DISCUSSION

Interfaces & To-Do's

Silvia Verdú-Andrés – Brookhaven National Laboratory

9th HL-LHC Collaboration Meeting | FNAL, 14-16 October 2019

Why defining interfaces is so important?

Plenty of motivations:

1) Procure device that is **safe, fully integrated, and functional** into LHC

2) Define **exchange of useful and necessary** (safety docs) **information,** how it gets validated, delivered.

3) Correct definition of some interfaces is critical; defines **responsibilities of each entity** (e.g. flange drawings, delivery status of cavity)

4) **Single location for all the project documentation on** physical and data **interfaces between entities**

5) Part of the documents **requested by DOE**
(FRS, Acc. Criteria, Acc. Plan, ICD)

When do we need to fix interfaces?

UPCOMING REVIEWS…		WHAT IS EXPECTED
Jan. 2020	*DOE Progress Review*	• Show **progress in drawings and documents**
Jun. 2020	*HL-AUP Final Design Review for Dressed Cavities (90% design complete)*	• **FRS revision** • **Final Design Report** (prep. by AUP), incl. finalized designs, drawings, tuning strategy, multi-physics analysis • **Shipping specs** • Defend mech. design by CERN (CERN representative needed)
Aug. 2020	*DOE CD-3 Review*	Finalized & Approved by AUP/CERN: • **Int. Cont. Doc. (ICD)** • **Acceptance Criteria** • Acceptance Plan • Parts from/to AUP/CERN

* TRIUMF's schedule aligns well with the AUP schedule: interfaces to be defined for Gate 2 (Feb. 2020)

What remains to be defined?

Item	WBS 302.3.01 Provides	WP4 Provides	Reference Documents, Drawings, etc.
Functional Specifications	N/A	Functional Specifications	Functional Specification [EDMS 1806220 v1.0 (US-HiLumi-doc-294)]
Functional Specification Drawings		Functional Specification Drawings	Func. Spec. Drawings: LHCACFCA0002 v.AE, LHCACFHC0219 v.0, LHCACFHC0141 v.0, LHCACFHC0210 v.0, LHCACFHC0151 v.0, cold H-shield, He tank
			Engineering Specification [EDMS 1389669 v2.5 §4.1.4.8]
Engineering Specifications	N/A	Engineering Specifications	Engineering Specification [EDMS 1389669 v2.5]
Compliance with Pressure Equipment Directive (PED 2014/68/EU) – Essential Safety Requirements for RF Dressed Cavities	N/A	Compliance with Pressure Equipment Directive (PED 2014/68/EU) – Essential Safety Requirements for RF Dressed Cavities	Guideline for compliance with CERN safety requirements for dressed cavities [EDMS 2058183 v0.3]

1) Updated, awaiting approval (Leonardo/Paolo): Func. Spec. (**due end 2019)**
2) To be discussed (Manuele): Func. Spec. Draw. for bare cavity (~**Feb'20)**
   2.1.) Define metrology map
3) To be reviewed (Suba/Zenghai): Func. Spec. Draw. for RF ancillaries (**~Feb'20)**
4) To be done (CERN): Func. Spec. Draw. for cold H-shield, He tank, and related
5) New version ongoing (Luca/Nuria): Eng. Spec. (**due by early 2020**)

1) Func. Req. Spec.

STATUS *New version ongoing*

TO BE READY BY **(end 2019)**

To be discussed:

- Dynamic heat load = 10 W incl. FPC and HOM couplers

  Already specified in Eng. Spec., but FDR requires footnote (reviewers inquired about this topic before).

- 1.5 W spec for 400 MHz power ”leakage”: too restrictive

Awaiting approval:

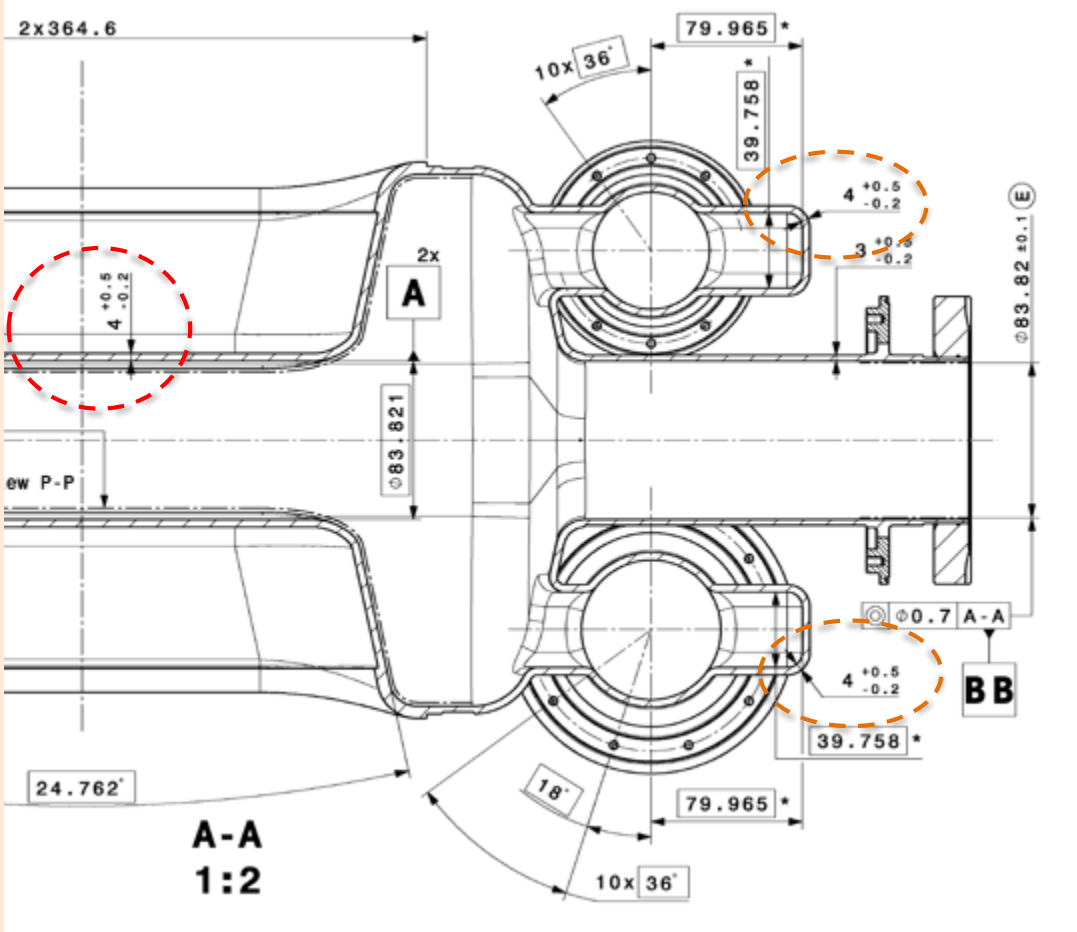
- Highlighted in yellow

RF and Performance Requirements		
R-T-01	F (Resonant Frequency at 2 K)	400.790 ± 0.15 MHz
R-T-02	Elastic Tuning Range	>=±150 kHz
R-T-03	V_T (Deflecting Voltage)* at 2 K	≥ 4.1 MV
R-T-04	P_{dyn} (Dynamic Heat Load at 2 K and 4.1 MV)	≤ 10 W
R-T-05	Q_0 (Quality Factor at 2 K and 4.1 MV)**	≥ 3.9 10^9
R-T-06	LFD (Lorentz Force Detuning Coefficient)	≤ 865 Hz/MV^2
R-T-07	dF/dp (Sensitivity to Liq. pressure fluctuations)	≤ 300 Hz/mbar
R-T-08	Pole Symmetry (Electrical Center deviation)	≤ 0.8 mm
R-T-09	HOM Filters Output Power (at 400.79 ± 0.1 MHz)	≤ 1.5 W
R-T-10	Frequency of the HOM around 760 MHz***	f_{760} <756.52 MHz or f_{760} > 766.52 MHz
R-T-11	HHOM filters need to be able to effectively pass through all HOMs.	Transmission curve deviate by less than -3dB compared to the theoretical curve
R-T-12	HOMs impedance threshold	The impedance threshold is 1MOhm/m up to 2GHz
R-T-13	Magnetic Field value at the cavity, Nb outer surface and minimum reduction factor K=B_{out}/B_{in}	1 μT and K>10
Physical Requirements		
R-P-01	Beam Aperture	84 ± 3 mm
R-P-02	Maximum Envelope	R ≤ 145 mm
R-P-03	Fundamental Power Coupler Port	D = 62 ± 0.5 mm
R-P-04	Maximum Weight of fully dressed cavity	<450 lbs
Cryogenic and Transportation Requirements		
R-C-01	Operating Temperature	2 K
R-C-02	Maximum Working (Nominal Operating) Pressure	2.1 (1.8) bar absolute
R-C-03	Shipping: cavities and all ancillaries should withstand the maximum allowable acceleration during shipping	10G

US HL-LHC AUP

2) Func. Spec. Drawing(s!)

MODIFICATIONS	RESULT OF	STATUS
Increase tolerance band for corners of H-HOM waveguide box	Too tight, cannot reproduce in fab	*Released; may need modification*



TO BE READY BY……. **(~Feb'20)**

5) Engineering Specifications

MODIFICATIONS	RESULT OF	STATUS
Lowest HOM frequency	DQW Team	*Awaiting approval*
Include 3D models as document requirements		*Awaiting approval*
Shipping requirements		*Awaiting approval*
Fundamental power leakage (1.5 W)		*To be implemented*
Qual. of HOM couplers in bench: 3 dB on S21 implies x2 (up or down) on impedance		*To be discussed*
RF coax cable spec to be included (e.g. power going out from each coupler into RF coax cable)		*To be discussed*
TO BE READY BY……		**(~Feb'20)**

Acceptance Criteria	Acceptance Criteria	Acceptance Report	RFD Dressed Cavity Acceptance Criteria [EDMS XXXXXXX v0.c (US-HiLumi-doc-1154)]
Acceptance Plan	Acceptance Plan	Signed Acceptance Plan	Acceptance Plan [EDMS XXXXXX (US-HiLumi-doc-XXX)]

4) Frozen, to be discussed (Paolo): Acceptance Criteria (**due by DOE Review, Jun.'20**)
5) Drafted: Acceptance Plan (**due by DOE Review, Jun.'20**)

4) Acceptance Criteria

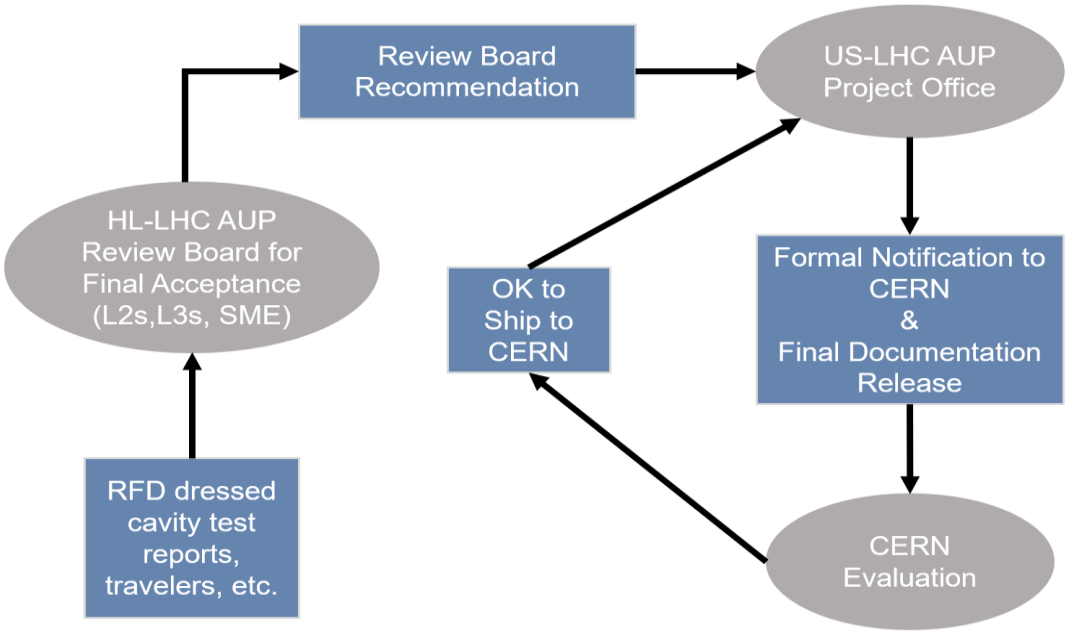
MODIFICATIONS		STATUS
Spec for H-field in test Dewar?	FNAL Director's Review CD-2	*To be discussed*
Qual. test of jacketed cavity: need to state tuner situation		*To be discussed*
Define test probes, setups		*To be discussed*
Qual. test of HOM filters		*To be discussed*
25 Ohm feedthrough HOM filter testing: identify strategy, hardware, limitations		*To be discussed*
TO BE READY BY……		**DOE Rev(Jun'20)**

5) Acceptance Plan [US-HiLumi-doc-1744]

STATUS *Drafted, did CERN approve?*

TO BE READY BY **DOE Rev(Jun'20)**

- To be signed by CERN and AUP management.
- Draft using example from magnets (US-HiLumi-doc-1148**,** about 4 pages). Contents:
  1. Acceptance process (see diagram)
     a. Review board for final acceptance
     b. Acceptance by FNAL of CERN supplied components
        (under discussion: Ti/SS transition tubes, cold H-shield)
     c. Receipt at CERN
  2. Acceptance criteria before shipment
  3. Acceptance criteria after arrival at CERN



RFD Cavity Electromagnetic Design (cavity, HOM dampers, RF pickup)	RF analysis results, 3D model (vacuum) for cavity and RF ancillaries	Acceptance Report	Functional Specification [EDMS 1806220 v1.0 (US-HiLumi-doc-294)] RFD Cavity 3D model (RF volume) [EDMS 2009911 v.2] RFD Dressed Cavities Conceptual Design Report [EDMS XXXXXXX (US-HiLumi-doc-164)] update as design report
Dressed RFD Cavity Analysis	Calculation Reports (LFD analysis, df/dP analysis, tuning)	Calculation Reports (structural analysis) according to safety requirements	Guidance for compliance with CERN safety requirements for dressed cavities [EDMS 2058183 v0.3] Engineering Specification [EDMS 1389669 v2.5] RFD Dressed Cavities Conceptual Design Report [EDMS XXXXXXX (US-HiLumi-doc-164)] update as calculation report

6) To be updated: FDR with latest EM design (**due by Jun'20**)
7) To be updated: FDR with calculation report or links to reports (**due by Jun'20**)
   - Incl. tuning strategy (Suba/Kurt): pre-loaded tuner, tuning range, etc.
   - Incl. contribution from (CERN) about multi-physics studies

Dressed RFD Cavity Design and Layout	N/A	Detailed drawings of assembly layout with all components in the dressed prototype RFD Cavity (internal magnetic shield, second beam pipe, instrumentation adaptors, etc.) and its status	Drawing of assembly layout with interfaces, incl. weight, components and features name, material, main dimensions [EDMS XXXXXX (US-HiLumi-doc-XXX)]
			Drawing of assembly status for delivery to CERN [EDMS XXXXXX (US-HiLumi-doc-XXX)]
			RFD Cavity 3D model (mech. volume) [EDMS XXXXXXXX]
			Engineering Specification [EDMS 1389669 v2.5]

8) To be drafted (???): drawing with assembly layout incl. interfaces, parts, etc. (**due end 2019**)
9) To be drafted (???): drawing with assembly as delivered (see next slide)
   - Incl. TRIUMF in discussion
10) Location???: RFD Cavity 3D model

9) The AUP deliverable

MODIFICATIONS	STATUS
1) What AUP builds + documentation	
Ti/SS interface (CERN or AUP)	*To be confirmed*
Bellows (AUP)	*To be confirmed*
2) Status in which AUP delivers to TRIUMF • The delivery includes: bare cavity under vacuum, cold H-shield, He tank, RF ancillaries, input probe, right-angle valve and burst disk ready for cold RF test, protected openings and bellows for tuning system, Ti-SS tubes. • Exploded view to identify by color who provides design and who provides fabricated item.	
Protective caps for transportation: HOM ceramic, bellows, second beam pipe, Ti/SS transition.	*To be discussed*
Protective caps for HOM ceramic of dressed cavity in cold test (ceramic exposed to helium, not vacuum)	*To be discussed*
RF pickup assembled to cavity for delivery	*To be discussed*
TO BE READY BY……	**FDR (Jun'20)**

RFD Cavity List of Materials	RFD Cavity List of Materials	Signature on "RFD Cavity List of Materials"	RFD Bare Cavity Material List [EDMS 2001102 v2.0 (US-HiLumi-doc-668, v8)]
			Material List for other parts like tank?
			Engineering Specification [EDMS 1389669 v2.5]
RF Ancillaries List of Materials	RF Ancillaries List of Materials	Signature on "RF Ancillaries List of Materials"	RFD RF Ancillaries Material List [EDMS XXXXXX (US-HiLumi-doc-XXX)]
			Engineering Specification [EDMS 1389669 v2.5]
Parts exchange between US HL-LHC AUP and CERN HL-LHC WP4	Parts exchange between US HL-LHC AUP and CERN HL-LHC WP4	Signature on "Parts exchange between US HL-LHC AUP and CERN HL-LHC WP4"	Parts exchange between US HL-LHC AUP and CERN HL-LHC WP4 [EDMS XXXXXX (US-HiLumi-doc-XXX)]

11) To be drafted: material list for other parts of deliverable (**due by Jun'20**)
12) To be drafted: material list for RF ancillaries (**due by Jun'20**)
13) To be drafted: parts exchange between AUP-CERN (see next slide)

13) Parts exchanged between US HL-LHC AUP & CERN HL-LHC WP4

STATUS	*Does not exist yet*
TO BE READY BY	**DOE Rev(Jun'20)**

- To be signed by CERN and AUP management.
- Draft using example from magnets (US-HiLumi Document 844**,** about 3 pages). Contents:
  1. Parts expected from CERN
  2. Parts expected from AUP
  3. Balance

MIP	Detailed Manufacturing and Inspection Plan	Acceptance Report (before cavity manufacturing)	Guideline for compliance with CERN safety requirements for dressed cavities [EDMS 2058183 v0.3]
			Engineering Specification [EDMS 1389669 v2.5] §15
			MIP

14) Status, location? (Manuele/ Paolo, Nuria): MIP (**due by Jun'20**)
- Is it shared across the two teams? MTF should come in parallel
- Status of associated procedures:
  - Visual inspection, surface treatment, tuning strategy
- QA/QC for cold H-shield (see next slide)

4) General MIP

MODIFICATIONS	RESULT OF	STATUS
"Bare cavity"		*CERN – AUP Needs to converge*
TO BE READY BY……		**FDR (Feb'20)**
"*Cold H-shield – QA/QC steps"*	[Some required by 1389669; others added by AUP. See also N. Templeton, Review 2017.]	*Discuss and add to general MIP*
Material qual. tests		
Dim. controls		
Inspection of parts		
Mock assembly		
RT H-field measurement		
Repeat if travelling		
Check magnetic permeability prior to assembly (Cryphy demagnetizes with shock)		
TO BE READY BY……		**DOE Rev(Jun'20)**

Packaging, shipping and shipping restraint	Packed dressed RFD cavity according to shipping agreements with CERN and Acceptance Plan	Approval to ship	Engineering Specification [EDMS 1389669 v2.5]
			Shipping requirements [EDMS XXXXXX (US-HiLumi-doc-XXX)]
			Shipping specifications [EDMS XXXXXX (US-HiLumi-doc-XXX)]
			Shipping frame and restraints drawings, location of protective covers, procedure for loading and unloading, spec for type and location of sensors

15) To be drafted: Shipping specifications with drawing of fixtures, instrumentation (**due by Feb'20**)

Item	WBS 302.3.02 Provides	WP4 Provides	Reference Documents, Drawings, etc.
Raw material coupons (Nb)	Raw material coupons (Nb)	Acknowledgement of Reception	Engineering Specification [EDMS 1389669 v2.5 §4.1.3]
Welding and brazing samples	Welding and brazing samples for most critical joints	Acknowledgement of Reception	Engineering Specification [EDMS 1389669 v2.5 §4.2.6.7 + 4.2.7.6]
Bellows samples	Bellows samples	Acknowledgement of Reception	Engineering Specification [EDMS 1389669 v2.5 §8.4.3]
Cold magnetic shield	Acknowledgement of Reception	Cold magnetic shield (might be provided by AUP)	Engineering Specification [EDMS 1389669 v2.5]
			Manipulation procedure
Ti-SS transition	Acknowledgement of Reception	Ti-SS transition (might be provided by AUP)	Engineering Specification [EDMS 1389669 v2.5]

16) Determine provider of cold H-shield

17) To be drafted: Handling Procedure for cold H-shield

18) Determine provider of Ti/SS transition

General Observations / Questions

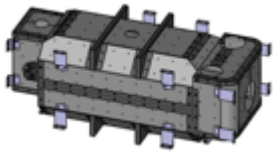
1) Reviewers asked about how we make sure that changes to interfaces are understood and agreed by both parts.
   - Which is the protocol to follow and which document describes such protocol?
2) Some CERN docs (Eng. Spec., Guidance for compliance with CERN safety…) are not uploaded in DocDB.
3) Prepared matrix with data interfaces per item … Nuria/Luca need to provide feedback to Silvia
4) ICD to be ready by CD-3 review
5) Make sure versions are up to date

Backup

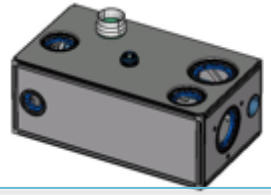
9) The AUP deliverable

Bare cavity

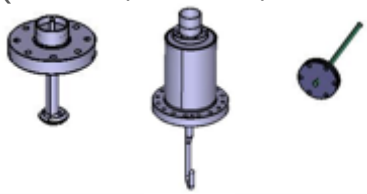
H-shield

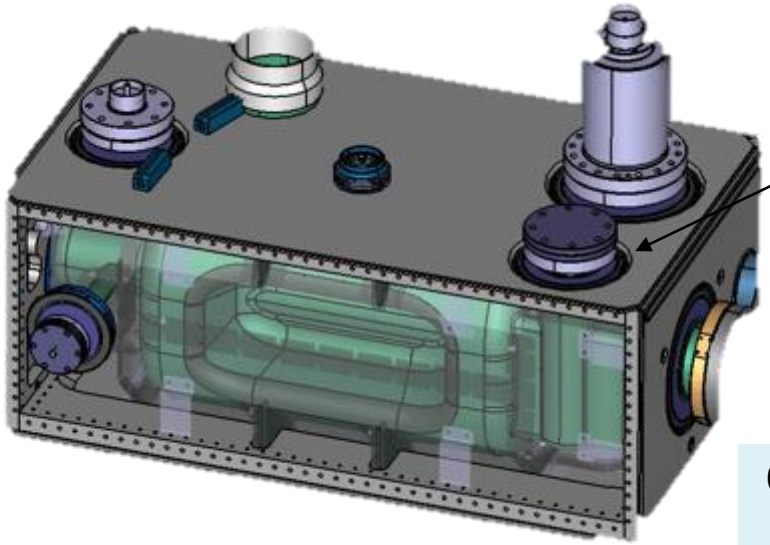


He tank



RF ancillaries
(VHOM, HHOM, Pickup)





0.53 m (W) x 0.61 m (H) x 1.18 m (L)
Weight: 195 kg

- Ship cavity **under vacuum**, **equipped** with input probe, right-angle valve and burst disk **ready for cold RF test;** protect openings.
- The delivery **also includes**: raw material coupons, welding/brazing samples, second beam pipe, two (2) cryoline tubes, two (2) tuning system bellows, mounting holes for various purposes.
- *Learned from dressed DQW cavity cold test*: **cracked feedthrough ceramics exposed to LHe**. **Strategy** to avoid damage is **under discussion**.

Documents across the collaboration: not full correspondence, not full overlap

WP4	AUP
Functional Spec. Dressed RFD Cavities, EDMS No. 1806220	Func. Req. Spec. (FRS)
Eng. Spec. Dressed Bulk Niobium Radio-Frequency Crab Cavities, EDMS No. 1389669	Acceptance Criteria: Overlaps with Eng. Spec., but requires more detailed definition of tests.
Guideline For Compliance With CERN Safety Requirements For Dressed Cavities, EDMS No. 2058183	Acceptance Plan: Some overlap with Eng. Spec., Upload docs in EDMS, MTF, hold point in MTF when all docs are uploaded and have green light; automatic email sent to AUP confirming acceptance and inviting to deliver. What about high-level management approval docs?
HL-LHC Quality Plan, EDMS No. 1513591	Interface Control Document (ICD): CERN will have an ICD that applies to all the partners.

DOCUMENT	DESCRIPTION
Acceptance Criteria	*Describes tests, measurements, or design studies required to decide if deliverable is qualified to be delivered to CERN*
Acceptance Plan	*Describes formalisms between entities for exchange of information, approvals, acknowledgements*
Interface Control Document	*Lists all interfaces (physical, data) between entities and points at documents describing them*

Data interfaces per item (I)

	Documentation required per item as indicated in Eng Spec (EDMS No. 1389669, V.2.5)	Bare Cavities	Beam Pipe	Cold H-Shield	Ti-SS Transition	Ti Bellows	Jacketed Cavities	HOM Couplers	Pickup Antenna	Dressed Cavities	GENERAL
1	Material Certificates										14.2
2	Manufacturing and Inspection Plan					8.5					14.2
3	Fabrication Procedures (incl. heat treat, HWPR, Chem Poli, Leak Test, Pressure Test)										14.3
4	Brazing Procedure										14.3
5	Material Traceability Records	4.1.3	5.1.2	6.1.2	7.2	8.5	10.1.2, 10.2	11.2	12.2		
6	Manufacturing Drawings of Item	4.1.4.8	5.1.3	6.1.5			10.1.4	11.3.2	12.3.2		
7	Manufacturing Drawings for Tooling	4.1.4.8						11.3.2	12.3.2		
8	3D Models	4.1.4.8						11.3.2	12.3.2		
9	Calculation Report (RF, Mech, etc.)	4.1.4	5.1.3	6.1.3		8.5	10.1.3	11.3.1	12.3.1		
10	Welding / Brazing Book	4.2, 4.3	5.2.3, 5.2.5.2			8.5	10.2.6, 10.3	11.5	12.4, 12.5		
11	NDT Report	4.2, 4.3	5.2.3, 5.2.5.2				10.2.6, 10.3	11.5	12.4, 12.5		
12	Heat Treatment Report	4.2.8.2						11.4.7	12.4*		
13	BCP Reports	4.2.8.1						11.4.7	12.4*		
14	Final Leak Test	4.3.5	5.3.4		7.3	8.5	10.3.4	11.5.7	12.4	13.2.1	
15	RGA Analysis Report	4.3.6	5.3.5				10.3.5			13.2.2	
16	Final Metrology	4.3.1	5.3.1	6.3.2			10.3.1	11.5.1	12.4		
17	Thickness Report (after chemical treatment)	4.3.1									
18	Warm Test Report	4.3.7.1					10.3.7.1	11.5.9	12.5.1	13.2.3.1	
19	Cold Test Report	4.3.7.2					10.3.7.2	13.2.3	13.2.3	13.2.3	
20	Temperature Profile Measurement Report			6.2.2							
21	Reduction Factor Measurement Report			6.3.4							
22	Qualification Report				7.3						
23	UT Report				7.3						
24	Metallographic Report				7.3						
						8.5					
						8.5					
								11.5.9			
32	Calculation Report Post-Test (HOM power)									13.2.3.3	
33	Test Procedures										14.4
34	Non-Conformity Reports										14.4
35	Transport and Handling Instructions										17
36	Compliance Verification (Formal clearance for installation in the LHC according to Inspection and Test Plan)										19

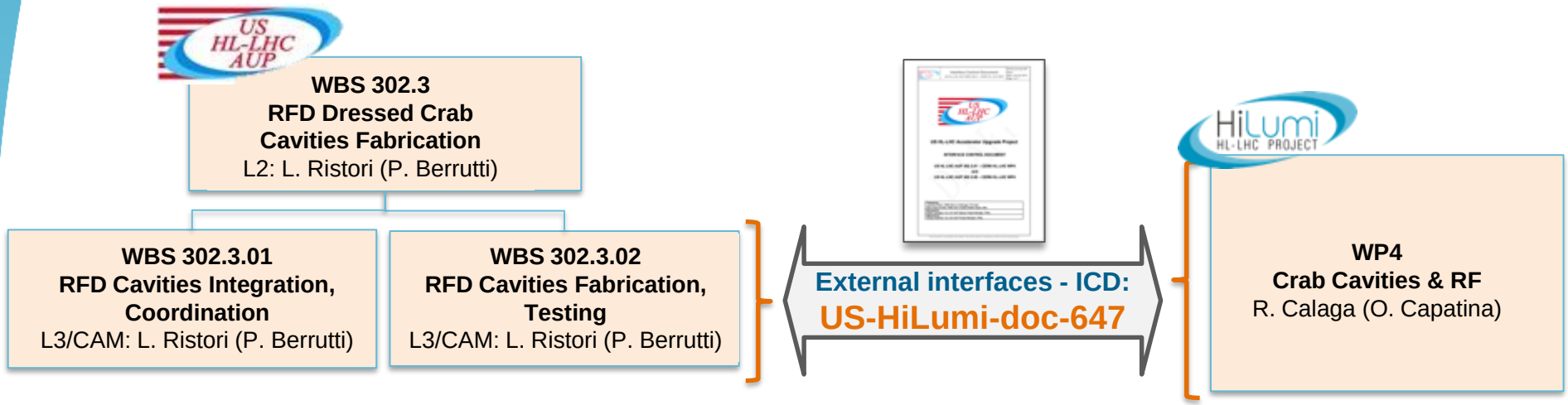
Feedback from Luca / Nuria on interfaces table: gather all corresponding tests under Non-Destructive Tests category

Data interfaces per item (II)

	Additional documentation exchange between CERN and AUP		
37	Func Spec		
38	Engineering Spec		
39	Func Spec Drawing		
40	Compliancewith Pressur Equipmeent Directive		
41	Acceptance Criteria		
42	Design of AUP Deliverable and Assembly Layout		
43	List of Materials for Cavity		
44	List of Materials for RF ancillaries		
45	List of parts from and to CERN		
46	Handover Report		
47	Handoff Report		
48	Safety documentation		
49	Transport Documentation		
50	Handover Inspection Resolution		
51	Acceptance Report		

ICD for external interfaces

- The **ICD for external interfaces** (US-HiLumi-doc-647) defines **technical interfaces (**physical and data), between **AUP** and **CERN WP4**:



STATUS – *Preliminary version ready*

- Preliminary = interfaces identified, not necessarily fully defined (acceptable level of completeness for CD-2)
- Reviewed by AUP interface manager
- Received feedback from CERN
- Working with CERN to compile files (documents, drawings, procedures, etc.) relevant to different interface control items.

As presented in DOE CD-2 Review

ICD for external interfaces

1. Introduction

This Interface Control Document (ICD) provides complete information about the **technical interfaces between** the **US HL-LHC AUP WBS 302.3 and** the **CERN HL-LHC WP4** entities named below. This document is for **external interfaces only** with CERN. Internal interfaces are defined in Ref. [US-HiLumi-doc-1702]. This ICD contains two tables: Table 1 – Physical Interfaces and Table 2 – Data Interfaces. Physical Interfaces include the flow of materials from one WBS entity to a CERN Work Package (WP), while Data Interfaces include the flow of data and documentation from a WBS entity to a CERN WP.

This document represents interfaces between the following two pairs of entities:

US HL-LHC AUP	CERN HL-LHC
WBS 302.3.01 RFD Cavities Design, Integration and Coordination	WP4 Crab cavities and RF
WBS 302.3.02 RFD Cavities Fabrication and Testing	WP4 Crab cavities and RF

Pair of entities for which interfaces are specified in the document

2. ICD Approval

Electronic signature is required by the following personnel:

US HL-LHC AUP	CERN HL-LHC
WBS 302.3.01 L3 Manager WBS 302.3.02 L3 Manager WBS 302.3 L2 Manager WBS Manager	WP4 Manager Deputy WP4 Manager
Project Management Office	Project Management Office
Deputy Project Manager	Deputy Project Manager
Project Manager	Project Manager

Chain of approval

Minutes – Meeting on Interfaces June 2019

- Most critical interface: the AUP delivery conditions.
  - Delivery conditions not specified yet.
  - The delivery includes: bare cavity, cold H-shield, He tank, RF ancillaries, input probe, right-angle valve and burst disk ready for cold RF test, protected openings and bellows for tuning system, Ti-SS tubes.
- CERN/UK provides cold H-shield (design); AUP will fabricate.
- Need to discuss some specifics for AUP delivery conditions:
  - Which pickup antenna installed in AUP delivery: cold RF test probe, LHC-type antenna?
  - Will the HOM feedthroughs be protected for cold RF testing of dressed RFD cavity in VTA?
- Luca provided feedback on current document:
  - Add bellows samples to physical interfaces (AUP → CERN)
  - Add cold H-shield to physical interfaces (CERN → AUP)
  - Ti-SS tubes might be provided by CERN (depends if fab is possible in AUP) To be confirmed.
- One of the documents related to shipping is the spec for sensor and accelerometer locations
- Try to use same nomenclature for documents / procedures in Acceptance Plan and in External ICD. For example: “Approval to ship” is equal to “Full Acceptance Plan Compliance”.
- Documents that need to be prepared for early Spring 2020 (before DOE CD-3 Review):
  - Drawing that defines AUP delivery conditions (incl. vacuum status)
  - Transport procedure (based on studies conducted by Kurt and Eric)
  - Update RFD Func Spec to include G that AUP deliverable has to withstand during transportation.
- In External ICD, color code who is responsible for each interface
- MTF filled along with the fabrication; it is a checkoff list of steps thar records approvals, non-compliances, etc.