

Impact of divertor configuration on tokamak performances: focus on WEST experiments supported by SOLEDGE2D modeling

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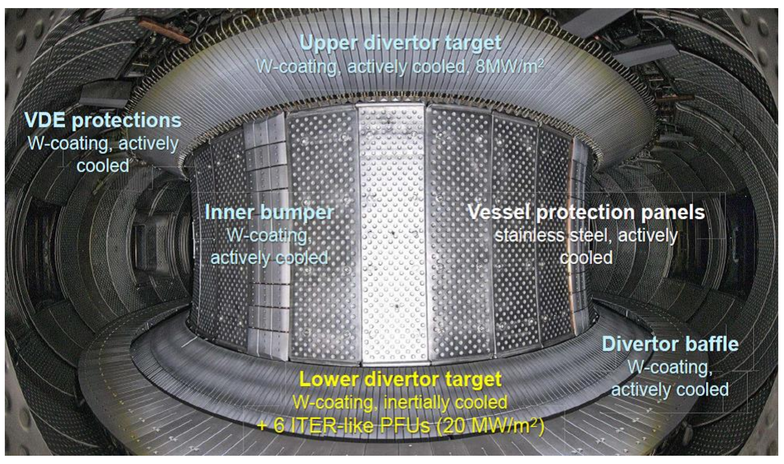
Impact of divertor configuration on tokamak performances: focus on WEST experiments supported by SOLEDGE2D modelling

G. Ciraolo[a*], R. Mao[b], N. Fedorczak[a], J.P. Gunn[a], H. Bufferand[a], J. Bucalossi[a], S. Baschetti[a], A. Gallo[c], Y. Marandet[c], E. Serre[b], P. Tamain[a], E. Tsitrone[a] & the WEST team*

[a] *CEA, IRFM, F-13108 Saint-Paul-Lez-Durance, France*
[b] *Aix Marseille Univ, CNRS, M2P2, Marseille, France*
[c] *Aix Marseille Univ, CNRS, PIIM, Marseille, France*

* guido.ciraolo@cea.fr

WEST TOKAMAK



I_p (q_{95}~2.5)	1 MA
B_T	3.7 T
R	2.5 m
a	0.5 m
A	5-6
κ	1.3-1.8
δ	0.5-0.6
V_p	15 m^3
n_{GW} (1MA)	1.5 $10^{20} m^{-3}$
P_{ICRH}	9 MW
P_{LHCD}	7 MW
$T_{flattop}$ (0.8 MA)	1000 s

- **A major upgrade for investigating**
  - Tungsten environment

Assessment of power handling capabilities/ lifetime of ITER-like tungsten divertor components under **high heat flux** in tokamak environment

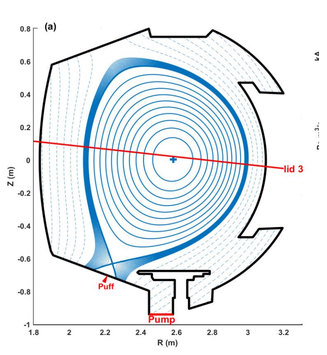
- **Taking full benefit from Tore Supra assets**
  - **Long pulse physics and operation**

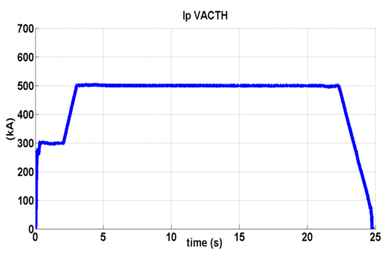
Master integrated plasma scenario over relevant **plasma-wall equilibrium time scale** in a metallic environment

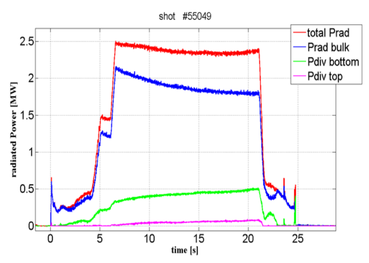
ANALYSIS OF WEST SHOT #55049 WITH SINGLE NULL DIVERTOR CONFIGURATION

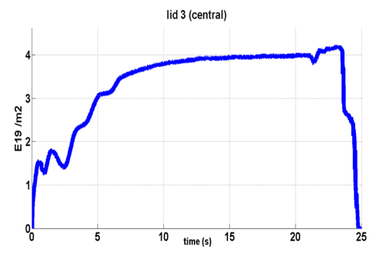
Parameter	Value
Ip	$500KA$
B_T	3.7T
R	2.5m
a	0.44m
κ	1.36
δ	0.46
P_{LHCD}	4MW
$T_{flattop}$	20s

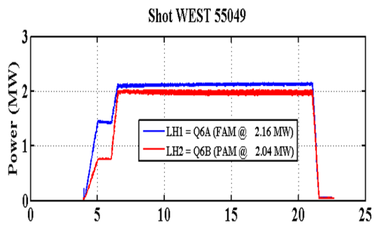
We focus on a recent long discharge in WEST, the shot #55049 of C4 campaign obtained in September 2019. We report below the main time traces of the experiment. The LH injected power was about 4MW for more than 10s, the total radiated power around 2.5MW, central line integrated density of about $4*10^{19} m^{-2}$ and plasma current of 500 kA with a height of the X point of about 80 mm from the wall.





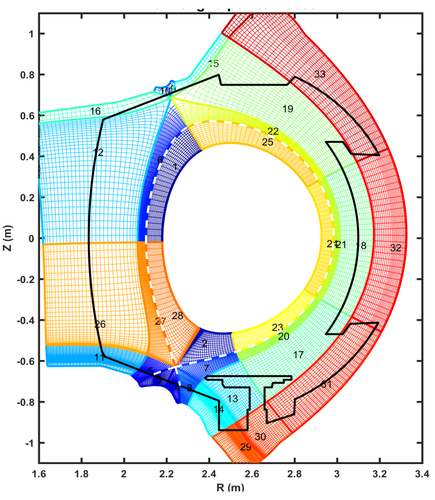






SOLEDGE2D-EIRENE NUMERICAL MODELLING

SolEdge2D meshgrid for WEST shot #55049 (SN configuration)



- **Multi-species plasma solver coupled to EIRENE for neutrals**
- **Solves equations for densities, parallel velocities, temperatures and electric potential**
- **Multi-species Zhdanov closure (no impurity trace and light impurity assumption)** provides linear relation between temperature gradients, velocities and heat fluxes and friction forces (see poster by H Bufferand)
- **Realistic wall geometry and flexible magnetic configuration (SN, DN, SF+, SF-…)**
- **Plasma up to the main chamber wall**
- **Advanced numerical scheme (shock capturing, immersed boundary condition….)**

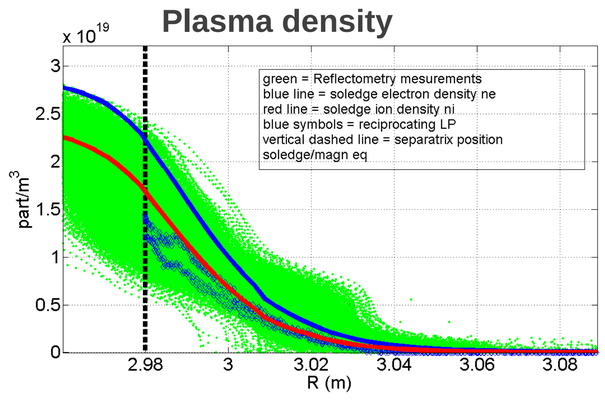
H Bufferand *et al,* Nucl. Fusion **55** (2015) 053025

Simulation setup, results and comparison with experiment

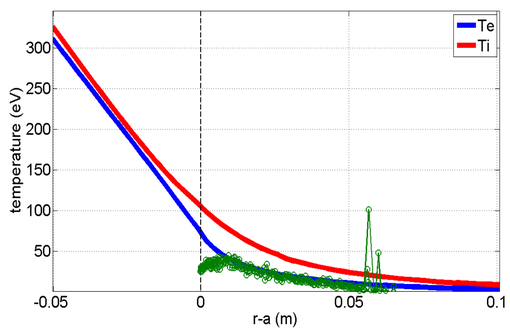
Pin	Nsep (feedback on gaspuff)	composition	R_n	Neutrals	Radial transport coefficients	wall
1.5 MW	$2 \cdot 10^{19}\ m^{-3}$	D + O (3%)	99 %	EIRENE	$D = \nu = 0.3 m^2 s^{-1}$ $\chi_e = \chi_i = 1 m^2 s^{-1}$	W

OUTBOARD MIDPLANE PROFILES

Plasma density

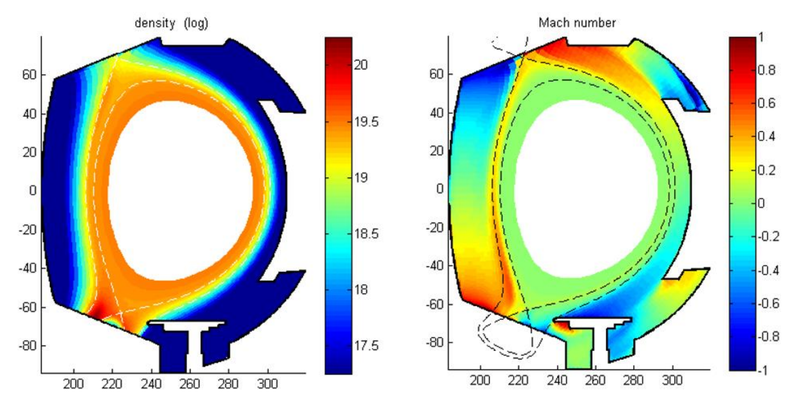


Ion and electron temperature

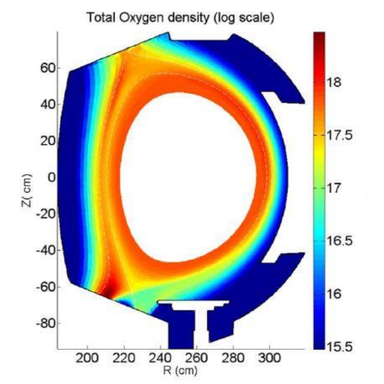


SOLEDGE SIMULATION FOR WEST SHOT #55049 :

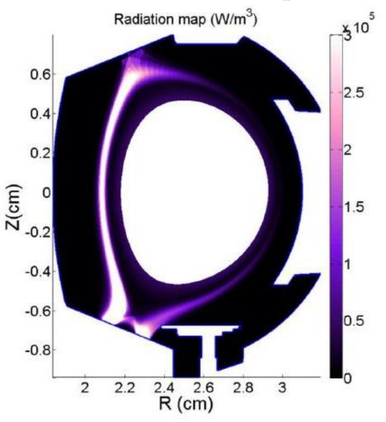
2D poloidal maps for main species D



2D poloidal map for oxygen density

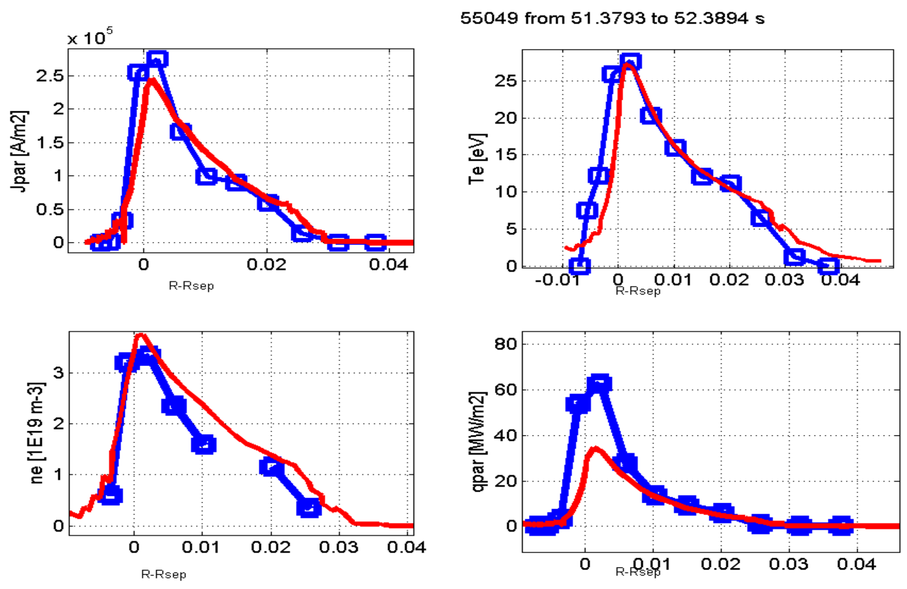


2D radiation map



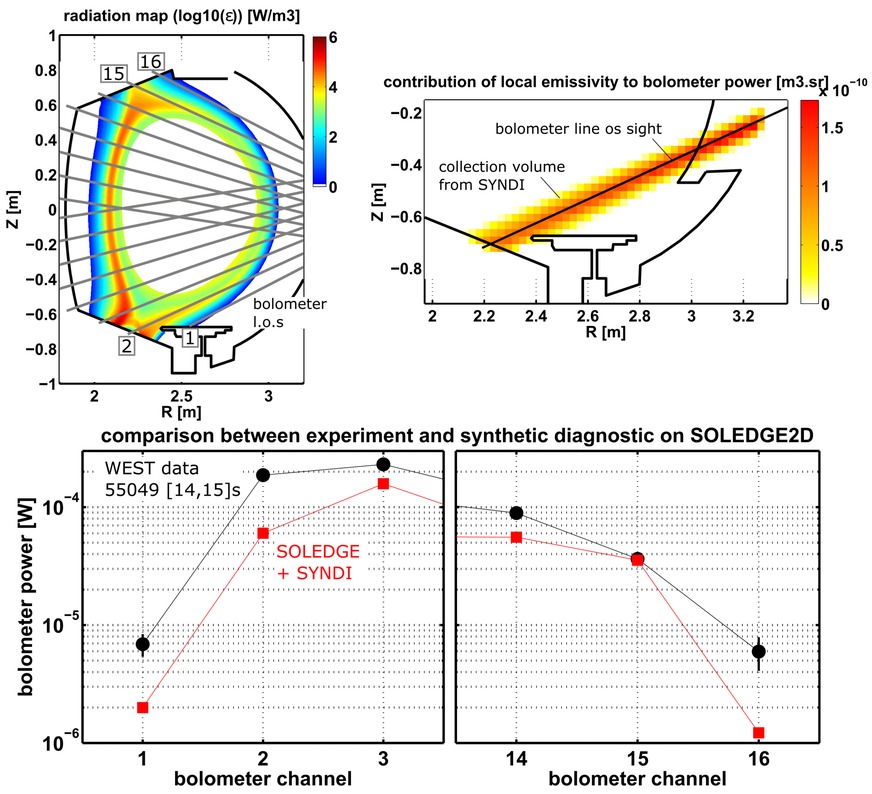
780 kW total radiated power in the simulation domain

BOTTOM DIVERTOR OUTER STRIKE POINT PROFILES



Parallel Ion saturation current, electron temperature, electron density and parallel heat flux on outer divertor target computed with Soledge2D-Eirene (red lines) and measured by Langmuir probes (blue symbols and line).

BOLOMETRY MEASUREMENTS AND SYNTHETIC DIAGNOSTICS



We consider the bolometer channels intercepting the edge and SOL plasma in WEST, that are channels from one to three and from 14th to 16th as shown on top left panel.

On the bottom panels we compare the estimation from experimental data (black symbols) with the ones obtained from the application of SYNDI to radiated map from SOLEDGE simulation.

One can notice that the simulation reproduces quite well the qualitative behavior and even a good quantitative comparison is obtained on the upper divertor channels.

Acknowledgements

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