

## Vacuum discharge



ID:irog

ID:loop\_voltage

$$\int_0^t \downarrow$$

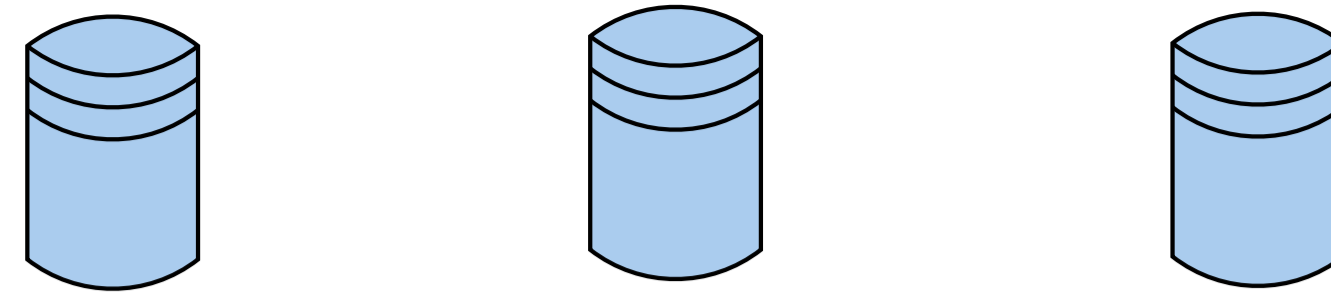


Loop Voltage  $U_l(t)$   
Chamber current  $I_{ch}(t)$



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

## Plasma discharge

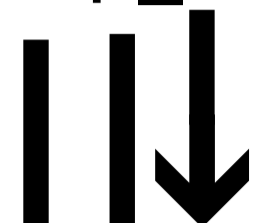


ID:irog

ID:loop\_voltage

ID:electron\_density

$$\int_0^t \downarrow$$



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

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  $\tau_E(t) = \frac{W_p(t)}{P_{loss}(t)}$