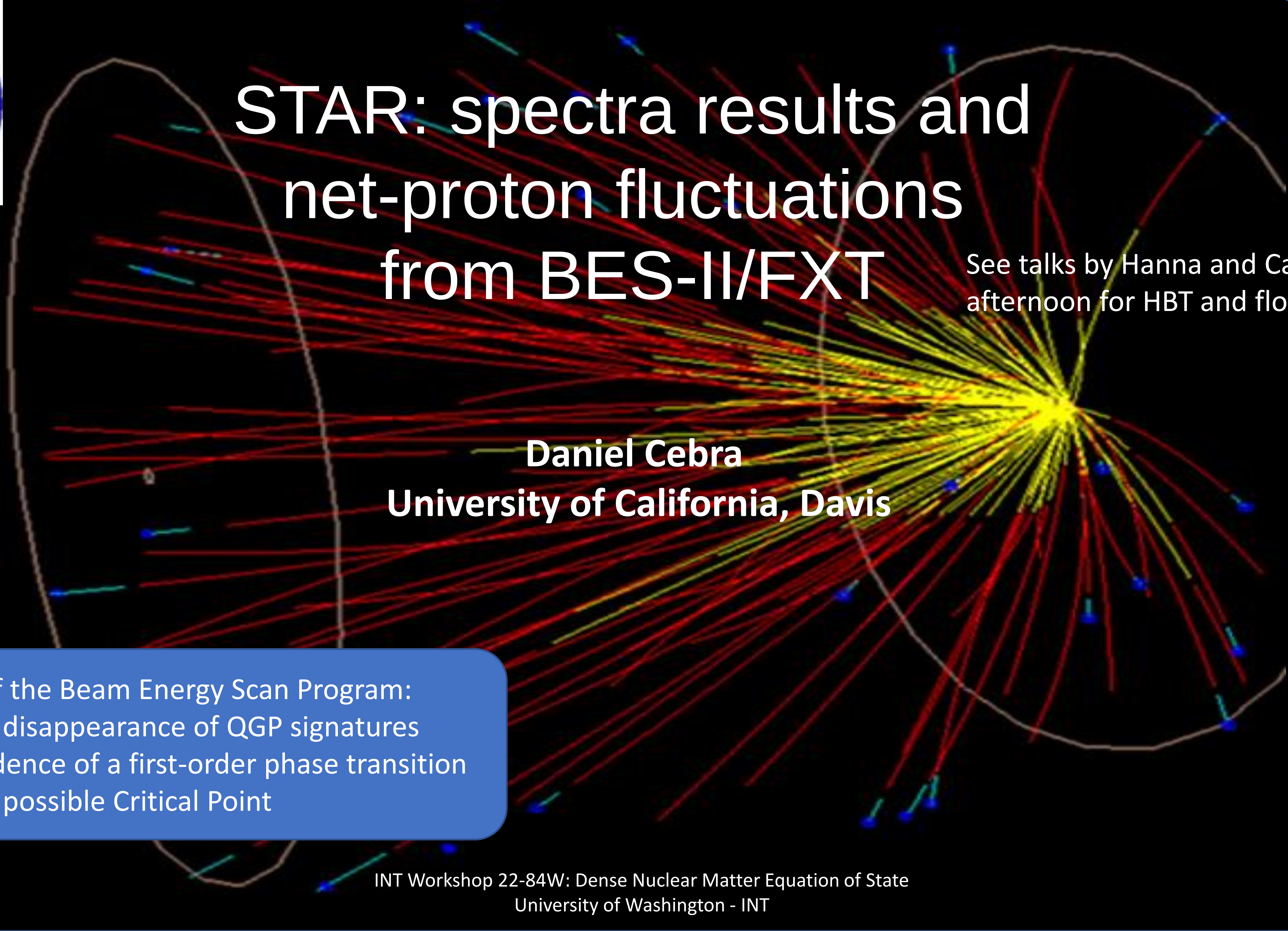


STAR: spectra results and net-proton fluctuations from BES-II/FXT

See talks by Hanna and Cameron this afternoon for HBT and flow results.

Daniel Cebra

University of California, Davis

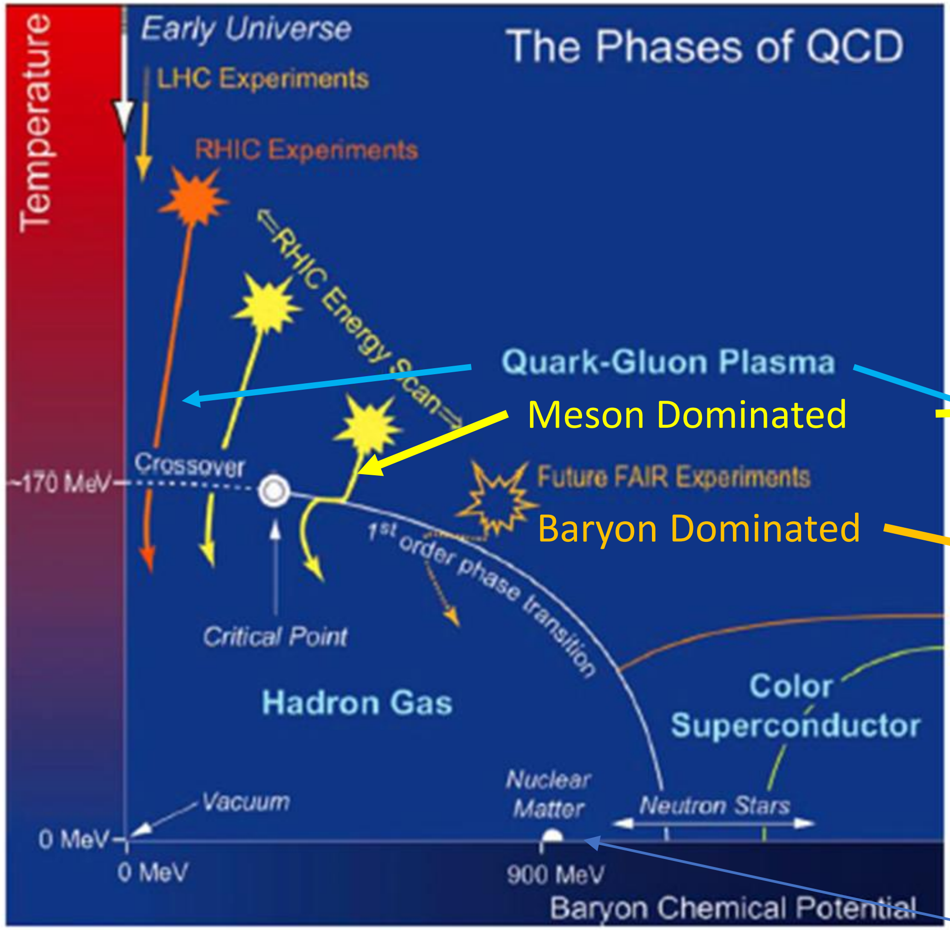
The Goals of the Beam Energy Scan Program:

1) Find the disappearance of QGP signatures
2) Find evidence of a first-order phase transition
3) Find the possible Critical Point

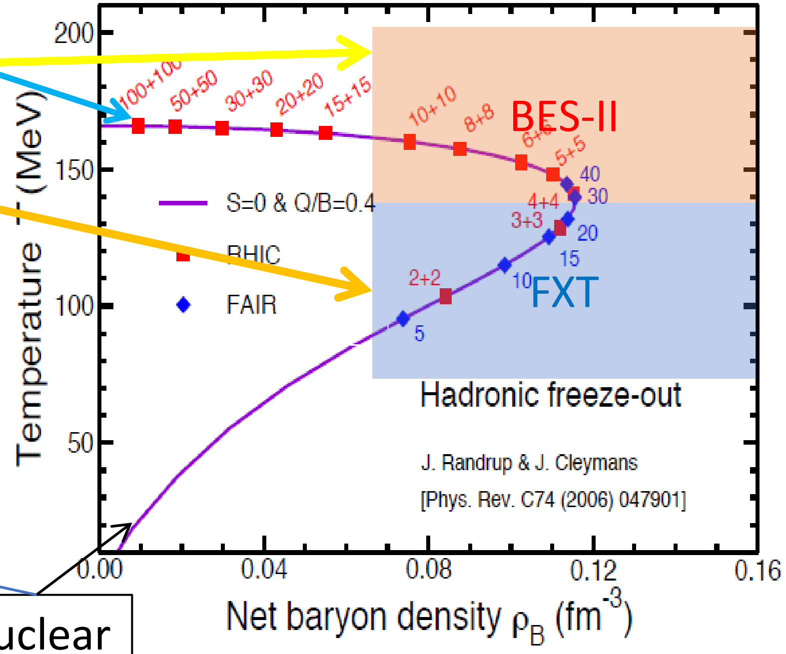
INT Workshop 22-84W: Dense Nuclear Matter Equation of State
University of Washington - INT

Motivation for Energy Scans

Onset of deconfinement; nature of the phase transition; Critical Point; Partonic Matter



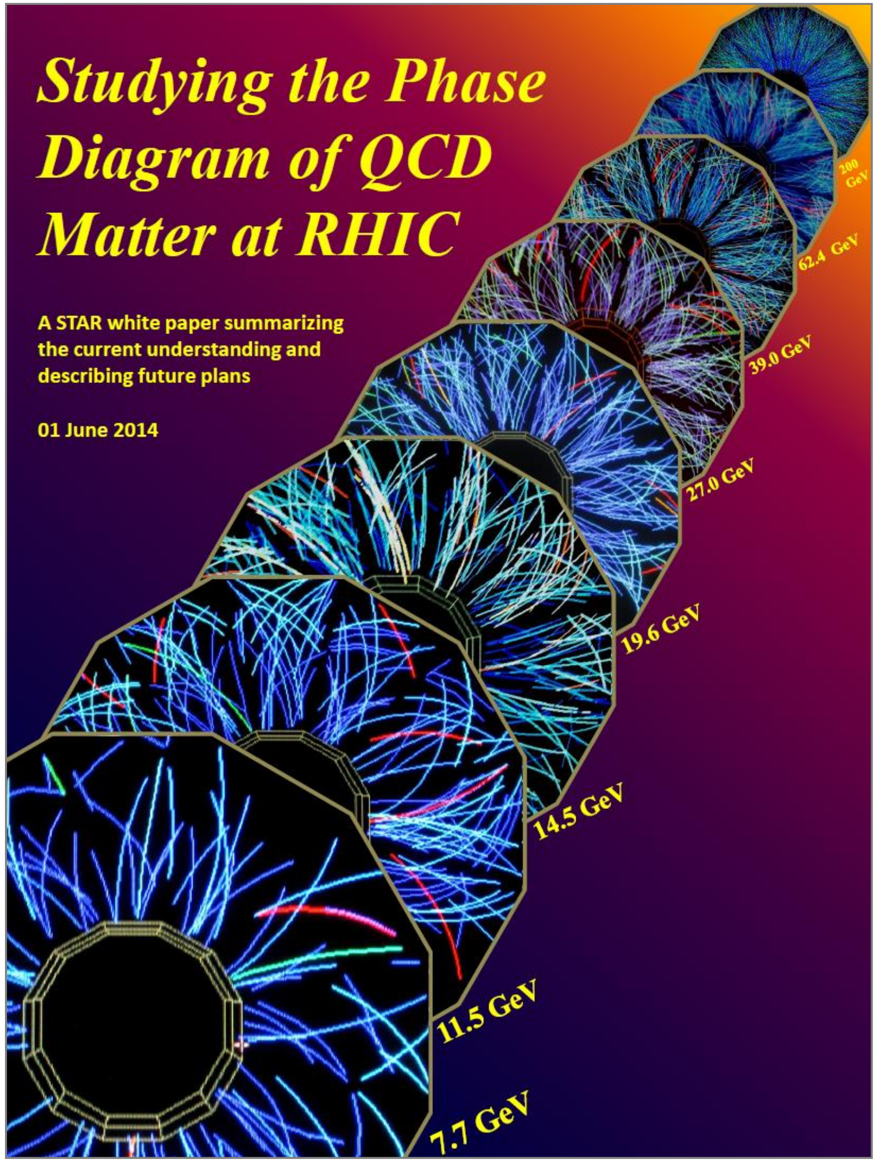
The goal of the energy scans is to study regions of the QCD which exhibit different behaviors and the transitions between such regions



There is strong motivation to study both the baryon and meson dominated regions

Nuclear Matter

BES-II Whitepaper 2014



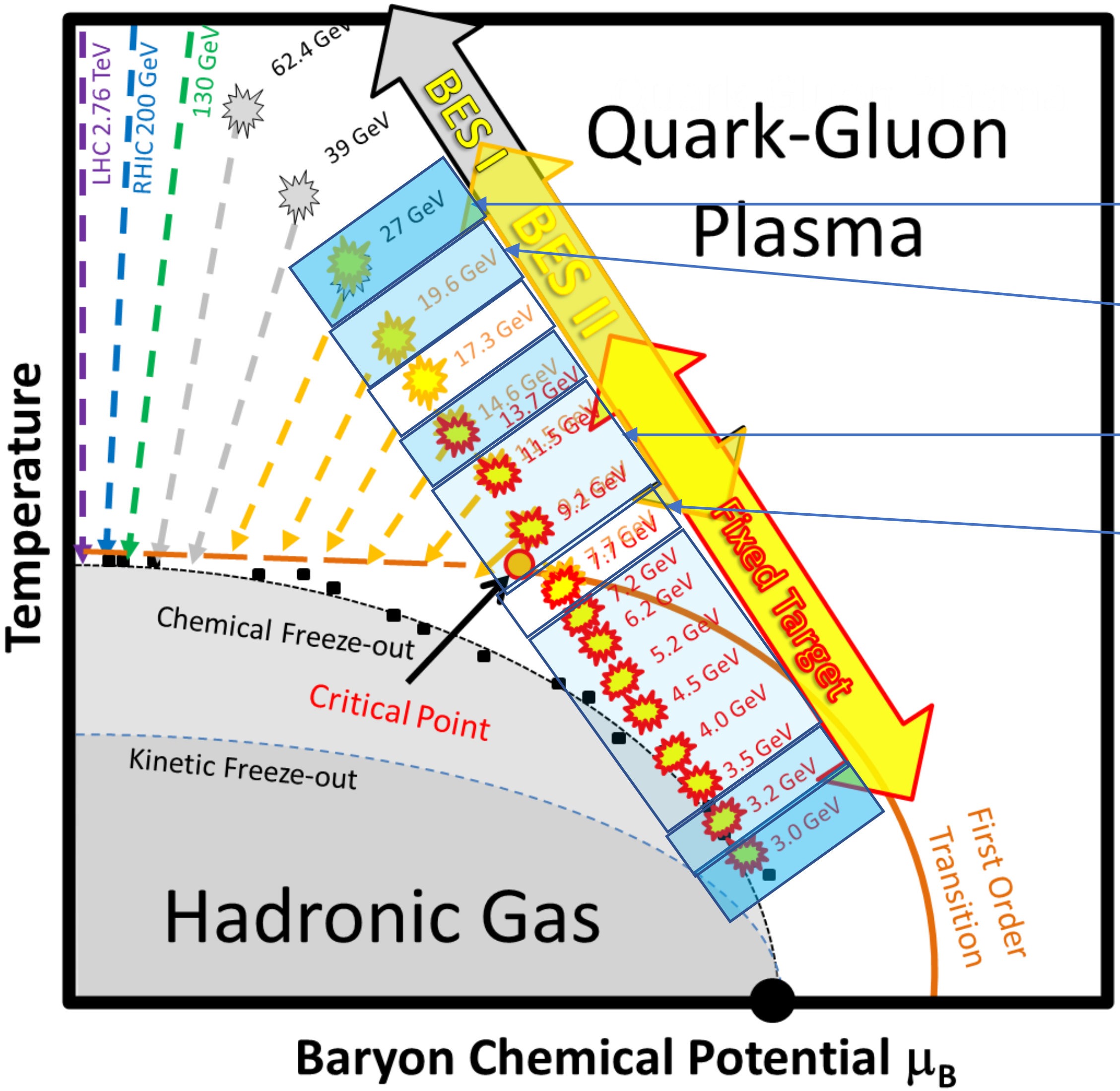
Beam Energy Scan II (2018-2021)

Select the most important energy range
➔ 3 to 20 GeV (**Add fixed-target program**)

Improve significance
➔Long runs, higher luminosity (**electron cooling**)

Refine the signals
➔ Detector improvements (**iTPC, eTOF, EPD**)

STAR Beam Energy Scan II – Mapping the QCD Phase Diagram
The Experimental Plan



Go from easiest to hardest

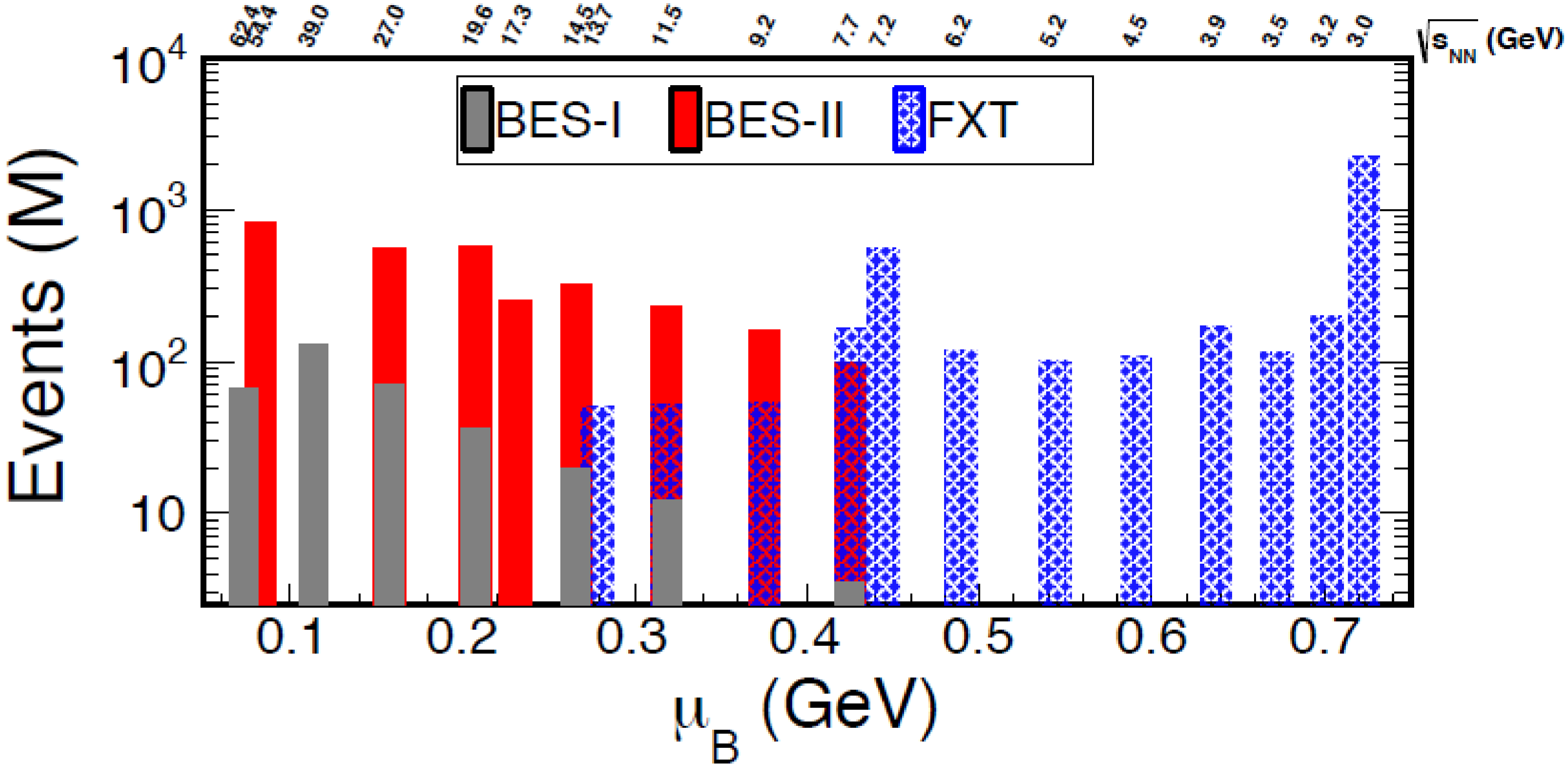
Run 18 -- 27 GeV, FXT 3.0, FXT 7.2
Beams are accelerated
Run 19 – 19.6, 14.6, FXT 3.2 GeV
No acceleration in RHIC
Run 20 – 11.5, 9.2, six FXT energies
Needs cooling at 9.2 GeV
Run 21 – 7.7, 17.3 GeV Collider
FXT 9.2, 11.5, 13.5, hi stats at FXT 3

The plan went well, all items in red were extra

The BESII collider program maps the approach to the transition from the QGP side of the QCD phase diagram.

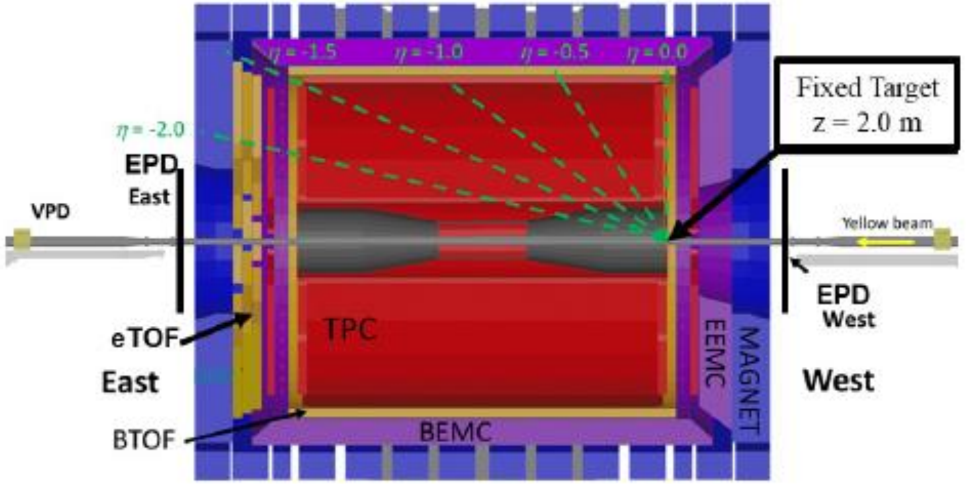
The FXT program maps the baryon-rich side of the phase diagram

- We have a lot of data.
- All collider energies have 10-20 times higher statistics compared to BES-I
- All FXT energies have at least 100 million events (500 million at 7.2 eV, 2 billion at 3.0 GeV)



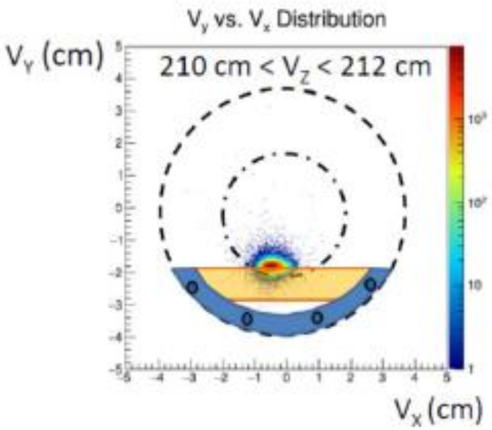
Fixed-Target (FXT) Program at STAR

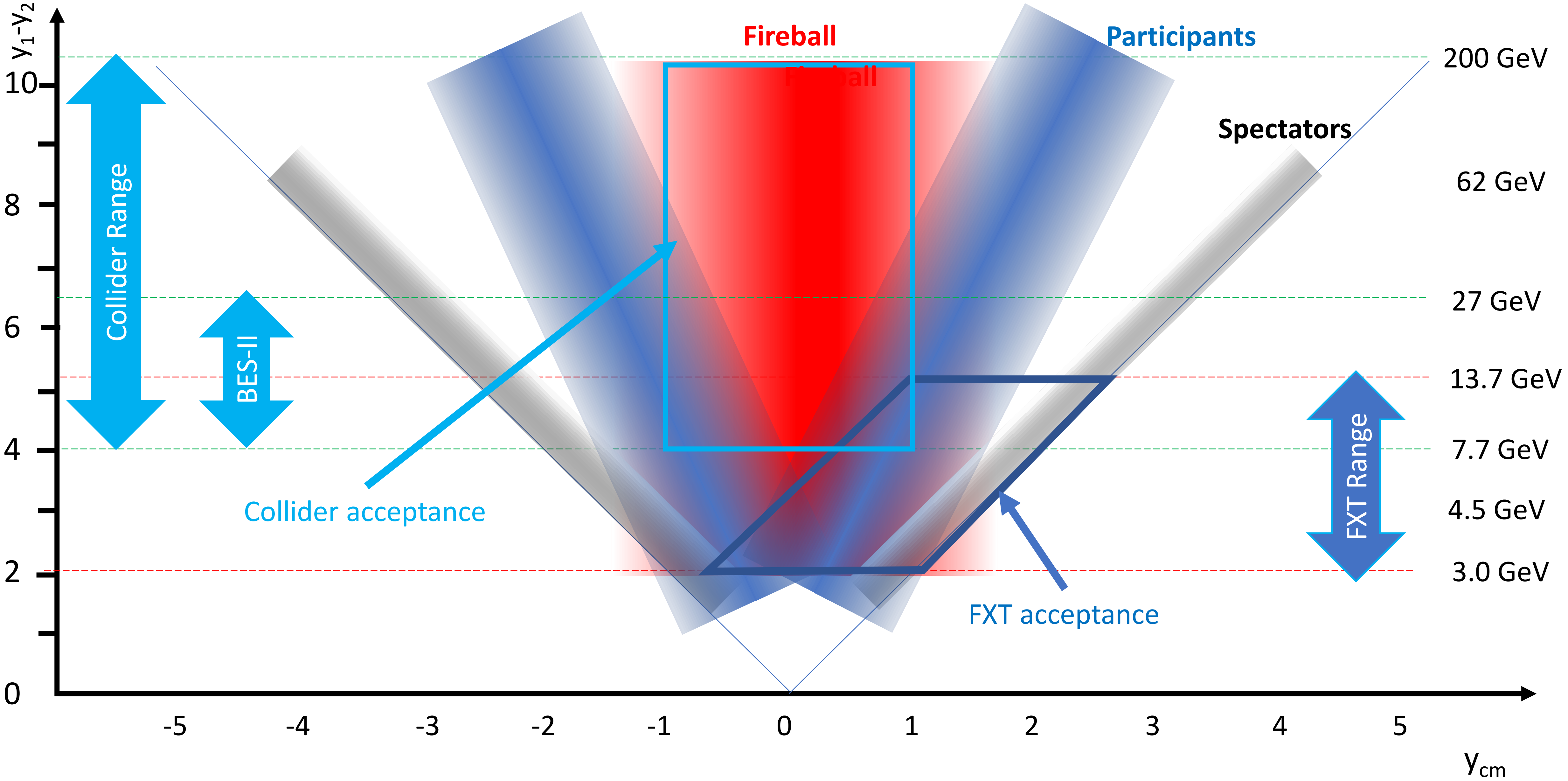
- Test run with gold target in 2015
- First physics runs at $\sqrt{s_{NN}}$ = 3.0 GeV and 7.2 GeV in 2018
- Now have data at $\sqrt{s_{NN}}$ of 3.0, 3.2, 3.5, 3.9, 4.5, 5.2, 6.2, 7.2, and 7.7 GeV **(and 9.2, 11.5, and 13.7 GeV)**



Challenges for FXT

- Shifting asymmetric acceptance wrt midrapidity
- At 7.7 GeV midrapidity moves to edge of Time Projection Chamber (TPC) acceptance
- Boost at higher energies shifts PID to rely more on TOF than TPC identification





The FXT part of the program is dominated by participant baryons, while the collider part sees mostly the fireball

The Path to Publication

- **Data Acquisition** ← Weekly QA of FastOffline and HLT
- **Calibration**
- **Production**
  - (Calibration and Production): See Gene Van Buren's Talk (yesterday)
- **Run-by-Run QA** — QA Board Meetings every other Friday at noon → Chair: Ting Lin
- **Centrality** — Centrality Definition Meetings Tuesday at 11AM → Chair: Grigory Nigmatkulov
- **Physics Analysis** — Analysis teams should report regularly in PWG → Chaired by Conveners
- **Paper Proposal Preview** — PAs present paper proposal to PWGC → Chair: Rongrong Ma, Takafumi Niida
- **God Parent Committee**
- **Collaboration Review**

Acquisition of the BES-II/FXT data went very well, even leaving some time for some opportunity systems.

Calibration, Production, and Post-production QA take some time, but teams are in place and data sets are becoming available for the analysis teams. With all data likely available for physics analysis within a year.

STAR plans to publish final results once all energies are available (with the exception of the 3.0 GeV FXT data).

I will focus on the 3 GeV Results

2018	Start	Stop	Good	Target	Status
27 GeV	May 10th	June 17th	555 M	700 M	Final
3.0 FXT	May 30th	June 4th	258 M	100 M	Final
7.2 FXT	June 11th	June 12th	155 M	none	Final
2019	**Start**	**Stop**	**Good**	**Target**	**Status**
19.6 GeV	Feb 25th	April 3rd	478 M	400 M	Preliminary
14.6 GeV	April 4th	June 3rd	324 M	310 M	Preliminary
3.9 FXT	June 18th	June 18th	52.7 M	50 M	Centrality
3.2 FXT	June 28th	July 2nd	200.6 M	200 M	Centrality
7.7 FXT	July 8th	July 9th	50.6 M	50 M	Centrality
200 GeV	July 11th	July 12th	138 M	140 M	Centrality
2020	**Start**	**Stop**	**Good**	**Target**	**Status**
11.5 GeV	Dec 10th	Feb 24th	235 M	230 M	*December*
7.7 FXT	Jan 28th	Jan 29th	112.5 M	100 M	Centrality
4.5 FXT	Jan29th	Feb 1st	108 M	100 M	Centrality
6.2 FXT	Feb 1st	Feb 2nd	118 M	100 M	Centrality
5.2 FXT	Feb 2nd	Feb 3rd	103 M	100 M	Centrality
3.9 FXT	Feb 4th	Feb 5th	117 M	100 M	Centrality
3.5 FXT	Feb 13th	Feb 14th	115.6 M	100 M	Centrality
9.2 GeV	Feb 24th	Sep 1st	161.8 M	160 M	*January*
7.2 FXT	Sep 12th	Sep 14th	317 M	None	*2022*
2021	**Start**	**Stop**	**Good**	**Target**	**Status**
7.7 GeV	Jan 31st	May 1st	100.9 M	100 M	*Quality Assurance*
3.0 FXT	May 1st	June 28th	2103 M	2.0 B	*2022*
9.2 FXT	May 6th	May 6th	53.9 M	50 M	*2022*
11.5 FXT	May 7th	May 7th	51.7 M	50 M	*2022*
13.7 FXT	May 8th	May 8th	50.7 M	50 M	*2022*
17.3 GeV	May 25th	June 7th	256.1 M	250 M	*2022*
7.2 FXT	June 3rd	July 3rd	88.6 M	None	*2022*

The only "final" results are from 2018 data.

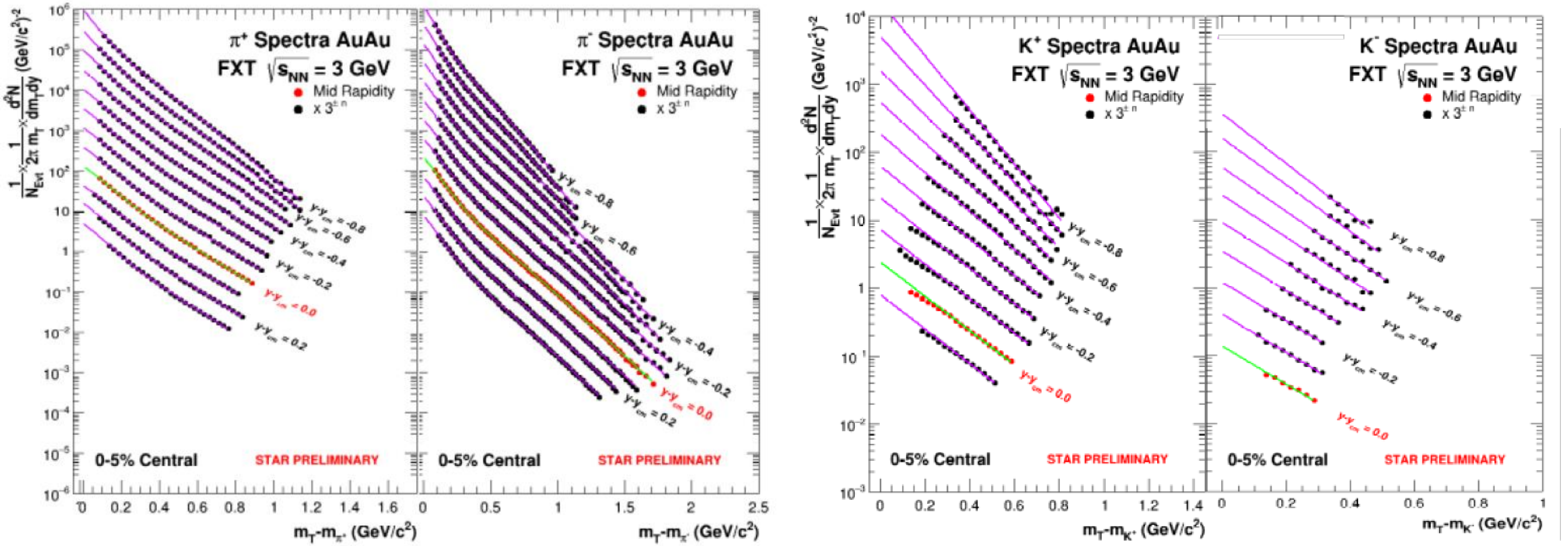
Results from the 19.6, 14.6, and 200 GeV data sets will be coming out soon.

The full FXT energy scan data have been produced and completed Quality Assurance

7.7 GeV Collider data have been given a high priority.

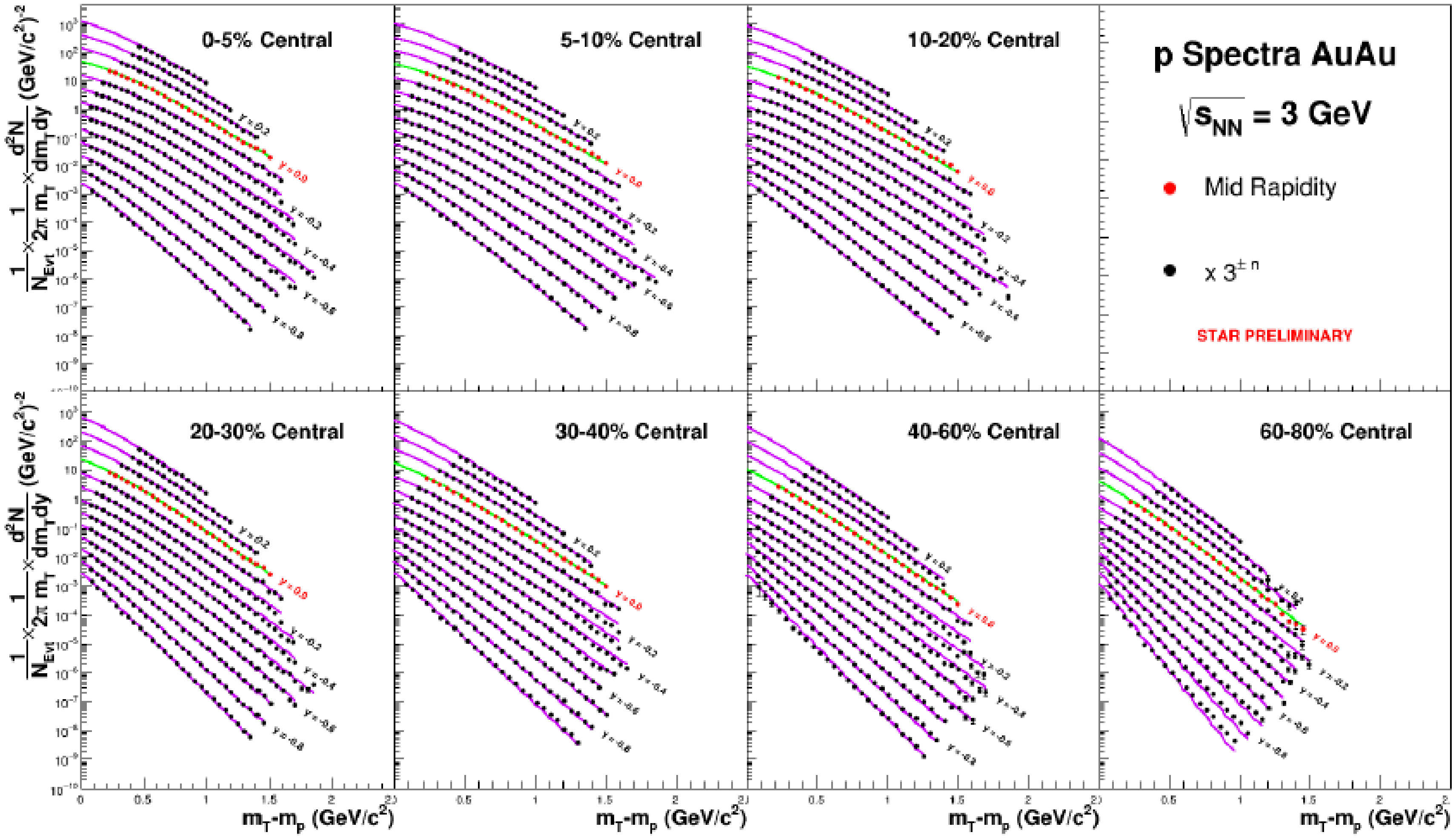
3.0 GeV Spectra: pions and kaons

At 3.0 GeV, we have acceptance, with good particle identification from target to center-of-mass rapidity
Spectra are analyzed for all rapidities, and for all centralities

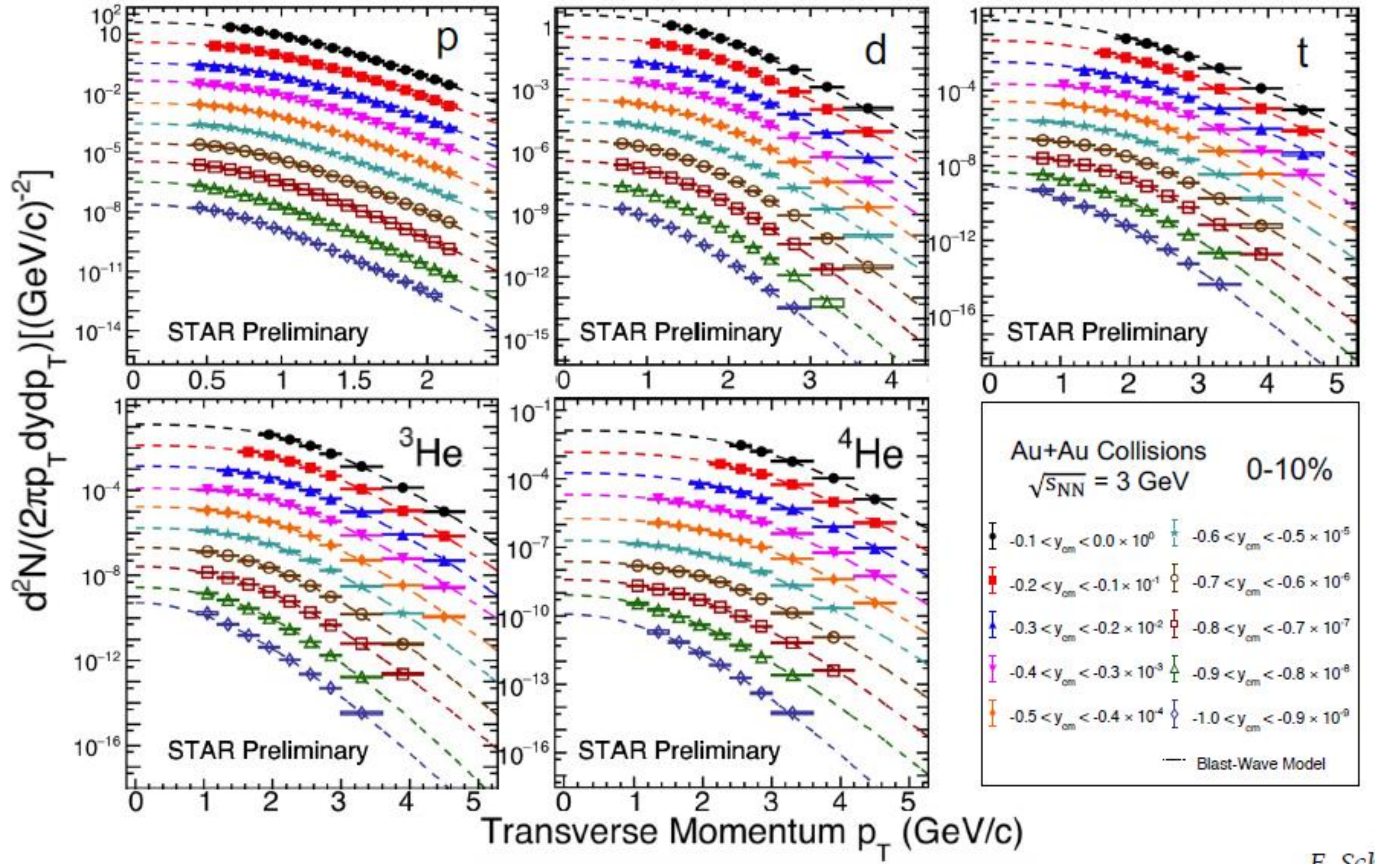


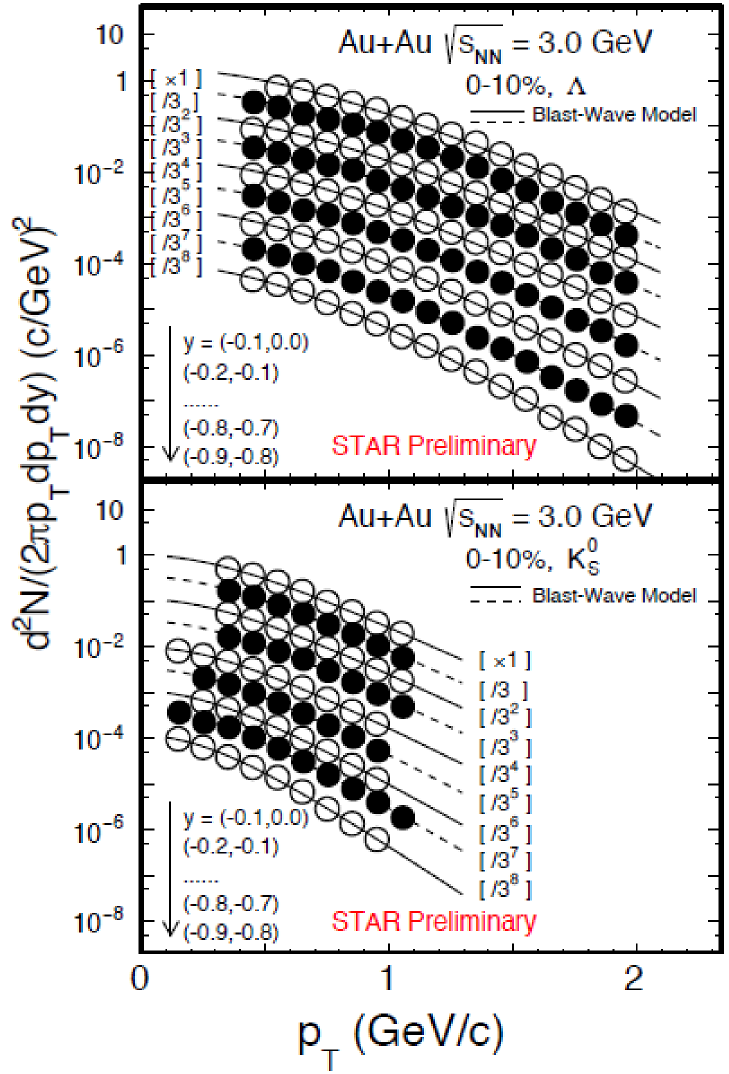
3.0 GeV Spectra: protons

- What we notice with the proton spectra, is that the extrapolation to low p_T is very important.
- We are using the Heinz blast wave for extrapolation ➔ But we know that this is wrong as it assumes boost invariance.



3.0 GeV Spectra: light nuclei, Λ, K^0_S



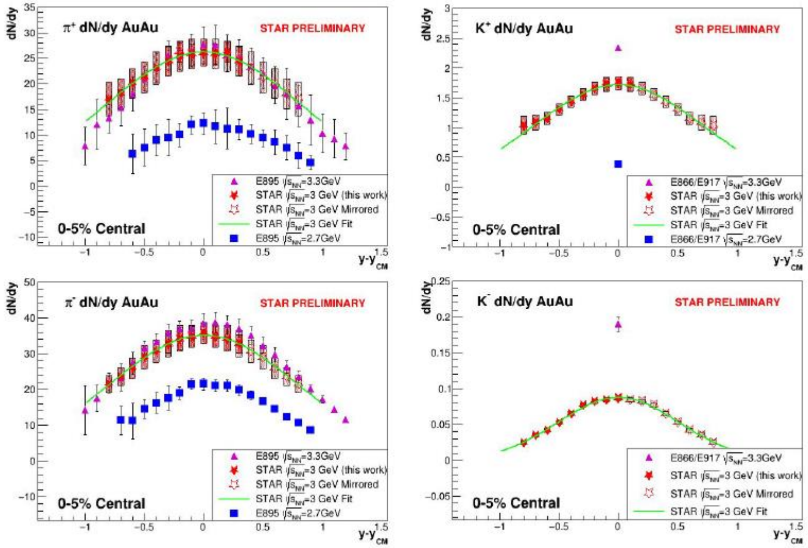


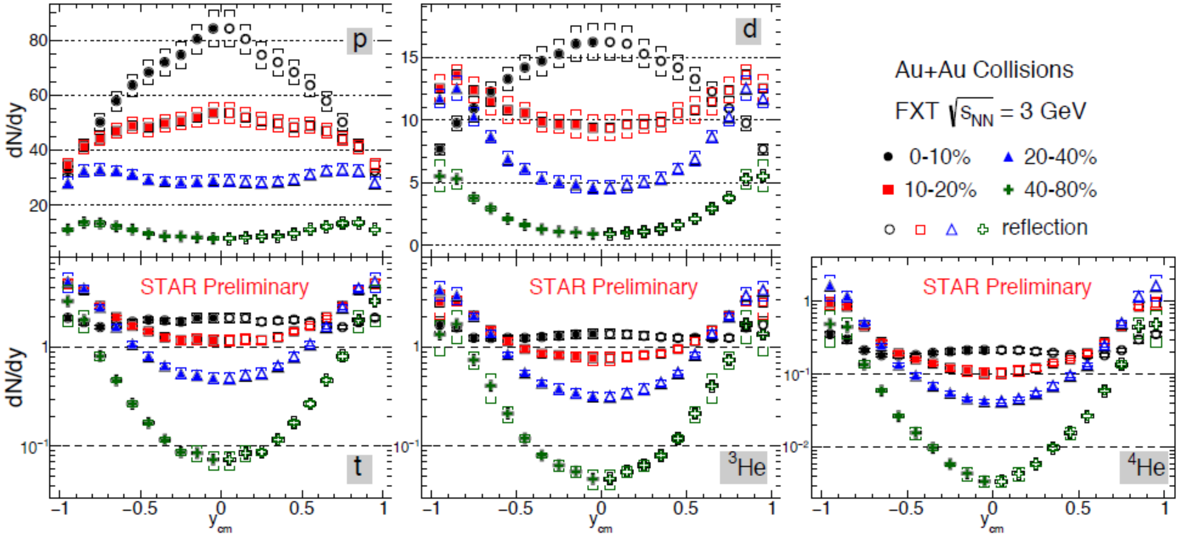
For light nuclei, the low p_T extrapolation is even more important. ➔ **We need a blast wave model that works at low energy**

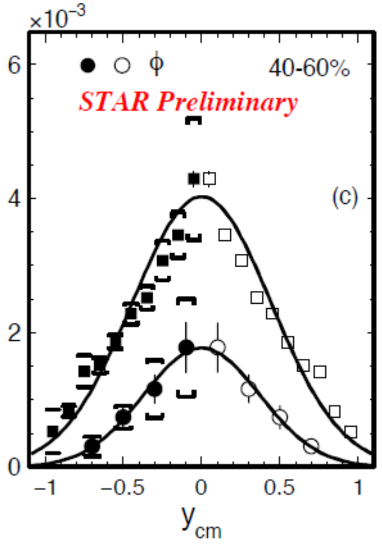
Particle Production at √s_{NN} = 3.0

From the spectra, rapidity densities have been generated for:

- π^+
- π^-
- K^+
- K^0_S
- K^-
- ϕ
- P
- Λ
- Ξ
- d
- t
- h
- α
- $^3_\Lambda H$
- $^4_\Lambda H$
- $^4_\Lambda He$







Note the importance of Δ's, stopping, and associated production of Λ's

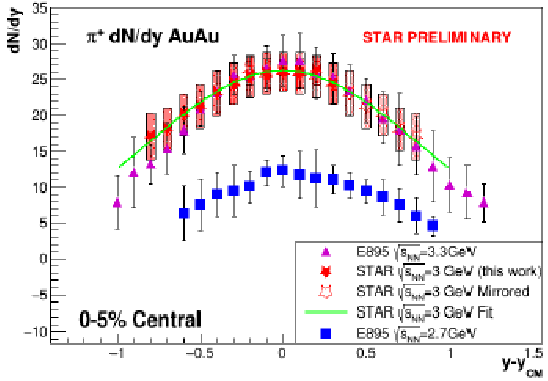
Pion Production at 3 GeV

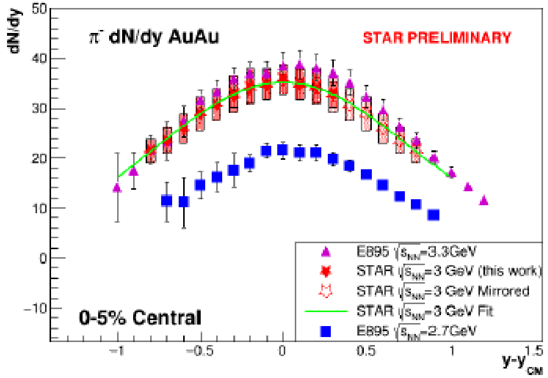
Pions measured at similar energies during the AGS heavy-ion program. What is new? And What do we learn?

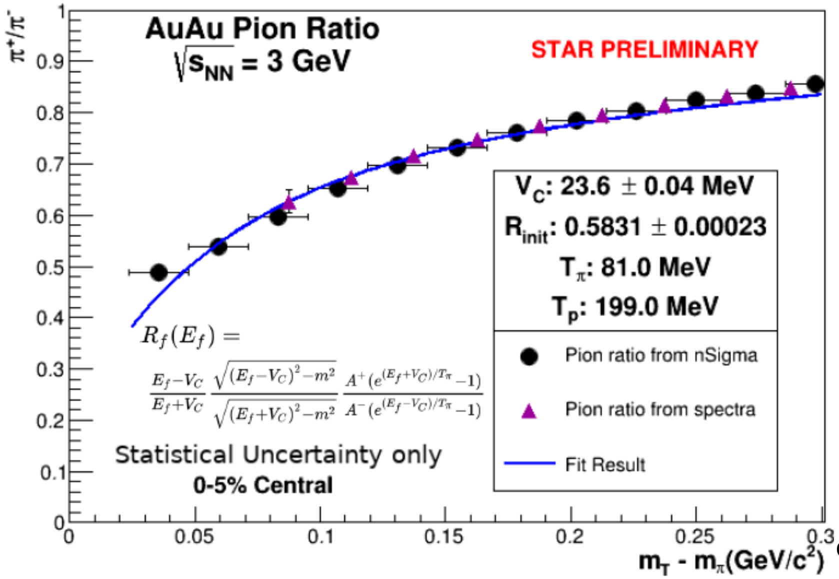
- Measurements at full rapidity

- Measurements at all centralities ➔ Can study the Coulomb potential as a the source gets smaller

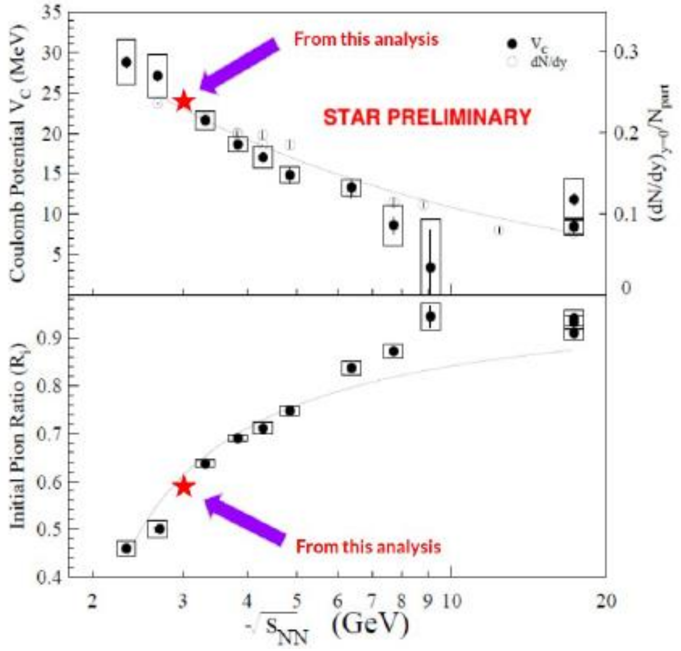
- The goal is to about the size of the system at freeze-out







Coulomb potential is proportional to proton dN/dy

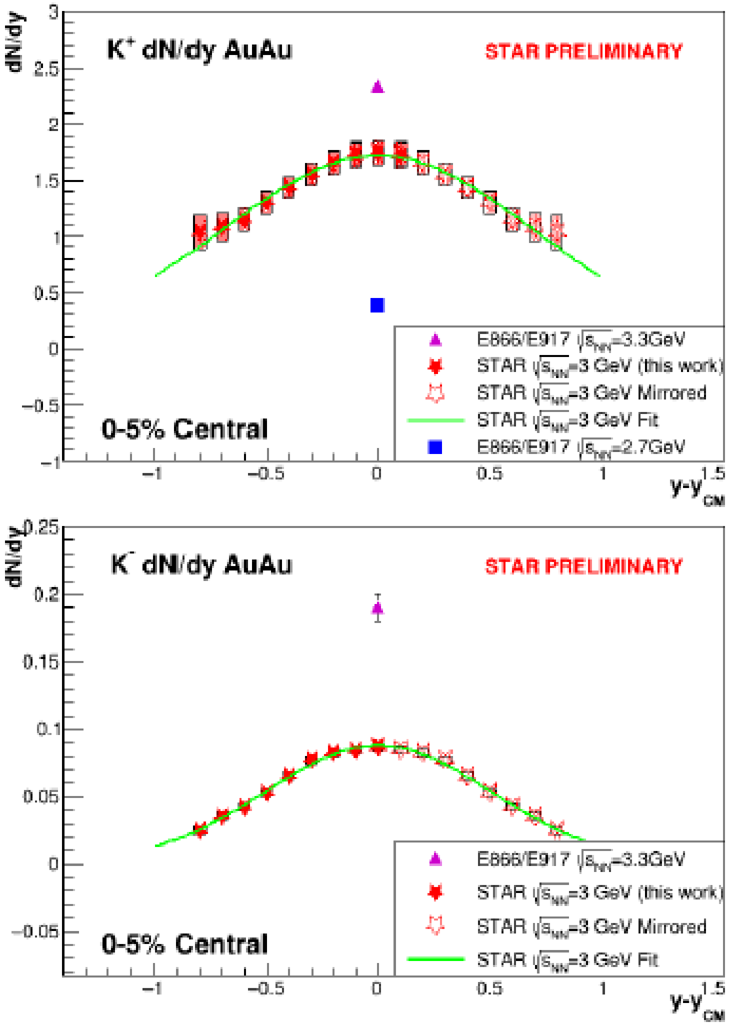


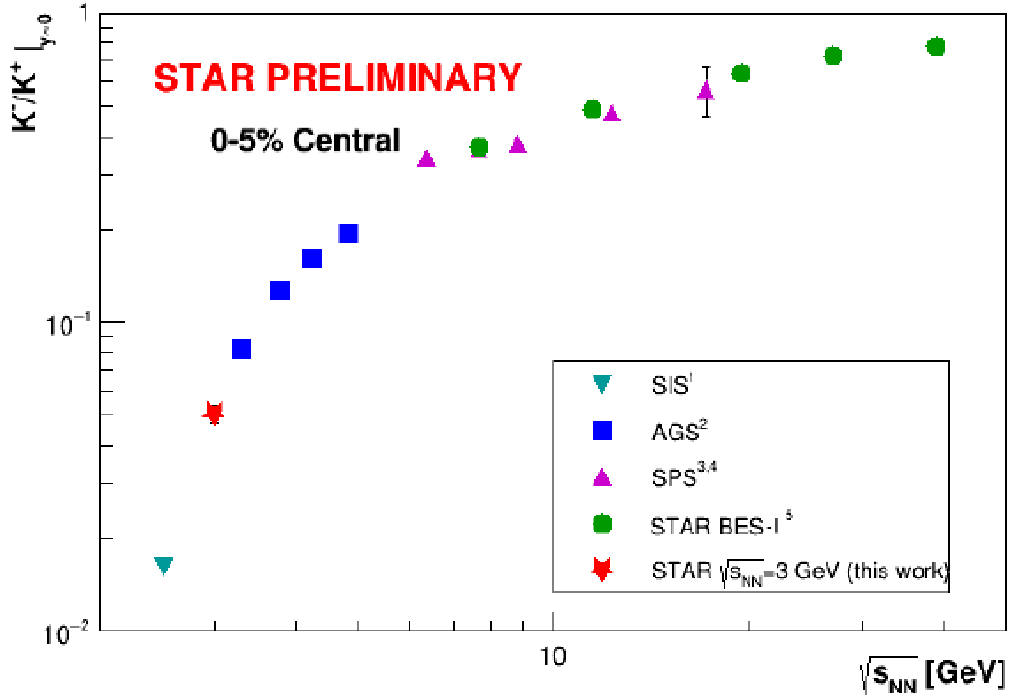
Work in progress: Coulomb potential as a function of centrality ➔ Since the Coulomb Potential depends on both Q and R, and the charge can be determined to be the proton dN/dy, one can draw inferences about the source size.

Kaon Production at 3 GeV

Kaons measured at similar energies during the AGS and SIS heavy-ion program. What is new? And What do we learn?

- Measurements at all rapidities
- Measurements at all centralities
- These results can help us understand the role of stopping and associated production





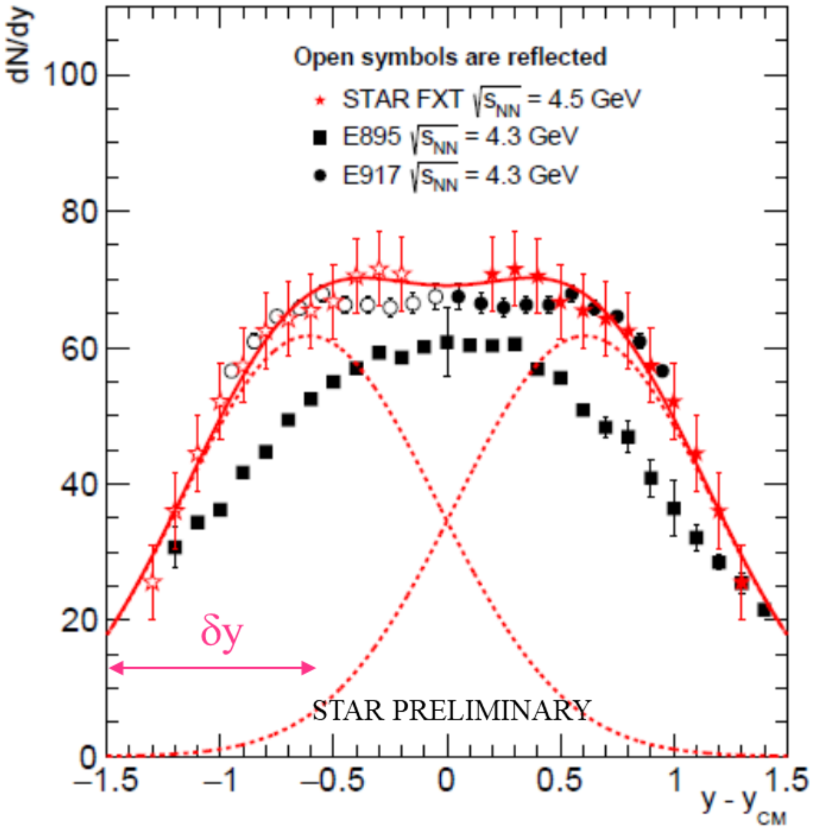
Ben Kimelman

Proton Production at 4.5 GeV

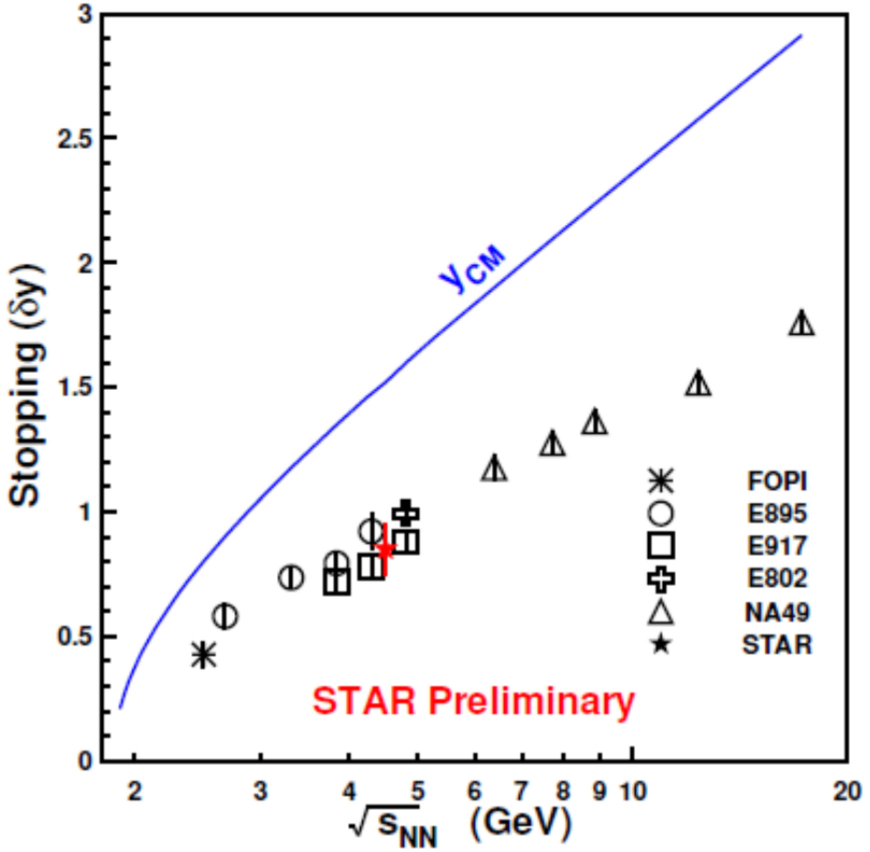
One thing that this slide illustrates is that we need a better understanding of stopping. Simple Gaussians to model the participants suggest that there would be proton yields backward of target rapidity.

protons measured at similar energies during the AGS heavy-ion program. What is new? And What do we learn?

- Measurements at all rapidities ➔ Stopping
- Measurements at all centralities ➔ **Stopping as a function of centrality ➔ Can probe how stopping changes as the number of collisions per nucleon changes**
- Can better understand the mechanisms of stopping

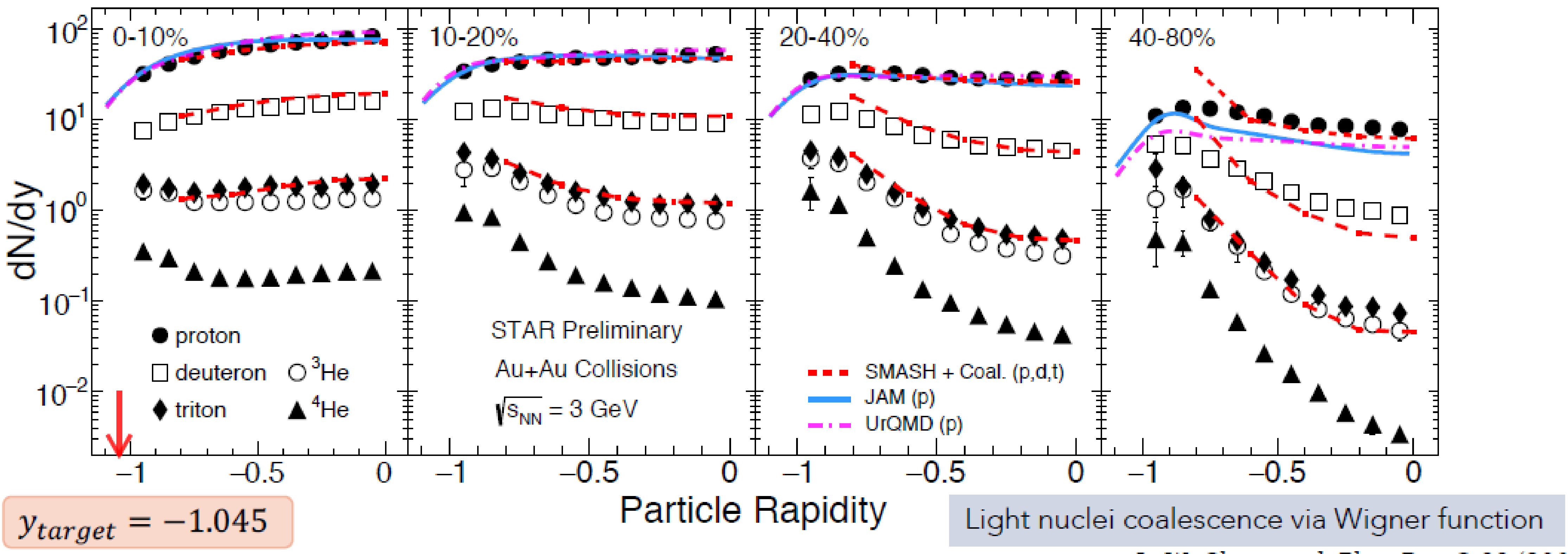


Consistent with AGS results (*)



Light Nucleus Production at 3.0 GeV

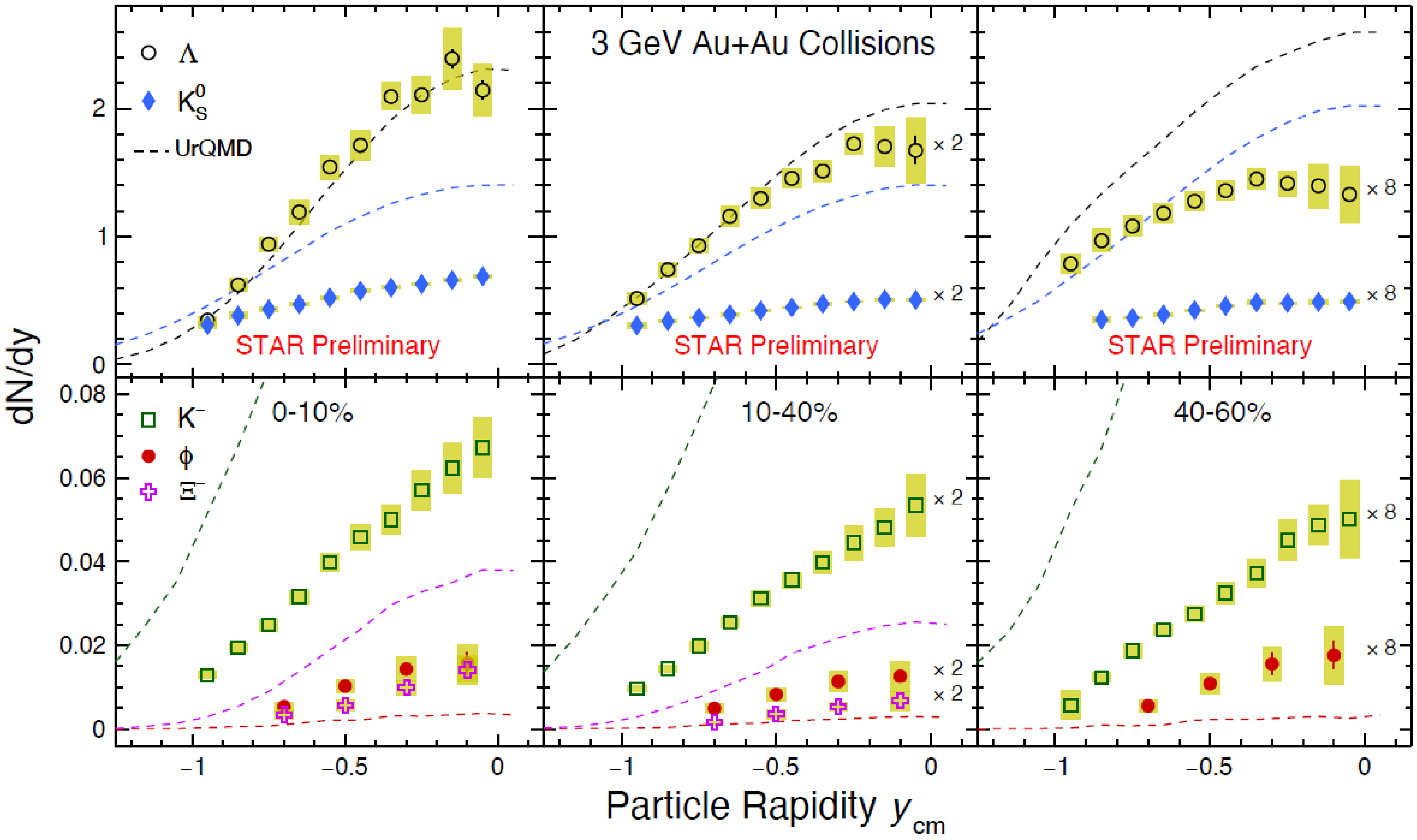
- Light nuclei are well described by models and by coalescence.
- **The differences between 3He and tritons is due to the neutron to proton ratio in gold, and this needs to be added to the coalescence modeling.**



L. W. Chen et al. Phys.Rev.C 68 (2003) 017601

Strange Particle Production at 3.0 GeV

The comparison of strange particle yields to UrQMD continues to be a challenge.



Phys. Lett. B 831 (2022) 137152

Lessons learned from spectra and rapidity densities at 3 GeV:

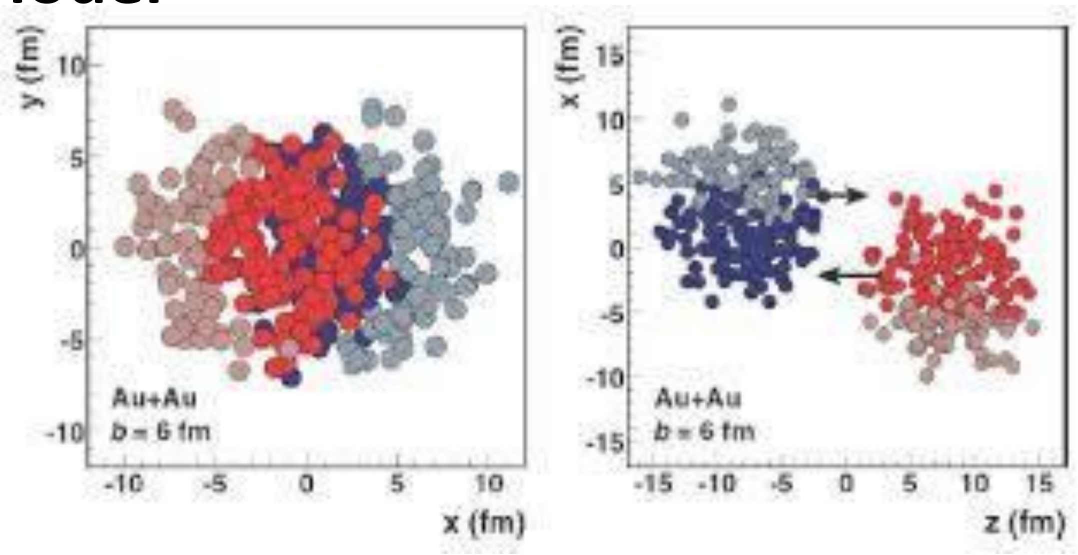
- The low p_T pions are strongly effected by the coulomb potential of the source.
- The charged kaons mostly comes from associated production.
- The Heinz blast wave needs to be modified to work in an environment which is not boost invariant.
- We need a better understanding of stopping.
- Light nuclei and produced through coalescence.
- Strange particle production is not well represented by UrQMD.

Further lessons we can be learned at 3 GeV:

With rapidity densities for almost all particles, we can add up the total charge, baryon number (and energy) to test conservation. ➔ We note that our total baryon number exceeds the predicted number of participants for all centralities.

➔ **Is something wrong? Efficiencies? Low p_T extrapolation? Maybe Glauber is "wrong"?**

Glauber Model



Glauber Model:

- Nucleons distributed with Woods-Saxon
- Nucleons do not scatter during collisions
- Collisions are determined by the inelastic σ_{pp}
- Particle production with negative binomial
- Crude hardness parameter (x)

  ➔ N = x Ncoll + (1-x) (Npart/2)

Basics:

- The Glauber model has been used to determine centrality by RHIC and LHC experiments since 2001
- The Glauber model considers particle production, not stopping of participant nucleons
- Hadron production in centered at the center-of-mass rapidity
- Closer to target rapidity, most charged hadrons are "stopped protons"
- Center-of-mass rapidity shifts through the FXT energy range ➔ Can not use RefMult

➔ The basic question is, does the Glauber model work for the STAR FXT systems? [Centrality bins? N_{part}?]

Should we worry about Glauber?

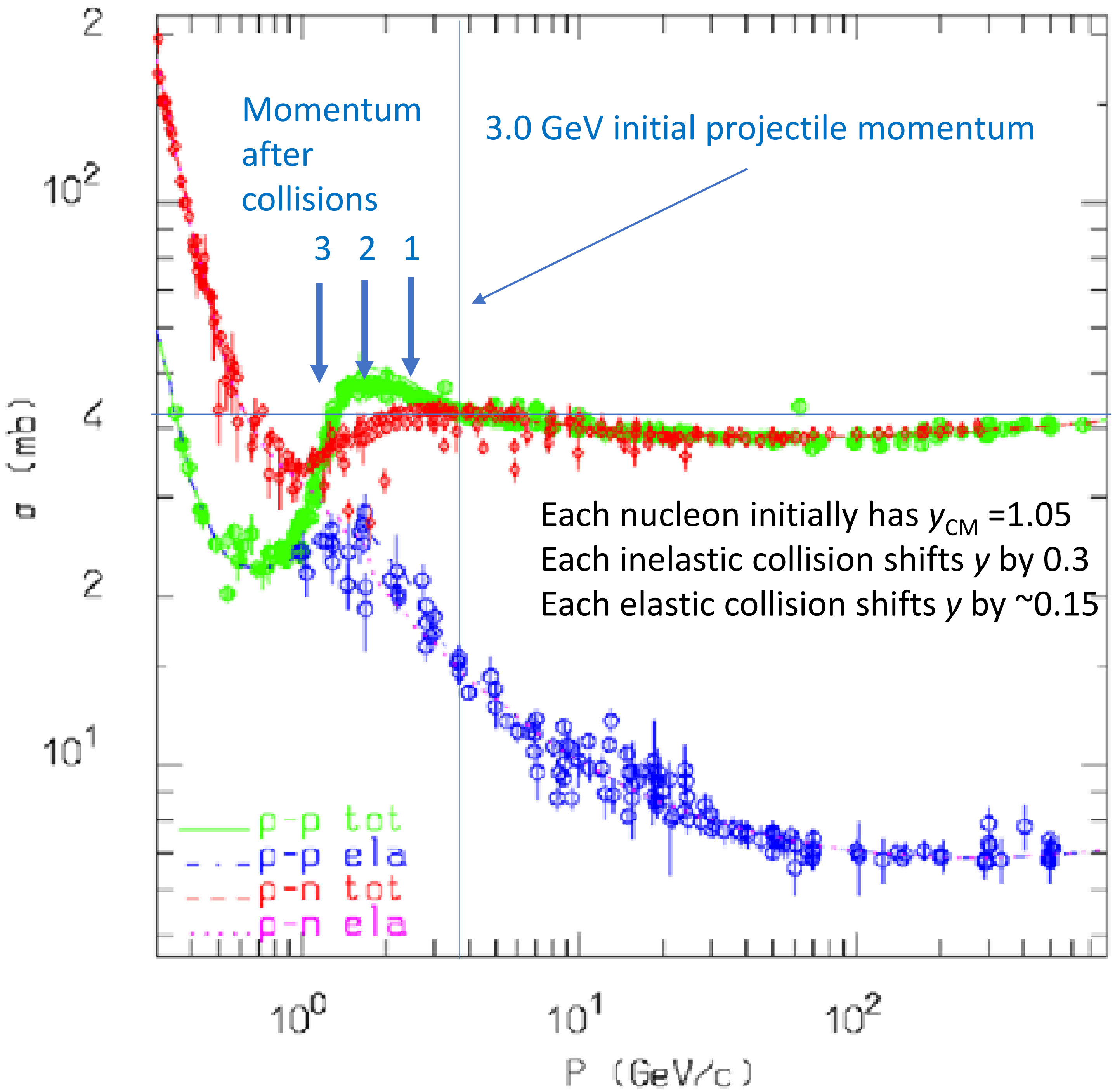
Inelastic, elastic, and total cross sections are very different.
At 3 GeV:

σ_{tot} = 42 mB
$\sigma_{inelatic}$ = 28 mB
$\sigma_{elastic}$ = 14 mB

pp and np cross sections are different.

Cross sections change rapidly with energy in the FXT regime.

Cross sections will change after each collision.



Can We use FXTmult and the Glauber Model to Measure Cross-sections (centrality bins)?

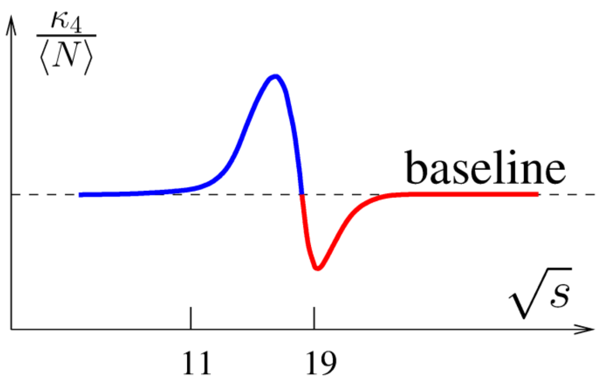
- In our methodology, we "measure" cross sections by comparing the observed multiplicity distributions to those expected using the two component (N_{part} and N_{coll}) negative binomial.

- The challenge is always what fraction of the cross section are you missing at low multiplicity.

- We performed a number of test to convince ourselves that the Glauber method was OK for centrality bins.
  - Comparison to E895 ➔ Fractions of total cross section are OK.
  - Study of HADES analysis ➔ Glauber matches their multiplicity distributions.
  - Study of Zero-bias triggered data ➔ Our understanding of the trigger bias is OK.
  - Comparison to UrQMD ➔ **Predicts significantly more participating nucleons.**

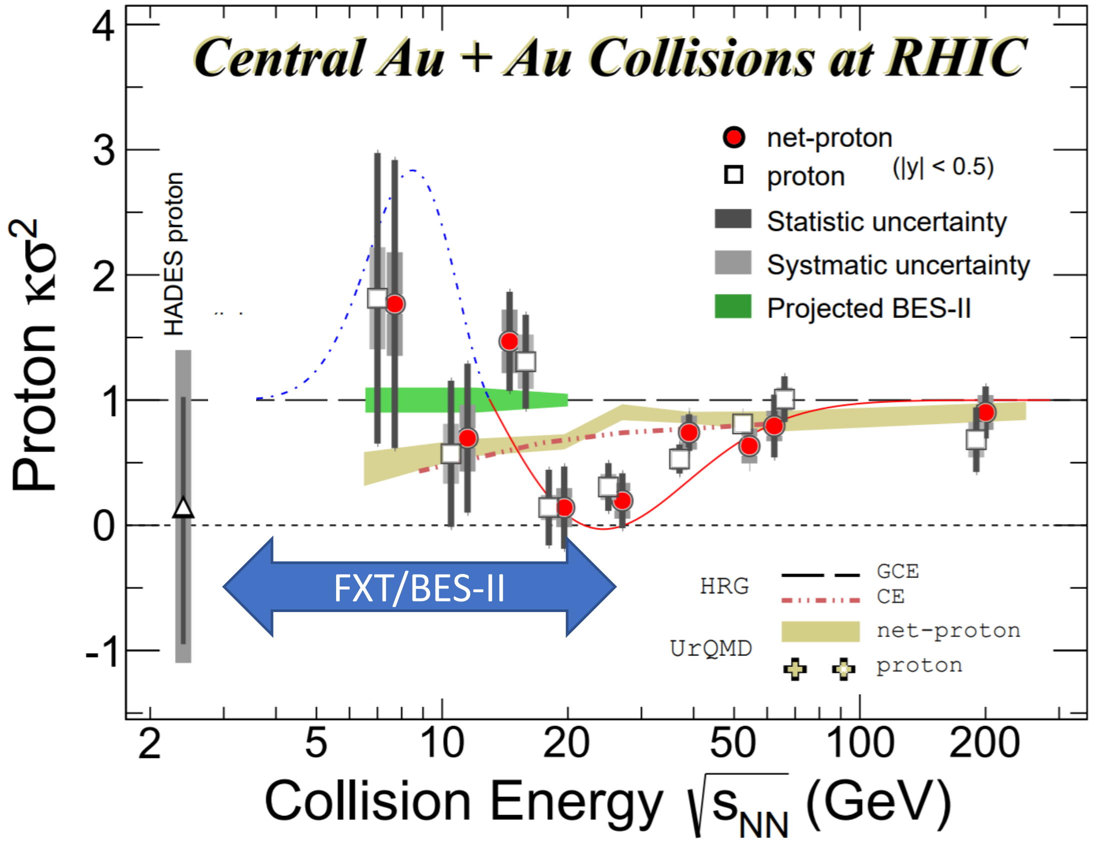
➔ **Centralities using Glauber are fine, but N_{part} and N_{coll} are questionable.**

The Search for the Critical Point
Proton Fluctuations – $\kappa\sigma^2$



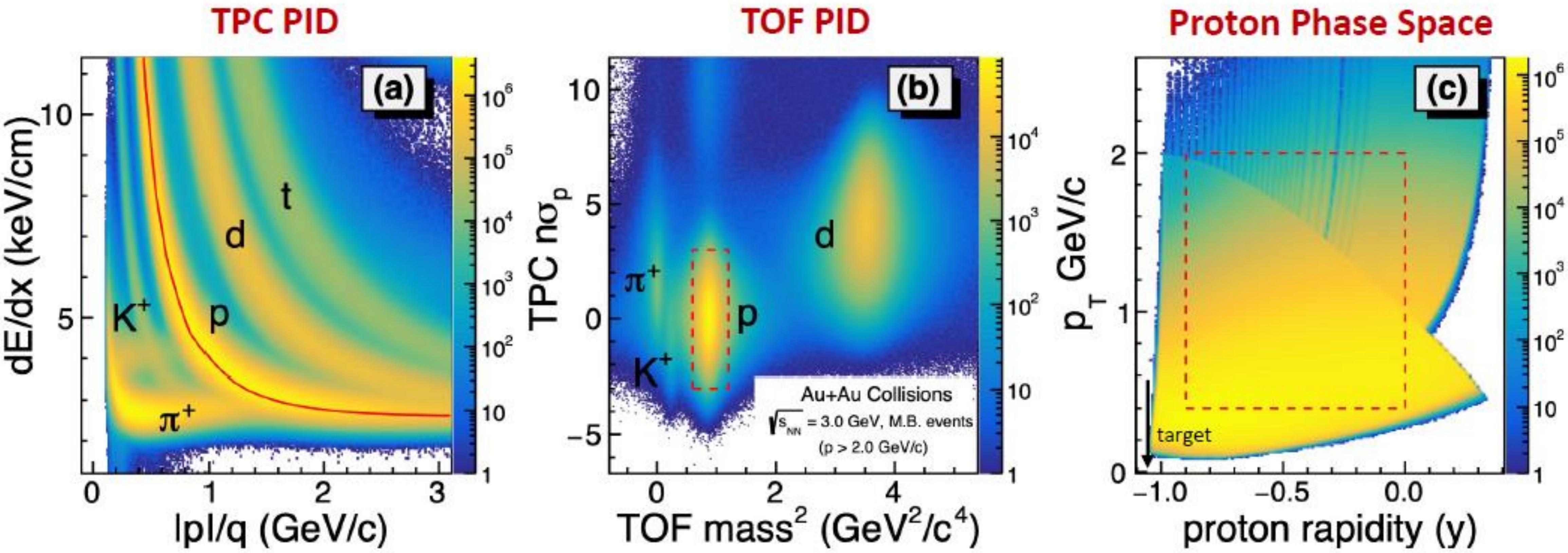
Are we consistent with final HADES result .

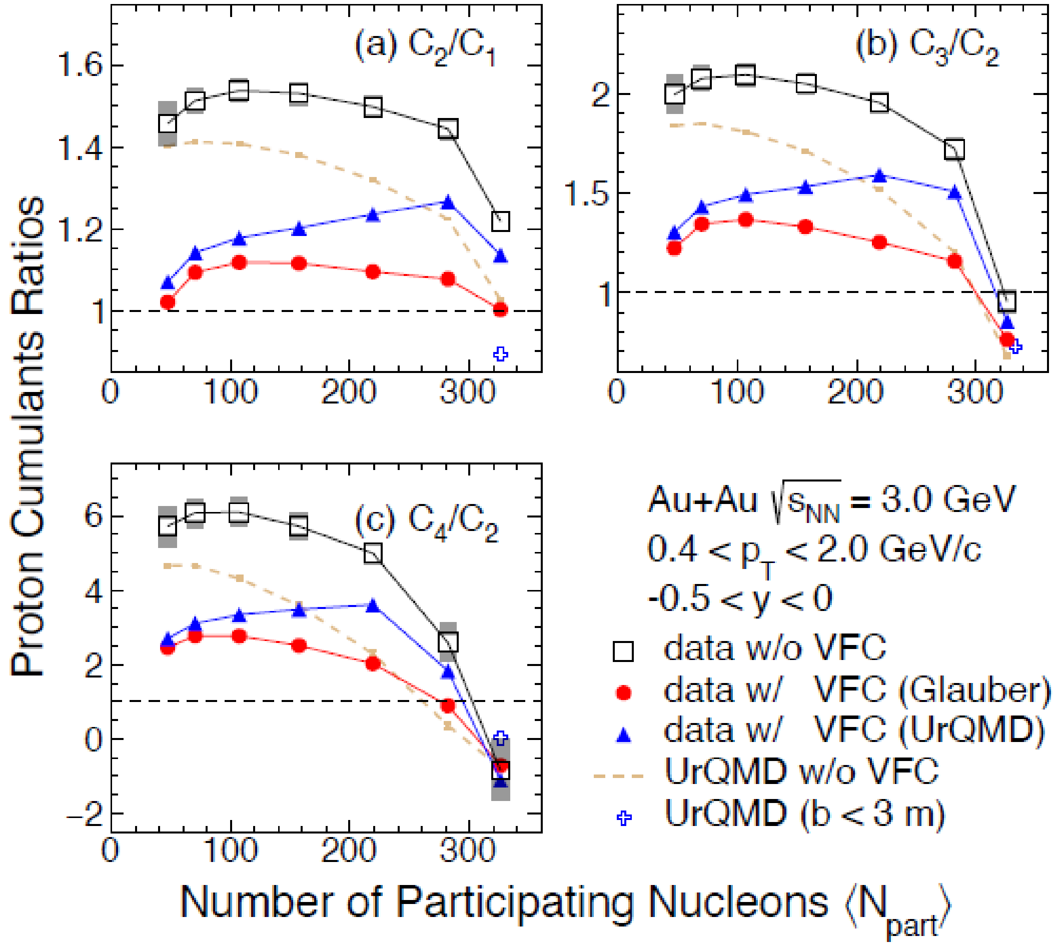
STAR had decided not to release preliminary results for this observable.

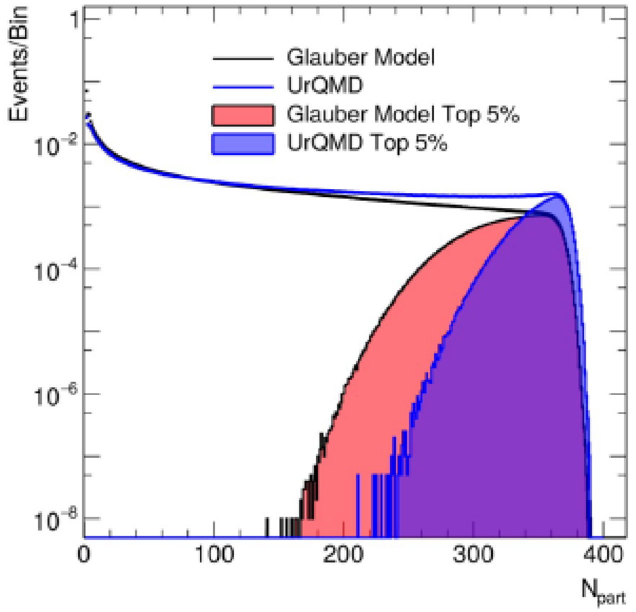


Our ability to study net-proton fluctuations is critically dependent on at particle identification and the acceptance

The analysis will get significantly more challenging for higher energy FXT data sets.

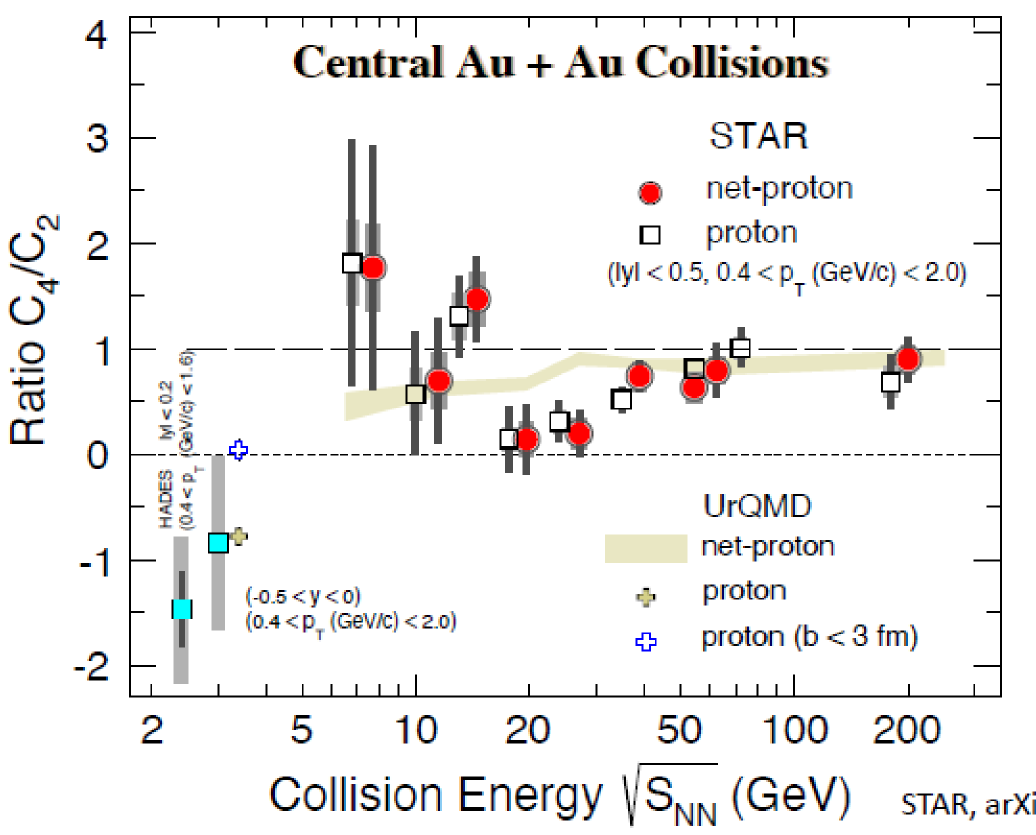






- A volume fluctuation correction method is tested on data
- Most central centrality are least affected by volume fluctuation correction

Braun-Munzinger, P. et al
Nuclear Physics A 960, 114 (2017)



STAR, arXiv:2112.00240

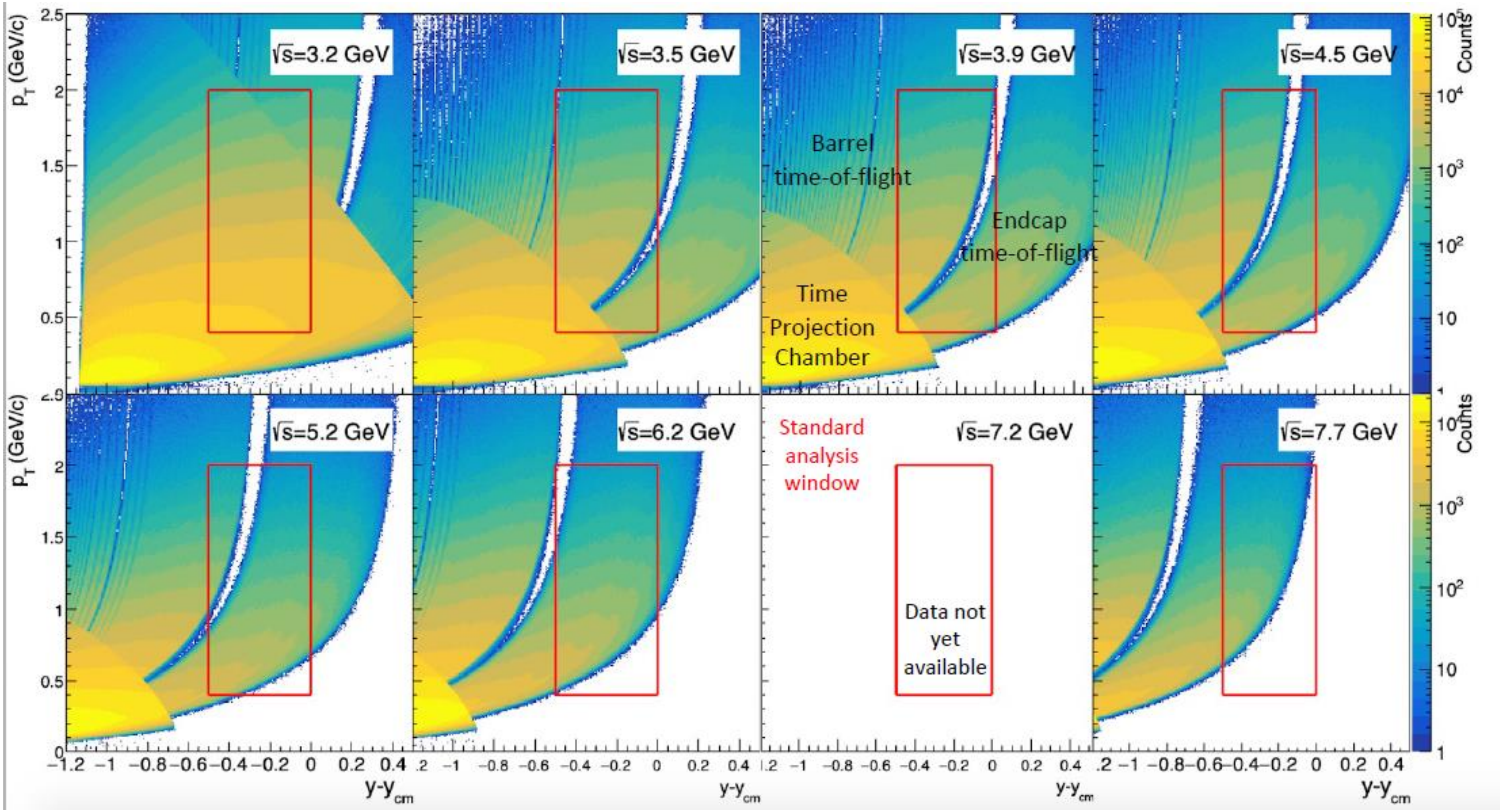
3.0 GeV Result is final ➔ no critical point at 3.0 GeV.

- Pre-preliminary results are already available at 3.2, 3.5, 3.9, 4.5, 14.6, 19.6, and 27 GeV.
- Study will be done at all energies
- At high (2B) statistics data was taken at 3 GeV – those data will be available this fall. The will allow studies of C6 and C8

➢ The suppression of C_4/C_2 is consistent with fluctuation driven by baryon number conservation which indicates a hadronic dominant region in the top 5% central Au+Au collisions at 3 GeV

➢ The QCD critical point, if discovered in heavy ion collisions, could only exist at energy higher than 3 GeV

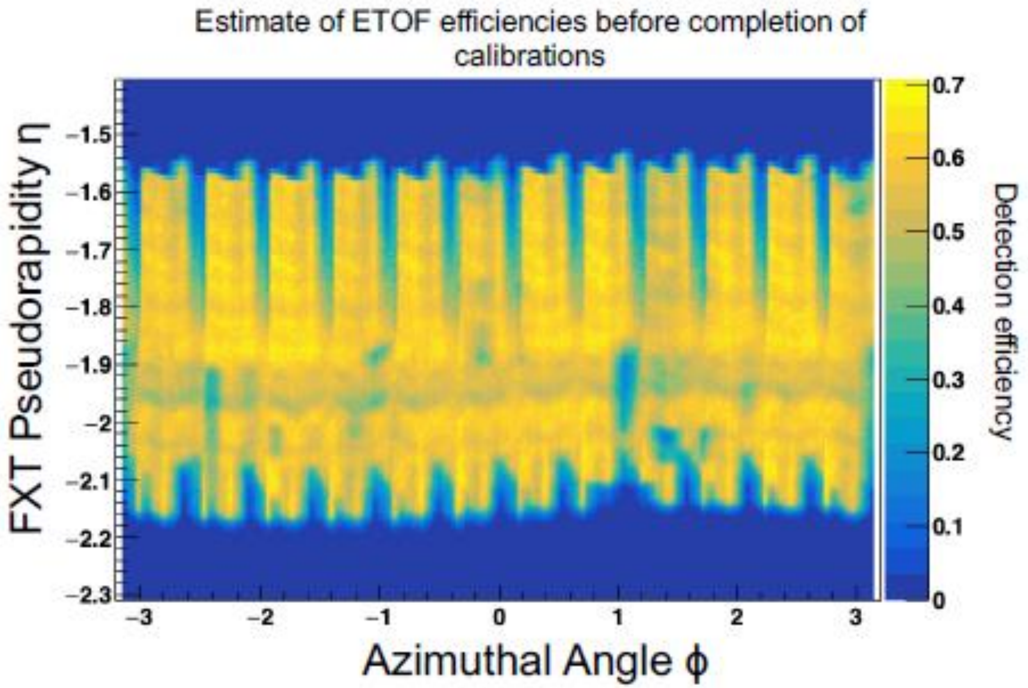
Acceptance with Particle Identification for each FXT Energy

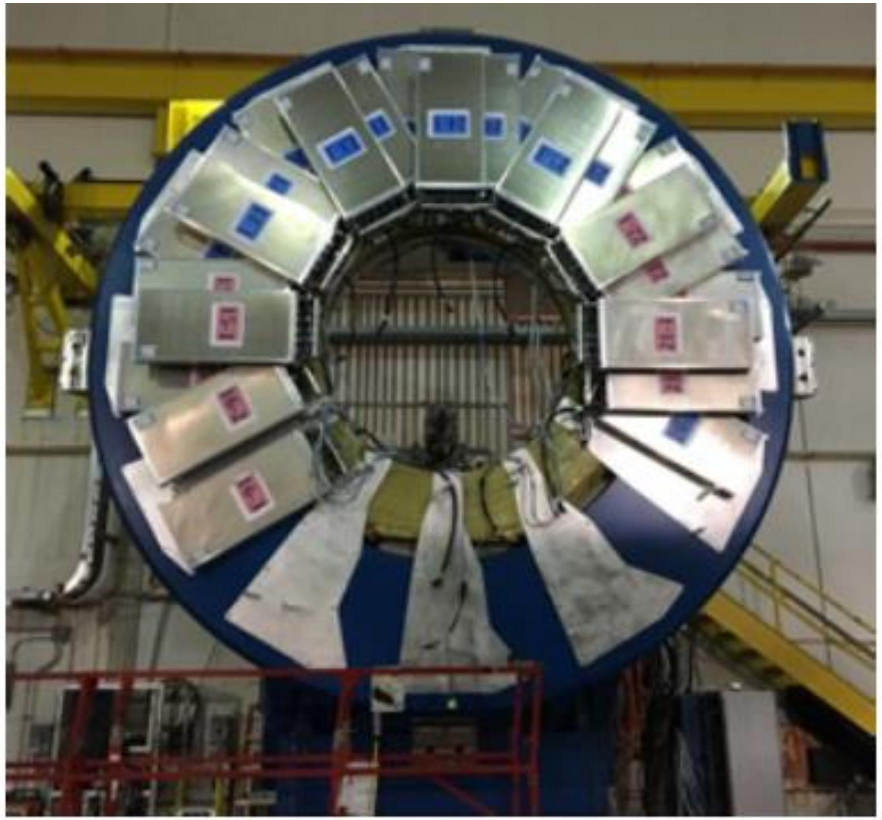


eTOF is Critical for Mid-rapidity Analysis at Higher FXT Energies

ETOF Details

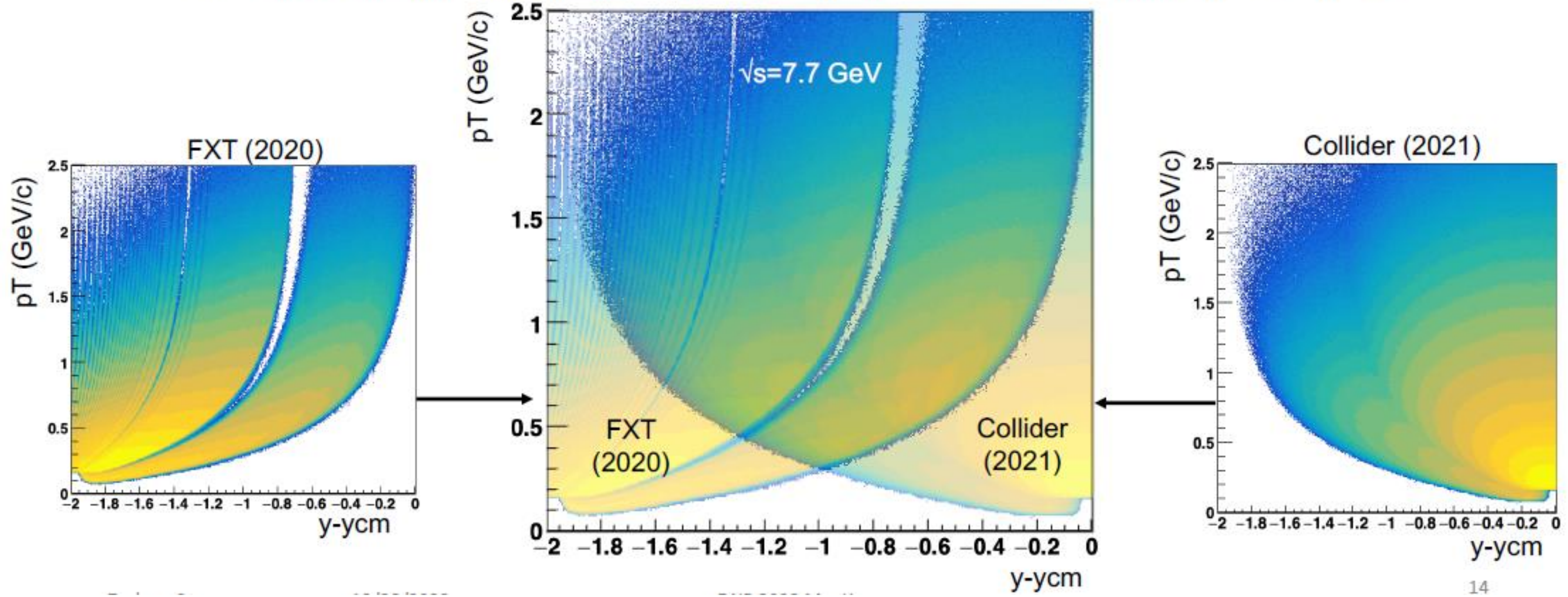
- CBM-TOF group provided ETOF system
- Provides particle identification over $1.55<\eta<2.2$
- Collected data for the Fixed-Target Program
- Calibrations still in progress.





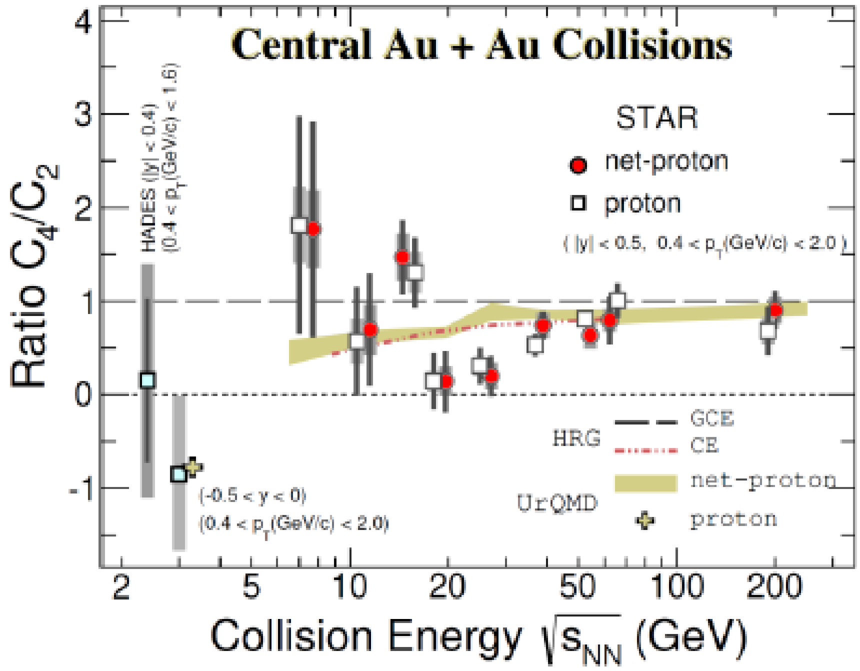
The “Overlap” Energy, 7.7 GeV, with both Collider and FXT data

- Acceptance overlap at 7.7 GeV for FXT and collider data provides a unique opportunity to benchmark our understanding of FXT methodologies against collider data
- This will not be a standard fluctuation analysis window, and will not be a part of the cumulant energy scan, but is important for building confidence in comparisons between the fixed-target program and collider results



The Significance of a Fluctuation Result at Higher FXT Energies will be Limited

- Significance of C_4/C_2 goes as $\sim \langle N_p^3 \rangle$
- Proton yields from E895 with expected detector acceptances+efficiencies can be used to predict $\langle N_p \rangle$ for FXT



STAR, Phys. Rev. Lett. 128, 202303 (2022) ; arXiv : 2209.11940.
Phys. Rev. Lett. 126, 092301 (2021); Phys. Rev. C 104, 024902 (2021)

Fixed Target

√s	Num Good events	Predicted $\langle N_p \rangle$ Eff. Uncorr
3.2	200.6M	32
3.5	115.6M	28
3.9	117M	24
4.5	108M	20
5.2	103M	16
6.2	118M	12
7.2	316.9M	8
7.7	112.5M	5

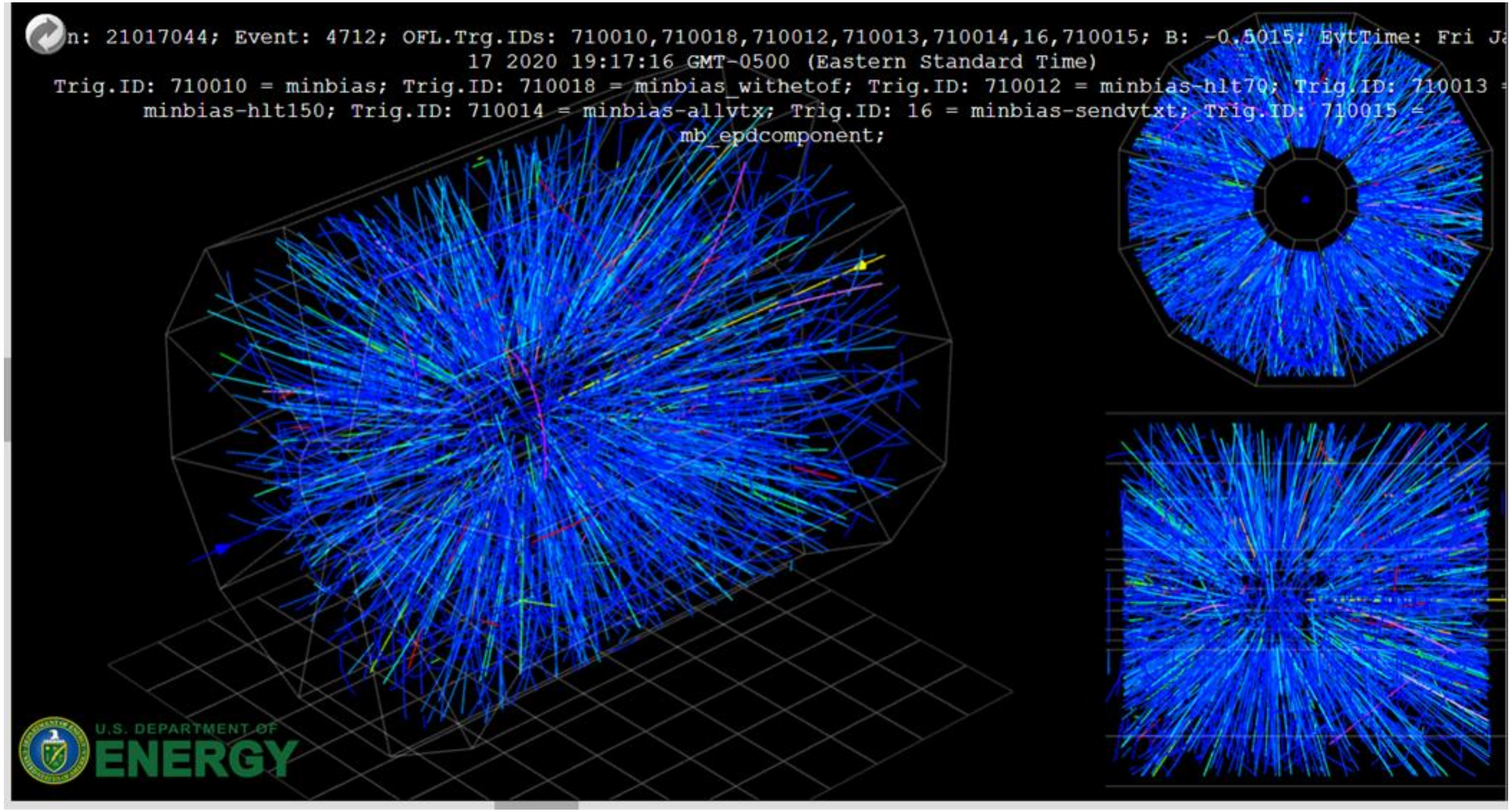
BES-II

√s	Num Good events	Predicted $\langle N_p \rangle$ Eff. Uncorr
7.7	101M	27
9.2	162M	24
11.5	235M	21
14.6	324M	18
17.3	256M	17
19.6	582M	16
27.0	555M	15
54.0	837M	11

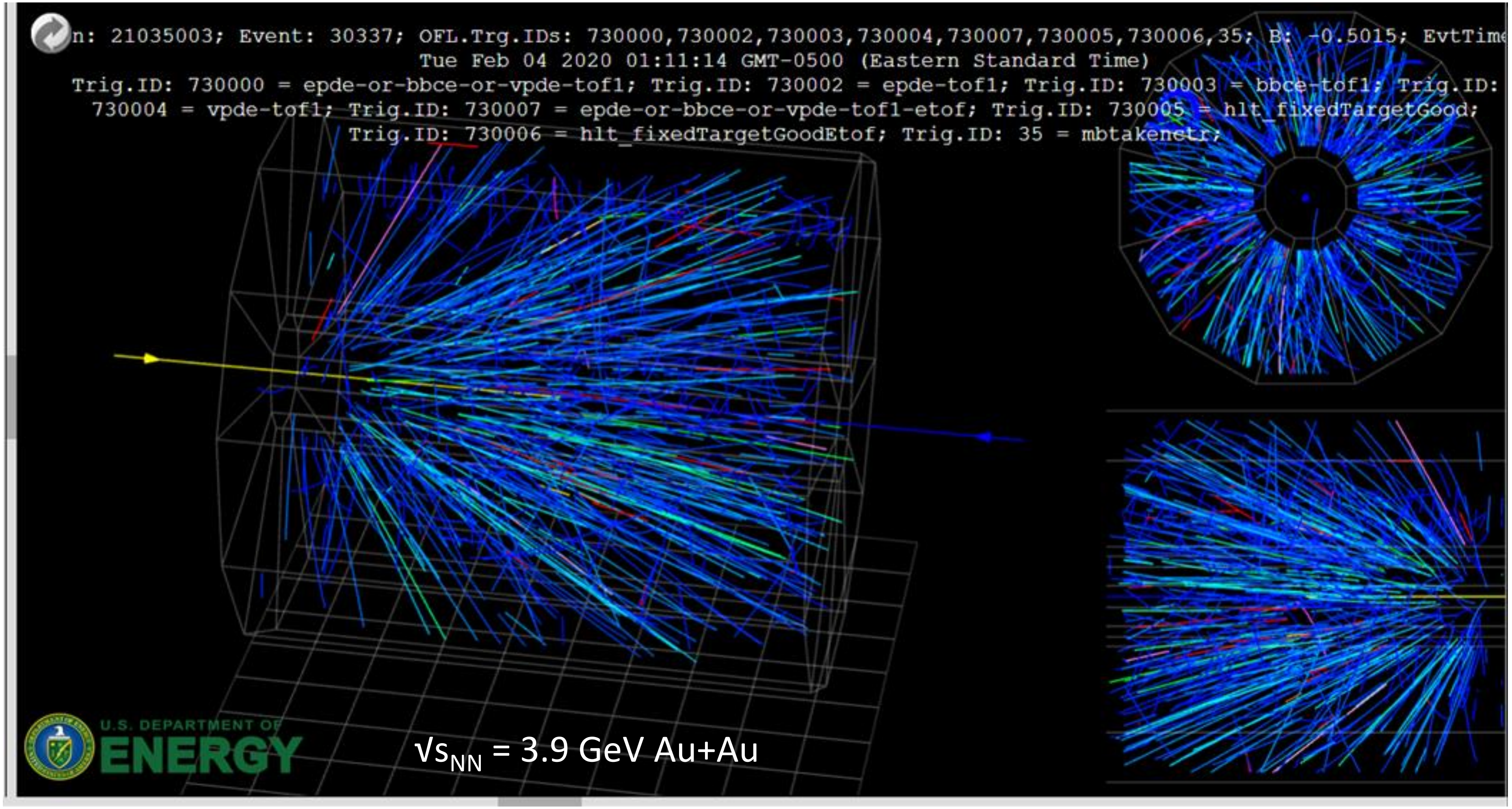
BES-I

√s	Num Good events	$\langle N_p \rangle$ Eff. Uncorr
7.7	5M	27
11.5	11.7M	21
14.6	24M	18
19.6	36M	16
27	70M	15
39	130M	12
62.4	67M	11

Online Event Display – Collider Event



Online Event Display – FXT Event



Summary

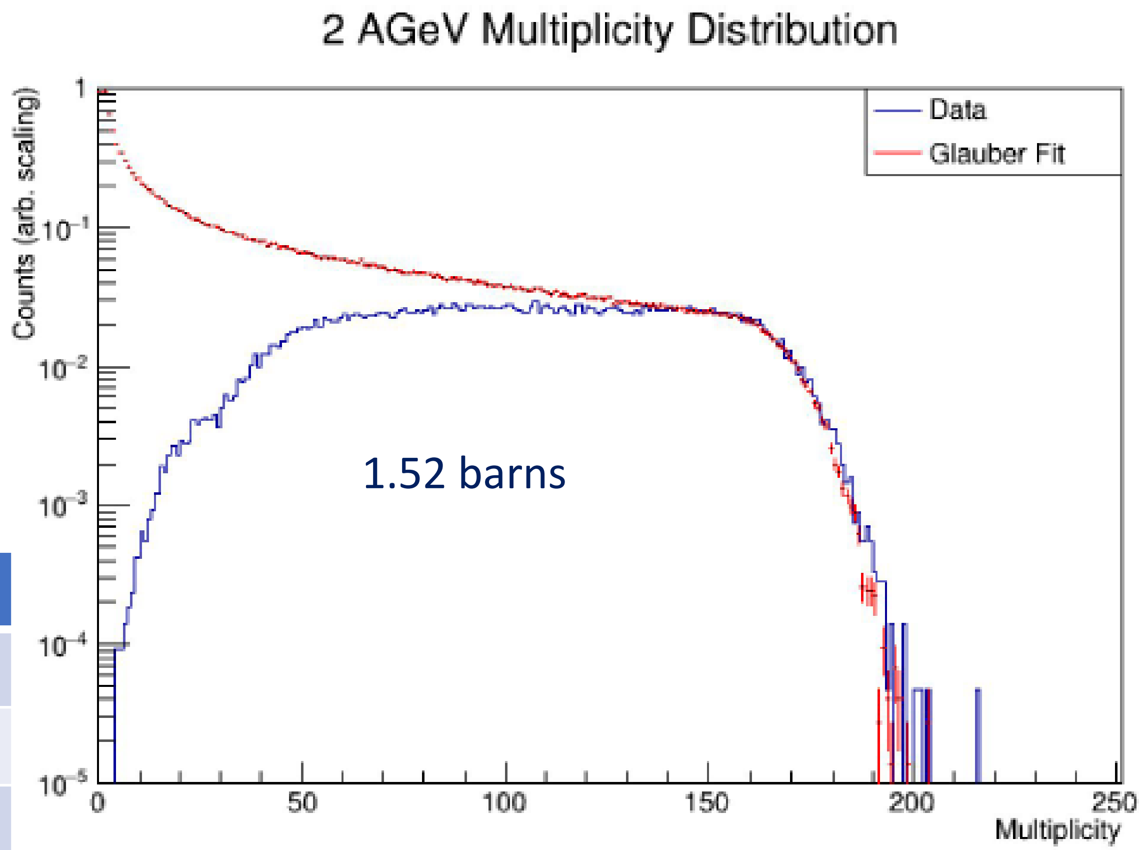
- Data taking for the STAR BES-II/FXT program was completed 2018 to 2021
- Au+Au collisions at seven collider and twelve FXT energies (with four FXT energies overlapping with the four lowest collider energies)
- Calibrations, data production and QA take time to get right and to date, only results from 3.0 and 27 GeV have been presented. New results from 19.6, 14.6, and FXT energies will be available soon.
- Spectra analysis have shown the need for a improved Blast Wave, a better understanding of stopping, and an improved Glauber model.
- Proton fluctuation results showed no critical behavior at 3.0 GeV.

BACKUPS

Comparison to E895

E895 2.0 AGeV

Settings
Lower cutoff: 130
Upper cutoff: 192
events data: 7.1E4
events MC: 1E6
μ range:[0.08,0.18]
k range: [2.7, 7.0]
x range: [0%, 10%]



Total Au+Au cross section is 6.78 barns

Parameters
x = 9%
μ = 0.107473
k = 6.22456

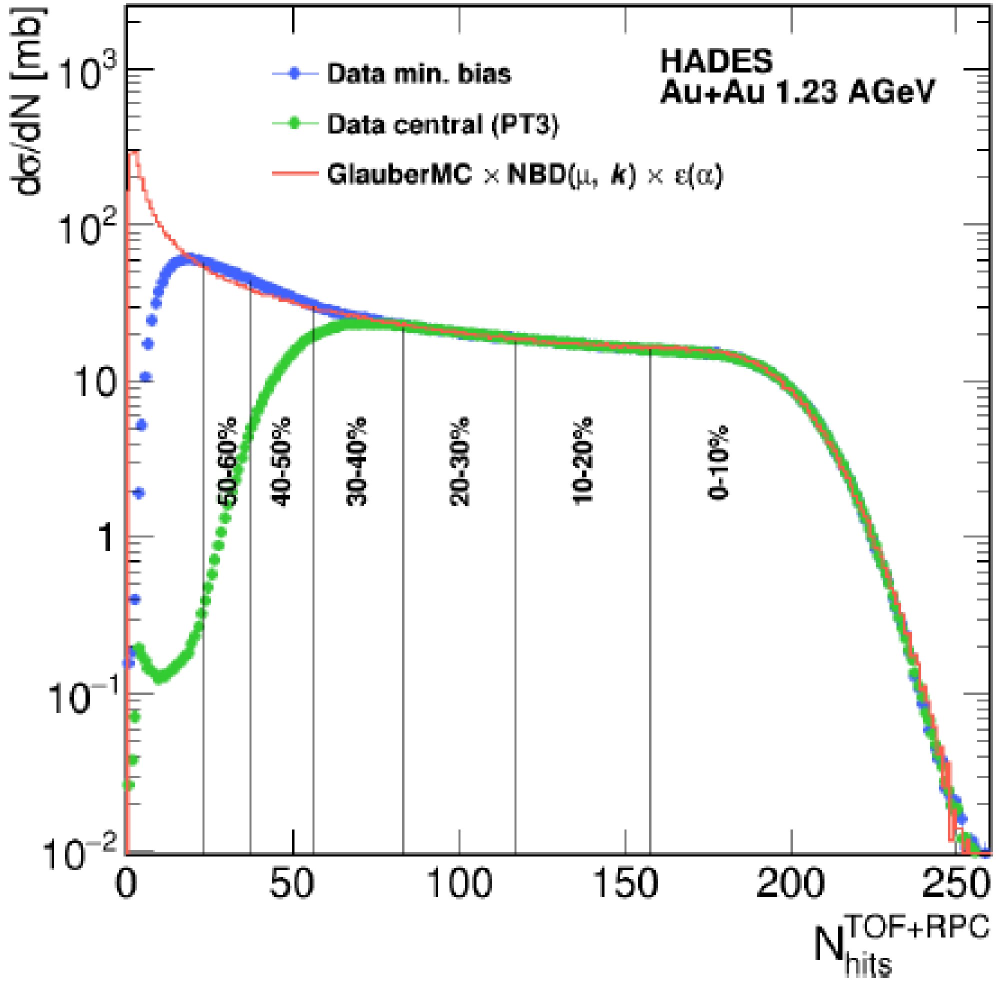
χ^2 = 132
Trigger Efficiency: 24%

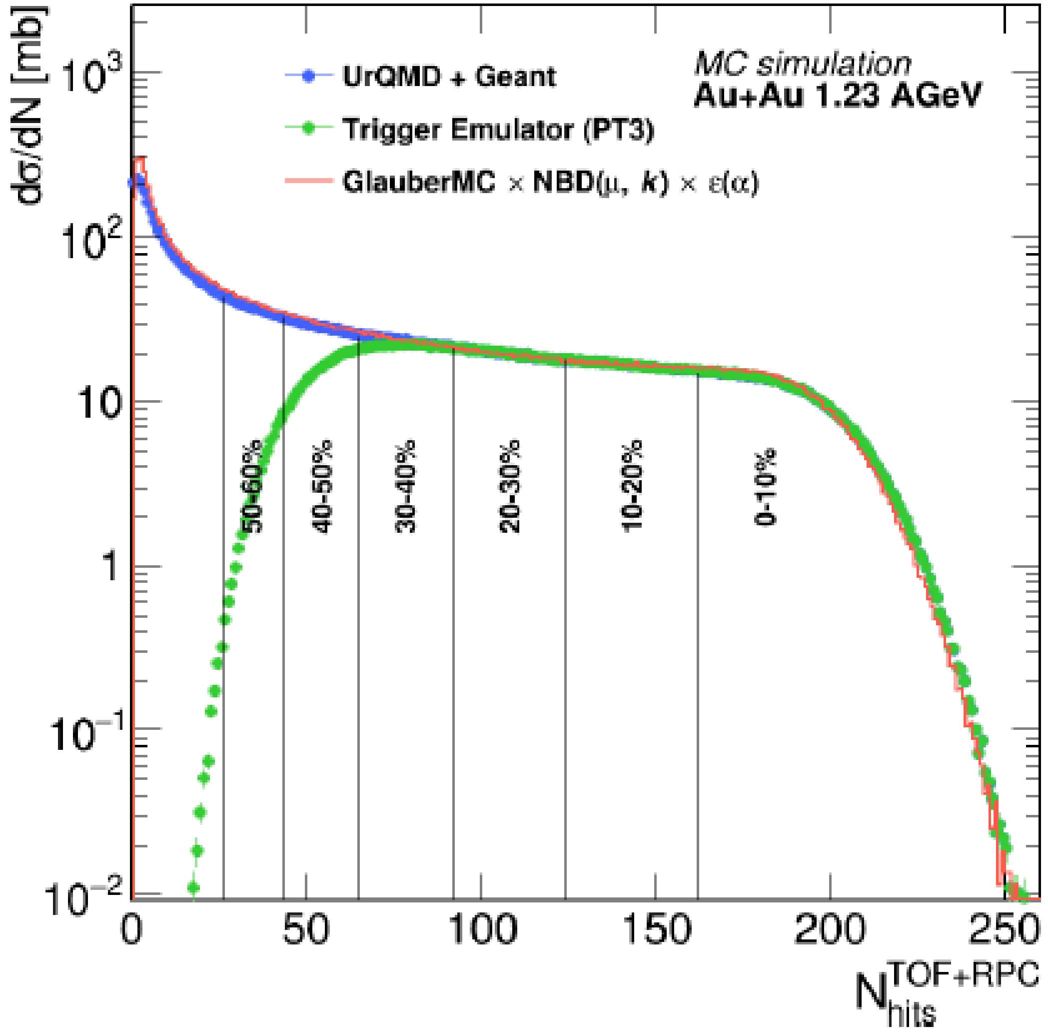
E895 measured 23%

Energy	E895 est.	Glaub. Est.
2 AGeV	23%	24%
4 AGeV	27%	25%
6 AGeV	68%	60%
8 AGeV	42%	40%

HADES Centrality Analysis

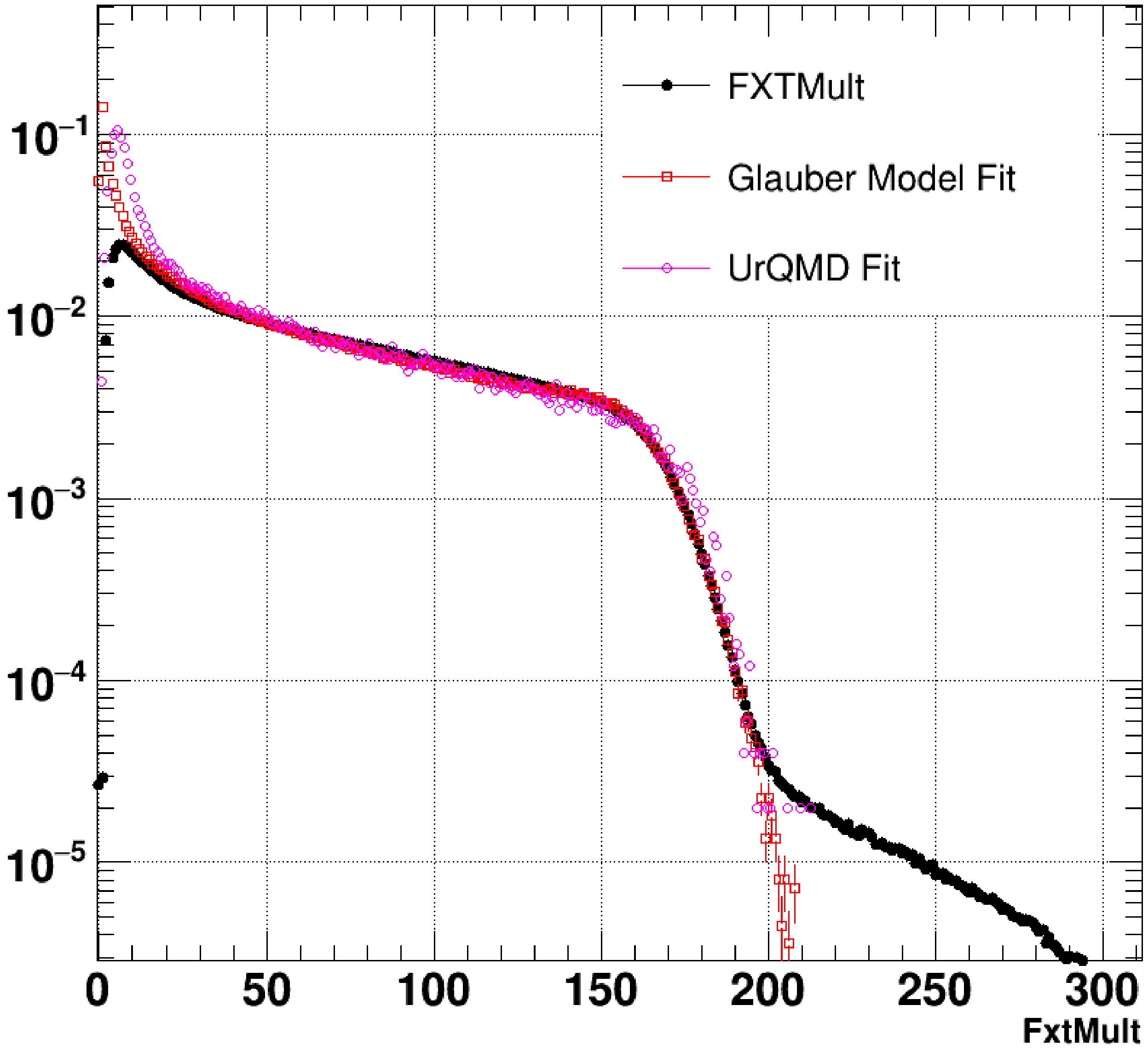
UrQMD matches, except at lowest Multiplicity





arXiv:1712.07993v2

Comparison to UrQMD



Conclusions of UrQMD Study

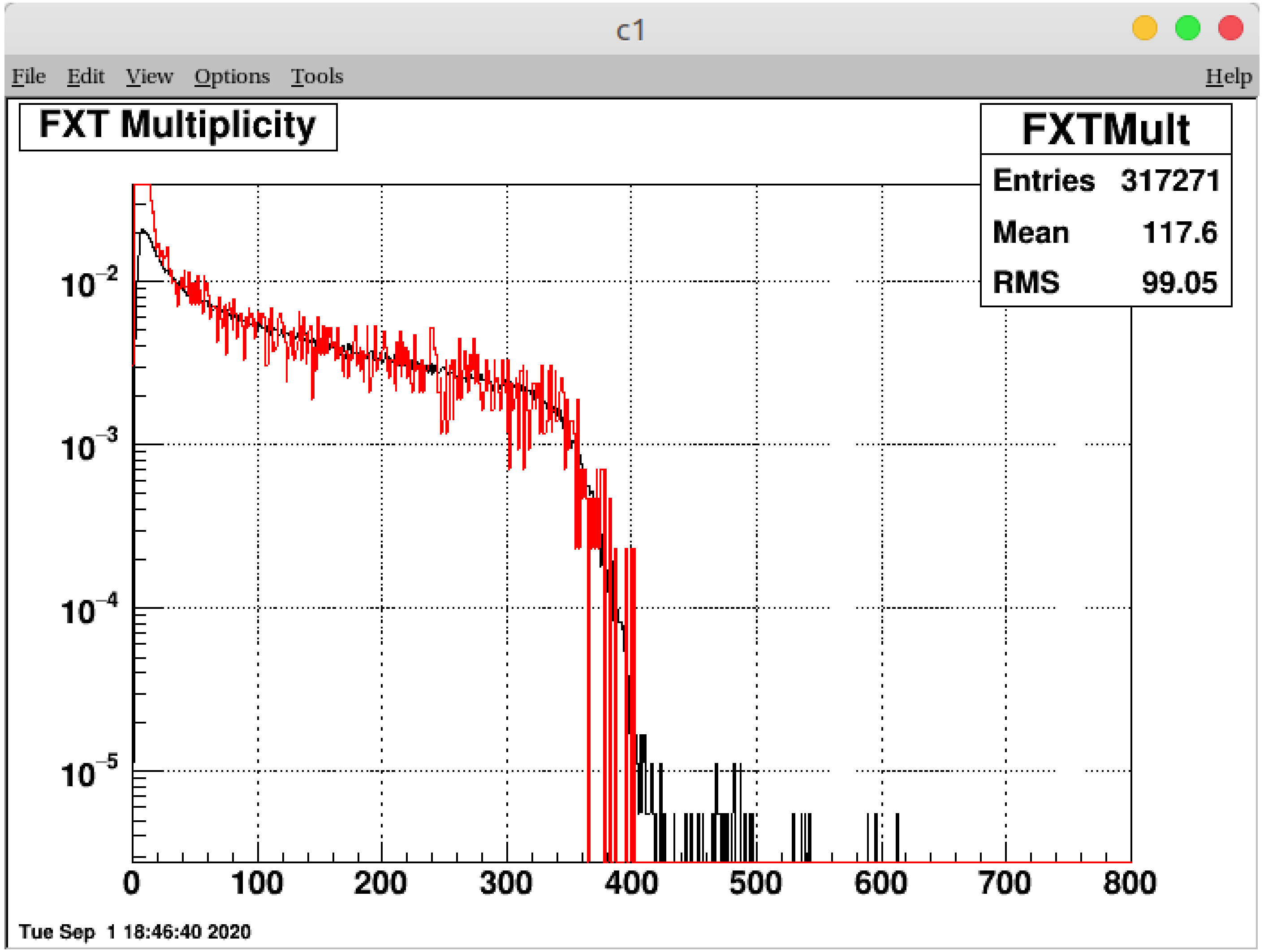
1) **UrQMD match data and Glauber model at high FXTMult**
2) **Slight mismatch at low FXTMult**

Zero Bias Study

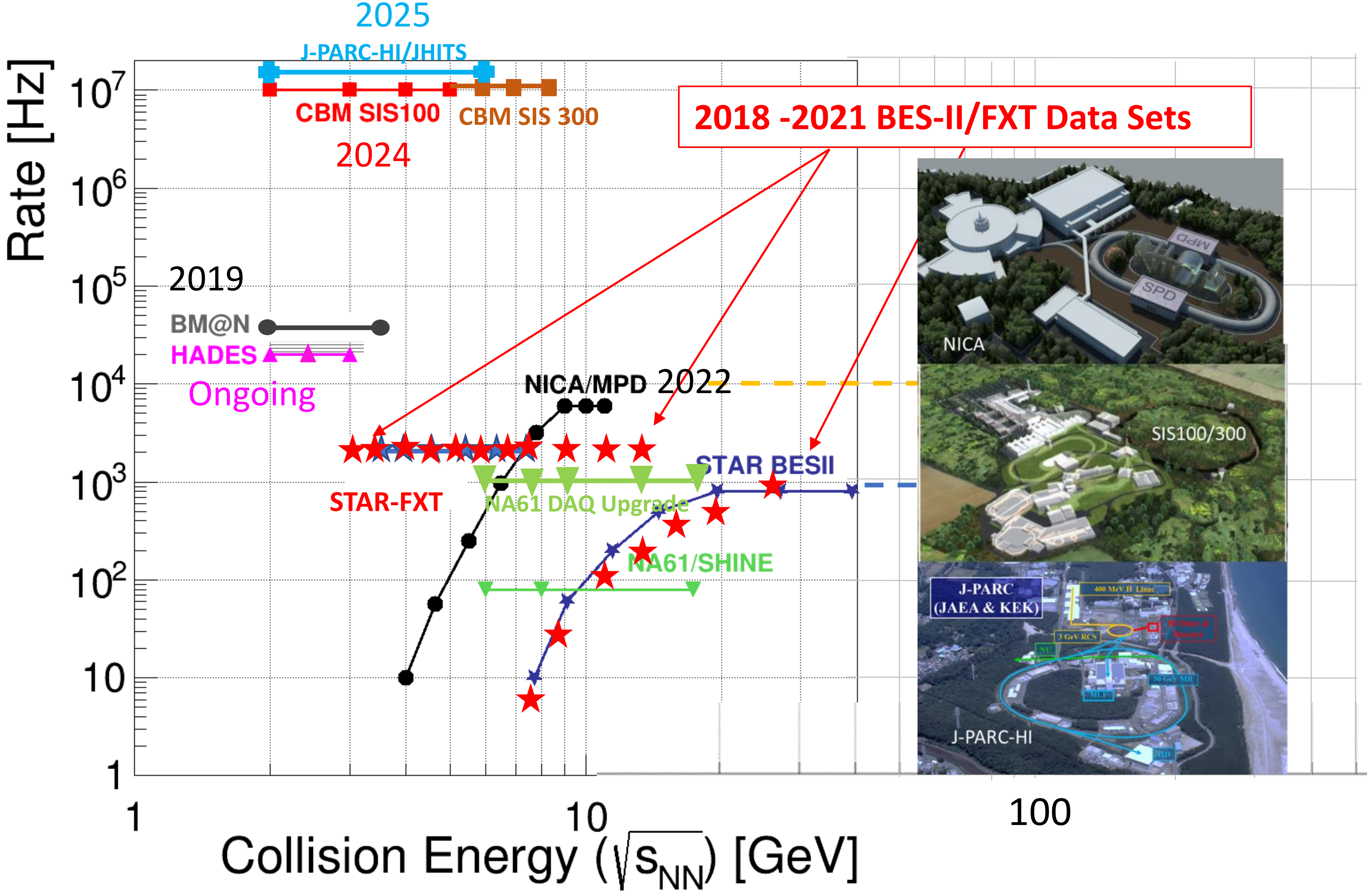
Zero bias data were taken in 2020

Compare the zero-bias data to the min-bias data

➔ There is essentially no trigger bias above FXTMult of 40.



We Have Competition for this Physics



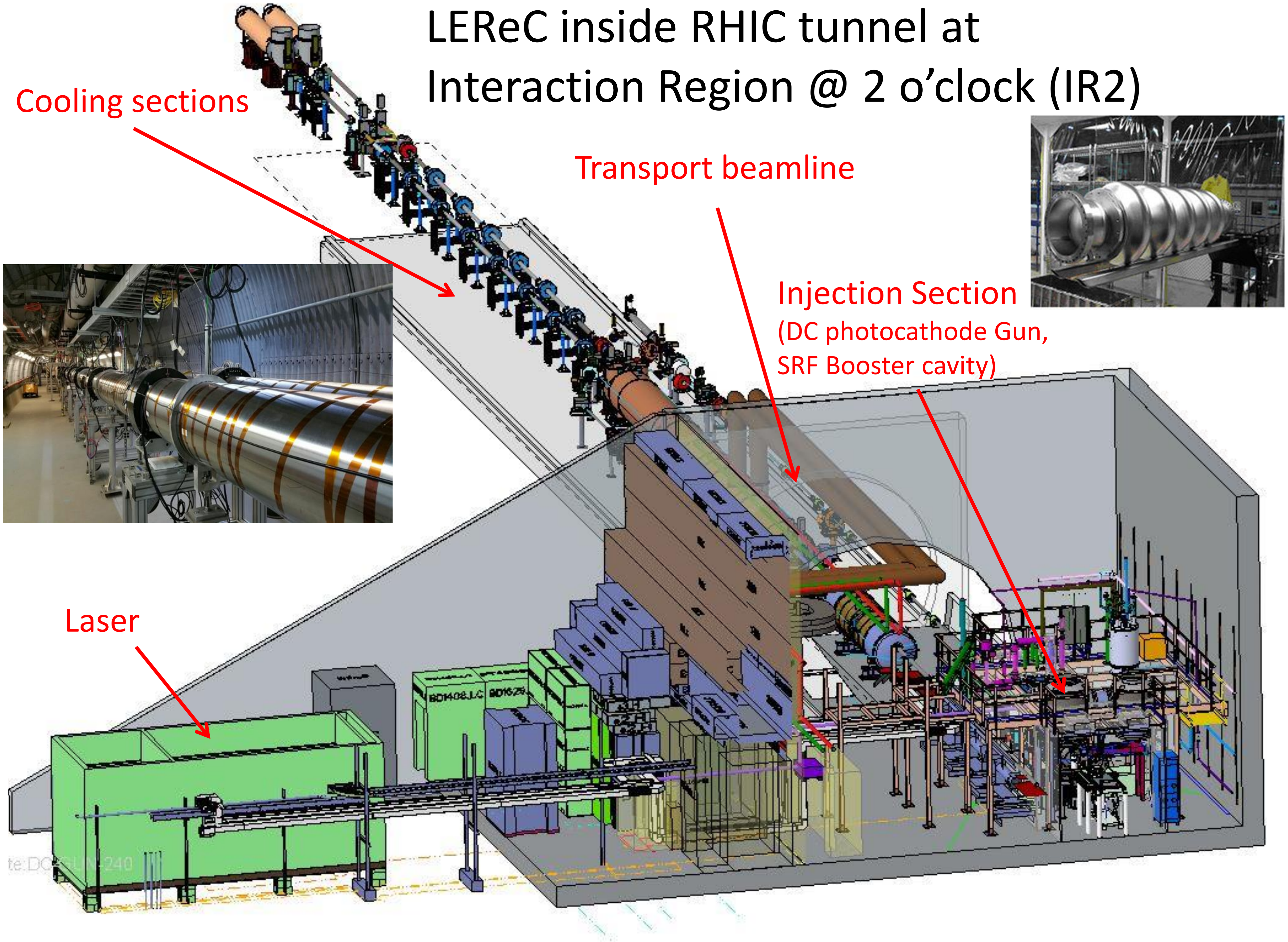
Beam E_T (GeV)	Beam E_k (AGeV)	Beam p_Z (GeV/c)	Rapidity y_{Beam}	$\sqrt{s_{NN}}$ (GeV)	Rapidity y_{CM}	Ch. Pot. μ_B (GeV)
3.85	2.92	3.73	2.10	3.0	1.05	721
4.59	3.66	4.50	2.28	3.2	1.13	699
5.75	4.82	5.67	2.51	3.5	1.25	666
7.3	6.4	7.25	2.75	3.9	1.37	633
9.8	8.9	9.44	3.04	4.5	1.52	589
13.5	12.6	13.5	3.37	5.2	1.68	541
19.5	18.6	19.5	3.73	6.2	1.87	487
26.5	25.6	26.5	4.04	7.2	2.02	443
31.2	30.3	31.2	4.20	7.7	2.10	420
44.5	43.6	44.5	4.56	9.2	2.28	372
70	69.1	70	5.01	11.5	2.51	316
100	99.1	100	5.37	13.7	2.69	276

Official (i.e. correct) FXT Variables

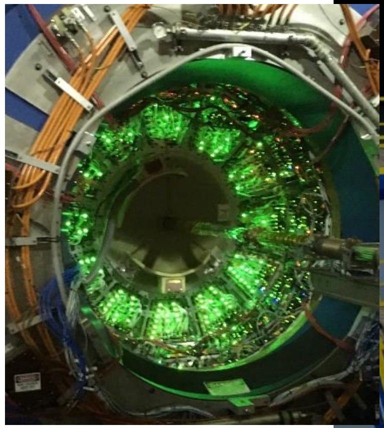
Nominal beam energies are often rounded to a few digits.
The correct calculations use the most precise beam energies, and the mass of the nucleon (not mass of proton on neutron)

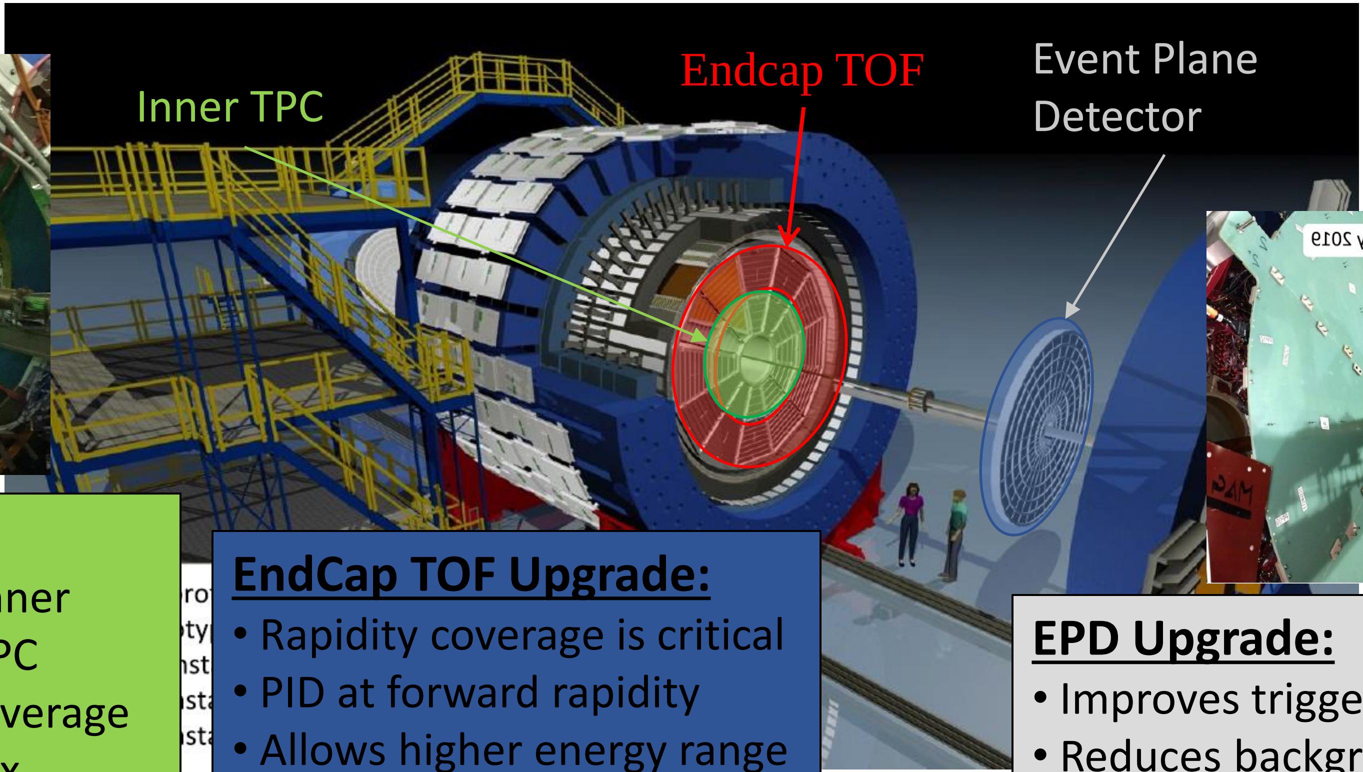
Nominal Beam Energy	Single Beam Energy	Single Beam Pz (GeV/c)	Fixed Target Root s	**Nominal FXT Root s**	Single Beam Rapidity	Center of Mass Rapidity	Single Beam Kinetic	Chemical Potential μ_B
100	100	99.996	13.713	**13.7**	5.369	2.685	99.07	0.276
70	69.684	69.678	11.470	**11.5**	5.008	2.504	68.75	0.317
44.5	44.5	44.490	9.200	**9.2**	4.559	2.280	43.57	0.372
31.2	31.2	31.186	7.737	**7.7**	4.204	2.102	30.27	0.420
26.5	26.537	26.521	7.154	**7.2**	4.042	2.021	25.61	0.443
19.5	19.5	19.478	6.170	**6.2**	3.734	1.867	18.57	0.487
13.5	13.5	13.468	5.185	**5.2**	3.366	1.683	12.57	0.541
9.8	9.796	9.752	4.470	**4.5**	3.044	1.522	8.86	0.589
7.3	7.309	7.249	3.918	**3.9**	2.749	1.375	6.38	0.632
5.75	5.761	5.685	3.531	**3.5**	2.509	1.254	4.83	0.666
4.59	4.593	4.498	3.208	**3.2**	2.278	1.139	3.66	0.697
3.85	3.847	3.733	2.984	**3.0**	2.096	1.048	2.92	0.721

LEReC inside RHIC tunnel at Interaction Region @ 2 o'clock (IR2)



The STAR Detector Upgrades → BES-II



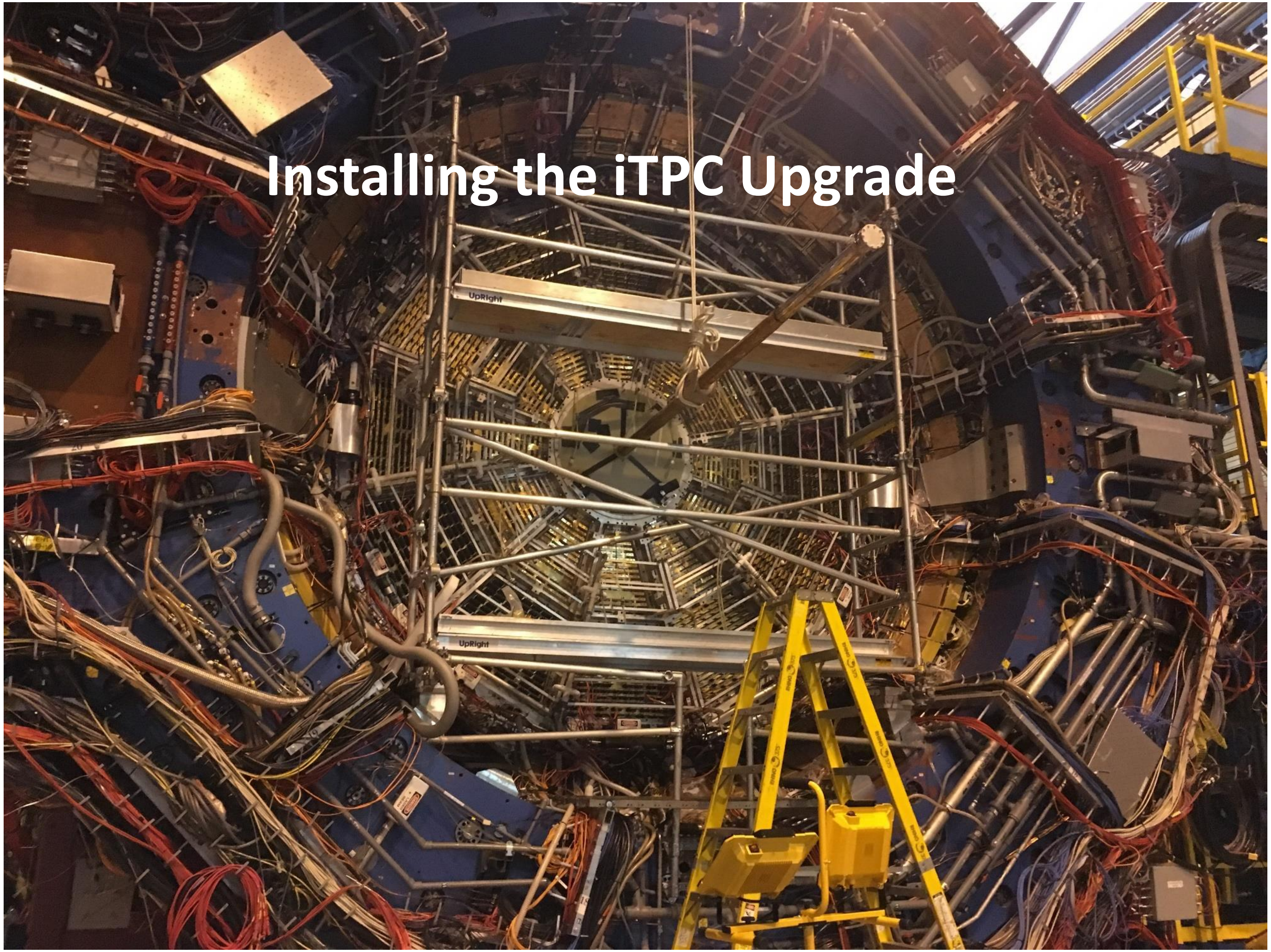


iTPC Upgrade:
- Rebuilds the inner sectors of the TPC
- Continuous Coverage
- Improves dE/dx
- Extends η coverage to 1.5 (2.2 for FXT)
- Lowers p_T cut-in from 125 MeV/c to 60 MeV/c
- Ready in 2019

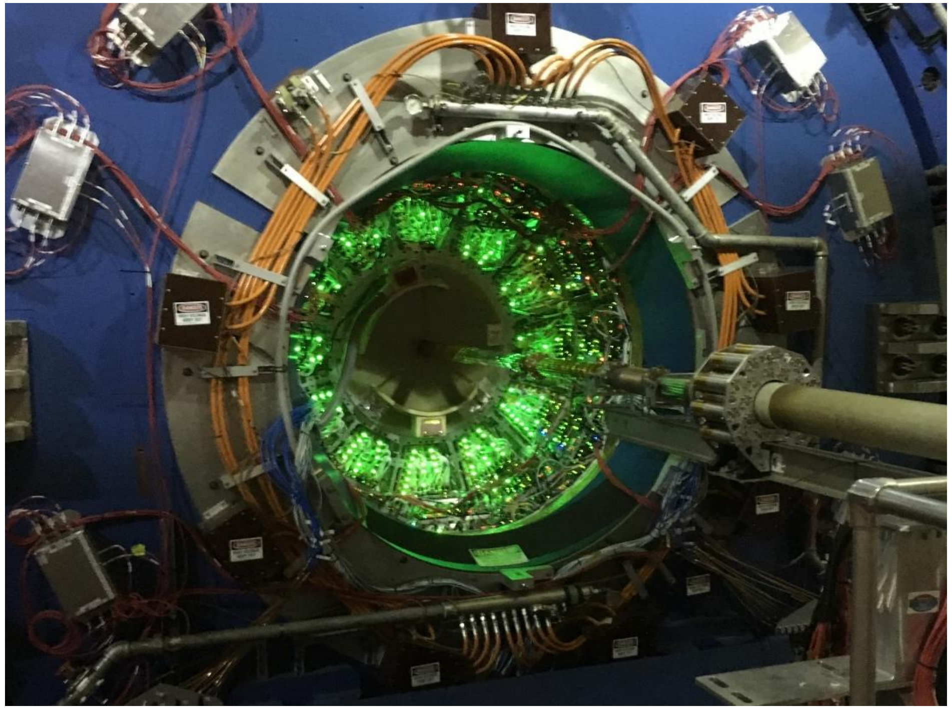
EndCap TOF Upgrade:
- Rapidity coverage is critical
- PID at forward rapidity
- Allows higher energy range of FXT program
- CBM/FAIR
- Ready 2019

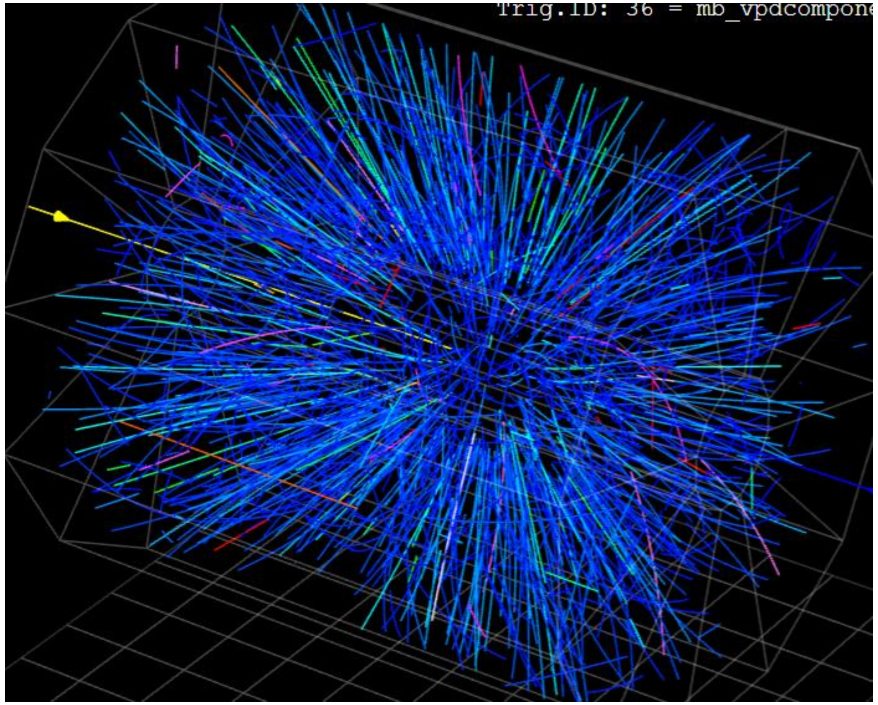
EPD Upgrade:
- Improves trigger
- Reduces background
- Allows a better and independent reaction plane measurement critical to BES and FXT
- Ready 2018

Installing the iTPC Upgrade



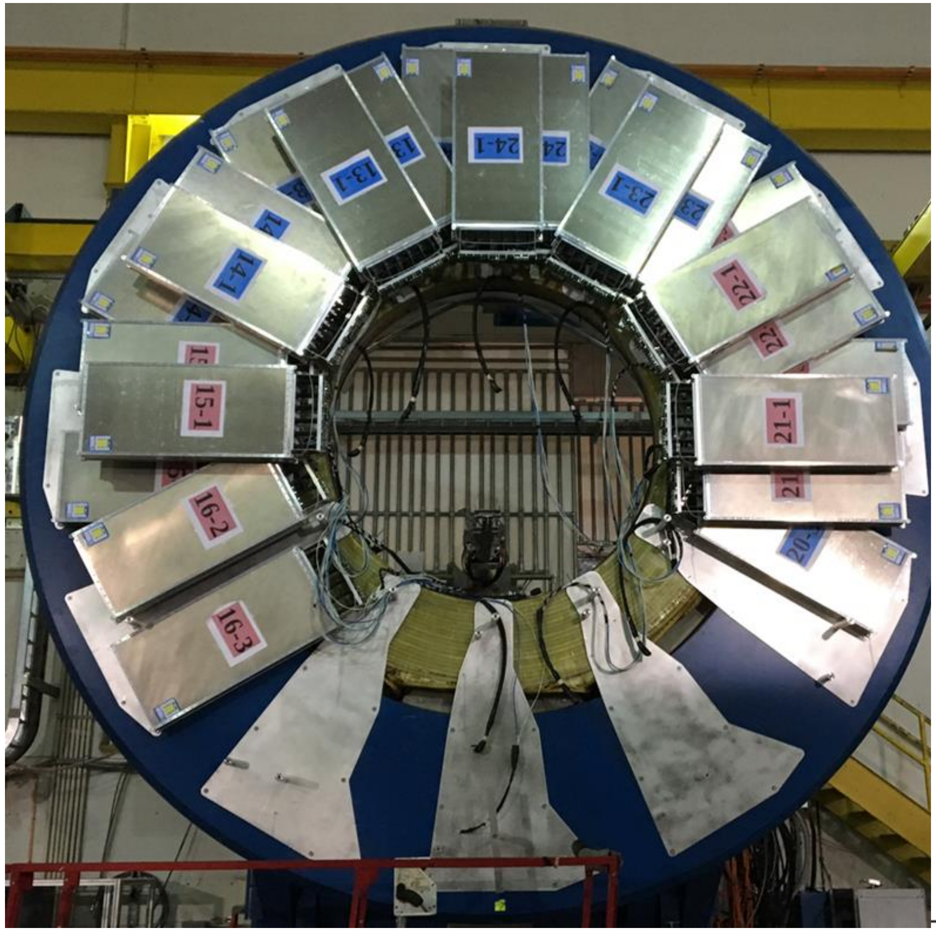
iTPC Upgrade – Current Performance

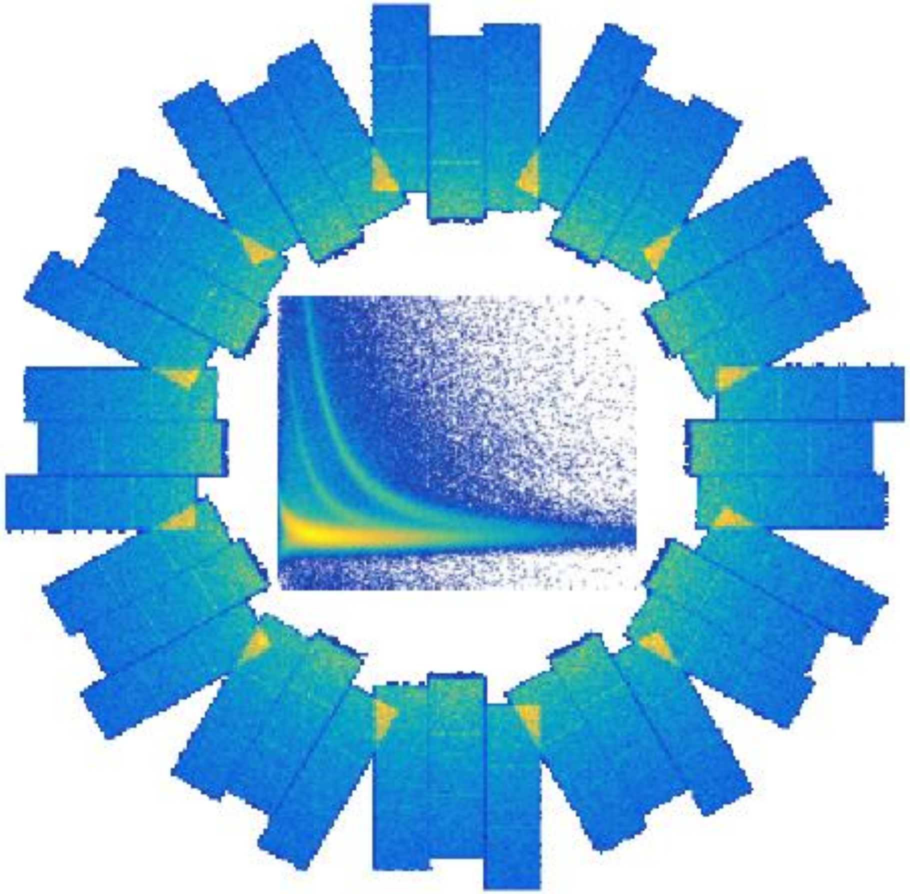




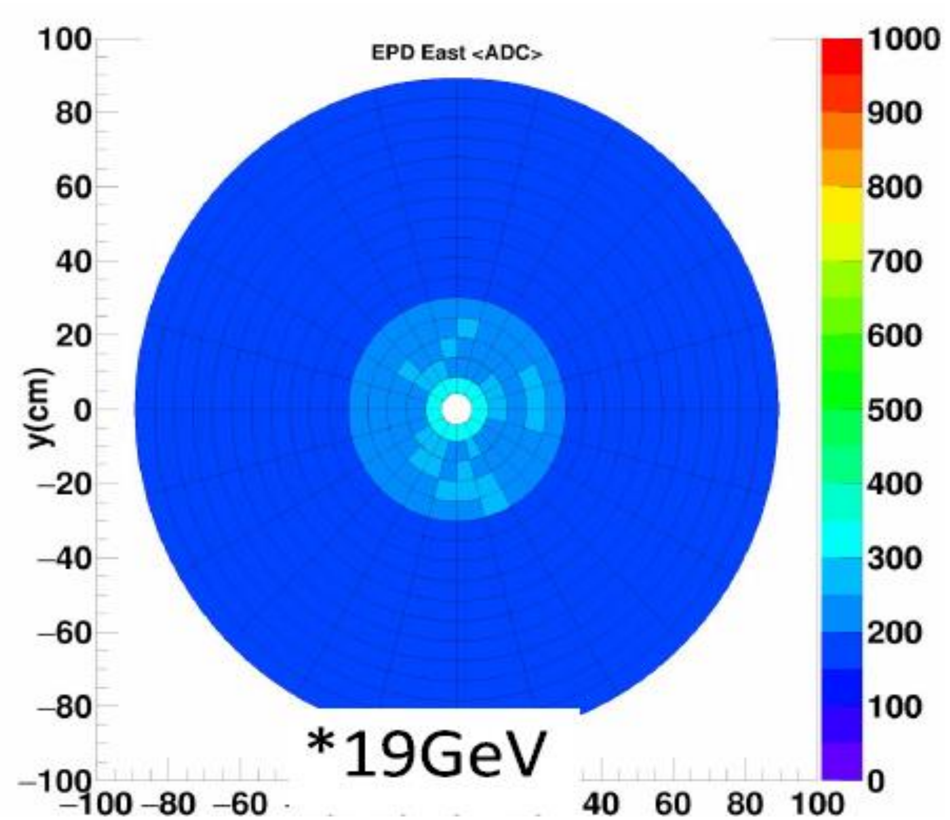
eTOF Upgrade – Current Performance

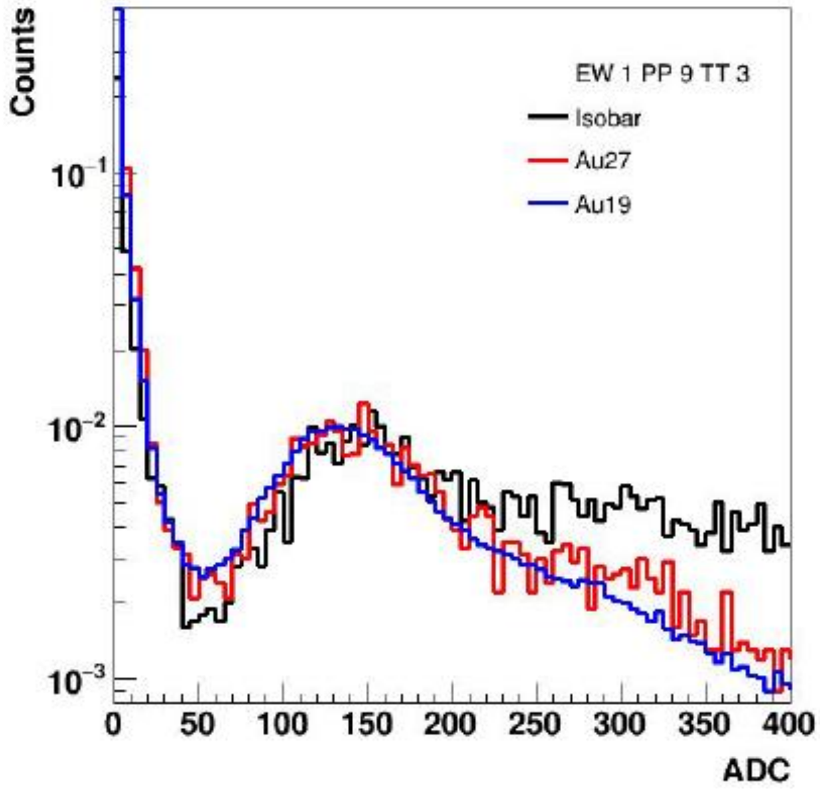
System time resolution ➔ 85 ps
Individual counter time resolution ➔ 65 ps



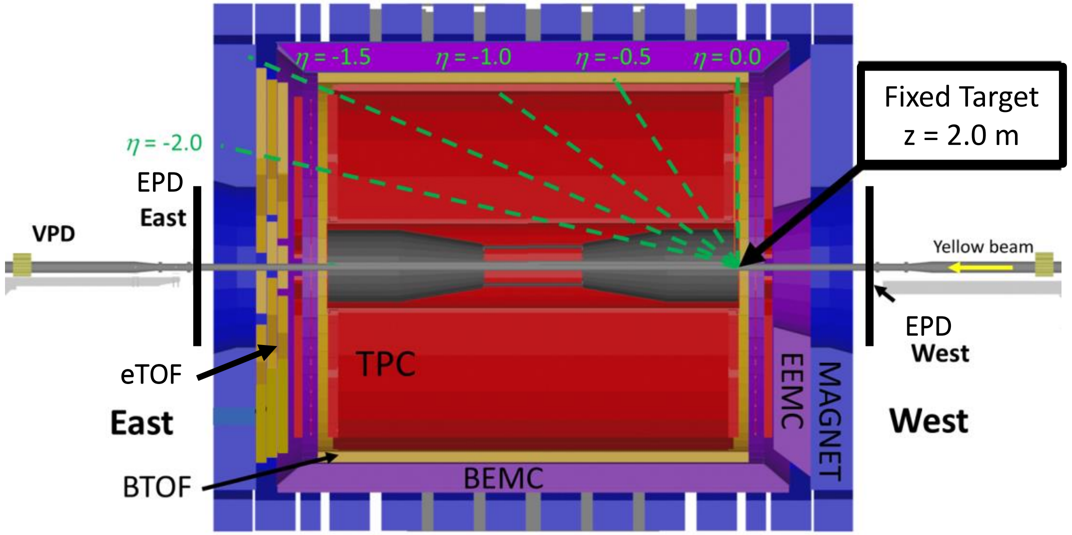


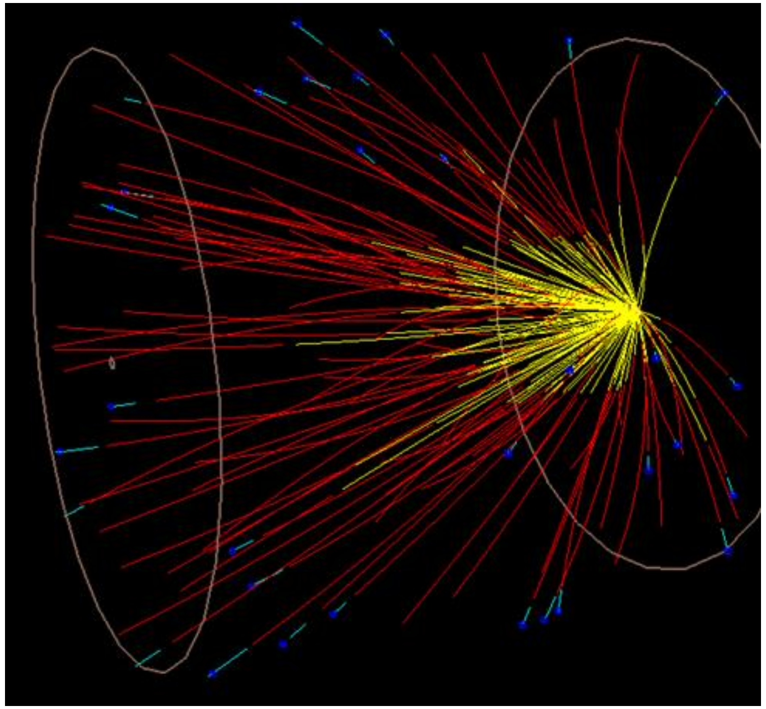
EPD Upgrade – Current Performance





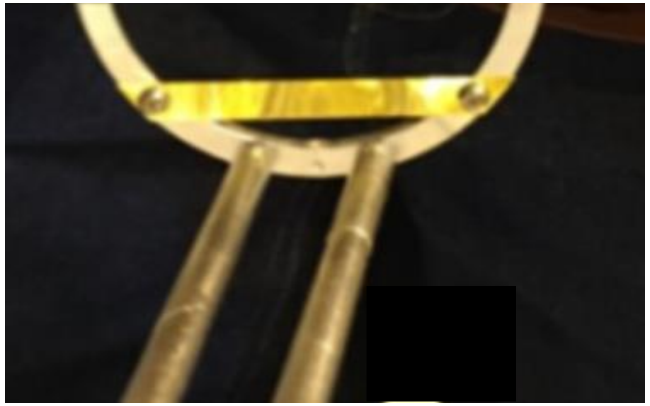
Fixed-Target Program Exp. Setup

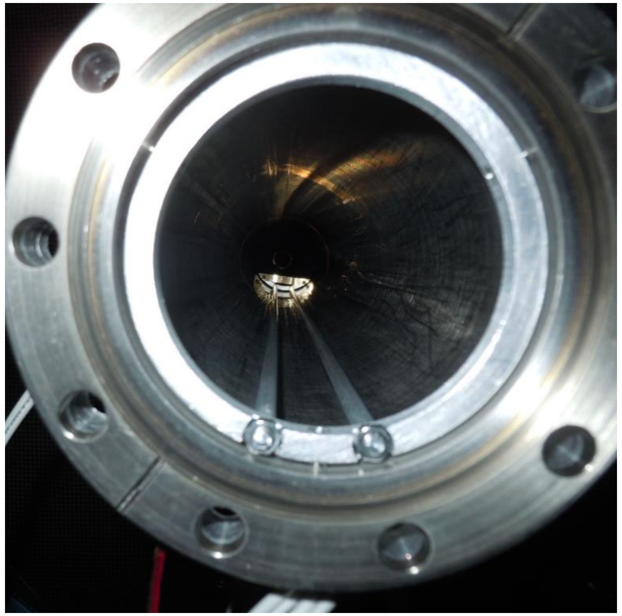




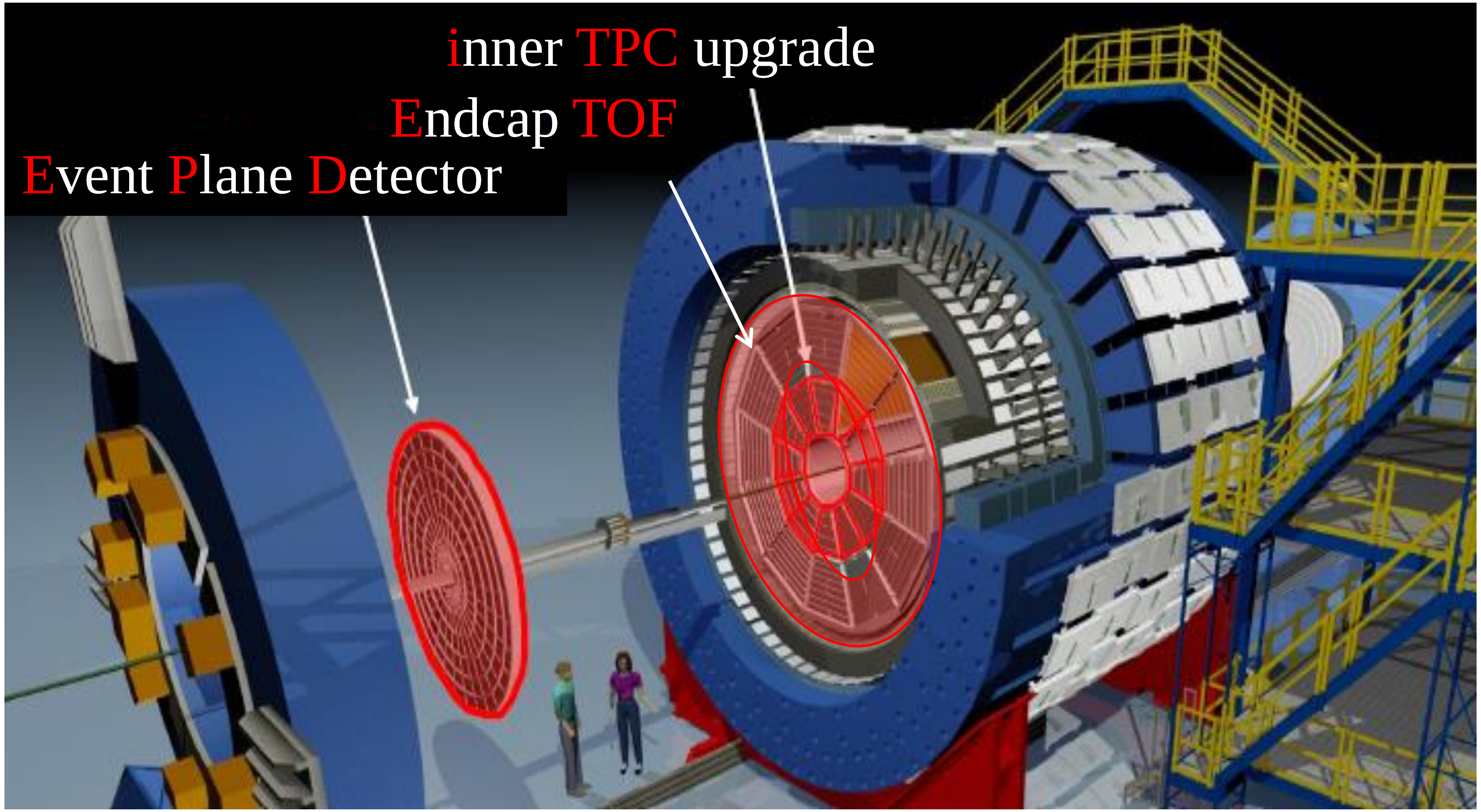
Gold Target:

- 250 μm foil
- 2 cm below the nominal beam axis
- 2 m from the center of STAR





The Upgrades are Important for the FXT Program



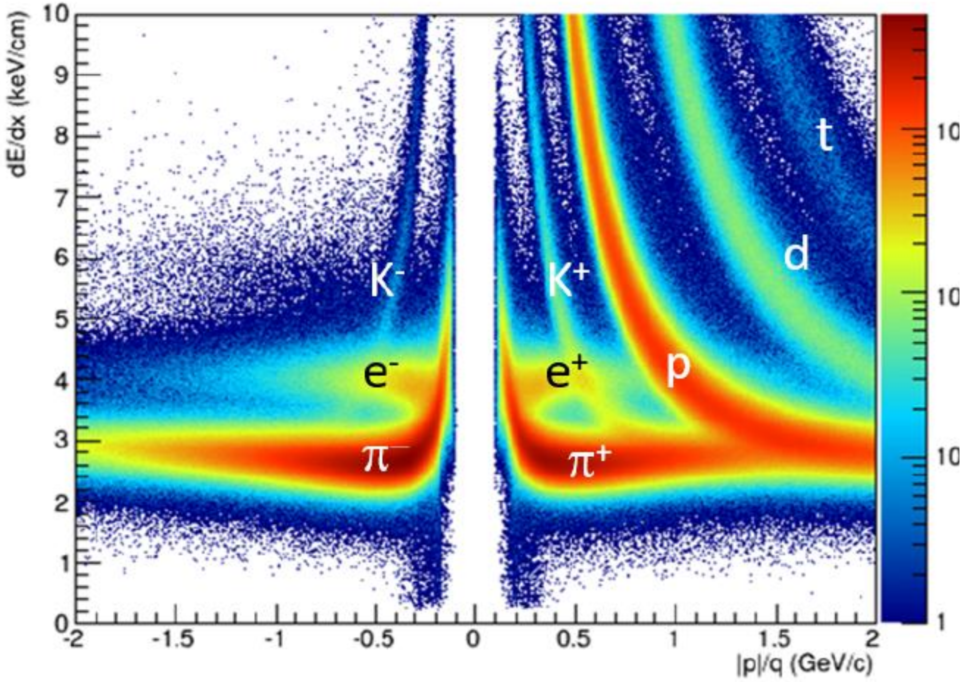
Detects Particles in the $0 < \eta < 2$ range

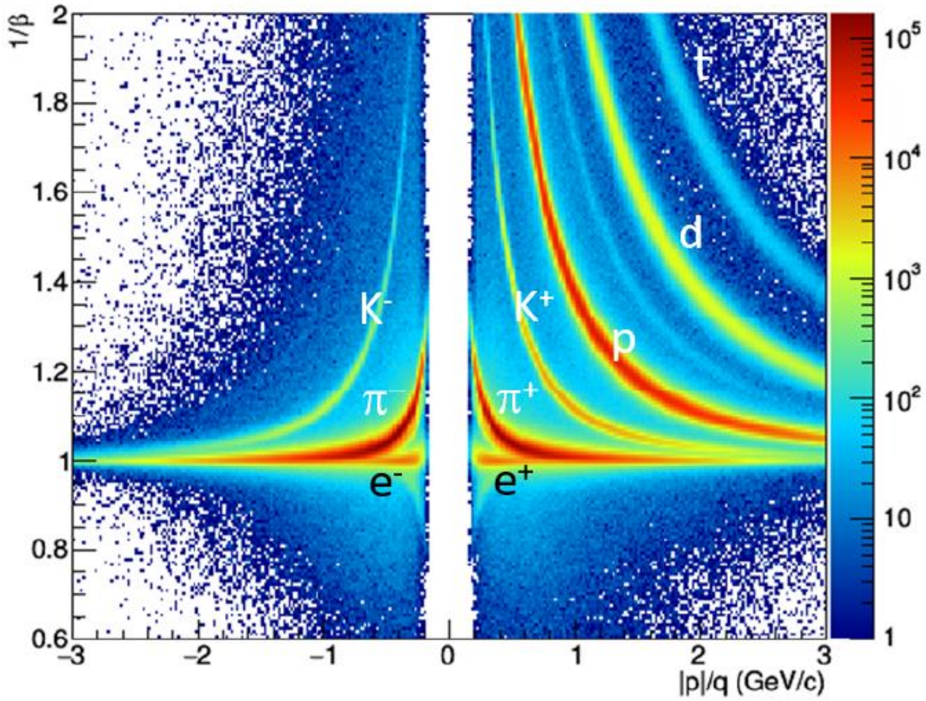
π, K, p, d, t, h, α through dE/dx and TOF

K^0_s, Λ, Ξ, Ω, ϕ, $^3_\Lambda H$, $^4_\Lambda H$ through invariant mass

Particle Identification

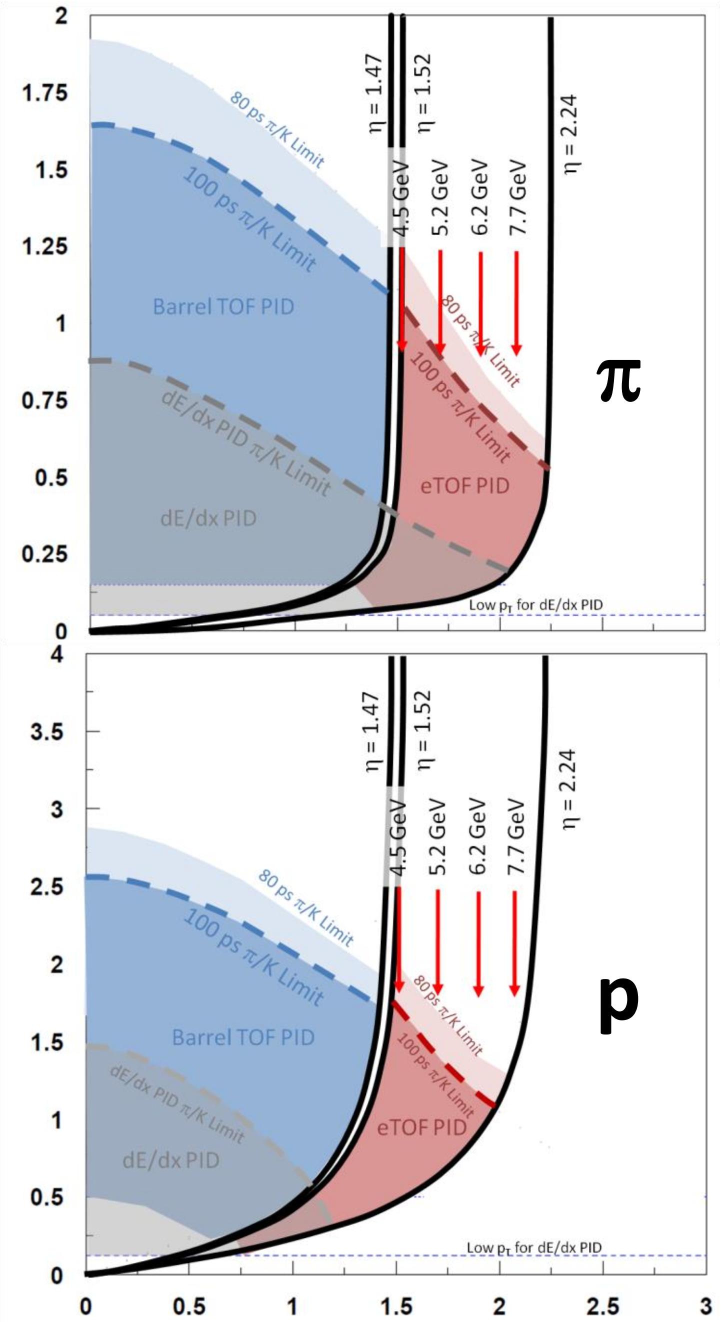
Because the tracks are longer, on average, for FXT events than for collider events, the resolutions for both dE/dx and $1/\beta$ are better in FXT mode than collider mode.





Acceptance for the FXT Program

FXT Energy $\sqrt{s_{NN}}$	Single Beam E_T (GeV)	Single beam E_k (AGeV)	Center-of-mass Rapidity	Chemical Potential μ_B (MeV)	Year of Data Taking
3.0	3.85	2.9	1.05	721	2018
3.2	4.59	3.6	1.13	699	2019
3.5	5.75	4.8	1.25	666	2020
3.9	7.3	6.3	1.37	633	2020
4.5	9.8	8.9	1.52	589	2020
5.2	13.5	12.6	1.68	541	2020
6.2	19.5	18.6	1.87	487	2020
7.2	26.5	25.6	2.02	443	2018
7.7	31.2	30.3	2.10	420	2020
9.1	44.5	43.6	2.28	372	2021
11.5	70	69.1	2.51	316	2021
13.7	100	99.1	2.69	276	2021



BES-II Physics Goals and statistics

Total of 7 collider energies

Collision Energy (GeV)	7.7	9.1	11.5	14.5	19.6
μ_B (MeV) in 0-5% central collisions	420	370	315	260	205
Observables					
R_{CP} up to $p_T = 5$ GeV/c	-	-	160	125	92
Elliptic Flow (ϕ mesons)	80	120	160	160	320
Chiral Magnetic Effect	50	50	50	50	50
Directed Flow (protons)	20	30	35	45	50
Azimuthal Femtoscopy (protons)	35	40	50	65	80
Net-Proton Kurtosis	70	85	100	170	340
Dileptons	100	160	230	300	400
$>5\sigma$ Magnetic Field Significance	50	80	110	150	200
Required Number of Events	100	160	230	300	400

Added two energies: 17.3 and 27

-
QM poster 19.6
QM talk – 27 GeV
QM talk, 2 poster
QM poster
Preliminary results – 27 GeV
QM talk – 27 GeV
QM poster

Total of 12 FXT energies

$\sqrt{s_{NN}}$ (GeV)	3.0	3.2	3.5	3.9	4.5	5.2	6.2	7.7
Single Beam Energy (GeV)	3.85	4.55	5.75	7.3	9.8	13.5	19.5	31.2
μ_B (MeV)	721	699	666	633	589	541	487	420
Rapidity y_{CM}	1.06	1.13	1.25	1.37	1.52	1.68	1.87	2.10
Observables								
Elliptic Flow (kaons)	300	150	80	40	20	40	60	80
Chiral Magnetic Effect	70	60	50	50	50	70	80	100
Directed Flow (protons)	20	30	35	45	50	60	70	90
Femtoscopy (tilt angle)	60	50	40	50	65	70	80	100
Net-Proton Kurtosis	36	50	75	125	200	400	950	NA
Multi-strange baryons	300	100	60	40	25	30	50	100
Hypertritons	200	100	80	50	50	60	70	100
Requested Number of Events	300	100	100	100	100	100	100	100

Added four energies:
7.2, 9.2, 11.5, 13.5
Added high statistics at 3 GeV

QM 2 posters 3
-
QM poster
QM talk
QM talk
QM talk (3,19.6, 27), 3 posters

QM talk – Light nuclei 3, 19.6, 27, poster
QM talk – pi,K,p 3 GeV
QM talk – strange hdrons, poster 3