PFA in a strip calorimeter

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introduction

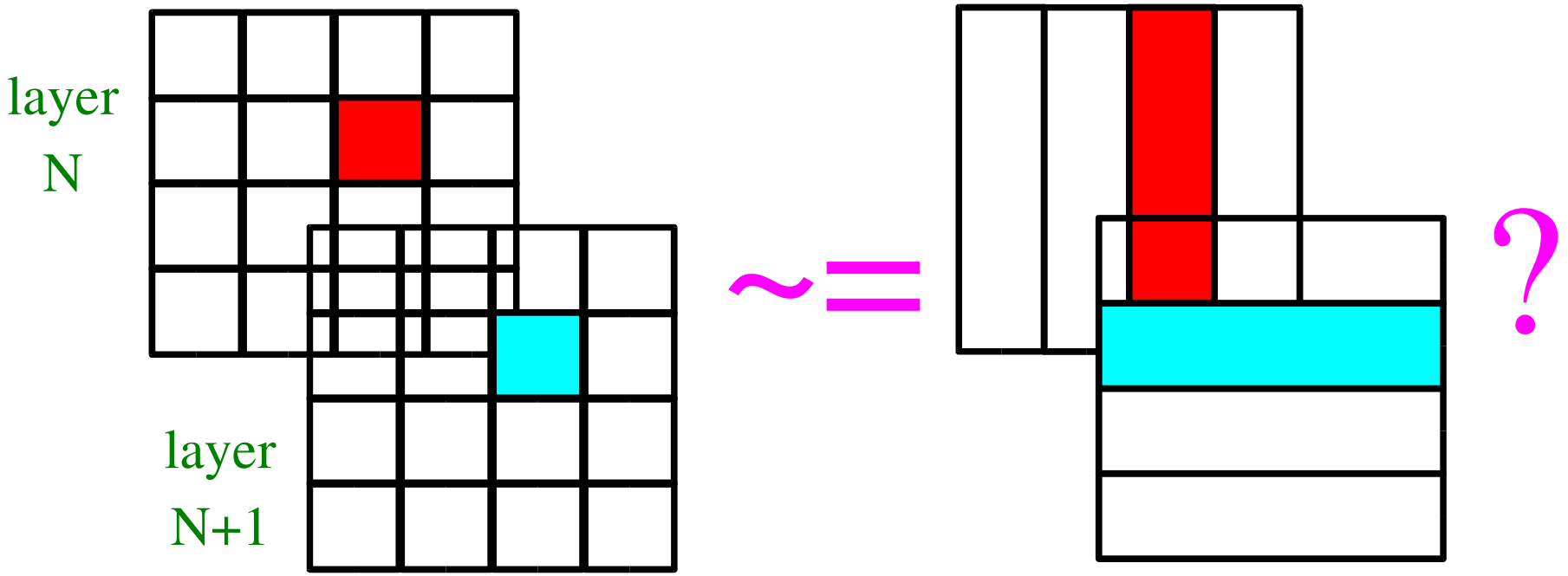
sketch of algorithm

preliminary results

introduction

active material of GLD calorimeter design has strips of scintillator
rather than square cells

idea: performance of 1x5 cm^2 strips similar to 1x1 cm^2 cells ?
=> performance / cost (~= # photon sensors)



present GLD (and other) PFA's designed for “square cell” calorimeters

developing clustering/PFA for strip calorimeter:

- tool to optimise strip size & shape
- should work on both square CALO cells and long strips
  for consistent comparisons

study in:

- GLD detector
- single particle events: understanding, debugging
- e+e- -> qq (uds) @ 91, 200 GeV

Algorithm overview

"tracking" of MIP-like calorimeter hits (seeded by tracks)

identification of MIP tracks

first clustering of remaining strips

combine clusters, seeded by tracks

combine remaining clustering (unseeded)

adjust clusters attached to tracks (consistent E/p)

use tracks as input to calorimeter reconstruction

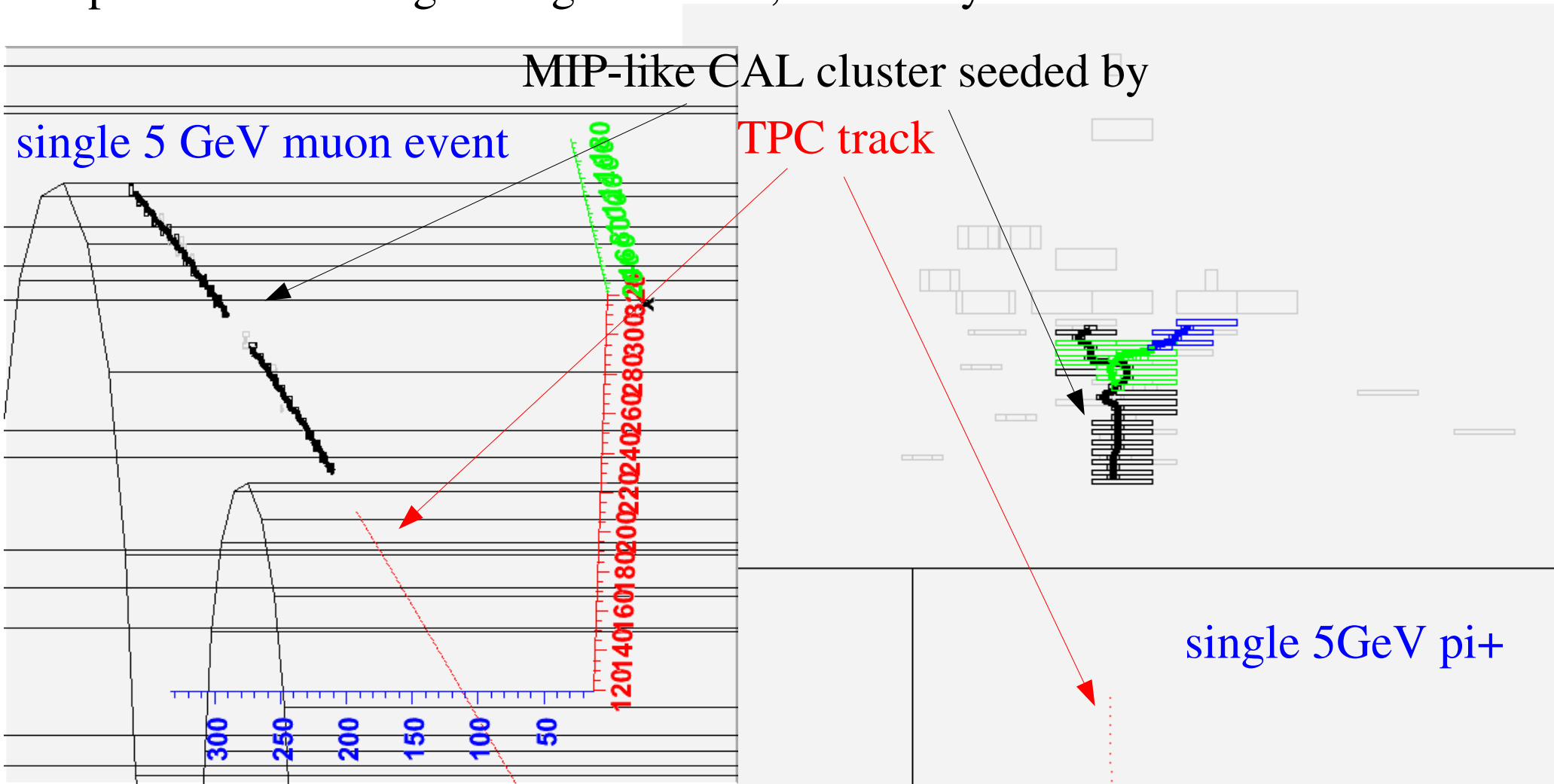
tracks are precisely measured objects

can help resolve some ambiguities due to strip geometry

1st step - identify MIPs in CALO

consider isolated hits with MIP-like energy deposit

perform “tracking” using these hits, seeded by TPC track

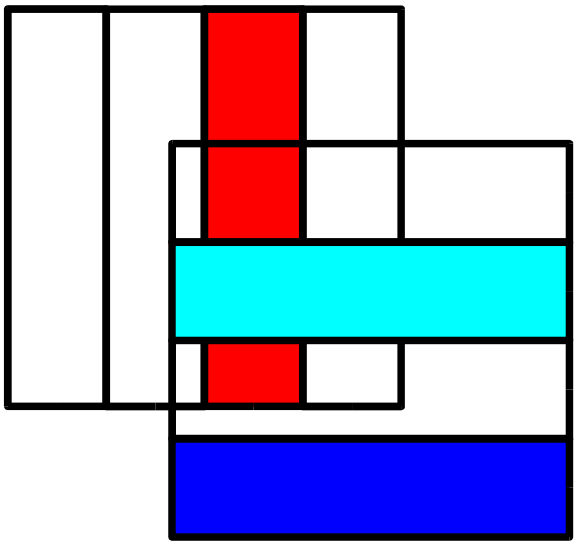


strip clustering algorithm

cluster energy deposits

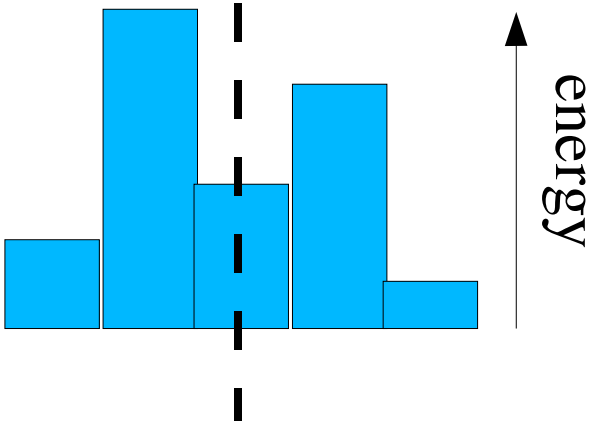
- don't over-cluster (combine deposits from different particles)
- don't under-cluster (split deposit from a single particle)

in strip geometry, deposits may be merged in one orientation,
separated in another



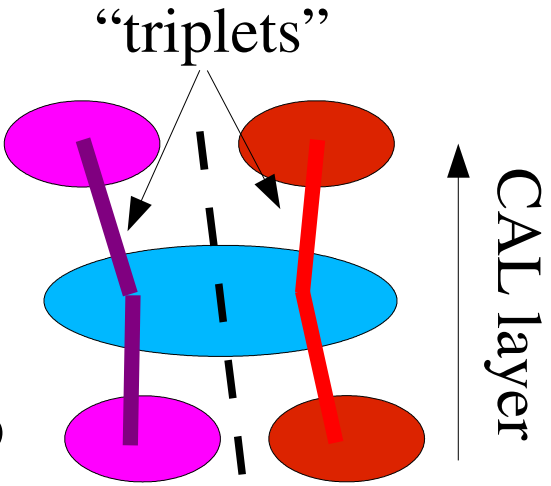
make “2-d” clusters within each layer

check for sub-structure: split if appropriate



combine 2-d clusters with clusters in

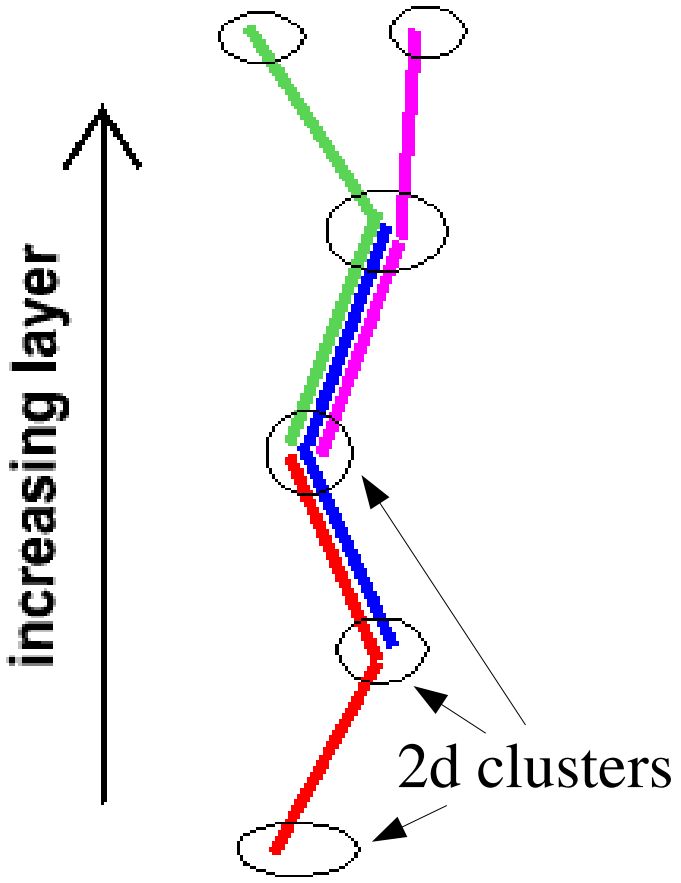
adjoining layers -> “triplets” of clusters



if cluster shared by several “triplets”, split it

important for strip geometry

define figure-of-merit for triplet: cluster overlap



now have collection of triplets

starting from inner ECAL, combine
overlapping triplets -> 3d clusters
use triplet figure-of-merit when faced
by several possibilities

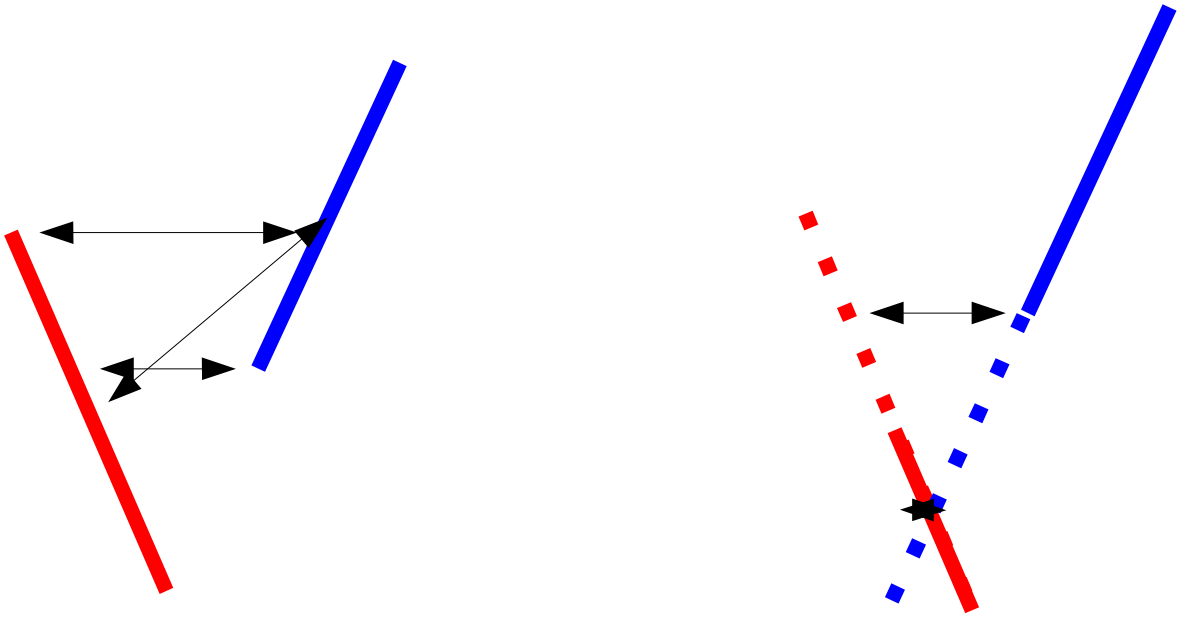
~ “tracking” in CALO

attach CAL clusters to TPC tracks - extrapolate track to calorimeter

attempt to get energy ~= track momentum by attaching nearby clusters

consider various measures of distance between clusters:

centre-to-centre, “impact parameter”...



split track-associated clusters if cluster energy inconsistent with track P

then consider remaining clusters (neutrals)

combine nearby clusters in similar way

now can reconstruct PFA jet energy:

track momenta + neutral energy deposits

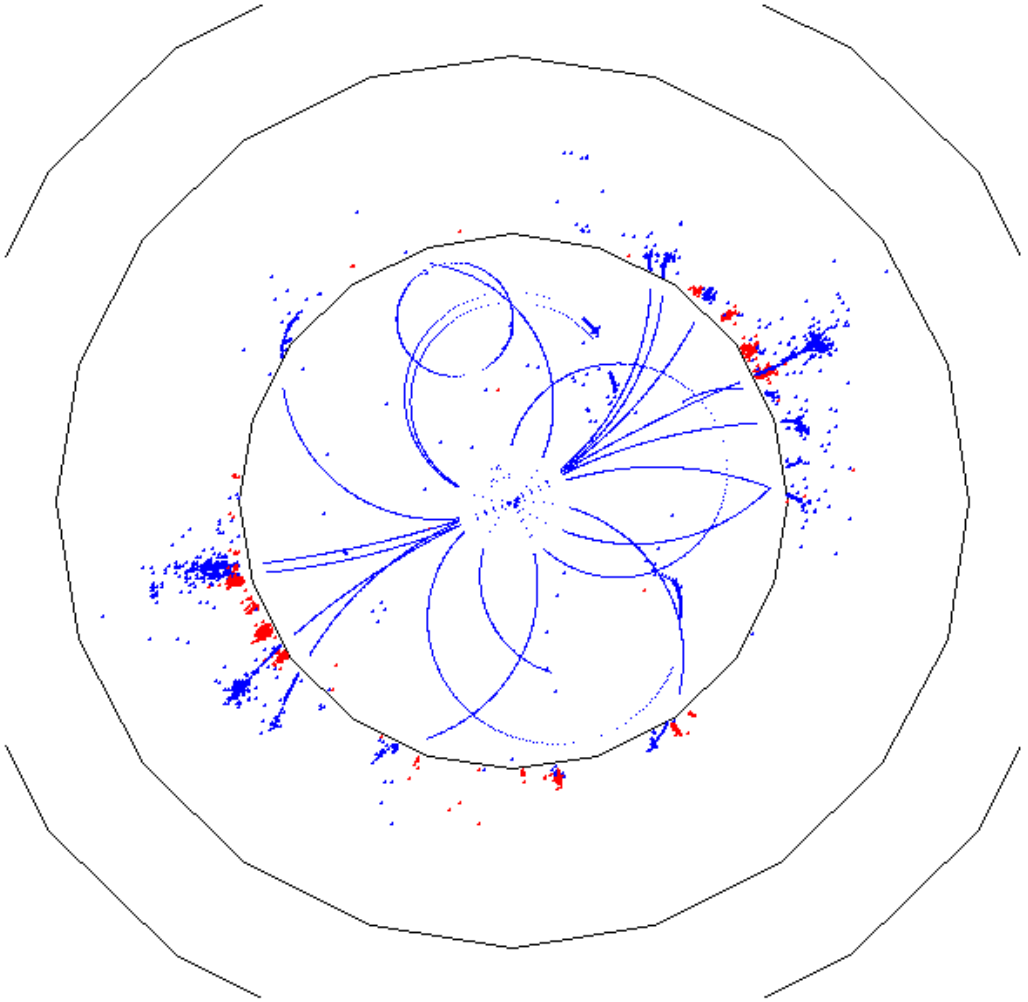
(+ unclustered energy?)

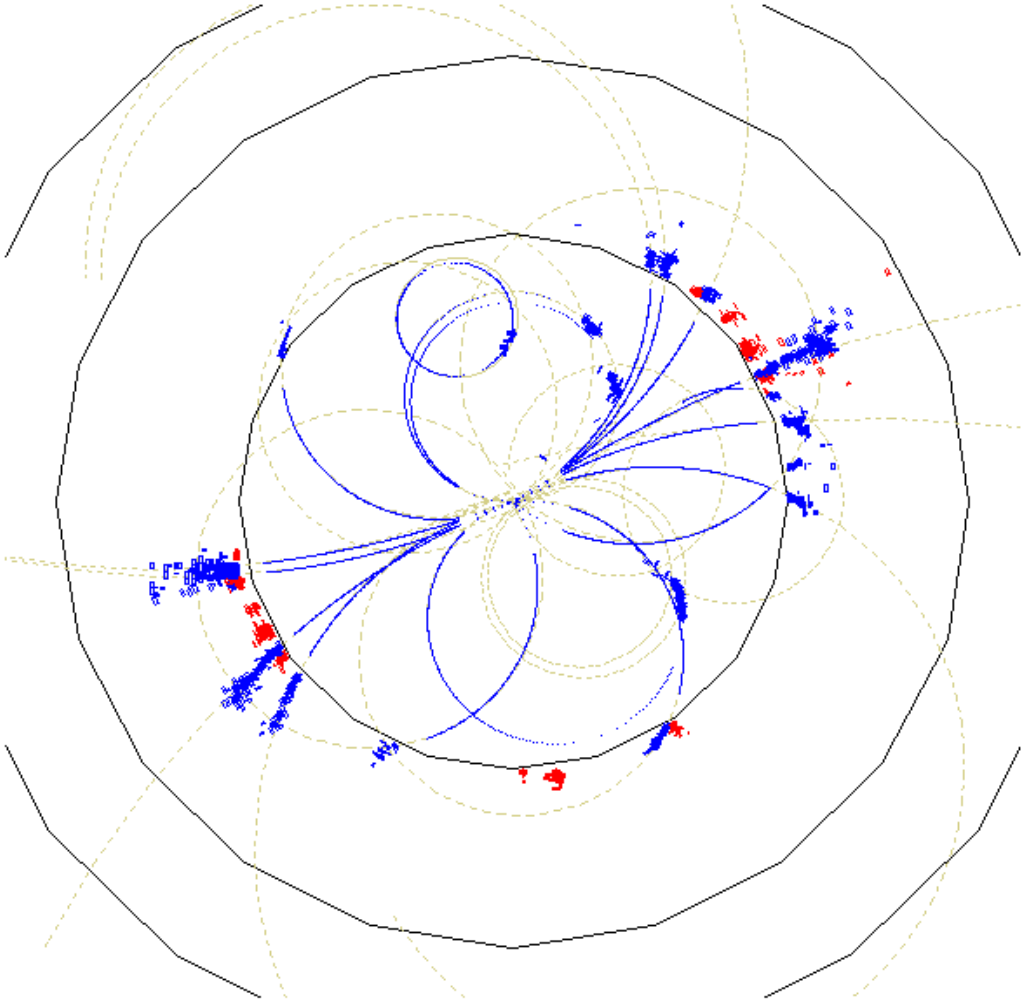
z0->qq (uds) event @ 91 GeV

charged neutral 1x1cm^2

MC information

reconstructed information



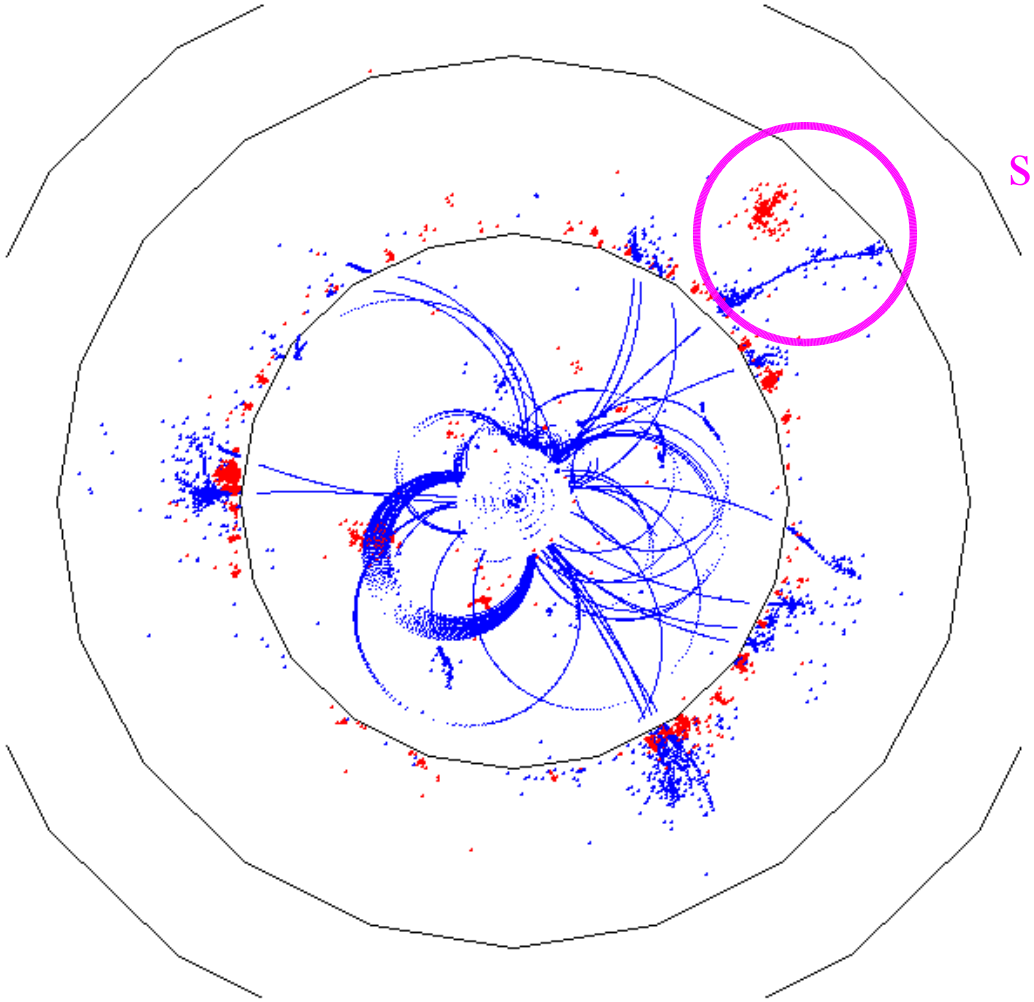


by eye, works well!

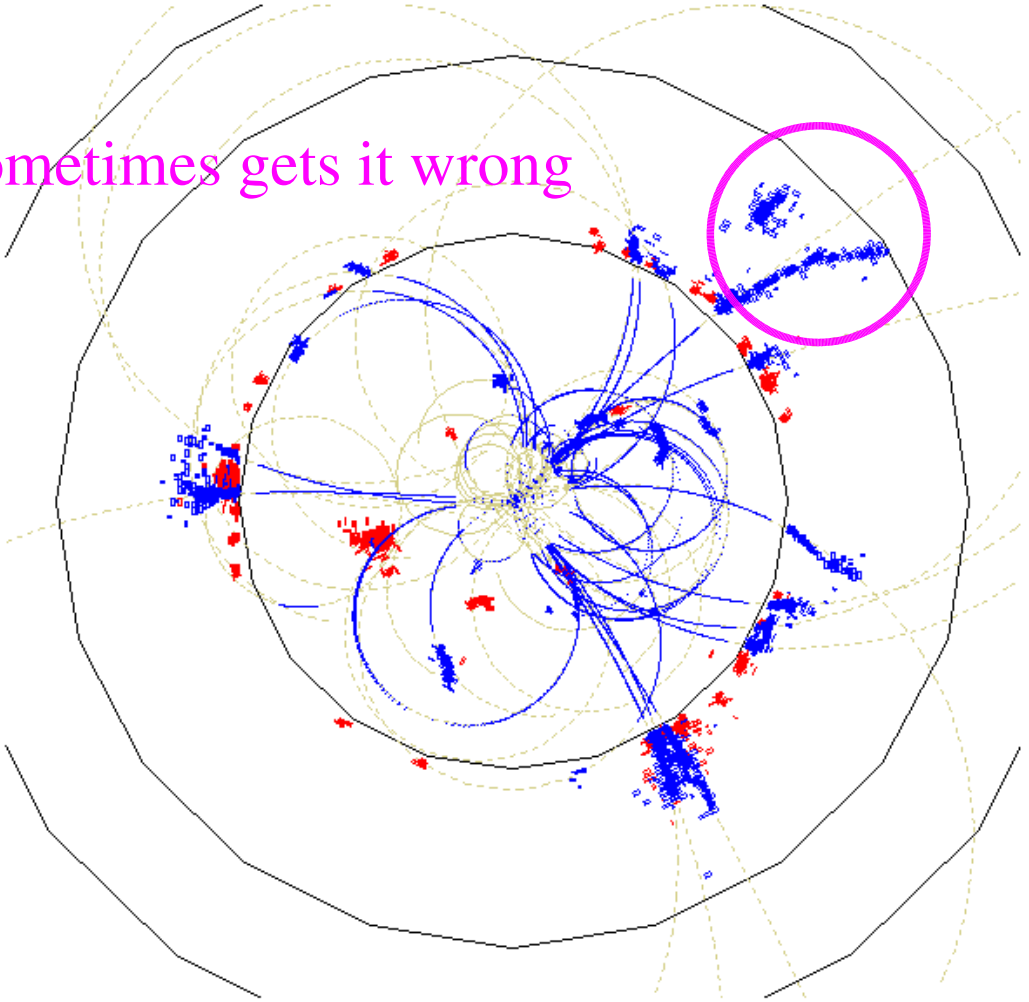
z0->qq (uds) event @ 200 GeV charged neutral 1x1cm^2

MC information

reconstructed information



sometimes gets it wrong

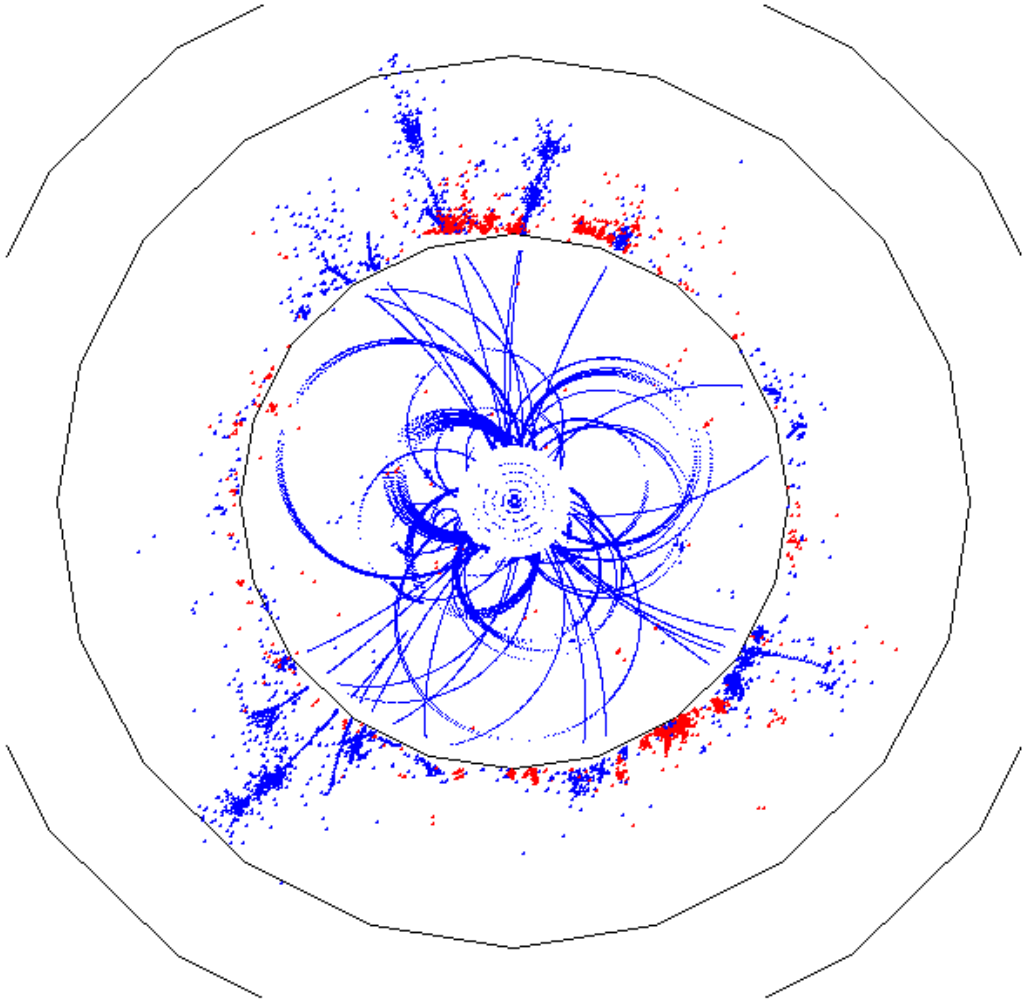


algorithm improvements necessary (& possible)

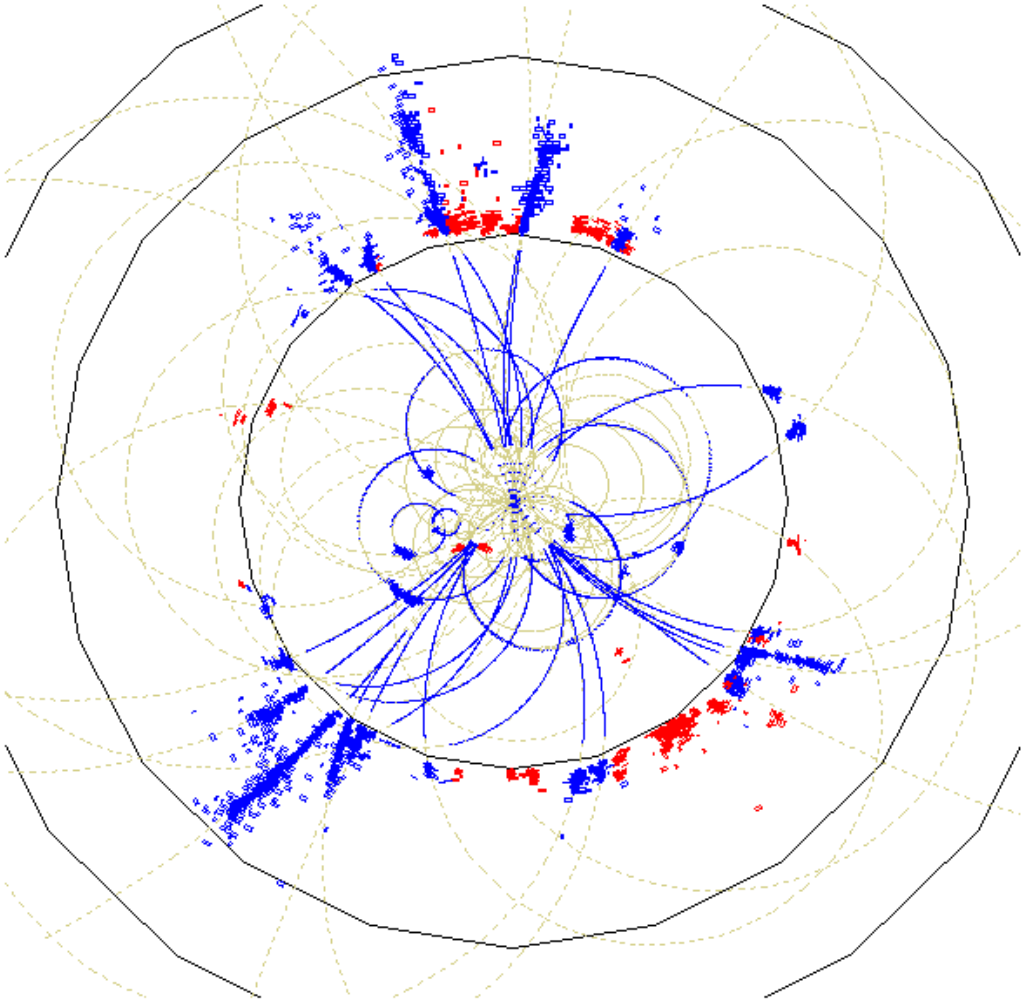
z0->qq (uds) event @ 200 GeV

charged neutral 1x1cm^2

MC information



reconstructed information



this event looks ~OK

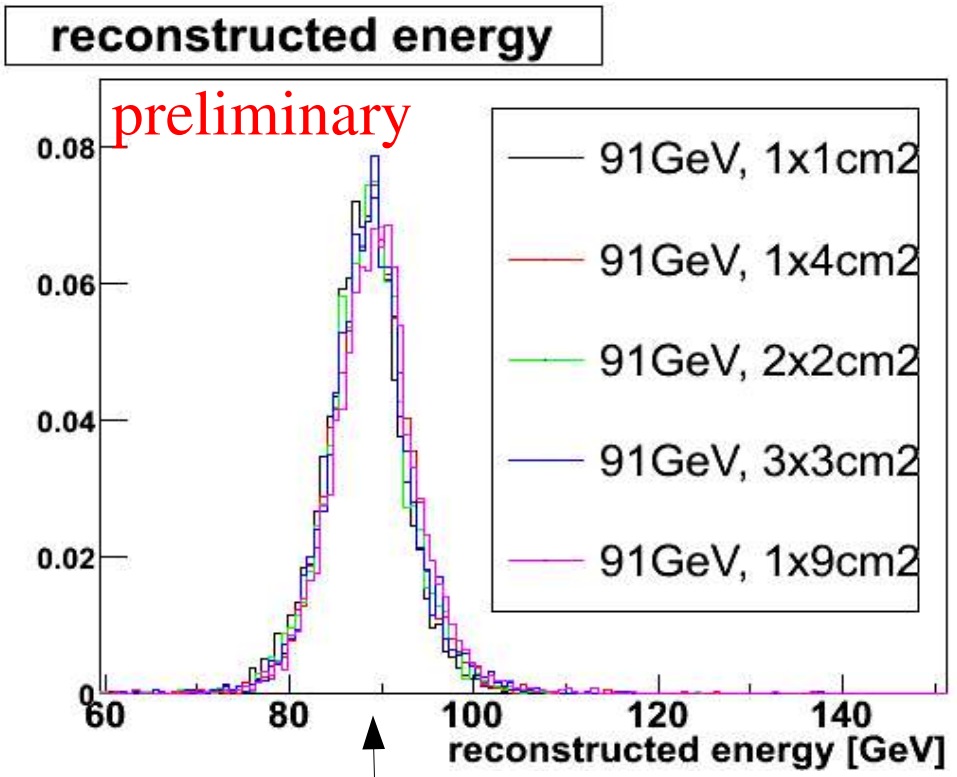
reconstructed PFA energy

try different tile/strip sizes

- EM/HD have same size

only central events cos(theta)<0.8

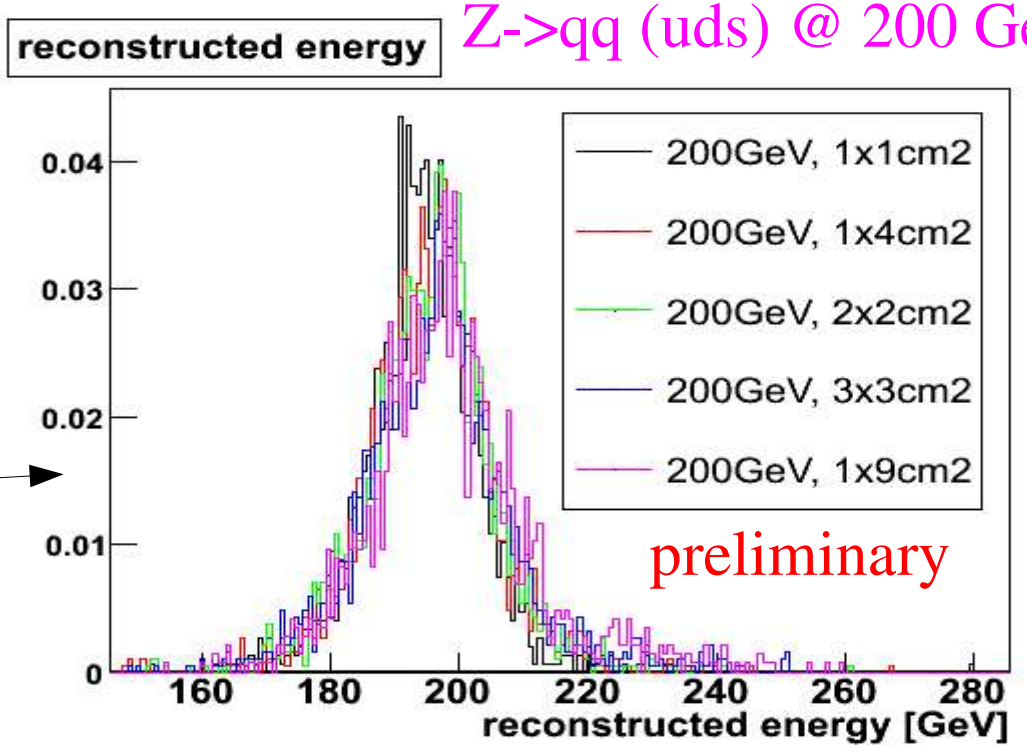
Z->qq (uds) @ 91 GeV



~45 GeV jets

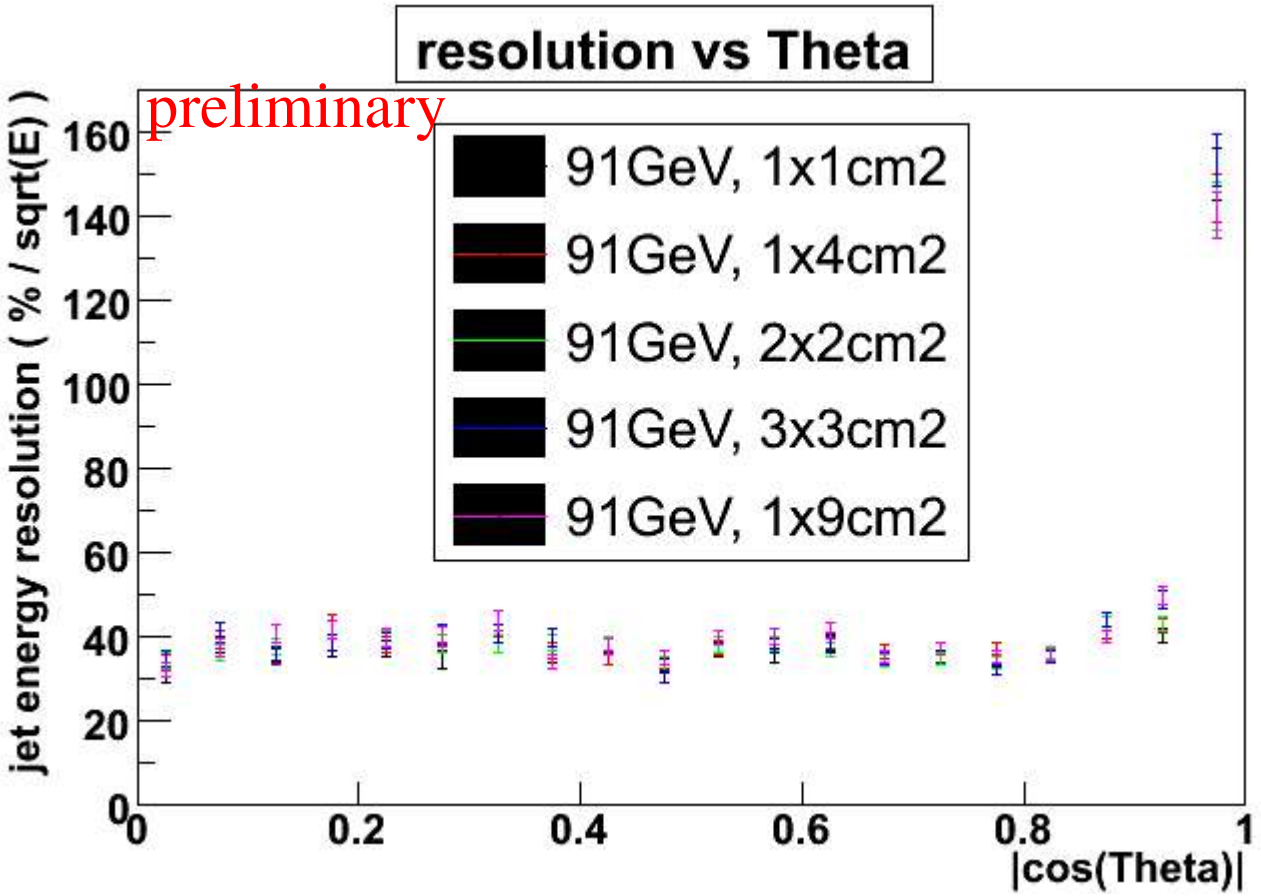
~100 GeV jets

Z->qq (uds) @ 200 GeV



jet energy resolution (RMS90) vs. cos(theta) in 91 GeV qq events

test different strip sizes



resolution ~35%/sqrt(E) in barrel

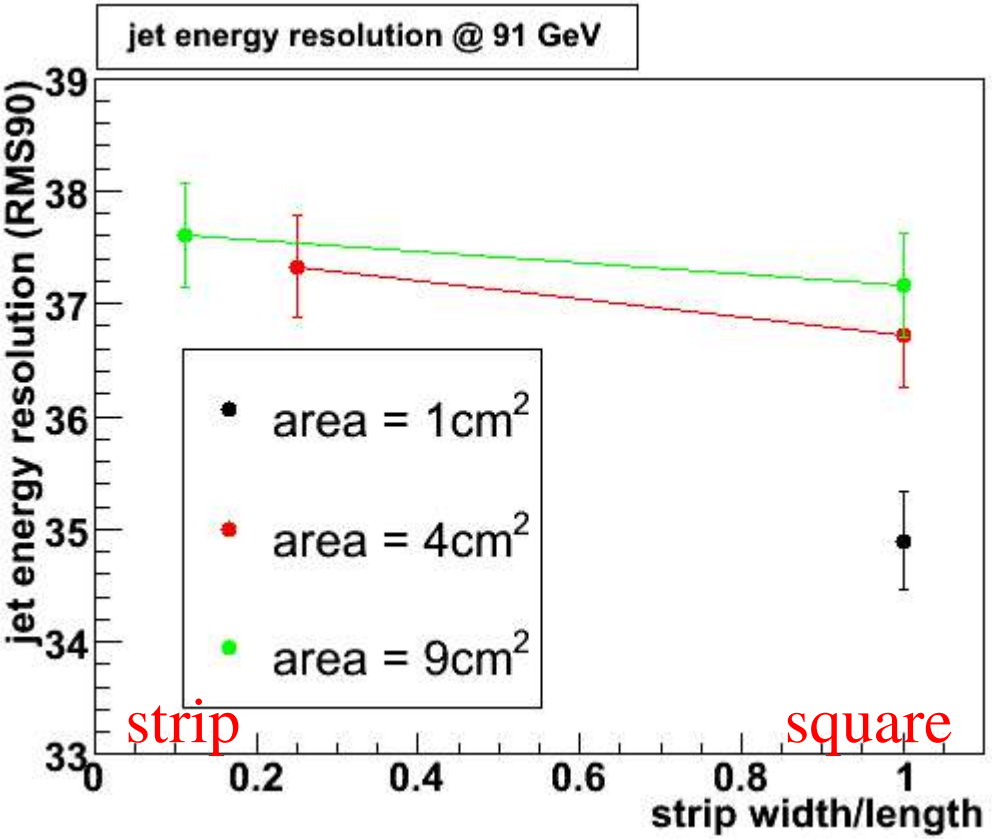
not too far from 30% goal

How does performance depend on strip aspect ratio (width/length)?

same # channels, different geometry

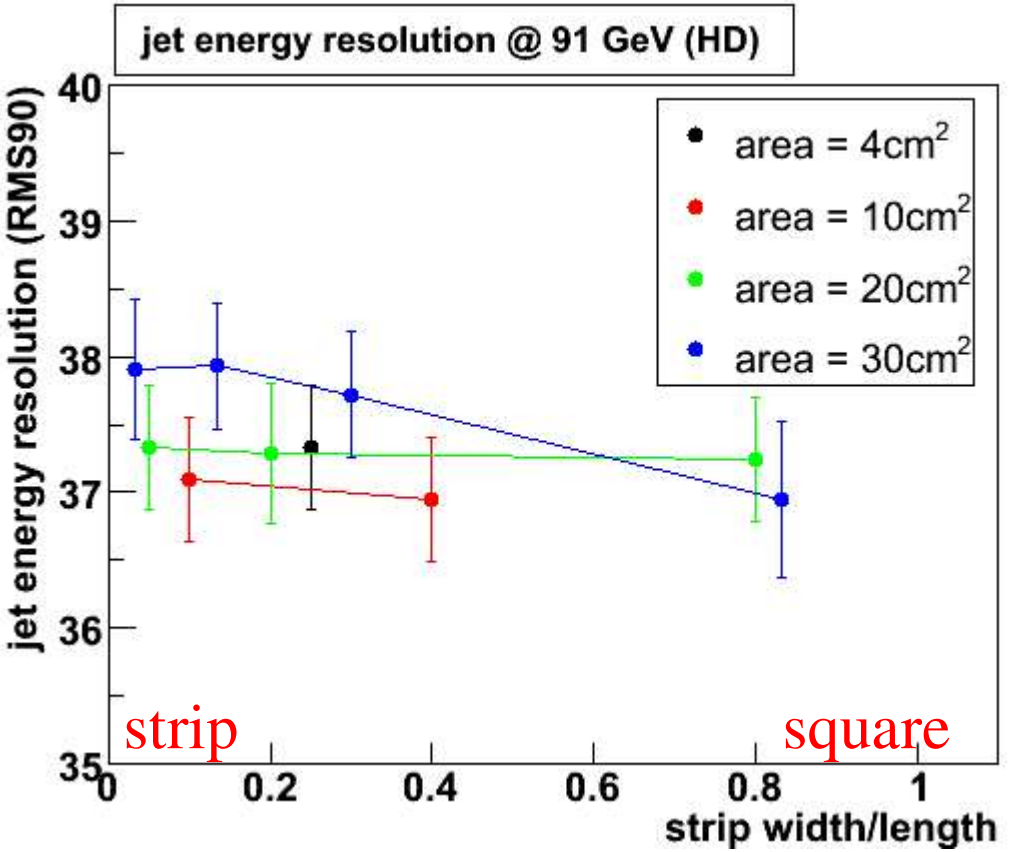
91 GeV qq events

all strips have same size



area looks more important than aspect ratio

EM fixed (1x4cm^2), vary HD strips

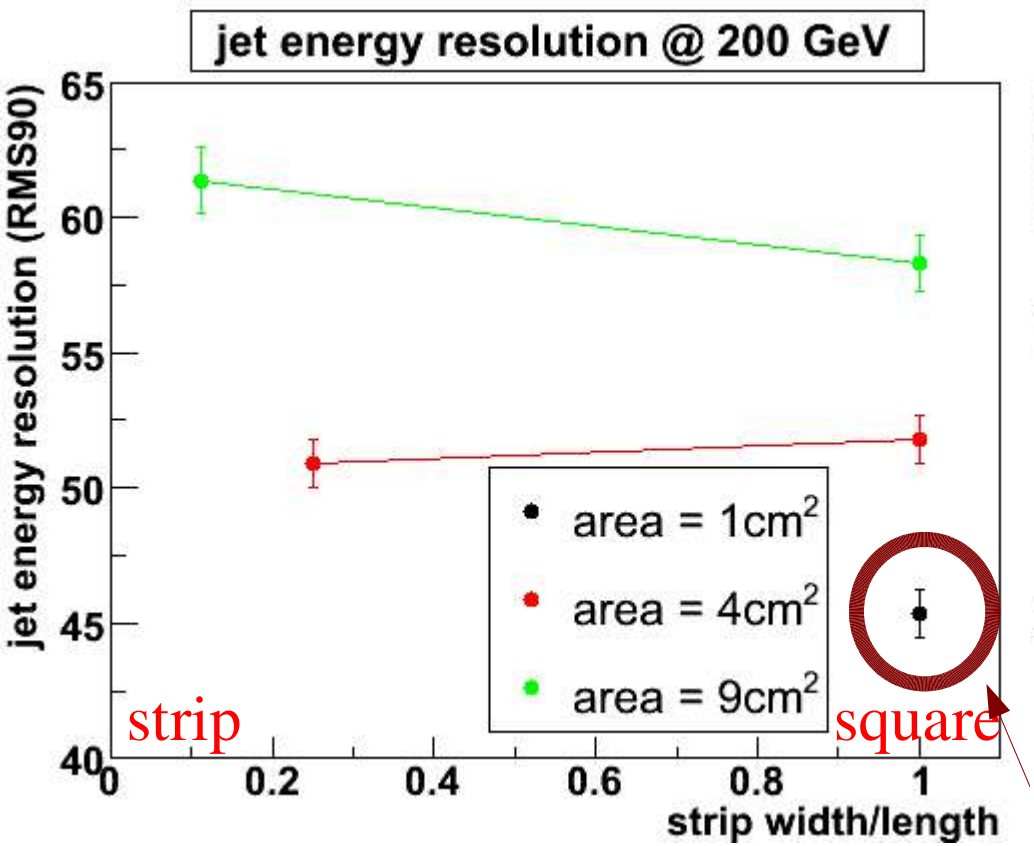


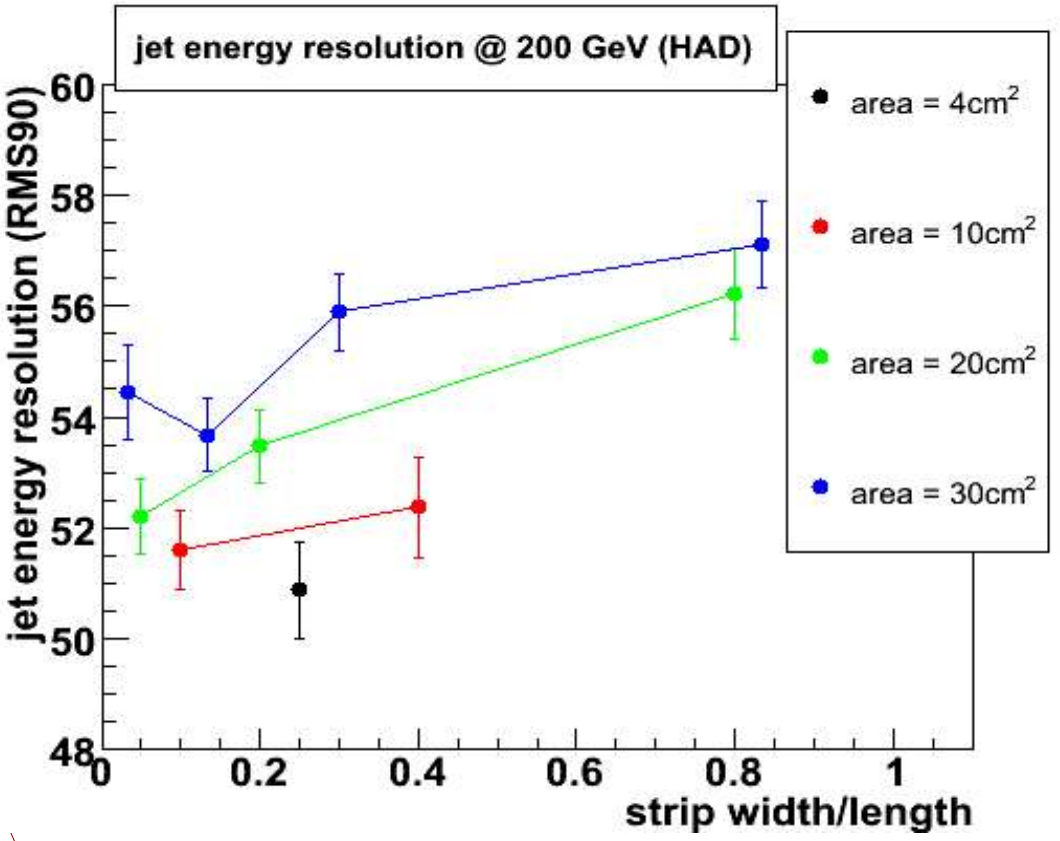
no strong dependence on aspect ratio or area

200 GeV qq events (uds only)

all strips have same size

EM fixed (1x4cm^2), vary HD strips





area looks more important than aspect ratio

aspect ratio does have some effect

strip better than square

resolution worse than e.g. PANDORA at high energy

further algorithm development needed

summary & preliminary conclusions

PFA for strip calorimeter under development

- performance ~OK @91 GeV, not so great @200 GeV
- further improvements needed

45 GeV jets:

- in EM, strip area looks more important than aspect ratio
- in HD ~ insensitive (in range considered)

100 GeV jets:

- in EM, strip area looks more important than aspect ratio
- in HD strips seem to perform better than tiles (@ equal area)

plans

continue PFA development (maybe integrate with Pandora?)