HGCAL DB - May 25th

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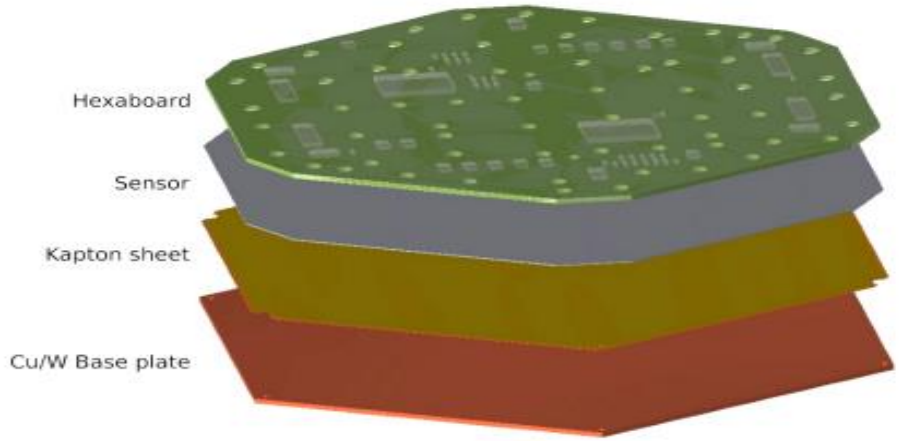
Upgrade & HGCAL

- Phase-2 upgrade of the CMS HGCAL will encompass tens of thousands of new sensors.
  - HL-LHC: high luminosity/pileup, radiation levels, ionizing energies.
- Extensive radiation campaigns have been conducted by CMS to determine suitable material and decide sensor layout parameters for operation in HL-LHC environment.
- Many institutions, such as FSU, routinely runs tests on these sensors to determine if they pass these requirements.
  - Achieving HL-LHC will require collaboration between institutions/users on sensors and their results -> Senor results must be stored in a central database.

Module Components

- HGCAL requires ≈ 27,000 Si detector modules:
  - CE-E module (electromagnetic) or a CE-H module (hadronic).

- At FSU, we only test sensors.



CE-E Si module

(PCB)

Si 8'' sensor

For electrical insulation from base plate

For placement onto cassettes

- When assembling these modules, users must have easy access to sensor info/results from a unified DB.

Wafer/sensor layout

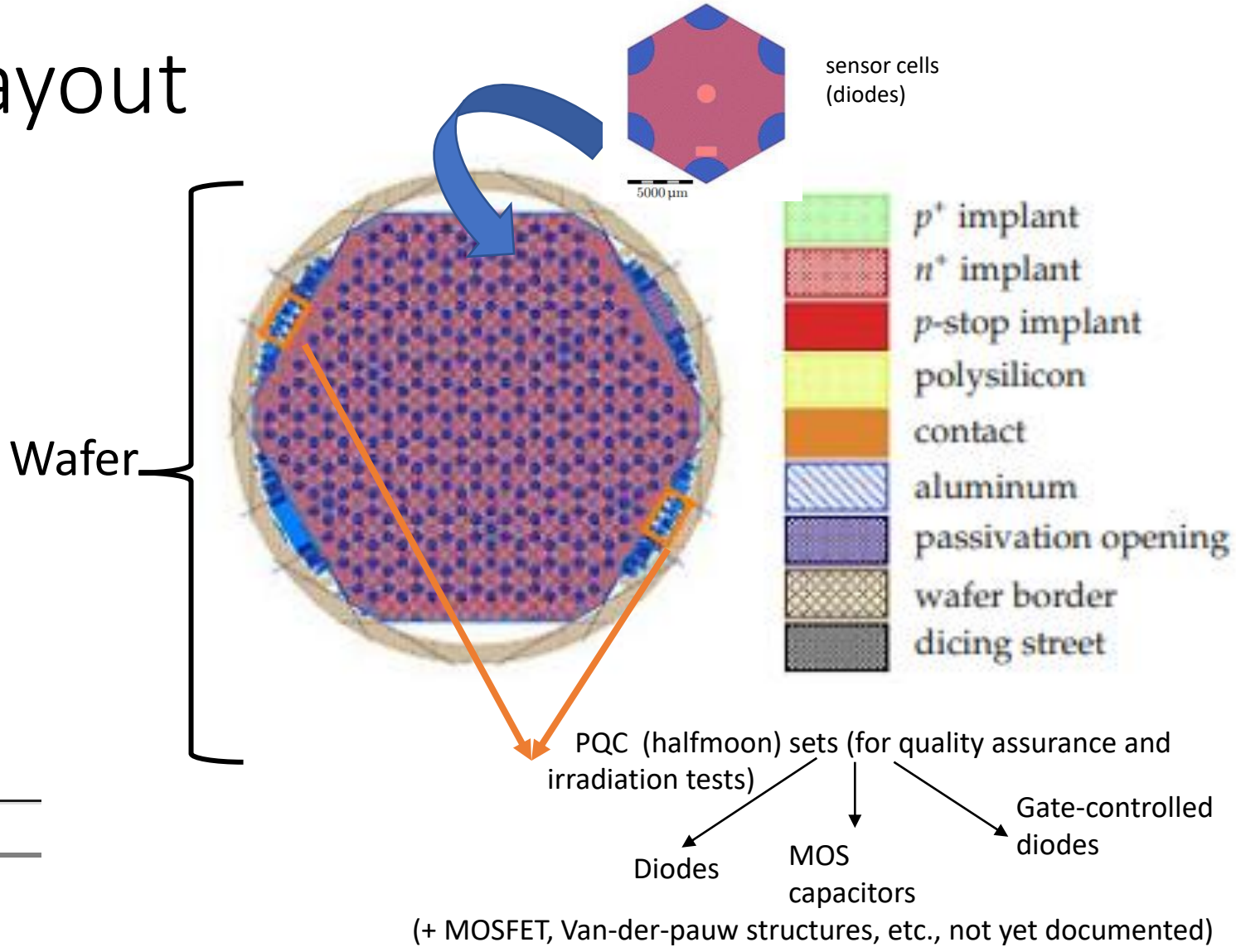
- At FSU, we run IV and

CV tests on Si sensors (SQC).

- We also do PQC, but its test procedures

are currently being developed.

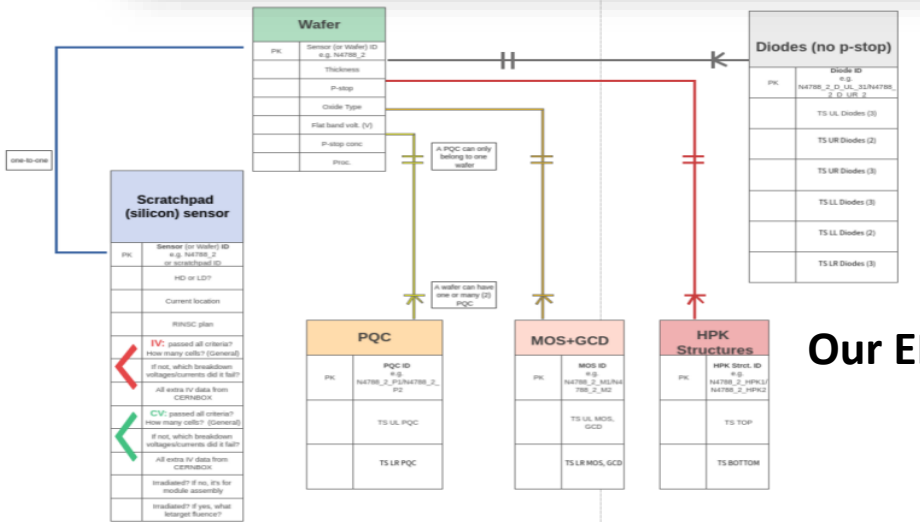
d_{act} (µm)	Full-size channels
120	432 (HD)
200	192 (LD)
300	192 (LD)



Spreadsheets to Database

- Summary results of Si sensor analyses.
 have been entered manually in spreadsheets (which grew organically), such as:
    - This is very **error-prone** and **time-consuming!**
    - With this it is also not possible to easily query sensor results/sensor attributes.
    - Doesn't capture **one** ⇔ **many** relationships.

									HPK full probe card					
Sensor ID	Scratch pad ID	Thick-ness	P-Stop	Oxide type	Flat band volt. (V)	P-Stop conc.	Proc.		I_tot_600V <100uA	I_tot_800V < 2.5* I_tot_600V	1) Ncell with I600 > 100nA	2) Ncell with I800 > 2.5 * I600 & I600>10nA threshold || I800>25nA & I600<10nA	3) More than 8 bad cells: requirem. 1) and 2)	4) More than two neighbou r cells bad: requirem. 1) and 2)
N4791_1	100088	300	com	A	-5	STD	FZ		Passed	Failed	1	0	Passed	Passed
N4791_2	100089	300	com	A	-5	STD	FZ		Passed	Passed	0	0	Passed	Passed
N4791_3	100090	300	com	A	-5	STD	FZ		Passed	Passed	0	0	Passed	Passed



Our ERD

- We constructed a relational (SQL) database that stores and updates sensor attributes, summary results, history, location, etc.

- Code: https://github.com/AliAlkadhim/FSU_HGCAL_DB
    - The power really comes in when our code is combined with **HGC_Sensor_IVCV_Analysis, at** https://gitlab.cern.ch/CLICdp/HGCAL/lcd_hgcal_analysisworkflows)

Driving Principles, and How We Achieve Them

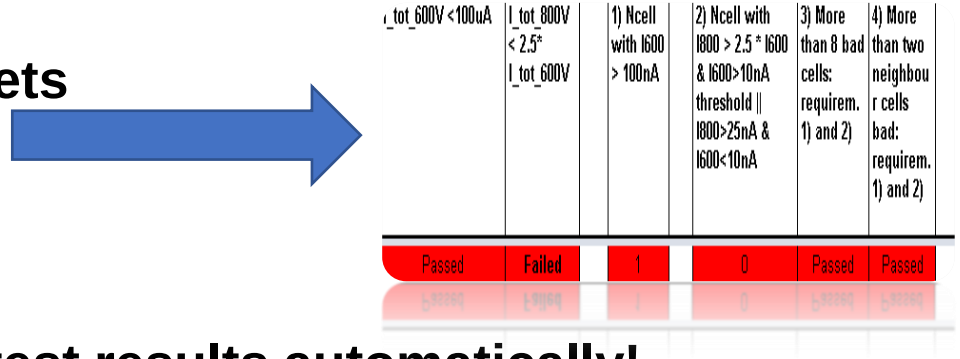
In order to exploit the data from results, avoid errors, and avoid wasting time, the database was built to have the following capabilities:

- ***Reconstruction***: The DB is able to quickly reconstruct all data that is previously taken (stored in spreadsheets) into a query-able DB.
  - `fsudb createdb --tablenames [select from options: Full_Sensor, HPK_structures, MOS_GCD, PQC, strip_sensors_logistics, HGC_CERN_Sensor_IV_Summary, etc.]`
- ***Modularity****:* Each time IV/CV analysis is run, the summary results + extra attributes are saved as a separate csv file, such that it can be reconstructed into a DB (with different tables) later.
- ***Fast Queries:*** we have a full SQL DB (with mysql) as well as an sqlite replica: the sqlite replica enables fast queries from terminal or python, as well as the use of the sqlitebrowser GUI.

Automated DB Updating

- ***Automation**:* our code supports *completely automated updating of the DB*.
  - Users can update the DB automatically if they wish to save the results from an IV/CV analysis.
  - **AnalyseMeasurement_IV <N_threads> <sensor_ID>**

  - **Previously: We manually update the spreadsheets by reading the resulting files/graphs.**



  - **Now: `fsudb updateDB IV`**
    - **With this, the DB is updated with the latest test results automatically!**
  - Should we use similar idea, but with the xml schema template and dbloader?
  - Similar automated updating should also be possible for PQC.

Sensor Tables Mapping to Global DB

- Let's work directly with each other (CERN, UCSB, FSU, etc.) and integrate our results/databases into one universal DB!
  - Preservation, access to each other's results, method unification, module assembly, etc.
- Tables, geometries, etc. have been defined in tables (Florian).
- Development DCA:

https://cmsdcadev.cern.ch

(GUI Doesn't work)

									HPK full probe card						
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N4791_3	100090	300	com	A	-5	STD	FZ		Passed	Passed		0		0	Passed	Passed

Extra fields we need to store

- We have instructions on copying

data to the DB with XML template, but how can we see what int2r and cmsr DBs look like?

  - Potentially most tables should be changed.

DCA Naming Scheme

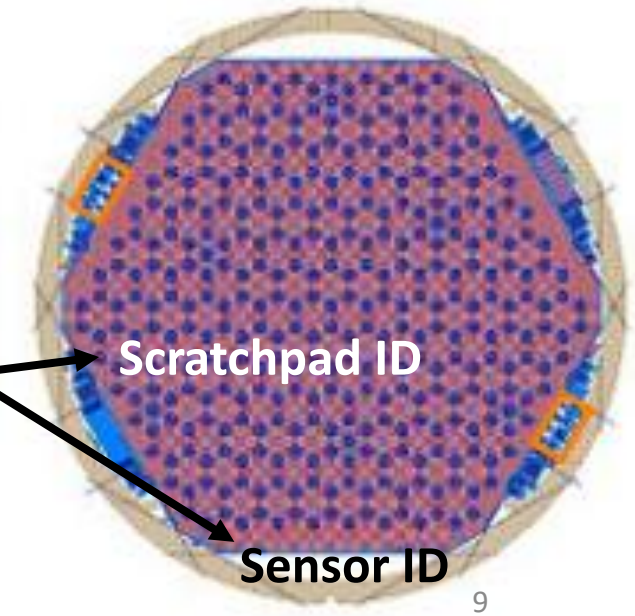
ID	1807
KindOfPart	HPK Six Inch 128 Cell Silicon Sensor
Manufacturer	Hamamatsu-HPK
Serial number	**HPK_6in_128_0003**
Name label	None
Barcode	None

- In Production DCA (https://cmsdca.cern.ch/hgc_cmsr/construct/parts/), {Serial Number, Barcode} → ID.

- Barcode: Something that was used when sensors are shipped on coin stacks – not relevant/used anymore!
- We get a column of sensor ID & Scratchpad ID from HPK;

we need to store both in DB!

- **Sensor ID**: once it's diced from wafer, it's no longer on sensor.
- So, if we have a diced sensor, there is no identifying feature on it other than the **scratchpad ID**.



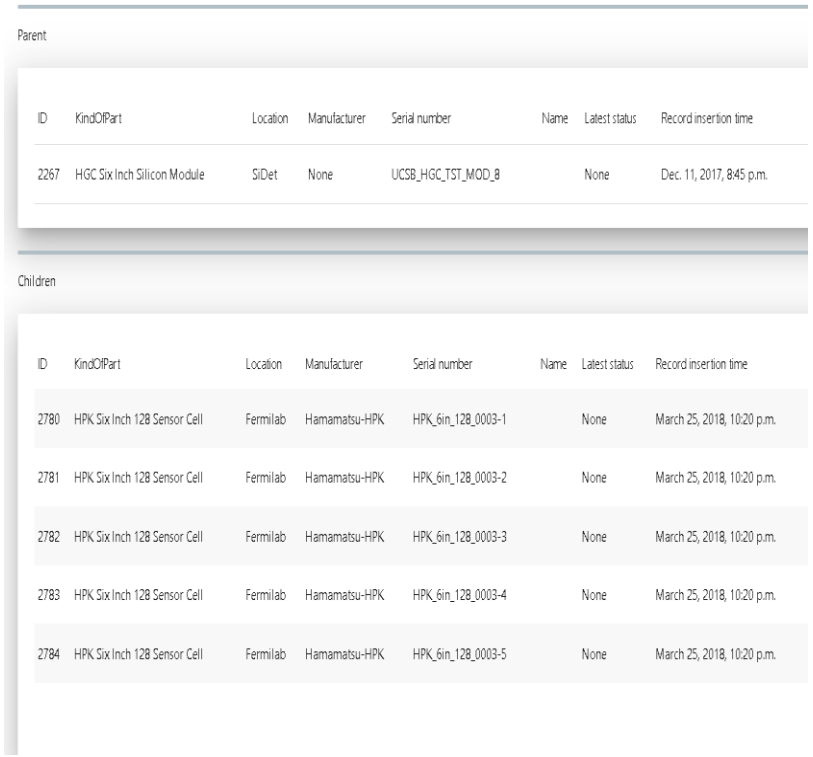
“Serial Number” & “Barcode” Naming Scheme

- Production DB:
  - HPK-AA-BBB-SensorID
  - E.g: Serial Number: HPk-8in-198-**N4791_1**
  - This naming scheme is fine with us!
- Development DB:
  - HGC_**YYY**_um_**ZZ**_**Type**_Si_Component ?
  - E.g: HGC_120um_HD_Full_Si_Sensor
- Instead of Barcode (replace this name!), we *need* to store Scratchpad ID.
- E.g. **100088** ⇔ HGC-8in-198-**N4791_1.**

- YYY: {120, 200, 300} (thickness)
- ZZ: {HD, LD} (density)
- Type: : {Full, Top, Bottom, Left, Right, Five, Three} (Geometries)
- Component: {PCB, Sensor, Kapton, Baseplate}
- AA: {6 in, 8 in}
- BBB: {198, 444} (No. Cells)

DCA GUI Parent/Child

- Production Detector Construction Application (DCA: https://cmsdca.cern.ch/hgc_cmsr/construct/parts/) GUI

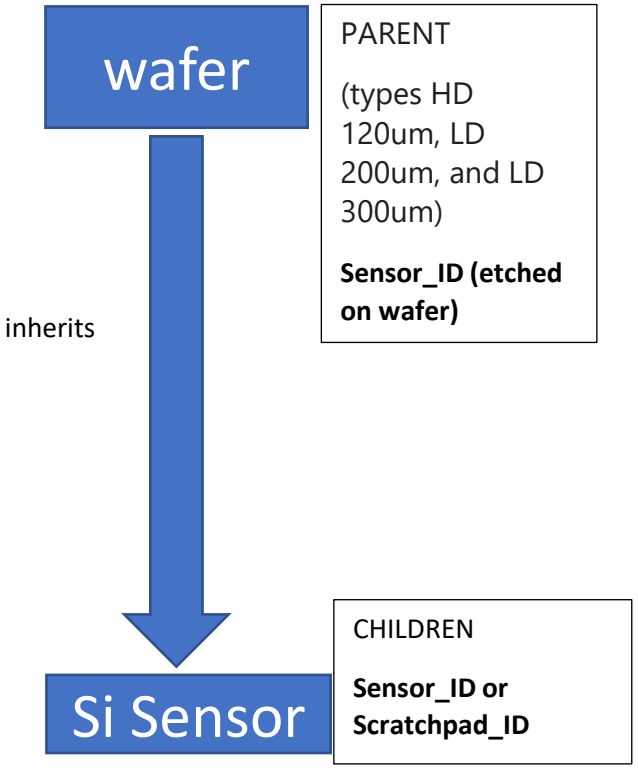


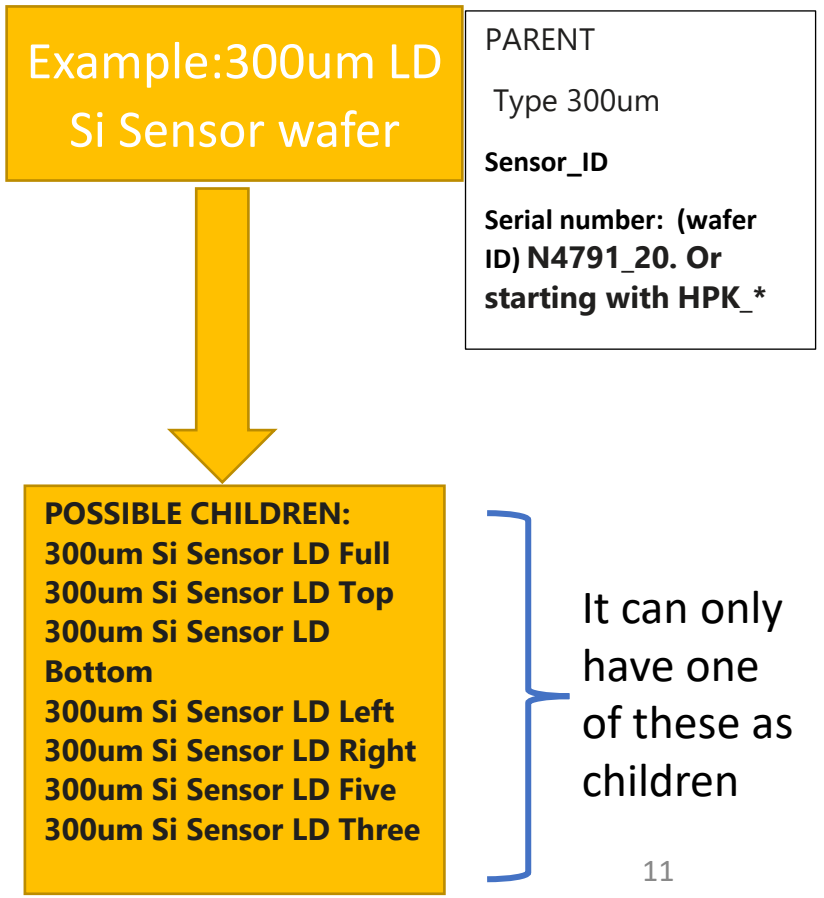
Parent

ID	KindOfPart	Location	Manufacturer	Serial number	Name	Latest status	Record insertion time
2267	HGC Six Inch Silicon Module	SiDet	None	UCSB_HGC_TST_MOD_8		None	Dec. 11, 2017, 8:45 p.m.

Children

ID	KindOfPart	Location	Manufacturer	Serial number	Name	Latest status	Record insertion time
2780	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-1		None	March 25, 2018, 10:20 p.m.
2781	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-2		None	March 25, 2018, 10:20 p.m.
2782	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-3		None	March 25, 2018, 10:20 p.m.
2783	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-4		None	March 25, 2018, 10:20 p.m.
2784	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-5		None	March 25, 2018, 10:20 p.m.





DCA GUI Parent/Child

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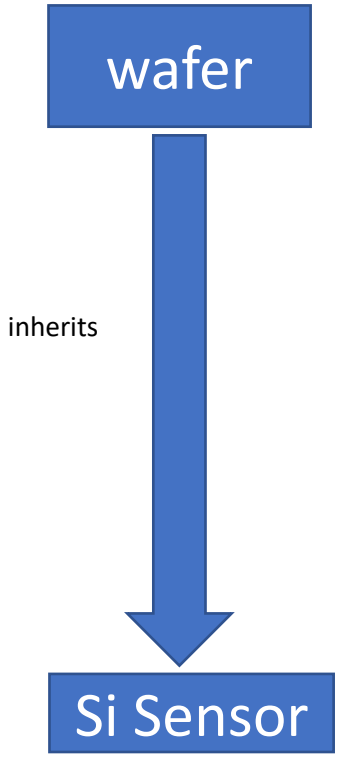
2267	HGC Six Inch Silicon Module	SiDet	None	UCSB_HGC_TST_MOD_8		None	Dec. 11, 2017, 8:45 p.m.

Children

ID	KindOfPart	Location	Manufacturer	Serial number	Name	Latest status	Record insertion time
2780	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-1		None	March 25, 2018, 10:20 p.m.
2781	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-2		None	March 25, 2018, 10:20 p.m.
2782	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-3		None	March 25, 2018, 10:20 p.m.
2783	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-4		None	March 25, 2018, 10:20 p.m.
2784	HPK Six Inch 128 Sensor Cell	Fermilab	Hamamatsu-HPK	HPK_6in_128_0003-5		None	March 25, 2018, 10:20 p.m.



PARENT

(types HD 120um, LD 200um, and LD 300um)

Sensor_ID (etched on wafer)

CHILDREN

Sensor_ID or Scratchpad_ID

Example:300um LD Si Sensor wafer

PARENT

Type 300um

Sensor_ID

Serial number: (wafer ID) N4791_20. Or starting with HPK_*_ N4791_20.

CHILDREN:

HPK_* _N4791_20-Full

HPK_* _ N4791_20-PQC-TL
HPK_* _ N4791_20-PQC-BR

If it has an LD Full sensor, the only other children it can have are 2 PQCs.

User Tables

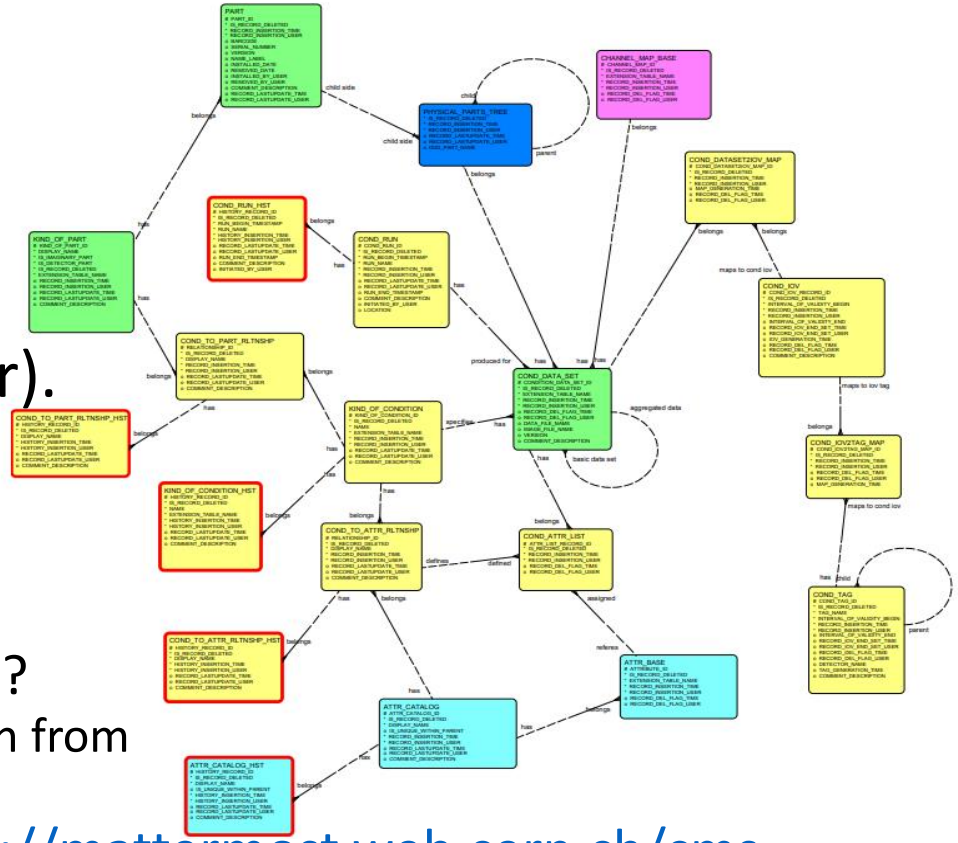
- User Tables has complicated

Connections and components (hidden from user).

- xml template is used to define

Upload our tables with dbloader.

  - How can we view what's in in2r/cmsr DBs?
  - Can XML template be used to transform the tables?
    - This might be needed, but would require collaboration from CERN, UCSB, etc. to reach consensus on what to store.
  - Is there a MM channel? If not, I created one: https://mattermost.web.cern.ch/cms-exp/channels/cms-hgcal-db



- In the future, we would like the uploading of test results to be automated.
- We would also like the results from the universal DB be very easy to query for everyone.

Thank you!

Backup

Backup

d_{act} (μm)	Full-size channels
120	432 (HD)
200	192 (LD)
300	192 (LD)

Parameter	LD		HD	
Total sensor area	1 561 880	mm^2	1 561 880	mm^2
Size of full cell	118	mm^2	52	mm^2
No. of cells	198		444	
No. of calibration cells	6		12	
Inter-cell distance	50	μm	50	μm
P-stop width	6	μm	6	μm
Width of inner guard ring implant	131.5	μm	131.5	μm
Width of outer guard ring implant	18	μm	18	μm
Minimum width of edge ring implant	400	μm	400	μm
Distance guard rings	44.5	μm	44.5	μm
Distance guard ring to edge ring	209.5	μm	209.5	μm
Metal overhang cells	12.5	μm	12.5	μm
Inner metal overhang inner guard ring	12.5	μm	12.5	μm
Outer metal overhang inner guard ring	10	μm	10	μm
Inner metal overhang outer guard ring	10	μm	10	μm
Outer metal overhang outer guard ring	50	μm	50	μm
Inner metal overhang edge ring	50	μm	50	μm