Pattern Recognition EVO

EVO, 22.1.2013

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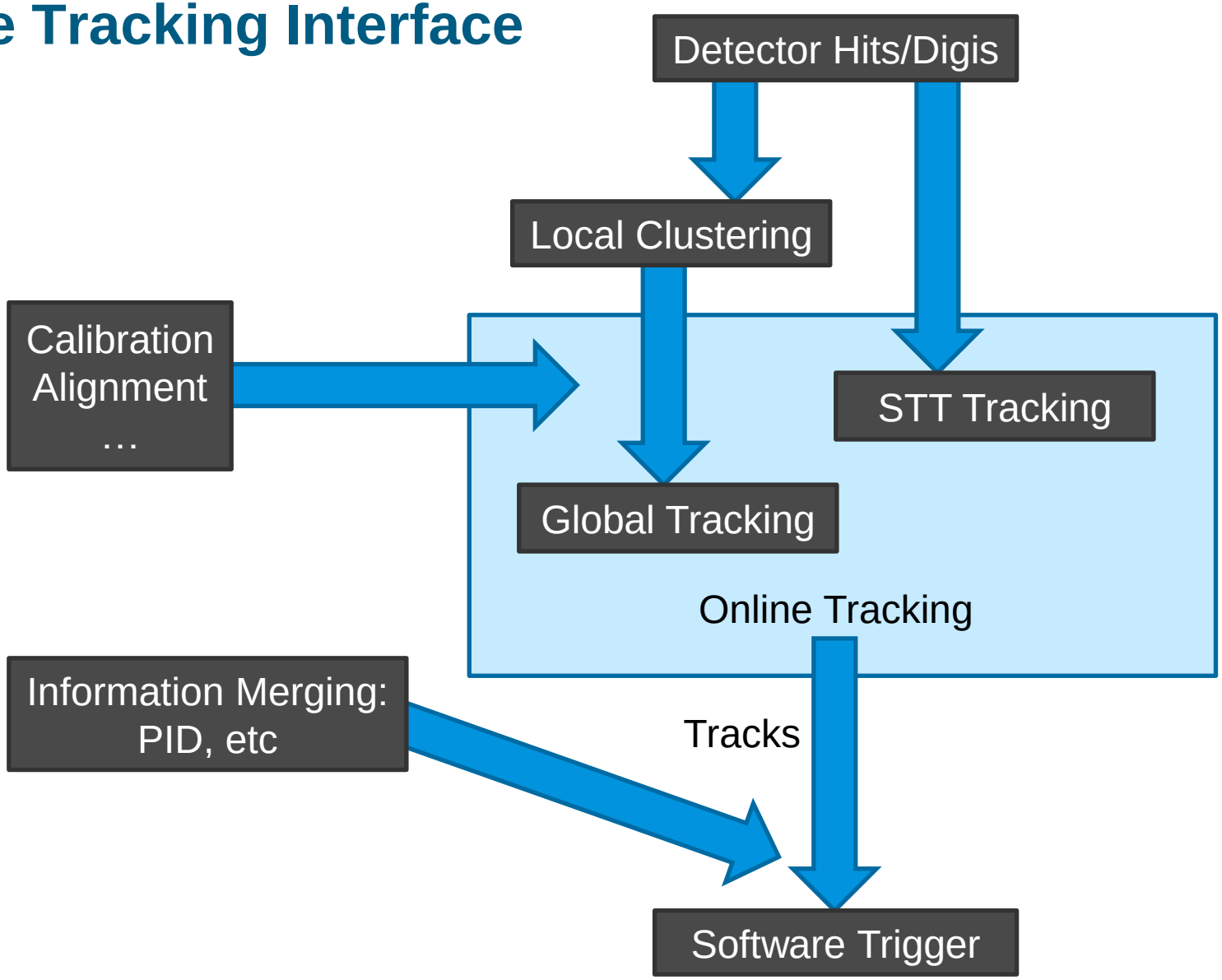
Online Tracking Framework

Continuous Online Tracking: Motivation/Concept

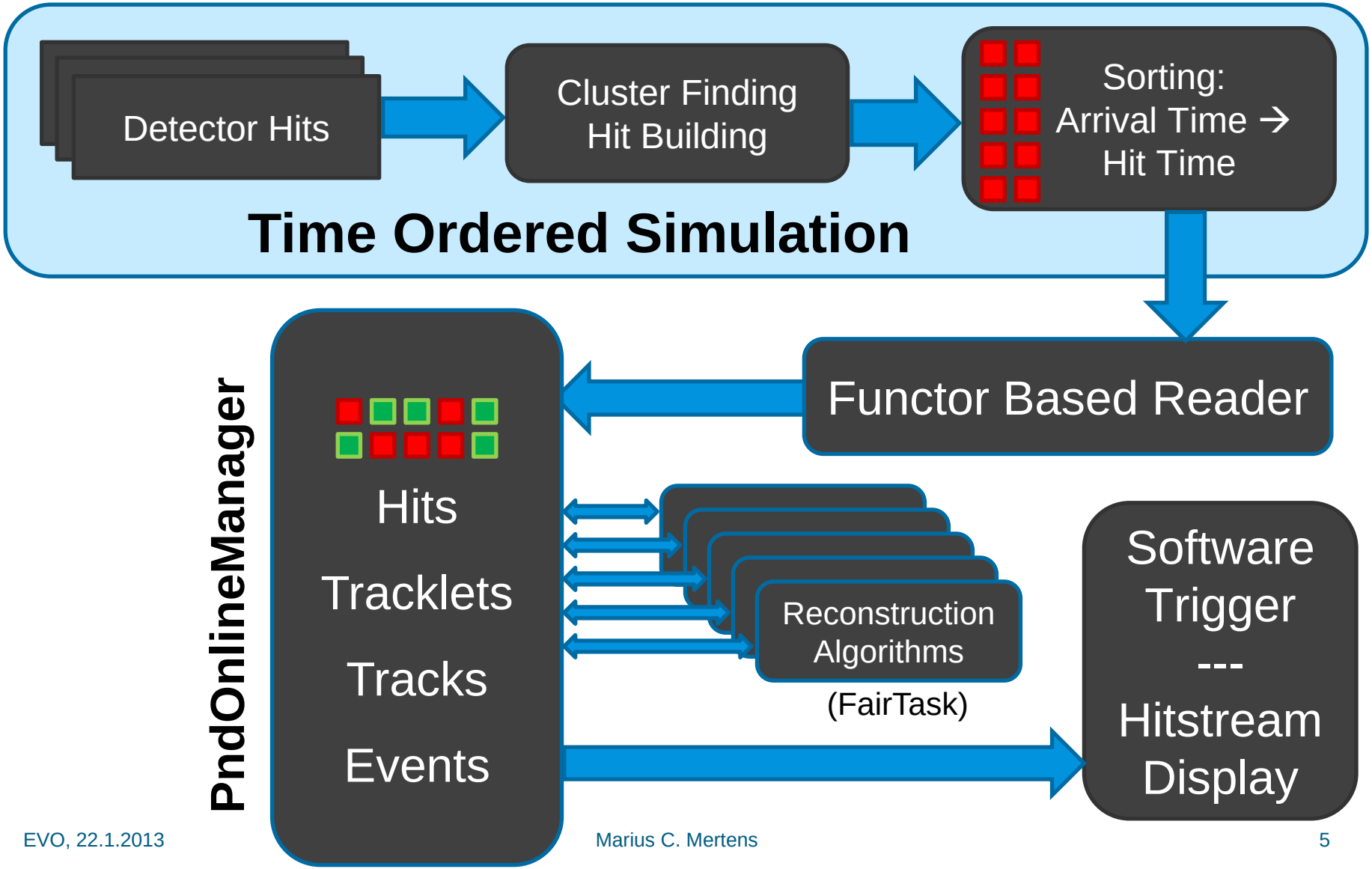
- Similar topology of signal and background
  → No simple criteria with high suppression potential
- Quasi-continuous high-rate operation of PANDA
  → Overlapping events, stateless pattern recognition started upon simple criteria may process redundant time windows
- Most channel selections require tracking information

- Data parellilism
- Dedicated algorithms optimized for different topologies
- Defined start conditions after barrier bucket gap

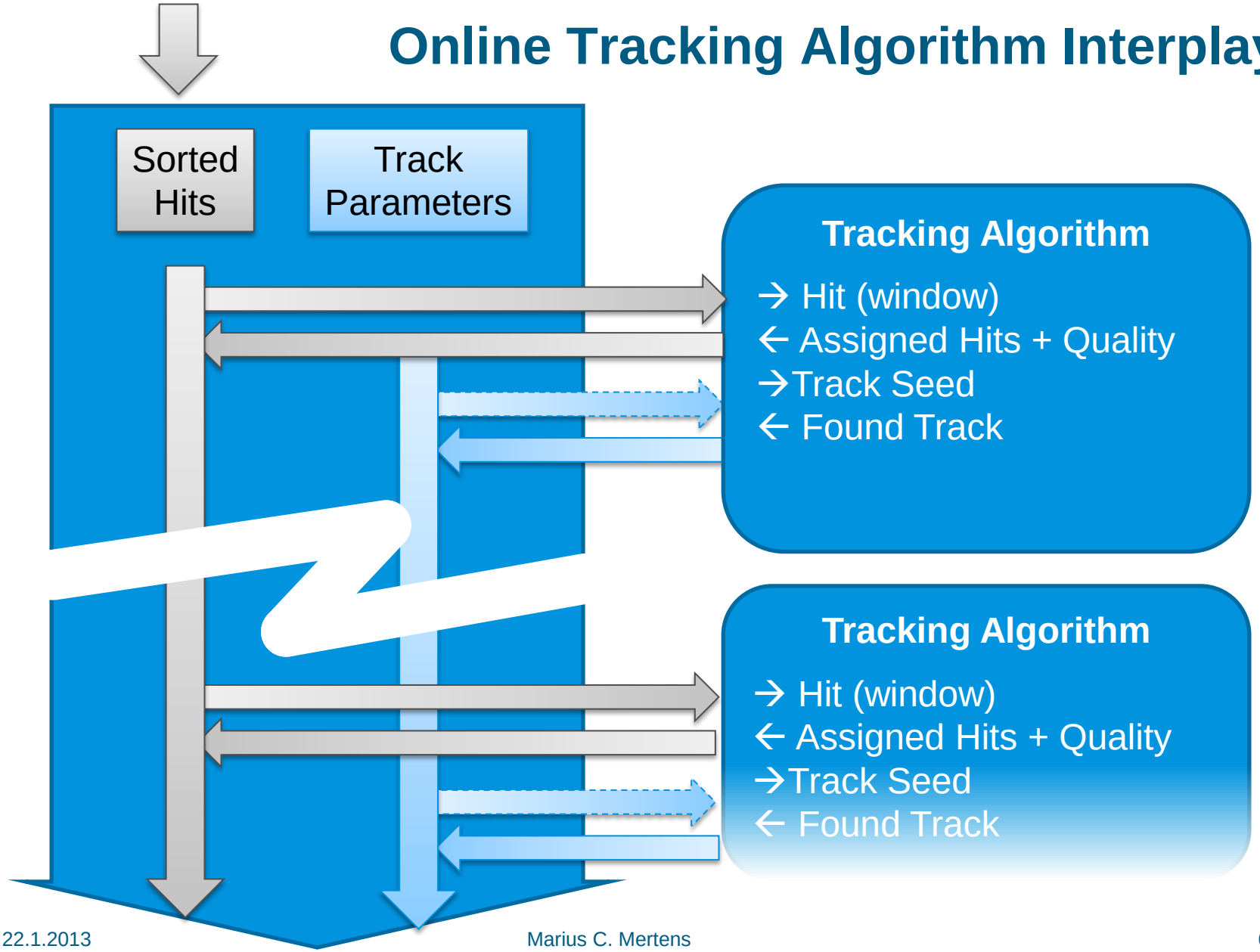
Online Tracking Interface



Continuous Online Tracking in OnlineManager



Online Tracking Algorithm Interplay



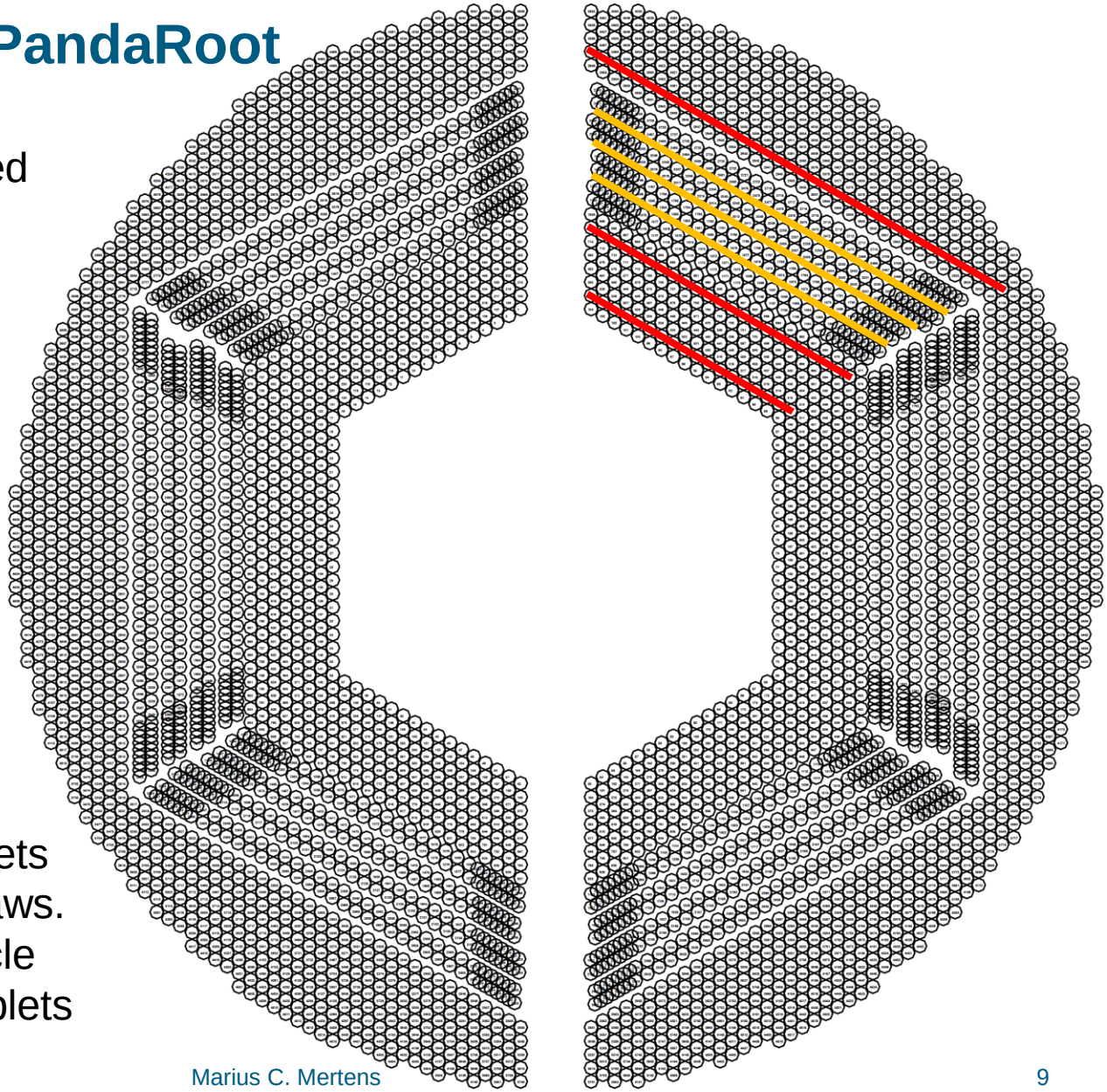
Triplet Finder

Triplet Finding in Axial Straws

- Basic properties:
  - *Finds tracks originating from the interaction point*
  - *Works in xy projection*
  - *No isochrone information used → Does not require t_0 or isochrone-drifttime calibration*
- Results:
  - *Track candidates*
  - *Associated hits*
  - *t_0 seed for selected tracks (hit timestamp constraints, matching with other detectors)*
- Carried out in three steps:
  - *Identification of hit triplets (or n-lets) around pivot cells*
  - *3 point circle calculation: Origin + 2 Triplets*
  - *Hit association via circle proximity*

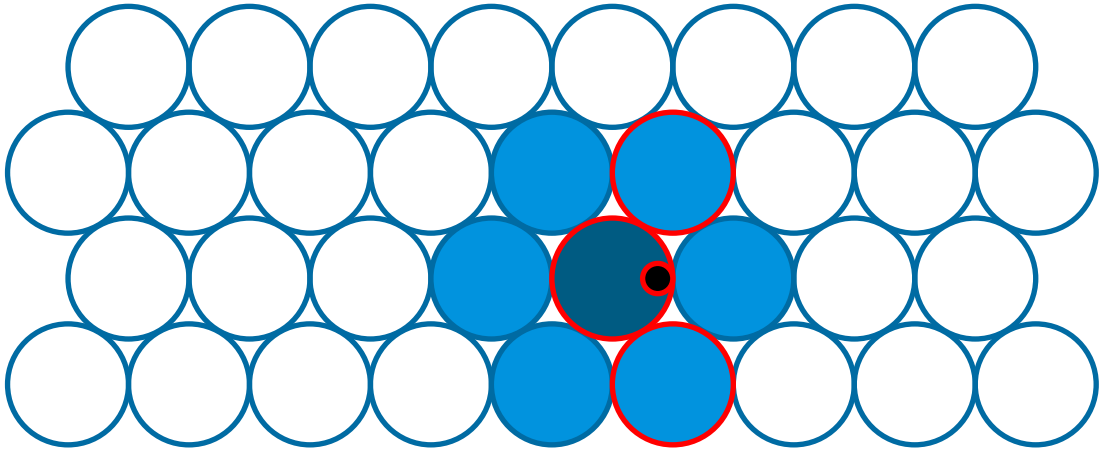
STT Geometry in PandaRoot

Axial pivot cells indicated in one sector (**red**)
Skewlet layer indicated in one sector (**orange**)



Tracking algorithm in OnlineManager:
Peter‘s Triplet Finder
→ Identification of hit triplets around selected pivot straws.
Analytic calculation of circle through origin and two triplets

Triplet Finding in Axial Straws



- Pivot cell is checked for hit
- Surrounding straws are checked for hits
- Center of mass of fired straws is calculated
  (small number of combinations → suitable for lookup table)

Triplet Finding in Axial Straws

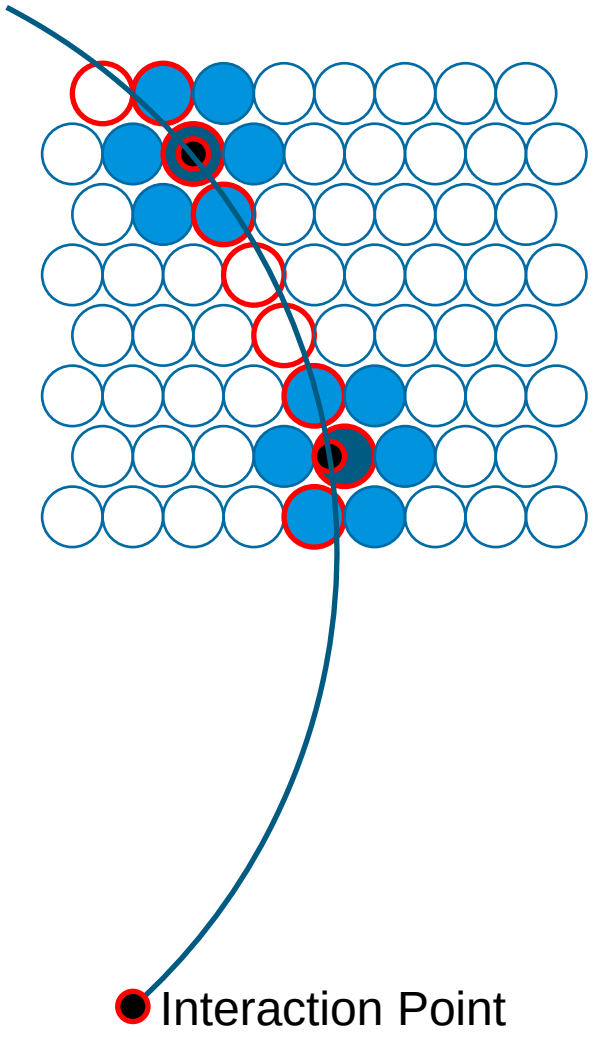
- Once two triplets are found, calculate circle through origin
- Associate nearby hits with track candidate

Track Verification:

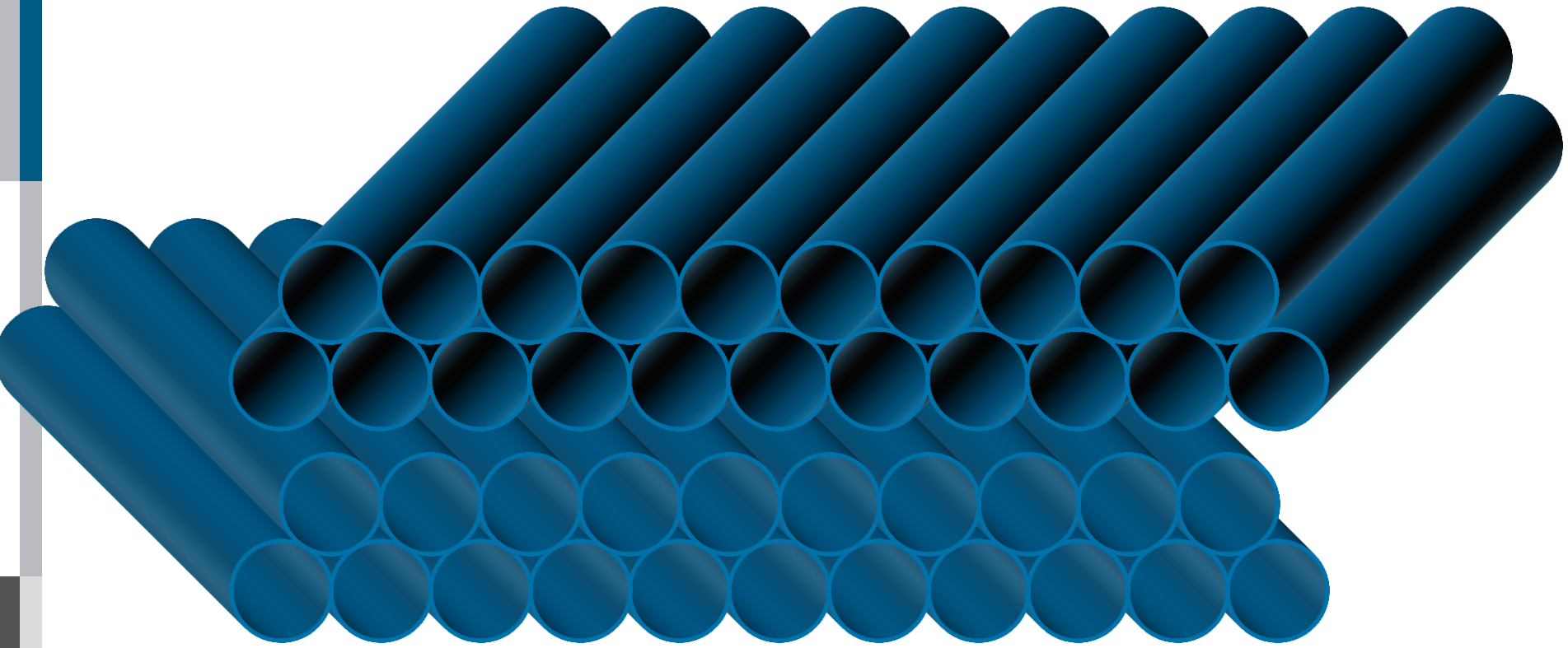
- Currently mix of curvature and associated hits
- Lots of room for improvement

Further possibilites:

- Distance sorting, Concurrent associations, Clutter veto, …
- Missing straw compensation: Pivot Straw triggered by neighbor straws
- Weight hits according to timestamp
- Improved Triplet merging



Triplet Finding in Skewed Straws: Skewlets



- Triplet search in individual skewed double layers
- Combination of adjacent double layers‘ Triplets to Skewlets
- Track matching in xy-projection
- Extraction of z-information

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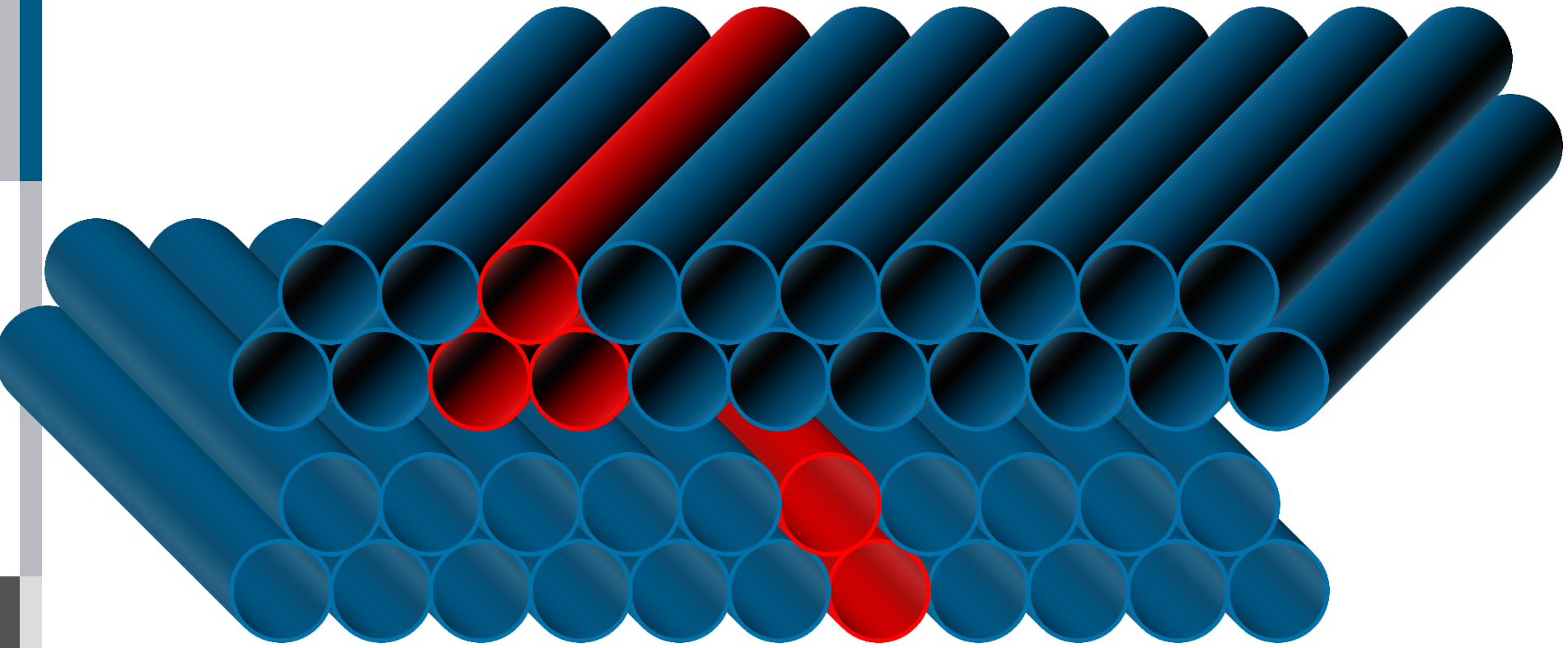

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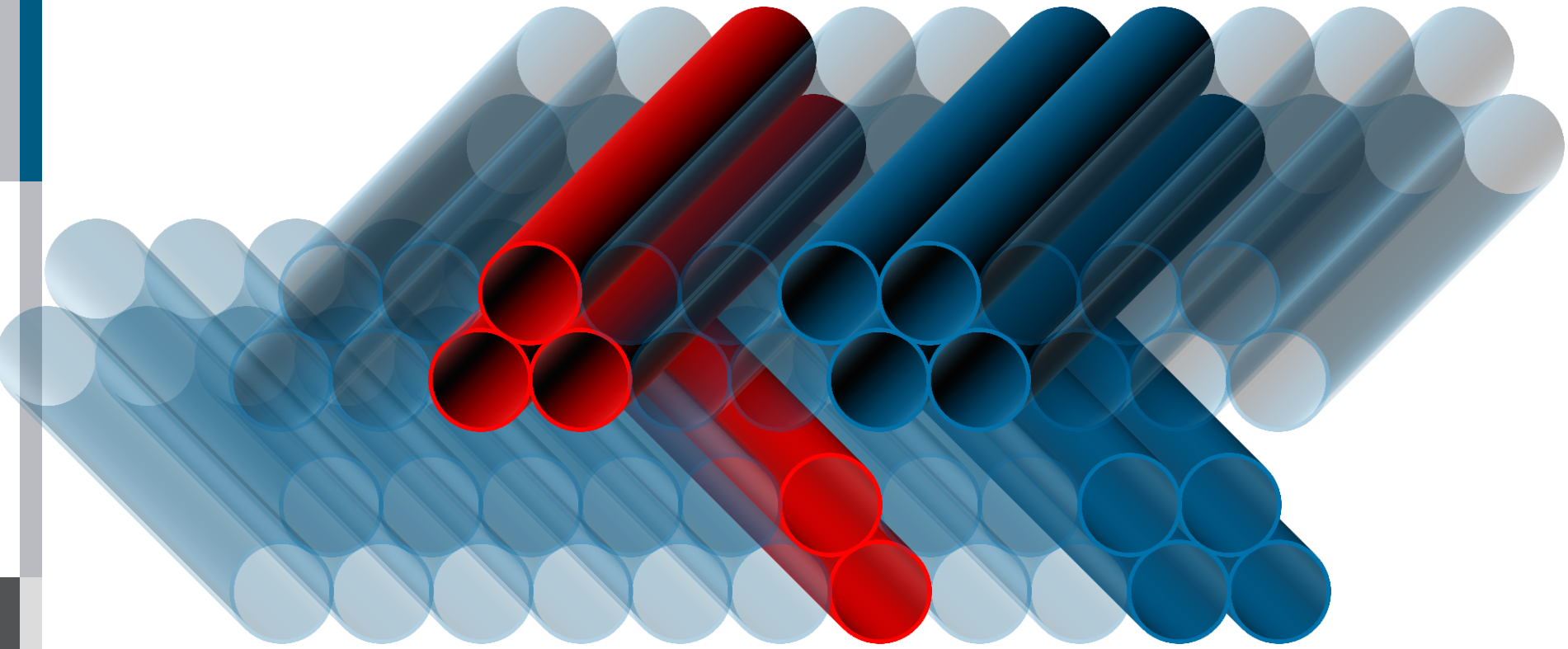

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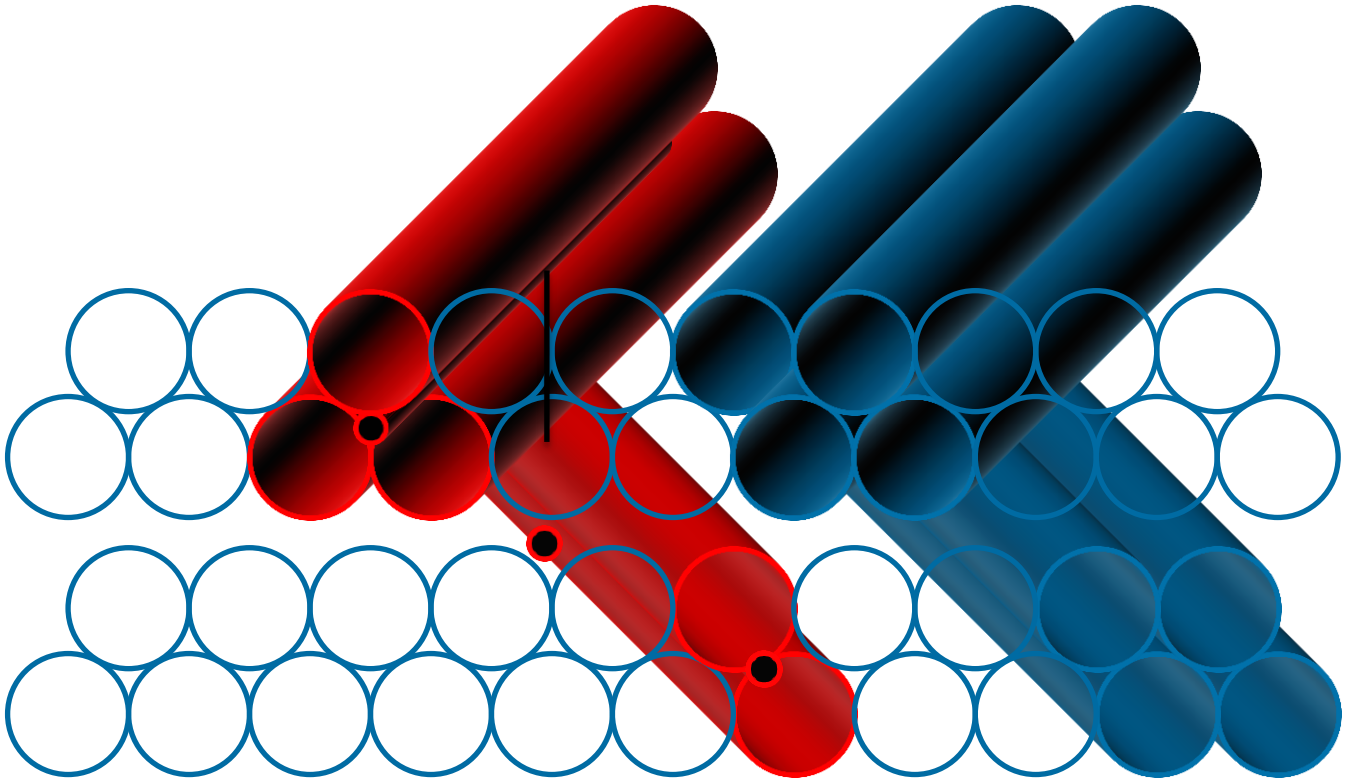

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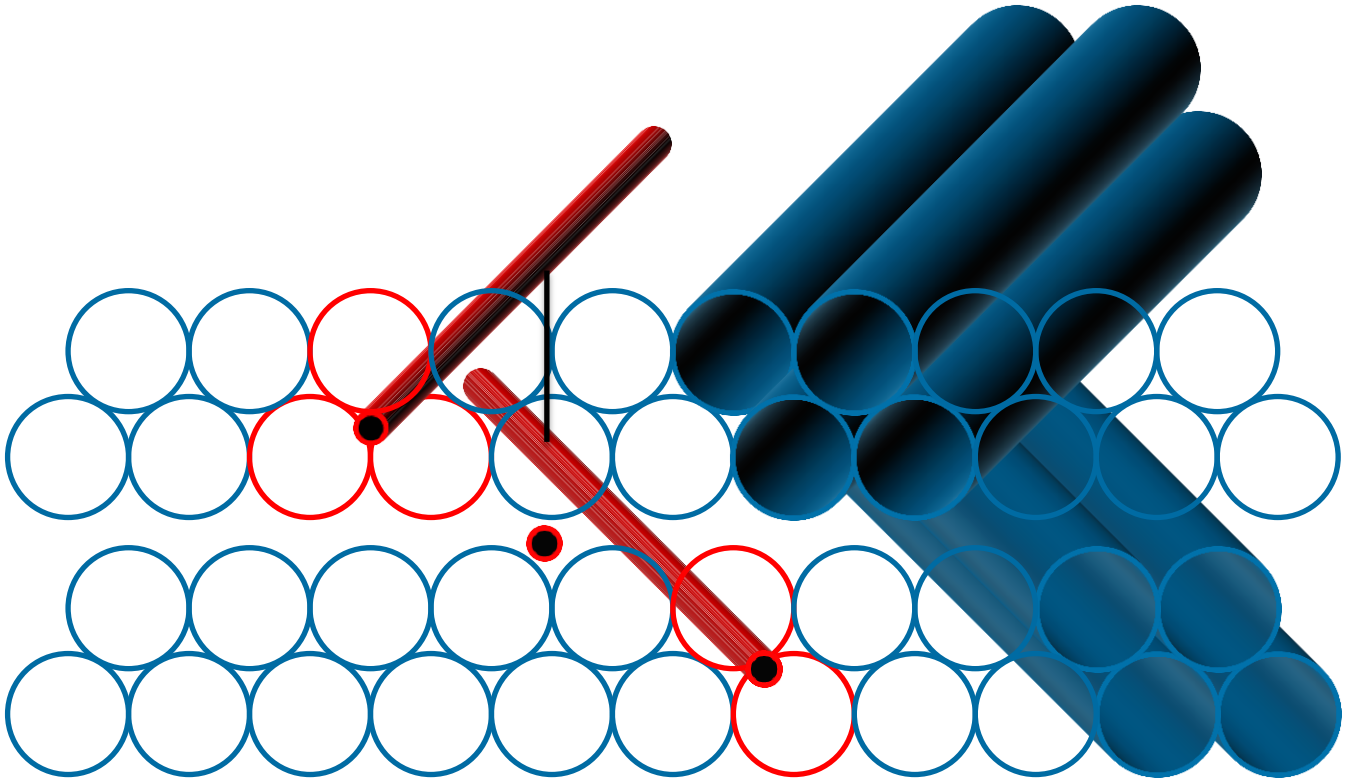

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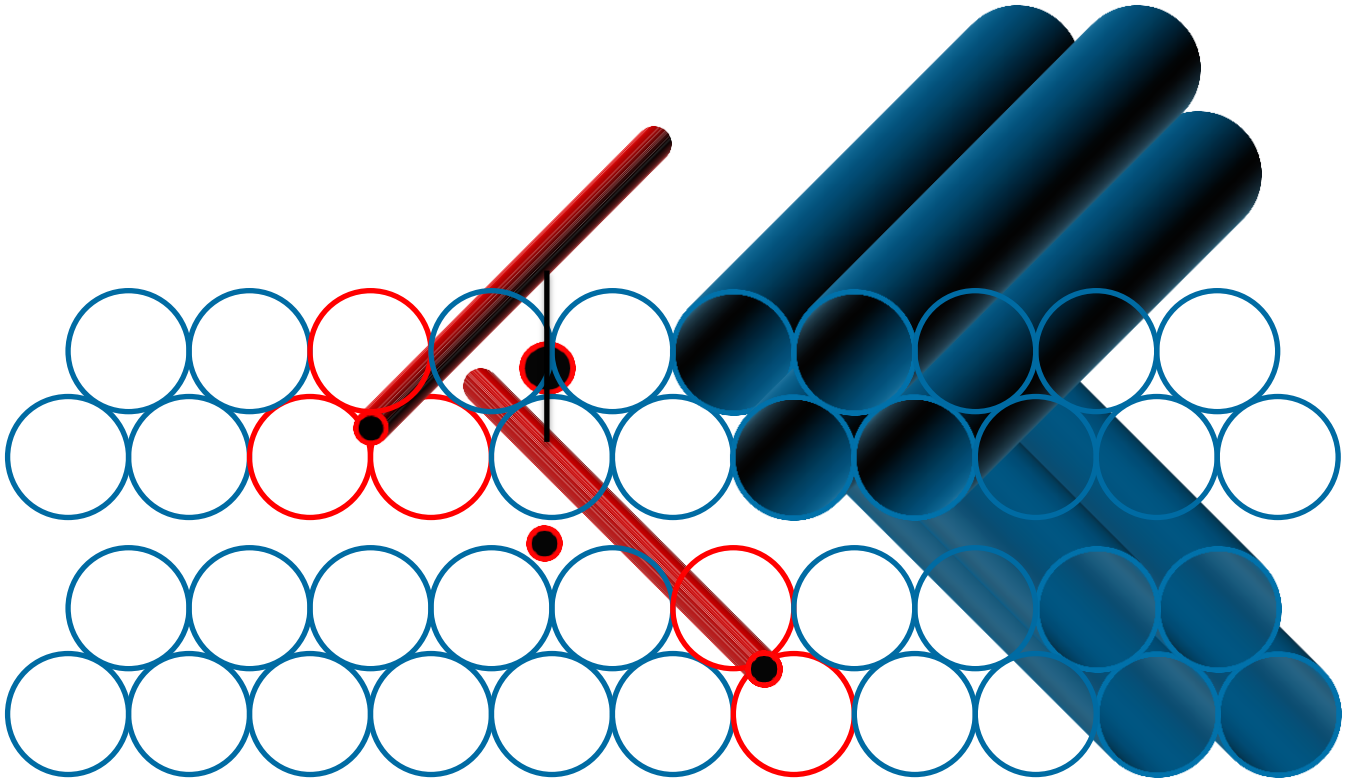

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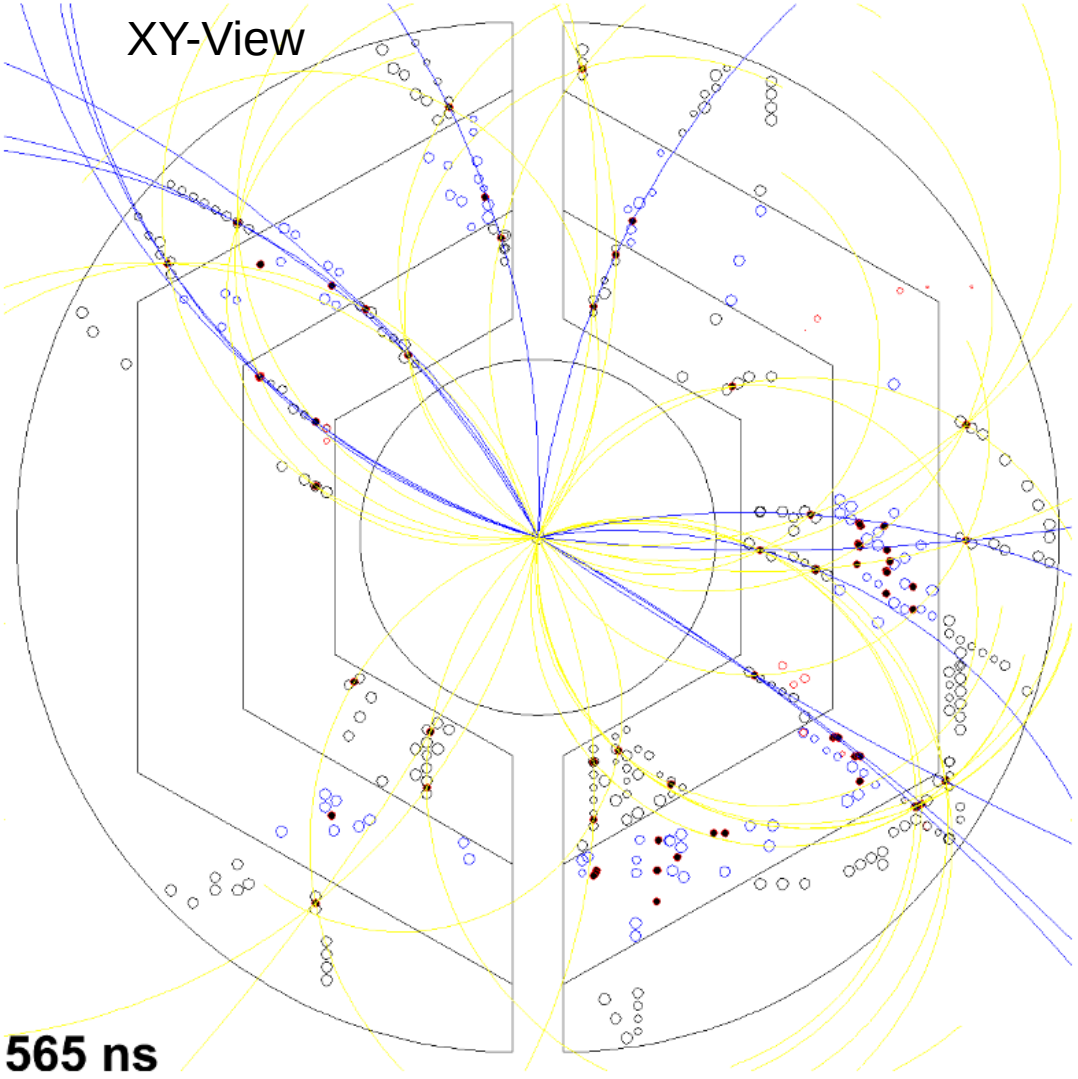
Hitstream Display: 15 GeV/c DPM, 50 ns mean time



Black circles: Early isochrone
Blue circles: Early skewed isochrone
Green circles: Close isochrone
Red circles: Late isochrone
Black dots: MVD hits
Green dots: MVD hits r/z > 0.3
Black+Red dots: Triplets/Skewlets
Yellow tracks: Vetoed
Blue tracks: Accepted

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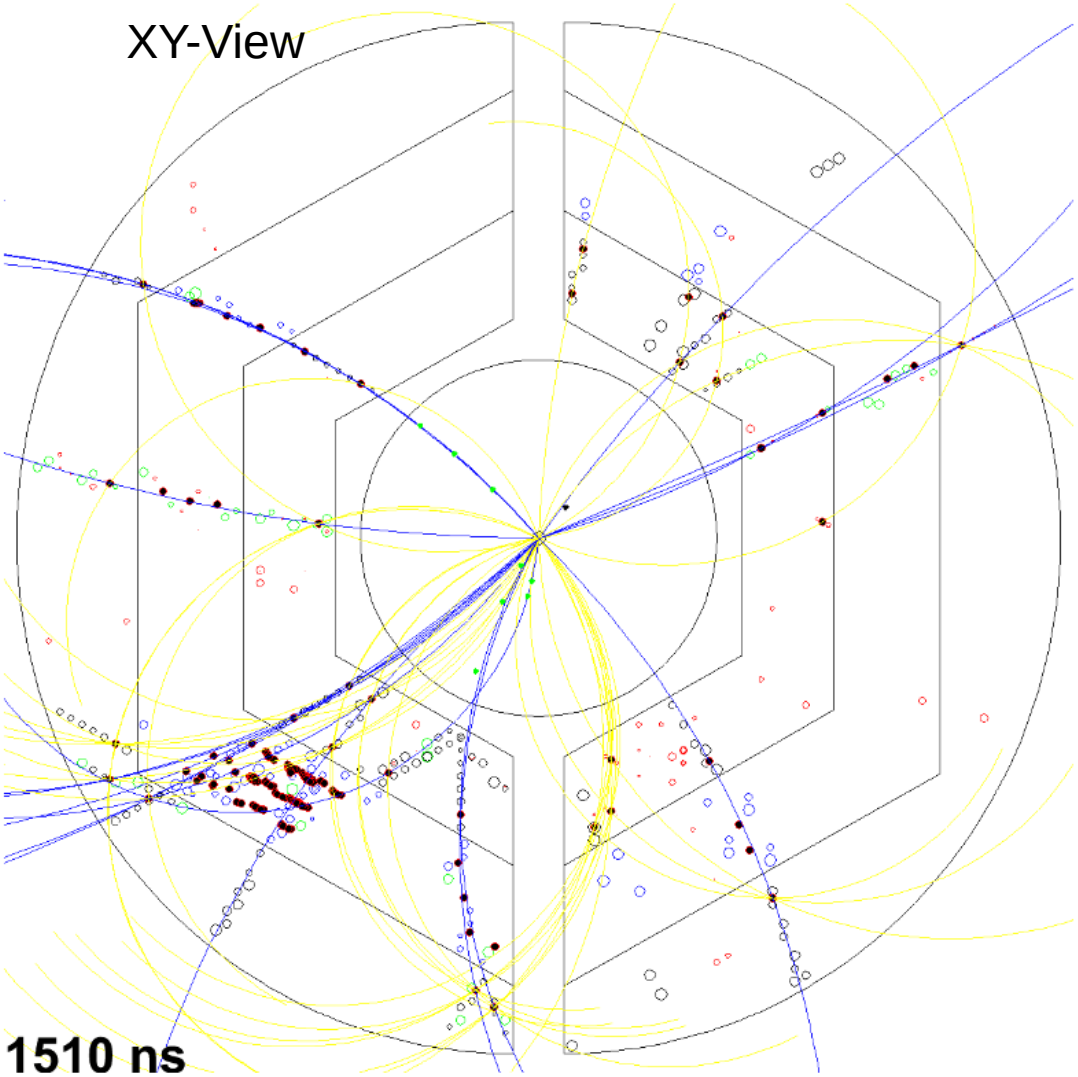

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More (Online) Tracking Algorithms

Algorithm	Comments
Hough Transform, Yutie Liang	FPGA implementation
Hough Transform, Mohammad Al-Turany/Andreas Herten	GPU implementation
Non-Origin Trackfinder, Lia Lavezzi	Focused on offline, online application(?)
Triplet Finder, MCM	No isochrone info required
Track Segment Finder + Linker, Sean Dobbs	Template based
Fast Combinatorial Finder / Fitter, Sean Dobbs	Based on CLEO‘s SOLO
Forward Hough, Martin Galuska	Focused on offline, applicable for online
Riemann Tracker, Tobias Stockmanns	Focused on offline, online application(?)
Global Tracking in PandaRoot, Gianluigi Boca	Focused on offline
Online pattern recognition, Pablo Genova	Uses neural networks

Other developments?