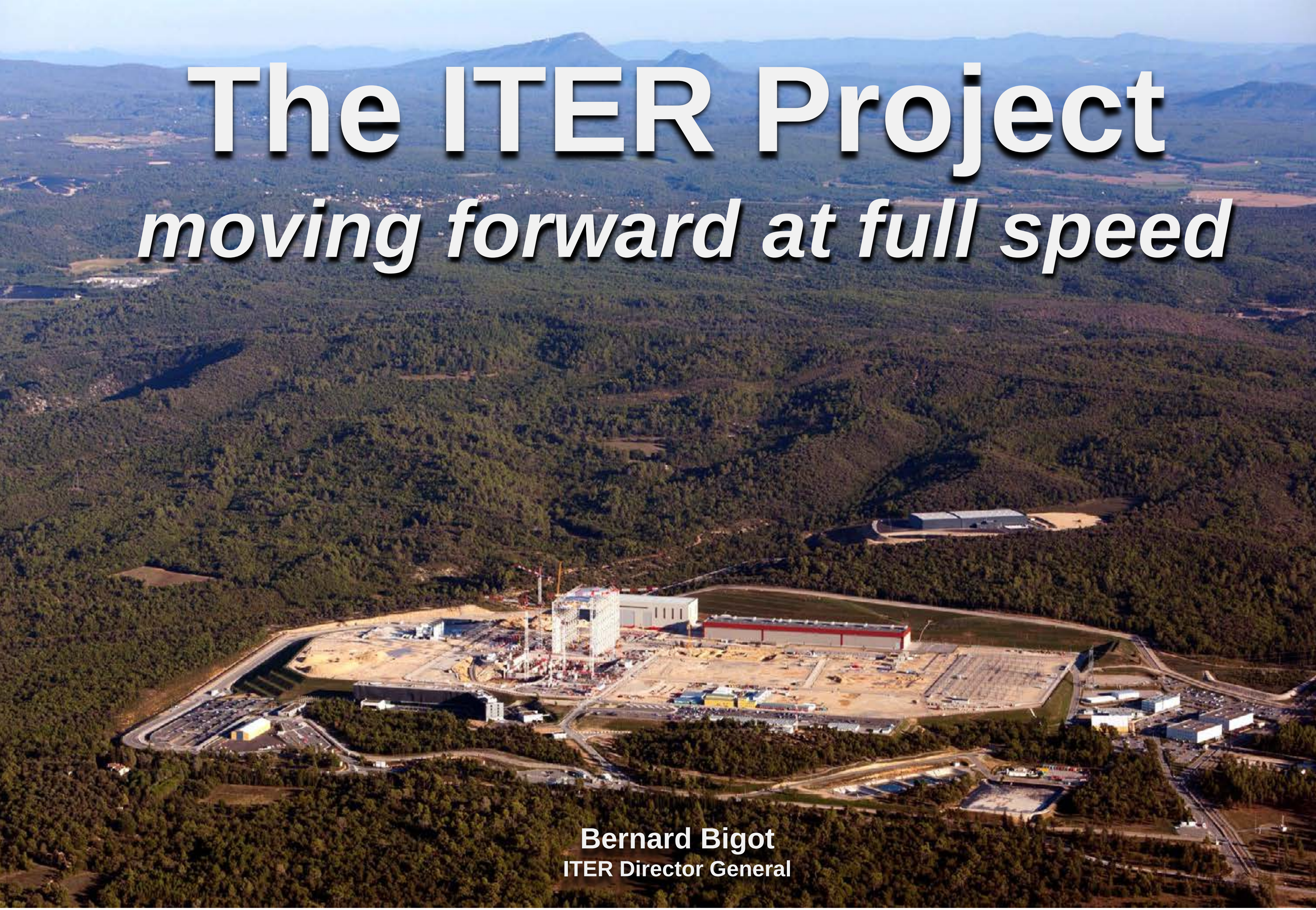


The ITER Project

moving forward at full speed

Bernard Bigot
ITER Director General

ITER

A multinational scientific collaboration without equivalent in history

A large-scale experiment to demonstrate the feasibility of fusion energy

Addressing present ITER challenges (1)

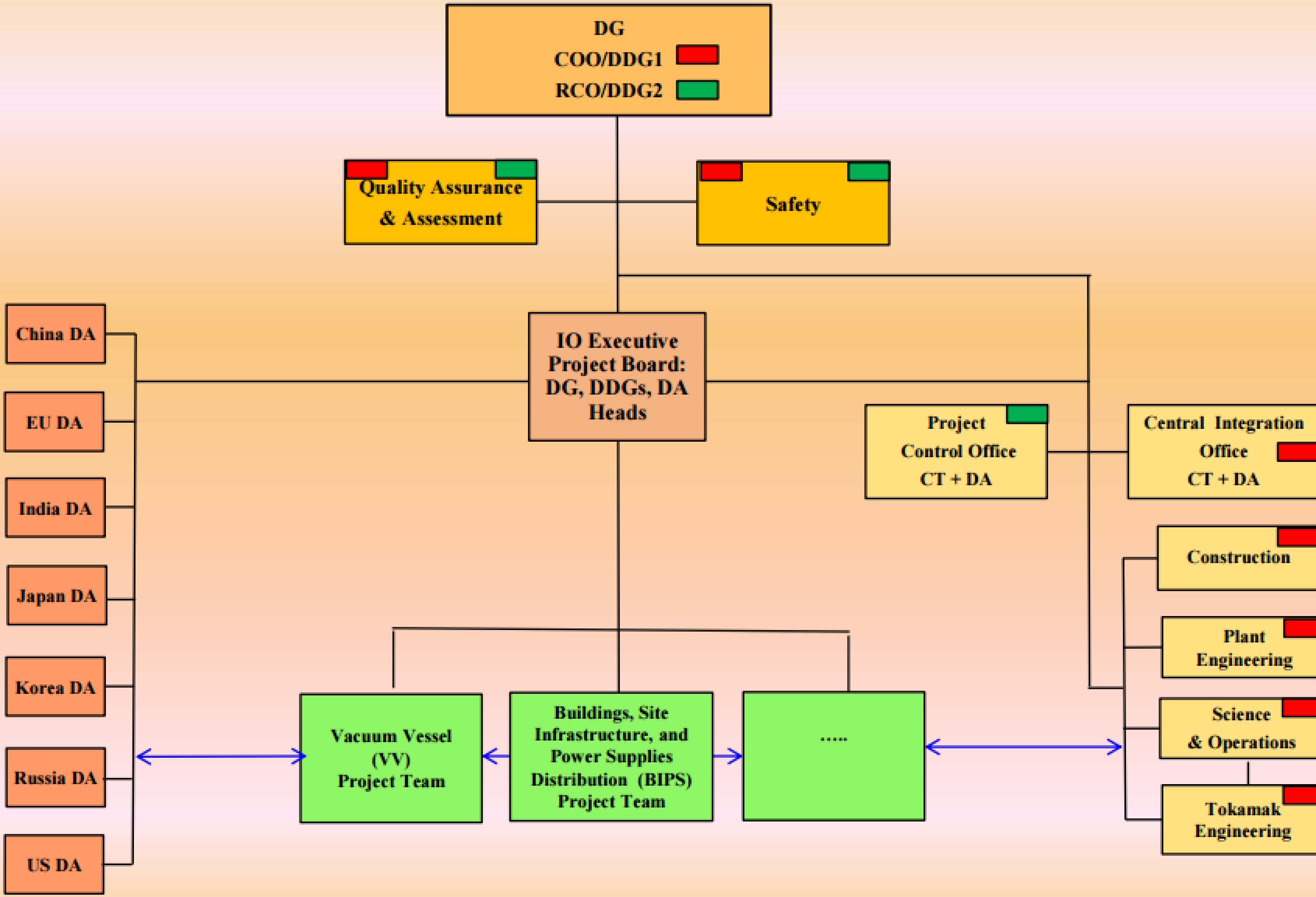
- March 2015: facing external scrutiny of the ITER project for escalating costs, unrealistic schedule commitments, a lack of transparency, and failure to provide coherent management *(Management Assessment Report 2013)*
  - Agreed to take the position of Director General, based on an Action Plan and a pledge of strong ITER Members' support to implement the recommendations.
  - Set clear priorities and aggressive timeline for reform **by end 2015**
    - Reorganization and integration of the ITER Central Team with Domestic Agencies (DG/DDG, Executive Project Board, Reserve Fund, Project Teams)
    - Finalization and stabilization of ITER critical component design
    - Comprehensive integrated bottom-up review of all activities, systems, structures, and components to build the ITER machine
    - Development of an optimized reliable resource-loaded schedule for timely, cost-effective construction and operation through start of D-T plasma.
    - Development of a strong, organization-wide nuclear project culture

Addressing present ITER challenges (2)

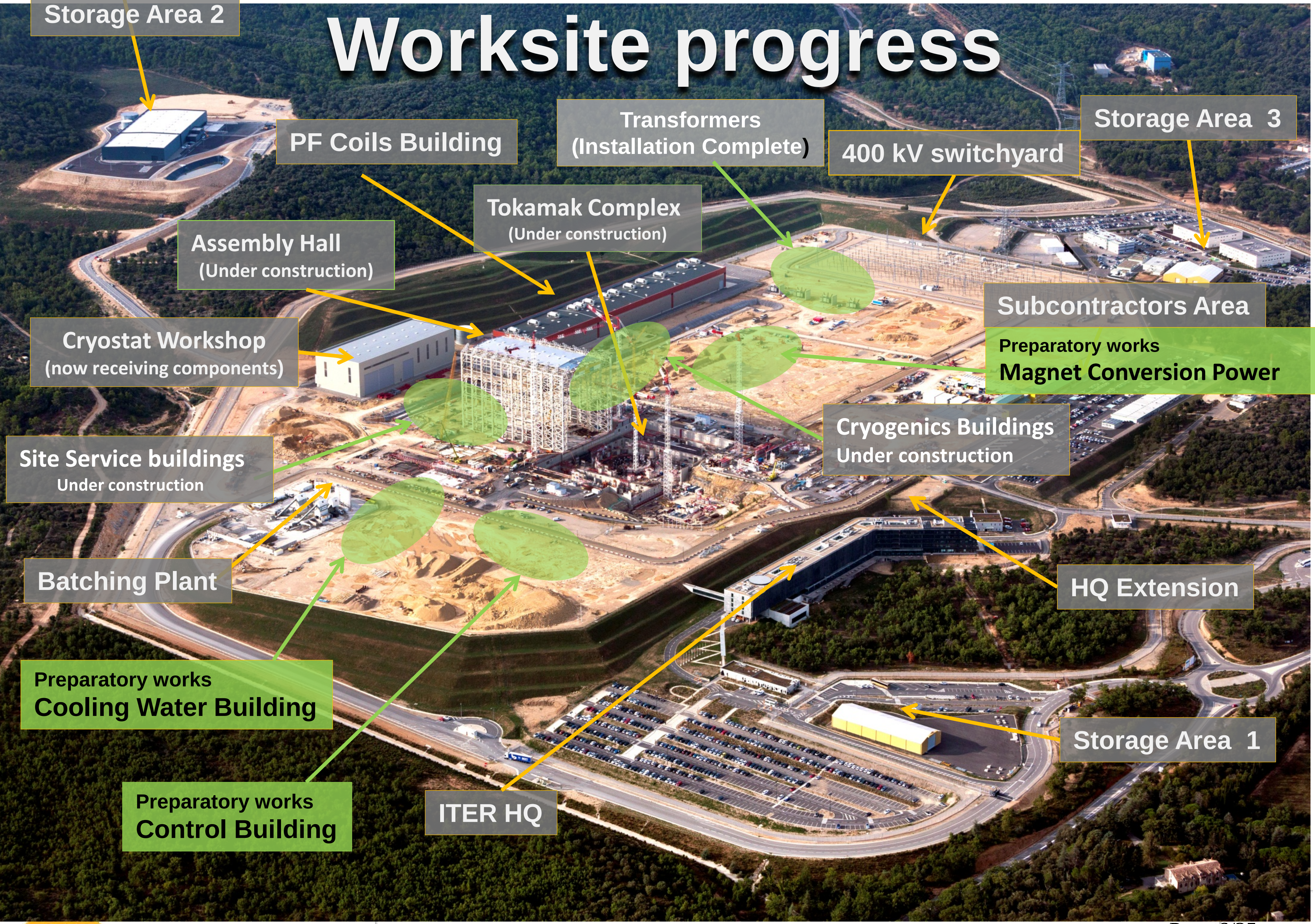
- November 2015: pivotal presentation to the ITER Council (IC-17) of the results
  - Decisions taken by IC will enable establishment of new baseline by mid-2016
  - Organizational changes completed to achieve a project culture
    - Completed hiring of senior management team
    - Integrated operations across departments, and across all Domestic Agencies
    - Created project teams in critical areas: Vacuum Vessel and Buildings
  - Design finalized; Integrated Review completed
    - Full understanding of complexity: more than 1 million parts, more than 150,000 sequenced activities, 1200 suppliers
    - On the way to establish new baseline (scope, schedule, costs, risks)
  - Prepared to set ITER on the right course for timely realization in the coming years

- *At the same time,* ***construction and component manufacturing at full speed***

ITER Project Organization (with detail of Project Teams)

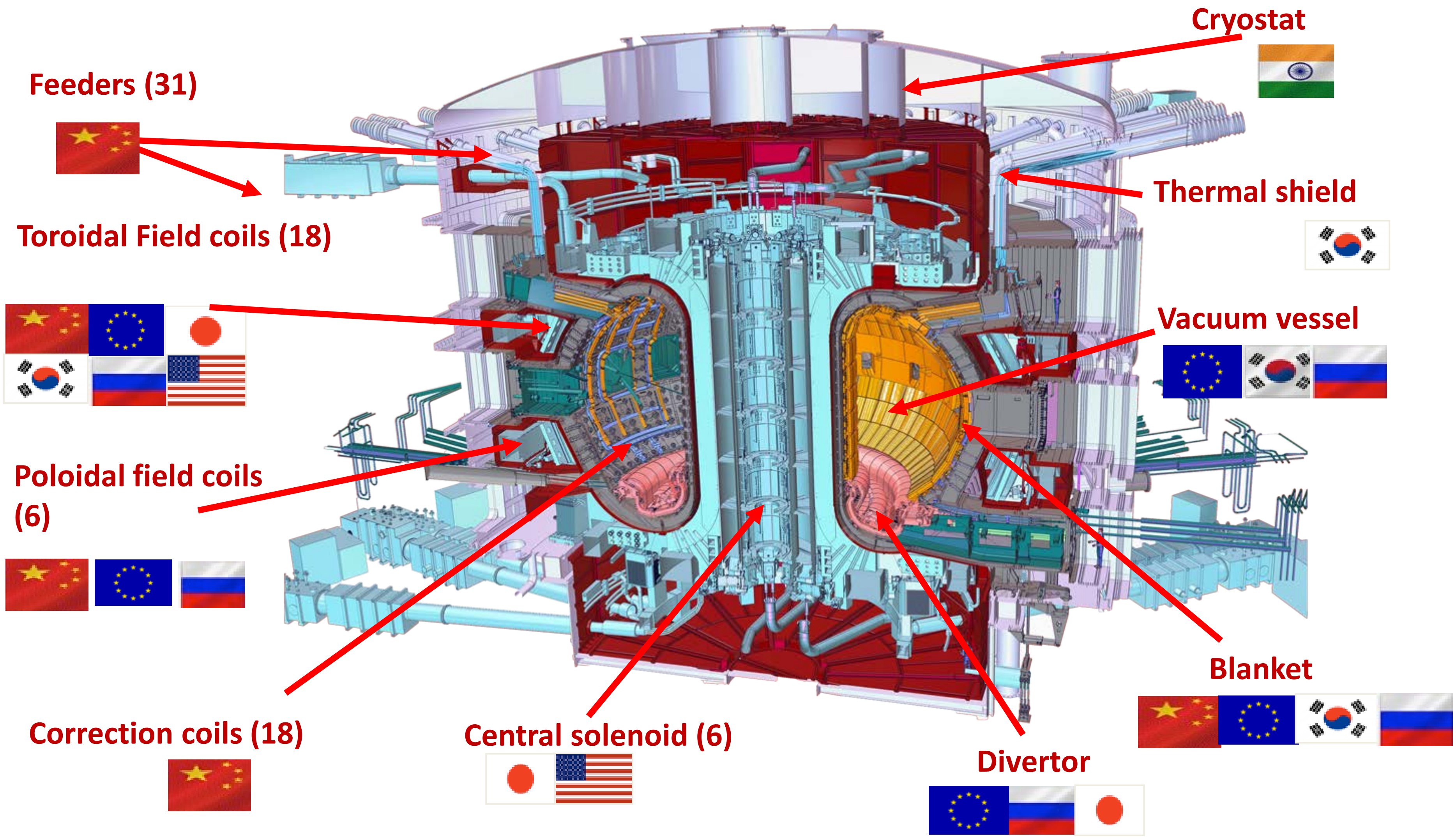


Worksite progress

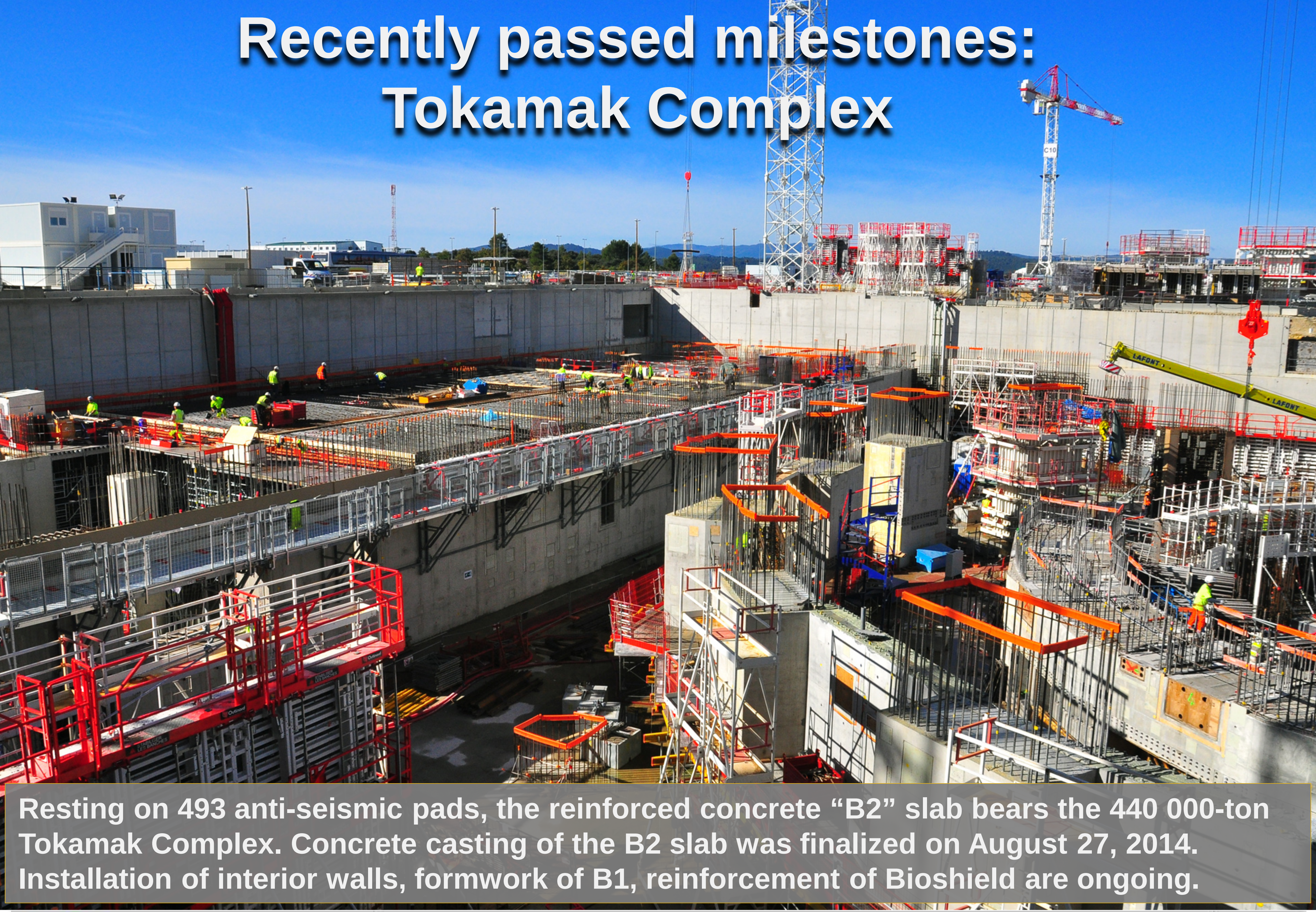


Who manufactures what?

The ITER Members share all intellectual property



Recently passed milestones: Tokamak Complex



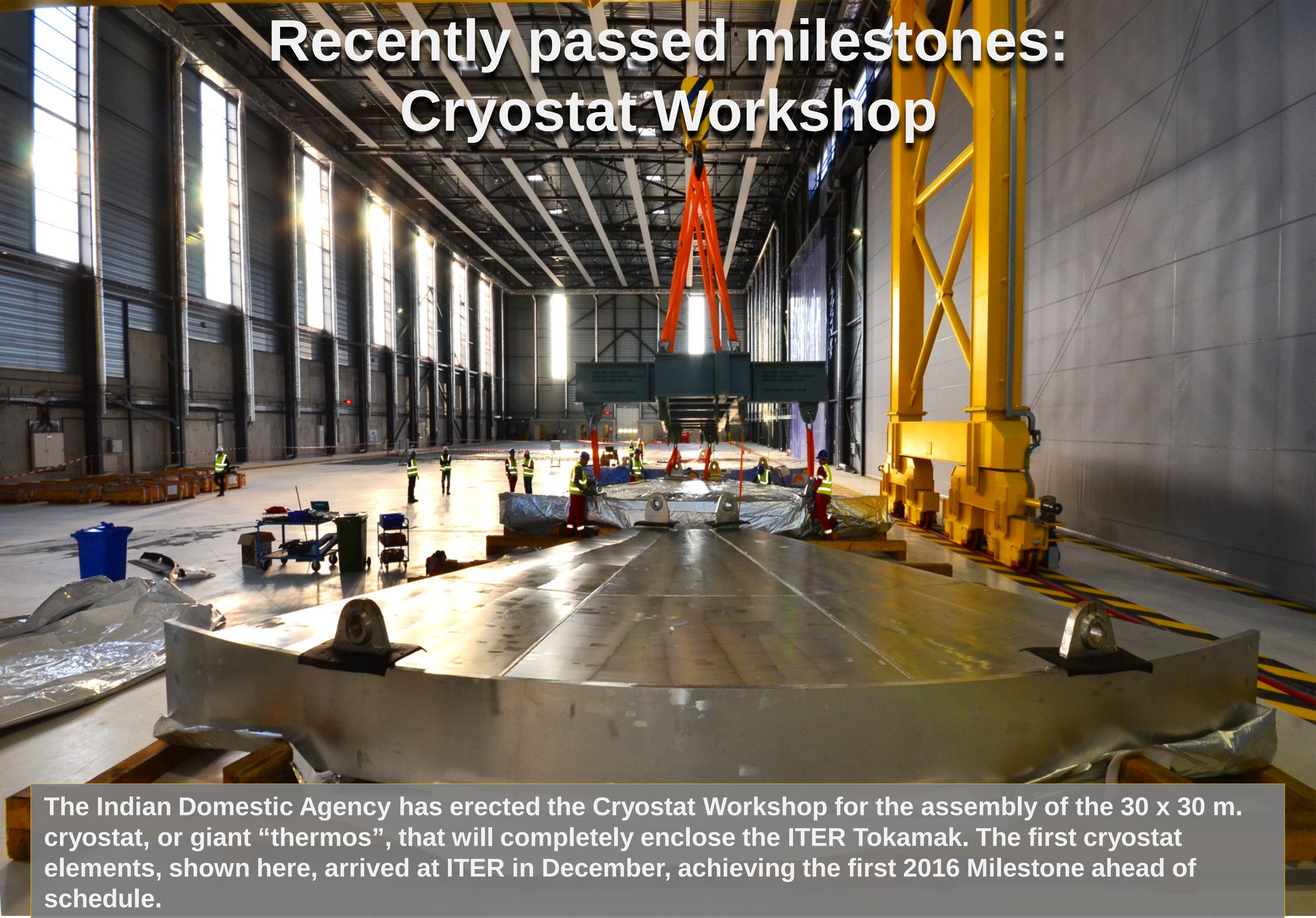
Resting on 493 anti-seismic pads, the reinforced concrete “B2” slab bears the 440 000-ton Tokamak Complex. Concrete casting of the B2 slab was finalized on August 27, 2014. Installation of interior walls, formwork of B1, reinforcement of Bioshield are ongoing.

Recently passed milestones: Assembly Hall

Before being integrated in the machine, the components will be prepared and pre-assembled in the building of 6000 m2 up to 60 meters. The 730-ton roof was put in place September 10-11, 2015. Cladding operations are ongoing.

Recently passed milestones: Cladding and Insulation of Assembly Hall

Recently passed milestones: Cryostat Workshop



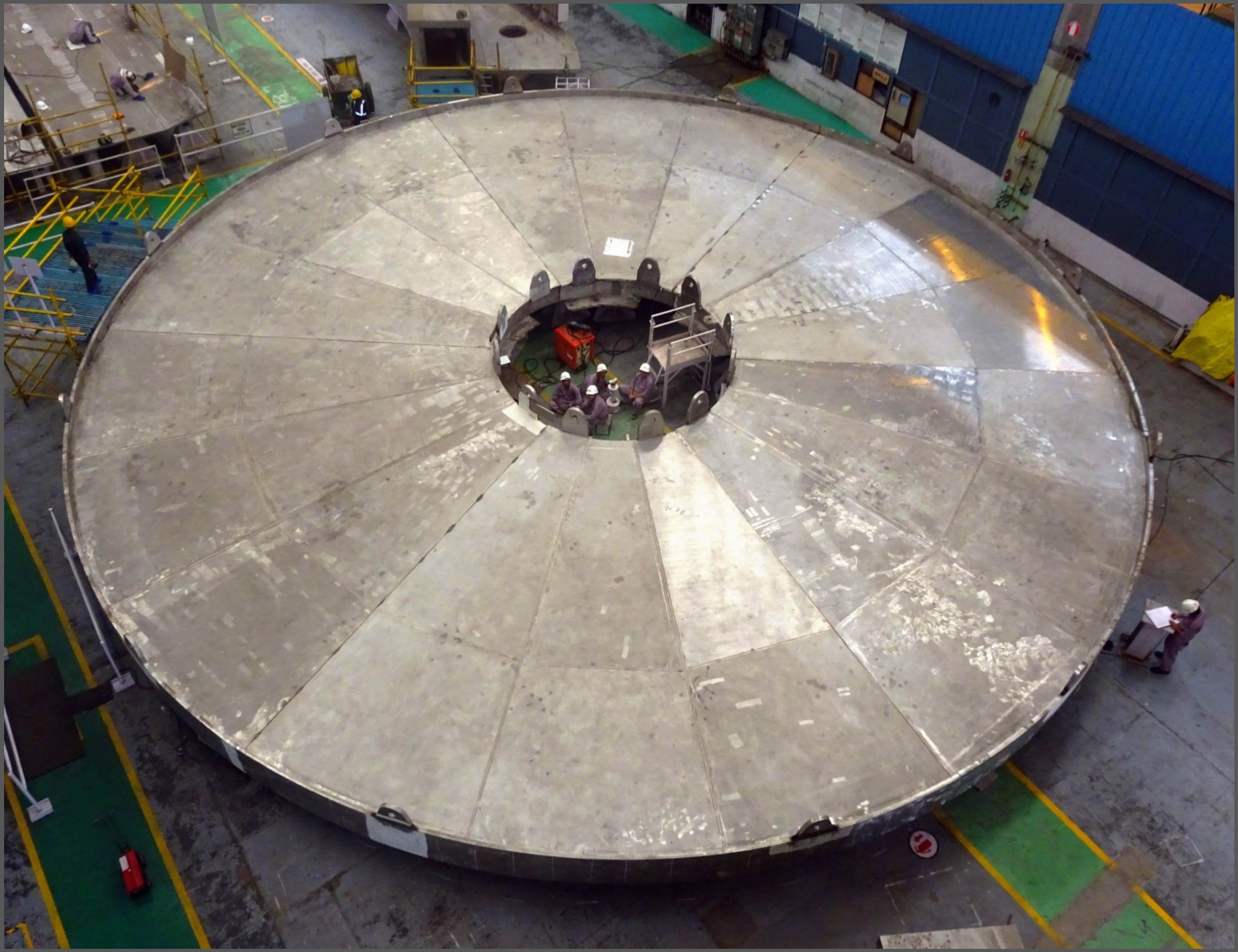
The Indian Domestic Agency has erected the Cryostat Workshop for the assembly of the 30 x 30 m. cryostat, or giant “thermos”, that will completely enclose the ITER Tokamak. The first cryostat elements, shown here, arrived at ITER in December, achieving the first 2016 Milestone ahead of schedule.

First plant components installed

Four US-procured 400 kV transformers have been positioned on the ITER platform. They are the first ITER plant components to be installed on site.

Manufacturing progress

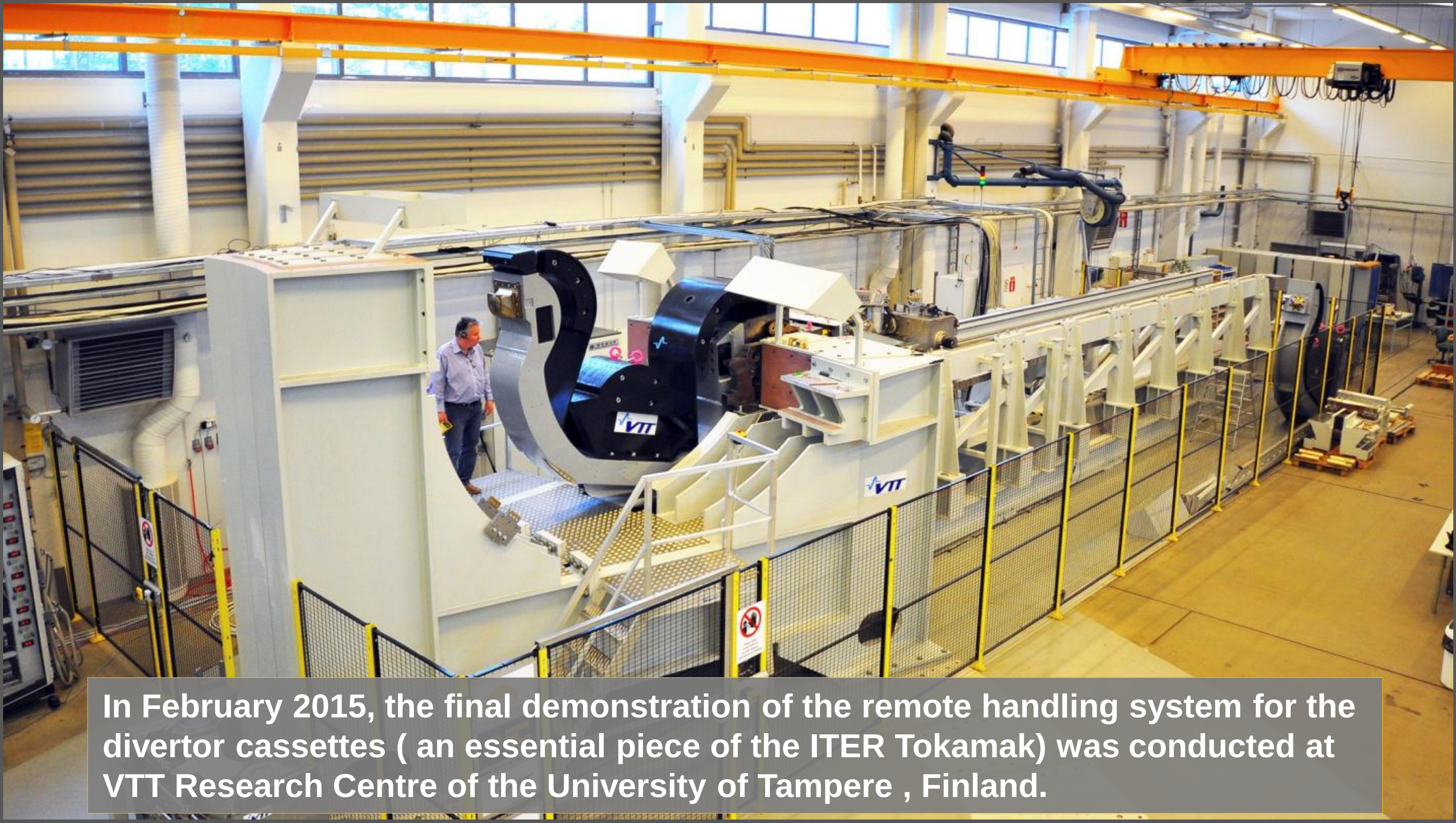
India



India is responsible for the fabrication and assembly of the 30 x 30 meter ITER cryostat. Pictured, six 60° base plates are temporarily assembled at the factory in order to check tolerances prior to shipment to the ITER site.

Manufacturing Progress

Europe



In February 2015, the final demonstration of the remote handling system for the divertor cassettes (an essential piece of the ITER Tokamak) was conducted at VTT Research Centre of the University of Tampere , Finland.

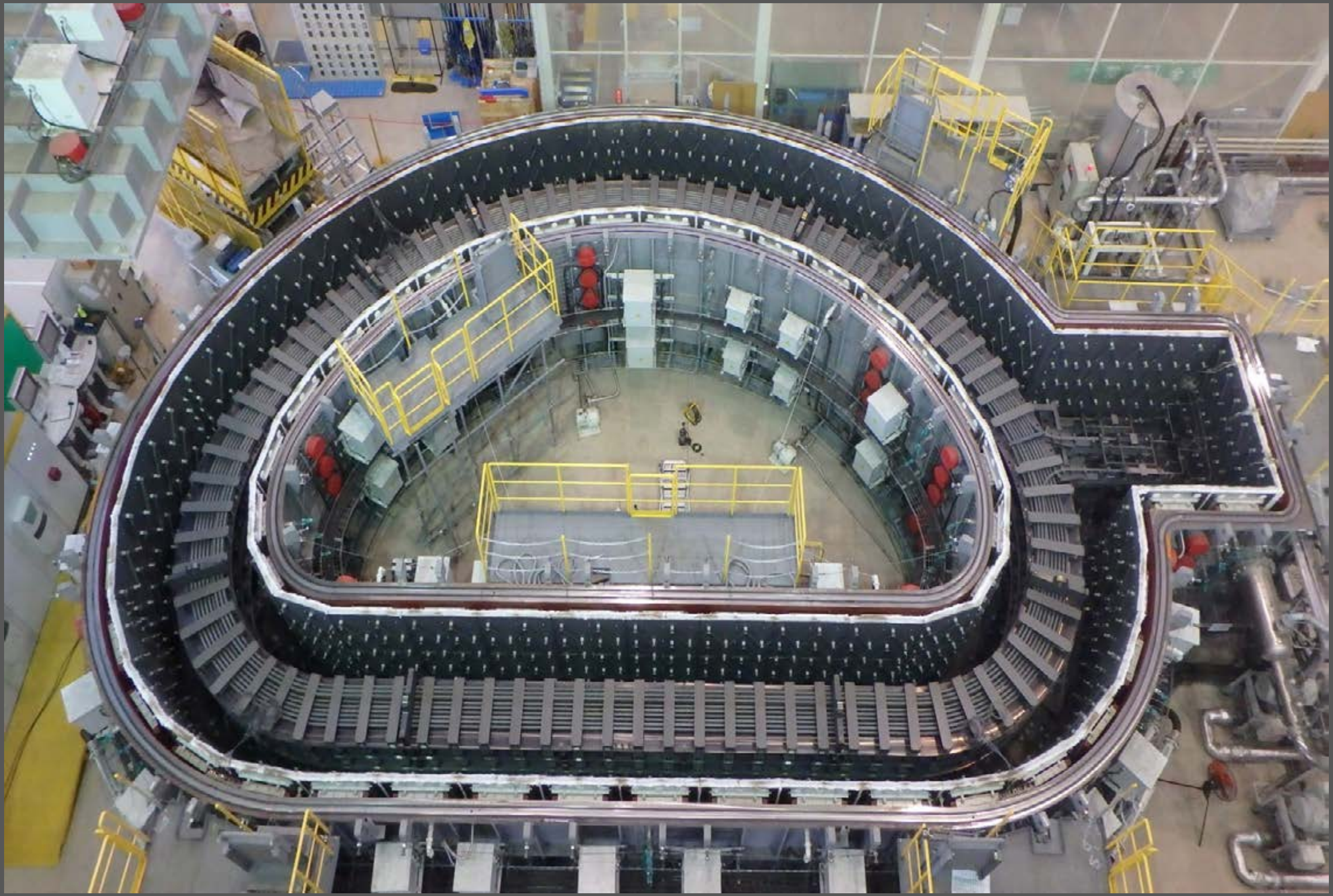
Manufacturing progress

China

China is responsible for the procurement of 14 poloidal field AC/DC converter units that will provide reliable, controlled DC power to the ITER poloidal field magnetic coils. The testing of a prototype converter unit opens the way to future batch production.

Manufacturing progress

Japan



Japan is manufacturing half of the 18 giant toroidal field coils needed for ITER. Here, the D-shaped pancake windings are heat treated at 650 °C for 100 hours to react tin and niobium to form the superconducting compound niobium-tin.

Manufacturing progress

Korea

In Korea, where two of nine vacuum vessel sectors are under construction, welding is carried out on the upper section of an inner shell—only a small piece of the full component.

Manufacturing progress
Russia

Russia completes its share of toroidal field conductor in June 2015. The milestone marks the end of a five-year campaign to manufacture 28 production lengths (more than 120 tons of material).

Manufacturing progress
USA

The US is responsible for the design, R&D, and manufacturing of the main central solenoid magnet (using conductor supplied by Japan), as well as the associated structure and tooling. At General Atomics' Magnet Technologies Center in Poway, California, winding operations began in April 2015 on a mockup module.

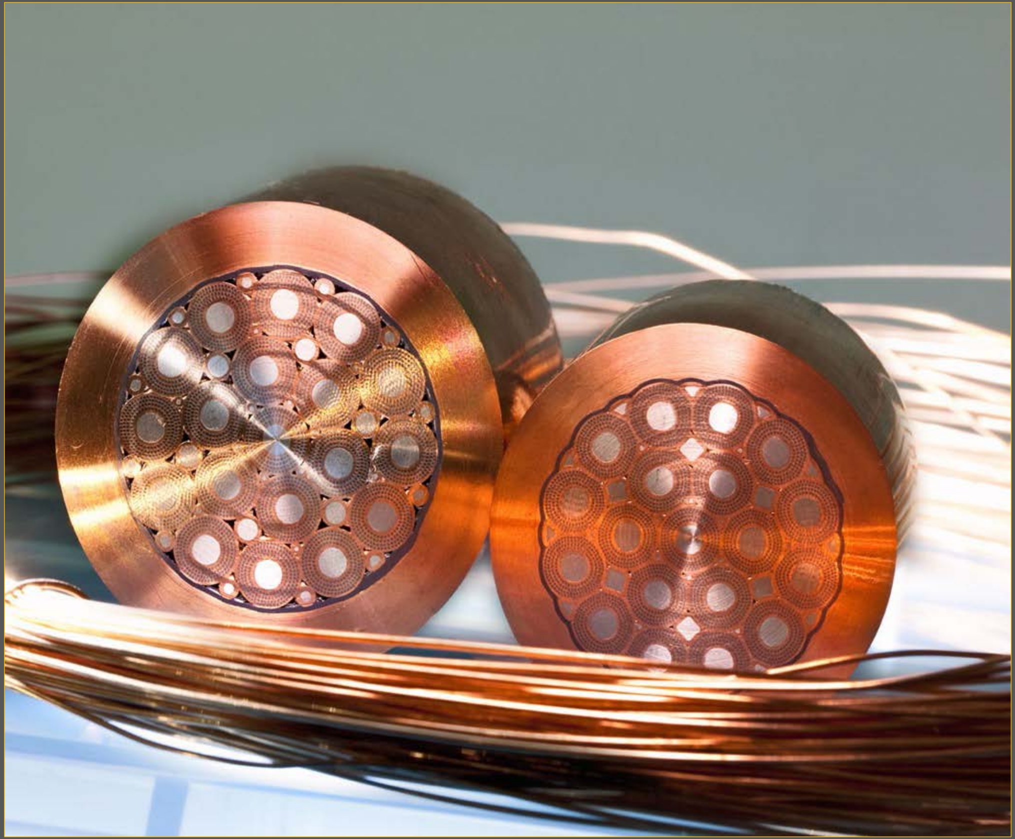
Door-to-door delivery

14 January 2015:	First of four 90-ton transformers procured by the US and manufactured in Korea
20 March 2015:	Detritiation tank (20 tons), procured by Europe
2 April 2015:	Detritiation tank (20 tons), procured by Europe
20 April 2015:	Second of four 90-ton transformers procured by the US and manufactured in Korea
7 May 2015 :	Two 80-ton, 61,000-gallon drain tanks for the tokamak cooling water system, procured by US
21 May 2015:	Three 90-ton transformers procured by the US and manufactured in Korea
17 Sept 2015:	Two drain tanks (79t.) for the cooling system, one (46 t.) for the neutral beam system
10 & 17 Dec. 2015:	Six 60° segments for tier 1 of the cryostat base by India (photo)

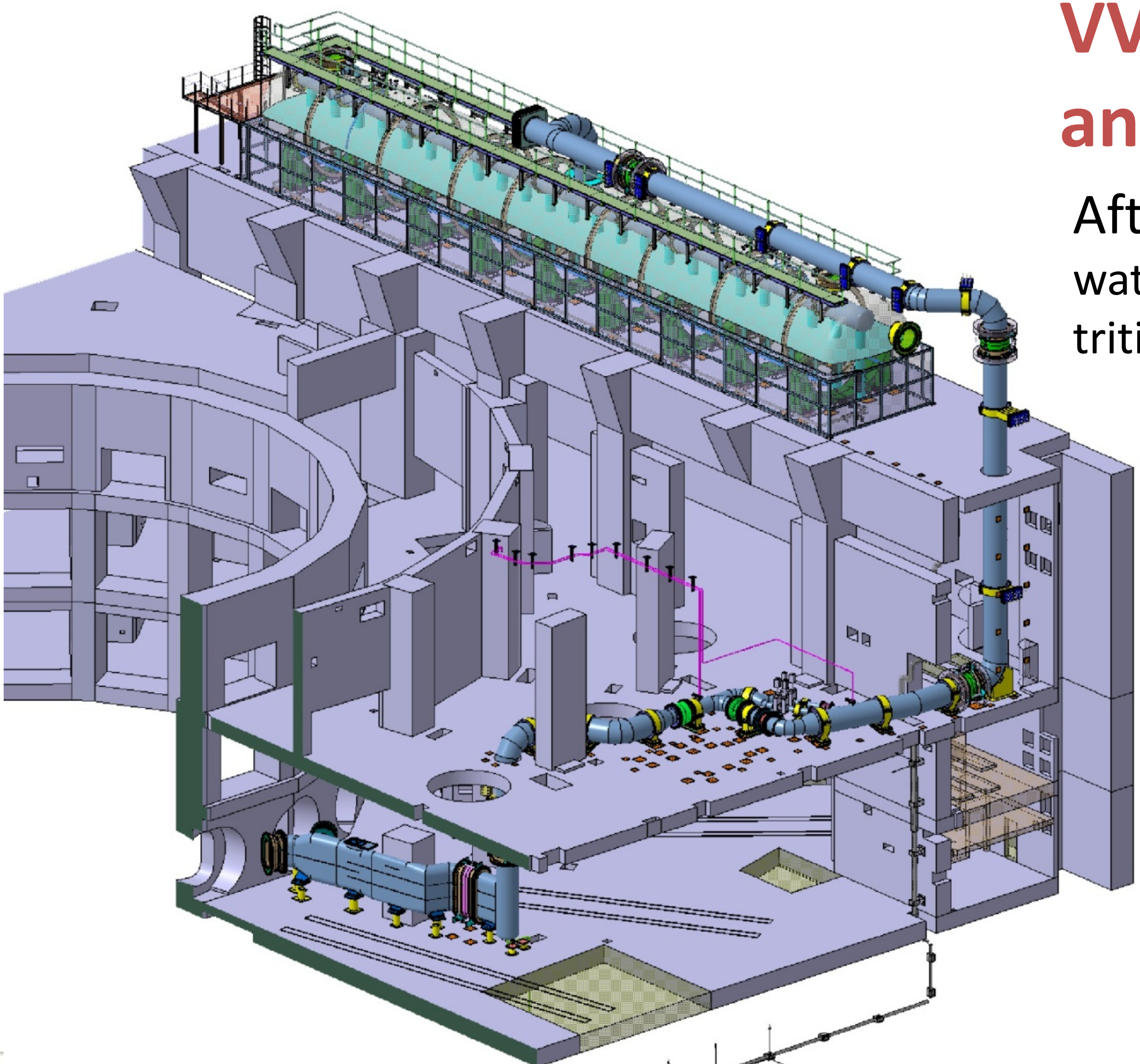
A multinational success

200 km, 2,800 tons of superconductors (80% of the total required) have been manufactured and validated

- The single largest superconductor procurement in industrial history is drawing to a successful close.
- An eight-year campaign to produce the superconductors for ITER's powerful magnet systems is in its final stages, with nearly 80 percent of the conductor unit lengths accepted by the ITER Organization.
- Six ITER Members—China, Europe, Japan, Korea, Russia and the United States—have been responsible for the production of 200 kilometres (2,800 metric tons) of cable-in-conduit conductors, worth an estimated EUR 610 million.



Design optimization: VVPSS

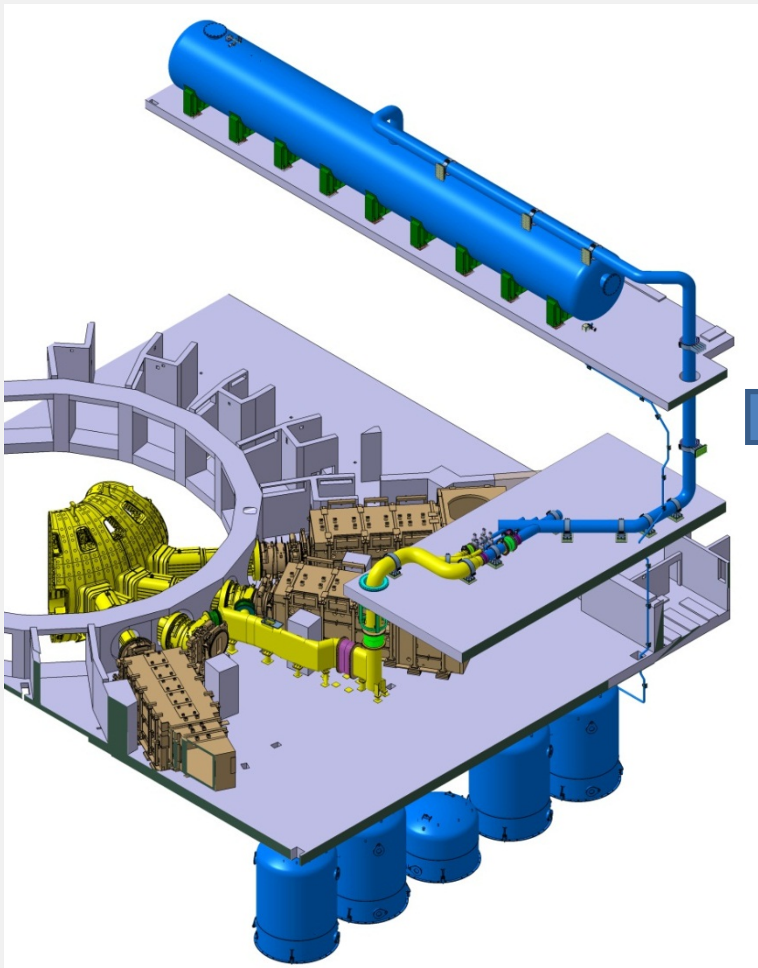


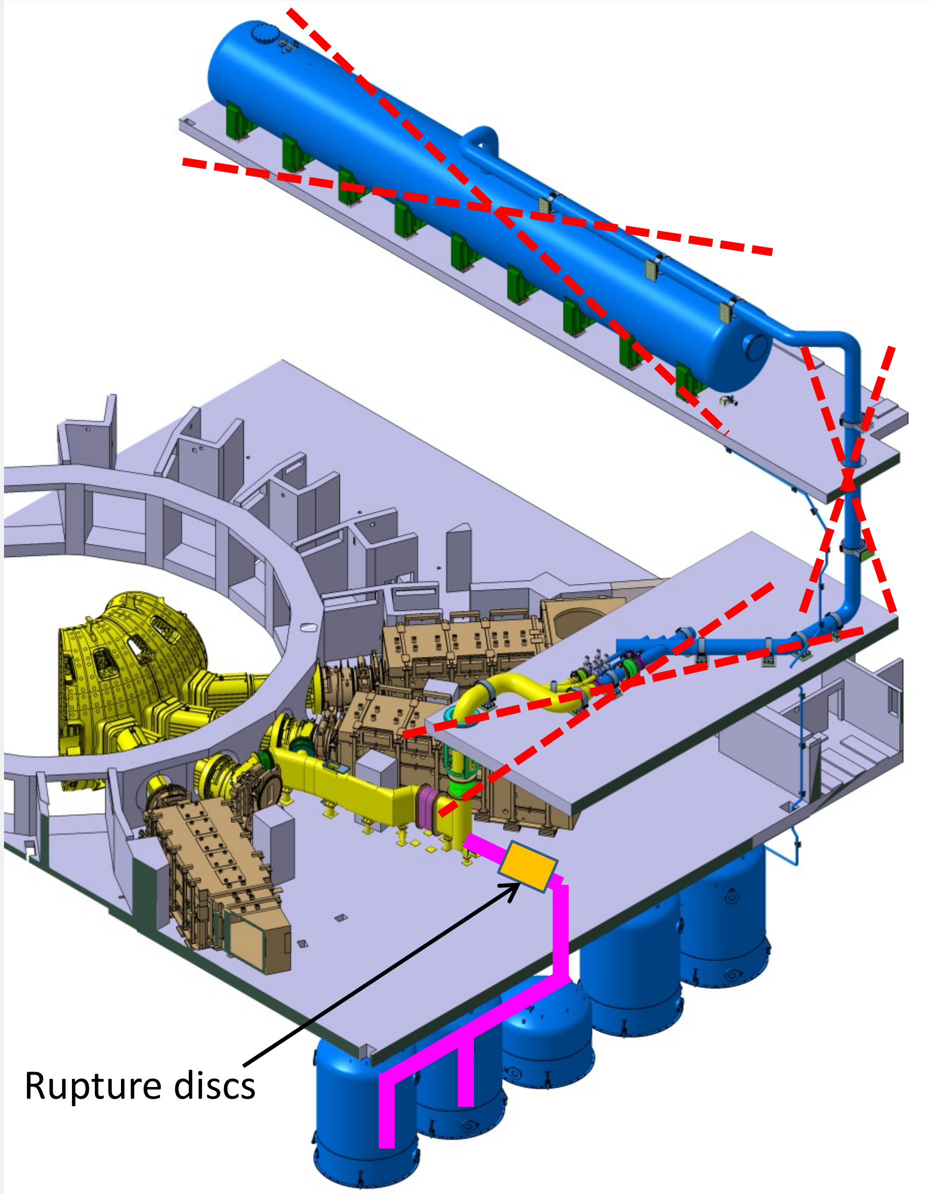
VVPSS localization and functioning

After ICE-IV: 1200 m3 of water @ 95 °C, 900 g of tritium, 350 g of ACP at L5!

Design optimization

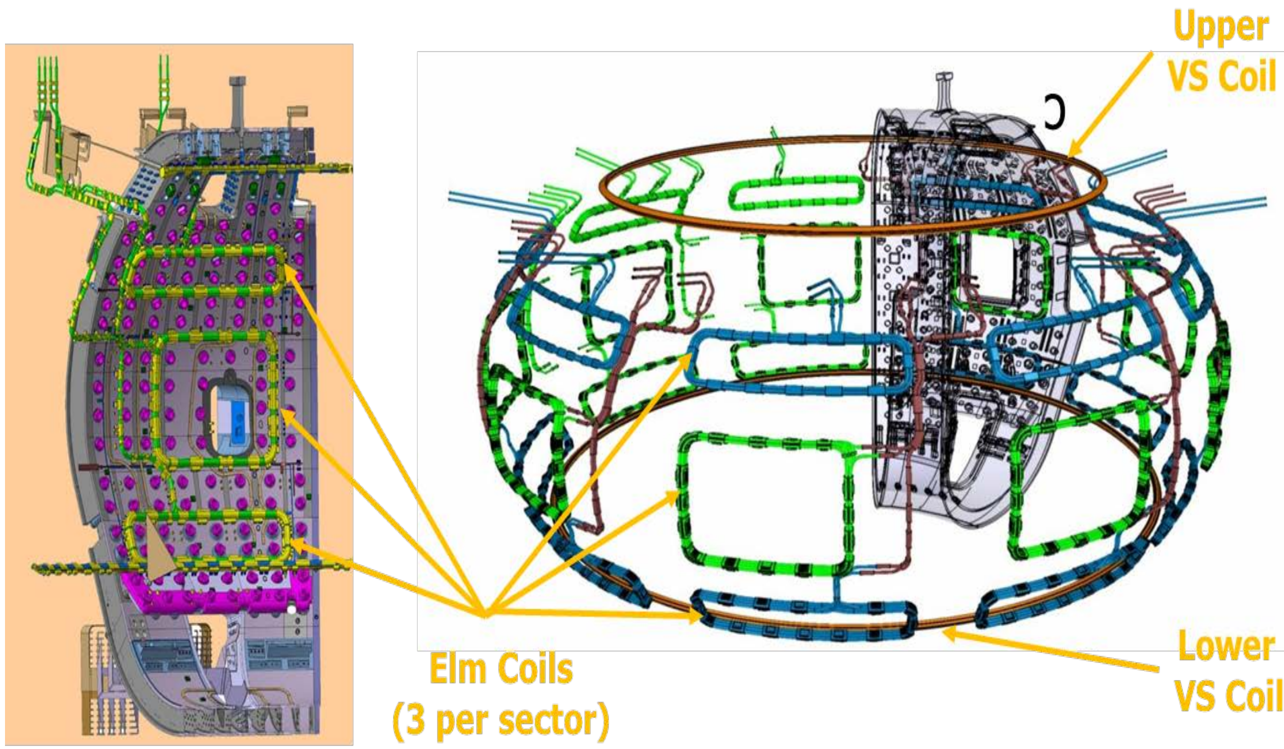
Modification of the discharge line of VVPSS under progress





Design optimization: ITER In-Vessel Coils

Conventional, water-cooled, in-vessel coils (IVCs), attached to the outboard part of the inner wall of the vacuum vessel, underneath the blanket modules, have an essential role in plasma operation.



(Courtesy of A. Encheva, ITER-CT)

The in-vessel coils comprise: **3 x 9 picture-framed, ELM coils** (aimed at controlling **Edge Localized Modes)** and **2 ring, VS coils** (aimed at controlling **Vertical Stability).**

Initial R&D

ELM Coil Prototype

120° VS Coil Prototype

(Courtesy of Y. Wu, ASIPP)

ITER_D_P8MC69 - Final report on the In-Vessel Coils (IVC) prototype review

- **ITER-CT** signed a **Task Agreement** with **CN-DA** on **3 Nov. 2011** for the design/manufacture of an **equatorial ELM coil prototype** and a **120° upper VS coil prototype.**

- **Design** was developed by **PPPL** and **manufacture** was carried out by **ASIPP**.

- Prototype manufacture was completed in **June 2014,** but a number of issues were identified **(*e.g.* cracking of Inconel 625 conductor jacket** after bracket brazing on ELM coil prototype).

- As a result, IO decided to revisit **ELM conductor/coil design by April 2015**.

Feasibility Studies: Long Conductor Length

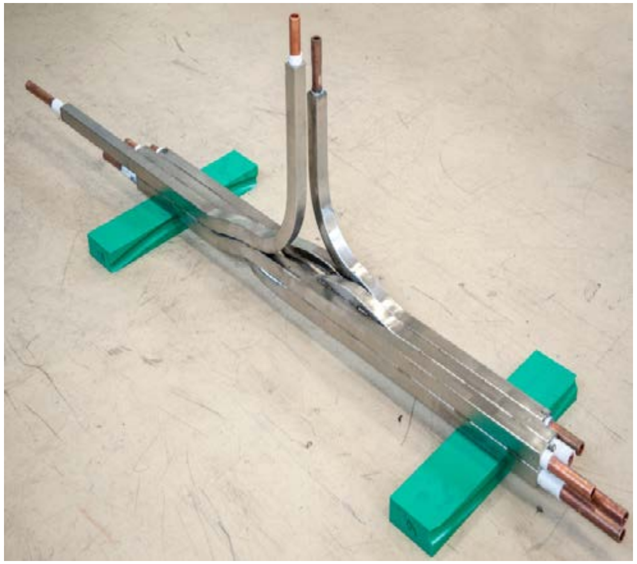
- The production of **conductor unit lengths of ~40 m** (without internal joint) was **successfully** completed. The conductor appeared to retain a very high insulation resistance (in excess of **1 TΩ)** up to **5 kV** without breakdown and exhibited an insulation resistance at room temperature **in excess of 100 GΩ.**
- Tight QA/QC is key.






(Courtesy of Y. Wu, ASIPP)

Feasibility Studies: 3D complex shaping



(Courtesy of A. della Corte, ICAS)

- Mock-up was manufactured using **2-D bender + additional tooling** and conductors were successfully formed to the **desired shape.**

- **Electrical insulation** of each conductor length was tested after assembly and all exhibited a resistance greater than **1 TΩ @ 1kV.**

Feasibility Studies: Welding

- A parallel study was carried out to demonstrate feasibility of **conductor winding pack welding** in the area of **90° bending;**

- Some **re-machining** had to be applied but the trial was **successful** and demonstrated that the conductors could be coupled **without any major local distortion.**

(Courtesy of A. della Corte, ICAS)

ITER Council Commitment: results of IC-17

- Council expressed appreciation for organizational reform, focus on project culture, and progress on construction and manufacturing
- Took decisive steps to ensure ITER Organization can ***keep the momentum***
  - Approved schedule for 2016-17, referenced to "Best Technically Achievable Schedule"
  - IO Central Team and Domestic Agencies committed to a series of 29 milestones for 2016-17, referenced to this schedule
  - Council will monitor achievement of these milestones to verify ITER is staying on track
  - Council approved re-allocation of existing funds to ensure capability of meeting this schedule
    - Includes recruitment of 148 additional staff through end of 2017
- Council will commission an independent review of the proposed schedule, budget and staffing plan
  - Will use this review to validate or amend the Best Technically Achievable Schedule, and to establish a new consolidated ITER baseline by the next Council meeting (June 2016)

ITER is moving forward!

ITER is moving forward!

ITER is moving forward!

ITER is moving forward!

ITER is moving forward!

Thank you for your attention

www.iter.org

ITER: effective organization for reliable results

1. *Director General given full authority to take technical decisions in best interest of the ITER Project*
   - *Pending technical issues jointly addressed for sensible coordinated resolution.*
2. *Simplified project-oriented organization with profound integration of IO Central Team and Domestic Agencies*
3. *Executive Project Board empowered to take timely decisions for effective global project management*
4. *Cost-effective "Central Reserve Fund" under DG's control to cover specific operations*
5. *Tight coordination of activities of joint IO-CT and DA Project Teams*
6. *Implementation of powerful coordinated tools for establishing a nuclear project culture*
7. *Human Resources optimized for improved efficiency and cost effectiveness*