ITER Hot Cell Facility

Technical Information Day

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17th of January 2025

iter
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Summary

- Introduction
- High-level maintenance & radwaste management functions
- Context: Hot Cell history, impact of the New Research Plan
- Detailed functional breakdown
- Scope Hot Cell Facility & main interfaces
- Illustration of pre-concept

The views and opinions expressed herein do not necessarily reflect those of the ITER Organization

Introduction

- **Welcome to this Technical Information Day on the ITER Hot Cell !**

- During the Market Survey launched end of June 2024, many companies had questions on the current design of the ITER Hot Cell
- The objective of this Information Day is to provide technical visibility
- The objective of this Information Day is NOT to provide information on the procurement process
- During the presentation, feel free to ask questions in the chat 

- During the Q/A session, we will go through the chat questions 

then, you can ask directly questions after raising your hand 

- Another Info day will be organized during the procurement process

Note that the meeting will be recorded

Summary

- Introduction
- **High-level maintenance & radwaste management functions**
- Context: Hot Cell history, impact of the New Research Plan
- Detailed functional breakdown
- Scope Hot Cell Facility & main interfaces
- Illustration of pre-concept

Why do we need a Hot Cell Facility?

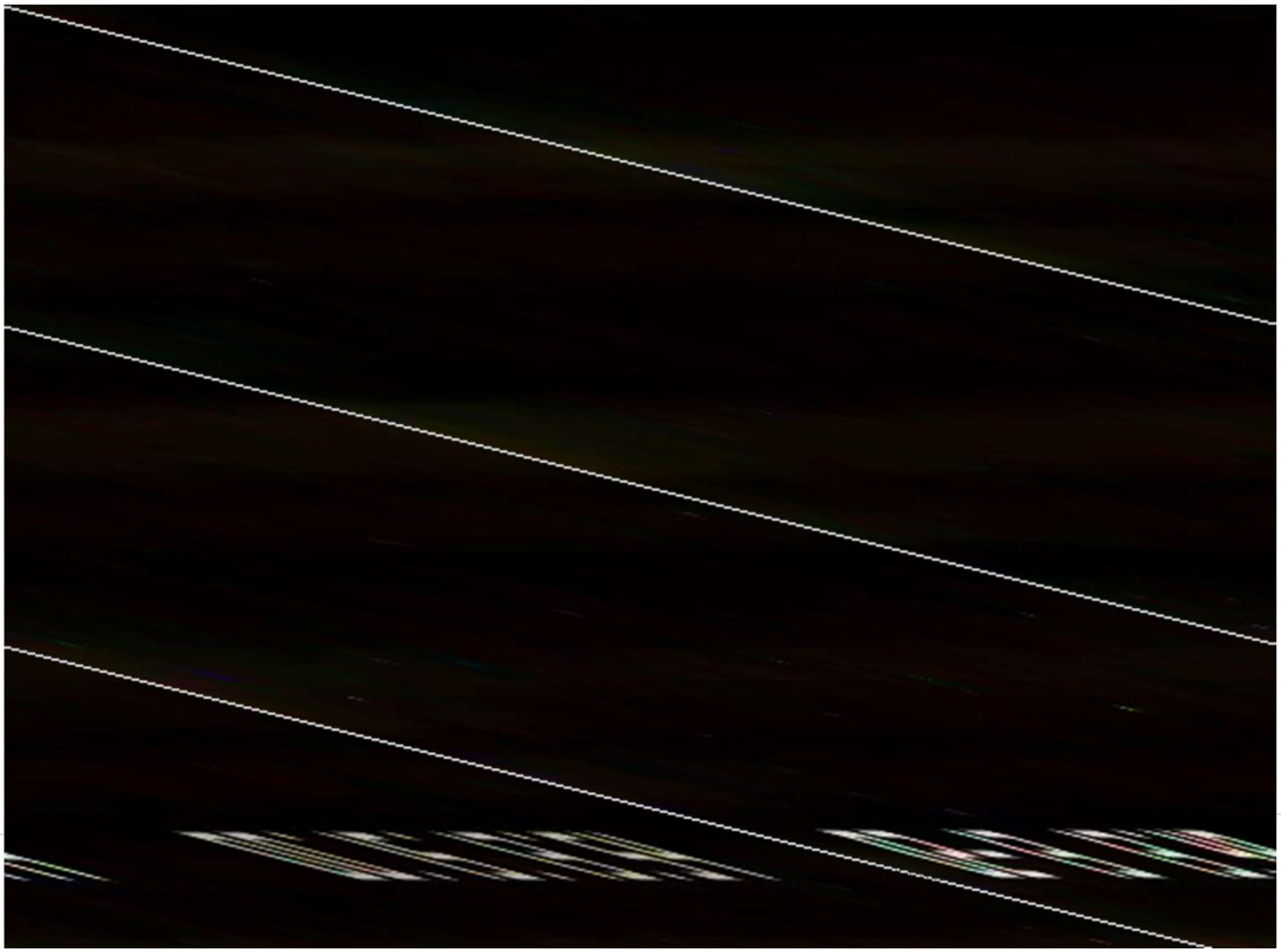
Fusion plasma

⇩

Neutron flux
→ Activation

✚

Erosion
→ Dust / contamination



Plasma in West Tokamak - CEA

Why do we need a Hot Cell Facility?

1 – Small repair or replacement of In Vessel Components (IVC)

In Vessel Components may fail or be damaged.

IVC are activated and contaminated (dust and Tritium)

Handling of IVC shall be remote

Buffer storage and small repair in Red Zone

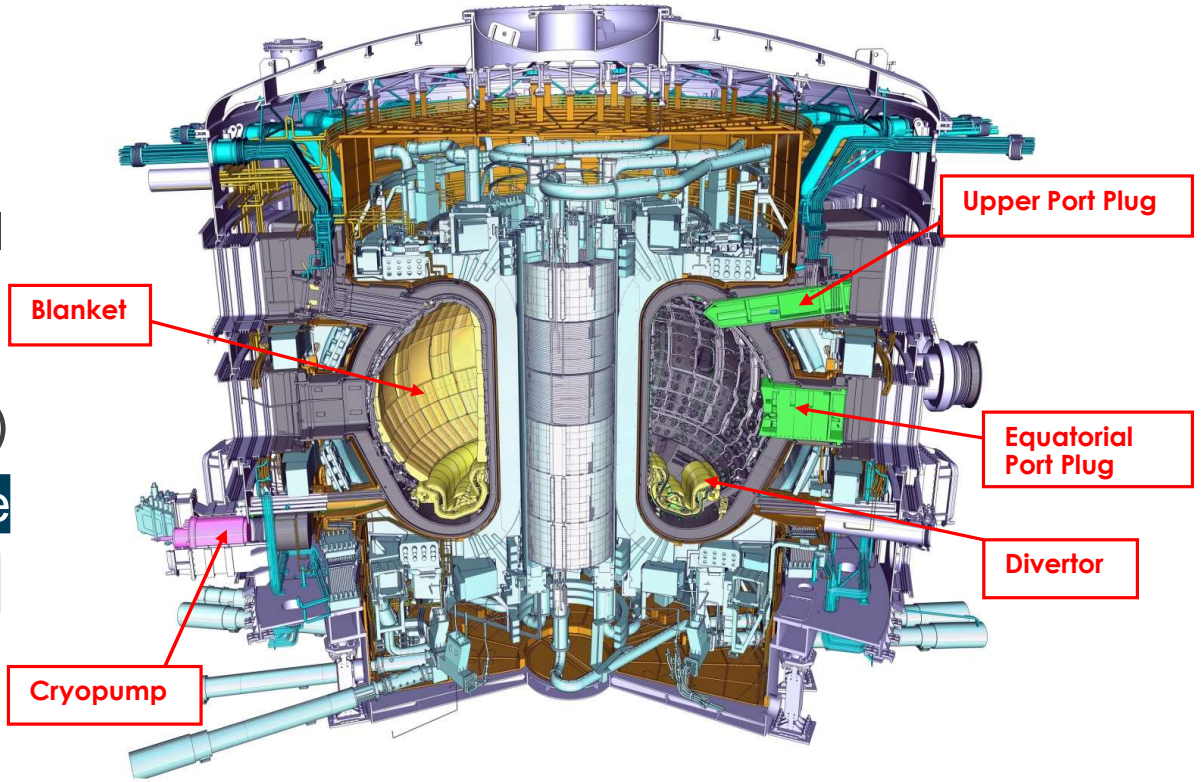
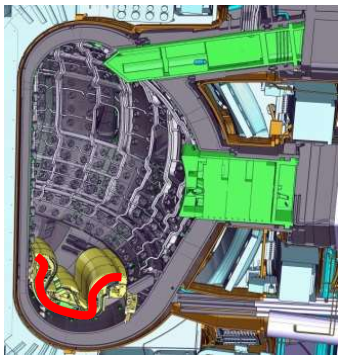
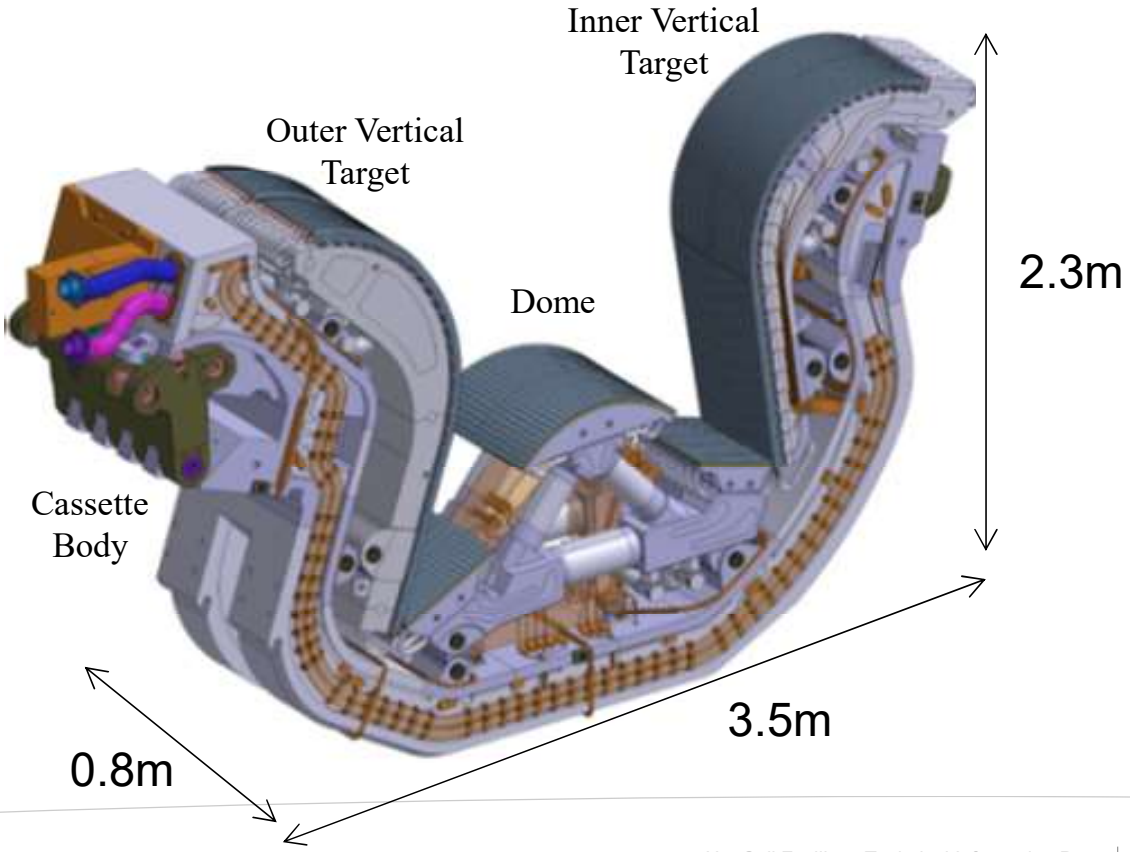


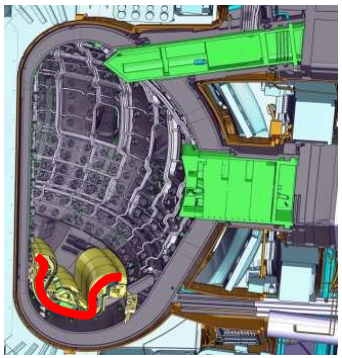
Illustration of Divertor





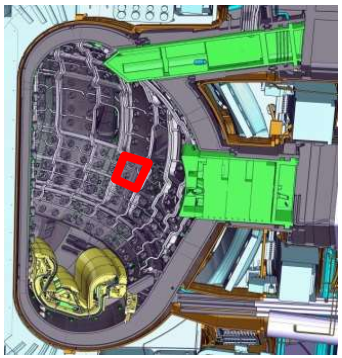
Divertor
~ 8 tons

Illustration of Divertor



Cassette Body
~ 4.6 tons

Illustration of Blanket



Blanket
Shield Block
(SB)

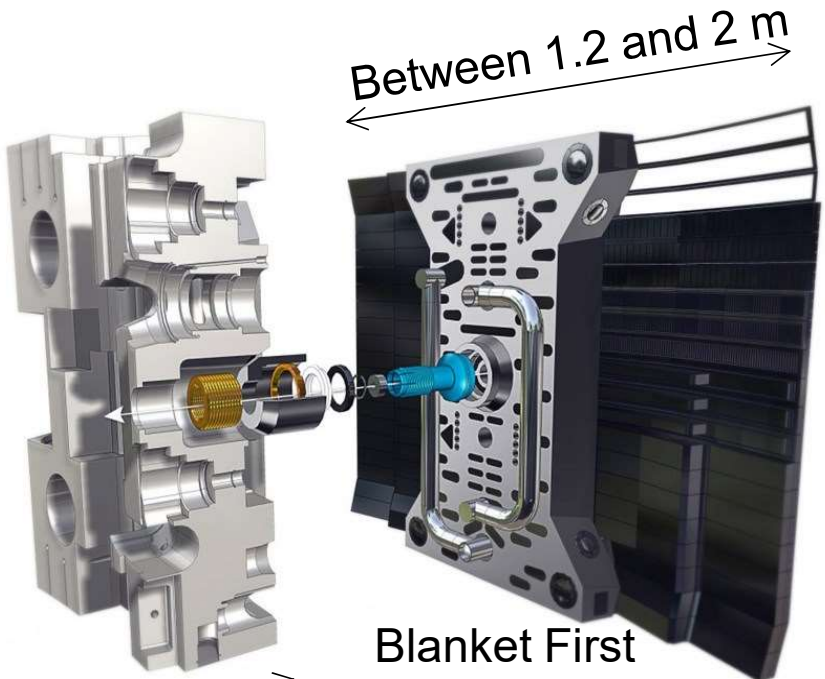
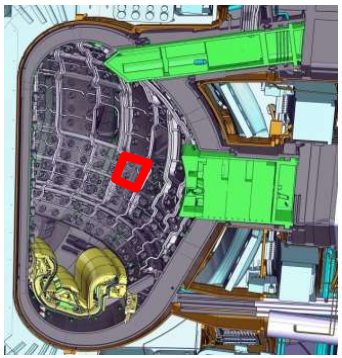
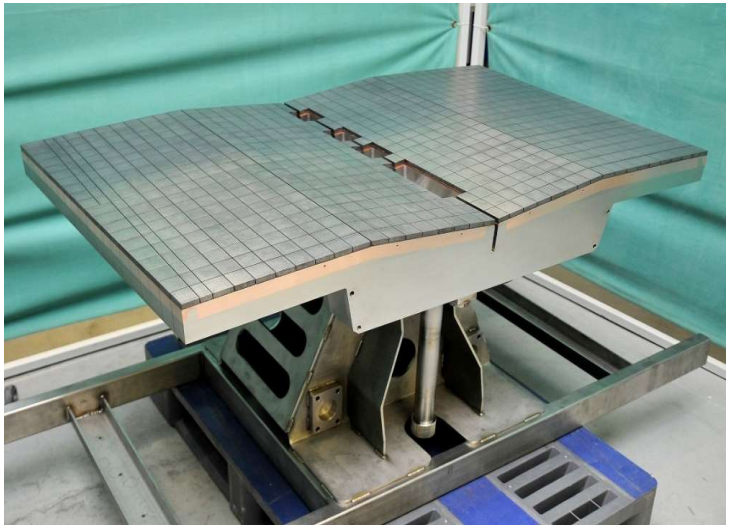


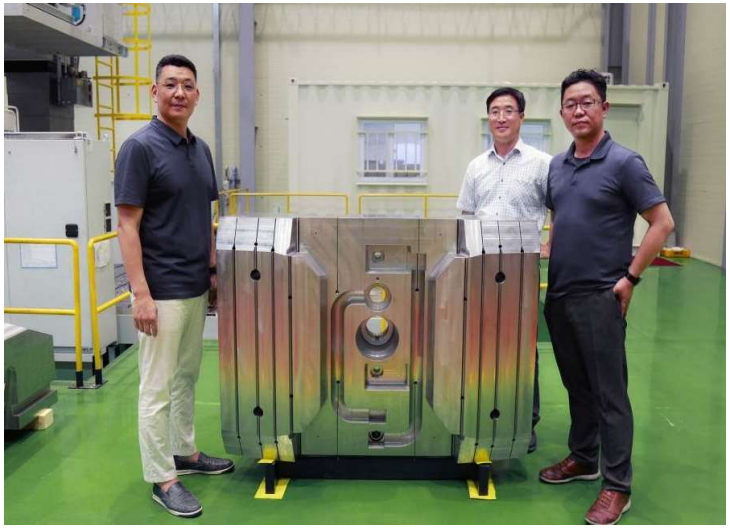
Illustration of Blanket





First Wall - Full size prototype – Atmostat-Alsyom for F4E

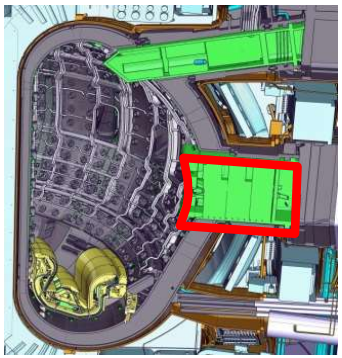
Blanket First Wall Panel (FWP)
between 600 and 800 kg



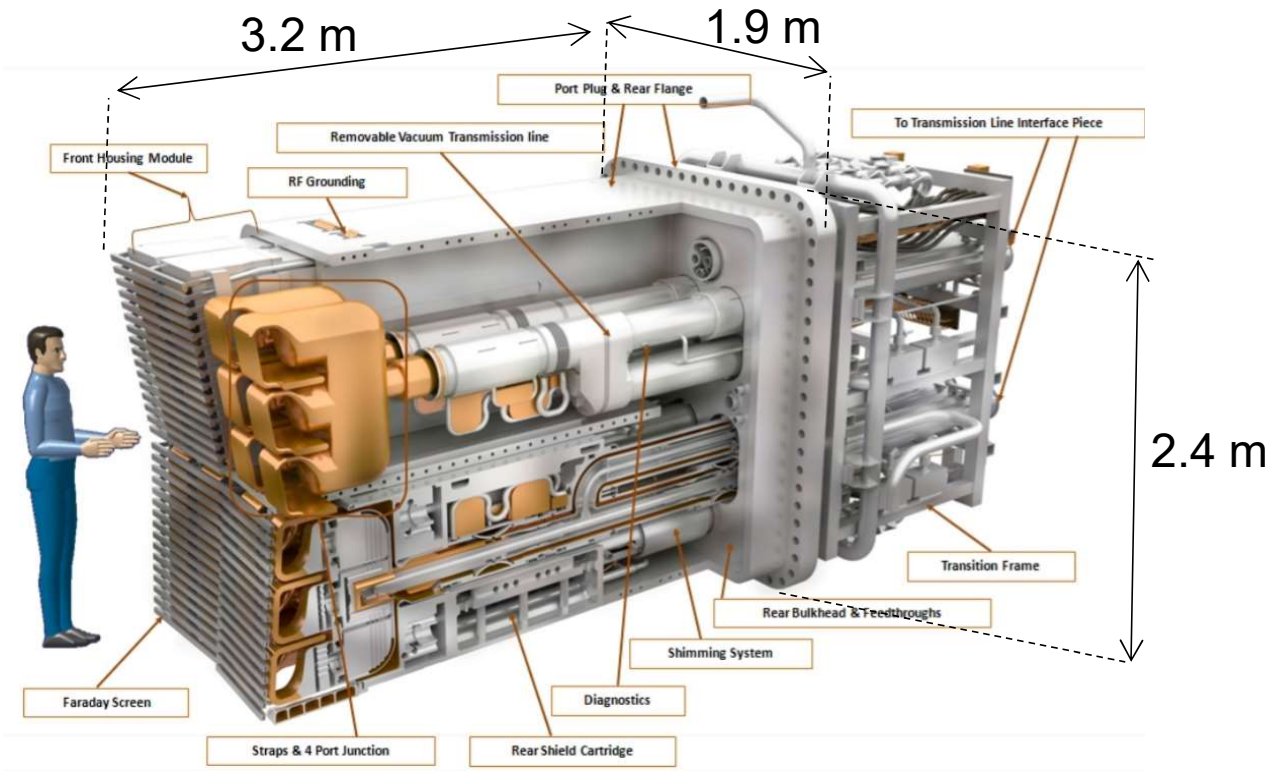
Shield Block – full size prototype

Blanket Shield Block (SB)
between 2 and 3 tons

Illustration of ICH Port Plug



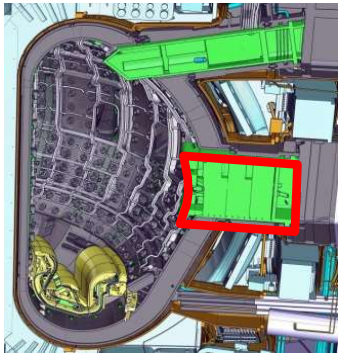
Max weight Port Plugs (EPP)
~ 50 tons



ICH Equatorial Port Plug

EPP: Equatorial Port Plug
ICH: Ion Cyclotron Heating

Illustration of TBM Port Plug



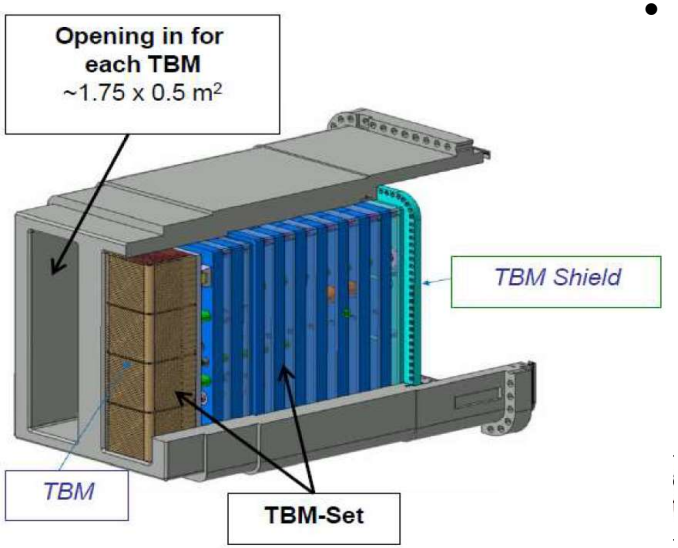


Illustration from ITER Test Blanket Module - ALARA Investigations for Port Cell Pipe Forest Replacement Jean Pierre Friconneau SOFT 2022

Remote operations HC:

- TBM Set to be extracted
- TBM part to be removed / exported

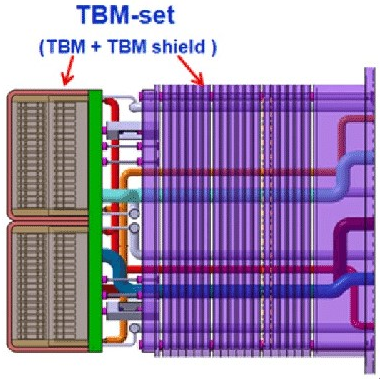


Illustration from Thermal-Hydraulic Analysis for Conceptual Design of Korean HCCR TBM Set Dong Won Lee - IEEE Transactions on Plasma Science · April 2016

Max weight Port Plugs (EPP)
~ 50 tons

Capabilities developed to perform “TBM operations” will be used to perform “Small repair”

TBM: Test Blanket module

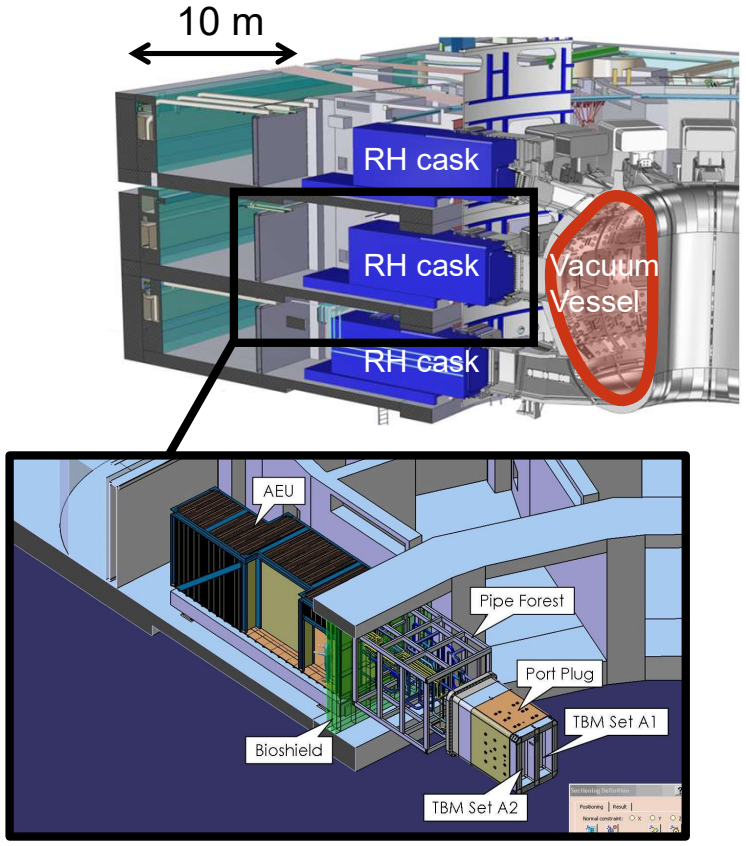
Why do we need a Hot Cell Facility?

2 - Maintenance of EVE (Ex-Vessel-Equipment)

EVE are large and heavy

Contamination and activation is limited but Tritium Source term is not negligeable

Maintenance and handling of EVE can be done Hands On or assisted.



Why do we need a Hot Cell Facility?

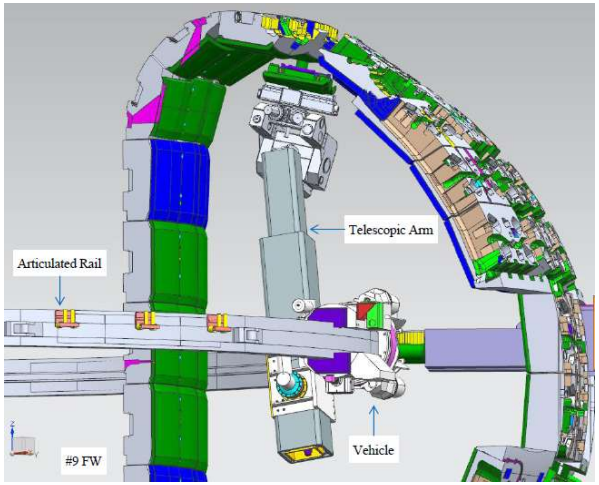
3 - Decontamination of Remote Handling System

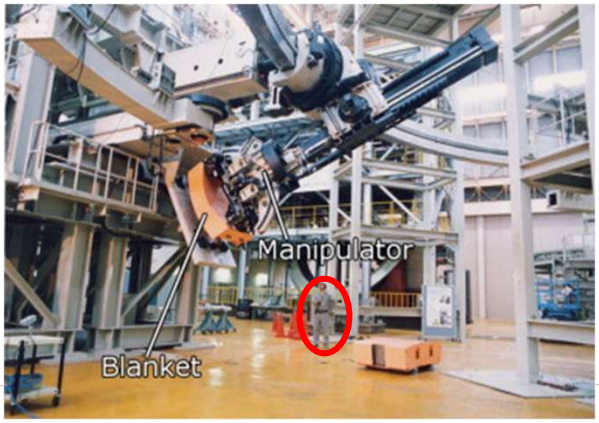
Example of RH Systems

Blanket Remote Handling System to handle blankets First Wall and Shield Block

Divertor Remote Handling System to handle Divertors

Decontamination of IRMS in the Hot Cell Facility, before export to another facility for maintenance and test





Mock-up Blanket RH System – IVT – JA DA

Why do we need a Hot Cell Facility?

4 - Radioactive waste (RW) management

Different type of waste

- TFA (very low-level waste) (1)
- Type A (low-level waste) (2)
- Liquid Radwaste

RW contaminated with Tritium

Treatment of Solid Radwaste, except IVC which are buffer stored

Treatment of Liquid Radwaste Effluents

Housekeeping TFA radwaste – ANDRA (3)

TFA radwaste at ANDRA (repository)

Type A radwaste – ANDRA

Transfer of Radioactive Liquid radwaste

(1) TFA: "Très Faible Activité" in French
(2) Type A: "FMA-VC Faible et moyenne activité à vie courte" in French
(3) ANDRA: French Final Radwaste repository

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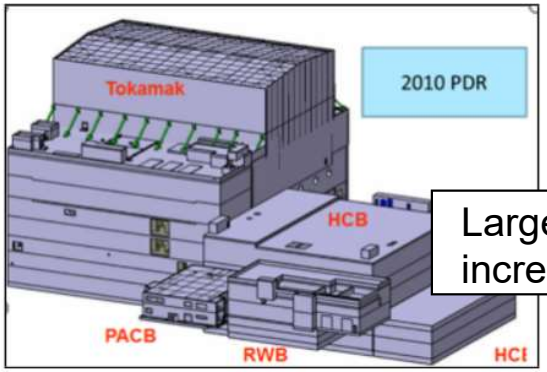
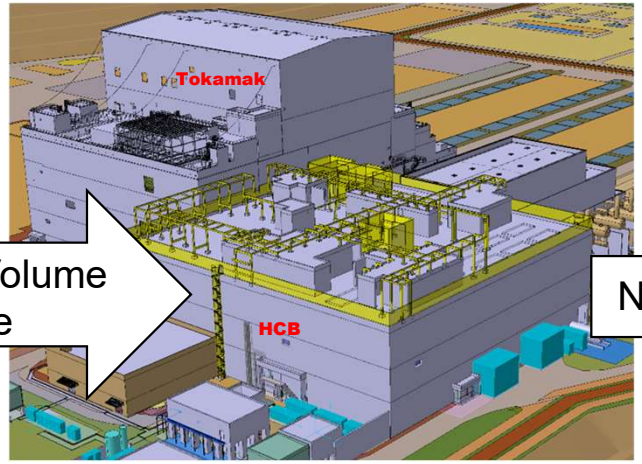
Hot Cell history, impact of the New Research Plan

Different configurations have been developed since 15 years



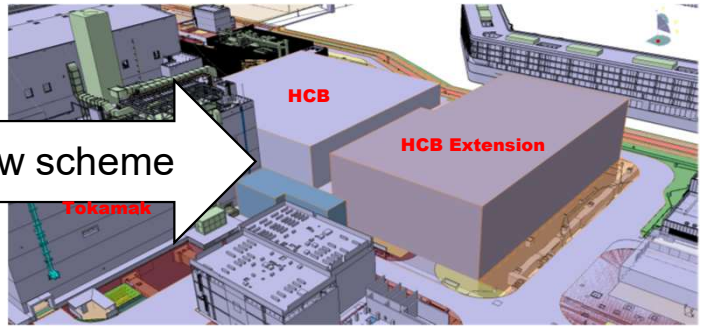
2010 Hot Cell

Large Volume increase



2021 Hot Cell

New scheme



2024 Hot Cell
Staged construction

2021 configuration was too complex

Hot Cell history, impact of the New Research Plan

Value analysis performed during the past years to rationalize requirements and to define design principles, aiming to reduce investment cost for Deuterium Tritium phase 1 (DT-1) configuration.

Many opportunities appeared and could be materialized with the new ITER Research Program (1), for instance:

- Staged approach of the ITER Research Program (Start of Research Operation / Deuterium Tritium phase 1 / Deuterium Tritium phase 2)
- Beryllium First Wall replaced by Tungsten First Wall
- Revision of maintenance strategy of Port Plugs
- No change of full set Divertors or First Wall Panels during DT-1
- Reduced dose rates, reduced contamination levels

(1) See https://www.iter.org/node/20687/new-baseline-prioritize-robust-start-exploitation

Hot Cell history, impact of the New Research Plan

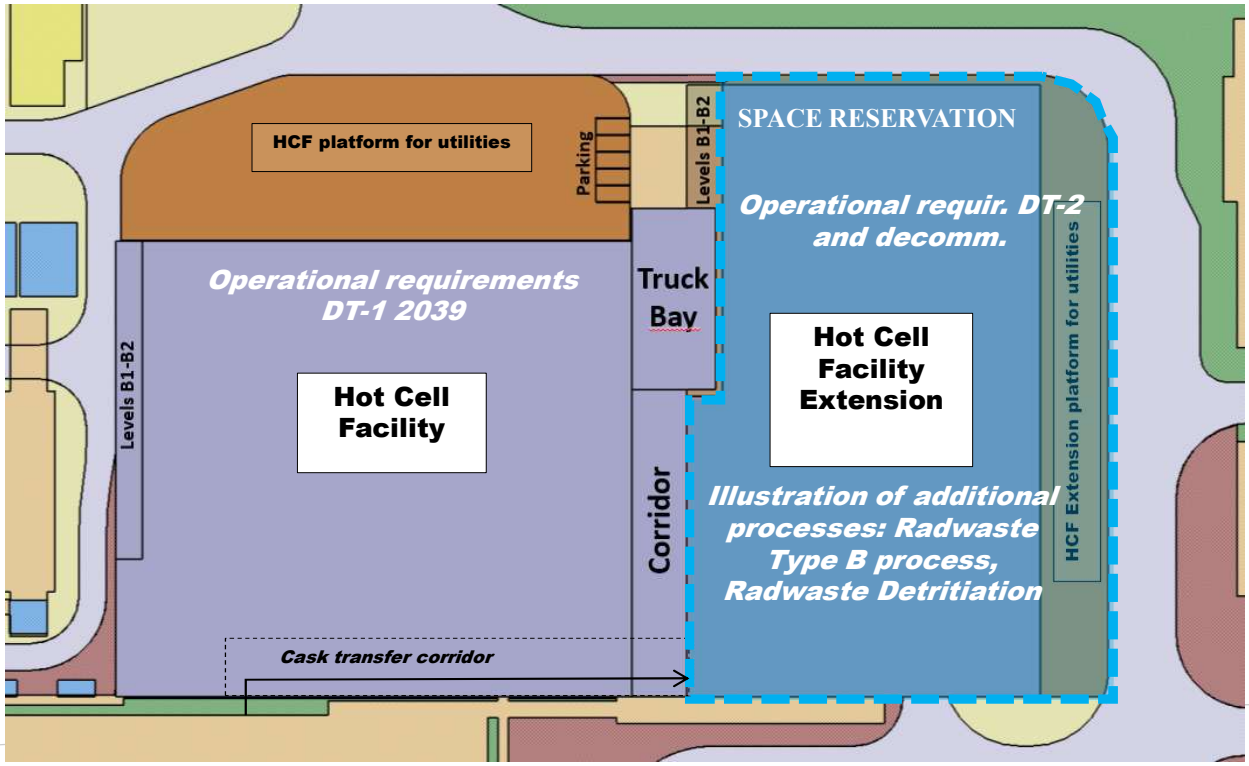
Main changes of the Hot Cell Facility requirements DT-1 and design principles:

- Reduced requirements for In-Vessel-Components: no more complex and challenging remote repair and remote Test of Port Plugs
- No Beryllium risk for hands-on operations
- No need to buffer store a full set of Divertor Cassettes
- No need to change First Wall Panels
- No Radwaste Detritiation process
- Limited number of discarded components during DT-1 phase, so no need to design and build a complex “Radwaste Type B” (1) process / facility
- Limited functions implemented in the Hot Cell Facility
- Reduced Radwaste inventory

(1) Radwaste type B = Medium Activity Long Lived Radwaste (‘’MAVL Moyenne Activité Vie Longue’’ in French)

Hot Cell history, impact of the New Research Plan

Staged construction of the Hot Cell Facility



Hot Cell Facility = Hot Cell Building + processes + services

Space reservation is allocated for a HCF extension → postponed to the next phases

It will be a separate building (*out of the scope of the HCF contract to be launched*)

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- **Detailed functional breakdown**
- Scope Hot Cell Facility & main interfaces
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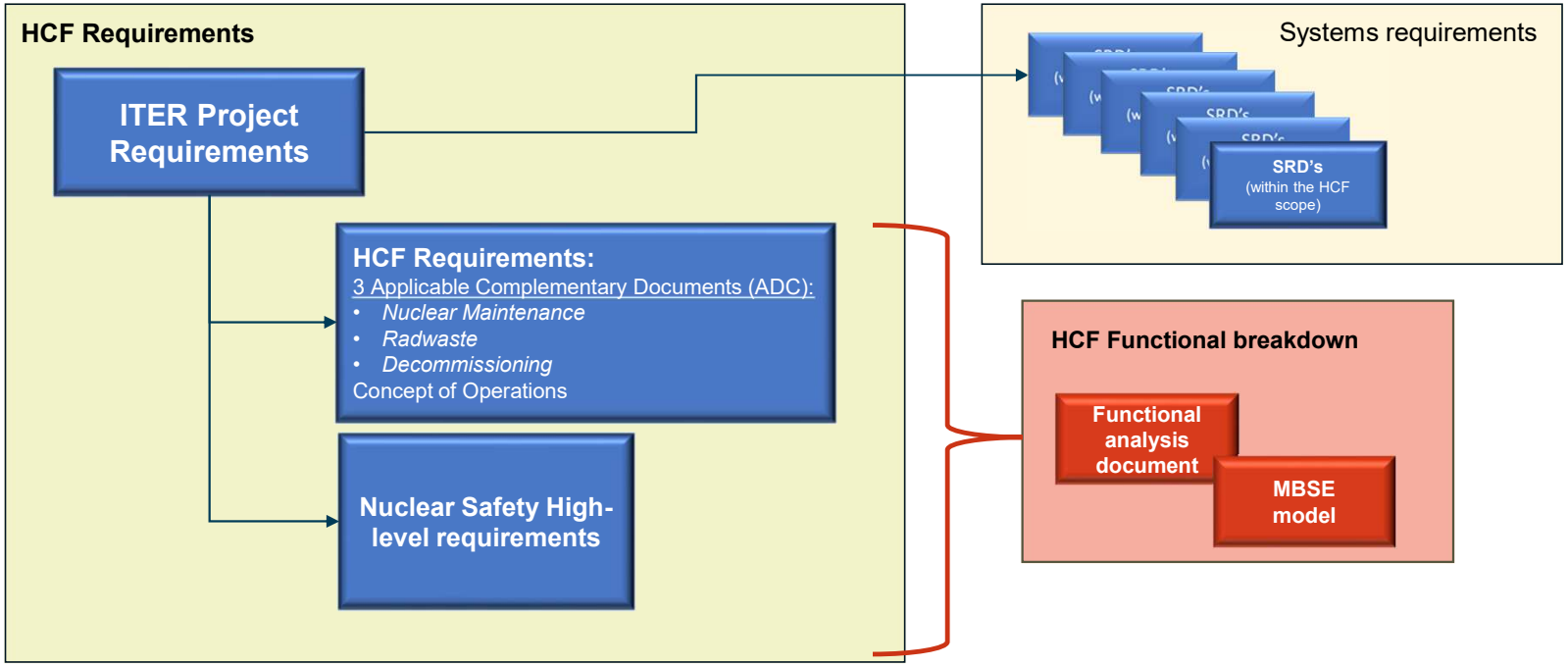
Detailed functional breakdown

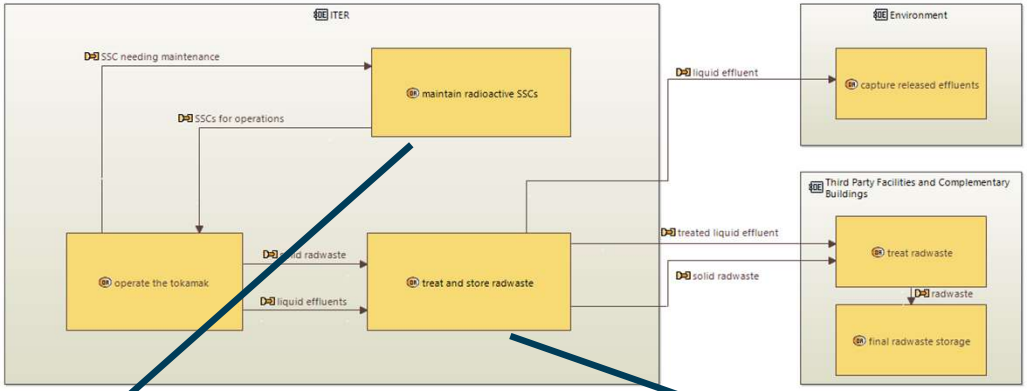
Overview of the documentation structure used for the Hot Cell Facility (HCF):



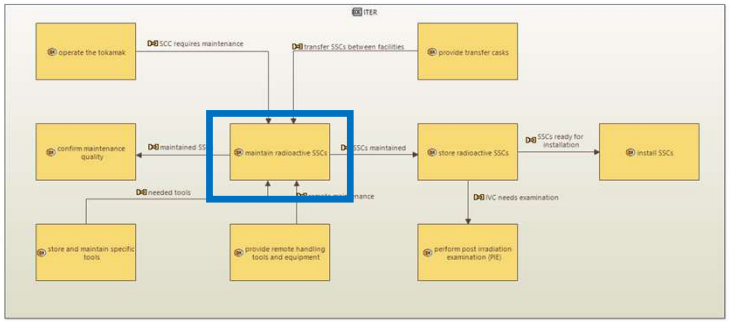
MBSE: Model Based System Engineering
SRD: System Requirement Document

Detailed functional breakdown

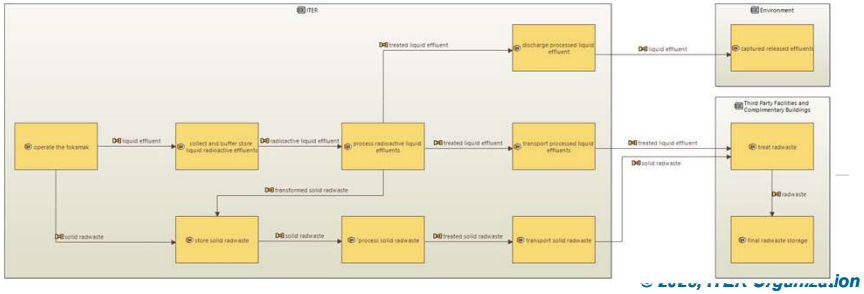
Hot Cell Facility main functions



Maintenance of components



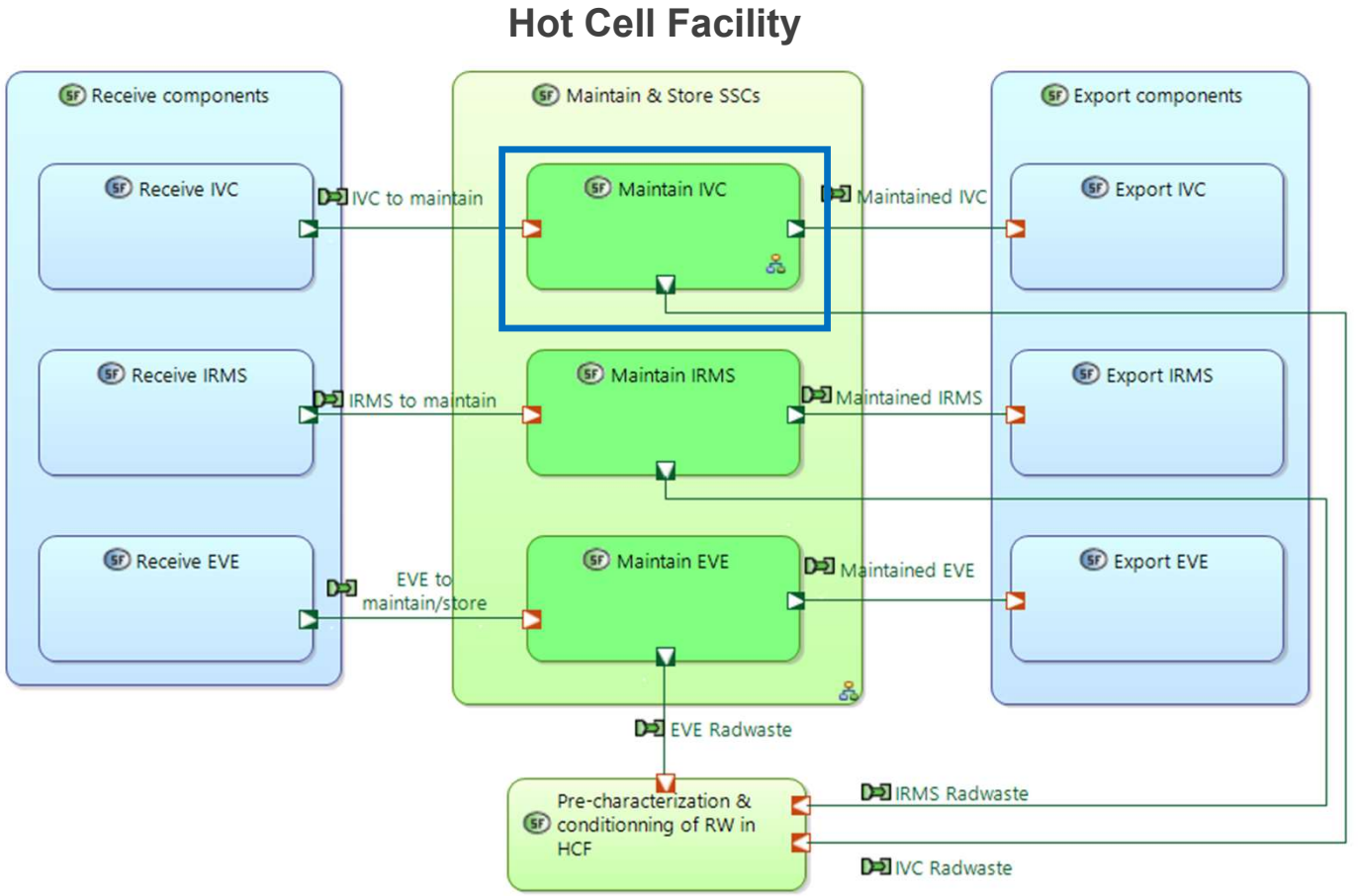
Treatment & storage of radwaste



Detailed functional breakdown

Maintenance of components

EVE: Ex-Vessel-Equipment
IRMS: ITER Remote Maintenance Systems
IVC: In-Vessel-Component
HCF: Hot Cell Facility
RW: Radwaste
SSC: System Structure & Component

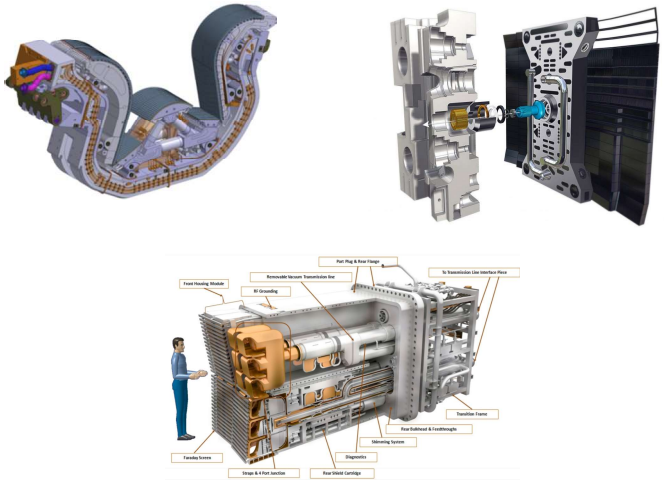


HCF scope

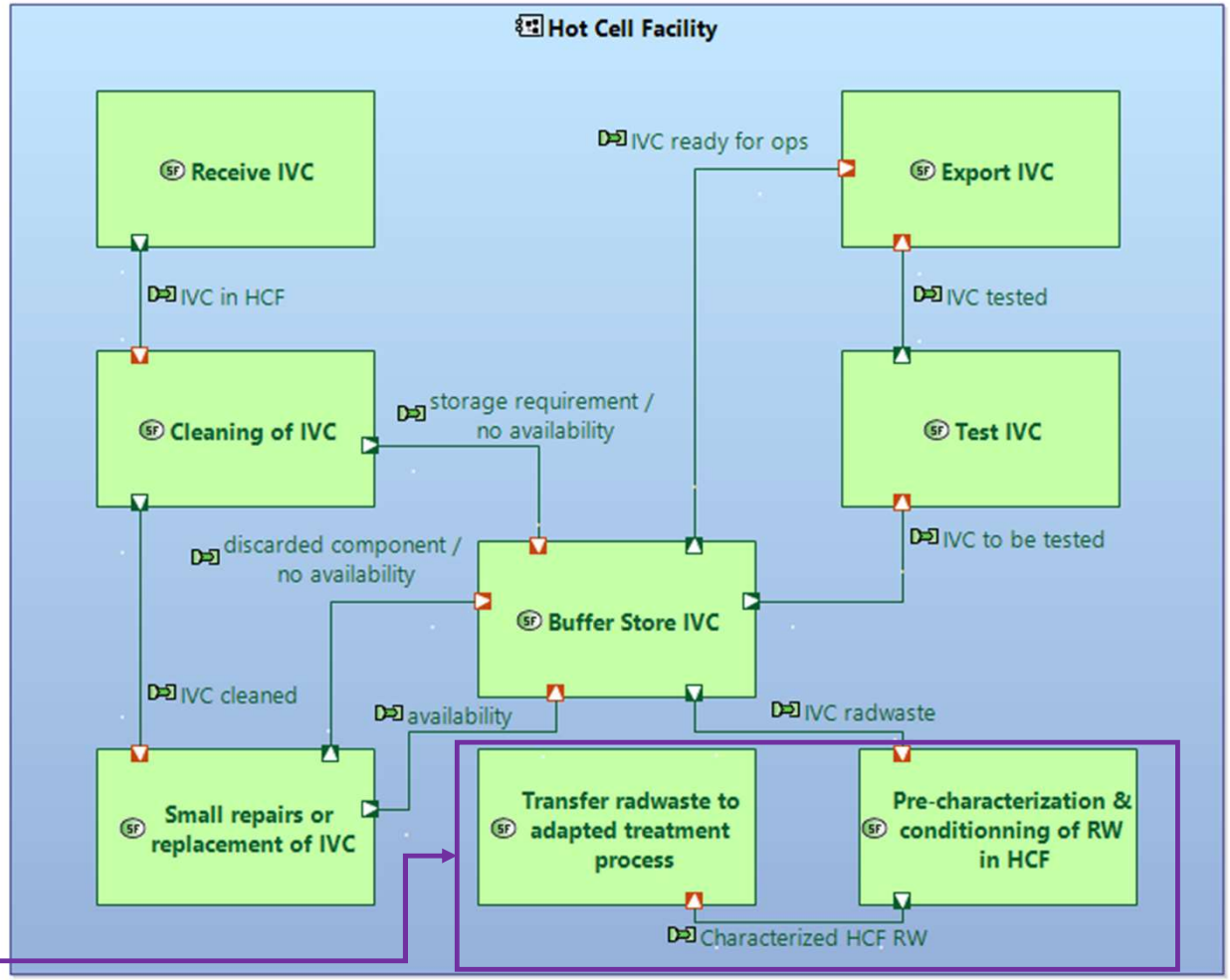
Out of HCF scope

Detailed functional breakdown

In-Vessel-Components maintenance

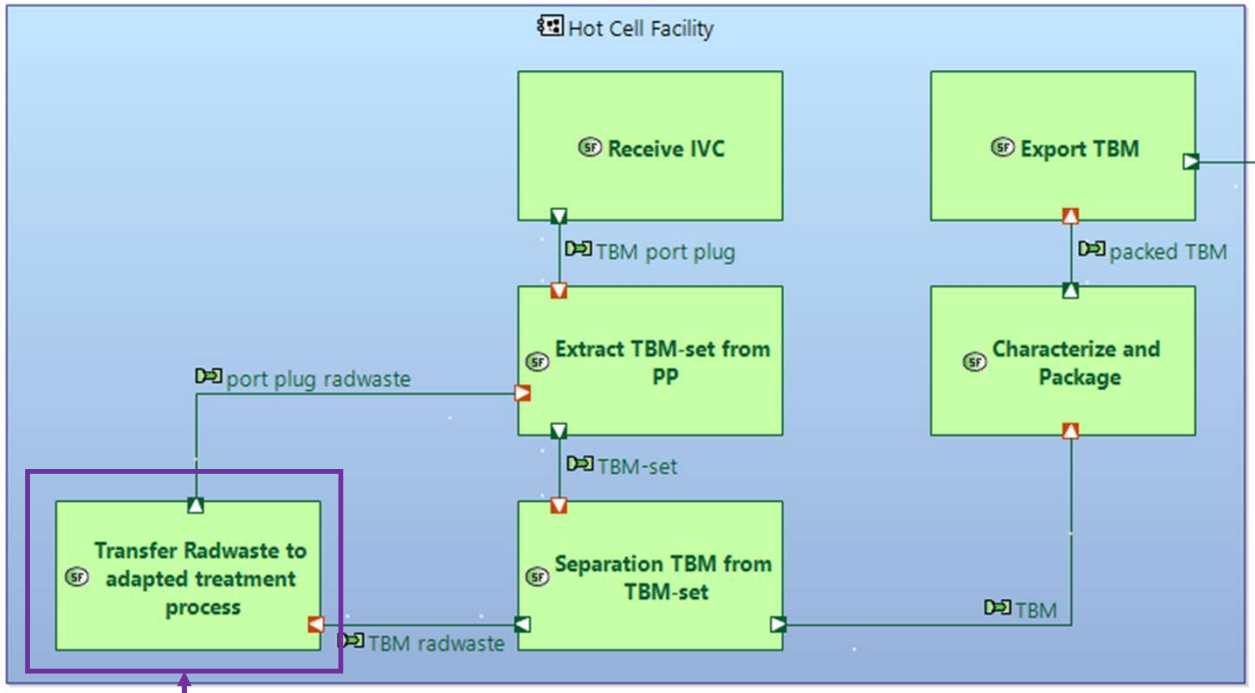


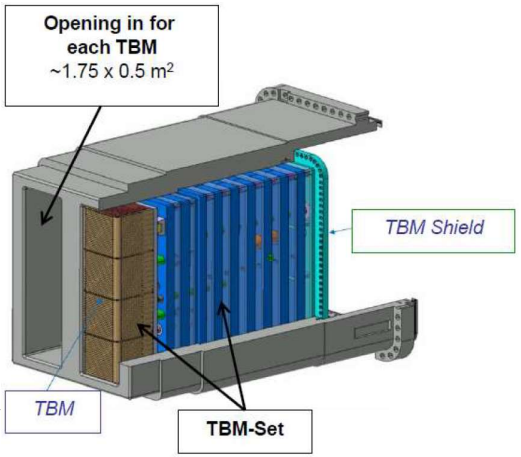
IVC: In-Vessel-Component
HCF: Hot Cell Facility
RW: Radwaste



Detailed functional breakdown

In-Vessel-Components maintenance: Focus Test Blanket Module (TBM) → Design driver for the IVC maintenance process





Connection to the radwaste process

IVC: In-Vessel-Component
HCF: Hot Cell Facility
PP: Port Plug

Detailed functional breakdown

Maintenance of components

EVE: Ex-Vessel-Equipment
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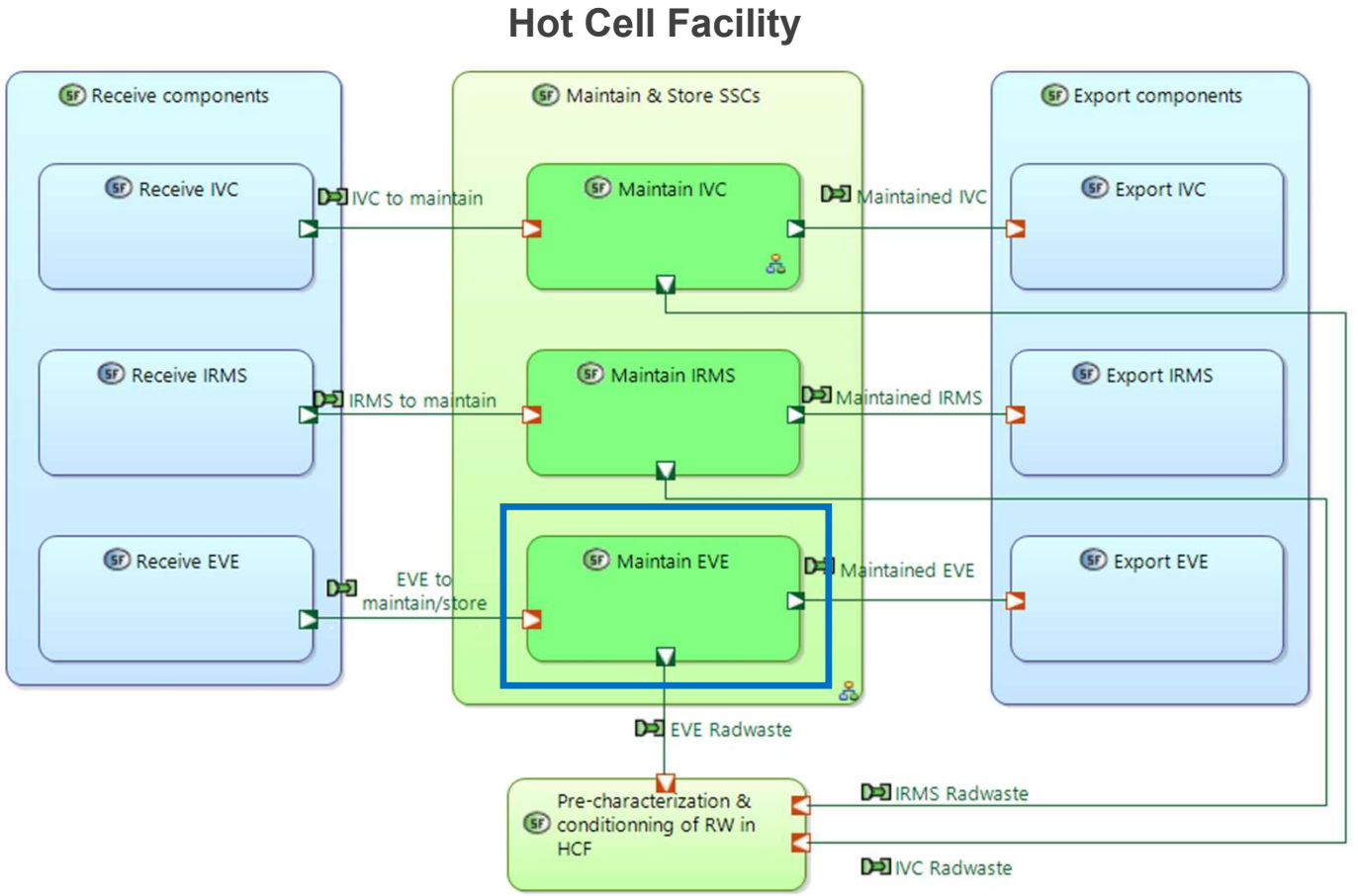
SSC: System Structure & Component



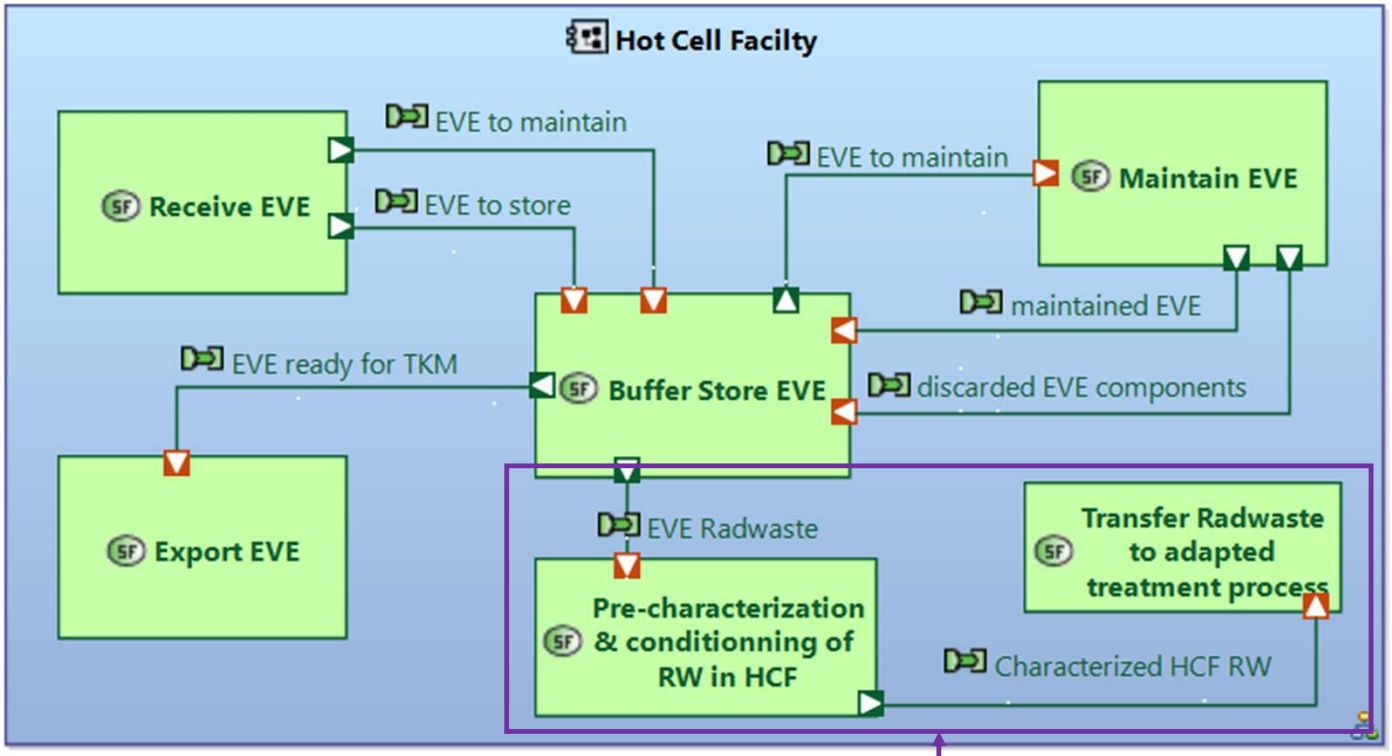
HCF scope

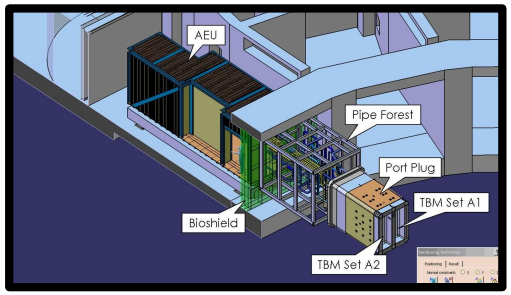
Out of HCF scope

Detailed functional breakdown

EVE: Ex-Vessel-Equipment
HCF: Hot Cell Facility
RW: Radwaste

Ex-Vessel-Equipment

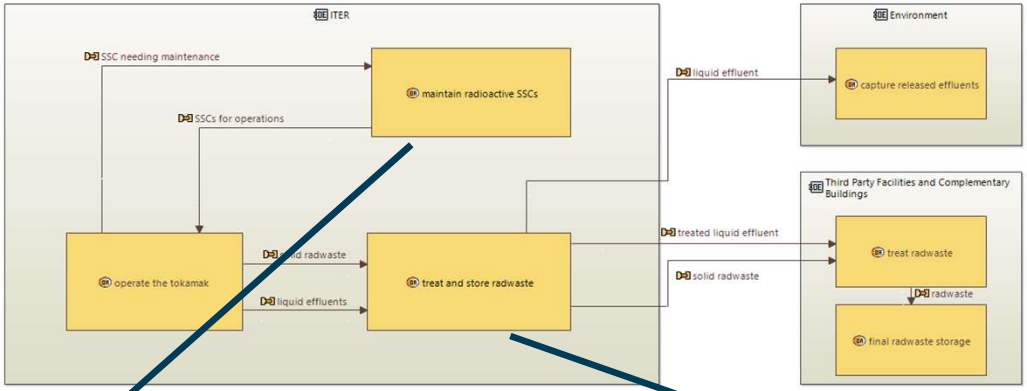




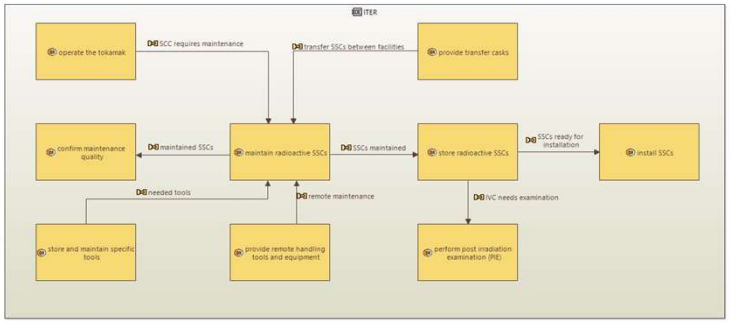
Connection to the radwaste process

Detailed functional breakdown

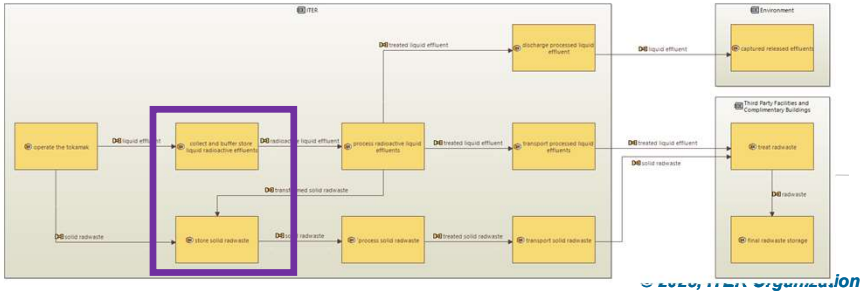
Hot Cell Facility main functions



Maintenance of components

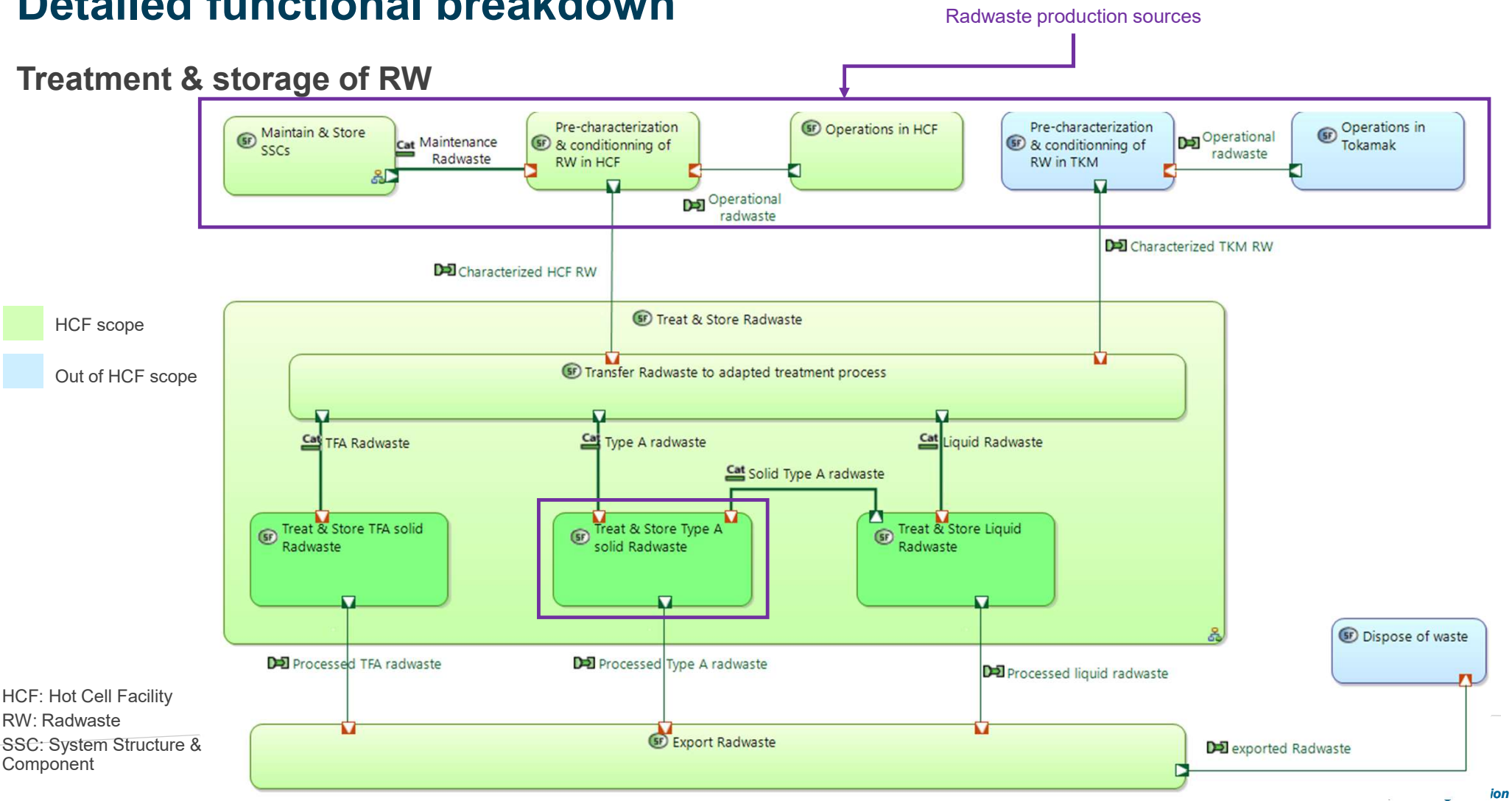


Treatment & storage of radwaste



Detailed functional breakdown

Treatment & storage of RW

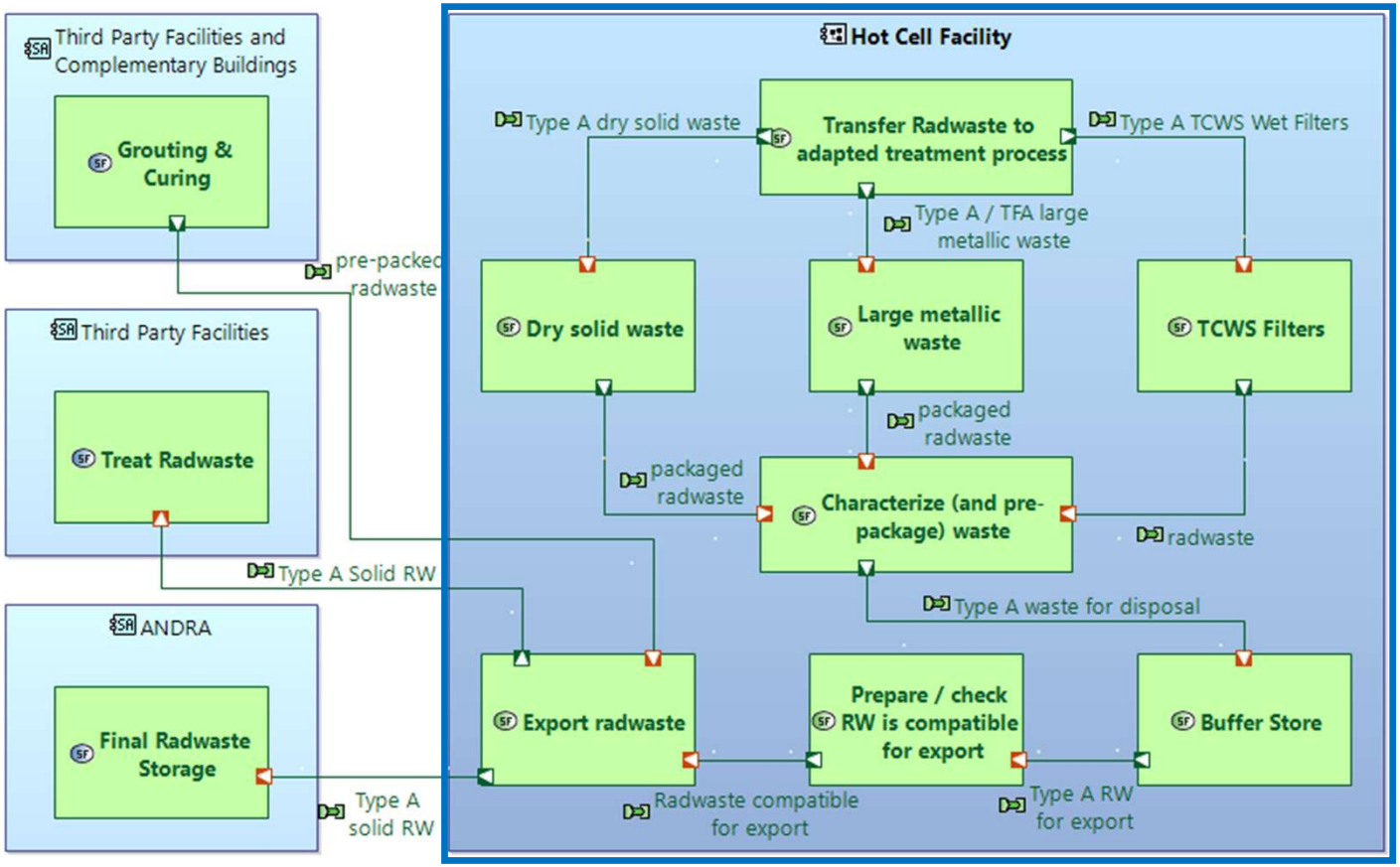


Detailed functional breakdown

ANDRA: French Final Radwaste repository
RW: Radwaste
TCWS: Tokamak Cooling Water System
Type A RW: Low level waste (FMAVC in French)

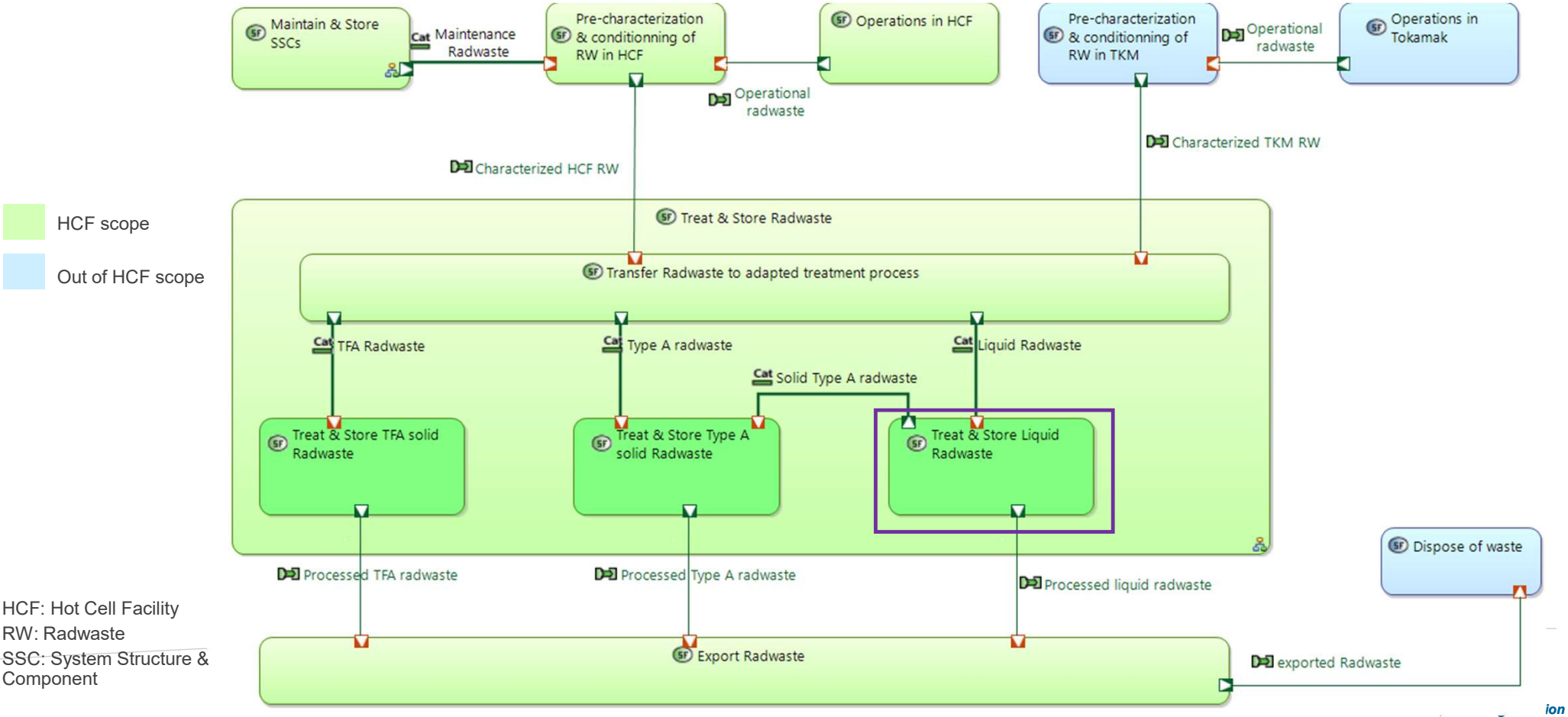
Type A solid Radwaste (RW)

HCF scope



Detailed functional breakdown

Treatment & storage of RW

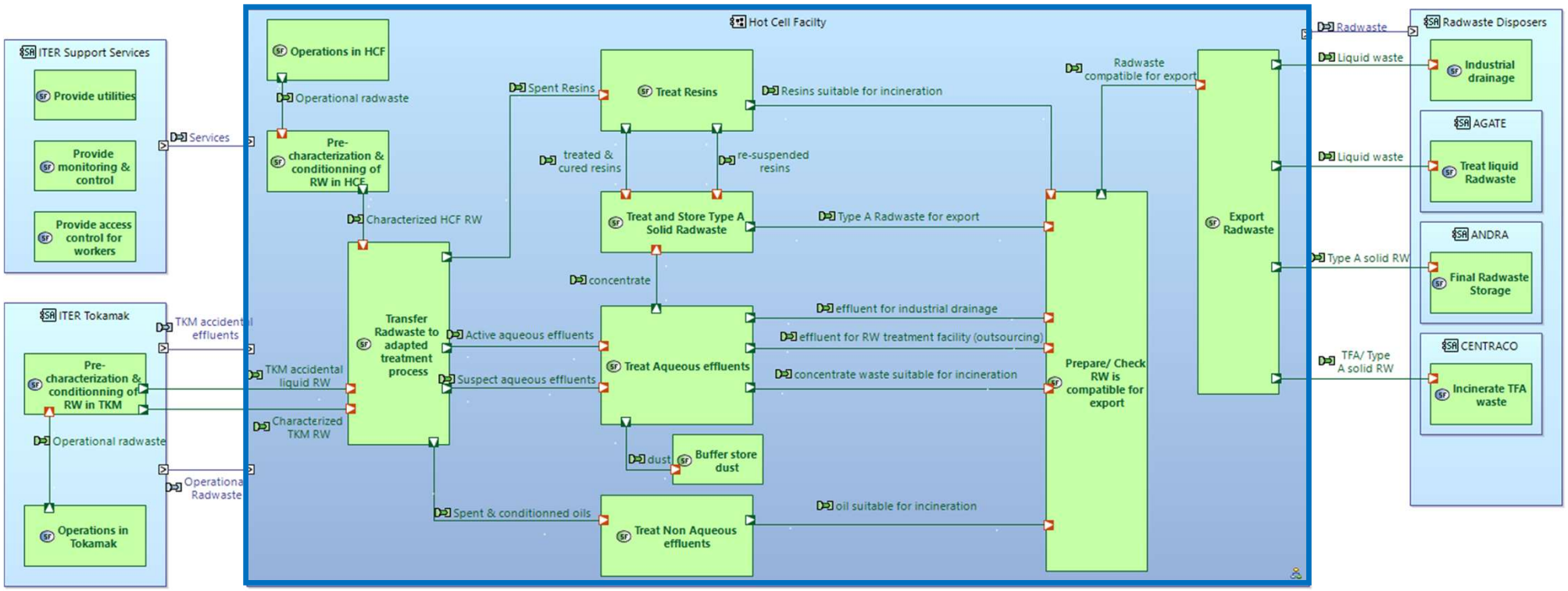


HCF: Hot Cell Facility
RW: Radwaste
SSC: System Structure & Component

Detailed functional breakdown

Type A Liquid effluents

HCF scope



AGATE: Liquid effluent treatment Facility outside ITER
ANDRA: French Final Radwaste repository
CENTRACO: Incineration Facility outside ITER
TCWS: Tokamak Cooling Water System
TKM: Tokamak

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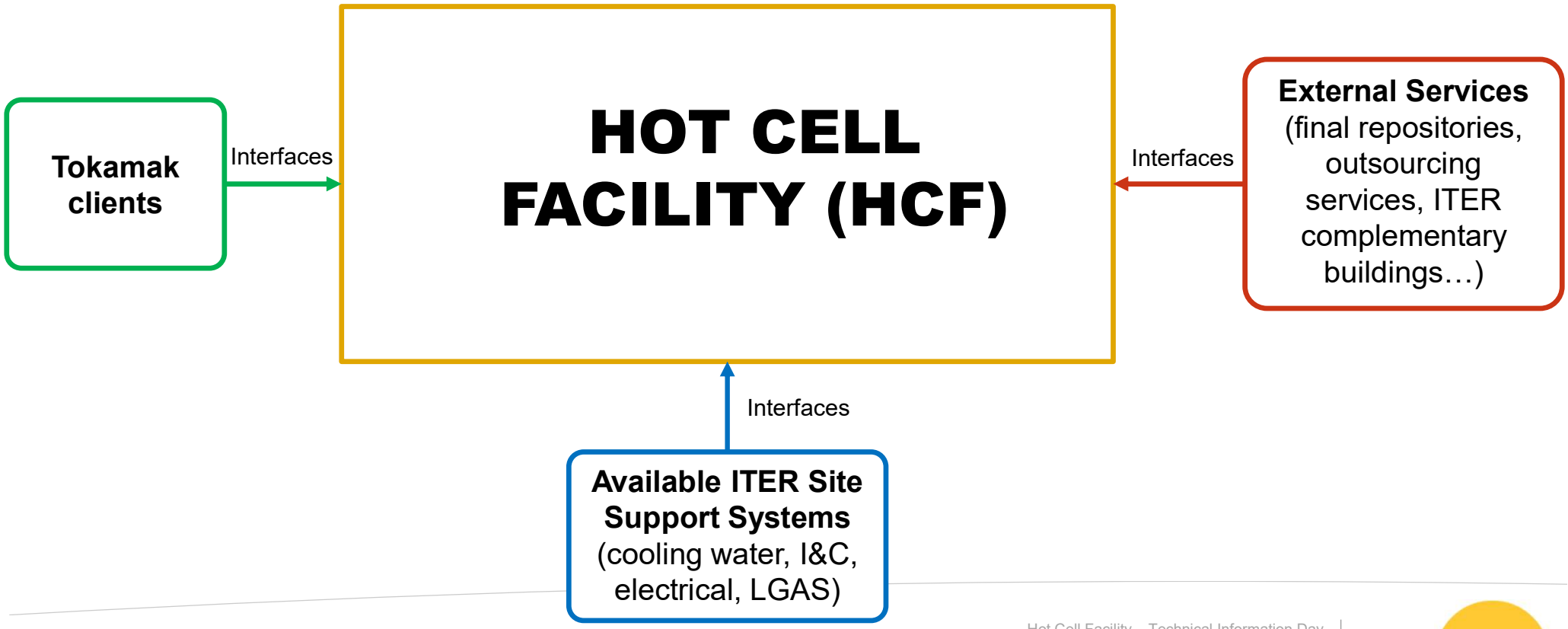
Hot Cell Facility contract scope & main interfaces

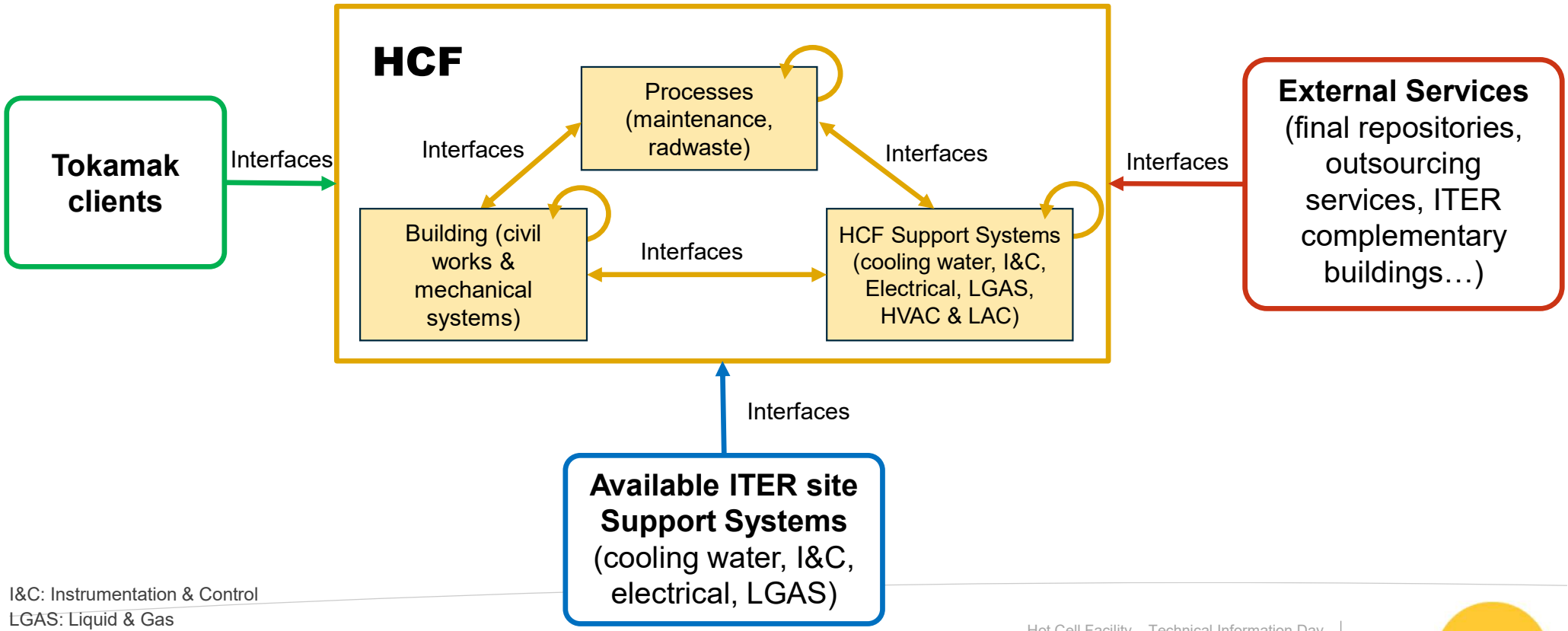
General overview of the Hot Cell Facility (HCF) and its main external interfaces



I&C: Instrumentation & Control
LGAS: Liquid & Gas

Hot Cell Facility contract scope & main interfaces

Overview of the Hot Cell Facility (HCF) and its main external and internal interfaces



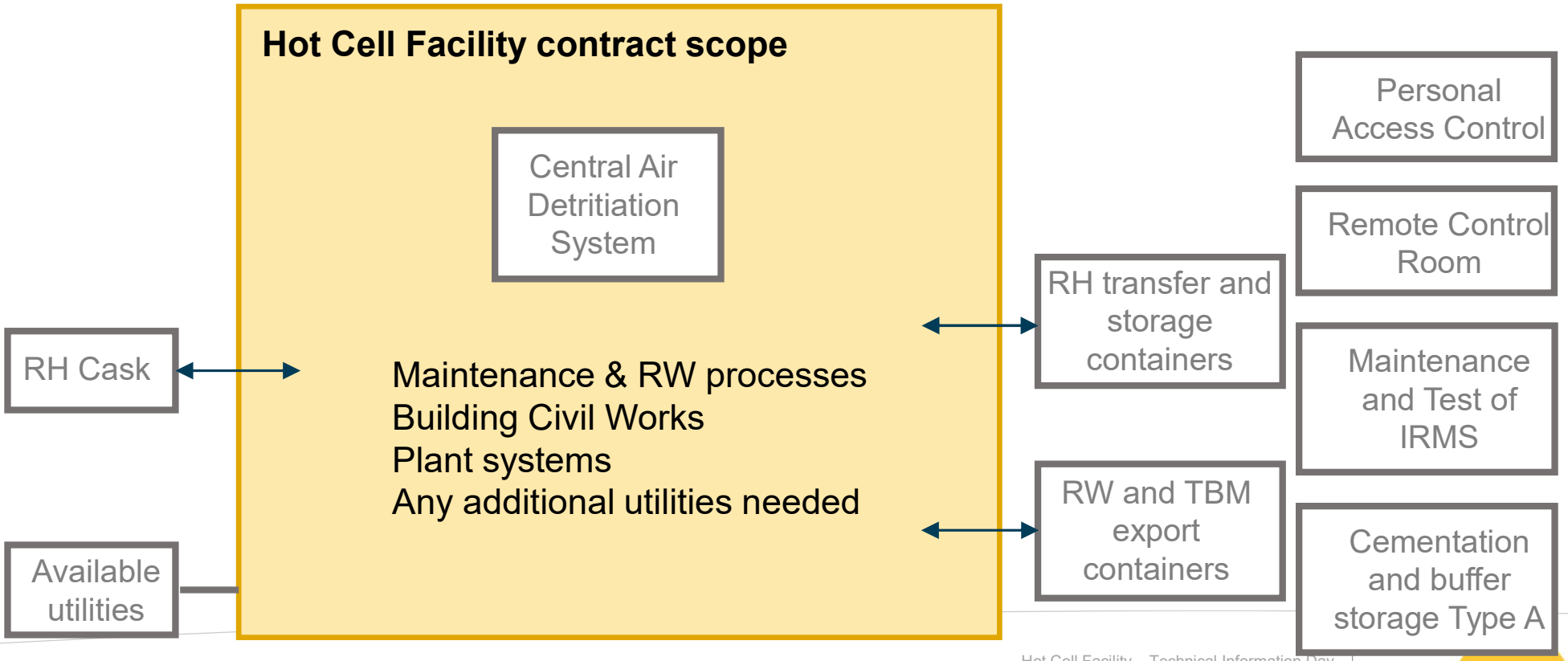
I&C: Instrumentation & Control
LGAS: Liquid & Gas
HVAC: Heating, Ventilation and Air Conditioning
LAC: Local Air Coolers

Hot Cell Facility contract scope & main interfaces

RH: Remote Handling
RW: Radwaste
TBM: Test Blanket Module

High-level visual of the HCF contract scope

In grey = out of scope



Hot Cell Facility contract scope & main interfaces

High-level HCF contract scope

HCF

Processes (maintenance, radwaste)	For the processes:
	- Remote handling maintenance (PBS 23.06):
	  • In-Vessel-Components maintenance (*except for the control room which is out of scope*)
	  • IRMS: decontamination processes (*IRMS maintenance and control room are out of scope*)
	- Integration of Ex-Vessel-Equipment maintenance (PBS 62)
	- Radwaste management (PBS 66)
	  • Type A solid RW: treatment (*except for the cementation and buffer storage before export out of ITER site out of scope*)
	  • Liquid RW treatment and storage
	  • TFA: only reception, characterization and export (*treatment and storage out of scope*)

Building (civil works & mechanical systems)	Building 21 and associated platform: - Hot Cell Building (HCB) civil works (PBS 62.21) - Hot Cell Building mechanical systems (doors, handling and lifting means, liner…) (PBS 62.21) - Site integration (PBS 61)

Note: the transport containers/flasks are out of scope

Hot Cell Facility contract scope & main interfaces

High-level HCF contract scope

HCF

HCF Support Systems (cooling water, I&C, Electrical, LGAS, HVAC & LAC)

For the support systems:

- HVAC & LAC, Drainage, Electrical distribution, Instrumentation & Control (I&C), Fire detection & suppression systems within the HCF (PBS 62)
- Air Detritiation System (ADS): *central unit systems out of scope* but major interface. Network distribution of ADS within HCF in the scope (PBS 32)
- Cask & Plug Remote Handling System (CPRHS): *out of scope* but major interface (PBS 23.03)
- Liquid & Gas (LGAS), Power Supply: network distribution within HCF in the scope and major interface with ITER site production units (PBS 65, PBS 43)
- Chilled Water System (CHWS) H1 and H2: in scope including the distribution within HCF (PBS 26)
- Cable Trays including the cables routing and pulling/termination for all systems is in the scope (PBS 44)
- CODAC, Central Interlock System & Central Safety System: integration of the common network architecture up to the cubicles in HCF. Cubicles and network from the cubicles up to the HCF systems in the scope (PBS 45, PBS 46 & PBS 48)
- Access Control: Doors, Camera, sensors, security access in scope and major interface (PBS 69)

CODAC: Control, Data Access and Communication
HVAC: Heating, Ventilation and Air Conditioning
LAC: Local Air Coolers

Summary

- Introduction
- High-level maintenance & radwaste management functions
- Context: Hot Cell history, impact of the New Research Plan
- Detailed functional breakdown
- Scope Hot Cell Facility & main interfaces
- **Illustration of pre-concept**

Illustration of pre-concept

Pre concept was based on

- Site constraints
- Requirements (ITER Project, Hot Cell and Radwaste Project, Systems, …)
- Recommendations for optimisation

The pre-concept is a viable proposal compliant with above.

The pre-concept layout is shared with the companies but it is not an input for the design.

The companies are expected to elaborate further optimised design.

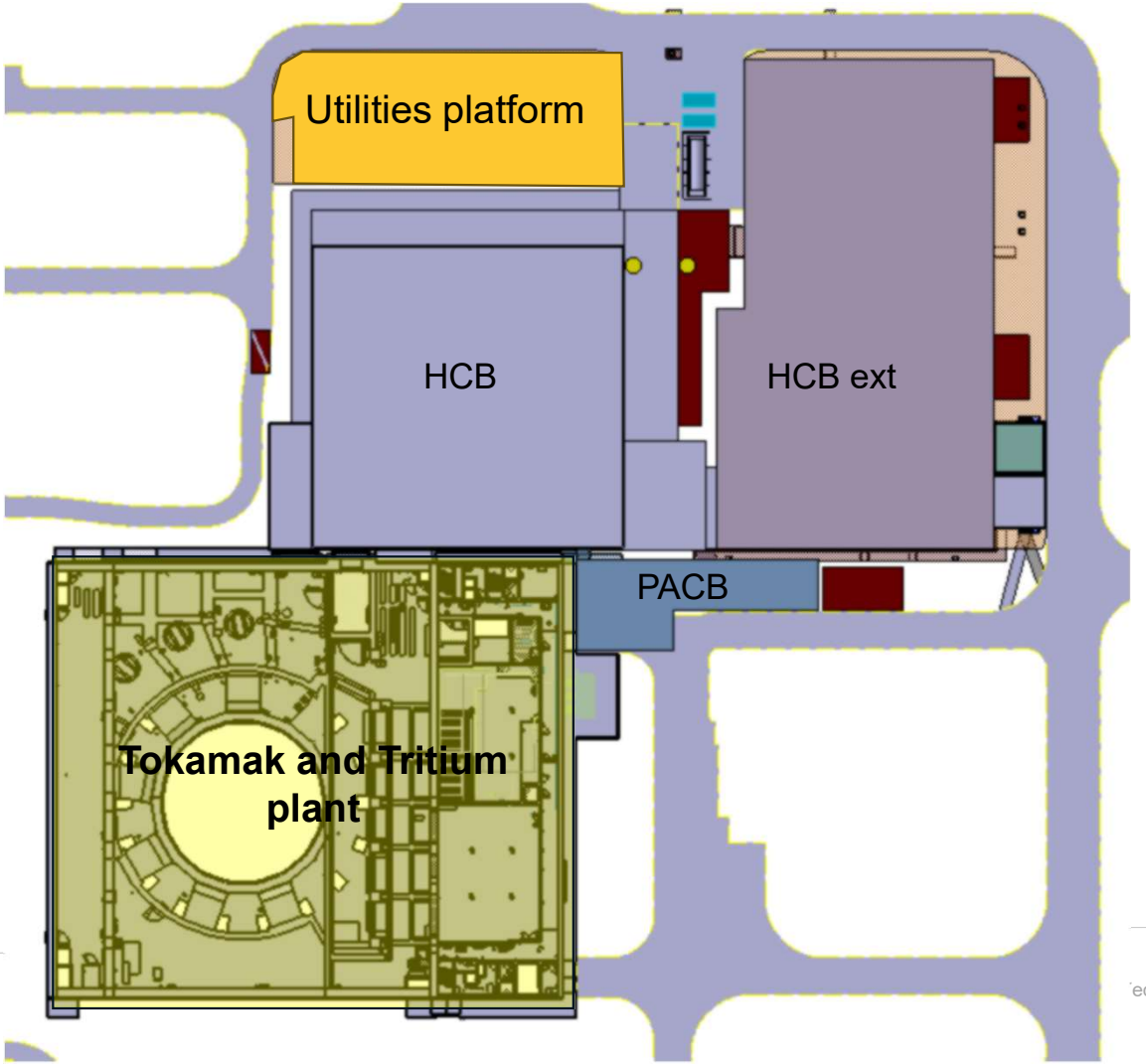
Major Design drivers and constraints used for Pre-concept

ITER Site Master Plan

- Area 28 is dedicated for the HCF

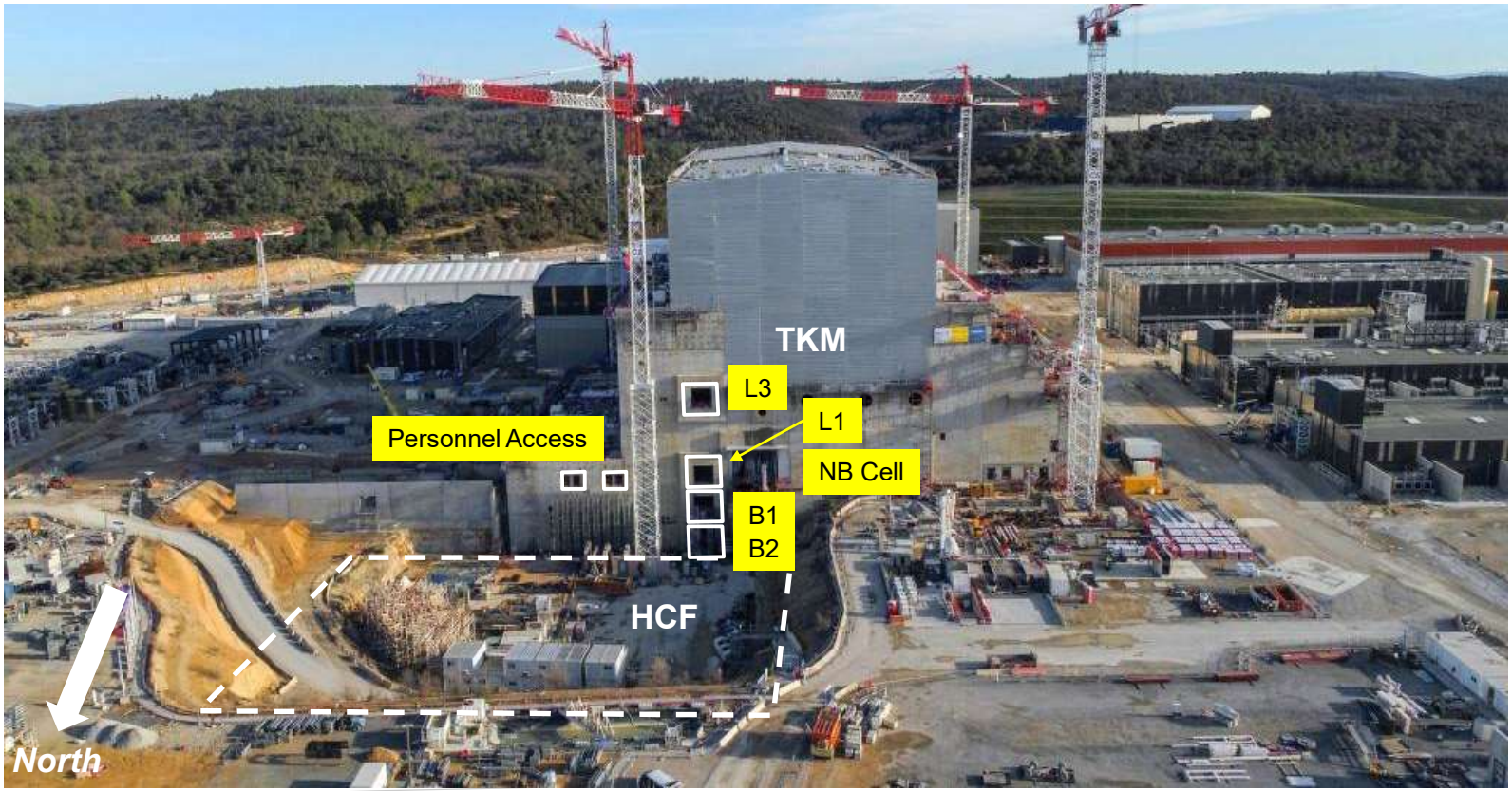
- Use of existing excavation (to avoid additional excavation during TKC operational phase)

→ Area 28 organization



Design drivers and constrains - Site Interfaces

- Tokamak Cargo Lift (B2, B1, L1 and L3)
- NB Cell access (L1)
- Drain tank room connection (B2/B1)
- DS connection (B1)
- Utilities – Ex:
  - Road L1 (import/export)
  - Liquid and Gas (Underground galleries)
  - Electrical galleries
  - Effluents



Hot Cell General Arrangement

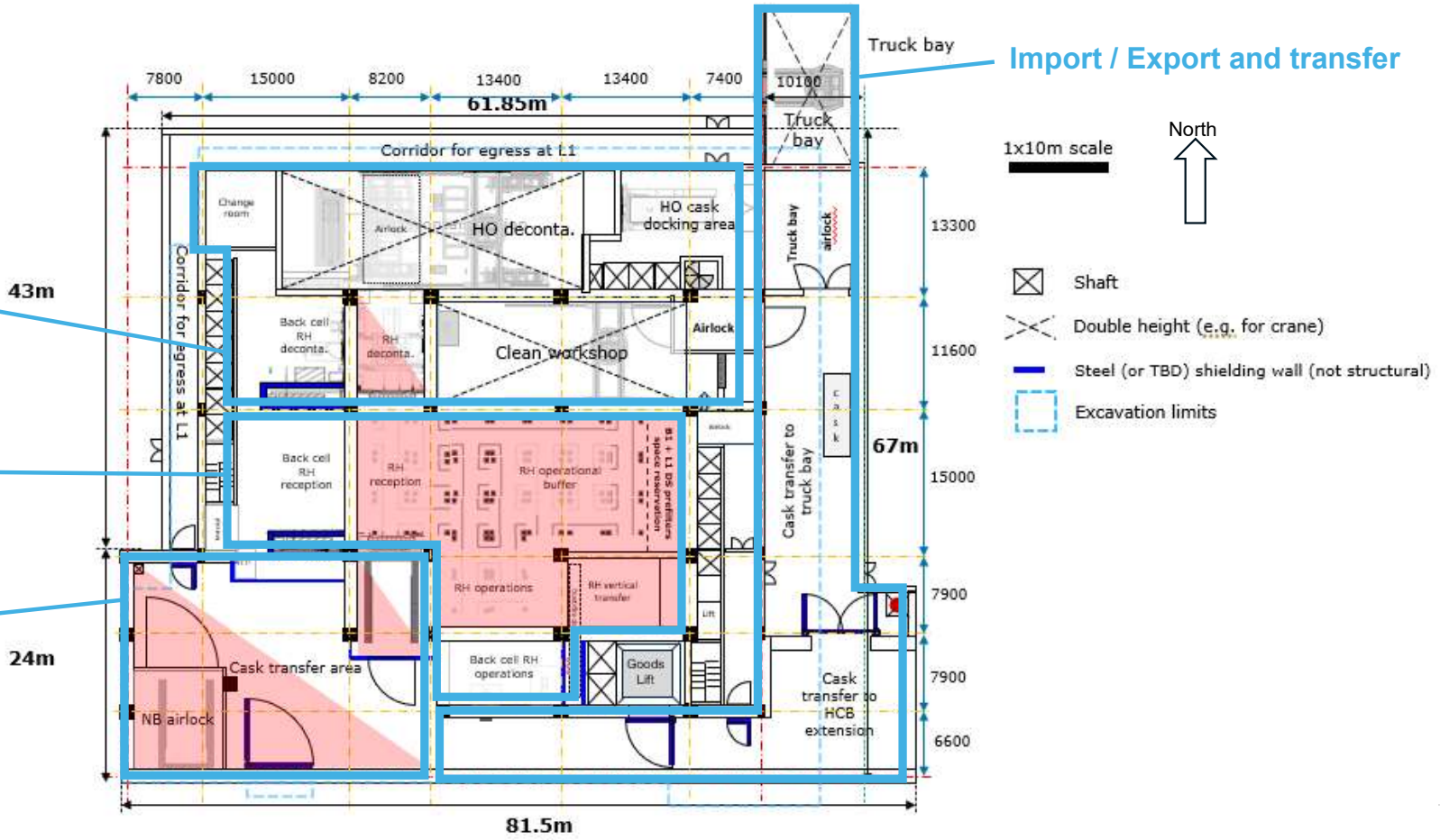
Five floors

- Level L1:

Decontamination / reconfiguration Remote Handling

Hot Cell Remote Handling areas

Cask transfer area

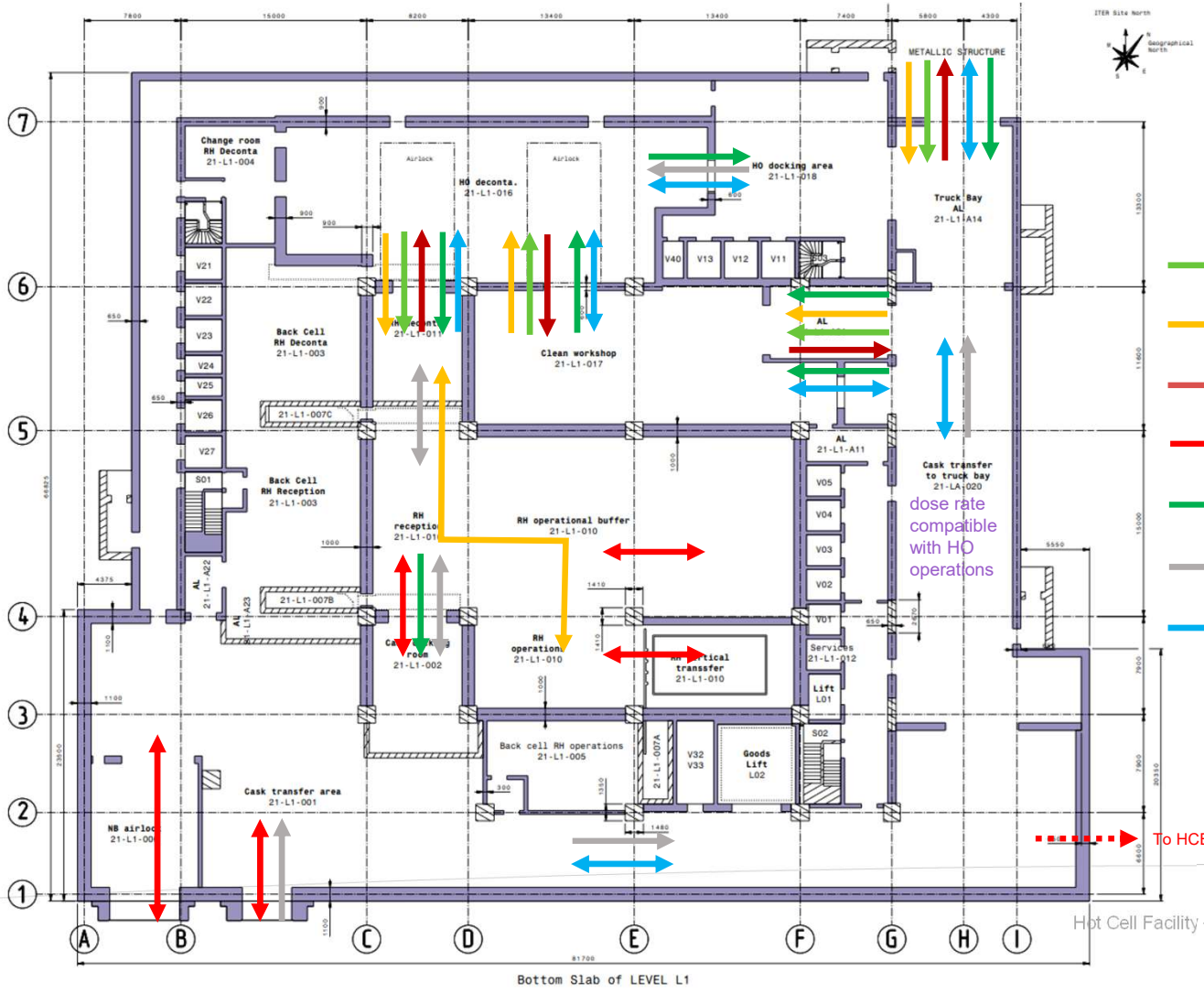


Studies to support the Pre-concept

Transverse assessment were performed

- **Movement of large equipment via cask transfer area**
- **Waste routing**
- **People access**
- **Radiological zoning and occupancy zoning**
- Occupancy
- Escape routes
- Maintenance access and trajectories

Studies to support the Pre-concept - Large SSC flow



Empty TBM flask

TBM canister

TBM flask loaded with canister

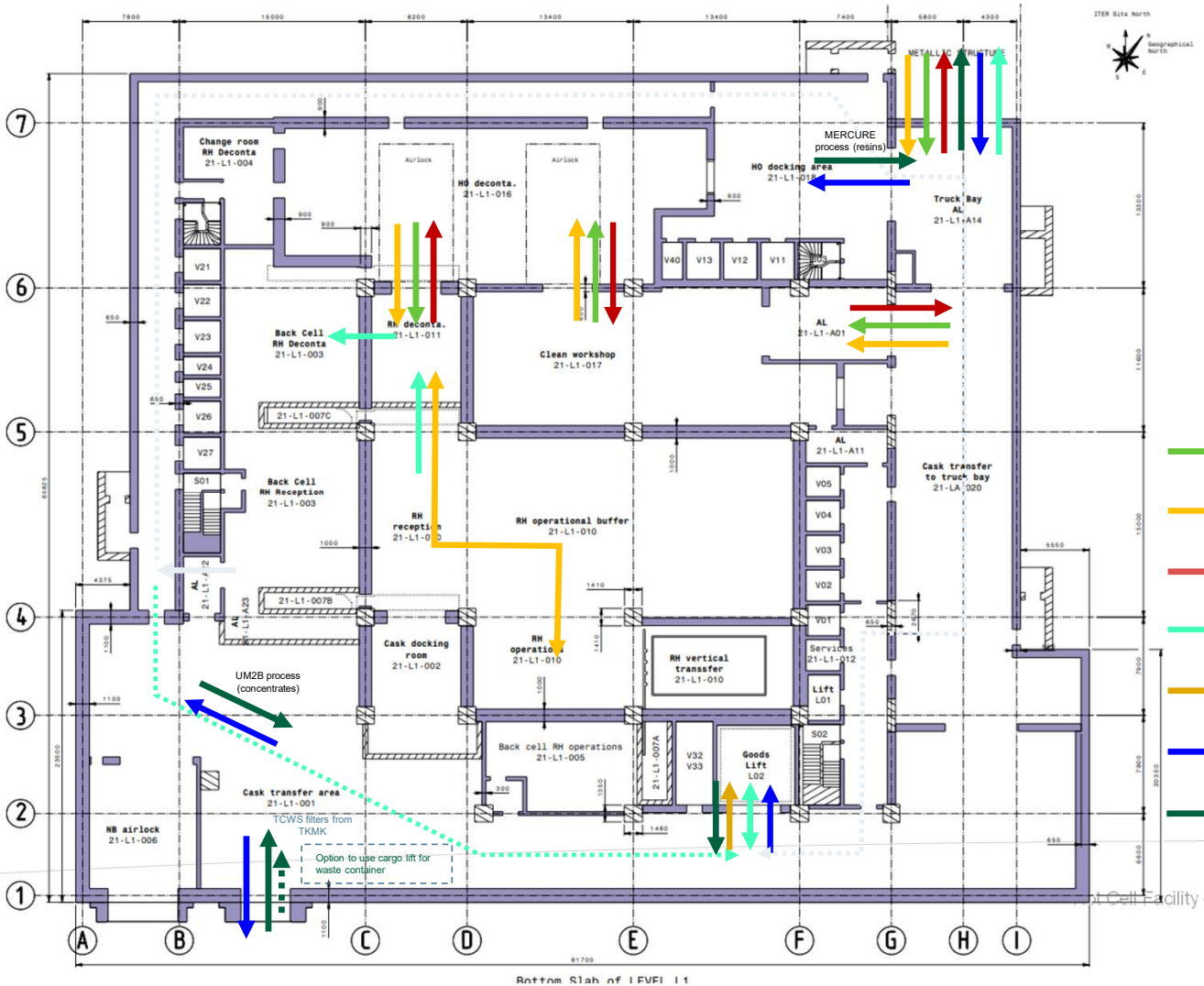
Activated IVC/NBC/SSC

New IVC/NBC/SSC

Contaminated IRMS

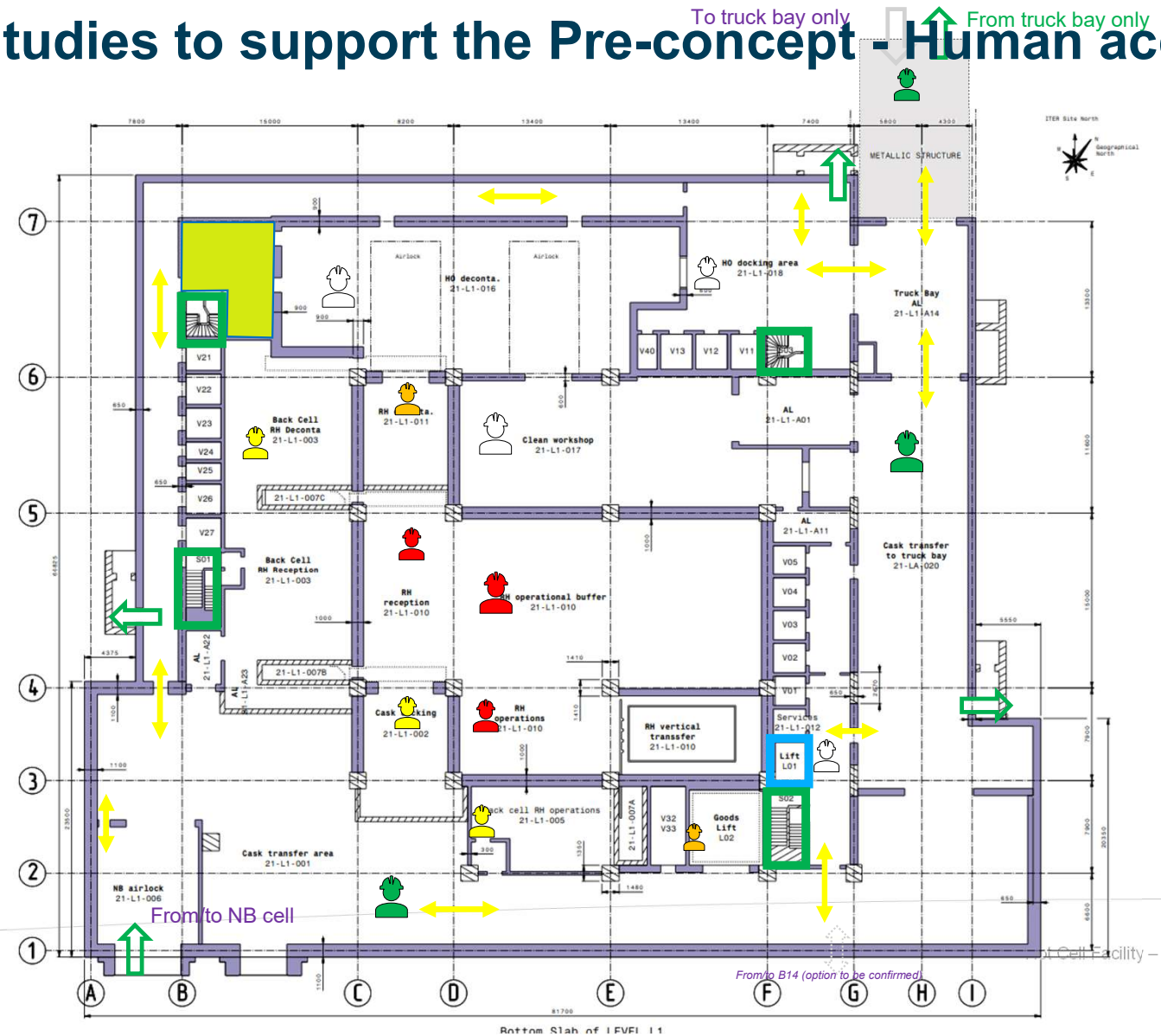
Clean IRMS

Studies to support the Pre-concept - Waste flow



- Empty TBM flask
- TBM canister
- TBM flask loaded with canister
- Samples to PIE lab
- Small solid radwaste
- Empty radwaste containers
- Filled and sorted solid radwaste containers

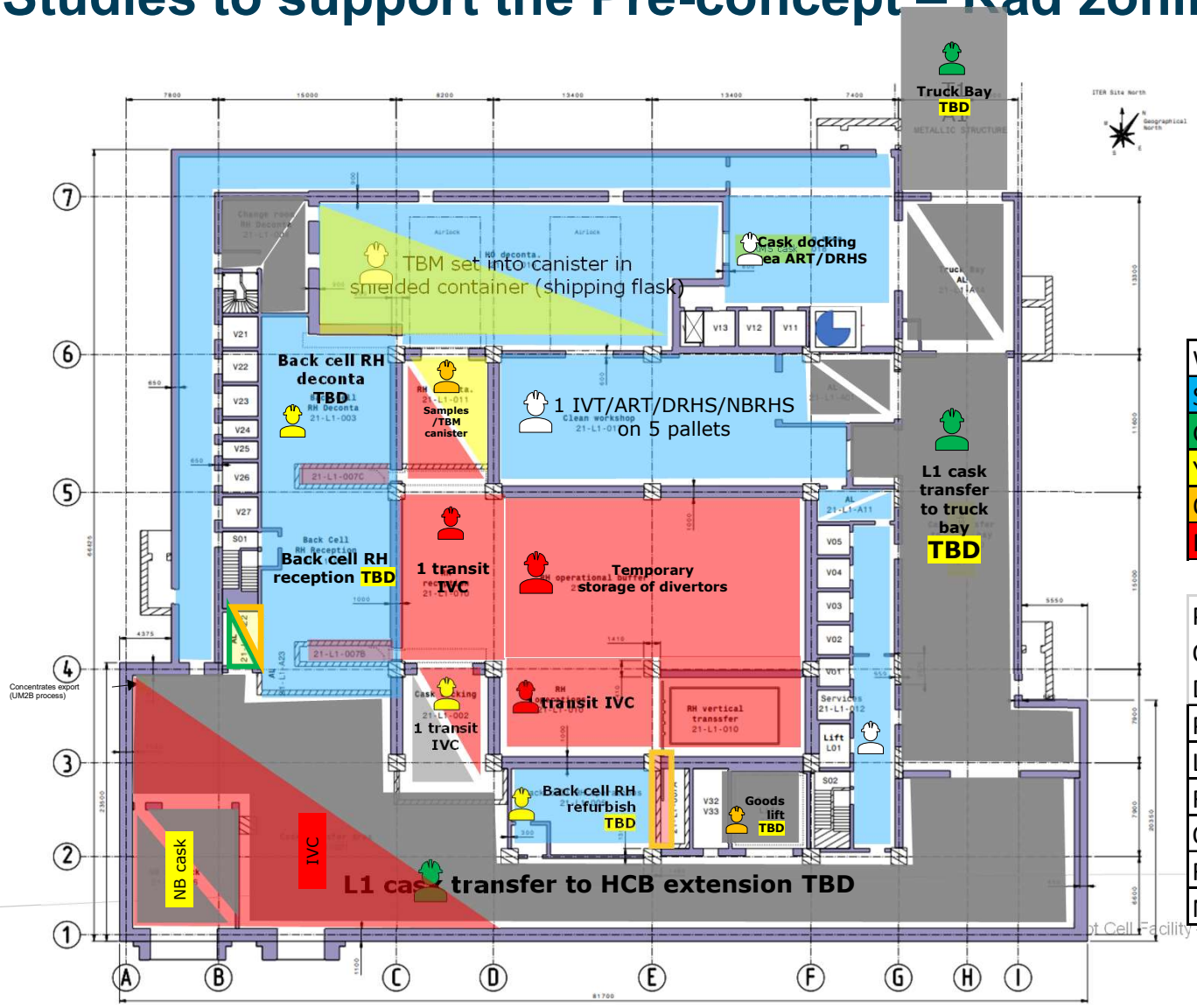
Studies to support the Pre-concept - Human access



Personnal Occupancy Definition	Hours per year
Permanent	2000
LTM	1000
Regular	365
Occasional	50
Rare	10
Never	0

- Normal access
- Emergency and normal access
- **Emergency exit <20m from stairs**
- Main access
- Corridors
- Change room

Studies to support the Pre-concept – Rad zoning

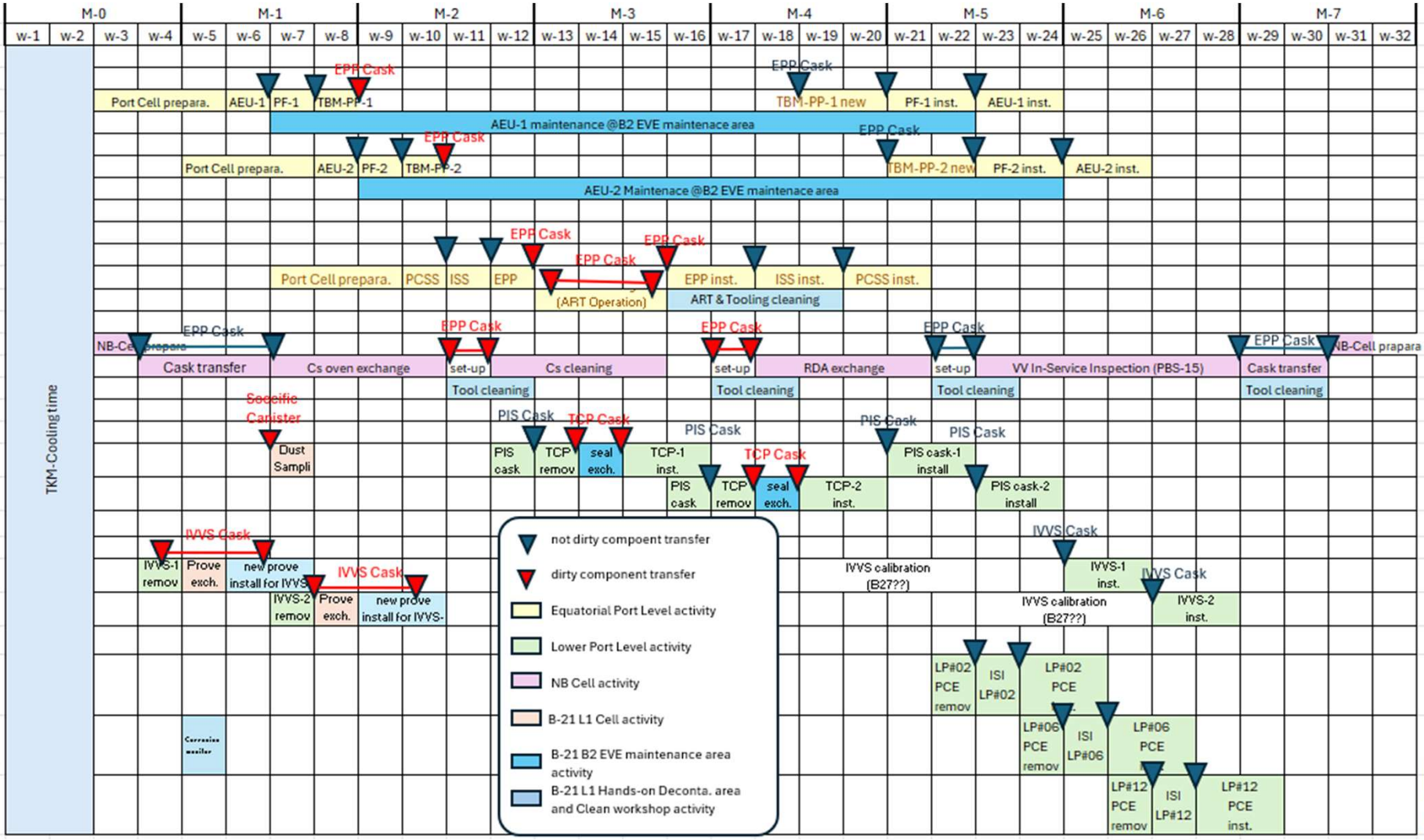


NB cask IVC Transient source terms

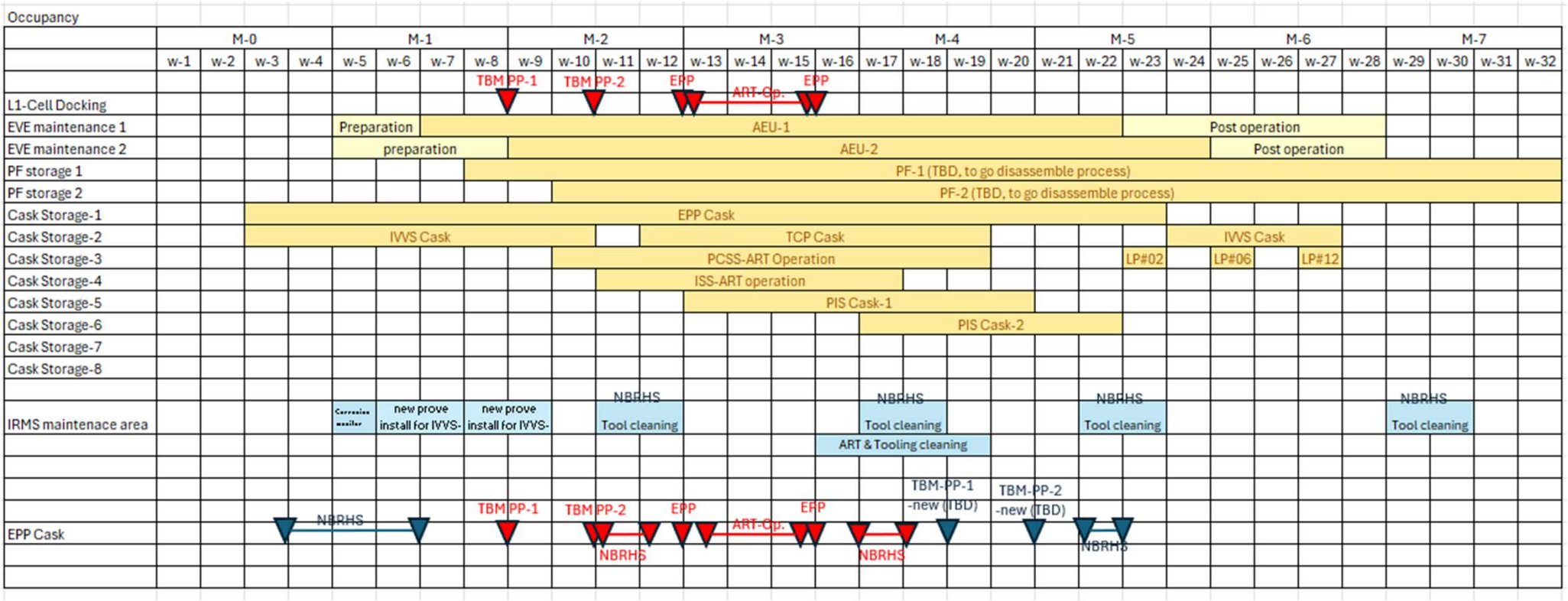
White area	< 0.5µSv/h
Supervised area	< 7.5µSv/h
Green controlled area	< 25µSv/h
Yellow controlled area	< 2mSv/h
Orange controlled area	< 100mSv/h
Red controlled area	> 100mSv/h

Personnal Occupancy Definition	Hours per year
Permanent	2000
LTM	1000
Regular	365
Occasional	50
Rare	10
Never	0

Studies to support the Pre-concept – E.g. Flow Analysis



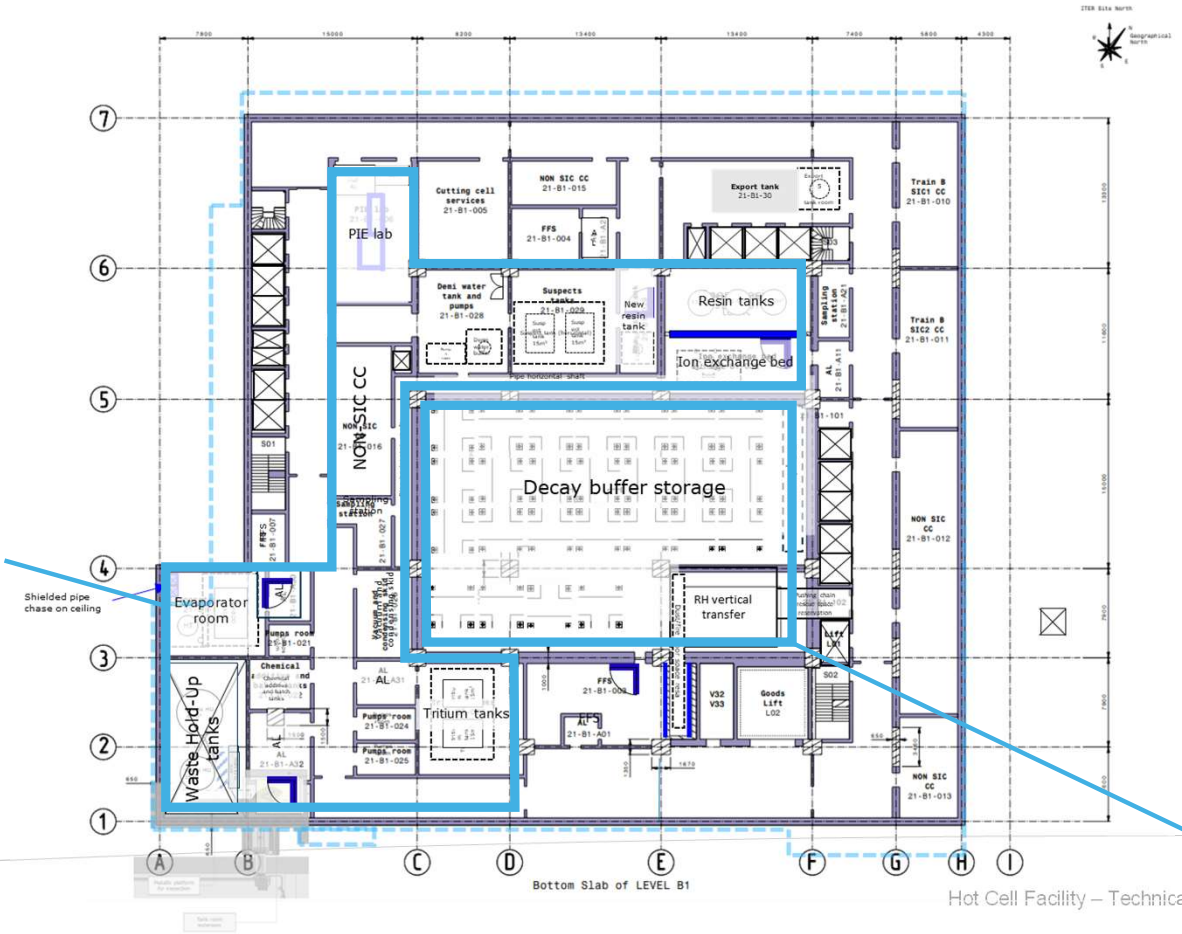
Studies to support the Pre-concept – E.g. Flow Analysis



Hot Cell General Arrangement

Five floors

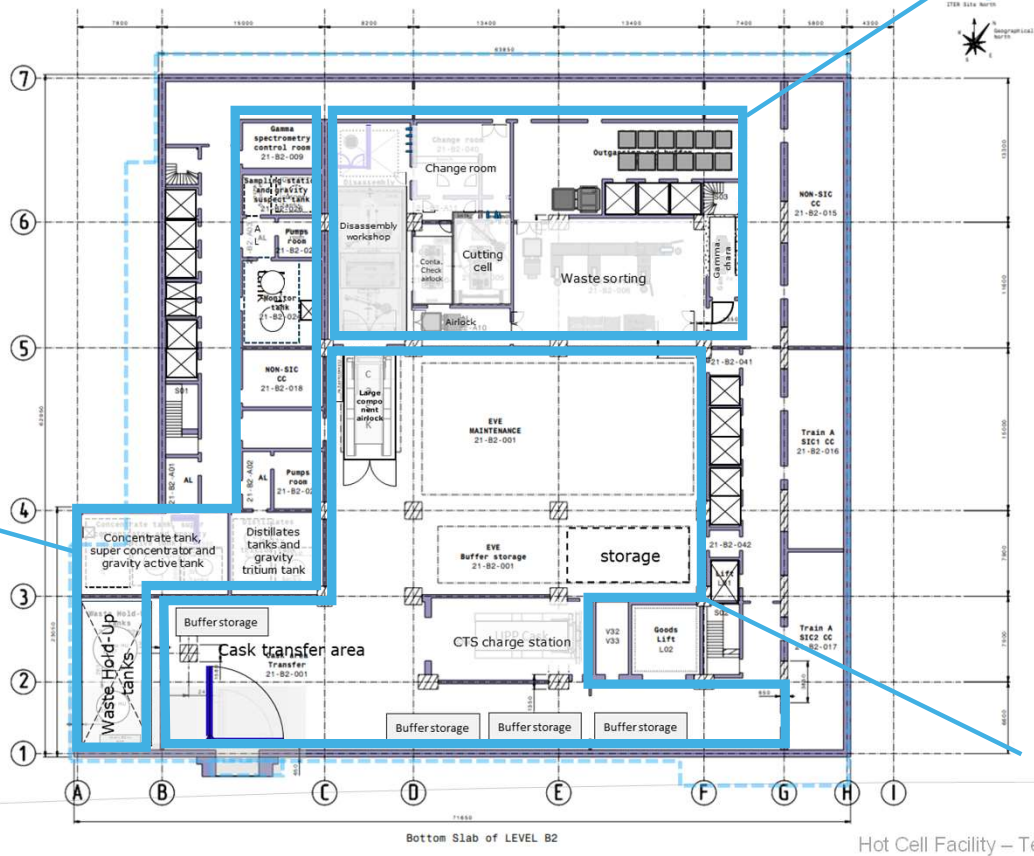
- Level B1:



Hot Cell General Arrangement

Five floors

- Level B2:



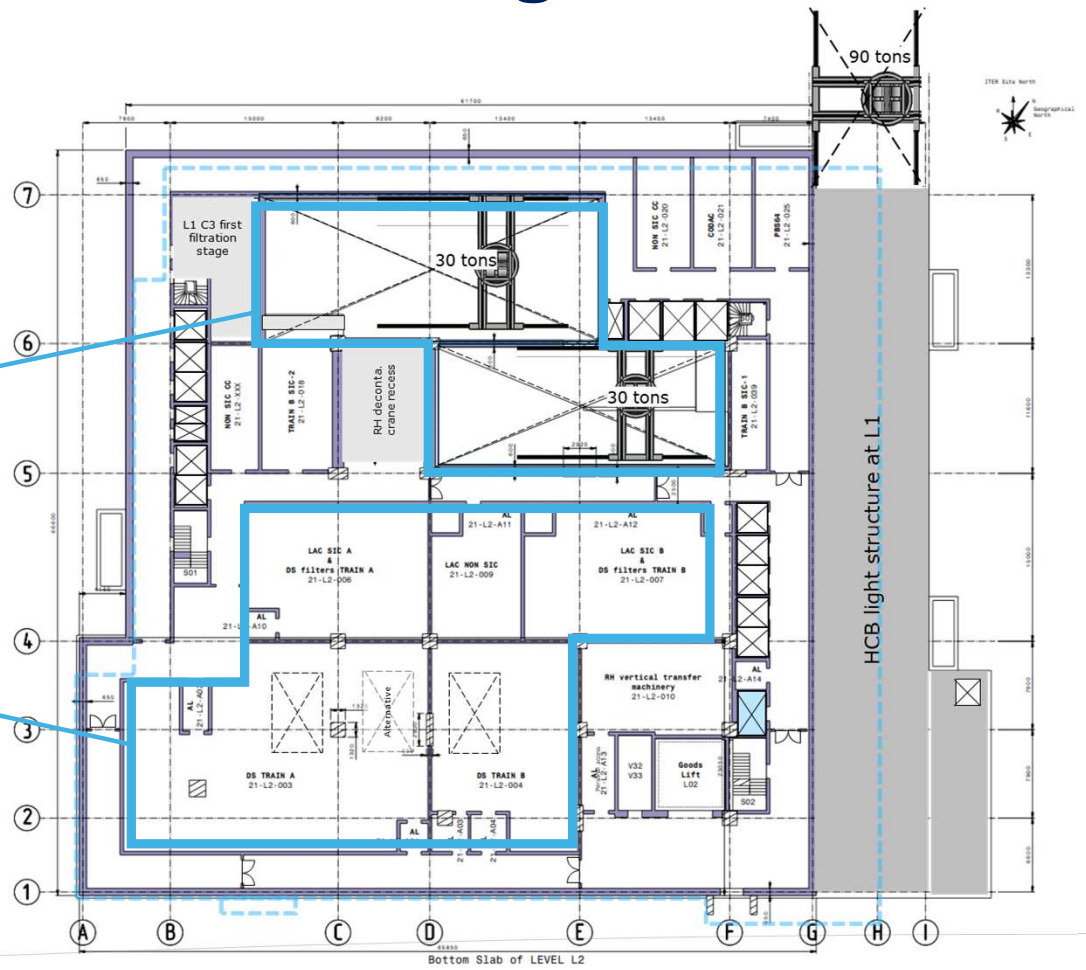
Hot Cell General Arrangement

Five floors

- Level L2:

Decontamination / reconfiguration Remote Handling

Air Detritiation System (DS) and Local Air Cooler (LAC)



North

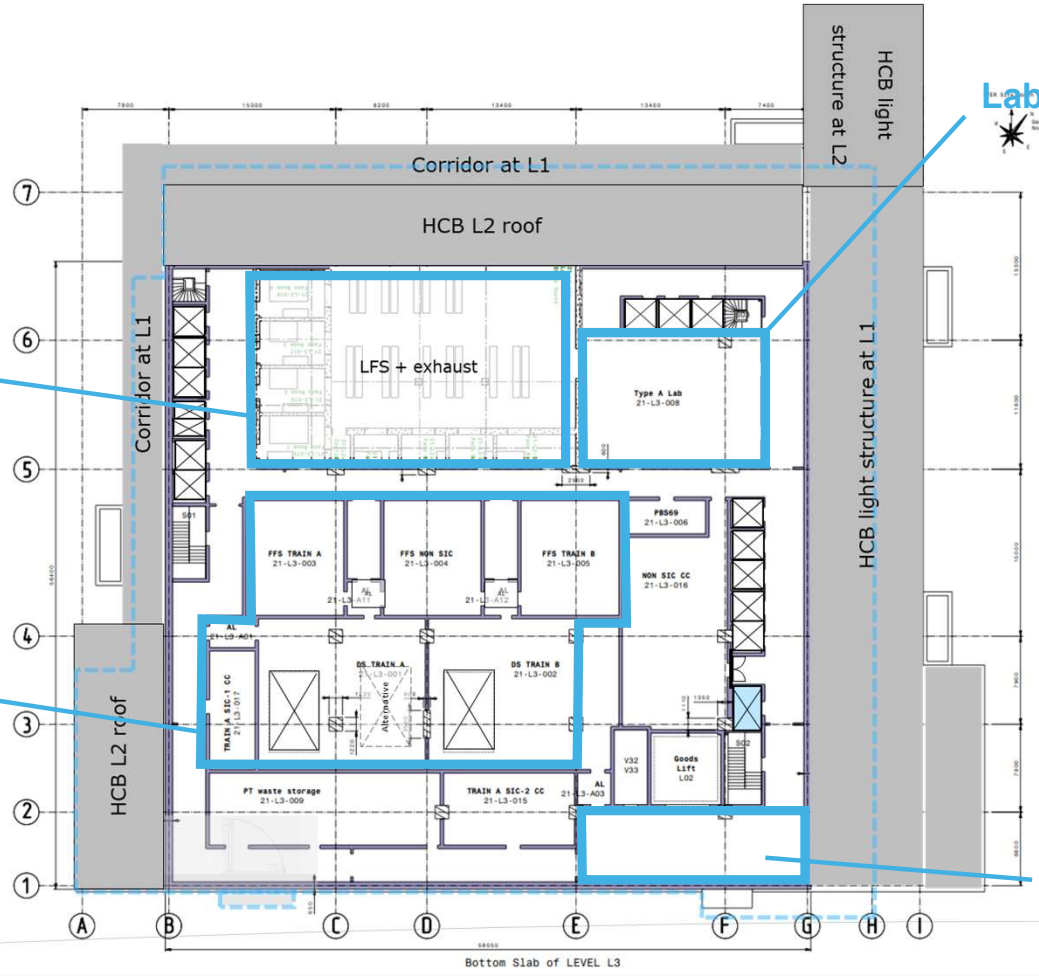
Hot Cell General Arrangement

Five floors

- Level L3:

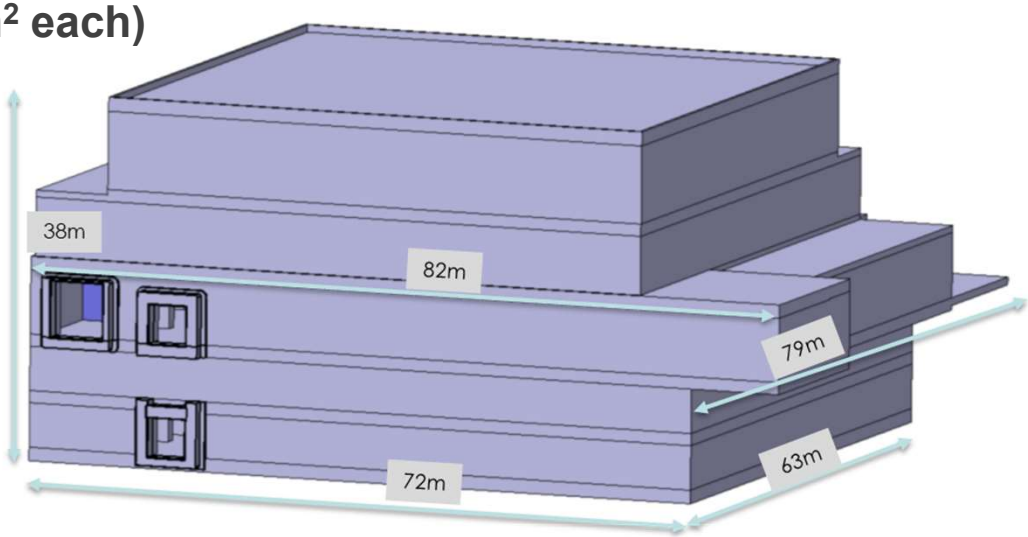
HVAC Rooms

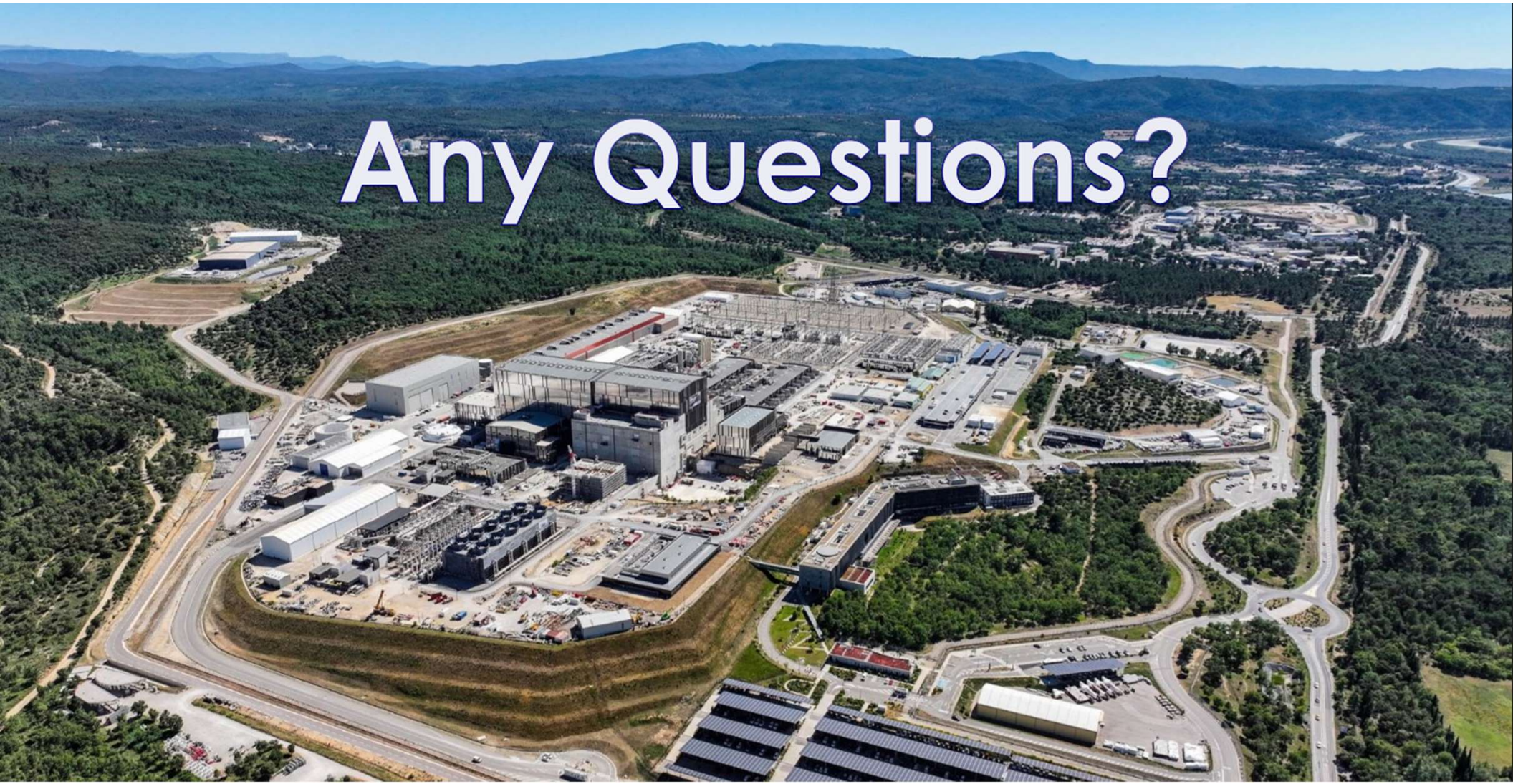
Air Detritiation System (DS) and Local Air Cooler (LAC)



Some figures of the Pre-concept

- Total Net Surface 16,000 m² including 1,600 m² C4 Red Zone
- Total Net Volume of the building 100,000 m³
- 90t crane in the import/export and two 30t crane in the decontamination workshop
- Trolley for 60t load transfer in red zones
- 14 Large Nuclear Doors (between 5 and 18m² each)
- Total Concrete Volume 40,000 m³
- Total Stainless Steel Liner Surface 4,500 m²




Any Questions?

Thank you!

ITER Hot Cell Facility

Technical Information Day

Alexis Dammann, Hot Cell Project Leader
Eva Noukou, Hot Cell Deputy Project Leader
Sarah Deguilhem, Hot Cell Technical coordinator
Mampaey Peggy, Hot Cell Layout coordinator

17th of January 2025

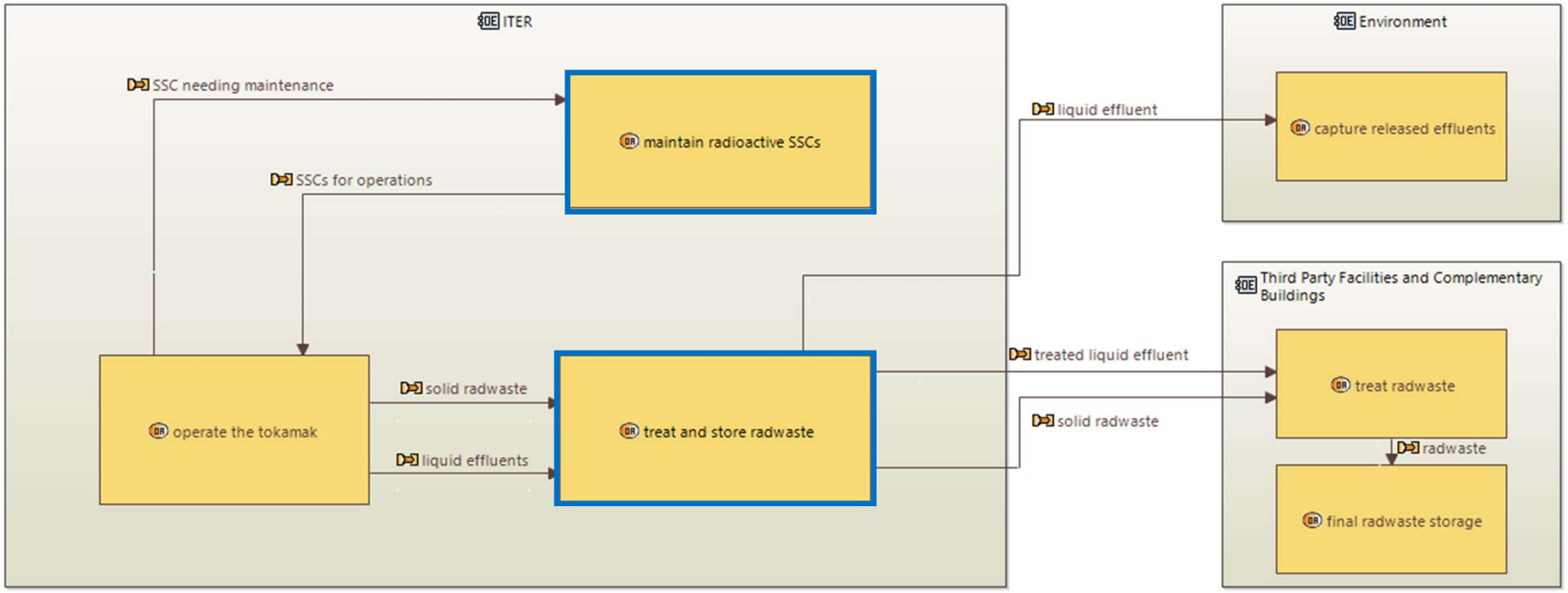
china eu india japan korea russia usa

Back up slides

Detailed functional breakdown

HCF scope

Hot Cell Facility main functions

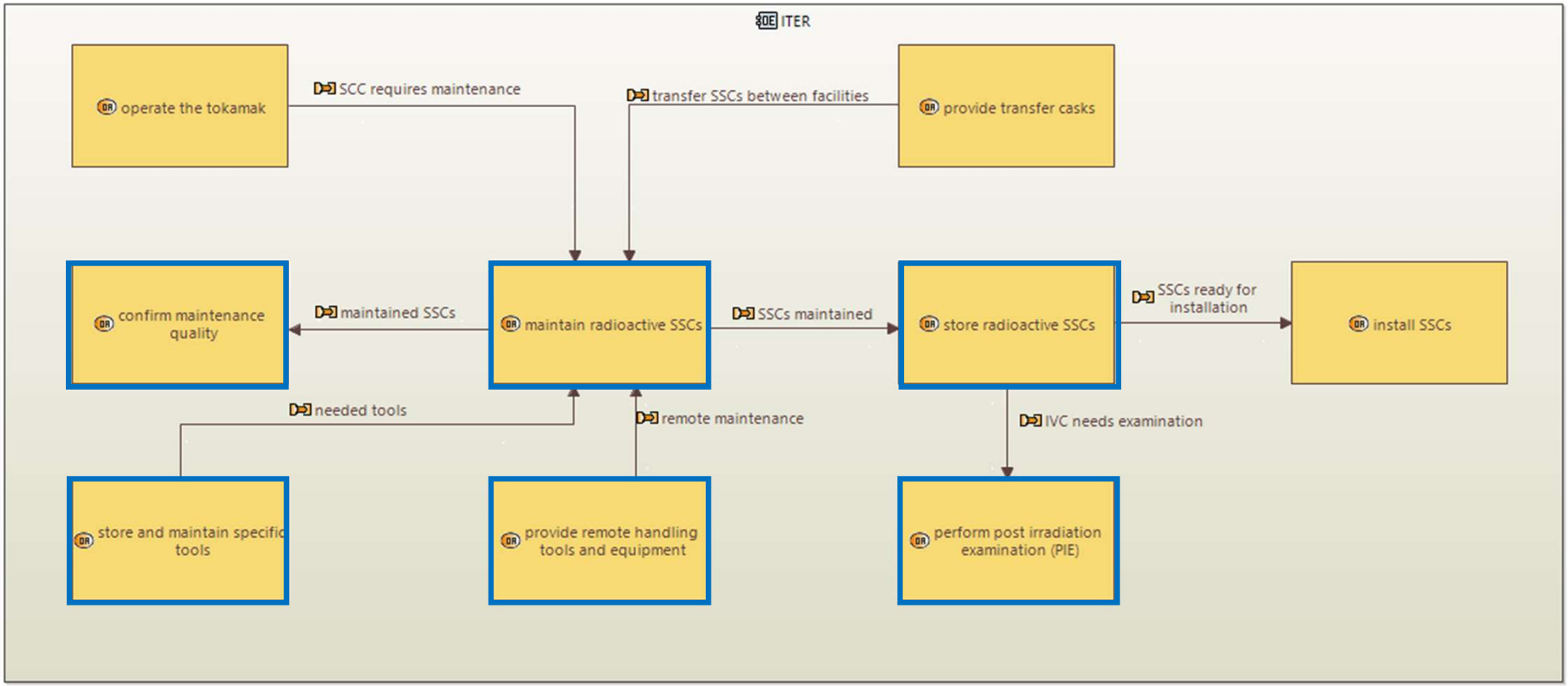


SSC: System Structure & Component

Detailed functional breakdown

HCF scope

Maintenance of components



SSC: System Structure & Component

Detailed functional breakdown

HCF scope

Treatment & storage of radwaste