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EPS 26
PLASMA PHYSICS EDINBURGH

O-308

Surface Dielectric Barrier Discharge characterization based on Mass Spectrometry diagnostic techniques

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Aims and motivations

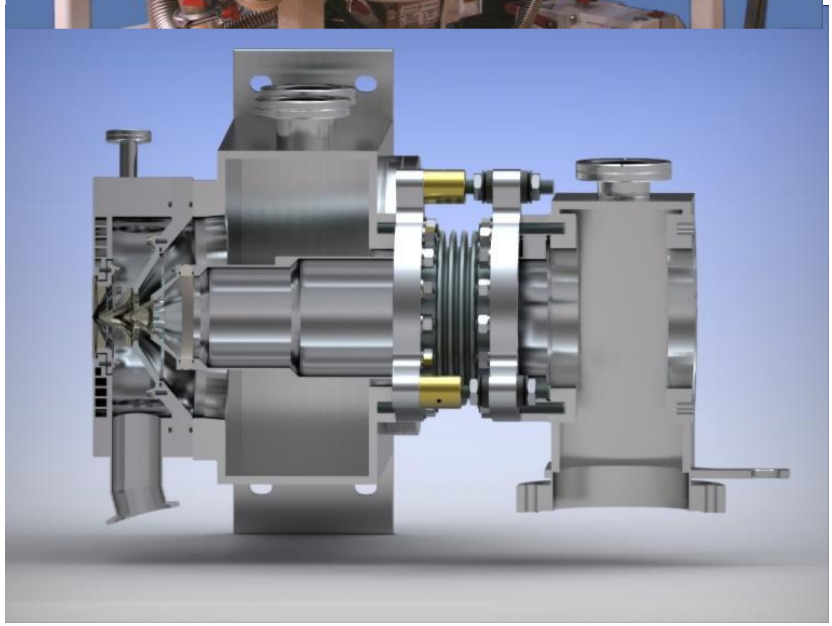
- Plasma processing has many important applications in microelectronics, optics, material protection, packaging, environment and health.
- Process control requires suitable diagnostics to probe directly the plasma gas-phase.
- Plasma gas-phase characterization would allow better understanding of the process conditions and help the optimization of the plasma treatments.
- Air sanitizarion could be achieved by devices producing plasma on the surfaces where it comes in contact with.

Study of the plasma state in Surface Dielectric Barrier Discharges

Mass spectrometry

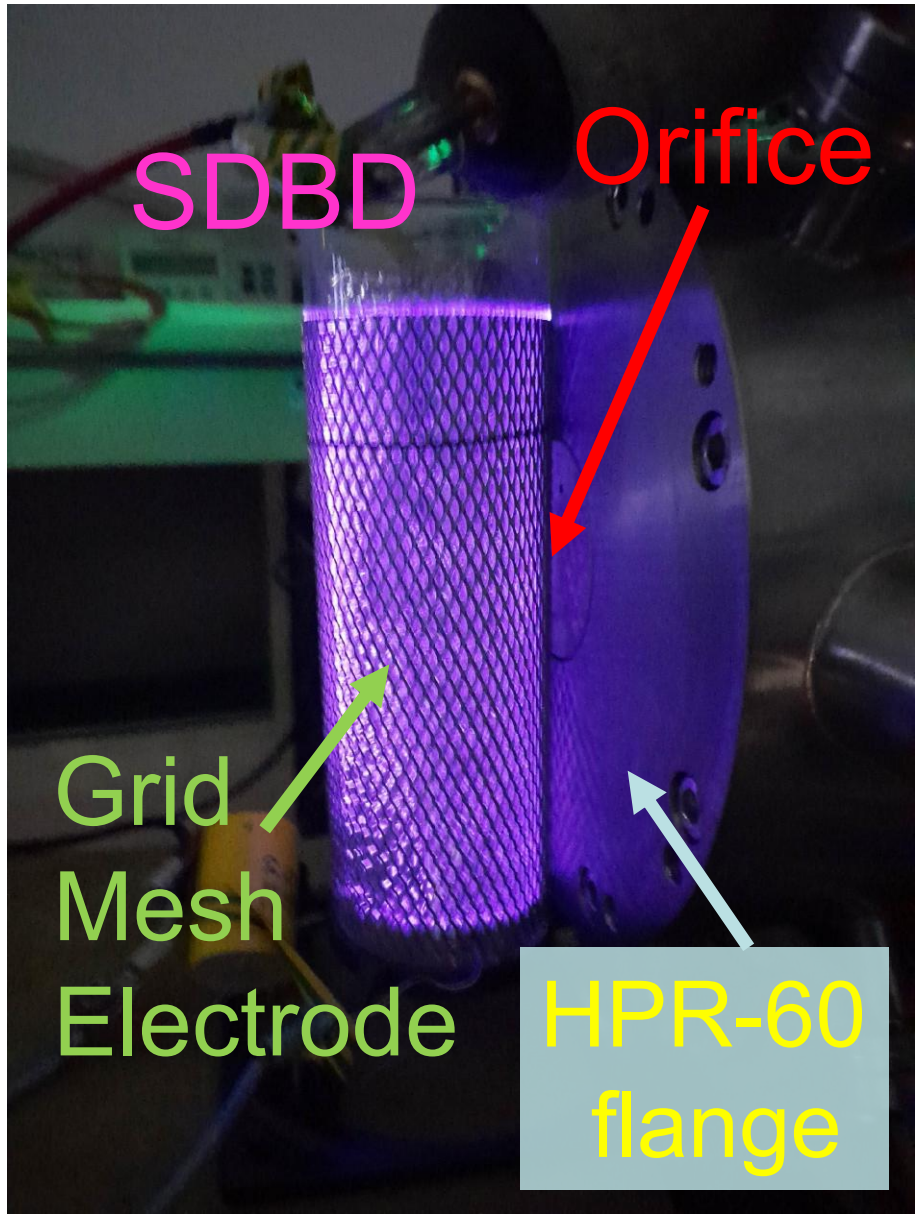
Information on neutral and charged species concentration in the discharge region has been obtained through an HPR-60 spectrometer by Hiden. It allows real-time sampling of neutrals and positive/negative ions from atmospheric pressure plasmas as well as measurements of the energy distribution of ions.

The sampling orifice (200 um) at the center of the disk cap, can be placed directly in contact with discharge area

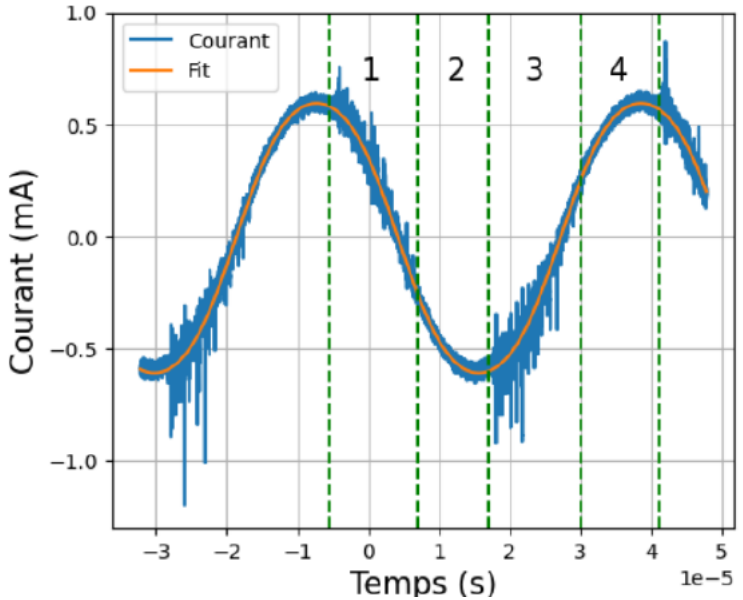


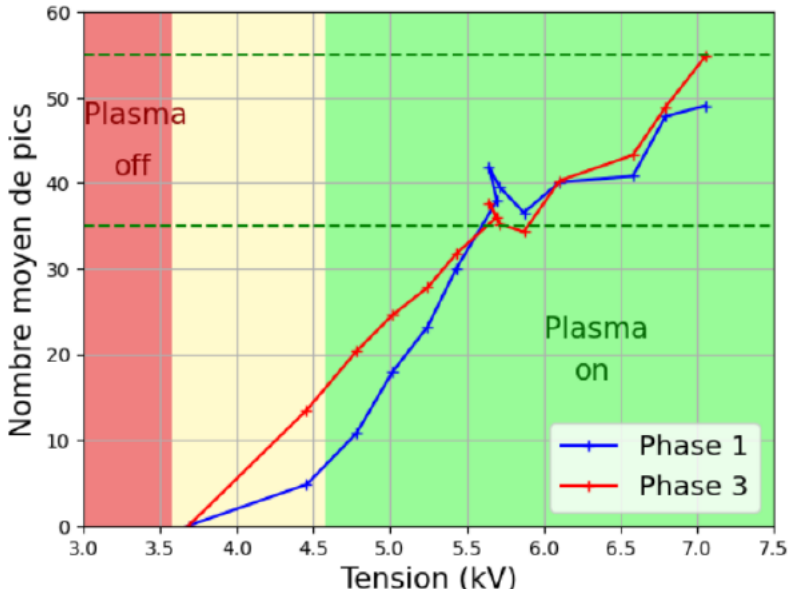
SDBD plasma device

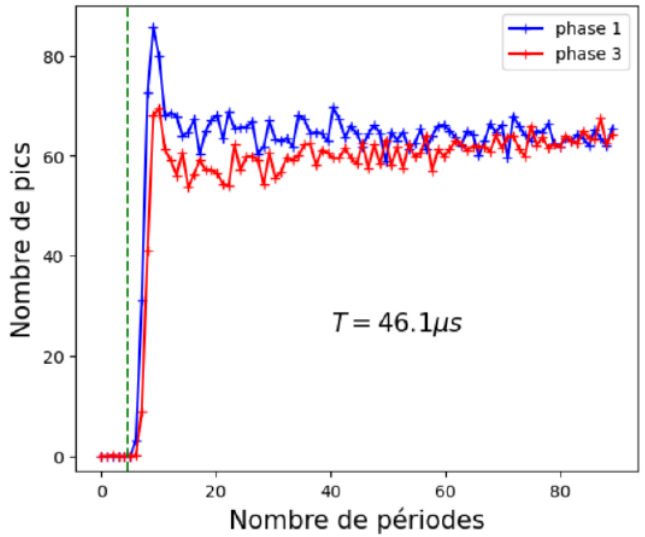
Plasma is produced on a cylindric pyrex surface covered by a stainless-steel grid. Inside the cylinder a stained copper tape is glued and driven by a HV signal fed by an almost resonant **AC transformer**.
A pattern of discharges sets in, going between the grid wires and the mesh rhomboidal holes of exposed glass and vice versa, in every AC cycles.
Amplitude and frequency of the HV controls the discharge number and some properties of the plasma gas-phase

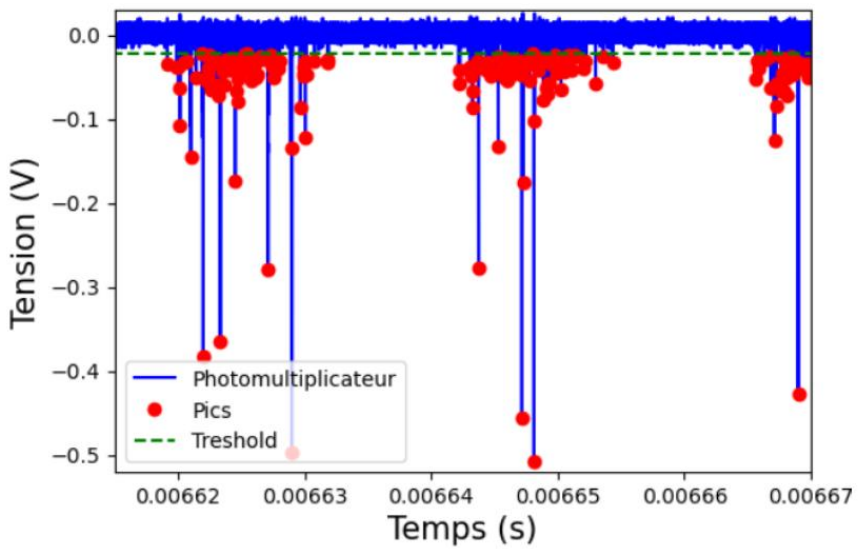


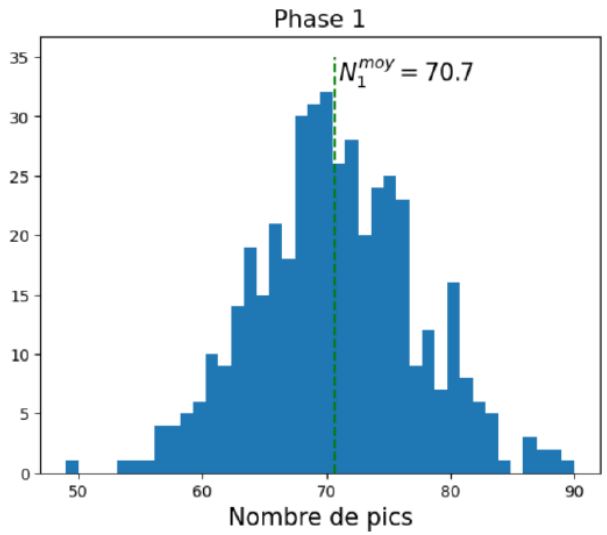
Plasma Properties

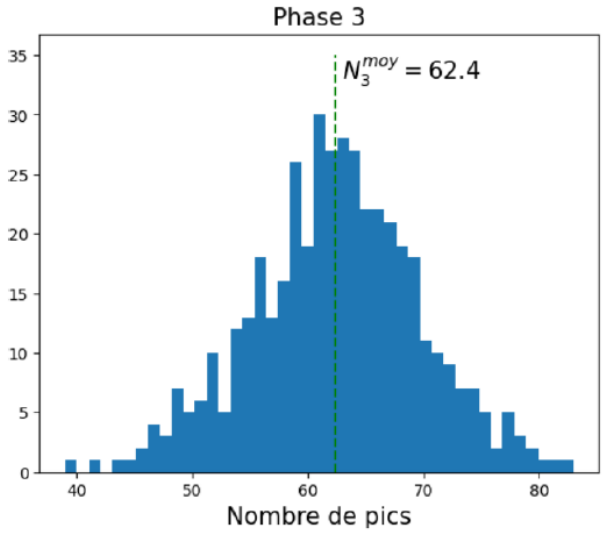




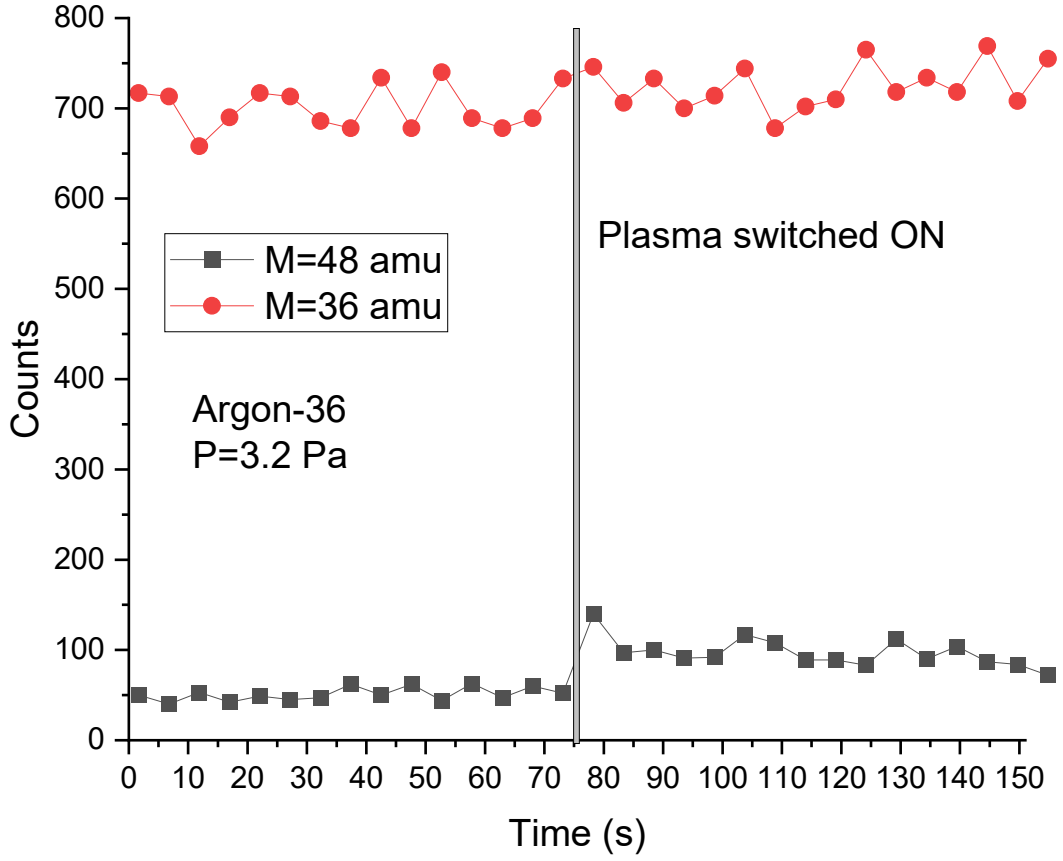


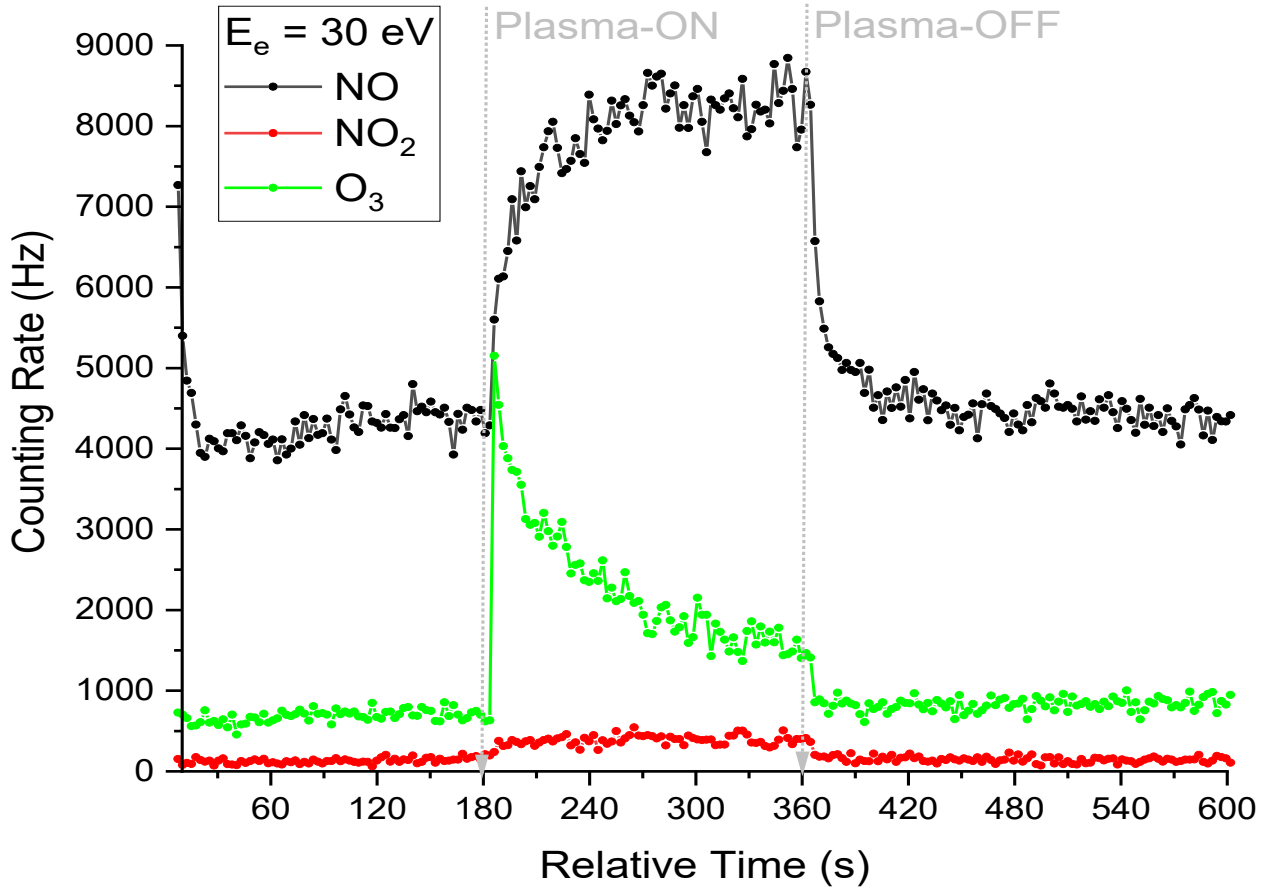






Neutral Molecules

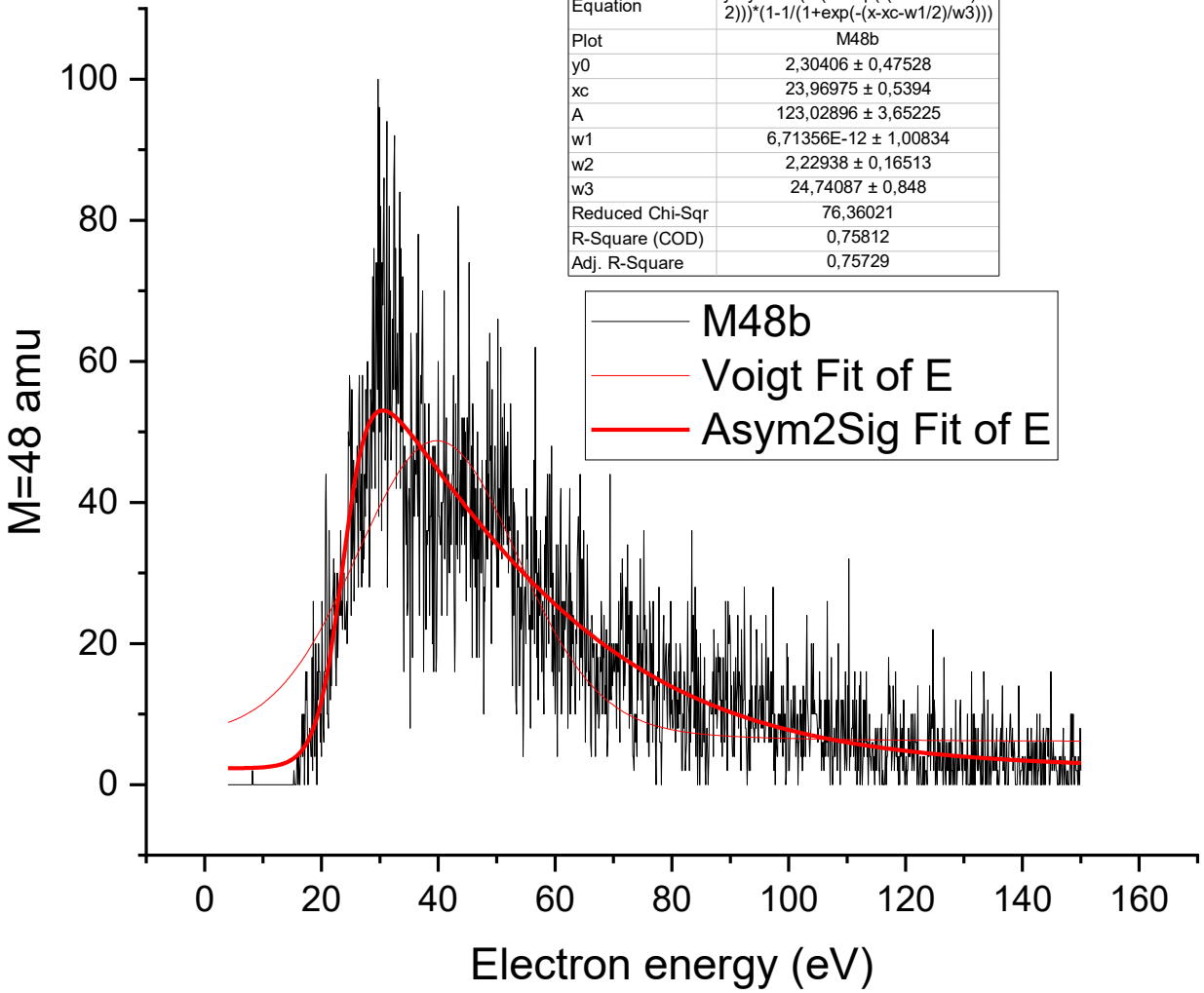


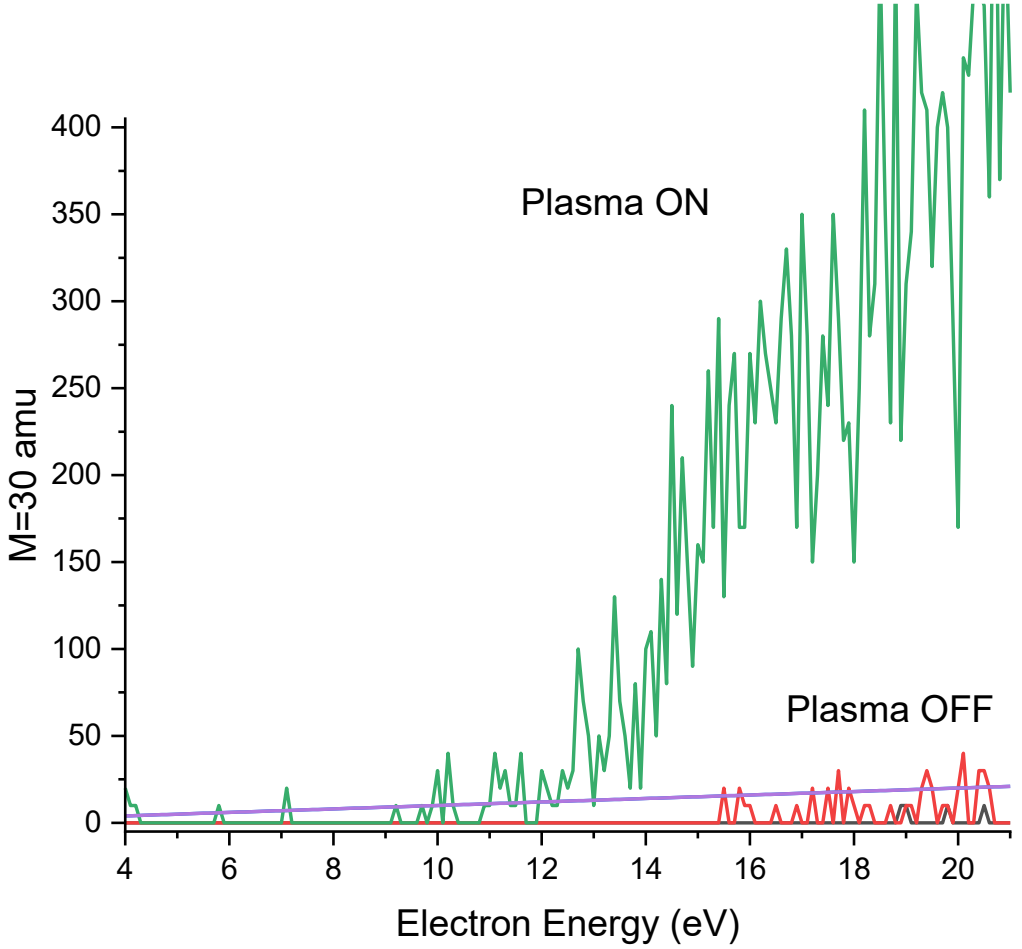


Sensitivity reaches sub-ppm levels

Neutral Molecules

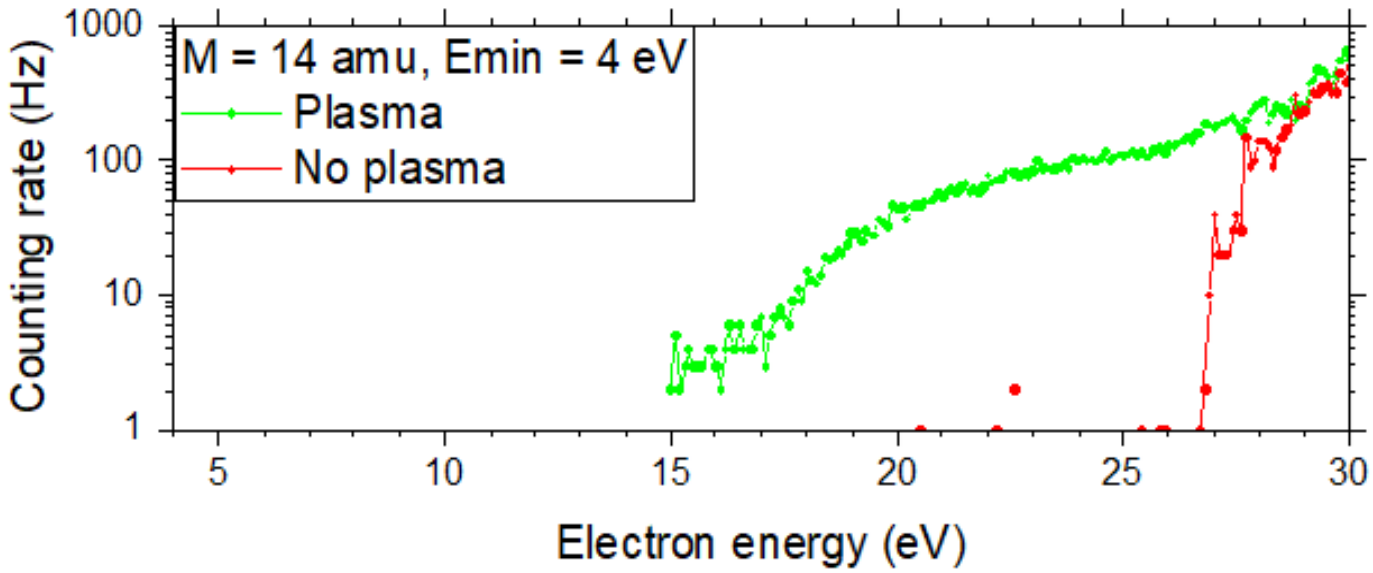
Model	Asym2Sig
Equation	y =y0+ A*(1/(1+exp(-(x-xc+w1/2)/w2)))*(1-1/(1+exp(-(x-xc-w1/2)/w3)))
Plot	M48b
y0	2,30406 ± 0,47528
xc	23,96975 ± 0,5394
A	123,02896 ± 3,65225
w1	6,71356E-12 ± 1,00834
w2	2,22938 ± 0,16513
w3	24,74087 ± 0,848
Reduced Chi-Sqr	76,36021
R-Square (COD)	0,75812
Adj. R-Square	0,75729

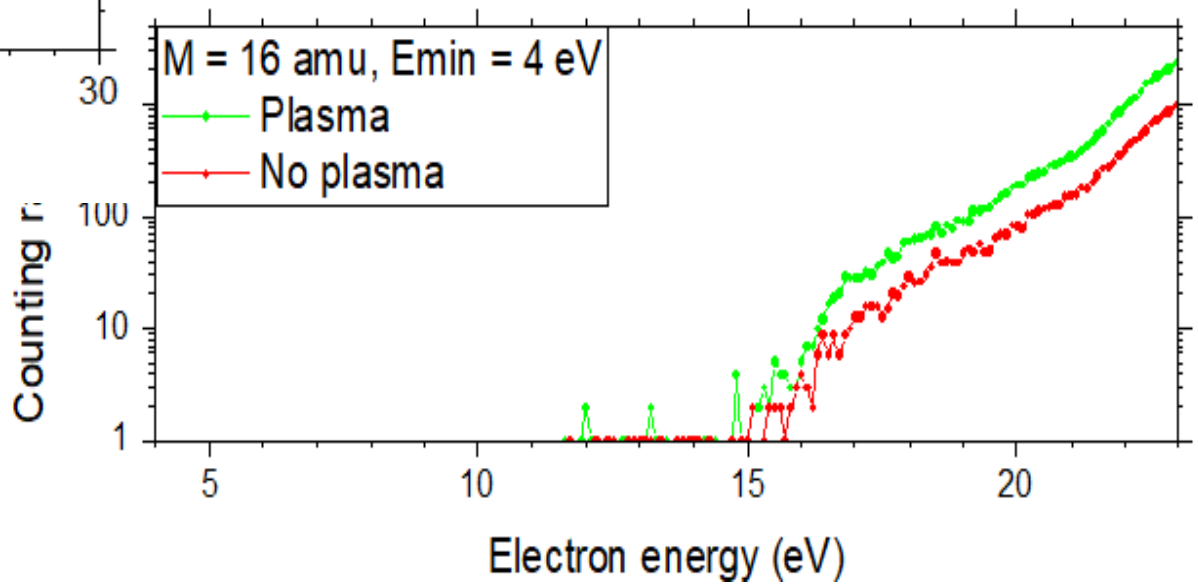




Near Threshold Ionization more efficient for Ozone

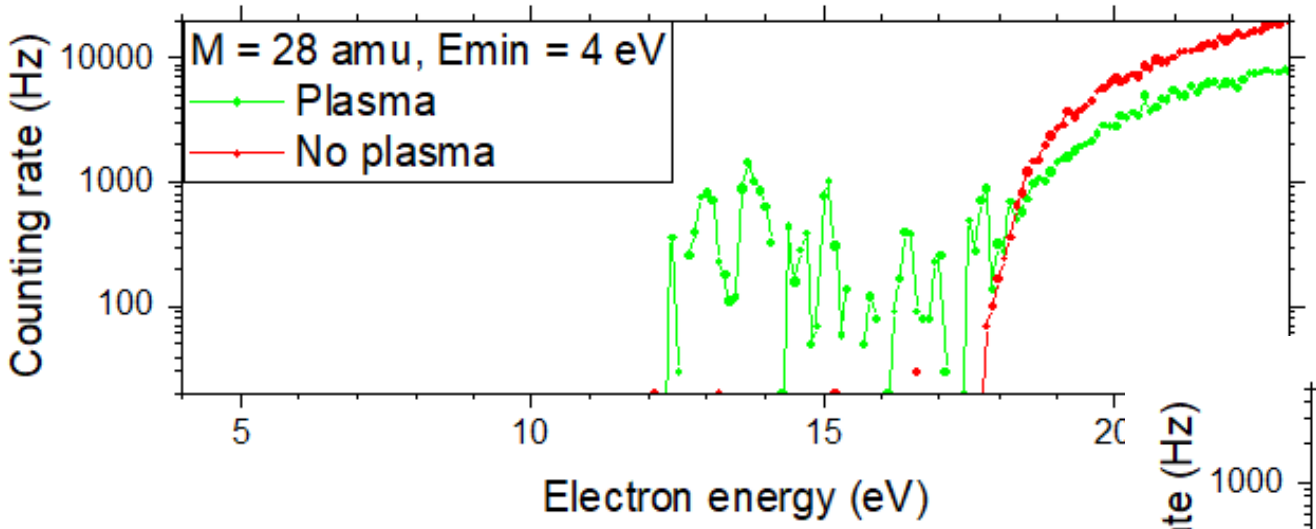
Atoms from Air Dissociation

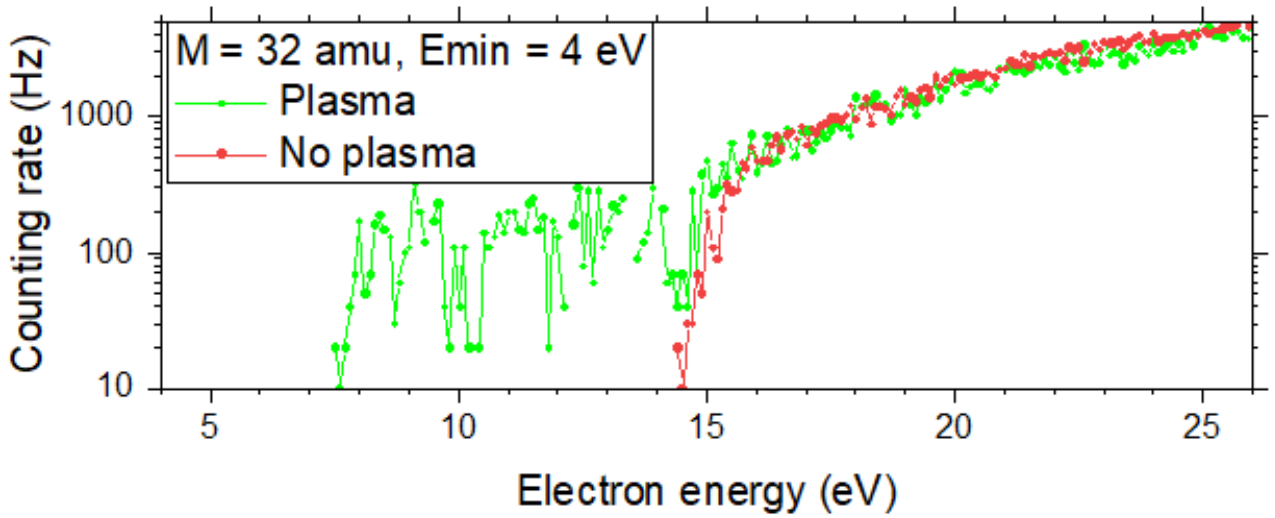




Different ionization threshold allows to differentiate signal from discharge atoms and fragmentation in the spectrometer

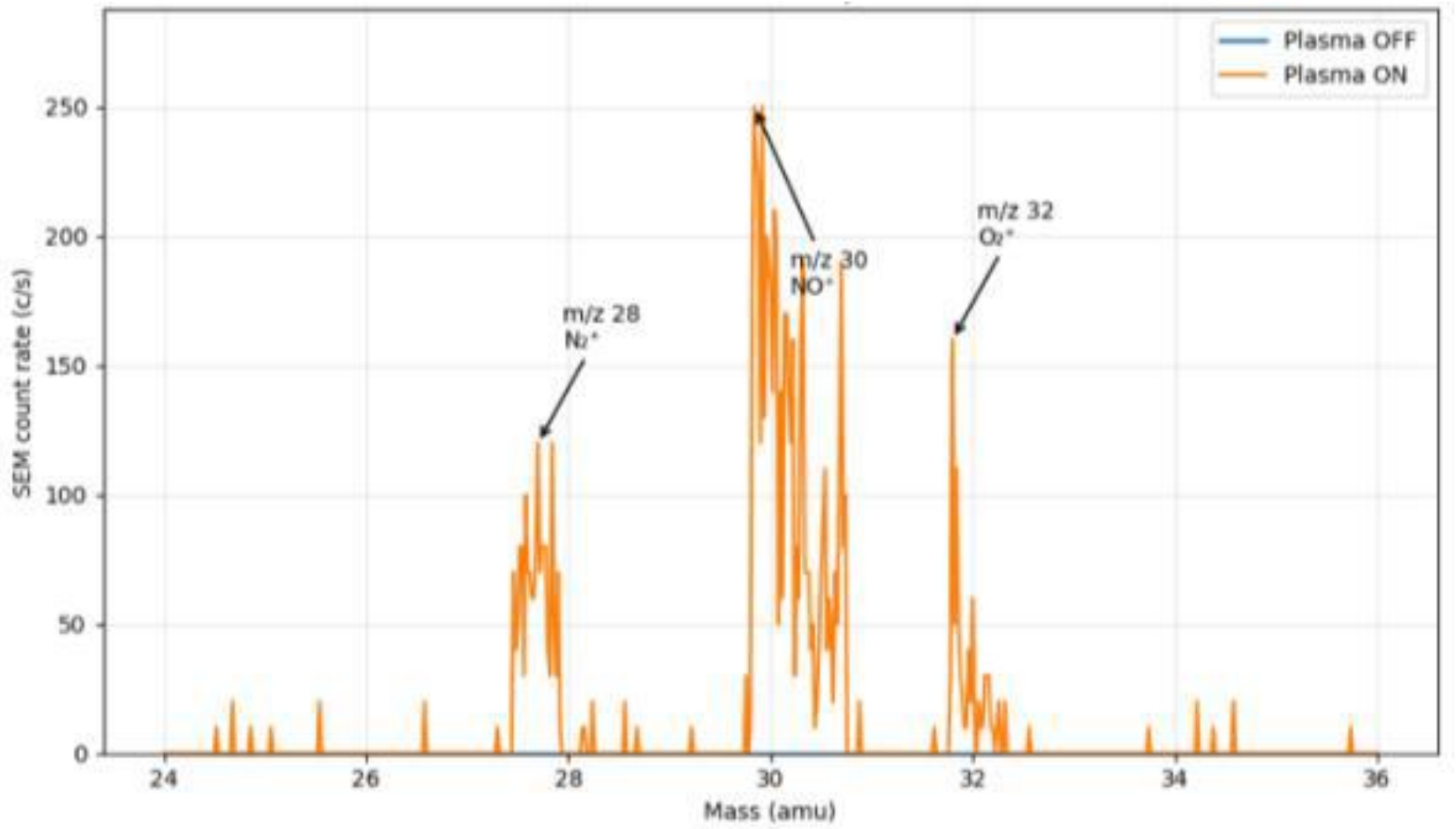
Air Excited States





Below ionization threshold signal is recorded in plasma gas-phase

Some Hints of Ions



Charge exchange dynamics

Conclusions:

- Plasma gas-phase in a SDBD device for air sanitization and VOC remediation was characterized.
- Neutral species at and below ppm levels could be measured.
- Some evidence of native plasma dissociation process was observed.
- Some data of formation and accumulation of metastables excited states was recorded.
- Some hints pointing to native ion composition detected.
- Lot of work to be performed waits us.

References

LTPD-05 D. Pal – EPS2026 Thursday poster session

R. Barni et al. – *AIP Advances* 13, 065207 (2023).