Bundesministerium
für Bildung
und Forschung

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

MIKADO APPROACH FOR THE TRACKML TRACKING CHALLENGE

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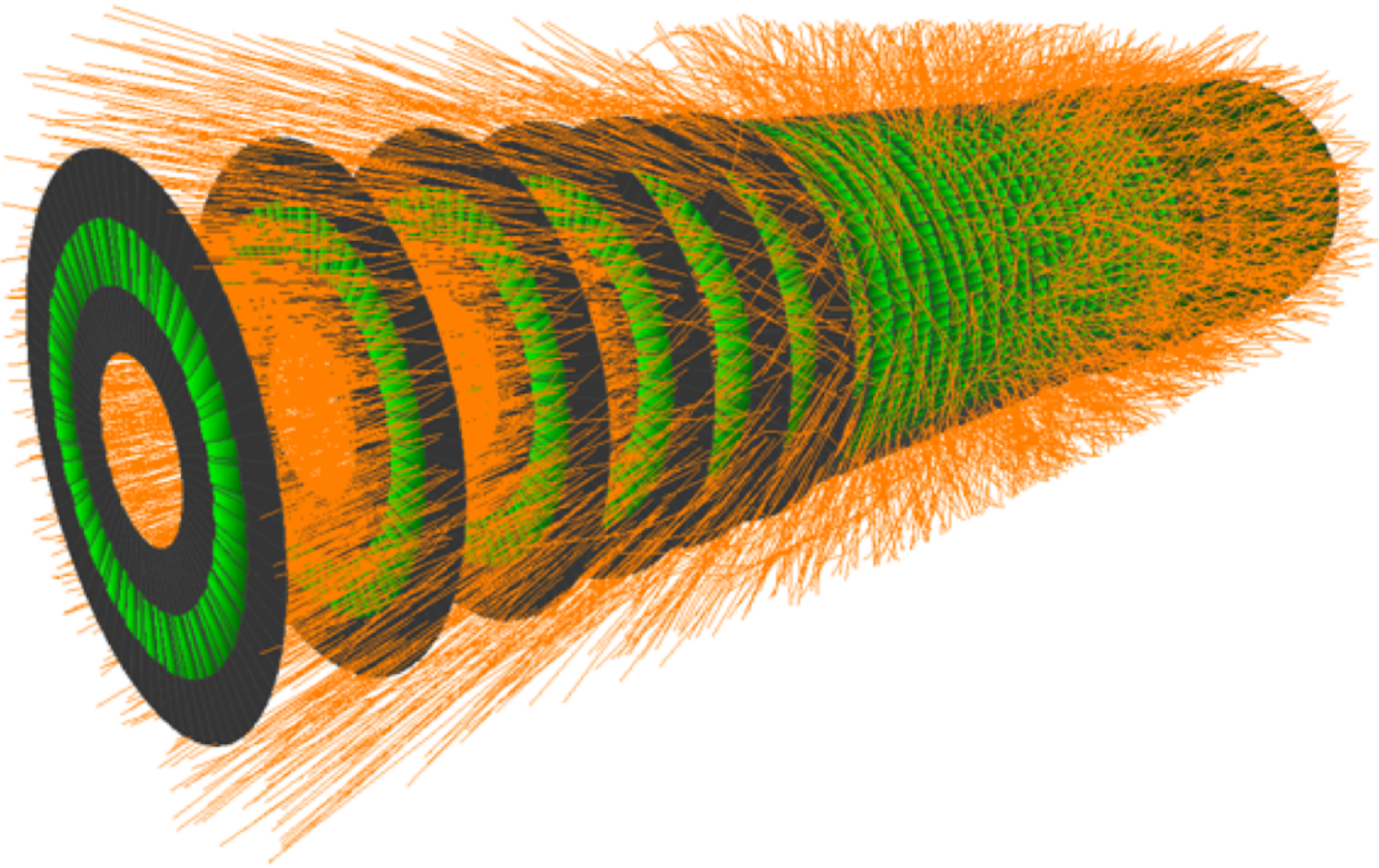
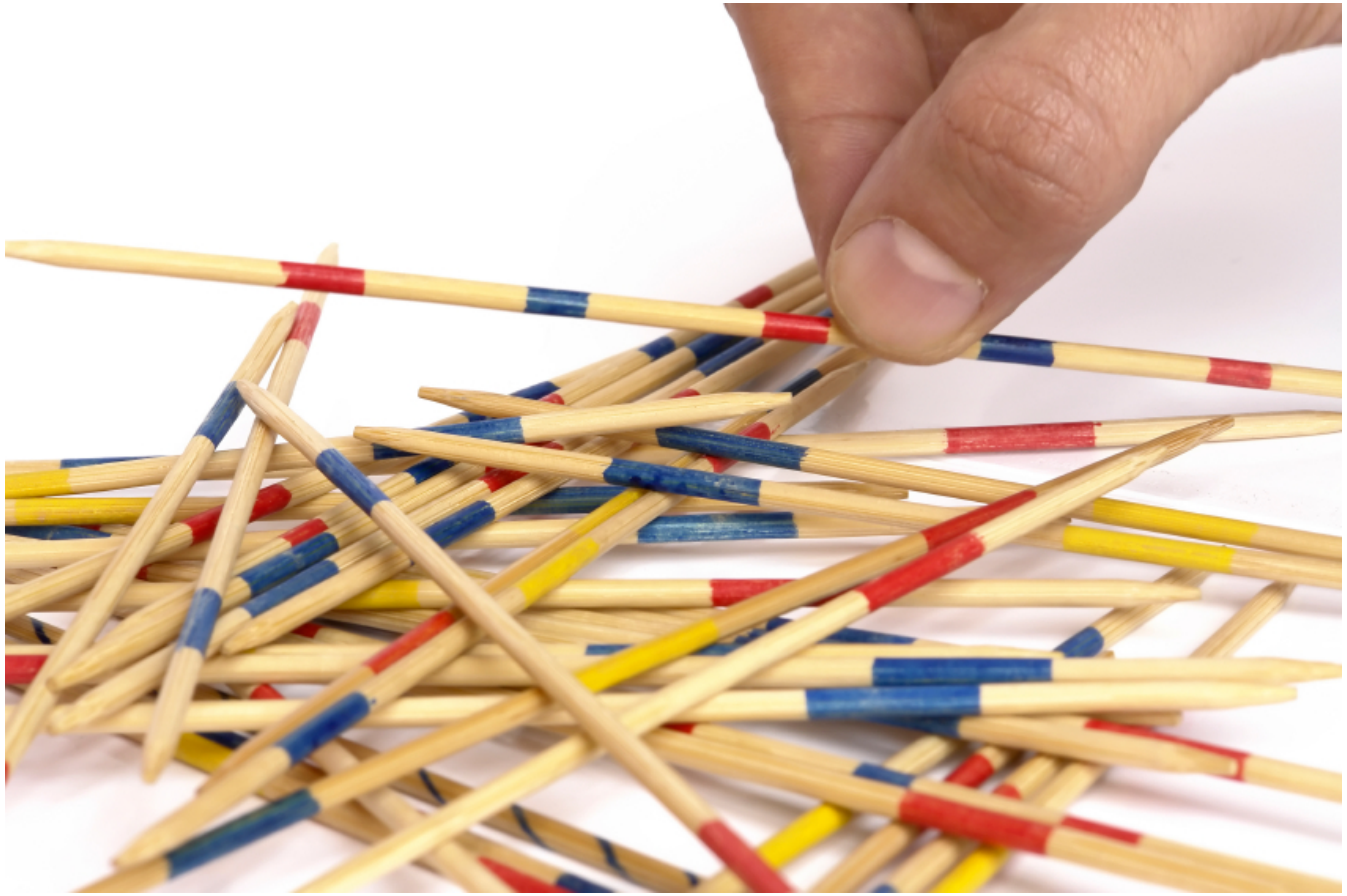
- **3-RD PLACE ACCURACY PHASE**
- **1-ST PLACE THROUGHPUT PHASE**



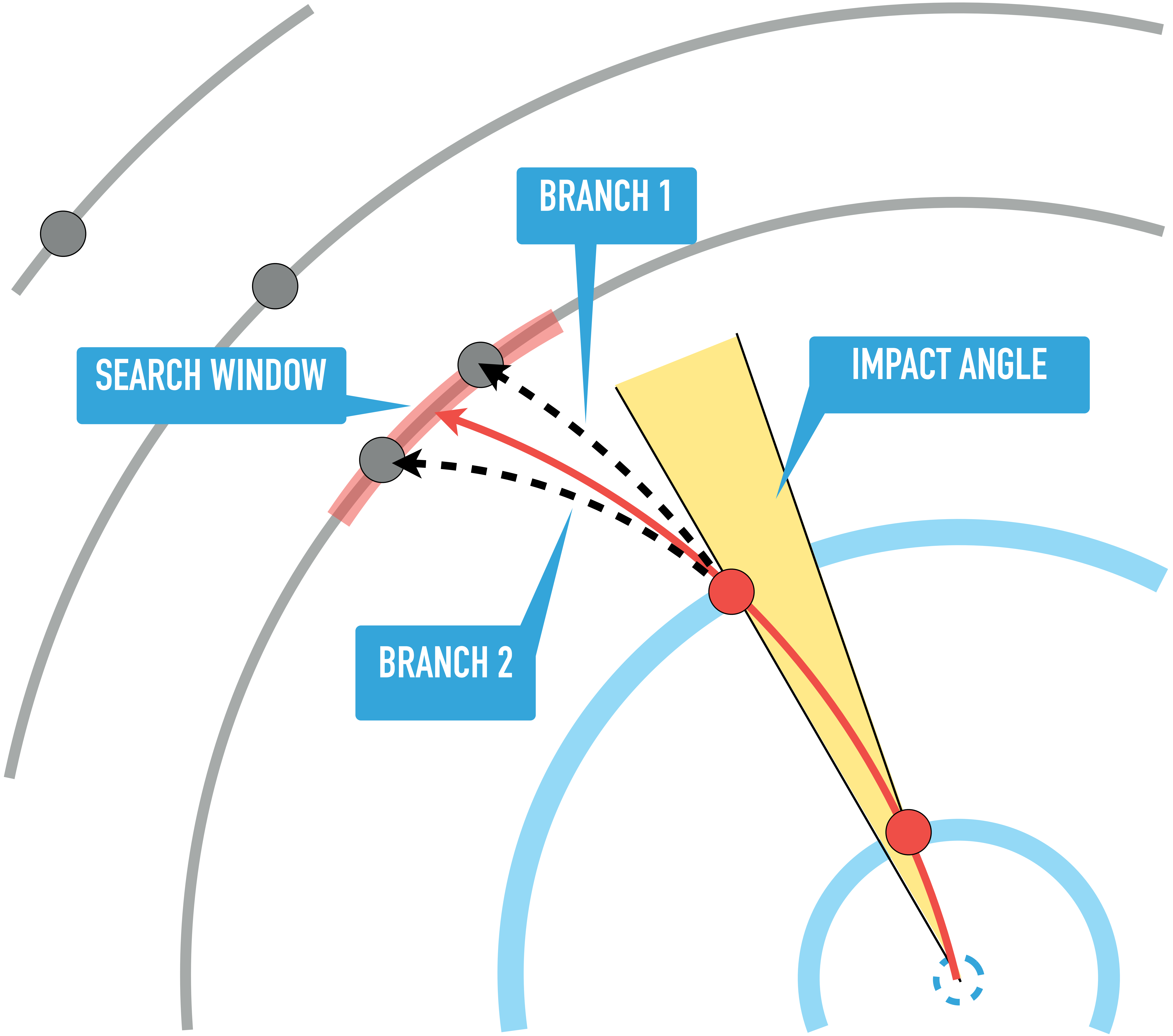
PARTICLE TRACKING CHALLENGE

- complicated detector geometry
- non-uniform magnetic field
- multiple scattering
- high dense events
- strict requirements for efficiency:
  100%== find all the hits on all the tracks



MIKADO APPROACH

- reconstruct data in small portions, not destroying the rest
- 60 reconstruction passes
- each pass process little combinatorics, therefore is extremely fast



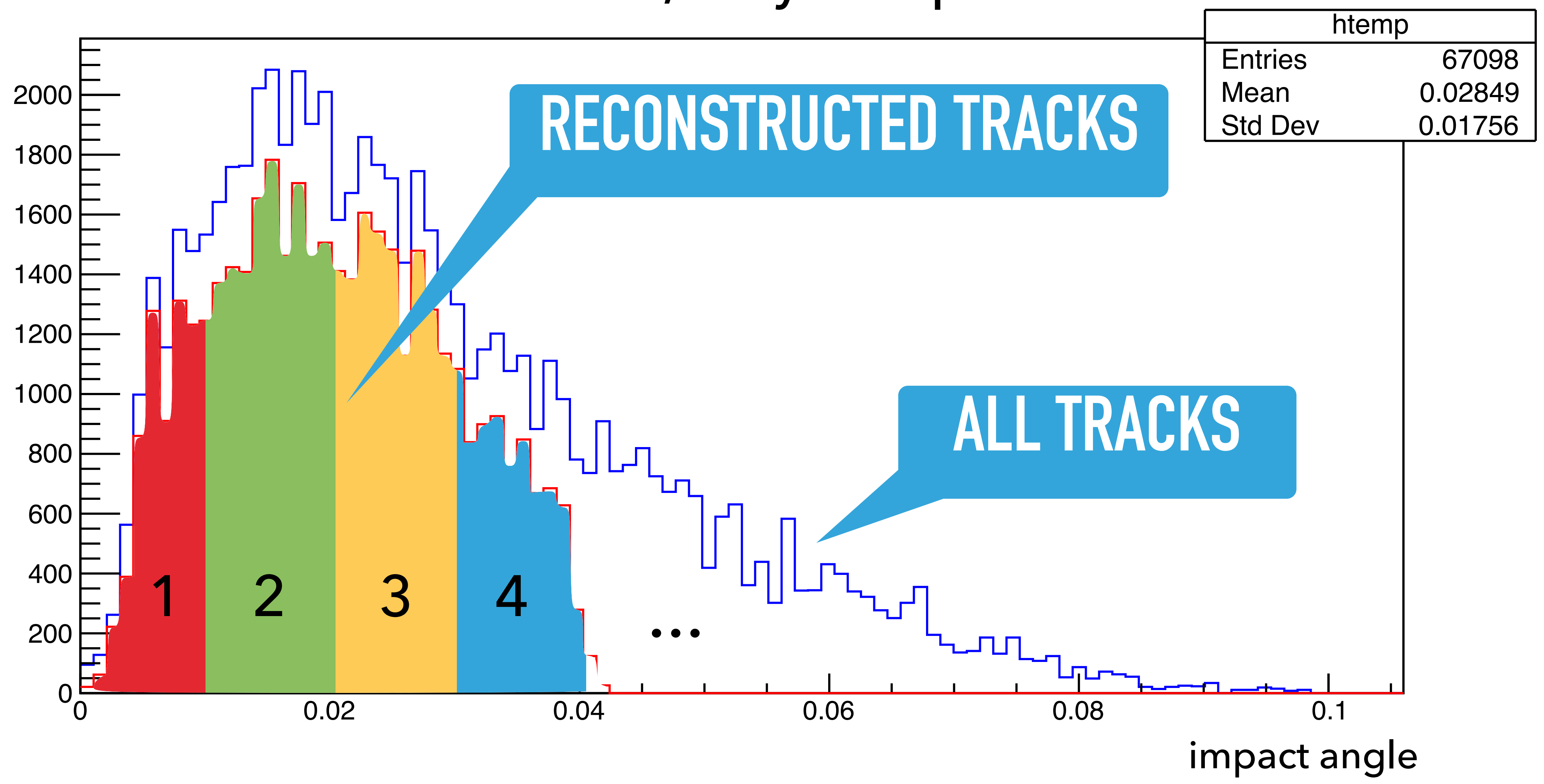
CONSTRUCTION LAYERS

- 2 fixed obligatory layers (optionally: 3 layers)
- fixed angular cuts for the second hit
- try many 2-hit combinations to create a track

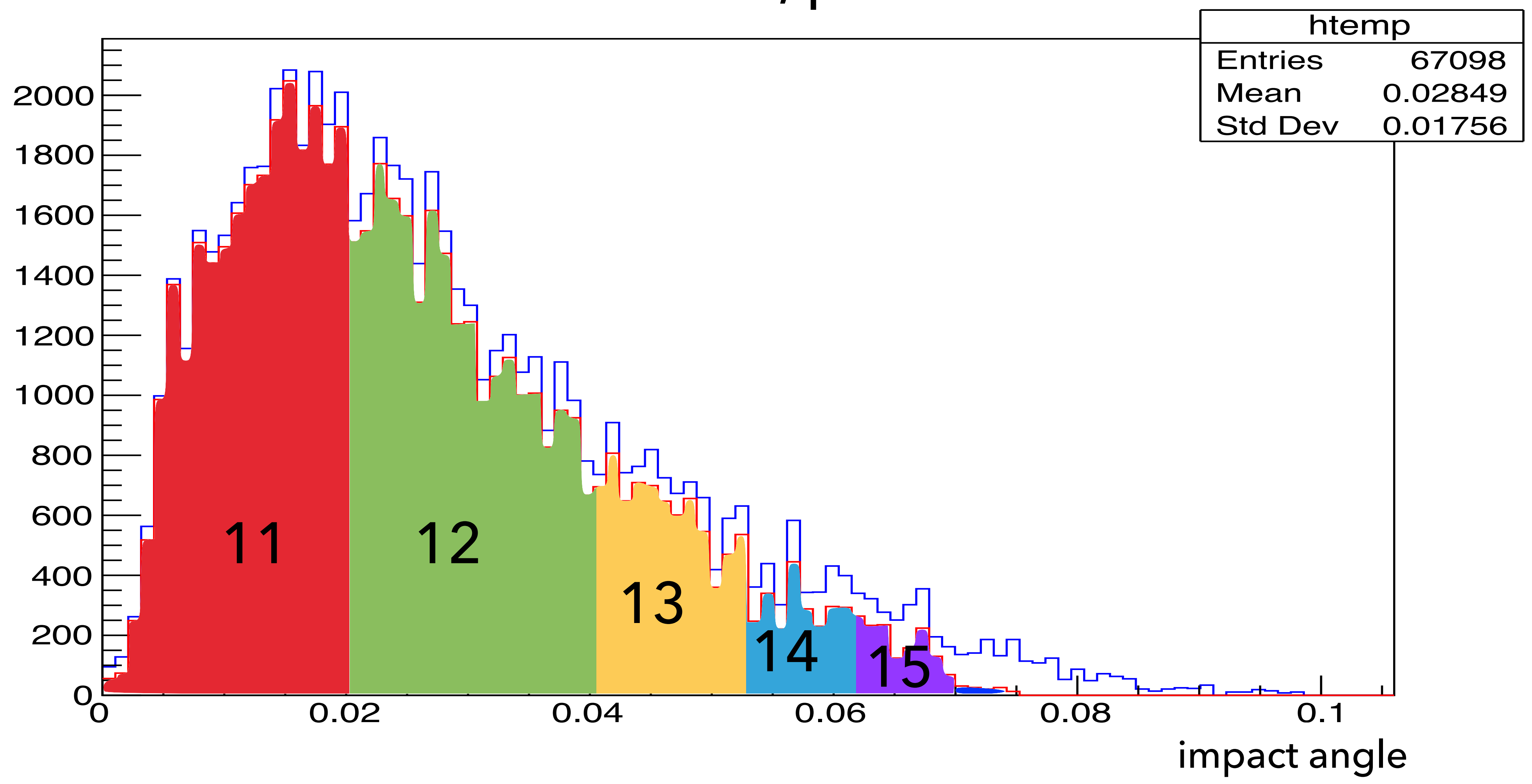
PROLONGATION LAYERS

- search in layers along the track
- fixed search windows
- make combinatorial branch at every hit (optionally: only one branch with the best hit)

Reconstructed tracks, very first passes



Reconstructed tracks, passes 11-15



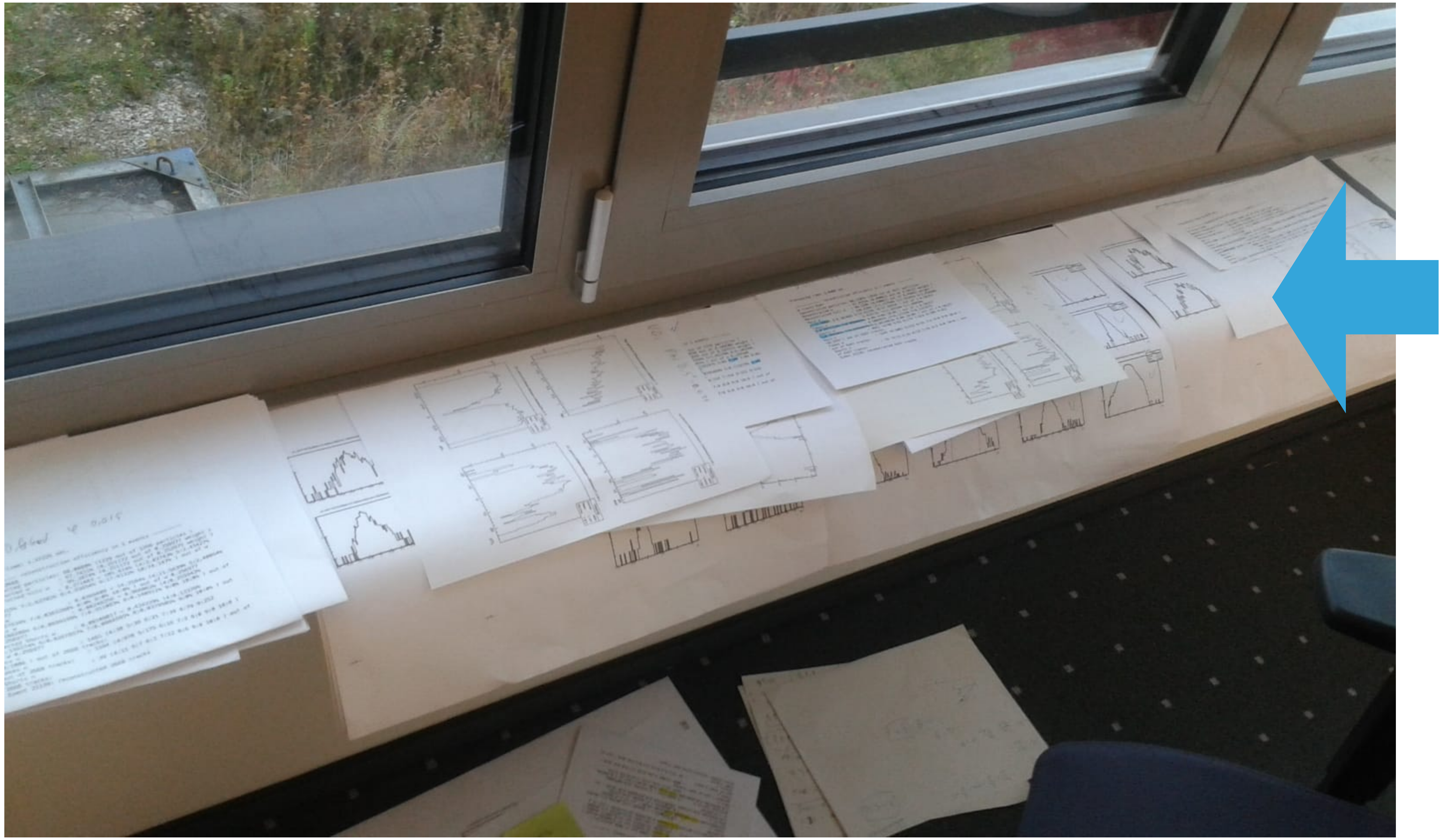
CALIBRATION OF CUTS (LEARNING)

- calibrate passes one by one, optimising partial result
- construction layers and impact angle are fixed, search windows are calibrated
- optimise for purity, not for efficiency
- calibrate parameters one after another
- optimisation criteria tuned manually, the optimisation is done automatically
- 60x300 parameters in total

optimisation criteria:

A*w_reconstructed - B*w_lost - C*w_wrong_assigned -> max

GOOD — BAD — VERY BAD

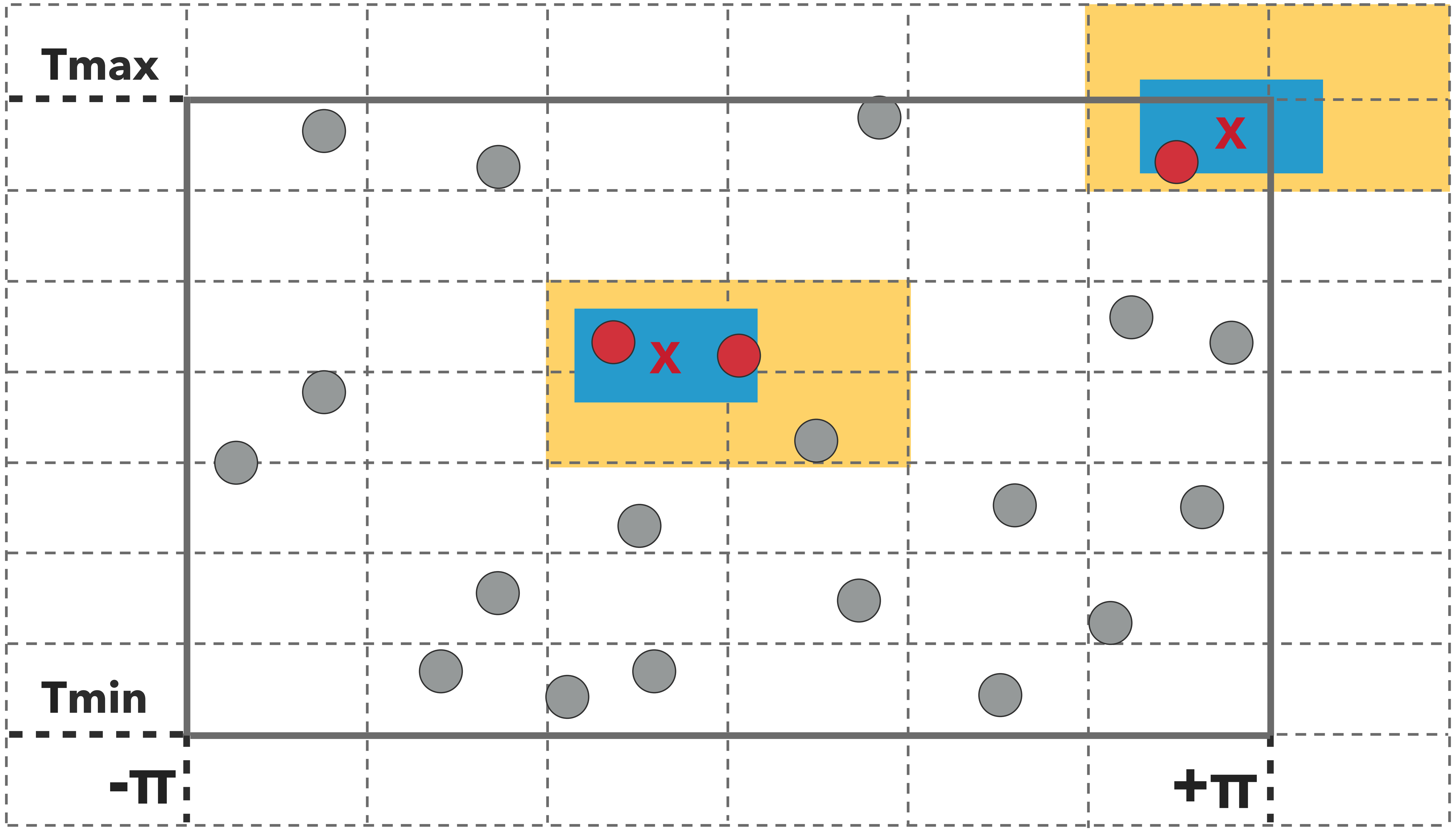


MANUAL TUNING OF PARAMETERS

- terrible work. That is how my place looks
- not very accurate

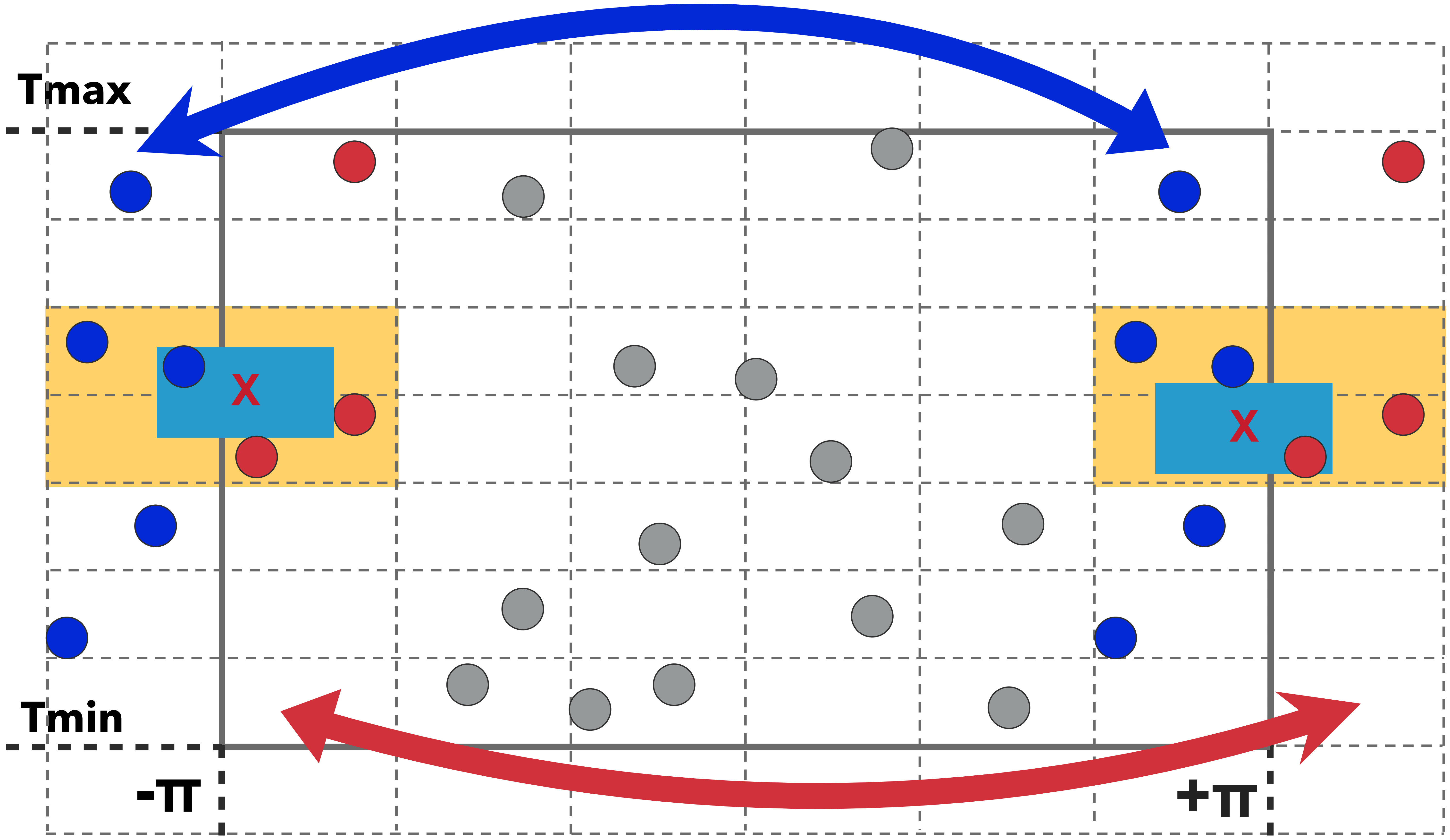
AUTOMATIC TUNING OF PARAMETERS

- home-made algorithm
- kind of a supervised learning
- parallelised on 1 machine, still quite slow



REGULAR 2D GRID

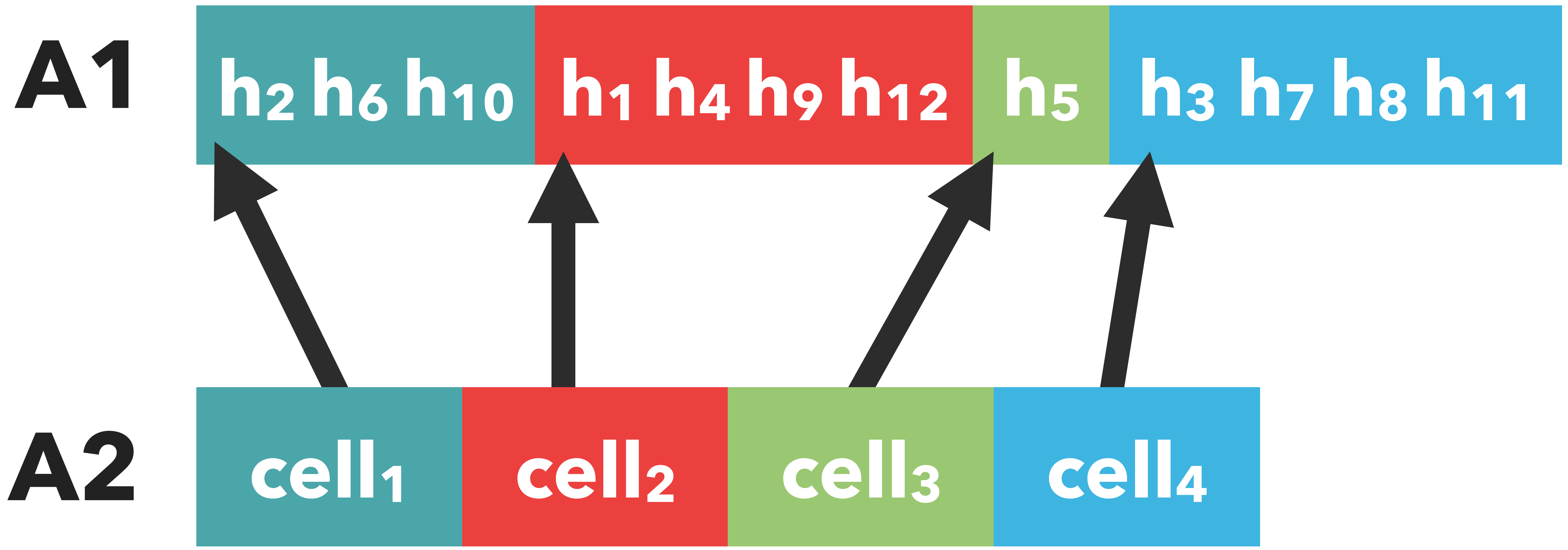
- the algorithm uses individual fixed-size search area on each detector layer
- grid spacing = search area
- the search is always performed in four grid cells
- fast calculation of the left-bottom search cell via modulo
- max N cells ≈ N hits
- empty rows around the layer



OVERLAPS IN Φ

- two extra rows in φ with duplicated hits
- no special treatment of ±π regions

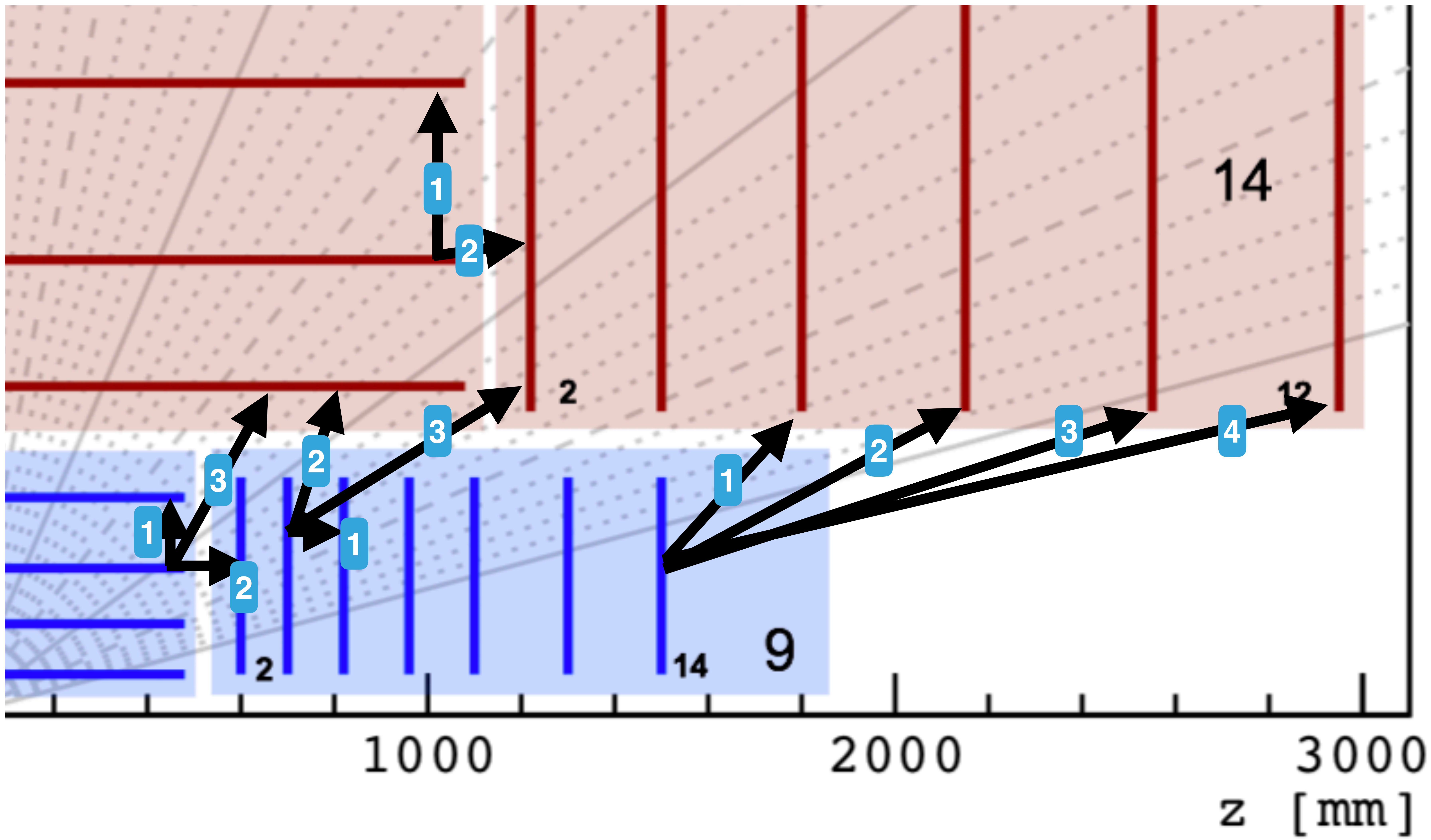
array of hits, ordered by their cell number



array of grid cells
cell = { index of the first hit; N hits}

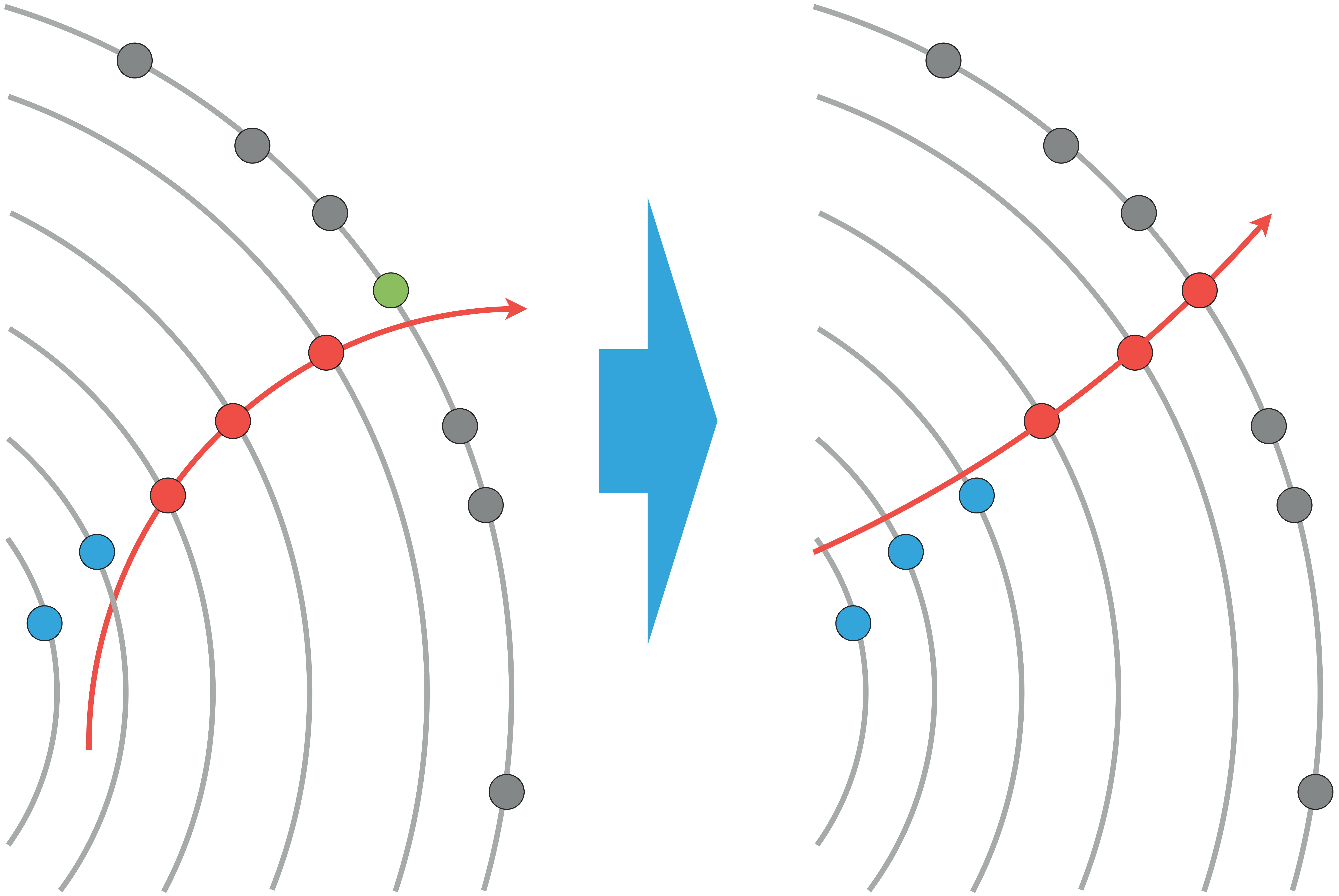
CREATION OF THE GRID

- loop over the hits: count n hits / cell
- loop over the cells: set pointers
- loop over the hits: copy hits to array



ORDERED LAYERS

- define possible next layers according to the geometry
- prolongate to 2-nd neighbour ONLY when no intersection with the 1-st neighbour
- exclude the opposite Z-side

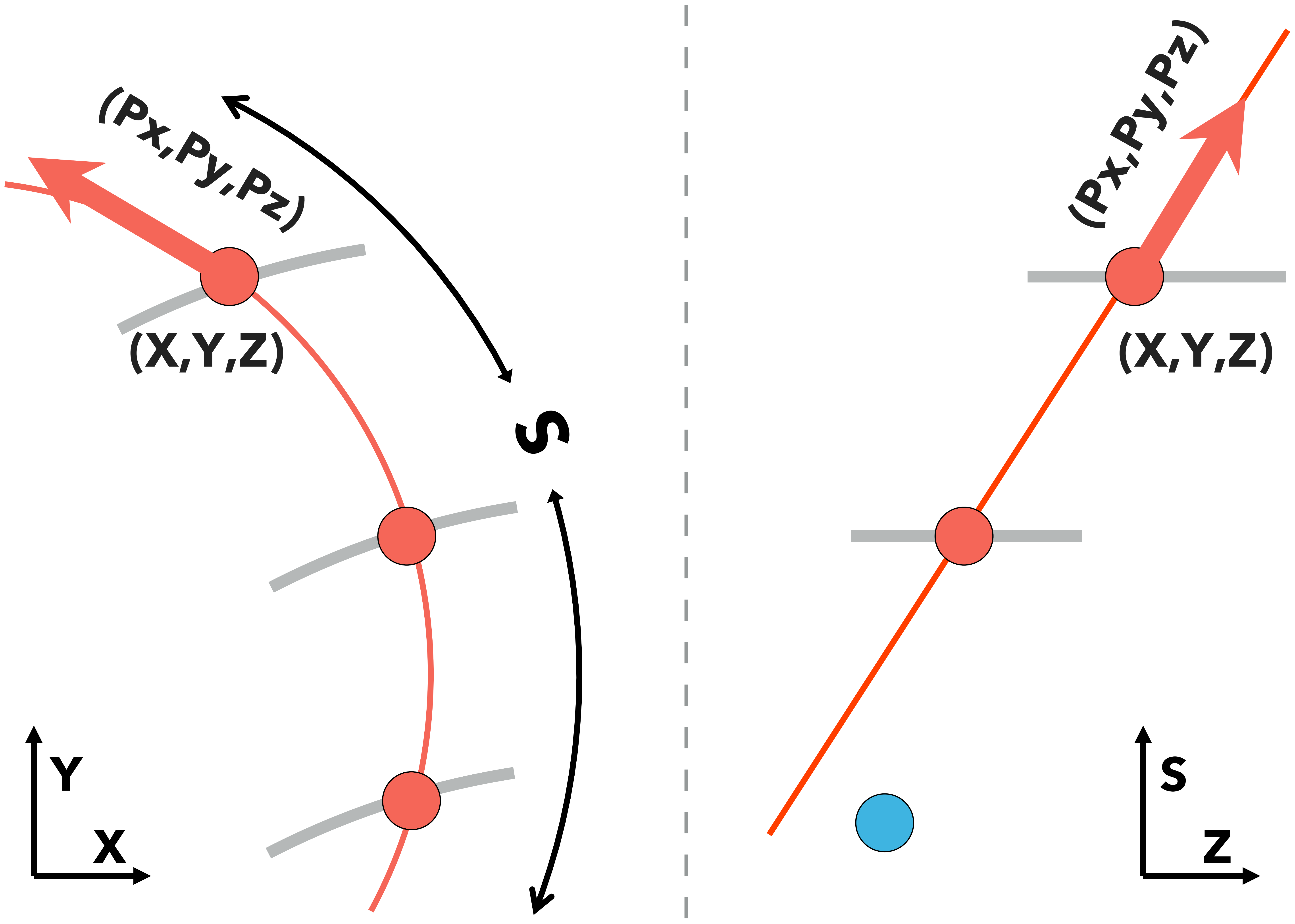


TRACK MODEL

- local 3-hit helix

TRACK PROLONGATION

- cross the next layer
- pick a hit
- refit with the new hit

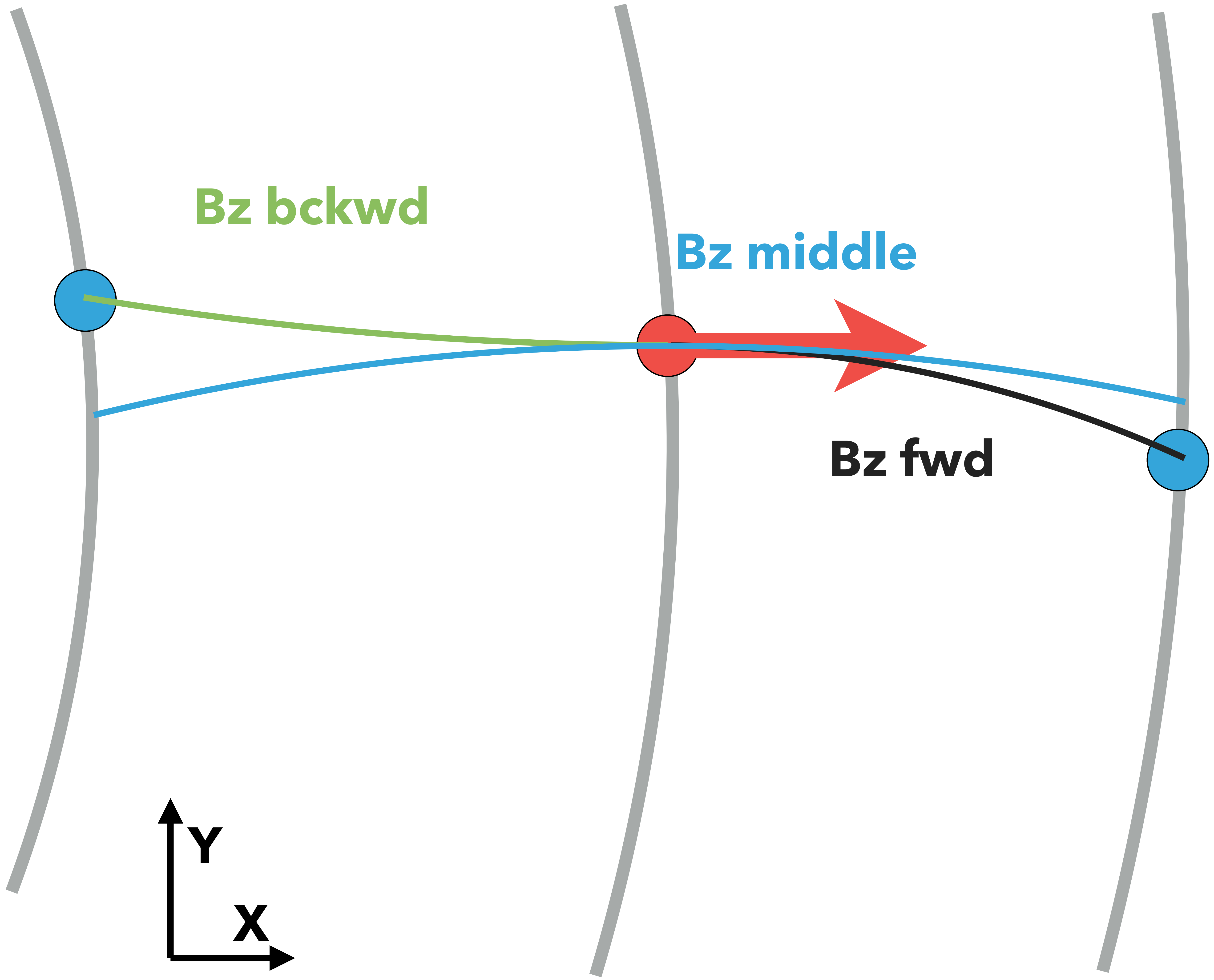


TRACK MODEL

- local 3-hit helix
- physical parameterisation: (X,Y,Z,Px,Py,Pz)

FIT

- 5 degrees of freedom but 6 measurements:
  - circle in XY through all 3 hits
  - line in SZ through the last 2 hits
- constant magnetic field taken at the middle hit



FIELD RECONSTRUCTION

- use true particle momentum to estimate forward, middle & backward magnetic field for every hit in the test sample

FIELD DESCRIPTION

- on every detector layer approximate the reconstructed (bck/mid/fwd) field values with polynoms

ACCURACY PHASE OF THE COMPETITION:

- 3-rd place
- 89% efficiency
- reconstruction time 20-80 sec / event

THROUGHPUT PHASE:

- 1-rd place
- 94.4% efficiency
- reconstruction time 0.56 sec / event