Status of the Road Search Tracking Algorithm

Tracker b - τ Meeting
01/31/06

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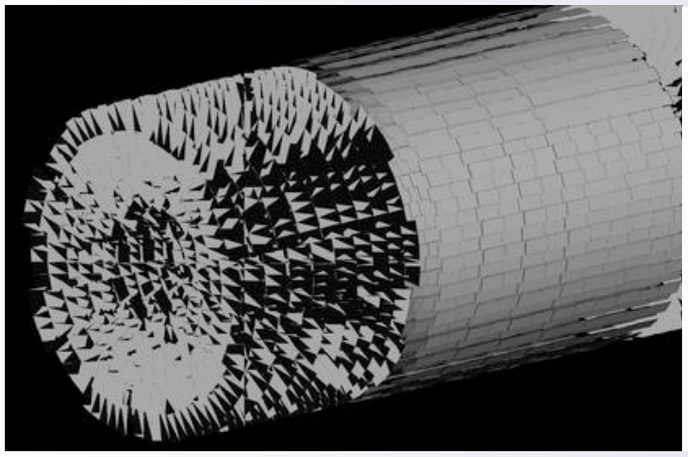
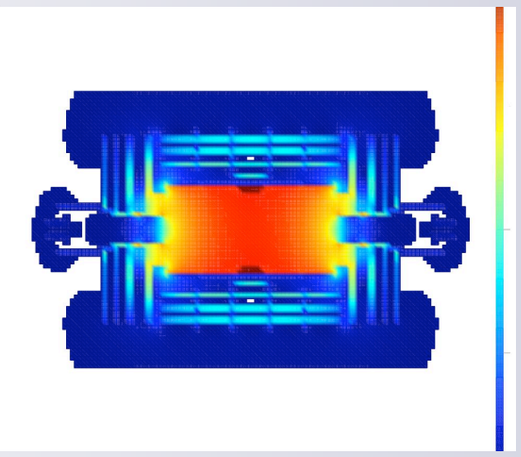
USCMS / Fermilab

Introduction & Outline





Introduction

- Clarify some aspects of the concept and the intention of the RoadSearch (RS)
- Update performance plots and start discussing non-pixel tracking
- Give a status of the CMSSW implementation of the RS

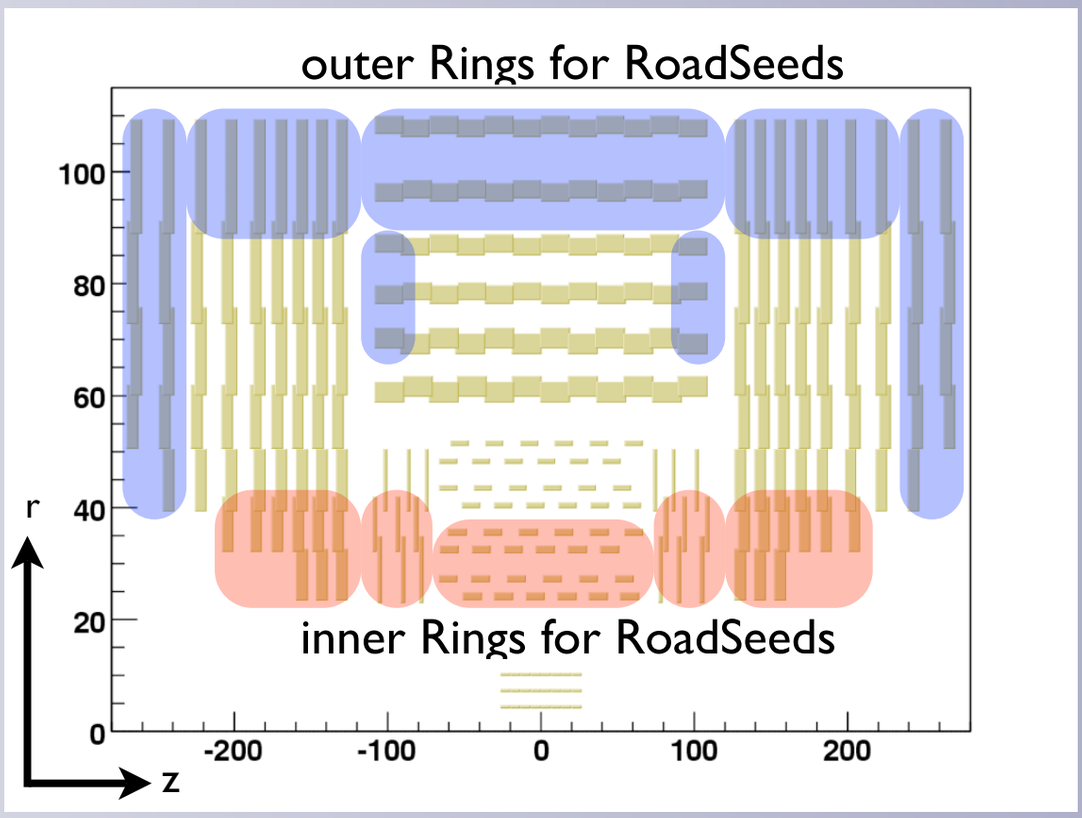
Outline

- Roadsearch introduction and motivation
- Efficiency definition
- The pixel question
- Performance plot update with pixels
- Performance plots without pixels
- CMSSW status
- Summary & Outlook

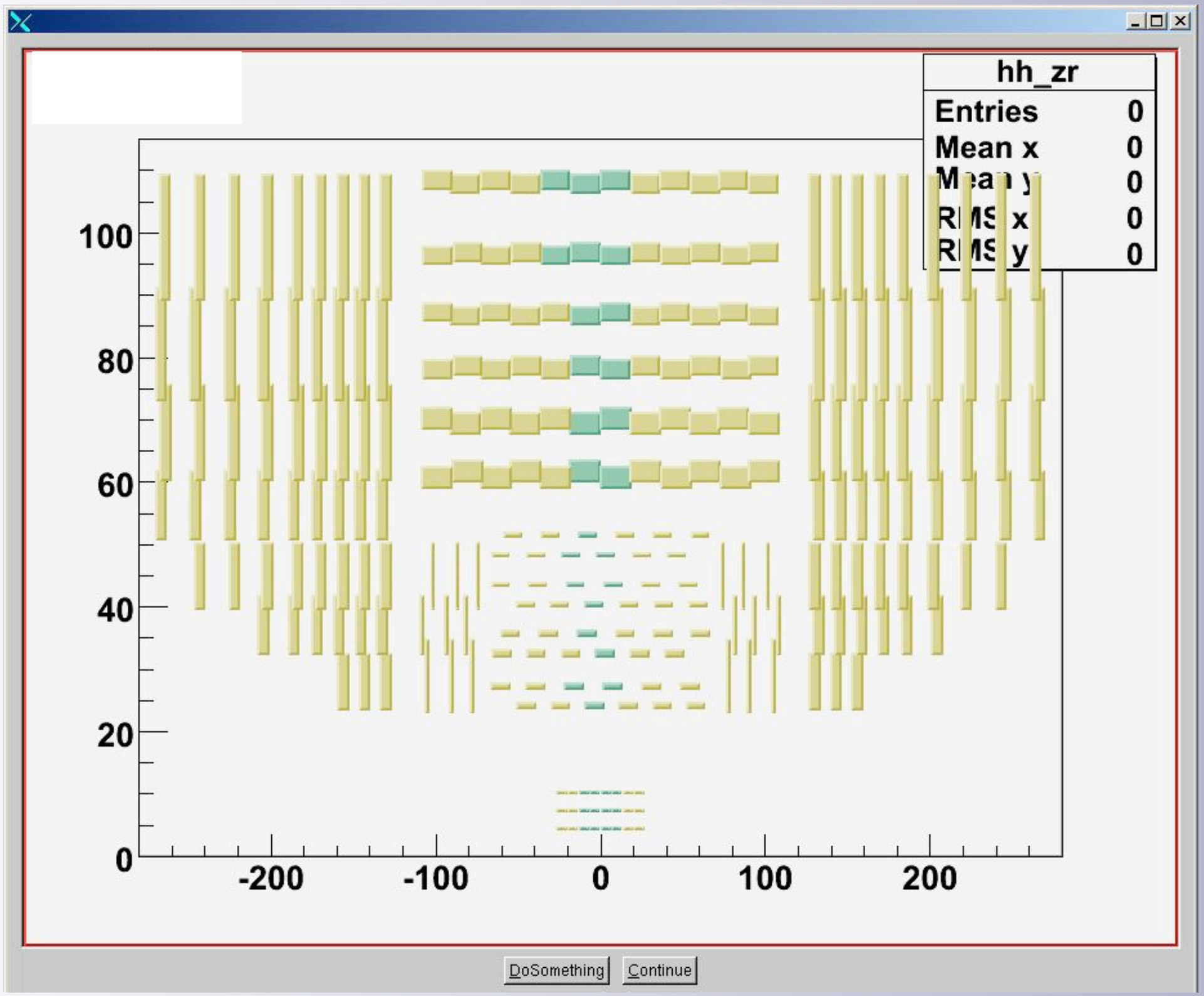
RoadSearch, Roads and Rings

Philosophy of RoadSearch

- Detector is subdivided into rings:
  - A Ring consists of all detector units summed over φ at a given r and z
- Step 1: Use Seed to determine initial trajectory through detector
  - Seed build from Hits in pre-defined inner and outer Seed Ring combinations (RoadSeed) passing Δφ cut
  - RoadSeeds are all linear extrapolations of an inner and outer Seed Ring combination compatible with the beamspot
- Step 2: Collect hits (Cloud) in window around trajectory in Road
  - Road consists of all Rings compatible with the linear extrapolation of the BeamSpot and the Seed Rings
- Step 3: Clean collection of hits ("Cloud")
  - Break ambiguities in hit collections
- Step 4: Apply final track fit



A Road


hh_zr
Entries 0
Mean x 0
Mean y 0
RMS x 0
RMS y 0
100
80
60
40
20
0
-200
-100
0
100
200
DoSomething
Continue

Motivation

- The RoadSearch Algorithm is meant to be an additional tracking possibility running simultaneously with the CTF
- Its function can be defined separately for two time periods:
  - Startup:
    - RS intended to provide robust tracking insensitive to detector configuration (alignment, etc.)
  - Normal Operation:
    - RS will provide additional tracking to cross check the CTF with a different approach
    - RS supplements the CTF in regions of phase space where the efficiency of the CTF is limited (forward)
- The implementation of the RS next to the CTF tracking code generalizes the structure and simplifies the implementation of a possible third, fourth, ... algorithm and the exchange of subcomponents.
- **What the RoadSearch is not meant to do:**
  - **The RoadSearch is not meant to replace the CTF!**

Algorithmical efficiency

- The CTF efficiency usually separates the algorithmical efficiency from the overall by applying cuts on the true level:
  - 2 pixel simhits
  - simhits span at least 8 layers
  - 50% hit sharing for true-reco track association
- For the current, basic implementation of the SeedFinder, the RS algorithmical efficiency currently cuts on
    - inner and outer Seed Hits
- 4 ways to compare the CTF and the RS:
  - Use overall efficiency (including geometry, etc.)
  - Drop the CTF specific part of the algorithmic efficiency definition
  - Add the RS specific part to the algorithmic efficiency definition (in this talk)
  - Find a common algorithmic efficiency

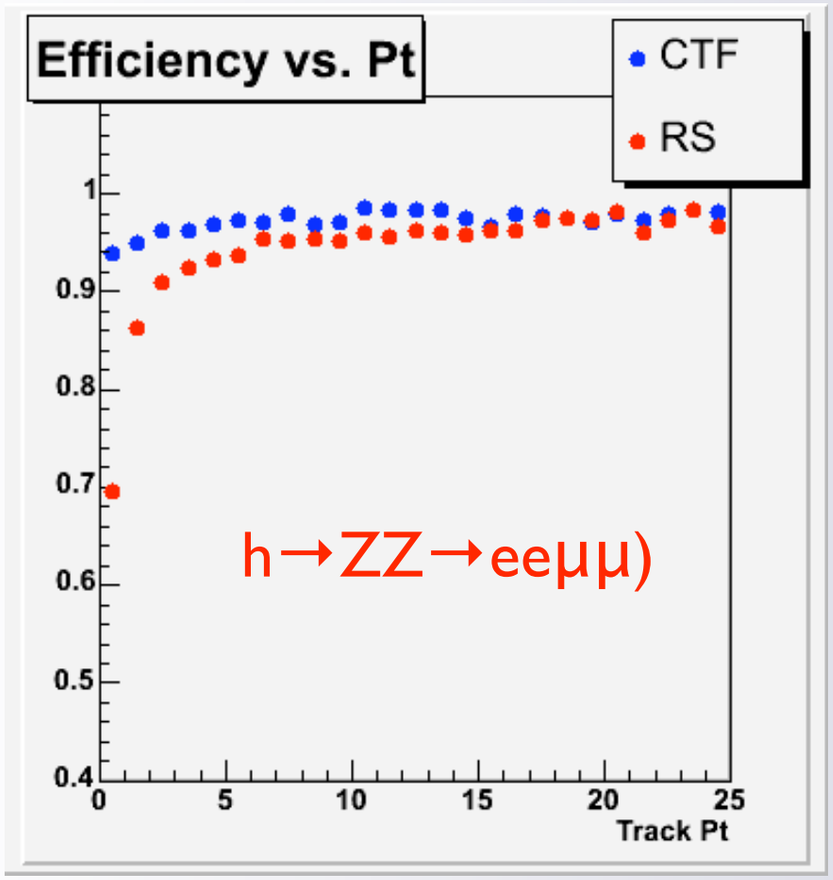
The Pixel Question

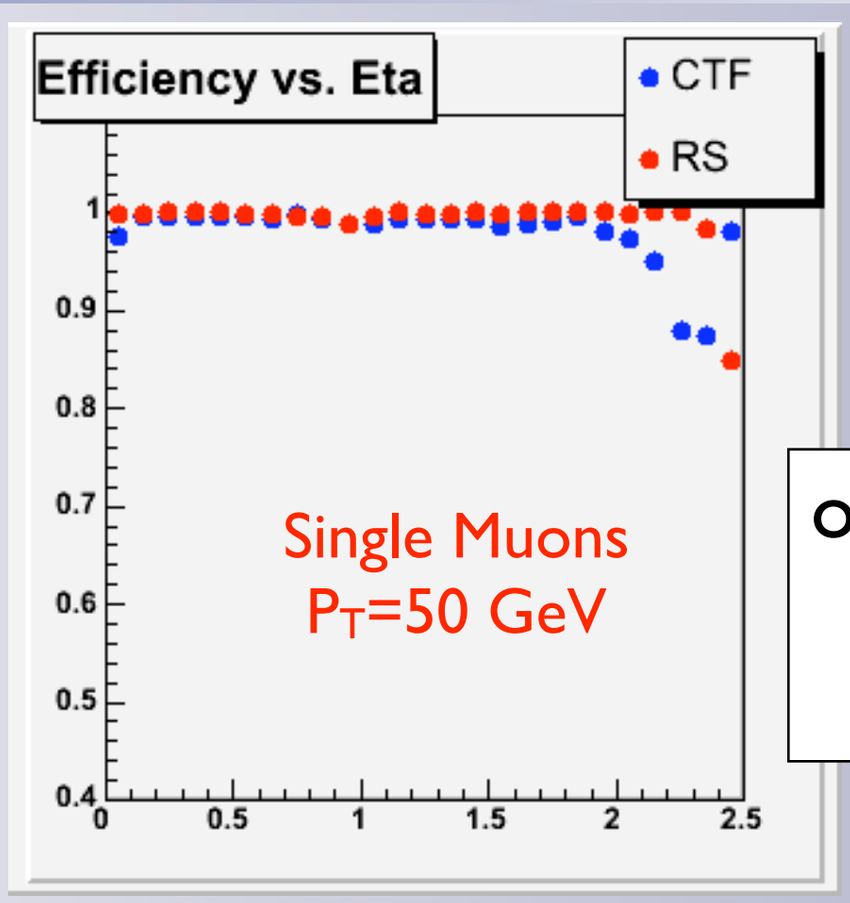
- At startup, the pixel systems will not be available for tracking.
- Two statements can be made concerning the pixels:

1. RS **will** use the pixel detector when it is there.
2. The RoadSearch algorithm is designed to use every tracking information from every available component.
3. The RoadSearch algorithm does not rely on the pixel system but see #1.

- Update of RS performance is separated into two sections:
  - Update of the performance using the pixels
  - Start of the pixelless performance discussion

Last presentation



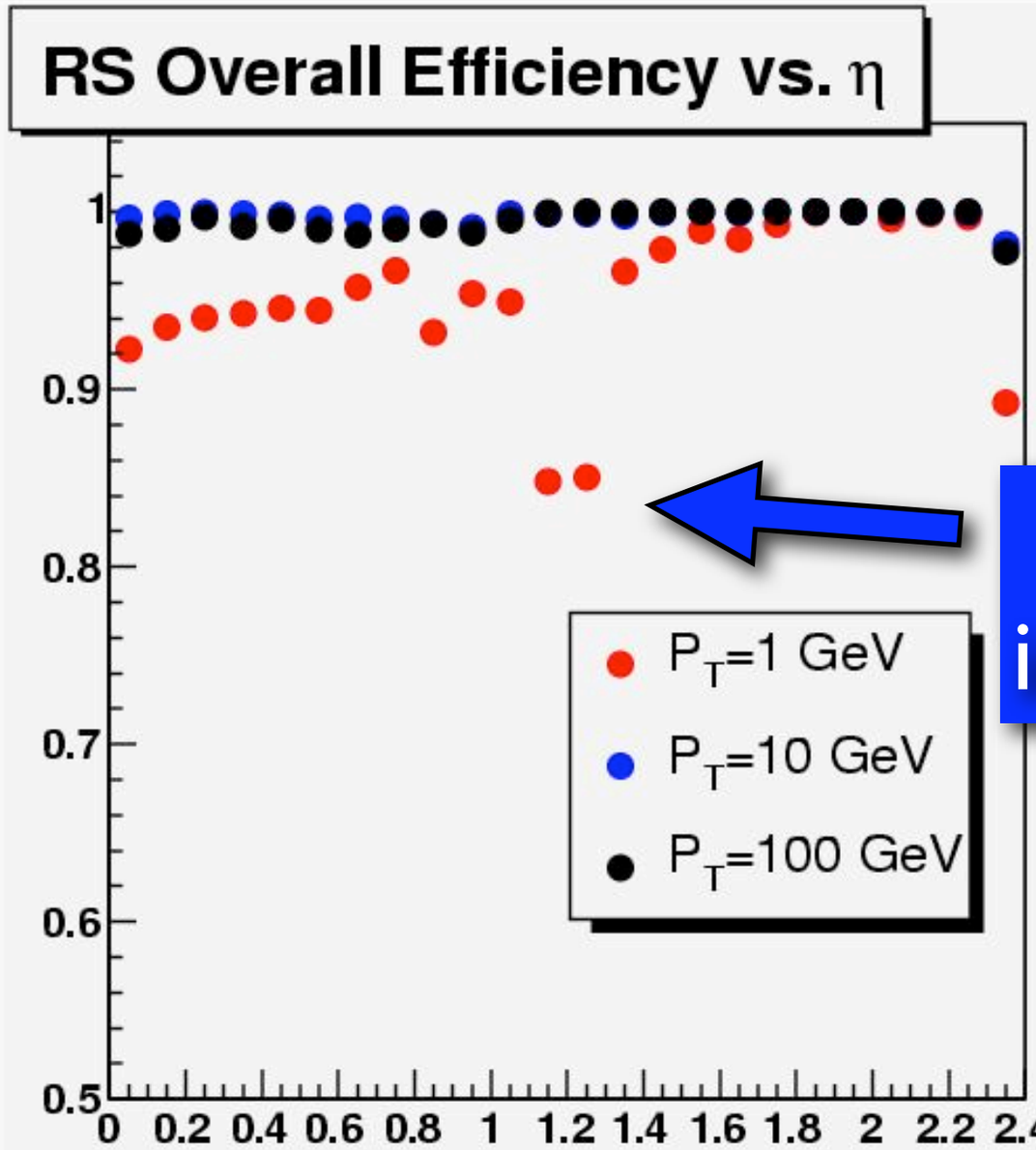


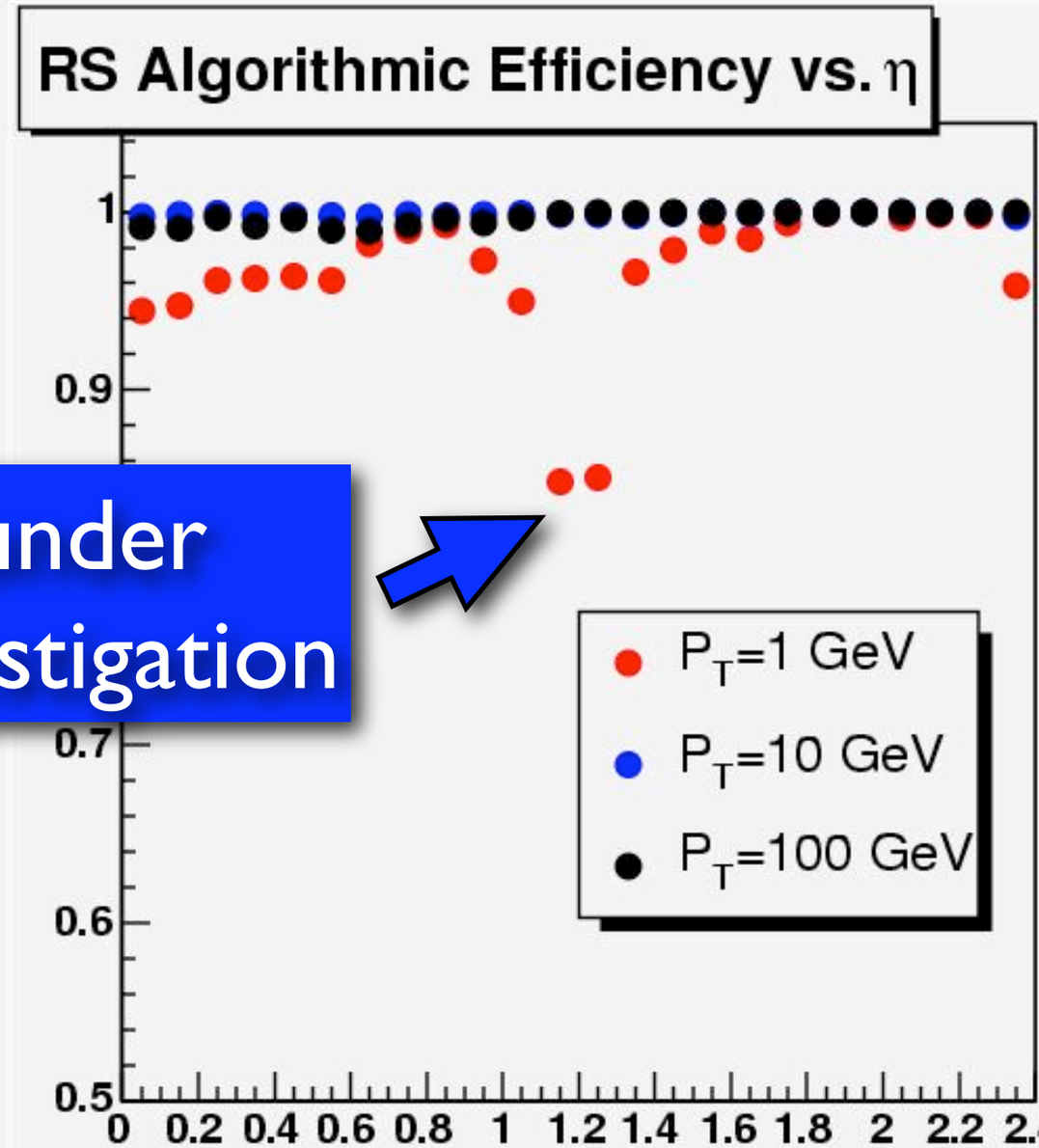
old denominator
=
CTF definition

- Action items:

1. p_T dependent roadsize to widen road for increased multiple scattering
2. Compare RS and CTF performance inside jets
3. Change Seeding (with pixels, using TOB stereo layer instead of TOB outer layer)

Single muon performance

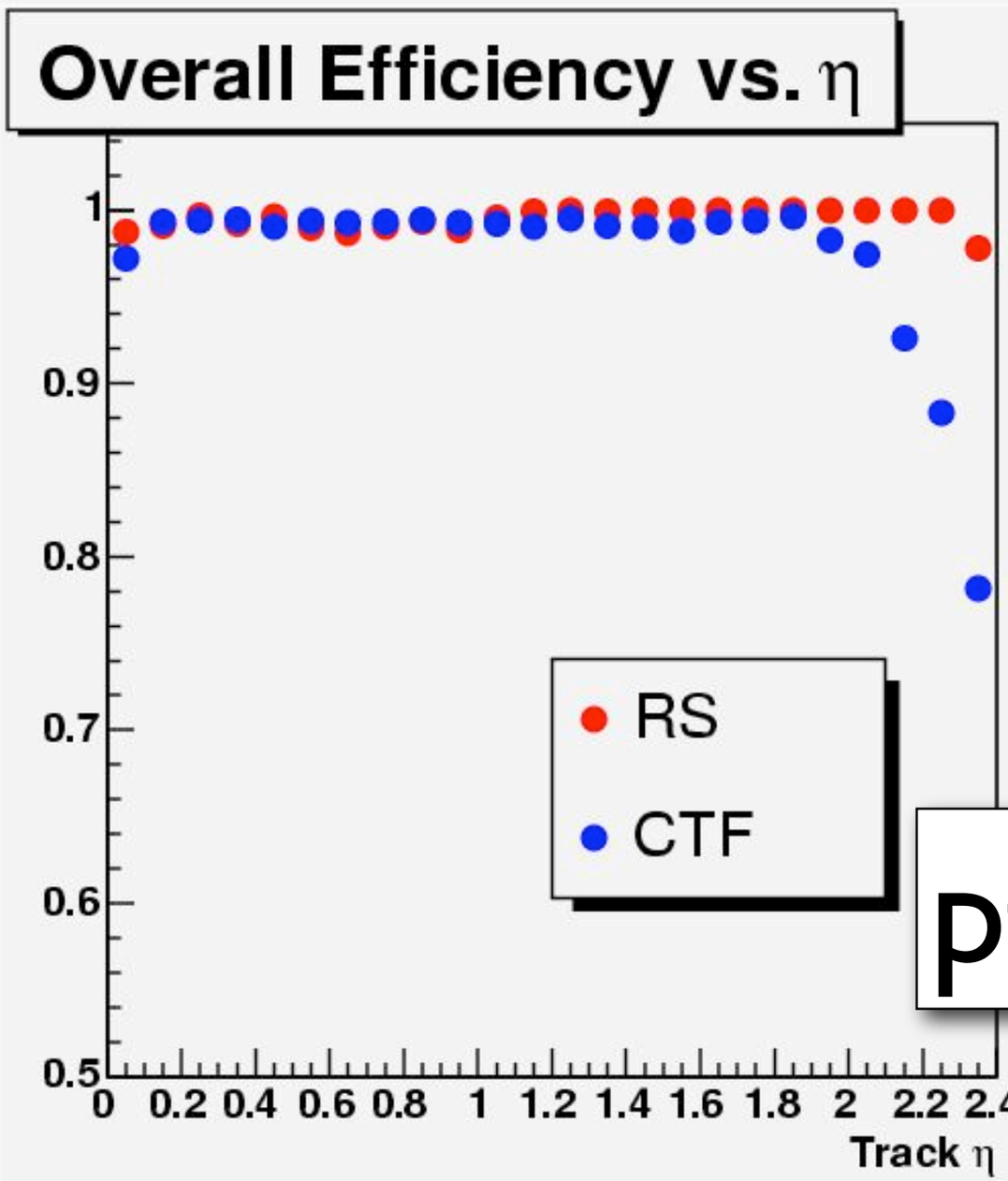


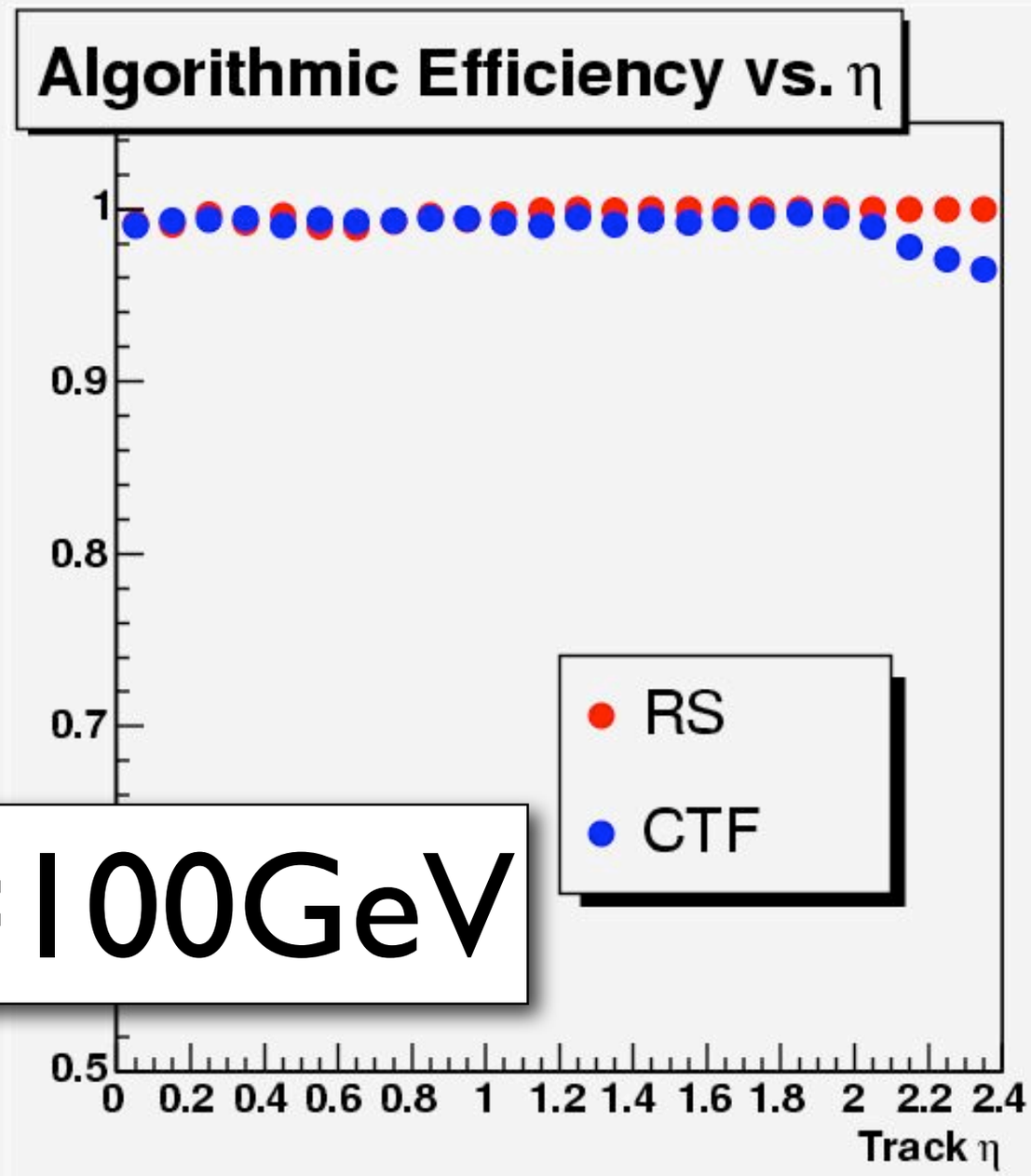


under investigation

- Changes: Widened Road for low p_T, reduced cut on number of layers hit if there are geometrical constraints (forward)
- Result: efficiency in barrel now consistently over 90%, change increased the efficiency by 3-4%

RS vs. CTF comparison for single muons

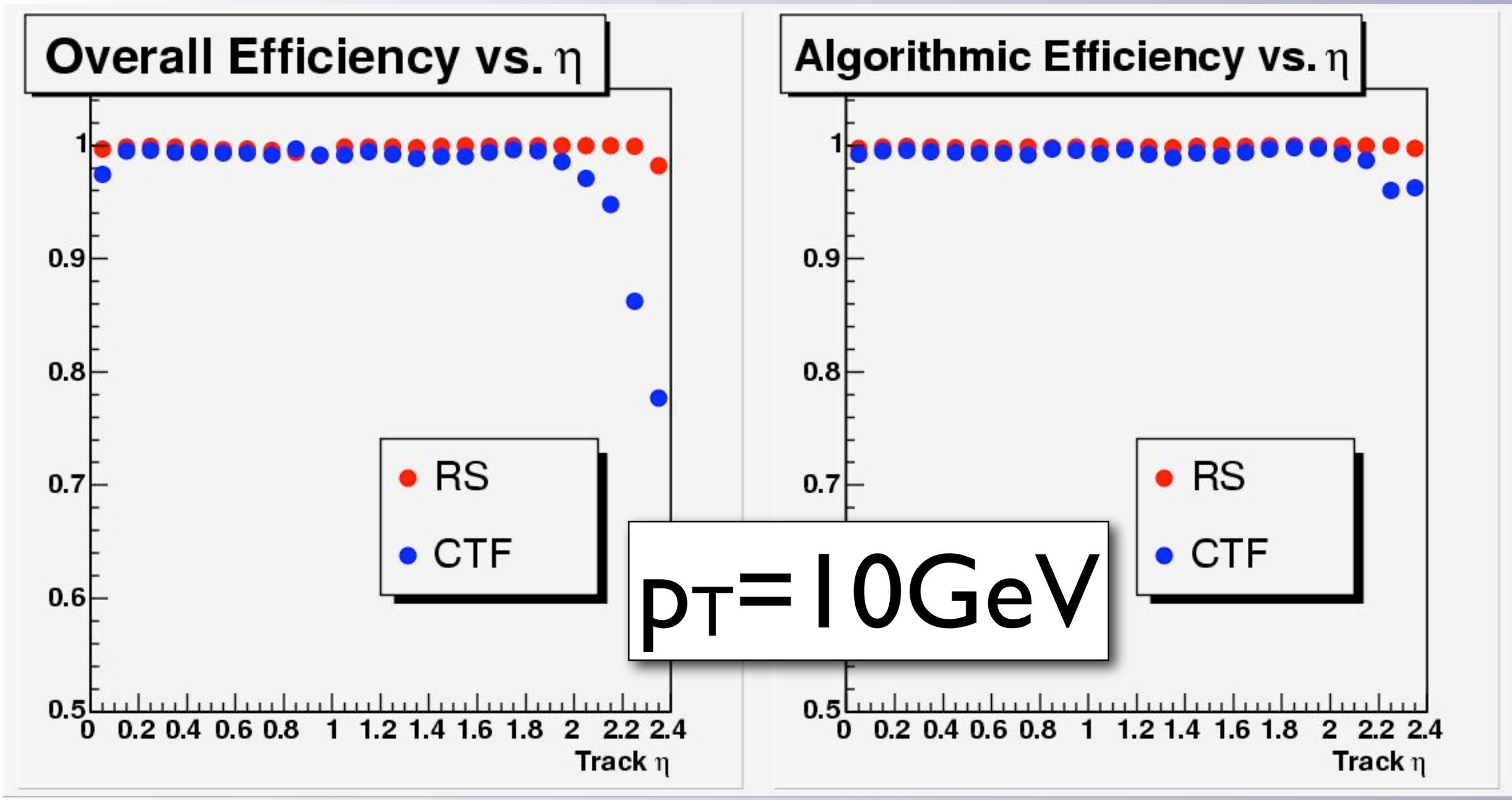




p_T=100GeV

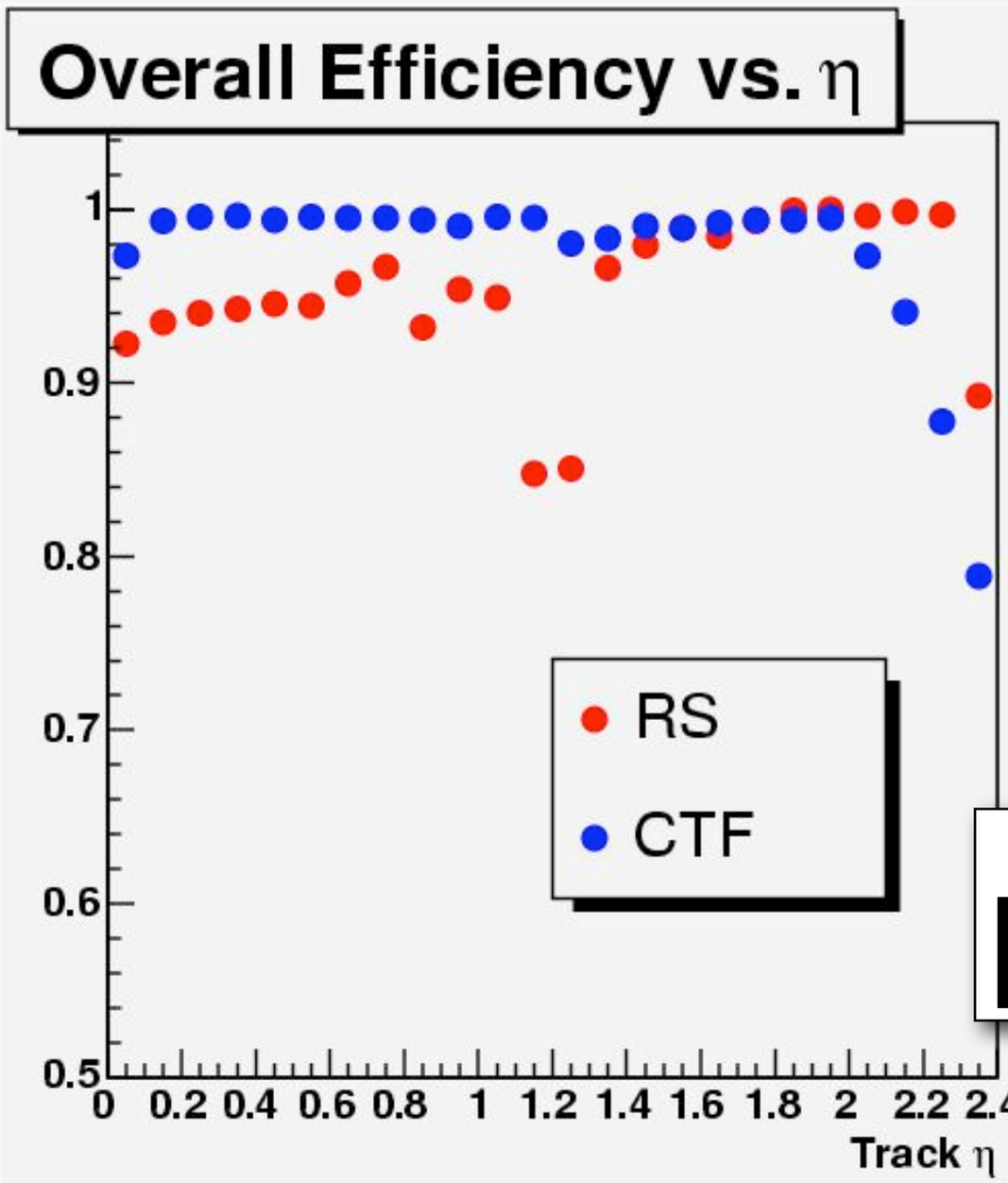
- Efficiency flat and close to 1
- Forward eta range promising

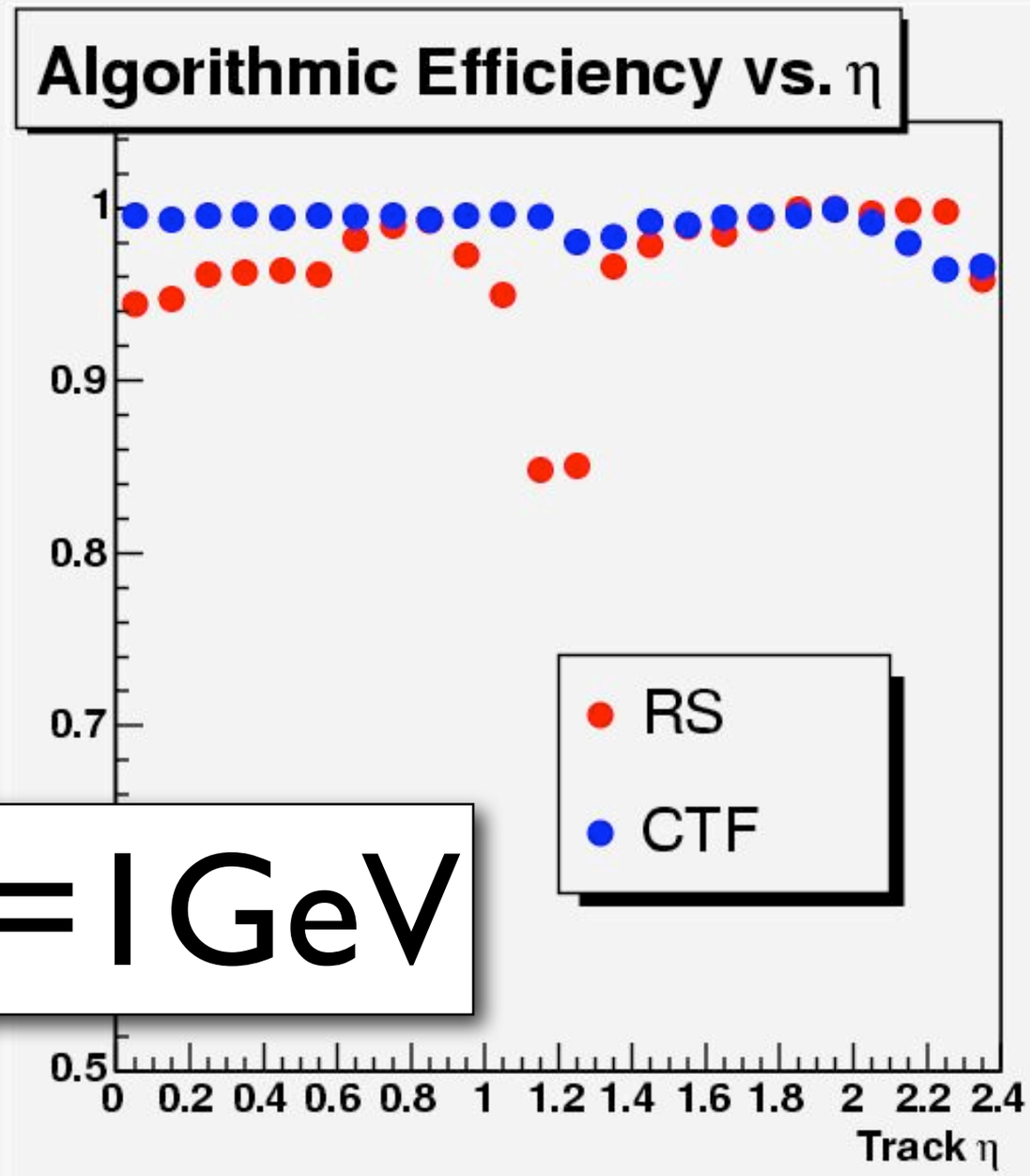
RS vs. CTF comparison for single muons



- Same picture as for p_T=100GeV

RS vs. CTF comparison for single muons

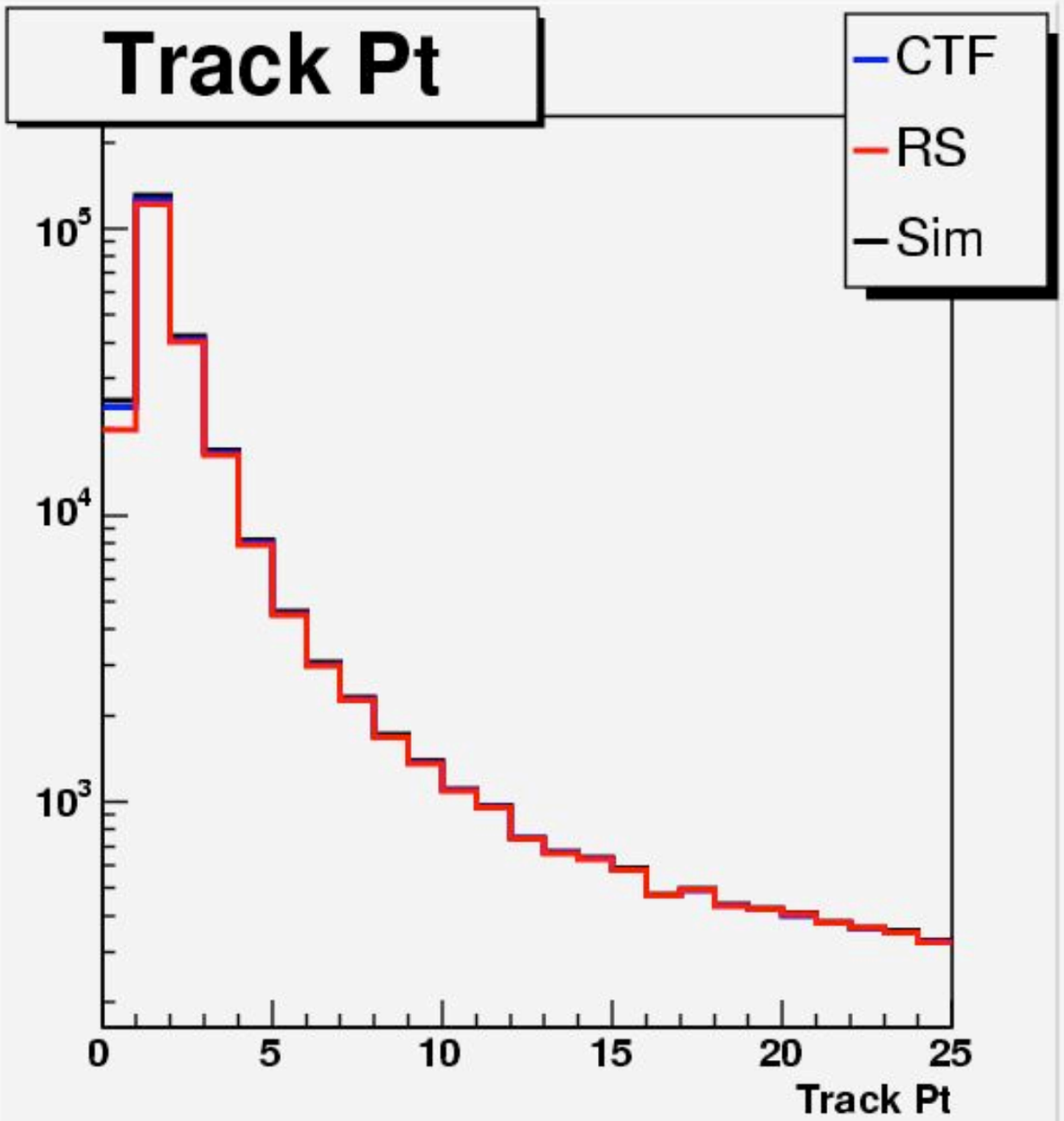


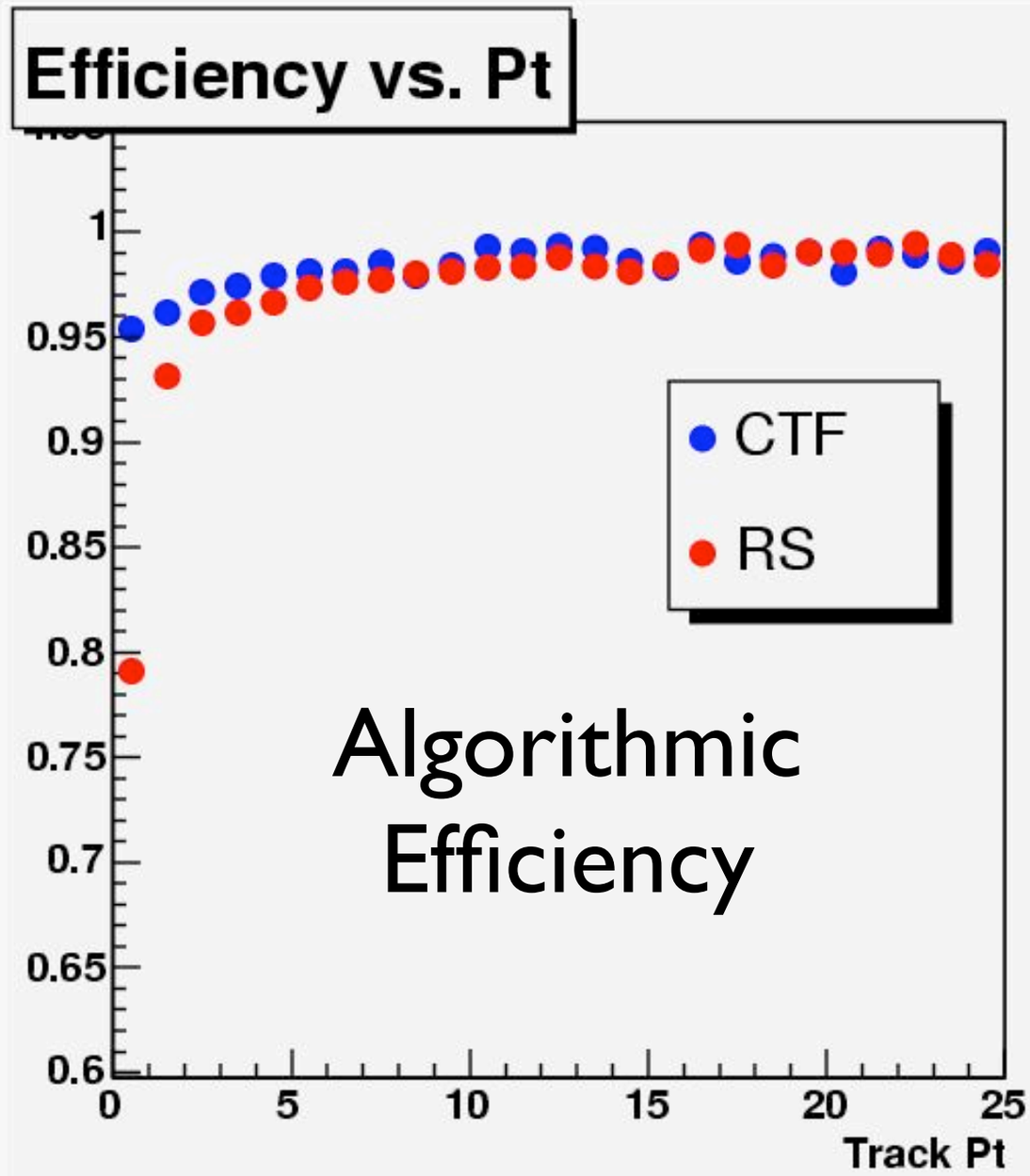


$p_T = 1\,GeV$

- Efficiency improved by 3-4% due to widened roads
- Remaining features under investigation

RS vs. CTF comparison for h→ZZ→eeμμ

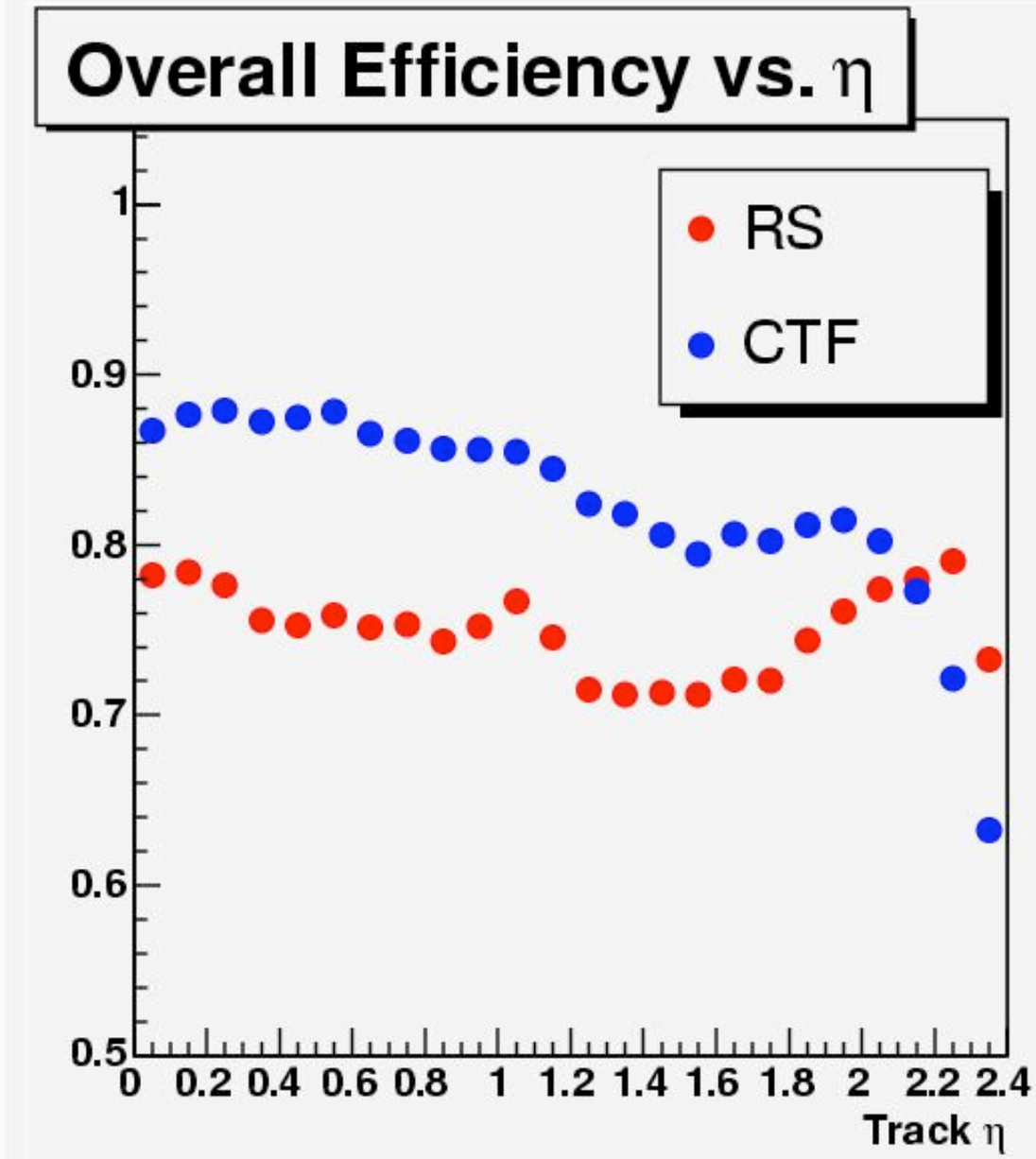


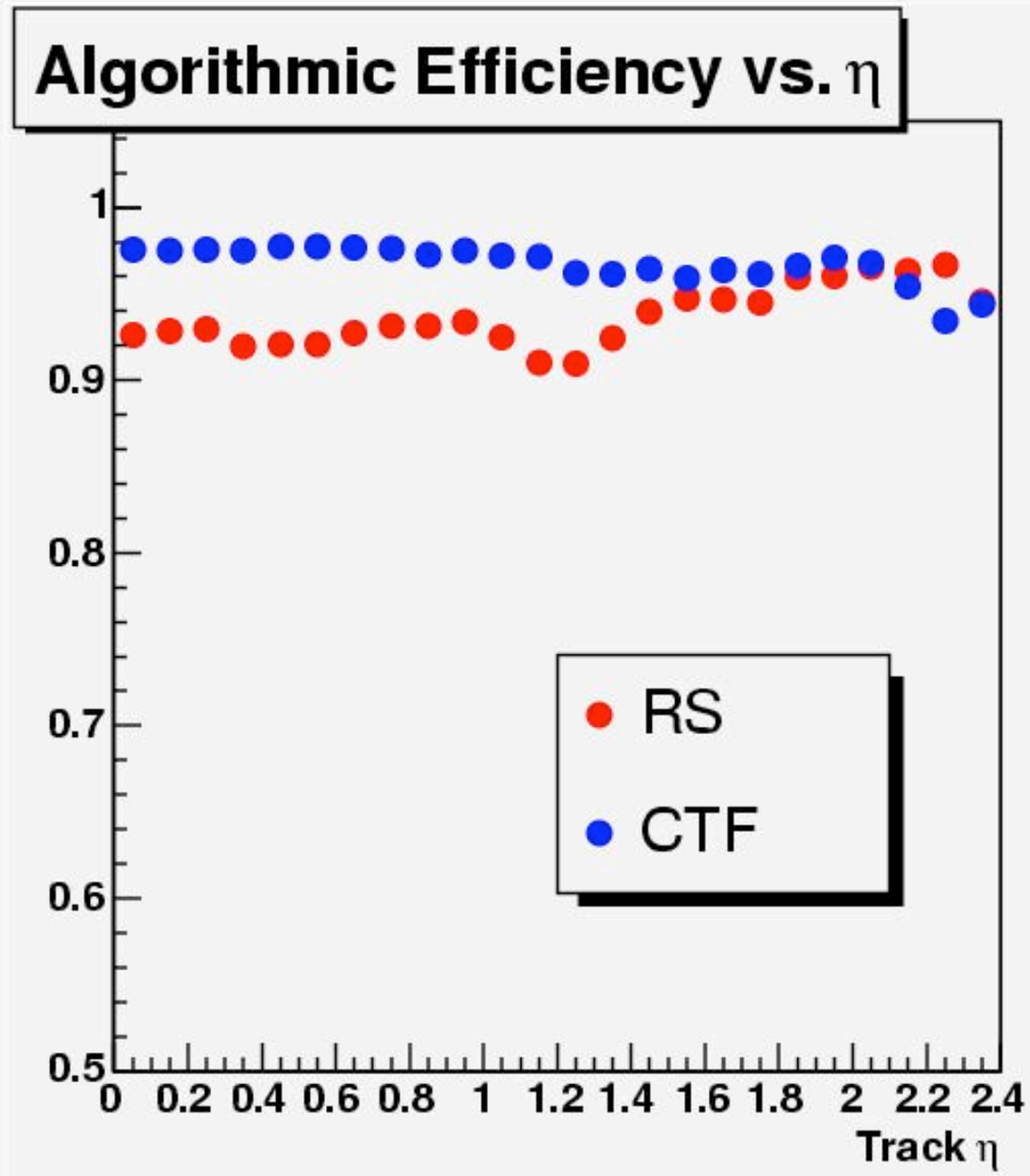


Algorithmic Efficiency

- Algorithmic RS efficiency compatible with CTF efficiency at higher p_T
- Inefficiencies can be seen at lower pT

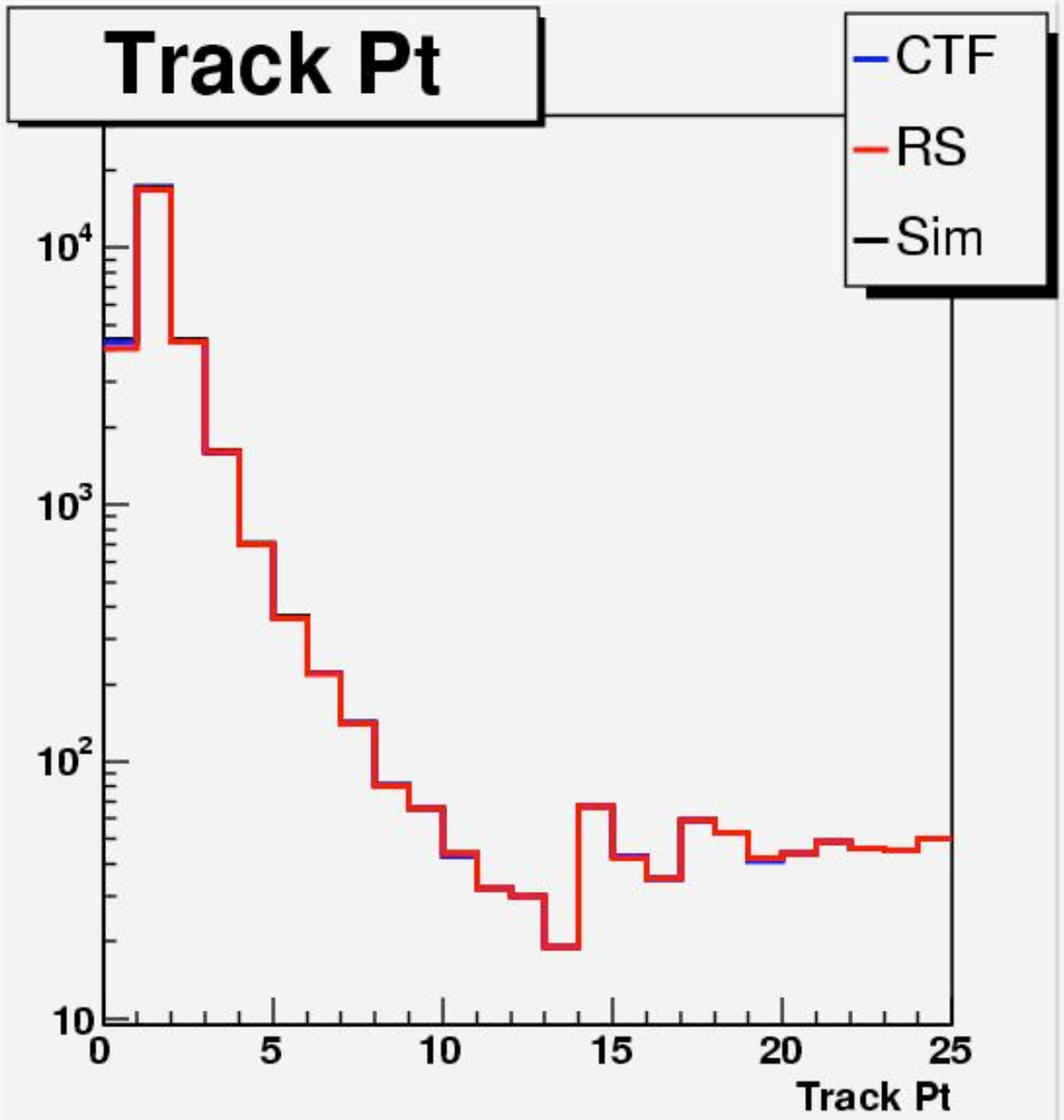
RS vs. CTF comparison for h→ZZ→eeμμ

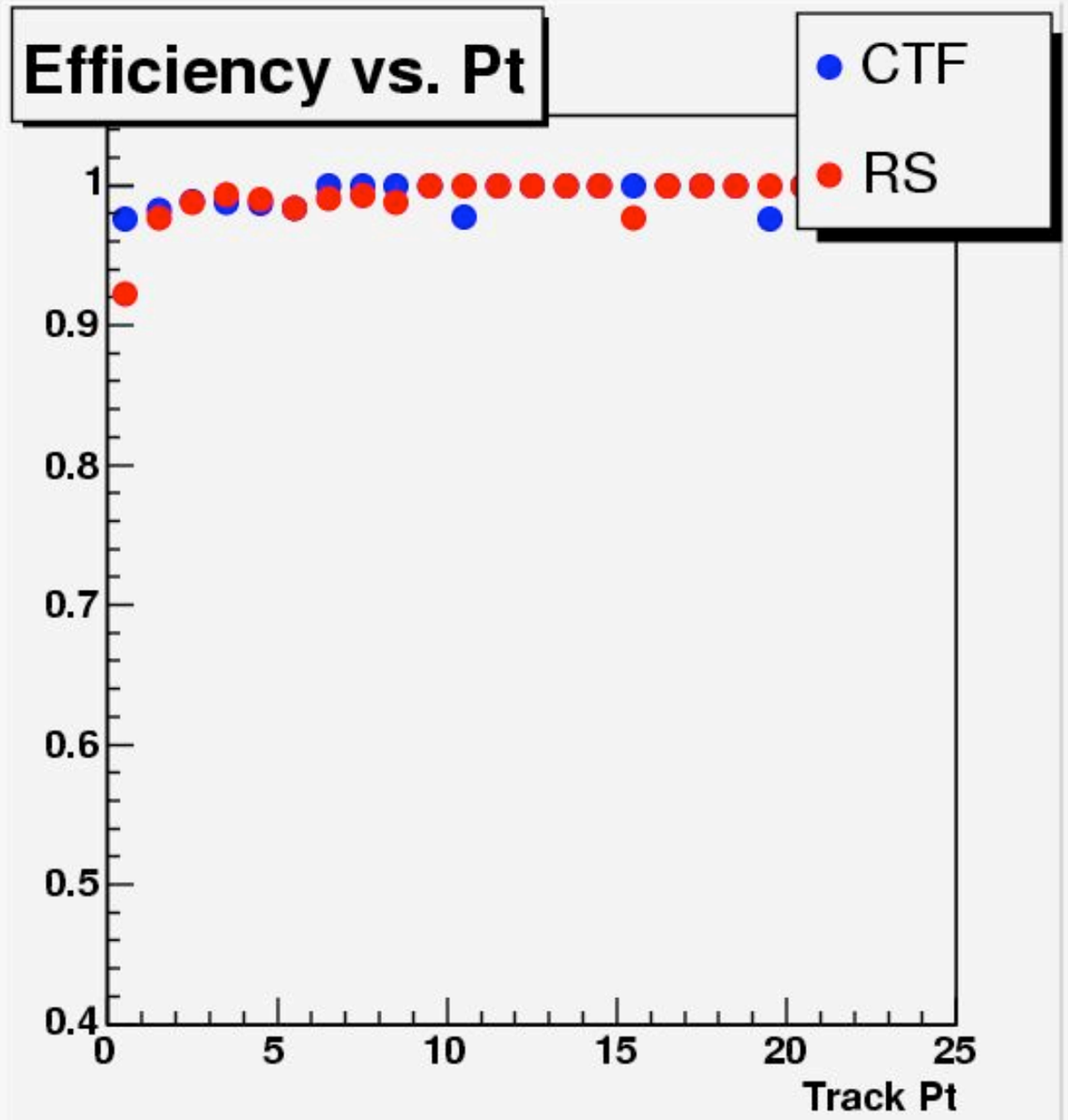




- Inefficiencies for lower p_T concentrated in barrel region

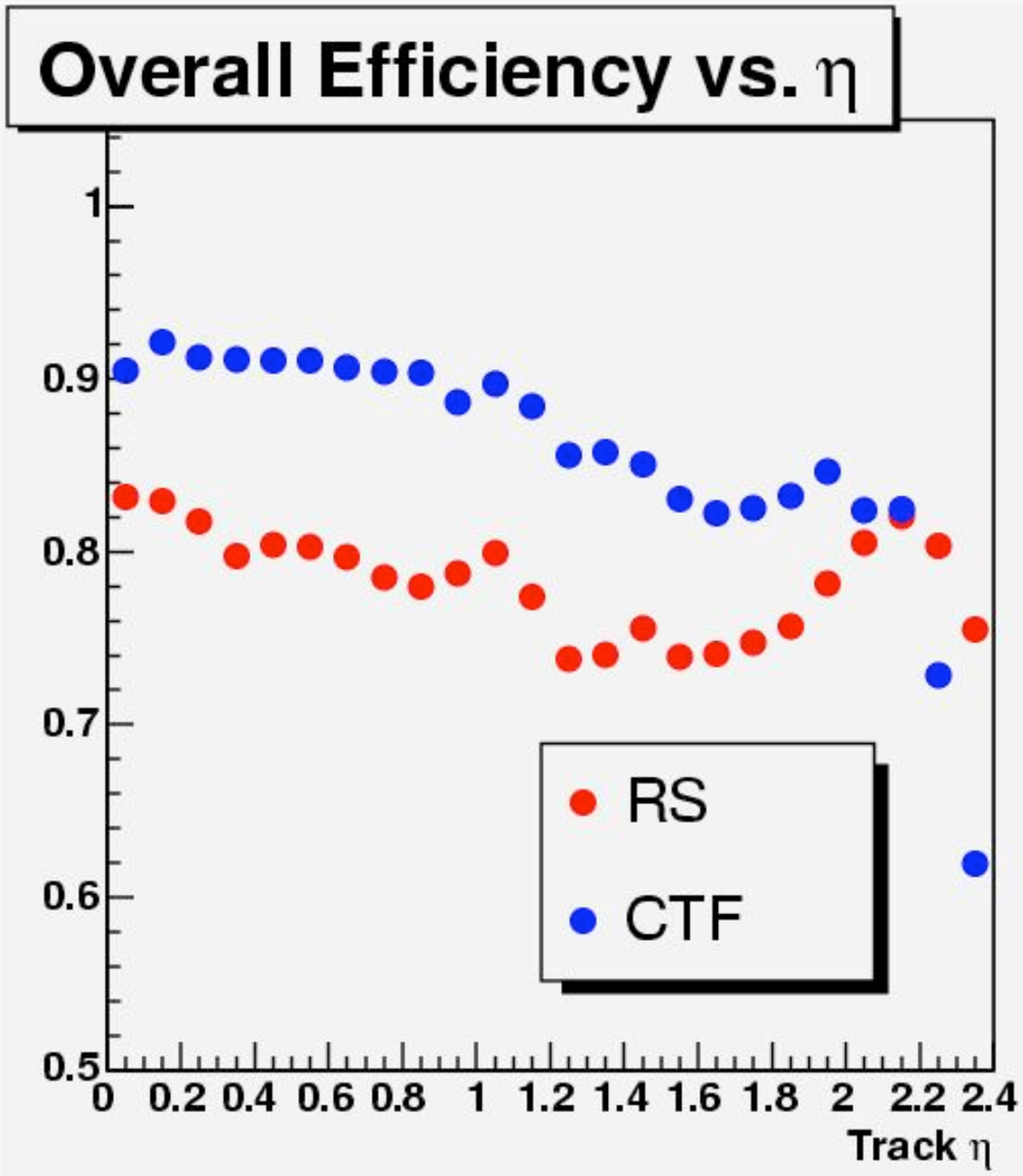
RS vs. CTF comparison for W→μν+pileup

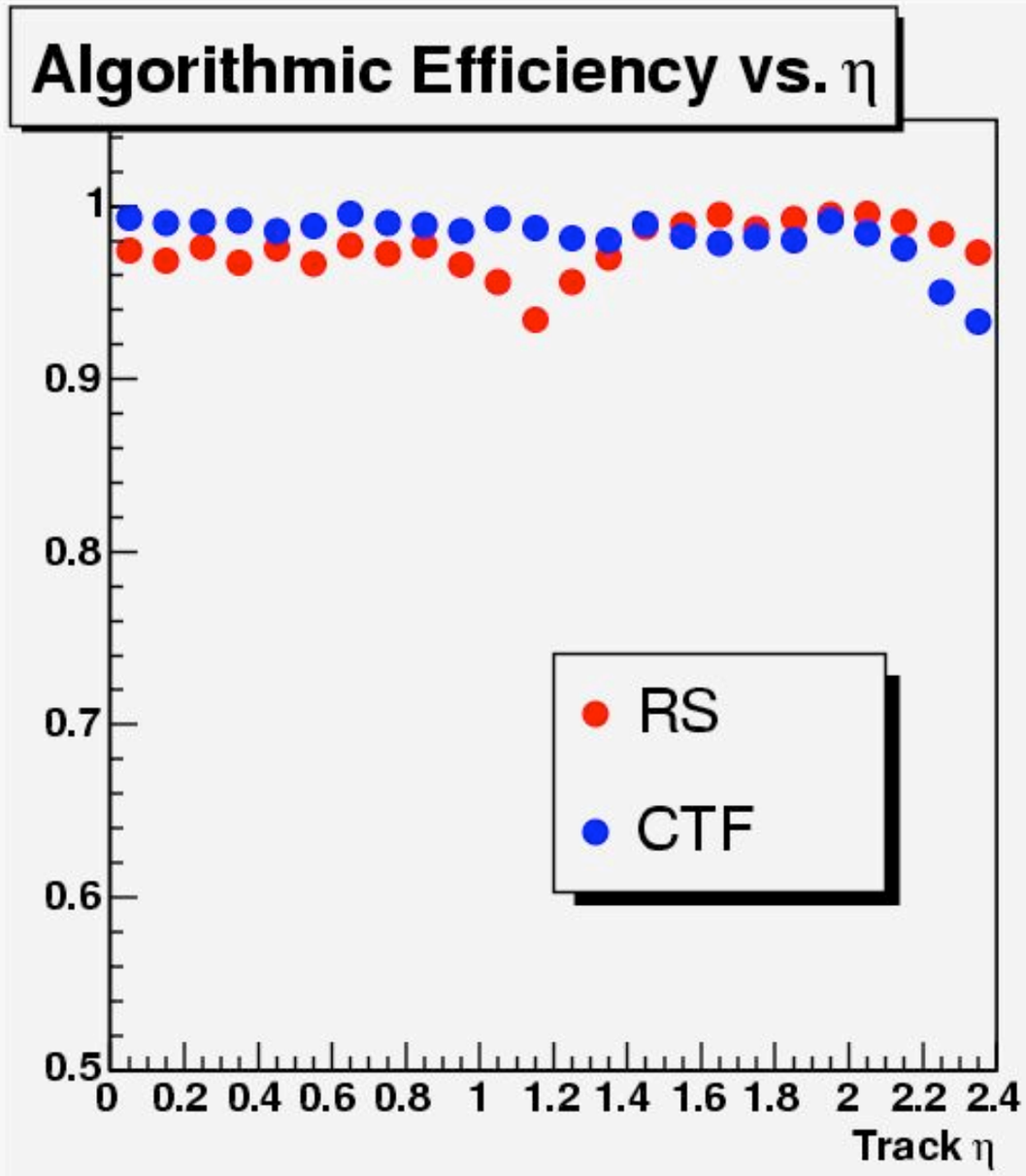




- Previously problems in the usage of SimTracks from PU
  - First plots with only taking into account SimTracks from the event

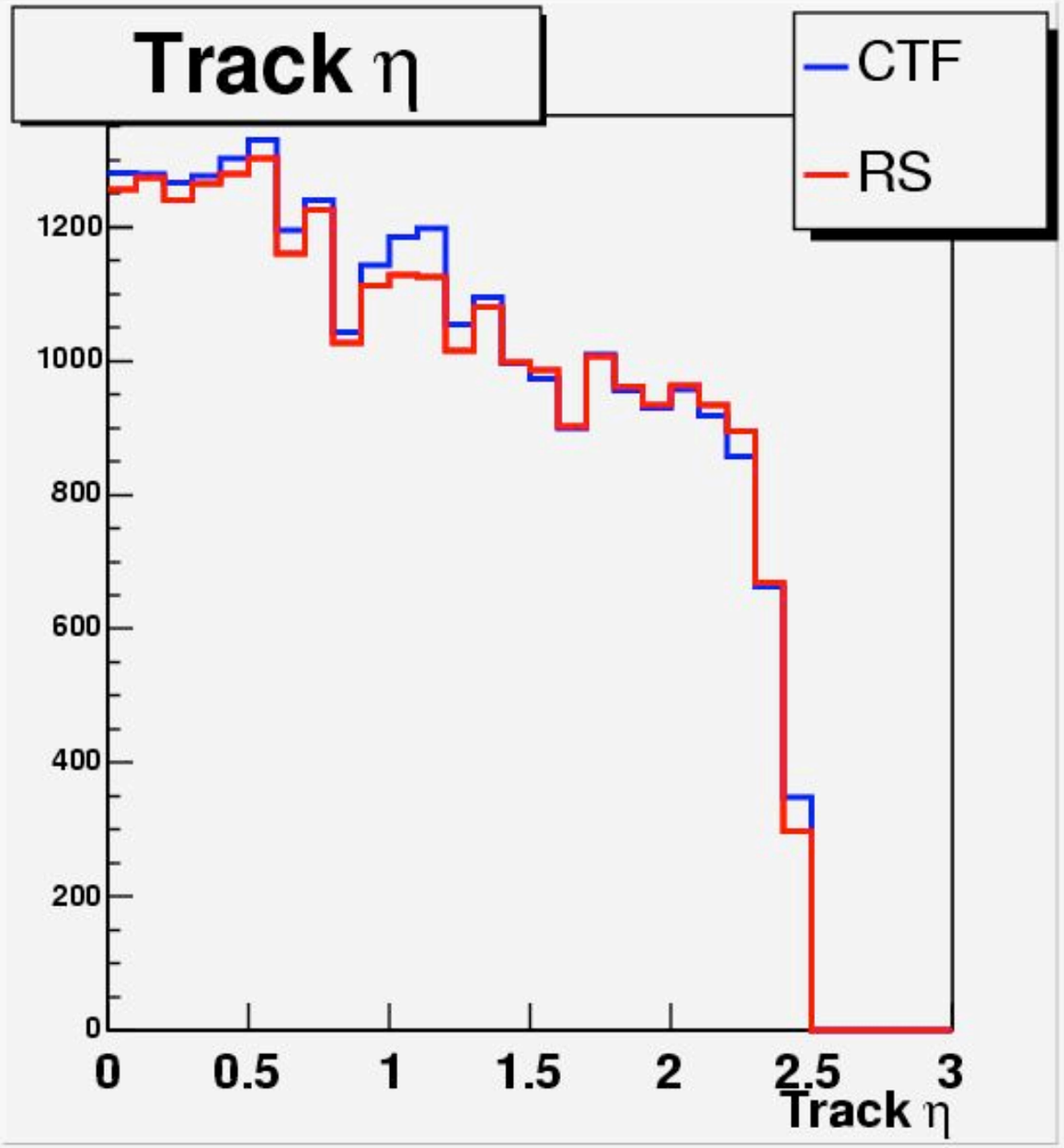
RS vs. CTF comparison for W→μν+pileup

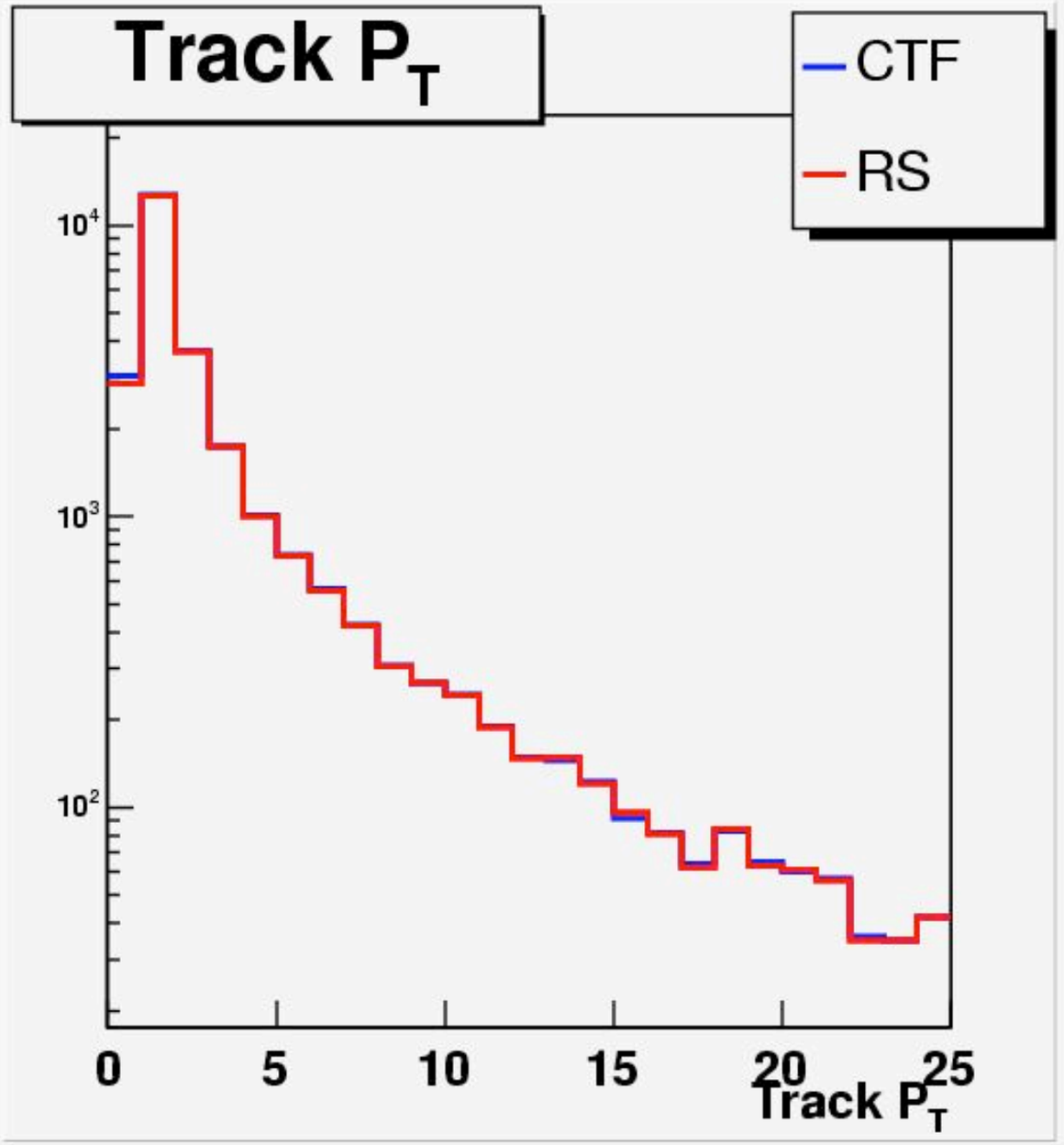




- Inefficiencies for lower p_T concentrated in barrel region less visible (under investigation)

RS vs. CTF comparison for b jets ($20 \leq p_T \leq 170$GeV)





- Problem in the usage of SimTracks from PU
- Here only the comparison of number of tracks of RS and CTF is shown

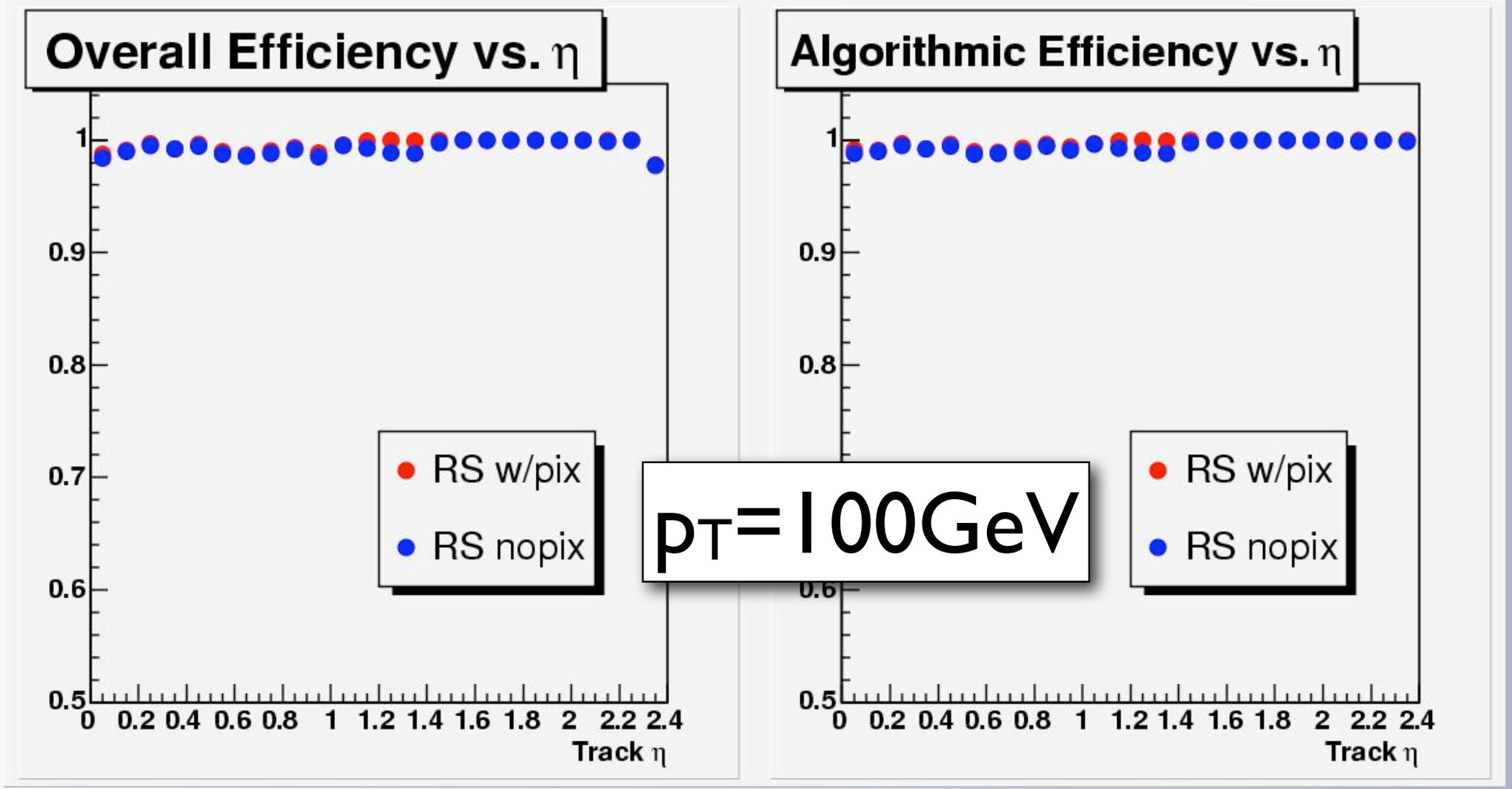
Timing

sample	mean number of tracks		time per event	
	CTF	RS	CTF	RS
single muon	1	1	0.09	0.06
h → ZZ → eeμμ	33.7	29.8	3.7	7.6
W → μν + pileup	43.3	40.7	14.3	23.9
b jets (120≤pT≤170GeV)	60.0	56.2	17.3	52.0

- time consumption in RS shows that it currently can stand even most dense events
- remark: optimization efforts currently went into efficiency and cloud building (time consumption reduction ~factor 50)

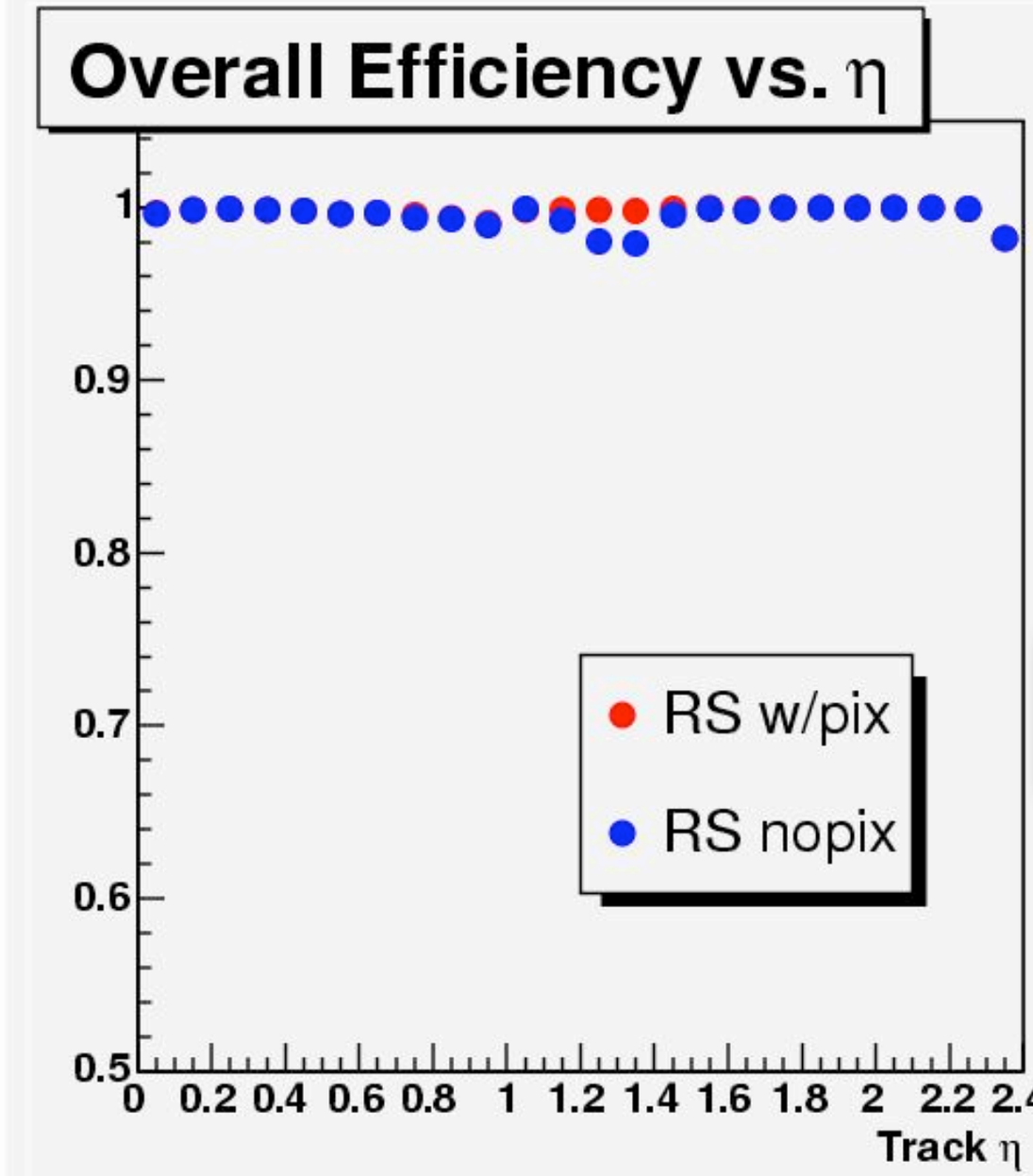
➡ **still large room for improvements**

RS w/pix vs. nopixels comparison for single muons

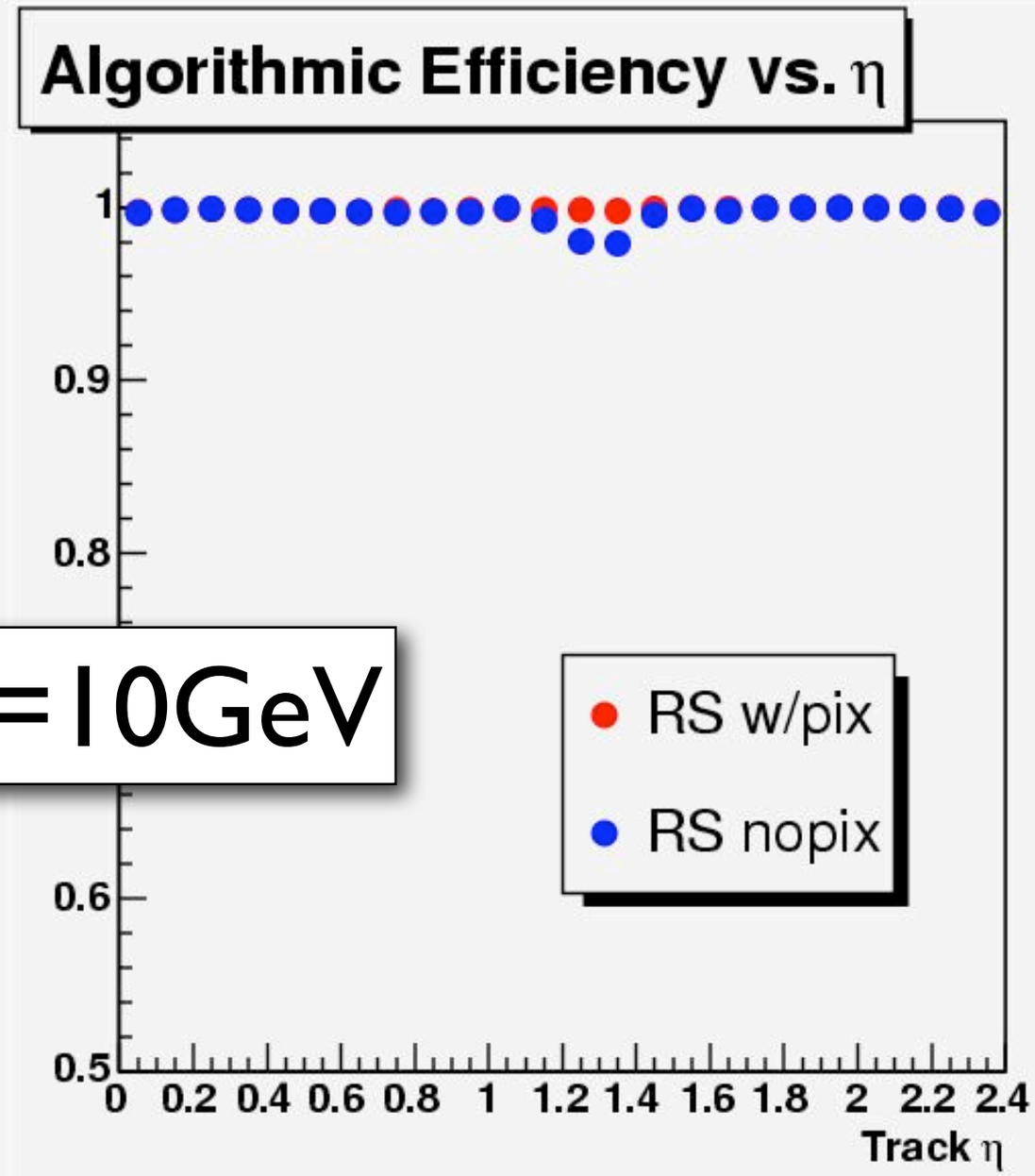


- No significant changes in dropping the pixels
  - exclude pixel information from cloudbuilding and further down the tracking chain, lower cut on used layers from 8 to 6
- **No** optimization done so far

RS w/pix vs. nopixels comparison for single muons

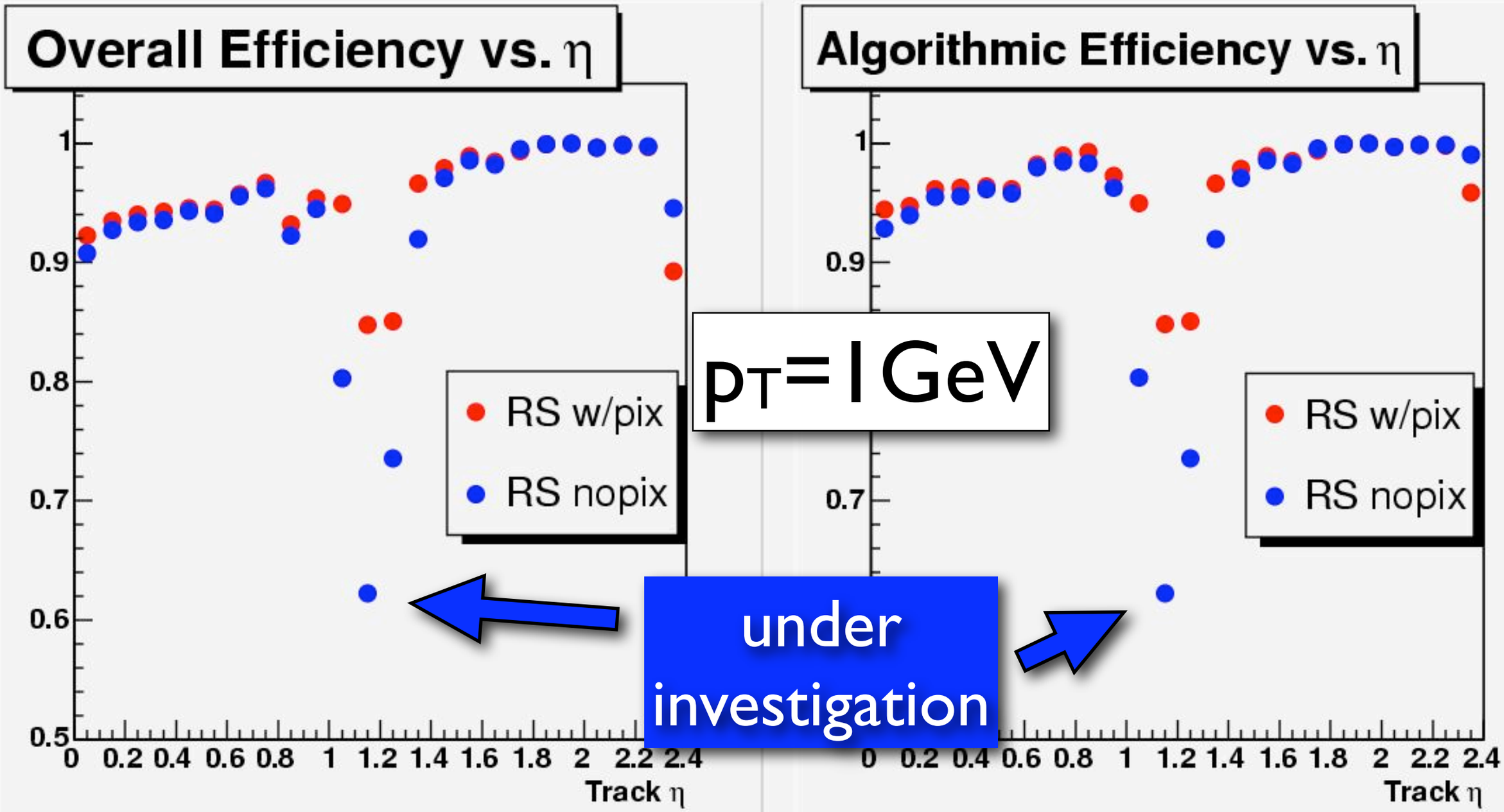


p_T=10GeV



- Same behavior like p_T=100GeV

RS w/pix vs. nopixels comparison for single muons



$p_T = 1\,GeV$

under investigation

- Pixelless efficiency very close to the pixel case.
- Effect in "region under investigation" enlarged

CMSSW: RS within the Tommaso Plan

Services:

Geometry Service

Magnetic Field Service

Roads

Modules:

RecHitConverter

SeedFinder

CloudMaker

CloudCleaner

TrackFitter

Products:

RecHits

Seeds

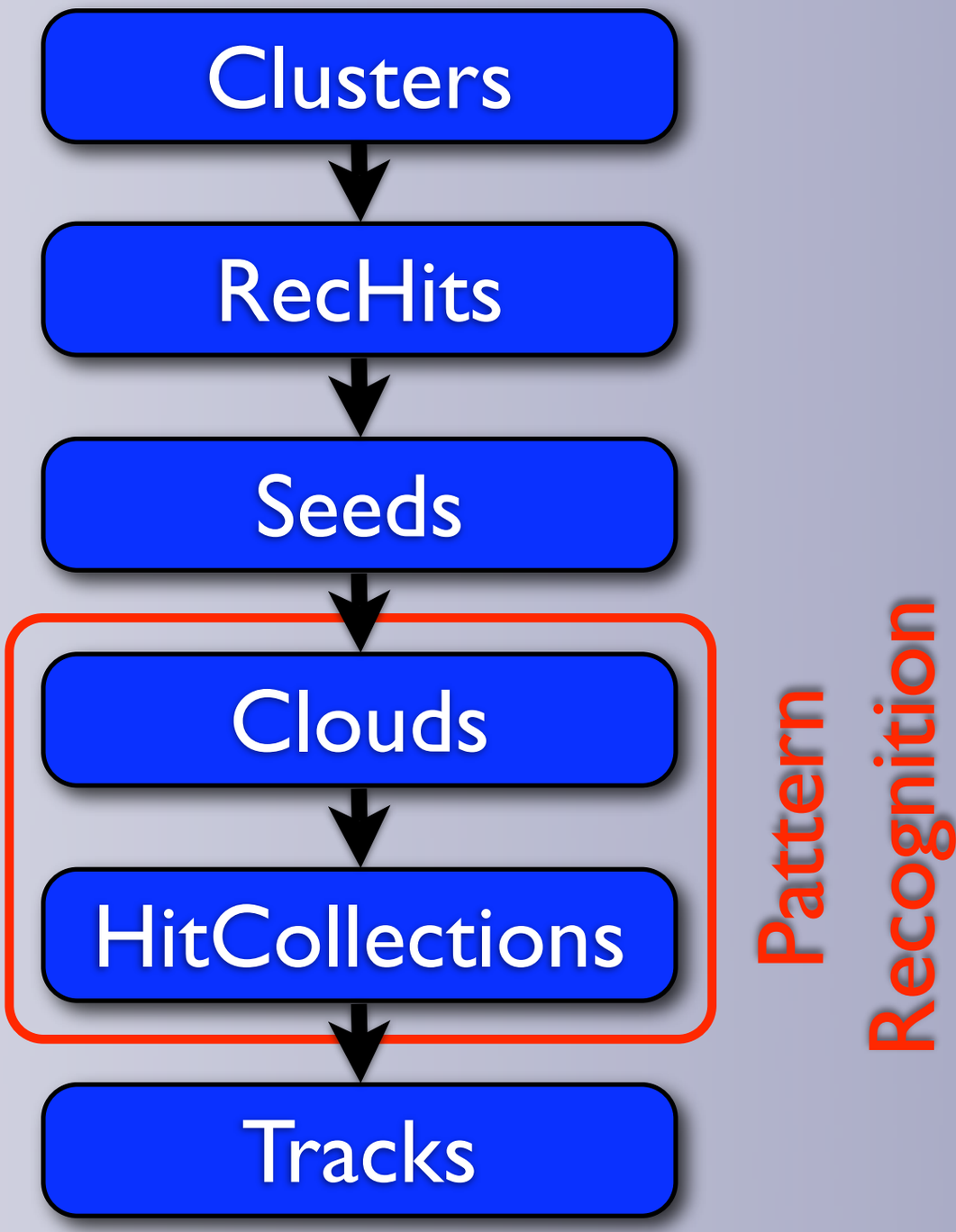
Clouds

HitCollections

Tracks

CMSSW implementation status

- Goal:
  - First implementation as close as possible to ORCA implementation
- Status since Tracking Software Workshop:
  - "not much time" :-)
  - still debugging simulation chain to actually test and debug SeedFinder and CloudMaker
  - RecHitConverter almost working



Summary & Outlook

- Performance studies of the pixel and pixelless RS in comparison to the CTF progressing
- Plans:
  - Compare to pixelless CTF (in contact with Boris)
  - Optimize performance in jets
    - Look into Seeding, etc.
  - **Move as soon as possible to CMSSW to concentrate manpower**
- CMSSW implementation progressing