



## FP8 EU Enhancement Projects – Cryopumps Project Update

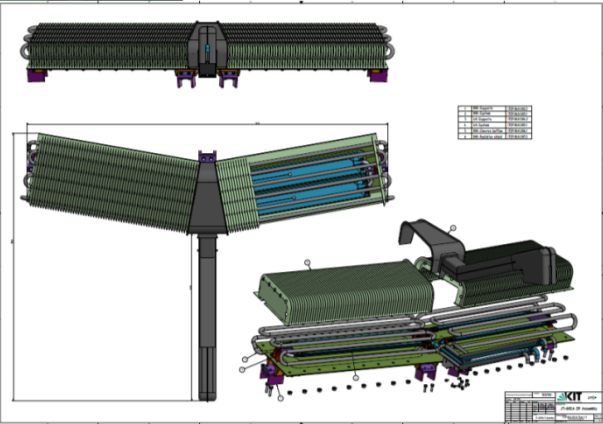
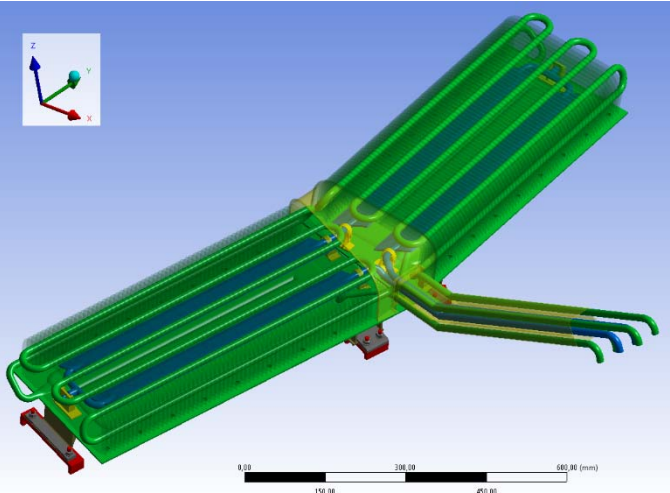
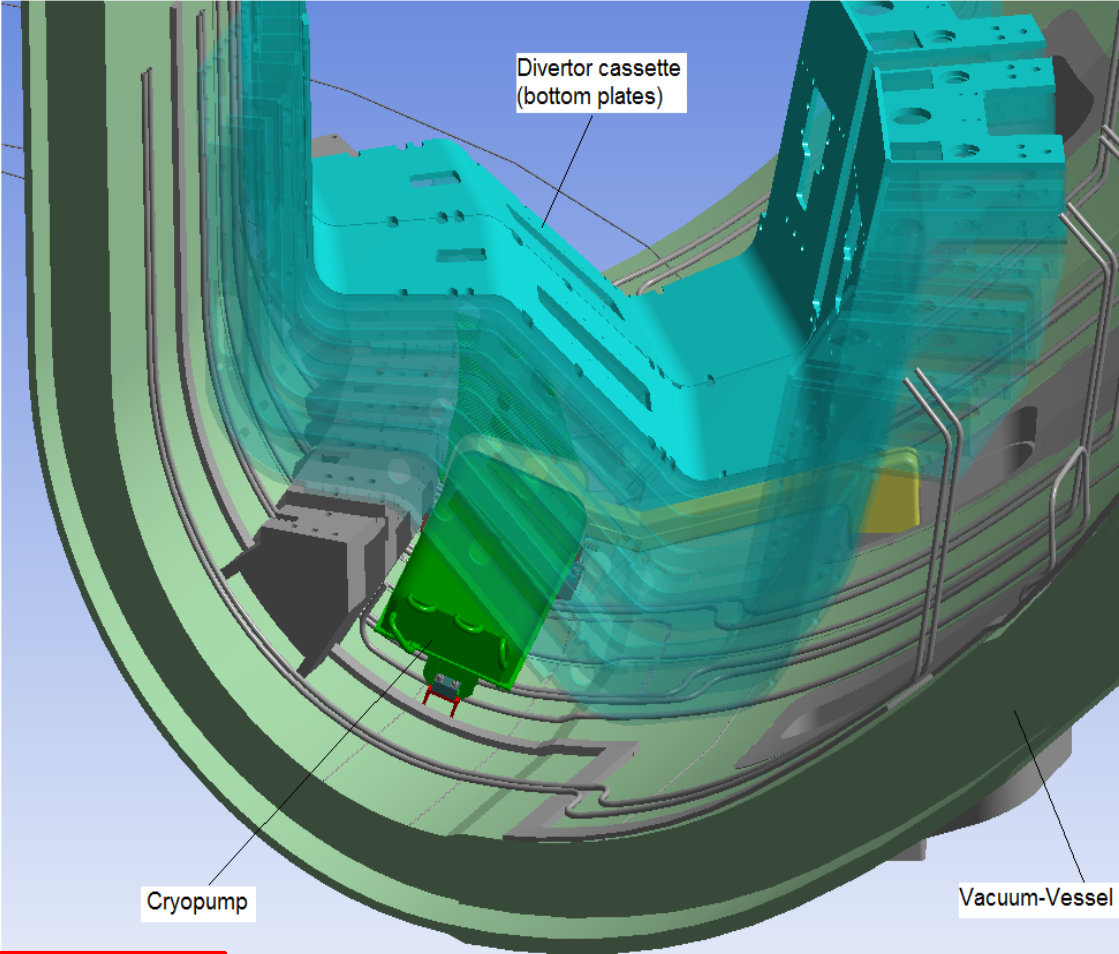
WPSA Annual Meeting, 4-6 May 2022  
Christian Day

Chris Day,  
Kazuma Fukui,  
Nandor Hajnal,  
Kazuya Hamada,  
Volker Hauer,  
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Shigetoshi Nakamura,  
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# Cryopump design



Contract: 9 identical cryopump units + 1 spare  
**+ 1 for test**



**40° sector**

# Evolution of the project



- Manufacturing contract awarded to company *Research Instruments*, Germany, started Jan 2021.
- The manufacturing design is based on detailed design drawings (KIT) and will provide the full set of cryopumps together with the quality documentation and an as-made-version of the CAD product.
- On the formal side:
  - The PA + Annex A has been signed in July 2021.
  - The Annex B (Tech Spec) has been signed in Aug 2021
  - There are three deliveries to QST:
    - The in-vessel supports in September 2021
    - The first batch (minimum 3 of the cryopumps) by May 2022
    - The remaining cryopumps by June 2022.
- The mirror Tech Spec between F4E and the manufacturer has been amended up to Sep 2021 in the course of the contract to be more specific in some minor design aspects.

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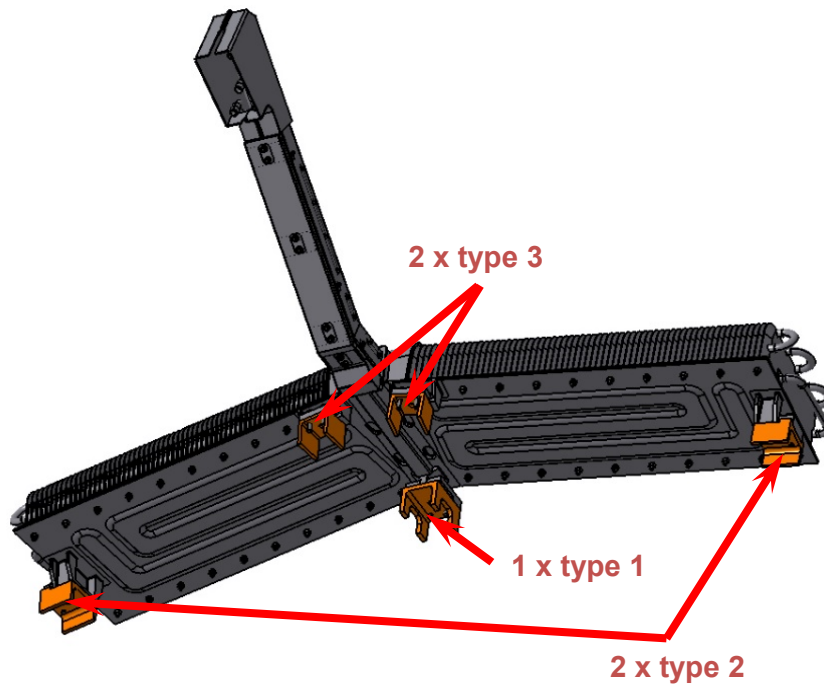
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# DEL1



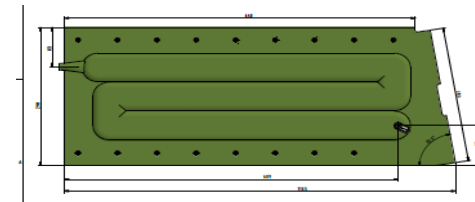
- Manufacturing readiness.
- Vacuum vessel supports for all cryopump units have been delivered to Naka in Sep 2021.
- Transfer of ownership from F4E to QST has been signed.



## Re-baseline of the project (1)



- In Mar 2022, the scope and timeplan of the project has been re-aligned in view of four aspects that mainly evolved in Q4/2021:
- There are issues regarding porosity in the laser welds of hydroformed components that do not meet the initial quality requirement (EN 1011, EN13919). It is believed, however, that this does not question the reliability of the component (as these components were validated against EPD by TÜV to burst above 5 x operation pressure).
- In order to demonstrate this, an additional cryopump (9→ 10) will be manufactured (FOAK) and subjected to a fatigue test:
- *'The first of a kind cryopump unit (panels, base plates, baffles and pipes), or all of the first of a kind's individual panels and base plates shall be subject to extended cyclic pressure test and subsequently helium leak tested at room temperature for 3000 full pressure cycles.'*



Current version of the manufacturing contract tech spec:

BA\_D\_29SPDN

## Re-baseline of the project (2)



- Delays in the approval of the coating procedure (which was planned to be adopted from the parallel project to manufacture the ITER cryopump). Close to be decided finally.
- Design adaptation to manufacture has taken much longer on the supplier side as planned originally and created initial delays.
- Lack of availability of resources at the supplier side, in particular regarding welding activities. This was also due to the parallel ITER cryopump manufacturing at the company, settled now.

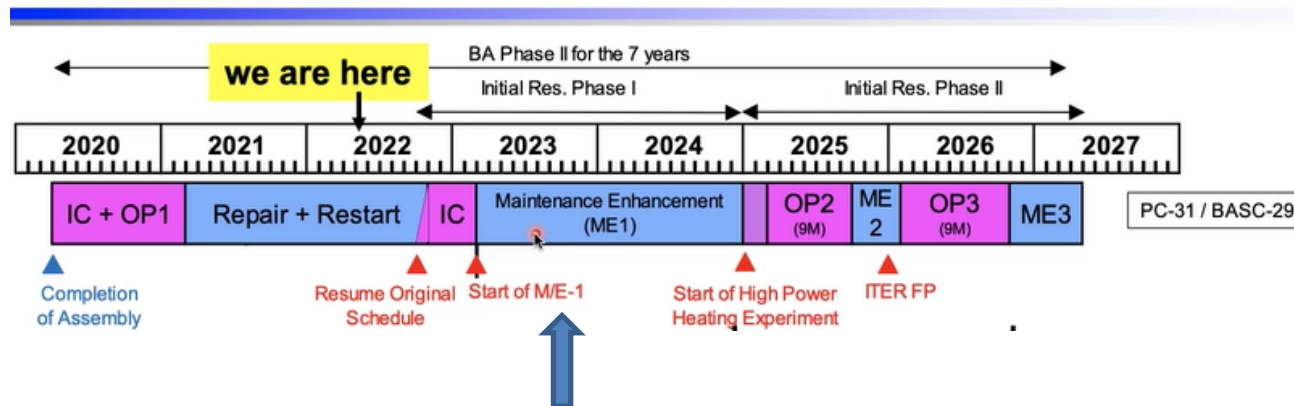
# Present status

- There are now 4 deliveries to QST:
  - The in-vessel supports in September 2021
  - The first batch (minimum 3 of the cryopumps) by Nov 2022
  - The remaining cryopumps by Dec 2022.
  - The last cryopump by Mar 2023.

Just in time



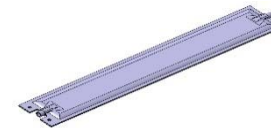
## Timeline for JT-60SA Project



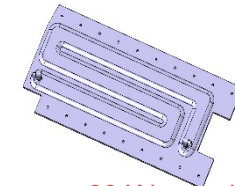
*The tentative timeplan foresees the cryopump installation around month 6 of ME1.*



- We are having weekly meetings with the manufacturer, to apply strict monitoring (and we feel that this is worth the effort).
- High level manufacturing steps:
  - Procurement of raw materials
  - Hydroforming the 80 K and 4 K components
  - Manufacturing of the chevron baffle
  - Blackening
  - Attaching heaters to 4 K panels
  - Charcoal Coating of the 4 K panels (4 identical per cryopump)
  - Quality testing throughout the whole workflow
  - Final testing



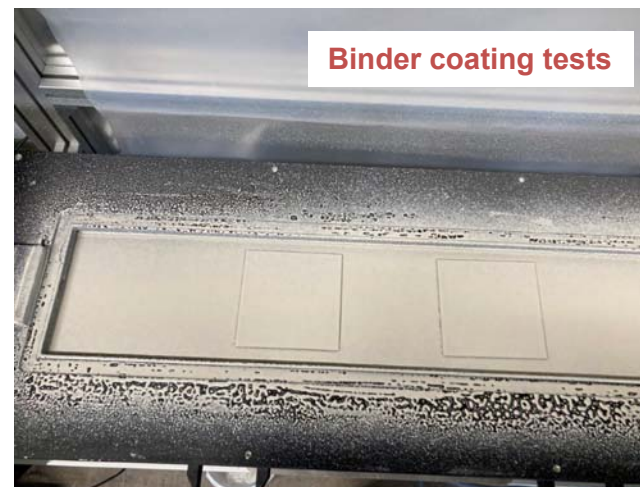
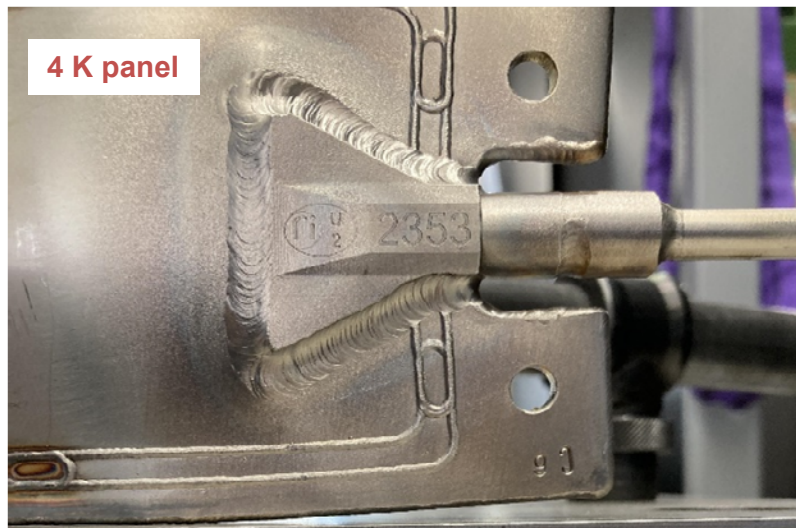
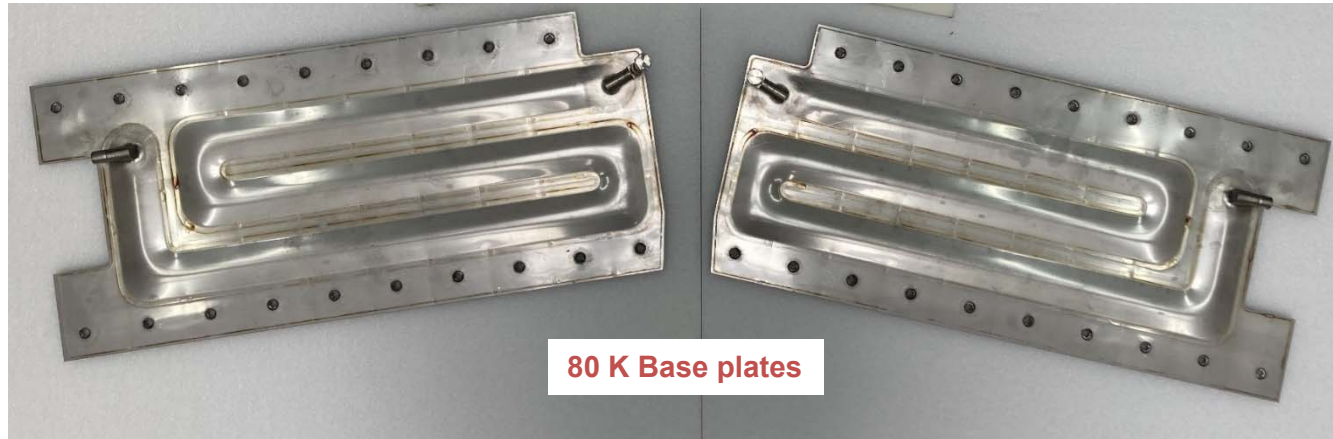
4 K panel



80 K base plate



# Manufacturing – hardware



## Conclusion



- The manufacturing of the JT-60SA cryopumps is in full swing.
- The manufacturing time has turned out to be longer than planned, but given the delays at JT-60SA due to the incident, there will be no problem.
- In OP2, JT-60SA will have a strong divertor pumping system in place, which allows stepwise variation of the pumping speed (by switching off some of the 9 installed cryopumps).

*thank you!*