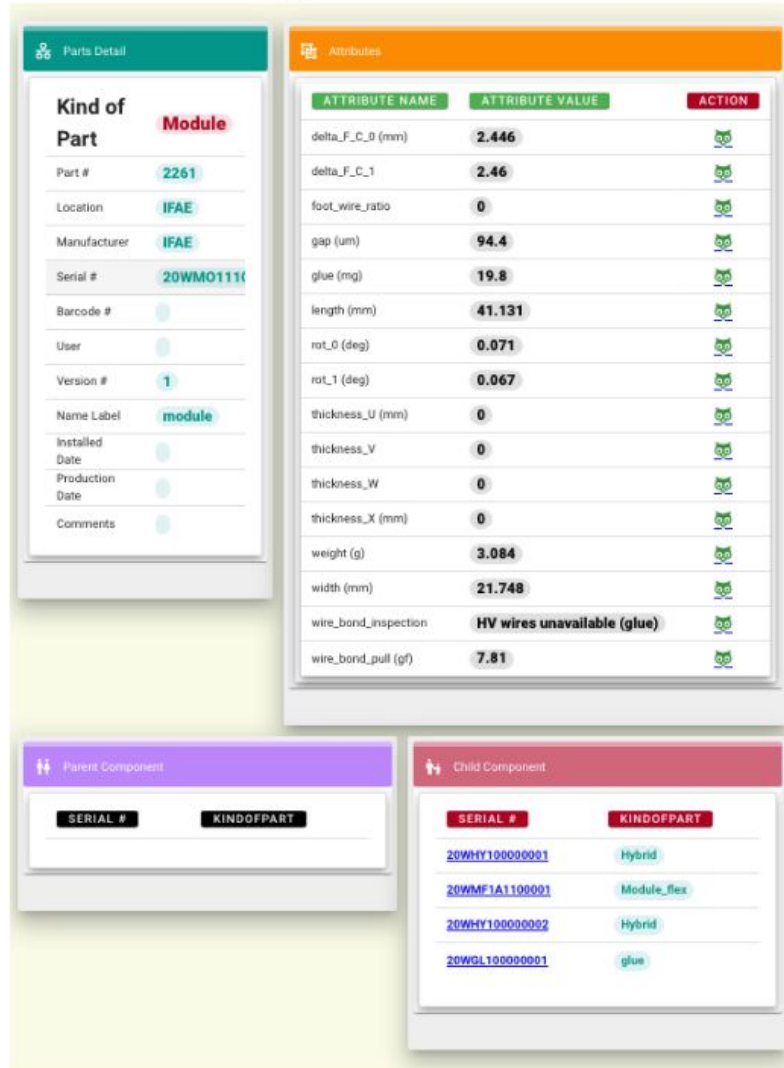
Parts Information

- Parts
- Parts To Attribute
- Parts List

Module Assembly

- Add Parts Tree
- Parts Tree List

• Module basic information



Parts Detail

Kind of Part: **Module**

Part #: 2261

Location: IFAE

Manufacturer: IFAE

Serial #: 20WMO1110

Barcode #:

User:

Version #: 1

Name Label: module

Installed Date:

Production Date:

Comments:

Attributes

ATTRIBUTE NAME	ATTRIBUTE VALUE	ACTION
delta_F_C_0 (mm)	2.446	
delta_F_C_1	2.46	
foot_wire_ratio	0	
gap (um)	94.4	
glue (mg)	19.8	
length (mm)	41.131	
rot_0 (deg)	0.071	
rot_1 (deg)	0.067	
thickness_U (mm)	0	
thickness_V	0	
thickness_W	0	
thickness_X (mm)	0	
weight (g)	3.084	
width (mm)	21.748	
wire_bond_inspection	HV wires unavailable (glue)	
wire_bond_pull (gf)	7.81	

Parent Component

SERIAL #	KINDOFPART
20WHY10000001	Hybrid
20WMF1A1100001	Module_flex
20WHY10000002	Hybrid
20WGL10000001	glue

Child Component

• Module attributes

• Children components of module

Relationship of components

Registered Module, Hybrid, Sensor

Module

Registered Module, Hybrid, Sensor

Hybrid

Sensor

The interface displays the following data for each component type:

Module Details:

- Kind of Part: **Module**
- Part #: 2261
- Location: IFAE
- Manufacturer: IFAE
- Serial #: 20WMO1111
- Barcode #: [empty]
- User: [empty]
- Version #: 1
- Name Label: module
- Installed Date: [empty]
- Production Date: [empty]
- Comments: [empty]

ATTRIBUTE NAME	ATTRIBUTE VALUE	ACTION
delta_F_C_D (mm)	2.446	[edit]
delta_F_C_I	2.46	[edit]
foot_wire_ratio	0	[edit]
gap (um)	94.4	[edit]
glue (mg)	19.8	[edit]
length (mm)	41.131	[edit]
rot_D (deg)	0.071	[edit]
rot_1 (deg)	0.067	[edit]
thickness_U (mm)	0	[edit]
thickness_V	0	[edit]
thickness_W	0	[edit]
thickness_X (mm)	0	[edit]
weight (g)	3.084	[edit]
width (mm)	21.748	[edit]
wire_bond_inspection	HV wires unavailable (glue)	[edit]
wire_bond_pull (gf)	7.81	[edit]

Hybrid Details:

- Kind of Part: **Hybrid**
- Part #: 2262
- Location: CERN
- Manufacturer: IFAE
- Serial #: 20WHY10000001
- Barcode #: 101
- User: [empty]
- Version #: 1
- Name Label: hybrid
- Installed Date: [empty]
- Production Date: [empty]
- Comments: [empty]

ATTRIBUTE NAME	ATTRIBUTE VALUE	ACTION
UBM	AEMTec	[edit]
charge_collection (uA)	0.09	[edit]
disconnected_bumps	none	[edit]
inspection	good	[edit]
side_of_module (L=left / R=right)	L	[edit]

Sensor Details:

- Kind of Part: **Sensor**
- Part #: 1001
- Location: CERN
- Manufacturer: IFAE
- Serial #: 20WS1211000002
- Barcode #: 12345
- User: [empty]
- Version #: 1
- Name Label: sensor
- Installed Date: [empty]
- Production Date: [empty]
- Comments: test

ATTRIBUTE NAME	ATTRIBUTE VALUE	ACTION
SENSOR_L12	1232	[edit]
columns	5	[edit]
location_in_wafer_added	1600000	[edit]
quality	12	[edit]
rows	2	[edit]
wafer_location_x	10	[edit]
wafer_location_y	2	[edit]

Parent Component Relationships:

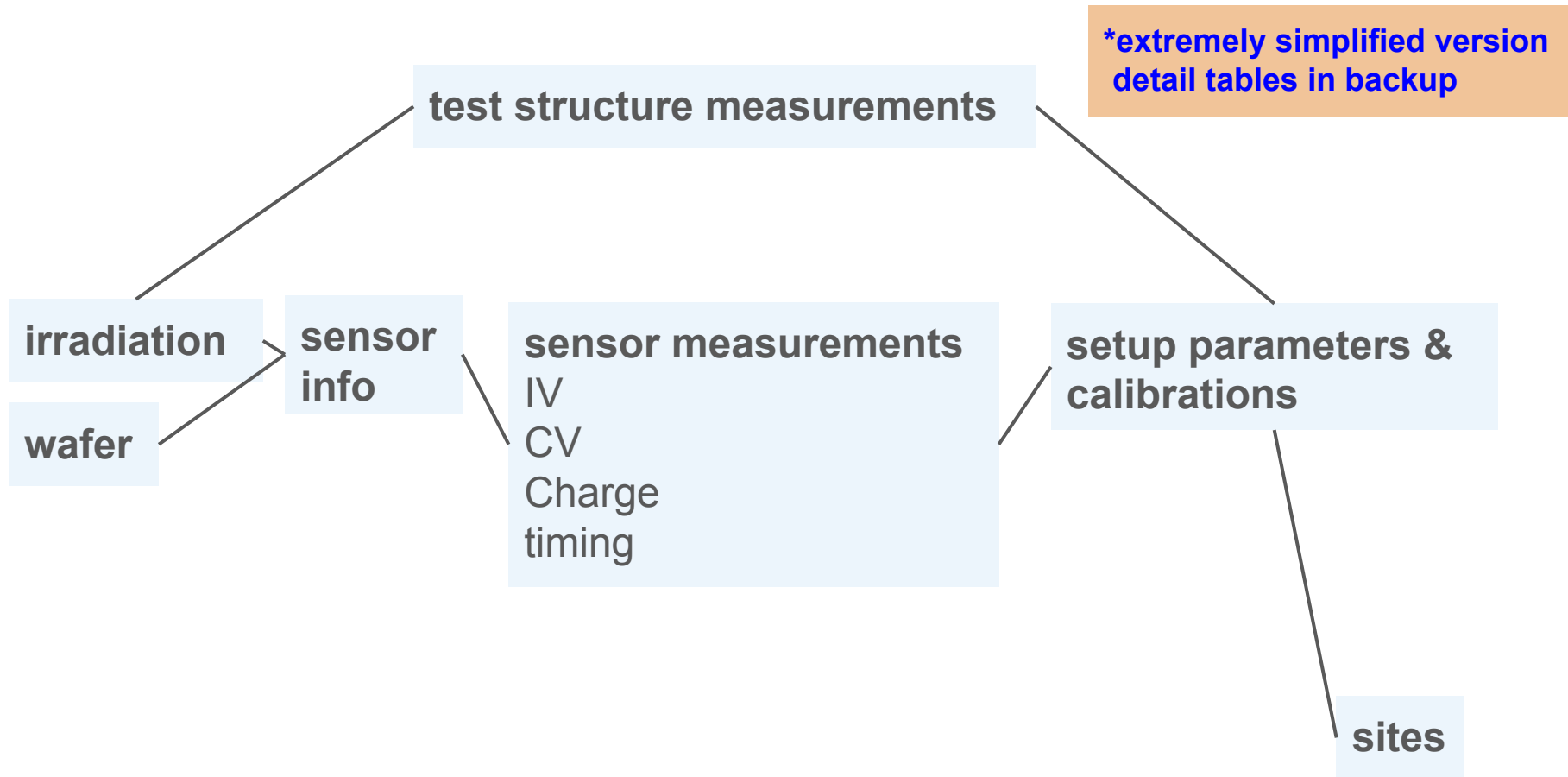
- Module Parent Component:** SERIAL # 20WMO11100001, KIND OF PART Module
- Hybrid Parent Component:** SERIAL # 20WHY10000001, KIND OF PART Hybrid
- Sensor Parent Component:** SERIAL # 20WHY10000001, KIND OF PART Hybrid

Child Component Relationships:

- Module Child Component:** SERIAL # 20WMO11100001 (Hybrid), 20WMO11100001 (Module_flex), 20WMO11100002 (Hybrid), 20WGL10000001 (glue)
- Hybrid Child Component:** SERIAL # 20WS1211000002 (Sensor), 20WAS10000001 (ASIC)
- Sensor Child Component:** SERIAL # 20WHY10000001 (Hybrid), 20WS1211000001 (Wafer)

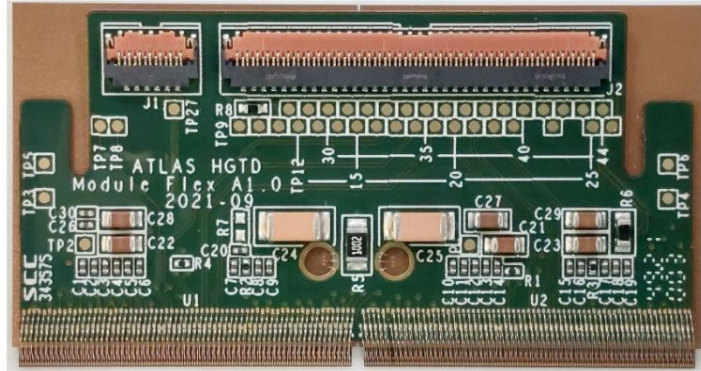
In development

- 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

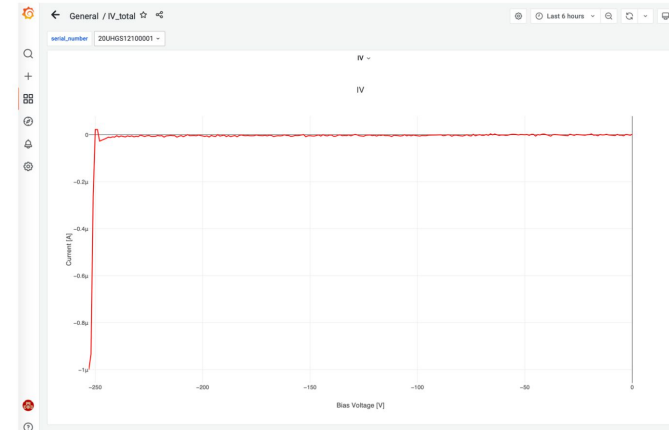


Flex tail

12

- 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

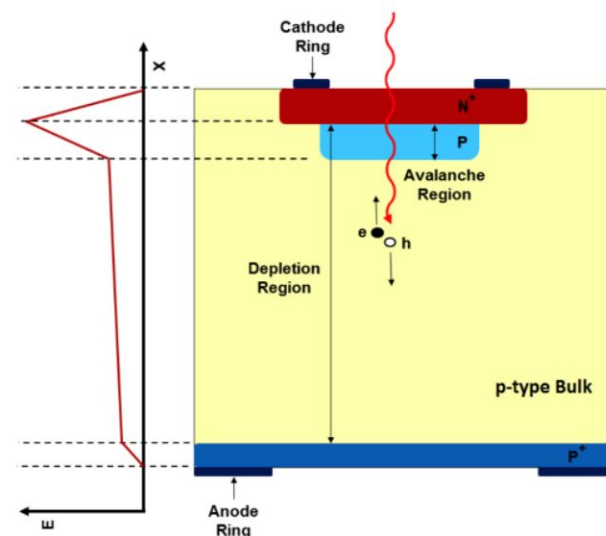
- HGTD Production Database is setup and hosted at CERN
- Has a flexible and generic database design for registering HGTD components
- Currently testing registration of components and making relationship links between the associated components
- Focusing on
 - Implementing functions to upload measurement 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

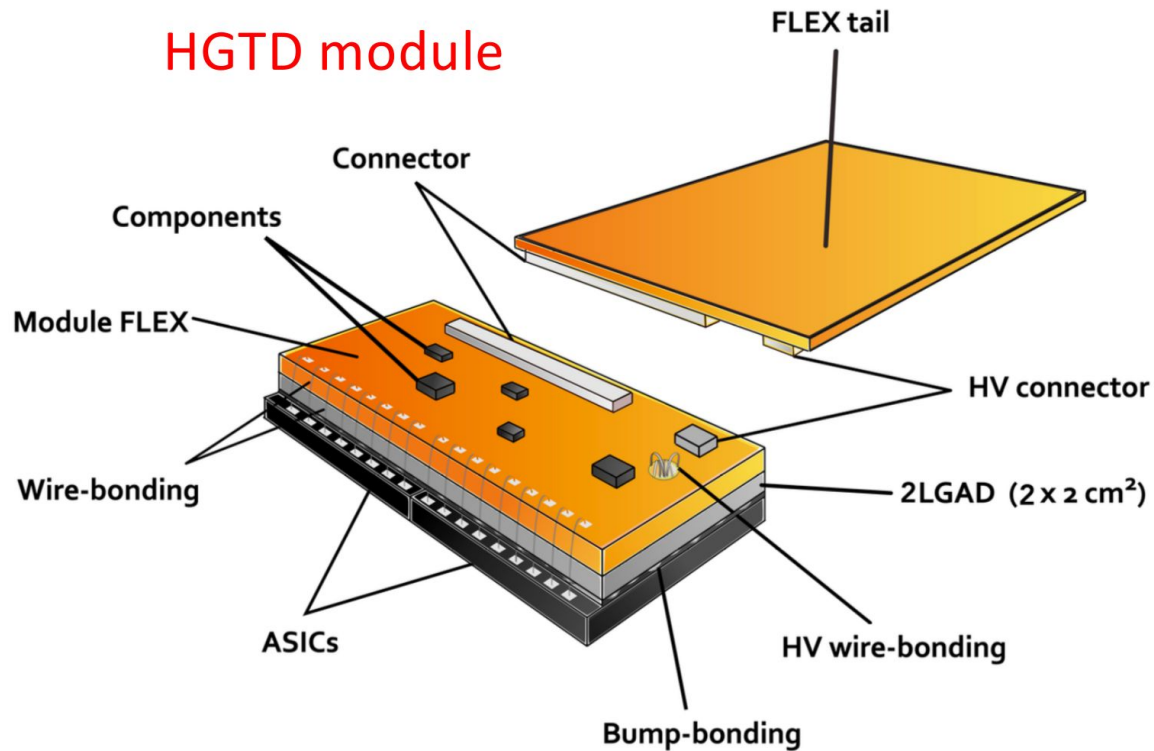
Low Gain Avalanche Diode: Sensors

- 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 size $1.3 \times 1.3 \text{ mm}^2$
 - Compromise between rise time, capacitance, occupancy
 - ▶ Signal level: 10 fC (w/20 gain) before and 4 fC (w/8 gain) after irradiation

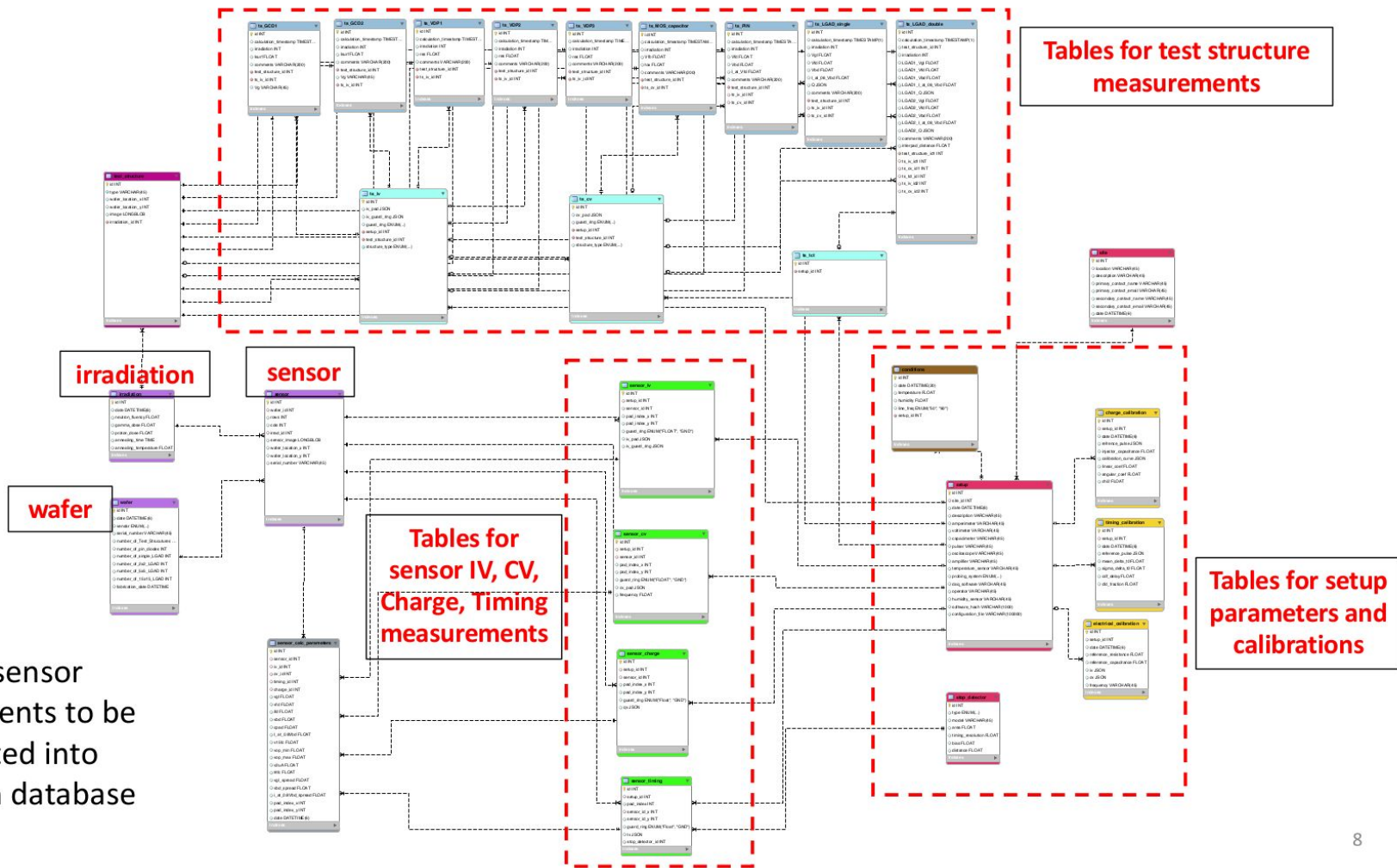


HDTD modules

- 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

