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Black tracks recognition and measurement

- Motivation
- Recognition technique
- Results
- Conclusions

Motivation

Normal vertex reconstruction relies on the detection of m.i.p. tracks crossing and/or disappearance

Around 80% of interaction vertices have black tracks attached and so it would be useful to recover this information automatically in order to have:

In standard acquisitions they are rejected on the base of form factor because they are too many,anyway they give :

⇒Stronger vertex signal
⇒Full reconstruction of interactions
⇒Information on heavy, slow fragments

In the last two years we considered the problem of black tracks on-line acquisition but the main problem was their insertion in DAQ programs

Recognition technique

Usual tracking algorithms are designed to reconstruct *mip* tracks that are almost orthogonal to the emulsion plane

Small, almost pointlike grains
No more than 1 grain per layer

Black tracks are thick and more isotropically distributed

Grains are merged in large clusters
Black tracks are often “flat”

The usual tracking technique does not fit the needs
A specific tracking algorithm must be developed

Recognition technique

Questions:

Is it possible to keep the current data-taking fashion?

Should we change the DAQ parameters (lighting, image handling)?

On-line or off-line?

Do we need new data structures to accommodate these data?

Recognition technique

Observations:

Black tracks are enhanced by the filter

Our filter is 2D, so it behaves isotropically
(1D filters would not)

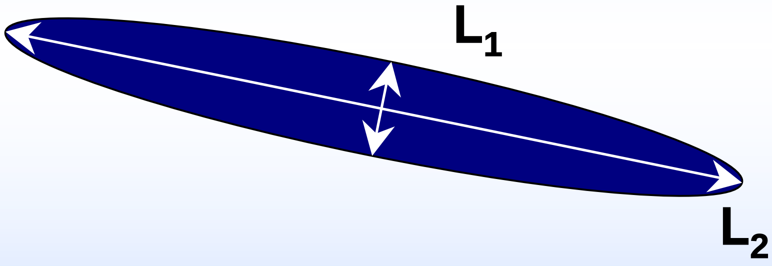
"Clusters" of black tracks are very different from grains of *mip* tracks and fog grains

"Gray" tracks are between shower and black and need further considerations (under study)

Recognition technique

Observations:

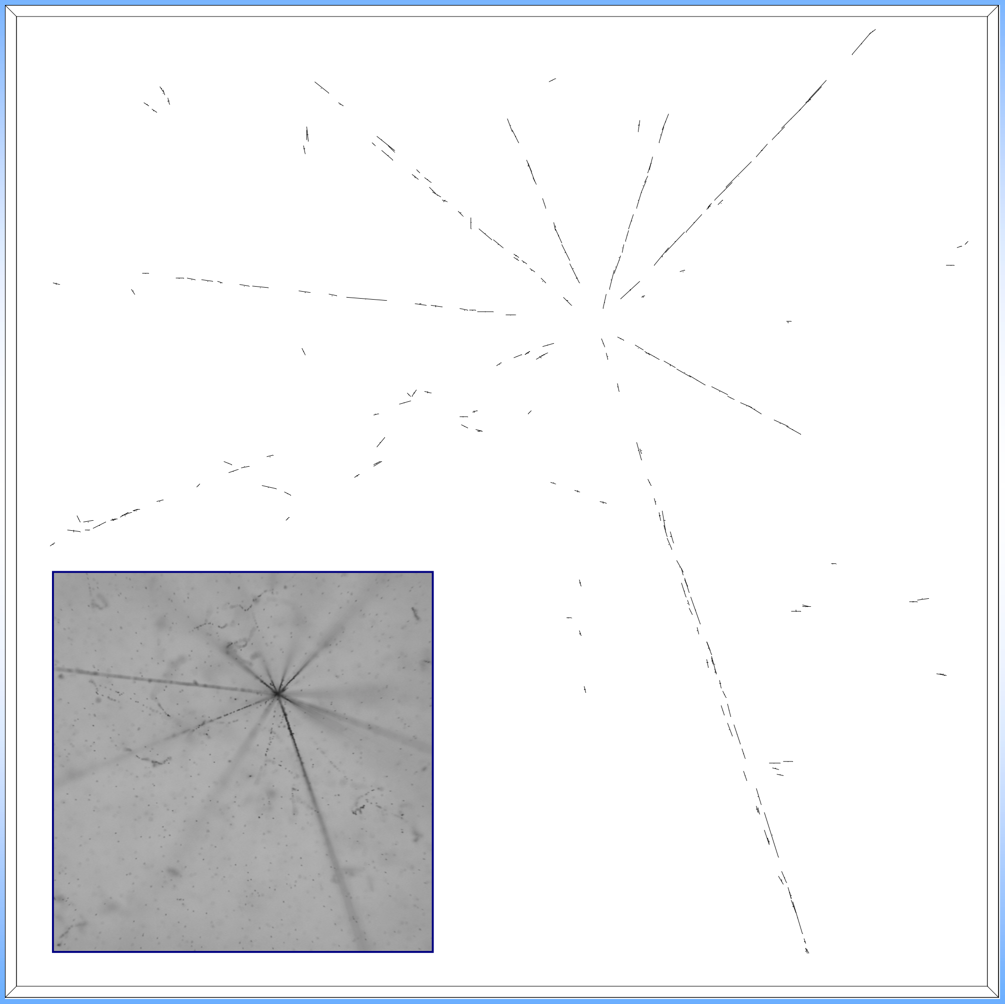
Black track clusters are not circles, and each of them points in the direction of the track it belongs to



Require $L_1/L_2 < 0.3$ to accept a cluster for black tracks
Let's check what survives the cut…

Recognition technique

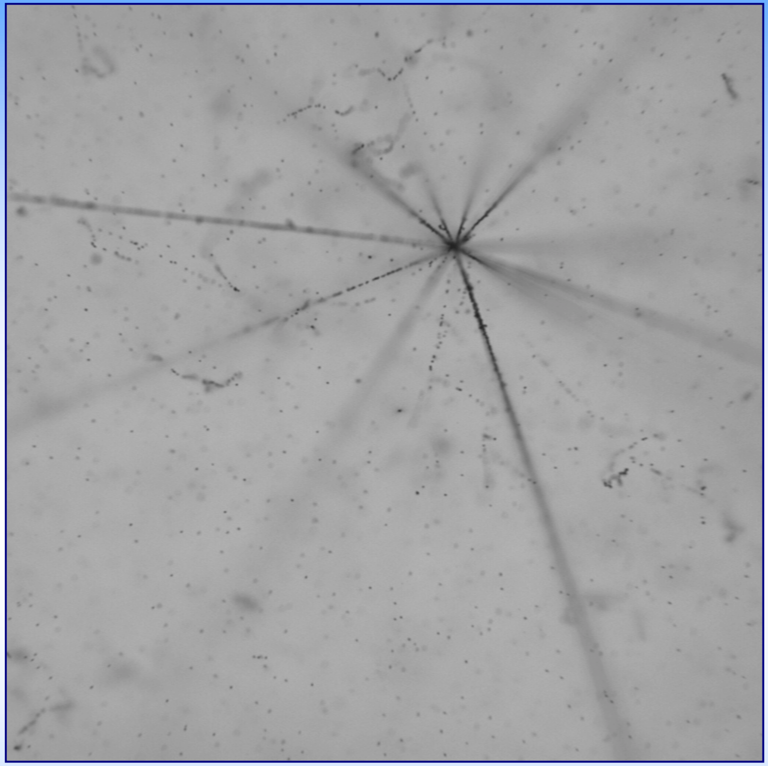
14 layers (2 μm spacing) summed up



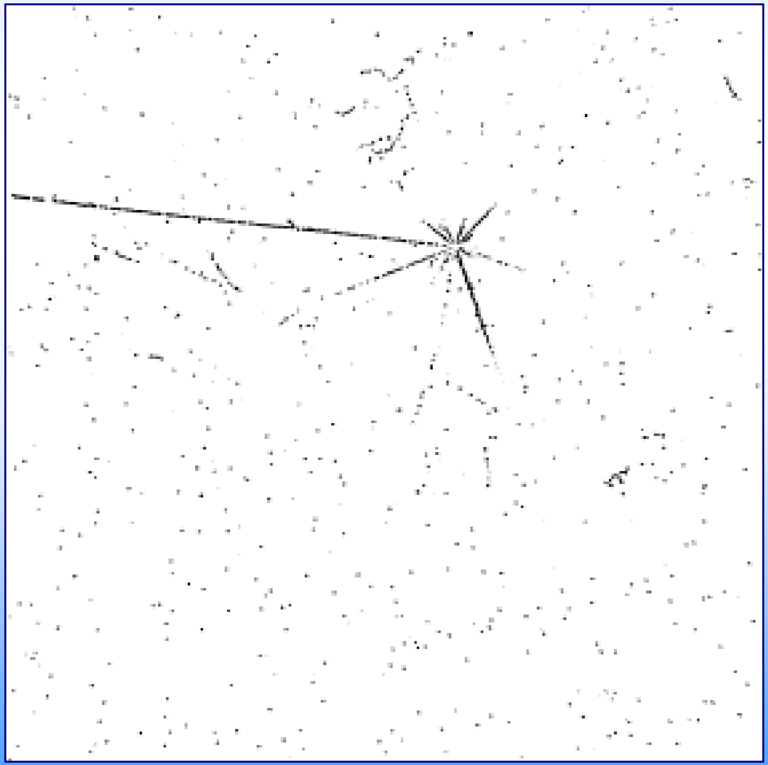
The threshold of the filter has the same value we use for normal (vertical, *mip*) tracks

Recognition technique

A look at the emulsion:



Filter & Threshold

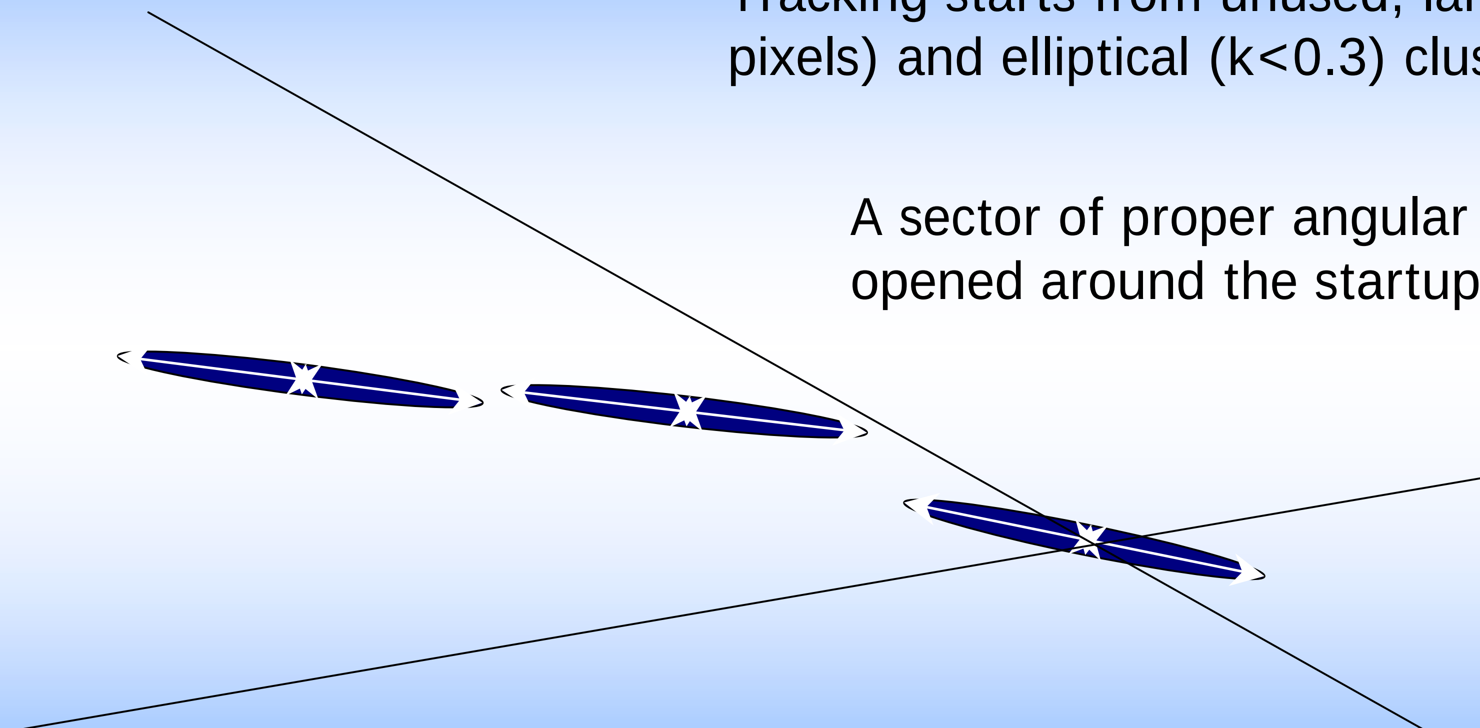


Recognition technique

Some details about tracking:

Tracking starts from unused, large (15 pixels) and elliptical (k<0.3) clusters

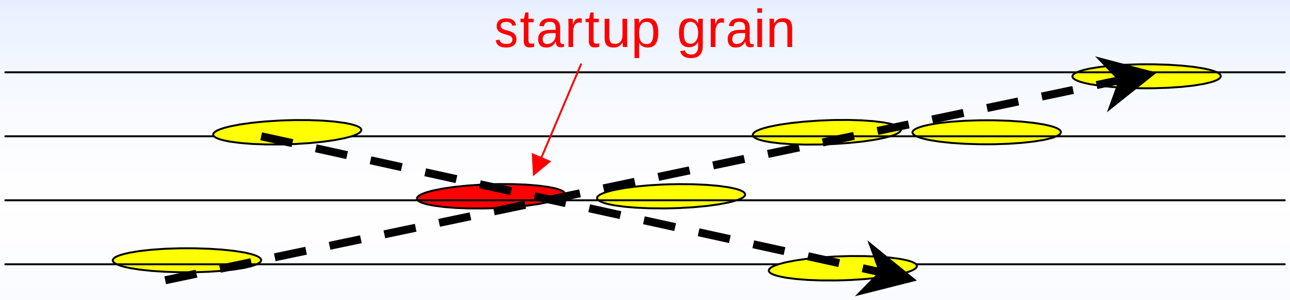
A sector of proper angular width (10°) is opened around the startup cluster



Of the clusters within the sector that have the major axis aligned (within 10°) with the startup cluster, the nearest one is appended and the procedure is iterated

Recognition technique

Some details about tracking:

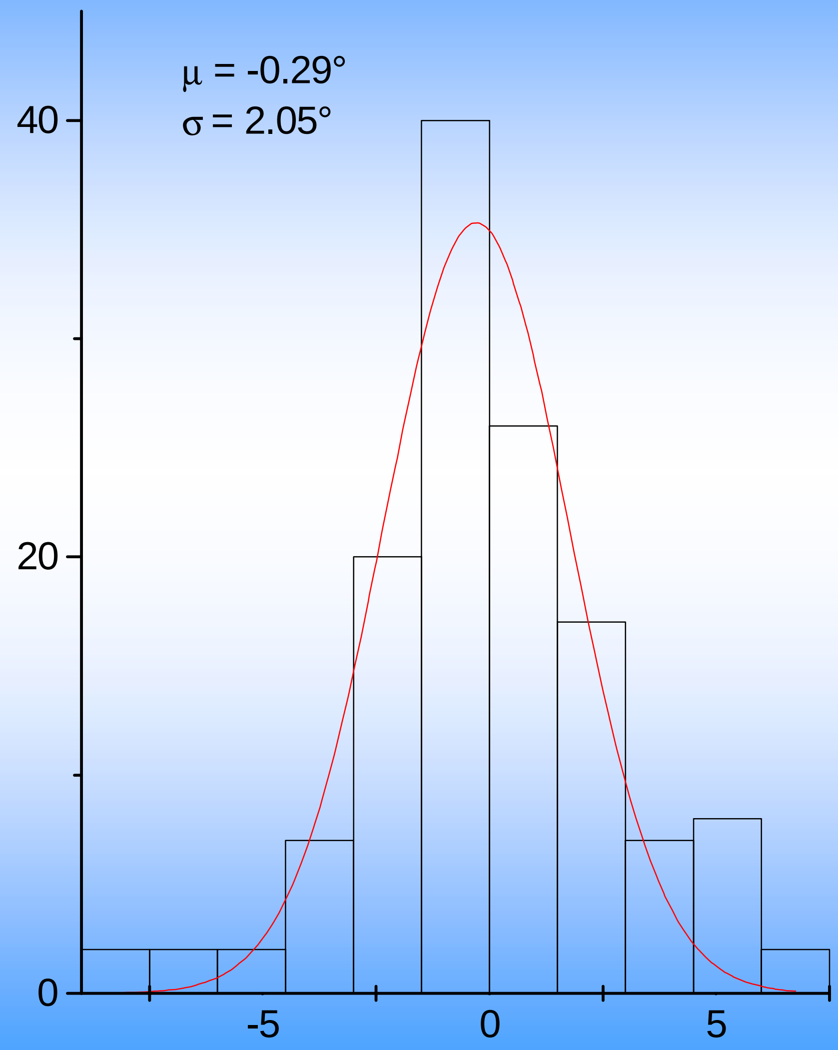


To reconstruct a track the startup grain is linked to several clusters in different directions

In the end we chose the direction that yields the longer track

Recognition technique

Agreement between single cluster plane direction and track direction (degrees)



Recognition technique

Observations:

The clusters provide a good estimate of the track direction

The number of clusters per track is much lower than in the case of *mip* tracks, but each track can have several clusters on a single layer

The component of the direction in the plane of view is much more precisely known than the component in the orthogonal direction

Distortion has almost no effect

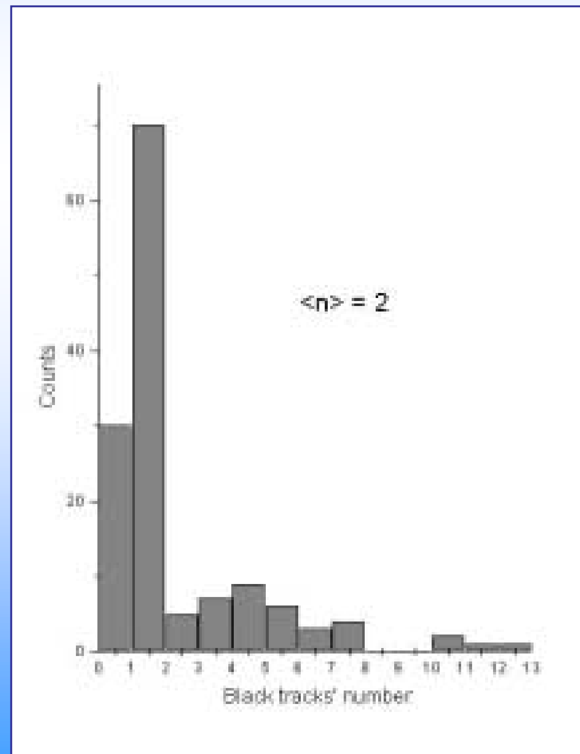
Tracks with very large angles (60° and more, or event flat) can be easily reconstructed

Volume scanning is required

Emulsion feedback results

CHORUS target sheets

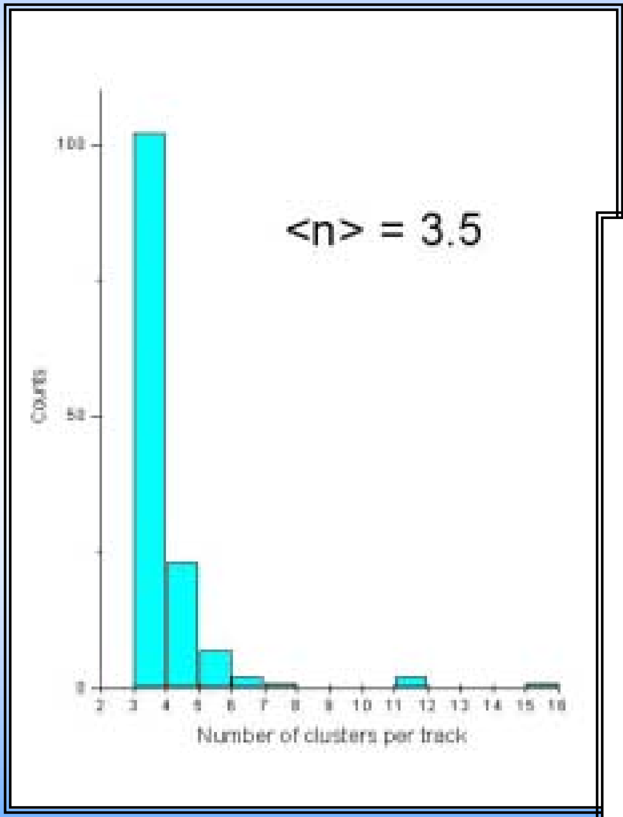
We acquired black tracks and m.i.p. over 40 vertices already located on two different target sheets.
Our request is that each black track must consist of at least 2 aligned clusters.

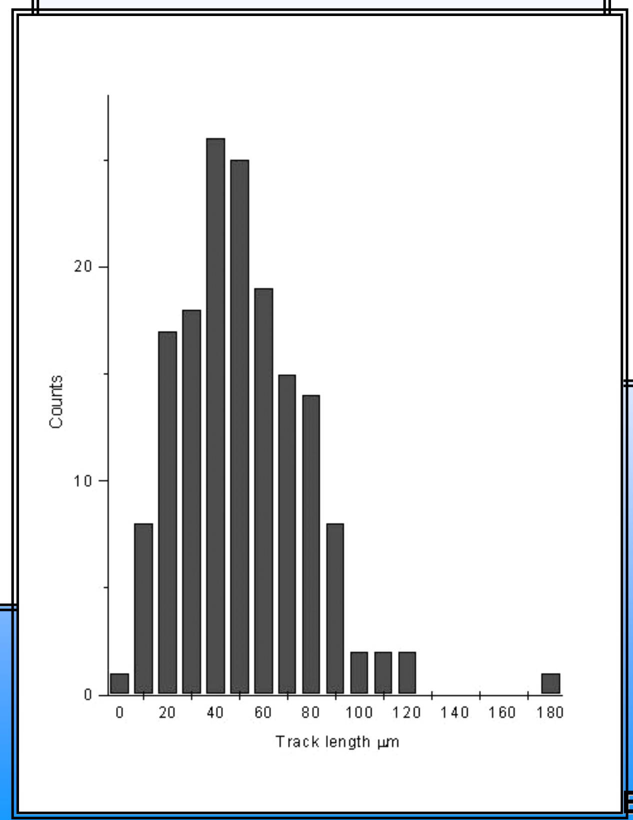


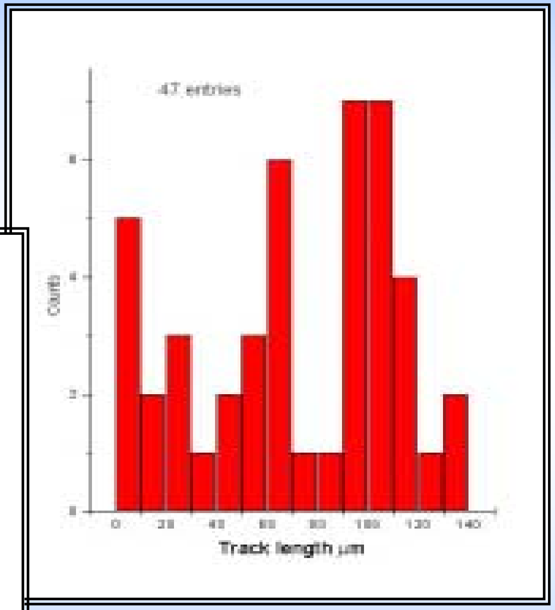
Mean number of black tracks at vertex

Results

Some statistics, mean number of cluster building up a black track and track lengths.





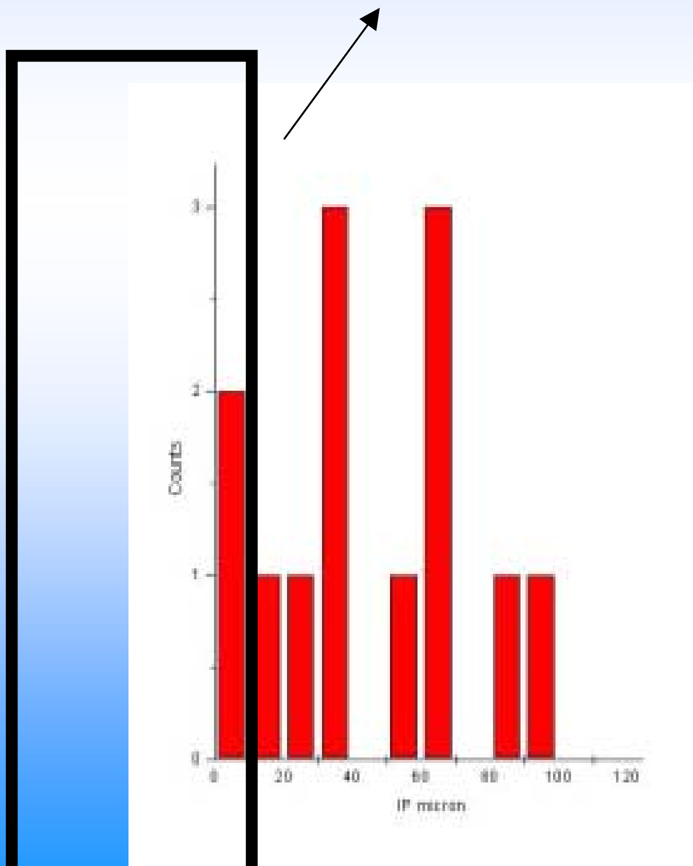


Results

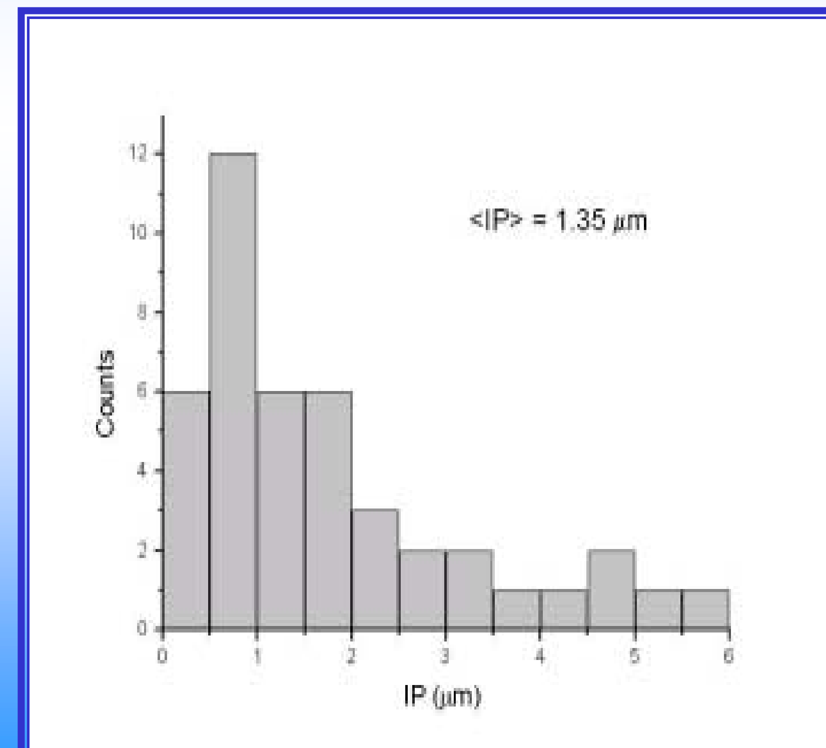
Preliminary

Horizontal precision (IP w.r.t. the vertex) :
from emulsion feedback we observed that vtx tracks have IP <10 μm

In a single reconstruction



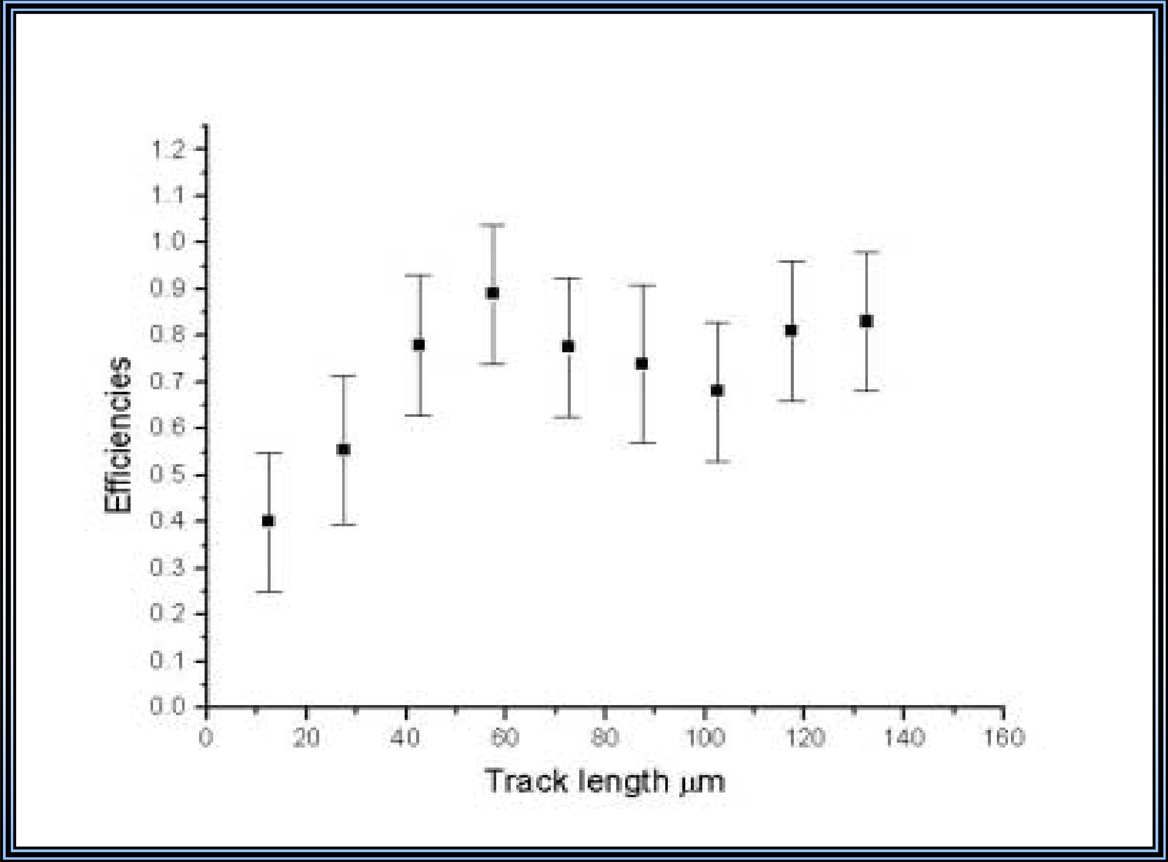
All reconstructed tracks at vertex



Results

Preliminary

Efficiencies



Tracks shorter than 140 µm ε = 70%

If black tracks are longer than 140 µm   ε =81 %

Conclusions

The method works

No appreciable CPU overload for this additional tracking:
no appreciable difference in scanning speed

A change in the data structure was required...
It took some time to evolve the old DAQ code

The filter and threshold are the same we use for *mip* tracks,
so no special data-taking procedure must be performed

The scanning code can execute 2 tracking algorithms , one for
almost-vertical tracks (mip) and another for flat tracks (black)

The acquisition of gray and vertical black tracks is under study