CERN

Tools for magnet testing and QA/QC

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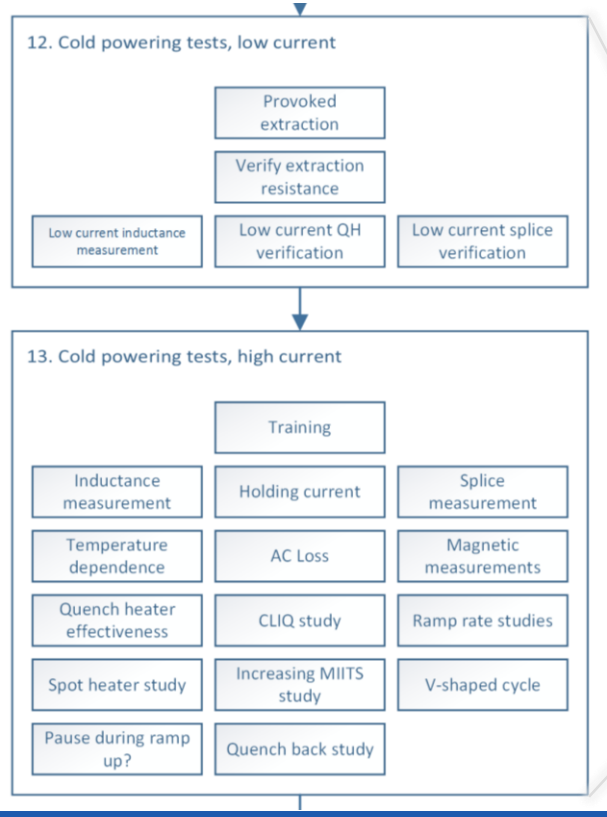
CERN – TE/MSC-TF

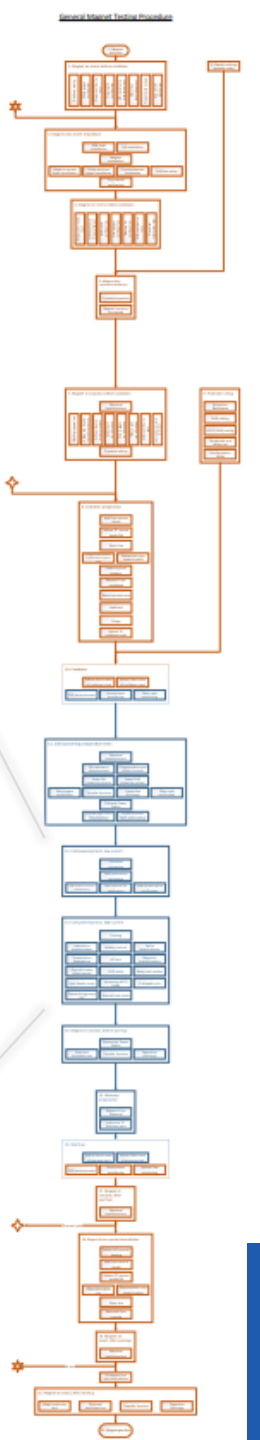
2018 05 09 @ Brookhaven National Laboratory

Testing is a complicated process

Incoming & registration → Setup preparation → Testplan creation → Installation → Cooldown → Testing → Warmup → Deinstallation → Departure

- Magnet basic info
- Testing team & setup
- Test plan procedure
- Measurements data
  - Raw data
    - high precision data (RRR, splices)
    - high freq data (quench)
    - other data (insulation, resistance)
  - Results
- Reports





Tools for magnet testing

National Instruments' DIAdem

- For data visualization, analysis, processing, reporting, etc

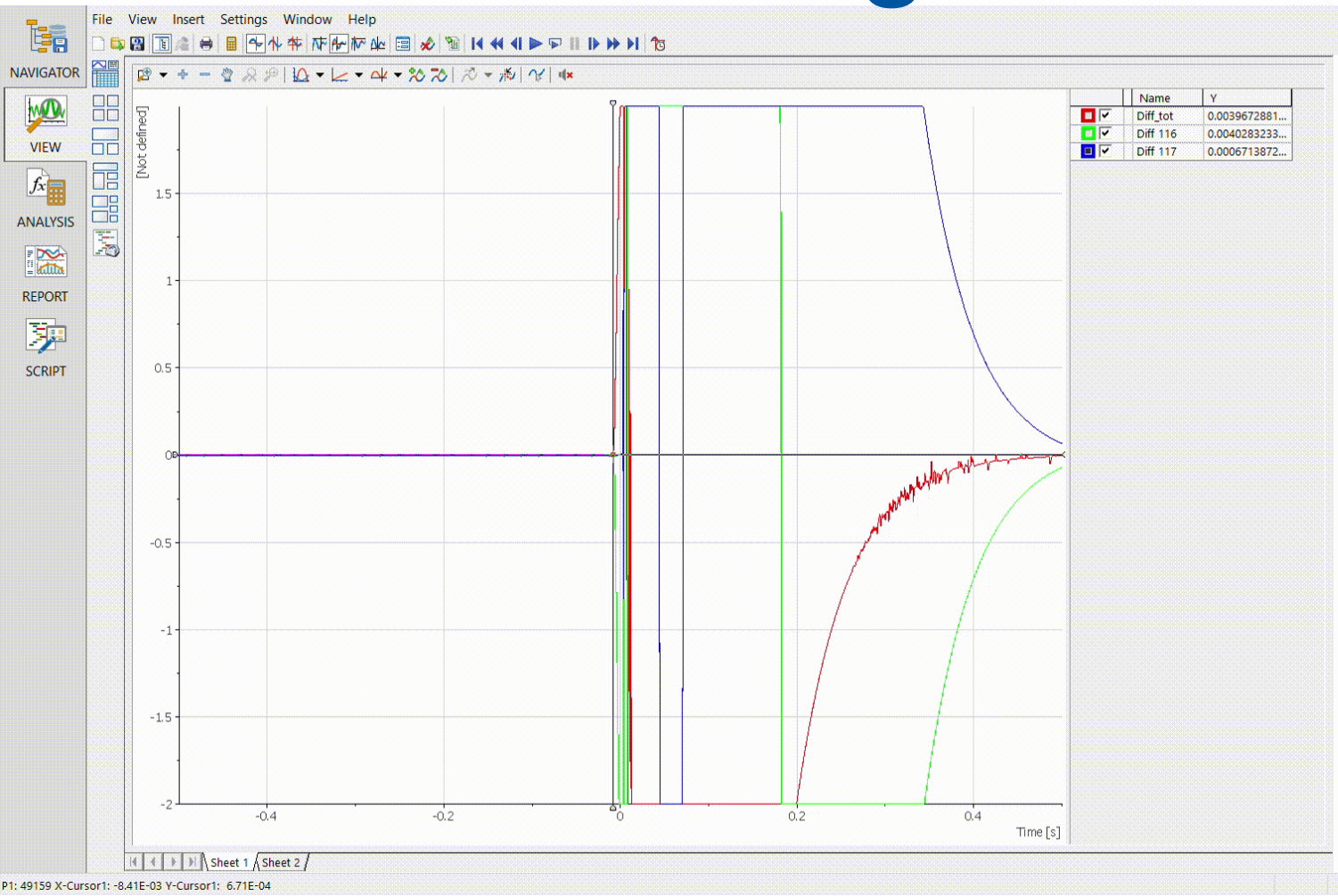
AQA

- For quench analysis

Carpenter

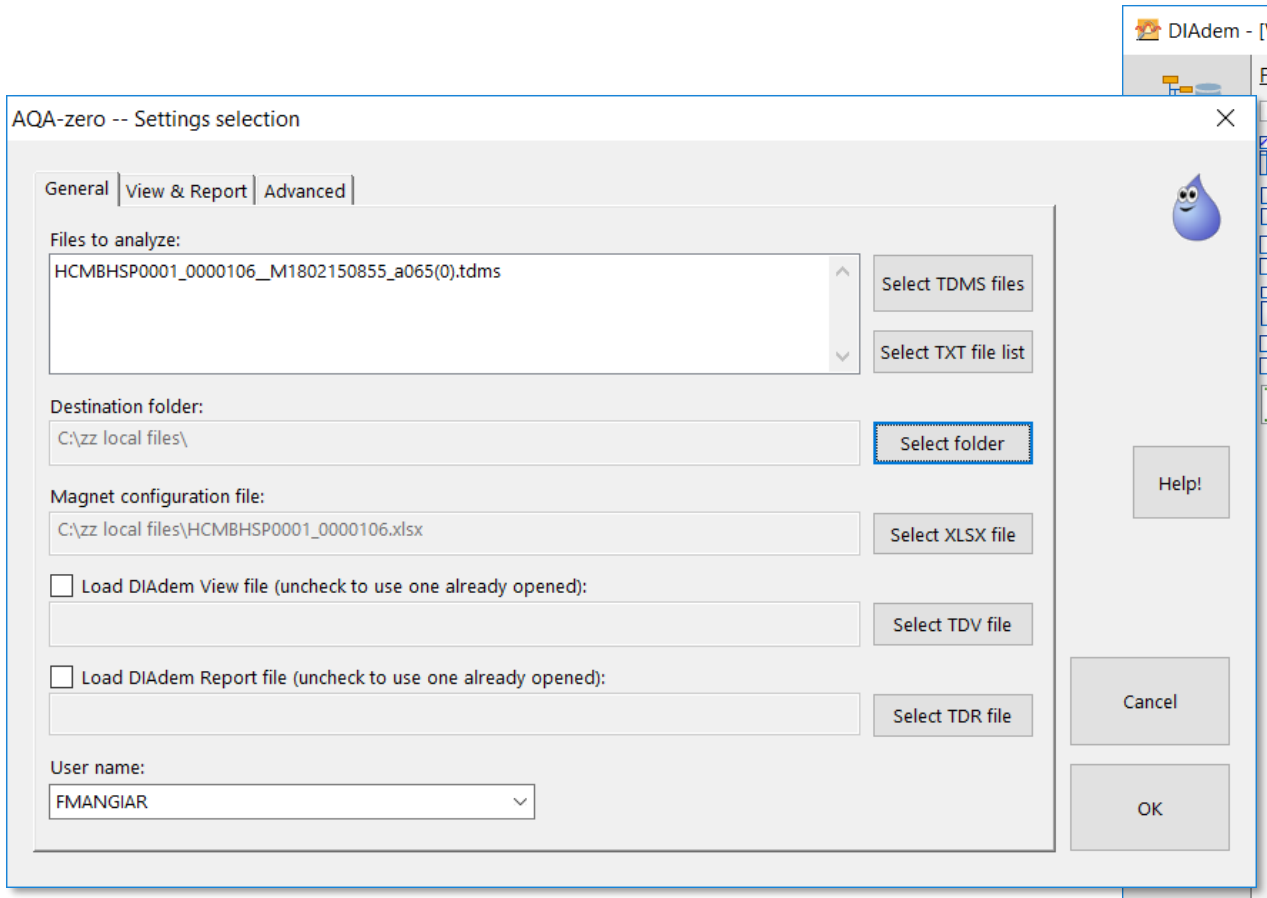
- For test follow-up, QA/QC and data storage

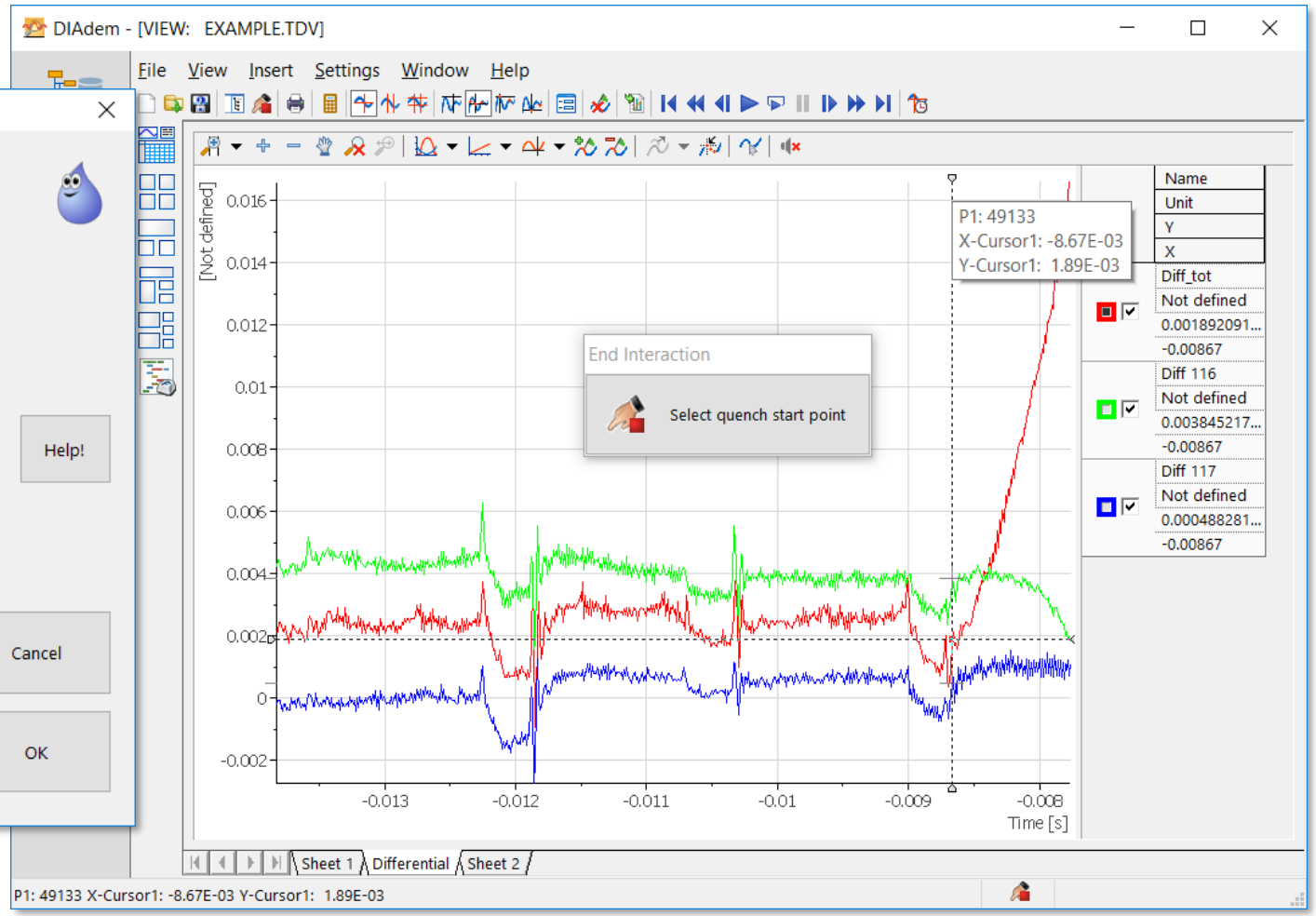
Data handling: DIAdem



- Visualize data
  - Zoom in/out
  - Compare curves
- Data manipulation
  - Sum, integrate, etc
- Scripting language embedded

Quench data processing: AQA





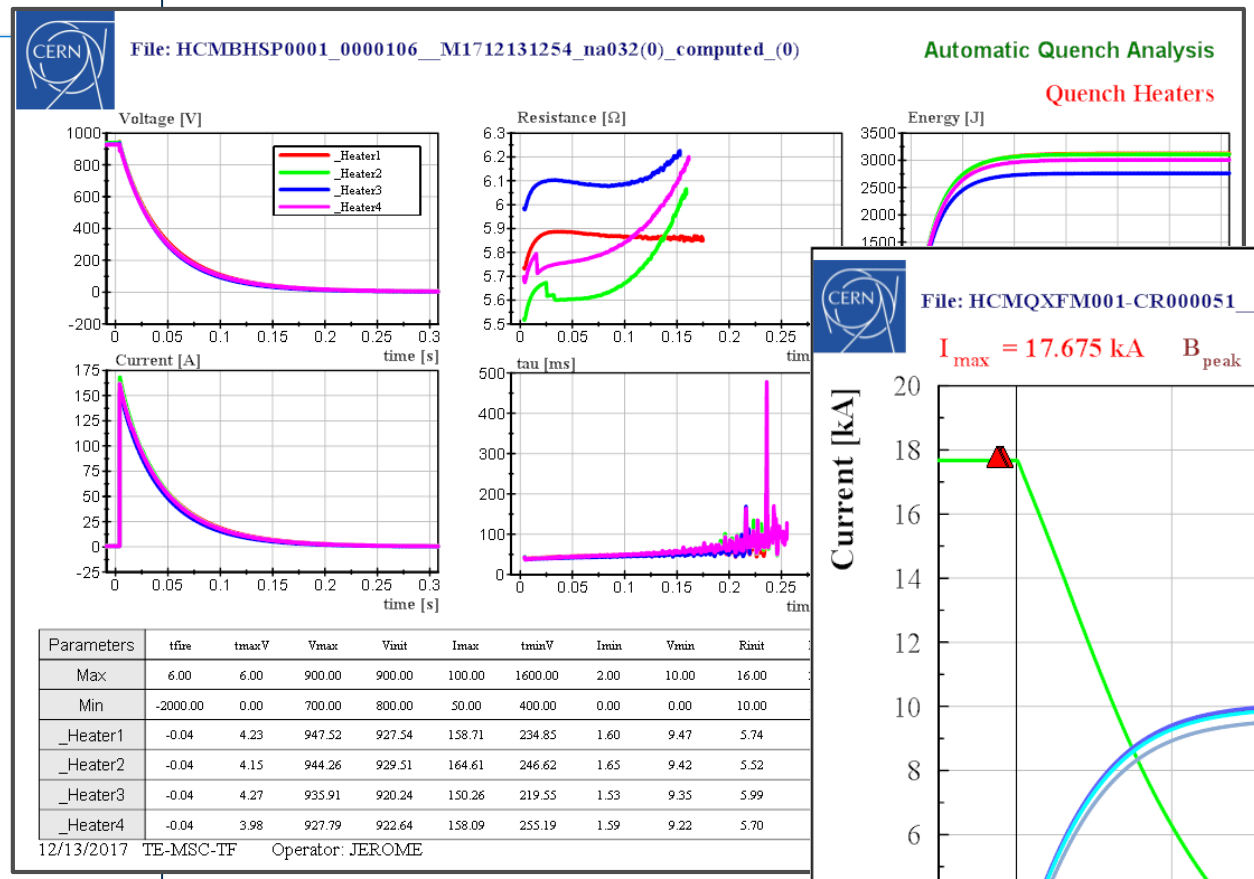
Quench data processing: AQA

HCMBHSP0001_0000106__M1712051628_na002(0)_AQAzero.txt - Notepad

File Edit Format View Help

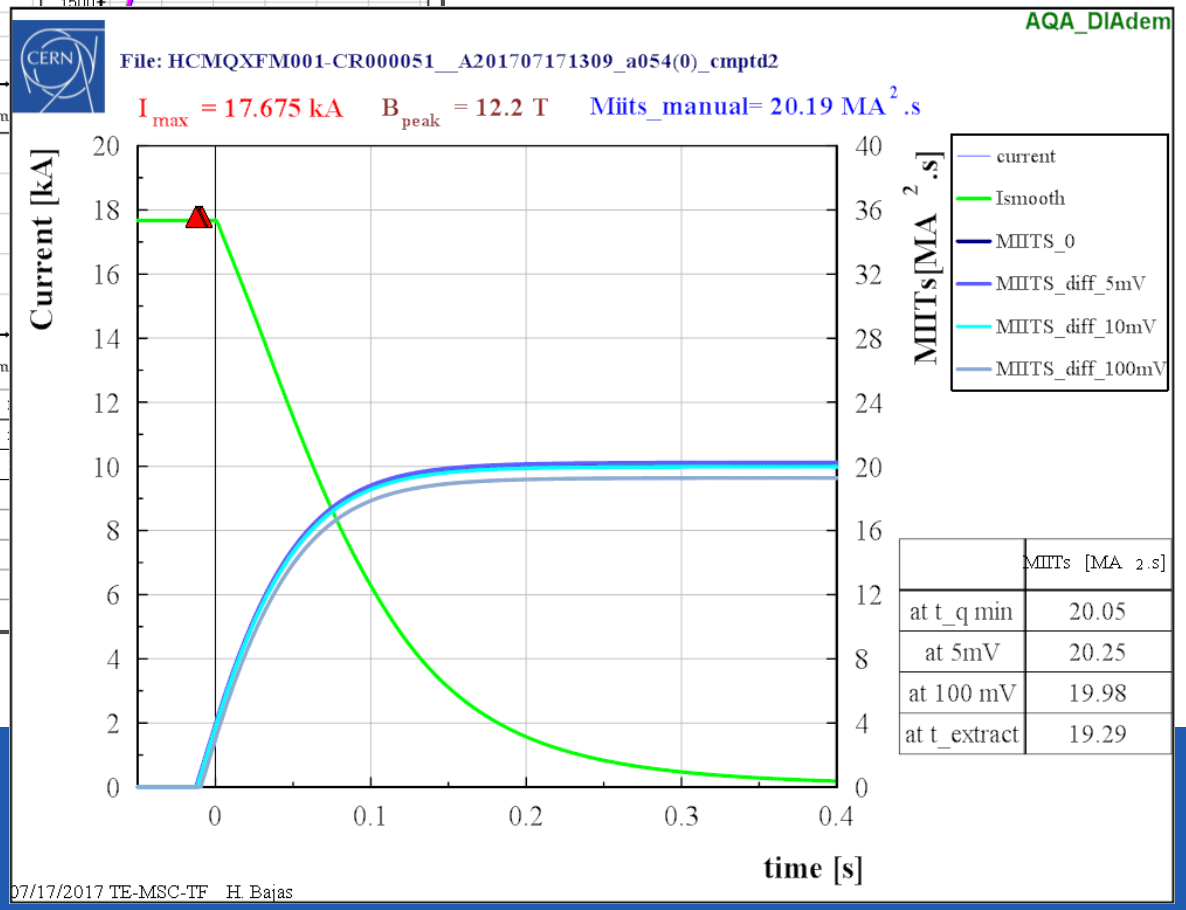
```
###Processed by: FMANGIAR
###Heading
#File name      unit
HCMBHSP0001_0000106__M1712051628_na002(0)
#Magnet Name    unit
HCMBHSP0001_0000106
#Test Date      unit
05/12/2017 16:28:00
#Analysis Date  unit
28/03/2018 15:00:26
#Temperature    unit
4.5     K
#Current        unit
3006.12 A
#dI/dt (t < 0)  unit
0.115   A/s
#dI/dt (t > 0)  unit
-1.85E+04       A/s
#MaxField       unit
3.02    T
#MaxGradient    unit
0       T/m
#Test Type      unit
Quench heater study
#Trigger Type   unit
Provoked
#Quench Cause   unit
NaN
#Precursor      unit
NaN

###Q.Det
#Q.Det Name     Q.Det Voltage   Q.Det Time
##Units [V]     [s]
Manual  7.26318913511932E-03    -0.04955
Auto_0  -2.62451372109354E-03   0
Auto_1  -2.62451372109354E-03   0
Auto_2  -2.62451372109354E-03   0
```



Parameters	tfire	tmaxV	Vmax	Vinit	Imax	tminV	Imin	Vmin	Rinit
Max	6.00	6.00	900.00	900.00	100.00	1600.00	2.00	10.00	16.00
Min	-2000.00	0.00	700.00	800.00	50.00	400.00	0.00	0.00	10.00
_Heater1	-0.04	4.23	947.52	927.54	158.71	234.85	1.60	9.47	5.74
_Heater2	-0.04	4.15	944.26	929.51	164.61	246.62	1.65	9.42	5.52
_Heater3	-0.04	4.27	935.91	920.24	150.26	219.55	1.53	9.35	5.99
_Heater4	-0.04	3.98	927.79	922.64	158.09	255.19	1.59	9.22	5.70

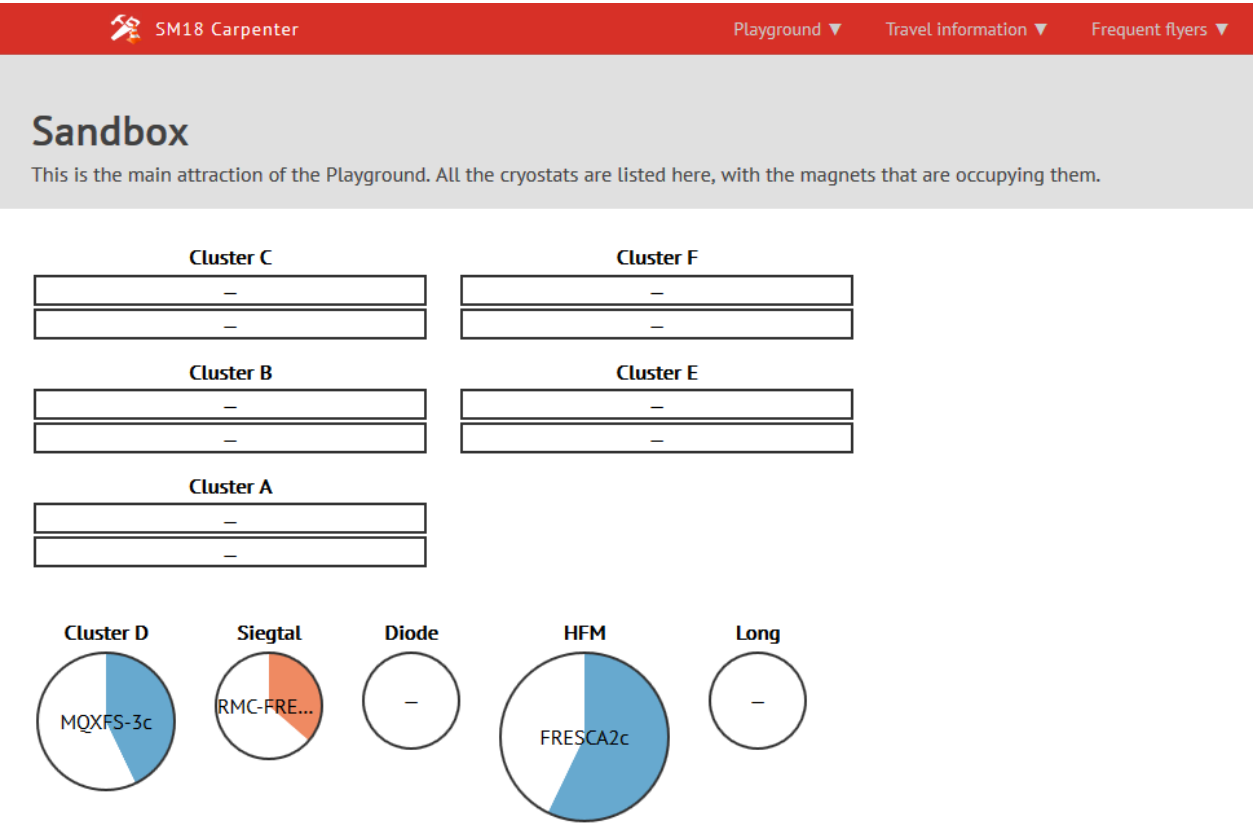
12/13/2017 TE-MSC-TF Operator: JEROME



	MIITs [MA 2 .s]
at t_q min	20.05
at 5mV	20.25
at 100 mV	19.98
at t_extract	19.29

07/17/2017 TE-MSC-TF H. Bajas

Carpenter New MSC-TF database system



https://sm18-carpenter.web.cern.ch/

Quality Assurance

Efficient communication between ourselves (i.e. in case of vacation) and other groups (i.e. with cryo team, strain measurements team)

Data processing and storage

Automatic reporting for EDMS/MTF (faster than manual reporting)

Easy statistics and data mining

Quality Control

Show what we're doing to interested people in real-time

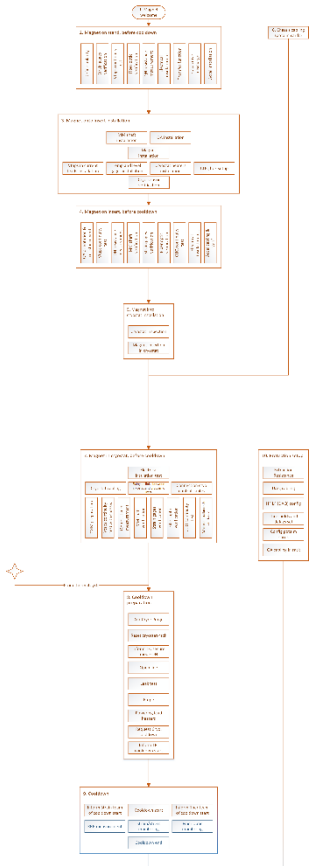
Internal/external users follow-up of activities at SM18

Carpenter main functionalities

- Web browser tool – universal and easy access from anywhere (local or remote)
- User management and privileges for controlled access
- All kind of testing data storing place
- Follow-up test tool
- Easy sharing (web link)

	resp_NAME	Notif	admin	engineer	operator	mechanic	electrician	cryogenist	hierarchy	owner	user	visitor
	resp_ID		a	e	o	m	l	c	h	w	u	v
Access to location:												
	Sandbox		y	y	y	y	y	y	y	y	y	y
Rooms	Warehouse		y	y	y	y	y	y	y	y	y	n
	VIP Lounge		y	y	y	y	y	y	y	y	y	n
	Customs		y	y	y	y	y	y	y	y	y	n
FreqFlyers	Magnets		y	y	y	y	y	y	y	y	y	n
	Users		y	y	y	y	y	y	y	n	n	n
	Reports		y	y	y	y	y	y	y	y	y	n
	Yearly view		y	y	y	y	y	y	y	n	n	n
Individual	Magnets		y	y	y	y	y	y	y	y	y	n
	Users		y	y	y	y	y	y	y	n	n	n
	Reports		y	y	y	y	y	y	y	y	y	n
Testplan view	Access		y	y	y	y	y	y	y	y	y	n
	Submit result	e	y	y	y	y	y	y	n	n	n	n
	Accept result	e,o	y	s	s	n	n	n	n	n	n	n
	Update result values	e,o	y	s	s	n	n	n	n	n	n	n
Reporting	Itinerary		y	y	y	y	y	y	n	n	n	n
	Internal		y	y	y	y	y	y	n	n	n	n
	External		y	y	y	y	y	y	y	y	y	n
Administration	MagnetRegistration		y	y	n	n	n	n	n	n	n	n
	EditMagnetRegistration		y	y	n	n	n	n	n	n	n	n
	MagnetCheckIn		y	y	n	n	n	n	n	n	n	n
	EditMagnetCheckIn		y	y	n	n	n	n	n	n	n	n
	EditMagnetCheckIn w/TP	e	y	n	n	n	n	n	n	n	n	n
	InsertInspection		y	y	n	n	n	n	n	n	n	n
	TestplanCreation	e,o	y	y	n	n	n	n	n	n	n	n
	ThermalCycleCreation	e,o	y	s	n	n	n	n	n	n	n	n
	EditTestplan	e,o	y	s	n	n	n	n	n	n	n	n
	ReportCreate	e,o,h,w	y	s	n	n	n	n	n	n	n	n
	AddUser	a,self	y	n	n	n	n	n	n	n	n	n
	EditUser	a,self	y	n	n	n	n	n	n	n	n	n
	Delete		y	n	n	n	n	n	n	n	n	n
	ToDo		y	n	n	n	n	n	n	n	n	n
	Palette		y	n	n	n	n	n	n	n	n	n
	Cookie		y	n	n	n	n	n	n	n	n	n

Testplan creation



SM18 Carpenter | Playground ▼ | Travel information ▼ | Frequent flyers ▼ | Admin tools ▼ | Signed in as: miduda (CERN) | Sign out

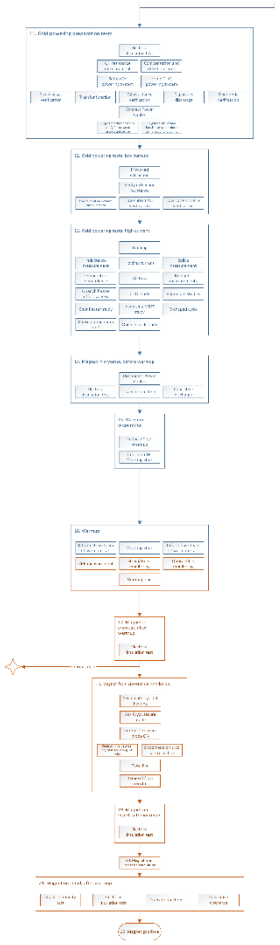
New Testplan Creation: SMC4 (SMC #4 - PIT - 201-202)

Testplan General Information

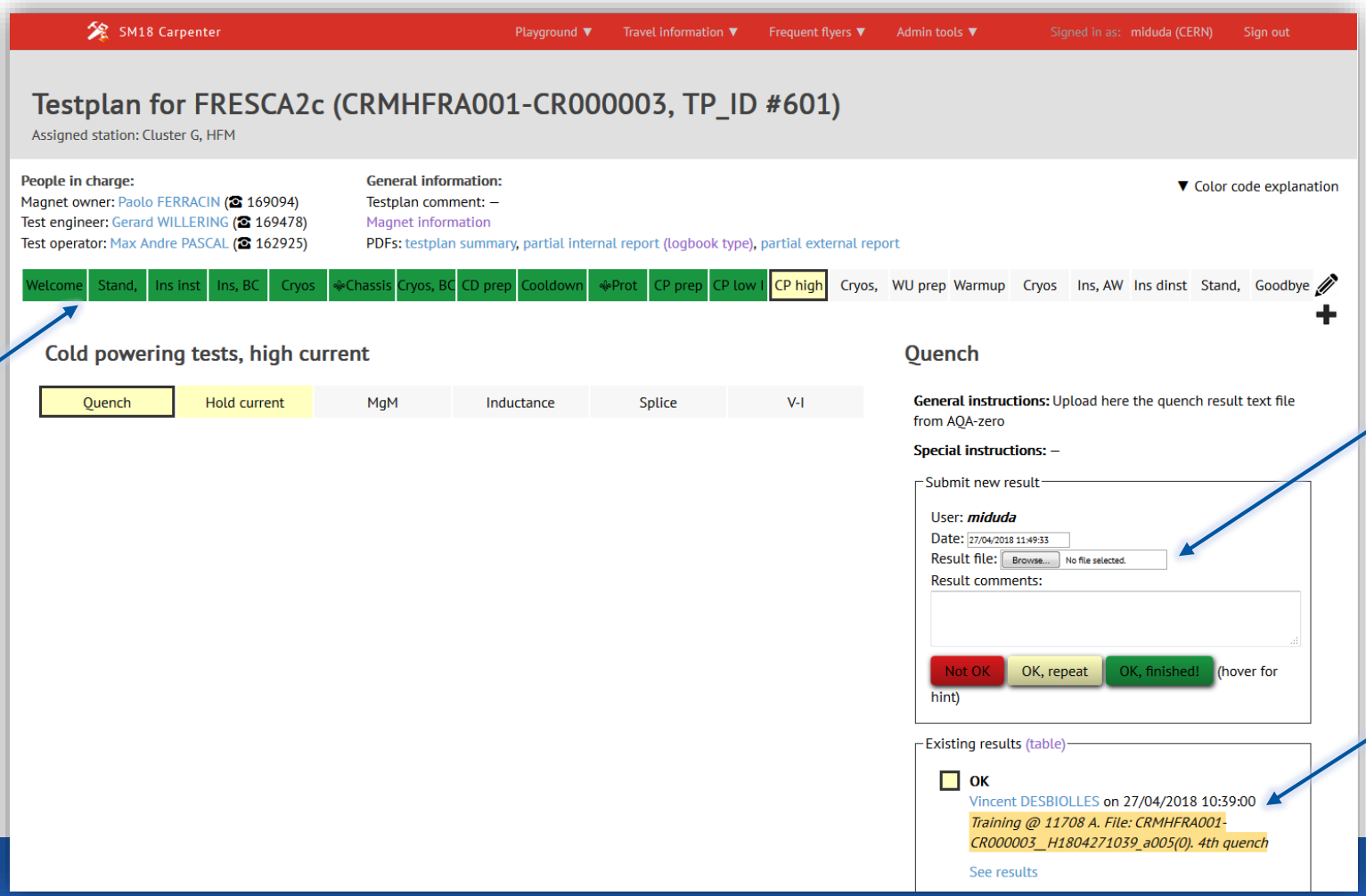
Testplan engineer*	-- select an option --
Testplan operator*	-- select an option --
Cryostat name*	-- select an option --
Testplan comment	

Testplan Activities Information

Order & Activity Name	*Special instructions*
Magnet welcome	
1.1.1 Magnet reception in SM18	
Magnet on stand, before cooldown	
2.1.1 Define polarity	
2.1.1 Voltage taps continuity test	
2.1.1 Electrical insulation test	
2.1.2 Strain gages verification	
2.1.2 Fiber optic verification	
2.1.2 Quench heater resistance measurement	
2.1.2 Accelerometer installation	
2.1.3 Transfer function	
2.1.3 Capacitive discharge	
Magnet onto insert installation	



Testplan follow-up

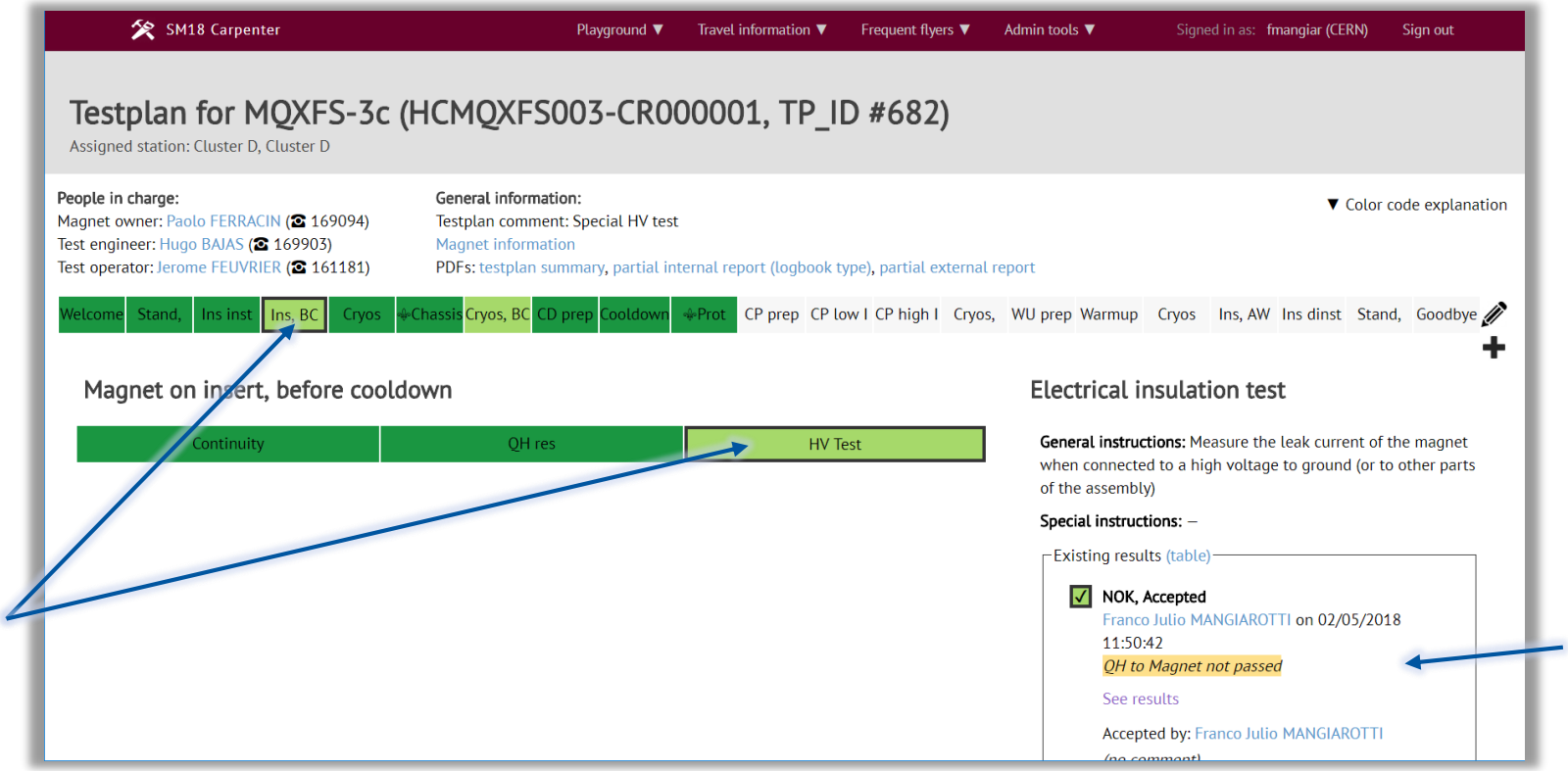


Green indicates finished steps

Upload data from a new quench

Last quench information

Testplan control



Lighter green indicates something not OK

Not OK result and comment, signed by operator

Data storage

HCMBHSP0001_0000106__M1712051628_na002(0)_AQAzero.txt - Notepad

File Edit Format View Help

```
###Processed by: FMANGIAR
###Heading
#File name      unit
HCMBHSP0001_0000106__M1712051628_na002(0)
#Magnet Name    unit
HCMBHSP0001_0000106
#Test Date      unit
05/12/2017 16:28:00
#Analysis Date  unit
28/03/2018 15:00:26
#Temperature    unit
4.5     K
#Current        unit
3006.12 A
#dI/dt (t < 0)  unit
0.115   A/s
#dI/dt (t > 0)  unit
-1.85E+04       A/s
#MaxField       unit
3.02    T
#MaxGradient    unit
0       T/m
#Test Type      unit
Quench heater study
#Trigger Type   unit
Provoked
#Quench Cause   unit
NaN
#Precursor      unit
NaN

###Q.Det
#Q.Det Name     Q.Det Voltage   Q.Det Time
##Units [V]     [s]
Manual  7.26318913511932E-03    -0.04955
Auto_0  -2.62451372109354E-03   0
Auto_1  -2.62451372109354E-03   0
Auto_2  -2.62451372109354E-03   0
```

Quench

General instructions: Upload here the quench result text file from AQA-zero

Special instructions: –

Submit new result

User: ***miduda***

Date: 27/04/2018 11:49:33

Result file: Browse... No file selected.

Result comments:

Not OK | OK, repeat | OK, finished! (hover for hint)

Cold powering tests, high current – Quench

Existing result

OK

Franco Julio MANGIAROTTI on 06/12/2017 15:56:00

Training @ 10756 A. File: HCMBHSP0001_0000106__M1712061556_na008(1)

File name

HCMBHSP0001_0000106__M1712061556_na008(1)

Test Date

06/12/2017 15:56:00

Analysis Date

11/04/2018 10:15:37

Test Type

Training

Trigger Type

Natural quench

Precursor

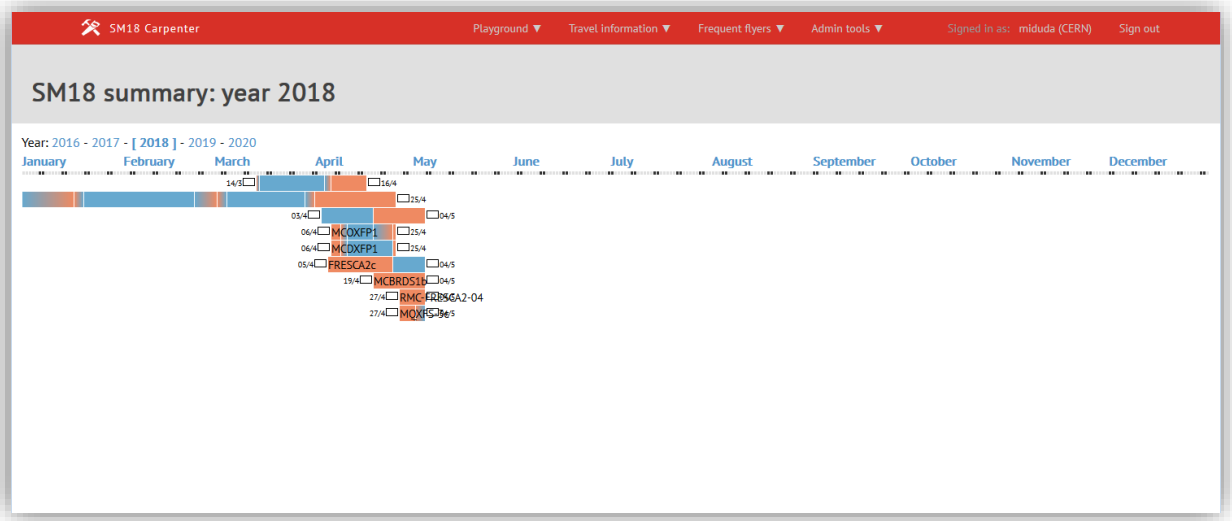
No

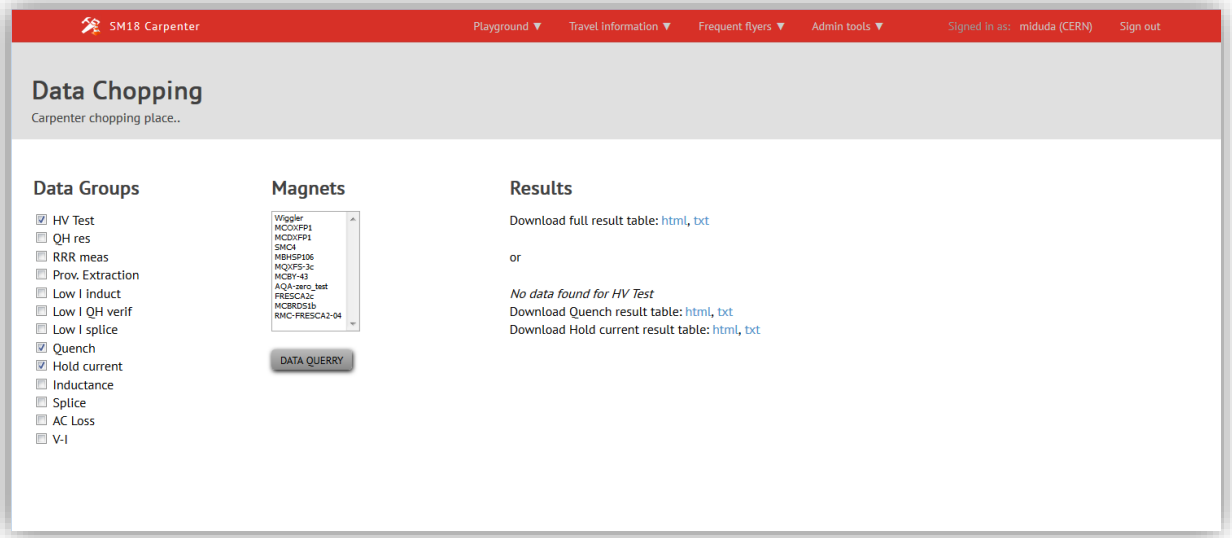
Quench Cause

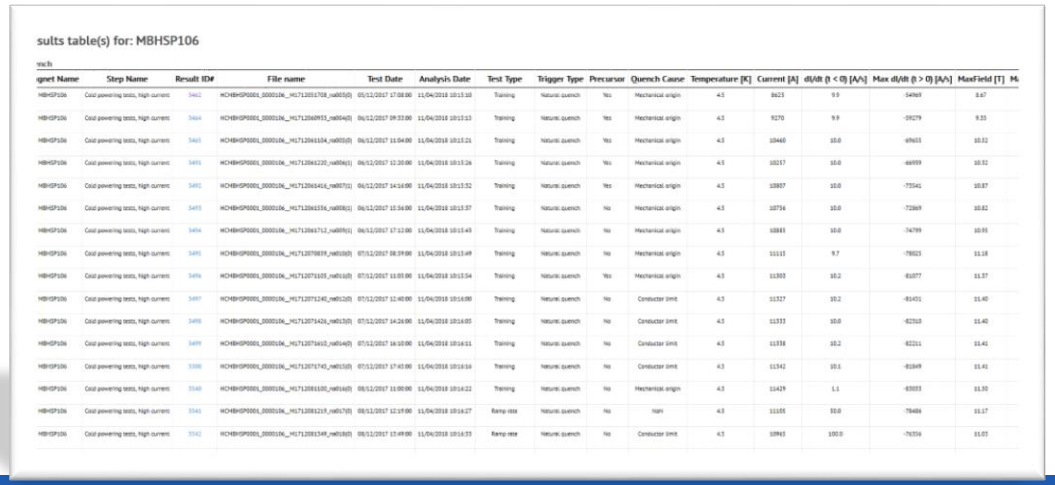
Mechanical origin

Travel information

- Yearly summary
- Data chopping
- Test reports*







Development

- Carpenter: 2 developers
  - First beta version: 1.5 months @ 100%
  - First working version: 4 months @ 20%
    - We also had some beta-testers
  - Currently: improvements & maintenance @ 10%

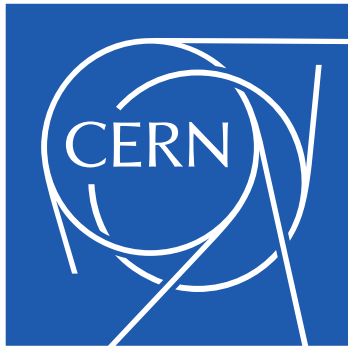
Implementation in a new place

- DIAdem, AQA, similar tools
  - Install and configure: < 1-2 days
- Carpenter
  - Test plan design: 3-5 days (local)
  - DB* and website implementation: 3-5 days
  - Maintenance: ~10%

*: assuming Oracle DB is available

Summary

- Magnet testing is a very complex process
- Having appropriate tools is important for quality assurance
  - Tools to analyze data and produce standard information (AQA, …)
  - Tools for test follow up and QC (Carpenter)


CERN