Positive ions backflow in the LCTPC: status of the possible gating systems

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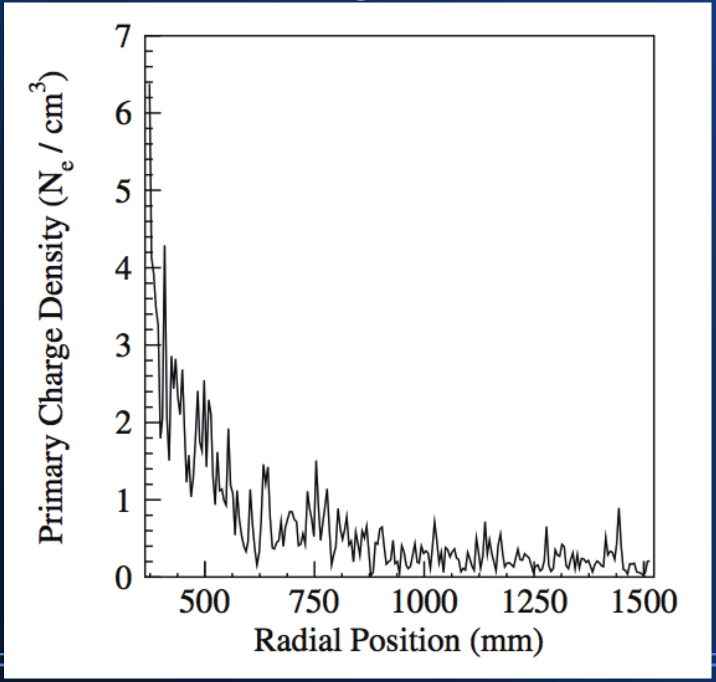
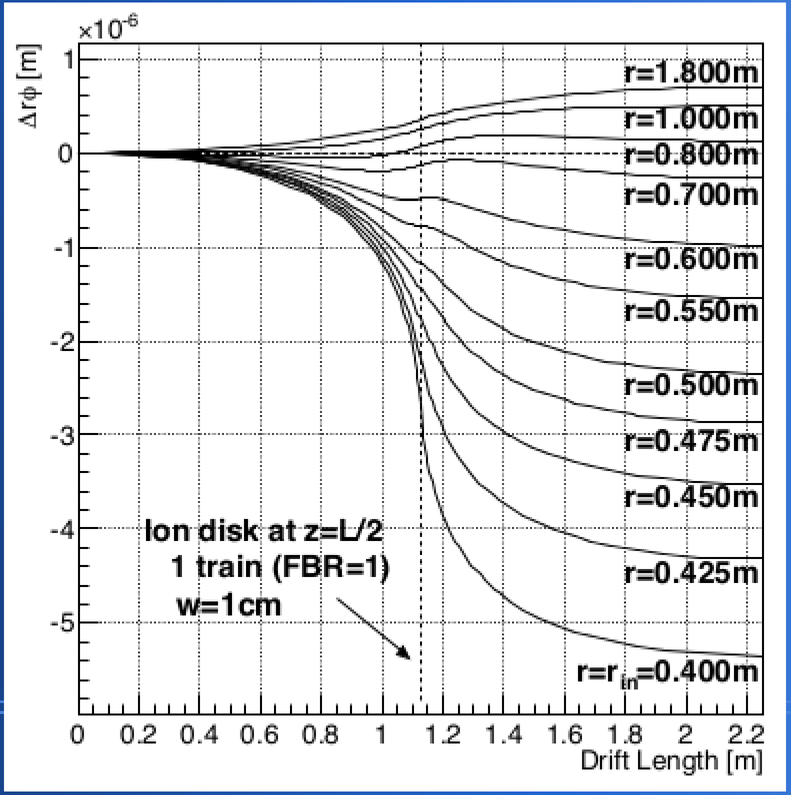
Outline

- Ion backflow at LCTPC
- GEM gate
- Wire gate
- Conclusions and outlook

Ion back flow in LCTPC

- Simulation by D.Arai and K. Fujii
  - Using BG simulation by A. Vogel
  - Assuming back flow rate of 3

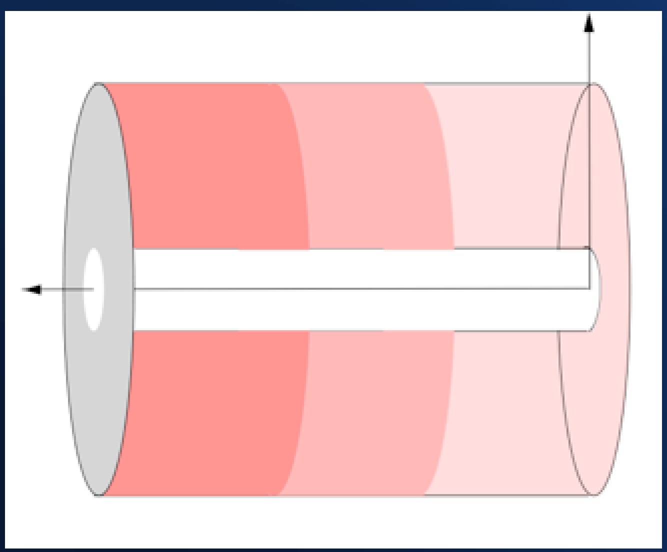




Ion back flow in LCTPC

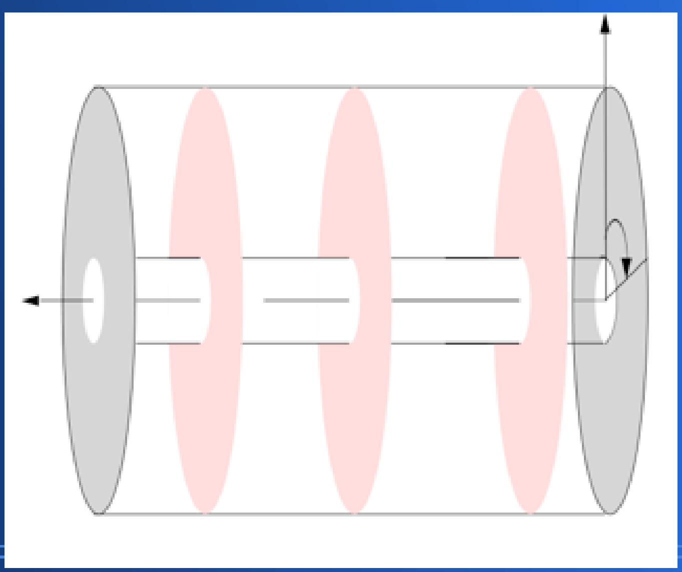
- Primary ions (produced in the drift volume)

~8µm



- Secondary ions (produced in amplification)

~60µm (too big)



Possible solutions

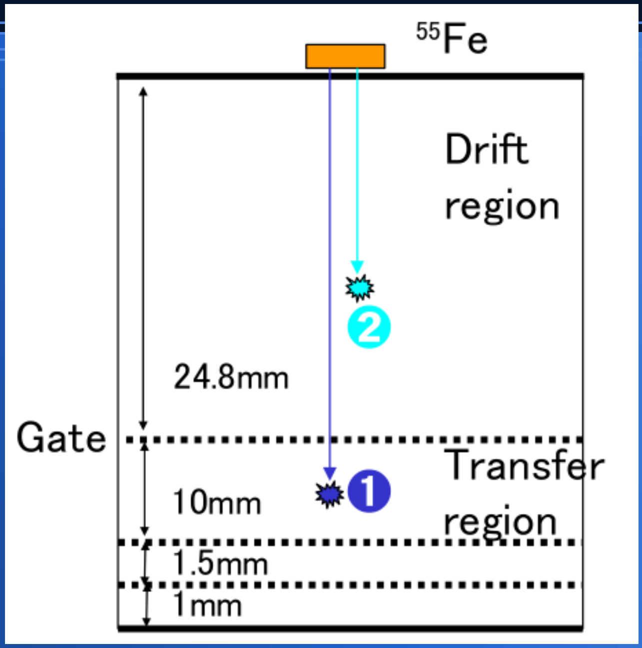
- Block secondary ions with a gate
  - Strong engineering constraint on the TPC design
- Correct in software
  - Require to keep track of all the background
  - Needs to be very well understood and calibrated
- Reduce ion back flow as much as possible
  - Strong reduction needed
  - Has to accommodate unexpected background

GEM gate

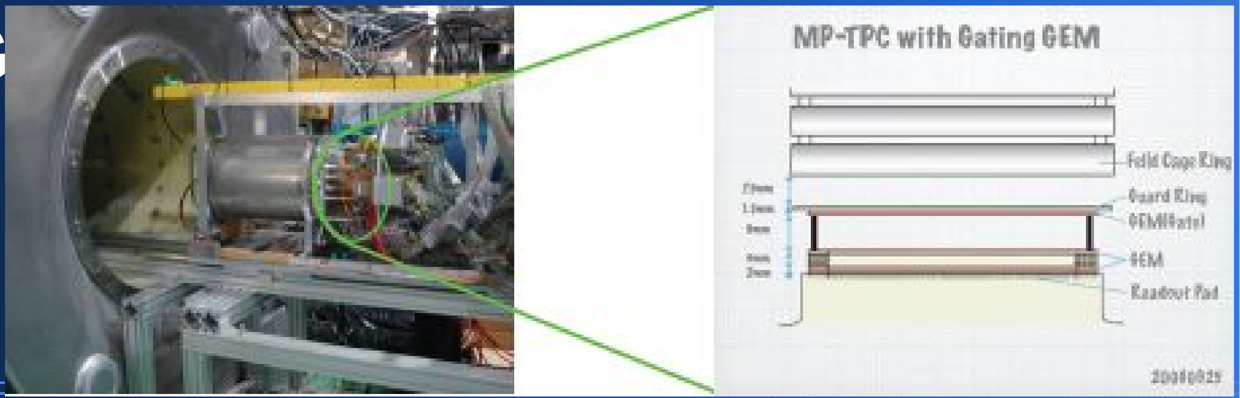
- Preliminary experiments
  - transparency measurement
  - resolution measurement
- Simulation
  - Reproduce the experiment
  - Large aperture, high B field

GEM gate experiments

- Transparency measurement
  - Compare the signal create before and after the gate
  - Systematic effects cancel out

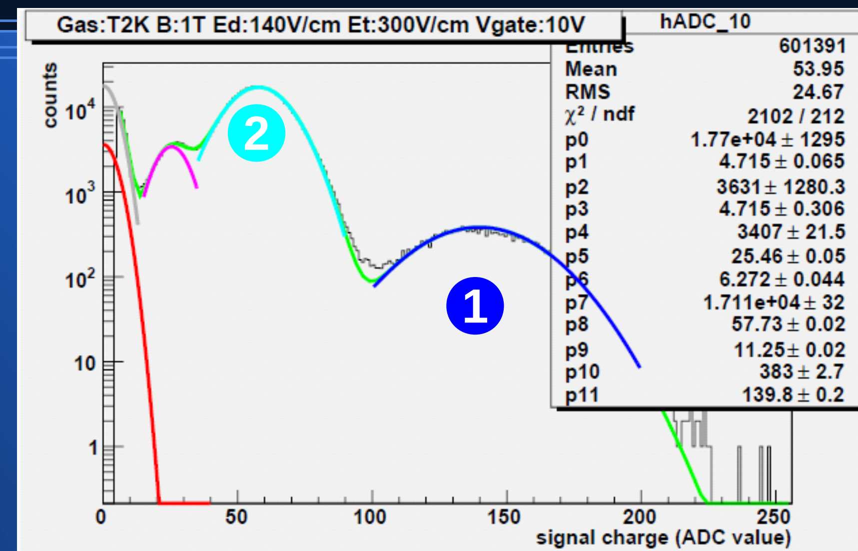


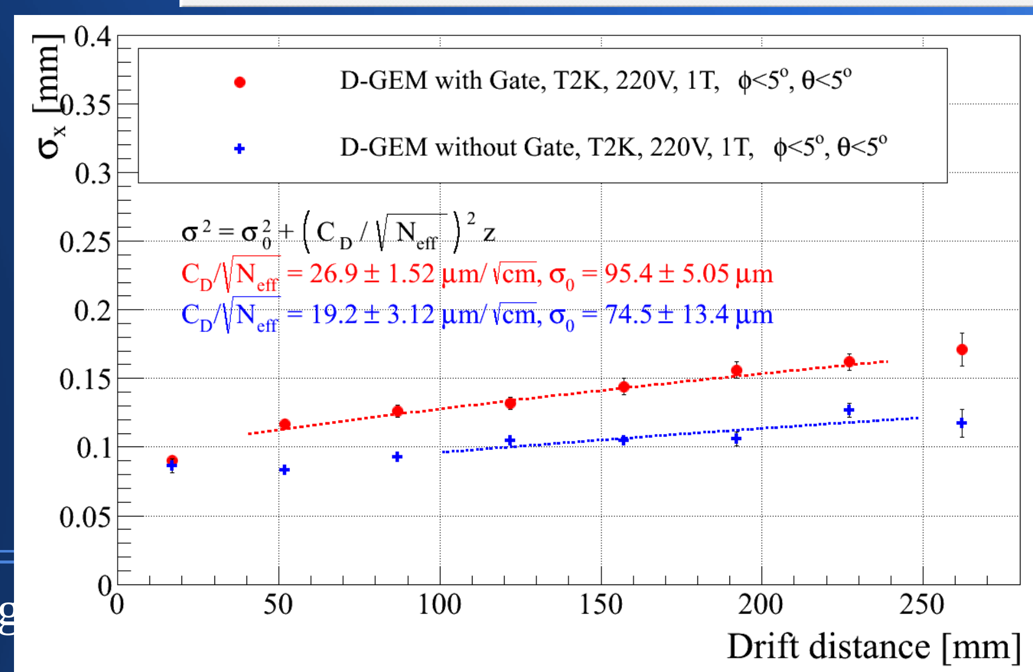
- Space resolution
  - MPTPC&PCMAG
  - calculate Neffective



Experiment Result

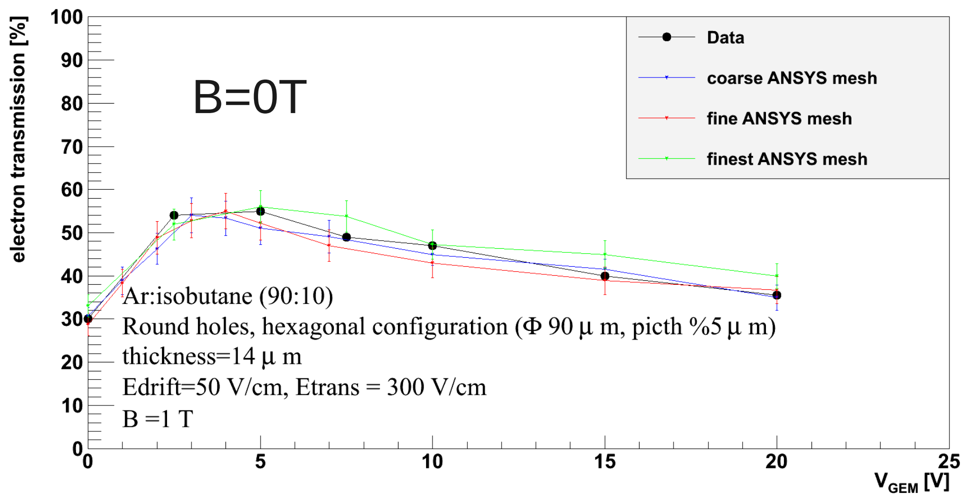
- Transparency ~50% at B=1T
- Consistent with 50% transparency

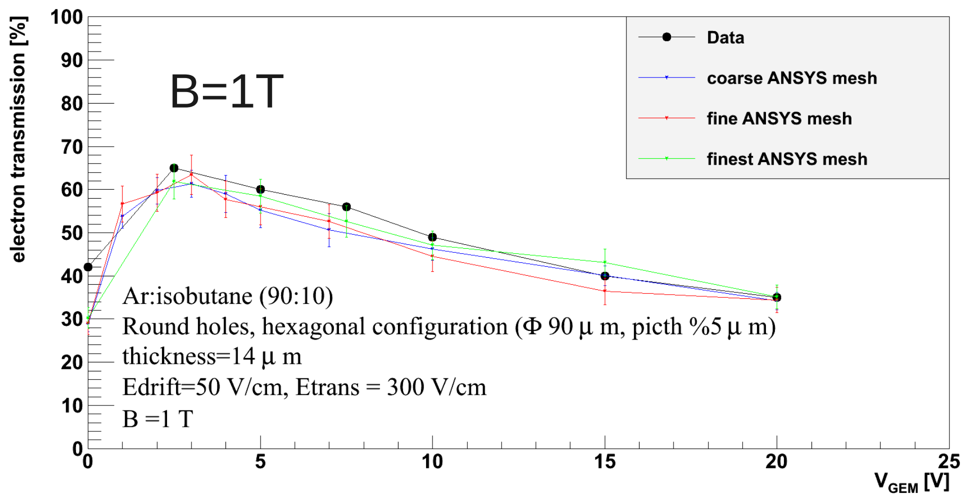




Simulation

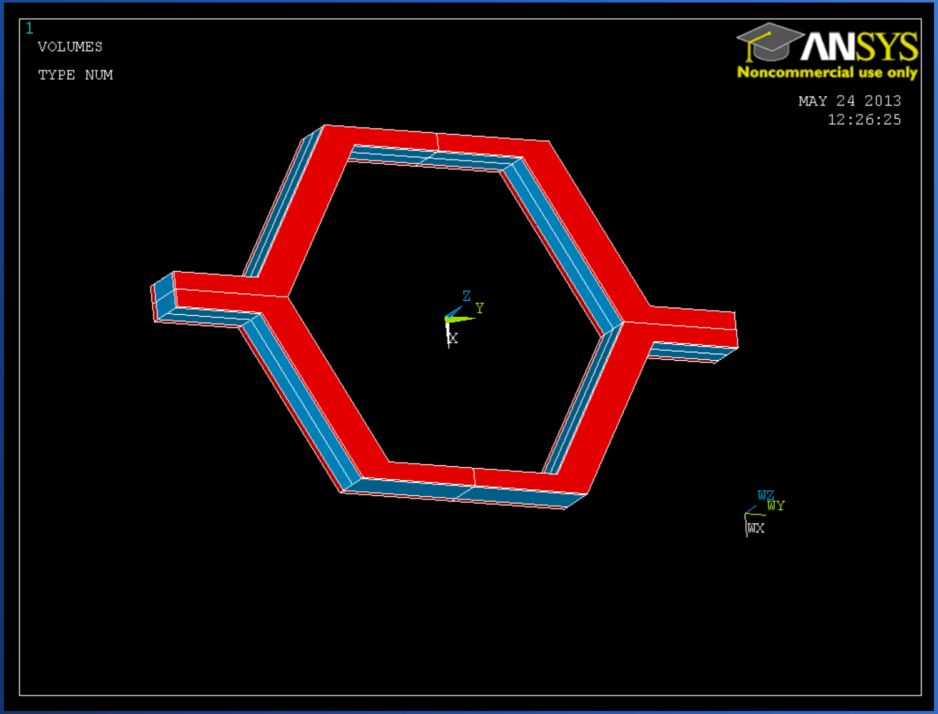
- Using Garfield++ and ANSYS
- Reproduces the experimental transparency measurement





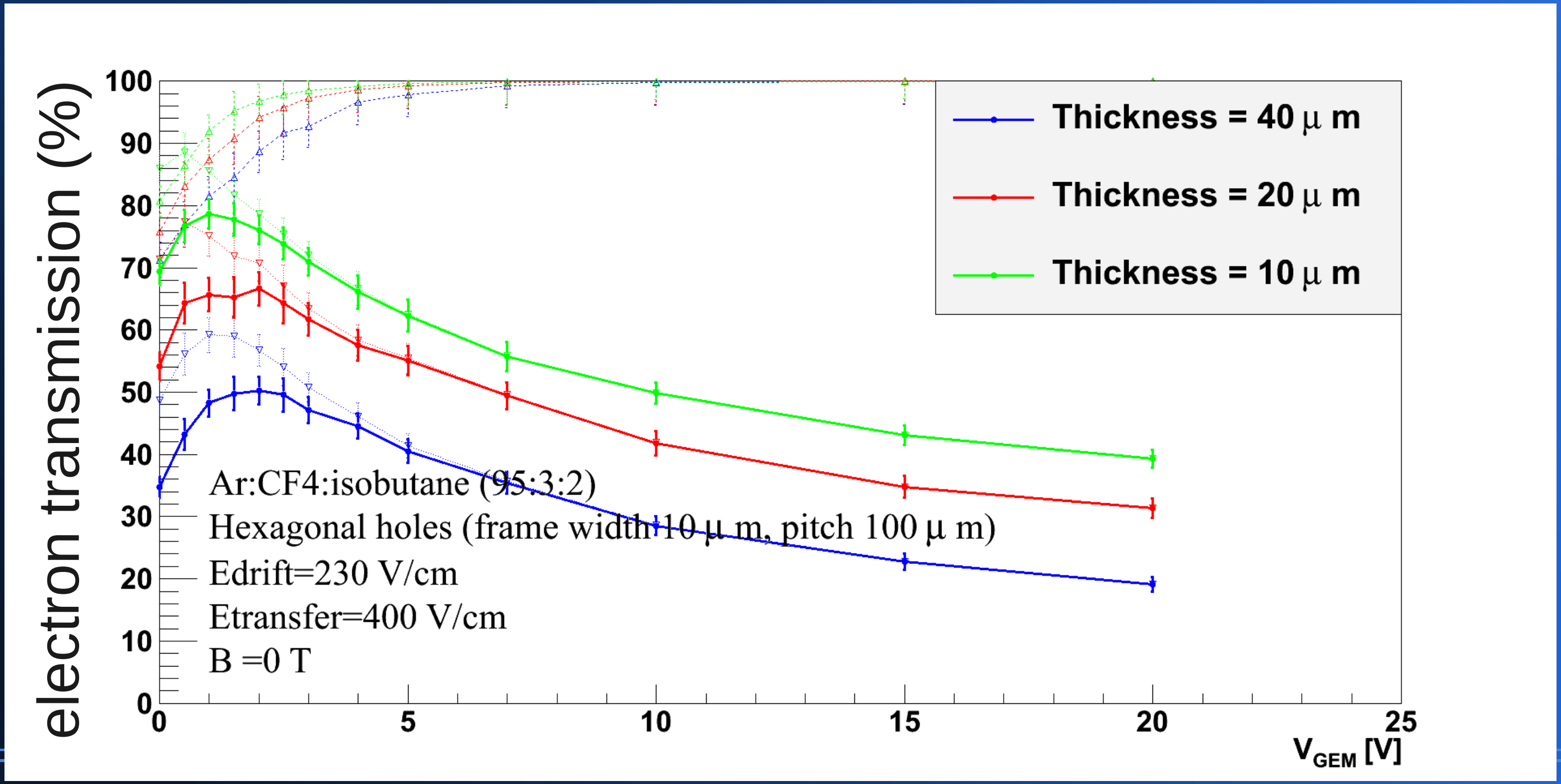
Large aperture

- Maximize the aperture
- Honeycomb structure
- 10μm wide, 100μm pitch
  - 90% aperture
  - difficult to build



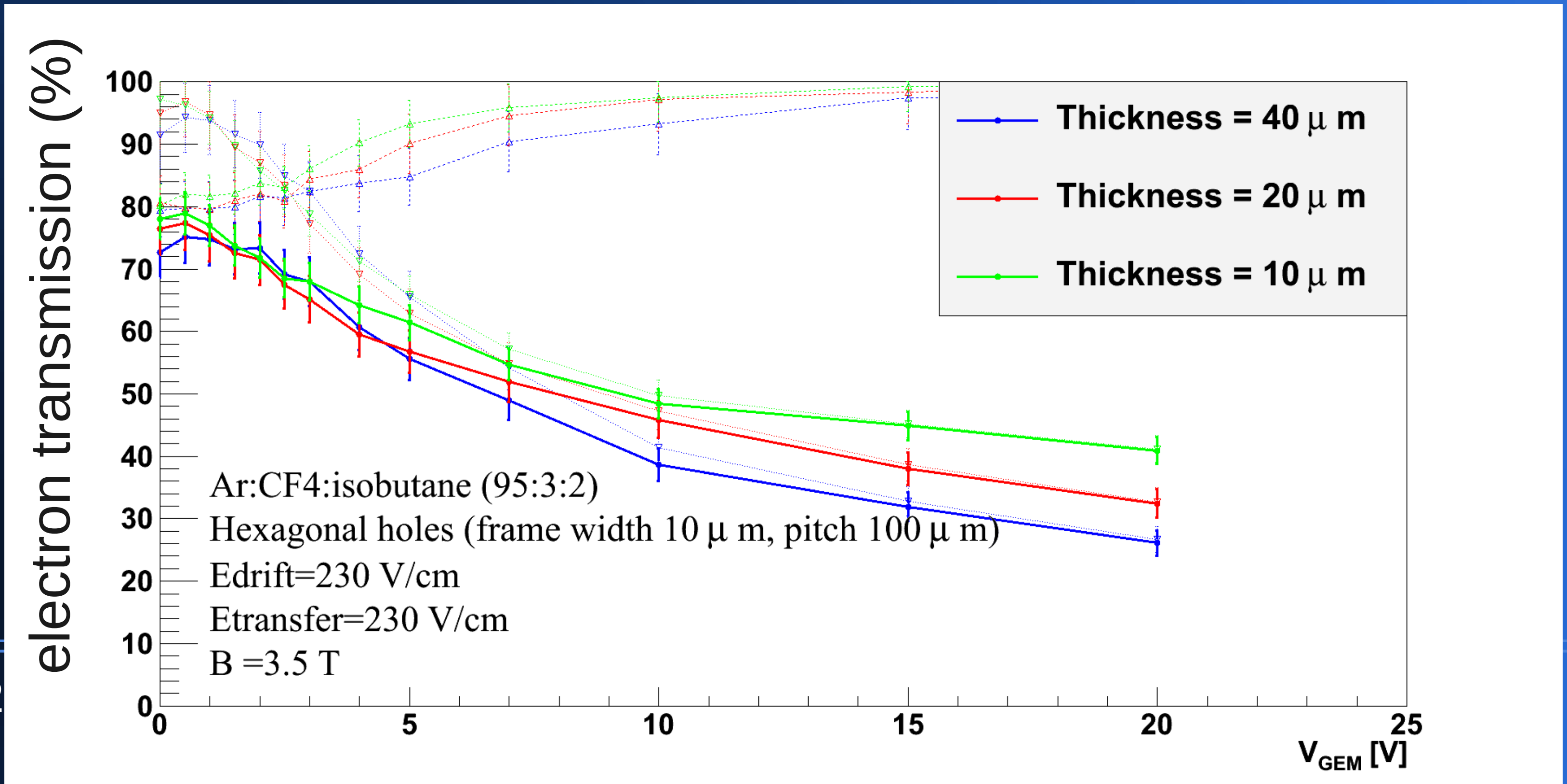
First result

- Without magnetic field
- Good transparency requires extreme conditions



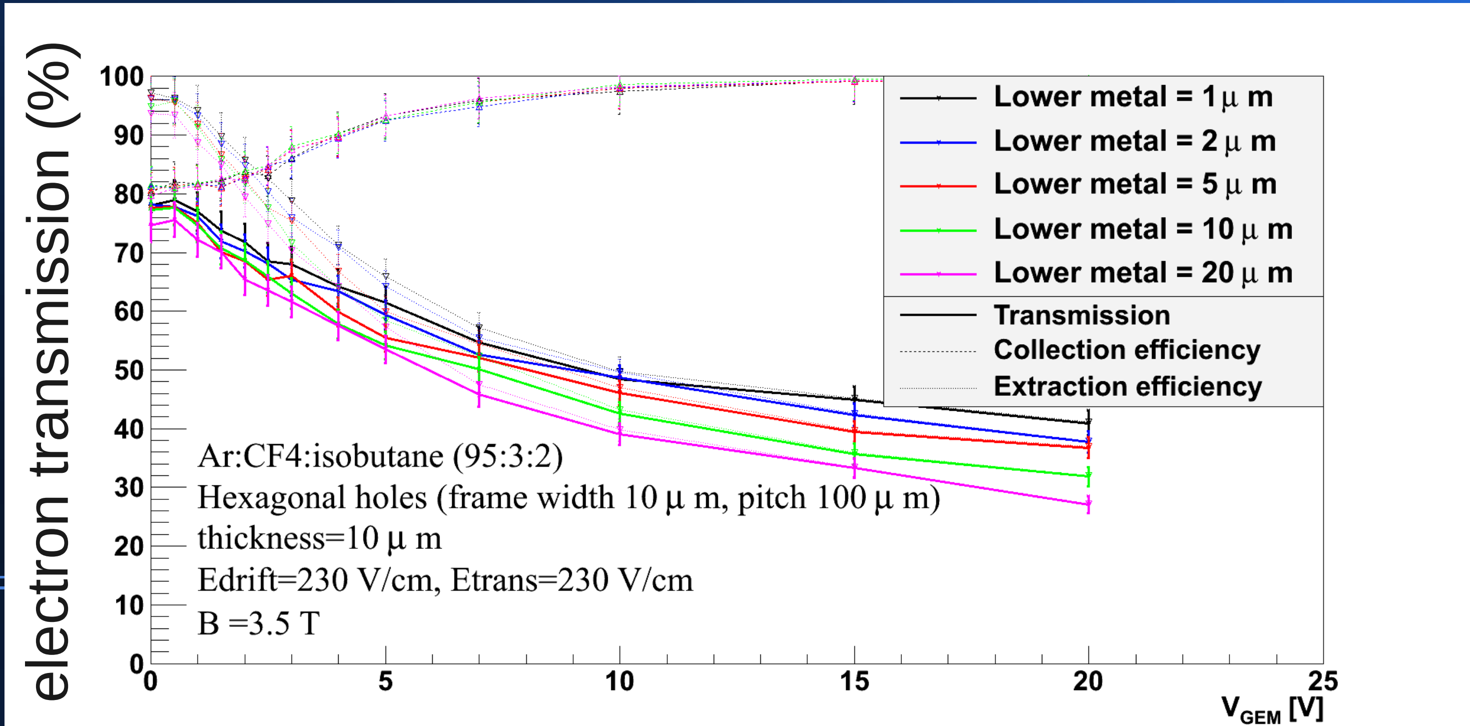
With 3.5T B field

- ωτ~10 => the electrons follow B, little diffusion
- Electric field and thickness have little influence
- Geometric transparency (81%)



Outlook on GEM gate

- In high B field, geometrical aperture is the key parameter
- Difficulties are mechanical
  - Maybe improved with thicker metal



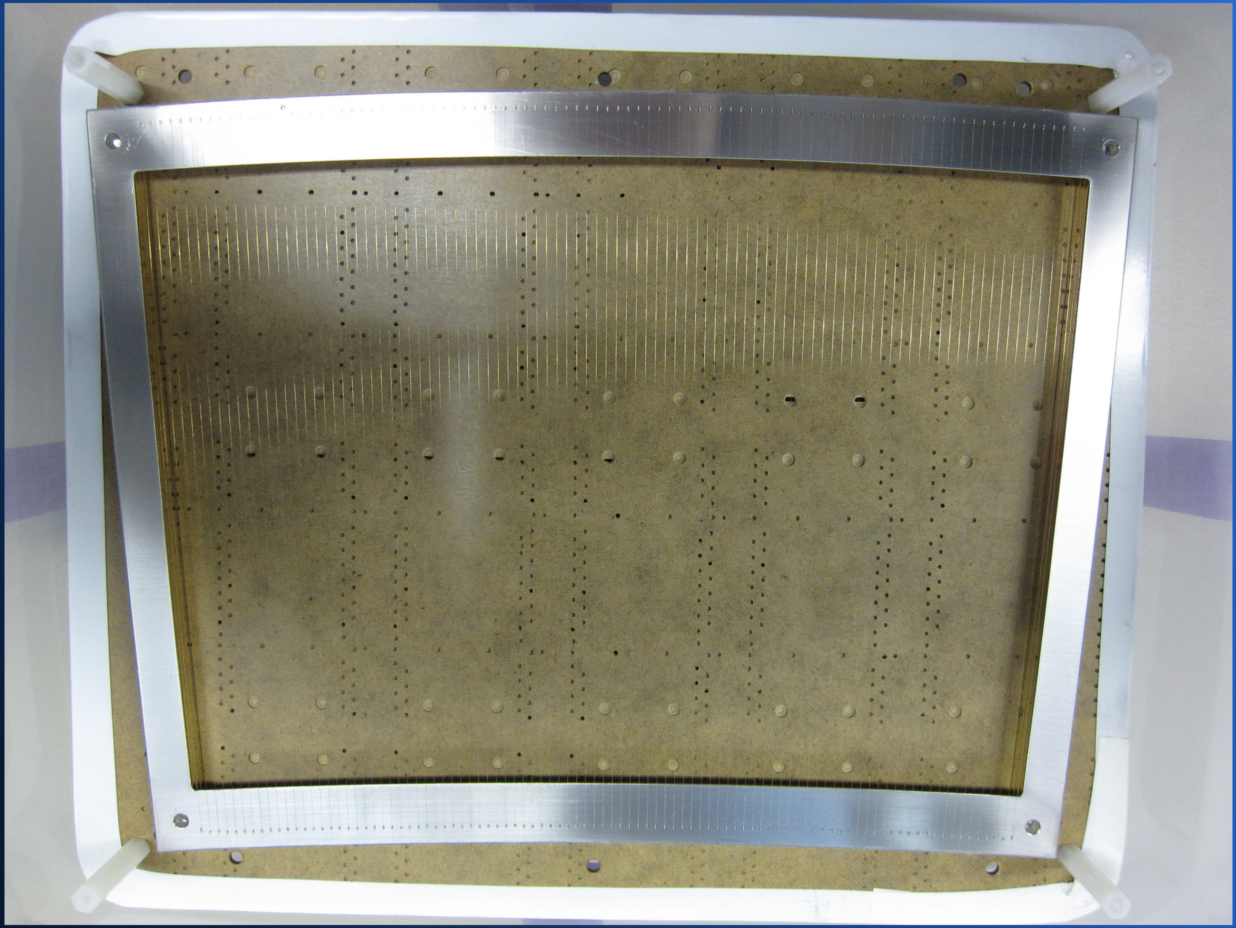
Wire gate

- Well known technology
- Difficult to adapt to the module structure
- Possible effects of B field

  => *Radial wires*

  - No radial support structure: minimises dead regions
  - ExB in the wire direction => minimises distrotions

Radial wire gate prototype



Status

- 3 prototypes were built
  - 30μm wires, 2mm pitch
  - spot welded on stainless steel frame
  - only one potential: no alternate potential closed gate scheme
- Could not be tested yet
  - small design error has to be fixed
- Planned test with laser at KEK
- Needs to be tested in B field

Conclusions and outlook

- An ion gate is necessary to reach the performance requirements of LCTPC
- Two technologies are considered: GEM or wires
  - Simulations show that at high B field, a GEM gate's transparency is defined by the geometrical aperture. Mechanical solutions have to be studied
  - A gate prototype with radial wires has been produced and will be tested at KEK