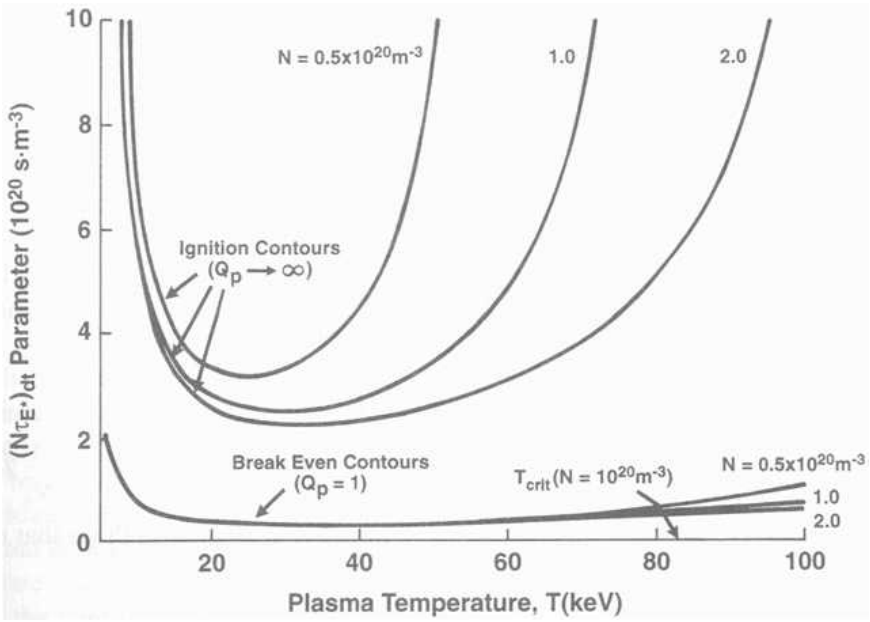
Fusion Reactor Engineering 2 (459.761)

Midterm Examination

3 November, 2020

1. (1) (10 points) If the plasma density is $10^{20}m^{-3}$, discuss the operating point of a fusion reactor according to the figure below.



(2) (10 points) Why is the ignition condition difficult to meet if the plasma temperature is too high?

2. (1) (20 points) Discuss what kind of a KSTAR scenario it is which is shown below.

(2) (10 points) Calculate the maximum energy confinement time of this scenario where the toroidal magnetic field at the magnetic axis and the major radius is 1.8 T and 1.8 m, respectively. The minor radius and the wall position are 0.5 m and 0.6 m, respectively.

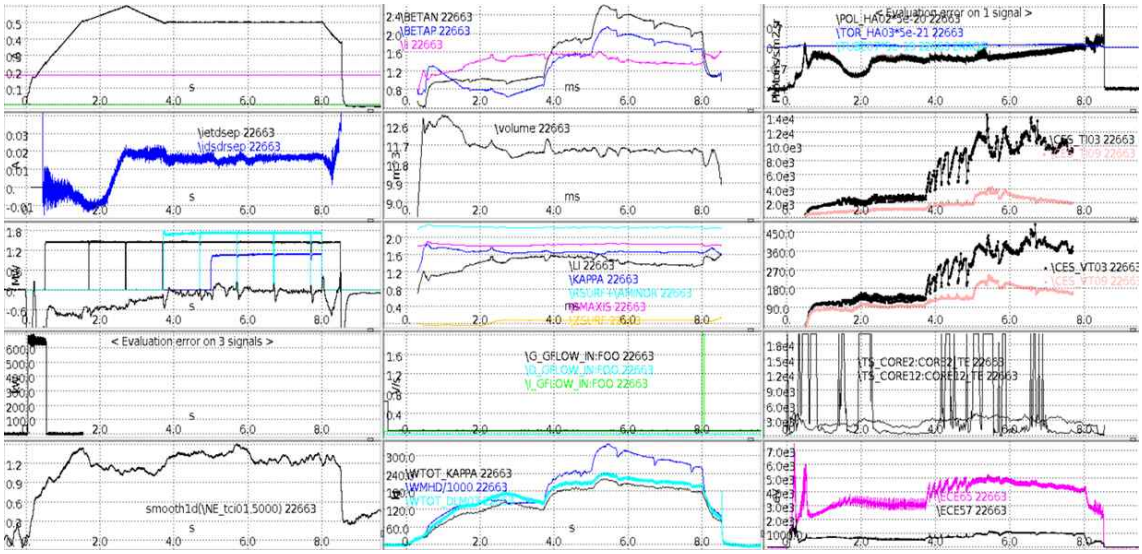
(3) (20 points) Calculate the central q-value, q(0) if the central toroidal current density $j_\Phi(0)$ is known to be 1.0 MA/m^2 in this shot.

(4) (10 points) Discuss if there is sawtooth in this shot.

(5) (10 points) Discuss if there is ELM in this shot.

(6) (10 points) Discuss why this scenario can be considered as a DEMO scenario

by comparing with H-modes.



row1: plasma current (black), magnetic field (magenta) / betaN, betap, internal inductance / D_α signals at different positions

row2: dRsep / plasma volume / Central and edge ion temperature

row3: Beam power of NBI A (black), B (cyon), and C (blue), loop voltage (black, flipped sign) / internal inductance, elongation, plasma positions / central and edge toroidal rotation

row4: startup gas puff / gas flow / central and edge electron temperature from Thomson Scattering measurements

row5: line averaged density / total stored energy with kappa correction (black), MHD energy (blue), total stored energy from diamagnetic loop (cyon) / Central and edge electron temperature from ECE measurements

"Though the mountains be shaken and the hills be removed, yet my unfailing love for you will not be shaken nor my covenant of peace be removed," says the LORD, who has compassion on you." (Isaiah 54:10)