# TPC GEM readout R&D

Snowmass workshop

July 14, 2001

Carleton GEM group:

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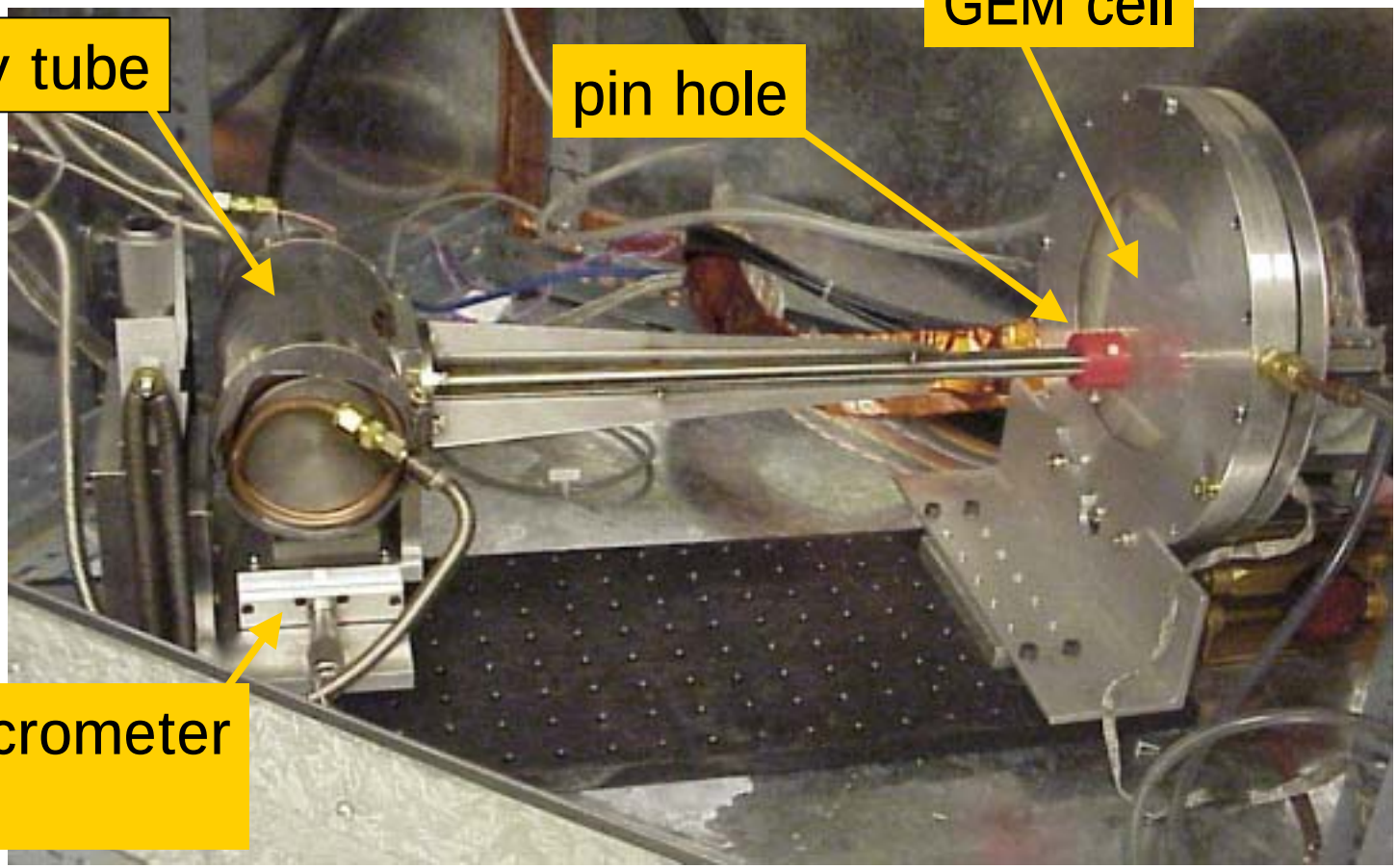
# Goals

- 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
    - $r$ -$\phi$ : 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:

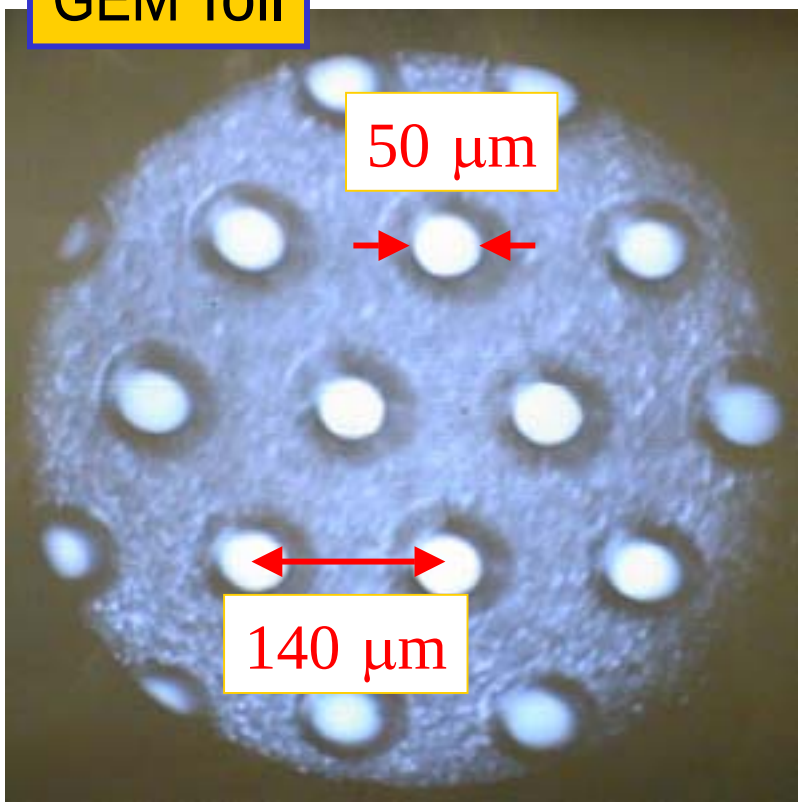
# Point resolution studies at Carleton



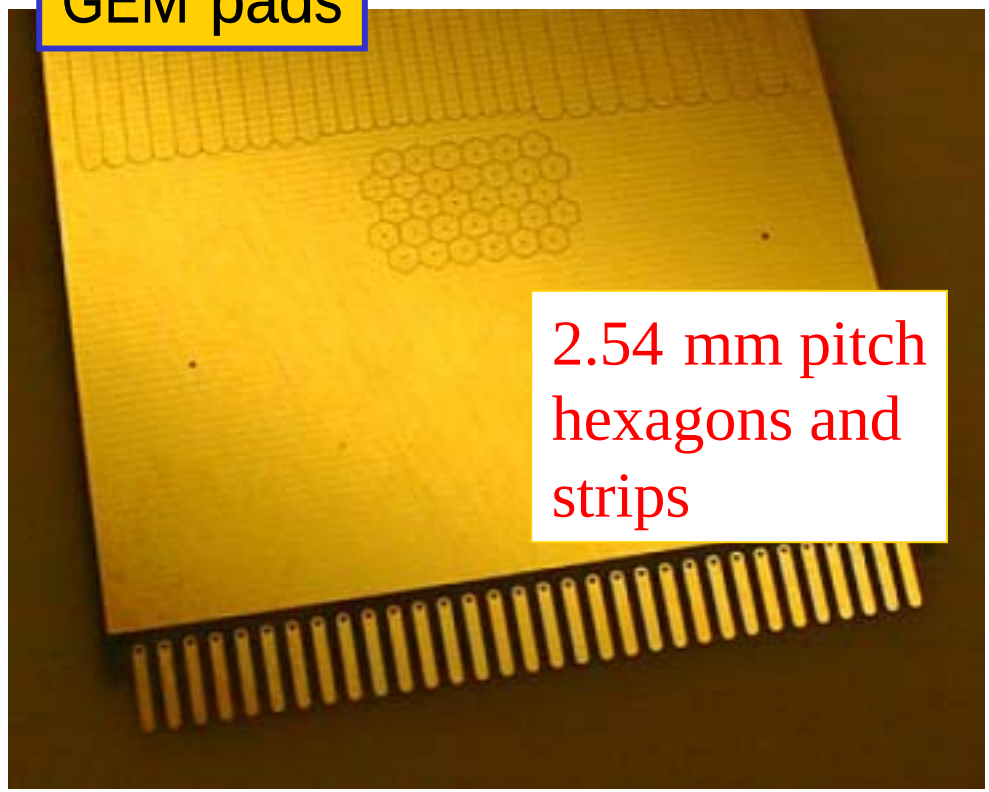
# GEM foils and pads

fabricated at the CERN PCB workshop

GEM foil

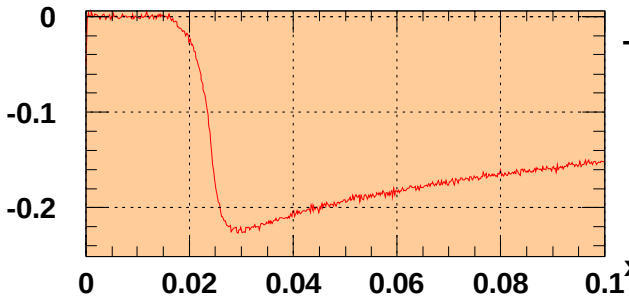


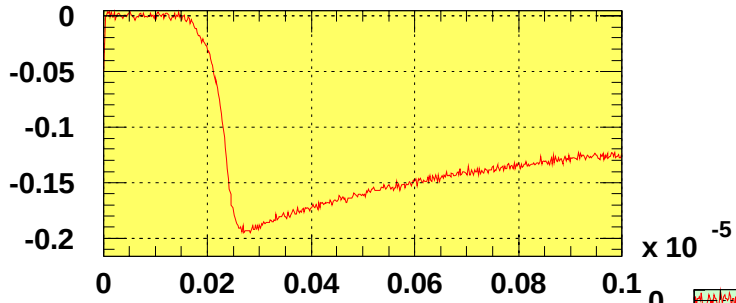

GEM pads

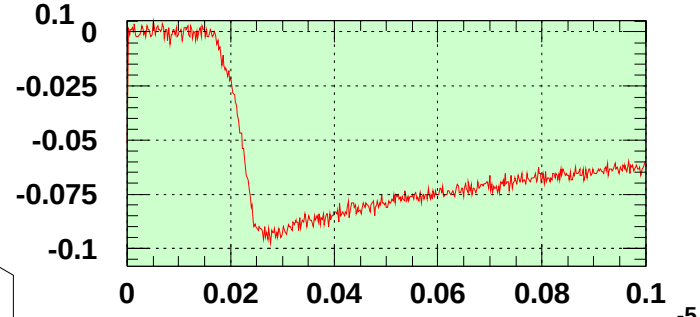


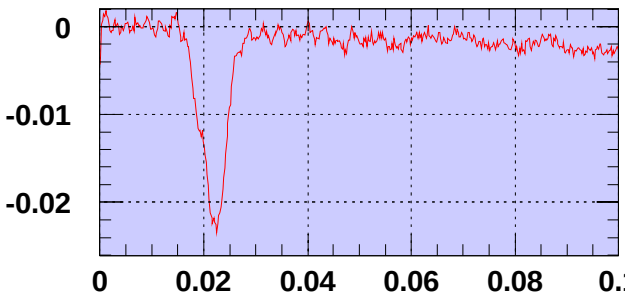
# An event

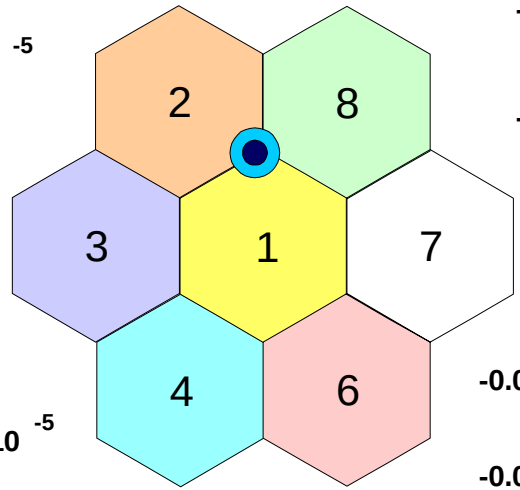
Ar $CO_2$ (90:10)
HQV810 preamps

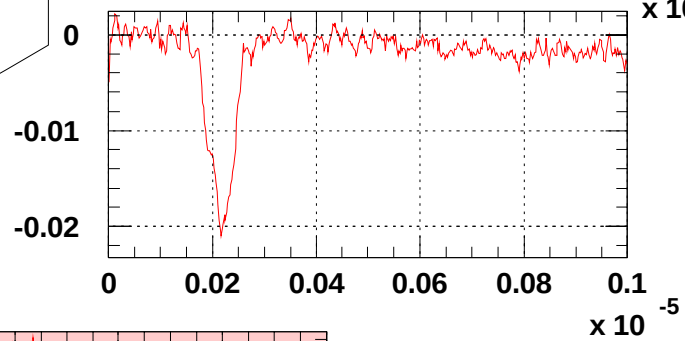


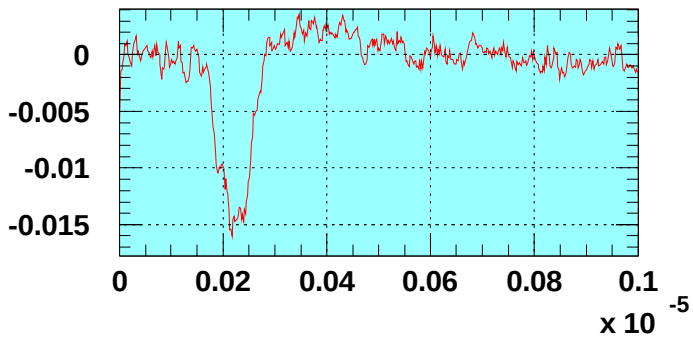



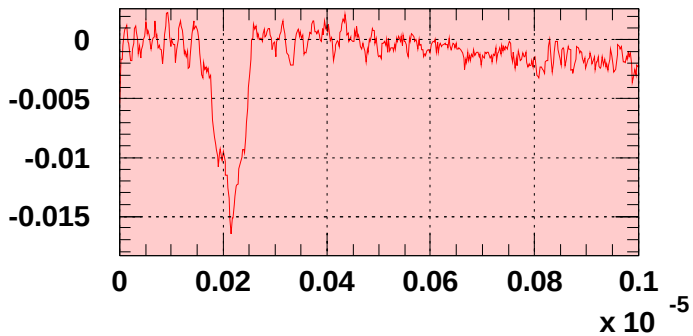



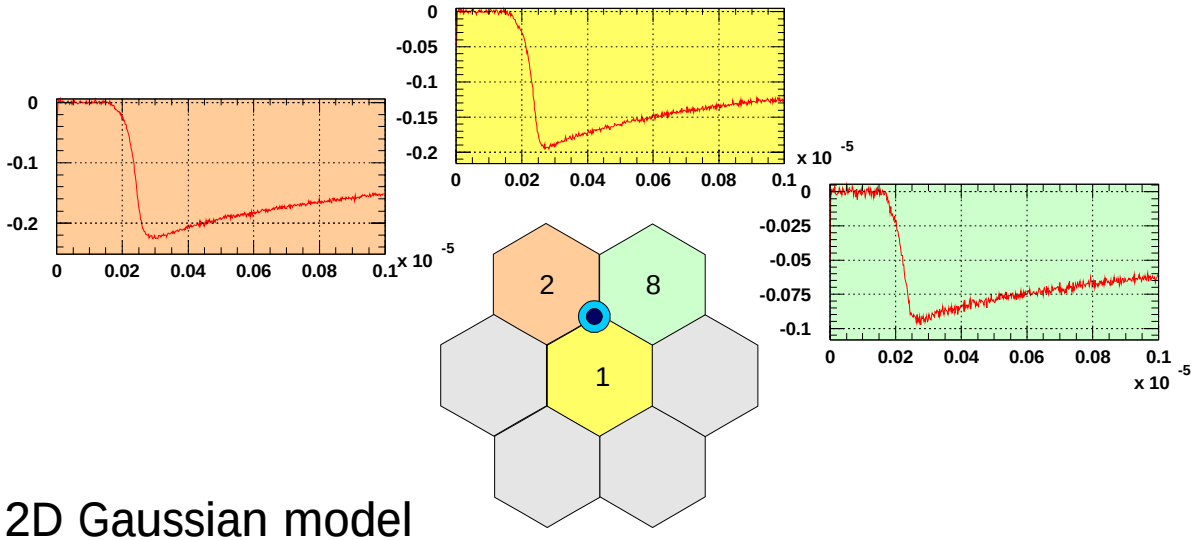



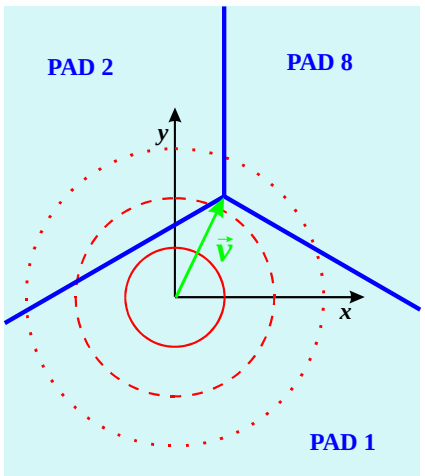



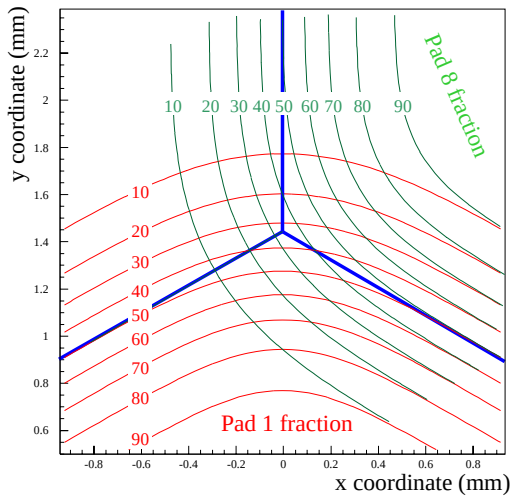



# Position estimate from charge sharing



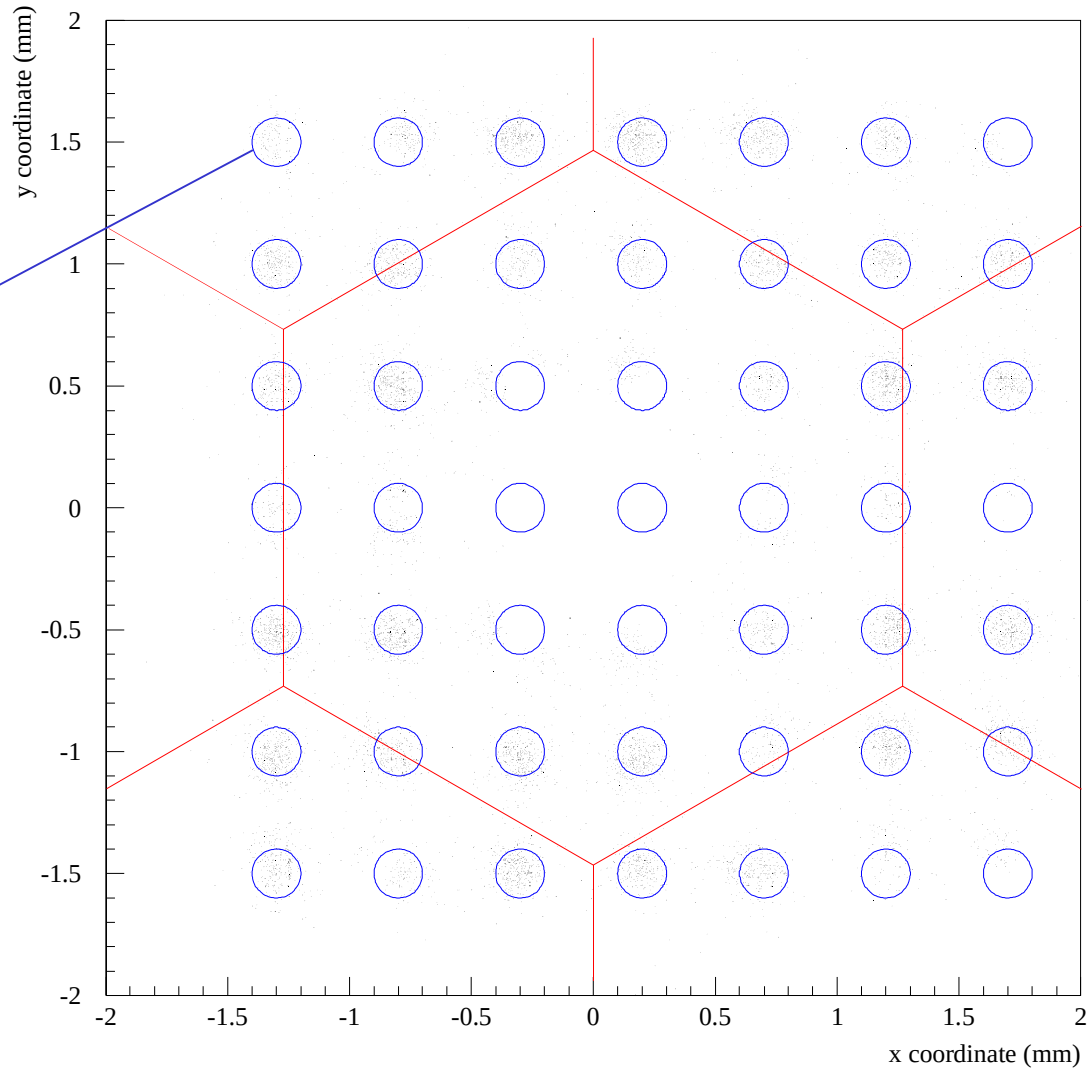

2D Gaussian model



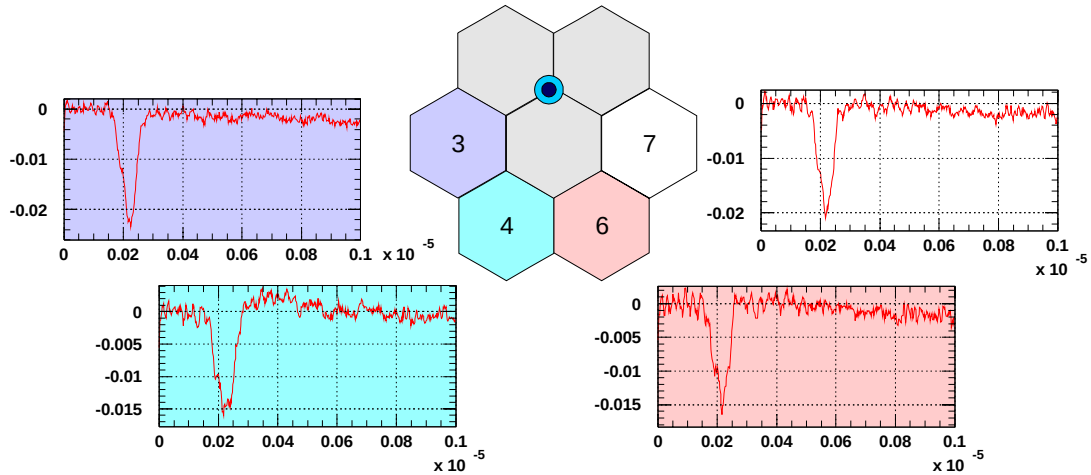
# Scan over entire pad – charge sharing

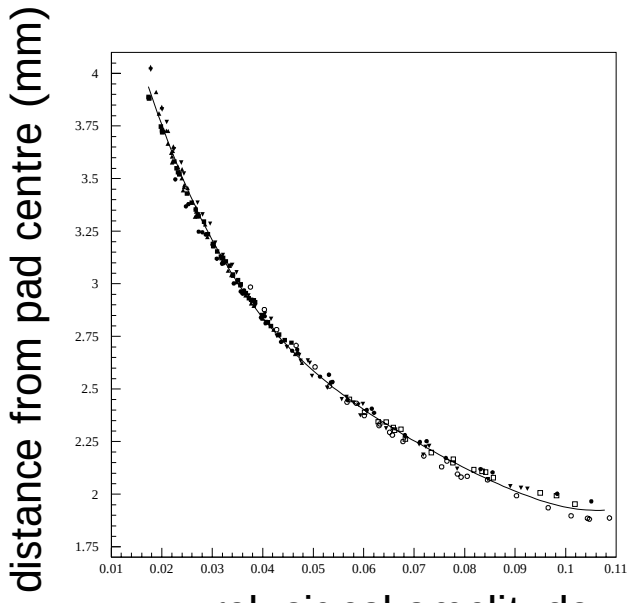
100 μm circles centred at pin hole locations during scan

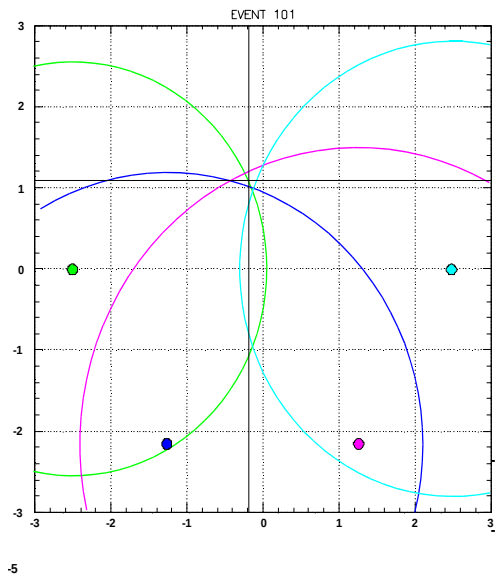



- With P10 gas:
  - cloud size 550 μm
  - x,y standard deviations: ~70 μm

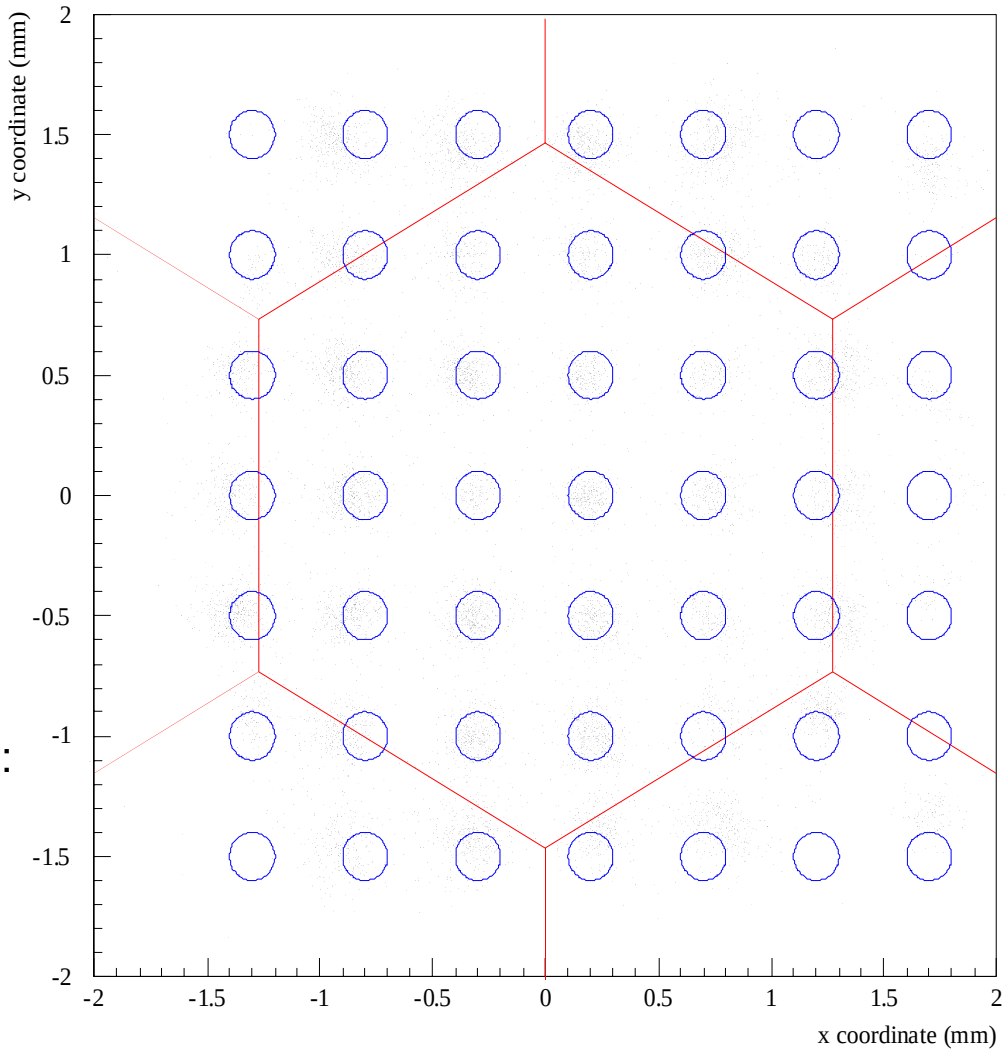
# Position estimate from induced signals



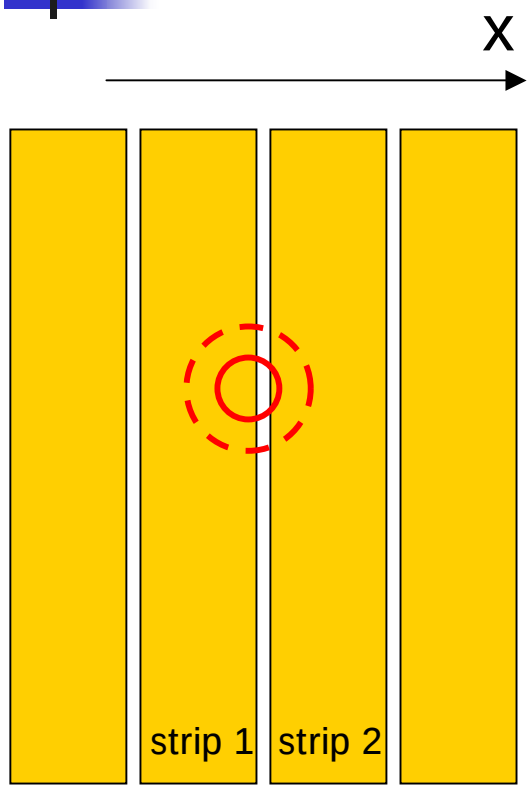



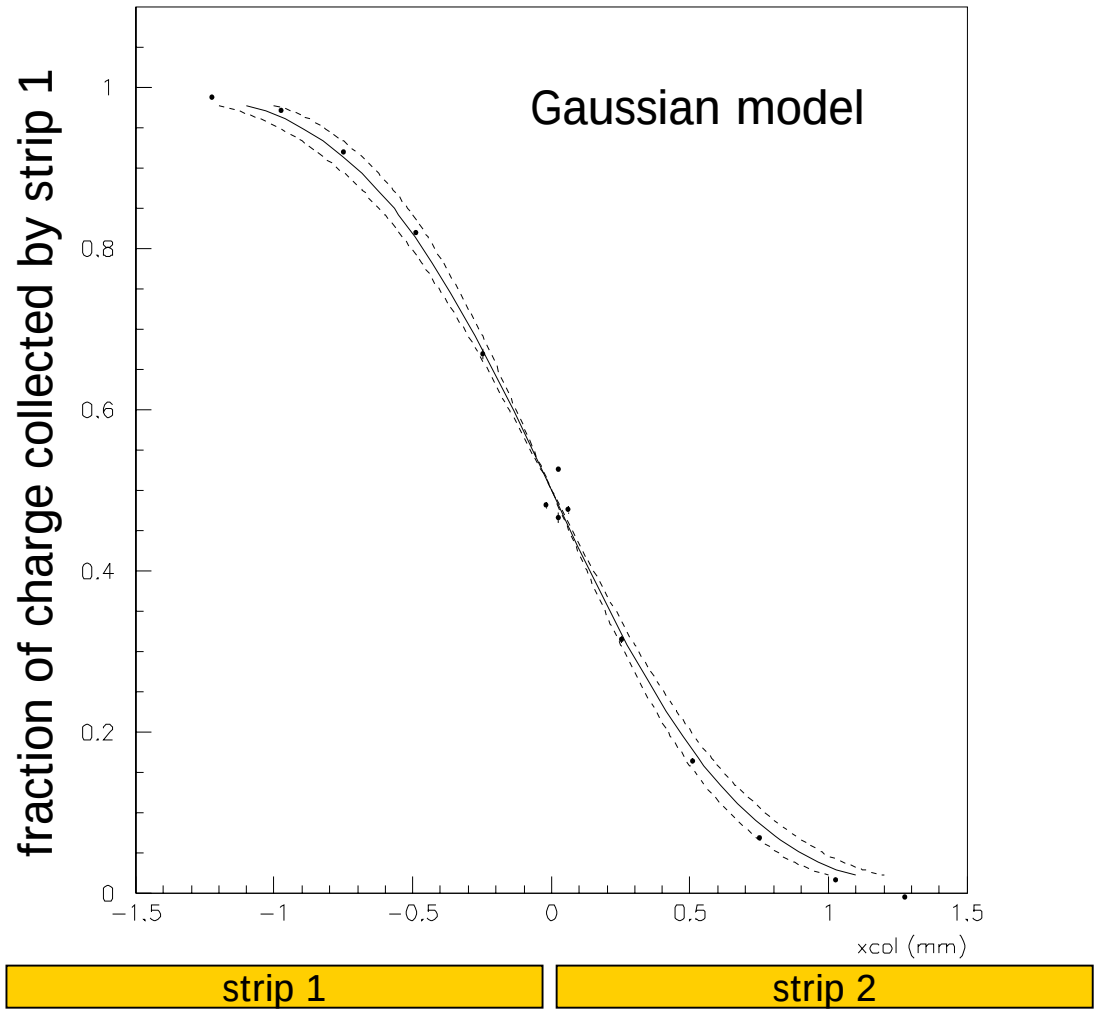
# Scan over entire pad – induced signals




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

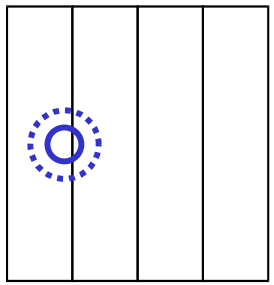
# Strip geometry – charge sharing

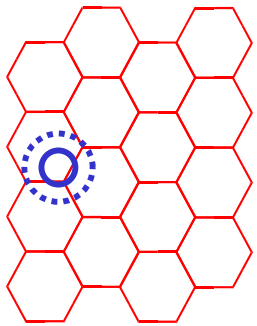


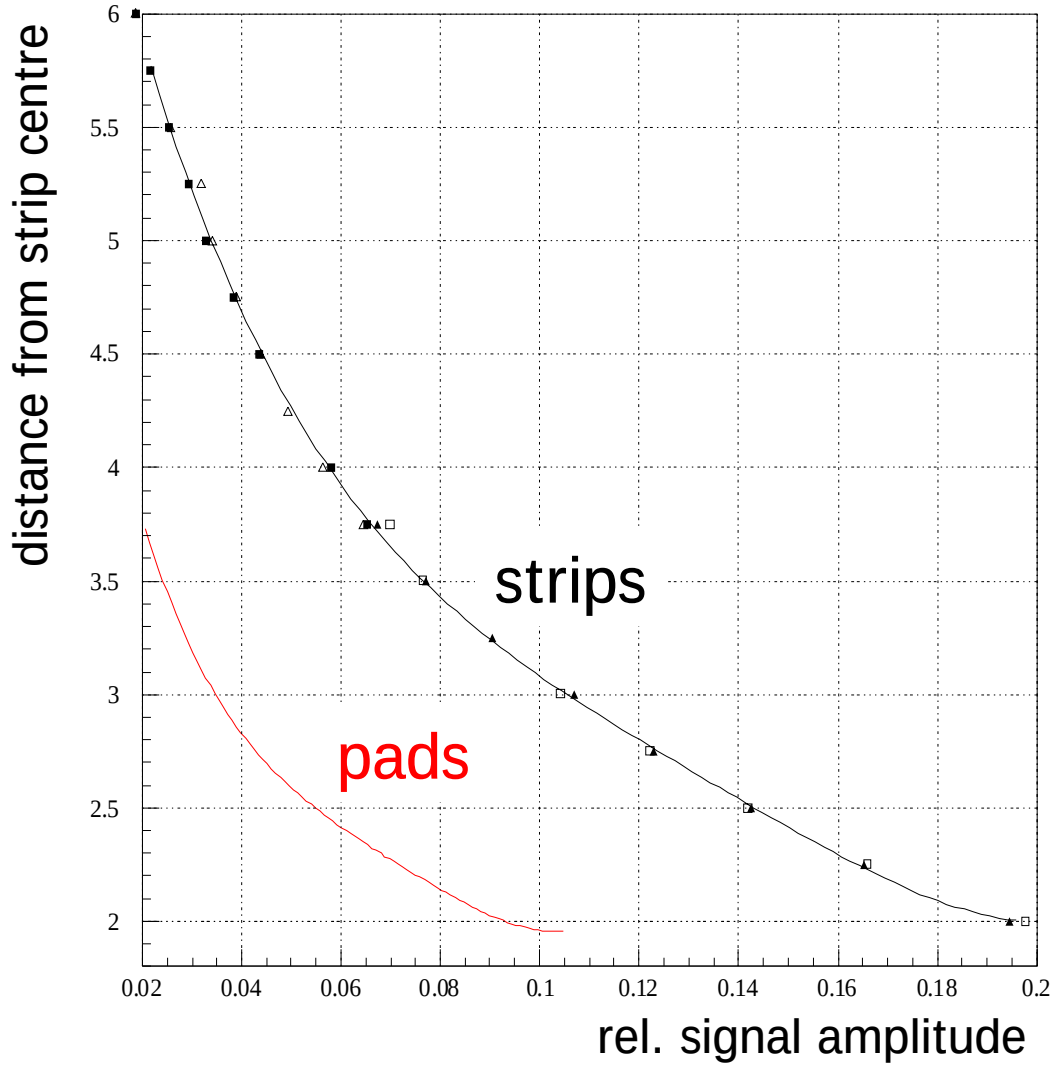




- With P10 gas:
  - x standard deviation: ~70 μm

# Strip geometry – induced signals



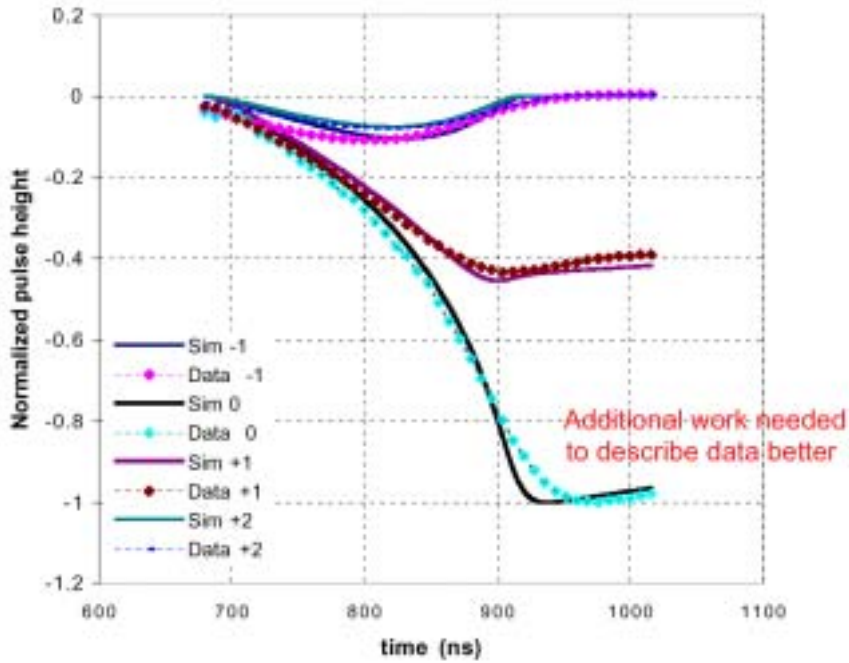


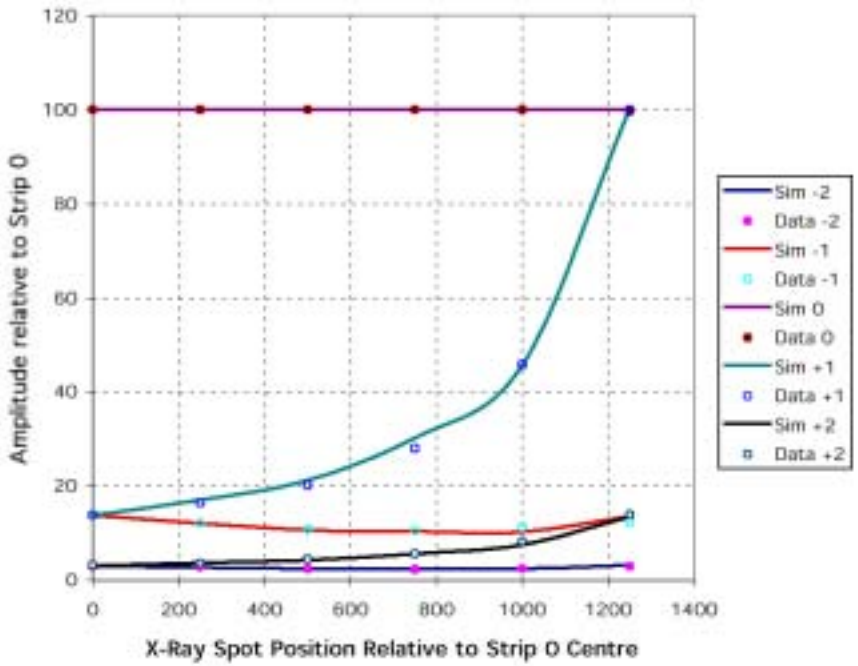



- Strip geometry has larger induced signals by factor of 2 – 3
  - x standard deviation: ~70 μm

# Simulation studies

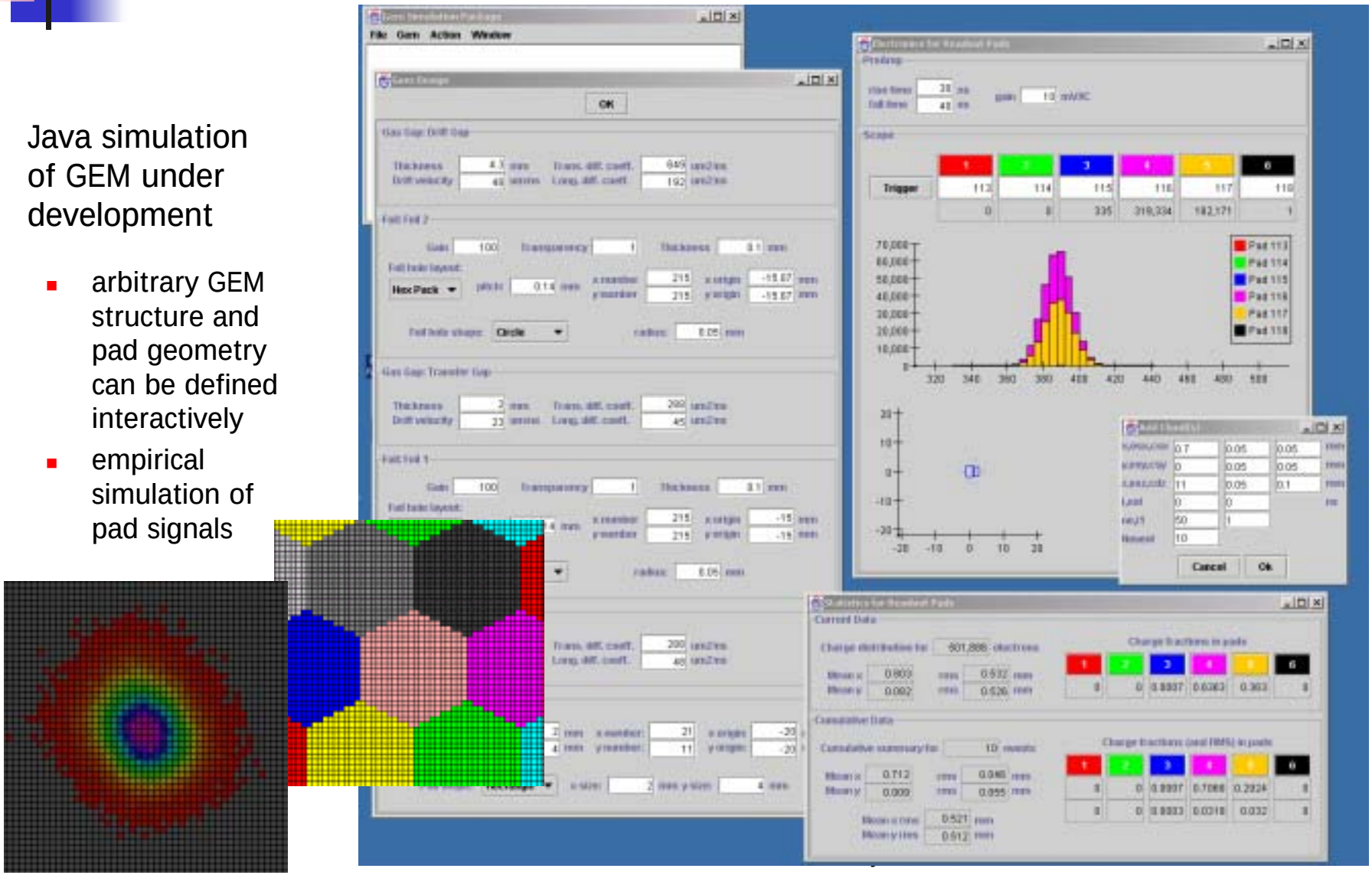
- Simulation using 1st principles confirms understanding of signals



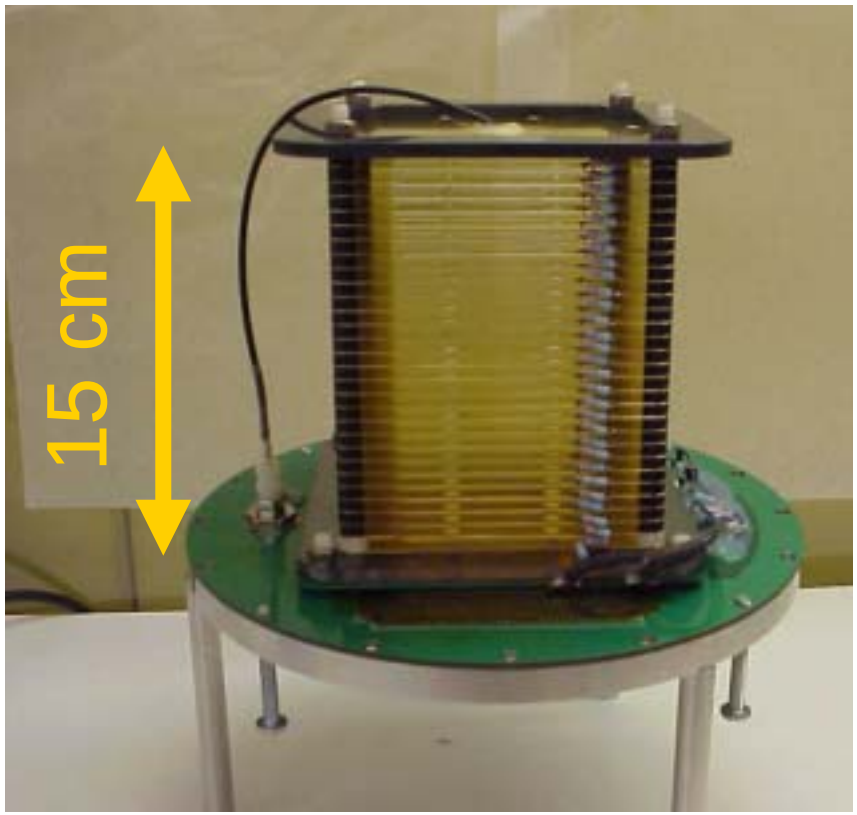
# Simulation studies (cont.)

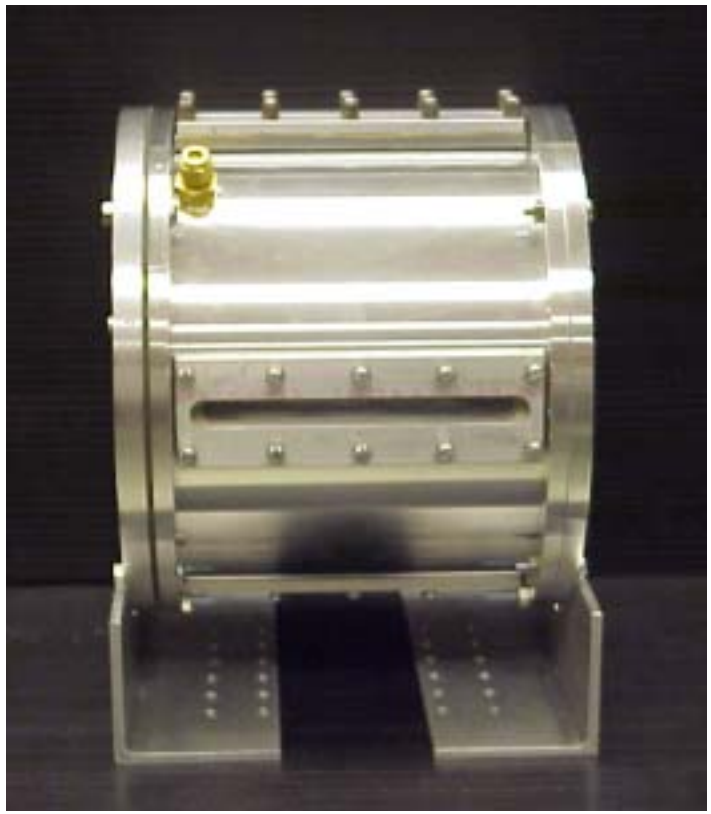
- Java simulation of GEM under development
  - arbitrary GEM structure and pad geometry can be defined interactively
  - empirical simulation of pad signals



# Plans for future studies

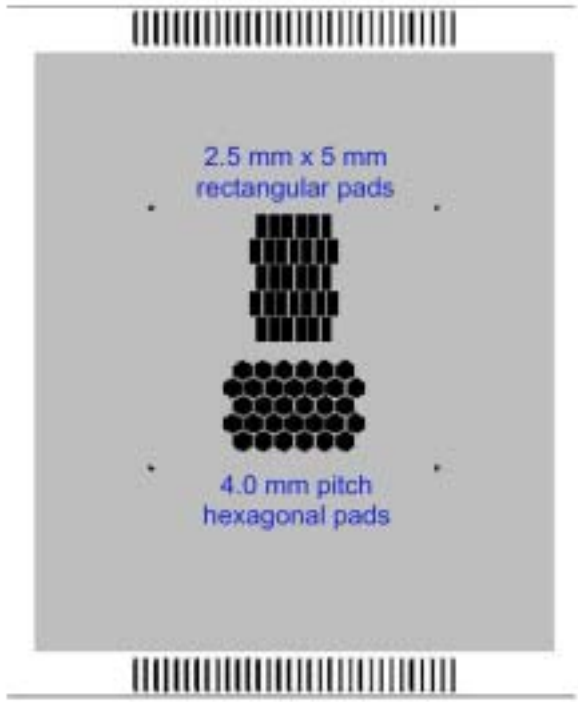
- Mini-TPC constructed and being commissioned



# Plans for future studies (cont.)

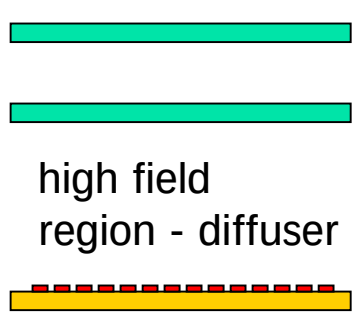
- Mini-TPC readout with cosmic ray telescope
  - 32 channels of custom 200 MHz FADC
  - new readout structures
  - estimate tracking resolution with triplets
  - two track resolution?
  - test beam?



# Issues

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

} all coupled for example:




  - optimize with simulation – check with data

- Long term stability of GEMs

- A lot of work to be done!