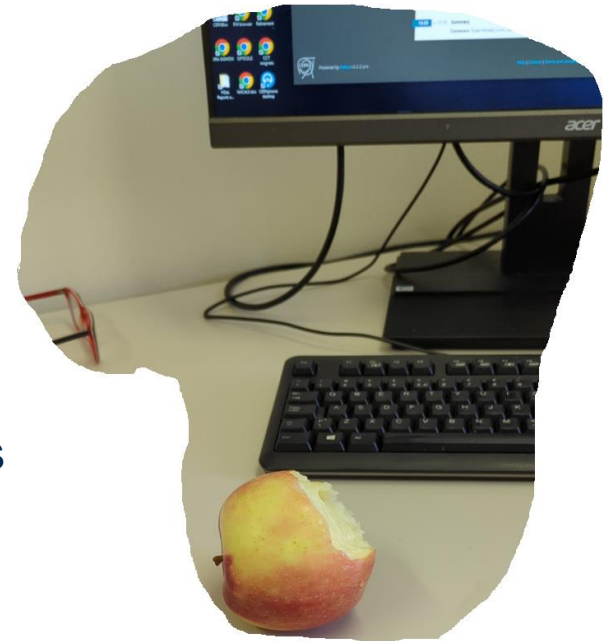


# MP3 Quench Database

Per Hagen, CERN

## Discussion topic

- Improve structure & contents
- Use existing data in FPA Notebooks



The apple doesn't fall far from the tree

# MP3 data usage (as of today)

- MP3 event analysis (HWC, operation)
  - Is circuit and protecting subsystems (magnets, leads, QPS, PC, QHs, EE) OK for repowering?
  - If Not OK, provide supporting information for subsystem experts
  - **Event simulation for non-trivial cases (independent activity)**
  - Update quench data with new event
- Scientific studies
  - Quench behavior and statistics (“holy grail” of SC magnets!)
  - Prediction of future quenches in training campaigns
  - Risk analysis (probability of having to warm-up sector for repair of equipment, or damaging “delicate” equipment hard to replace)
- Other “MP3” data not related to quench (*not topic of this presentation*)
  - ELQA circuit health qualifications, transfer functions, “shorts”
  - Evolution of splice R in magnets and busbars (special HWC tests)
- **Difficult to know what event parameters can be of importance for future studies!**

# How we do FPA today

Run SWAN FPA Notebook for a single event (trip, quench)

```
In [4]: 1 circuit_type = 'RB'
2 fgc_pm_search = FgcPmSearchModuleMediator(DateTimeBaseModule(start_date_time = search_start.isoformat(sep=' '),
3 end_date_time = search_end.isoformat(sep=' ')),
4 circuit_type=circuit_type)
```

Circuit name: RB.A23 Start: 2022-10-20 12:32:12.347428+01: End: 2022-10-22 12:32:12.347428+01:

Analysis: Manual Automatic Done by: hagen

Find FGC PM entries: Querying PM for FGC entries on 2022-10-21 13:32:12.347428+02:00 Days: 2/2

FGC PM Events: 2022-10-21 01:26:25.120000+02:00

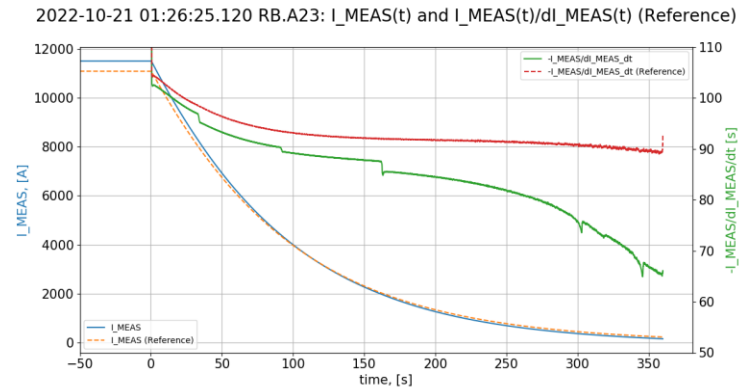
Time range for search of FGC PM events around selected event [s]: 5

The analysis is executed in Manual mode.  
Selected FGC PM event 2022-10-21 01:26:25.120000+02:00.  
CIRCUIT NAME RB.A23  
FGC PM events in circuits of subsector: A23

generated



html report

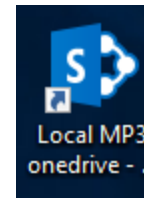
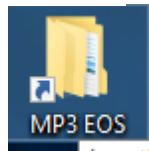


copy & paste from .csv



MP3 excel quench file

Circuit Nan	Circuit Fami	Period	Date [FG]	Time [FG]	FPA Reason	Timestamp_PIC	Delta_t[FGC-PIC] [ms]	Delta_t[EE_even-PIC] [ms]
RB	RB	Operation	2008	13:14:15				
RB.A78	RB	Operation	2022	22/09/2022	16:11:44 Magnet quench	22/09/2022 16:11:43.932	28	590
RB.A78	RB	Operation	2022	22/09/2022	16:11:44 Magnet quench	22/09/2022 16:11:43.932	28	590
RB.A78	RB	Operation	2022	22/09/2022	16:11:44 Magnet quench	22/09/2022 16:11:43.932	28	590
RB.A23	RB	Operation	2022	21/10/2022	01:26:25 Magnet quench	21/10/2022 01:26:25.095	25	598
RB.A23	RB	Operation	2022	21/10/2022	01:26:25 Magnet quench	21/10/2022 01:26:25.095	25	598
RB.A23	RB	Operation	2022	21/10/2022	01:26:25 Magnet quench	21/10/2022 01:26:25.095	25	598
RB.A23	RB	Operation	2022	21/10/2022	01:26:25 Magnet quench	21/10/2022 01:26:25.095	25	598
RB.A23	RB	Operation	2022	21/10/2022	01:26:25 Magnet quench	21/10/2022 01:26:25.095	25	598
RB.A23	RB	Operation	2022	21/10/2022	01:26:25 Magnet quench	21/10/2022 01:26:25.095	25	598
RB.A45	RB	Operation	2022	13/11/2022	18:24:34 QPS trip	13/11/2022 18:24:34.105	35	586
RB.A45	RB	Operation	2022	13/11/2022	18:24:34 QPS trip	13/11/2022 18:24:34.105	35	586
RB.A45	RB	Operation	2022	13/11/2022	18:24:34 QPS trip	13/11/2022 18:24:34.105	35	586
RB.A45	RB	Operation	2022	13/11/2022	18:24:34 QPS trip	13/11/2022 18:24:34.105	35	586

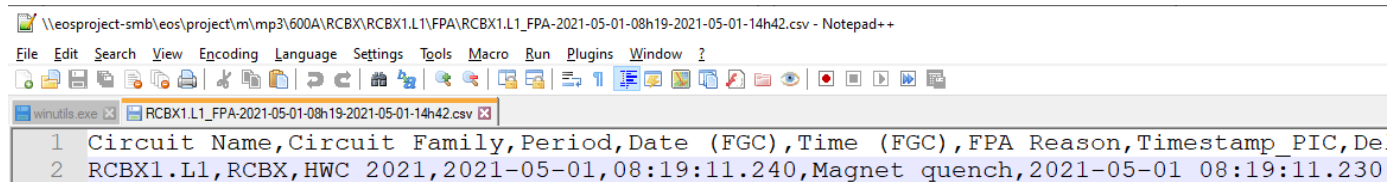


lock file when updating

# Excel specific problems!

*Discussion topic. I am not the Oracle of Delphi so I do not have all the answers!*

- **We experienced one or more file corruptions during HWC**
  - For this reason, and secondly, I am not sure about the IT doing backup on a regular basis, I make snapshot backups once in a while when there is MP3 activity going on: \\eosproject-smb\eos\project\m\mp3\QuenchFilesBackup
- **File sometimes remains locked after update**
  - Fortunately Excel tells who the person locking the file is. I have learnt to live with this problem. It “mainly” delays the propagation from Notebook .csv to Excel. This can be a real problem if next person to analyse needs the data!
- **Excel date/time formats**
  - We use ISO 8601 recommendations in the .csv made by the FPA Notebooks to avoid ambiguity. So far so good. Still we need to use the Excel special **copy&paste values** to have the same formatting as in the previous row. I remember documenting this year(s) ago. Last, but not least, the data is still there in any case so I reformat stuff when I see something strange.



The screenshot shows a Notepad++ window with the following content:

```
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
winutils.exe RCBX1.L1_FPA-2021-05-01-08h19-2021-05-01-14h42.csv
1 Circuit Name,Circuit Family,Period,Date (FGC),Time (FGC),FPA Reason,Timestamp_PIC,De
2 RCBX1.L1,RCBX,HWC 2021,2021-05-01,08:19:11.240,Magnet quench,2021-05-01 08:19:11.230
```

# Excel and OneDrive strategy

*Discussion topic. I am not the Oracle of Delphi and here I am without answers!*

- Long term future of our Microsoft OneDrive website as a collaborative tool???
- Simply migrate files to EOS where we have all the Notebook reports in any case (consistent approach) ???
- Remember Monty Python 1971: *And Now for Something Completely Different*
- Relational database???
- Something already exists off the shelf (inside CERN)???
- We need:
  - Update of a single event from Notebook FPA or manually for exceptions
  - Browse and edit web user interface
  - Download selection of data to [Excel, PowerPoint, analytic tools]
- This problem can also be seen in the context of signal monitoring and storing of is derived data (like busbar R evolution). Store into NXCALS and extract via TIMBER into analytic tools???

# External applications RB use case

During operation:  
interlock history  
gives “big picture”

History Buffer

Mode:  History  Snapshot  Online

Time Filter (LOCAL TIME): Start: 21/10/2022 01:26:25, End: 21/10/2022 01:26:26

Event: 282

Local Time	Source	Type	Item	Description	Message	Status	Invalid
2022.10.21 01:26:25.094	Monitoring INPUT	PLC	CIP.UA27.AR2	Output of the CPLD Matrix	ST_MATRIX	BAD	<input type="checkbox"/>
2022.10.21 01:26:25.095	Input	A	RB.A23.ODD	Sector 2 to 3 Main bending, B1 and B2 in series	ST_ABORT_PIC	BAD	<input type="checkbox"/>
2022.10.21 01:26:25.096	Monitoring INPUT	PLC	CIP.UA27.AR2	Output of the CPLD Matrix	ST_MATRIX	BAD	<input type="checkbox"/>

Energy Extraction  
must be checked  
with PM Powering  
Playback

qps-13kA >> Version: 5.1.6 Responsible: TE-MPE-MS Software Team (167226 - mpe-software-coord@cern.ch)

General System Overview | 13kA Microswitches specific data | DQAMS signals data

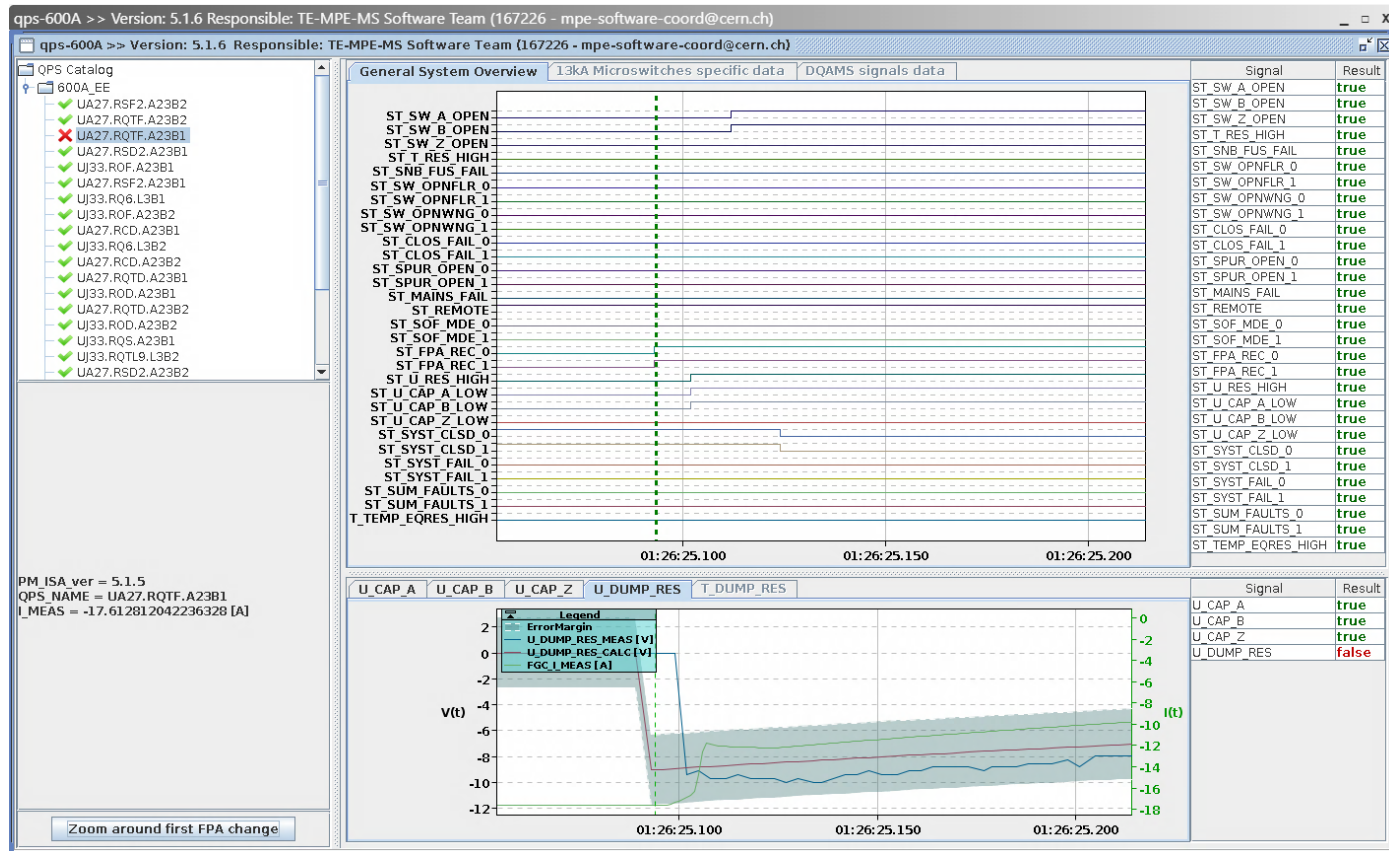
Signal	Result
DQSB:ST_REC_FPA1	true
DQSB:ST_REC_FPA2	true
DQSB:ST_SYST_OPEN	true
DQSB:ST_PWR_PERM	true
DQSB:ST_TST_SOF...	true
DQSB:ST_SOF_CAR...	true
DQSB:ST_REMOT...	true
DQSB:ST_CABLES...	true
DQSB:ST_RES_FLO...	true
DQSB:ST_RES_OVE...	true
DQSB:ST_RES_OVE...	true
DQSB:ST_RES_FAN...	true
DQSB:ST_FAN_CB...	true
DQSB:ST_BUS_FLO...	true
DQSB:ST_PS_IM_OK	true
DQSB:ST_FAULT_PS...	true
DQSB:ST_FAULT_PS...	true
DQSB:ST_NO_OPEN...	true
DQSB:ST_NO_OPEN...	true
DQSB:ST_NO_OPEN...	true
DQSB:ST_NO_OPEN...	true
DQSB:ST_FLT_M1_0	true
DQSB:ST_FLT_M2_0	true
DQSB:ST_FLT_M1_1	true
DQSB:ST_FLT_M2_1	true
DQSB:ST_OVERCUR...	true
DQSB:ST_OVERCUR...	true
DQSB:ST_OVERCUR...	true
DQSB:ST_OVERCUR...	true
DQSB:ST_SNUB_FAIL	true

Graph: V(t) vs Time (01:27:00.000 to 01:31:00.000). Legend: Error Margin, U\_DUMP\_RES\_CALC [V], U\_DUMP\_RES\_MEAS [V].



# External applications 600 A use case

- Many cases with red “flags” because U\_DUMP\_RES based upon theoretical calculated curves (does not consider current, quenchback, timing tolerances?)
- Serious problems with EE are very rare or perhaps non-existent so we often alert EE experts for no good reason!



# FPA parameters collected (today)

Take RB as “use case”. All others are essentially subsets / variants.

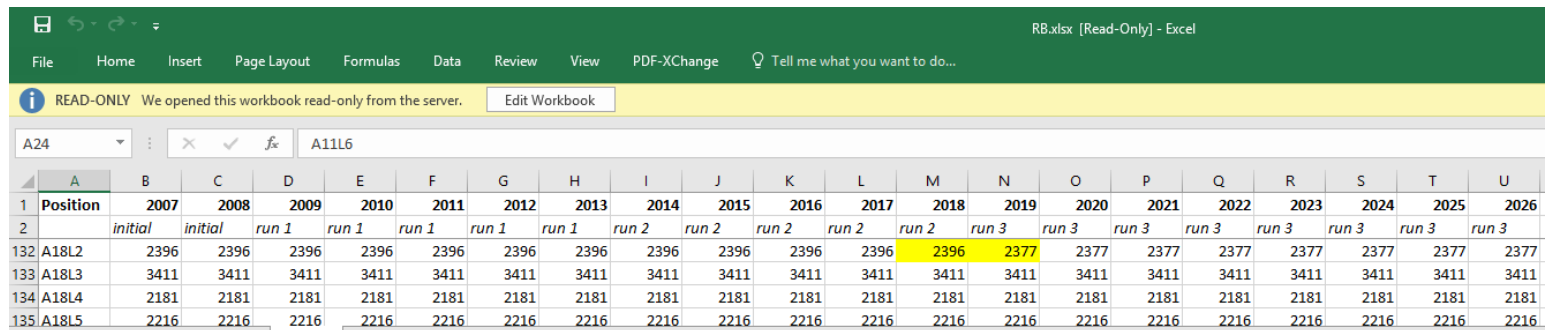
- Circuit name, type, date+time, period: HWC, Operation
- PIC time and PM timing wrt PIC:  $\Delta t(\text{FGC})$ ,  $\Delta t(\text{EE}_{\text{ODD,EVEN}})$
- Circuit parameters for start of FPA:
  - $I$ ,  $\Delta I/\text{dt}$  or  $t_{\text{plateau}}$ ,  $\hat{U}_{\text{EE}_{\text{ODD,EVEN}}}$
  - **Analyser: FPA reason, Quench # in circuit if HWC, Comments**
- Circuit parameters during FPA:
  - MIITS:  $10^6 \int I^2 dt$
  - $\hat{I}_{\text{earth}}$
  - **Analyser: EE OK? VF OK?**
- For each quenched magnet:
  - Cell, QPS crate,  $t_{\text{pic}}$ ,  $\Delta t(\text{iQPS})$ ,  $\Delta t(\text{nQPS})$ , # in event, QH OK?
  - $I_{\text{magnet}}$ , aperture (EXT/INT)
  - $\Delta U_{\text{QS0}}/\text{dt}$ ,  $\hat{U}_{\text{symm}}$ ,  $\Delta \hat{U}_{\text{symm}}/\text{dt}$  (**last 2 not implemented!**)
  - **Analyser: QDS trigger, quench # in circuit if HWC**
  - $R_{\text{max\_diode\_leads}}$  @  $I_{\text{diode\_leads}}$
- Notebook + API versions
- Magnet data (MB #, SC cable types, SM18  $I_{1\text{st}_q}$ ) using cell lookup



# FPA parameters (continued)

Take RB as “use case”. All others are essentially subsets / variants.

- Look in **layout** sheet if we want to know the magnet in cell as function of time

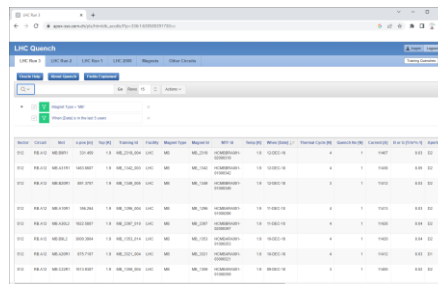


The screenshot shows an Excel spreadsheet titled "RB.xlsx [Read-Only] - Excel". The spreadsheet has a grid with columns labeled A through U and rows numbered 1 through 135. The first row (row 1) contains the word "Position" in column A, followed by years from 2007 to 2026. The second row (row 2) contains the word "initial" in column B, followed by "run 1" through "run 3" for each year. The data rows (rows 132-135) show numerical values for each position and year. For example, row 132 (A18L2) has values: 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2396, 2377, 2377, 2377, 2377, 2377, 2377, 2377. The values for 2018 and 2019 are highlighted in yellow.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Position	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2		initial	initial	run 1	run 1	run 1	run 1	run 1	run 2	run 2	run 2	run 2	run 2	run 3	run 3	run 3	run 3	run 3	run 3	run 3	run 3
132	A18L2	2396	2396	2396	2396	2396	2396	2396	2396	2396	2396	2396	2396	2396	2377	2377	2377	2377	2377	2377	2377
133	A18L3	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411	3411
134	A18L4	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181	2181
135	A18L5	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216

- Filter in RB sheet if we want to know the (quench) history as function of time. SM18 quenches in another Excel dump from Oracle.

( next slide )



The screenshot shows an Oracle database query result titled "LHC Quench". The table has columns for "Quench ID", "Magnet", "Quench Type", "Quench Date", "Quench Duration", "Quench Energy", "Quench Current", "Quench Voltage", "Quench Power", "Quench Loss", "Quench Status", "Quench Comment", and "Quench Location". The data rows show various quench events for different magnets, including SM18.

Quench ID	Magnet	Quench Type	Quench Date	Quench Duration	Quench Energy	Quench Current	Quench Voltage	Quench Power	Quench Loss	Quench Status	Quench Comment	Quench Location
001	SM18	Normal	2007-01-01	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
002	SM18	Normal	2007-01-02	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
003	SM18	Normal	2007-01-03	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
004	SM18	Normal	2007-01-04	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
005	SM18	Normal	2007-01-05	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
006	SM18	Normal	2007-01-06	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
007	SM18	Normal	2007-01-07	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
008	SM18	Normal	2007-01-08	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
009	SM18	Normal	2007-01-09	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18
010	SM18	Normal	2007-01-10	10	1000000000	10000	100000000	1000000000	1000000000	Success		SM18



# http://cern.ch/lhc-quench

Showing a small subset of data so more columns available.  
Updated until 2020 with help of Excel Visual Basic code

**LHC Quench** hagen Logout

LHC Run 3 | LHC Run 2 | LHC Run 1 | LHC 2008 | Magnets | Other Circuits Training Quenches

[Oracle Help](#) [About Quench](#) [Fields Explained](#)

Q  Go Rows 15  Actions

Sector	Circuit	Slot	s-pos [m]	Top [K]	Training Id	Facility	Magnet Type	Magnet Id	MTF Id	Temp [K]	When [Date] ↑	Thermal Cycle [N]	Quench No [N]	Current [A]	B or G
S12	RB.A12	MB.A31L2	1869.1307	1.9	MB_2438_001	SM18	MB	MB_2438	HCMBALA001-02000438	1.9	03-FEB-09	0	1	11042	
S12	RB.A12	MB.A31L2	1869.1307	1.9	MB_2438_002	SM18	MB	MB_2438	HCMBALA001-02000438	1.9	04-FEB-09	0	2	12209	

# FPA data improvements since end of HWC

- Missing old data in Notebook FPA format (general problem):
  - FPA Notebooks developed for the LS2 HWC (> 2020)
  - I have collected RB FPA data for Run 2 after a few simple code modifications (nQPS buffers often created long time after event and sometimes missing)
  - In progress: Code modifications for RB FPA Run 1 and hopefully all the way back to 2007
  - But collecting RB FPA data is so far manual work \*
- In progress: Correction of  $\Delta U_{\text{res}}/dt$  for IPQ quench file thanks to new algorithm and automation work by Zinur, Lena, Ola ...

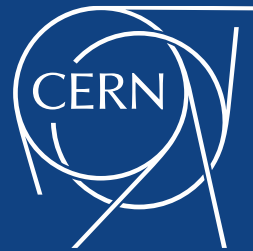
\* Quote from Forrest Gump movie 1994:  
"My mama always said, life is like a box of chocolates. You never know what you're gonna get."

# Now it is your turn!

*In a democratic world we must learn to live with our different view of things*

- Improve structure & contents of FPA Notebooks
- Use existing data in FPA Notebooks





[www.cern.ch](http://www.cern.ch)