ITER Controls Design Status & Progress

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Acknowledgements:
Many colleagues in the CODAC group, ITER Members and ITER IO

Synopsis

- ITER Project Quick Start
- System Scope & Management Challenges
- Some Current Activities

What are ITER's Aims?

The overall programmatic objective:

- to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes.

- **The principal goal:**
  - to design, construct and operate a tokamak experiment at a scale which satisfies this objective.

- **ITER** is designed to confine a plasma in which α-particle heating dominates all other forms of plasma heating:

$\Rightarrow$ ITER will be the world's first experimental fusion reactor with a **self-sustained burning** plasma of **several hundred** seconds (Inductive operation) to **several thousand** seconds (Non-inductive operation) duration

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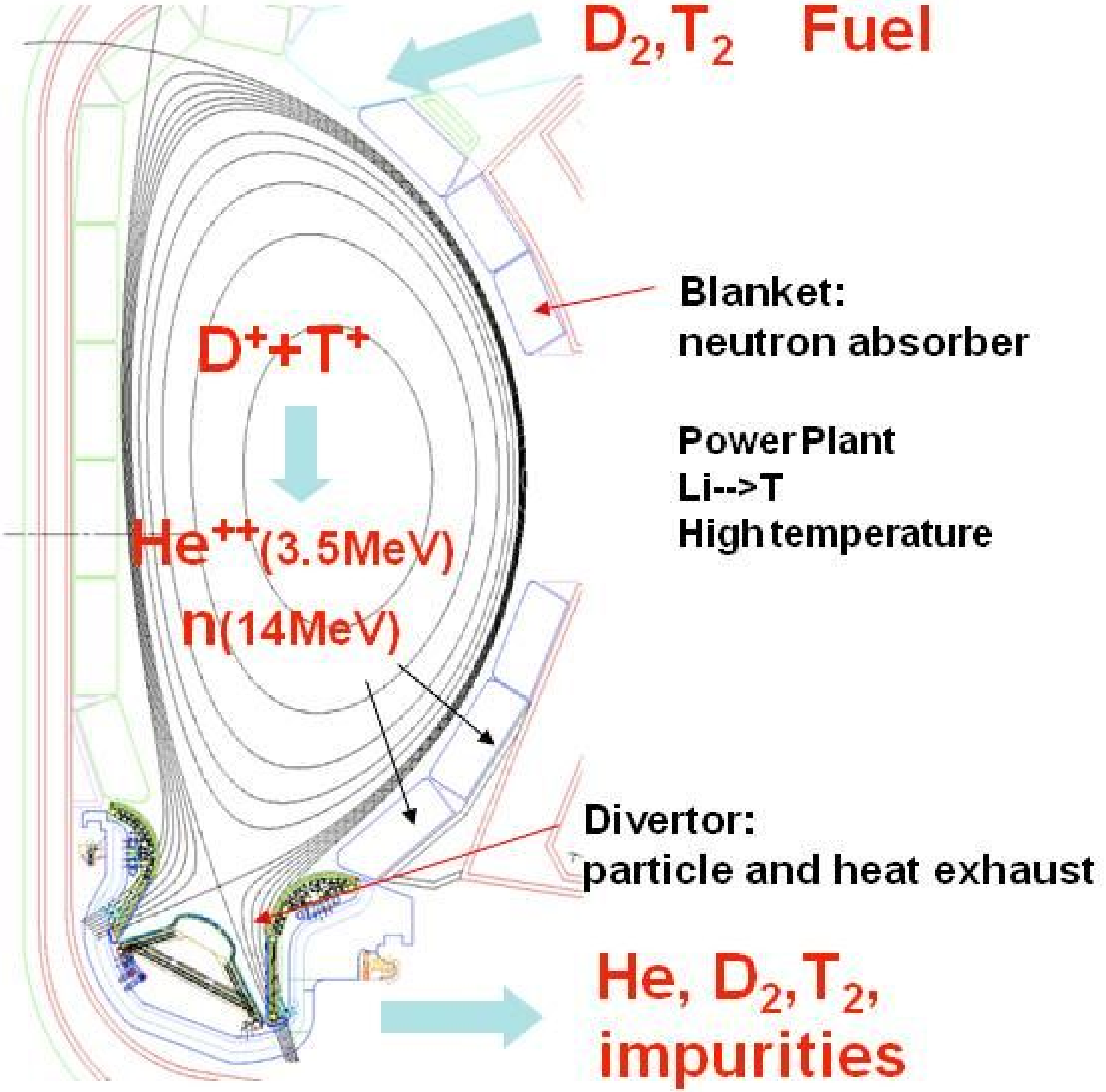
Challenge #1: Long Plasma Pulses

Fusion Power Production in ITER

ITER Plasma:

R/a:	6.2 m /2 m
Volume:	830 m^3
Plasma Current:	15 MA
Toroidal field:	5.3 T
Density:	10^{20} m^{-3}
Peak Temperature:	2×10^8 K
Fusion Power:	500 MW
Plasma Burn	300 - 500 s
(“Steady-state”	~3000 s)



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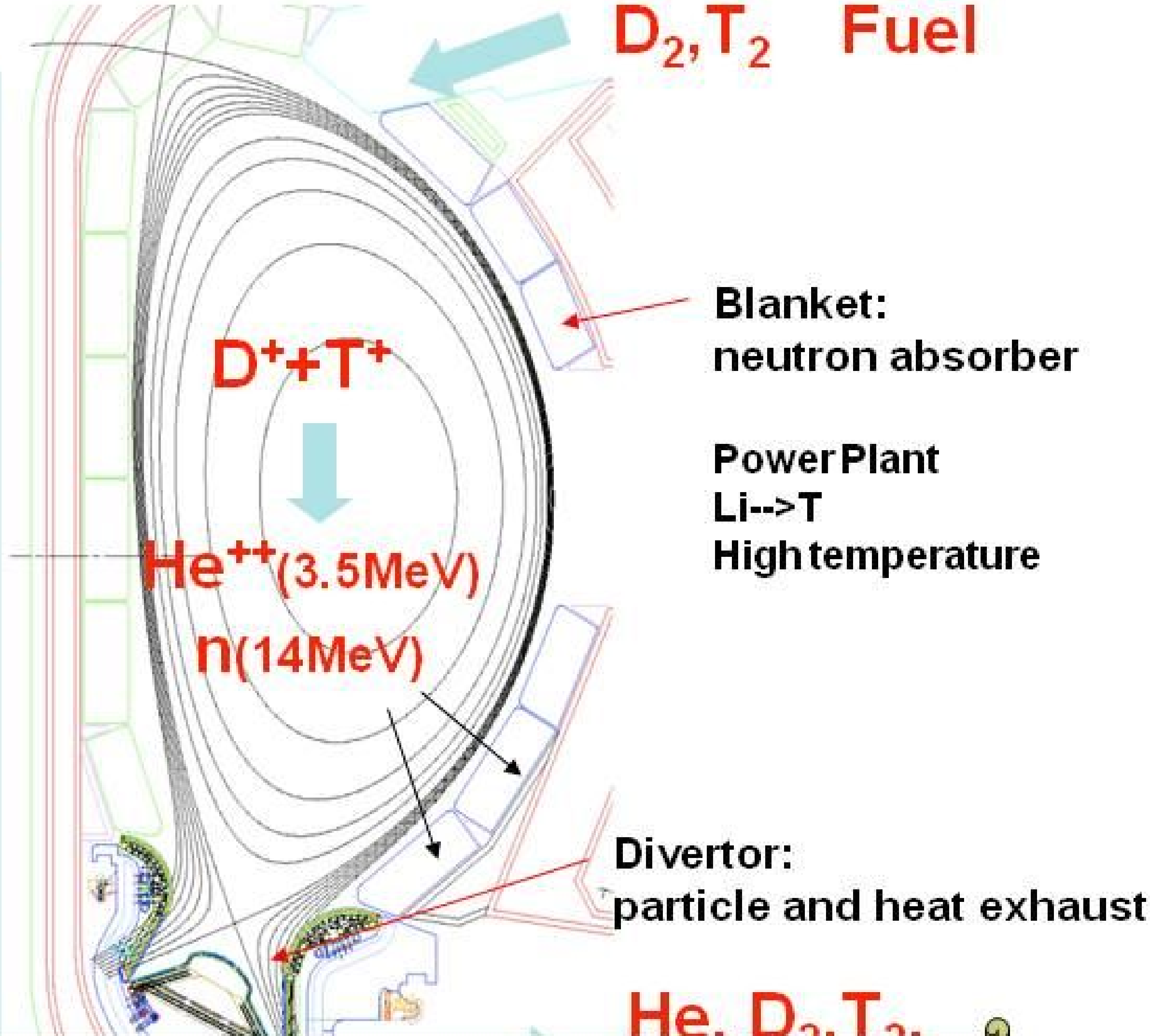
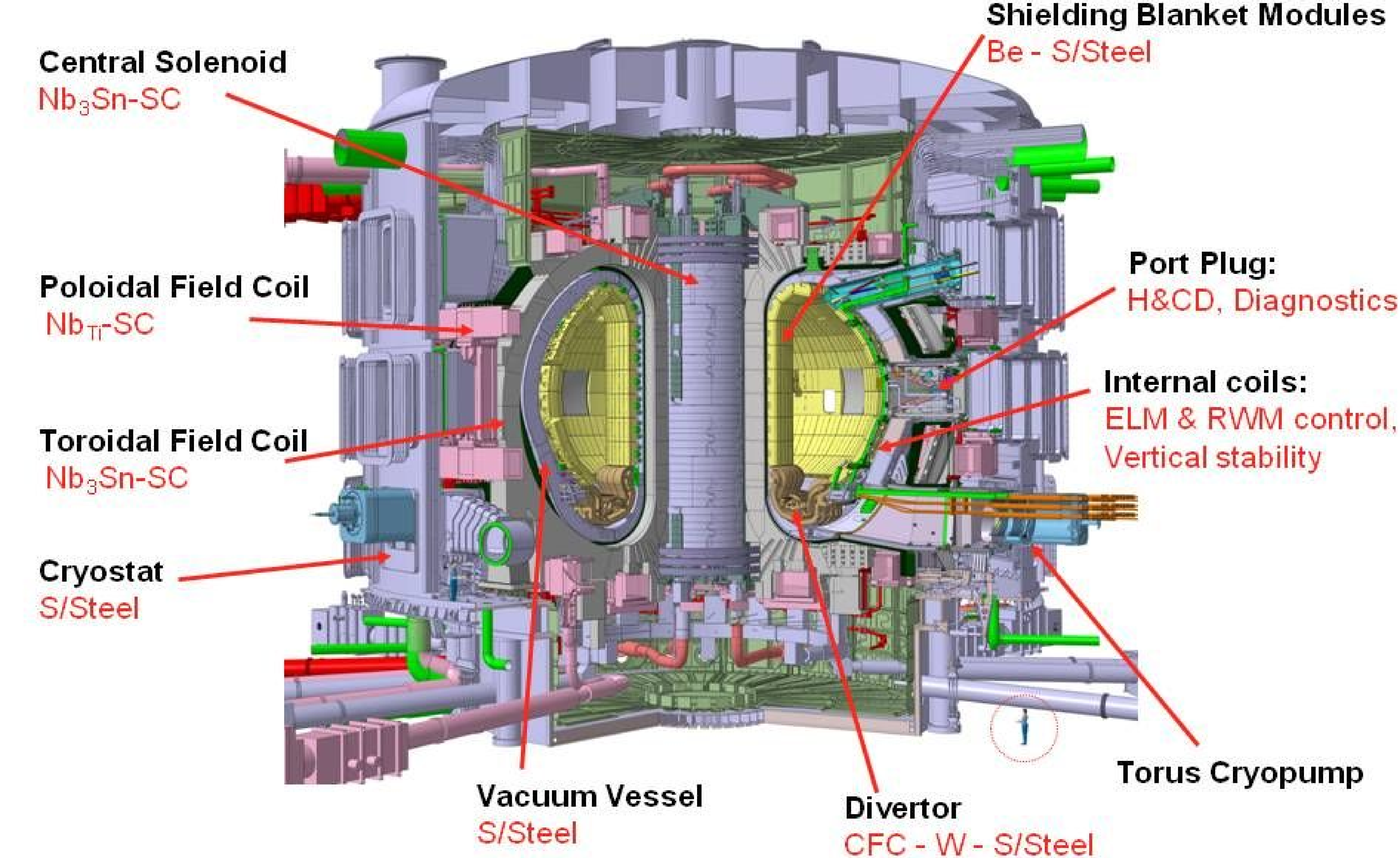
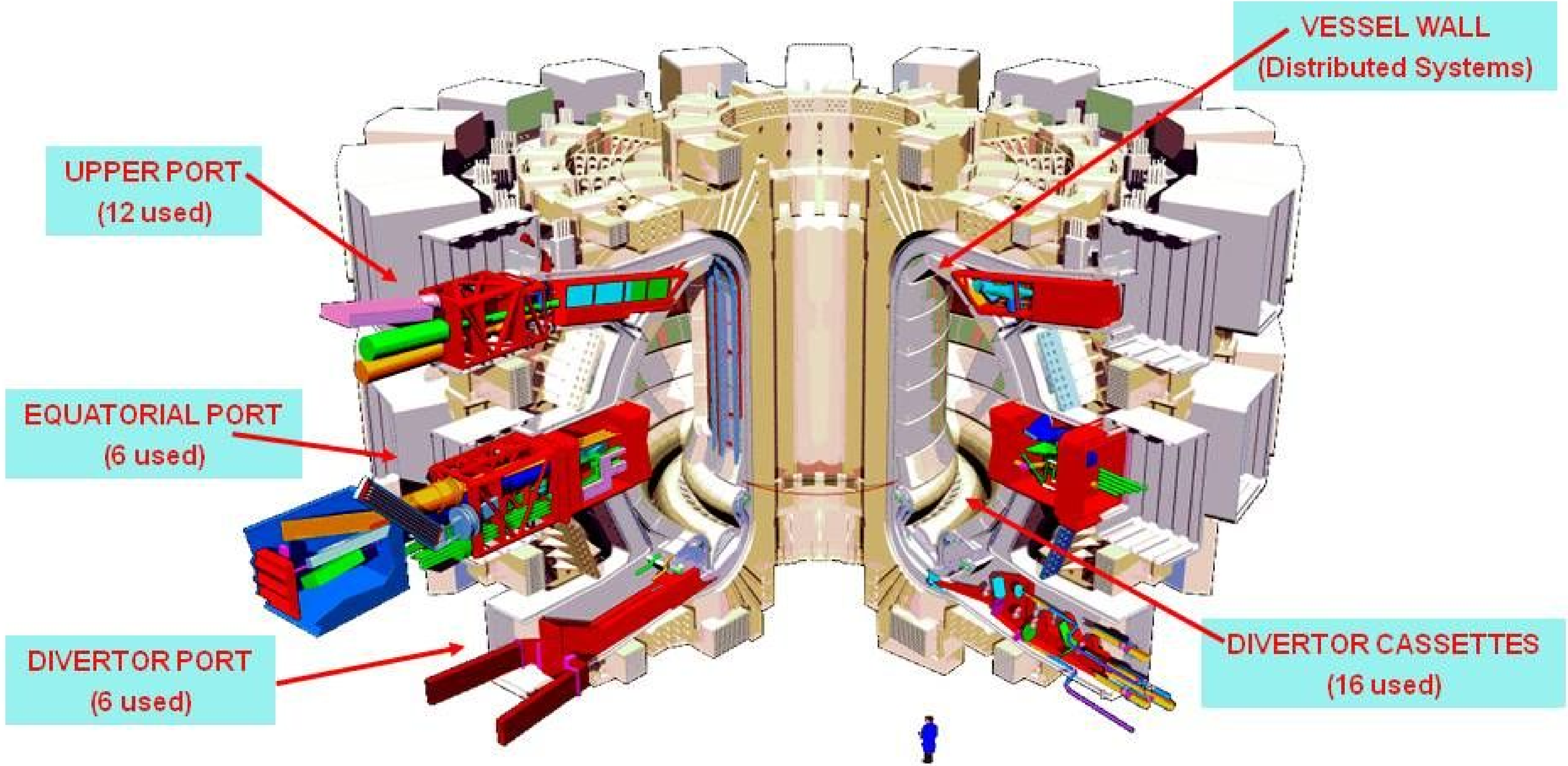


Challenge #2: Nuclear Installation

Overview of the ITER Tokamak

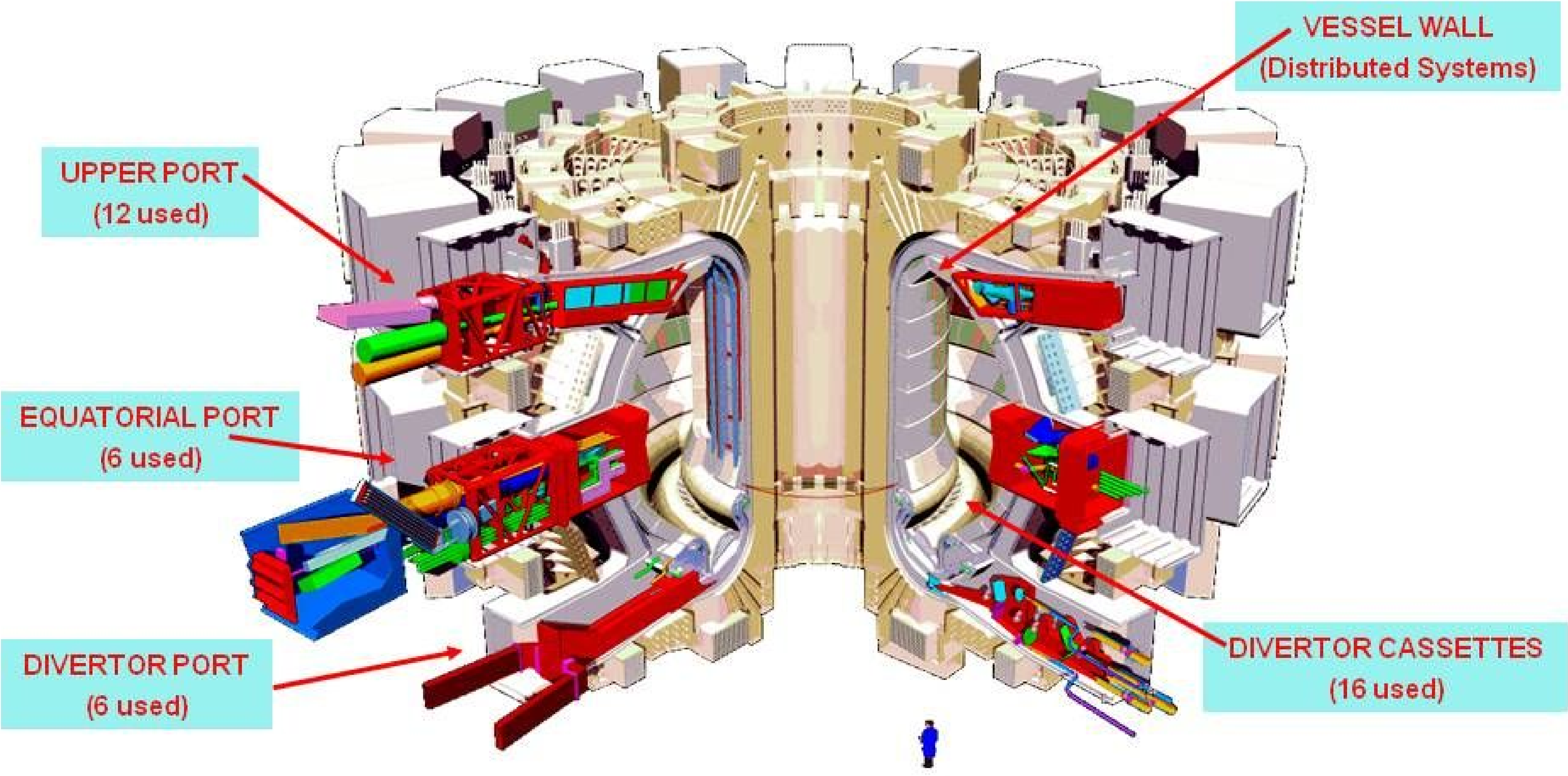


Plasma Diagnostics



- **About 40 large scale plasma measurements systems foreseen:**
  - Measurements from DC to γ-rays, neutrons, α-particles, plasma species
  - Diagnostics required for protection, control and physics studies

Plasma Diagnostics



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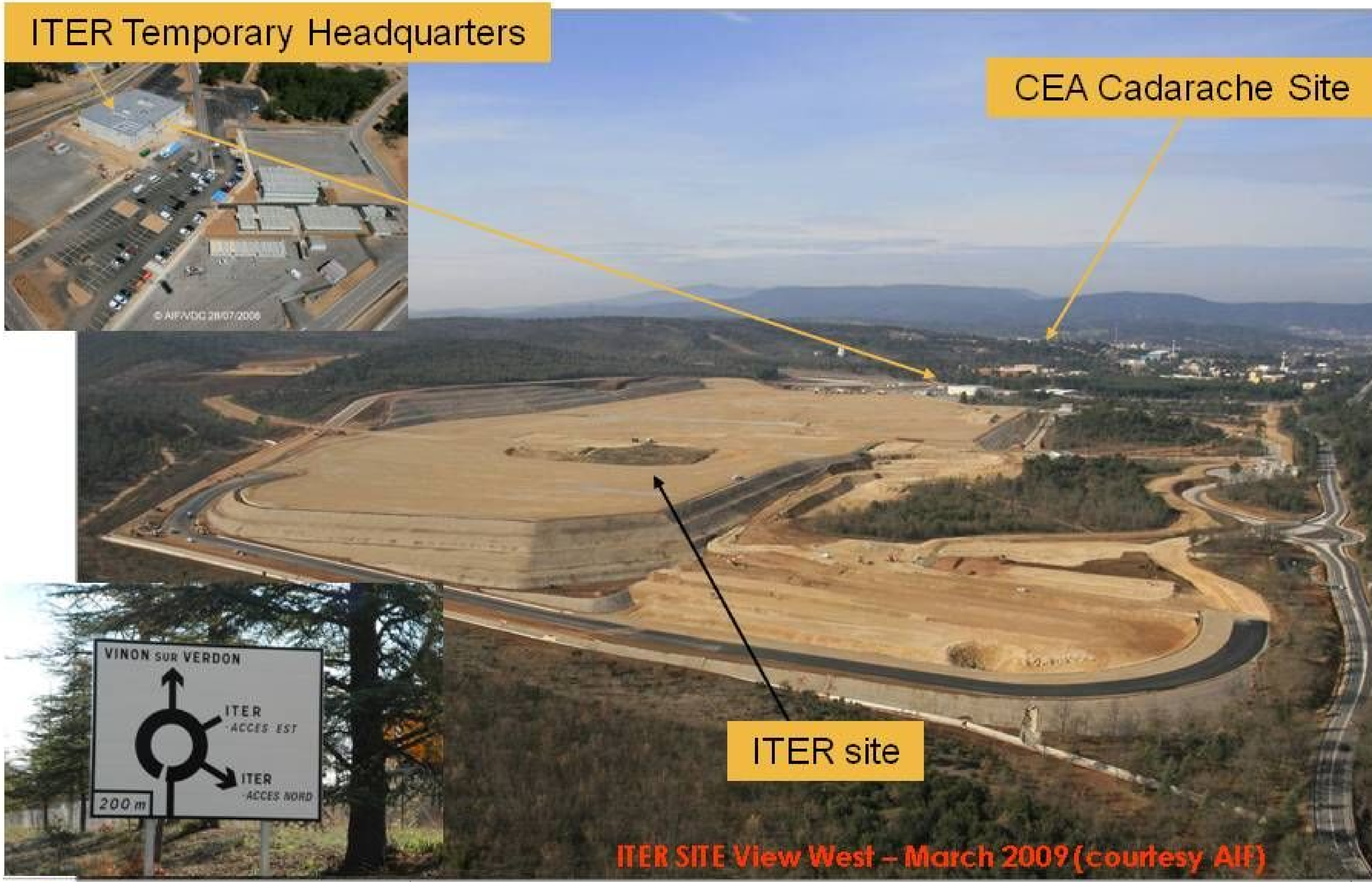
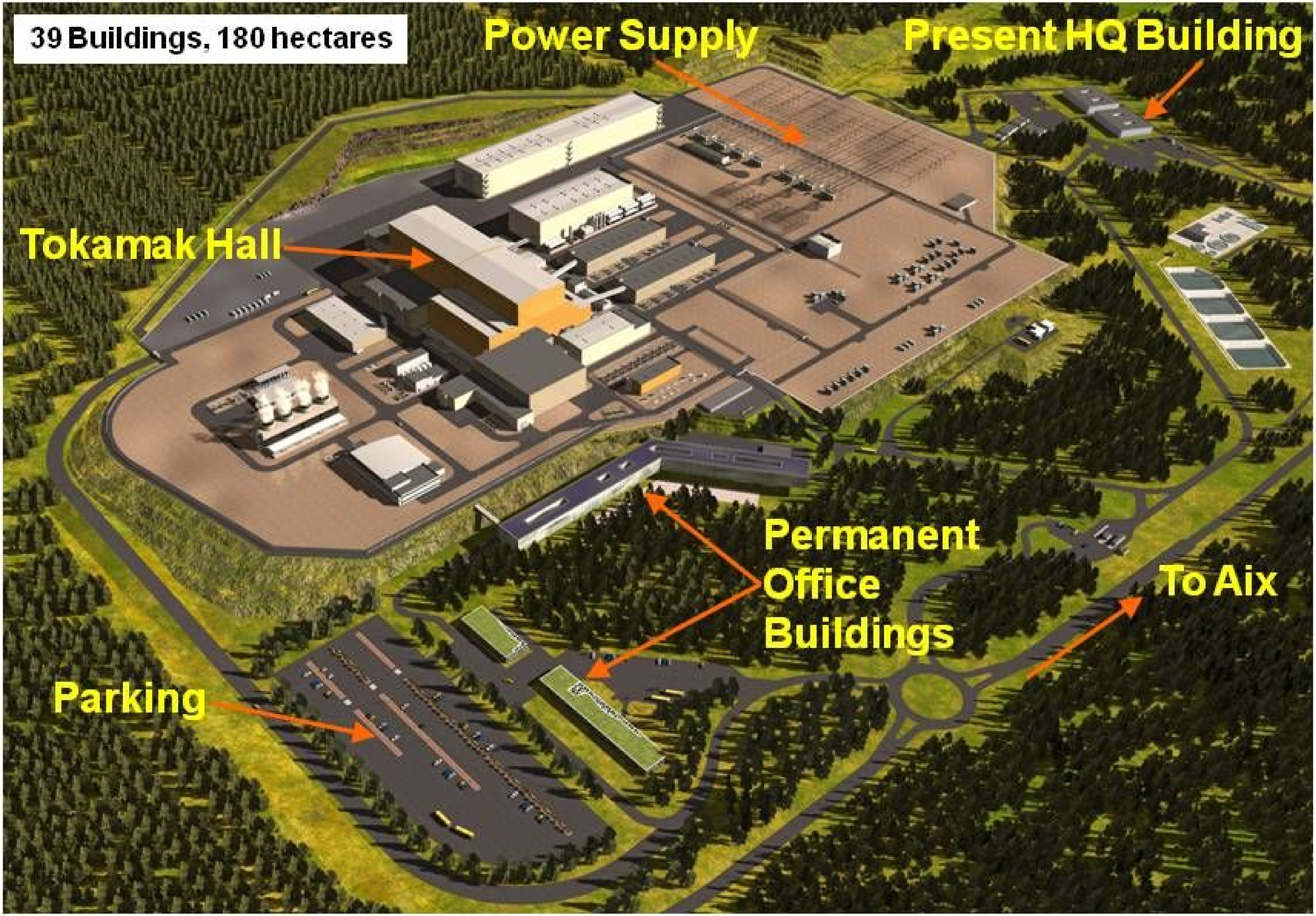
Challenge #3: Huge and Complex

ITER Construction at Cadarache

ITER Site preparations advancing - platform leveling complete



ITER Site End of Construction



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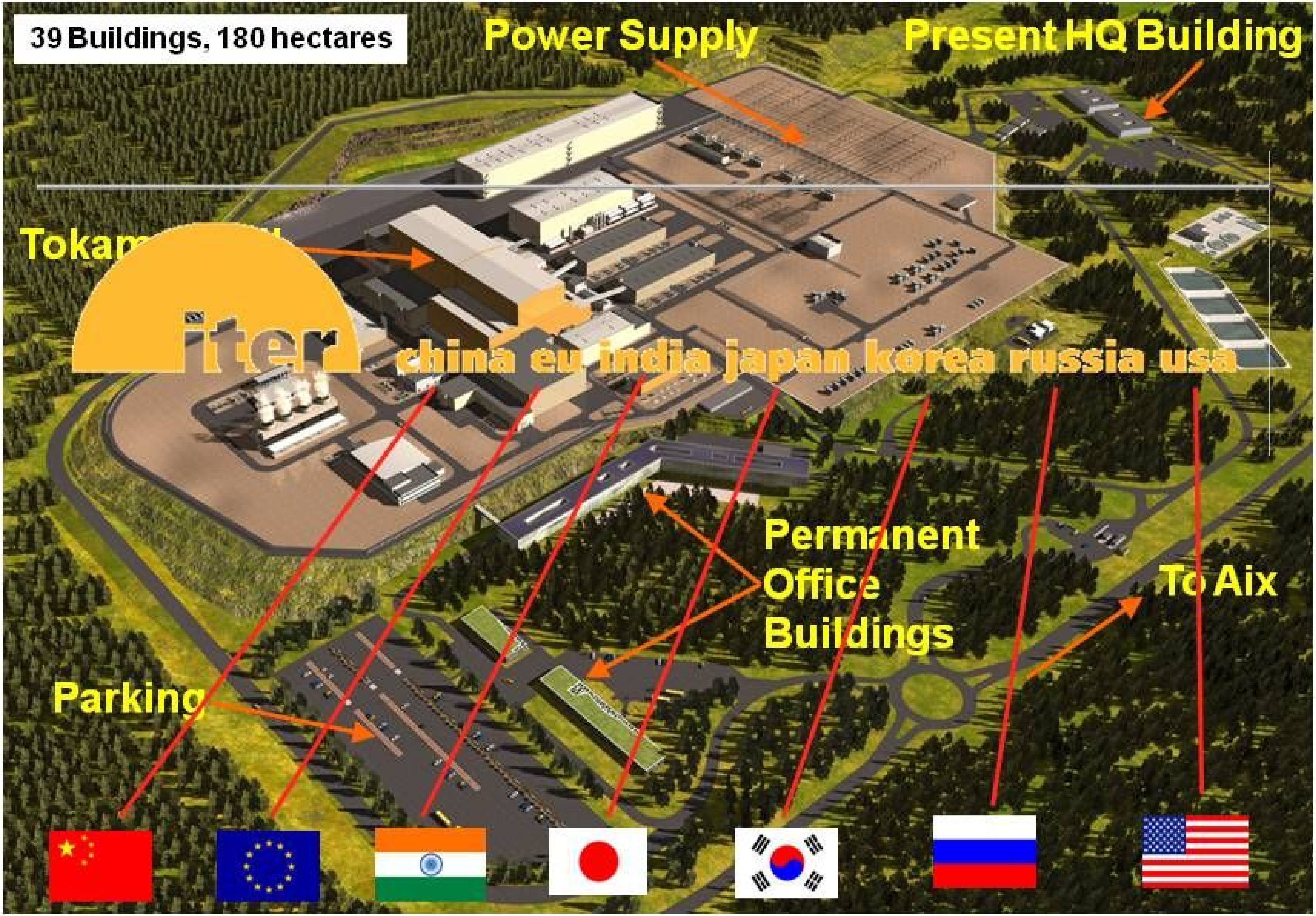
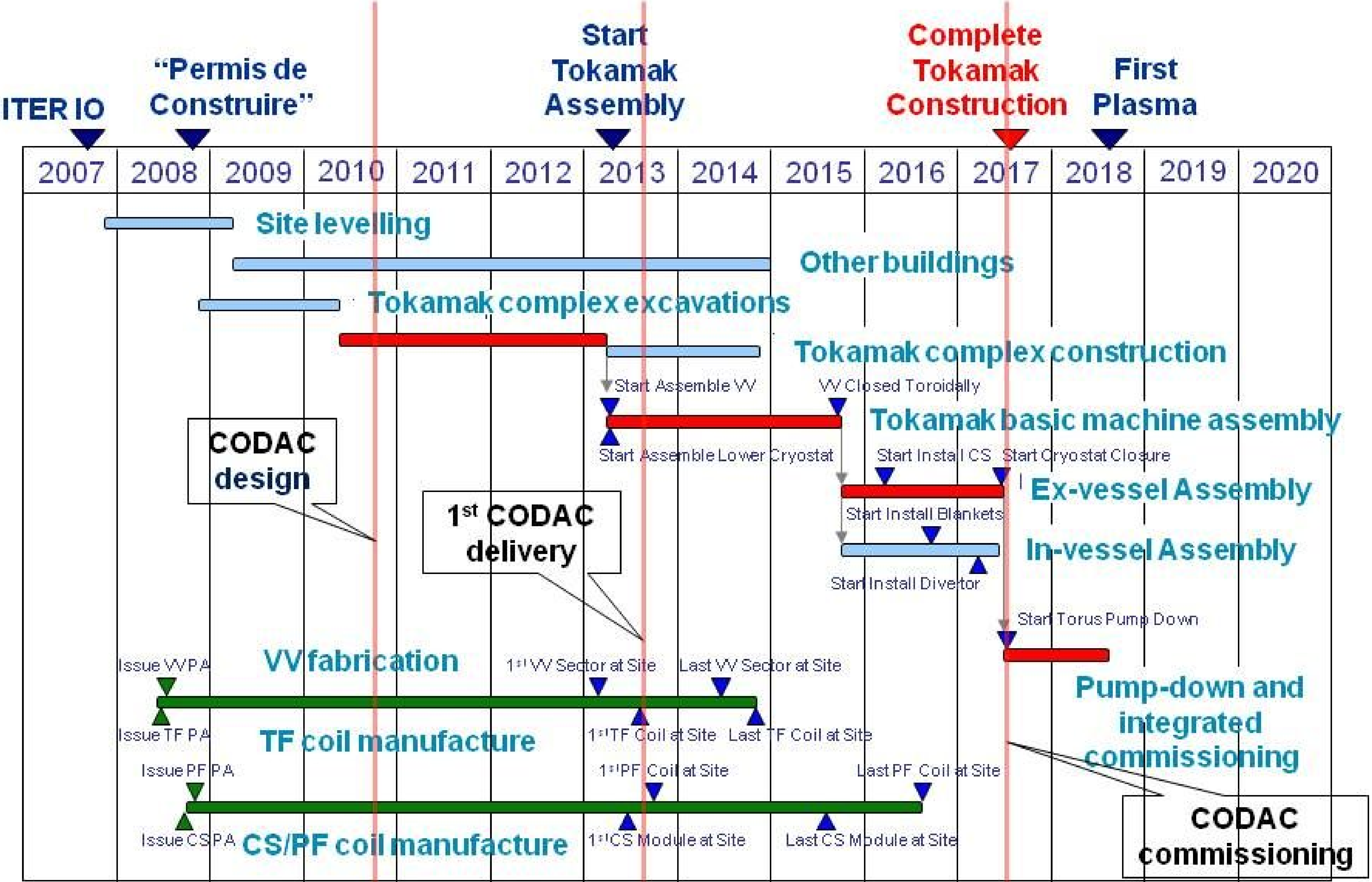


ITER Reference Project Schedule



Project Schedule under revision as part of revised Project Baseline preparation !!!

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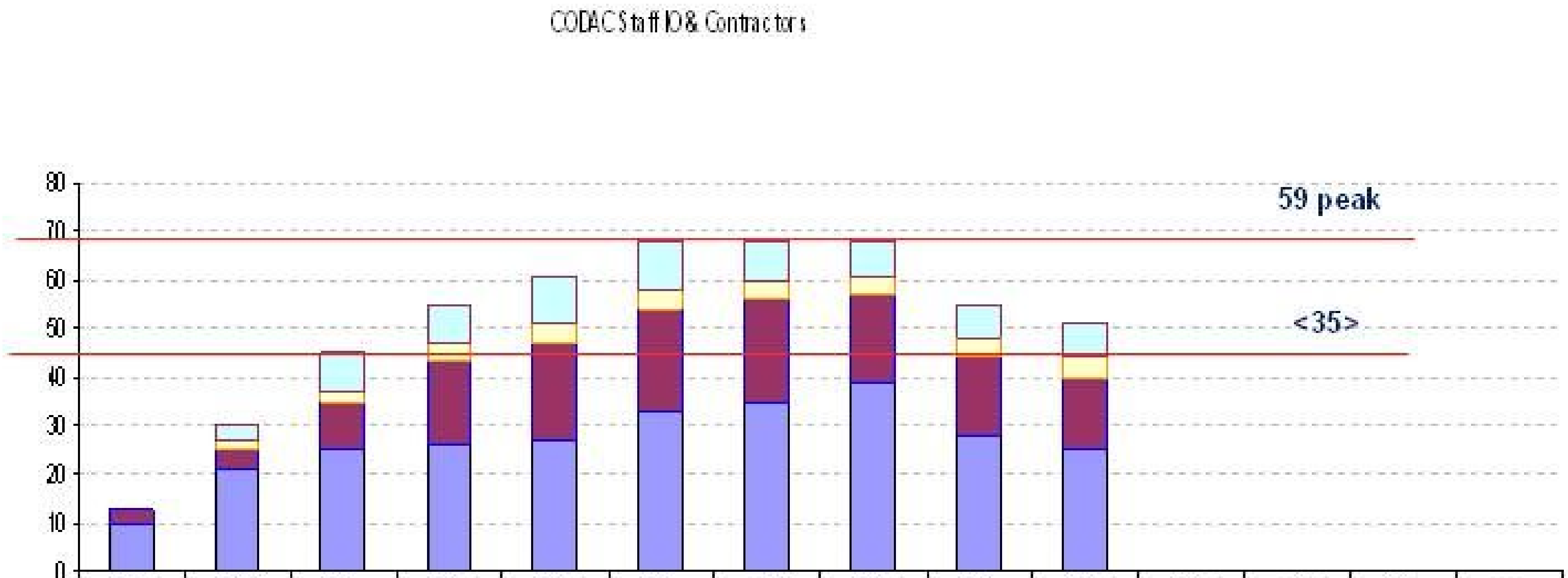
Brief History

A conceptual design of CODAC was developed by Jo Lister, with support from the fusion community, in 2006 and 2007.

This conceptual design was successfully reviewed in Nov 2007.

A CODAC group started to form at ITER Organization Cadarache in spring 2008.

Today that group counts 14 and will raise to 19 at the end of 2009.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Technician Support - Contractors	0	3	8	8	10	10	8	7	7	7				
Engineering Support - Contractors	0	2	2	4	4	4	4	4	4	4				
IO SUPPORT STAFF	3	4	10	17	20	21	21	18	16	15				
IO PROFESSIONAL STAFF	10	21	25	26	27	33	35	39	28	25	0	0	0	0

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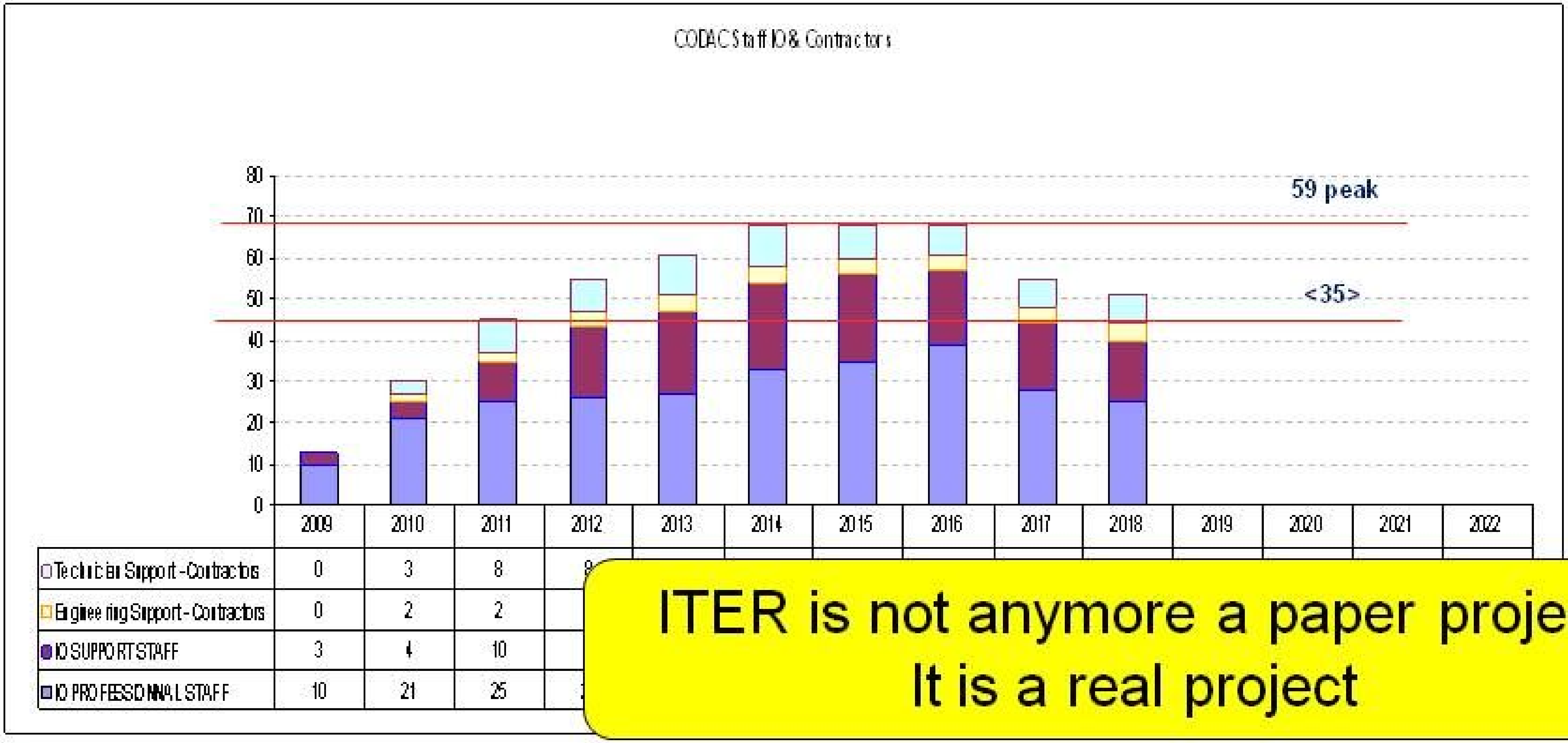
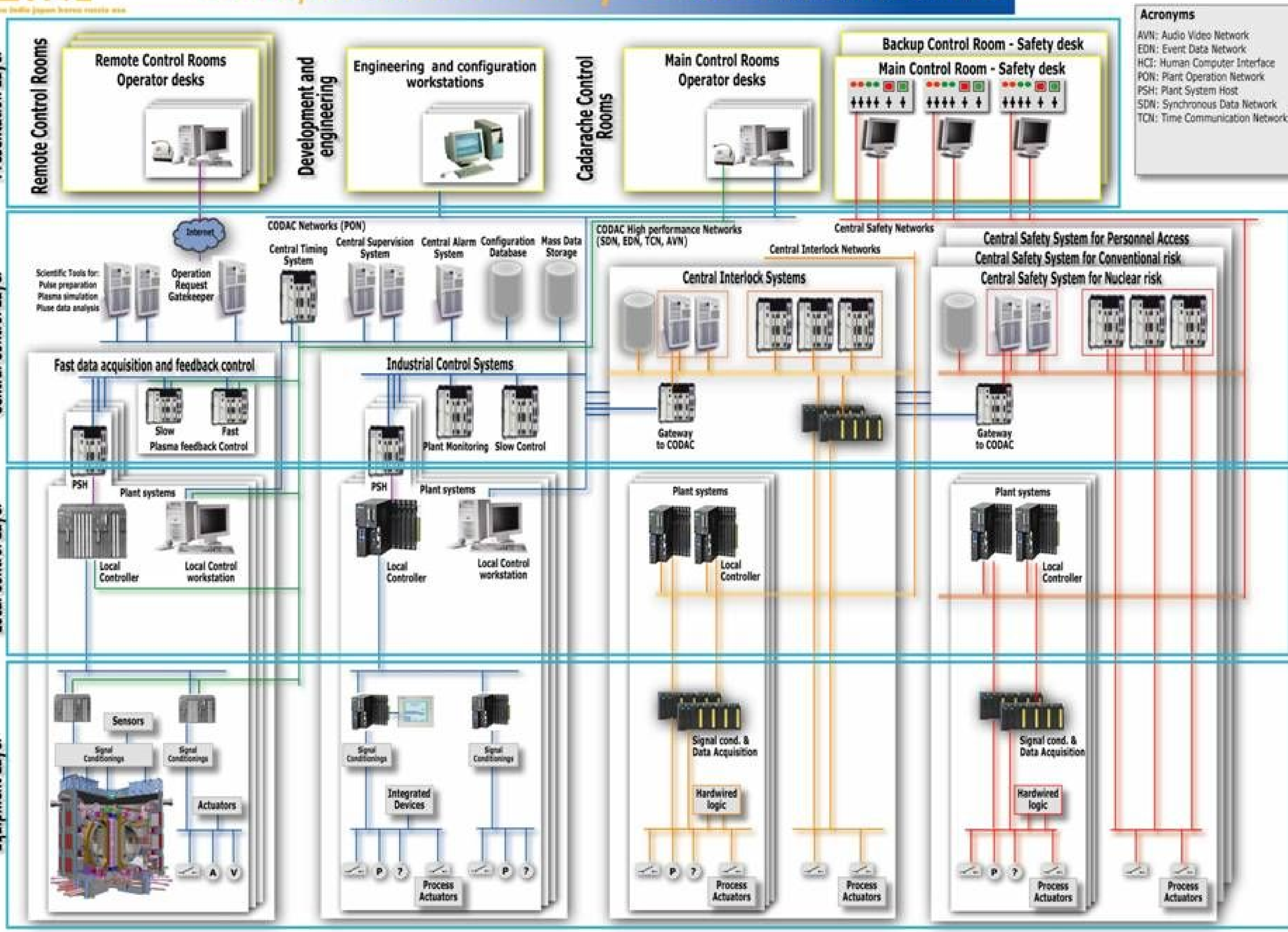
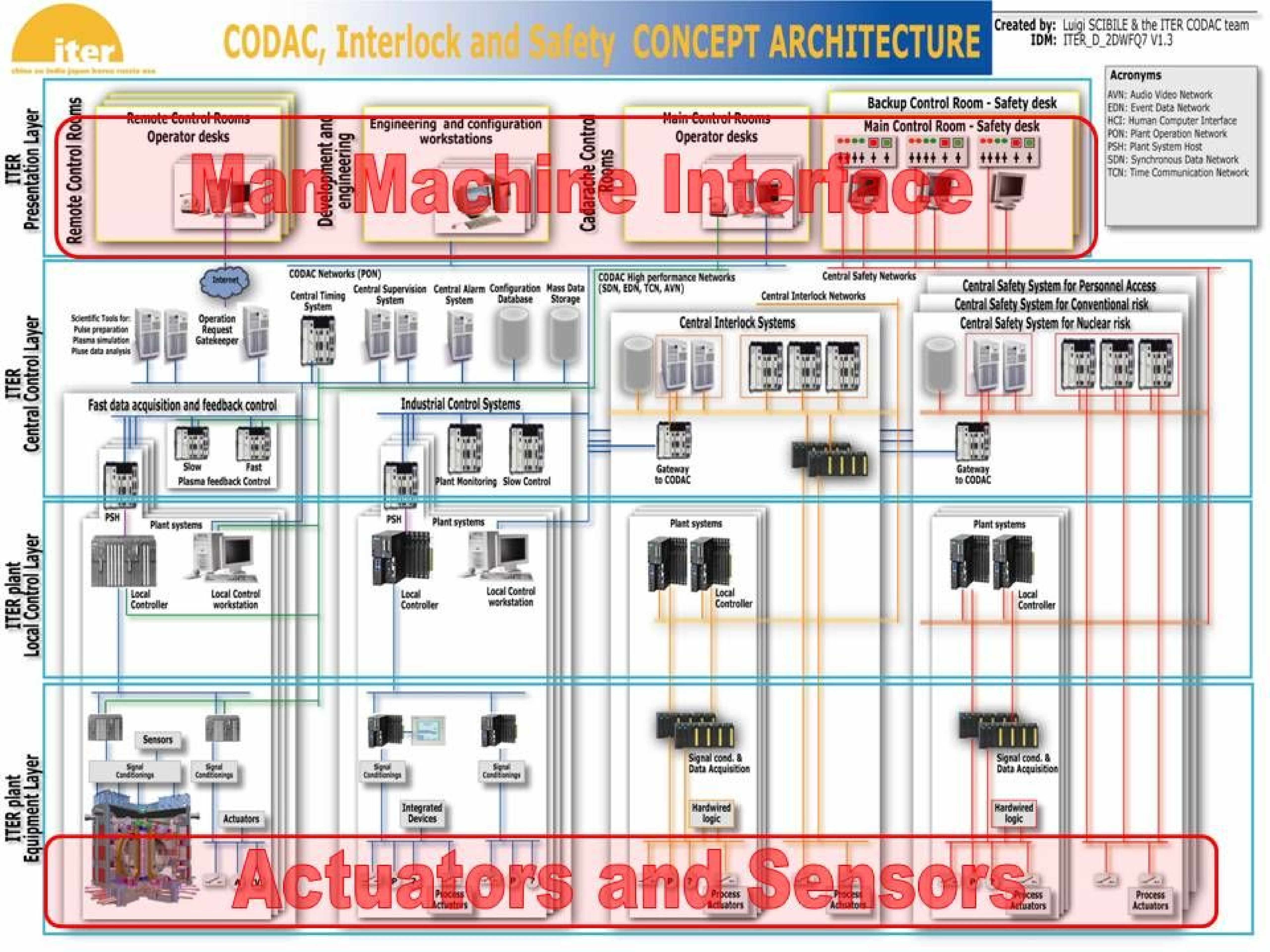


ITER is not anymore a paper project
It is a real project

CODAC, Interlock and Safety CONCEPT ARCHITECTURE

Created by: Luigi SCIBILE & the ITER CODAC team
IDM: ITER_D_2DWFQ7 V1.3




CODAC, Interlock and Safety CONCEPT ARCHITECTURE
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Acronyms
AVN: Audio Video Network
EDN: Event Data Network
HCI: Human Computer Interface
PON: Plant Operation Network
PSH: Plant System Host
SDN: Synchronous Data Network
TCN: Time Communication Network
ITER Presentation Layer
Remote Control Rooms
Remote Control Rooms Operator desks
Development and engineering
Engineering and configuration workstations
Cadarache Control Rooms
Main Control Rooms Operator desks
Backup Control Room - Safety desk
Main Control Room - Safety desk
Man Machine Interface
ITER Central Control Layer
Internet
CODAC Networks (PON)
Scientific Tools for: Pulse preparation Plasma simulation Pluse data analysis
Operation Request Gatekeeper
Central Timing System
Central Supervision System
Central Alarm System
Configuration Database
Mass Data Storage
CODAC High performance Networks (SDN, EDN, TCN, AVN)
Central Safety Networks
Central Interlock Networks
Central Interlock Systems
Central Safety System for Personnel Access
Central Safety System for Conventional risk
Central Safety System for Nuclear risk
Fast data acquisition and feedback control
Slow
Fast
Plasma feedback Control
Industrial Control Systems
Plant Monitoring
Slow Control
Gateway to CODAC
Gateway to CODAC
ITER plant Local Control Layer
PSH
Plant systems
Local Controller
Local Control workstation
PSH
Plant systems
Local Controller
Local Control workstation
Plant systems
Local Controller
Plant systems
Local Controller
ITER plant Equipment Layer
Sensors
Signal Conditionings
Signal Conditionings
Actuators
Signal Conditionings
Signal Conditionings
Integrated Devices
Signal cond. & Data Acquisition
Hardwired logic
Signal cond. & Data Acquisition
Hardwired logic
Process Actuators
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Process Actuators
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Actuators and Sensors

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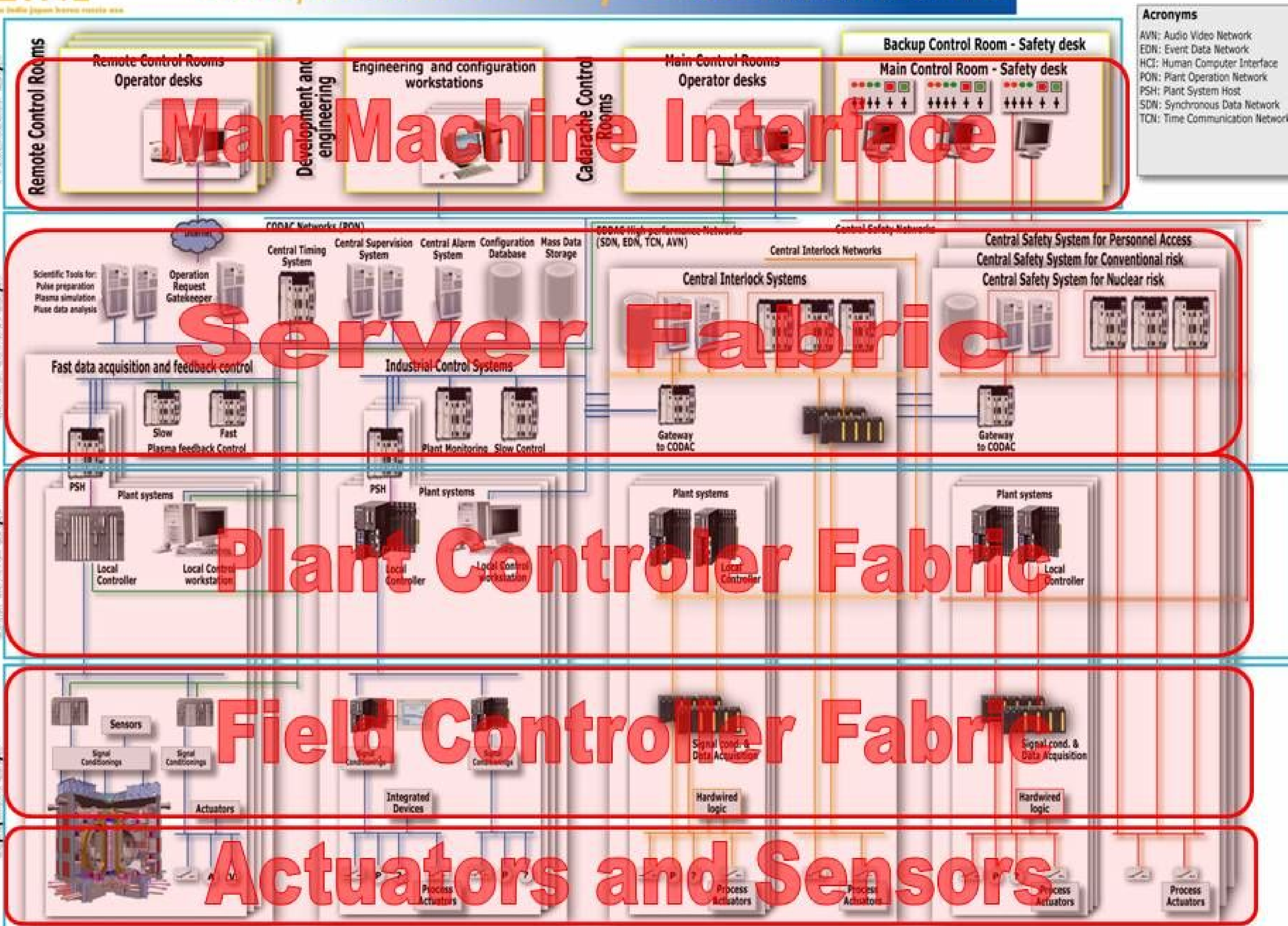
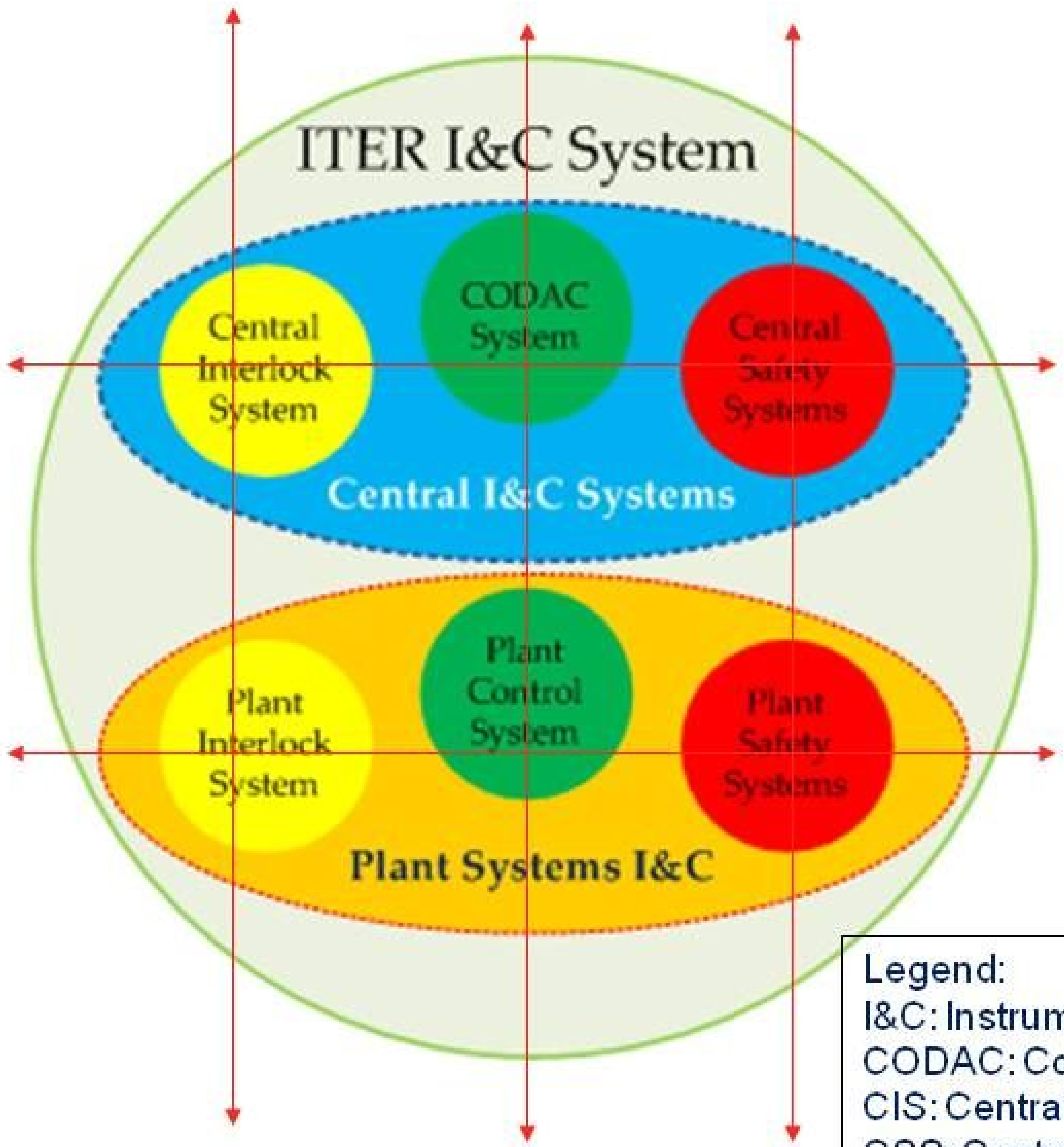


Definitions



Legend:
I&C: Instrumentation and Control
CODAC: Control, Data Access and Communication
CIS: Central Interlock System
CSS: Central Safety System

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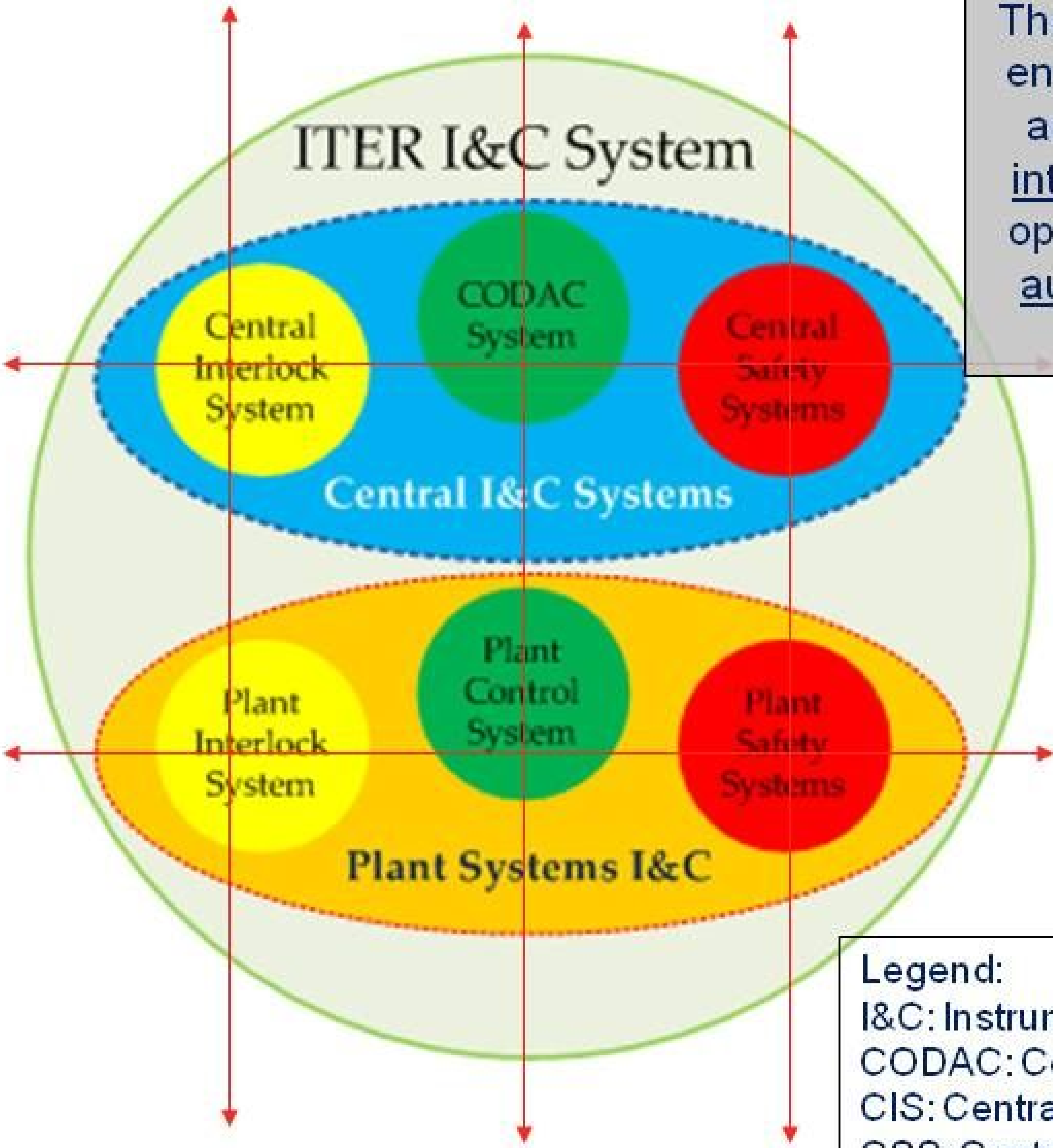

The primary goal of ITER I&C is to ensure all ITER Plant System I&C are designed, implemented and integrated such that ITER can be operated as a fully integrated and automated system from a single main control room.

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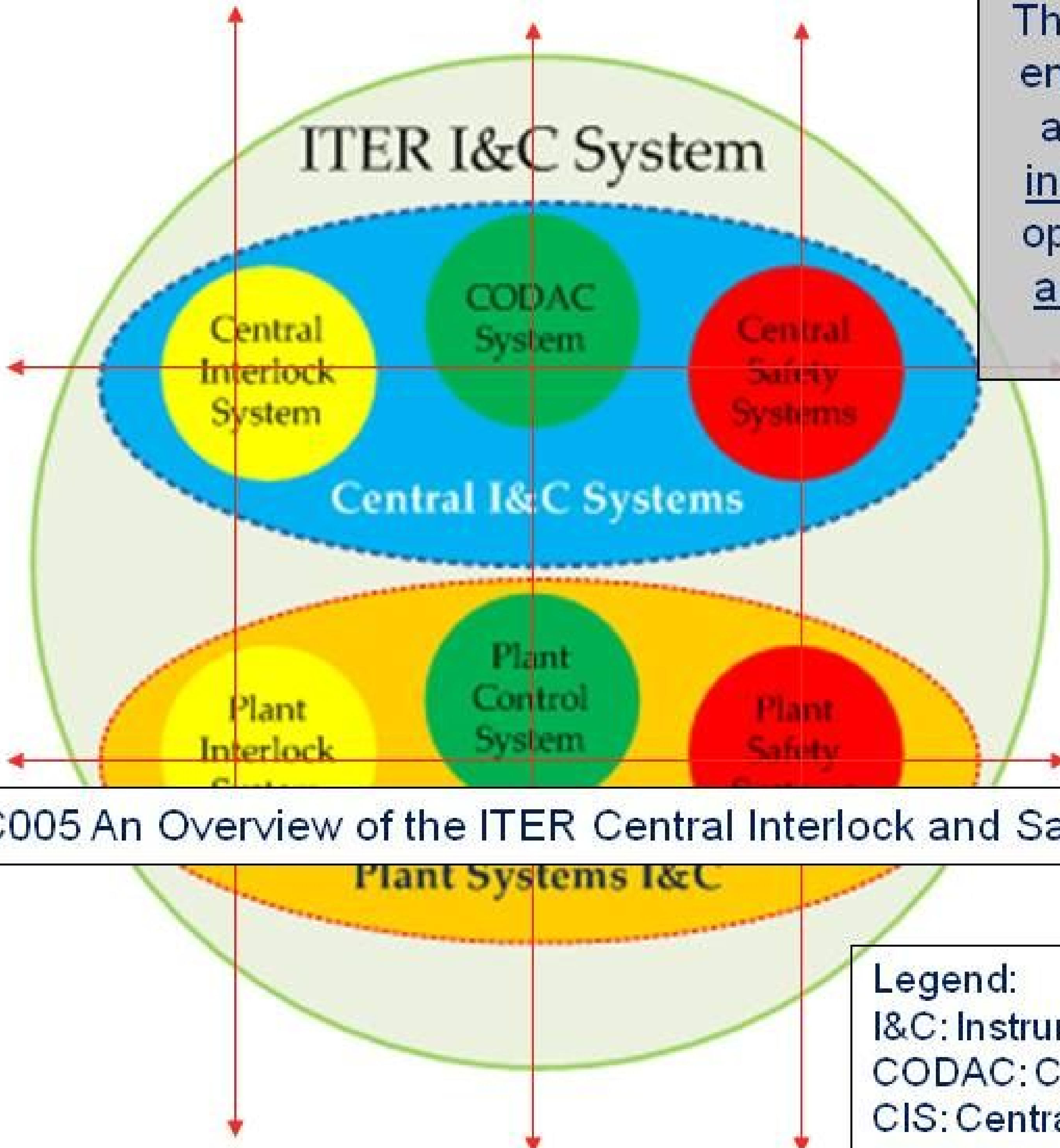

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WEC005 An Overview of the ITER Central Interlock and Safety Systems, L.Scibile(ITER)

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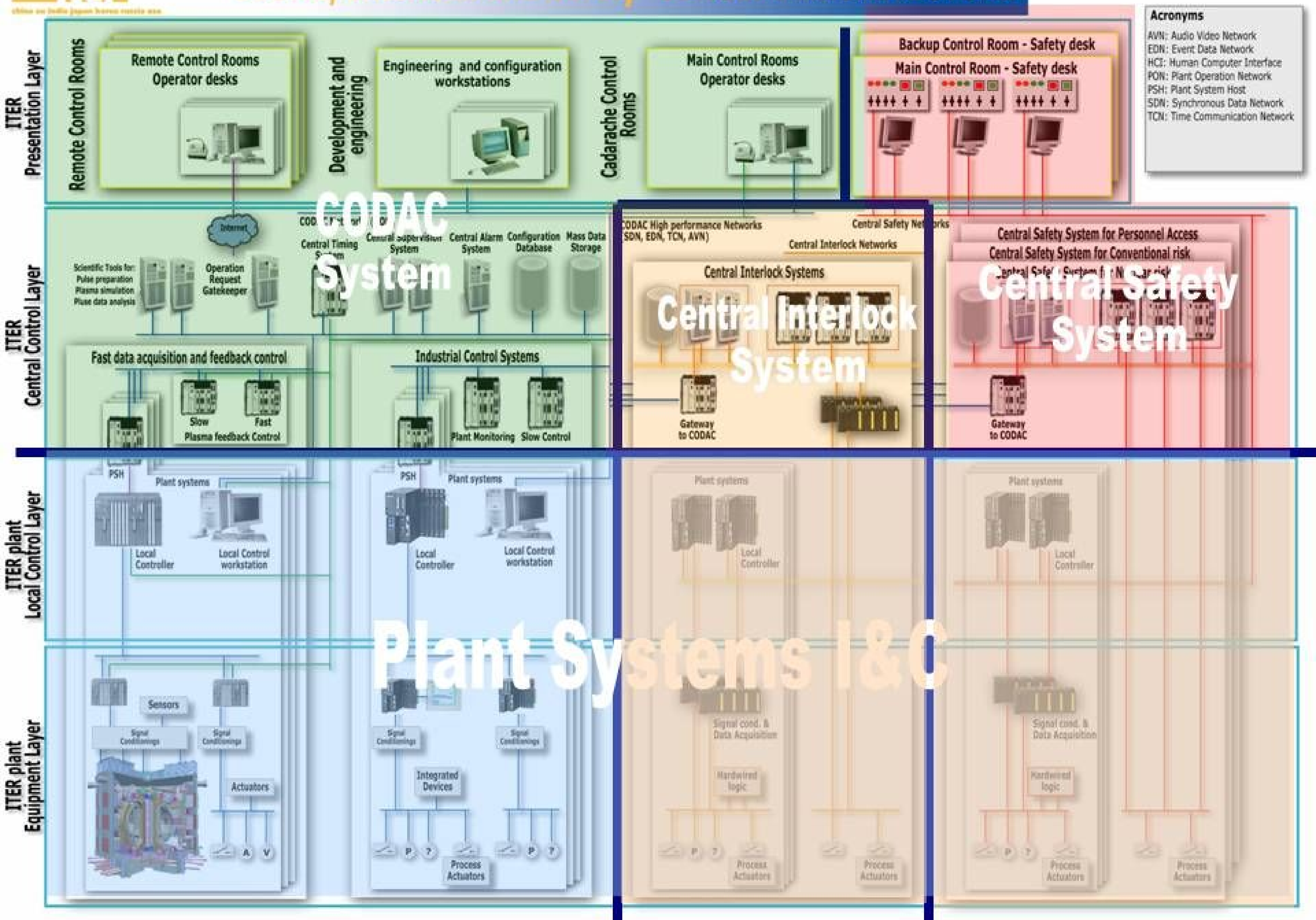

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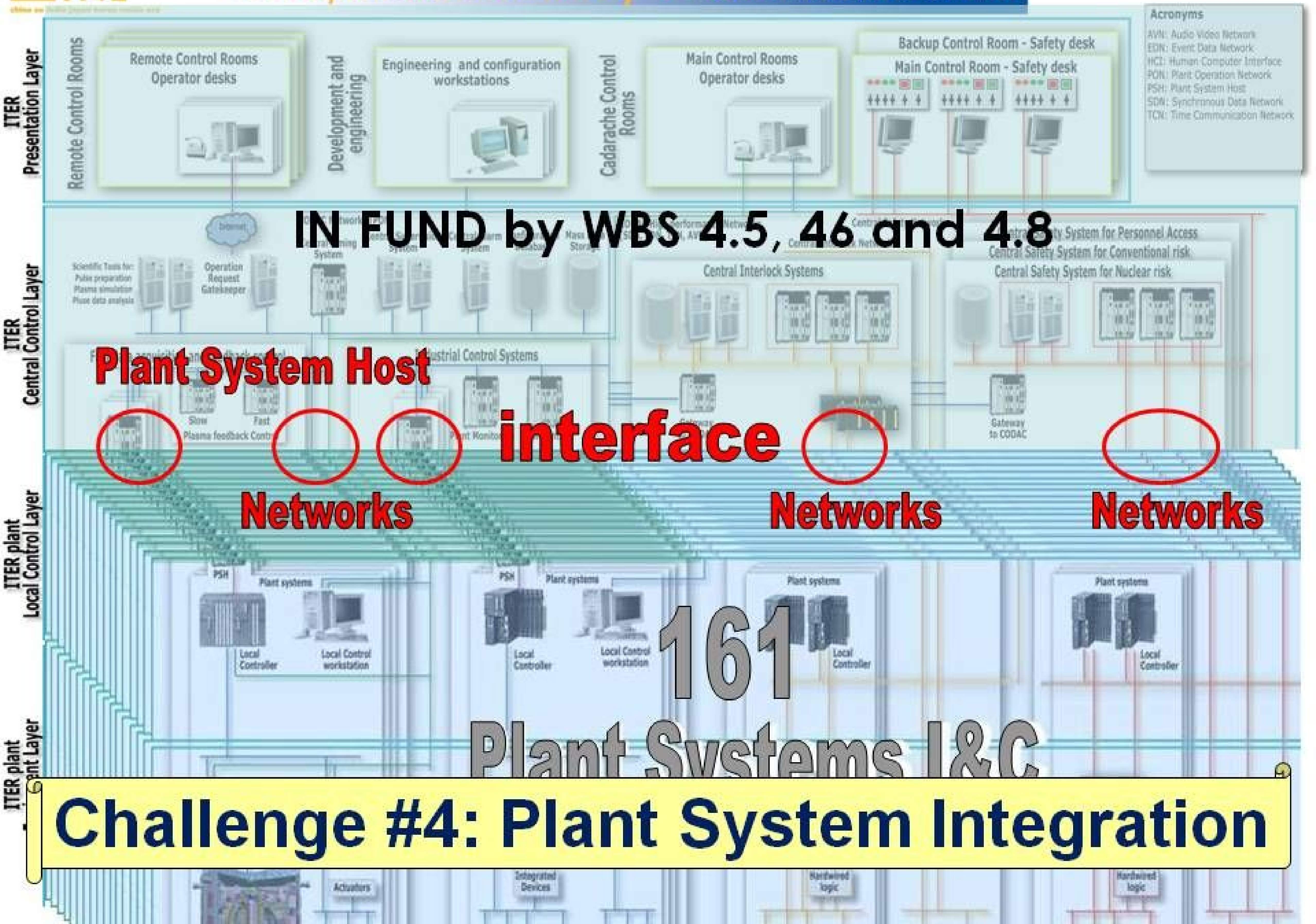
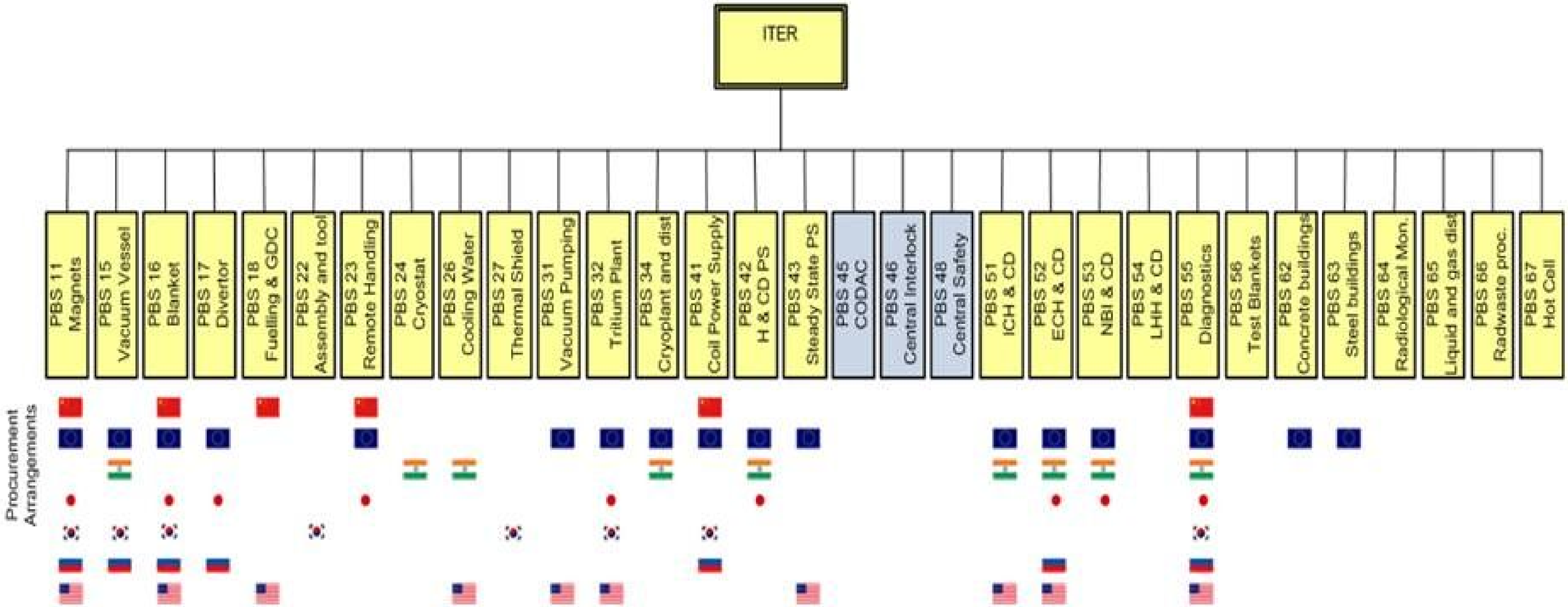


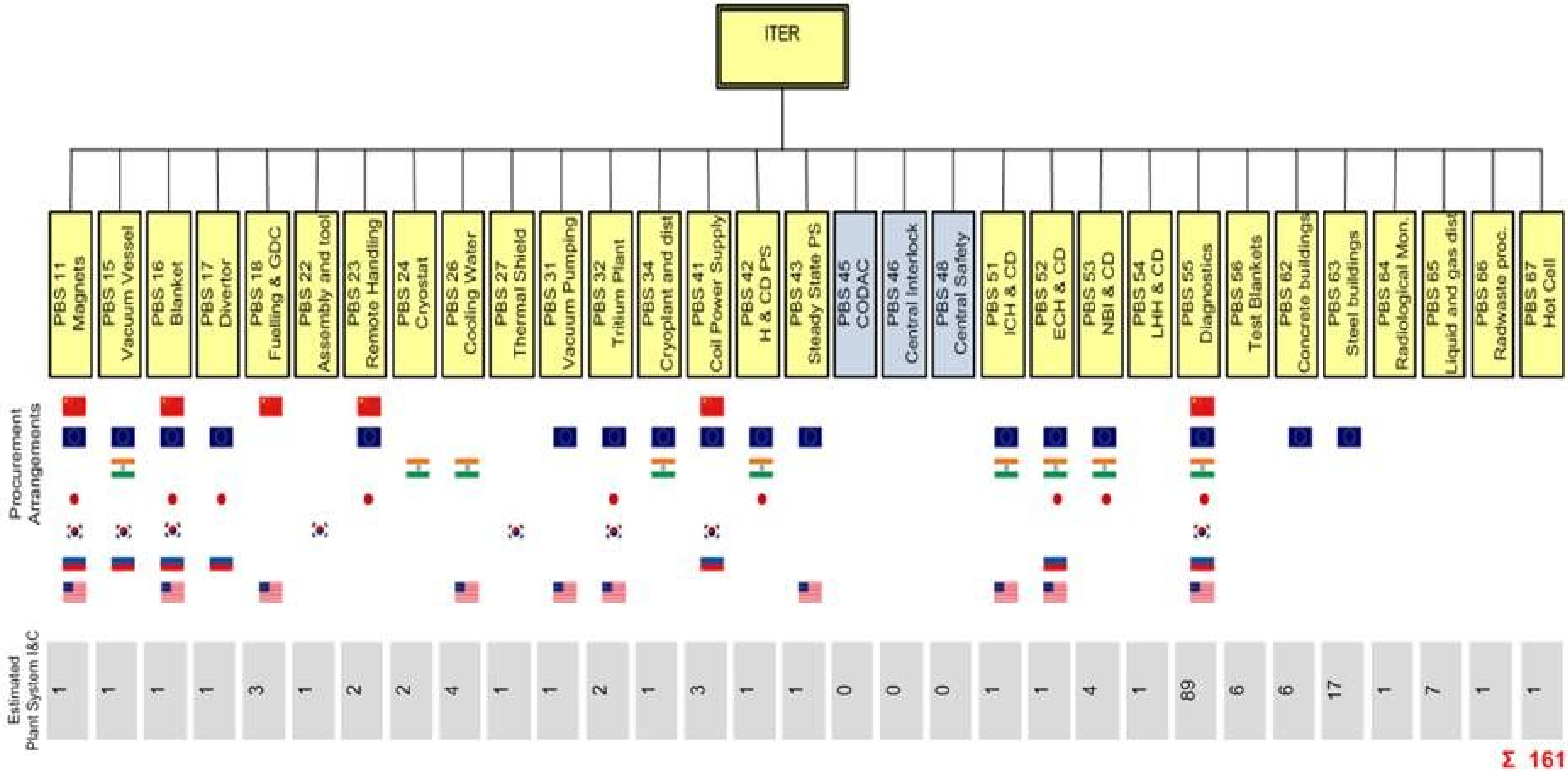
Challenge #4: Plant System Integration

Plant System I&C Identification



Plant System I&C Identification

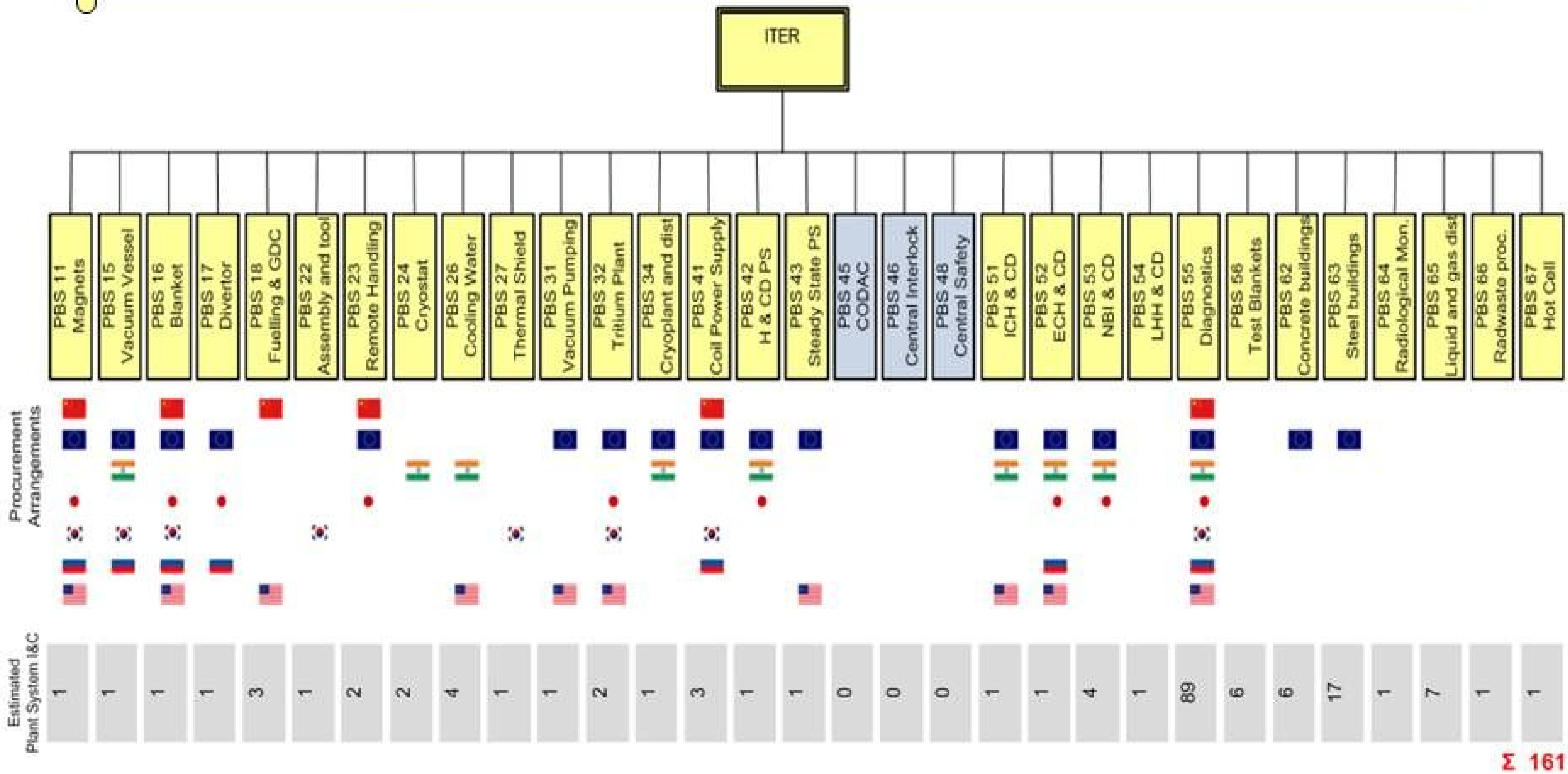
161 Plant Systems (number still changing)



A Plant System I&C has one and only one Plant System Host

Plant System I&C Identification

Challenge #5: In Kind Procurement



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Plant Breakdown Structure & Interface Matrix

PBS Matrix		11	15	16	17	18	22	23	24	26	27	31	32	34	41	42	43	44	45	46	47	48	51	52	53	54	55	56	58	61	62	63	64	65	66	69	70	98
ITER Magnet Sys	11						✓	✗	•		•	•		•	•		•		•	✓		✓					•				✓			✓				
VV ELM and Manifolds	15			•	•	•	•	•	•	•	•	•	✗	✗			•		•	•			•	•	✓	•	•	•			✓		✗		✗			
Blanket systems	16		•		✓	✗	✓	✗		•		✗	✗				•		•	✓			✓	✗	✓	✗	✗	✗			✓		✗	✗	✗			
Divertor	17		•	✓		✓	✓	✓		•		✓	✓				•		•	✓							✓				✓		✓	✗	✓			
Fueling&WallConditioning	18		•	✗	✓		✗	✗	✗	•	✗	✗	✗	✗			•		•	✓		✓	✓	✗	•		✗				✓			✓	✗			
Machine Assembly&Tooling	22	✓	•	✓	✓	✗		✗	✓	✓	✓	✓	✗	✗	✗		✓		•				✗	✓	✓	✗	✗	✗		✓	✓	✗		✓	✗			
Remote Handling System	23	✗	•	✗	✓	✗	✗		✗	✗	✗	✗	✗				•		✗	✓		✓	•	✗	✓	✗	✗	✗		✗	•		✗	✓	✗			
Cryostat	24	•	•			✗	✓	✗		•	✗	✗	✗	✗			•		•			•					✗				✓			✓				
Cooling Water System	26		•	•	•	•	✓	✗	•			•	•	•	•		•		•	•		•	•	•	✓	•	•	•		✓	✓	✓		✓	•			
Thermal Shield	27	•	•			✗	✓	✗	✗			✗		✗			•		•								✗				✓				✗			
Vacuum	31	•	•	✗	✓	✗	✓	✗	✗	•	✗		✗	•			•		•	•		•	•	✗	•	✗	✗	✗			✓			✓	✗			
Tritium plant	32		✗	✗	✓	✗	✗	✗	✗	•		✗					•		•	✓		✓			•		•	✗			✓		✗	✓	✗			
Cryoplant & Distribution	34	•	✗			✗	✗		✗	•	✗	•			✗		•		•	✓		✓		✗			✗			✓	✓	•		✓				
Coil Supply&Distribution	41	•					✗			•				✗			•		✓	✓		✓								✓	✓	✓		✓				
H&CD Power supply	42																																					
SSEN	43	•	•	•	•	•	✓	•	•	•	•	•	•	•	•				✓	✓		✓	•	•	•	•	•	•		•	•	•	•	•	•			
Cable Trays System	44																																			✗		
CODAC	45	•	•	•	•	•	•	✗	•	•	•	•	•	•	✓		✓			✓		✓	✓	•	✓	•	✗	•		✓	✓	✓	•	✓	✓	•		
Central Interlock system	46	✓	•	✓	✓	✓		✓		•		•	✓	✓	✓		✓		✓			✓	✓	•	✓	✓	•	•		✓	✓	✓	•	✗				
Plasma Control System	47																																					
Central Safety system	48	✓				✓		✓	•	•		•	✓	✓	✓		✓		✓	✓				✓	✓		•	•		✓	✓	✓	✓	✓	•			
IC H&CD system	51		•	✓		✓	✗	•		•		•					•		✓	✓							✗				✓	•		✓	✓			
EC H&CD system	52		•	✗		✗	✓	✗		•		✗		✗			•		•	•		✓					✗			✗	✓	•	✗	✓	✗			
Neutral Beam H&CD system	53		✓	✓		•	✓	✓		✓		•	•				•		✓	✓		✓					✓			✓	•	✗	✓	✓	✓			
Lower Hybrid H&CD system	54		•	✗			✗	✗		•		✗					•		•	✓							✗			✗	✓	✓		✓	✗			
Diagnostics	55	•	•	✗	✓	✗	✗	✗	✗	•	✗	✗	•	✗			•		✗	•		•	✗	✗	✓	✗					•	✗	✗	✓	✗			
Test Blanket Modules Sys	56		•	✗			✗	✗		•		✗	✗				•		•	•		•									✓			✓	✗			
Port Plug Test Facility	58																																					
Site	61						✓	✗		✓				✓	✓		•		✓	✓		✓		✗	✓	✗					✗	✓		✗	✗	✗		
ReinforcedConcreteBuild	62	✓	✓	✓	✓	✓	✓	•	✓	✓	✓	✓	✓	✓	✓		•		✓	✓		✓	✓	✓	•	✓	•	✓		✗			✓	✗	✓	✗		
Steel frame buildings	63						✗			✓				•	✓		•		✓	✓		✓	•	•	✗	✓	✗			✓				✗	✗	✗		
Radiolg & Env Monitoring	64		✗	✗	✓			✗					✗				•		•	•		✓		✗	✓		✗				✓				✗			
Liquid&Gas Distribution	65	✓		✗	✗	✓	✓	✓	✓	✓		✓	✓	✓	✓		•		✓	✗		✓	✓	✓	✓	✓	✓	✓		✗	✗	✗			✓			
RadwasteTreatment&Storag	66		✗	✗	✓	✗	✗	✗		•	✗	✗	✗				•		✓			•	✓	✗														
Access Control &Security	69																	✗	•																			
Site Outside Platform	70																																					
External Services	98																																					

Click the white cell on the left create/delete interfaces

- ✓ All documents are approved.
- • There is at least one document to be approved.
- ✗ An interface is identified, but no documents are generated.

Plant Breakdown Structure & Interface Matrix

PBS Matrix		11	15	16	17	18	22	23	24	26	27	31	32	34	41	42	43	44	45	46	47	48	51	52	53	54	55	56	58	61	62	63	64	65	66	69	70	98
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Machine Assembly&Tooling	22	✓	•	✓	✓	✗		✗	✓	✓	✓	✓	✗	✗	✗		✓		•				✗	✓	✓	✗	✗	✗		✓	✓	✗		✓	✗			
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Cryostat	24	•	•			✗	✓	✗		•	✗	✗	✗	✗			•		•			•					✗				✓			✓				
Cooling Water System	26		•	•	•	•	✓	✗	•			•	•	•	•		•		•	•		•	•	•	✓	•	•	•		✓	✓	✓		✓	•			
Thermal Shield	27	•	•			✗	✓	✗	✗			✗		✗			•		•								✗				✓				✗			
Vacuum	31	•	•	✗	✓	✗	✓	✗	✗	•	✗		✗	•			•		•	•		•	•	✗	•	✗	✗	✗			✓			✓	✗			
Tritium plant	32		✗	✗	✓	✗	✗	✗	✗	•		✗					•		•	✓		✓			•		•	✗			✓		✗	✓	✗			
Cryoplant & Distribution	34	•	✗			✗	✗		✗	•	✗	•			✗		•		•	✓		✓		✗			✗			✓	✓	•		✓				
Coil Supply&Distribution	41	•					✗			•				✗			•		✓	✓		✓								✓	✓	✓		✓				
H&CD Power supply	42																																					
SSEN	43	•	•	•	•	•	✓	•	•	•	•	•	•	•	•				✓	✓		✓	•	•	•	•	•	•		•	•	•	•	•	•			
Cable Trays System	44																																			✗		
CODAC	45	•	•	•	•	•	•	✗	•	•	•	•	•	•	✓		✓			✓		✓	✓	•	✓	•	✗	•		✓	✓	✓	•	✓	✓	•		
Central Interlock system	46	✓	•	✓	✓	✓		✓		•		•	✓	✓	✓		✓		✓			✓	✓	•	✓	✓	•	•		✓	✓	✓	•	✗				
Plasma Control System	47																																					
Central Safety system	48	✓				✓		✓	•	•		•	✓	✓	✓		✓		✓	✓				✓	✓		•	•		✓	✓	✓	✓	✓	•			
IC H&CD system	51		•	✓		✓	✗	•		•		•					•		✓	✓							✗				✓	•		✓	✓			
EC H&CD system	52		•	✗		✗	✓	✗		•		✗		✗			•		•	•		✓					✗			✗	✓	•	✗	✓	✗			
Neutral Beam H&CD system	53		✓	✓		•	✓	✓		✓		•	•				•		✓	✓		✓					✓			✓	•	✗	✓	✓	✓			
Lower Hybrid H&CD system	54		•	✗			✗	✗		•		✗					•		•	✓							✗			✗	✓	✓		✓	✗			
Diagnostics	55	•	•	✗	✓	✗	✗	✗	✗	•	✗	✗	•	✗			•		✗	•		•	✗	✗	✓	✗					•	✗	✗	✓	✗			
Test Blanket Modules Sys	56		•	✗			✗	✗		•		✗	✗				•		•	•		•									✓			✓	✗			
Port Plug Test Facility	58																																					
Site	61						✓	✗		✓				✓	✓		•		✓	✓		✓		✗	✓	✗					✗	✓		✗	✗	✗		
ReinforcedConcreteBuild	62	✓	✓	✓	✓	✓	✓	•	✓	✓	✓	✓	✓	✓	✓		•		✓	✓		✓	✓	✓	•	✓	•	✓		✗			✓	✗	✓	✗		
Steel frame buildings	63						✗			✓				•	✓		•		✓	✓		✓	•	•	✗	✓	✗			✓				✗	✗	✗		
Radiolg & Env Monitoring	64		✗	✗	✓			✗					✗				•		•	•		✓		✗	✓		✗				✓				✗			
Liquid&Gas Distribution	65	✓		✗	✗	✓	✓	✓	✓	✓		✓	✓	✓	✓		•		✓	✗		✓	✓	✓	✓	✓	✓	✓		✗	✗	✗			✓			
RadwasteTreatment&Storag	66		✗	✗	✓	✗	✗	✗		•	✗	✗	✗				•		✓			•	✓	✗														
Access Control &Security	69																	✗	•																			
Site Outside Platform	70																																					
External Services	98																																					

Click the white cell on the left create/delete interfaces

✓ All documents are approved.

• There is at least one document to be approved.

✗ An interface is identified, but no documents are generated.

Plant Breakdown Structure & Interface Matrix

PBS Matrix		11	15	16	17	18	22	23	24	26	27	31	32	34	41	42	43	44	45	46	47	48	51	52	53	54	55	56	58	61	62	63	64	65	66	69	70	98
ITER Magnet Sys	11						✓	✗	•		•	•		•	•		•		•	✓		✓					•				✓			✓				
VV ELM and Manifolds	15			•	•	•	•	•	•	•	•	•	✗	✗			•		•	•			•	•	✓	•	•	•			✓		✗		✗			
Blanket systems	16		•		✓	✗	✓	✗		•		✗	✗				•		•	✓			✓	✗	✓	✗	✗	✗			✓		✗	✗	✗			
Divertor	17		•	✓		✓	✓	✓		•		✓	✓				•		•	✓							✓				✓		✓	✗	✓			
Fueling&WallConditioning	18		•	✗	✓		✗	✗	✗	•	✗	✗	✗	✗			•		•	✓		✓	✓	✗	•		✗				✓			✓	✗			
Machine Assembly&Tooling	22	✓	•	✓	✓	✗		✗	✓	✓	✓	✓	✗	✗	✗		✓		•				✗	✓	✓	✗	✗	✗		✓	✓	✗		✓	✗			
Remote Handling System	23	✗	•	✗	✓	✗	✗		✗	✗	✗	✗	✗				•		✗	✓		✓	•	✗	✓	✗	✗	✗		✗	•		✗	✓	✗			
Cryostat	24	•	•			✗	✓	✗		•	✗	✗	✗	✗			•		•			•					✗				✓			✓				
Cooling Water System	26		•	•	•	•	✓	✗	•			•	•	•	•		•		•	•		•	•	•	✓	•	•	•		✓	✓	✓		✓	•			
Thermal Shield	27	•	•			✗	✓	✗	✗			✗		✗			•		•								✗				✓				✗			
Vacuum	31	•	•	✗	✓	✗	✓	✗	✗	•	✗		✗	•			•		•	•		•	•	✗	•	✗	✗	✗			✓			✓	✗			
Tritium plant	32		✗	✗	✓	✗	✗	✗	✗	•		✗					•		•	✓		✓			•		•	✗			✓		✗	✓	✗			
Cryoplant & Distribution	34	•	✗			✗	✗		✗	•	✗	•			✗		•		•	✓		✓		✗			✗			✓	✓	•		✓				
Coil Supply&Distribution	41	•					✗			•				✗			•		✓	✓		✓								✓	✓	✓		✓				
H&CD Power supply	42																																					
SSEN	43	•	•	•	•	•	✓	•	•	•	•	•	•	•	•				✓	✓		✓	•	•	•	•	•	•		•	•	•	•	•	•			
Cable Trays System	44																																			✗		
CODAC	45	•	•	•	•	•	•	✗	•	•	•	•	•	•	✓		✓			✓		✓	✓	•	✓	•	✗	•		✓	✓	✓	•	✓	✓	•		
Central Interlock system	46	✓	•	✓	✓	✓		✓		•		•	✓	✓	✓		✓		✓			✓	✓	•	✓	✓	•	•		✓	✓	✓	•	✗				
Plasma Control System	47																																					
Central Safety system	48	✓				✓		✓	•	•		•	✓	✓	✓		✓		✓	✓				✓	✓		•	•		✓	✓	✓	✓	✓	•			
IC H&CD system	51		•	✓		✓	✗	•		•		•					•		✓	✓							✗				✓	•		✓	✓			
EC H&CD system	52		•	✗		✗	✓	✗		•		✗		✗			•		•	•		✓					✗			✗	✓	•	✗	✓	✗			
Neutral Beam H&CD system	53		✓	✓		•	✓	✓		✓		•	•				•		✓	✓		✓					✓			✓	•	✗	✓	✓	✓			
Lower Hybrid H&CD system	54		•	✗			✗	✗		•		✗					•		•	✓							✗			✗	✓	✓		✓	✗			
Diagnostics	55	•	•	✗	✓	✗	✗	✗	✗	•	✗	✗	•	✗			•		✗	•		•	✗	✗	✓	✗					•	✗	✗	✓	✗			
Test Blanket Modules Sys	56		•	✗			✗	✗		•		✗	✗				•		•	•		•									✓			✓	✗			
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Site	61						✓	✗		✓				✓	✓		•		✓	✓		✓		✗	✓	✗					✗	✓		✗	✗	✗		
ReinforcedConcreteBuild	62	✓	✓	✓	✓	✓	✓	•	✓	✓	✓	✓	✓	✓	✓		•		✓	✓		✓	✓	✓	•	✓	•	✓		✗			✓	✗	✓	✗		
Steel frame buildings	63						✗			✓				•	✓		•		✓	✓		✓	•	•	✗	✓	✗			✓				✗	✗	✗		
Radiolg & Env Monitoring	64		✗	✗	✓			✗					✗				•		•	•		✓		✗	✓		✗				✓				✗			
Liquid&Gas Distribution	65	✓		✗	✗	✓	✓	✓	✓	✓		✓	✓	✓	✓		•		✓	✗		✓	✓	✓	✓	✓	✓	✓		✗	✗	✗			✓			
RadwasteTreatment&Storag	66		✗	✗	✓	✗	✗	✗		•	✗	✗	✗				•		✓			•	✓	✗														
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	Click the white cell on the left create/delete interfaces
✓	All documents are approved.
•	There is at least one document to be approved.
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Challenge #4: Plant System Integration

Challenge #5: In Kind Procurement

Strategies to master it…

- Standardization
- Plant Control Design Handbook (PCDH) and associated documents
- Integrated Product Teams (IPT)
- Early delivery of CODAC Core System (mini-CODAC)
- Plant System I&C information gathering (plant profile database)
- Good interface definitions (interviews)
- Interface control documents (S-ICD), Interface Sheets (IS)
- Follow up by incremental reviewing and designing

Objectives of Plant Control Design Handbook

The Plant Control Design Handbook (PCDH) defines methodology, standards, specifications and interfaces applicable to all ITER Plant Systems Instrumentation & Control (I&C)

I&C standards are essential for ITER to

- Integrate all Plant Systems into one integrated control system
- Maintain all Plant Systems after delivery acceptance
- Contain cost by economy of scale (spare parts, expertise)

The PCDH is applicable to all Procurement Arrangements

ITER Organization (IO)

- develops,
- supports,
- maintains and
- enforces

these standards

- Living document
- Latest release May 2009
- New major releases each year
- Publicly available

http://www.iter.org/org/team/chd/cid/codac/Pages/default.aspx

PV and Signal Naming Convention

For any plant system signal or plant system PV reflecting an I&C signal:

PPPPPP-TTT-NNNN:AAAA[RRRR]-SSS

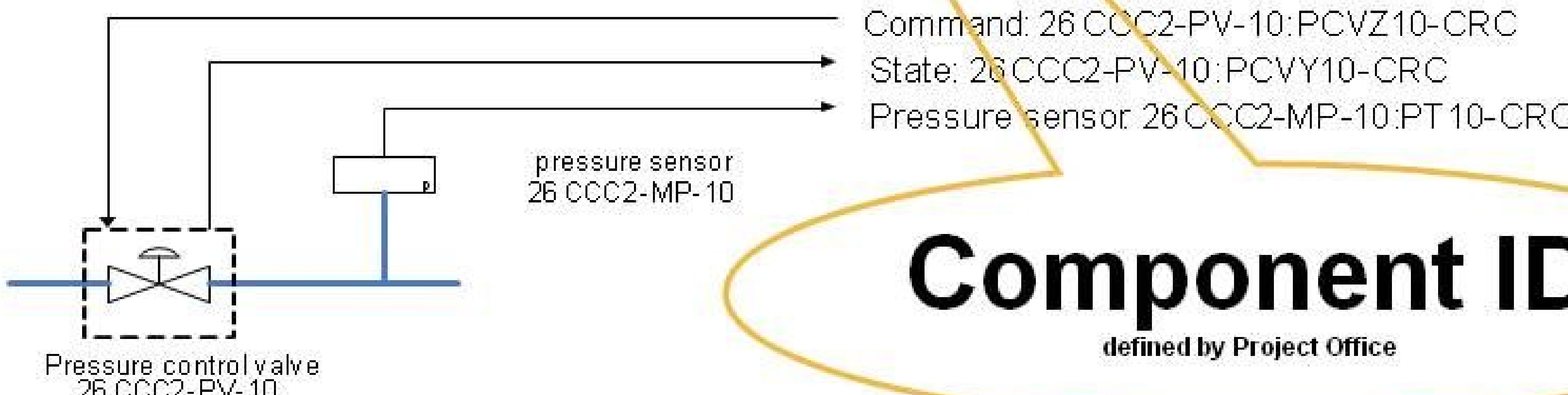
For any other PV:

PPPPPP-TTT-NNNN:FFFFFFFFFFFF

PPPPPP = Project Breakdown Structure level 3 identifier.

TTT = Functional Category Designator (managed by DO).

NNNN = Sequential Number (managed by DO).



Component ID

defined by Project Office

PV and Signal Naming Convention

For any plant system signal or plant system PV reflecting an I&C signal:

PPPPPP-TTT-NNNN:AAAA[RRRR]-SSS

For any other PV:

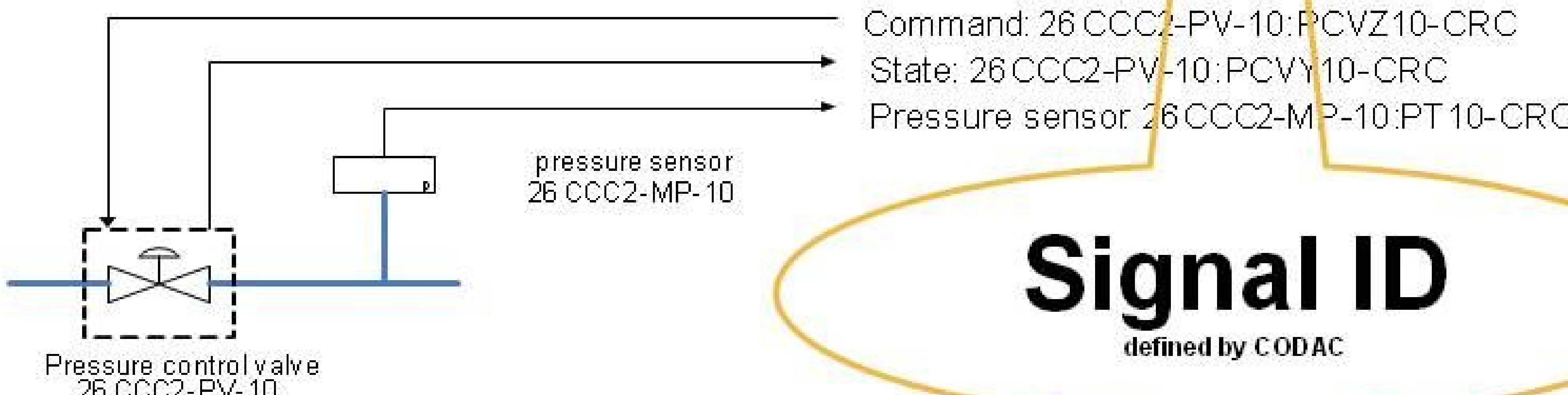
PPPPPP-TTT-NNNN:FFFFFFFFFFFF

AAAA = identify sensor/actuator class using the ISA-5.1-1984 (R1992) standard for instrumentation symbols and identification.

RRRR = identify several sensors/actuators of the same class [optional].

SSS = identify the signal type.

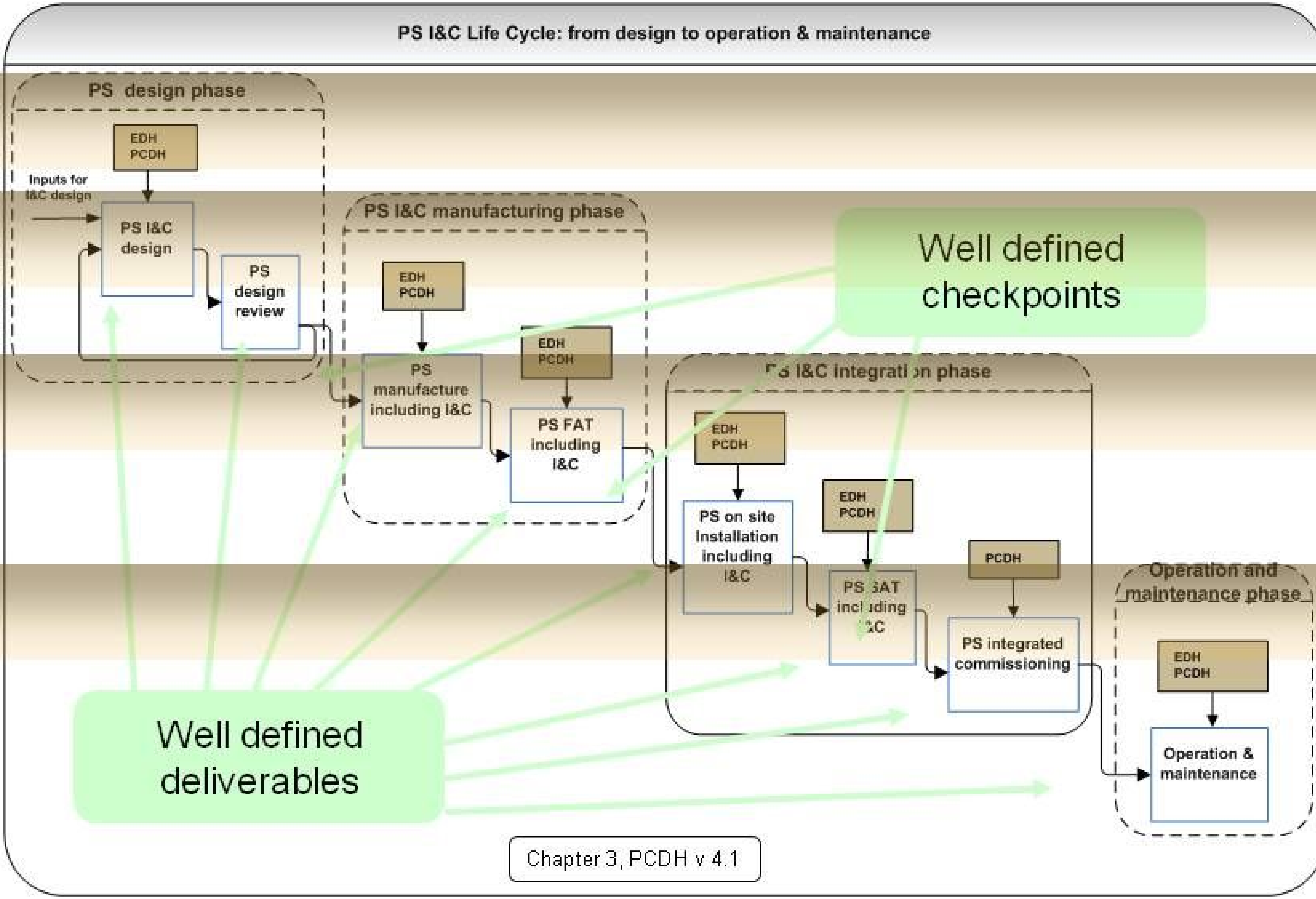
FFFFFFFFFFFF = free identifier (length limited to 12 characters.)



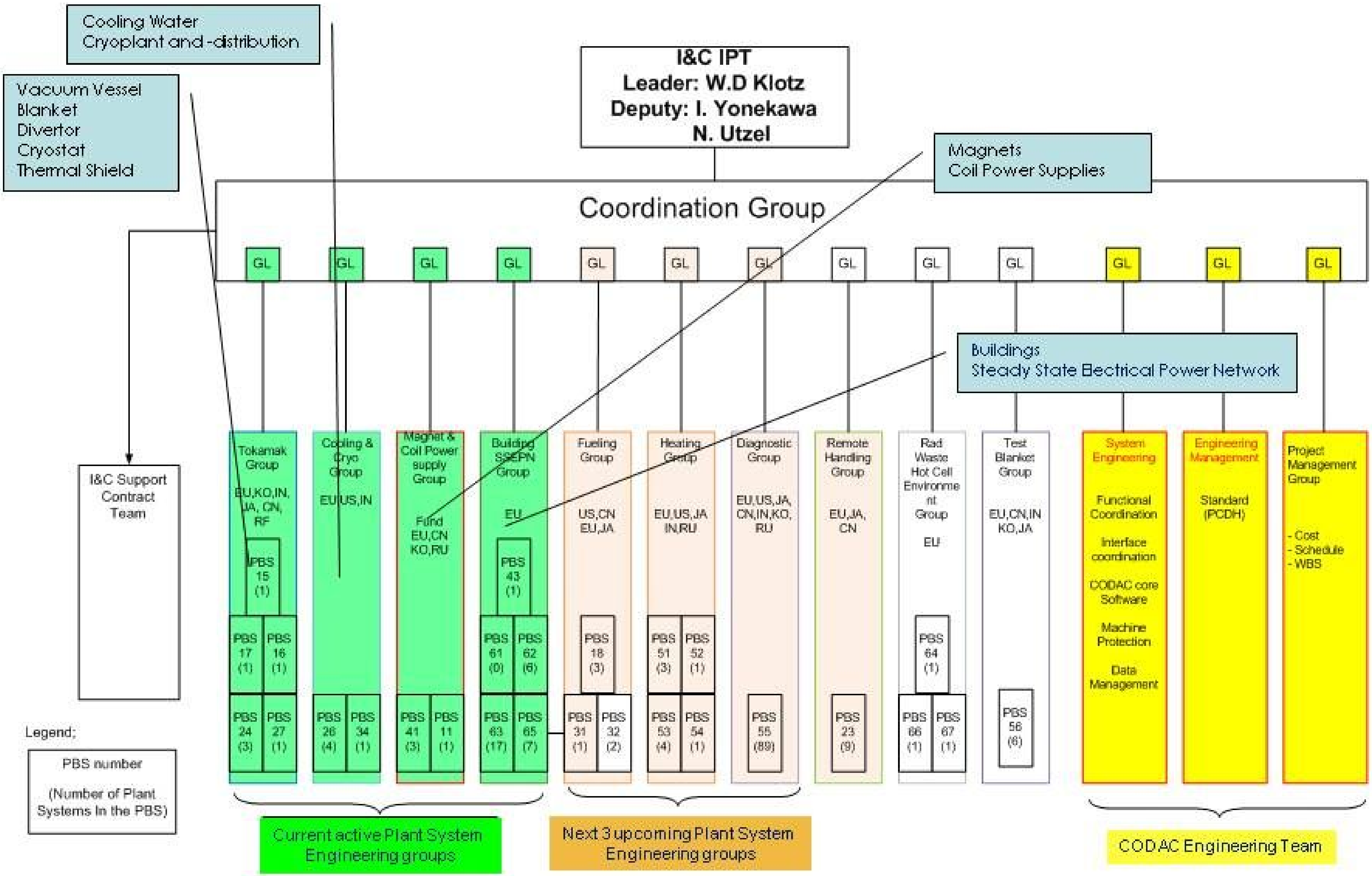
Signal ID

defined by CODAC

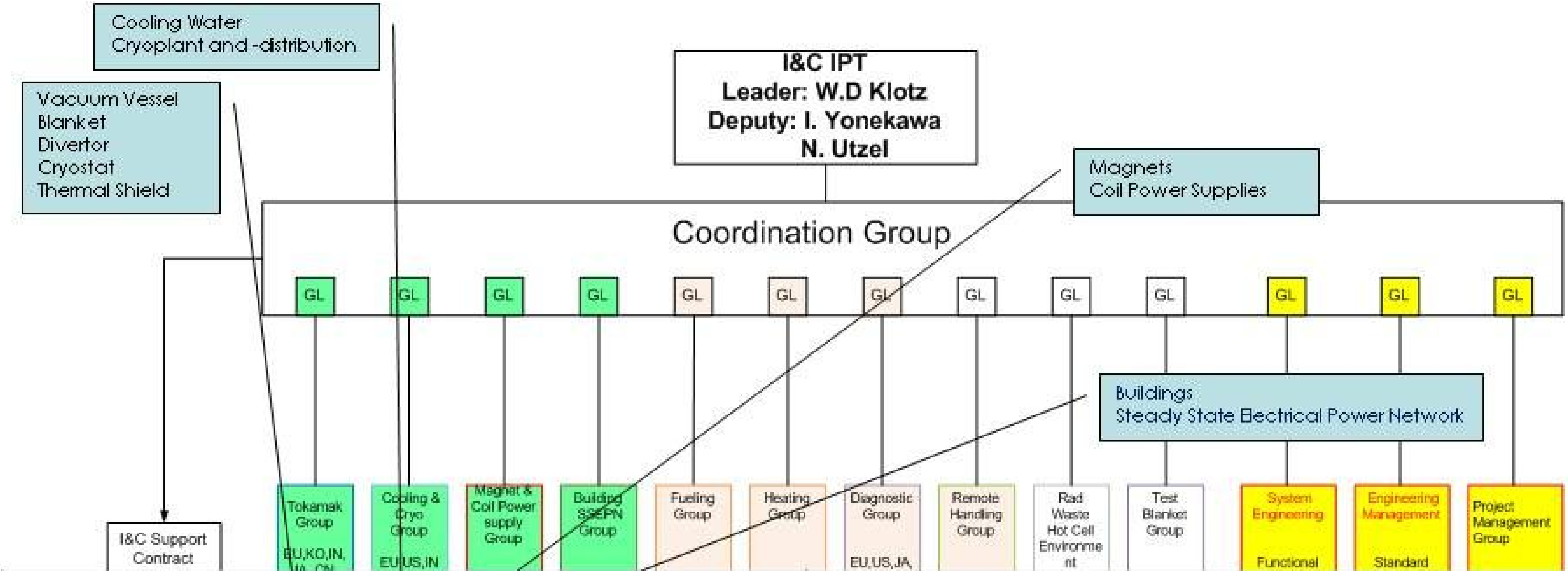
Plant System I&C Life Cycle



I&C Integrated Product Team



I&C Integrated Product Team



ITER Organization IO	Seven Members Domestic Agencies DA
– Planning / Designing – Integration / QA / Safety / Licensing / Schedule – Installation – Testing + Commissioning – Operation	– Detailing / Designing – Procuring/Manufacturing – Delivering – Supporting installation – Conformance Controlling

Synopsis

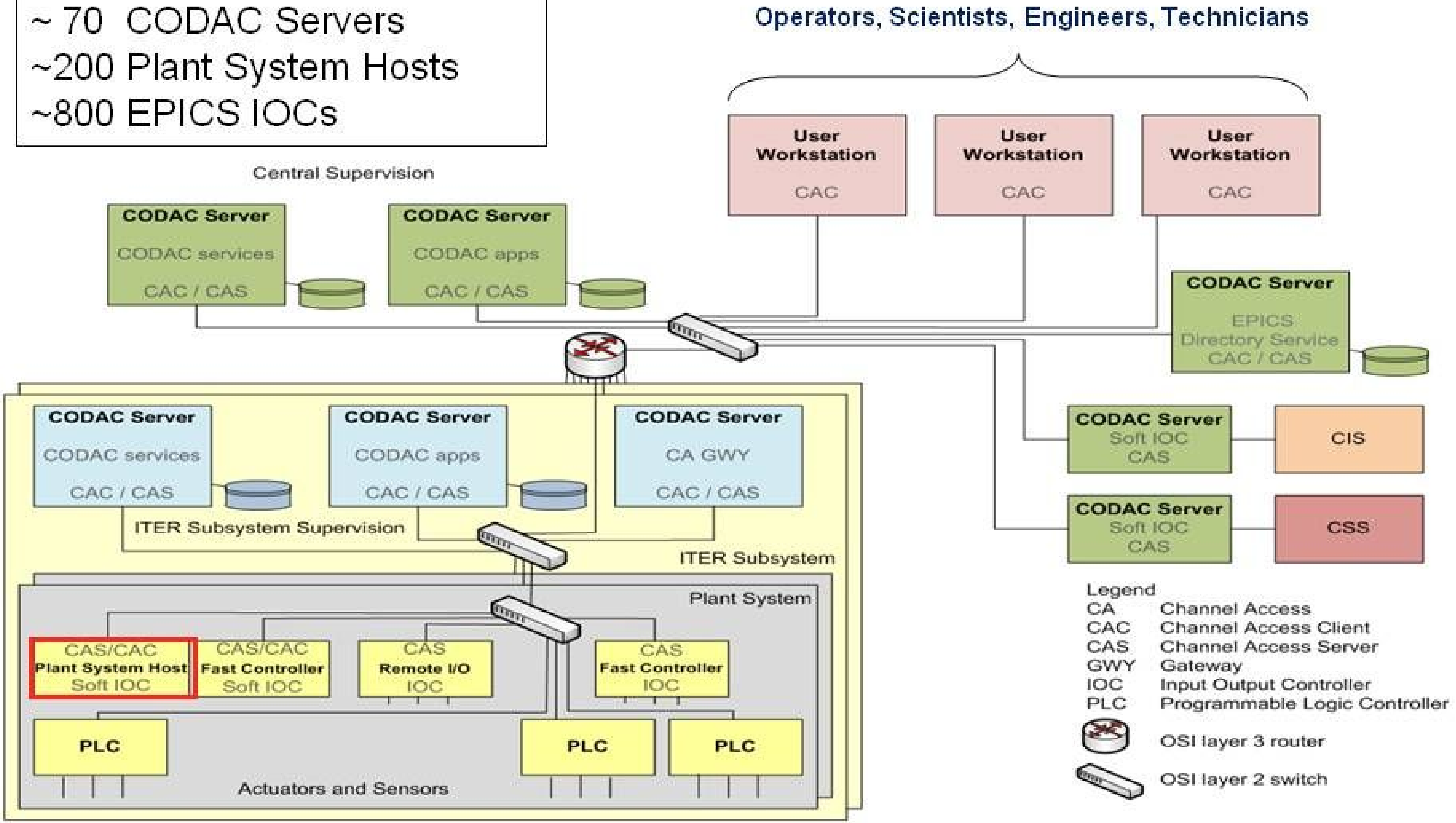
- ITER Project Quick Start
- System Scope & Management Challenges
- Some Current Activities

Standards Decisions Taken/Prepared

Taken	Outstanding
EPICS as middleware	**Cubicle** standard soon finished (single brand)
PLC equipment: **Siemens S7** (industrial and SIL3)	**Signal Handbook** defines standard signal conditioning. (to be released this year)
Red Hat Linux as major OS	**MDSplus**
Application environment: **Java, Eclipse, RCP, CSS**	**Real Time** Operating System
IEEE 1588 time synchronization	Standards for **High Performance Networks**
COTS as much as possible	Standards for **Fast Controllers** (chassis based)

Network Architecture Design

~150 Consoles/Workstations
~ 70 CODAC Servers
~200 Plant System Hosts
~800 EPICS IOCs



10 Plant System Groups or Subsystems (yellow) each consisting of X Plant Systems (gray)

Equipment Access

PICMG 1.0/1.1/1.3

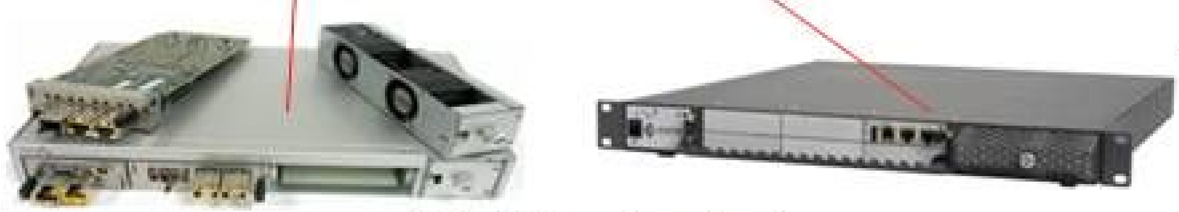
- Device Access by PLC
  - <u>Slow control: below 10Hz</u>
  - Siemens SP7
  - Ethernet remote IO
  - Field bus

Catalog of recommended modules

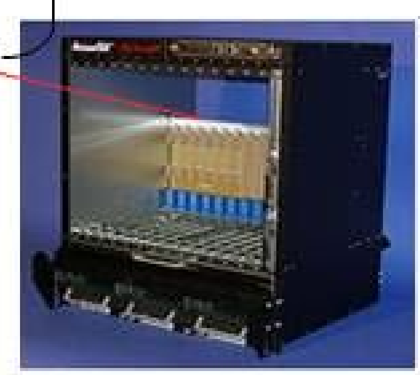
- Device Access by PCIe/PXIe enabled hardware
  - <u>Fast control: above 10Hz</u>
  - PCI, PXI and PCI Express
  - AdvancedTCA and PCI Express
  - µTCA, AMC and PCI Express
- No VME – legacy technology

PXIe 1056 chassis

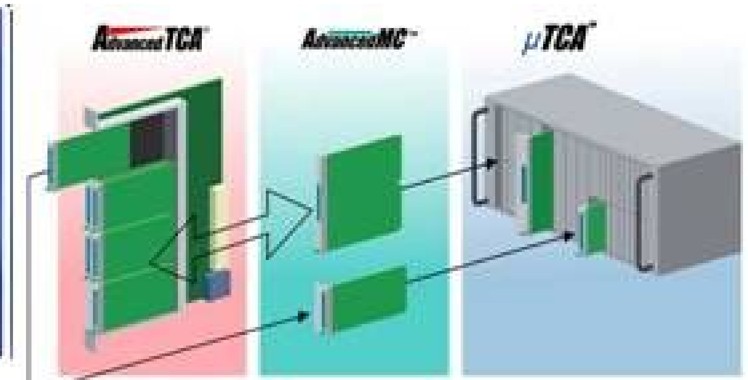
Selection to be done case by case
Still too early



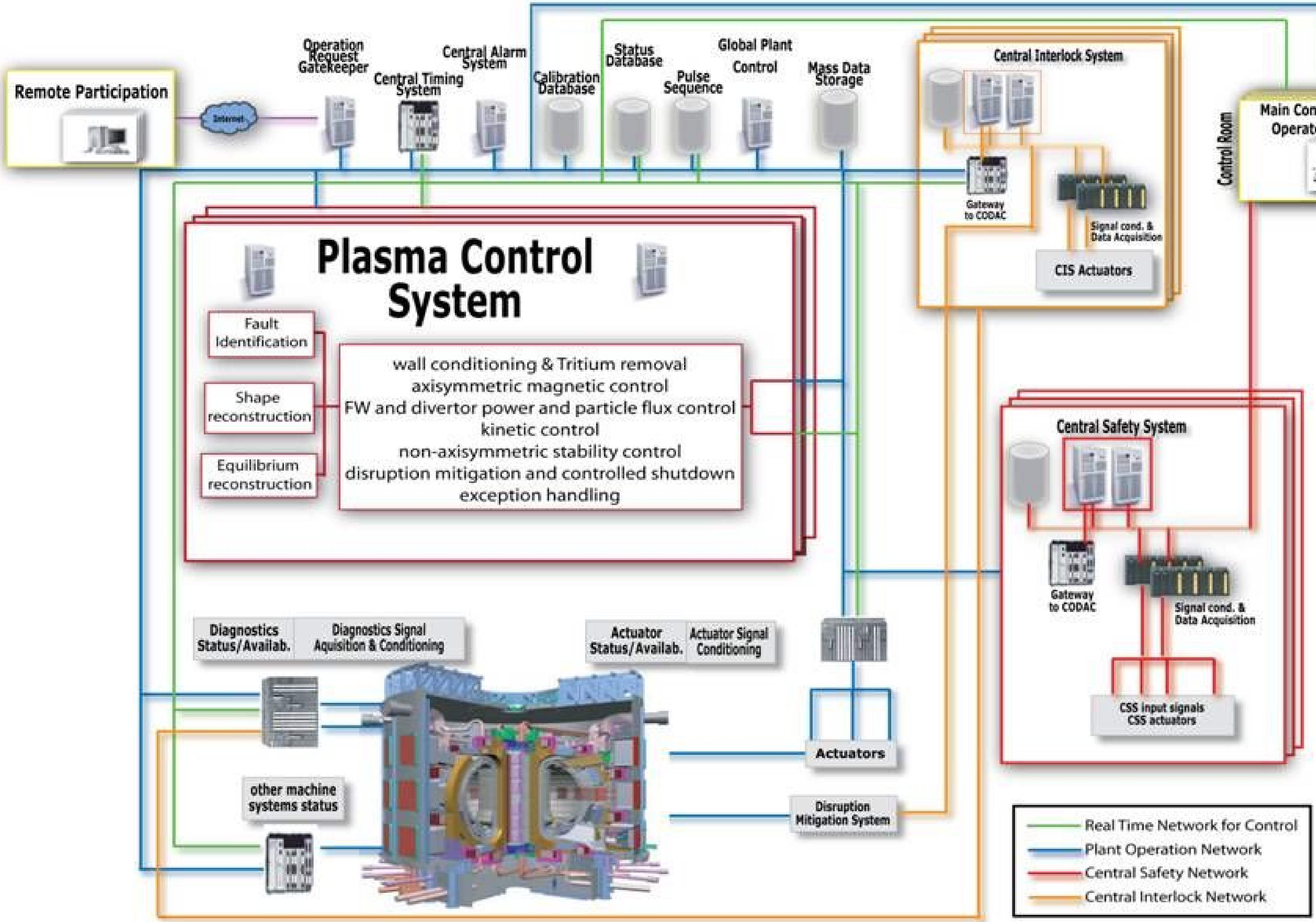
µTCA AMC carrier chassis



PIGMG 3.0 ATCA chassis



Plasma Control System within CODAC



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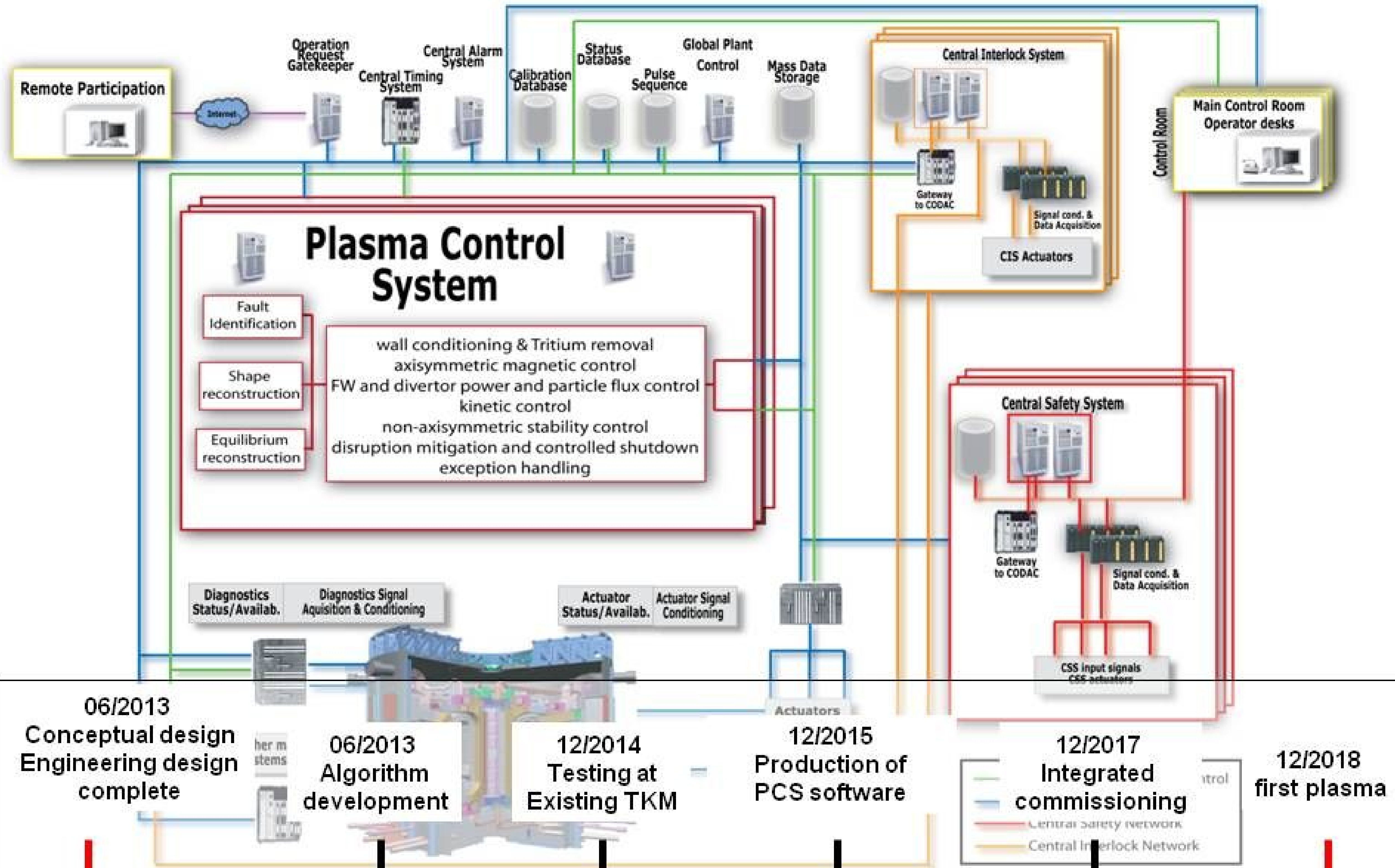
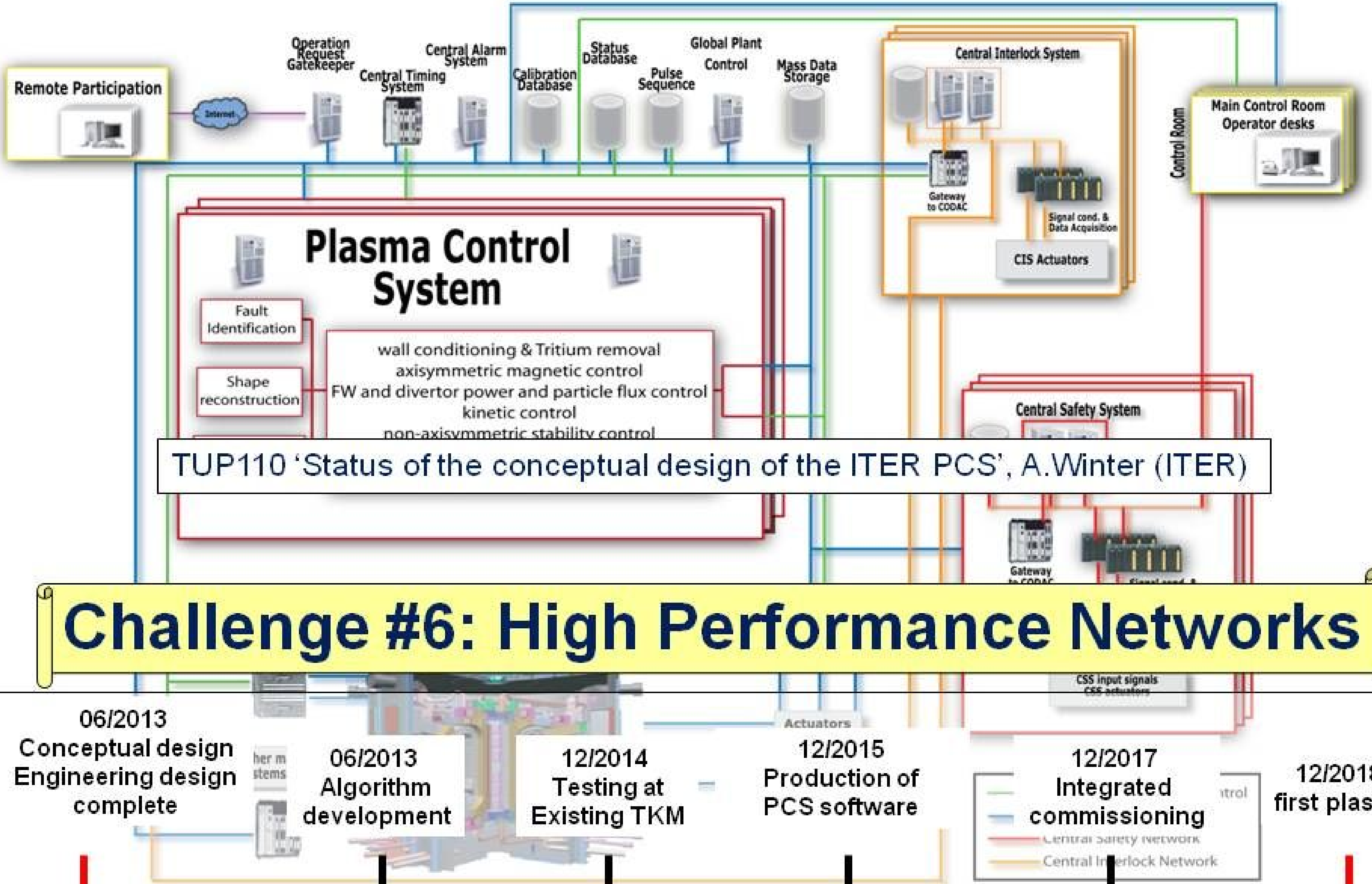


- 06/2013 Conceptual design Engineering design complete
- 06/2013 Algorithm development
- 12/2014 Testing at Existing TKM
- 12/2015 Production of PCS software
- 12/2017 Integrated commissioning
- 12/2018 first plasma

Plasma Control System within CODAC



TUP110 'Status of the conceptual design of the ITER PCS', A.Winter (ITER)

Challenge #6: High Performance Networks

- 06/2013 Conceptual design Engineering design complete
- 06/2013 Algorithm development
- 12/2014 Testing at Existing TKM
- 12/2015 Production of PCS software
- 12/2017 Integrated commissioning
- 12/2018 first plasma

High Performance Networks

Name	Requirements	Purpose	Status
AVN Audio/Video Network	30 frames /sec -1024 x 1024 frame size 200 camera positions (with audio), 10 large display screens, 100 TV displays over ITER site	Visualization Diagnostics Surveillance	•lossless - 10GigE Vision; •lossy: H.264 •required very late..2018..!!
EDN Event Distribution Network	Event latency - 10 μs	Event distribution	No use case found for 10μsec , Shall be merged with SDN
TCN Time Communication Network	50 to 100 nsec resolution with 5% to 10% jitter	Synchronization, Trigger, Timestamp	IEEE 1588 MRF from Micro Research White Rabbit Initiative: CERN http://www.ohwr.org
SDN Synchronous Data Bus Network	Control Loop (acquisition, transfer, calculation, actuator): •0.5 to 100 msec with 1% jitter @ payload 20 to 40 Mbytes/sec •10 to 100 μs with very low payload	Plasma Feedback Control	•UDP-based/switched fabric networks •Reflective (Shared) Memory Network •De-facto standard PCI-express as local computer bus interface could bridge the time gap to the next years Specify: •that all computer systems (also in plant systems) need one or more PCEe x 16 slots to hold any communication network card •that any network solution must have PCIe computer interface •dealy, if possible, the concrete network solution by some years.

Plasma Control System requires deterministic, quasi real-time communication and time synchronization between distributed nodes

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EDN Event Distribution Network	Event latency - 10 μs	Event distribution	No use case found for 10μsec , Shall be merged with SDN
TCN Time Communication Network	50 to 100 nsec resolution with 5% to 10% jitter	Synchronization, Trigger, Timestamp	IEEE 1588 MRF from Micro Research White Rabbit Initiative: CERN http://www.ohwr.org
SDN Synchronous Data Bus Network	Control Loop (acquisition, transfer, calculation, actuator): •0.5 to 100 msec with 1% jitter @ payload 20 to 40 Mbytes/sec •10 to 100 μs with very low payload	Plasma Feedback Control	•UDP-based/switched fabric networks •Reflective (Shared) Memory Network •De-facto standard PCI-express as local computer bus interface could bridge the time gap to the next years Specify: •that all computer systems (also in plant systems) need one or more PCEe x 16 slots to hold any communication network card •that any network solution must have PCIe computer interface •dealy, if possible, the concrete network solution by some years.

Plasma Control System requires deterministic, quasi real-time communication and time synchronization between distributed nodes

CODAC Core Systems and mini-CODAC

CODAC Core Systems will be a well defined product to be exported to all Plant System I&C developers.

CODAC Core Systems will comprise some hardware and all software required to develop, interface and test plant systems I&C.

mini-CODAC will be a lightweight subset of CODAC Core Systems.

mini-CODAC will be a portable SCADA system based on EPICS and Open Software tools.

CODAC Core Systems software comprises communication middleware (EPICS, IOC,…), plant system self-description -schemas and –tools plus SCADA functionalities.

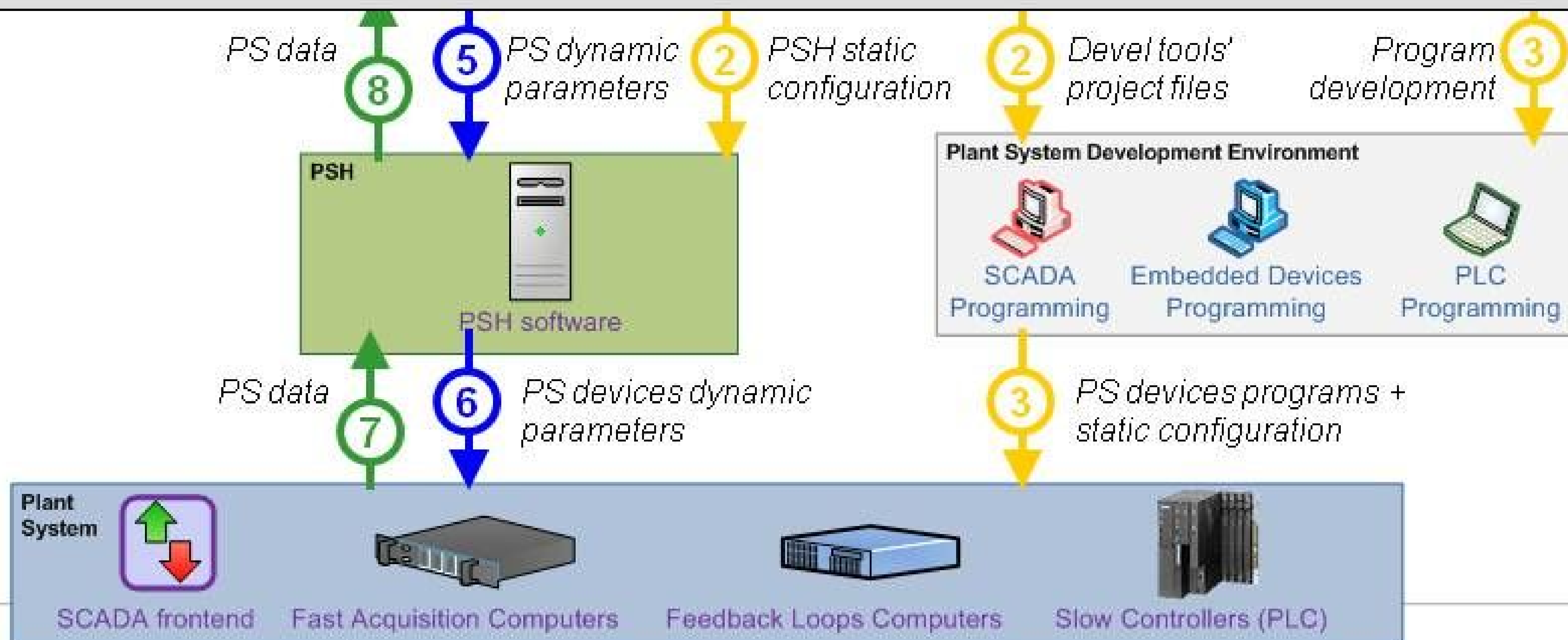
CODAC Core Systems will be released on a yearly basis with the first release planned for February 18, 2010.

MOC004 Development of the ITER CODAC Core Systems, F.DiMaio(ITER)

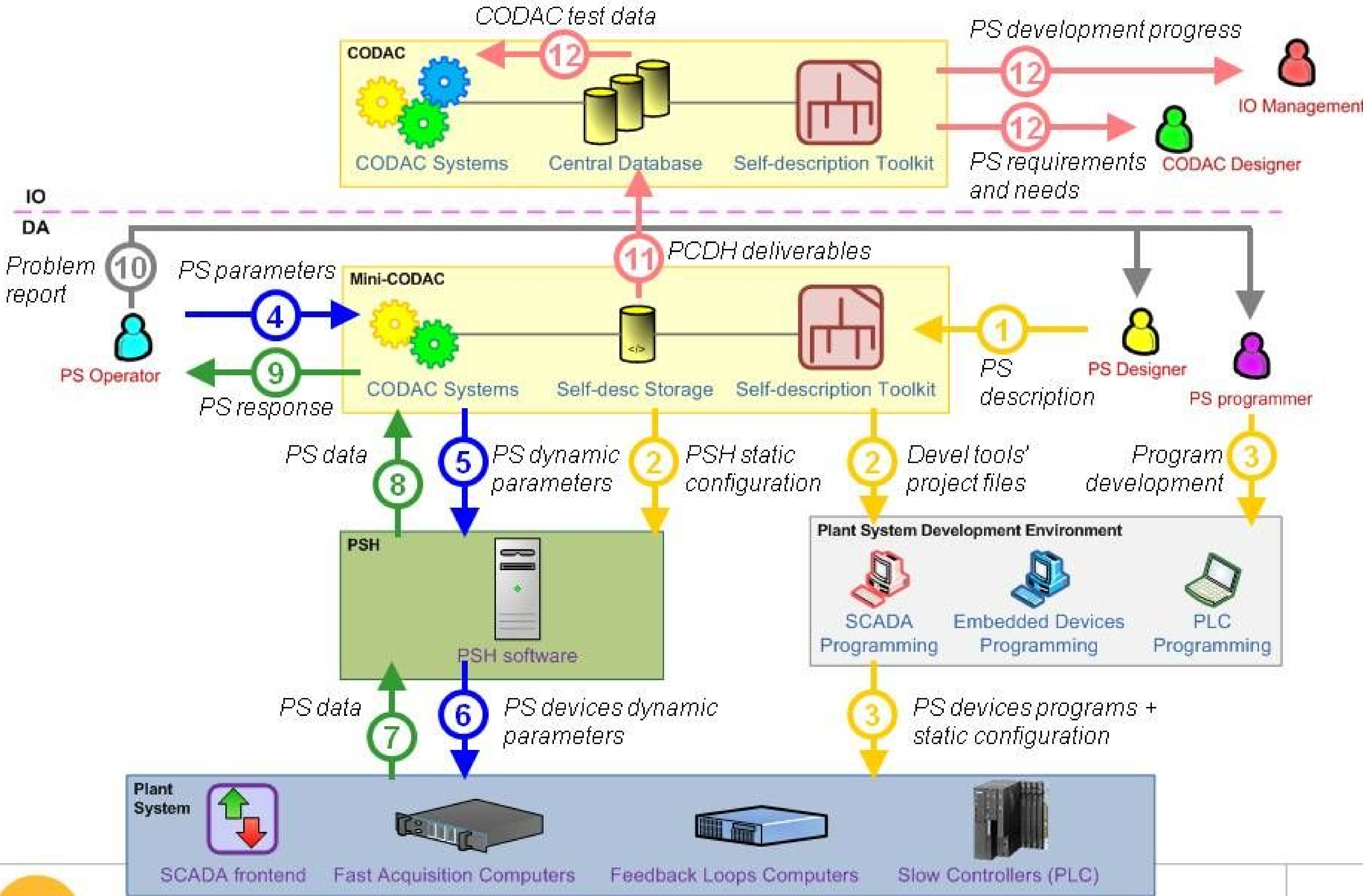
Plant System Self-Description

A concept of providing all the necessary information about Plant Systems along with the Plant Systems themselves. The ultimate goal is to make both Plant Systems I&C and CODAC software system-neutral, decreasing hard-coding of system specifics and increasing software configuration by external data.

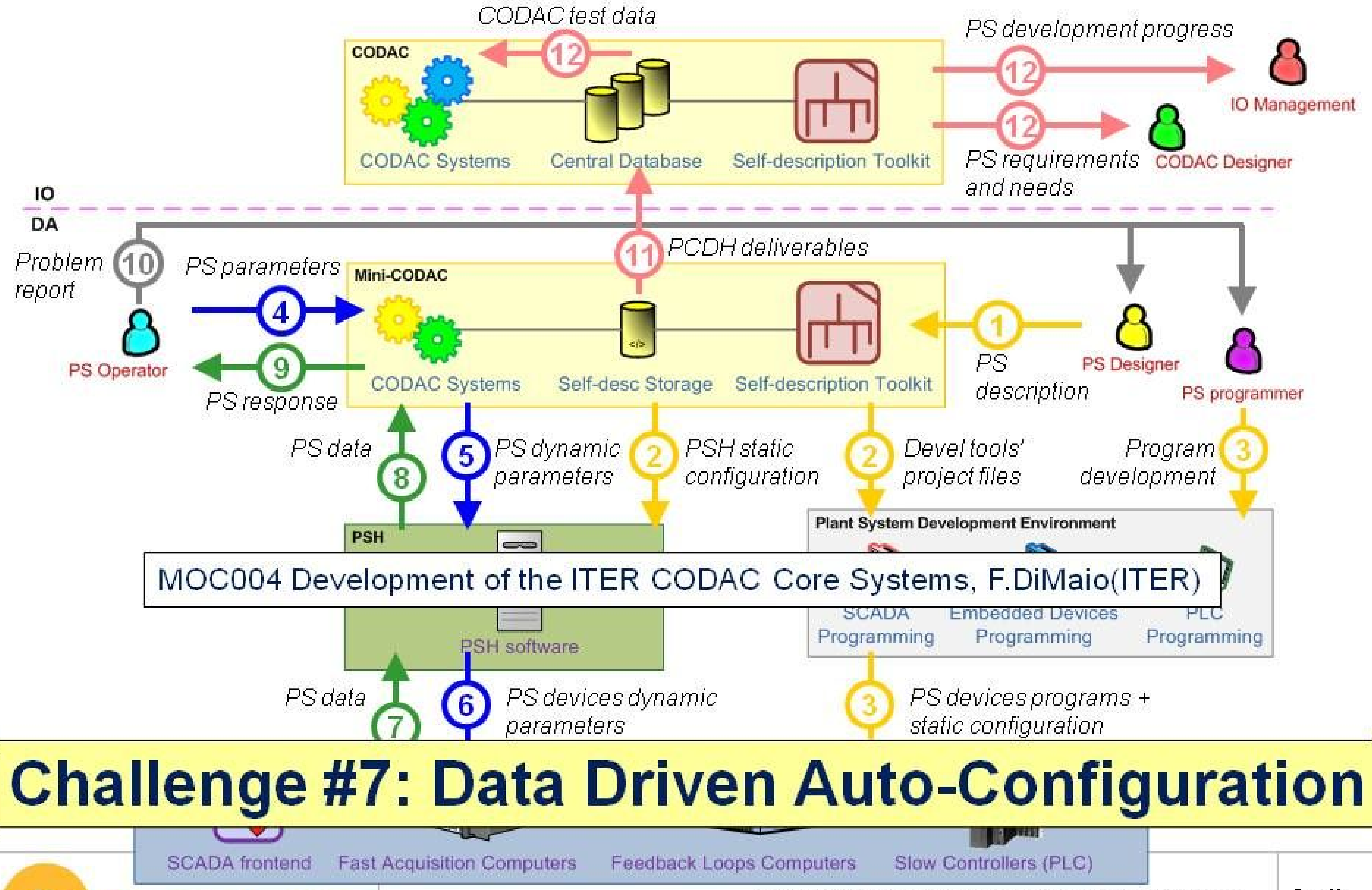
Self-description will be based on state-of-the-art XML tools and technologies.



Plant System Self-Description



Plant System Self-Description



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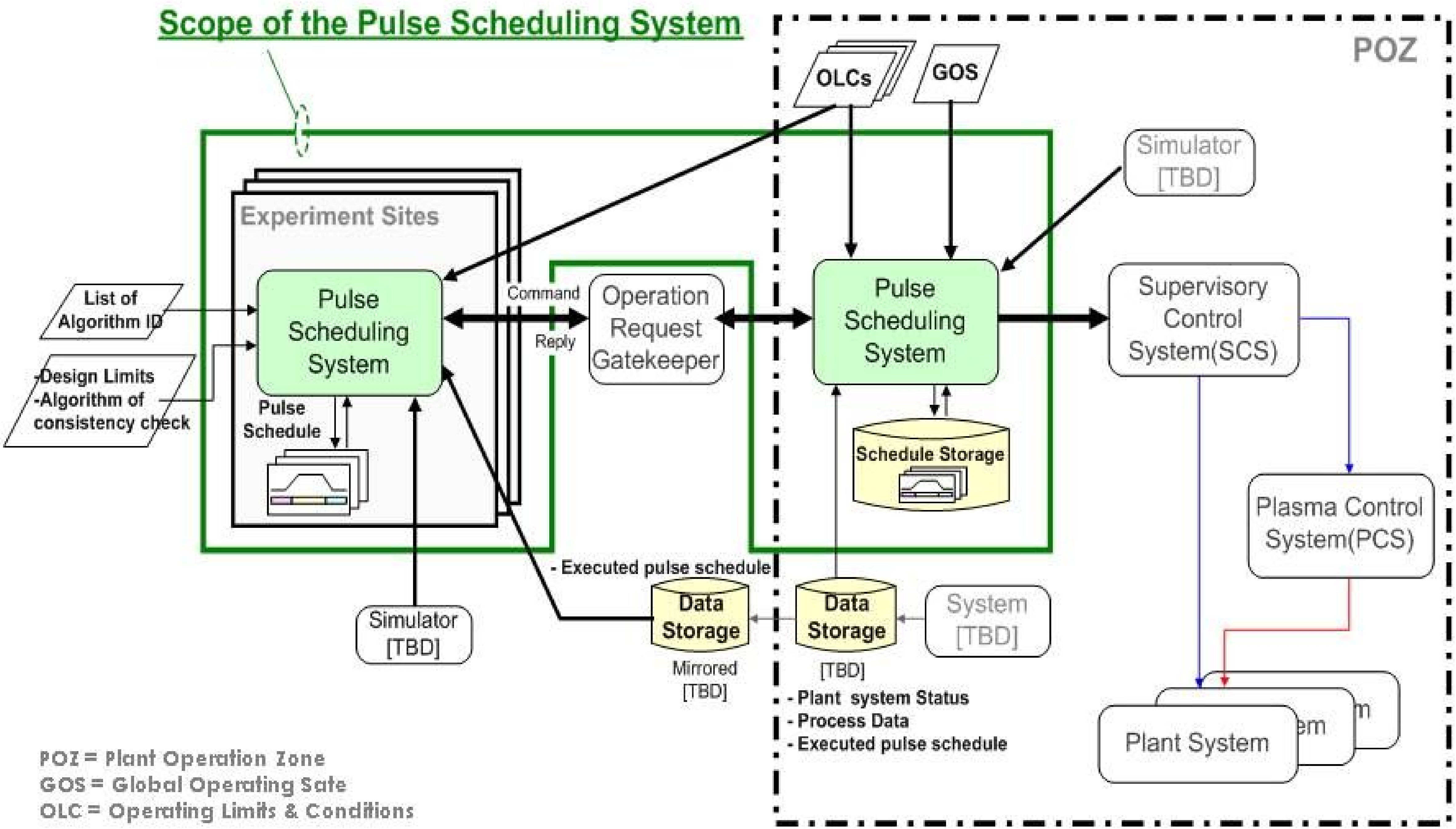
Challenge #7: Data Driven Auto-Configuration

Pulse Scheduling Requirements Analysis

Pulse Scheduling Data Flow



POZ = Plant Operation Zone
GOS = Global Operating Sate
OLC = Operating Limits & Conditions

Contracts to come soon

Contract Number	Description	WBS
NEW	* CODAC Engineering Support (A Wallander)	4.5
NEW	* I&S Engineering Support (L Scibile)	4.6
D-10-005	Consulting for CODAC standard software/hardware environment	4.5
D-10-006	Design, Implement, Supply and Integrate Fast Plant System	4.5
D-10-007	Prototype Monitoring and supervising CODAC	4.5
D-10-008	Supply mini CODAC application layer modules	4.5
D-10-009	Prototype plasma control system architecture	4.5
D-10-010	Software QA support. Tools and procedure for requirement tracking, documentation, versioning, testing, packaging, configuration control etc. (A Wallander)	4.5
D-10-011	Develop tools to support self-description (D Stepanov)	4.5
D-10-012	Design High Performance Networks	4.5
D-10-013	Design scientific data streaming	4.5
D-10-015	Evaluate highly available interlock architectures	4.5
D-10-016	Technology Integration Support	4.5
D-10-017	Assistance Contract for CODAC, Interlock and Safety - extension of CT/2009/1206 L Scibile	4.6
D-10-019	Cooperation Agrement CERN machine protection	4.6
D-10-020	Analysis of fault scenarios for machine protection	4.5
D-10-022	Development equipment for CIS	4.6
D-10-023	Engineering models for plasma feedback control and protection	4.6
D-10-024	Prototype Integration of Pulse Execution System	4.5
D-10-025	Prototype evaluation of I&C safety system architecture	4.6
NEW	CODAC Tasks orders against Framework CT Engineering & Technical Support	4.5

Contracts to come soon

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D-10-009	Prototype plasma control system architecture	4.5
D-10-010	Software QA support. Tools and procedure for requirement tracking, documentation, versioning, testing, packaging, configuration control etc. (A Wallander)	4.5
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D-10-023	Engineering models for plasma feedback control and protection	4.6
NEW	CODAC Tasks orders against Framework CT Engineering & Technical Support	4.5

Challenge #8: Heavy Contract Management

Example MCR Building Conceptual Design