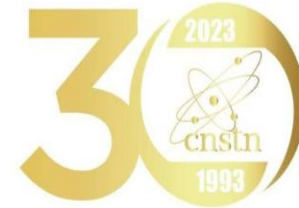




**MPFuS 2023**  
**LA 3IÈME ÉCOLE DE LA PHYSIQUE DU**  
**PLASMA ET DE LA FUSION DANS LA**  
**RÉGION MENA-MPFUS 2023**  
**DE 12 AU 16 JUN 2023 À HAMMAMET**



# Predicting Plasma Creation in GOLEM Experience vis-a-vis Hydrogen Pressure

4th GROUP(DZ-MA-SN)

Encadré par Jullien Hillairet

# Data Scraping

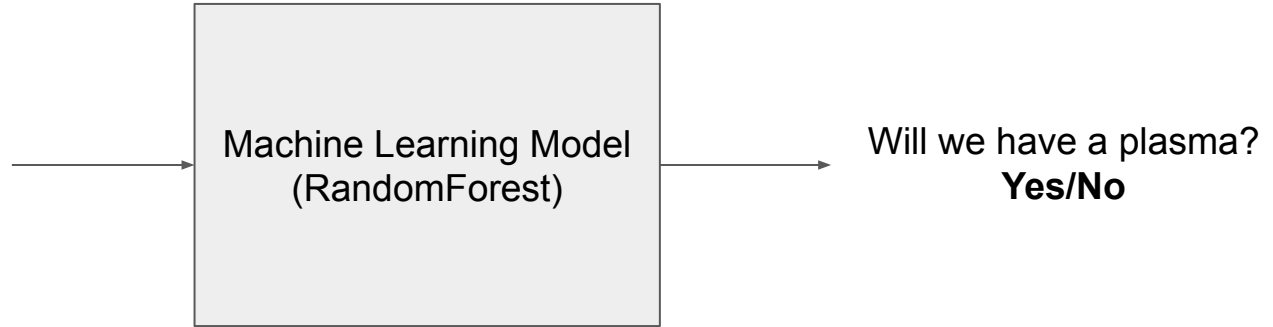
	p_before	p_chamber_pressure_predischarge	t_cd_discharge_request	U_Bt_final	U_CD_final	t_start	b_plasma	u_loop_max_manual
40000	0.90	94.1	1500.0	1005.0	529.0	0.000	0.0	12.261719
40001	0.92	16.3	1500.0	1009.0	513.0	3.832	1.0	12.900000
40002	0.93	25.7	1500.0	1018.0	520.0	3.940	1.0	13.041406
40003	0.93	28.3	1500.0	1013.0	516.0	4.684	1.0	14.119531
40004	0.92	19.5	1500.0	1019.0	628.0	3.626	1.0	14.527344
...	...	...	...	...	...	...	...	...
42242	1.09	14.9	1000.0	1301.0	624.0	0.000	0.0	14.843750
42243	1.05	14.8	1000.0	1302.0	604.0	3.123	1.0	14.722656
42244	1.02	15.0	1000.0	1300.0	576.0	3.240	1.0	13.787500
42245	0.99	19.6	1000.0	1301.0	552.0	3.195	1.0	14.001563
42246	3.65	29.9	1000.0	814.0	524.0	3.307	1.0	12.489062

1803 rows × 8 columns

# Machine Learning #1

## GOLEM UI inputs:

- p\_before
- p\_predischarge
- U\_Bt
- U\_cd
- t\_cd

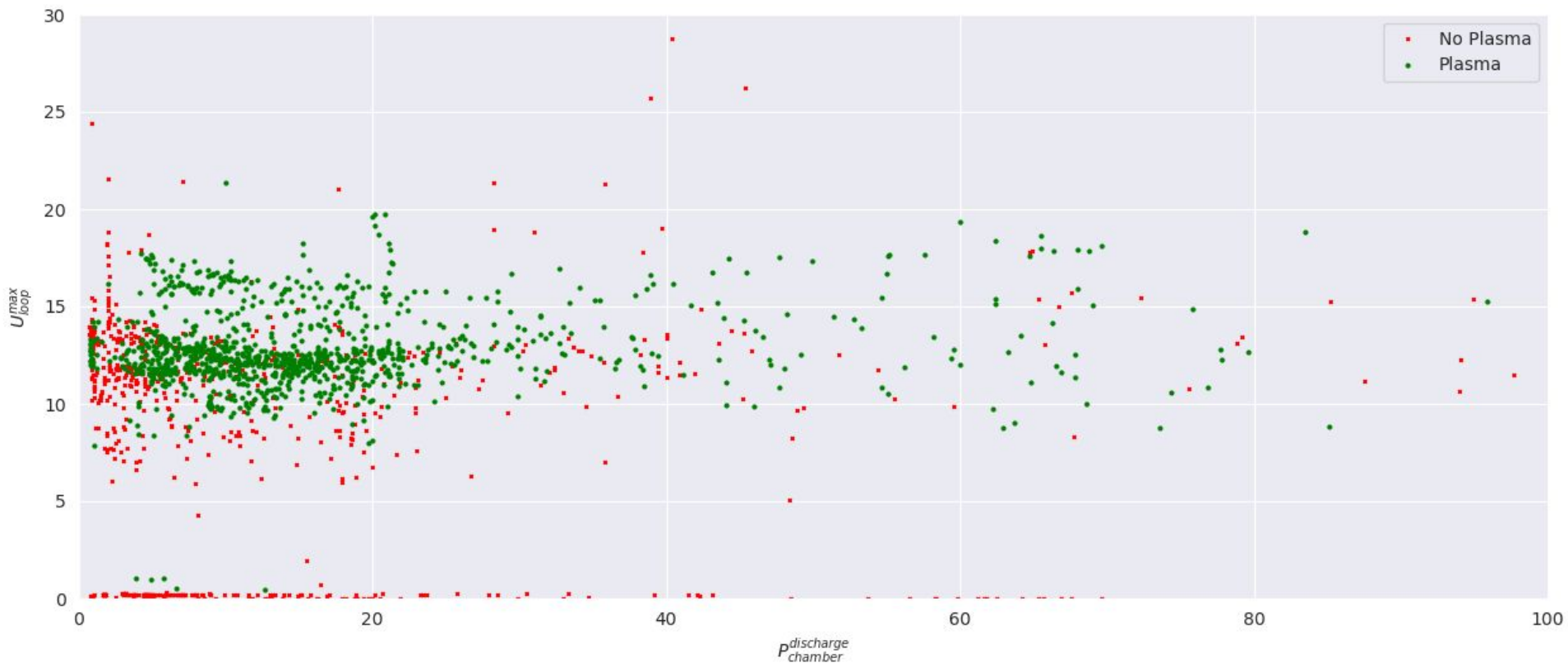


# Results

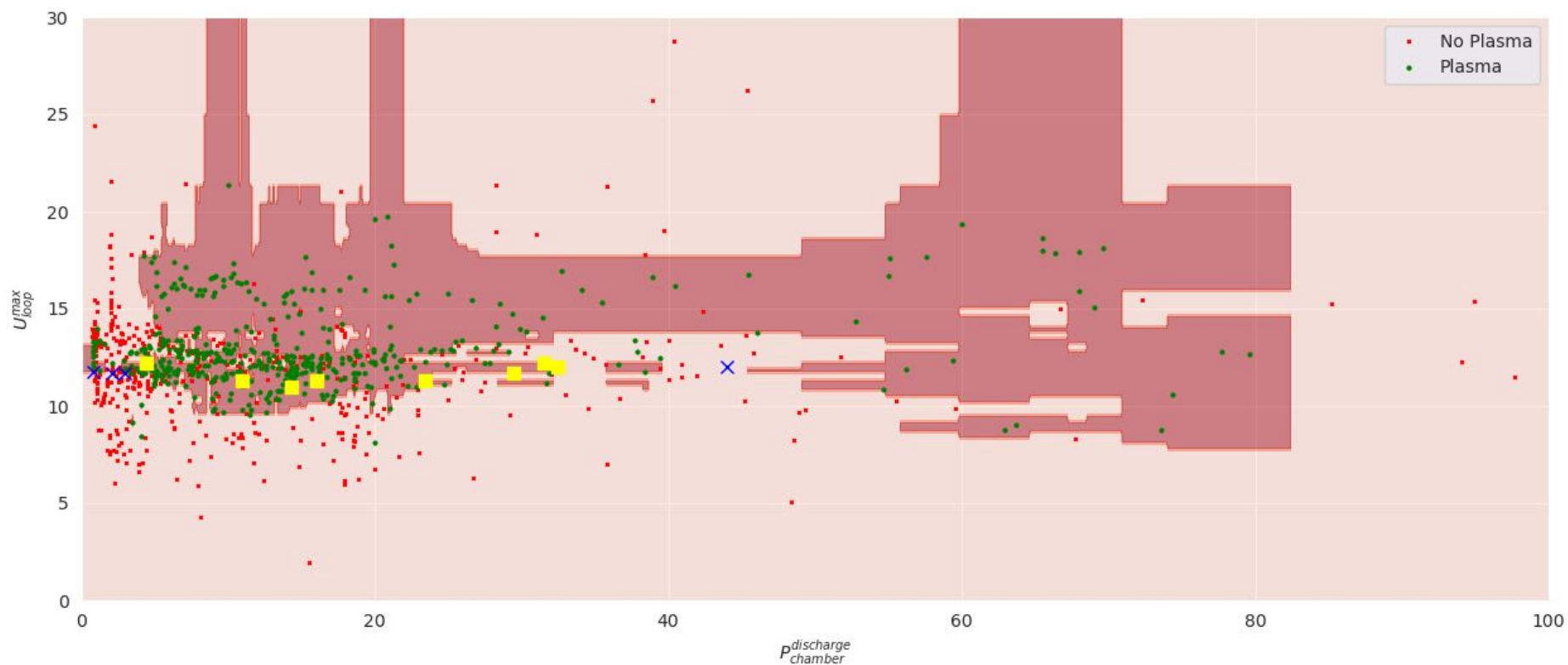
- Score on the dataset is: **85.08%**
- Score on the results of Wednesday (all groups): **79.63%**
- Score on our group's results: **92.3%**

N° shot	Exact value	Predicted value	Correct/error of prediction
42274	1	1	correct
42282	1	1	correct
42284	1	1	correct
42288	0	1	Error
42290	1	1	correct
42294	0	0	correct
42313	1	1	correct
42314	0	0	correct
42315	0	0	correct
42316	1	1	correct
42317	1	1	correct
42318	1	1	correct

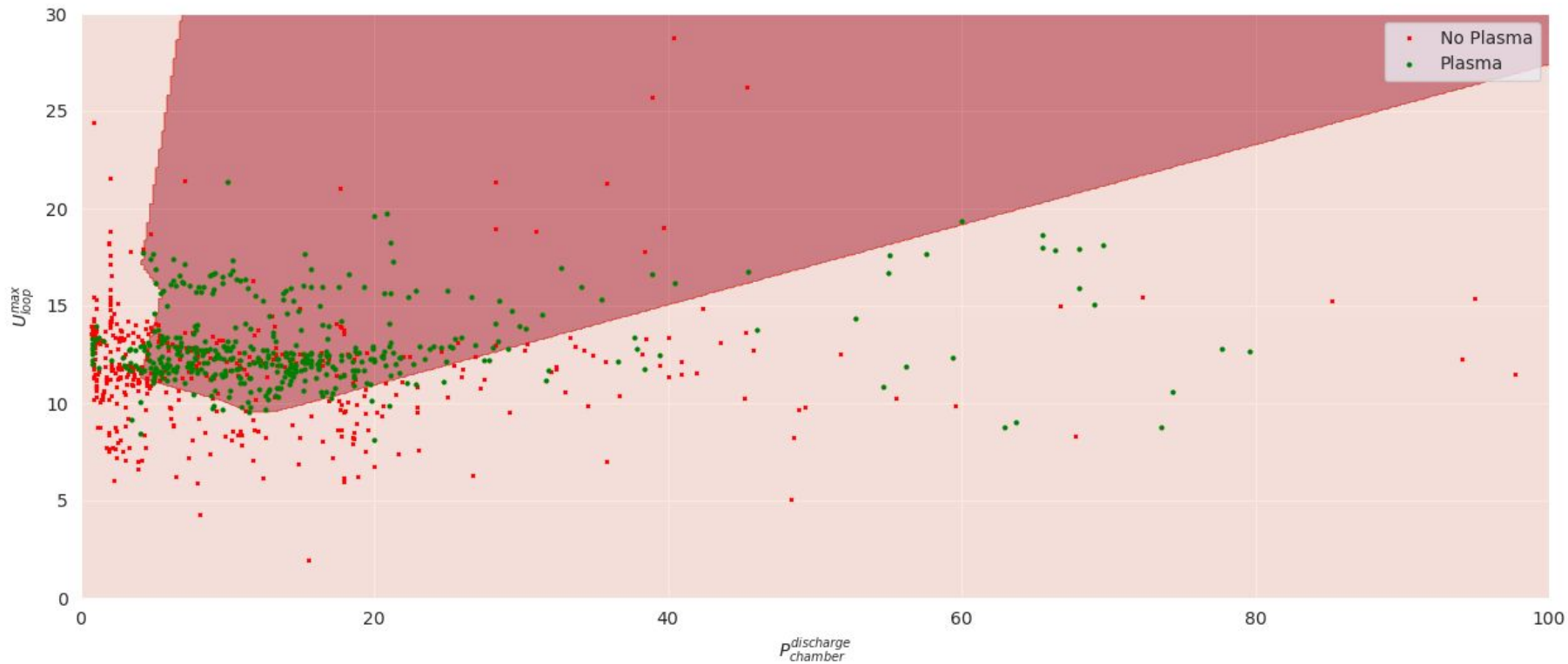
$$\text{PlasmaCreation} = f(U_{loop}^{max}, p_{predischarge})$$



# Machine Learning #2



# Deep Neural Network

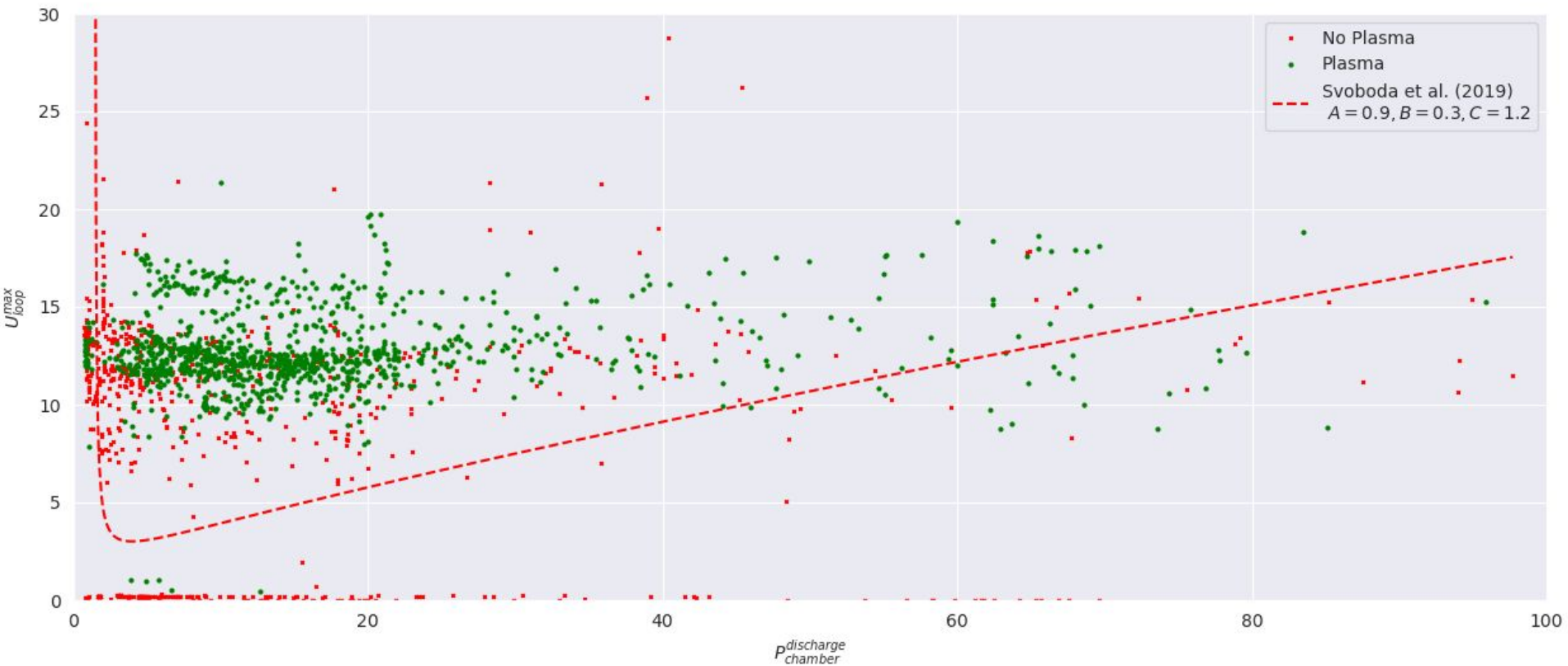




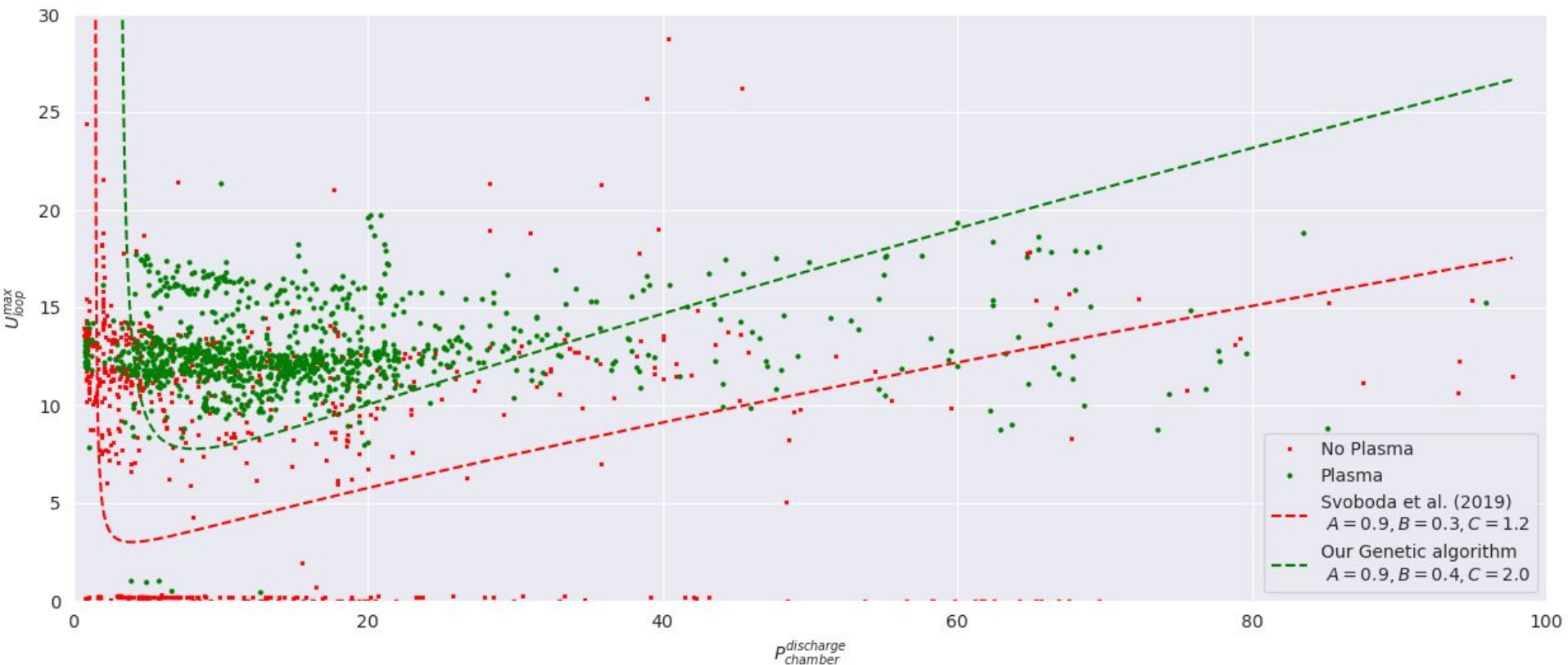
# Paschen's Law

$$E = \frac{Bp}{\ln(Apd) - C}$$

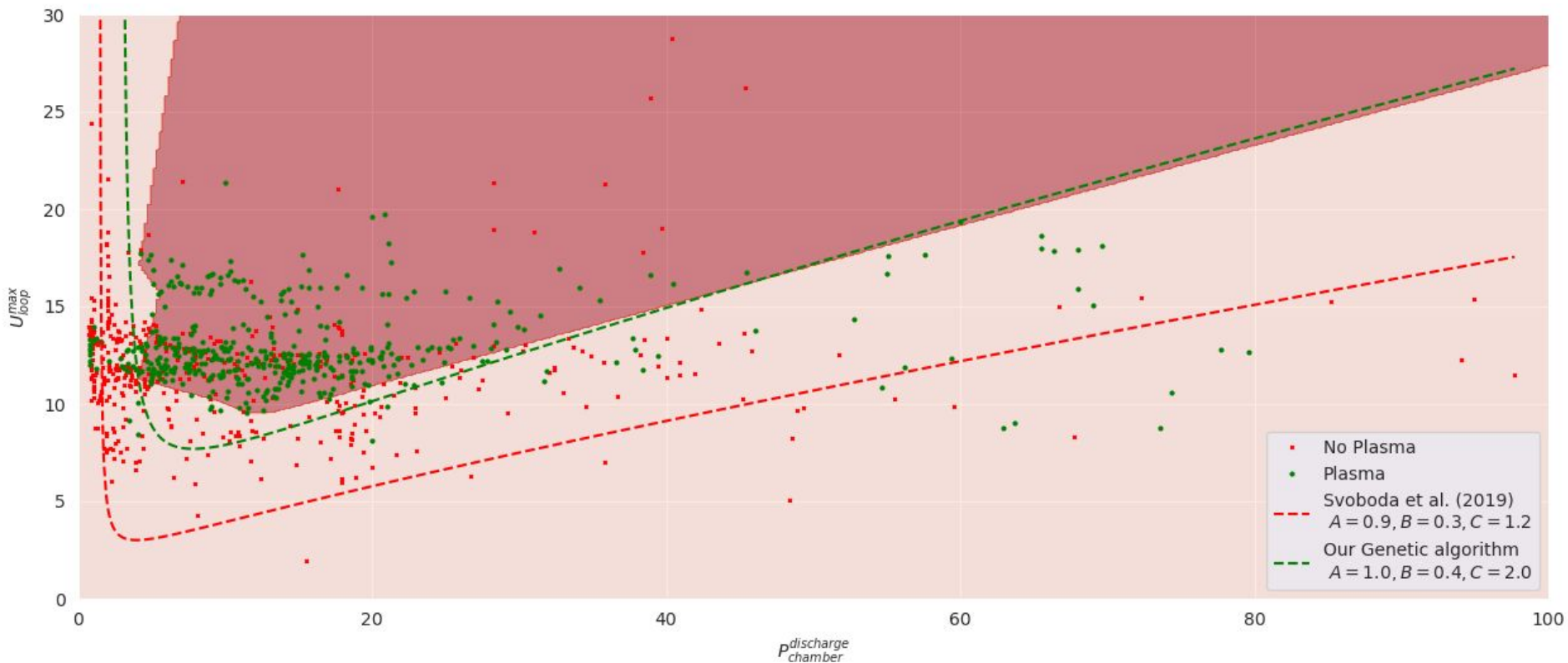
# Paschen's Law: Svoboda et al. 2019



# Paschen's Law: Genetic Algorithm

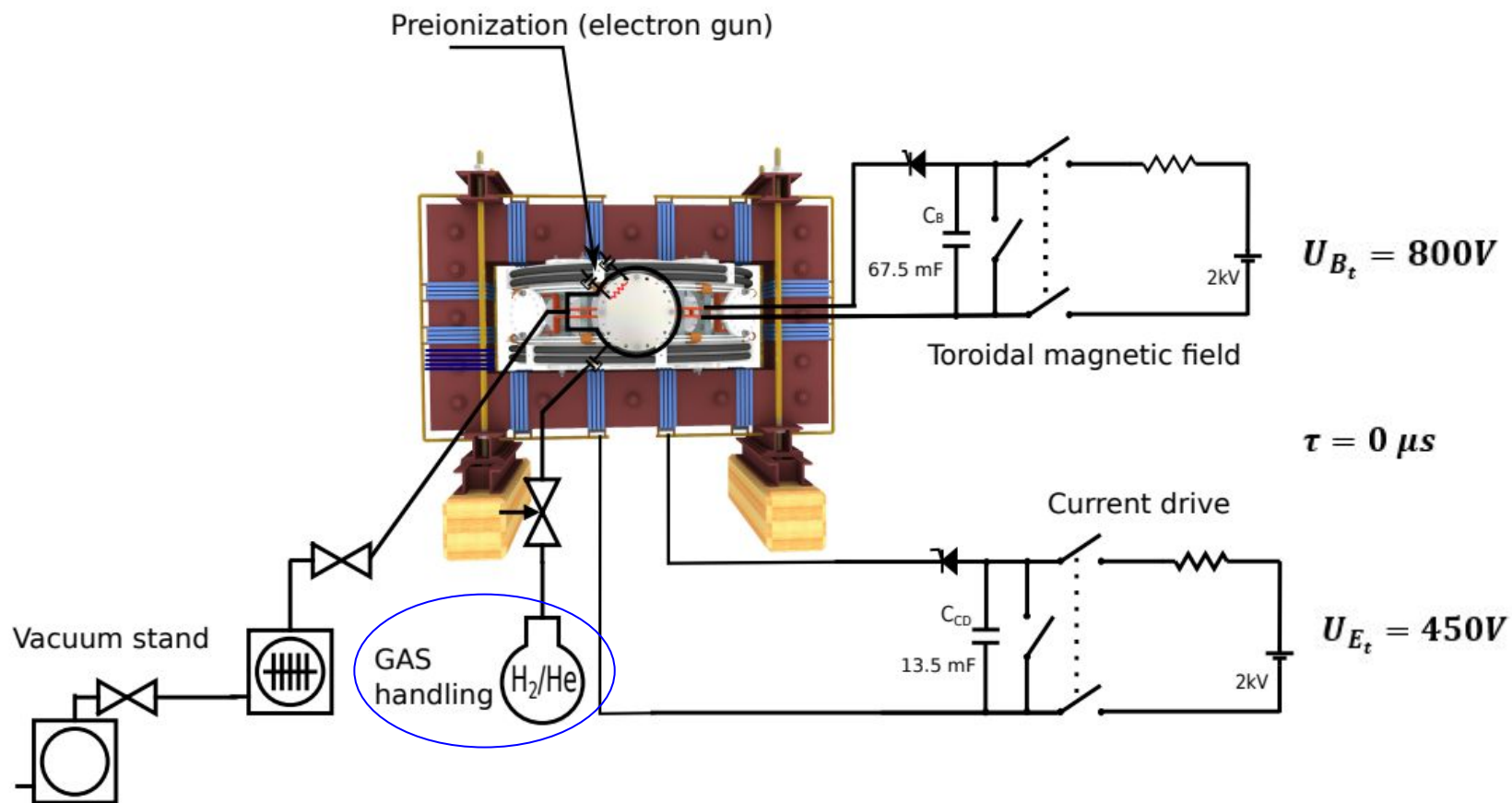


# Paschen's Law vs Deep Neural Network

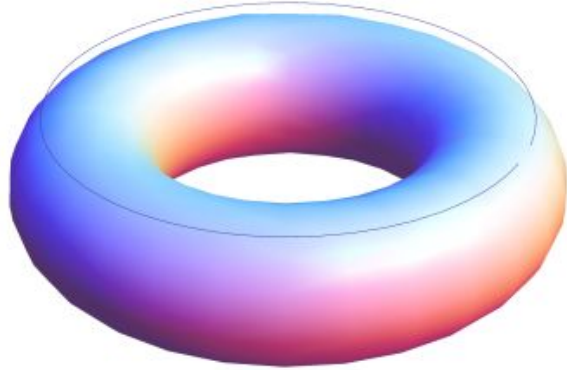


**GOLEM Tokamak Remote control**

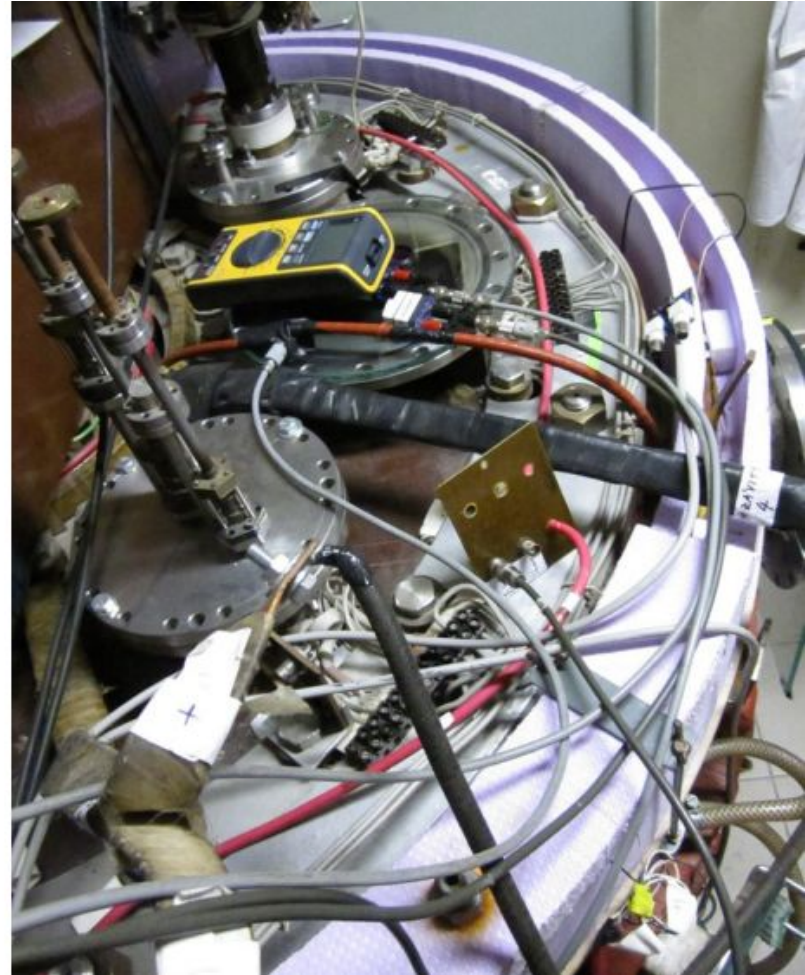
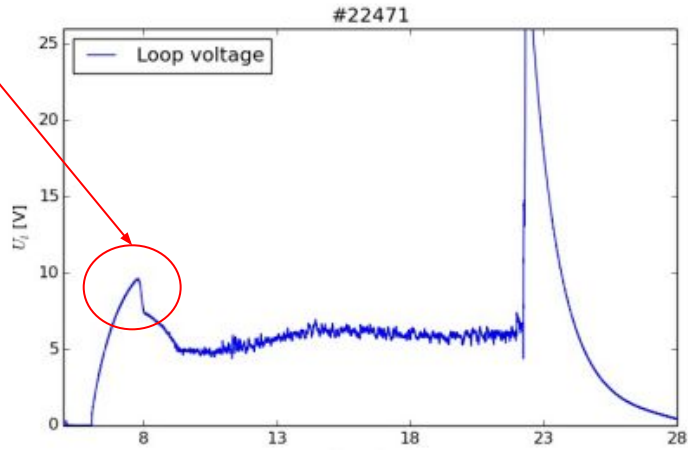
- **Experimental setup and parameters:**



- Loop voltage measurement



Breakdown voltage



Measured Pressure (mPa)	Breakdown Voltage (V)
0,82	11,779
2,13	11,702
2,94	11,668
4,41	12.173
11	11.295
16	11.323
14,3	10.986
23,4	11.318
32,5	11.980
29,5	11.705
31,5	12.179
44	12,012

$$U_l = E_t \times d$$

$$d = 2\pi R_0$$

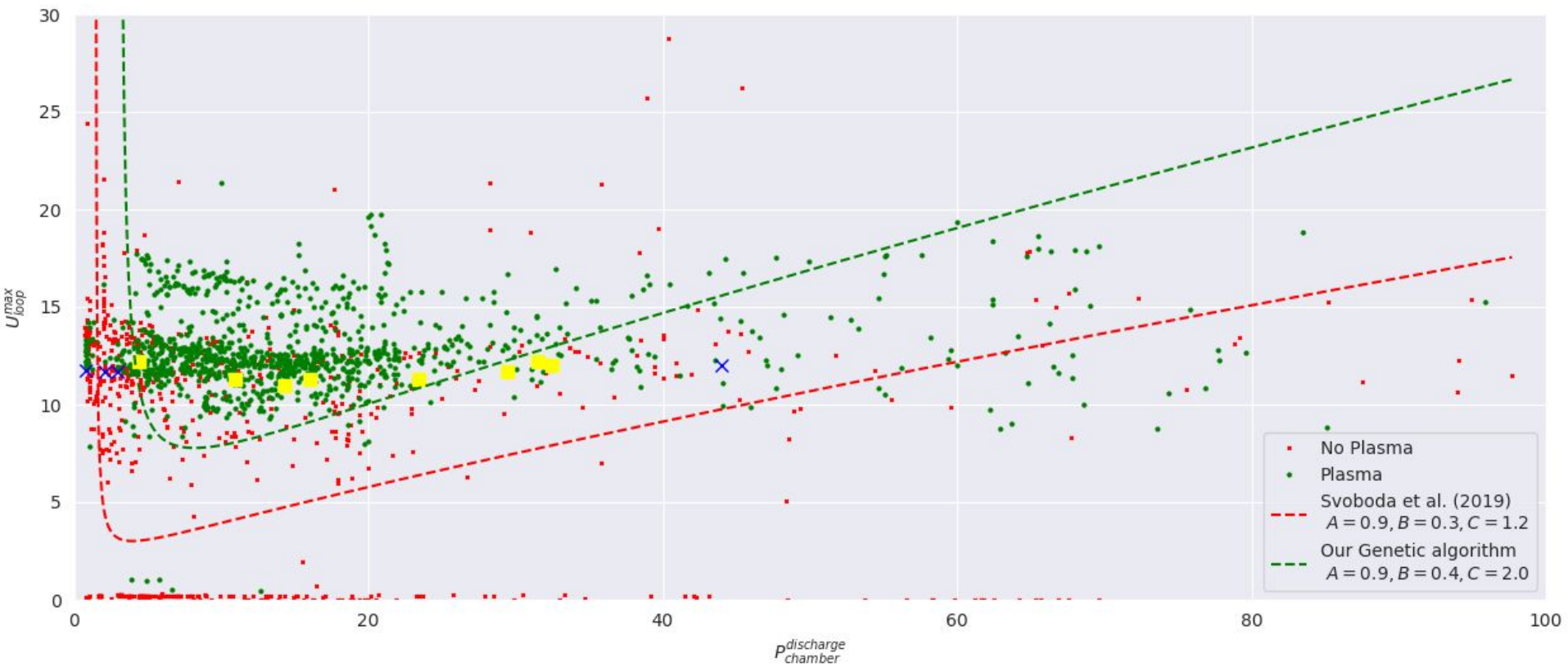


Plasma

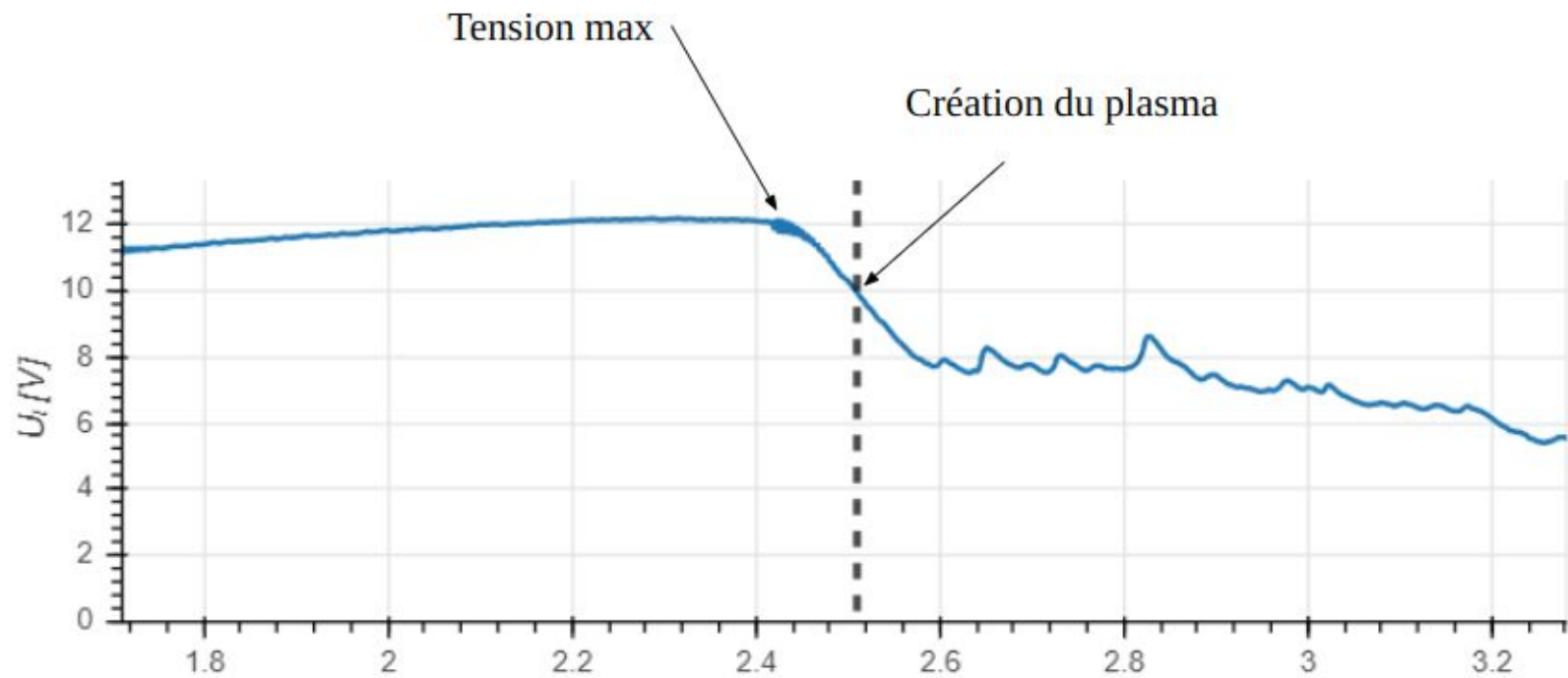


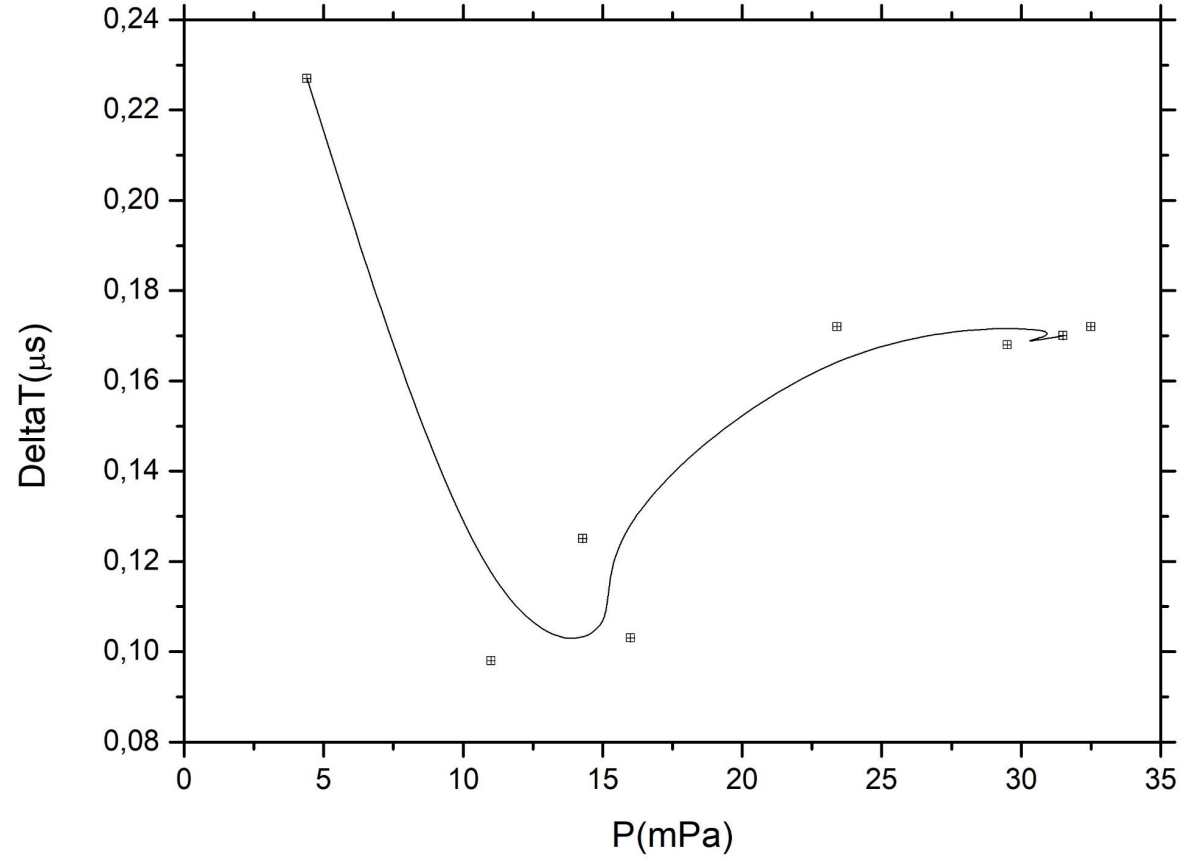
No Plasma

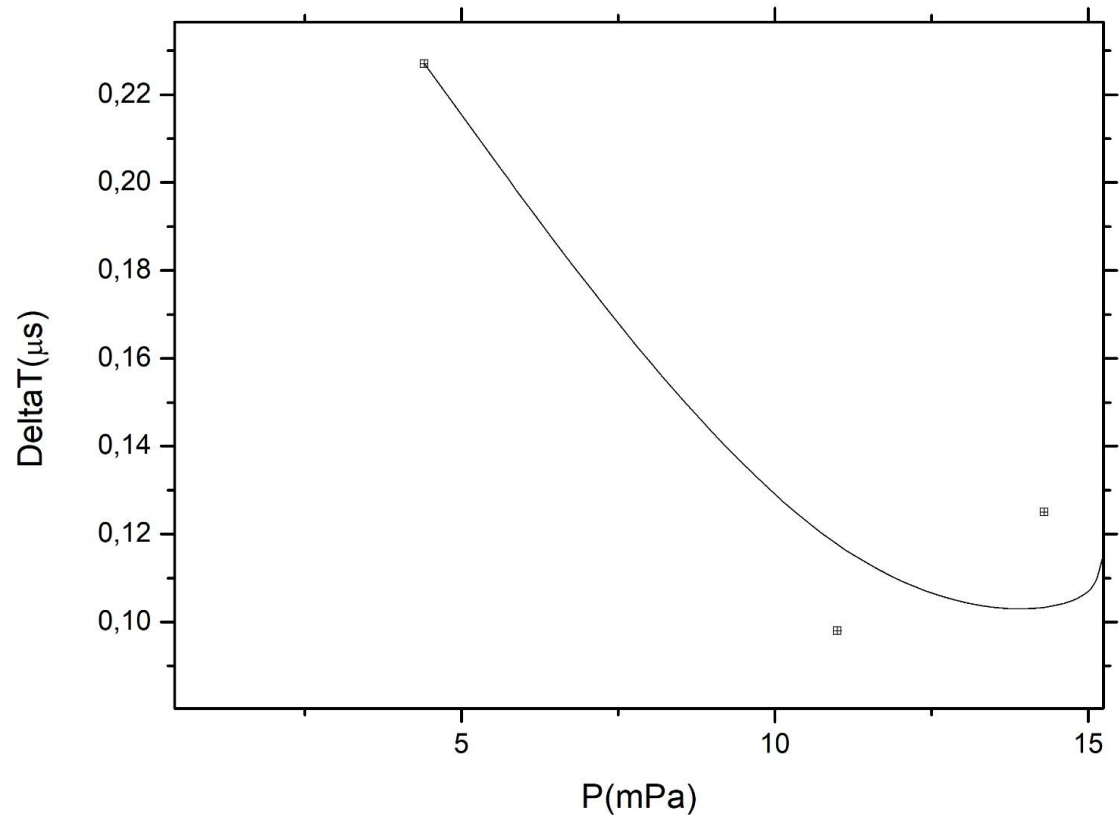


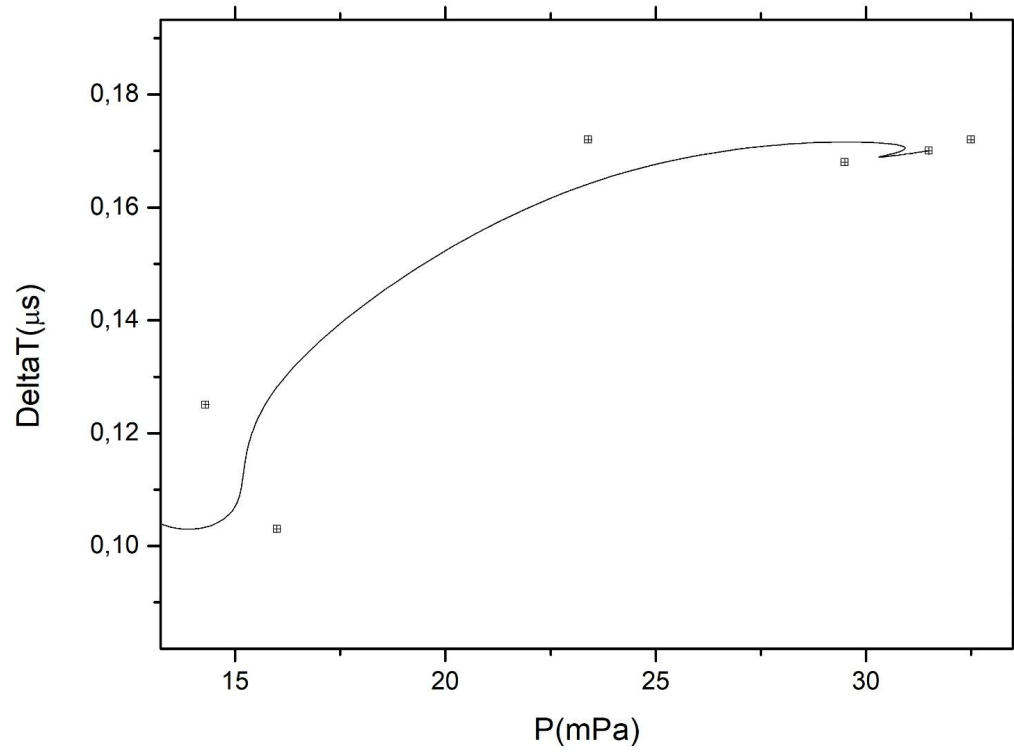


**BONUS: Study of the  $\Delta t = f(p)$**









Thank you