TPC Studies at University of Victoria

ALCPG meeting
SLAC, January 2004

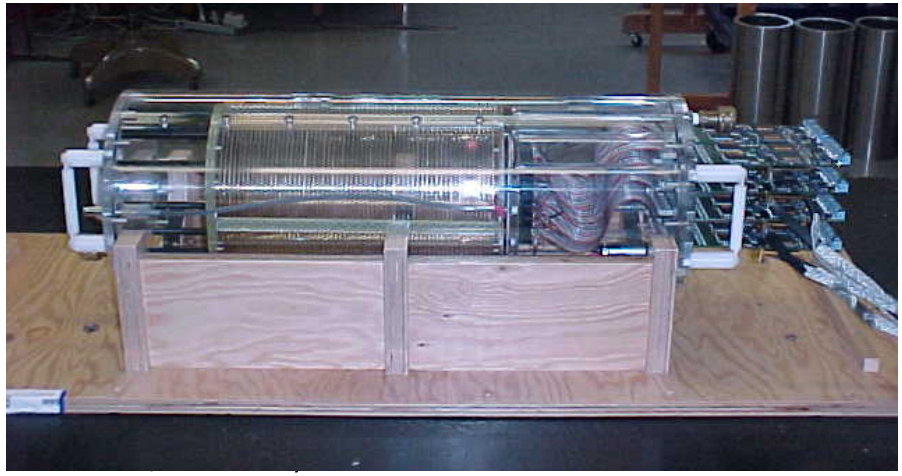
Dean Karlen
University of Victoria / TRIUMF

Outline

- Victoria group & TPC
- Reminder of GEM defocusing
  - Results from TRIUMF magnetic field tests
- Update since Cornell
  - Results from DESY magnetic field tests
- Plans for the coming year

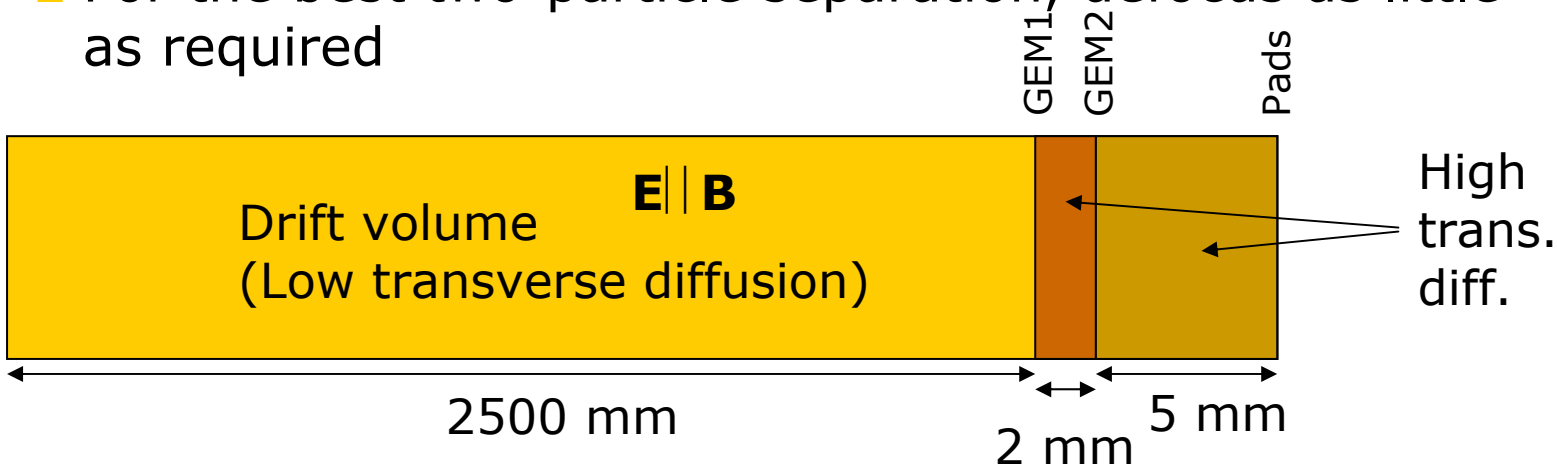
Victoria TPC R&D

- Victoria TPC Group:
  - D.K.
  - Research associate: Paul Poffenberger
  - Graduate students: Gabe Rosenbaum, Thanos Michailopoulos
- Victoria TPC:
  - 30 cm drift, double GEM, 2x7 mm^2 pads, STAR electronics

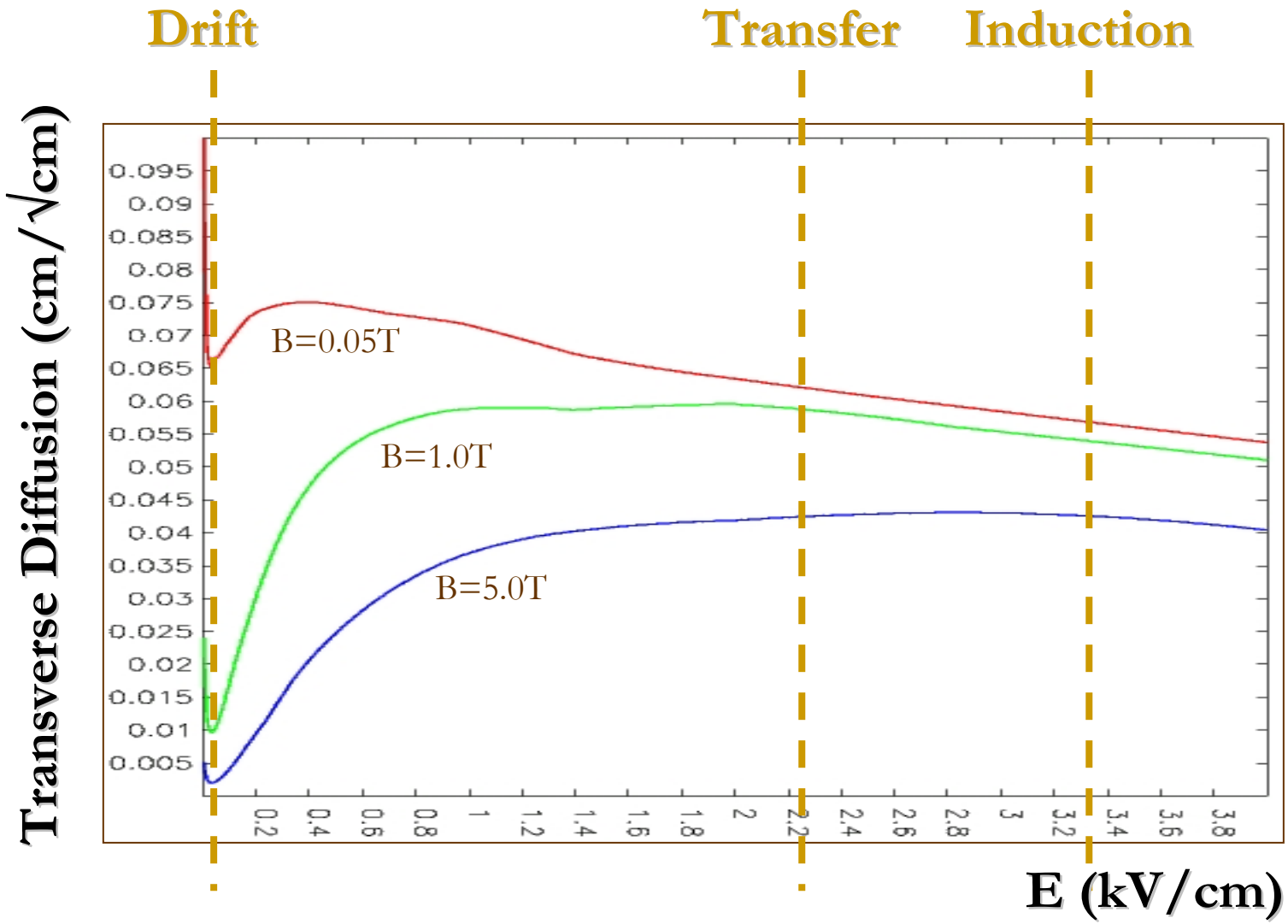


TPCs with GEM readout

- Even with very low transverse diffusion in the drift volume, relatively wide pads (few mm) can be used with GEM readout:
  - Use gas diffusion between the GEMs to spread the charge over a larger region
    - Since the defocusing occurs during and after the gain stage, the track resolution is not sacrificed
    - For the best two-particle separation, defocus as little as required



Example: P5


Drift
Transfer
Induction
Transverse Diffusion (cm/√cm)
0.095
0.09
0.085
0.08
0.075
0.07
0.065
0.06
0.055
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
B=0.05T
B=1.0T
B=5.0T
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
E (kV/cm)

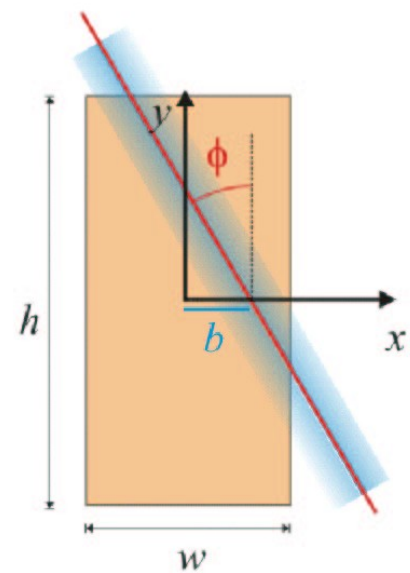
Limited defocusing

- Minimum defocusing required to retain track resolution:

$$\sigma \approx \tfrac{1}{4}\,\text{pad width}$$

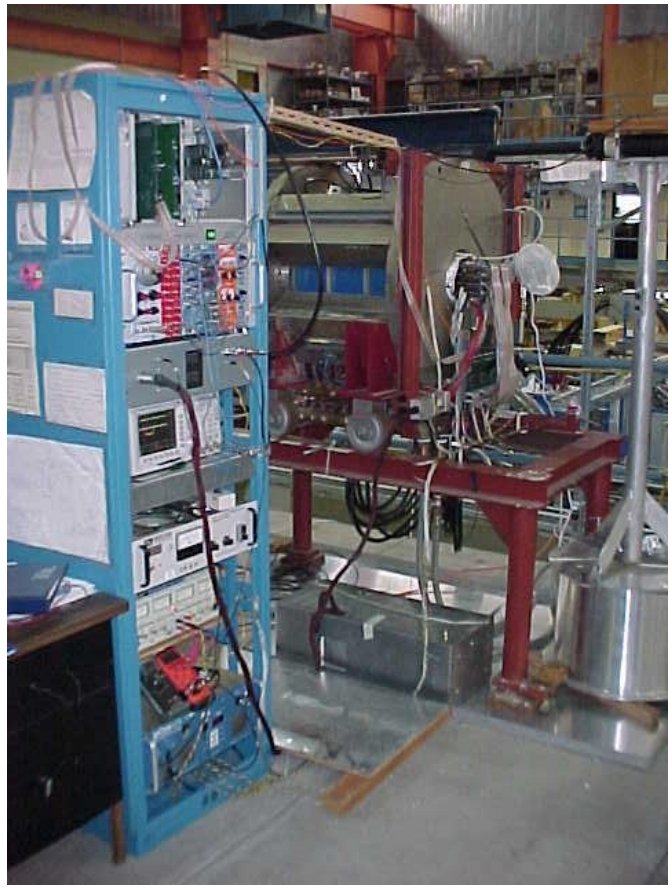
- Charge sharing typically over 2 pads:
  - Important to account for non-linear sharing
  - Track fitting is performed by maximum likelihood:

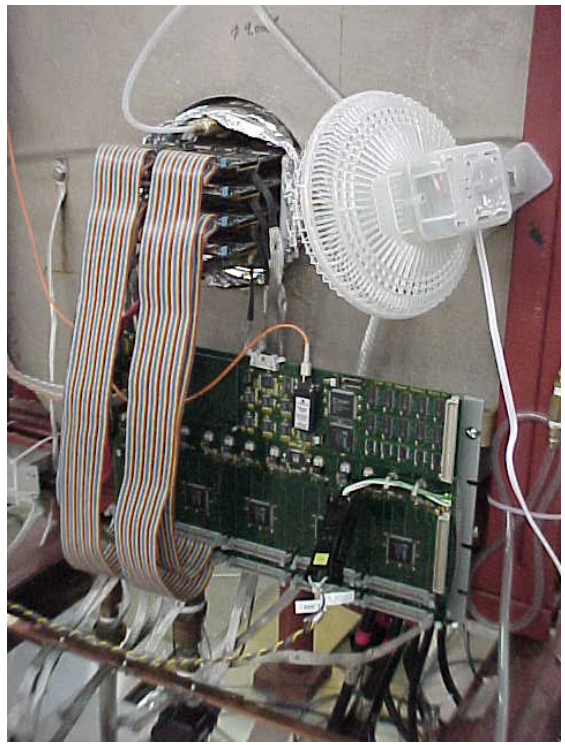
$$x_0, \phi_0, \sigma, r^{-1}$$



First GEM-TPC tracking in B fields

- TRIUMF tests (0 – 0.9 T)

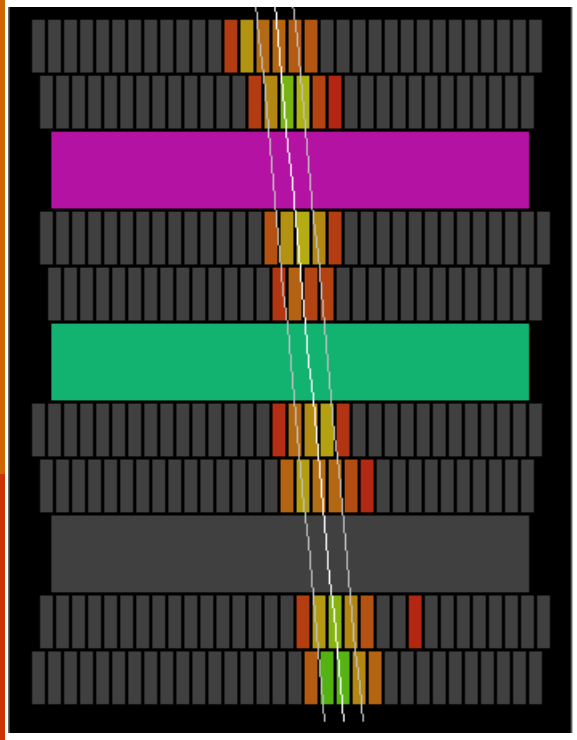




Example events at ~ 25 cm drift

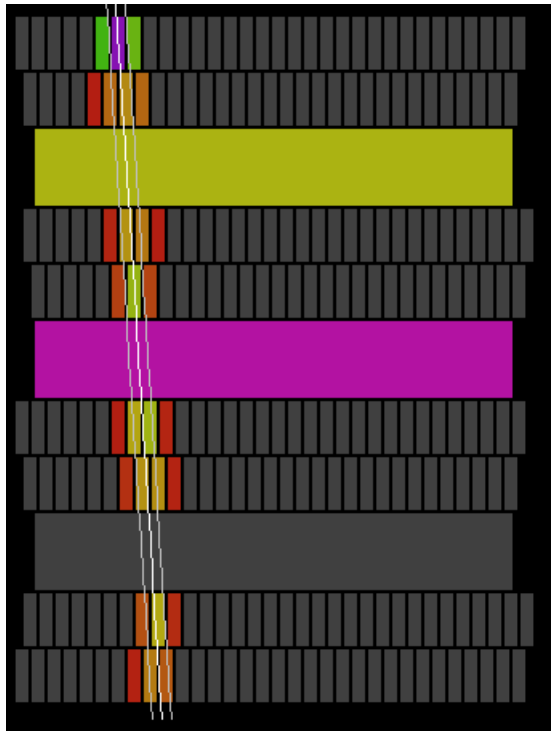
- Gas: P10

0 Tesla



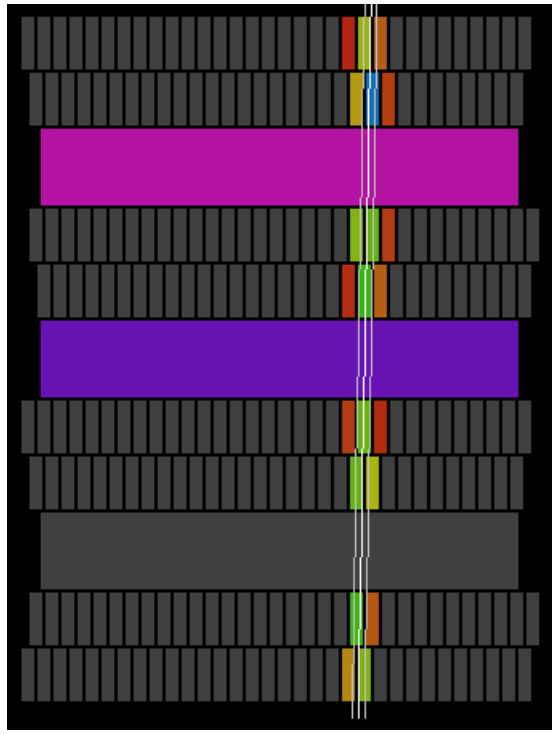
σ = 2.3 mm

0.45 Tesla



σ = 1.2 mm

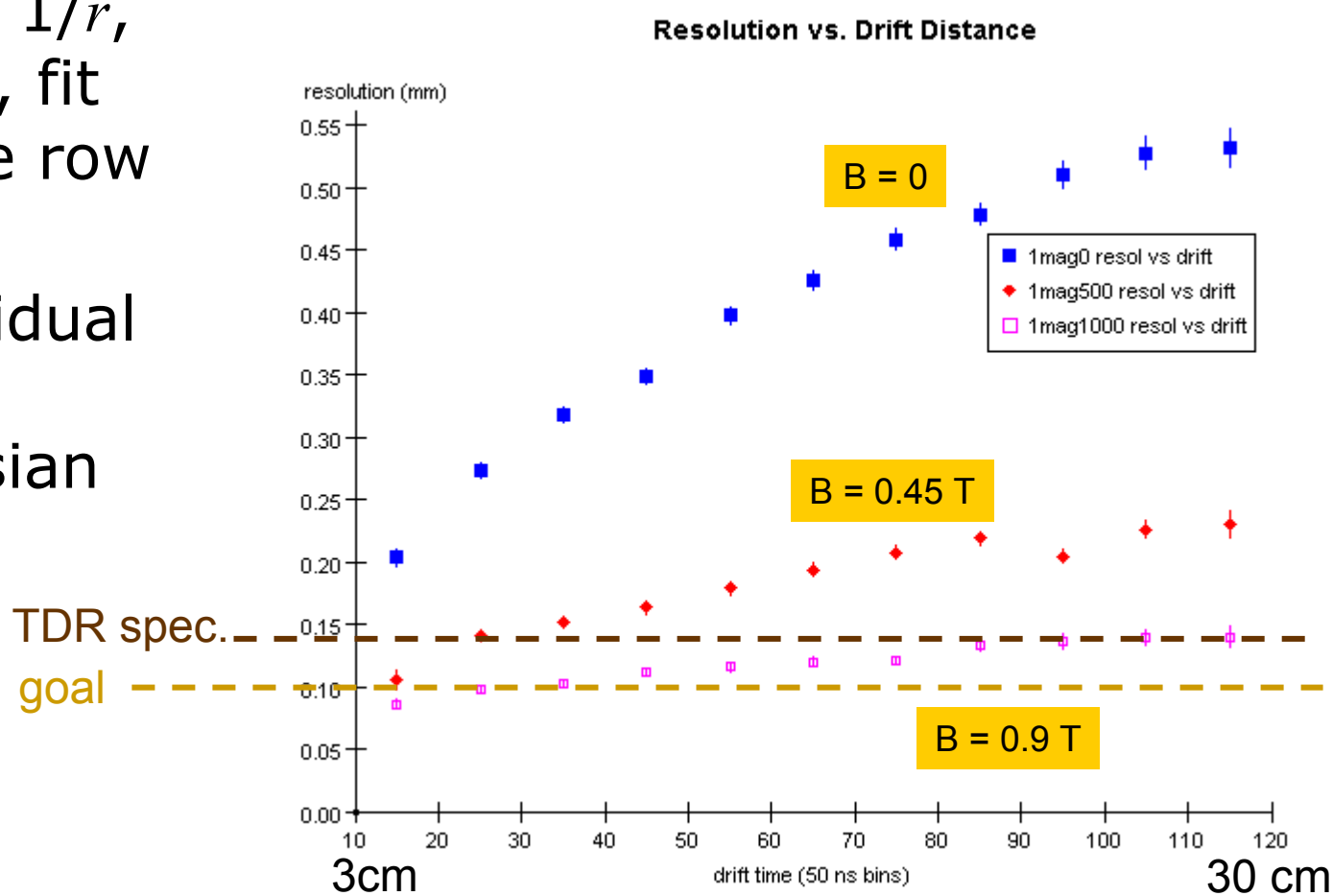
0.9 Tesla



σ = 0.8 mm

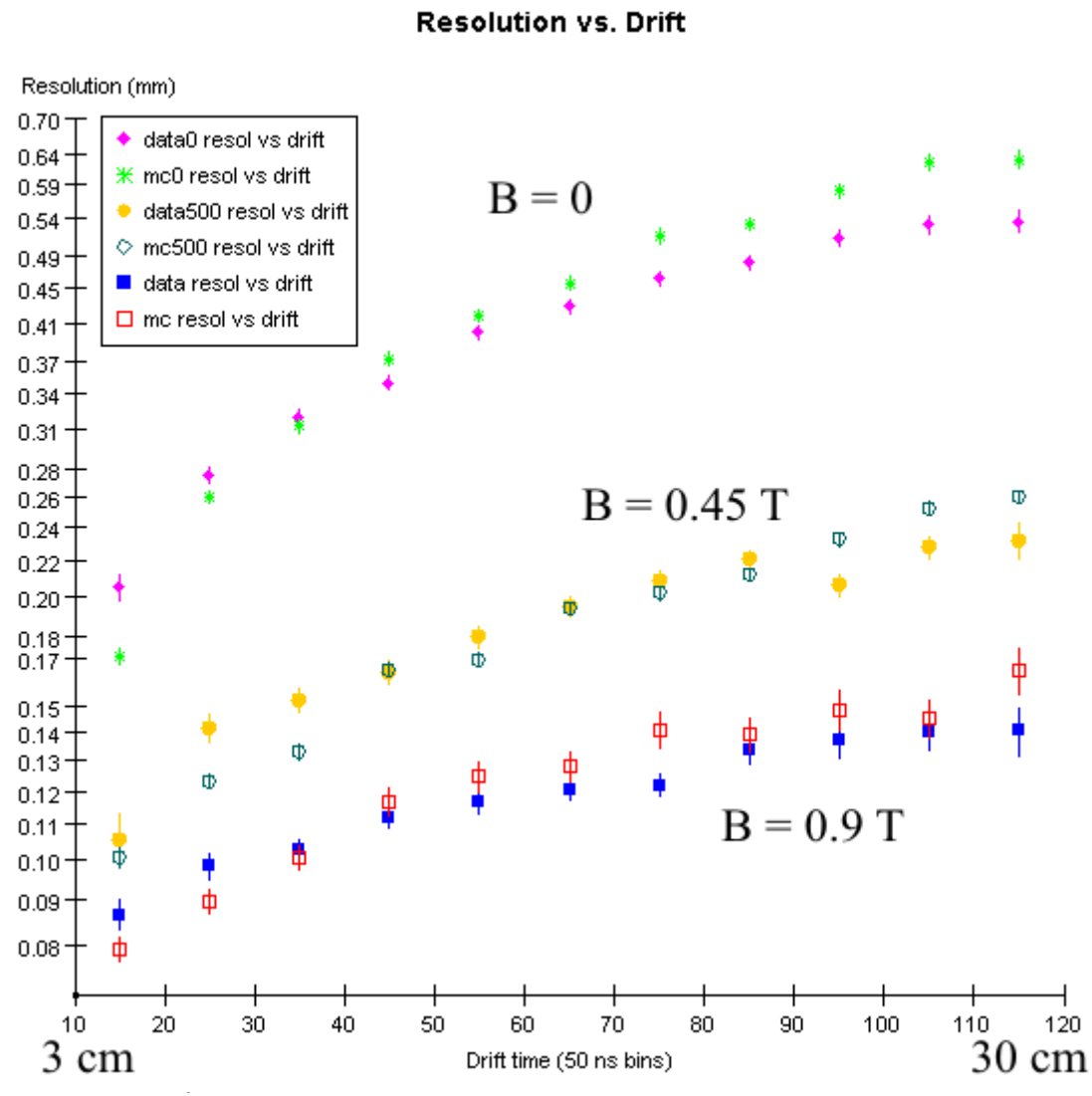
Tracking resolution (preliminary)

- Fit track to all but one row:
  - fix ϕ_0, $1/r$, and σ, fit to one row alone
  - x_0 residual fit to Gaussian

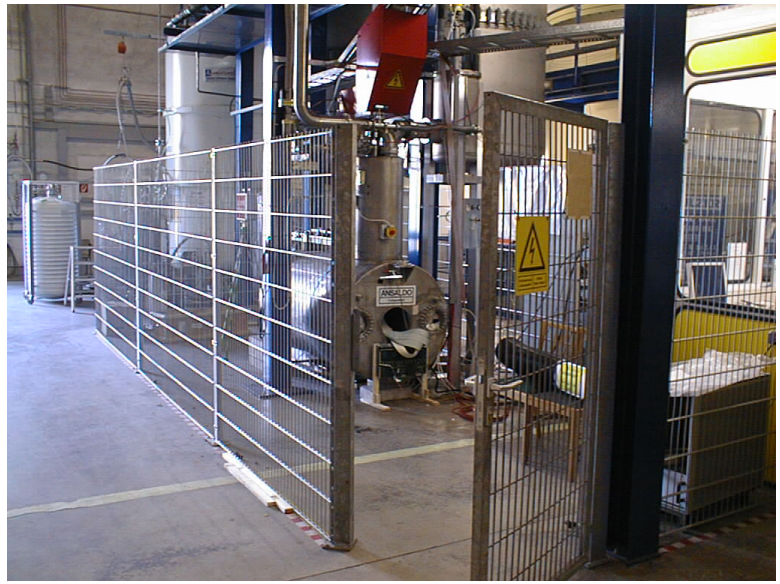


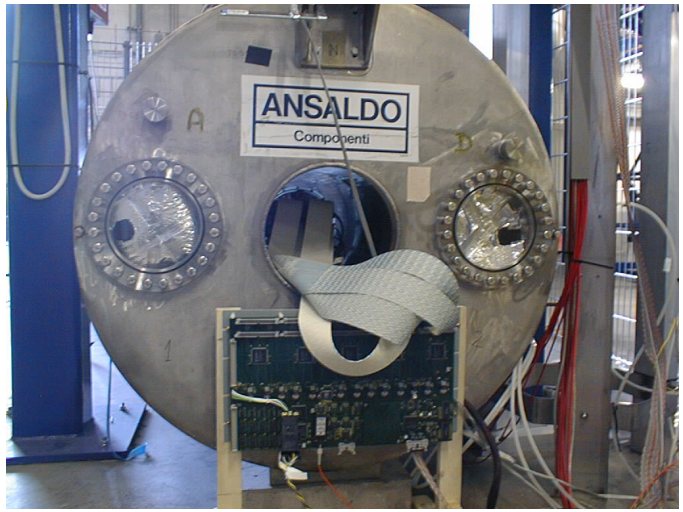
Comparison with MC simulation

- Simple simulation of GEM operation
- Good agreement with data
- Preliminary results…



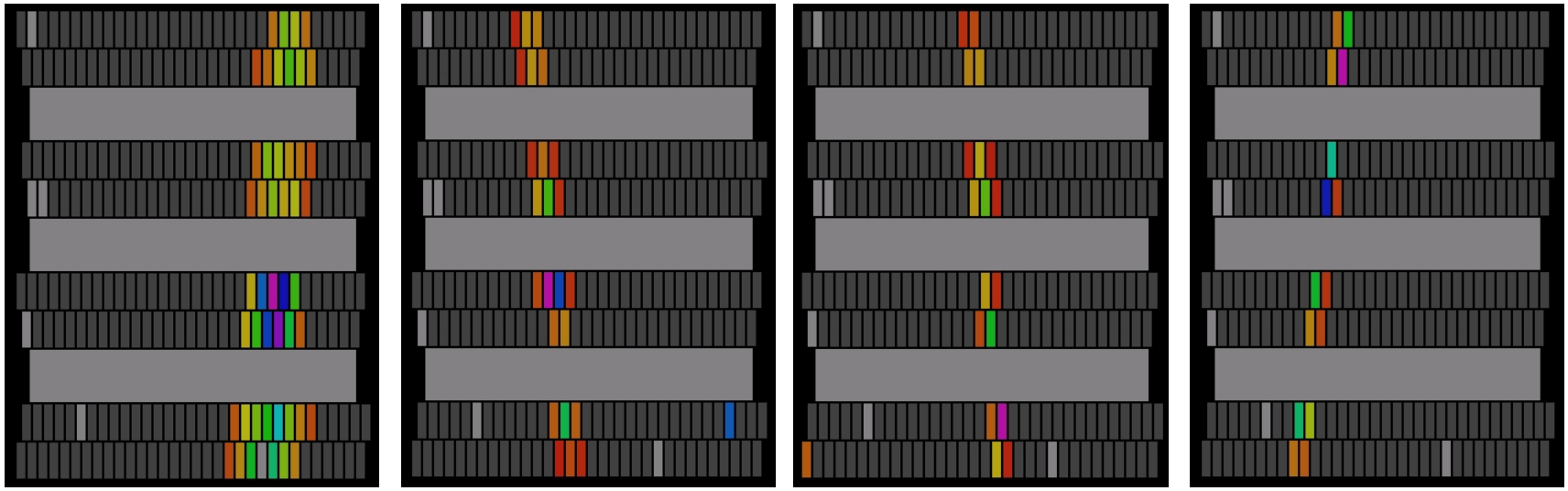
DESY tests (0 – 5.3 T)





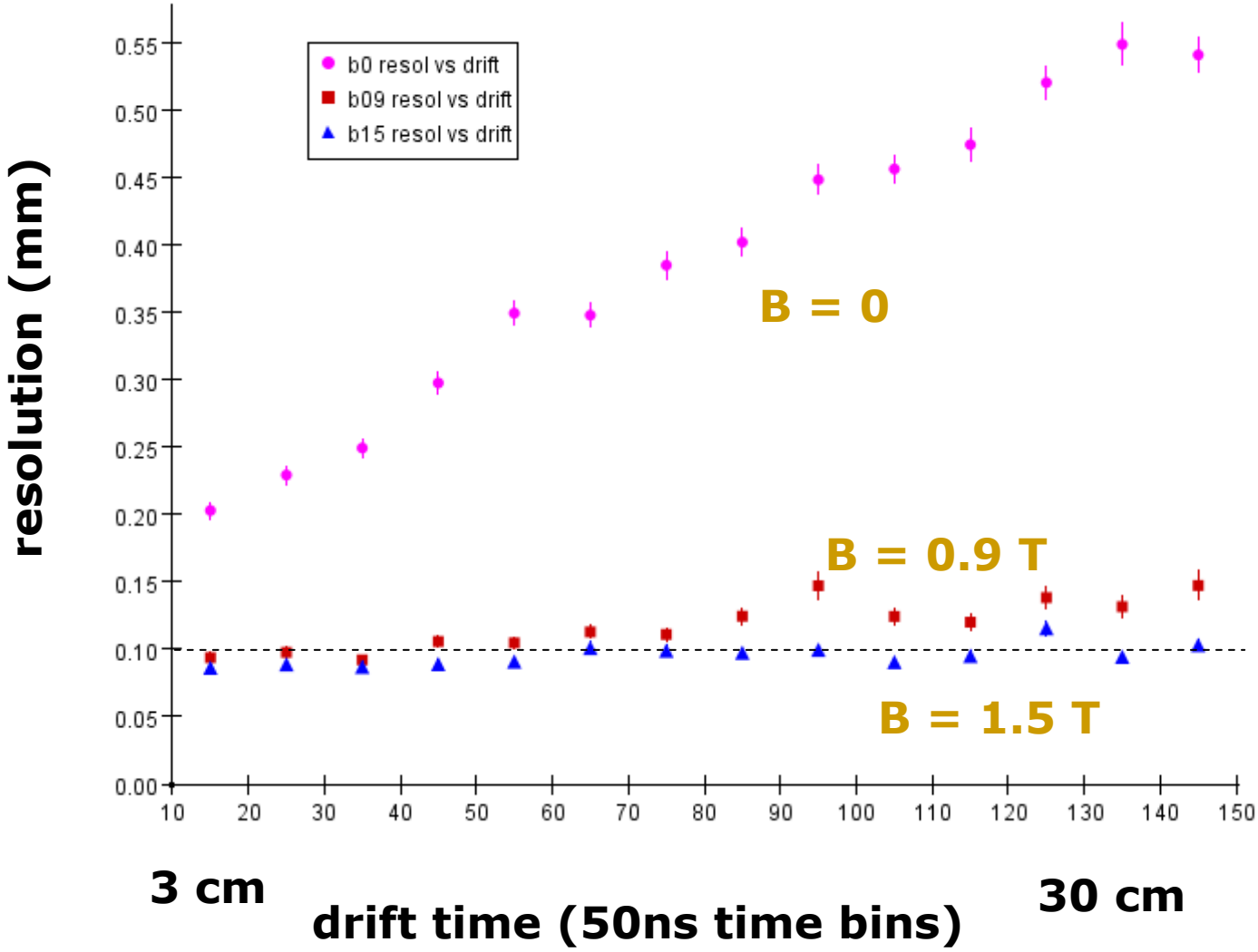
Example events at ~ 25 cm drift

- Gas: P5



B=0T B=0.9T B=2.5T B=4.5T

Tracking resolution (preliminary)



Preliminary results

- Tracking resolution $\leq$ 100 μm for all drift distances for B $\geq$ 1.5 T
  - Further improvement for higher fields not yet realized…
- Defocusing values larger than expected
  - Maintain $\sigma \approx \frac{1}{4} w$

B(T)	σ_0 (mm)	sim σ_0 (mm)
0.	1.14	0.21
0.9	0.66	0.43
1.5	0.60	0.42
2.5	0.52	0.40
3.5	0.53	0.38
4.5	0.55	0.36
5.3	0.51	-

Plans for the coming year…

- Full analysis of DESY/TRIUMF data sets
- Further modification of STAR readout electronics:
  - Remove baseline ramp-up during first 0.5 μs
    - Remove reset of preamp at each trigger
  - Remove ion tail correction
- Try out micromegas readout (Purdue/3M), with resistive anode to spread signal
  - Build a second readout endplate for quick change between GEM and micromegas

Plans for the coming year…(cont.)

- Prepare for laser tests in 5T DESY magnet
  - Build a new outer acrylic cylinder with quartz windows
  - Design remote laser transport optics for use in DESY magnet (2 cm clearance)
  - Perform laser tests without field in Canada
  - If all goes well, bring system to DESY (late summer 2004?)
    - Study distortions with single tracks: calibration
    - Demonstrate 2 track resolving power
    - Examine distortions from ion feedback
    - Compare GEM and micromegas readouts