Carleton R&D studies of GEM readout for a TPC tracker

TESLA detector R&D kickoff

CERN, May 9, 2001

Carleton GEM group:

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http://www.physics.carleton.ca/~karlen/gem

Outline

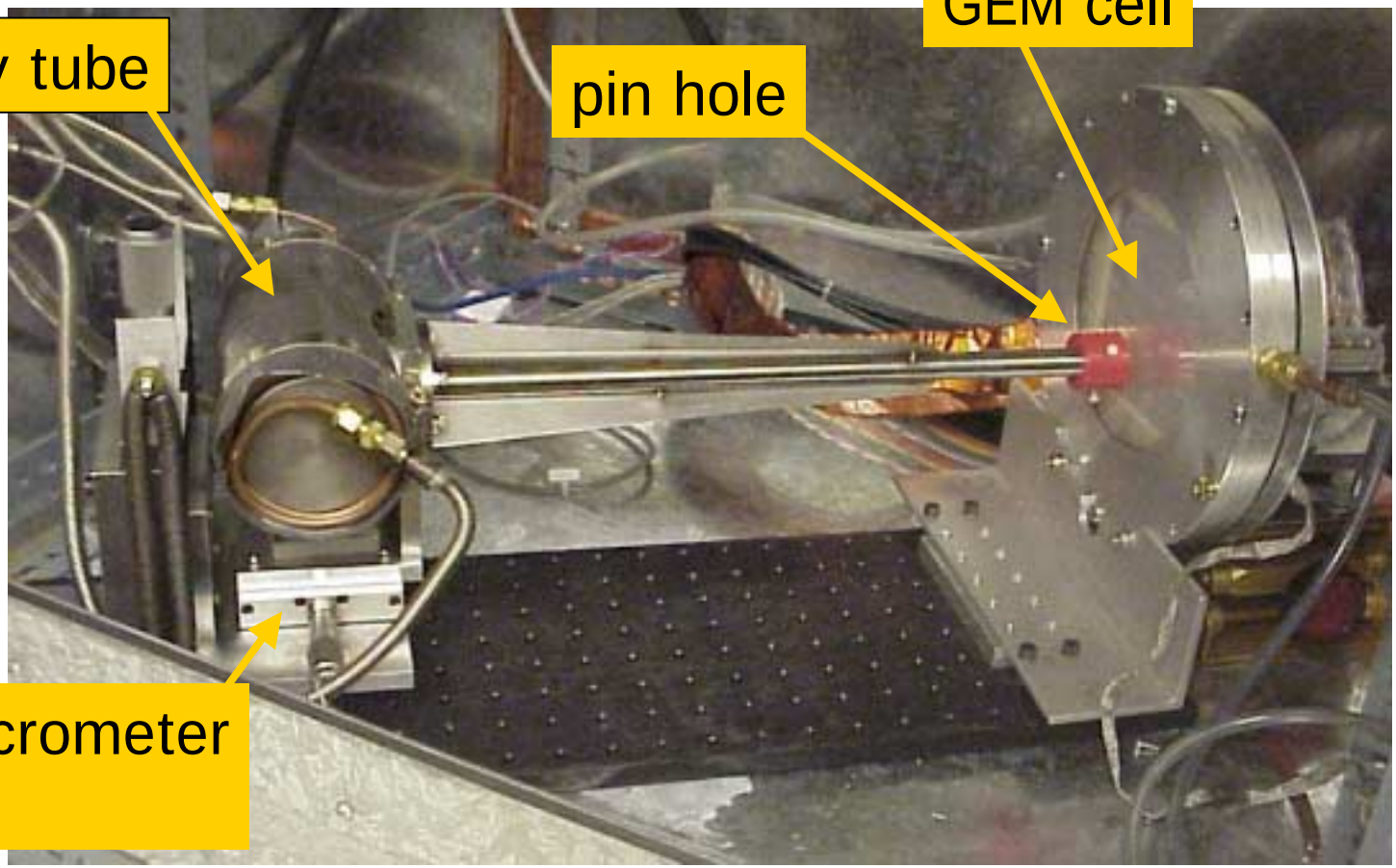
- Goals
- Ongoing activities:
  - space point resolution studies
    - for details: attend May 10 meeting
  - simulation studies
- Plans for future studies:
  - GEM readout of mini-TPC
  - available resources
- Issues to be addressed

Goals

- To demonstrate that the potential advantages for GEM readout can be realized:
  - Improved space point resolution
    - **E**×**B** and track angle systematics suppressed
  - Improved two particle separation power
    - r -ϕ : signals distributed over smaller area
    - z : faster induction pulses ($v_e > v_{ion}$)
  - Natural ion feedback suppression
    - no gating required (non-triggered expt.)
  - Less mass in the TPC endcap
    - no wires held under tension

present focus:

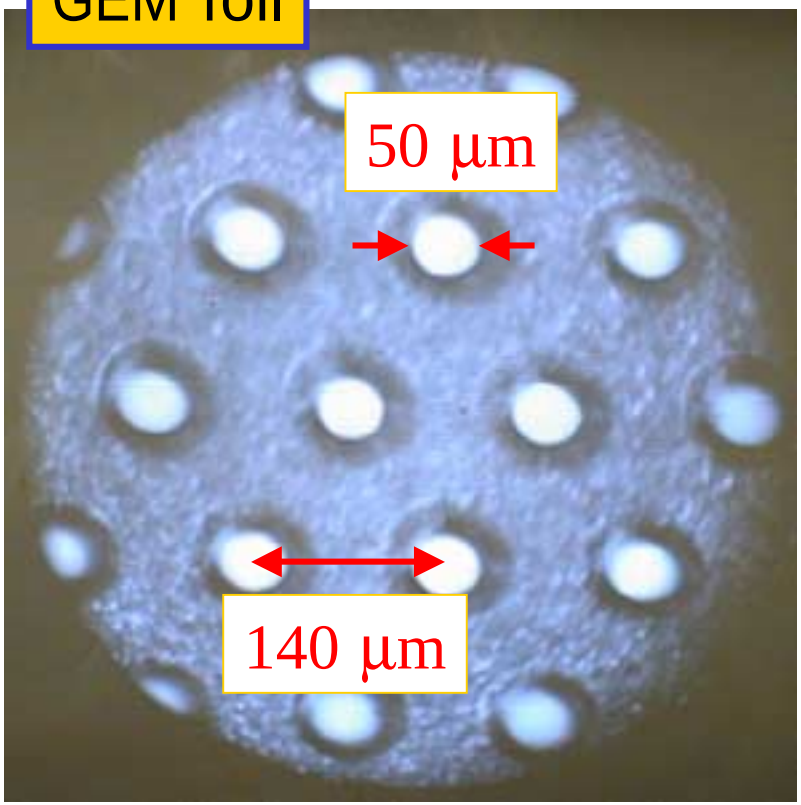
Point resolution studies at Carleton



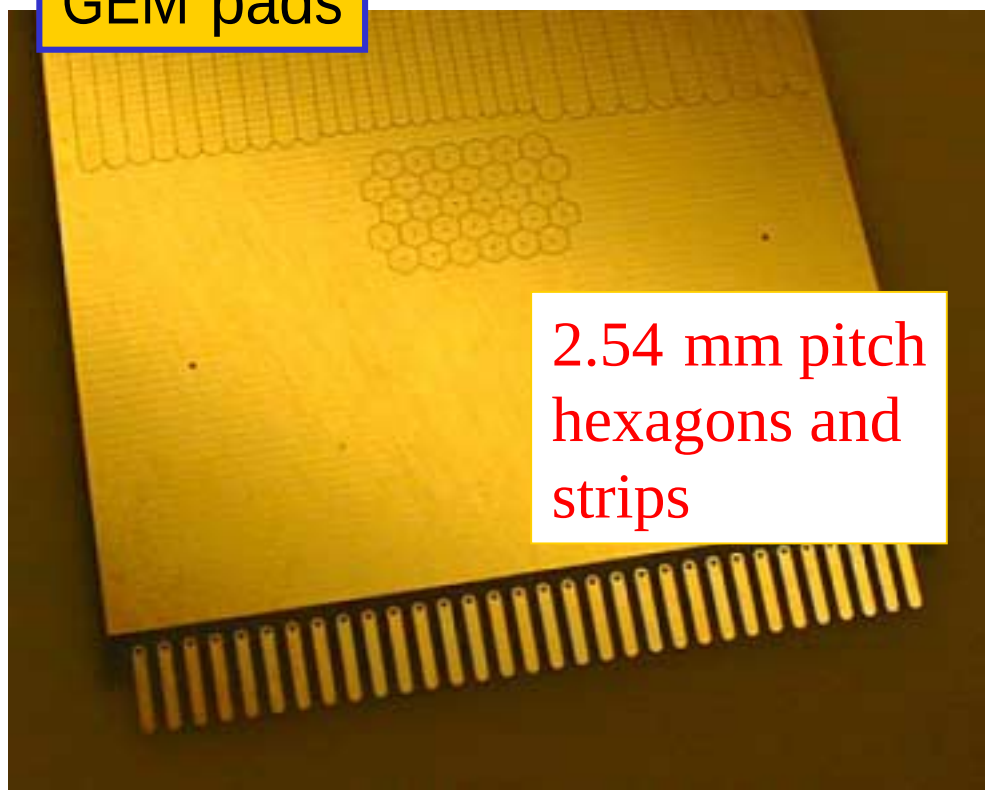
GEM foils and pads

fabricated at the CERN PCB workshop

GEM foil

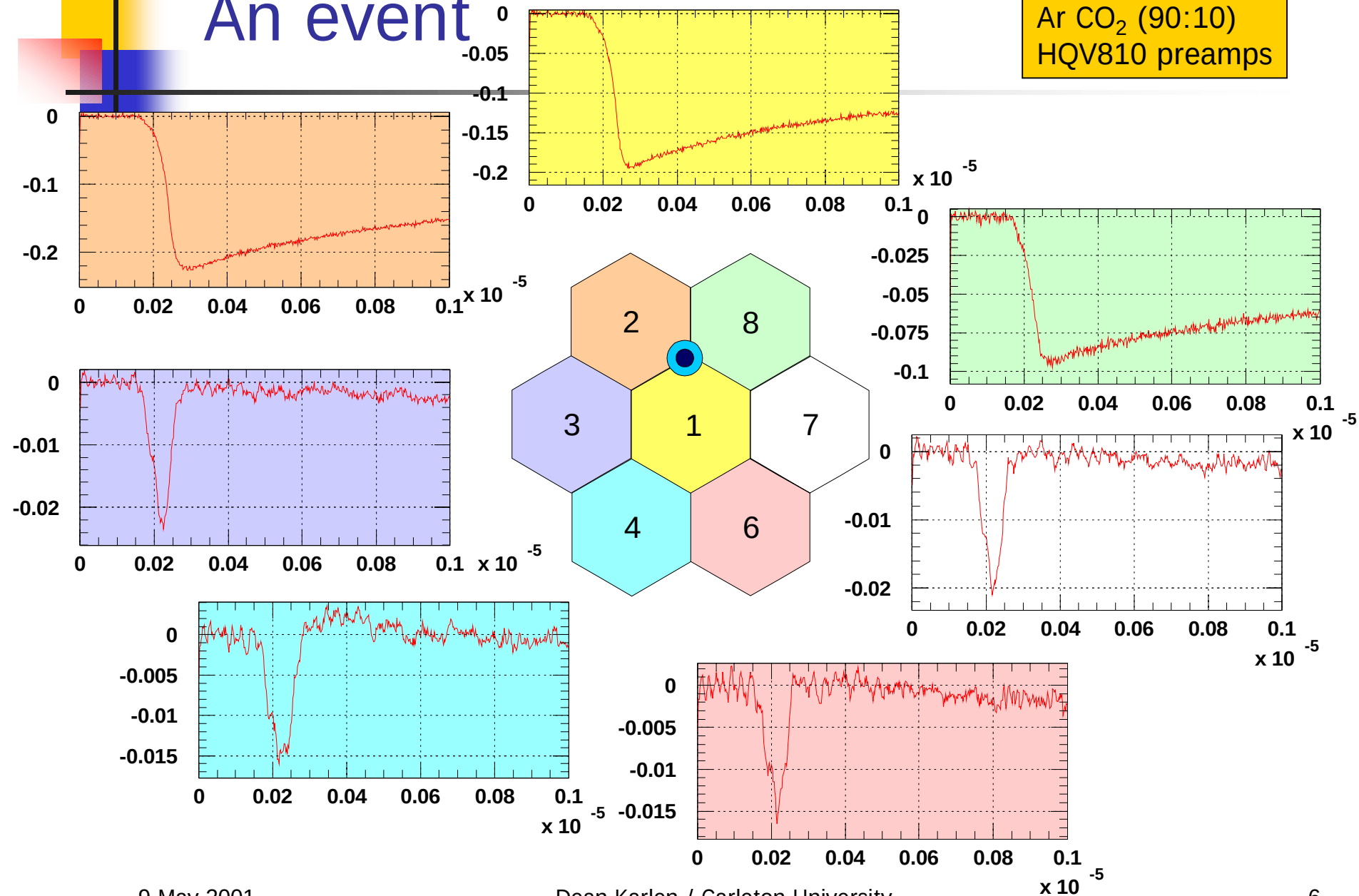


GEM pads

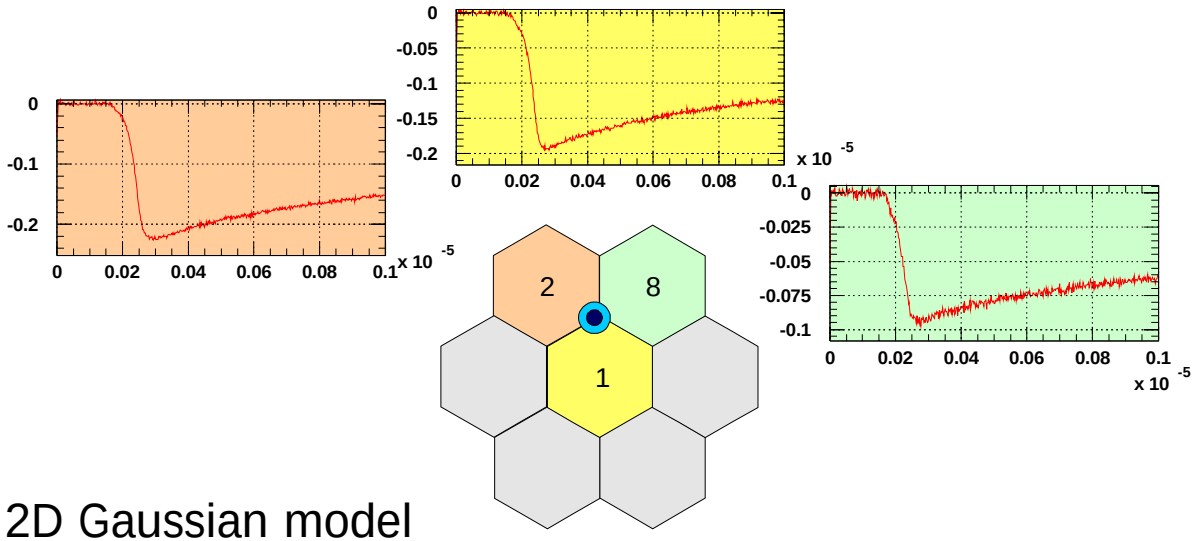


An event

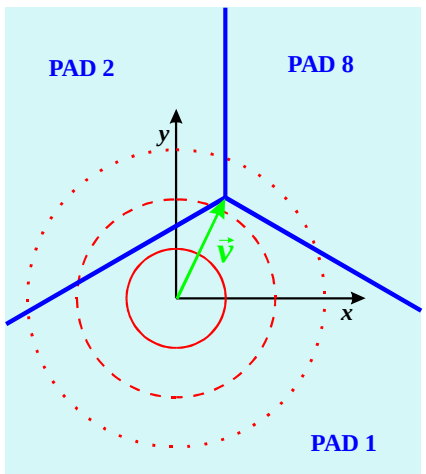
Ar CO_2 (90:10)
HQV810 preamps

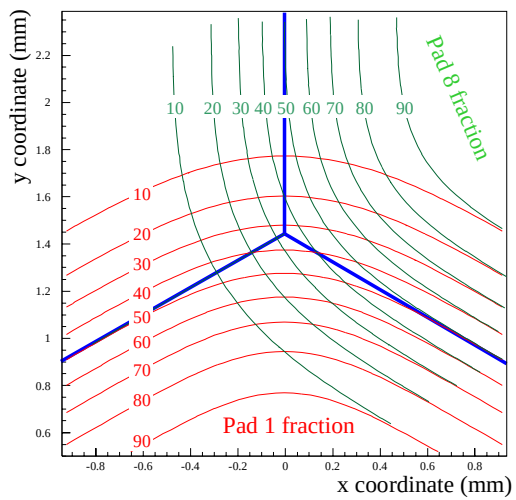


Position estimate from charge sharing



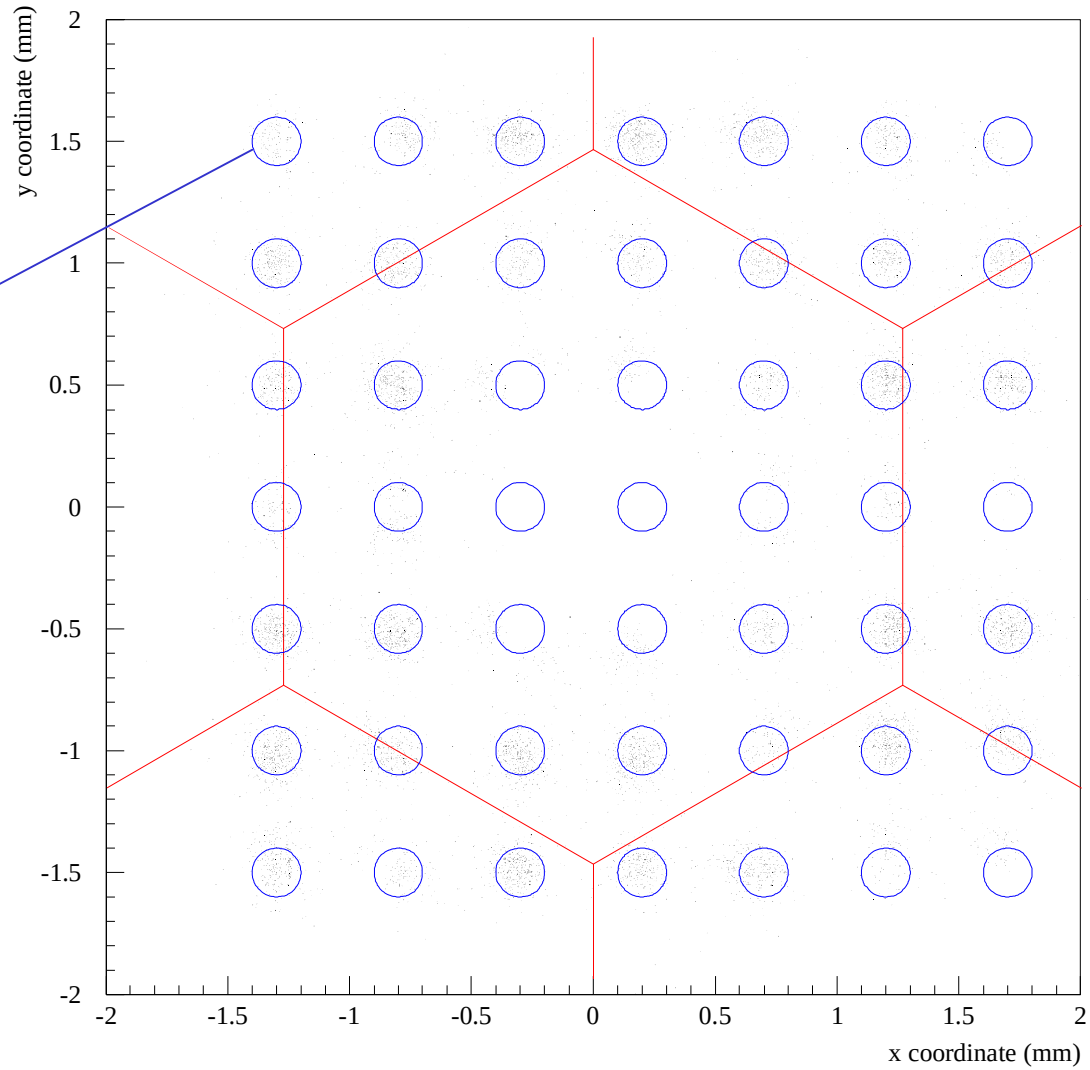
2D Gaussian model





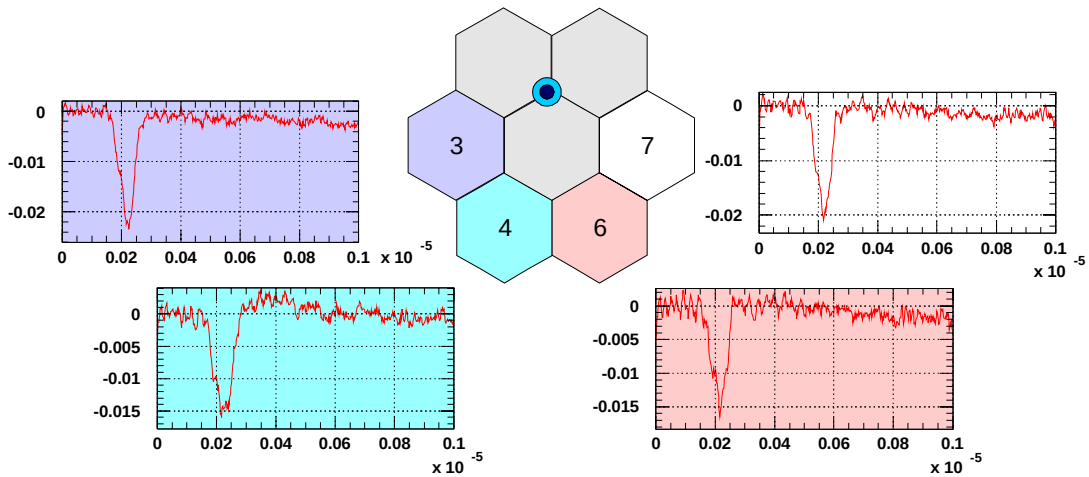
Scan over entire pad – charge sharing

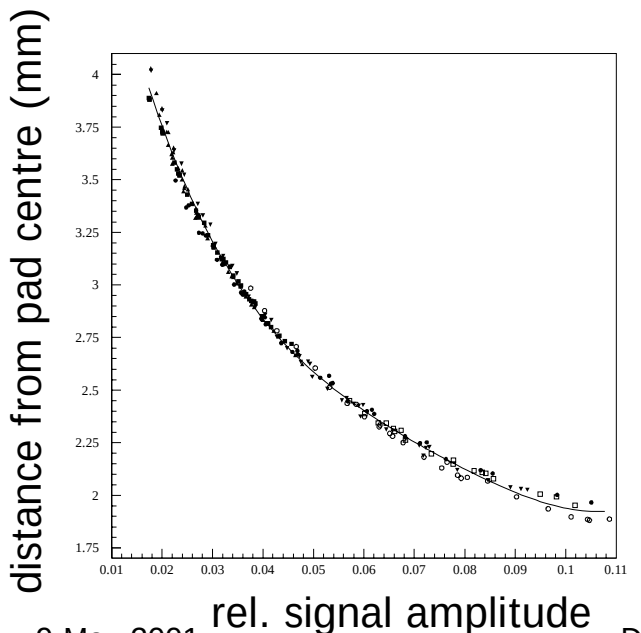
100 μm circles centred at pin hole locations during scan

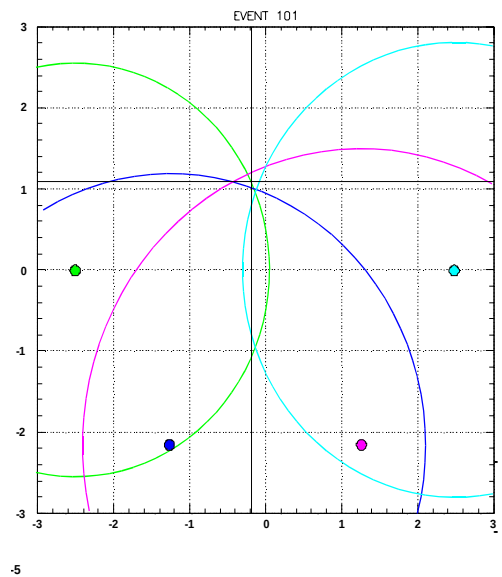


- With P10 gas:
  - cloud size 550 μm
  - x,y standard deviations: ~70 μm

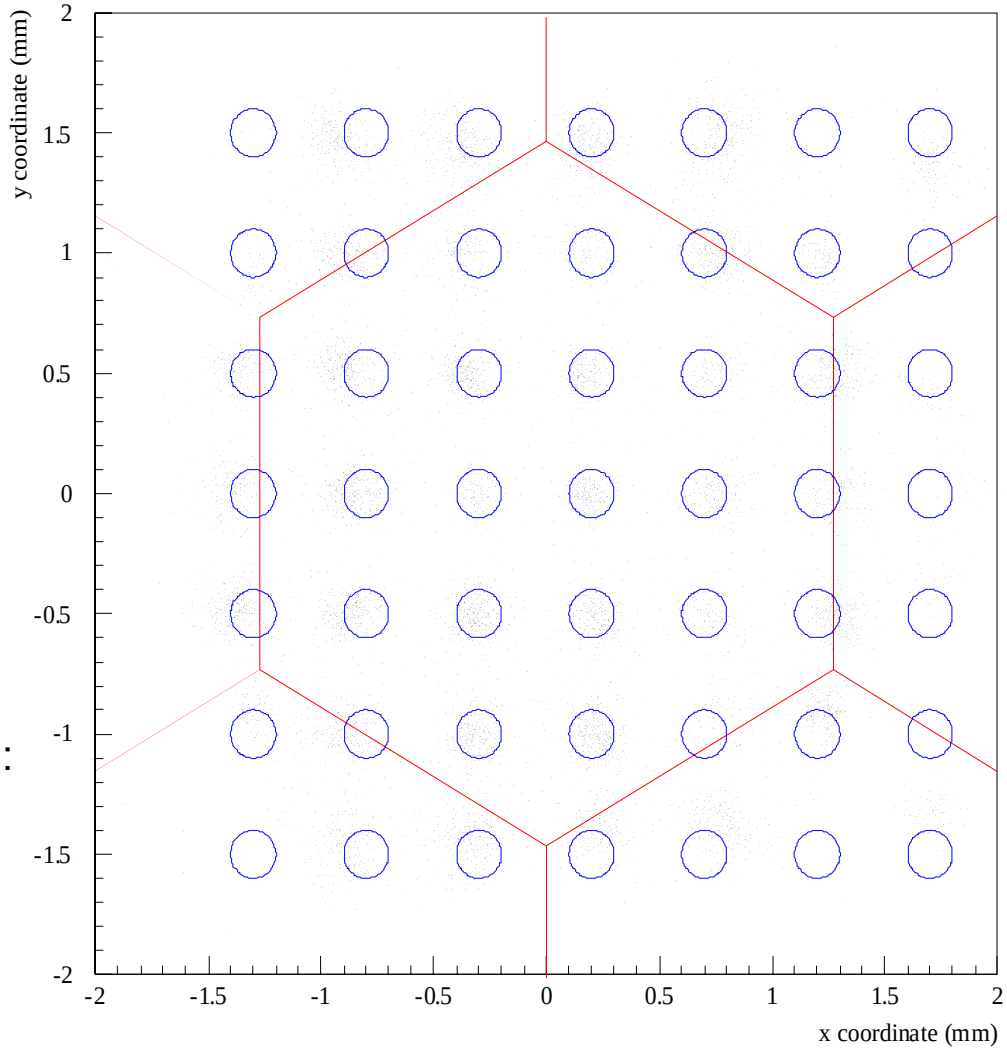
Position estimate from induced signals





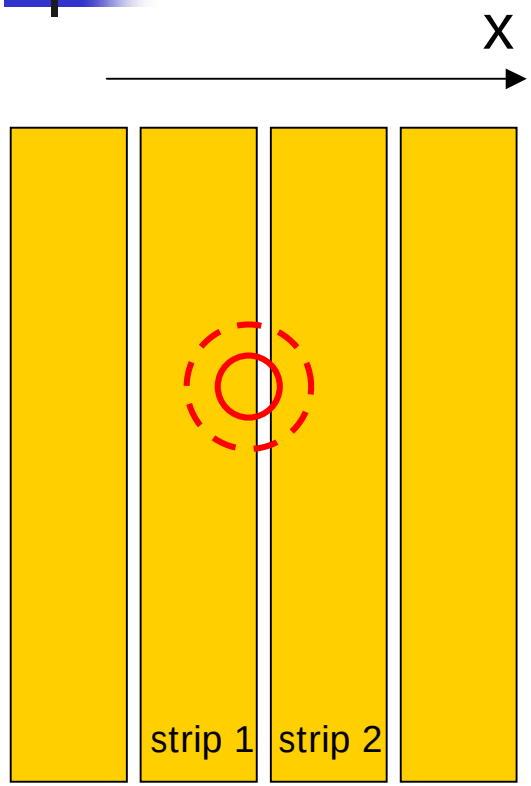


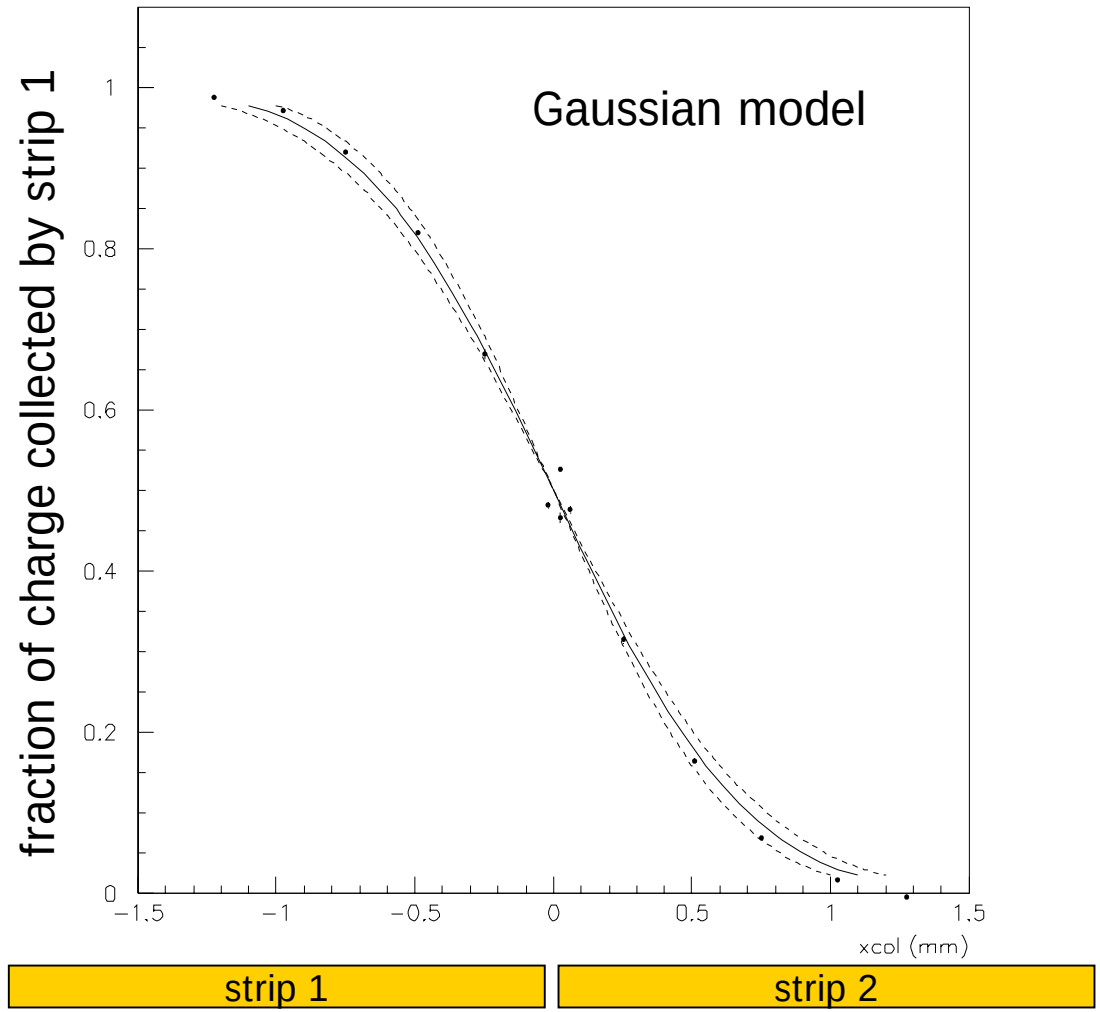
Scan over entire pad – induced signals



- With P10 gas:
  - x,y standard deviations: ~80 μm
  - note: systematics in x clearly seen

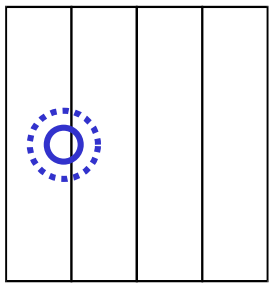
Strip geometry – charge sharing

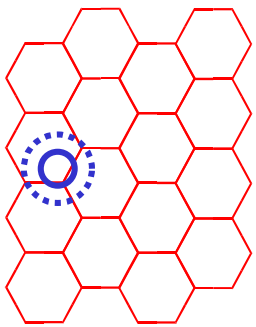


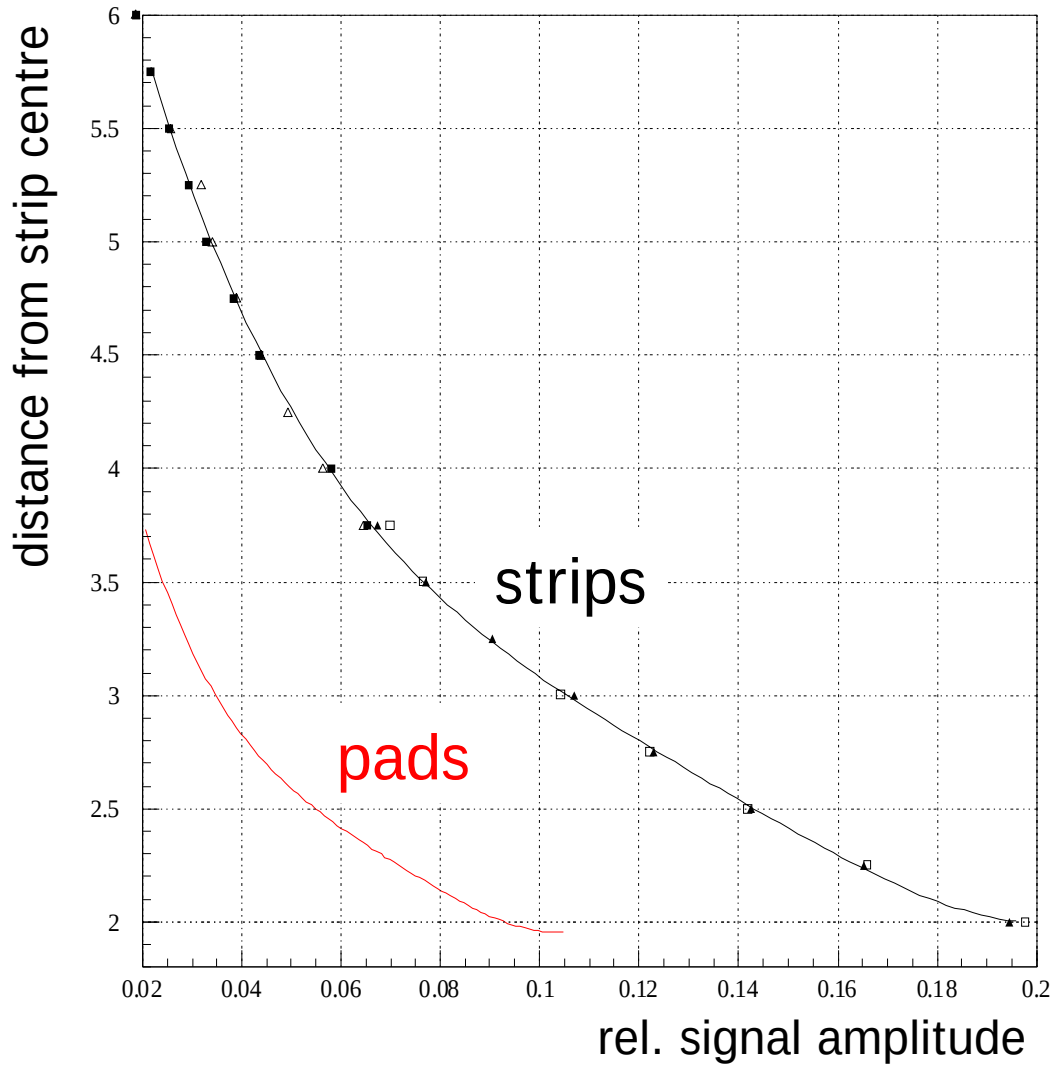


- With P10 gas:
  - x standard deviation: ~70 µm

Strip geometry – induced signals



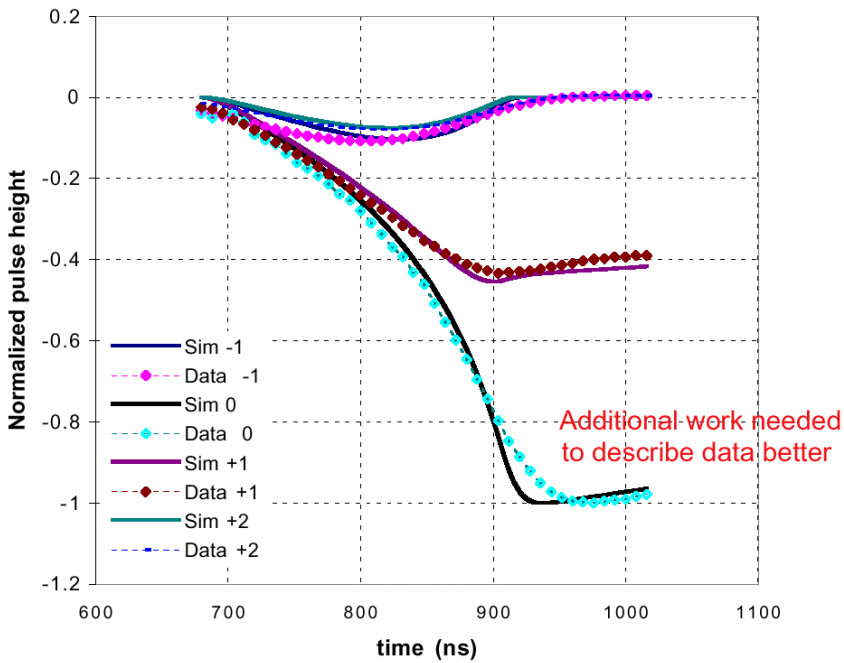


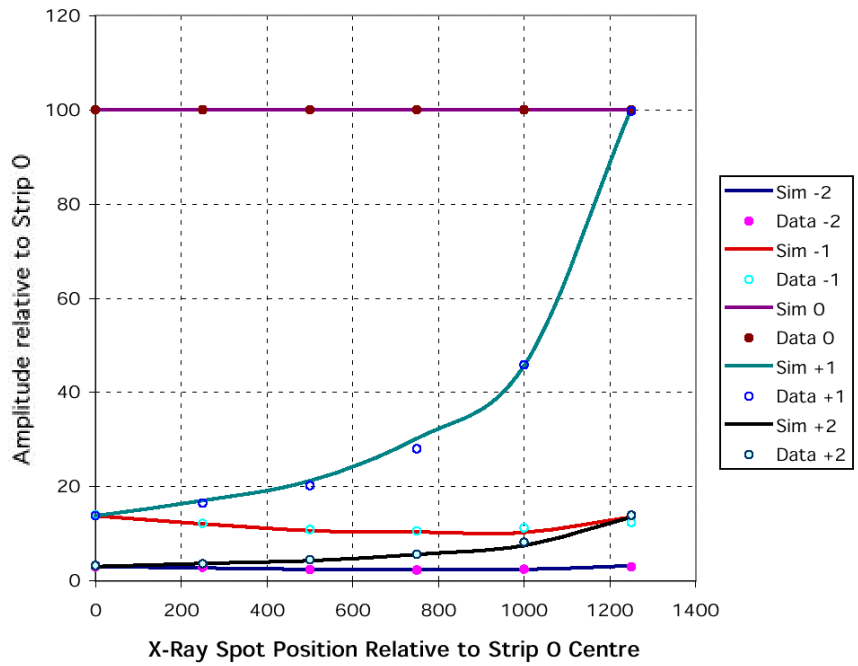


- Strip geometry has larger induced signals by factor of 2 – 3
  - x standard deviation: ~70 μm

Simulation studies

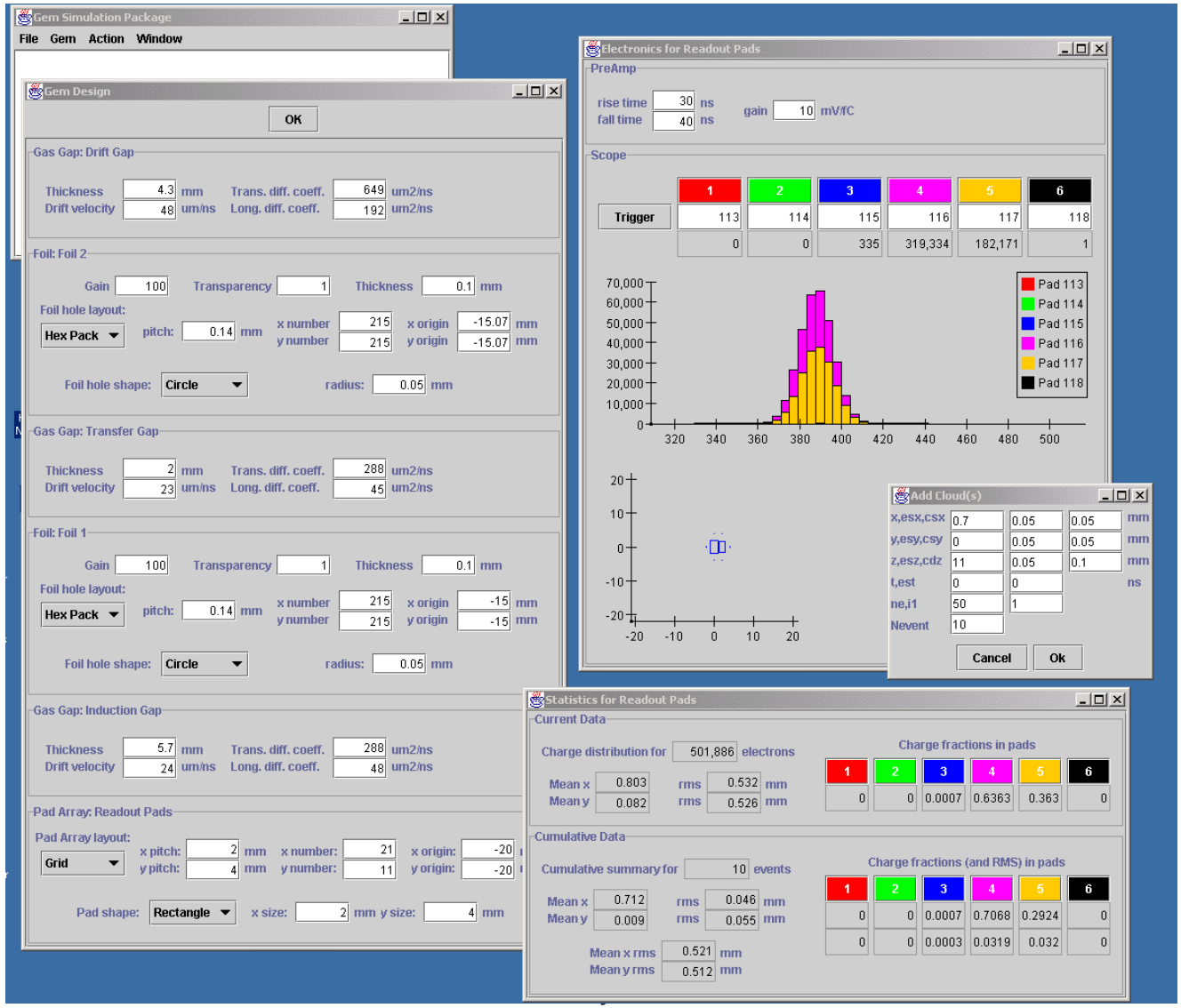
- Simulation using 1st principles confirms understanding of signals





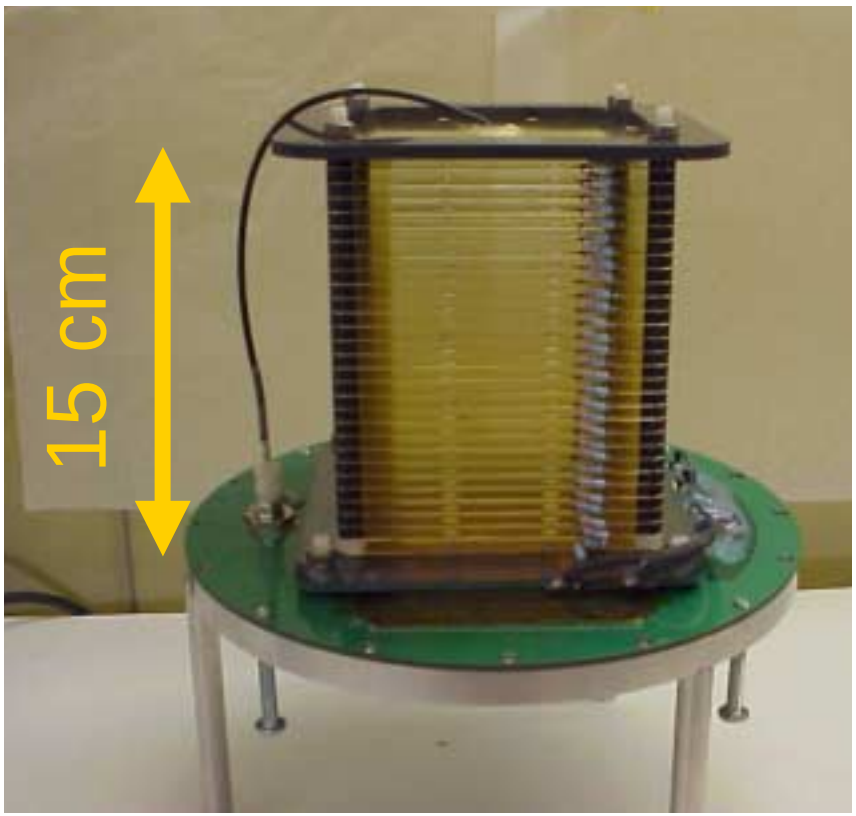
Simulation studies (cont.)

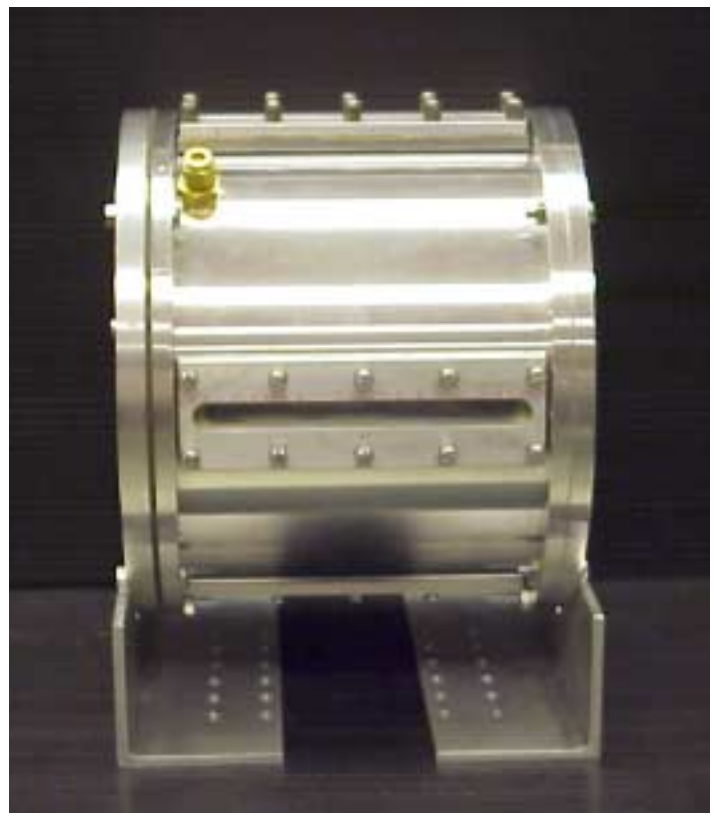
- Java simulation of GEM under development
  - arbitrary GEM structure can be defined interactively
  - empirical simulation of pad signals



Plans for future studies

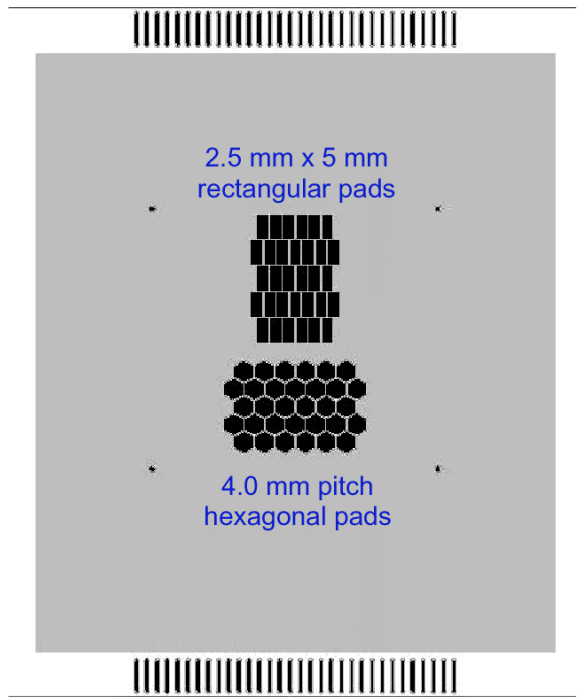
- Mini-TPC constructed and being commissioned





Plans for future studies (cont.)

- Mini-TPC readout with cosmic ray telescope
  - 200 MHz FADC developed by J.P. Martin (Montreal)
  - new readout structures
  - estimate tracking resolution with triplets
  - two track resolution?
  - test beam?



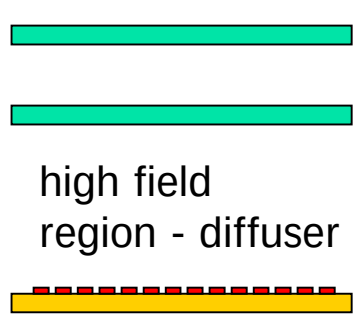
Available resources

- Received Canadian funding (~150 k CHF/yr) for three years to carry out GEM/TPC R&D
- Personnel:
  - M. Dixit, D. Karlen : primary research time
  - R. Carnegie, H. Mes : fraction of research time
  - J. P. Martin : FADC readout system
  - Post-doc : leaving soon – looking for replacement
  - Summer and co-op students
  - Carleton designers and machine shop (STC)

Issues

- Optimization of design
  - gas choice
  - GEM stages
  - pad design

} all coupled for example:



  - optimize with simulation – check with data

- Long term stability

- A lot of work to be done!