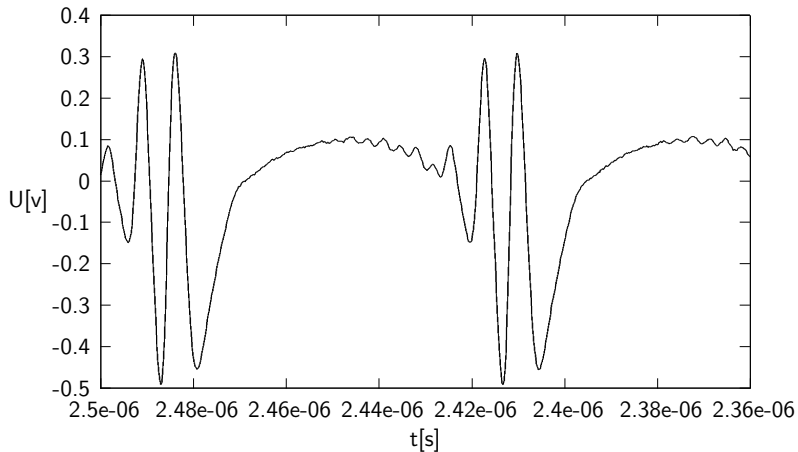


# Higher harmonic frequencies in capacitive discharges and their using for monitoring of plasma processing

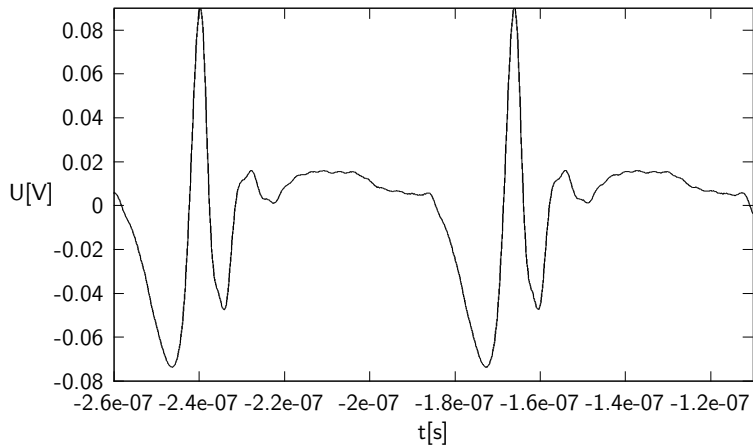
P.Dvořák , V.Buršíková , R. Žemlička

October 31, 2011

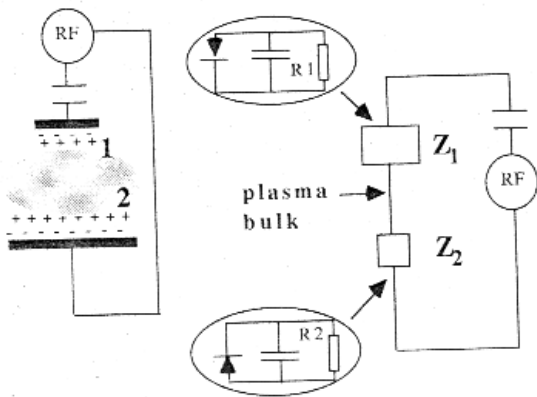
# Waveforms of RF voltage



# Waveforms of RF voltage



# Circuit diagram



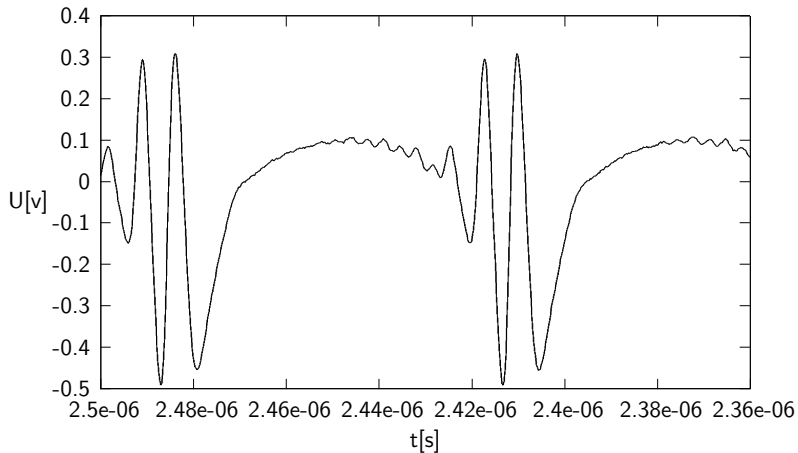
For constant concentration of electrons:

$$j = ne \frac{dD}{dt} \quad (1)$$

$$u = \frac{ne}{2\epsilon_0} D^2 \quad (2)$$

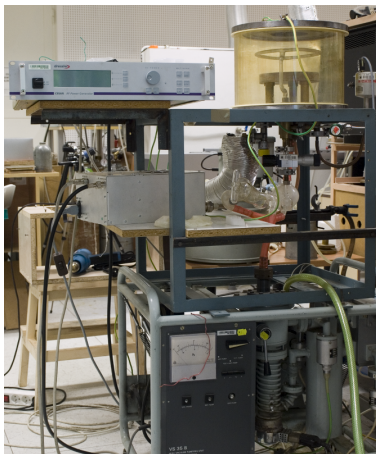
- $j = -D_0 n e \omega \sin(\omega t) \Rightarrow D = D_0(1 + \cos(\omega t))$
- $u = \frac{ne}{2\epsilon_0} D_0^2 (1 + \cos(\omega t))^2 \propto (1 + 2\cos(\omega t) + \cos^2(\omega t))$
- $\cos^2 \omega t = \frac{1}{2} (1 + \cos 2\omega t)$

# Waveforms of RF voltage



$$U(t) = U_0 + \sum_{n=1}^{\infty} U_n \cos(n\omega t - \varphi_n) \quad (3)$$

# Photo of reactor



# Plasma etching: End-point detection.

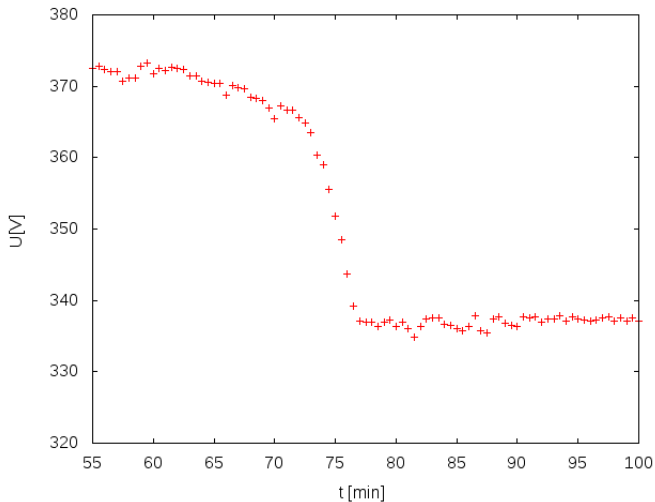
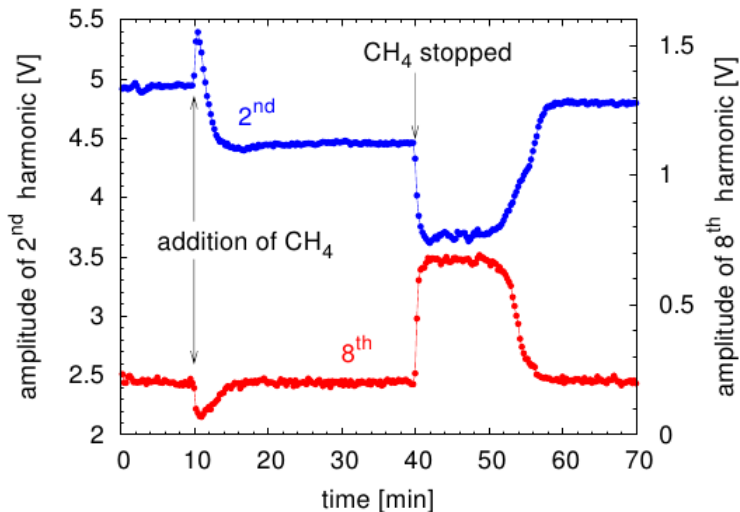


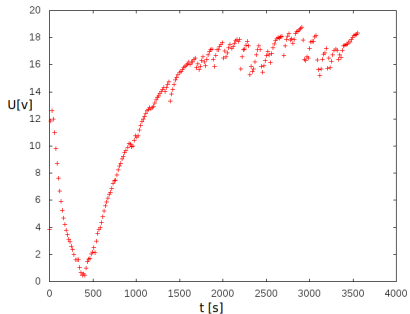
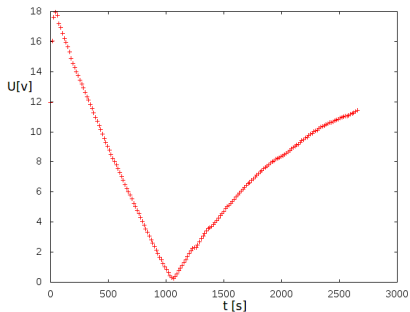
Figure: Fundamental harmonic



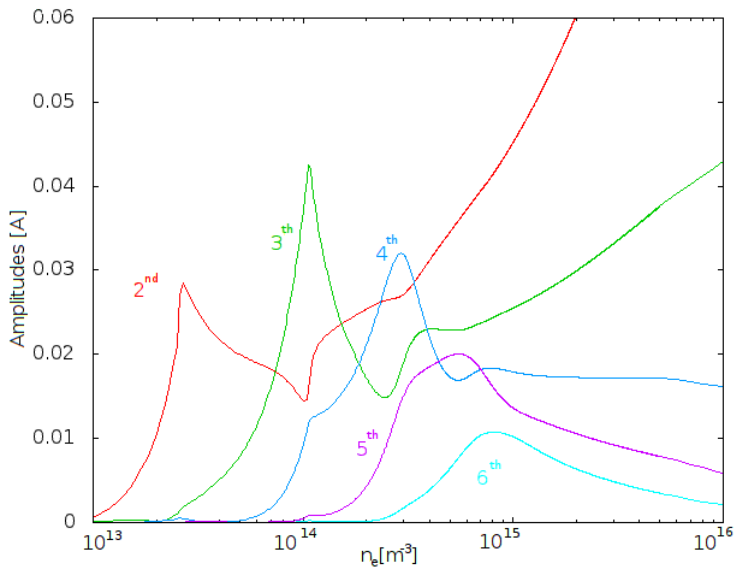
# Monitoring of deposition and etching



# Detection of dust - 3<sup>th</sup> harmonic



# Simulation of higher harmonics



Thank you for your attention