The ITER project progress

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iter
china eu india japan korea russia usa

WORKSITE CONSTRUCTION & COMMISSIONING HIGHLIGHTS

TOROIDAL FIELD COILS

- 18 + 1 coils
- 41 gigajoules
- 11.8 Tesla

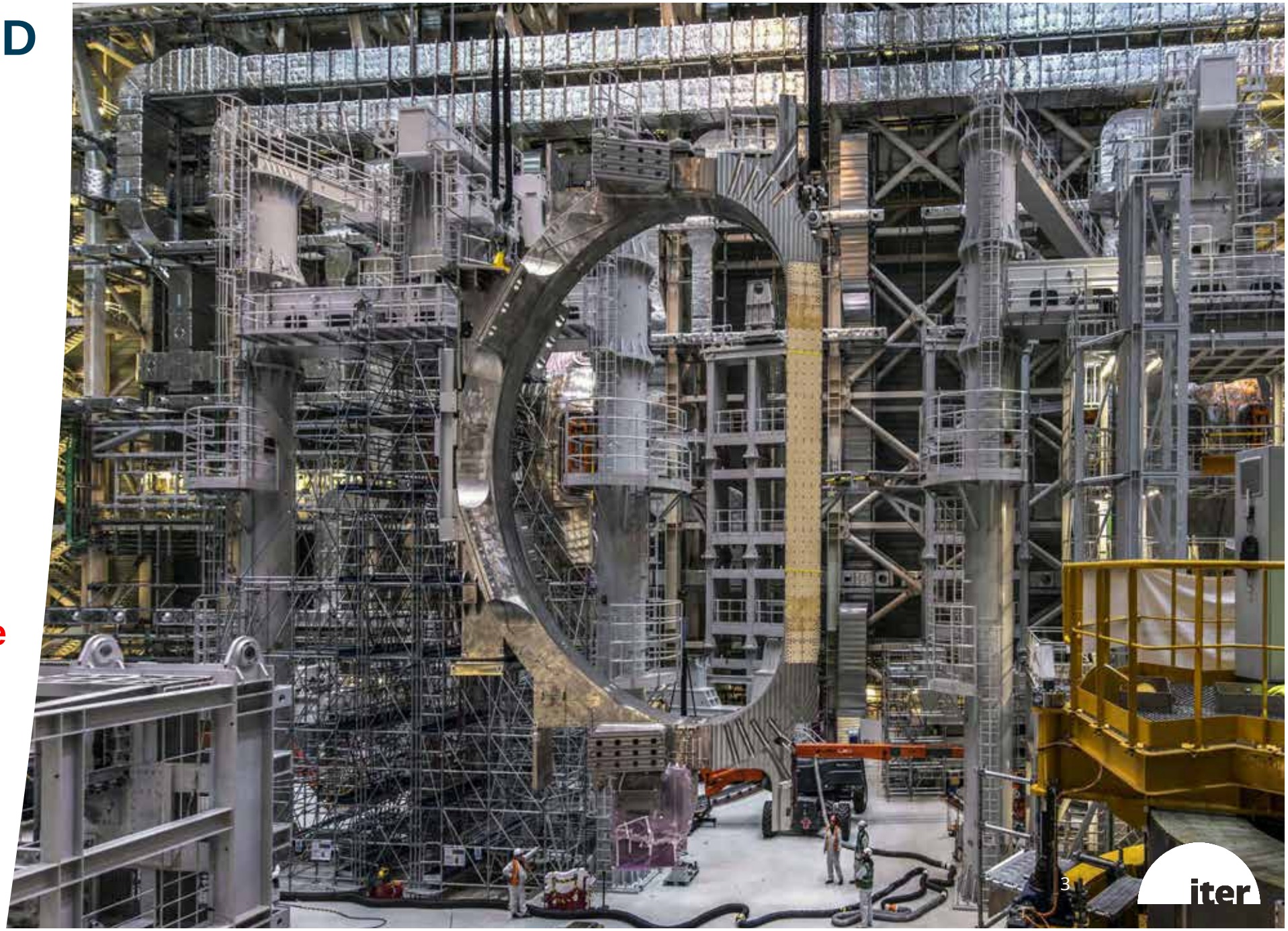
Each coil:

- 360 tonnes
- 9 x 17 metres

Status:

Manufacturing of all 19 coils completed.

All coils already onsite



POLOIDAL FIELD COILS

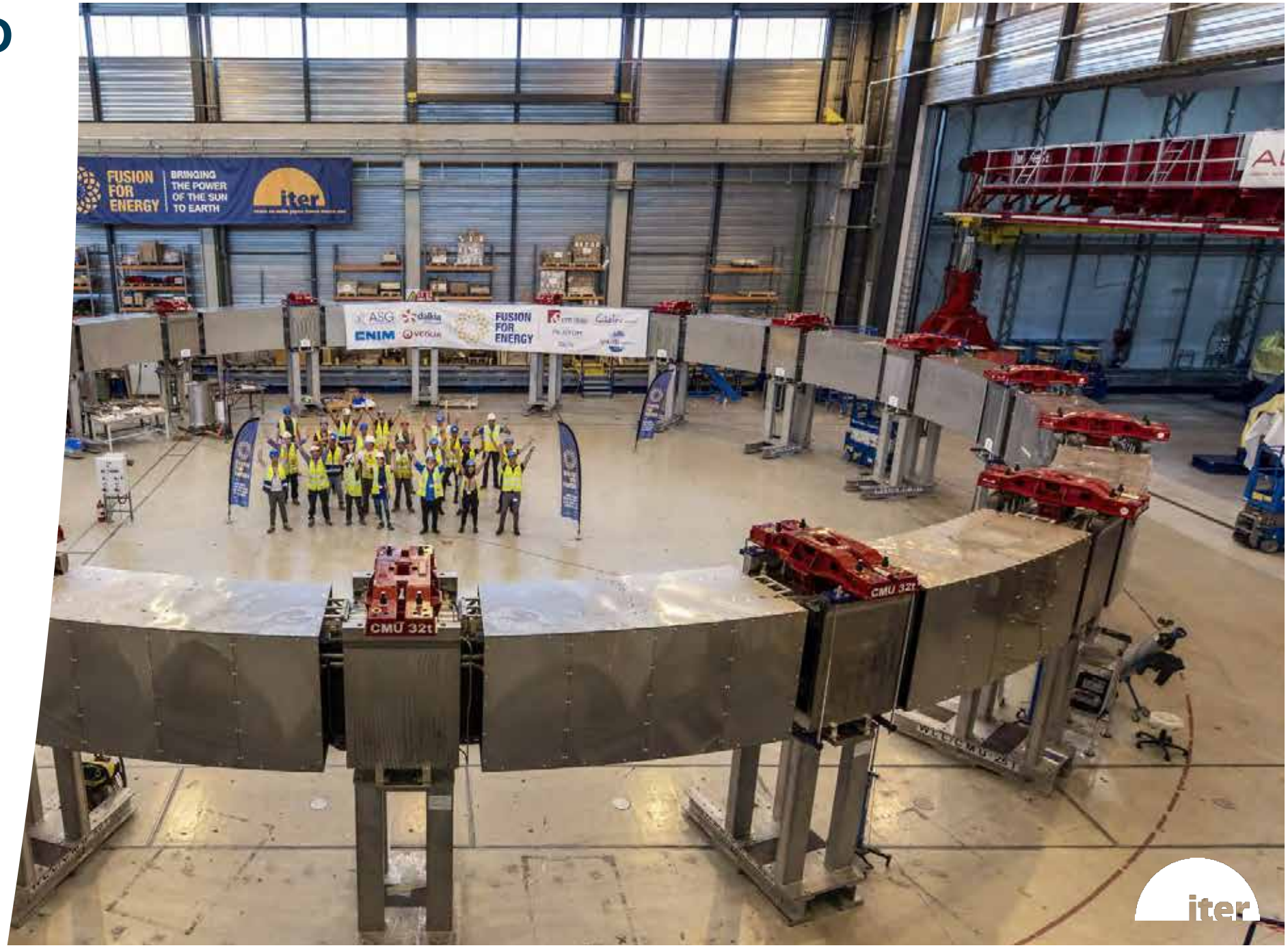
Six coils, the largest with a diameter of 24 metres, weighing 400 tonnes.

Total magnetic energy: 4 gigajoules

Maximum magnetic field: 6 Tesla

Status:

All PF delivered on-site



CENTRAL SOLENOID

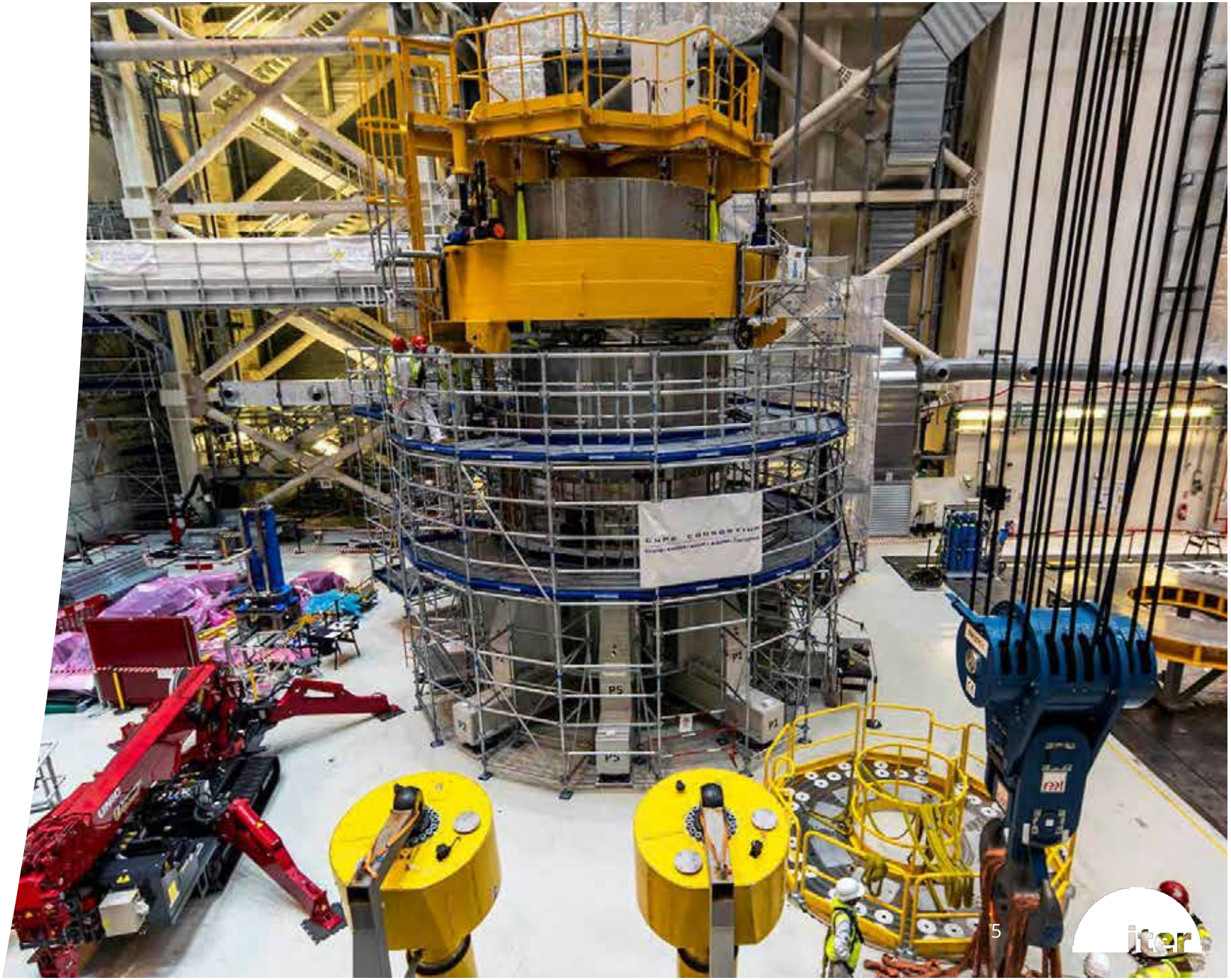
Height: 18 metres
Diameter: 4.13 metres
Total weight: 1000 tonnes
Peak field strength: 13.1 Tesla
Operating voltage: 14 kV
Operating current: 45 kA
Stored energy: 5.5 gigajoules

Status:

Four modules of the Central Solenoid installed on the assembly platform.

Two more modules to be delivered from San Diego.

#3 module was damaged during testing, now being repaired, will be used as a spare.



COOLING WATER SYSTEM

Heat Rejection System: ITER's cooling water system is capable of removing 1.2 gigawatts of heat. Equipment installation and system commissioning are complete, and the system is operational.

CRYOGENIC PLANT

75kW @ 4 Kelvin

Equipment installation is complete, and has entered pre-commissioning phase.

OTHER MANUFACTURING HIGHLIGHTS

The Domestic Agencies have completed the fabrication and delivery of a substantial portion of ITER's First-of-a-Kind components.

4 Vacuum Vessel sectors complete

Cryostat Manufacturing is complete

Bottom correction coils installed

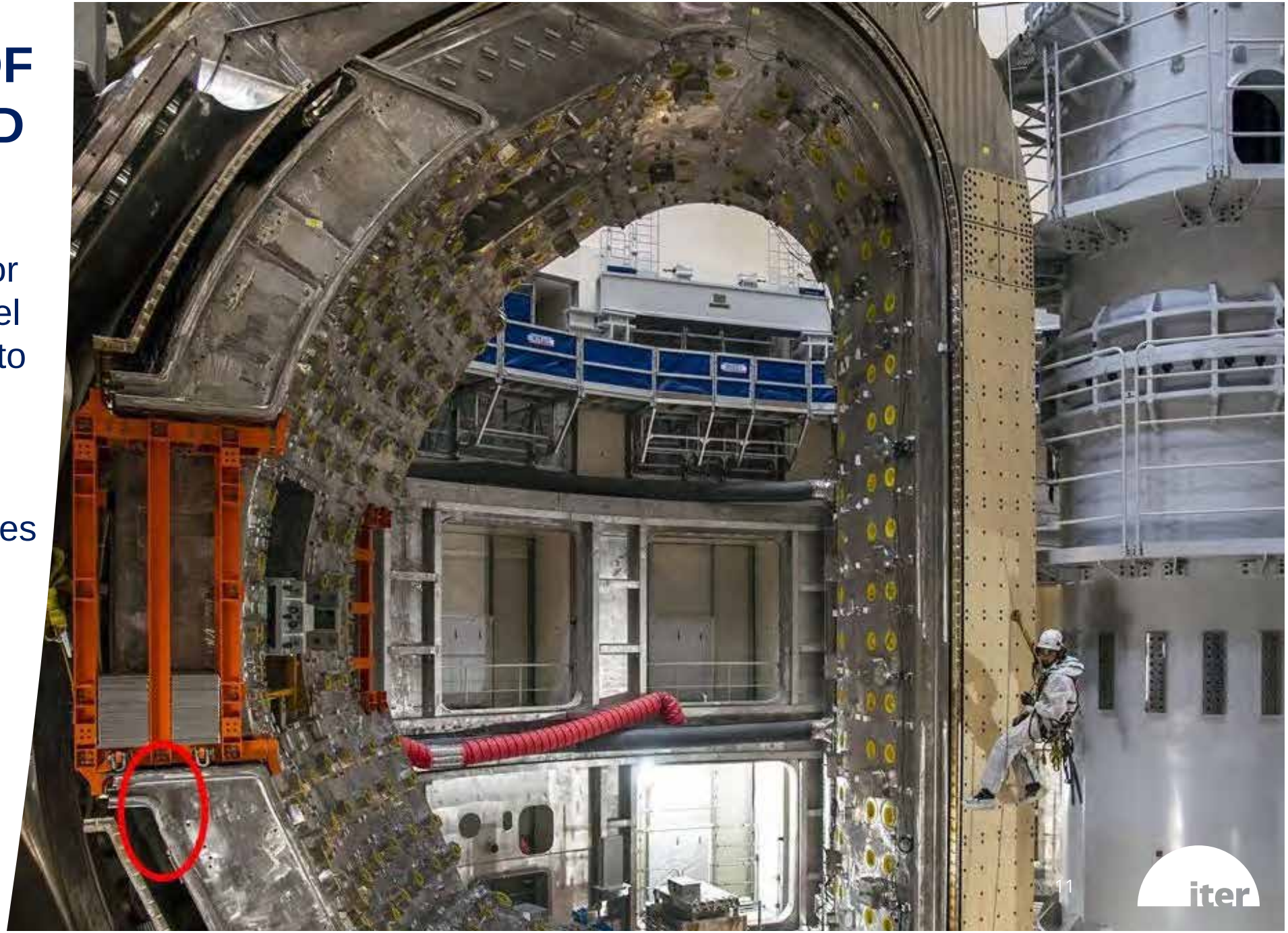
5 Vacuum Vessel sectors on-site, the others in advanced stages of production

CHALLENGES OF FIRST-OF-A-KIND COMPONENTS

The first complete Vacuum Vessel Sector Module was lifted into the tokamak pit in May 2022 ...

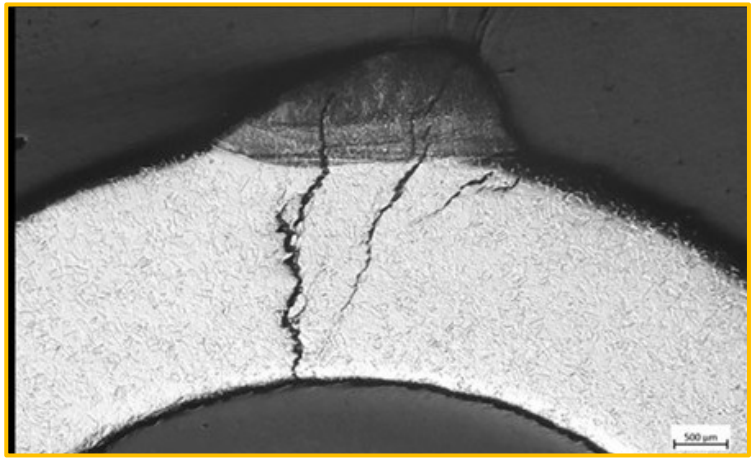
CHALLENGES OF FIRST-OF-A-KIND COMPONENTS

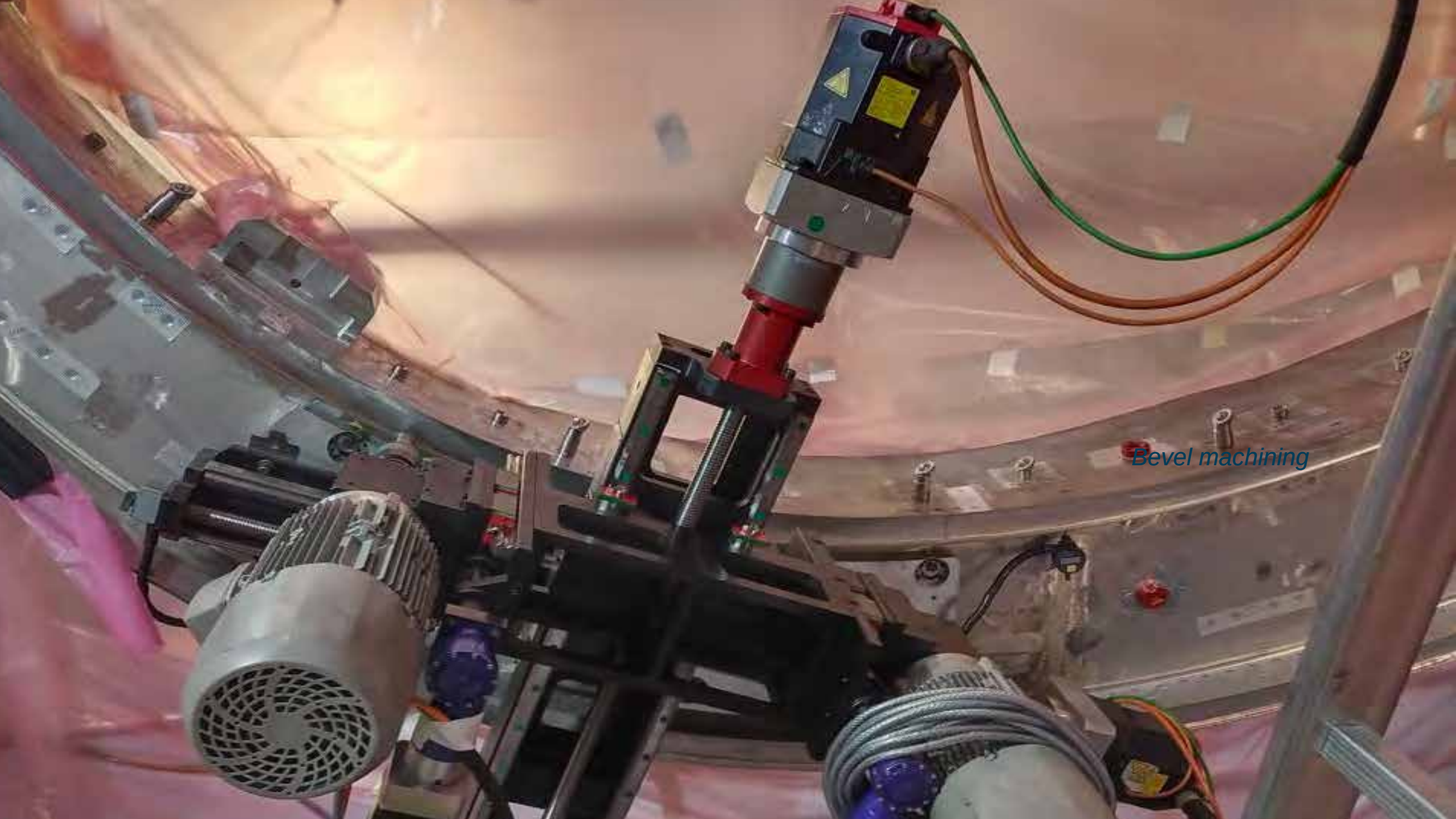
… but the sector-to-sector welding of Vacuum Vessel sectors was reassessed to be too challenging to perform *in situ,* based on the previously identified geometric non-conformities in the field joints.



CHALLENGES OF FIRST-OF-A-KIND COMPONENTS

Leakage was also identified in thermal shield cooling piping due to chloride stress corrosion.





Bevel machining

VVTS REPAIR PROCESS

- Replacement of corroded pipes with new 316L pipes
- 2 mm panel machining to eliminate potential panel corrosion risk
- Surface polishing replacing Ag coating for good emissivity: surface roughness less than 0.1 µm – lower emissivity at 80K

VVTS MANUFACTURING

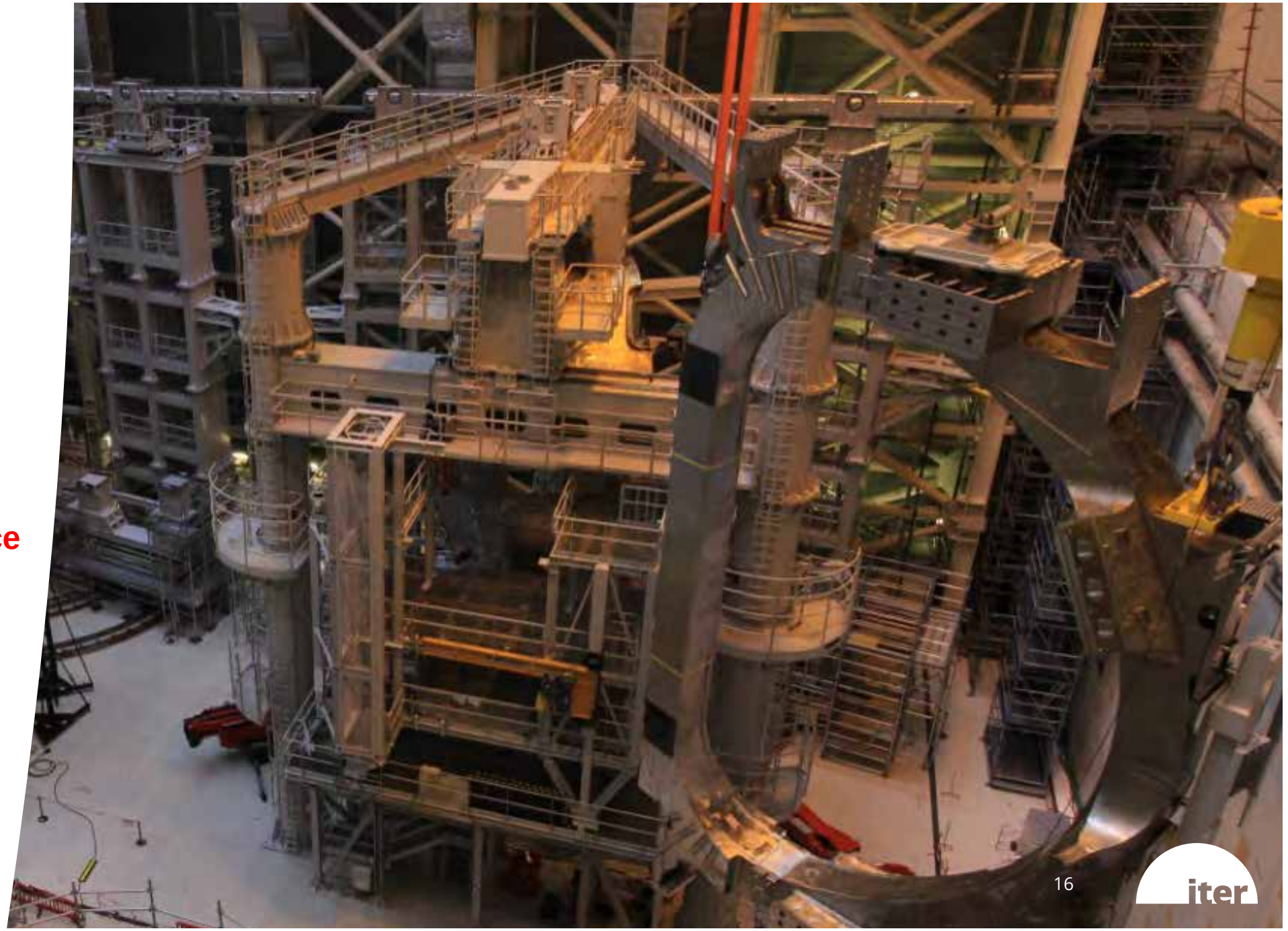
A risk mitigation measure: a contract to manufacture 3 (or more) new VVTS sectors progressing as planned.

CHALLENGES OF FIRST-OF-A-KIND COMPONENTS

The ITER tokamak assembly has now restarted.

2024:

- **Schedule Performance Index=0.99**
- **Cost Performance Index=1.14**



The PREVIOUS (2016) BASELINE:

- Designed to reach **First Plasma** – any symbolic plasma experiment – as rapidly as possible
- Constrained by the fact that some key components would not be available
- First Plasma scheduled for end-2025: a brief, low-energy machine test (100 kA)
- To be followed immediately by further in-vessel components assembly
- Reaching **full plasma current in 2033, and starting DT operations in 2035**

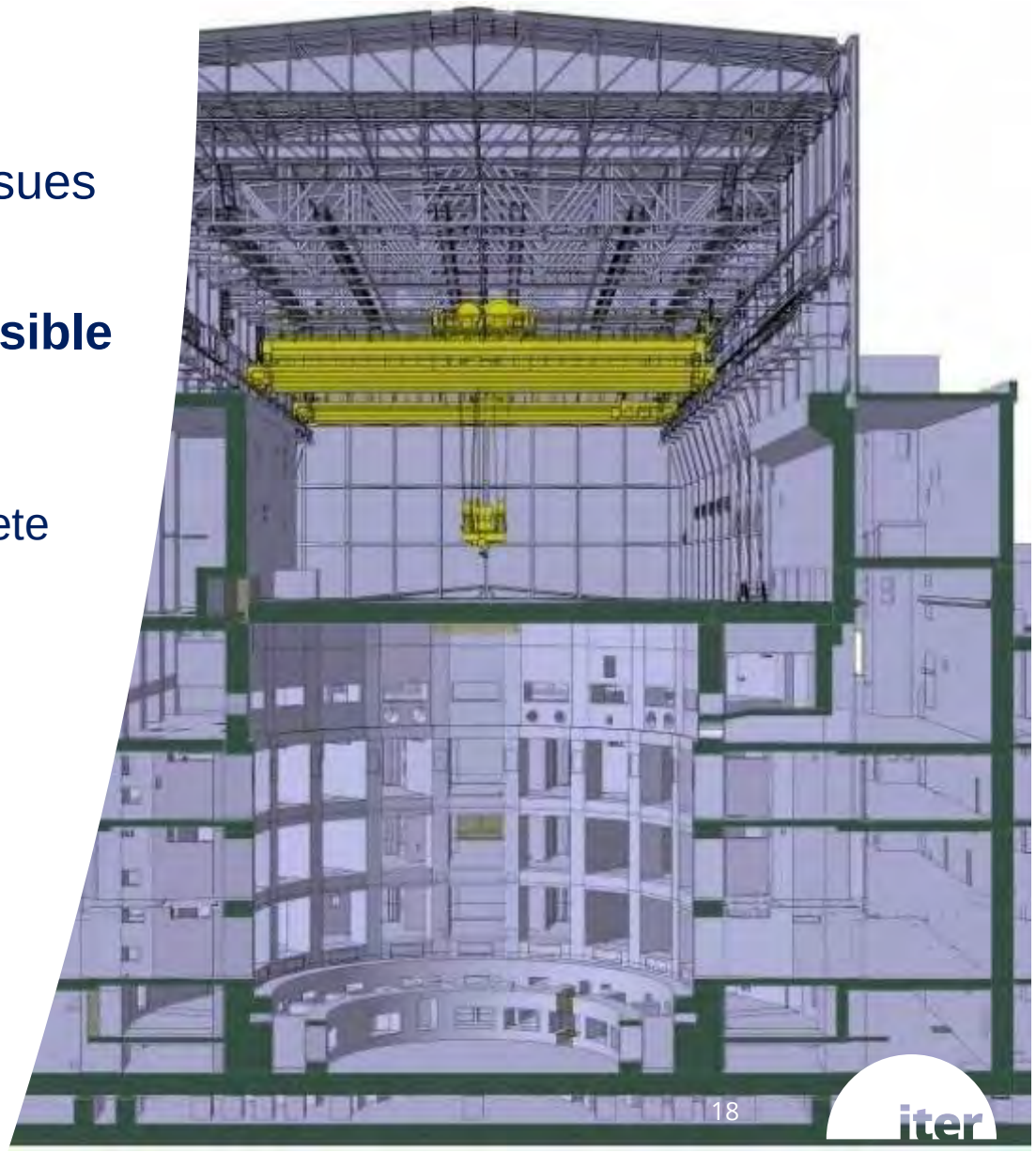
OVERVIEW OF NEW PROJECT BASELINE PROPOSAL

WHY? Delays in deliveries (e.g. VV), issues of quality, issues with regulator, Covid impacts, unrealistic plans

GOAL: **Deliver substantive research as rapidly as possible**

KEY CHANGES:

- More components are now available to build a more complete machine
- Start of Research Operations targeted in **2034**
  - To include 27 months of research
  - Full Magnetic Energy: delayed from 2033 to **2036**
- Start of DT Operations Phase: delayed from 2035 to **2039**

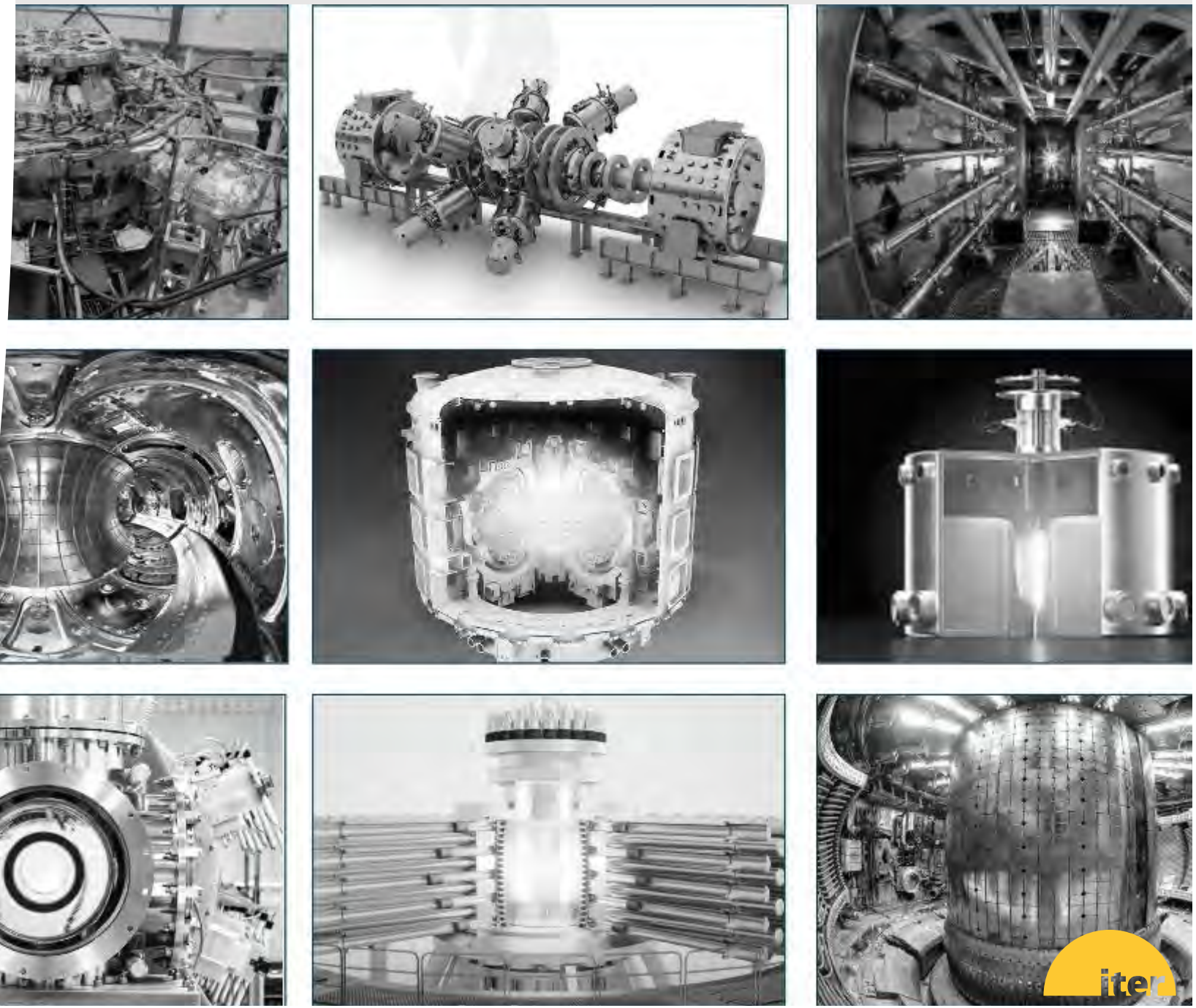


The NEW (2024) BASELINE

- Designed to reach **First Plasma** – and immediately after to move to full magnetic energy to commission machine as much as possible before final FW installation
  - Less risky commissioning, research, safety demonstration plan
    - Start of Research Operation (SRO) 15 MA/5.3T, to include successful demonstration of magnet reliability, control system, disruption mitigation, using H and DD plasmas
    - DT-1: DT operation focused on achievement of specific project goals -> Q ≥ 10, 300-500s with limited fluence (1/100 of end-of-life)
    - DT-2: Full achievement of Project goal (safety demonstration based on DT-1)
  - Stepwise licensing and safety demonstration
  - TF Test facility under fabrication, a few TF coils will be tested at 4k
  - Replacement of Beryllium with Tungsten for First Wall
  - Increase of heating power
  - VV welding re-sequenced, from triplets to 9 sectors simultaneously
  - Assembly contracts reformulated, refocus on key assembly tooling

ENGAGEMENT WITH PRIVATE SECTOR FUSION INITIATIVES

- Requested by ITER Council, November 2023
- Initial workshop held at ITER, May 2024
  - **350** participants
  - Strong private sector endorsement
- Establishing channels for further engagement and knowledge sharing
  - ITER Design Handbook
  - Systematic approach for access to ITER documents
  - Incorporation of appropriate resource and legal constraints
  - Discussions with ITER technical experts
  - Open-sourcing of some ITER science software
  - Etc.



IBF/25

ITER BUSINESS FORUM

23 - 25 April 2025

Marseille

THE NEXT ITER BUSINESS FORUM WILL TAKE PLACE IN MARSEILLE FROM APRIL 23rd to APRIL 25th, 2025

READY FOR MACHINE ASSEMBLY!

The next ITER Business Forum will take place in Marseille, France, from 23 to 25 April 2025.

ITER is moving forward!

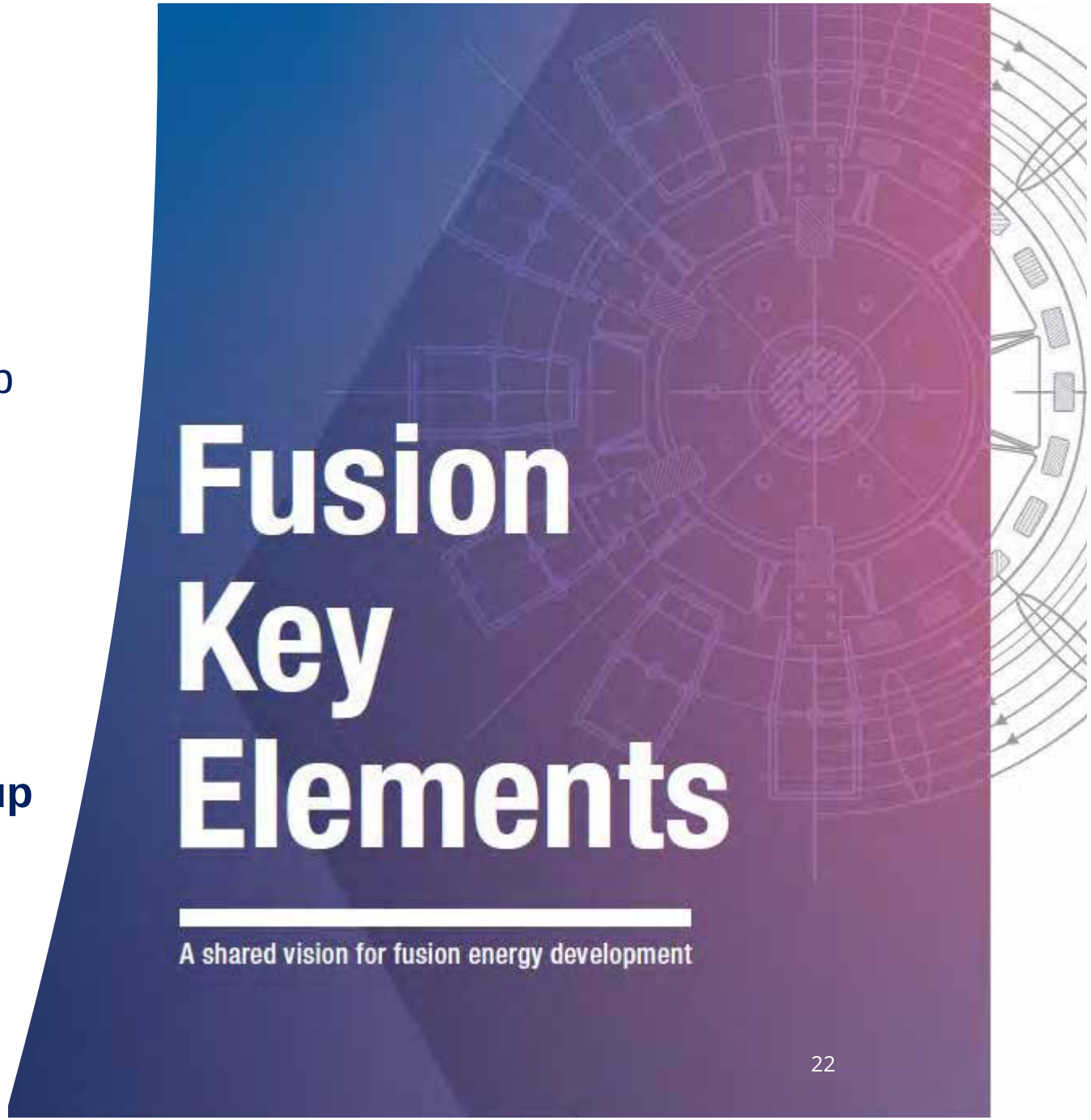
Join the next International ITER Business Forum in Marseille from 23 to 25 April 2025!

The character of the city, its identity and its location at the heart of the Calanques are what make Marseille a unique and pleasant city to visit. Marseille is considered one of the 50 greatest places in the world (Times Magazine).

A SHARED VISION FOR FUSION ENERGY DEVELOPMENT

The **Fusion Key Elements**, edited by the IAEA, was endorsed by the World Fusion Energy Group inaugural ministerial meeting in Rome

https://www.iaea.org/events/ministerial-meeting-of-the-iaea-world-fusion-energy-group



Updated ITER Research Plan (proposal to ITER Council)

Now		~18 months	~27 months (start autumn 2034)		~10 months
Engineering fabrication of system	Pre-SRO assembly	Integrated Commissioning I	Start of Research Operation (SRO)	Post SRO Assembly	Integrated Commissioning II

Install:
- Actively cooled W divertor
- Blanket shield blocks
- Inertial W First Wall panels
- 40 MW ECH
- 10 MW ICH

- Commission PCS and Protection Systems to reduce risks in DT-1
- Hydrogen L-mode to 15 MA/5.3T
- Demonstrate H-mode DD plasmas
- First assessment of boronization, fuel retention/recovery, ICWC

- Final, actively cooled W First Wall
- NBI: 33 MW
- ECH: 40 → 60-67 MW
- ICH: 10 → 20 MW
- Final diagnostics set

DT-2, ~3 x 10^{27} neutrons

FPO-y	FPO-(...)	FPO-x
DT (Q=10), high duty ≥ 500 s Q ≥ 5, 1000, 3000 s		

DT-1 ~ 10 years, ~3 x 10^{25} neutrons

FPO-5	FPO-4	FPO-3	FPO-2	FPO-1
D, DT (Q=10) ≥500 s High duty, 250 MW, ≥300 s	D, DT (Q=10) 500 MW, ≥300 s	D, DT (Q=10) 500 MW, ~50 s	D, DT, 100 MW, ~50 s	H, H+T, D

(start autumn 2039)

Q = 10 burn extension