ITER & CODAC Core System Status Update

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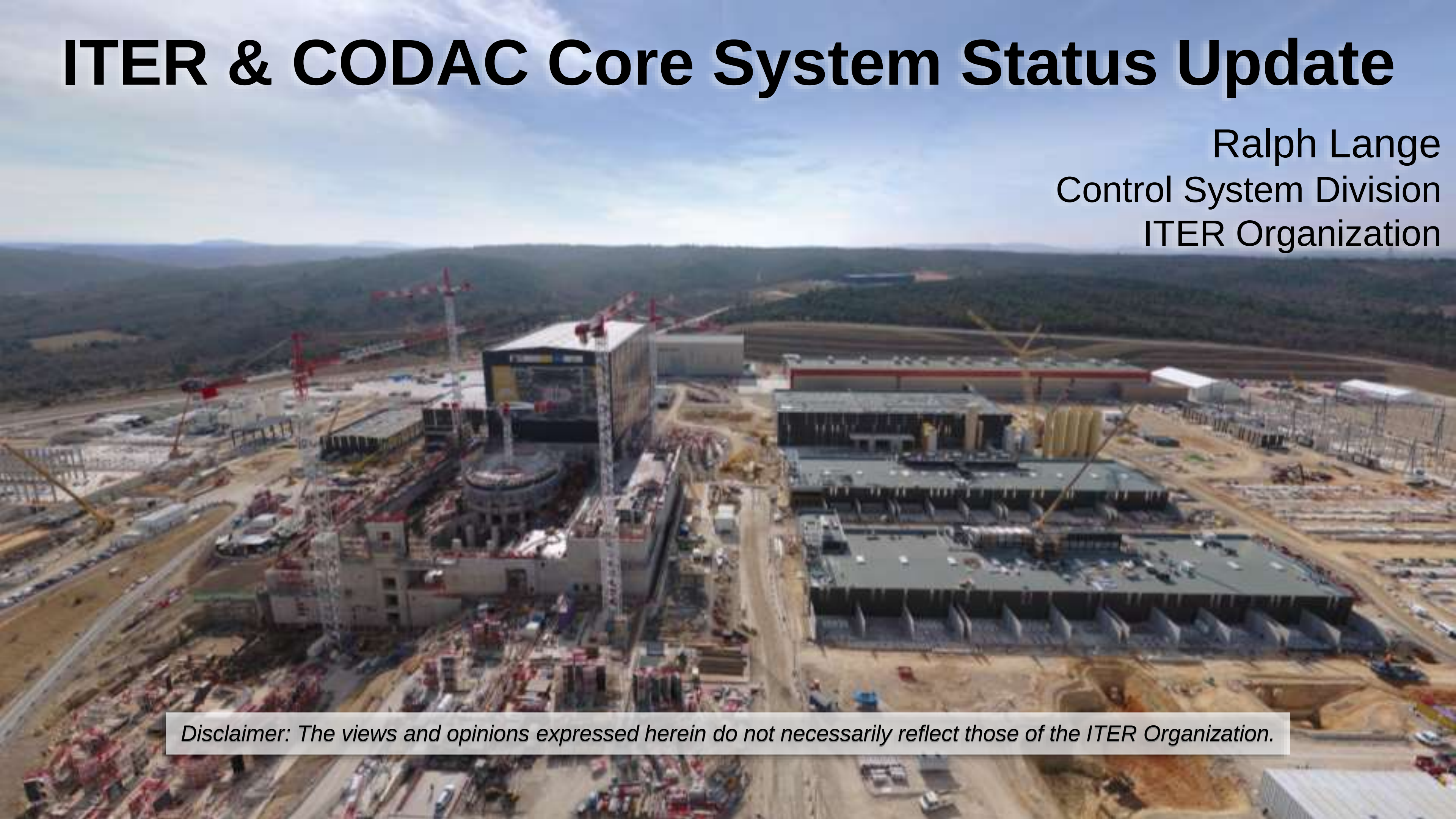
ITER Organization



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Outline

- Overview and Status
  - Architecture, Networks, Infrastructure
  - Standardization: Specification, Hardware, Software, Support
  - Central Systems and Applications
- Challenge 1: Control with no Building
  - Integration Schedule
  - Mitigation of Controls Building Delay
- Challenge 2: Scale
  - Example: Nuclear Safety
  - Example: Cubicles (19” racks) and Buildings

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Update

OVERVIEW AND STATUS

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High Level Requirements

The ITER control system

performs the

functional integration of the ITER plant

and

enables integrated and automated operation

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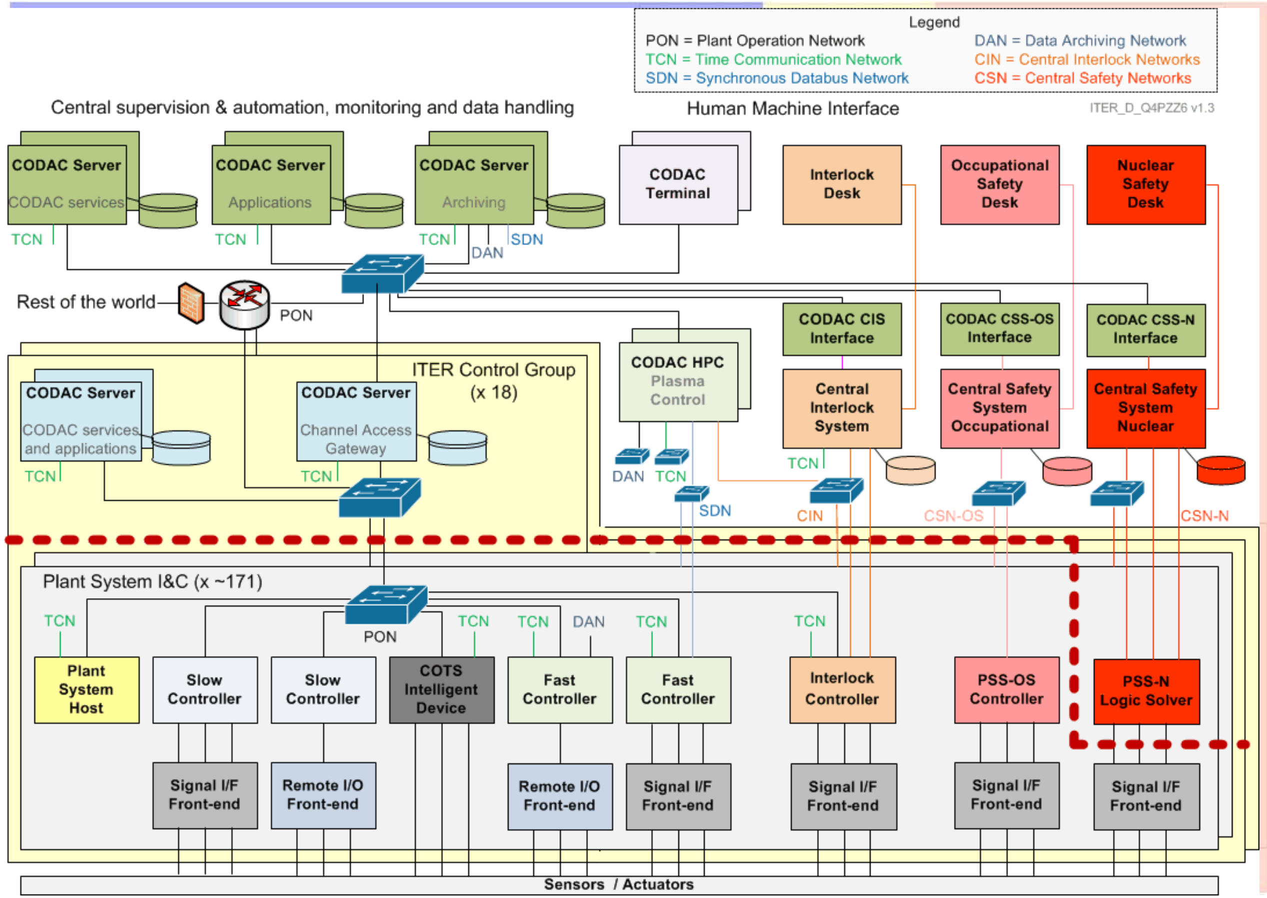

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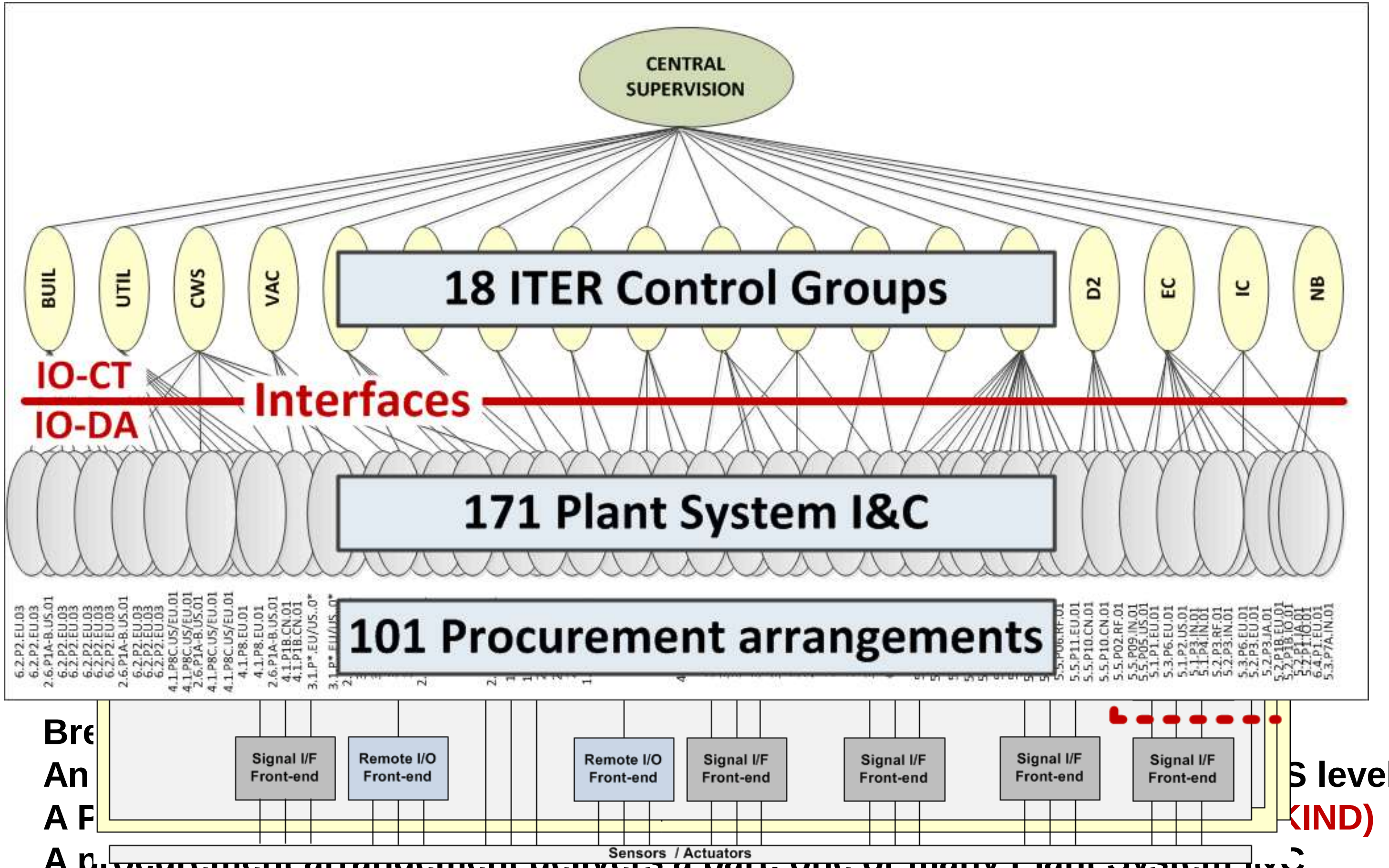
Architecture



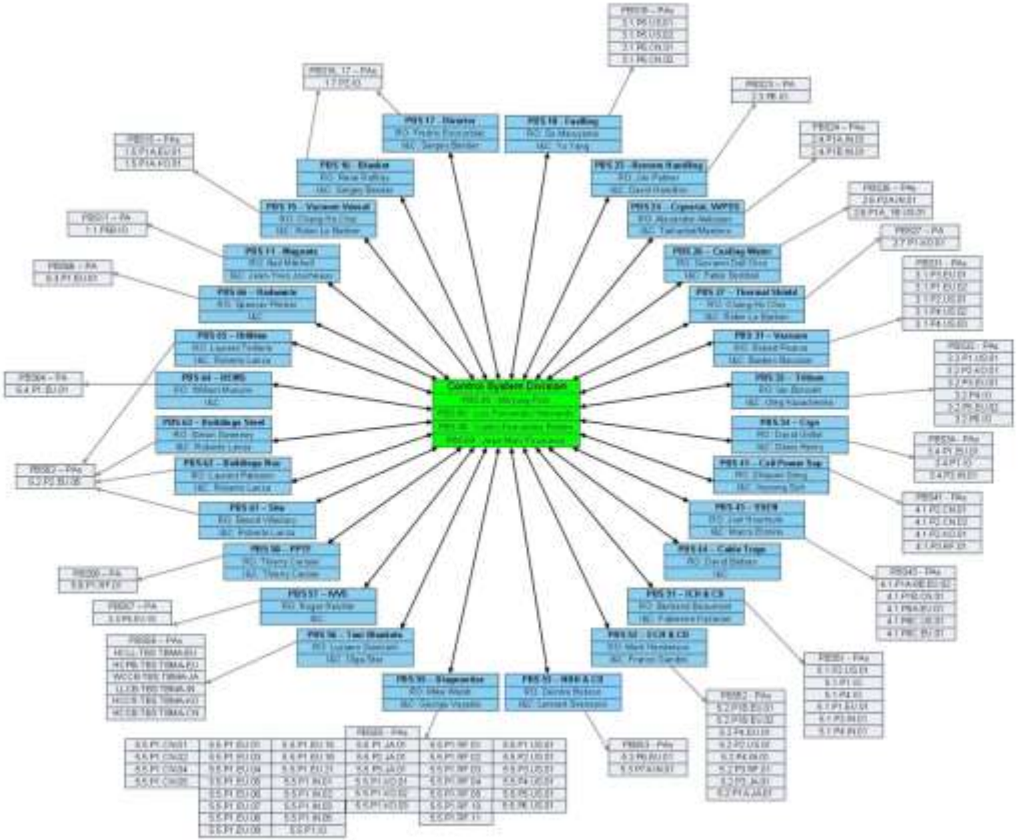
CBS 1

CBS 2

CBS = Control Breakdown Structure

- Bre
- An ... S level 2)
- A F ... KIND)
- A procurement arrangement delivers a part, one of many Plant System I&C

- **171 local Control Systems** (so-called Plant Systems I&C) scattered and supplied by **101 Procurement Arrangements** covering **28 PBS**



Challenge: Integration

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Standardization

- Documentation – Plant Control Design Handbook (PCDH)
  - Specifications, guidelines, catalogues
- Hardware
  - cubicles, controllers, input/output, network interfaces
- Software (common open source framework)
  - CODAC Core System
- Instrumentation & Control Integration Kit
  - Distributed for free to all plant system I&C

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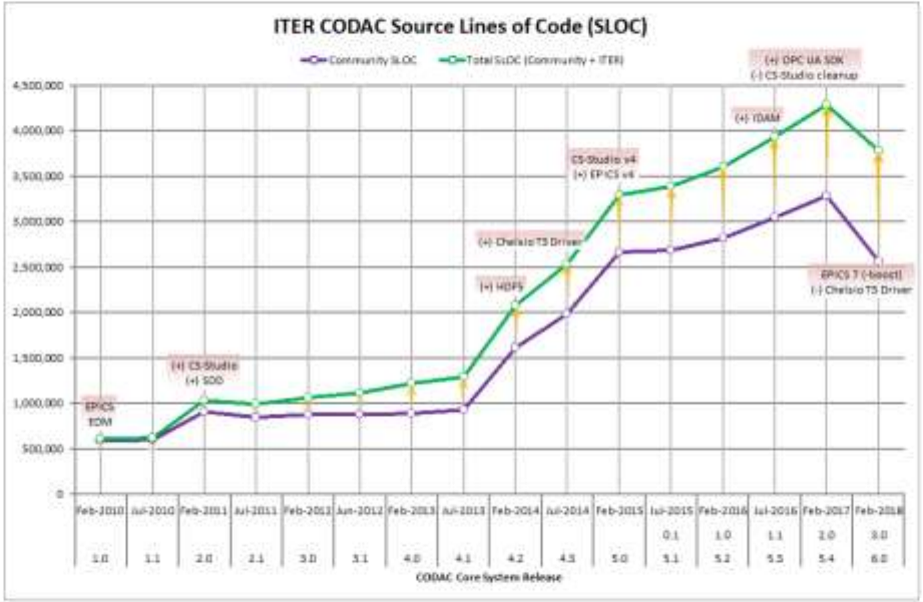
CODAC Core System

The base software for ITER Control System released once or twice per year and providing common services like:

- Communication
- Configuration
- Human Machine Interface
- Archiving
- Alarming
- Input/output device drivers
- ….

Infra	2013		2014		2015		2016		2017	2018	2019	2020	2021
RHEL 6.3 MRG-R 2.1	4.0	4.1	*4.2*	*4.3*	*Support*								
RHEL 6.5 MRG-R 2.5 EPICS 3.15					5.0	5.1	5.2	5.3	5.4	*Support*			
RHEL 7.x EPICS 3.16										*6.0*	*6.1*	*6.2*	*6.3*



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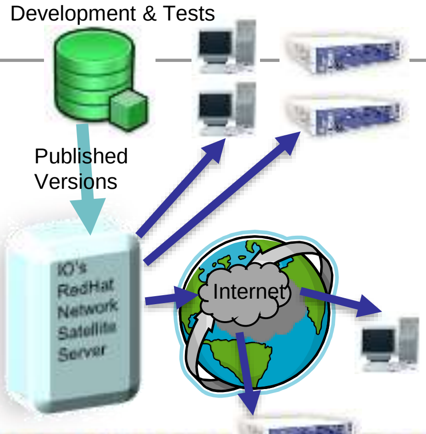
CODAC Core System

Distributed to all plant system suppliers
- 154 instances at 63 organizations

Maintained and upgraded throughout ITER lifetime

Supported by
- CCS Hands-On workshop at IO and DA premises
- CCS Training in IO On-Line Learning Center
- Help-desk : codac-support@iter.org



Human Machine Interface Standardization

- Plant System operator workstation: 3 screens, 1 keyboard/mouse
  - Ultra high definition resolution
    3840 x 2160 (4K) at 60Hz
  - 24 inches
  - Aspect ratio of 16:9

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iter china eu india japan korea russia usa

CODAC Operation Applications

CODAC Operation Applications are ITER dedicated software packages deployed on dedicated central servers

1. Preparation

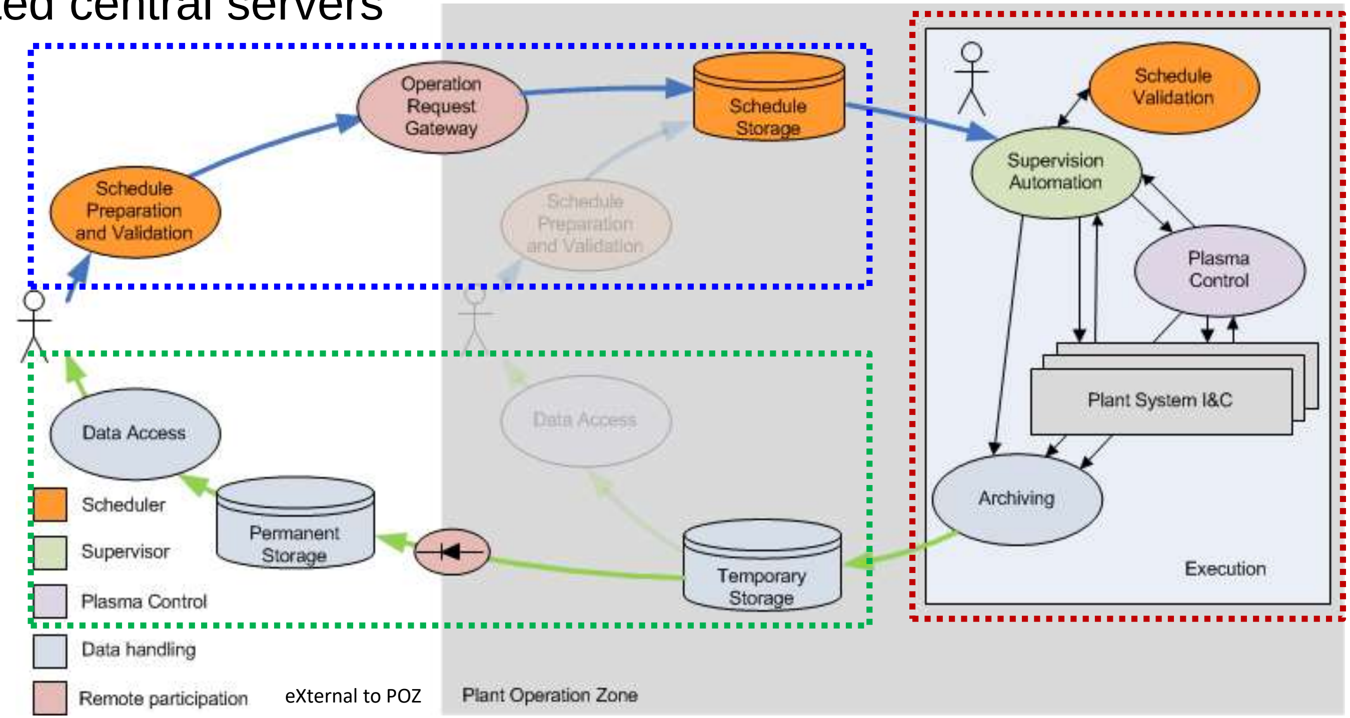
Scheduling (PSPS)
Gateway (ORG)

2. Execution

Control (PCS)
Supervision (SUP)

3. Analysis

Data handling
Data access



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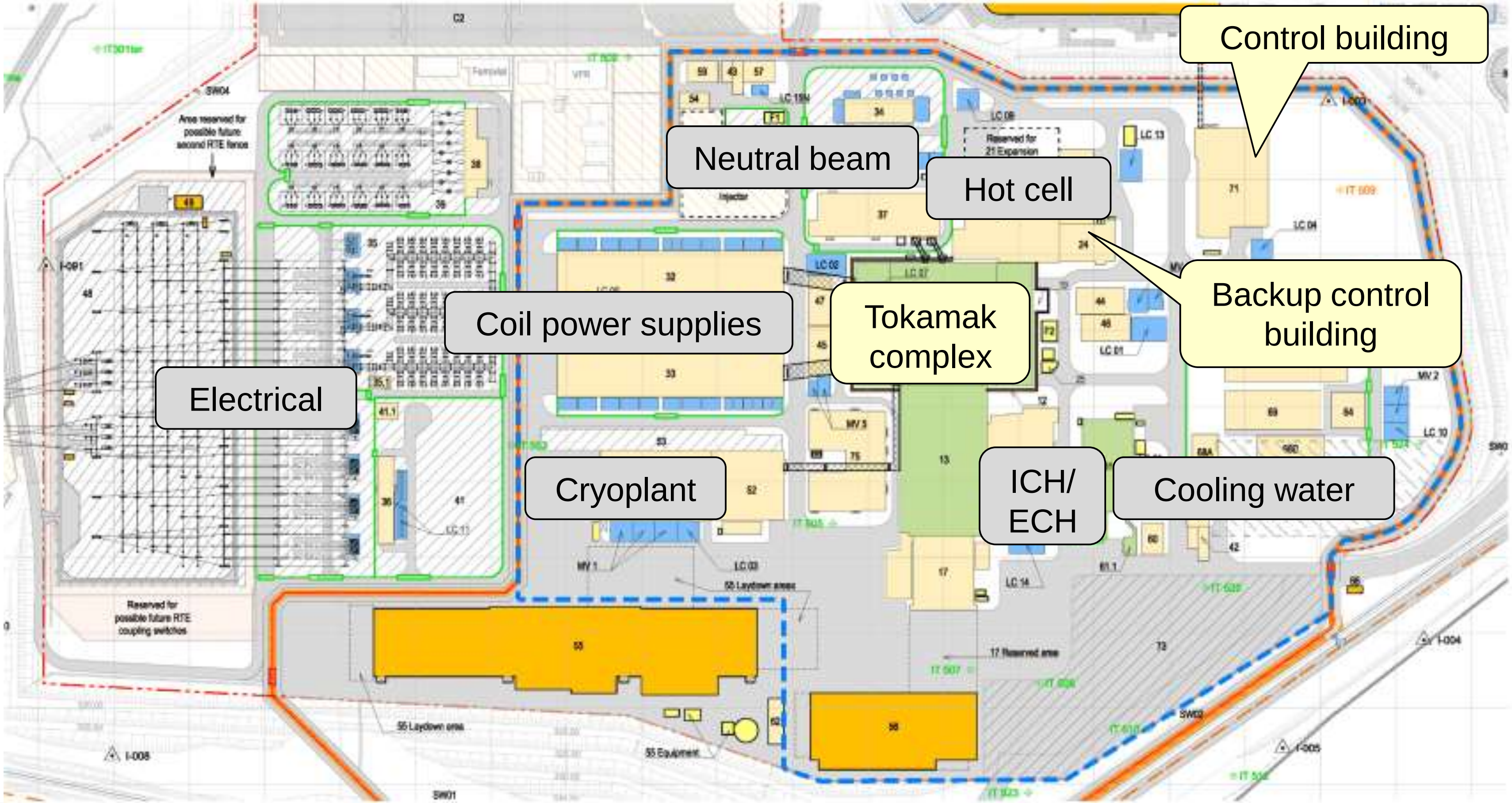
Infrastructure



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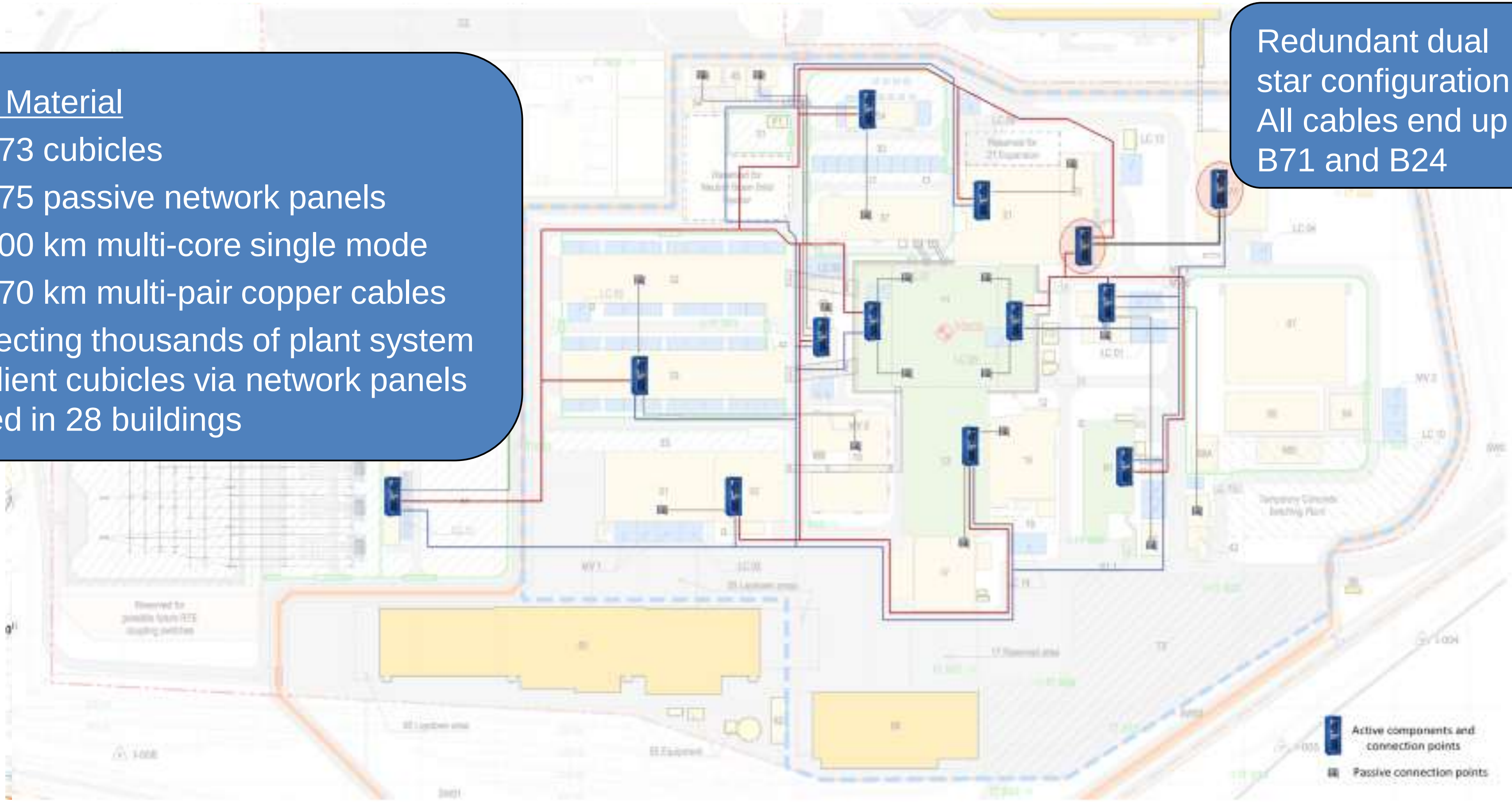
Infrastructure

Redundant dual star configuration
All cables end up in B71 and B24

Bill of Material

- 173 cubicles
- 175 passive network panels
- 300 km multi-core single mode
- 170 km multi-pair copper cables

Connecting thousands of plant system I&C client cubicles via network panels located in 28 buildings



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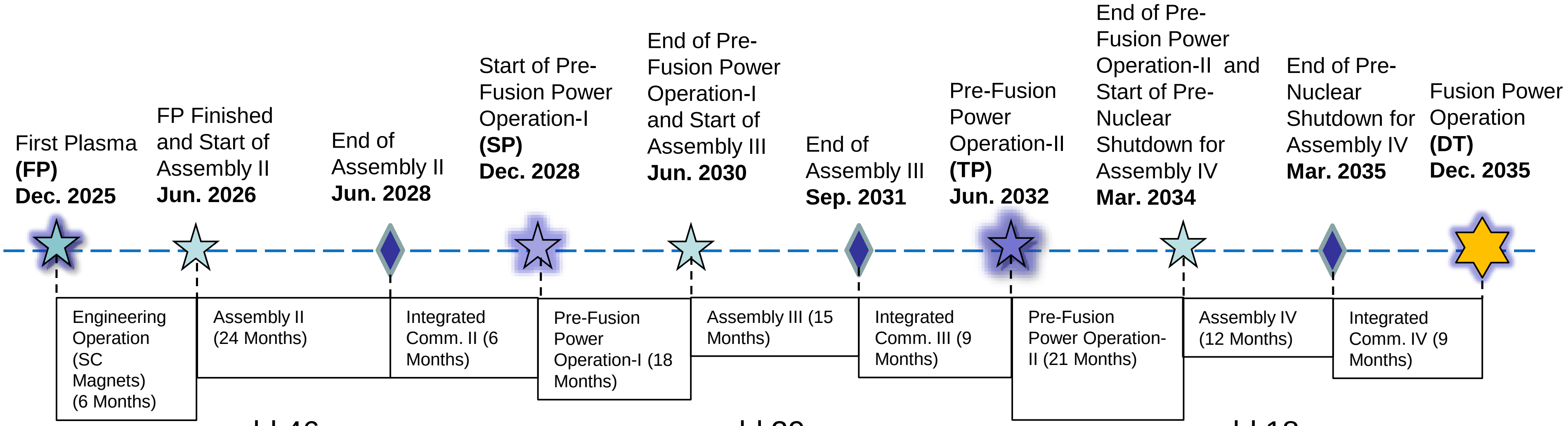
ITER 2016 baseline approved by ITER Council in November 2016
Underpinned with detailed resource loading
Staged approach



add 46
plant system I&C

add 29
plant system I&C

add 18
plant system I&C

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Challenge 1

CONTROL WITH NO BUILDING

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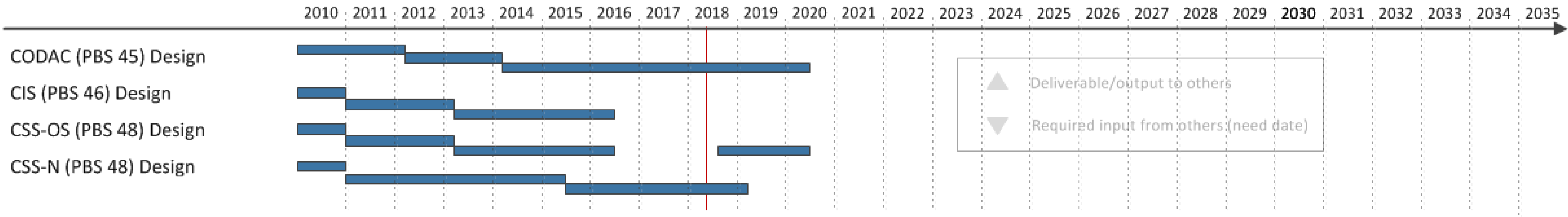
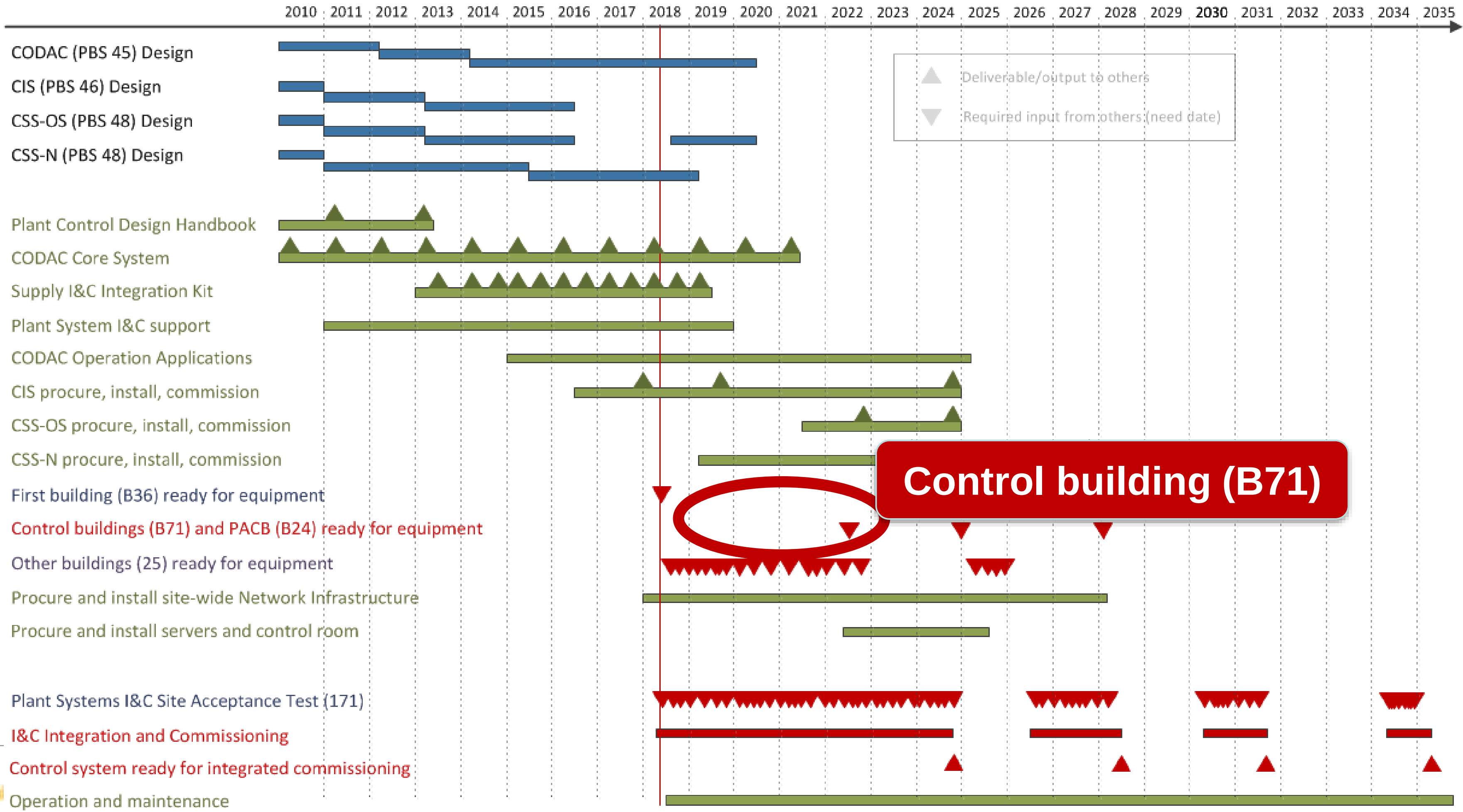
Schedule



Design of central control systems almost complete

Schedule



2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035
Deliverable/output to others
Required input from others (need date)
CODAC (PBS 45) Design
CIS (PBS 46) Design
CSS-OS (PBS 48) Design
CSS-N (PBS 48) Design
Plant Control Design Handbook
CODAC Core System
Supply I&C Integration Kit
Plant System I&C support
CODAC Operation Applications
CIS procure, install, commission
CSS-OS procure, install, commission
CSS-N procure, install, commission
First building (B36) ready for equipment
Control buildings (B71) and PACB (B24) ready for equipment
Other buildings (25) ready for equipment
Procure and install site-wide Network Infrastructure
Procure and install servers and control room
Plant Systems I&C Site Acceptance Test (171)
I&C Integration and Commissioning
Control system ready for integrated commissioning
Operation and maintenance
Control building (B71)

Mitigation – Temporary Control Rooms

Requirements

- The central infrastructure and services must be available soon
- Human Machine Interfaces must be provided for plant system I&C integration
- Migration of all plant systems I&C control to B71 must be achieved within 18 months

Implementation

- Create temporary local autonomous “islands” in strategic buildings, providing central services and Human Machine Interfaces
- Connect islands with temporary cables to provide inter building connectivity
- Maximize emulation of final system to simplify migration to B71

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Temporary Control Rooms – Functions

The following functions are provided as services to the plant systems:

- Human Machine Interface
- Data handling including archiving, storage and access
- Inter plant communication
- Role based access control
- Alarm handling
- Time synchronization
- Electronic logbook
- Access to central software repository and issue tracking (configuration control)
- Development stations for software updates (fast turn-around)
- Central supervision and monitoring
- Access to archived data from office

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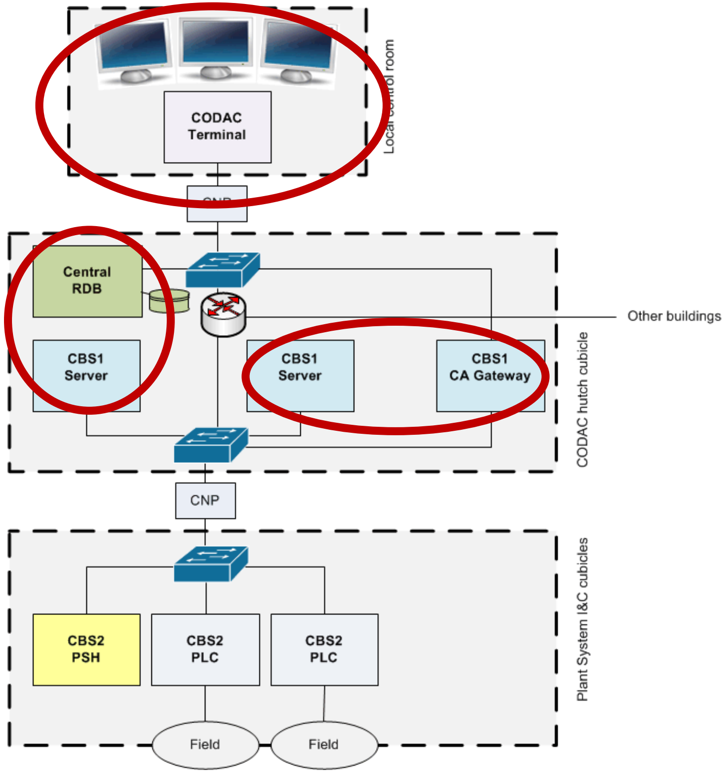
Temporary Control Rooms – Implementation



1. Install central servers in existing CODAC network cubicles
2. Standard HMI stations in suitable room
3. Add Interlock and Safety when applicable (local test tools)
4. Cover all Plant Systems for First Plasma (before Control Building availability) by eleven Temporary Control Rooms

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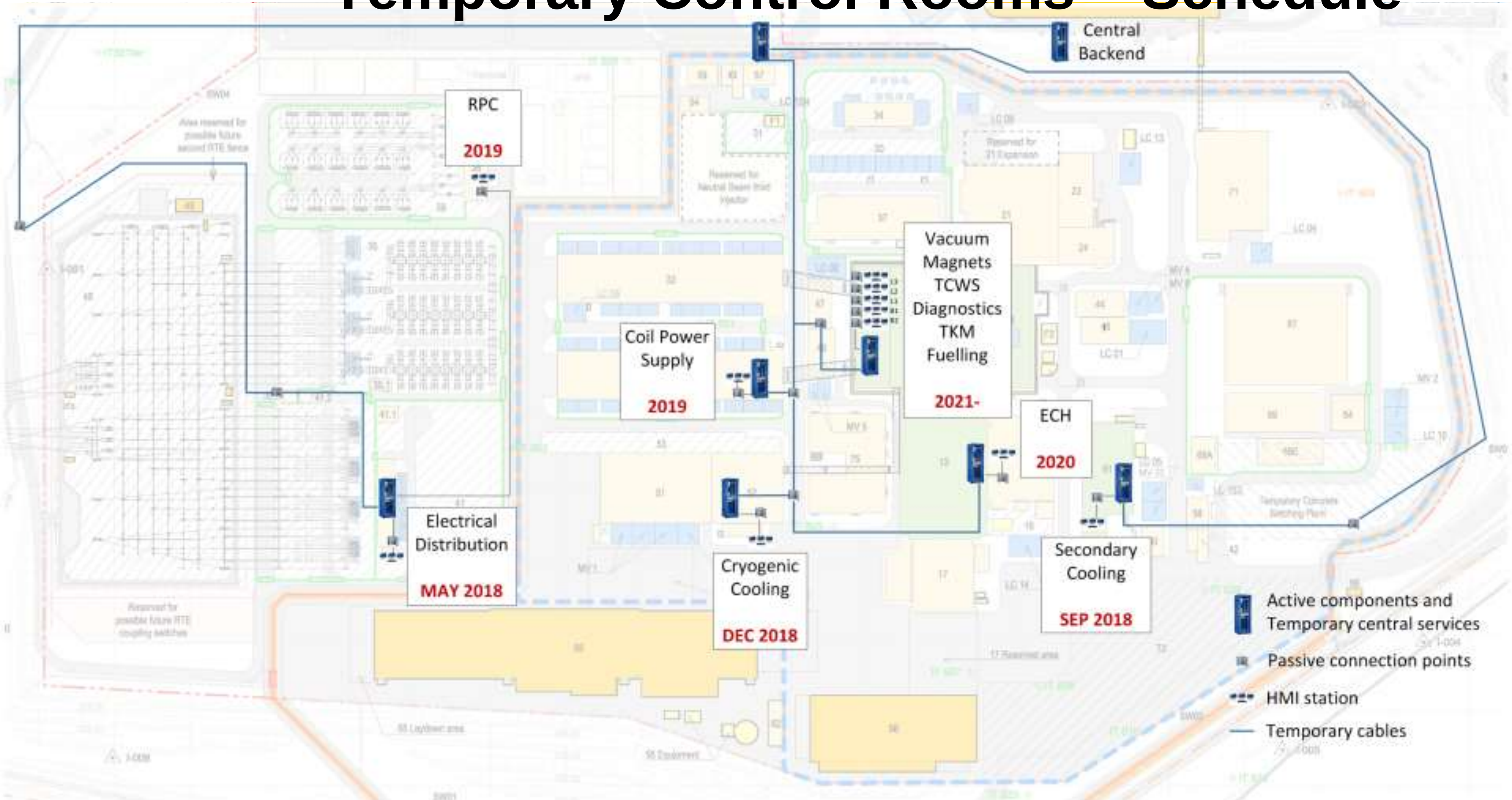
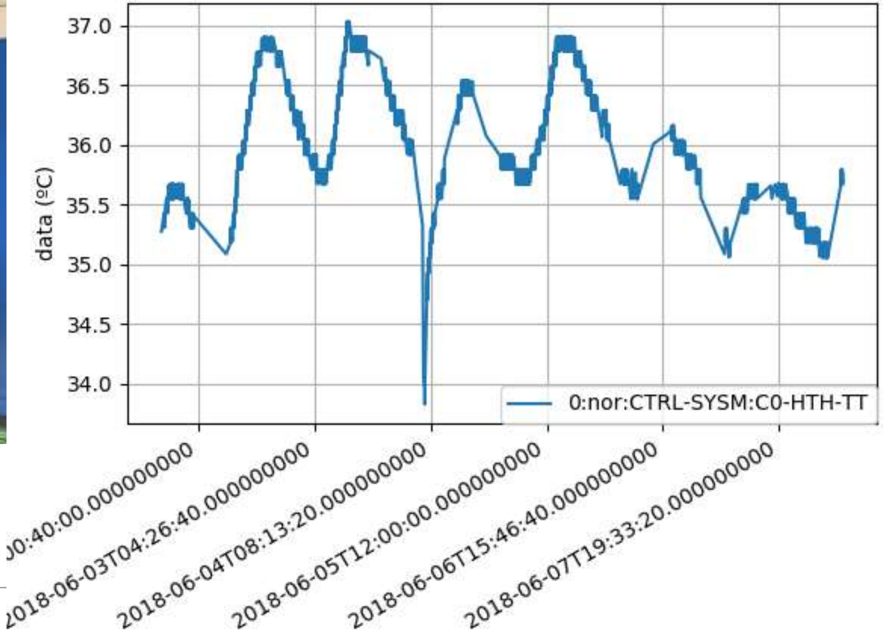
Temporary Control Rooms – Schedule



Temporary Control Rooms – Status

- First Temporary Control Room in Building 36 (electrical) powered up
- I&C Integration and Commissioning starts NOW



Challenge 2

SCALE

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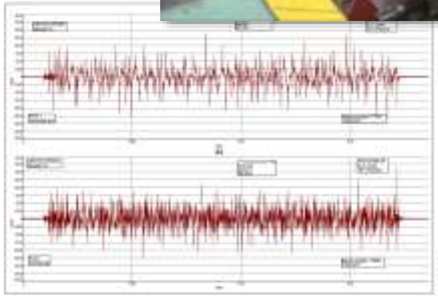
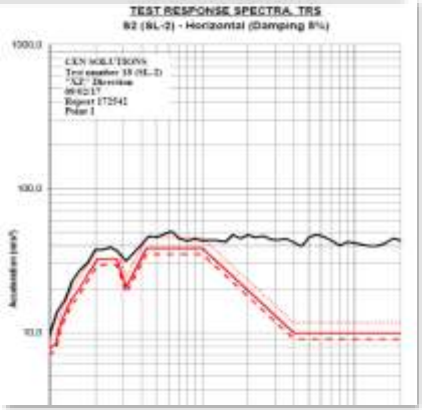
Example: Nuclear Safety

- Confinement of radioactive material
- Protection from exposure to ionizing radiation

- Two separate signal chains
- Extensive qualification of components





24.1 m/s^2 at the shaking table
101 m/s^2 in heaviest sampler

Cost per signal:

- Fission reactor: ~3,000 € (proprietary hw)
- ITER: ~1,500 € (commercial hw)

Number of signals:

- Fission reactor: 200-400
- ITER: 40,000

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Example: Cubicles and Buildings

- How many 19” racks do you have in your facility?
- ITER will have about 3,500 cubicles, each equipped with a PLC that is monitoring the cubicle status
- With an EPICS database of 20 records per cubicle, that’s 70,000 records just for cubicle monitoring

- The building integrator plans to install pretty large PLCs (S7 1518) with up to > 50,000 signals per PLC

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Thank you

ps. Check out the drone flight videos!