Simulated annealing in the IOWA clustering

- Physics: pseudo-events with one charged hadron
  - scoring vs. cone algorithms
- Combinatorical complexity: multiple charged hadrons
- Comparison original clustering \ simulated annealing
- Further plan
- Conclusion

Simulated annealing

Physically motivated method to quickly approximate the global minimum of a function ("cost") of a discrete system.

Variant: Threshold Accepting (TA).

choose **initial configuration**;

for (**threshold T =** $T_0 \geq T_1 \geq T_2 \geq \ldots \geq T_n = 0$) {

  choose **new configuration** which is small perturbation of the old configuration;

  if (cost(new configuration) < cost(old configuration) + T)

    old configuration = new configuration;

}

(journal of computational physics 90, 161 1990)

Threshold accepting: implementation in the hadronic clustering

initial configuration:

assign all clusters to some track

new configuration:

randomly associate some cluster to some track,

or un-associate

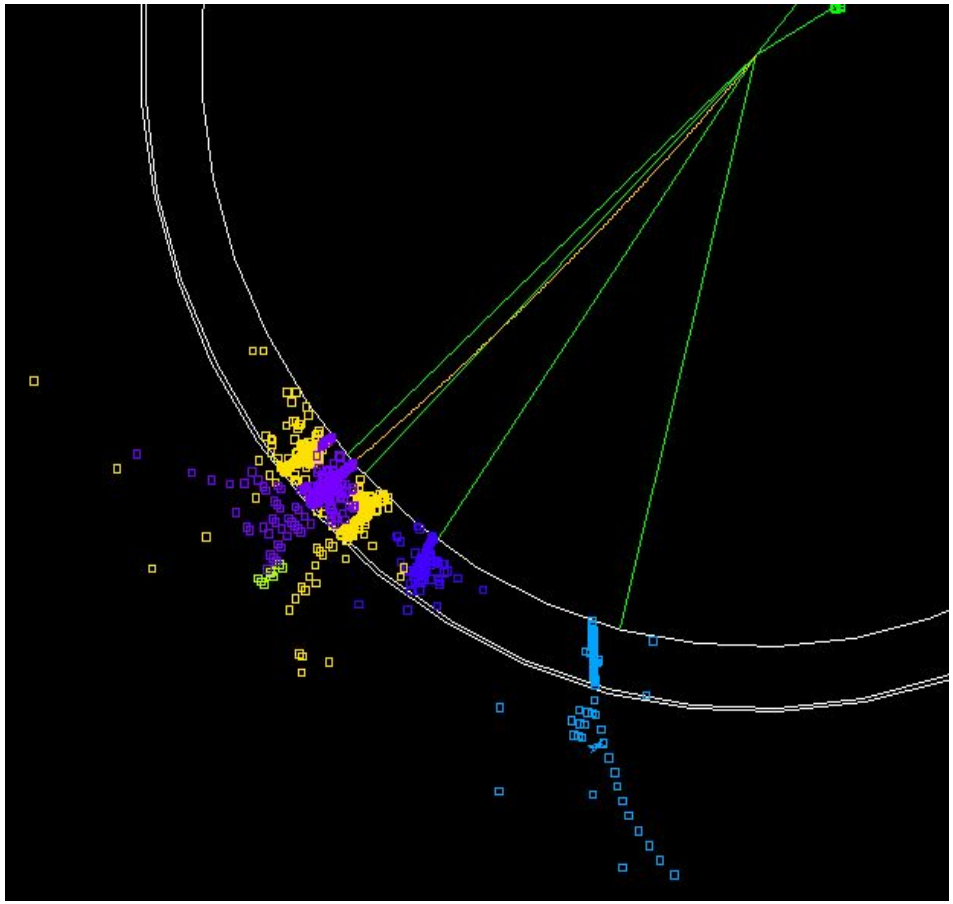
threshold T =

35 (100 times) ... 20 (100 times), 15 (200 times),

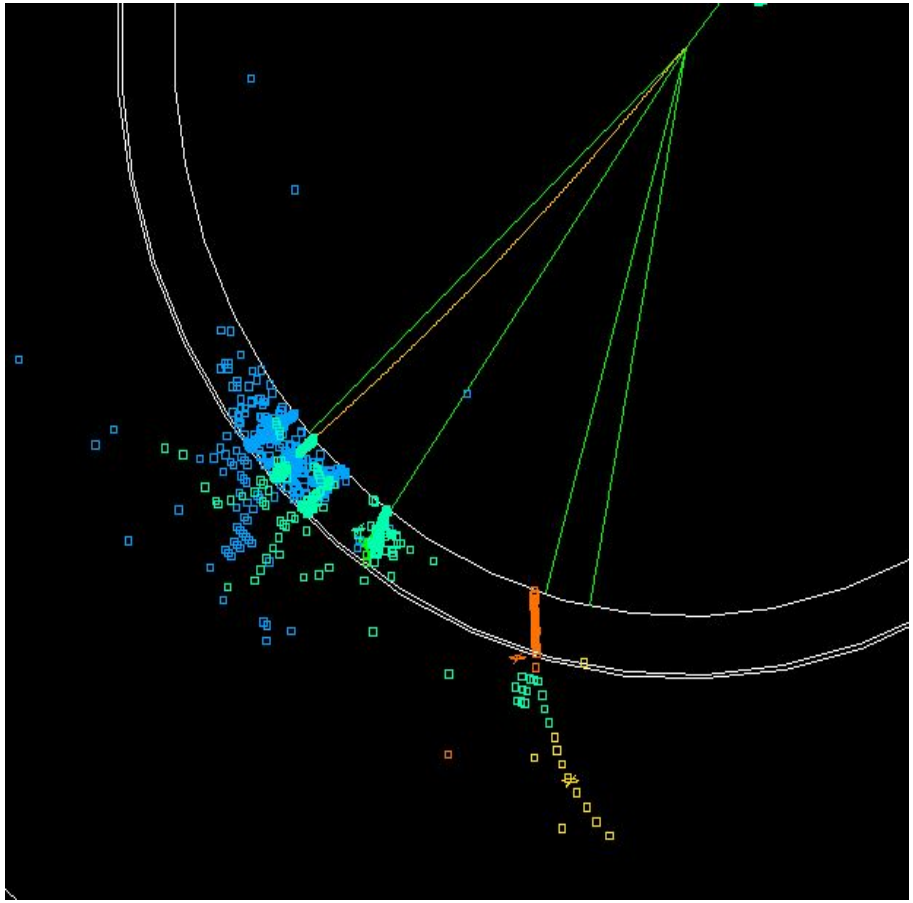
10 (300 times), 5 (400 times), 0 (100 times) .

Physics: one charged hadron

50 GeV single d, artificially 1 charged hadron



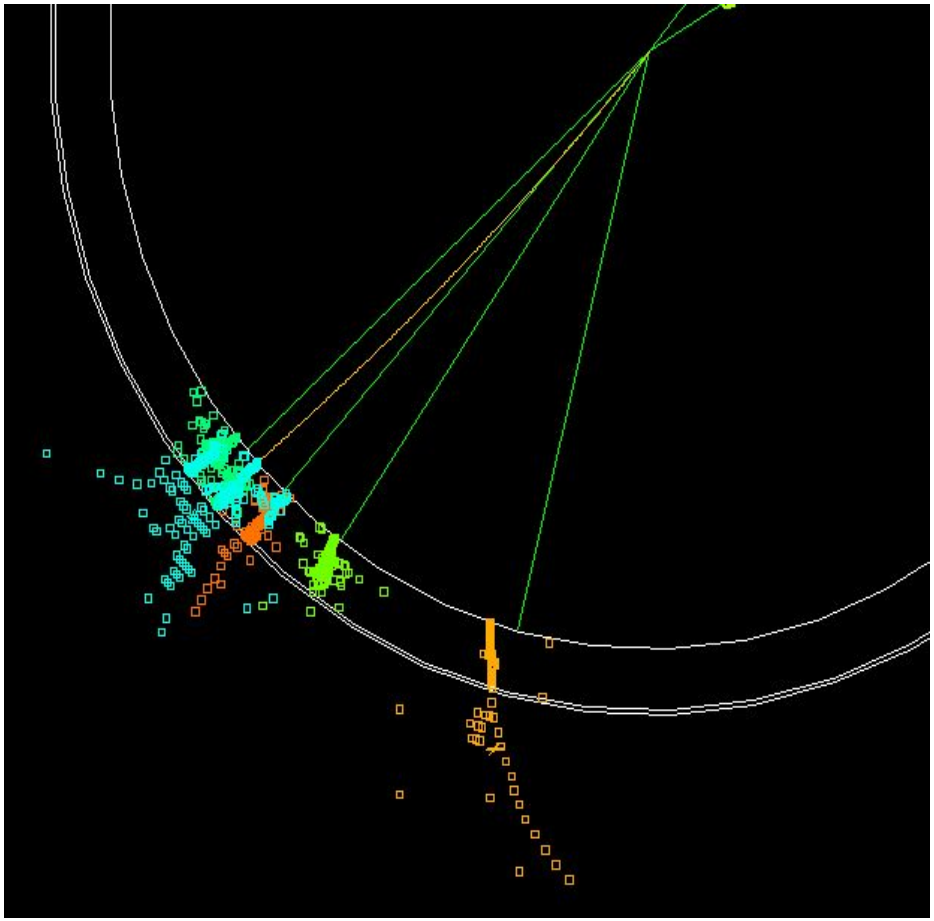
- IOWA clustering

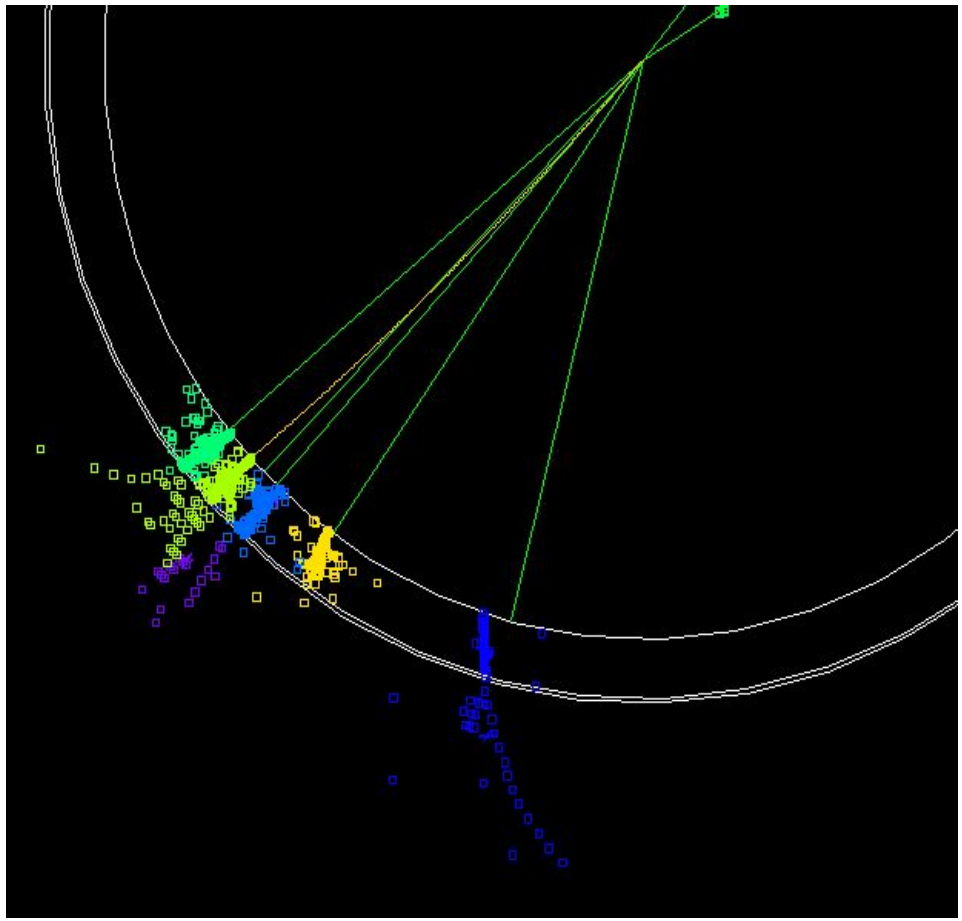


- TA, cost function = |E-P|

Physics: one charged hadron

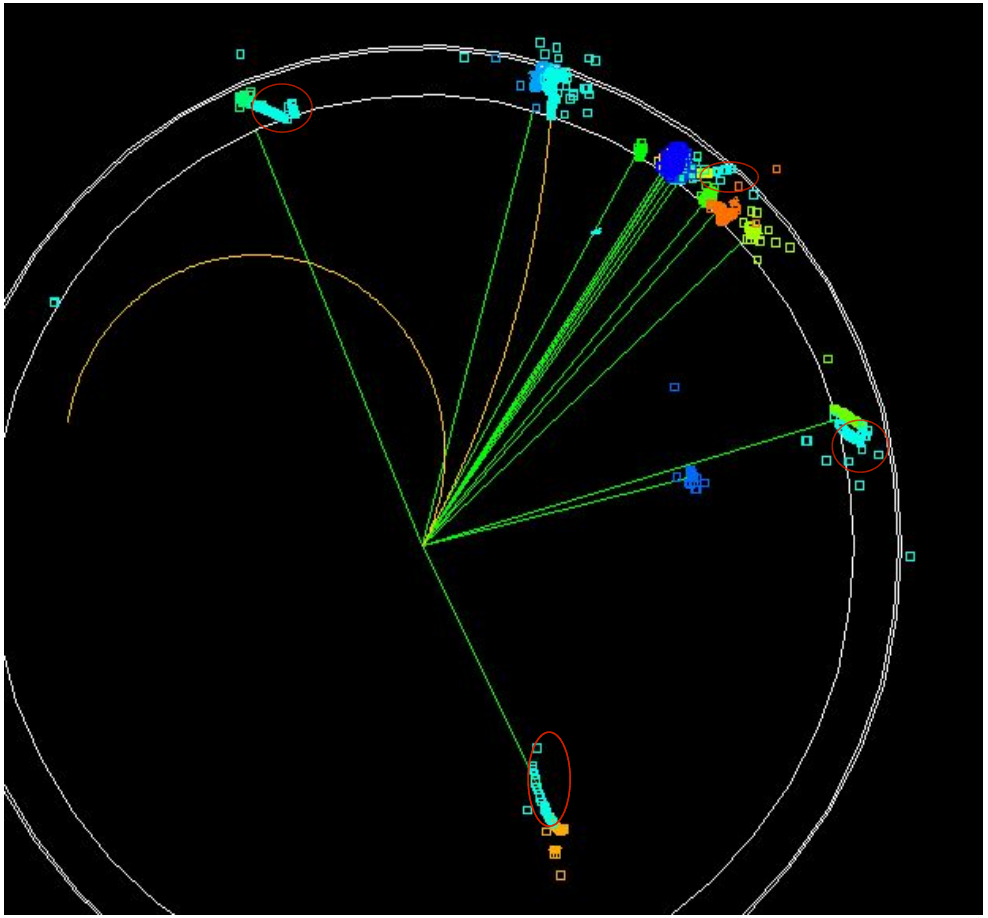
- cost function = |E-P| +\-0.005 for every breaking\joining of a link above threshold 0.7

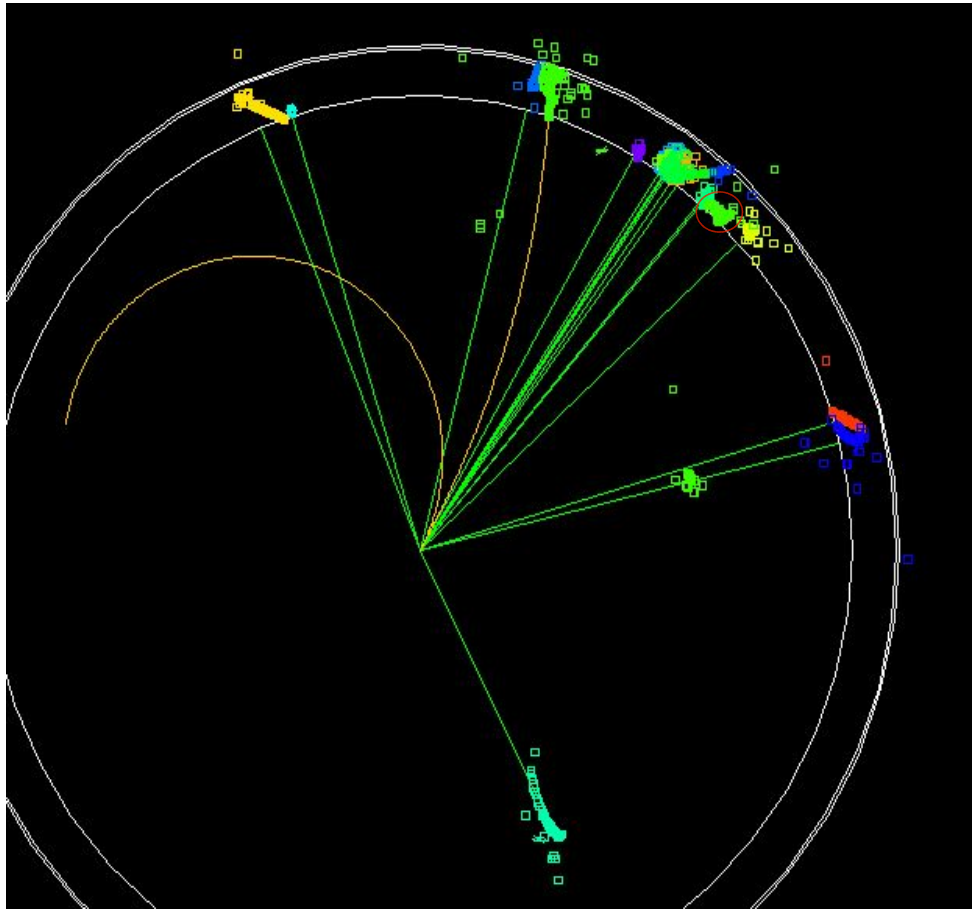




- cheating on scoring

Physics: one charged hadron

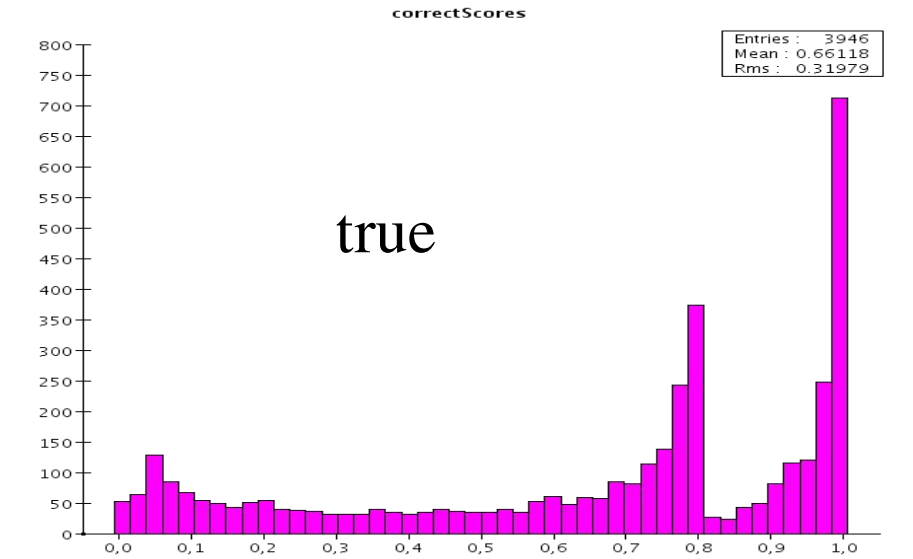


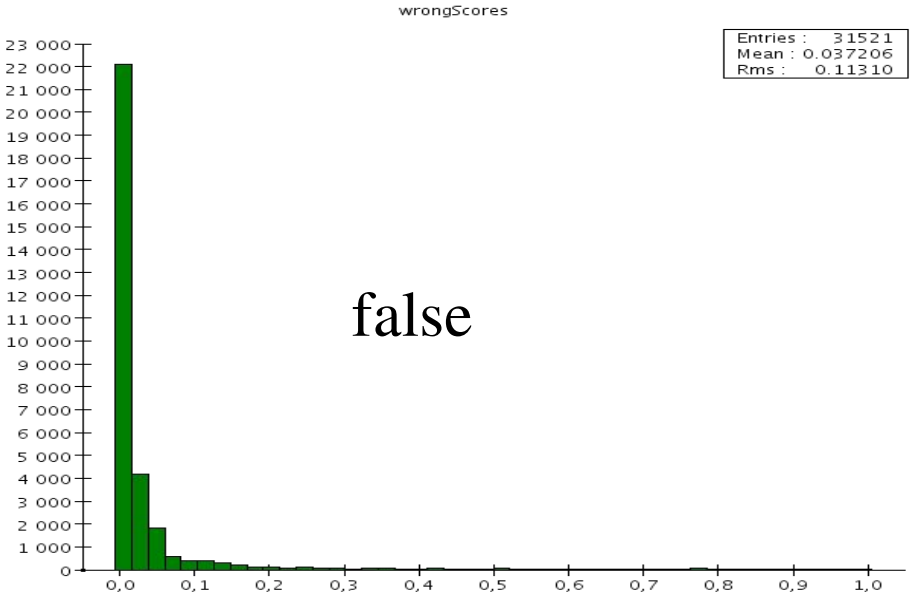


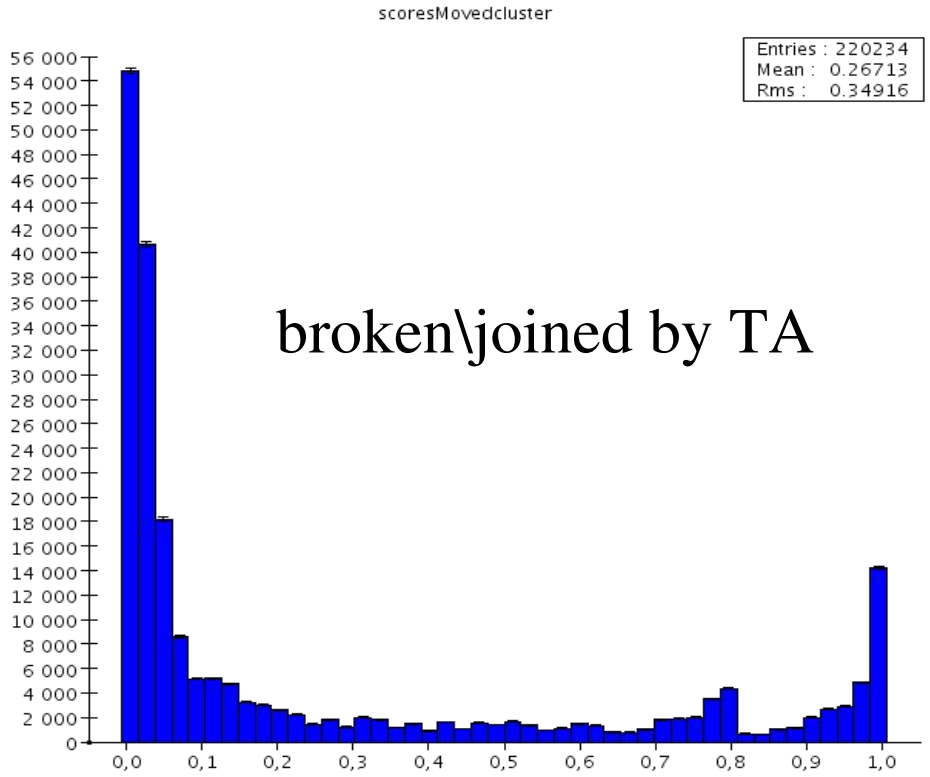
- cost function =|E-P| +\-0.005 for every breaking\joining of a link above threshold: “globe algorithm”

- cost function = |E-P| +\- 0.005 (-\+0.014) for link with score 1.0 (0.0).

Physics: one charged hadron

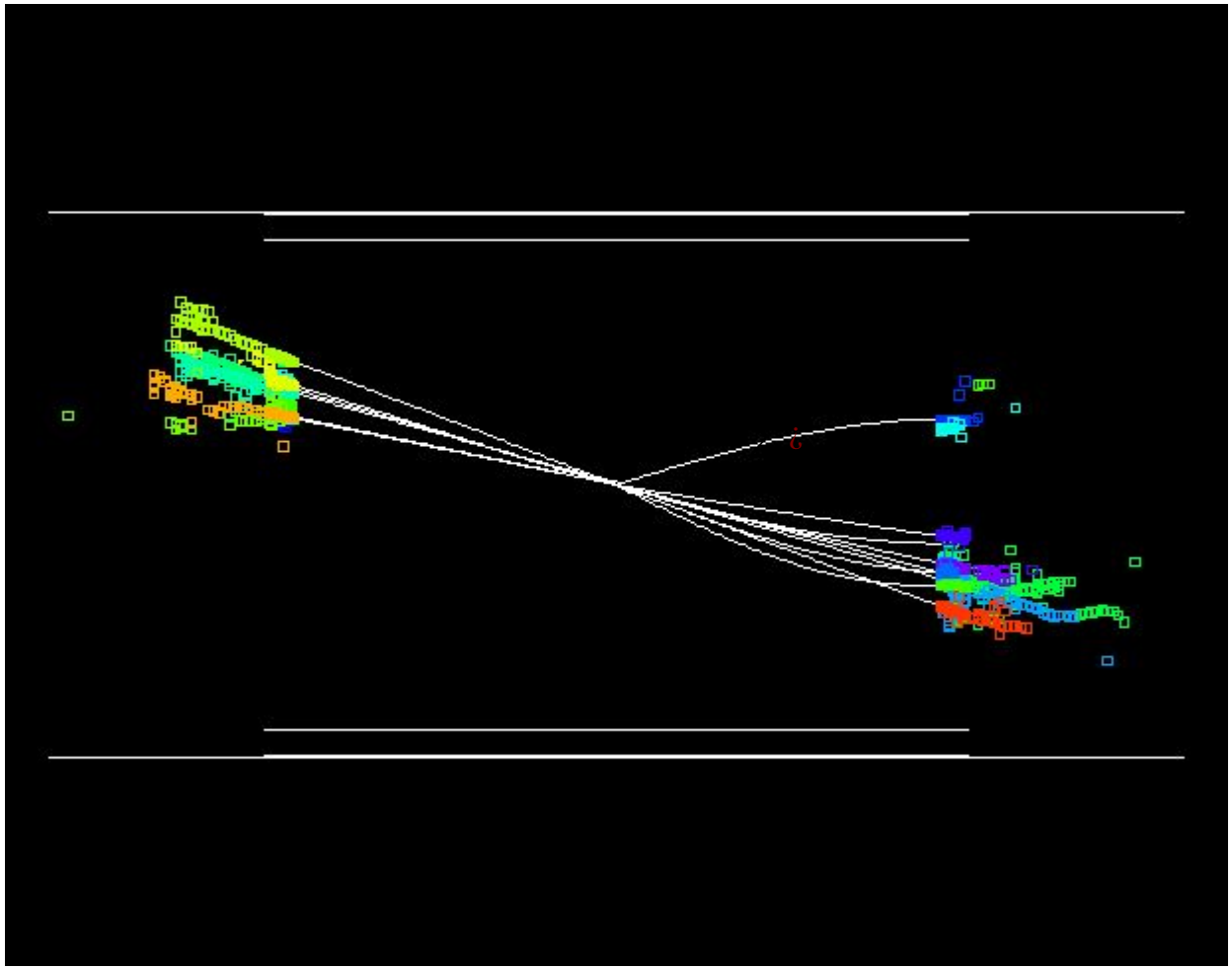






TA could be framework to make maximum use of good scoring without\prior to cone algorithms.

Complexity: Multiple charged hadrons



100 GeV qq.

- cost function = $\sum_i |E_i - P_i| / \sigma(E_i)$ +\- 0.005(-\+0.014)•$\sqrt{P_i}$ / 11 [GeV]

Comparison

Given clustering

- link threshold
- strict momentum ordering
- cone algorithms

Threshold accepting

- soft linking
- no momentum ordering (so far)
- no aggressiveness, no “stealing” (in principle): equilibrium

Plan

- Apply TA in 500 GeV qq for performance test
- Bottom-up:
  - quantitative studies and improvements
  - more complex events
  - PFA "Jets"
  - handle punch-through
  - improve dependence of cost function on link score, or score itself
  - neutral reconstruction in TA

Conclusion

- An algorithm working in equilibrium can solve many problems:
  - track aggressiveness
  - cone aggressiveness
  - jet cause “track A steals critical part of track B”
  - imbalances (e.g. jet outlier)
  - negative mean reconstructed energy
- Link scores can be used further in this approach