ILC simulation

Determining the detector requirements of the very forward tracker

towards the LOI

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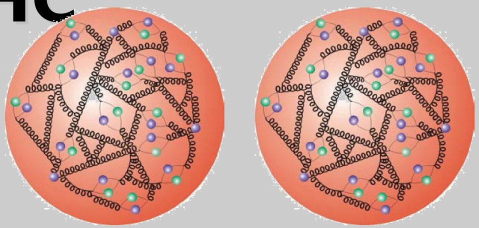
Outline

- ✔ Ingredients: detailed machine parameters + overall detector concept
- ✔ Benchmarking: From physics programme to detector requirements
- ✔ Results so far: FTD requirements
- ✔ Outlook: towards the LOI

Ingredients
detailed knowledge of the environment

LHC

p  p

Protons collide at **E_{cm}~14 TeV**

ILC

e^+ • • e^-

$e^+ e^-$ at **E_{cm}~ 0.5-1 TeV**

	LHC	ILC
Event rates	1 GHz (min. bias)	1 kHz (γγ→hadrons)
Bunch crossings	25 ns (40 Mhz) fast read-out	Relaxed 300 ns (15kHz)
Bunch structure	Continuous	1ms / 200 ms (0.5 % duty cycle)
Triggering	1 event in 10^7	No hardware trigger
Radiation – ionizing	1-100 Mrad/yr	≤ 10 krad/yr
– non-ionizing	NIEL dose 10^{15} n/cm^2	? (student working)
Occupancy /	Pile-up of ~25 min. bias events	γγ→hadrons 2 tracks/crossing
Backgrounds	~800 tracks/crossing	pair production important at small R

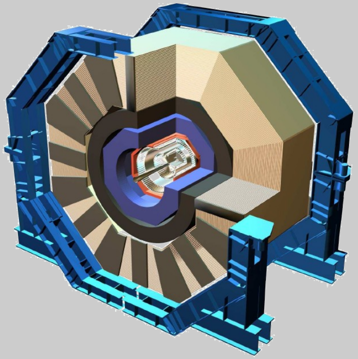
Detailed detector concepts

relate the detector design

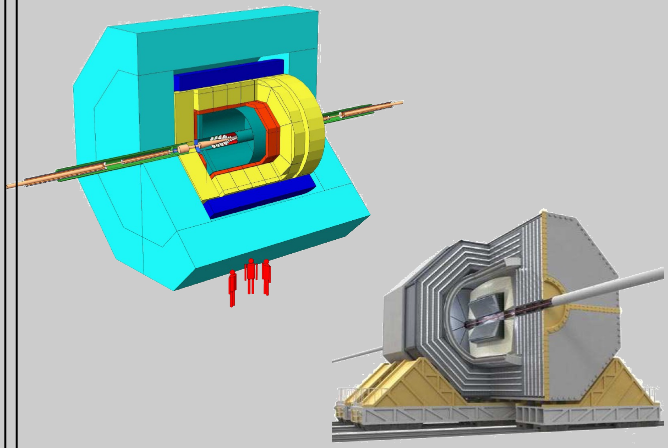
parameters to the

overall physics performance

SiD

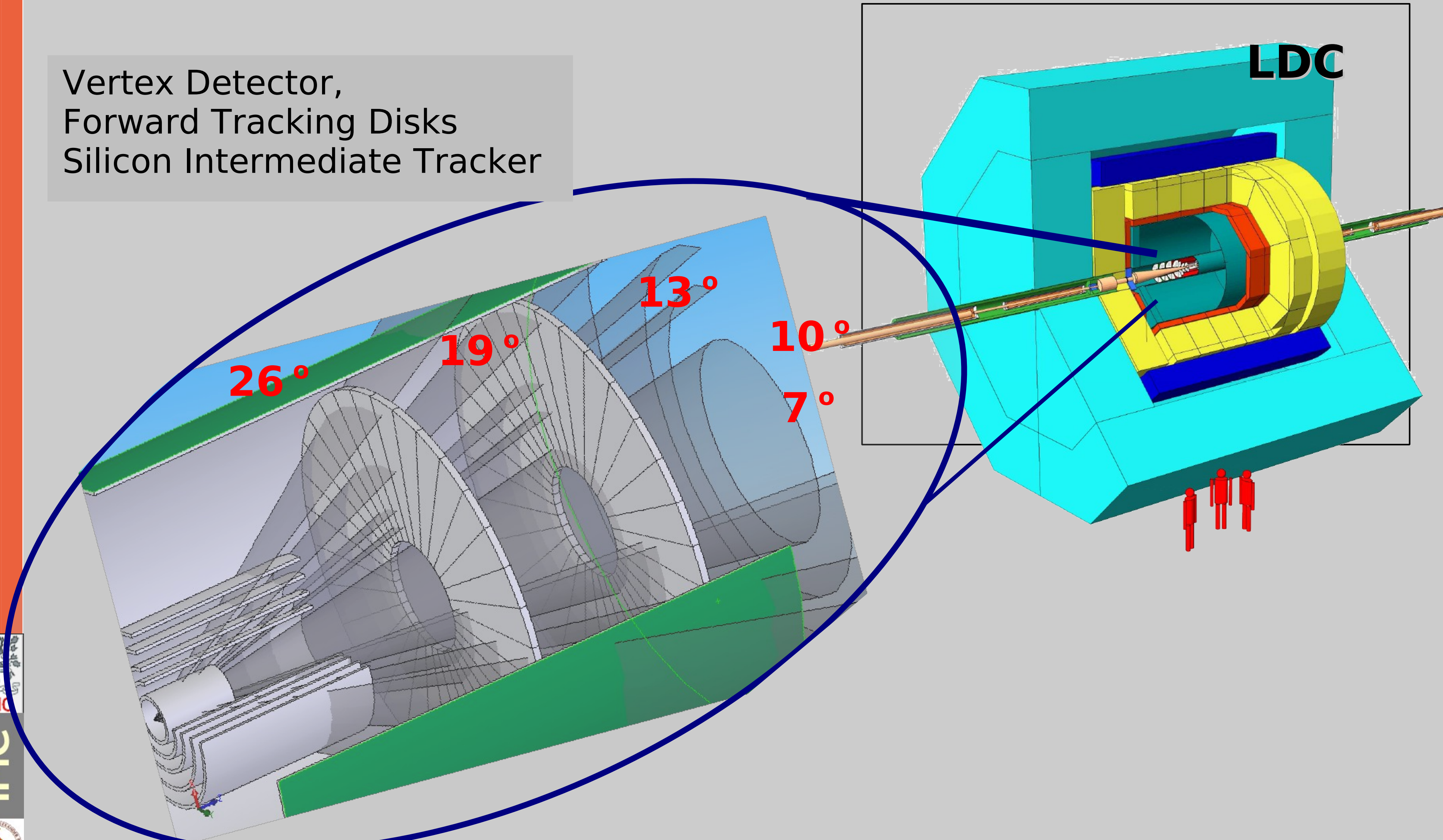


ILD

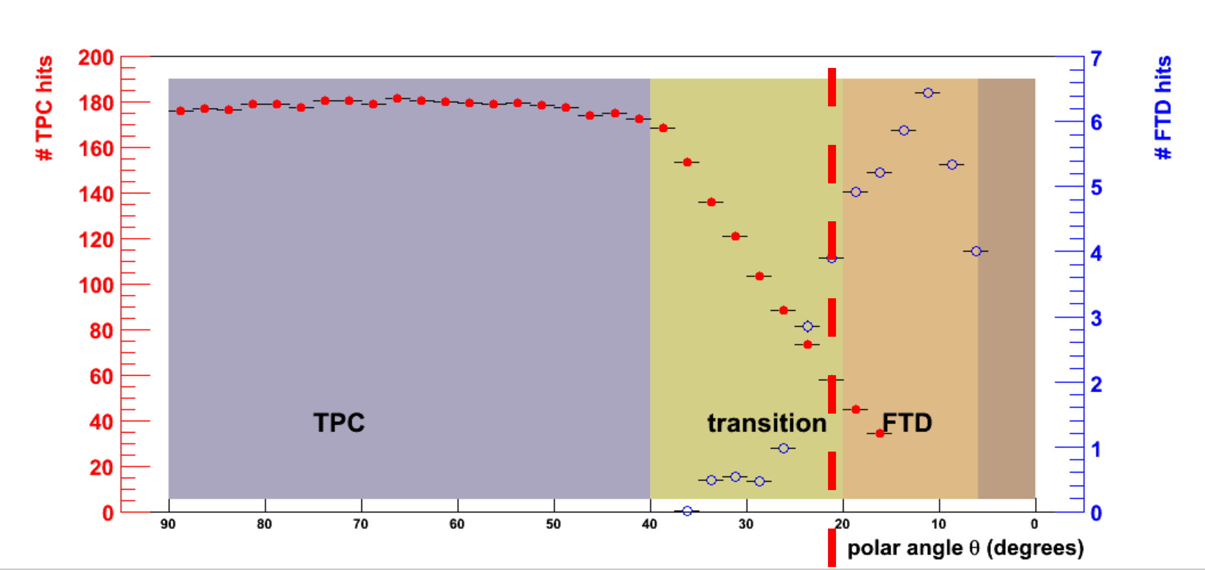


Ingredients
the innermost tracker elements

Vertex Detector,
Forward Tracking Disks
Silicon Intermediate Tracker



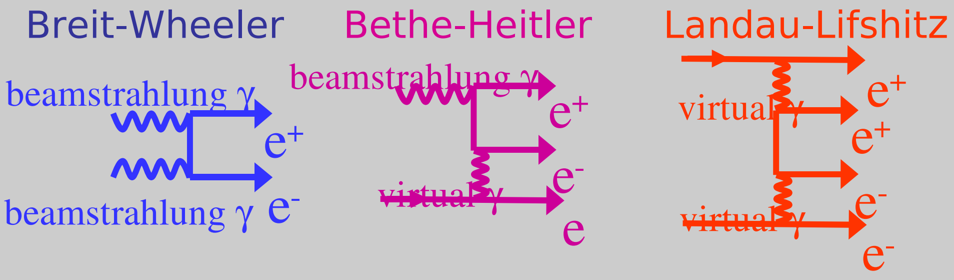
Ingredients
LDC forward tracking

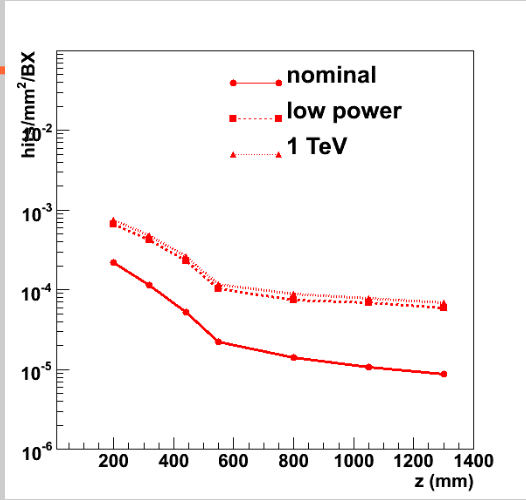


20 °

TPC - FTD interplay in LDC
hits vs. polar angle
R_{TPC} = 30 cm

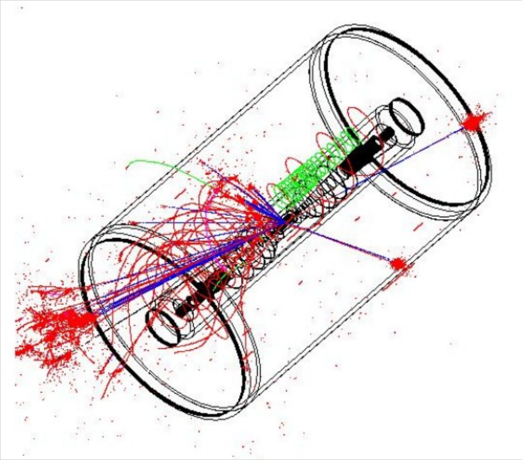
Ingredients
LDC forward tracking





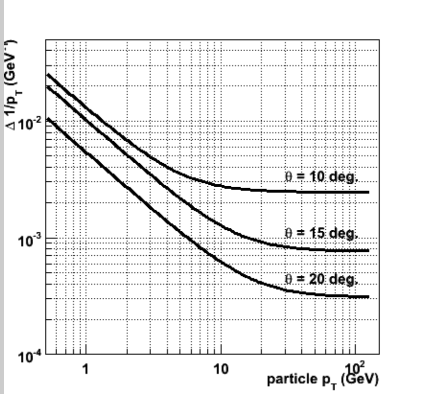
Environment:
significant machine background
abundant low momentum tracks

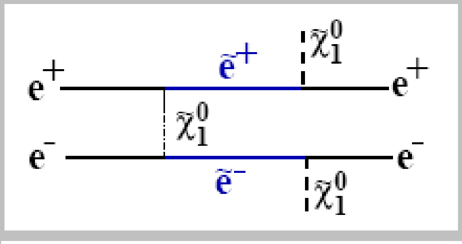
Interplay with other detectors for very low angle tracks:
in case of a long barrel vertex detector design, forward tracking must be capable of standalone pattern recognition

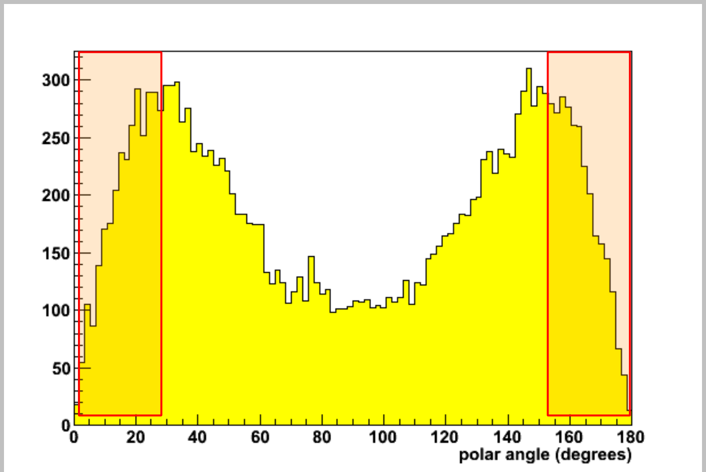


Benchmarking
from physics programme to detector requirements

Do not just look at single, high p_T muons







"Forward physics"

At high √s many physics channels have a strong preference for this region.

Selectron t-channel production in SUSY benchmark point SPS1a

Forward tracking: challenges

momentum resolution with unfavourable field orientation

lever arm, R-ϕ resolution

impact parameter measurement for very forward tracks

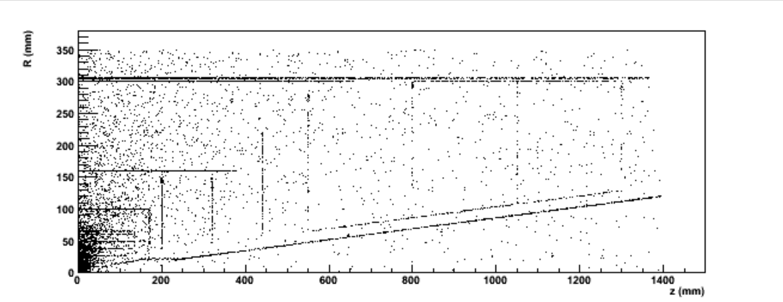
material and resolution disk0 + VXD services

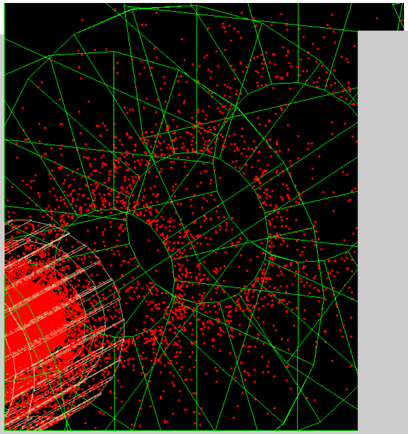
standalone pattern recognition in presence of background and low momentum tracks

R-segmentation, material, read-out speed

minimal distortion of particles/global performance

material





Forward tracking requirements

Challenges of ILC very Forward Tracker are being studied in detail . Write-up of results in progress
(see simulation session and http://ific.uv.es/~vos/ilc/ilcFastForward)

The very forward region has a specific set of environmental constraints and requirements:

- tight control of material budget $\rightarrow$ 0.2-0.5 % X0
- best achievable R ϕ resolution $\rightarrow$ 5 μm
- moderate segmentation in R $\rightarrow$ 500 μm – 1 cm
- moderate background level $\rightarrow$ 1-2 x 10^{-4} hits/mm^2/BX
- fast read-out $\rightarrow$ < 10s of BX

FTD 1-3: investigating VXD technologies (hybrid pixels as back-up solution)
FTD 4-7: double sided micro-strips

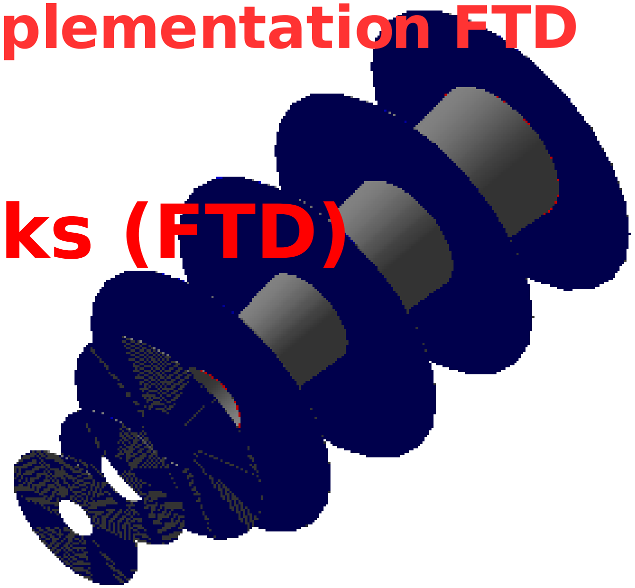
Moving ahead: Mokka implementation FTD

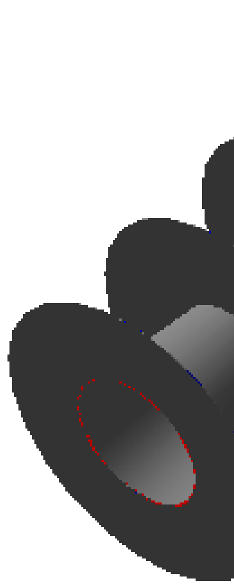
Forward Tracking Disks (FTD)

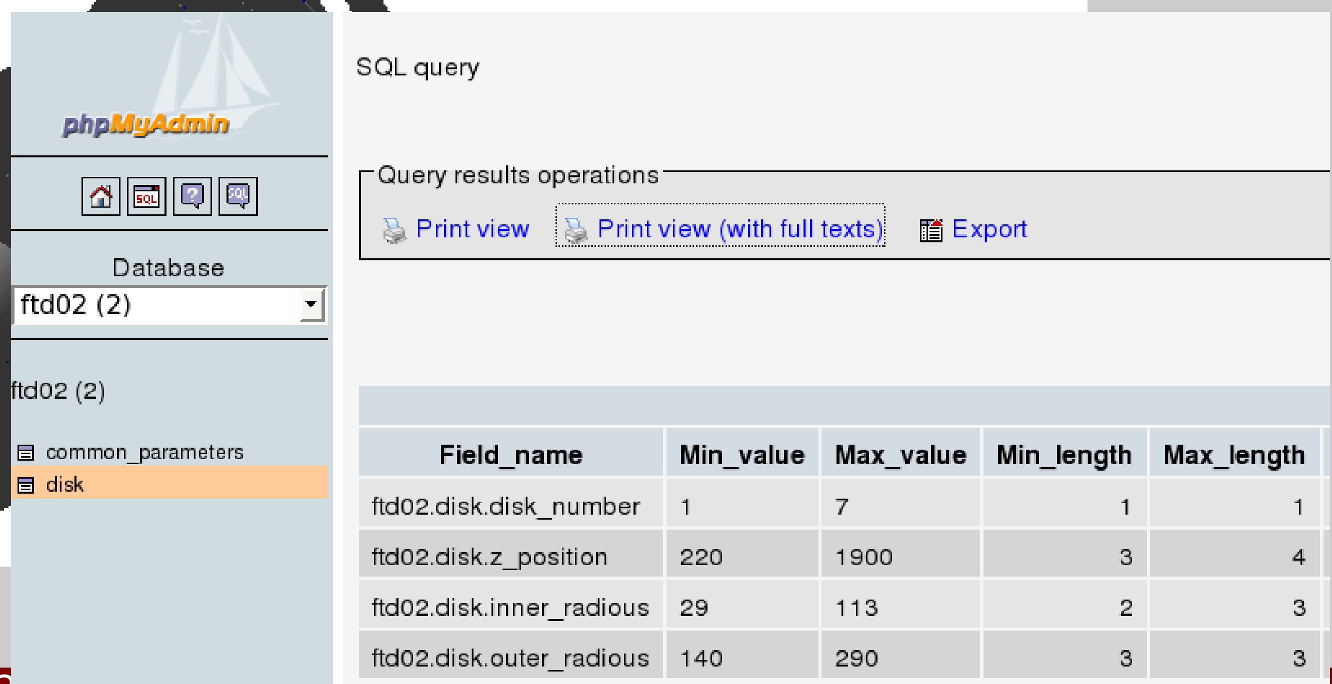
3 pixel disks (1 % X_0)

4 strip disks (0.5 % X_0)

extended layout wrt TESLA







Field_name	Min_value	Max_value	Min_length	Max_length
ftd02.disk.disk_number	1	7	1	1
ftd02.disk.z_position	220	1900	3	4
ftd02.disk.inner_radious	29	113	2	3
ftd02.disk.outer_radious	140	290	3	3

V. Saveliev

Moving ahead: digitization

SiLC provided a document specifying the resolutions of all sub-detectors.

Adopted by MarlinReco digitizer, as far as technically feasible.

Impossibility to smear local coordinates: a major problem for FTD

	z-value	Inner radius	Outer radius	thickness	R-ϕ resolution	z-resolution	Read-out time
FTD disk 1	220 mm	29.0 mm	140.0	50 μm	7 μm	100 μm	~ 10s BX

Space points smeared by 7 μm in X,Y
An all-pixel FTD!!!!

Tools – track fitting

CMS Kalman filter tool-kit.

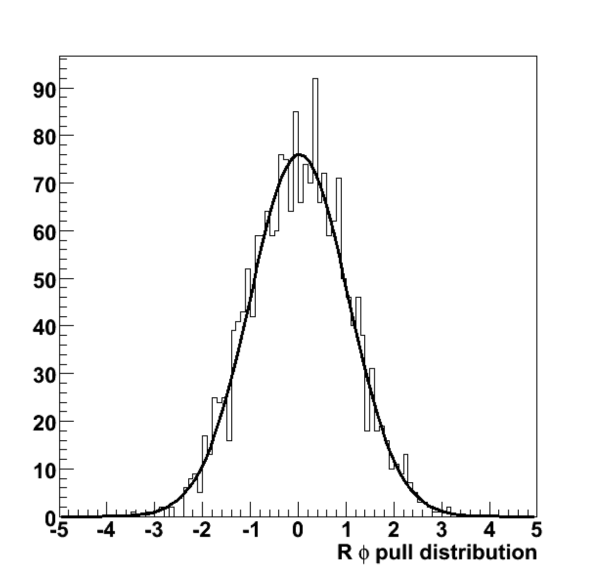
The result of years of work by a lot of people. Validated in large-scale MC productions.

Extracted all relevant code in a series of libraries with limited external dependencies (CLHEP, ROOT). Thoroughly validated on toy geometries.

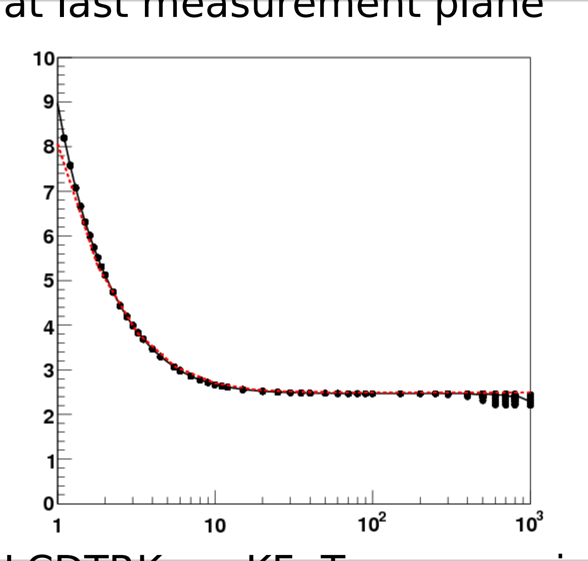
Interfaced to MarlinReco (GEAR geometry, LCIO hits)

Release in MarlinReco.

Use for SiD as well.



pull distribution R ϕ coordenate at last measurement plane

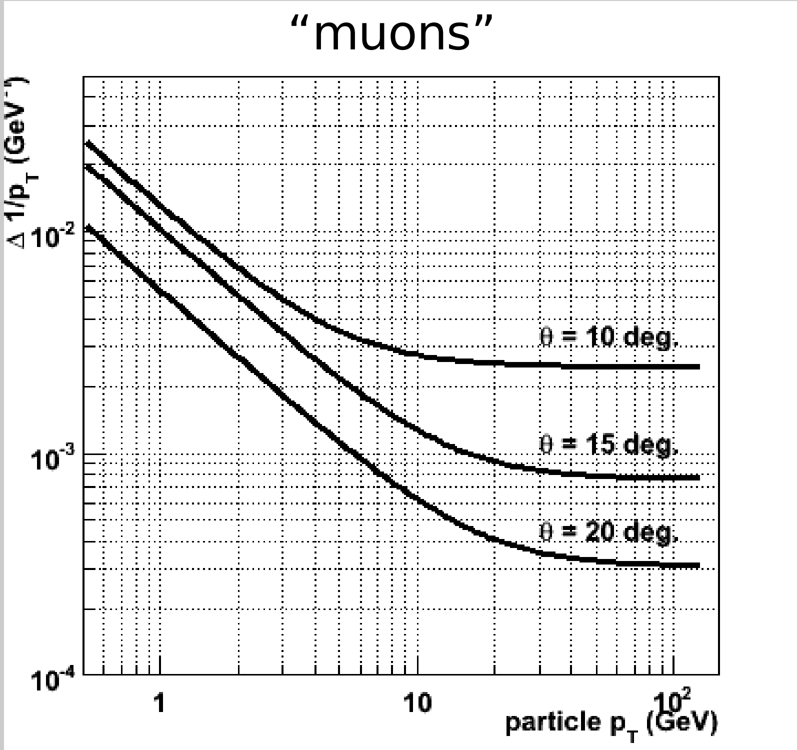


LCDTRK vs. KF: Transverse impact parameter resolution vs p_T

Moving ahead:

Study tracker performance using full simulation for standalone muons (compare to fast simulation), pions, electrons

Then move to some real physics (s-lepton analysis)



Summary

Aim to provide a generic tool in MarlinReco for tracking studies in the very forward region

Determined FTD requirements: still writing up the results

Hopefully new results for IEEE Dresden (October) and LCWS (November)