



Magnetic measurements strategy for HL-LHC interaction region magnets

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1 October 2018 - Geneve

SCOPE OF MAGNETIC MEASUREMENTS

- Quality control of assembly
- Early indicator of field quality for fine tuning of design
- Assembly of cold mass
- Fiducialization
- Construction of magnetic model of HL LHC

TYPE OF SYSTEMS

- CS: coil scanner
 - One measuring coil moved along the magnet
- SC: shaft chain
 - Several measuring coils
- SW: stretched wire
 - For field integral direction etc.
- AC mole
 - With system to determine the position of the measuring coil

STRATEGY: Q1/Q3

- All magnets require local field harmonics measurements at room temperature as a diagnosis tool and to anticipate actions for fine tuning of field quality;
- All magnets require field centre, direction and axis measurements at room temperature for cold mass assembly and fiducialization;
- All magnets require TF and integral field harmonics measurements at 1.9 K to build the magnetic model of HL-LHC;
- A **subset of magnets** require a second measurement at CERN for cross-calibration of transfer function.

STRATEGY: Q2

- All magnets require local field harmonics measurements at room temperature as a diagnosis tool and to anticipate actions for fine tuning of field quality;
- All magnets require field centre, direction and axis measurements at room temperature for cold mass assembly and fiducialization;
- All magnets require TF and integral field harmonics measurements at 1.9 K to build the magnetic model of HL-LHC.

STRATEGY: MCBXFA/B

- All magnets require local field harmonics measurements at room temperature as a diagnosis tool and to anticipate actions for fine tuning of field quality;
- Prototype MCBXFB magnets require field centre, direction and axis measurements at room temperature to verify cold mass assembly;
- Prototype MCBXFA magnets require field centre, direction and axis measurements at room temperature to verify cold mass assembly and fiducialization;
- A **subset of magnets** (4 for each type) require TF and integral field harmonics measurements at 1.9 K to build the magnetic model of HL-LHC.

STRATEGY: HO CORRECTORS

- The room temperature magnetic measurements do not give useful information on the assembly, **and therefore are not required**;
- TF and field harmonics measurements during vertical test at 4.2 K in LASA are not required since can be replaced by measurements at CERN; measurements on a subset of magnets are required by LASA as strategic for the laboratory;
- Room temperature measurements of field centre and direction during assembly are required for the **prototype cold mass only**;
- **A subset of magnets (4 of each type)** require 1.9 K measurements of TF and field harmonics to build the HL-LHC magnetic model.

STRATEGY: D1

- No need of measuring field harmonics at room temperature; since the coil is in the final position only after shell welding, the anticipation with respect to the 1.9 K measurements in vertical position is not considered to be relevant compared to the effort; (still under discussion)
- All magnets field harmonics shall be measured at 1.9 K in vertical position to validate the assembly and allow to fine tune field quality if needed;
- All magnets field direction shall be measured at room temperature for alignment before finalizing the cold mass;
- All magnets field centre and direction, TF and field harmonics shall be measured at 1.9 K in horizontal position to build the magnetic model of the HL-LHC.

STRATEGY: D2

- All magnets (two apertures in Al sleeve) field harmonics shall be measured at room temperature to validate the assembly and allow to fine tune field quality if needed; the single aperture measurements could also provide relevant information (to be decided after model and prototype);
- All magnets field centre and direction shall be measured at room temperature during cold mass assembly and fiducialization;
- All magnets field centre and direction, TF and field harmonics shall be measured at 1.9 K to build the magnetic model of the HL-LHC.

STRATEGY: D2 CORRECTORS

- All magnets field harmonics shall be measured at room temperature to validate the assembly;
- All magnets field centre and direction shall be measured at room temperature during cold mass assembly;
- **A subset of magnets (4 out of 12)** field centre and direction, TF and field harmonics shall be measured at 1.9 K to build the magnetic model of the HL-LHC.