

## **Update on GEM-TPC Studies at Carleton**

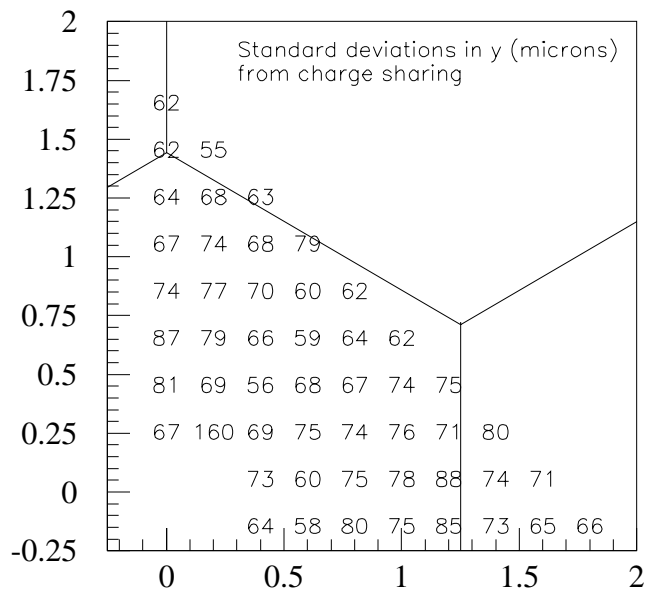
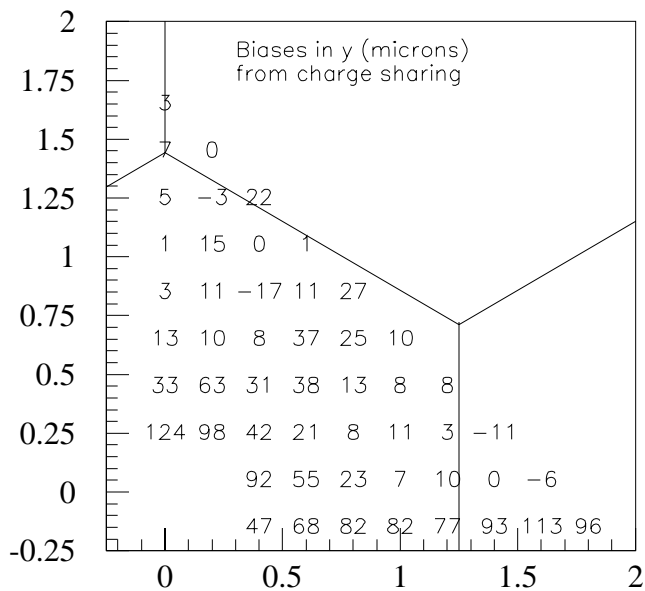
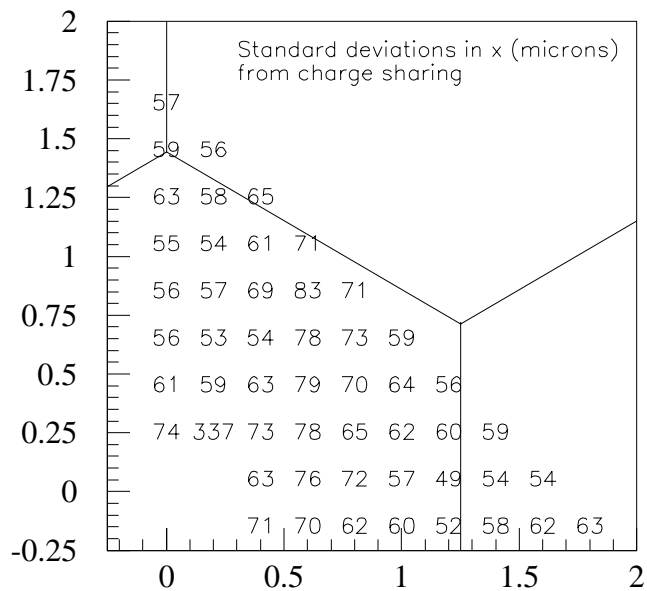
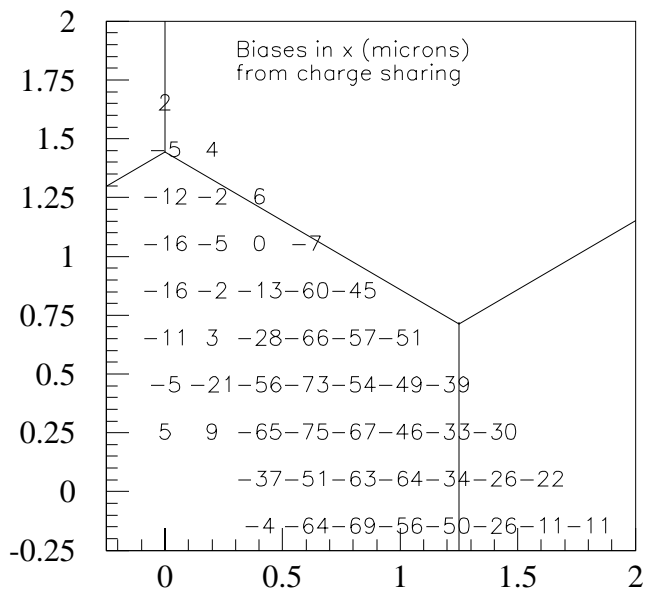
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M. Garrett<sup>1</sup>, D. Karlen<sup>1</sup>, H. Mes<sup>1</sup> & E. Neuheimer<sup>1</sup>**

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- **Spatial resolution measurement made with  
2.5 mm hex pads using a collimated x-ray source**
- **Detailed pad response function studies with long  
2.5 mm wide anode strips**
- **Work in progress and R & D plans**

## **Spatial Resolution Measurement for Hex Pads with Collimated X-Ray Source**

- **Electron distribution at the pads fitted to a 2-D model Gaussian in (x & y)  $\sigma \approx 600 \mu\text{m}$   
Integrate Gaussian to get *direct* pad charge signal  
Pad induction signal parameterized from data**
- ***Direct* pad charge resolution,  $\sigma_X \approx \sigma_Y \approx 60\text{-}70 \mu\text{m}$   
Method efficient when  $\geq 3$  pads share charge  
Significant biases observed**
- **Spatial resolution from the induction signal  
 $\sigma_X$  &  $\sigma_Y$  comparable to that from charge sharing  
Also affected by biases**
- **Biases reduced by calibration determined from the data. Procedure not well reproducible, however**
- **Need calibrated, low noise & crosstalk electronics  
and better handle on systematics!**
- **Significant improvements already with Tektronics  
gain calibration & crosstalk now better than 0.1%**

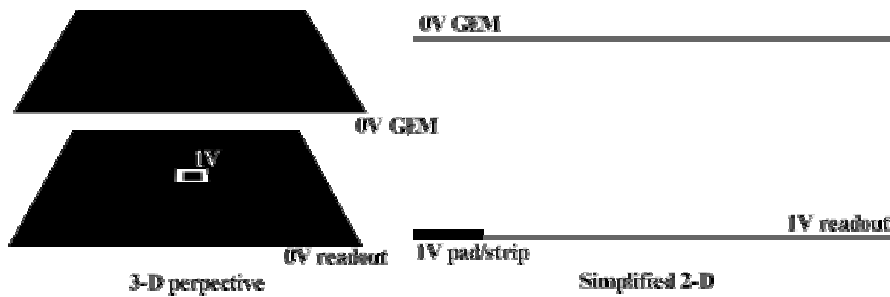


## **Pad response Function Studies** **Simulation and Measurement**

- **First principles approach with aim to simulate the GEM-TPC tracking performance at the detector level**
- **Initial studies with long strip shaped anode pads (simpler than hexagonal pads)**
- **Compare with measurement**

# GEM Induction Pulse Simulation for Strip Shaped Anodes

- Use Ramo's theorem [principle of superposition]  
(Pad induction current,  $I = neE_z v_d / V_0$ )



- Solve Laplace's equation:

$$V(r, z) = \frac{4 \sin \alpha b \cos \alpha r \sinh \alpha z}{(2p+1)\pi \sinh \alpha H}$$

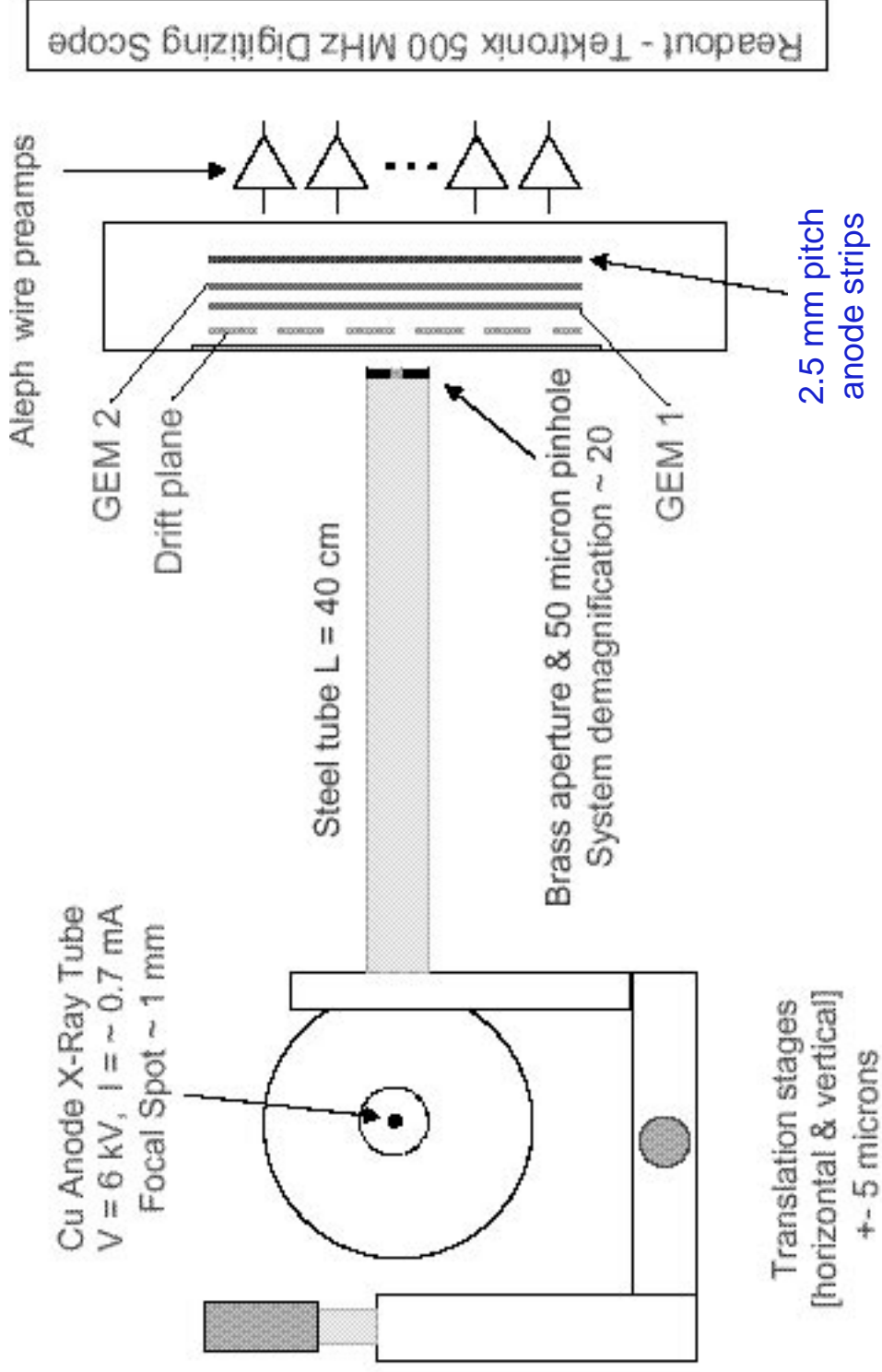
$\alpha = (2p+1)\pi/a$ ,  $a$  = GEM size,  $r$  = pad width,  
 $b = r/2$ , and  $H$  = induction gap height.

- P10 diffusion at high fields

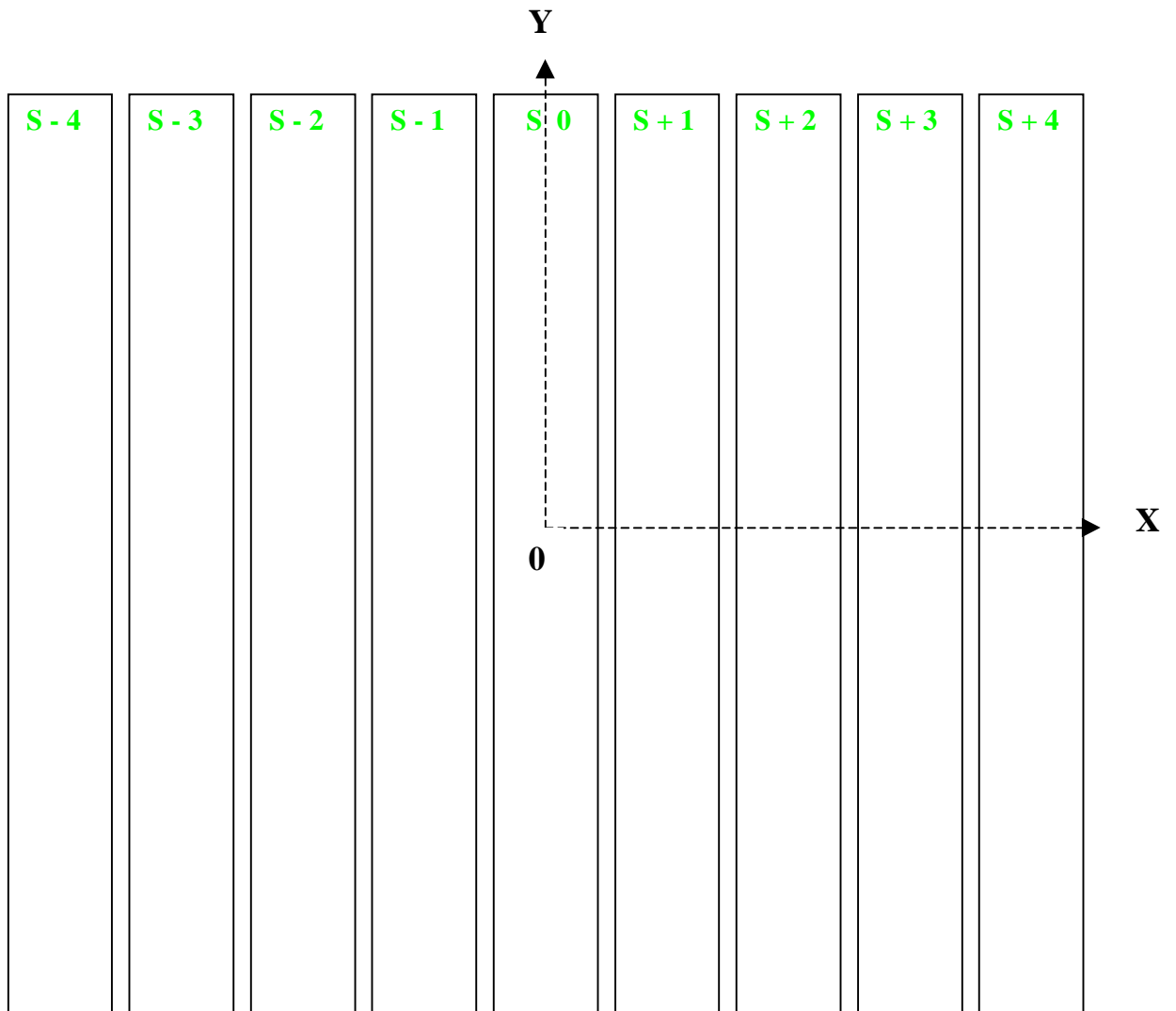
$$\sigma_{\text{Transverse}} \approx 600 \mu\text{m}/\sqrt{\text{cm}}, \sigma_{\text{Longitudinal}} \approx 200 \mu\text{m}/\sqrt{\text{cm}}$$

- Convolute preamplifier shaping time effects  
(Aleph TPC wire preamps)

## Setup for Pad Response Function Studies with Long Strip Shaped Anode Pads

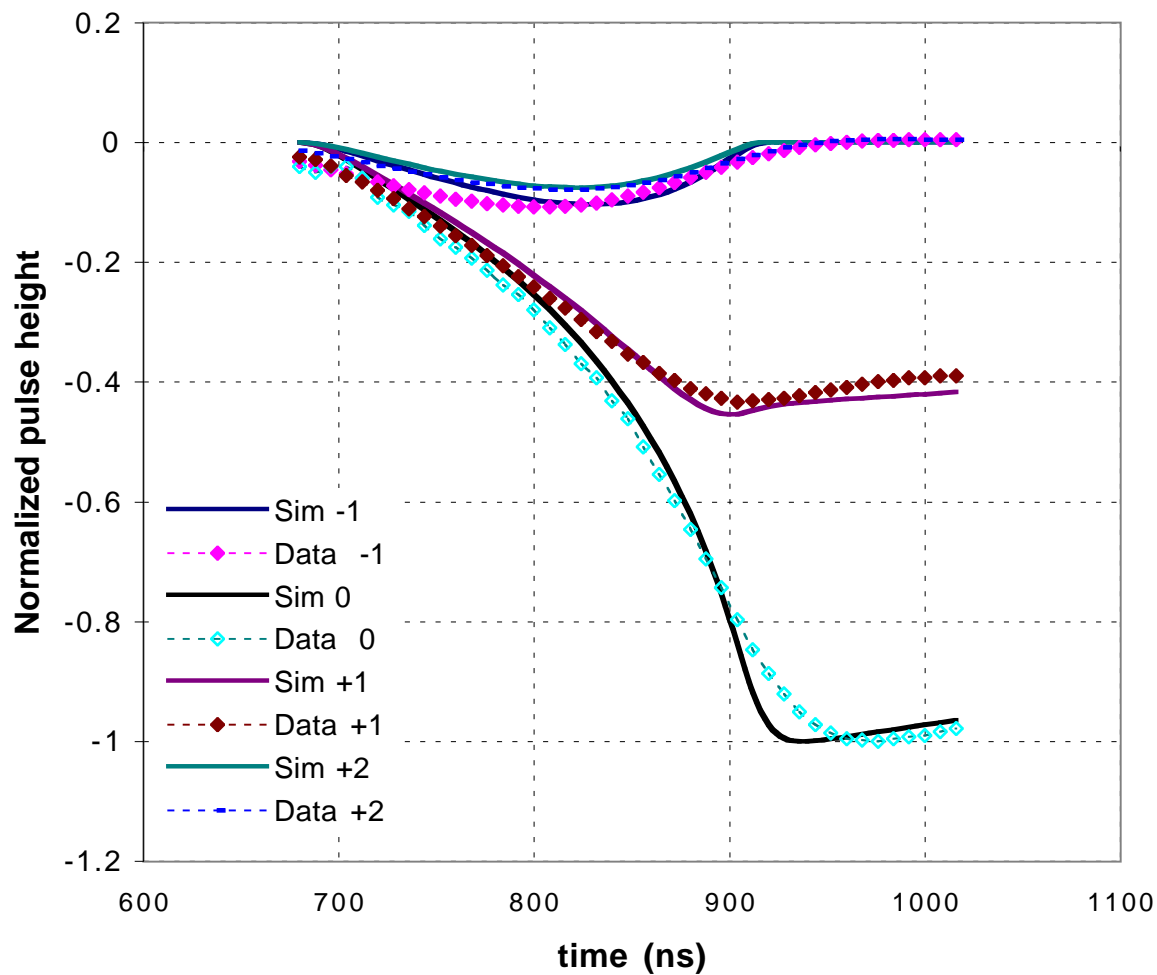


## GEM Pad Response Function Studies with Anode Strips



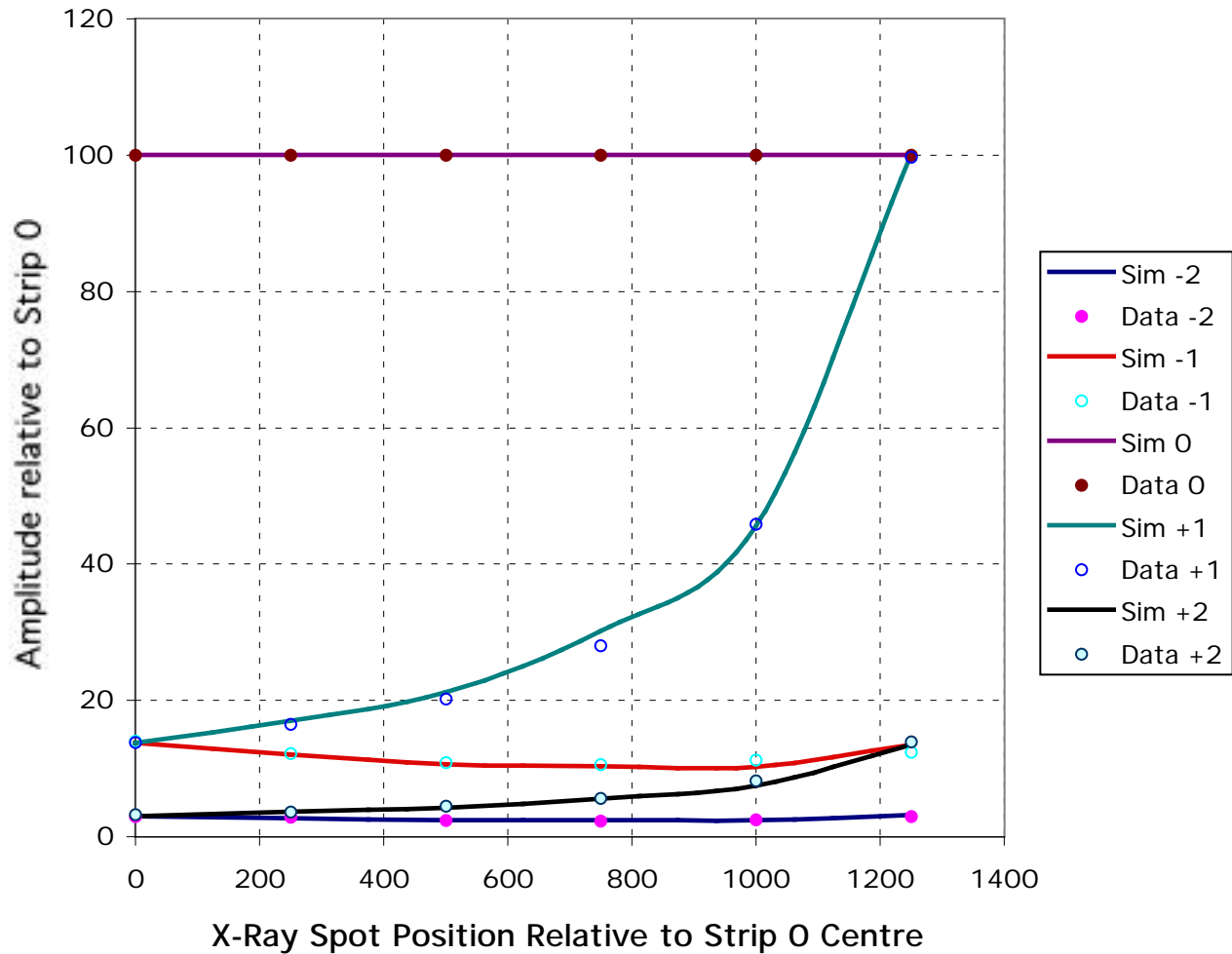
**Parallel Anode Strips on 2.5 mm pitch (space between strips = 50  $\mu\text{m}$ )**

**GEM Pulse Shape Simulation for Strip Anodes  
(Readout Strips on 2.5 mm)  
Simulation versus Average Pulse Shape  
(X-Ray Spot Position = 1 mm)**





# Peak Pulse Amplitudes on Anode Strips as a Function X- Ray Spot Position Measurement versus Simulation



## **Work in progress and R & D plans**

- **Mini-TPC assembly - 15 cm drift, 32 pad readout**
- **8 channels 200 MHz FADCs working at Montreal  
Remaining 24 channels by May end**
- **Besides hexagonal, investigate other pad designs:  
e.g. 2.5 mm x 5 mm rectangular pads  
Larger induction amplitude - may be less affected by  
noise. However, some crosstalk may be larger  
Also more complicated pad response function  
function**
- **Expect to begin cosmic tests by summer**

