Database development and usage for prototype and pre-series testing

Ali Al Kadhim

HGCAL Week
June 21, 2022

Outline

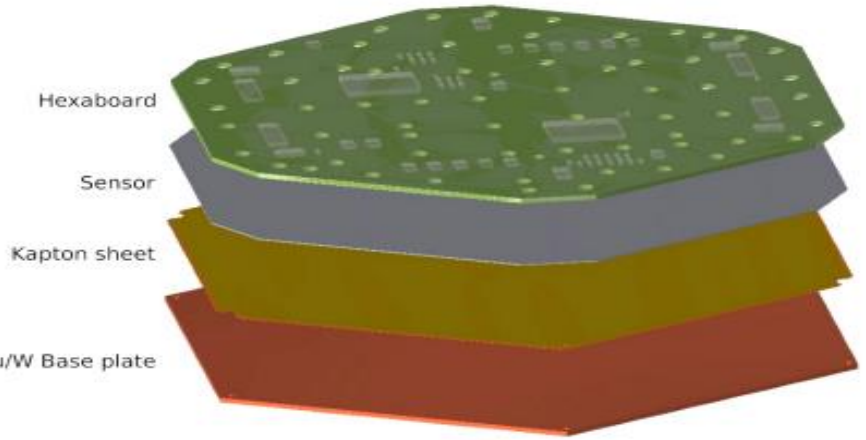
- Motivation
- Personal involvement: spreadsheets to database (DB)
- CMS HGCAL DB overview
- DB Graphical User Interface (GUI) and XML schemas
- Connecting to the DB with SQLDeveloper tutorial
- Proposed changes to DB and HGCAL community involvement

Motivation

- Phase-2 upgrade of the CMS HGCAL will encompass tens of thousands of new sensors.
- Extensive campaigns have been conducted by CMS to determine suitable material and layout parameters for operation in HL-LHC environment.
- Sensor Quality Control (SQC) institutions routinely run tests on these sensors to determine if they pass these requirements.
  - Successful HGCAL construction will require collaboration between institutions/users on sensors and their results -> Sensor results must be stored in a central database (DB)!

Motivation

- HGCAL requires ≈ 26,000 Si detector modules (5% are tested):
  - CE-E module (electromagnetic) or a CE-H module (hadronic).
- A unified HGCAL DB allows users from all institutions access to test results, status, location, etc.
- When assembling these modules, users must have easy access to sensor info/results from a unified database.



CE-E Si module

(PCB)

Si 8'' sensor

For electrical insulation from base plate

For placement onto cassettes

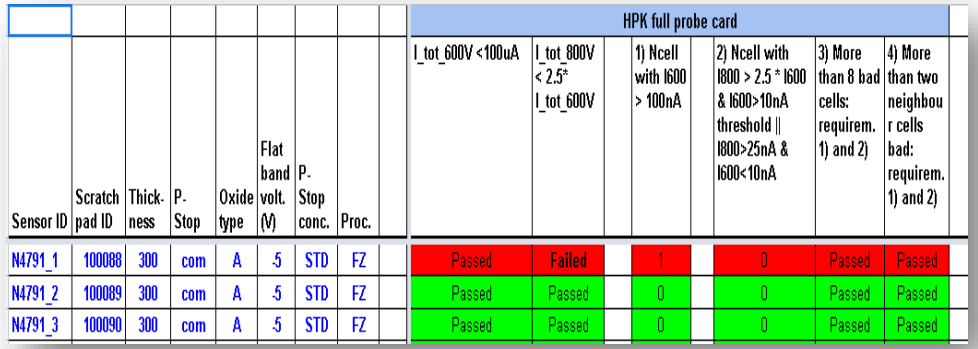
Spreadsheets to Database

- 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!**
  - **Not query-able.**
  - Doesn't capture **one-to-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

~~Spreadsheets~~ to Database

- Summary results of Si sensor analyses.

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(which grew organically), such as:

  - This is very **error-prone** and **time-consuming!**
  - **Not query-able.**
  - Doesn't capture **one-to-many** relationships.

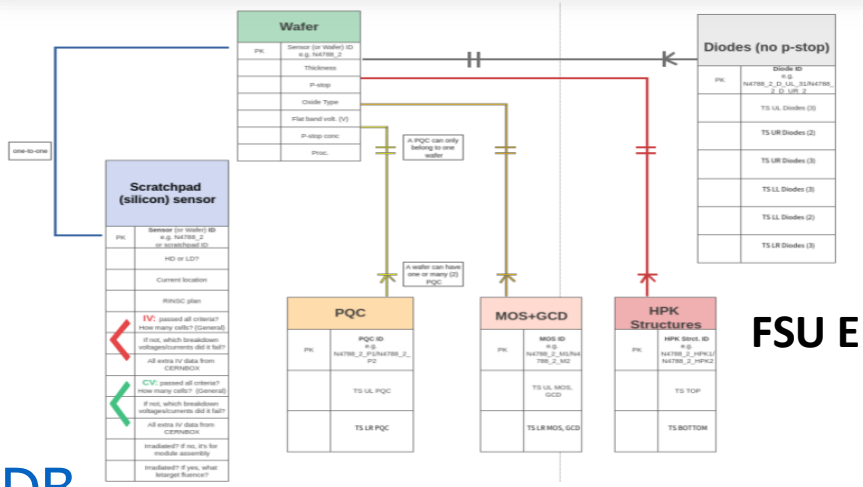
- We (FSU) constructed a relational (SQL) database

that stores and updates sensor attributes,

summary results, history, location, etc.

- Code: https://github.com/AliAlkadhim/FSU_HGCAL_DB
- More on FSU HGCAL DB here: https://indico.cern.ch/event/1164937/contributions/4891850/attachments/2451443/4200827/HGCAL_DB_May25_Alkadhim.pdf

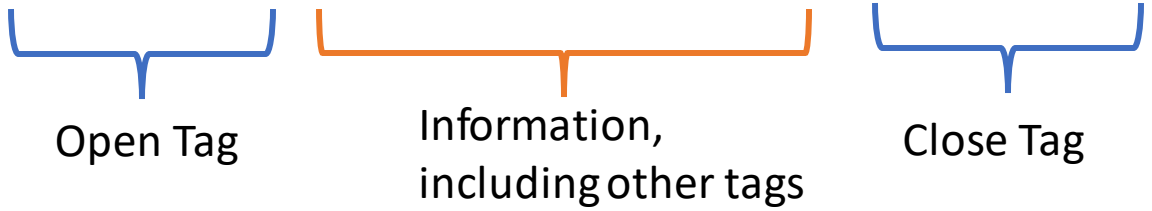
								HPK full probe card					
Sensor ID	Scratch pad ID	Thick-ness	P-Stop	Oxide type	Flat band volt. (V)	P-Stop conc.	Proc.	I_tot_600V <100uA	I_tot_800V < 2.5* I_tot_600V	1) Ncell with I600 > 100nA	2) Ncell with I800 > 2.5 * I600 & I600>10nA threshold || I800>25nA & I600<10nA	3) More than 8 bad cells: requirem. 1) and 2)	4) More than two neighbour 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



FSU ERD

CMS HGCAL DB

- Global DB for all HGCAL parts, tests, modules, etc. from all testing, production, etc. institutions.
- There are 2 instances of HGCAL Database (DB)
  - HGCAL Development DB – **INT2R** Database
  - HGCAL Production DB – **CMSR** Database
- To learn more about the different schemas in the HGCAL DB, see https://indico.cern.ch/event/1164937/contributions/4891851/attachments/2451351/4200663/XML%20Templates%20HGCAL%20Si%20Sensors.pdf
- The DB (I will discuss INT2R, but the two are nearly identical), is based on XML schemas.
- XM has tag-based syntax (like HTML), all it is: <TAG_NAME> ……..DATA…… <TAG_NAME>



HGCAL DB

HGCAL DB consists of the following inter-connected schemas (accounts), each used to store different data types:

Tables in these schemas are related to each other!

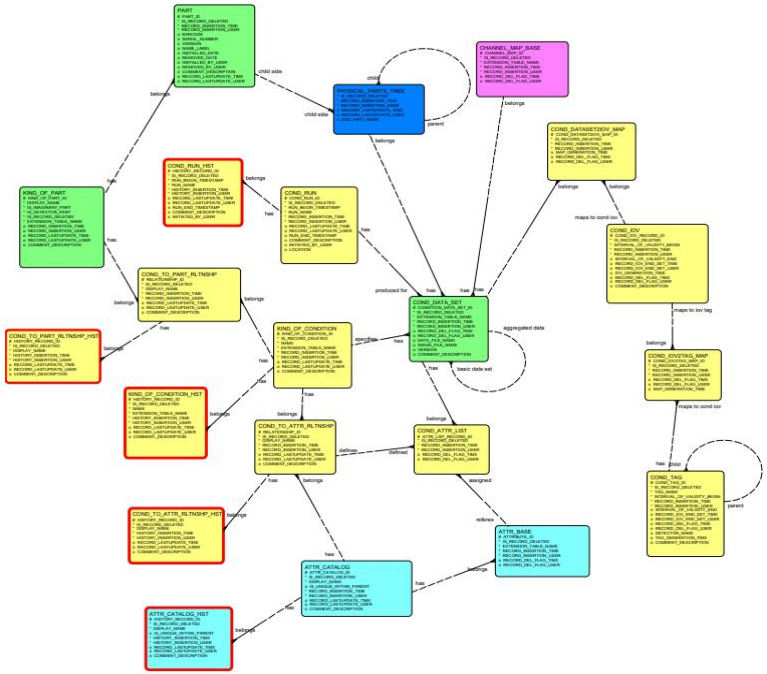
- **CMS_HGC_CORE_ATTRIBUTE**
  to store attribute information related to parts and data types
- **CMS_HGC_CORE_COND**
  to store meta data of user-generated data (**conditions data).**
- **CMS_HGC_HGCAL_COND**
  To store **detailed tables** for specific user-generated test data.
- **CMS_HGC_CORE_CONSTRUCT**
  to store detectors **parts.**
- **CMS_HGC_CORE_IOV_MGMNT**
  to store data IOVs (**interval of validity**) of user generated data.
- **CMS_HGC_CORE_MANAGEMNT**
  to store "management" data type, e.g. locations, institutions, etc.

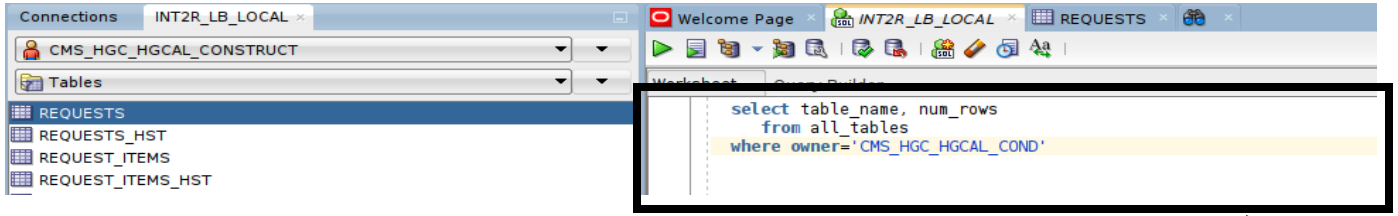
- Every part has a *kind of Part* and a *serial Number,* and is uniquely identified in the DB by this pair of parameters.

Accessing the Database with SQLDeveloper

- **`SQLDeveloper`** is the preferred way to access and query this XML database.
- For more instructions on how to access and view the database, see the backup slides!
- Once connected, you can see the CMS_HGC_* schemas previously mentioned.
- You can also do any SQL queries (also in backup).

Sample ERD





Sample SQL query

Connecting to the DB with SQLDeveloper Tutorial

- Now put the following text in a file named **tnsnames.ora** and put it in your **/etc/** directory.

tnsnames.ora

```
int2r_lb_local=(
    DESCRIPTION=
    (ADDRESS= (PROTOCOL=TCP) (HOST=localhost) (PORT=10131))
    (ADDRESS= (PROTOCOL=TCP) (HOST=localhost) (PORT=10132))
    (LOAD_BALANCE=yes)
    (CONNECT_DATA=
    (SERVER=DEDICATED)
    (SERVICE_NAME=int2r_lb.cern.ch)
    (FAILOVER_MODE=
            (TYPE=SELECT)
            (METHOD=BASIC)
            (RETRIES=180)
            (DELAY=5)
        )
    )
)
```

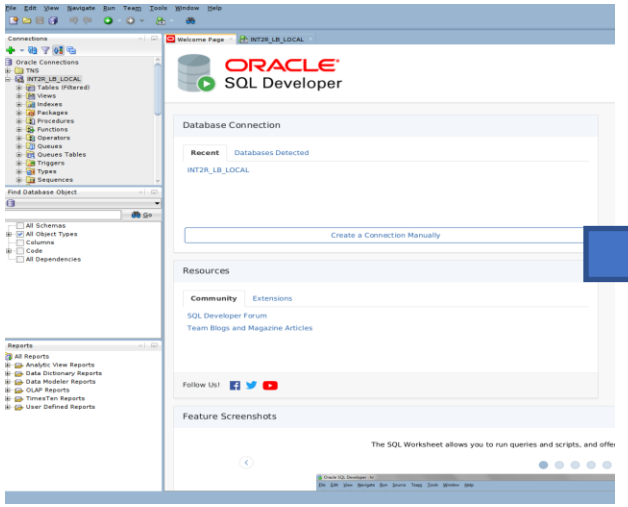
- Now `ssh` to lxplus

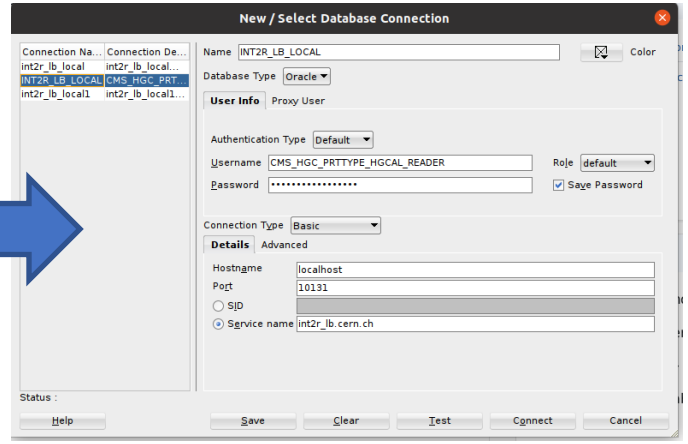
```
ssh -XY -L 10131:itrac1609-v.cern.ch:10121 -L 10132:itrac1601-v.cern.ch:10121 username@lxplus.cern.ch
```

Where username is your lxplus username.

Connecting to the DB with SQLDeveloper Tutorial

- Launch SQLDeveloper (on unix by typing **`sqldeveloper`**).
- Press "Open a Connection Manually" in the front page.
- On the "New / Select Database Connection" Dialogue box, fill:
  - Name: **INT2R_LB_LOCAL**
  - Username: CMS_HGC_PRTTYPE_HGCAL_READER
  - Password: HGCAL_Reader_2016
    - Check "save password" if you want.
  - Hostname: localhost
  - Port: 10131
  - Check on "Service name"
  - Service name: int2r_lb.cern.ch
  - Press "Connect"
  - You're connected!

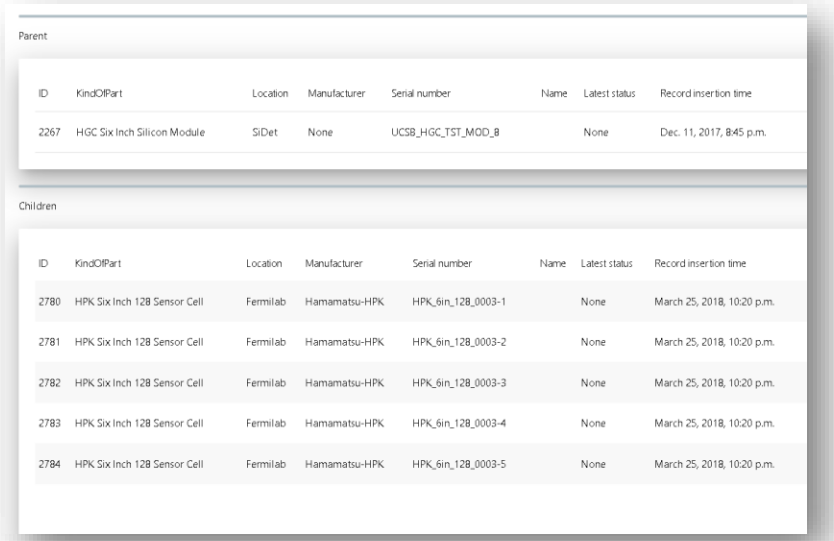




GUIs! OMS and DBA

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

High level Information on detector assembly parts: mainly for current status and tracking (location)

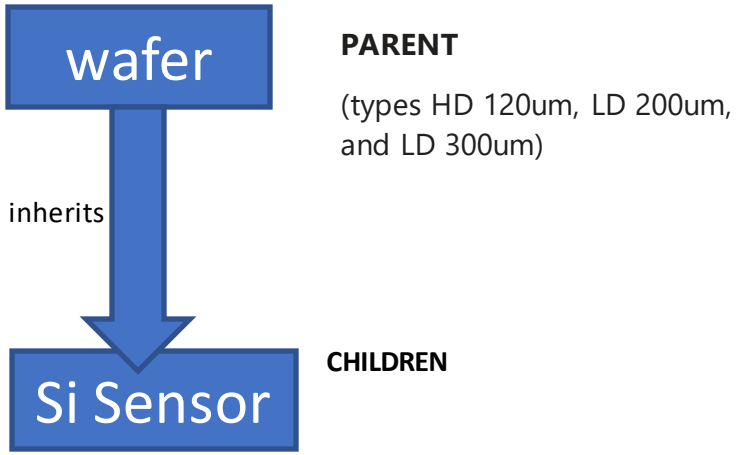


Parent

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.



PARENT

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

CHILDREN

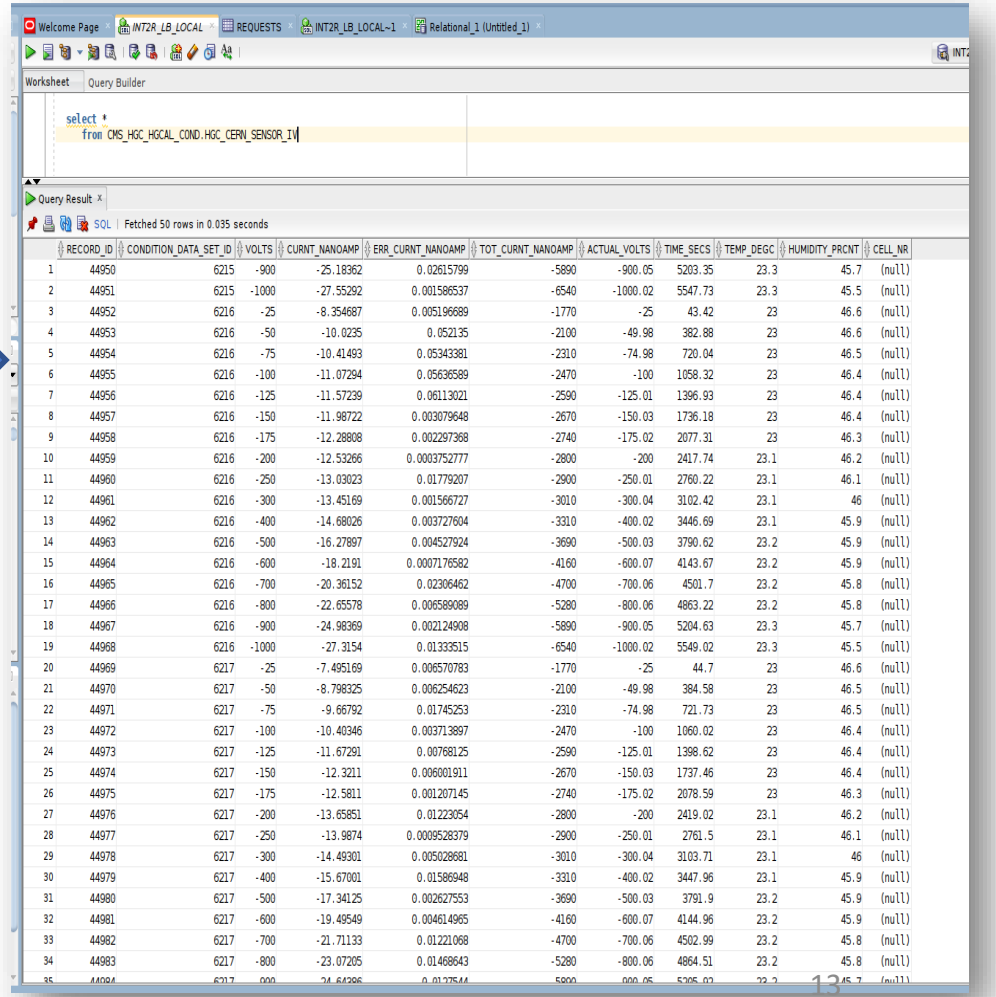
- To view OMS, you need to set up an ssh tunnel with a proxy. Instructions on how to do that can be found here:
  - https://twiki.cern.ch/twiki/pub/CMS/HGCALDataBase/ssh-tunnel-for-development-oms-dca-dec-2019.pdf

The DB is XML schema

XML Template for HGC_CERN_SENSOR_IV table

```
<ROOT>
    <HEADER>
        <TYPE>
            <!-- Comment: Table Name -->
            <EXTENSION_TABLE_NAME>HGC_CERN_SENSOR_IV</EXTENSION_TABLE_NAME>
            <!-- Kind of condition name -->
            <NAME> HGC CERN Sensor IV</NAME>
        </TYPE>
        <RUN>
            <RUN_NAME>Your Run Name</RUN_NAME>
            <!-- Enter your timestamp -->
            <RUN_BEGIN_TIMESTAMP>2018-05-14 00:00:00</RUN_BEGIN_TIMESTAMP>
            <RUN_END_TIMESTAMP>2018-05-14 00:00:00</RUN_END_TIMESTAMP>
            <INITIATED_BY_USER>Your Name</INITIATED_BY_USER>
            <LOCATION>CERN</LOCATION>
            <COMMENT_DESCRIPTION>Your Comments</COMMENT_DESCRIPTION>
        </RUN>
    </HEADER>
    <DATA_SET>
        <PART>
            <!-- Kind of Part name -->
            <KIND_OF_PART>HGC Sensor</KIND_OF_PART>
            <!-- Sensor serial number -->
            <SERIAL_NUMBER>XXXXXXXXXXXXXXXXXXXX</SERIAL_NUMBER>
        </PART>
        <DATA>
            <!-- table columns with data -->
            <VOLTS>-25</VOLTS>
            <CURNT_NANOAMP>-7.609905</CURNT_NANOAMP>
            <ERR_CURNT_NANOAMP>0.01653122</ERR_CURNT_NANOAMP>
            <TOT_CURNT_NANOAMP>-2000</TOT_CURNT_NANOAMP>
            <ACTUAL_VOLTS>-25</ACTUAL_VOLTS>
            <TIME_SECS>10</TIME_SECS>
            <TEMP_DEGC>23</TEMP_DEGC>
            <HUMIDITY_PRCNT>46.6</HUMIDITY_PRCNT>
            <CELL_NR>YYYY</CELL_NR>
        </DATA>
        .
        .
```

Viewed in SQLDeveloper



	RECORD_ID	CONDITION_DATA_SET_ID	VOLTS	CURNT_NANOAMP	ERR_CURNT_NANOAMP	TOT_CURNT_NANOAMP	ACTUAL_VOLTS	TIME_SECS	TEMP_DEGC	HUMIDITY_PRCNT	CELL_NR
1	44950	6215	-900	-25.18362	0.02615799	-5890	-900.05	5203.35	23.3	45.7	(null)
2	44951	6215	-1000	-27.55292	0.001586537	-6540	-1000.02	5547.73	23.3	45.5	(null)
3	44952	6216	-25	-8.354687	0.005196689	-1770	-25	43.42	23	46.6	(null)
4	44953	6216	-50	-10.0235	0.052135	-2100	-49.98	382.88	23	46.6	(null)
5	44954	6216	-75	-10.41493	0.05343381	-2310	-74.98	720.04	23	46.5	(null)
6	44955	6216	-100	-11.07294	0.05636589	-2470	-100	1058.32	23	46.4	(null)
7	44956	6216	-125	-11.57239	0.06113021	-2590	-125.01	1396.93	23	46.4	(null)
8	44957	6216	-150	-11.98722	0.003079648	-2670	-150.03	1736.18	23	46.4	(null)
9	44958	6216	-175	-12.28808	0.002297368	-2740	-175.02	2077.31	23	46.3	(null)
10	44959	6216	-200	-12.53266	0.0003752777	-2800	-200	2417.74	23.1	46.2	(null)
11	44960	6216	-250	-13.03023	0.01779207	-2900	-250.01	2760.22	23.1	46.1	(null)
12	44961	6216	-300	-13.45169	0.001566727	-3010	-300.04	3102.42	23.1	46	(null)
13	44962	6216	-400	-14.68026	0.003727604	-3310	-400.02	3446.69	23.1	45.9	(null)
14	44963	6216	-500	-16.27897	0.004527924	-3690	-500.03	3790.62	23.2	45.9	(null)
15	44964	6216	-600	-18.2191	0.0007176582	-4160	-600.07	4143.67	23.2	45.9	(null)
16	44965	6216	-700	-20.36152	0.02306462	-4700	-700.06	4501.7	23.2	45.8	(null)
17	44966	6216	-800	-22.65578	0.006589089	-5280	-800.06	4863.22	23.2	45.8	(null)
18	44967	6216	-900	-24.98369	0.002124908	-5890	-900.05	5204.63	23.3	45.7	(null)
19	44968	6216	-1000	-27.3154	0.01333515	-6540	-1000.02	5549.02	23.3	45.5	(null)
20	44969	6217	-25	-7.495169	0.006570783	-1770	-25	44.7	23	46.6	(null)
21	44970	6217	-50	-8.798325	0.006254623	-2100	-49.98	384.58	23	46.5	(null)
22	44971	6217	-75	-9.66792	0.01745253	-2310	-74.98	721.73	23	46.5	(null)
23	44972	6217	-100	-10.40346	0.003713897	-2470	-100	1060.02	23	46.4	(null)
24	44973	6217	-125	-11.67291	0.00768125	-2590	-125.01	1398.62	23	46.4	(null)
25	44974	6217	-150	-12.3211	0.006001911	-2670	-150.03	1737.46	23	46.4	(null)
26	44975	6217	-175	-12.5811	0.001267145	-2740	-175.02	2078.59	23	46.3	(null)
27	44976	6217	-200	-13.65851	0.01223054	-2800	-200	2419.02	23.1	46.2	(null)
28	44977	6217	-250	-13.9874	0.0009528379	-2900	-250.01	2761.5	23.1	46.1	(null)
29	44978	6217	-300	-14.49301	0.005028681	-3010	-300.04	3103.71	23.1	46	(null)
30	44979	6217	-400	-15.67001	0.01586948	-3310	-400.02	3447.96	23.1	45.9	(null)
31	44980	6217	-500	-17.34125	0.002627553	-3690	-500.03	3791.9	23.2	45.9	(null)
32	44981	6217	-600	-19.49549	0.004614965	-4160	-600.07	4144.96	23.2	45.9	(null)
33	44982	6217	-700	-21.71133	0.01221068	-4700	-700.06	4502.99	23.2	45.8	(null)
34	44983	6217	-800	-23.07205	0.01468643	-5280	-800.06	4864.51	23.2	45.8	(null)

Converting .txt results to .xml DB files (using the XML layout)

- **`HGCAL_sensor_db_interface:`**
  - https://gitlab.cern.ch/CLICdp/HGCAL/hgcal_sensor_db_interface
  - Example Usage
    - Convert HPK data to .txt:
      - `python db_convert_hpk_to_txt.py -i '/home/data/cms/results/hamamatsu/HPK_8in_432ch_120um/200805_S15591-03(ES1) inspection sheet.xlsx'`
    - Convert .txt data to .xml:
      - `python db_register_data_iv.py -i '/home/data/cms/results/hamamatsu/8-432-120E-00-N1308-00001/8-432-120E-00-N1308-00001_IV.txt' --serial '8-432-120E-00-N1308-00001-SE-1' --run 'IV Test 01' --location 'CERN' --operator 'Florian Pitters' --comment 'Nothing special.'`
- Similar operations can also be found here
  - https://github.com/AliAlkadhim/FSU_HGCAL_DB/tree/master/CMS_HGCAL_DB/XML_TABLES

Uploading to the DB (CMSR or INT2R)

- Once the XML files for the data that you want to store in the DB have been generated (based on the templates mentioned previously here and here), you can upload to the DB using DBLoader.
  - `DBloader` code: https://github.com/valdasraps/cmsdbldr
- More instructions to upload are in backup slides.
- To upload to the INT2R (development) database, do
  - `scp <file.xml> xml joshi@dbloader-hgcal.cern.ch:/home/dbspool/spool/hgcal/int2r`
- To upload to the CMSR (production) databse, do
  - `scp <file.xml> xml joshi@dbloader-hgcal.cern.ch:/home/dbspool/spool/hgcal/int2r`

We Need More Involvement & Input from HGCAL!

- Everyone from HGCAL (testing, module assembly, etc.) is encouraged to upload to the DB!
- If you need permissions to upload to HGCAL DB, please contact Imran (Muhammad.Imran@cern.ch), Rao (muhammad.atif.shad.rao@cern.ch), or Umesh (joshi@fnal.gov).
- Attend an HGCAL DB meeting https://indico.cern.ch/category/11190/ .
- Do we want to add extra information (tables or attributes) to the DB? We are working on changes, but we need your valued opinions!
  - E.g. `HGC_CERN_SENSOR_IV_SUMRY` has summary of grading criteria for sensors. Do we want to add more information to this summary?
  - Should the sensor tables include extra information, e.g. current location?
  - Perhaps sensors should also have a tag, whether they have been tested or not (only 5% of sensors undergo testing).

Backup

SQL Developer: installation

- Follow the instructions on https://docs.oracle.com/cd/E39885_01/doc.40/e38928/install.htm#RPTIG122 for installation instructions on any system.
- Important: SQL Developer requires JDK 7 or above. Download from https://www.oracle.com/java/technologies/downloads/#java8 and make sure your default Java in your system points to this **Oracle JKD.**
  - This means setting the `JAVA_HOME` and `JKD_HOME` environment variables are pointing to the Oracle Java.
  - Doing **`java -version`** should result in "java version …" not "openjkd version …"
- SQLDeveloper could now be launched.
- On Unix, launch with **`sqldeveloper`** to see that it works.

Connecting to the Database with SQLDeveloper (1)

tnsnames.ora

- Now put the following text in a file named **tnsnames.ora** and put it in your **/etc/** directory.
- Now ssh to lxplus

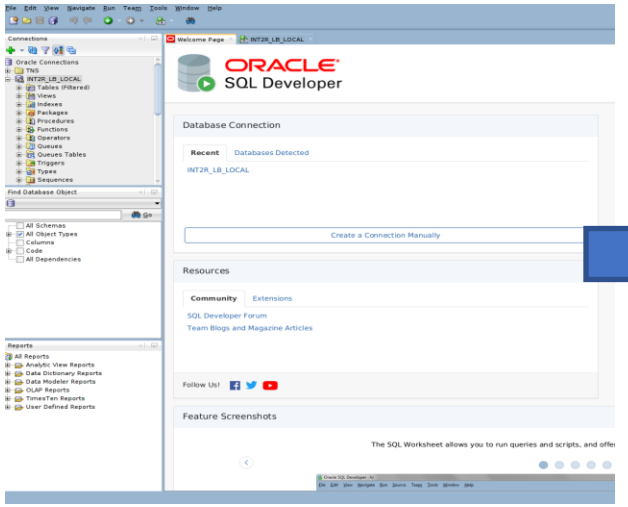
```
int2r_lb_local=(
    DESCRIPTION=
    (ADDRESS= (PROTOCOL=TCP) (HOST=localhost) (PORT=10131))
    (ADDRESS= (PROTOCOL=TCP) (HOST=localhost) (PORT=10132))
    (LOAD_BALANCE=yes)
    (CONNECT_DATA=
    (SERVER=DEDICATED)
    (SERVICE_NAME=int2r_lb.cern.ch)
    (FAILOVER_MODE=
            (TYPE=SELECT)
            (METHOD=BASIC)
            (RETRIES=180)
            (DELAY=5)
        )
    )
)
```

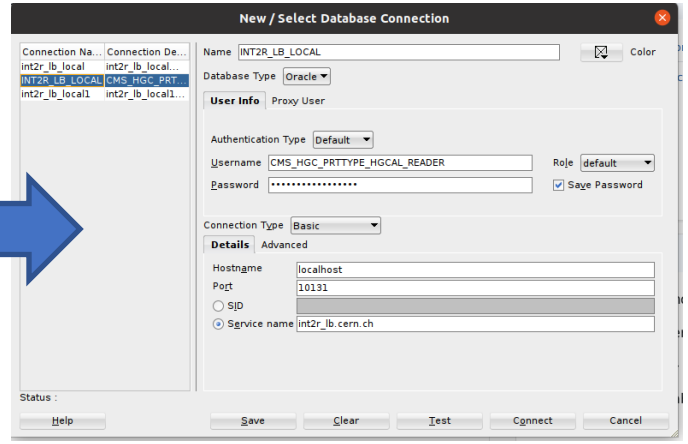
```
ssh -XY -L 10131:itrac1609-v.cern.ch:10121 -L 10132:itrac1601-v.cern.ch:10121 username@lxplus.cern.ch
```

Where username is your lxplus username.

Connecting to the Database with SQLDeveloper (2)

- Launch SQLDeveloper.
- Press "Open a Connection Manually" in the front page.
- On the "New / Select Database Connection" Dialogue box, fill:
  - Name: **INT2R_LB_LOCAL**
  - Username: CMS_HGC_PRTTYPE_HGCAL_READER
  - Password: HGCAL_Reader_2016
    - Check "save password" if you want.
  - Hostname: localhost
  - Port: 10131
  - Check on "Service name"
  - Service name: int2r_lb.cern.ch
  - Press "Connect"





Connecting to the Database with SQLDeveloper (3)

- Click View at the top of the screen.
- Click on “Find DB Object”
- Click on this database icon and select **INT2R_LB_LOCAL**
- Click on the **+** sign on the left of “**All Schemas**”
- Scroll down to entries that start with “CMS_HGC_*” and check one (or more) that you want to view.
  - For us the relevant tables are actually ones like “HGC_CERN_SENSOR_IV”
- Then click on “Go” (which has binoculars next to it).

Uploading to the HGCAL DB (1/2)

- Generate XML files for your data based on the templates
  - Templates from Umesh: https://indico.cern.ch/event/1164937/contributions/4891851/attachments/2451351/4200663/XML%20Templates%20HGCAL%20Si%20Sensors.pdf
  - Find the relevant templates from the documentation: https://twiki.cern.ch/twiki/bin/view/CMS/ConstructionDB
  - Scripts that can help in conversion to xml can be found here or here (or write your own scripts).
- You can upload to the DB using DBLoader.
  - DBloader code: https://github.com/valdasraps/cmsdbldr

Uploading to the HGCAL DB (2/2)

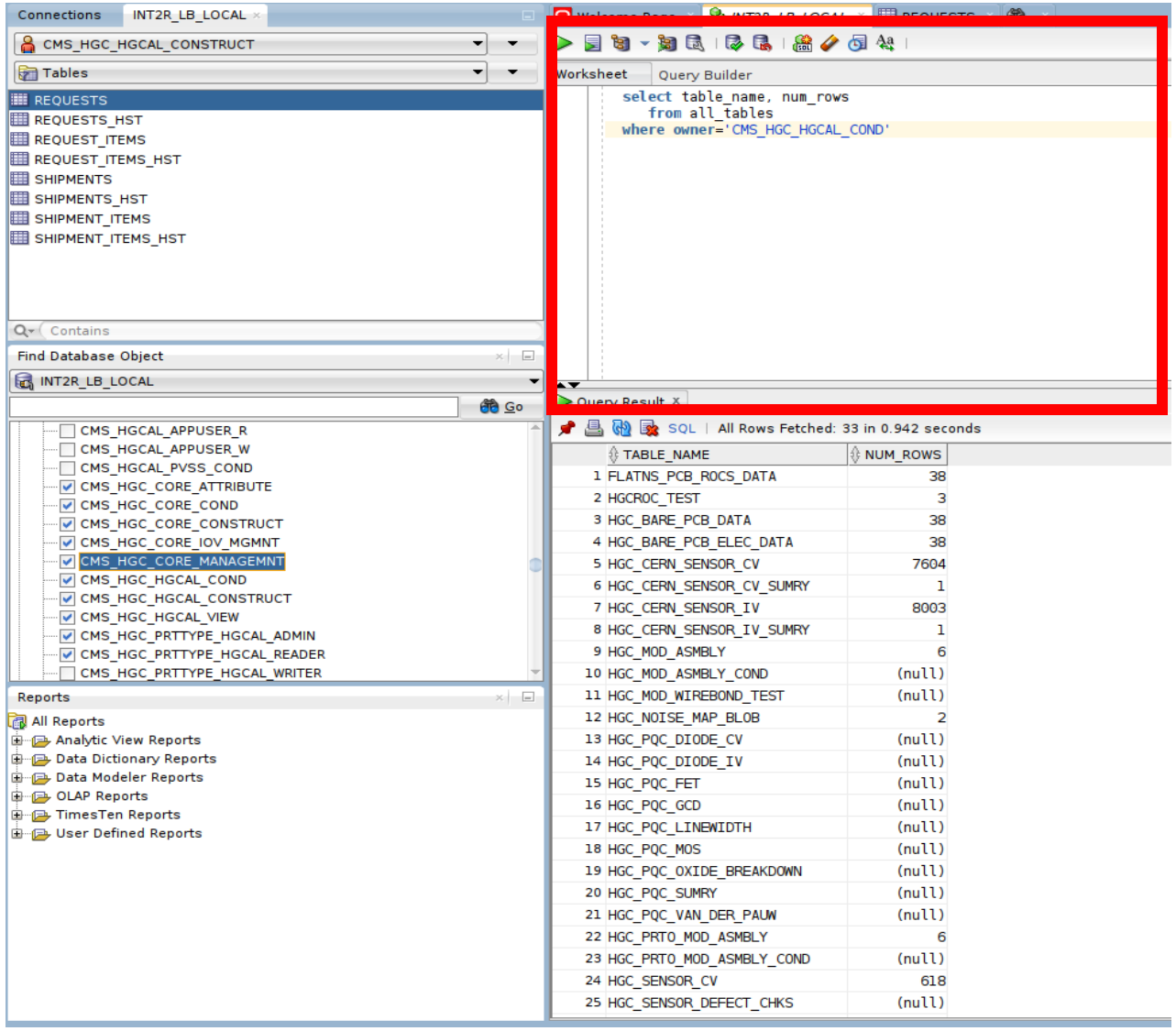
- To upload to the INT2R (development) database, do
  - scp <file.xml> xml joshi@dbloader-hgcal.cern.ch:/home/dbspool/spool/hgcal/int2r
- To upload to the CMSR (production) databse, do
  - scp <file.xml> xml joshi@dbloader-hgcal.cern.ch:/home/dbspool/spool/hgcal/int2r
- Check the status of the job on /home/dbspool/state/hgcal/int2r/filename.xml
  - E.g. joshi@dbloader-hgcal.cern.ch:/home/dbspool/state/hgcal/int2r/filename.xml
- Check the log file /home/dbspool/logs/hgcal/int2r/filename.xml for log information.

0: success
Not 0: error

Queries in SQLDeveloper Example 1

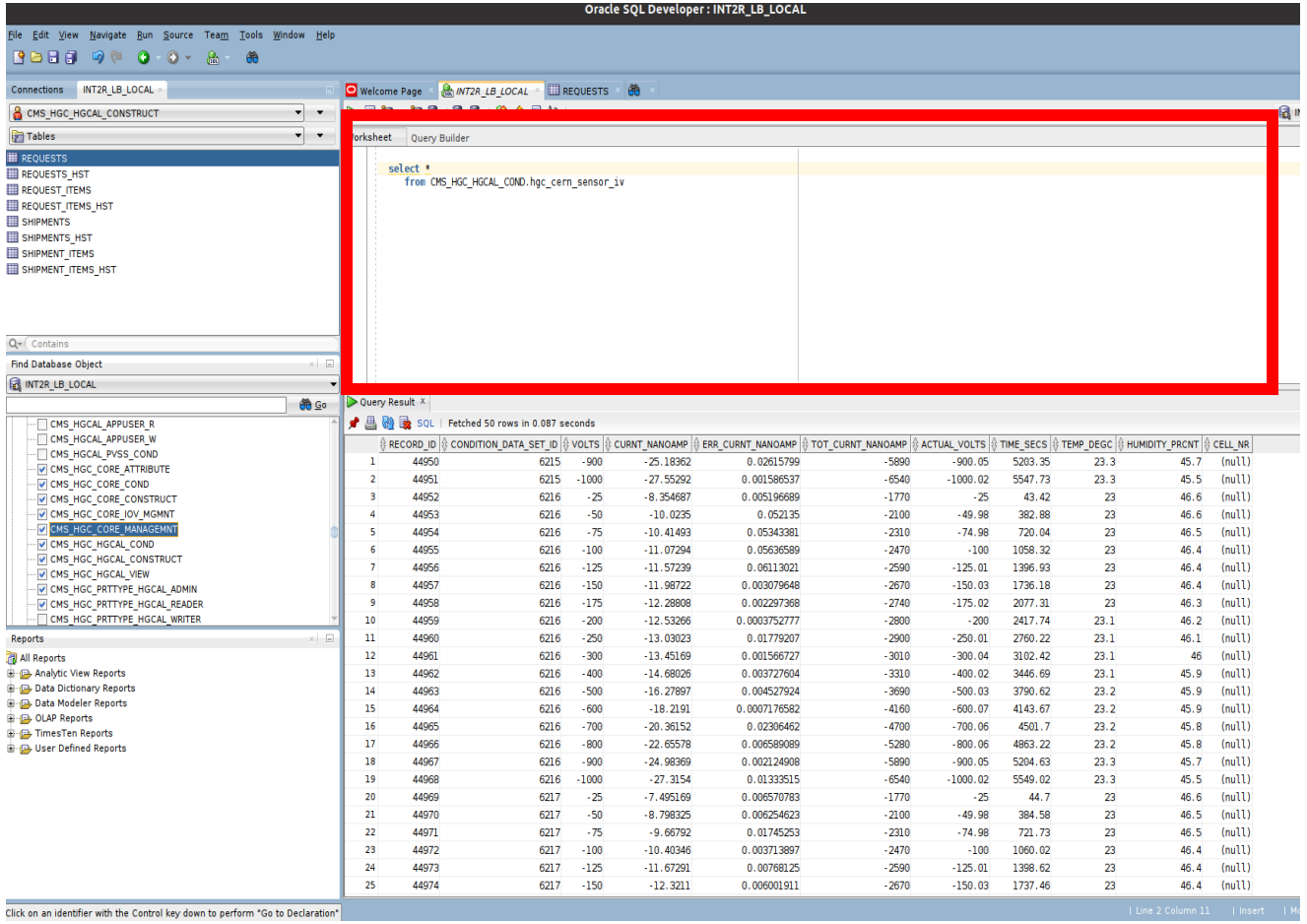
- On "worksheet" tab, write any SQL query
- Press ctrl+enter to execute.

(you don't have to check any tables, since you
Have access to all
of INT2R_LB_LOCAL.)

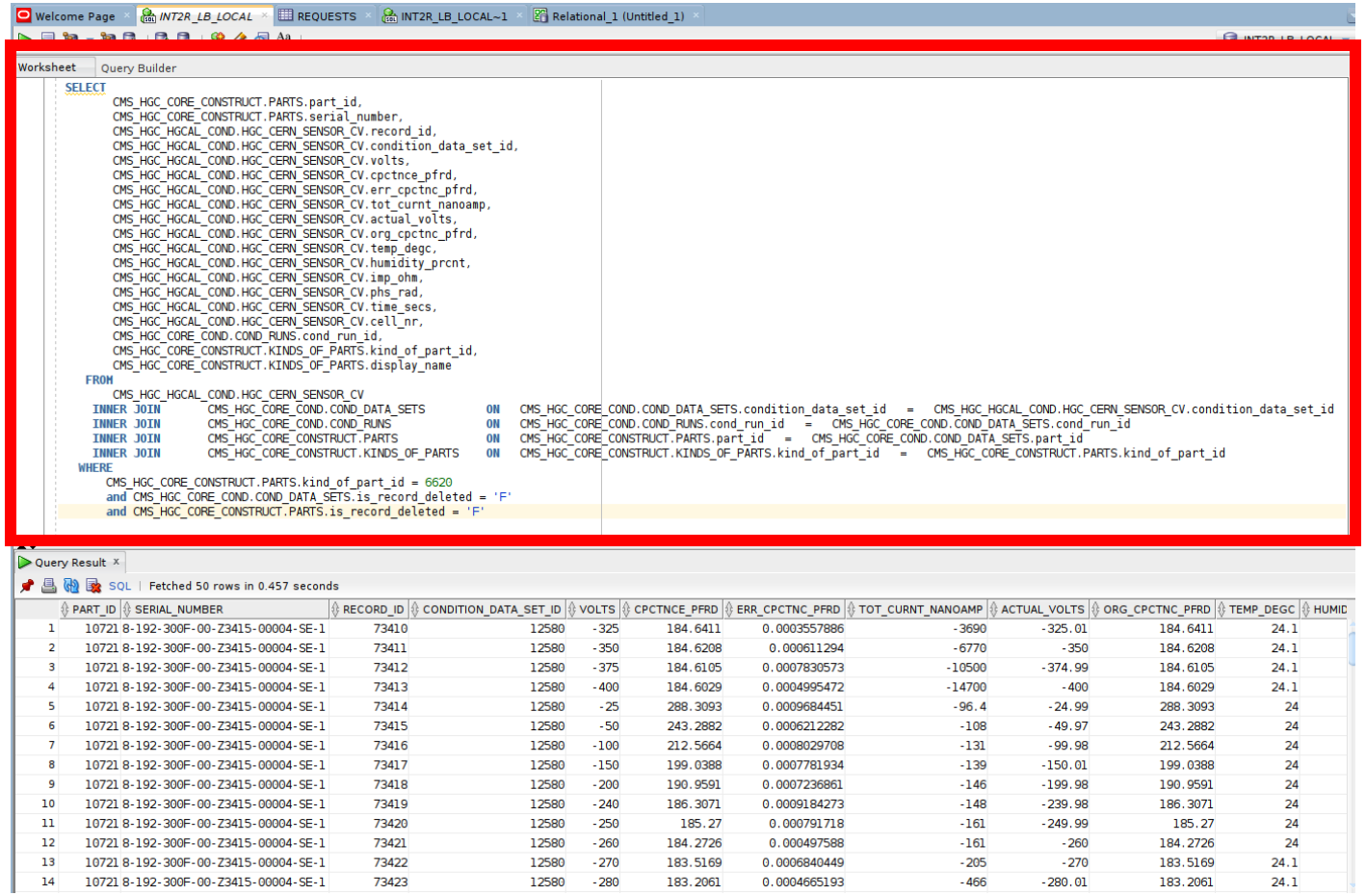


Queries in SQLDeveloper Example 2

- See everything in the "HGC_CERN_SENSOR_IV" table.



You can make SQL Queries infinitely complex!



```
SELECT
       CMS_HGC_CORE_CONSTRUCT.PARTS.part_id,
       CMS_HGC_CORE_CONSTRUCT.PARTS.serial_number,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.record_id,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.condition_data_set_id,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.volts,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.cpctnce_pfrd,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.err_cpctnc_pfrd,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.tot_curnt_nanoamp,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.actual_volts,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.org_cpctnc_pfrd,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.temp_degc,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.humidity_prcnt,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.imp_ohm,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.phs_rad,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.time_secs,
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.cell_nr,
       CMS_HGC_CORE_COND.COND_RUNS.cond_run_id,
       CMS_HGC_CORE_CONSTRUCT.KINDS_OF_PARTS.kind_of_part_id,
       CMS_HGC_CORE_CONSTRUCT.KINDS_OF_PARTS.display_name
  FROM
       CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV
    INNER JOIN       CMS_HGC_CORE_COND.COND_DATA_SETS         ON   CMS_HGC_CORE_COND.COND_DATA_SETS.condition_data_set_id   =   CMS_HGC_HGCAL_COND.HGC_CERN_SENSOR_CV.condition_data_set_id
    INNER JOIN       CMS_HGC_CORE_COND.COND_RUNS              ON   CMS_HGC_CORE_COND.COND_RUNS.cond_run_id   =   CMS_HGC_CORE_COND.COND_DATA_SETS.cond_run_id
    INNER JOIN       CMS_HGC_CORE_CONSTRUCT.PARTS             ON   CMS_HGC_CORE_CONSTRUCT.PARTS.part_id   =   CMS_HGC_CORE_COND.COND_DATA_SETS.part_id
    INNER JOIN       CMS_HGC_CORE_CONSTRUCT.KINDS_OF_PARTS    ON   CMS_HGC_CORE_CONSTRUCT.KINDS_OF_PARTS.kind_of_part_id   =   CMS_HGC_CORE_CONSTRUCT.PARTS.kind_of_part_id
  WHERE
      CMS_HGC_CORE_CONSTRUCT.PARTS.kind_of_part_id = 6620
      and CMS_HGC_CORE_COND.COND_DATA_SETS.is_record_deleted = 'F'
      and CMS_HGC_CORE_CONSTRUCT.PARTS.is_record_deleted = 'F'
```

Fetched 50 rows in 0.457 seconds

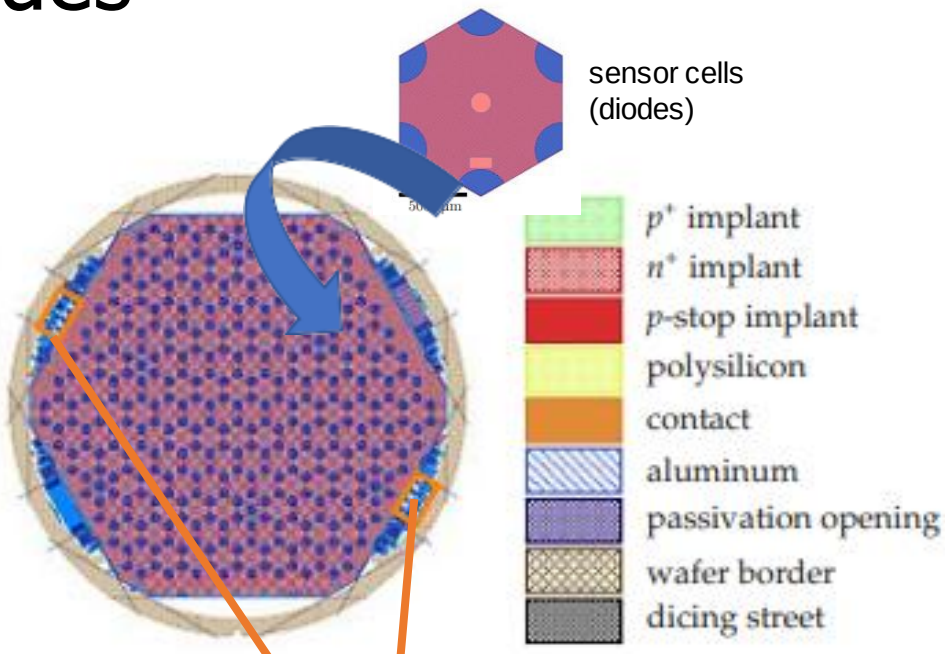
	PART_ID	SERIAL_NUMBER	RECORD_ID	CONDITION_DATA_SET_ID	VOLTS	CPCTNCE_PFRD	ERR_CPCTNC_PFRD	TOT_CURNT_NANOAMP	ACTUAL_VOLTS	ORG_CPCTNC_PFRD	TEMP_DEGC	HUMID
1	10721	8-192-300F-00-Z3415-00004-SE-1	73410	12580	-325	184.6411	0.0003557886	-3690	-325.01	184.6411	24.1	
2	10721	8-192-300F-00-Z3415-00004-SE-1	73411	12580	-350	184.6208	0.000611294	-6770	-350	184.6208	24.1	
3	10721	8-192-300F-00-Z3415-00004-SE-1	73412	12580	-375	184.6105	0.0007830573	-10500	-374.99	184.6105	24.1	
4	10721	8-192-300F-00-Z3415-00004-SE-1	73413	12580	-400	184.6029	0.0004995472	-14700	-400	184.6029	24.1	
5	10721	8-192-300F-00-Z3415-00004-SE-1	73414	12580	-25	288.3093	0.0009684451	-96.4	-24.99	288.3093	24	
6	10721	8-192-300F-00-Z3415-00004-SE-1	73415	12580	-50	243.2882	0.0006212282	-108	-49.97	243.2882	24	
7	10721	8-192-300F-00-Z3415-00004-SE-1	73416	12580	-100	212.5664	0.0008029708	-131	-99.98	212.5664	24	
8	10721	8-192-300F-00-Z3415-00004-SE-1	73417	12580	-150	199.0388	0.0007781934	-139	-150.01	199.0388	24	
9	10721	8-192-300F-00-Z3415-00004-SE-1	73418	12580	-200	190.9591	0.0007236861	-146	-199.98	190.9591	24	
10	10721	8-192-300F-00-Z3415-00004-SE-1	73419	12580	-240	186.3071	0.0009184273	-148	-239.98	186.3071	24	
11	10721	8-192-300F-00-Z3415-00004-SE-1	73420	12580	-250	185.27	0.000791718	-161	-249.99	185.27	24	
12	10721	8-192-300F-00-Z3415-00004-SE-1	73421	12580	-260	184.2726	0.000497588	-161	-260	184.2726	24	
13	10721	8-192-300F-00-Z3415-00004-SE-1	73422	12580	-270	183.5169	0.0006840449	-205	-270	183.5169	24.1	
14	10721	8-192-300F-00-Z3415-00004-SE-1	73423	12580	-280	183.2061	0.0004665193	-466	-280.01	183.2061	24.1	

Want to Generate ERDs? You can do that too!

- Click **File**, then **Data Modeler,** then **Import,** then **Data Dictionary**
- Select DB Connection (e.g. INT2R_LB_LOCAL), and click Next
- Select a schema (e.g. CMS_HGC_HGCAL_COND), and click Next
- Select all the objects in the schema, and click Next
- Resulting ERD:

SQC, PQC and their Analysis Codes

- HexDaq is used for the output of raw data test results.
- SQC (sensor Quality Control) tests (such as IV and CV) tests the actual Si sensors. Analysis code for the results is lcd_hgcal_analysis_workflows.
- PQC (Process Quality Control) is performed on test structures. Analysis codes is analysis-pqc.



PQC (halfmoon) sets (for quality assurance and irradiation tests)

Diodes

MOS capacitors

Gate-controlled diodes

(+ MOSFET, Van-der-pauw structures, etc., not yet documented)