

French Fusion, Past, Present and Future



Jean Jacquinet

Senior Advisor to ITER DG

Scientific Advisor to CEA

Chair of IEA FPCC

Early days 1958 to 1977



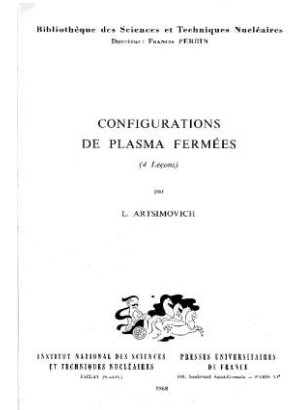
Donato **Palumbo**, '58
Euratom programme vision



Michel **Trocheris**, 1958
CEA sites FAR and Grenoble
1st Euratom association



Artsimovitch, lectures in Saclay, FEC '68
in Novosibirsk then Tokamak tsunami



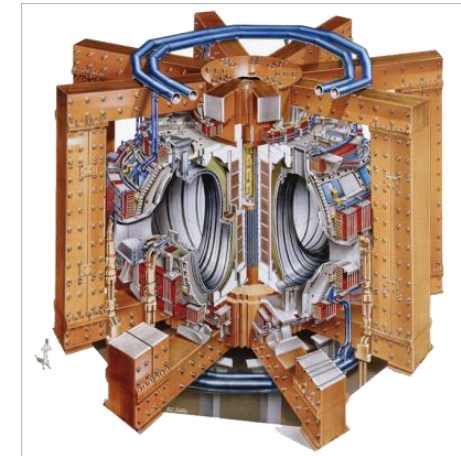
Paul-Henri **Rebut**
designs TFR and JET,
1st director ITER EDA



TFR: Tokamak Fontenay aux Roses
Extends Russian results in '72
then additional heating starts:
NBI, ICRH and LH (Grenoble)



JET design team in Culham in November 1977



JET: Joint European Torus
1st plasma '83 still on top!

➔ World and European collaborative programme firmly established in IAEA, IEA, EURATOM

Move to Cadarache and superconductors



Robert Aymar designed **TORE SUPRA**
2nd director of **ITER EDA**
former director of **CERN**



CEA fusion regrouped in Cadarache '80-84
Tore Supra MA class with SC TF coils 1.8K
Routine operation **FEC Nice '88** and since **35 years**



The **fully actively cooled** vacuum vessel
Record 6 minute pulse (FEC 2002 Lyon)
LHCD multijunction launchers
Studies of **turbulence** with reflectometry
Studies of **edge filaments** and intermittency
H inventory on carbon PFCs
never saturates → Tungsten

➔ **Emphasis on long pulses, CD, turbulence and plasma surface interactions**

2000+ : why not ITER in Cadarache!



2000: a site for ITER is a priority

New studies start in 2000

Local authorities support strongly
JJ and R. Pellat on the proposed
ITER site



C. Haigneré Research Minister, B. Bigot,
M. de la Gravière, R. Aymar **FEC 2002 LYON**



Part of the **EU negotiating team** in Aomori
Aymar, Jacquinet, Watteau, Varandas, Finzi



Site study group EISS (Head P. Garin)

Seen here in 2005 with some high level additions!

Active negotiations among 4 candidate sites.

**In June 2005 the 7 final ITER partners choose
Cadarache.**

**A joint EU/Japan 'Broader Approach' is launched
in Japan.**

21 Nov 2006: ITER agreement signed



Just a few of the EU fusion community



R. Aymar et P-H Rebut



Claudie Haigneré



President J. Chirac and the 7 signatories of the ITER Agreement

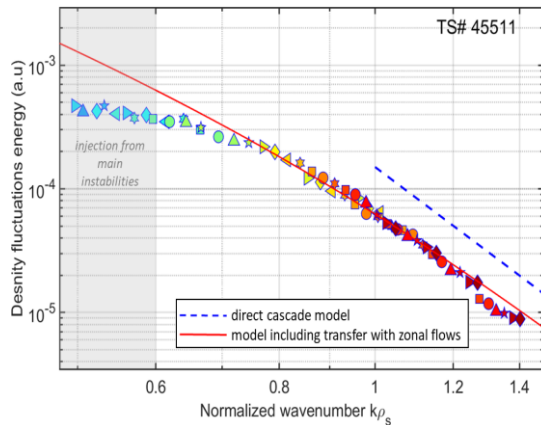


Provence dignitaries and 4 university professors

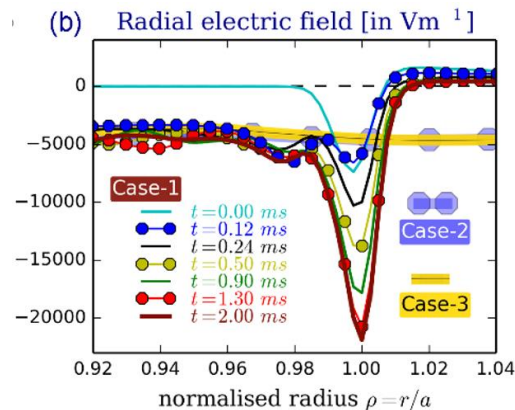


B. Bigot HC

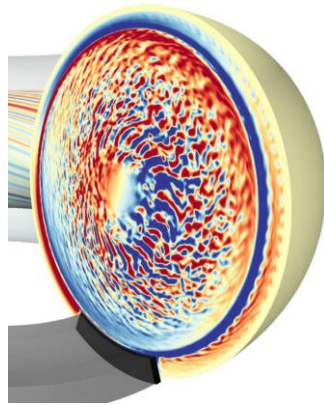
Achievements and way forward



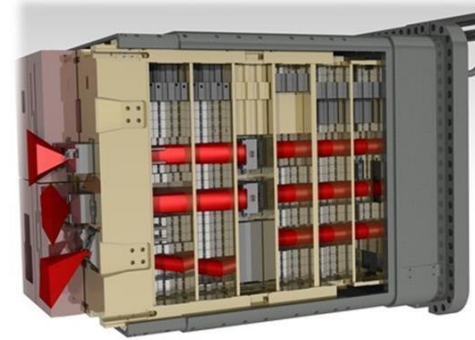
Spectrum of density fluctuations**
Effects of zonal flows



Confinement barriers in GYSELA*



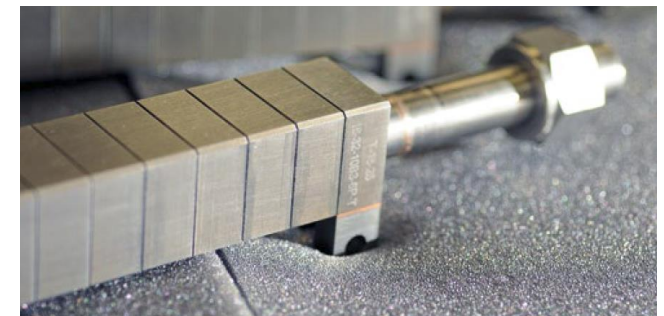
GYSELA gyrokinetic code
integrates the edge*



ITER wide angle viewing
system



J. Bucalossi introducing **WEST**
platform for ITER***



ITER-like tungsten monobloc

Contribute to ITER via WEST, HADES, Titan etc.

ITER-like divertor modules, wide angle viewing, high TC feeders
Foster collaboration with the private and public/private sectors

➔ 1000 participants in the ITER business forum

Prepare ITER scientific experiments

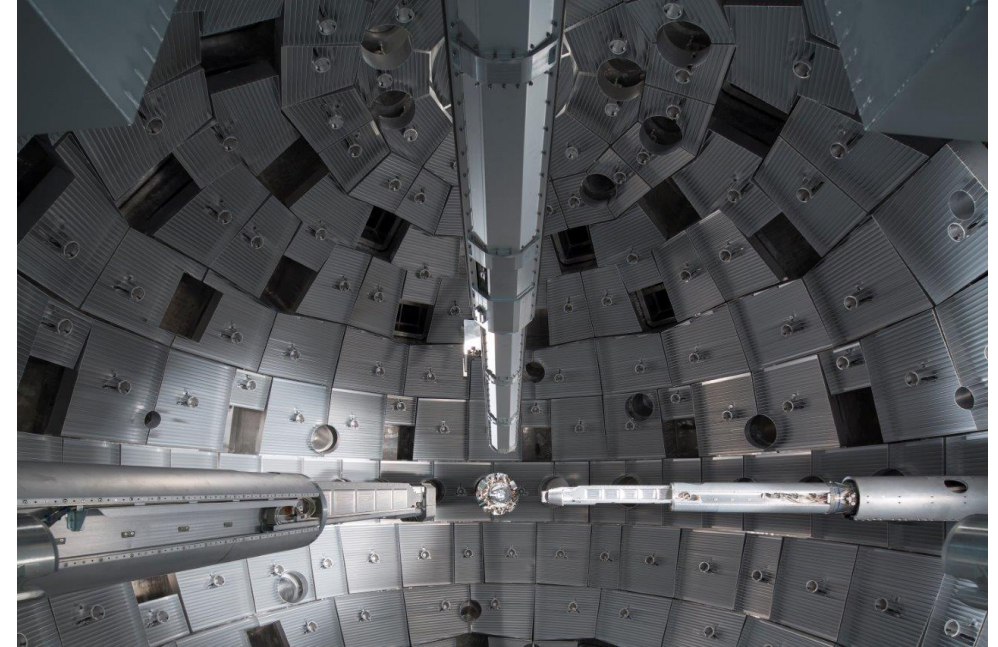
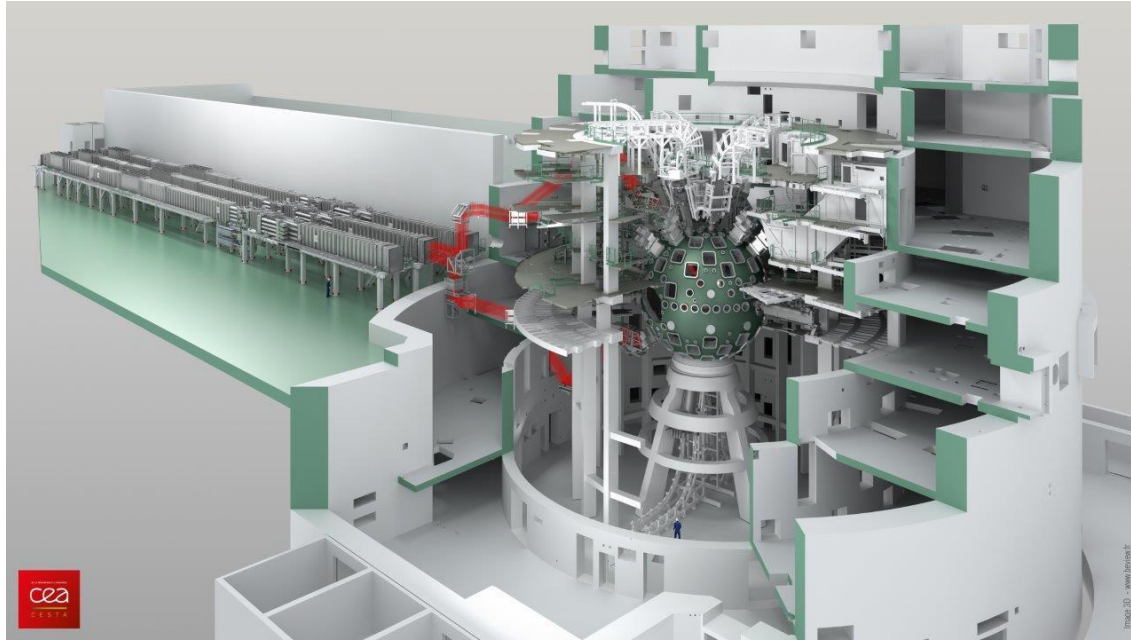
Theory, modelling, diagnostics
Next generation of scientists (Fusion master, Erasmus Mundus)

Contribute to DEMO

Material characterisation, remote handling etc.

@ this conf. * G. Dif-Pradalier, ** L. Vermare, *** J. Bucalossi also E. Nardon disruption mitigation + many other contrib.

Inertial Fusion with LMJ and Petal



Lasers converge inside the **10mm gold hohlraum**

Laser lines and the 10m vacuum sphere installed in the 300m building built by CEA DAM

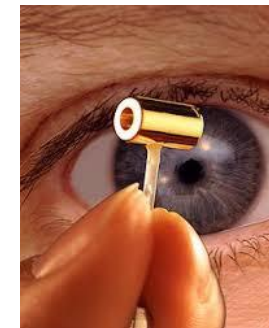
176 laser beam for 1 Mega Joule at 351nm

1st experiments in 2019 with 48 beams

Experiments with 80 beams are coming next

Peta watt laser added for fast ignition experiments which are open to academic research*

* S. Baton this conf.



Hohlraum

Final words

I would like to stress that the time spent in the fusion programme has been **very rich for me.**

Half of my career has been spent in France, the other half abroad mainly in the UK but also in the US and in Japan. I have met **wonderful colleagues and lasting friends.**

The spirit of **open international collaboration** promoted by the pioneers Artsimovitch and Palumbo has prevailed until now. It has paved the way to building the scientific consensus on JET then on ITER. This is remarkable and unique.

Let me finish this talk by **urging you, the scientists of the future**, to cherish this intense collaboration and to develop it even further.

I wish you a very productive conference!