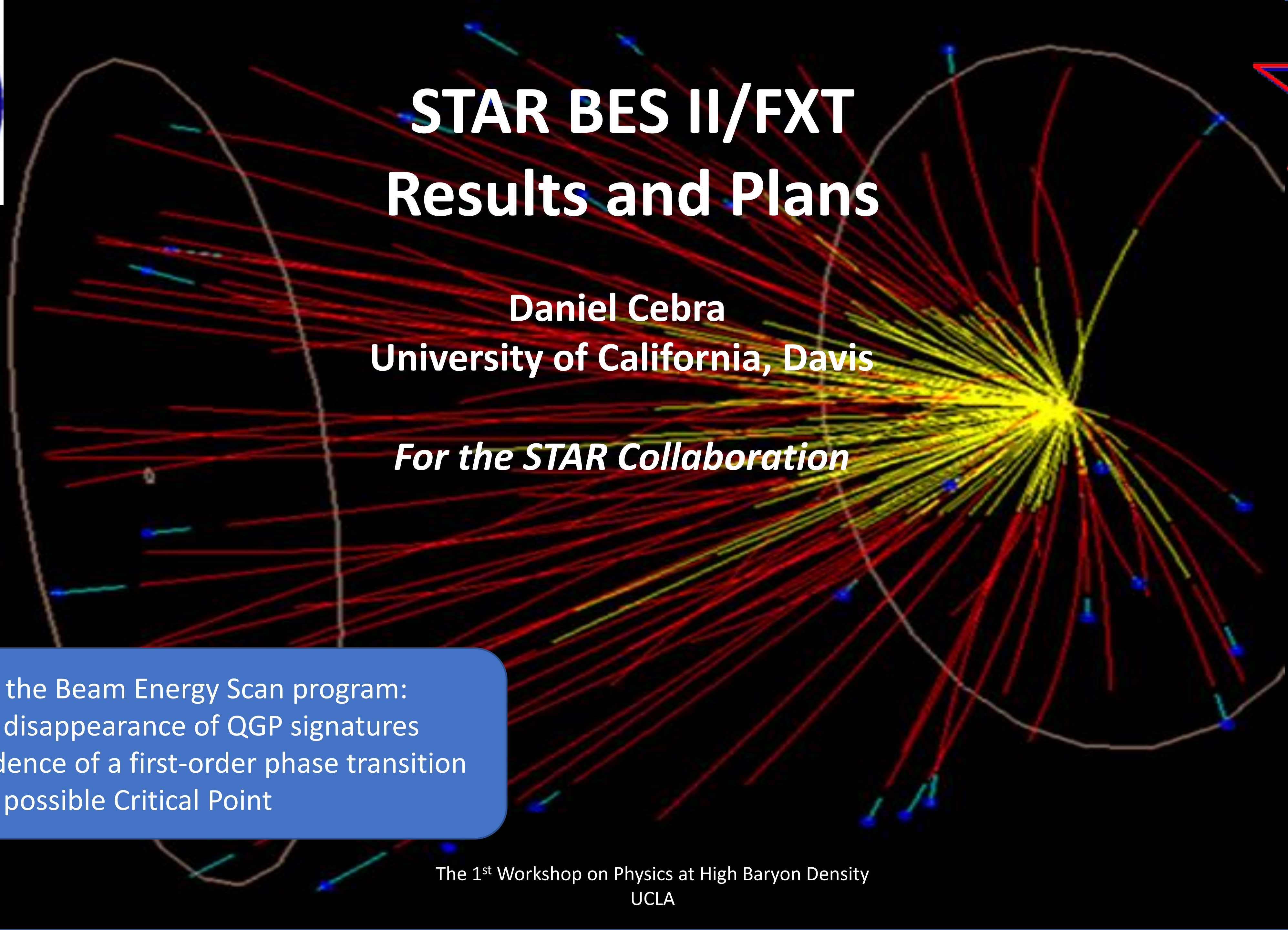


STAR BES II/FXT
Results and Plans

Daniel Cebra
University of California, Davis

For the STAR Collaboration

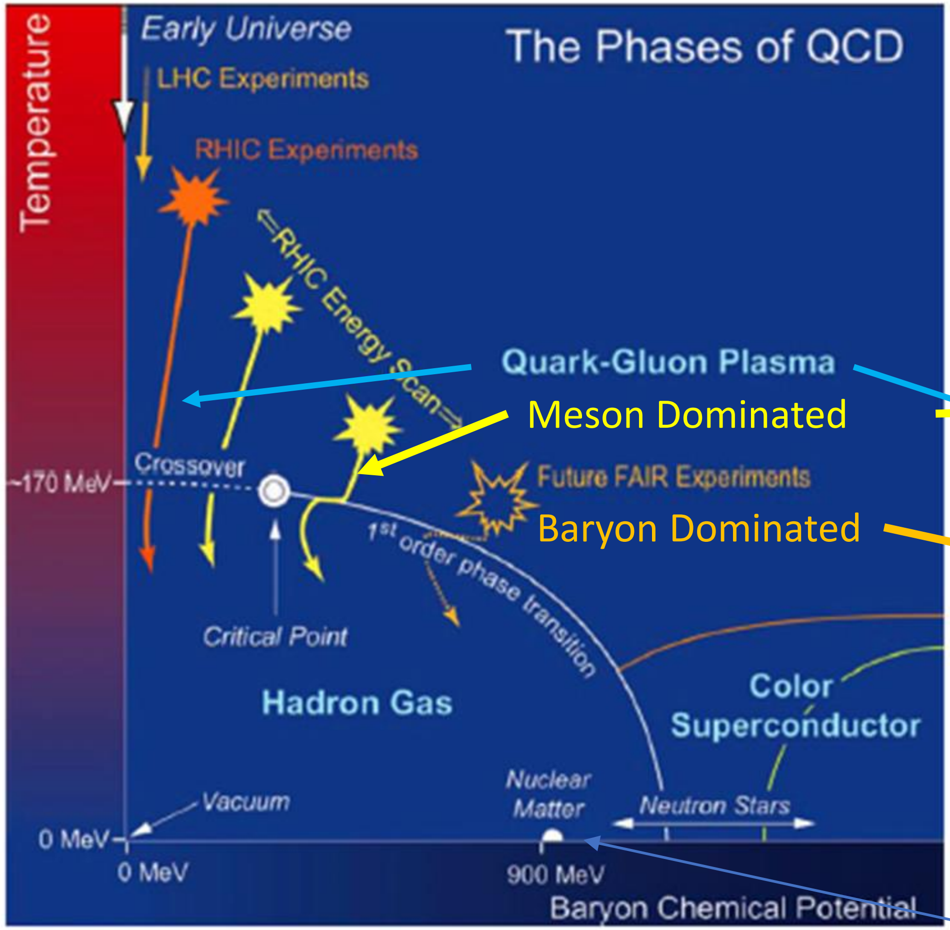
The goals of the Beam Energy Scan program:

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

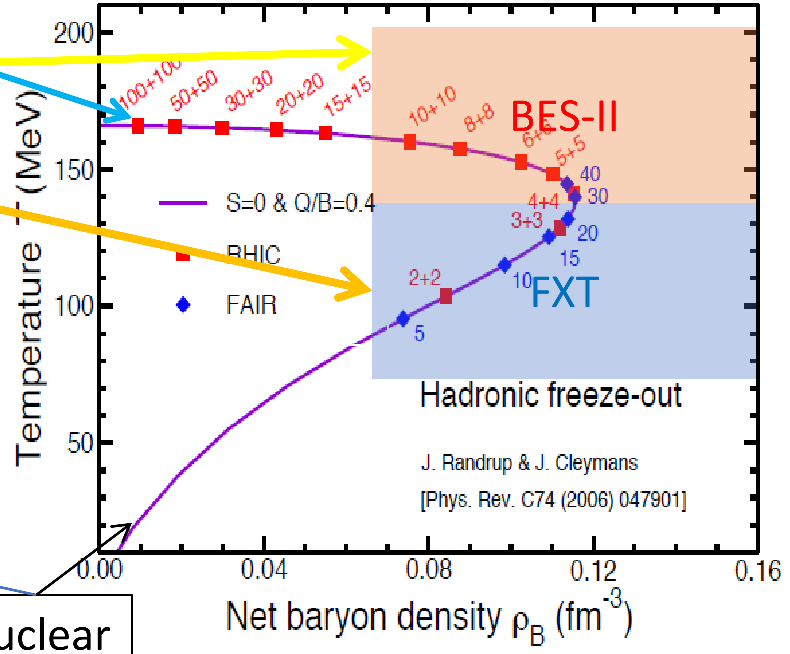
The 1st Workshop on Physics at High Baryon Density
UCLA

Motivation for Energy Scans

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



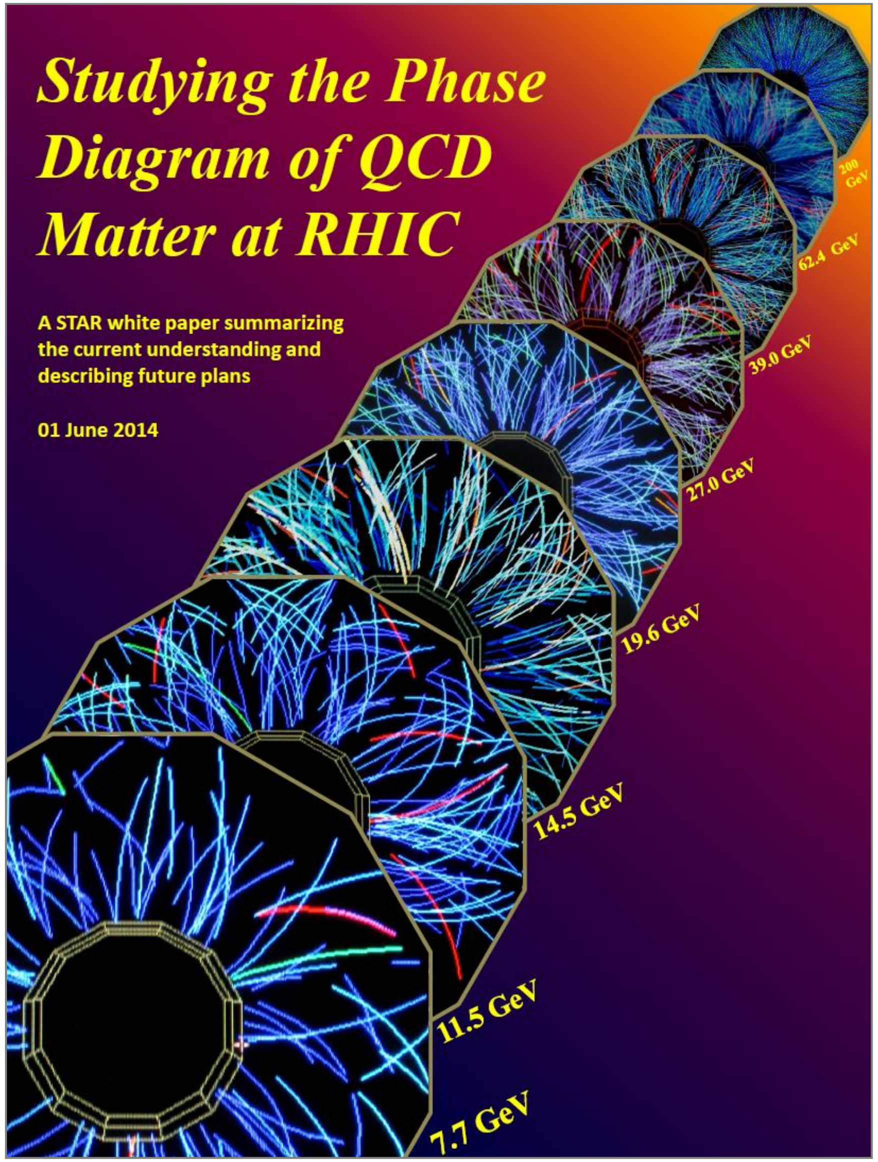
The goal of the energy scans is to study regions of the QCD which exhibit different behaviors and the transitions between such regions



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

Nuclear Matter

BES-II Whitepaper 2014



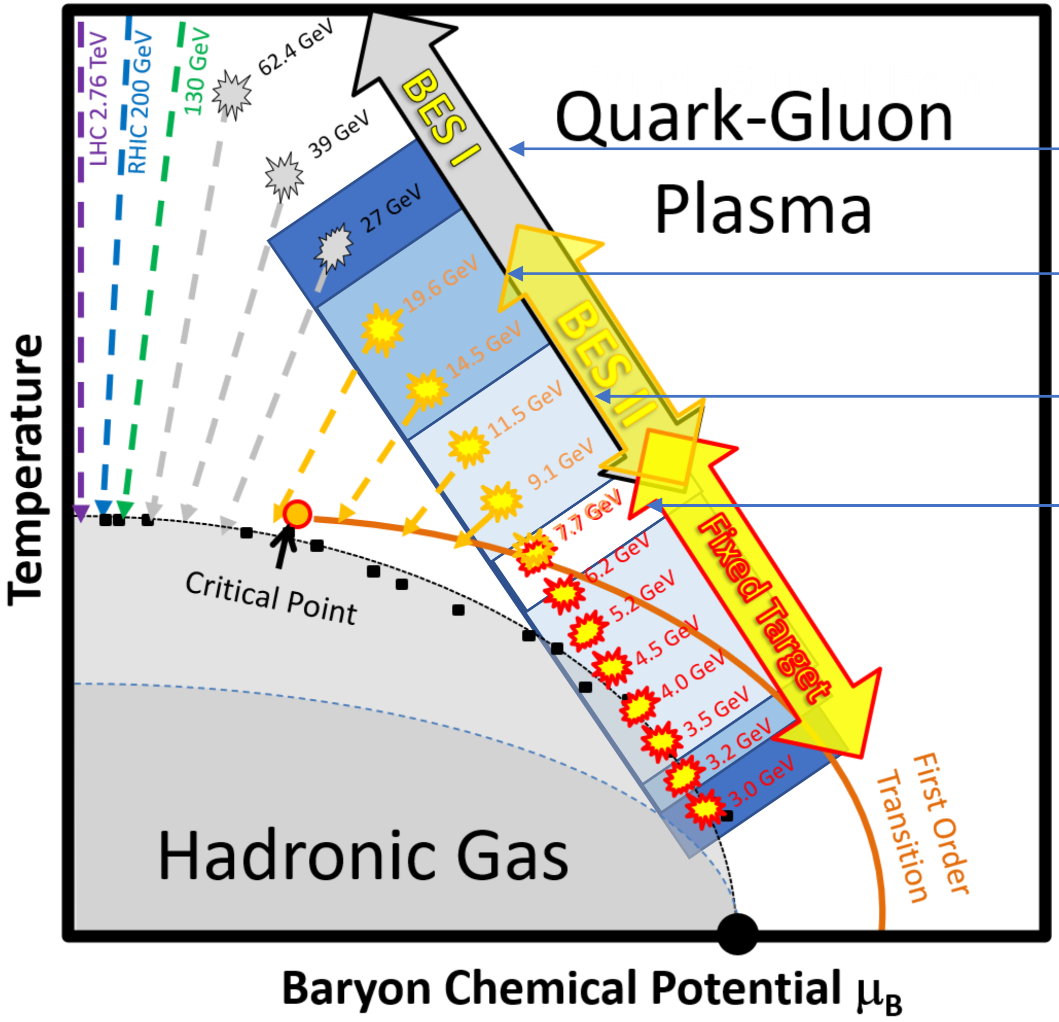
Beam Energy Scan II (2018-2021)

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

BES-II Physics Goals and statistics

STAR

Total of 7 collider energies

Added two energies: 17.3 and 27

Note, there are talks by:
X.Sun – Alignments
YH Leung – Hypernuclei
G.Wang -- Collectivity

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	QM poster 19.6
Chiral Magnetic Effect	50	50	50	50	50	QM talk – 27 GeV
Directed Flow (protons)	20	30	35	45	50	QM talk, 2 poster
Azimuthal Femtoscopy (protons)	35	40	50	65	80	QM poster
Net-Proton Kurtosis	70	85	100	170	340	Preliminary results – 27 GeV
Dileptons	100	160	230	300	400	QM talk – 27 GeV
$>5\sigma$ Magnetic Field Significance	50	80	110	150	200	QM poster
Required Number of Events	100	160	230	300	400	

Total of 12 FXT energies

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

$\sqrt{s_{NN}}$ (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	QM 2 posters 3
Chiral Magnetic Effect	70	60	50	50	50	70	80	100	-
Directed Flow (protons)	20	30	35	45	50	60	70	90	QM poster
Femtoscopy (tilt angle)	60	50	40	50	65	70	80	100	QM talk
Net-Proton Kurtosis	36	50	75	125	200	400	950	NA	QM talk
Multi-strange baryons	300	100	60	40	25	30	50	100	QM talk (3,19.6, 27), 3 posters
Hypertritons	200	100	80	50	50	60	70	100	
Requested Number of Events	300	100	100	100	100	100	100	100	

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

How are we doing so far?

The 27 GeV, 3.0 FXT, and 7.2 FXT have been available for over a year. Many results are final

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	
19.6 GeV	Feb 25th	April 3rd	582 M	400 M	Preliminary
14.6 GeV	April 4th	June 3rd	324 M	310 M	Post-prod QA
3.9 FXT	June 18th	June 18th	52.7 M	50 M	Produced
3.2 FXT	June 28th	July 2nd	200.6 M	200 M	Post-prod QA
7.7 FXT	July 8th	July 9th	50.6 M	50 M	Produced
200 GeV	July 11th	July 12th	138 M	140 M	*March ?*

New preliminary results from 19.6 GeV will be shown at QM2022

Things to look forward to

Completed the bulk of the physics program. Roughly one day for each energy

2020	Start	Stop	Good	Target	Status
11.5 GeV	Dec 10th	Feb 24th	235 M	230 M	*Summer?*
7.7 FXT	Jan 28th	Jan 29th	112.5 M	100 M	Produced
4.5 FXT	Jan29th	Feb 1st	108 M	100 M	Produced
6.2 FXT	Feb 1st	Feb 2nd	118 M	100 M	Produced
5.2 FXT	Feb 2nd	Feb 3rd	103 M	100 M	Produced
3.9 FXT	Feb 4th	Feb 5th	117 M	100 M	Produced
3.5 FXT	Feb 13th	Feb 14th	115.6 M	100 M	Produced
9.2 GeV	Feb 24th	Sep 1st	161.8 M	160 M	*Summer?*
7.2 FXT	Sep 12th	Sep 14th	317 M	None	

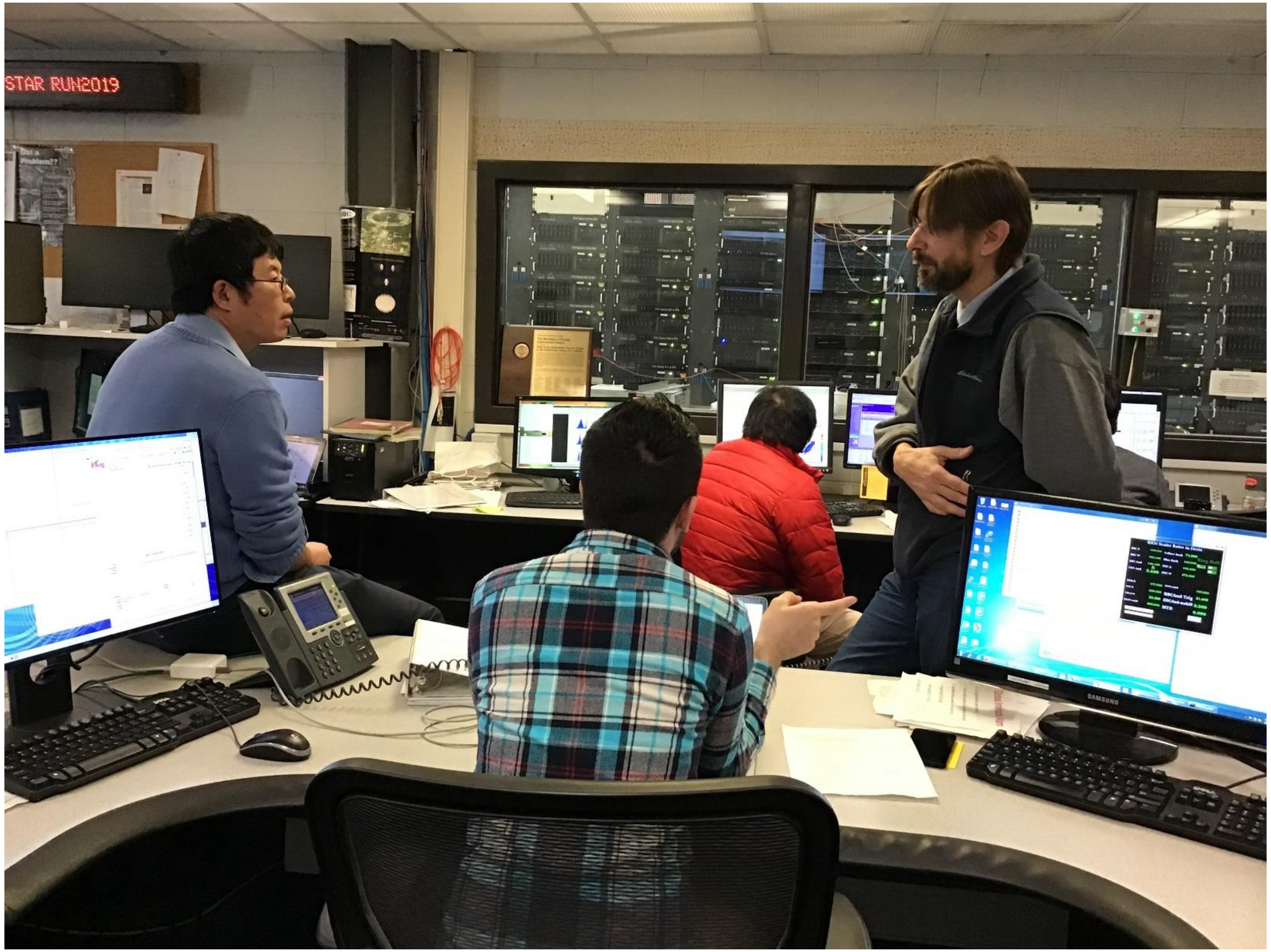
Long run for hypernuclei and higher moments

Added more overlap energies to study stopping

2021	Start	Stop	Good	Target	Status
7.7 GeV	Jan 31st	May 1st	100.9 M	100 M	*May?*
3.0 FXT	May 1st	June 28th	2103 M	2.0 B	
9.2 FXT	May 6th	May 6th	53.9 M	50 M	
11.5 FXT	May 7th	May 7th	51.7 M	50 M	
13.7 FXT	May 8th	May 8th	50.7 M	50 M	
17.3 GeV	May 25th	June 7th	256.1 M	250 M	
17.2 FXT	June 3rd	July 3rd	88.6 M	None	

All BES-II/FXT data will be available by the end of this year

Results

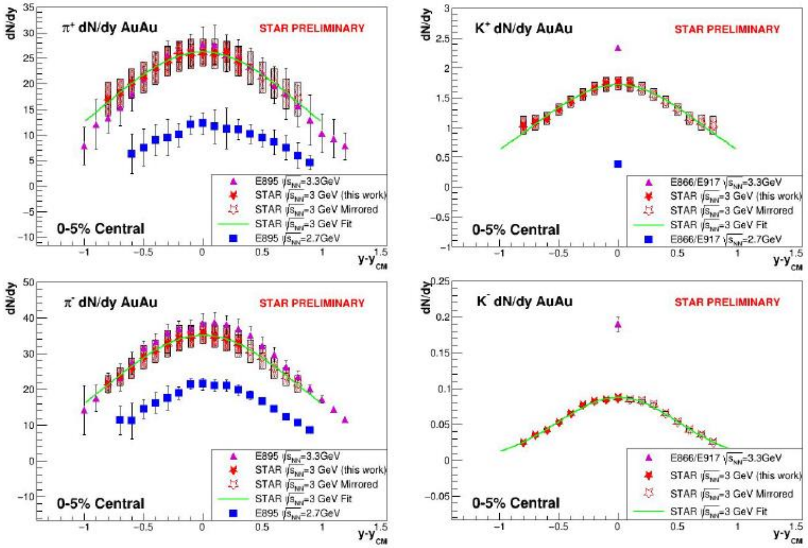


Particle Production at $\sqrt{s_{NN}}$ = 3.0 and 27 GeV

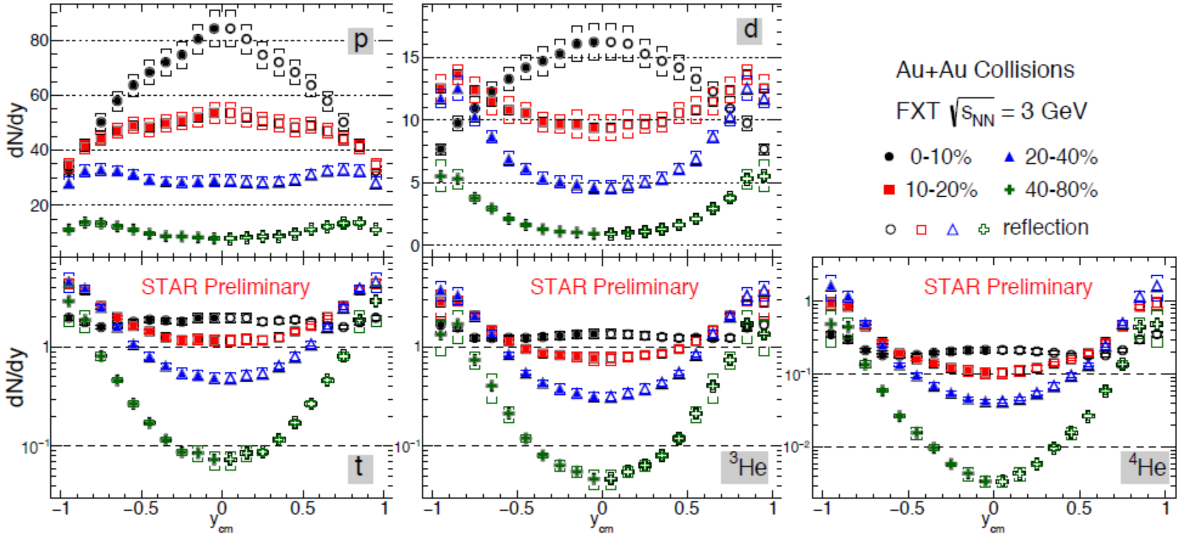
Spectra and rapidity densities have been measured for:

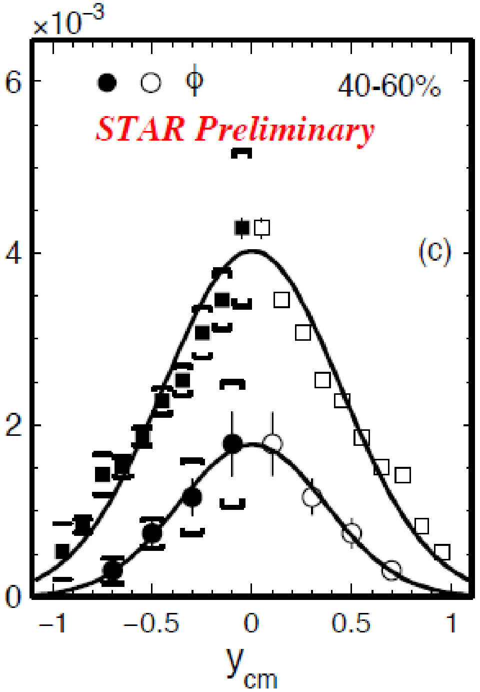
- π^+
- π^-
- K^+
- K^0_S
- K^-
- ϕ
- P
- Λ
- Ξ
- d
- t
- h
- α
- ${}^3_\Lambda H$
- ${}^4_\Lambda H$
- ${}^4_\Lambda He$

At QM2022:
- Three talks
- Three Posters



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

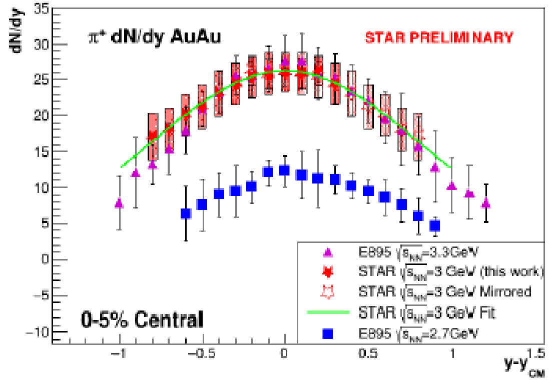


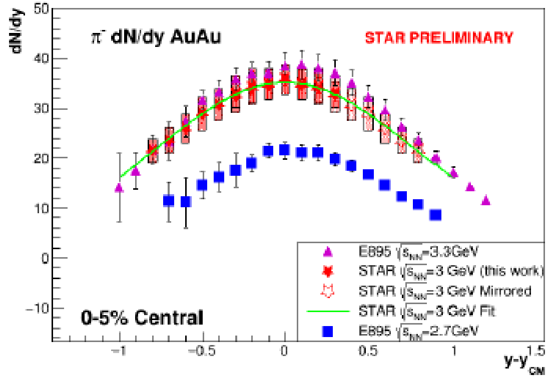


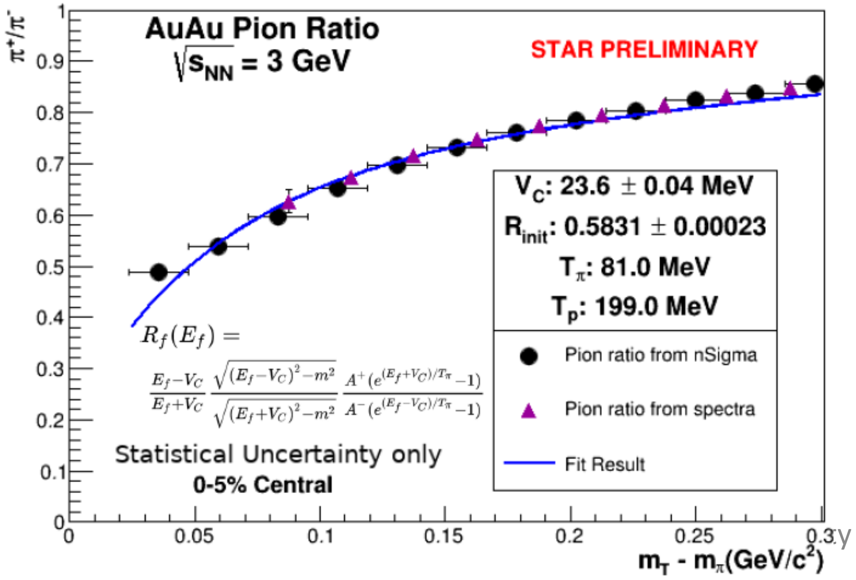
Pion Spectra at 3 GeV

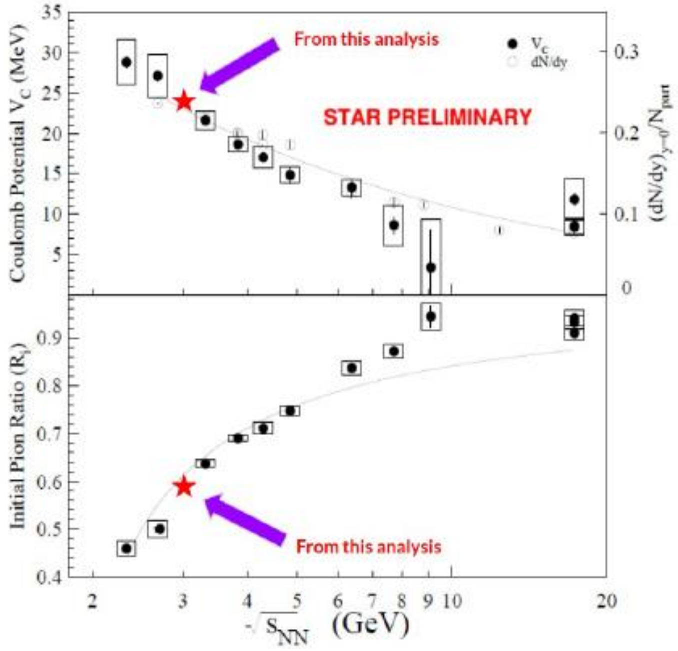
Pions measured at similar energies during the AGS heavy-ion program. What is new? And what do we learn?

- Measurements at full rapidity
- Measurements at all centralities ➔ Can study the Coulomb potential as the source gets smaller
- The goal is to infer about the size of the system at freeze-out









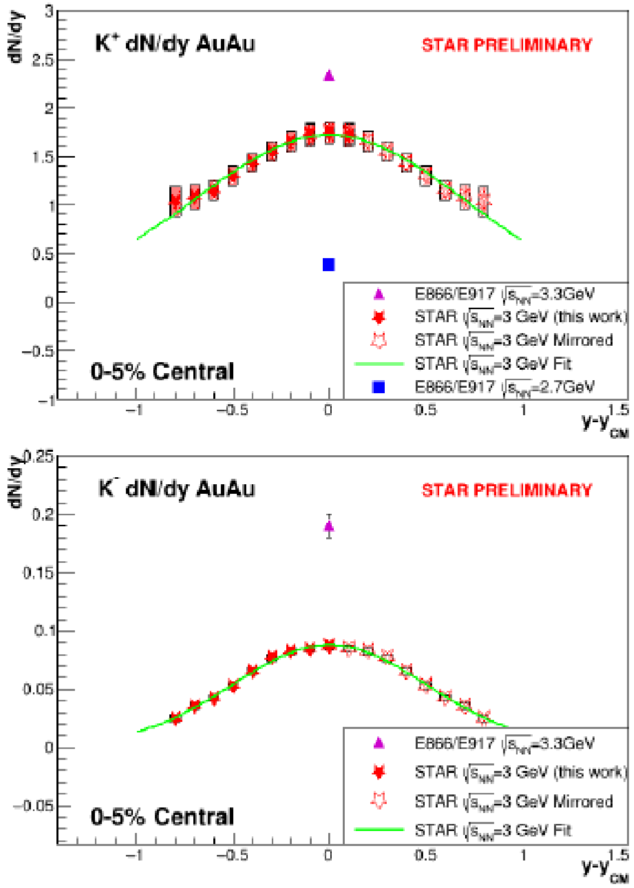
Coulomb potential is proportional to proton dN/dy

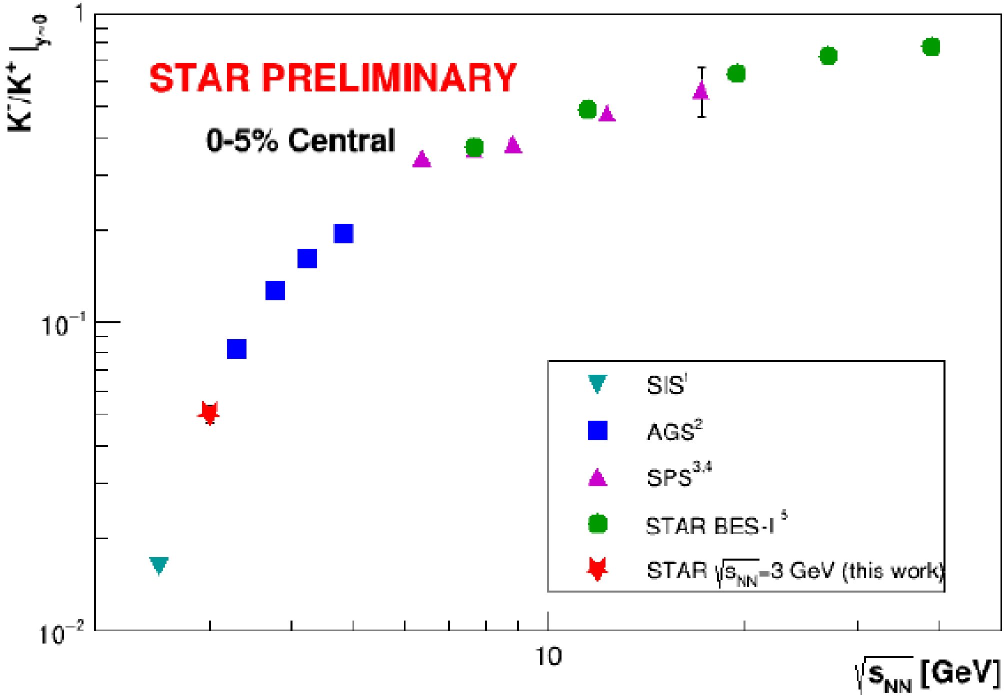
Work in progress:
Coulomb potential as a function of centrality ➔ Since the Coulomb potential depends on both Q and R, and the charge can be determined to be the proton dN/dy, one can draw inferences about the source size.

Kaon Spectra 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



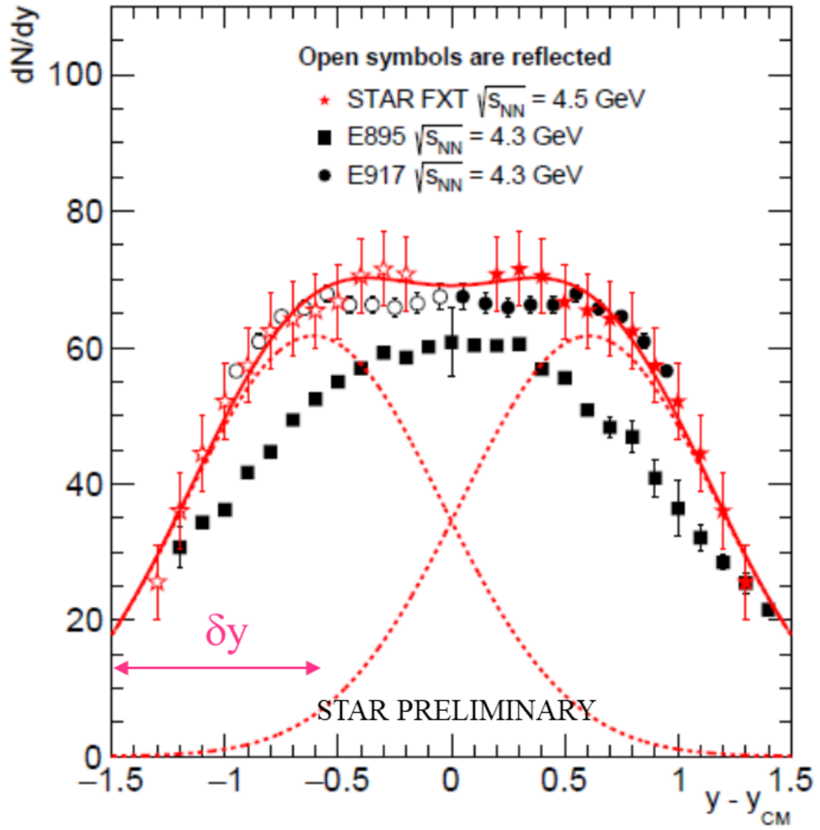


Proton Spectra at 3 GeV

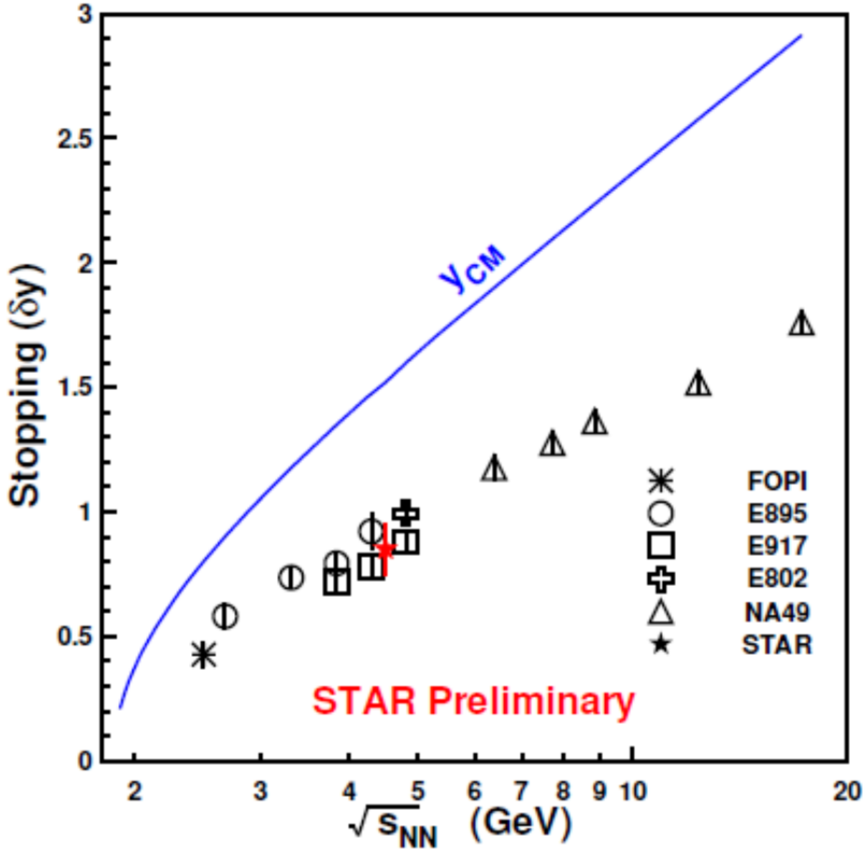
OK, I am fibbing here, these are really results from our 4.5 GeV test run, the 3 GeV results will be shown at QM2022.

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

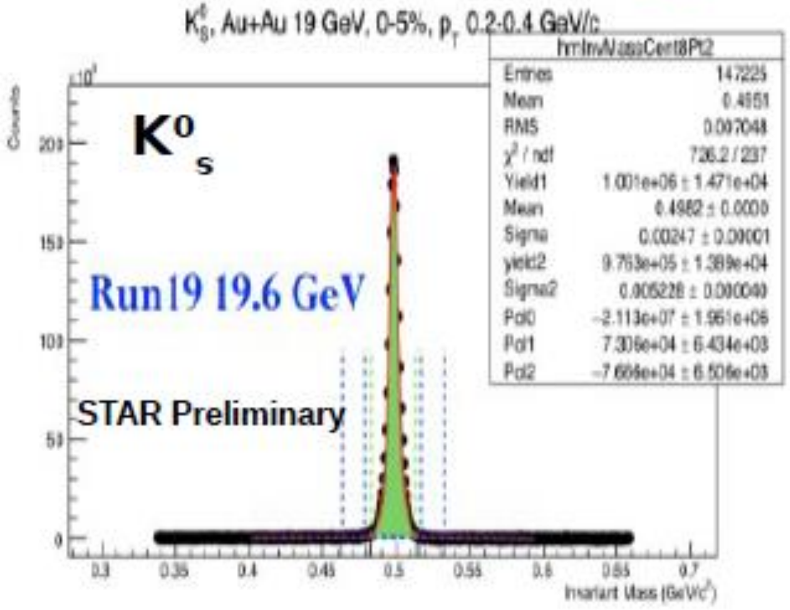
- Measurements at all rapidities ➔ Stopping
- Measurements at all centralities ➔ **Stopping as a function of centrality ➔ Can probe how stopping changes as the number of collisions per nucleon changes**
- Can better understand the mechanisms of stopping



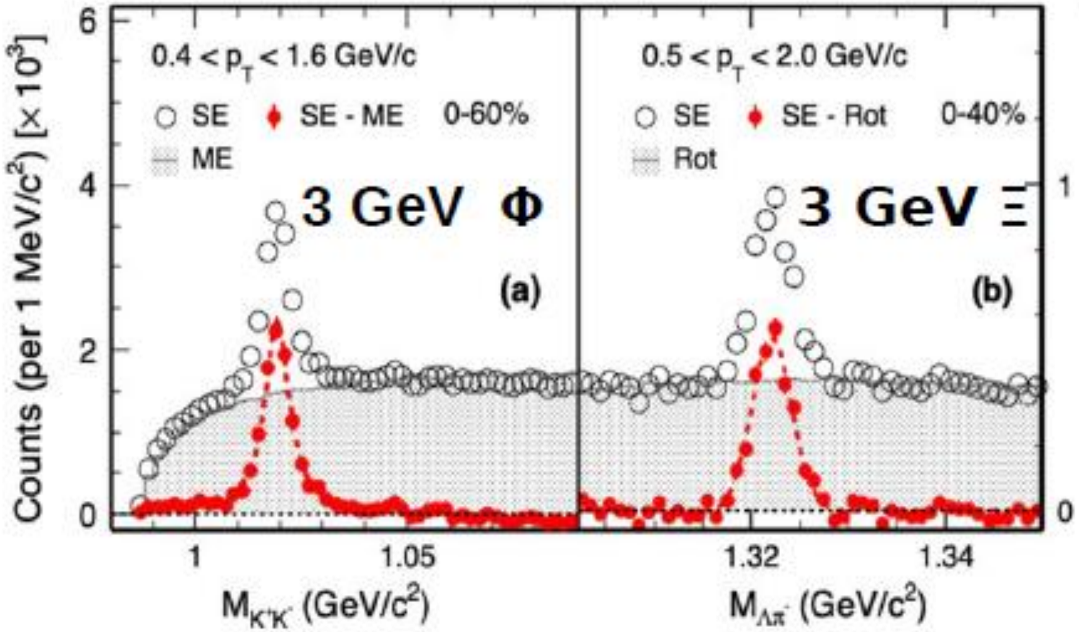
Consistent with AGS results (*)

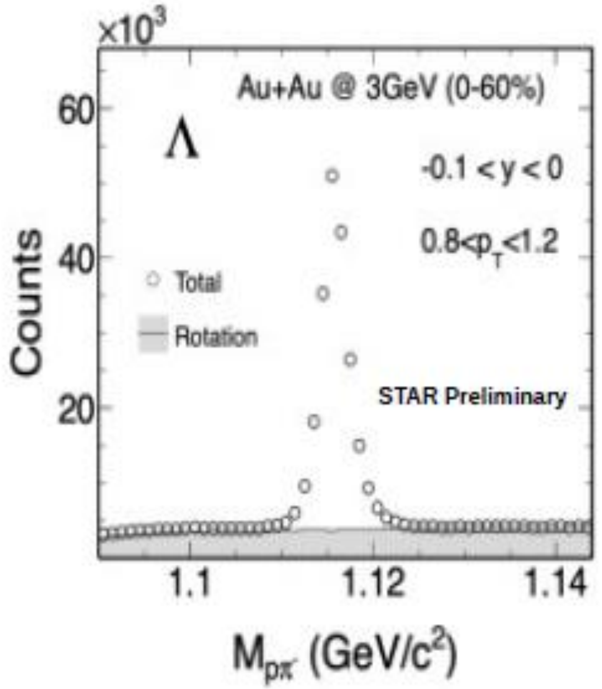


Strange Hadron Production at 3 GeV



ArXiv Nucl-Ex 2108.00924



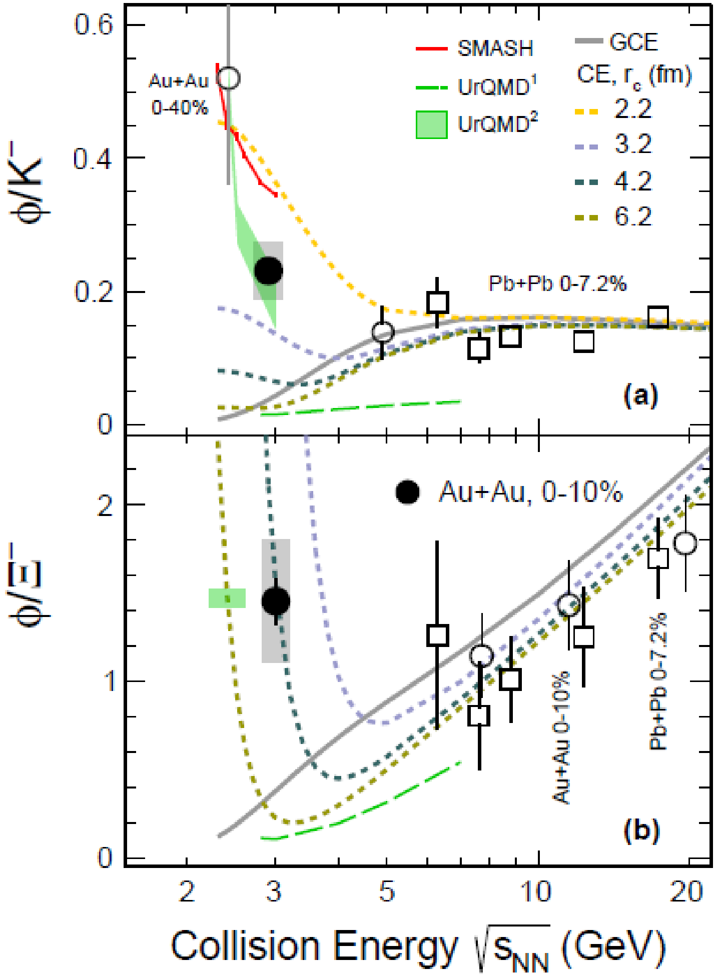


ϕ and Ξ spectra have been published

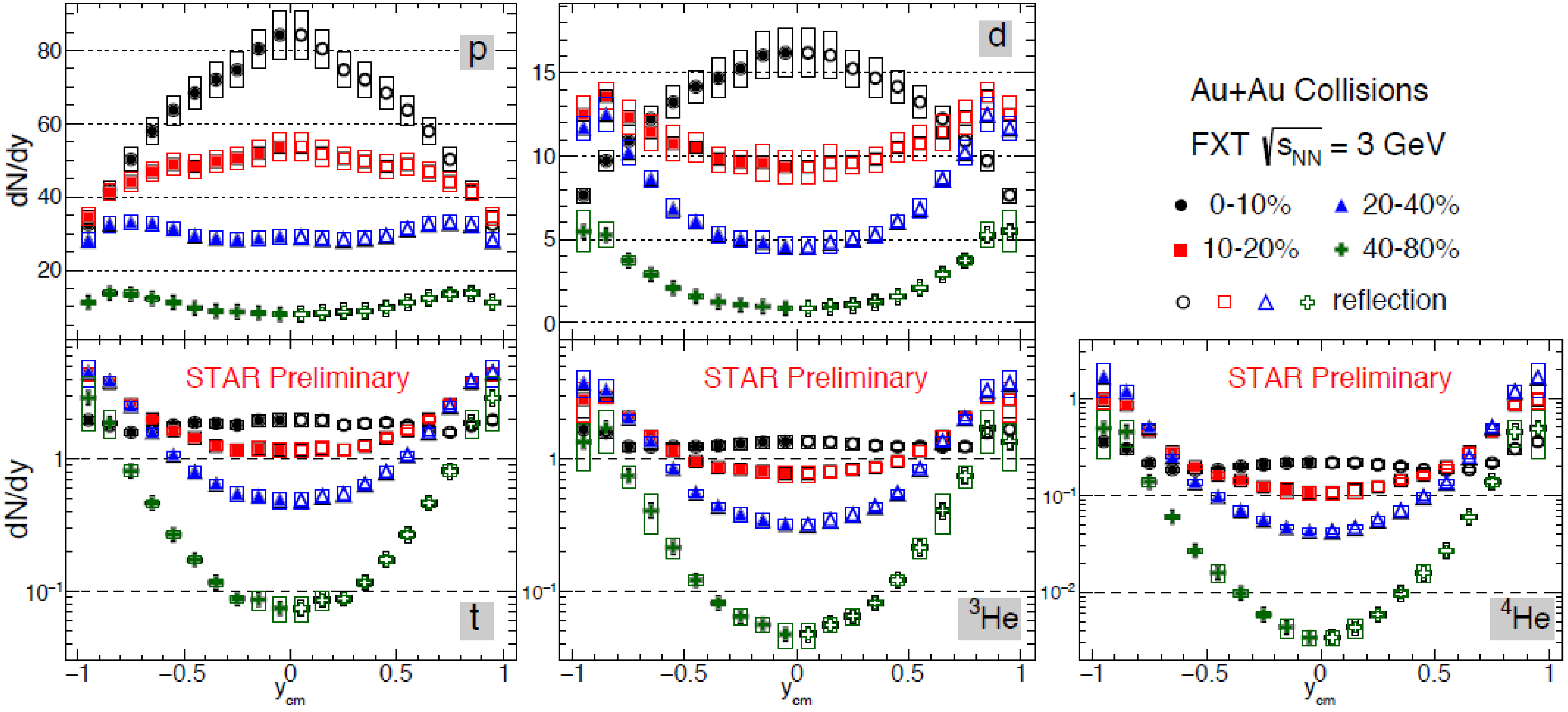
K^0_S and Λambda spectra will be shown at QM2022

The ϕ meson is very near to threshold for the 3 GeV collisions. Ratios of the ϕ to other strange hadrons is very sensitive to the interaction radius in the Canonical Ensemble

ArXiv Nucl-Ex 2108.00924



Production of Light Nuclei in Au+Au Collisions at $\sqrt{s_{NN}}$ = 3 GeV



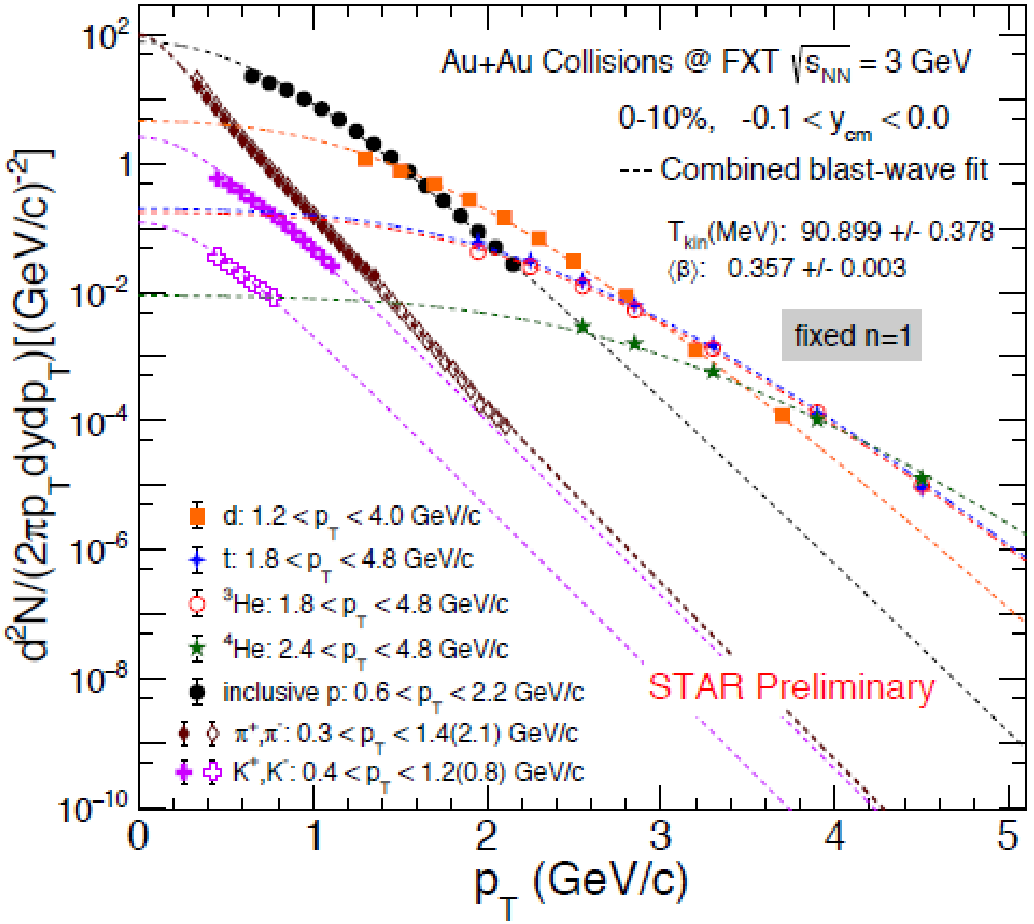
Light nuclei have been measured at many energies ➔ generally consistent with trends

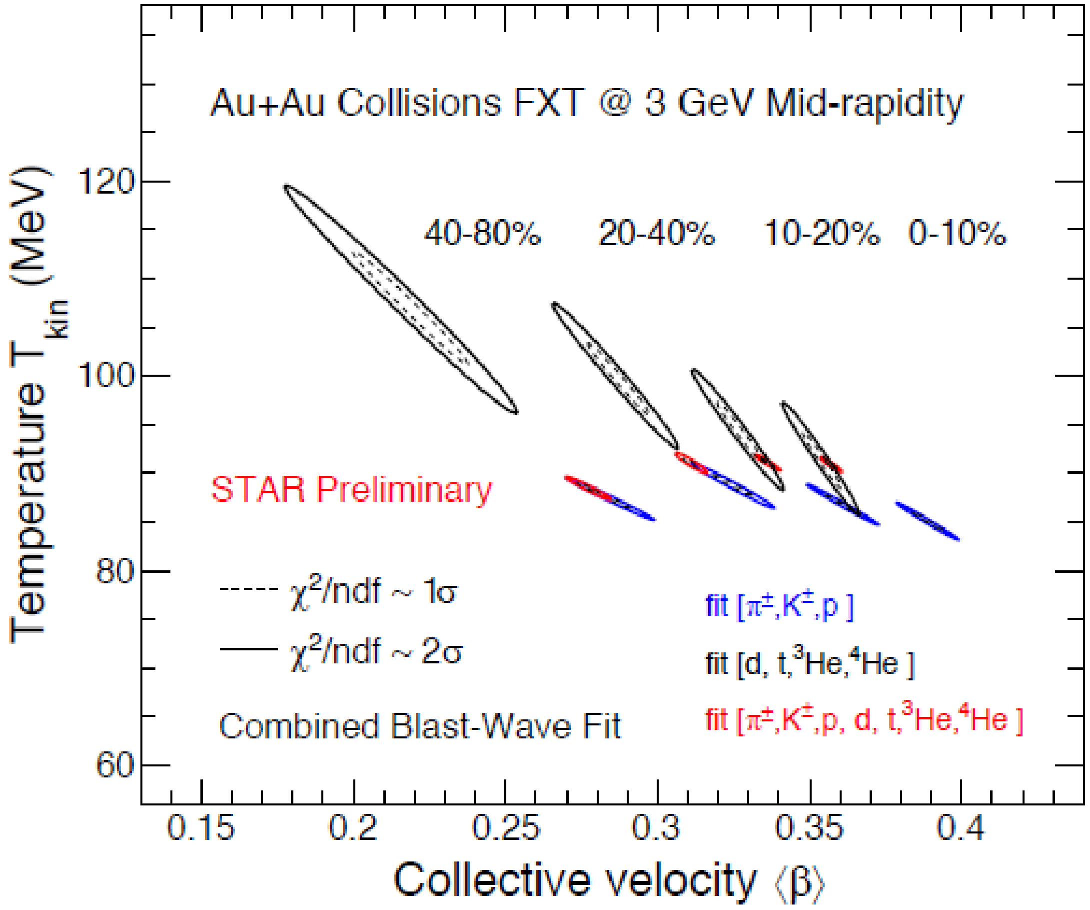
The Key physics topics are the formation of light nuclei

➔ Is the coalescence model correct? We can study this as a function of centrality and rapidity

Production of Light Nuclei in Au+Au Collisions at $\sqrt{s_{NN}}$ = 3 GeV

Studies of the radial flow of light nuclei compared to light hadrons ➔ What is the effect of coalescence



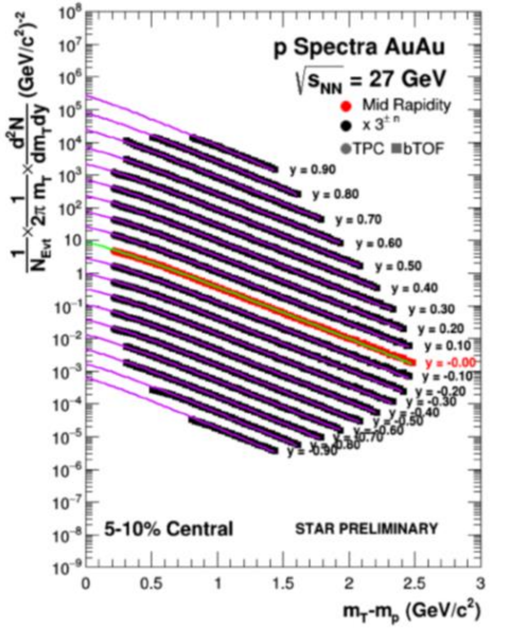


Particle production at 3 GeV: Status and plans

- The spectra and yields will all be preliminary by the QM2022 meeting
- Currently checking for consistency in terms of conservation of Baryon number, Charge, and Strangeness
- Performing global blast wave fits as a function of rapidity and centrality ➔ Need a model the properly describes this energy regime
- Performing thermal model fits as a function of rapidity and centrality
- Performing coalescence model fits to understand the production mechanism for the light nuclei

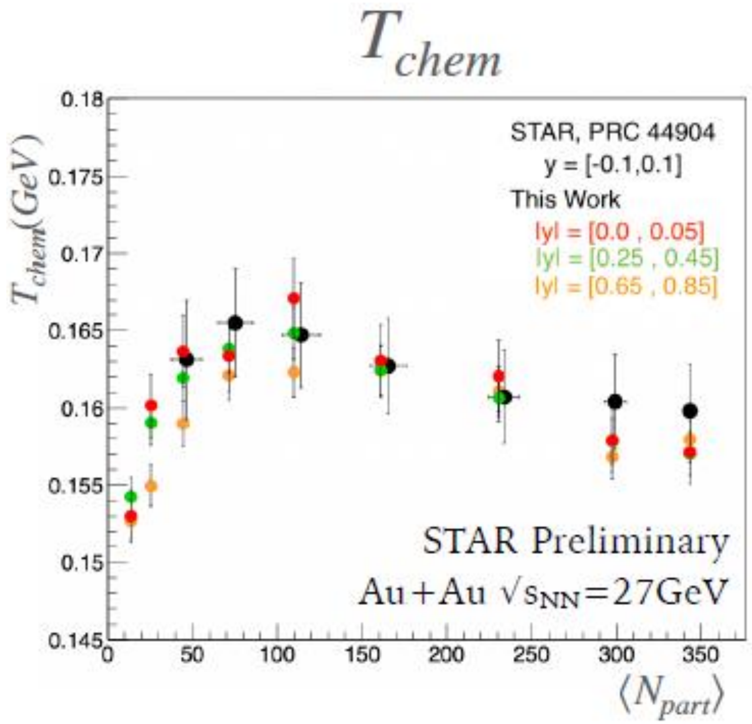
➔ Will carry out similar systematic studies at all energies as the data are available

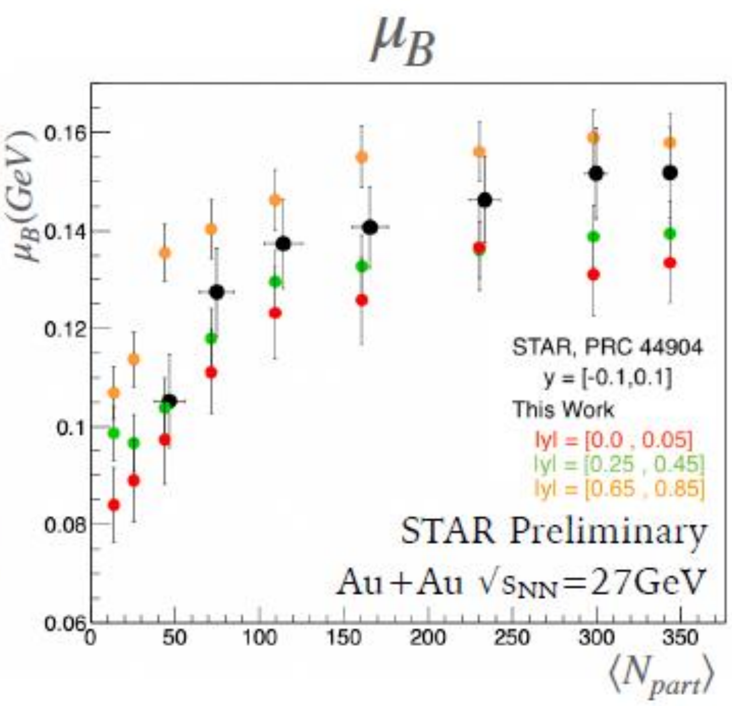
Study of identified hadrons in Au+Au collisions at $\sqrt{s_{NN}}$ = 27 GeV

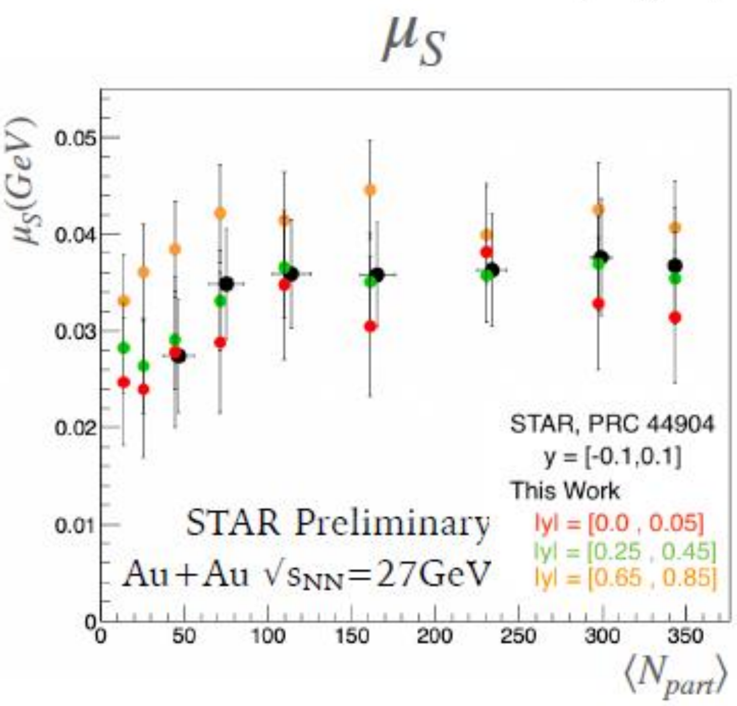


27 GeV Spectra were measured in BES-I, what is new, what do we learn?

➔ Extend the rapidity coverage ➔ **Both μ_B and μ_S are seen to change with rapidity**







Femtoscopy at $\sqrt{s_{NN}}$ = 3.0 GeV

The first STAR HBT results from BES-II/FXT will be shown at QM2022

These first results will show correlation functions of light nuclei

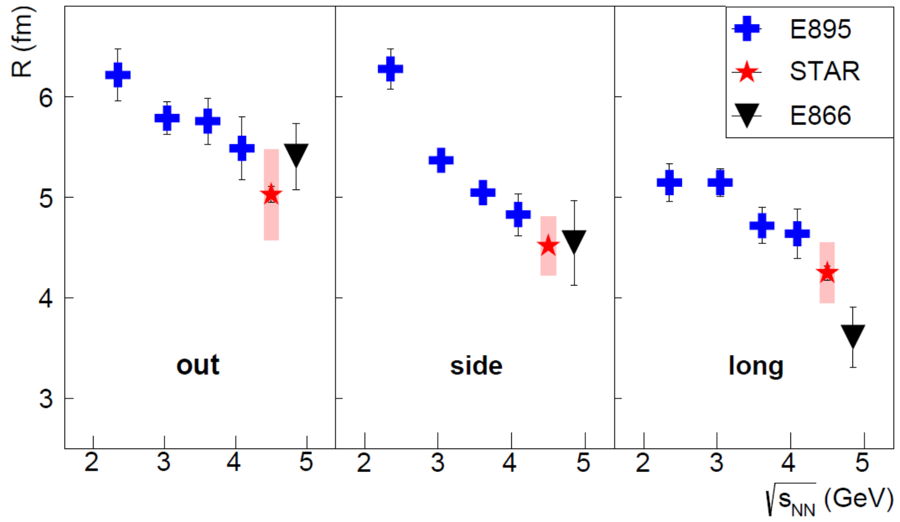
Plans are to study azimuthal HBT and the source tilt angle as a function of energy when the data are available

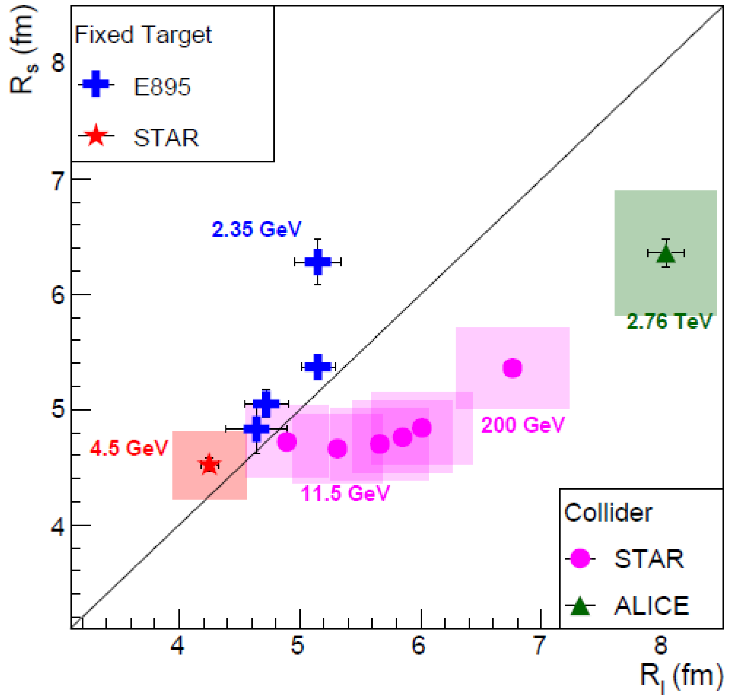
Again, here we show the results from the 4.5 GeV test run

This illustrates the asHBT

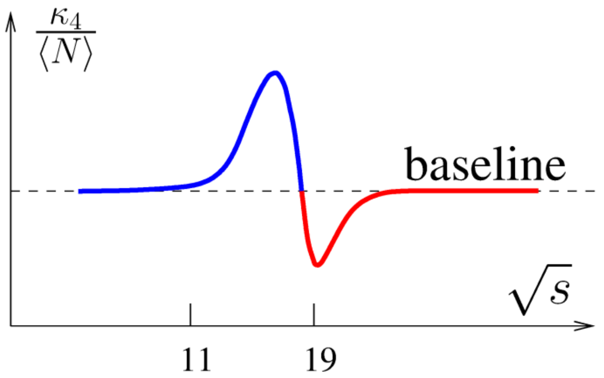
With the higher statistics in the BES-II/FXT data sets, we can also resolve the tilt angle

Phys. Rev. C **103** (2021) 34908





Proton Fluctuations – $\kappa\sigma^2$

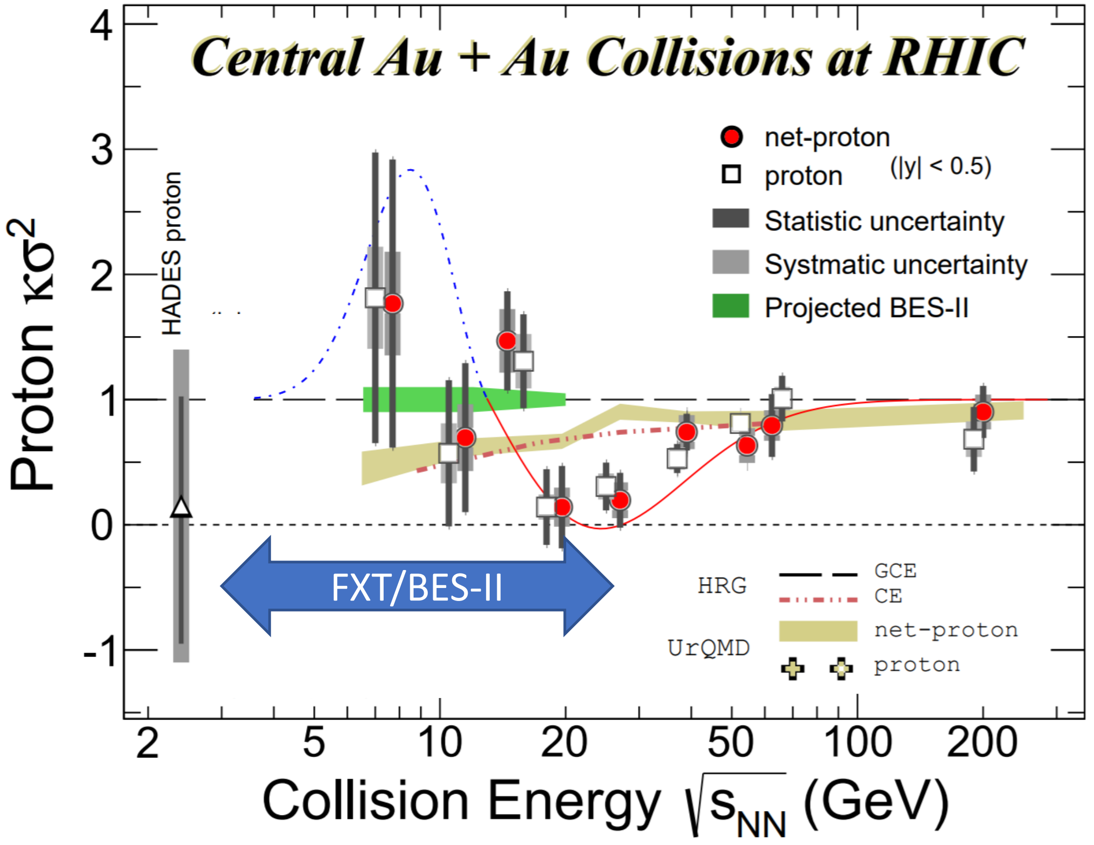


Preliminary HADES result was high

Their new final result is credible

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

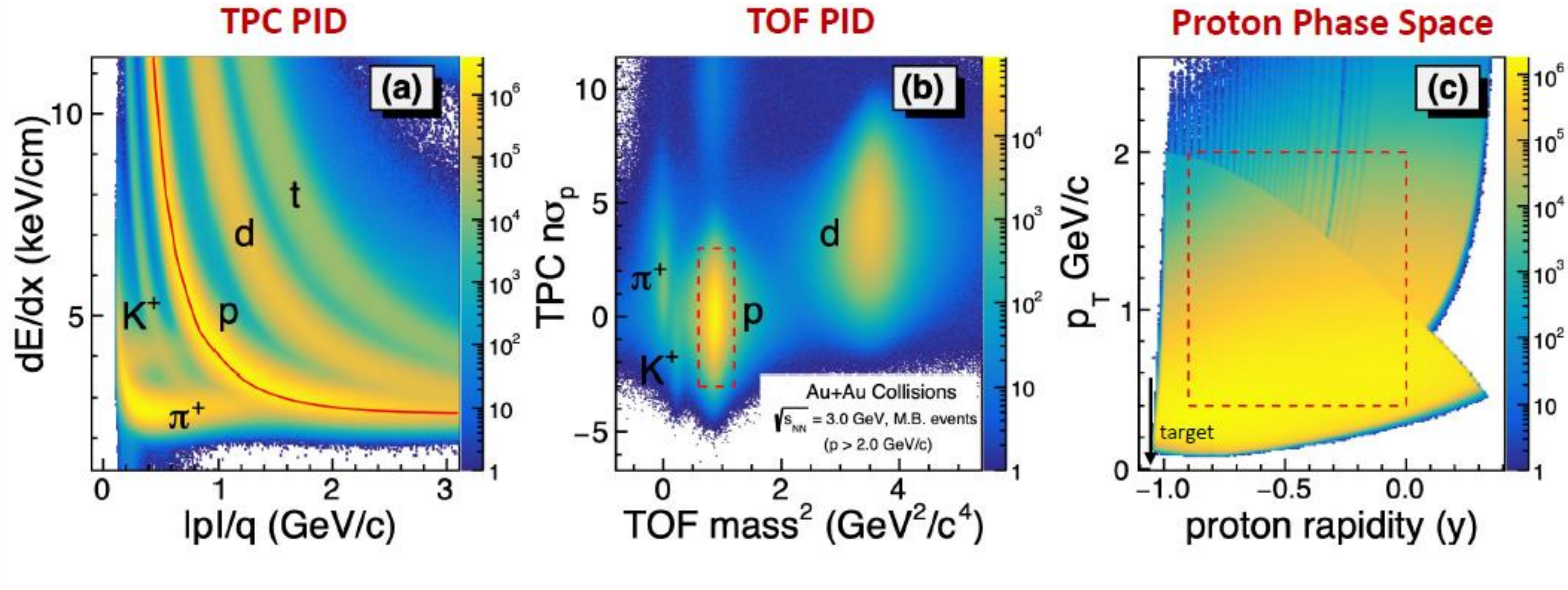
PRL 126, 092301, PRC 104, 024902



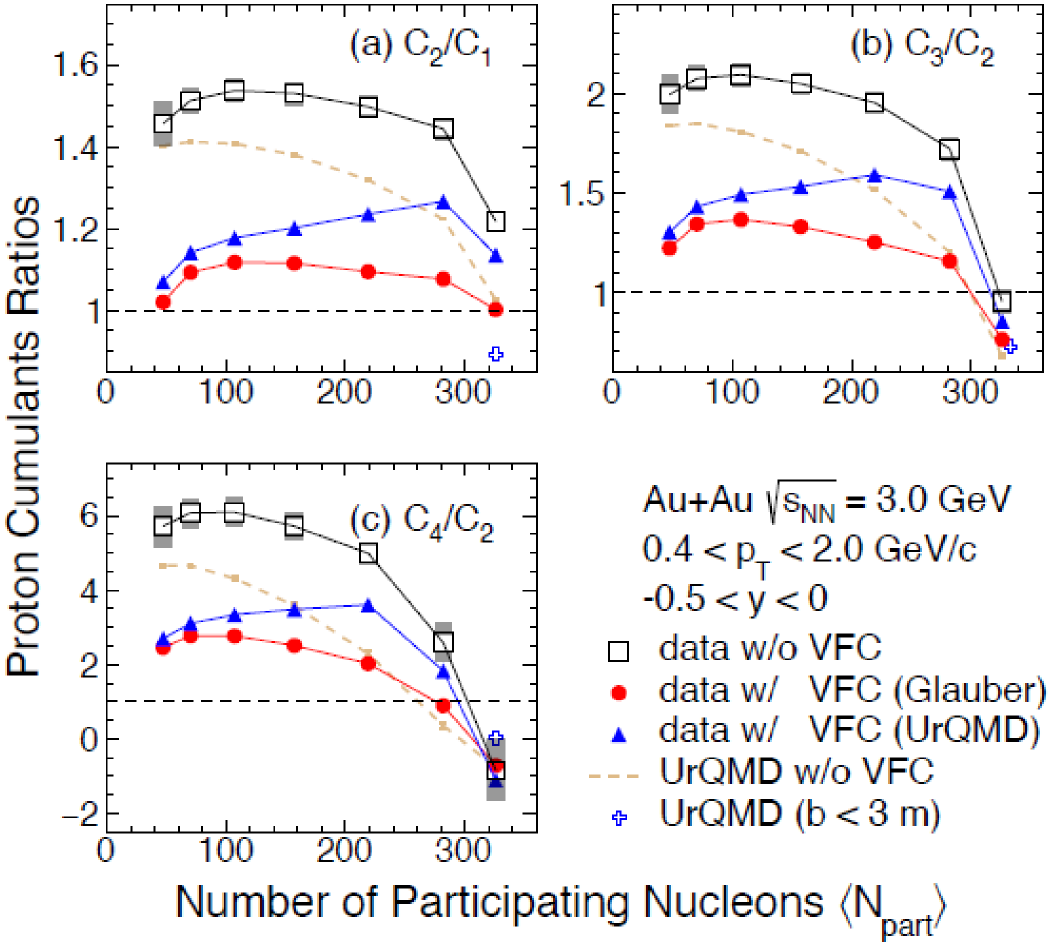
At QM2022:
- Two talks

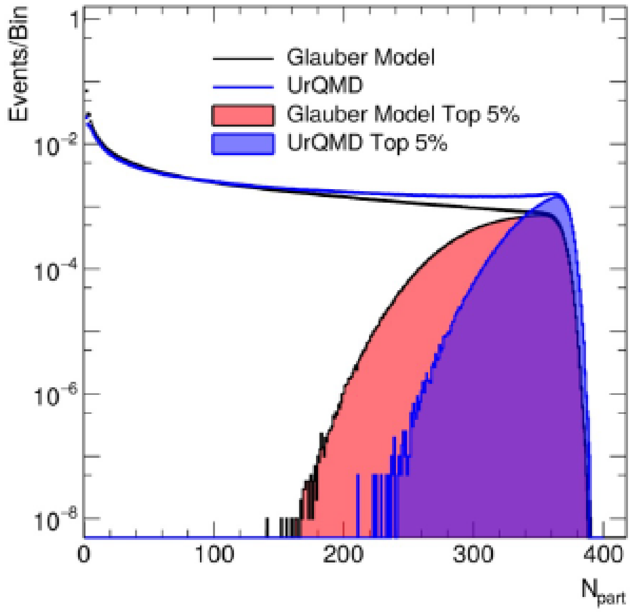
Our ability to study net-proton fluctuations is critically dependent on the particle identification and the acceptance

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



STAR ArXiv 2112.00240

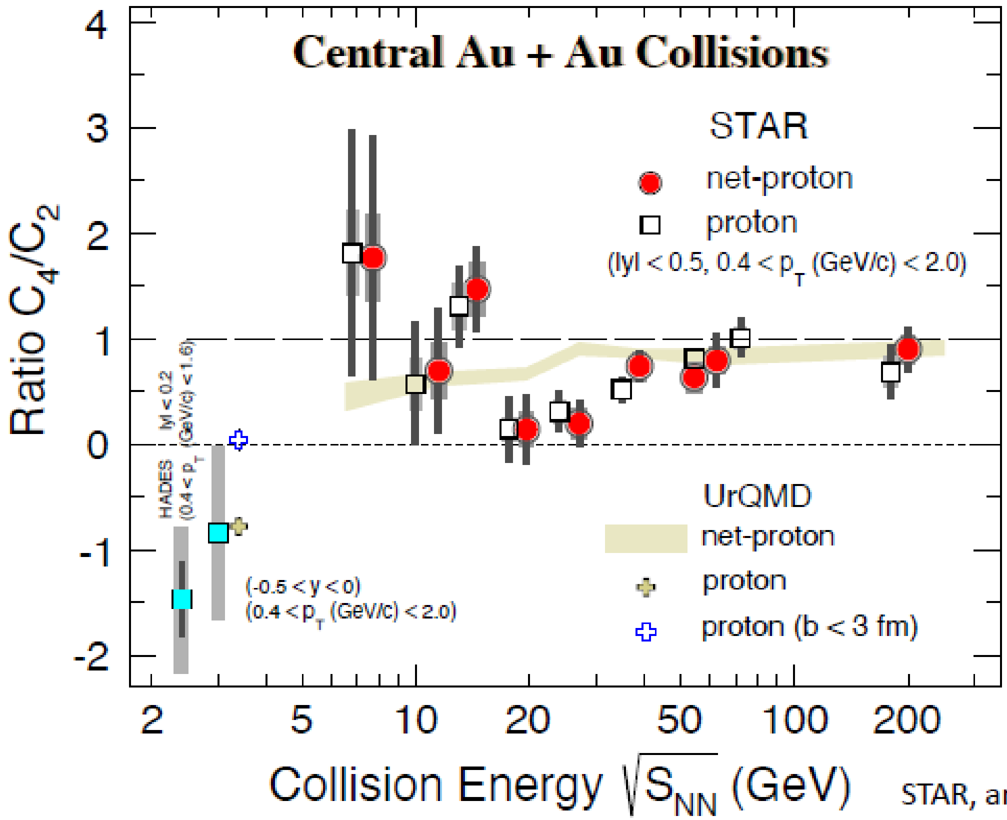




Braun-Munzinger, P. et al
Nuclear Physics A 960, 114 (2017)

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

PRL 126, 092301, PRC 104, 024902



STAR, arXiv:2112.00240

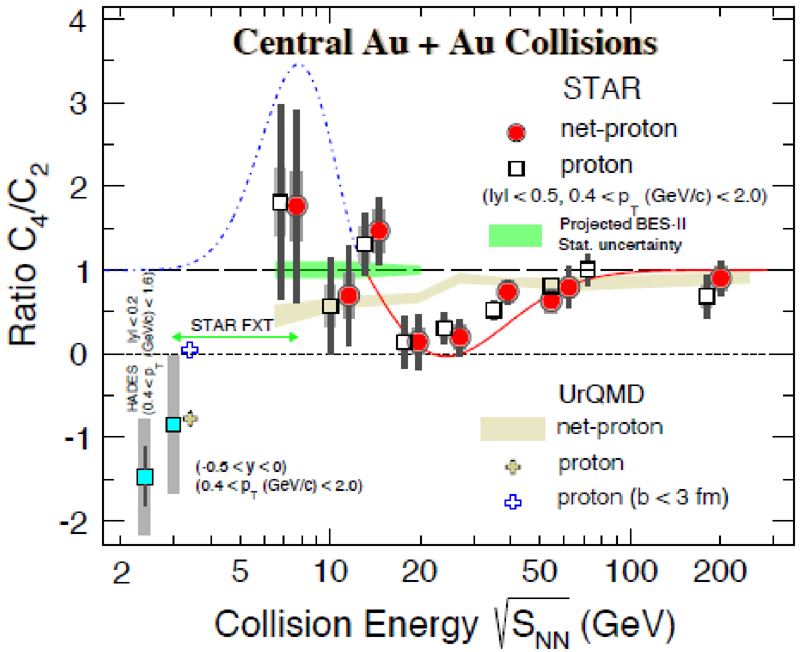
Plans:

- Pre-preliminary results are already available at 3.2, 14.6, 19.6, and 27 GeV
- Study will be done at all energies
- A high (2B) statistics data was taken at 3 GeV – those data will be available this fall. The will allow studies of C_6 and C_8
- Studies will also be extended to net-K and net -Λ

- 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

Statistics of Au+Au Collisions in BES	
$\sqrt{s_{NN}}$ (GeV)	BES–II / BES-I (million)
19.6	400 / 36
17.3	250
14.5	300 / 20
11.5	230 / 12
9.1	160
7.7	100 / 4
3.2 (FXT)	200
3 (FXT)	2000

STAR also collected FXT data at $\sqrt{s_{NN}}$ = 3.5, 3.9, 4.5, 5.2, 6.2, and 7.7 GeV.



STAR, arXiv:2112.00240
PRL 126,092301; PRC 104, 024902

- BES-II collected 10 times larger statistics than BES-I in $\sqrt{s_{NN}}$ = 3 - 19.6 GeV Au+Au collisions
- Measurements on those datasets will be crucial to search for the QCD critical point at high baryon density region

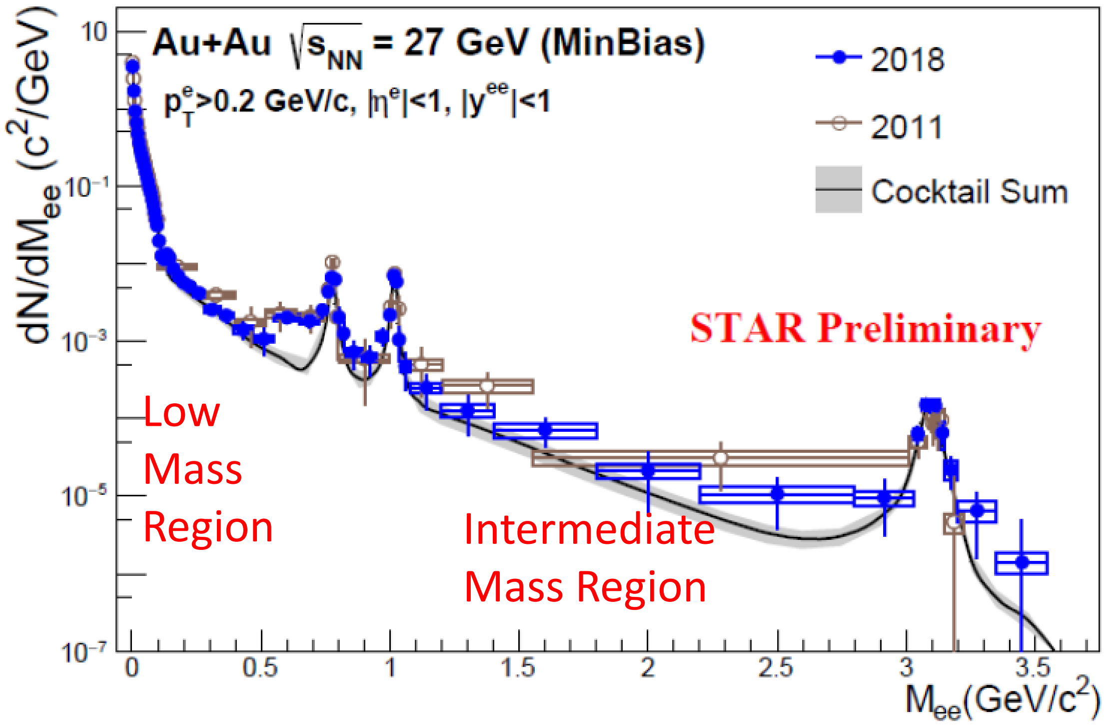
Will Remove Before Presentation

Slide left so as not to create an offset

Dileptons at $\sqrt{s_{NN}}$ = 27 GeV

Recent progress has comparing the yields above cocktail to models to extract properties of the collisions

➔ Temperature in the LMR is representative of late stage of the collision
➔ Temperature in the IMR is representative of an early phase of the collision



Dilepton results will be studied at all collider energies

Dilepton results from the FXT energies will be more challenging, however there analyses being pursued

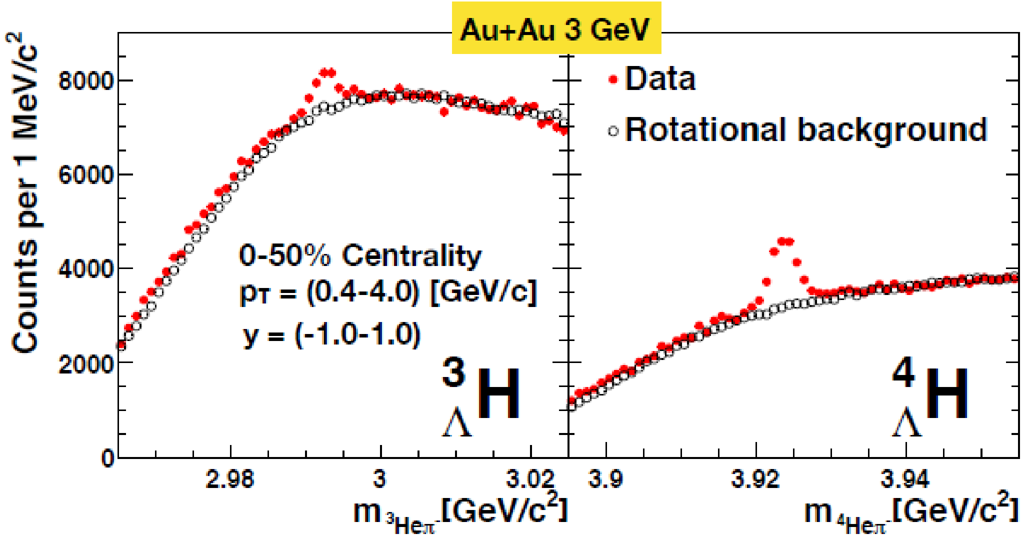
At QM2022:
- One talk

See talk by YH Leung

Hyper-nuclei $\sqrt{s_{NN}}$ = 3.0 and 27 GeV

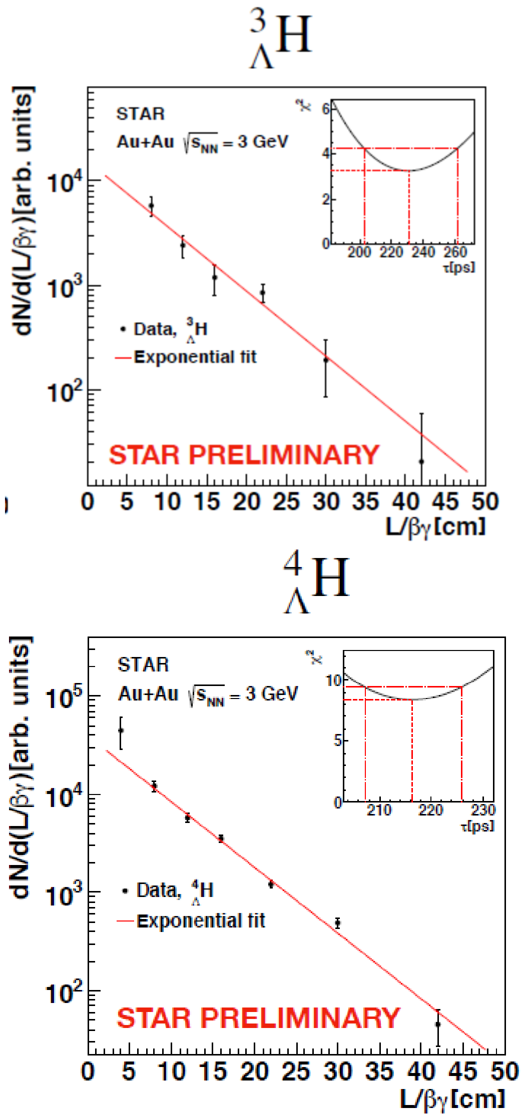
Does being bound within a nucleus stabilize or de-stabilize a hyperon?

➔ A hyperon is a baryon which includes a strange quark



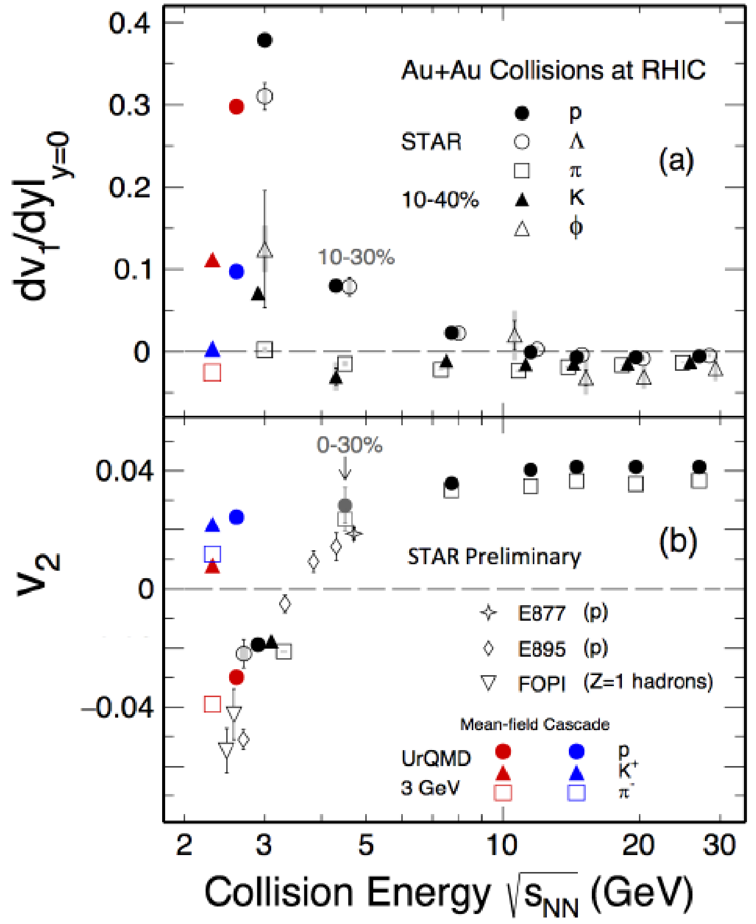
At QM2022:

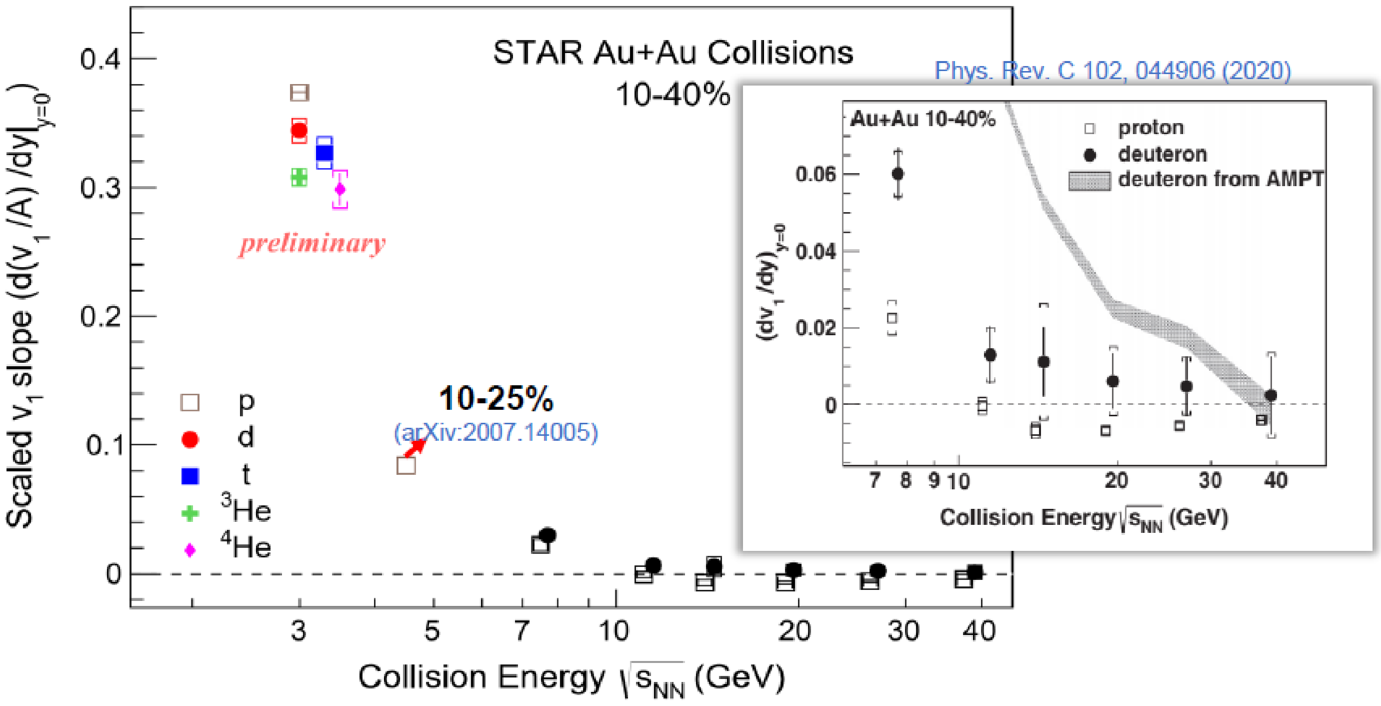
- One talks
- Three Posters



See talk by G. Wang

Flow results at $\sqrt{s_{NN}}$ = 3.0 GeV





At QM2022:

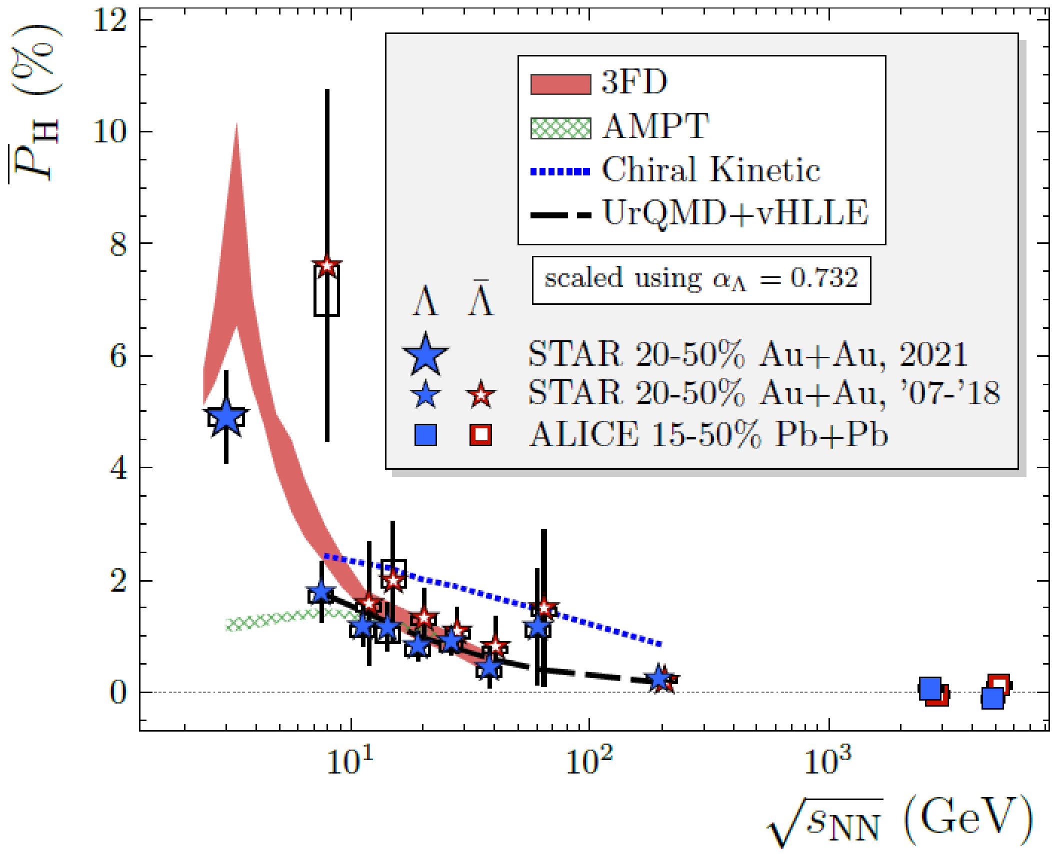
- One talks
- Three Posters

Global Polarization at $\sqrt{s_{NN}}$ = 3 and 27 GeV

See talk by X.Sun

Here I just show a plot of the first published results

Phys. Rev. C **104** (2021) 61901



BES-II/FXT Physics Program 2018-2021

Physics Goals

The Onset of Deconfinement:
- High p_T suppression (R_{CP}) ✓
- NCQ scaling of elliptic flow (ϕ and K mesons)
- LPV through three particle correlators (CME)
- Strangeness enhancement ✓
- Polarizations and alignments ✓

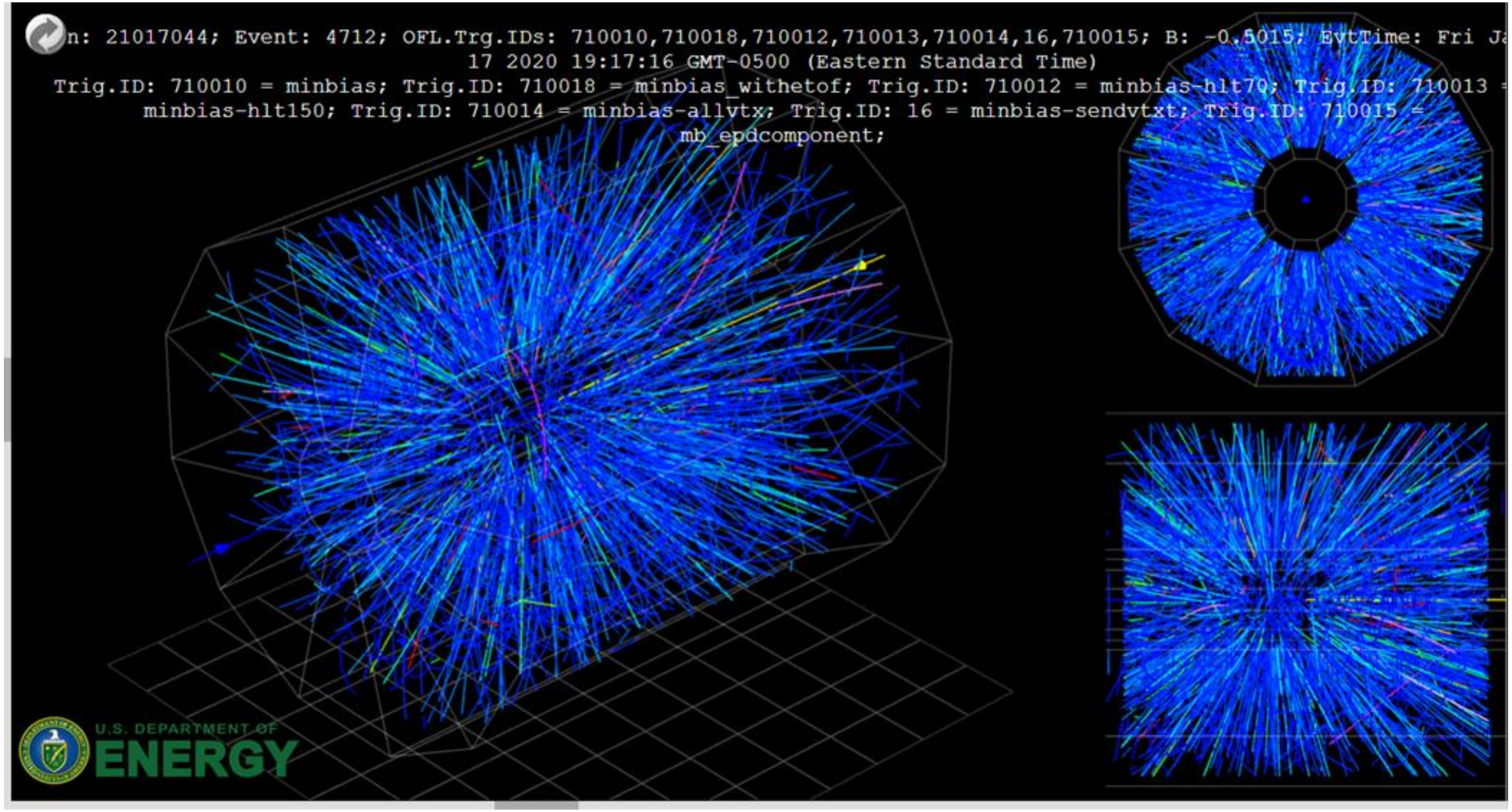
Compressibility → First Order Phase Transition
- Directed flow ✓
- Tilt angle of the HBT source (asHBT)
- The volume of the HBT source
- The zero crossing of the elliptic flow (~6 AGeV) In Progress
- Volume measures from Coulomb potential ✓

Criticality:
- Higher moments ✓
- Particle ratio fluctuations In Progress

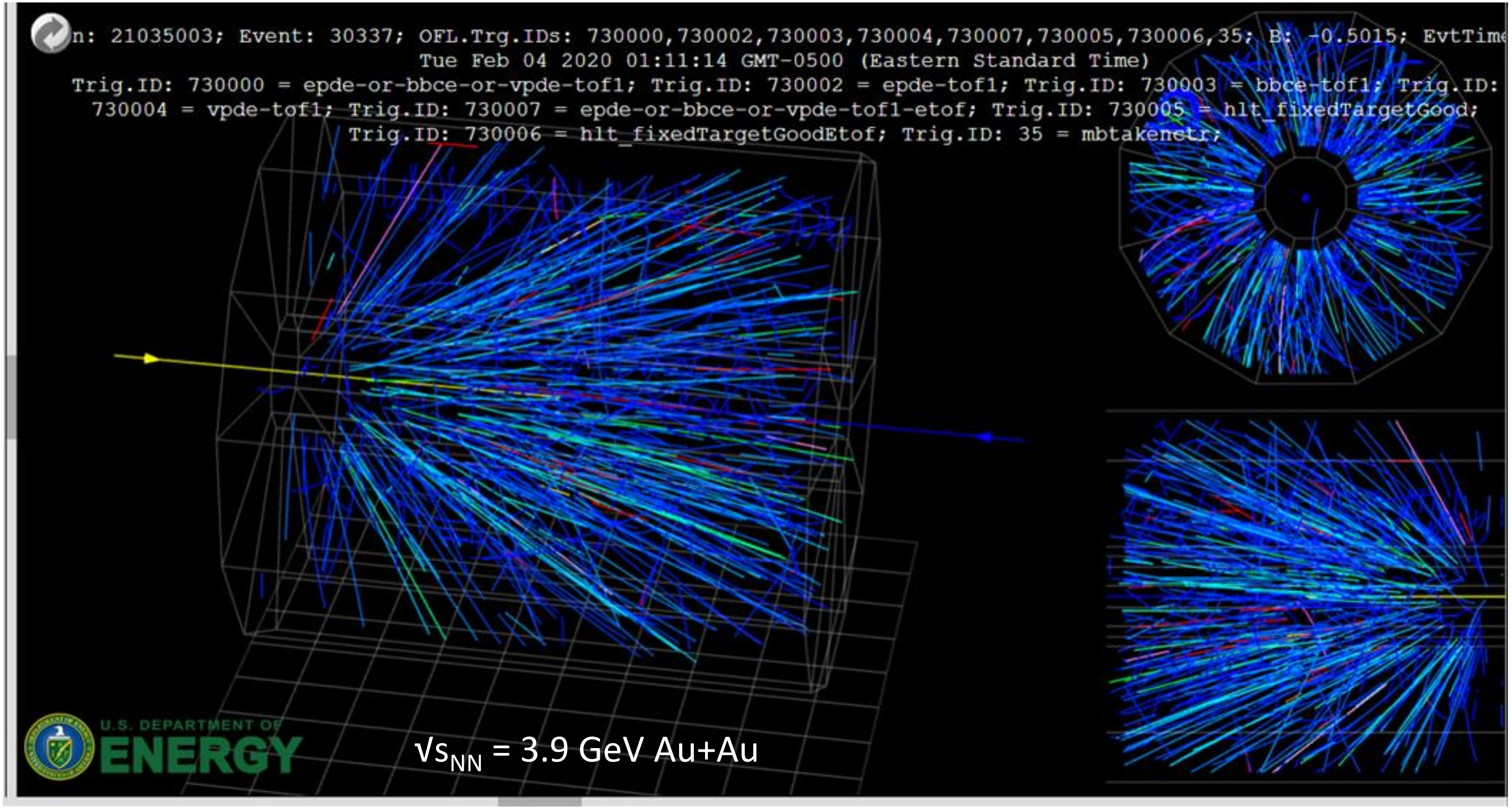
Chirality:
- Dilepton studies ✓

Hypernuclei:
- Lifetime of the hypertriton ✓

Online Event Display – Collider Event



Online Event Display – FXT Event

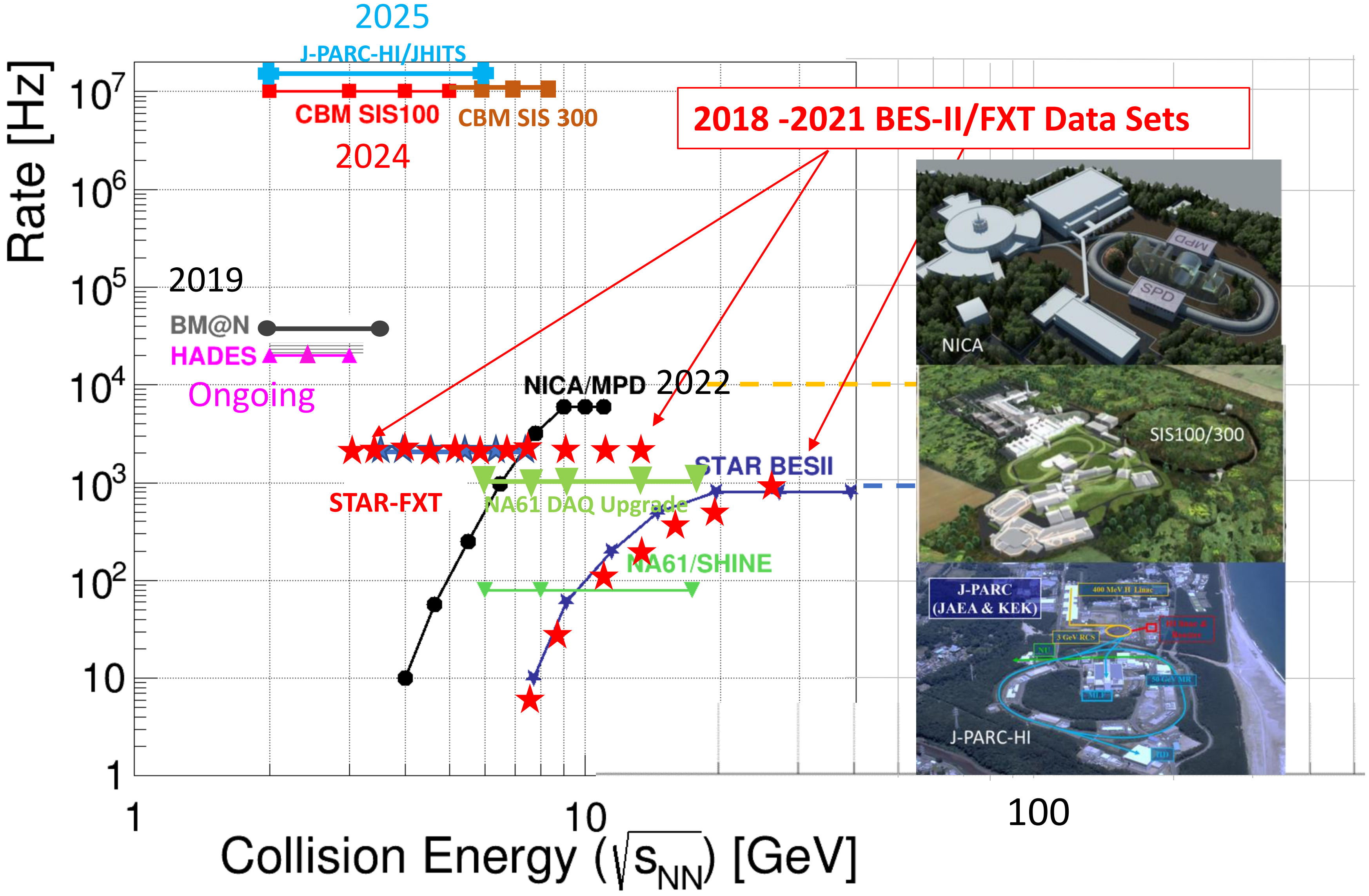


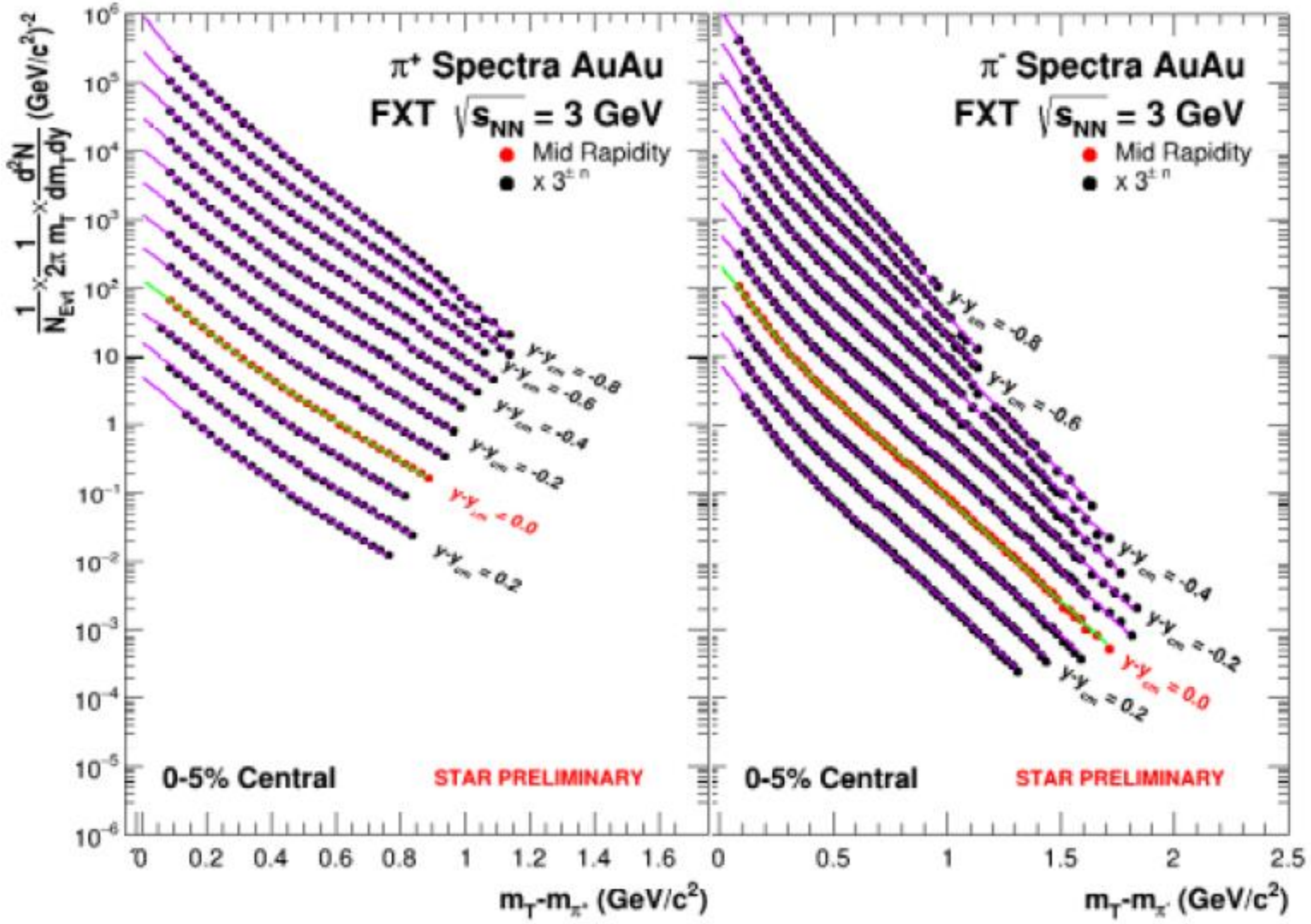
Summary

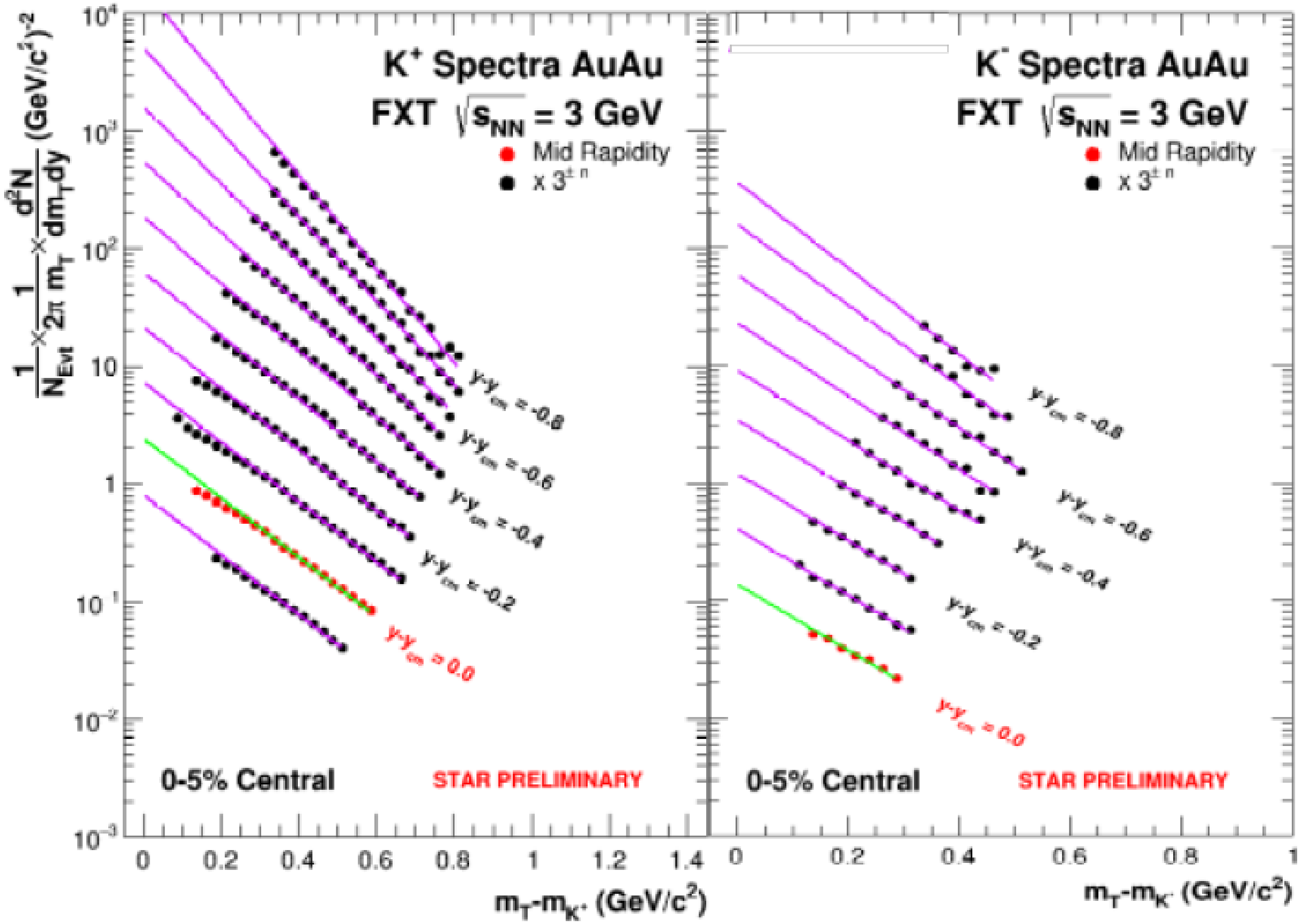
- Data taking for the STAR BES-II/FXT program was completed 2018 to 2021
- Au+Au collisions at seven collider and twelve FXT energies (with four FXT energies overlapping with the four lowest collider energies)
- Calibrations, data production and QA take time to get right and to date, only results from 3.0 and 27 GeV have been presented. New results from 19.6 will be first shown at QM2022
- All data sets should be available by the end of the year
- Most analyses identified in the proposal are underway and teams are in place to complete the analysis of the additional energies when they become available

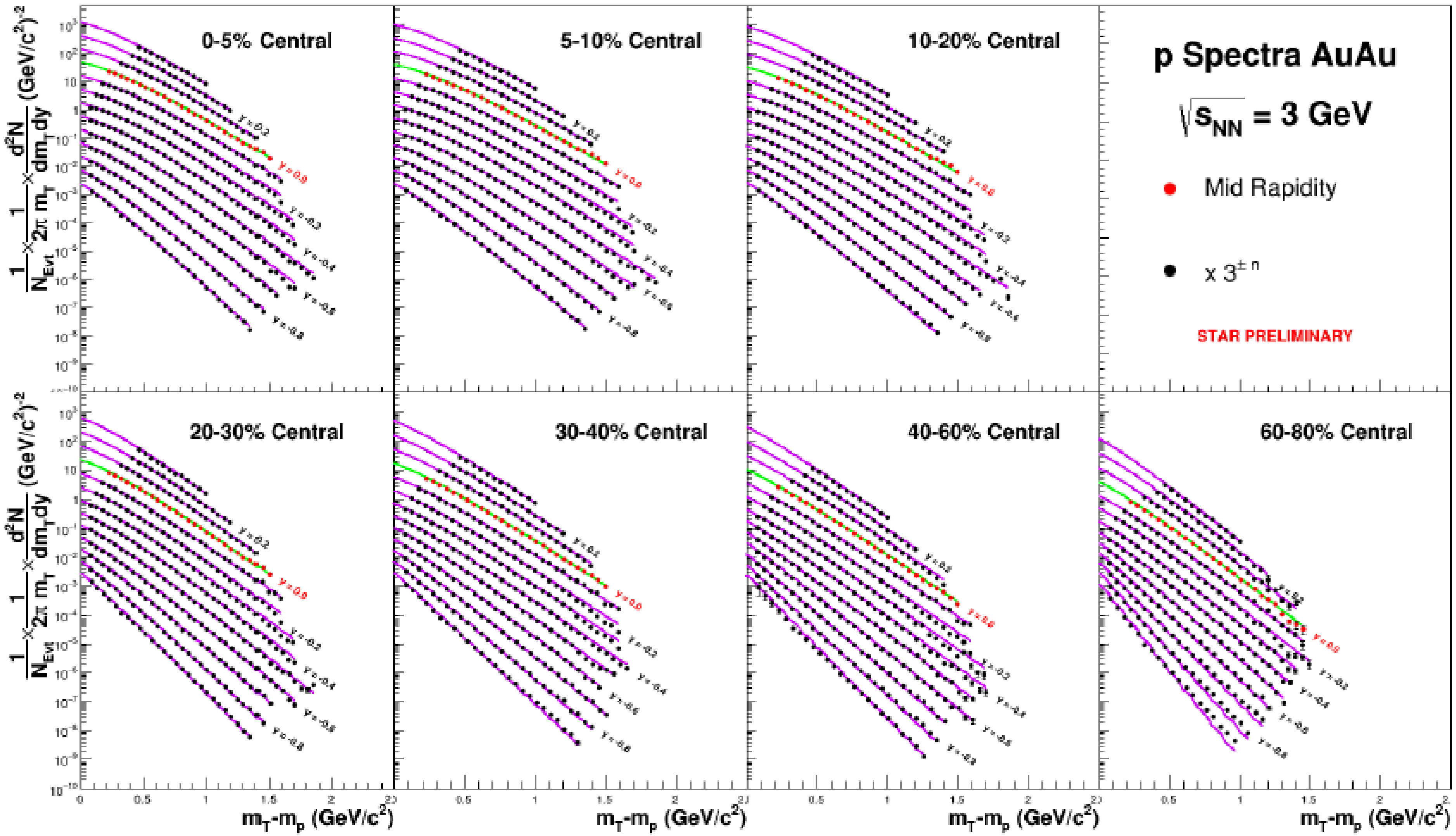
BACKUPS

We Have Competition for this Physics




π+ Spectra AuAu
FXT √sNN = 3 GeV
Mid Rapidity
x 3±n
y-ycm = -0.8
y-ycm = -0.6
y-ycm = -0.4
y-ycm = -0.2
y-ycm = 0.0
y-ycm = 0.2
0-5% Central
STAR PRELIMINARY
π- Spectra AuAu
FXT √sNN = 3 GeV
Mid Rapidity
x 3±n
0-5% Central
STAR PRELIMINARY
mT-mπ (GeV/c2)

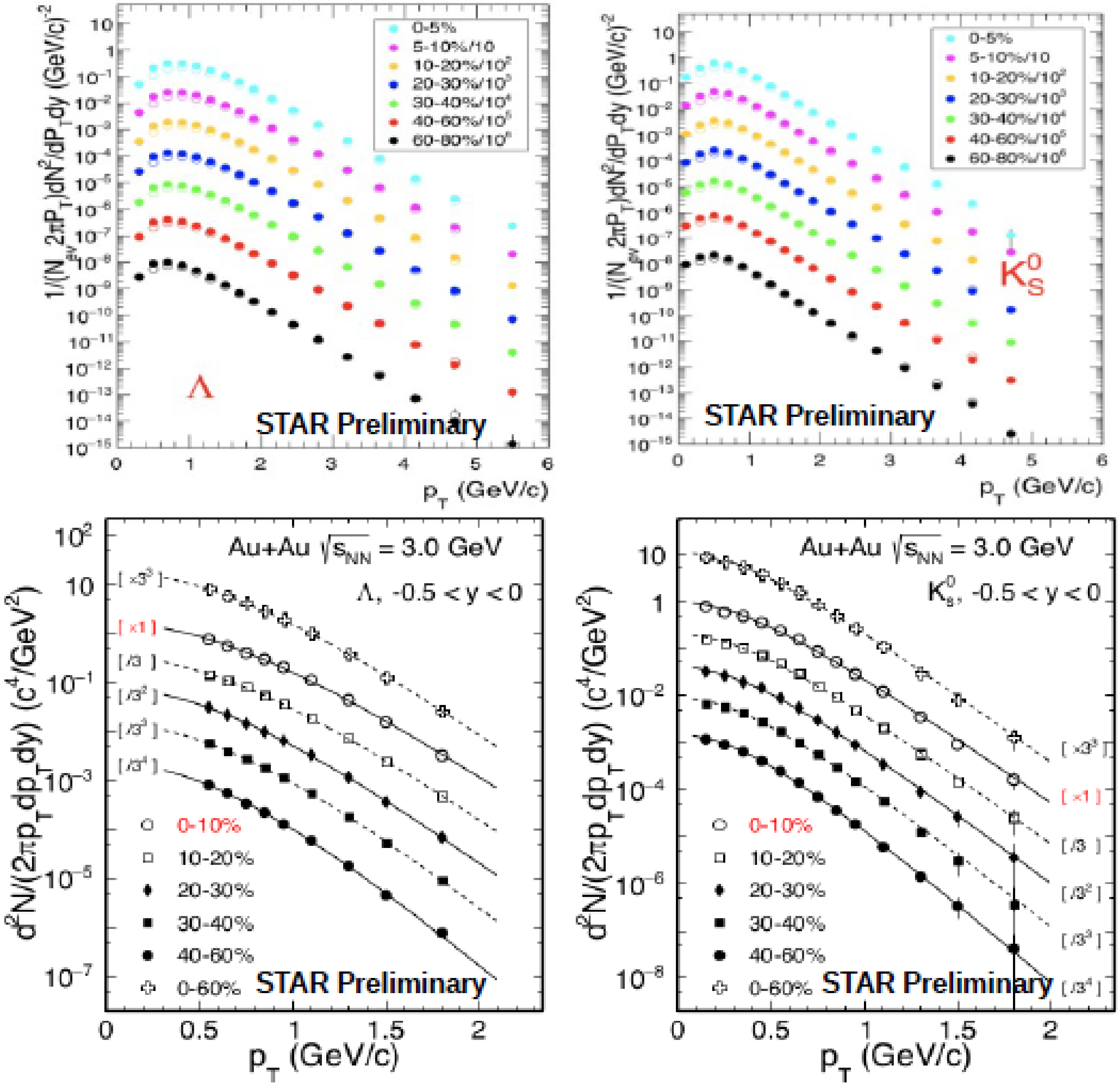

K^+ Spectra AuAu
FXT $\sqrt{s_{NN}}$ = 3 GeV
Mid Rapidity
x $3^{\pm n}$
y-y$_{cm}$ = -0.8
y-y$_{cm}$ = -0.6
y-y$_{cm}$ = -0.4
y-y$_{cm}$ = -0.2
y-y$_{cm}$ = 0.0
0-5% Central
STAR PRELIMINARY
m_T-m_{K^+} (GeV/c^2)
$\frac{1}{N_{Evt}} \times \frac{1}{2\pi m_T} \times \frac{d^2N}{dm_T dy}$ (GeV/c^2)$^{-2}$
K^- Spectra AuAu
FXT $\sqrt{s_{NN}}$ = 3 GeV
Mid Rapidity
x $3^{\pm n}$
y-y$_{cm}$ = -0.8
y-y$_{cm}$ = -0.6
y-y$_{cm}$ = -0.4
y-y$_{cm}$ = -0.2
y-y$_{cm}$ = 0.0
0-5% Central
STAR PRELIMINARY
m_T-m_{K^-} (GeV/c^2)



p Spectra AuAu
$\sqrt{s_{NN}}$ = 3 GeV
Mid Rapidity
x $3^{\pm n}$
STAR PRELIMINARY
0-5% Central
5-10% Central
10-20% Central
20-30% Central
30-40% Central
40-60% Central
60-80% Central
$\frac{1}{N_{Evt}} \times \frac{1}{2\pi\, m_T} \times \frac{d^2N}{dm_T dy}$ $(GeV/c^2)^{-2}$
m_T-m_p (GeV/c^2)

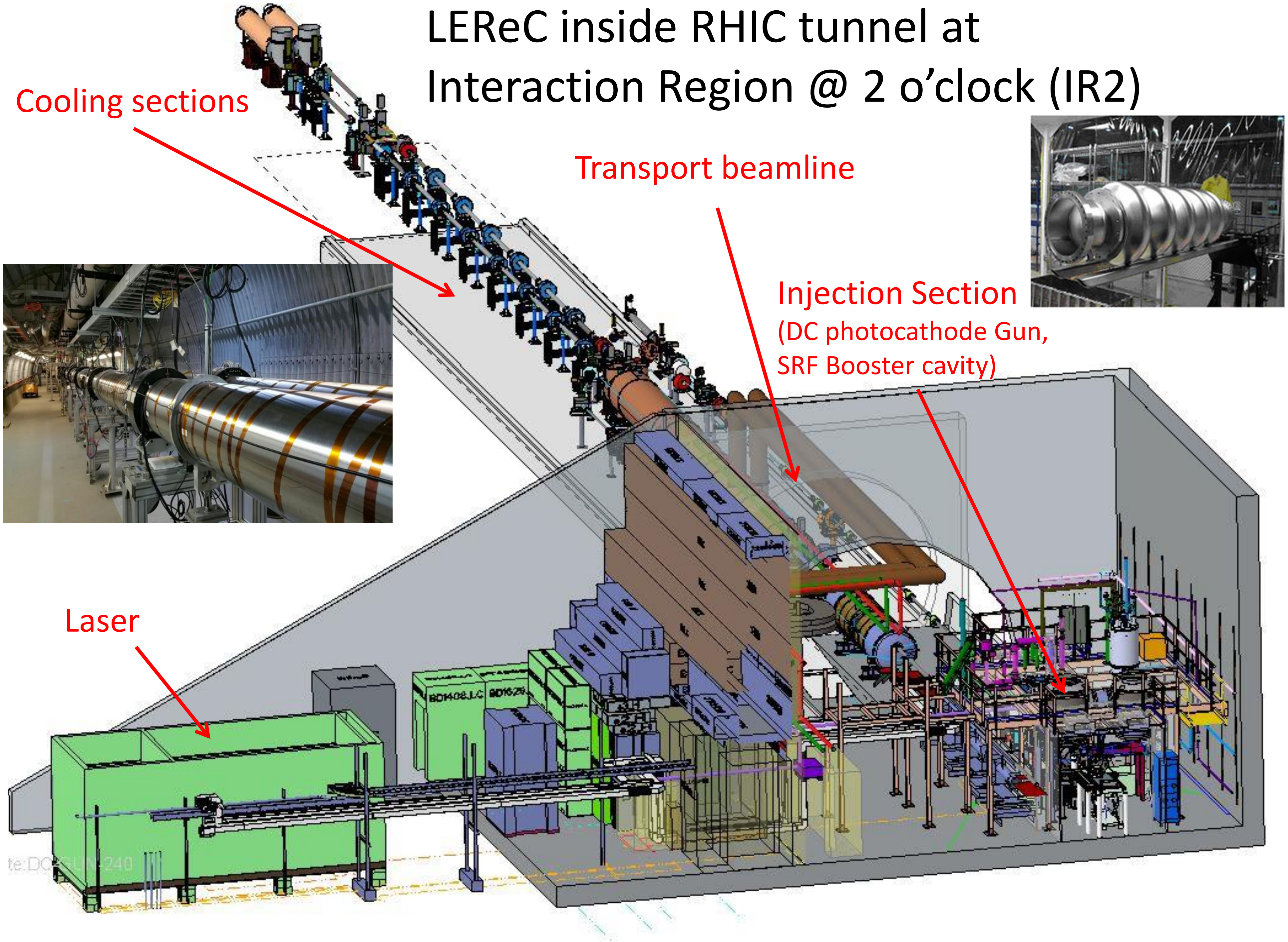
19.6 GeV

3.0 GeV

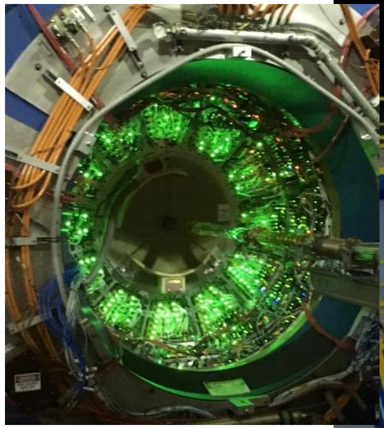


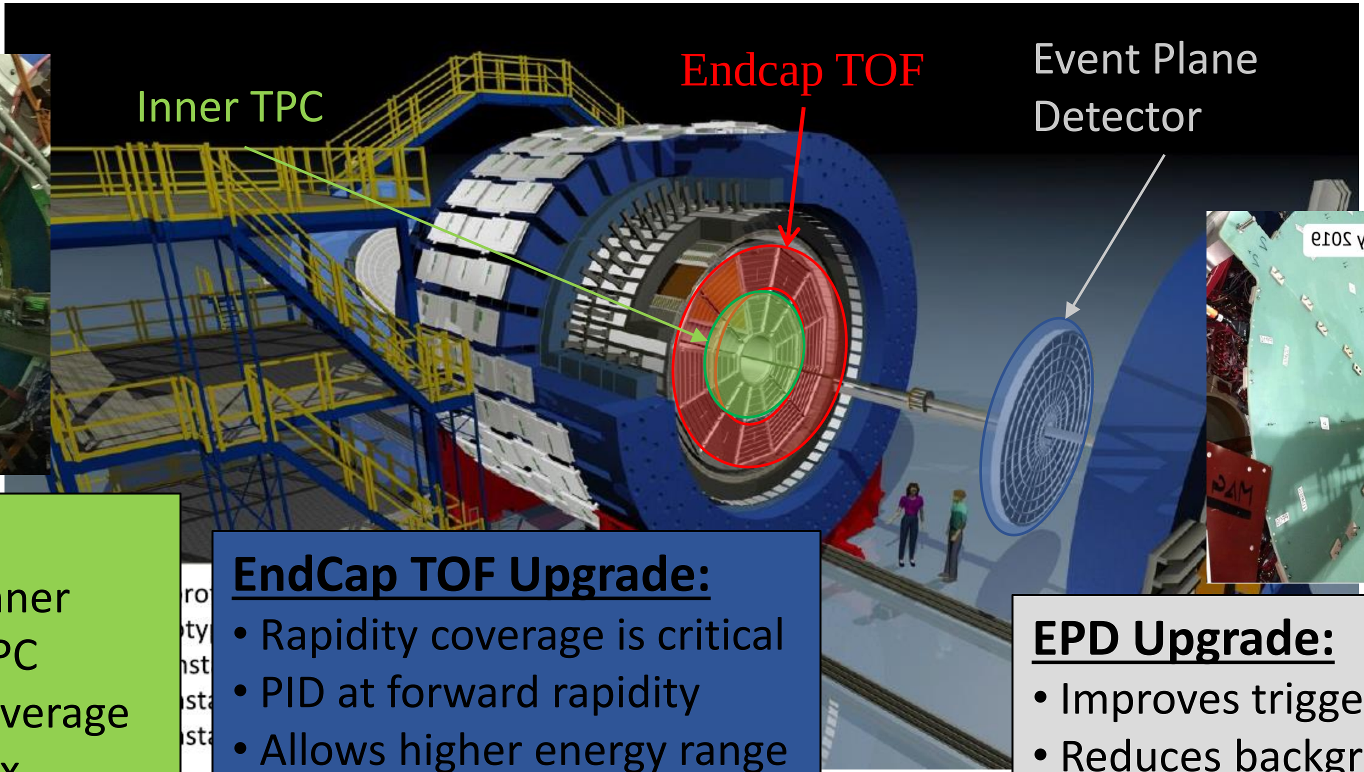
Beam E_T (GeV)	Beam E_k (AGeV)	Beam p_Z (GeV/c)	Rapidity y_{Beam}	$\sqrt{s_{NN}}$ (GeV)	Rapidity y_{CM}	Ch. Pot. μ_B (GeV)
3.85	2.92	3.73	2.10	3.0	1.05	721
4.59	3.66	4.50	2.28	3.2	1.13	699
5.75	4.82	5.67	2.51	3.5	1.25	666
7.3	6.4	7.25	2.75	3.9	1.37	633
9.8	8.9	9.44	3.04	4.5	1.52	589
13.5	12.6	13.5	3.37	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

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



The STAR Detector Upgrades → BES-II



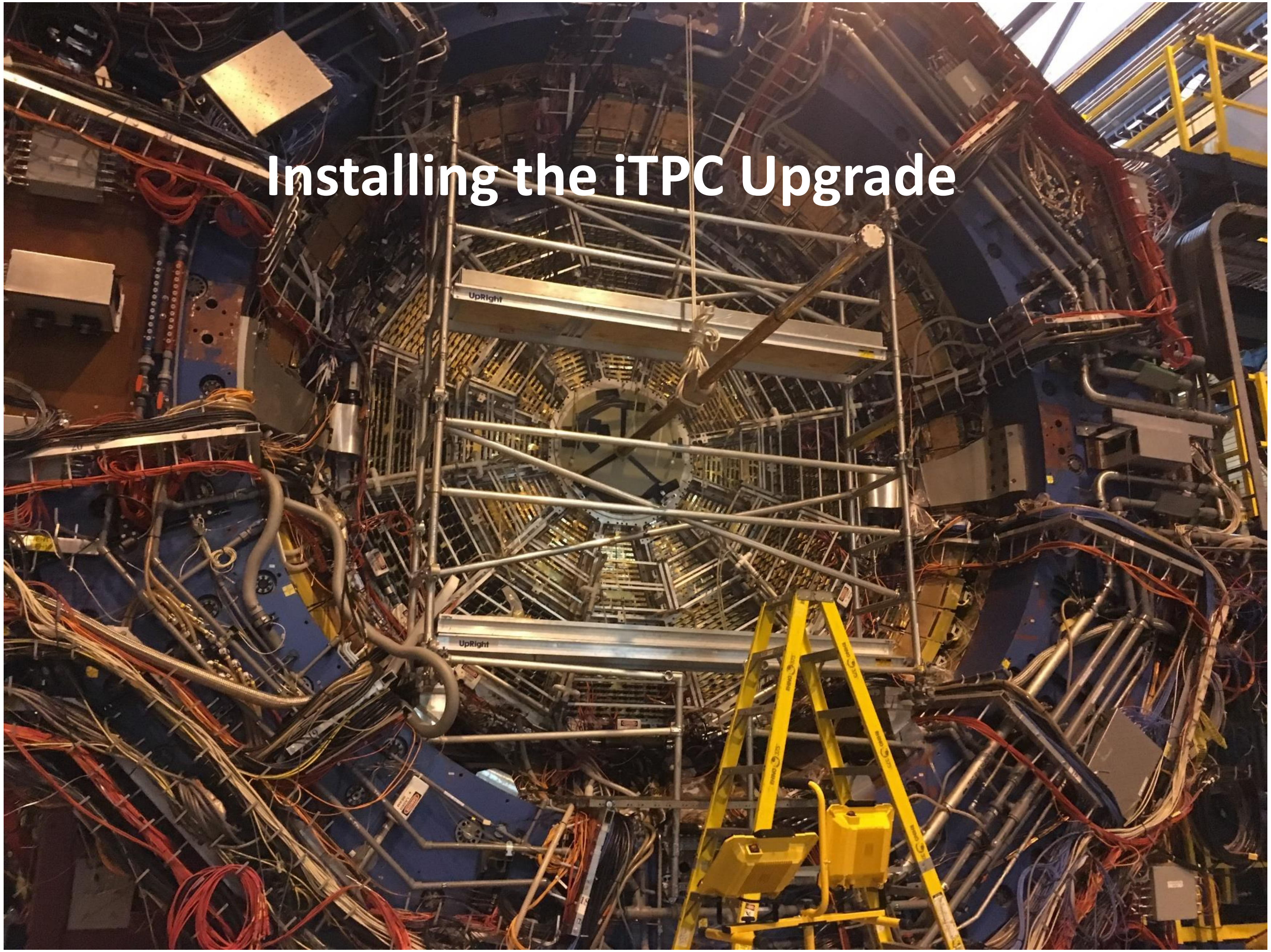


iTPC Upgrade:
- Rebuilds the inner sectors of the TPC
- Continuous Coverage
- Improves dE/dx
- Extends η coverage to 1.5 (2.2 for FXT)
- Lowers p_T cut-in from 125 MeV/c to 60 MeV/c
- Ready in 2019

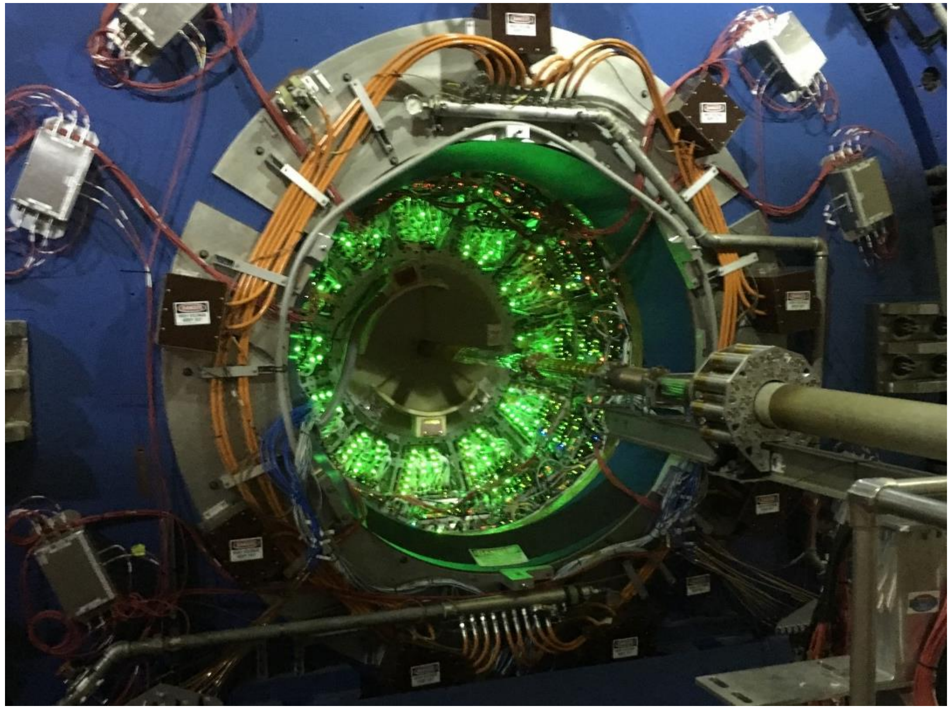
EndCap TOF Upgrade:
- Rapidity coverage is critical
- PID at forward rapidity
- Allows higher energy range of FXT program
- CBM/FAIR
- Ready 2019

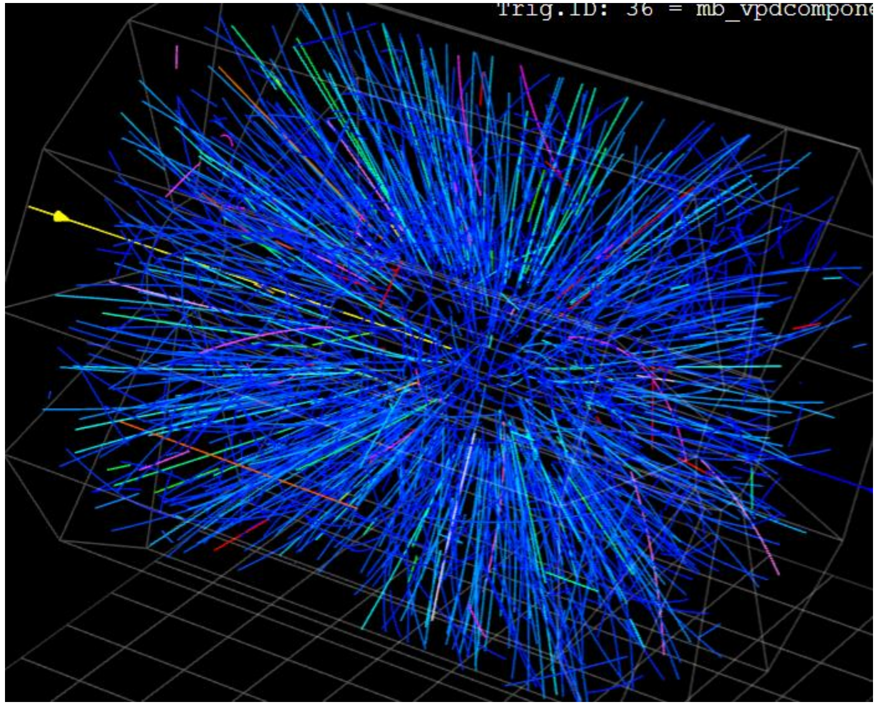
EPD Upgrade:
- Improves trigger
- Reduces background
- Allows a better and independent reaction plane measurement critical to BES and FXT
- Ready 2018

Installing the iTPC Upgrade



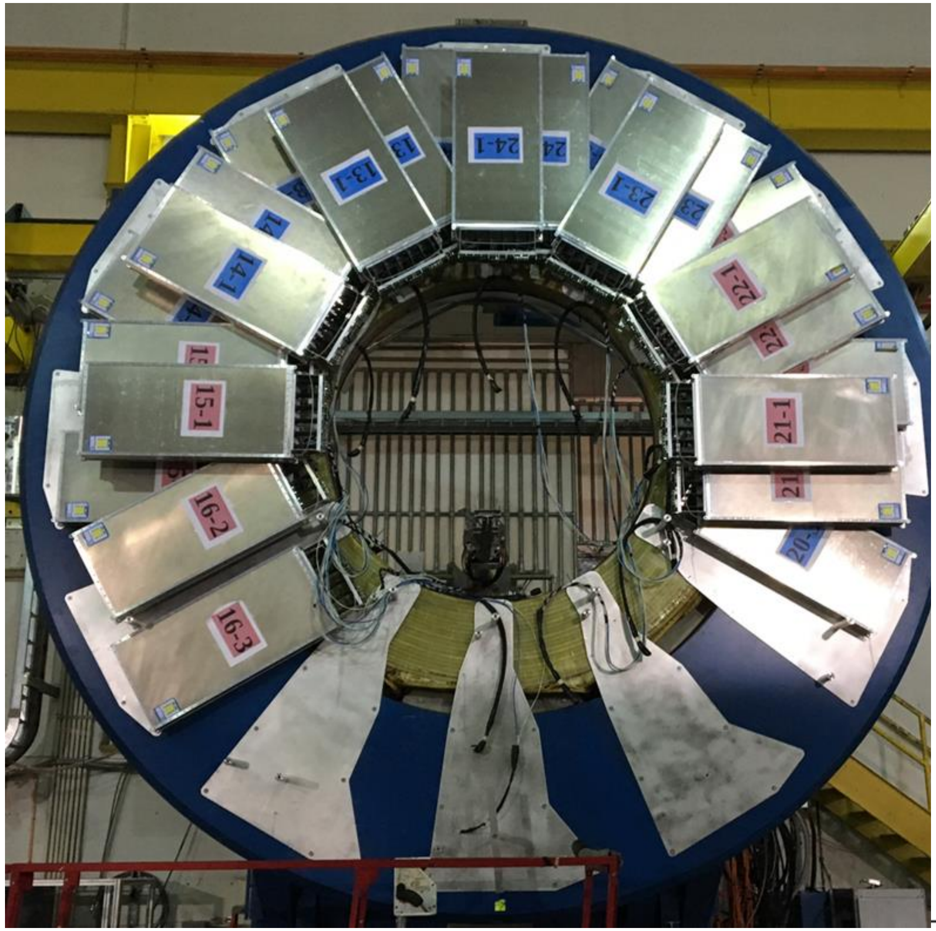
iTPC Upgrade – Current Performance

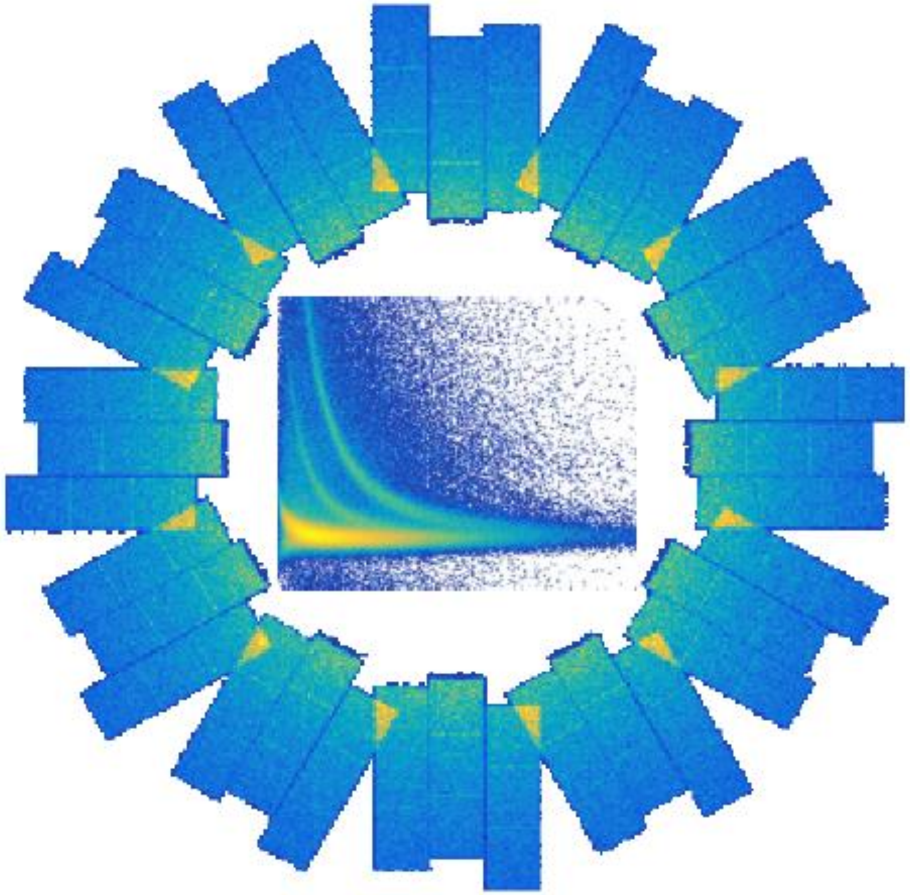




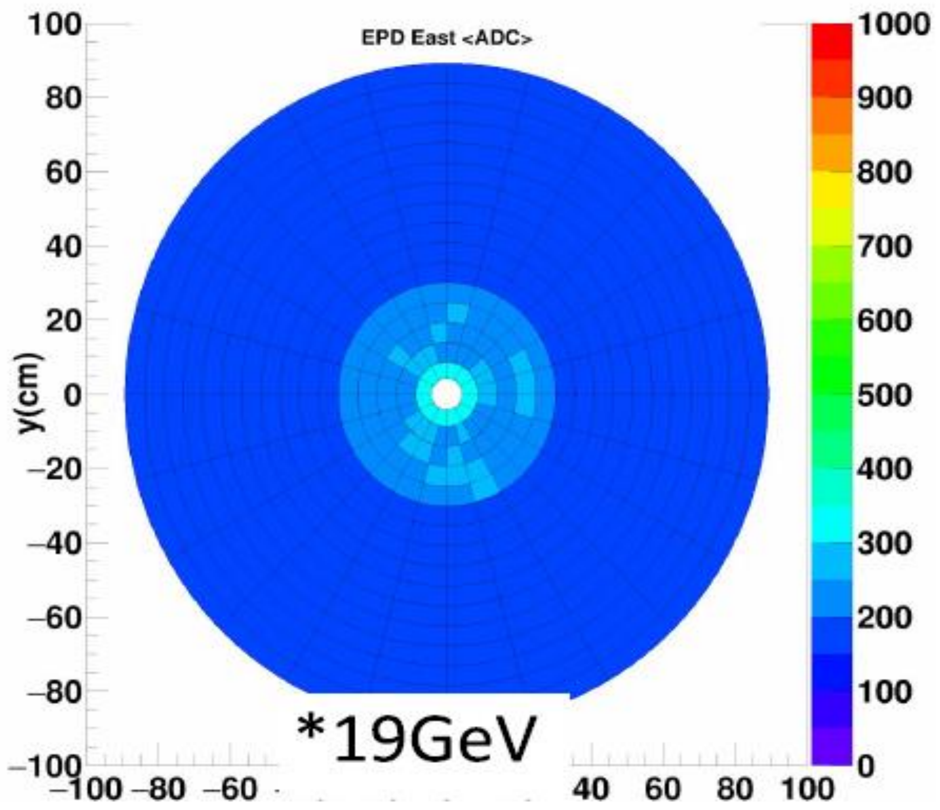
eTOF Upgrade – Current Performance

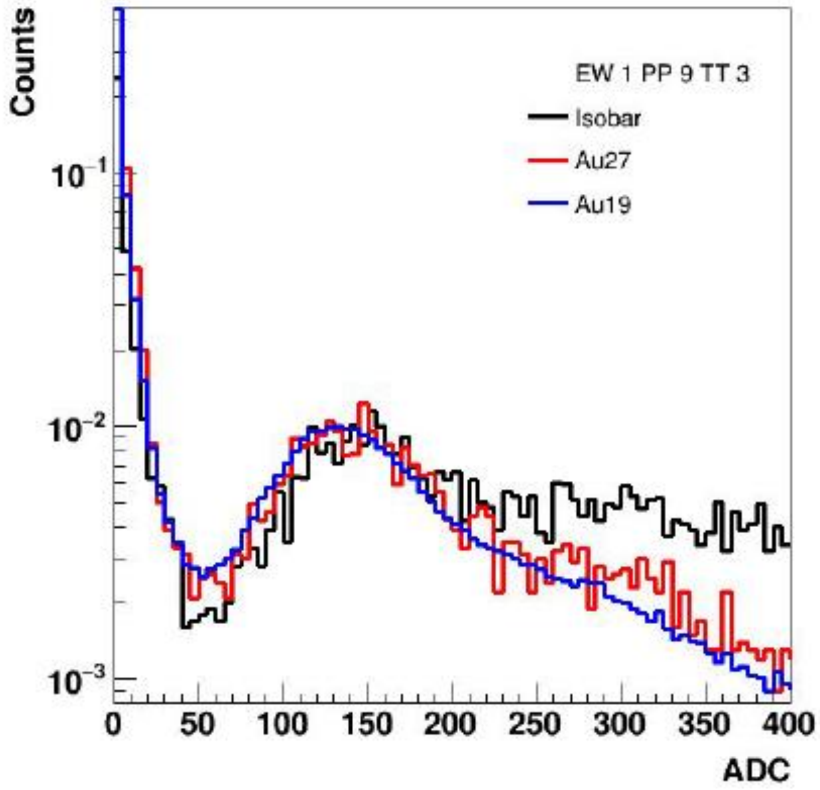
System time resolution ➔ 85 ps
Individual counter time resolution ➔ 65 ps





EPD Upgrade – Current Performance

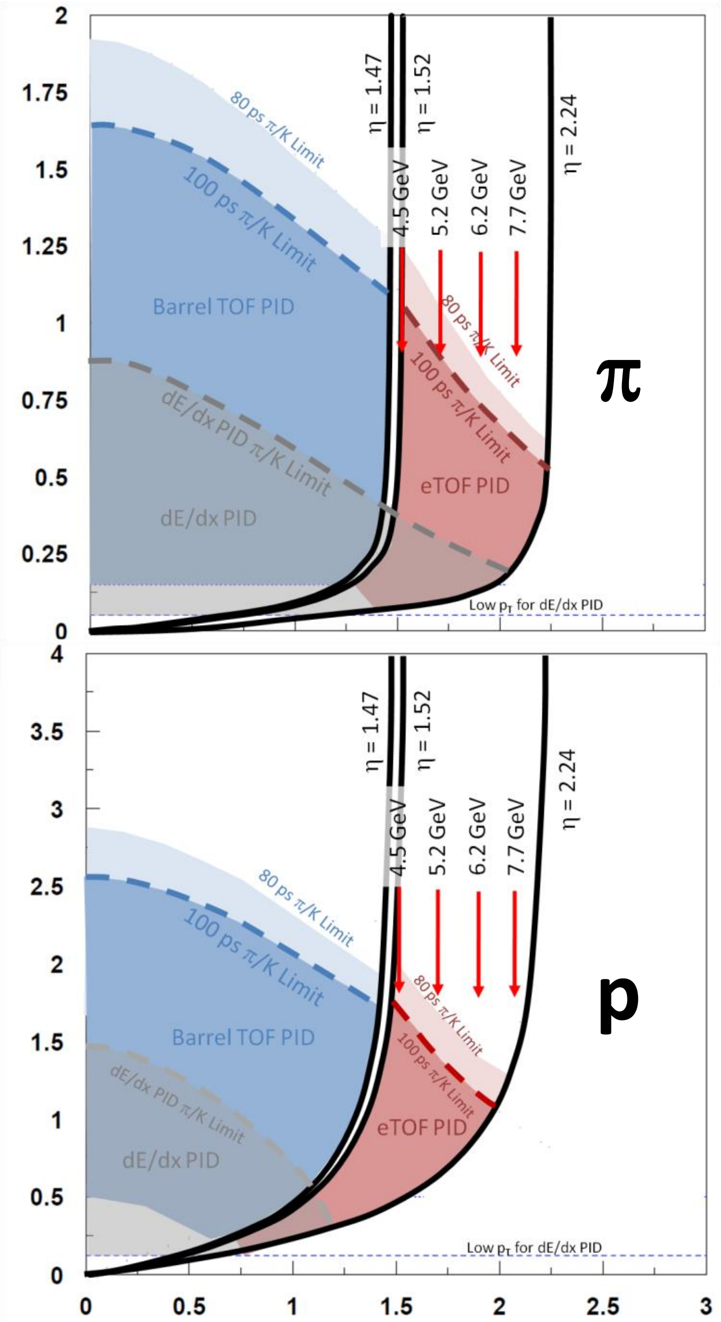




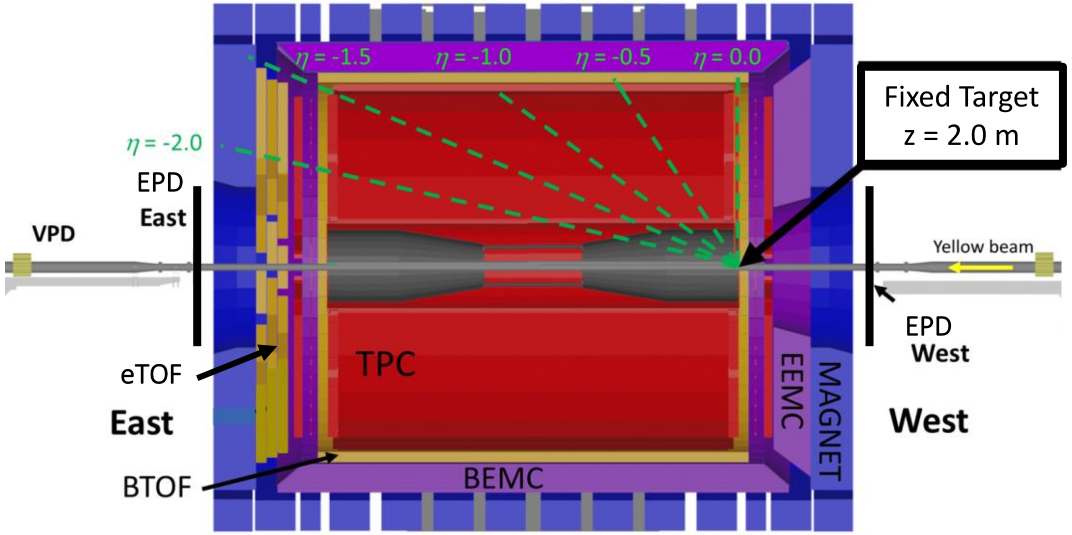
FXT Program

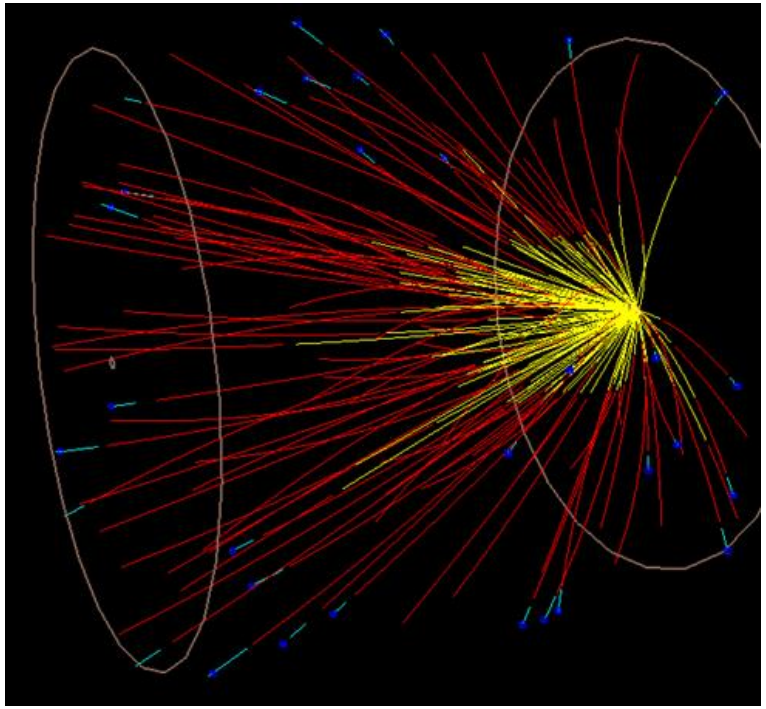
Collider Energy	Fixed-Target Energy	Single beam AGeV	Center-of-mass Rapidity	μ_B (MeV)
62.4	7.7	30.3	2.10	420
39	6.2	18.6	1.87	487
27	5.2	12.6	1.68	541
19.6	4.5	8.9	1.52	589
14.5	3.9	6.3	1.37	633
11.5	3.5	4.8	1.25	666
9.1	3.2	3.6	1.13	699
7.7	3.0	2.9	1.05	721

- Data rate is DAQ limited
- Would need 100 Million Events at each energy to make the sensitivity of BES-II
- Two days per energy



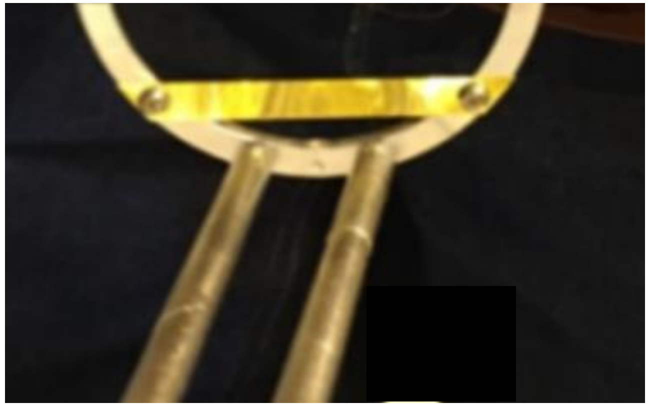
Fixed-Target Program Exp. Setup

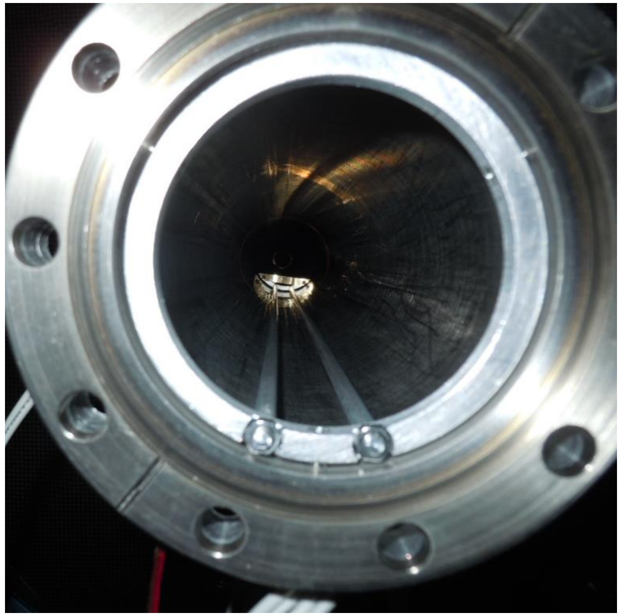




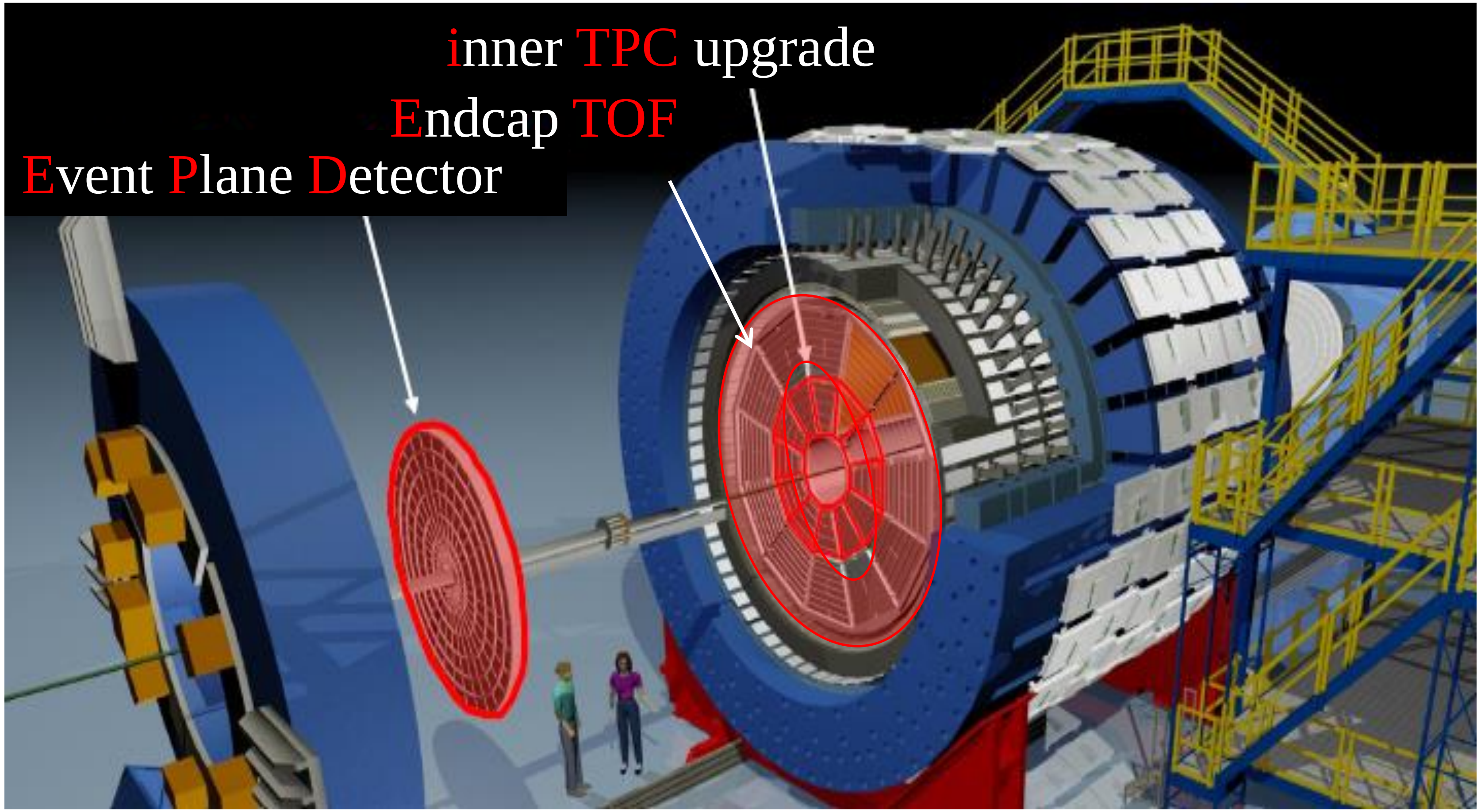
Gold Target:

- 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



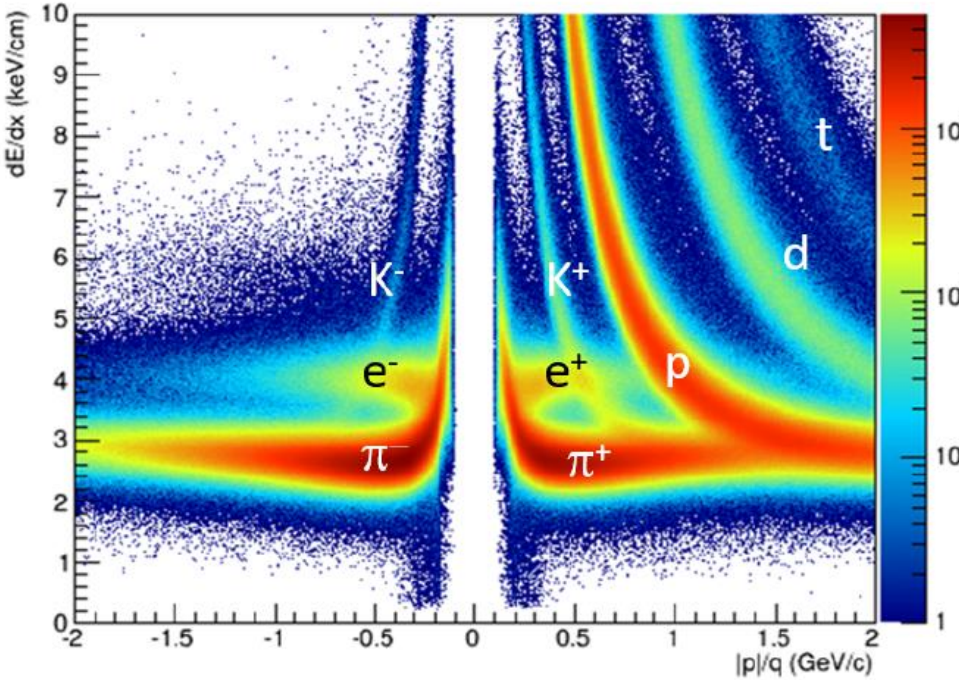
Detects Particles in the $0 < \eta < 2$ range

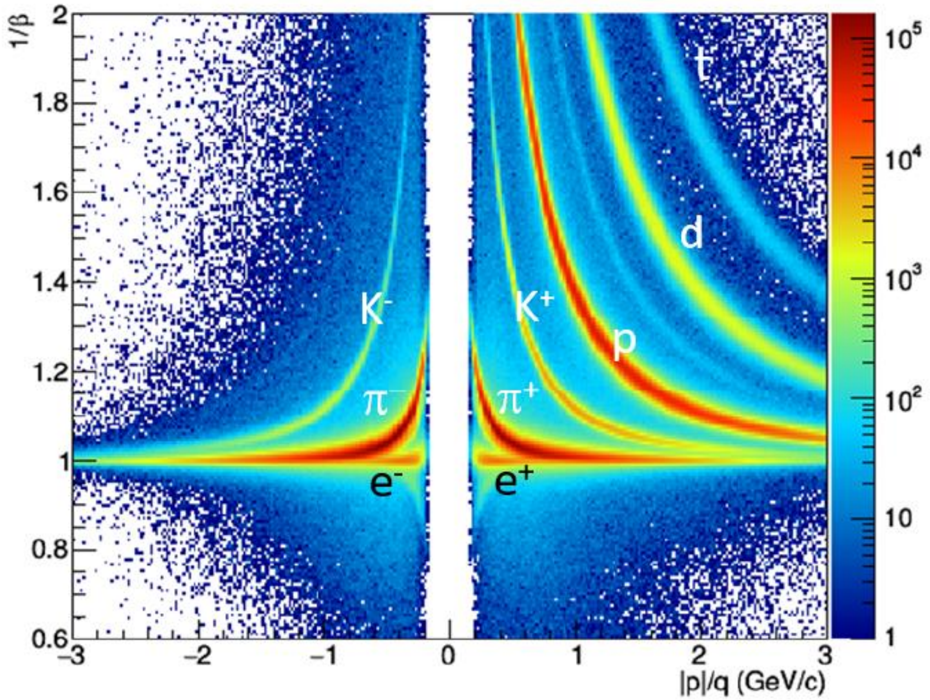
π, K, p, d, t, h, α through dE/dx and TOF

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

Particle Identification

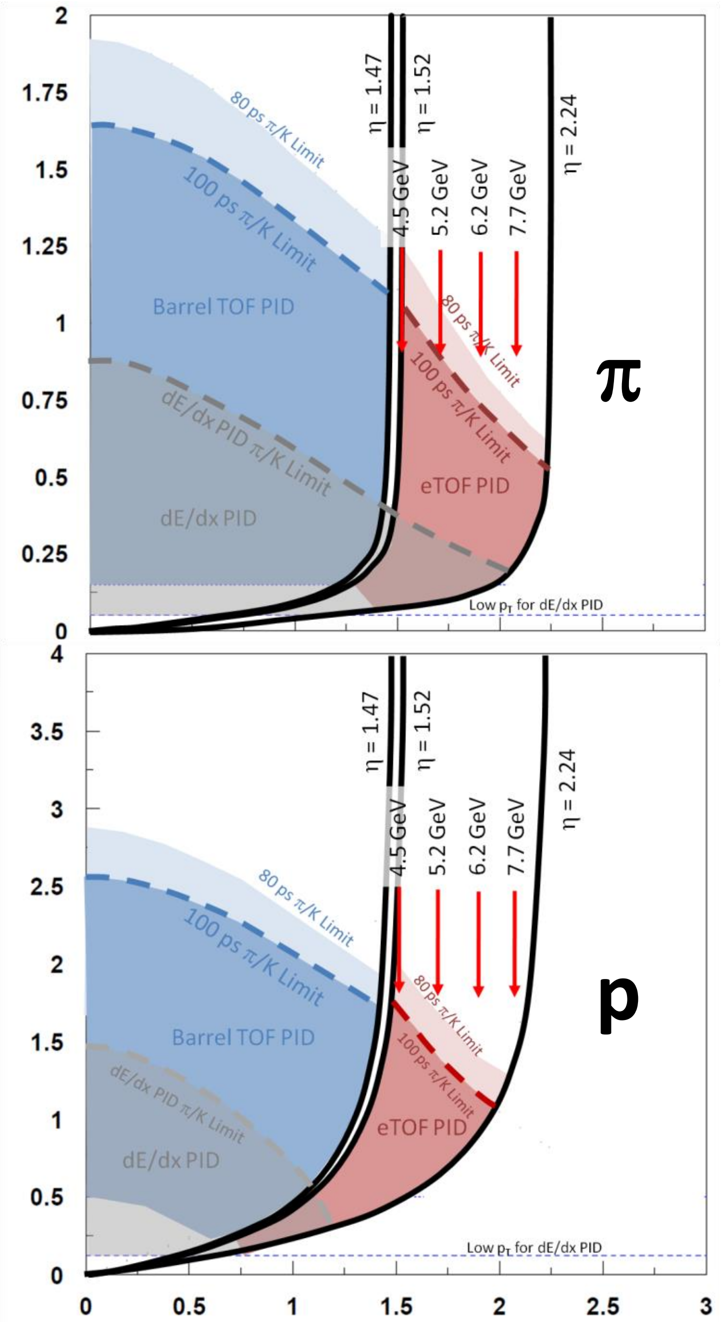
Because the tracks are longer, on average, for FXT events than for collider events, the resolutions for both dE/dx and 1/β are better in FXT mode than collider mode.



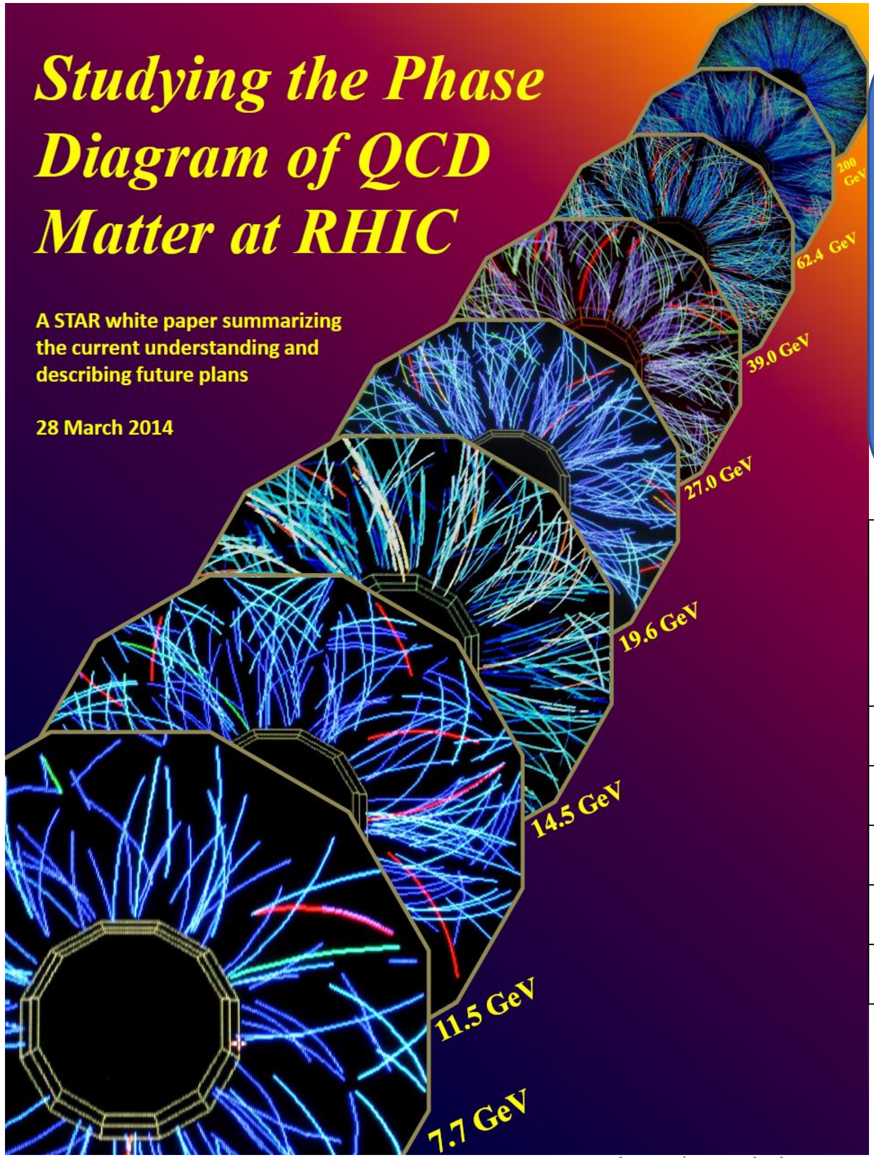


Acceptance for the FXT Program

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



Beam Energy Scan Phase-II



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

The Fixed-Target Program will extend the search range for all of these features of the QCD phase diagram up to μ_B = 720 MeV

Collision Energy (GeV)	Fixed Target $\sqrt{s_{NN}}$	Center of Mass Rapidity	Single Beam Kinetic	Chemical Potential Collider	Chemical Potential μ_B (MeV)
19.6	4.471	1.522	8.87	206	589
14.5	3.904	1.370	6.32	264	633
11.5	3.528	1.253	4.82	316	666
9.1	3.196	1.134	3.62	375	699
7.7	2.985	1.049	2.92	422	721

Overall Run Status (2018)

Energy	Start	Finish	First Run	Last Run	HLTgood	Target
3.85 FXT	May 31st	June 4th	19151029	19155022	258 M	100 M
26.5 FXT	June 5th	June 18th	19156034	19169017	155 M	none
27 GeV	May 10th	June 17th	19139960	19168040	558 M	1000 M

Overall Run Status (2019)

Energy	Start	Finish	First Run	Last Run	HLTgood	Target
19.6	Feb 25th	April 3rd	20056032	20093036	582 M	400 M
14.6	April 4th	June 3rd	20094048	20154013	324 M	310 M
3.85 FXT	June 9th	June 9th	20160024	20160027	3.7 M	5 M
7.3 FXT	June 18th	June 18th	20169029	20169055	52.7 M	50 M
7.7	June 3rd	June 27th	20154047	20178014	2.9 M	4 M
4.59 FXT	June 28th	July 2nd	20179040	20183025	200.6 M	200 M
9.2	June 28th	July 8th	20179016	20189017	1.0 M	none
31.2 FXT	July 8th	July 9th	20190006	20190024	50.6 M	50 M
200	July 11th	July 12th	20192001	20193026	138 M	140 M

Overall Run Status (2020)

Energy	Start	Finish	First Run	Last Run	HLTgood	Target
11.5 GeV	Dec 10th	Feb 24th	20056032	21055017	235 M	230 M
31.2 FXT	Jan 28th	Jan 29th	21028011	21029037	112.5 M	100 M
9.8 FXT	Jan29th	Feb 1st	21029051	21032016	108 M	100 M
19.5 FXT	Feb 1st	Feb 2nd	21032049	21033017	118 M	100 M
13.5 FXT	Feb 2nd	Feb 3rd	21033026	21034013	103 M	100 M
7.3 FXT	Feb 4th	Feb 5th	21035003	21036013	117 M	100 M
5.75 FXT	Feb 13th	Feb 14th	21044023	21045011	115.6 M	100 M
9.2 GeV	Feb 24th	Sep 1st	21055032	21245010	161.8 M	160 M
26.5 FXT	July 29th	Sep 14th	21211028	21258004	316.9 M	none
7.7 GeV	Sep 2nd	Sep 11th	21246012	21255021	3.2 M	none

FXT with eTOF (2020 and 2021)

Energy	Percent w/ eTOF	HLTgood total	Target w/ eTOF
31.2 FXT	90.4 %	101.7 M	100 M
19.5 FXT	68.1 %	80.4 M	80 M
13.5 FXT	86.3 %	88.9 M	70 M
9.8 FXT	67.3 %	72.7 M	65 M
7.3 FXT	90.9 %	106.4M	50 M
5.75 FXT	86.0 %	99.4 M	70 M
26.5 FXT	94.3 %	298.7 M	none
3.85 FXT	98.8 %	305.3 M	300 M
44.5 FXT	93.3 %	50.3 M	50 M
70 FXT	97.5 %	50.4 M	50 M
100 FXT	99.8 %	50.6 M	50 M
3.85 FXT			

2020 (rows 31.2 FXT – 26.5 FXT); 2021 (rows 3.85 FXT – 3.85 FXT)

Overall Run Status (2021)

Energy	Start	Finish	First Run	Last Run	HLTgood	Target
7.7 GeV	Jan 31st	May 1st	22031042	22121018	100.9 M	100 M
3.0 FXT	May 1st	May 5th	22121036	22125011	306.6 M	300 M
9.2 FXT	May 6th	May 6th	22126010	22126029	53.9 M	50 M
11.5FXT	May 7th	May 7th	22126045	22127018	51.7 M	50 M
13.7 FXT	May 8th	May 8th	22128001	22128011	50.7 M	50 M
O+O 200	May 11th	Min Bias	22131011	22136010	403.9 M	400 M
O+O 200	May 16th	Central	22136011	22141016	212.4 M	200 M
O+O 200	May 21st	Flip Field	22141039	22144006	125.0 M	100 M
17.3 GeV	May 25th	June 7th	22145017	22158019	256.1 M	250 M
3.0 FXT	June 7th	June 28th	22159051	22179022	1796 M	1.7 B
d+Au 200	June 28th	July 7th	22180043	22188007	216.9 M	200 M
7.2 FXT	June 3rd	July 3rd	22154936	22184019	88.6 M	none

Probing Strangeness Canonical Ensemble with K-, phi(1020) and Xi- Production in Au+Au Collisions at sqrt{s_NN} = 3 GeV
Submitted Dec. 23, 2021
e-Print Archives (2108.00924)

Light Nuclei Collectivity from 3 GeV Au+Au Collisions at RHIC
Submitted Dec. 8, 2021 , published Feb. 1, 2022
Phys. Lett. B **827** (2022) 136941
e-Print Archives (2112.04066)

Probing Strangeness Canonical Ensemble with K-, phi(1020) and Xi- Production in Au+Au Collisions at sqrt{s_NN} = 3 GeV
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Phys. Lett. B **827** (2022) 136941
e-Print Archives (2112.04066)

Measurements of Proton High Order Cumulants in sqrt{s_NN} = 3 GeV Au+Au Collisions and Implications for the QCD Critical Point
Submitted Dec. 2, 2021
e-Print Archives (2112.00240)

Disappearance of partonic collectivity in 3 GeV Au+Au collisions at RHIC
Submitted Nov. 24, 2021 , published Mar. 10, 2022
Phys. Lett. B **827** (2022) 137003
e-Print Archives (2108.00908)

Measurements of H3L and H4L Lifetimes and Yields in Au+Au Collisions in the High Baryon Density Region
Submitted Oct. 18, 2021
e-Print Archives (2110.09513)