Installation, commissioning, and testing of the HB650 CM at PIP2IT

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C1Po2D-08

Cryogenic Plant

- Superfluid Cryogenic Plant Capacity
  - Measured 25 g/s helium liquefaction rate
  - 720 W capacity on HTTS (40K supply & 80K return) at max liquefaction rate
  - 118 W capacity on LTTI (5K supply & 80K return at max liquefaction rate

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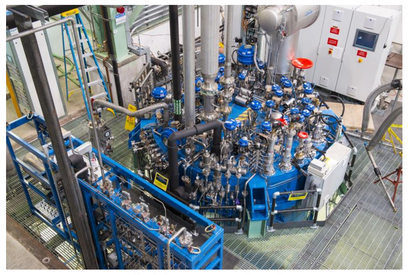

Superfluid Cryogenic Plant

Compressors & Pumps

- 5 x Mycom Compressor Skids
  - 4 for SCP, 1 for purification
  - Delivers up to 60 g/s
  - Suction pressure ~1 bar
  - Discharge pressure <= 20 bar
- KVS1
  - Kinney KMBD 10000 roots blower
  - Kinney KLRC 2100 liquid ring pump
- KVS2 & KVS3
  - Kinney KMBD 3200 roots blowers
  - KLRC 950 liquid ring pumps

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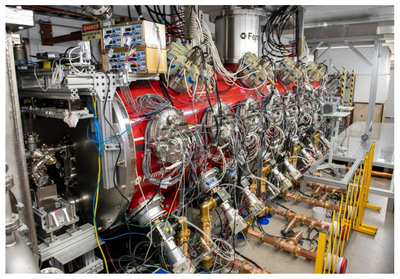
KVS1

KVS3

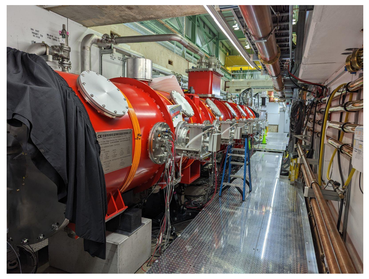
Mycom Skid

PIP2IT

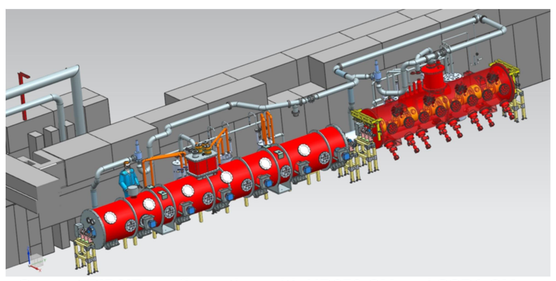
- The first use of the PIP-II Injector Test Facility (PIP2IT) cave was to commission the entire front end of the PIP-II linac, which included running beam through both the HWR and prototype SSR1 cryomodule
- Moving forward the PIP2IT cave will instead be used as a cryomodule test stand to test and commission each of the PIP-II cryomodules. Currently the PIP2IT cave is used for testing the prototype High-Beta 650 MHz (HB650) cryomodule.



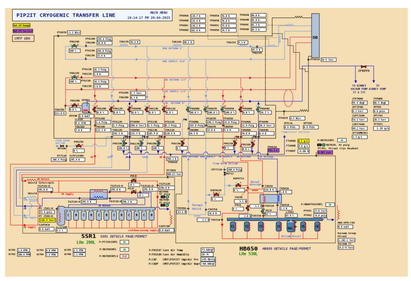
SSR1



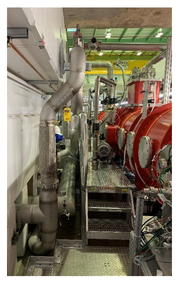
HB650



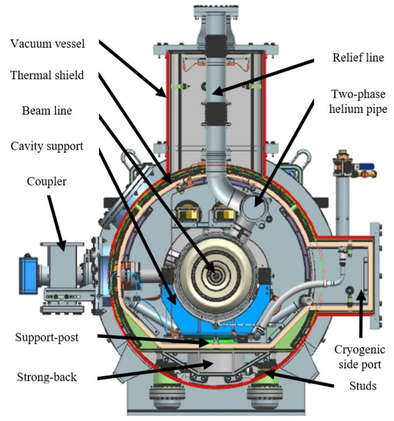
Current PIP2IT configuration with HB650 CM and SSR1 CM



PIP2IT HMI



HB650 Adapter Transfer Line

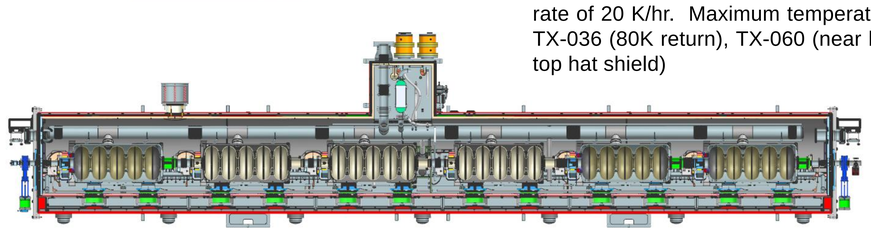


HB650 Cryomodule

- Six 650 MHz SRF cavities
- Total accelerating voltage of 119.7 MV
- Up to 4 HB650 cryomodules included in PIPII.
- Partners include STFC in the UK and RRCAT in India
- First prototype test run completed in PIP2IT
- Future test runs planned for prototype in PIP2IT

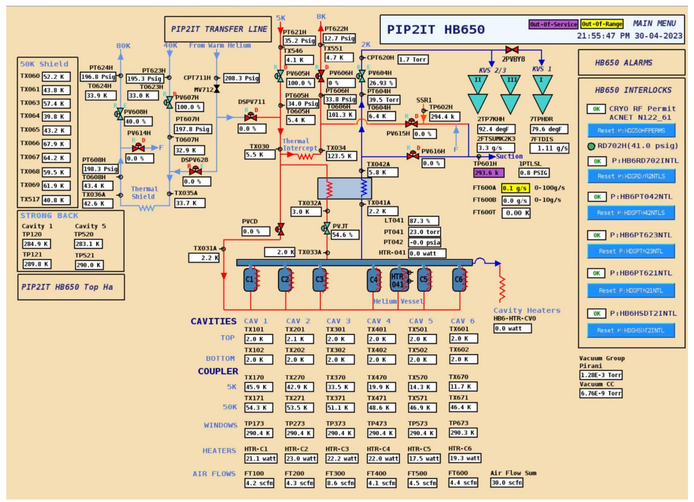
HB650 Cryomodule Thermal Constraints

- HTTS Supply can be controlled between 290K and 40K utilizing warm gas mixing
- LTTI and SRF cavity supply be controlled between 290K and 40K utilizing warm gas mixing
- No thermal constraints on SRF cavity circuit when cavities > 175 K or < 90K. However, SRF cavities to be cooled >= 20K/hr between 175 K and 90 K.
- No cooldown constraints on LTTS
- No cooldown rate constraints on thermal shield, which is designed for nominal cooldown rate of 20 K/hr. Maximum temperature difference of 100K between TX-035 (40K supply), TX-036 (80K return), TX-060 (near base of top hat shield) and TX-063 (also near base of top hat shield)



HB650 Interlocks

- Valves to compressor suction open and all other 5K & 2K circuit cryogenic valves close if 2K bath pressure exceeds 1.7 bar (25 psia) to prevent overpressure
- All 5K & 2K circuit valves close if rupture disk bursts to conserve helium
- If the HTTS warm mixing valve is open and the transfer line pressure is less than the mixing pressure, then close all HTTS cryogenic valves and open the valve to compressor suction
- If the HTTS 100 K temperature constraint is exceeded, then close all HTTS cryogenic valves and open the valve to compressor suction
- If the SRF cavity warm mixing valve is open and the transfer line pressure is less than the mixing pressure, then close all 5K & 2K circuit cryogenic valves and open the valve to compressor suction



PIP2IT HB650 Details HMI

HB650 Cryomodule Fast Cooldown

- Large and directional thermal gradients across the superconductor during transition has the effect of sweeping the magnetic fields out of the bulk material.
- Leads to Improved performance of nitrogen doped SRF cavities
- SRF cavities soak to 50K for at least 2 hours prior to start of fast cooldown
- > 20 K/min is desired cooldown rate
- Expected that >= 80 g/s supply rate needed to achieve cooldown rate
- Bottom of cavities >> 20 K/min at 9.2 K
- Top of cavities ~ 20 K/min approaching 9.2 K
- Flow rate > 150 g/s by time top of cavity starts to cool
- Valve sizing equations per IEC 60534 used to estimate flow rate

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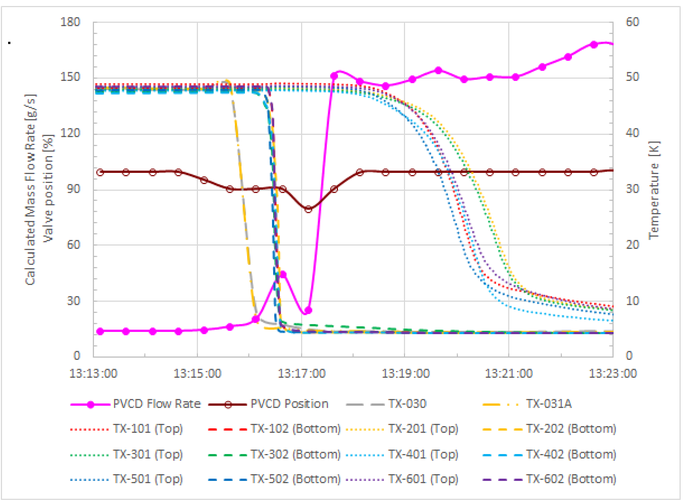

PIP2IT Conversion

- An adapter transfer line was designed and fabricated to adapt from the HWR CM bayonet configuration to the HB650 bayonet configuration.
- All future PIP2 Cryomodules will have the same bayonet configuration as the prototype SSR1 and HB650 cryomodules
- The higher 2K circuit design pressure for HB650 and other future cryomodules allows the rupture disk to be vented outside the PIP2 cave

Acknowledgement

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