



Dark discharge for investigation of plasma-chemical reactions

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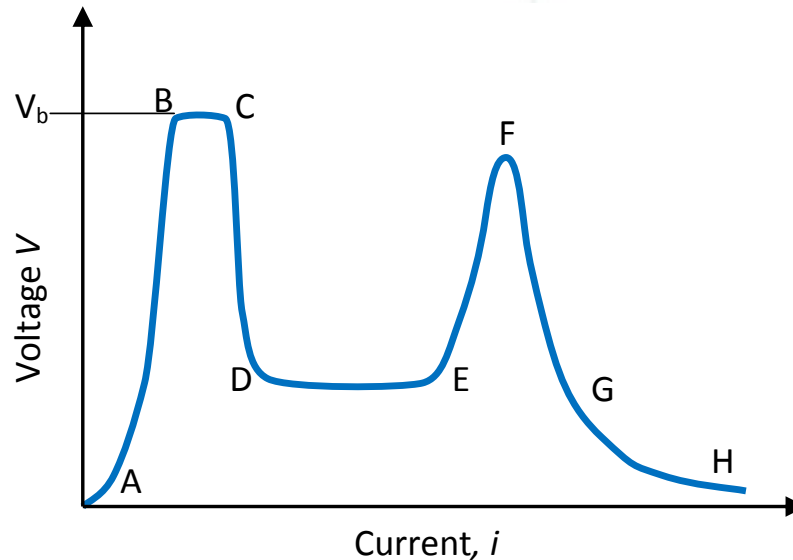


PlasTEP

plasma for environment protection

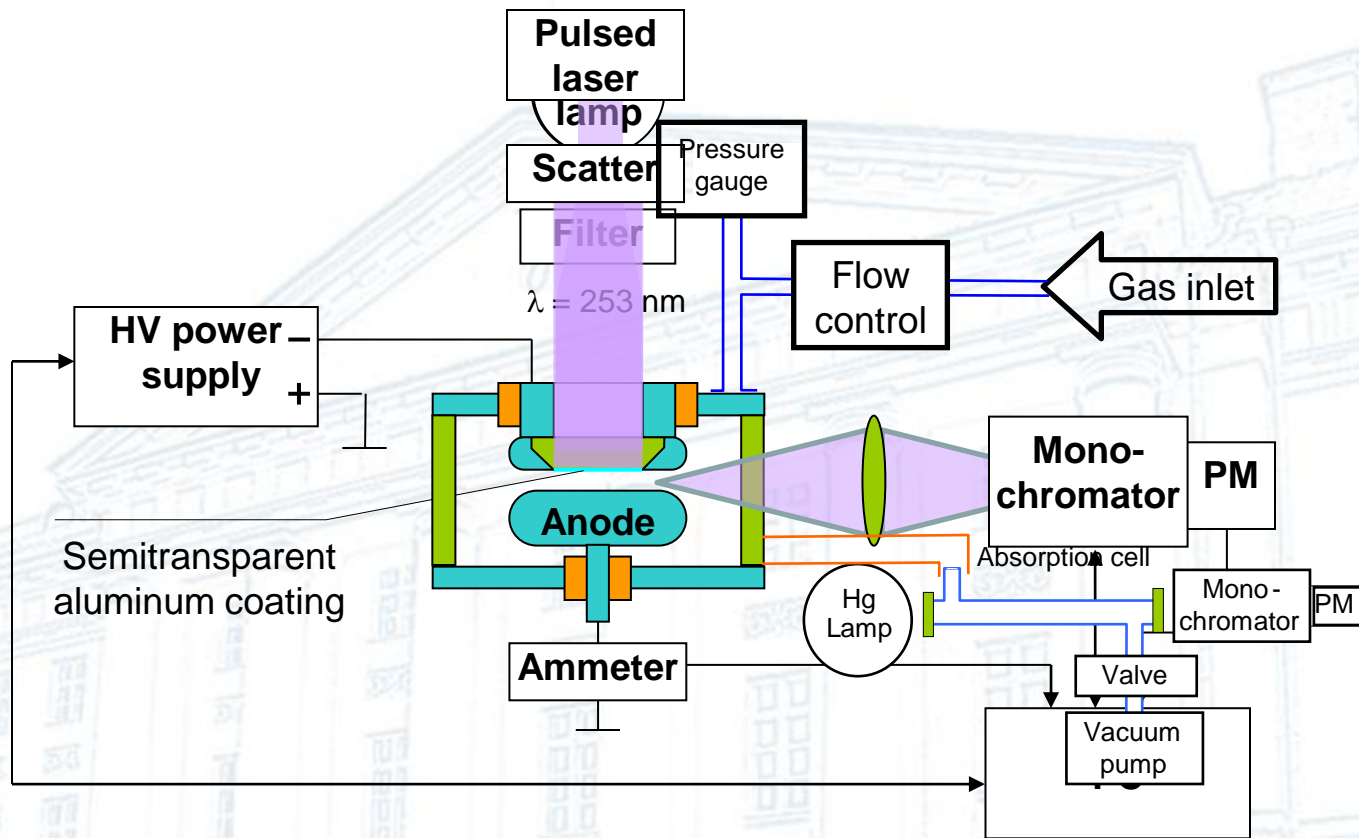
GasDischarges 2010, Greifswald - PlasTEP workshop 9. Sept 2010

V-*i* characteristic of a discharge

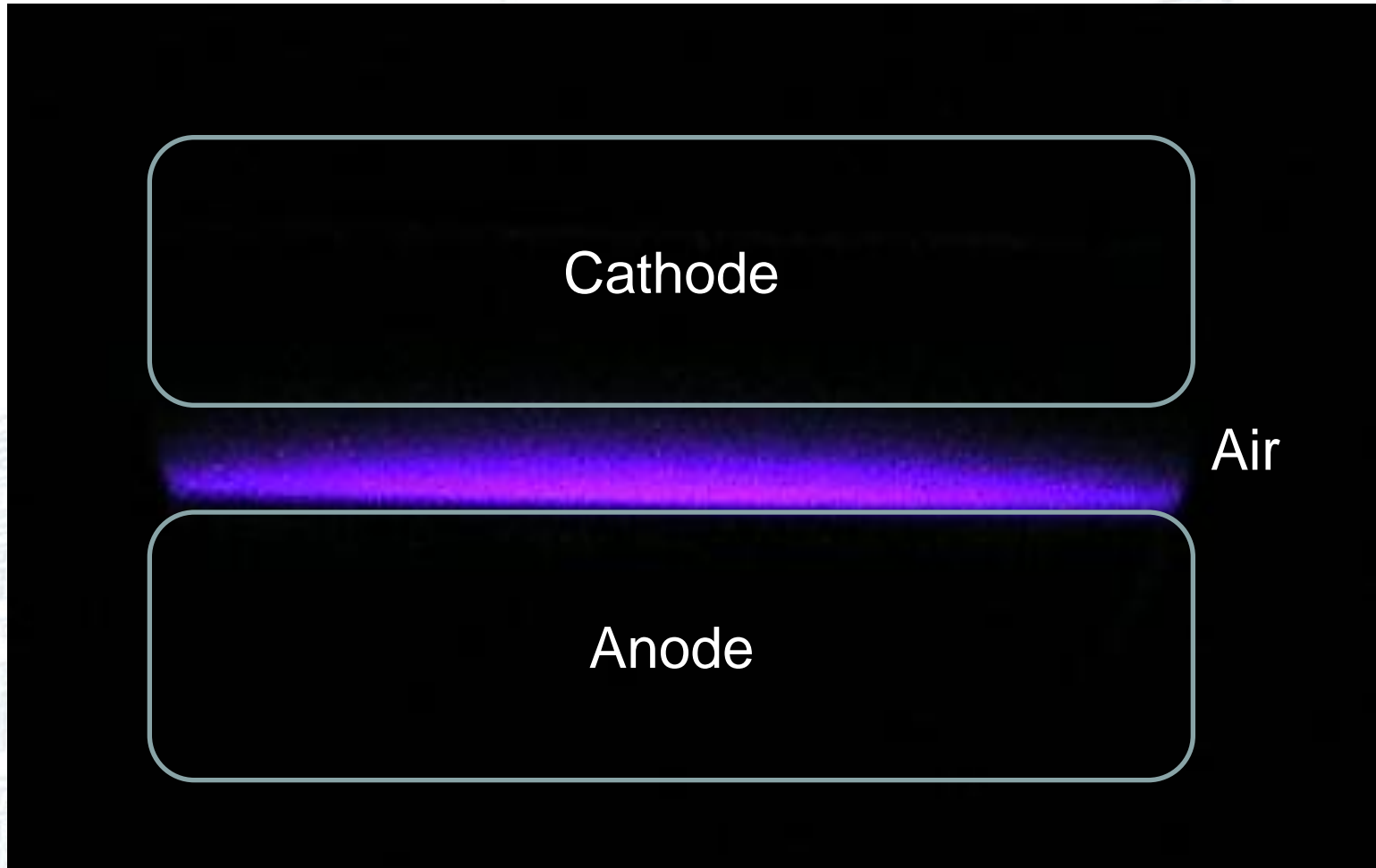


- A-B – non-self-sustained discharge, an external source of electrons is necessary;
- B-C – Townsend dark discharge;
- D-E – normal glow discharge;
- E-F – anomalous glow discharge;
- F-G – transition to arc;
- G-H – arc .

The discharge cell



Original photo of a discharge in air



$p = 50 \text{ kPa}$, diameter of electrodes – 18 mm,
distance between anode and cathode – 2 mm, $i = 10 \text{ } \mu\text{A}$.



Determination of electric field strength in plasmas

A spectroscopic method :
Transitions

- $N_2(C^3\Pi_u, \nu = 0) \rightarrow N_2(B^3\Pi_g, \nu = 0)$
- SPS, $\lambda = 337.1$ nm

and

- $N_2^+(B^2\Sigma^+_g, \nu = 0) \rightarrow N_2^+(X^2\Sigma^+_g, \nu = 0)$
- FNS, $\lambda = 391.4$ nm

The ratio of the intensities of those bands $R_{391/337}$



Determination of electric field strength in plasmas

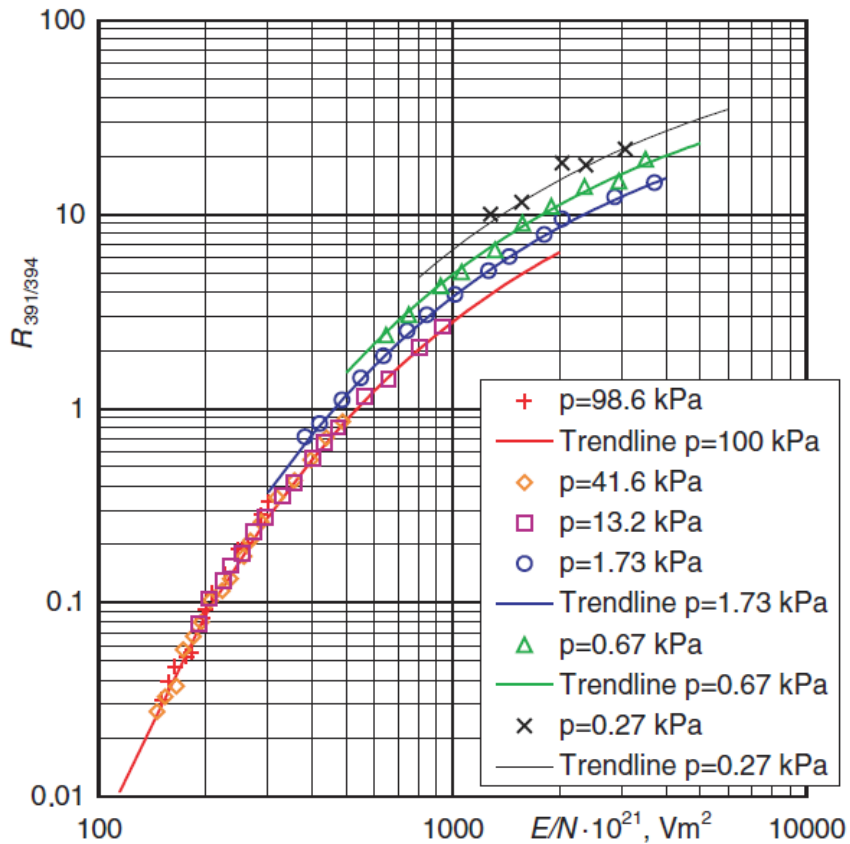


Figure 5. $R_{391/394}$ at different pressures.

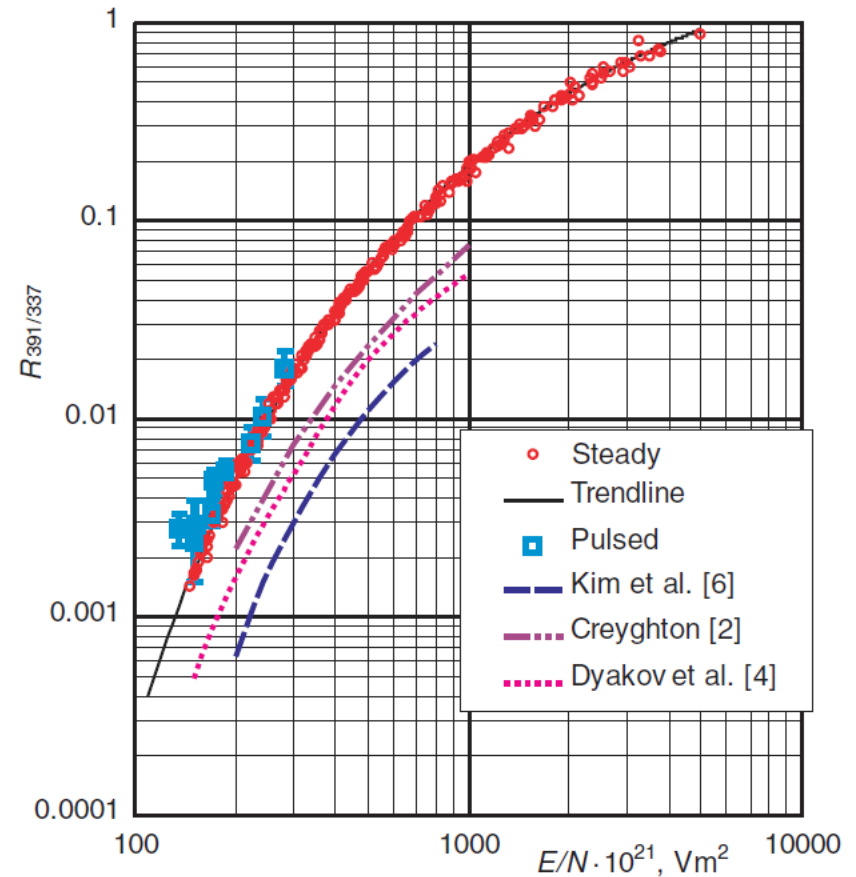
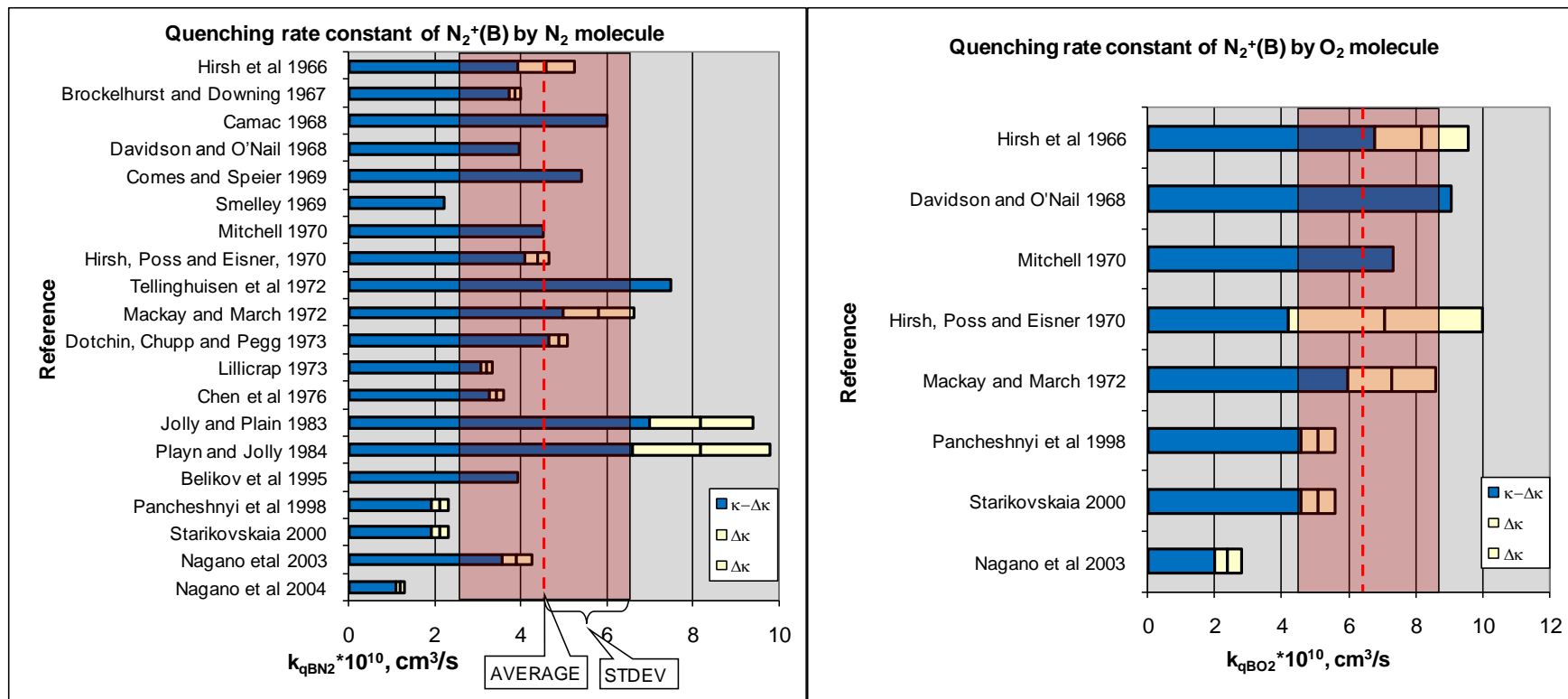


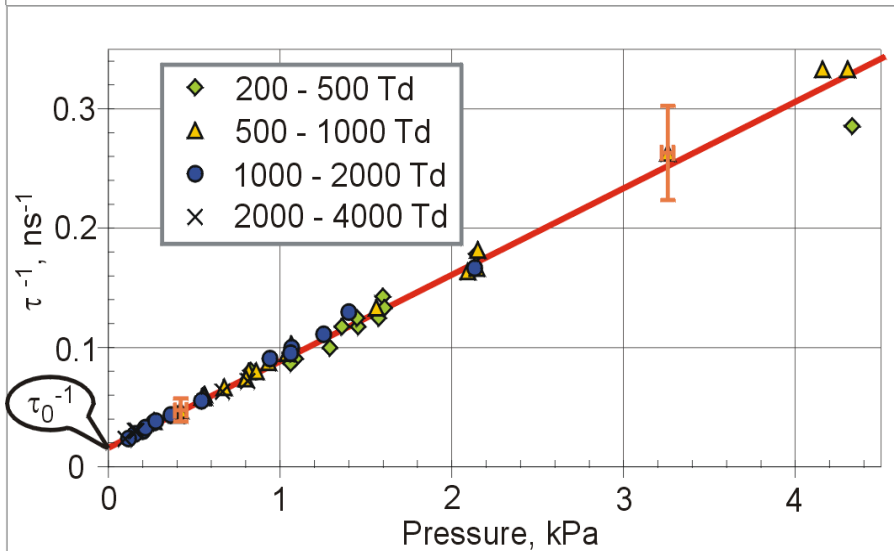
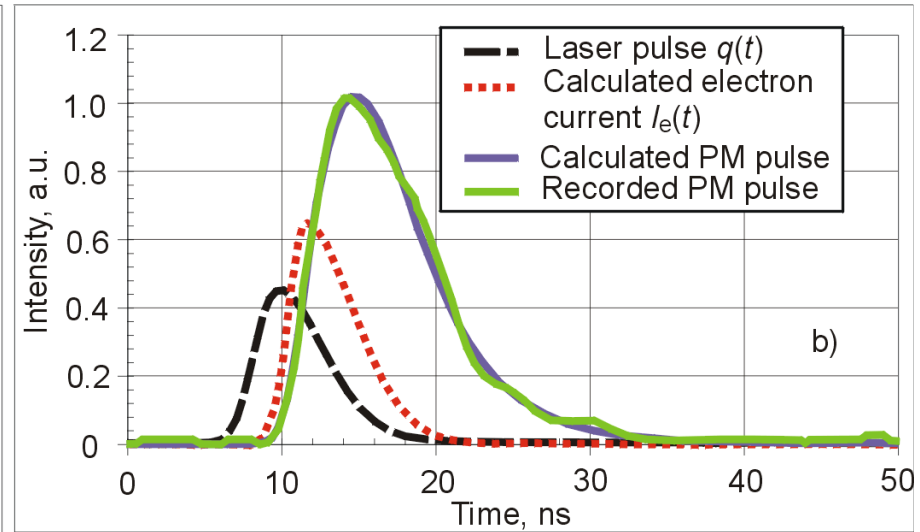
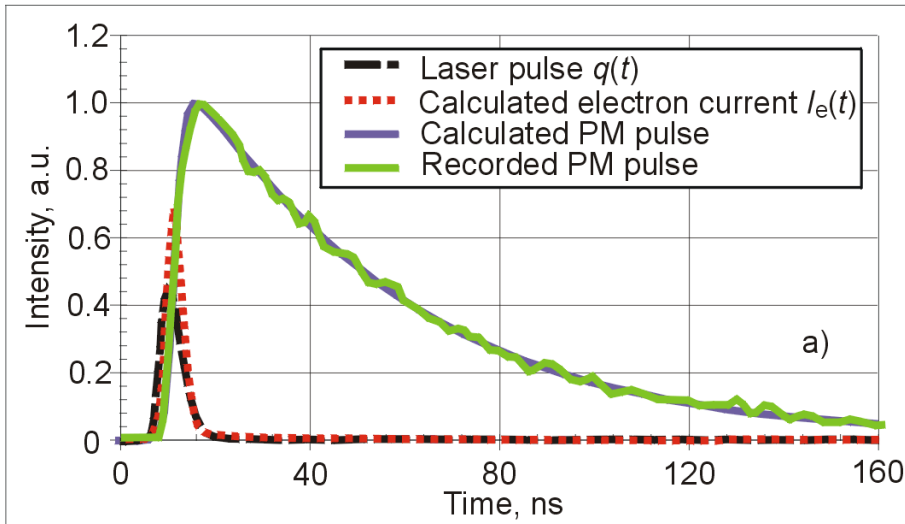
Figure 6. Intensity ratio $R_{391/337}$ of nitrogen bands reduced to standard conditions ($p = 100 \text{ kPa}$ and $T = 0^\circ \text{C}$). Data points—our experiment. Dashed curves—theoretical results of other authors.

Measurement of collisional quenching rates of nitrogen states



Quenching rate coefficients of the state $N_2^+(B)$ obtained by different authors.

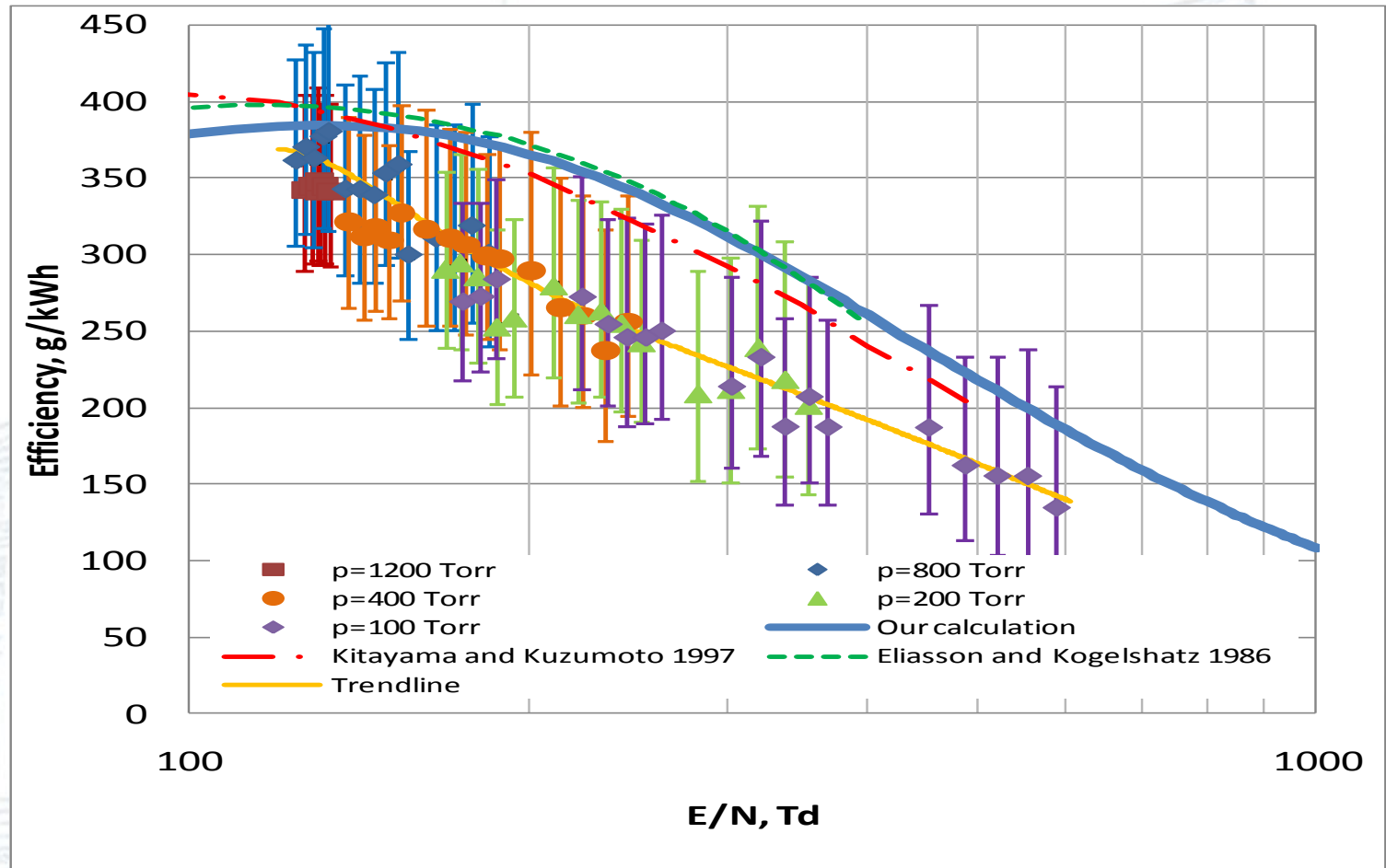
Measurement of collisional quenching rate of B-state of nitrogen ion



Examples of recorded and calculated pulses.

Experimental points registered at different E/N values. $N_2^+(B^2\Sigma_g^+, \nu = 0)$ state

Ozone generation in dark discharge



Ozone generation efficiency in oxygen as a function of E/N at different pressures.



Conclusions

- The unique property of dark discharge is that it enables to relate main characteristics of different plasma-chemical reactions to the electric field strength value.
- We determined experimentally the intensity ratio of spectral bands of N_2 as a function of the electric field strength in a wide region of E/N values.
- It was found that the quenching of the nitrogen ions B-state (FNS) is independent of the electric field strength.
- In case of ozone generation, there is a systematic difference between our experimental results and calculations according to the simplest theoretical model.



Thank you for your attention!

