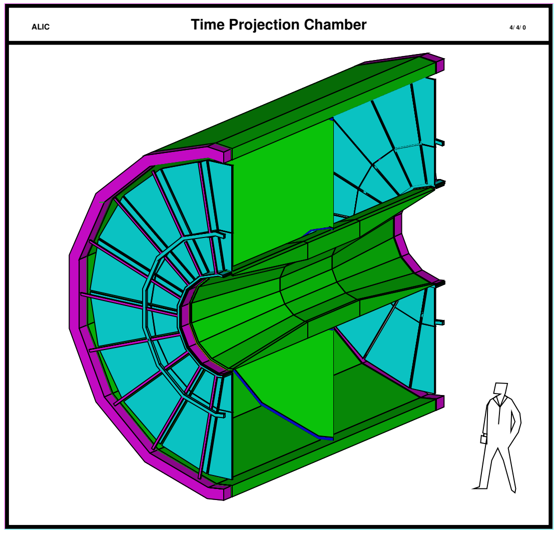
Outline

- TPC simulations
- Kalman filter: Advantages and shortcomings
- Cluster finding
- Track finding
- Definition of the tracking efficiency
- Present results & problems

TPC simulations (Marek Kowalski & Marian Ivanov)

Geometrical features:

- $R_{in}/R_{out} \approx 87/252$ cm, $L \approx 250$ cm
- sector opening angle 20^0
- pad shapes 75×40 and 100×60 mm^2



Phyisical processes:

- all GEANT processes
- diffusion
- gas gain fluctuations
- $E \times B$ effect
- responses in time and pad directions
- noise
- crosstalk

Kalman filter: Advantages and shortcomings

Advantages:

- simultaneous track recognition and reconstruction
- matrices not more than 5×5
- natural way to take into account multiple scattering
- possibility to take into account mean energy losses (fluctuations as well ?)
- efficient way to match tracks between different detectors

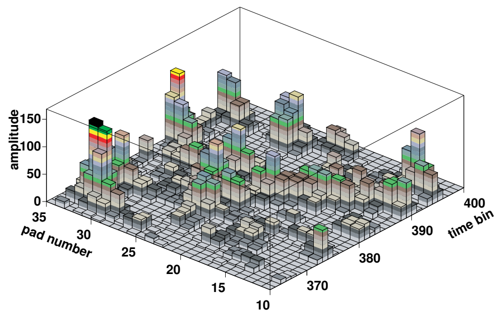
Shortcomings:

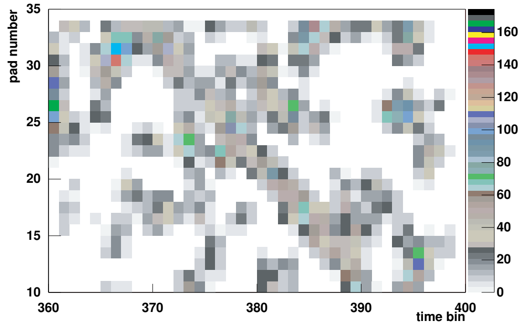
- track "seeds" have to be provided
- clusters have to be reconstructed **before** tracking
- "local" nature of the method (what if there are many clusters inside the "road" ?)
- sensitivity to p.d.f. of measured space points

Cluster finding

Occupancy: $10 \div 40$ %

- search for groups of adjacent digits with signals above the zero suppression level (preclusters)
- for each precluster search for all its local maxima
- cut all the local maxima at the level of the nearest saddle point
- calculate center of gravity for each group of these cut digits (clusters)
- errors are assumed to be proportional to clusters' dispersions





Track finding

Track parametrisation:

$$\begin{cases} y(x) = y_0 - \frac{1}{C}\sqrt{1-(Cx-\eta)^2} \\ z(x) = z_0 - \frac{\tan\lambda}{C}\sin^{-1}(Cx-\eta) \end{cases}$$

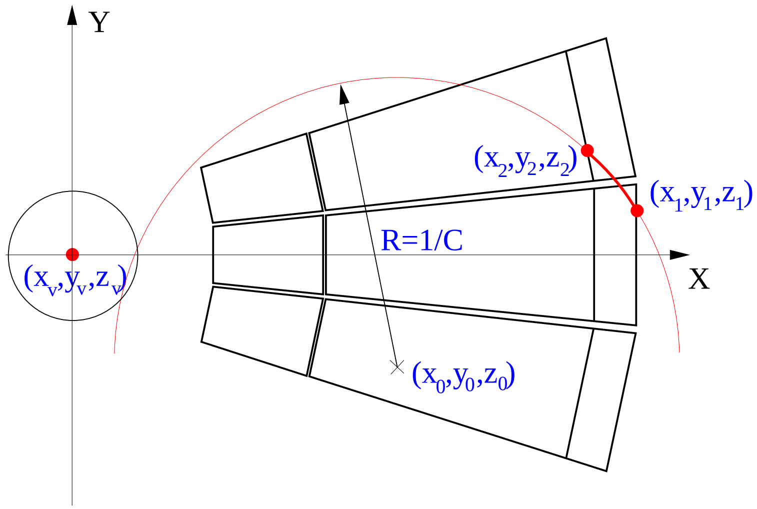
"State vector":

$$\mathbf{x}^T = (y,\ z,\ C,\ \tan\lambda,\ \eta),$$

where $\eta \equiv Cx_0$

Seed finding:

- for each pair (x_1, y_1, z_1) (x_2, y_2, z_2) and primary vertex $(x_v, y_v, z_v) \Rightarrow$ initial approximation of the "state vector".
- for each $(\Delta y_1, \Delta z_1)$ $(\Delta y_2, \Delta z_2)$ and the diameter of the beam pipe $\Rightarrow$ initial approximation of the covariance matrix.



Track propagation and assignment of clusters are done in a standard way. Multiple scattering and mean energy losses are taken into account during the track propagation.

Definition of the tracking efficiency

"Found good" track:

- number of assigned clusters larger than 40 % of the total number of pad rows
- not more than 10 % of clusters are assigned incorrectly
- at least half of the innermost 10 % of clusters assigned correctly

"Found fake" track:

- a track with the sufficient number, but incorrect assignment, of clusters

"Generated good" track:

- at least one digit on at least 40 % of pad rows
- at least one digit on the pad rows chosen for the seed-finding procedure

Tracking efficiency:

$$\epsilon_{\text{good}} = \frac{N_{\text{found good}}}{N_{\text{generated good}}}$$

Probability to find "fake" tracks:

$$\epsilon_{\text{fake}} = \frac{N_{\text{found fake}}}{N_{\text{generated good}}}$$

CERN/BNL

Present results & problems

dN_{ch}/dy	$\epsilon_{good}(\epsilon_{fake})$, %	$\Delta p_t/p_t(5\ GeV/c)$, %	dE/dx (max. digit), %
1500	98 (0)	1.6 (5.1)	7.8 (7.0)
8500	93 (3)	2.0 (8.5, 4.5*)	17.3 (9.0)

* if the primary vertex is included in fit

Computing resources per one simulated TPC event ($dN_{ch}/dy = 8300$)

	CPU time, h**	RAM, Mb	Disk space, Mb
hit generation	8.0	400	2500 (200 ?)
digitization	13.5	750	400
reconstruction	0.5	550	5

** on 25 SpecINT95 machine

And at long last:

HOW SHOULD WE UNFOLD CLUSTERS ???