Un toc d'enginyeria: trobada d'enginyeres

Gemma Godia Alastuey

Senior Mechanical Engineer, PMP® at NIER INGENIERIA

NIER

Enginyers Industrials de Catalunya

About me

PROFESSIONAL BACKGROUND

02/2011
08/2016
IDOM CONSULTING, ENGINEERING, ARCHITECTURE

ETSEIB - UPC

08/2016
03/2022
ITER ORGANIZATION

03/2022
NIER INGENIERIA

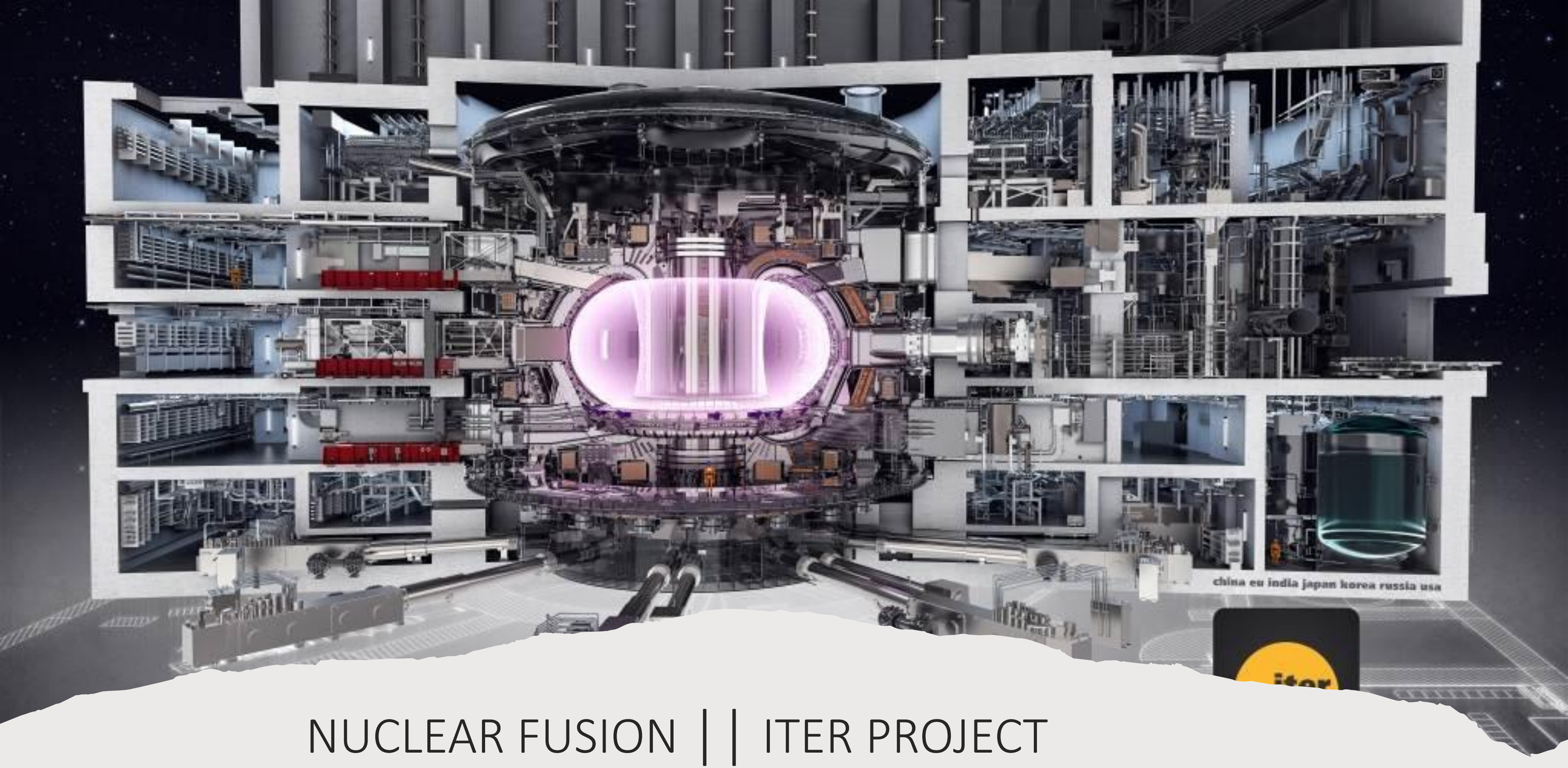
TECHNICAL SKILLS

MS INDUSTRIAL ENGINEERING
PMP CERTIFICATION
WELDING SOLUTIONS, NDTs, RCC-E, ANSYS, RECIPIENTS A PRESSIÓ, others.
POSTGRAU ECONOMIA CIRCULAR

SOFT SKILLS

ESCOLTA ACTIVA, CONVERSACIONES DE LIDERAZGO, others.

THERE IS MORE ...



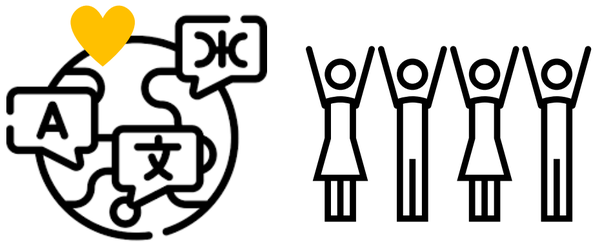
NUCLEAR FUSION || ITER PROJECT

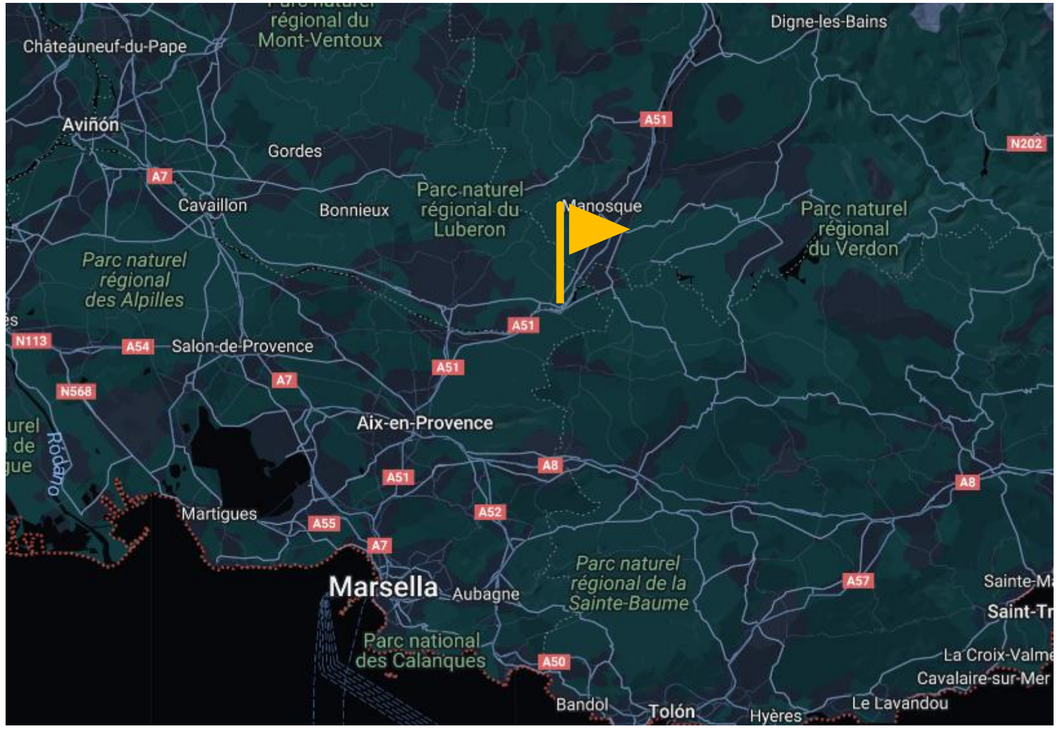
ITER: THE WAY - WHO FORMS ITER?

ITER ORGANIZATION

INTERGOVERNMENTAL ORGANIZATION CREATED BY AN INTERNATIONAL AGREEMENT FORMALLY ESTABLISHED ON 24 OCTOBER 2007 . RESPONSIBLE FOR THE DESIGN, MANUFACTURE, ASSEMBLY AND OPERATION OF THE ITER DEVICE, THE WORLD´S LARGEST AND MOST POWERFUL TOKAMAK.

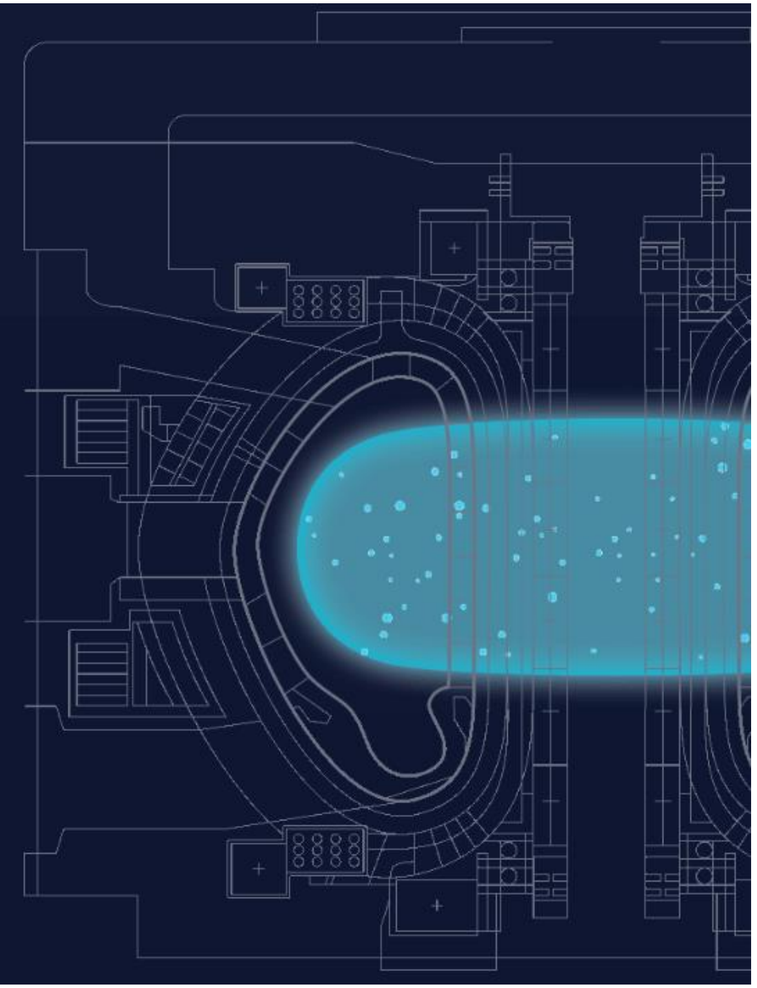
ALL IN ALL, 6.500 PEOPLE – 1.102 DIRECTLY EMPLOYED STAFF (2023) FROM 90 COUNTRIES





https://www.iter.org/news/videos/630

ITER: THE WAY – WHAT FOR?



Images: https://www.iter.org/few-lines

ACHIEVE A DEUTERIUM-TRITIUM PLASMA IN WHICH THE FUSION CONDITIONS ARE SUSTAINED MOSTLY BY INTERNAL FUSION HEATING

GENERATE 500 MW OF FUSION POWER IN ITS PLASMA

DEMONSTRATE THE SAFETY CHARACTERISTICS OF A FUSION DEVICE

To demonstrate the scientific and technological feasibility of fusion power for **PEACEFUL** purposes at industrial scale

Fusion has the potential to provide a **NEARLY LIMITLESS** and **CLEAN SOURCE of ENERGY**

GENEVA, 1985.

R.REGAN AND M. GORBACHEV PROPOSED INTERNATIONAL COLLABORATION FOR DELVELOPING FUSION ENERGY FOR PEACFUL PURPOSES.

1986,

EU AND JAPAN JOIN. DESIGN WORK BEGIN IN 1988. THE FINAL DESIGN OF ITER WAS APPROVED BY ITS MEMBERS IN 2001. CHINA AND KOREA JOIN THE PROJECT IN 2003, FOLLOWED BY INDIA IN 2005. THIS SAME YEAR, THE ITER SITE IS STABLISHED IN THE SOUTH OF FRANCE.

PARIS, 2006

THE ITER AGREEMENT IS SIGNED AT THE ELYSÉE PALACE BY THE 7 ITER MEMBERS. THE CEREMONY IS HOSTED BY PRESIDENT JACQUES CHIRAC AND EUROPEAN COMMISION PRESIDENT MR. DURAO BARROSO..

Images: https://www.iter.org/few-lines

ITER: THE WAY – HOW WILL ITER DO IT?

WE BOTTLE THE SUN

© Paulo Valdivieso - https://www.flickr.com/

RECREATING THE
FUSION
REACTION AS
OCCURS IN THE SUN

HOW? BUILDING A TOKAMAK MACHINE

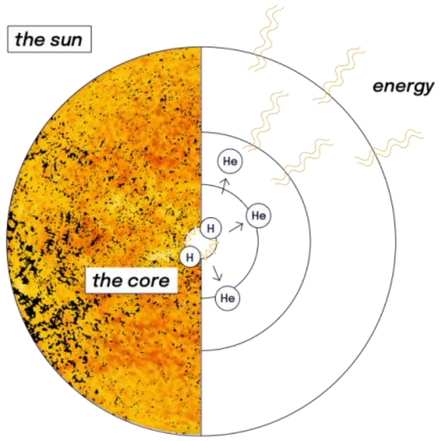
ENHACING HYDROGEN ISOTOPES TO FUSE
TO FORM HELIUM AND RELEASE HUGE AMOUNTS OF
ENERGY.

TO ACHIEVE FUSION IN A LABORATORY:

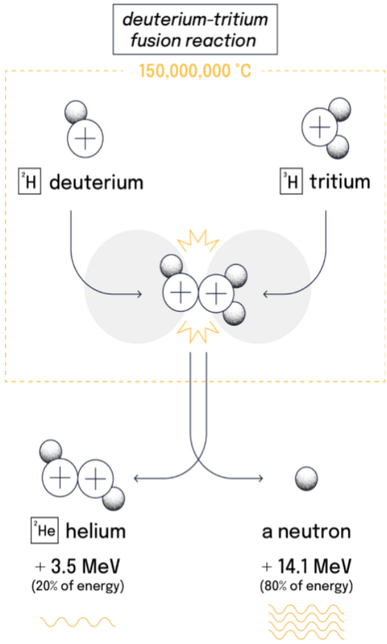
- VERY HIGH TEMPERATURES
- SUFFICIENT PLASMA PARTICLE DENSITY
- SUFFICIENT CONFINEMENT TIME

150 MILLION
DEGREES
CELSIUS

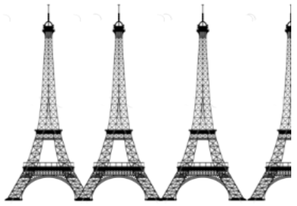
X 10 HOTTER THAN THE SUN



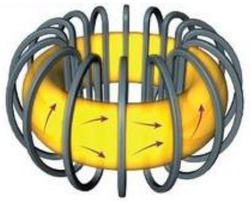
FUSION - Combining light atomic nuclei (e.g., hydrogen isotopes) to form heavier elements.



ITER TOKAMAK. SOME NUMBERS



3,5 TIMES THE WEIGHT OF THE EIFFEL TOWER



WORLD'S LARGEST TOKAMAK - 30M HEIGHT AND PLASMA VOLUME OF 840M^3

ITER TOKAMAK - ONE MILLION COMPONENTS

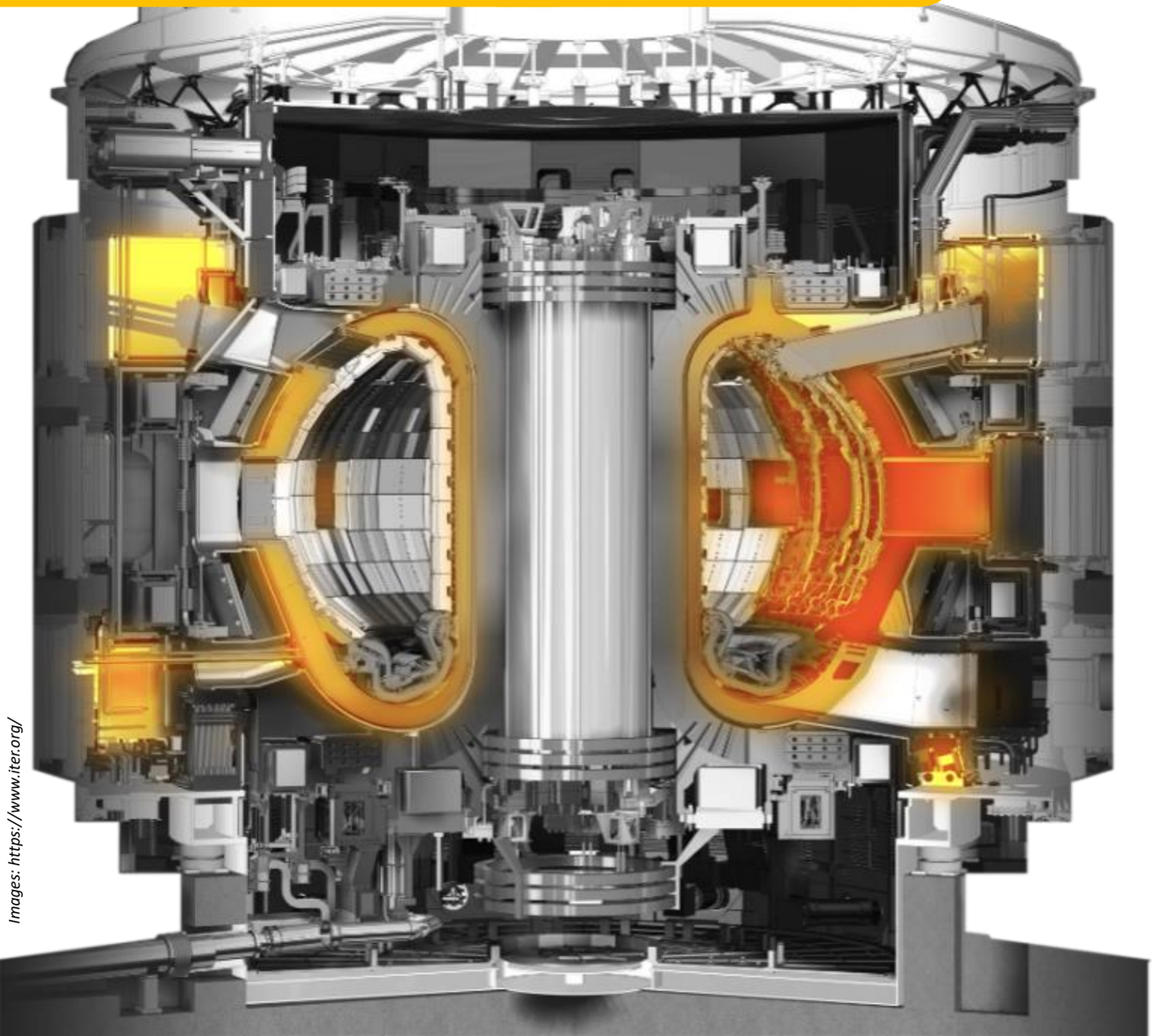
PLANT SYSTEMS SUCH AS RADIO FREQUENCY HEATING, FUEL CYCLE, CRYOGENIC, COOLING WATER, VACUUM, CONTROL, AND HIGH VOLTAGE ELECTRICAL

P_{IN} ~50 MW

P_{OUT} ~500 MW

Q ≥10

ITER TOKAMAK. VACUUM VESSEL



Images: https://www.iter.org/

THE **VACUUM VESSEL** IS THE PLASMA CONFINEMENT CHAMBER.

STEEL CHAMBER **8,000 TONES**

19.4 m ACROSS (OUTER DIAMETER) & 11.4 m HIGH

MANUFACTURED IN **SECTORS**, LATER ASSEMBLED

PORTS FOR DIAGNOSTICS, CONTROL, FUEL, HEATING, VACUUM PUMPING, ETC.

CLOSED SYSTEM WITH **STRINGENT** LEAK-TIGHTNESS

UNDER **ULTRA HIGH VACUUM**

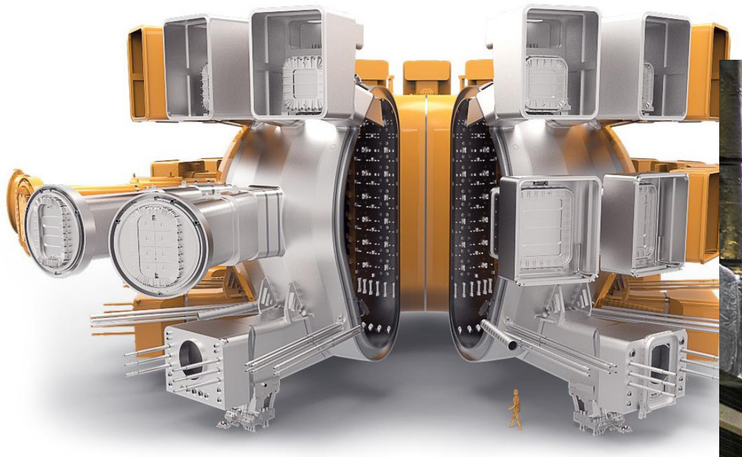
(10^{-7} Pa).

NO DIRECT LINK WITH THE ENVIRONMENT

EMBEDED IN A **SECOND VACUUM CONTAINER** CALLED **CRYOSTAT**

ITER TOKAMAK. VACUUM VESSEL

Images: https://www.iter.org/



VACUUM VESSEL SECTOR INSTALLATION

https://www.iter.org/videos?id=637

ITER TOKAMAK. MAGNETS SYSTEM

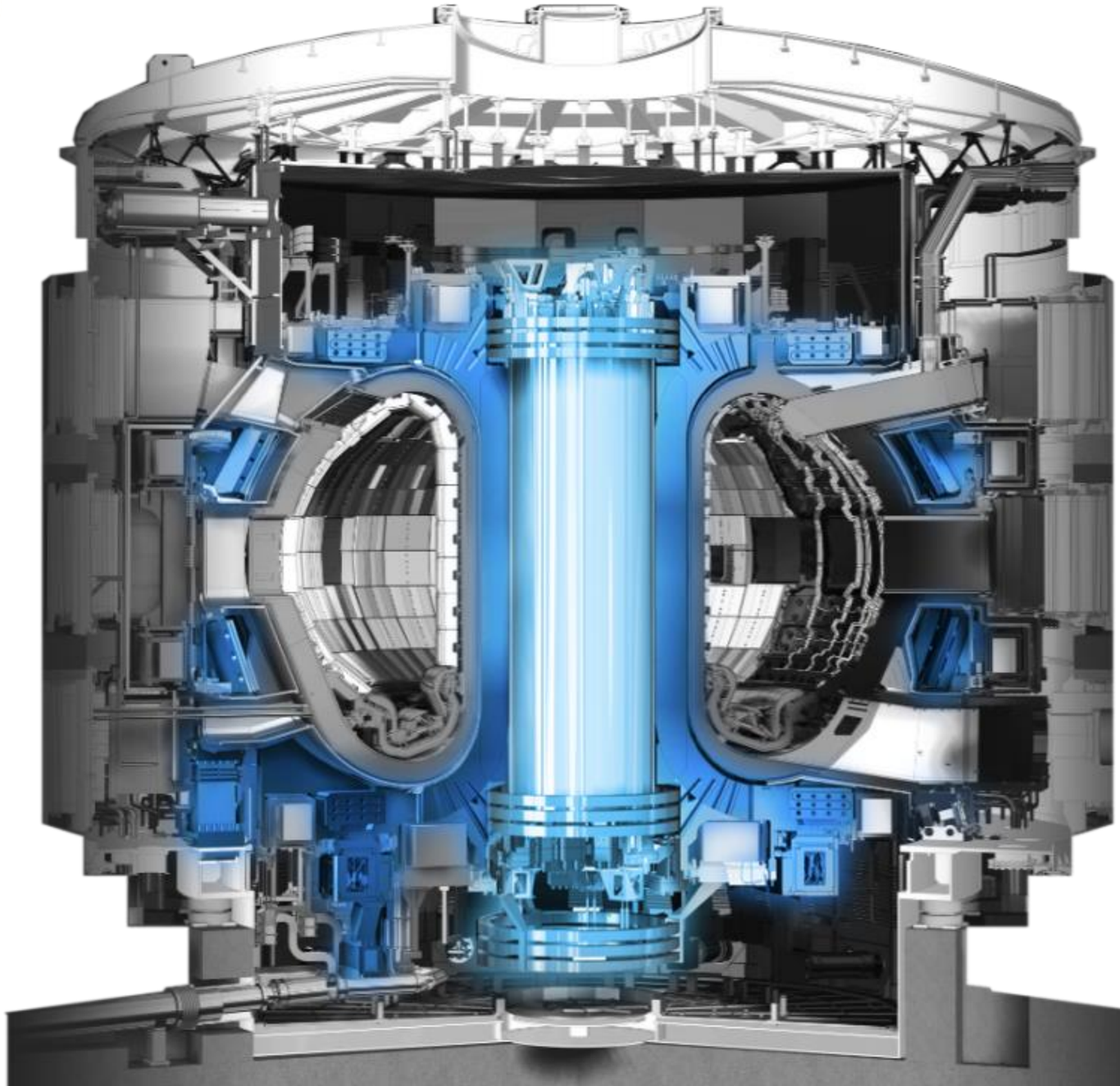
AT HIGH TEMPERATURES REQUIRED FOR FUSION D AND T ARE IONIZED (“PLASMA”). HOT DT CAN BE CONTAINED BY MAGNETIC FIELDS

INITIATE, CONFINE, SHAPE AND CONTROL THE ITER PLASMA

WEIGHTS 10,000 TONES

SUPERCONDUCTING
MAGNETS TO -269 °C (4K)

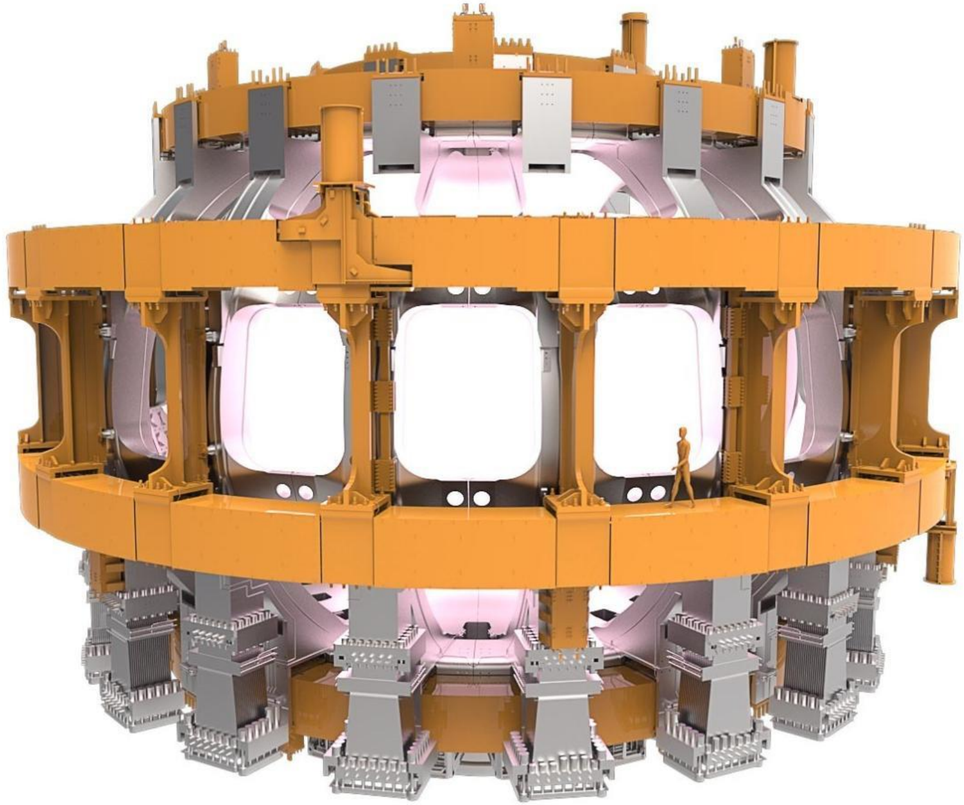
100,000 KM OF NIOBIUM-TIN (Nb3Sn) SUPERCONDUCTING STRAND



Images: https://www.iter.org/

ITER TOKAMAK. MAGNETS SYSTEM

PF3



Images: https://www.iter.org/

PF2, PF3, PF4, AND PF5 WERE TOO BIG TO BE SHIPPED!

DIAMETER = 17 TO 24 METRES
WEIGHT = 200 TO 400 TONNES

ITER TOKAMAK. CRYOSTAT

PROVIDES HIGH VACUUM, (10^{-4}Pa) ULTRA-COOL ENVIRONMENT FOR THE ITER VACUUM VESSEL AND THE SUPERCONDUCTING MAGNETS.

STEEL CHAMBER 3,900 TONES

30 m WIDE AND HEIGHT

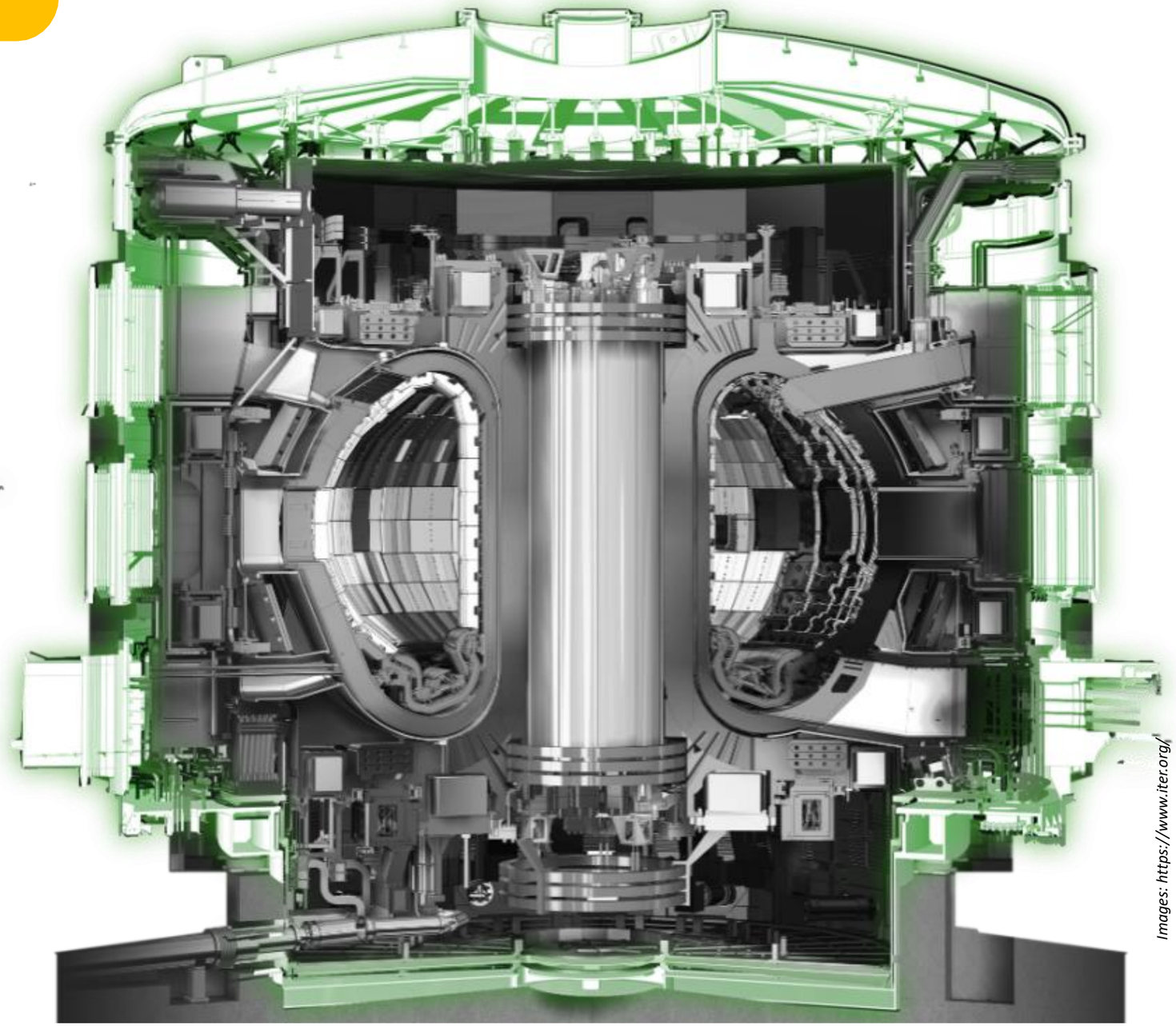
CRYOSTAT BASE WILL BE THE SINGLE LARGEST LOAD OF ITER TOKAMAK ASSEMBLY

PENETRATIONS TO ALLOW ACCESS FOR MAINTENANCE

ACCESS FOR COOLING SYSTEMS, MAGNET FEEDERS, AUXILIARY HEATING, DIAGNOSTICS, ETC.

FIRST MACHINE COMPONENT INSTALLED:

https://www.iter.org/videos?id=521



Images: https://www.iter.org/

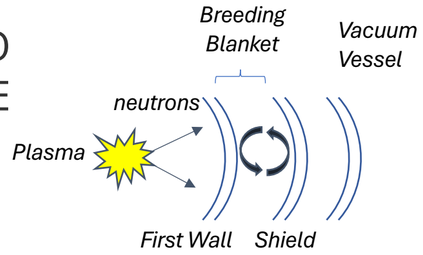
WHERE ARE WE NOW?

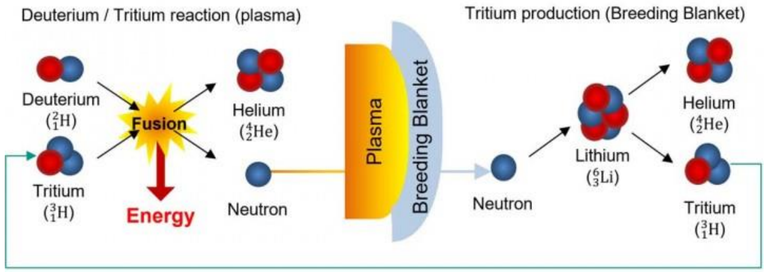
ITER Timeline

2005	Decision to site the project in France
2006	Signature of the ITER Agreement
2007	Formal creation of the ITER Organization
2007-2009	Land clearing and levelling
2008	Machine component fabrication begins
2010-2014	Ground support structure and seismic foundations for the Tokamak Complex
2010-2024	Construction of ITER plant and auxiliary buildings (excepting the Hot Cell Facility)
2012	Nuclear licensing milestone: ITER becomes a Basic Nuclear Installation under French law
2015…	Largest components are transported along the ITER Itinerary
2020	Machine assembly begins
2023	Completion of Tokamak Building civil works
2024 (June)	Updated ITER baseline proposal submitted to the ITER Council

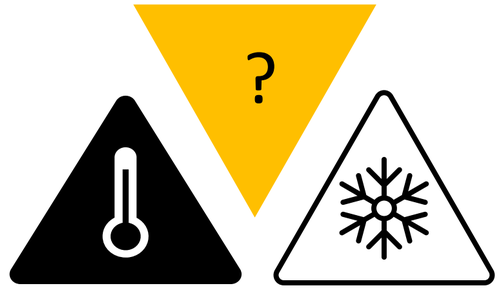
CHALLENGES TO OVERCOME

FUSION SCIENTISTS AND ENGINEERS TO FIGURE OUT HOW TO CLOSE THE DEUTERIUM-TRITIUM FUEL CYCLE.





EFFICIENT HEAT REMOVAL FOR ELECTRICITY GENERATION



MATERIALS THAT CAN WITHSTAND THE INTENSE TEMPERATURES FOUND WITHIN THESE MACHINES

HIGH TEMPERATURE SUPERCONDUCTING (HTS) MAGNETS

MANUFACTURING AND ASSEMBLY

HEAT AND PARTICLE EXHAUST FROM THE PLASMA

CONCLUSIONS

OTHER FACILITES ARE BEING BUILT TO PROVIDE USEFUL INFORMATION TO SCIENTIESST (IFMIF DONES). SMALLER TOKAMAKS, HAVE BEEN WORKING FOR DECADES (JET). THE LEARNINGS IN THEIR OPERATION AND FINDINGS ARE KEY TO PREDICT WHAT IS GOING TO HAPPEN IN LARGER DEVICES SUCH AS ITER AND DEMO.

THE WAY TO FUSION INCLUDES MORE THAN TOKAMAKS. STELLARATORS (W7X) AND LASER-BASED DEVICES ARE BEING DEVELOPED TO PROVIDE THE SCIENTIFIC COMMUNITY AND HUMANITY WITH OTHER ALTERNATIVES.

PRIVATE COMPANIES HAVE EXPRESS THEIR INTEREST IN FUSION. CURRENT RESEARCHES AND WORK WILL BE VERY USEFUL IN THE WAY TO ACHIEVE COMMERCIAL REACTORS.

FUSION IS NOT A SPRINT BUT A MARATHON

LINKS

https://www.iter.org/

https://fusionforenergy.europa.eu/

https://www.iaea.org/es

https://euro-fusion.org/

Let’s ignite our future!