On Core-SOL Integration in Scenario Modelling for ITER

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Presented at the ISM meeting,
Cadarache, March 8, 2011

Core-SOL integration: why?

ISM goal: find a scenario providing necessary performance, consistent with available controls and satisfying technical limitations on all systems involved

SOL/Divertor: one of such systems with limitations on target power loading, He removal and plasma detachment, controlling core fuelling and impurity contamination

Over-simplified SOL models offer little help:

could provide separatrix *n* and *T*, but

no neutrals, no geometry, no wall interactions

→ *no relation to technical limitations*,

no model of control actuators

such as gas puff, pumping speed or impurity injection

No experiment yet in the parameter range of ITER

→ Internal consistence of the model extremely important

Core-SOL integration: how?

Scenario studies: long time scale (hundreds sec)

SOL/Divertor: time scale of tens msec → quasi-steady-state

➔ Direct coupling impractical:

SOL/Div much slower computationally

Indirect ("mediated") coupling:

parameterization of SOL/Div results
in terms of separatrix parameters
input: power and charged particle fluxes from core
(BC for SOL/Div)
output: n_i, T_e, T_i, Γ_n, E_n (BC for core)

Produces solutions for the core consistent with SOL/Div

Translates SOL/Div constraints to the core

Avoids using non-controllable BC (e.g. n_{sep}) for the core

Being used now for operational window studies

Episode 7: integration with core

Different time scales for core and edge ➔ direct coupling impractical

Scalings to parameterise SOLPS results → b.c. for ASTRA (1D)

ASTRA: pedestal model; (n, T, Γ_n, E_n) = F($q_\perp$, Γ_i) at separatrix

Control: P_{aux}, Γ_{core} for core; Γ_{puff} for q_{pk}, S_p for He → real controls

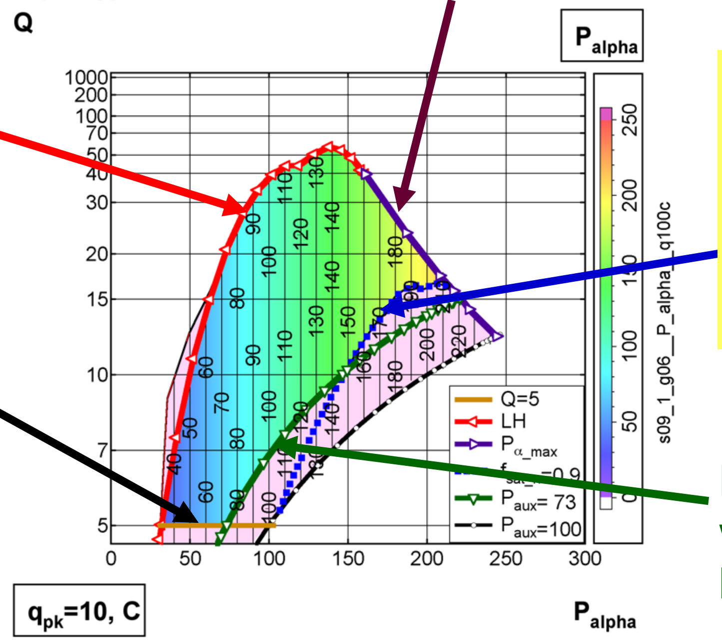
➔ Operational window for the whole ITER consistent with divertor

Window limits

Low-n, high-T, high fusion cross-section branch: no P_α rollover

No H-L transition

Q is not lower than minimum required for ITER mission (5 for ITER)



Throughput within limit, no full detachment

$$f_{sat\_n} = \mu^{0.43} < 0.9$$

Required heating power within design limits (73MW)

Effect of q_{pk} limitation