Science and Technology Facilities Council

RFD Prototype: Assembly lessons learned

12th HL-LHC Collaboration Meeting

21/09/2022

Edward Jordan

Mechanical Project Engineer

Science and Technology Facilities Council

Progress to Date

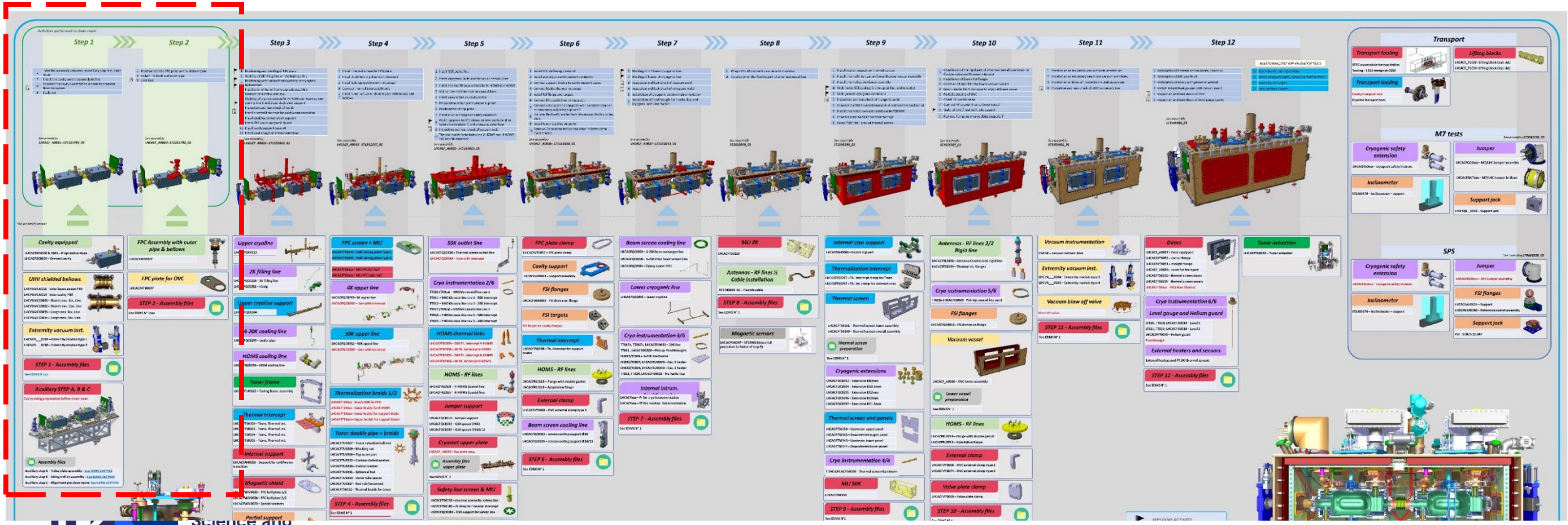
21/09/2022

Auxiliary STEP A, B, C, D: ☑

STEP 1: ☑

STEP 2: ☑

String Cleanroom Assembly



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Progress to Date

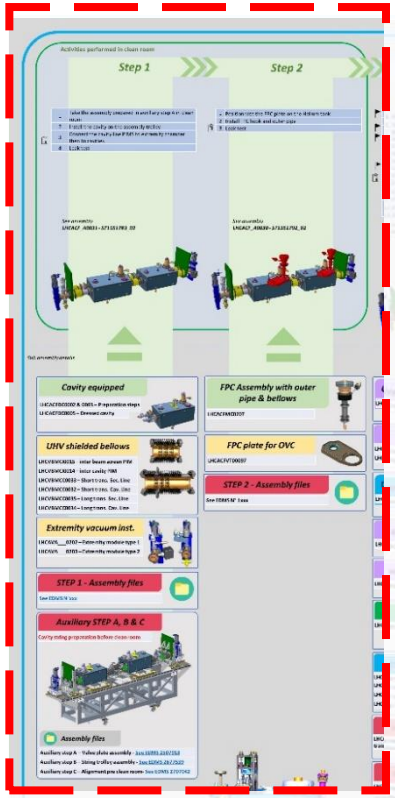
21/09/2022

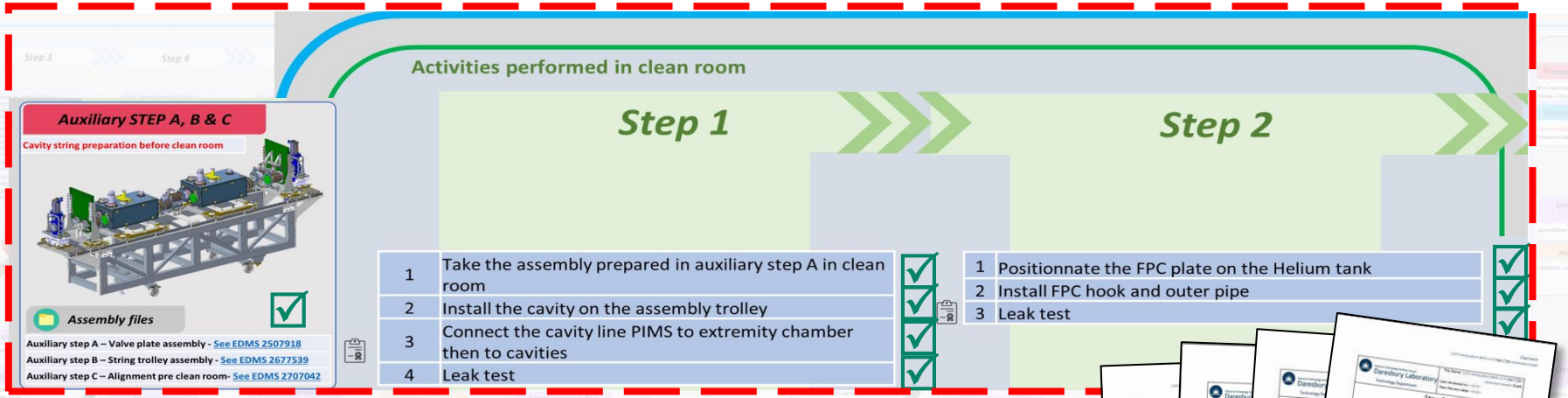
Auxiliary A, B, C, D: ☑

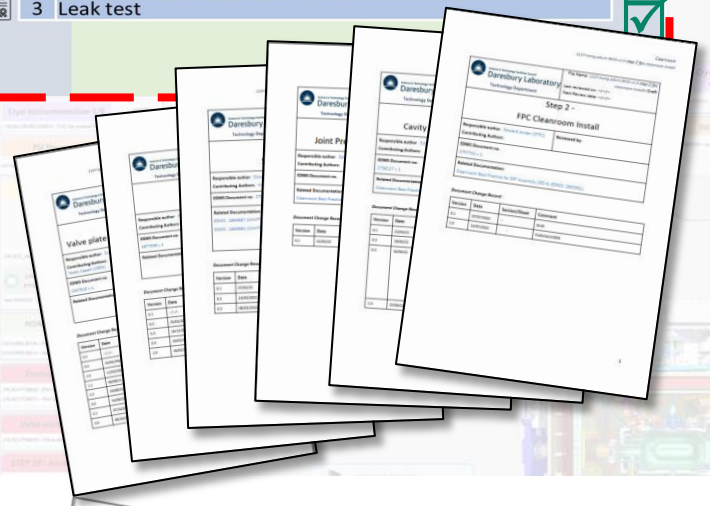
STEP 1: ☑

STEP 2: ☑

String Cleanroom Assembly







Auxiliary Step A	–	EDMS: 2507918
Auxiliary Step B	–	EDMS: 2677539
Auxiliary Step C	–	EDMS: 2707042
Auxiliary Step D	–	EDMS: 2731628
Step 1	–	EDMS: 2736227
Step 2	–	EDMS: 2757741

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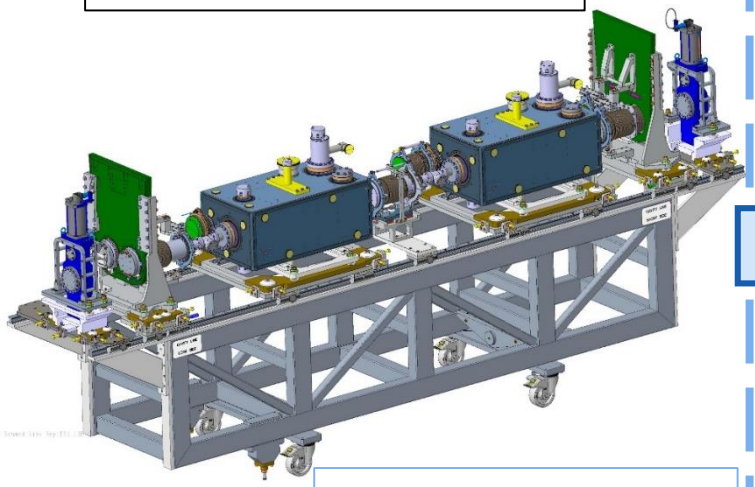
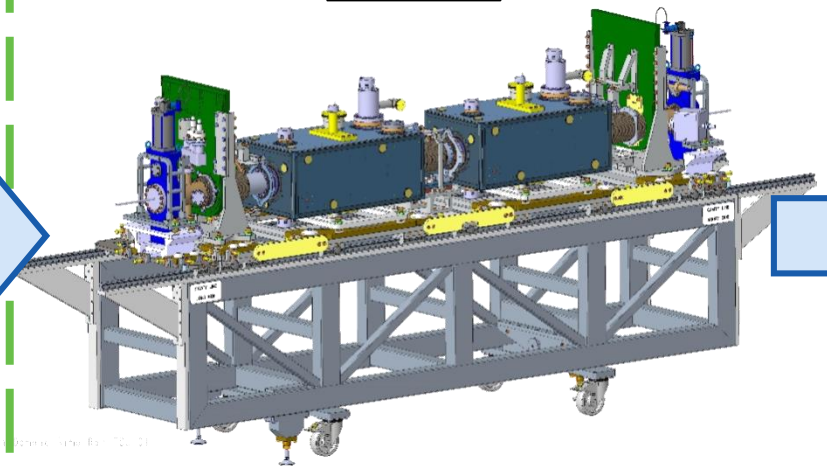
Auxiliary Steps A,B,C,D

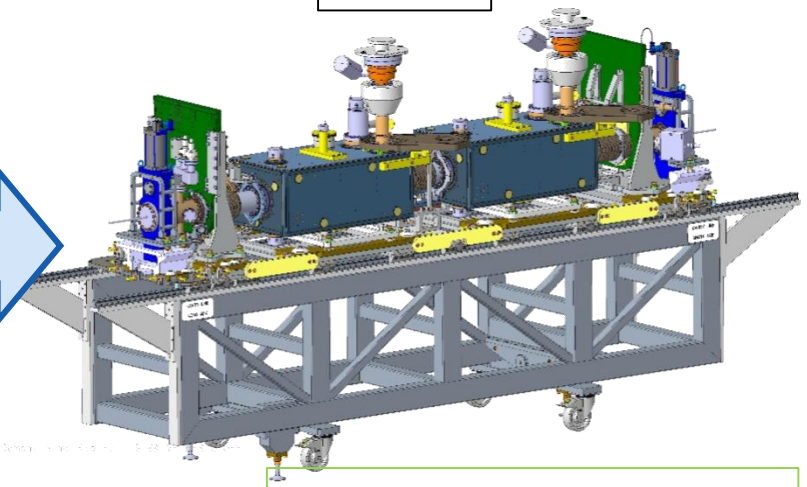


Outside Cleanroom

STEP 1



STEP 2



Inside Cleanroom (ISO4)

String on Trolley (pre-cleanroom aligned)

PIMS + Cavities cavity line Joints made (Cleanroom ISO4)

FPC installed to cavity x2 (Cleanroom ISO4)

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Engineering challenges

Challenge #1

Complexity of design

Challenge #2

Studs on Cavity String Joints

Challenge #3

Scheduling

Engineering challenges

Challenge #1

Complexity of design

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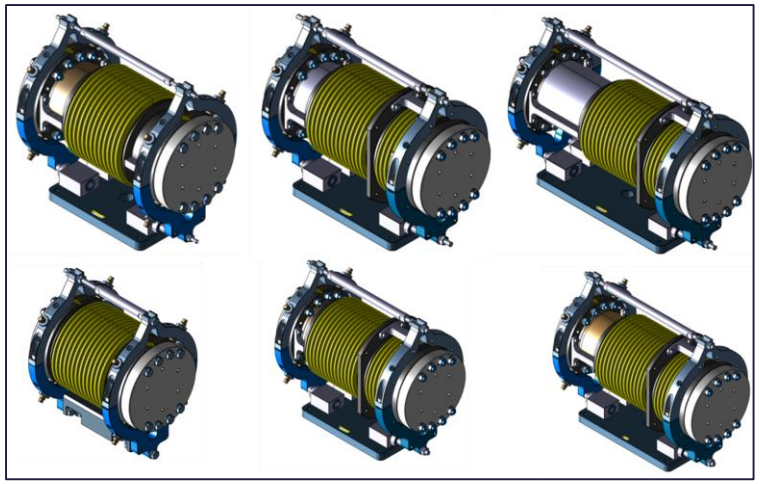
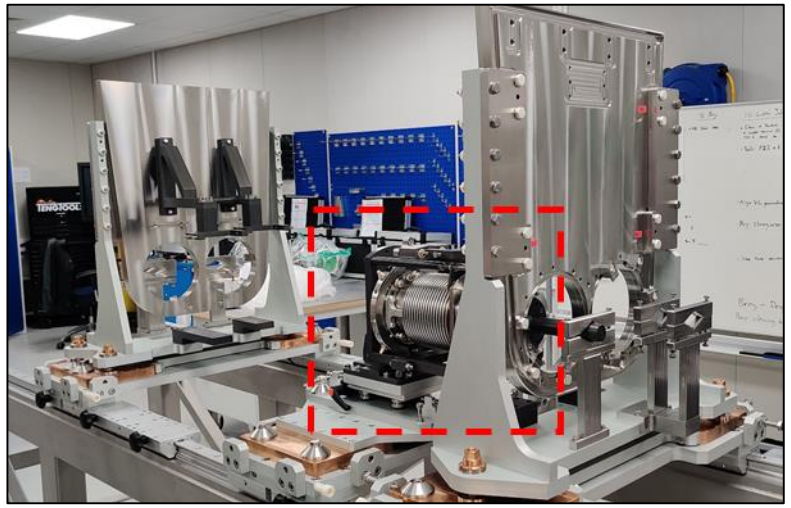
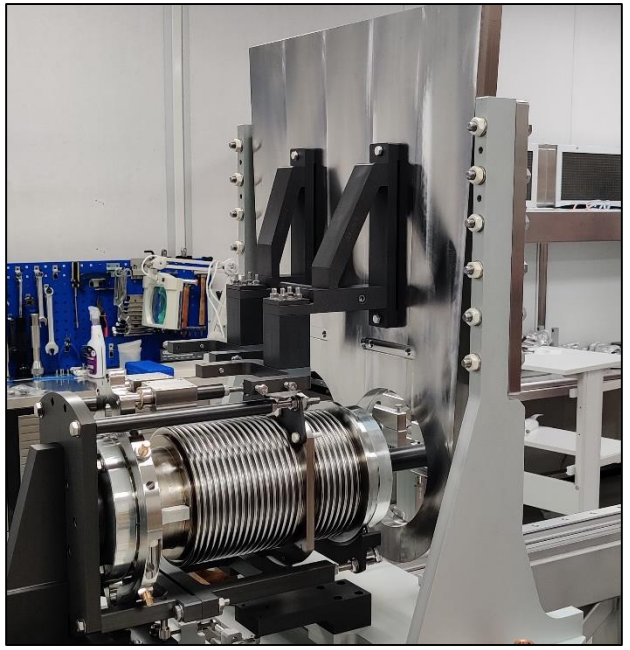
Challenge #1

Complexity of design

- Auxiliary Steps ABCD comprises 200+ discrete steps
- Over 400 unique components
- Easy to confuse items with one another







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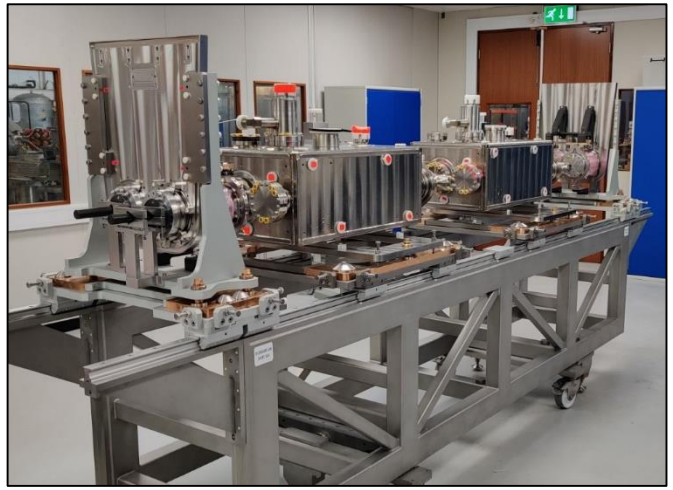
6x Plug in Modules (PIMS)

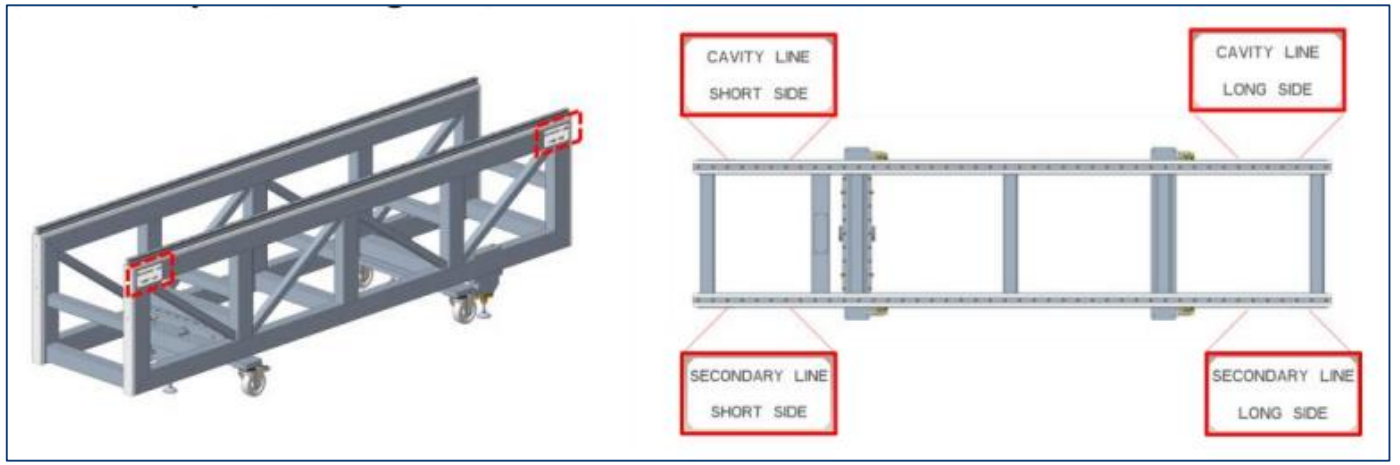
- Each unique position and orientation captured correctly

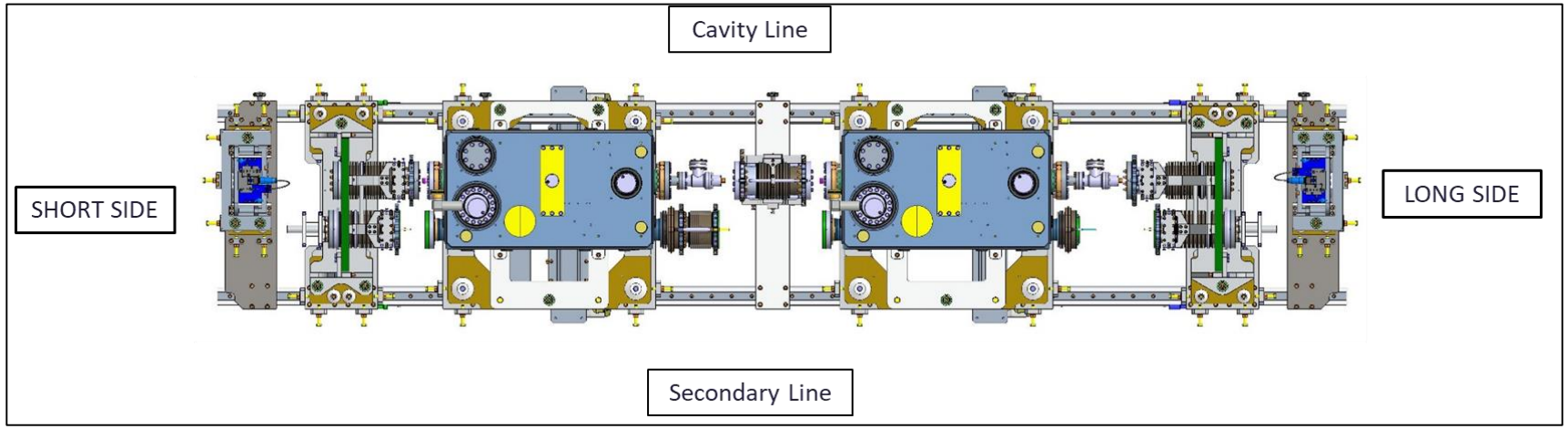
Challenge #1

Complexity of design

- Ensure common nomenclature observed throughout







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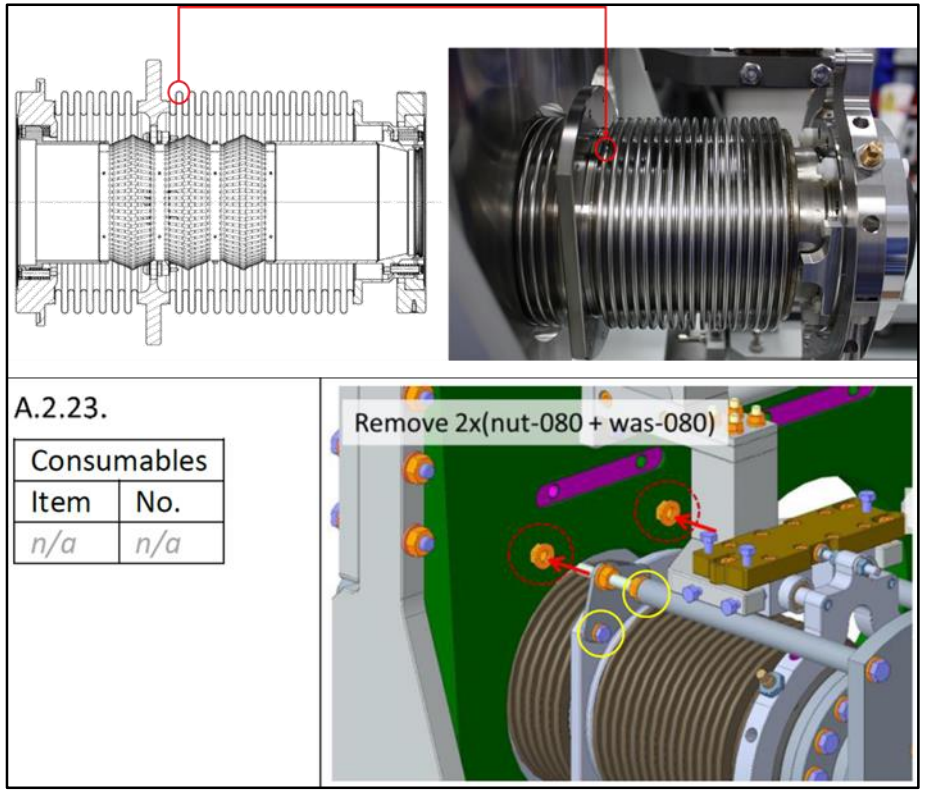
Challenge #1

Complexity of design

RFD Short CW Transition LHCVBMCC0033 Dent | **LHC-ACFVW-QN-0001**

- Error during assembly led to a dent on the secondary line CWT,
- Highlighted the need to follow assembly procedures carefully,
- Non-conformance is to be closed once secondary line vacuum integrity has been demonstrated, (coming weeks)



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Engineering challenges

Challenge #1

Complexity of design

Challenge #2

Studs on Cavity String Joints

Challenge #3

Scheduling

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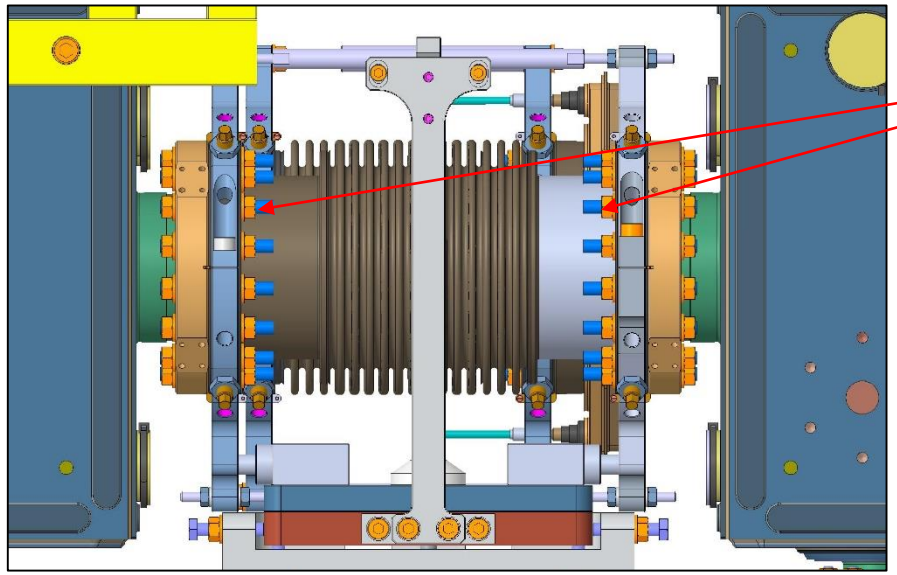
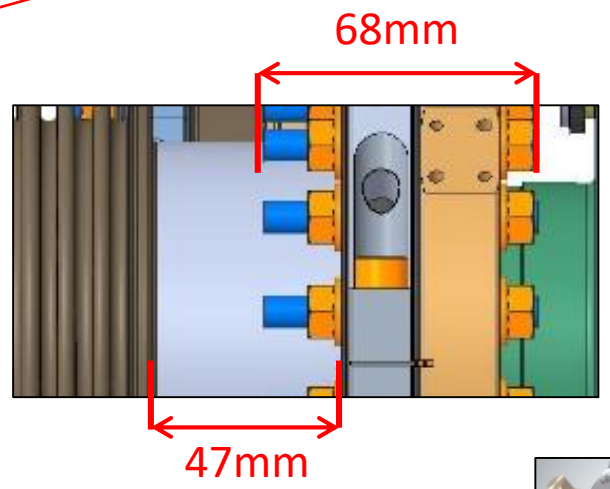
Challenge #2

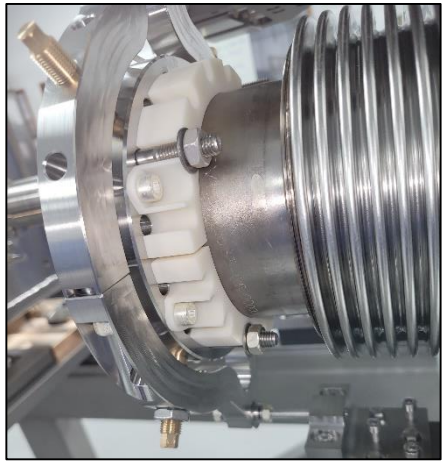
Studs on Cavity String Joints

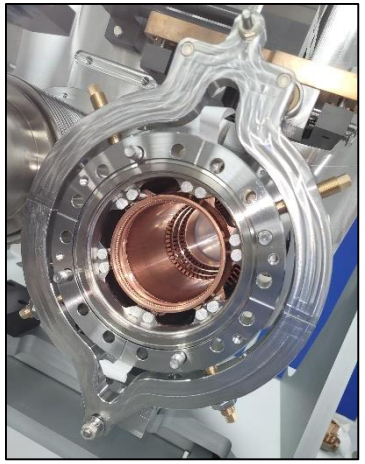


- Studs are longer than clearance behind flange
- Studs need to be pre-placed into PIMS before joint is made



- Therefore, **studs cannot be replaced once joint operation begins**





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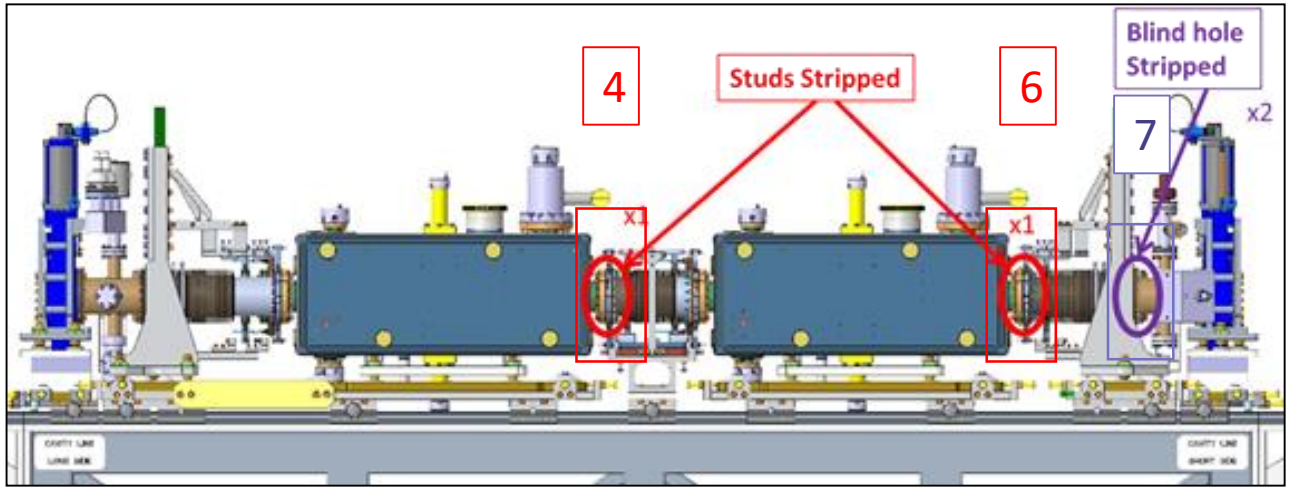
Challenge #2

Studs in Cleanroom

Threads Stripped on String Joints (STEP 1) |**LHC-ACF_A-QN-0001**



- Joints 4, 6, 7 experience thread failures

Cause: combination of poor thread form on fasteners & difficulty of joint arrangement to gauge force/feel feedback during torque setting.

Remedy: blind holes and stud threads re-tapped in-situ in cleanroom, vacuum integrity check passed.

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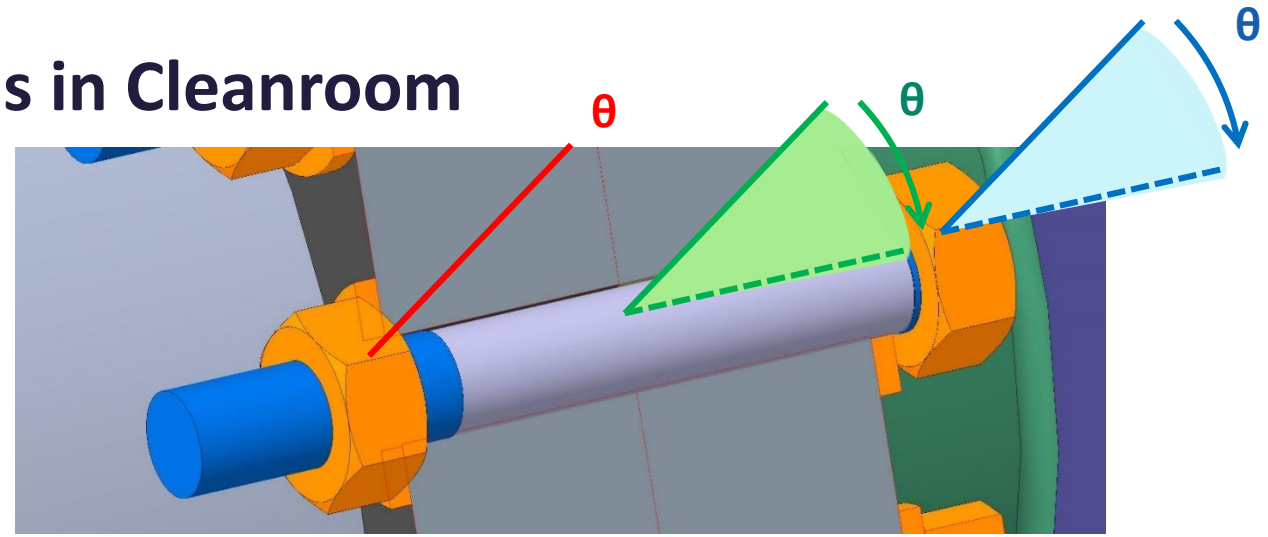
Challenge #2

Studs in Cleanroom



- When torque is applied to the Nut on the stud, there is no way to monitor if the stud is rotating/stationary
- Silver coating of nut means thread form is inconsistent
- Therefore, difficult to monitor force feedback and stud position during torque application
- Remedy for the series will to ensure the Studs used have a slot or equivalent to prevent rotation

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Engineering challenges

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Scheduling

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Challenge #3

Scheduling (Covid / Brexit / Global Issues)

- Arrival of long lead items impacting build phases
  - Outer Vacuum Chamber (Valveplates are the first item on string assembly)
  - Cryoline (Main item installed on step 3)

- Also delays to short/medium lead time items and tooling impacting the build & mechanical design
  - Cleanroom tooling – delays in the manufacture of these items impacted into other work streams
  - String Lifting equipment – ”

- Availability of these items makes it difficult to plan visits from CERN personnel
  - FPC Install
  - FSI install
  - Various Instrumentation install

- New trade barriers between EU + UK has drained project resource (Brexit)
  - A logistical issue that has consumed a lot of resource from staff not specialised in customs/ logistics.

Thank your for your attention,

Questions?

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