STAR REPORT FOR THE 2015 RHIC RETREAT

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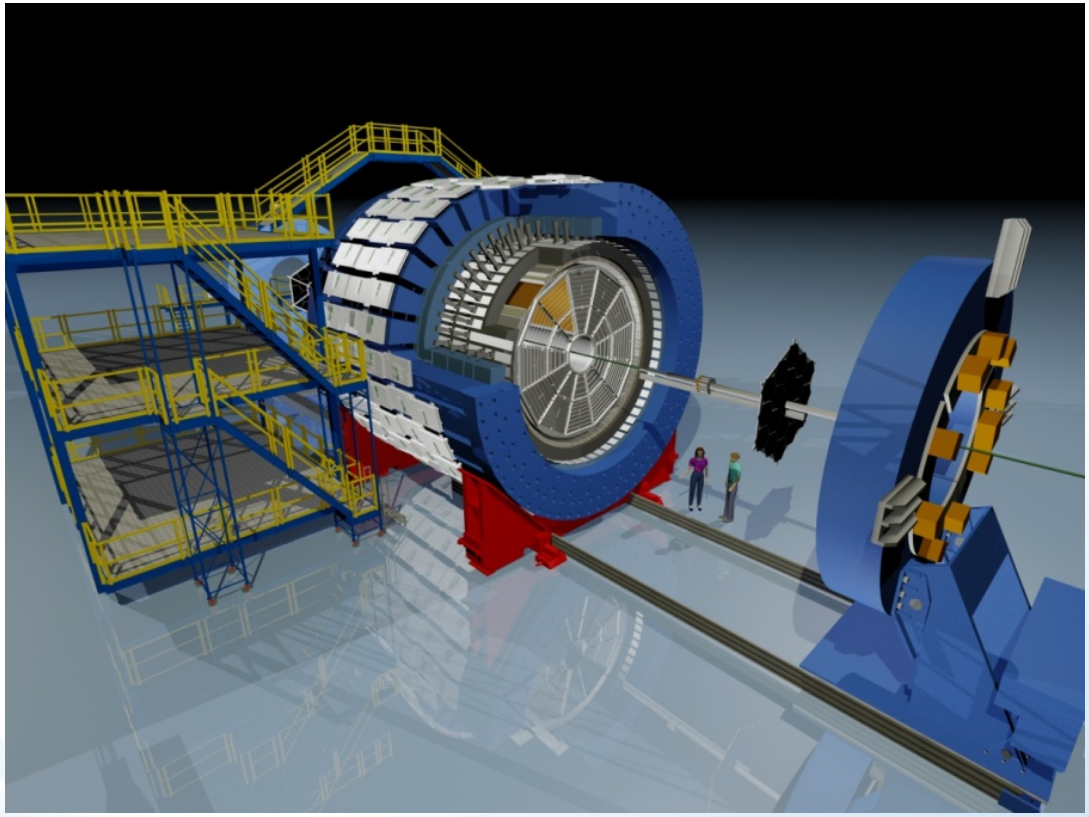
For the STAR Collaboration
July 27, 2015

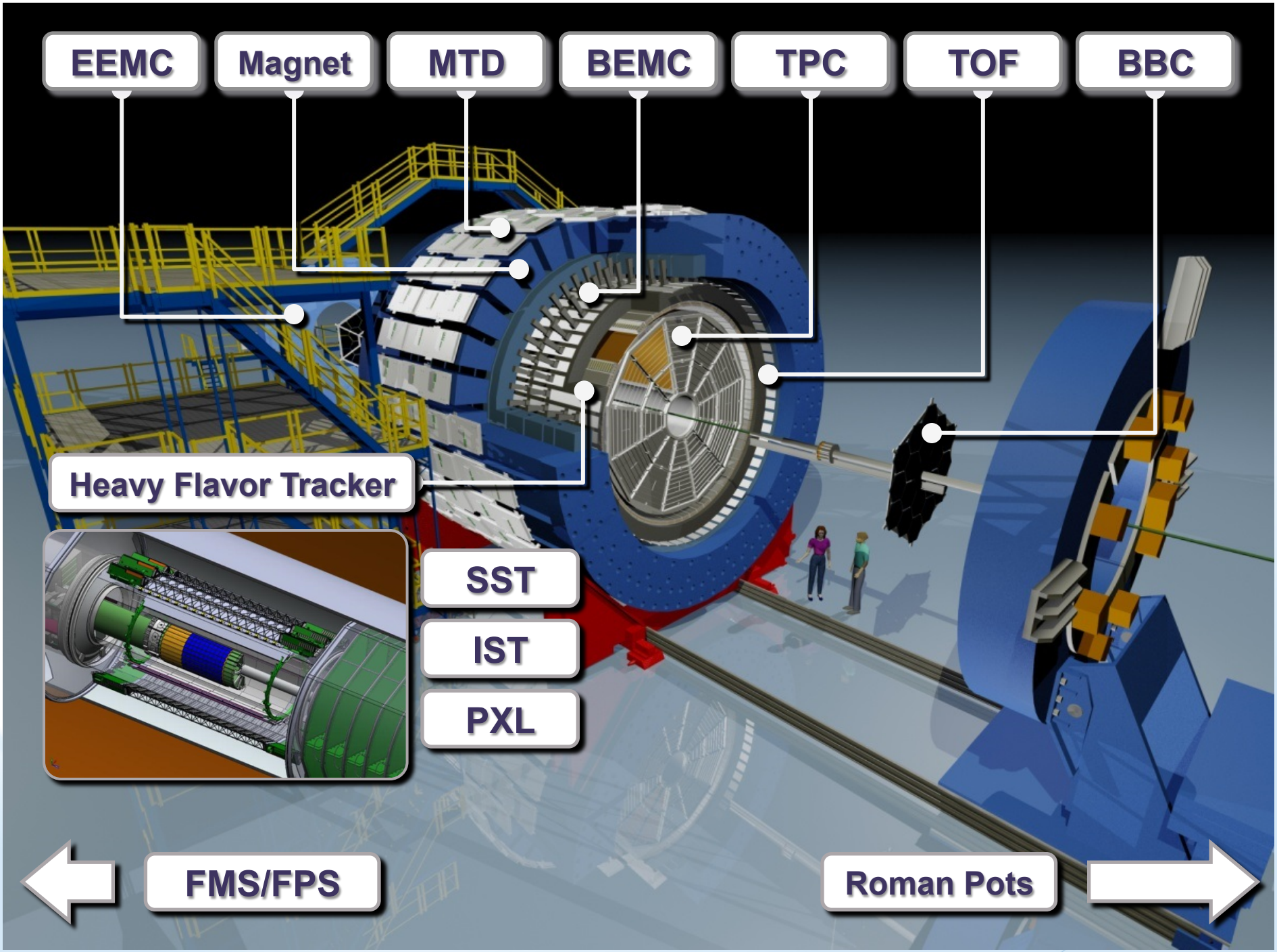
BROOKHAVEN NATIONAL LABORATORY
a passion for discovery

U.S. DEPARTMENT OF ENERGY | Office of Science

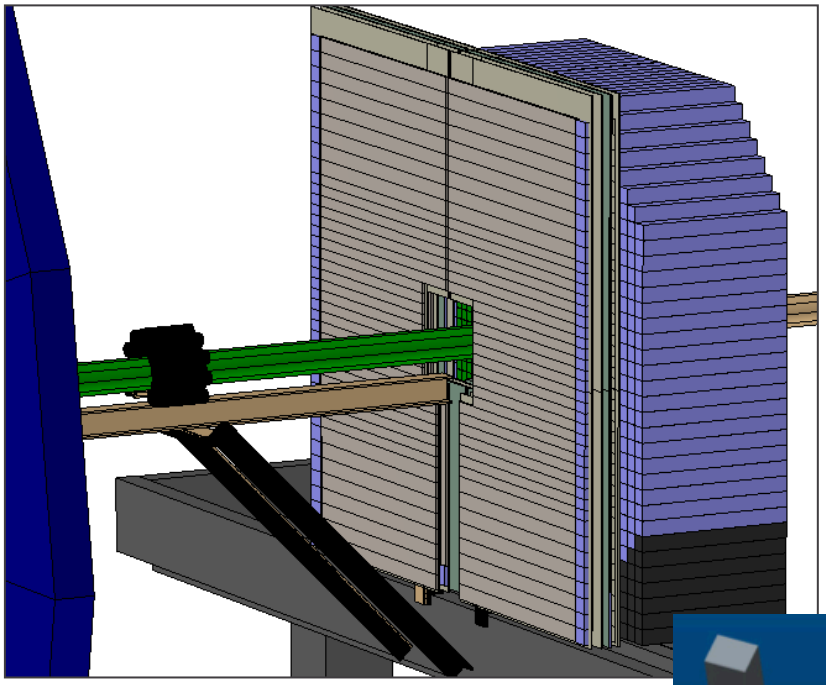
Outline

- New/enhanced detector sub systems for Run 15
- Data set Goals and achievements
- STAR's Running Efficiency
- Desired luminosity profile for Run 16 AuAu
- Comments on Run 15
- Summary

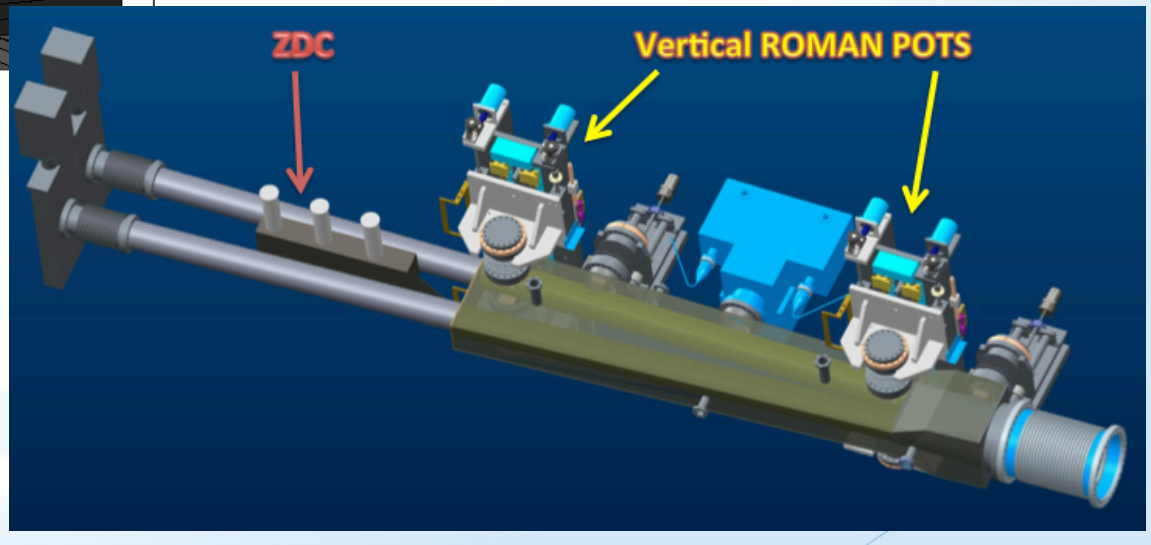



EEMC
Magnet
MTD
BEMC
TPC
TOF
BBC
Heavy Flavor Tracker
SST
IST
PXL
FMS/FPS
Roman Pots

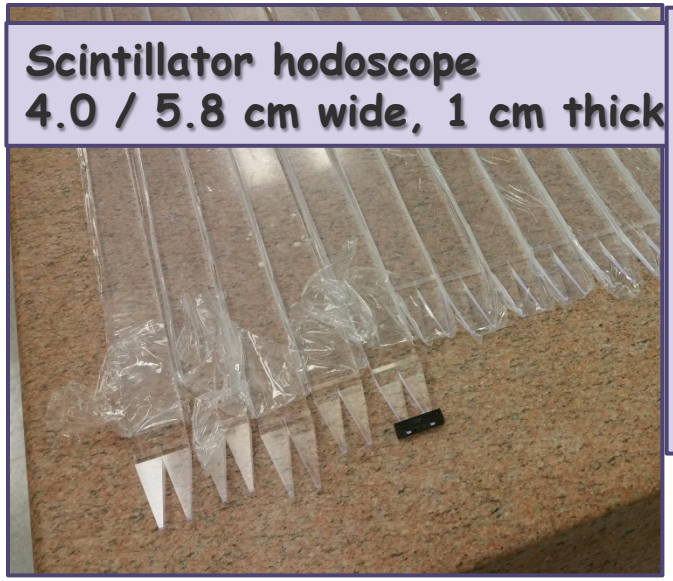
New Detector capabilities for Run 15.



- FMS pre shower detector
- Refurbished FMS
- Pp2pp phase II*
- Al cables on inner PXL layer

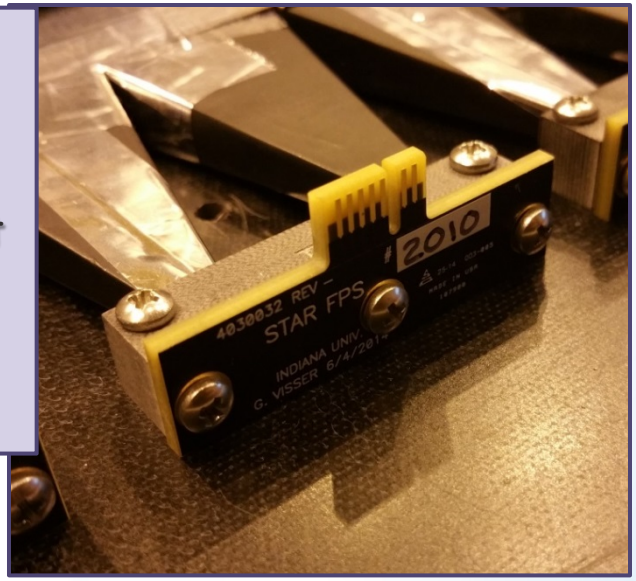


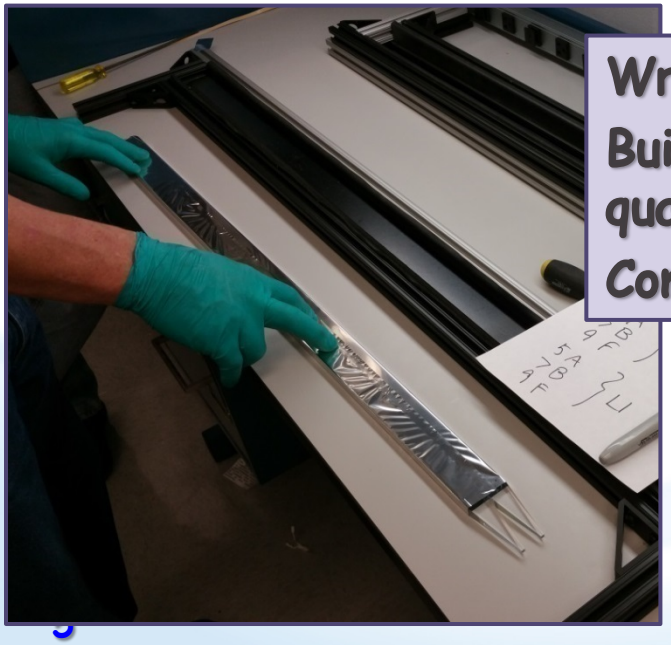
FORWARD PRESHOWER CONSTRUCTION



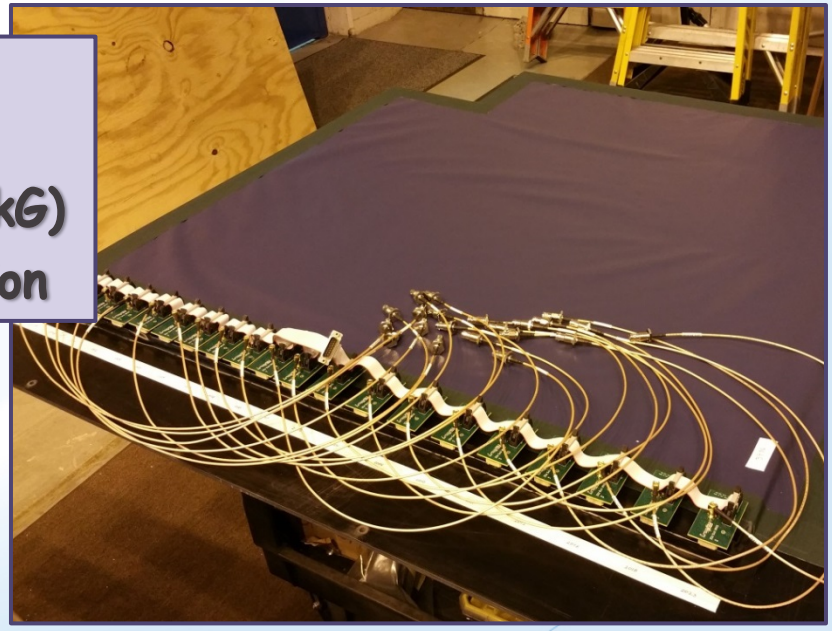
Scintillator hodoscope
4.0 / 5.8 cm wide, 1 cm thick

- Double pyramid light guide
- SiPM readout
- Three layers for 2d hit reconstruction
- channels
- Pb converter (~1 X_0)





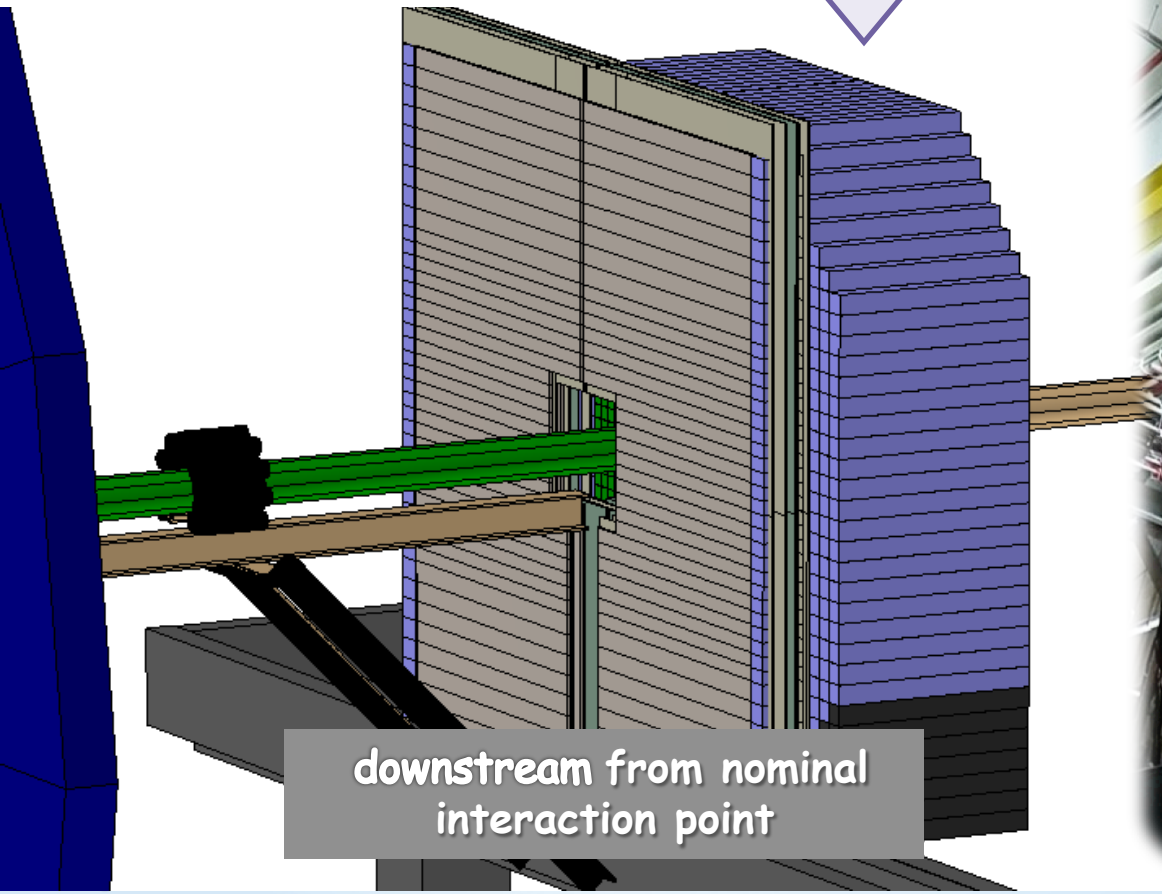
Wrapping at BNL
Built in complete quadrants (~ 100 kG)
Compact installation



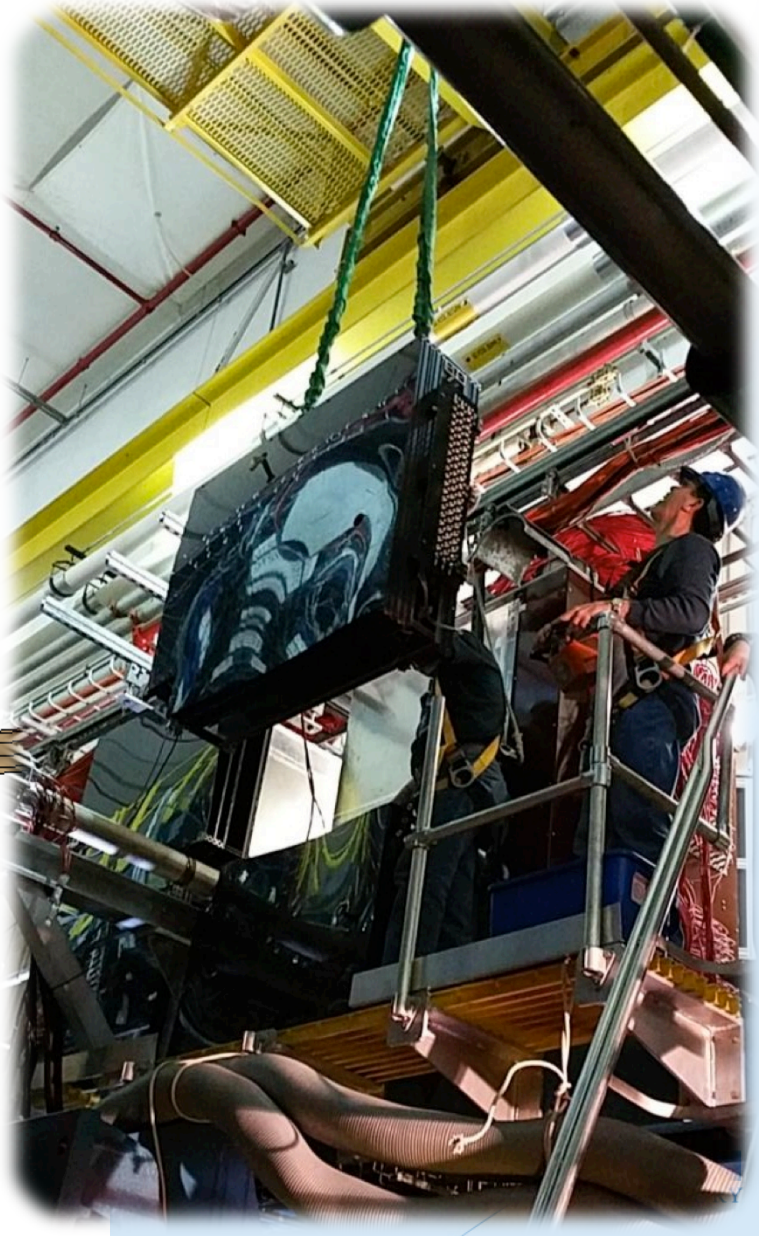
PRESHOWER AT FORWARD RAPIDITIES

Preshower
scintillator hodoscope

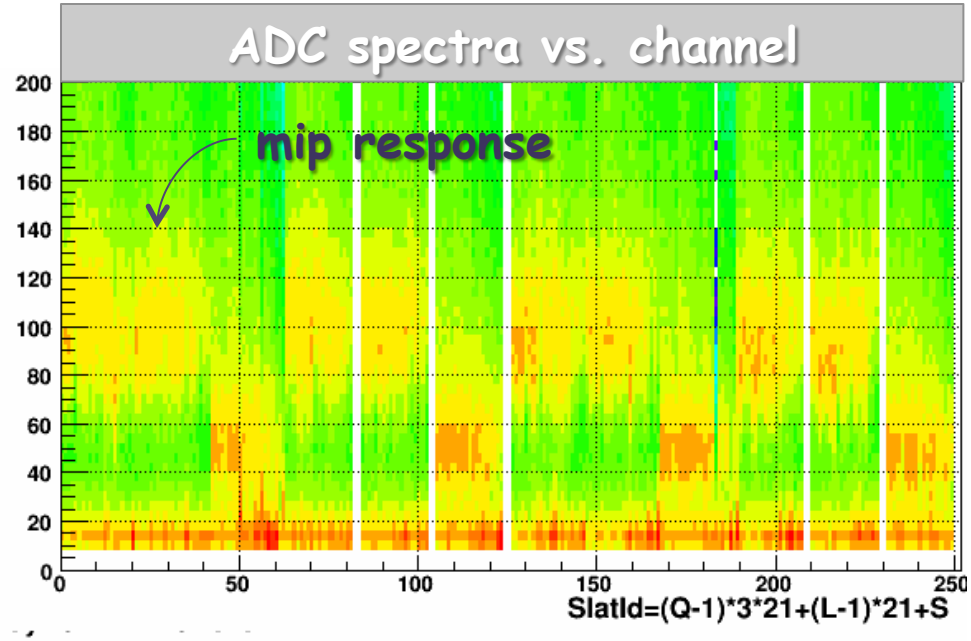
Forward Meson Spectrometer
476+788 PbGl towers

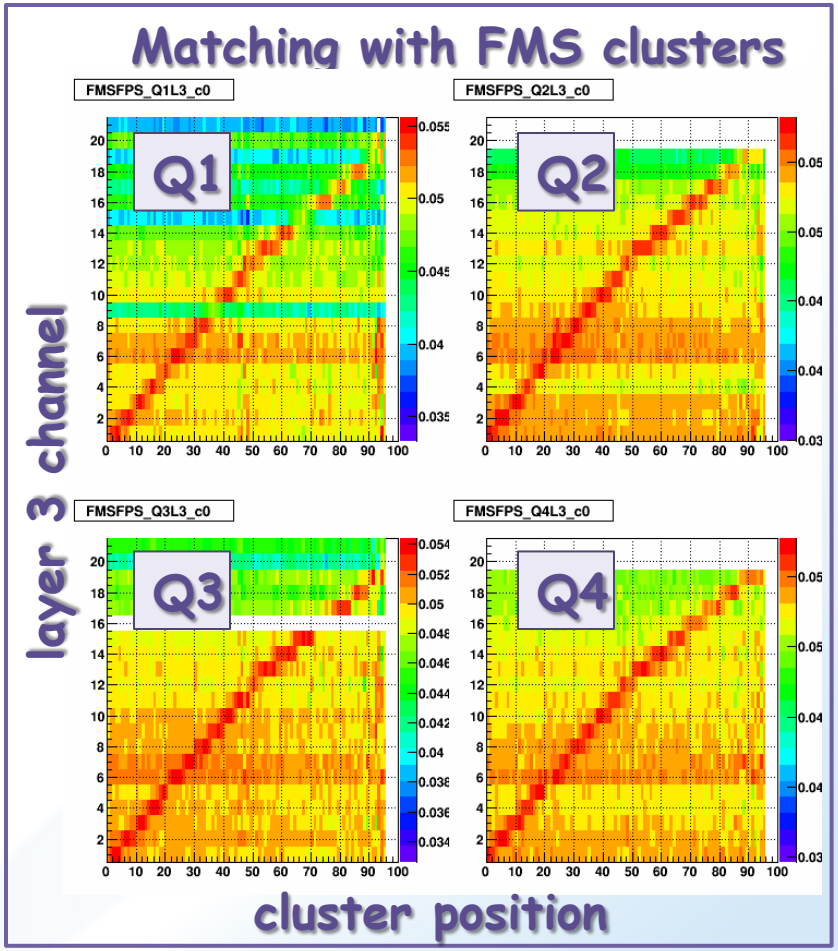


downstream from nominal interaction point



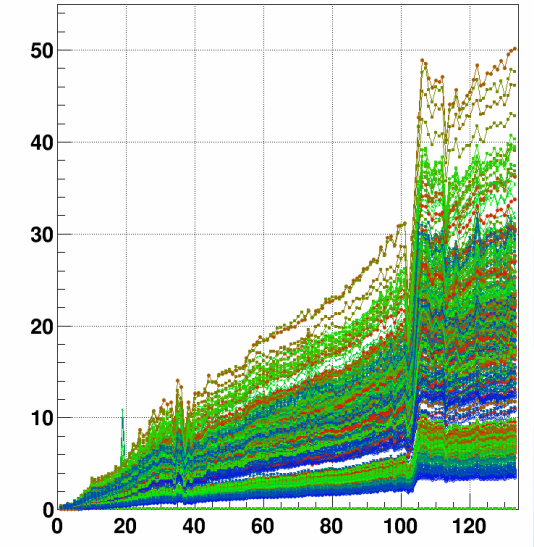
PRESHOWER PERFORMANCE IN RUN 15





Radiation damage:

- Monitoring of dark current in SiPM
- Collision related
- Very susceptible to background



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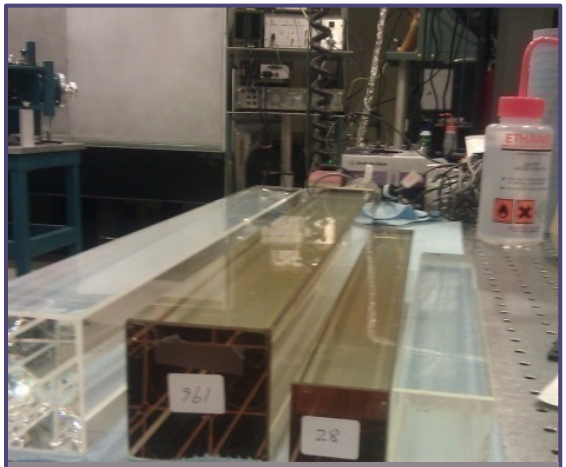
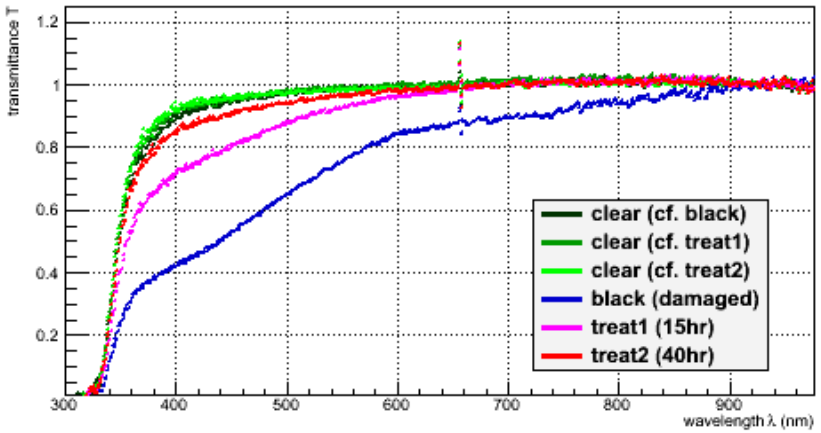
FMS REFURBISHING IN 2014

Replacement of PMT and bases



Curing of radiation damage

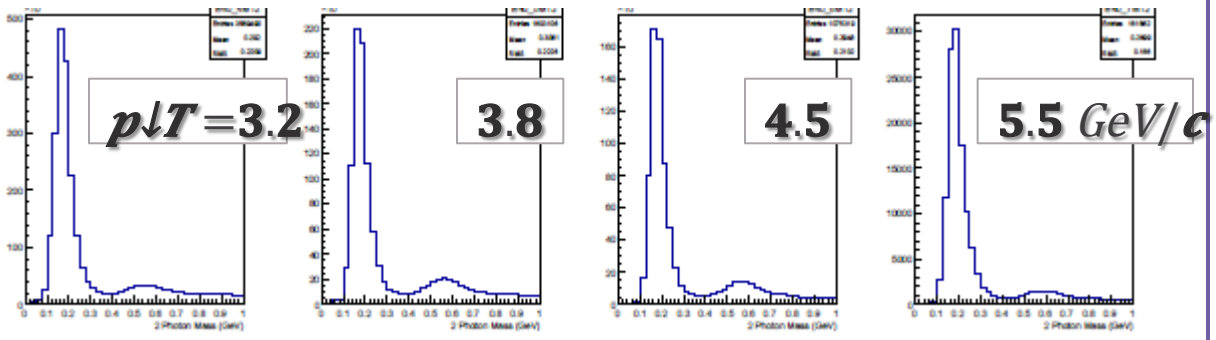
PbGl transparency after UV curing



FMS PERFORMANCE IN RUN 15

Invariant mass distributions in p+Au

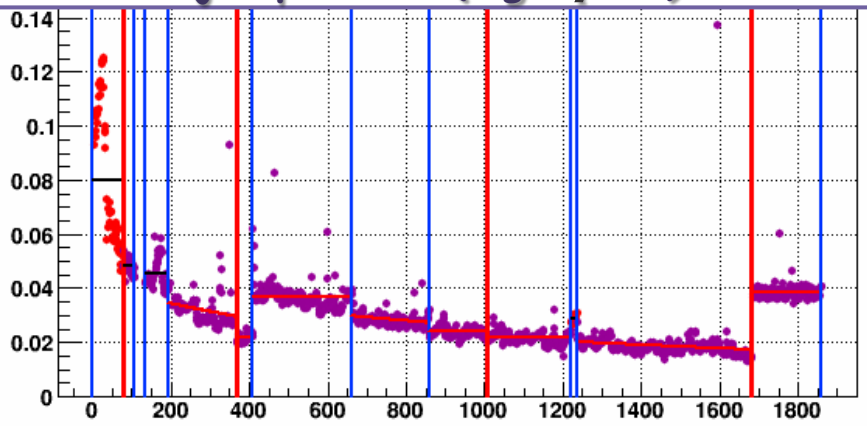
$\langle E_{\gamma\gamma} \rangle$=40 GeV/$c^2$



⇦ Similar or better in p+p collisions

Trigger performance

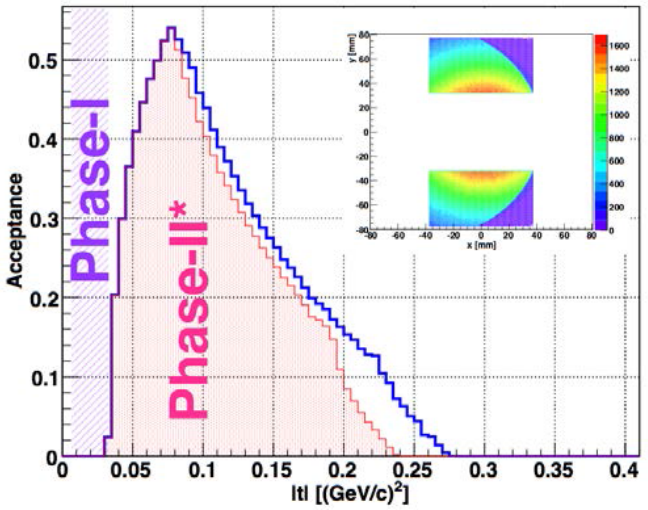
jet patch 2 (high-p_T)

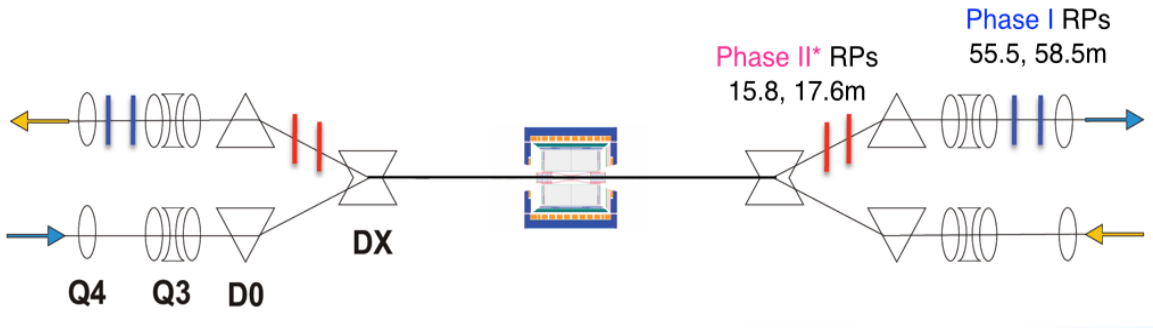


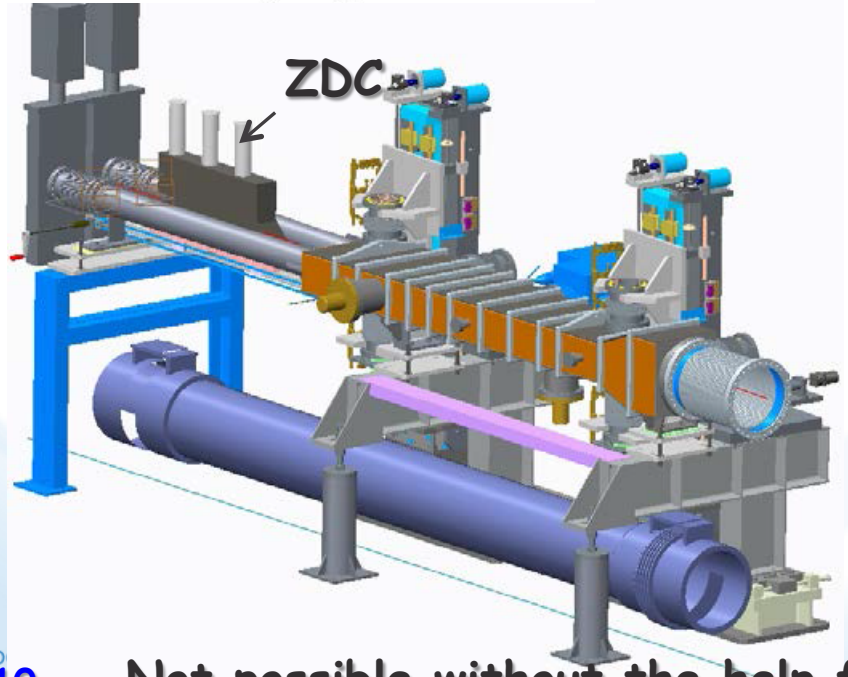
- The FMS is in its best shape ever!
- Gains balanced for p_T-triggering
- Signs of radiation damage (not unexpected)

ROMAN POT PHASE II* (RUN15)

Pp2pp slides courtesy of Wlodek Guryn via Robert Pak in UIC talk







- Allows taking data without special accelerator conditions,
- Required 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.

Not possible without the help from CAD!!!

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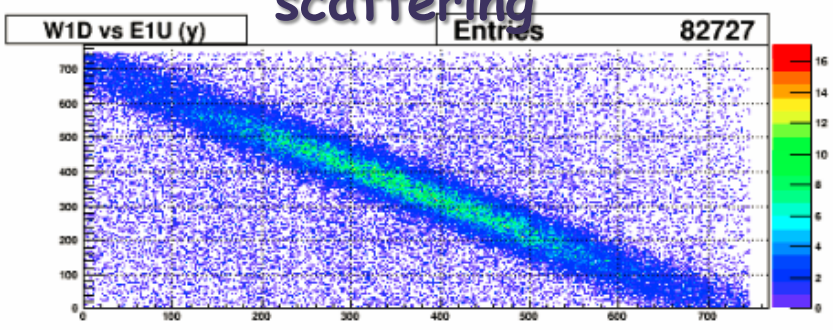
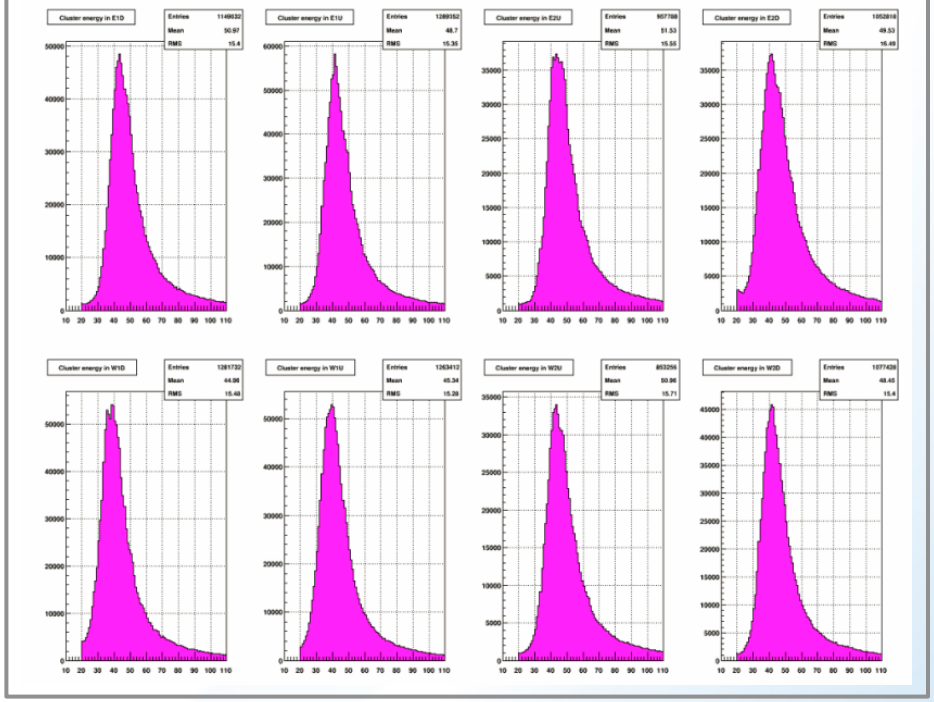
STAR ROMAN POT PERFORMANCE IN RUN 15

Collinearity: elastic p+p scattering

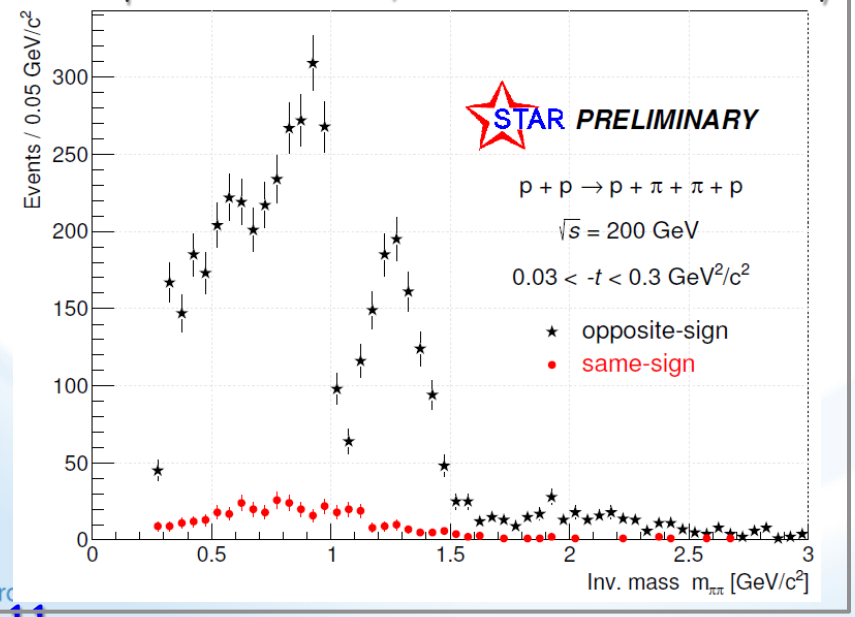


dE/dx in all layers



Central exclusive production

no acceptance correction, statistical uncertainties only



- Very successful operation
  - Roman Pot team & shift crew
- Fast-offline alignment studies

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STAR EXECUTIVE SUMMARY
(FROM 2014 PAC MTG)

Run	Energy	Duration	System	Goals	priority	sequence
15	√s = 200GeV	5-week	Transverse p+Au	saturation physics, ridge and reference, L=300 nb^{-1}	1	**3**
	√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 Dg(x) L=50 pb^{-1}, 60% pol.	2	**1**
16	**$\sqrt{s_{NN}}$ = 200GeV**	**10-week**	**Au+Au**	**L_c, D v_2, R_{AA}, Υ 10nb^{-1}, 2billion MB**	**1**	**1**
	√s = 510GeV	**7-week**	**Transverse p+p**	**A_N of W$^{\pm}$, g, Drell-Yan, L=400 pb^{-1}**	**2**	**2**

PAC Recommendation for Run 15 Collider Operation

For Run 15 the PAC recommends the following (in *order of priority*):

- 9 weeks of polarized p+p collisions at $\sqrt{s}$ = 200 GeV, *and*
- 5 weeks of p+Au collisions at $\sqrt{s}$ = 200 GeV with transverse polarization of the proton
- 2 weeks of p+Si (Al) collisions at $\sqrt{s}$ = 200 GeV with transverse polarization of the proton

For Run 15, in a 22 cryo-weeks scenario, both p+p, p+Au and p+Si running are recommended. In the case of a shorter run, the p+p and p+Au programs would have higher priority.

12 wks of pp requested drops to 9 wks
7 wks of pAu drops to 5 wks
2 wks of p-Al added

STAR Plan for the pp running is to:

- start with 5 weeks of longitudinally polarized beams
- followed by 4 weeks of transversely polarized beams.

Use time during the longitudinal running to complete commissioning of the FMSps, FMS, and pp2pp sub systems.

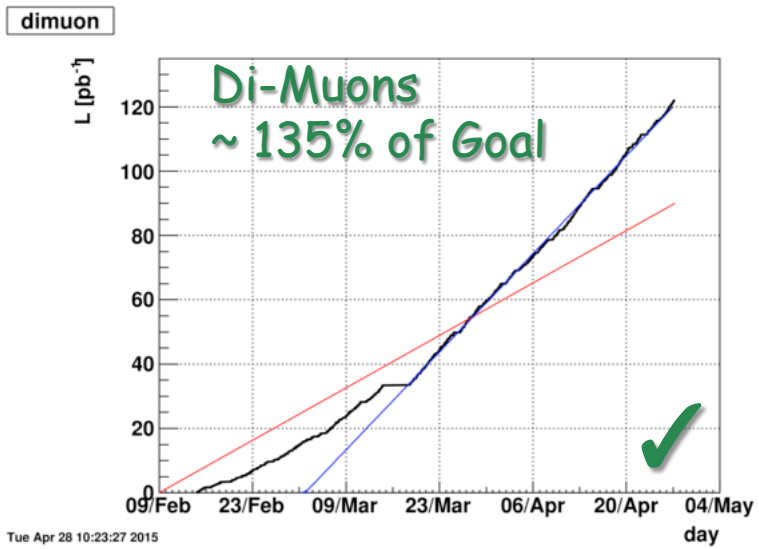
RUN 15 TIMELINE TO DATE

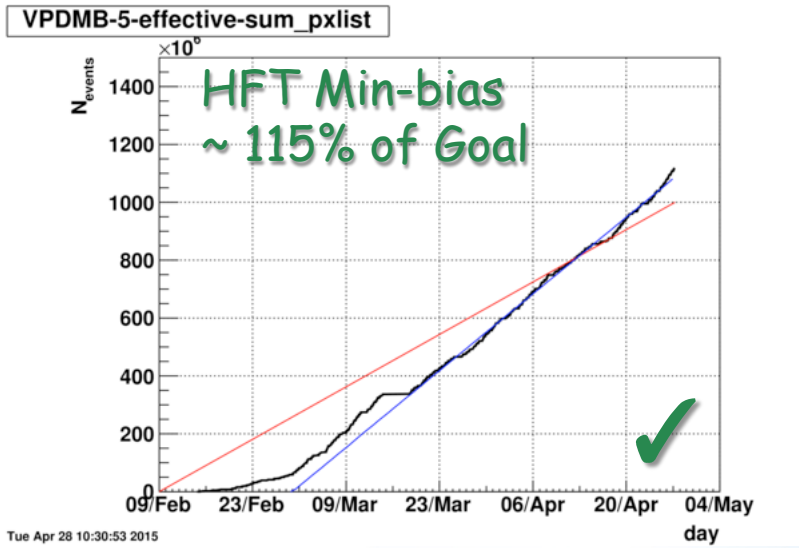
- January 13th: Started two person Shifts, and started flowing flammable gases for Cosmic Ray testing and data accumulation.
- January 20th: RHIC Cooldown to liquid Helium temperature starts, turned on STAR Magnet, continued Cosmic Ray commissioning and data taking.
- January 25th: First overnight RHIC beams for Collider commissioning.
- February 3rd: Started four person Shifts at STAR.
- February 7th: First Overnight collisions for Experiment set up.
- February 10th: Physics running declared by RHIC
- February 12th: STAR starts "longitudinal" 200 GeV pp physics data program.
- March 3rd: Problem with Spin Rotator settings for STAR resolved.
- March 5th: STAR starts Transverse 200 GeV pp physics data program.
- March 17th: STAR asks for a 2 wk extension to pp program to allow for coming back to pp longitudinal data. Approved on March 24th.
- April 3rd: Transverse pp program ends, Longitudinal pp program begins.
- ~ Mid April: Total pp Total & elastic cross section measurement.
- April 27th: Longitudinal pp program ends. P-Au setup begins.
- May 5th: STAR p-Au physics data set accumulation begins
- May 20th: Fixed Target AuAu test
- June 8th: p-Au run ends, p-Al setup begins
- June 22nd: p-Al program ends. Run 15 Beam Operations end

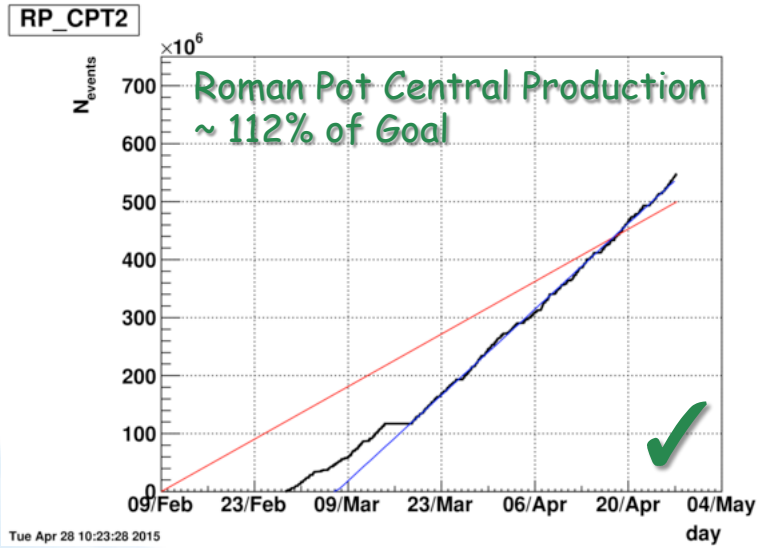
Key: SETUP pp 200 Long pp 200 Trans p-Au p-Al

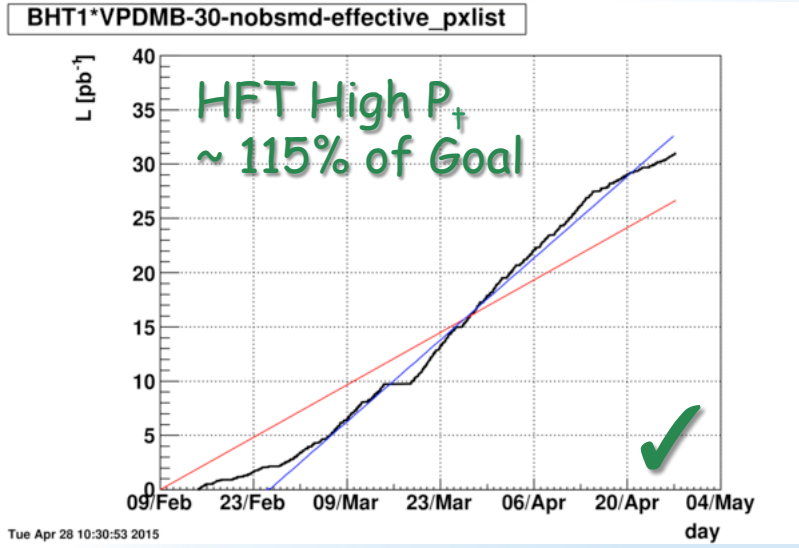
SUMMARY OF DATA SET GOALS AND DATA SETS ACCUMULATED

UNPOLARIZED 200 GEV pp GOALS AND ACHIEVED





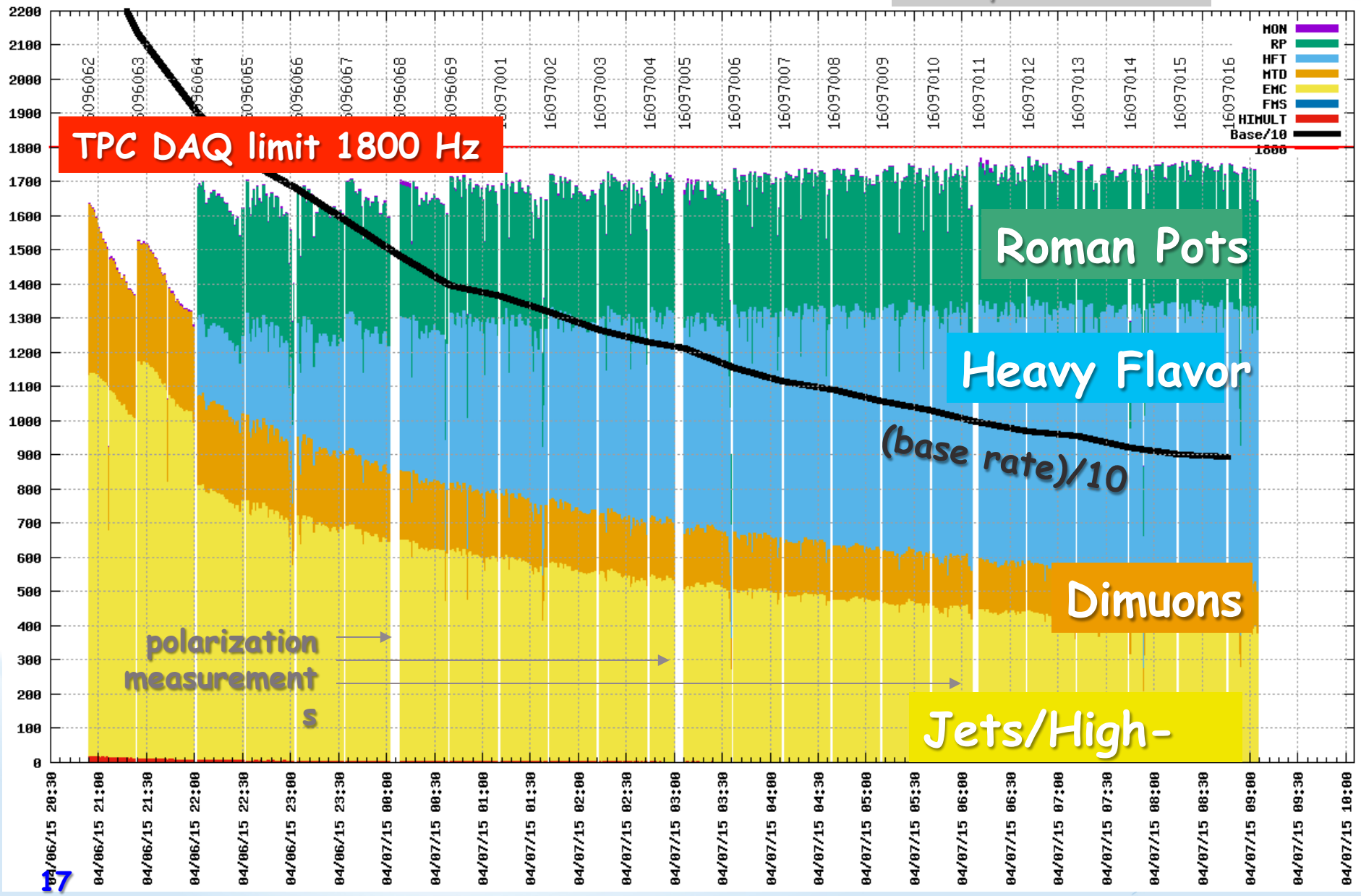




All unpolarized 200 GeV pp Data Set Goals Exceeded

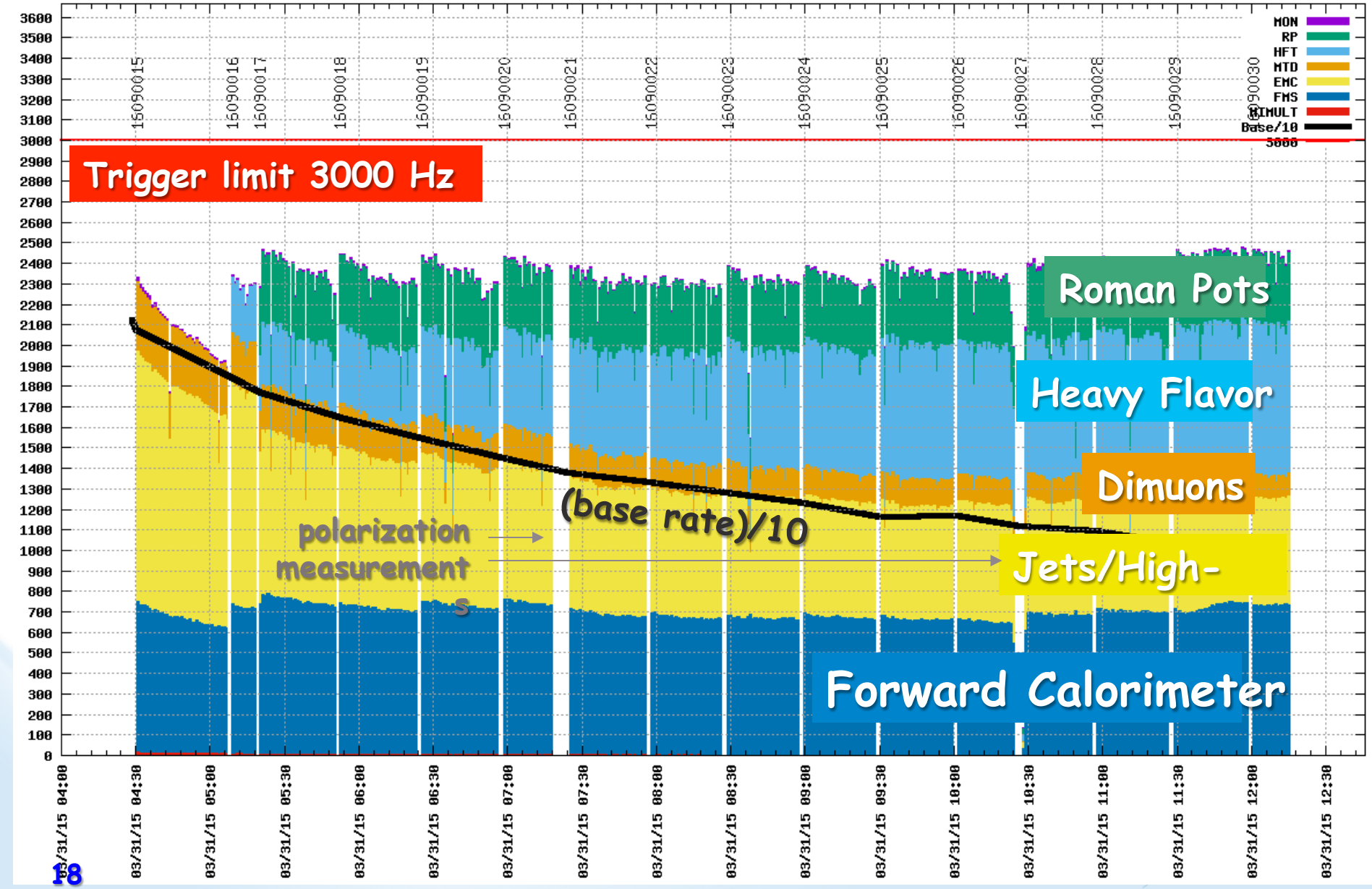
TPC BANDWIDTH IN P+P

example fill 18882

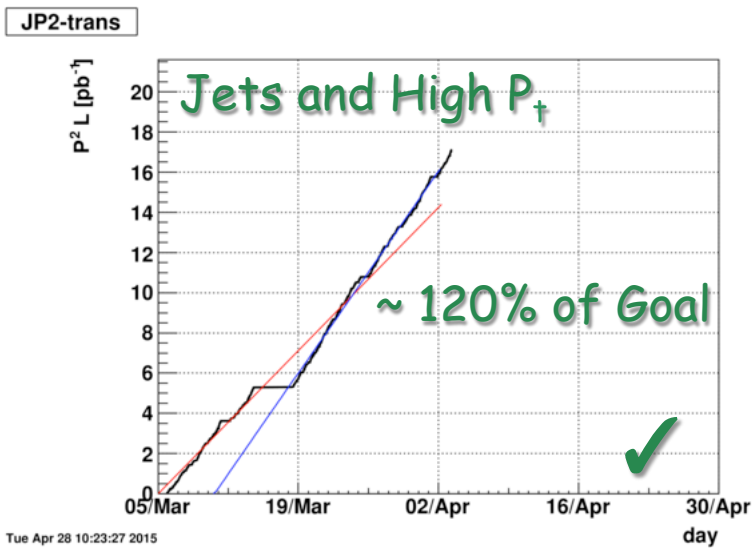


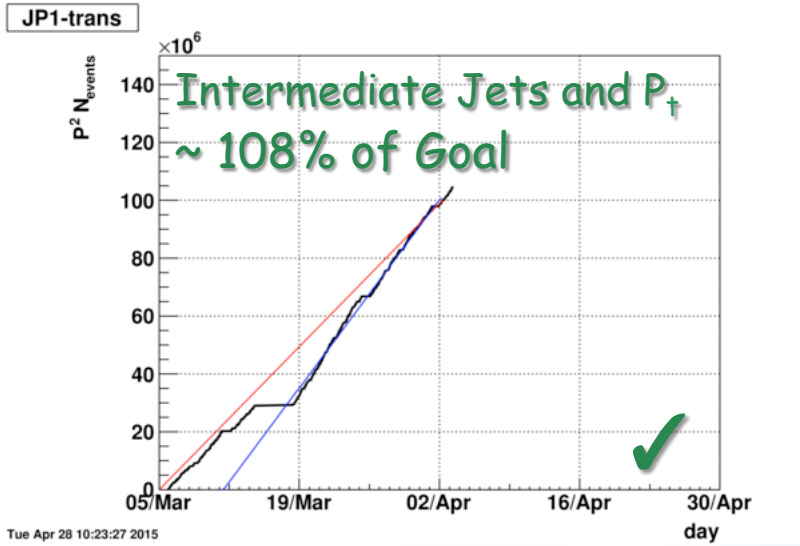
TRIGGER BANDWIDTH IN $p+p$

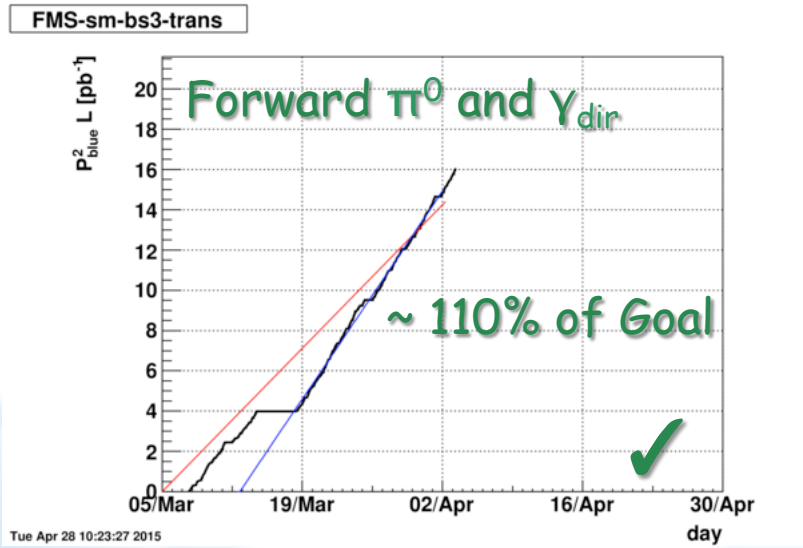
example fill 18847



TRANSVERSE 200 GEV pp GOALS ACHIEVED



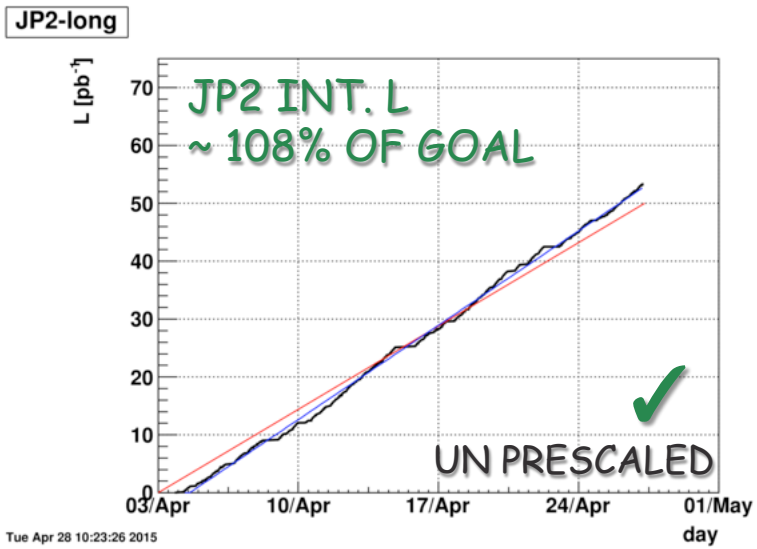




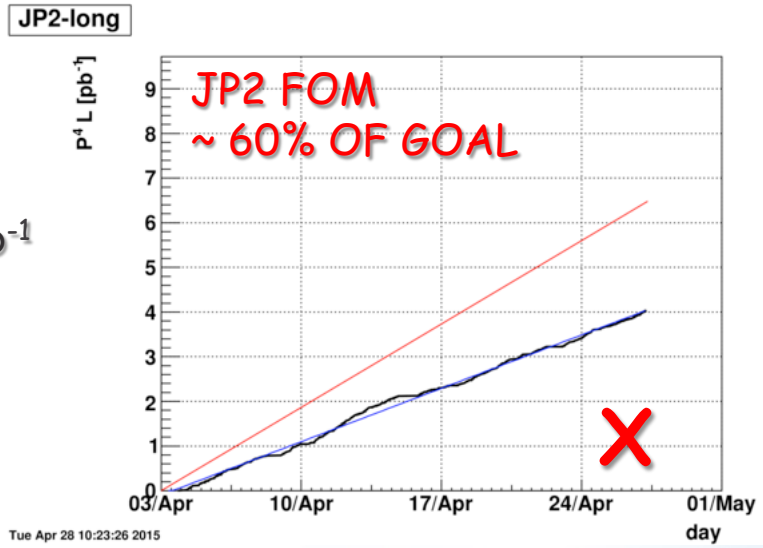
Goal:
L = 40 pb^{-1}
P = 60%
P^2 * L (FOM) = 14.4 pb^{-1}

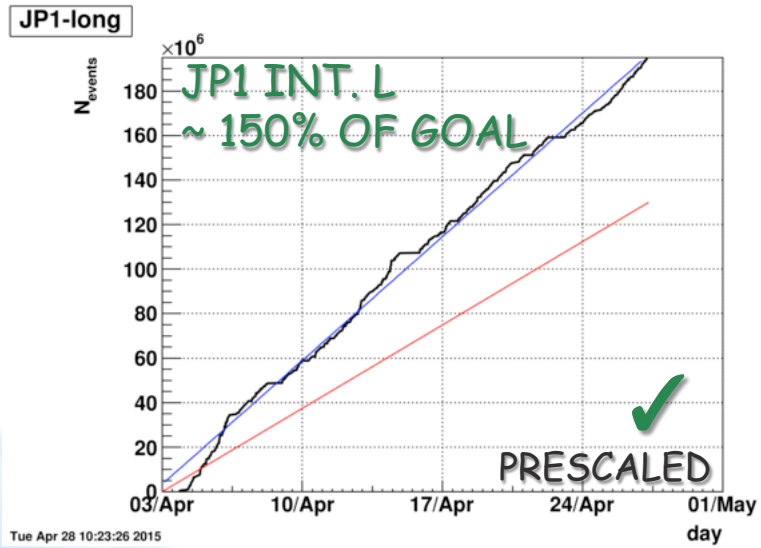
All Transverse 200 GeV pp Data Set Goals Exceeded

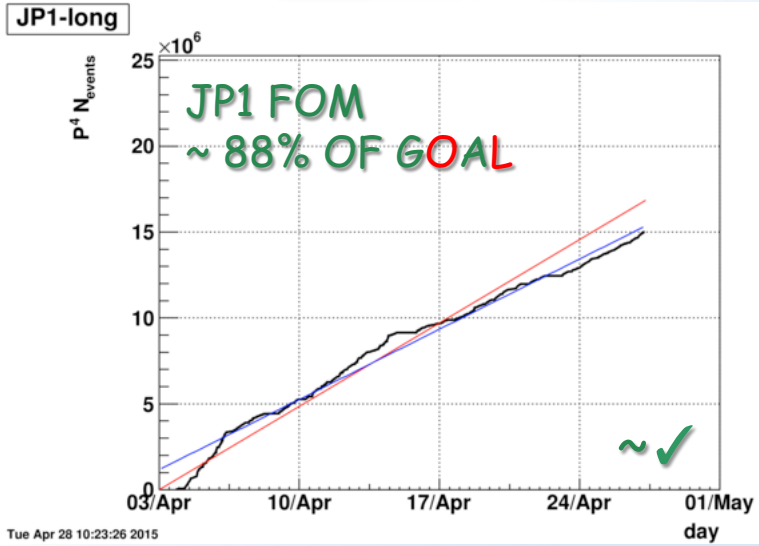
LONGITUDINAL 200 GEV pp GOALS AND ACHIEVED



JP2 Goal:
$L = 50\ pb^{-1}$
$P = 60\%$
$P^4 * L = 6.5\ pb^{-1}$

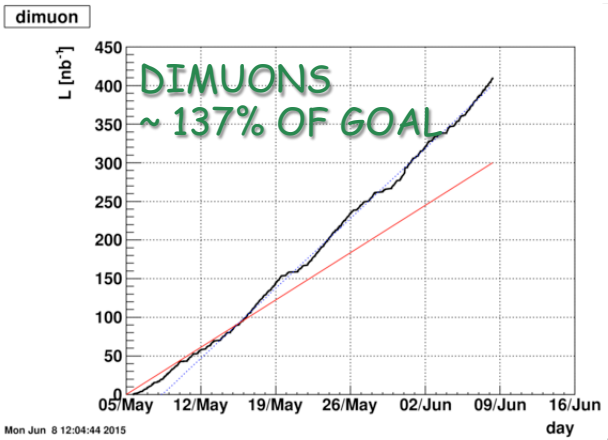


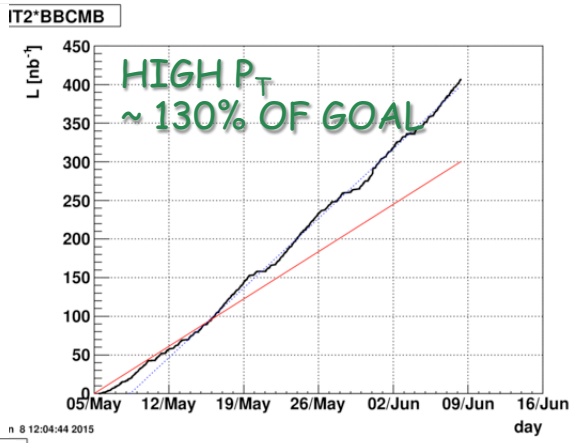


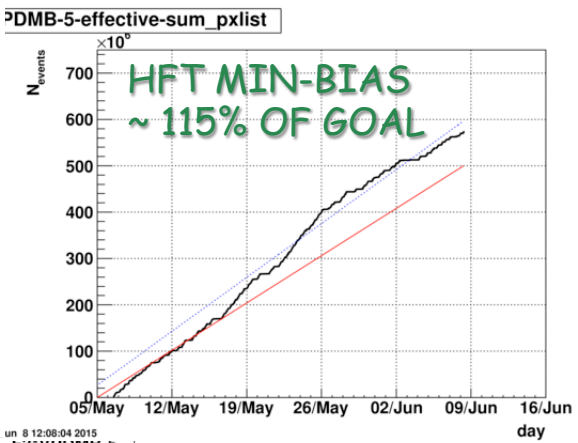


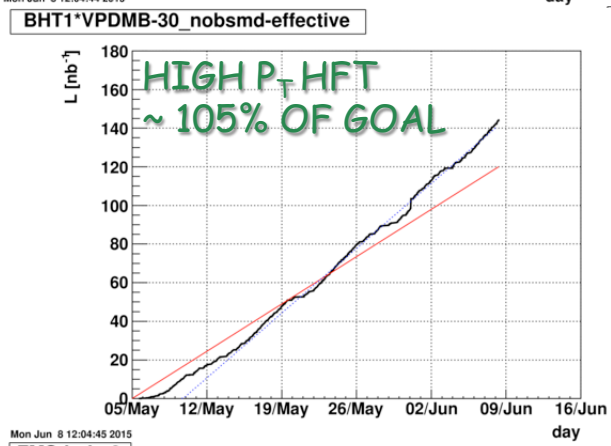
THE LOWER THAN EXPECTED POLARIZATION PREVENTED REACHING THE JP2 FOM GOAL

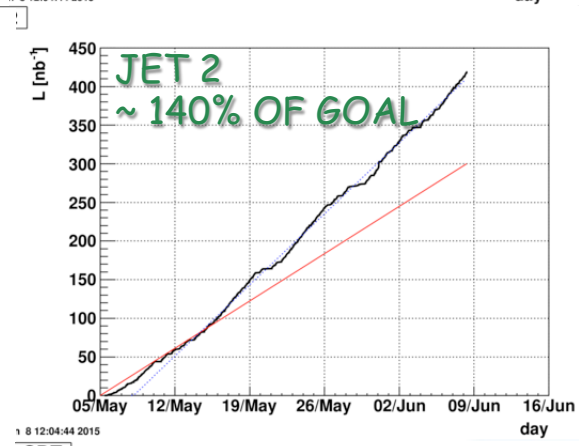
200 GEV p_{TRANS} - AU GOALS AND ACHIEVED

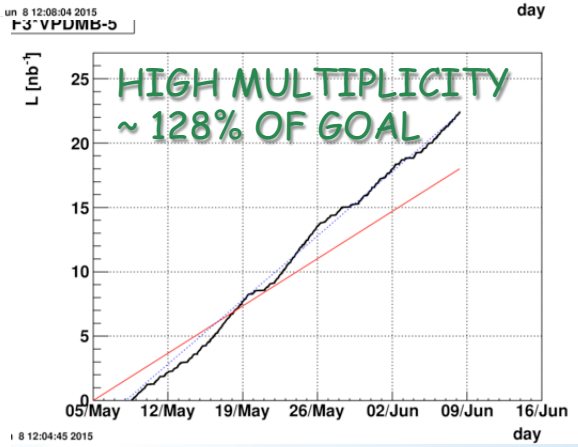


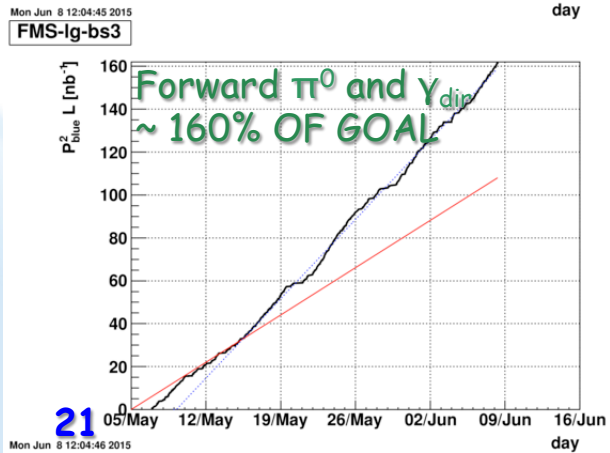


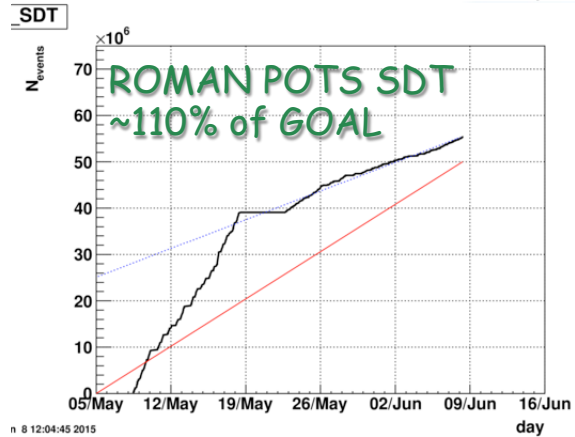












ALL P-AU GOALS HAVE MET OR EXCEEDED

L=300 nb^{-1}, P = 60%

FOM = p^2L = 108 nb^{-1}

p-AU RUN WENT EXTREMELY WELL

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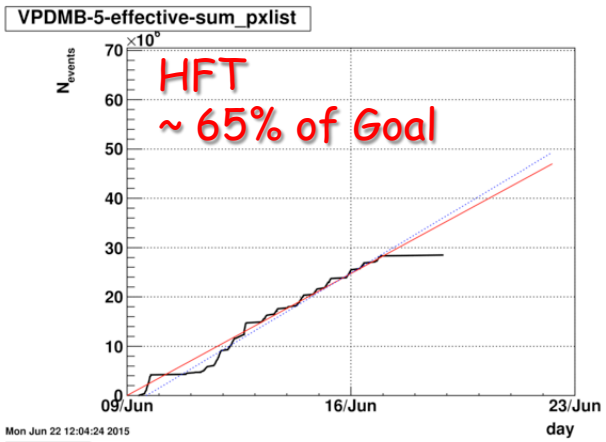
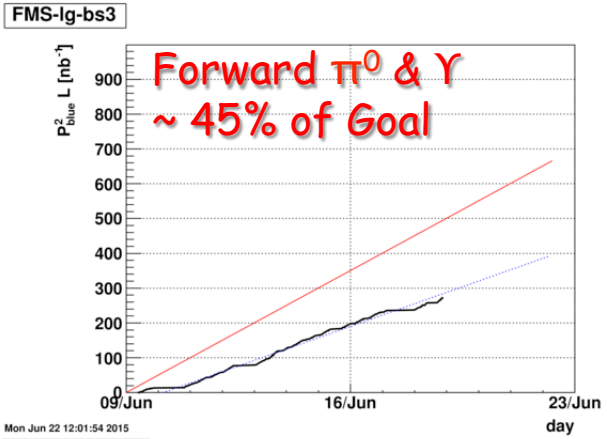
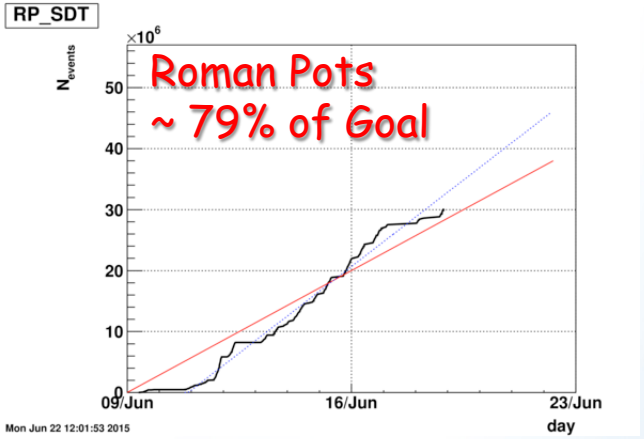
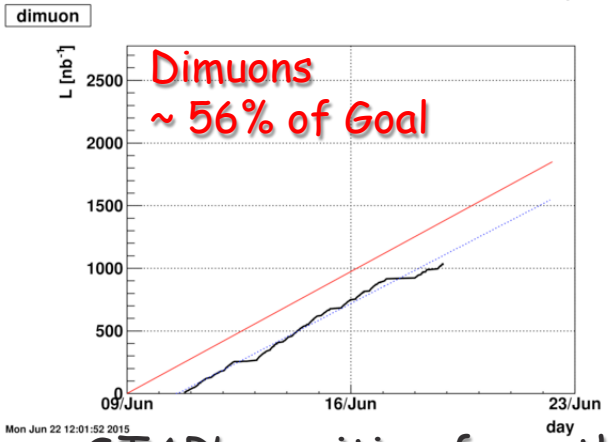
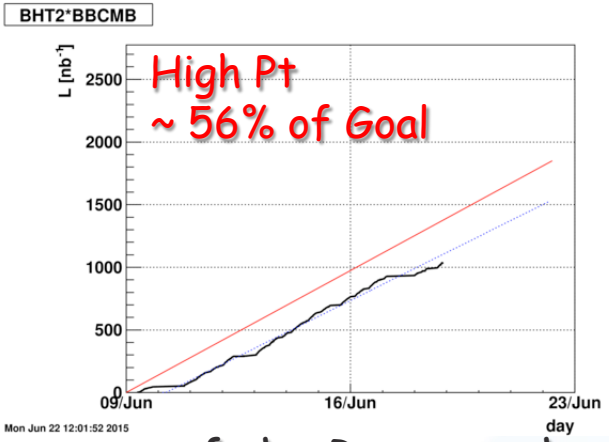
200 GEV p_{TRANS} - Al GOALS AND ACHIEVED







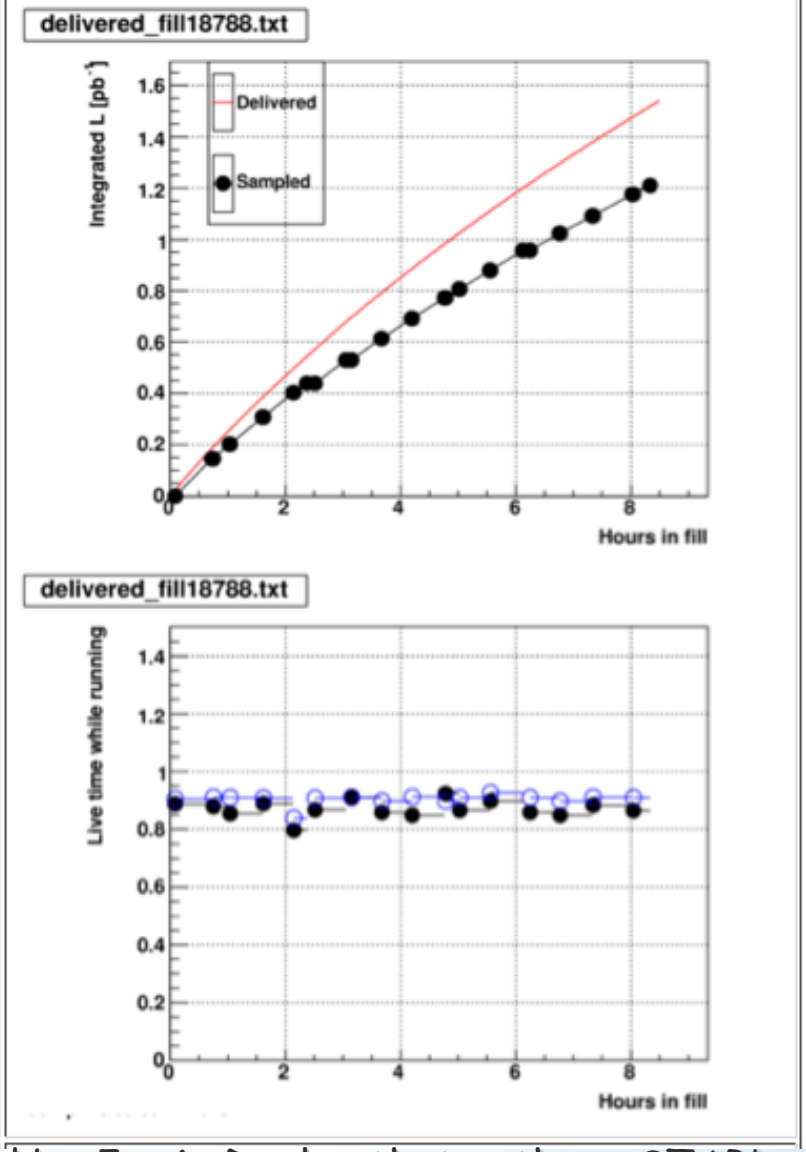




- STAR's position from the start of the Run was that we wanted to achieve our complete p-Au data set goals before moving on to p-Al. This was accomplished.
- Once the decision to proceed with p-Al was made, we pushed to get a solid p-Al data set as well.
- Extremely unfortunate that the off normal condition of the Magnet transformer forced the STAR Magnet to be turned off before the end of the Run.

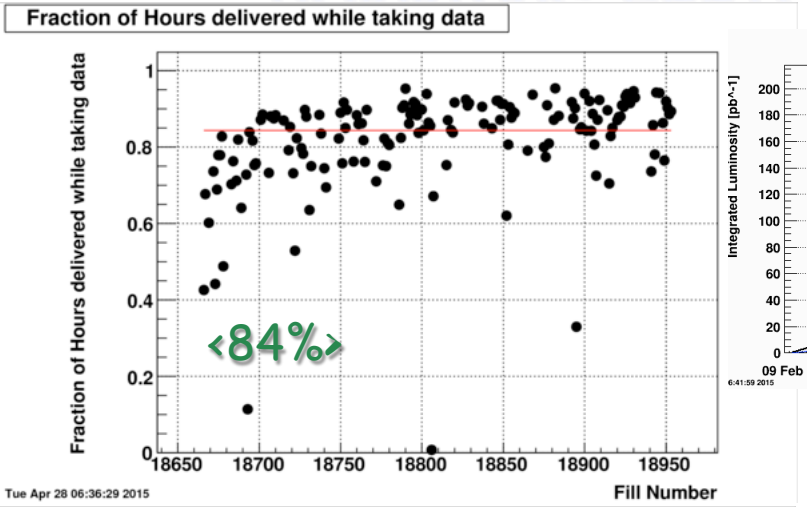
STAR'S RUNNING EFFICIENCY IN RUN 15

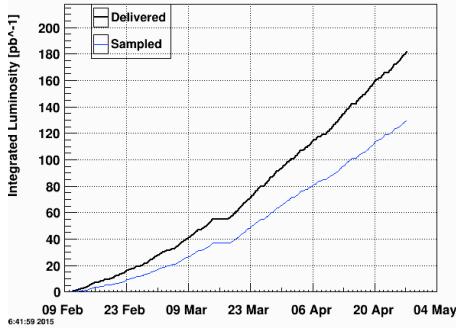
Fill 18788
Started Thu Mar 19 00:09:38 2015
Ended Thu Mar 19 08:39:19 2015
8.5 Hours
Total delivered: 1.540 pb^-1
Sampled Fraction: 0.816
after correction by average TCULive/Live: 1.039
Fraction of L delivered while taking data: 0.901
Fraction of hours delivered while taking data: 0.903
Minutes lost before first run: 5.0 Frac: 0.010
Minutes lost after last run: 9.6 Frac: 0.019
Luminosity fraction lost before first run: 0.014
Luminosity fraction lost after last run: 0.014
Average Live Time while taking data: 0.872
Live Time from TCU Counters while taking data: 0.906
Luminosity fraction lost in lasers: 0.000
Hours lost in lasers: 0.0 Frac: 0.000

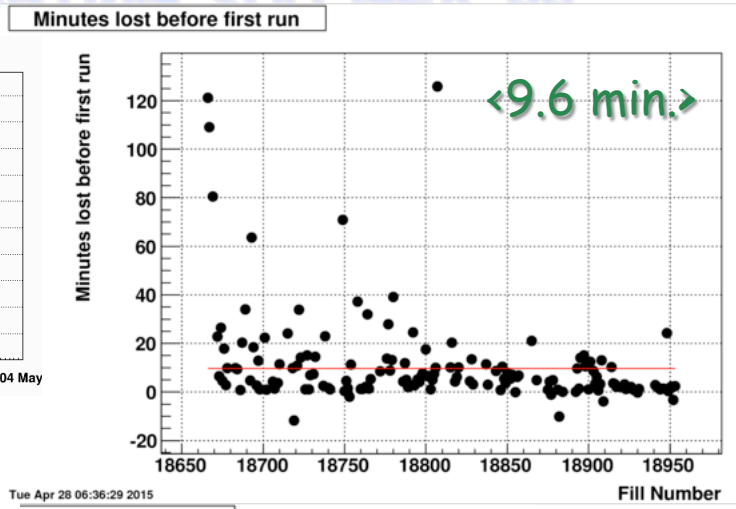


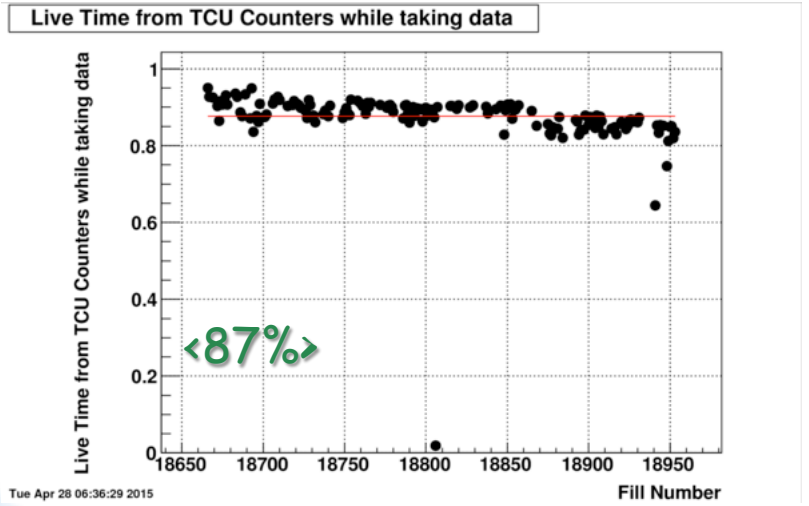
Nice utility provided and maintained by Jamie Dunlop that gathers STAR's running efficiency on a Fill by Fill basis (http://www.star.bnl.gov/protected/common/triggerPages.html)

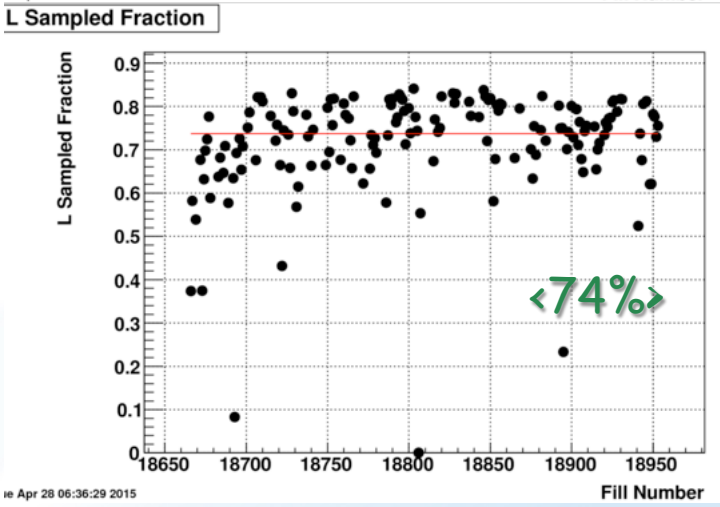
RUNNING EFFICIENCY DURING 200 GEV pp











Very good overall running efficiency. Mantra "Every minute counts"

To first order: (0.84 uptime)(0.87 livetime) = 0.73 ~ Sampled L.

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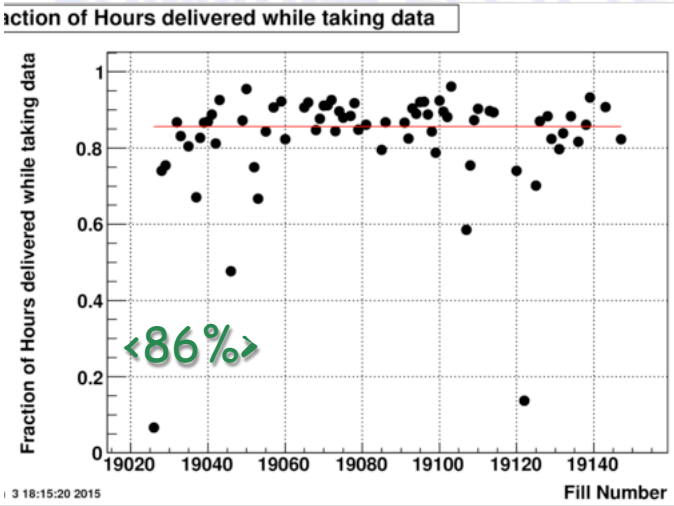
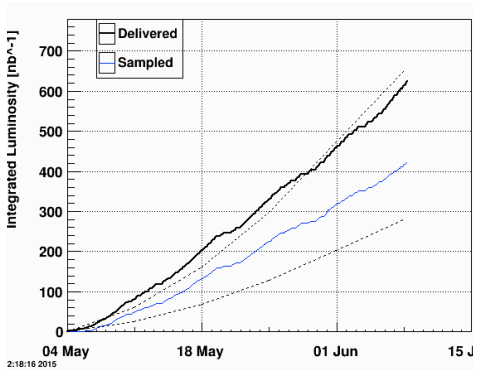
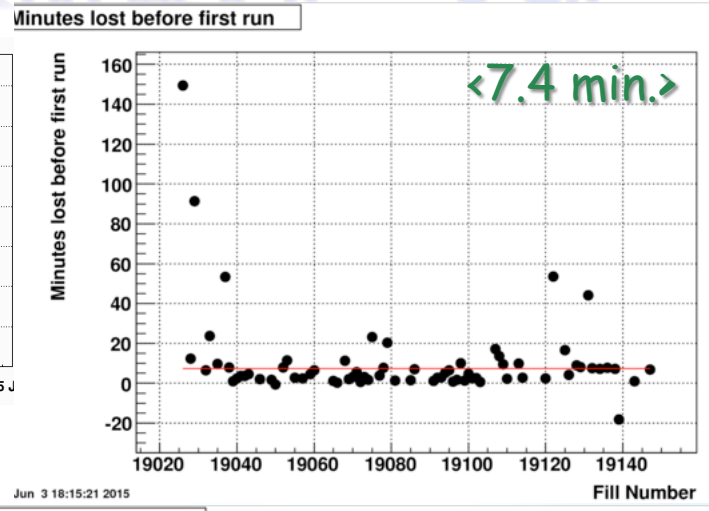
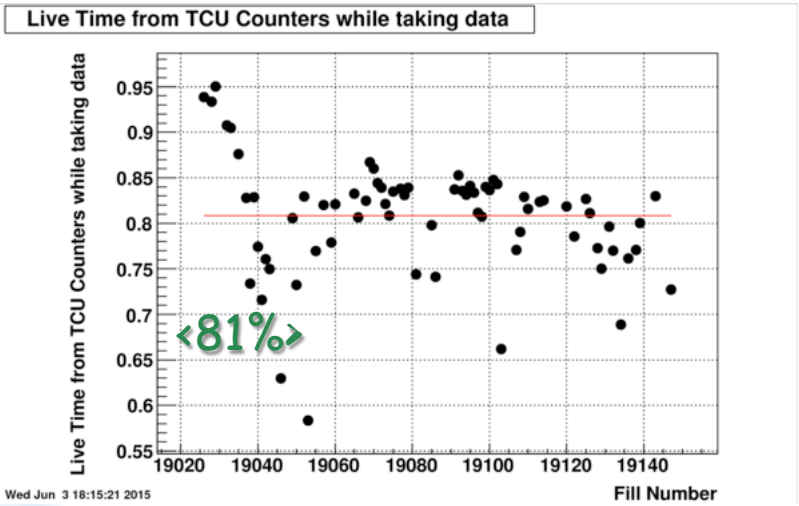
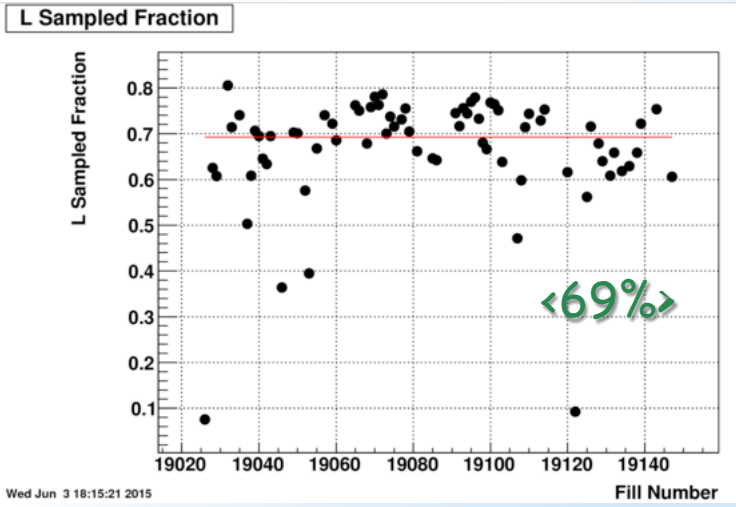
RUNNING EFFICIENCY DURING 200 GEV p_{trans} - Au











Very good overall running efficiency for p-Au.

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LUMINOSITY PROFILE DESIRED FOR RUN 16 AUAU

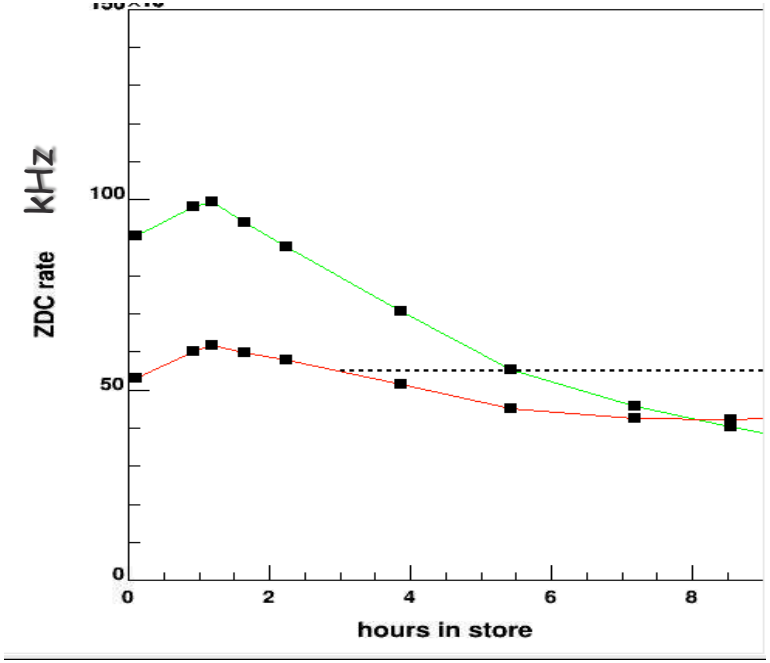
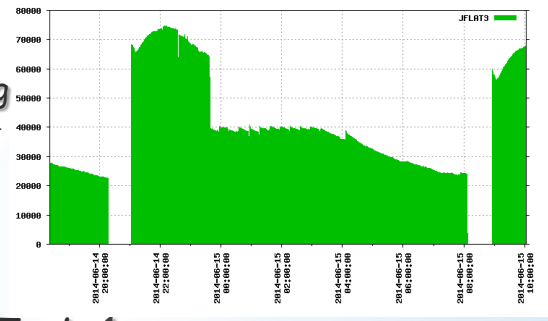


Figure 6-2 (From BUR):
ZDC rates for requested beam profile. The green curve shows the scaled ZDC rate (luminosity for 10b cross section) as the expected maximum luminosity, and the red a luminosity profile with a dynamic beta*.

Red indicates what can be delivered if beta* is changed from 1.2 early in the store to 0.5 late in store

Run 14 HFT Running
40 kHz



In the proposed scenario the delivered luminosity is ~0.17 nb^{-1} per store.
In the Run14 Au+Au at 200 GeV the average physics-on hours per day were 13.5 hours i.e. 94.5 per week.
Thus RHIC can deliver ~94.5/9*0.17 ~ 1.8 nb^{-1}/week in this running mode.
Even though the delivered luminosity is not the maximum that can be delivered, it still allows STAR to reach the proposed goals for both the minimum bias goals (2 Mevts) and the high luminosity goals (10 nb^{-1}).

"RETREAT" TYPE COMMENTS FOR RUN 15
(I.E. WHAT COULD PERHAPS BE DONE BETTER)

Comment 1: When either/both the Collider and the Experiment observations don't make sense, more quickly question all relevant assumptions or beliefs.

- This refers to the protracted time spent early in Run 15 to figure out and resolve the issues with the Longitudinal polarization setup at STAR.

Comment 2: Make a concerted effort not to present the Experiments with Collider conditions (e.g. Higher luminosities, higher backgrounds, etc.) between ~ 11 pm and 9 am that they haven't run with during the day.

- At least for STAR, we run a large number of parallel triggers (~ 50), the bulk of which are prescaled, with an overall system tune to maximize the utility of the delivered RHIC luminosity throughout the store. We can tune this system to just about any conditions, but presenting conditions we haven't seen on overnight hours can lead to inefficiencies.

SUMMARY

- The early start to STAR Commissioning with Cosmic Rays was beneficial.
- All "new" sub systems (FMS, FPS, Roman Pots) came online very efficiently and quickly, and performed very well throughout Run 15.
- Though our requested 12 wks was reduced to 10.6, we achieved the majority of our pp data set goals (exception JP2 long.)
- The collider reconfiguration and p-Au run went extremely well.
- The p-Al Run was going very well until the unfortunate issue with the Magnet transformer.
- The STAR running efficiency was fairly high throughout Run 15.
- The Shutdown Plan calls for STAR to remain in the IR over the FY 15 Shutdown.
- We can look forward to a lot of interesting Physics in the data sets we've taken in RHIC Run 15.

- All in all, an extremely successful Run 15 for STAR.

It is with pleasure that STAR Thanks C-AD for the Run 15 Beams