Phone meeting 21 Juillet 2004
Micromegas TPC R&D

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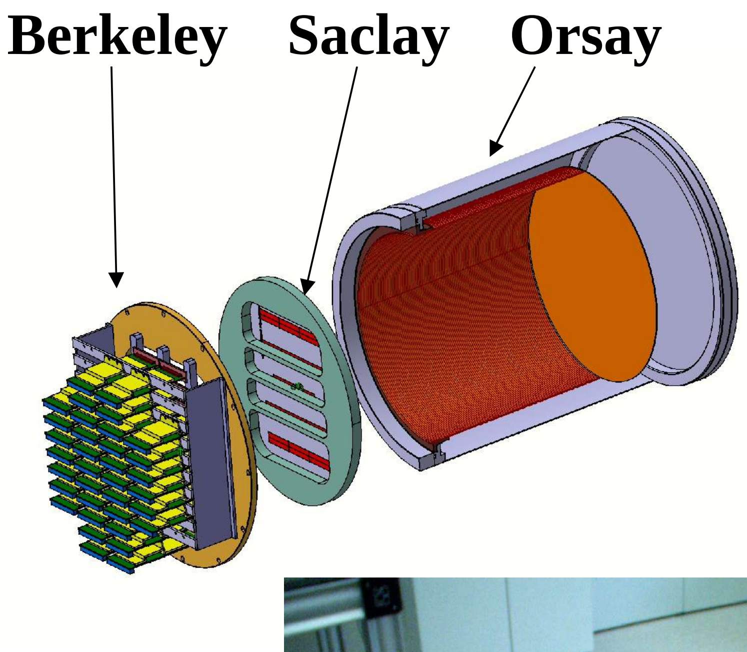
TPC R&D Collaboration

Outline

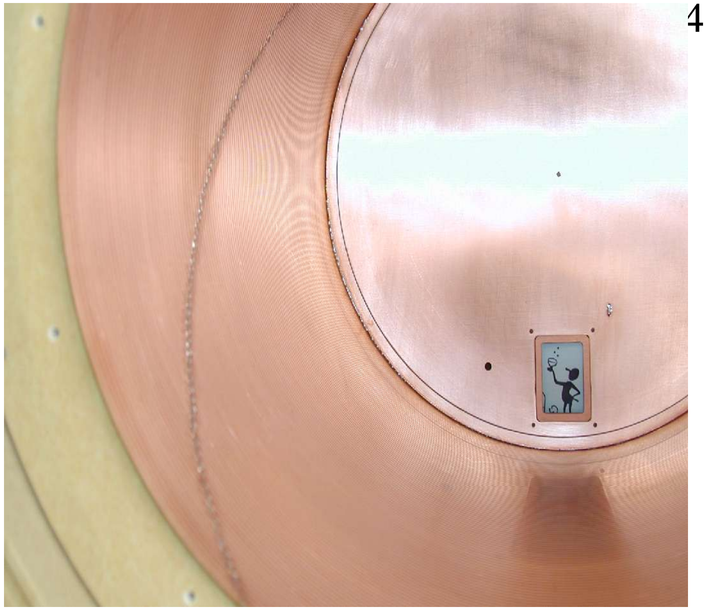
- Chamber design and pad layout
- Cosmic ray test stand
- Recent data taking
- New ArCF4 results
  - Diffusion
  - Attenuation
  - Position resolution

Chamber design and pad layout

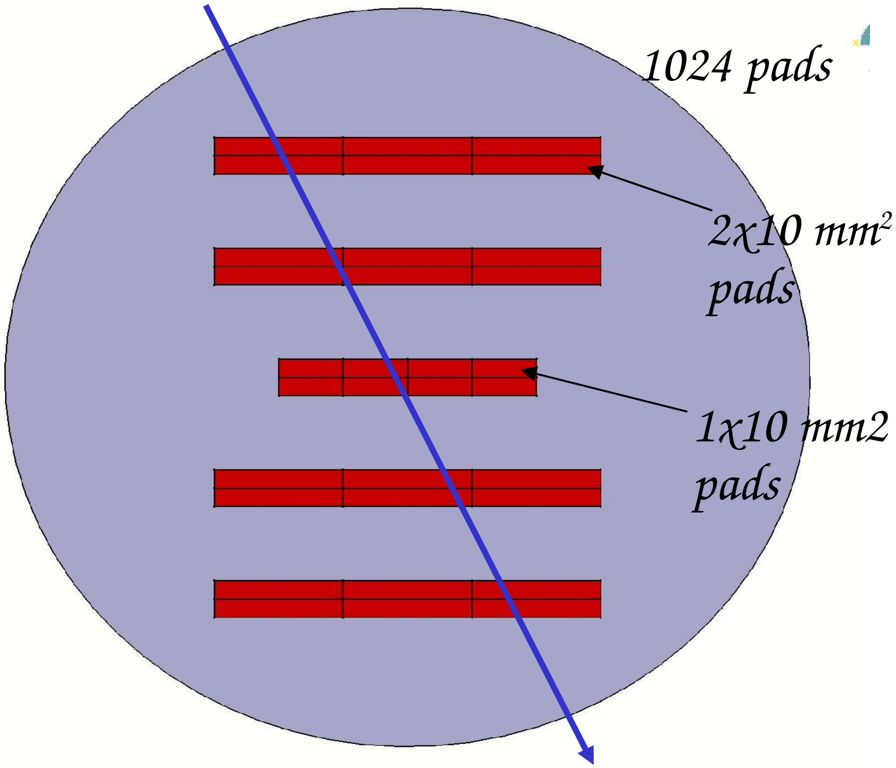


Chamber

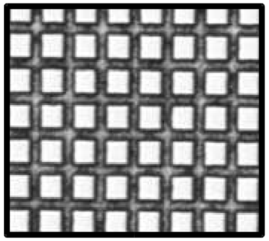
diameter 50 cm
length 50 cm



Readout anode pad plane

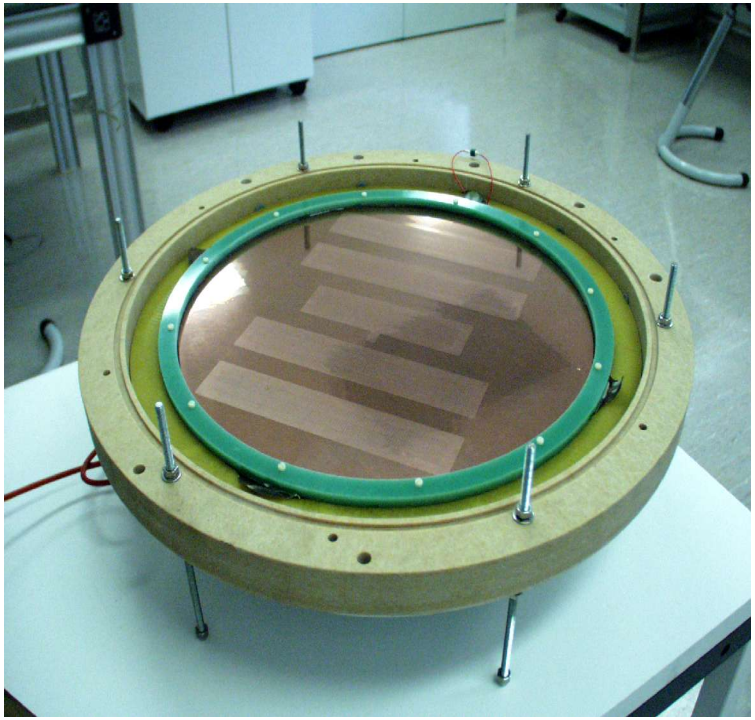


Mesh



50 µm pitch

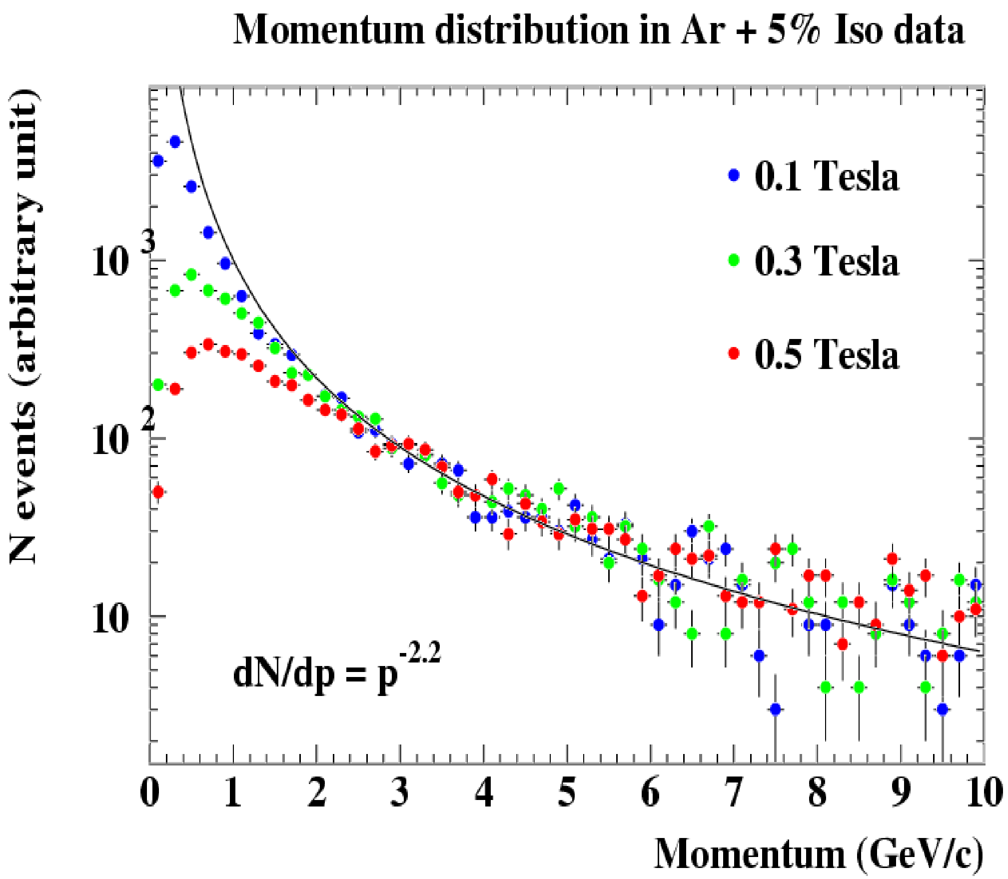
50 µm gap



Cosmic ray test stand

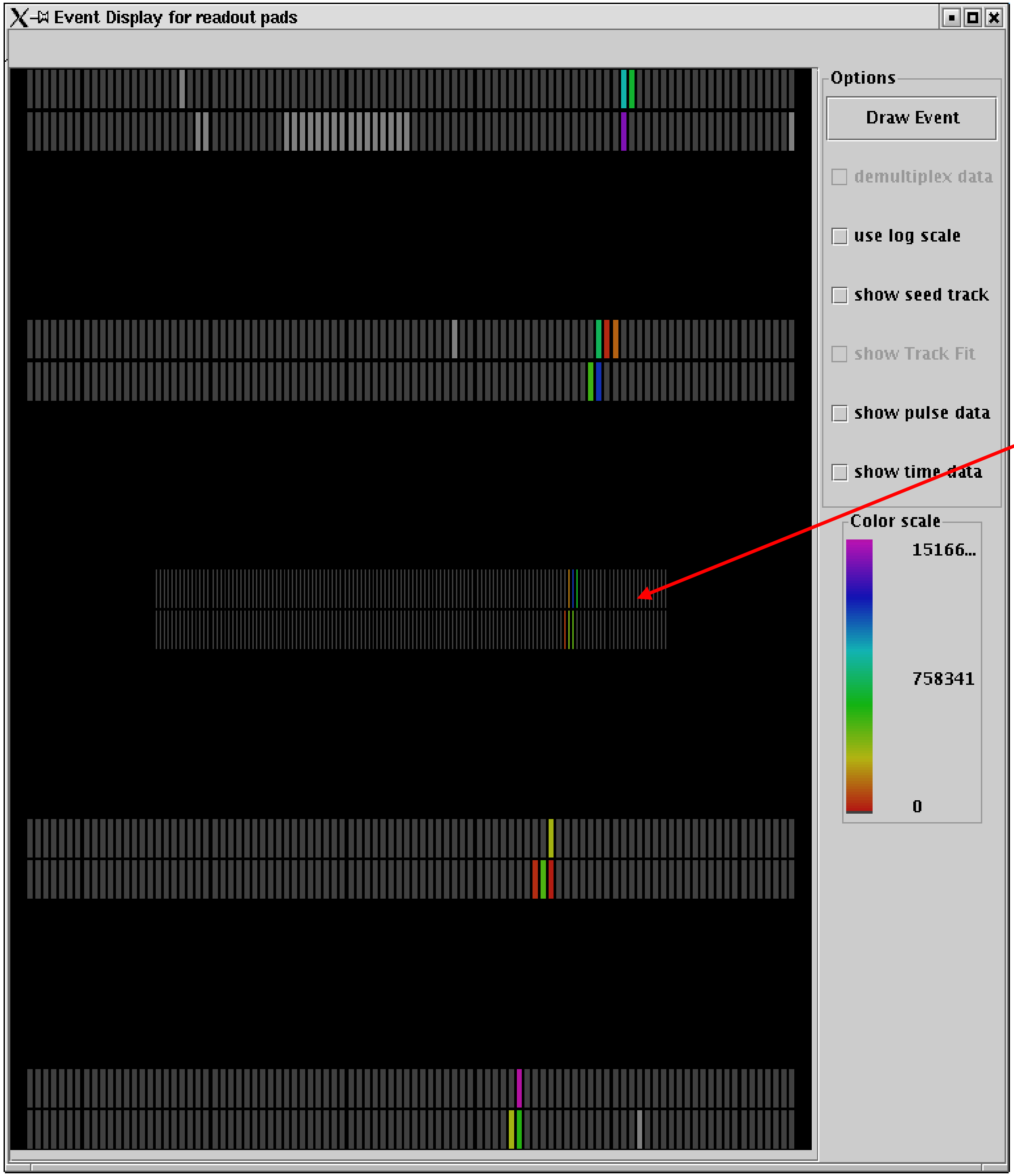
Superconducting magnet
runs at
0.1, 0.3, 0.5, 0.7, 1, 1.5 & 2 Tesla

Trigger: 2-3 fold scintillator
efficiency 10 – 50 %
(lower at high fields)

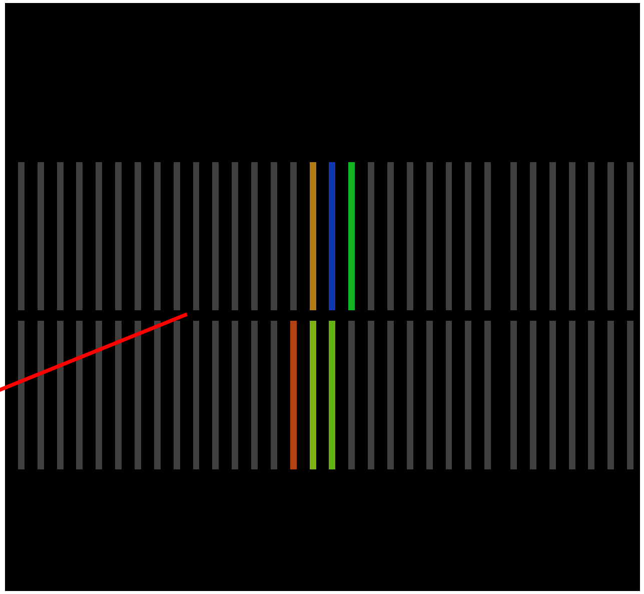


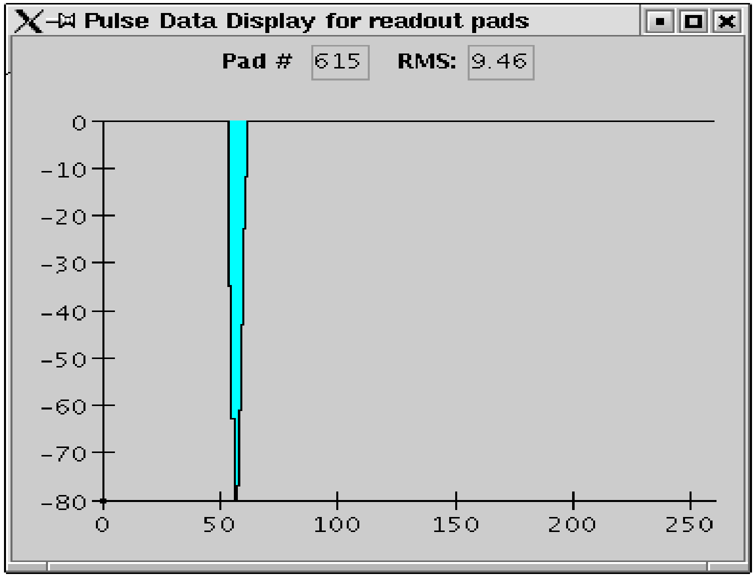
Data acquisition:
direct memory transfer
(no selection, formatting, ...)
overall improvement X20

Online event display



Rows 4 & 5





Apr./May 2004 Data taking

We planned a Micromegas TPC data run for just after the Paris LCWS meeting. After a short startup to cool down the magnet and make significant improvements to the DAQ system, we took data for 3 weeks with 3 different gases:

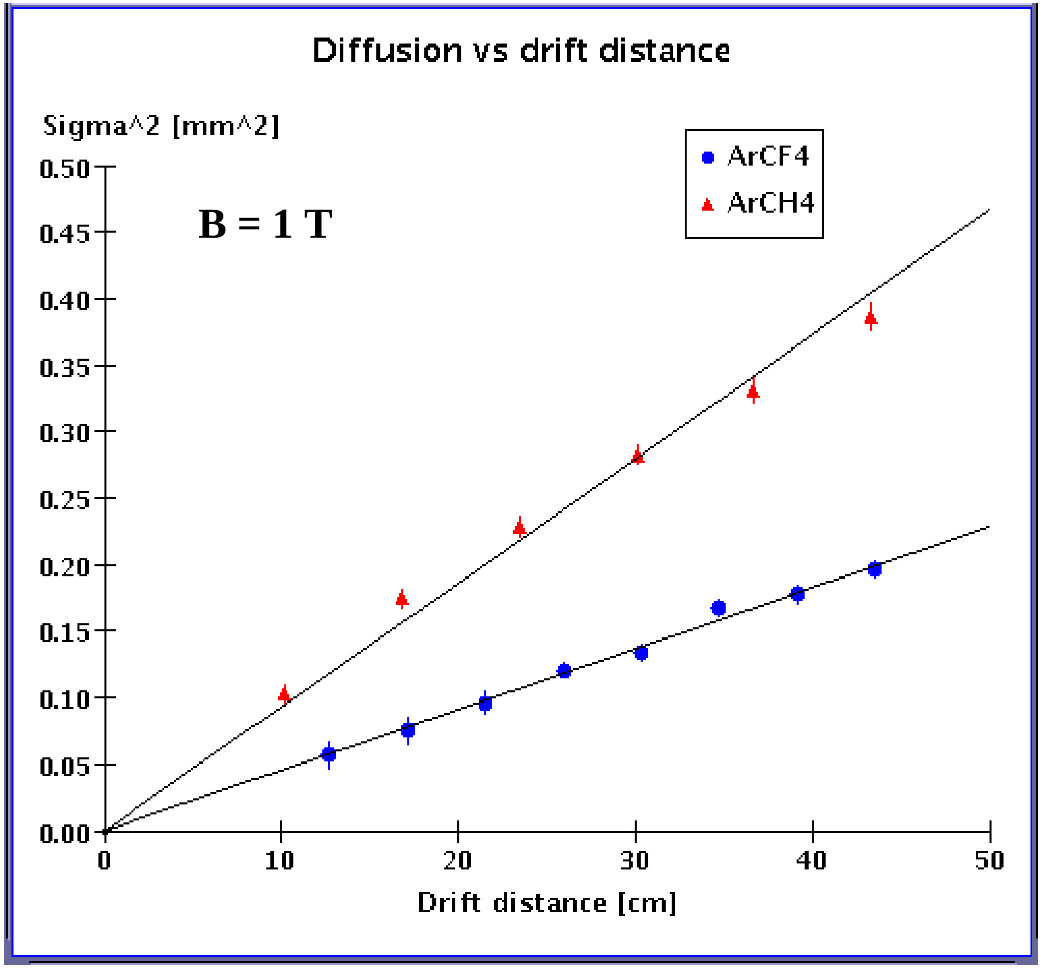
Ar-CF4:3% B = 0.1, 0.3, 0.5, 0.7, 1.0 T

Ar-CH4:10% B = 0.1, 0.3, 0.5, 0.7, 1.0, 1.5, 2 T (**P10**)

Ar-Isobutane B = 0.1, 0.3, 0.5, 0.7, 1.0, 1.5 T

High statistics runs at B = 0.5T and 1T were taken overnight.

We processed the data in parallel with data taking and had new results a few days afterwards, like the plot shown.

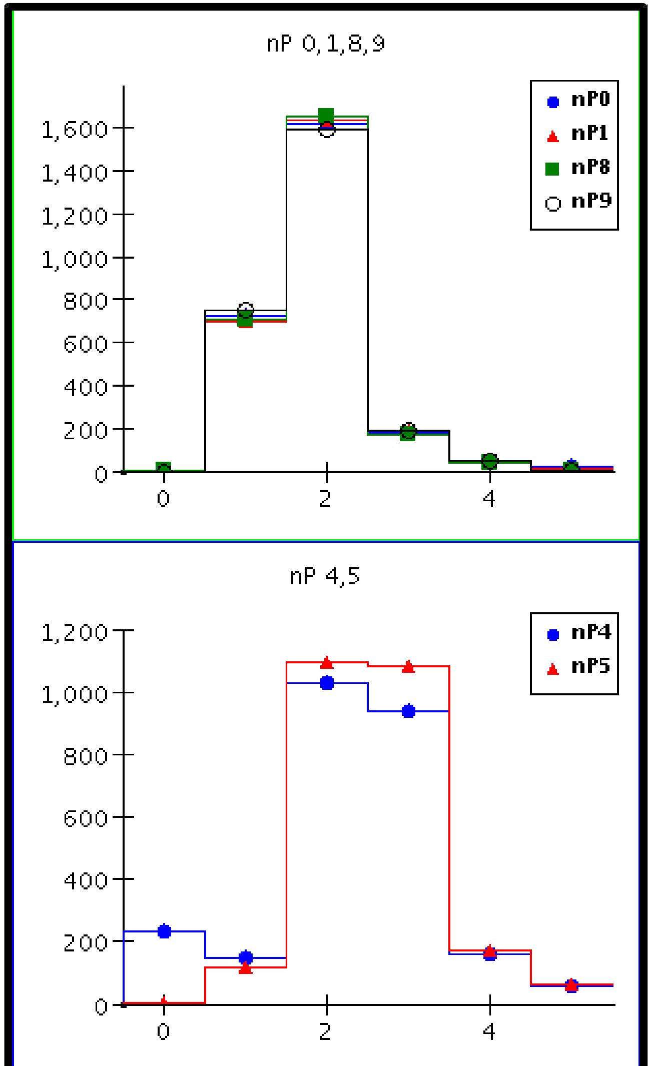


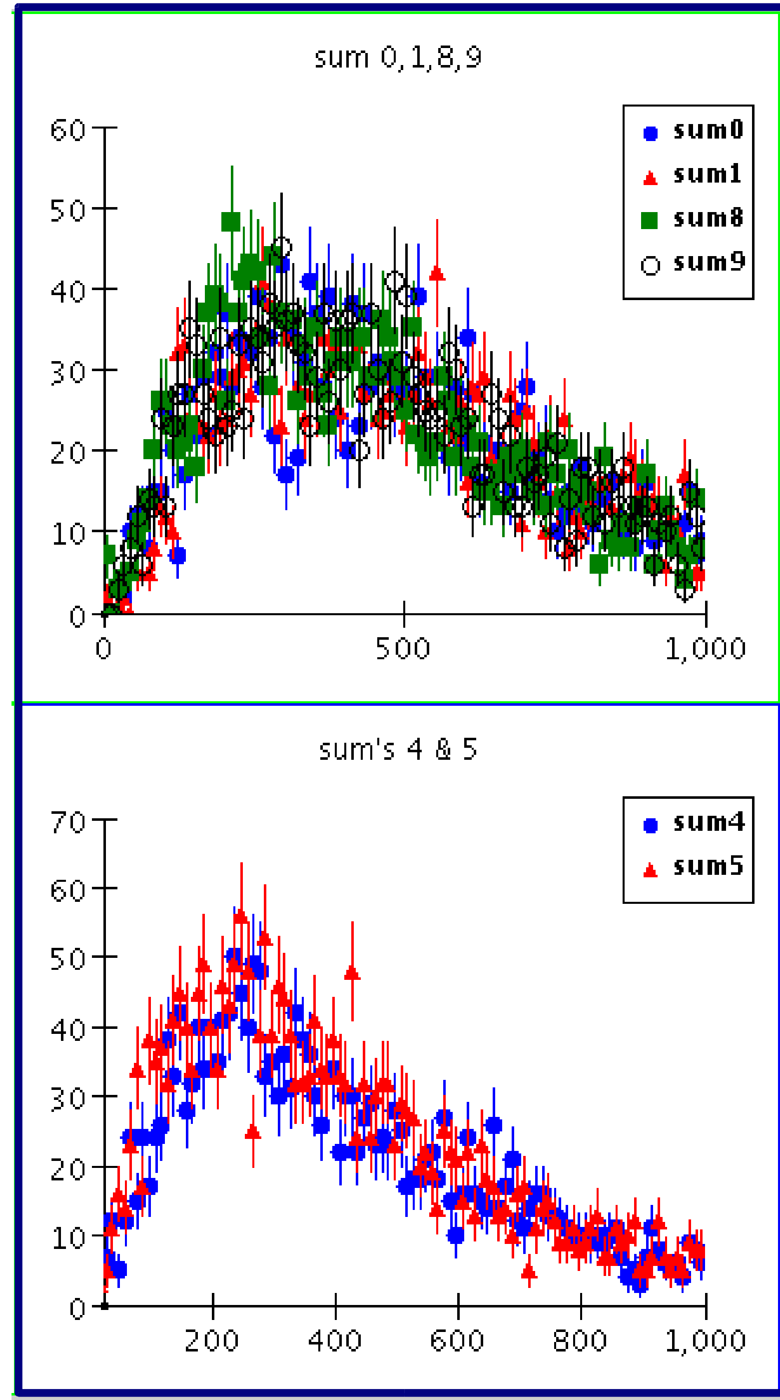
We've spent the last 2 months developing the analysis and preparing final results. I plan to only present our near final results from analysis of the ArCF4 data at this meeting.

Micromegas operation

We've been able to obtain good smooth running of our Micromegas TPC. The chamber seems to have very uniform gain response, and the electronic noise is quite low.

Plots are shown of the number of pads forming each cluster and of the summed amplitude signals for both 2X10 mm^2 pad rows (#0,#1,#8 & #9) and the 1X10 mm^2 pad rows (#4 & #5).





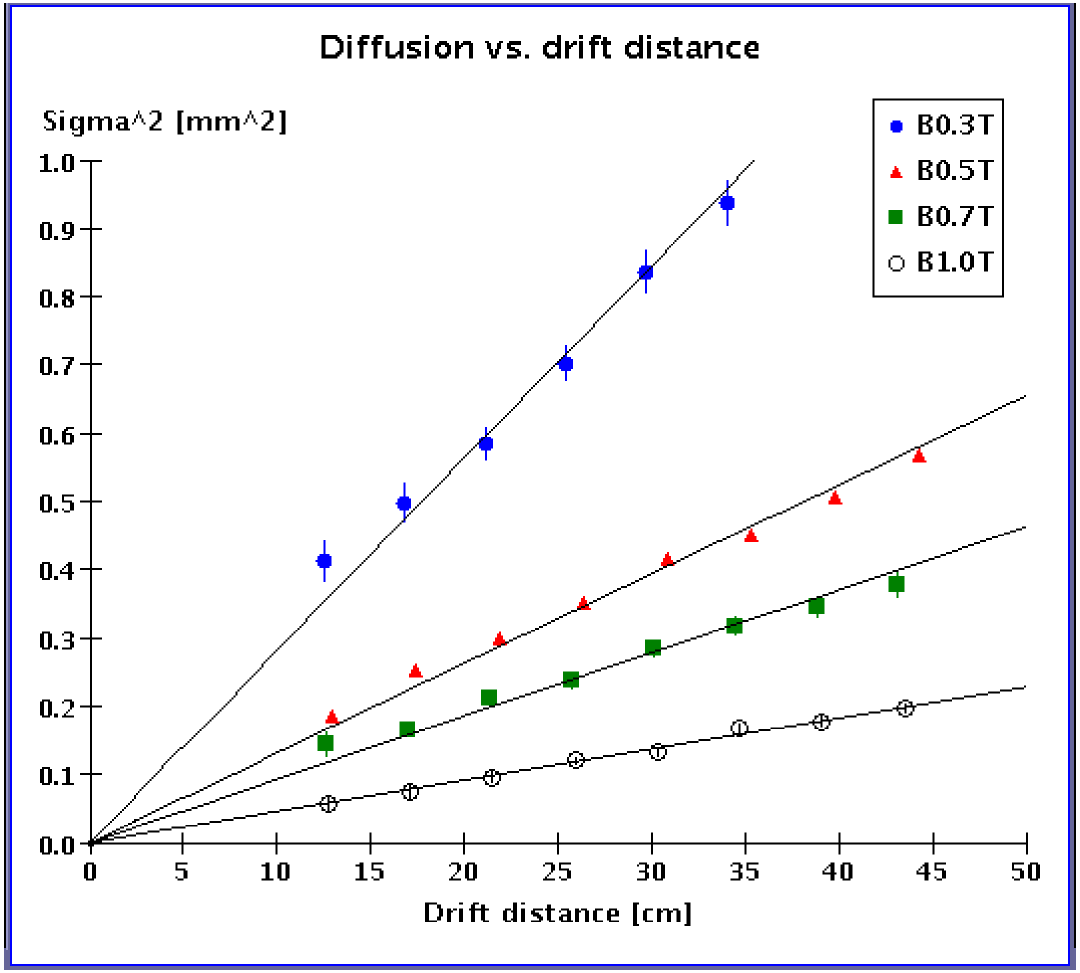
New Ar-CF4:3% results

We've taken high quality data with the same gas and voltage conditions at several different magnetic fields, as shown in the plot of transverse diffusion vs. drift distance.

We have developed ntuple analysis software to look into the following performance characteristics of our Micromegas TPC operating with ArCF4:

- Drift velocity
- Transverse diffusion
- Gas attenuation
- Position resolution
- dE/dx resolution
- Timing resolution

For the rest of my talk I will concentrate on our analysis of the higher statistics B = 1T data.



Plans

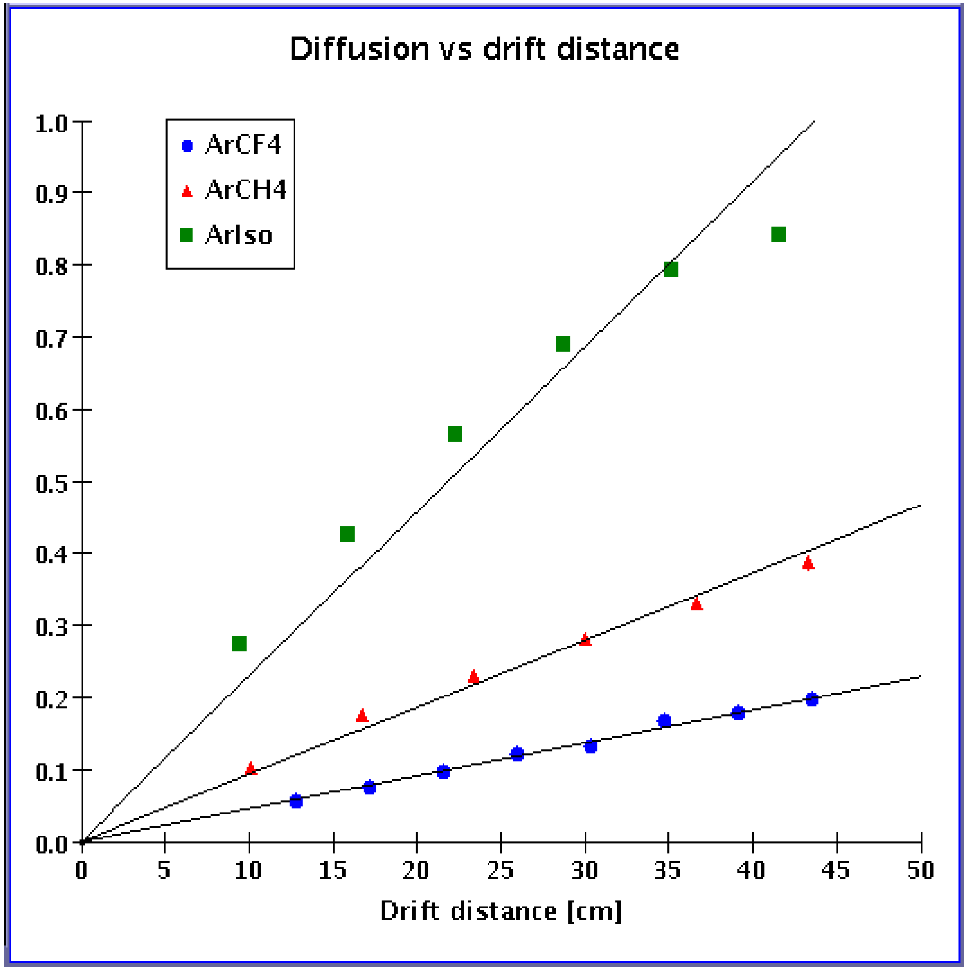
- Continue Ar-CF4:3% data analysis
  - Longitudinal diffusion
  - ...
- Analysis of data for other gases:
  - Ar-CH4:10% (P10)
  - Ar-Isobutane:5%
- Talk at Rome IEEE meeting
- Future data taking:
  - Other conditions ?
  - Using charge spreading

TPC Timing and Background Sensitivity

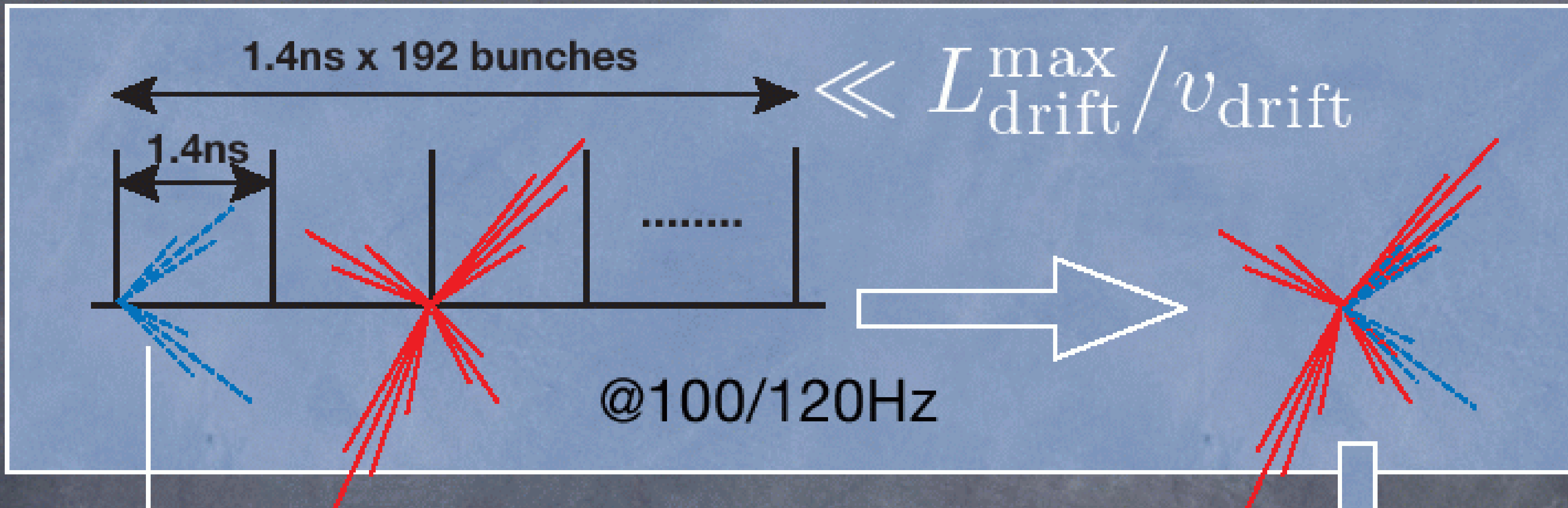
- Mike Ronan
- LBNL (Berkeley)

TPC Background Sensitivity

- **Tracking w/ Pair Backgrounds**
  - Tracking is essentially unaffected by expected e^+e^- pair backgrounds.
  - Most reconstructed pair tracks will be rejected by timing.
- **Neutron backgrounds**
  - Recoil protons from n-H scattering will travel along magnetic field lines, fully occupying the readout of a pixel. However there are more than 2 X 10^6 TPC pixels.
  - Several "new" TPC gases are presently being considered.
- **Random "salt & pepper" backgrounds**
  - TPC tracking is essentially unaffected by random hits at levels of more than X10 expected total background occupancies.



JLC/NLC Bunch Structure and Min-Jet BG



All the tracks will be recorded as from a single event

2-Photon Mini-Jet Production

$$\langle E \rangle \simeq 2.5\ \mathrm{GeV}$$
$$\langle n_{\mathrm{ch}} \rangle \simeq 5$$

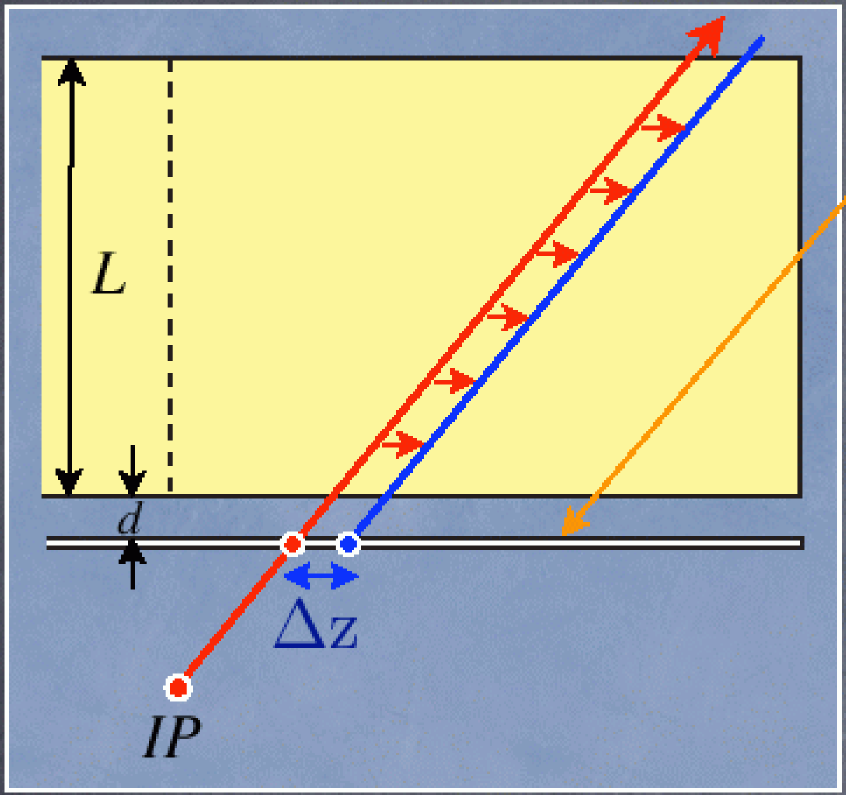
in chamber acceptance

Confusion in topology recognition

Degradation of M-jet resolution

....

In the Case of TPC



External Z Detector (T0 Device)

Wrong T0 makes a Z-shift!

$$\Delta z = v_{\mathrm{drift}} \times \Delta T_0$$

Naively we expect

$$\sigma_{\Delta T_0} \simeq \frac{2\sigma_z}{v_{\mathrm{drift}}\sqrt{n}} \left[1 + 3\left(\frac{d}{L}\right) + 3\left(\frac{d}{L}\right)^2 \right]^{-\frac{1}{2}}$$

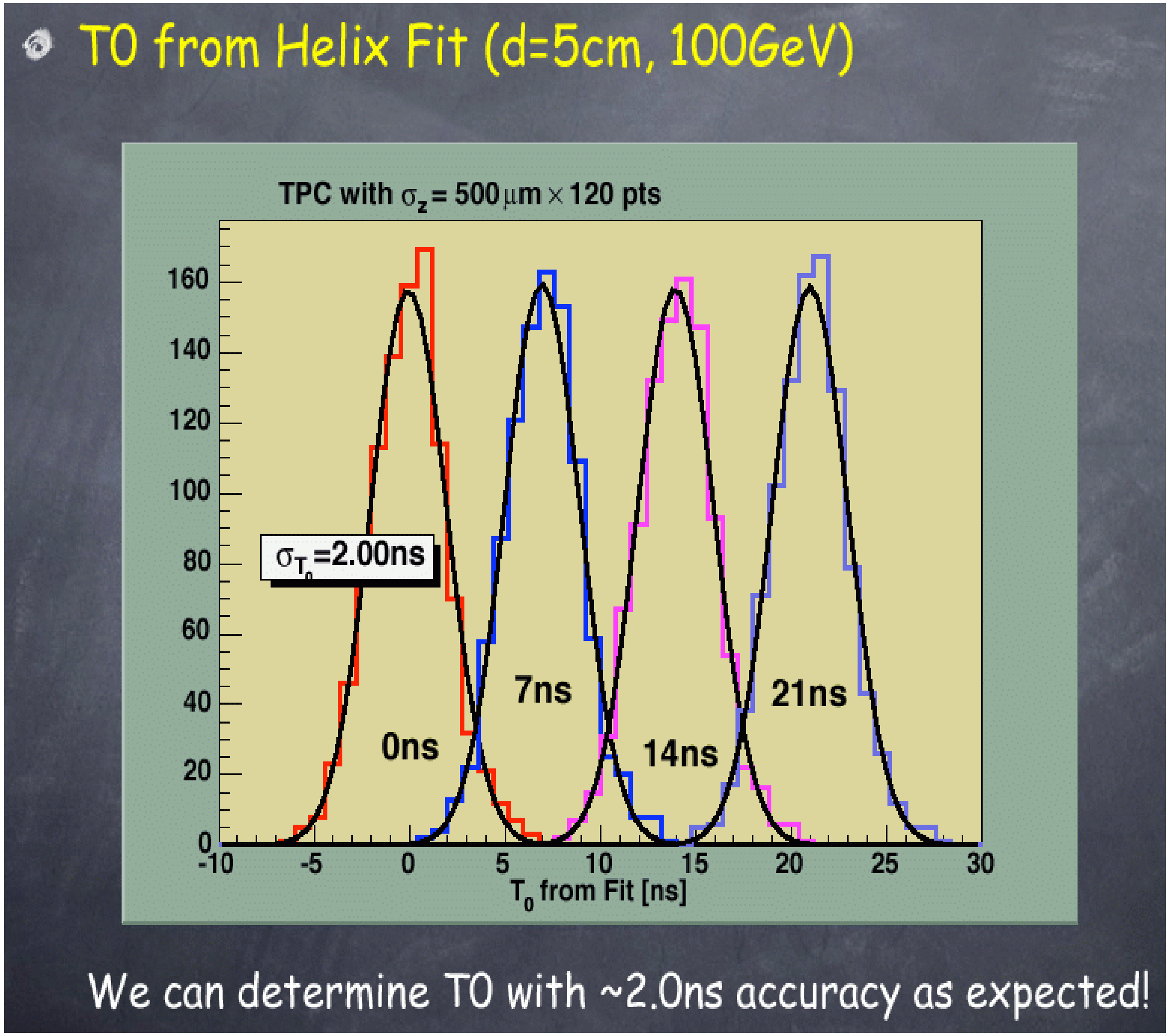
$$\simeq \frac{2\sigma_z}{v_{\mathrm{drift}}\sqrt{n}} \quad \text{if} \quad \left(\frac{d}{L}\right) \ll 1$$

Assuming that Z resolution of the external detector is negligible

$$\sigma_z = 500\ \mu\mathrm{m}$$
$$v_{\mathrm{drift}} = 5\ \mathrm{cm}/\mu\mathrm{s}$$
$$n = 120$$

$$\sigma_{\Delta T_0} \simeq 2.0\ \mathrm{ns}$$

- For TPC
  - Take σ_z = 500 μm, n = 120 and v_{drift} = 5 cm/μsec.
  - Assume external T0 device with 10 micron z resolution.
- Helix fit TPC hits including the external Z hit with T0 as an additional fit parameter.
- Low pT tracks
  - Multiple scattering effects are larger since only one break point.
  - Material just in front of timing device doesn't affect resolution.



Summary

- TPC track timing at the nsec. level in LC multi-jet environment is possible using external z measurement.
- Background estimates for a future Linear Collider are quite reasonable.
- A TPC doesn't appear to be particularly sensitive to expected LC backgrounds
- Current TPC detector R&D with different gases may lead to a significant reduction of neutron backgrounds.