



Connecting and Integration of the Instrumentation in the DCM

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[HL-LHC Magnet Circuit Instrumentation Day 2023](#)

DCM overview

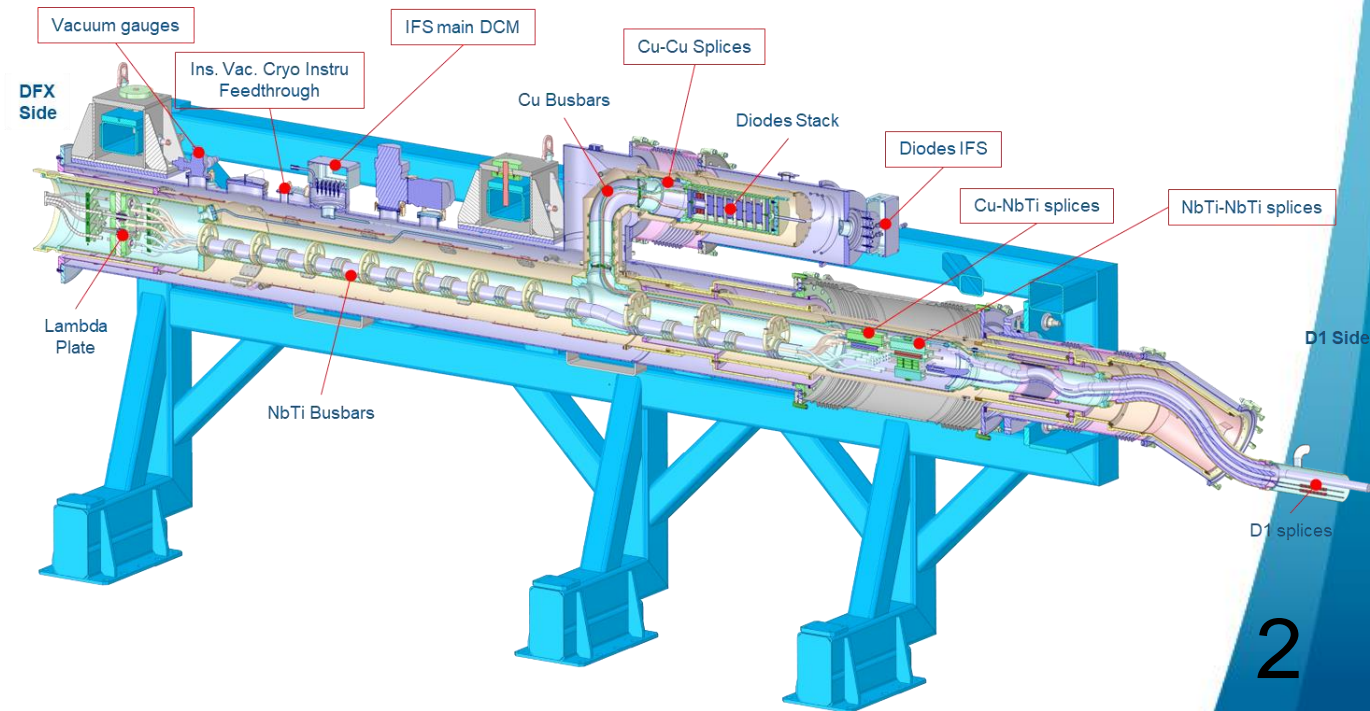
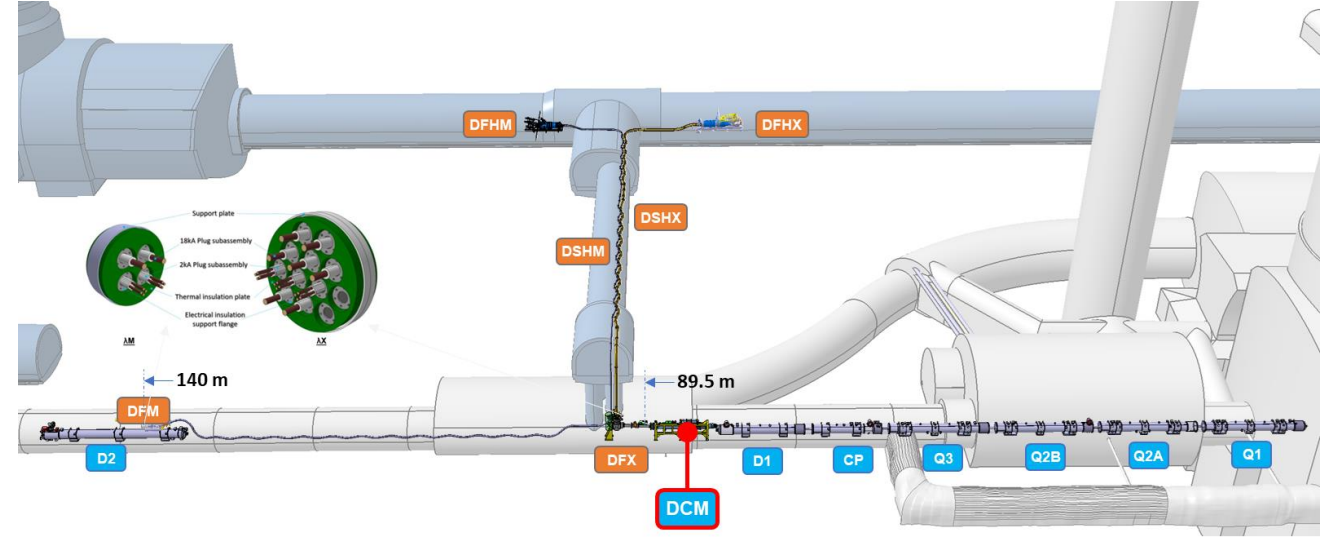
- DCM part of IT chain of magnets cryostats
- Common cryogenic volume
- Common insulation vacuum volume
- Electrical continuity of conductors

Functions

- Integrate and provide operating conditions for:
 - Cold diodes
 - Lambda plates
- Route SC busbars
- Present instrumentation feedthroughs and interfaces
- Interface with WP6a

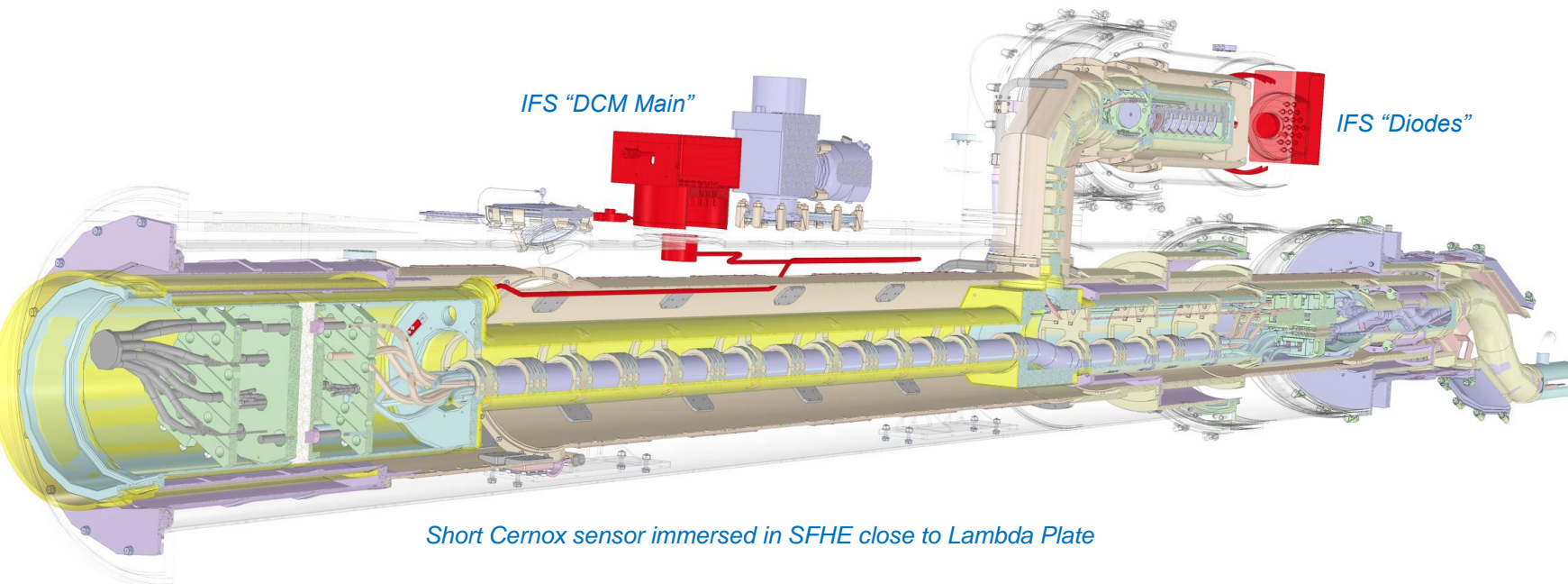
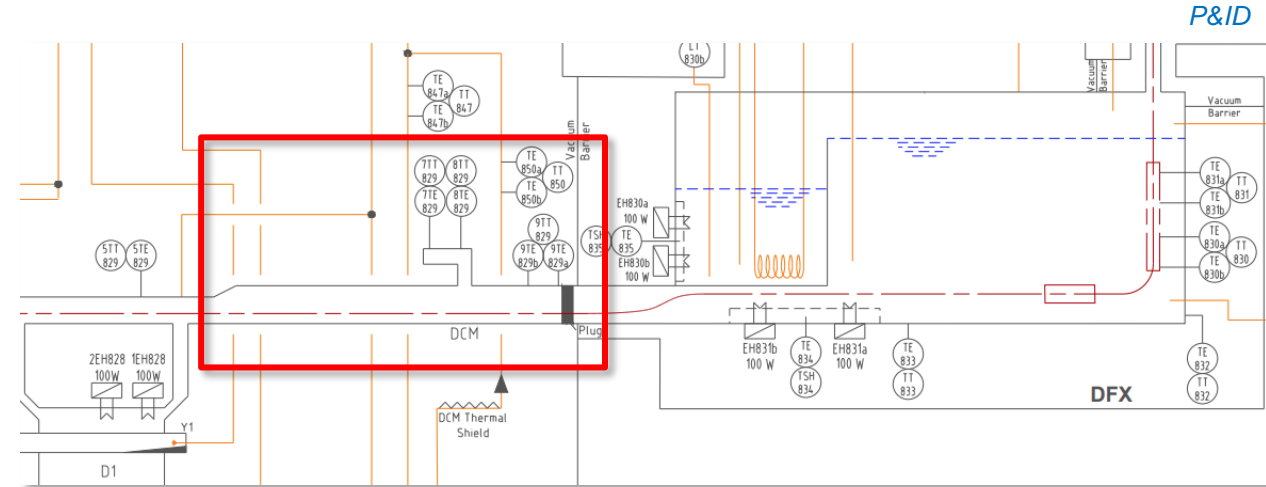
Key features wrt instrumentation

- Two IFS flanges
 - Cold diodes
 - Main DCM)
- Two groups of splices
 - Diodes interconnect (x5)
 - DCM-D1 interconnect (x24)

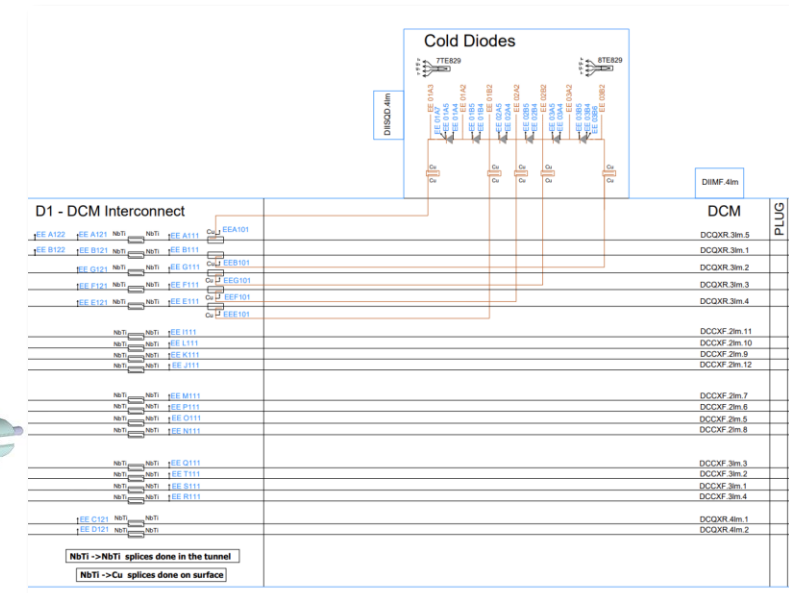


Instrumentation scheme for the DCM

- Electrical V-taps : [LHCLSDIX0001](#)
 - DCM main IFS : 31 V-taps
 - Diodes IFS : 14 V-taps + 7 I-taps
- Cryogenic : [LHCLSQRG0041](#)
 - DCM main IFS
 - 0 TT for Tunnel version
 - 2 TT for String version
 - Diodes IFS : 4 TT
 - Insulation vacuum : 2 TT
- No vacuum gauges installed on DCM



Short Cernox sensor immersed in SFHE close to Lambda Plate



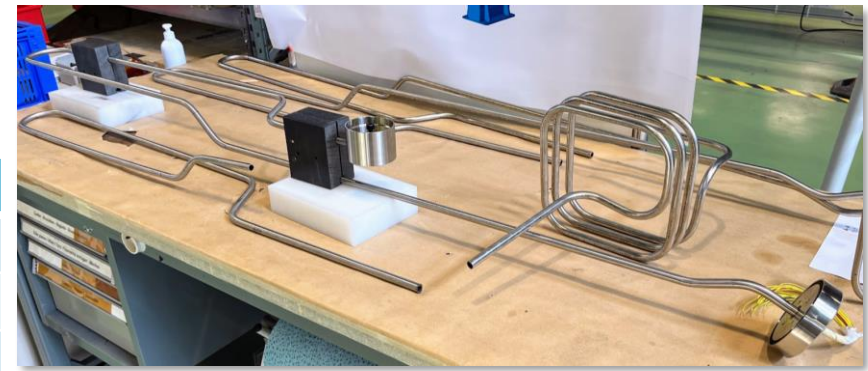
Wires connection, routing and testing

Wires types : same wires as for magnets & WP6a

	Type	AWG	Conductor	Layout	Insulation	OD
TT in helium	Axon - HT3007	AWG30	Copper	4-in-1	Polyimide	1.70 mm
TT in vacuum	Habia - B/Mang 0.12 N4		Manganin	4-in-1	Polyamide	1.00 mm
V-taps	Axon - HH2619	AWG26	Copper	Single	Polyimide	0.95 mm
I-taps	Axon - HH2019	AWG20	Copper	Single	Polyimide	1.50 mm

Routing :

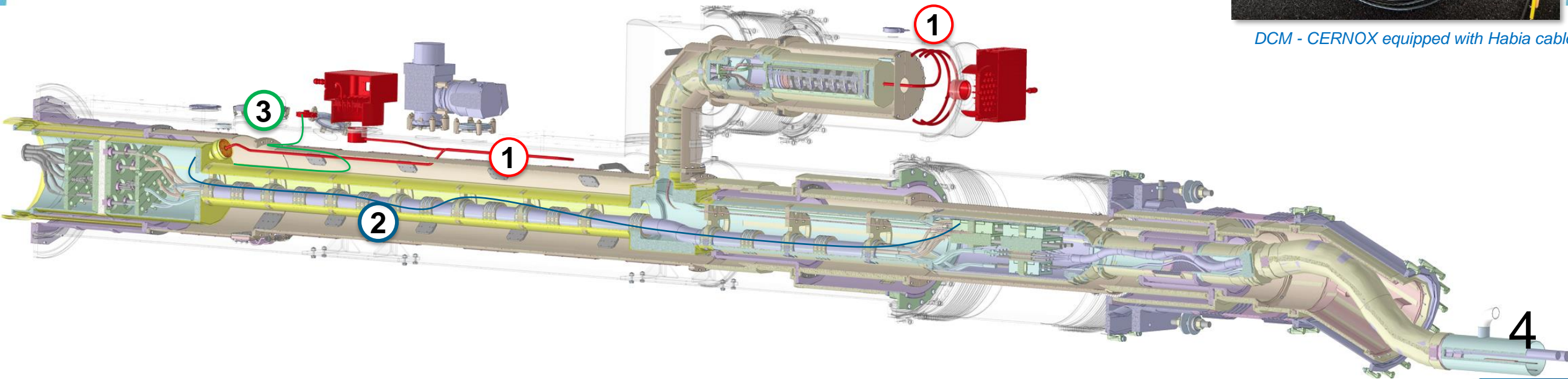
1. From IFS flange to Helium vessel :
 - Wires bundle in fibre glass sleeves
 - Capillaries pre-assembled, cold shocked and QC tested before installation
2. Inside helium vessel : fibre glass sleeves along busbars
3. Insulation vacuum : usual routing technique with cryogenic tape



DCM IFS capillaries in production in SM12



DCM - CERNOX equipped with Habia cable



Wires connection, routing and testing

HV test sequence

Wires connection

- TT-sensors
 - Inside He vessel: connected at installation
 - Insulation vacuum: pre-wired, connection to MIL8
- V-taps
 - Installed during soldering operation
 - Follow same procedures as for magnets EDMS [236866](#)

Testing :

- EDMS [2747011](#) in work with MCF
- HV tests at RT in air from 10 kV down to 1.5 kV
- Electrical Design Criteria document not released yet

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EDMS NO.	REV.	VALIDITY
2366866	5.0	VALID

REFERENCE
LHC-MQXFB-FP-0026

Date: 2023-03-15

FABRICATION PROCEDURE
HL-LHC / WP03

Aimant MQXFB Nb₃Sn
Connexions Internes de l'aimant MQXFB
Etape K.13 du MIP [2]



Test ID	Component	Test configuration under RT, air, 1 bara	DC Test Voltage	Voltage Ramp Rate (V/s)	Leakage Current Requirement (µA)	Testing time at DC test voltage (s)	Illustration
Phase 0 : individual component							
0	IFS wiring for DCM IFS: V-taps, Cryo heaters and TT_sensors, before connection to anything, as a bunch of wires	V-Taps & EH wires, wire to other wires shorted and connected to GND, included TT sensors wires	10 kV	200	<10	60	
		TT conductors: 4 wires shorted (impossible to test wire to wire since the TT sensor is connected to the 4 wires) vs all others wires shorted and connected to GND, included TT sensors wires	200 V	10	<0.5		
B2	IFS wiring for DCM IFS before connection to anything, after inserting in IFS tube, before shaping	V-Taps & EH wires, wire to other wires shorted and connected to GND, included TT sensors wires, with the IFS tube grounded	10 kV	200	<10	60	
		TT conductors: 4 wires shorted (impossible to test wire to wire since the TT sensor is connected to the 4 wires) vs all others wires shorted and connected to GND, included TT sensors wires, with the IFS tube grounded	200 V	10	<0.5		
A2	IFS wiring for DCM IFS before connection to anything, after inserting in IFS tube, after shaping, after thermal shock at LN2	V-Taps & EH wires, wire to other wires shorted and connected to GND, included TT sensors wires, with the IFS tube grounded	10 kV	200	<10	60	
		TT conductors: 4 wires shorted (impossible to test wire to wire since the TT sensor is connected to the 4 wires) vs all others wires shorted and connected to GND, included TT sensors wires, with the IFS tube grounded	200 V	10	<0.5		
A1	Diodes stack, with short length wires	V-Taps & I-taps shorted together vs (GND + TT sensors wires)	3 kV	200	<10	60	
		TT conductors: 4 wires shorted vs all others wires shorted and connected to GND, including other TT sensors wires	100 V	10	<0.5		
Phase 1 : Intermediate testing during DCM Main Horizontal assembly							
B1	Plugs assembled on the Lambda Plate	bus bars vs GND and in between for 4-in-1 type plugs, with DCM cryostat grounded	3 kV ???	200	<10	60	
		No TT sensors nor wires at this stage					
B4	Main DCM fully equipped with the capillary tube mounted and the instrumentation wires connected at the cold part and at the warm part (to the DCM cover flange)	bus bars and EH wires vs GND + TT sensors wires, with DCM cryostat grounded	3 kV	200	<10	60	
		TT conductors: 4 wires shorted vs all others wires shorted and connected to GND, including other TT sensors wires, with DCM cryostat grounded	100 V	10	<0.5		
B5	Main DCM fully equipped with the capillary tube mounted and the instrumentation wires connected at the cold part and at the warm part (to the DCM cover flange)	bus bars and EH wires vs GND + TT sensors wires, with DCM cryostat grounded	2 kV	200	<10	60	
		TT conductors: 4 wires shorted vs all others wires shorted and connected to GND, including other TT sensors wires, with DCM cryostat grounded	100 V	10	<0.5		
Phase 2 : Intermediate testing during Diodes cryostat assembly							
A4	Diode cryostat with diodes stack assembled in it and wires routed up to IFS flange	V-Taps & I-taps shorted together vs (GND + TT sensors wires)	2 kV	200	<10	60	
		TT conductors: 4 wires shorted vs all others wires shorted and connected to GND, including other TT sensors wires	100 V	10	<0.5		
A5	Diode cryostat with diodes stack assembled in cryostat, wires routed up to IFS flange with IFS box installed	V-Taps & I-taps shorted together vs (GND + TT sensors wires)	2 kV	200	<10	60	
		TT conductors: 4 wires shorted vs all others wires shorted and connected to GND, including other TT sensors wires	100 V	10	<0.5		
Finale QC on Main DCM assembly before dispatch							
C1	Main DCM in final configuration: fully equipped with the diodes stack installed and all instrumentations	bus bars (diodes V-Taps & I-taps shorted together) and EH wires vs (GND + TT sensors wires)	1500 V	200	<10	60	
		TT conductors: 4 wires shorted vs all others wires shorted and connected to GND, including other TT sensors wires	100 V	10	<0.5		

Documentation

- V-taps layout LHCLSDIX0001
- Cryogenic instrumentation : [LHCLSQRG0041](#)
- Electrical design criteria [EDMS 2747011](#)
- IFS flanges : EDMS 2896437 & 2896449