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MISK Calculations for F. Poli's ITER cases

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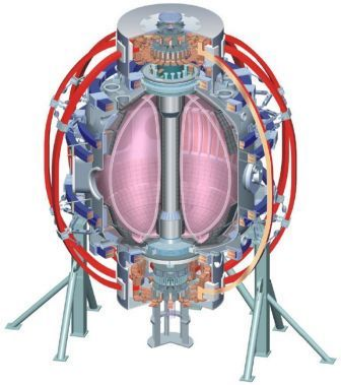
February 17th, 2012



Cases

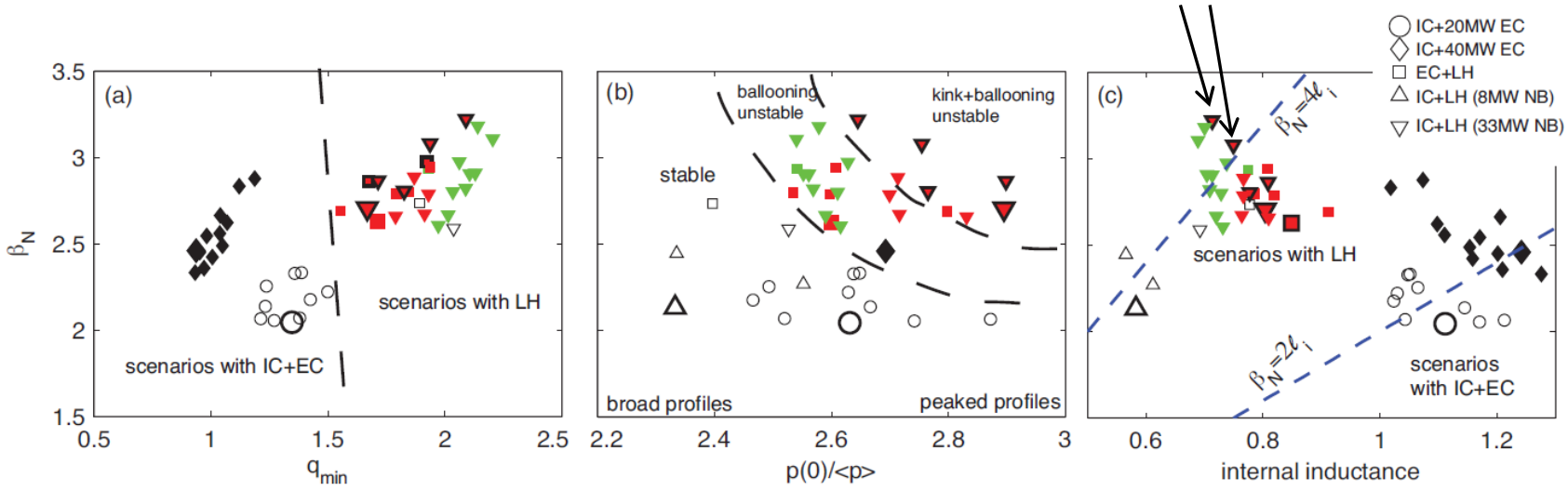


FIG. 18: (Colour online) (a) Normalized pressure vs minimum safety factor for all scenarios with 33 MW beam heating. The large q configurations with 8 MW and 16 MW of NB are not reported in this figure. (b) Normalized pressure vs pressure peaking factor. For the configurations with 40MW of EC only the reference case is reported in this figure. (c) Normalized pressure vs internal inductance. Open symbols indicate ideal MHD stable equilibria, red and green symbols indicate equilibria unstable to ballooning modes with n_{cr} - respectively - smaller and larger than $n_{cr} = 50$. Kink unstable plasmas are red with black border when stabilized by the wall, black when not stabilized.

[F. Poli *et al.*, submitted to Nucl. Fusion (2012)]

Two discharges selected:

34039 @ 2500s

34041 @ 2500s

Heating mix: 33MW NBI, 20MW IC, 40MW LH

Question:

- How does this affect the EP distribution function?

PEST Fluid δW results

34039 @ 2500s

Marginal b = 0.414

Marginal eigenvalue = -0.3469e-5

δWinf = -0.15478102e-1

δW_b = 0.53414071e-2 (b = 0.35)

δW_b = 0.52933525e-2 (real wall)

(very similar)

34041 @ 2500s

Marginal b = 0.789

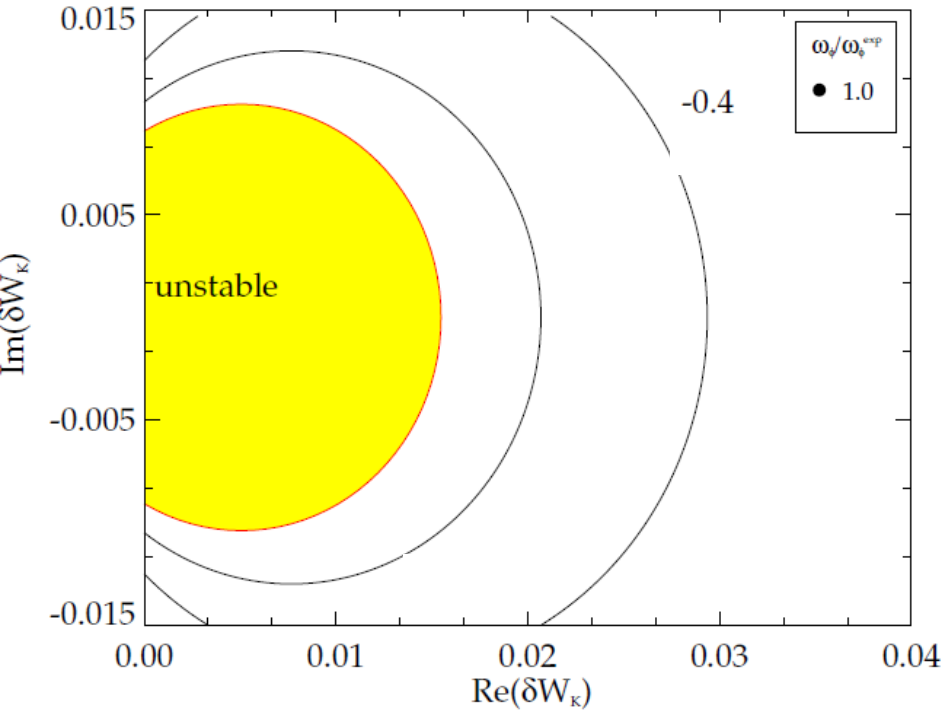
Marginal eigenvalue = -0.6606e-6

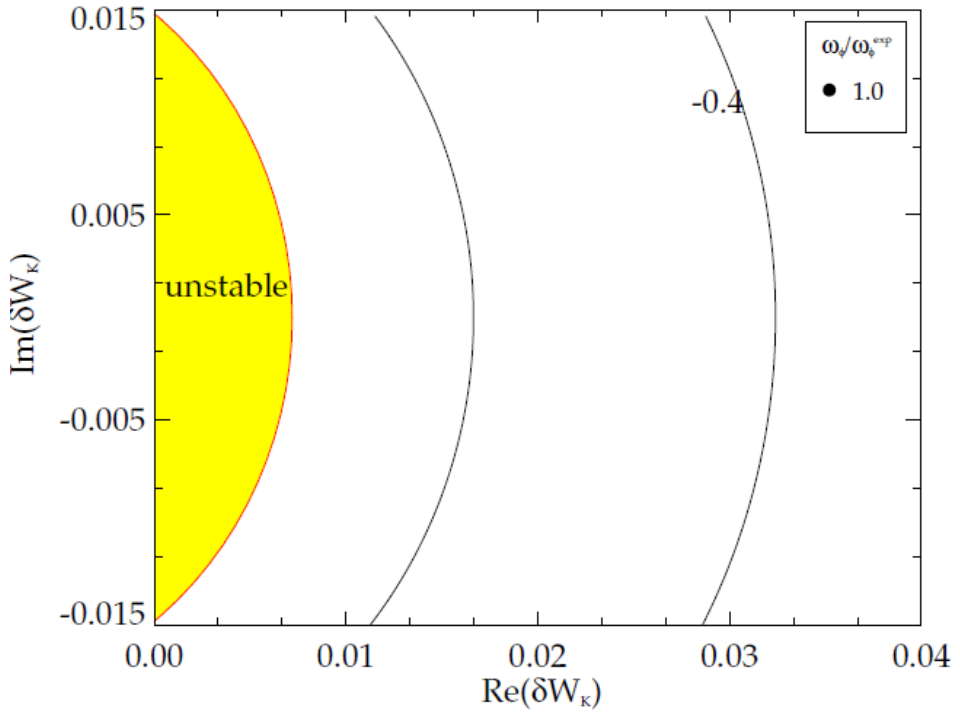
δWinf = -0.72005936e-2

δW_b = 0.30589234e-1 (b = 0.35)

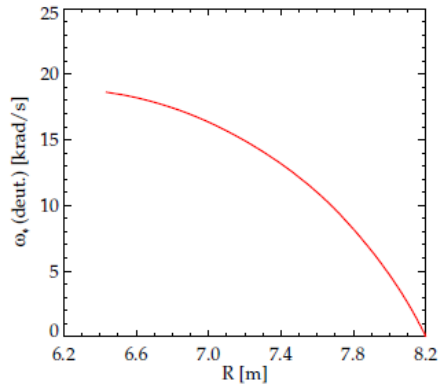
δW_b = 0.29883532e-2 (real wall)

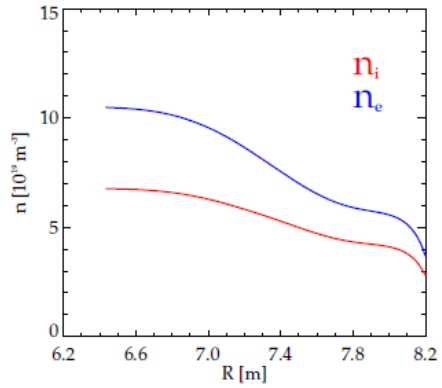
(very similar)

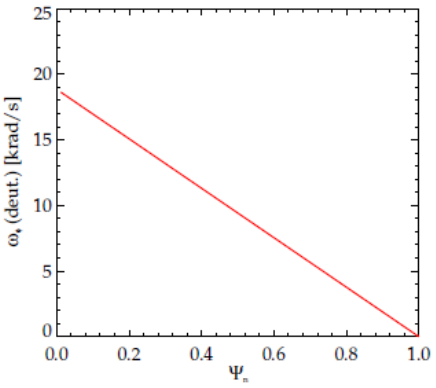


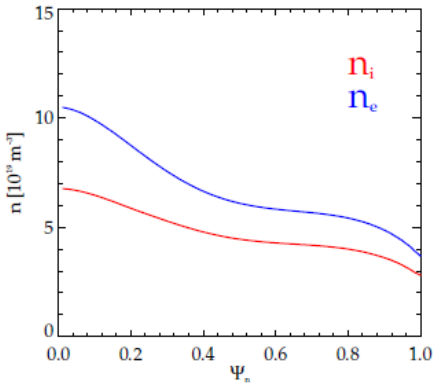


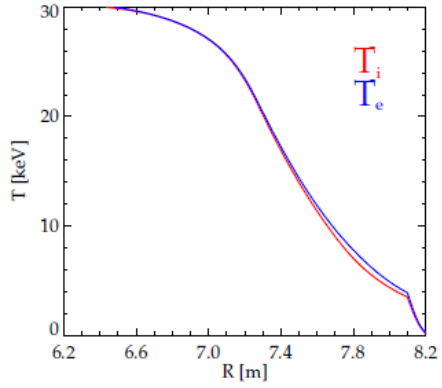
Profiles, 34039 @ 2500s

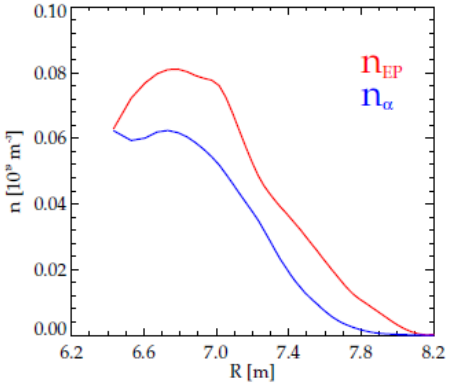


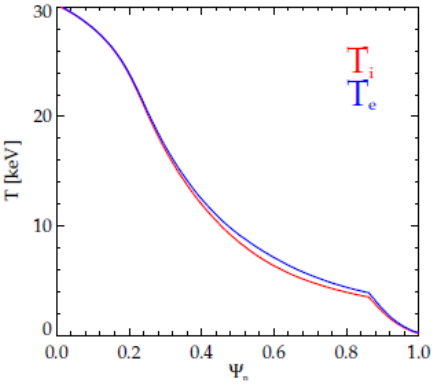


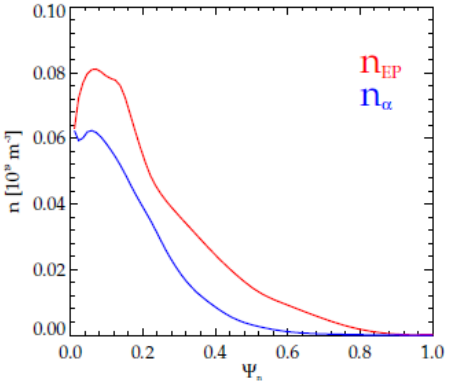


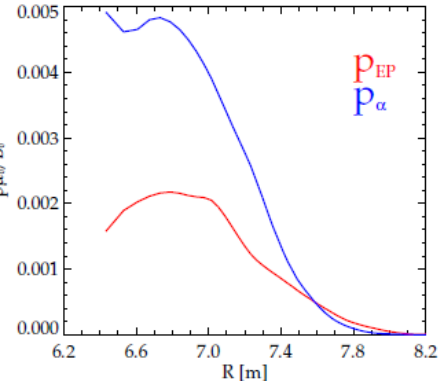






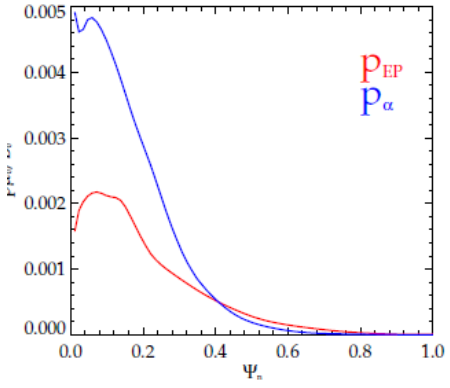




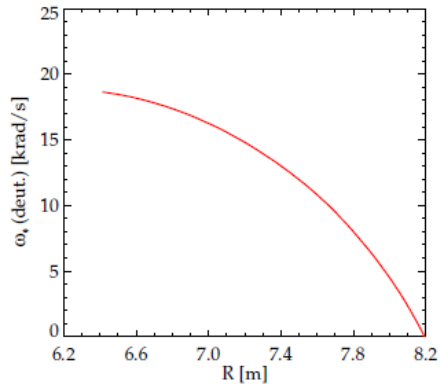


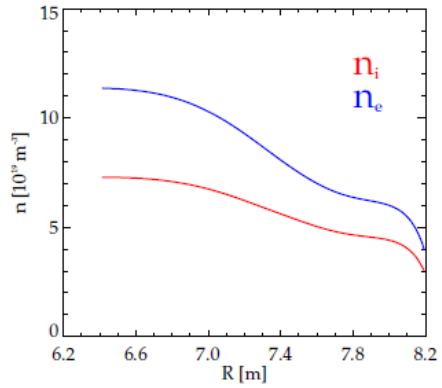
Notes:

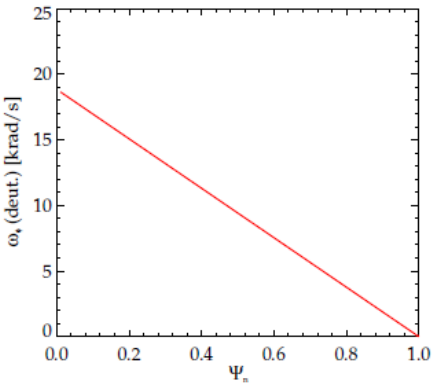
- TRANSP run without rotation
- n_i is split between 50% deuterium and 50% tritium

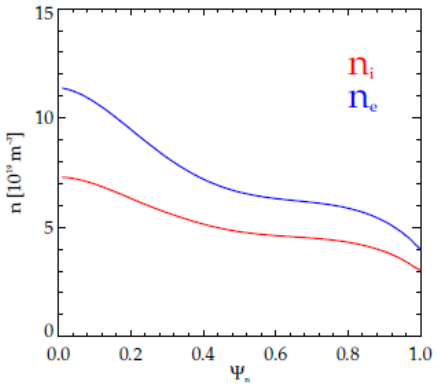


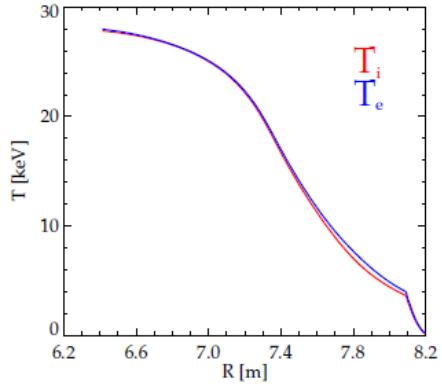
Profiles, 34041 @ 2500s

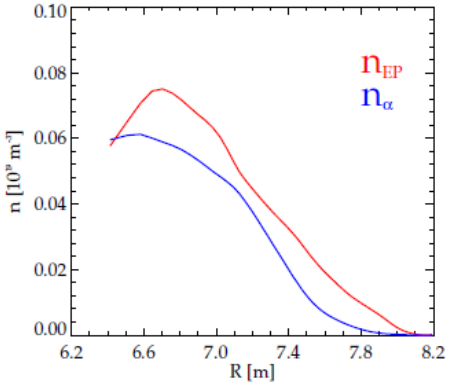


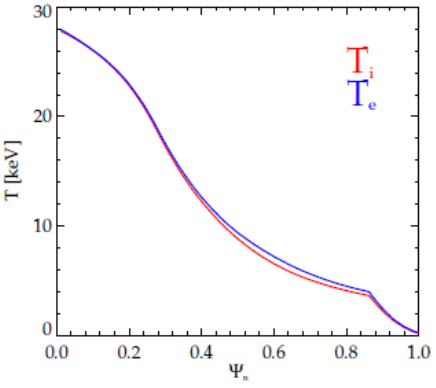


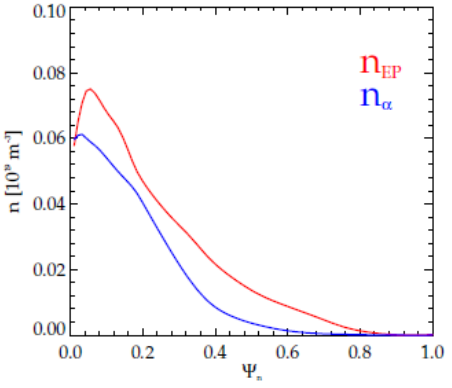


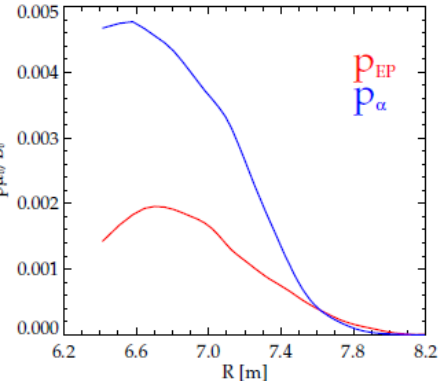






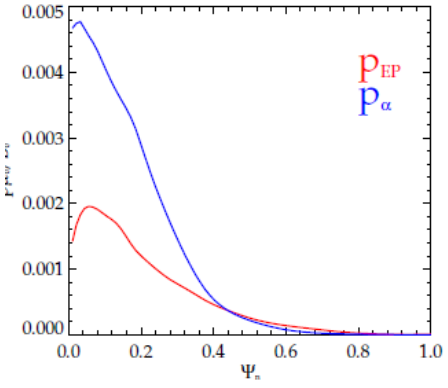






Notes:

- TRANSP run without rotation
- n_i is split between 50% deuterium and 50% tritium



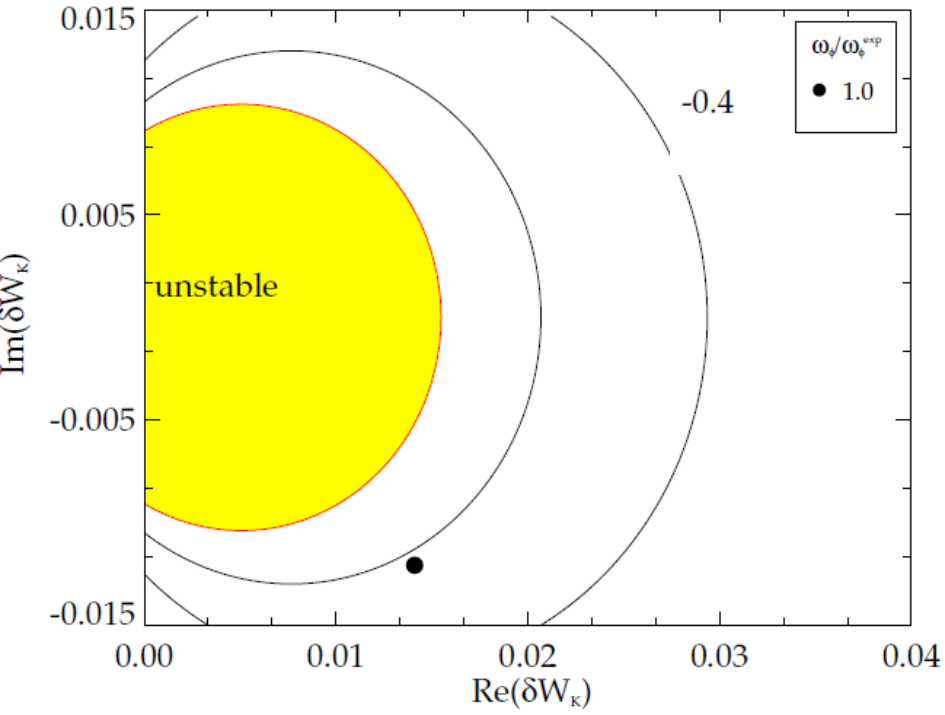
MISK Kinetic δW_K results, thermal particles only, with deuterium and tritium

$$\delta W_K = \sum_j \sum_{l=-\infty}^{\infty} 2\sqrt{2}\pi^2 \int\int\int \left[|\langle H/\hat{\varepsilon}\rangle|^2 \frac{(\omega - n\omega_E)\frac{\partial f_j}{\partial \varepsilon} - \frac{n}{Z_j e}\frac{\partial f_j}{\partial \Psi}}{n\langle\omega_D^j\rangle + l\omega_b^j - i\nu_{\text{eff}}^j + n\omega_E - \omega} \right] \frac{\hat{\tau}}{m_j^{\frac{3}{2}} B} |\chi| \hat{\varepsilon}^{\frac{5}{2}} d\hat{\varepsilon} d\chi d\Psi,$$

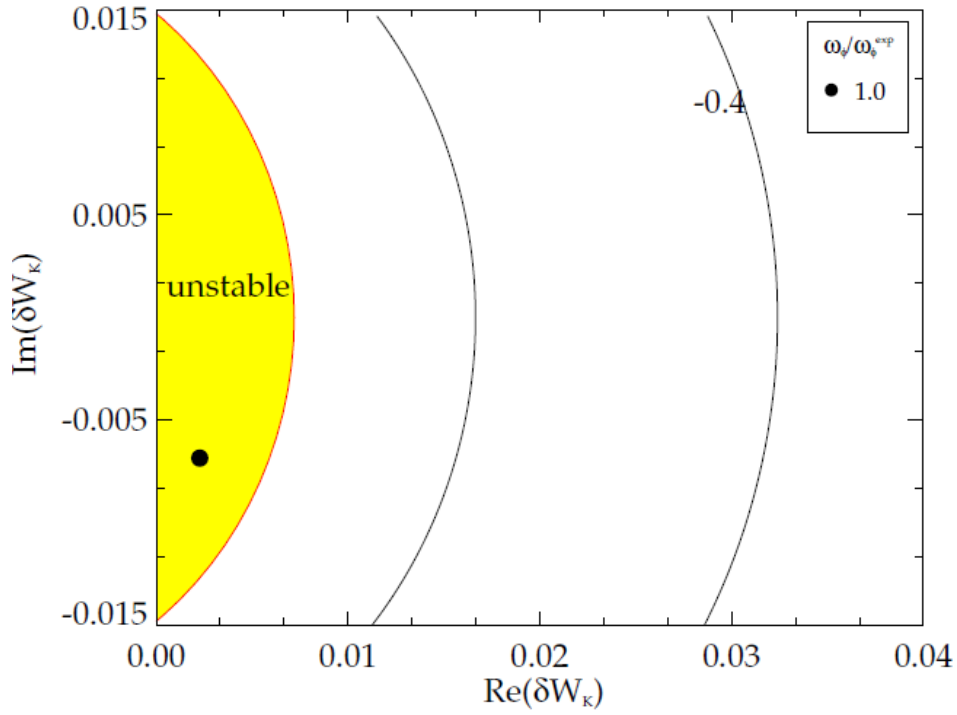
go like $m^{-1/2}$

Splitting to 50% deuterium and 50% tritium makes very little difference (vs. 100% deuterium). Need to recheck the effect on Alfven layers.

34039 @ 2500s



34041 @ 2500s



Alpha particles

When including alpha particles, I had to pay close attention to the 50% deuterium and 50% tritium mix, because it matters for the alpha's slowing-down distribution:

$$f_j^{\alpha}(\varepsilon,\Psi) = n_j A_{\alpha} \left(\frac{m_j}{\varepsilon_{\alpha}}\right)^{\frac{3}{2}} \frac{1}{\hat{\varepsilon}^{\frac{3}{2}} + \hat{\varepsilon}_c^{\frac{3}{2}}} \qquad \varepsilon_c = \left(\frac{3\sqrt{\pi}}{4}\right)^{\frac{2}{3}} \left(\frac{m_j}{m_e}\right) \left(\frac{m_e}{n_e} \sum_i \left(\frac{n_i Z_i^2}{m_i}\right)\right)^{\frac{2}{3}} T_e$$

34039 @ 2500s

β_i = 0.92 %

β_e = 1.39 %

β_{α} = 0.23 %

β_{EP} = 0.12 %

[R. Budny, Phys. Plasmas **17**, 042506 (2010)]

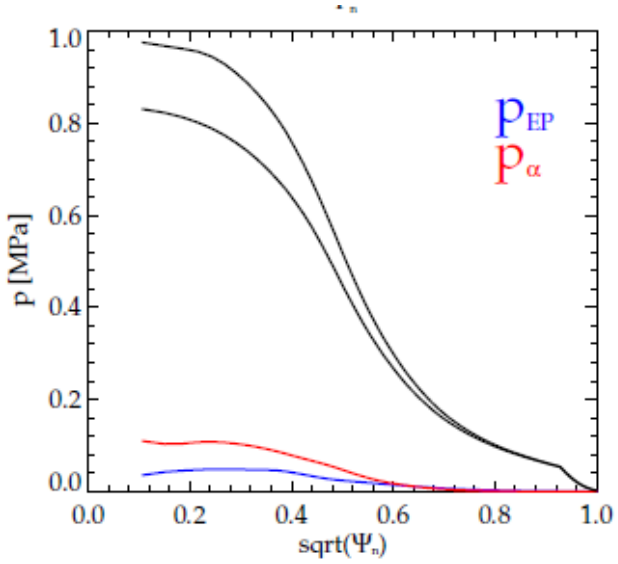
34041 @ 2500s

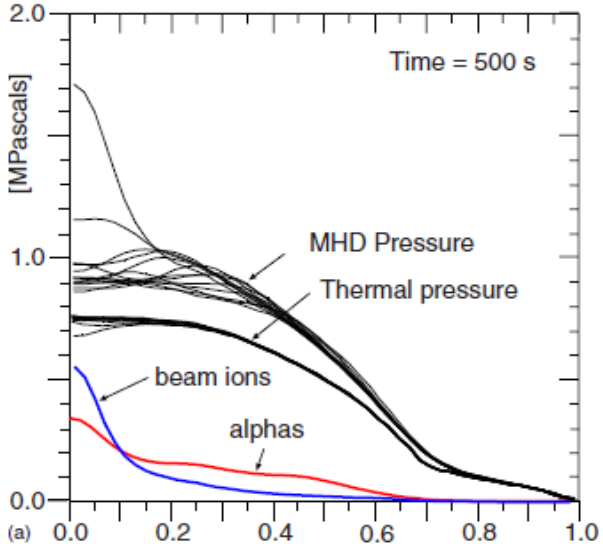
β_i = 0.98 %

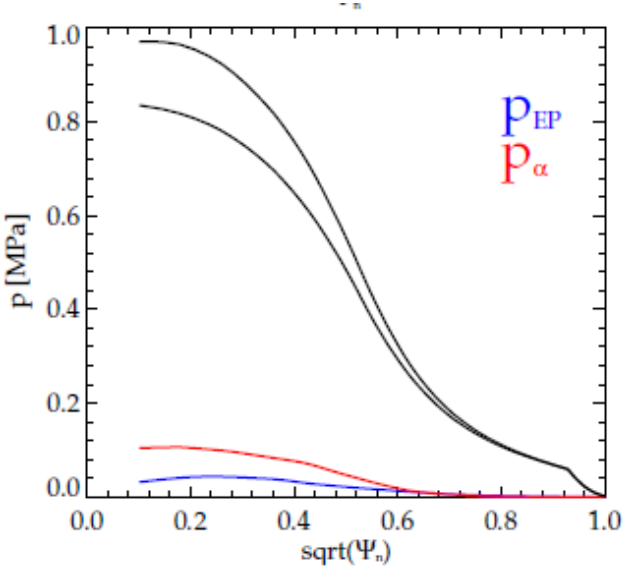
B_e = 1.49 %

β_{α} = 0.23 %

β_{EP} = 0.10 %



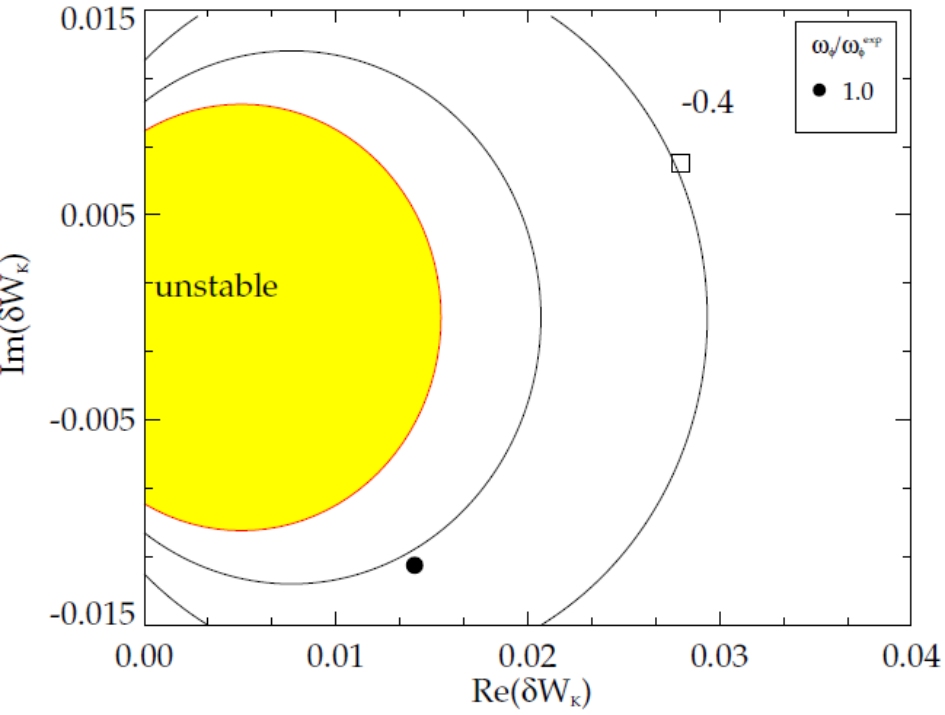




Results with alpha particles included

Alpha particles seem to have a surprisingly large effect – have to check why that is.

34039 @ 2500s



34041 @ 2500s