



Tools for magnet testing and QA/QC

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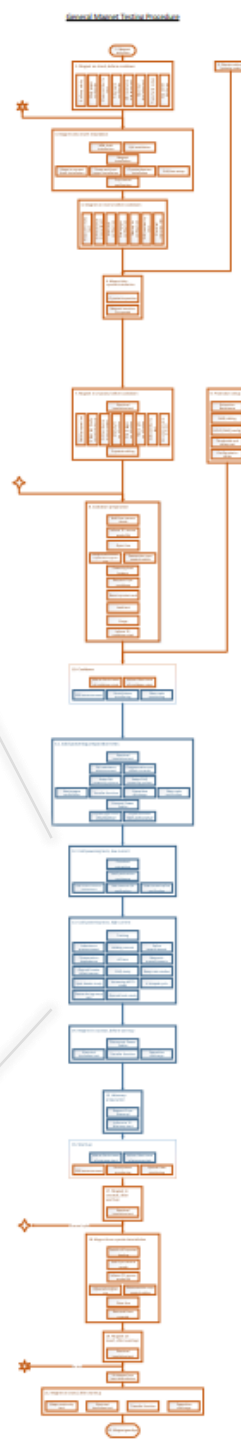
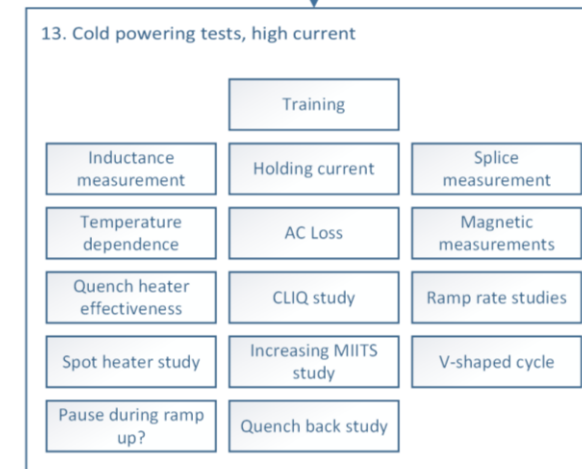
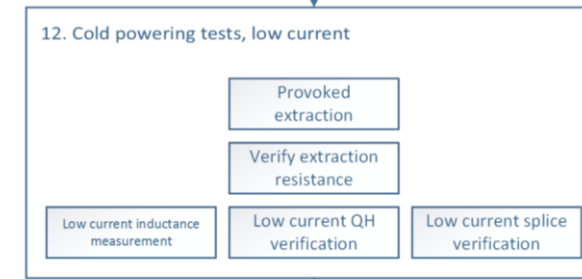
2018 05 09 @ Brookhaven National Laboratory



Testing is a complicated process



- 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

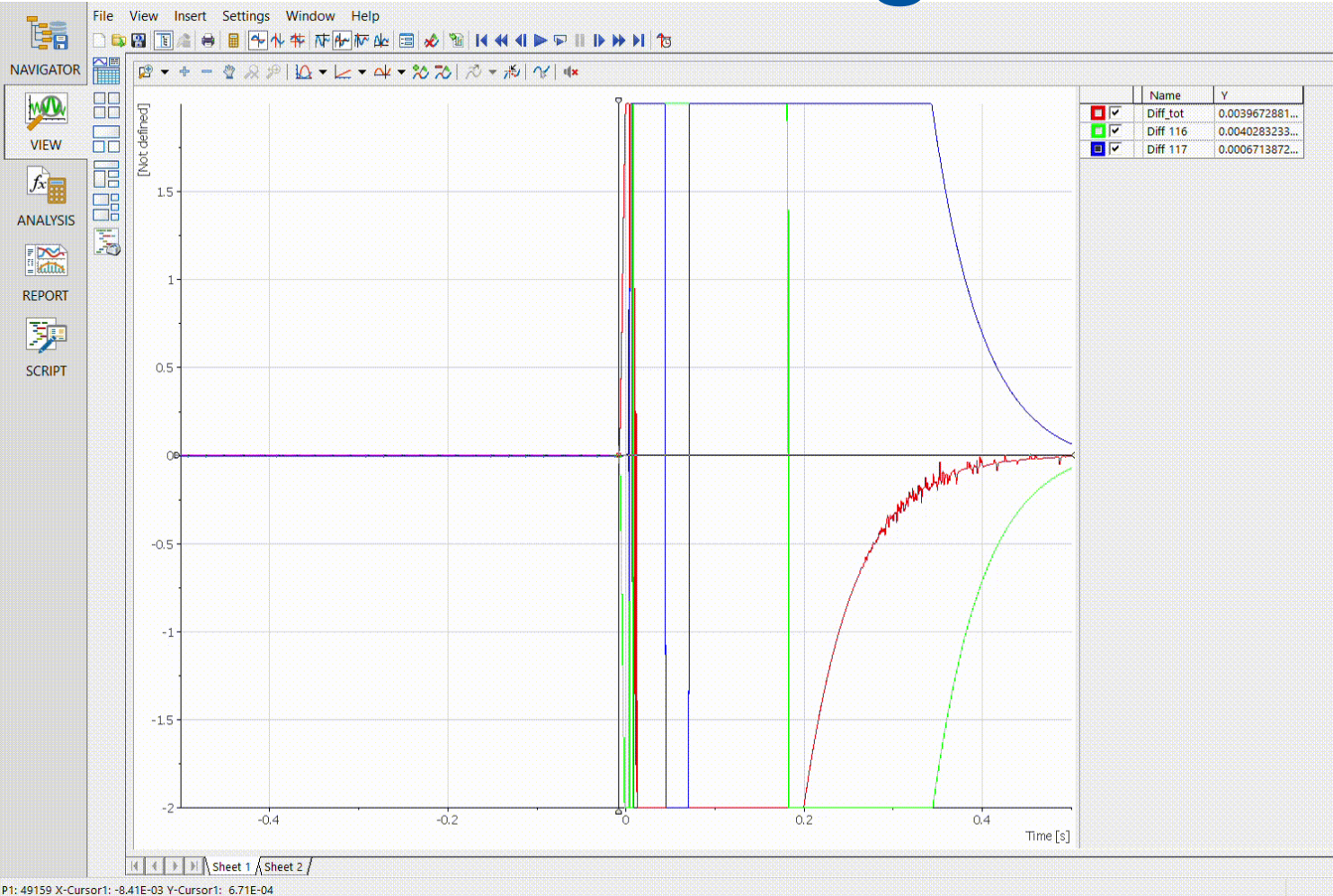
- For quench analysis



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

The image displays the DIAdem software interface. On the left, the 'AQA-zero -- Settings selection' dialog is open, showing configuration options for file analysis, destination folders, and magnet configurations. The 'Files to analyze' field contains 'HCM BHSP0001_0000106_M1802150855_a065(0).tdms'. The 'Destination folder' is 'C:\zz local files\'. The 'Magnet configuration file' is 'C:\zz local files\HCM BHSP0001_0000106.xlsx'. The 'User name' is 'FMANGIAR'. On the right, the main DIAdem window shows a plot of quench data. The plot has a y-axis labeled '[Not defined]' ranging from -0.002 to 0.016 and an x-axis labeled 'Time [s]' ranging from -0.013 to -0.008. Three data series are plotted: green, red, and blue. A vertical dashed line is positioned at approximately -0.00867 s. A tooltip for this line shows 'P1: 49133', 'X-Cursor1: -8.67E-03', and 'Y-Cursor1: 1.89E-03'. A dialog box 'End Interaction' with the instruction 'Select quench start point' is overlaid on the plot. A table on the right side of the plot shows the following data:

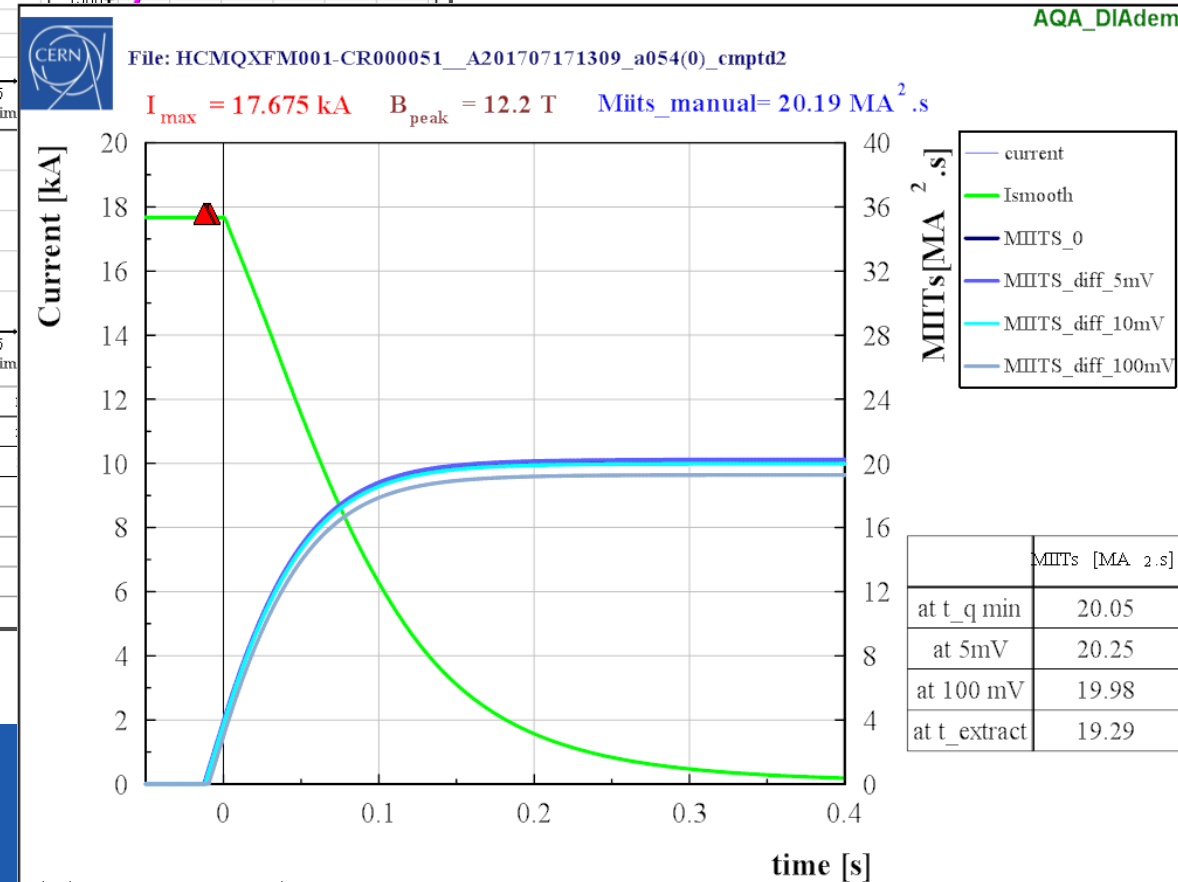
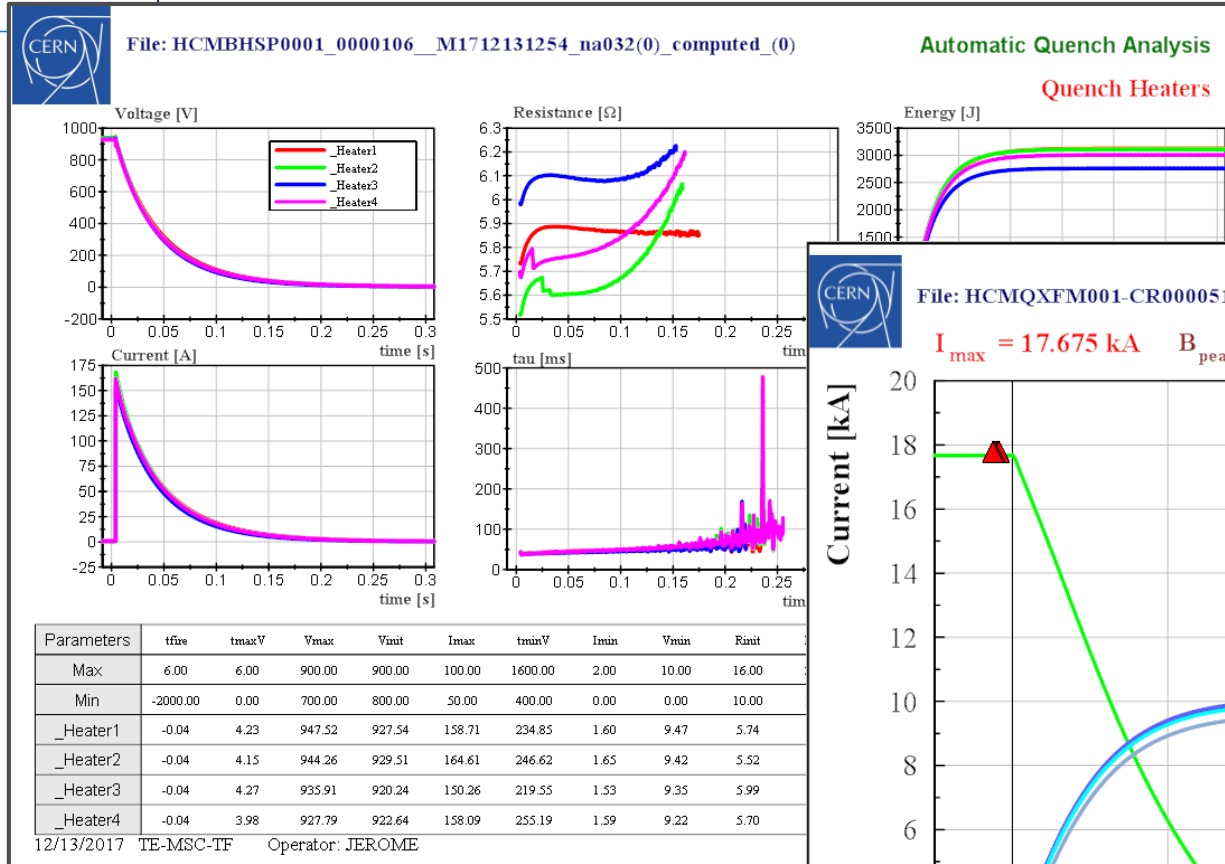
Name	Unit	Y	X	Diff_tot
Not defined	Not defined	0.001892091...	-0.00867	Diff 116
Not defined	Not defined	0.003845217...	-0.00867	Diff 117
Not defined	Not defined	0.000488281...	-0.00867	

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
    
```



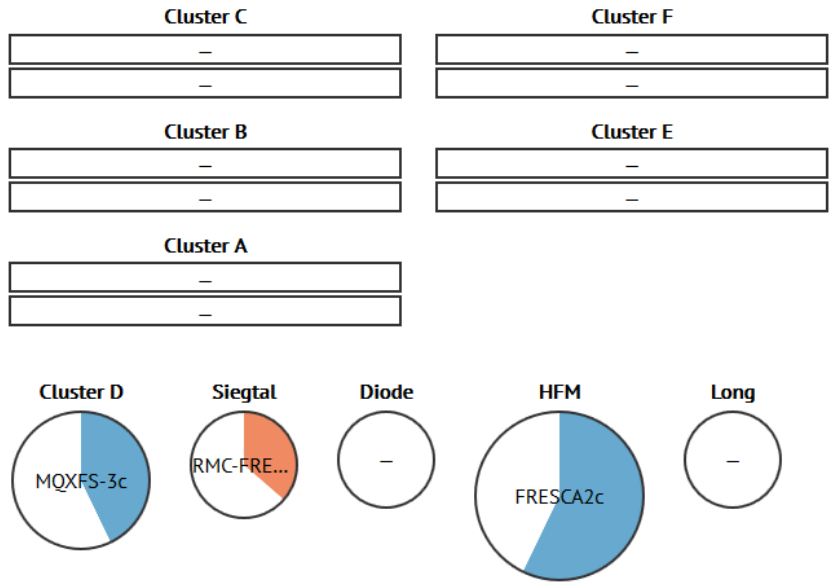
Carpenter

New MSC-TF database system

SM18 Carpenter Playground Travel information Frequent flyers

Sandbox

This is the main attraction of the Playground. All the cryostats are listed here, with the magnets that are occupying them.



<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



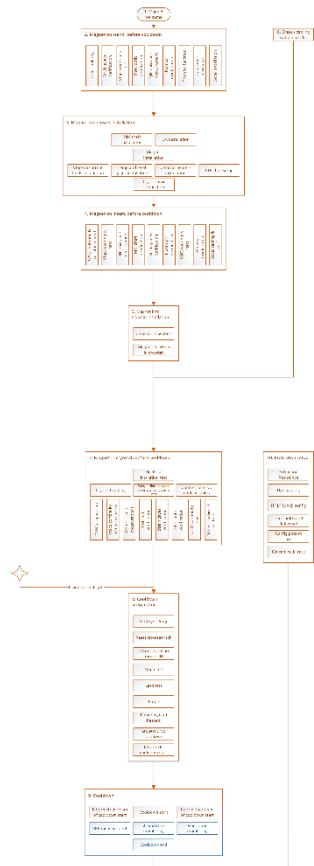
Carpenter main functionalities

- 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)

		Notif	admin	engineer	operator	mechanic	electrician	cryogenist	hierarchy	owner	user	visitor
resp_NAME	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	y
Rooms	Warehouse	y	y	y	y	y	y	y	y	y	y	n
	VIP Lounge	y	y	y	y	y	y	y	y	y	y	n
	Customs	y	y	y	y	y	y	y	y	y	y	n
FreqFlyers	Magnets	y	y	y	y	y	y	y	y	y	y	n
	Users	y	y	y	y	y	y	y	y	n	n	n
	Reports	y	y	y	y	y	y	y	y	y	y	n
	Yearly view	y	y	y	y	y	y	y	y	n	n	n
Individual	Magnets	y	y	y	y	y	y	y	y	y	y	n
	Users	y	y	y	y	y	y	y	y	n	n	n
	Reports	y	y	y	y	y	y	y	y	y	y	n
Testplan view	Access	y	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	y	n	n	n	n
	Internal	y	y	y	y	y	y	y	n	n	n	n
	External	y	y	y	y	y	y	y	y	y	y	n
Administration	MagnetRegistration	y	y	n	n	n	n	n	n	n	n	n
	EditMagnetRegistration	y	y	n	n	n	n	n	n	n	n	n
	MagnetCheckIn	y	y	n	n	n	n	n	n	n	n	n
	EditMagnetCheckIn	y	y	n	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	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	n
	ToDo	y	n	n	n	n	n	n	n	n	n	n
	Palette	y	n	n	n	n	n	n	n	n	n	n
	Cookie	y	n	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

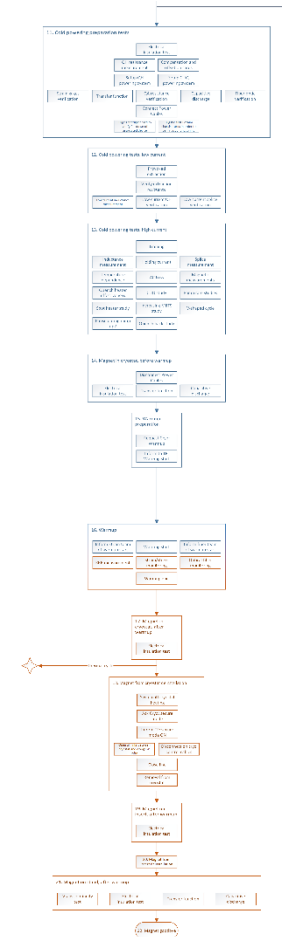
New Testplan Creation: SMC4 (SMC #4 - PIT - 201-202)

Testplan General Information

Testplan engineer*	-- select an option --
Testplan operator*	-- select an option --
Cryostat name*	-- select an option --
Testplan comment	<input type="text"/>

Testplan Activities Information

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



Testplan follow-up

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

Testplan for FRESKA2c (CRMHFRA001-CR000003, TP_ID #601)

Assigned station: Cluster G, HFM

People in charge:
Magnet owner: Paolo FERRACIN (☎ 169094)
Test engineer: Gerard WILLERING (☎ 169478)
Test operator: Max Andre PASCAL (☎ 162925)

General information:
Testplan comment: –
Magnet information
PDFs: testplan summary, partial internal report (logbook type), partial external report

▼ Color code explanation

Welcome | Stand | Ins inst | Ins, BC | Cryos | Chassis | Cryos, BC | CD prep | Cooldown | Prot | CP prep | CP low | CP high | Cryos, WU prep | Warmup | Cryos | Ins, AW | Ins dinst | Stand | Goodbye

Cold powering tests, high current

Quench | Hold current | MgM | Inductance | Splice | V-I

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: No file selected.
Result comments:

(hover for hint)

Existing results (table)

<input type="checkbox"/> OK
Vincent DESBIOLLES on 27/04/2018 10:39:00
Training @ 11708 A. File: CRMHFRA001-CR000003_H1804271039_a005(0). 4th quench
See results

Green indicates finished steps

Upload data from a new quench

Last quench information



Testplan control

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

Testplan for MQXFS-3c (HCMQXFS003-CR000001, TP_ID #682)

Assigned station: Cluster D, Cluster D

People in charge:
Magnet owner: Paolo FERRACIN (☎ 169094)
Test engineer: Hugo BAJAS (☎ 169903)
Test operator: Jerome FEUVRIER (☎ 161181)

General information:
Testplan comment: Special HV test
Magnet information
PDFs: [testplan summary](#), [partial internal report \(logbook type\)](#), [partial external report](#)

▼ Color code explanation

Welcome Stand Ins inst **Ins, BC** Cryos Chassis Cryos, BC CD prep Cooldown Prot CP prep CP low I CP high I Cryos WU prep Warmup Cryos Ins, AW Ins dinst Stand Goodbye

Magnet on insert, before cooldown

Continuity QH res **HV Test**

Electrical insulation test

General instructions: Measure the leak current of the magnet when connected to a high voltage to ground (or to other parts of the assembly)

Special instructions: –

Existing results (table)

☑ NOK, Accepted Franco Julio MANGIAROTTI on 02/05/2018 11:50:42 <i>QH to Magnet not passed</i> See results Accepted by: Franco Julio MANGIAROTTI (no comment)
--

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:

Result file:

Result comments:

◀ 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

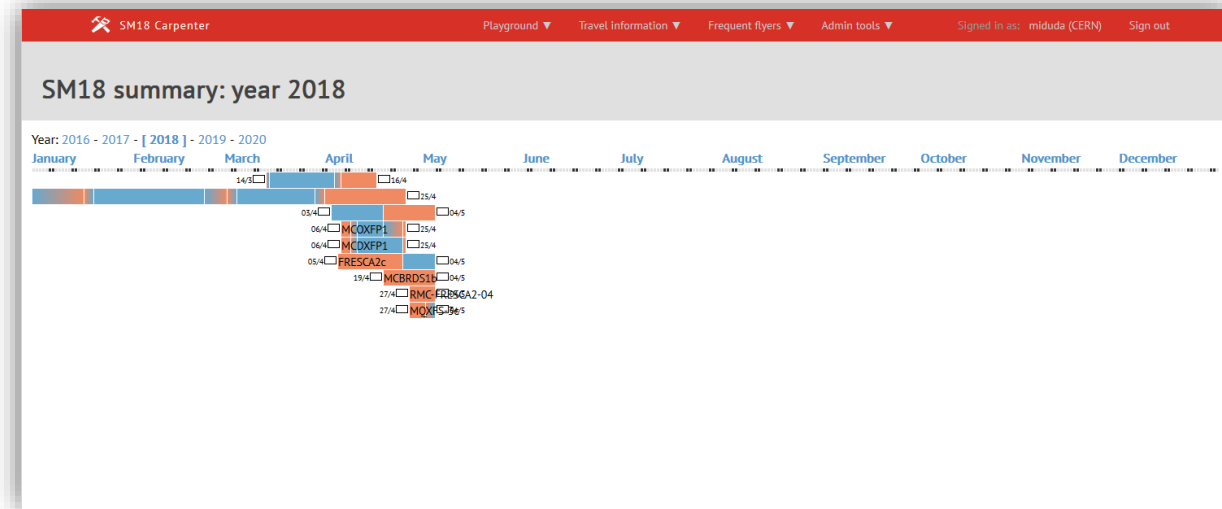
Quench Cause
Mechanical origin

Travel information

- Yearly summary
- Data chopping
- Test reports*

subts table(s) for: MBHSP106

agent Name	Step Name	Result ID#	File name	Test Date	Analysis Date	Test Type	Trigger Type	Precursor	Quench Cause	Temperature [K]	Current [A]	dI/dt [< 0] [A/s]	Max dI/dt [> 0] [A/s]	MaxField [T]	H _q
MBHSP106	Cold powering tests, High current	3462	HCHBGP000L_000001M_HL712051708_H0000	06/12/2017 17:08:00	11/04/2018 10:11:58	Training	Natural quench	Yes	Mechanical arcing	4.3	8625	9.9	14900	8.27	
MBHSP106	Cold powering tests, High current	3463	HCHBGP000L_000001M_HL712049193_H0000	06/12/2017 19:33:00	11/04/2018 10:13:13	Training	Natural quench	Yes	Mechanical arcing	4.3	8270	9.9	19279	8.33	
MBHSP106	Cold powering tests, High current	3463	HCHBGP000L_000001M_HL712049193_H0000	06/12/2017 19:33:00	11/04/2018 10:13:13	Training	Natural quench	Yes	Mechanical arcing	4.3	10460	10.0	47651	10.31	
MBHSP106	Cold powering tests, High current	3465	HCHBGP000L_000001M_HL712049193_H0000	06/12/2017 11:04:00	11/04/2018 10:15:23	Training	Natural quench	Yes	Mechanical arcing	4.3	10217	10.0	46919	10.32	
MBHSP106	Cold powering tests, High current	3465	HCHBGP000L_000001M_HL712049193_H0000	06/12/2017 11:04:00	11/04/2018 10:15:23	Training	Natural quench	Yes	Mechanical arcing	4.3	10807	10.0	17541	10.87	
MBHSP106	Cold powering tests, High current	3465	HCHBGP000L_000001M_HL712049193_H0000	06/12/2017 11:04:00	11/04/2018 10:15:23	Training	Natural quench	No	Mechanical arcing	4.3	10754	10.0	17289	10.82	
MBHSP106	Cold powering tests, High current	3476	HCHBGP000L_000001M_HL712048172_H0000	06/12/2017 17:13:00	11/04/2018 10:13:43	Training	Natural quench	No	Mechanical arcing	4.3	10883	10.0	14789	10.95	
MBHSP106	Cold powering tests, High current	3476	HCHBGP000L_000001M_HL712048172_H0000	07/12/2017 18:39:00	11/04/2018 10:13:49	Training	Natural quench	No	Mechanical arcing	4.3	11111	9.7	17823	11.18	
MBHSP106	Cold powering tests, High current	3476	HCHBGP000L_000001M_HL712048172_H0000	07/12/2017 18:39:00	11/04/2018 10:13:54	Training	Natural quench	Yes	Mechanical arcing	4.3	11300	10.2	18277	11.37	
MBHSP106	Cold powering tests, High current	3487	HCHBGP000L_000001M_HL712047242_H0000	07/12/2017 12:40:00	11/04/2018 10:16:00	Training	Natural quench	No	Conductor joint	4.3	11327	10.2	18451	11.40	
MBHSP106	Cold powering tests, High current	3488	HCHBGP000L_000001M_HL712047242_H0000	07/12/2017 14:24:00	11/04/2018 10:16:05	Training	Natural quench	No	Conductor joint	4.3	11333	10.0	18210	11.40	
MBHSP106	Cold powering tests, High current	3489	HCHBGP000L_000001M_HL712047161_H0000	07/12/2017 16:10:00	11/04/2018 10:16:11	Training	Natural quench	No	Conductor joint	4.3	11338	10.2	18231	11.41	
MBHSP106	Cold powering tests, High current	3500	HCHBGP000L_000001M_HL712047141_H0000	07/12/2017 17:43:00	11/04/2018 10:16:58	Training	Natural quench	No	Conductor joint	4.3	11342	10.1	18389	11.41	
MBHSP106	Cold powering tests, High current	3549	HCHBGP000L_000001M_HL712048100_H0000	08/12/2017 10:00:00	11/04/2018 10:16:22	Training	Natural quench	No	Mechanical arcing	4.3	11429	1.1	18351	11.50	
MBHSP106	Cold powering tests, High current	3549	HCHBGP000L_000001M_HL712048100_H0000	08/12/2017 12:19:00	11/04/2018 10:16:27	Training	Natural quench	No	None	4.3	11555	10.0	17684	11.57	
MBHSP106	Cold powering tests, High current	3542	HCHBGP000L_000001M_HL712048100_H0000	08/12/2017 13:49:00	11/04/2018 10:16:33	Training	Natural quench	No	Conductor joint	4.3	10962	100.0	16750	11.02	



Data Chopping

Carpenter chopping place..

Data Groups

- HV Test
- QH res
- RRR meas
- Prov. Extraction
- Low I induct
- Low I QH verif
- Low I splice
- Quench
- Hold current
- Inductance
- Splice
- AC Loss
- V-I

Magnets

Wggle
 MCOXFP1
 MCOXFP1
 SMC4
 MBHSP106
 MQXFS-3c
 MCEY-43
 AQA-zero_test
 FRESCA2c
 MCBRD51b
 RMC-FRESCA2-04

DATA QUERY

Results

Download full result table: [html](#), [txt](#)

or

No data found for HV Test

Download Quench result table: [html](#), [txt](#)

Download Hold current result table: [html](#), [txt](#)



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)

