



# POSSIBILITIES OF SORTING IN HL-LHC: HARDWARE CONSTRAINTS

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# Sorting possibilities

- Seven cryomagnets to be installed per IP side
  - 2 Q1/Q3, 2 Q2, 1 CP, 1 D1, 1 D2
- Four of them have jumper
  - D1, CP and Q2b have a transverse jumper (90 degrees to the beam axis); D2 has a longitudinal jumper
  - Once you have a transverse jumper the slot is fixed
- Cryostating has two phases:
  - Insertion in the cryostat (phase I). Q1/3, Q2a/b and D1 are tested after this phase
  - Customization for tunnel (phase II). **D2 and CP can only be tested after this phase** because of the local heat exchanger (for D2) or for the local current leads (CP)
- With the new baseline phase II starts in 2025 for Q1/Q2/Q3 and D1 ([EDMS 2767515](#))
  - So we will have a bunch of cryomagnets to make sorting if needed

# Sorting flexibility before phase I cryostating

- D2, D1, CP have four possible slots (L and R of IP1 or IP5)
- Q1/Q3 will have eight possible slots
- Q2a will have four possible slots
- Q2b will have four possible slots
- Magnets available by beginning 2025:
  - About 2/3 of Q1/Q3 (but all magnets vertical tested)
  - About 2/3 of Q2
  - All D1 vertical tested
  - Half D2 tested at 1.9 K, half tested at room temperature
  - Considering that our schedule has no contingency, these quantities are likely to be reduced by 30%

# Sorting flexibility after phasel cryostating

- D2 have four possible slots (L and R of IP1 or IP5)
- D1, CP and Q2b will have no freedom
- Q1 will have two possible slots, due to slope of the tunnel (IP1L or IP5 R – IP1R of IP5L)
- Q3 will have two possible slots, due to slope of the tunnel (IP1L or IP5 R – IP1R of IP5L)
- Q2a will have two possible slots, due to slope of the tunnel (IP1L or IP5 R – IP1R of IP5L)

# Sorting possibilities before cryoassembly test

- Rotation of the magnet by 90/180/270 degrees after loading (Q1/Q2/Q3)
  - This option proposed during the discussions following the sorting kick-off meeting (August 31, <https://indico.cern.ch/event/1168827/> )
  - This means having the possibility of changing the sign of some multipoles once the room temperature measurement is available
  - Up/down asymmetry is created when the connection box is done (last phase of magnet construction – this determines the position of the poles in the cross-section and all the not allowed multipoles
  - This possibility will be analysed both at CERN and in the US
- Magnets in cold mass (only for Q1/Q3):
  - There is **no possibility of couple two particular MQXFA magnets when making the cold mass** – this would have a strong impact on the schedule
- Cold mass:
  - MQXFB will become either Q2a or Q2b at the level of cryostating

# Self-correction of half of non allowed systematics

- All magnetic measurements are provided in the reference system of the magnet (seen from connection side)
- Quadrupole magnets will be installed alternating the connection side and the non connection side seen from the IP
- This will entail an automatic correction of any possible systematic  $a_4$ ,  $a_6$ , ... and  $b_3$ ,  $b_5$ , ... present in the measurements of the magnet seen from the connection side

