REPORT ON RUN 14, THE VIEW FROM STAR

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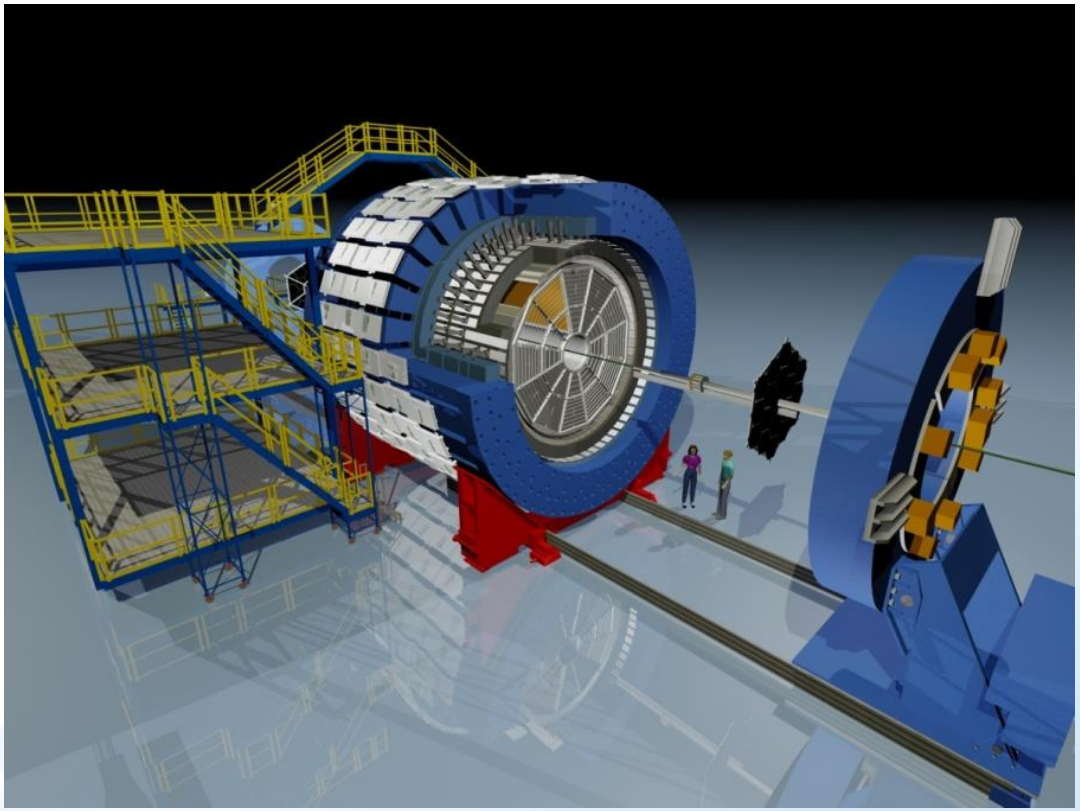
For the STAR Collaboration
August 13, 2013

BROOKHAVEN NATIONAL LABORATORY
a passion for discovery

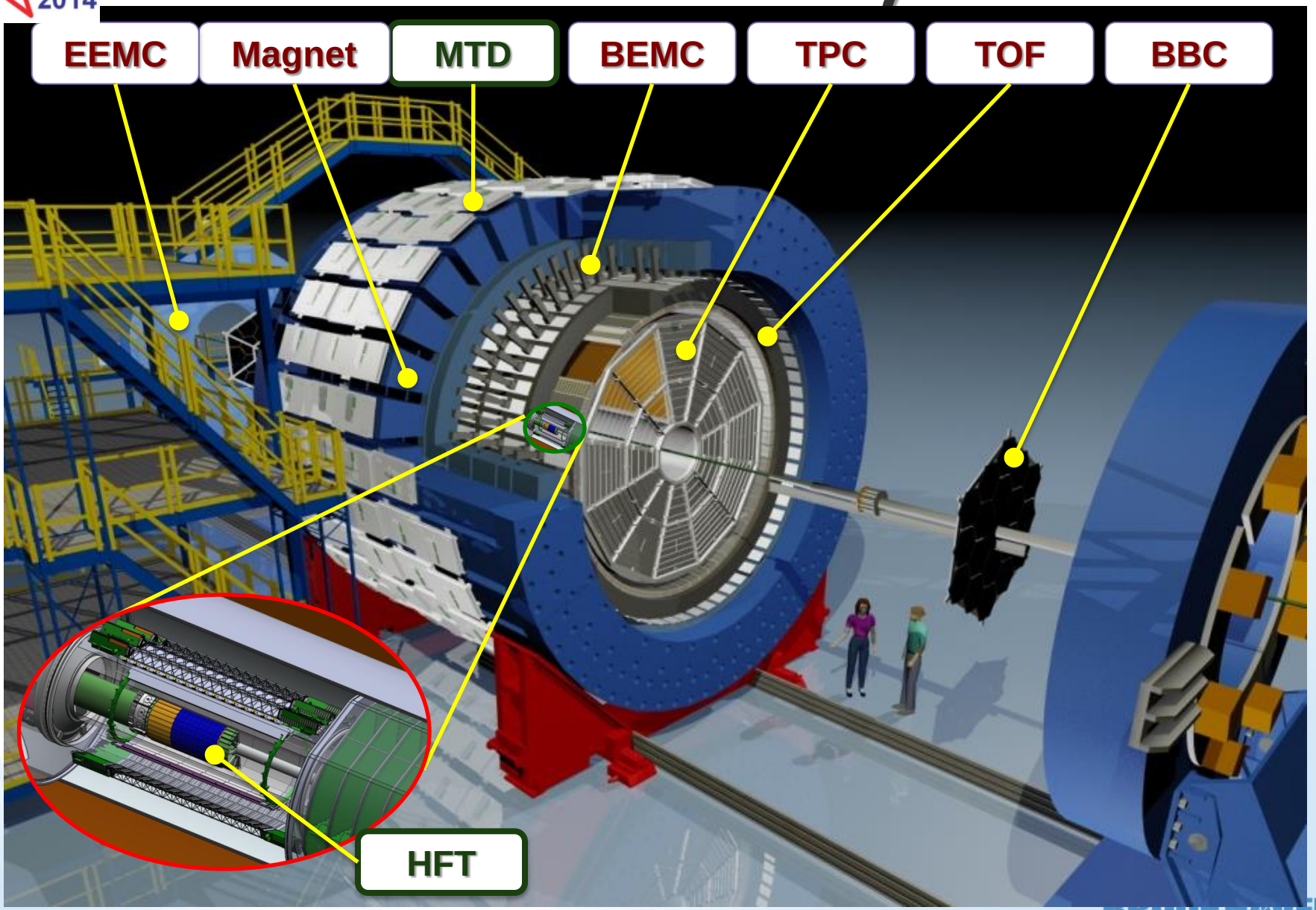
U.S. DEPARTMENT OF ENERGY | Office of Science

Outline

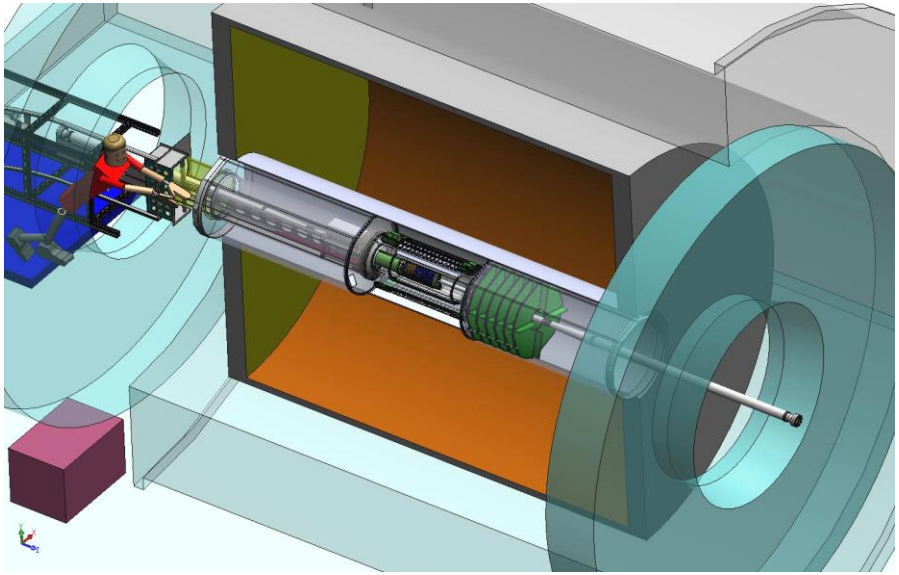
- New/enhanced detector sub systems for Run 14
- STAR Running Efficiency
- Summary of data sets accumulated
- Shutdown work in preparation for Run 15
- Critique comments for Run 14
- Summary

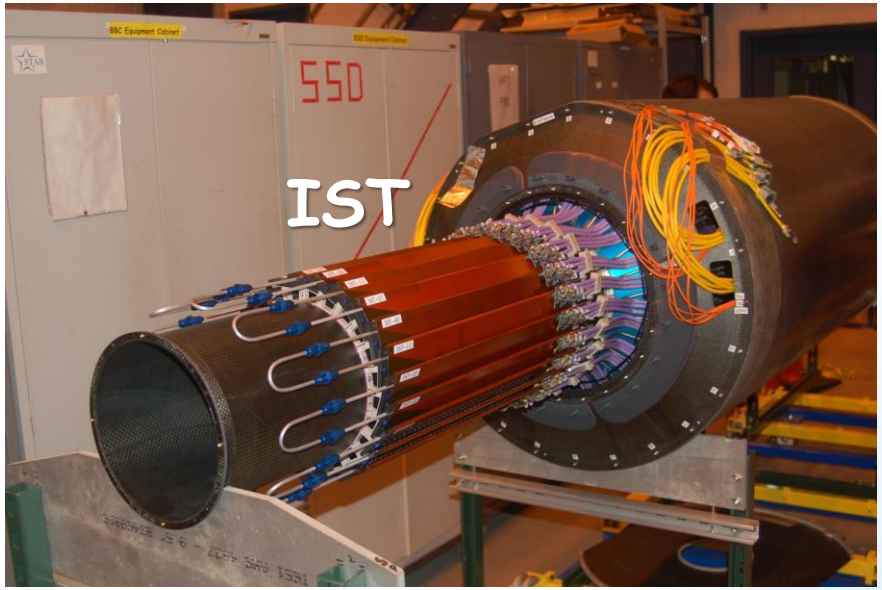


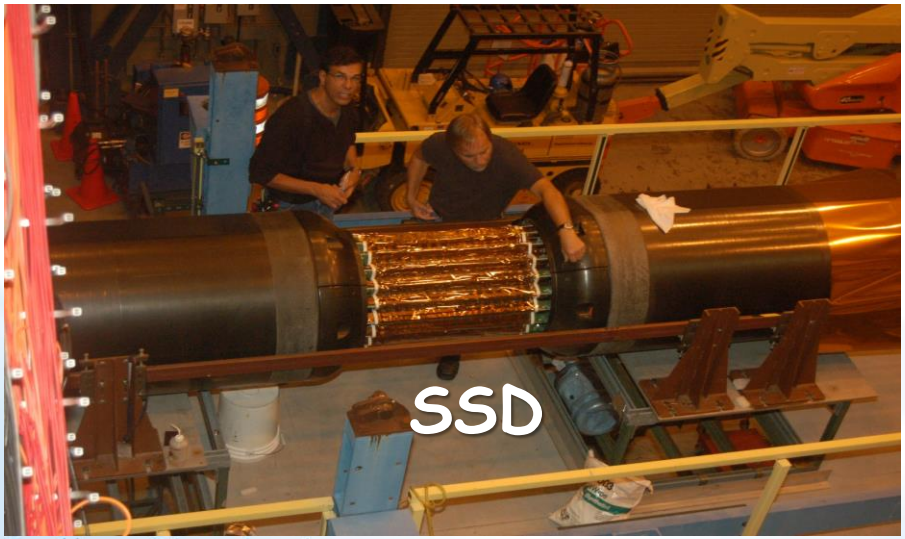
STAR Detector System

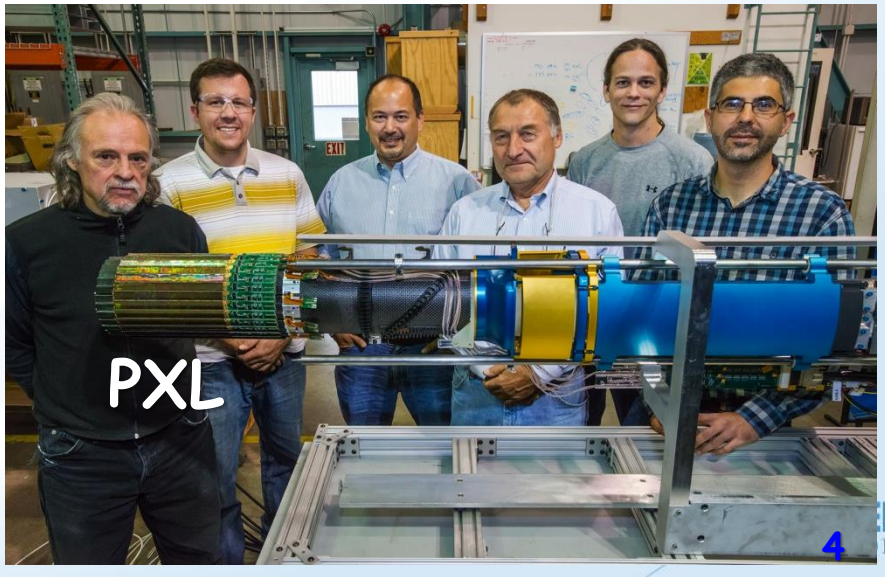


HEAVY FLAVOR TRACKER

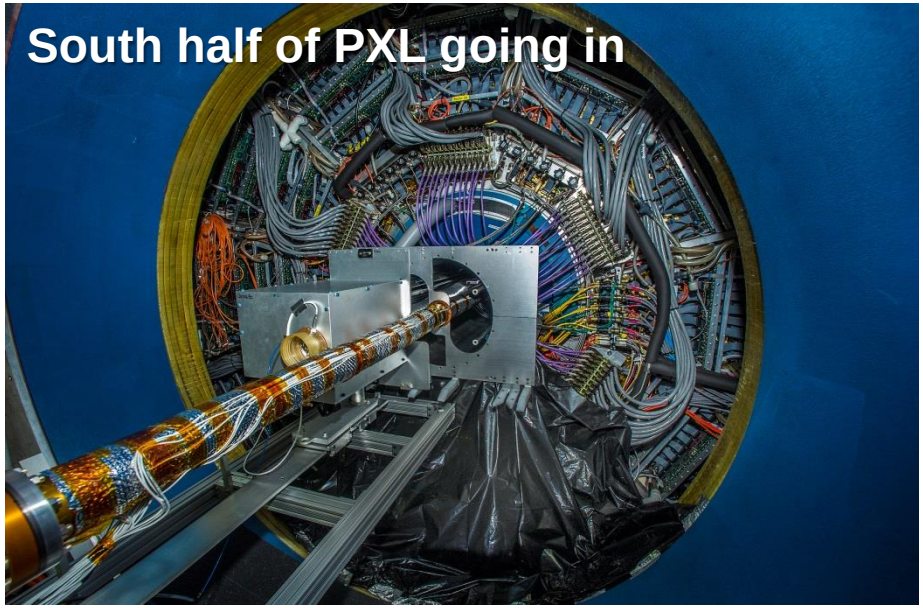


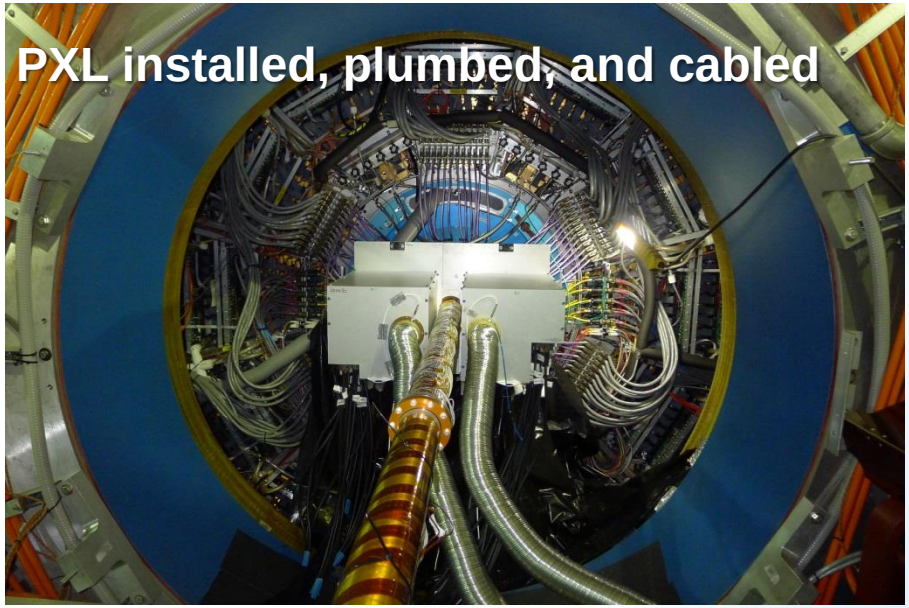


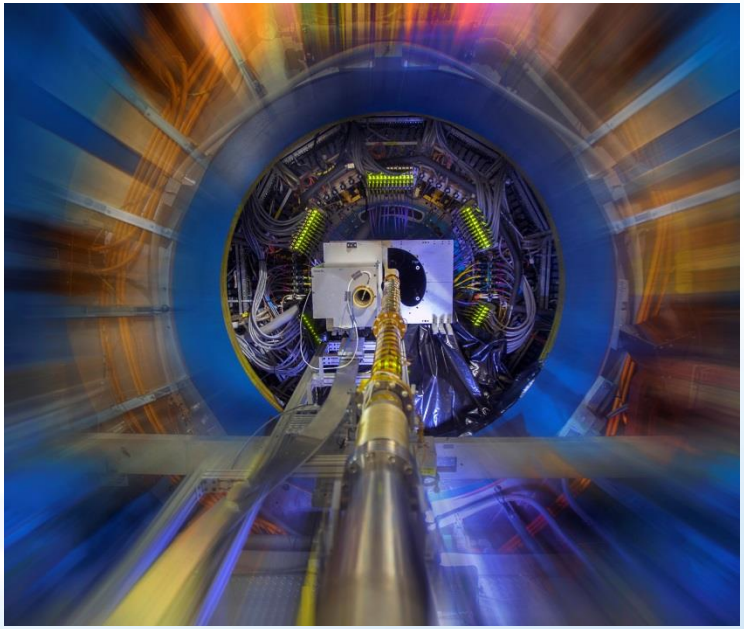




PXL Installed, plumbed for air, and cabled January 24 – 26th

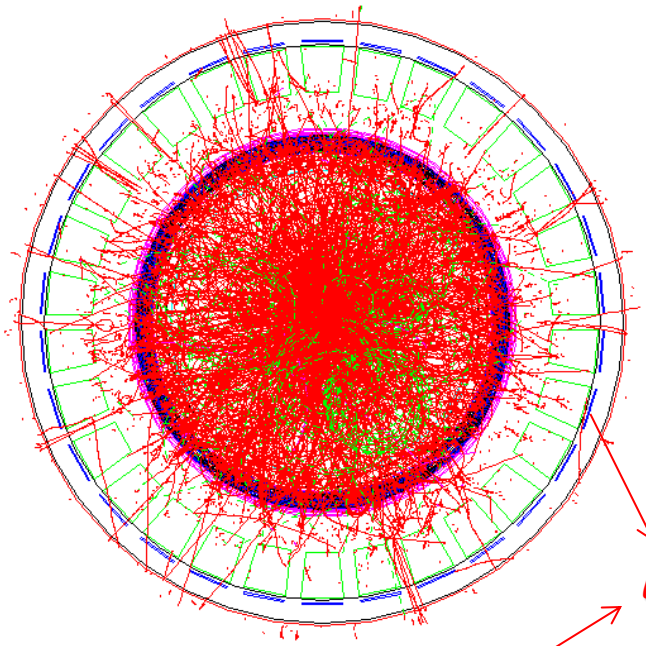


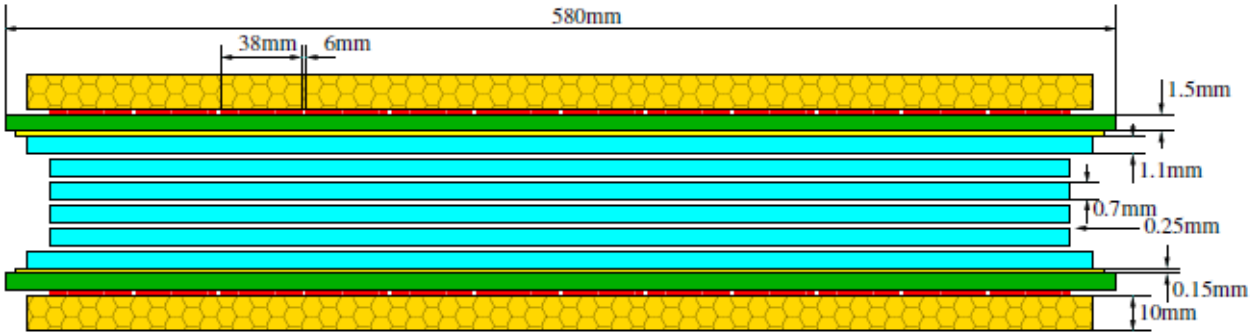


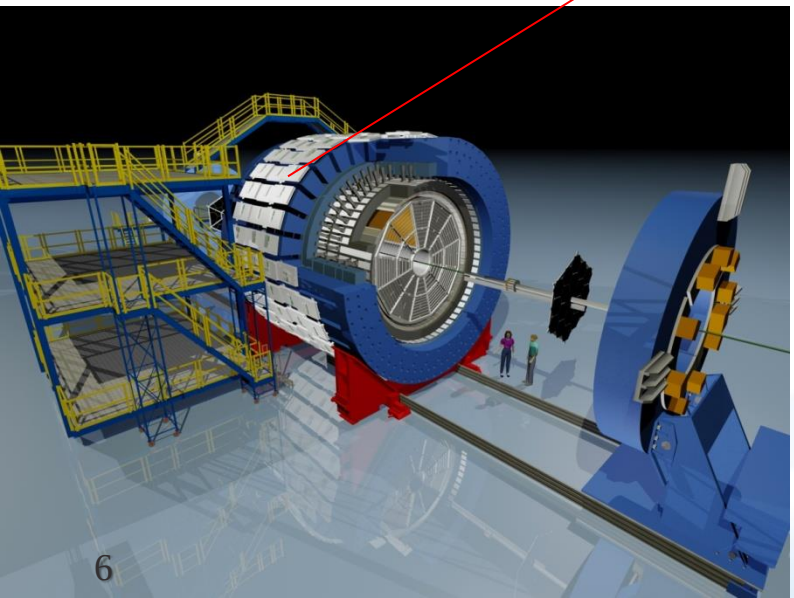


Artsy Picture courtesy of Joe Robino, BNL Photography

THE MTD AT STAR







Multi-gap Resistive Plate Chamber (MRPC): gas detector, avalanche mode

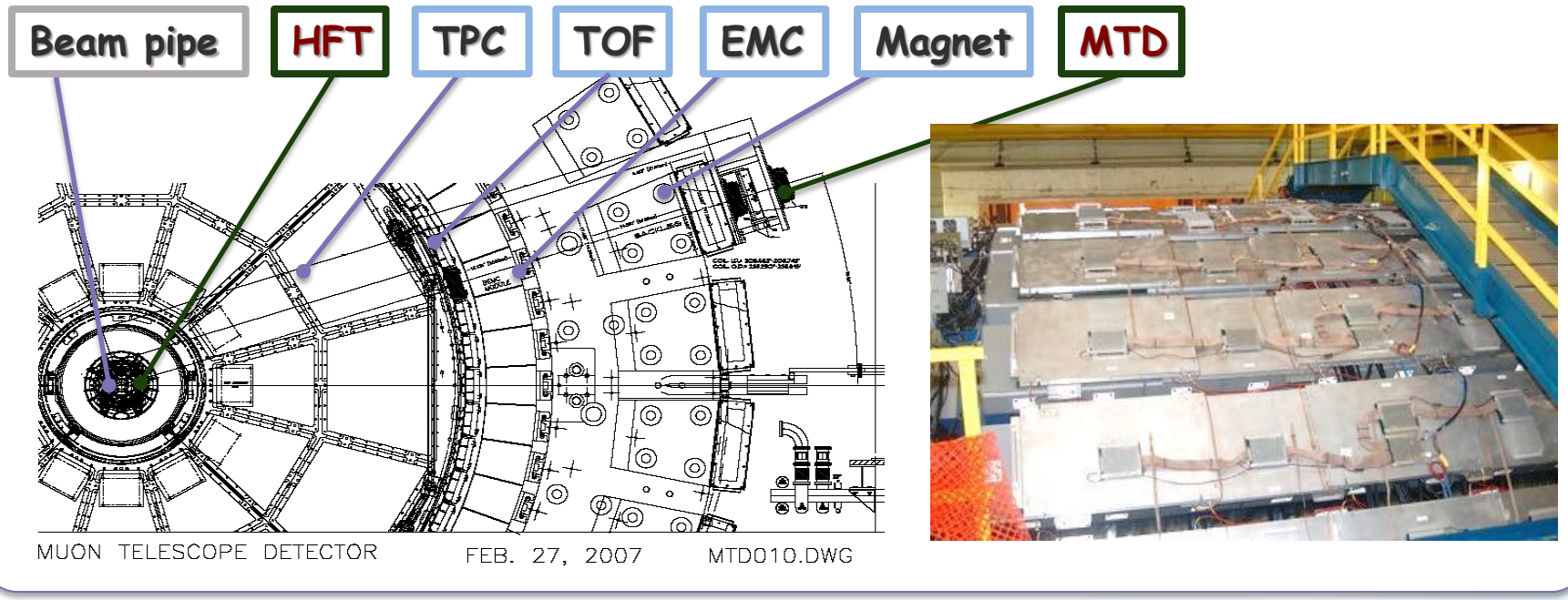
A detector with long-MRPCs covers the whole iron bars and leave the gaps in-between uncovered. Acceptance: 45% at $|\eta|<0.5$

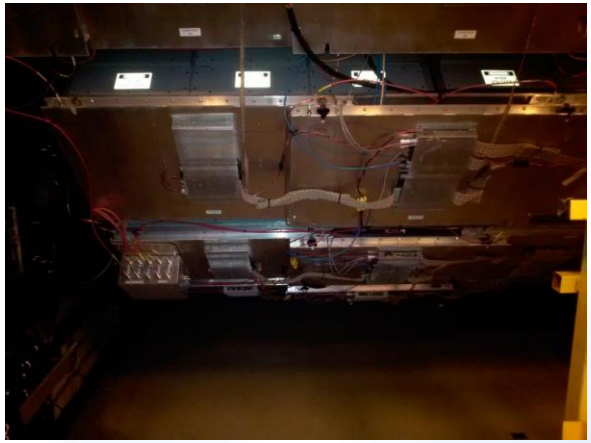
122 modules, 1464 readout strips, 2928 readout channels (full system)

Long-MRPC detector technology, electronics same as used in STAR-TOF

Slide courtesy of L. Ruan

STATUS: MUON TELESCOPE DETECTOR





Run 14 installation (under STAR)

Complete system installed and operational for Run 14

RHIC Run 14 Retreat

PHYSICS REQUEST FOR RUN-14

Run	*	Beam Energy	Time	System	Goals
14	2	$\sqrt{s_{NN}}$ = 15 GeV	3-week	Au + Au	1) 150M M.B. events for CP search 2) Fixed-target data taking
	1	$\sqrt{s_{NN}}$ = 200 GeV	14-week	Au + Au	HFT & MTD heavy flavor hadron measurements L=10 nb^{-1}, 1000M M.B.

Di-muon, e-muon utilizing the completed Muon Telescope Detector (MTD)

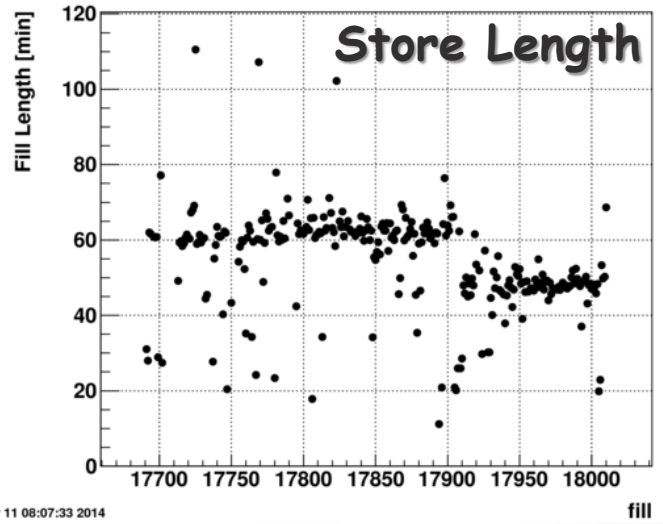
Open heavy flavor minimum bias program with the newly installed Heavy Flavor Tracker (HFT)

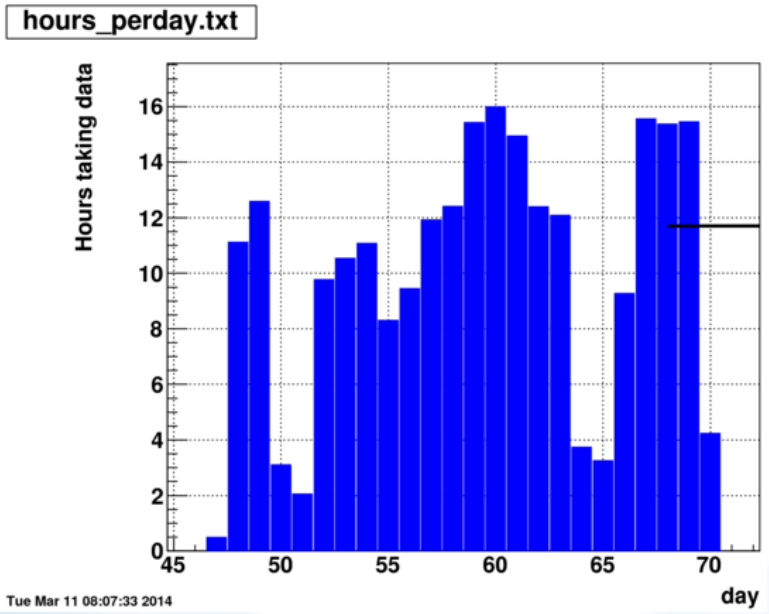
These programs are multi-year for AA and pp 200 GeV

BES-I: filling the gap in mu_B between 11.5 and 19.6 with 14.5 GeV

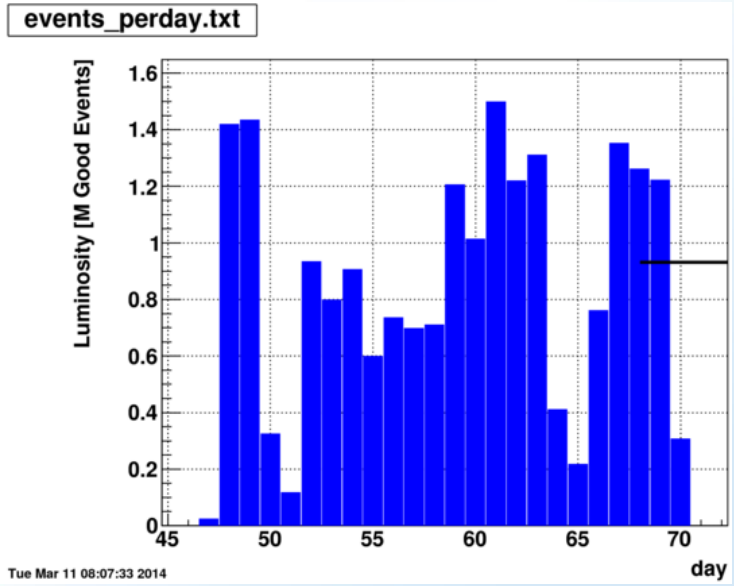
14.6 GeV Au+Au Physics Run

Feb 13th: First Collisions
Feb 17th: Start Taking Data
Mar 11th: reach mb Goals
Mar 11th: 14.5 GeV run over
Acquired: 21 M VPD_mb in 22 Days





Average of ~ 12 hrs/day taking data

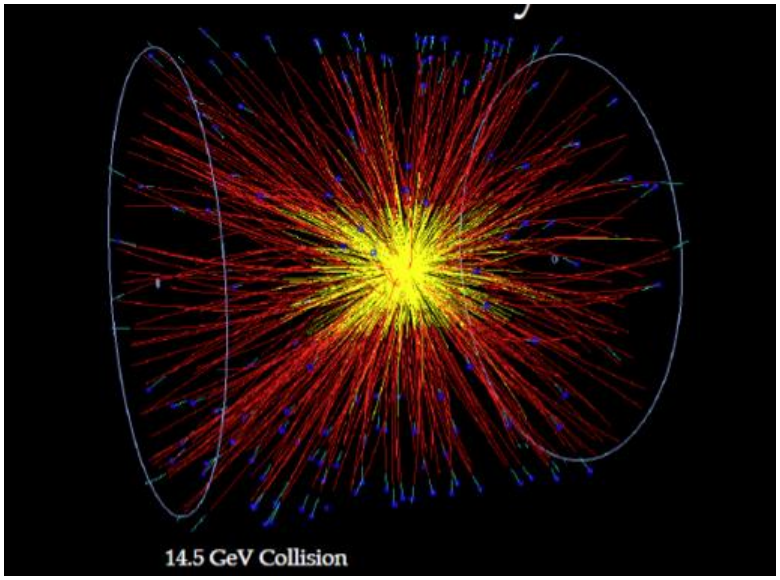


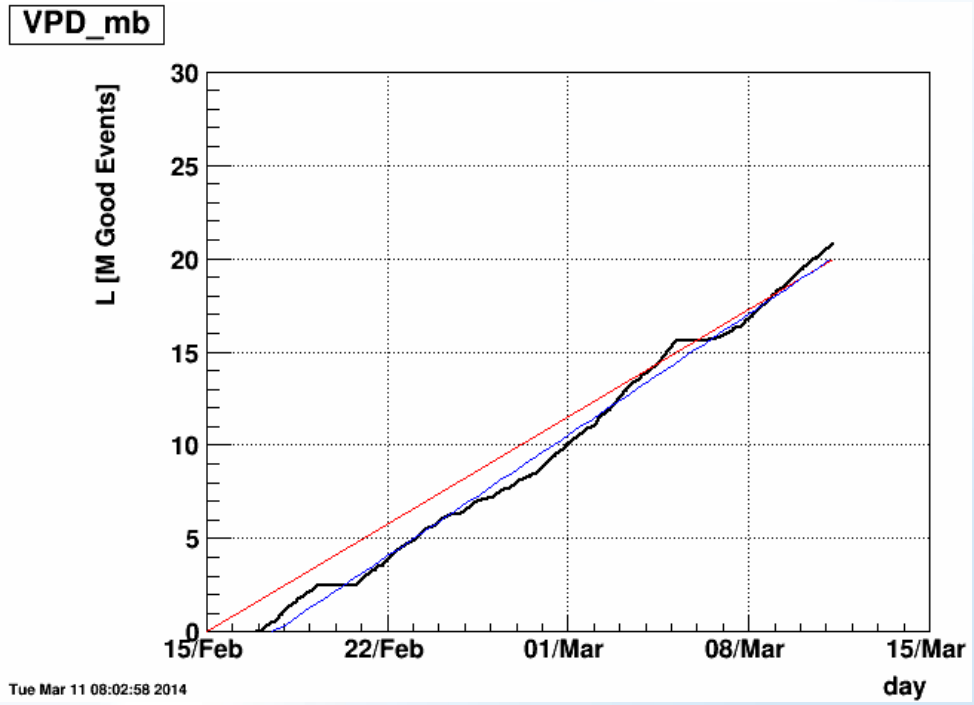
Average of ~ 950 kevts/day

Run 14 14.6 GeV AuAu Data Set

Statement of 14.6 GeV Data Set Goal:

To accumulate enough raw event triggers such that, when the data is analyzed, we end up with at least 20 million events of "*good*" collisions, defined as having Vr (sqrt(vx^2 +Vy^2) within 1.5 cm of the nominal beamline, and Vz (along the beamline) within +- 30 cm of the center of STAR.

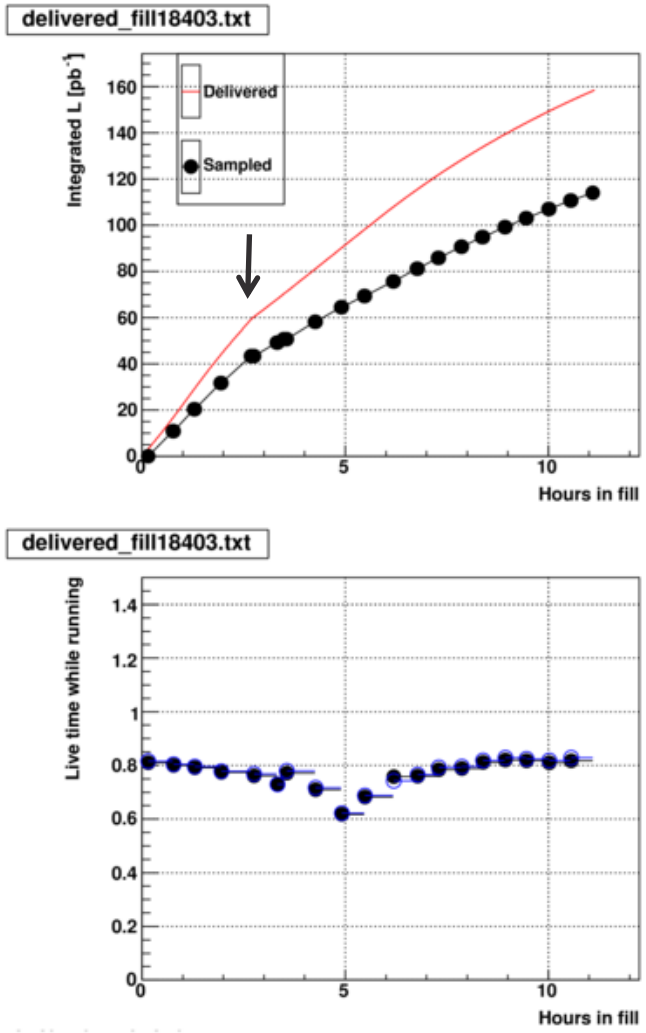




We met our 14.6 GeV Data set goal.

STAR'S RUNNING EFFICIENCY FOR 200 GEV AU+AU

Fill 18403
Started Sun Jun 8 07:23:28 2014
Ended Sun Jun 8 18:31:41 2014
11.1 Hours
Total delivered: 158.439 ub^-1
Average delivered: 39.518x10^26 cm^-2s^-1
Sampled Fraction: 0.727
after correction by average TCULive/Live: 1.011
Fraction of L delivered while taking data: 0.937
Fraction of hours delivered while taking data: 0.942
Minutes lost before first run: 8.9 Frac: 0.013
Minutes lost after last run: 3.0 Frac: 0.005
Luminosity fraction lost before first run: 0.019
Luminosity fraction lost after last run: 0.002
Average Live Time while taking data: 0.768
Live Time from TCU Counters while taking data: 0.776
Luminosity fraction lost in lasers: 0.000
Hours lost in lasers: 0.0 Frac: 0.000

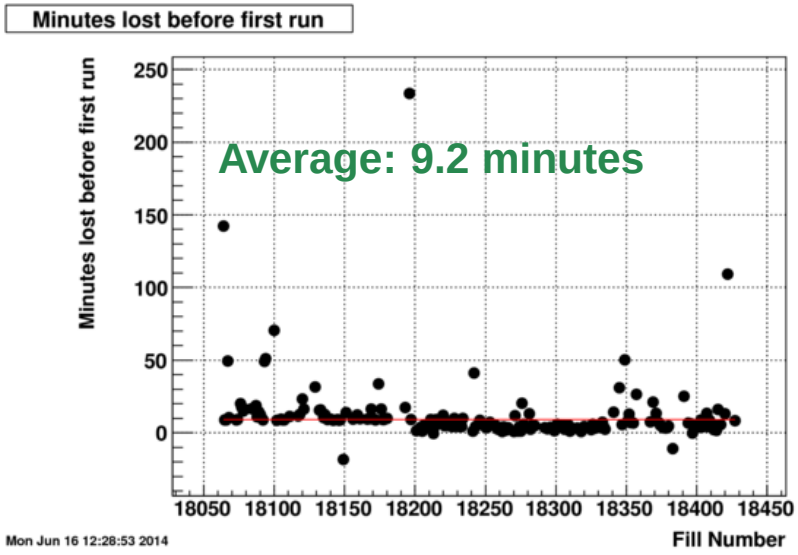


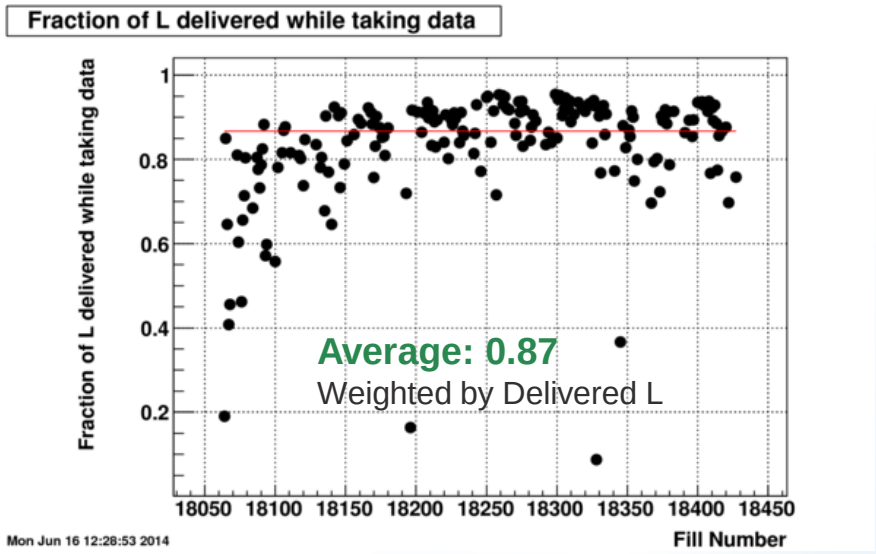
Example of how data on STAR's running efficiency is collected, calculated, and plotted for each RHIC Store.

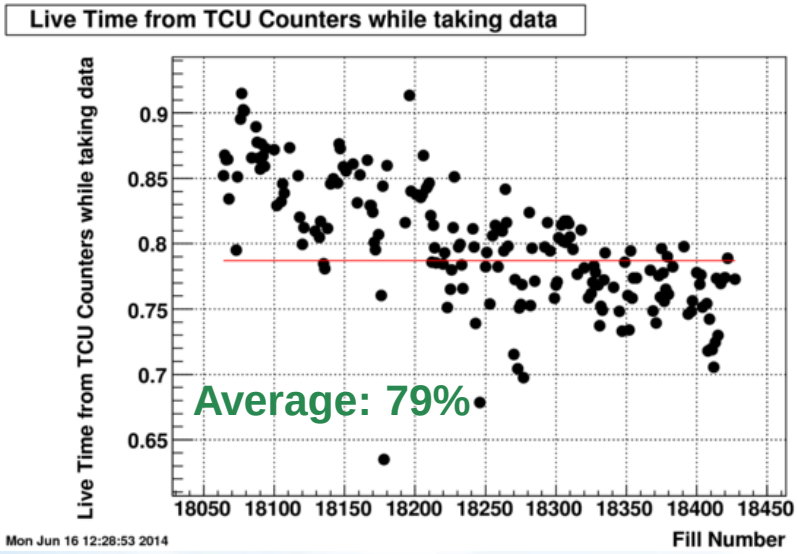
Following slide shows these store by store calculated values plotted for the entire RHIC Run 14 200 GeV Au+Au.

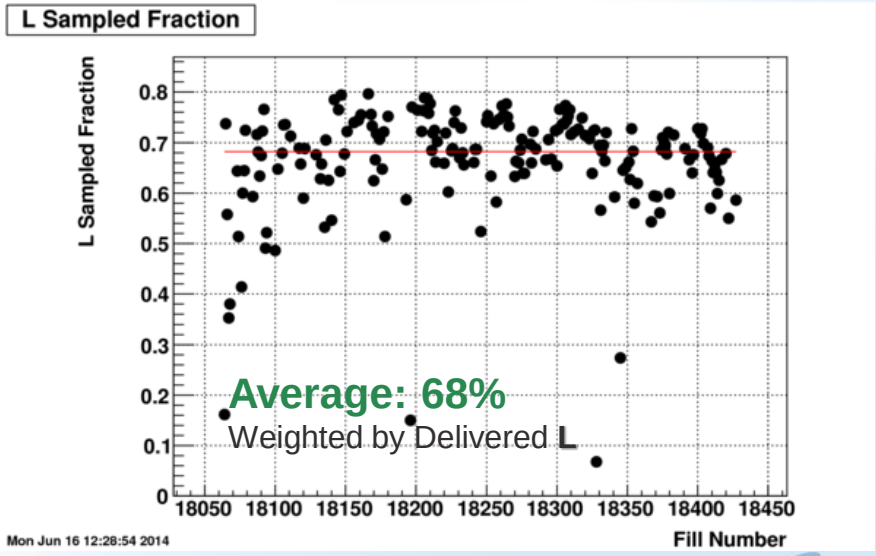
Utility and Web page done by J. Dunlop

STAR'S RUNNING EFFICIENCY FOR RUN 14



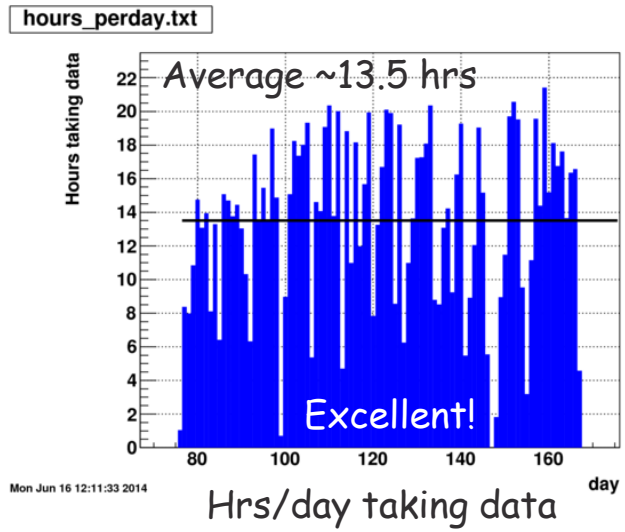




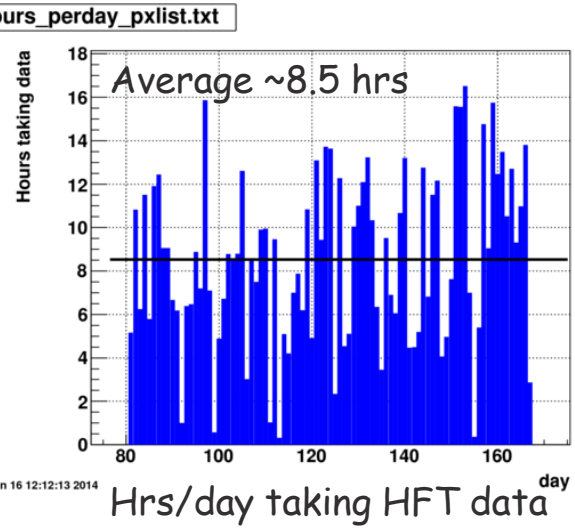


Plots only include 200 GeV Au+Au Fills up to June 16th

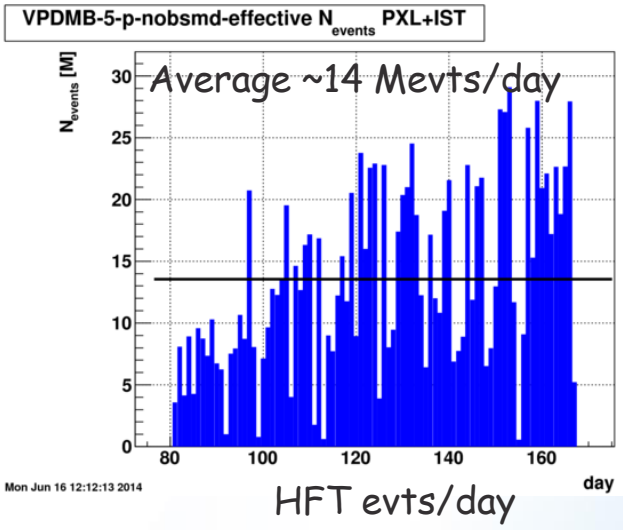
Run Optimization for 200 GeV Au-Au Data Run, balancing competing goals



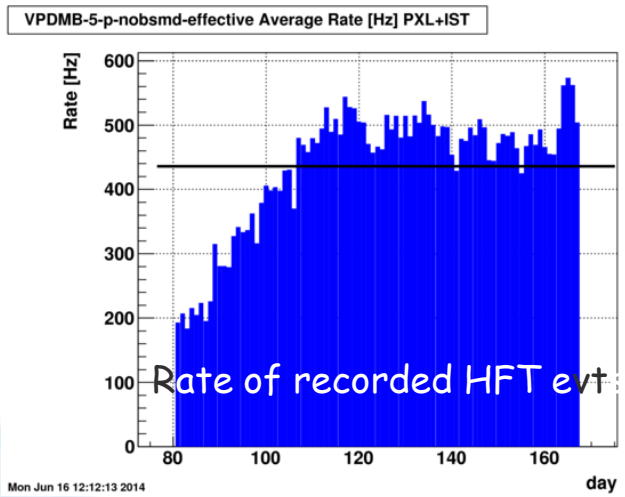
Hrs/day taking data

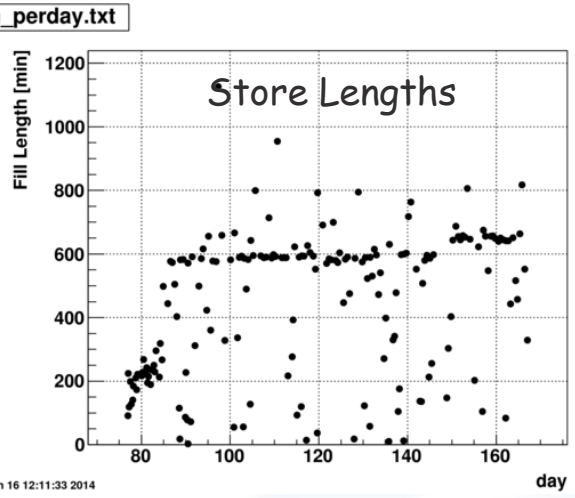


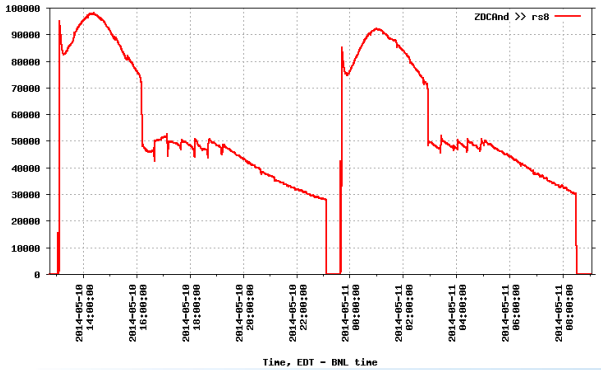
Hrs/day taking HFT data



HFT evts/day





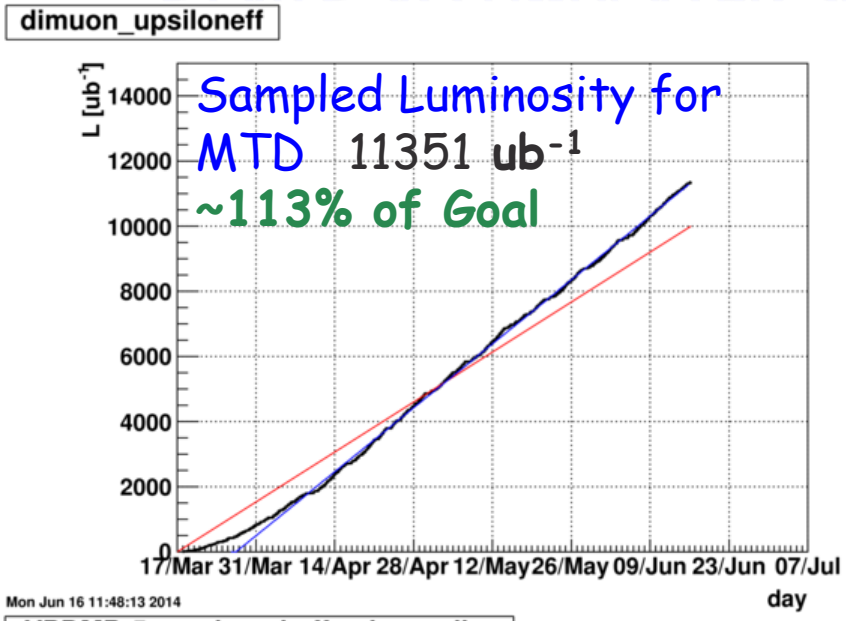


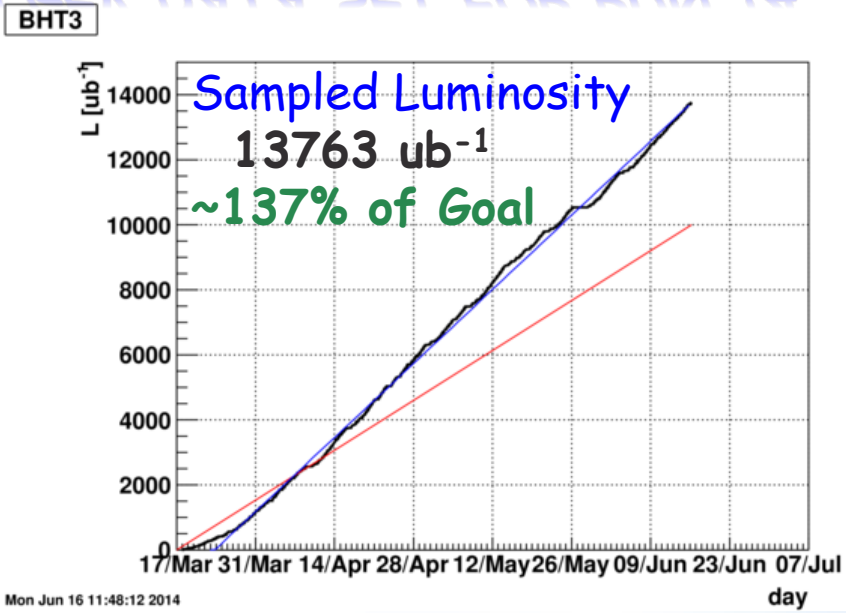
"Tuned" lumi. Profile (THOR)

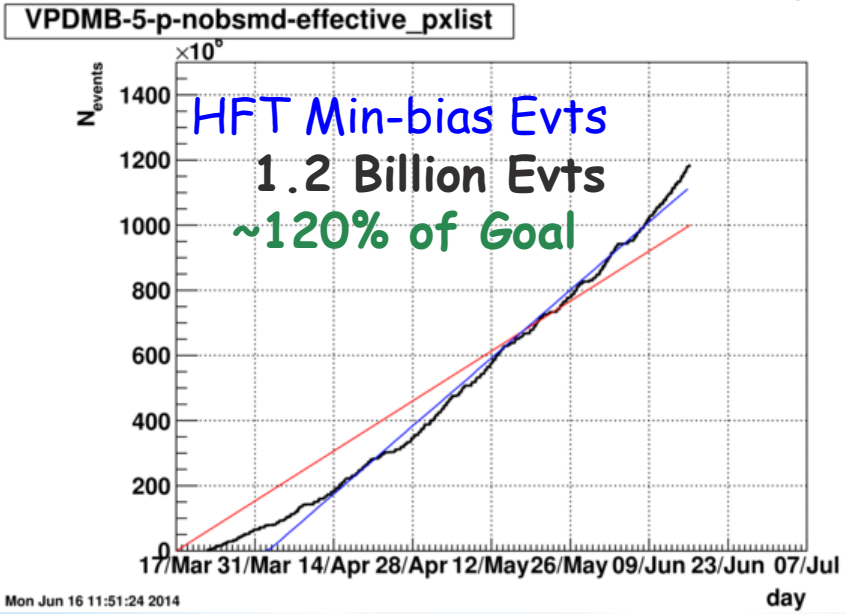
- MTD samples all of the high luminosity part of the store (Luminosity)
- HFT is included at interaction rates <=55 kHz to minimize latch up rates, and pileup (Time at store)
  - Record ~ 7-8h for HFT minbias program out of 10-11
  - HFT readout at ~ 1KHz; Rate to tape after protection and HLT selection ~500

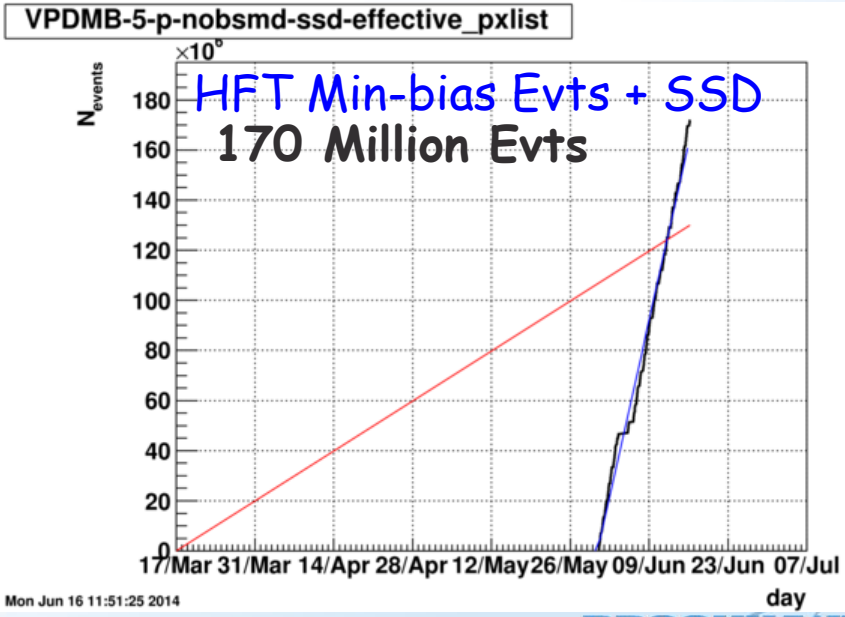
Thanks to CA-D for implementing these procedures

STAR'S ACCUMULATED 200 GEV DATA SET FOR RUN 14



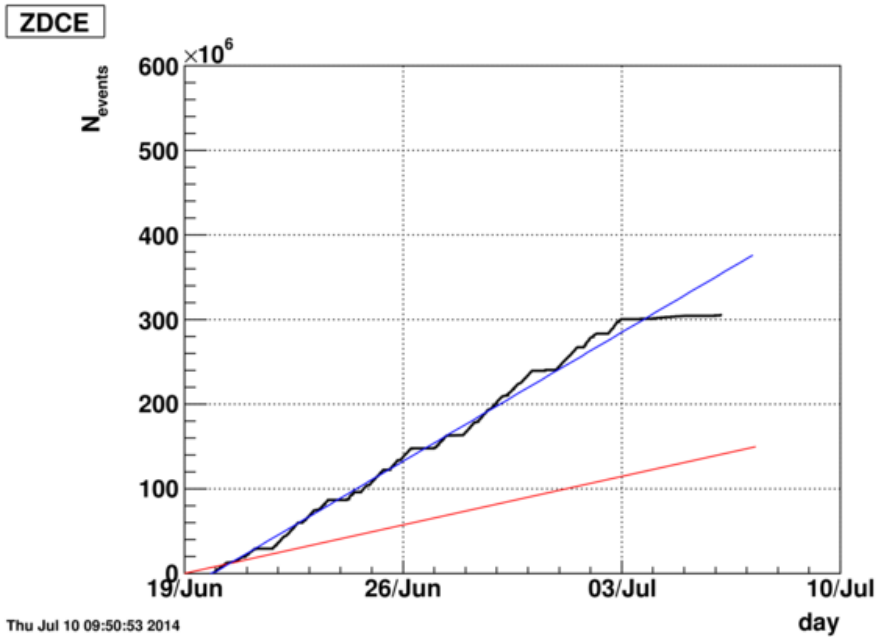


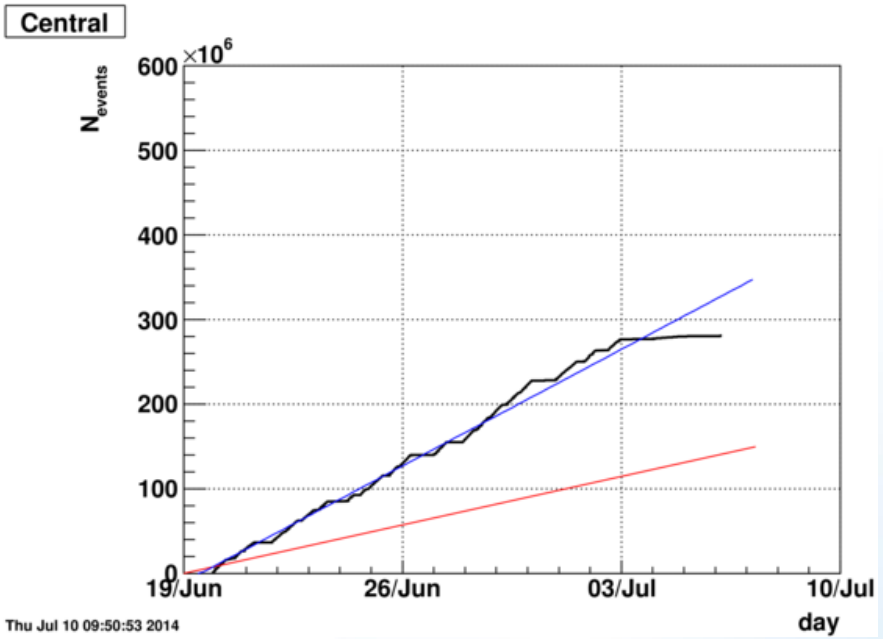




We met our 200 GeV Data set goals.

STAR's Accumulated He^3-Au Data set for Run 14





Goals STAR formed during the run (He3-Au was not in plan) were to collect 150 Mevts of min-bias and "central" collisions.

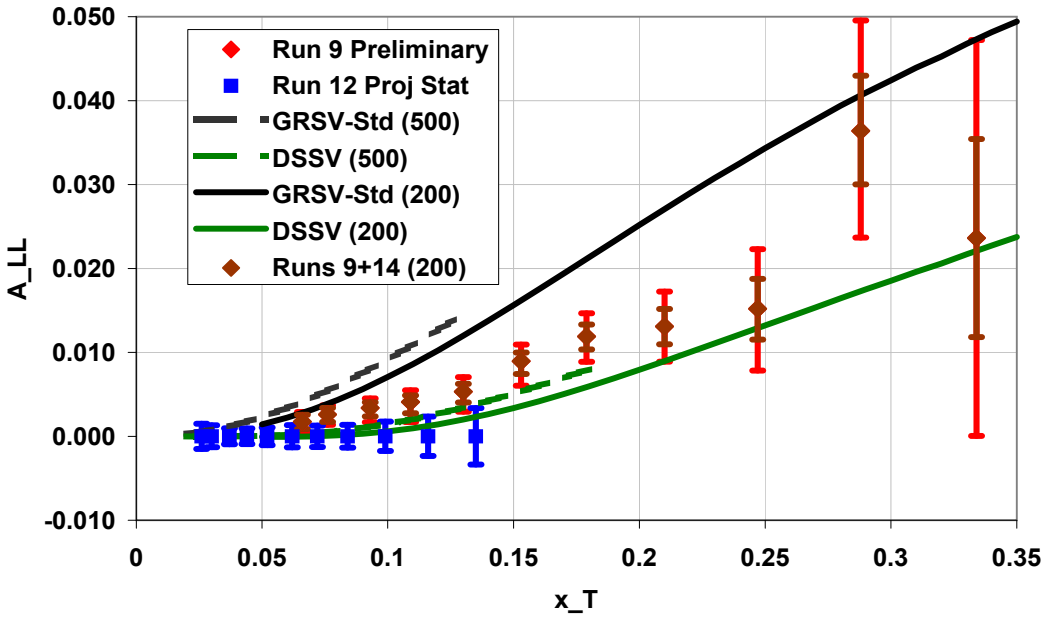
Goals were exceeded.

EXECUTIVE SUMMARY
(FROM 2014 PAC MTG)

Run	Energy	Duration	System	Goals	priority	sequence
15	$\sqrt{s_{NN}}$=200GeV	5-week	Transverse p+Au	saturation physics, ridge and reference, L=300 nb^{-1}	1	**3**
	$\sqrt{s}$=200GeV	12-week	1) p+p	1) HI reference L=90 pb^{-1}, 500M MB		
			2) transverse 6 weeks	2) Study transversity, Sivers effects L=40 pb^{-1}, 60% pol.	2	**2**
			3) longitudinal 6 weeks	3) Study $\Delta g(x)$ L=50 pb^{-1}, 60% pol.	2	**1**
16	**$\sqrt{s_{NN}}$=200GeV**	**10-week**	**Au+Au**	**Λ_c, D v_2, R_{AA}, Υ 10nb^{-1}, 2billion MB**	**1**	**1**
	$\sqrt{s}$=510GeV	**7-week**	**Transverse p+p**	**A_N of W$^{\pm}$, γ, Drell-Yan, L=400 pb^{-1}**	**2**	**2**

AFTER RUNS 2009 TO 2015 ARE ANALYZED

Inclusive Jet @ $|\eta| < 1$:



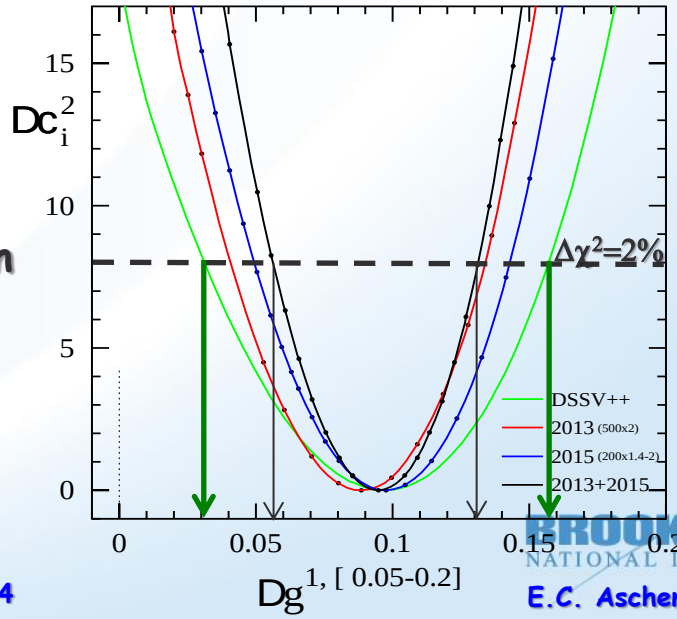
x-range:

200 GeV: 0.05 – 0.2 (1)
500 GeV: 0.005 – 0.2 (1)

Di-Jets: constrain the shape of $\Delta g(x,Q^2)$

2015 200 GeV pp longitudinal

factor ~2 reduction in $\int \Delta g(x,Q^2)$ in the 200 GeV x-range

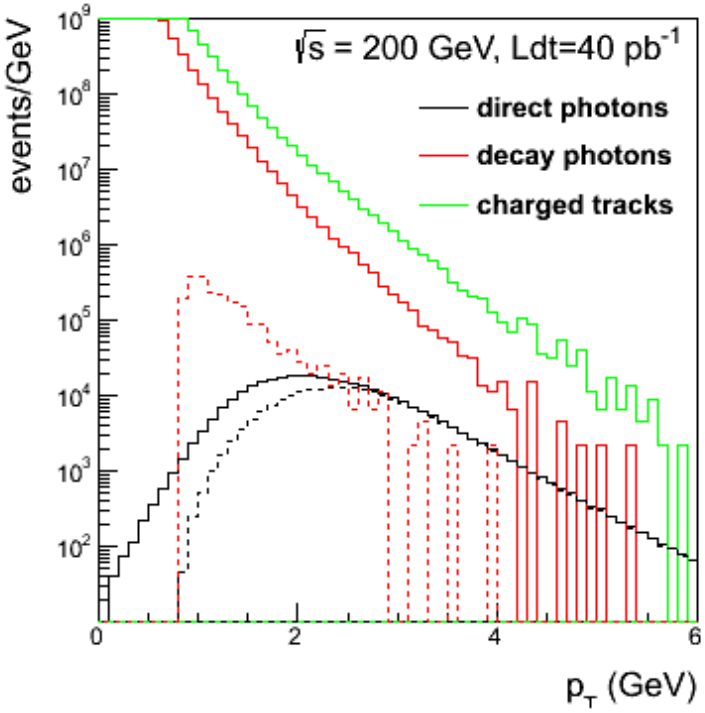


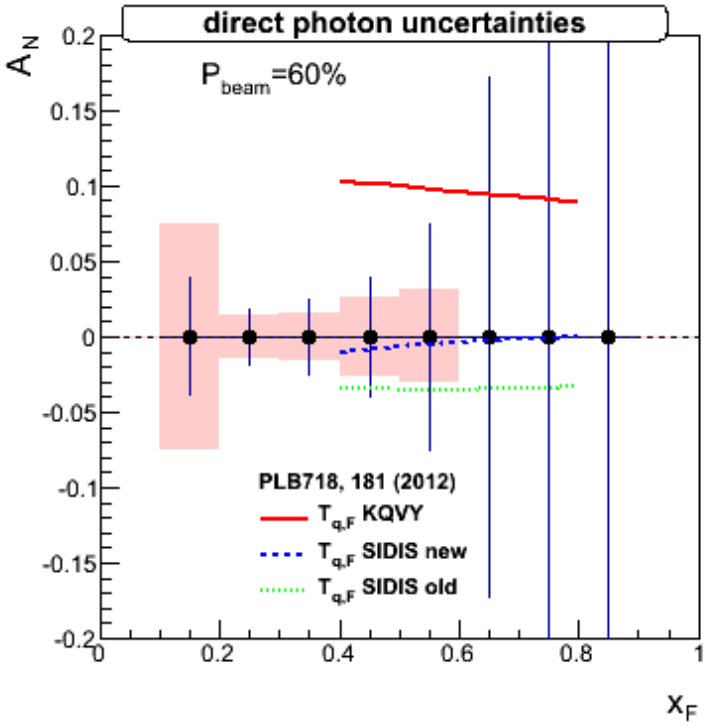
RUN15 TRANSVERSE SPIN GOALS

6 weeks of transversely polarized:
Study transversity, Sivers effects,
A_N direct photon -> Sivers ftn.
L=40 pb^{-1}, 60% pol.

Preshower for FMS:
photon_survival ≥ 0.98
hadron_survival ≤ 0.02

Track matching FMS/PS1,2
$n_{cluster} = 1$ (above 1 GeV)
$E_{cl} > 15.0$ GeV
$p_T > 2.0$ GeV
For systematic uncertainty:
$A_N(\pi^0, \eta) \approx \max(A_N(\pi^0))$





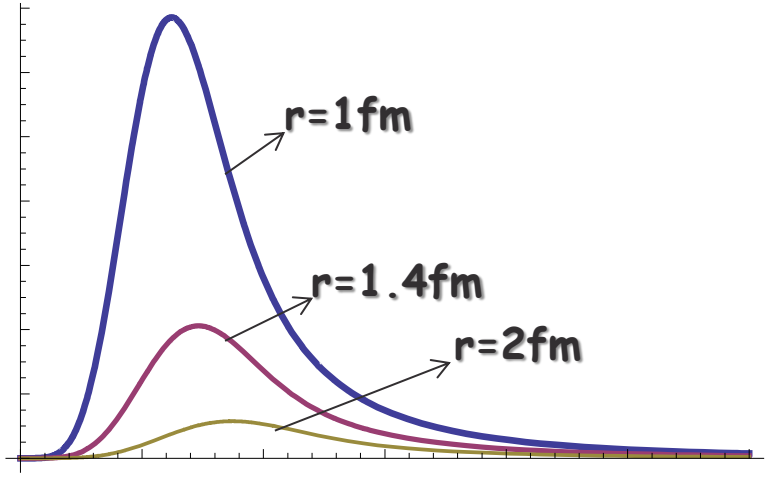
A_N IN p↑A OR SHOOTING SPIN THROUGH CGC

( )

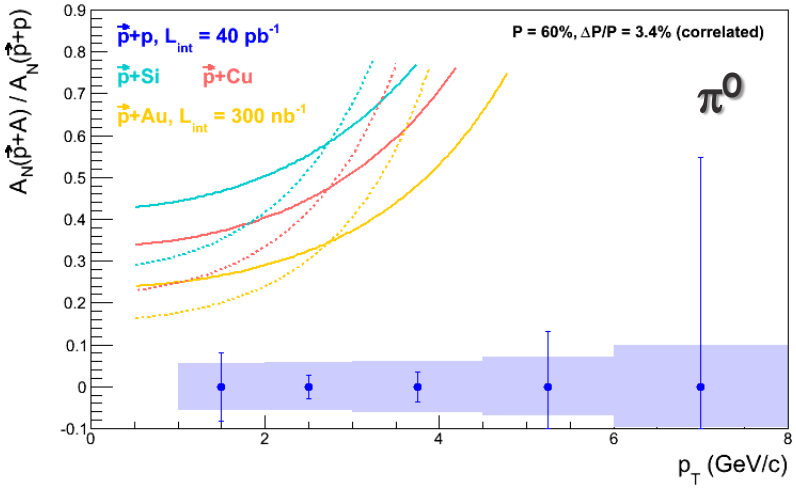
strong suppression of odderon STSA in nuclei.

Y. Kovchegov & M.D. Siever
arXiv:1201.5890.

Q_s=1GeV



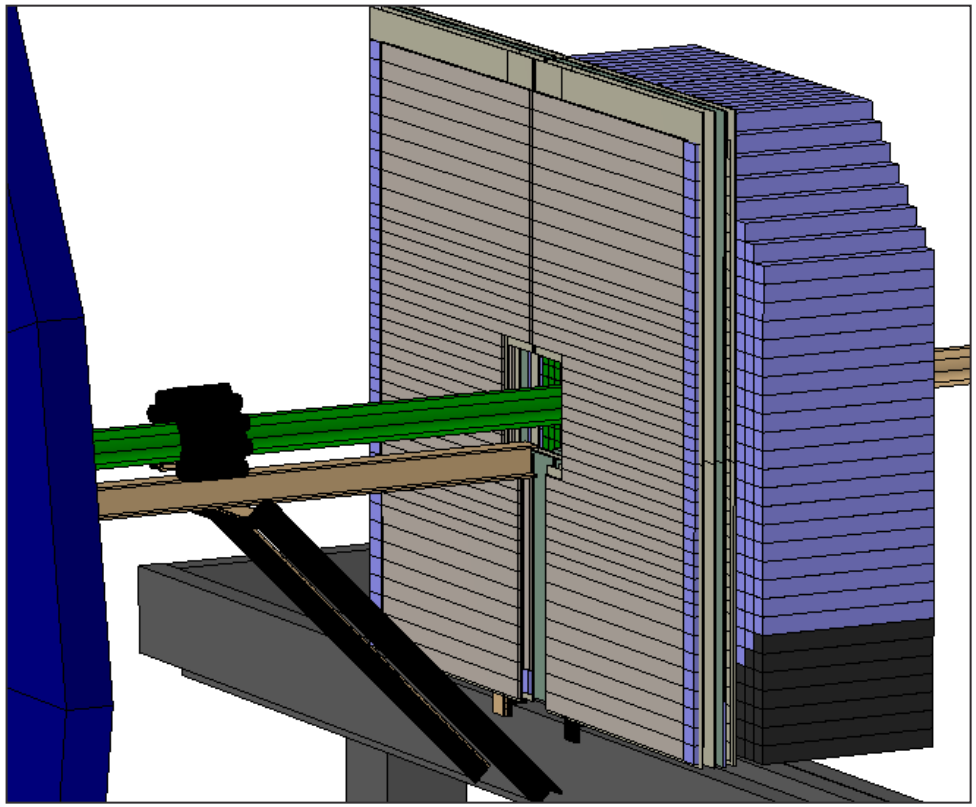
- Very unique RHIC possibility p↑A
- Synergy between CGC based theory and transverse spin physics
- A_N(direct photon) = 0
- The asymmetry is larger for peripheral collisions



STAR: projection for upcoming pA run
Curves: Feng & Kang arXiv:1106.1375
solid: Q_s^p = 1 GeV
dashed: Q_s^p = 0.5 GeV

first measurement p+Au 2015
A-scan 2020+

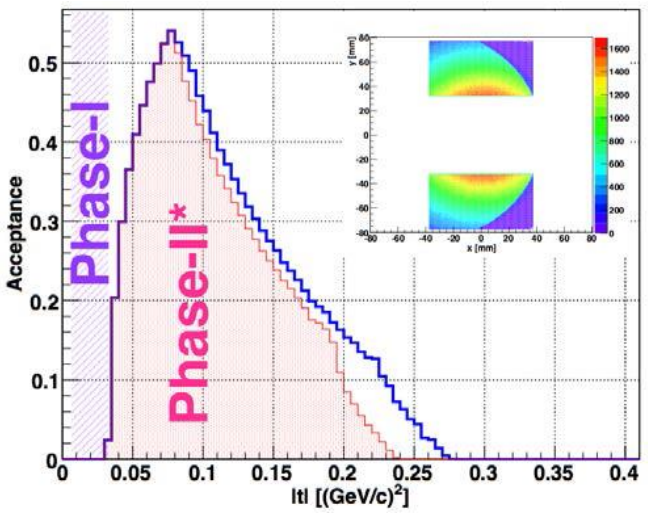
FMS WITH PRE-SHOWER FOR RUN15

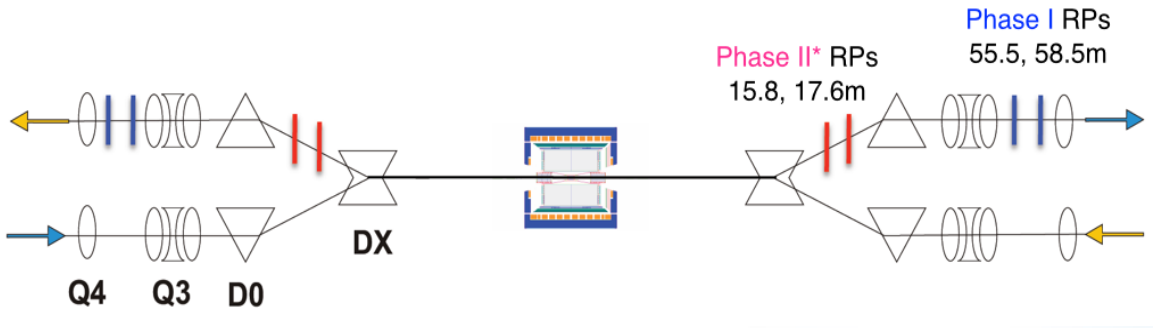


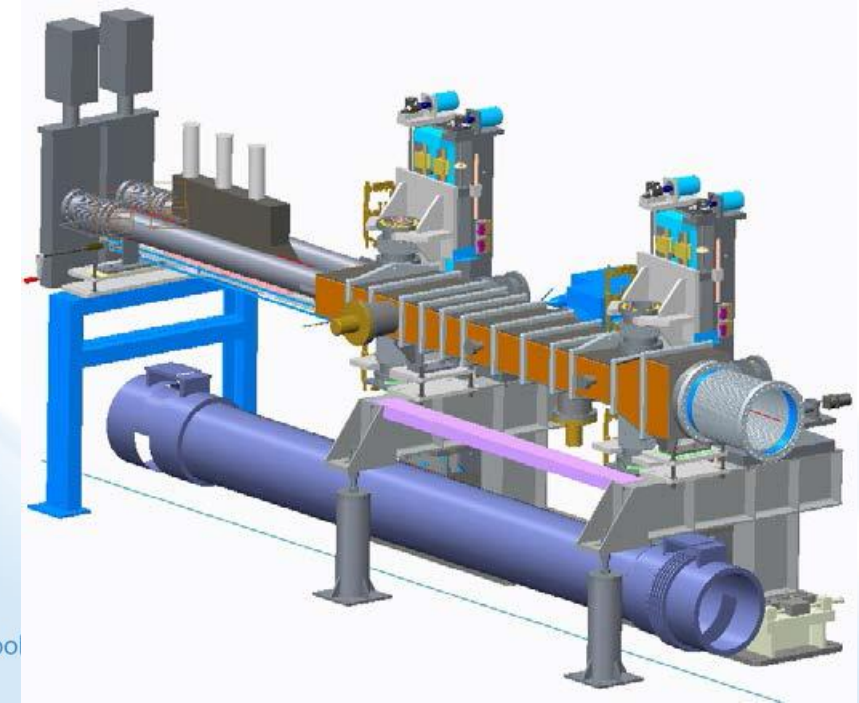
- Physics aim
  - Direct photon measurements
- Forward Meson Spectrometer is being refurbished
- pre-shower added
- 3 layer hodoscope at $2.5 < \eta < 4.0$

FMS pre-shower:
scintillators with Pb convertor and SiPM readout

ROMAN POT PHASE II* (RUN15)







- Will allow taking data without special accelerator conditions,
- Requires new vacuum chamber in DX-D0 region
- Uses Roman Pot system and detectors of pp2pp
- A_N for diffractive processes
- Exotic states

Design accommodates horizontal RPs to allow spectator proton tagging for future $p^{\Uparrow}D$ and $p^{\Uparrow}He^3$ collisions.

Comment on "Things that could be done better" for Run 14 critique

Reminder that these RHIC Retreats were started with one of the key goals of reviewing the just completed run, and identifying and discussing "things that could be done better".

In general, the entire RHIC complex and program ran very well for Run 14. This leads to few specific aspects where one could say "This could be done better".

The one component of the Operation that does come to mind to me was the perceived disconnect between the discussed and scheduled vs the actual time spent for "Machine Development" efforts, in particular with respect to the 56 MHz RF development.

Very early on an issue was that no one associated with the effort attended the scheduling mtgs, and we were left to speculate on their time and resource needs.

I don't have it "quantified", but my impression was that the time scheduled for these efforts was often exceeded, at times by several (i.e. up to 4 or so) hours.

My impression when I'd inquire at subsequent mtgs as to "what happened" and "how/who made the decision to extend the time" was that exactly how the decisions to allocate additional time were made, and by whom, were neither clear nor consistent.

For Consideration: Should a specific individual be made/held responsible for these decisions?

(N.B. An hour of RHIC time is ~ 40 k$)

SUMMARY

- Installed, commissioned, and acquired physics data sets for two major new/extended sub systems in Run 14 (100% of MTD, complete HFT (PXL, IST, & SST)).
- STAR and RHIC Running Efficiencies were very good.
- We exceeded both our 14.6 and 200 GeV Au+Au data set accumulation goals.
- Plans for Run 15 include the refurbished FMS, new psFMS, and Phase II Roman Pots.

IST assembly, June 25, 2013

Last but not least, a big THANK YOU from STAR to C-AD for delivering the high time at store, high luminosity, and dynamic/optimized beam conditions during Run 14!