ICALEPCS2017
Barcelona · Spain, October 8-13
Palau de Congressos de Catalunya
www.icalepcs2017.org

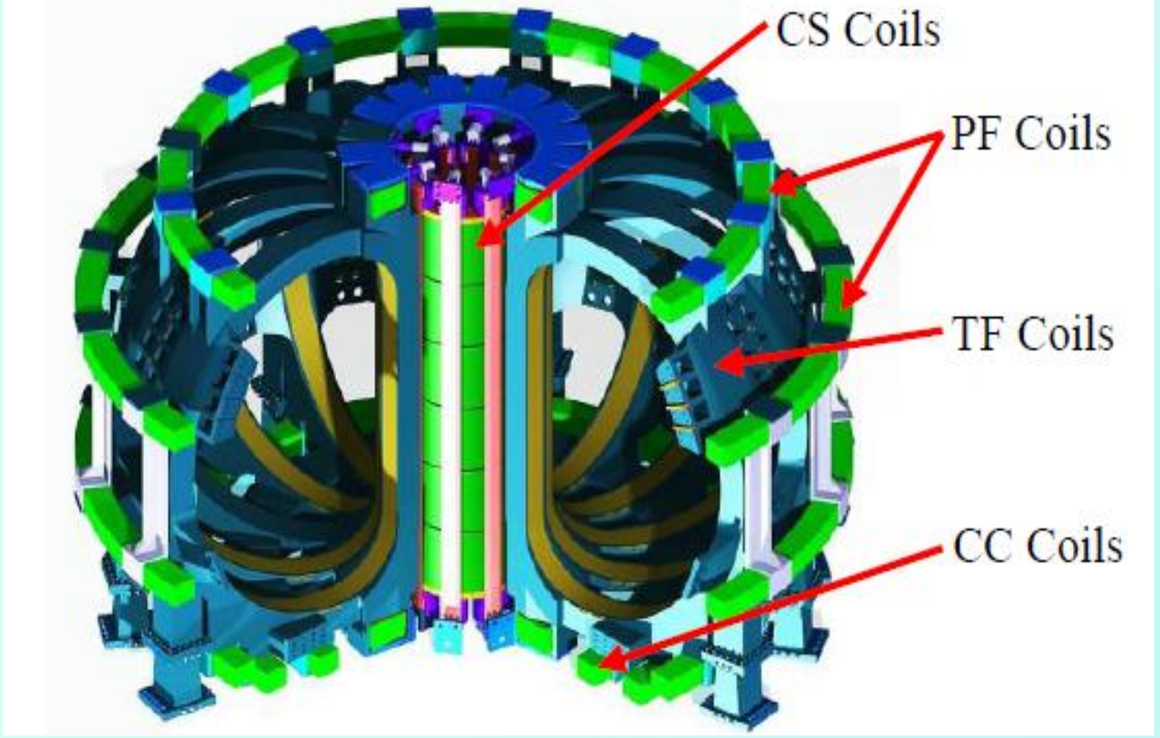
Conceptual Design of the Cryogenic Control System of TF Coil Test Facility

Ming Zhuang Liangbing Hu Zhigang Zhu

Institute of Plasma Physics, Chinese Academy of Sciences Hefei, 230031, China
E-mail: zhm@ipp.ac.cn

INTRODUCTION

- **China Fusion Engineering Test Reactor (CFETR) is superconducting Tokamak device which is next-generation engineering reactor between ITER and DEMO.**
- **Magnet system of CFETR consists of 16 TF coils, 6 CS coils and 6 PF coils and another 2 PF coils(CC1 and CC2) at the bottom of the device to produce the snowflake and super-x equilibrium shape.**
- **The toroidal magnetic field of CFETR is generated by 16 D-shaped superconducting coils which is winded with 132Nb3Sn CICCCs with a height of about 14m and about 11m width.**
- **CFETR TF test facility includes cryogenic system, cryostat, vacuum system, power supply system, magnet protection system, instrumentation and control system.**
- **The cryogenic system of CFETR coil test facility consists of compressors, oil removal system, cold box, pure GHe storage, helium external purifier, impure GHe storage, recovery compressor, LHe dewar, LN2 tanks gas bags and distribution system**
- **This paper presents the conceptual design of cryogenic control system for CFETR TF coil test including of architecture, hardware design and software development.**

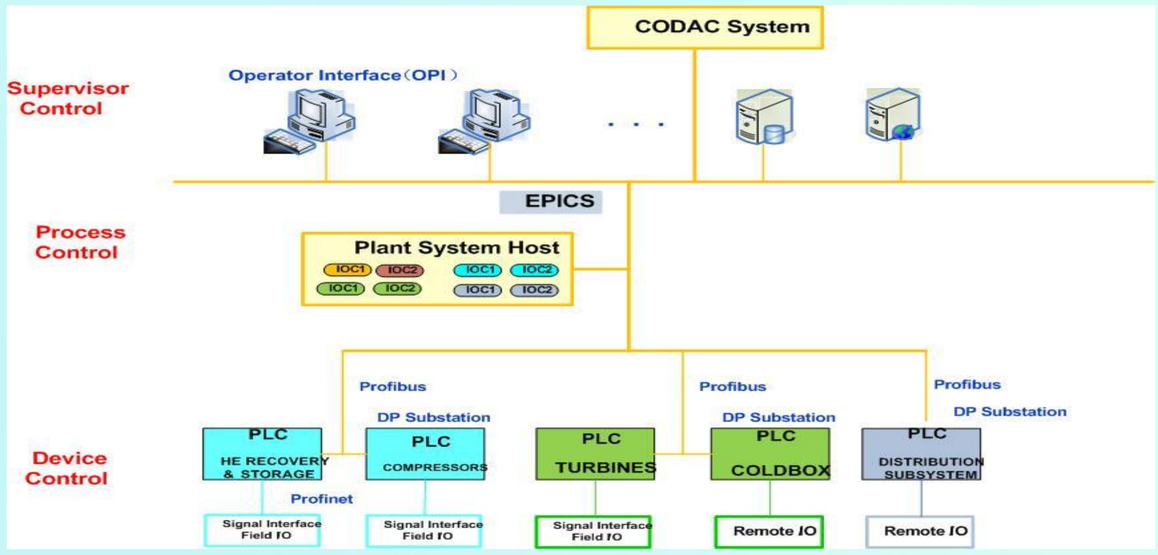


Magnets system of CFETR

Requirements of Cryogenic Control system

- Full and semi automatic operation in all specified steady state and non-stationary modes as well as transitions between the modes.
- Visualization of the system parameters via an operator-friendly and easy for interpretation display of the surveys, symbols, trend-diagrams and reports.
- Adjustment parameters of the system and its separate components.
- Developing of new software and downloading it into the control system without interruption of the helium refrigerator operation.
- Safe shut-down of the helium refrigerator in case of a fault as well as restart after fixing the fault.
- Automatic notification of the concerned parties such as main control room, the helium refrigerator control room, stand by operators, etc. about a failure via hard wired interlocks, SMS and as software signal.
- Archiving the data.
- Possibilities of an easy extension of the control system

Design of Cryogenic Control System



Structure of cryogenic control system

◆The control system is based on EPICS (Experimental Physics and Industrial Control System).

◆The structure software of Programmable Logic controllers (PLC) will be used in the filed device control layer for the implementation of process and operational modes.

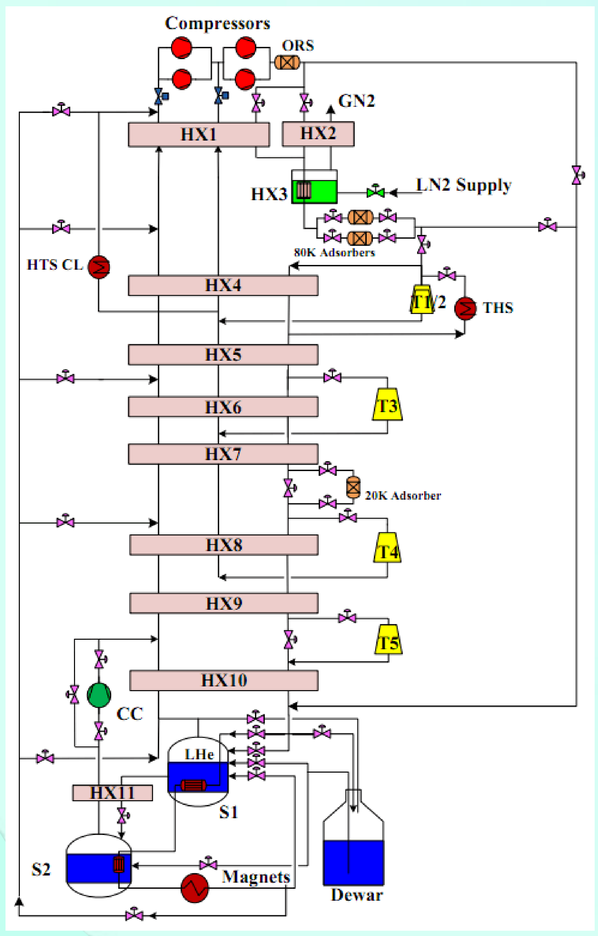
◆There are five PLC sites to be responsible for the subsystem of helium refrigerator including of recovery system, compressor system, turbine system, coldbox and distribution system.

◆The hardware configuration of IOC in process layer selects the cPCI bus industrial computer with VxWorks or Linux operating system.

◆The HMI is developed based on CSS(control system studio)

◆The communication of PLC master controller and subsystem is based on Profibus.

Cryogenic System of TF Coil Test Facility



Basic parameters

●Equivalent Refrigeration
~5kW@4.5K(+Shield Cooling)

●Refrigeration Cycle
Modified Claude Cycle with 5 turbines (LHe temperature level)

●Temperature level
4.5K/3.5K
cold compressor to lower the saturation pressure to 0.47bara

●Operational modes
Standard refrigeration mode,
Peak refrigeration mode,
Liquefier mode

●Cryogenic Users:
TF coils
HTS Current leads
THS Shields

CONCLUSION

◆CFETR TF coil test facility is to test the electromagnetic and stability of TF coils at nominal operating current and cryogenic temperature to minimize the risk of malfunction.

◆ The cryogenic control system for CFETR TF coil test facility has been developed based on EPICS. This conceptual design will be conducive to the engineering design.

◆The control logic and process modes will be analyzed in detail in next step.