



STAR Run 16 Schedule

Propose 5.5 weeks of Au+Au data-taking for the rest of the run

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for the STAR Collaboration

Machine/Experiment Schedule Meeting 04/12/2016

Run 16 Heavy-Flavor Program

- Completion of DM12

2016	DM12 (new)	Measure production rates, high p_T spectra, and correlations in heavy-ion collisions at $\sqrt{s_{NN}} = 200$ GeV for identified hadrons with heavy flavor valence quarks to constrain the mechanism for parton energy loss in the quark-gluon plasma.
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DM12 uses the increase in RHIC luminosity that is part of the RHIC luminosity upgrade and associated detector upgrades to study rare particles with charm quarks, and possibly particles with bottom quarks, as a demanding way to learn how matter flow and energy loss are established in the partonic phase at RHIC.

Au-Au 200 GeV Highest Priority of STAR and PAC for Run-16

Run 16 proposed by STAR

Run	Energy	Duration	System	Goals	Priority	Sequence
16	$\sqrt{s_{NN}}=200$ GeV	13-wk	Au+Au	$\Lambda_c, D, v_2, R_{AA}, \Upsilon, R_{AA}$ 10nb ⁻¹ , 2billion MB	1	1
	$\sqrt{s_{NN}}=19.6$ GeV	1-wk	d+Au	100M MB	2	2
	$\sqrt{s_{NN}}=39$ GeV	1-wk	d+Au	400M MB	2	3

PAC recommendation of 10 weeks of Au+Au; additional 2 floating weeks

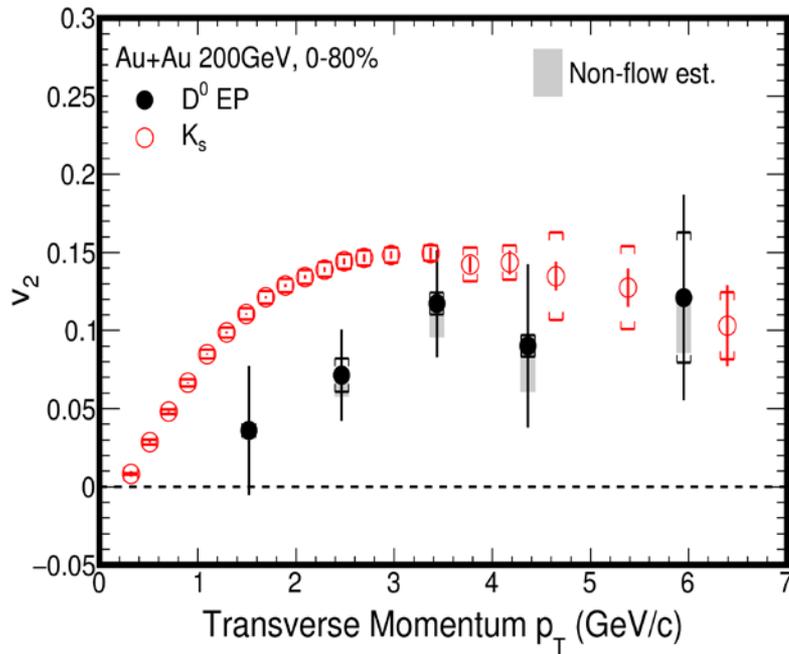
Could have reached goals: 95 hours*10wk*3600seconds*600Hz=2B

RHIC Machine Efficiency not Luminosity key

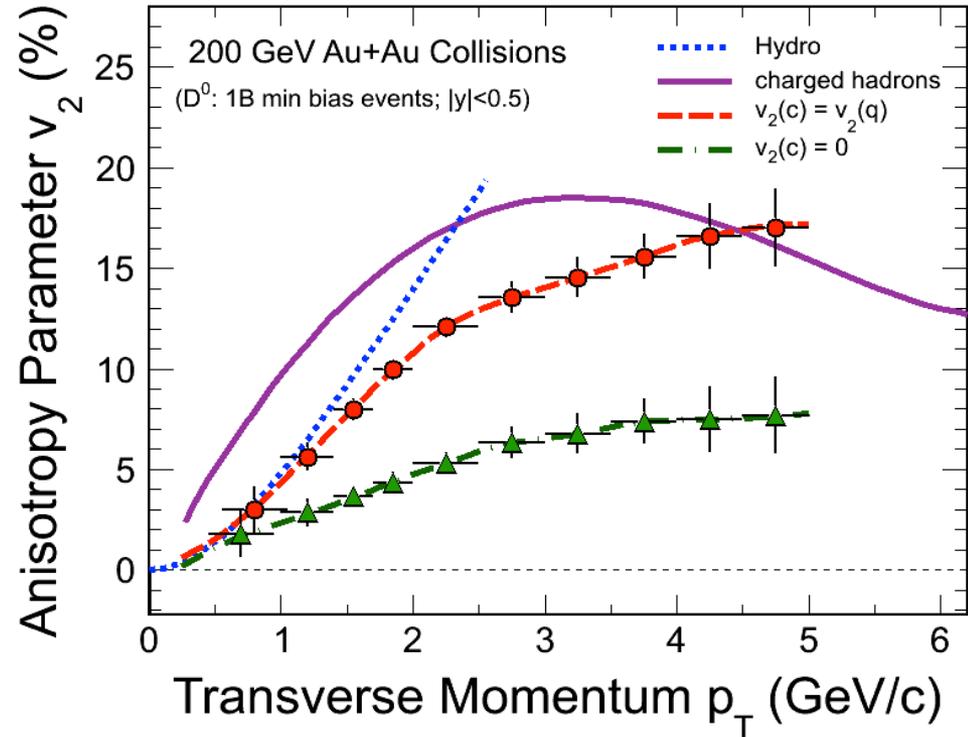
STAR Operation and Optimization - key to achieving this goal.

Goal 1: Open charm flow

Current Run-14 data – Paper in GPC
(Presented at QM2015)



HFT Projection for Au+Au **run14** + **run16**

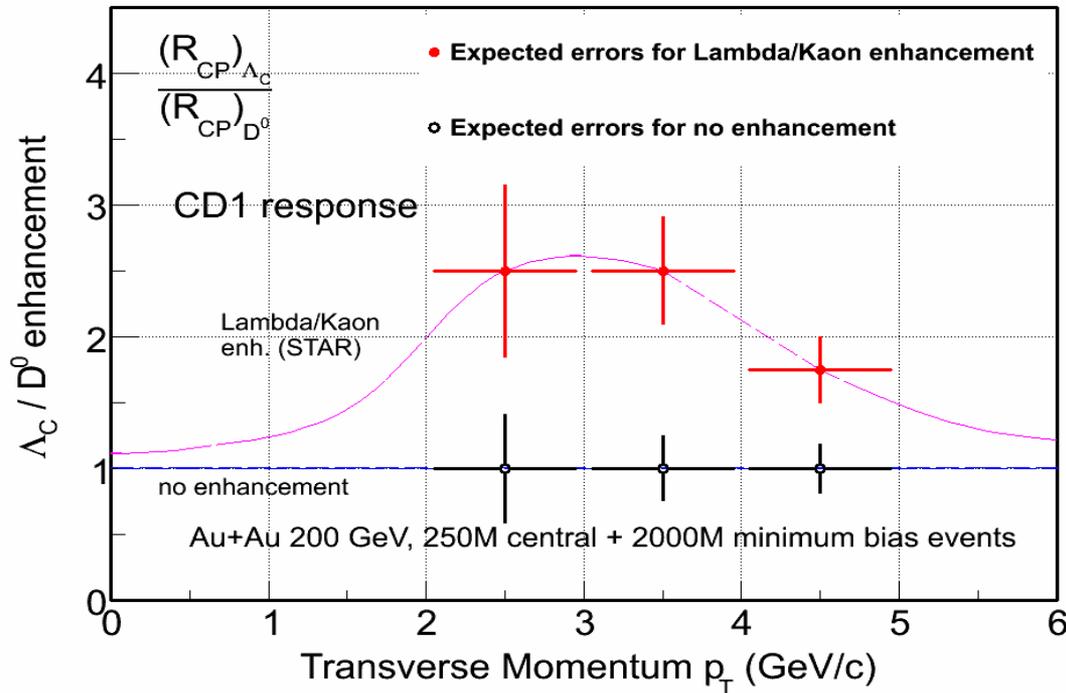


Centrality Dependence of charm v_2

Precision result from Run 16

: Needs 2 billion Minbias Au+Au events at 200GeV

Goal 2: Charm coalescence

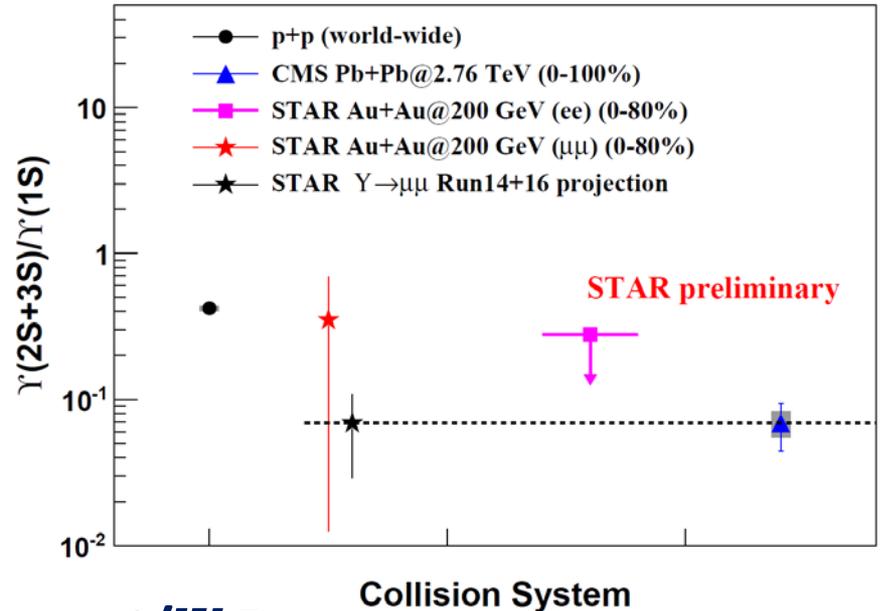
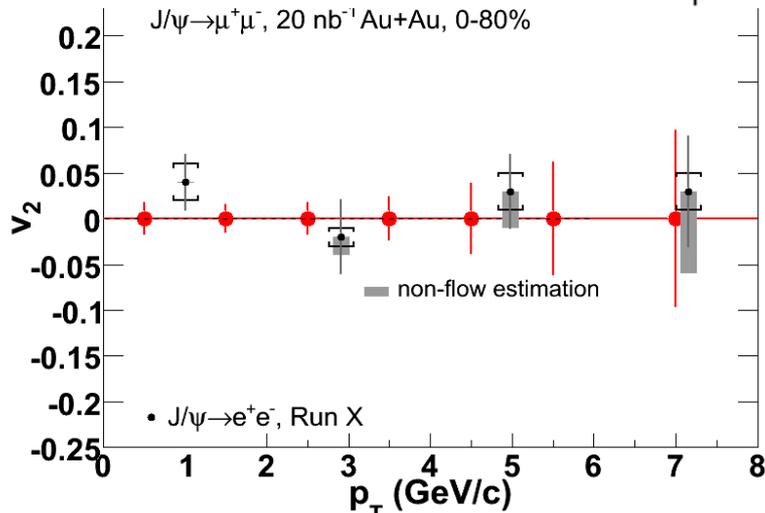
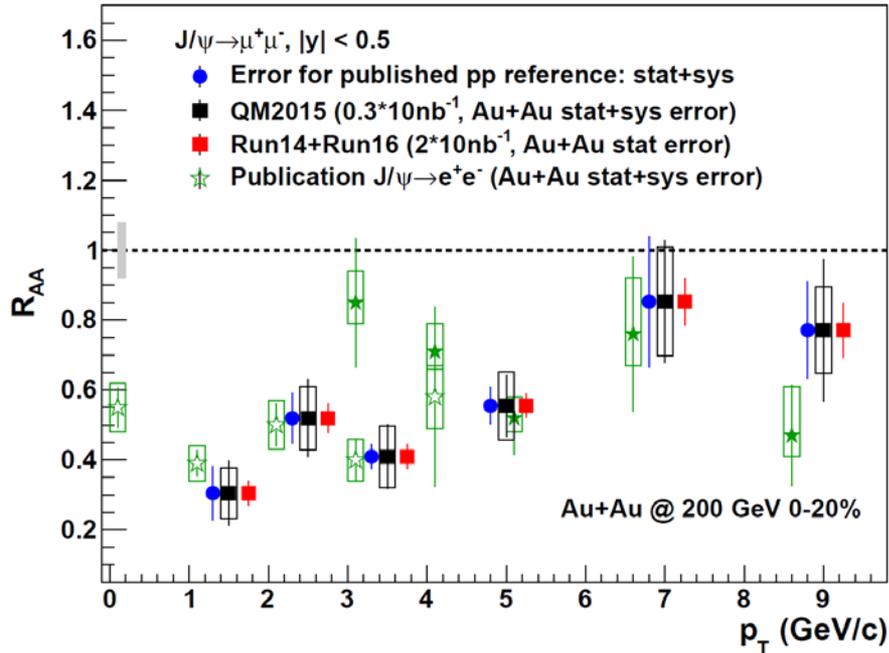


Charmed baryon enhancement?

NEW with run16 data:

Needs 2 billion Minbias Au+Au events at 200GeV

Goal 3: Quarkonia Suppression and v_2



J/ψ R_{AA}

J/ψ v_2

$\gamma(2S+3S)/\gamma(1S) \sim 10\text{-}20\%$ error

Results need Run14 + Run16:
Need 20 nb^{-1} sampled Luminosity

Many improvements since Run14

Open Charm (HFT) related: (MB events)

- Cables: Cu => Al Cable for HFT readout: up to x2 better S/B low- p_T D^0
- Refurbished PXL and SSD firmware: ~18% PXL dead in Run-14
SSD improves tracking 10% (20% for D_s)

Overall factor of 3.6 improvement for D^0

- Vertex Cut quality improvement (~15%)
- Pile-up protection study w/o 30% more data volume and 10% worse efficiency
optimize protection (10%)
- Re-populate TPC ASIC and RDO, DAQ software optimization, online disk and network, +50% faster readout speed, reduced deadtime
- Bring up detector at RHIC Flattop and detector ramp down for beam dump
Run 16: 7 (5) minutes vs Run 14: 9 (11) minutes

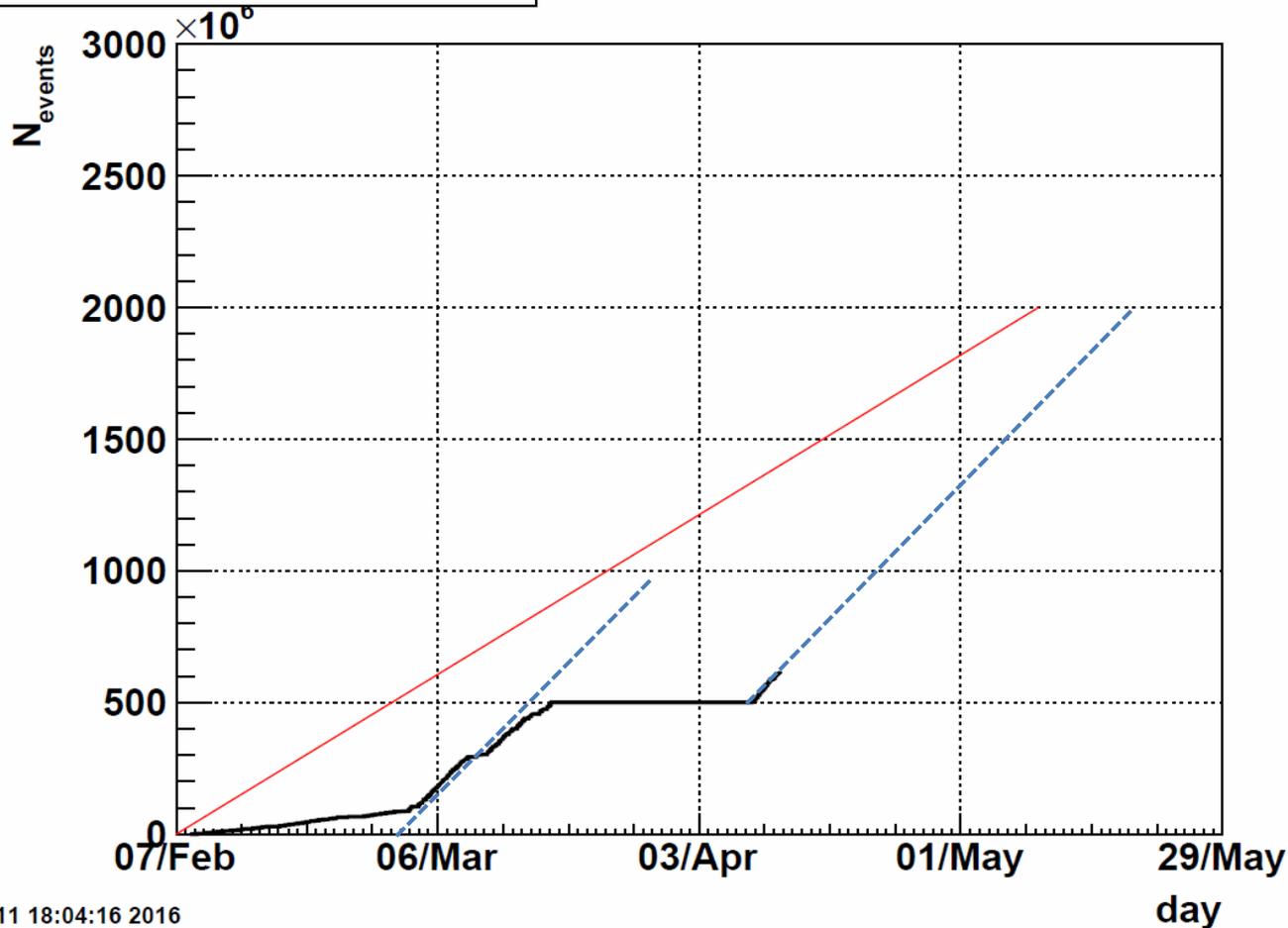
Quarkonia (MTD) related: (triggered/luminosity)

- High-Level Trigger dedicated to online dimuon selection x2 fewer events to tape
- Express stream of Upsilon candidates x10 reduction
- Reduce monitoring triggers to minimum required

HFT Data accumulation and projection

VPDMB-5-p-effective_pxlist

HFT good minbias events



Mon Apr 11 18:04:16 2016

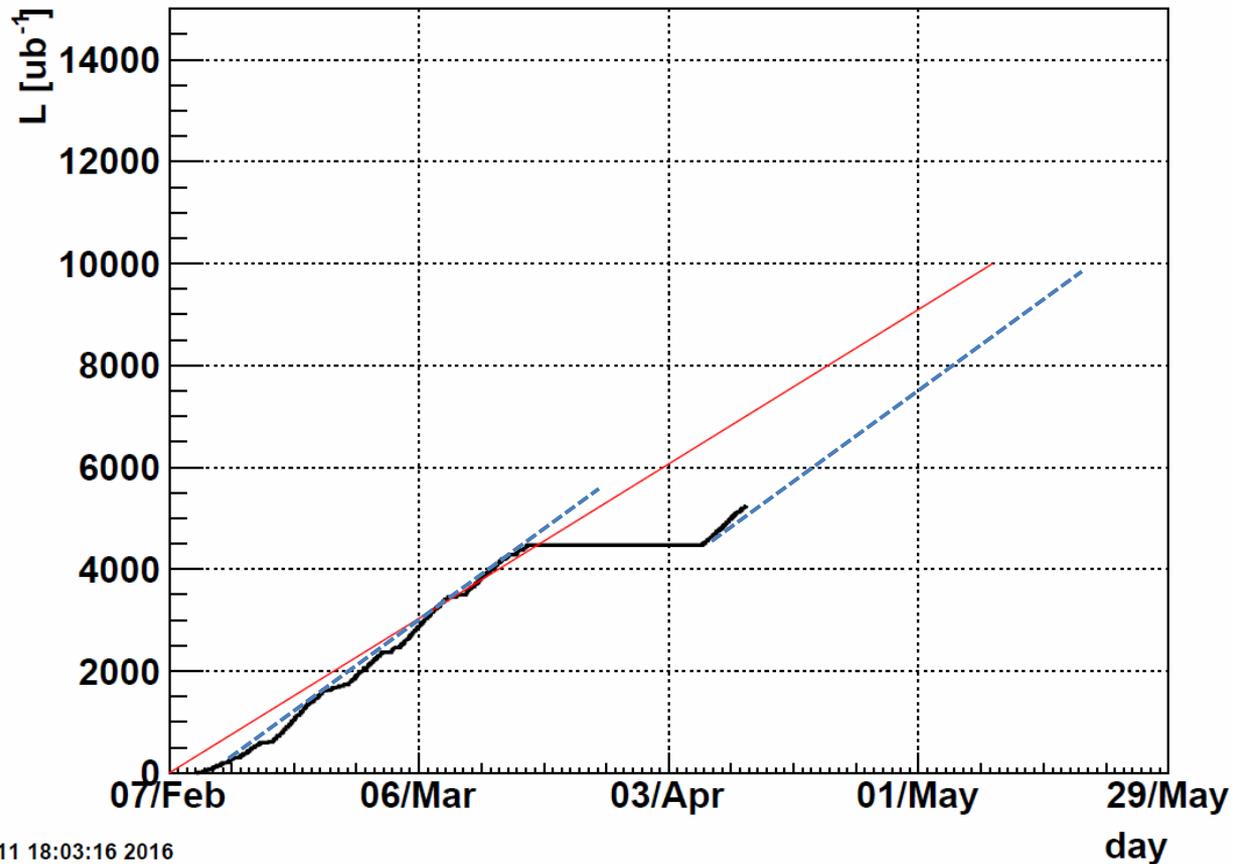
Charm data ~30-40% short of our goal

95hours*3600*700*6.2weeks=1.5Billion events

MTD Data accumulation and projection

MTD Upsilon luminosity

di-muon_upsiloneff



Mon Apr 11 18:03:16 2016

Upsilon data ~20% short of our goal

Four Main Setbacks

1. Online Vertex Selection Efficiency (-5-10%)

A version of hardware has been commissioned during the first 5 weeks, final implementation in March 16. improve efficiency 17%

2. Uptime (-15%)

Run 14 over 95 DAQ hours per week (110 CAD hours)

Run 16 about 85 DAQ hours per week (94 CAD hours)

3. Loss of sensors (-10%)

Half of sectors 6 and 7 due to radiation since March 9 (seems associated with unexpected beam dumps when whole TPC trips)

4. HFT readout Firmware (-20%)

Low efficiency due to incorrect time latch

Affects data from first 3 weeks

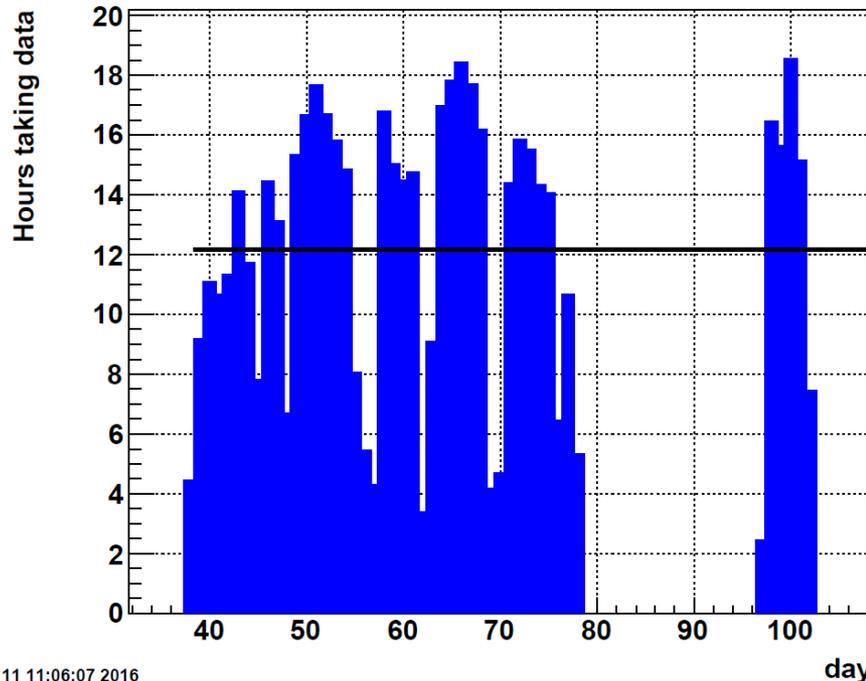
Unclear at this moment whether the loss due to this issue is recoverable or not (still investigating)

Uptime (-15%)

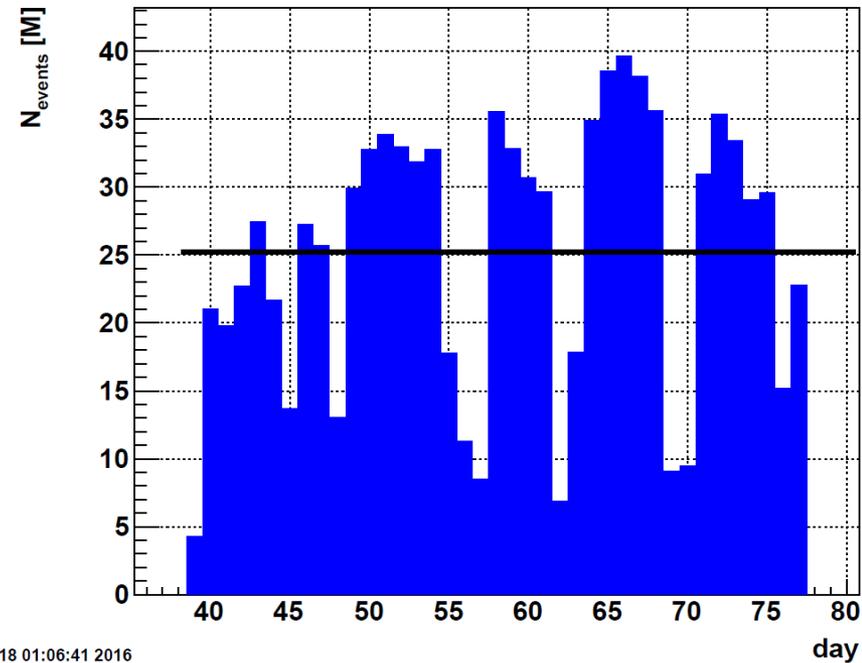
Average Hours/day

Average Number Events/day

hours_perday.txt



VPDMB-5-p-effective N_{events} PXL+IST



Mon Apr 11 11:06:07 2016

Fri Mar 18 01:06:41 2016

12 hours of actual data-taking time per day (89% efficiency of delivered beam time)
= 85 DAQ hours, 94 CAD hours/week

Short of projected 95-100 DAQ hours (110 CAD hours/week) needed to reach goals

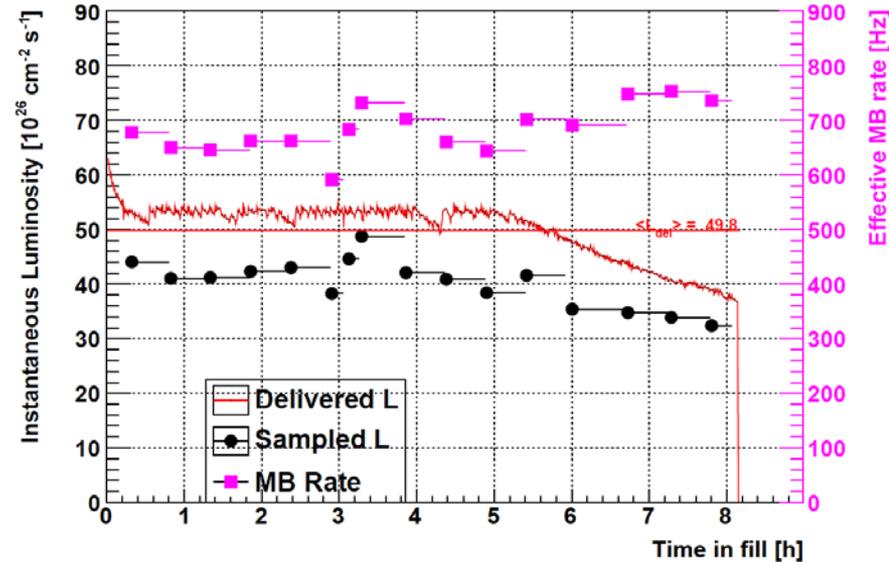
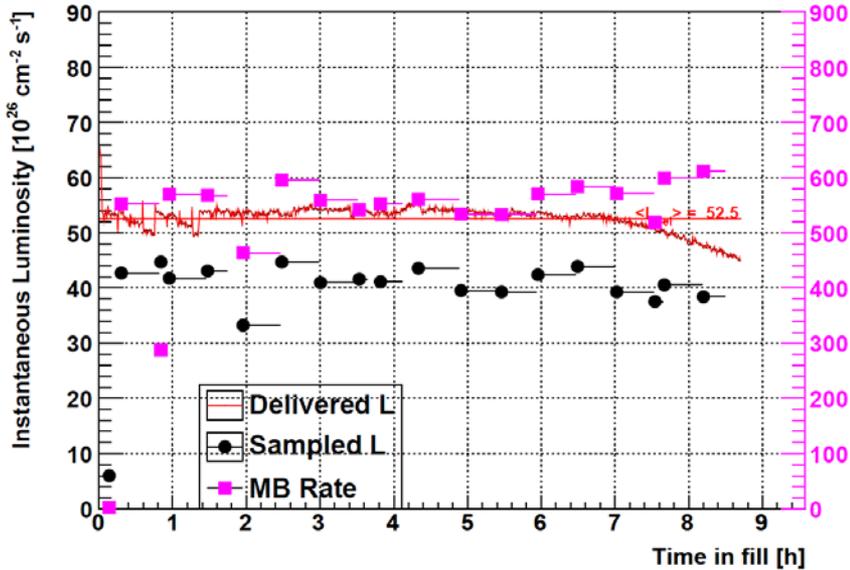
Typical Luminosity and Rate

Fill 19682

Before Vertex Improvement

Fill 19705

After Vertex Improvement



Livetime: 80%;

Vertex Cut Improvement: 17% in good HFT events

600--700Hz effective HFT minbias events

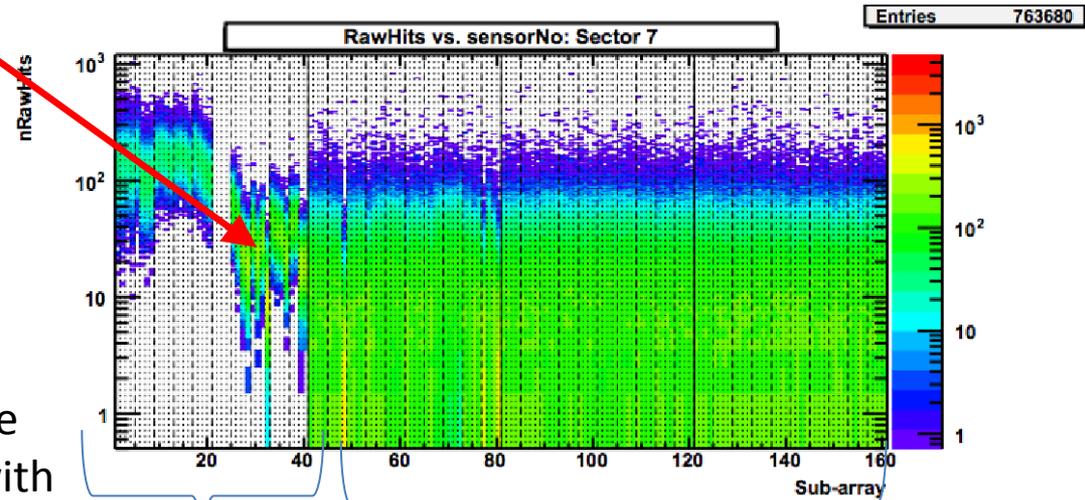
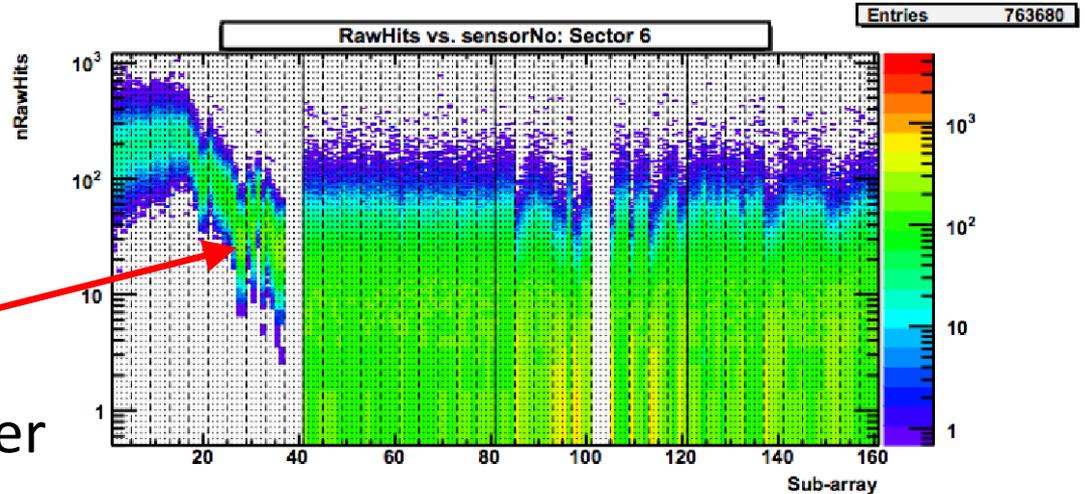
- Very flat luminosity, thank you, CAD!

HFT Sensor Loss

NOTE Log Scale!

Developed in early March
low hit efficiencies on half inner
ladders on sectors 6 and 7
(10% in total)

(evidence for sudden and unrecoverable
radiation damage possibly associated with
unexpected beam aborts)



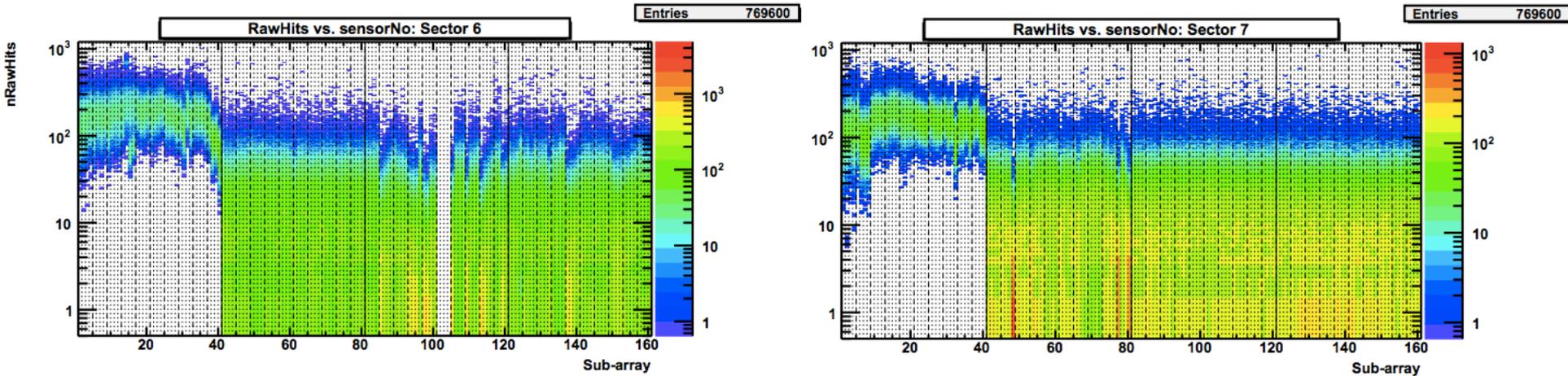
Summary and Request

- **Key Goal of Run-16 : Complete DM12**
 - High profile and high impact physics: charm thermalization, energy loss and quarkonium dissociation
- **RHIC Luminosity profile is very good (flat as requested)**
- **Many improvements for run16 from STAR**
 - Substantial investment to meet goals
- **Four main setbacks:**
 - Uptime (15%)
 - Early firmware issue (20%)
 - First 5 weeks of online vertex efficiency (10%)
 - Loss of efficiency due to radiation since 4th week (10%)
- **short of our goals for open charm (~40%) and Quarkonium (~20%)**
 - linear extrapolation
- **Request 5.5 weeks Au+Au at 200GeV for the remainder of run 16**
 - ~2 weeks of extension (5.5 weeks of operation upto March 18)
 - RHIC operation resumed April 6 (Wednesday), +6.2 weeks to May 20 (Friday) (6 weeks to July 1)
 - Puts us within 10% of our targeted goals (>95 DAQ hours, no further loss of sensors)

Backup slides

Sensor Loss – Sector 6

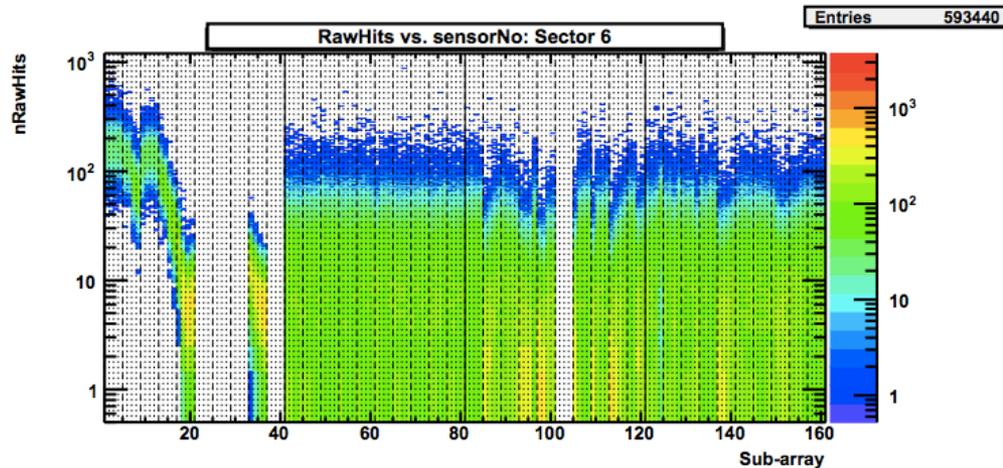
PXL raw hits distributions from Sector 6 (left) and 7 (right) from run 17068056 - good status



On March 8, around 6:30pm, an unexpected beam abort caused massive trips in 20% TPC inner sectors.

The first several runs after this event seemed to be OK, however, on March 9, around 3:30am, PXL current turns bad, and the run QA shows

PXL raw hits distribution from Sector 6 from run 17069010



Sensor Loss – Sector 7

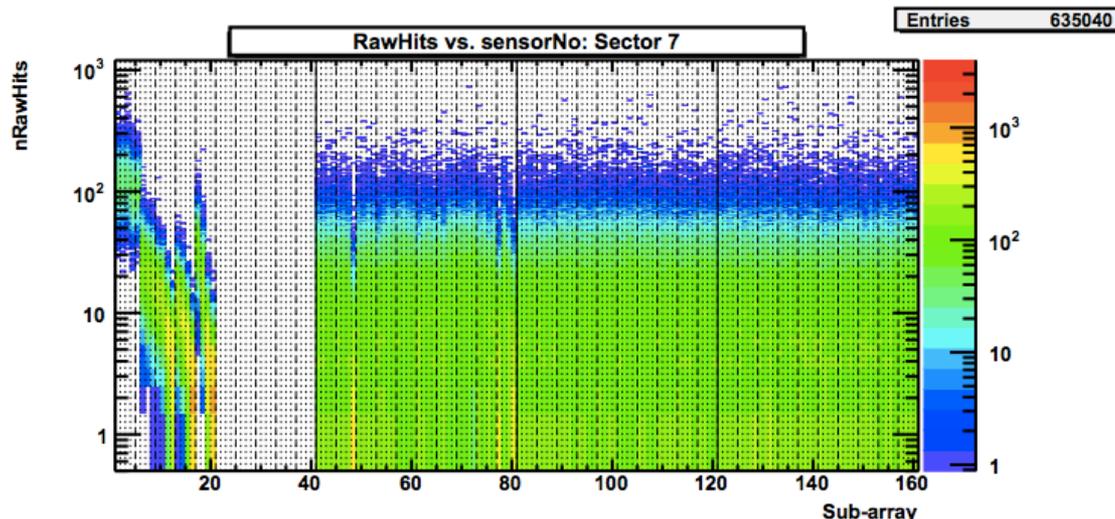
On March 15, around 11am, another unexpected beam abort caused massive trips in TPC inner sectors.

PXL sector 7 inner ladder firstly turned bad in run 17077007, 3:50am on March 17.

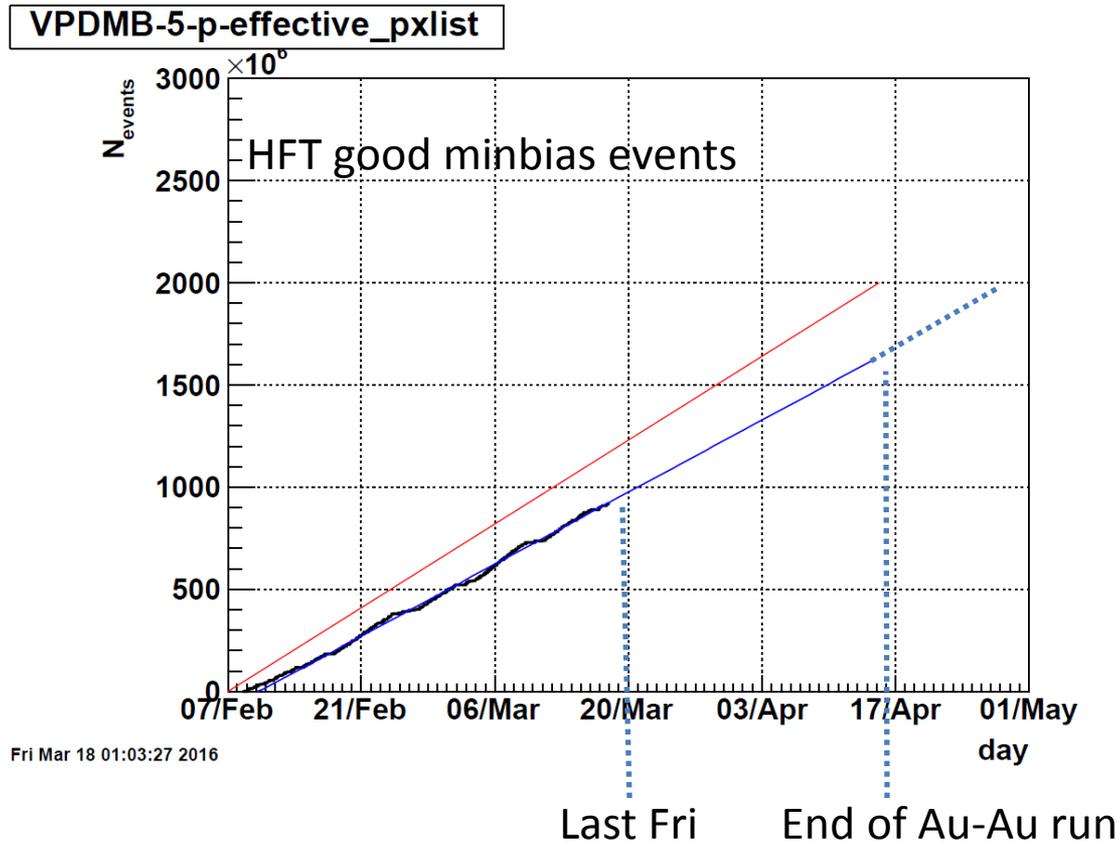
On March 17, around 8:30am, another unexpected beam abort caused massive trips in TPC inner sectors.

It seemed this loss is not a direct consequence of an unexpected beam dump, but it can be related to the poor radiation environment, which triggered the beam abort later.

PXL raw hits distribution from Sector 7 from run 17077007



HFT Data accumulation and projection

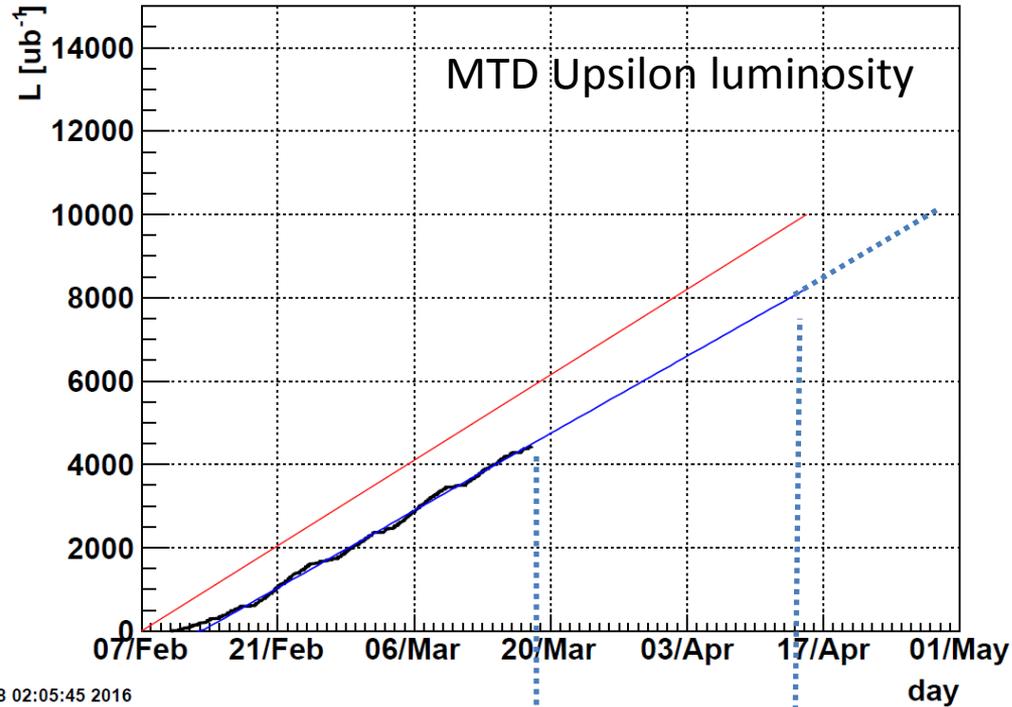


Charm data ~20% short of our goal

(has not folded in: low efficiency due to firmware issue first 3 weeks)

MTD Data accumulation and projection

di-muon_upsiloneff



Fri Mar 18 02:05:45 2016

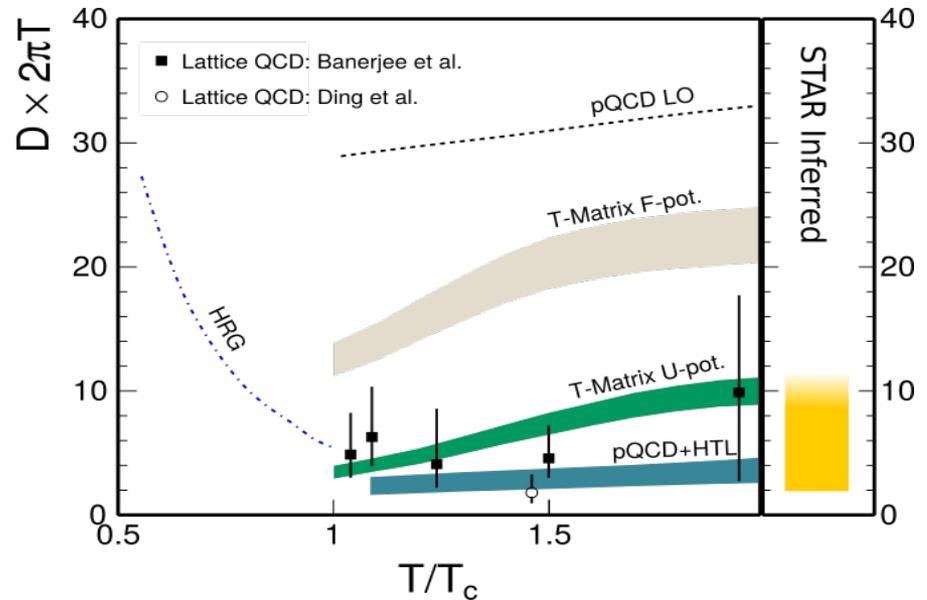
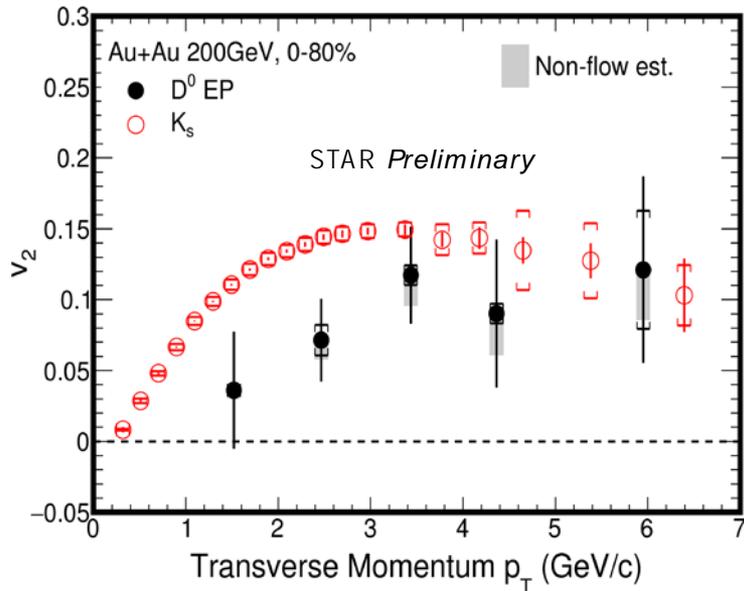
Last Fri

End of Au-Au run

Upsilon data ~20% short of our goal

Run 14 data presented at QM15

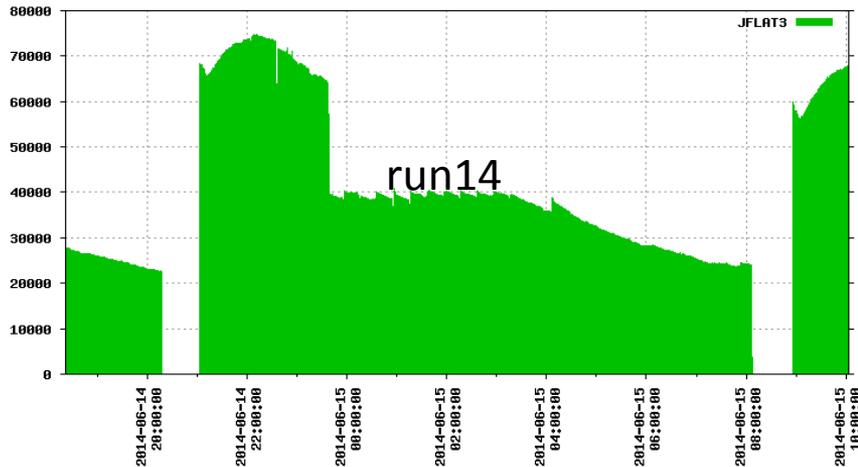
Paper in STAR committee review



Brownian motion (diffusion) of heavy quarks

- Heavy Flavor Tracker (HFT) delivers its first results
- First result of quarkonia suppression from the Muon Telescope Detector (MTD)
- Charm flows at RHIC top energy
- Extracted diffusion coefficient compared to theory

Proposed HFT operation mode in run16



Limitation of options in operation mode

<55KHz to reduce deadtime and LU rate

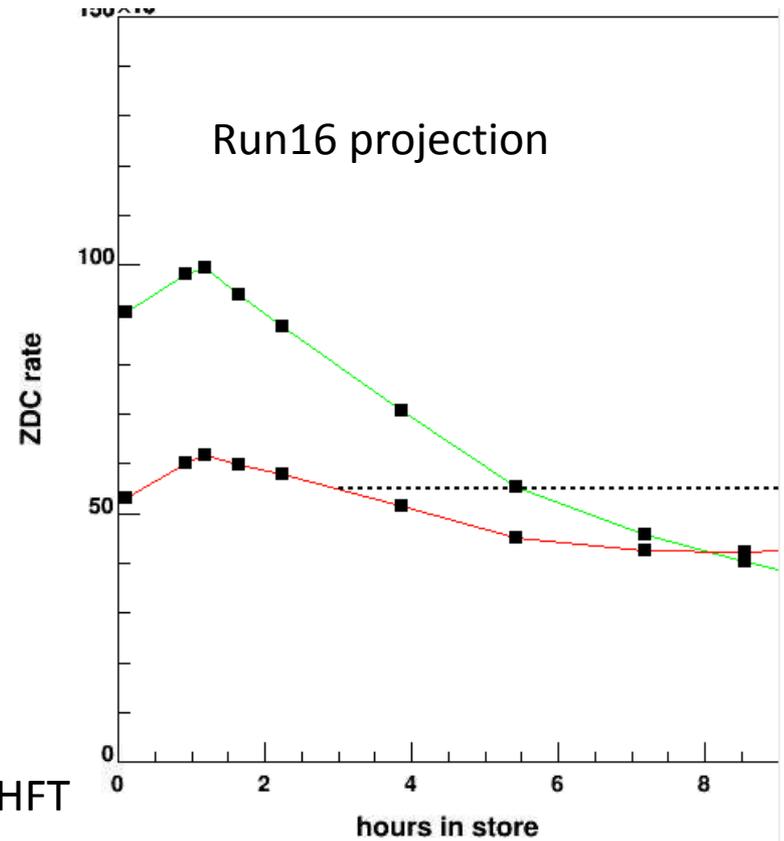
Store length for optimized luminosity

Perform dynamic beta* squeeze

Projection from this mode:

1.8nb⁻¹/week delivered for MTD and 2 billion MB for HFT

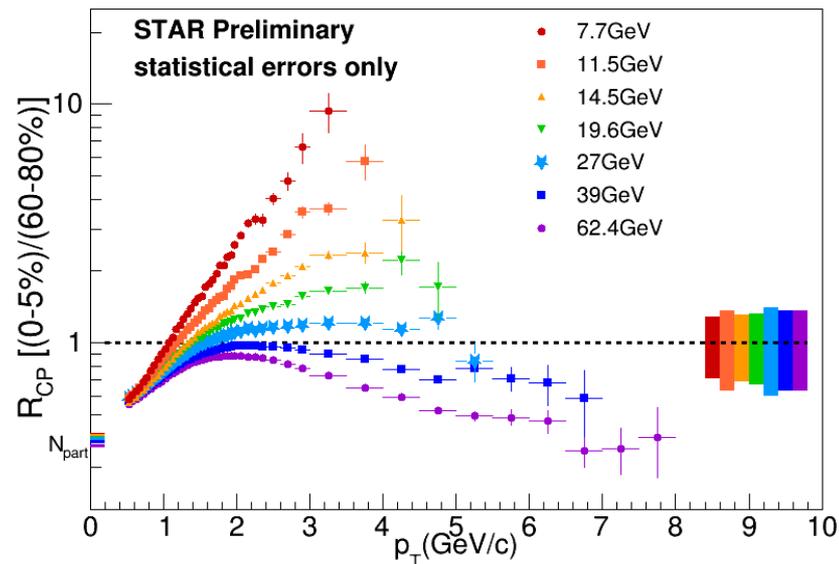
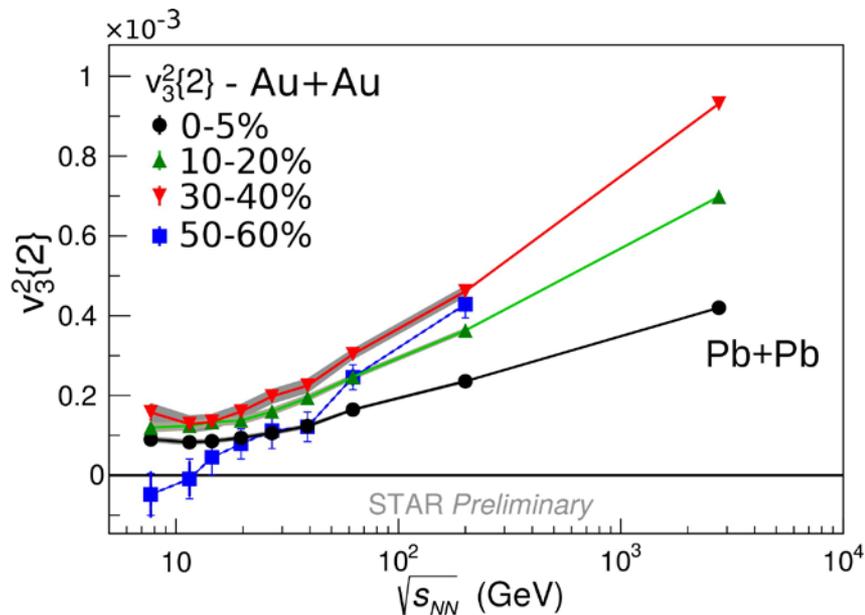
requires **13 weeks** of operation



Presented at
06/2015 PAC and
01/19/2016
schedule meeting

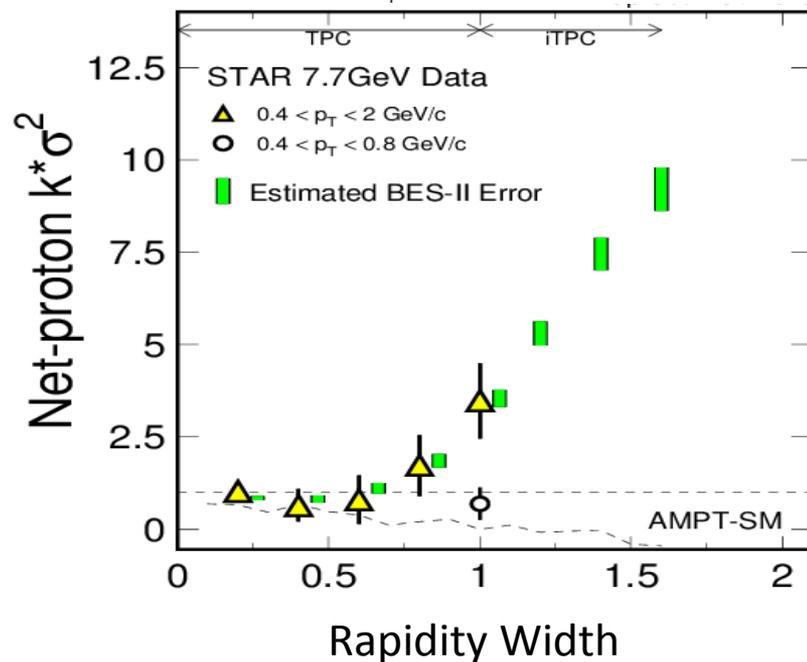
**RHIC Machine Efficiency not Luminosity,
STAR Operation and Optimization
Are keys to achieve this goal.**

(STAR) Map QCD phase diagram

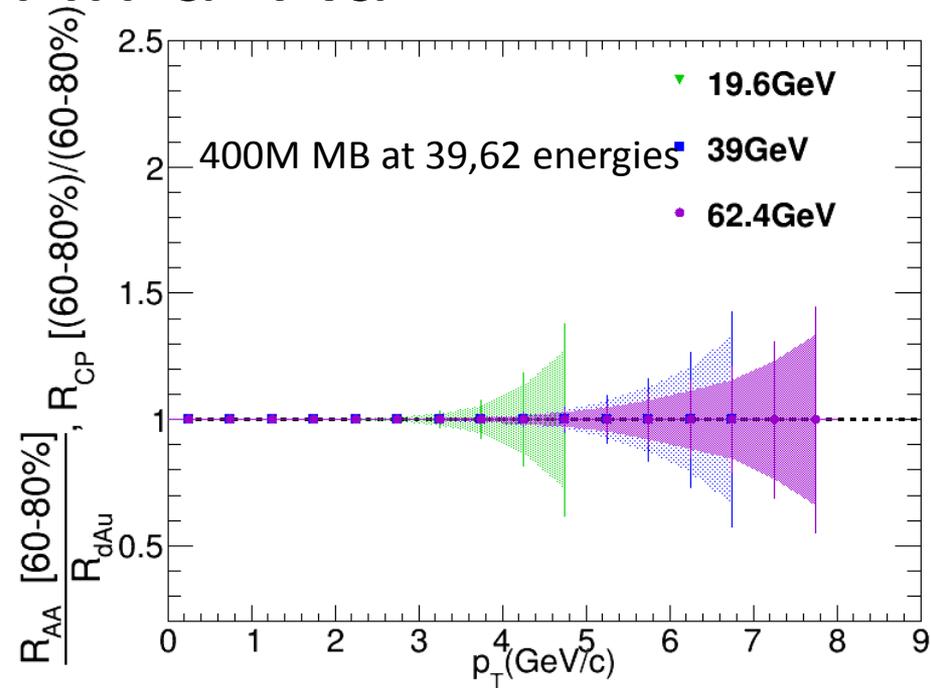
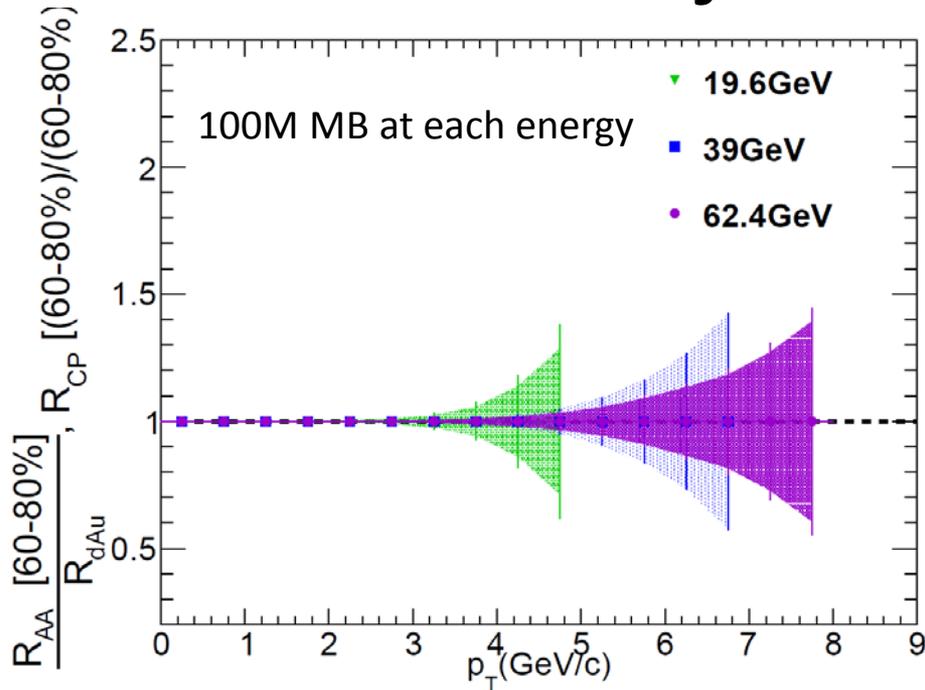


Beam Energy Scan Program:

- **Turn off QGP Signatures**
triangle flow (v_3) in peripheral at low energy consistent with zero; onset of jet quenching
- **Search for first-order phase transition**
minimum net-proton v_1 slope from interplay between baryon stopping and soft EOS
- **Search for critical point**
net-proton Kurtosis possibly not Poissonian and grow with accepted rapidity window



Projection in d+Au



Strangeness particles need also about 400M events,
Then errors are dominated by Au+Au

