

منتدى دبي العالمي
لإدارة المشاريع

DUBAI INTERNATIONAL
PROJECT MANAGEMENT FORUM

5th EDITION الدورة الخامسة

8 - 11 ديسمبر 2018 • مدينة جميرا • دبي

8 - 11 December 2018 • MADINAT JUMEIRAH • DUBAI



PARALLEL SESSION STREAM

ITER Project Management

Hans-H. ALTFELD,
Head of
Project Control Office
ITER

www.dipmf.ae

BUILDING NATIONS

- ❑ **ITER: What is it?**
- ❑ **Fusion Physics**
- ❑ **The ITER Machine**
- ❑ **ITER Governance**
- ❑ **ITER Project Management**
- ❑ **Summary**



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ITER: What is it?

- ❑ **ITER (International Thermonuclear Experimental Reactor) is the world's largest project attempting to generate energy out of fusion of atomic nuclei**
- ❑ **The idea for ITER was born at an US-USSR summit in Geneva in 1985, when presidents Reagan and Gorbachev proposed a project to develop fusion energy ...“as an unlimited source of energy for the benefit of mankind”.**



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الطبعة الثالثة
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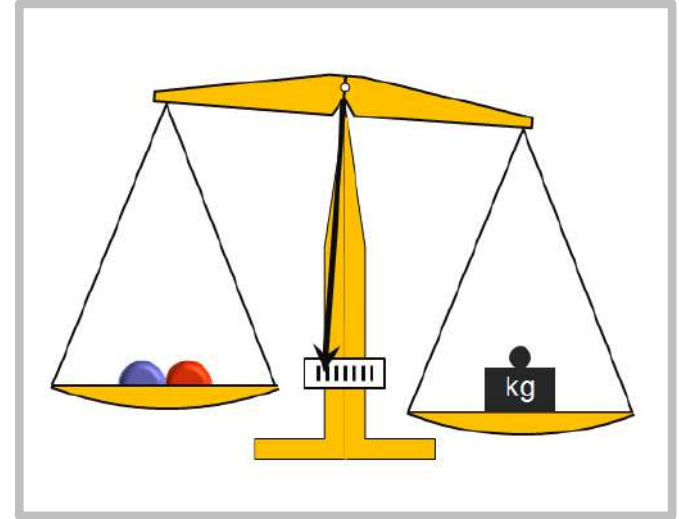


Fusion Physics

The Mass Defect

- ❑ When atomic nucleons of low mass number are fused together, they lose mass (Δm)
- ❑ According to Einstein, this Δ mass is equivalent to a huge amount of 'binding energy', which gets released
- ❑ This binding energy has also to be invested in order to separate the nucleons

$$\Delta E = \Delta mc^2$$



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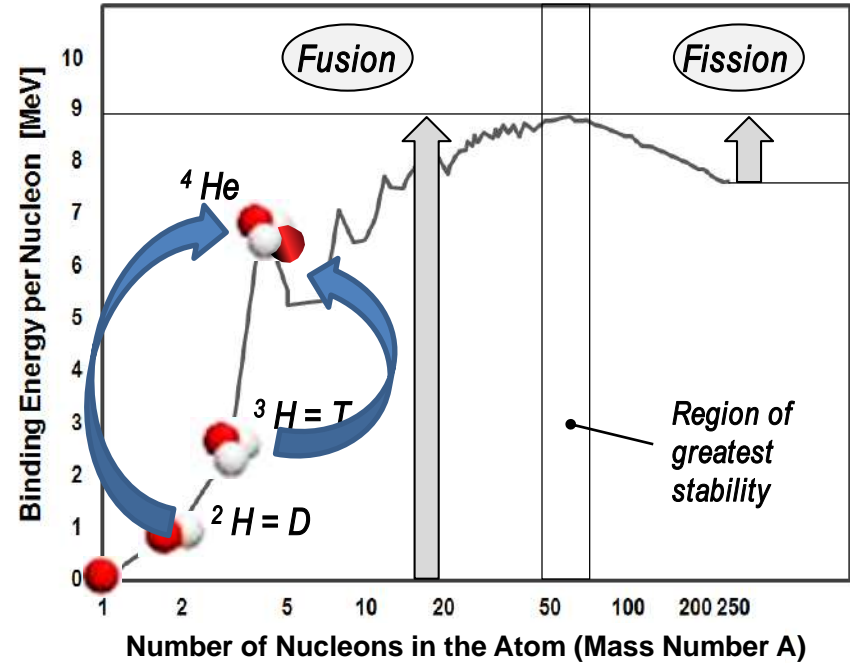
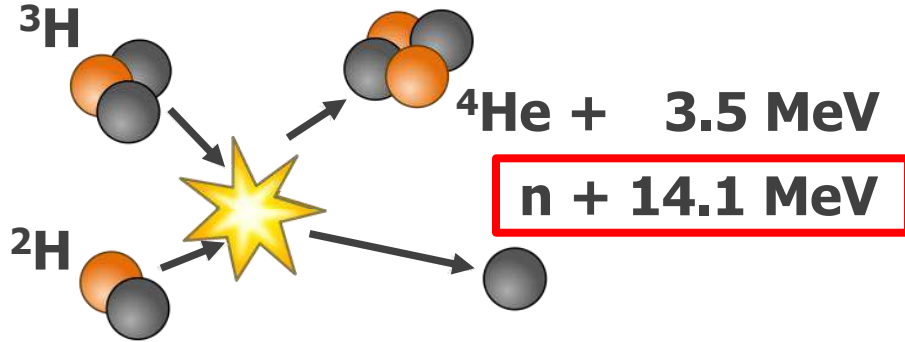


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Fusion Physics

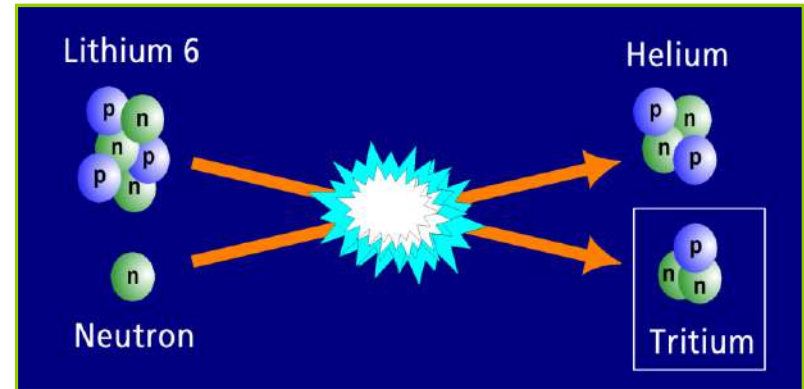
The Binding Energy



Fusion Physics

The Fuel

- ❑ Enough Deuterium in sea water for millions of years (0.015%)
- ❑ Tritium is not available naturally on Earth, but there is a solution
 - ➔ Tritium breeding from Lithium
- ❑ Conservative estimates call for available Lithium resources for thousands of years
- ❑ Tritium is radioactive with a half-life of 12.3 years



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Fusion Physics

The Promise of Fusion

- ❑ **48 GJ/13 000 kWh of electricity can be generated from 2 litres of water and 250 g of lithium-containing ore**
- ❑ **This is equivalent to the energy content of 1 ton of oil and sufficient for a 4 person household for 1 year**



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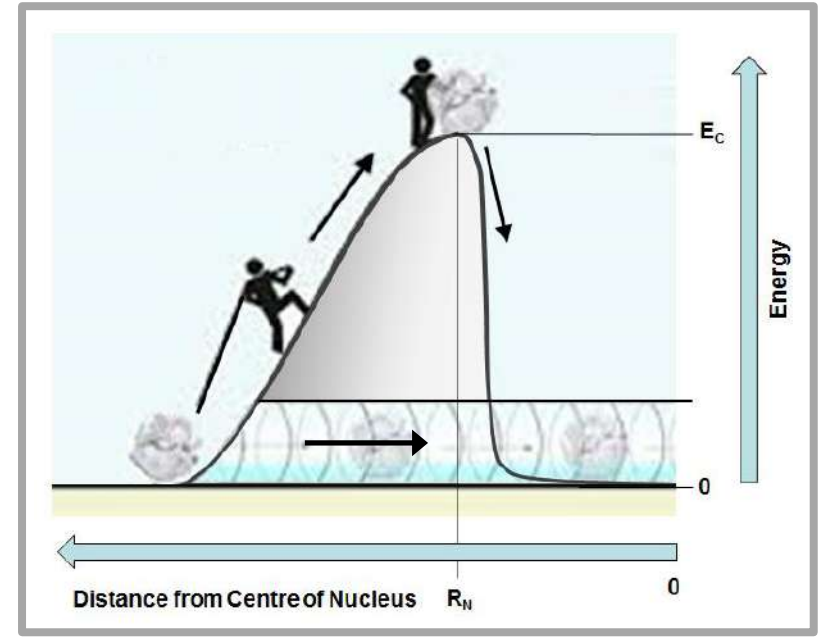
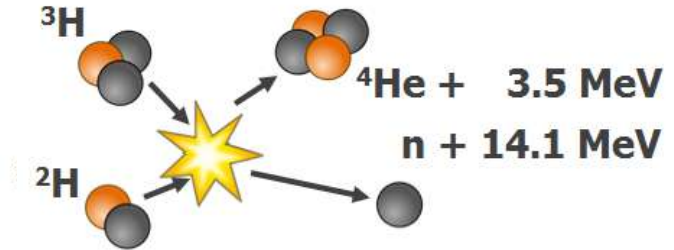
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Fusion Physics

The Coulomb Barrier

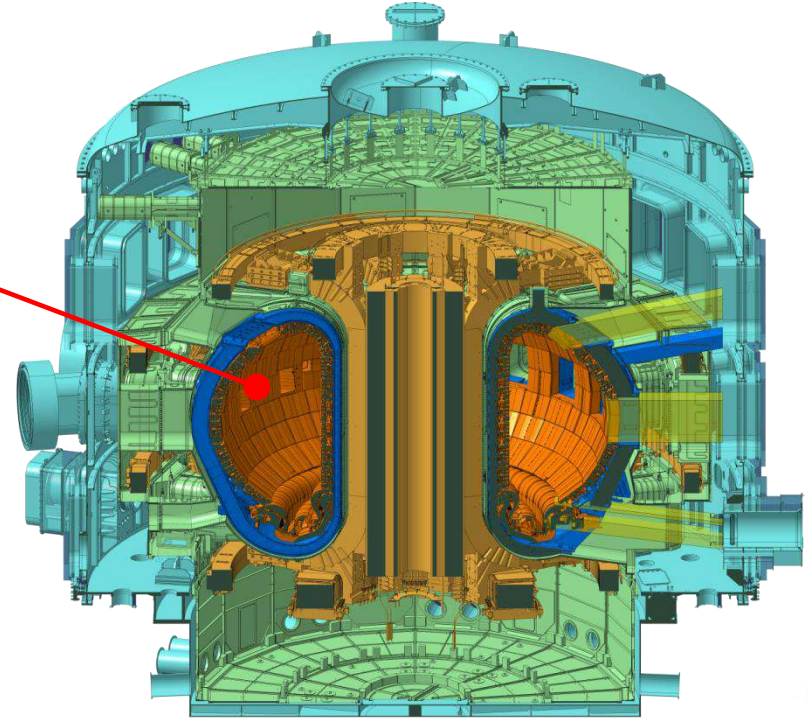
E_c [MeV]	E_c [MK]	Probability
0.400	5,000	1:1
0.012	150	$10^5:1$



The ITER Machine

Fundamental Engineering Concepts

- Protected environment



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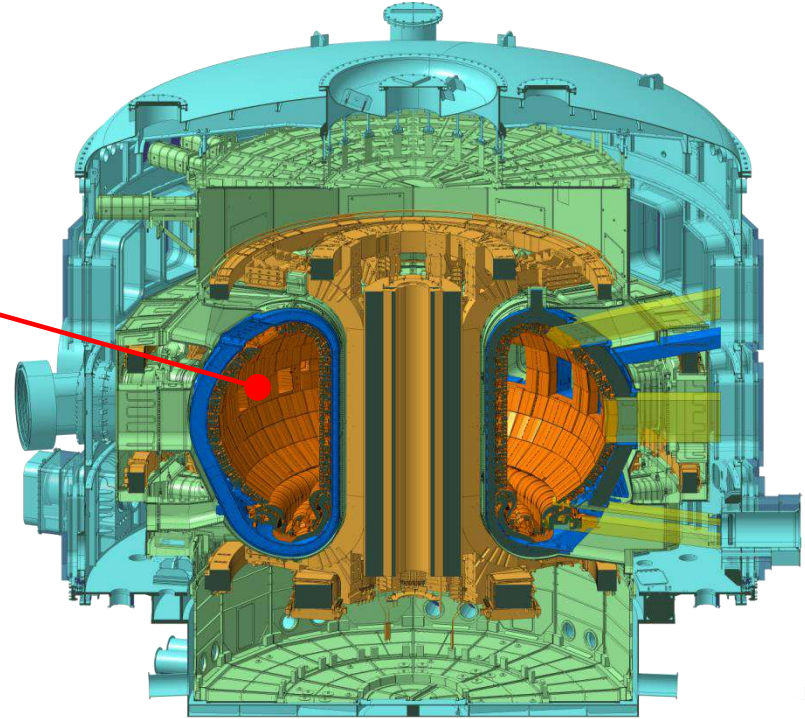
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The ITER Machine

Fundamental Engineering Concepts

- ❑ Protected environment
- ❑ Extremely high vacuum



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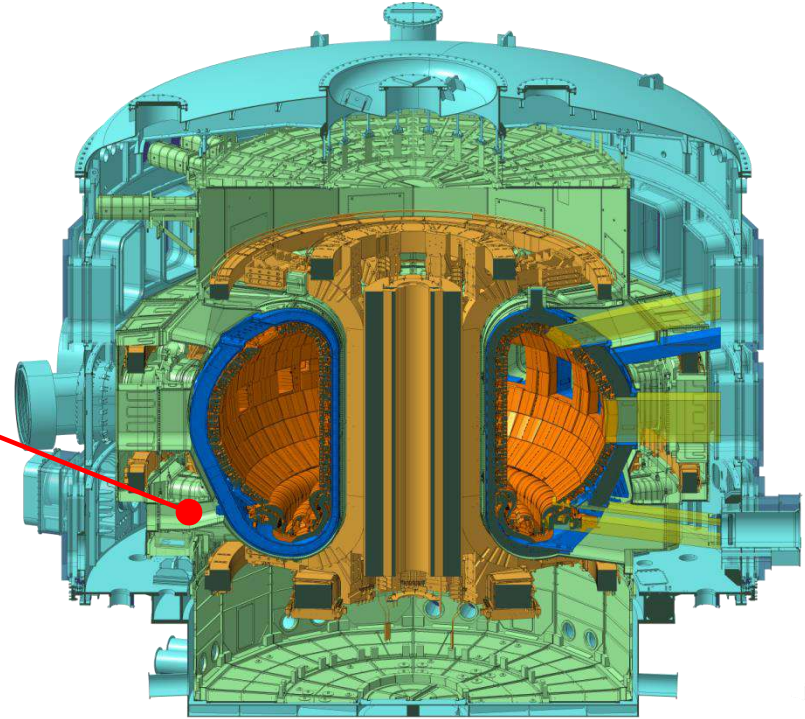
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The ITER Machine

Fundamental Engineering Concepts

- ❑ Protected environment
- ❑ Extremely high vacuum
- ❑ Fuel injection devices



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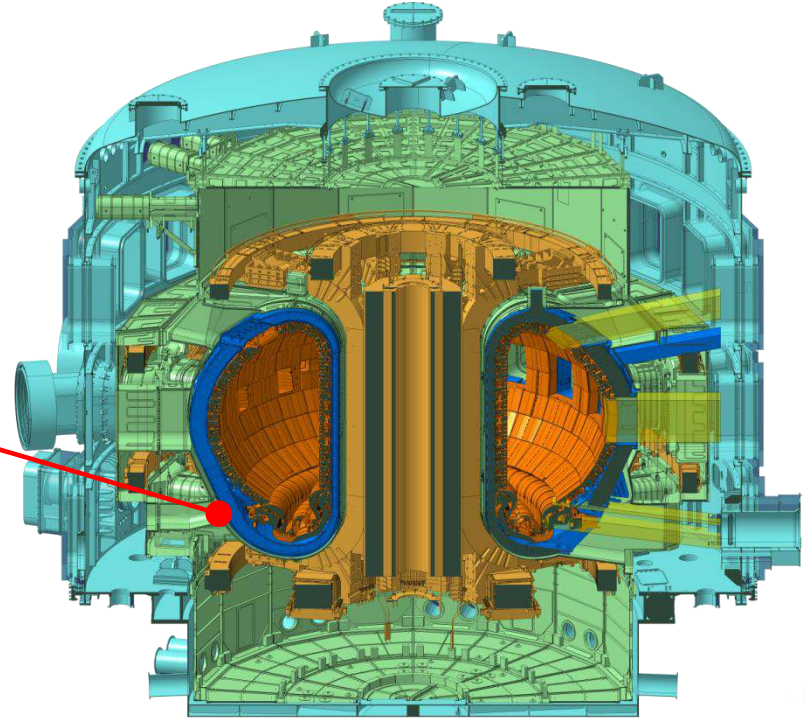
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The ITER Machine

Fundamental Engineering Concepts

- ❑ Protected environment
- ❑ Extremely high vacuum
- ❑ Fuel injection devices
- ❑ Ash extraction devices



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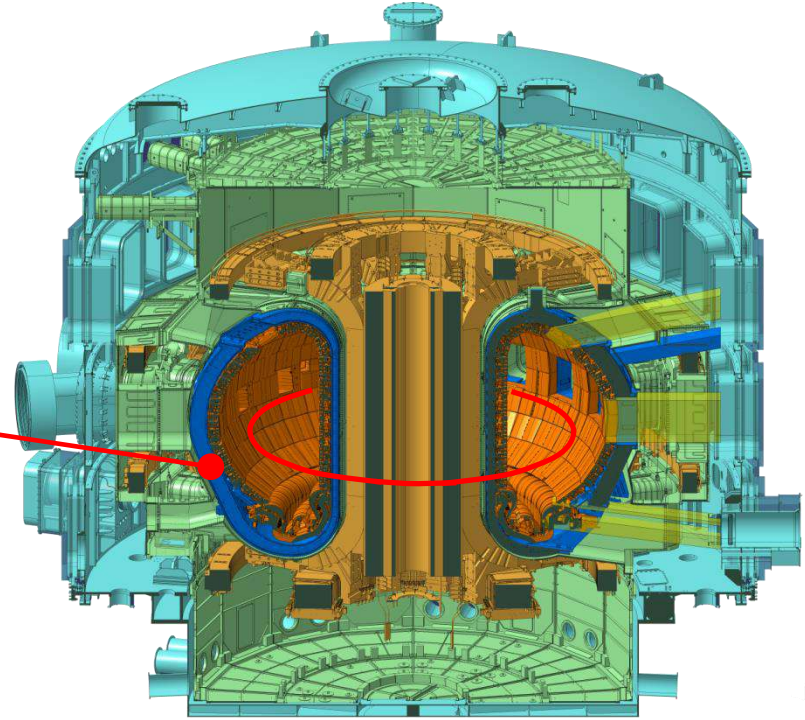
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The ITER Machine

Fundamental Engineering Concepts

- ❑ Protected environment
- ❑ Extremely high vacuum
- ❑ Fuel injection devices
- ❑ Ash extraction devices
- ❑ First Wall and cooling system



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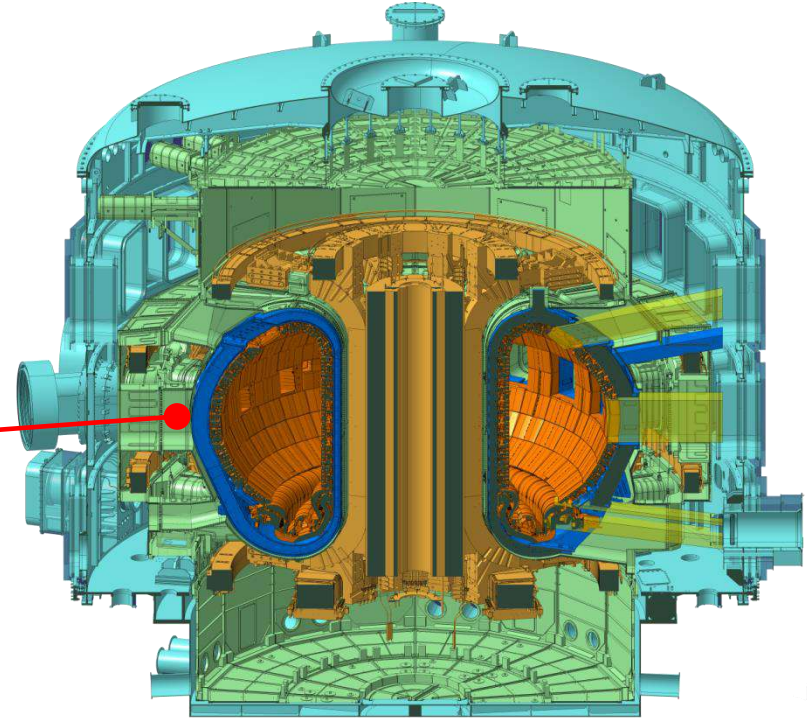
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- ❑ First Wall and cooling system
- ❑ Heating devices → plasma



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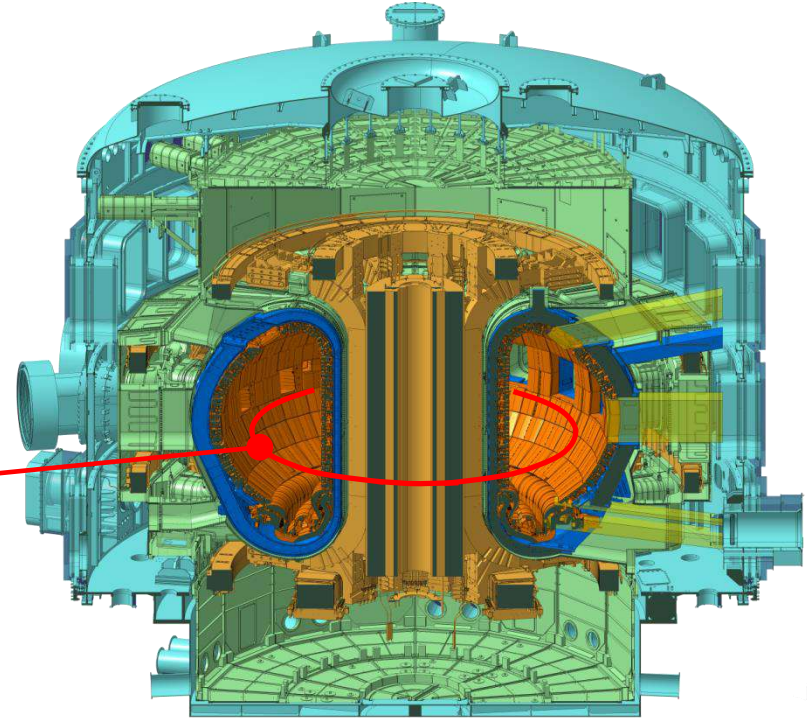
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- ❑ Magnetic confinement



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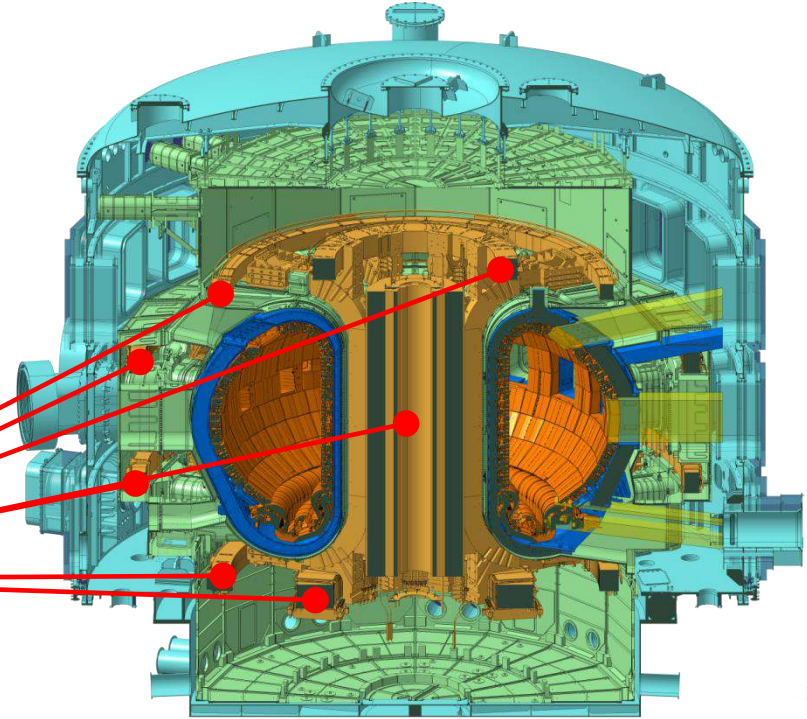
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- ❑ Magnetic confinement
- ❑ Superconductive magnets



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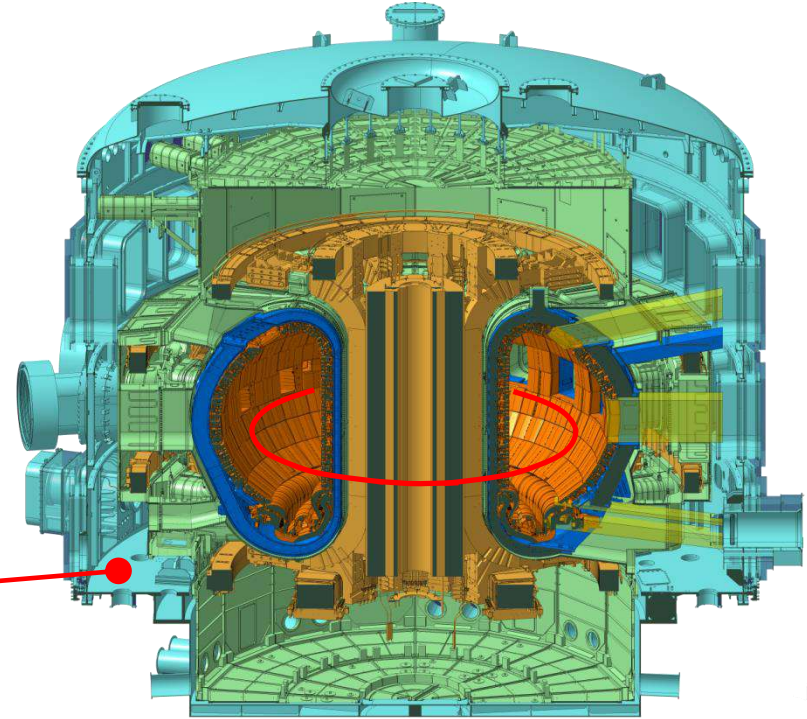
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- ❑ Magnetic confinement
- ❑ Superconductive magnets
- ❑ Cryostat



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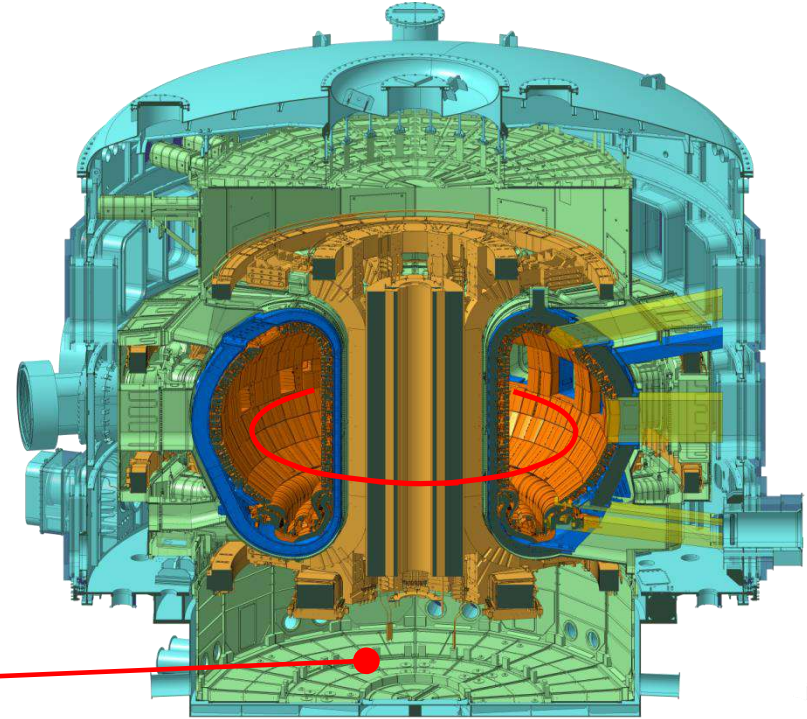
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- ❑ Magnetic confinement
- ❑ Superconductive magnets
- ❑ Cryostat
- ❑ Thermal Shield



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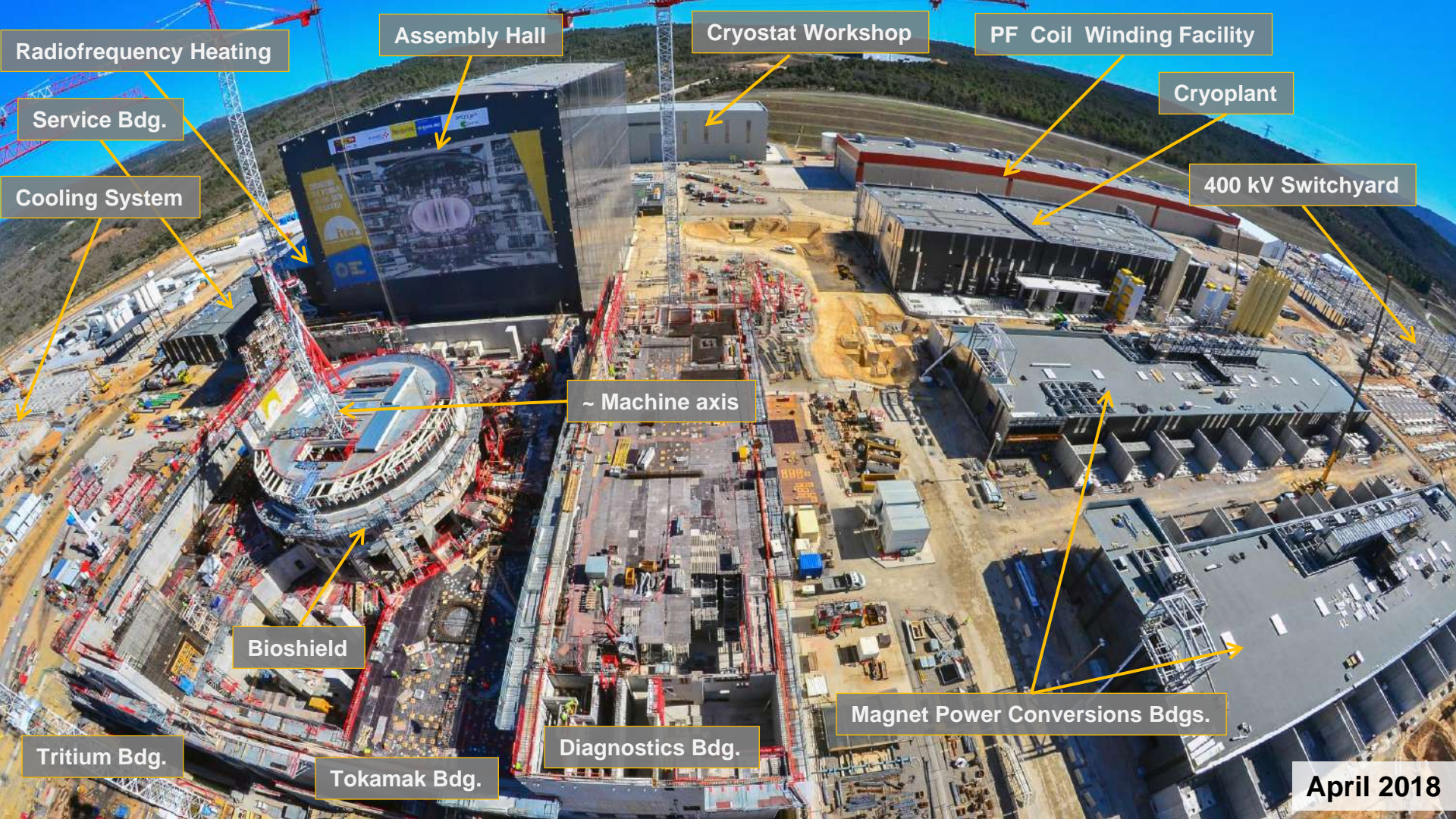


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Radiofrequency Heating

Assembly Hall

Cryostat Workshop

PF Coil Winding Facility

Cryoplant

Service Bdg.

Cooling System

400 kV Switchyard

~ Machine axis

Bioshield

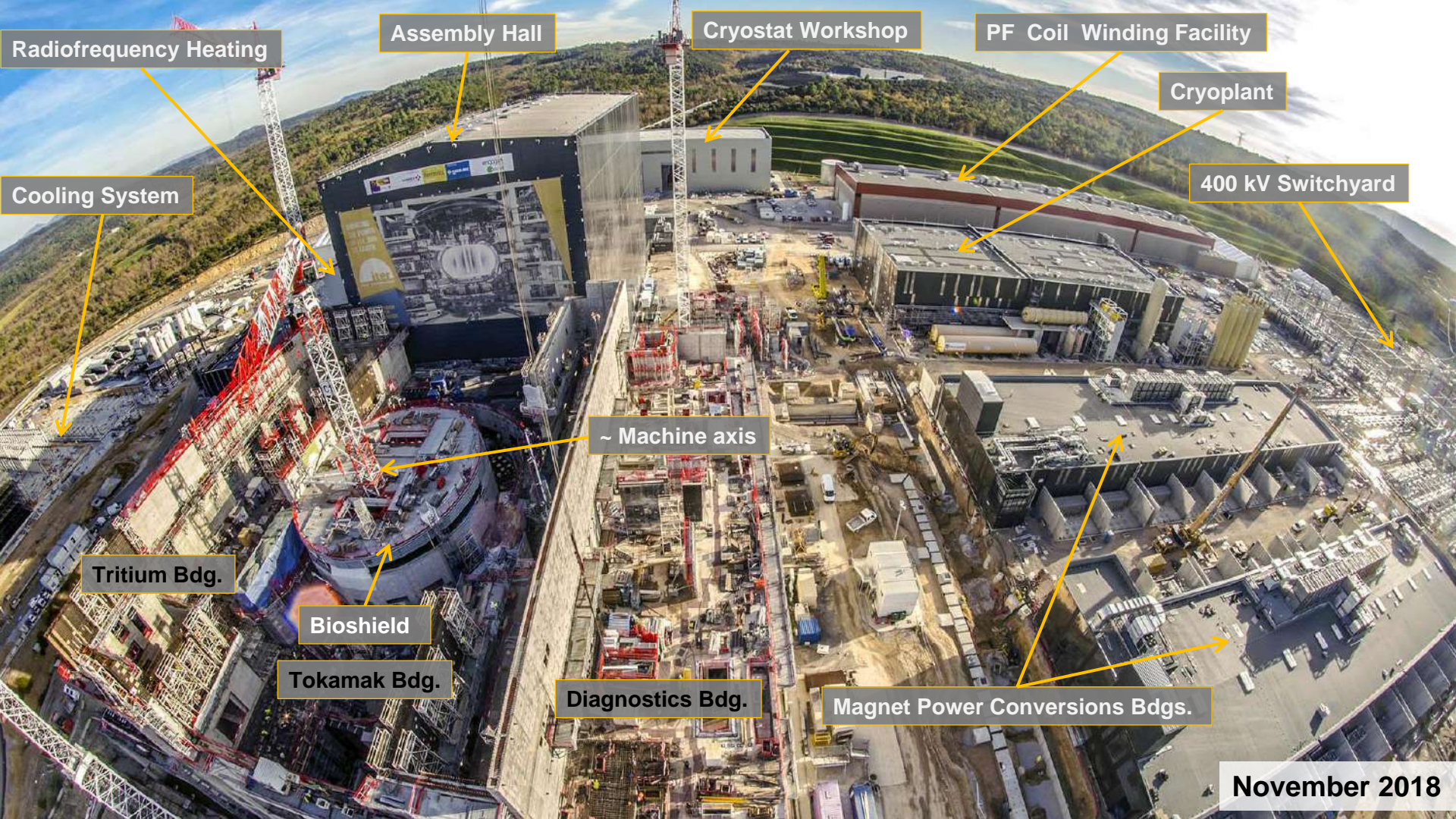
Magnet Power Conversions Bdgs.

Tritium Bdg.

Tokamak Bdg.

Diagnostics Bdg.

April 2018



Radiofrequency Heating

Assembly Hall

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Cryopant

Cooling System

400 kV Switchyard

~ Machine axis

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Bioshield

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Diagnostics Bdg.

Magnet Power Conversions Bdgs.

November 2018

ITER Governance

Governance Models

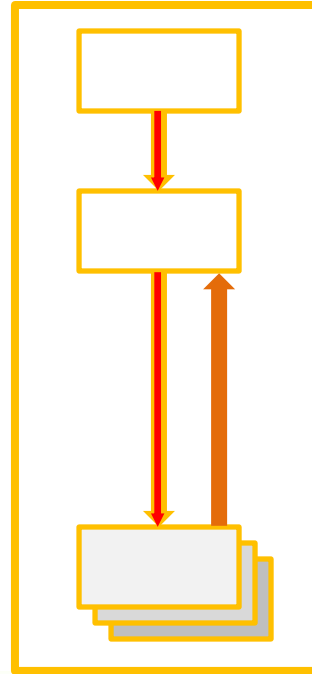
National

- Flow of Money
- Flow of Deliverables
- Strategic Direction Input / Technical Integration

Government(s)

Central Integrator

Supplier



Similar Culture

in terms of

- Language
- Ways-of working
- Contracting
- Project Management
- Systems Engineering
- Etc.



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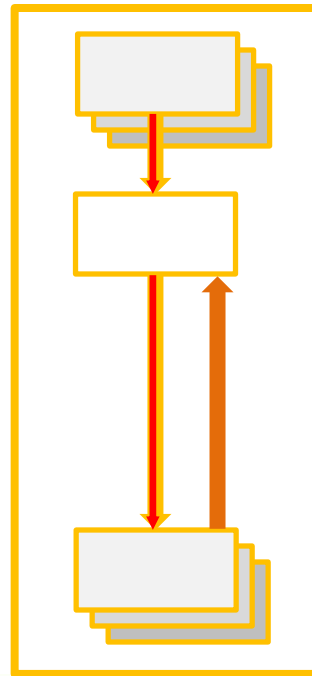
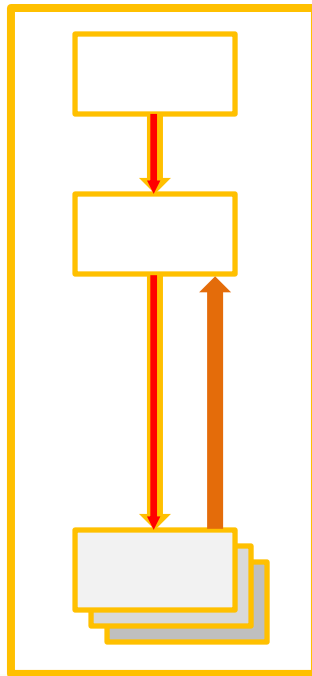
ITER Governance

Governance Models

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National

Regional



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ITER Governance

Governance Models

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Government(s)

Central Integrator

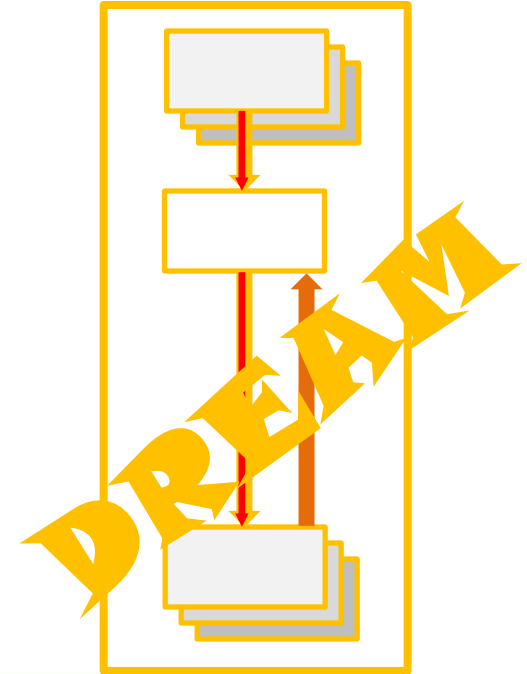
Supplier

Very Different Cultures

in terms of

- Language
- Ways-of working
- Contracting
- Project Management
- Systems Engineering

Global (as Regional)



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ITER Governance

Governance Models

- Flow of Money
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- Strategic Direction Input / Technical Integration

Government(s)

Central Integrator

'National Translator'

Supplier

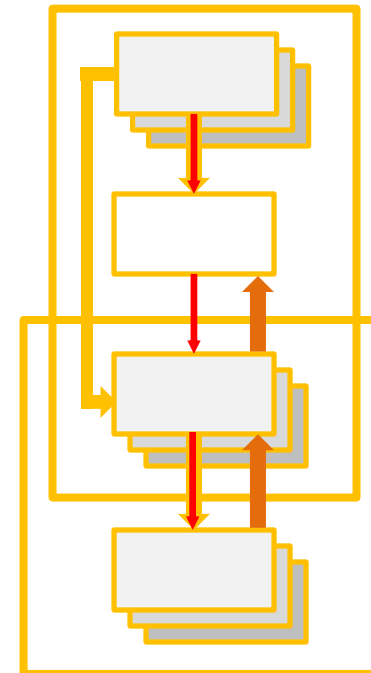
Very Different Cultures

in terms of

- Language
- Ways-of working
- Contracting
- Project Management
- Systems Engineering

→ A 'Translator' is needed

Global



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Governance Models

- Flow of Money
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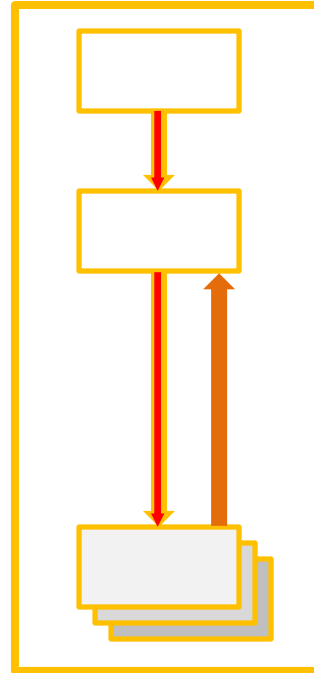
Government(s)

Central Integrator

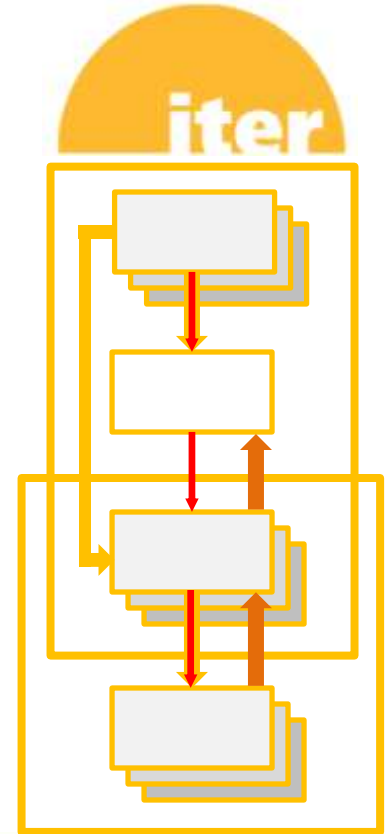
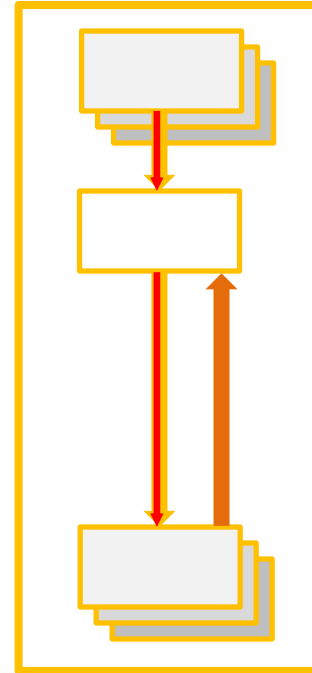
'National Translator'

Supplier

National



Regional



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ITER Governance

ITER Agreement

- ❑ **28 June 2005: The ITER Members unanimously agreed to build ITER on the site proposed by Europe**
- ❑ **21 November 2006: The ITER Agreement was signed at the Élysée Palace, in Paris.**
- ❑ **The seven ITER Members represent more than 50% of the world's population and about 85% of the global GDP**



China EU India Japan Korea Russia USA



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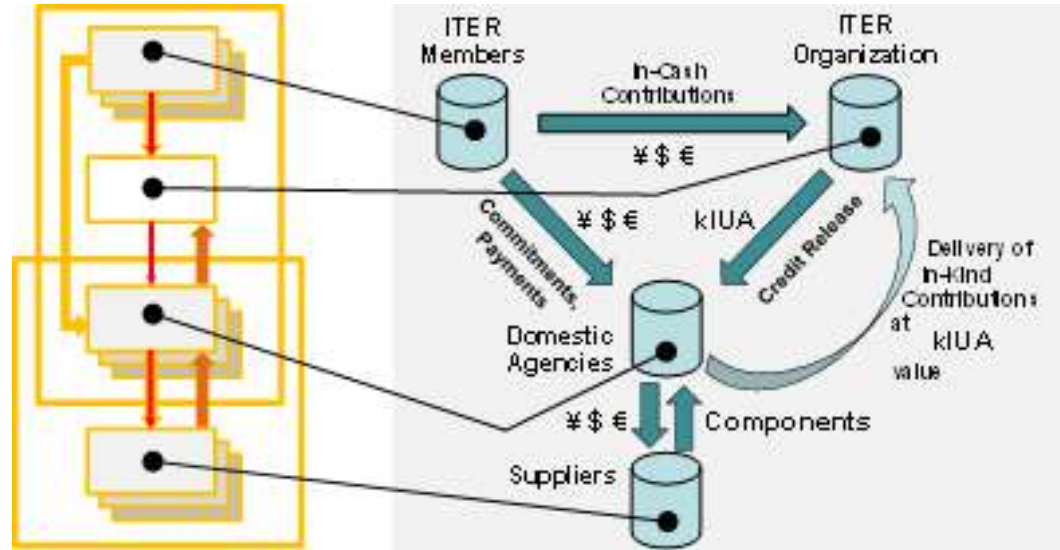
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ITER Governance

ITER Agreement

- The 7 ITER Members make cash and in-kind contributions (90%) to the ITER Project. They have established Domestic Agencies to handle the contracts to industry.
- The ITER Organization Central Team manages the ITER Project in close collaboration with the 7 Domestic Agencies.
- The ITER Members share all Intellectual Property generated by the Project.



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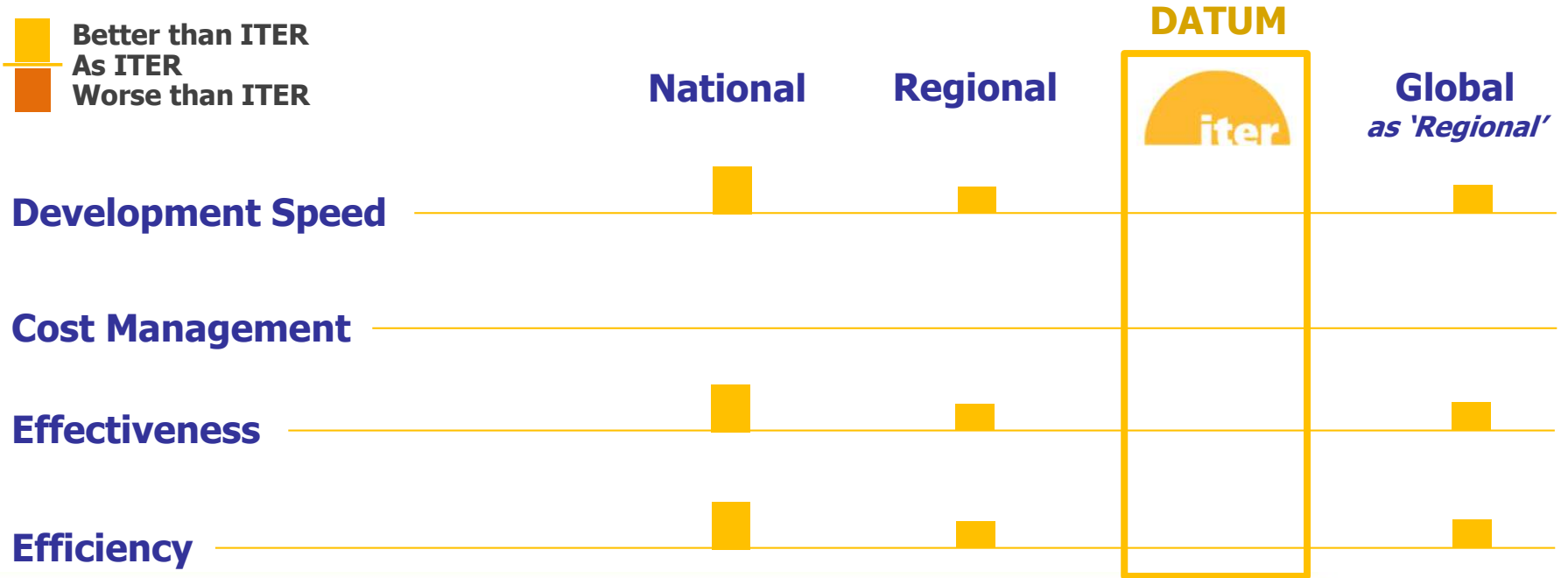
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ITER Governance Qualitative Comparison

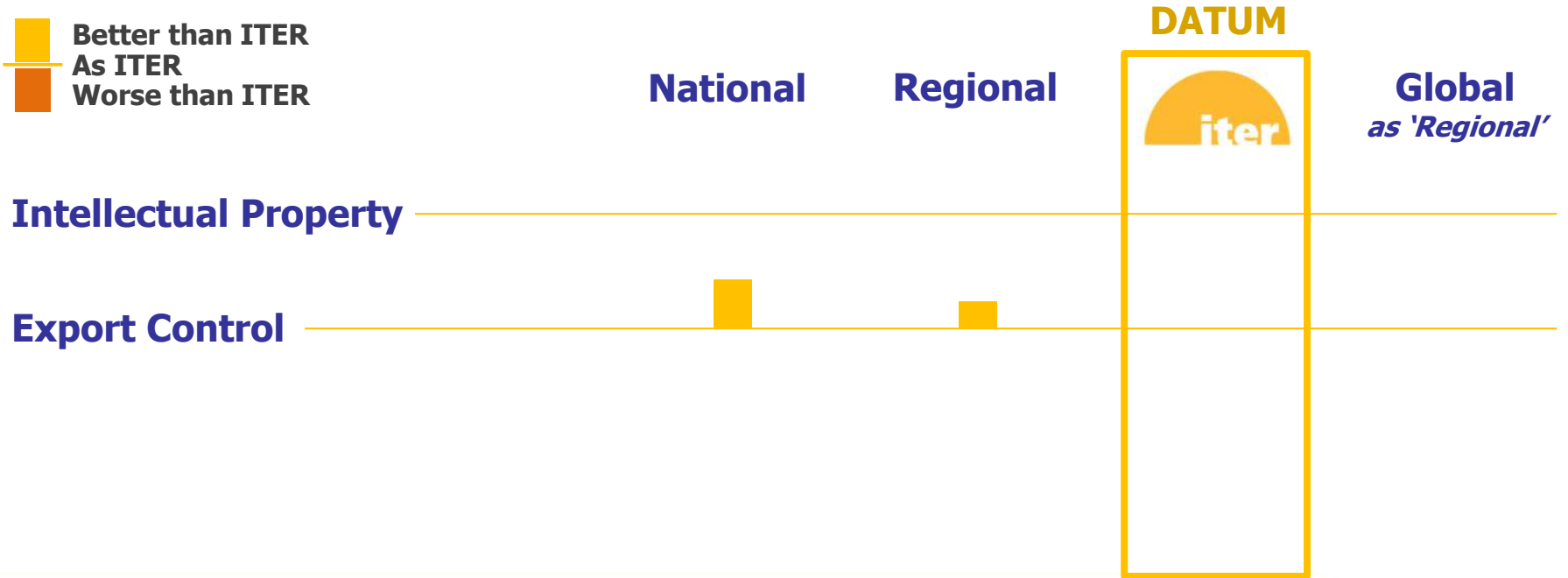
 Better than ITER
 As ITER
 Worse than ITER



ITER Governance

Qualitative Comparison

 Better than ITER
 As ITER
 Worse than ITER



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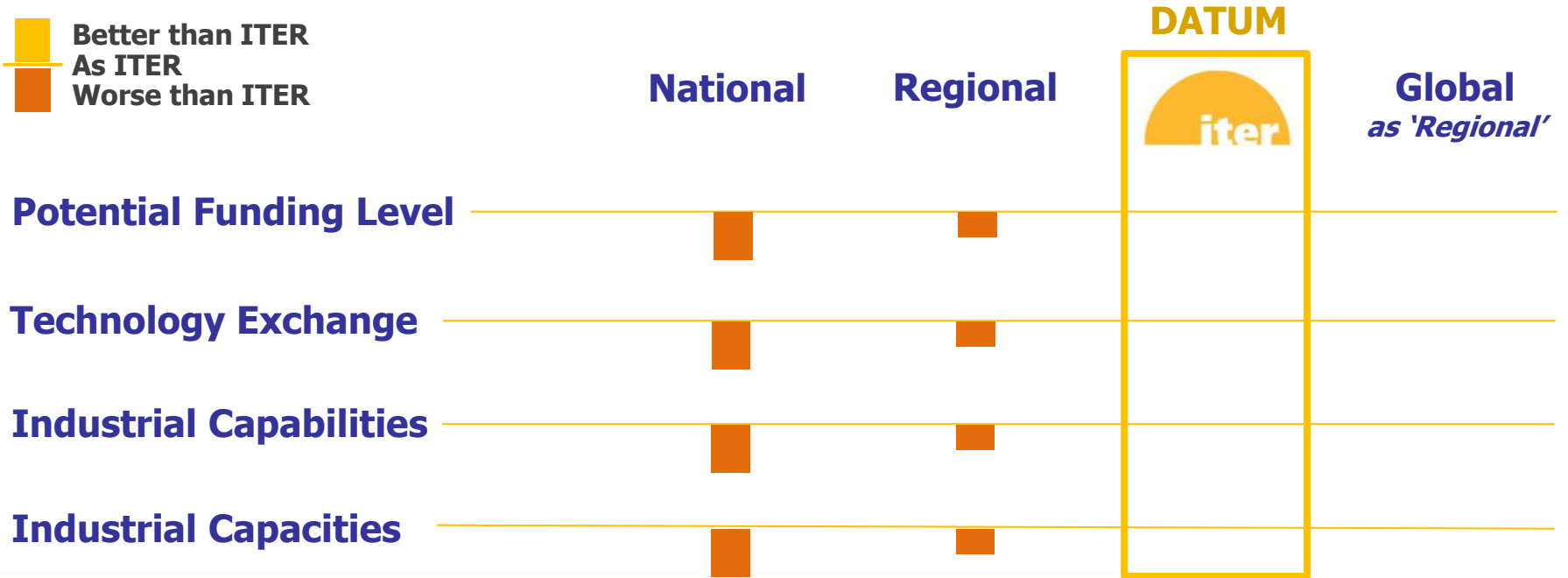
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ITER Governance

Qualitative Comparison

 Better than ITER
 As ITER
 Worse than ITER

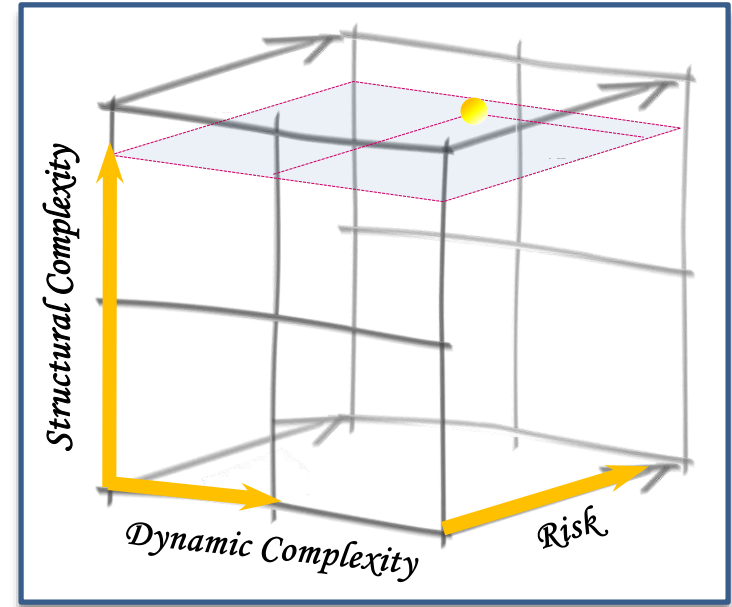


ITER Project Management

Project Complexity

- ❑ High Structural Complexity
- ❑ Medium Dynamic Complexity
- ❑ More than medium Risk

➔ **A Project of significant Complexity!**



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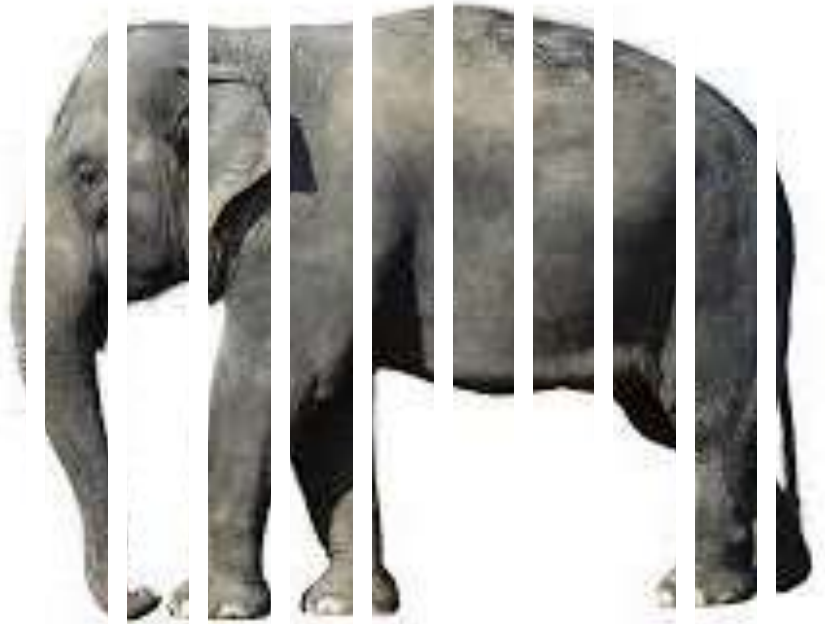
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ITER Project Management

Addressing Structural Complexity



➔ **Slicing the Elephant**



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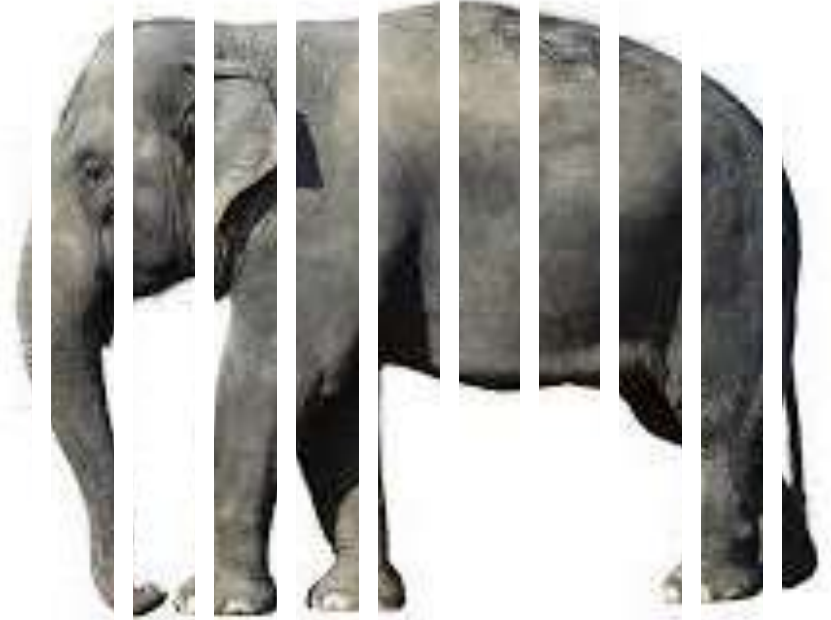
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ITER Project Management

Addressing Structural Complexity

- ❑ Break down of content along different dimensions, e.g.
 - ❑ System
 - ❑ Work
 - ❑ Requirements / V&V
 - ❑ Schedule
 - ❑ Site
 - ❑ Organization



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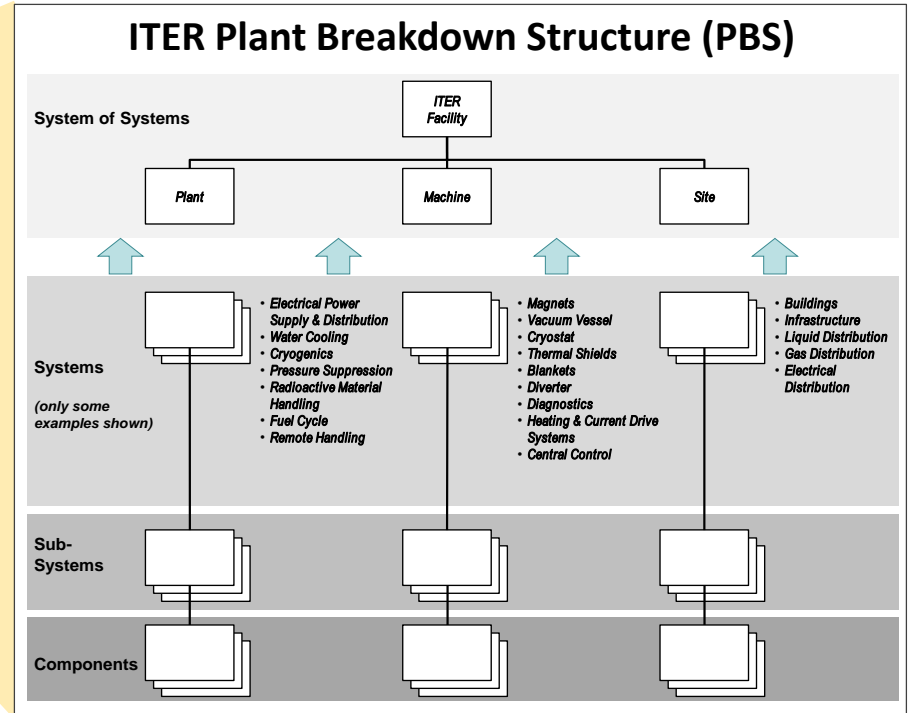


ITER Project Management

Addressing Structural Complexity

- Break down of content along different dimensions, e.g.

□ System



ITER Project Management

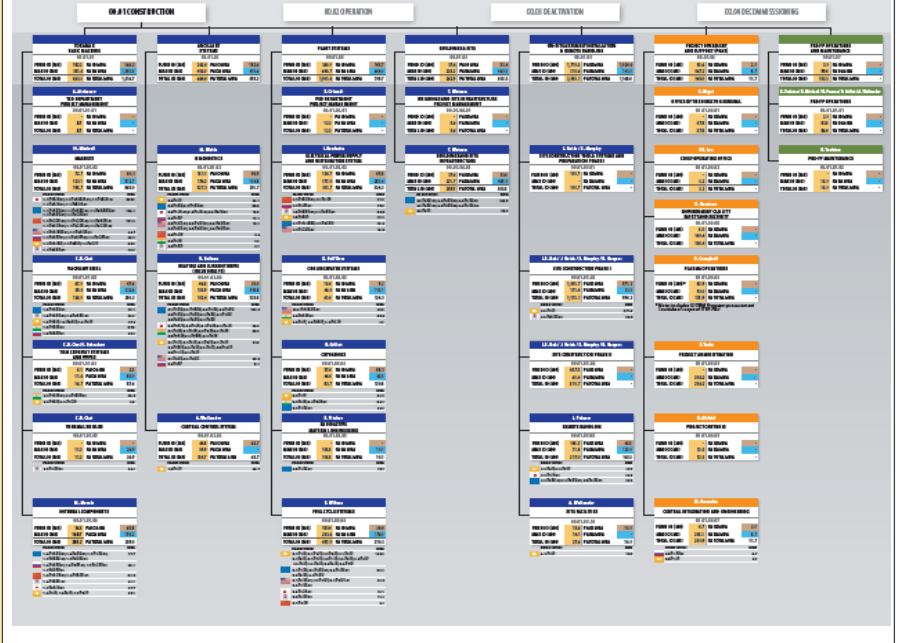
Addressing Structural Complexity

□ Break down of content along different dimensions, e.g.

□ System

□ Work

ITER Work Breakdown Structure (WBS)



ITER Project Management

Addressing Structural Complexity

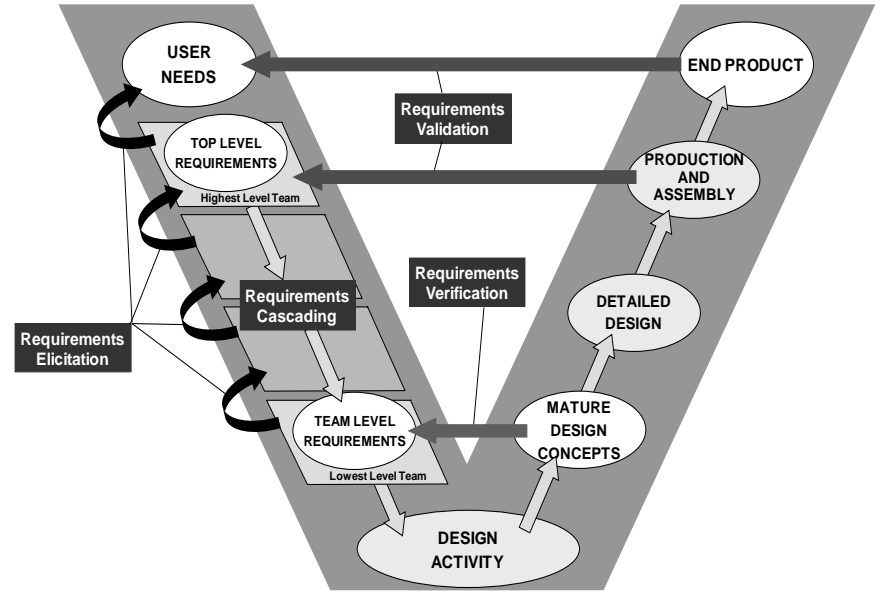
❑ Break down of content along different dimensions, e.g.

❑ System

❑ Work

❑ Requirements

ITER Requirements Management



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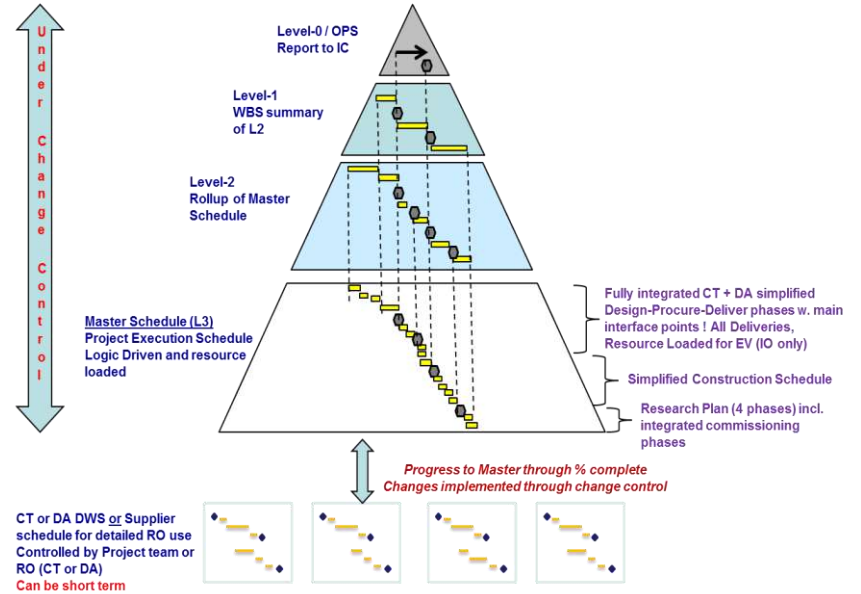
□ System

□ Work

□ Requirements

□ **Schedule**

ITER Schedule Governance

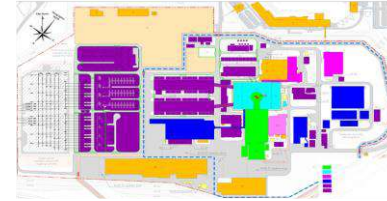


ITER Project Management

Addressing Structural Complexity

- ❑ Break down of content along different dimensions, e.g.
 - ❑ System
 - ❑ Work
 - ❑ Requirements
 - ❑ Schedule
 - ❑ Site

ITER Geographic Breakdown Structure (GBS)



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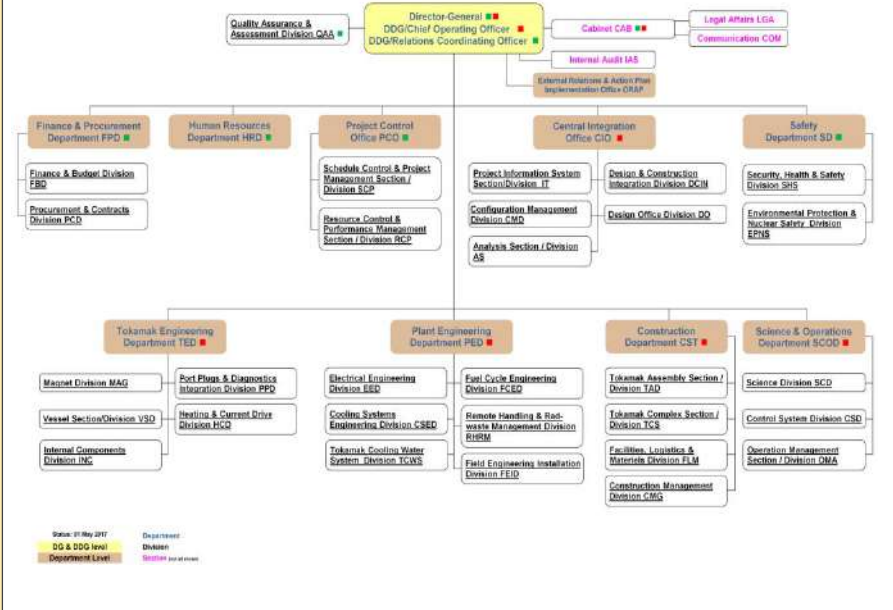
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Addressing Structural Complexity

❑ Break down of content along different dimensions, e.g.

- ❑ System
- ❑ Work
- ❑ Requirements
- ❑ Schedule
- ❑ Site
- ❑ **Organization**

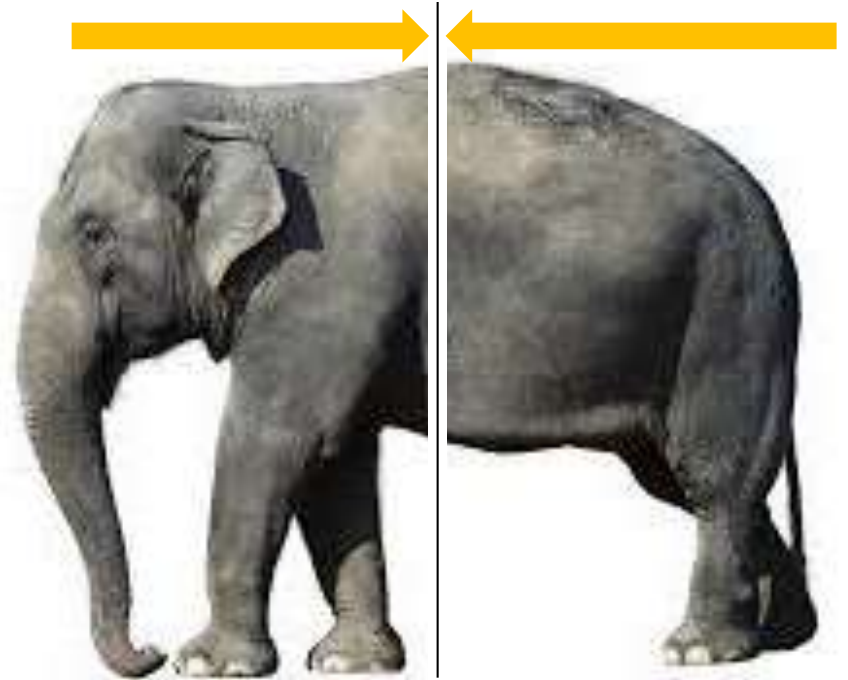
ITER Organization Breakdown Structure (OBS)



ITER Project Management

Addressing Structural Complexity

- ❑ 'Slicing the Elephant' requires tight management and control of I³
 - ❑ Interfaces
 - ❑ Interdependencies
 - ❑ Interchangeabilities



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ITER Project Management

Addressing Structural Complexity

- ❑ 'Slicing the Elephant' requires tight management and control of I^3
 - ❑ Interfaces
 - ❑ Interdependencies
 - ❑ Interchangeabilities

➔ **Structural Breakdowns must be fully connected**



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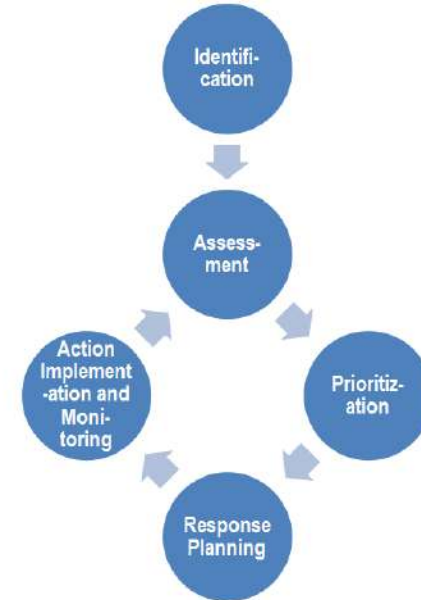
ITER Project Management

Addressing Risk

- ❑ **ITER Project Baseline comes without any initial contingencies for cost and schedule**
- ❑ **The Project has to identify and generate opportunities to manage issues and risks**

➔ **Professional, but classical R&OM**

ITER R&OM



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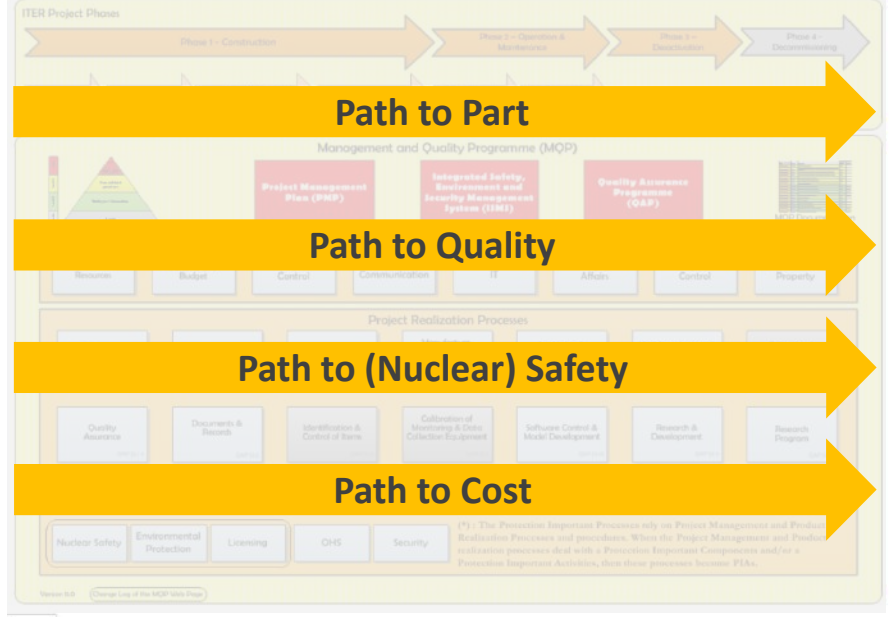
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Addressing Dynamic Complexity

□ Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.

□ Processes

ITER Management & Quality Program (MQP)



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Addressing Dynamic Complexity

- ❑ Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
 - ❑ Processes
 - ❑ Adherence to Processes

Adhering to Processes ...



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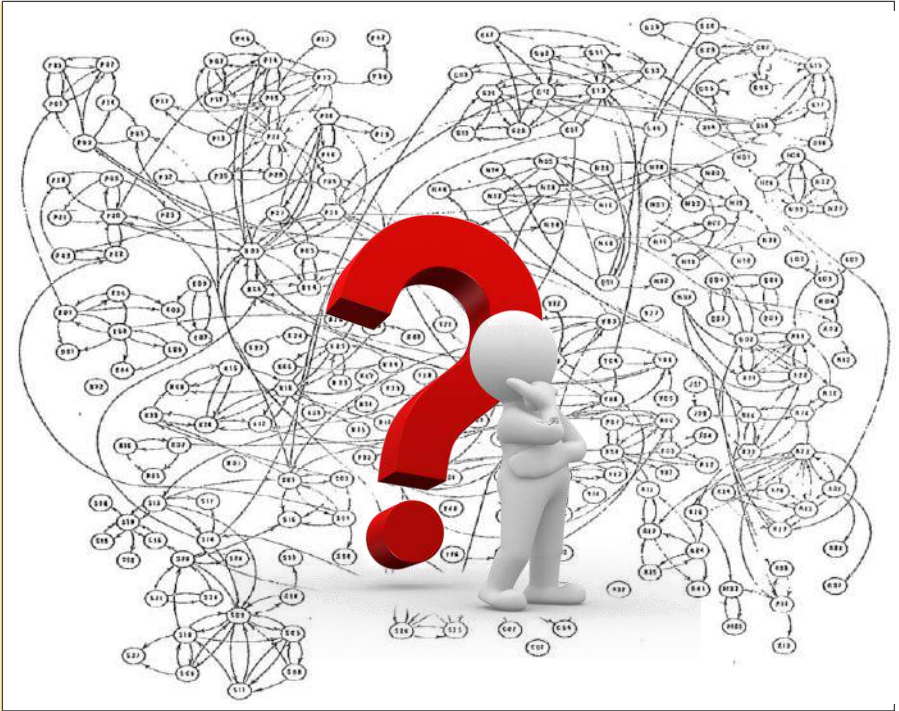
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Addressing Dynamic Complexity

- ❑ Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
 - ❑ Processes
 - ❑ Adherence to Processes
 - ❑ Effective Communication



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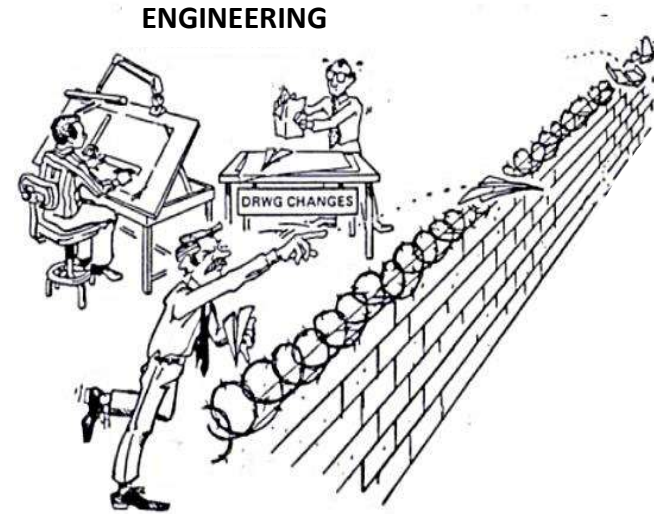


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Addressing Dynamic Complexity

- ❑ Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
 - ❑ Processes
 - ❑ Adherence to Processes
 - ❑ **Effective Communication**

(1) Integrated Project Teams



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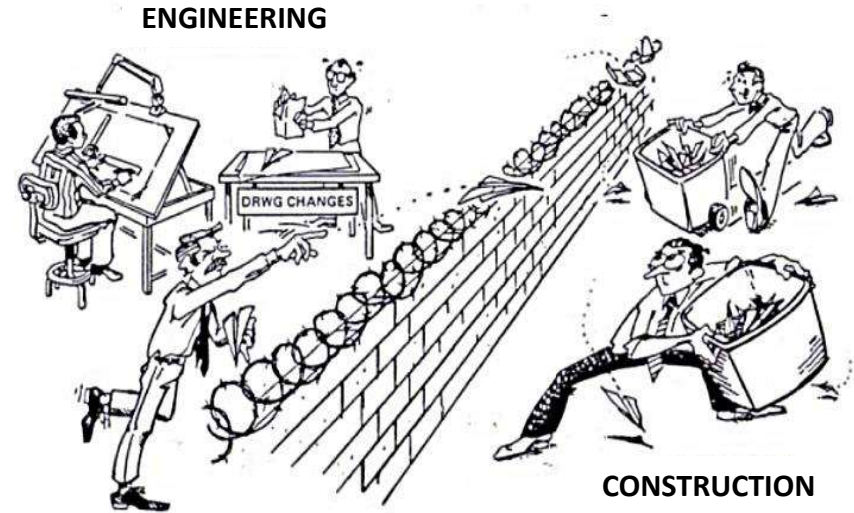


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Addressing Dynamic Complexity

- ❑ Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
 - ❑ Processes
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(1) Integrated Project Teams



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Addressing Dynamic Complexity

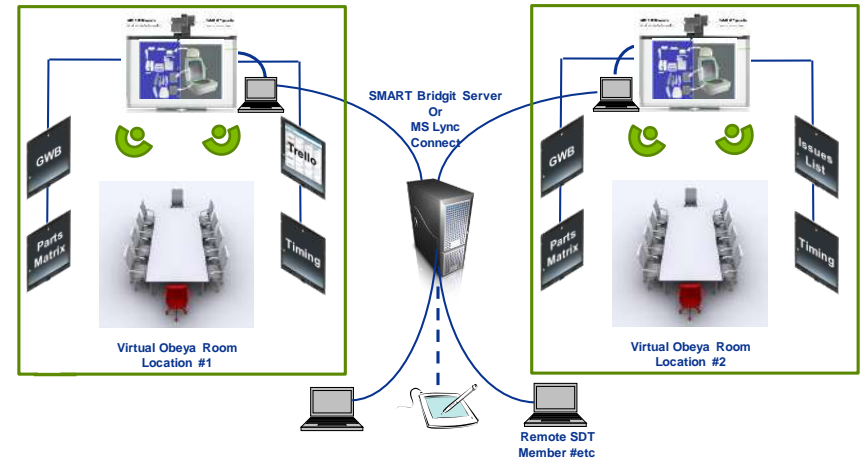
❑ Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.

❑ Processes

❑ Adherence to Processes

❑ **Effective Communication**

(2) Worldwide Connectivity

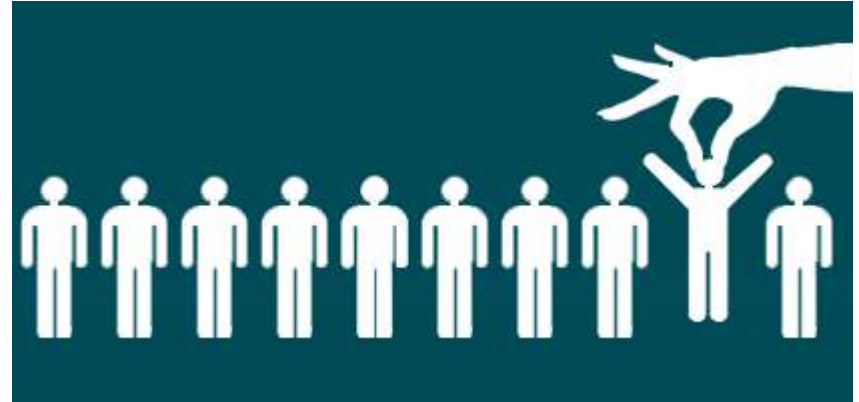


ITER Project Management

Addressing Dynamic Complexity

- ❑ Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
 - ❑ Processes
 - ❑ Adherence to Processes
 - ❑ Effective Communication
 - ❑ **Competences of People**

(1) Experience-based People Selection



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Addressing Dynamic Complexity

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 - ❑ **Competences of People**

(2) ITER Academy



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Addressing Dynamic Complexity

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 - ❑ Processes
 - ❑ Adherence to Processes
 - ❑ Effective Communication
 - ❑ **Competences of People**

(3) Annual Performance Assessment



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Addressing Dynamic Complexity

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 - ❑ Effective Communication
 - ❑ Competences of People



Frequency
of Change



Effective Communication and People Competences for ITER



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Summary: Fusion Energy

- ❑ Nuclear fusion is the power source of the universe – source of light and heat for the sun and stars
- ❑ Fusion has the potential to be a nearly inexhaustible source of energy in the future
- ❑ Fusion is carbon neutral, comparatively 'clean' and safe
- ❑ No risk of nuclear accidents (e.g. core melt in Fukushima Daiichi, explosion in Tschernobyl)
- ❑ Fusion does not produce long lived radioactive waste, for which the timescale is manageable
- ❑ Reactor contains only fuel for a few seconds



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Summary: Technology

- ❑ Plasma physics in novel, uncharted regimes
- ❑ Heat flux to the walls at the limit of available technology
- ❑ Largest superconducting magnetic coils ever built
- ❑ Remote handling robotics at an unprecedented scale
- ❑ Cryo- and vacuum systems amongst the largest ever built
- ❑ Plasma diagnostic at the limit of current R&D



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Summary: Governance

- ❑ **The ITER Agreement is an increasingly successful example of international collaboration for a complex and unique first of a kind project.**
- ❑ **A big advantage is the idea of 'juste retour'. This approach — 90% of Member funding as "in-kind" components — is unique.**
- ❑ **Managed poorly, for a project of extraordinary complexity, this could be a recipe for failure.**
- ❑ **Managed successfully, with strong project management, systems engineering, risk management, etc., this approach is a recipe for mutual benefit**



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Summary: Project Management

- ❑ **ITER PM is all about addressing the project's Structural Complexity, Dynamic Complexity and Risk**
- ❑ **'Slicing the Elephant' is the classical response to Structural Complexity, also applied at ITER**
- ❑ **Addressing Risks is done using classical methodologies, too**
- ❑ **Addressing Dynamic Complexity, however, still requires significant effort beyond the classical thinking**



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➔ **ITER: one of the most exciting projects to be on!**

Thank You!

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