Recent changes in the CDC software

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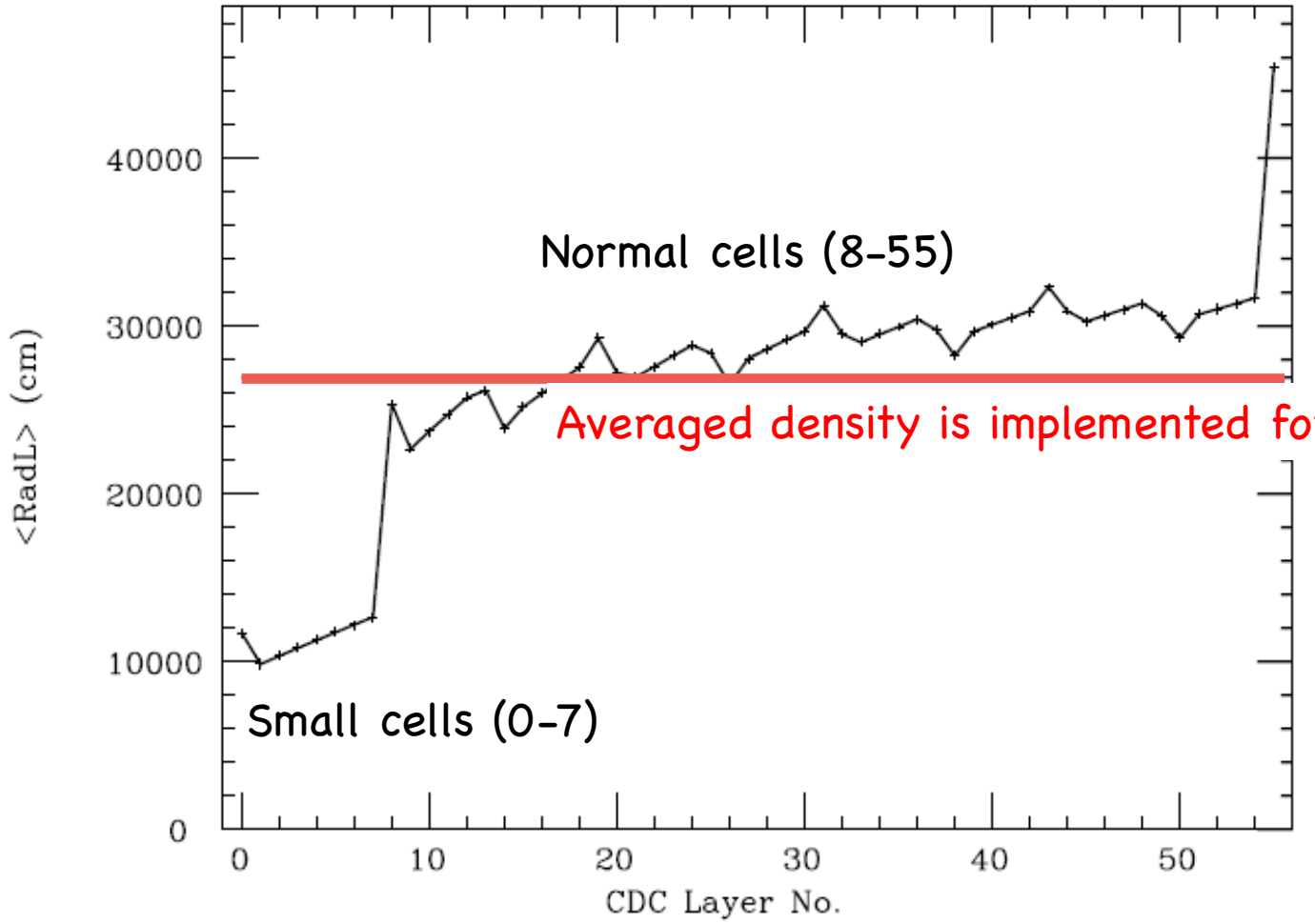
Outline

- Current status
  - Materials of the CDC tracking volume.
  - Sag effects.
  - Realistic XT-relation.
  - Other issues (TOF, Propagation delay, etc...).
- Future plan.

CDC materials

- The CDC material will be modified.
  - Currently, the mixture of gas and wire was used.
  - The wire (~57,000 in total) and gas (He-ethane) is explicitly implemented.
- The results are,
  - Geant4 accepts all the wires and seems working.
  - Genfit seems working in the new realistic geometry.
  - Job speed is under investigation.
- More details :
  - http://kds.kek.jp/getFile.py/access?contribId=0&resId=0&materialId=slides&confId=14244
- If any problems, we will implement wire layers instead of all wires.

Materials in the CDC tracking volume



Averaged density is implemented for every layers.

Wire sag effects

- The gravitational sag effect is implemented by Ozaki-san.
- Model: parabola approximation.
- designed tension : 50 g for all sense wires.
- The sag effect can be turn on in CDC.xml.
  - WireSag tag : false -> true
  - max. ~200 μm
- The electrostatic force effect is not included.

XT-relation

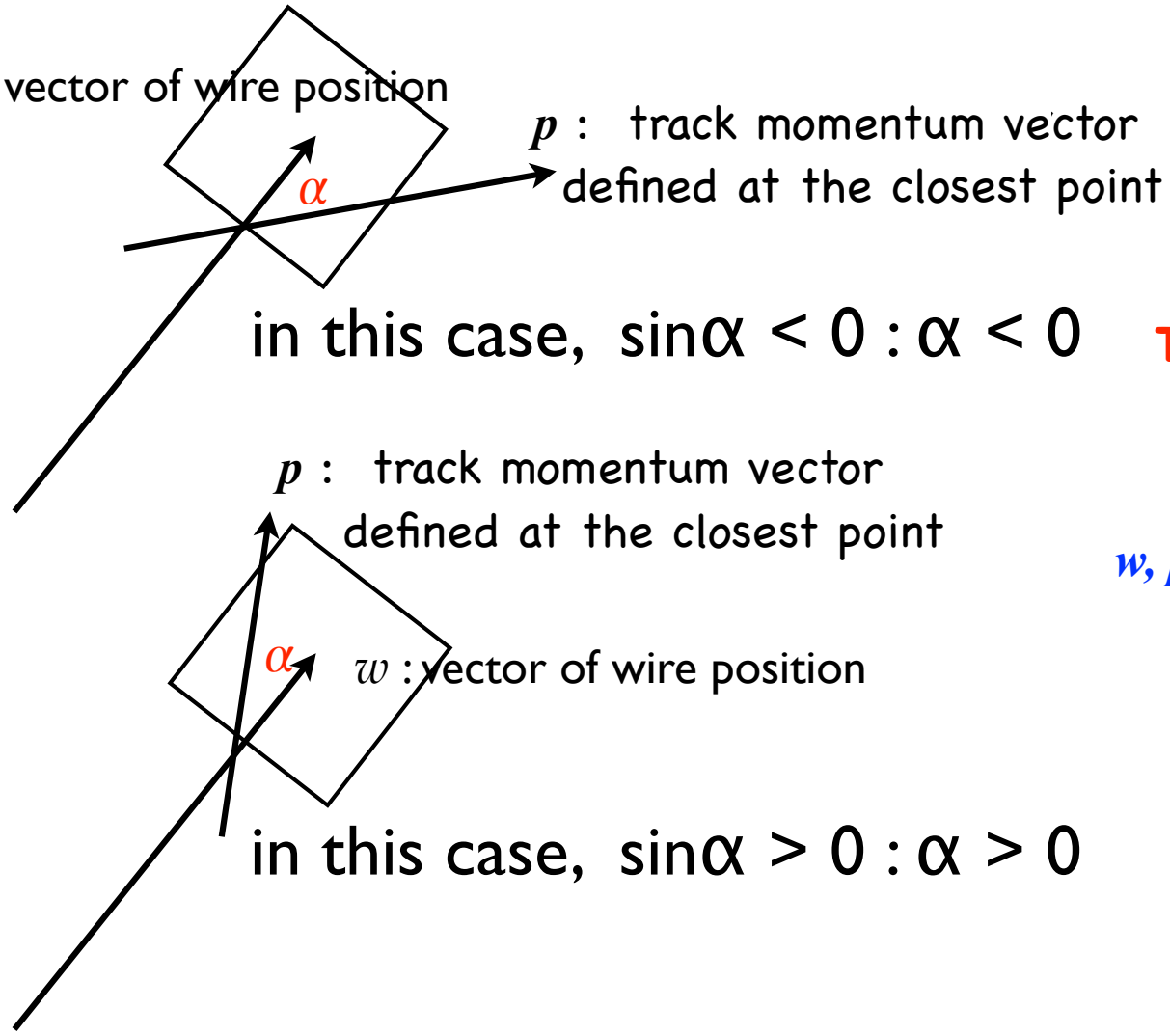
- Default XT-relation : linear v = 40 μm/nsec, σ = 130 μm.
  - Users use "SimpleTDCCountTranslator".
- The 1st version of the realistic XT-relation and σ.
- xt = xt(layer, L/R), layer: layer ID (0-55), L/R : Left/Right (implemented in Aug.).
- σ = σ(layer, dL), layer : layer ID, dL : drift length (implemented in Nov.).
  - Users use "RealisticTDCCountTranslator".
- See details:
  - http://kds.kek.jp/getFile.py/access?resId=0&materialId=6&confId=13871

Simulated conditions

- XT-relations are calculated with Garfield.
- Layer, Left/Right
- θ = 17, 40, 60, 90, 120, 130, 150 deg.
- α = -90 - 80 deg. (10 deg. step).
- Fitting function
  - 5th order polynomial (most of the cell)
    + linear function (outer ridge area).
- Details are described in Nakano-san's presentation.
- http://kds.kek.jp/getFile.py/access?contribId=1&resId=0&materialId=slides&confId=14317

N.B. the sag effect is not included in this calculation.

Definition of angle (α)

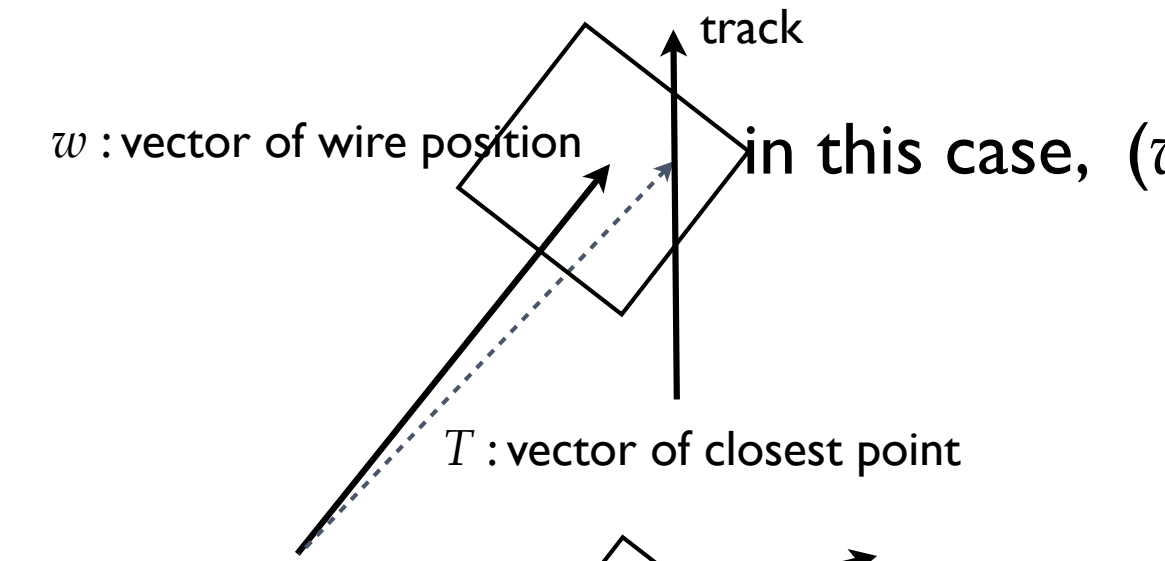


$$\sin\alpha \equiv \left(\frac{\vec{w} \times \vec{p}}{|\vec{w}| \cdot |\vec{p}|} \right)_z$$

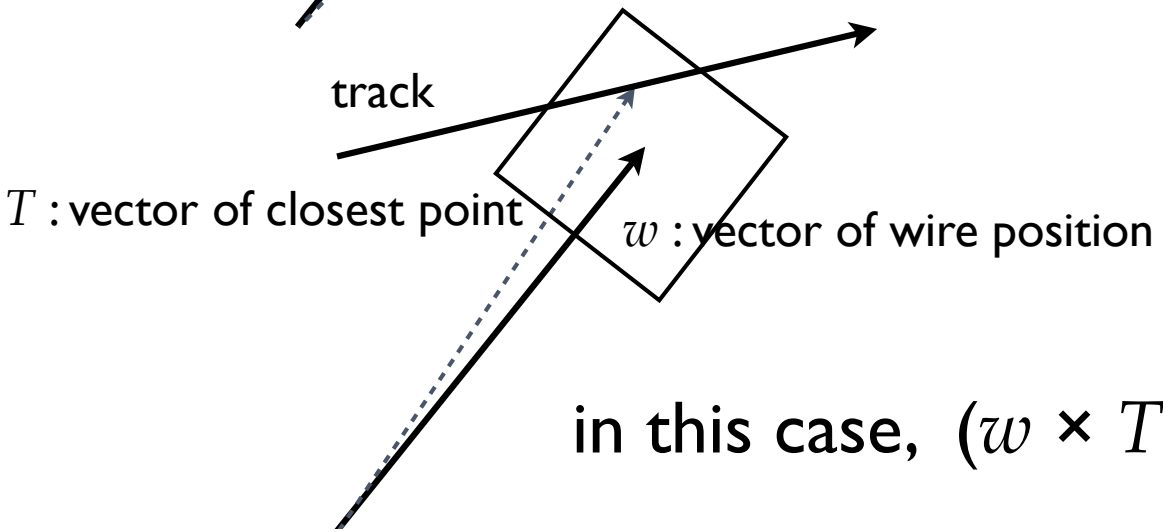
The view point is forward of the Belle detector.

w, p : defined in XY ($r\phi$) -plane

Definition of Left/Right



in this case, $(w \times T)_z < 0$: left



in this case, $(w \times T)_z > 0$: right

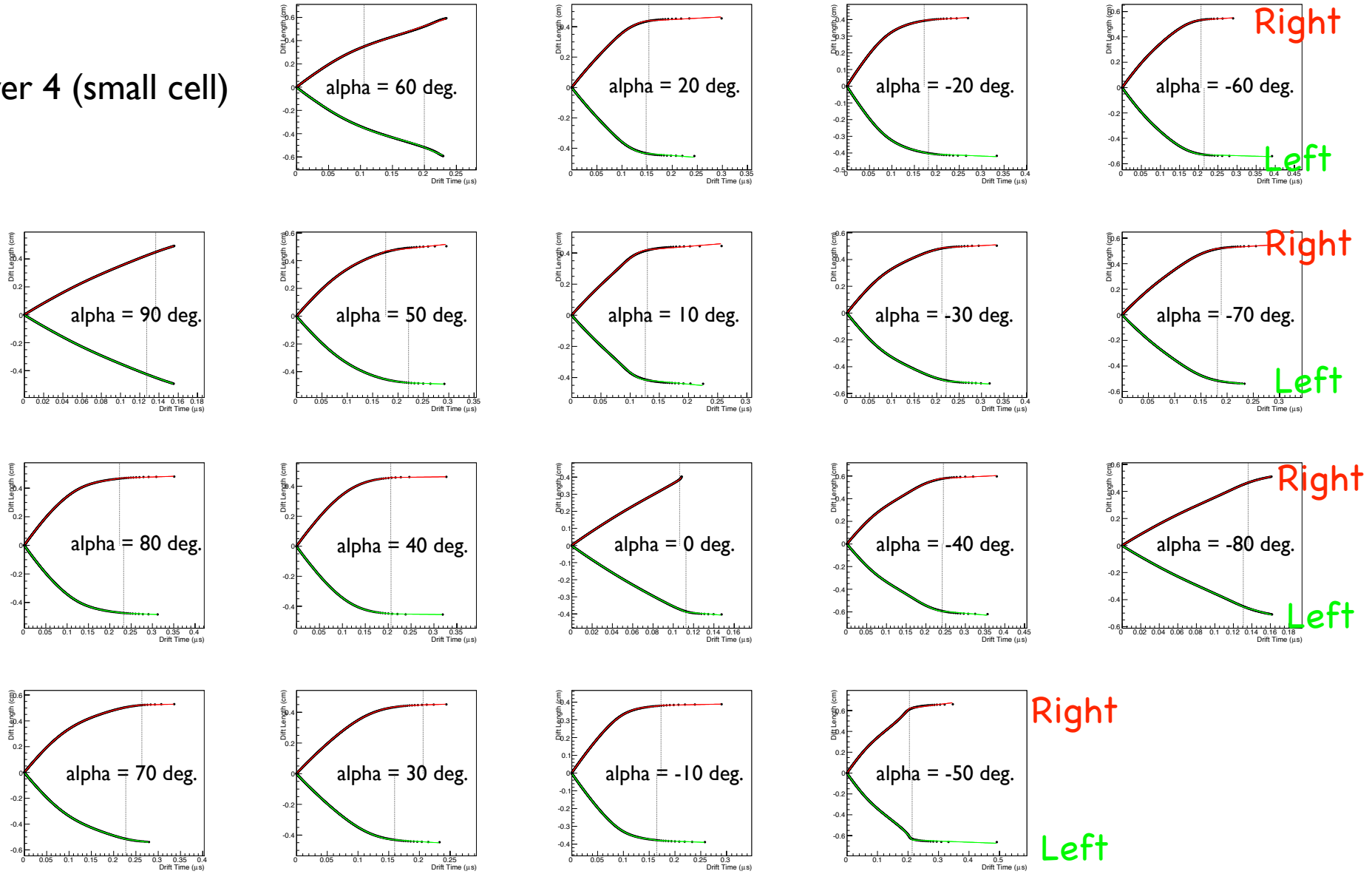
$(w \times T)_z < 0$: left

$(w \times T)_z > 0$: right

The view point is forward of the Belle detector.

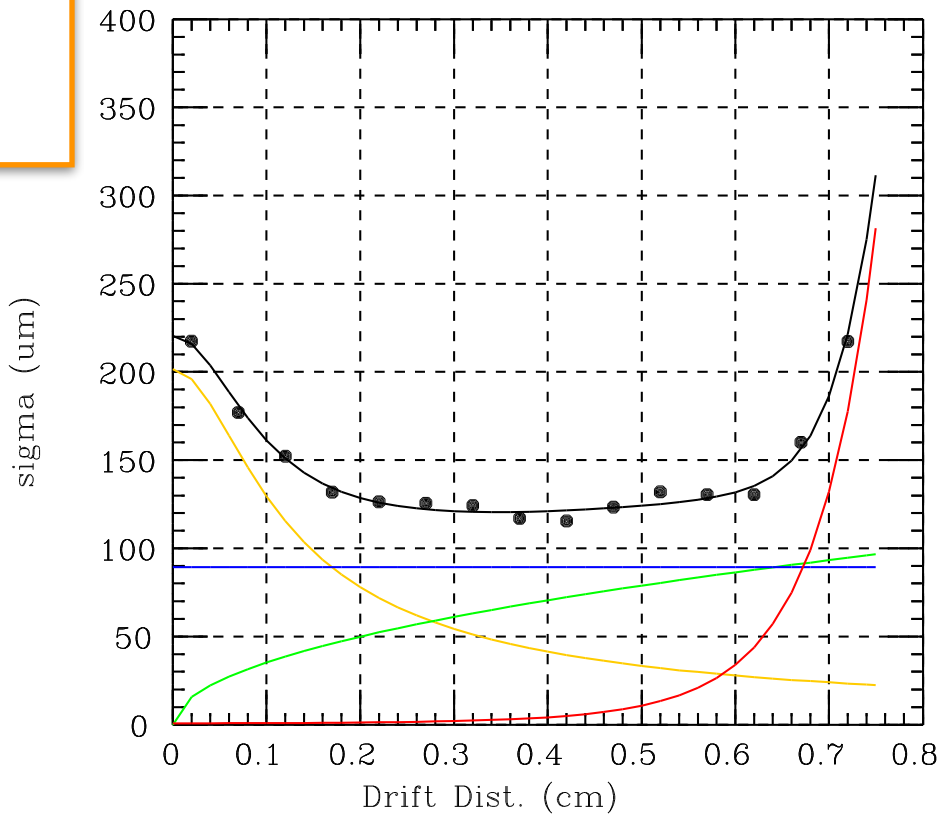
Example of simulated

layer 4 (small cell)



Spatial resolution from beam test

Test beam data (2011)
1 GeV/c e^- beam
No B field
He based gas



Fitted parameters are used in the simulation.

Definition

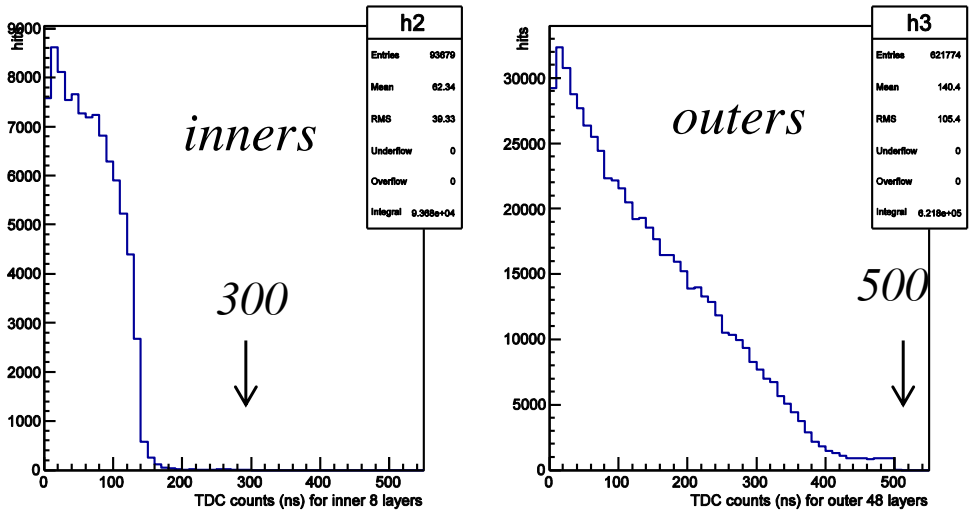
$$F(x) = \sqrt{\left(a_0 \cdot \sin\left(\arctan\left(\frac{a_1}{x}\right)\right)\right)^2 + \left(a_2 \cdot \sqrt{x}\right)^2 + (a_3)^2 + \left(a_4 \cdot \exp(a_5 \cdot x^2)\right)^2}$$

Primary ion statistics — Difusion — Fluctuations due to electronics — Distortion of electric field

Hit Efficiency

- **Hit eff. for default case (linear x-t)**
  - **~100%**
    - **40 um/ns * 300 ns = 1.2 cm > cell size for the layers#0 - 7;**
    - **40 um/ns * 500 ns = 2.0 cm > cell size for the layers#8 – 55.**
- **Hit eff. for realistic x-t**
  - **No longer 100% due to the max. driftTime cut (300 or 500 ns).**
  - **In particular, a cell is inefficient for a particle crossing the boundary betw. the cell and the neighboring cell in the same layer. ← inclined incidence due to finite r of curvature of a track.**
  - **driftTime (TDC) distribution output from CDCDigitizer:**

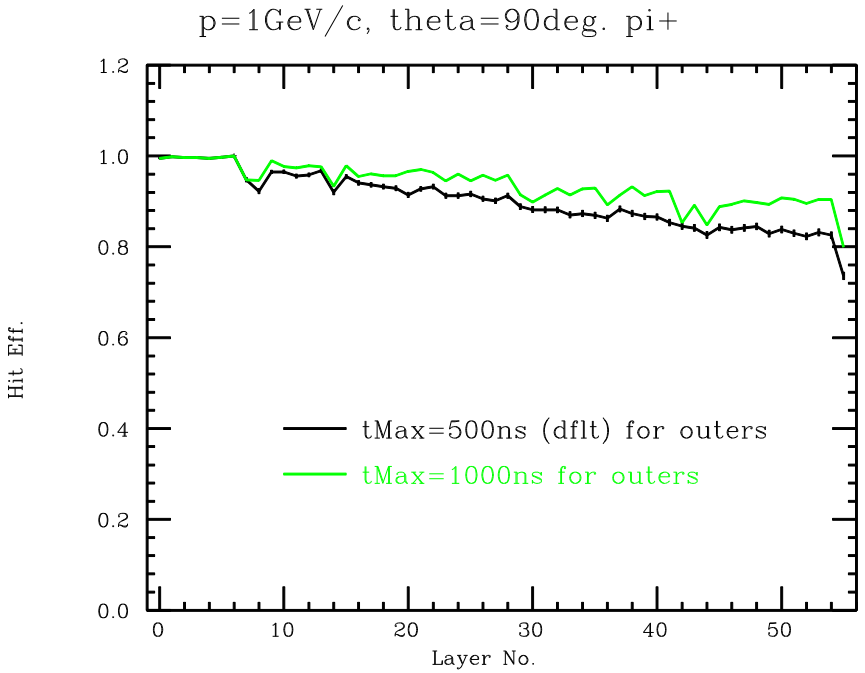
Ozaki-san's slide

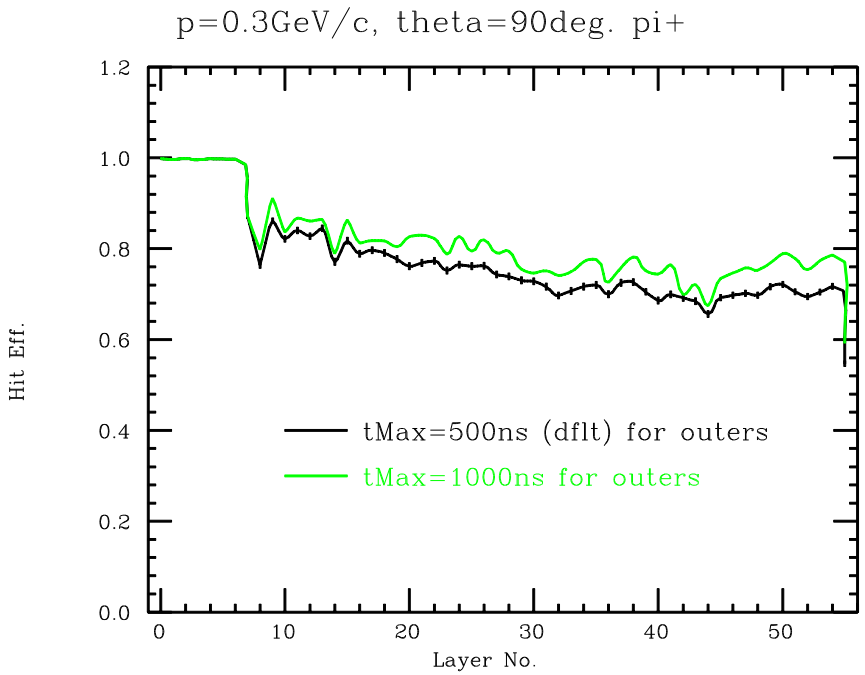


e.g. TDC counts for p=0.3 GeV/c pi+, theta=90 deg.

inner layers → ~100%
outer layers → <100%

…Hit Efficiency





Lower eff. due to inclined incidence

Other issues (not recent ones!)

- TOF (from IP to the sense wire) effect is implemented.
  - Turn on in the CDCDigitizer (off by default).
- Effect of the propagation delay in the sense wire is implemented.
- propagation speed = ~0.9 × c (measured) = 27.25 cm/nsec.
  - Turn on in the CDCDigitizer (off by default).
- "Negative TDC (hit timing)" occurs when the beam BGs hit the CDC before the signal.
  - "Negative TDC" is turned off by default.

Future plan

- New material definitions will be released by the end of this year.
  - If any problems, the release will be postponed.
- XT-relations will include α, θ dependence by the end of this year.
- More elaborate XT and σ with Garfield and Heed etc.
  - Validity check by using beam test results (B = 0).
- Electrostatic force effect : by 3 months later (next B2GM).
- Documentation
  - Doxgen : Descriptions of new methods etc….
  - Twiki : Prepare the documents how to use new features.
- Requests are welcome! please post the cdc-soft ml.