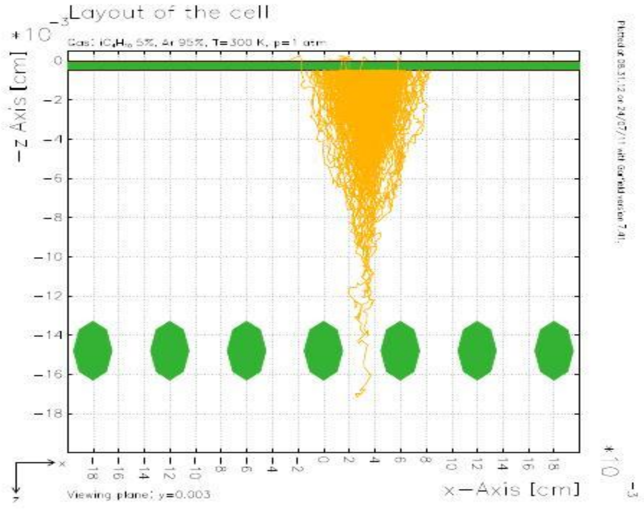
Numerical Studies on IBF of BULK Micromegas

SINP @ RD51

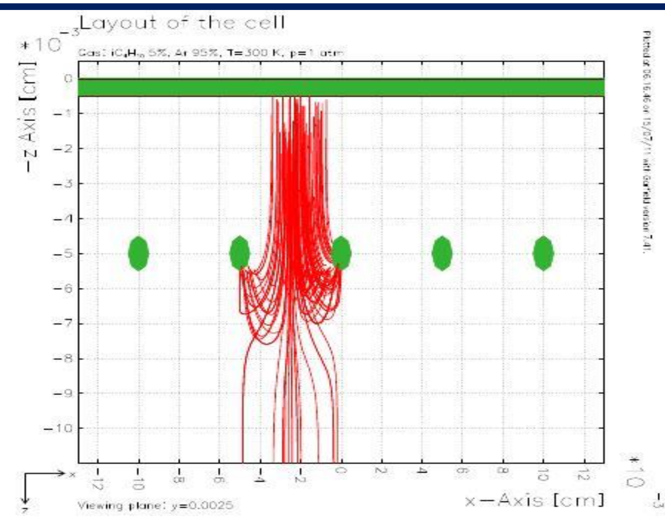
Ion Backflow

- Secondary ions from amplification region drift to drift region
- Space charge accumulation, distortion of electric field, degradation stable operation
- Related to detector ageing
- Micromegas micromesh stops a large fraction of these ions
- Backflow fraction : $N_b/N_t \propto (1/FR)(p/\sigma_t)^2$ where

  $N_b \rightarrow$ average number of back-flowing ions
  $N_t \rightarrow$ average total number of ions
  $FR \rightarrow$ field ratio,
  $p \rightarrow$ pitch of the mesh,
  $\sigma_t \rightarrow$ diffusion



Avalanche of Electrons (2D picture)



Drift of Secondary Ions (2D picture)

Earlier Work

Several interesting IBF studies on all kinds of MPGDs: Experimental, Semi-analytic, Numerical

For example, from Max's thesis, we see:

•BF decreases with increase in field ratio FR and with decrease in p^2 as both relate to the funnel radius.

•Backflow fraction should decrease with increase in field ratio but should become much less sensitive to σ_t/p.

•2D computations show that total number of back-flowing ions remains same and BF becomes independent of σ_t/p - predicted for values of $\sigma_t/p > 0.5$.

Present Work

Our attempt has been to push the boundaries further through the use of Garfield-neBEM-Heed-Magboltz framework for all computations.

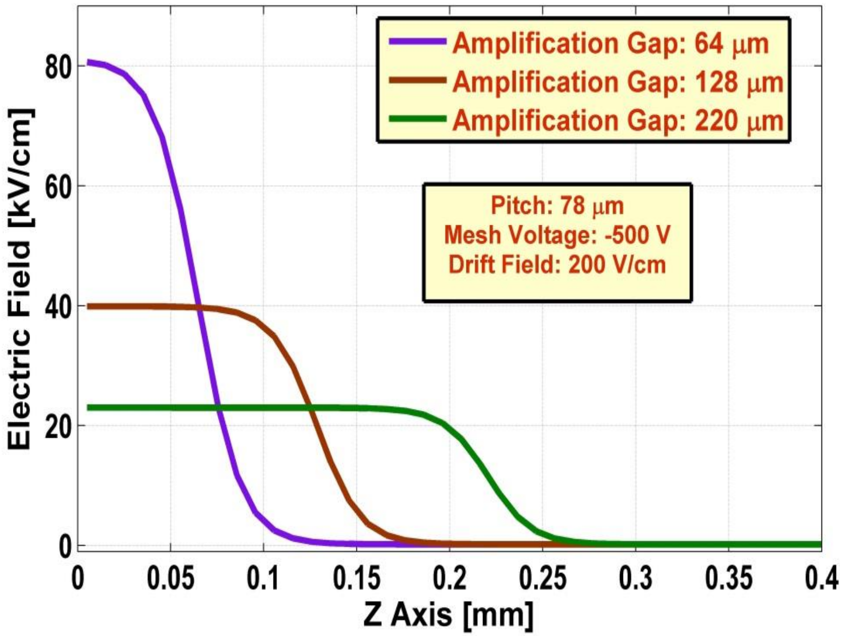
neBEM developments that were crucial for the study:

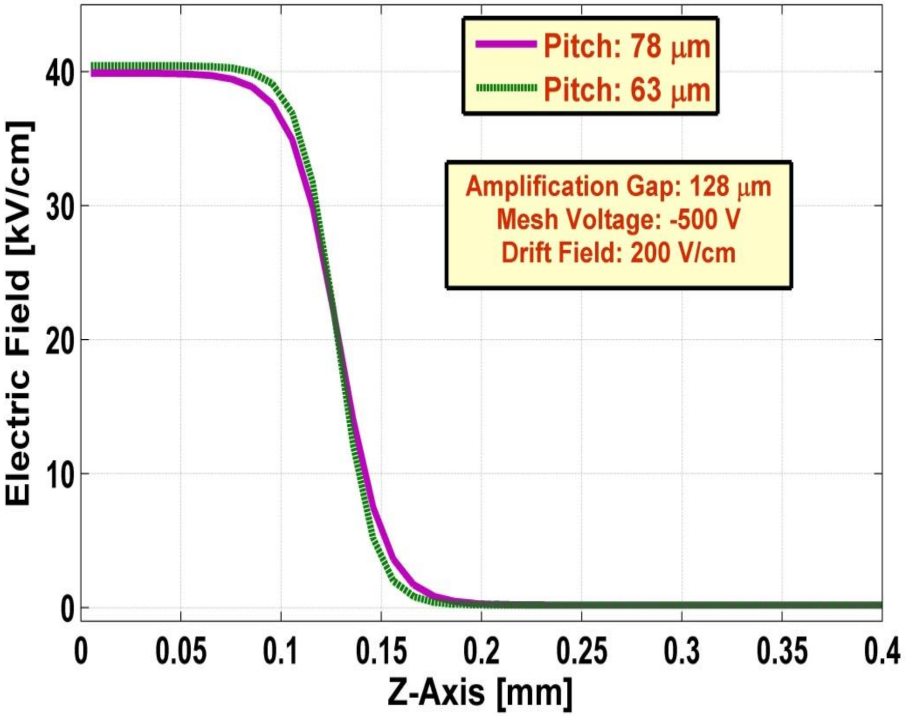
•Optimization of field calculations to achieve a large range of drift fields, especially *values as small as 25V/cm*.

•Extensive use of the recently developed fast-volume approach so that a reasonable statistics (*around 10,000 events*) is maintained in all the studies.

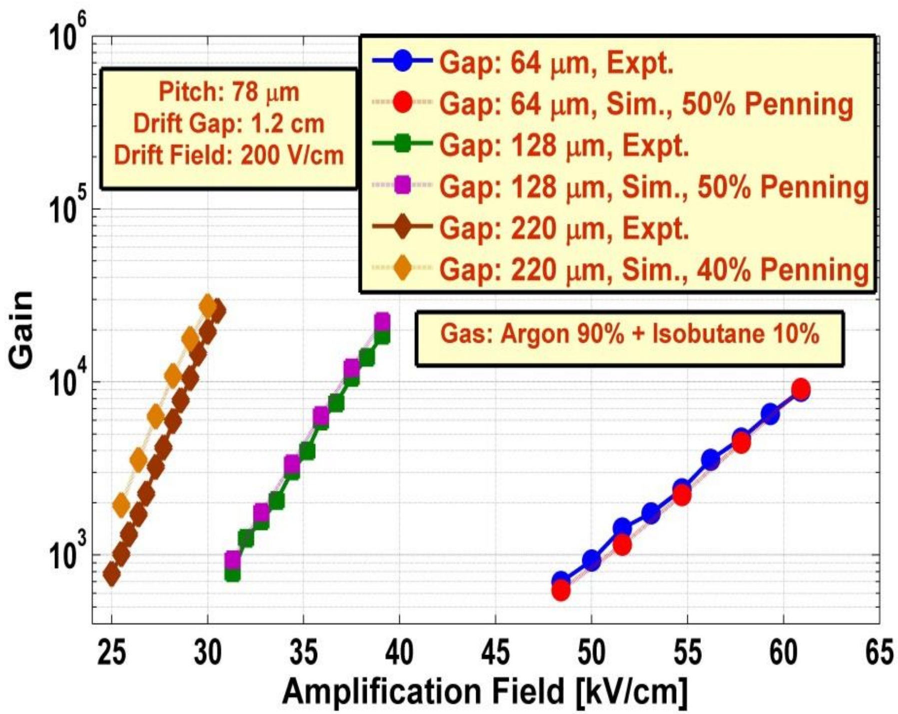
Important parameters: Field, Gain, Resolution, Transparency, Diffusion

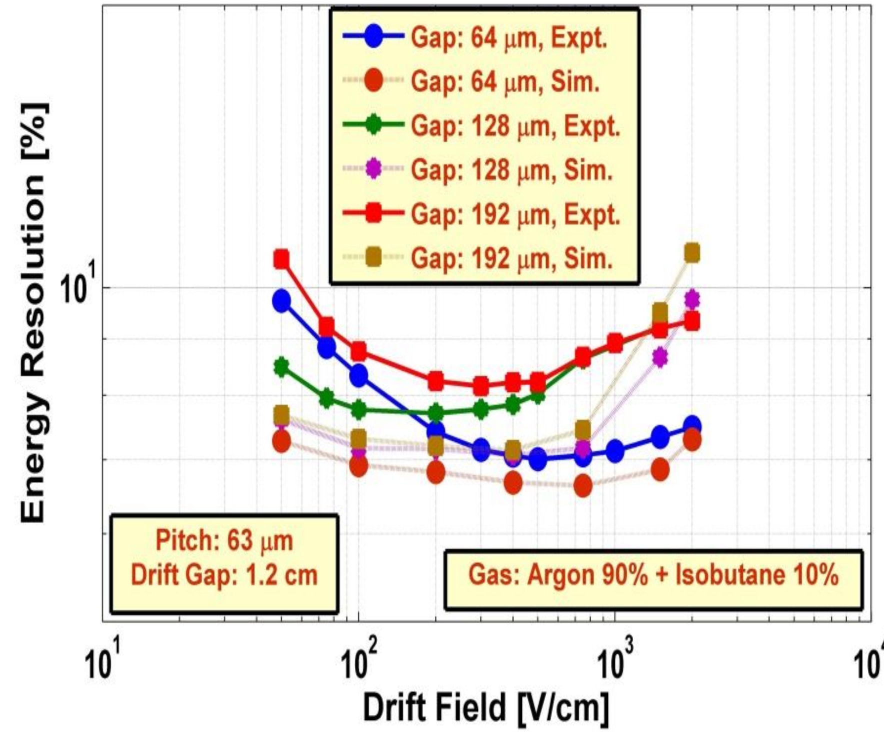
Variation of electric field with change in geometrical parameters of Micromegas

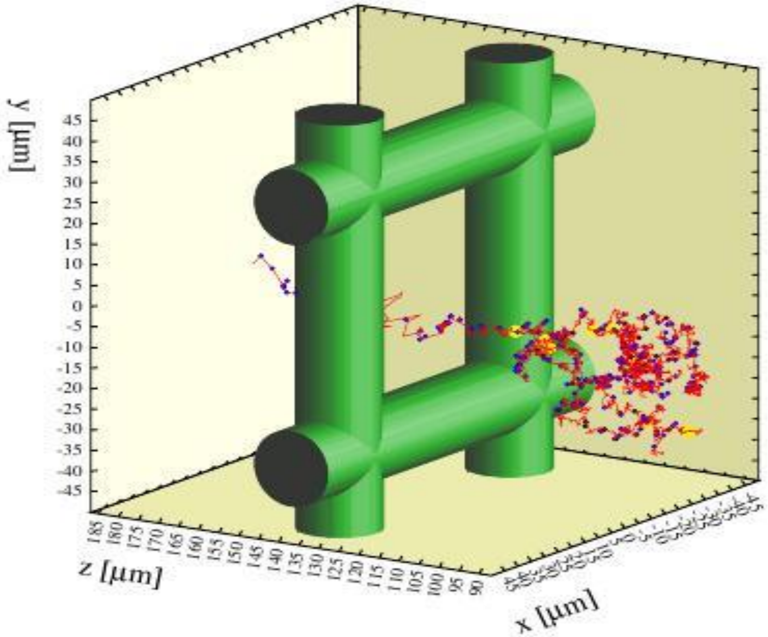




Variation of gain and energy resolution with change in geometrical parameters of Micromegas







Estimation of Electron Transparency

- *Fraction of electrons arriving in amplification region*
- *Depends on field ratio, drift voltage*
- *Depends on hole-pitch*

Every electron collision is connected with red lines,

● inelastic collisions ● excitations ● ionizations.

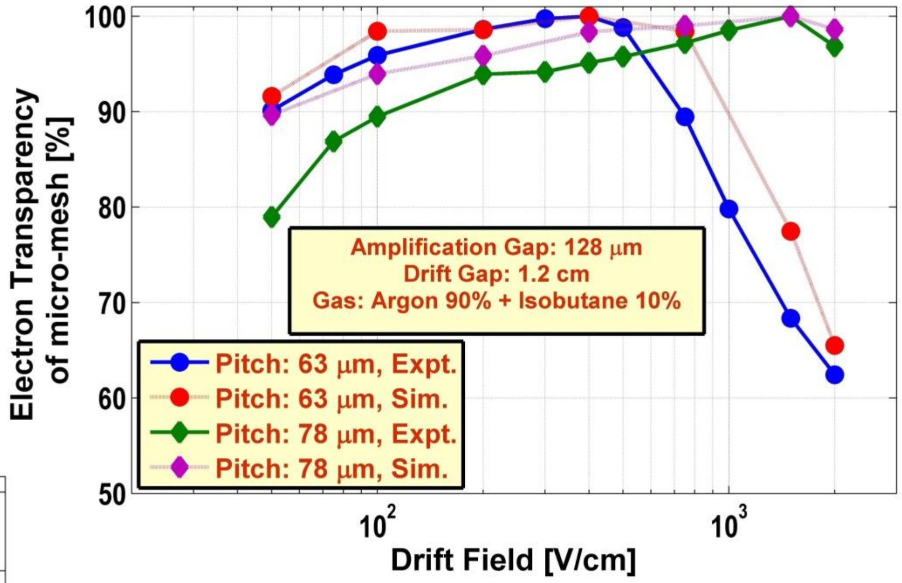
Experiment :

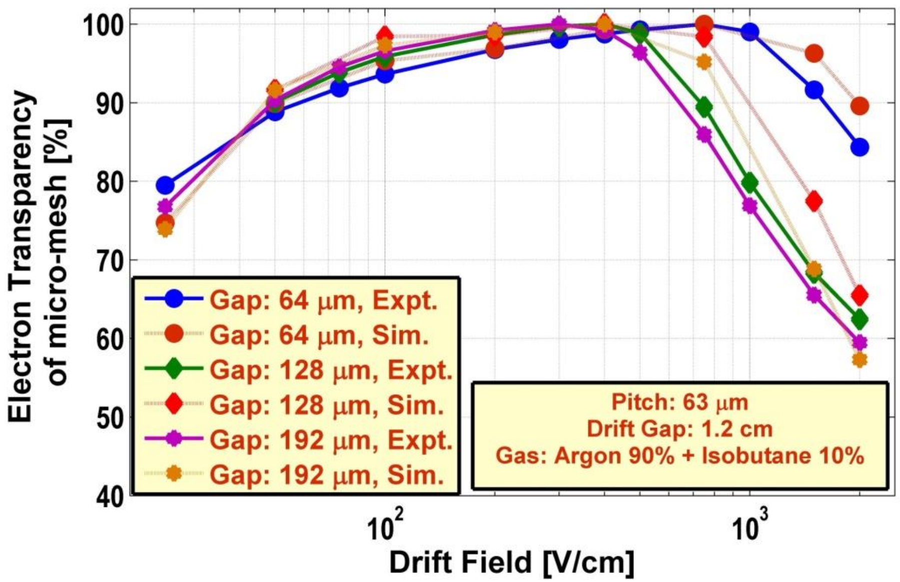
Ratio of signal amplitude at a given E_{drift} over signal amplitude at E_{drift} where gain is maximum

Simulation:

- ❖ Microscopic tracking of electrons from randomly distributed points (at different heights above mesh)
- ❖ Model for mesh: three-dimensional polygonal approximation of cylinders

Variation of electron transparency with change in geometrical parameters of Micromegas

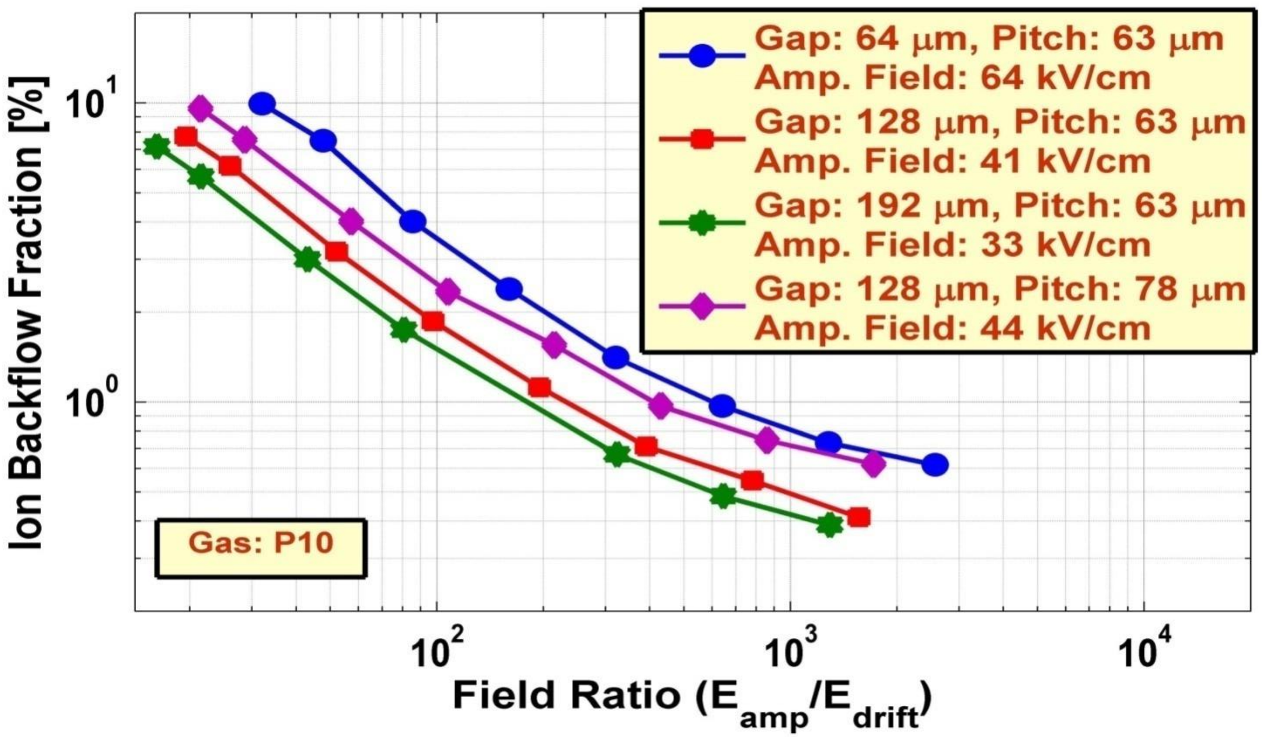




This is a particularly difficult job for numerical simulation, especially for lower values of drift field.

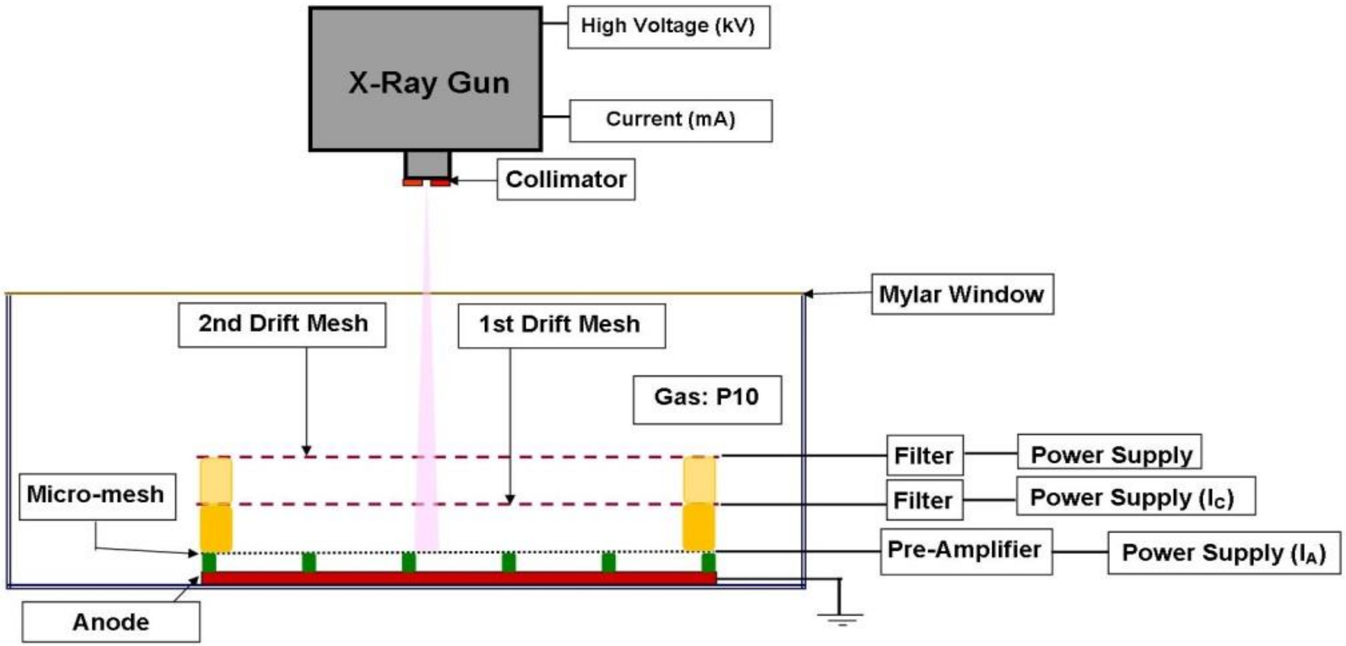
Simulation results agree quite well with Experimental Data

IBF for Micromegas having different design parameters - Simulation



- BF does decrease with increase in field ratio FR and with decrease in p^2 (note results for the amplification gap of 128 μm).
- BF decreases with increase in amplification gap.
- It remains to be seen whether it is much less sensitive to σ_t/p for values > 0.5.

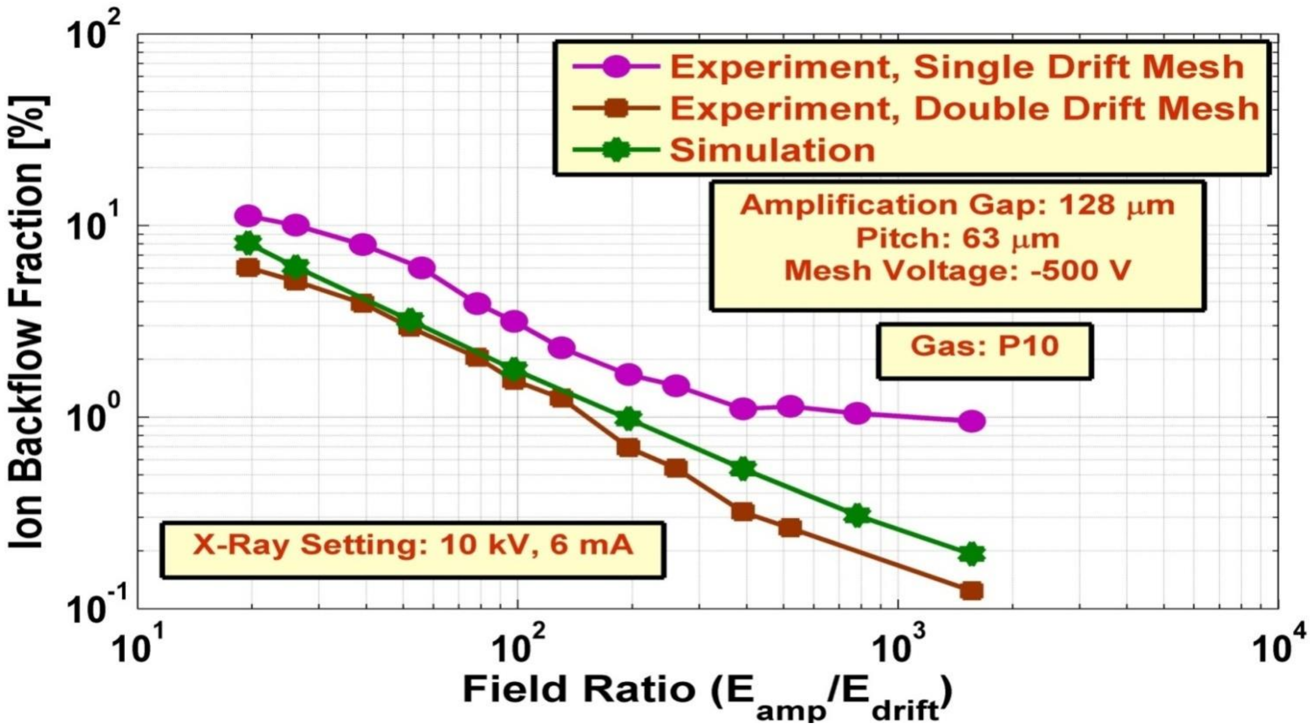
Experiment on IBF



- Preliminary data taken at CEA, Saclay
- Detailed discussion in Nayana's talk in WG2
- We are trying to build two different set ups at SINP

Comparison between experiment and simulation

Variation with IBF with Field Ratio



- Simulation results are encouraging
- Physics issues such as the effect of space charge need to be included
- This is very much a `work in progress' - need further numerical investigation and experimental verification

Members

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THANK YOU