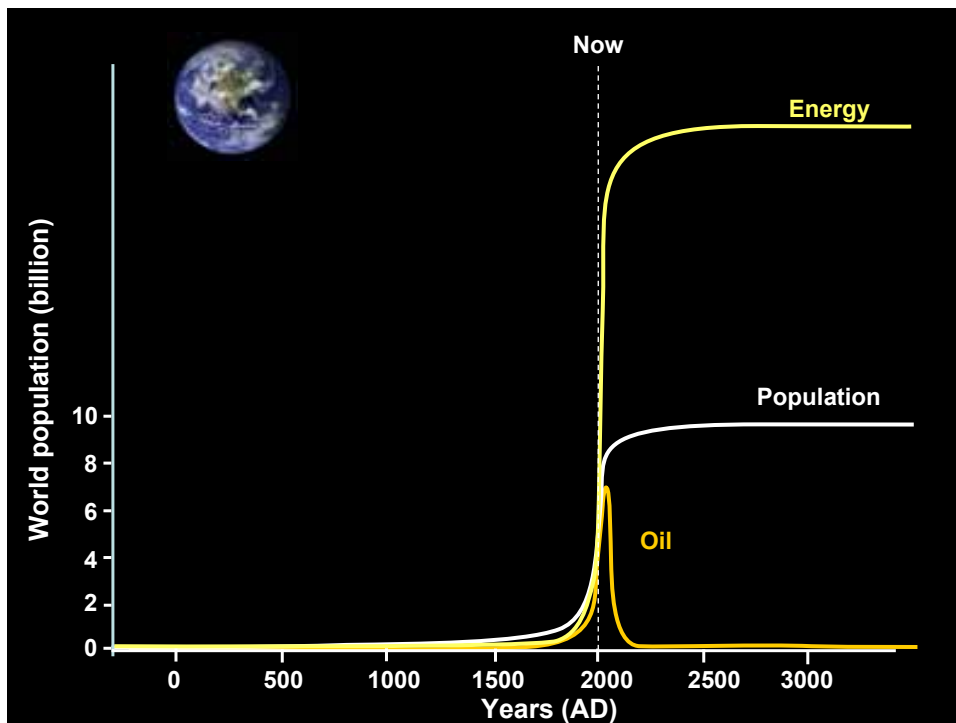
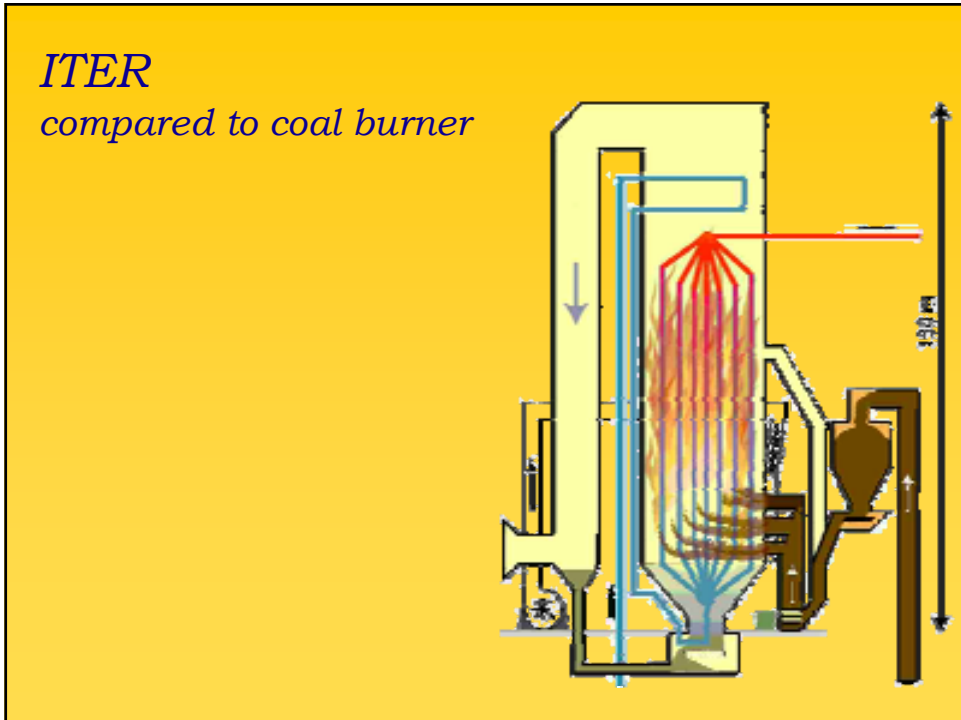
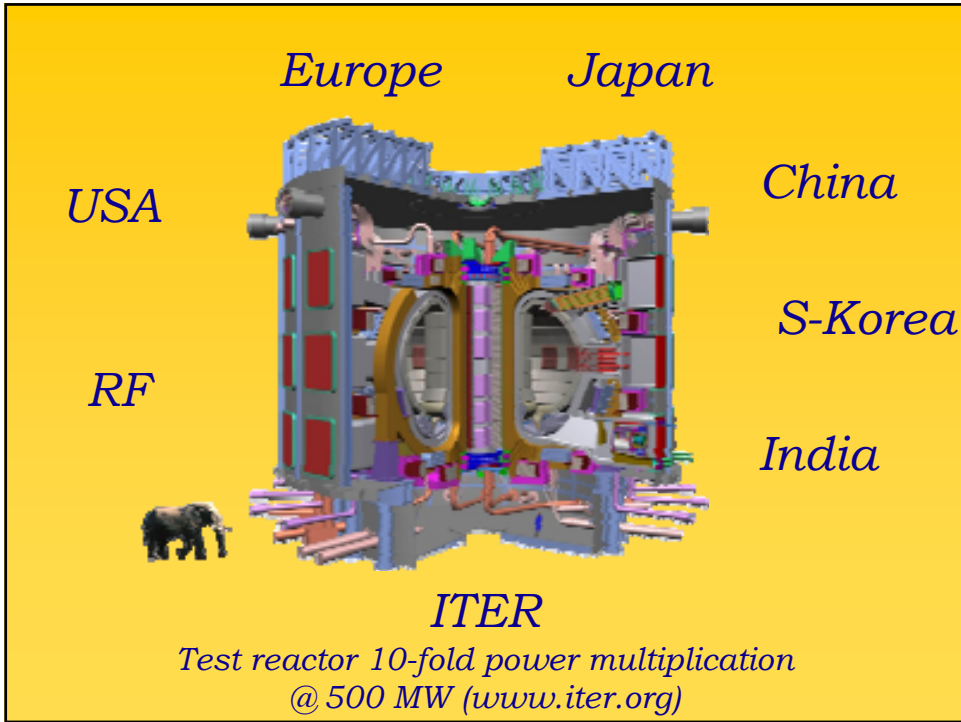


Fusion: the 7 scientific challenges between us and clean power.

Niek Lopes Cardozo

FOM-institute for Plasma Physics Rijnhuizen
Eindhoven University of Technology





“The president has made achieving commercial fusion power the highest long-term energy priority for our Nation”

USA DoE Office of Science Strategic Plan, February, 2004



“China wants to be among the first nations to generate electricity from fusion”

Chinese government, when China joined ITER, January 2003



“South Korea will grow into one of the world’s top five countries in nuclear fusion energy technology by 2021, and will start commercial generation of electricity through nuclear fusion by 2040.”

President Roh Moo-Hyun, Sept 2007



“Europe’s contributions to ITER will ensure that the EU stays at the forefront of this field. I am convinced that we have to vigorously pursue our objective to realise fusion energy. For a safer and sustainable future of our planet.”

EU Commissioner Potocnik, 2005

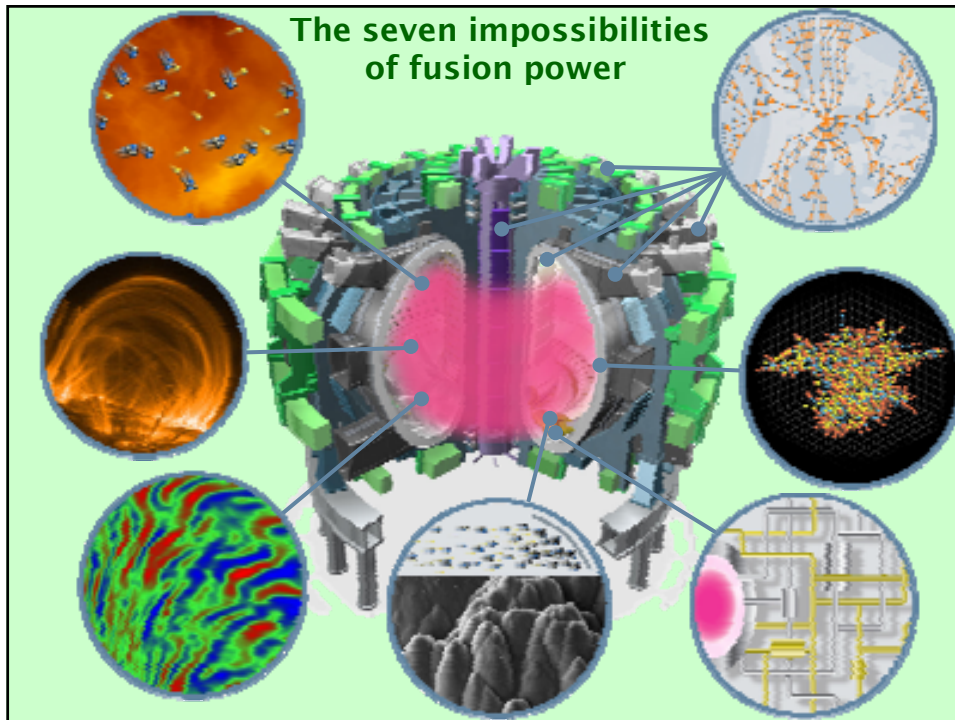


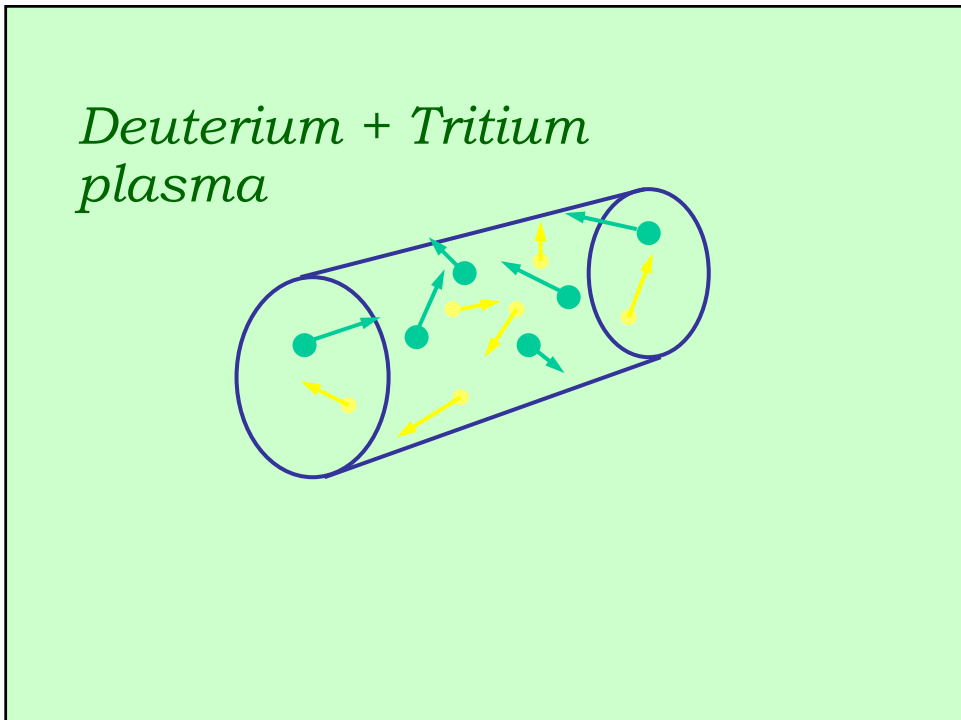
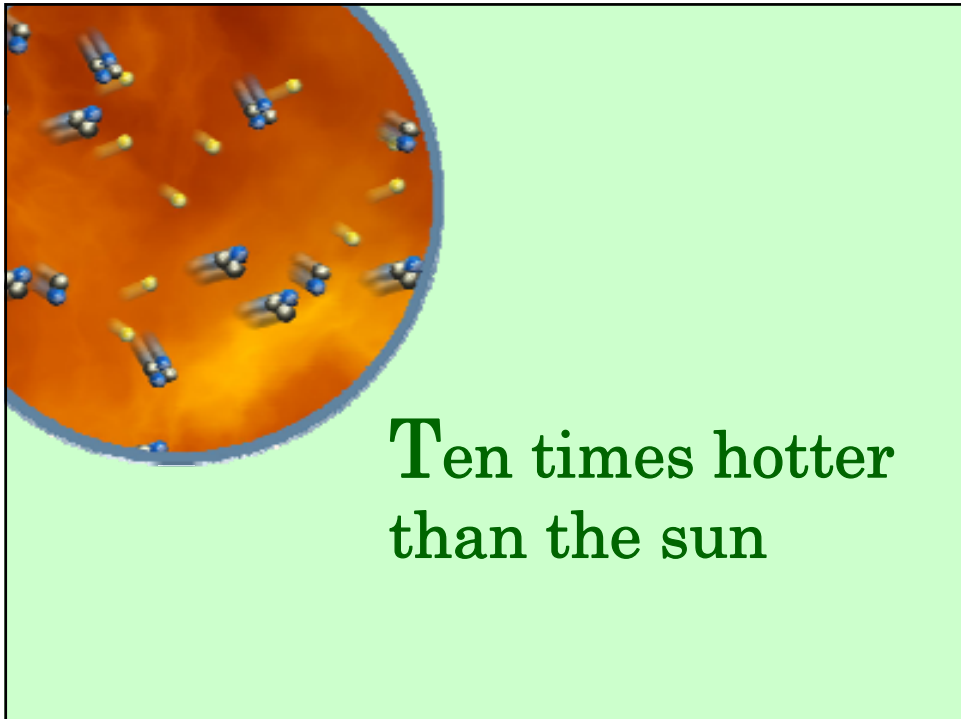
Europe, the USA, Japan, China, Russia, S-Korea and India

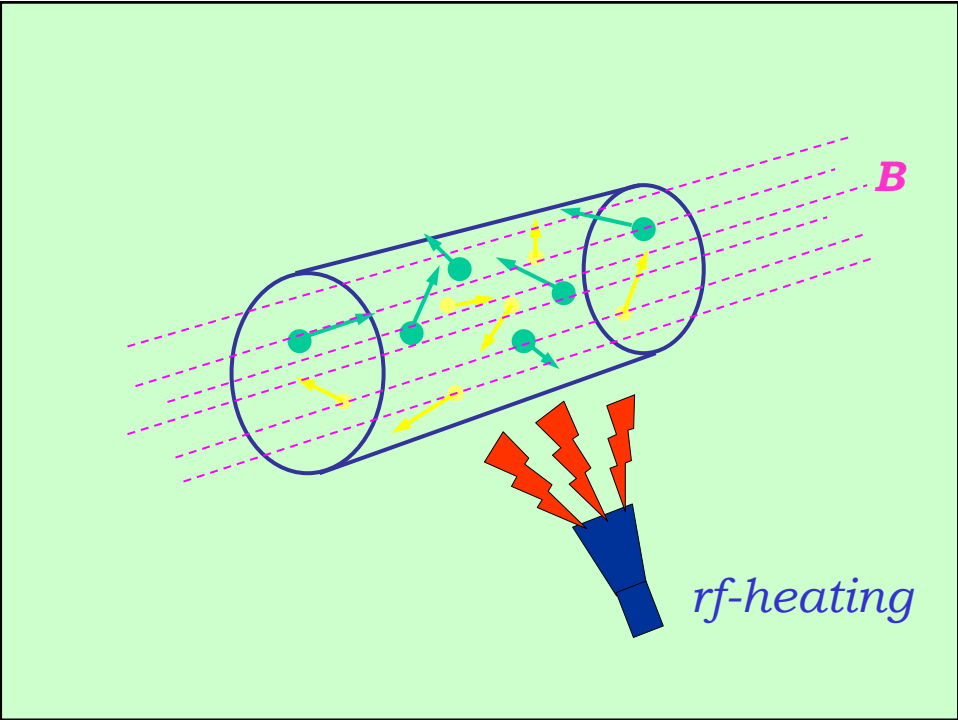
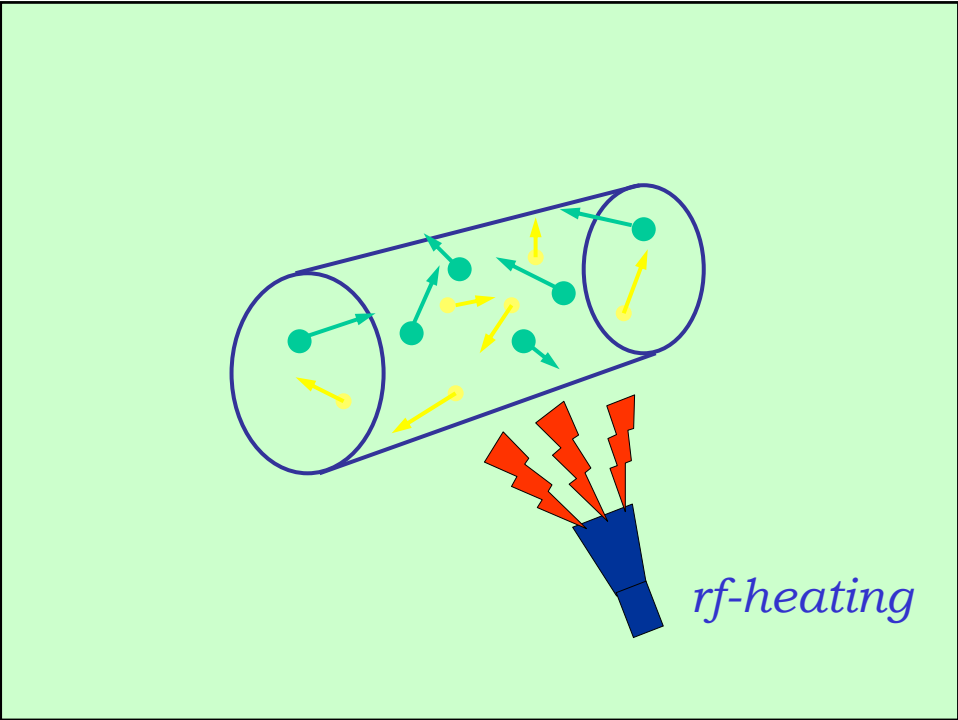
want fusion because

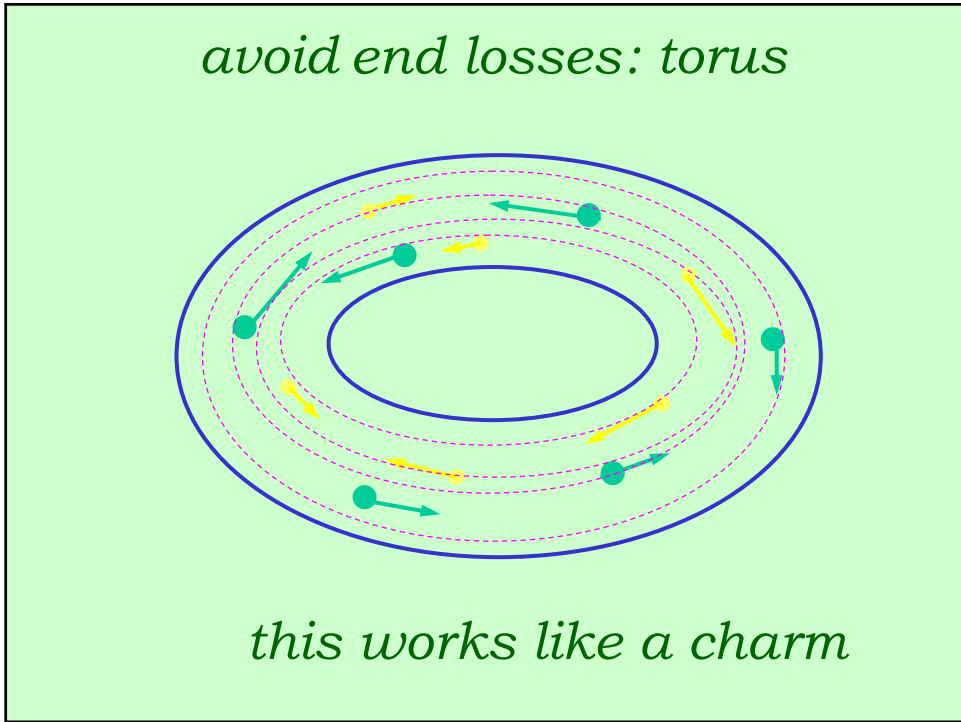
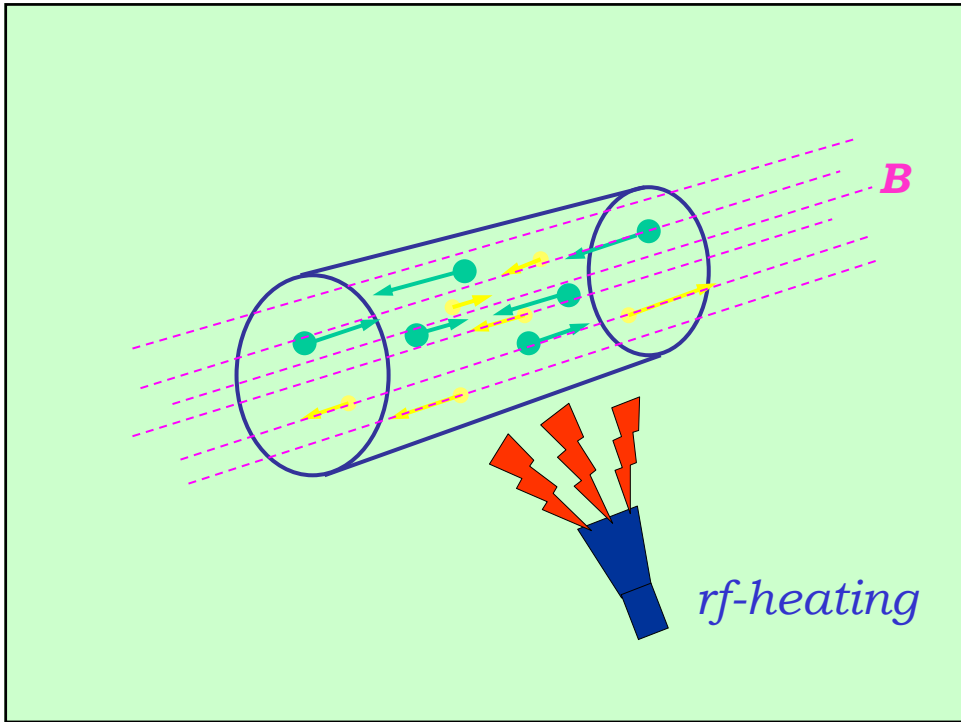
- Zero CO₂, Clean, Safe
- Security of supply
- No proliferation issue

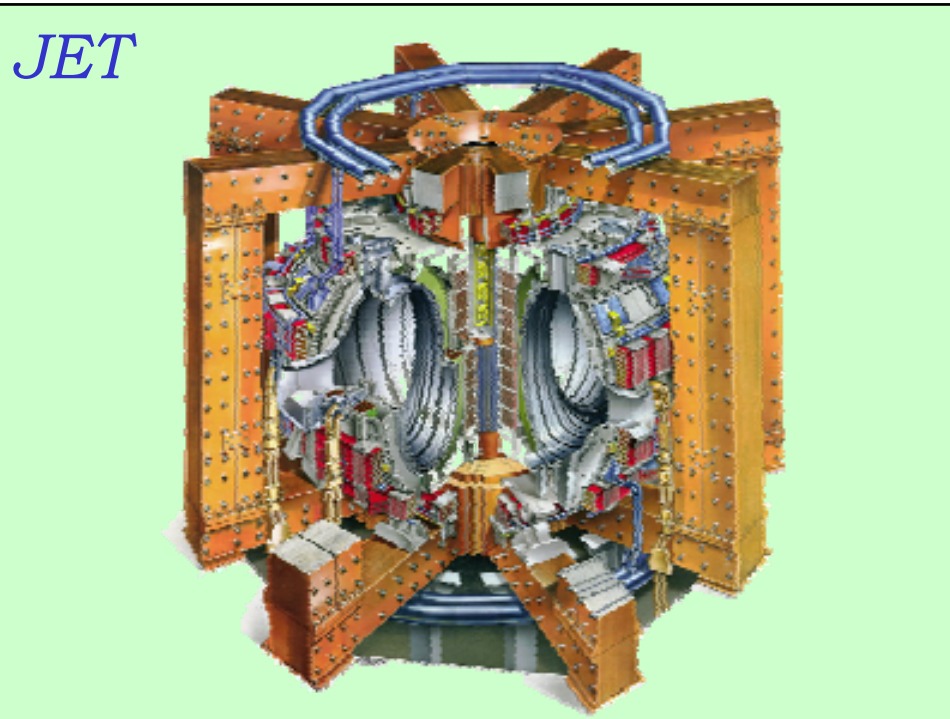
Drawback... Fusion is difficult!

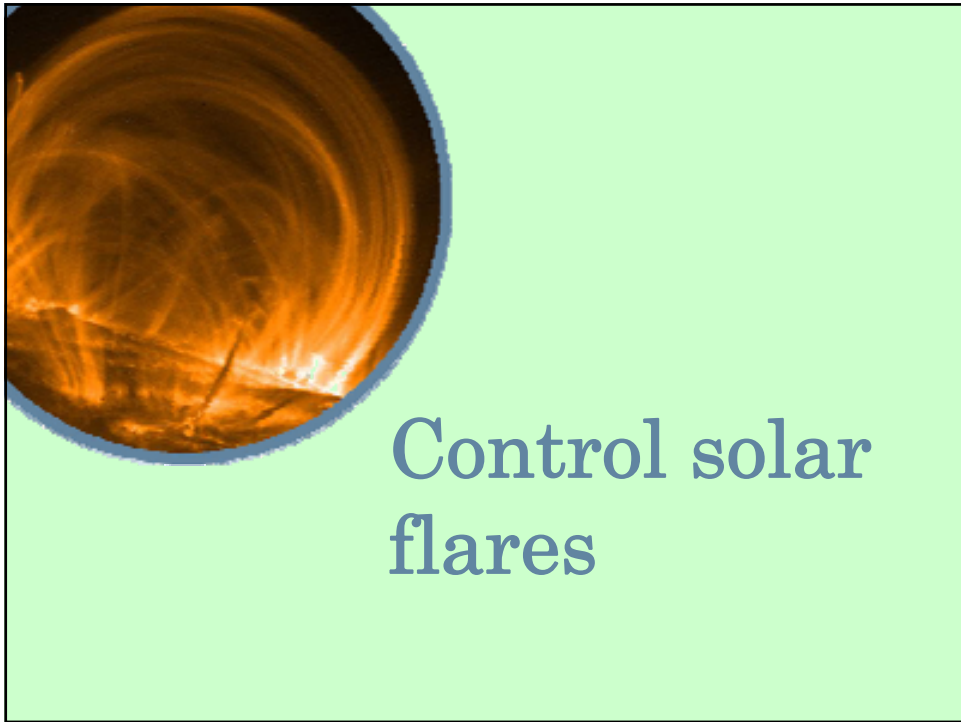










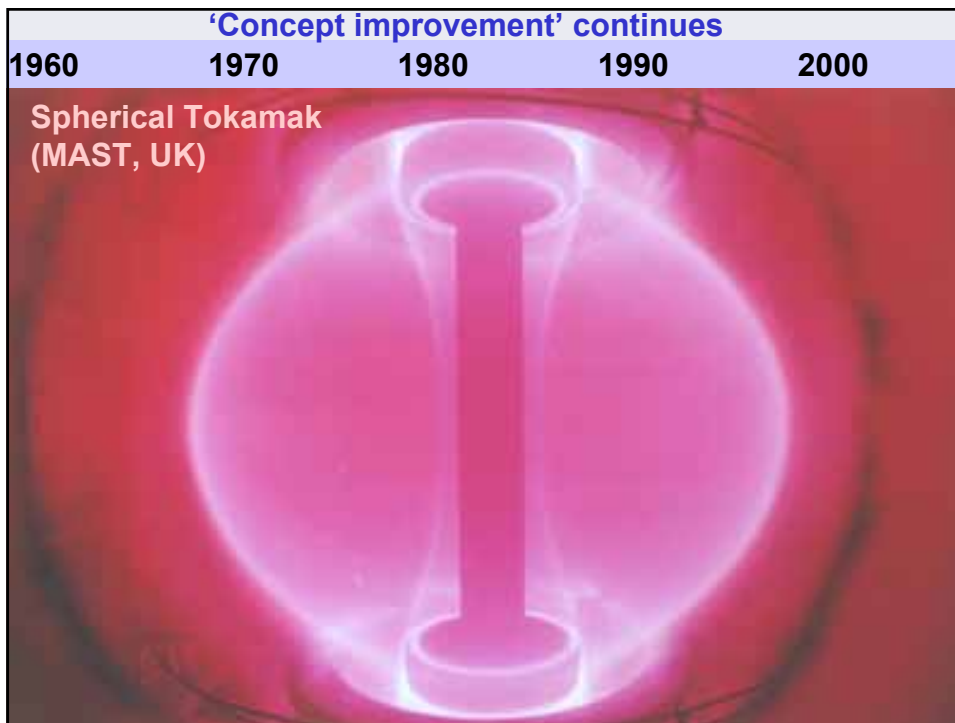
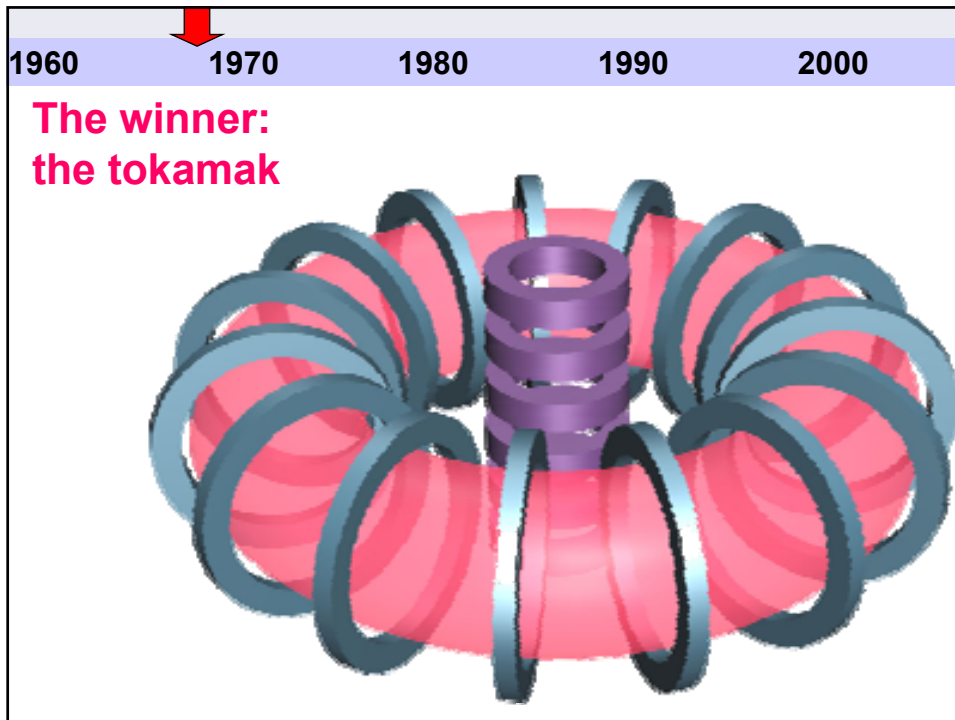


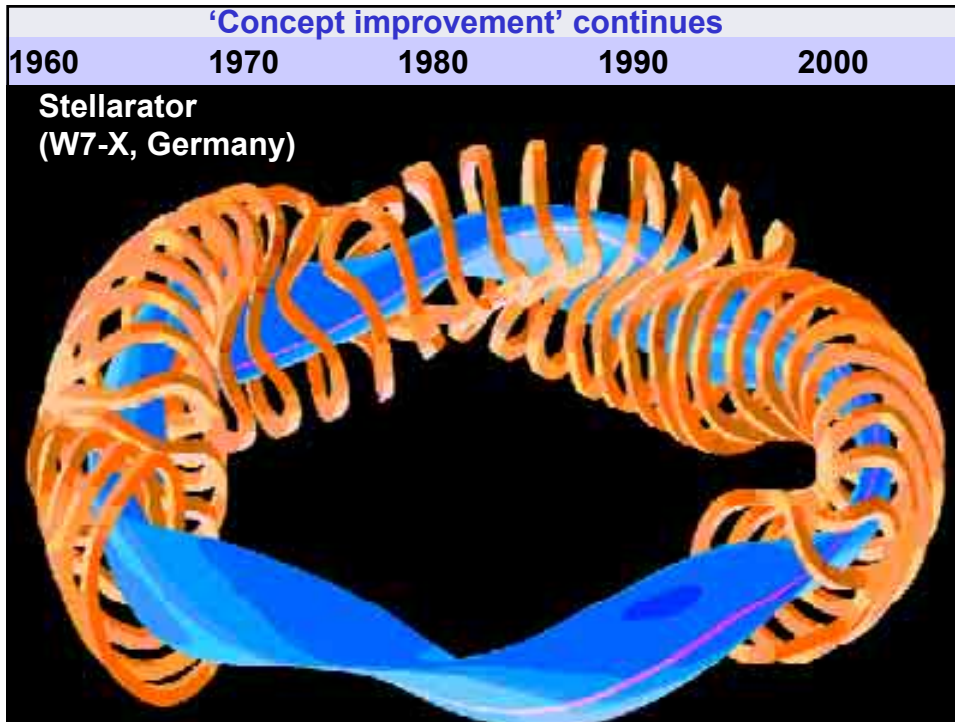
1960 1970 1980 1990 2000

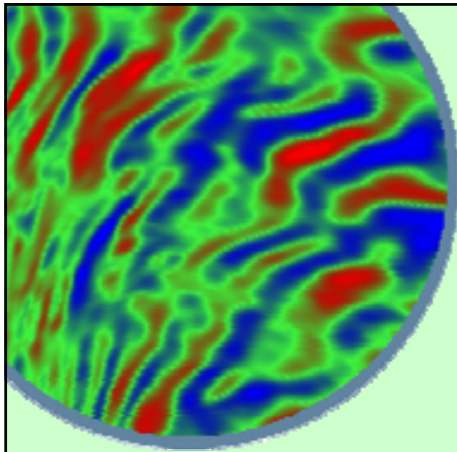
Sixties: exploring magnetic confinement configurations

The diagrams illustrate various magnetic confinement configurations:

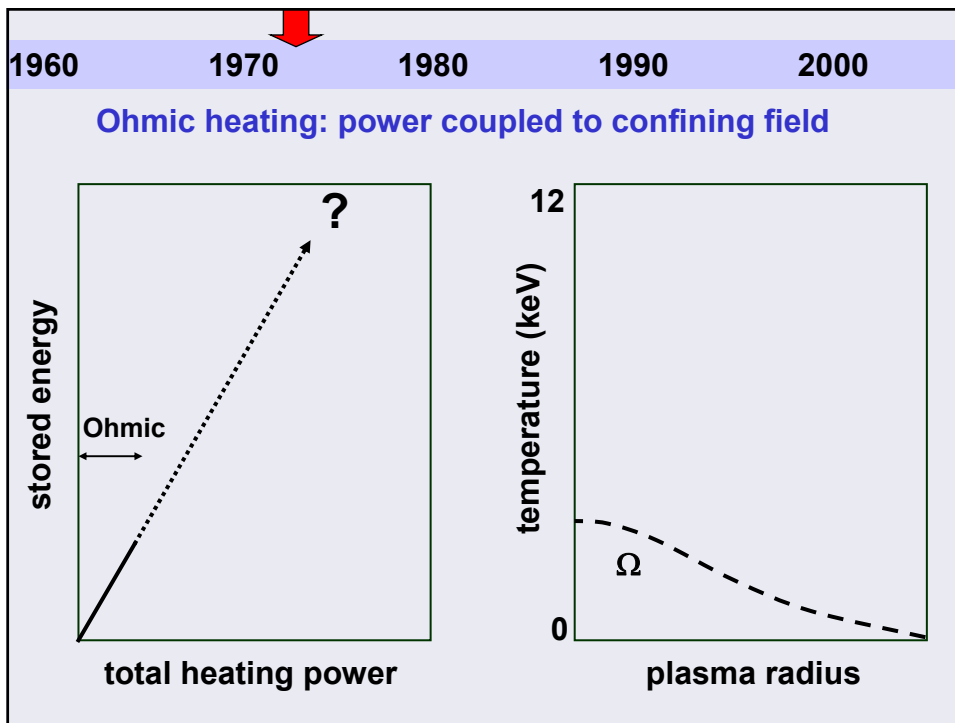
- A vertical cylindrical device with a central rod and external magnetic fields.
- A cross-section of a toroidal device with a central rod and external magnetic fields.
- A diagram of a plasma column with external magnetic fields.
- A diagram of a plasma configuration with a central rod and external magnetic fields.
- A large diagram of a toroidal device with a complex magnetic field structure.

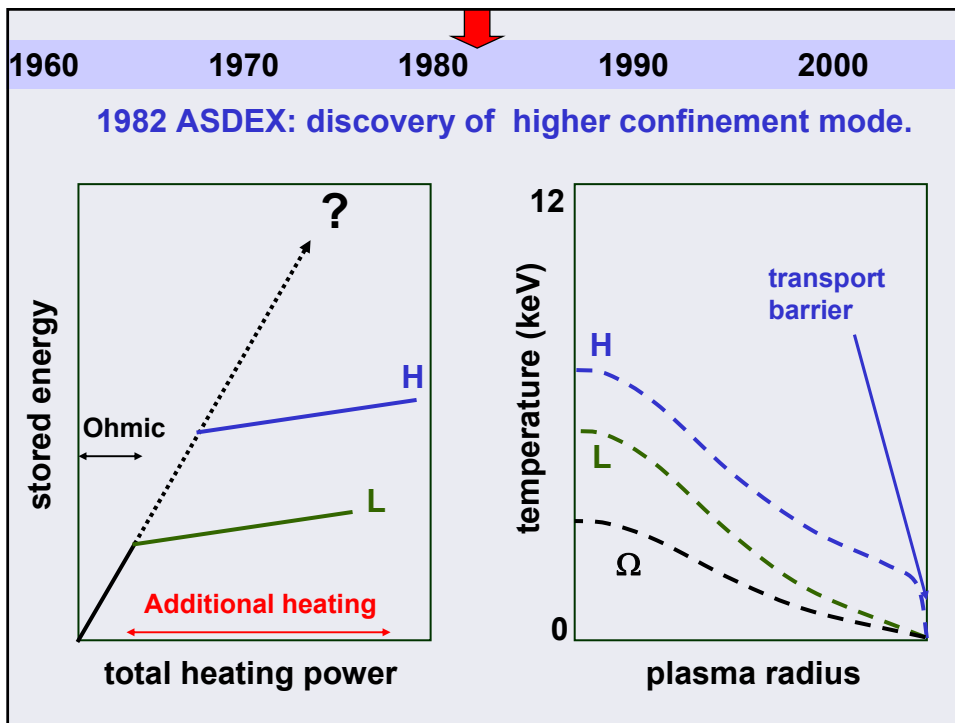
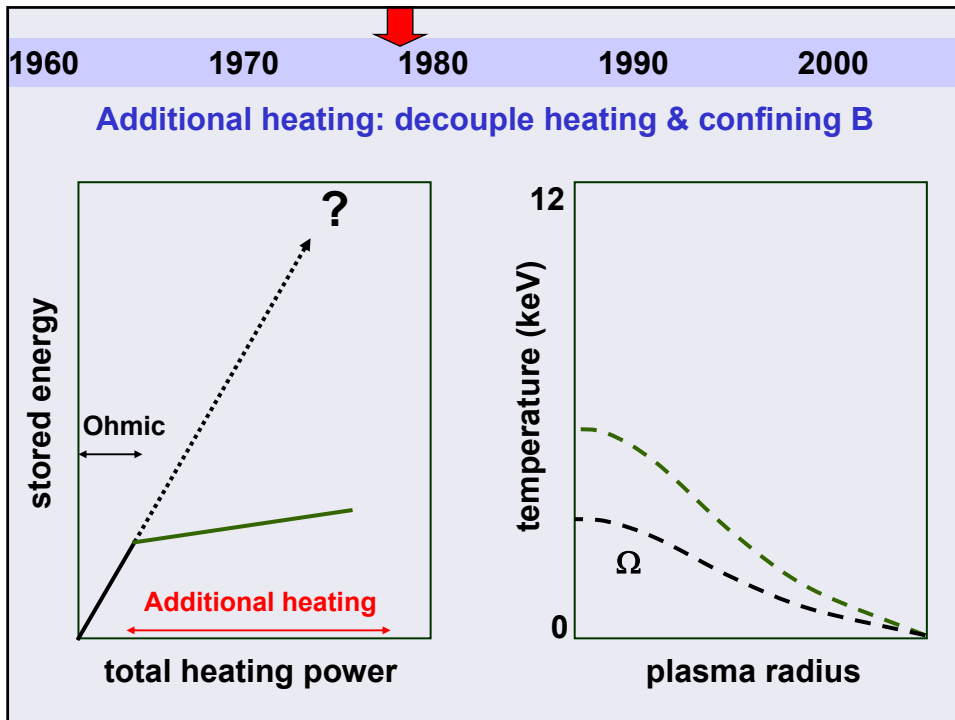


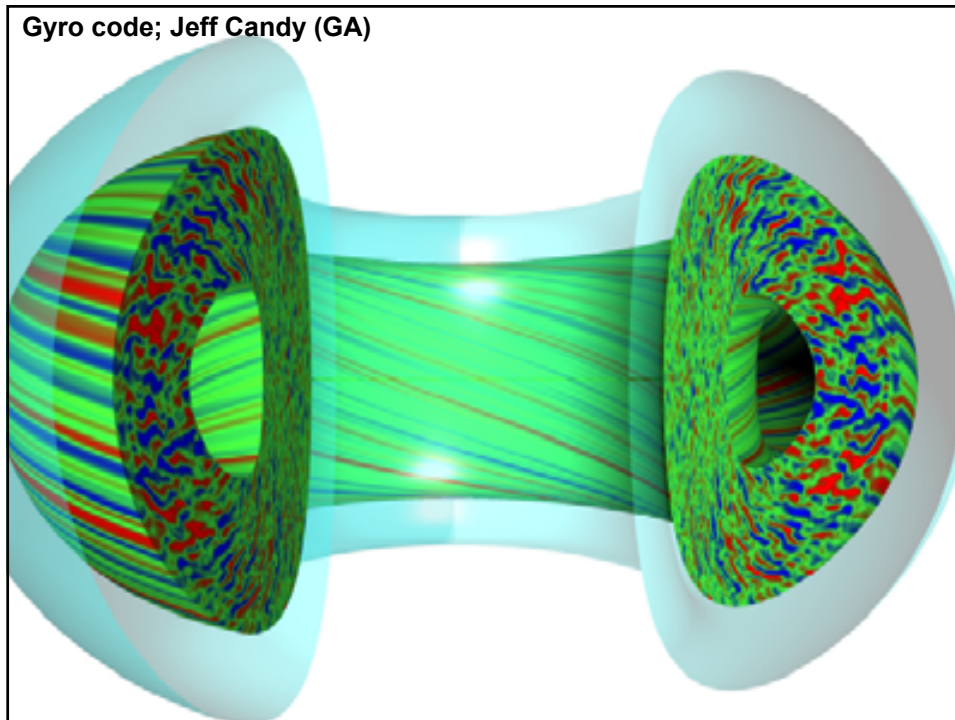
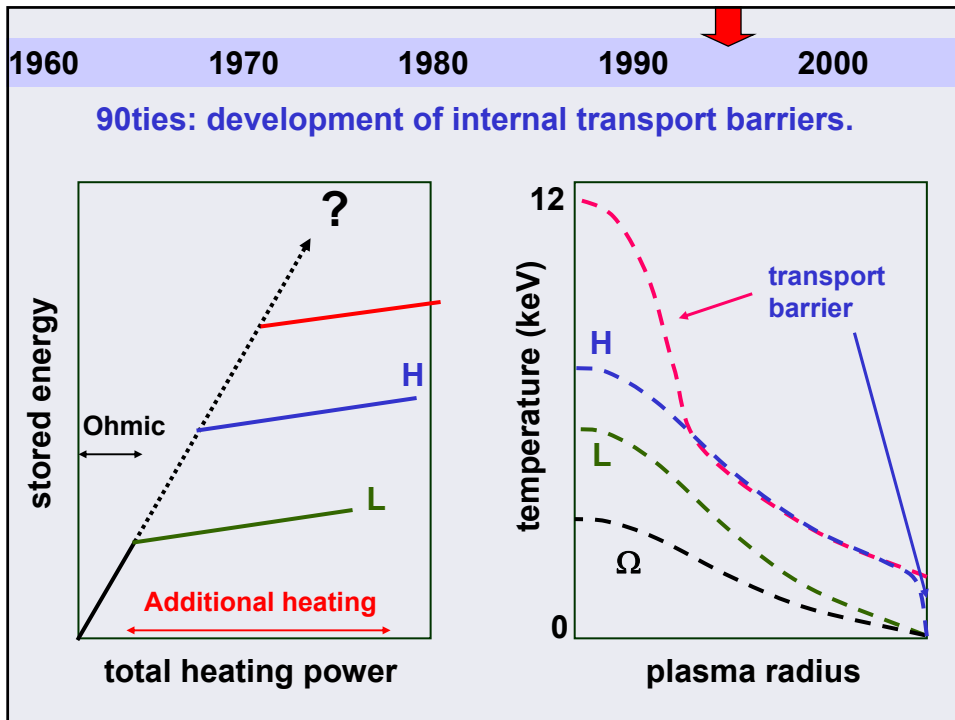




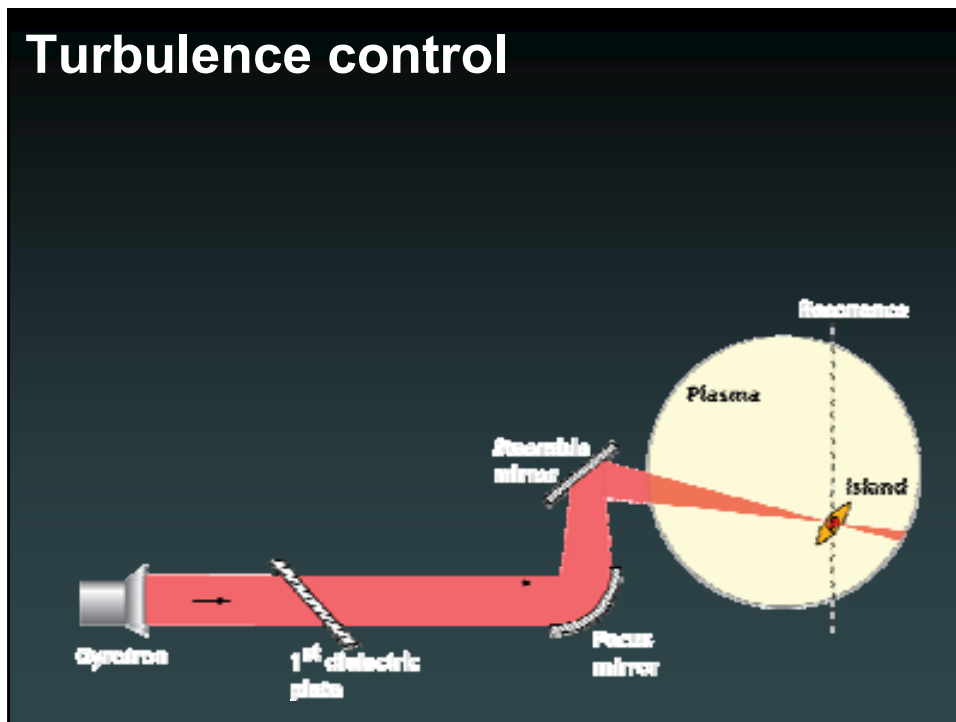
Thermal insulation
as good as
styrofoam



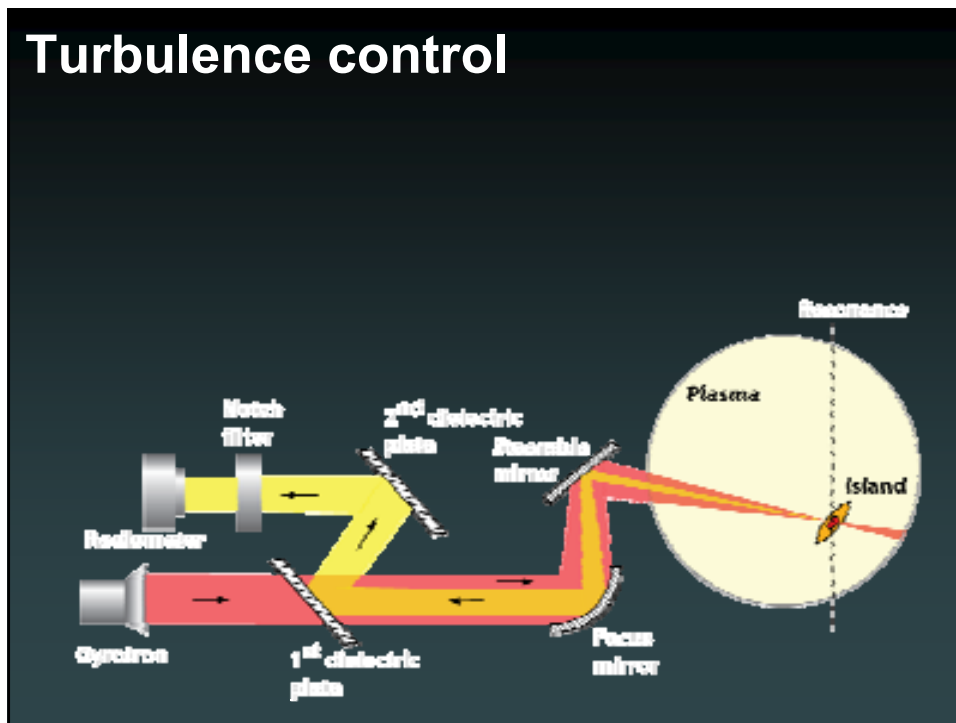




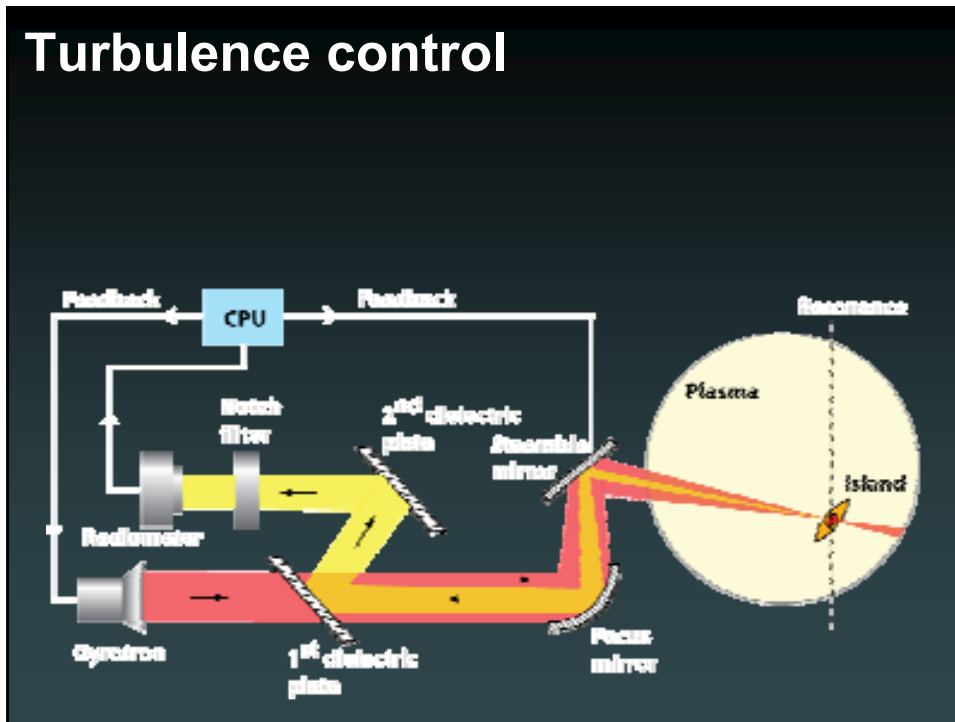
Turbulence control



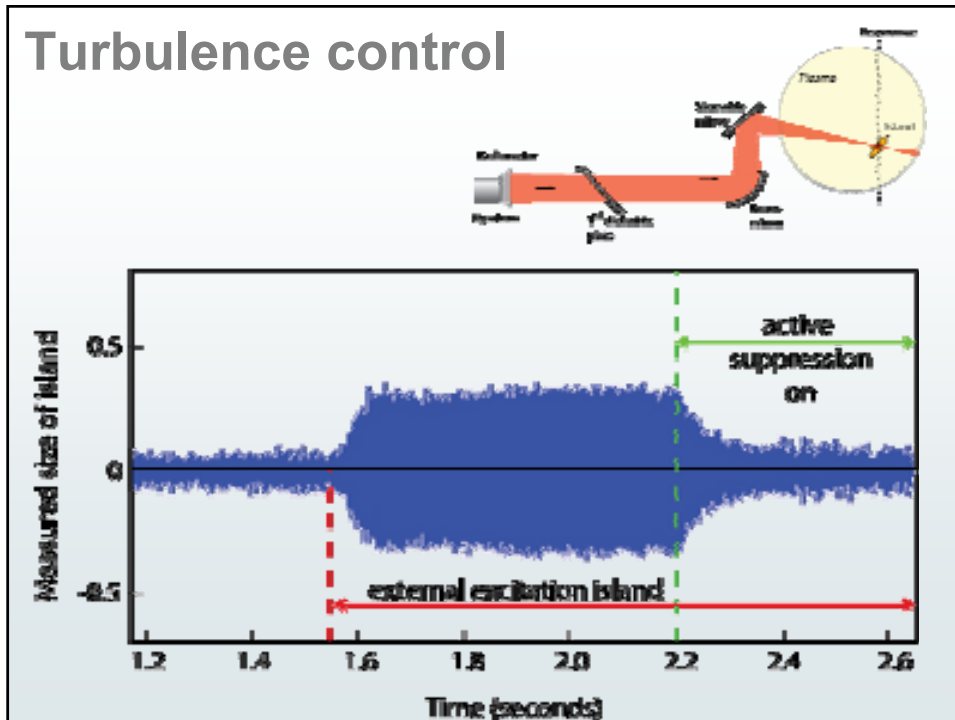
Turbulence control



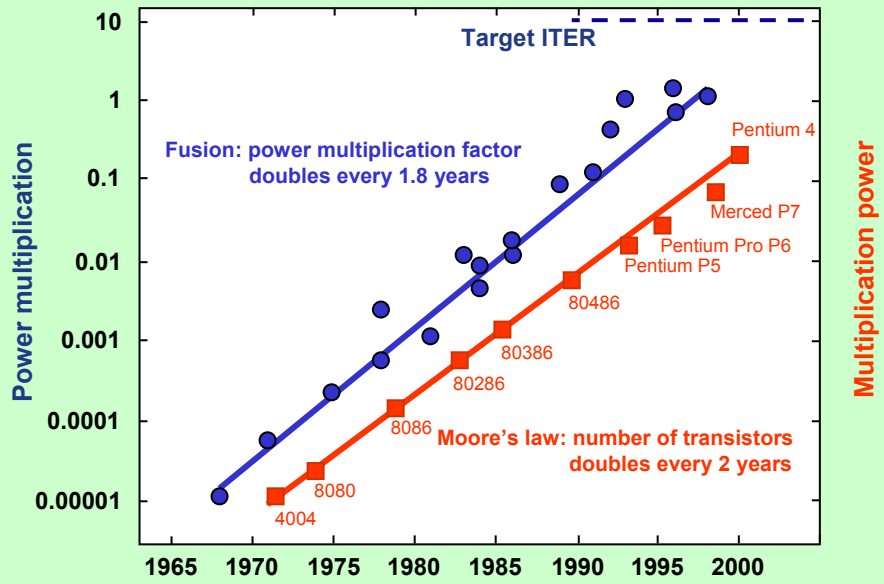
Turbulence control



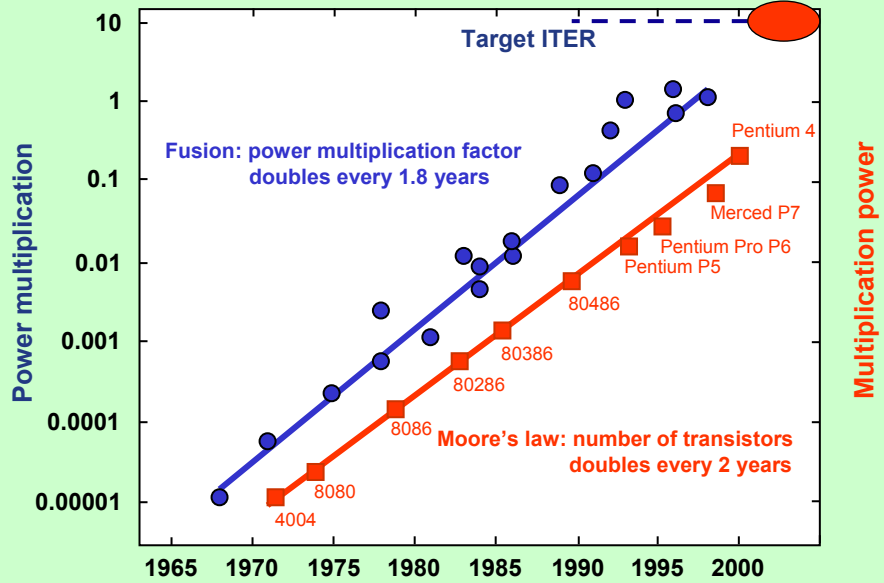
Turbulence control

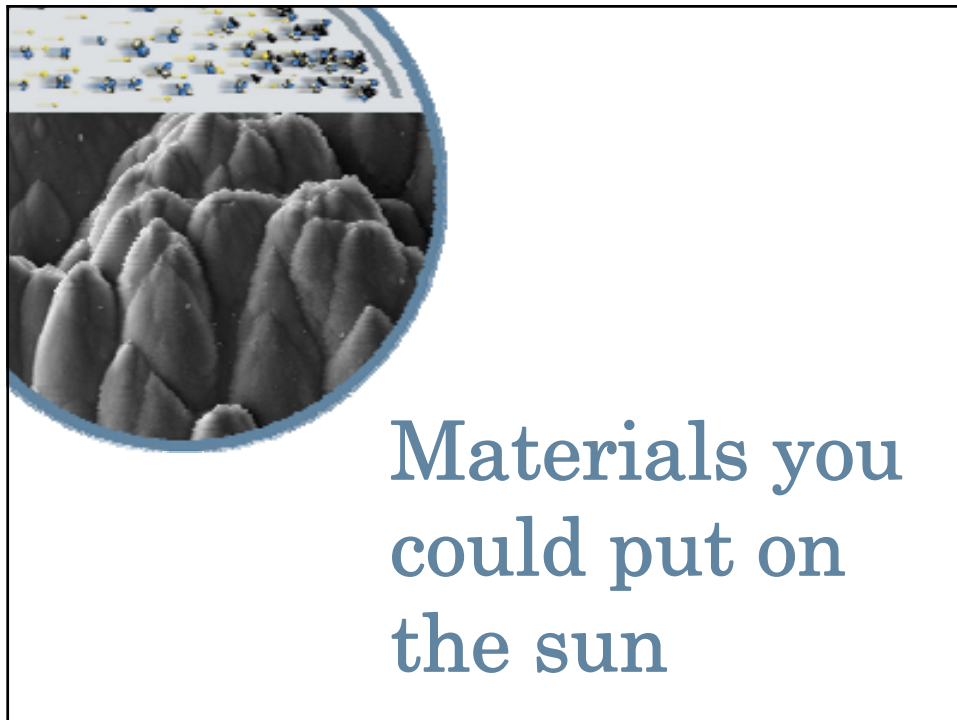
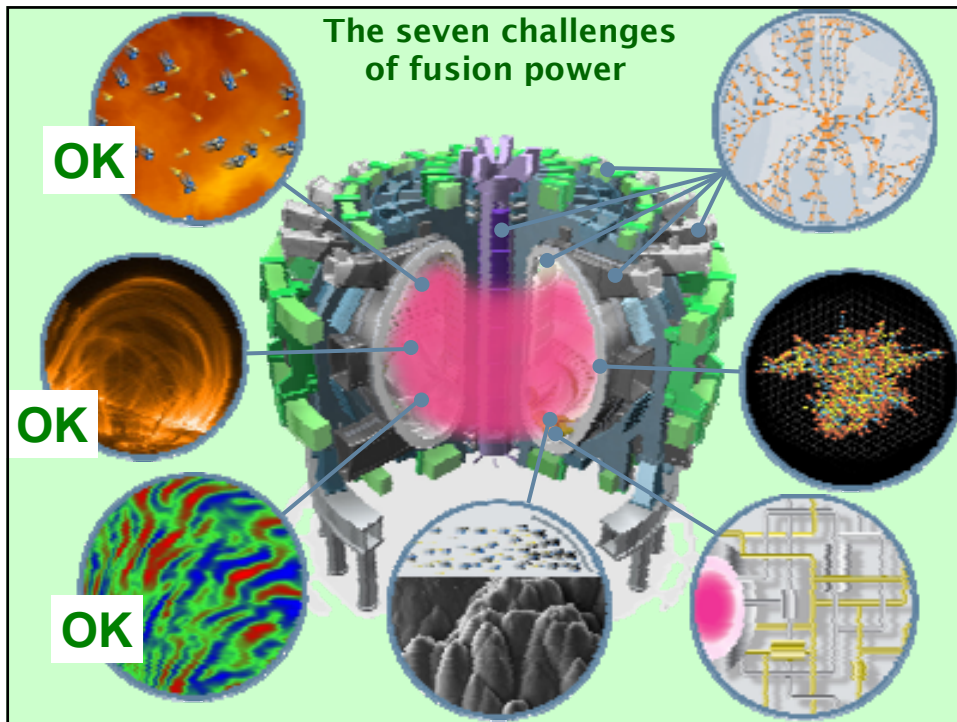


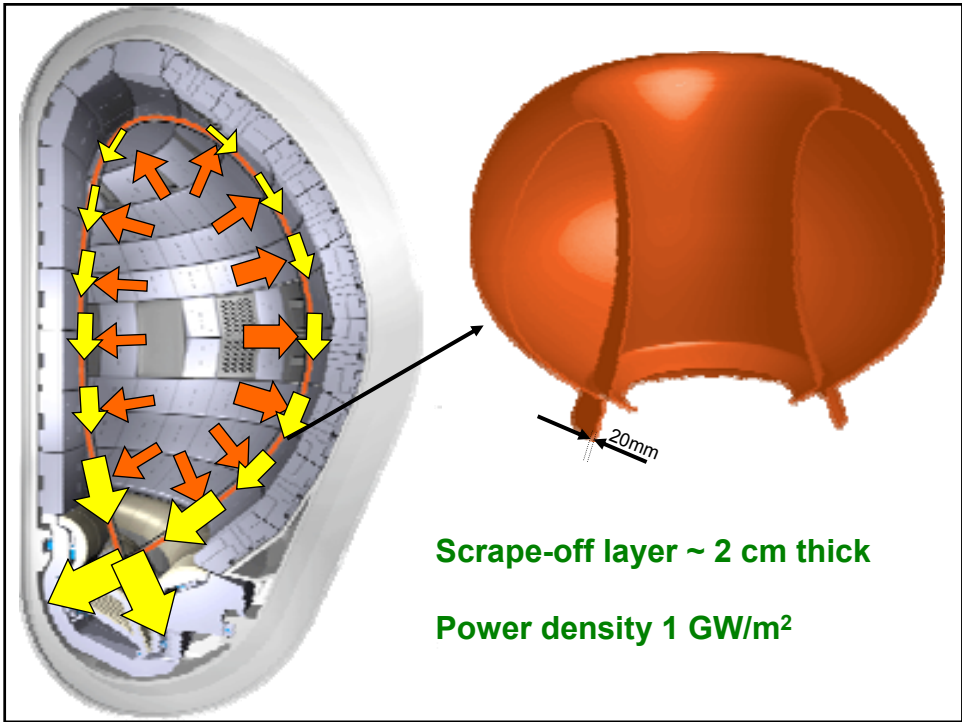
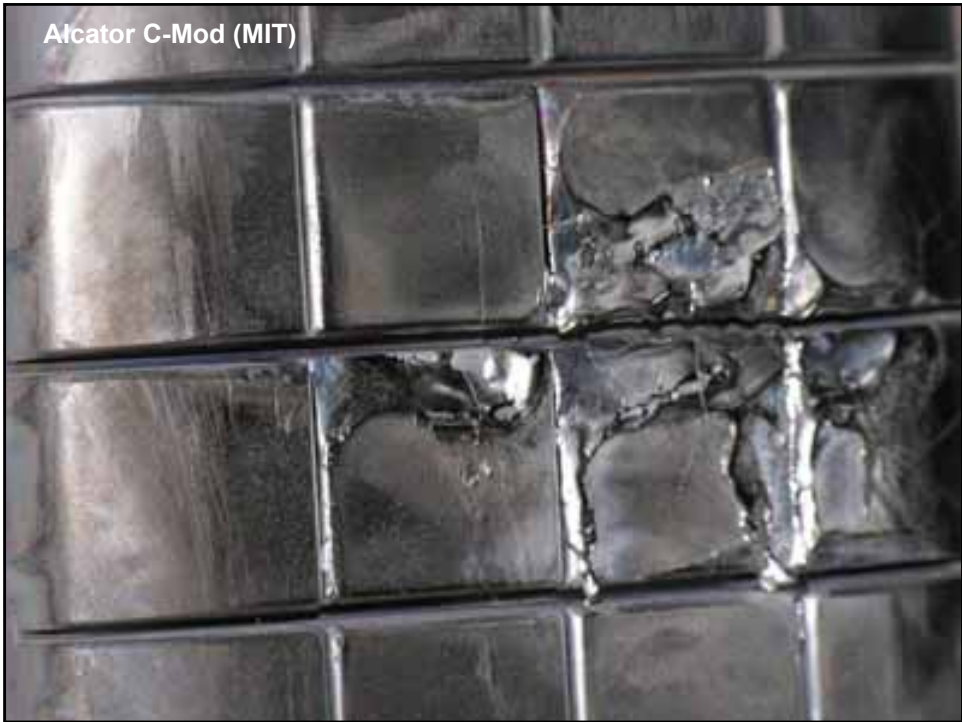
High T, stable confinement, insulation: under control



High T, stable confinement, insulation: under control

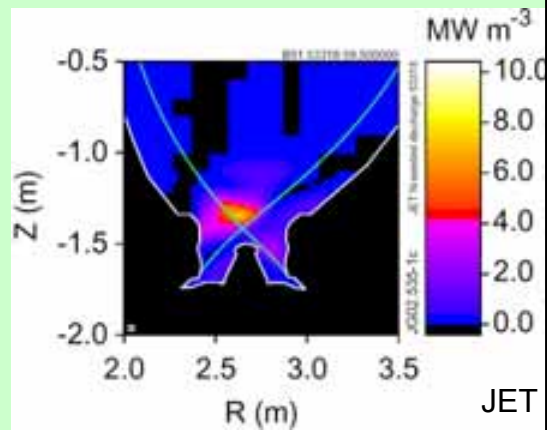


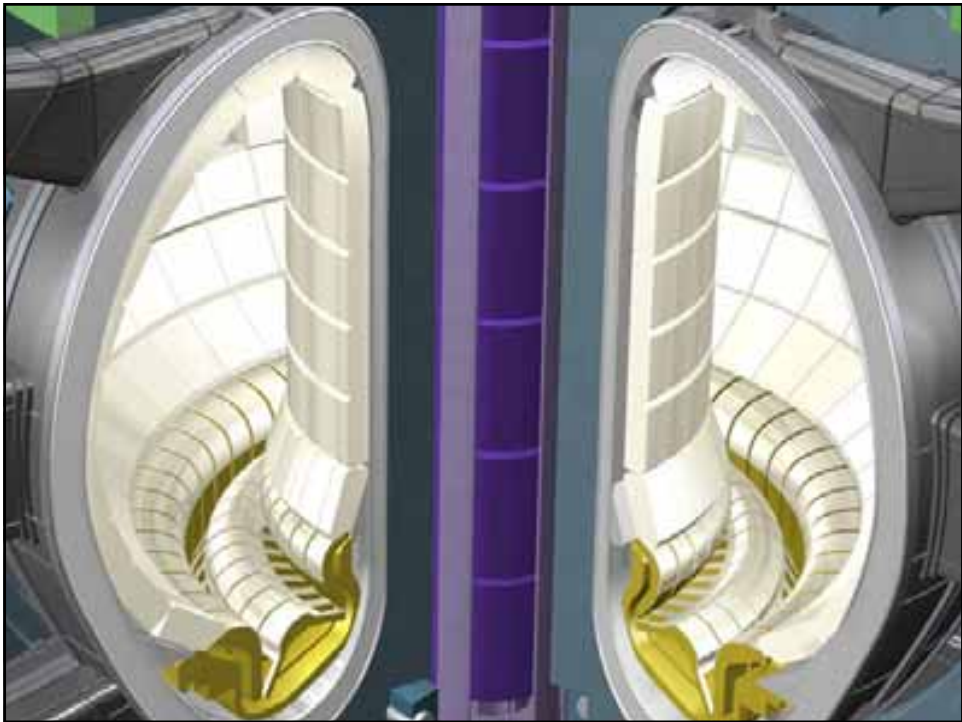
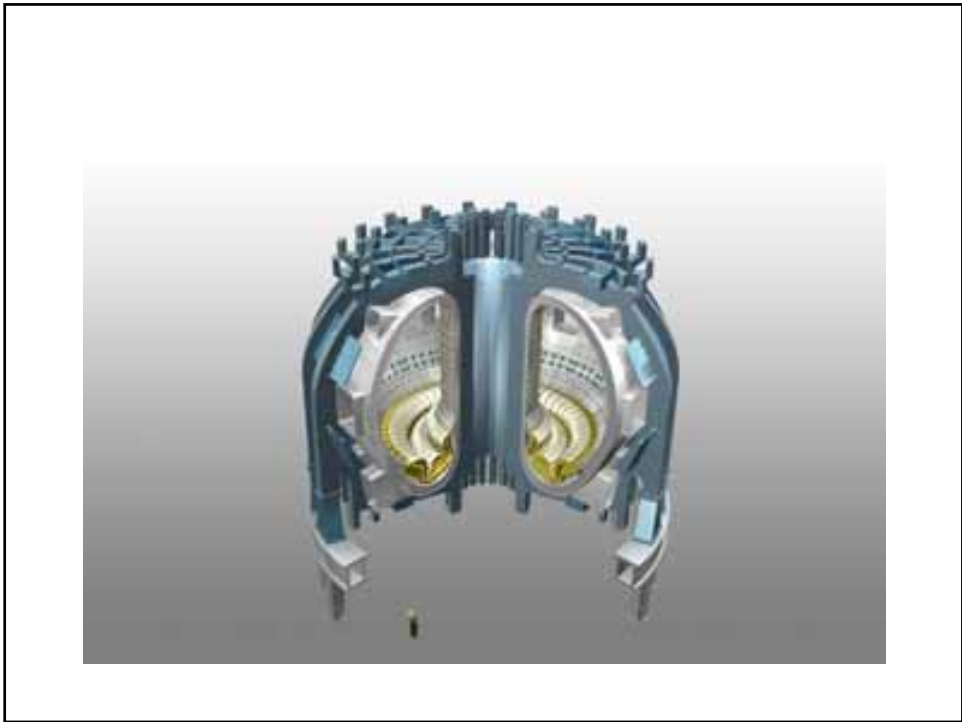


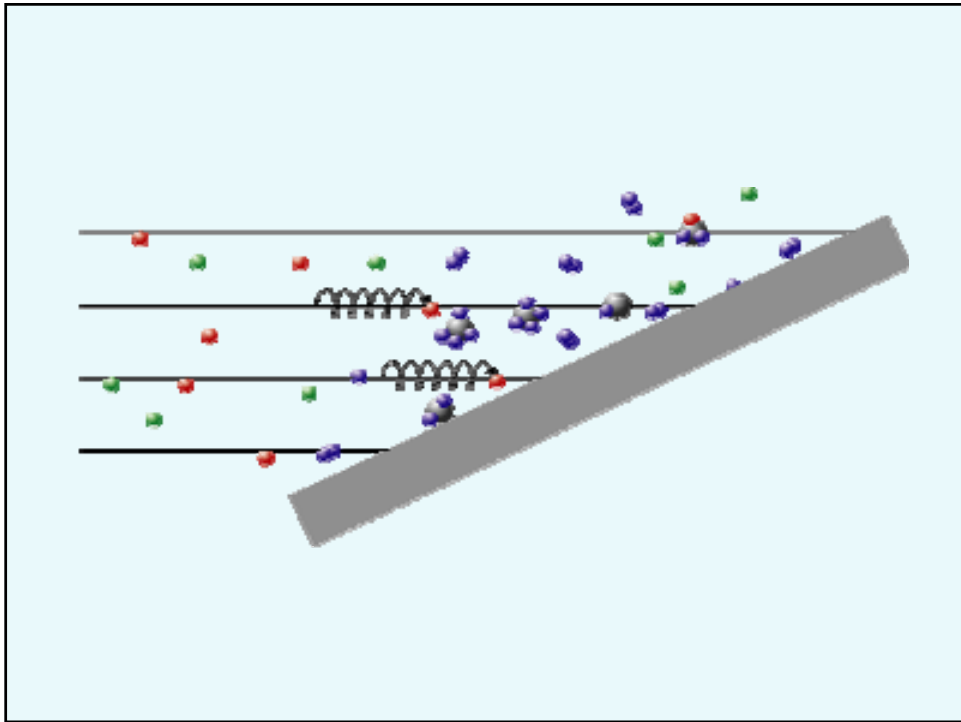
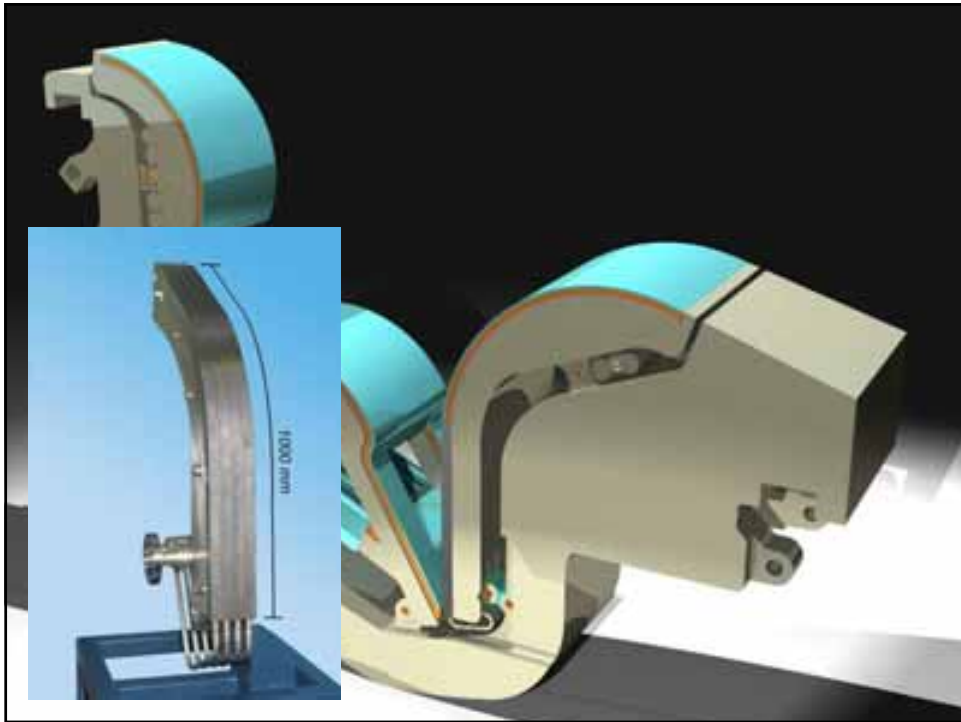


How to reduce 1 GW/m² to a tolerable value?

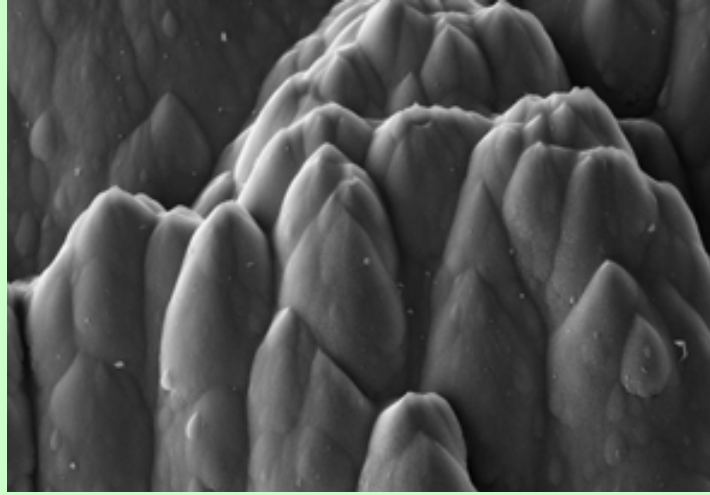
- geometry of divertor
- radiate 90% of the power
- 'detach' the plasma (T < 10 eV)







carbon deposits in TEXTOR (FZ-Julich)



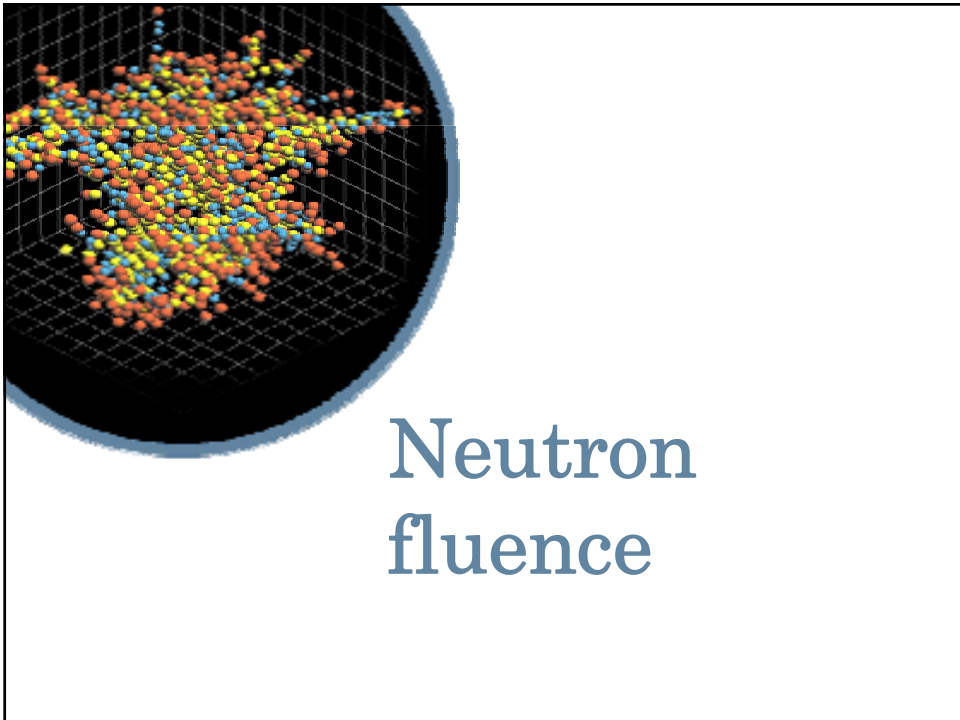
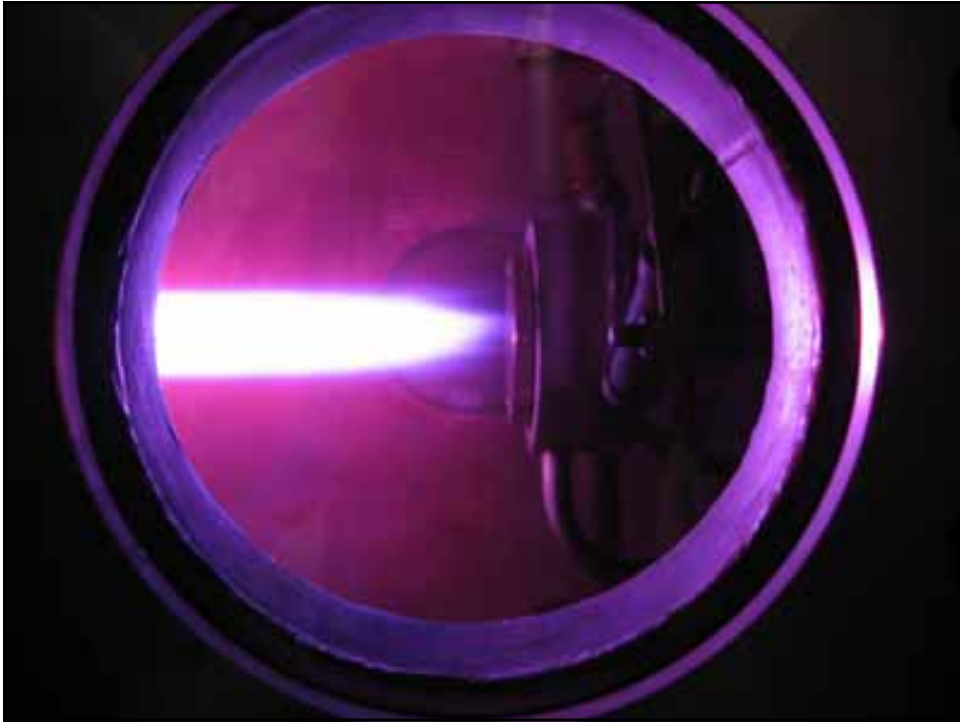
50 micron

High-power linear plasma generators at FOM:

operational: Pilot-PSI

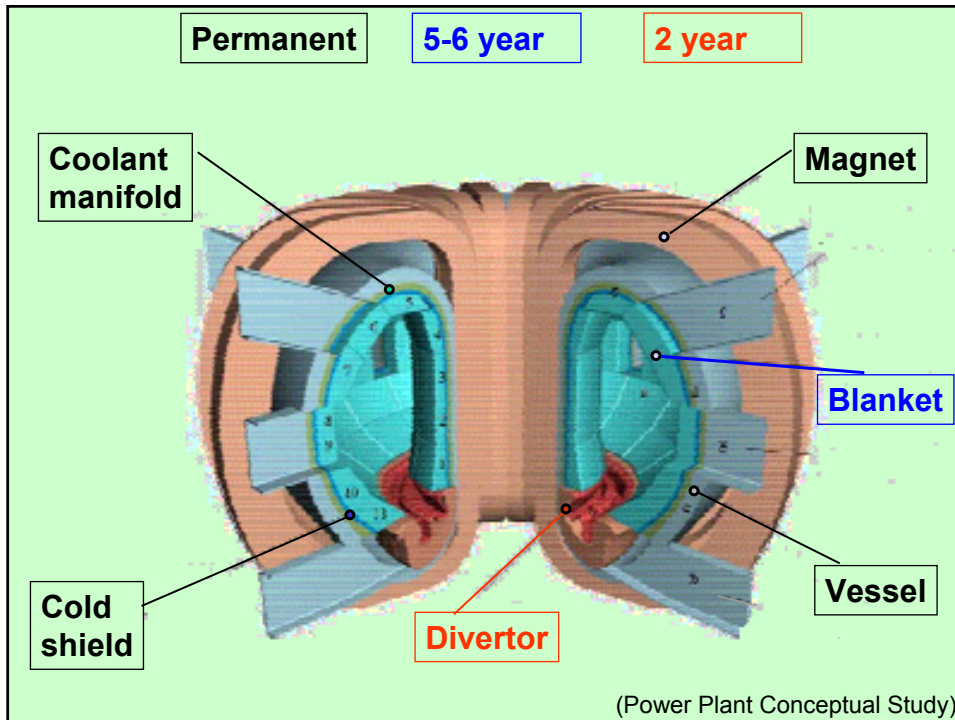
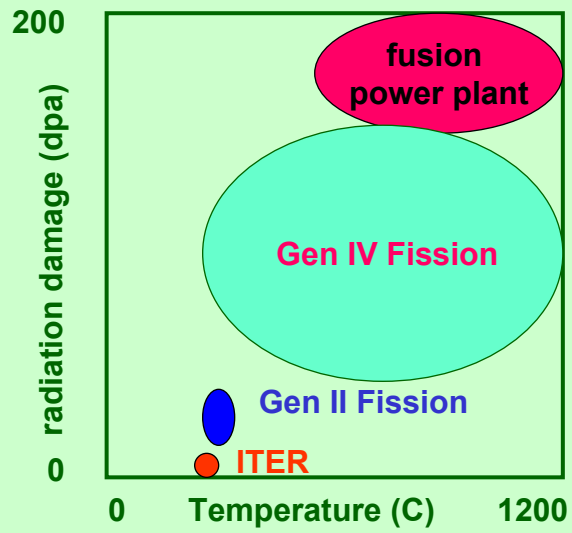
under construction: Magnum-PSI



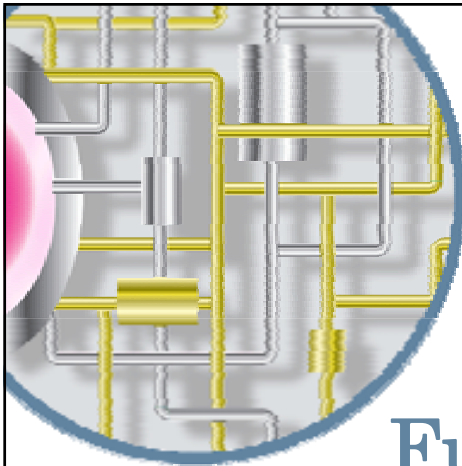
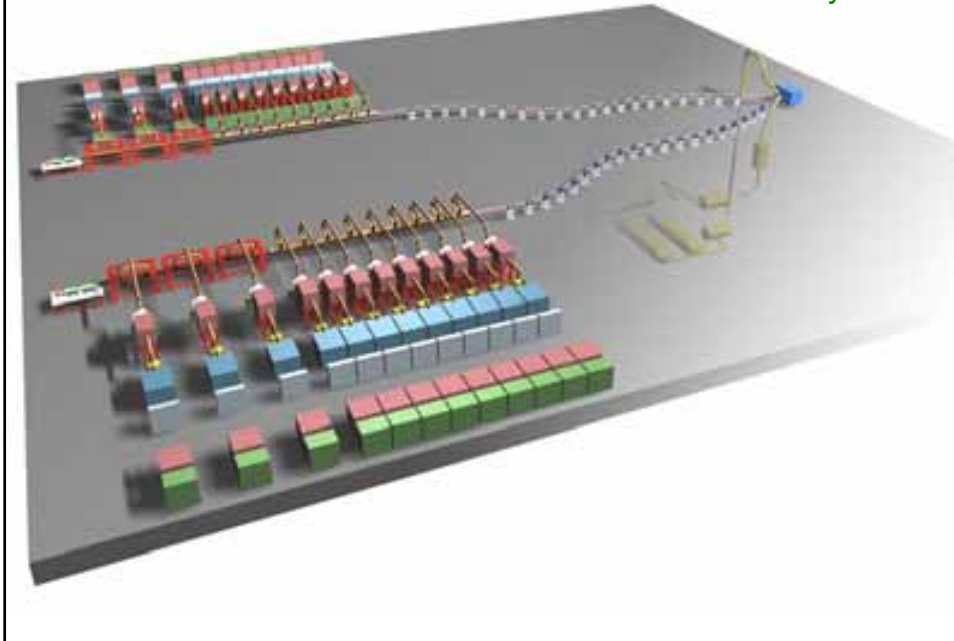


Neutron
fluence

Material development: parallels with fission

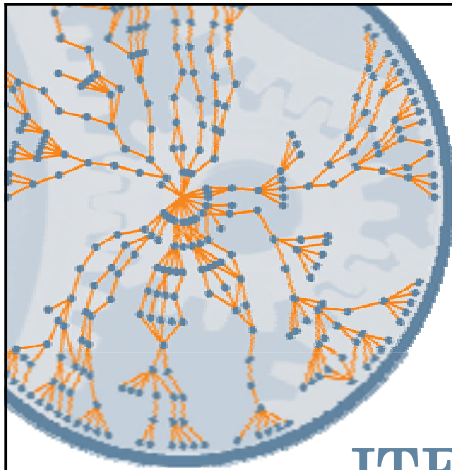
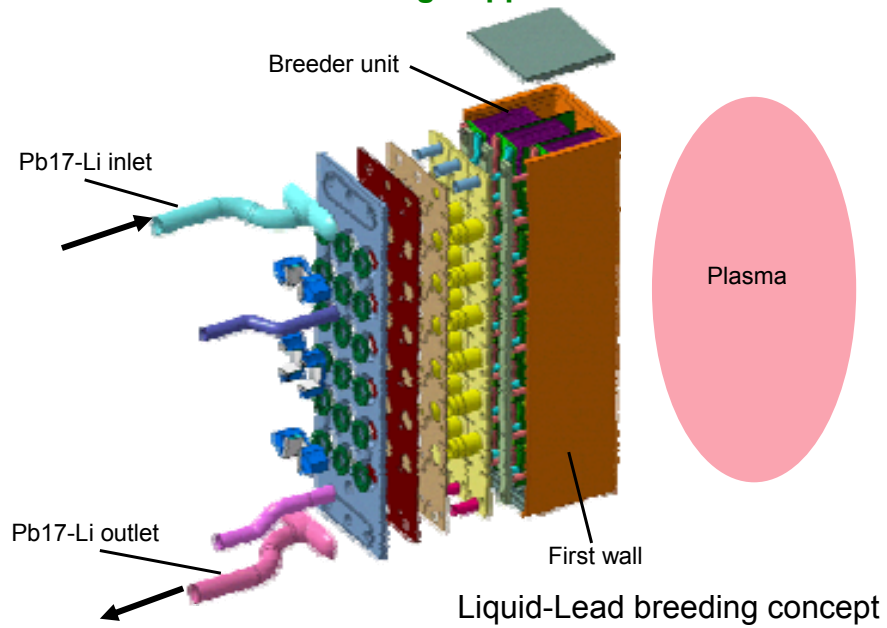


IFMIF - International Fusion Materials Irradiation Facility

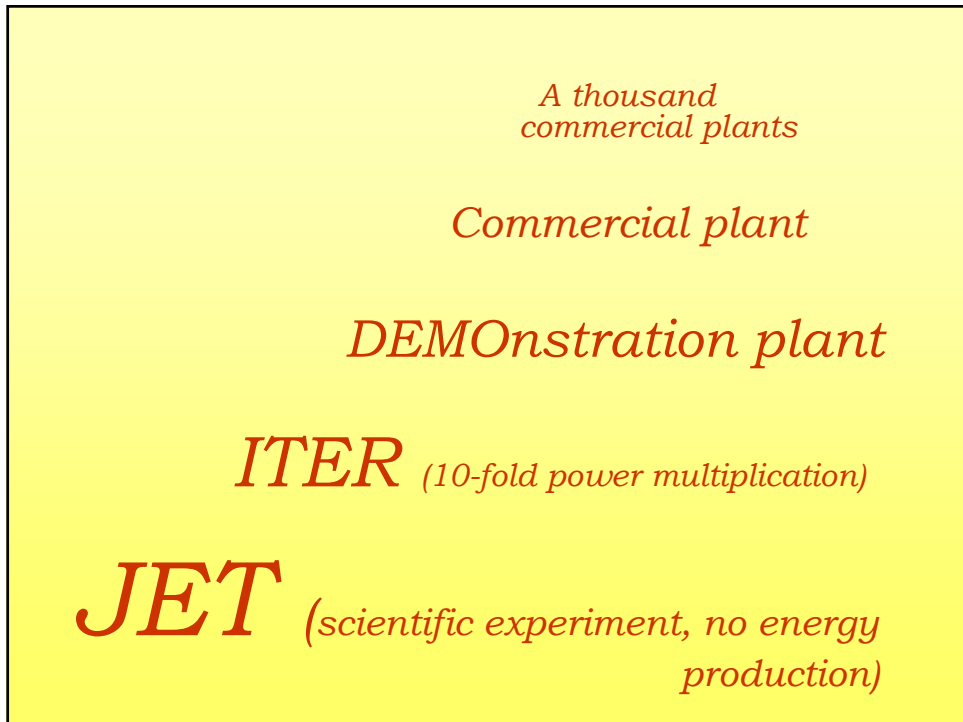
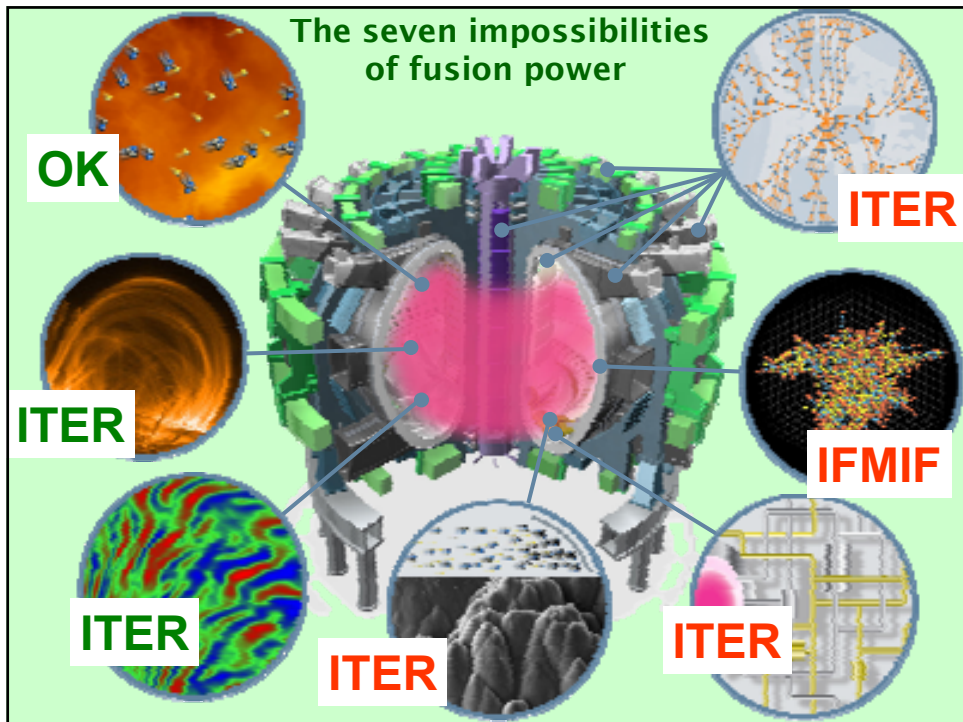


Fuel cycle,
the tritium
must be bred

For a breeding ratio of 1.1, a tritium has to go round the plant 1000 times without being trapped



ITER: most complex
device on earth
10.000.000 parts



Will fusion come in time?

