

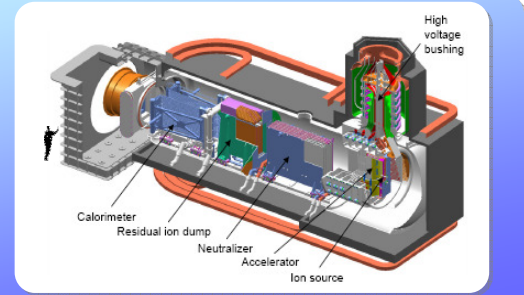
## Introduction

### Two Neutral Beam Injectors (NBI) are required in ITER:

- To deliver a total of 33 MW of heating power.
- 1MV and 40 A in Deuterium and at 870 kV and 46 A in Hydrogen.

The construction of the Test Facility has started in Padova, it is aimed to test and optimize the NBI and to assist the operations in ITER, is in progress. The beam accelerator is composed of five acceleration grids each polarized at increasing voltages, with steps of 200 kV.

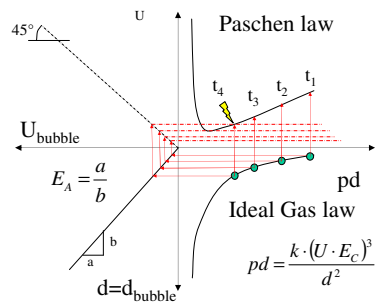
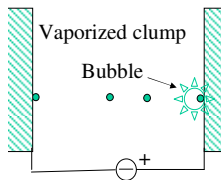
The voltage holding capability to sustain with adequate safety margin the full voltage with the duty cycle of 1 hr ON – 3 hrs OFF is one of the most challenging issues for the NBI experiment.



## The Probabilistic model for the Voltage holding prediction in the large gap configurations

### 1-The Slivkov's model and the definition of W

$$W = U \cdot E_C \cdot E_A^2$$



### 2-The Weakest Link Theory and the Weibull's distribution

$$dP_{Bj} = N(W_j) \Delta A_j \quad R_j = 1 - dP_{Bj} \approx \exp(-dP_{Bj})$$

$$P = 1 - \prod R_j = 1 - \prod \exp(-dP_{Bj}) = 1 - \exp(-\sum dP_{Bj}) = 1 - \exp(-\int_A N(W) \cdot dA)$$

$$N(W) = \left(\frac{W}{W^*}\right)^m \quad P = 1 - \exp\left[-\int_A \left(\frac{W}{W^*}\right)^m \cdot dA\right]$$

### 3-The trajectories computation

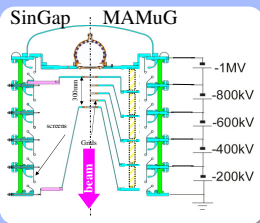
In order to compute the probability integral, it is necessary to retrieve U and both electric fields  $E_A$  and  $E_C$  at the ends of the clump trajectories.

**Charge q and mass m of the clump are unknown ! BUT**

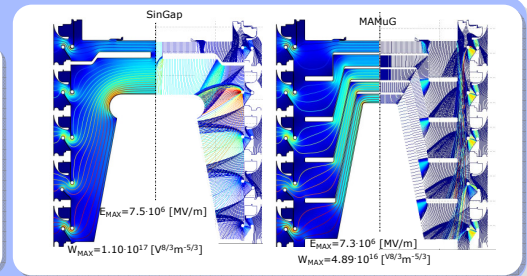
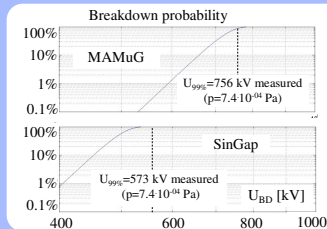
if the clump start the trajectory with initial zero velocity, it is not relativistic and the charge is conserved during the flight,

**the trajectory does not depends** neither on q and m of the clump nor on the voltage (s).

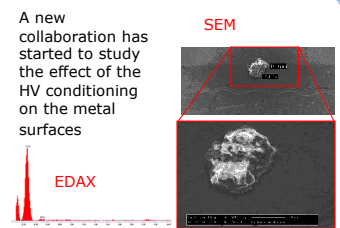
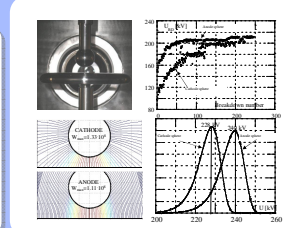
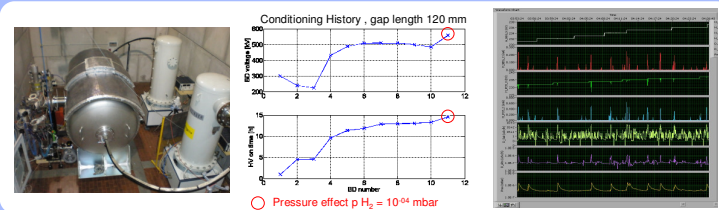
## The Comparison between SINGAP and MaMUG at the MTF of Naka



The model was benchmarked with the experimental results of the two configurations.  $W^*$  and m was fitted with the SINGAP results, the same parameter was used to predict the MaMUG behavior.



## Experimental activities in Padova



## Conclusions

- A method to predict the behavior of an HV multi-electrode system insulated by vacuum has been proposed
- The first benchmark with the experimental results shows encouraging results
- Benchmarking with dedicated experimental campaigns are in progress in Padova