TPC R&D status

Outline

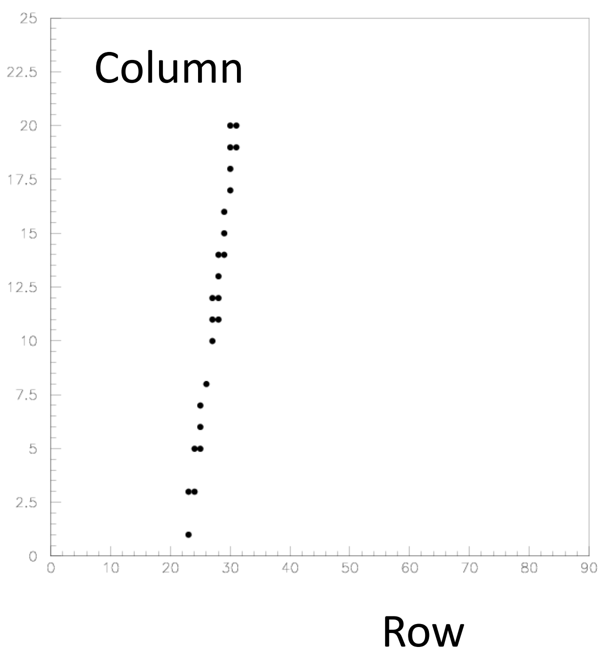
- Data analysis
- Tracking resolution studies

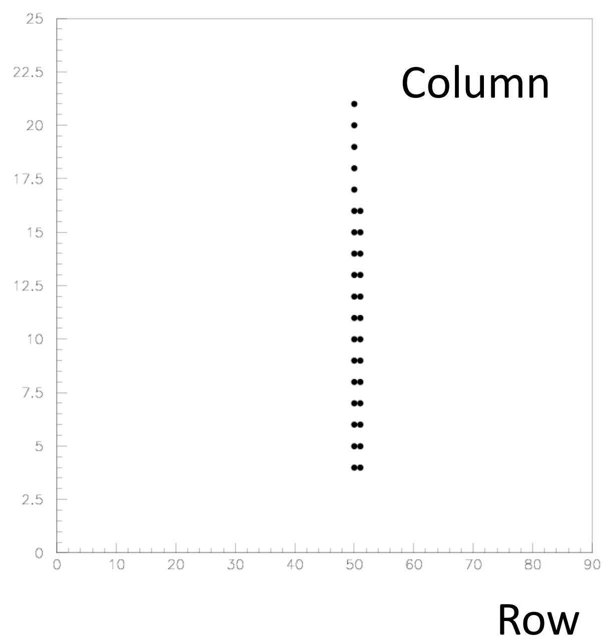
Data analysis

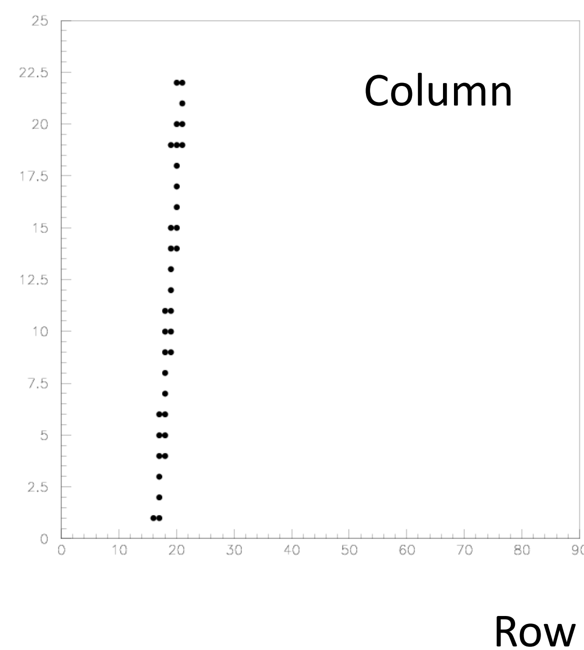
- We took a few hundred of events
- No zero suppression
- Very long time frames : 511 clock cycles
- Sampling frequency : 100 MHz
- Shaper peaking time : 200 ns
- Use Fabrice’s .acq to root converter (based on ILC monitoring code
  - To be developed further…
- Analysis done on resulting root files
- Using root compresses data by factor of ~10
- Zero suppression plus shorter time frames will compress even further

Some tracks

- Plot row vs col for frames with max sample > 500 adc counts



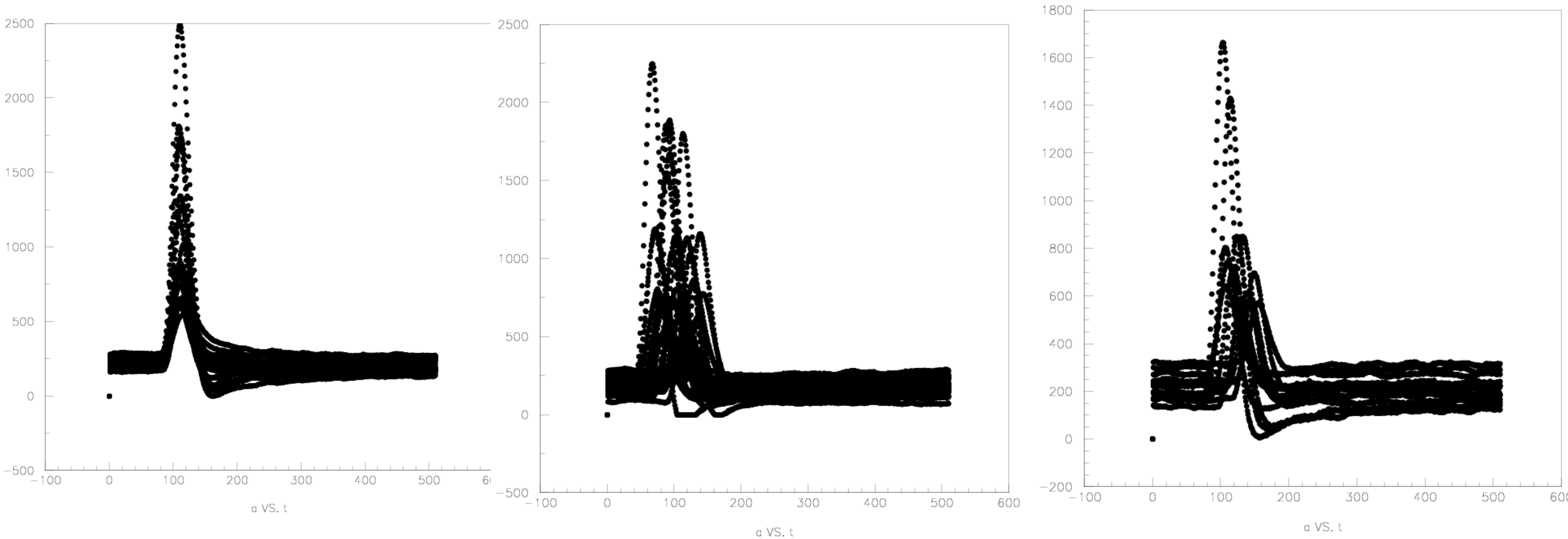




Straight tracks clearly seen !

Pulseshapes

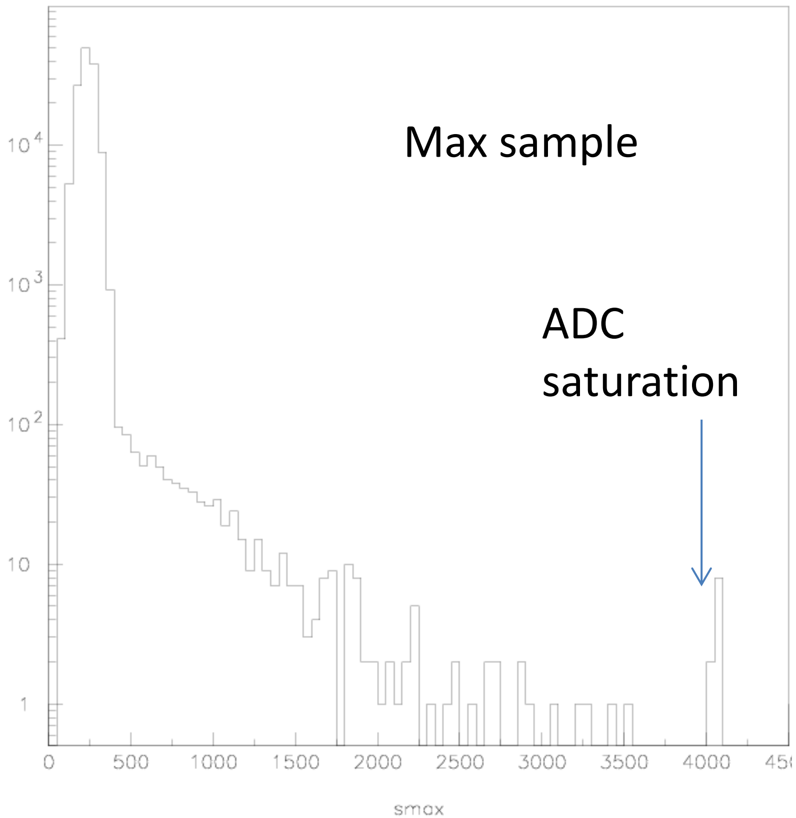
ADC counts

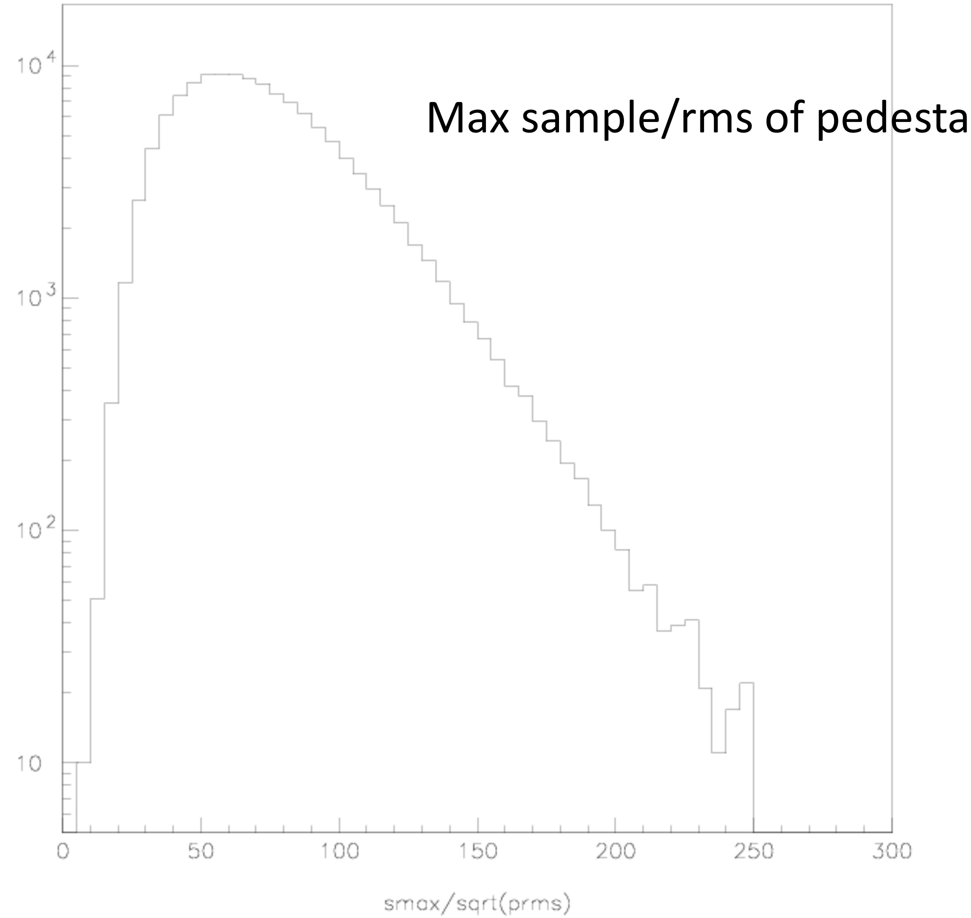


Time (samples, 1 sample=10 ns)

Timing differences clearly visible
Pulse shapes differences also visible

Amplitude distribution



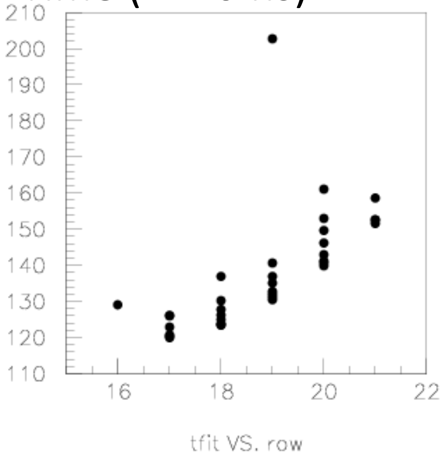


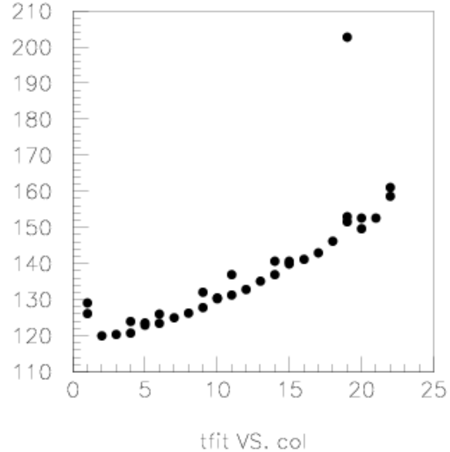
ADC count

HT/readout electronics settings make good use of ADC dynamic range

Timing

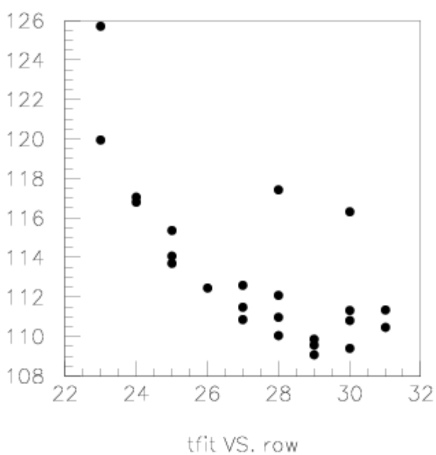
Time (1=10 ns)

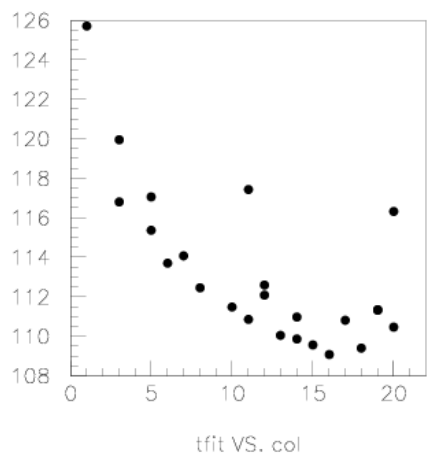


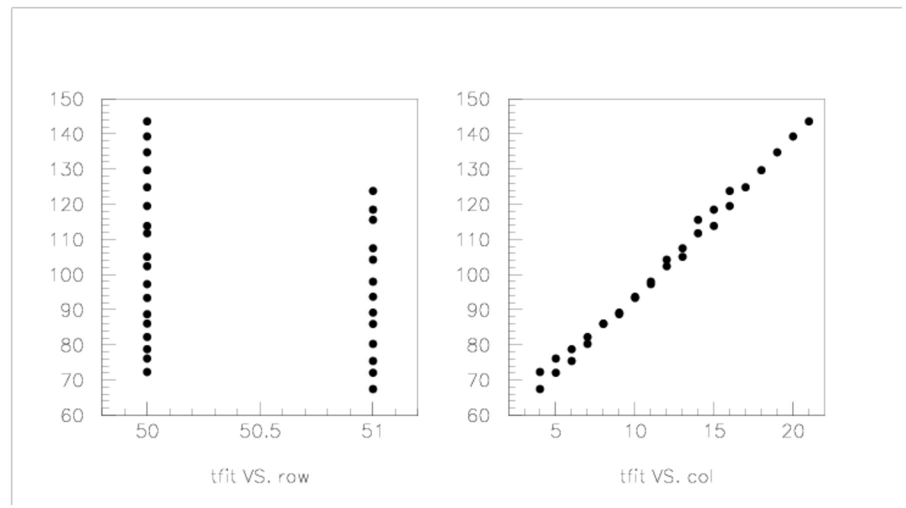


Row

Column

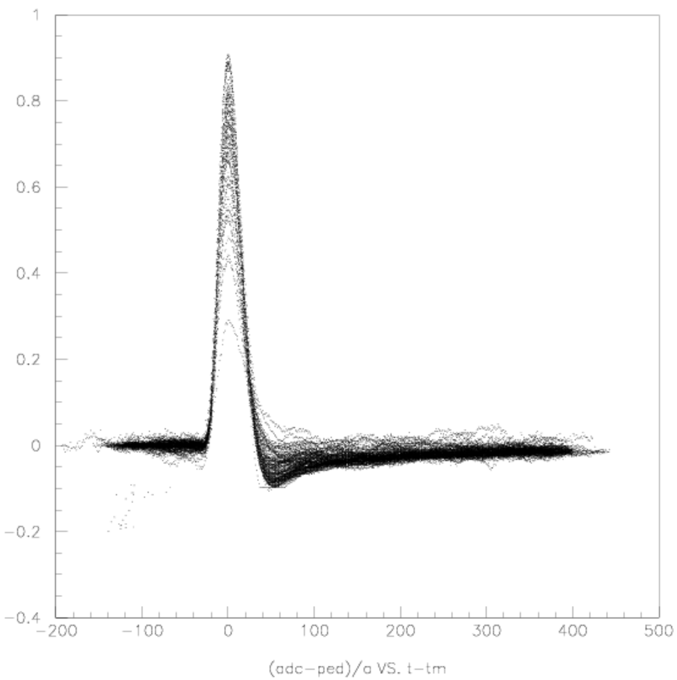


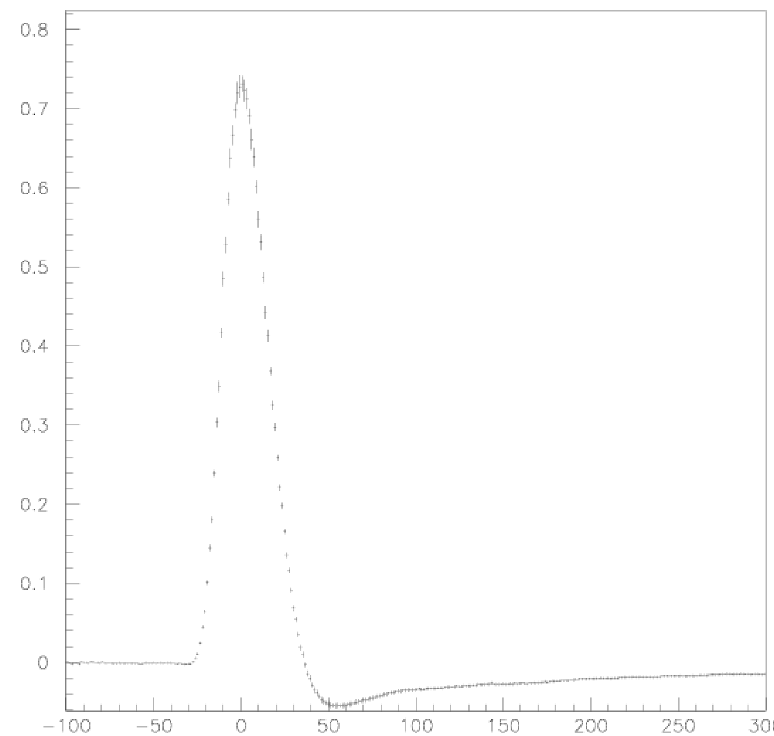




Shapes as a funtion to track distance maximal pad

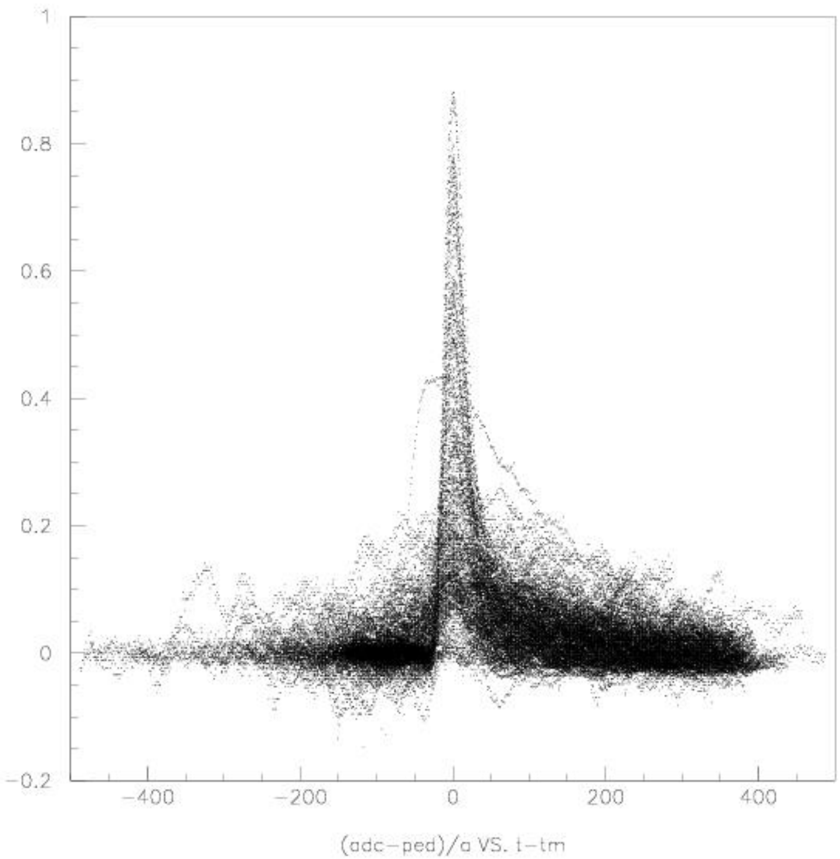
(ADC-pedestal)/ADCMax

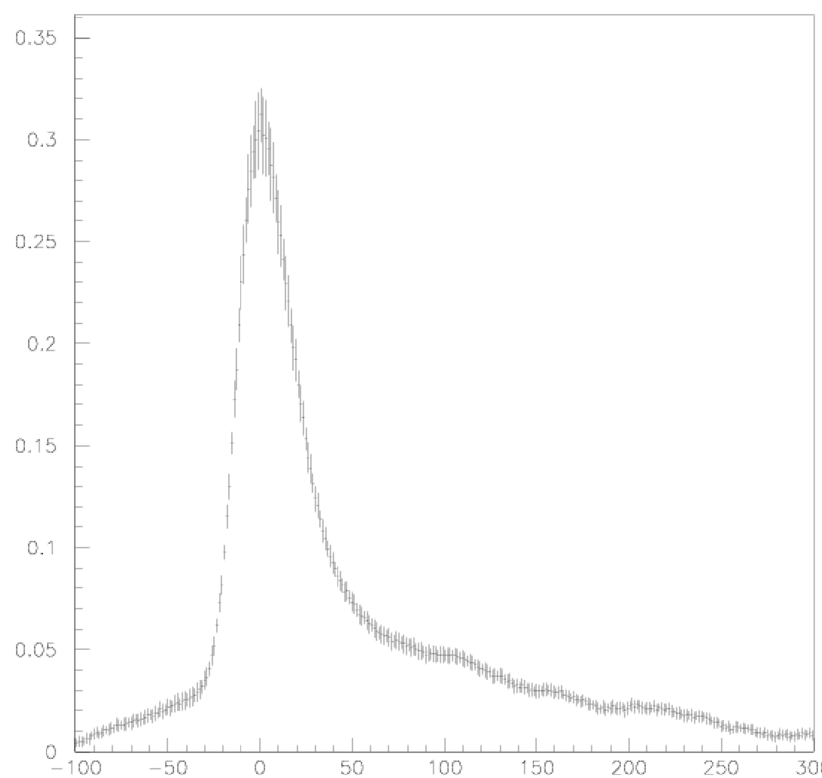




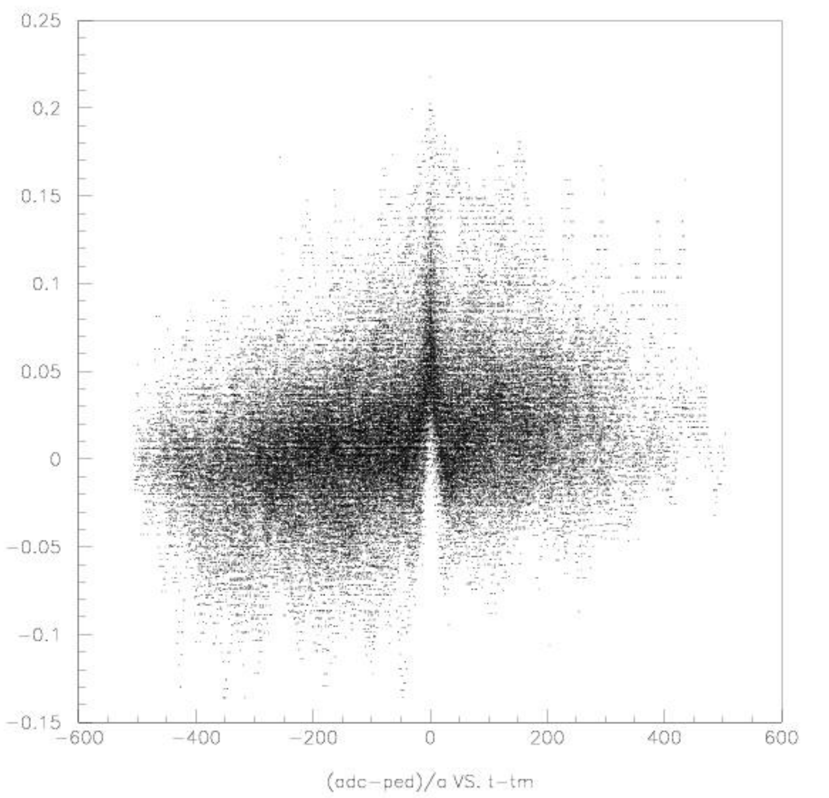
Time (1=10 ns)

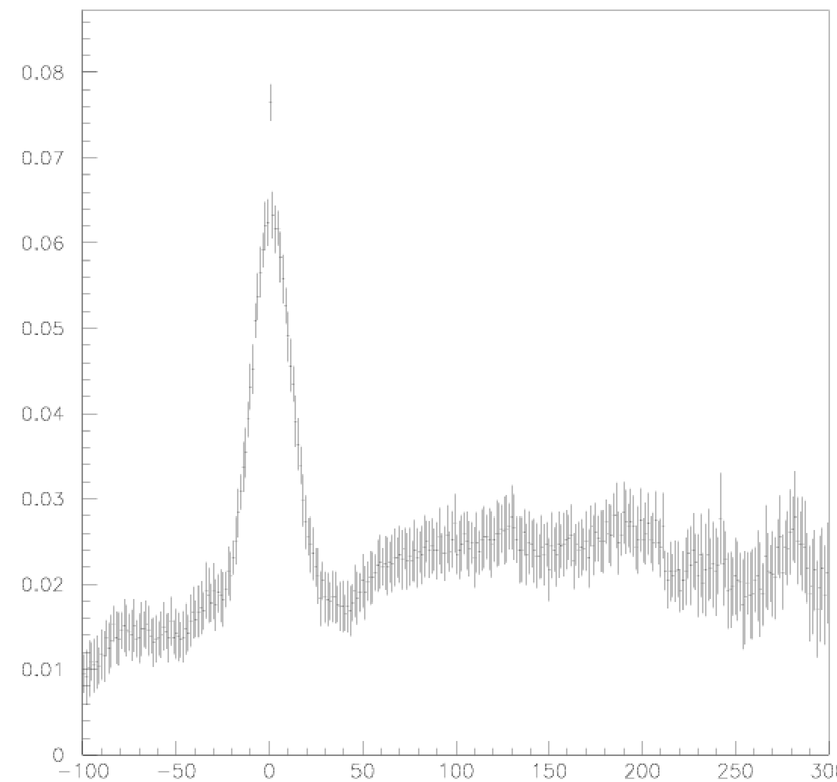
Shapes as a funtion to track distance max+/-1 pad



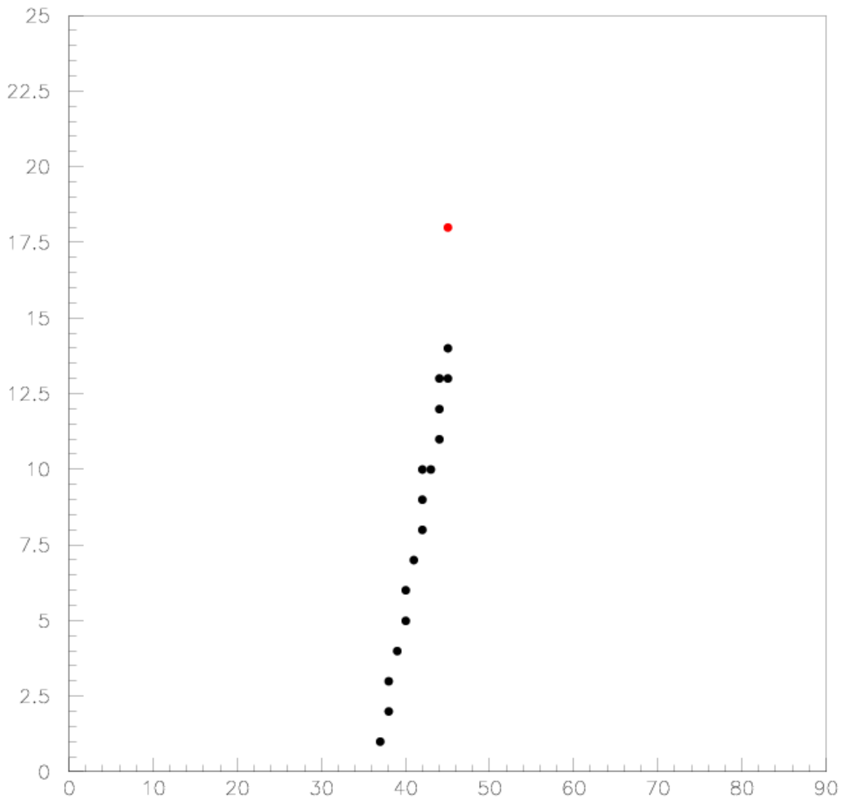


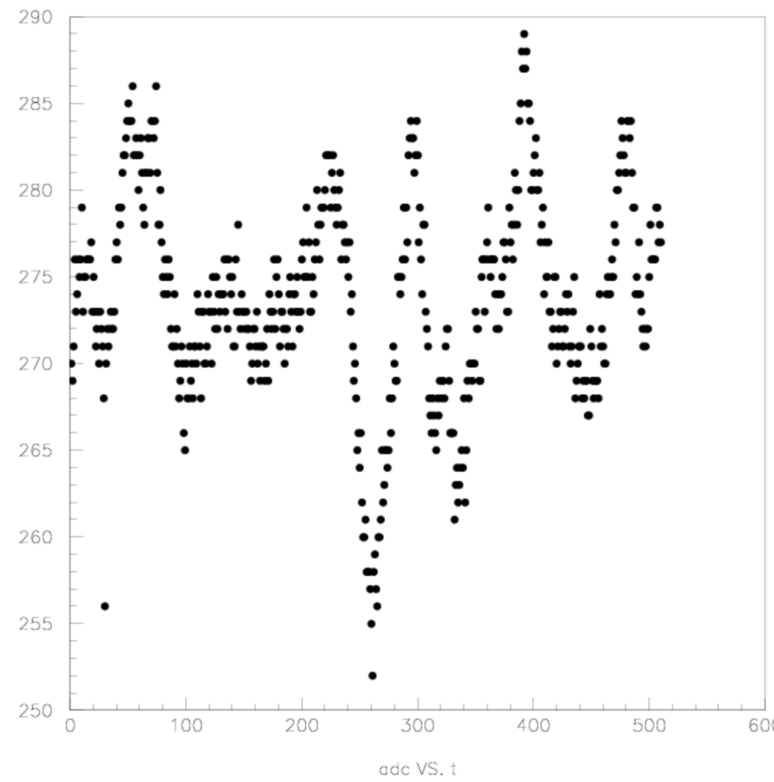
Shapes as a funtion to track distance max+/-2 pad





Abnormal pad signal





What comes next ?

- Define ESD format :
  - Local pedestal, noise amplitude, timing, signal quality
  - Correspondance with geometry and readout topology
- Build cleaning algorithm
  - Reject abnormal pads/signals
- Take long runs

Idres (pointed to me by Sergei)

The ATLAS Experiment

High Luminosity Upgrade

The program idres calculates the error matrix of the track-fit parameters for magnetic tracking spectrometers. Tracks are described by five helix parameters at the origin. The resolution for these parameters depends on the magnetic field B, the initial track transverse momentum Pt, the track angle eta, as well as on the geometry, radiation length and resolution of the detectors that do the tracking.

The program is based on the mathematics given in the note "Parameterisation of the Inner Detector Performance" by E-J Buis, R Dankers, A Reichold, S Haywood, 21 Jan 1998 - ATLAS Inner Detector note 97-195 . Idres can now handle both perfect solenoidal fields and imperfect ones, given as a table of values of (B_r, B_z) on an (r, z) grid, carrying out the double B-integrals in the Buis et al. document.

Input

All the parameters needed by idres are supplied in an external file (a simple text file). The file contains a list of B-fields, transverse-momenta, and eta angles followed by a description of the detector layout as cylinders or discs, each with the radiation length and resolutions (precision and second coordinates) given. The data is "free-format" - items are separated by white space or end-of-lines. You can spread the input out over as many or few lines as you want. Best is to get an example file and amend it; the exact input definition is given below:

Units: magnetic field in T; lengths in m (including resolutions); momenta in GeV/c; angles as pseudo-rapidity except for B-field integration angles, which are given in radians

Key:

```
() groups things together (e.g. before a ...), but leave out of your file

<> Replace angle-brackets and contents with desired value

... Repeat the preceding item as often as needed

[ |  | ...] Select one of the items

Any other characters should be given literally (as keywords) (probably case-sensitive).
```

Input definition:

```
[B <b-field | files <Brfilename> <Bzfilename>  >... end |
 bIntegral <nStepsR> <rMin> <rMax> <nStepstheta> <thetaMin> <thetaMax>  |
 eta <eta>... end |
 pt <Pt>... end |
 cylinder
    (<radius> <zstart> <zend> <%X0> <sigma-rphi> <sigma-z>)...
 end |
 disc
    (<inner-radius> <outer-radius> <z> <%X0> <sigma-rphi> <sigma-r>)...
 end |
 cone
```

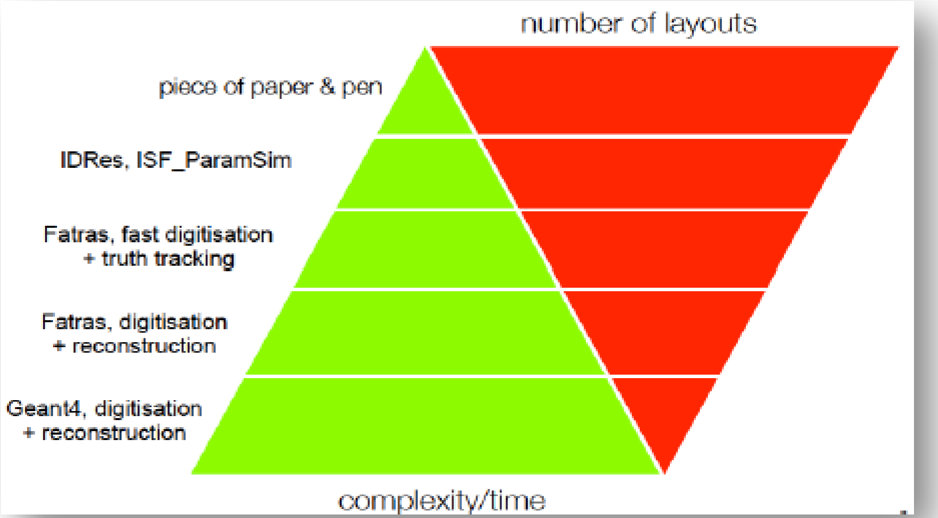
Idres advantages

- Code is easier to use than Trackerr
- Encoding of geometry much simpler
- Can be used also for fcc-hh
- Can work with complicated B topology : accepts B-maps

ITK week, 23/02/2015

How to choose the best layout

- ✓ The main scope of the ILTF is to identify the best layout, with a shared and agreed choice in the community.
- ✓ There is no way to fully evaluate the performance of all the ones around.

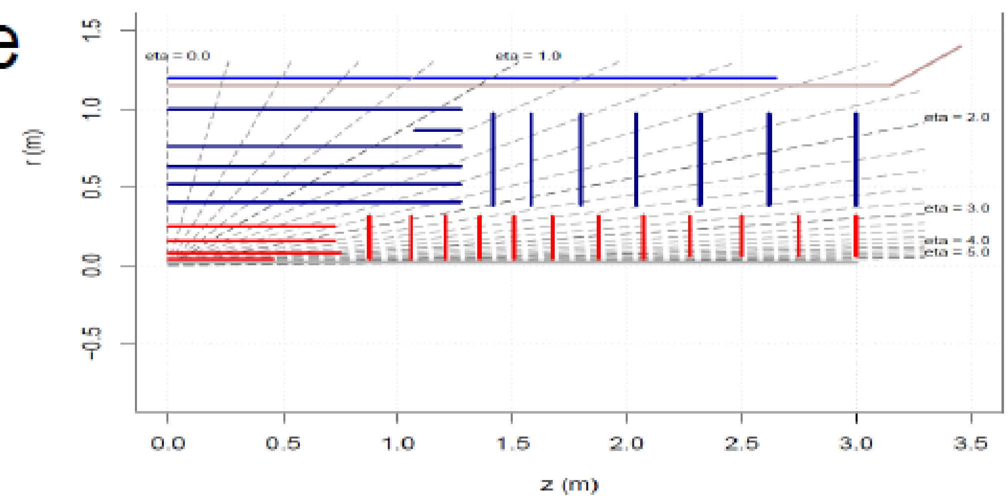


A.Salzburger
https://indico.cern.ch/event/355826/

- ✓ The consideration to reduce the number of layouts as the evaluation of the performances increases in complexity is pretty obvious.
- ✓ But how to do it? We do not want any *a priori* cut - including not enough manpower to support and evaluate the project if valuable.

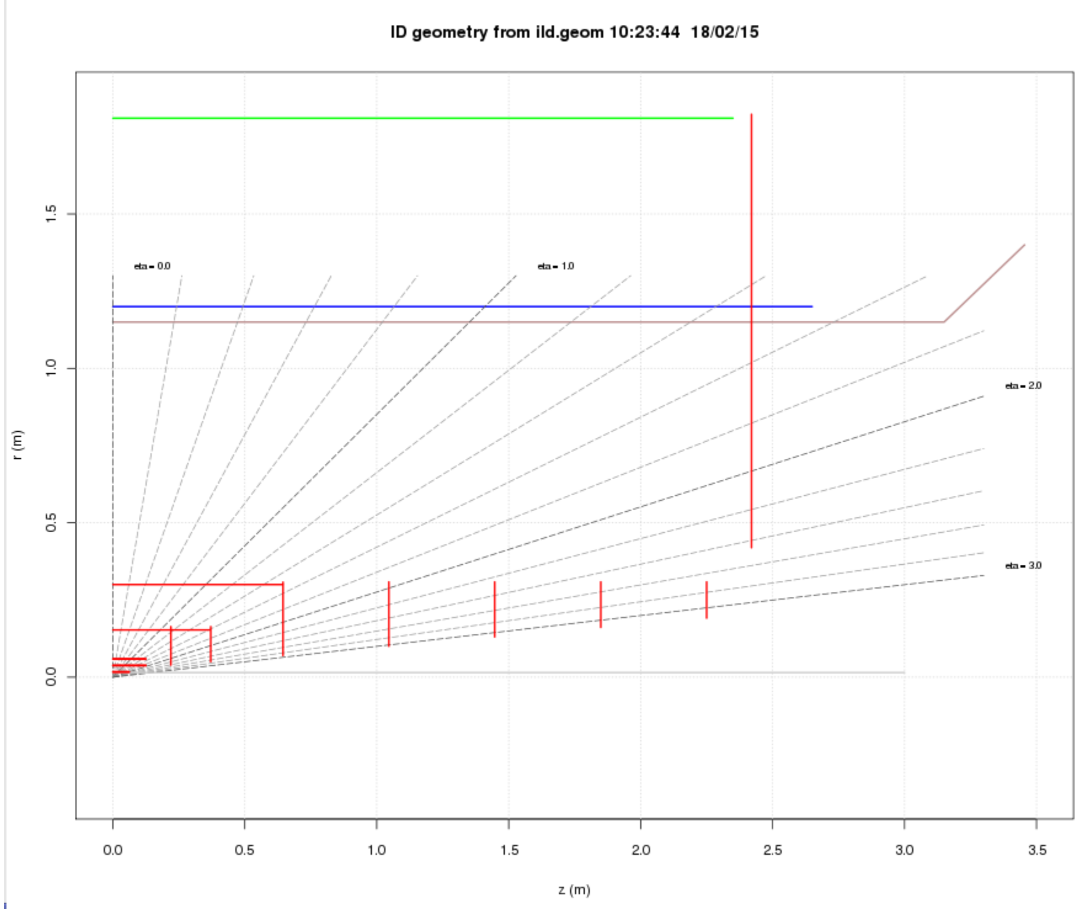
Tools: IDRes

- For fast initial layout studies
- Traces muon like particles through thin measurement layers with a specified resolution
- Can provide:
resolutions, some material effects, hit coverage, hermeticity
- Some extensions possible



Status

- ILD geometry fully encoded



ILD layout as encoded

The current layout of the proposed vertex detector is summarised in Table III-2.1. It is based extensive simulation and technical studies. The parameters are considered conservative.

Table III-2.1
Vertex detector parameters. The spatial resolution and read-out times are for the CMOS option described in section 2.1.2.1.

	R (mm)	$\|z\|$ (mm)	$\|\cos\theta\|$	σ (μm)	Readout time (μs)
Layer 1	16	62.5	0.97	2.8	50
Layer 2	18	62.5	0.96	6	10
Layer 3	37	125	0.96	4	100
Layer 4	39	125	0.95	4	100
Layer 5	58	125	0.91	4	100
Layer 6	60	125	0.9	4	100

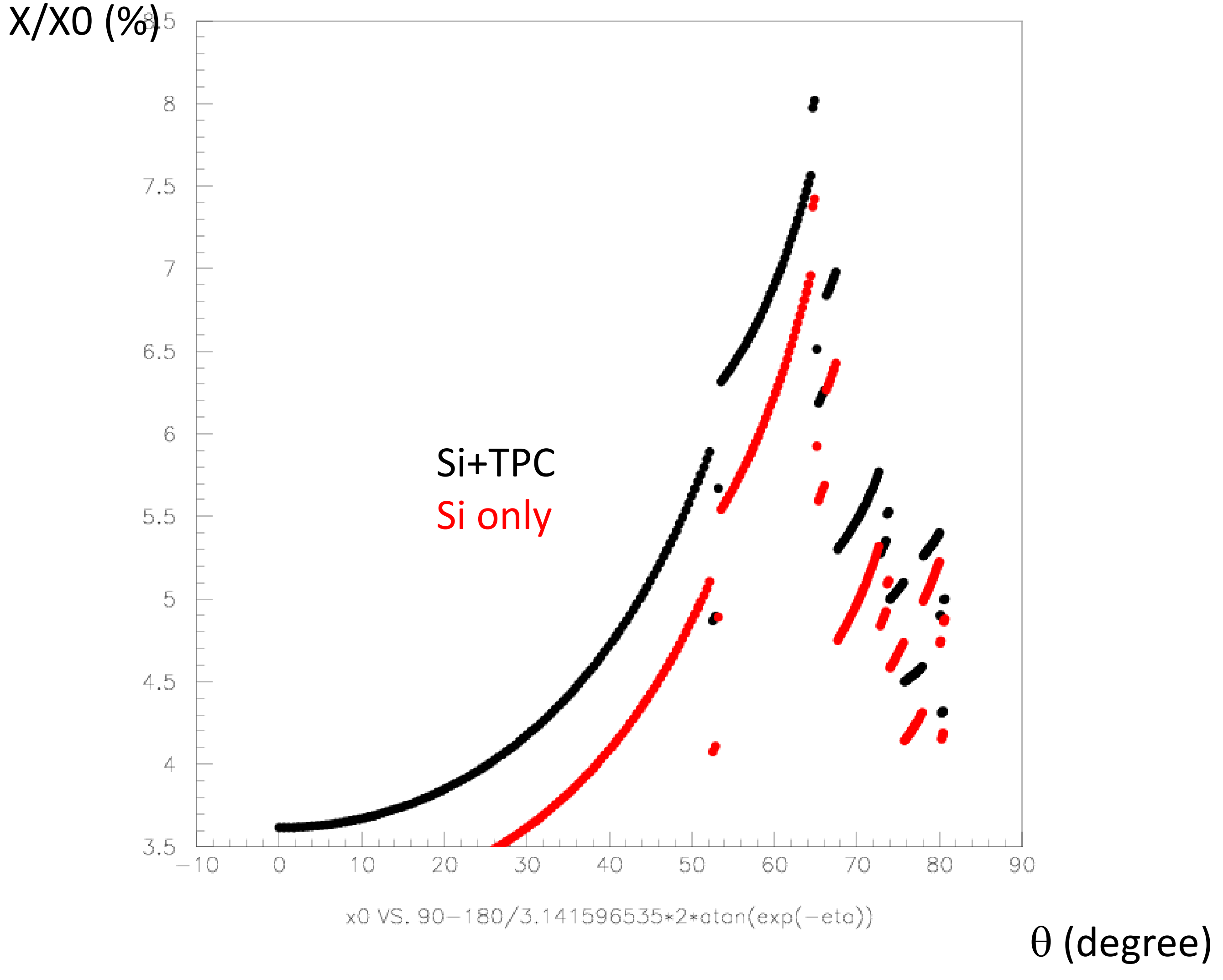
Table III-2.2
Main parameters of the central silicon systems SIT, SET, and ETD.

SIT (baseline = false double-sided Si microstrips)					
Geometry			Characteristics		Material
R [mm]	Z [mm]	cos θ	Resolution R-ϕ [μm]	Time [ns]	X_0 [%]
153	368	0.910	R: σ=7.0	307.7 (153.8)	0.65
300	644	0.902	z: σ=50.0	σ=80.0	0.65
SET (baseline = false double-sided Si microstrips)					
Geometry			Characteristics		Material
R [mm]	Z [mm]	cos θ	Resolution R-ϕ [μm]	Time [ns]	X_0 [%]
1811	2350	0.789	R: σ=7.0	307.7 (153.8)	0.65
ETD (baseline = single-sided Si micro-strips)					
Geometry			Characteristics		Material
R [mm]	Z [mm]	cos θ	Resolution R-ϕ [μm]		X_0 [%]
419.3-1822.7	2420	0.985-0.799	x: σ=7.0		0.65

Table III-2.3
Layout of the Forward Tracking Disks. The quoted single hit resolution for the pixel disk depends on its technological implementation which has also an effect on the material budget.

FTD (baseline: pixels for two inner disks, microstrips for the rest)				
	Geometry		Characteristics	Material
R [mm]	Z [mm]	cos θ	Resolution R-ϕ [μm]	RL [%]
39-164	220	0.985-0.802		0.25-0.5
49.6-164	371.3	0.991-0.914	σ=3-6	0.25-0.5
70.1-308	644.9	0.994-0.902		0.65
100.3-309	1046.1	0.994-0.959		0.65
130.4-309	1447.3	0.995-0.998	σ=7.0	0.65
160.5-309	1848.5	0.996-0.986		0.65
190.5-309	2250	0.996-0.990		0.65

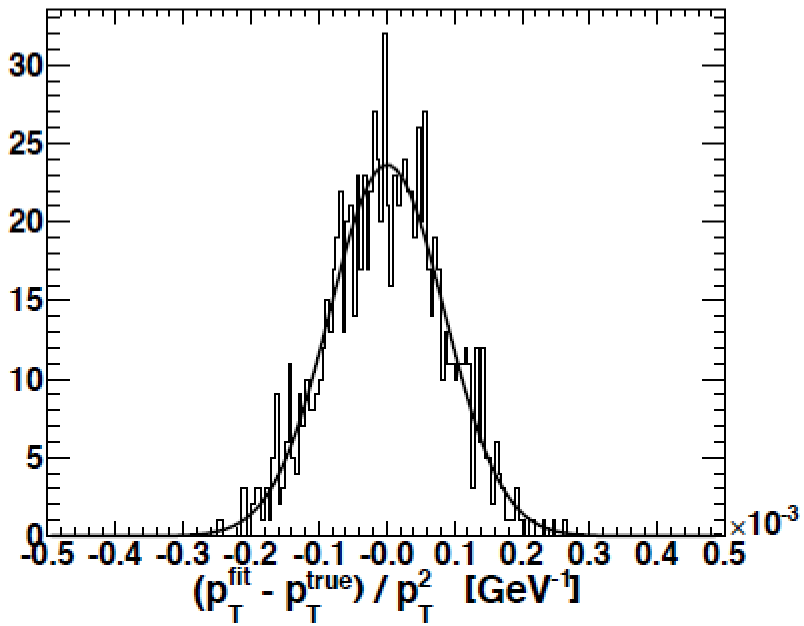
Material budget estimates



Validation plots

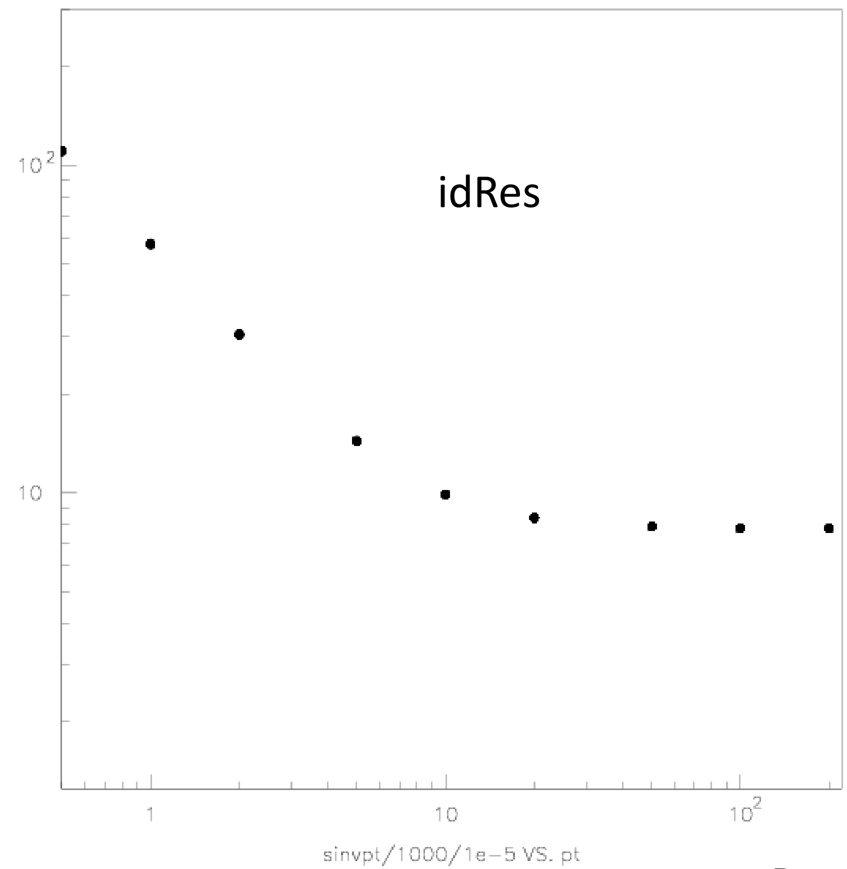
Plot F. Couderc TPC only

$\sigma_{r\varphi} = 100\mu m$



$\Rightarrow \sigma(1/pT) = 8.5 \times 10^{-5}$ / GeV

$\sigma(1/Pt) \times 10^{-5}$

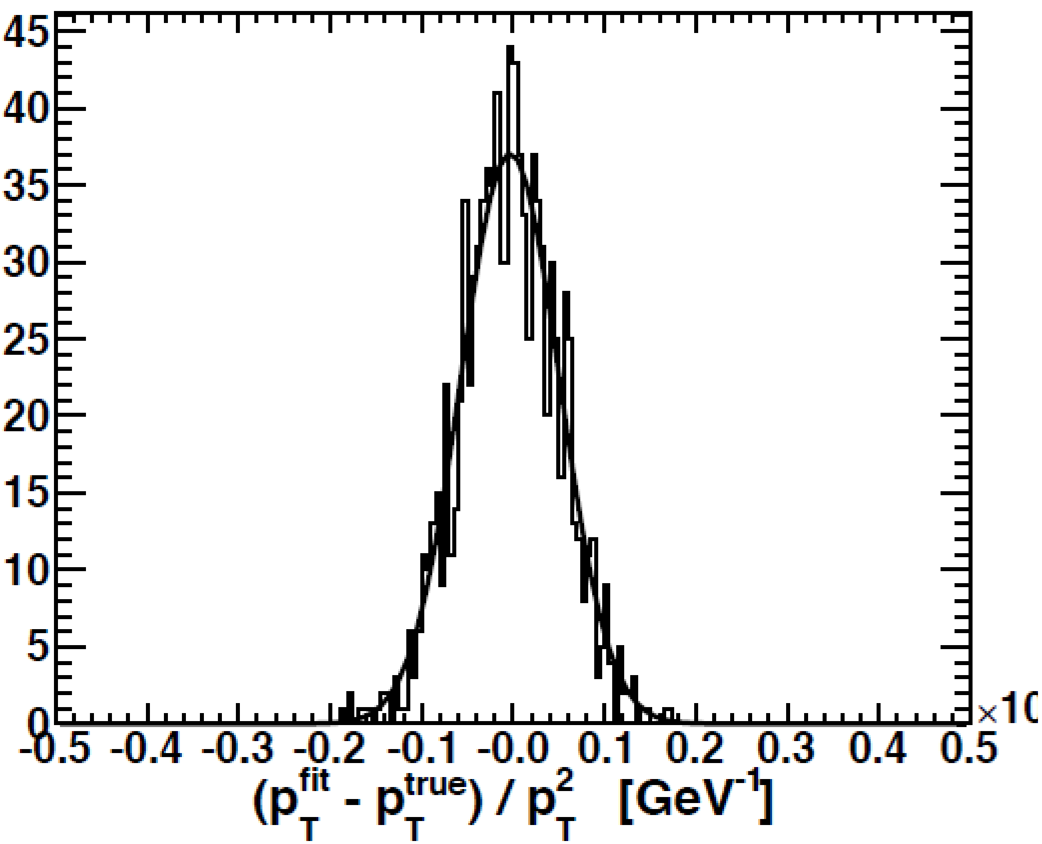


Pt

Validation plots

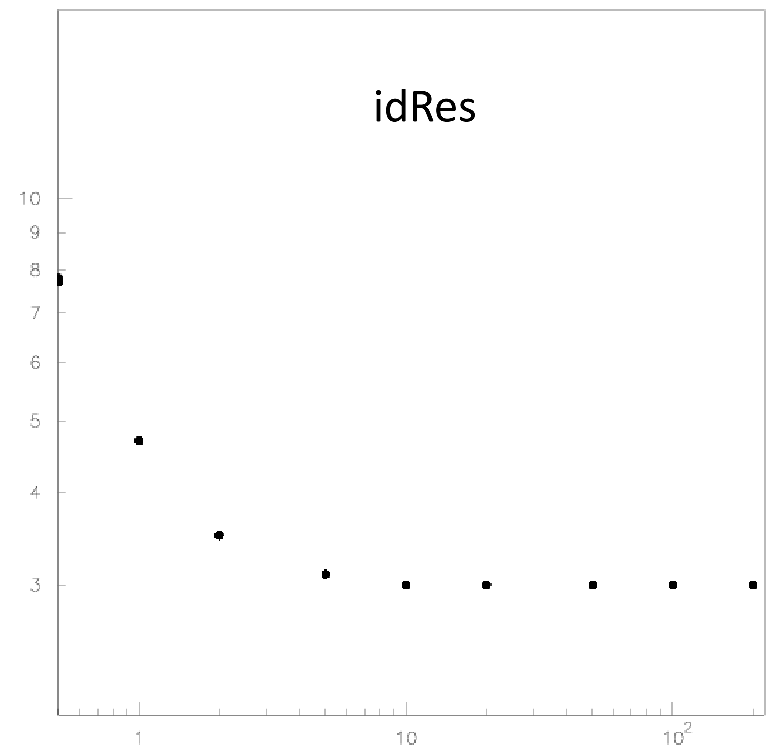
Plot F. Couderc

Only Si tracker



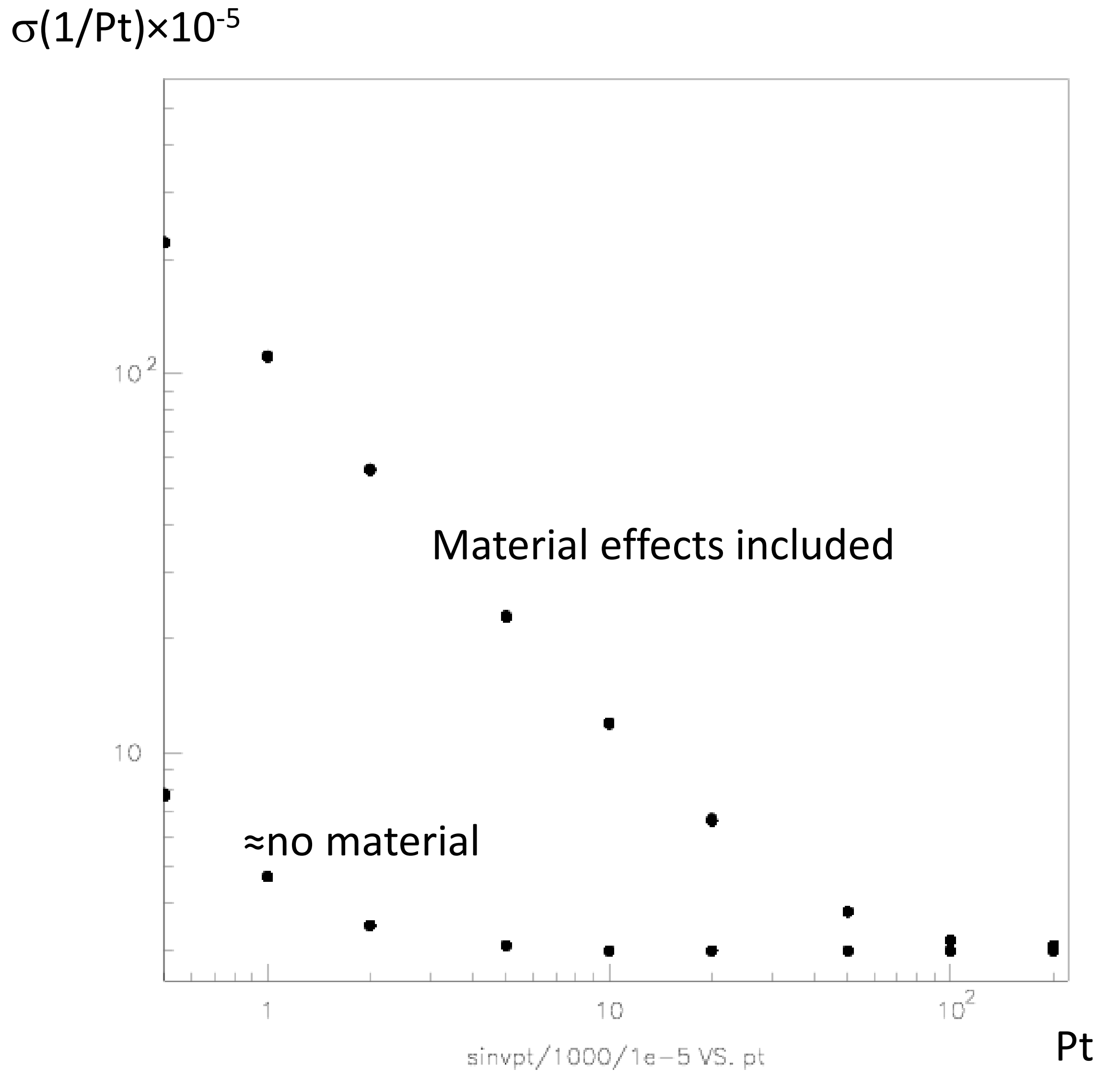
$\Rightarrow \sigma(1/pT) = 5.4 \times 10^{-5}$ / GeV

$\sigma(1/Pt) \times 10^{-5}$



Pt

Material effects, Si only



Angular dependance (Si+TPC)