

# ITER Hot Cell Facility

## Status and main challenges

Virginie Beaudoin

M. Benchikhoun, A. Dammann, A. Gray  
S.M.Basha, V.Ivanov, M.Kotamaki

# Contents

- The ITER project
  - ✓ In-vessel component
  - ✓ Remote Handling tools
  - ✓ Overview of ITER site
- ITER Hot Cell Facility
  - ✓ Functions
  - ✓ Design drivers
  - ✓ Interfaces
  - ✓ Current layout
  - ✓ Safety
- Site construction progresses

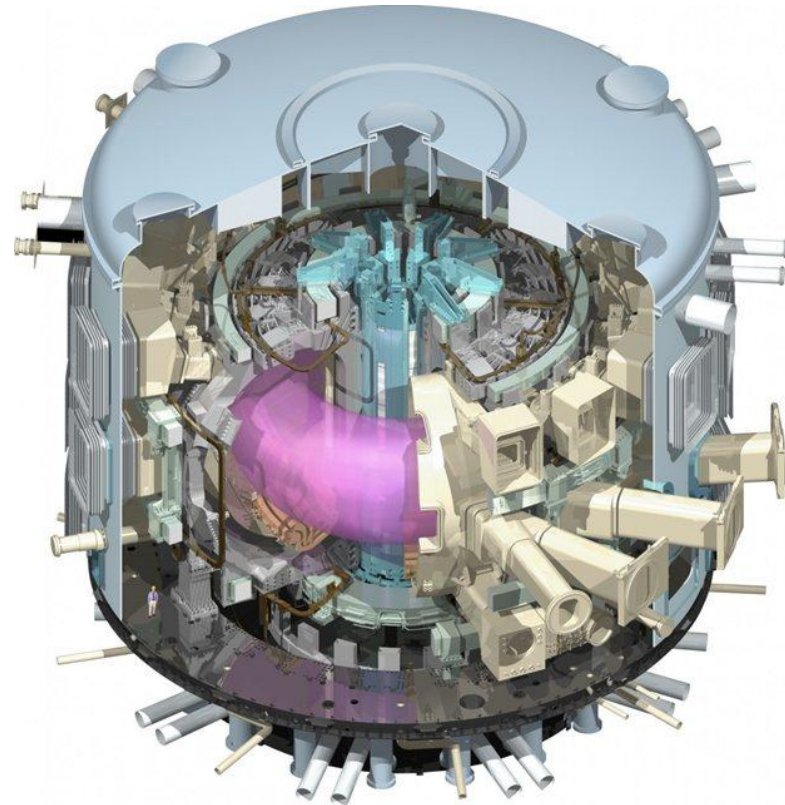
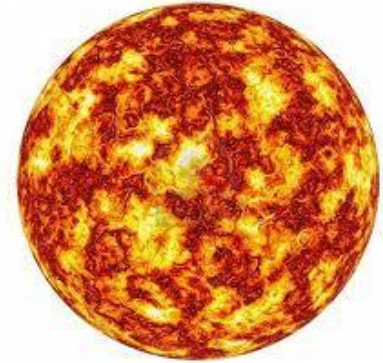
# The ITER project

The overall programmatic objective is to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes.

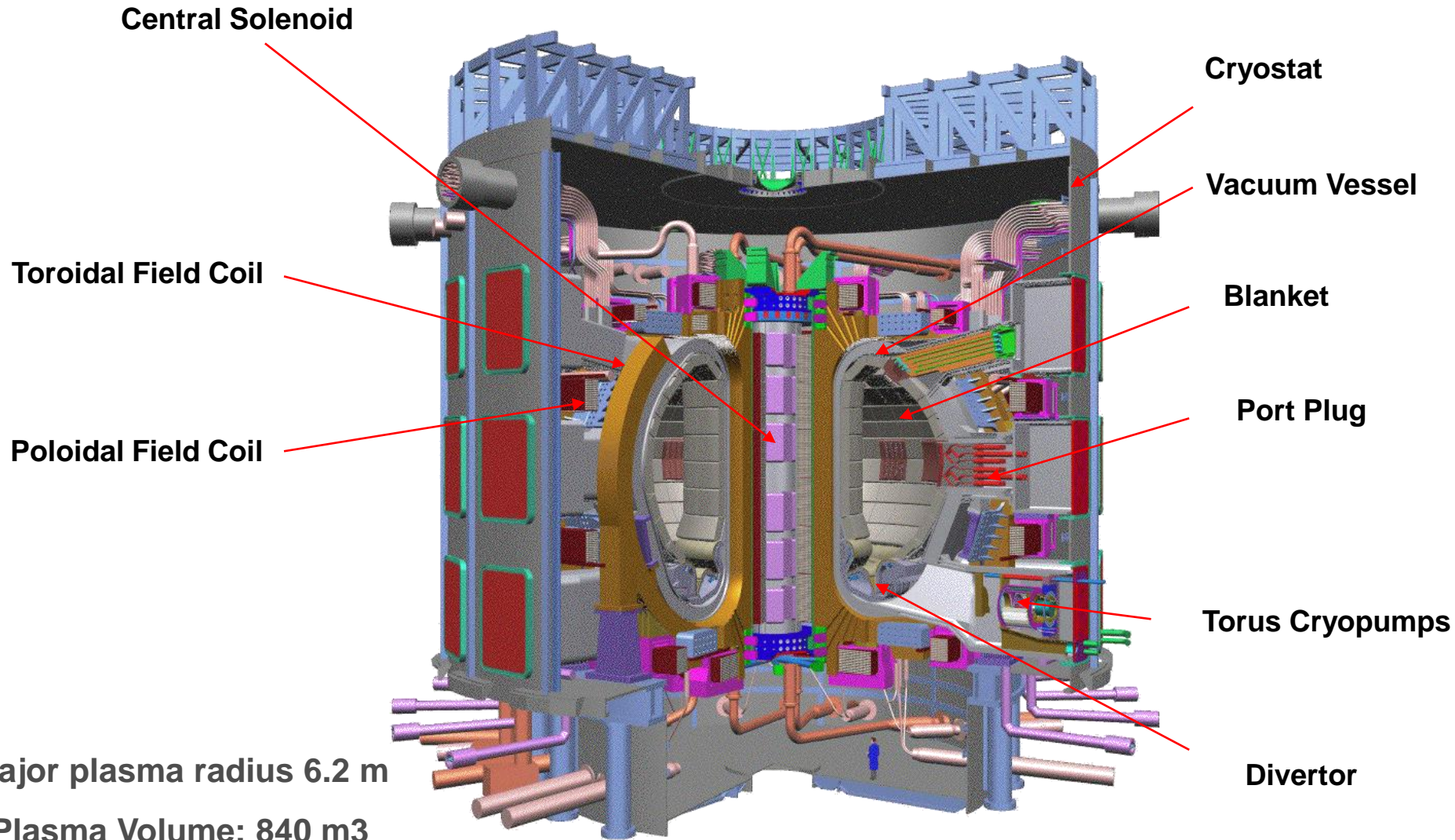
The principal goal  **$Q \geq 10$**

input power	50 MW
output power	500 MW

Seven parties have joined the project  
90% of the contributions are in kind.



# The core of ITER



Major plasma radius 6.2 m

Plasma Volume: 840 m<sup>3</sup>

Fusion Power: 500 MW

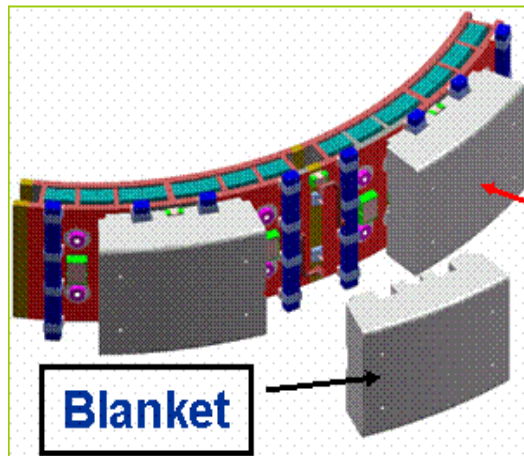
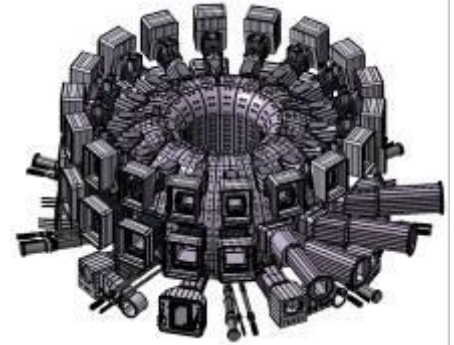
Machine mass: 23350 t (cryostat + VV + magnets)  
- shielding, divertor and manifolds: 7945 t + 1060 port plugs  
- magnet systems: 10150 t; cryostat: 820 t



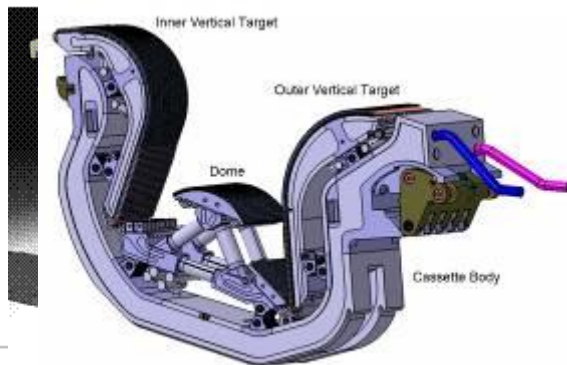
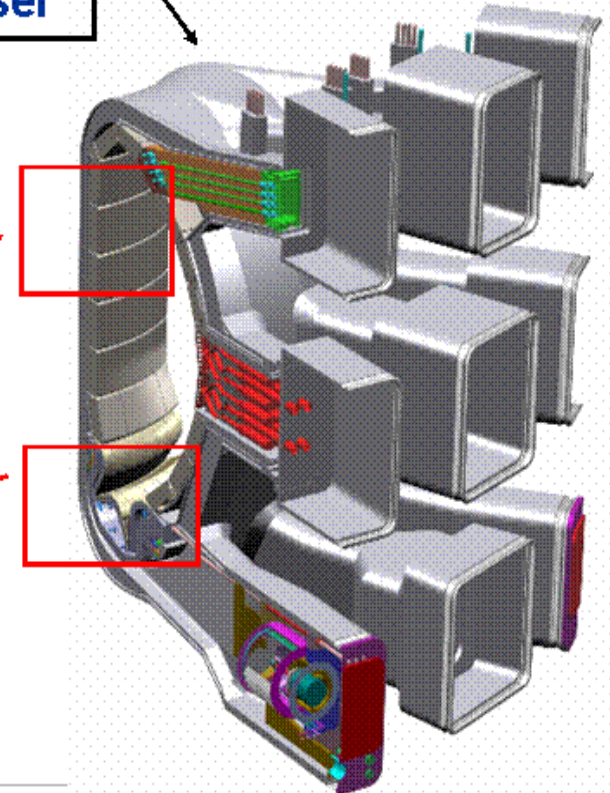
# In-Vessel Components

Key issues resolved:

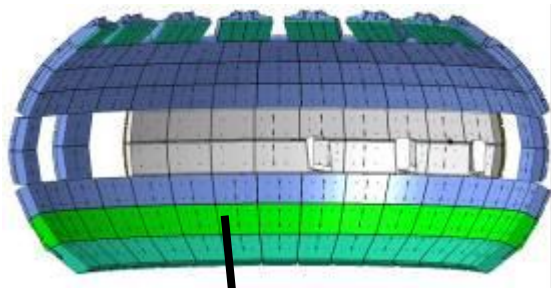
- Blanket loads on VV
- Neutron shielding
- Blanket manifold design & interface with VV
  - VV manufacturability



Vacuum Vessel



Divertor

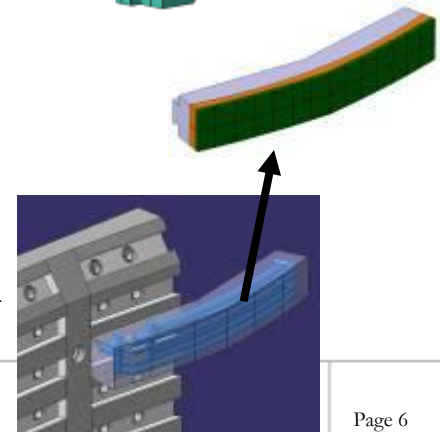
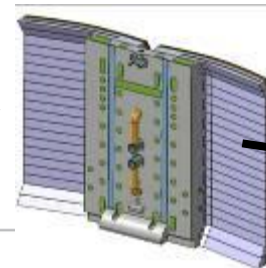
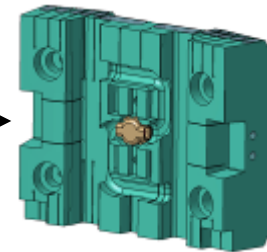
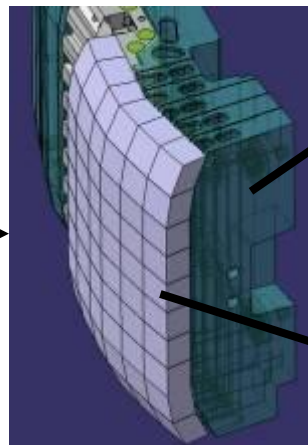
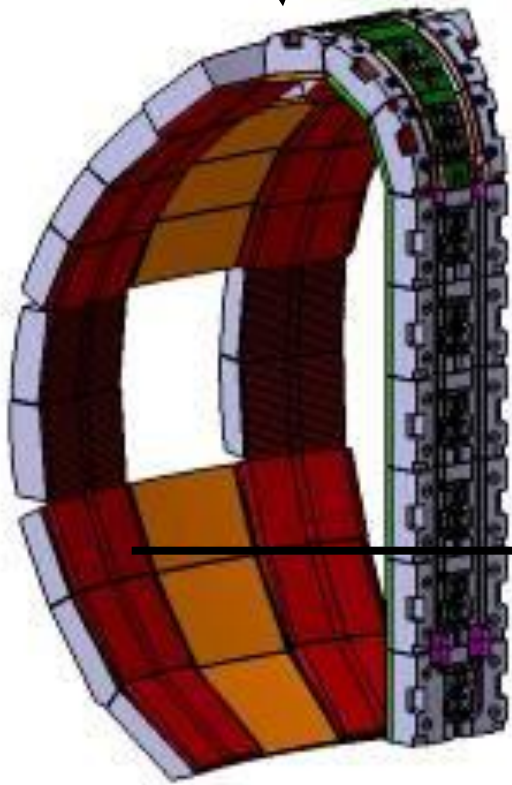


# Blanket Modules

## Scope

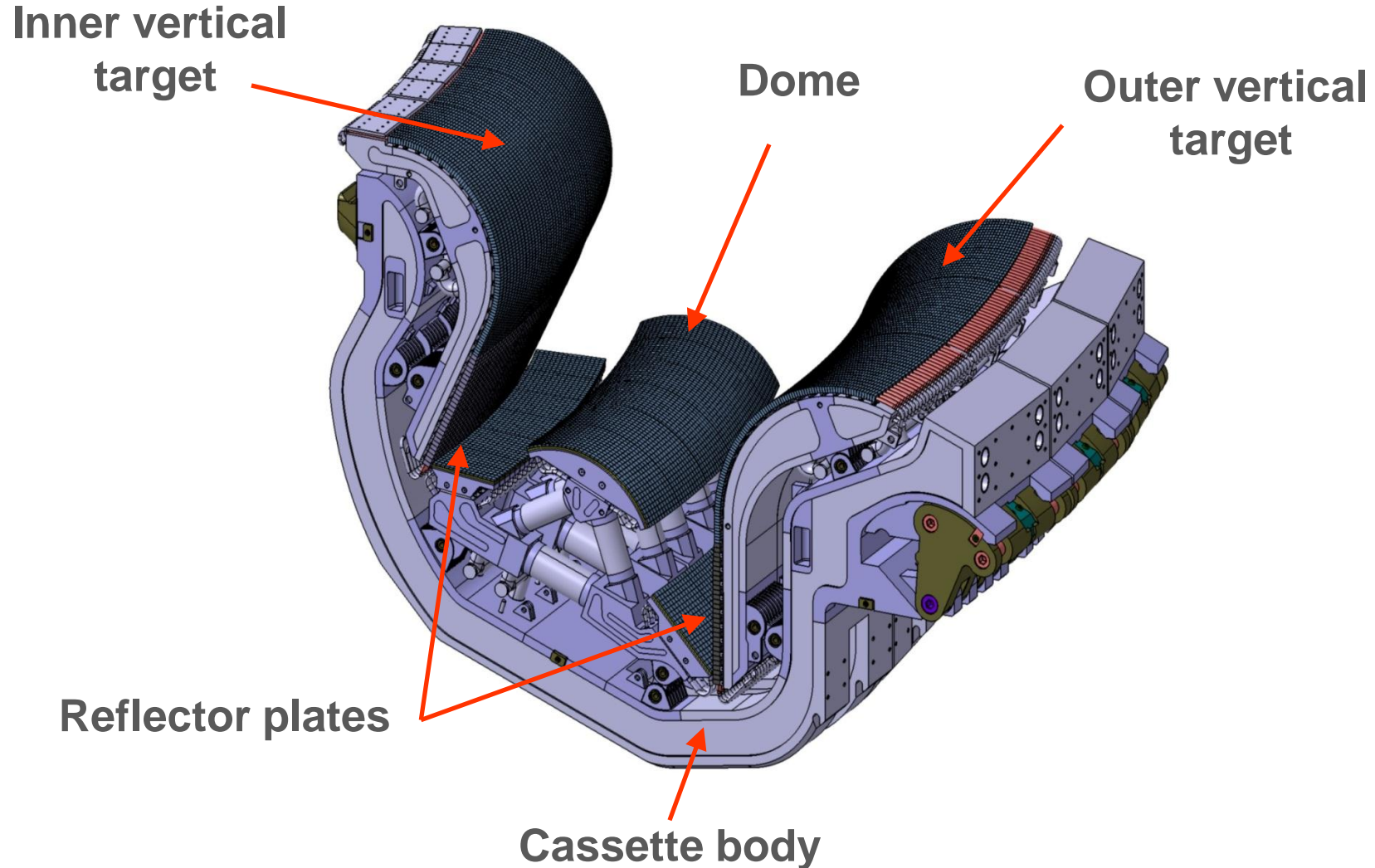
- 440 blanket modules at ~4 ton each
- ~40 different blanket modules

Separable first wall is implemented



# Divertors

54 Divertor assemblies  
~8.7 tons each

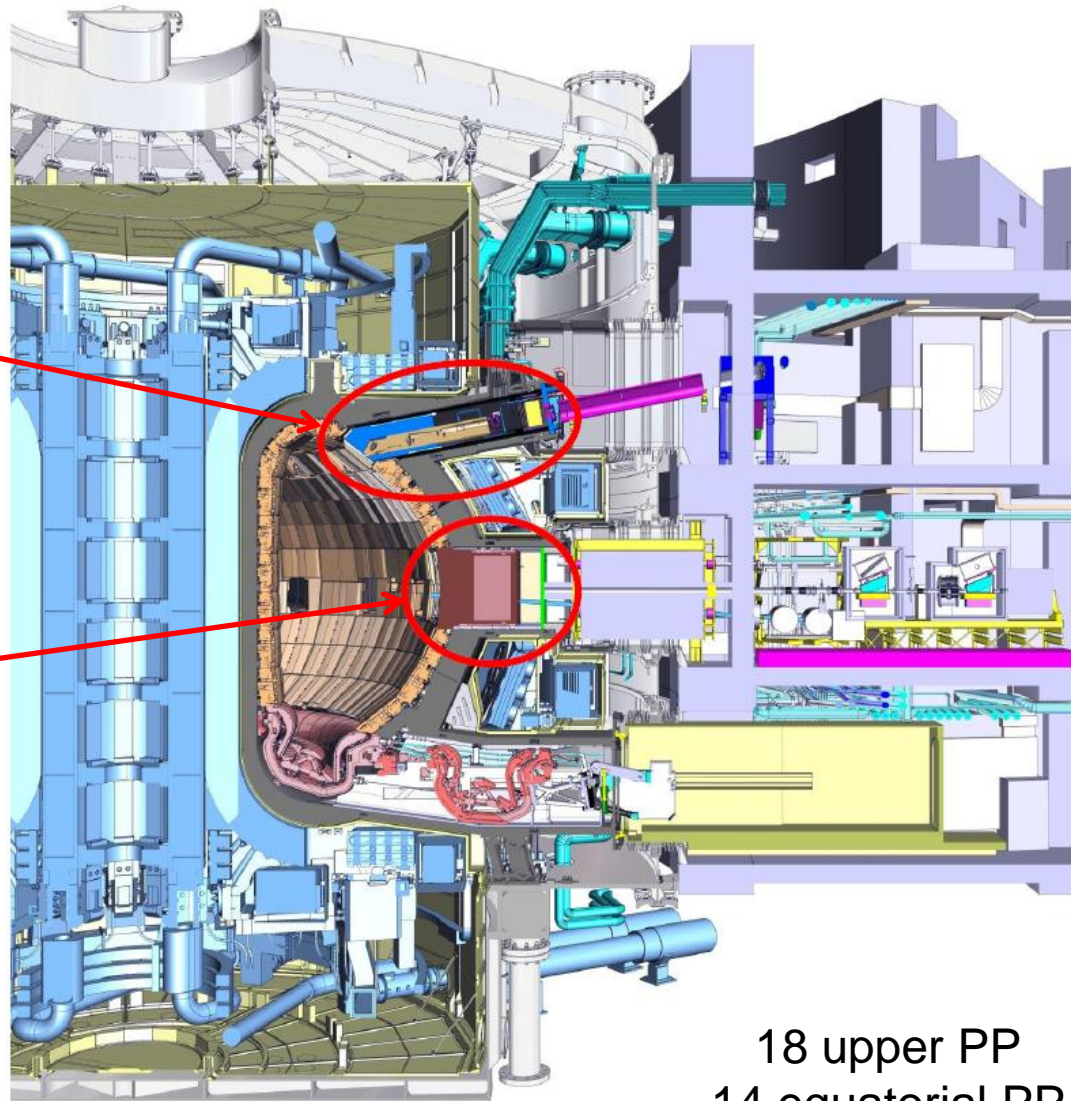




# Port Plug

**Upper port plug**  
5.6 m x 1.1 m x 0.9 m  
25 tons

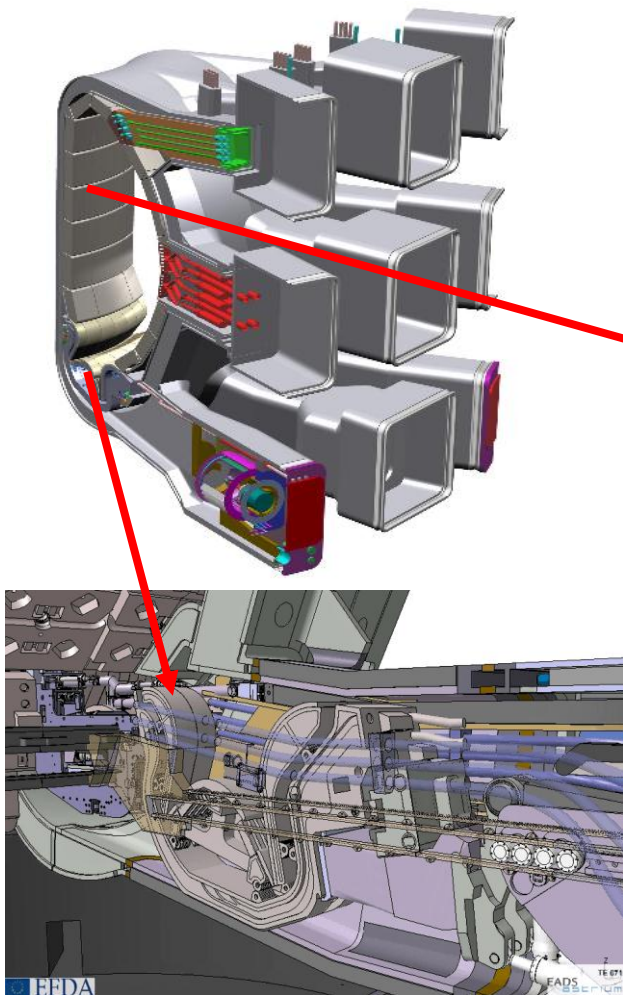
**Equatorial port plug**  
3.3 m x 1.9 m x 2.2 m  
45 tons



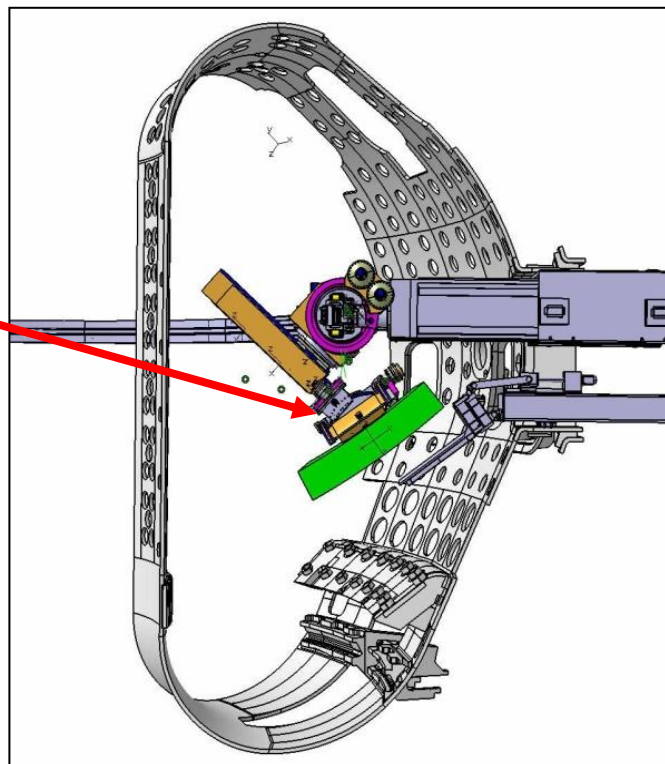
18 upper PP  
14 equatorial PP



# In-Vessel Remote Handling tools

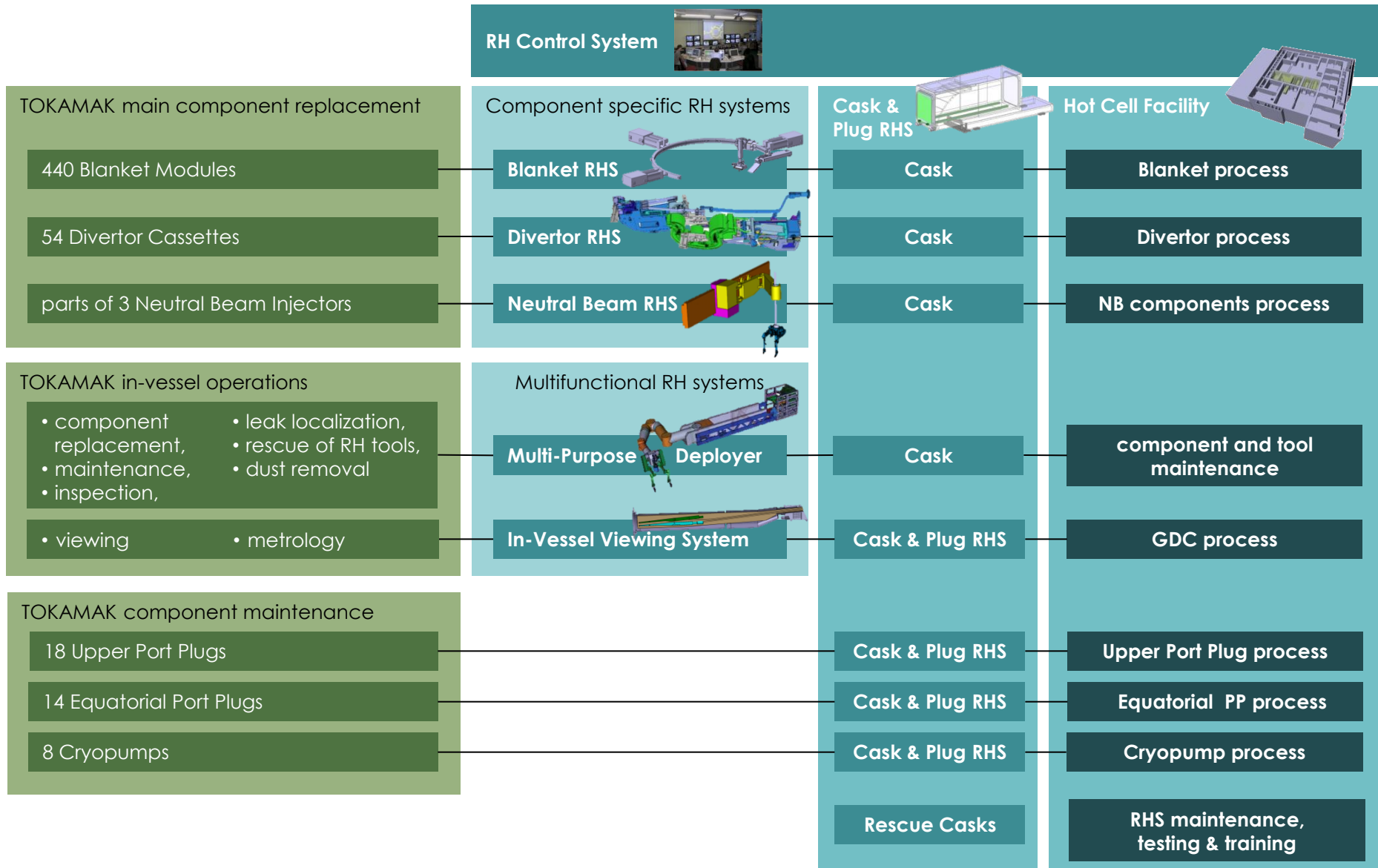


Divertor Cassette Handling ~8.7 tons



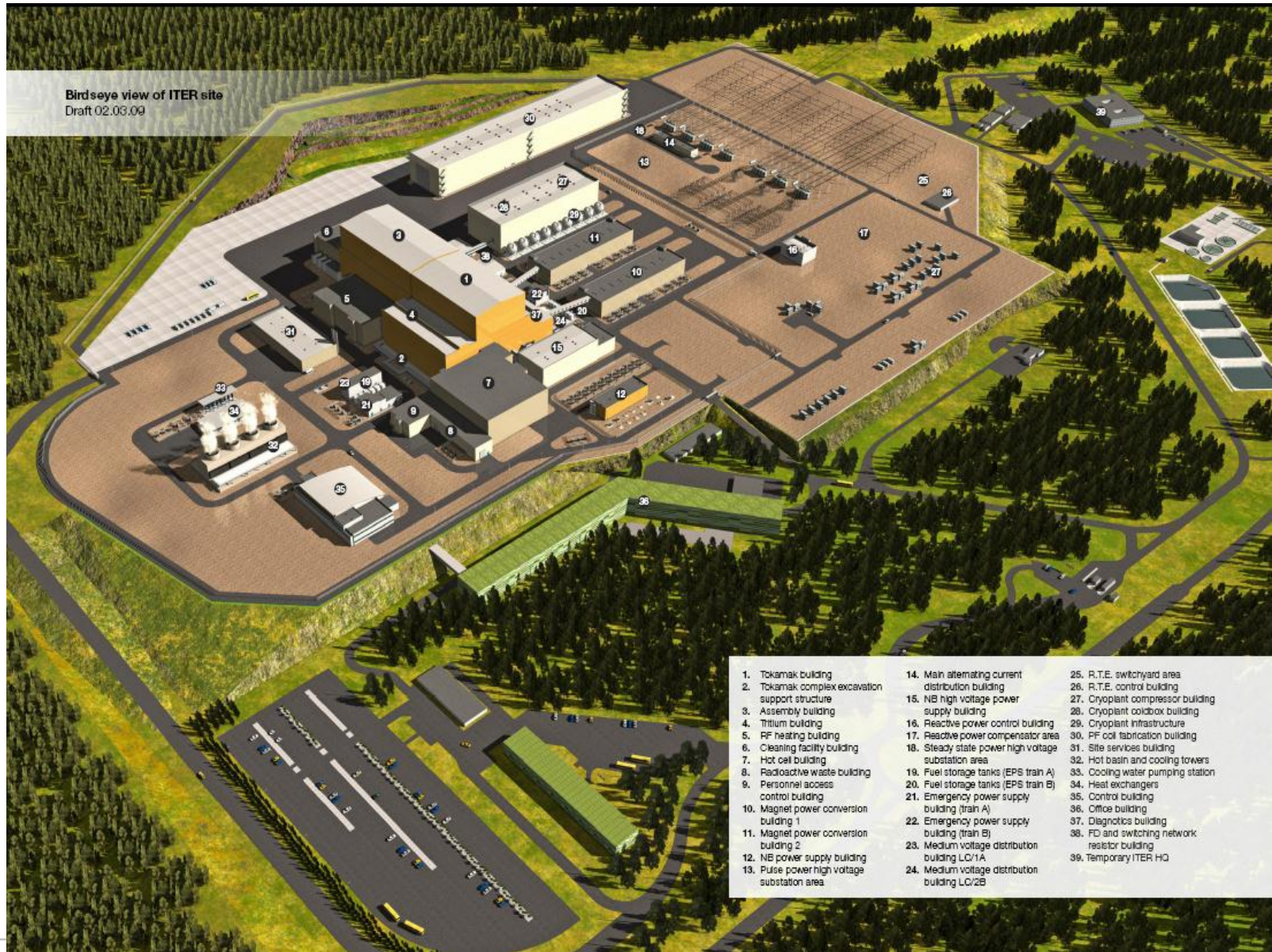
Blanket Module Handling ~ 4 tons

# ITER Remote Handling System - Overview





# Overview of ITER site



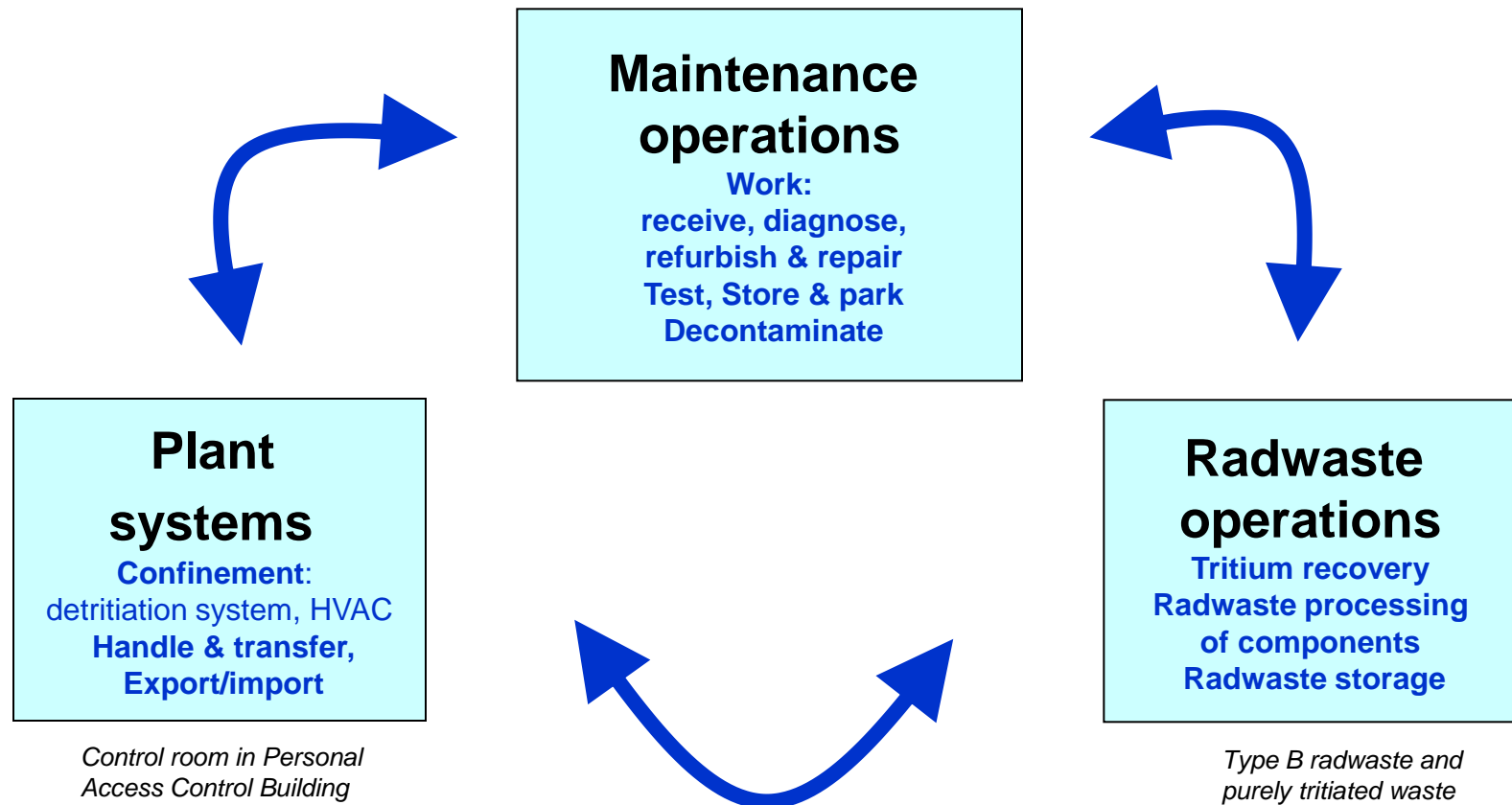


# Contents

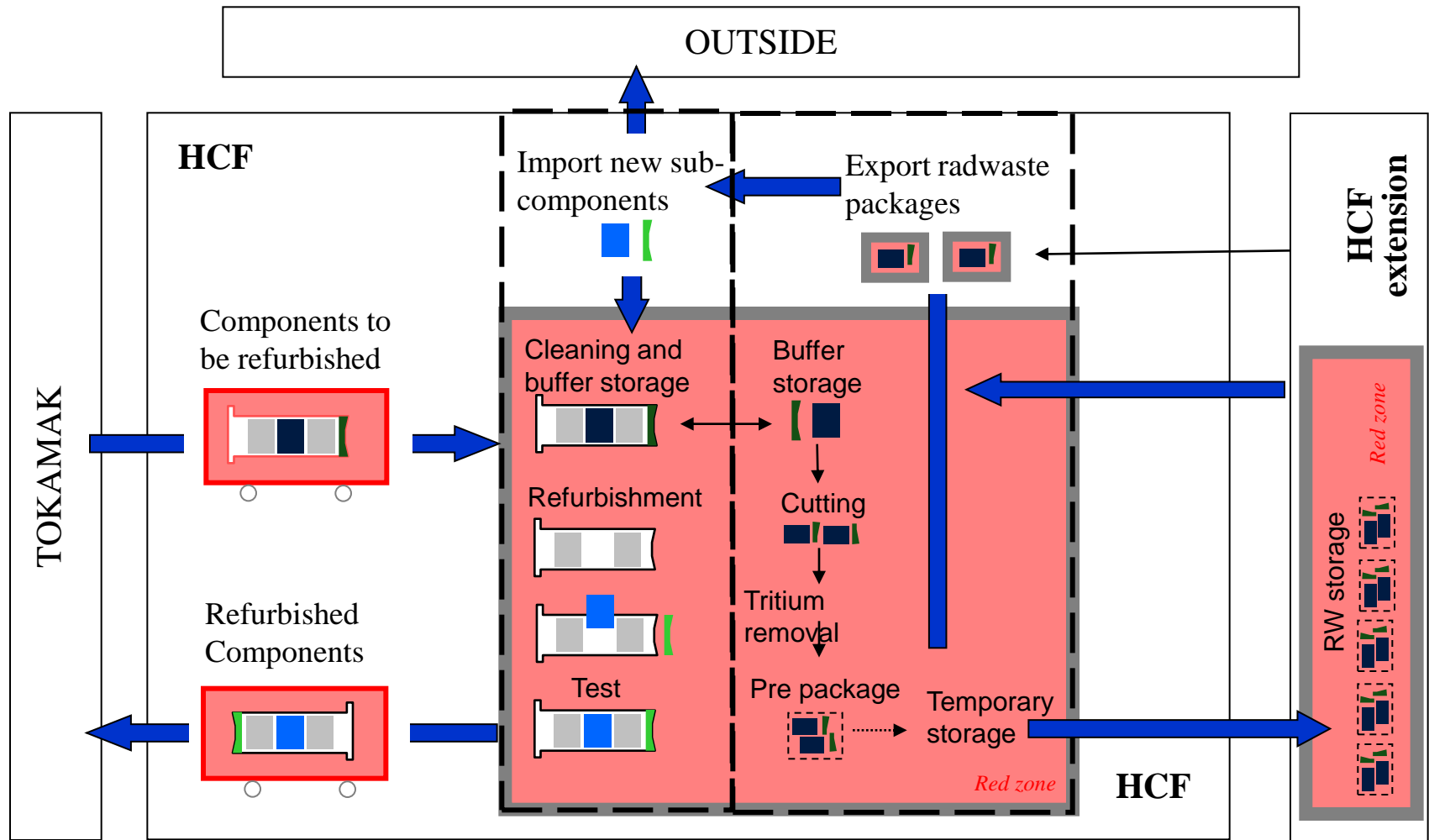
- The ITER project
  - ✓ In-vessel component
  - ✓ Remote Handling tools
  - ✓ Overview of ITER site
- ITER Hot Cell Facility
  - ✓ Functions
  - ✓ Design drivers
  - ✓ Interfaces
  - ✓ Current layout
  - ✓ Safety
- Site construction progresses

# Hot Cell Facility functions

- **ITER Hot Cell Facility (HCF) (building 21)** is designed to support the Tokamak during the assembly, operation, de-activation and dismantling phases.
- **The Hot Cell Facility key functions:** [maintenance operations, radwaste operations] ~70%, plant systems ~30 %.

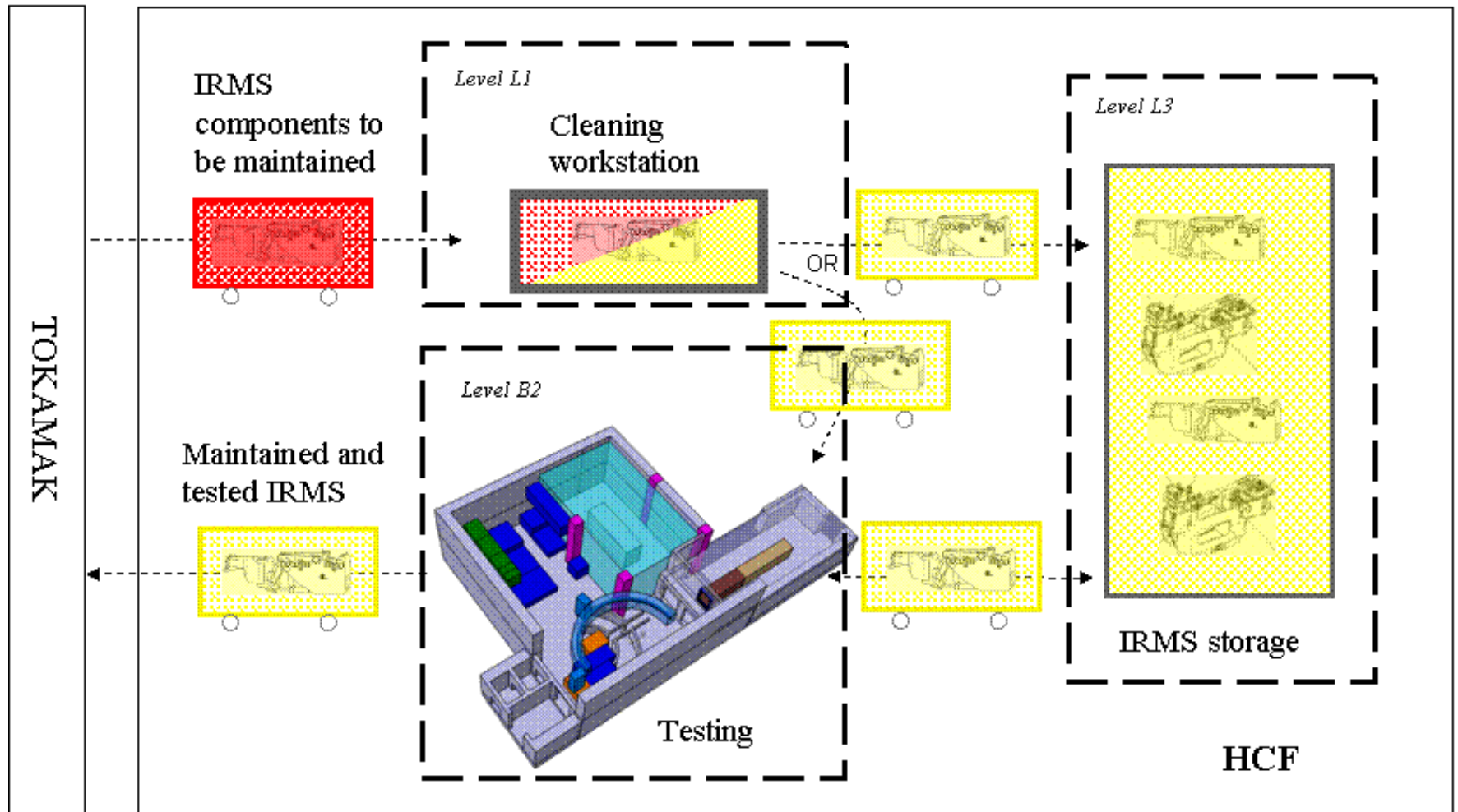


# Flow diagram - refurbishment of in Vessel components / radwaste treatment & storage





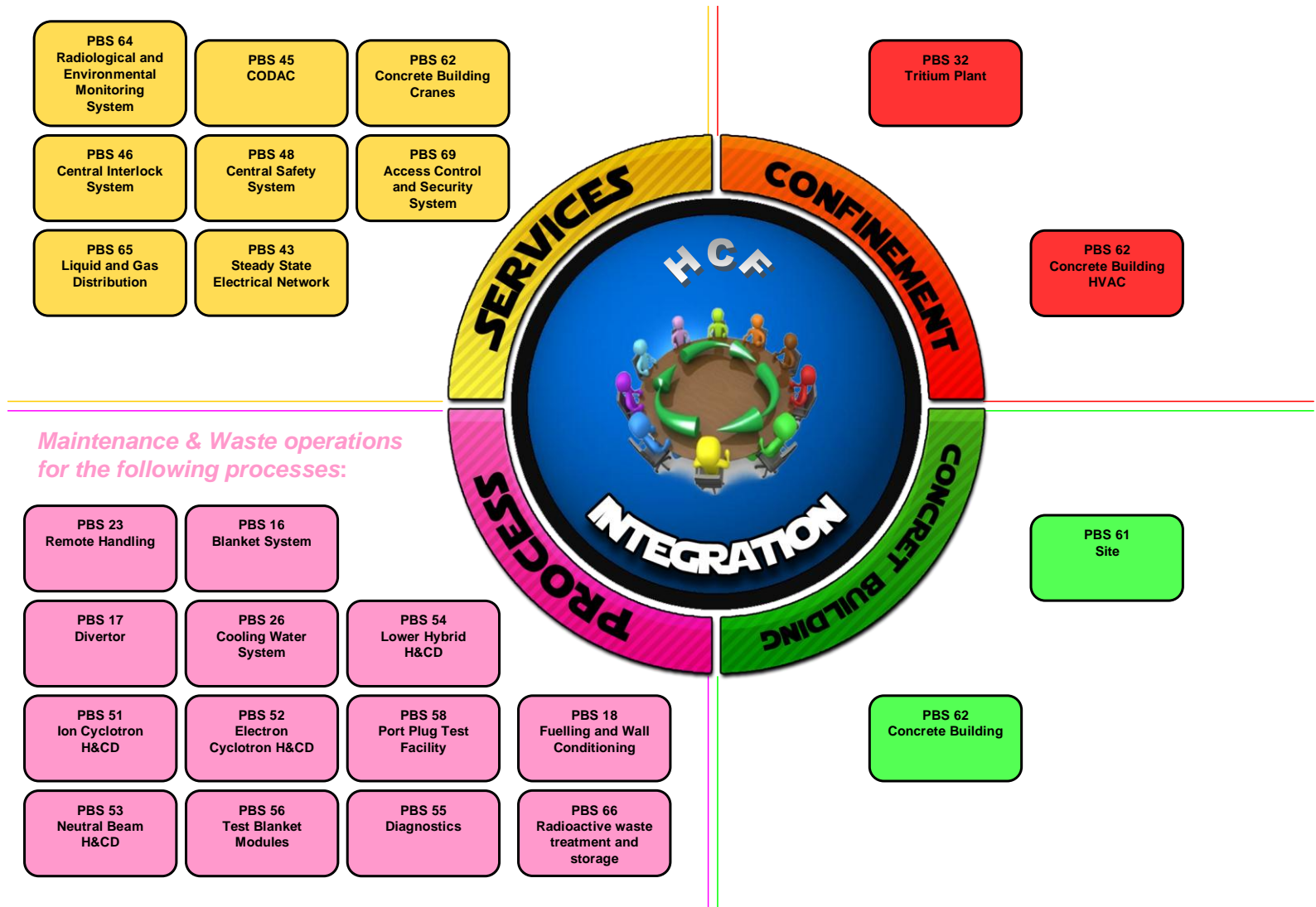
# Flow diagram - maintenance of RH tools



# Hot Cell Facility design drivers

- **Safety**
  - Confinement
  - Radiation shielding
  - HCF safety
- **Integration of systems housed by the HCF**
  - In vessel components
  - Port plug test facilities
  - Remote Handling equipment and tools,
  - Radwaste treatment & storage system,
  - Detritiation system ...
  - HCF integration in a reinforced concrete building
- **Operations**
  - Machine availability
  - Maintenance strategy
  - HCF availability
- **Flexibility**
  - To maintain flexibility in the design as much as possible

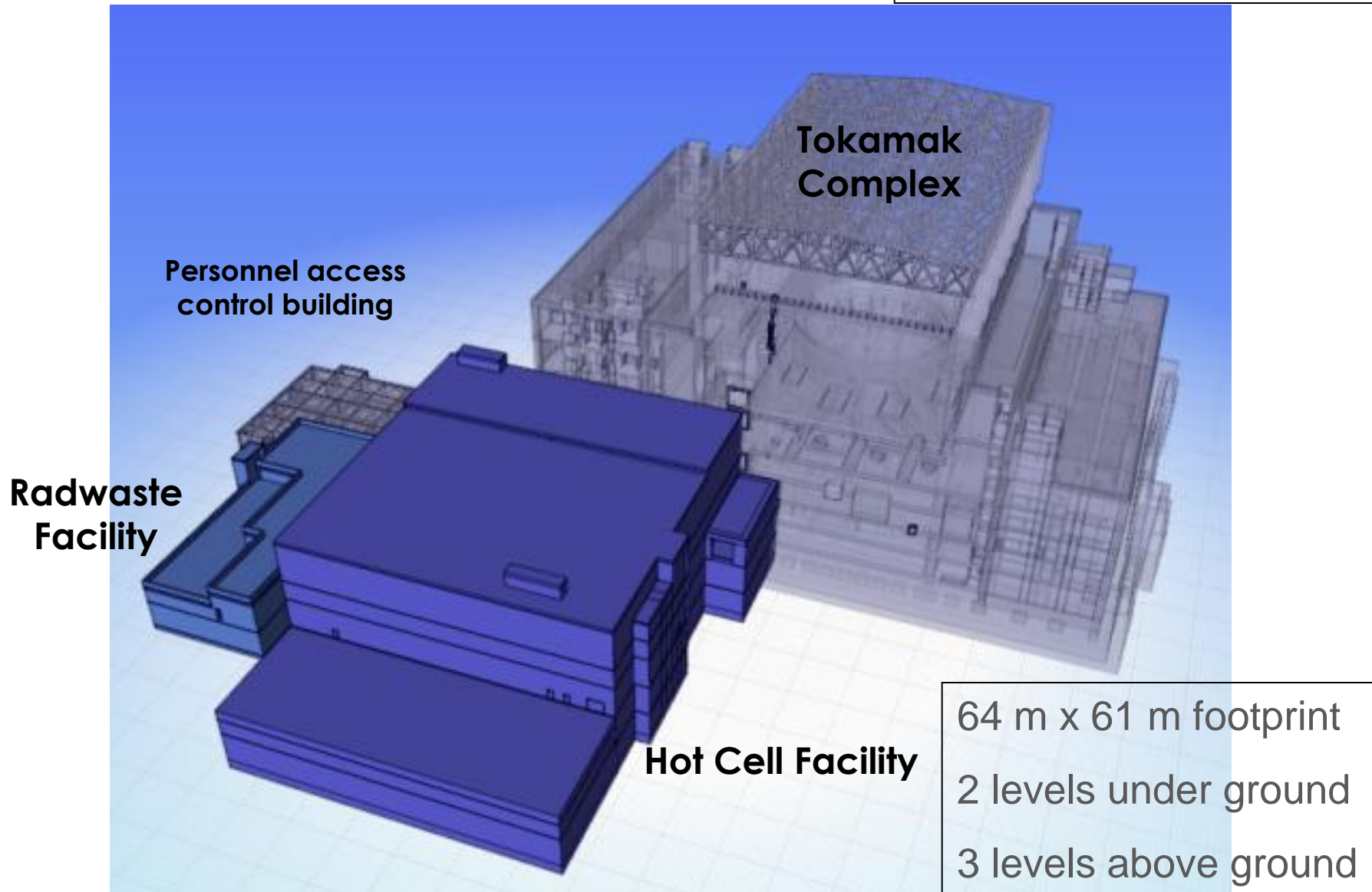
# INTERFACES for the HCF





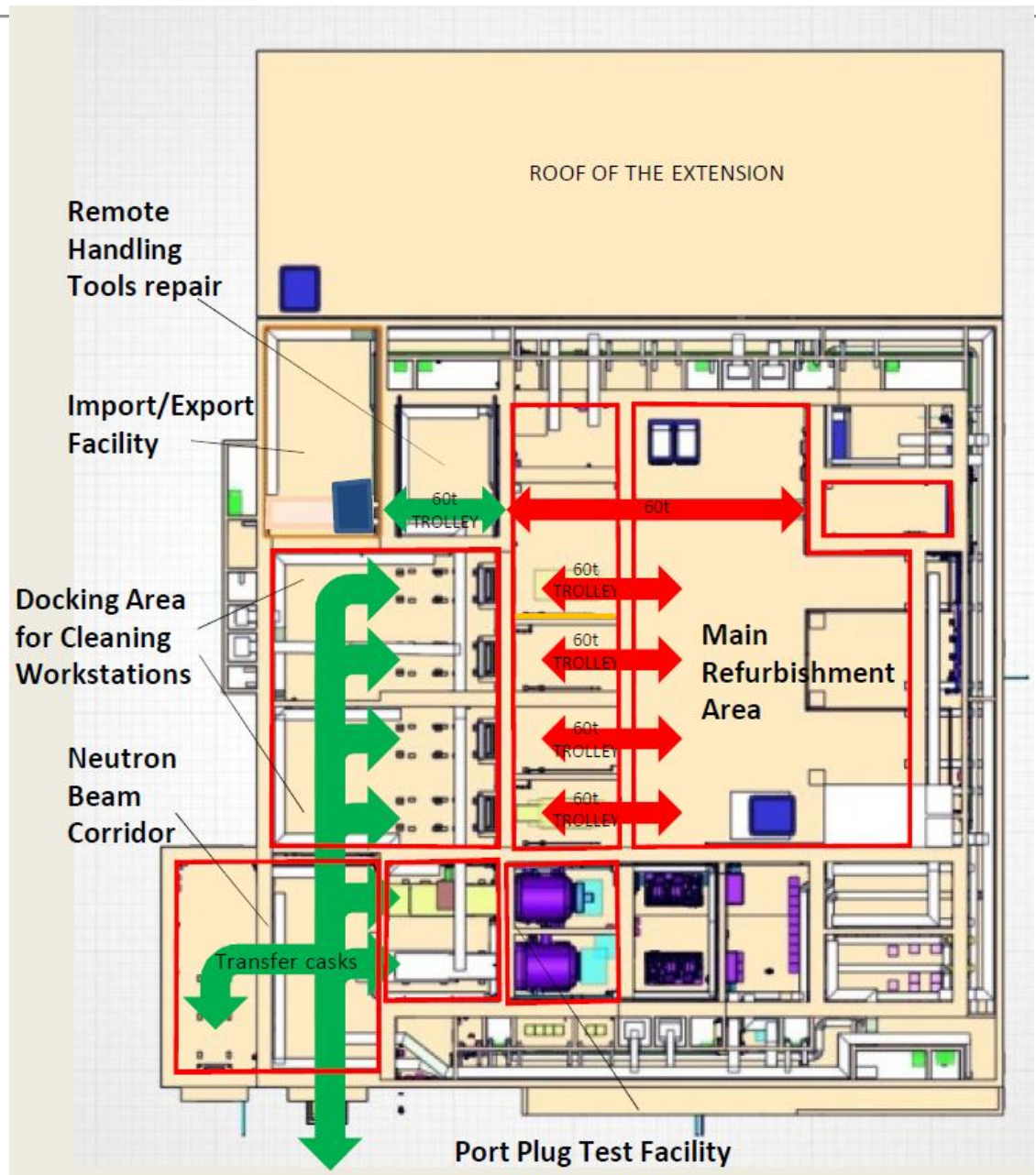
# External features

Connection with the TKM



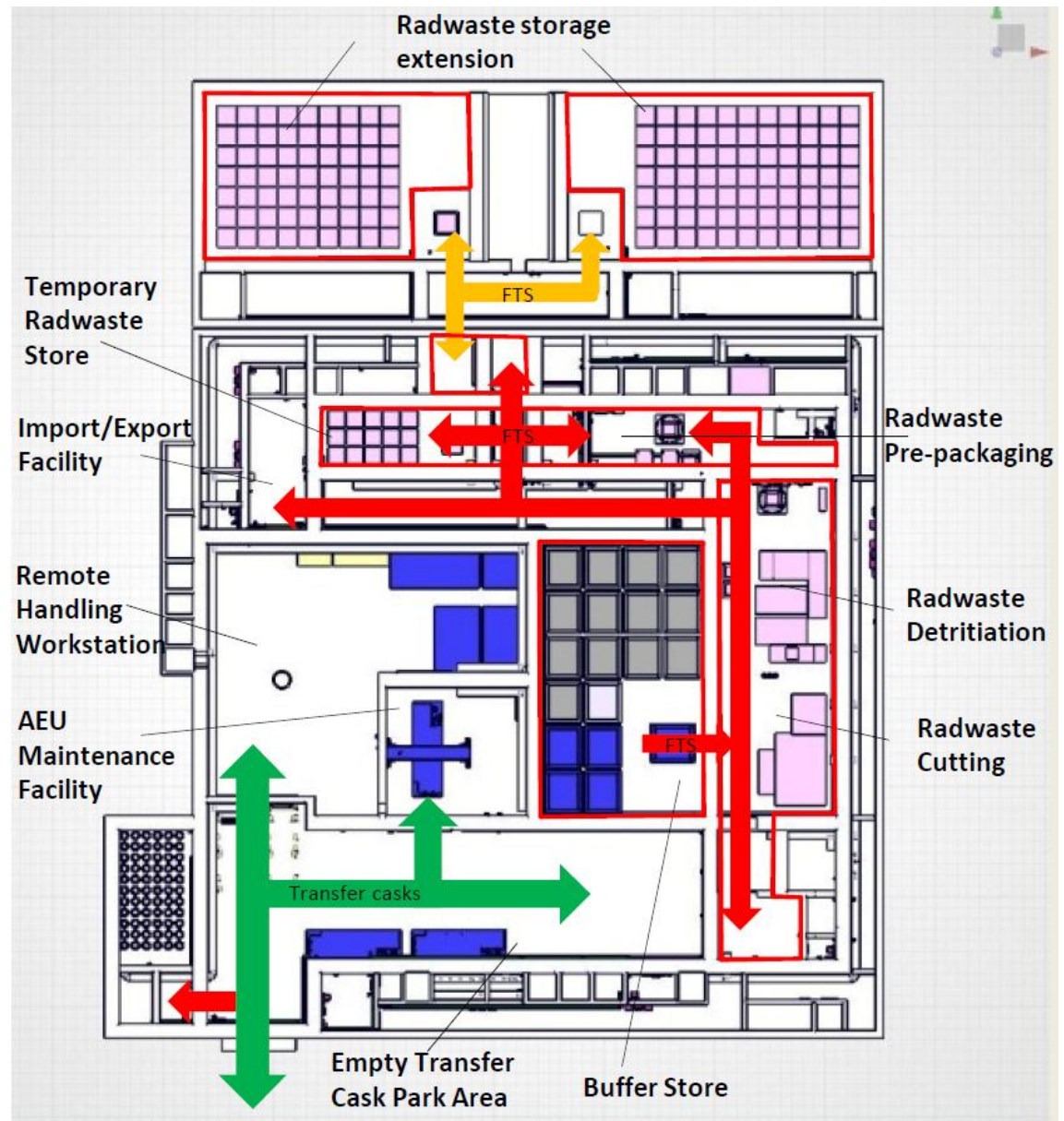
# Hot Cell Facility, level L1

- The import / export facility,
- The docking station of transfer casks to the red zone,
- The reception/cleaning workstations,
- The refurbishment workstations (port plugs, TBM, other vacuum vessel components),
- The testing workstations (port plugs, TBM, other vacuum vessel components),
- The buffer storage for port plugs,
- The HCF remote handling preparation, decontamination and repair area;
- Link to Neutral Beam cell.



# Hot Cell Facility, level B2

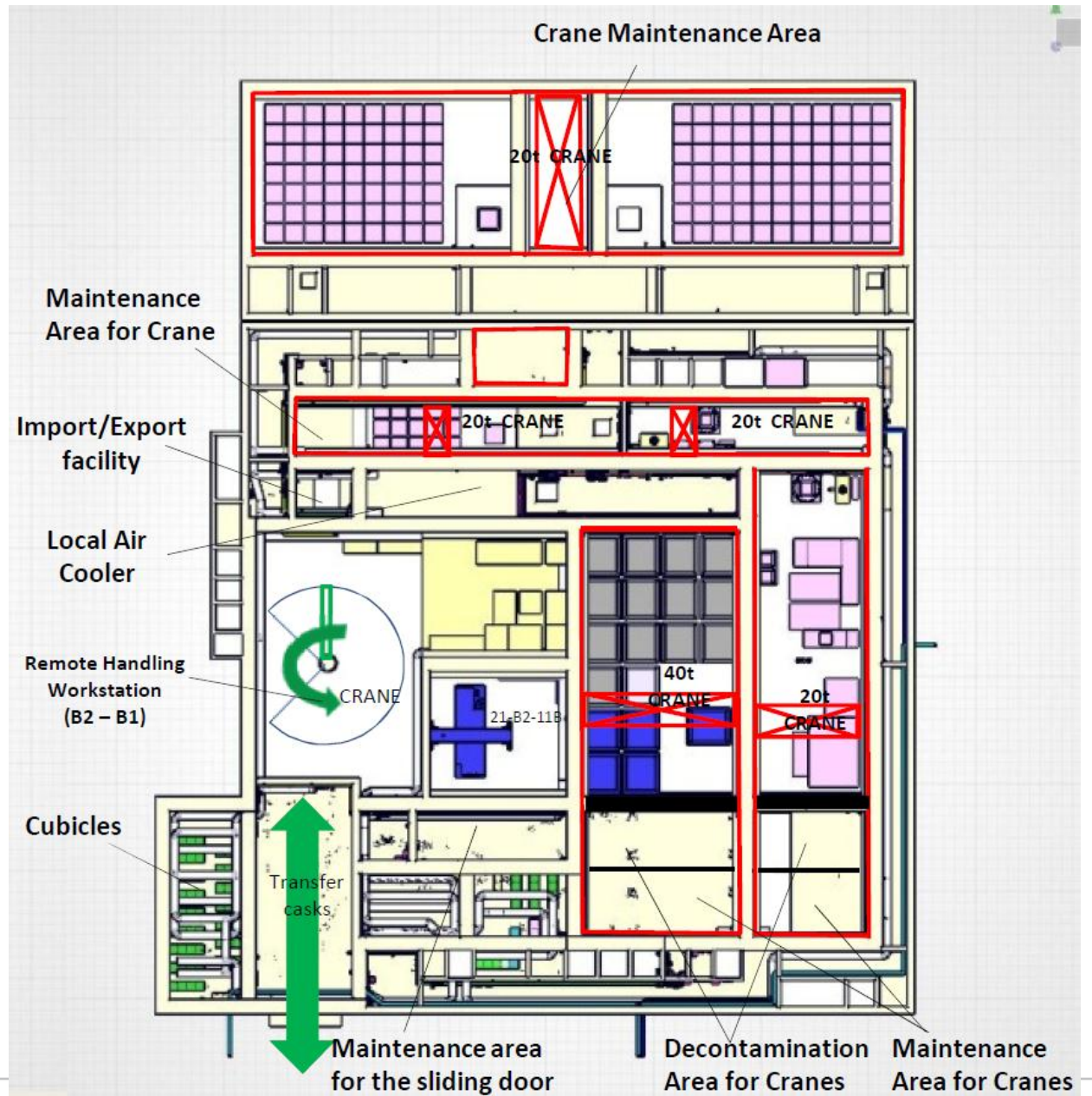
- Buffer storage of discarded components
- Type B radwaste treatment, and temporary storage area
- Extension for radwaste storage;
- Purely tritiated radwaste storage area;
- ITER Remote Maintenance Systems (IRMS), including transfer casks
- Ancillary Equipment Unit (AEU) maintenance area,
- Transfer cask park area.





# Hot Cell Facility level B1

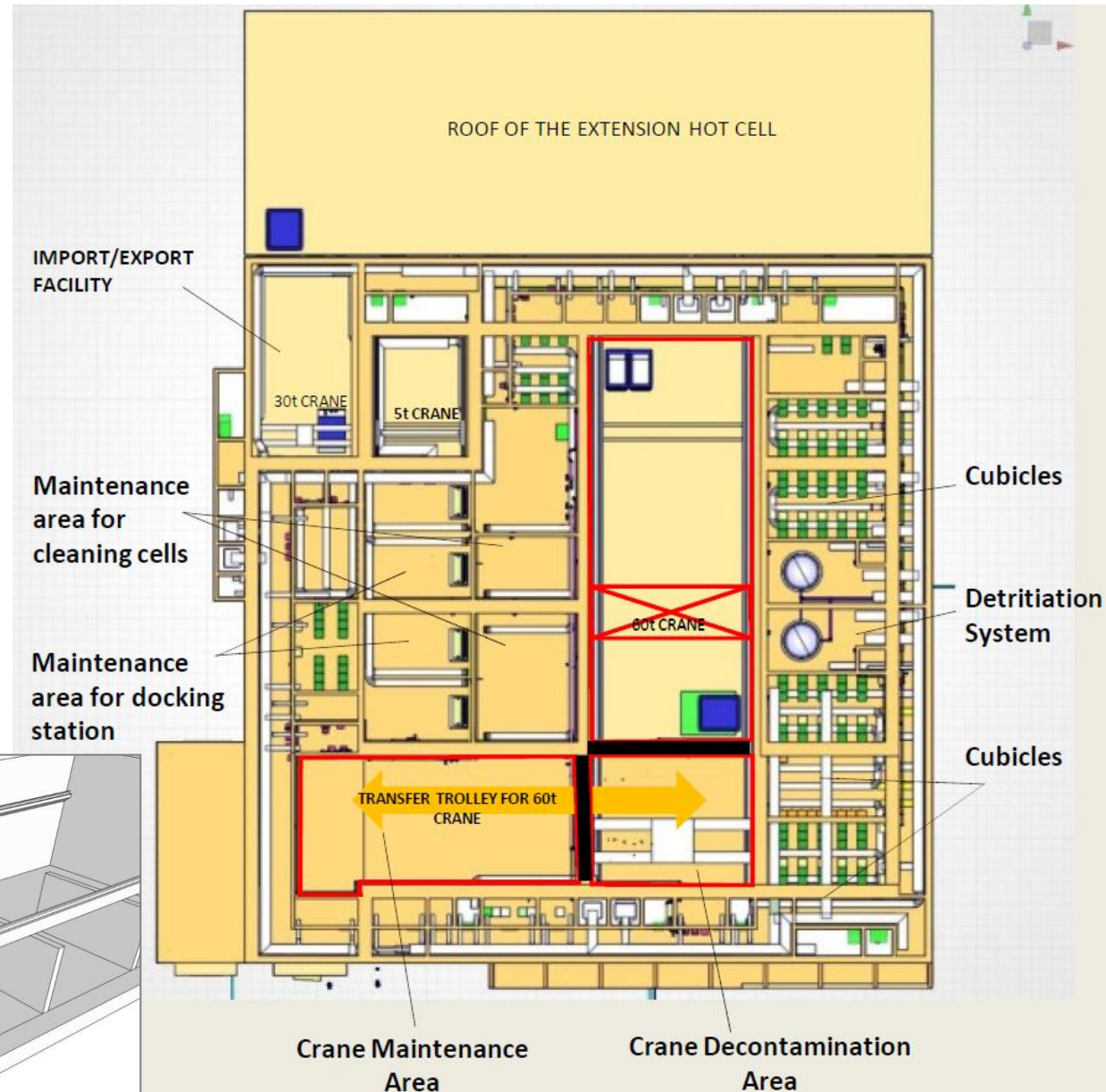
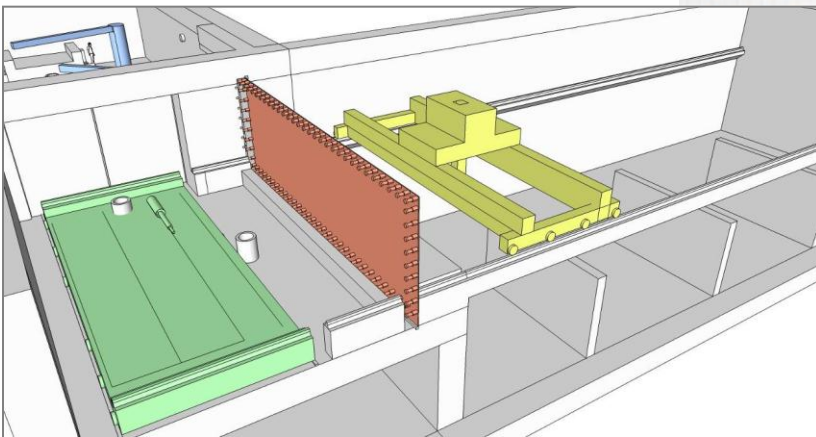
- Decontamination areas of cranes used at B2 level before their maintenance
- Maintenance areas of cranes
- Services and utilities
- Cubicles and distribution boards
- Technical galleries





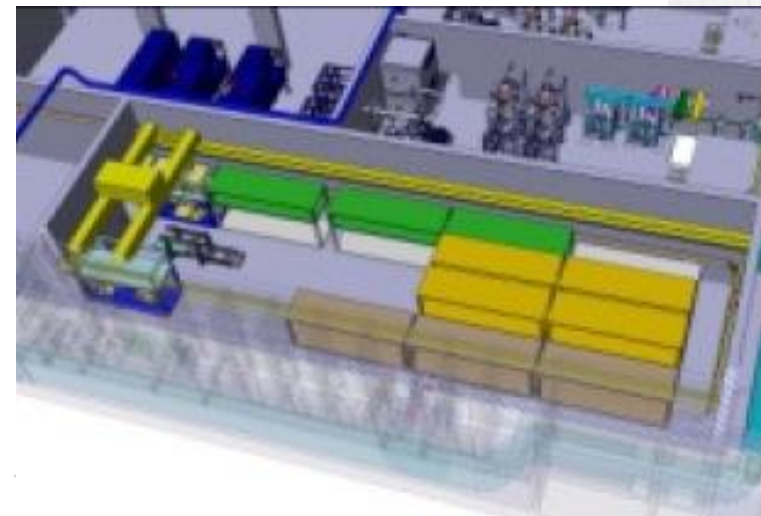
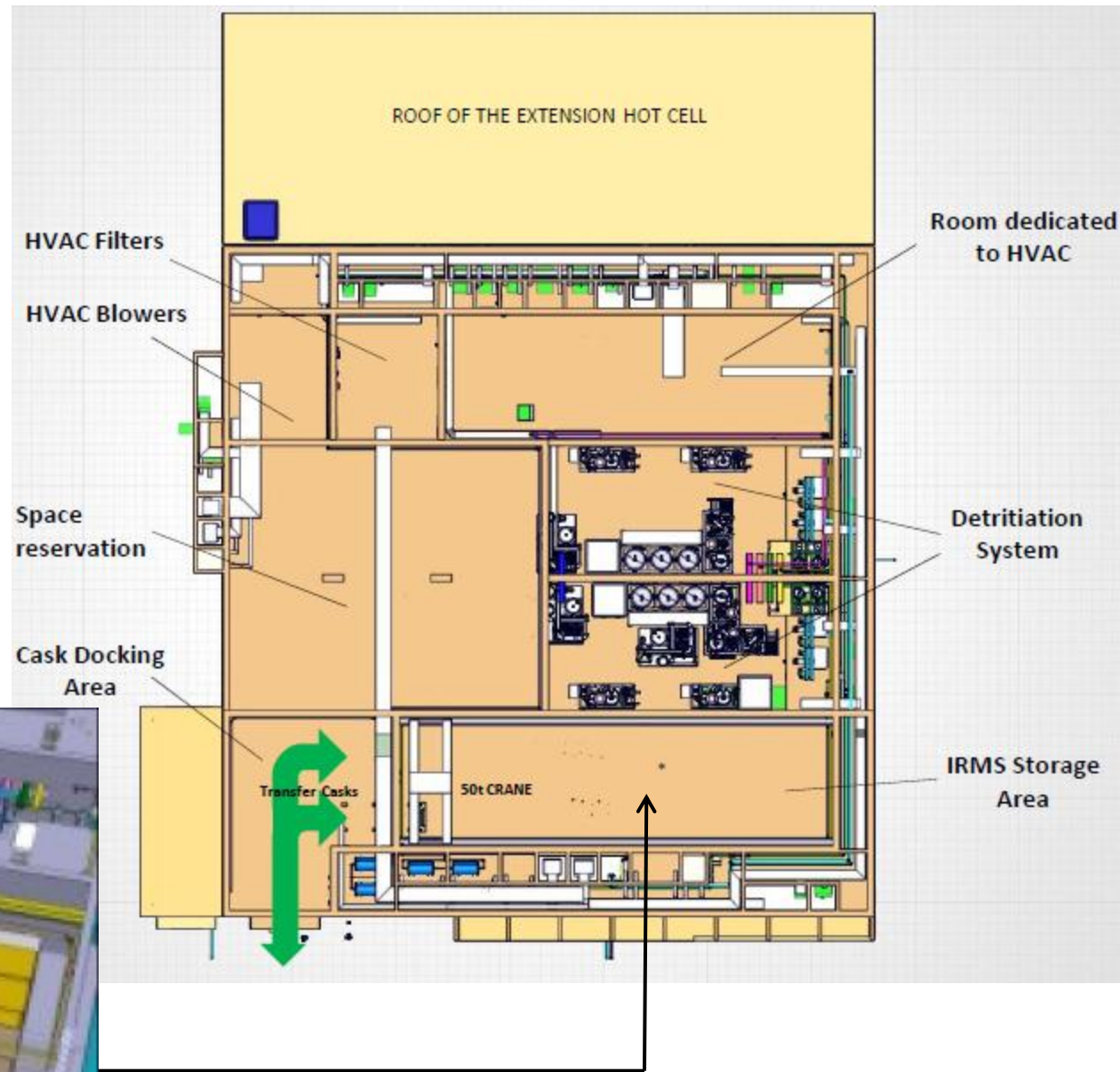
# Hot Cell Facility level L2

- Decontamination and maintenance of crane used in level L1,
- Services for cleaning cells and cask docking stations,
- Cubicles
- DS system (L2 - L3)



# Hot Cell Facility level L3

- HVAC plant,
- Detritiation system plant,
- Storage of remote handling equipment,
- Reserved area for possible extension

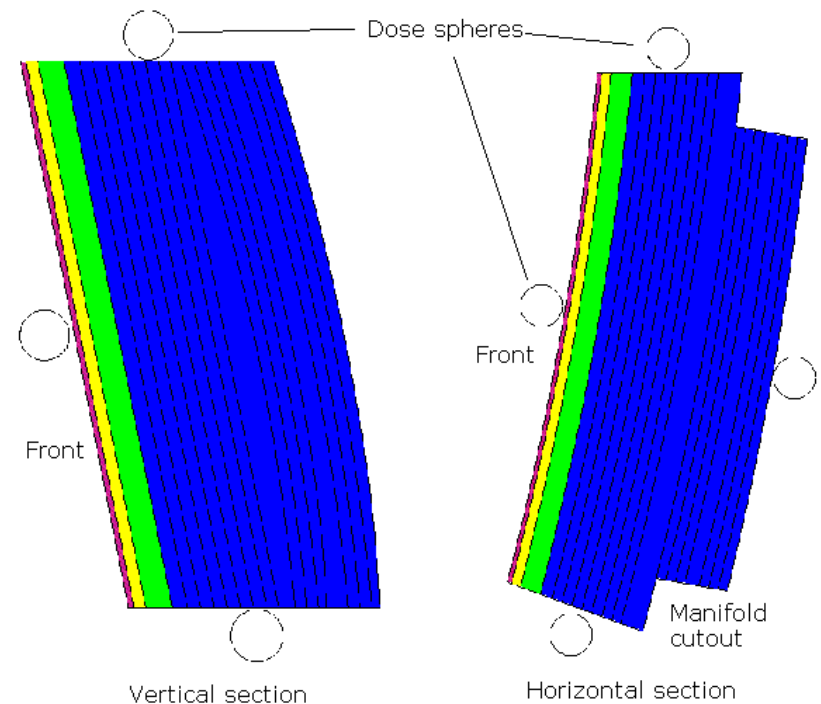


# Dose rate and shielding

Location	Dose (Sv/hr)
Front	215.0
Left side	78.8
Right side	68.7
Back	2.91
Top	48.6
Bottom	45.2

A radiation level of **215 Sv/h** has been taken into account for the design. A wall thickness of **1.25 m** was demonstrated for the hot cells to be compliant with the safety limits for exposure, as leading to less than **10  $\mu$ Sv/h** behind the wall.

Model of blanket module showing spheres in which dose was evaluated:



# Confinement

- Source term: activated dust and tritium
- Main challenge: tritium confinement
- 2 confinement system : static + dynamic (sub atmospheric pressure)
  - hot cells are the first static confinement completed by the Detritiation System (depression cascade)
  - building is the second static confinement completed by HVAC and a connection to DS in case of tritium leakage
- The hot cells located in red zones are stainless steel lined in order to reach the suitable leak tightness.



# Ventilation zone in HCF

Confinement Class	Application for HCF	Ventilation Zone Colour Code	Sub atmospheric pressure	Leak Rate
<b>C2</b>	Normal HVAC with filtered exhaust and able to be detritiated/filtered		-50 Pa	100%vol/d
<b>C3</b>	Filtered and detritiated exhaust steam		-100 Pa	24%vol/d
<b>C4**</b>	Filtered and detritiated exhaust steam		-150 Pa	24%vol/d
<b>C4***</b>	Filtered and detritiated exhaust steam		-200 Pa	24%vol/d

Direct access/opening to C4 zones is provided only through C3 zones

# Contents

- The ITER project
  - ✓ In-vessel component
  - ✓ Remote Handling tools
  - ✓ Overview of ITER site
- ITER Hot Cell Facility
  - ✓ Functions
  - ✓ Design drivers
  - ✓ Interfaces
  - ✓ Current layout
  - ✓ Safety
- Site construction progresses

# The platform, one year ago





# Site Construction Progresses (1)



**View of the On-site Construction**



**Concrete Walls & Anti-Seismic Tokamak Complex**



**PF Coil Winding Building**



**Inside PF Coil Building**



## Site Construction Progresses (2)



**ITER HQ Building**



**Bridge linking HQ Building and the**



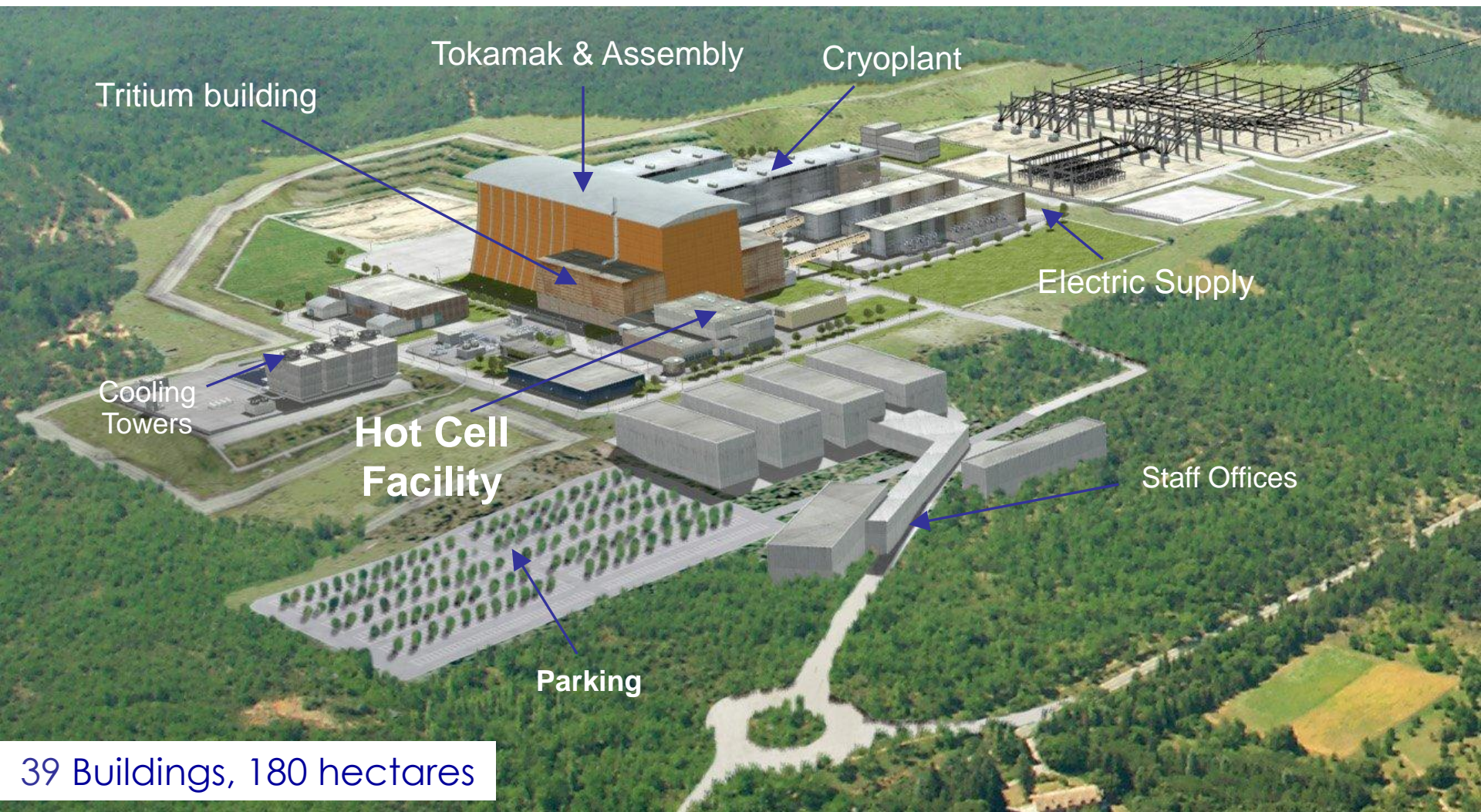
**Future ITER Council Room**



**ITER Platform Switchyard**



# Future ITER site



Thank you for your  
attention

