HW 5, due on Feb 25

Based on tour next week,

1. Discuss pressure balance in IEC. Set up an expression for it and comment on how mechanical force is transmitted to outside world. (Note $T_i >> T_e$) Is the mechanical structure required easier (or harder) to engineer than in a Tokamak? (Need to state what structure is required in the Tokamak)

2. Consider the θ-pinch experiment – how is the current created to cause the pinch B-field? In the G+L notes on web, Eq. 3.26, p=200nkT applies to a z pinch. Reformulate this expression (the Bennett Relation) for a θ-pinch. What has been assumed about β for these devices? Why was a θ-pinch chosen for the experiment vs. a Z pinch?

3. Plasma wall interactions can involve plasma particles hitting a metallic wall and also radiation heating of the wall. Consider a steady state $n=10^{14}$ cm^{-3}, 20 keV DT plasma with a confinement time of 1s, in a torus R=6m and a (minor radius)=2.0 m.

i) What is the power (W/cm^2) carried by escaping particles hitting the first wall surface? (Assume all particles hit the wall and the escaping flux is uniform around the plasma surface. Assume particles escape with $\bar{E} = \frac{3}{2}kT$.) If the wall is iron and each D-T ion hitting knocks out an average 1/5 iron atom, what is the erosion rate (mm/yr)? Does this problem seem serious? What is the UIUC group doing to get around it?

ii) Assume the iron atoms end up in the plasma creating an impurity density of iron. What density (ion atoms/plasma ions) would cause the P_{Rad} (Bremsstrahlung + Cyclotron radiation) to double? Assume fully stripped iron. Assume β=0.3 and $\Psi=10^{-2}$. Under this condition, what is the radiation power density (W/cm^2) hitting the first wall? How does it compare with the power density by escaping plasma particles of i)? With the neutron power density?

4. The D-T α particle is created at 3.5 MeV. To contain it and heat the plasma, $r_{g\alpha}$< a (a=minor radius of the device). For the β=0.3 DT plasma at n=1014 cm-3 and 20 keV, what is the minimum a required for effective α particles heating?

5.7 and 5.9 in text book.

Optional extra credit: 5.4 and 5.5 in the text book.