Basic Tracking Variables in Xmas Reprocessed Data

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Tracking Working Meeting, 25 January CERN

Outline

- Dataset and Event Selection
- 900 GeV Data vs MC: Dec19 ReReco vs.STARTUP V8K
- 2360 GeV Data vs MC: Dec19 ReReco vs.STARTUP V8L
- STARTUP MC Comparison: V8K vs V8I
- 900GeV Dec19th vs Dec14 ReReco
- Dec19th Skim: 341 vs 336patch3
- Conclusion

http://home.fnal.gov/~ygao/CMS/Tracking/LhcTrackAnalyzer/CMSSW_3_3_6_patch3/

Dataset and Event Selection

- Dec19thReReco:

  /MinimumBias/BeamCommissioning09-BSCNOBEAMHALO-Dec19thSkim_336p3_v1

- Dec14thReReco:

  /MinimumBias/BeamCommissioning09-BSCNOBEAMHALO-Dec19thSkim_336p3_v1

- MinBias STARTUP MC Samples

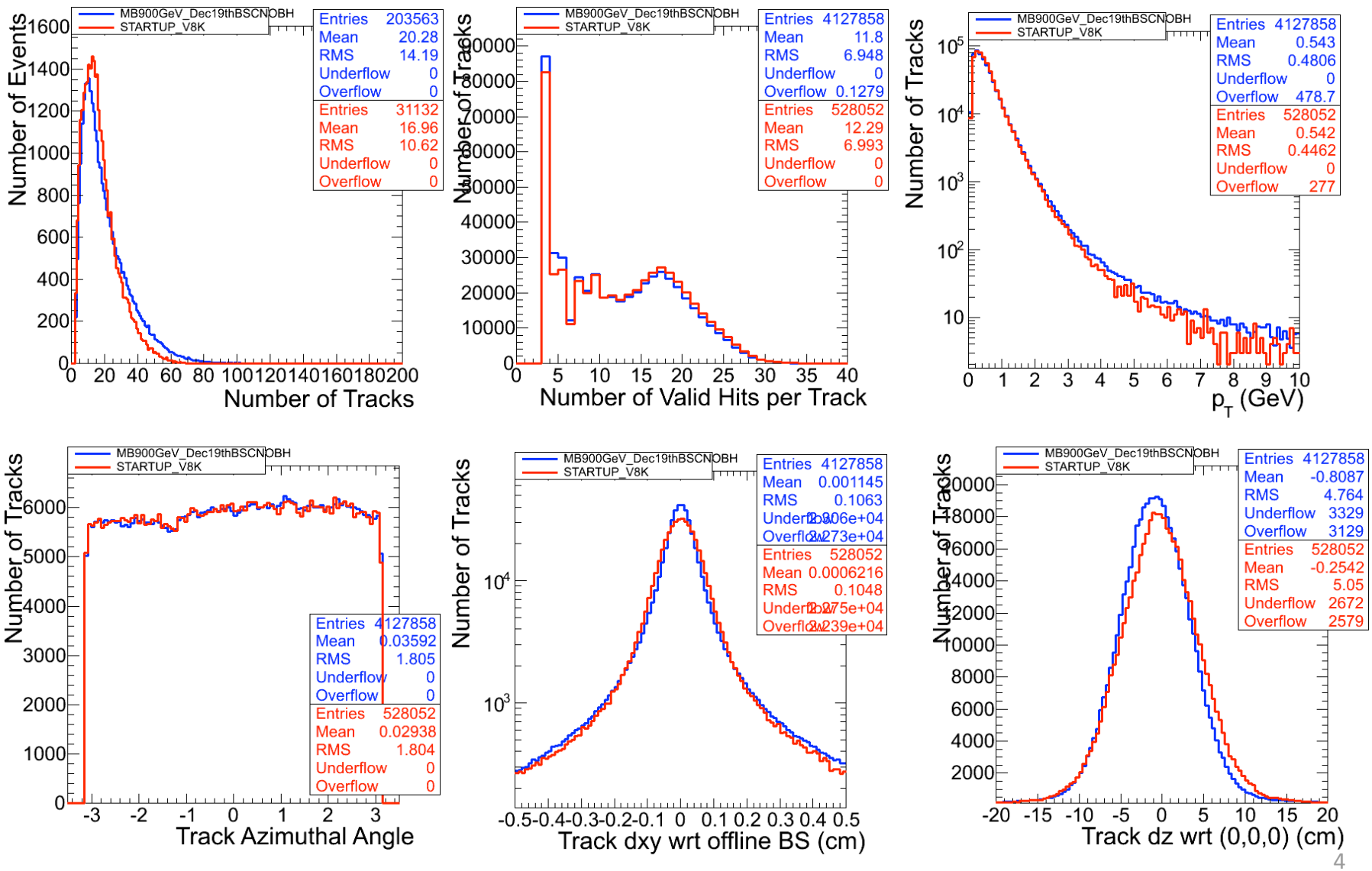
  /MinBias/Summer09-STARTUP3X_V8K_900GeV-v1/
  /MinBias/Summer09-STARTUP3X_V8I_900GeV-v2/
  /MinBias/Summer09-STARTUP3X_V8L_2360GeV-v1/

- Dec19th ReReco data use new CMS global position and reference frame, while all MC samples are generated in the old CMS frame

1. Select good run/lumi in data from Andrea Venturi's Study:
   http://venturia.home.cern.ch/venturia/Collisions2009/2009_collisions_results.htm
2. TechBit 0 && (40||41) && !(36-39) for Data
3. TechBit (40||41) for MC
4. At least one real primary vertex
5. Fraction of HighPurity tracks > 0.2

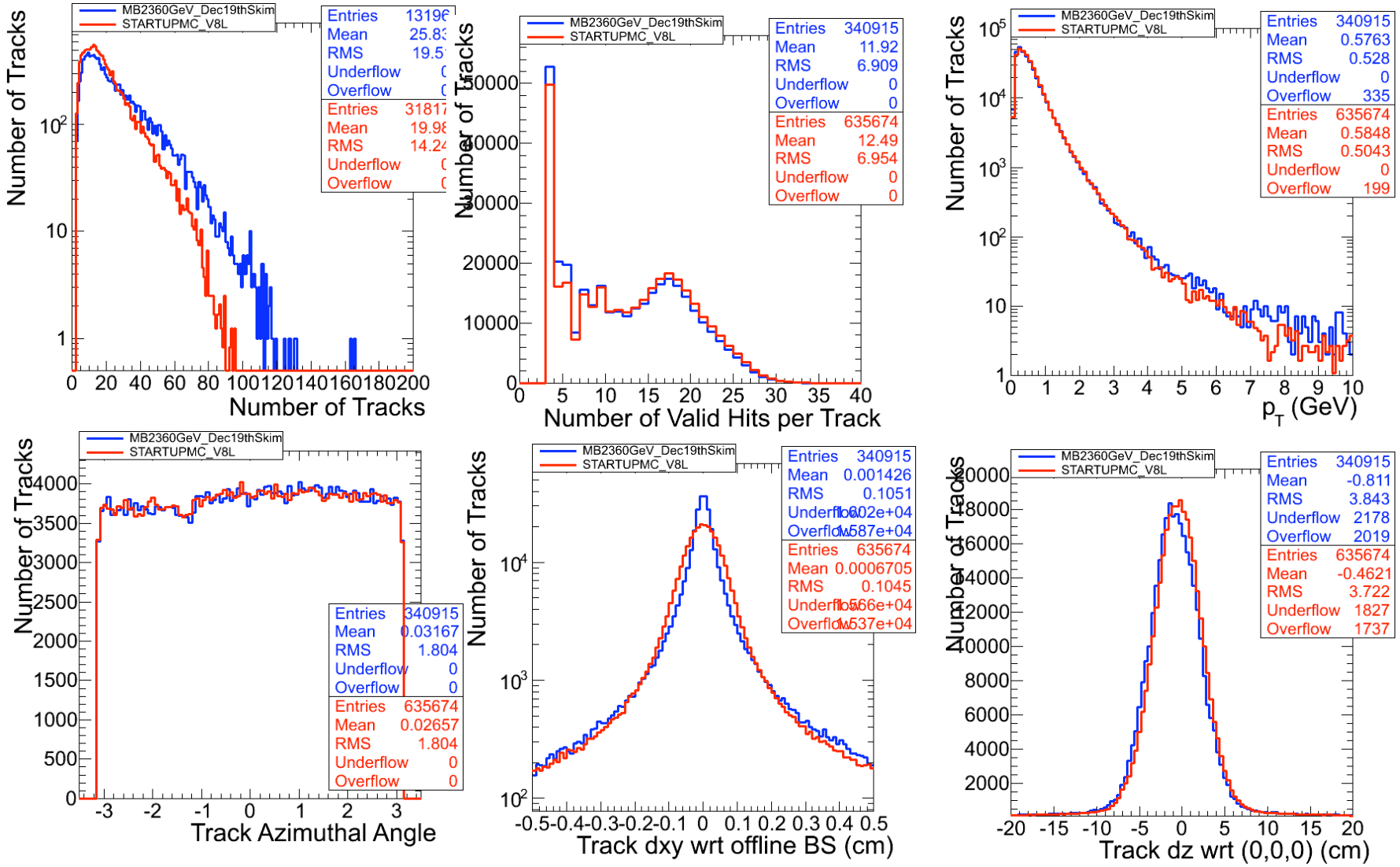
900GeV: Dec19thReReco vs STARTUPMC(V8K)

- BS: Dec19th Run dependent from bs fit V8K MC (0.1936,0.168,-0.29)cm



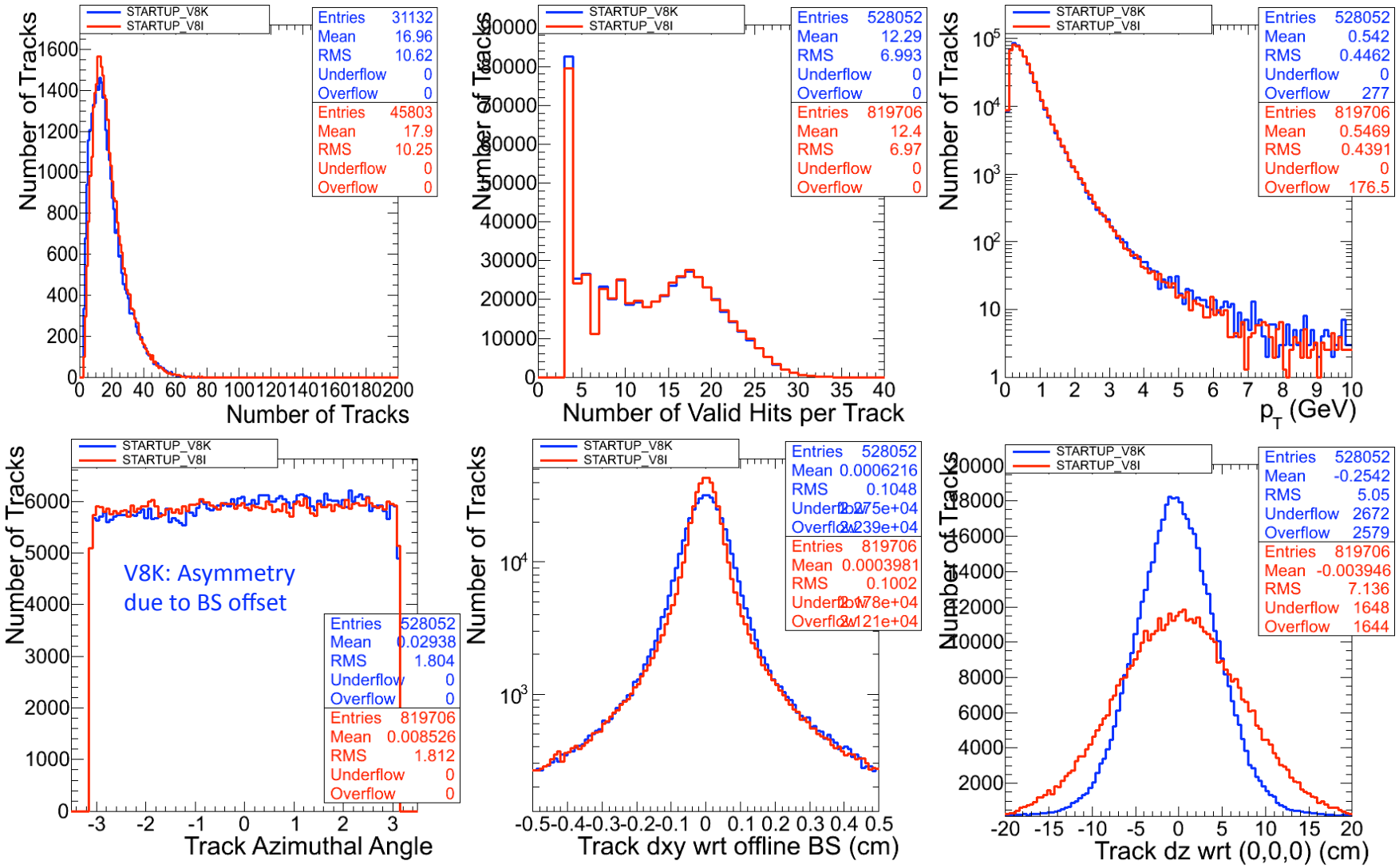
2360GeV: Dec19thReReco vs STARTUPMC(V8L)

- BS: Dec19th Run dependent from bs fit, V8L MC (0.20,0.164,-0.47)cm



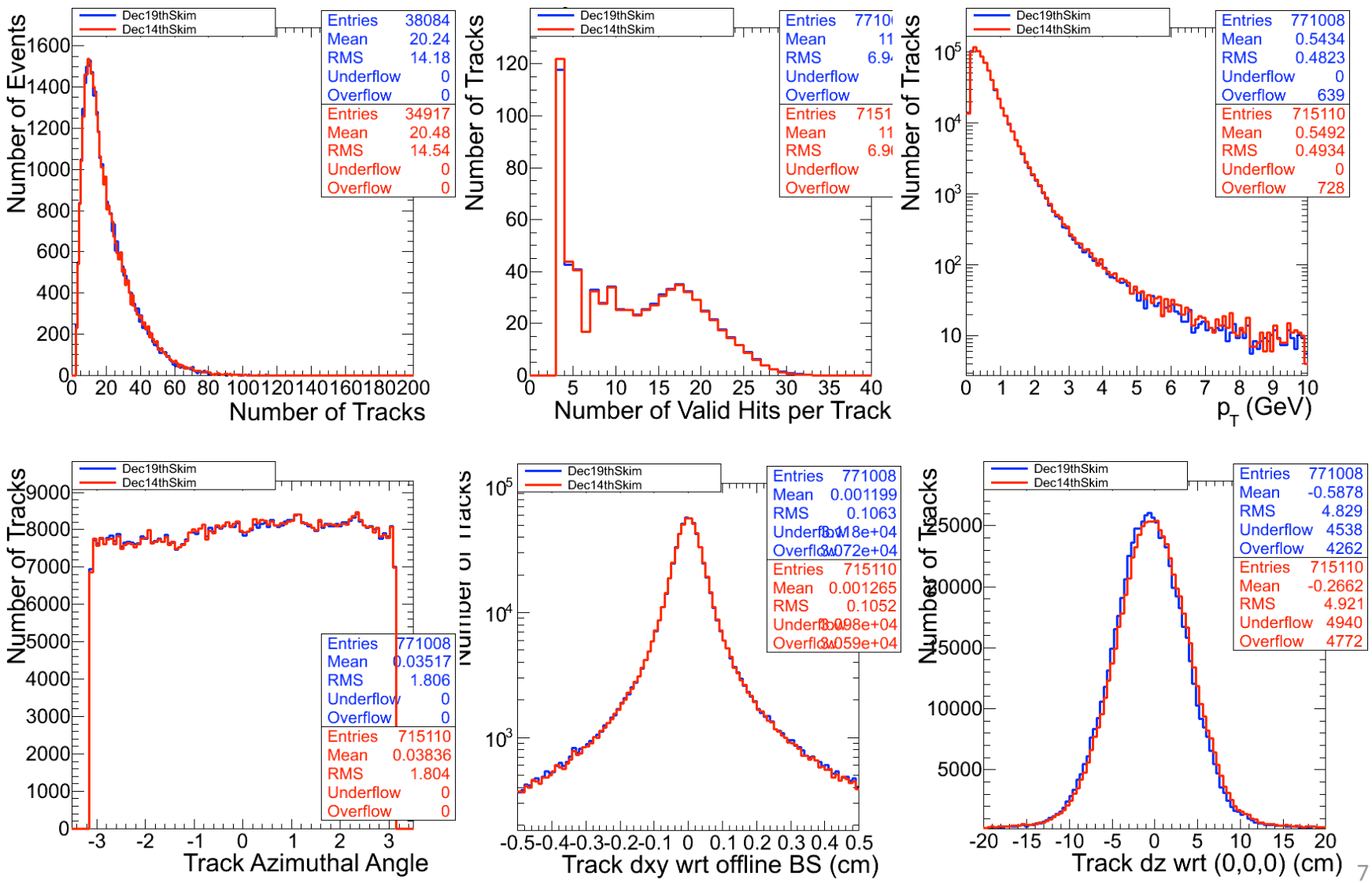
900GeV STARTUPMC V8K vs V8I

- BS: V8K (0.1936,0.168,-0.29)cm, σZ=4.5cm V8I (0.032,0,0) cm σZ=7.4cm



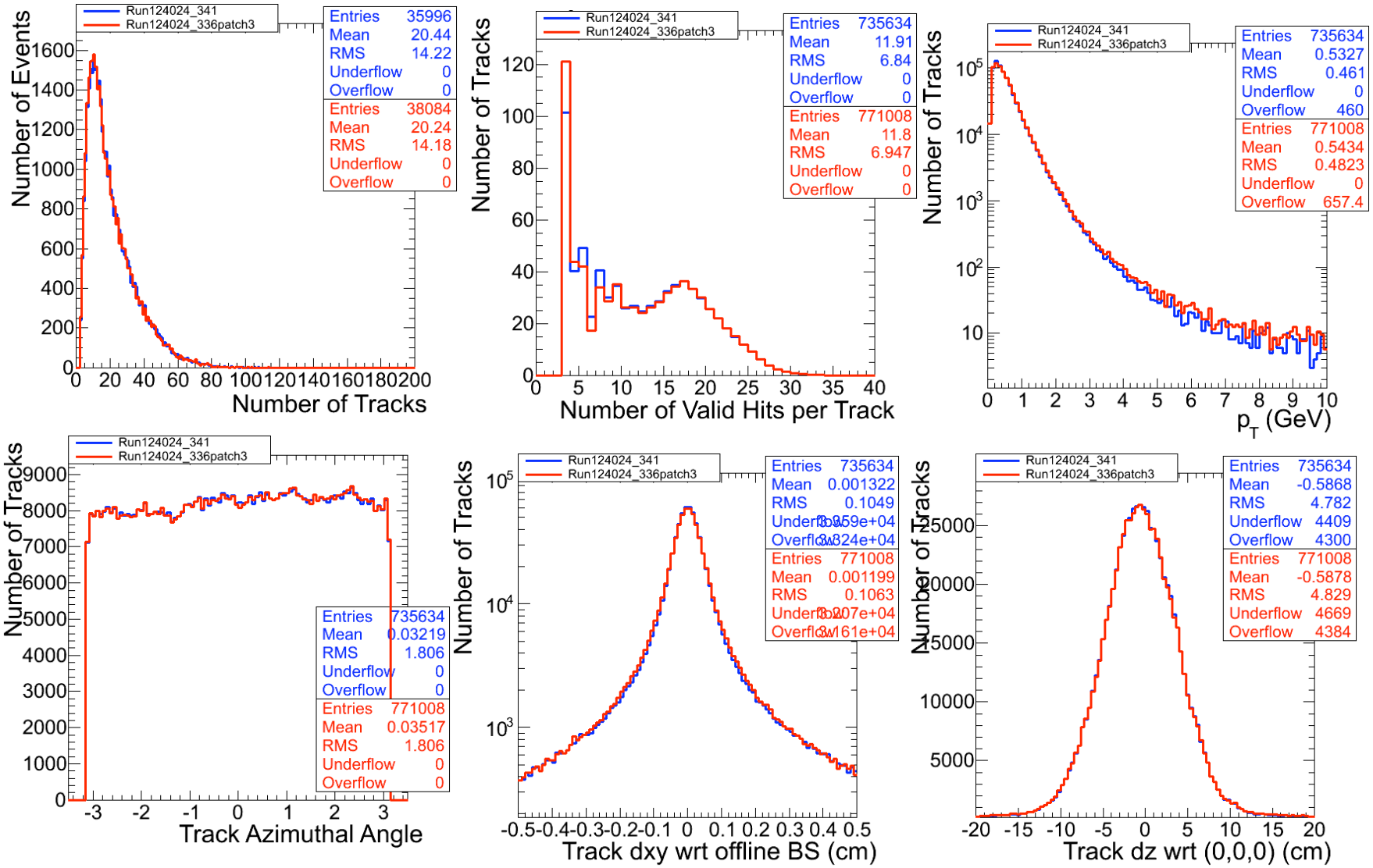
900GeV Dec19thSkim vs Dec14thSkim

- Dec19th (old cms frame) Dec14th Skim (new cms frame)



Dec19th Skim 341 vs 336patch3

- 341 use 1Dhit for the barrel hits (TIB/TOB), improves the track chi2



Conclusion

- Data vs MC agree well for Dec19th Skim v.s. STARTUP(V8K/L)
- Dec19th vs Dec14 ReReco agree well
- Various MC samples agree for the tracking parameters
- Data reprocessed with 341 and 336patch3 is consistent

Note on BS and cms reference change

- In general, they doesn't affect tracking quality much
- The track phi distribution becomes asymmetric given BS offset

Preliminary Primary Vertex Resolution from Xmas Reprocessing

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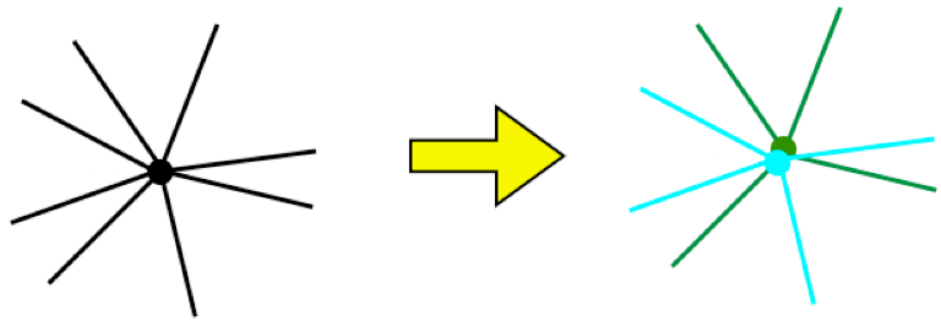
Outline

- Brief Reminder of the Two-Vertex Method
- Dec19th ReReco and MC Dataset and Event Selection
- Two-Vertex Method Sanity Checks (Tracks, Weights)
- Two-Vertex Method Validation on MC Samples
- Resolution and Pulls in Dec19th ReReco Data/MC
- Summary and Plans
- Twiki:

  https://twiki.cern.ch/twiki/bin/viewauth/CMS/PrimaryVertexResolution

  https://twiki.cern.ch/twiki/bin/viewauth/CMS/PisaVertexing

Algorithm Description



1. Split tracks into two independent sets
   - Tracks are filted by the same trkfilter as "offlinePrimaryVertices"

     D_0 signficance < 5 nPixelHits>2 nHit> 7 $\chi^2/\mathrm{ndof} < 5$

   - Tracks are ordered in descending order of p_T
   - For each pair, randomly select which track goes to which trackset
2. Run primaryvertex fit on each track set
   - Use the fitter without BS constraint "offlinePrimaryVertices"
3. Compare the two fitted vertex positions and calculate
   - Resolution: σ of the gaussian fit to $\frac{x_1 - x_2}{\sqrt{2}}$
   - Pull: σ of the gaussian fit to $\frac{x_1 - x_2}{\sqrt{\sigma x_1^2 + \sigma x_2^2}}$

Resolution and Pulls Calculations

1. Calculate residuals of reconstructed vertex positions
   - MC Method: $x_{rec} - x_{sim}$
   - Two-Vertices Method: $\frac{x_{rec1} - x_{rec2}}{\sqrt{2}}$

2. Calculate pulls of reconstructed vertex positions
   - MC Method: $\frac{x_{rec} - x_{sim}}{\sigma x_{rec}}$
   - Two-Vertices Method: $\frac{x_{rec1} - x_{rec2}}{\sqrt{\sigma x_{rec1}^2 + \sigma x_{rec2}^2}}$

3. Fit residuals in a given nTrack bin with Gaussion
   - Resolution is taken as the fit σ Fit Range: +/- 2RMS
   - Statistics in each nTrack bin affects the fit performance

4. Fit pulls in a given nTrack bin with Gaussion
   - Check the fit σ consistency with 1.0 Fit Range: +/- 2RMS
   - Statistics in each nTrack bin affects the fit performance

Primary Vertex in Dec19thReReco and MC

- The PrimaryVertex fitter cuts are loosened compared to StdReco

  The value quoted in () are the one in Std Vtx Reconstruction in 336patch3

  - PVTX selector

    offlinePrimaryVertices.PVSelParameters.maxDistanceToBeam = 2 (0.05) cm

  - Track Filter

    offlinePrimaryVertices.TkFilterParameters.maxNormalizedChi2 = 20 (5.0)
    offlinePrimaryVertices.TkFilterParameters.minSiliconHits = 6 (7)
    offlinePrimaryVertices.TkFilterParameters.maxD0Significance = 100 (5)
    offlinePrimaryVertices.TkFilterParameters.minPixelHits = 1 (2)

  - Z Cluster

    offlinePrimaryVertices.TkClusParameters.zSeparation = 10 (0.1) # cm

- With the above relaxed Cuts, primary vertex efficiency is high

  ~ 95 Dec19th BSC Skim
  ~ 93% with Tech40||41 in STARTUPMC3X_V8K/L

Dec19th Skim and MinBias MC Datasets

- Dec19thReReco Dataset Path:

  /MinimumBias/BeamCommissioning09-BSCNOBEAMHALO-Dec19thSkim_336p3_v1

- Select good run/lumi from Andrea Venturi's Study:

  http://venturia.home.cern.ch/venturia/Collisions2009/2009_collisions_results.htm

  ✓900GeV Run/Lumi:
  ('123592:2-123592:12', '123596:69-123596:max', '123615:66-123615:max',
  '123732:57-123732:109', '123815:8-123815:max', '123818:2-123818:42',
  '123906:18-123906:28', '123908:1-123908:12', '124006:1-124006:max','
  '124020:12-124020:max', '124023:39-124023:max', '124024:1-124024:max',
  '124027:24-124027:max', '124230:26-124230:max')

  ✓ 2360GeV Run/Lumi: ('124120:1-124120:max', '124275:1-124275:30')

- MinBias 900GeV STARTUPMC: 420K events

  /MinBias/Summer09-STARTUP3X_V8K_900GeV-v1/

- MB@2360GeV STARTUPMC: 20K events

  /MinBias/Summer09-STARTUP3X_V8L_2360GeV-v1/

Event Selection in Data/MC

- Selection Common to Data/MC

  1. Technical Trigger Bit Selection (40||41)
  2. At least 1 real Primary Vertex reconstructed
  3. HighPurity Track Fraction > 0.2 for events with nTracks > 10

- Additional TechBit Selection for Data

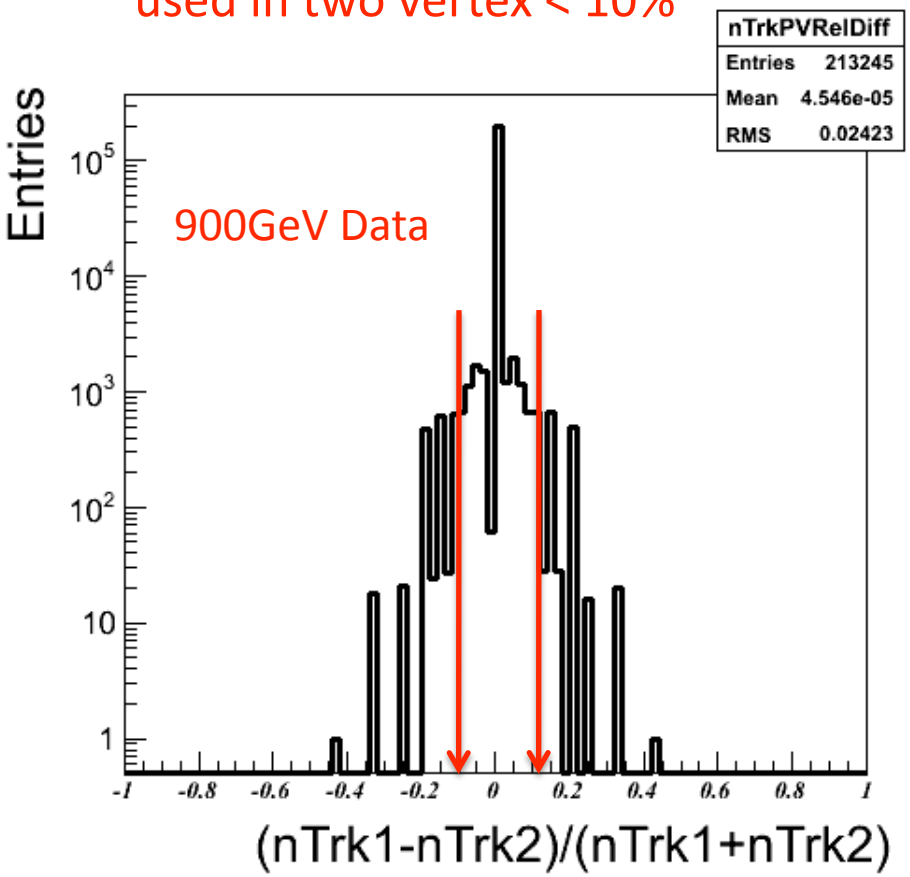
  1. BPTX: TechBit 0
  2. Veto BeamHalo: !(36-39)

	#Evts	Bit (40||41)	GoodPvtx	HighPurity	#Evts left
900GeV Dec19thSkim	285K	100%	93.7%	97.3%	260K
900GeV MC 3X_V8K	420K	67.1%	92.9%	97.8%	256K
2360GeV Dec19thSkim	13847	100%	95.4%	98.1%	12959
2360GeV MC 3X_V8L	20K	67.8%	93.9%	98.1%	12491

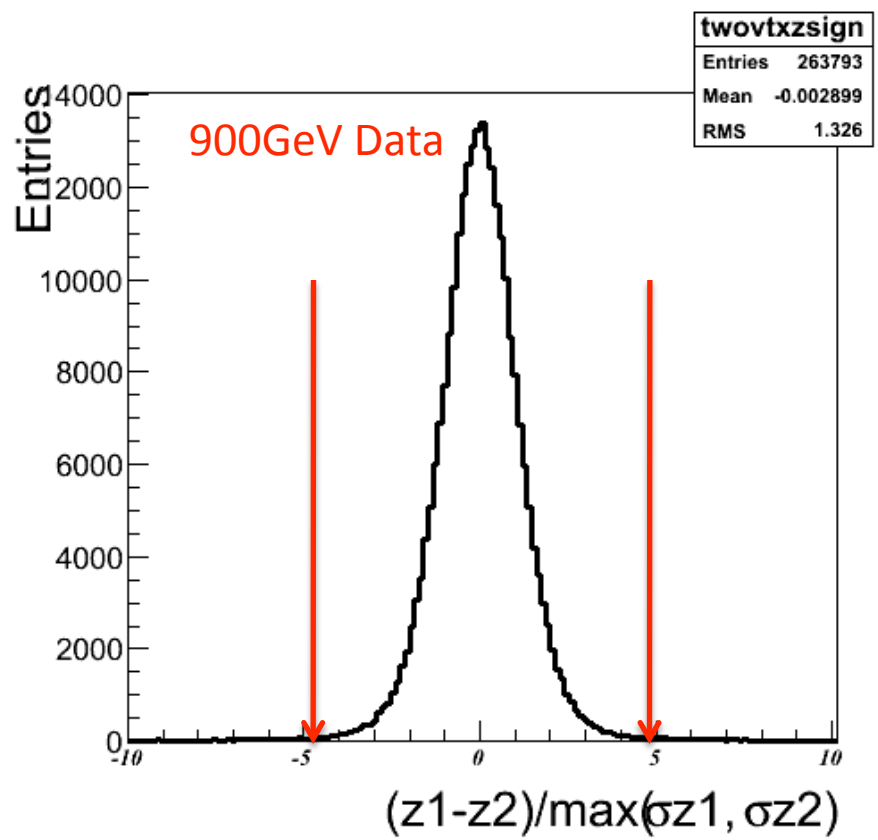
Two-Vertex Matching Selection

We assume that the split vertices have the same properties, we apply matching selection on the two vertices prior the resolution study.

1. The relative difference of #Tracks used in two vertex < 10%



2. Z separation < 5 σ

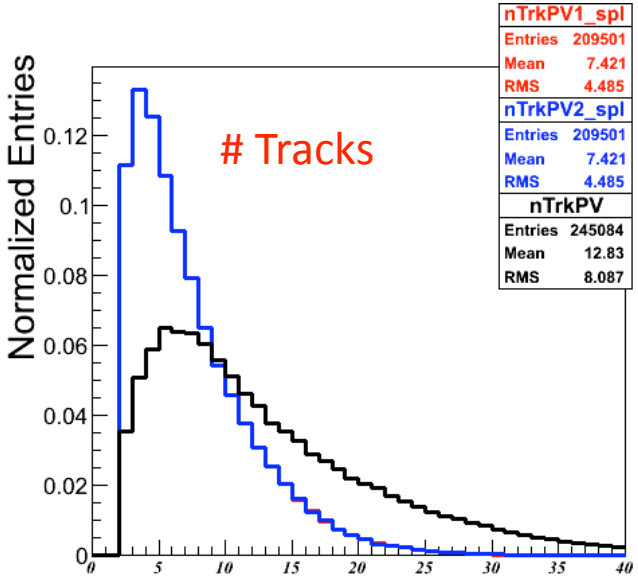


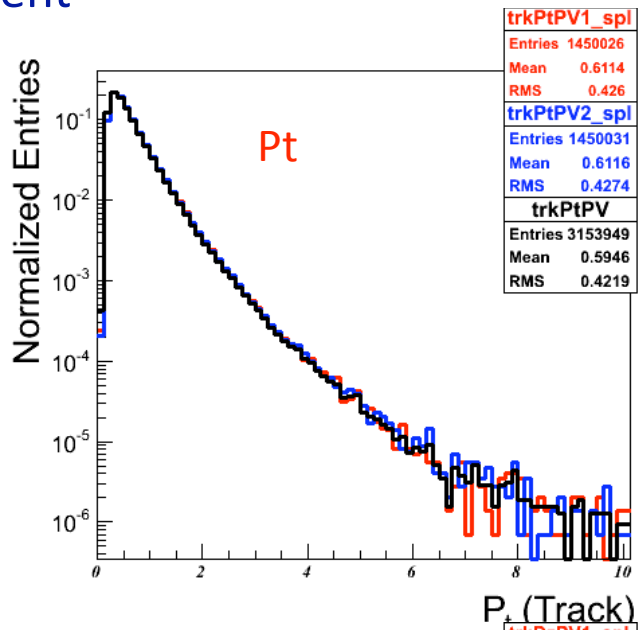
Two-Vertex Track Consistency Checks

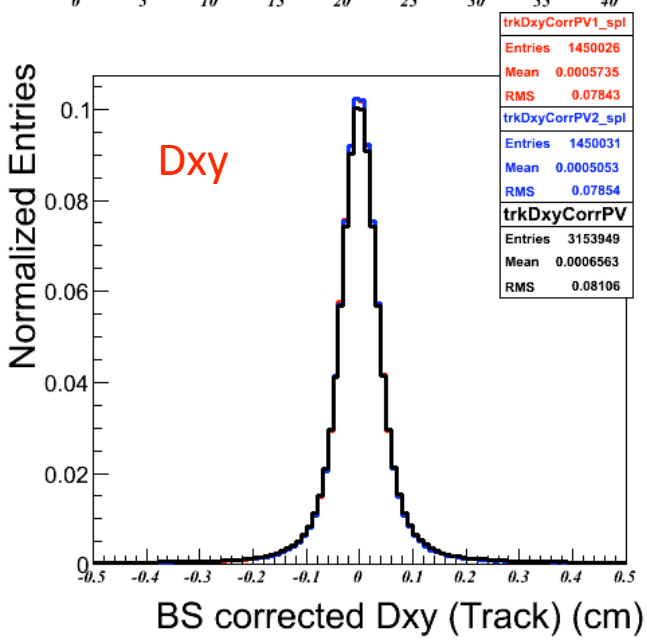
- The tracks used in the two vertices are consistent

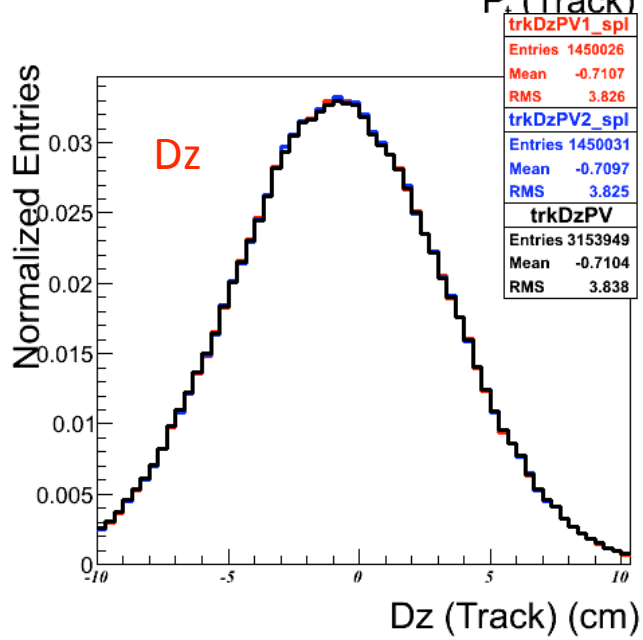
black: pvtx fitted using all tracks

blue/red: split two vertices using split tracksets



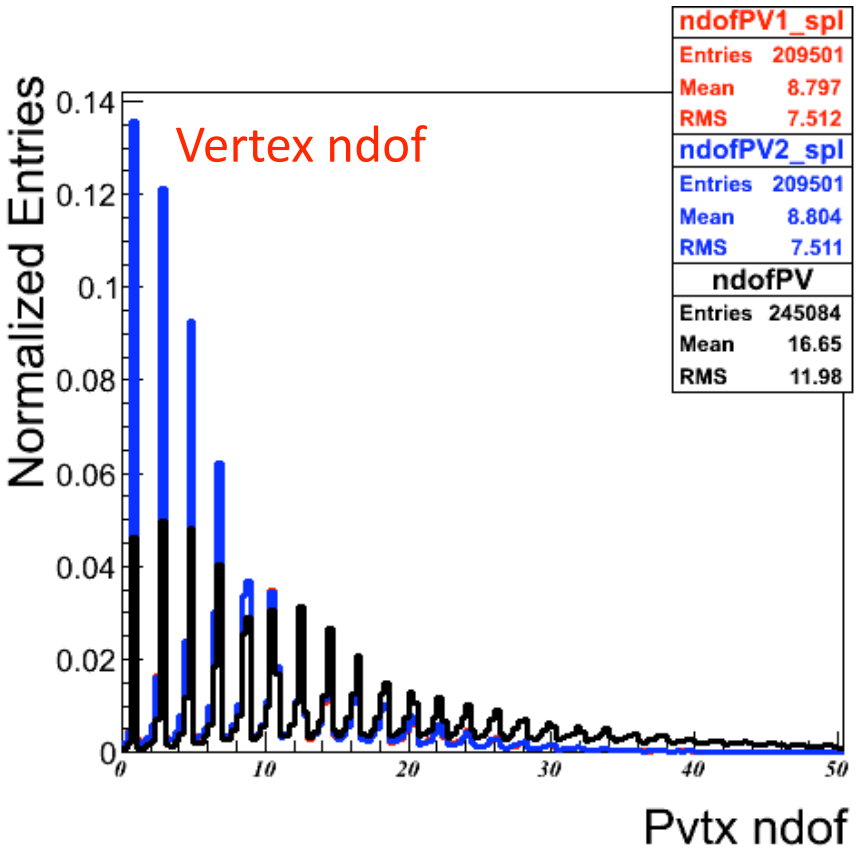


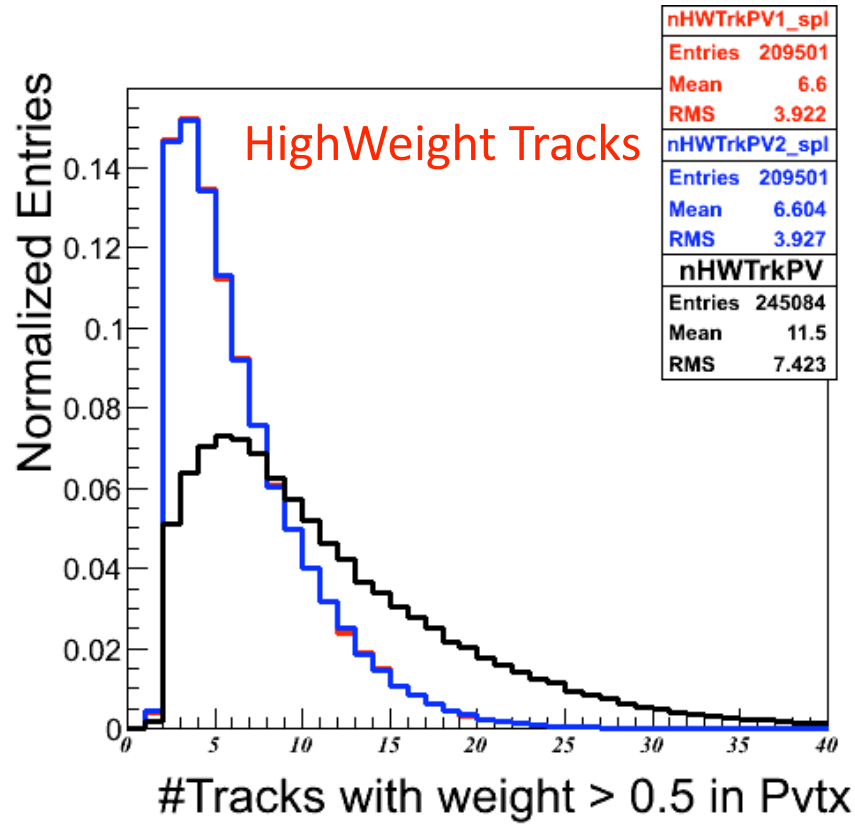




Two-Vertex Fit Consistency Checks

- Check vertex ndof and # high weight(>0.5) tracks



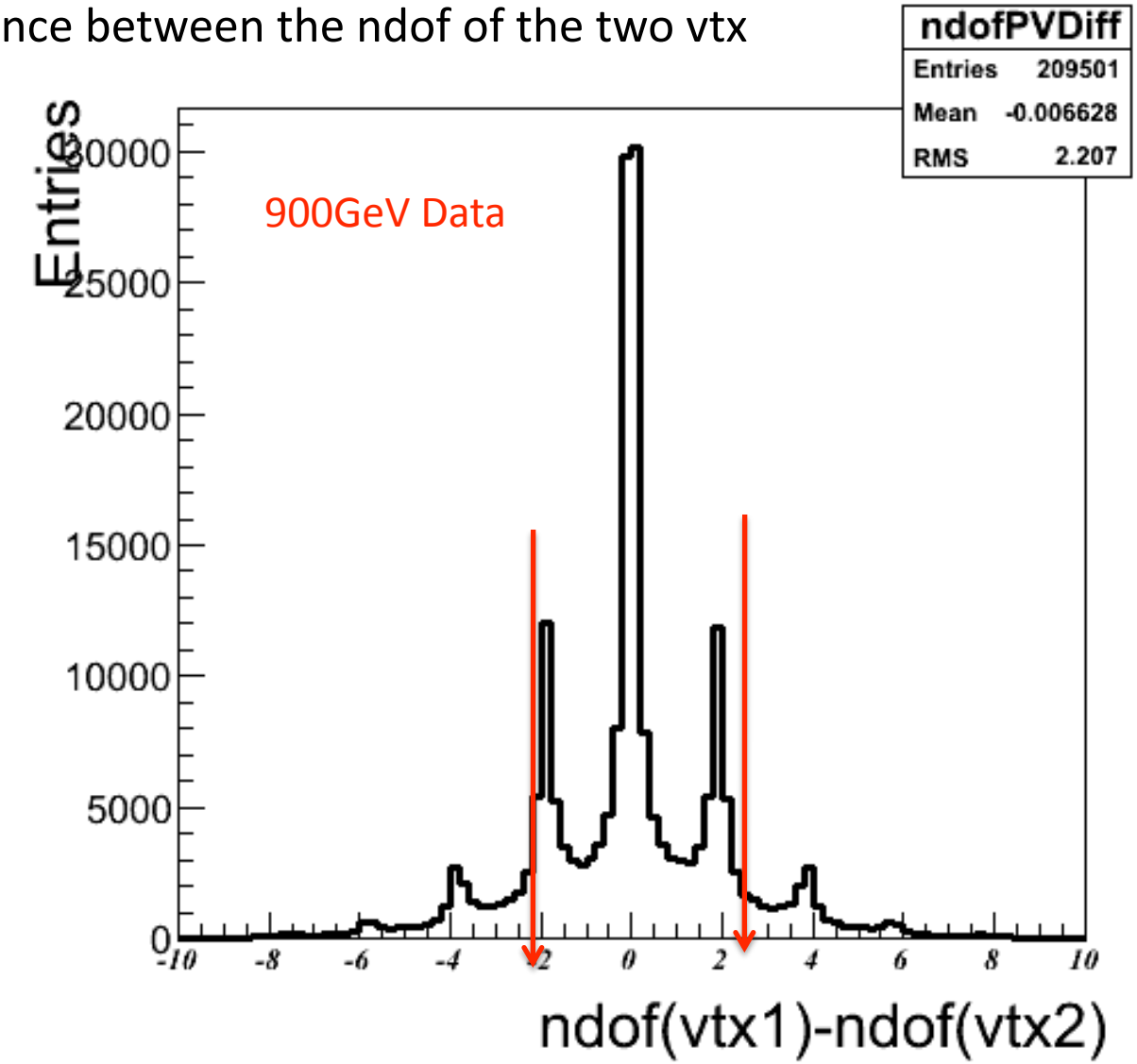


- Distinct narrow peaks indeed high weight (~1) tracks are efficiently split
- # Tracks with weight > 0.5 differ from the total Tracks by less than 1

Thanks to Wolfgang Adam and Thomas Speer for the advice in this topic

More on Two-Vertex Fit Consistency Checks

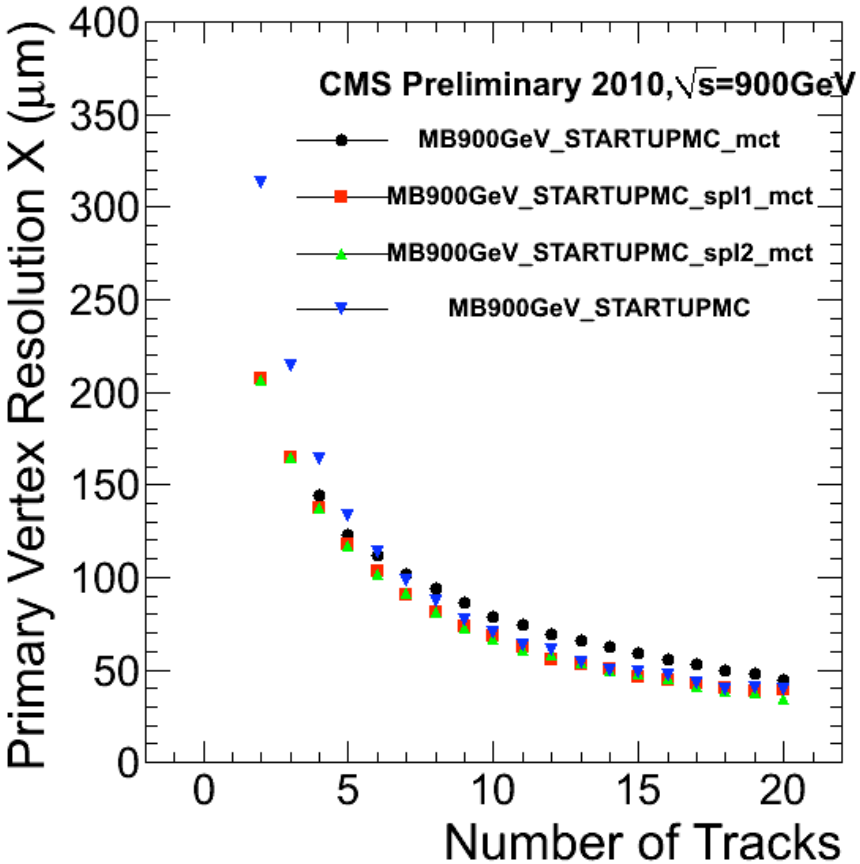
- The difference between the ndof of the two vtx

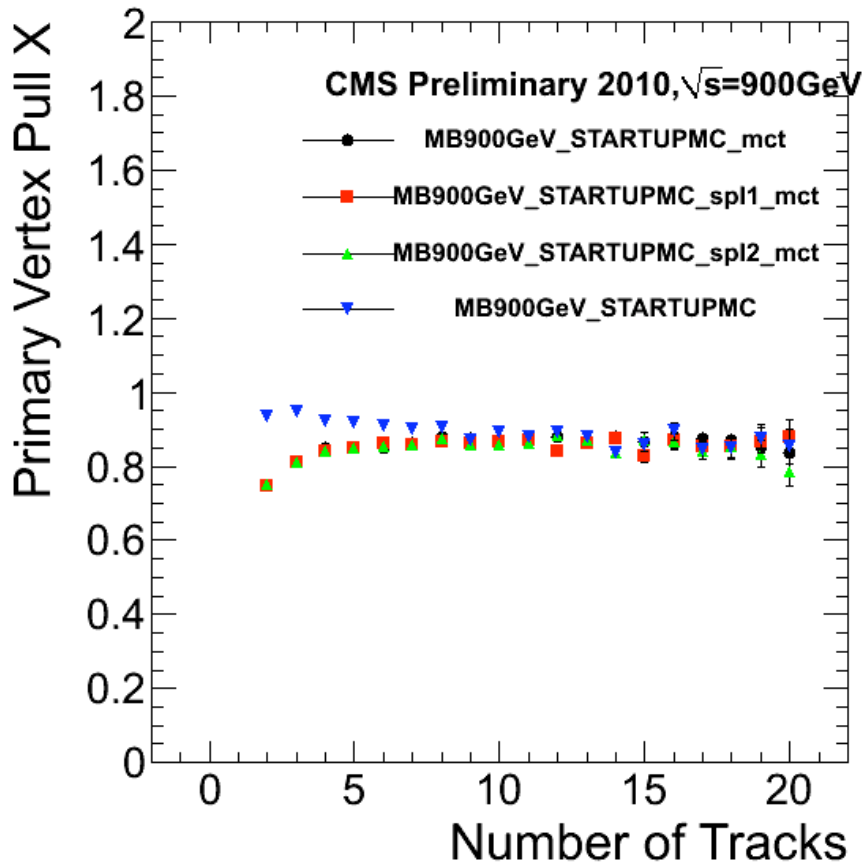


- Most cases, the two vtx differ within 1 highweighted track

Resolution X Validation on 900GeV MC

- See if the two-vertex method are consistent with MC method (rec-sim)

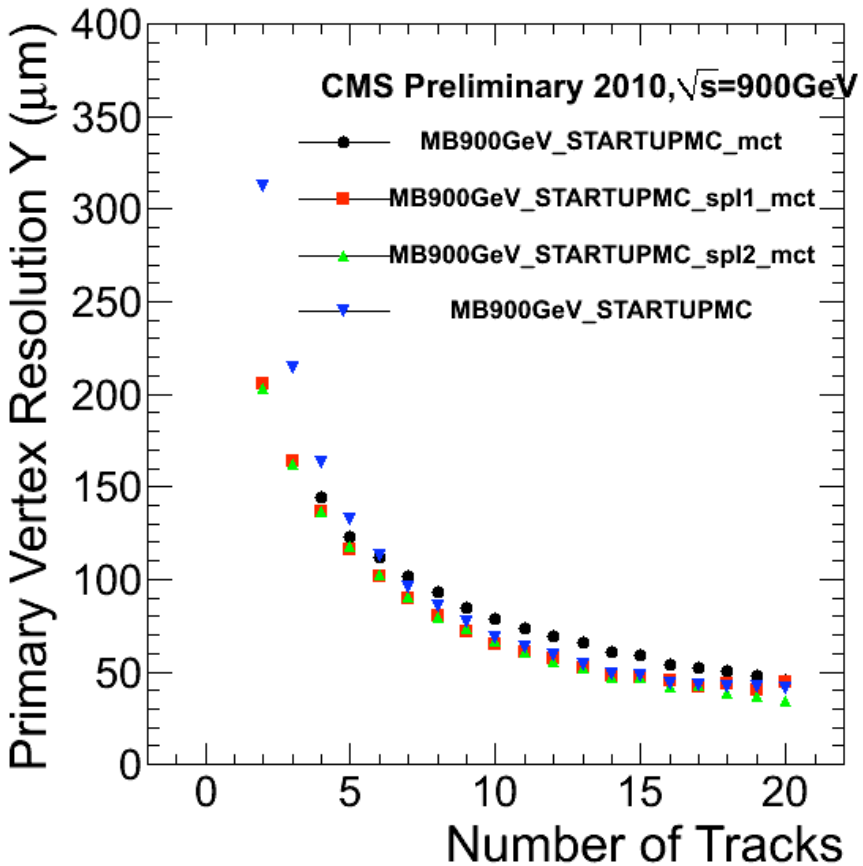


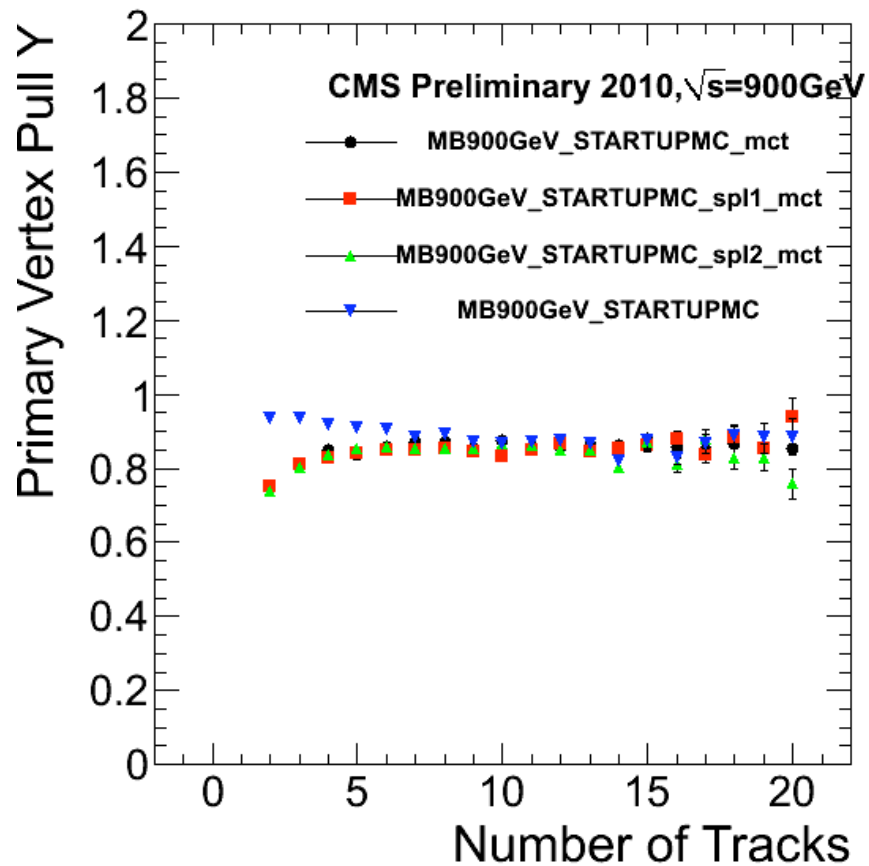


- Puzzle: The MC method gives slightly larger resolution (< 10 mum)

Resolution Y Validation on 900GeV MC

- See if the two-vertex method are consistent with MC method (rec-sim)

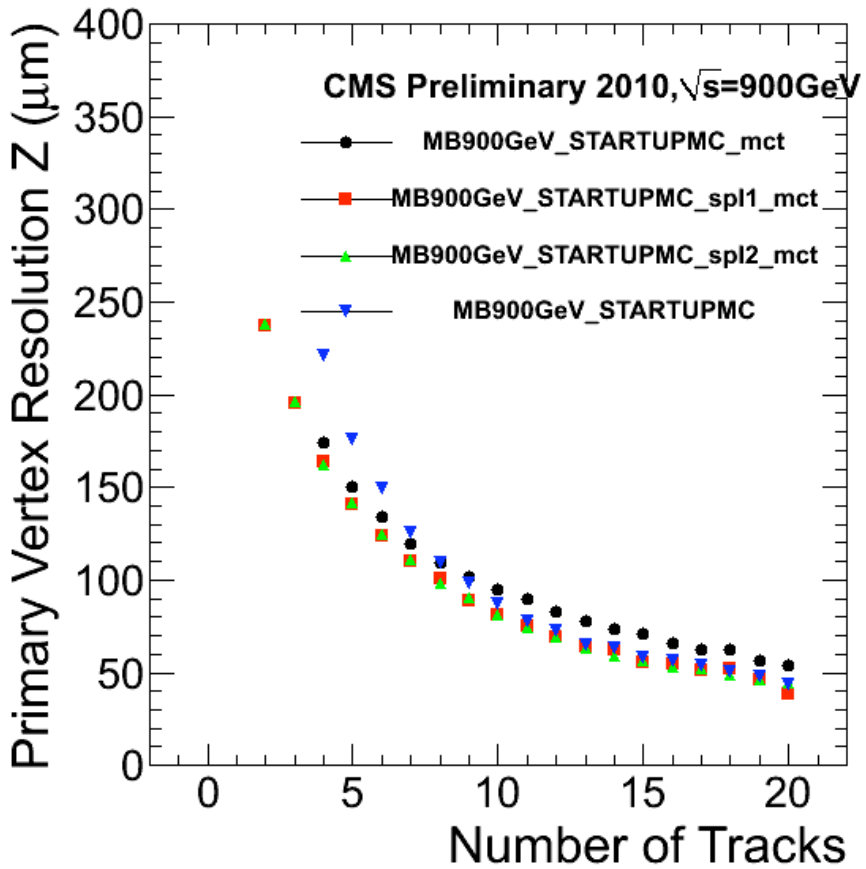


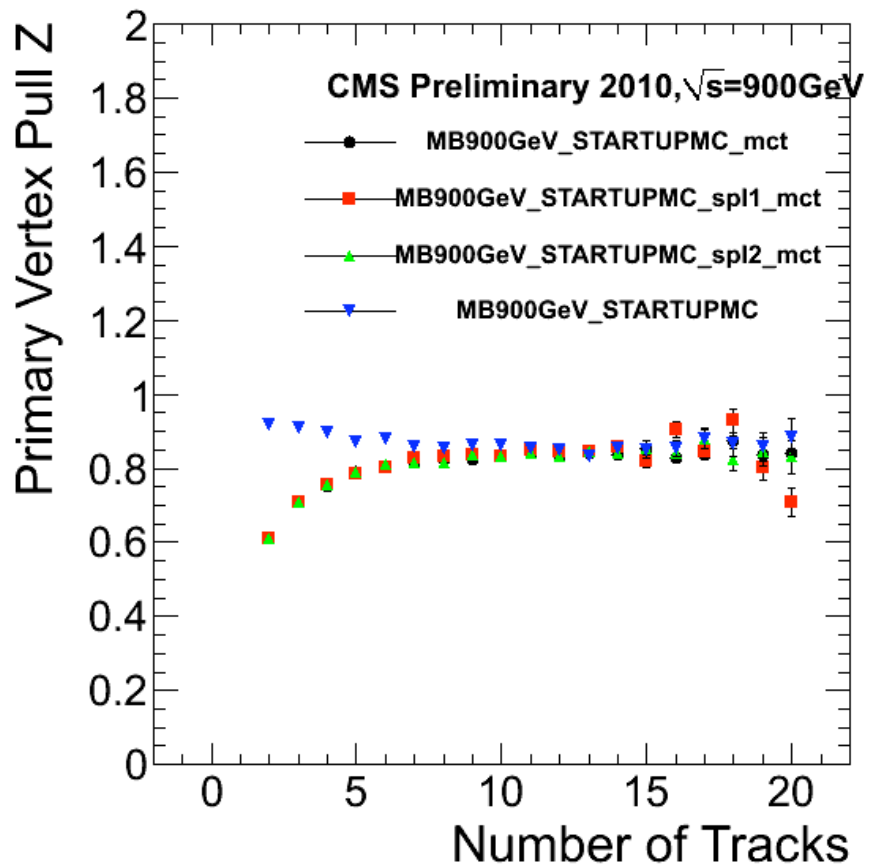


- Puzzle: The MC method gives slightly larger resolution (< 10 mum) at tails

Resolution Z Validation on 900GeV MC

- See if the two-vertex method are consistent with MC method (rec-sim)

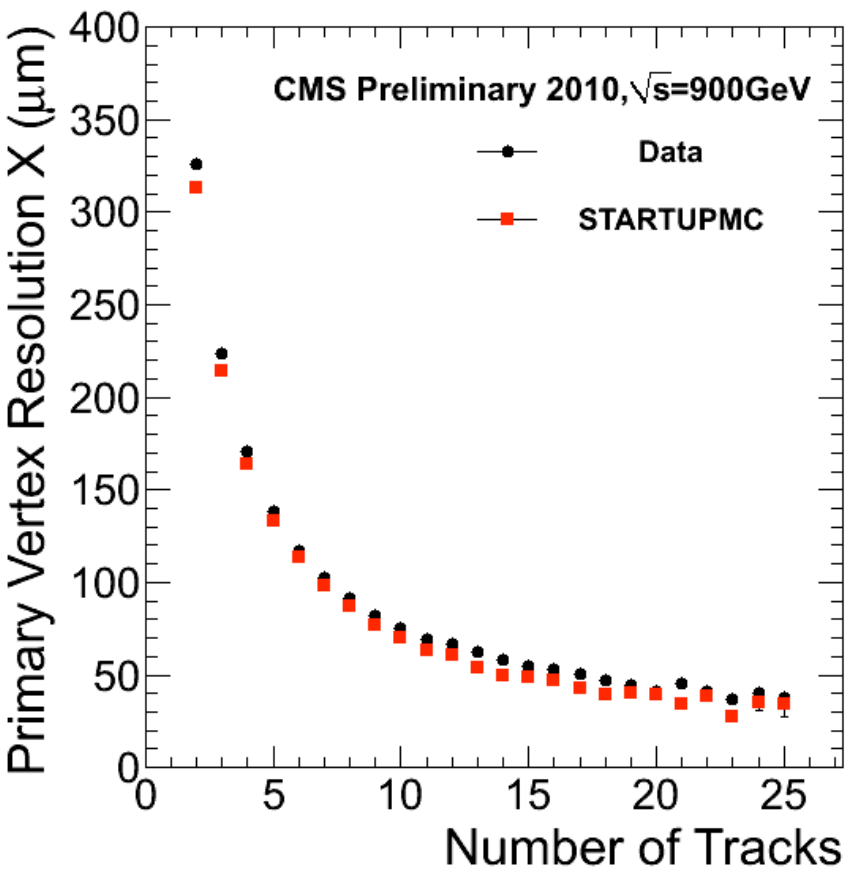


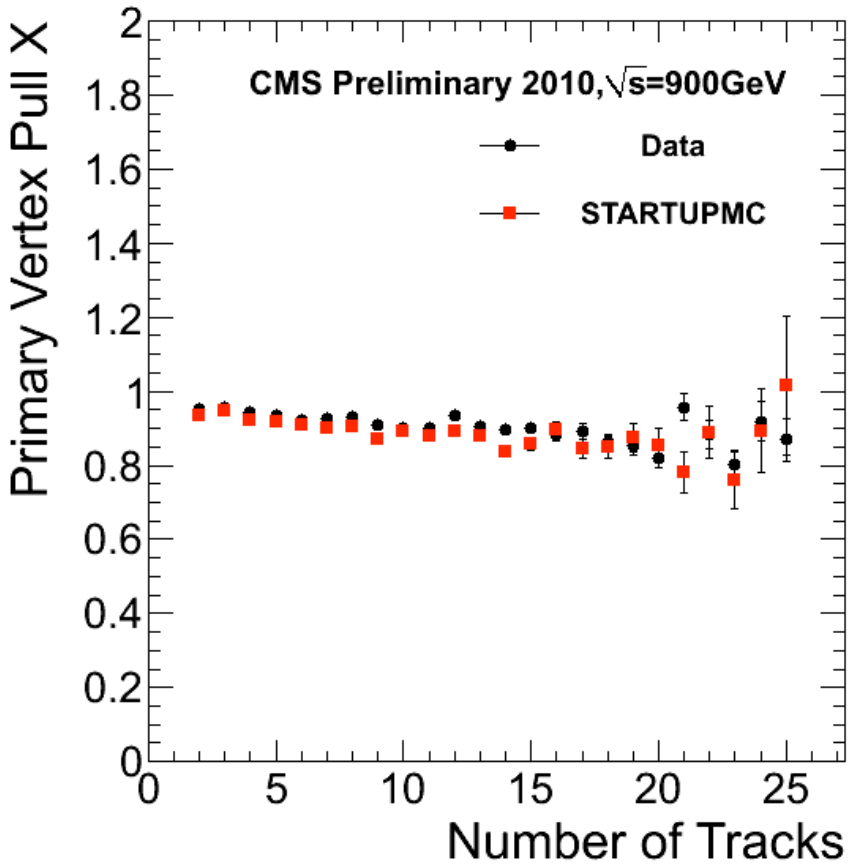


- Puzzle: The MC method gives slightly larger resolution (< 10 mum) at tails

Resolution X Data/MC @ 900GeV

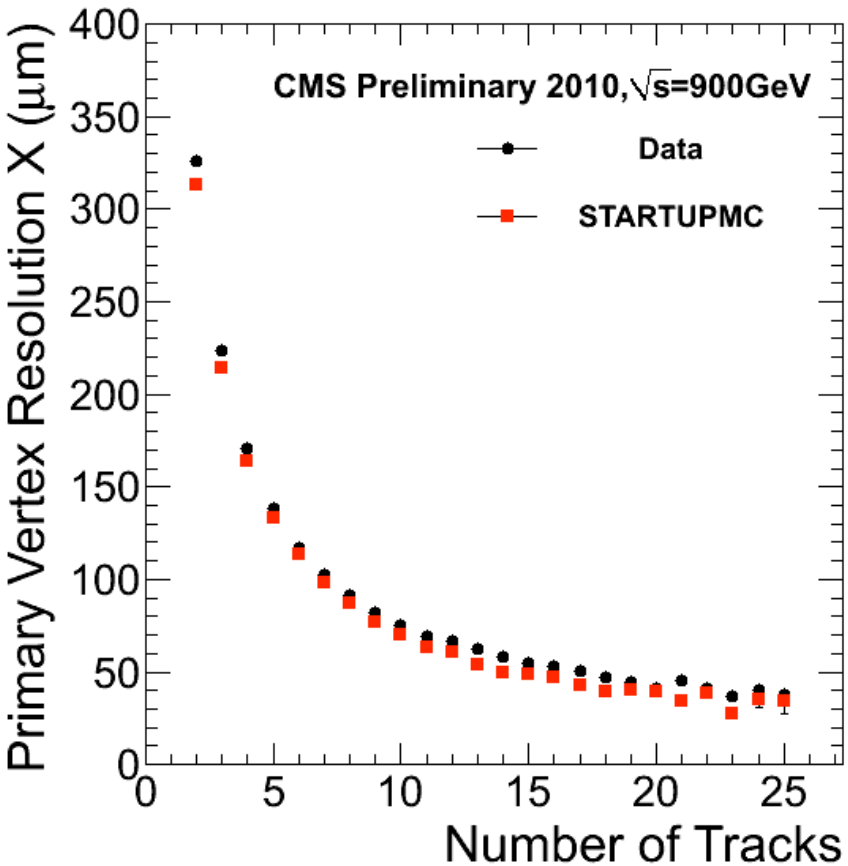
- Data and STARTUPMC are in good agreement

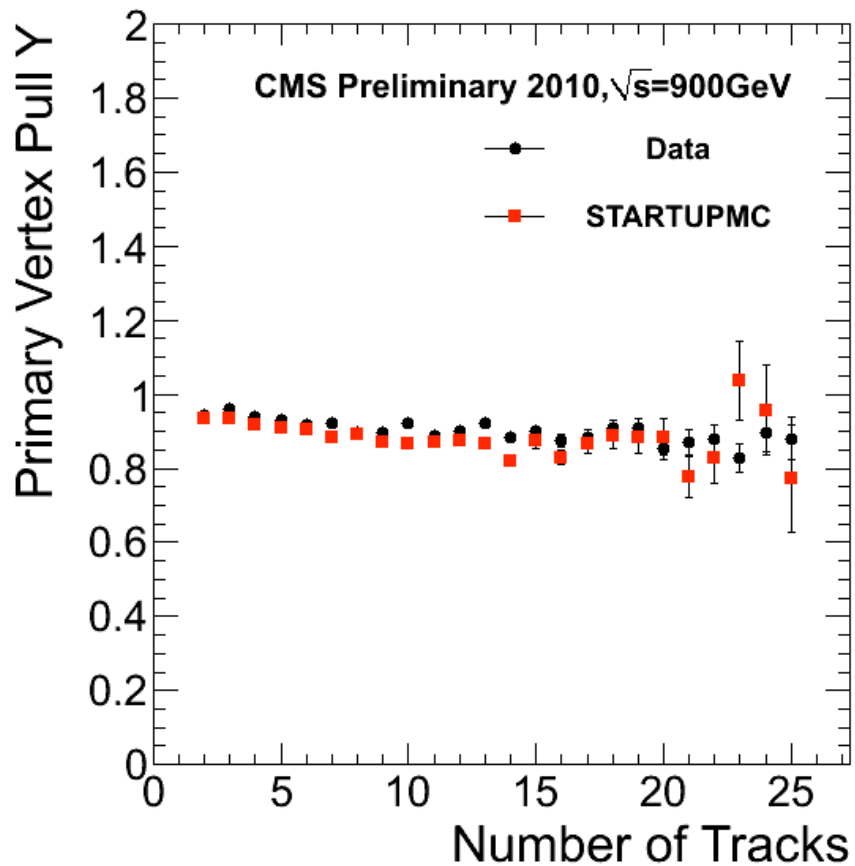




Resolution Y Data/MC @ 900GeV

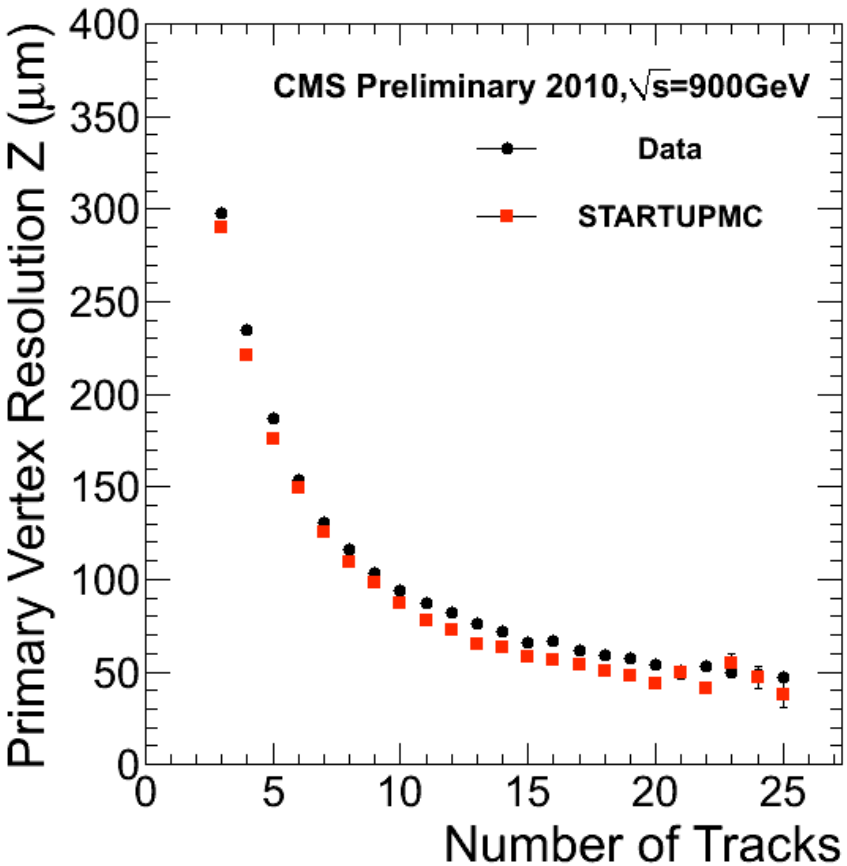
- Data and STARTUPMC are in good agreement

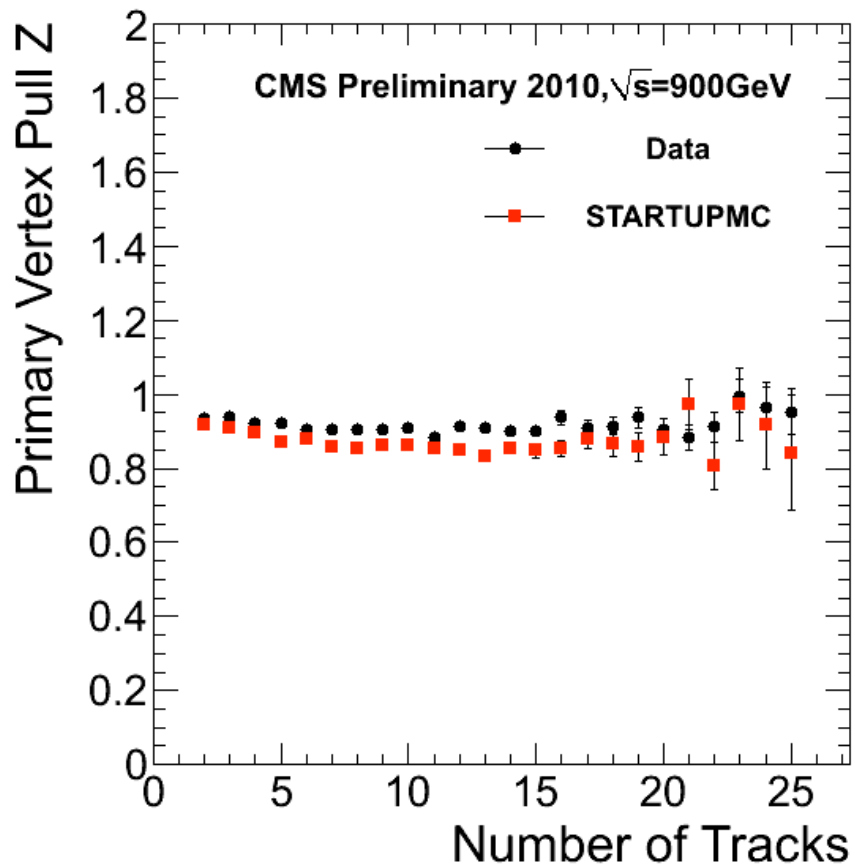




Resolution Z Data/MC @ 900GeV

- Data and STARTUPMC are in good agreement





Summary

- We measured the primary vertex resolution in Dec19thReReco data

  nTracks>10: $\sigma X \leq$ 50 mum, $\sigma Y \leq$ 50 mum, $\sigma X \leq$ 90 mum

  beam transverse width ~300 (200) mum in 900 (2360) GeV runs

- Resolution in Data is consistent with the STARTUP MC

- The Pull RMS in data is consistent with MC, also with the expected unity.

- The 900GeV and 2360GeV results are consistent, with full results linked from:
https://twiki.cern.ch/twiki/bin/view/CMS/PrimaryVertexResolution#Results_from_the_Dec19thReReco

Plans

- Investigate the resolution difference of MC method and two-vertex method

- Merge the tools from 3 institutions and finalize the method

- Study the systematic effects (pT) on the resolution results