Plans for Release of STAR Data for Runs 13 and 14

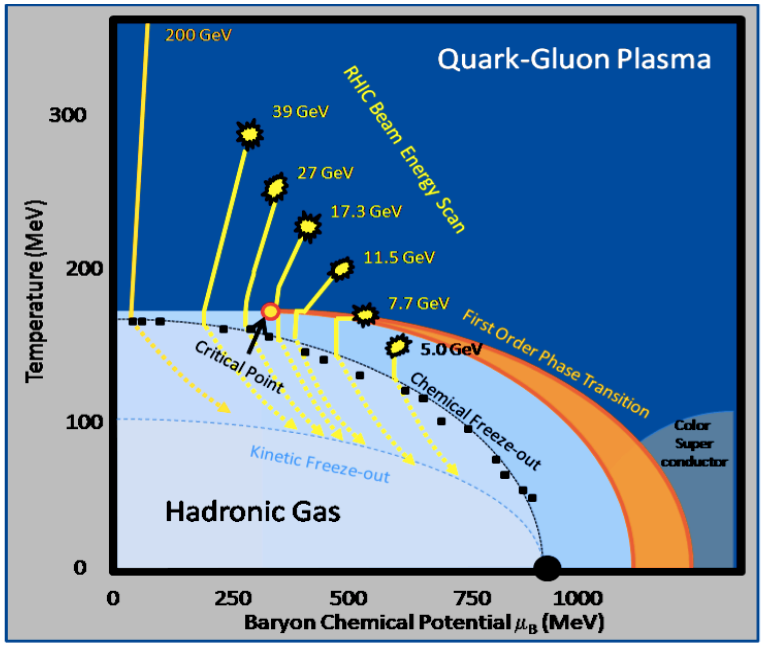
Renee Fatemi (Univ. of Kentucky)
Frank Geurts (Rice Univ.)

Outline

- STAR Physics & Detector
- Publications 2014/2015
- Offline Physics Production
- Run 13 & 14
  - Production Status
  - Analysis Highlights

RHIC: eight key unanswered questions

Hot QCD Matter



1: Properties of the sQGP

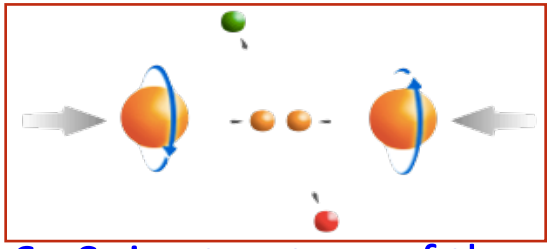
2: Mechanism of energy loss: weak or strong coupling?

3: Is there a critical point, and if so, where?

4: Novel symmetry properties

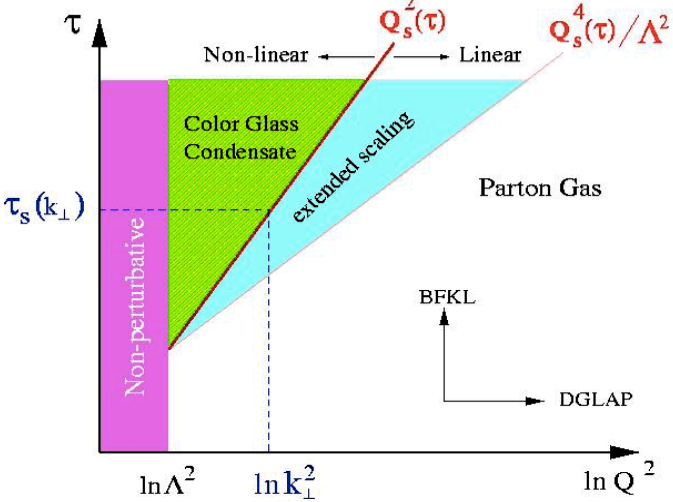
5: Exotic particles

Partonic structure



6: Spin structure of the nucleon

7: How to go beyond leading twist and collinear factorization?

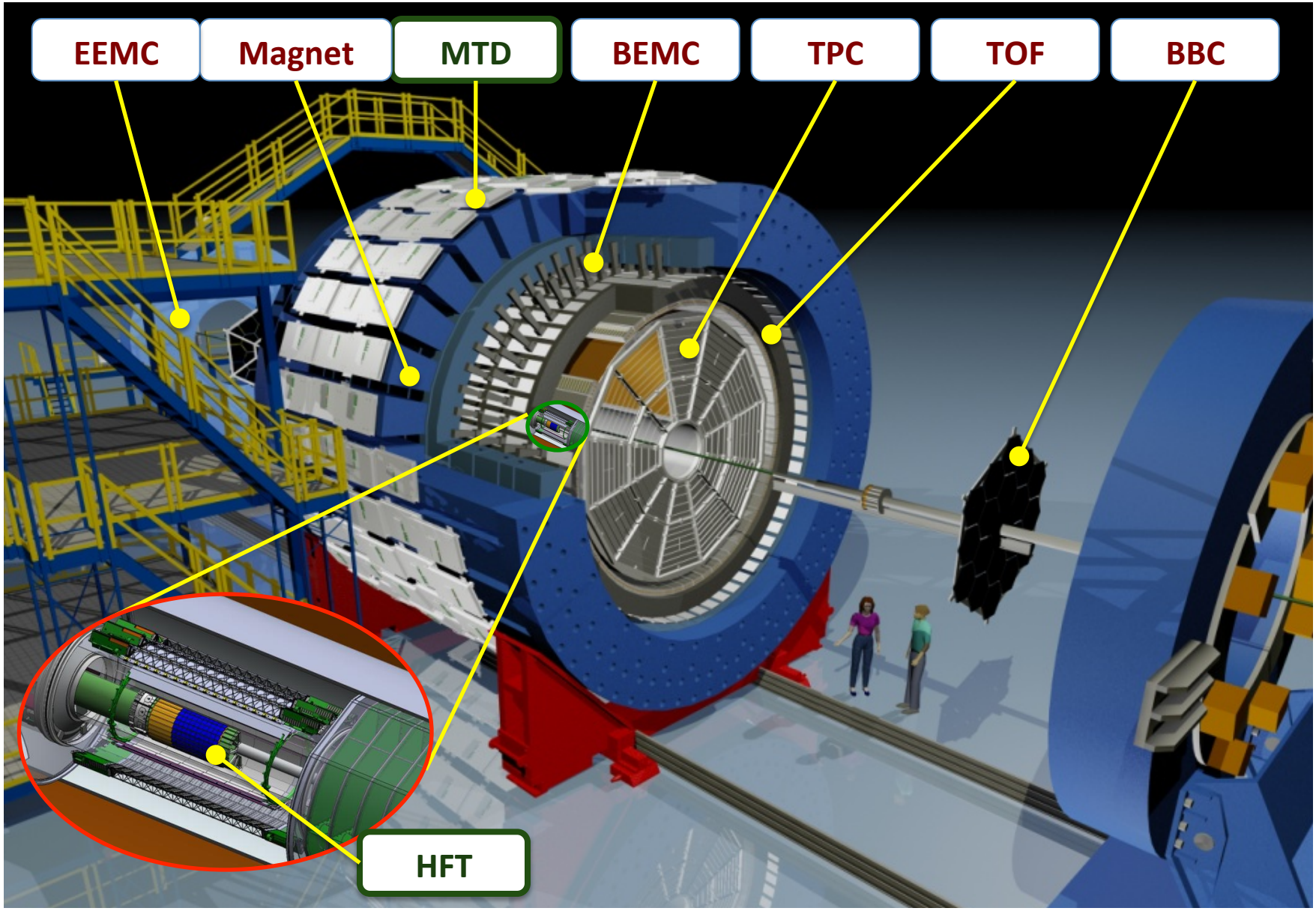


8: What are the properties of cold nuclear matter?

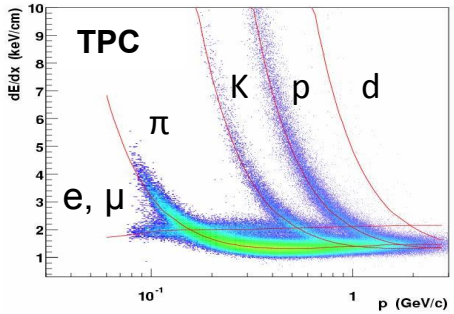
STAR Decadal Plan

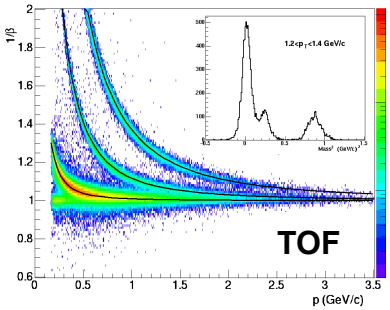
http://www.bnl.gov/npp/docs/STAR_Decadal_Plan_Final%5b1%5d.pdf

STAR Detector System

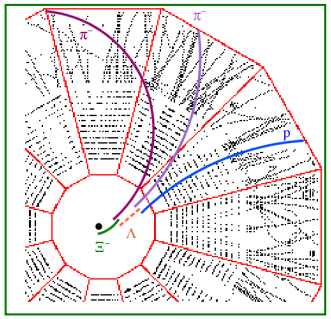


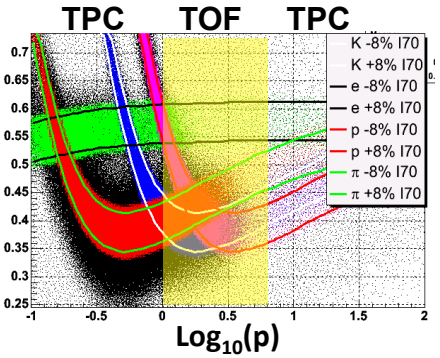
Particle Identification at STAR



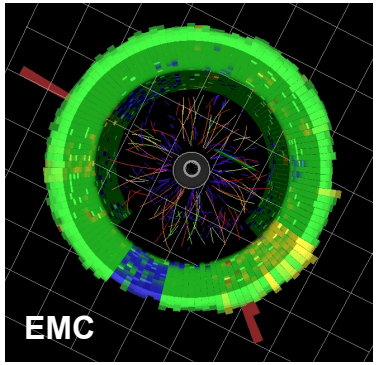


Charged hadrons

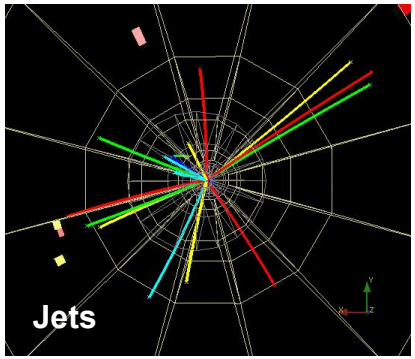




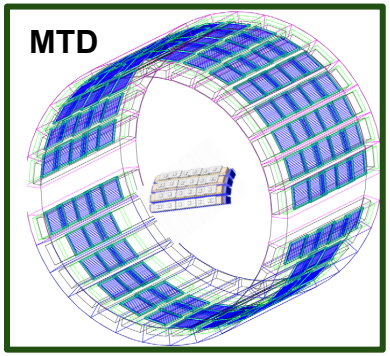
Hyperons & Hyper-nuclei



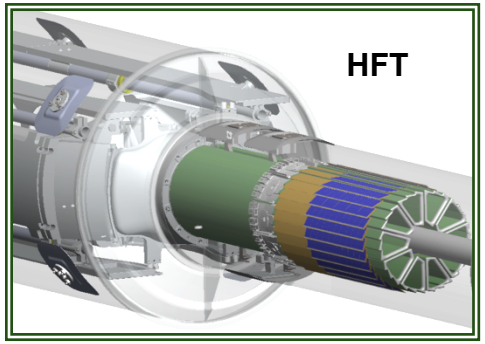
Neutral EM particles



Jets & Correlations



High p_T muons



Heavy-flavor hadrons

Multiple-fold correlations for the identified particles!

STAR Detector Systems

	Period	Detectors	Physics
	2001-2010	**TPC**	*u, d, s*
	2009	DAQ1000	
	2010	TPC + TOF	*u, d, s + dilepton*
	2013	TPC + TOF + MTD	
	2014	TPC + TOF + MTD **+ HFT**	*u, d, s, c, b + dilepton*

- STAR: large coverage, excellent PID, fast DAQ
  - detects nearly all particles produced at RHIC
  - multiple fold correlation measurements
  - Probes: bulk, penetrating, and *bulk-penetrating*
- STAR: perfect mid-y collider experiment
- STAR: expanding into forward rapidity regions

Citation Summary

Source: inspire.net

Generated on 2015-06-04

172 papers found, 172 of them citeable (published or arXiv)

Citation summary results	Citeable papers	Published only
Total number of papers analyzed:	172	172
Total number of citations:	20,037	20,037
Average citations per paper:	116.5	116.5
Breakdown of papers by citations:		
Renowned papers (500+)	9	9
Famous papers (250-499)	10	10
Very well-known papers (100-249)	36	36
Well-known papers (50-99)	32	32
Known papers (10-49)	69	69
Less known papers (1-9)	14	14
Unknown papers (0)	2	2
h_{HEP} index [?]	69	69

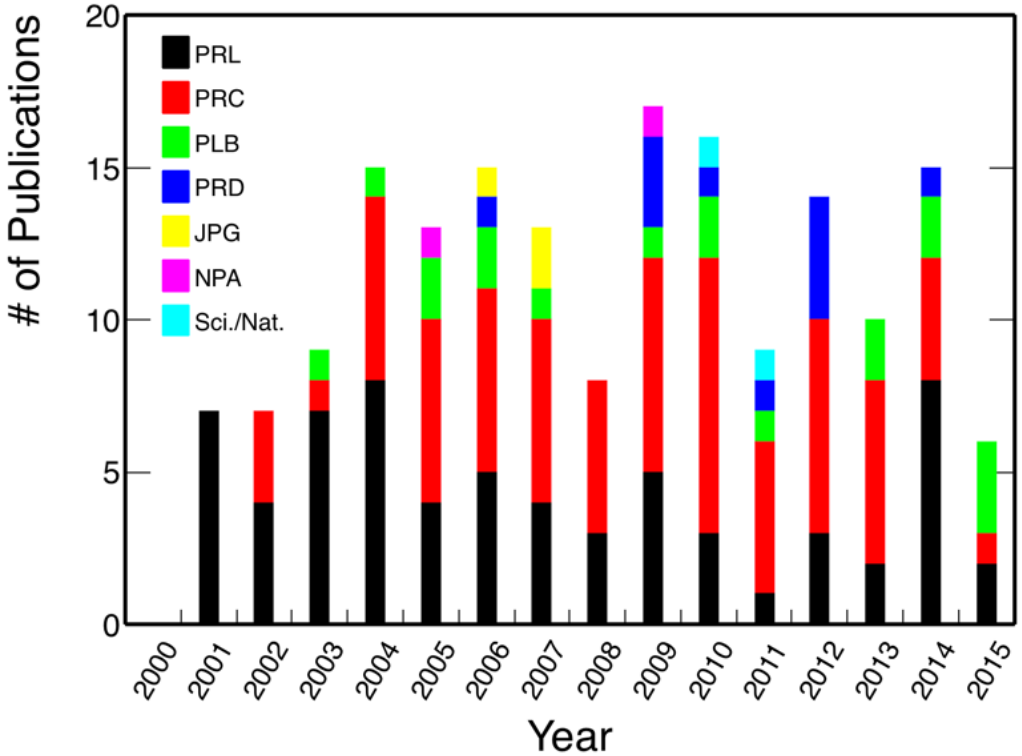
Citations

- as per June 4
- 20,037
- 172 peer-reviewed scientific papers
- 2005 white paper: 2049
- average citations/paper: 116.5

Renowned and Famous Papers: 9 + 10

- 2014: 6 and 9

STAR Publication History



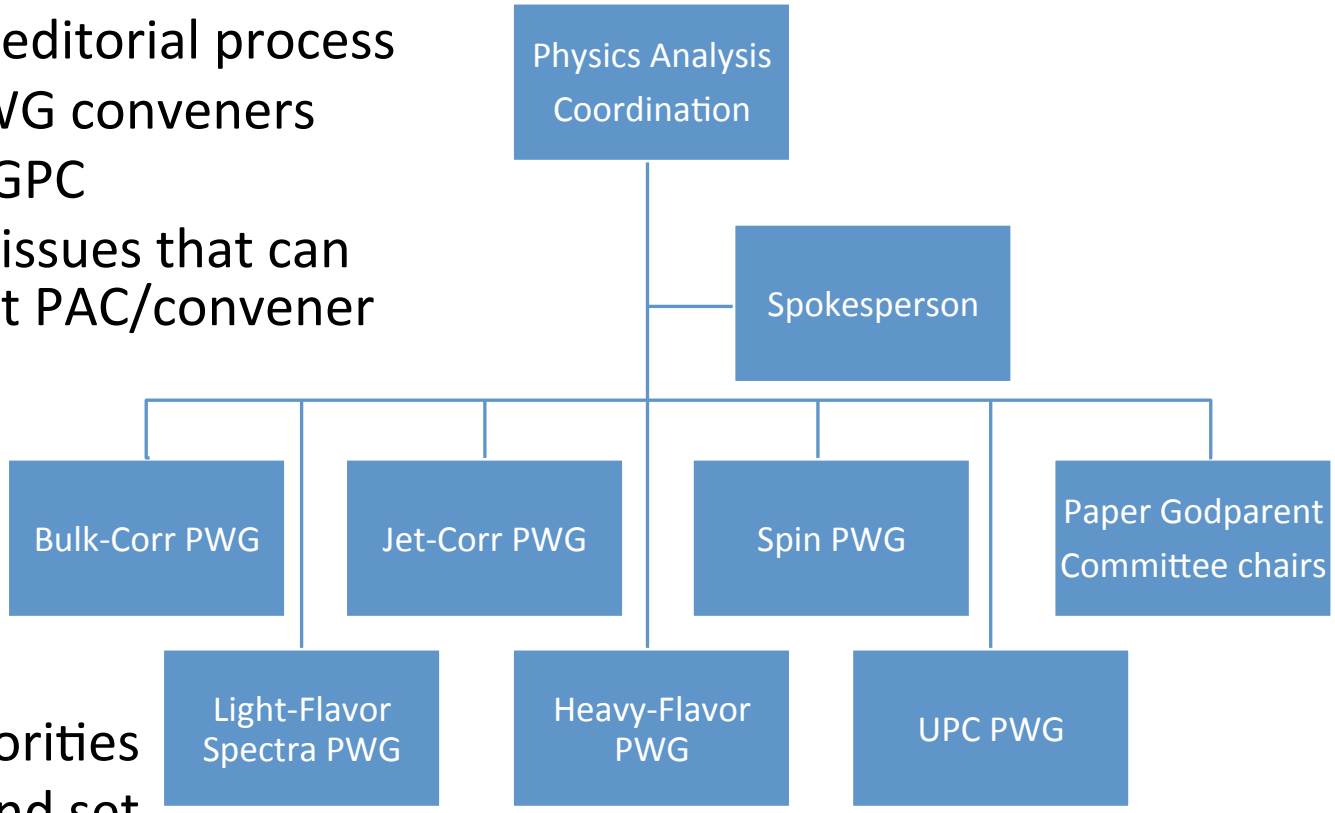
June 2014 – 2015

- 15 published papers
  - 7 PRLs, 3 PRCs, 5 PLBs
- 9 submitted
- 10 in collaboration (GPC) review process
- 15 proposals readied for GPC
- 7 PhD graduations

Physics Organization: PWGs & Editorial Board

New entity in STAR's editorial process

- GPC chairs and PWG conveners
- Track progress in GPC
- Quickly recognize issues that can benefit from direct PAC/convener involvement
- not a new layer



Physics production priorities regularly reviewed and set by the joint PWGs

Formal Paper Process

tracked by PWGs ⟷ *tracked by Editorial Board*

PWGC "early" preview

introduction
outline of data
and physics
draft plots

PWG review

review physics analysis
review draft
technical note
(incl. analysis code)

GPC

review paper
ensure persuasive
physics message
technical accuracy
correctness of analysis

Collaboration Review

open for comments
from all of STAR +
5 institutional readers

Journal Submission / Referee Report

distribute report to
the collaboration
work with GPC on response

2014/2015 Submitted Papers

Long-range correlations in d+Au

- Long-range Δη dihadron correlations in d+Au
  - 1502.07652 (accepted by PLB)
- Effect of event selection on jetlike correlations in d+Au at 200GeV
    - recently accepted, Phys. Lett. B **743** (2015) 333

Dielectron measurements

- dielectron v_2 in 200GeV Au+Au
  - Phys. Rev. C **90** (2014) 64904
- dielectron mass spectra
  - 1504.01317 (long paper, subm. to PRC), and Phys. Rev. Lett. **113** (2014) 22301
- leptonic decay of ϕ(1020) in 200GeV Au+Au
  - 1503.04217 (subm. to PLB)
- acceptance corrected dielectron mass spectra in 19.6 and 200GeV Au+Au
    - 1501.0534 (subm. to PLB)

Beam Energy Scan

- CMW and charge asymmetry dependence of π v_2
  - 1504.02175 (acc. by PRL)
- Beam energy dependence of v_1 of protons, antiprotons, and pions
    - Phys. Rev. Lett. **112** (2014) 162301

Au+Au at 200GeV

- v_2 in Au+Au and U+U
  - 1505.07812 (subm. to PRL)
- charge-to-neutral correlations at forward rapidity
  - Phys. Rev. C **91** (2015) 34905
- Measurement of ΛΛ correlations
  - Phys. Rev. Lett. **114** (2015) 22301
- dihadron correlations with identified leading hadrons in 200GeV Au+Au and d+Au
  - 1410.3524 (subm. to PRC)

Transverse polarized p+p at 200GeV

- Transversity measurements in polarized p+p at 200GeV
  - 1504.00415 (subm. PRL)

Paper Plans in PWGs: Previewed

pwg	date	title/url
Heavy	May 2013	NPE production and v_2 in Au+Au@200GeV
Bulk-Corr	March 2014	light-nuclei v_2 in BES
LFS	March 2014	R_{CP} in BES
LFS	August 2014	Coulomb effect in Au+Al (fixed target)
Spin	August 2014	dijet cross-sections/ A_{LL}
LFS	September 2014	direct virtual photons
Bulk-Corr	November 2014	v_1 for kaons in BES
Heavy	November 2014	J/ψ in Au+Au @{39,62,200}GeV
Spin	December 2014	Collins in p+p@500GeV
Spin	December 2014	W A_N
LFS	January 2015	muonic atom search
Heavy	April 2015	Upsilon production in U+U@193GeV
Spin	May 2015	γ-jet cross sections p+p@200GeV
Jet-Corr	May 2015	Direct photon and charged hadron azimuthal correlations
LFS	May 2015	strangeness in BES

Offline Physics Production

- Physics production priorities regularly reviewed and set by the joint PWGs
  - with input from Software & Computing leadership

Priorities from PWGs (mid 2014)

1. Run-13 p+p
   - finalize W production and proof-of-principle for geometry/distortion corrections
2. Run-14 14.6 GeV
   - fully calibrated, final production
3. Run-14 200 GeV
   - fully calibrated, final production
4. Run-14 ^{3}He and/or Run-12 U+U
   - followed by Cu+Au

Modification (early 2015)

- Strong interest from PWG to increase run-12 Cu+Au priority w.r.t. ^{3}He+Au
  - PWG request motivated by preliminary CME & LPV results

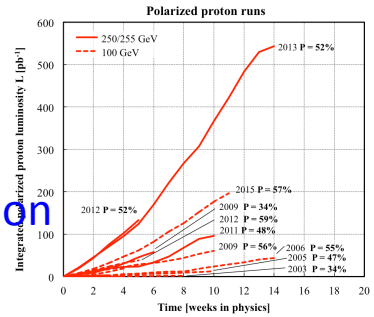
Prioritization 2014/15 – considerations:

1. W-production p+p continuation of Run-13 production.
   - Original production half halted due to tracker/geometry issues.
2. LRP planning - 14.6GeV results.
   - Case for BES-2. Meeting in September [2014]. Document due by end of 2014.
3. BUR 16 - Case for 2016 continued Heavy-Flavor program.
   - HFT/MTD results at 200 GeV
4. QM2015 - First results from STAR's Heavy-Flavor at 200GeV (HFT/MTD).
   - Requires >50% processed for meaningful results.
5. Existing Run-14 preview production [early 2014] for 14.6GeV has issues regarding tracking and calibration

Run 13 and 14 Production Status

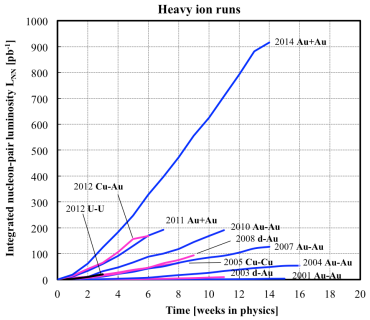
Run 13 p+p@510GeV

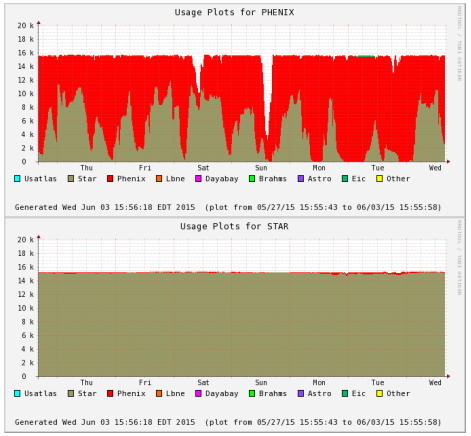
- First half produced
  - started Feb.'14
- 2nd half after PXL inclusion
  - finished by Dec.'14
  - includes MTD



Run 14:

- preview productions
  - Au+Au@14.6GeV
  - h+Au@200GeV
  - small sample
  - limited calibration
  - initially limited physics scope
- Au+Au @ 14.6GeV
  - production finished Jan.'15
- Au+Au @ 200GeV
  - started Mar'15
  - includes HFT and MTD
  - well underway (as of now):
    - 700M (incl. HFT)
    - MTD stream :: ~300M
  - 70% ~Dec.'15
  - 100% ~Feb'16
- h+Au @ 200GeV
  - full production, post QM'15





STAR User's jobs moving to PHENIX nodes

very high production efficiency

Concern about lack of scaling of available computing resources

Computing resources

Computing resource planning done every 3 years. Based on:

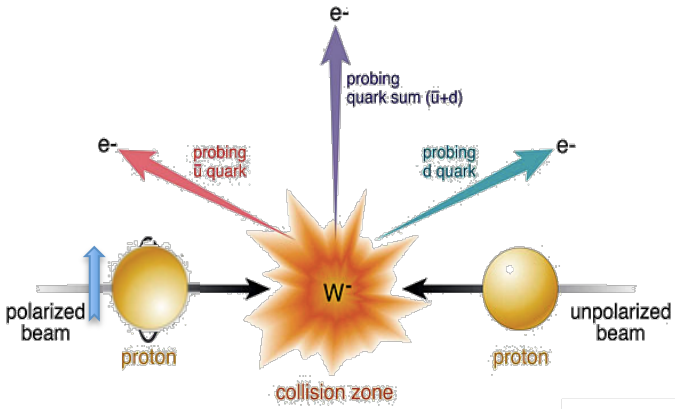
- BUR plans & performance projections
- Detector upgrade plans
- Historical trends – time for event reconstruction within 12% of projected – uncertainty mostly due to trigger selection.
- Contingency margin at 15% level

DATASET	Production STATUS
2014	70% by end of 2015
2014	100% by spring of 2016
2015	50% "preview" by end of 2016
2015	100% pass by 2018
2017	100% ~ 2020!

Lots of good physics potentials but limited resources!

STAR will continue to develop production plans based on physics priority, but issues compound with the years.

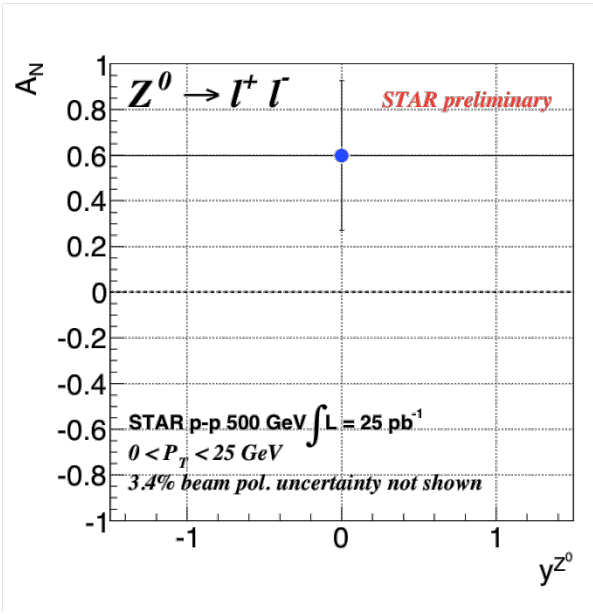
Spin highlights: $W^{\pm}$ A_N

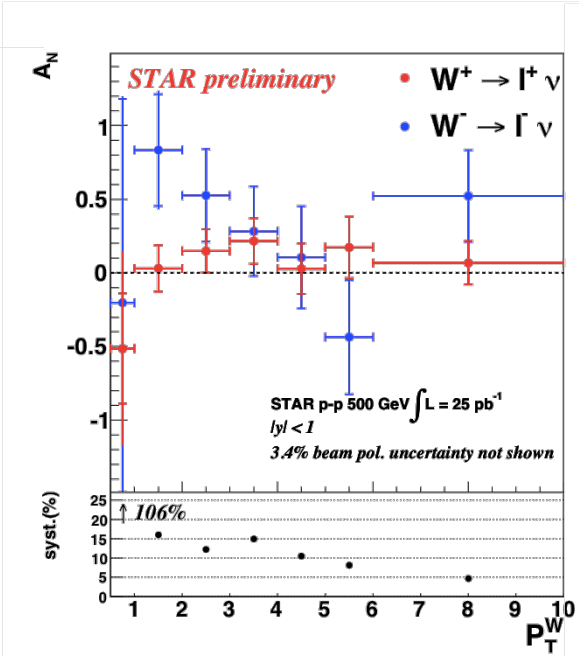


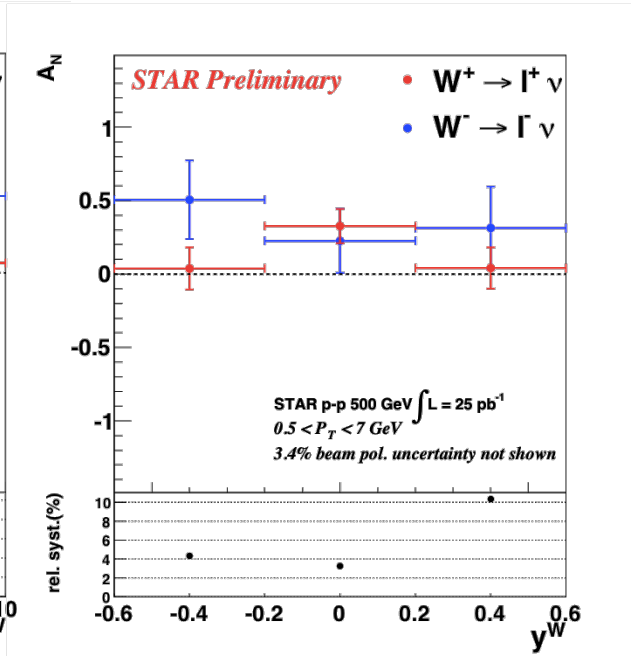
$W^{\pm}$ transverse single-spin asymmetry A_N

- constrain sea-quark Sivers function

run 11 (transverse, 500GeV) ~25 pb^{-1}





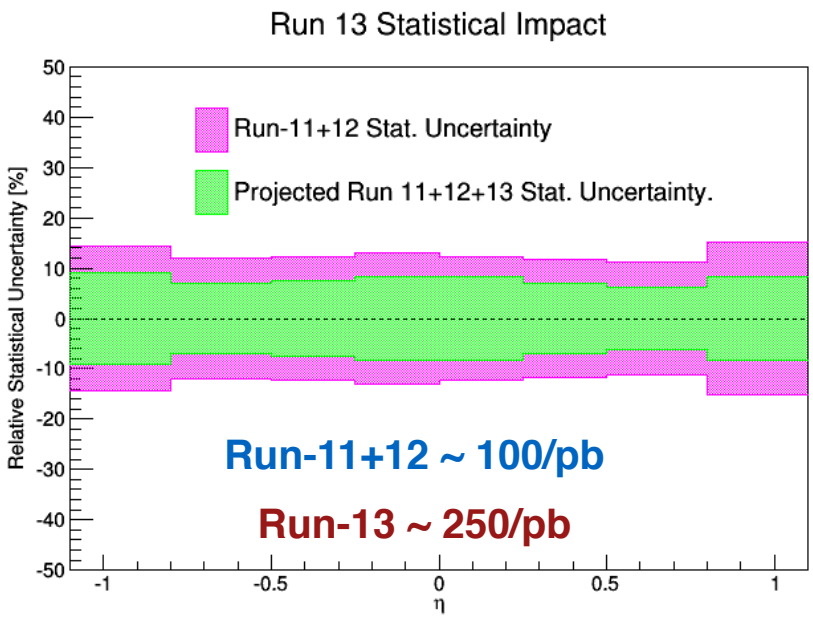


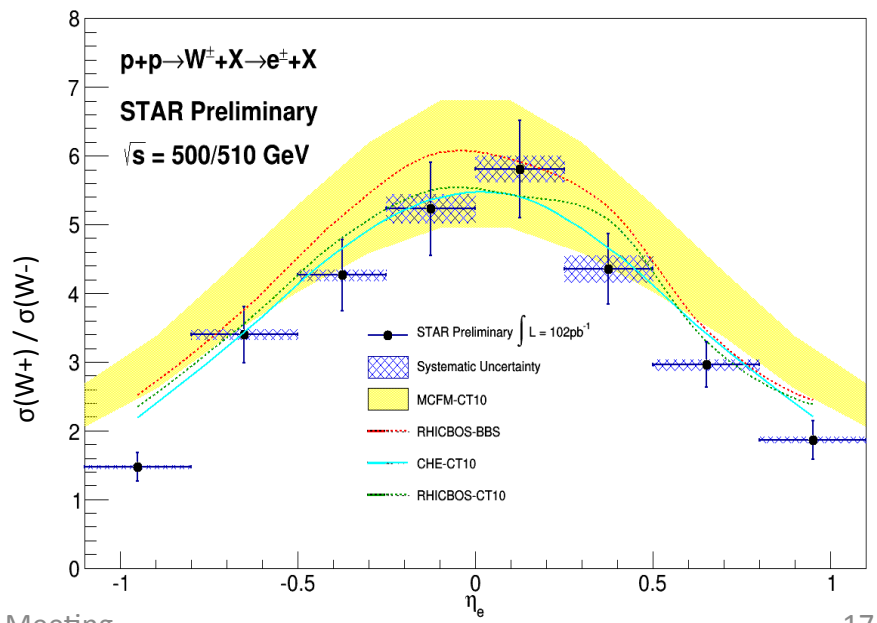
Spin highlights: $\sigma(W^{\pm})$

$W^{\pm}$ production cross sections ratio -> unpolarized light sea quarks PDF

run 11 (transverse, 500GeV) ~ 25pb^{-1}
run 12 (long, 510GeV) ~77 pb^{-1}
run 13 (long, 510GeV): ~250pb^{-1}

- 2013 will provide significant improvement in stat. uncertainties
  - 2013 p+p production finished
  - ➢ analysis underway



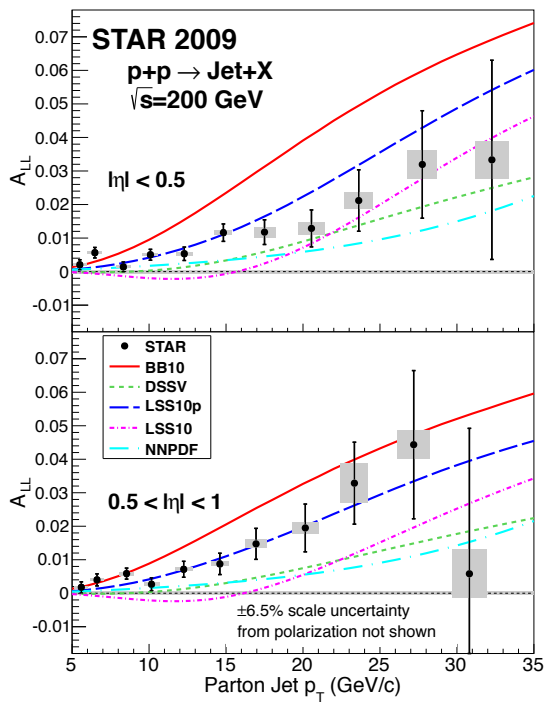


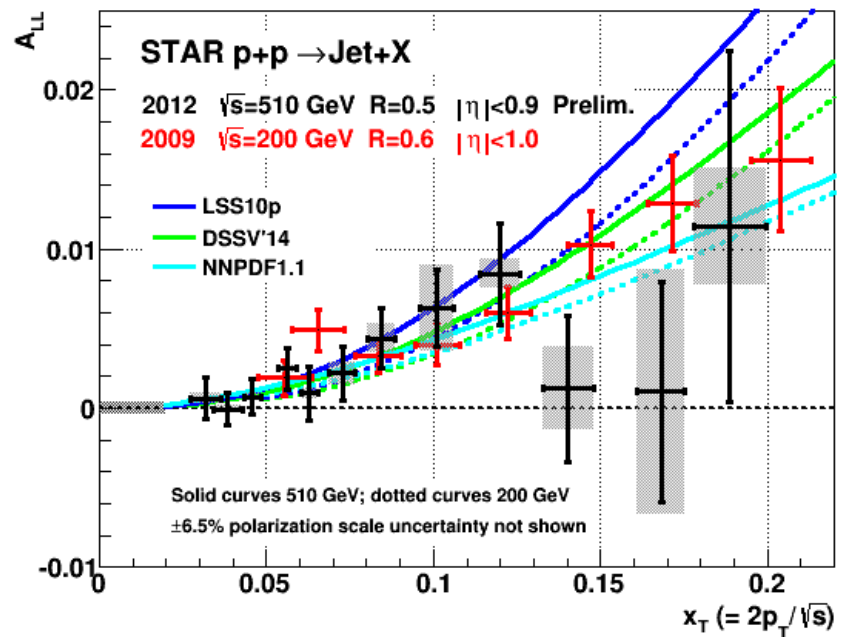
Spin Highlights: Inclusive Jet A_{LL}

Gluon contribution to spin of protons $\Delta g(x)$

- run 9 (200GeV) submitted to PRL

1405.5134



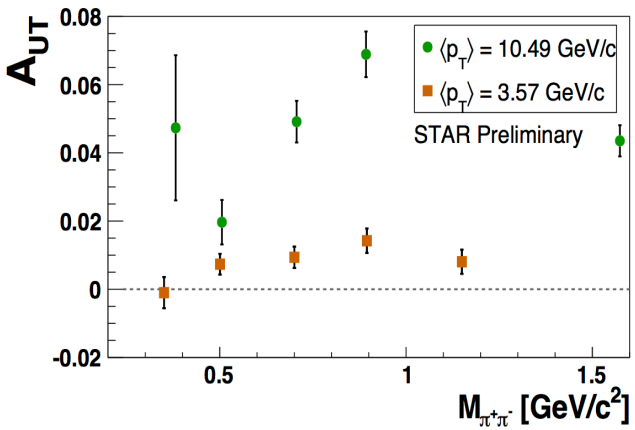


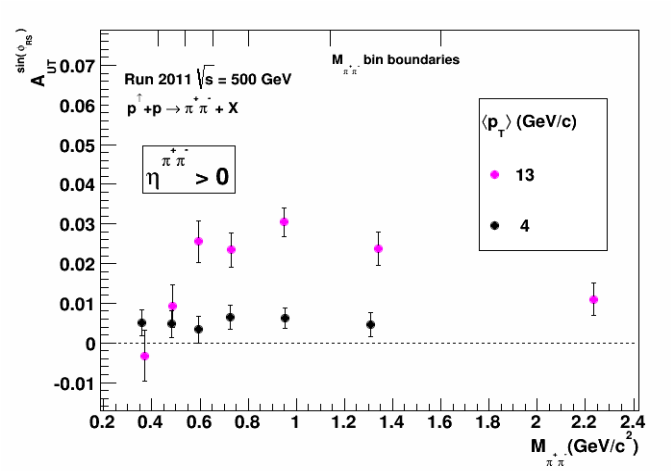
inclusive A_{LL} at 510 GeV

- will involve runs 12 and 13
  - run-12 510GeV data agrees well with 200GeV in the overlapping x_T region

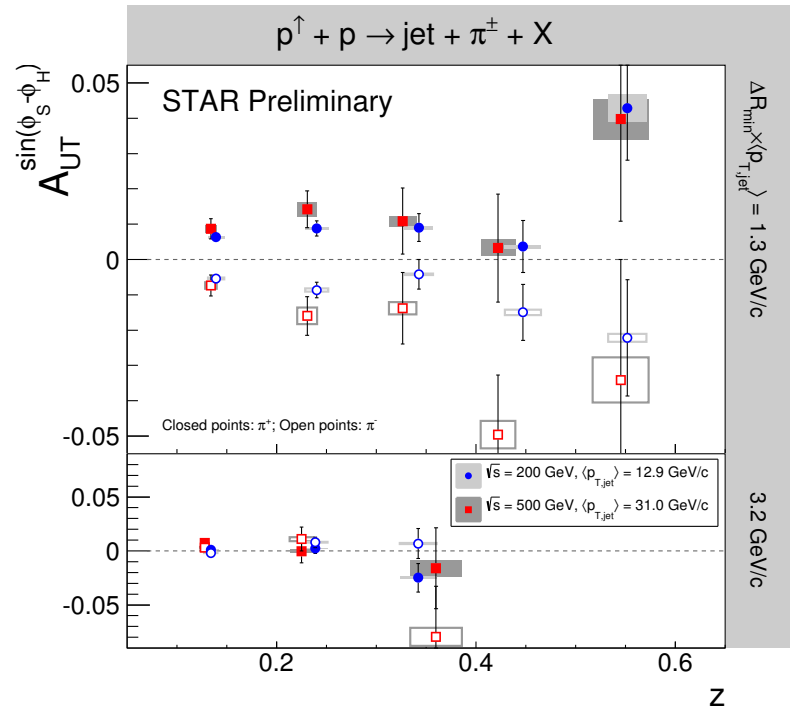
Spin Highlights: Transversity

IFF A_N in pp 200 & 500 GeV





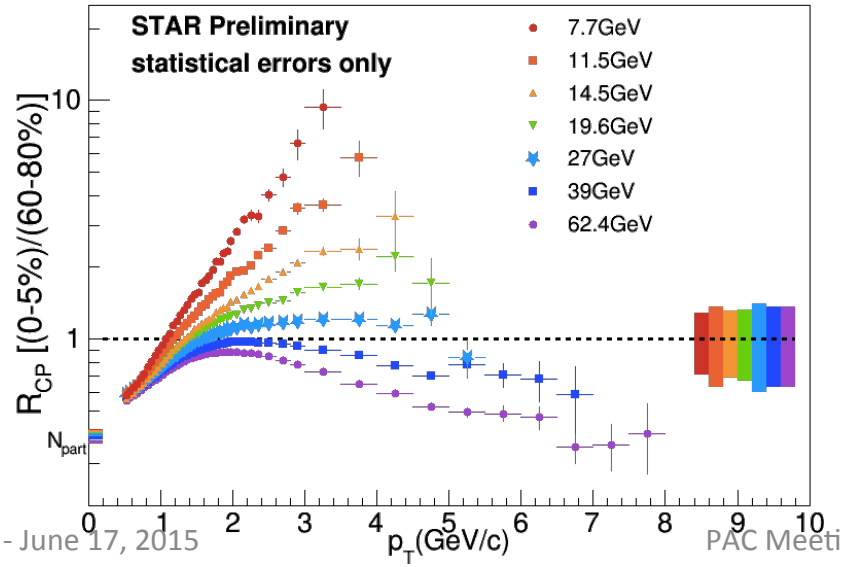
Collins A_N in pp 200 & 500 GeV

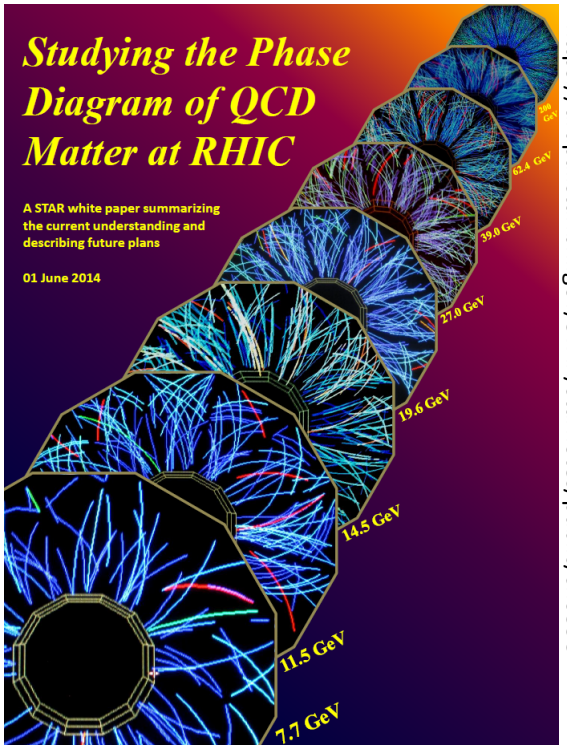


First signals of transversity in pp collisions!
Important tests of evolution and universality!

Heavy-Ion Highlights: 14.5 GeV Au+Au

- Concludes Beam Energy Scan – Phase 1
  - many BES papers have been submitted/accepted in the past years (7 acc., 5 subm.)
- Most 14.5GeV analyses are at their final stages
  - 24M events (BES-2 request for ~300M)
- June 2015 Collaboration Meeting:
  - ➢ 19 analyses that involve 14.5GeV data
  - ➢ preliminary results available for all key BES analyses



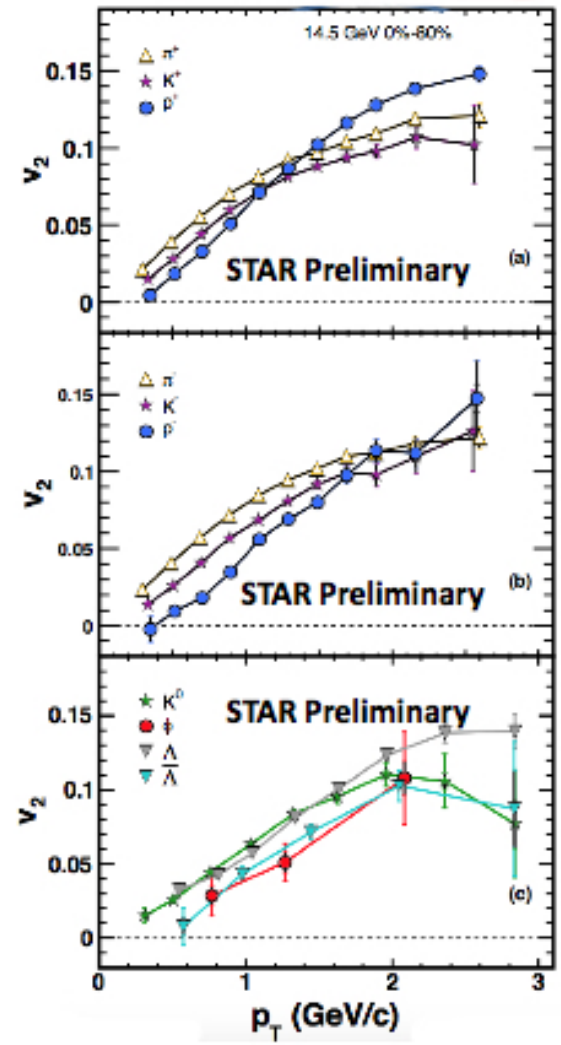


https://drupal.star.bnl.gov/STAR/starnotes/public/sn0598

Au+Au 14.5GeV results

Publication Strategy:

- Results will be integrated with several (BES) paper proposals that are already in an advanced state:
  - Kaon v_1 measurements
  - Identified particle v_2
  - BES v_3
  - RCP of charged and identified hadrons
  - Rapidity density
- In addition, key results will be shown at QM2015
  - 3.9GeV fixed target analysis using 14.5GeV data
  - strangeness: Ω, ϕ, Ks, Λ, and Ξ results
  - Light nuclei B_2

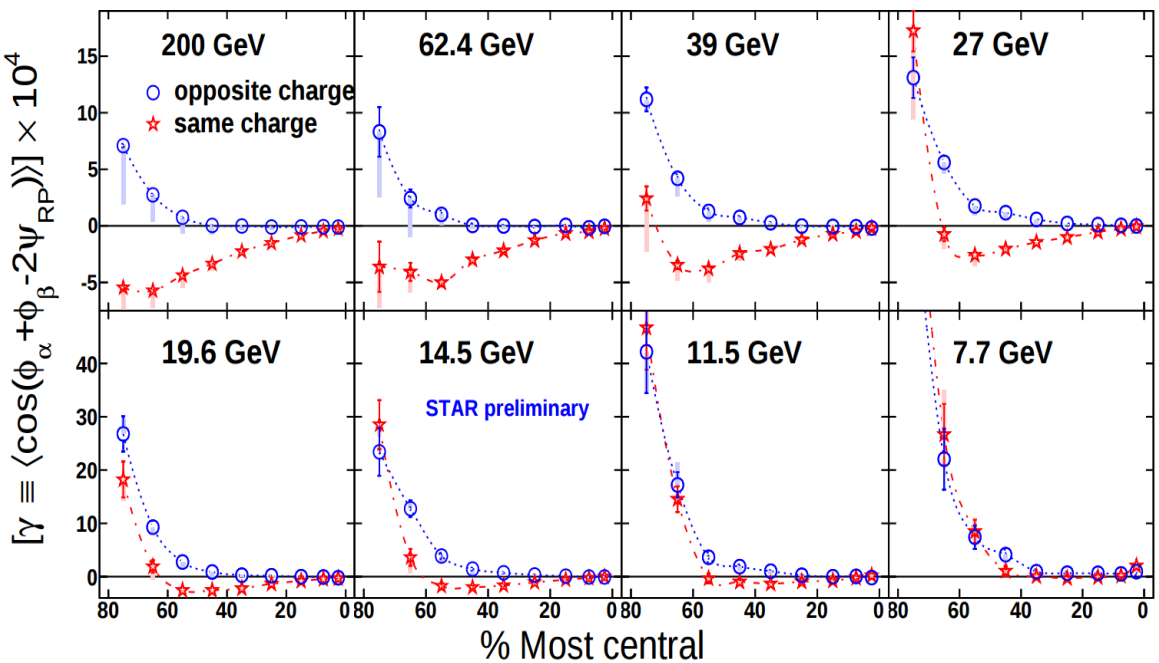


Heavy-Ion Highlights
CME and Au+Au 14.5 GeV

see Gang Wang's contribution

Charge Separation in BES

- different γ_{os} and γ_{ss} consistent with CME expectations
- charge separation diminishes at lower energies
  - ➢ 14.5 GeV follows the trend

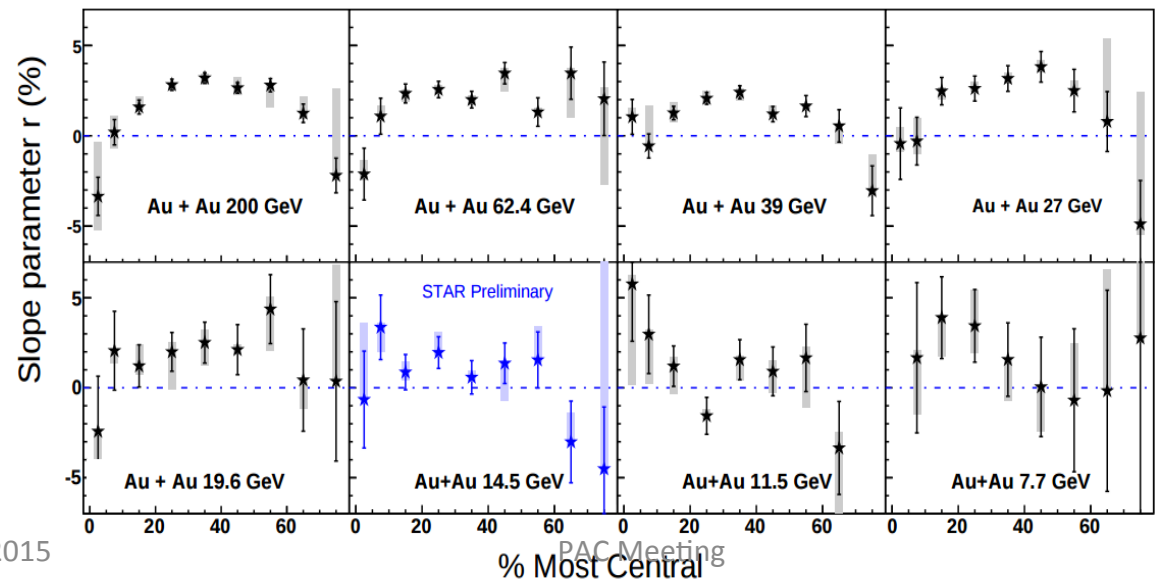


Heavy-Ion Highlights
CMW and Au+Au 14.5 GeV

v_2 of particle and anti-particles as a function of the charge asymmetry A_{ch}

- slope parameter in $v_2^{\pm}=v_2^{base} \pm (q_e/\rho_e)\, A_{ch}$

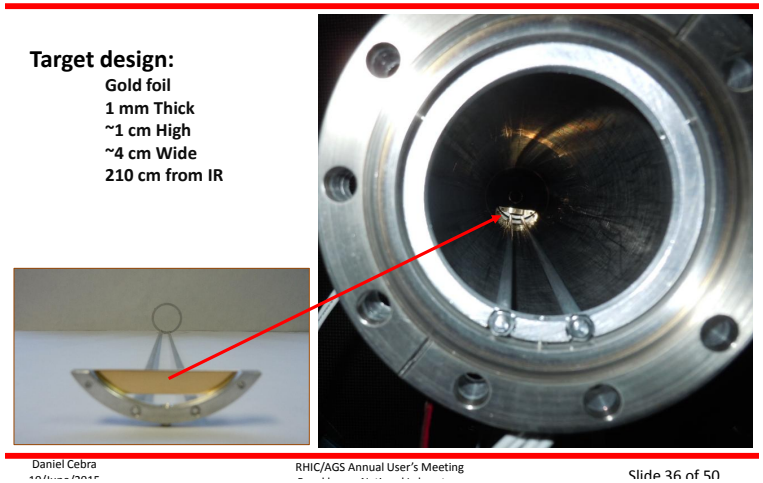
- Chiral Separation Effect + Chiral Magnetic Effect → Chiral Magnetic Wave
  - collective excitation
  - signature of chiral symmetry restoration
- STAR measurements at 200GeV consistent with CMW theoretical calculations
  - similar trend pattern down to 19.6 GeV



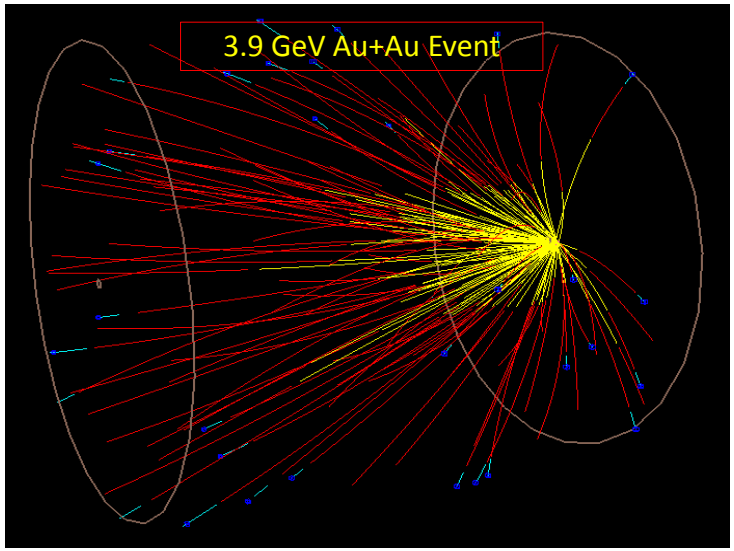
Heavy-Ion Highlight: Fixed Target

- Gold target inserted in 14.5 GeV run
  - $\sqrt{s_{NN}}$ = 3.9 GeV
  - 2015: test run with beam lowered for direct collisions with target ($\sqrt{s_{NN}}$=4.5 GeV)
- ➢ Fixed target preliminary results consistent with published data

Target Design 2014 and 2015



Daniel Cebra at AUM'15



Lots of background, but the target events are evident

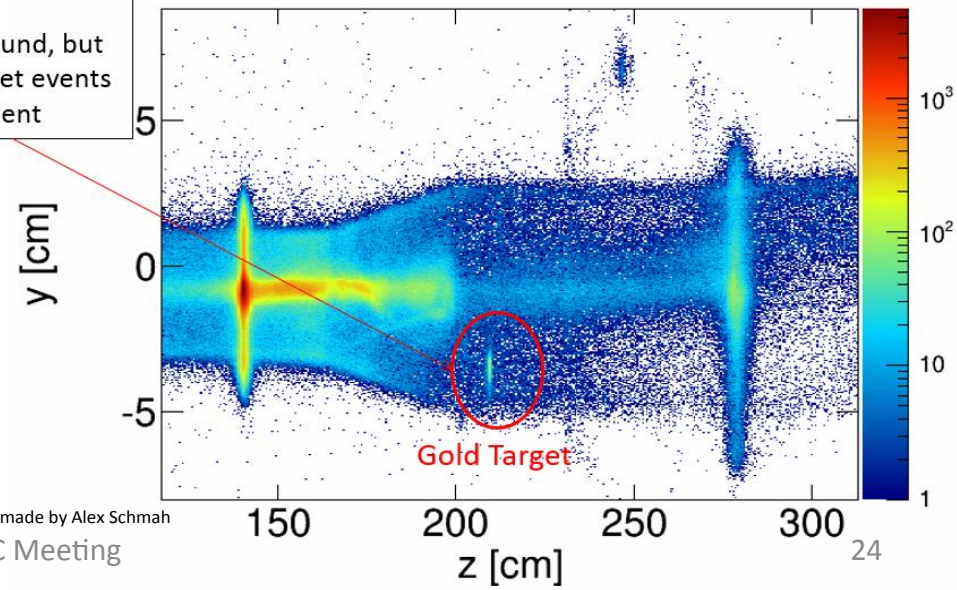


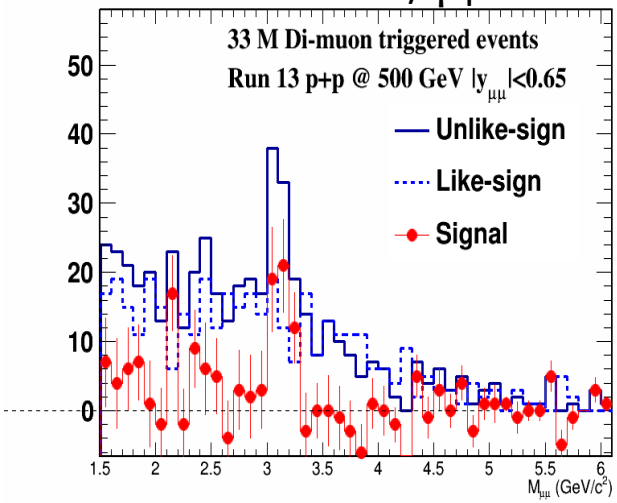
Figure made by Alex Schmah

Heavy-Ion Highlights: Quarkonia

J/ψ→μ+μ-(BR~6%), ϒ→μ+μ-(BR~2.5%)

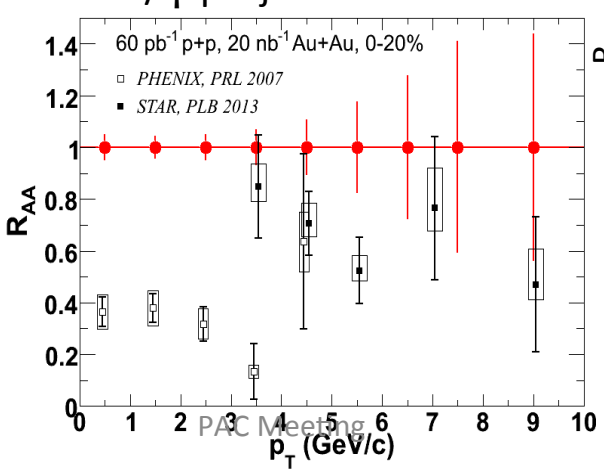
- no γ conversion
- less Bremsstrahlung → better resolution
- less contribution from Dalitz decays
- trigger capability for J/ψ in central A+A

Reconstructed J/ψ peak

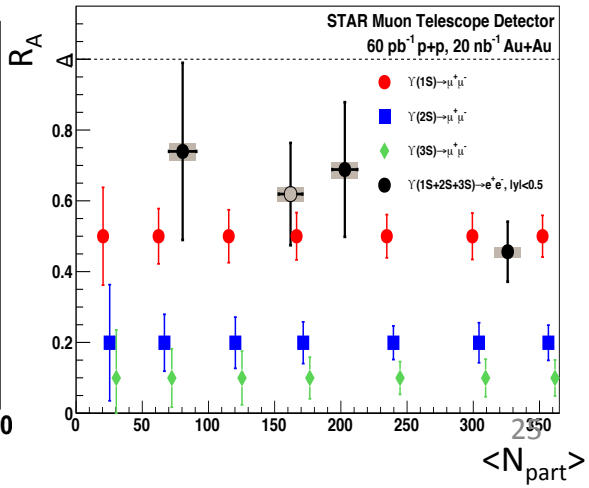


- Run 13: MTD dimuon trigger commissioning
  - ➢ J/ψ production in pp@510GeV
- Run 14 data with full MTD
  - analyses ongoing
  - ➢ J/ψ RAA/v2

J/ψ projected stat. errors



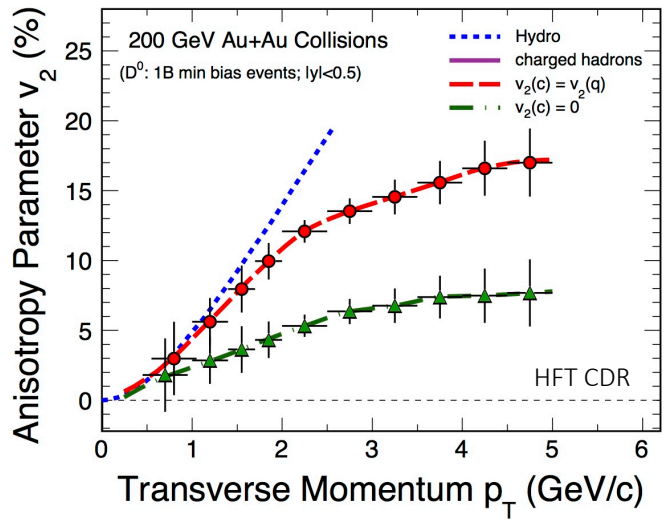
ϒ projected stat. errors

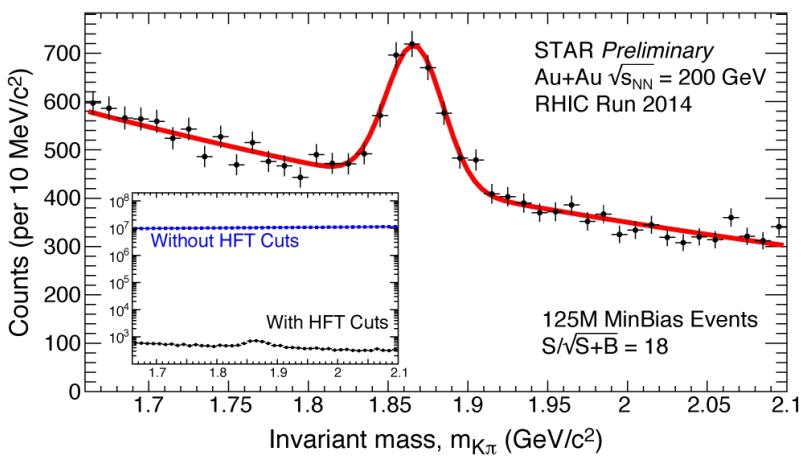


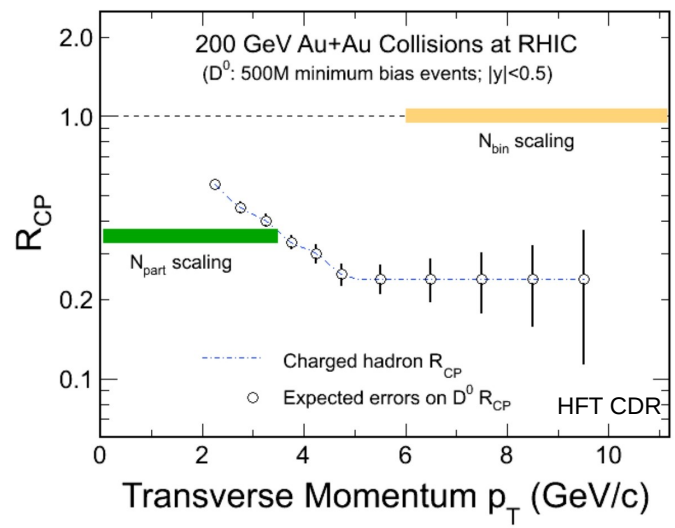
Heavy-Ion Highlights: Open Charm

- HFT will enable high-precision open-charm measurements
  - charm v_2 and R_{CP}
- Analyses are all ongoing
  - $D^{0/*/\pm}$ $R_{AA/CP}$ and v_2
  - D_S measurements

➢ clear D^0 signal with HFT
  - when compared without







STAR at Major Conferences in 2015

SPIN 2014 + DIS 2015

- open heavy-flavor
- IFF and Collins A_N in pp @ 200,500 GeV
- jet A_{LL} measurements in p+p @ 200,500 GeV
- $W^{\pm}$ A_L in pp@510 GeV
- $W^{\pm}$ A_N measurements in p+p
- $W^{\pm}$ cross sections ratios pp
- STAR forward upgrades

HardProbes 2015

- accepted: 6 oral + 4 posters
- one plenary (invited)

- di-jet imbalance
- jet production
- open charm

HardProbes 2015 (cont'd)

- bottomonium production
- J/ψ in pp@500GeV
- dielectron and direct virtual photon
- [poster] D0 reconstruction with HFT

SQM 2015

- accepted: 6 oral
- one plenary (invited)

- J/ψ and ψ(2S) in pp@{200,500}GeV
- BE correlations of kaons in p+p
- strangeness in U+U
- central dependence v2 of multi-strange particles
- K^0, Λ, and Ξ measurements @14.5GeV
- Phi-meson v2 in UU and AuAu

Summary

- Runs 13 and 14 have been very successful runs
  - new HFT & MTD with improved DAQ and high luminosities
  - STAR has entered its high-precision Heavy-Flavor era
  - 14.5GeV data set concludes BES Phase-1
- Run 13 p+p production finished
  - data is included in ongoing analyses
- Run 14 productions are underway
  - 14.6 GeV ready, analyses in final stages
  - 200 GeV ongoing, expect to finish by Feb'16
    - aim to have >50% ready by QM2015
  - small ^{3}He+Au set produced, full production after QM2015
    - statistics preview sample limited
  - ➢ concern regarding scalability of offline production resources
- BES results and papers steadily made available to HI community
  - 14.5GeV results to be integrated in existing BES paper proposals

➢ Looking forward to new data sets with new results!

STAR Paper Proposal Tracking

Note: input to each plot involves published papers only