Follow up from Conceptual Design Review

Vittorio Parma, CERN TE-MSC

Meetings on DFX

- DFX design coordination: Weekly DFX videoconference meetings (Friday p.m.) with SOTON (+ skype meetings during the week): 20 meetings https://indico.cern.ch/category/10765/

- Dry run, 12 April (https://indico.cern.ch/event/812900/) organized by A.Ballarino.

- Tunnel integration:
  - 1 topical WP06a meeting (A.Ballarino)
  - Since two week, specific weekly meetings (Friday a.m.) by WP15 Advancement on DFX - SC Link - DFM integration (P.Fessia, M.Amparo, https://espace.cern.ch/HiLumi/WP15/SitePages/WP6A%20Integration.aspx)

Long list of actions and follow-up (for reference only)

Action	Description (defined in dry run of 12 April 2019, see edms 2149078)	Person	Status 19/06/19
1	WP6a Integration Meeting will take place in the next coming weeks – when more advanced drawings will be available and before the DDR	Amalia	Now specific integration meetings (WP15) in place since 2 weeks
2	Functional Specification of the DFX will be updated by Y. L., who will also write a technical specification document, to be used by SOTON for the prototype production, and an interface document (DFX to D1, DFX to DSH and DFC to cryogenic components of HL-LHC WP9)	Yann	Functional spec. updated, available since beginning June; Tech.specification available since 1 week
3	Routing of the instrumentation wires and position of the connectors (top/vertical and bottom/horizontal) shall be decided and reported in the DFX technical specification	Yann	Routing studied on the basis of a new instrumentation document by J.Fleiter, and proposal of IFS elaborated for the DFX.
4	Input shall be given to M. Bajko (HL-LHC WP15 Co-leader) to launch a study for the integration of the DFX in the String	Robin	WP16 received information in May, a first integration proposal for the string has been done.
5	All cryogenic instrumentation shall be listed and communicated to Jerome Fleiter	Yann	Instrumentation needs clarified and integrated in a common instrumentation document by J.Fleiter.
6	There was therefore a consensus on the use of the AMI gauges. V.P. will take over this issue	Vittorio	AMI gauges will be used by SOTON
7	R.B. will integrate the gauges and the drawings	Robin	Action dropped.
8	One thermometer will be integrated in the DFX (for liquid control on horizontal part) – to be added to the list of DFX instrumentation	Yann	Done. Also additional heater added for He boil-off in horizontal part. All included in instrumentation document.
9	There an urgent need to agree on the horizontal length of the DFX. V.P. in WP6a coordination meeting	Vittorio	Proposal presented in DFX meeting of 17/05 and agreed between WP03 and WP06a: https://indico.cern.ch/event/819815/
10	It was decided to increase the maximum static heat load in the DFX from 20 W to 30 W (action Y.L.: to update the functional specification)	Yann	Done, Functional spec. updated by Yann.
11	The thermal conduction of the instrumentation wires has not yet been quantified yet: Y.Y. and Y.L. will perform the calculations, recommend the length of the wires, and define the routing	Yann+Yifeng	Done. Calculated heat loads by SOTON.
12	Y.Y. and Y. L. will perform a buckling study for the case when there is 1 bar in the SC Link vacuum. Y.L. will do the calculations and discuss with Y.Y	Yann+Yifeng	Done, design changes implemented by SOTON.
13	Definition of design (and test) pressure. ...Y.L. to iterate and come with a commonly agreed value	Vittorio (not Yann)	Done. New PS defined, Functional Spec. updated by Yann
14	The maximum heat load of the plug into the 1.9 K bath (10 W to 20 W maximum) will be specified and discussed with WP3. To define the mechanical interface, the bus and the heat load and to write functional specification	Yann	Ongoing. Now plug exported to DCM under WP03.
15	to call a WP6a meeting on the (above) topic (WP3 Leader and Rosario Principe shall attend).	Amalia	Ongoing work on bus bars design.
16	Show DFX integration model (with sequence of assembly) in the LHC tunnel.	Robin	Done by SOTON.
17	Include sequence of leak tests in the DFX assembly sequence	Yann+Robin	Done.
18	safety valves and deflectors to be defined and documented	Vittorio	Safety devices chosen and located. Integration study needs iterations to facilitate accessability. Deflectors to be studied.
19	Vacuum pumps locations in the tunnel to be defined	Yann	Discussed with VSC. Integration in to-do list with WP15.
20	Routing of Nb-Ti bus-bar in DFX to be defined	Jerome	Descoped from study of DFX. Interfaces in He vessel defined for supporting bus bars. Agreed ID350 of He tube.

Follow-up of CDR recommendations

Recommendation	Description	Proposed Actions	Lead person	Status and comments
1	Complete the functional/interfaces Specification that is needed as: 1. main part of the Technical Specification and 2. reference document for the future Collaboration Agreement with Southampton University. The following, less straightforward, design requirements should be added: 3. access limitations due to the available volumes in the Tunnel; 4. accessibility for maintenance/repair; 5. re-working of components; 6. electrical integrity aspects, etc.	Update specification (EDMS 1905633) by Y.Leclercq.	Yann	Done. Functional specification updated (EDMS2052614); New Tech.Specification prepared (EDMS2169136); New Interface Specification prepared (EDMS2157597). Docs shared for comments. Should be formally approved.
2	Complete the design of the new developed concept (“cryo-fountain”). 1. A final optimization of the two chambers volume ratio should be done considering nominal operation conditions and pre-defined limits for Cryo OK signals for powering. 2. The committee recommends to set the minimum operation autonomy of the system in case of He supply cut, to 10 min instead of 5 min. 3. Design of the extension pipe for the safety devices shall be completed. This last point will need a tight collaboration with WP15 to integrate the proposed solution at the Tunnel/vertical core interface). 4. The conceptual mechanical design seems complete, but the technical details that still need to be finalized could become critical for the correct and successful assembly of the DFX “in situ” and in case of future required intervention for maintenance/repair. 5. The final diameter of the horizontal DFX vessel could probably be reduced and this will have a positive impact on the reduction of the total LHe volume of the system. 6. The final position of the plug must be fixed (it will also depend on the integration of the Cold Diode Box to be developped together with WP03).	1. & 2. Check of cryo functionalities (volumes, levels, etc.) by SOTON; 3. CERN to provde input on safety elements (elements, valves, etc.), SOTON to propose extension pipe routing; 4. SOTON to propose detailed solution, CERN to check intergrability; 5. Diameter to be defined by SOTON; 6. Updating of position of plug by CERN;	1.&2. Wendel/Yifeng; 3. Vittorio + Wendel/Yifeng; 4. Wendel/Yifeng + Robin; 5. Wendel/Yifeng; 6. Yann	Done. 1. Major redesign made by SOTON following CDR, requirements of "cryo fountain" defined in Functional Spec. --> see SOTON's presentation. 2. Done; 3. Done, integration impact in progress --> see presentation on safety; 4. Done. See DFX assembly steps by SOTON , and tunnel installation steps by CERN, and integration study by WP15. 5. and 6. New position of plug and horizontal section developed with WP03, plug now part of CDM under WP03.

Follow-up of CDR recommendations 2.

3	Finalize the mechanical design of the system/components optimizing aspects like: 1. Mountability: Number of components, welds feasibility and their QA/QC aspects, integration of ancillaries, required tooling. 2. Reliability: Minimize risk of leaks, optimize instrumentation integrity aspects. 3. Maintainability: Minimize the planned interventions on cryogenic and protection instrumentation sensors; for each expected intervention, check the availability of space (at completion of LS3 installations, this will be one of the most crowded regions of the LHC Tunnel). 4. Reparability: Check the existence of tooling (e.g. welds-cutting and welding machines) and allocated space for its utilization in case of inspections and minor repairs to be done in the Tunnel (ex. repair of instrumentations, repair of leaks, etc.). 5. It is recommended to further investigate the possible integration of the vacuum barrier on the top flange interface with the DSHX. This solution should bring advantages as minimization of acting forces eventually developed and a better vacuum sectorization between different elements of the system. 6. Interfaces of the DFS system seem to be correctly accounted for. 7. The electrical design, based on equipment already reviewed in other occasions (MgB2 conductor, bus bars, etc.) seems under control. The plugs and lambda-plates are developed starting from the LHC experience but a full re-qualification of design-components-processes is needed and is ongoing.	1., 2., 3., 4. Detailed design by SOTON and installation/integration checks by CERN; SOTON to propose the assembly sequece with tooling and CERN will check compatibility of space with cutting/welding machines. 5. Already discussed, formal confirmation of present solution; 6. IFS Vittorio to check with with Michele. 7. design on-going of electrical design and plugs by CERN	1.,2.,3. Wendel/Yifeng + Robin; 4. Robin; 5. Amalia; 7; SCD + Yann	Done. For 1. to 4. --->see SOTON's presentation. 5. Assessed and discussed with VSC: we remain on original proposal. 6. see proposal for IFS and instrumentation in presentations.7. See work progress in presentations.
4	Procurement plan for feedthroughs for voltage taps should be activated as soon as possible in synergy with other WPs that could have the same needs. This issue must be discussed at the Magnet Circuit Forum.	Provide input to SOTON for IFS feedthroughs. It is proposed to use the LHC type solution;	Vittorio+Yann	In progress. Instrumentation document ready (by J.Fleiter), IFS routing proposal studied (see presentations). Warm feedthroughs and connections are still in study (but not impacting DFX design); MCF meeting on topic still pending.

Follow-up of CDR recommendations 3.

5	A detailed analysis of the Installation and Repair/De-installation sequencing is essential to be developed in parallel to the DFX system design. This is due to the impact that the sequence of operations could have on the finalization of the mechanical design details. 1. Reparation of the MgB2/NbTi splices is today assumed as a mandatory design requirement for the DFX design (by SOTON) 2. The Review Committee is not convinced that this will be possible; a detailed study on the feasibility of this repair scenario in the Tunnel has to be done. 3. It is recommended to perform this study (considering the activation level expected, "in situ" vertical splicing assembly, etc.) and compare it with other more "destructive" repairing interventions. 4. In case an "in-situ" repair is unfeasible, or a more destructive scenario is necessary, this specific repairing case should not be considered as a mandatory requirement for the DFX design (as it is at present).	SOTON to propose an installation; CERN's input on machines. 1. ,2. 3., 4., CERN to study, based on concept SOTON the repair strategy up to the in-situ repair of the splices.	1.,2.,3.,4., Robin + Yann + Jerome	Done. See presentations from SOTON and CERN for assembly and tunnel environment. Tunnel installation study preliminary, definition of procedures, specific tooling will be studied in due time.
6	Since the DFX prototype will be firstly tested in SM18 and needed for the HL-LHC String program, WP16 Team should be informed of the DFX Technical Meetings outcome in order to check the compatibility of the design with the SM18 requirements and the studies for the String.	Present to WP16 the new vertical concept. Elaborate on feasibility in SM18.	Amalia	Done. WP16 has now a first integration of the cold powering system in the SM18. It confirms feasibility of integration. Study of installation still to be made.

Follow-up of CDR recommendations 4.

7	During the 1st assembly and test in SM18, a plan should be prepared to recreate conditions as similar as possible to the ones in the LHC Tunnel. In other words: use the DFX assembly activities in SM18 as a real assembly test of what will be done later in the Tunnel. This could provide valuable indications for optimization of the assembly procedures.	as per action 6.	as per action 6.	Still pending.
8	The Review Committee recommends to organize the next DFX review (DDR) only once the technical design report is completed. The interface between CERN and SOTON regarding development and approval of Manufacturing Drawings should be clarified.	CERN to orgnaise DDR. Wendel to come to CERN and integrate the design team of MME. Vittorio to clarify with Michele the understanding of the "technical design report".	Amalia for DDR; Yifeng+Vittorio with input from Robin for detailed design drawings.	Done. Even if these is no formal tech. design report (to be produced) we believe we have addressed most if not all of the design issues (to be assessed in this review). The Tech.Specification is now available.

Follow-up of CDR recommendations 5.

9	In order to keep a realistic prototype schedule, revise and analyse the procurement phases trying to identify eventual mitigation actions and back-up solutions.	SOTON	Yifeng	See proposal by SOTON in this review.
10	The strategy and policy for the DFX spares procurement and spare assembly in the tunnel should be better defined (e.g. availability of spares as individual components). The extreme boundary conditions in the LHC Tunnel imply that some “controlled dismounting” activities could probably be not feasible. Possible variants (due to R/L symmetry and IP1/5 slopes) must be properly incorporated within the spare policy.	SOTON+CERN	Yifeng+Vittorio	Still pending. R/L options will depend on finalization of detailed design. Spare policy will follow. Present baseline is still that the prototype is the spare.

Ongoing work

Design:

- DFX horizontal section, internal supports, bellows and accommodation of tunnel slope and transversal offset still to be detailed → see SOTON's presentations
- IFS integration in DFX (CERN model with SOTON only since 2 weeks) in progress
- MLI not seen at a detailed level (blankets, overlaps, assembly attachments, etc.) but with dedicated work this can be easily translated to detailed level
- Cryogenic lines and jumper connection to QXL, provisional proposals, but final configuration still to be rubber-stamped (thermal shield return line through DCM ? DFX specific lines connection to QXL through flexible, detailed design still pending). Not considered to be a show-stoppers.

Integration:

- Integration of latest model from SOTON very recent (last week), this is work in progress → see presentation of WP15 (Marian Amparo)
- Provisionally no show stopper (but reviewers to say!) but many points to be checked and fine tuned (e.g. final position under shaft, matching tunnel slope, space sharing with other equipment, accessibility to safety devices, deflector, etc.)

Assembly in Industry, in SM18 and in tunnel:

- Provisional sequence of assy, including QC provisions (see SOTON) compatible with tunnel assembly, but space limitations will be very constraining for this type of work. (This is an intrinsic drawback of the vertical DFX design, but acceptable considering the advantages for the MgB2 cable system)
- The tunnel installation still needs to be studied, including specific tooling, and QC devices (e.g. clam-shell for leak detection), but we have not identified show-stoppers;
- → see presentations for more details

Looking forward to your wise feedback !

Thank you !

Q/A ?