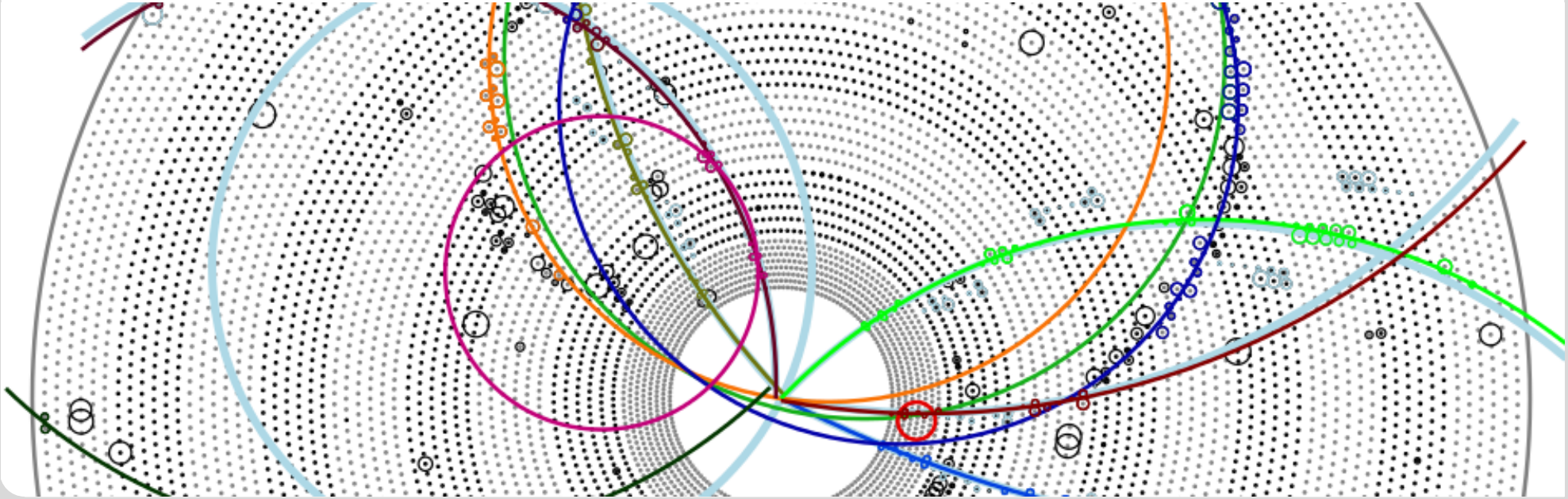
Karlsruher Institut für Technologie

T_0-Estimation using CDC Drift Circles and `EventT0` dataobject.

F2F Tracking Meeting Hamburg.

Nils Braun (based on work by Tobias Schlüter) | 23.11.2016

IEKP - KIT



Motivation

- In the normal mode, we will have a bunch-Crossing every 2 ns. The CDC is read out (triggered) approx. every 30 ns and fed into the Level1 trigger.
- The global event time T_0 (the time of the bunch crossing this event was created in) has to be determined to a precision of approx. 2 ns, the rest is known from the accelerator system.
- Different possibilities to determine T_0:
  - TOP (very good time resolution, but needs tracks in TOP. Not present in Cosmics test).
  - L1-Trigger (trigger jitter approx. 10 ns, 20 ns in worst case. Distribution?)
  - CDC (Measuring drift circles is anyway a time measurement)

How does it work (taken from Tobias Schlüter)

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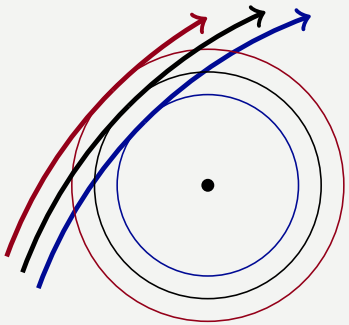
What Does a Drift Chamber Measure?



Measurement Procedure

- passing charged particle ionizes gas
- gas cloud collapses on wire
- difference
  T(passage of particle) – T(collapse)
  gives distance of passage

How do we know the passage time?

Usually:

- Starting time of the track is evaluated
- T(Passage) =Track Length / Velocity

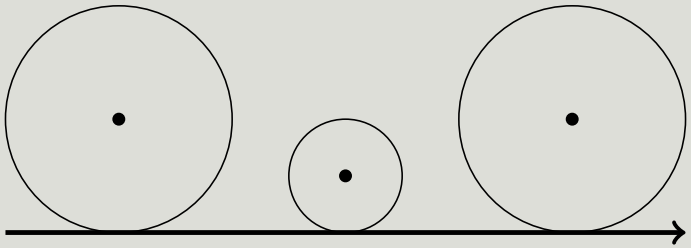
A drift chamber is a device that measures time, positions are inferred.

How does it work (taken from Tobias Schlüter)

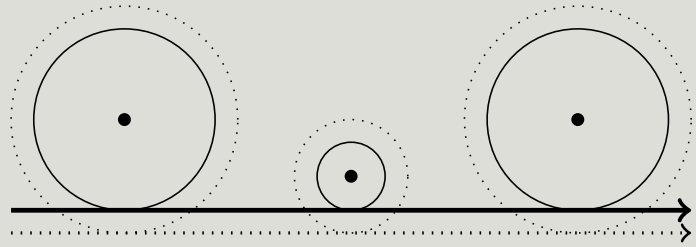
What Happens if the Time is Badly Known?

The simplest case, straight lines, all hits on one side.

Correct Timing

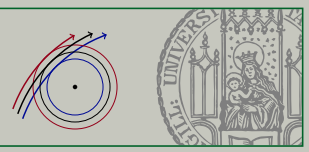


Passage Time Underestimated



- position measurement depends on the evaluated drift time
- In this simple case a bias in time leads to bias in position.

How does it work (taken from Tobias Schlüter)



Tracking problem:

$$\chi^2 = \sum_{\text{hits i}} (m_i - H_i s)^T R_i^{-1} (m_i - H_i s) = \min$$

Minimize the distance between the measurements m_i and the projections H_i of the track parameters s, i.e. the residuals r, weighted by the residual covariances

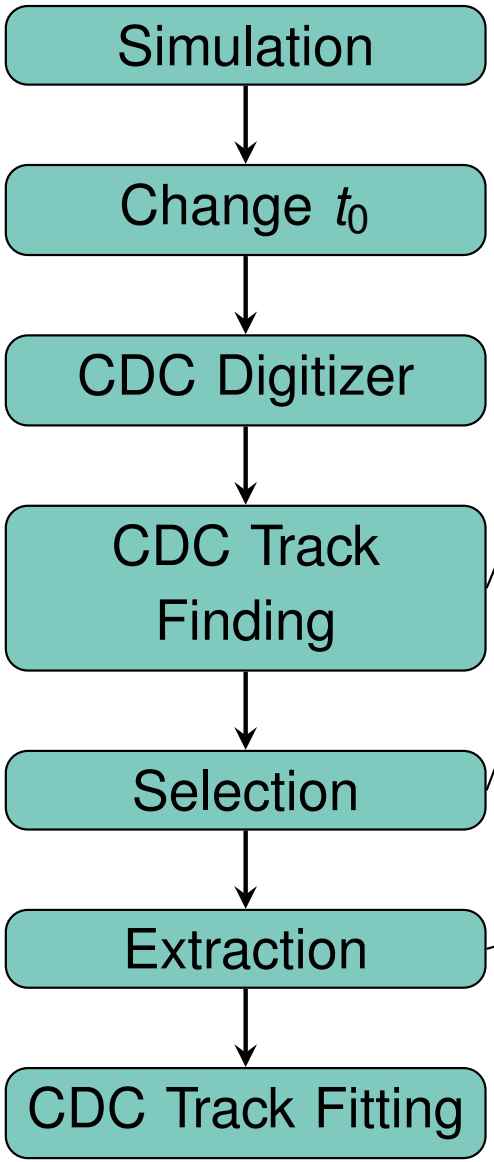
$$R_i = V_i - H_i C H_i^T$$

(V_i measurement covariance, C covariance of track params)
Alignment problem:

$$\chi^2 = \sum_{\text{tracks } k} \sum_{\text{hits } i} (m_{ik}(a) - H_{ik} s_k)^T R_{ik}^{-1} (m_{ik}(a) - H_{ik} s_k) = \min$$

Find the track parameters s_k and the set of alignement parameters a that simultaneously minimize this χ^2.

TrackTimeExtractionModule



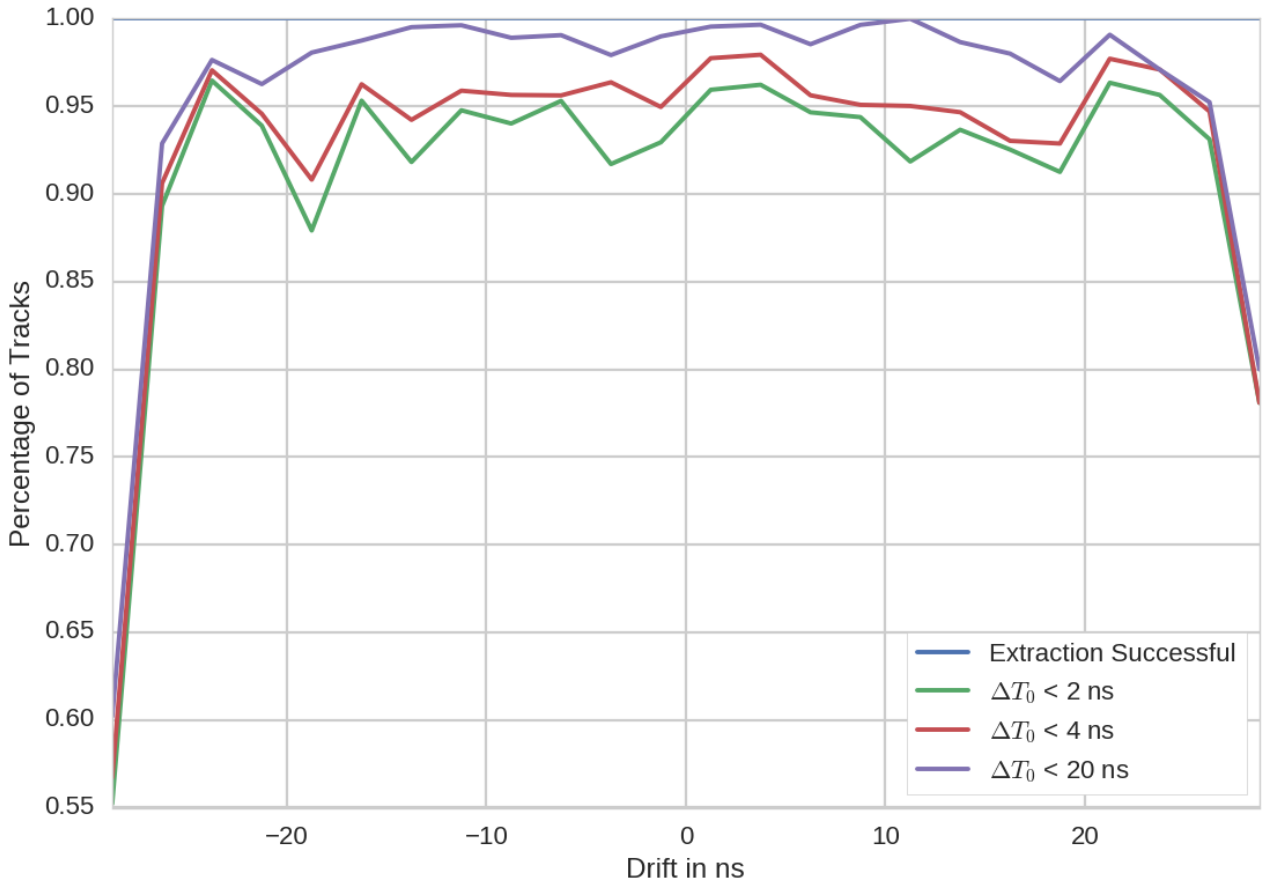
Normal CDC reconstruction with default settings.

Fitable track with highest p_T.

Iterative Grid-Search approach

- Start from 4 t_0 seeds.
- Extract time twice iteratively (if fitable)
- If one (or more) is converged: use this.
- Else: use best result so far, extract again twice. Repeat.

With advanced technique: Full hadronic event with normal CDC reconstruction



Attention: Hard cut at 30 ns.

`EventT0` dataobject

Doing the extraction, a general `EventT0` dataobject was needed:

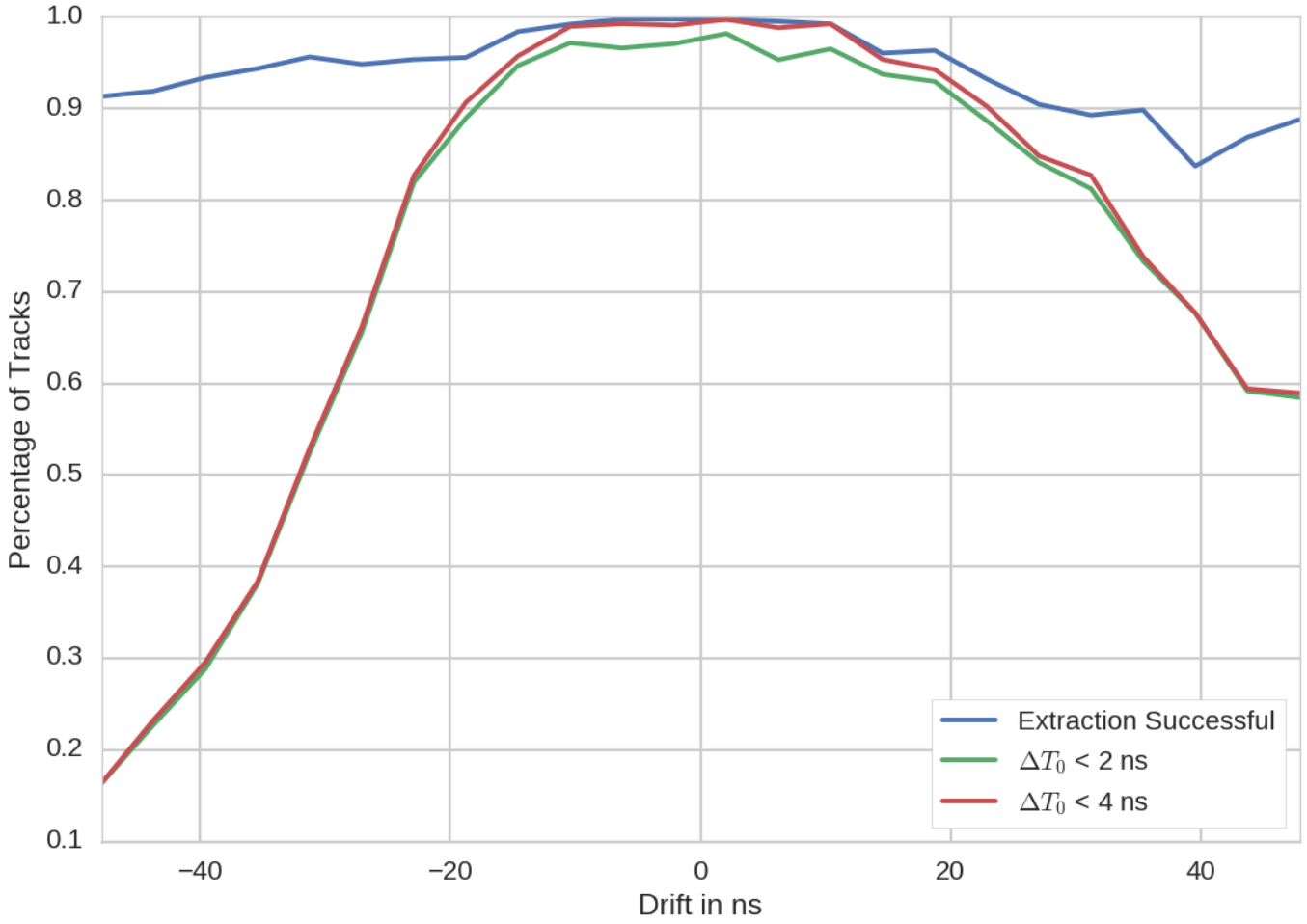
- `StoreObjPtr` with single instance, storing all extracted times together with their uncertainty and the detector they came from.
- Functions to calculate the weigted average and the uncertainty.
- *More than one extraction per detector possible?*
- *How to calculate the uncertainty?*

Summary

- First implementation of Track Time Extraction using CDC hits works already quite well.
- Code is in release 8.
- `EventT0` will be (also) used by TOP.
- First test: CDC Cosmics test end of the year.
- *Is runtime performance an issue here?*

Backup

Using only one iteration (MC)



No grid search or “advanced” convergence criterias used.