EUROfusion

The EU roadmap to fusion energy

Tony Donné, Jérôme Pamela

Inauguration Swiss Plasma Center

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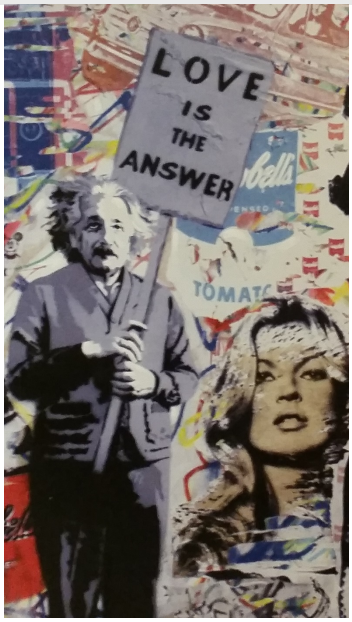
After a day of thinking about the big challenges of nuclear fusion….

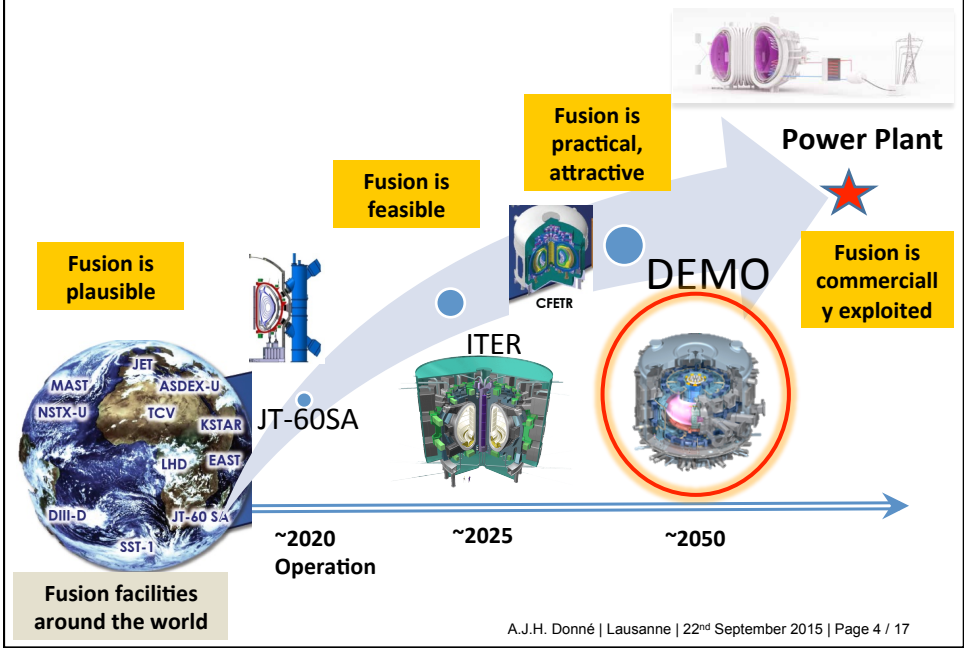
…I entered my hotel room and found this on the wall



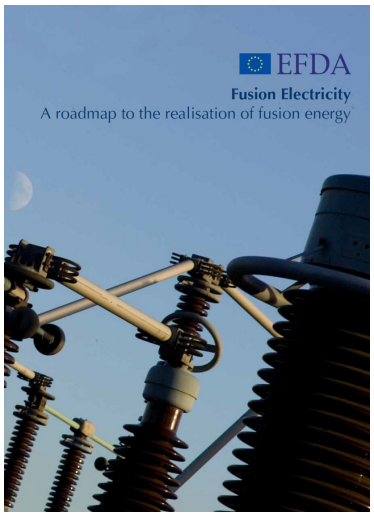
EUROfusion coordinates R&D in fusion research

29 Research Units (+ numerous Third Parties) in 27 European countries working together to achieve the ultimate goal of the Fusion Roadmap

Roadmap towards fusion electricity



Fusion Roadmap



http://www.euro-fusion.org/

Eight important missions

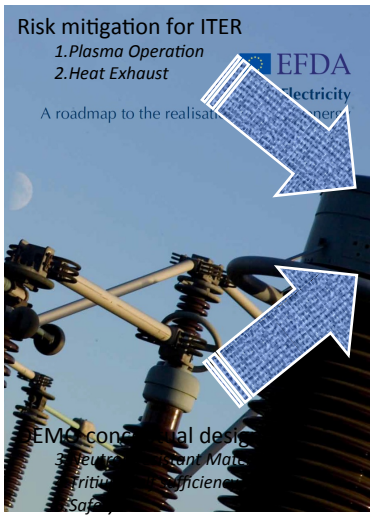
- For each mission:
  - overview present status
  - list of unresolved and urgent issues
  - research & development plan
  - estimation of required resources

Three periods

- 2014 – 2020
  (Building ITER & Supporting Experiments)
- 2021 – 2030
  (Exploiting ITER and Designing DEMO
- 2031 – 2050
  (Building and Exploiting DEMO)

Important to intensify the involvement of industry

Fusion Roadmap

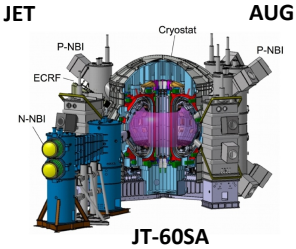


6.Integrated DEMO Design
7.Competitive Cost of Electricity

Back-up strategy
8.Stellarator

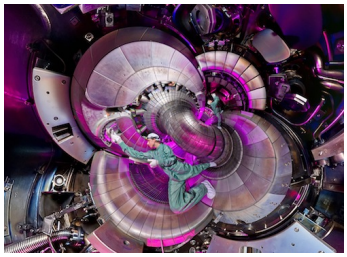
Mission 1: Plasma operational scenarios

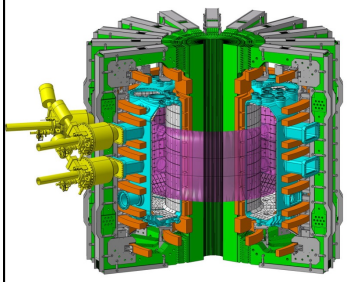
JET



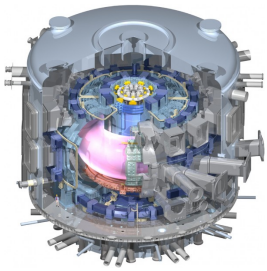
JT-60SA

AUG

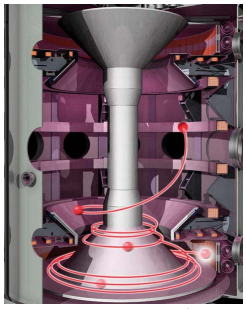




TCV

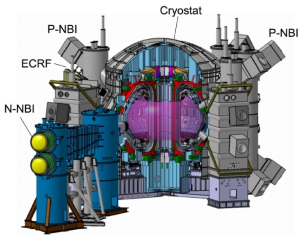


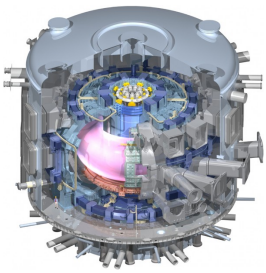
ITER



MAST Upgrade

Mission 1: Plasma regimes of operation

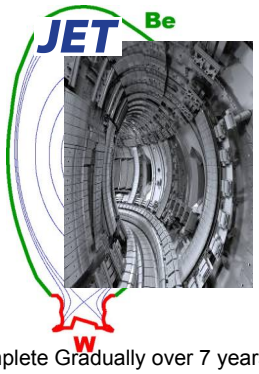


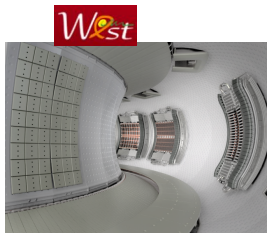


- Demonstrate and qualify regimes that meet the needs of ITER and DEMO
- High fusion performance with metallic PFCs by improving transport and by controlling MHD instabilities.
- Acceptable power depositions in the W divertor, radiate as much as possible power while keeping high performance
- Develop integrated scenarios with controllers (MHD, detached divertor, dilution…)
- Try to achieve steady state conditions

Preparation on existing devices: JET, MST-devices, JT-60SA + other international collaborations

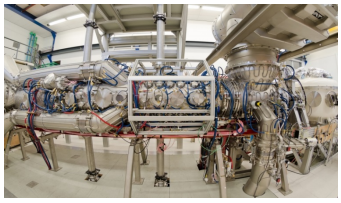
Focus on machines with a metal wall





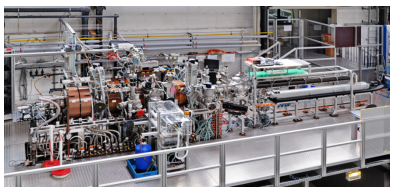
- **ASDEX Upgrade**:
  - conversion to all W PFCs complete Gradually over 7 years
  - in 2014 Massive outer W-divertor and Bare Steel Tiles and new divertor manipulator allowing large area sample insertion
- **JET**:
  - ITER-like Wall Be wall and W divertor change in one shutdown
  - Integrated test with DT scenario compatibility in 2017
- **Tore Supra**→ WEST project (2016) :
  - from limiter to divertor configuration, from carbon to W environment,
  - Access to long pulse operation with actively cooled W-monoblocks components

Mission 2: Heat exhaust and PFC materials studies



Magnum-PSI

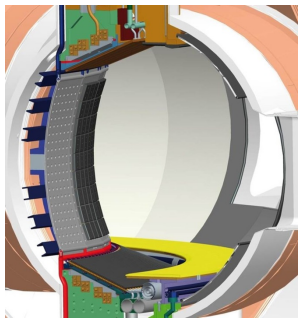
Pilot-PSI



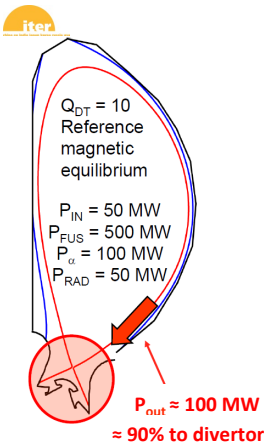
PSI-2

JUDITH-1

WEST



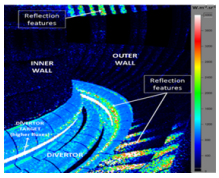
Mission 2: Heat Exhaust Systems

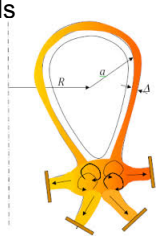


[courtesy D. J Campbell, ITER research plan]

The baseline strategy 'detached' divertor together with research in alternative divertor solutions: Super-X, snowflake, liquid metal divertors

- Detachment control for ITER and DEMO
- Efficient PFC operation for ITER and DEMO
- Predictive models for ITER and DEMO divertor/ SOL
- Investigate alternative power exhaust solutions
- Research to find more robust materials

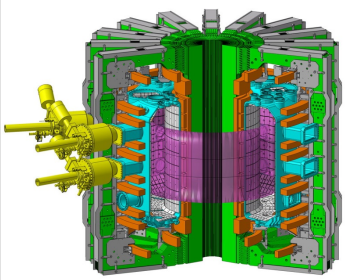




Main existing : JET, MST, PFC test devices, JT-60SA + other international collaborations
Potentially a Divertor Test Tokamak?

Mission 2: ….but also heat exhaust systems

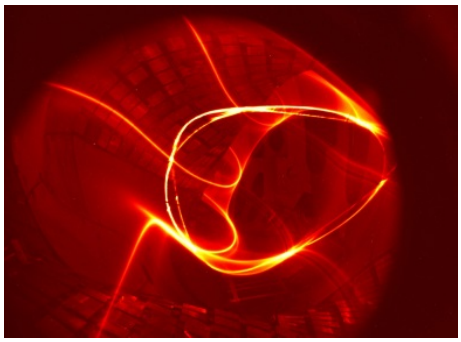
Test of special divertor geometries in TCV (snowflake) and MAST Upgrade (Super X)



TCV

MAST Upgrade

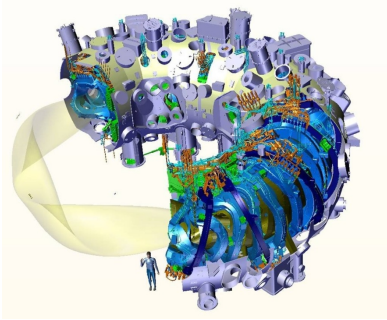
Mission 8: Stellarator



- Device commissioning completed
- First plasma scheduled soon (licensing issues pending

Wendelstein 7-X

Greifswald (Germany)
commissioning in progress (Jun. 2015)



HELIAS-type stellarator

- N_f=5, R/a = 5.5m/0.53m
  → **30 m³ plasma volume**
- 50+20 **superconducting** coils (2.5T)
- ~8+7MW (**ECRH**, NBI) + ICRH (later upgrades)

Missions 3-7: DEMO

- Materials
- Early neutron source & design

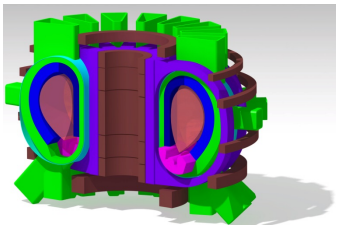
Mission 3

- Breeding blankets
- Safety & environment

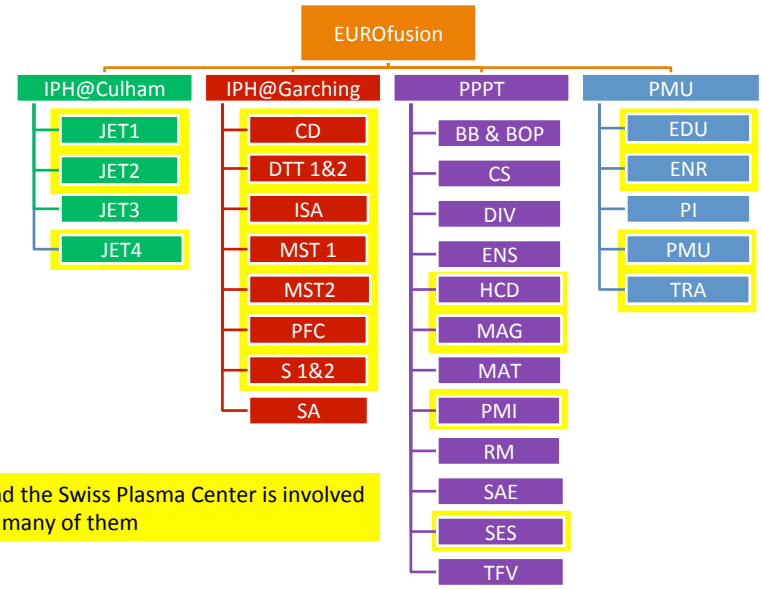
Mission 4,5

- Design Integration and Physics Integration
- Magnet system
- Divertor
- Tritium and fuelling
- Heating and current drive
- Diagnostics and control
- Remote maintenance systems
- Containment structures
- Heat transfer, balance-of-plant

Mission 6,7

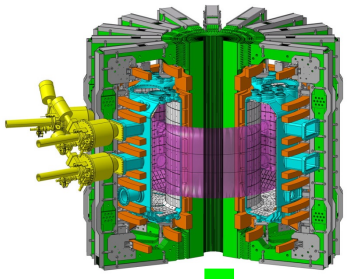


EUROfusion is organized in many Work Packages

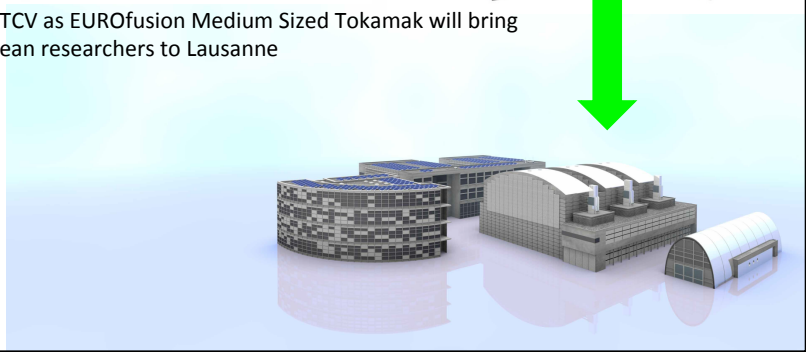


and the Swiss Plasma Center is involved in many of them

TCV is one of key devices in missions 1 & 2



The start of TCV as EUROfusion Medium Sized Tokamak will bring many European researchers to Lausanne



Congratulations

CRPP has been always an important player in the European fusion programme

The Swiss Plasma Centre is expected to continue that tradition

All colleagues of the EUROfusion Programme Management Unit and the General Assembly congratulate the Swiss Plasma Center with its inauguration and wish it much success in the future