Mon-Af-Po1.11-06

Operation of the helium cryogenic system for the hybrid magnet at CHMFL

J. Li, Y. Xie, Z. Ouyang, H. Li, Q. Meng, L. Shi, X. Ai, M. Fang, X. Chen and D. Kuang

High Magnetic Field Laboratory, Chinese Academy of Sciences. Hefei 230031, China.

Background

The hybrid magnet which consists of a 34 T resistive insert and an 11 T superconducting outsert has been put into operation early this year at the High Magnetic Field Laboratory of the Chinese Academy of Sciences (CHMFL). The superconducting outsert made of Nb_3Sn cable-in-conduit conductor (CICC) technology is designed to provide 11 T field in 800 mm room temperature bore. The superconducting coils whose total cold mass is 11 tonnes are cooled with forced flow supercritical helium at 4.5 K.

Summary

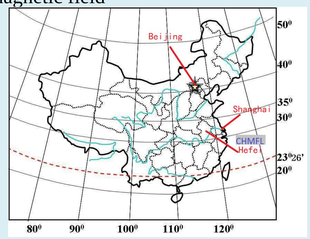
At CHMFL, construction and commissioning of the helium cryogenic system which have the functions of liquid helium production and hybrid magnet cooling is finished. At 4.5 K, the field of the hybrid superconducting outsert is increased to 10 T, and combined with the water-cooled magnet, 40 T in a 32 mm clear bore is obtained. The helium cryogenic system achieves the expected performance. Thermal-hydraulic measurement and control under magnetic and cryogenic condition also give satisfactory results. For the target of 45 T field in this year, Perfection of each sub-system including helium cryogenic system is processing.

About the CHMFL

The main missions of the Lab:

1）Develop series of high field magnets (hybrid magnets, superconducting magnets and water-cooled magnets)

2）Research on physics, functional material, chemistry, life sciences and pharmacology in the extreme high magnetic field

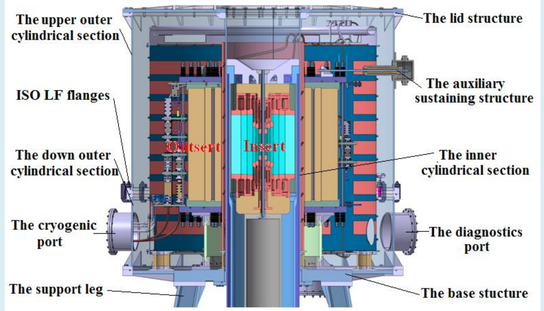


Magnets we have:

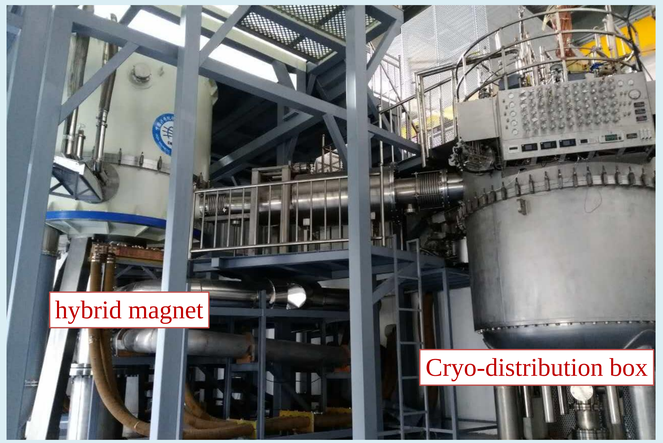
Water-cooled magnets	WM1	38.5T@32mm
	WM2	25T@50mm
	WM3	20T@200mm
	WM4	27.5T@32mm
	WM5	35T@50mm
Superconducting magnets	SM1	8T@100mm
	SM2	20T@50mm
	SM3	18.8T@54mm
	SM4	9.4T@400mm
Hybrid magnets	HM1	45T@32mm

The hybrid magnet

Combined system	Field contribution	Operating temperature	Coil /conductors	Clear bore
SM	11T	4.5 K	CICC	800mm
WM	34T	RT	Florida Bitter	32mm

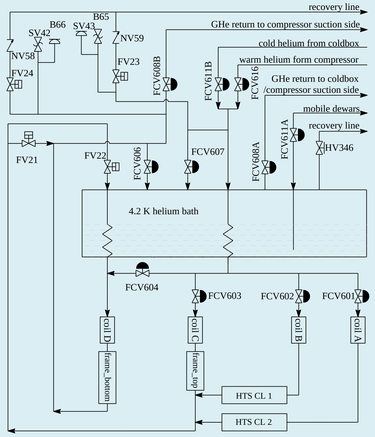


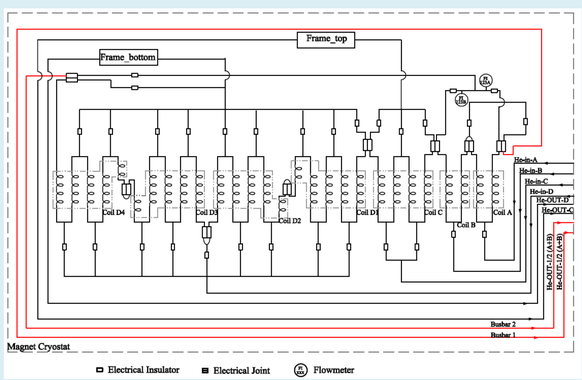
The helium cryogenic system



LHe plant (360W at 4.5 K or 110 L/h has been operated LHe production for 5 years

Cryogenic circuits

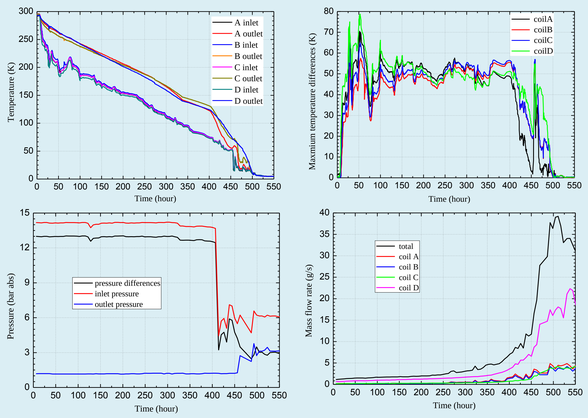




The frour sub-coils are totally divided into 26 cooling-channels which are hydro-dynamically connected in parallel.

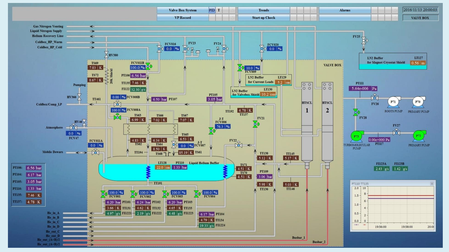
All system assembly work was finished at September, 2016.

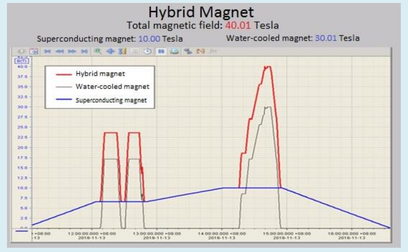
Cooldown



It takes 23 days to cool down the superconducting outsert to 4.5 K. The process is divided into three phases: 300-140 K, 140-20 K and 20-4.5 K.

Commissioning and operation





The maximum temperature of the coils is below 5.0 K when stand-by, and when the hybrid magnet is operating at 40 T field, the value is 5.3 K. The total Pressure differences is 3.5 bar in operation.

Magnetic affection on the components:

Magnetic shields are covered to the positioner of each cryogenic valves to avoid magnetic affection. Turbo molecular pump and vacuum gauges are also shielded.

Measurement deviation happens to some CLTS thermometers and capacitance LN_2 level probe. Calibration or replacement is needed after operation.