Evaluating validity of Glauber Model Centrality prediction at $\sqrt{s_{NN}} = 7.2$ GeV FXT

For the STAR Centrality Working Group

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Motivation

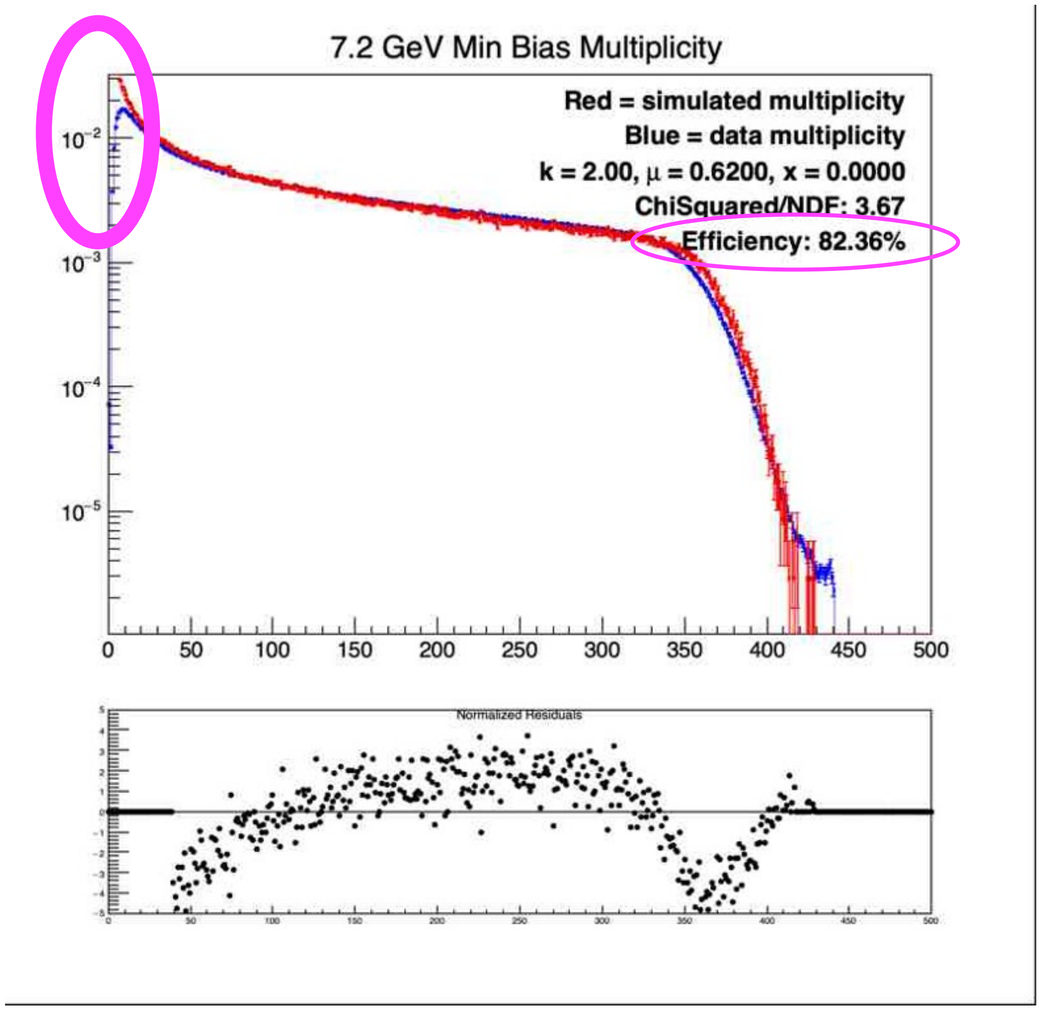
Glauber Model fit mismatches low end multiplicity for $\sqrt{s_{NN}}$ = 7.2GeV for epde-or-bbce-or-vpde-tof1 trigger

- Glauber Model is widely used in determining centrality at various energies
- Glauber Model does not predict the multiplicity distribution well at low end for $\sqrt{s_{NN}}$ = 7.2GeV FXT 2020 under epde-or-bbce-or-vpde-tof1 trigger
  - Trigger bias
- Baryon number and charge are not conserved at lower energies especially $\sqrt{s_{NN}}$ = 3.0 GeV

Observation

26p5GeV_FXT_2021 (MinBias trigger Example)

- Multiplicity from epde-or-bbce-or-vpde-tof1 trigger has a mismatch at low multiplicity compared to Glauber Model fit
- Fit region (40 , 375)
  - > 375 pileup
  - < 100 Trigger bias (Looking at pulls)
- Possible reasons:
  - Trigger bias (discriminating event selection to record)
  - Glauber Model assumptions become less valid at this energy



Fitting done by Ian Dickenson from UC Davis

BQS not conserved at 3.0 GeV

Slide from Daniel Cebra
Baryon, Charge, Strangeness conservation

- Measurement produced from pion through cascade
- Expectation produced from Glauber Model
- Evidence that there is a problem at $\sqrt{s_{NN}}$ =3.0GeV FXT
- Question: Where does the Glauber Model start to break down?

Particle	4π Yield	Error	Reference	Thermal	Charge	ΣQ	Baryon	ΣB	Strange	ΣS
π^+	**52**		**BK Aug 30**	50	1	52	0	0	0	0
π^0	**58**		**Estimated**	59	0	0	0	0	0	0
π^-	**65**		**BK Aug 30**	68	-1	-65	0	0	0	0
K^+	**2.54**		**BK Aug 30**	2.3	1	2.54	0	0	-1	-2.54
K^0_S	**1.32**	**0.03**	**XZ Sep 07**	1.2	0	0	0	0	0	0
K^0_L	1.32		estimated	1.2	0	0	0	0	0	0
K^-	**0.10**		**BK Aug 30**	0.1	-1	-0.10	0	0	1	0.10
p	**122**		**BK Aug 30**	125	1	122	1	122	0	0
n	**169**		**Estimated**	178	0	0	1	169	0	0
d	**26.6**	**2.0**	**HL Dec 17**	25.4	1	26.6	2	53.2	0	0
t	**3.85**	**0.26**	**HL Dec 17**	4.20	1	3.9	3	11.6	0	0
h	**2.85**	**0.26**	**HL Dec 17**	2.90	2	5.7	3	8.6	0	0
α	**0.47**	**0.04**	**HL Dec 17**	0.50	2	0.9	4	1.9	0	0
Λ	**2.91**	**0.29**	**TL Aug 31**	1.60	0	0	1	2.91	1	2.91
Σ^+	0.28		Estimated	0.25	1	0.28	1	0.28	1	0.28
Σ^0	0.30		Estimated	0.27	0	0	1	0.3	1	0.30
Σ^-	0.31		Estimated	0.28	-1	-0.31	1	0.31	1	0.31
Ξ^0	0.013		Estimated	0.006	0	0	1	0.013	2	0.027
Ξ^-	**0.014**	**0.002**	**YZ Aug 03**	0.006	-1	-0.014	1	0.014	2	0.028
Sum						148		369		1.41
Glauber 0-10%			$\langle N_{part} \rangle$	311		125		311		0

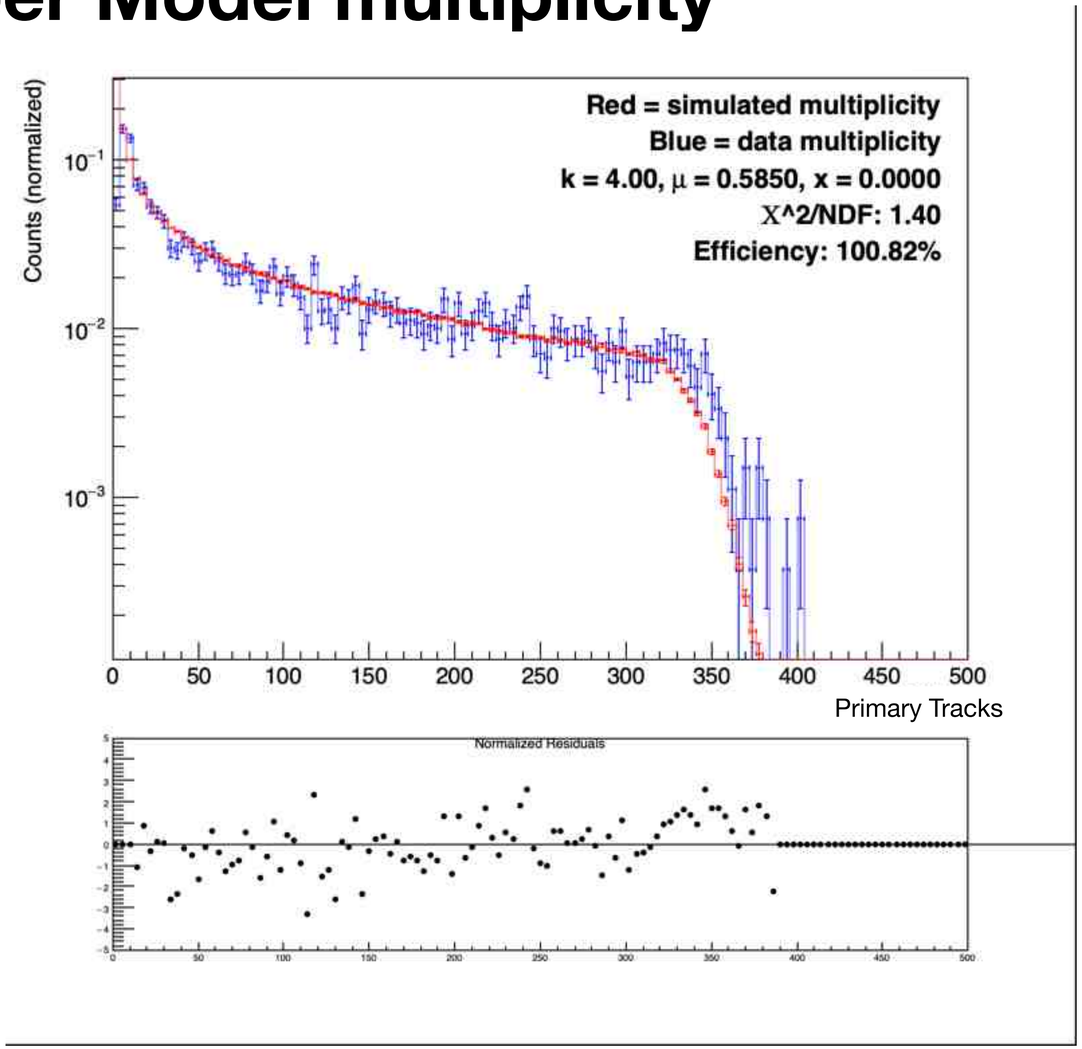
Expected baryon number: 311

Observed baryon number: 369

Remove Trigger bias

Compare zero bias trigger with Glauber Model multiplicity

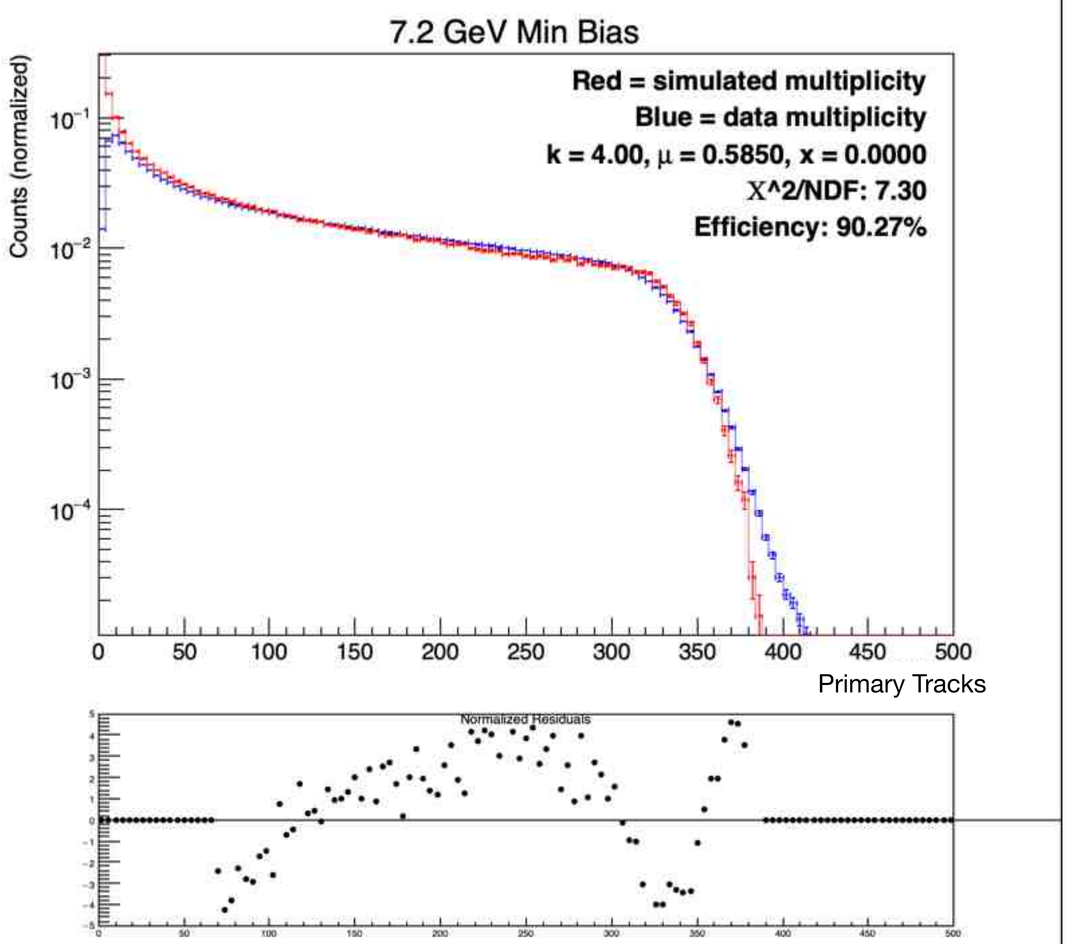
- Look at zero-bias trigger (Yellow Beam sync) to avoid trigger bias at 26.5GeV_FXT_2020
  - YellowBeamSync trigger is a zero bias trigger recording all events with the yellow bucket filled and no further requirement
- Good fit (Chi2 / NDF =1.40) overall
- Still mismatch for primary tracks (0,12), possible reasons:
  - Vertexing bias (requirement to have a TPC vertex)
- Check our understanding of bias (0,12)
  - Getting epde multiplicity distribution from muDST
- Need more statistics
  - 80000 events instead of 4000



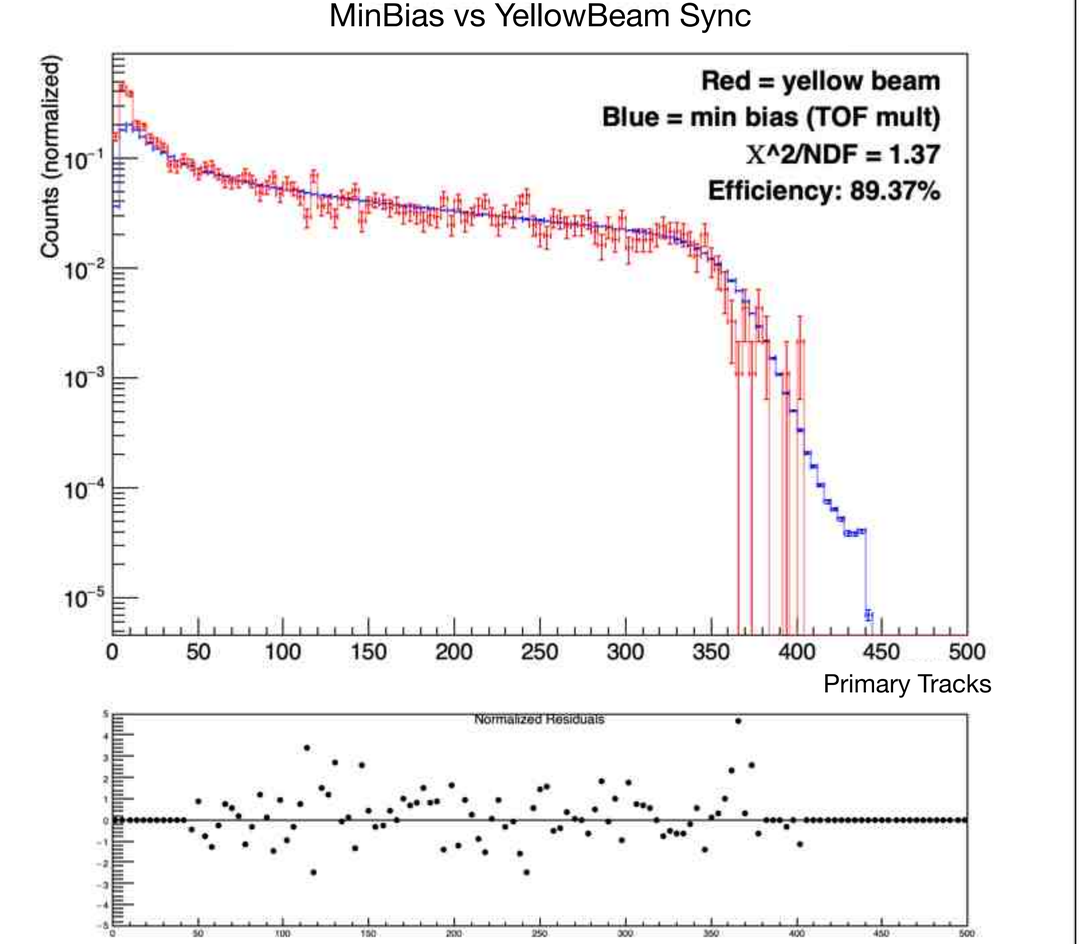
Fitting done by Ian Dickenson from UC Davis

Fitting

Minimizing Chi2/NDF by applying parameter fits from zero-bias trigger to other triggers



- Glauber model mismatch are still present



- Zero and minbias matches down to 20

- Attribute to the actual trigger bias

Production Request

st_yellow for $\sqrt{s_{NN}}$ = 3.0GeV, 7.2GeV, 9.2GeV, 11.5GeV, 13.7GeV (FXT) Run 2021

- Verify the reliability of Glauber Model predicted centrality at 3.0GeV
- $\sqrt{s_{NN}}$ = 7.2 GeV (26.5GeV FXT 2020) is currently the only dataset with YellowBeamSync trigger data produced
- Need zero-bias data to verify the validity of Glauber Model at each energy
- Run over the same analysis for checkmark of centrality bins
- Proceed to light flavor spectra analysis to check for BQS conservation

Conclusion

- Still have mismatches of Glauber Model predictions on MinBias trigger
- Therefore, we would like the st_yellow from 2021 to be produced

Thank you!

Backup slides

Challenge

Why suspect Glauber Model validity at lower energies?

- Potential signs of Glauber Model may break down at lower energies
- Glauber Model made assumptions:
  - No energy is lost between collisions
  - Nucleons follow straight lines
  - Participating nucleons being excluded from multiplicity are not valid at lower energies
- Baryon number and charge is not conserved at 3.0 GeV (See next slide)

26p5GeV_FXT_2020 st_yellow

bTOF>=1

- Got rid of out-of-time tracks
- Low statistics