

# Interlock System Equipments for Conventional Magnets

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# Purposes

- Magnets protection against overheating
  - Switch off the Power Converter
- Provide the magnet status to the Beam Interlock System (BIS)
- Display the state of the power converter (operational or not)

# Components

- Thermoswitch for thermal protection of the coils
- Water flow monitor for the water flow control
- Box for thermoswitches interconnection
- Indicator to display the power converter status
- Connection for the communication with Beam Interlock System
- Connection for the tests during commissioning and maintenance

# Magnets type

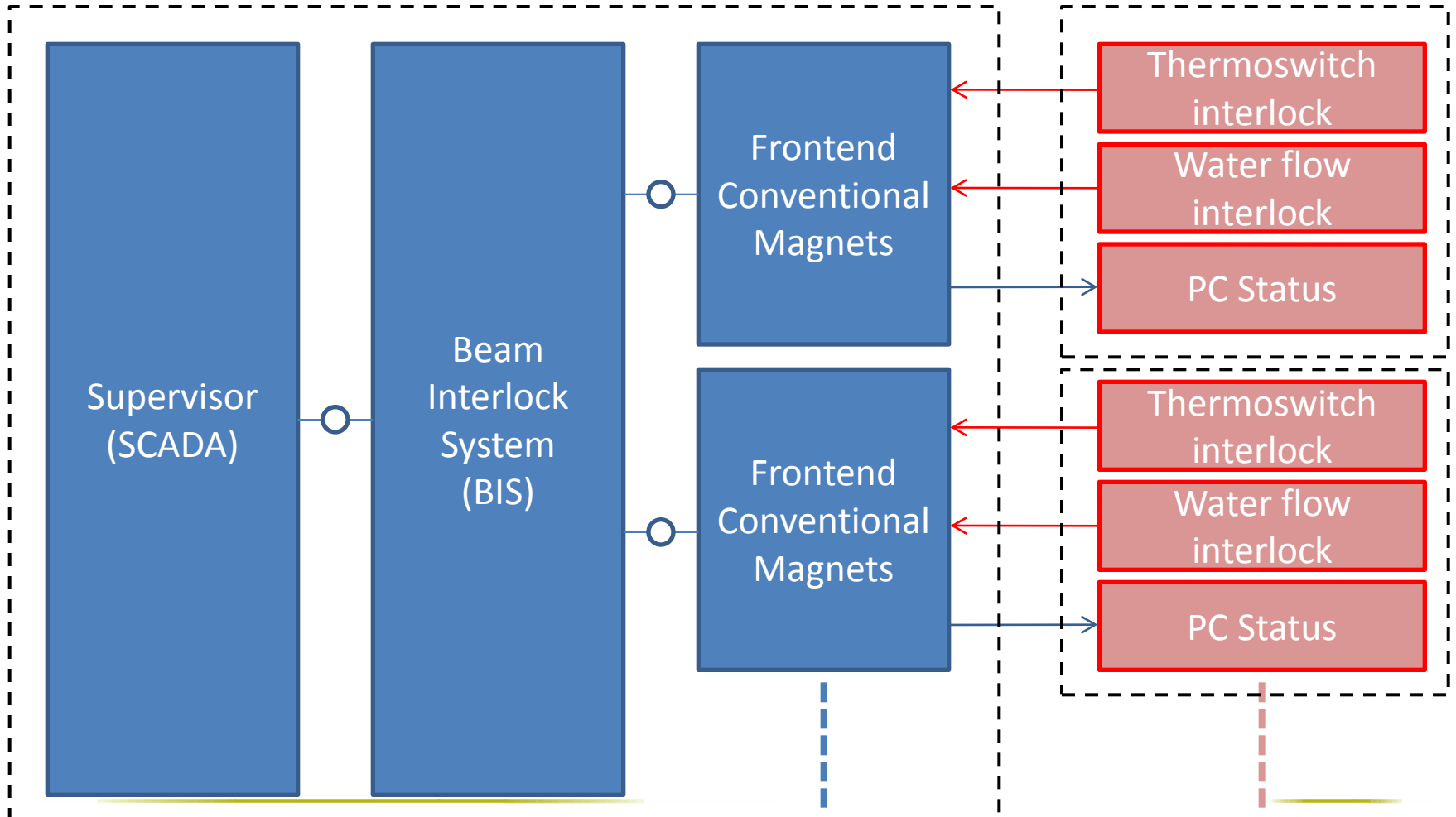
	Item	1 cooling circuit device	2 cooling circuits device	3 cooling circuits device	4 cooling circuits device	
LINAC&LEBT	MBHA (Spectrometer)		5			
	MBSA (Switching Dipole)		3			
	MCXA (Corrector hor+vert)		<u>19</u>			
	MQZA (Quadrupole)		22			
	MSOA (Solenoid)		<u>6</u>			
MEBT	MBHB (Dipole Magnet)		4			
	MCXB (Corrector hor+vert)		9			
	MQZB (Quadrupole)	11				
SYNCHROTRON	MBHC/MBHD (Dipole Magnet)		20			
	MCHC (Corrector horizontal)	<u>11</u>				
	MCVC (Corrector vertical )	<u>9</u>				
	MINC (Betatron core)	<u>1</u>				
	MQAC (Quad air cored)	<u>1</u>				
	MQZC/MQSC (Quadrupole/ skewed Quad)		27			
	MXZC (Sextupole)			6		
HEBT & Treatment Rooms	MBHE (Dipole Magnet)				13	
	MBVF (Dipole 90 deg)				1	
	MCXE (Corrector hor/vert)				20/20	
	MQZE (Quadrupole)				81	
	MSHE (Scanning dipole hori)				6	
	MSVE (Scanning dipole vert)				6	
	Estimate of magnets for the gantry					10
	Spare box				9	
	TOTAL	33	115	6	167	<b>320</b>

  : air cooling magnets

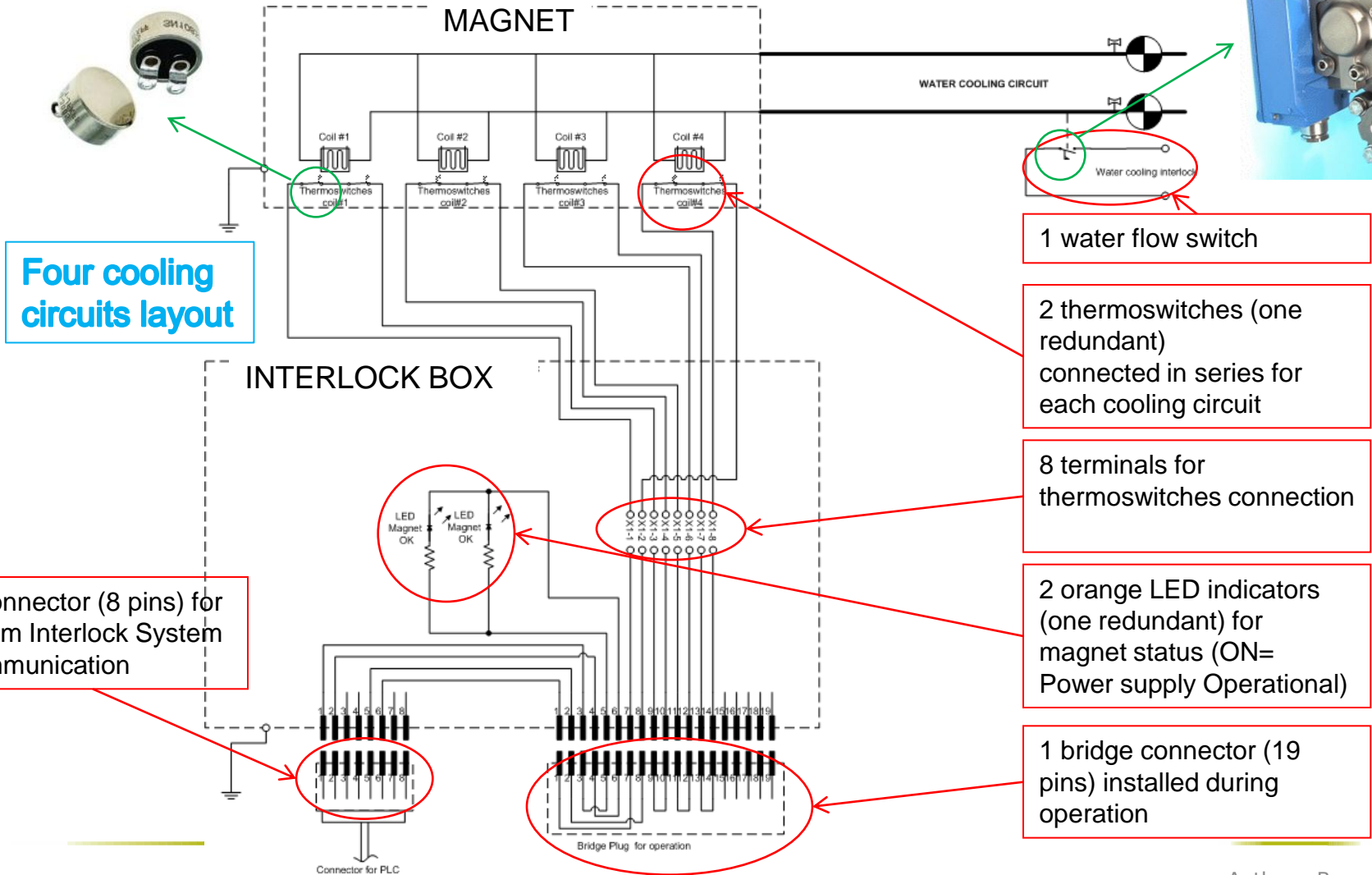
# Magnet Interlock System

## Controls

## Magnets



# Magnet Interlock System



Four cooling circuits layout

1 water flow switch

2 thermoswitches (one redundant) connected in series for each cooling circuit

8 terminals for thermoswitches connection

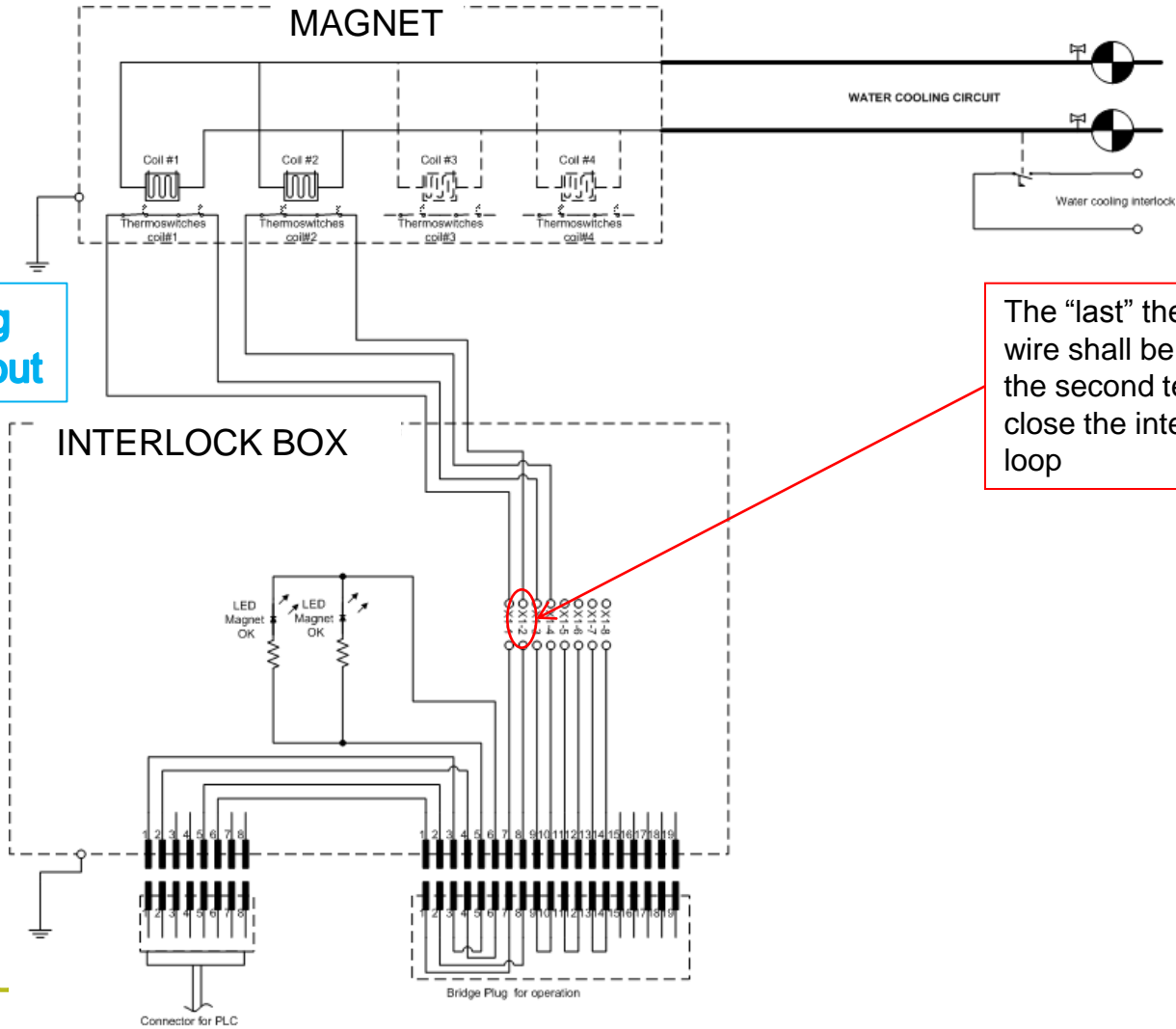
2 orange LED indicators (one redundant) for magnet status (ON= Power supply Operational)

1 bridge connector (19 pins) installed during operation

1 connector (8 pins) for Beam Interlock System communication

# Magnet Interlock System

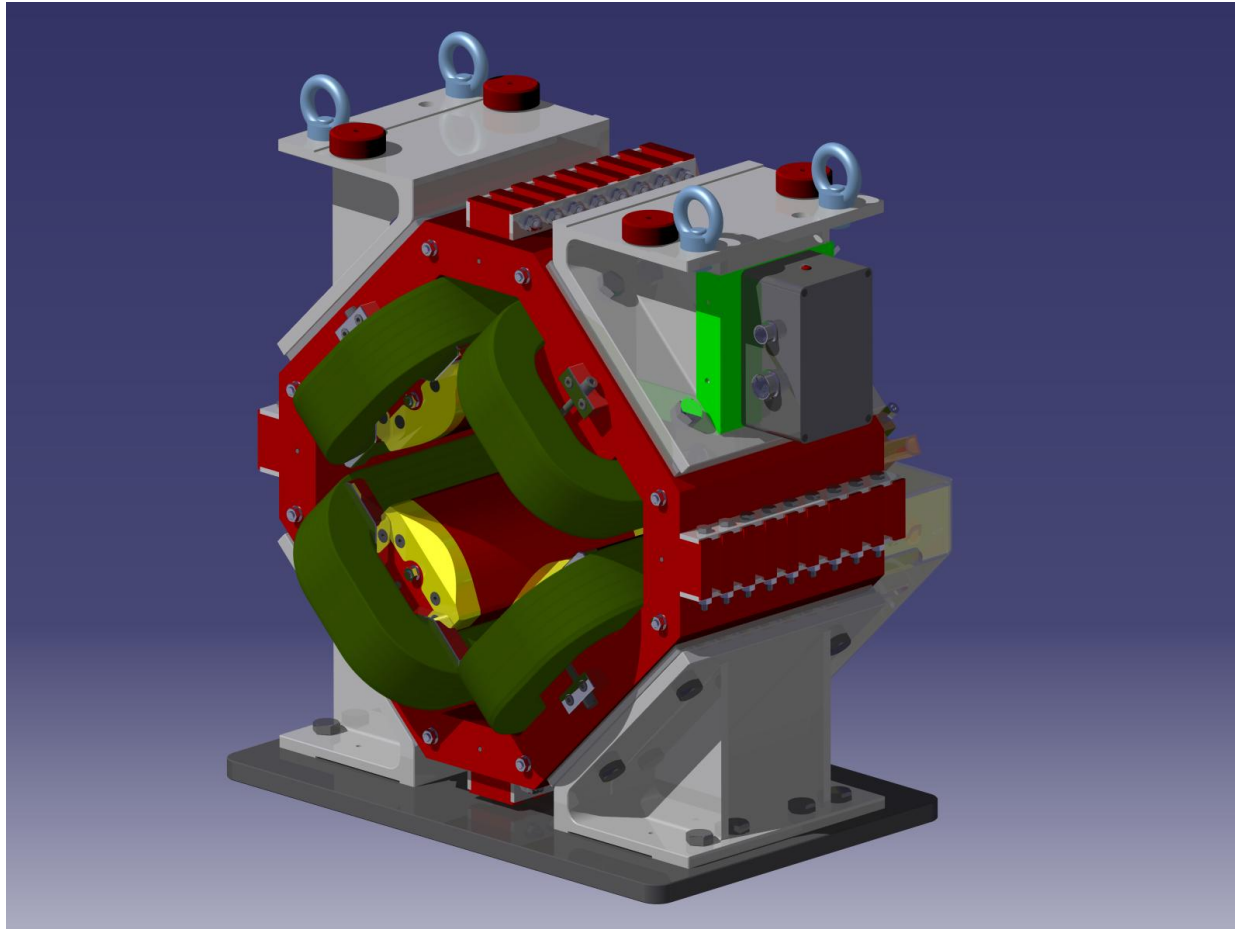
Two cooling circuits layout



The "last" thermoswitch wire shall be connected to the second terminal => close the interlock switch loop

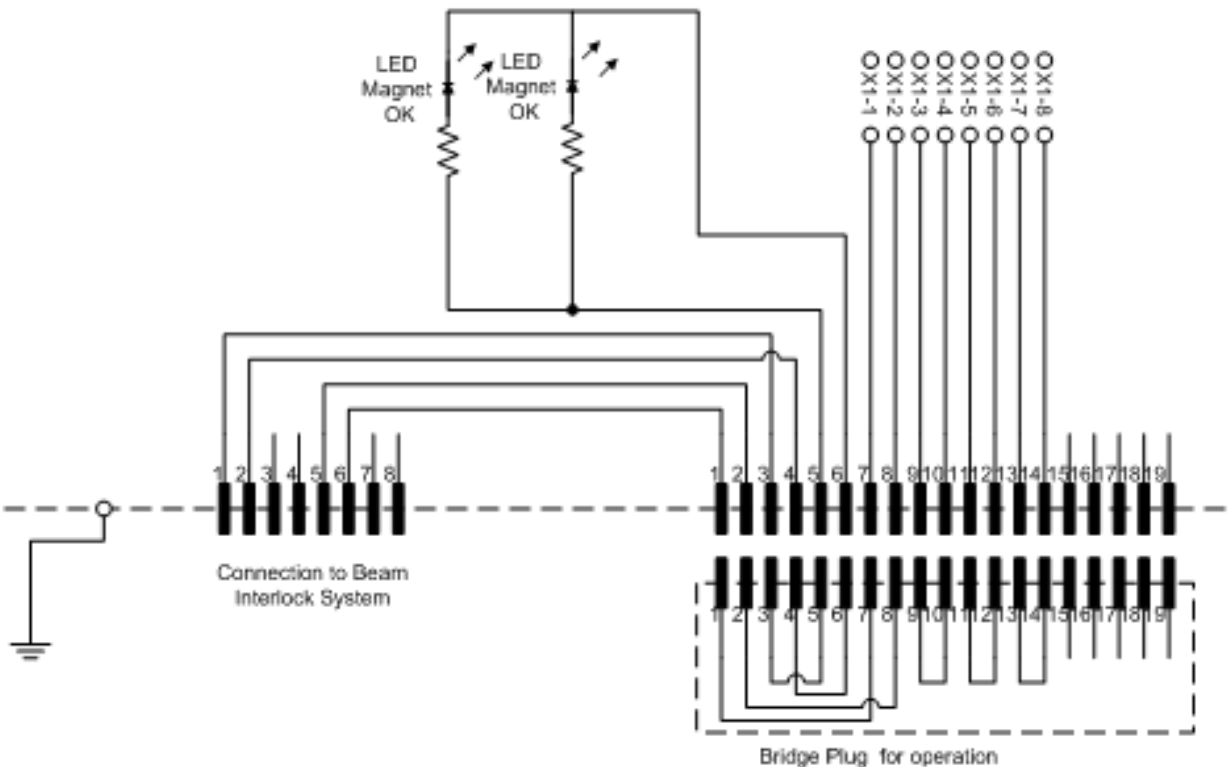


# Magnet Interlock System



# Interlock Box

INTERLOCK BOX



Purpose:

- Junction box for the thermoswitches
- PC indicator
- Connection to the BIS
- Connection for the tests

Characteristics:

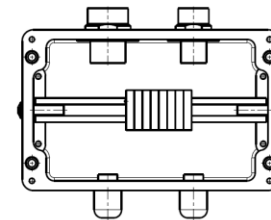
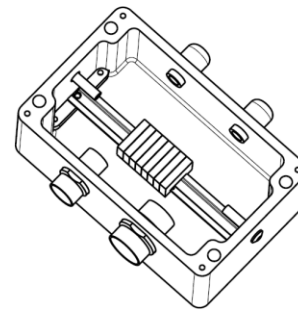
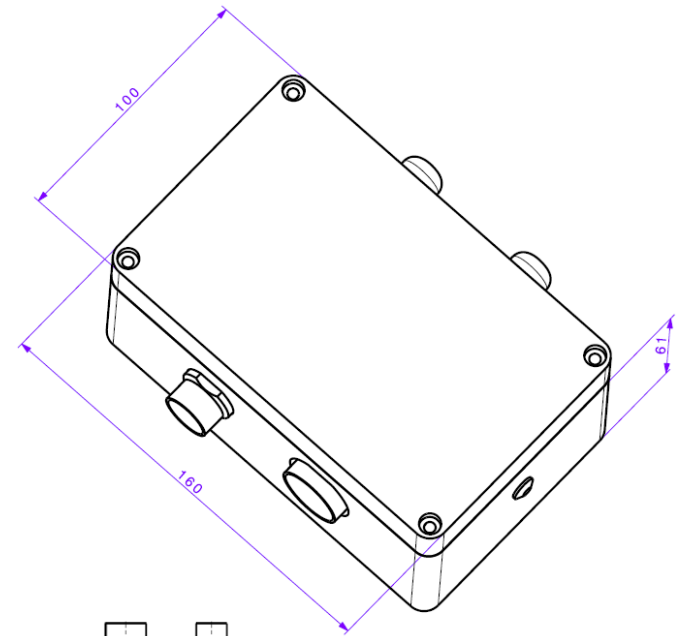
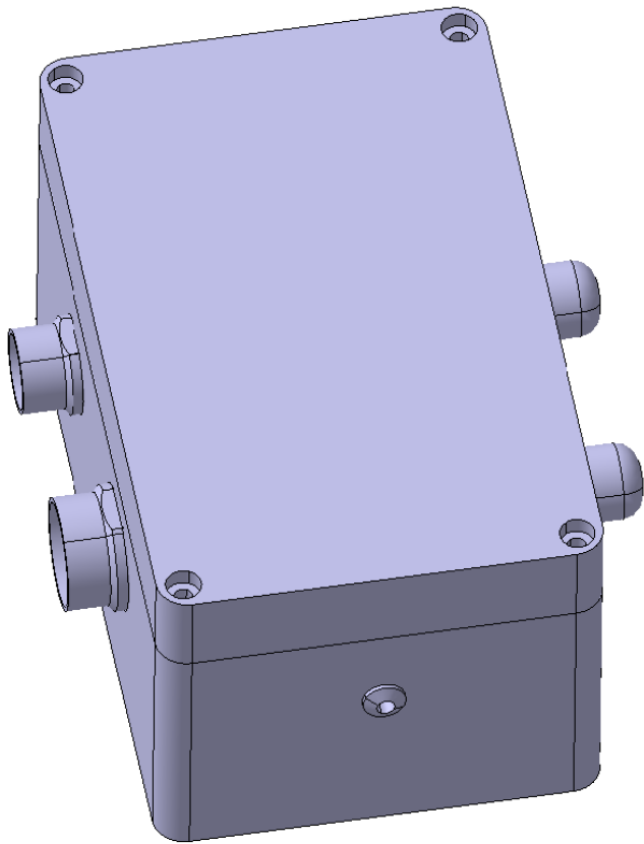
- **Standard for all magnets**
- Radiation resistance
- Redundant indicators
- No disconnection required from BIS during maintenance
- the 8 pins connector respects the requirements for the BIS (ES-10017-a-MMA)

Quantity:

- 330 (including 9 spares)

**The LEDs do not specify if the magnet is in a safety state for intervention on it**

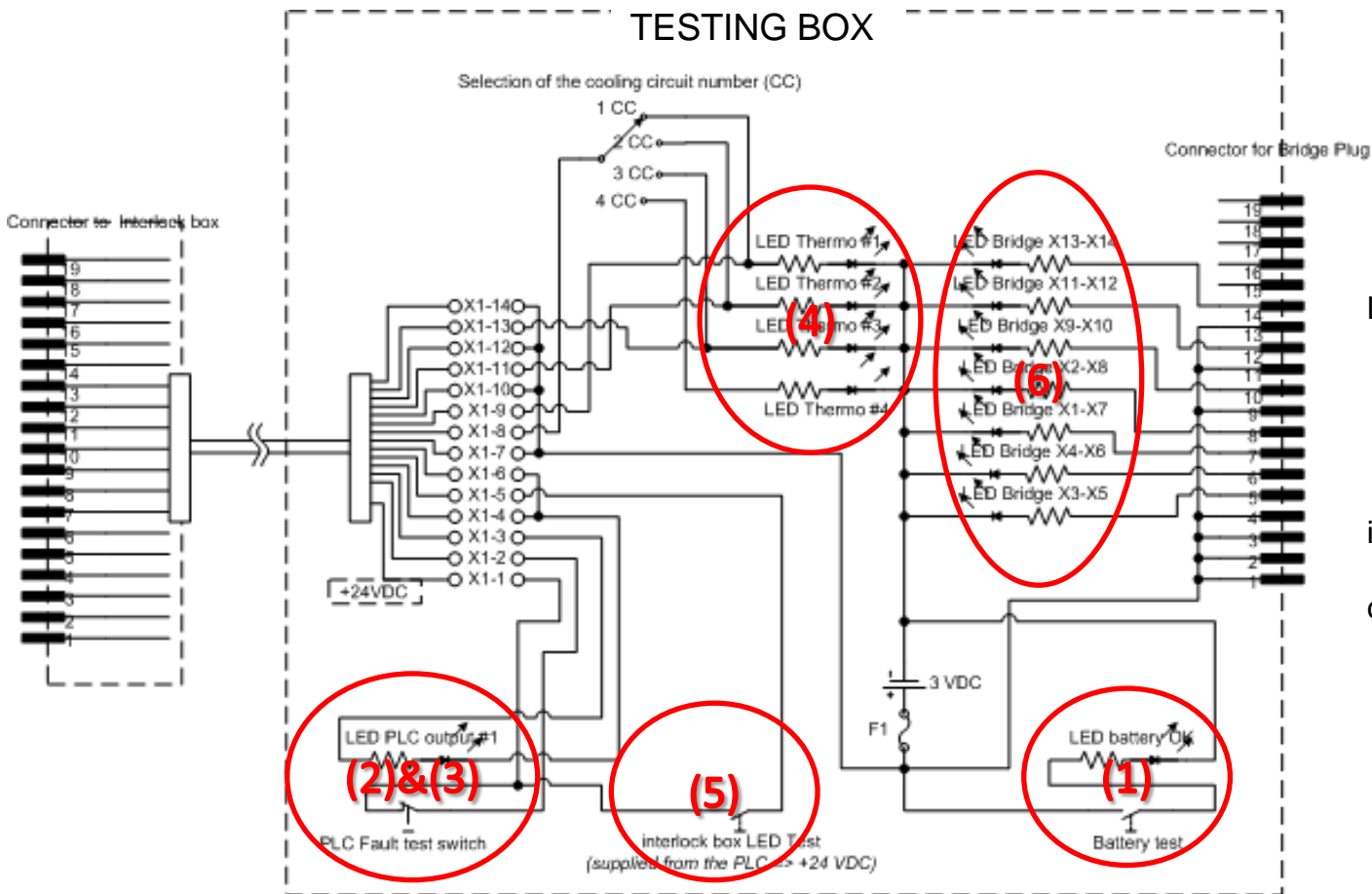
# Interlock Box



# The testing box

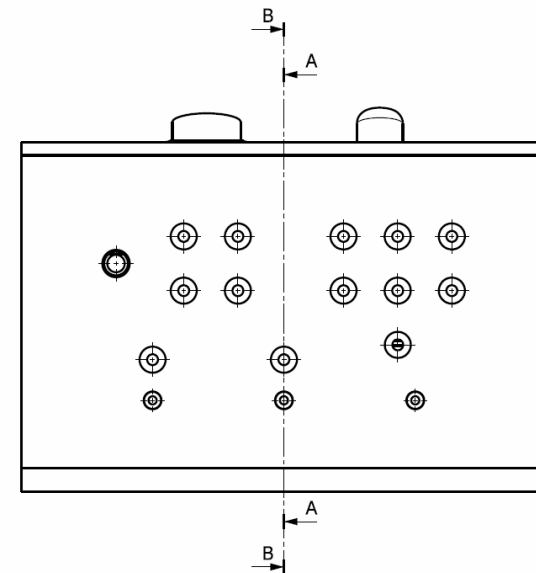
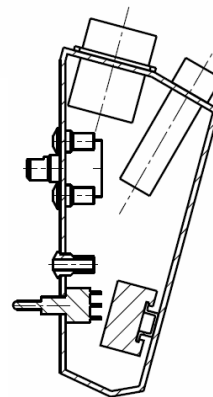
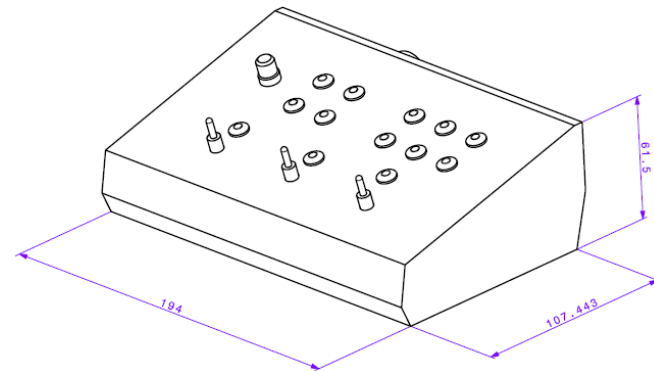
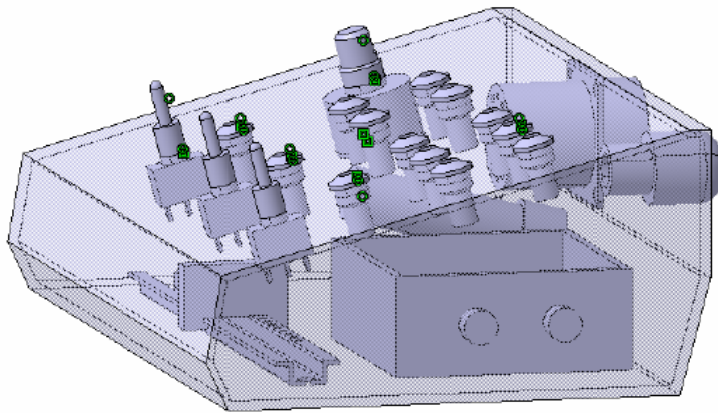
- Purpose:
  - Interlock verification during the commissioning
  - Diagnostic during operation
  - Allows to test the interlock boxes and BIS connection
- Characteristics:
  - Standard for all magnets type
  - No radiation resistance required
  - No electrical network connection required

# The testing box

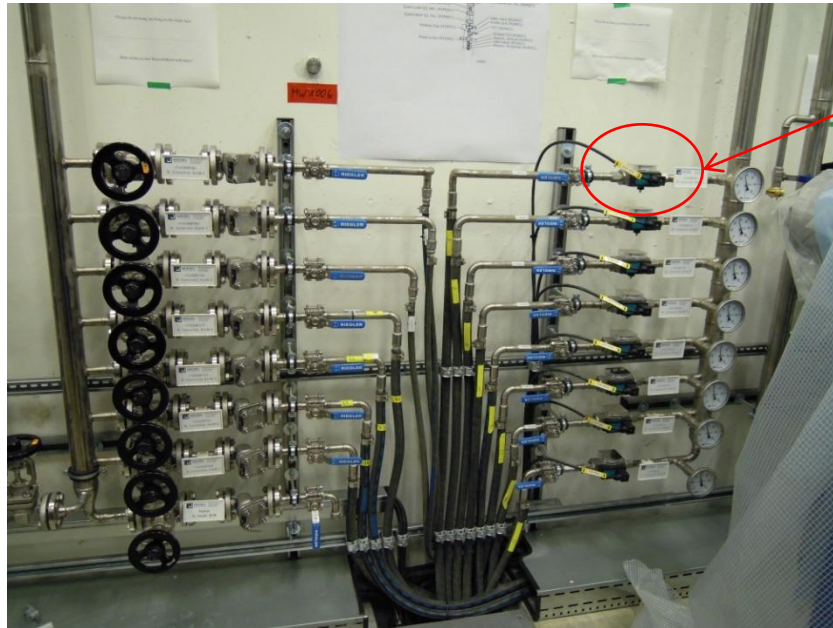


- List of available tests:
- (1) self-test (box battery)
  - (2) output to BIS
  - (3) input from BIS
  - (4) thermoswitches
  - (5) LED indicators on the interlock box
  - (6) bridges in the 19 pins connectors

# The testing box



# Water Flow monitors



Water flow monitor

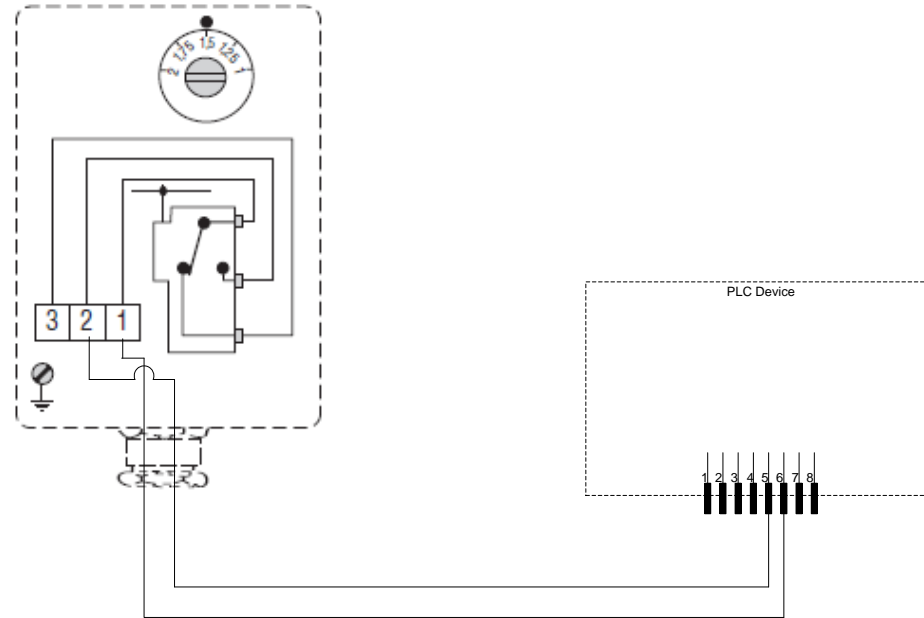
Particularities:

- One for each water cooled magnet
- No redundant system
- Installed next to the water manifolds on the water outlet
- Cable directly connected to the Beam Interlock System (with respect to the cable and color code defined in ES-10017-a-MMA)

Example of water distribution system (UKGM Marburg)

# Water Flow monitors

- Connections



- Quantity
  - 225 (including 10 spares)



# Conclusion

- Standardization of the interlock box
- Possibilities to test the Magnet Interlock System
- Adaptations for the water flow interlock

Thank you for your attention

Questions?