First Results on the VXD Tracking Studies

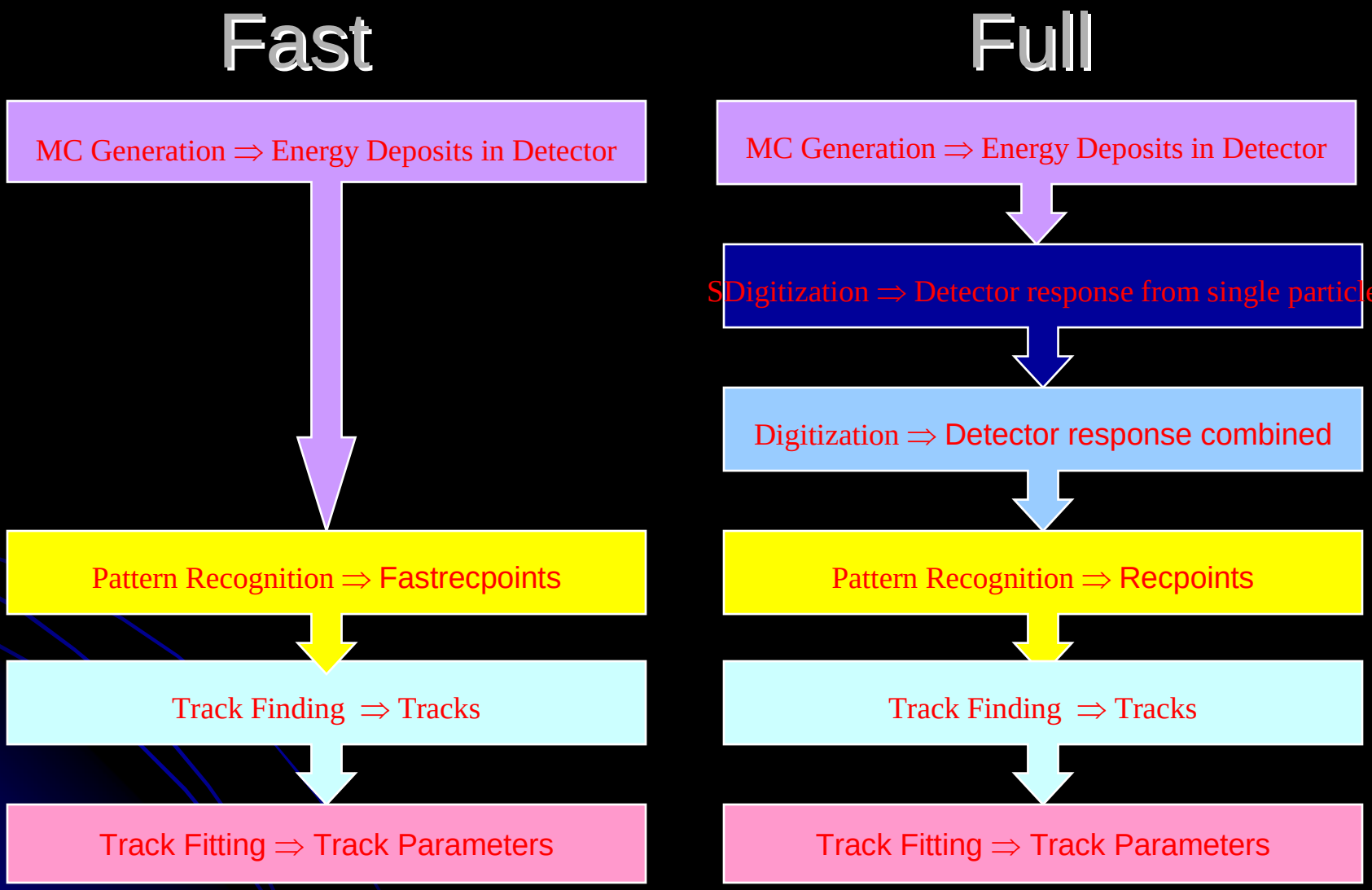
On behalf of 4th Concept Software Group

D. Barbareschi
V. Di Benedetto
E. Cavallo
F. Ignatov
A. Mazzacane
G. Terracciano

Outlook

- All studies have been conducted in the ILCroot framework
- Studies are the contribution to the DCR
- Several Event Generators used:
  - Pandora-Pythia
  - Guinea-Pig
  - Box

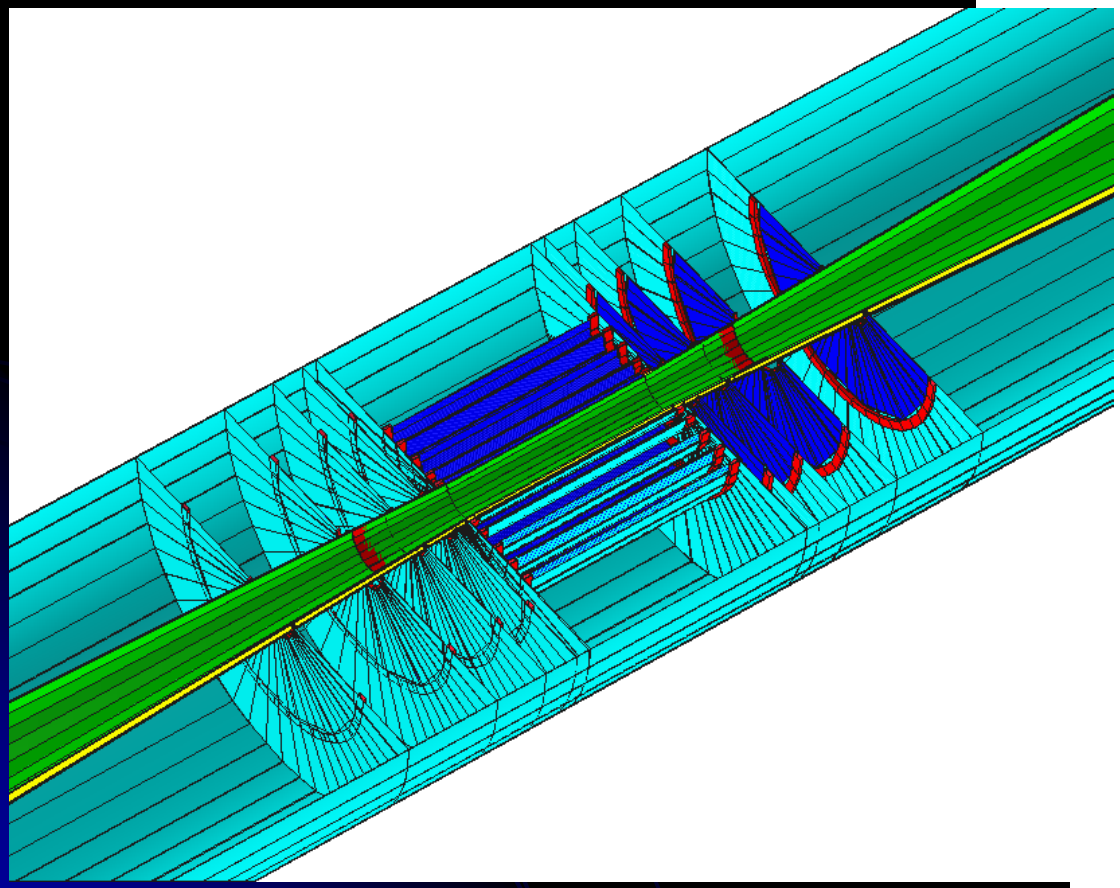
Simulation Steps

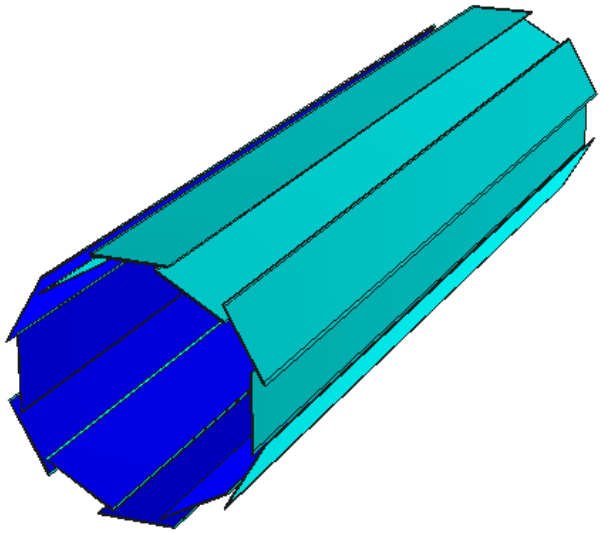


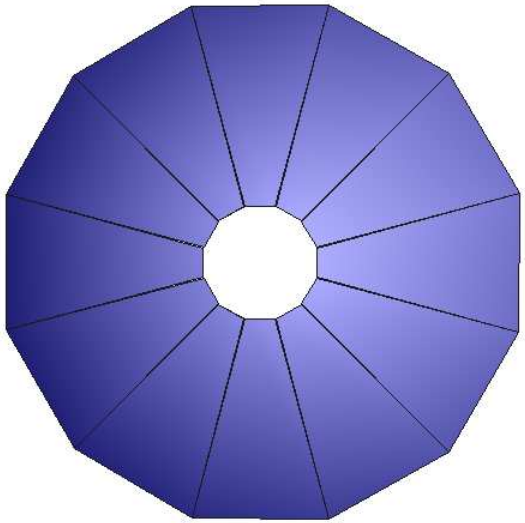
VXD Simulation

- Geat3 for hit production
- Gaussian smearing of hits (5μm x 6 μm) to make Fastrecpoints
- Pattern recognition through Parallel Kalman Filter + Standalone Tracker

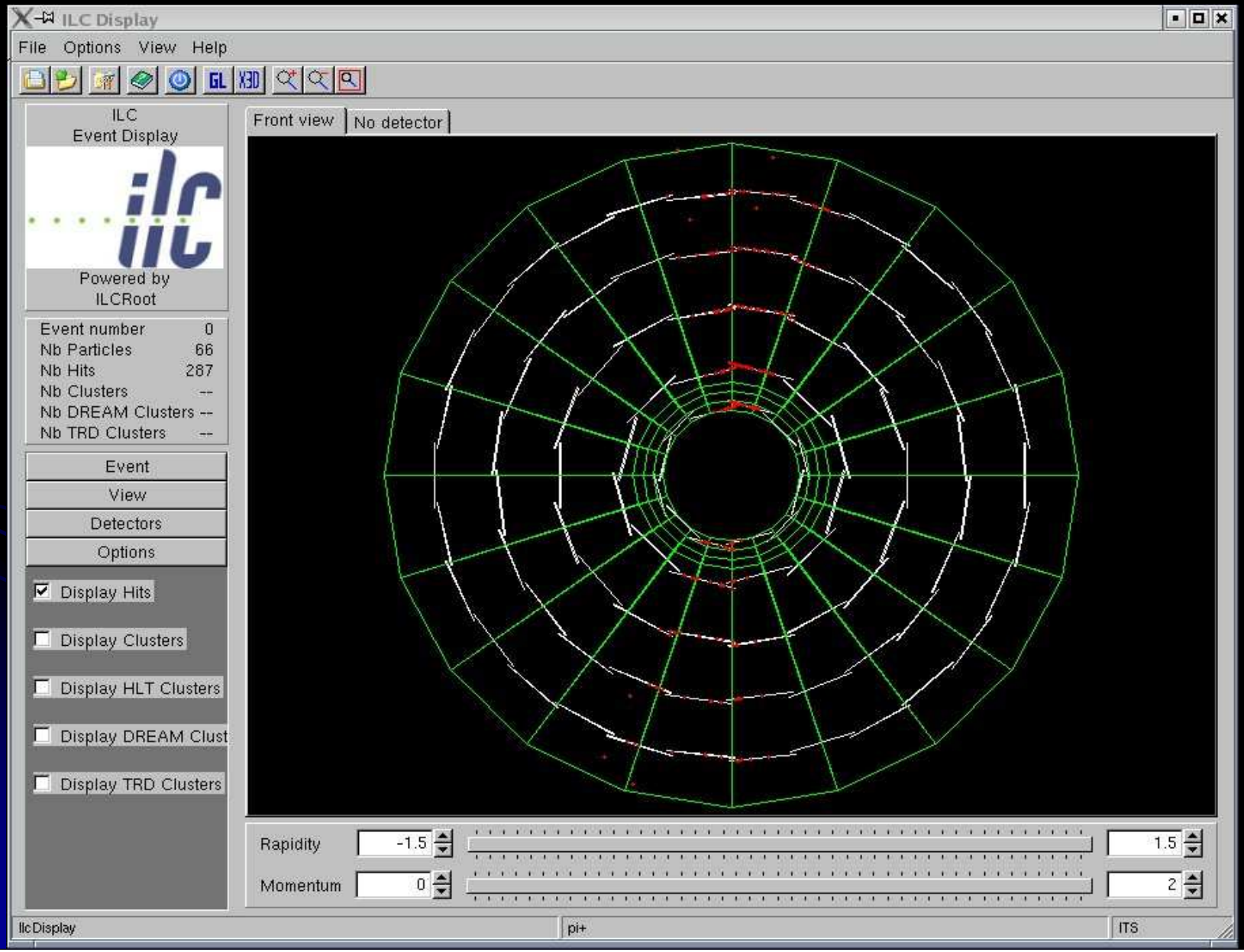
SiD/4th VXD (May06)



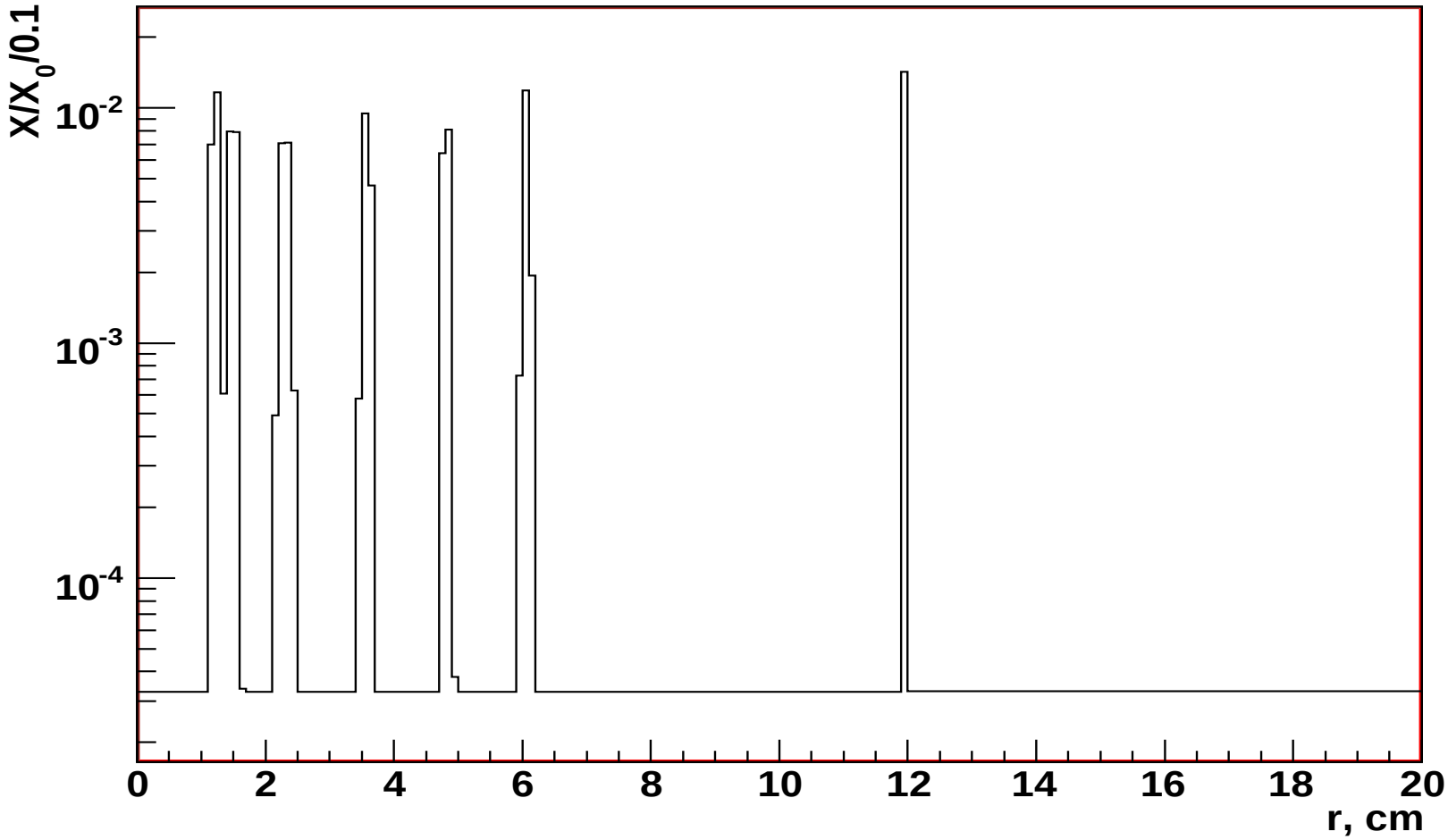




VXD Event Display



Material Budget (BP + VXD)

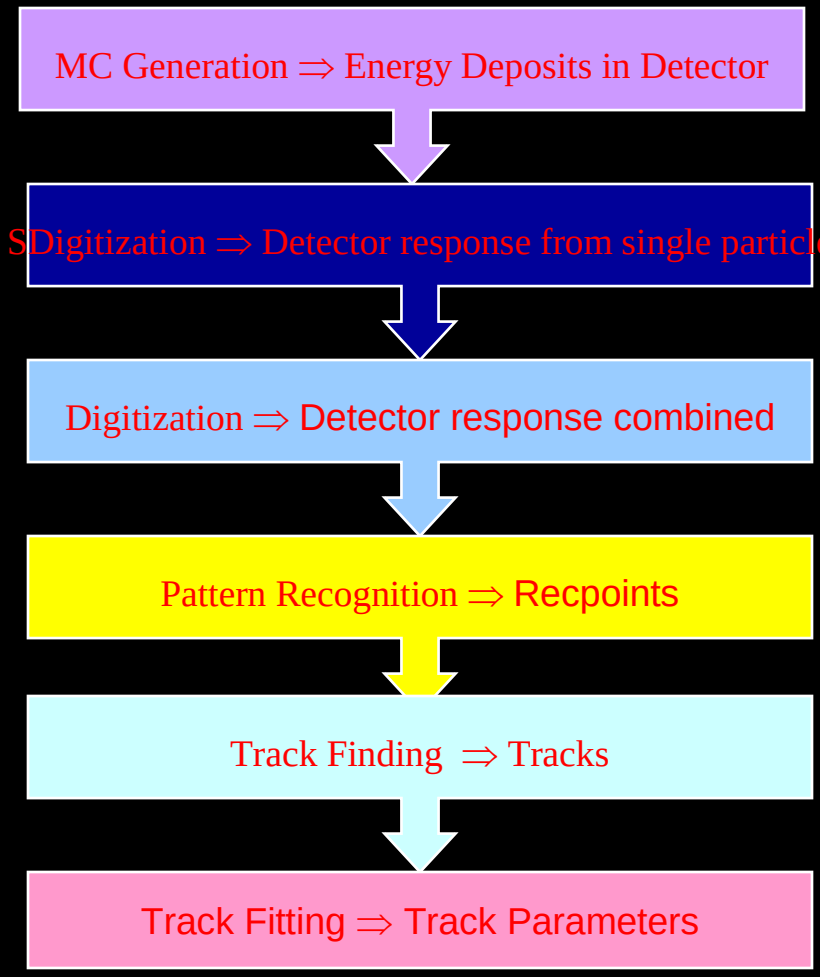


Material Budget (η=0)

- Beam Pipe: 0.18% X/X_o
- VXD:
  - Detector & support: 0.8% X/X_o
  - Outer shield: 0.16% X/X_o

VXD Full Simulation

- Hits: produced by MC (G3,G4,Fluka)
- SDigits: simulate detector response for each hit
- Digits: merge digit from several files of SDigits (example Signal + Beam Bkgnd)
- Recpoints: Clusterize nearby Digits
- Pattern recognition through Parallel Kalman Filter



VXD SDigitization

- Follow the path of the track inside the silicon in steps of up to 1 μm
- Per each step:
  - convert the energy deposited into charge
  - spreads the charge asymmetrically across several pixels:

$$f(x,z) = Errf(x_{step}, z_{step}, \sigma_x, \sigma_z)$$

$$\sigma_x = \sqrt{T \cdot k / e \cdot \Delta l / \Delta V \cdot step}$$

$$\Delta l = Si\,tickness, \quad \Delta V = bias\,voltage, \quad \sigma_x = \sigma_x \cdot fda$$

- Simulate capacitive pixel coupling by switching on nearby pixels
- Add random noise
- Simulate electronic threshold

SDigitization Parameters

- Size Pixel X = 20 μm
- Size Pixel Z = 20 μm
- Eccentricity = 0.85 (fda)
- Bias voltage = 18 V volts
- cr = 0% (coupling probability for row)
- cc = 4.7% (coupling probability for column)
- threshold = 3000 Electrons
- electronics = 0 (elettronic noise)

Clusterization

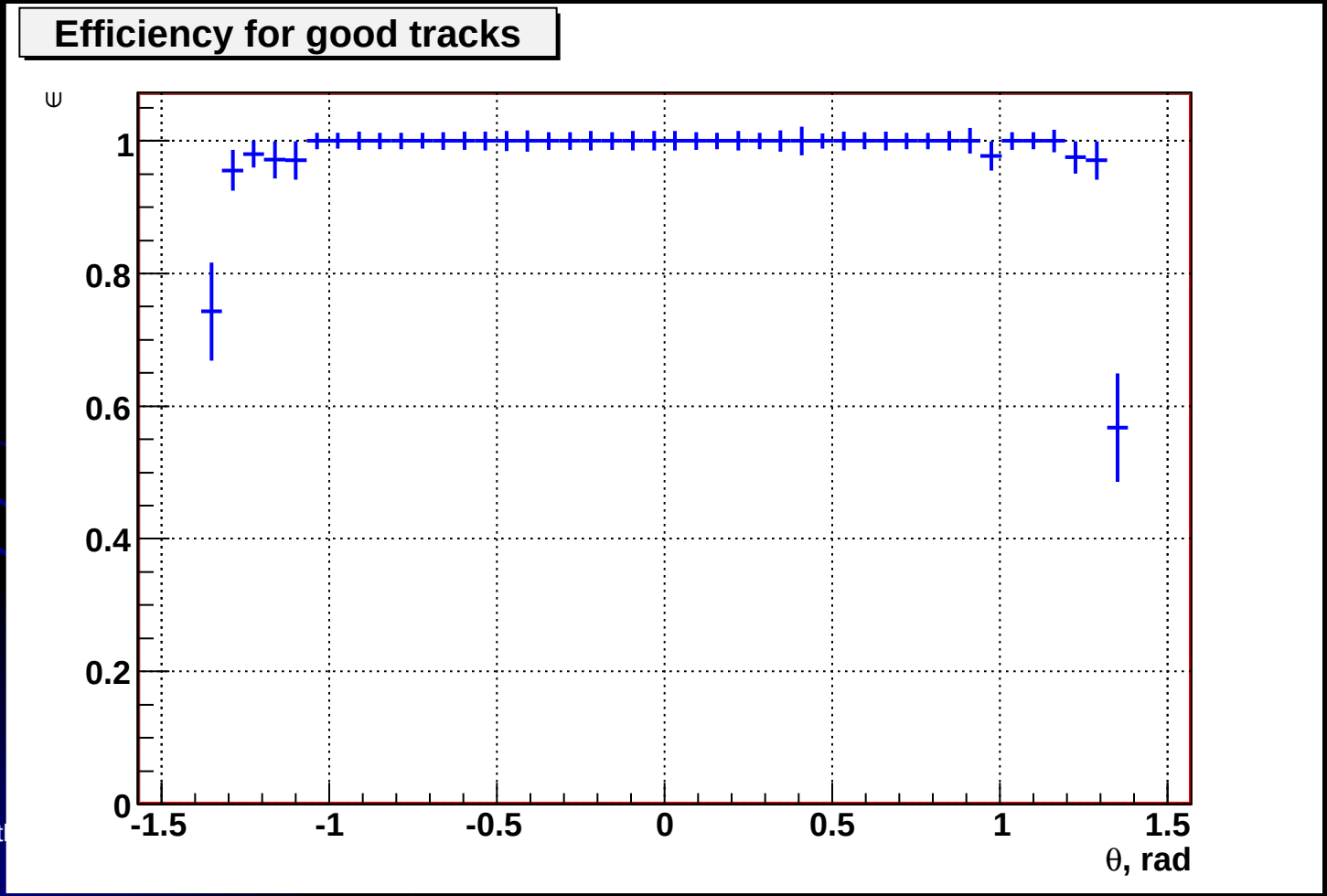
- Create a initial cluster from adjacent pixels (sidewise only)
- subdivide the initial cluster in smaller NxN clusters (N to be optimized)
- Kalman filter picks up the best clusters

VXD Standalone Tracker

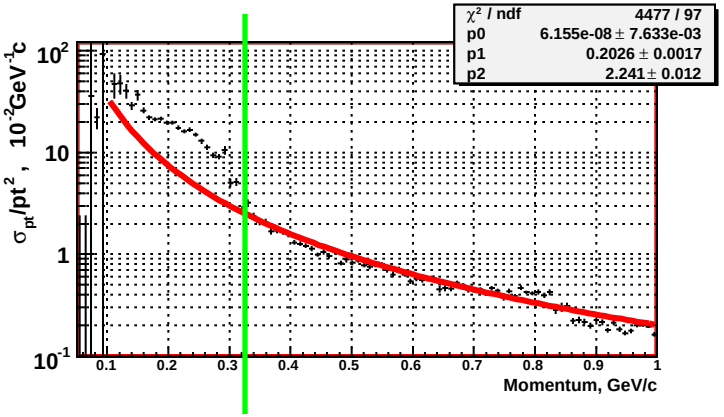
- Uses Clusters leftover from Parallel Kalman Filter
- Requires at least 4 hits to build a track
- Cluster finding in VXD in two steps
  - Step 1: look for 3 RecPoints in a narrow row or 2 + the beampoint.
  - Step 2: prolongate to next layers each helix constructed from a seed.
- After finding clusters, all different combination of clusters are refitted with the Kalman Filter and the tracks with lowest χ^2 are selected.
- Finally, the process is repeated attempting to find tracks on an enlarged road constructed looping on the first point on different layers and all the subsequent layers.
- In 3.5 Tesla B-field -> P_t > 20 MeV

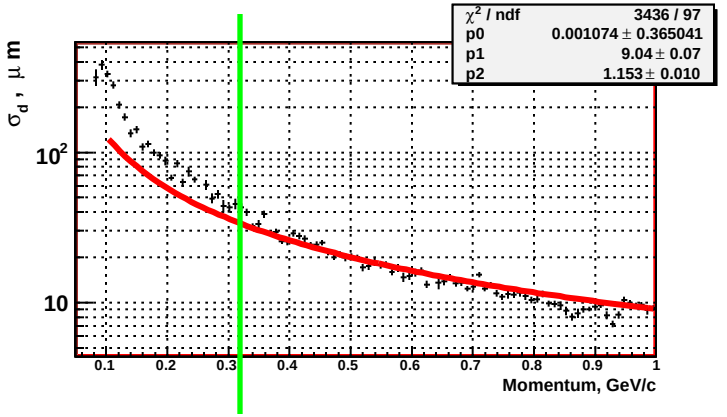
Standalone Tracker Performance (1)

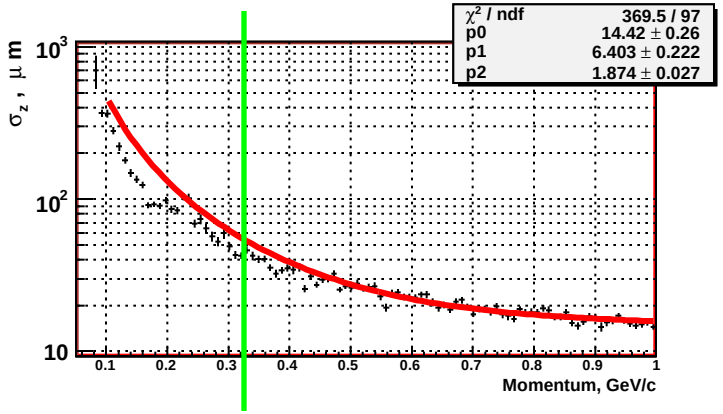
- 10 muons/evt (P_t range 20-1000 MeV)

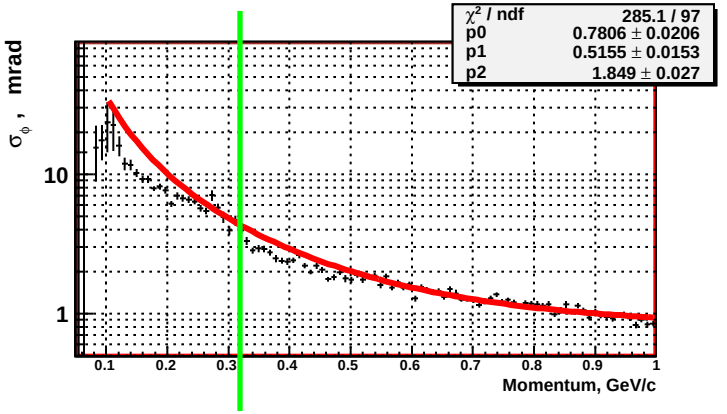


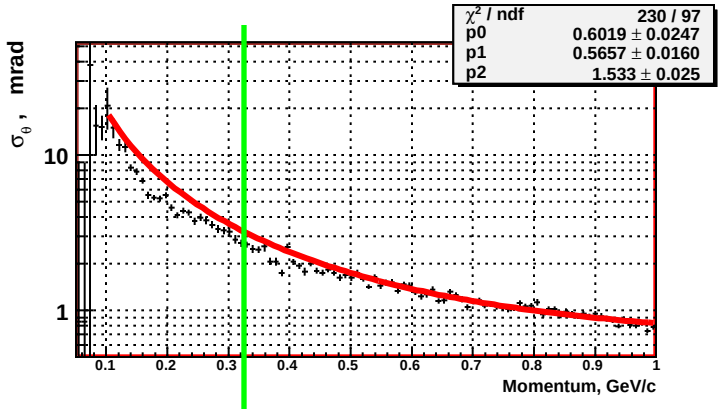
Standalone Tracker Performance (2)





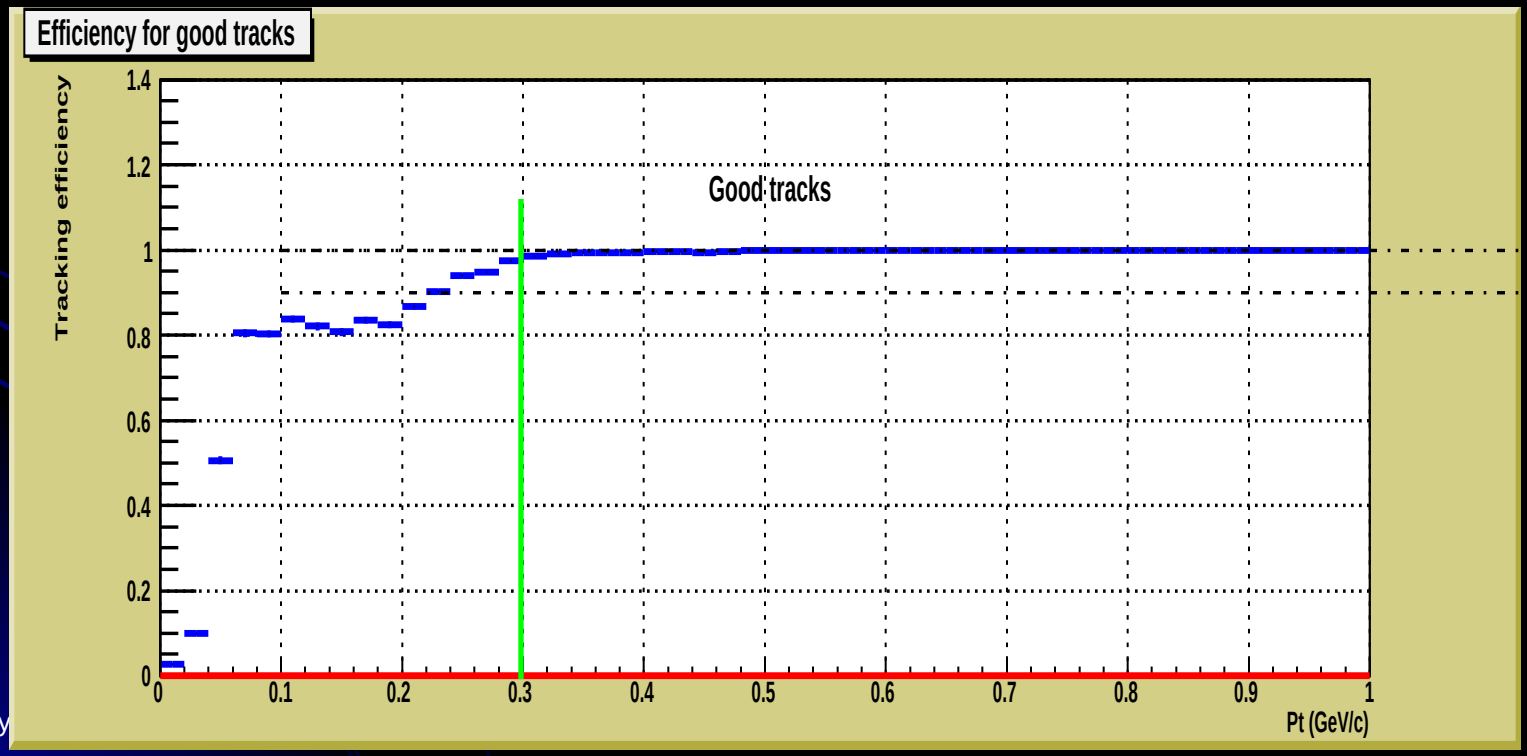






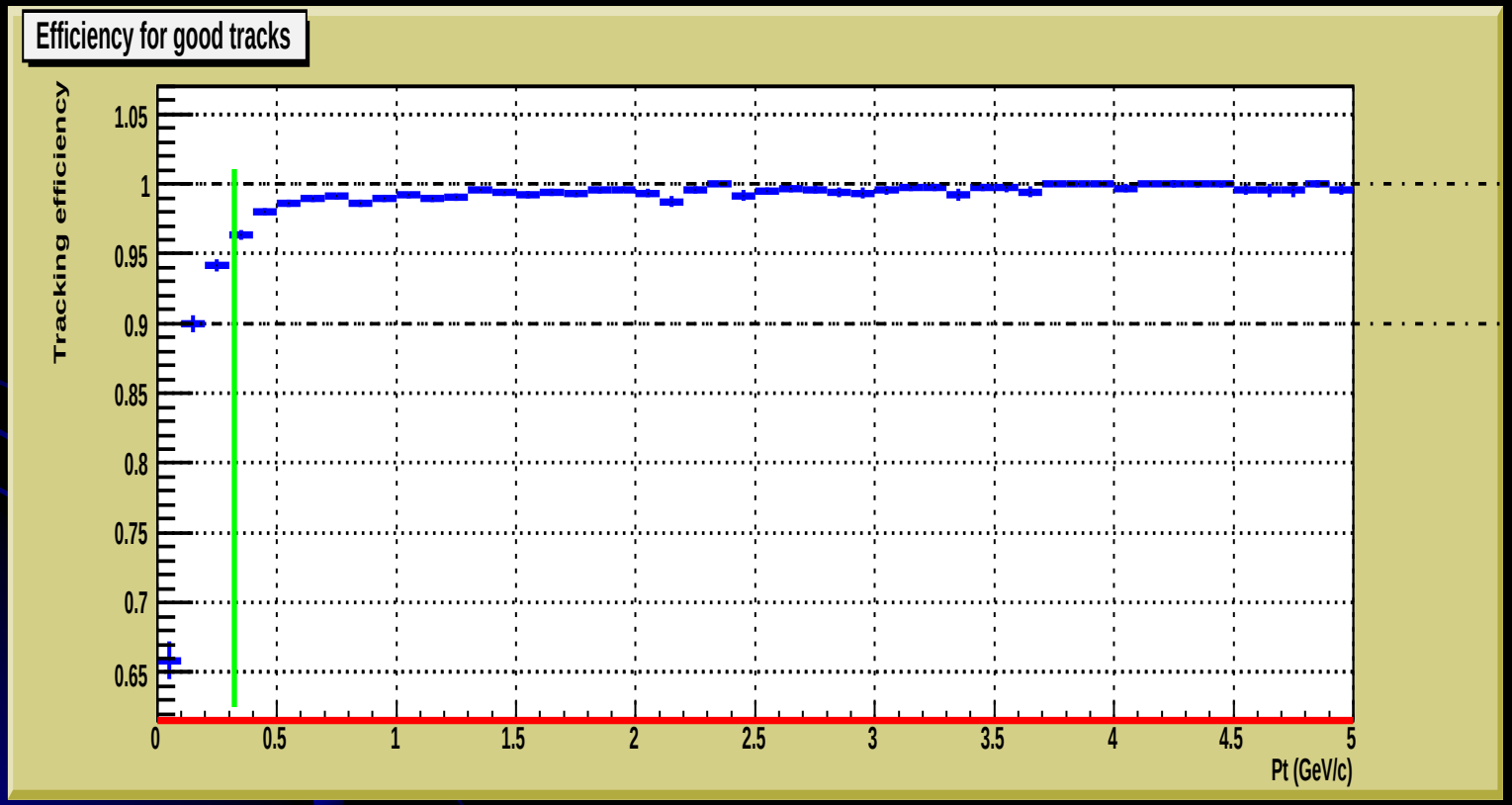
Standalone Tracker Performance (3)

- 10 muons/evt (P_t range 20-1000 MeV)
- $|\tan(\lambda)|<2.57$



Standalone Tracker Performance (4)

- e^+e^- -> $t\bar{t}$ -> 6 jets



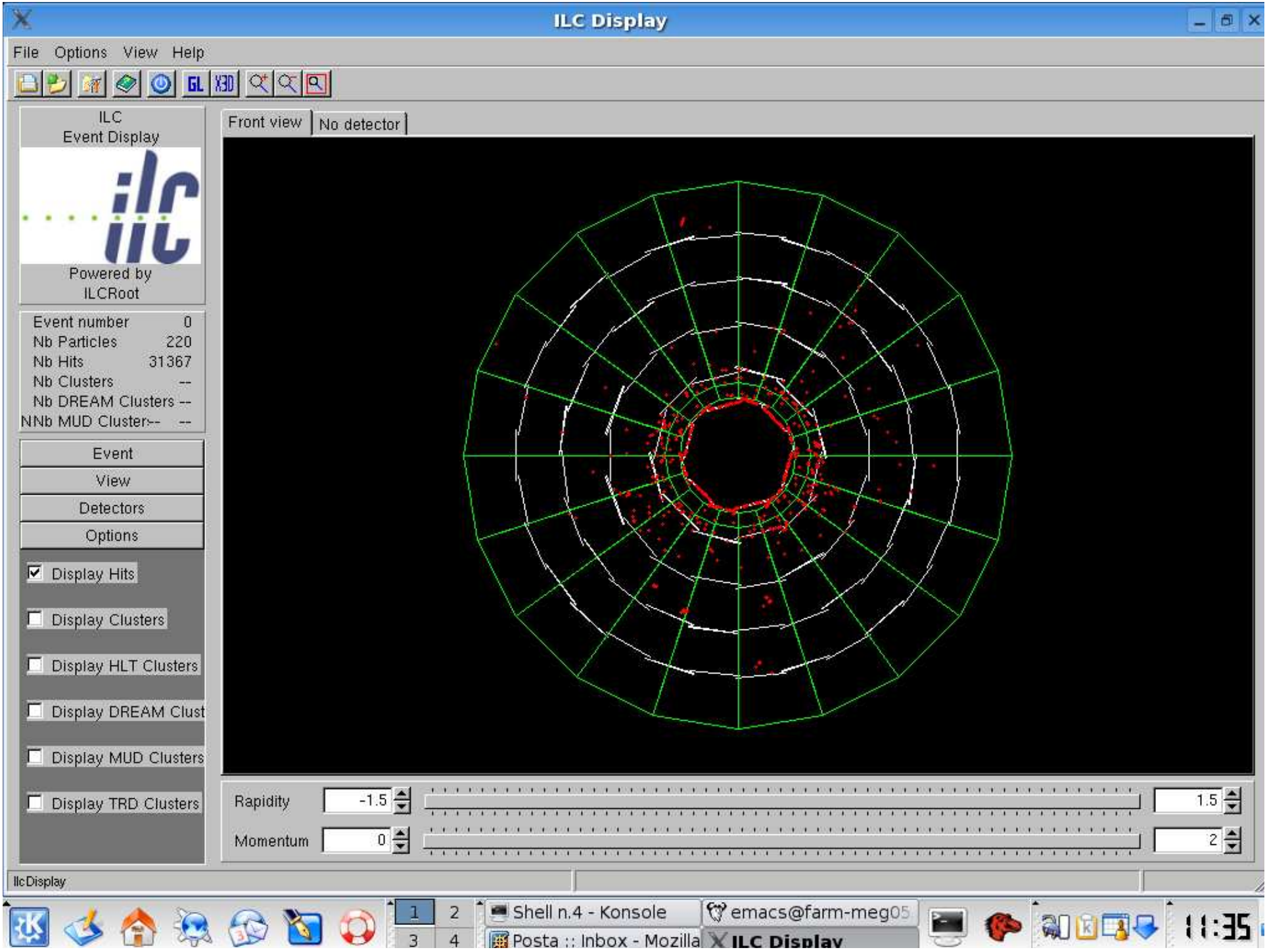
Beam Pair Background Study

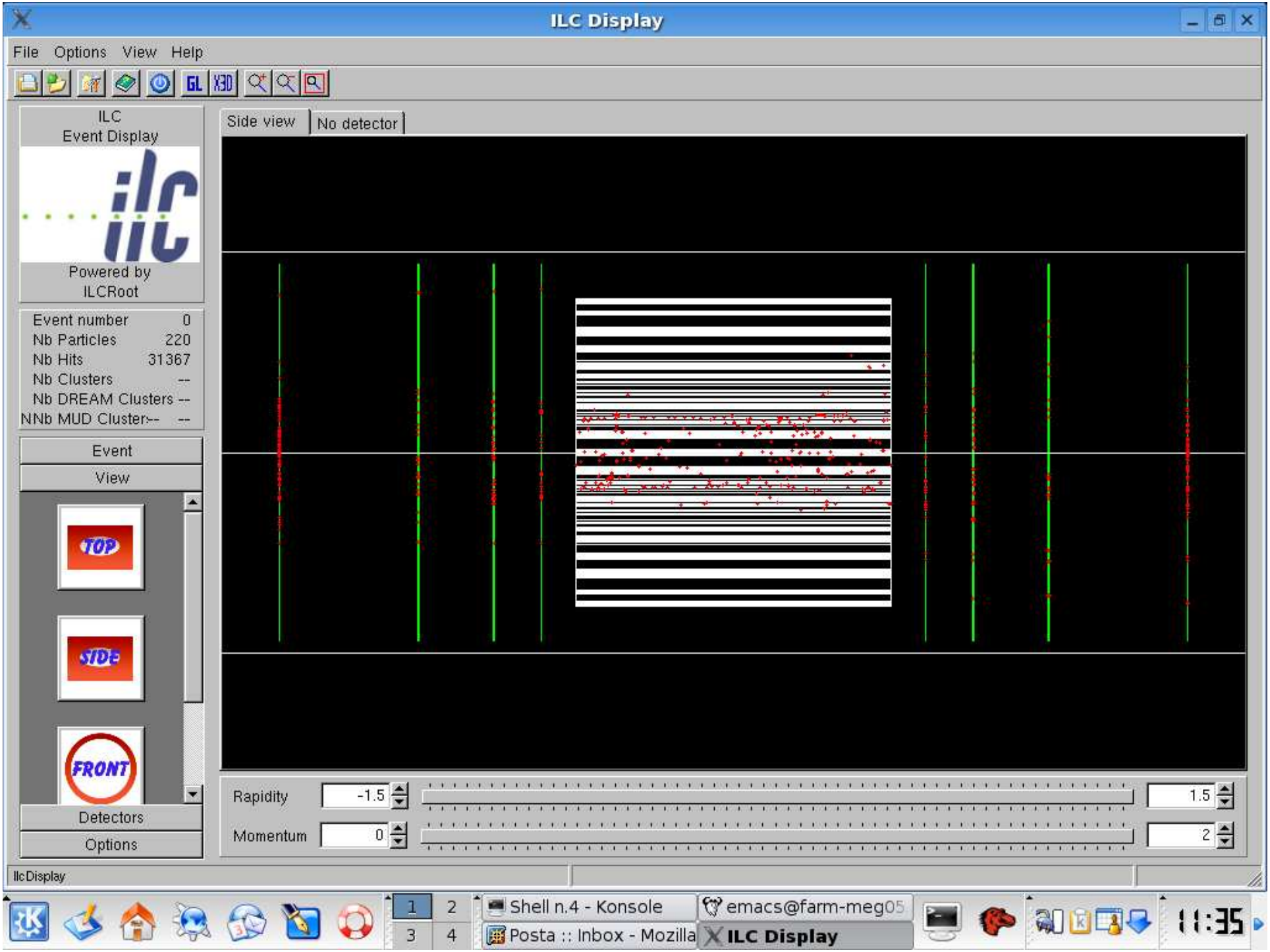
Preliminary

- Study coordinated by Rob Kutsckhe
- Interface to Guinea-Pig output added to ILCroot
- Full Digitization used for this study
- Tested with current SA VXD tracker and generic accelerator parameters

Acc.dat

```
$ACCELERATOR:: NLC-B-500
{ energy    = 245.  ;
  particles = 0.95 ;
  emitt_x  = 4.5 ;
  emitt_y  = 0.1 ;
  beta_x = 12. ;
  beta_y = 0.12 ;
  sigma_z = 120. ;
  dist_z    = 0  ;
  espread = 0.003 ;
  which_espread = 0;
  offset_x  = 0   ;
  offset_y  = 0.   ;
  waist_x = 0 ;
  waist_y = 0 ;
  angle_x = 0 ;
  angle_y = 0 ;
  angle_phi = 0 ;
  trav_focus = 0 ;
  charge_sign = -1;
}
```


ILC Display
File Options View Help
ILC
Event Display
Powered by
ILCRoot
Event number 0
Nb Particles 220
Nb Hits 31367
Nb Clusters --
Nb DREAM Clusters --
NNb MUD Cluster-- --
Event
View
Detectors
Options
Display Hits
Display Clusters
Display HLT Clusters
Display DREAM Clust
Display MUD Clusters
Display TRD Clusters
Front view
No detector
Rapidity -1.5 1.5
Momentum 0 2
IlcDisplay
Shell n.4 - Konsole
emacs@farm-meg05
Posta :: Inbox - Mozilla
ILC Display
11:35


ILC Display
File Options View Help
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Event number 0
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Nb DREAM Clusters --
NNb MUD Cluster-- --
Event
View
TOP
SIDE
FRONT
Detectors
Options
Side view
No detector
Rapidity -1.5 1.5
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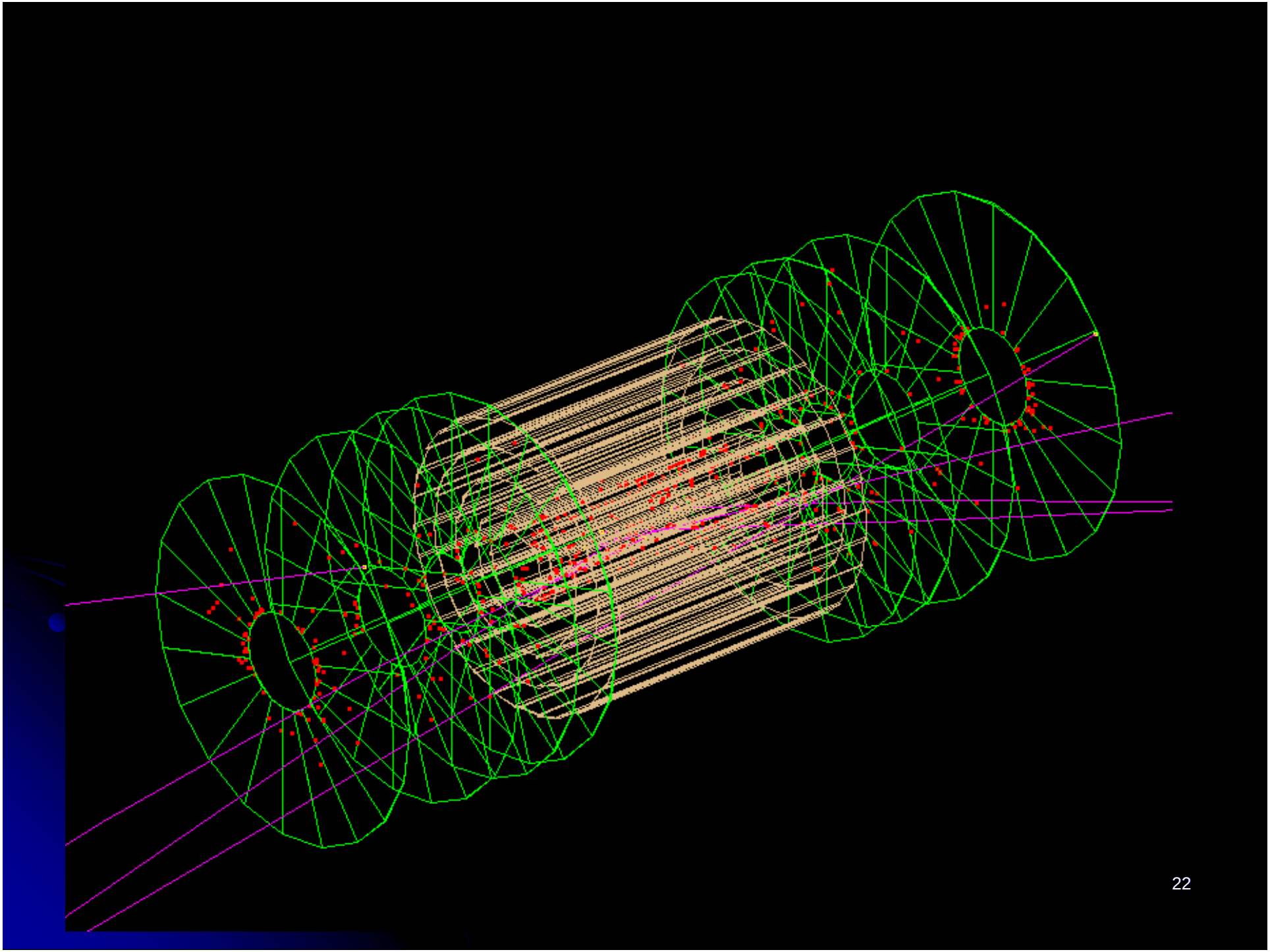

Should we worry?

- 31367 hits
- 20 reconstructed particles (8 in the Central Tracker)
- Better not to overlook this background

What's Next

- Reconstruction in VXD with hit smearing is OK
- Full digitization and clusterization completed last week
- Currently under test
- Preliminary results are very consistent with gaussian smearing
- Need to optimize:
  - Clusterization algorithm (very dependent on the VXD technology)
  - Error from clusterization