PROTOTYPE DESIGN FOR UPGRADING EAST SAFETY AND INTERLOCK SYSTEM

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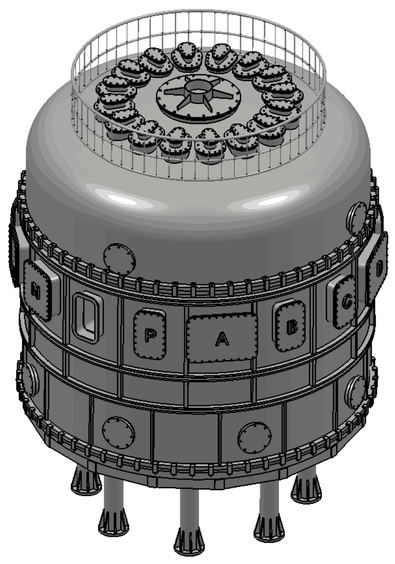
Abstract The national project of experimental advanced superconducting tokamak (EAST) is an important part of the fusion development stratagem of China, which is the first fully superconducting tokamak with a non-circle cross-section of the vacuum vessel in the world. The safety and interlock system (SIS) is in charge of the supervision and control of all the EAST components involved in the protection of human and tokamak from potential accidents. A prototype for upgrading EAST SIS has been designed. This paper presents EAST machine and human protection mechanism and the architecture of the upgrading central safety and interlock system.

Background

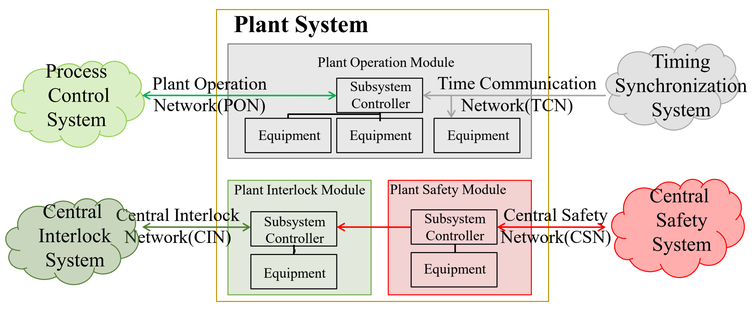
Experimental Advanced Superconducting Tokamak (EAST)

Magnetically Confined Fusion Engineering



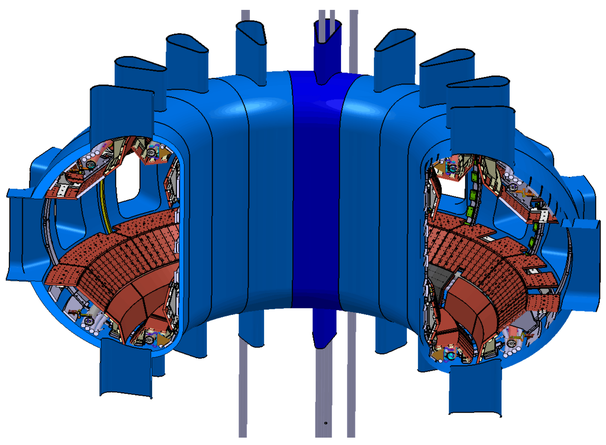
Main parameters of fusion project	
Toroidal field, B_0	3.5 T
Plasma current, I_p	1 MA
Major radius, R_0	1.7 m
Minor radius, a	0.4 m
Aspect ratio, R/a	4.25
Elongation, K_x	1.6-2
Triangularity, δ_x	0.6-0.8
Neutral Beam Injection	4 MW/ line
2.45GHz Lower Hybrid Current Drive	4 MW
4.6 GHz Lower Hybrid Current Drive	6 MW
Electron Cyclotron Resonance Heating	1 MW
Core Temperature	~ 100 million
Pulse Length	~1000s

Motivation



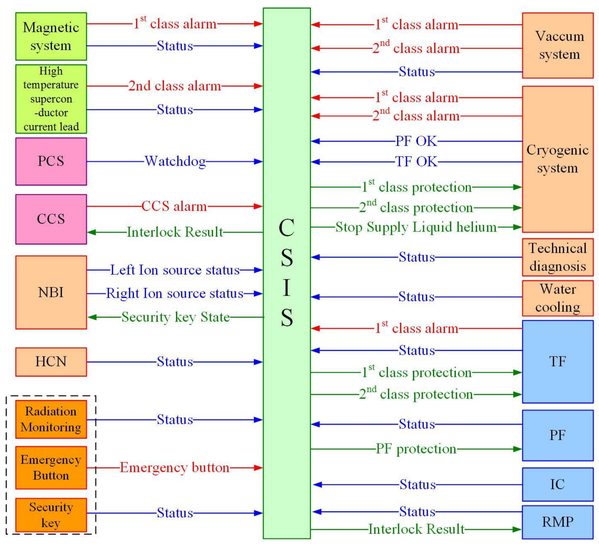
Main Goals:

- Response time ~ 50us
- More stable
- Friendly HMI
- Integrated safety function

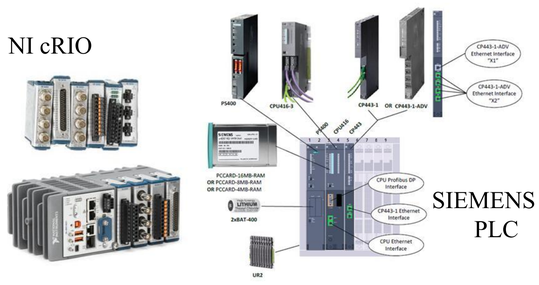


Main Subsystems	
Vacuum	SLOW
Cryogenic System	SLOW
Power Supply System	FAST
Water Cooling System	SLOW
Plasma Diagnostics	SLOW
Data Acquisition & Central Control	FAST
Plasma Control System	FAST
Ion Cyclotron Range of Frequency	FAST
Lower Hybrid Current Drive	FAST
Electron Cyclotron Resonance Heating	FAST
Neutral Beam Injection	FAST

Interface between CSIS and plant systems

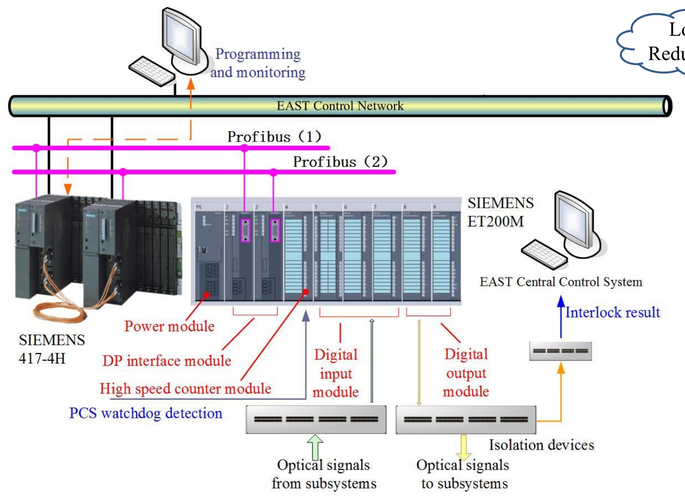


Signal	Value	Response
Status	High	OK
	Low	alarm
1st class alarm	High	1st class protection
	Low	OK
2nd class alarm	High	2nd class protection
	Low	OK
Protection	High	actuator
	Low	null

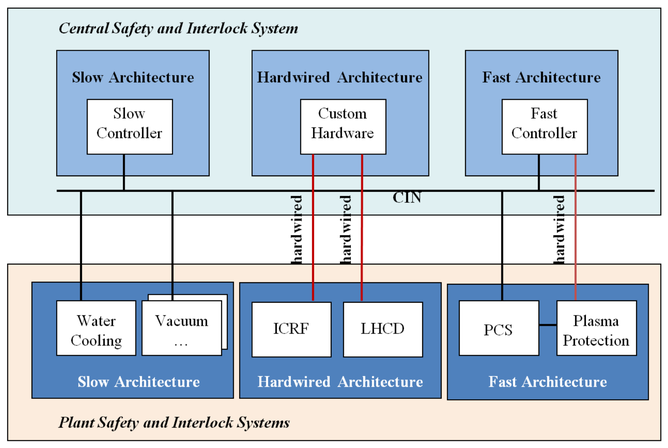


Hardware for FAST & SLOW architecture

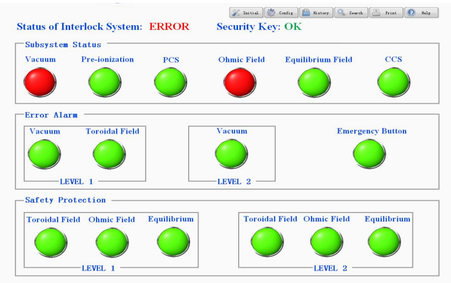
System Components



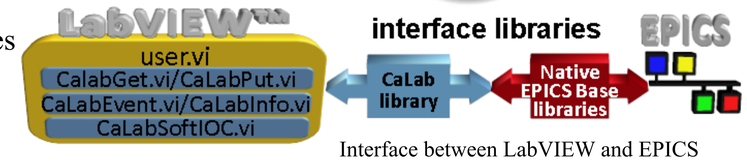
Implement of CSIS slow architecture



Structure of the prototype SIS



- Supports all EPICS data types
- Low network load
- Easy create, read and write EPICS variables

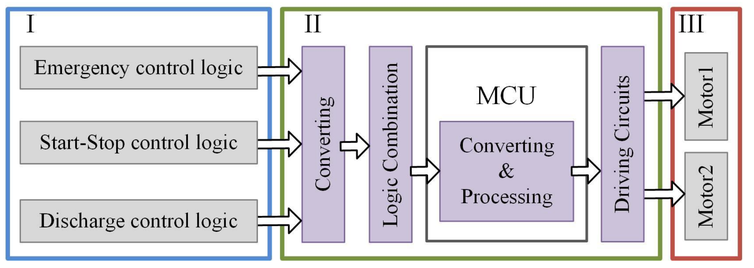


Interface between LabVIEW and EPICS

Personal Safety Facilities in CSIS

Security key | Face recognition switch | Emergency button | Neutron (n) and Gamma ray (c) detector

All the statuses are integrated in the central safety and interlock system



Logic in Part I decides the states of motors' rotation and water door's proper position

Summary

EAST central safety and interlock system has been designed. SIEMENS PLC and National Instruments cRIO are integrated into a single system taking care of slow and fast interlock functions. The fast safety and interlock system is able to react within 50μs. Work supported by the National Key R&D Program of China No.2017YFE0300504 and No.2018YFE0302104.