



UKAEA
Fusion:
Powering the Future?

education@ukaea.uk



**To lead the delivery of
sustainable fusion energy
and maximise scientific and
economic benefit**



Why fusion?

Fusion has little or no environmental impact

Fusion does not produce any 'long-lived' radioactive waste

There is no risk of critical safety events e.g. 'meltdown'

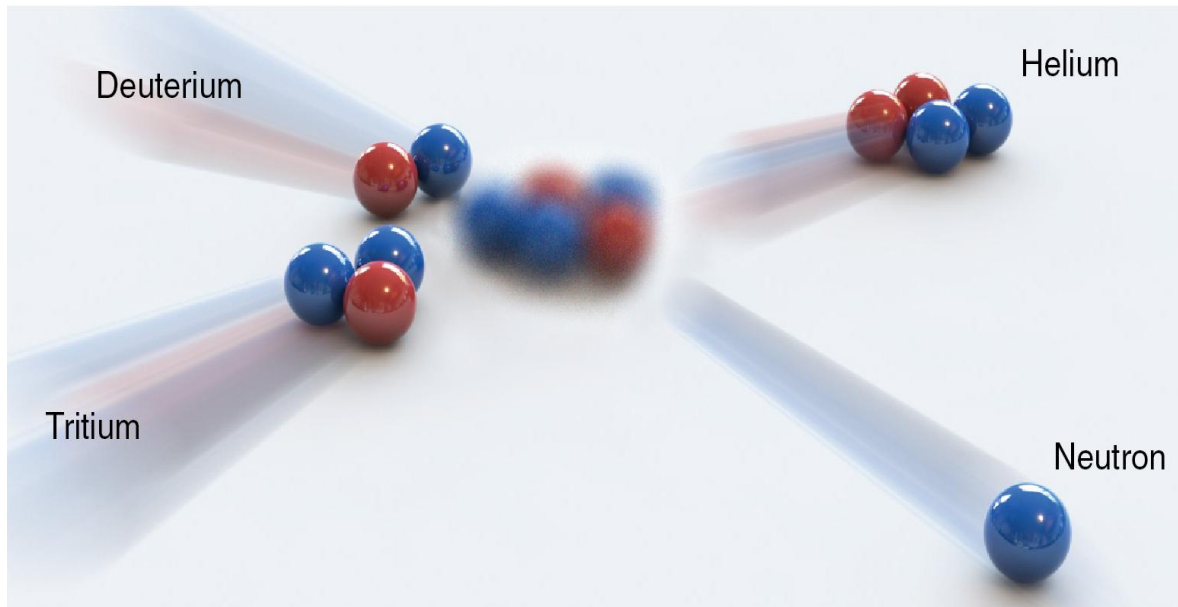
The fuels are abundant

Deuterium is freely available in



Fusion ...

...occurs when two light nuclei are forced together, producing a larger nucleus and a neutron.



The combined mass of the two small nuclei is greater than the mass of the nucleus they produce

The extra mass is changed into energy:

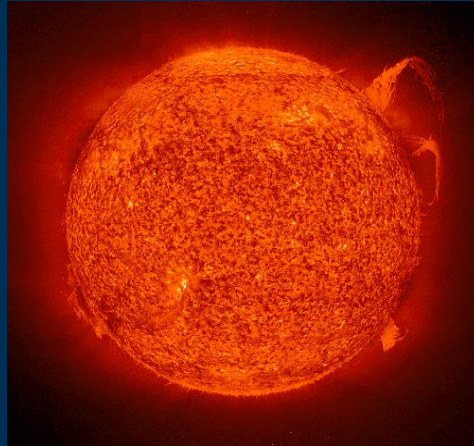
$$E = mc^2$$

But fusion is really hard ...

Like charges repel

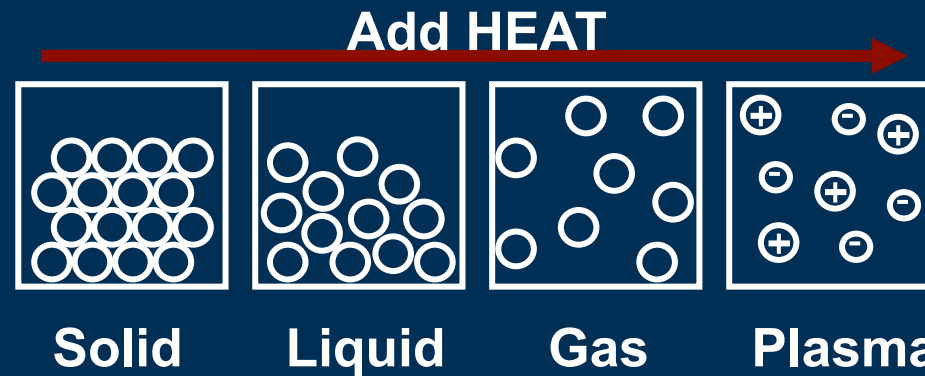
We need a
balance of :

- Density
- Temperature
- Confinement

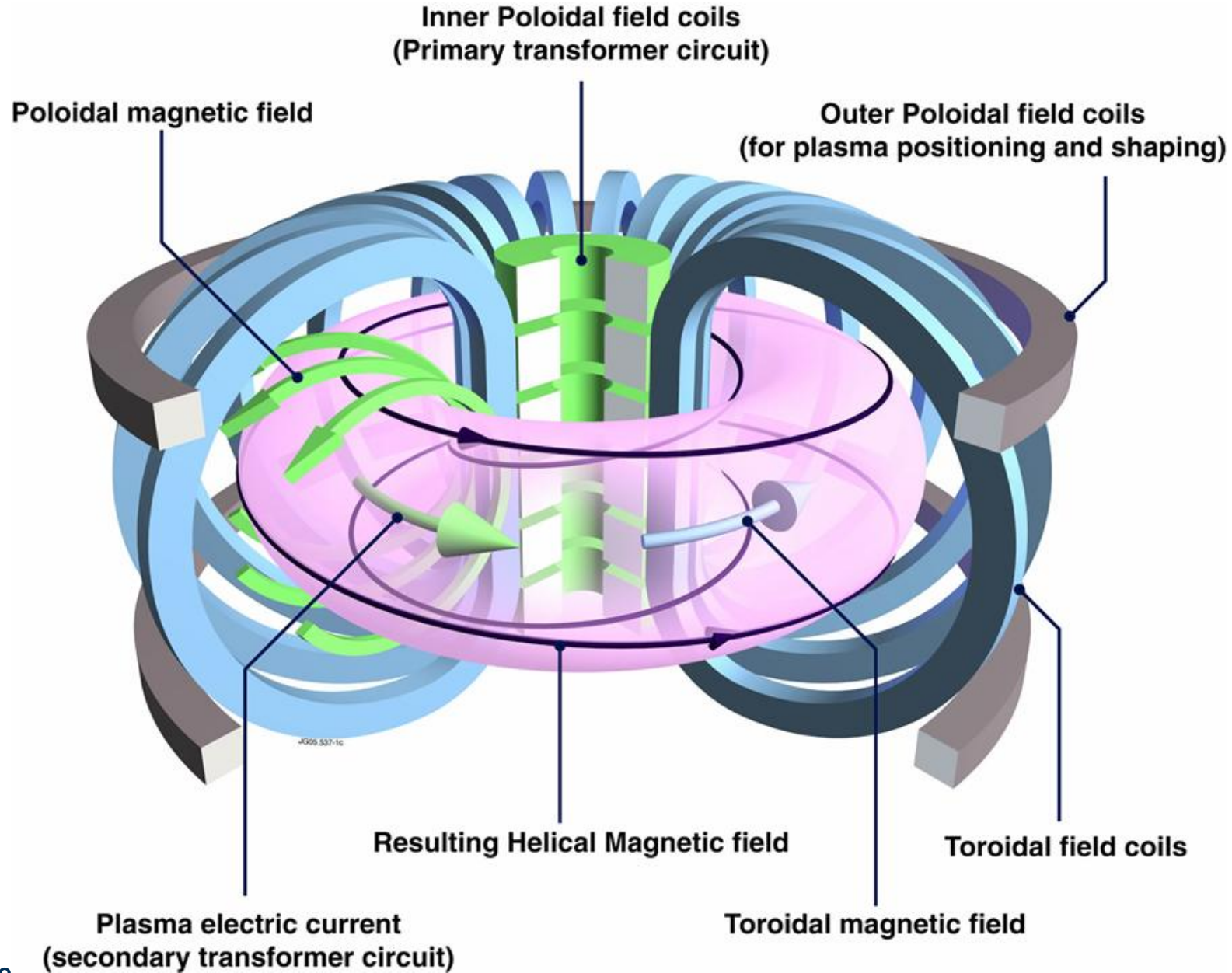


Centre of the sun = 15
million °C

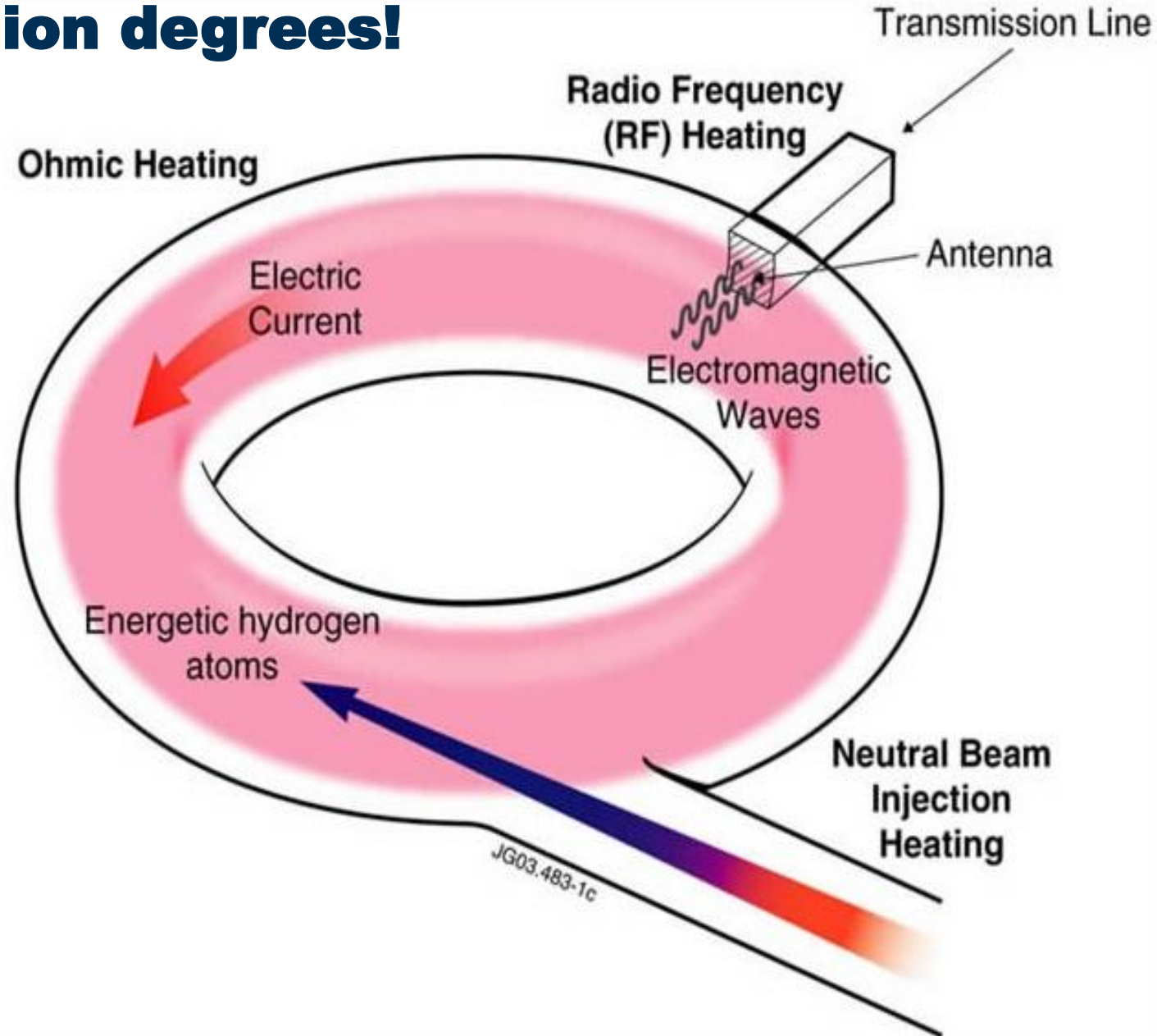
We need in excess of
150 million °C



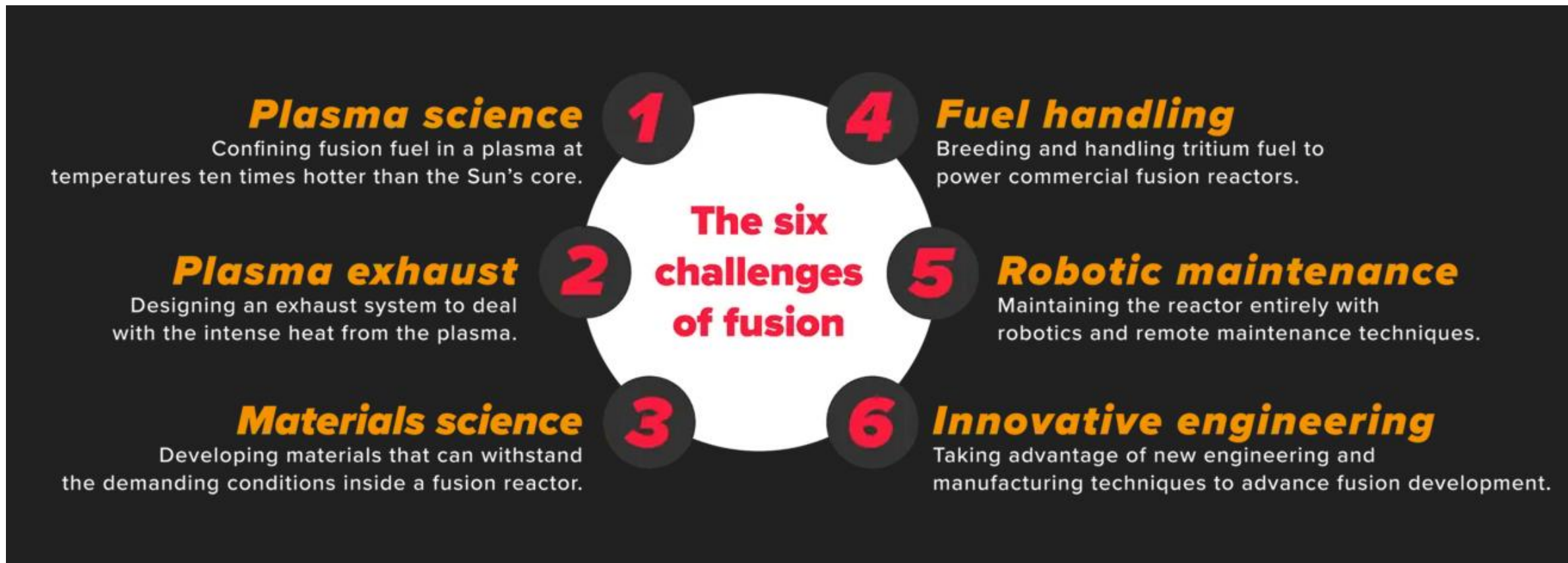
The tokamak ...



Heating the Tokamak up to 150 million degrees!



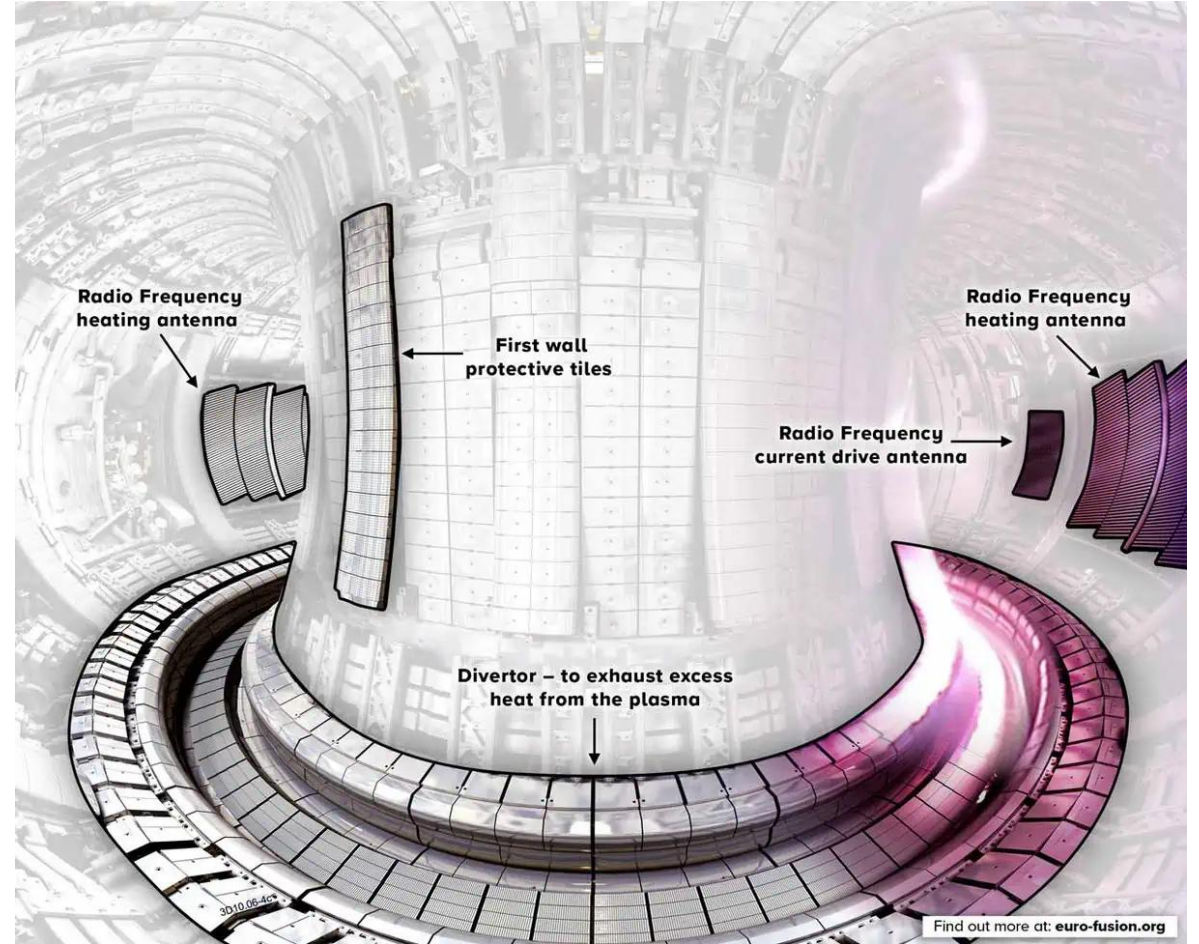
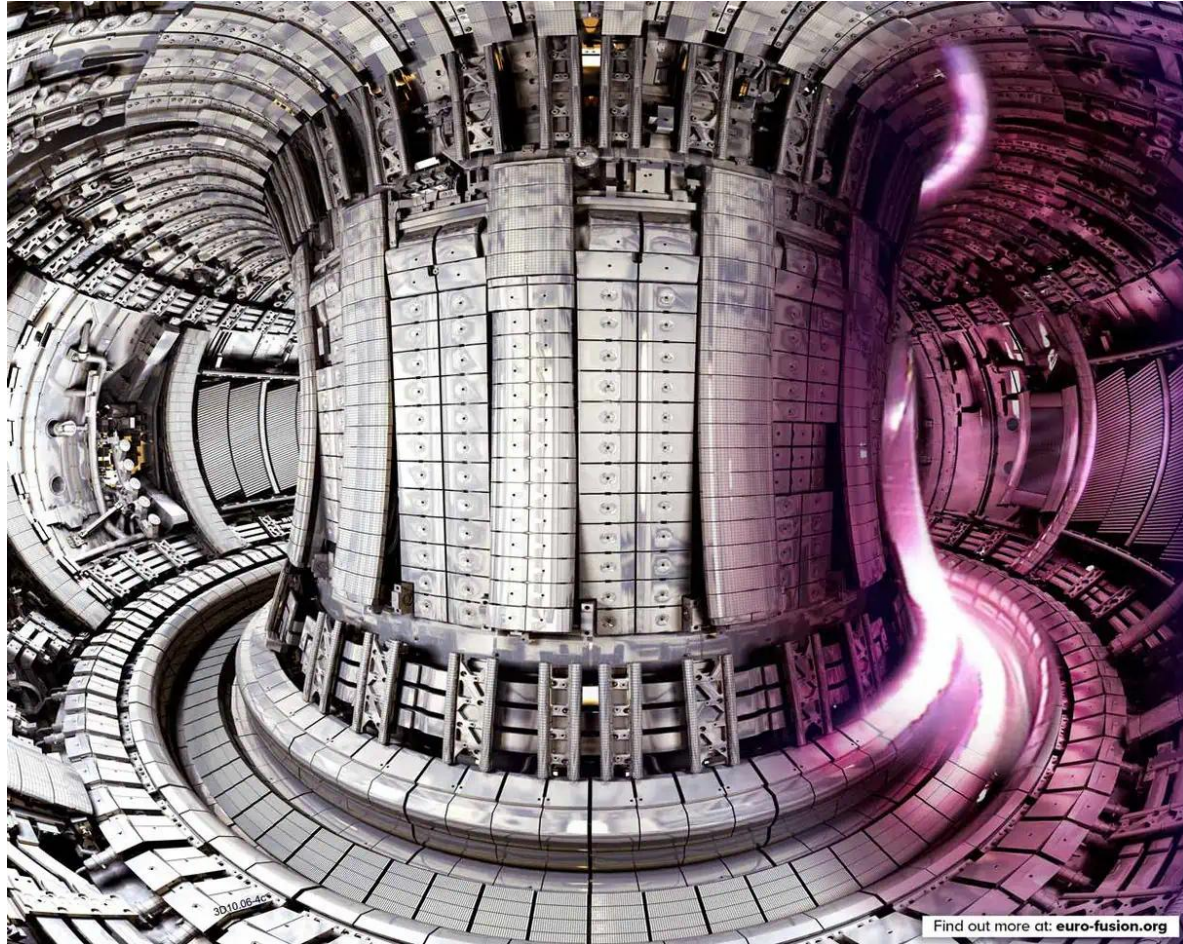
Research Challenges



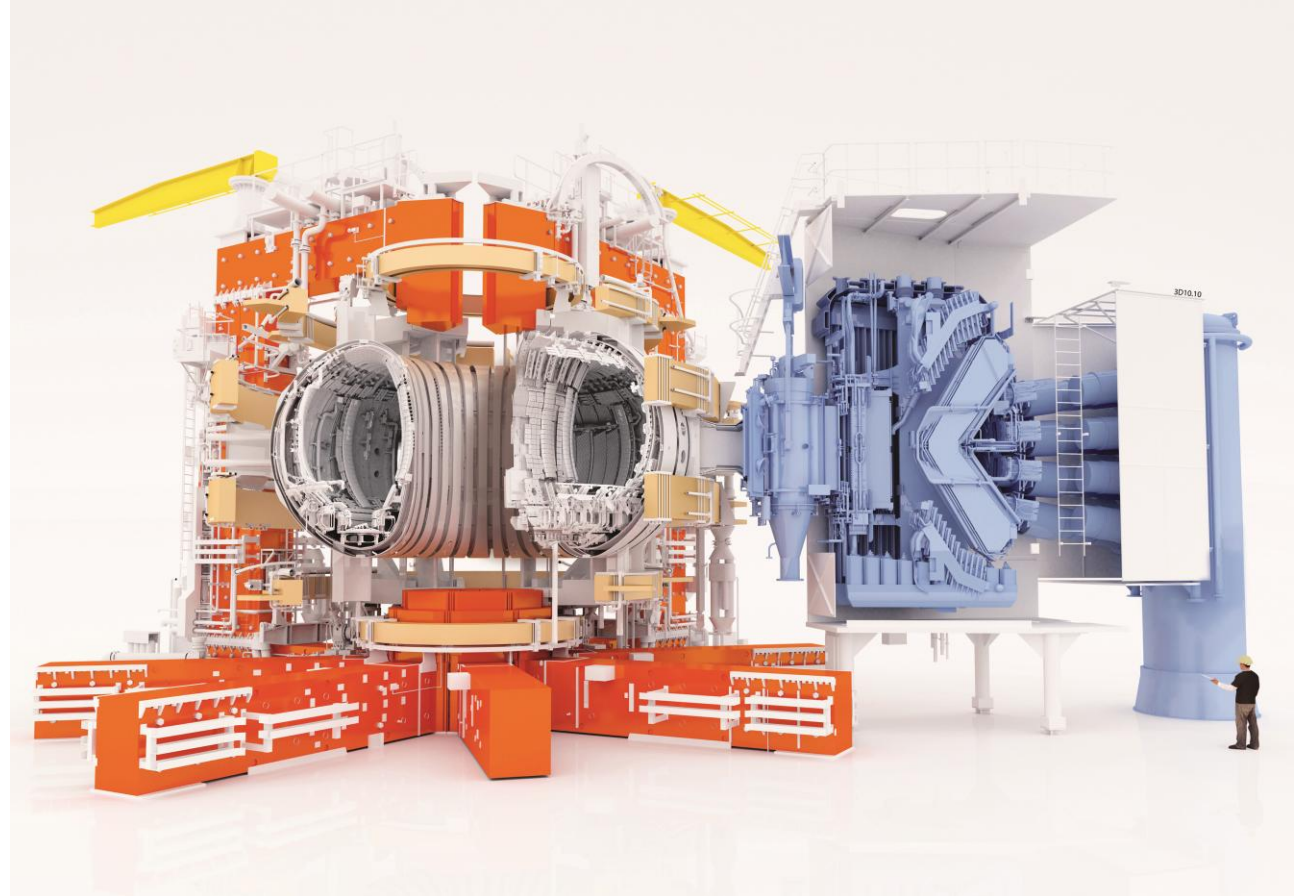
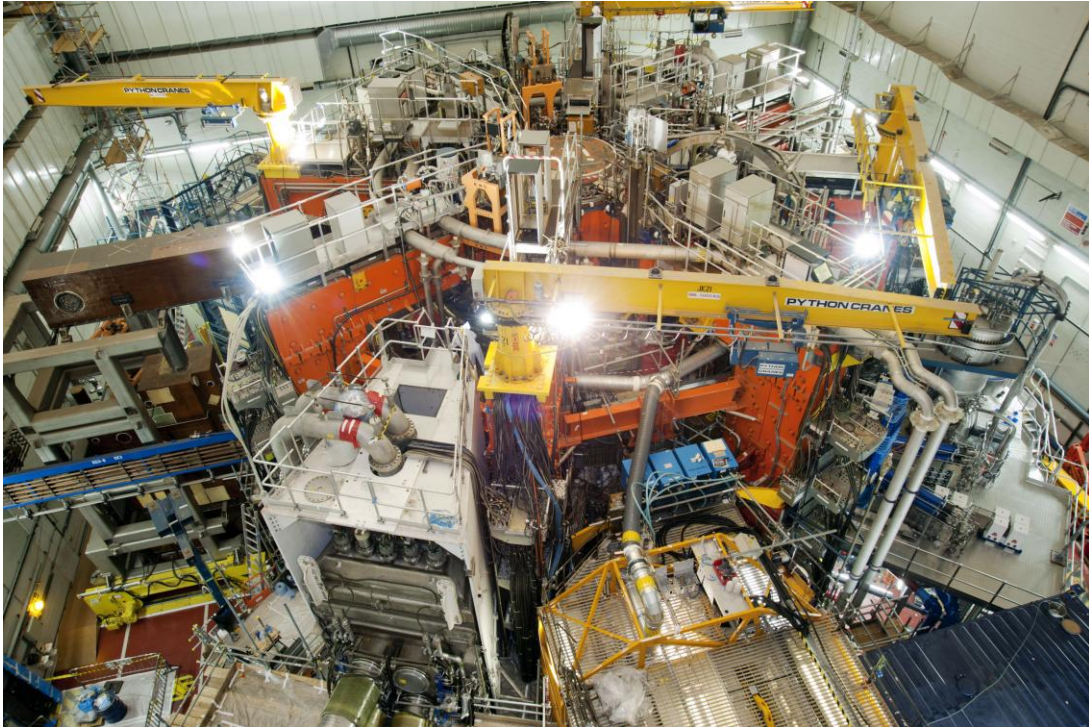
UKAEA sites



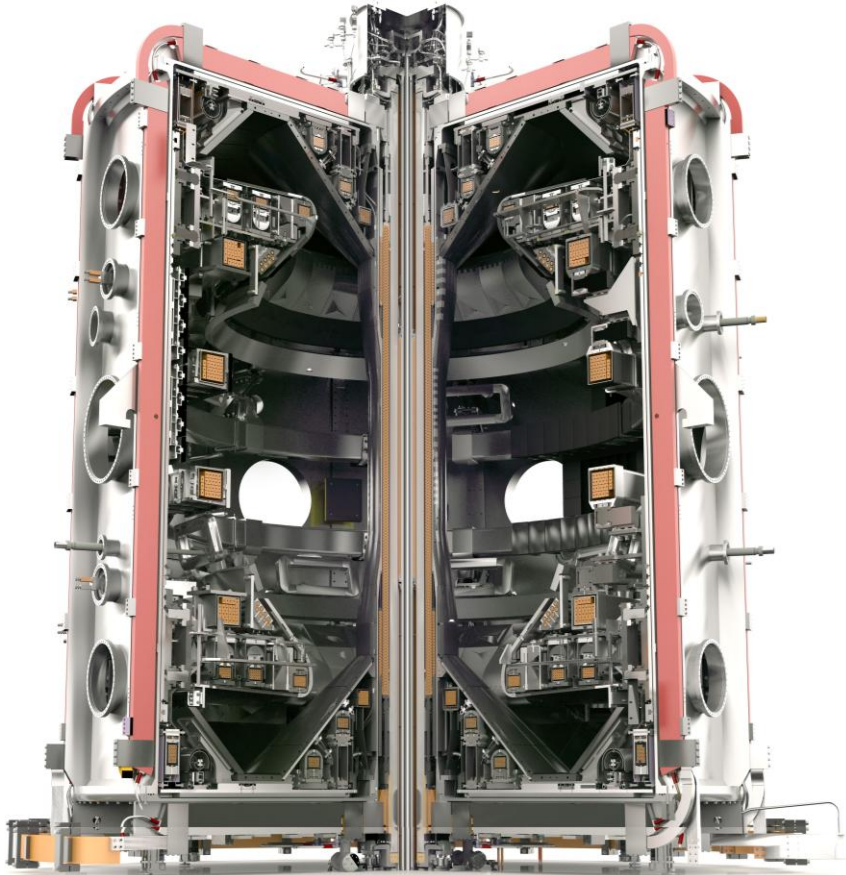
JET – Joint European Torus



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MAST Upgrade



Mega Amp Spherical Tokamak

Investigating tokamak physics at a more compact scale.

Present upgrade will improve understanding of exhaust physics in this configuration.

RACE

RACE - Remote Applications in Challenging Environments

RACE offers robotics expertise and facilities to fusion projects and to wider industrial partners (e.g. nuclear decommissioning, space, big science work etc.) – tapping into a worldwide remote applications market worth billions.



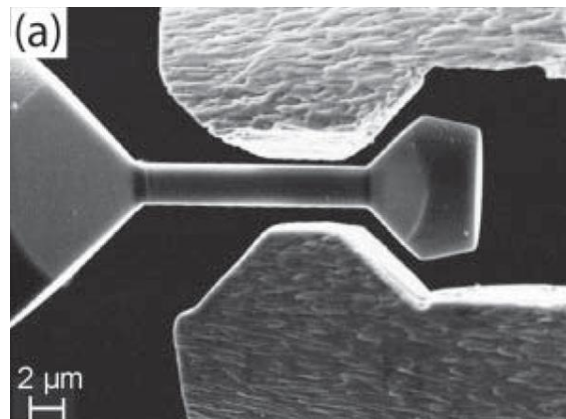
Materials Research Facility (MRF)



Universities

UKAEA

Sellafield

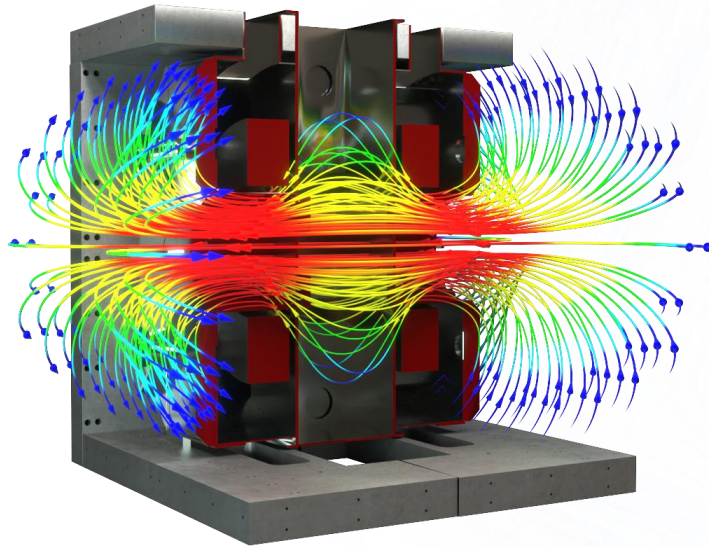


Processing and analysis of radioactive material and undertaking micromechanical testing of fusion and fission material samples – with UK universities and other labs.

UKAEA South Yorkshire Fusion Energy Technology Centre

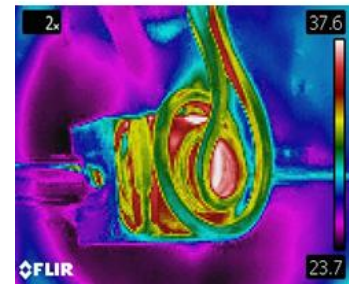
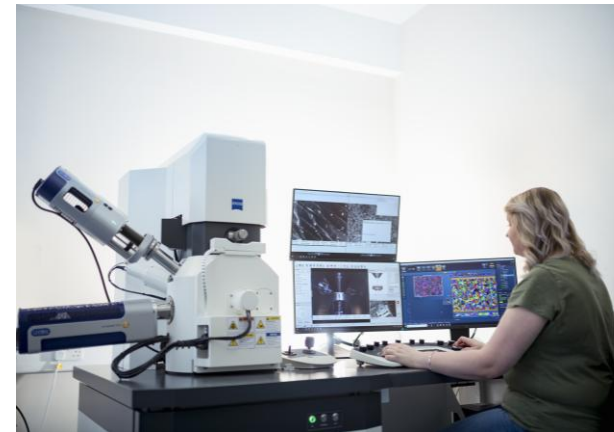
The South Yorkshire site supports industry and supply chain development in the manufacturing heartland of the UK

The site hosts facilities that develop fusion technologies, address engineering challenges and solve technology-focused problems inside and outside of fusion



UKAEA Eni H3AT Tritium Loop

- Building on strong tritium research foundations at UKAEA which is world leading in tritium research and technology innovation
- H3AT aims to develop technology capability to demonstrate the operation of a continuous, closed loop fuel cycle at pilot plant scale, **de-risking and providing increased investor confidence in tritium process plant designs for future fusion power plants such as STEP**
- Operational by 2030



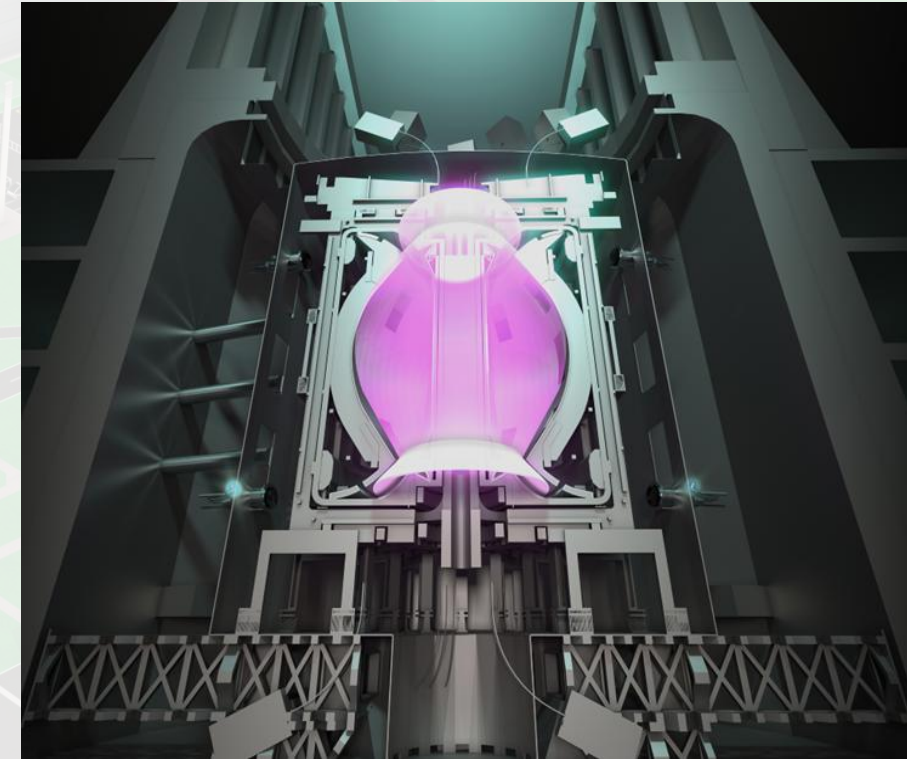
Fusion is now in the 'delivery era'



STEP

Spherical Tokamak for Energy Production

- STEP is prototype power plant that will demonstrate the ability to generate net electricity from fusion
- It will also determine how the plant will be maintained through its operational life and prove the potential for the plant to breed its own fuel
- The first phase of the programme is to produce a concept design. It will be a spherical tokamak, and the first to be connected to the National Grid

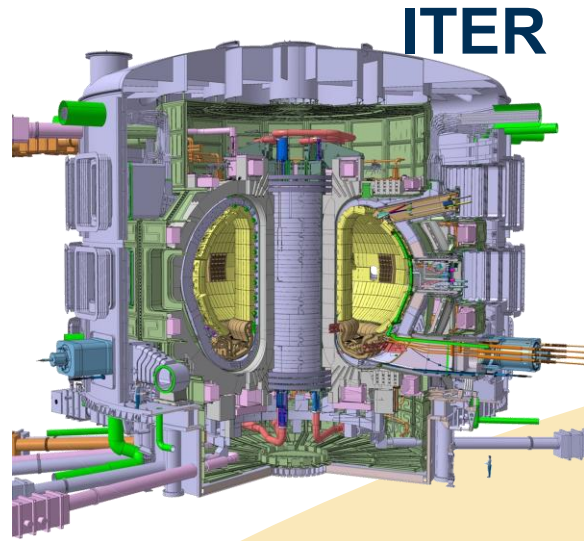


2020

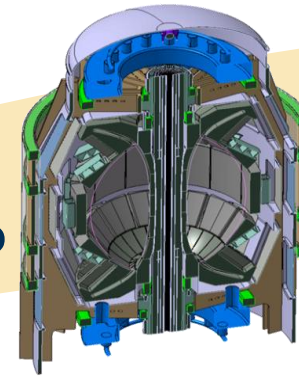
2030

2040

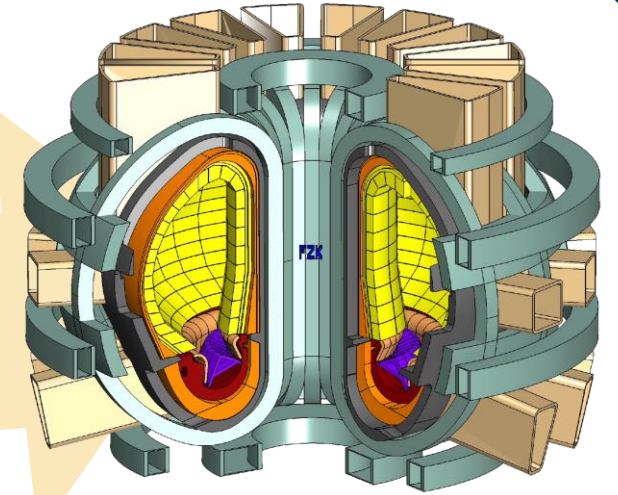
2050



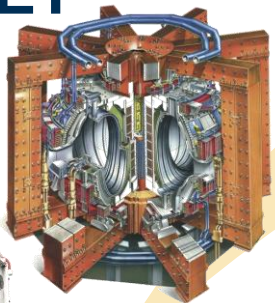
STEP



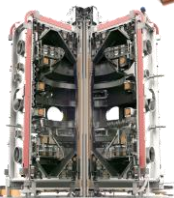
DEMO



JET



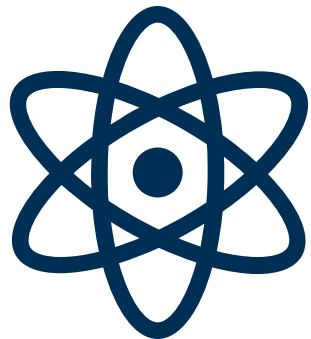
MAST-U



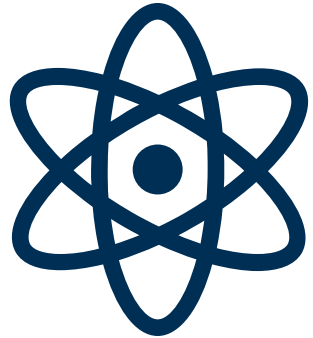


UK Atomic
Energy
Authority

Why Fusion?



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Sustainable

Fusion produces
no CO₂

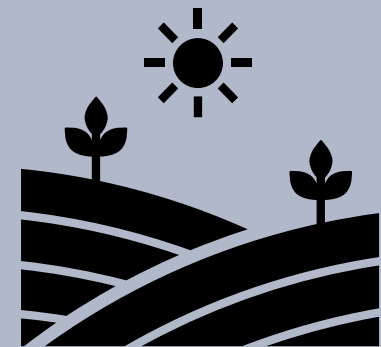
Fully sustainable
energy source



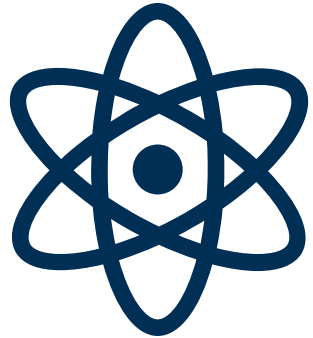
Low Activation

No high level
radioactive waste

Waste has a
shorter life than
fission waste



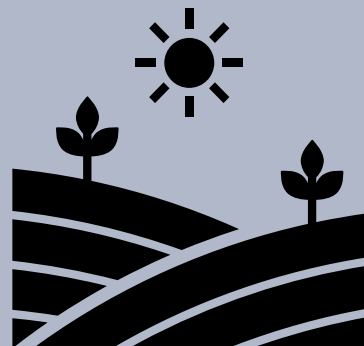
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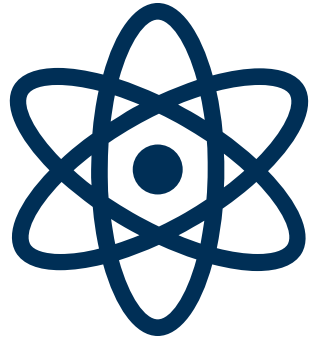
Safe

No risk of a
runaway reaction

Machine will be
shielded



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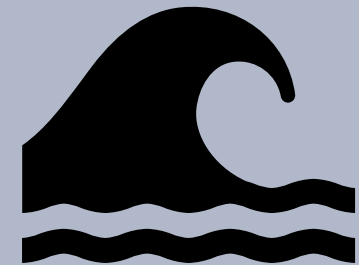
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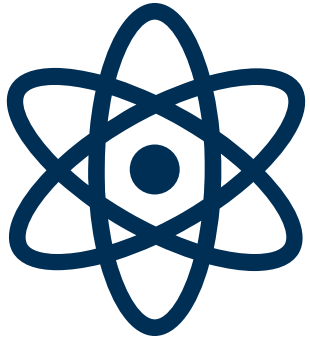
Abundant

Deuterium fuel is
in seawater

Tritium produced
using Lithium



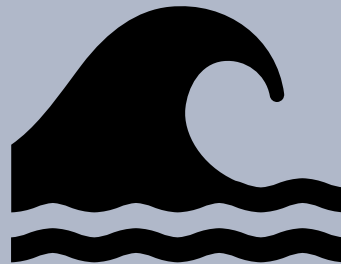
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Deuterium fuel is
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Near-Limitless

Incredibly fuel
efficient

‘Always on’, can
be built anywhere



UKAEA's Belief



We believe fusion energy can be an environmentally responsible part of the world's energy supply in the second half of this century



How to find out more...

On the web:

- www.ukaea.org
- www.euro-fusion.org

By email: Communications@ukaea.uk

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Any Questions ?