Large χ^2 CTF Tracks and OutliersRejection Study on CRAFT09

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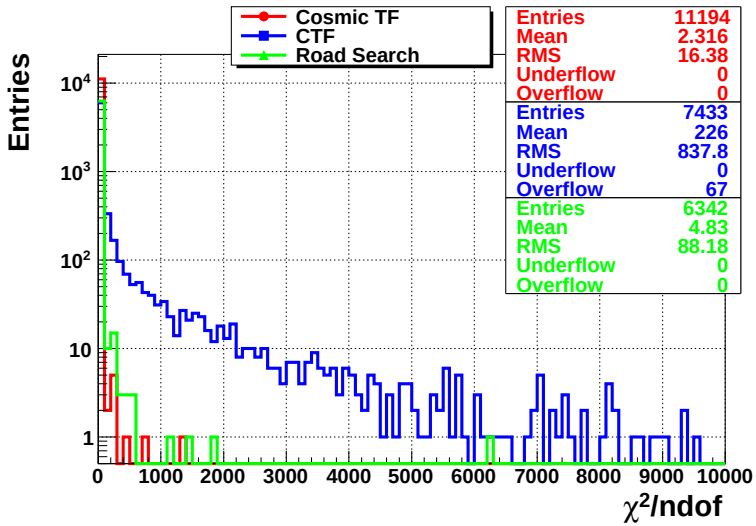
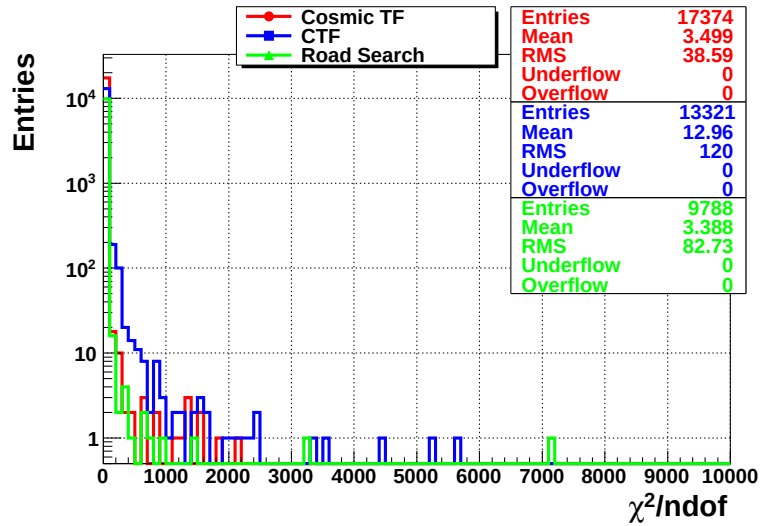
Outline

- Large χ^2/dof CTF tracks in CRAFT09
  - Compare of CRAFT09/08 data
  - Compare 311/225 reconstruction on same CRAFT08 data
- OutliersRejection impact on CRAFT09 and 310 MC
  - Track parameters comparison in CTF/COS/RS
  - Rejected hits population based on CTF 1-track events
  - BreakTrajWith2ConsecutiveMissing effect on CTF tracks
- Summary and Plans

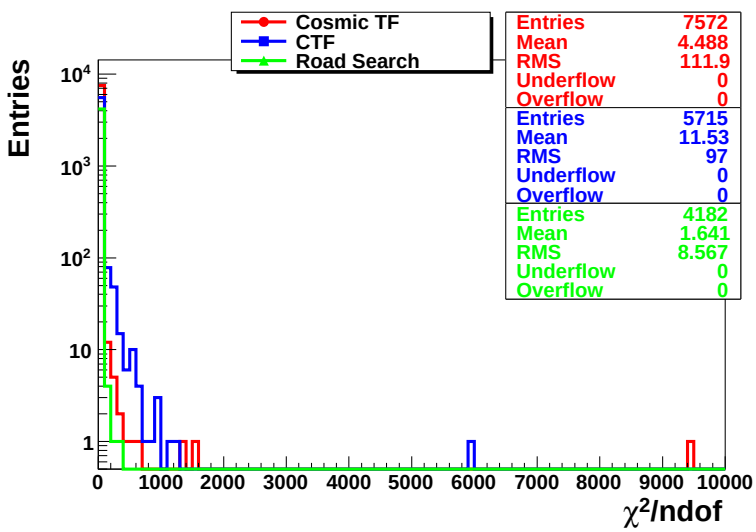
Large χ^2/dof CTF tracks in CRAFT09

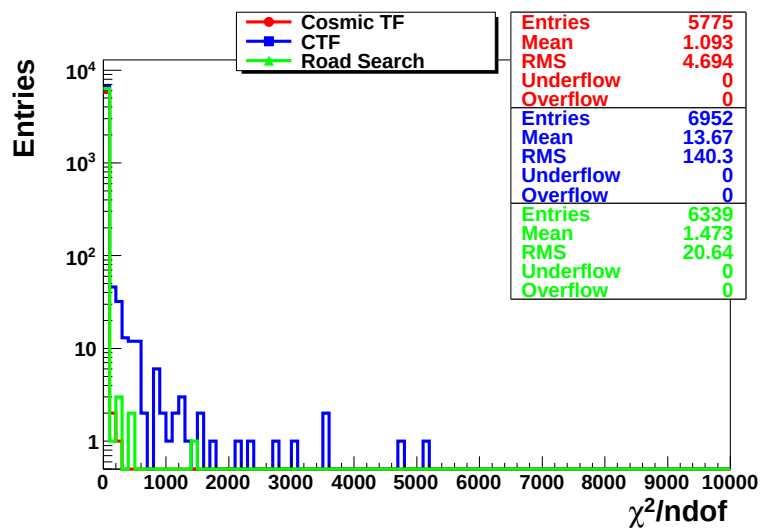
- Large χ^2/dof CTF tracks in B-off (left)/on(right)





- TrackingPoing (left) and SuperPointing (right) Skims





Possible Contributions to the large χ^2 tracks

- Tracker has more noise in early CRAFT09 (hard to track)

- Tracking Reconstruction changes in Rel 311
  - CRAFT08 Tracker Geometry constant could be changed
  - APE in CRAFT09 is inflated relative to best estimate from CRAFT08
  - Inclusion of APE in the seeding hit uncertainty σ

http://indico.cern.ch/getFile.py/access?contribId=4&resId=1&materialId=slides&confId=63422

- It would be ideal to isolate each source, but not easy technically
  - Compare of CRAFT09/08 data
  - Compare 311/225 reconstruction on same CRAFT08 data

CTF χ^2 CRAFT09/08 Comparison (I)

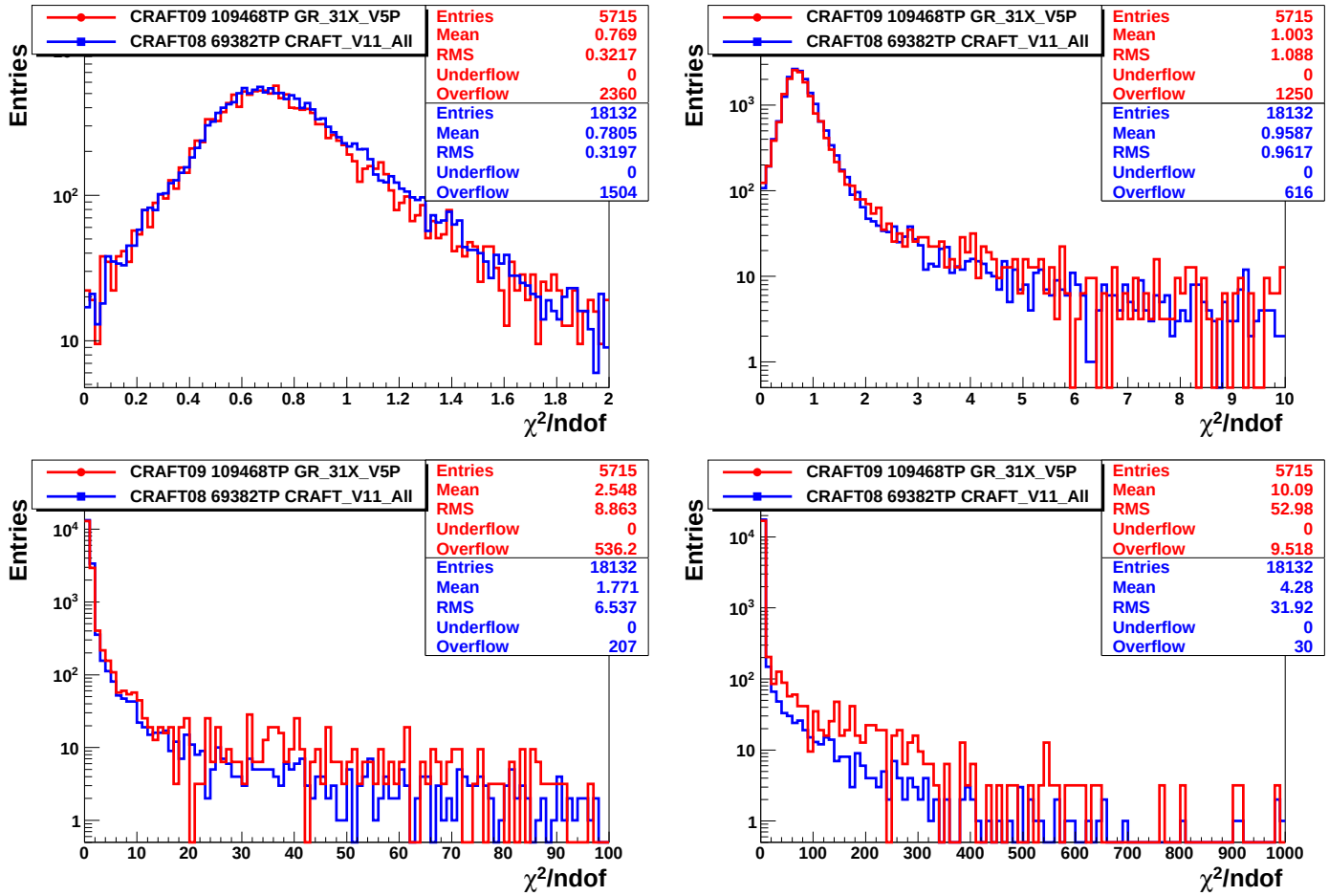
- Dataset
  - 311: /store/data/CRAFT09/Cosmics/RAW-RECO/GR09_31X_V5P_TrackingPointing_322-v1/
  - 225: /store/data/Commissioning08/Cosmics/RAW-

RECO/CRAFT_ALL_V11_225_ReReco_FromTrackerPointing_v1/

- GlobalTag
  - 311: GR09_31X_V5P
  - 225: CRAFT_ALL_V11
- Tracker Geometry
  - 311: Tracker_Geometry_v5_offline
  - 225: Tracker_Geometry_v3_offline
- Tracker Geometry Err (APE)
  - 311/225: Tracker_GeometryErr_v3_offline

CTF χ^2 CRAFT09/08 Comparison (II)

- CRAFT09 histograms and under/overflow are normalized to 08



- χ^2/ndof bulk region (< 2) remain unchanged in CRAFT09
  - CRAFT08 alignment constant is robust against the run condition
- CRAFT09 has higher tails (10-1000)

Reconstruct CRAFT08TP data in 311/225 (I)

- Isolate the Run condition contribution to the χ^2 difference
  - Directly probe the TrackerGeometry and/or APE effect

- Validate tracking performance with 25K events from Run 68500

  https://twiki.cern.ch/twiki/bin/view/CMS/GRReprocessing#E_Reprocessing_of_the_TrackerPoi

- Dataset:

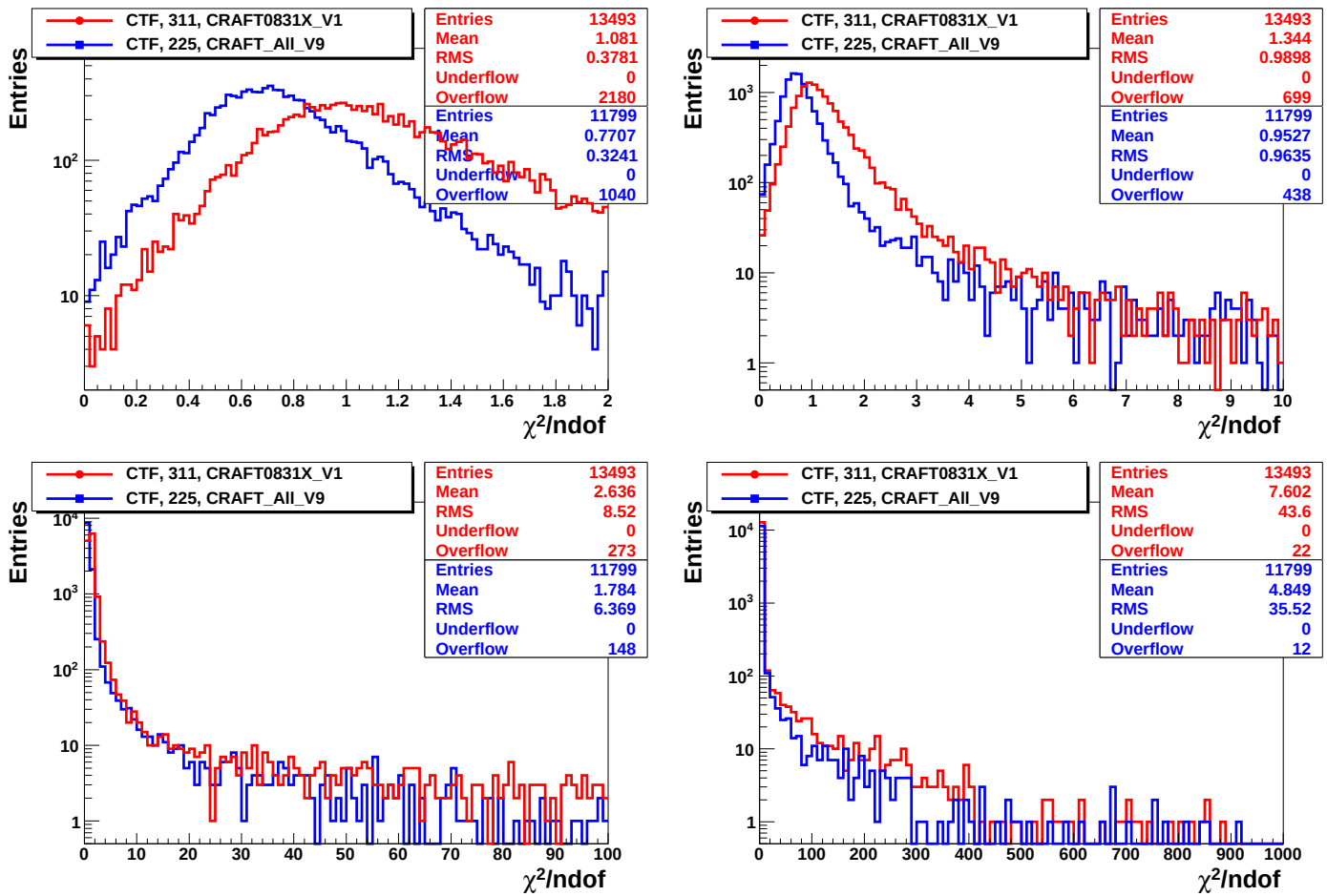
  - 311: Commissioning08/Cosmics/RAW-RECO/CRAFT0831X_V1_311_ReReco_FromTrackerPointing_v1/
  - 225: Commissioning08/Cosmics/RAW-RECO/CRAFT_ALL_V9_TrackingPointing_225-v3/

- GlobalTag/Tracker Geometry/APE

  - 311: CRAFT0831X_V1/TrackerGeometry_v5_offline/TrackerGeometryErrors_v5_offline
  - 225: CRAFT_ALL_V9TrackerGeometry_v3_offline/TrackerGeometryErr_v3_offline

Reconstruct CRAFT08TP data in 311/225 (II)

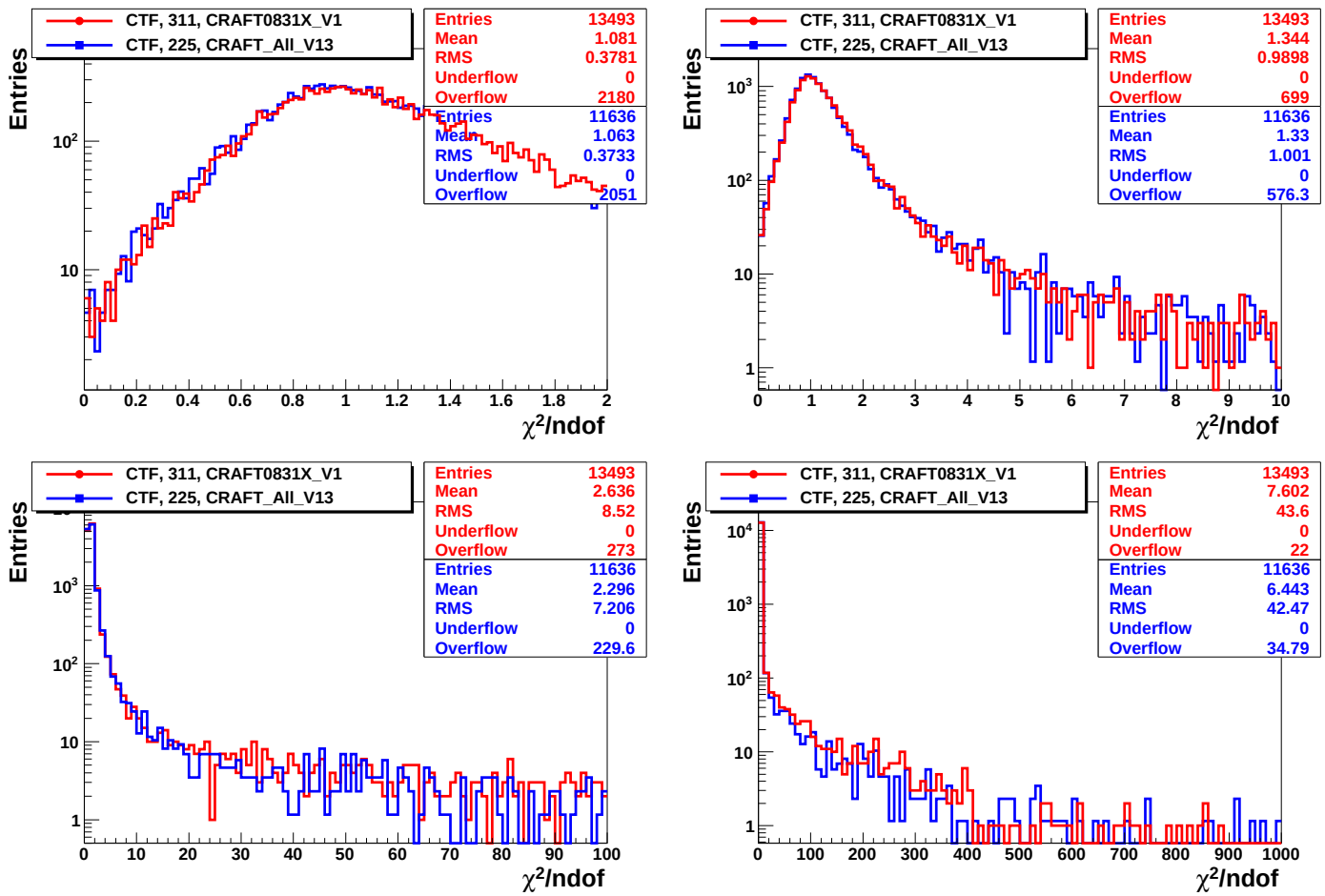
- 311 has better TrackerGeometry and smaller APE



- χ^2/ndof bulk region (< 2) is shifted in 311 due to the improved APE
- 311 has slightly higher tail

Reconstruct CRAFT08TP data in 311/225 (III)

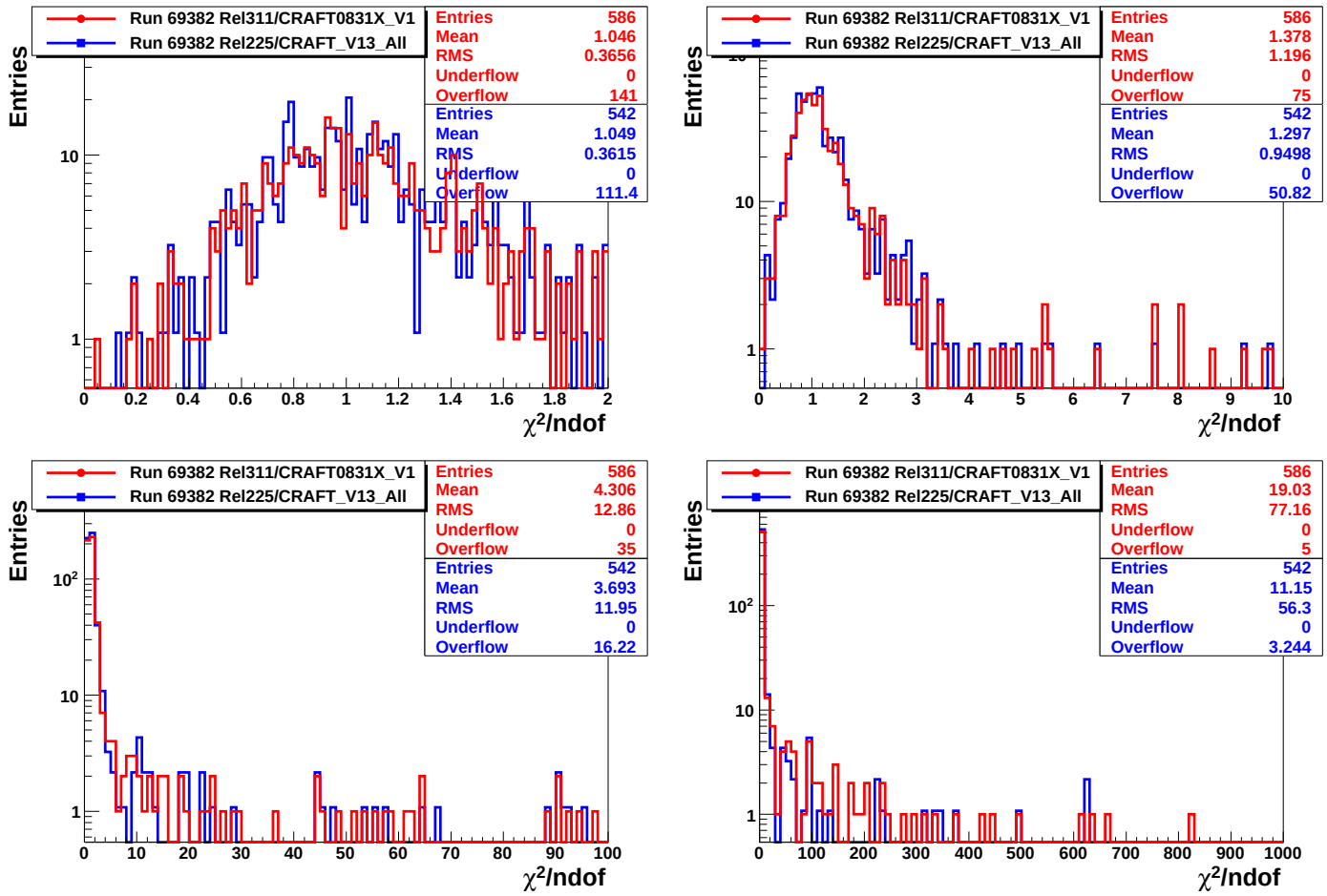
- ReTracking the 225 data with globalTag CRAFT_ALL_V13
  - process.siStripMatchedRecHits*process.siPixelRecHits*process.tracksP5
  - 311/225 have the same APE/TrackerGeometry



- χ^2/ndof is consistent between 311 and 225 reconstruction
  - *But, CRAFT08 TP data does not have the possible large χ^2 tracks with spurius hits in seeding*

Reconstruct CRAFT08 Raw data in 311/225

- To see the effect of including APE in seeding hit σ
  - GlobalTag: 311 (CRAFT0831X_V1) 225 (CRAFT_ALL_V13)
  - 311/225 have the same APE/TrackerGeometry



- CTF χ^2 is consistent between 311 and 225 RECO
  - *Including APE in seeding Hit σ is not the dominant source of CTF χ^2 high tail. Detector noise?*

Brief Reminder of OutliersRejection

- OutliersRejection is implemented in the final fit
  - Reject hits with large χ^2 over a thresold cut and refit the track
  - The rejected hits could be noisy, from another track, or generated from complex nuclear processes.

- The χ^2 cut is optimized to satisfy the following:
  - Not to worsen the tracking efficiency xsxc
  - Improve fake rate
  - Improve as much as possible the quality of the tracks
  - Keep the CPU time at a reasonable level

- Test for OutliersRejection cuts $\chi^2 < 30$

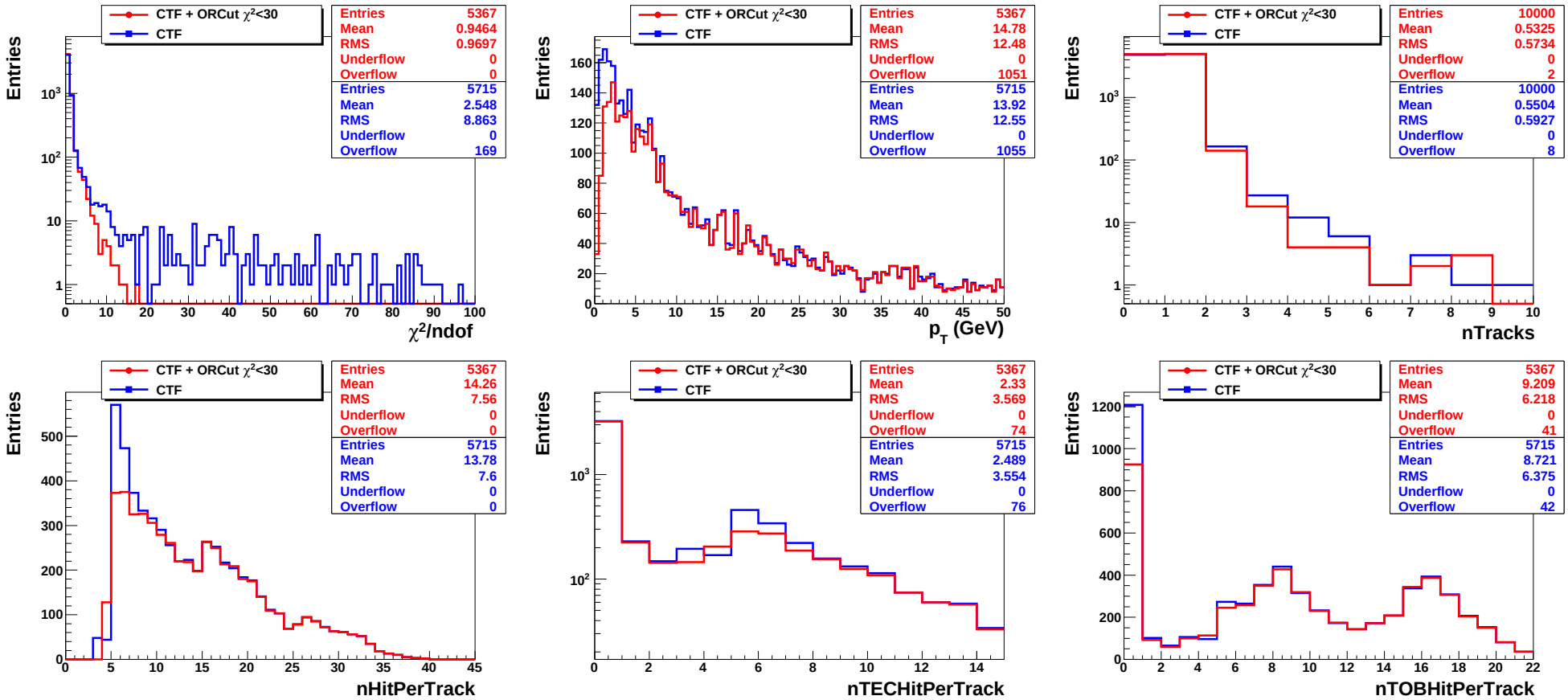
- BreakTrajWith2ConsecutiveMissing is turned off (ON by default)

- Twiki Page: https://twiki.cern.ch/twiki//bin/view/CMS/OutliersRejection

OutliersRejection Impact on CTF Tracks (I)

- Run109468-TrackingPointing, selection ϵ is 94.3%
  - CRAFT08 Run69382, selection ϵ is 98.6% with cut χ^2>15

$-\chi^2 < 30$ $-$no cut

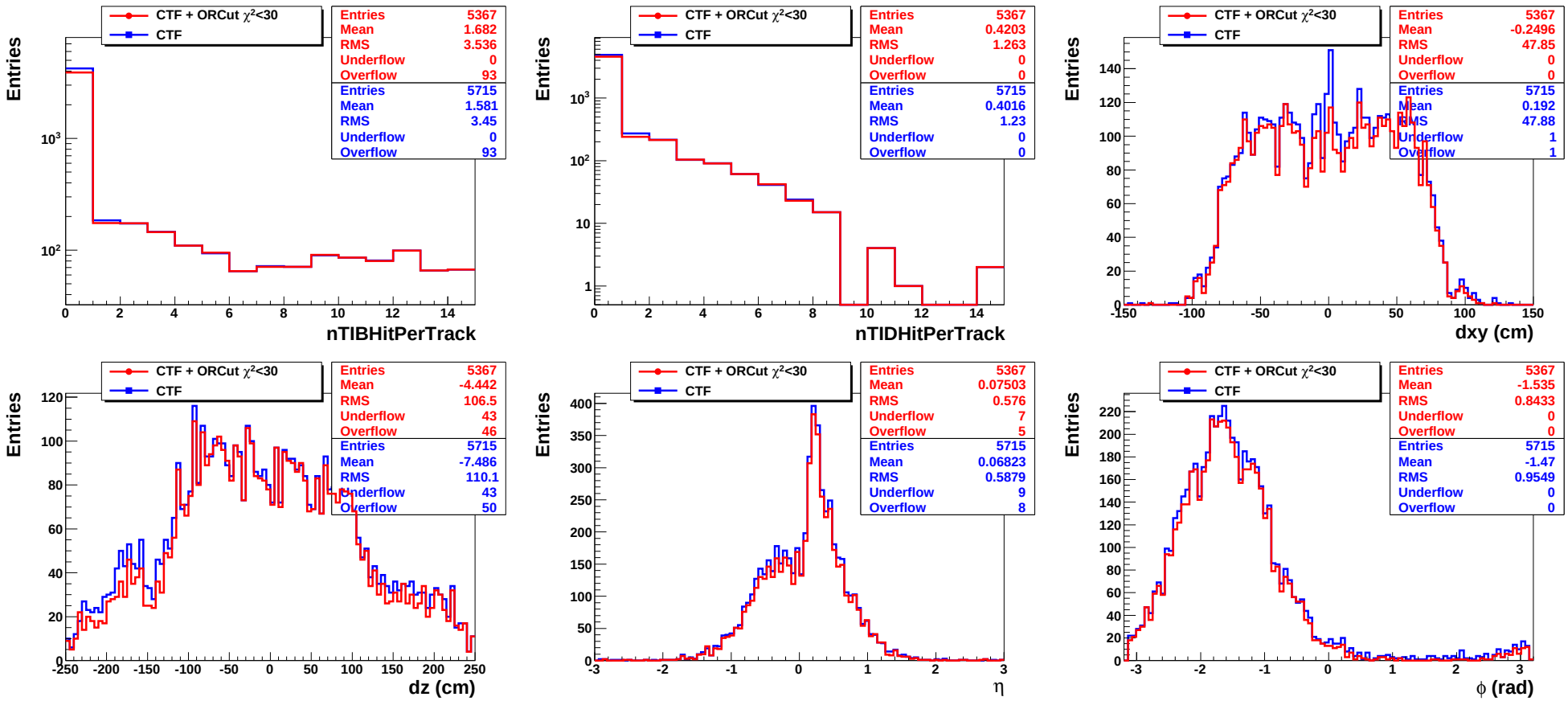


- OutliersRejection removes low p_T/nHit tracks (multi-Track Evt)

OutliersRejection Impact on CTF Tracks (II)

- Other track parameters are consistent with/without OutliersRejection

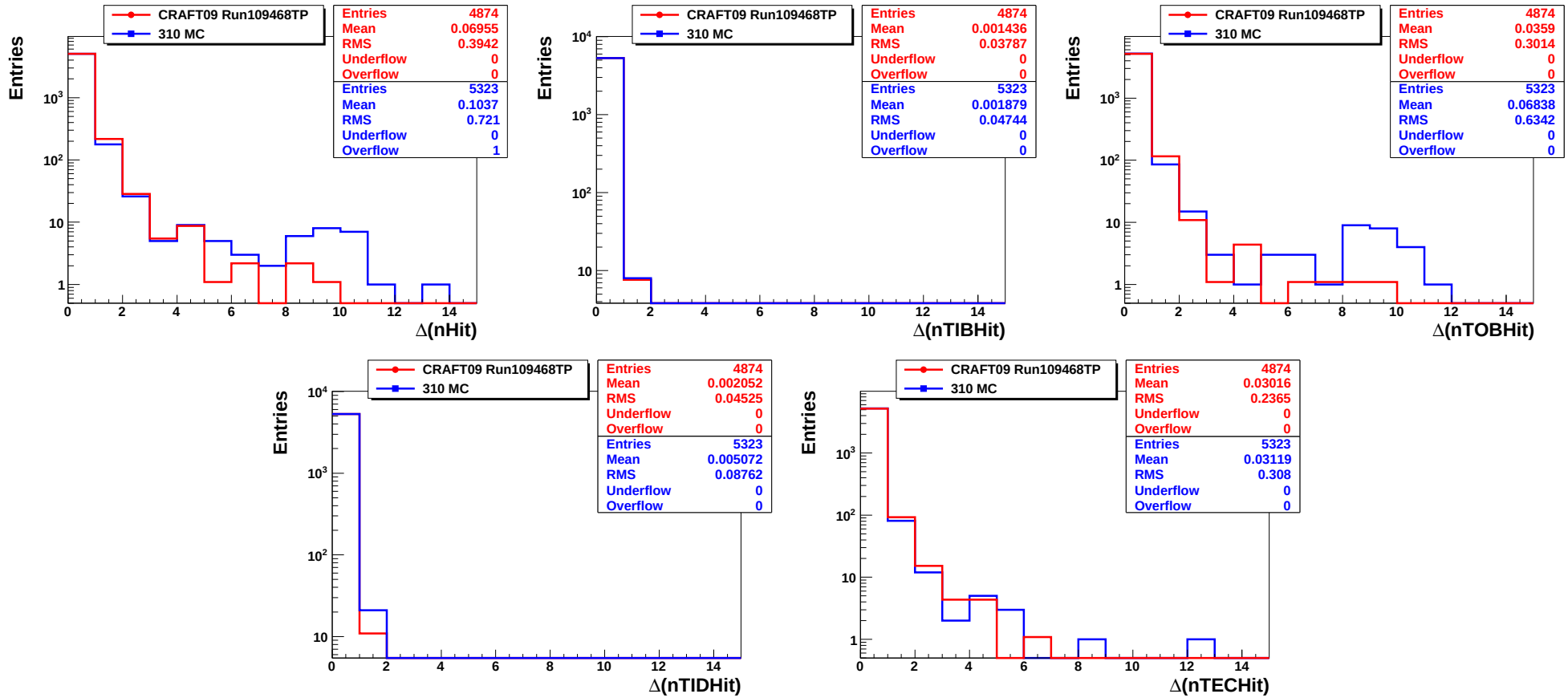
$-\chi^2 < 30$ — no cut



- OutliersRejection will be activated for CTF tracks with $\chi^2 < 20$

Rejected Hits Population in Tracker for CTF Tracks

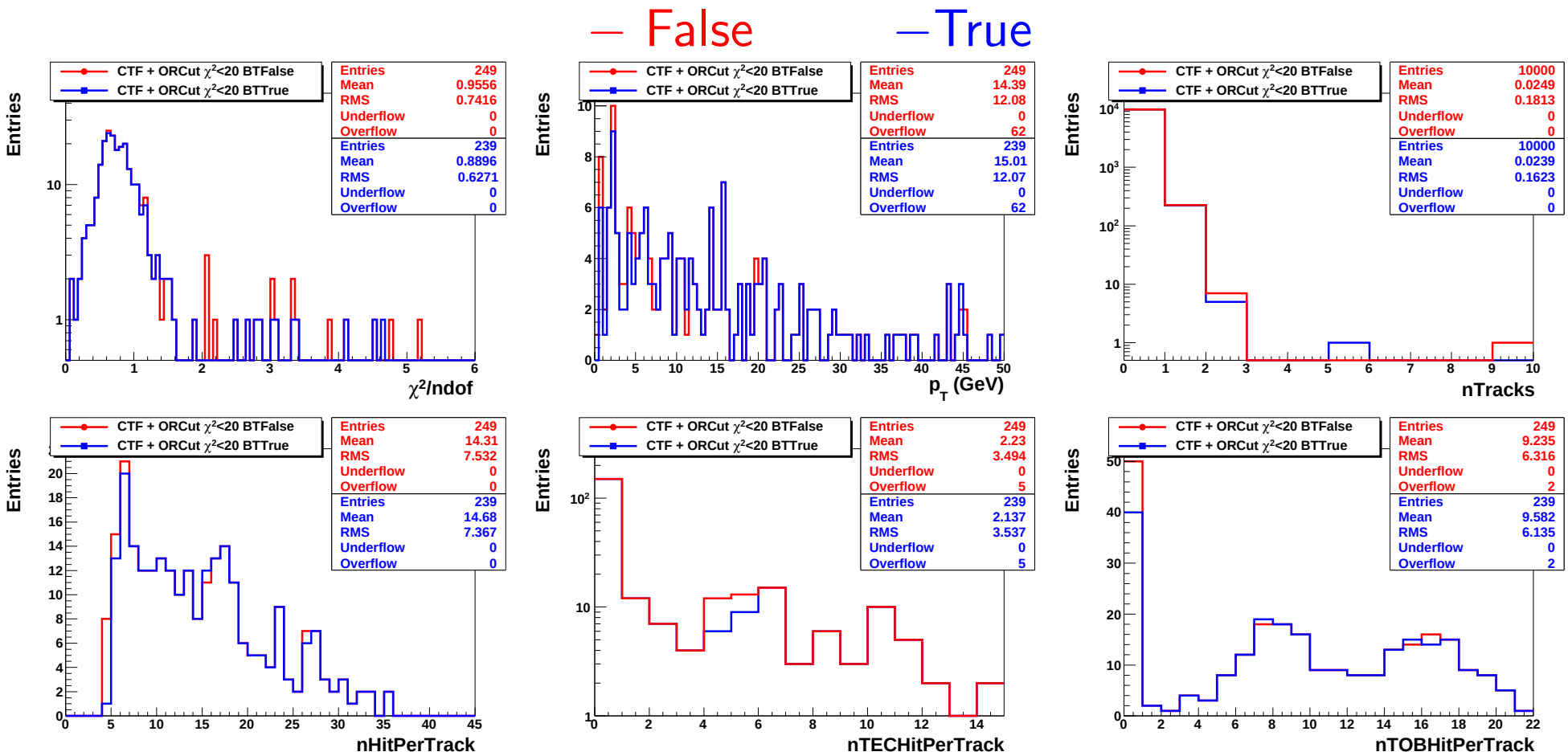
- Compare CRAFT09 data(red) and MC(blue) with $\chi^2 > 30$
- Only 1-track events are used, and data is normalized to MC



- No Pixel hits are rejected
- Most rejected hits are located in TOB and TEC

BreakTrajWith2ConsecutiveMissing effect

- Setting BreakTrajWith2ConsecutiveMissing=True, OR could remove the entire second half of the tracks, resulting more than 10 hits loss.

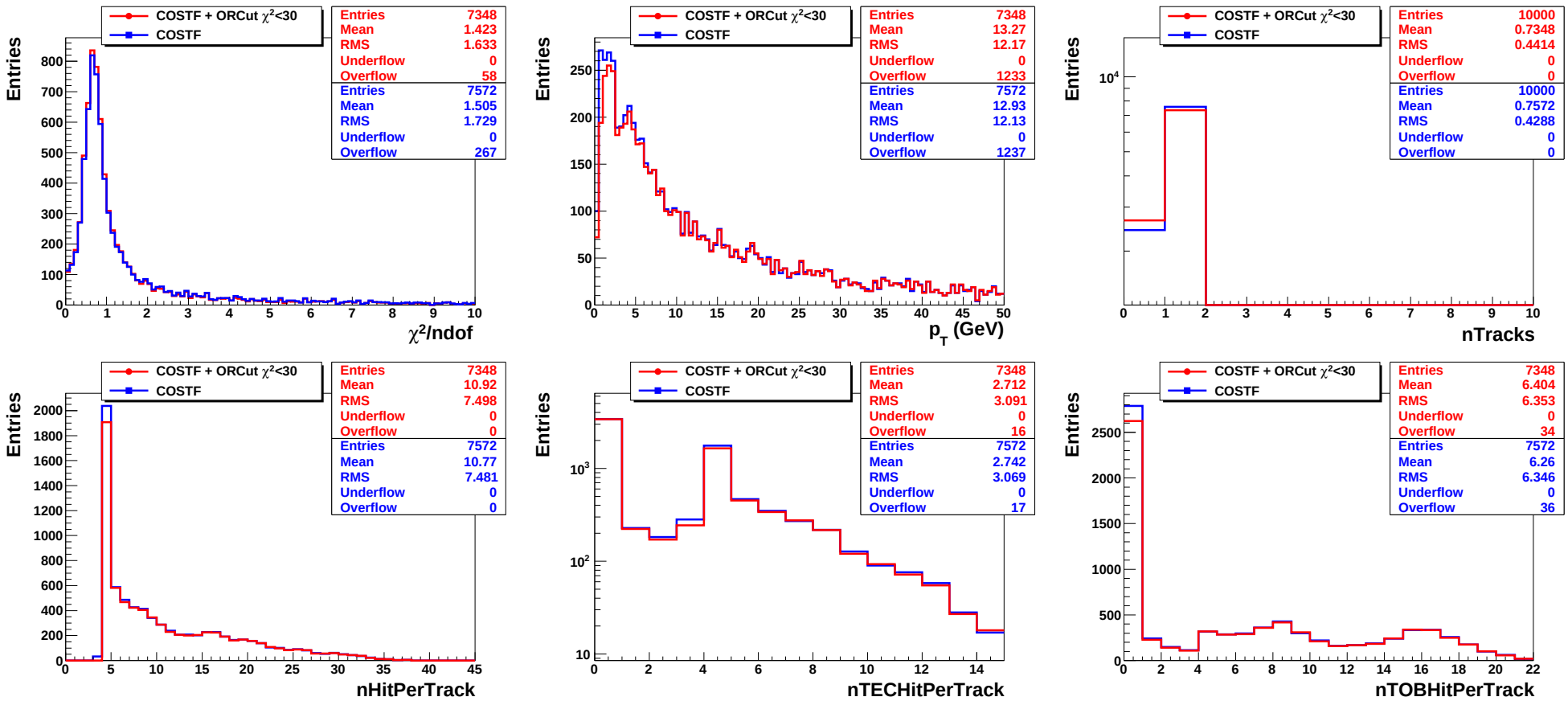


- BreakTrajWith2ConsecutiveMissing=False recovers the mistakenly removed hits in good tracks at the cost of slight increase in fake rate

OutliersRejection Impact on COS Tracks (I)

- Run109468-TrackingPointing, selection ϵ is 97.1%

$-\chi^2 < 30$ — no cut

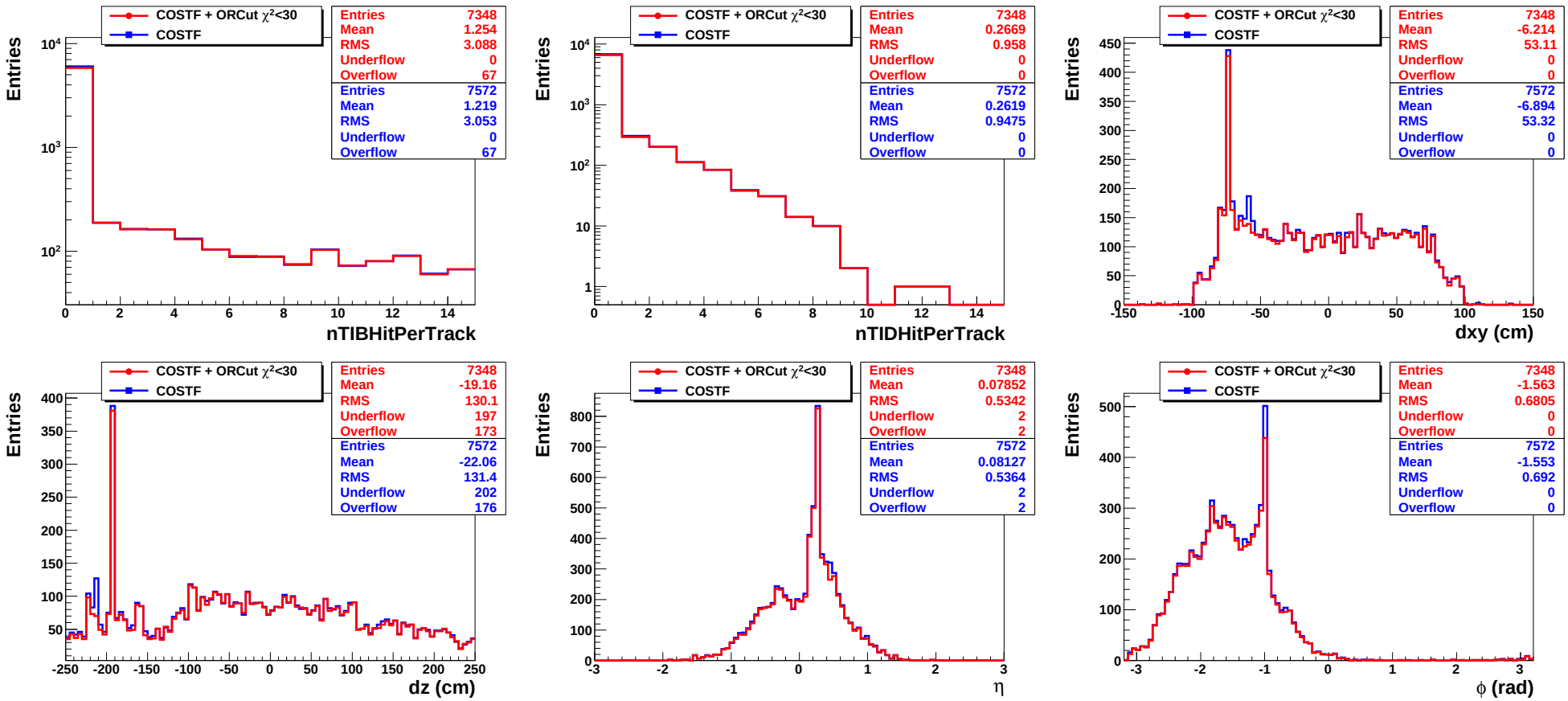


- OutliersRejection removes low p_T/nHit tracks
- OutliersRejection effect is small

OutliersRejection Impact on COS Tracks (II)

- Other track parameters are consistent with/without OutliersRejection

$-\chi^2 < 30$ — no cut

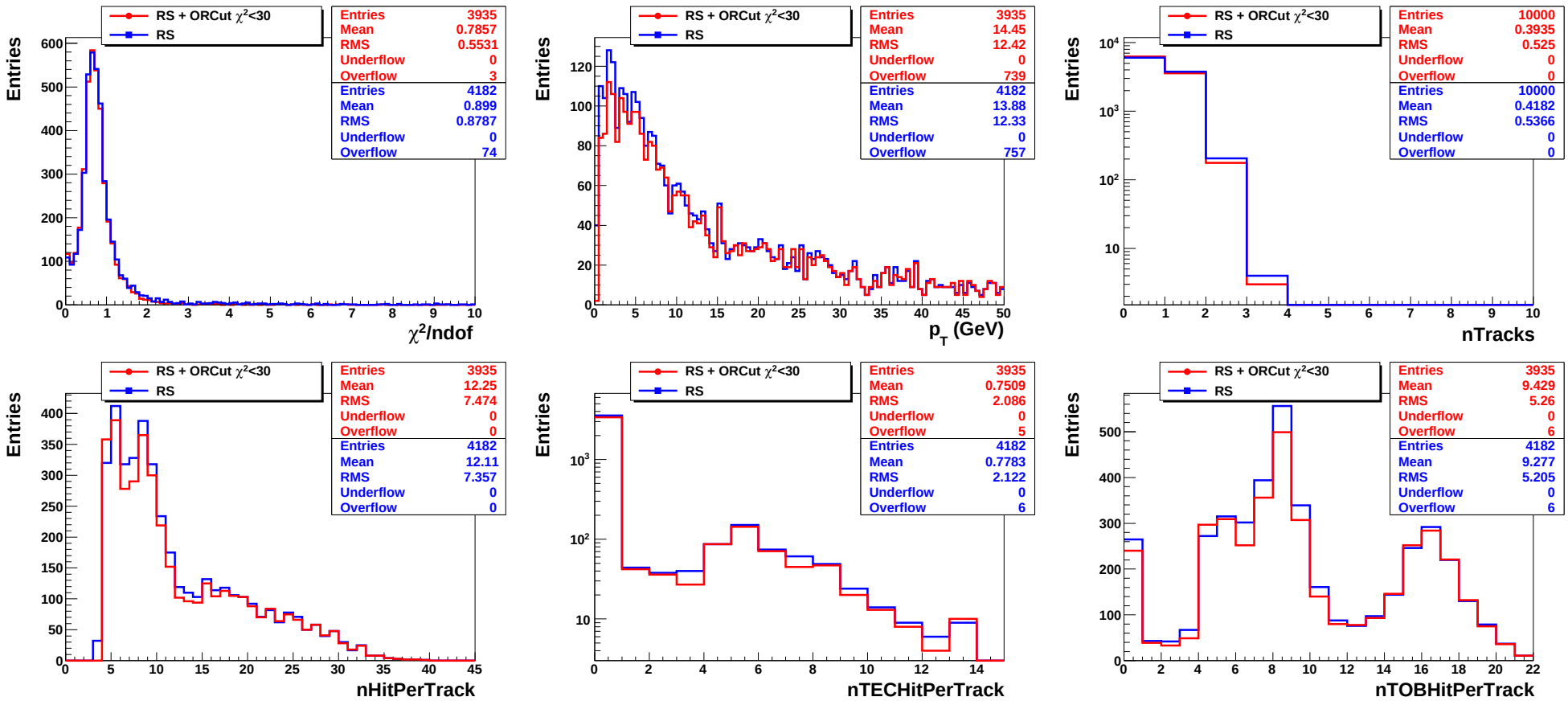


- OutliersRejection will not be activated for COS tracks

OutliersRejection Impact on RS Tracks (I)

- Run109468-TrackingPointing, selection ϵ is 94.6%

$-\chi^2 < 30$ — no cut

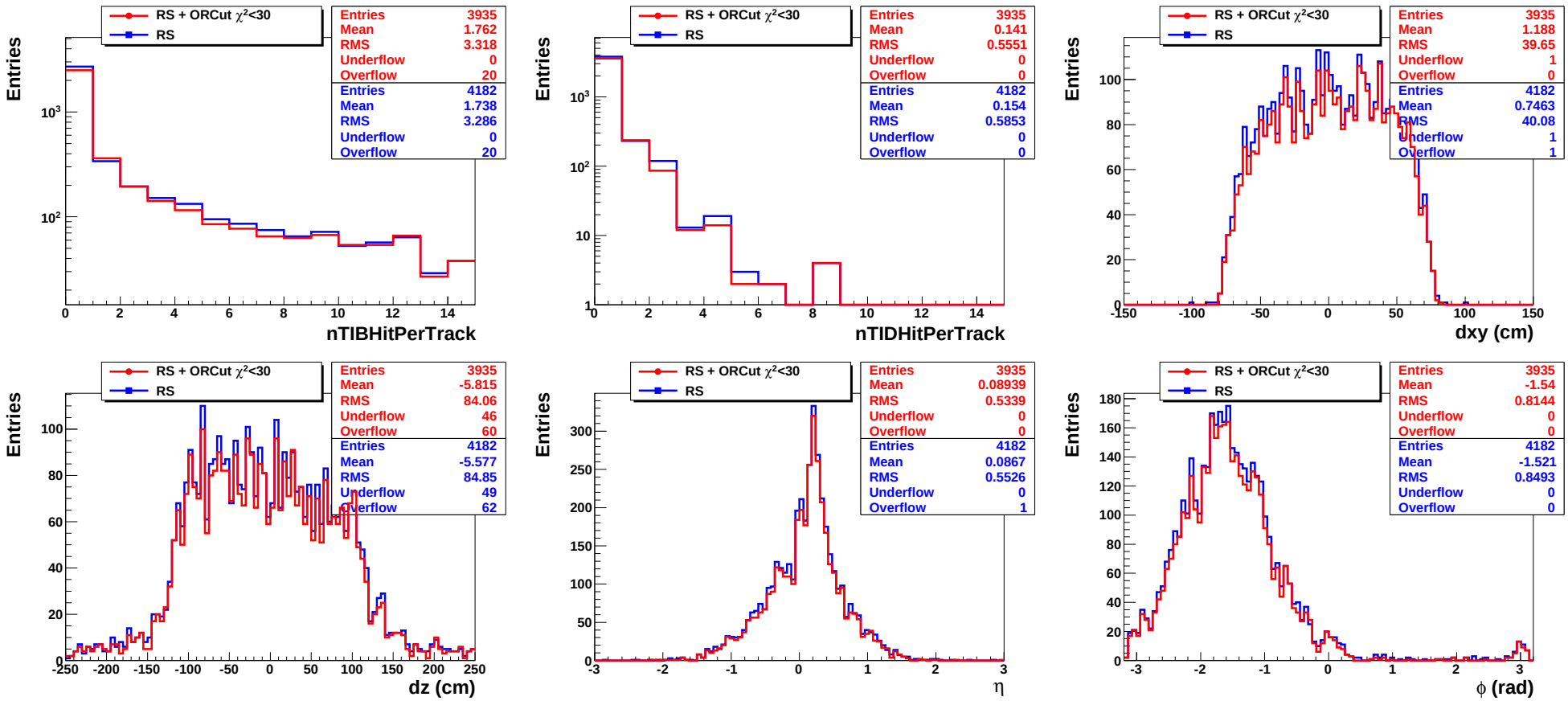


- OutliersRejection removes low p_T/nHit tracks
- OutliersRejection effect is small

OutliersRejection Impact on RS Tracks (II)

- Other track parameters are consistent with/without OutliersRejection

$-\chi^2 < 30$ — no cut



- OutliersRejection will not be activated for RS tracks

Summary and Plans

- Studied possible sources to the large χ^2 CTF tracks in CRAFT09
  - Direct CRAFT09/08 comparison=> alignment constant robust
  - Reco. same CRAFT08TP data in 311/225=>APE inflation is not the reason
  - Reco. same CRAFT08 Raw data in 311/225: including APE in seeding hit σ effect not dominant
  - Most possible source left: Detector noise
  - Track reconstruction in 311 CRAFT09 is performing well
- OutliersRejection shows improvement on CTF tracks in CRAFT09
  - CTF Rejection rate is 5.7% with $\chi^2 > 30$
  - Rejected hits mainly locate in TOB/TEC
  - OutliersRejection is activated for CTF tracks only
  - Implemented in RecoTracker/TrackProducer V05-06-06 and accepted for 323 patch
- Plans
  - .....