

# The Relationships among Energy Confinement Time, Toroidal Magnetic Field, and Electric Field

By Group Five

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# Energy Confinement Time



Definition : Average time taken for the energy to escape the plasma, usually defined as the total amount of energy stored in the plasma divided by the rate at which energy is lost.

$$\tau_E = A \frac{W_p}{P_\Omega} \quad \dots(1)$$

Higher energy confinement time will make fusion reactions more likely to occur.

## Scaling Law

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$$\tau_E = A I_p^{\alpha_I} B^{\alpha_B} \bar{n}^{\alpha_n} P_\Omega^{\alpha_P} \dots(2)$$

where

$$\begin{aligned}\alpha_I &\approx 0.9 \\ \alpha_B &\approx 0.2 \\ \alpha_n &\approx 0.4 \\ \alpha_P &\approx -0.7\end{aligned}$$

**Recall  
that**

$$P_{inj}(t) = P_\Omega(t) = U_{loop}(t)I_P(t) = R_P(t)I_P(t)^2$$

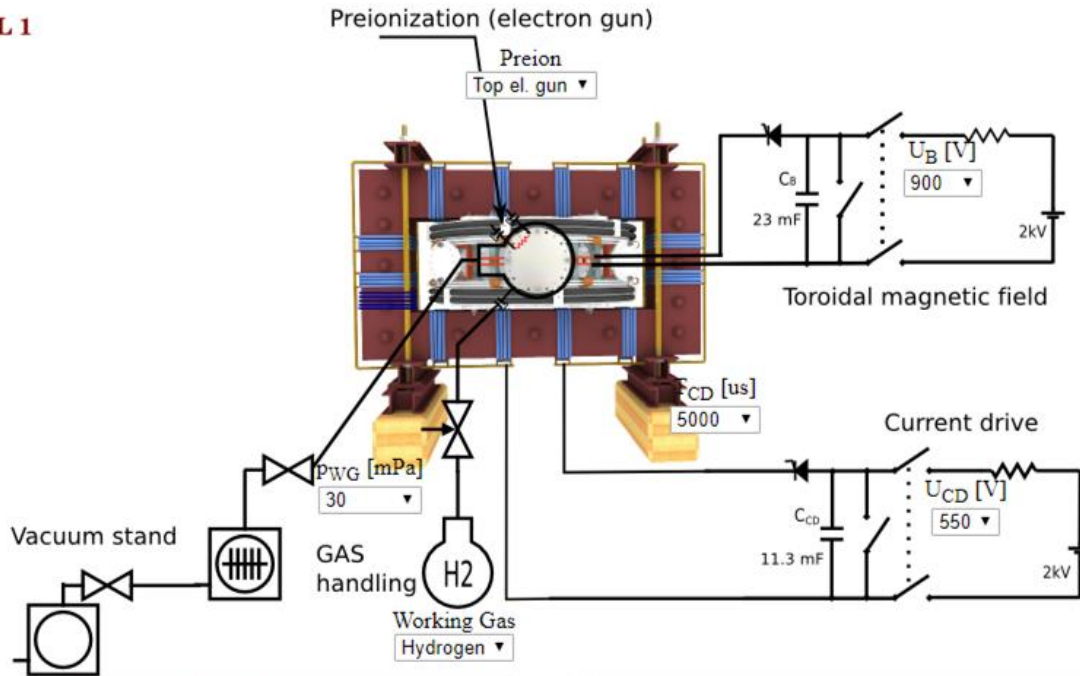
# Toroidal Magnetic Field ; $B_{\text{tor}}$

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$$B(t) \approx \frac{1}{C_B} \left( \sum_{j=0}^{t/\Delta t} U_B(t_j) \Delta t \right) - U_{B,offset} t \quad \dots(3)$$

# Methodology

LEVEL 1



Variables:

$U_B$

$U_{CD}$

Constants:

gas : H<sub>2</sub>

$P_{WG} = 30$  mPa

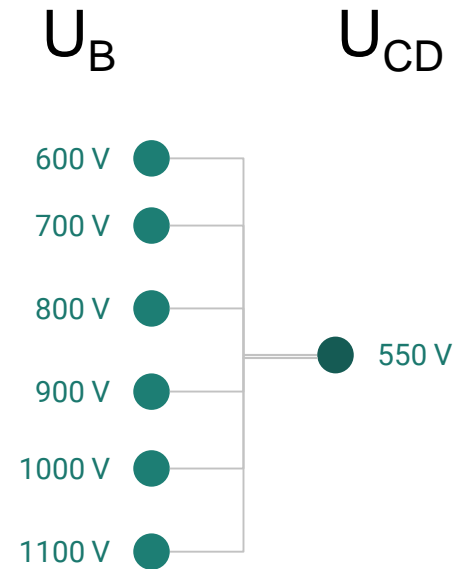
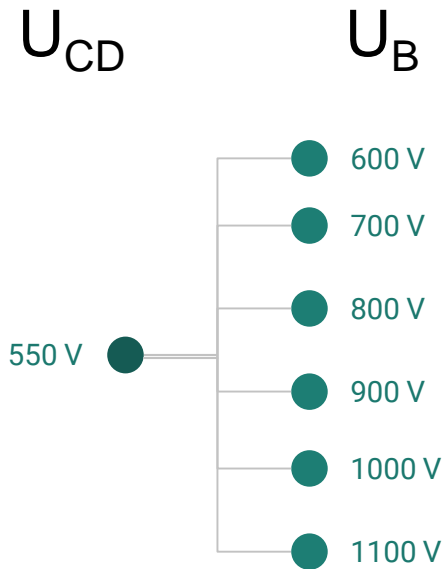
$T_{CD} = 5$  ms

Group nb.5 - 550\_900

Place the discharge setup into the queue

Note: We use cookies to record last set parameters in your browser to simplify parameter scans.

# Methodology



# Results $(U_{CD} = 700 \text{ V})$

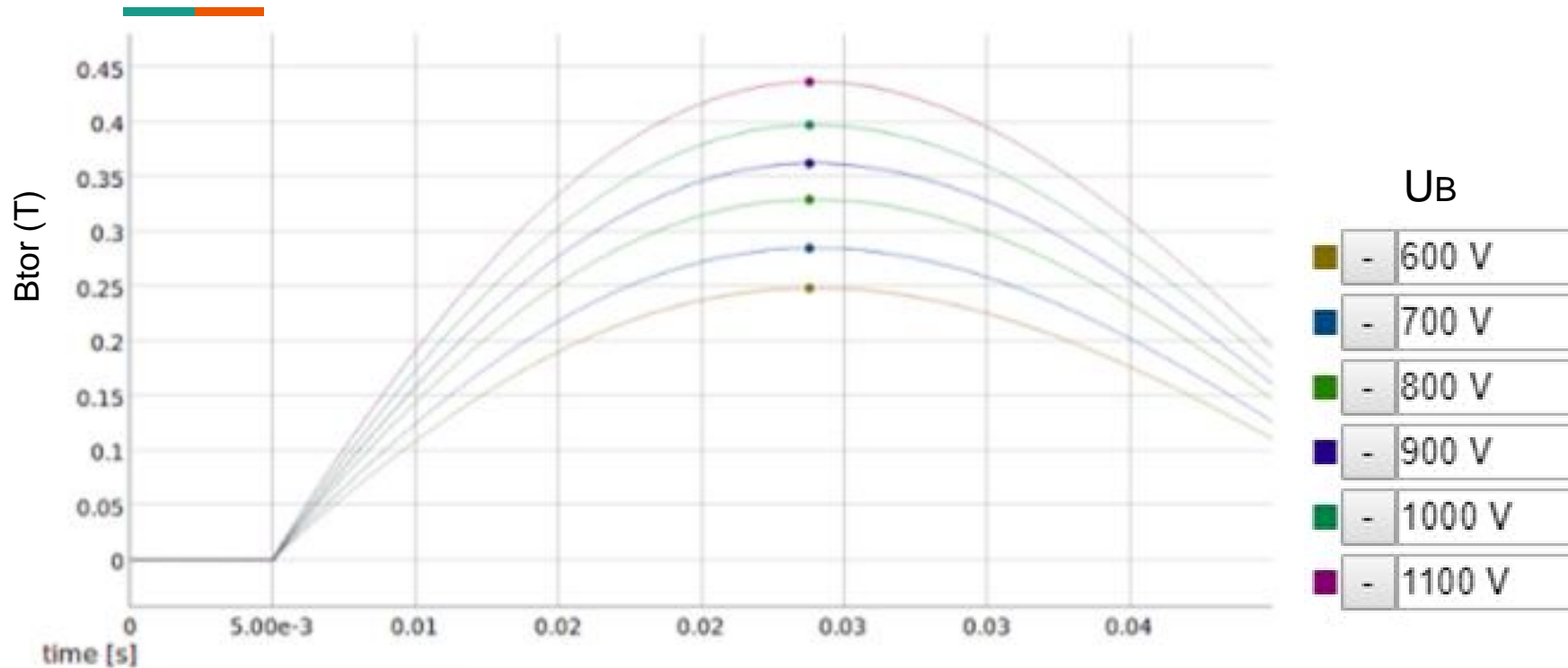
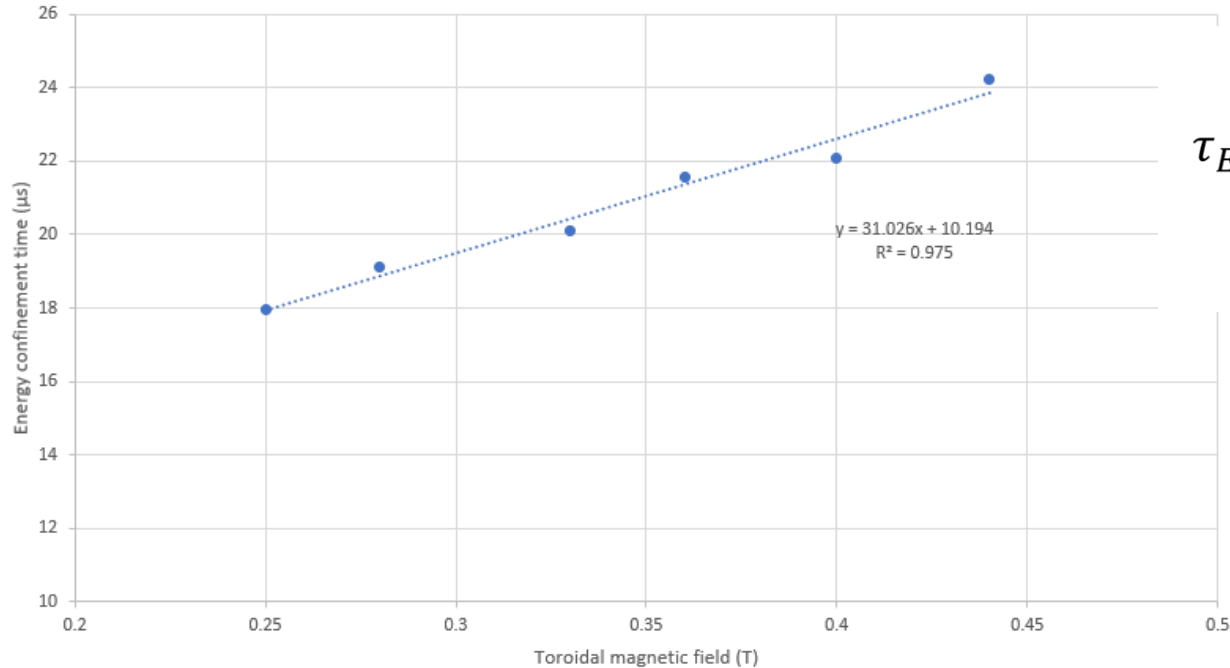


Fig. 1

# Results

The Relation between Energy Confinement Time and Toroidal Magnetic Field  
for  $U_{CD} = 700$  V



$$\tau_E = \frac{3}{8} \times \frac{n_e k_B T_e V_p}{I_p U_{loop}} = \frac{3}{8} \times \frac{W_p}{P_\Omega}$$

Fig. 2



# Results

The Relation between Energy Confinement Time and Voltage

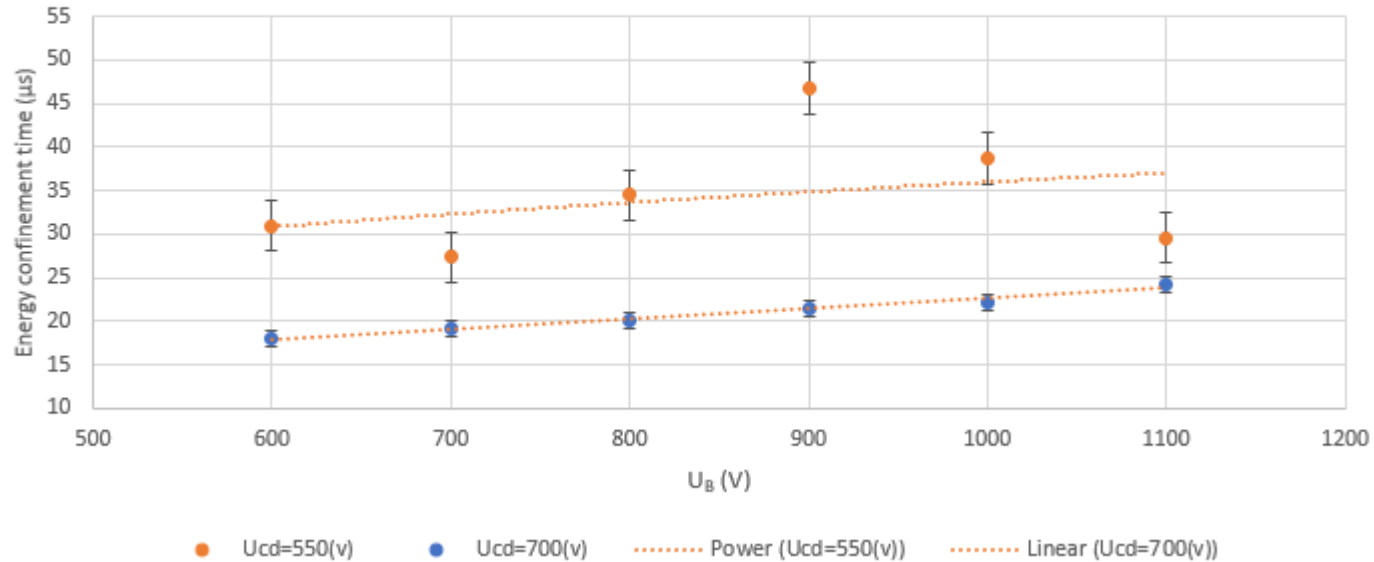


Fig. 4

# Results

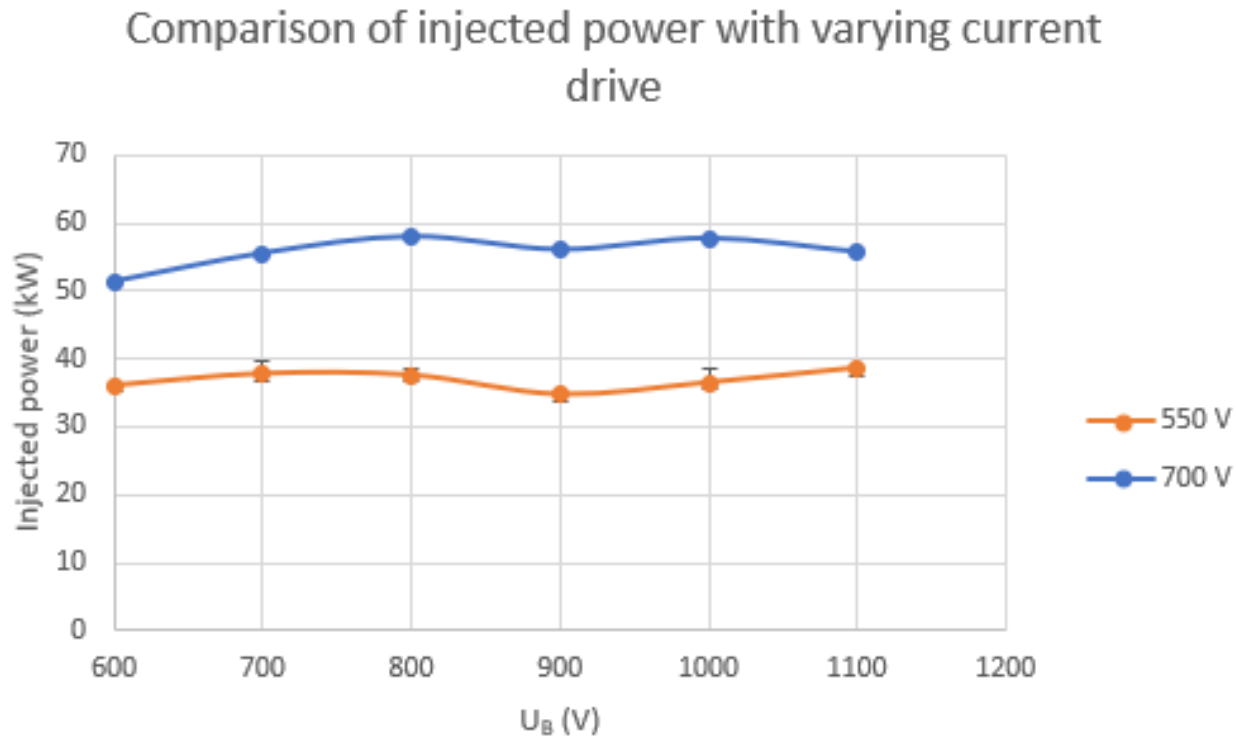
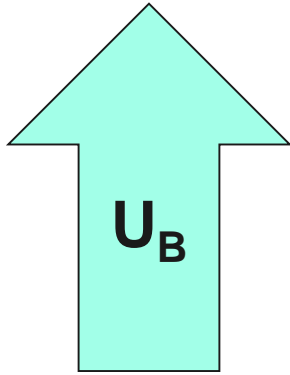
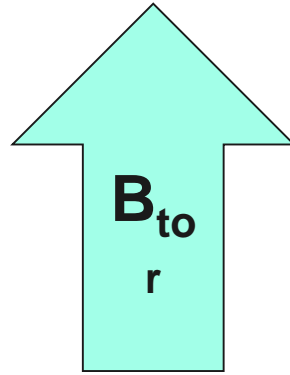


Fig. 3

# Conclusions and Recommendations



Eq. 3  
Fig. 1



Eq. 2  
Fig. 2

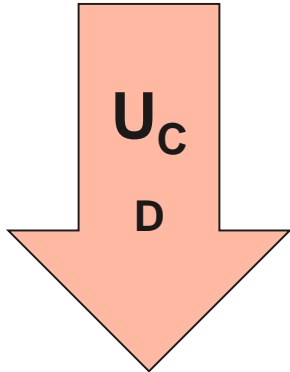
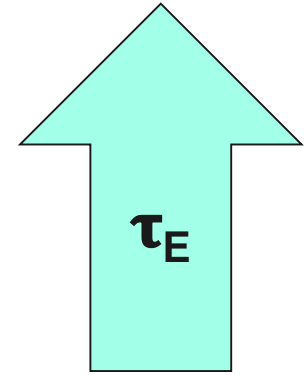
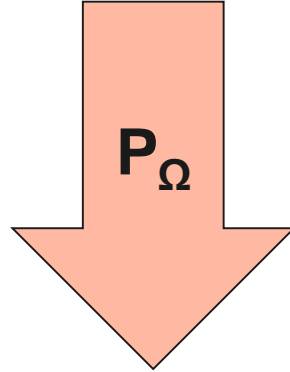
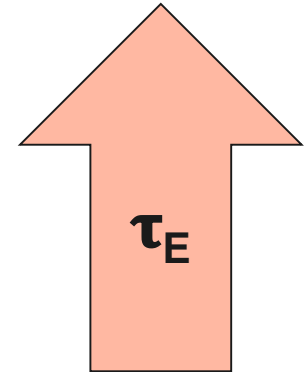


Fig. 3



Eq. 1  
Fig. 4



# References



[http://fusionwiki.ciemat.es/wiki/Energy\\_confinement\\_time](http://fusionwiki.ciemat.es/wiki/Energy_confinement_time)

Guirlet, Remy. Hands-on project : Experiment on GOLEM.

A serene sunset scene featuring a large, glowing sun partially obscured by the silhouettes of several trees. In the foreground, a person is walking a dog across a field, with a fence visible behind them. The overall atmosphere is peaceful and contemplative.

**Thank you**

Energy confinement times,

$$P_{\text{tot}} = P_{\text{add}} - P_{\text{loss}}$$

$$P_{\text{tot}} = \frac{dW_p}{dt} = P_{\text{add}} - P_{\text{loss}}$$

$$P_{\text{loss}} \propto W_p$$

$$P_{\text{loss}} = c W_p = c \frac{W_p}{\tau_E}$$

steady state:  $\frac{dW_P}{dt} = P_{\text{add}} - P_{\text{loss}}$

$$P_{\text{add}} = P_{\text{loss}}$$

$$P_{\text{add}} = \frac{W_P}{\tau_E}$$

$$P_{\Omega} = \frac{W_P}{\tau_E}$$

$$\tau_E = \frac{W_P}{P_{\Omega}} \quad \#$$

where  $P_{\Omega} = I_p U_{\text{loop}}$