Level 3 Secondary Vertex Finding Algorithm

Status Report
Off-line calibration workshop:
September 25-29, LPNHE-Paris

A. Duperrin, M. Talby,
E. Kajfasz, F. Villeneuve-Séguier
(CPPM)
in collaboration with G. Brooijmans &
Run II Vertex Reconstruction Group
(Fermilab)

$\boxed{1}$ **D0 Run II STT Trigger Scheme**

$\boxed{2}$ **L3 SV Finding Algorithm Scheme**

$\boxed{3}$ **What is available ?**

$\boxed{4}$ **What is currently under developement ?**

$\boxed{5}$ **Plan**

Production Status report

Silicon Microstrip Tracker
(26 september 2000)

Barrel 1 :

- tested succesffully in 10 % test stand
  - $\geq$ 45000 channels have been read out without problem
  - Noise studies looks good
  - Data integrity looks good

South 1/2 cylinder :

- 2 barrels/disks are already in
- 3rd barrel/disk should have gone yesterday
- 3 end disks should go in by the end of the week
- Need to cable it up
- H disks : 1 disk ready, 2nd soon

$\Rightarrow$ should leave sidet by November first 2000

North 1/2 cylinder :

- barrel 4 : already mated with a disk $\rightarrow$ 10 % test-stand
- started installing ladders in barrel 5 and 6 in //
- Production ladders should be done by mid-october

$\Rightarrow$ Hopes to be ready by the end of the ye

What is available ?

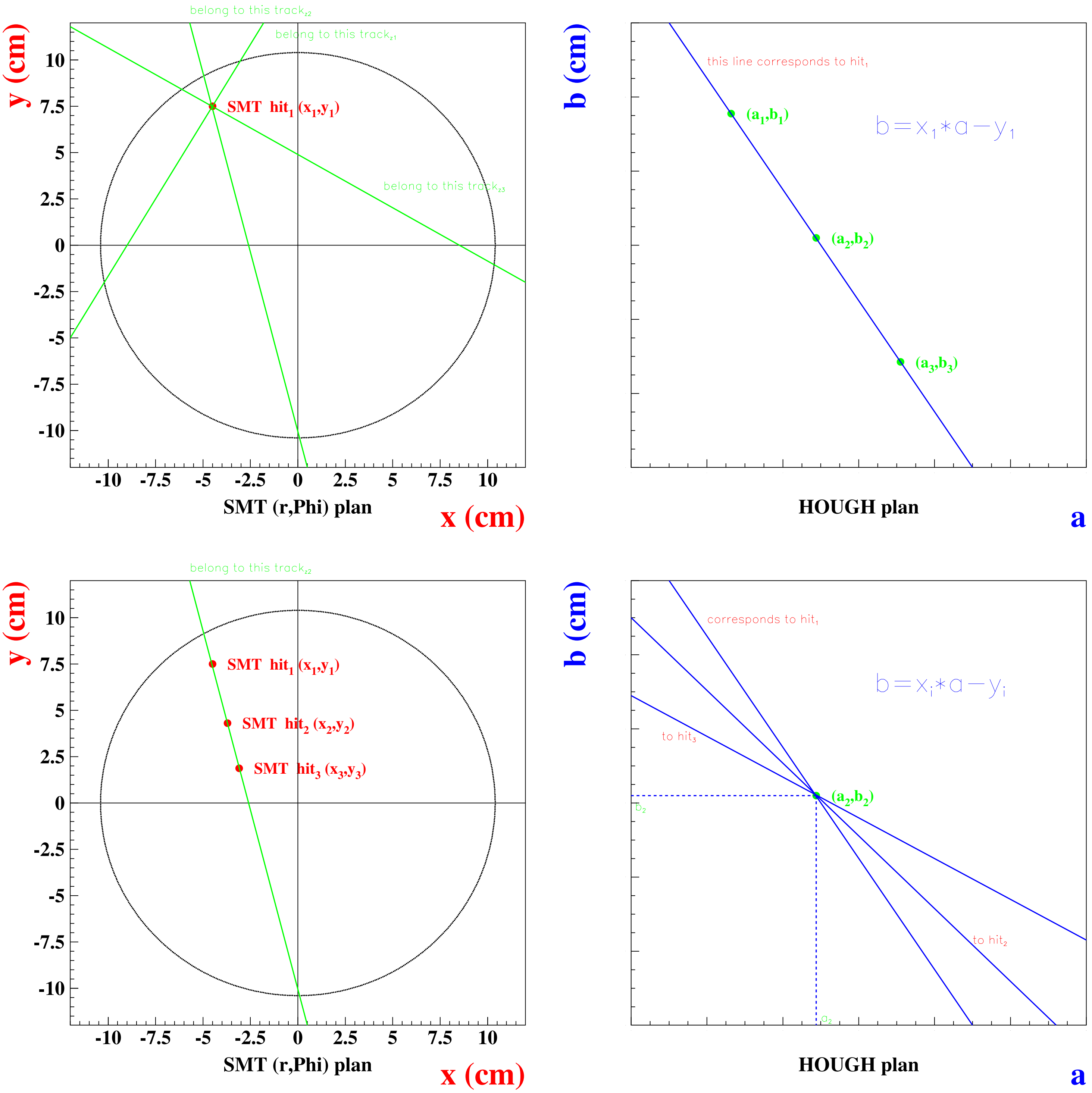
Two methods:

Hough transform and analytical approach

- both methods based on straight tracks (high p_t) in $r - \phi$ plan
- the 2 methods tested with 5 muon track events sample and their performances compared

  $\Rightarrow$ results presented at the vertex meeting on june 20th
- both methods are implemented in l3fhough_vertex v00-02-12

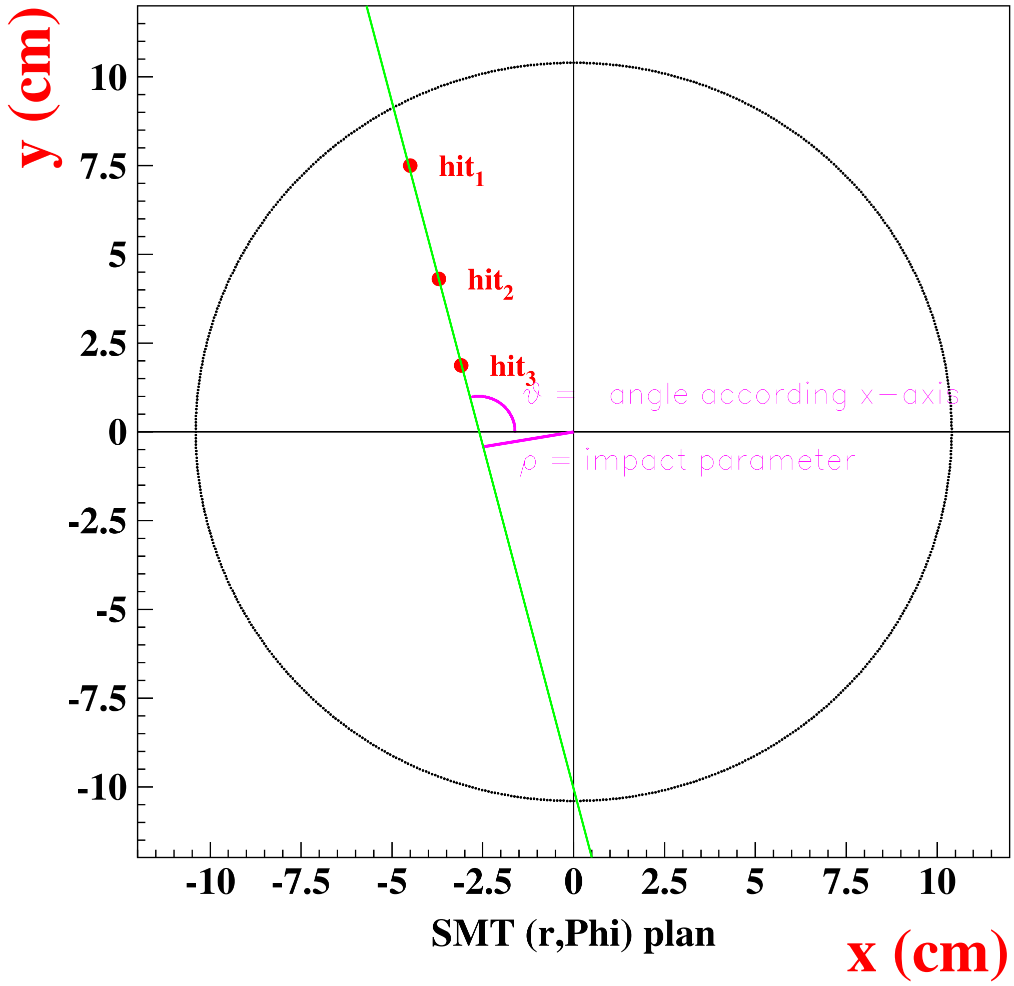
$\boxed{1}$ SMT Tracking with an Hough Transform



the accumulation in the (a, b) plan
$\Rightarrow$ defines the line connecting the hits

Current implementation

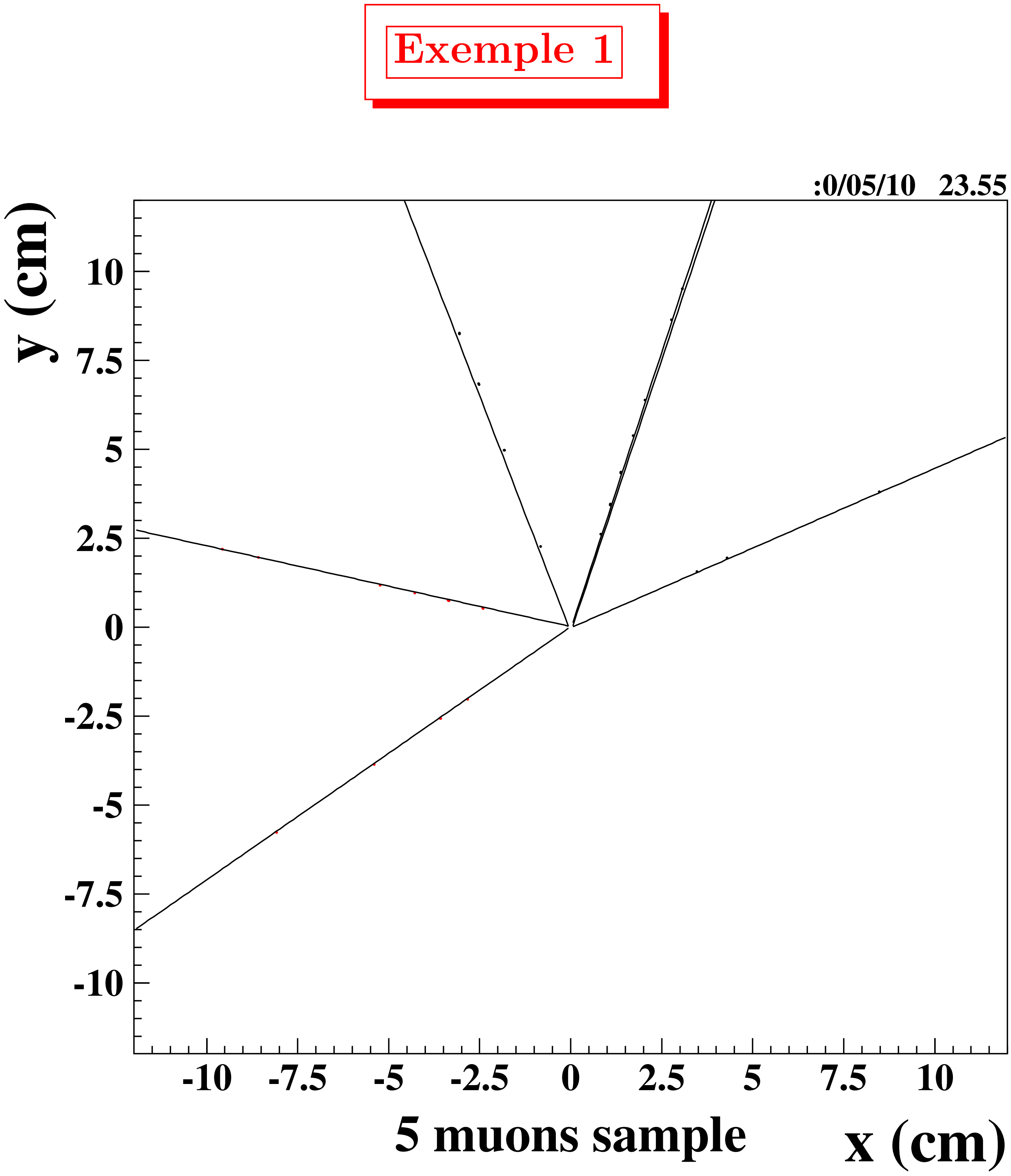
- Couples of bugs have been fixed



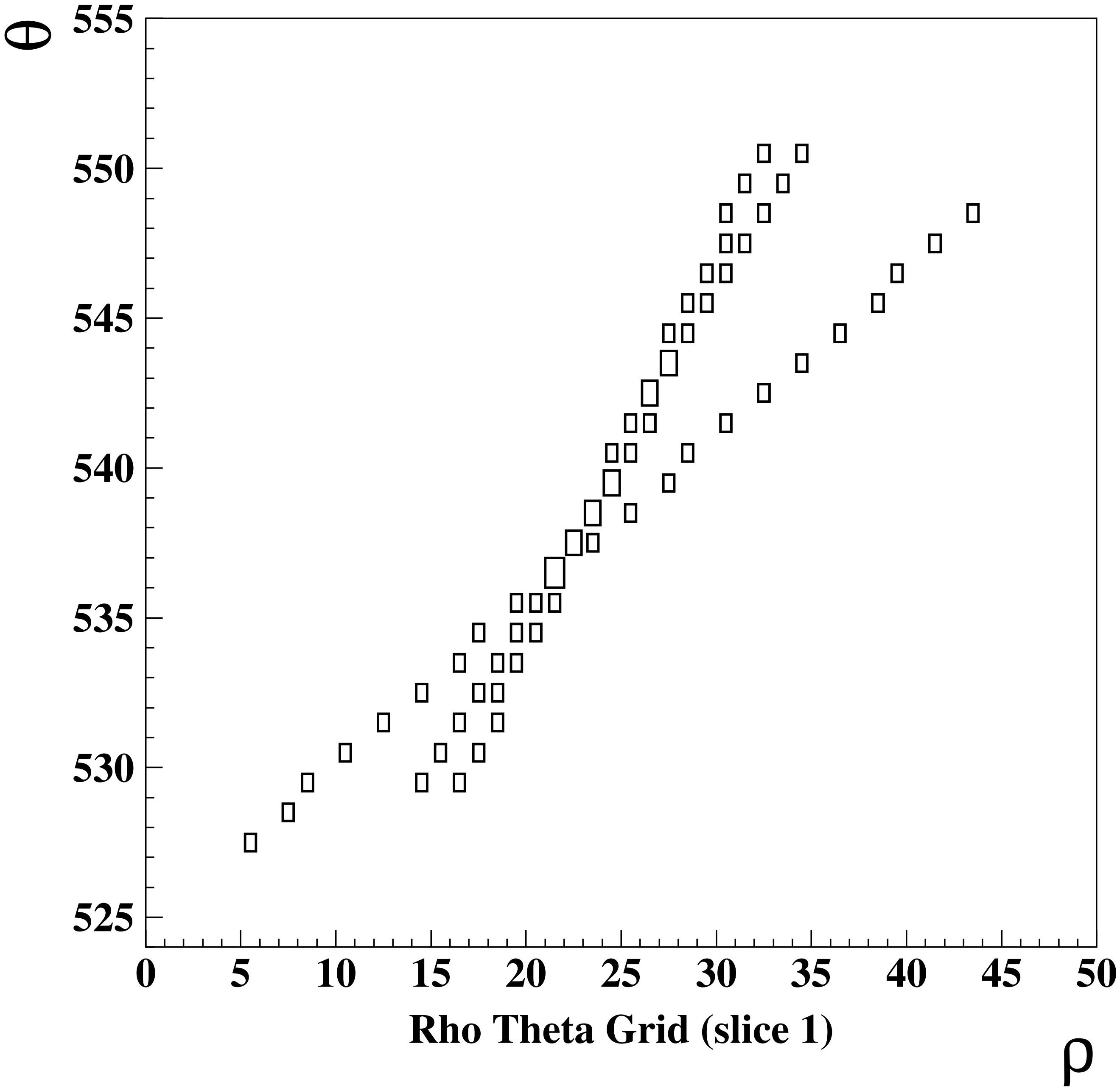
- Origine = center of the detector
- Use the "normal" track parametrization :

$$b = -xa + y \Rightarrow x \sin\theta - y\cos\theta = \rho$$

- $-1\ mm \leq \rho \leq +1\ mm$ (to be optimized)
- $0^o \leq \theta \leq 180^o$ (scan only $-1^o \leq \theta_{hit} \leq +1^o$)
- 2 slices (separates hits in 2 diff. hemispheres)

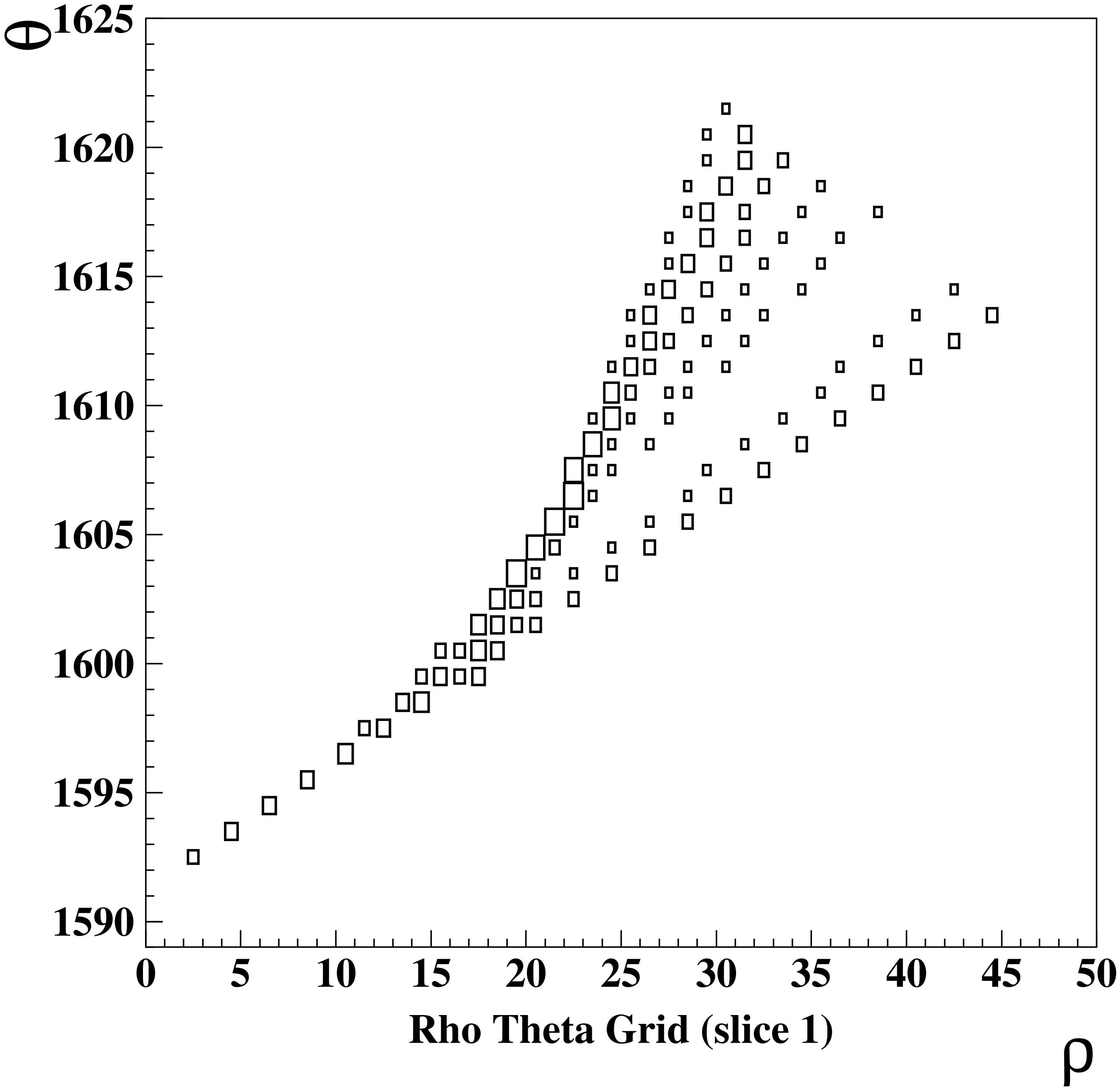

Exemple 1
:0/05/10 23.55
y (cm)
10
7.5
5
2.5
0
-2.5
-5
-7.5
-10
-10
-7.5
-5
-2.5
0
2.5
5
7.5
10
5 muons sample
x (cm)

Zoom on the first accumulation (i.e first 3 hits) :



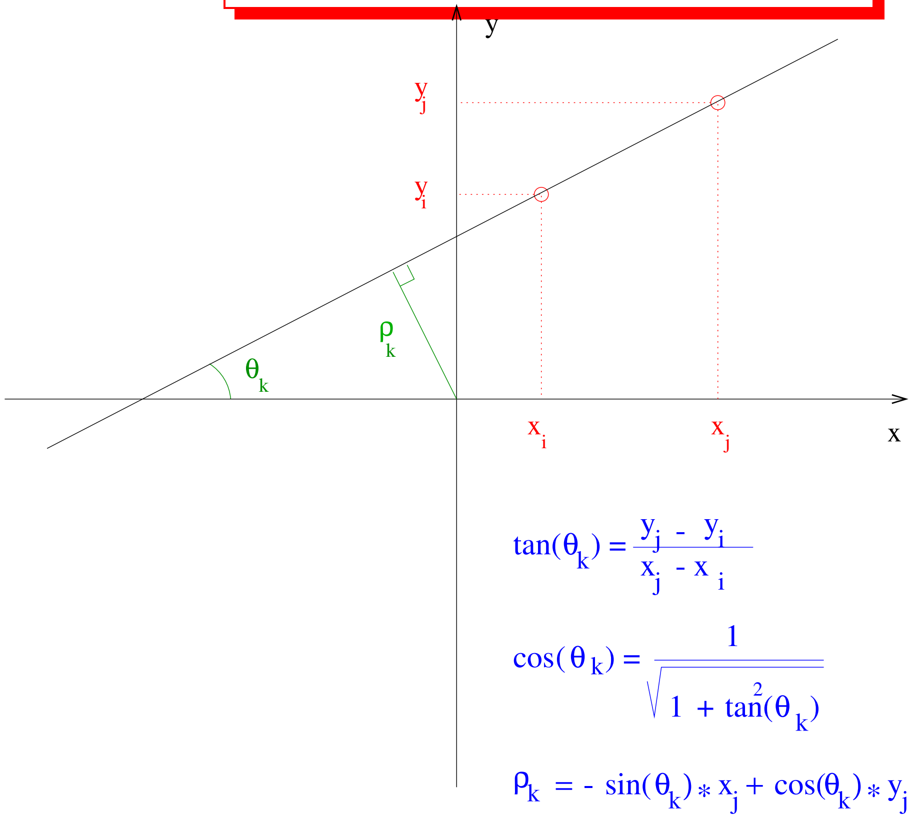
in this case, it is quite easy to find
the accumulation point
(fixes the values of ρ and θ
of the tracks connecting these 3 hits)

Zoom on the second accumulation (i.e next 7 hits) :



in this case, it is not easy to find
the accumulation point

$\boxed{2}$ Analytical method

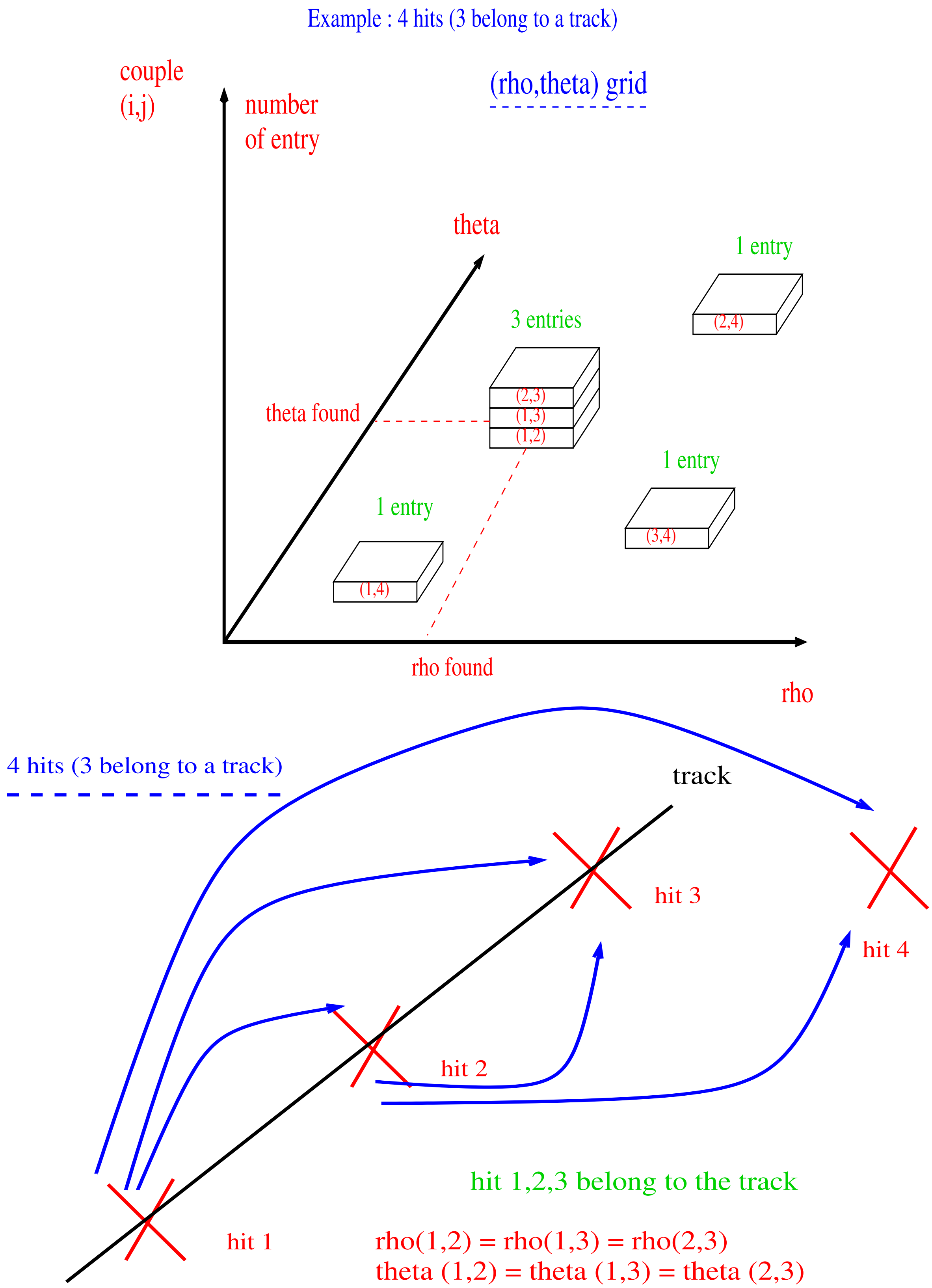


- **track parameters = clusters of $\cos\theta$ and ρ values with at least 3 hits couples**
- **vertex positions = clusters of x_v and y_v vertex positions with the highest number of entries**

$$x_v = \frac{\rho_i cos\theta_j - \rho_j cos\theta_i}{sin\theta_j cos\theta_i - sin\theta_i cos\theta_j}$$

$$y_v = \frac{\rho_j}{cos\theta_j} + x_v \cdot tg\theta_i$$

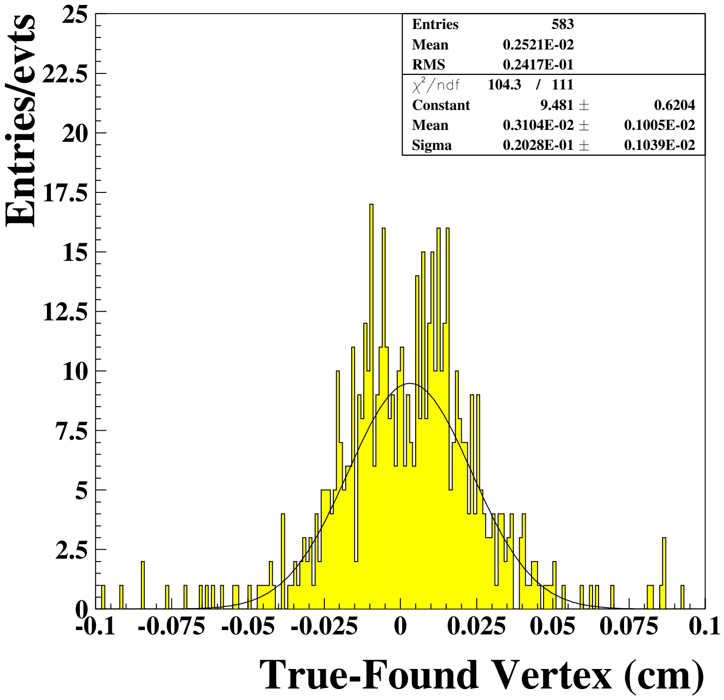
Grid : fill only cells corresponding to an intersection

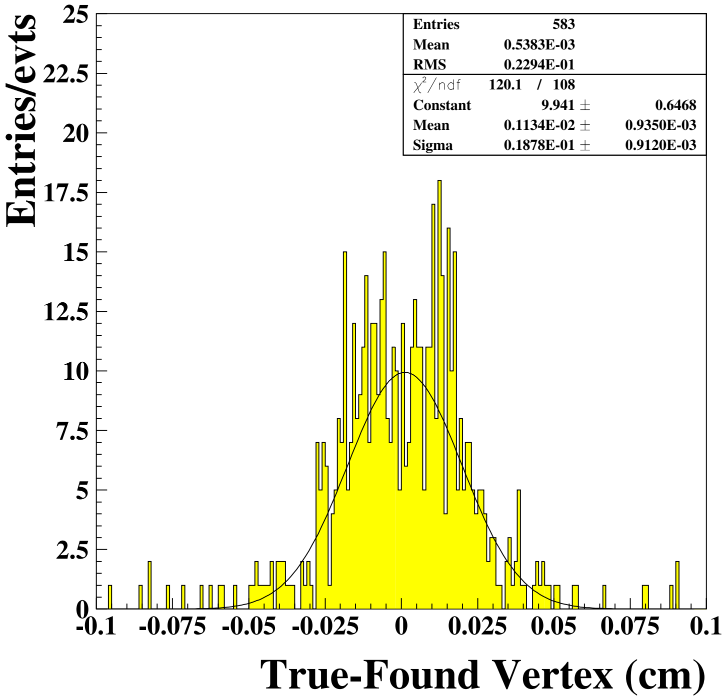


Results with 5 muons from a displaced Vertex

- **True vertex − Found vertex (cm):**

200 × 300 bins for $\rho \times \theta$ grid
$150\mu m \times 0.6^o$ for $\rho \times \theta$ grid





With this new $\rho \times \theta$ grid :

- Resolution $\simeq 200\mu m$
- Time $\simeq 0.5ms$/events

Remark : results for the Hough Transform :

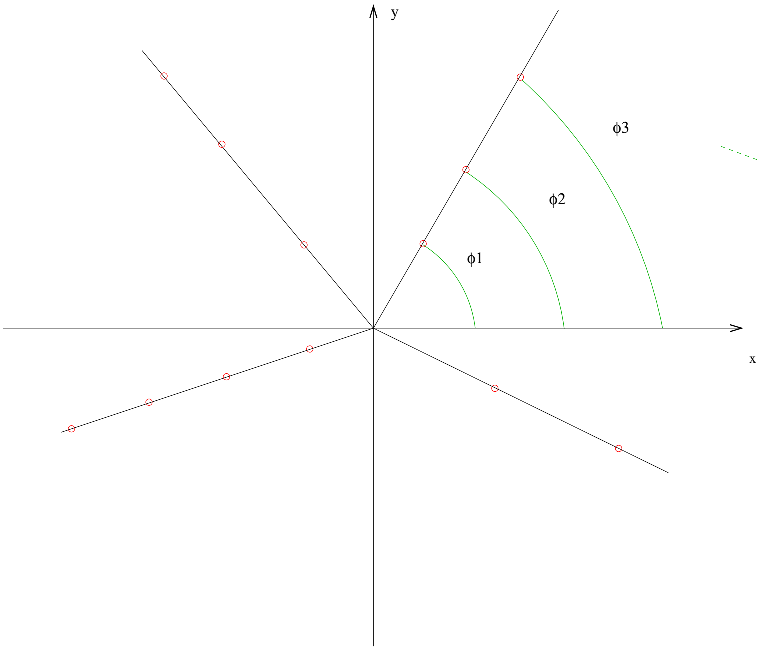
- Resolution $\simeq 300\mu m$
- Time $\simeq 30ms$/events

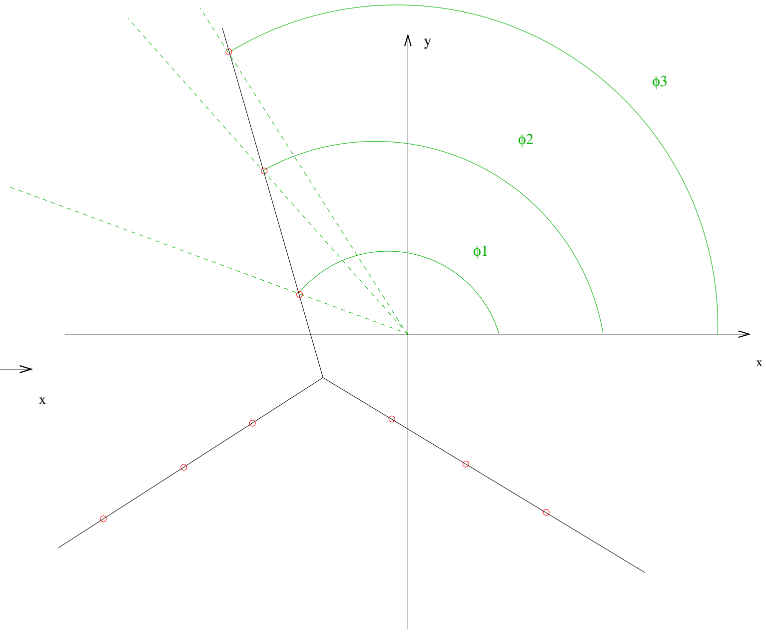
$\Rightarrow$ less efficient

Hits cleaning algorithms

Goal: reduce CPU time

Basic idea: remove hits belonging to tracks pointing to the primary vertex before applying secondary vertex finding algorithm



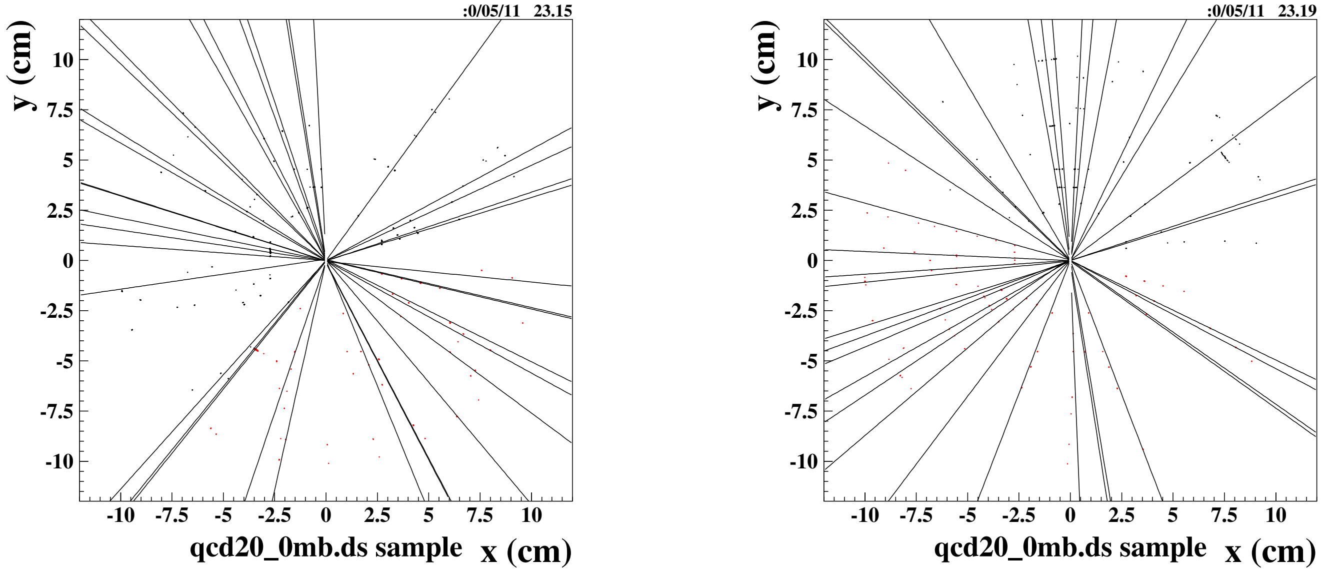


Hits cleaning algorithm based on hits clustering in φ

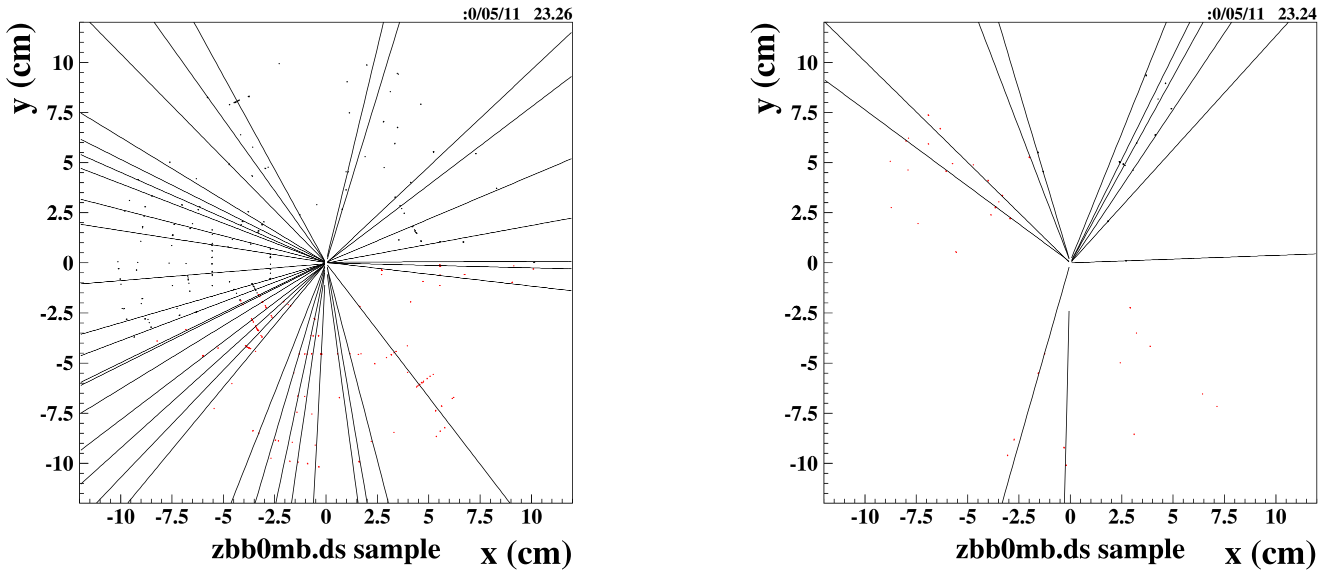
Strategy:

- Store φ angle of hits in an array of 2^o bin width
- remove hits belonging to φ clusters with at least 3 hits

QCD with 0 mb



$Zb\bar{b}$ with 0 mb



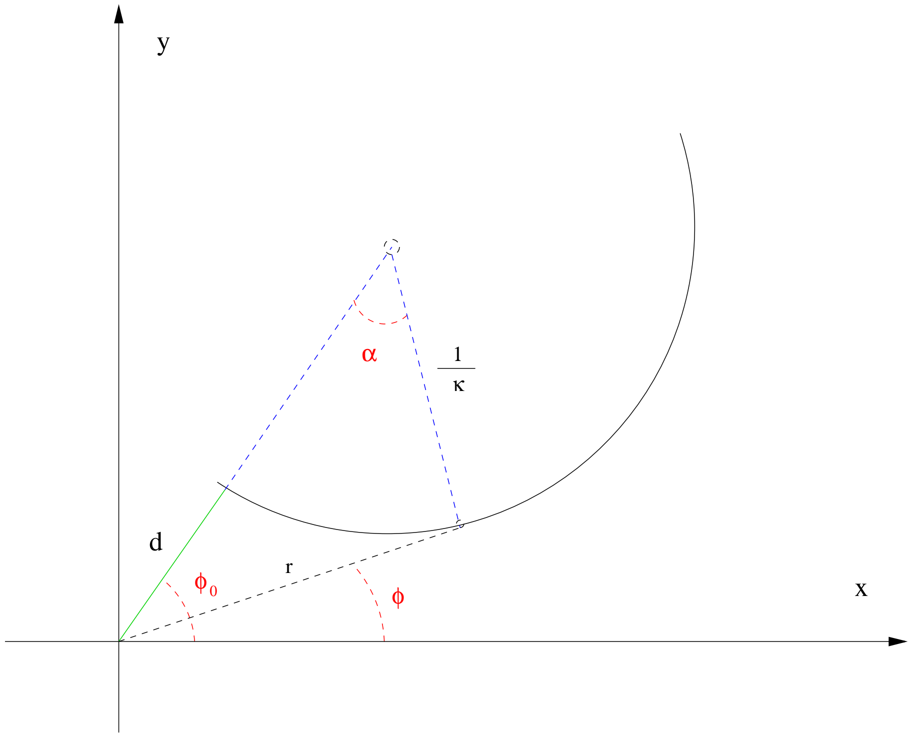
would be necessary to take into account
the magnetic field in the parametrization

What is currently under developement ?

New algorithm to reconstruct curved tracks in $x - y$ plan

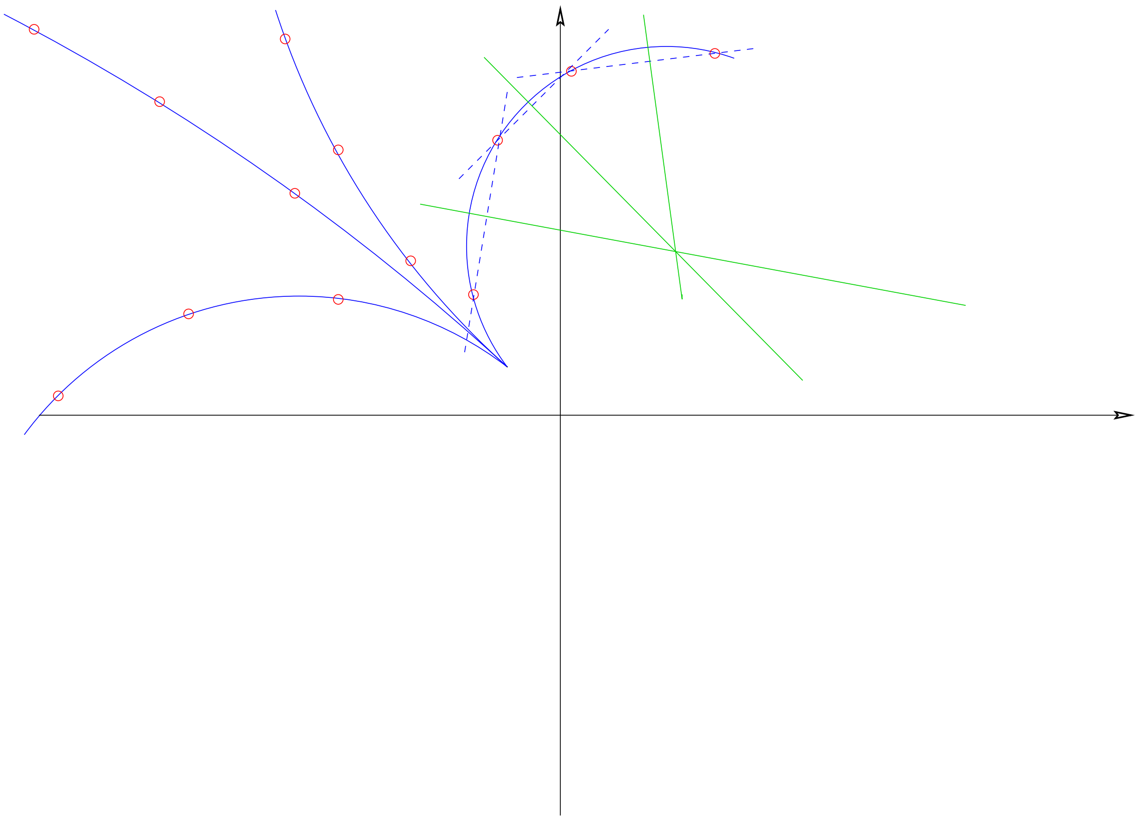
- **more general approach:** covers low and high p_t tracks reconstruction
- **but more complex problem:**

  $\Rightarrow$ **3 free parameters (d, ϕ_0, κ) instead of 2 (ρ, θ)**



Strategy

- compute the parameters of the line orthogonal to the one joining each pair of hits
- compute the coordinates of the intersection between all the orthogonal lines
- centers of the reconstructed arc of circles = points with the highest number of intersections



$\Rightarrow$ **The algorithm is implemented but not fully tested**

Plan

1. Short term (October)
   - test the timing and vertex resolution performances of the new algorithm on simple events
   - train the Hough transform, the analytical method and the new method on physics events and compare their performances (timing, vertex resolution, efficiency, purity, ...)
2. Mid-term (December)
   - finish the performances and the optimisation studies of the 3 algorithms and make the decision which one to keep
   - documentation.

rem :
In November-December, Gustaaf Brooijmans will be for 2 months at CPPM