EuCARD Meeting

Orsay, May 5th 2011

WP10.8:

Plasma Discharge Cleaning

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Plasma Discharge Cleaning

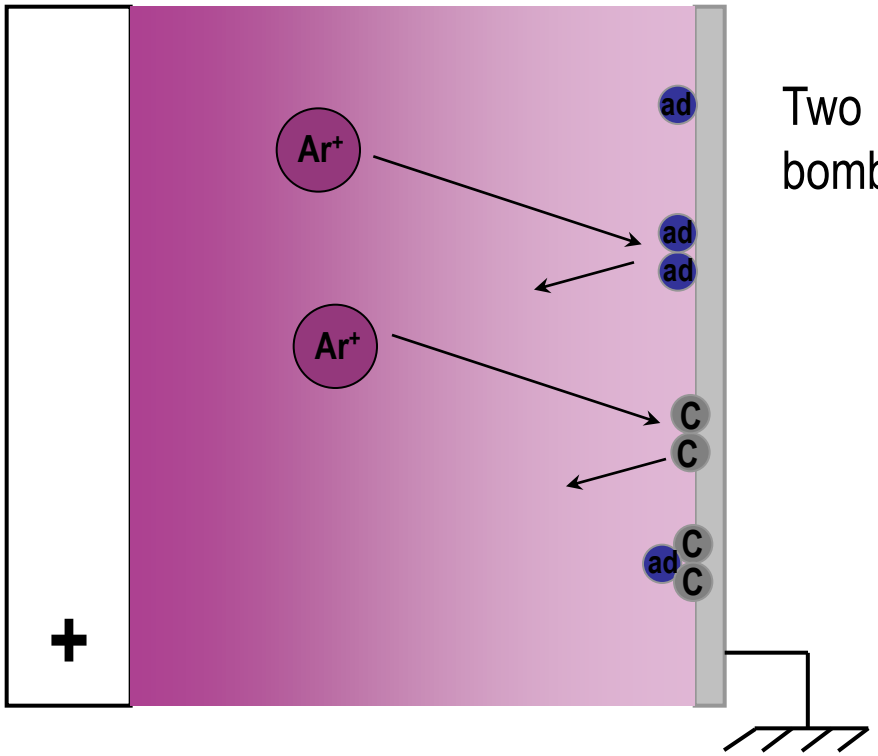
Study context

- Test of a new surface treatment procedure to avoid degassing problem during RF coupler conditioning.
- Possibility of its integration in the global coupler preparation procedure to replace or at least to diminish baking step duration (72h).
- Observing the effects of such treatment on coupler conditioning procedure.

Plasma Discharge Cleaning

Principal

Create a plasma discharge from a given gas and produce an ion bombardment of the surface to clean under a pressure of about 10^{-1} mbar.



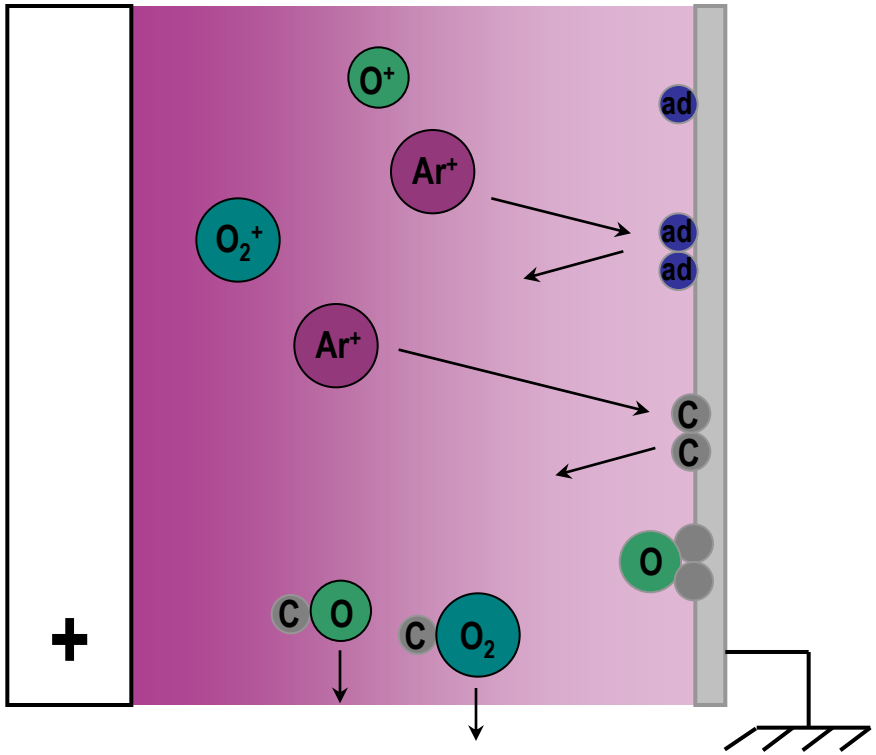
Two mechanisms can occur during surface bombardment by gas discharge ions:

- Gas molecules desorption
- Secondary ion emission or/and sputtering of surface elements (carbon, oxides, surface material)

Plasma Discharge Cleaning

Effect of oxygen addition in gas discharge

Oxygen addition in the gas discharge (in low percentage) allows:



- Increasing ions secondary emission yield
- O_2^+ and O^+ ions creation in the discharge that react with carbon emitted from the surface to form CO2 and CO pumped in the laminar flux
- Instable surface metallic oxides formation, easily eliminated by the discharge, that avoid exposed surfaces contamination by metallic emitted ions

Consequences of plasma discharge cleaning

- Gas molecules desorption: benefic for the conditioning procedure
- Ions secondary emission of carbon (or C sputtering): there is two contrary arguments, the first is that surface carbon is a good trap to adsorbed gas, its elimination will facilitate gas desorption. In another hand, carbon play a positive role in lowering SEY, its elimination may increase this surface parameter.
- Surface state modification: Ions secondary emission and element sputtering cause surface roughness change. This point is benefic to lowering the SEY of the surface and thus avoid surface intense electronic activity.

All this aspect have to be controlled for a better optimization of procedure parameters.

Plasma Discharge Cleaning

Procedure monitoring

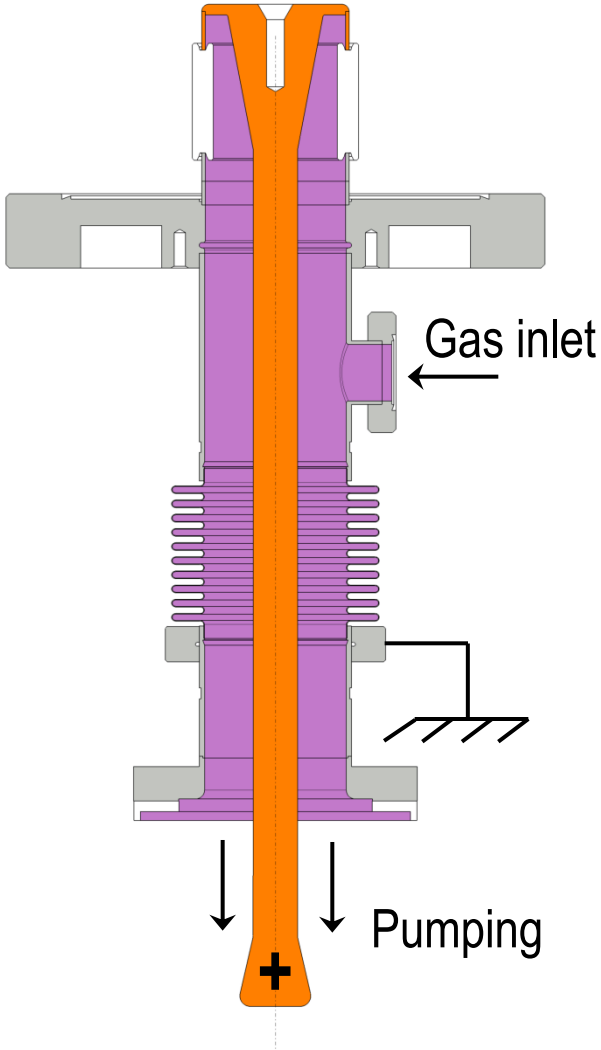
A good monitoring before, during and after plasma discharge cleaning will allow to judge the efficiency of the procedure and will permit a good optimization of its parameters and duration

- ✓ Gas molecules desorption ⟶ RGA monitoring
- ✓ Ions secondary emission (and/or sputtering) of surface elements (especially carbon)
  - ↗ RGA monitoring
  - ↘ SEY measurement of treated surface
- ✓ Surface state modification by plasma eaching
  - ↗ SEM observation
  - ↘ SEY measurement of treated surface

Plasma Discharge Cleaning

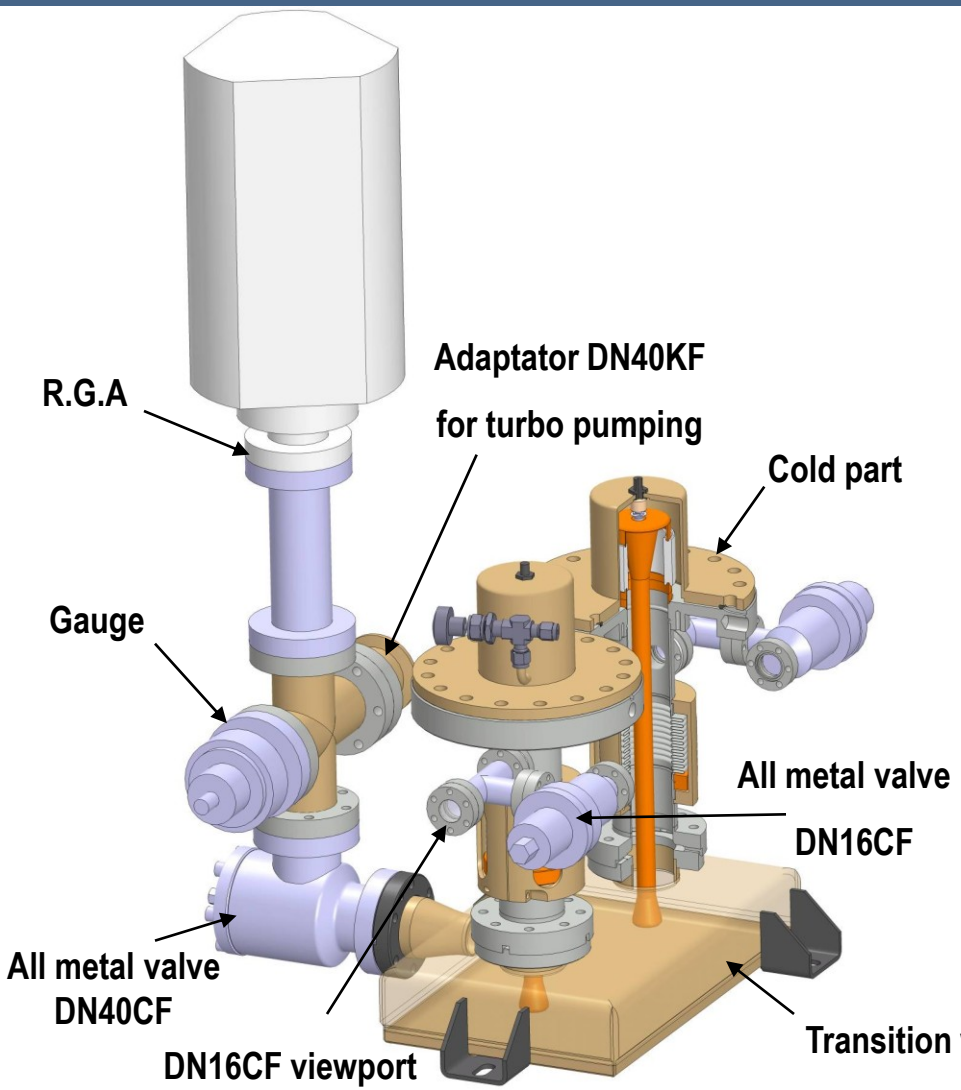
Plasma discharge cleaning of power coupler

- Gas discharge introduction into internal coupler part
- Controlled pumping to reach 10^{-1} mbar pressure and create a laminar pumping flux
- Direct current bias application with a positive antenna voltage and a grounded coupler corps
- Plasma creation at all power coupler internal parts



Plasma Discharge Cleaning

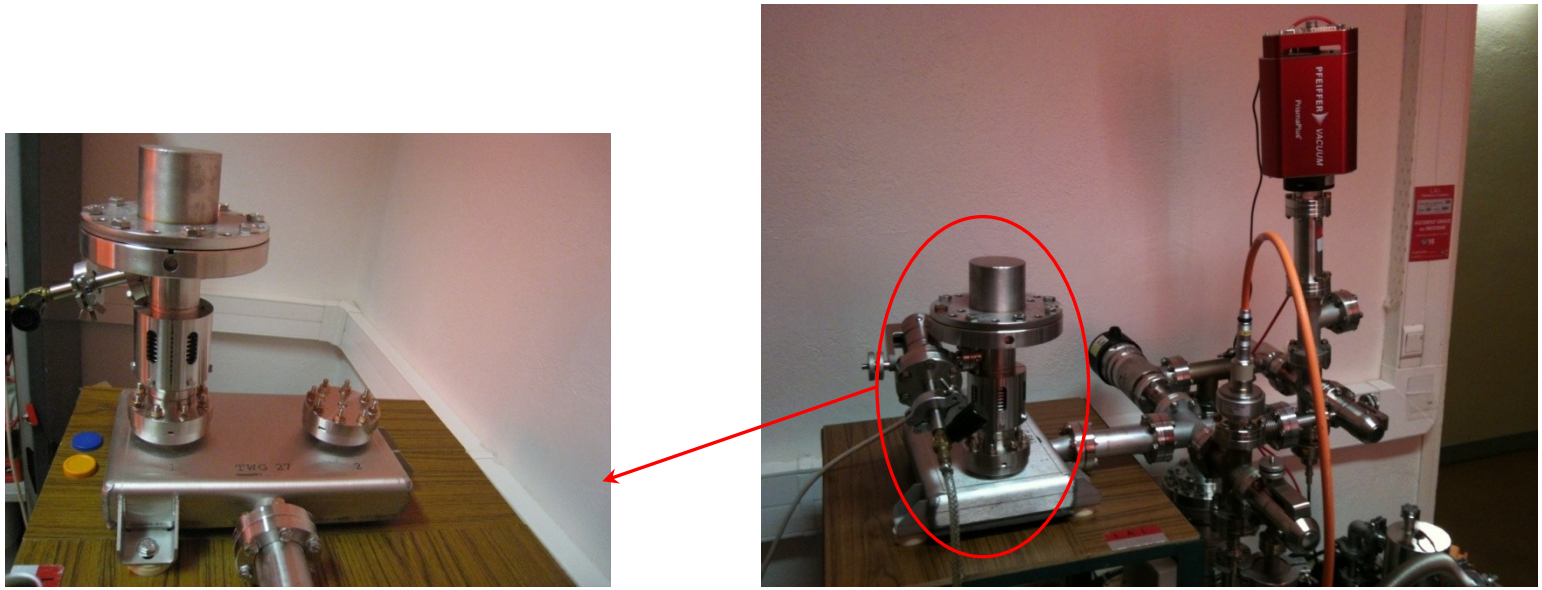
Experimental assembly



- Treatment of two cold coupler parts and the transition wave guide box (TWG) in the same time
- Gas inlet in the top of cold coupler parts and pumping at the exit of the TWG to get a laminar flux
- The RGA for pumped gas analysis
- Copper samples could be placed at the internal of the coupler for SEY measurements after treatment.

Plasma Discharge Cleaning

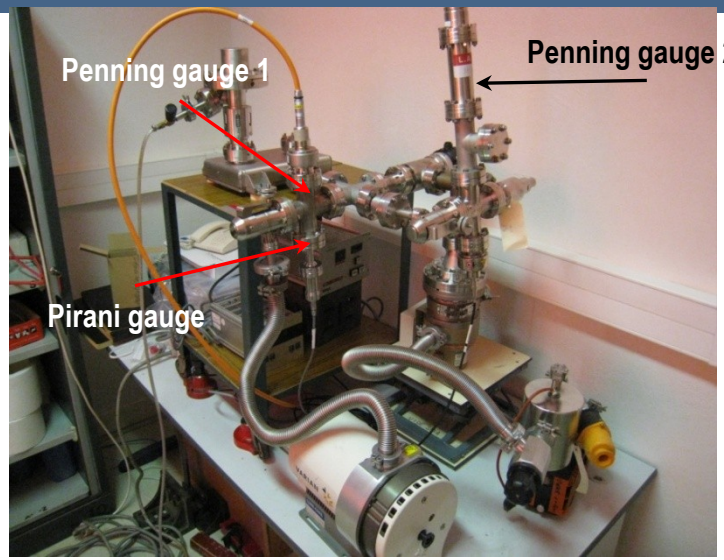
Experimental assembly

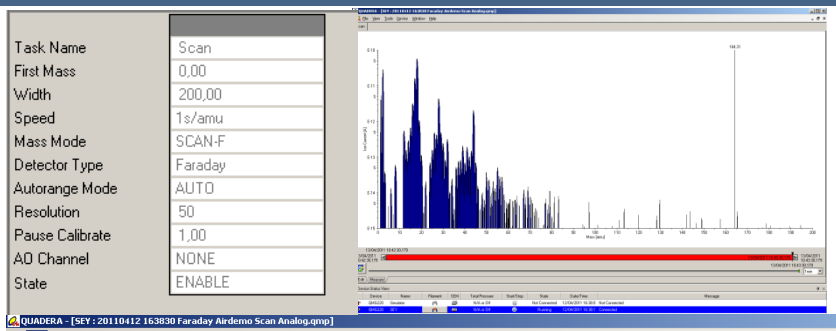


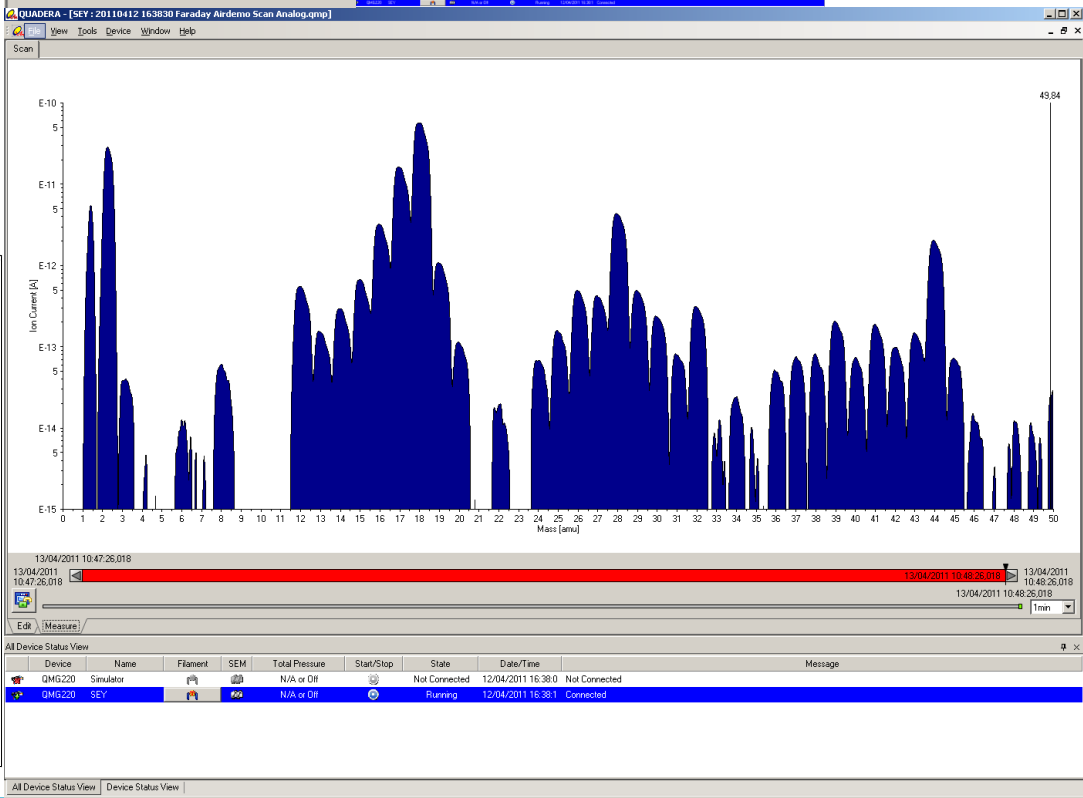
System vacuum characterization before plasma discharge cleaning

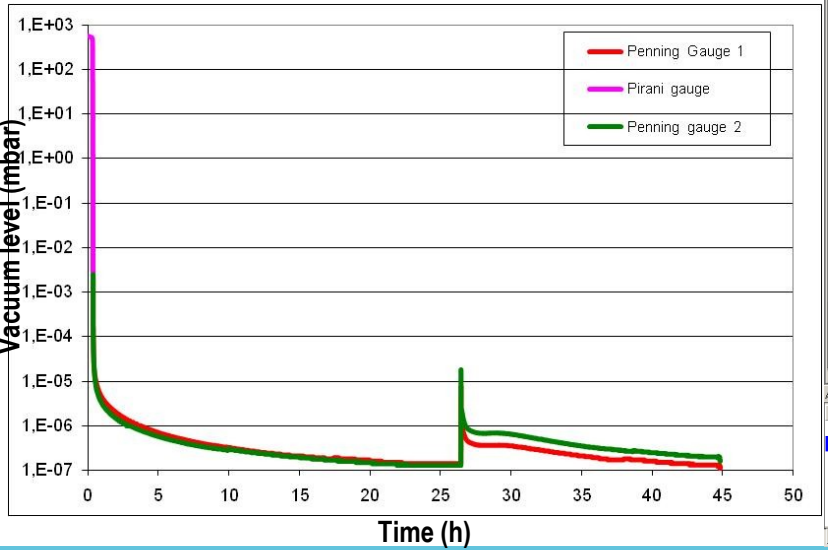
Plasma Discharge Cleaning

System vacuum characterization









Plasma Discharge Cleaning

Still to do…

Several experimentations needed to optimize:

- Cleaning discharge parameters:
  - Gas composition,
  - Antenna voltage,
  - Gas flow rate,
  - Vacuum level
- Procedure duration for a good cleaning
- Conditioning of a plasma discharge treated coupler