# New software for ITS upgrade studies

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# Outline

- motivations
- how-to
- status
  - simulation
  - reconstruction
- conclusions

# Motivations

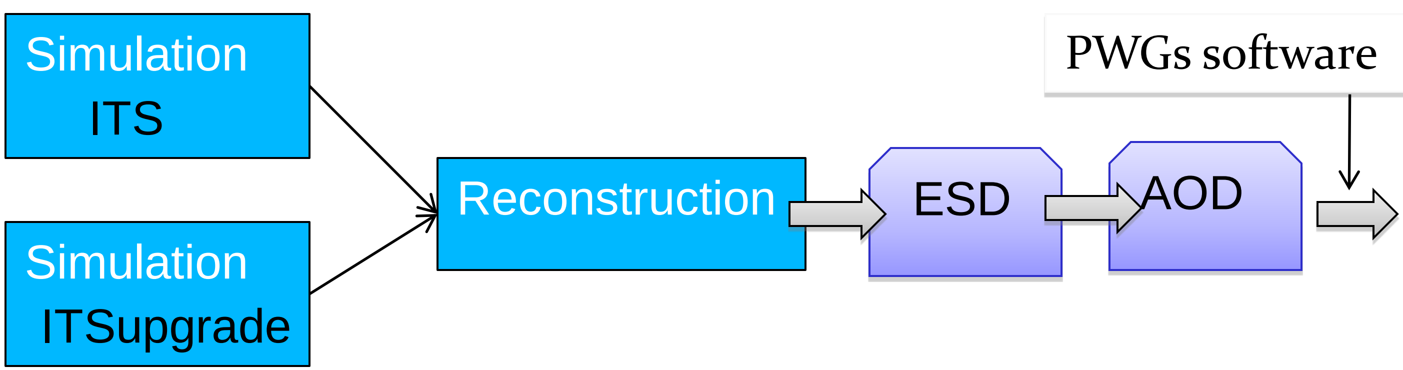
- We need a tool to simulate possible upgrades of the ITS detectors, in order to
  - evaluate their physics performances, depending on the layout
  - to guide the design of the new detector

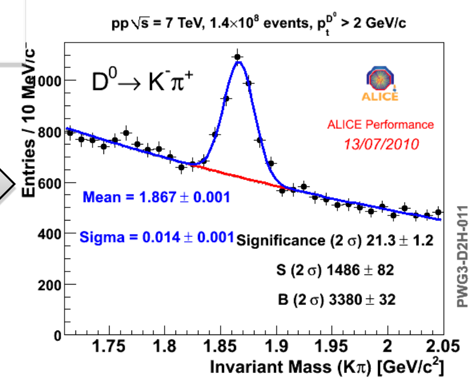
- Optimization of the configuration can be done with respect to:
  - number of layers
  - thickness of sensitive detector & material budget of each layer
  - radii of layers
  - spatial resolutions of detector (layer by layer)

# How to

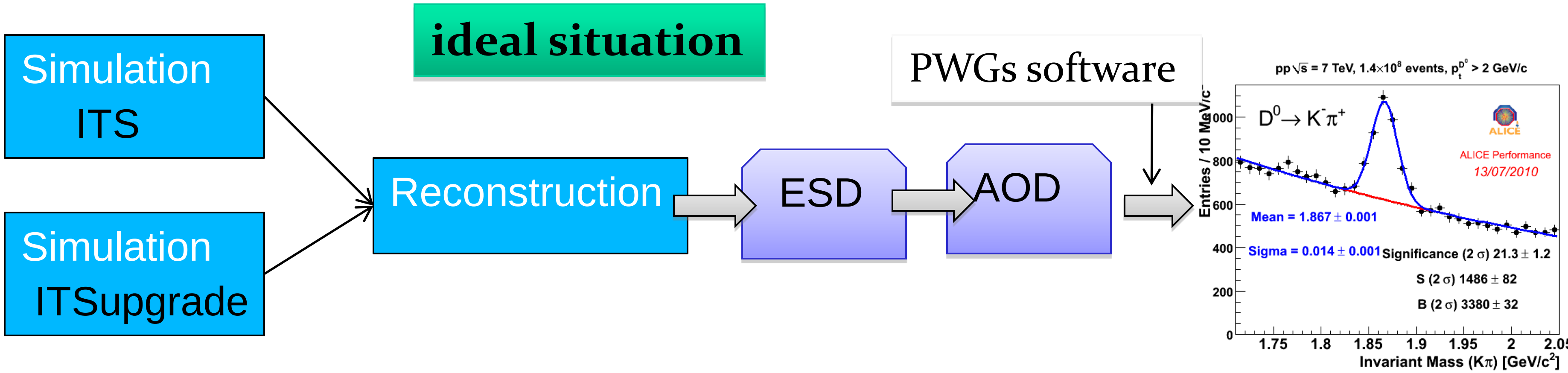
- introduce the software to simulate the new detector into the AliRoot package
  - replace the actual ITS with ITSupgrade (with an option to be set in the Config.C)

- In such a way, we would have the final analysis tools available to make performance studies on a few benchmark channels (e.g. $D^0 \rightarrow K\pi$, $\Lambda_c \rightarrow pK\pi$ )

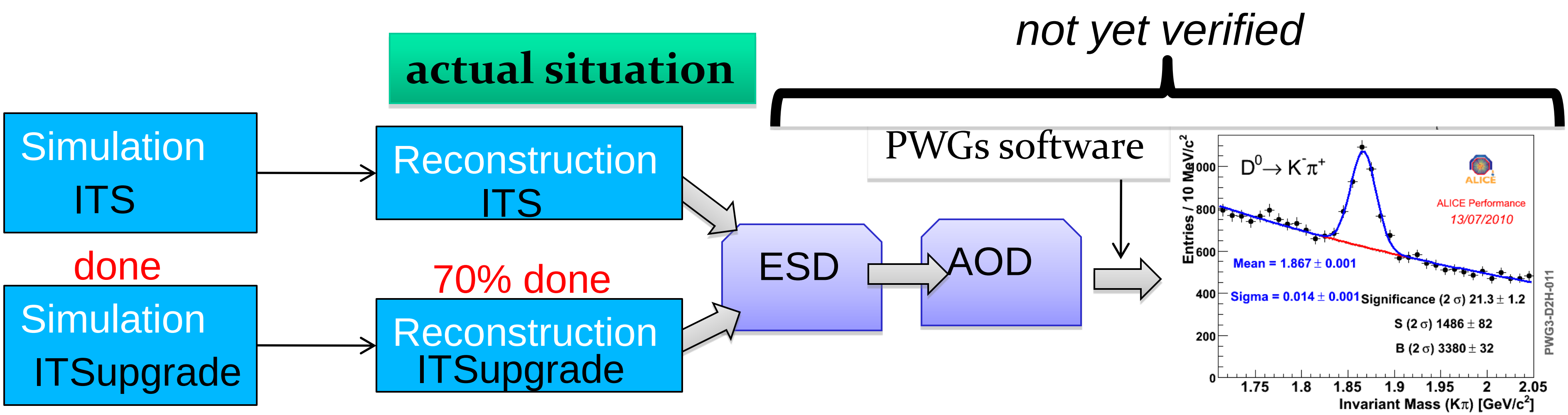


# How to




- actually the geometry description of the ALICE detectors is coded deeply into the reconstruction software, so we have already something like that:



# Status of simulation

- The detector geometry should be as flexible as possible
  - same code for different n. of layers, sensor thicknesses, material budgets, cell segmentations
- Implementation:
  - **Detector Parameters** (i.e. number, thicknesses and radii of layers, parameters of beam pipe) set in the Config.C
  - **layer** = silicon cylinder (sensitive volume) + copper coaxial cylinder (overall material budget )
  - **cell segmentation**: virtual and adjustable to simulate the space resolution of each layer
  - **Response model** (i.e. from Hits→SDigits→Digit): fast simulation

# Status of simulation

- Example of a geometry implementation for a seven layer configuration

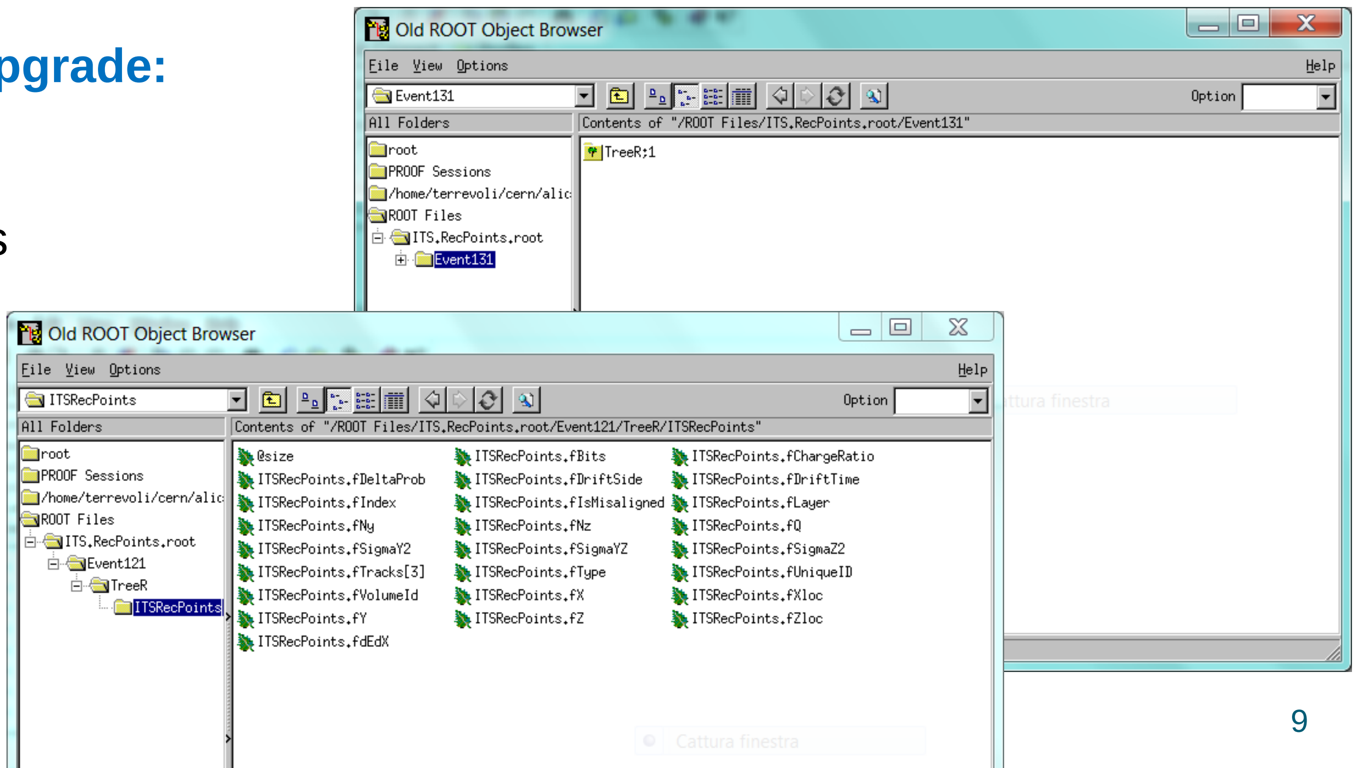
# Status of reconstruction

| | |
|---|---|
| 1. Clusterization | *done* |
| 2. Tracking | |
| • ITSupgrade standalone | |
| • track finding | *done* |
| • track fitting | |
| • global fitting (Rieman) | *done* |
| • Kalman | *working on* |
| • Combined barrel tracking | *not considered* |

# Status of reconstruction **clusterization**

- Clusterization (Digits→RecPoints) steered by standard AliReconstruction class
  - build **TreeR** filled with **RecPoints** in the standard format and container of AliRecPoint

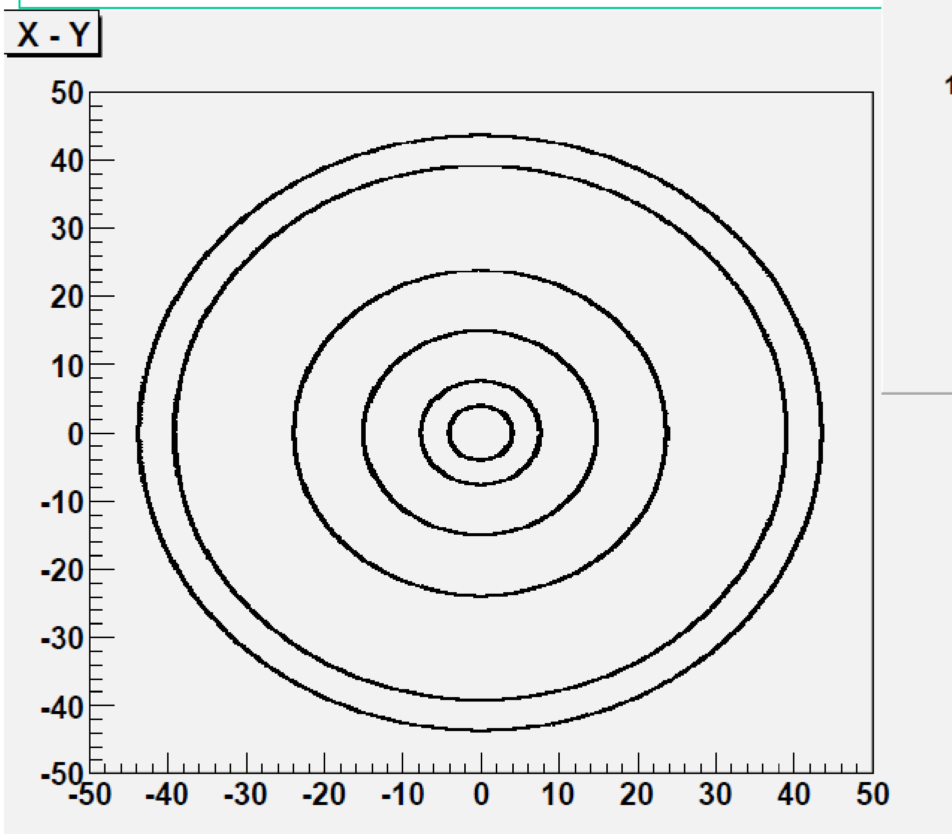
**RecPoints of ITSupgrade:**
- global coordinates
- energy loss
- number of electrons
- cluster type

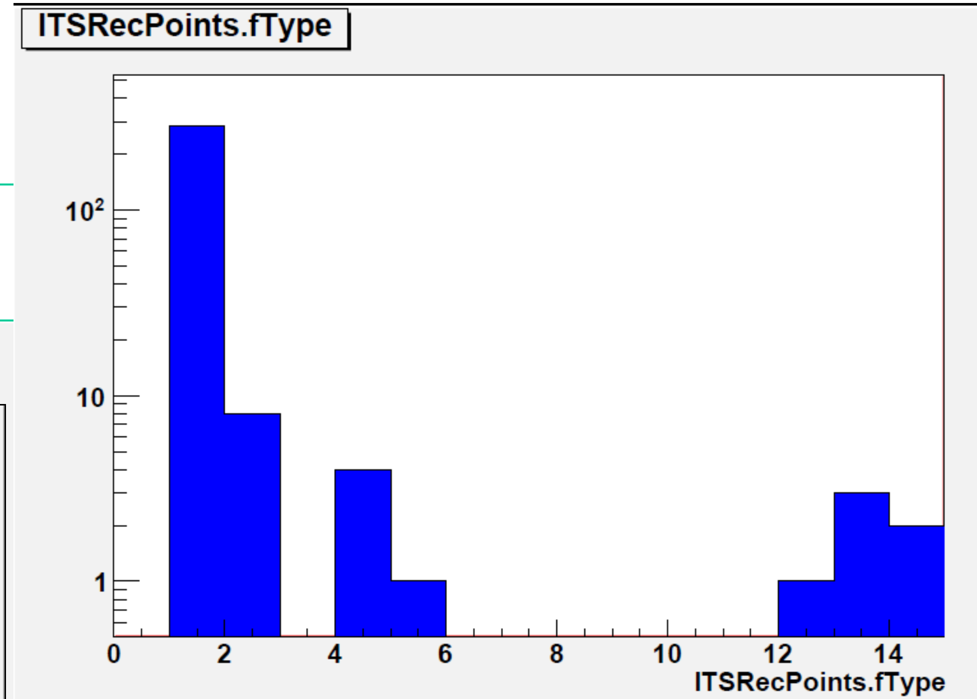


# Status of reconstruction

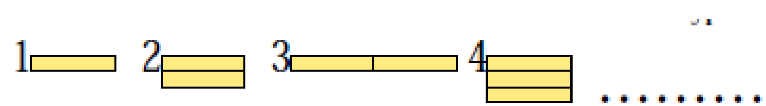
**clusterization**

Projection in XY plane of RecPoints (global coordinates)




Cluster type



# Status of reconstruction tracking

**Strategy:** adapt the tracking method of ITSStandAlone

STEP 1 : TrackFinding →re-write **FindTrack** method for ITSupgrade

done

STEP 2 : Fitting Methods for the ITSupgrade

- ✓ Global Fitting: (e.g. AliRieman)
  - Test of the clusterization and track finding procedure
- ✓ Write a Kalman method for the upgrade

done

on going

# Validation of the simulation tools

## **Preliminary tracking with a global fit**

- Perfect Track Finding using the MC truth:
    - The selection of the clusters belonging to a given track is done by a selection on the trackID (track info from the MC kinematics)

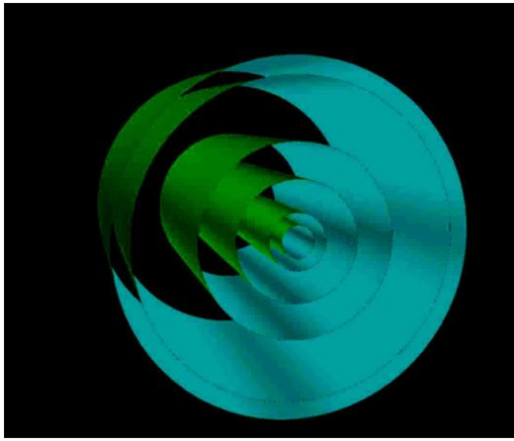
- Global Fitting with AliRieman
    - Rieman fit: Spatial Points projected on the "Rieman sphere" → linearization of equations of the $\chi^2$ minimization

- Analysis of the reconstructed tracks
    - Each "AliRieman"-track is converted into an "AliExternalTrackParam". The latter provides the relevant track information, e.g. the impact parameter.

# Validation of the simulation tools

First performance study: Config.C with AliITSupgrade set with the design parameters of the present ITS

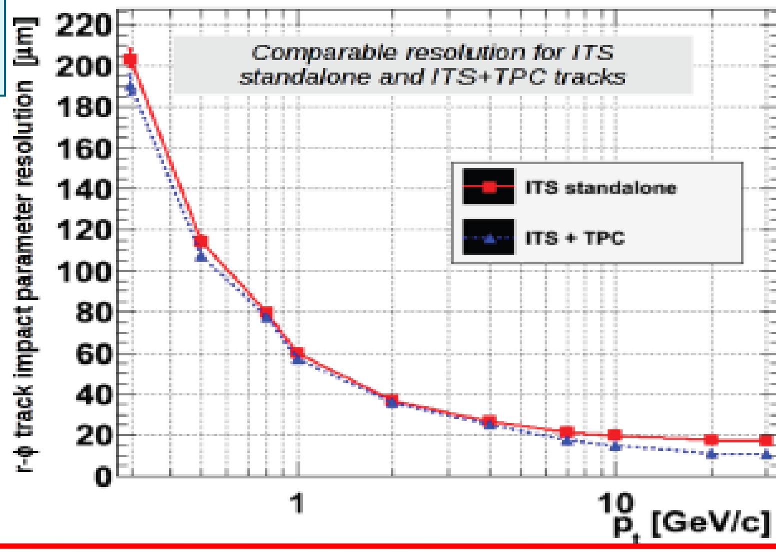
- ✓ virtual segmentation set so as to obtain the actual resolution of SPD, SDD, SSD
- ✓ same radii of the actual ITS
- ✓ same material budget of the actual ITS ($X/X_0$ = 8% in tot)



| | SPD | SDD | SSD |
|---|---|---|---|
| # of layers | 2 | 2 | 2 |
| radius (cm) | 3.9 & 7.6 | 15 & 24 | 38 & 43 |
| spatial precision (µm) | rφ =12µm<br>z = 100µm | rφ =35µm<br>z = 25µm | rφ =20µm<br>z = 830µm |

# Factor of merit
Impact parameter resolution

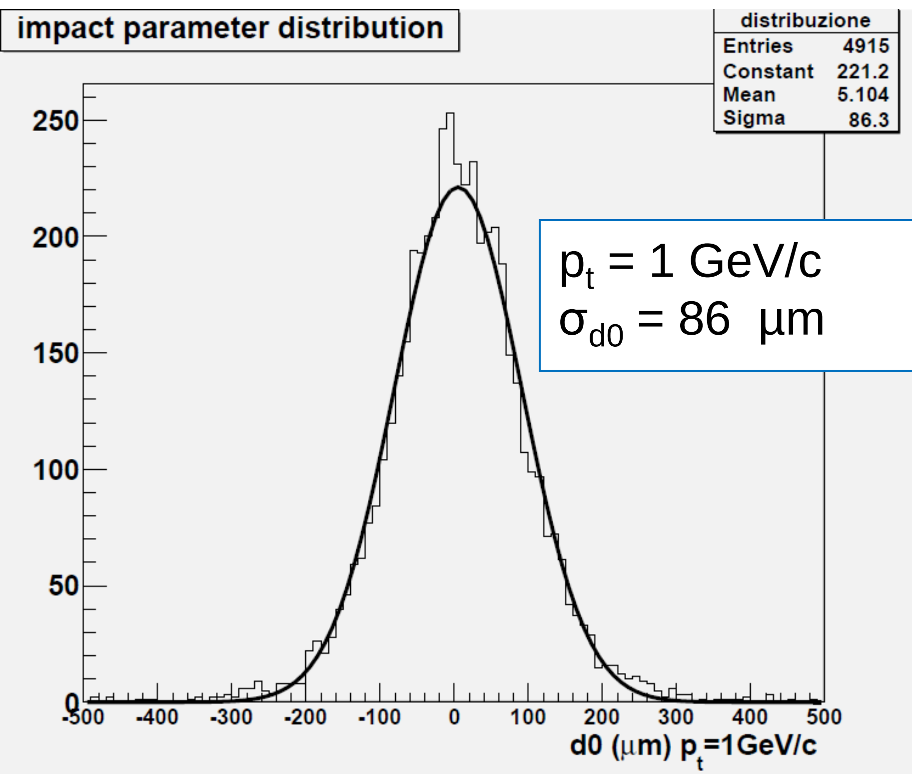
**Official ITS and Kalman Filter StandAlone reconstruction** →



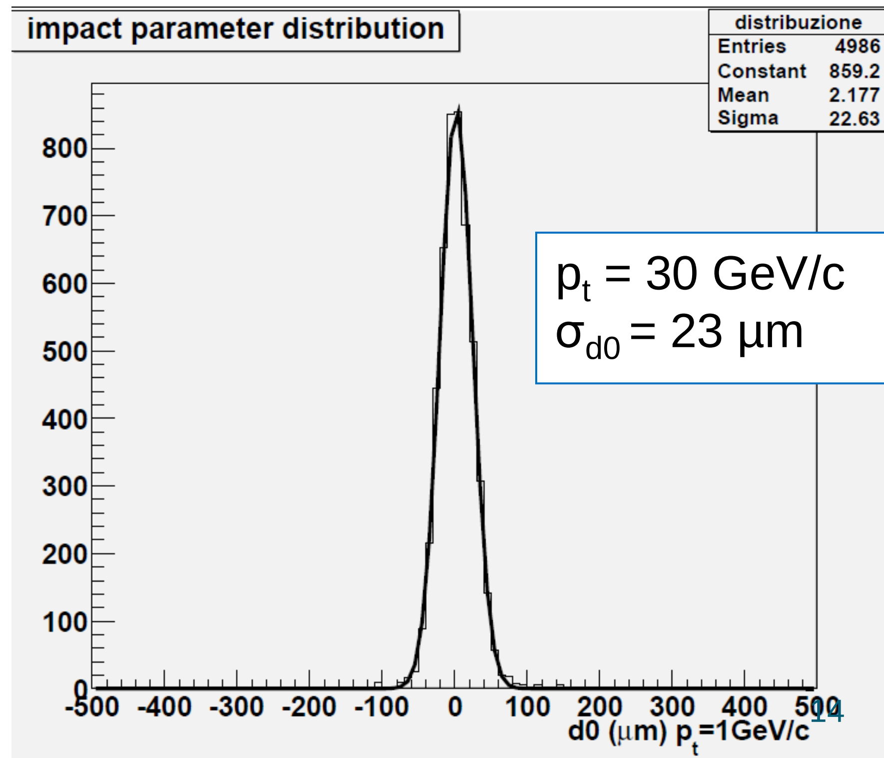

$p_t$ = 1 GeV/c
$\sigma_{d0}$ = 60 μm

$p_t$ = 30 GeV/c
$\sigma_{d0}$ = 20 μm

# Simulation and reconstruction with ITSupgrade (Rieman)




$p_t$ = 1 GeV/c
$\sigma_{d0}$ = 86 μm




$p_t$ = 30 GeV/c
$\sigma_{d0}$ = 23 μm

# Validation of the simulation tools

In the previous slide :

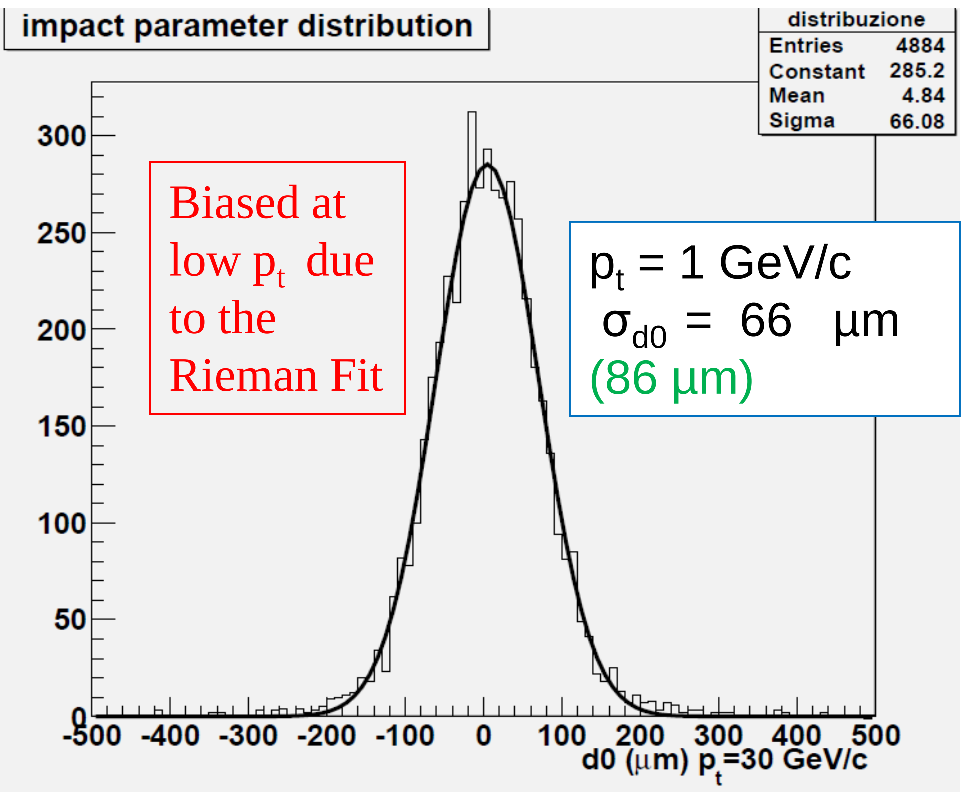
Discrepancy at low momentum due to the usage of the Rieman fit (verified by using AliRieman instead of AliITStrackerMI also in the actual simulation)

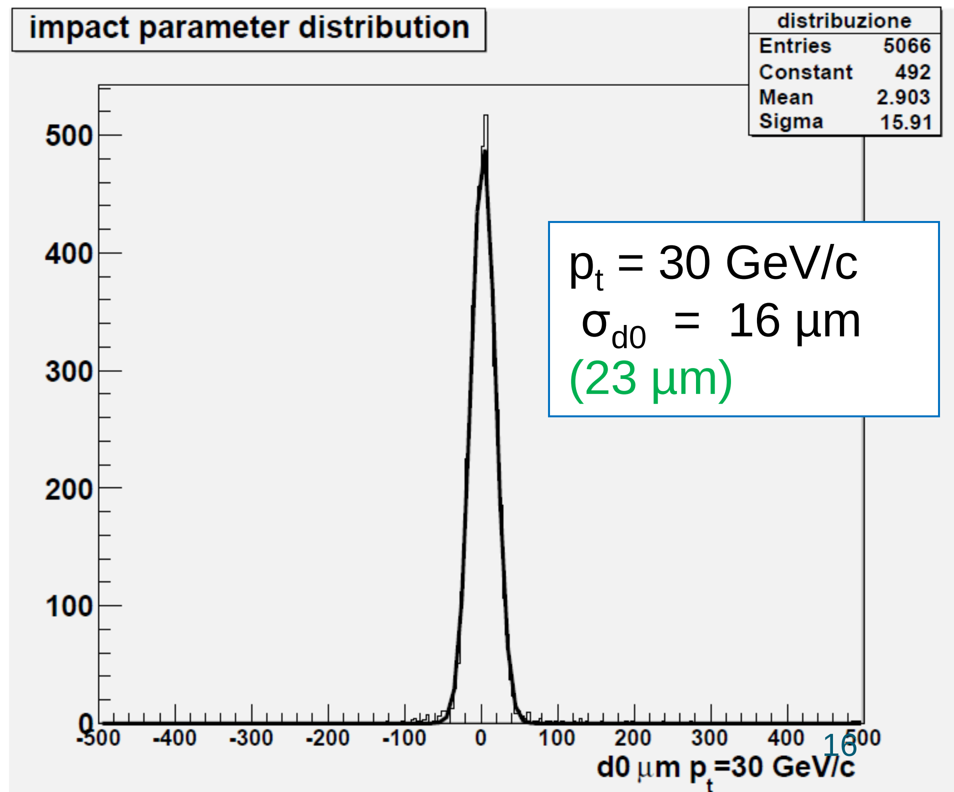
- Global fitting (i.e. Rieman) provides the best description of a track as a whole
- Kalman fitting provides by definition a much better local description of a track (hence better description of the impact parameter)

- **next**: use the Kalman Filter

# ITS upgrade: example of a new configuration

- 7 equidistant layers: first layer at 2.5 cm ( beam pipe radius at 2.0 cm )
    - SPD0 - SPD1 - SPD2 - SDD1 - SDD2 - SSD1 - SSD2
    - Present ITS: 6 layers, 1st layer at 3.9 cm
- same segmentation, resolution and thickness of the actual SPD, SDD, SSD



# Conclusion

- A flexible tool to simulate prototypes of an upgraded ITS detector is being developed within AliRoot:

    ✓ from Hits to RecPoints → **OK**
    ✓ the development of the track reconstruction is ongoing

- Results shown at previous ITS meetings
    ✓ general agreement to commit the code to the svn AliRoot repository