The JET ITER-like Wall - Status and Experimental Programme

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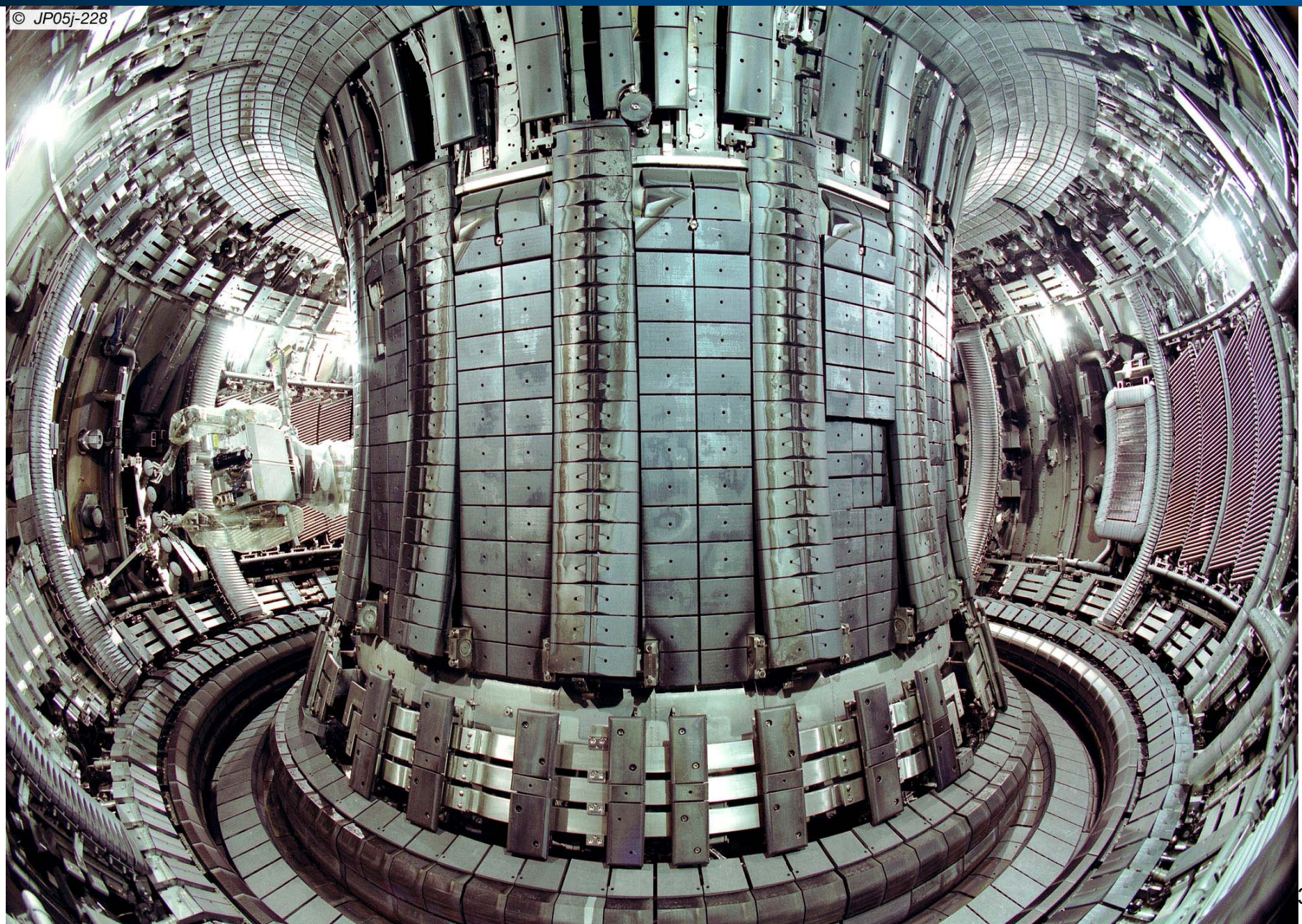
PFMC13 – May 9th 2011 Rosenheim

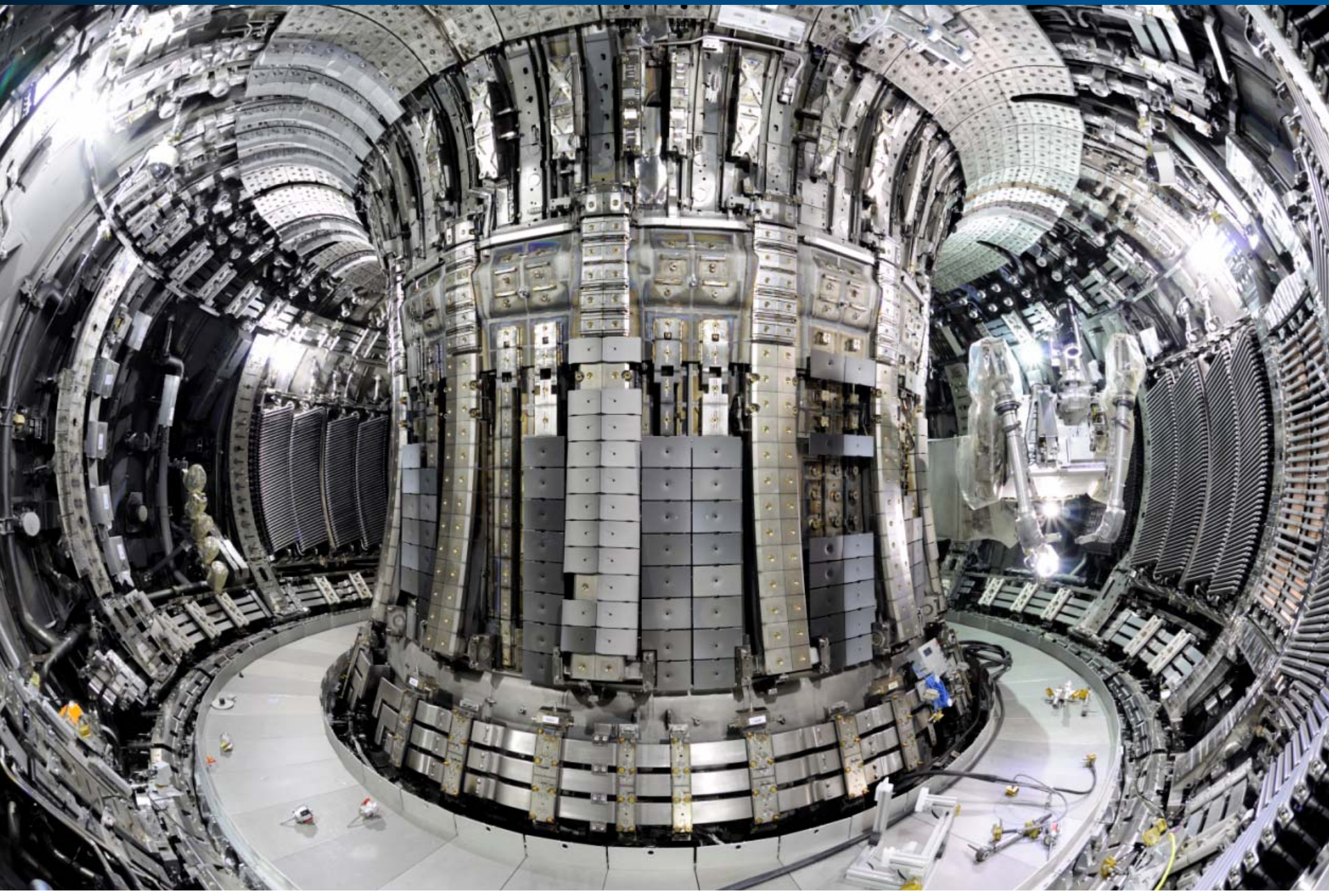
Outline

- Tour of the ITER-like Wall
- Remote handling overview
- There's more to the JET upgrade than the ILW
- The 2011/12 Experimental Programme

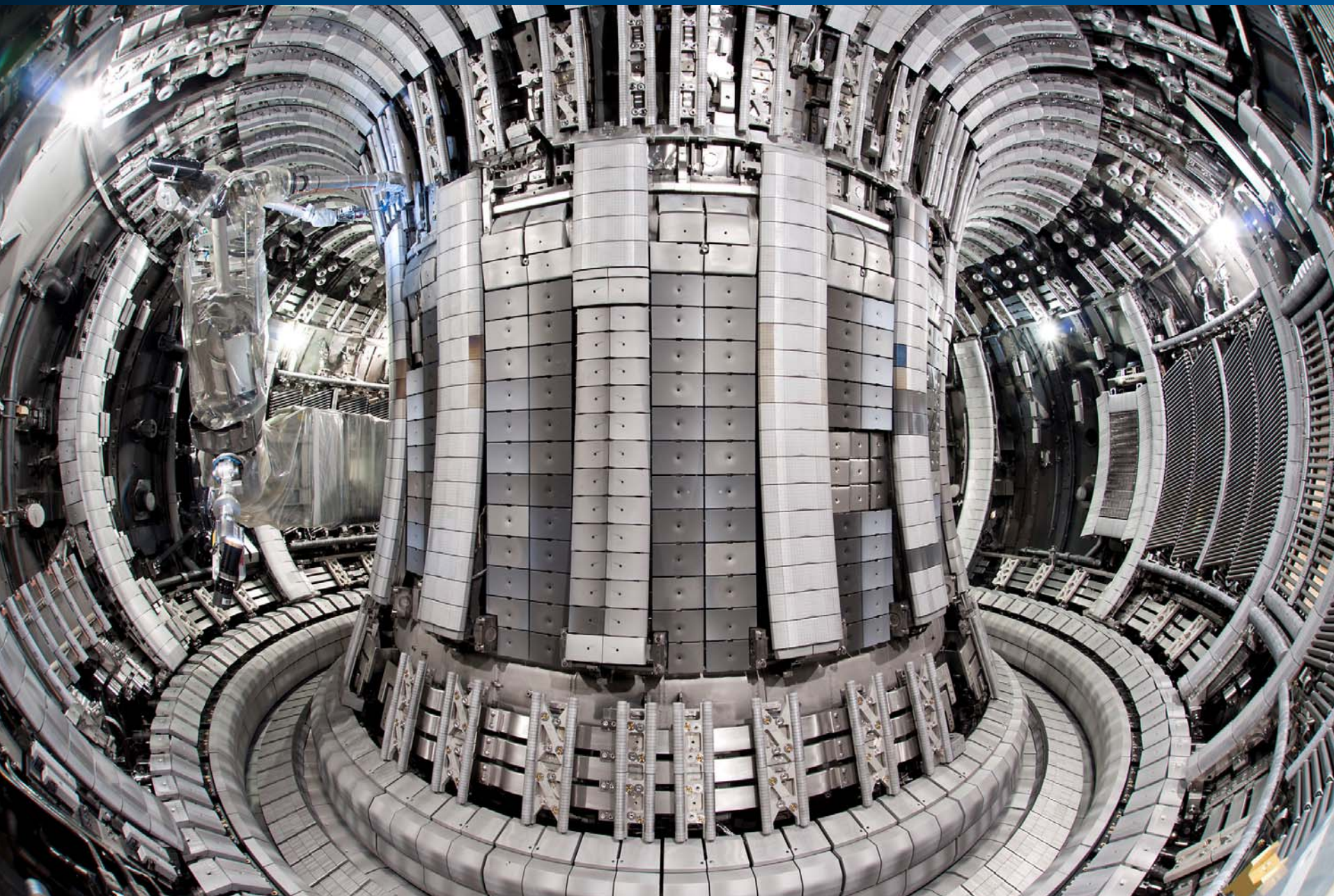
The Carboniferous Era of JET 2009



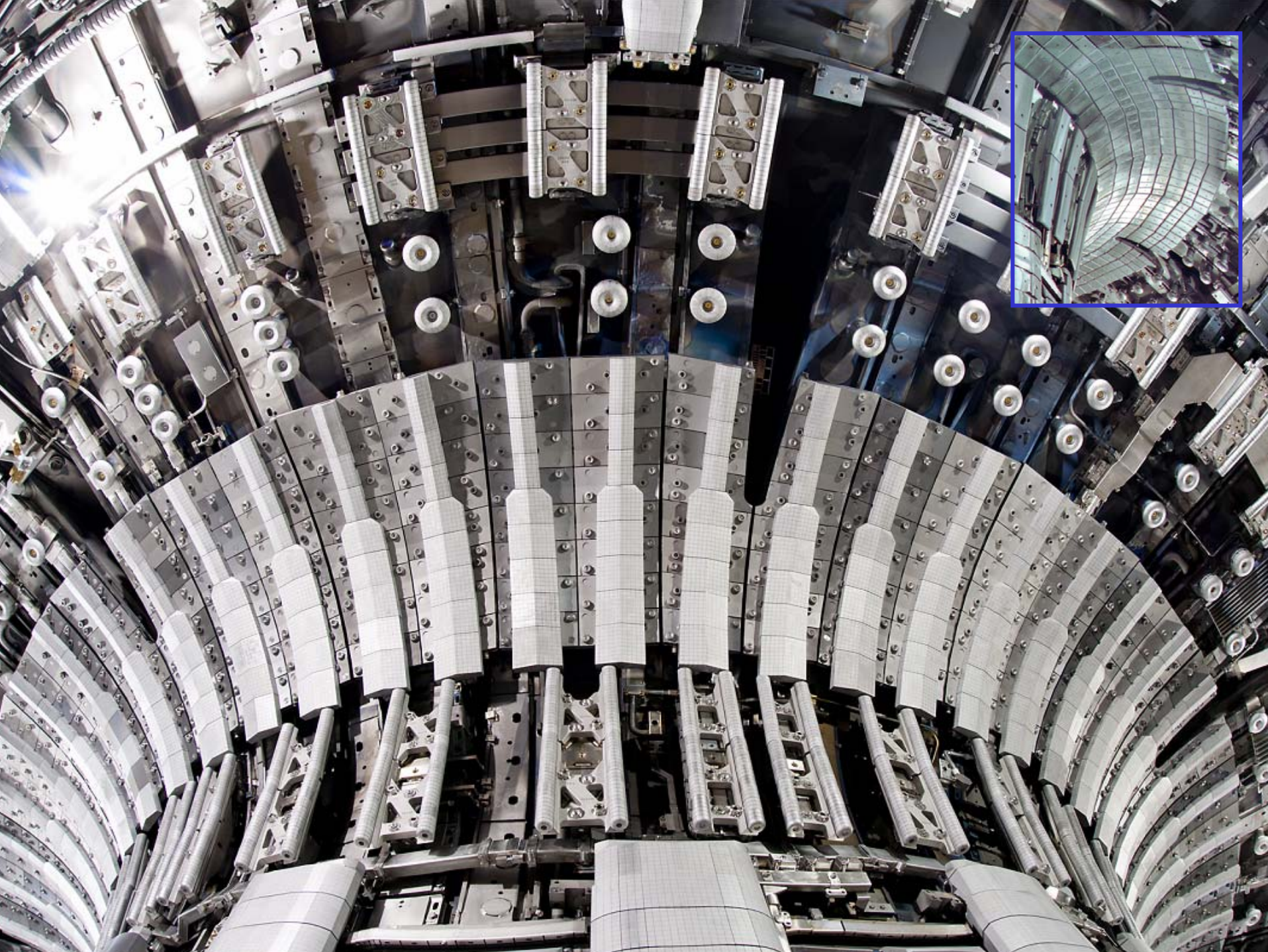
19th September 2010



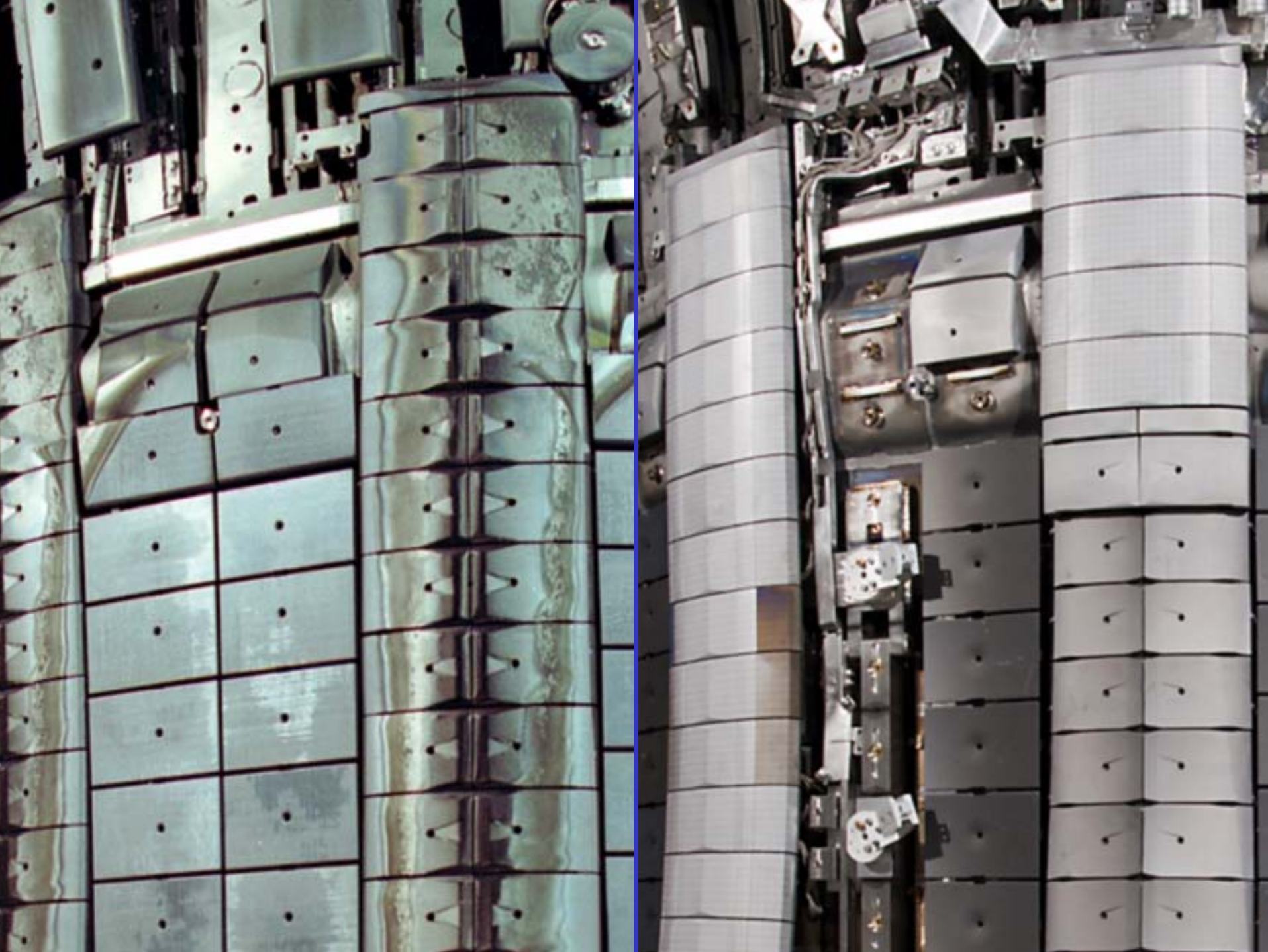
The ITER-like Wall – 8h May 2011

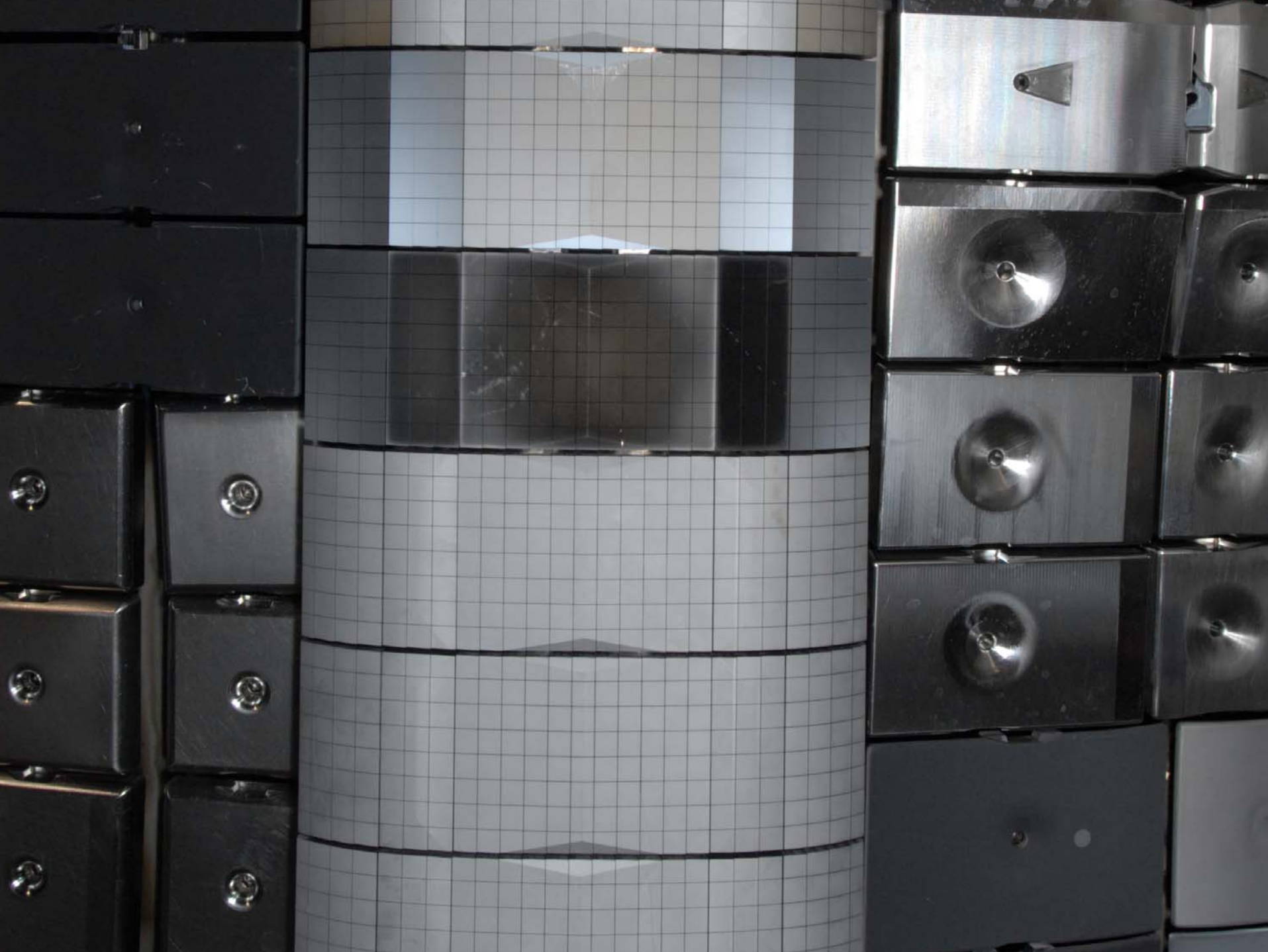


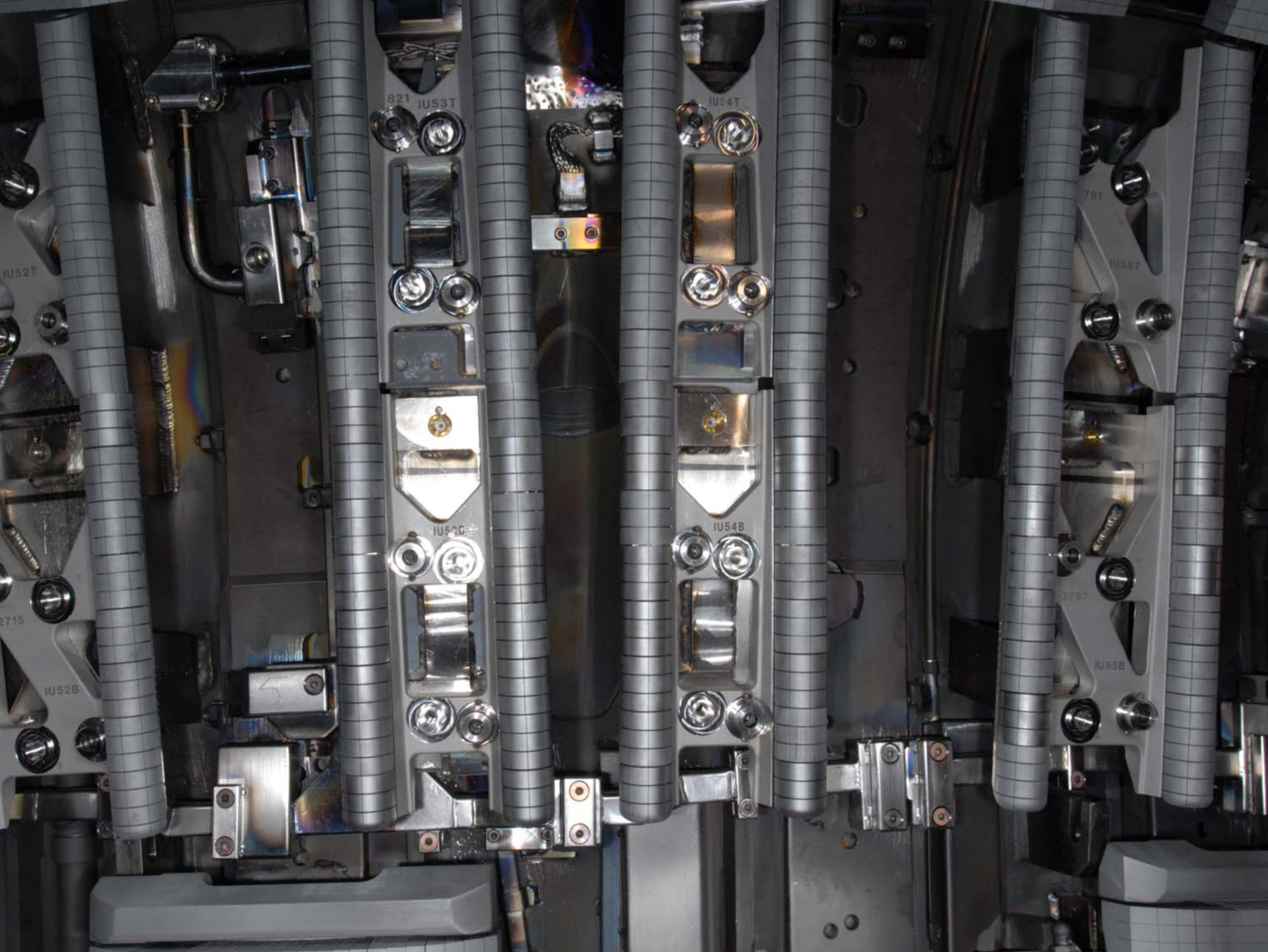

Mertens I-06




OU35T
OU34T






821
IU53T
IU54T
IU52T
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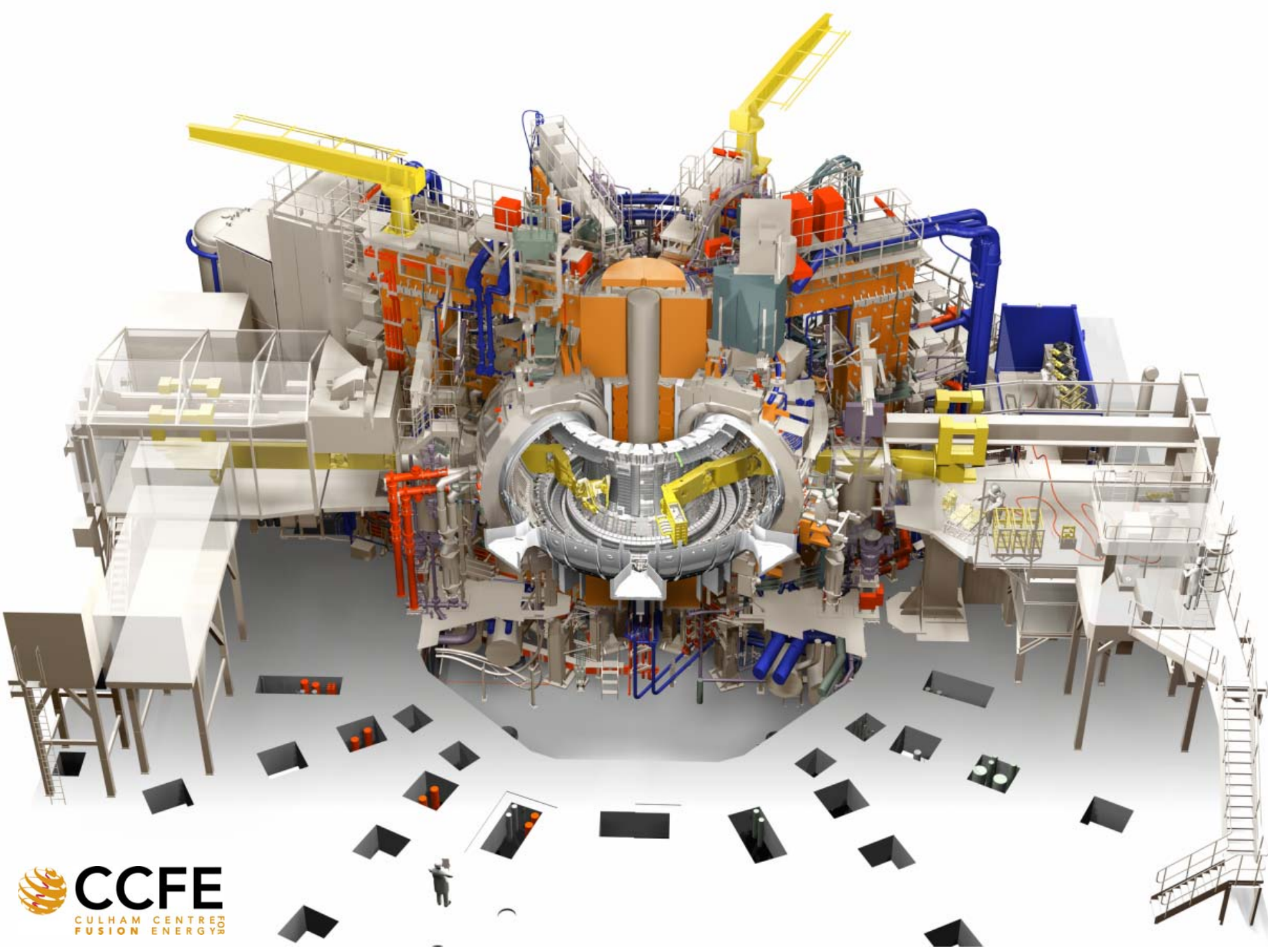
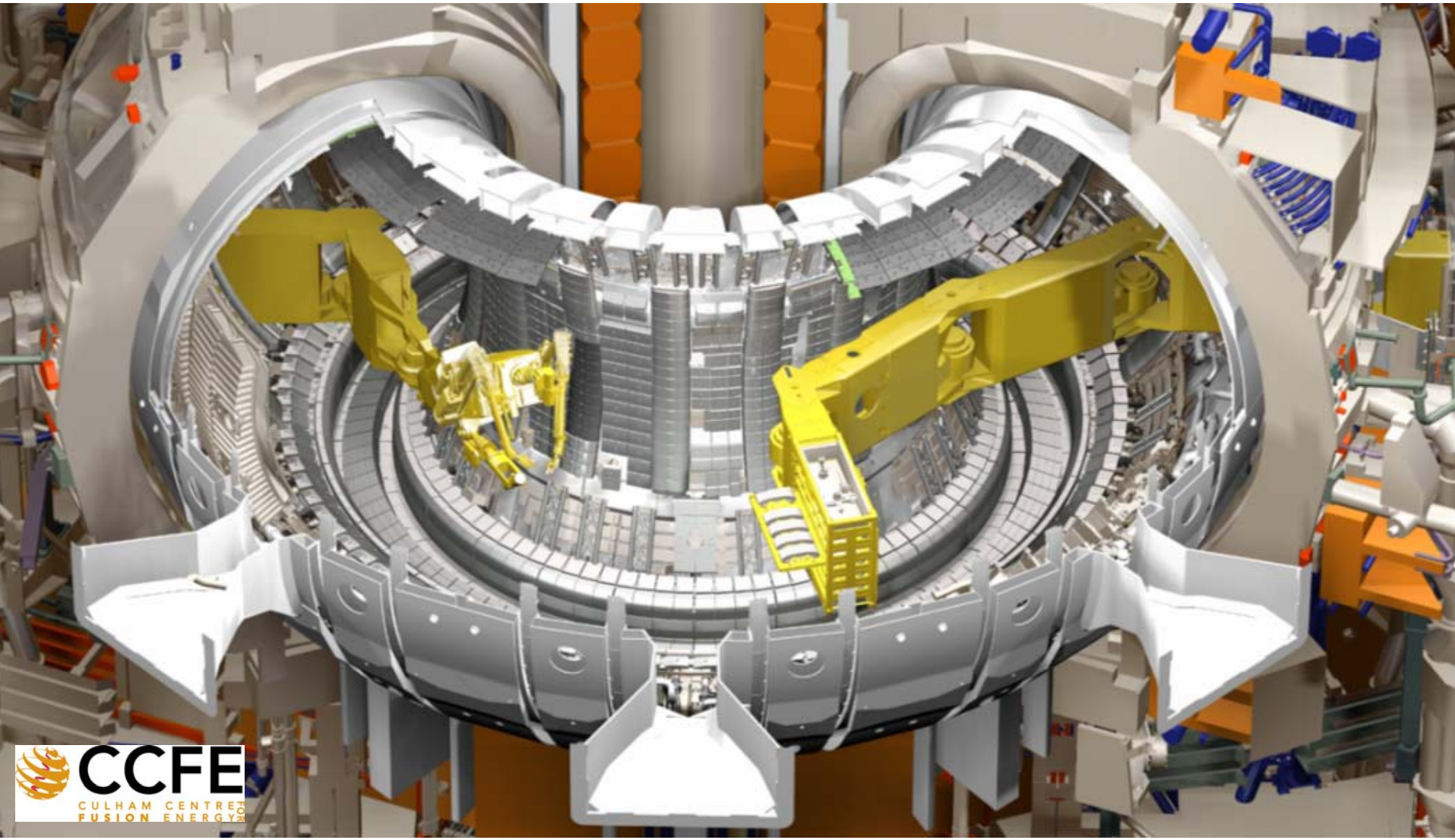
IU54B
IU52B
IU55B

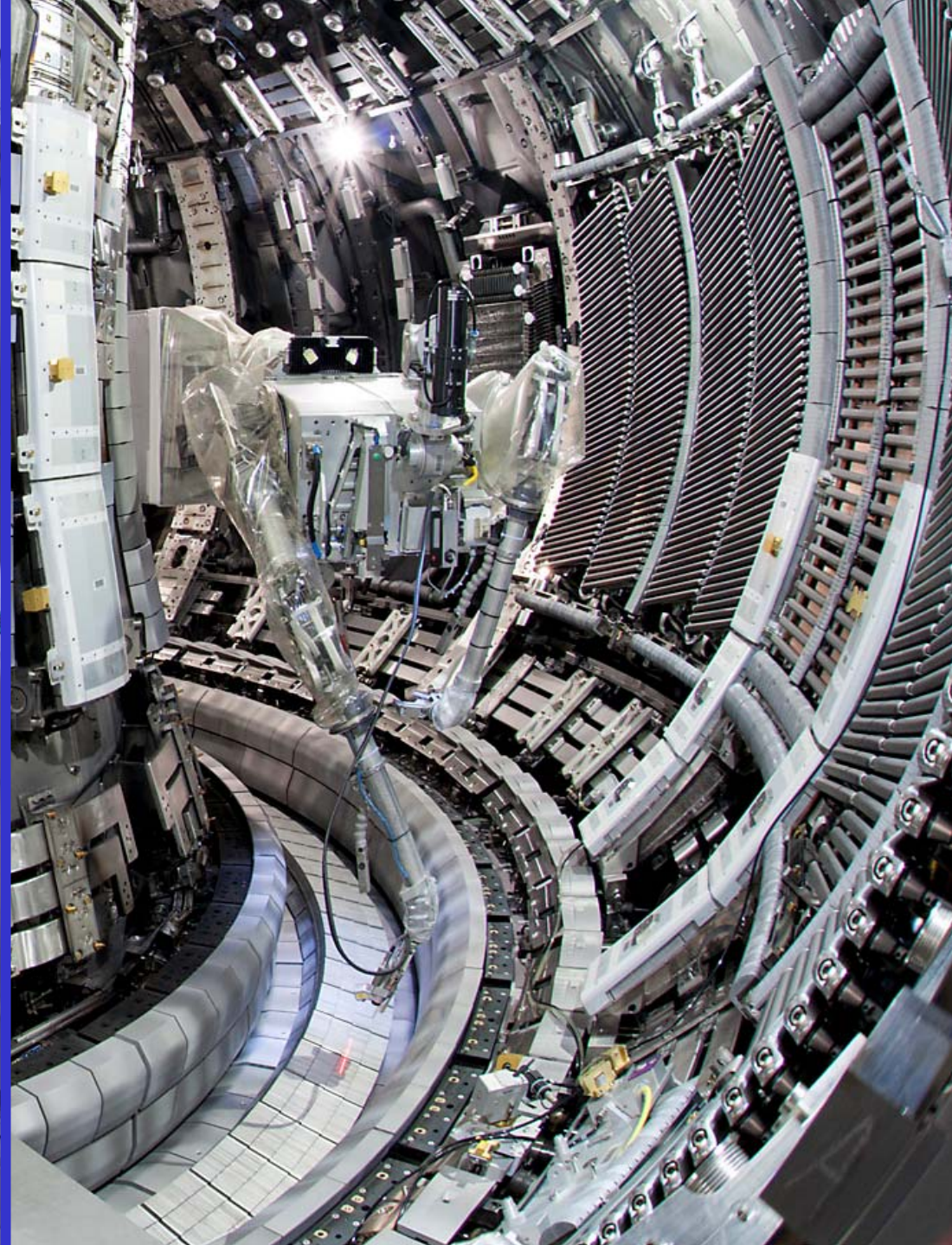
ITER-like Wall Project Metrics

Number of installed items	2,880
Number of individual tiles:	5,384 Be tiles (~2 tons Be / ~ 1m^3) 1,288 W-coated CFC tiles 9,216 W-lamellas (~2 tons W / ~ 0.1m^3) **15,828**
Total number of parts:	82,273 counting bulk W modules as one part
Bulk W total parts:	191,664 including 100,080 shims
Total cost including manpower:	~60M€


CCFE
CULHAM CENTRE FOR FUSION ENERGY

Remote handling booms in JET



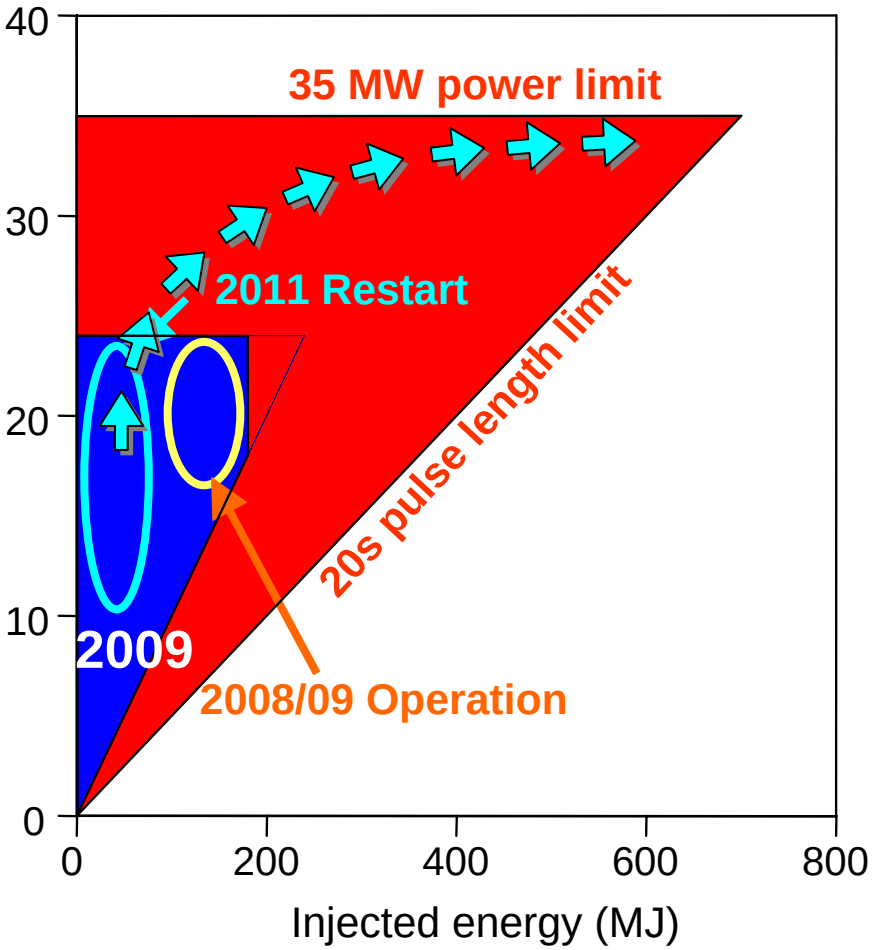


There's more to this upgrade than the wall

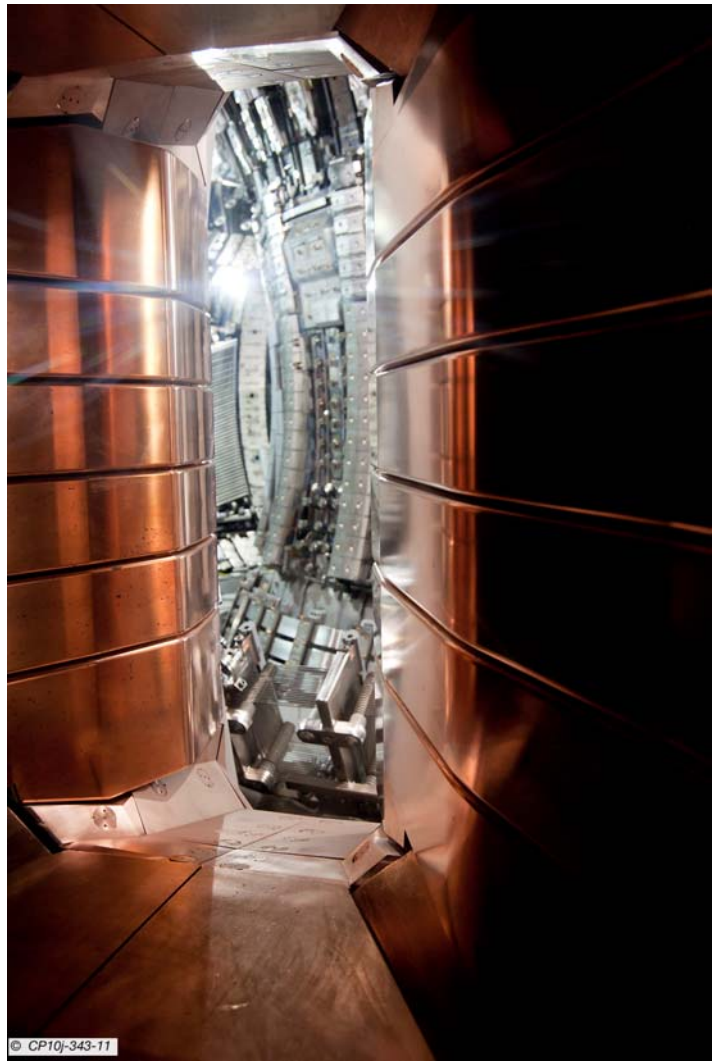
- Neutral beam
- Diagnostics – mostly wall related (e.g.SIW)
- Protection system for the wall (PIW)
- Plasma control, EFCC (ELM mitigation), POET (early X-point)
- …and more

Neutral Beam Upgrade ⇨ Expanded Operating Space

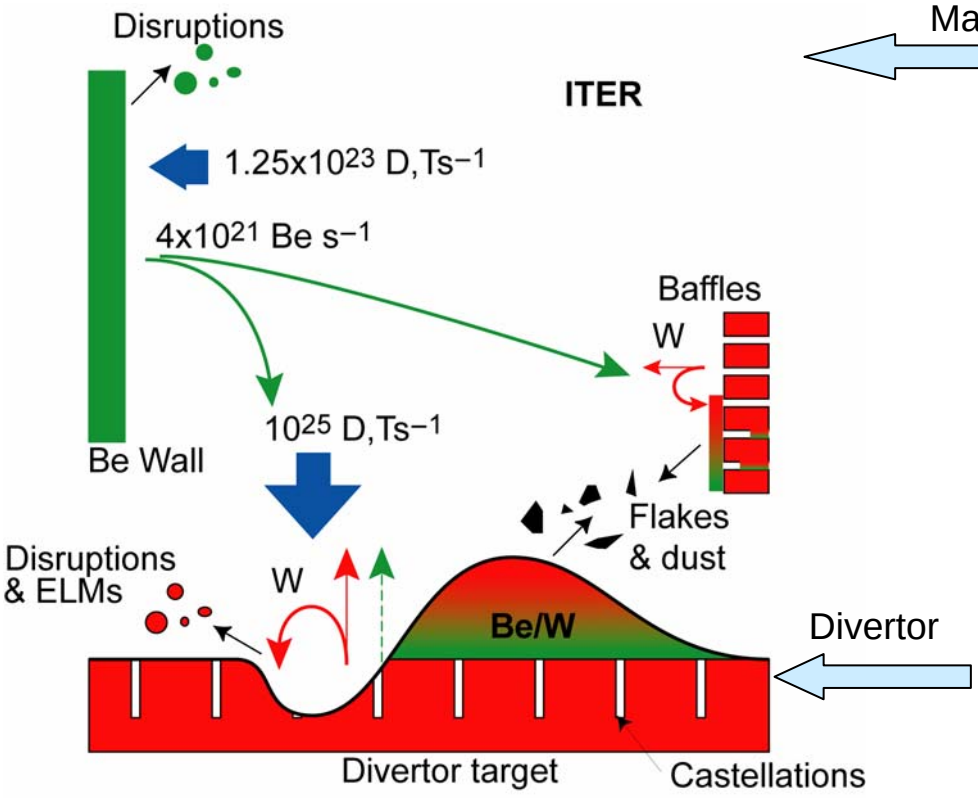
Increases beam capability



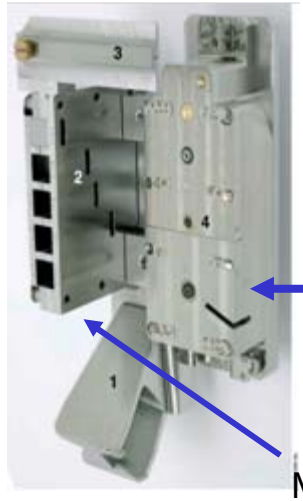
Actively cooled duct



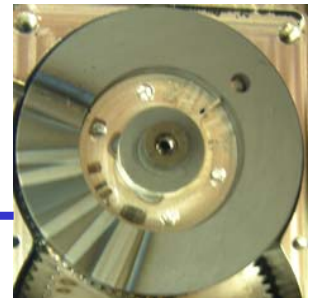
New set of Erosion-Deposition Diagnostics



Main Wall

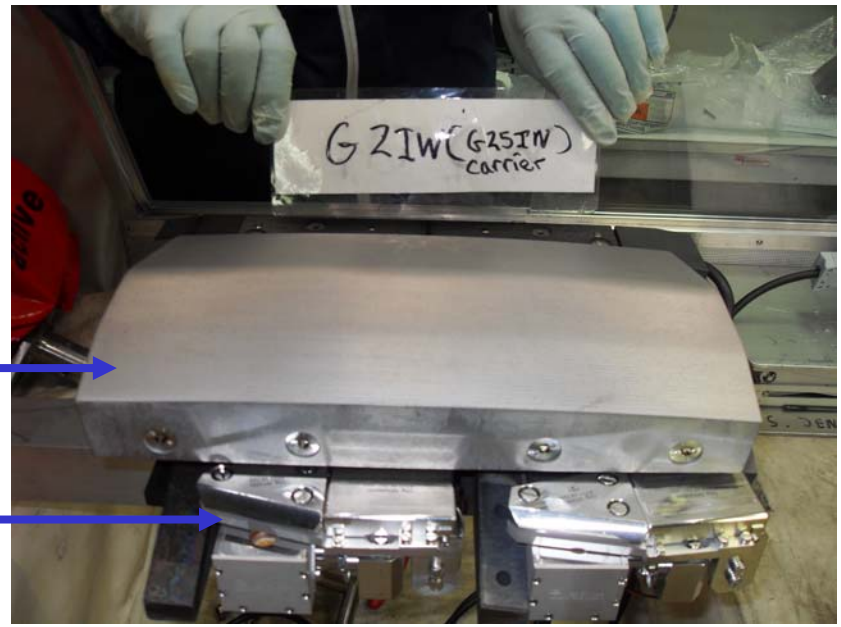


Rotating collector



Mirror cassettes
(Ivanova)

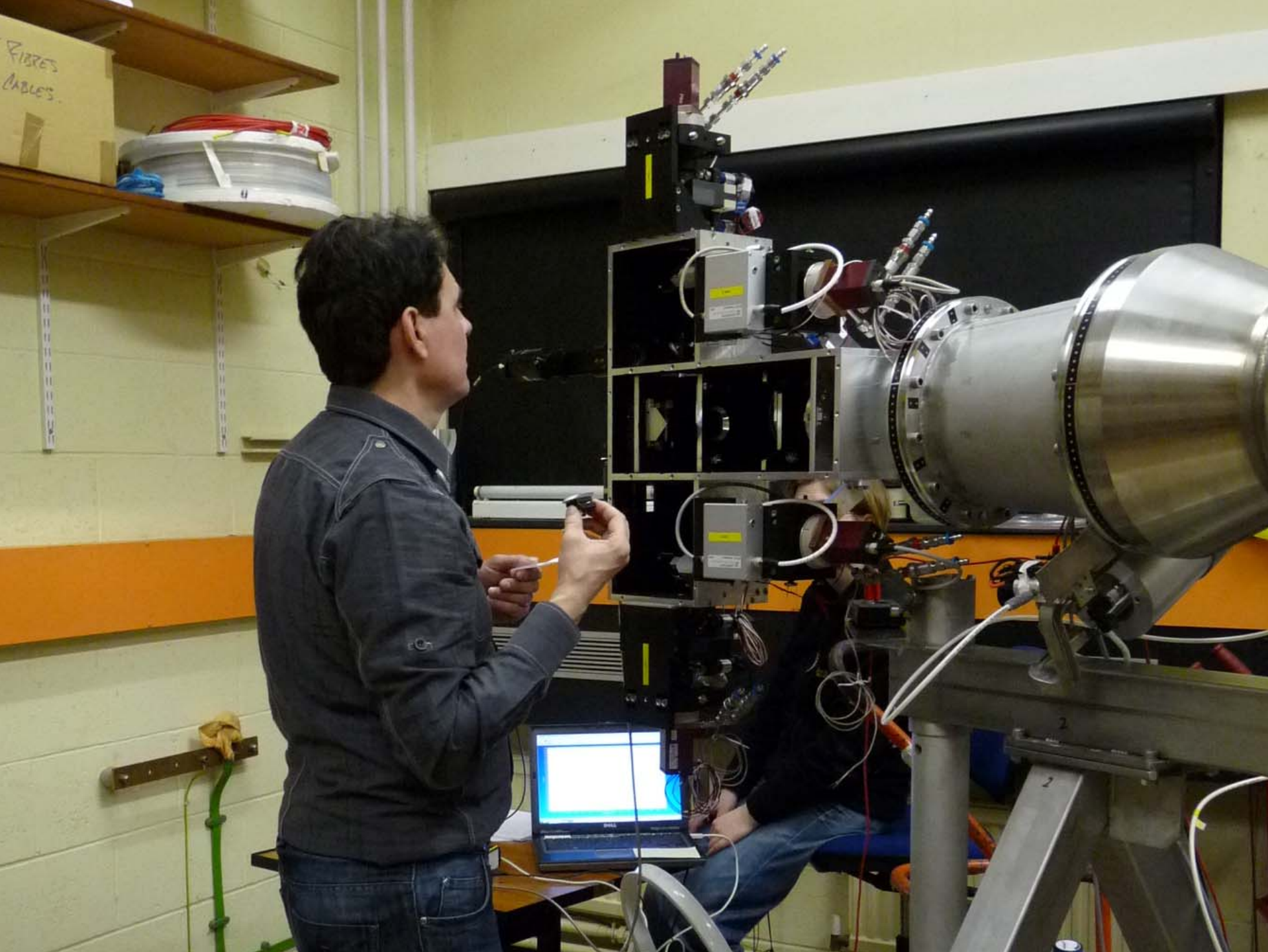
Divertor



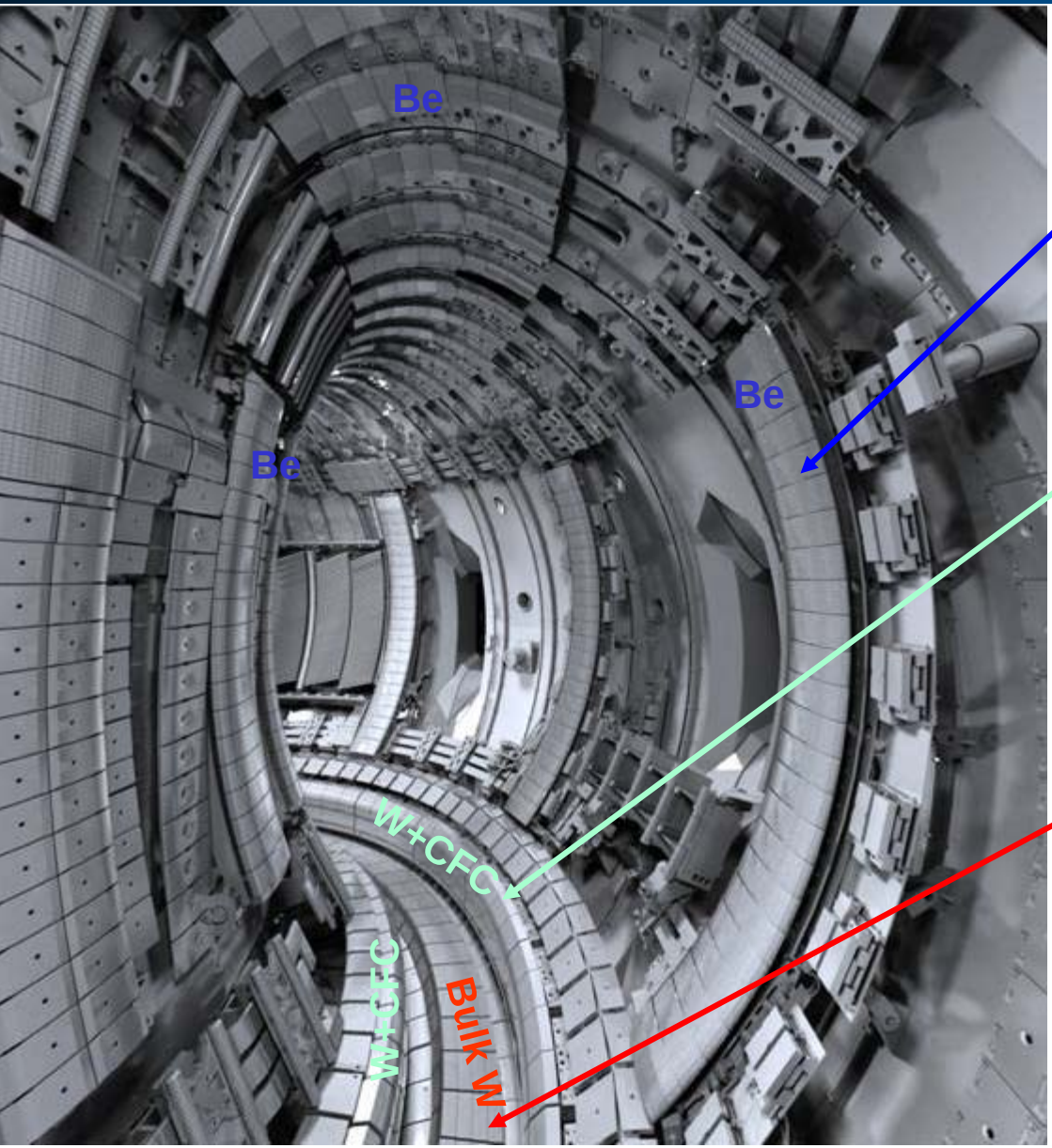
Special marker layers for ion beam analysis

..and tile profiling (Widdowson)

Quartz Micro-Balances


FIBRES
CABLES

Summary of ITER-like Wall limits



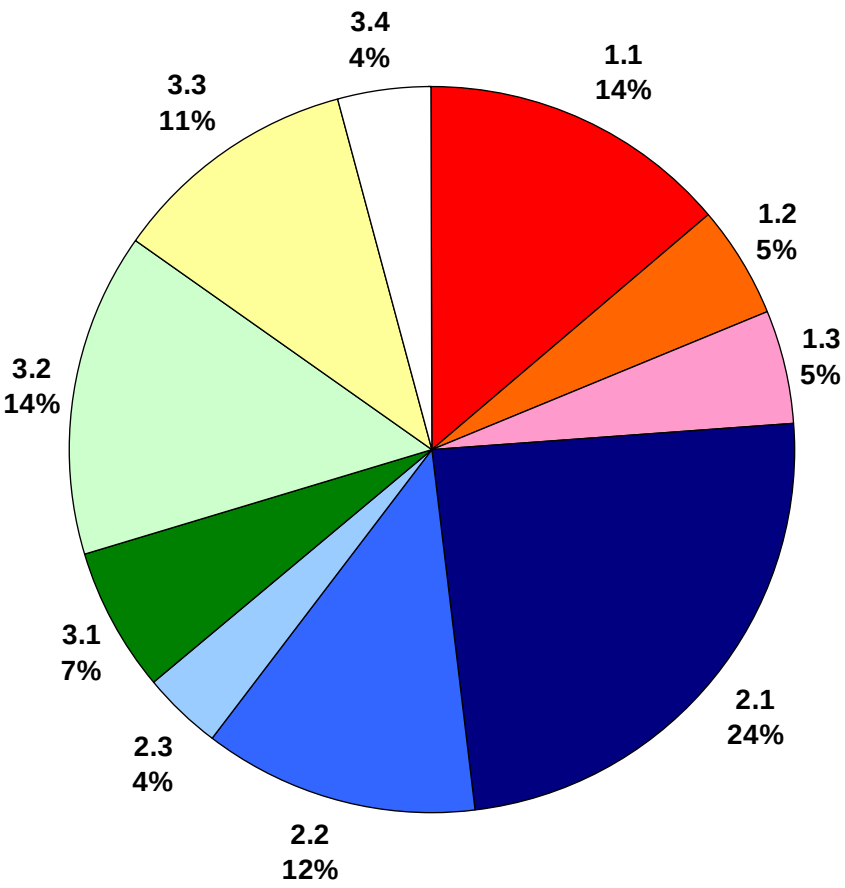
Solid Be
Surface temperature < 900°C
<22MJm^{-2}s$^{-1/2}$ (impact energy)

W-coated CFC
Temperature <1200°C (carbidization)
ELMs: <5 MJ m^{-2} s$^{-1/2}$ (Thomser)

W stacks
Surface temperature limit
<1200°C-2200°C
20-35MJm^{-2}s$^{-1/2}$,
Fixings, <350°C, <60MJ/m^2/stack (Mertens)

Programme preparation - Headlines

Proposals received (~205)

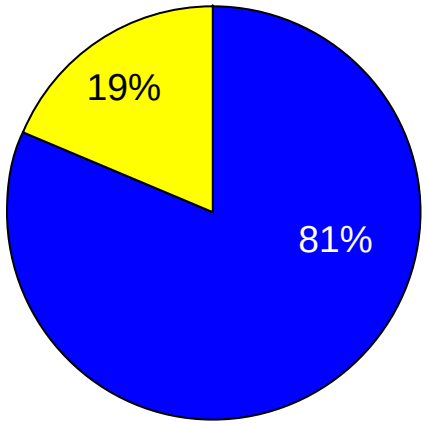


1. **Characterisation of the ITER-like Wall**
   - 1.1 Fuel retention and material migration
   - 1.2 Material limits and long-term samples
   - 1.3 Transient and steady-state power loads

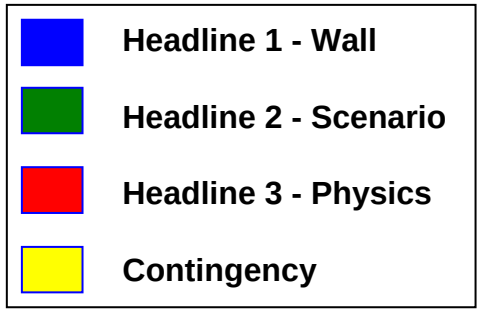
2. **Exploration of ITER operating scenarios with the ITER-like Wall**
   - 2.1 Develop plasma scenarios
   - 2.2 Assess plasma scenarios
   - 2.3 Explore scenarios in domains closest to ITER dimensionless parameters

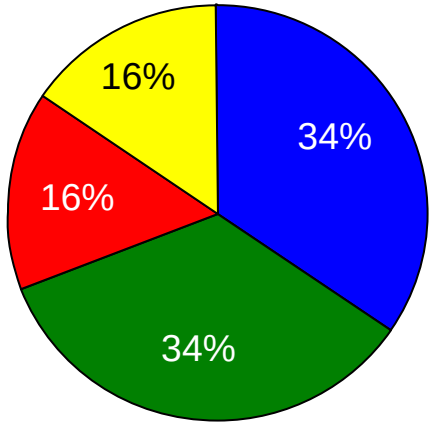
3. **Physics issues essential to the efficient exploitation of the ILW and ITER**
   - 3.1 Divertor and Scrape-Off Layer physics
   - 3.2 Confinement, pedestal and ELM physics
   - 3.3 Disruptions, MHD and fast particle physics
   - 3.4 Diagnostic issues for ITER

Time allocated by Headline C28 & C29

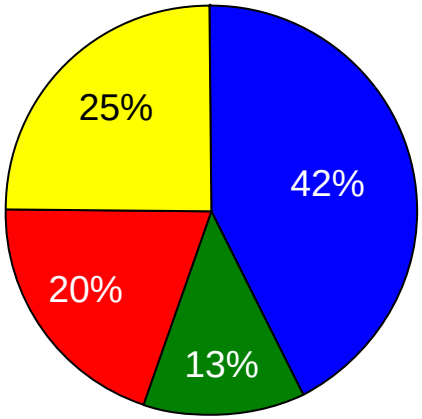


C28a: 8 days
Ohmic – migration/mixing

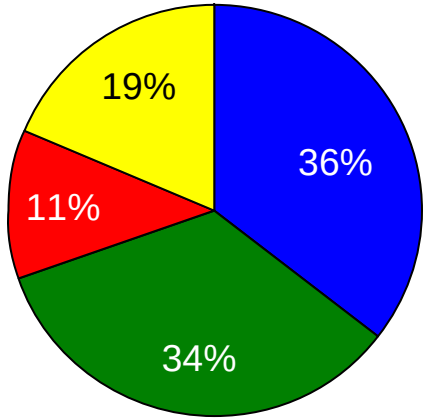




C28b: 15 days
L-mode, 1st H-mode



C28c: 20 days
H-mode

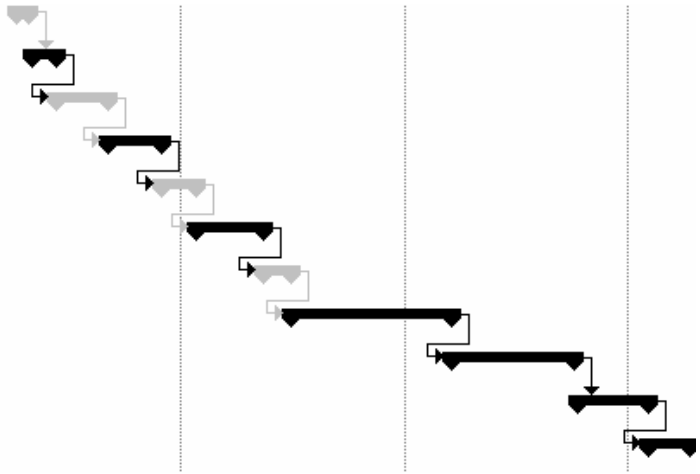


C29: 46 days
Routine H-mode

Experiments in C28-C29:	52
Parasitic experiments:	39
Back-up experiments:	15

Gradual expansion of operating space

Restart 1 - including conditioning studies
C28A Ohmic studies - first material migration/mixing
Restart 2
C28B L-mode Studies and initial H-mode
Restart 3
C28C Establish and characterise first H-modes
Restart 4
C29 Establish and exploit robust H-modes and ELM mitigation
C30A Expansion of operating space including hybrid modes
C30B Exploitation of available operating space
C30C Operation prior to long term sample retrieval



- Restart blocks interleaved with Campaign C28 blocks.
- Plan is based on five-day double-shift operation (Restart and Campaign C28-29)
- 182 experimental days in C28-C29-C30.
- Detailed plan established for C28-C29.
- C30 to be consolidated in Nov 2011 in a Programme meeting

C28 Campaign

	Scenario Development	PFMC Relevant Experiments
R1	1 limiter phase, X-point formation and low shape	
C28a	First ohmic scenario	Initial Be erosion, material mixing and retention
R2	More shapes + PPCC: HT3, V5, SFE PIW end-to-end tests First NBI box, ICRH, LH	
C28b	L-mode qualification First H-mode attempts	Monitoring pulse preparation Limiter plasma characterisation Intrinsic impurity composition C/Be migration study Fuel retention using AGHS in L-mode First disruption studies Be & W power handling
R3	WALLs energy limits Second NBI box + advanced limit setting Increased ICRH + ECT VDE tests	
C28c	H-mode qualification with ILW Baseline H-mode at 2.5MA (1st)	W-screening peaking and control Particle balance with N injection Fuel retention using AGHS in H-mode Material migration to remote areas Characterisation of heat load including ELMs Disruption heat load Bulk W tile power handling

Conclusions

- The JET ITER-like Wall is complete
- First plasma due early August
- Thanks to ILW and other upgrades the 2011/12 JET programme promises to be immensely influential for ITER