EIROforum

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The European Fusion Development Agreement

and its JET experiment explore the potential of fusion as an energy source

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Preparing for ITER

ITER now being constructed, due to operate in 2020

ITER aims to produce 10x more power than input

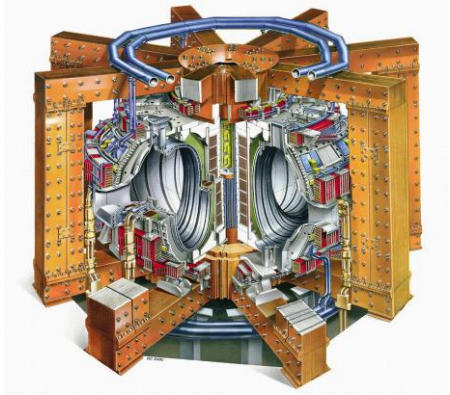
ITER Pit

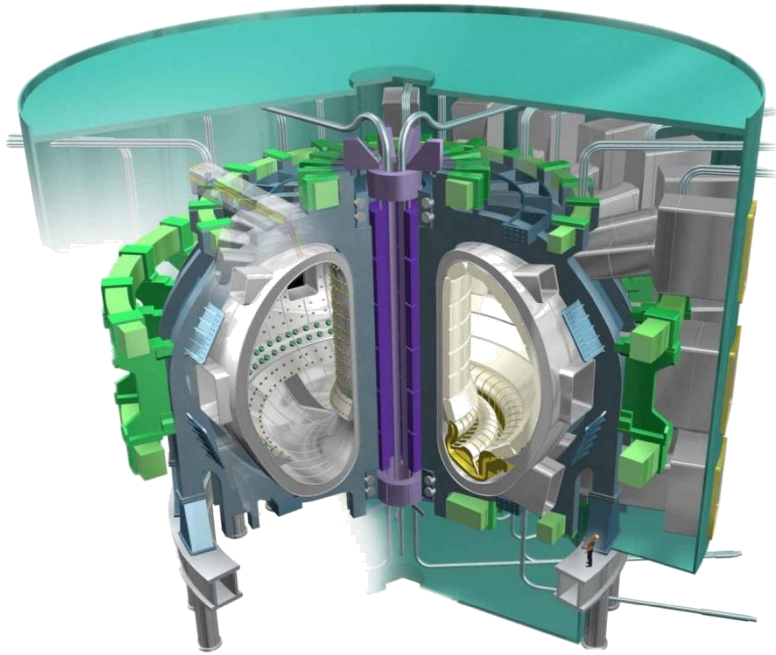
Tokamak Complex Construction

Coil Winding Building

JET: On the path to ITER

The ITER design is based largely on the success of JET

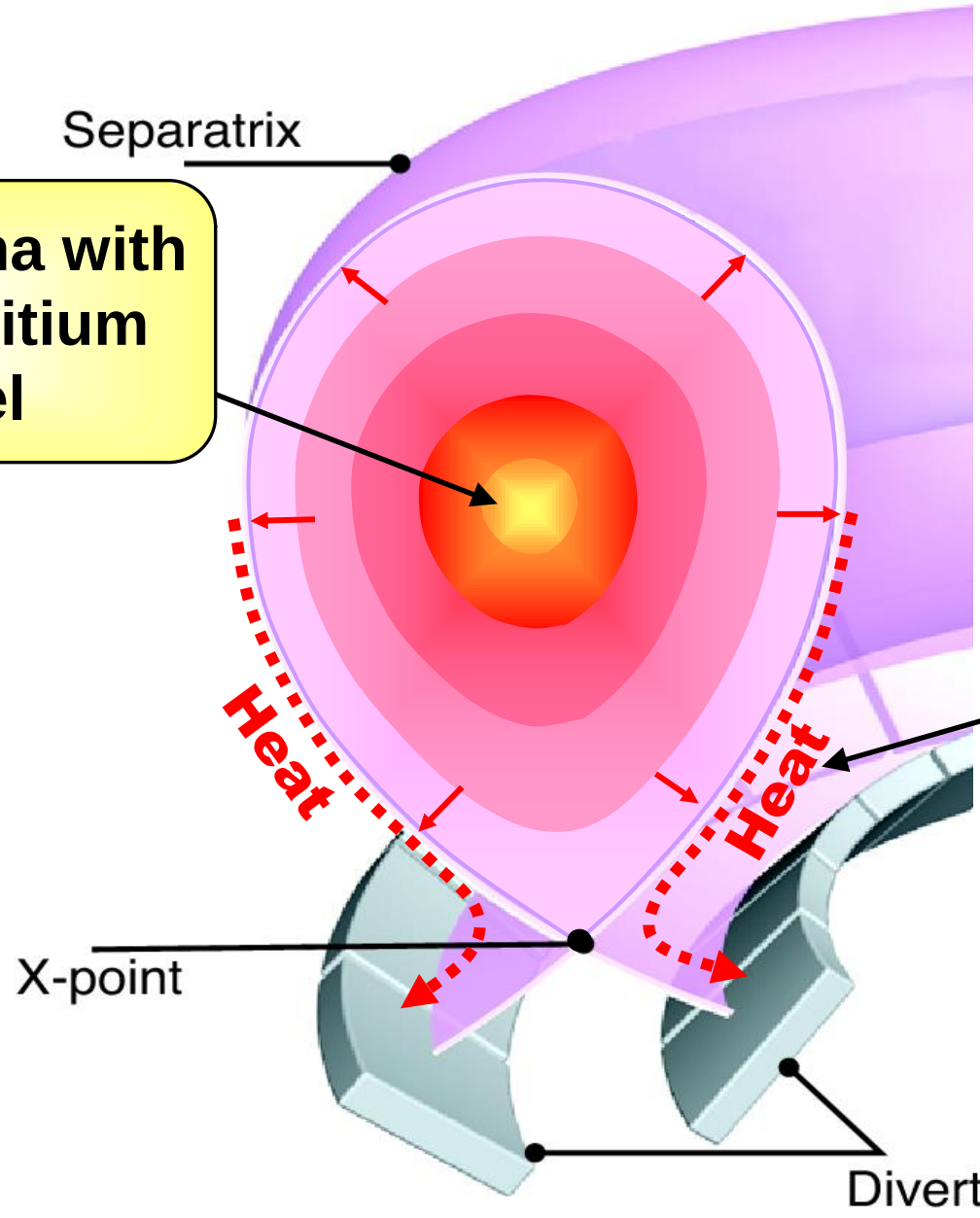




	JET	ITER
Machine diameter	6 m	12 m
Plasma volume	80 m^3	800 m^3
Fusion power	~16 $MW_{thermal}$	~500 $MW_{thermal}$
Fusion power / Input power	Q<1	Q=10

ITER Operation will be optimally prepared with JET

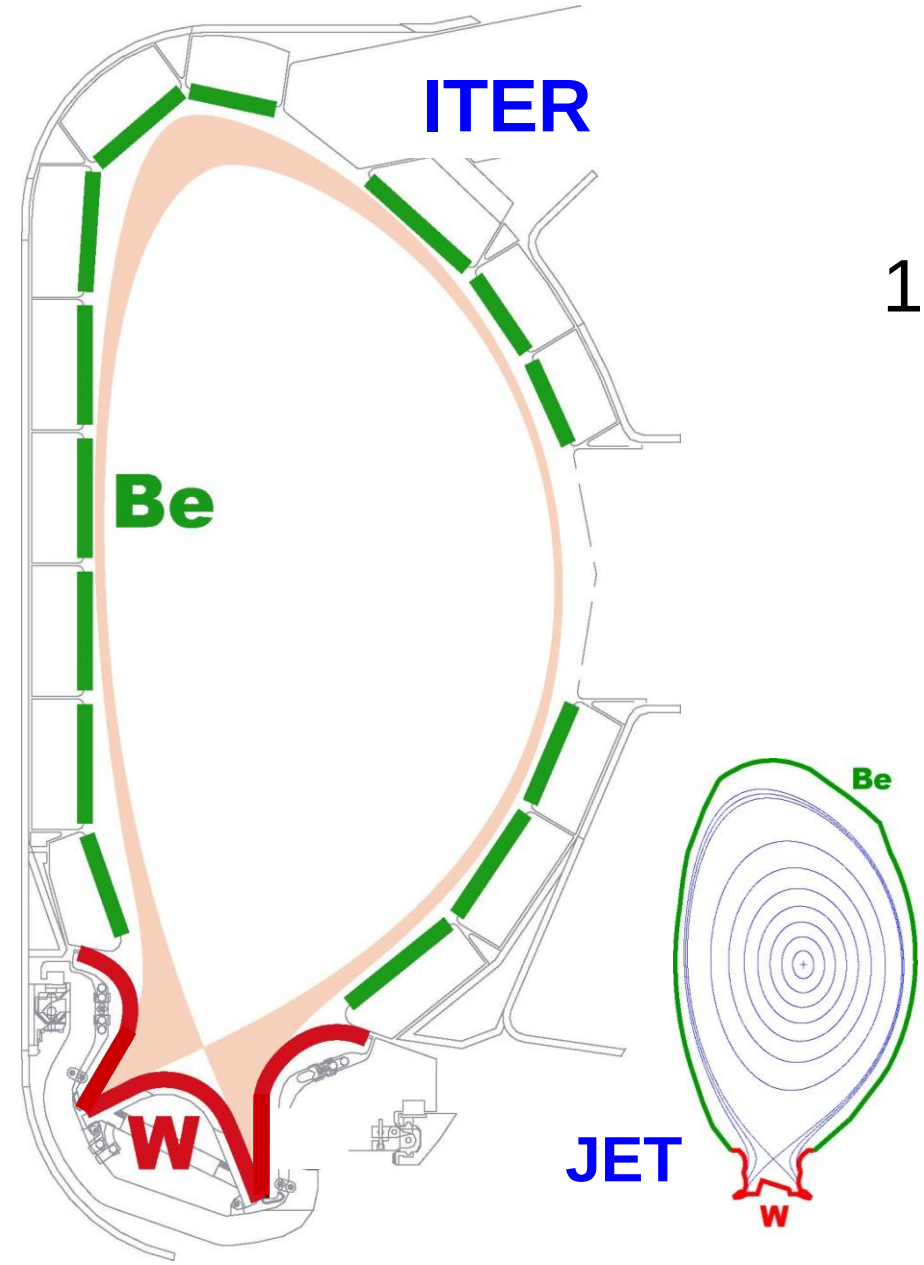
Developing ITER scenarios



Burning plasma with Deuterium-Tritium (D-T) fuel

Handling heat loads & reducing Tritium retention

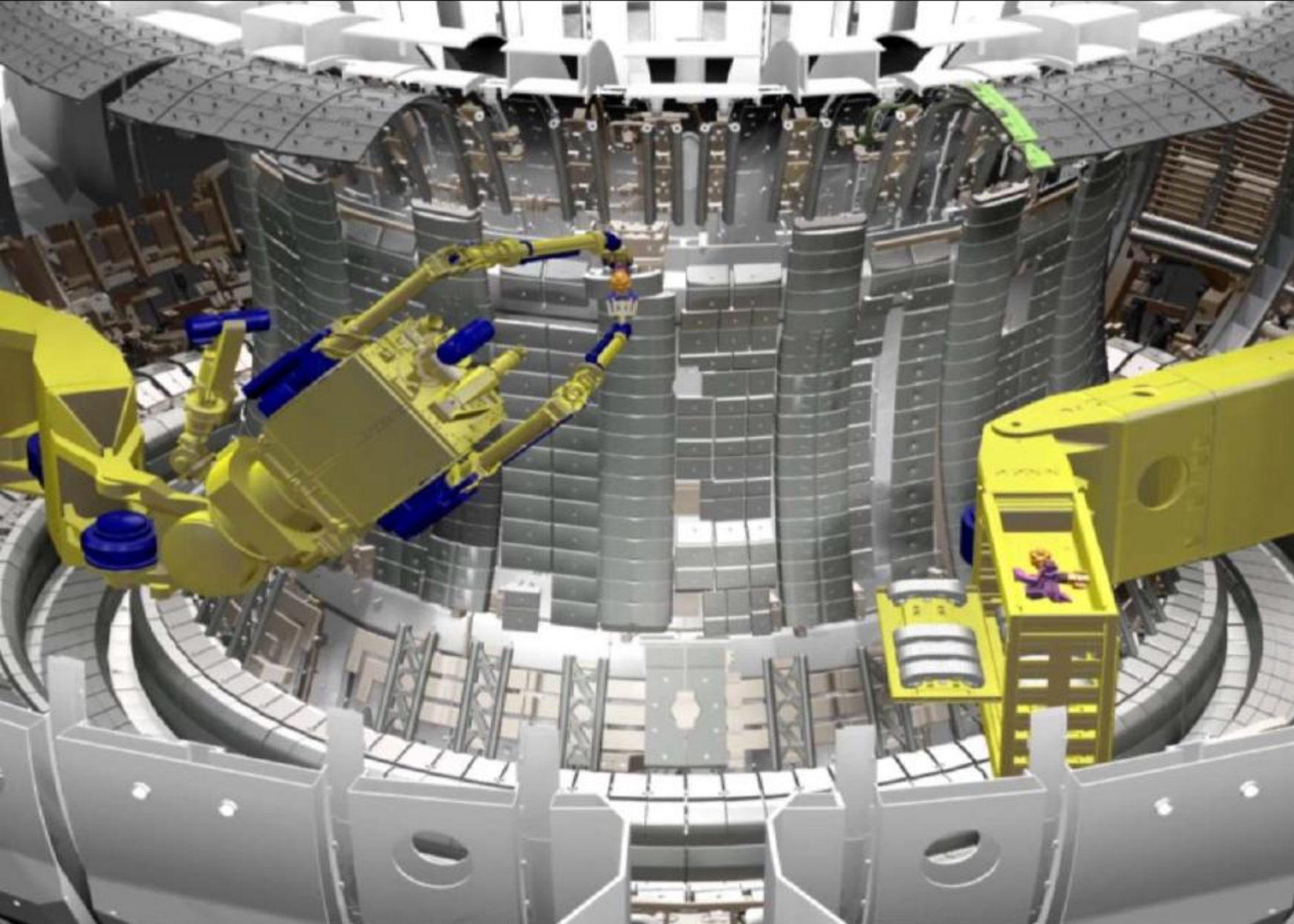
Only JET has ITER-like wall

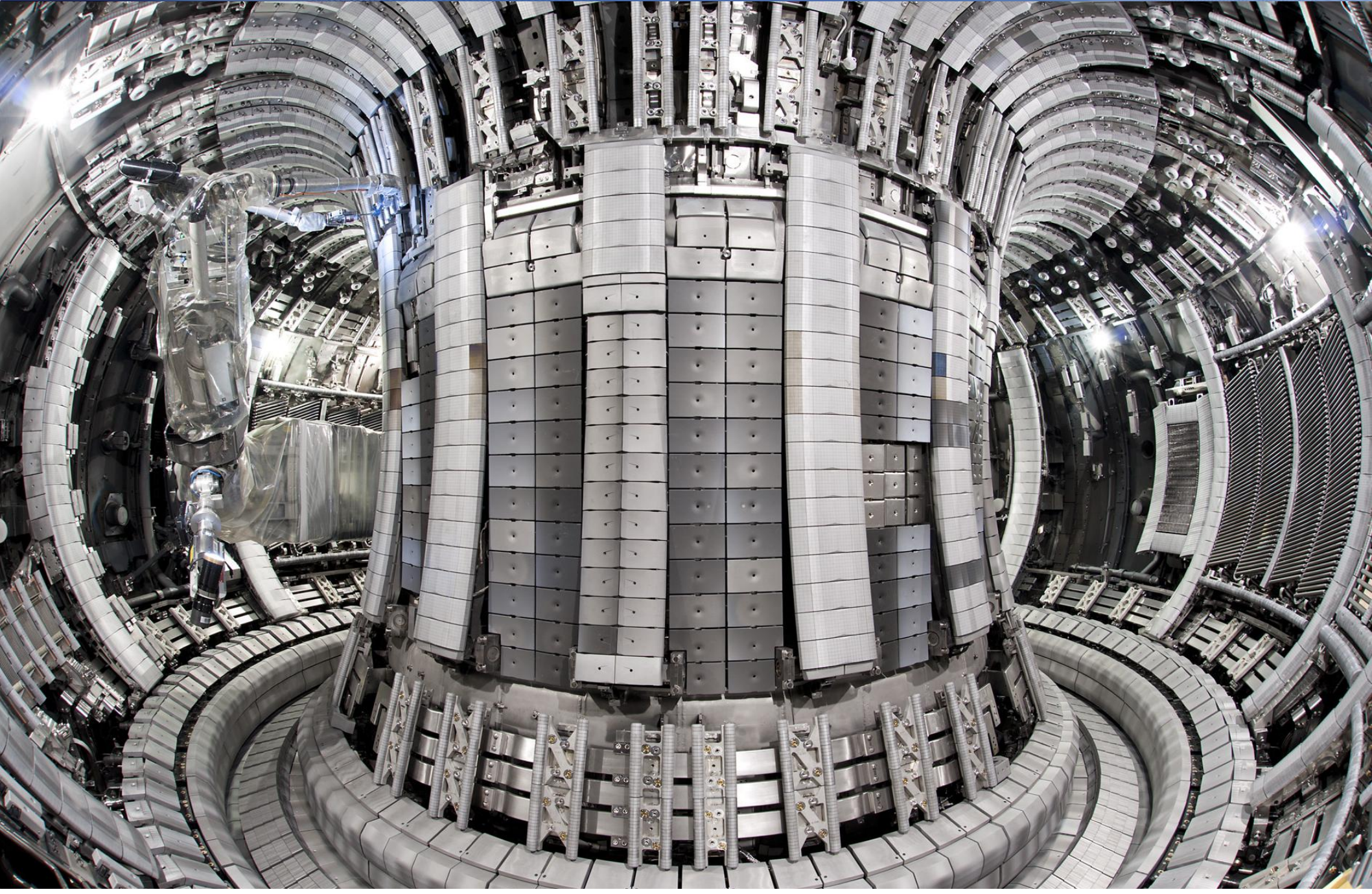


Tungsten divertor and Beryllium wall for ITER

1. To maximise operational space
2. To reduce tritium retention compared to Carbon wall

Never been tested until now in JET

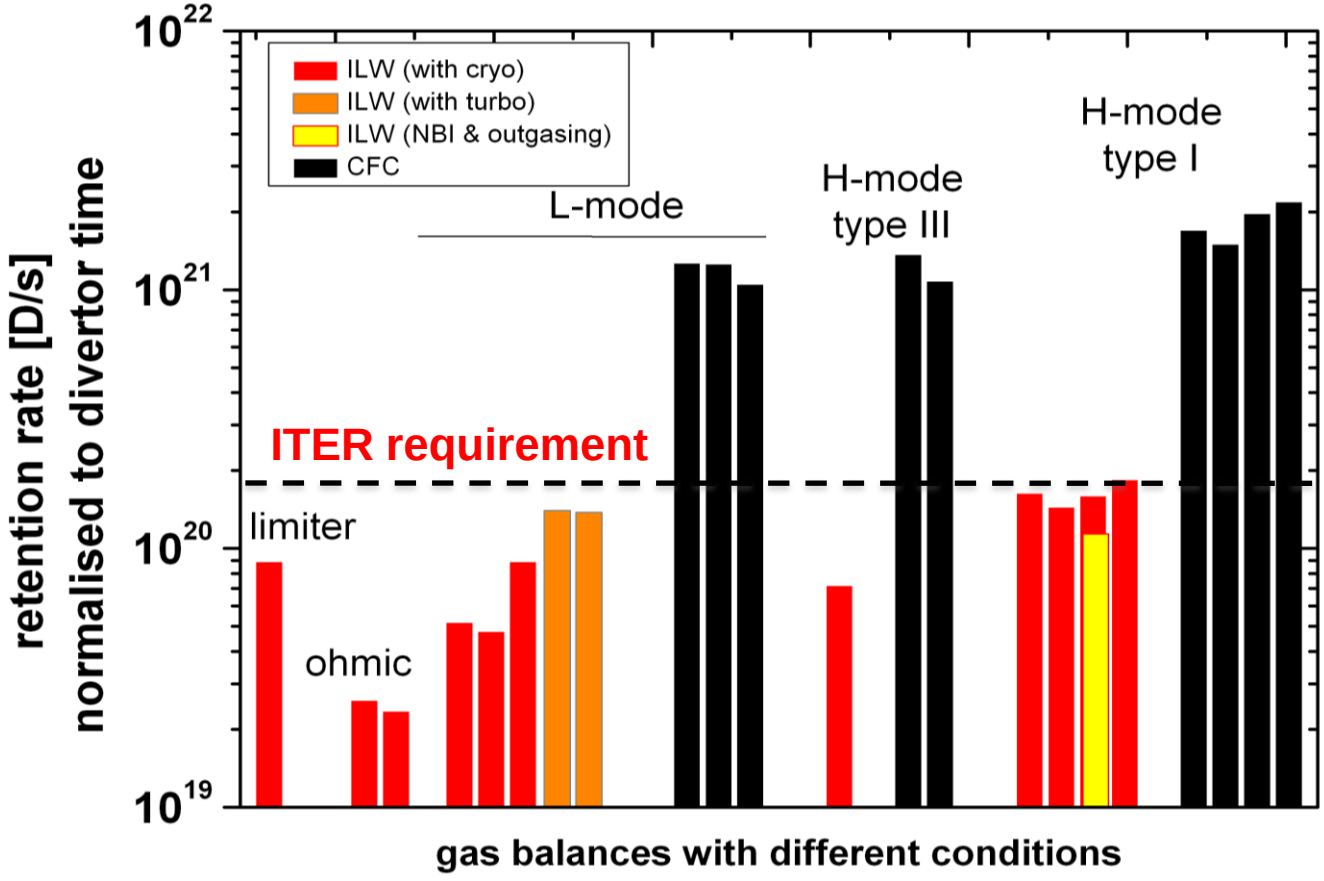




ILW = 2880 installable items, 15828 tiles
(~2 tonnes Beryllium, ~2 tonnes Tungsten)

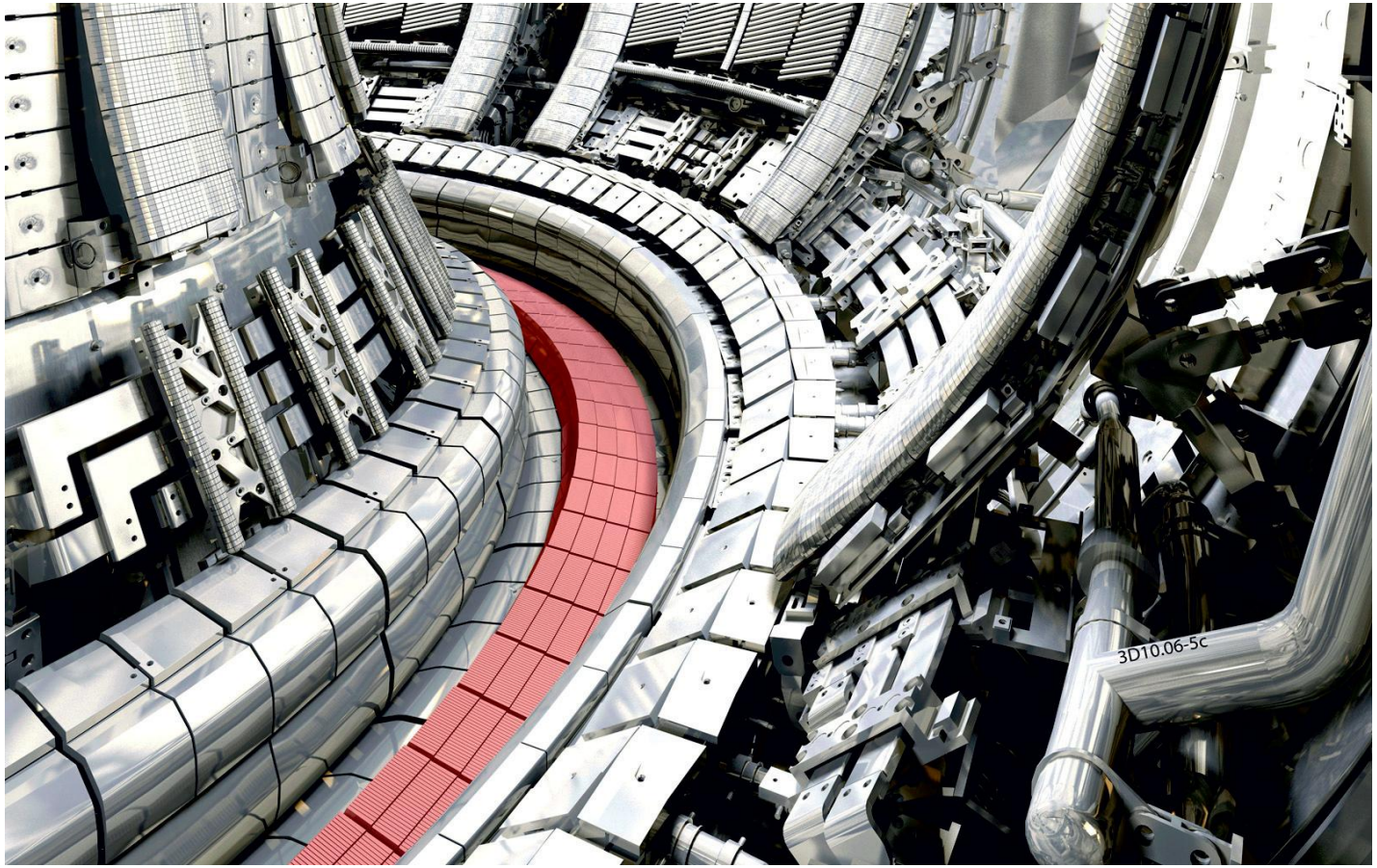
Fuel Retention in line with ITER needs

Measured fuel retention is more than 10x lower with the ILW, consistent with predictions made before installation



Dealing with the heat loads

The bulk tungsten divertor is designed for a maximum local temperature of the plasma-facing tungsten of 2200°C and a maximal energy deposition of 60 MJ/m^2

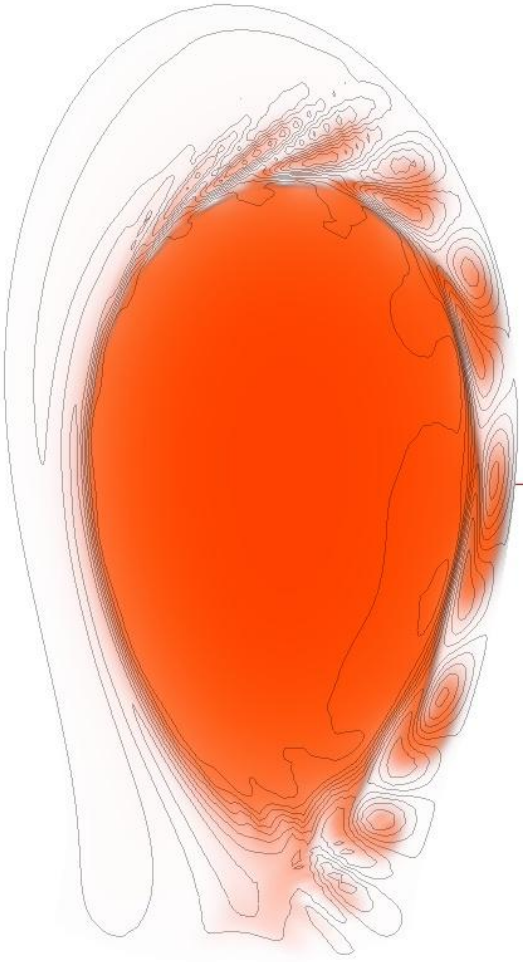


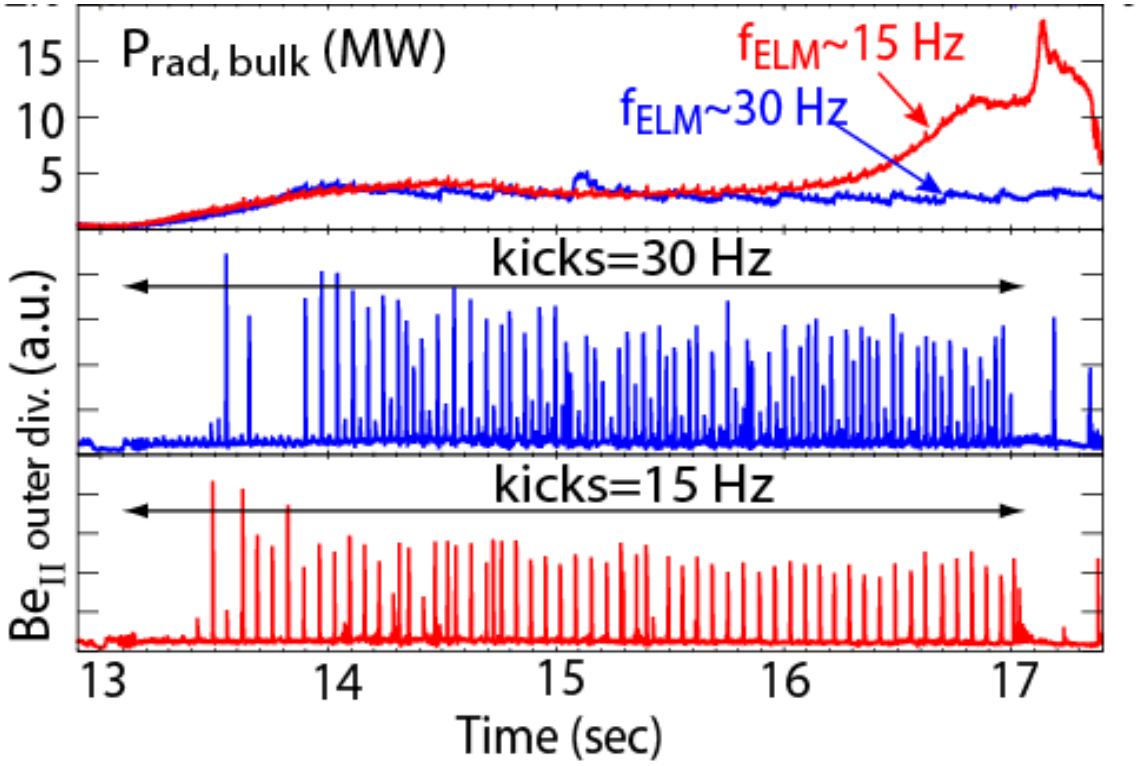
Routine operation performed at 30MJ/m^2 and T_{surf} up to 1000°C

Divertor tested up to 48MJ/m^2 and T_{surf} ~1200°C

Edge Localised Mode pacing

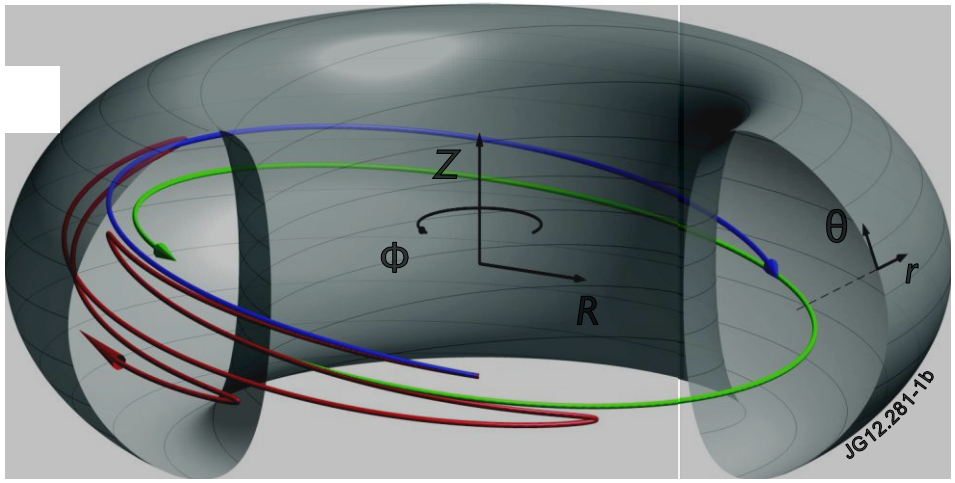
- Increasing frequency of Edge Instabilities reduces core accumulation of tungsten and improves performance

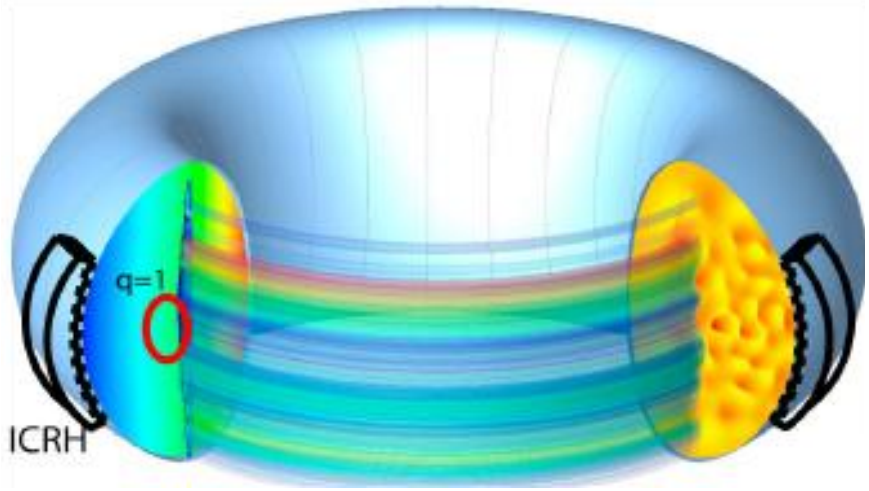


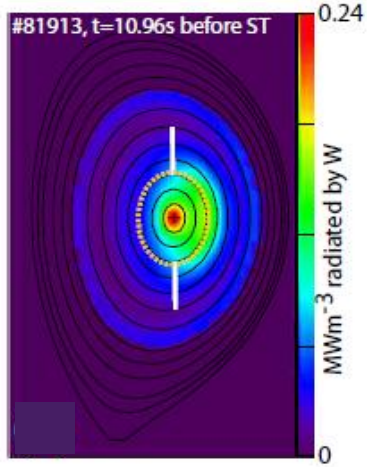


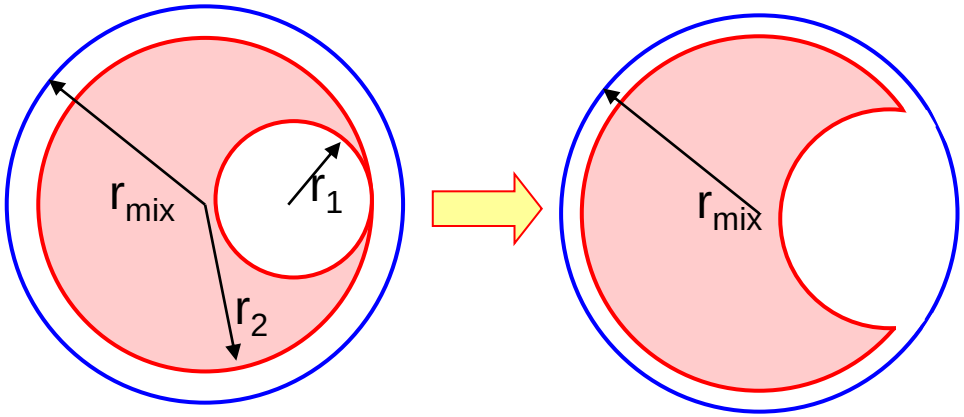
Controlling core reconnection events

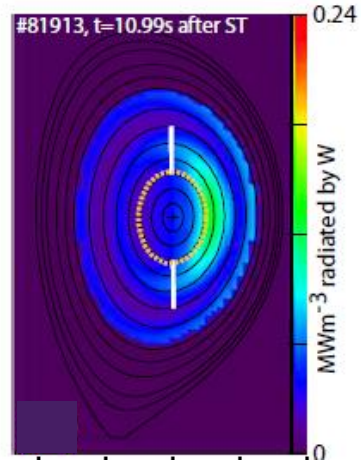
- Energetic particles affect plasma instabilities
- They can be tailored to reduce tungsten peaking





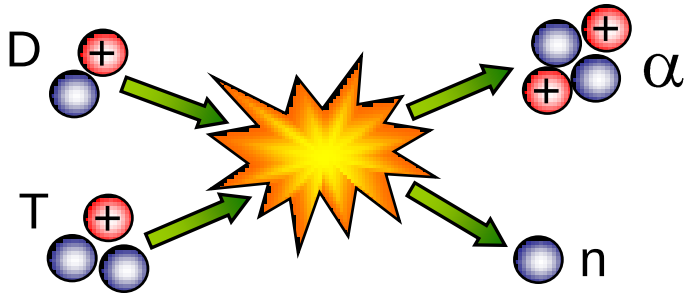






Energetic Particles in Plasmas

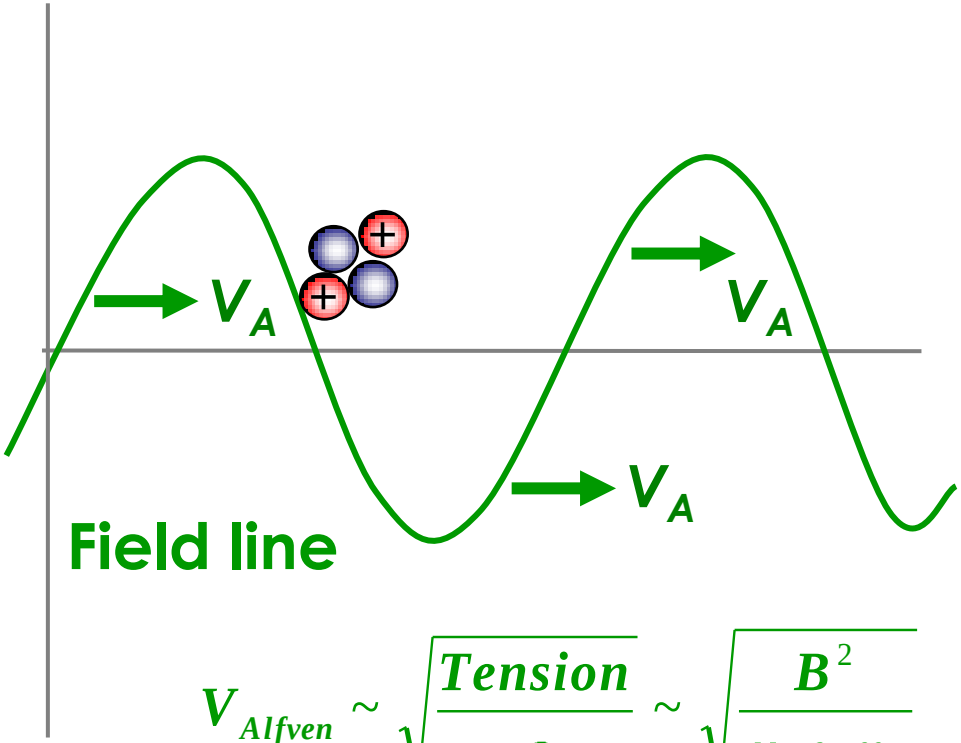
New physics in presence of energetic ions (α's in reactor)



$V_{Ti} << V_A < V_\alpha << V_{Te}$

For ITER:

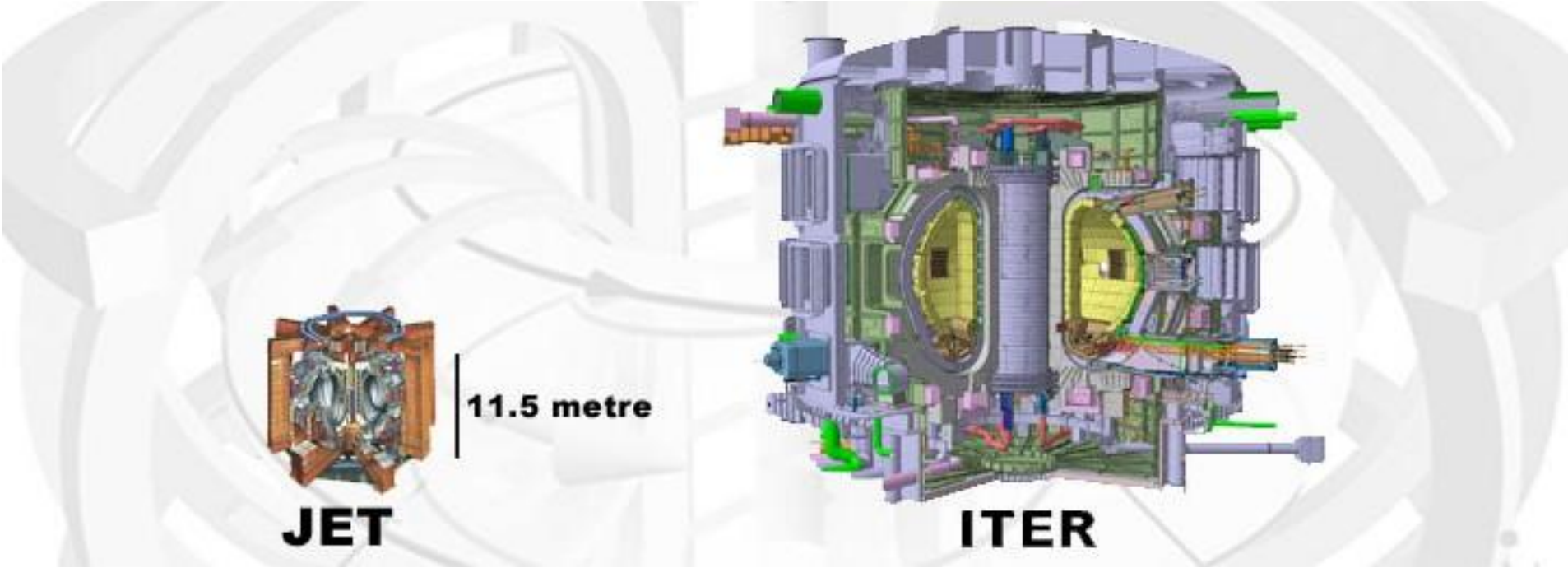
- 9×10^5 m/s
- 8×10^6 m/s
- 12×10^6 m/s
- 6×10^7 m/s



$$V_{Alfven} \sim \sqrt{\frac{Tension}{\rho}} \sim \sqrt{\frac{B^2}{\mu_0 n_i m_i}}$$

- Particles at $V \sim V_A$ exchange energy with wave:
  - Particles drive instabilities
  - Result in redistribution of current and result in loss of heating power

Challenges and Opportunities for JET



JET has demonstrated that Tritium-retention is in line with ITER needs

Working to demonstrate high confinement in ITER scenarios with ITER-like wall

Longer term opportunity to demonstrate control closer to ITER burning plasma conditions