Vacuum discharge

ID:irog

ID:loop_voltage

$\int_0^t$

Loop Voltage $U_l(t)$
Chamber current $I_{ch}(t)$

Plasma discharge

ID:irog

ID:loop_voltage

ID:electron_density

$\int_0^t$

Loop Voltage $U_l(t)$
Chamber+plasma current $I_{ch+p}(t)$

Tokamak GOLEM plasma volume $V_p \approx 80$ l
Boltzman constant $k_B = 1.38 \cdot 10^{-23}$ J/K

Chamber resistance $\overline{R_{ch}} \approx \frac{U_l(t)}{I_{ch}(t)}$

Plasma current $I_p(t) = I_{ch+p}(t) - I_{ch}(t) = I_{ch+p}(t) - \frac{U_l(t)}{\overline{R_{ch}}}$

Plasma resistivity $R_p(t) = \frac{U_l(t)}{I_p(t)}$

Plasma heating power $P_{OH}(t) = R_p(t) \cdot I_p^2(t)$

Central Electron temperature
(Spitzer formula)
GOLEM case
$T_e(0,t) = 0.9 \cdot R_p(t)^{-2/3}$

The loss power $P_{loss}(t) = P_{OH}(t) - \frac{dW_p}{dt}$

Total electron energy content $W_p(t) = V_p \frac{n_e(t) k_B T_e(0,t)}{3}$

Hint: stationary plasma state, when $\frac{dW_p}{dt} = 0$ (plasma current flat top) $\rightarrow$ easy calculation

The electron energy confinement time $\tau_E(t) = \frac{W_p(t)}{P_{loss}(t)}$