Summary of WP12-SYS02 activity on DEMO1 scenario profile consistency

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WP12-SYS02 – Profile consistency

ISM meeting, 23 May 2013

Summary of design parameters assumptions

- Global parameters taken from "DEMO1 design summary – July 2012", R. Kemp

- Main parameters:

I_p = 14 MA

B_T = 6.79

R = 9, a = 2.25, k = 1.56, δ = 0.33

P_{aux} = 50 or 100 MW

Target P_{fus} ~ 1.5 GW

Summary of physics assumptions

- Fixed pedestal (T_{ped} ~ 5 keV, ne_{ped} ~ 0.85 n_G)

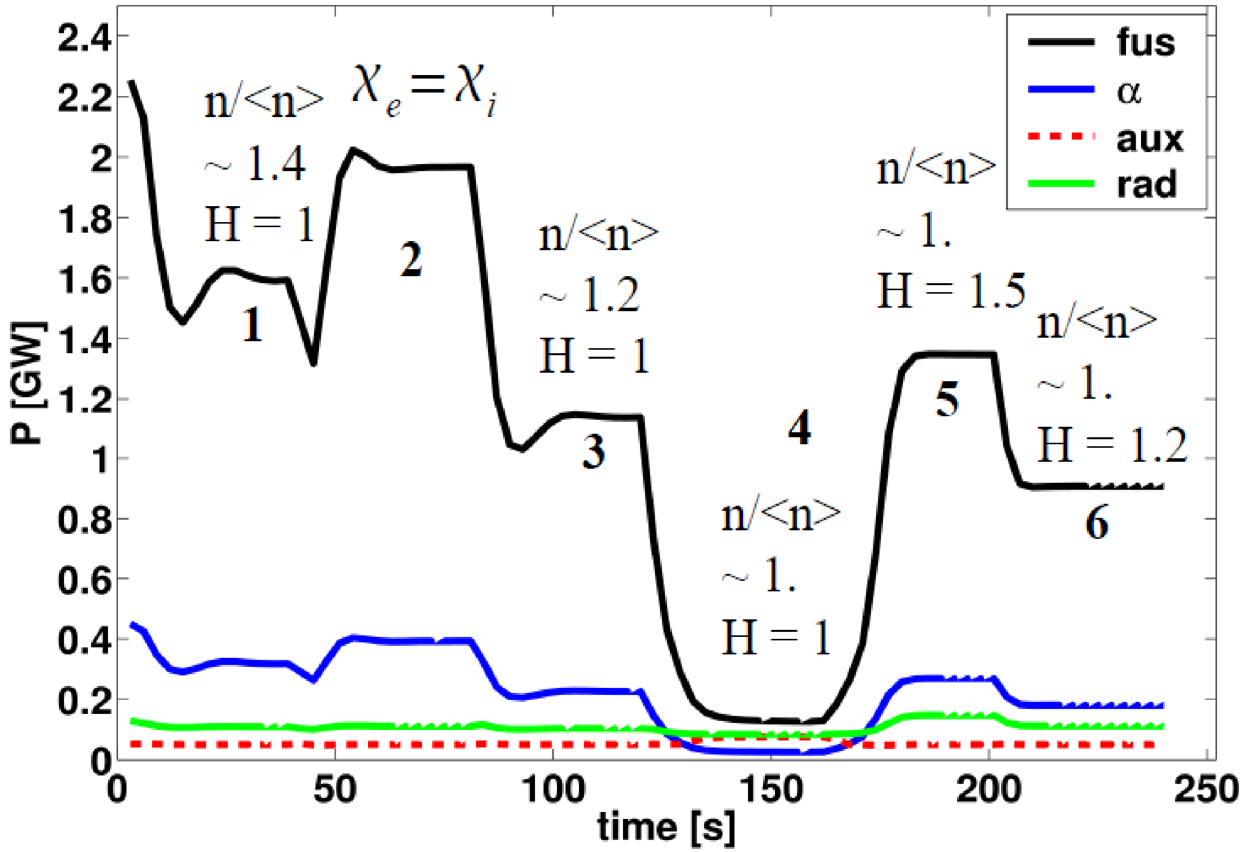
- Scans performed in χ_e/χ_i, H, injected power, pinch coefficients, radiated power

- Z_{eff} and radiated power either arbitrary or obtained from COREDIV calculations (R. Zagorski *et al.*)

- Simulations also performed with TGLF [G. M. Staebler *et al.*] to check achievability of profiles gradients

- Of course there are caveats linked to limitations of models (in particular for a high-β burning plasma)

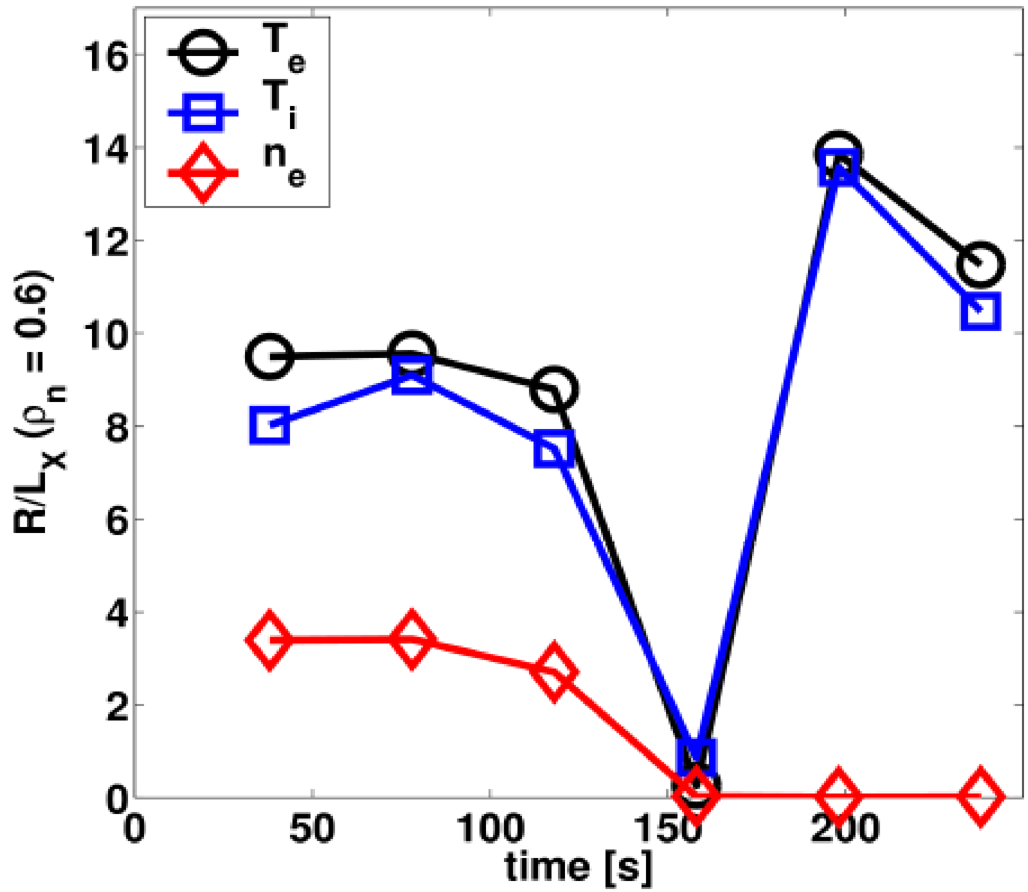
Sensitivity to transport assumptions



- Density peaking a really big player (flat density requires very high H factor)

- Ion-dominated transport regime is of course detrimental

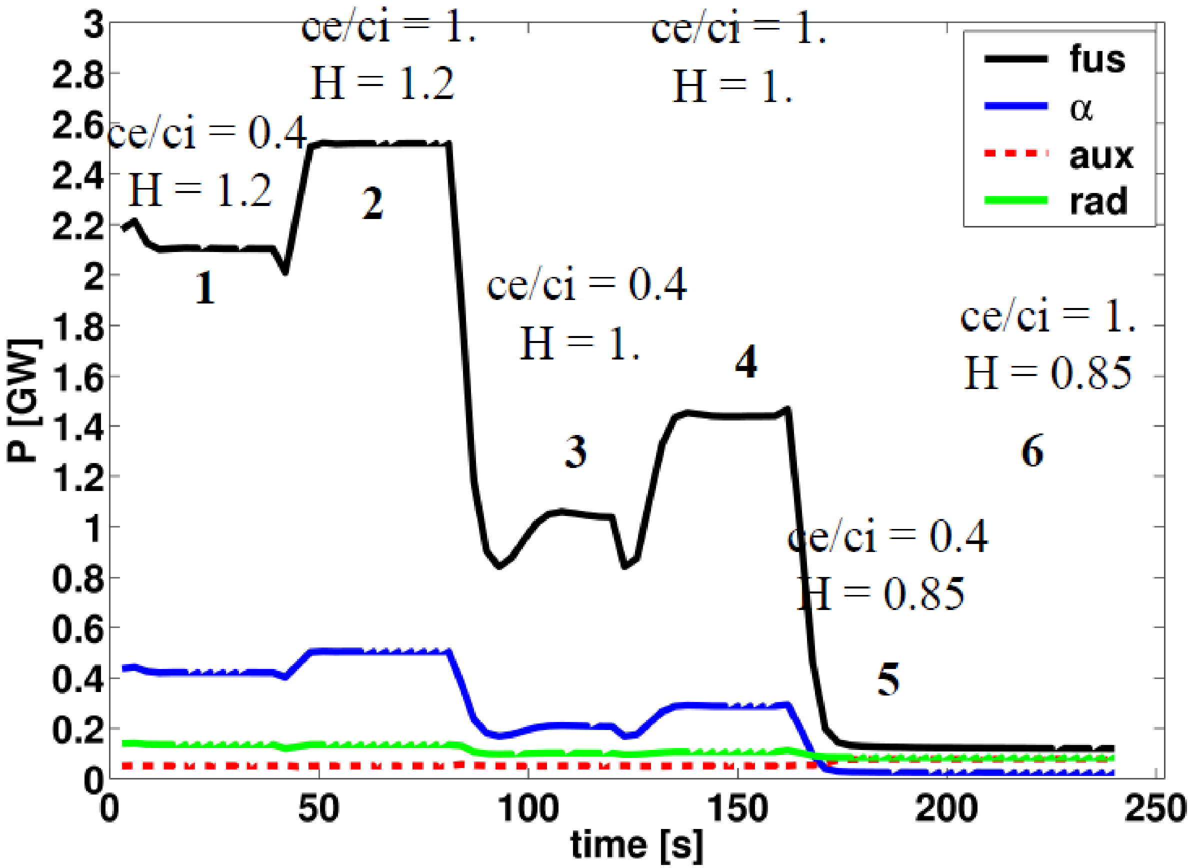
Local gradients



- T n-gradients in the order of 8-10, R/Ln ~ 3-4

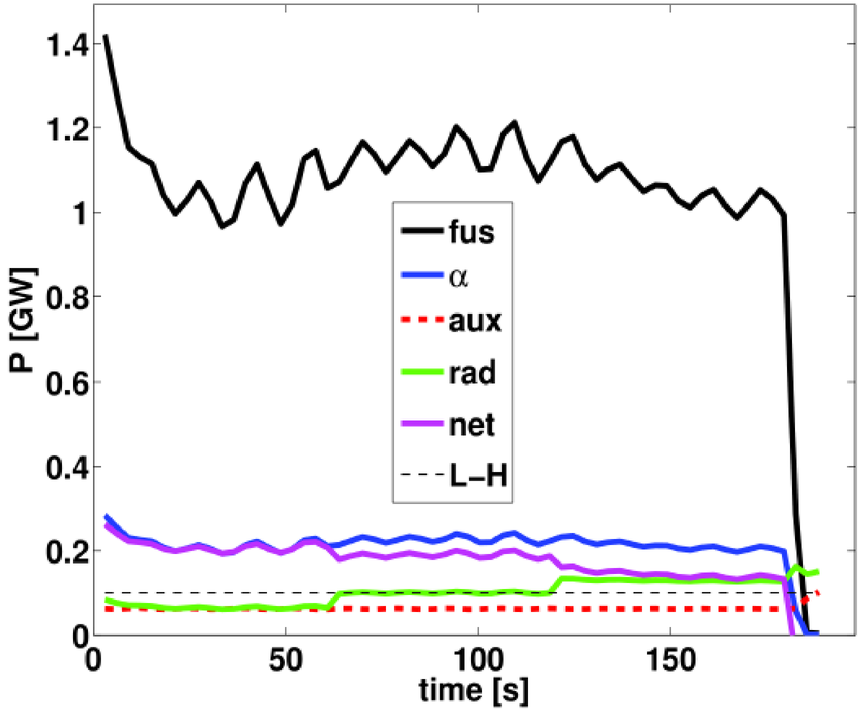
- It is plausible that the T n-gradients are moderately above threshold (ITG-TEM)

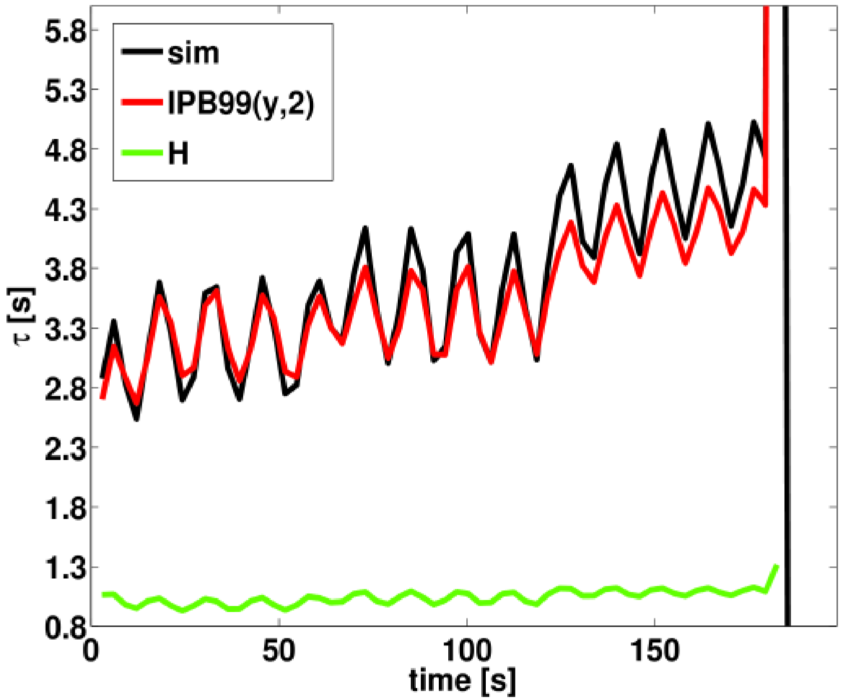
Sensitivity to confinement assumptions



- With moderate density peaking fixed (~ 1.3), no plasma for H ~ 0.85

Sensitivity to radiated power using TGLF

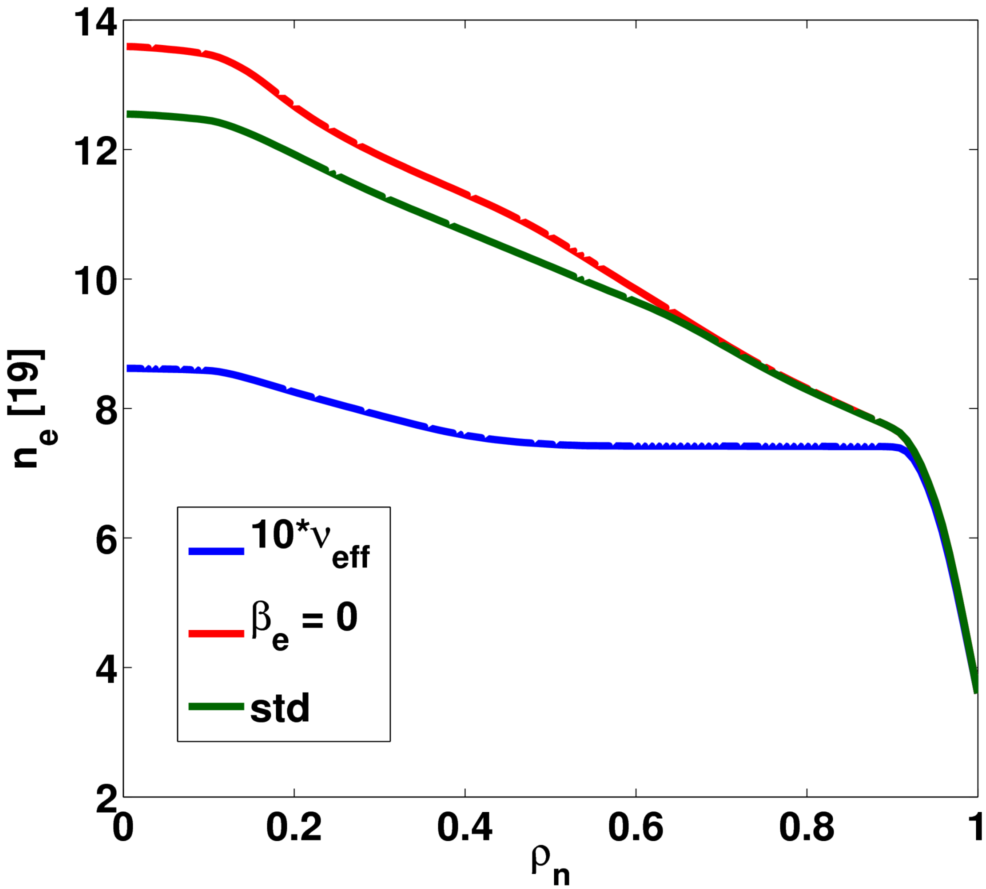




- Radiation fraction scan (full radiated power ~ 150 MW). With 50 MW P_{aux}

- Plasma survives up to ~ 120 MW of radiated power due to the power degradation effect, however net power through separatrix drops below L-H transition at 150 MW of radiated power

Sensitivity of density peaking to collisionality, from TGLF



- DEMO collisionality is the key ingredient
- EM effects not so drastic as seen from GS2 (predicts peaking ~ 1.1-1.15). To be checked with NL calculations ?

Summary of results obtained so far

- With assumed pedestal, target fusion power reached if density peaking is substantial (~ 1.3-1.4), comparable ion-electron confinement, with H ~ 1 or larger. However Te, Ti gradients somewhat larger than present-day experiment observations.

- TGLF predicts a moderate density peaking (~ 1.3-1.4, depending on conditions) due to low collisionality of DEMO scenario. However it also predicts moderate Te, Ti gradients, which lead to moderately reduced P_{fus} with respect to target scenario.

- In self-consistent calculations, the plasma could sustain a large core radiation before collapsing basically due to the net power through separatrix dropping below the L-H transition.

- Going from 50 to 100 MW P_{aux}, the situation is self-similar, with some more margin of operation (at a cost in Q of course).

- The obtained results suggest that the present DEMO1 scenario should require some rethinking to allow more margins by changing some key parameter that regulates, above everything, ion confinement.