HL-LHC INTEGRATION MEETING

DSHX document

M. Curylo

HL-LHC WP6A – 08/12/2021

Finalization of DSHX length

Scope of the internal note is to define the nominal routing and final length.

Possible actions:

A) approval of the technical note (EDMS: 2414364)

- in its current state

OR

- application of all details

(shape of protection cover in section 1 is not finalized !)

(supports in section 4,5 are not ready !)

OR

B) … (another solution)

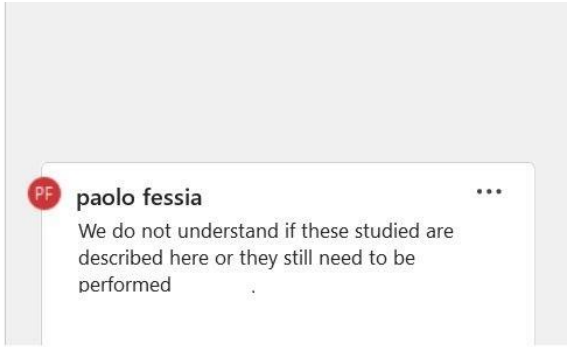
e.g. Decision document (DMR)

TECHNICAL NOTE: Remarks

1.2 Routing Study

Basic requirements for the routing of DSH systems are described in [5], which specifies a minimum snaking path to allow MgB_2 cable contraction at cryogenic temperature. Some aspects of the DSHX final routing configuration require more detailed study and analysis, depending on:

- The available space for DSHX 'waves' in each tunnel section where DSHX is placed.
- The position of interfaces and surrounding devices in the tunnels.
- The tooling used to maintain DSHX in their operational configuration (fixed points).
- Limitations from transport and tunnel geometries.
- Calculation methods for estimation of nominal length.



Marcin:
OK, the sentence will be worded differently. These points was studied, taken into accountant during analysis.

TECHNICAL NOTE: Remarks

INPUT DATA

Integration CAD models provided by the WP15 team were used for detailed study. Integration models use simplified DF cryostat models. The main 3D geometries and 2D documents are listed below:

- New service tunnels:
  - IP1: **ST1120743_01** (P1_HL_LHC_Underground_Integration_2020)
  - IP5: **ST1120186_01** (P5_HL_LHC_Underground_Integration_2020)
- HL-LHC machine components (v.1.5):
  - IP1-L: **ST0990131_01** (HL_IP1_L_1101_INTEG. LS3)
  - IP1-R: **ST0990128_01** (HL_IP1_R_1101_INTEG. LS3)
  - IP5-L: **ST0968836_01** (HL_IP5_L_1506_INTEG. LS3)
  - IP5-R: **ST0966906_01** (HL_IP5_R_1506_INTEG. LS3)
- DFX simplified:
  - IP1-L: **ST1172968_04** (DFX Point 1 Left Simplified)
  - IP1-R: **ST1172968_05** (DFX Point 1 Right Simplified)
  - IP5-L: **ST1172968_03** (DFX Point 5 Left Simplified)
  - IP5-R: **ST1172968_06** (DFX Point 5 Right Simplified)
- Reference layout drawings of HL-LHC machine (v.1.5):
  - IP1-L: LHCLSXH_0001
  - IP1-R: LHCLSXH_0002
  - IP1-L: LHCLSXH_0009
  - IP1-R: LHCLSXH_0010

?

paolo fessia

Missing the 4 simplified models for the DSHX

Reply

Marcin:
It's probably about simplified DFHX models, not DSHX (to be confirmed)

IP5 and IP1 R: ST1228847_11
IP5 and IP1 L: ST1228847_12

paolo fessia

Probably swapped

Reply

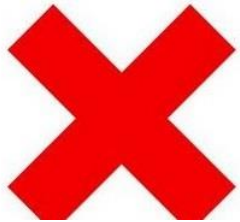
Marcin:

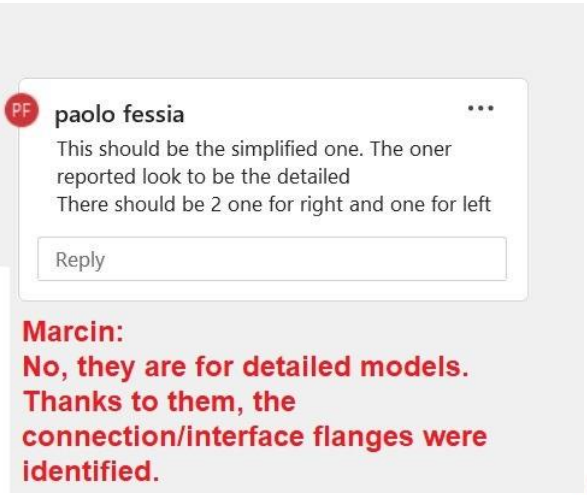
OK, corrected in the document

TECHNICAL NOTE: Remarks

The detailed design of DSHX interfaces and the adjacent WP6A devices are listed below:

- DFHX:
  - Cryostat DFHX: **ST1228847_01** (LHCDFHX_0001)
  - DSHX termination adjacent to DFHX (Welded interface SC-Link-DFHX Ø100):
    - CERN specification: **ST1332433_01** (LHCDSH_C0006, EDMS 2455692)
    - Supplier implementation: EDMS 2592800 (in preparation)
- DFX:
  - **ST1172968_01** (DFX Vertical v3.5.13 Master)
  - **ST1220063_01** (DFX TEST ASSEMBLY)
  - DSHX termination adjacent to DFX (Welded interface DFX Ø100 SC-Link):
    - CERN specification: **ST1358980_01** (LHCDSH_C0009, EDMS 245569
    - Supplier implementation: EDMS 2592800 (in preparation)



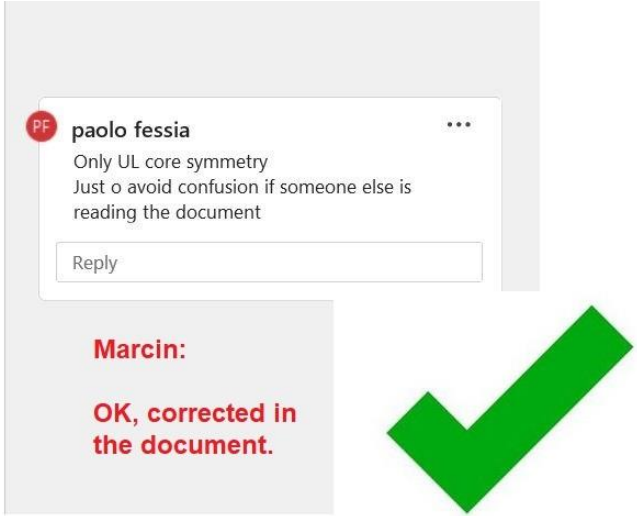


TECHNICAL NOTE: Remarks

Both types of DFH use a dedicated local coordinate system for the HL-LHC project: CERN 1102 for IP 1 and CERN 1503 for IP 5. For the installation and positioning process in the new service gallery UR, the DFH will use some orientation points related with gallery geometries in respect to these systems. Core symmetry in relation to the IP allows their central plane to be used as a reference for positioning. The nominal height of 700 mm above the floor of the UR shall be obtained through adjustment of the support frame of the DFH. The tables below summarize the base point coordinates for DFH devices and the position of local orientation for installation. Fig. 5 shows the interface flange positions of both types of DFH in relation to the core plane and nominal height above the UR tunnel floor.

Table 1. Reference positions of the DFHX system.

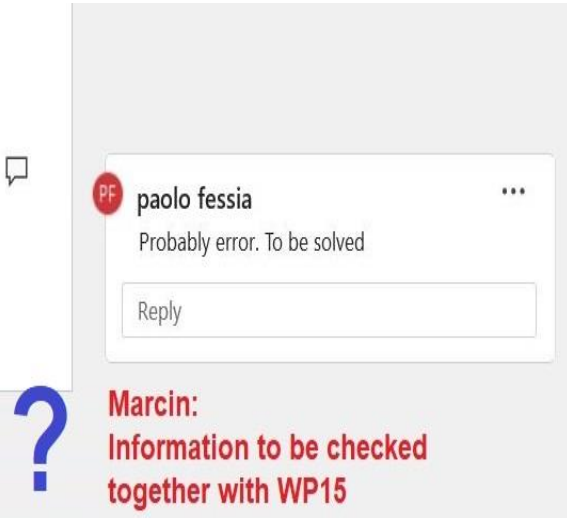
IP # - # : AXIS SYSTEM	SIDE (L): X, Y, Z [mm]	SIDE (R): X, Y, Z [mm]
IP 1 – DFHX: CERN 1102	53200, - 83000, 8925	53200, 83000, 10975
IP 5 – DFHX: CERN 1503	53200, - 83000, 10975	53200, 83000, 8925
IP 1 – CORE PLANE: CERN 1102	NA, - 93250, NA	NA, 93250, NA
IP 5 – CORE PLANE: CERN 1503	NA, - 93250, NA	NA, 93250, NA



TECHNICAL NOTE: Remarks

Table 2. Reference positions of the DFX system

IP # - #: AXIS SYSTEM	SIDE (L): X, Y, Z [mm]	SIDE (R): X, Y, Z [mm]
IP 1 – DFX: CERN 1102	0, - 92980, 810	0, 92965, 3025
IP 5 – DFX: CERN 1503	0, - 92965, 3025	-15, 92990, 815



TECHNICAL NOTE: Remarks

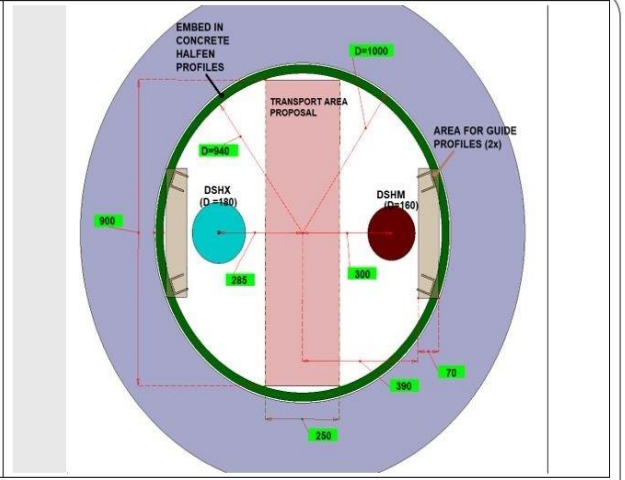
REFERENCE :

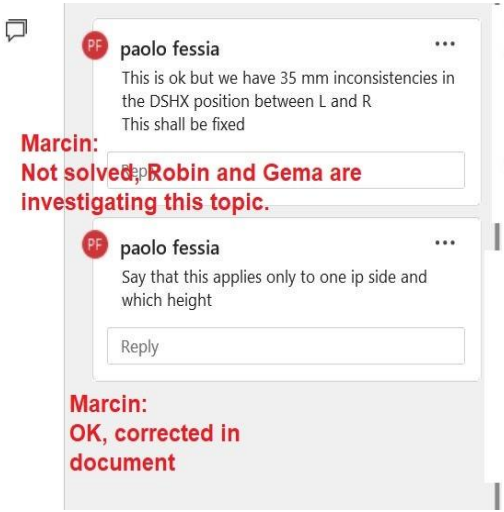
2 Tunnel Integration Assumptions

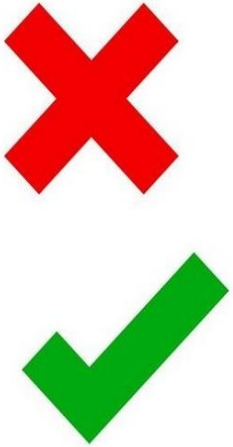
For each of the two DSHX cryostats installed on both sides of IP1 and IP5, the integration environment should be considered individually. However, some general assumptions are taken for all installed systems and for the routing study:

- 40 mm distance from the outer surface of the DSHX (braid) to the side wall of the trenches and the tunnel walls.
- Due to the different depths of the trenches and sizes of their covers, a distance of 260 mm (± 5 mm) from the trench cover top surface (floor level of UR and UL tunnels) to the central axis of the DSHX was selected as nominal.

TECHNICAL NOTE: Remarks

Core (vertical shaft), cross-section, area of output to LHC tunnel	





TECHNICAL NOTE: Remarks

The first section is identical for all cases. Section 1 includes the connection interface to the DFHX cryostat in the UR tunnel surface, where the initial DSHX section is straight (320 mm). The path then enters the horizontal trench, with an assumed bending radius: this transition covers shape of wavy pattern, and it ends on the first fixed point in the UR trench. The position of the drop into the trench affects access for surrounding systems like the Ventilation Unit Rack (EN-CV system). The rest of the path in this section includes routing in the UR trench, using all the available width to create wavy pattern, and a 90° transition to the UL trench, where it ends with a fixed point. Baseline studies for nominal routing assume the creation of two wavy patterns in this section with an amplitude around 250 mm. The first wave shape is obtained in the direction of descent (with the mid-point of the wave maintained by dedicated support). On the entire length of this transition (~ 4 m), an additional protection system around the DSHX is planned (in case of electrical arc). A second wave assumes a path in the horizontal direction in the UR trench.

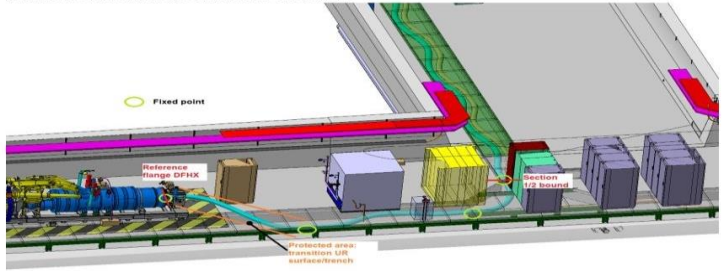


Fig. 9 Layout of section 1 of DSHX routing scenario

paolo fessia
To make clearer that is only the part external to trench
Mode I not provided to integration so not

Reply

Marcin:

The figure shows only the place for this system. No concept has been proposed at this moment.

?

4.2 Section 2

The second section covers routing of the DSHX in the UL trench, bringing it to the surface of the service tunnel. In section 2, the DSHX and DSHM cryostats share the available width of the trench, significantly influencing the maximum amplitude for a wavy path (max. 390 mm). A 320 mm wave amplitude is chosen as nominal. The assumed worst-case scenario concerns the right side of IP, which includes the longest sector of horizontal trench, for which the nominal number of waves is 4 (for the left side of the IP there will be 2 waves). The last segment of this section ensures the transition to the nominal height (1200 mm between the bottom surface of the cryostat and the ground level) in the UL tunnel. As in section 1, the transition area will be protected by a dedicated cover in the 5 m long sector (one cover for both type of DSH systems).

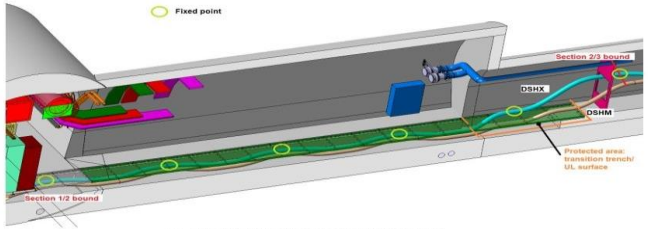


Fig. 10 Layout of section 2 of DSHX routing scenario

paolo fessia
Again protection not provided yet to integraqtion

Reply

Marcin:

The figure shows only the place for this protection system. No concept has been proposed at this moment.

?

TECHNICAL NOTE: Remarks

The last section of the DSHX contains the vertical region where the point of integration with the DFX device is located. In each scenario, the location of the interface point is different because of the tilt and slope of the tunnels.

Due to the complexity of the guiding system in the vertical section, the nominal path of section 5 does not assume the introduction of a wave system (as an option, it is believed to be a possibility to introduce one nominal wave with a minimum amplitude of 250 mm, but this should be verified on an appropriate mock-up system).

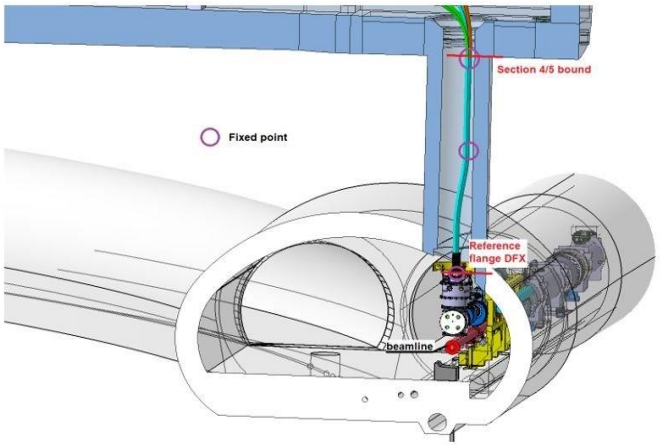


Fig. 13 Layout of section 5 of DSHX routing scenario

paolo fessia
Both for the section 4 and 5: we do not have a proposal for the supporting tooling and the guide tooling in the core.
We cannot approve that support and ensure that there is enough space
03 December 2021, 14:20

paolo fessia
As the DFX interface point is slightly different it should be stated that the difference will be compensated along the core length or in the tolling at the entrance point in the core
03 December 2021, 14:24

Reply

Marcin:
Work on this supports is ongoing.
That's right, we don't have a final concept in these areas.

Marcin:

OK, this information will be added.

TECHNICAL NOTE: Remarks

For manufacturing, the length shall be rounded up from the nominal value of 73.44 m to L_N = **74.0 m**. The resulting asymmetric integration flexibility range of +0.33/-1.45 m still accommodates the specified manufacturing tolerance of ± 0.3 m, but with additional margin against insufficient length.

For contractual purposes, the total length of the DSHX cryostat A including termination assemblies (see fig. 3) is specified instead: with the dimensions of the cryostat terminations fixed by design, the resulting length is **A = 74.5 m**.

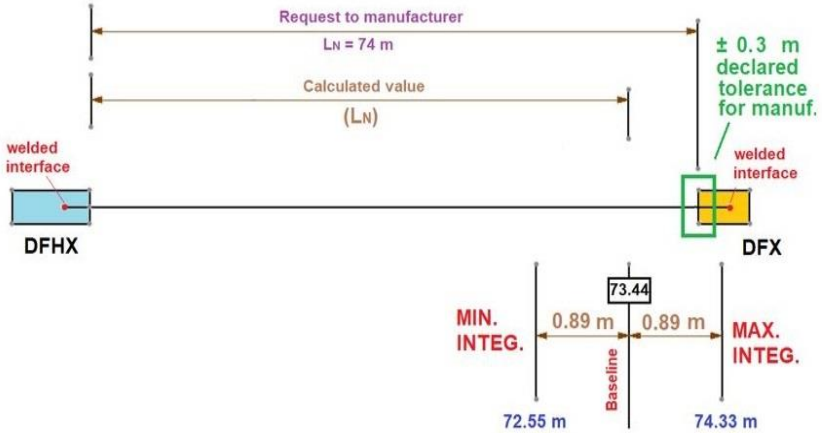


Fig. 14 Diagram with description of nominal values.

paolo fessia

WP6A takes the responsibility to compensate for this extra 0.6 m of margin in the assigned installation volume

Reply

Marcin:

this point, was discussed and adopted by WP6A

TECHNICAL NOTE: Remarks

Fig. 14 Diagram with description of nominal values.

Additional parameters that may slightly affect the final routing in the tunnels are listed below (values will be verified in future studies):

- Final accuracy of new tunnels
- Detailed design of supporting structures for DSHX and DSHM
- Length of rigid sections in fixpoints (confirmed size of fixing clamps)

paolo fessia

Missing hence not approvable

Reply

- Confirmed assembly sequence of WP6A components in HL-LHC project from the general planning
- Protection system due to electric arc [15]

6 REFERENCES

Marcin:

For discussion, mention it or not

?

paolo fessia

Missing hence not approvable