

*Extracting the electron-induced
molecular desorption coefficient using
an electron detector*

Ubaldo Iriso

Many thanks to:

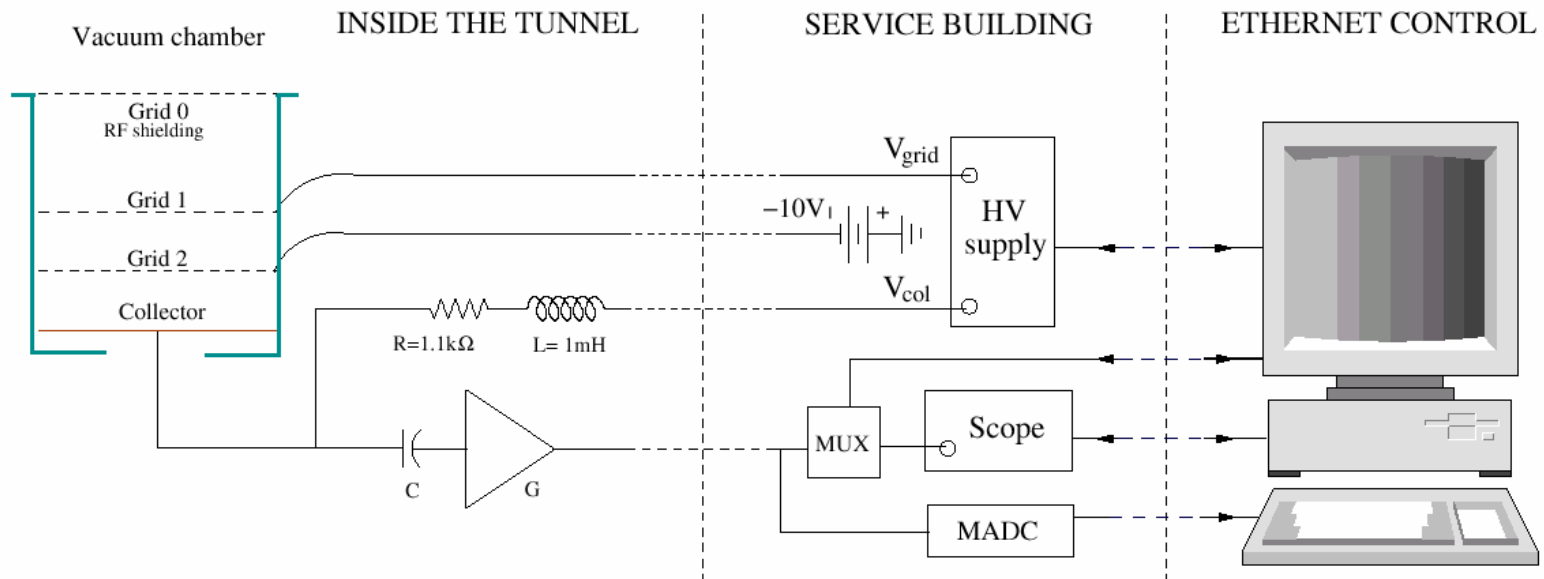
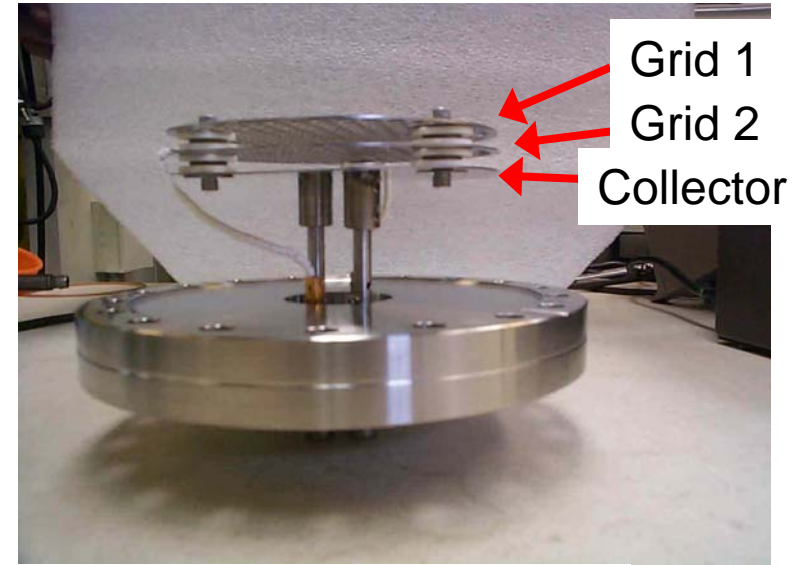
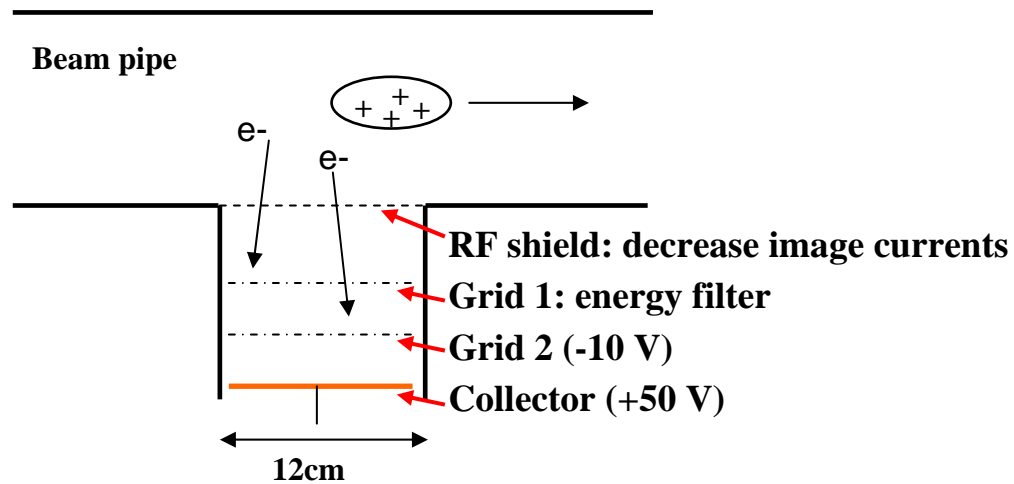
M. Blaskiewicz, A. Drees, W. Fischer, H. Hseuh, S. Peggs, G. Rumolo,
R. Tomás, P. Thieberger, and S.Y. Zhang

Contents

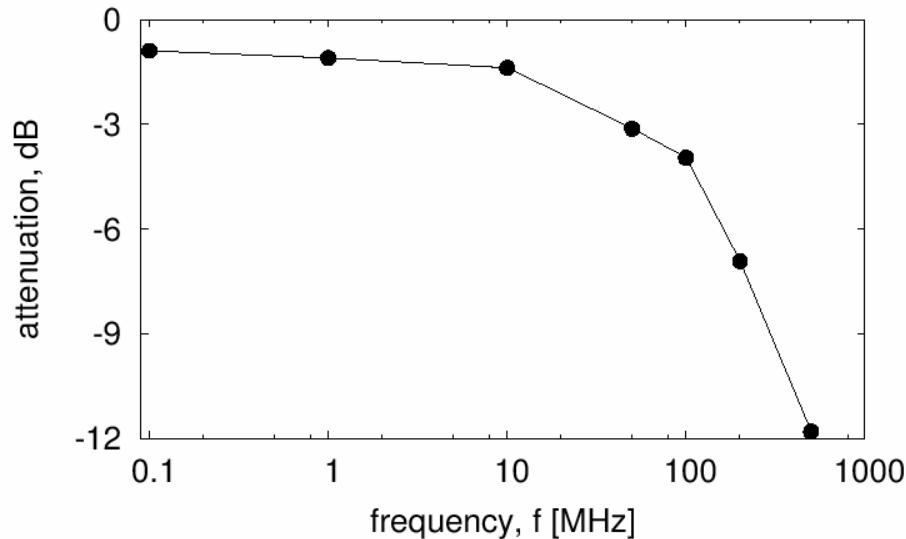
- 1. Introduction**
 - a) Calibration of the RHIC e-detector**
 - b) Snapshot examples**
- 2. Electron-induced molecular desorption**
- 3. Evolution of η_e for baked and unbaked surfaces**
- 4. Electron energy spectrum**
- 5. Conclusions**

1. Introduction

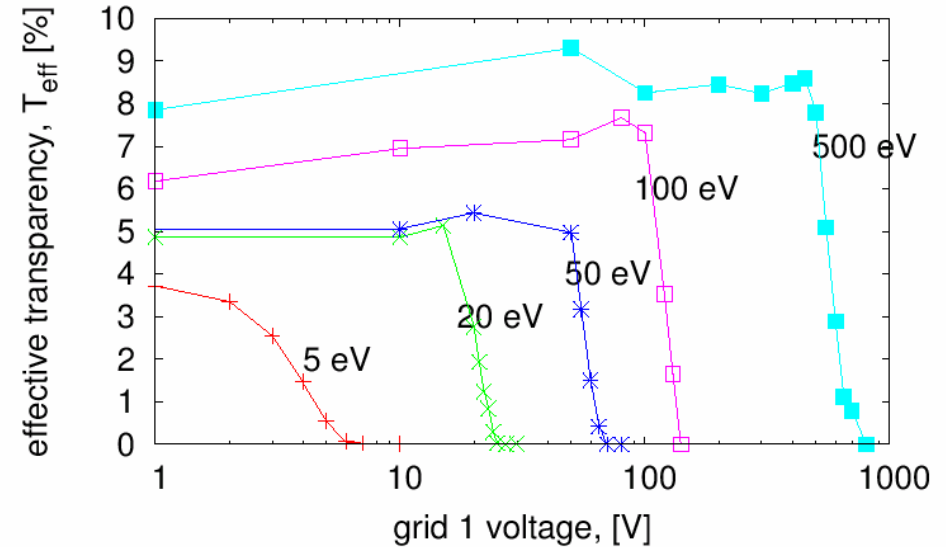
- Electron detector at RHIC (very similar to APS, SPS, KEK...)



1.a. Calibration of the RHIC e-detector



Bandwidth calibration of the ED
 → the system electronics and/or cable length does not affect the signal below 50MHz (3 dB limit)



Electron detector transparency*:
 → % of electrons that traverse all the grids and can reach the collector

→ These two calibrations provide the e- flux to the wall for a given ED voltage

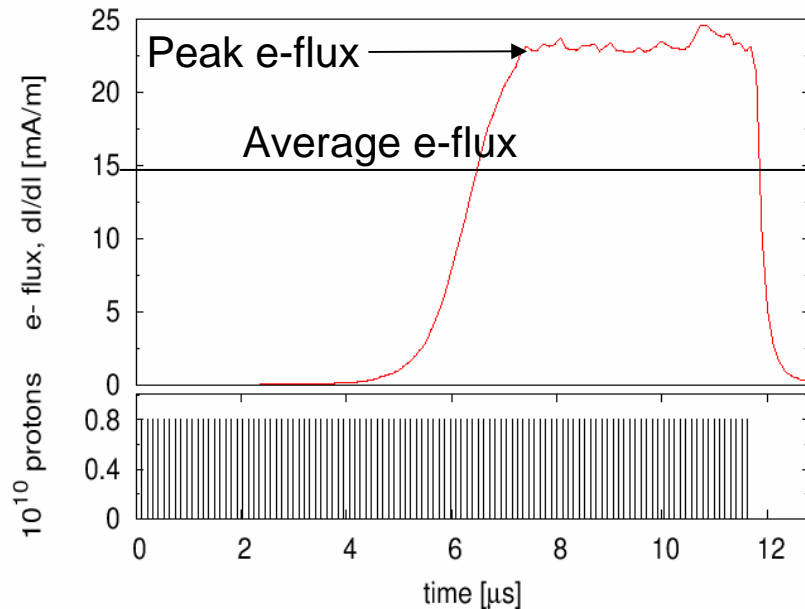
$$\frac{dI}{dA} = \frac{V}{ZGA_{ED}T_{eff}}$$

Z : line impedance
 G : amplifier gain
 A_{ED}: ED surface
 T_{eff} : effective transparency

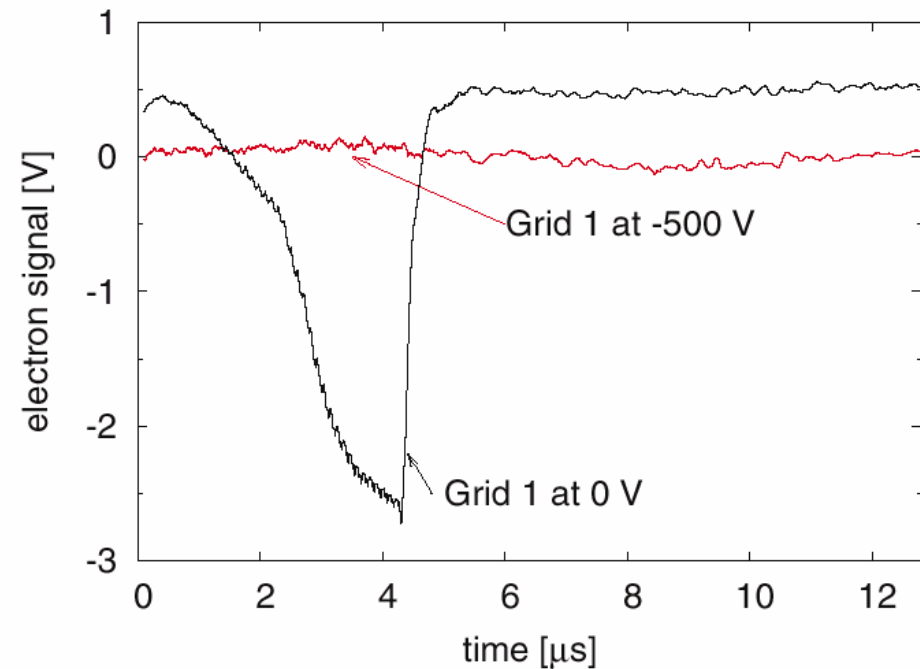
See *P. He et al, TPAG004, PAC'03.

1.b. Snapshot examples:

Simulation of an e-cloud build up:



Polarizing 'grid 1' filters e- energy:



- Distinguish between peak e- signal and average e-signal
- Filter electron energy

2. Electron induced molecular desorption

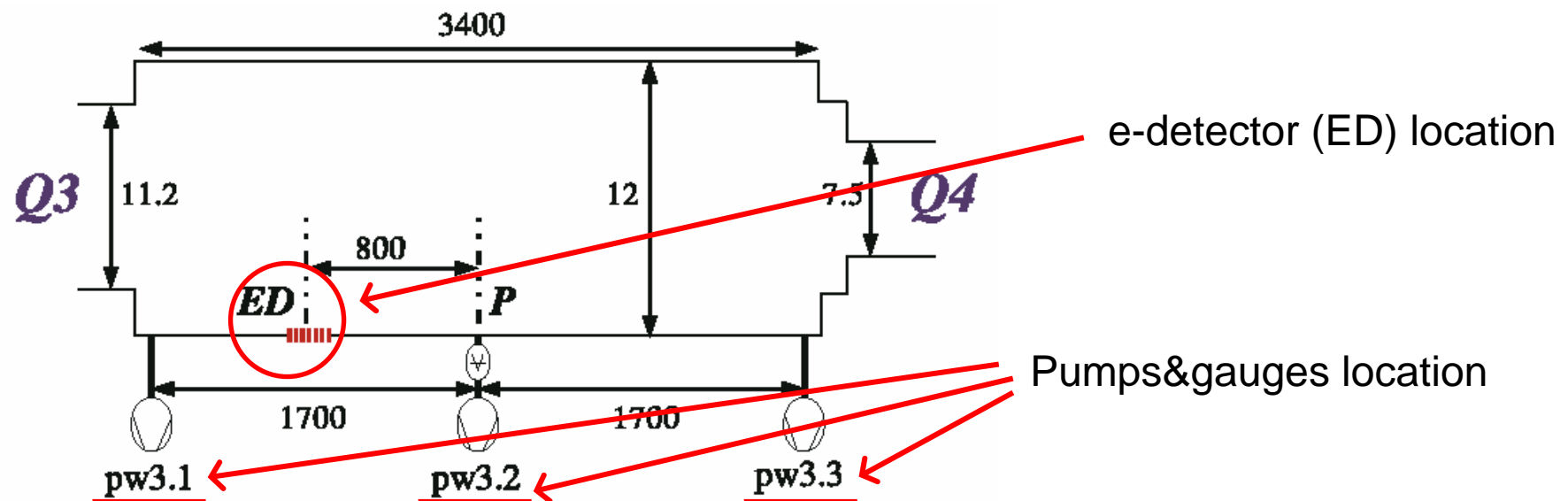
The pressure in presence of an e-cloud*:

$$P(z) = P_0 + \eta_e \frac{kT}{e} \left\langle \frac{dI}{dl} \right\rangle_{\tau} \left[\frac{2Lz - z^2}{2c} + \frac{L}{S} \right]$$

$\left\{ \begin{array}{l} \eta_e = \# \text{ molecules / electron} \\ \langle dI/dl \rangle = \text{linear electron flux to the wall,} \\ \text{time averaged over one turn} \\ 2S = \text{pumping speed} \end{array} \right.$

- ➔ Assuming a periodic structure (pumps spaced by 2L)
- ➔ z origin at a vacuum pump location

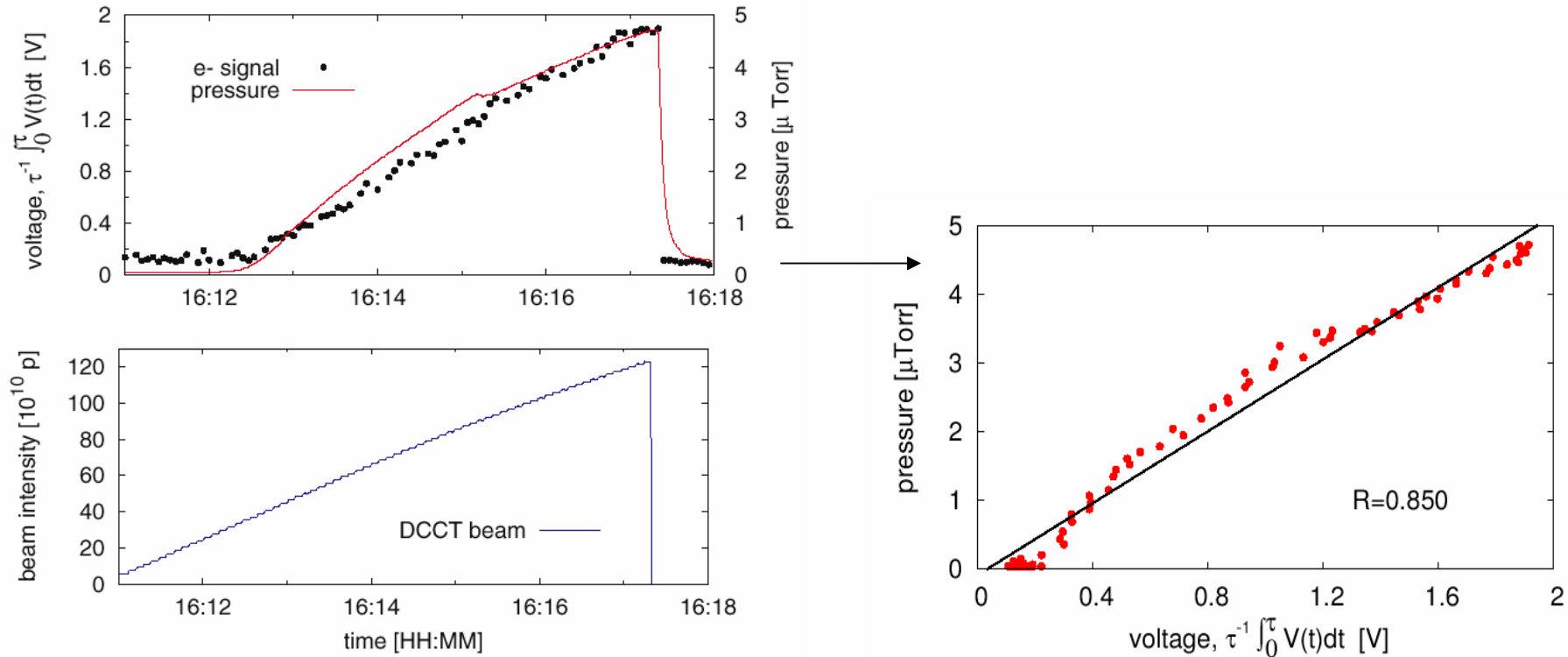
Experimental setup at BO2 in RHIC (unbaked stainless steel):



*See U. Iriso and W. Fischer, PRST-AB, 8, 113201, 2005

2. Electron induced molecular desorption

Evolution of the average flux and pressure during electron clouds at BO2



Using a simple linear regression, infer desorption coefficient η_e .

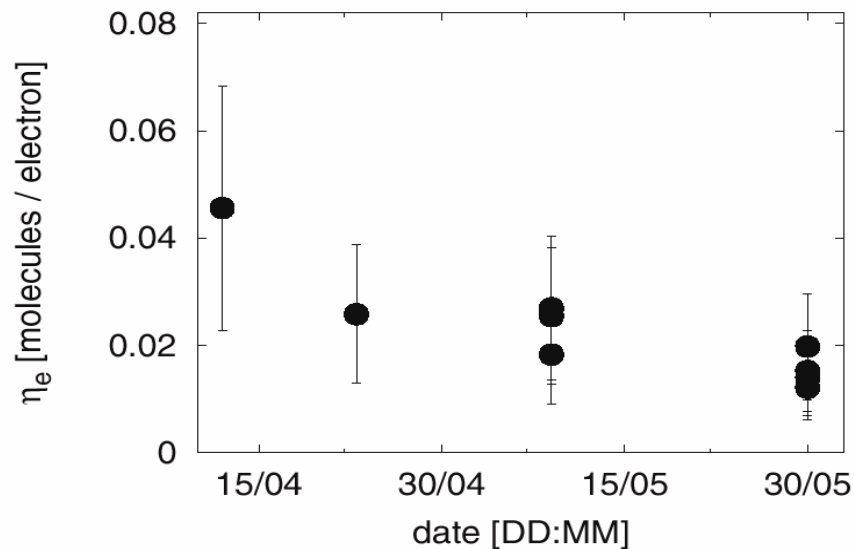
In this case, $\eta_e = 0.01 \pm 50\%$.

(error stems from the uncertainty in pressure readings and pumping speed values)

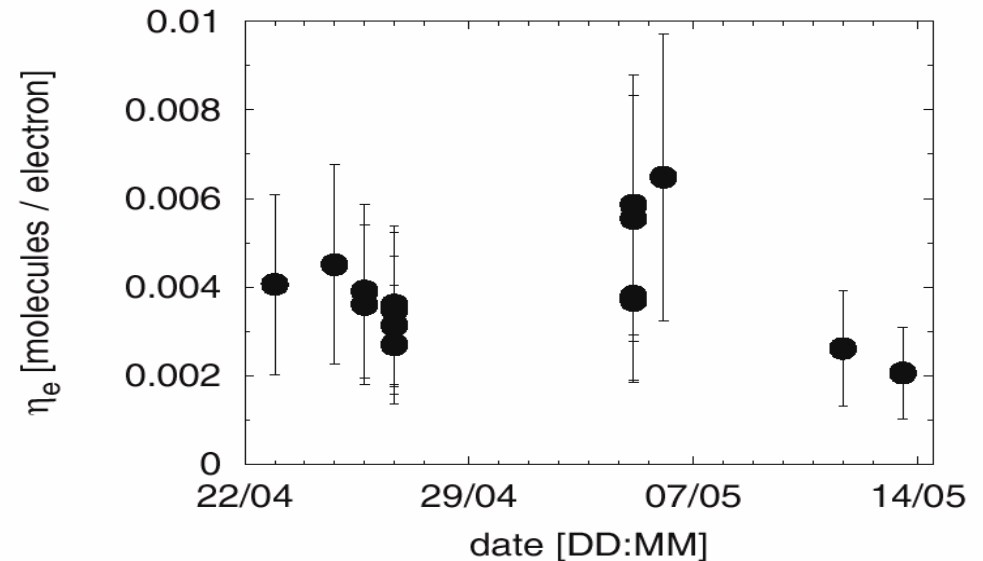
3. Evolution of η_e for baked and unbaked stainless steel

- Following the evolution of $\eta_e \rightarrow$ evaluation of the surface conditioning

Unbaked stainless steel (“BO2”)

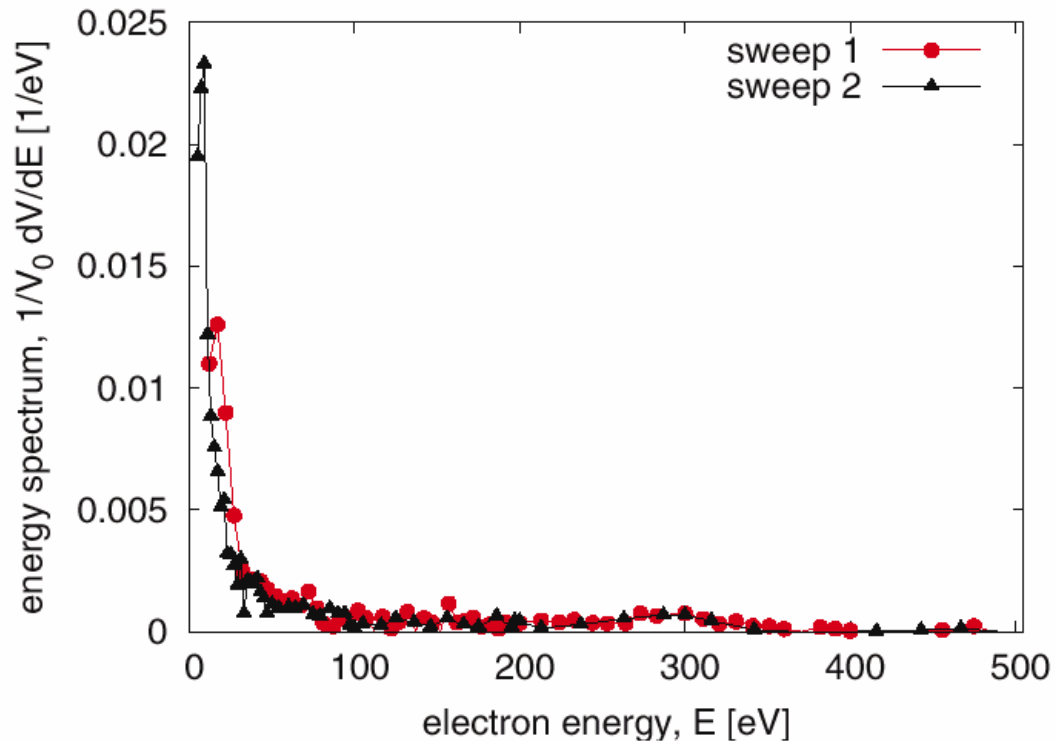


Baked stainless steel (“IR12”)



- Unbaked stainless steel suffers small conditioning.
- Baked surfaces do not seem to suffer any scrubbing (low energy e-, low flux, or both)

4. Energy spectrum



Since the desorption coefficient depends a lot on the electron impact energy, it is relevant to characterize the energy spectrum.

$\langle N_b \rangle \sim 1.6e11$ protons/bunch
bunch spacing = 107ns
45 bunches in the machine

- Large peak of low energy e^- (~ 10 eV)
- Spectrum extends up to ~ 300 eV – upper limit cannot be precisely determined because of the high ED noise.

5. Conclusions

- A proper calibration of the ED allows to infer the electron flux into the wall
- Using the pressure and ED readings, the desorption coefficient is inferred for both baked and unbaked surfaces.
- Baked η_e are about an order of magnitude lower than unbaked η_e , and results are consistent with laboratory measurements
- The electron energy spectrum during multipacting extends up to $\sim 300\text{eV}$ (low fraction). The spectrum shows a large peak at low energy ($\sim 10\text{eV}$).