Capabilities
at STFC Daresbury laboratory

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STFC Daresbury Capabilities

- Project Management
- **Mechanical Engineering**
- Electrical Engineering
- Advanced power supplies
- Motion control
- Control & Personnel safety
- **Survey & Alignment**
- **Vacuum processing & testing**
- Lasers
- **Vacuum Science**
- Magnets
- **RF**
- **Cryogenics**
- Diagnostics
- High Voltage

Daresbury Facilities - ETC

Machine shop

Assembly area

Vacuum Laboratory

- 4 x ovens to 250^{o}C
- vacuum furnace to 1100^{o}C
- Air oven to 150^{o}C
- Leak detection & test facilities.

Clean Rooms

ALICE Photoinjector vessel
In ISO 4 Cleanroom

Vacuum Test Facilities at Daresbury

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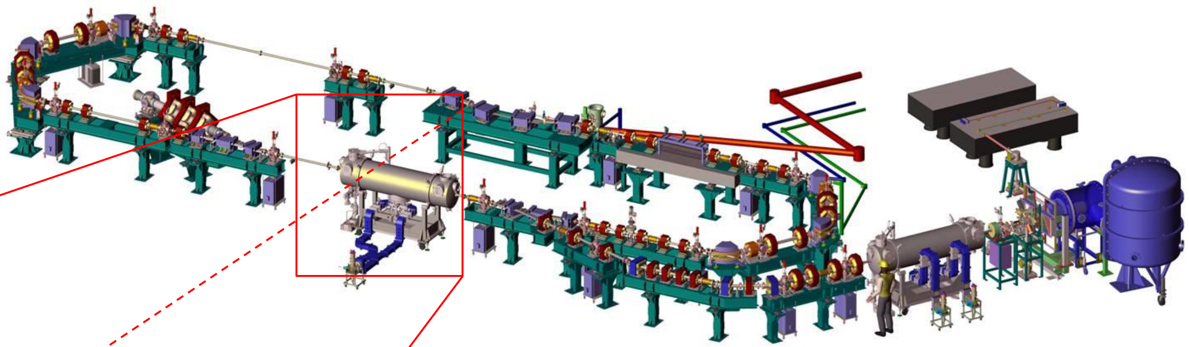
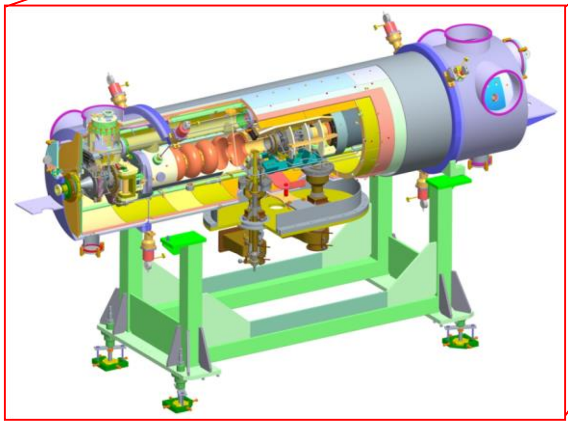
Particle test facility – I
be a 'particle controlle
accelerator and this fa
will allow ESS to deter
their procedures and
design choices

DICC - Daresbury International Cryomodule Collaboration

The aim – To build and test the ERL Cryomodule with beam on ALICE

Accelerator and **L**asers
in **C**ombined **E**xperiment

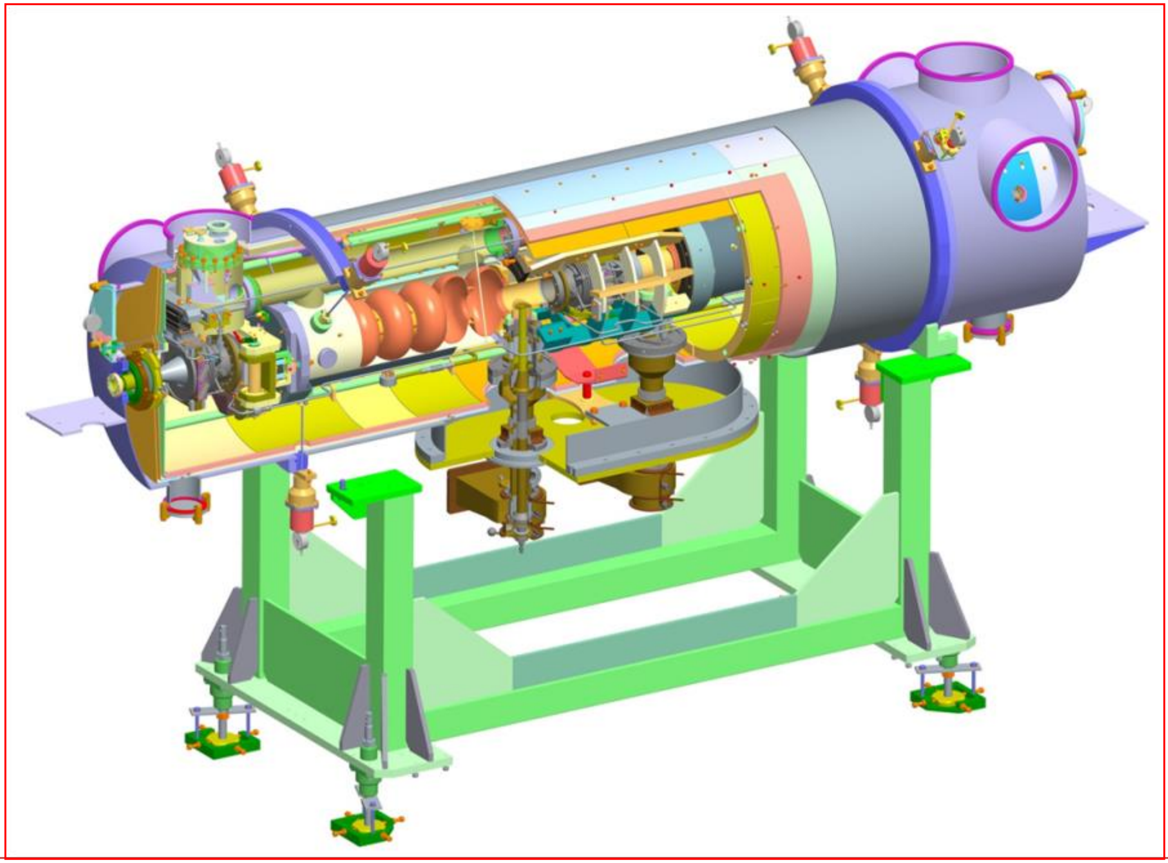




Dimensioned to fit on the ALICE ERL facility at Daresbury:

- Same cryomodule footprint.
- Same cryo/RF interconnects.
- ‘Plug Compatible’ with existing cryomodule

DICC - Daresbury International Cryomodule Collaboration



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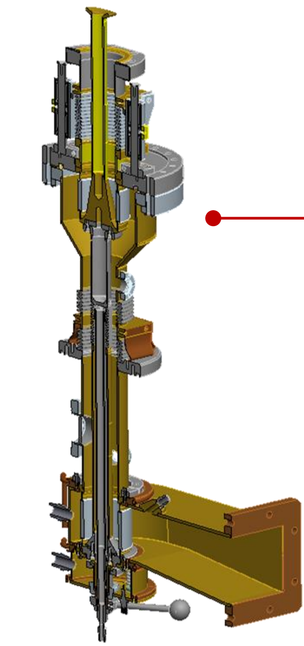
BERKELEY LAB

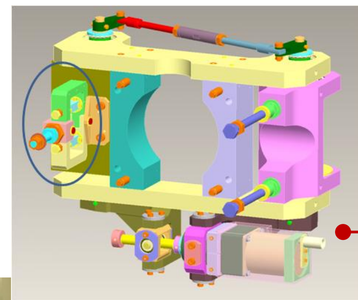
TRIUMF

DESY

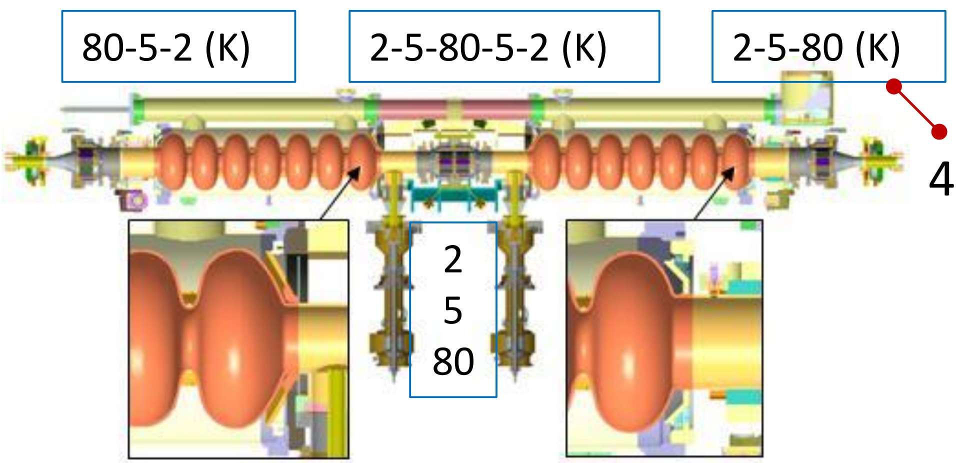
HZDR

Major Variations in the Design



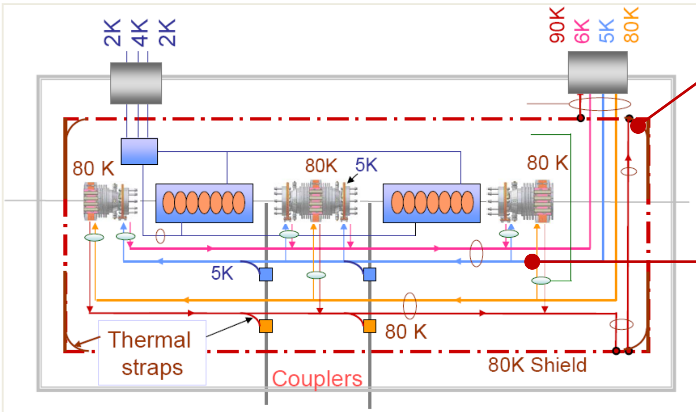


1. High Power Input couplers
   Cornell ERL injector coupler
2. Modified Saclay-II tuners
   Wider aperture.
   Low voltage piezo cartridges.
3. HOM absorbers
   Cornell ERL injector CM with Ferrite Absorbers (@ 80K)

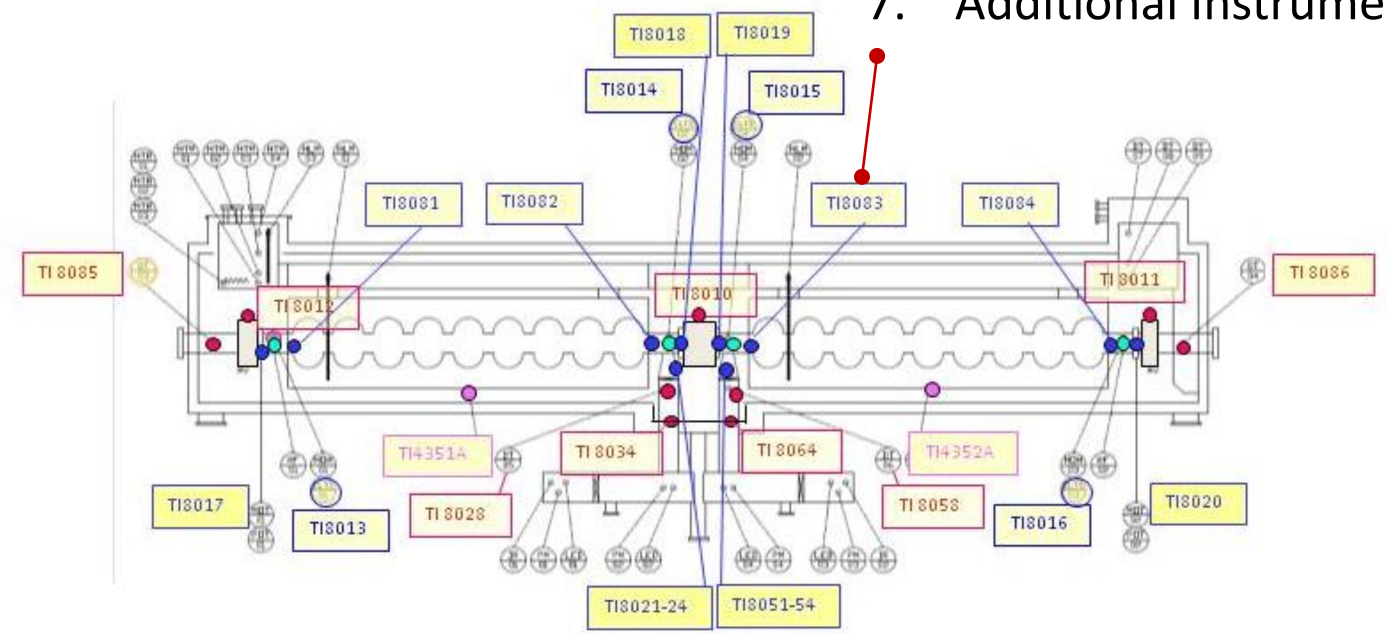


4. Several thermal transitions (intercepts) cooled by GHe

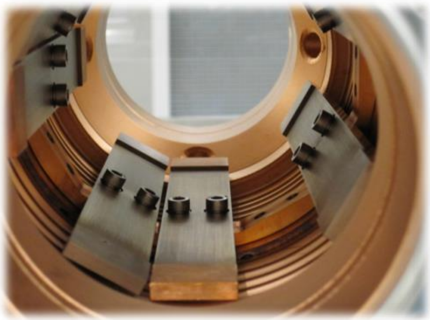
Major Variations in the Design

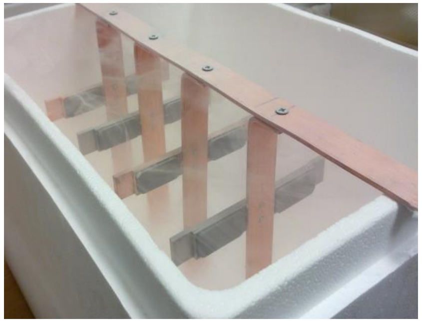


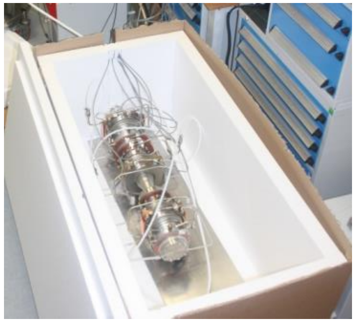
5. Radiation Shield, HOMs and thermal intercepts cooled with GHe
6. Additional thermal management scheme
7. Additional Instrumentation



Intermediate Qualification Tests on HOM Absorber







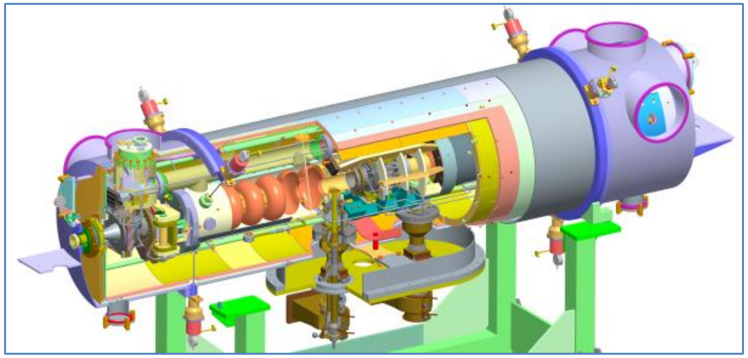
TT2 TILE REMOVAL → COLD TESTING OF CERAMIC TILES → ASSEMBLY AND ORBITAL WELDING

↓

THERMAL CYCLING TO 80K AND LEAK CHECK

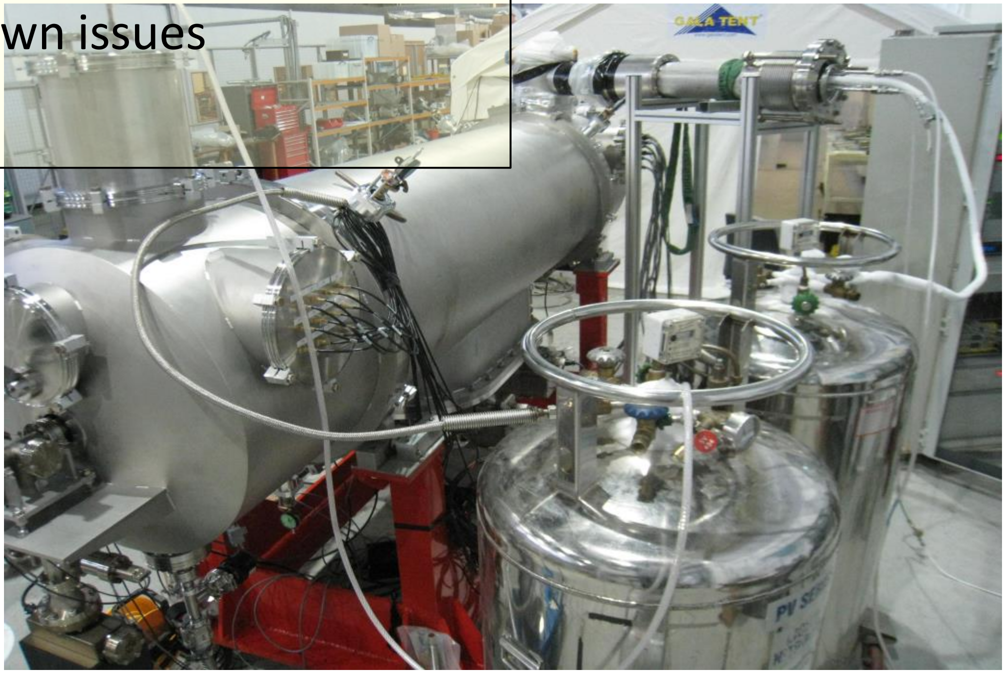
↓

DISMANTLE AND INSPECTION → READY FOR FINAL ASSEMBLY

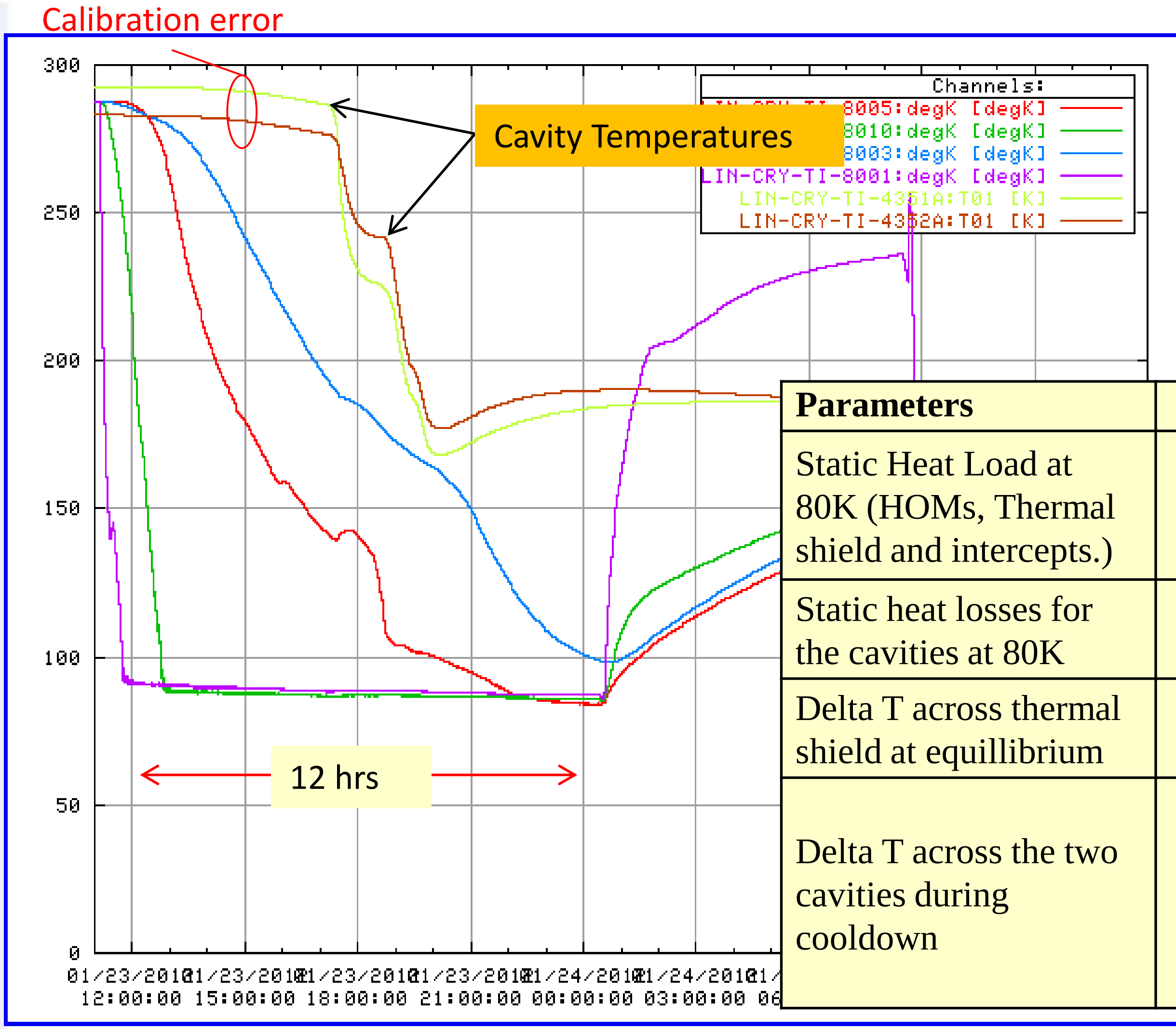


Off-line Cold Tests

- Check the cryogenic performance
- Understand the processes and establish commissioning and operating procedures
- Validate instrumentation
- Make the task of integration with ALICE easier
- Identify and resolve any unknown issues

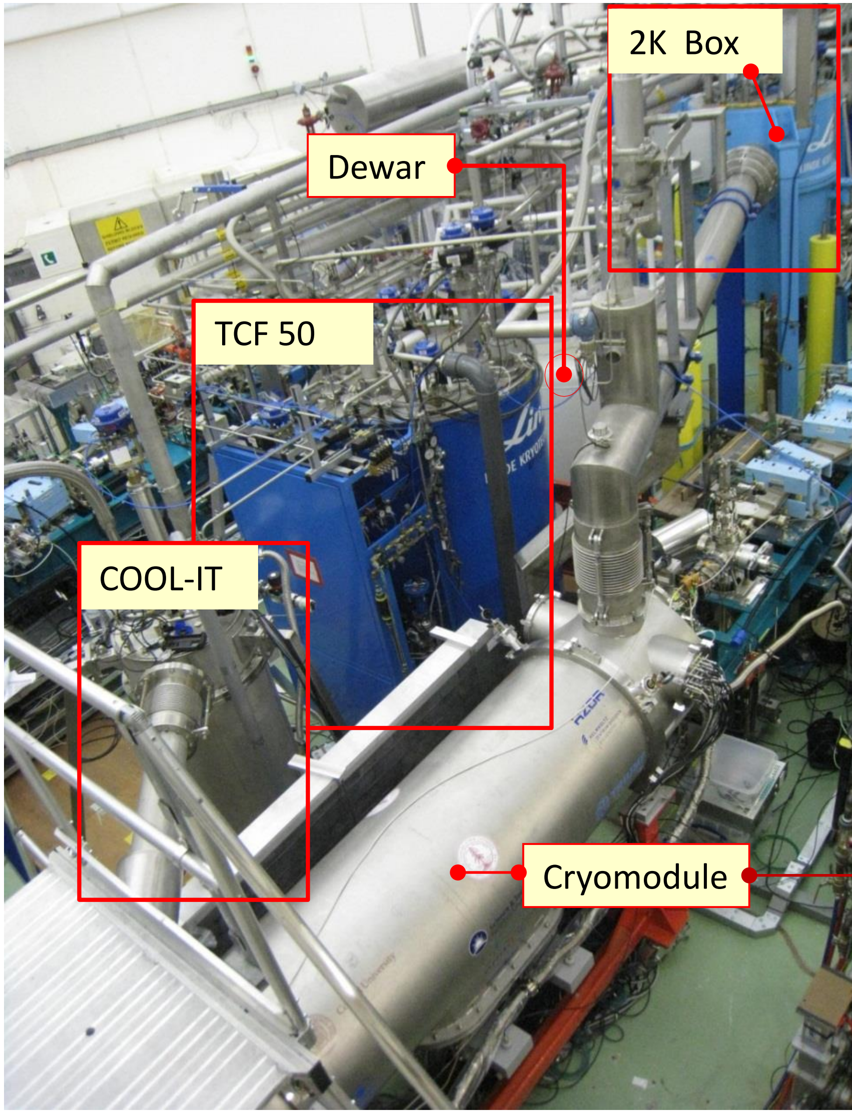


Off-line Cold Tests – with LN2



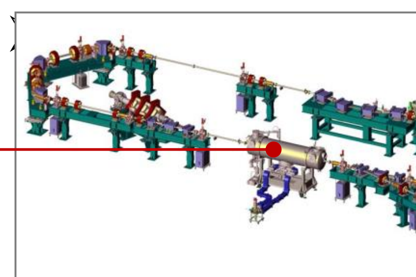
Parameters	Measured*	Specification
Static Heat Load at 80K (HOMs, Thermal shield and intercepts.)	~ 7 W	20W
Static heat losses for the cavities at 80K	~ 3.5 W	15 W at 4K
Delta T across thermal shield at equillibrium	< 5K	<10K
Delta T across the two cavities during cooldown	< 5K	< 5K Currently 50K to 60K for ALICE

Integration and Commissioning – Installation on ALICE

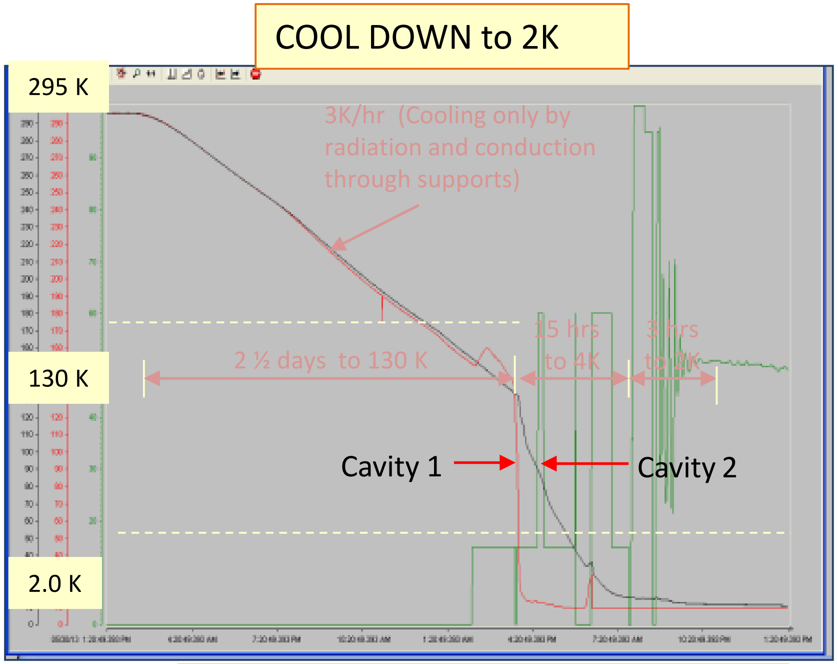


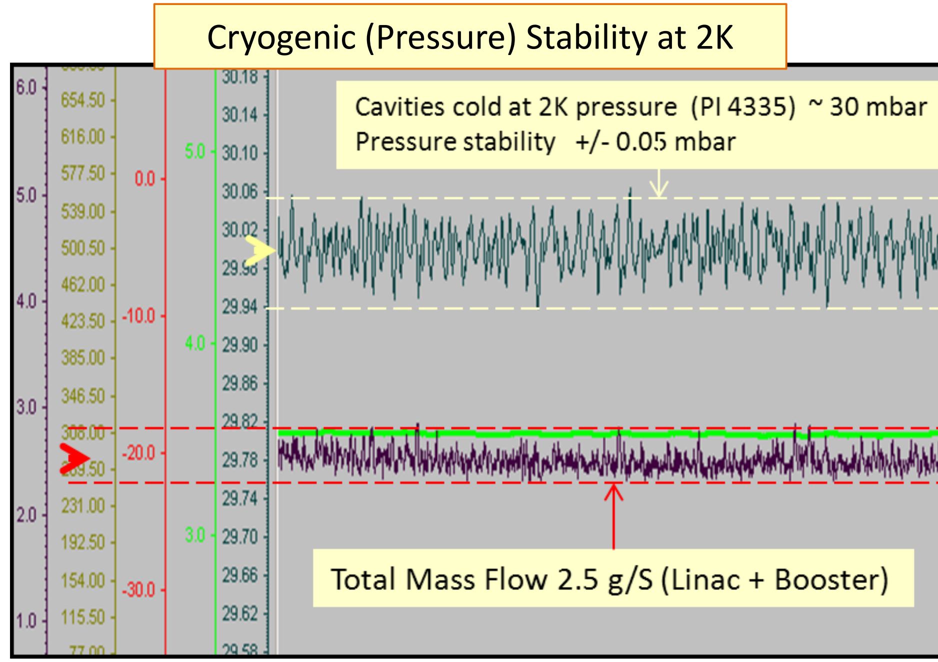
Preliminary cool down

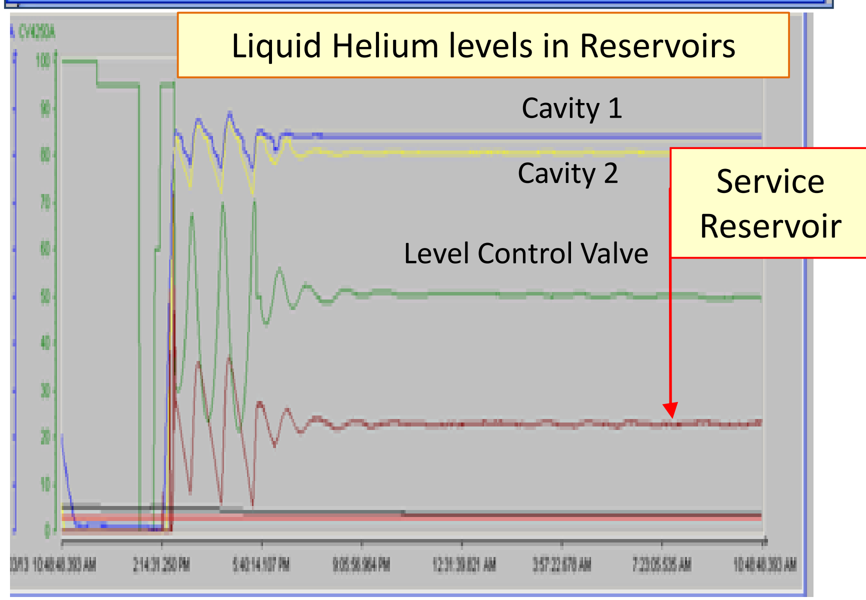
- Cryomodule cooled to 2K
- Static heat load measured at 2K~ 6W
  Similar to previous cryomodule, Spec- 15W
- Base heat load measured at 2K ~ 2.5 g/s
  Similar to previous cryomodule
- Intermediate Temperatures has been achieved with GHe using **COOL-IT**
  Gas pressure ~ 2 barA
- HOMs, coupler intercepts and thermal shield are connected in series
  - *Circuit 1: T_{in} ~ 89K , T_{out} ~ 99K*
  - *Circuit 2: T_{in} ~ 13.5K , T_{out} ~ 15.5K*
- Pressure stability at 2K (30mbar) ±0.05 mbar
- tion is in progress

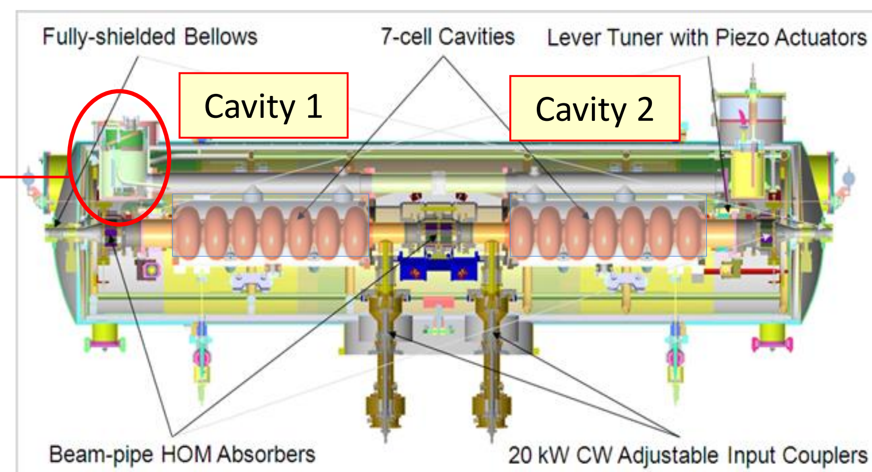


Integration and Commissioning – CM Cryogenic Performance

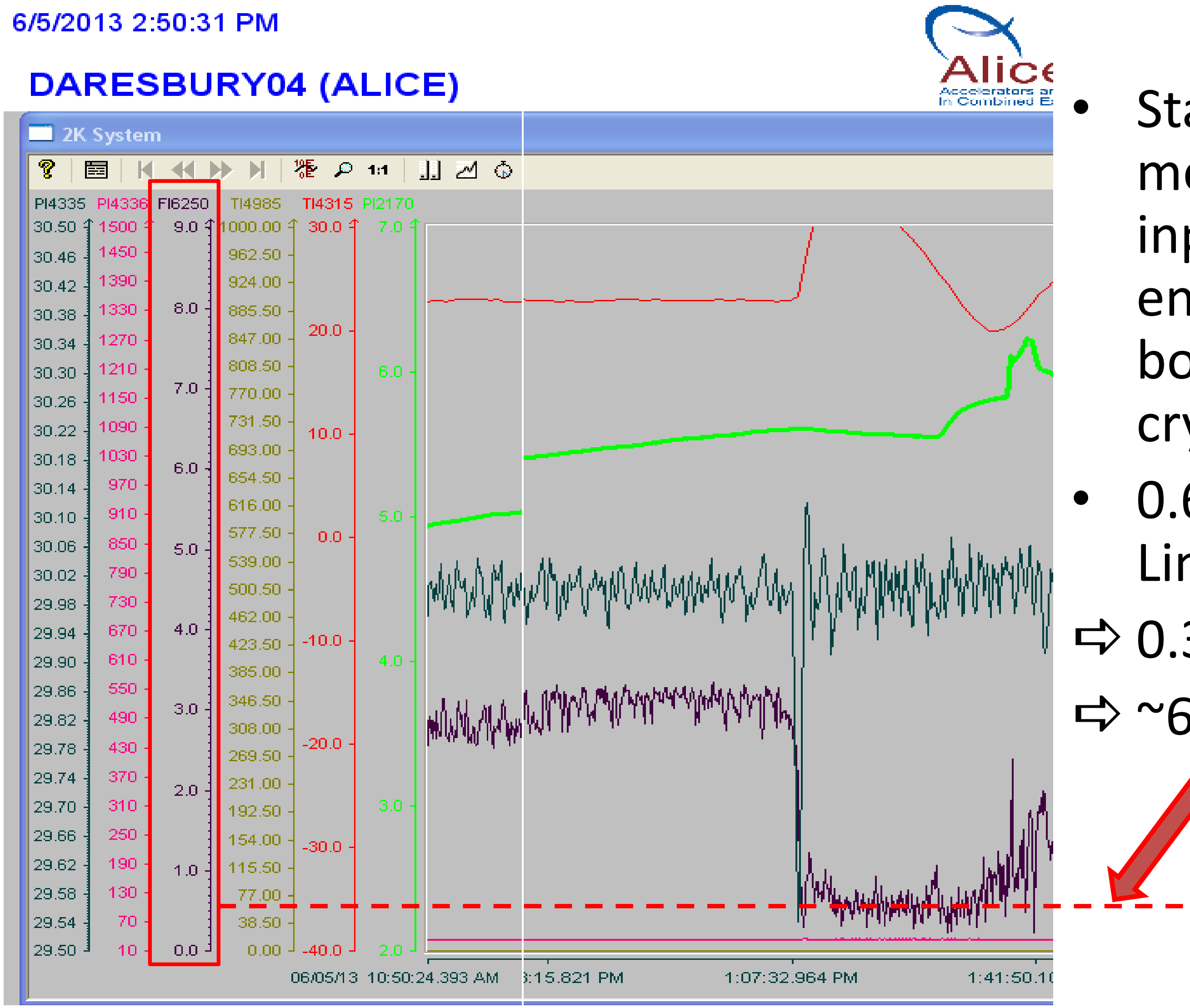








Integration and Commissioning – CM Static Heat Load at 2K



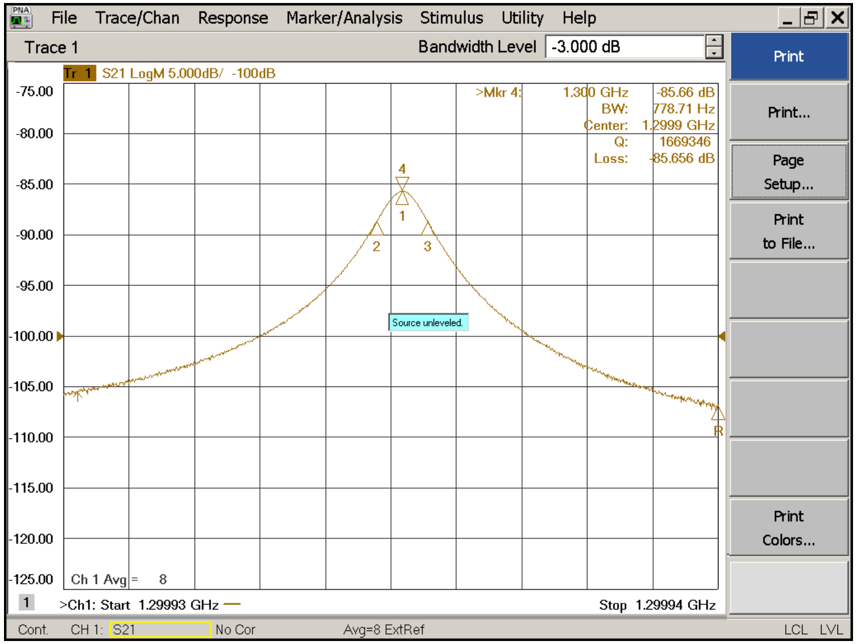
- Static heat load measured with all the input valves closed to ensure that only the boil off from the cryostat is measured
- 0.6 g/S total mass flow Linac + Booster

➪ 0.3 g/S per module

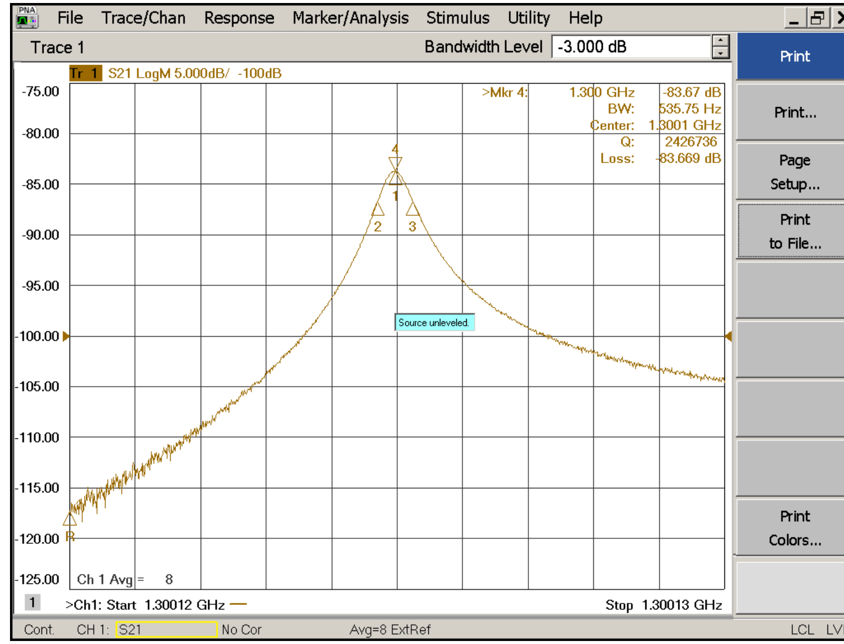
➪ ~6.2 W per cryomodule

Integration and Commissioning – Cavity Frequency

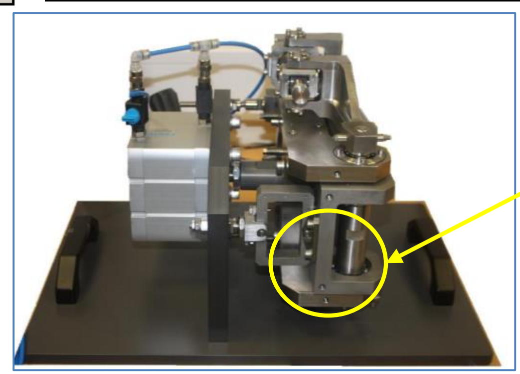
- Linac 1



- Linac 2

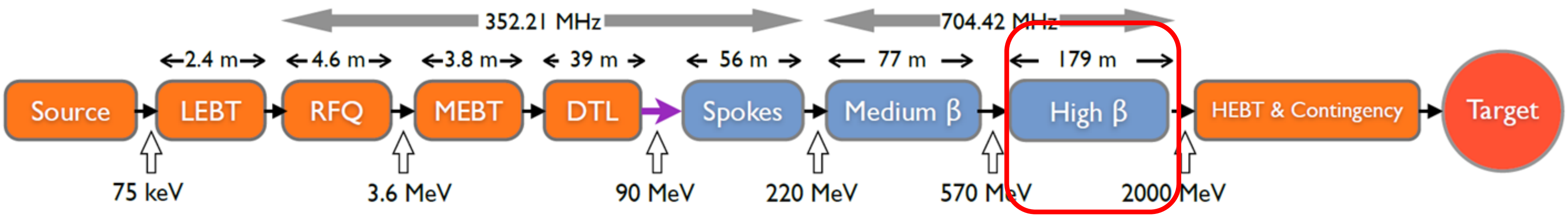


- Cavity tuner operation verified
- Tuning achieved
- Tuning range ±350 kHz
- Q_{ext} adjusted
- Full extent of adjustment to be determined



Previous mechanical issue

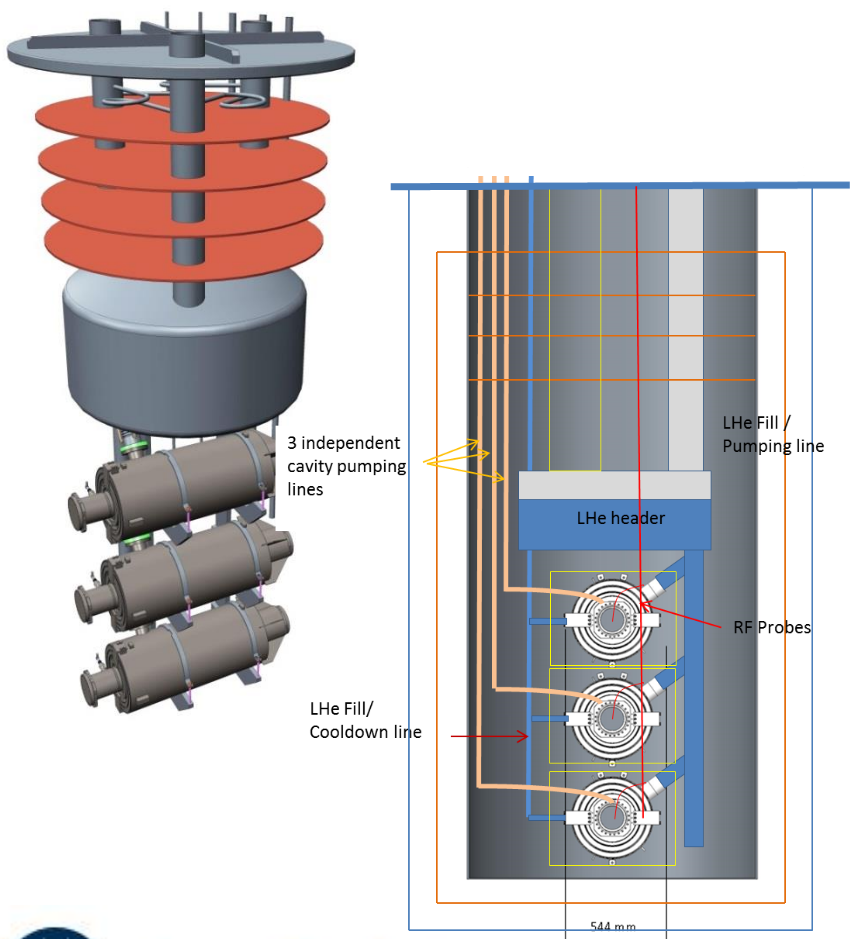
ESS



UK contribution **€184m**

ESS Test requirements		
No of High Beta Cavities to test (84 +4)	88	
Additional tests assuming 30% reprocessing	27	
Total number of tests anticipated	115	
Duration available to complete all the tests	117	Weeks
Required throughput rate	1	Cavity per week
How can this be achived ?		
Target rate of test	1.5	Cavities / weeks
Developing the **infrastructure** and **work flow** to test 3 cavities simulteneously		
Total number of cold tests anticipated	39	
Duration of each tests	2	weeks
Number of weeks to test all the cavities	78	
Flexibility in schedule for shutdown + maintenance etc.	39	
Infrastructure + Work Flow to be designed for	3 Cavities / two weeks	
Minimum Rate of test	3 Cavities / two weeks	
Maximum Rate of tests	6 Cavities / two weeks	

Alternative Approach:
Horizontal Tests in a Vertical Cryostat

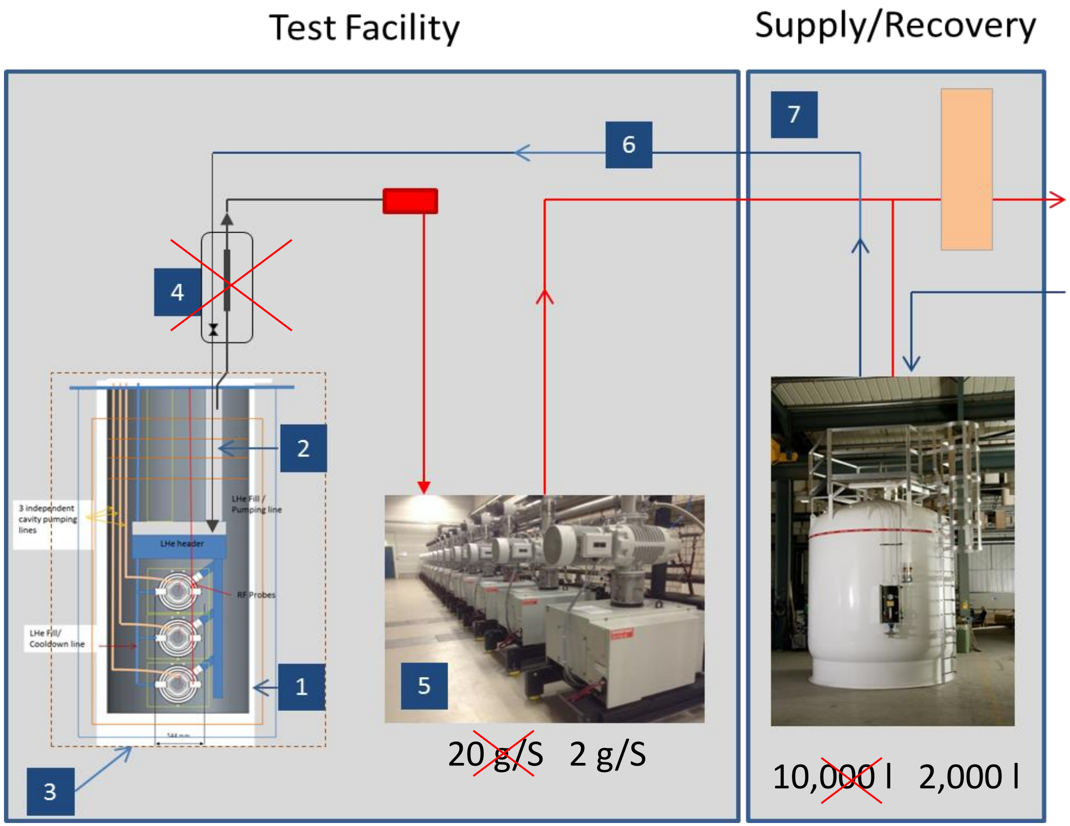


- Test 3 cavities simultaneously.
- Each cavity already has its own helium vessel:
  - Necessary and sufficient condition is to cool the cavity to 2K
  - Can be easily achieved by filling liquid helium in its own vessel (with a volume of ~ only 50 l)

Cryogenic Requirements:

- LHe per test reduces from:
  - ~~~7500 l to~~ ~1500 l **(factor of 5!)**
- Gas handling capacity reduces from:
  - ~~~20 g/S to~~ < 2 g/S **(factor of 10!)**
- Significantly simplified and lower cost ancillaries (~~2K Hex~~, 2K pump, distribution Pipes, Valves, safety devices , etc.)

Benefits



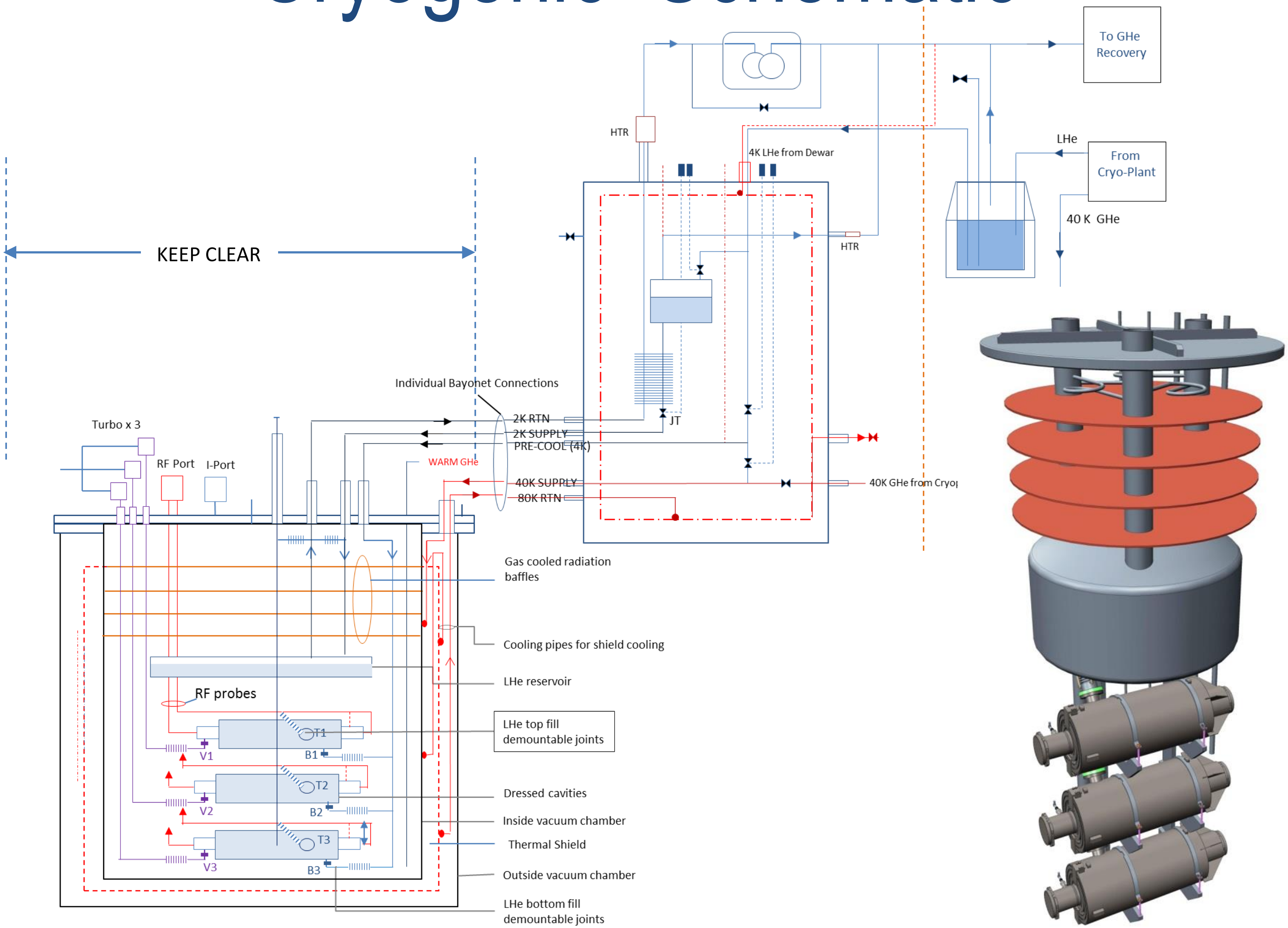
1 Liquid Helium Dewar	5 2K Sub atm pumps	9 UHV
2 Cavity Support	6 LHe/GHe distribution	10 Aux Vacuum
3 Magnetic Shield	7 Cold storage/ Recovery	11 RF Instrumentation & Control
4 2K Heat exchanger	8 Liquid He Supply and warm storage	12 Cryo Instrumentation

- Horizontal tests – Performance in near final configuration
- Automatic leak checks on helium vessel (Not possible in bath cryostat)
- More confidence in performance
- More than 75% saving on LHe
- Reduced test duration (quick cool-down/ warm up)
- Lower Operational Hazards (due to lower gas flow/less quantity of LHe)
- 75 % Saving on LHe and Gas Storage

Risks / Issues

- Additional assembly steps
- Additional leak checks during assembly

Cryogenic Schematic



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Summary

- STFC-DL has a rich experience in working with international collaborations
- Excellent assembly facilities including UHV cleaning, ISO 4 clean rooms
- Developed and delivered SRF cryomodules from design to commissioning
- Developed our own procedures for conducting intermediate qualification test
- All the processes are governed by ISO 9000 QA / QC std