French Fusion, Past, Present and Future

Jean Jacquinot
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
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, Jacquinot, 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

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

Just a few of the EU fusion community

Provence dignitaries and 4 university professors

R. Aymar et P-H Rebut

Claudie Haigneré

B. Bigot HC
Achievements and way forward

Spectrum of density fluctuations**
Effects of zonal flows

GYSELA gyrokinetic code integrates the edge*

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.
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.
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!