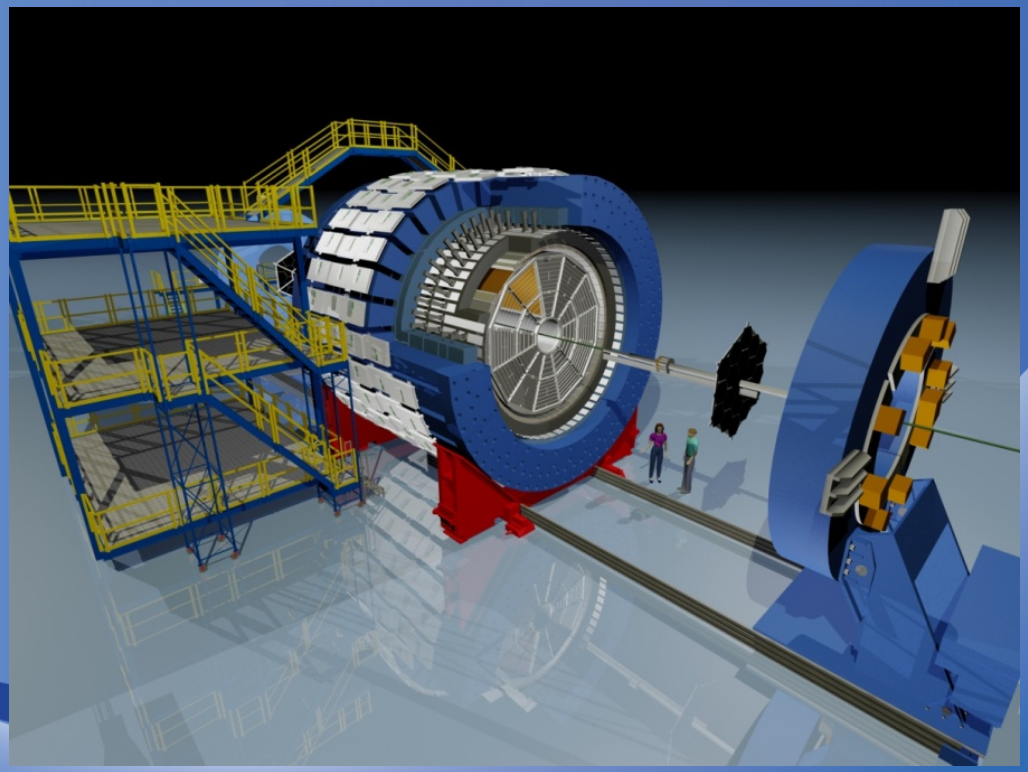
STAR RUN 17 PERFORMANCE
& BRIEF COMMENTS FROM THE SCHEDULING PHYSICIST

Bill Christie

RHIC Retreat

August 8, 2017



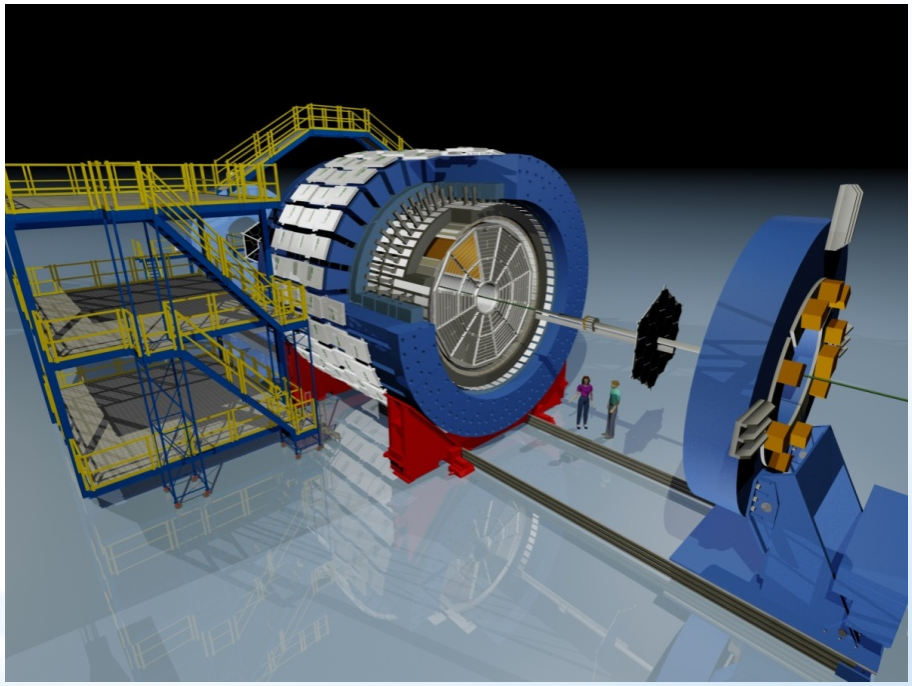
BROOKHAVEN NATIONAL LABORATORY

a passion for discovery

U.S. DEPARTMENT OF ENERGY | Office of Science

Outline

- Data set Goals (BUR)
- Changes for Run 17
- Luminosity leveling for Run 17 510 GeV transverse pp
- STAR's Running Efficiency
- Data Set Goals and Achievements
- Summary for STAR
- Scheduling Physicist Comments on Run 17
- Summary for Scheduling Physicist



EXECUTIVE SUMMARY TABLE

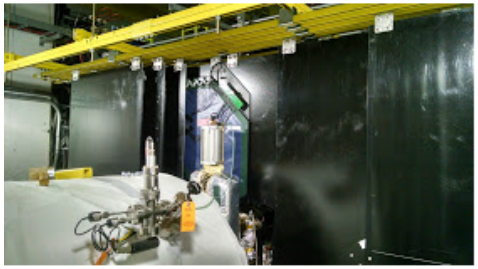
Run	Energy	Duration	System	Goals	priority	Sequence
17	$\sqrt{s_{NN}}$=500 GeV	13-wk	Transverse p+p	A_N of $W^{\pm}$, g, Drell-Yan, L=400 pb^{-1}, 55% pol	1	1
		1-wk	p+p	RHICf		2
		2-wk	CeC			
	$\sqrt{s_{NN}}$=62.4 GeV	4-wk	Au+Au	Jets, dileptons, NPE 1.5B MB	3	3
18	$\sqrt{s_{NN}}$ =200 GeV	3.5-wk	Ru+Ru	1.2B MB	2	4
	$\sqrt{s_{NN}}$=200 GeV	3.5-wk	Zr+Zr	1.2B MB	2	5
	$\sqrt{s_{NN}}$=27 GeV	2-wk	Au+Au	>500M MB	3	6

Options from guidance:
1) 24 cryo-weeks in run 17, 13 weeks in run 18
2) 19 cryo-weeks in run 17, 13 weeks in run 18
3) If only 15 weeks in run 17, all for pp500

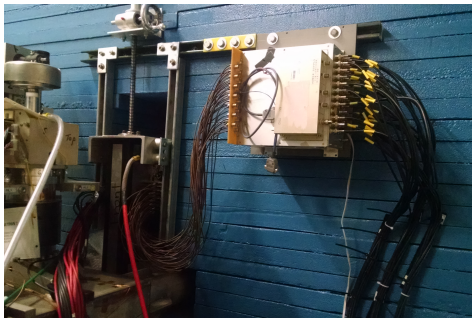
STARs goal for the "rare" triggers during the 510 GeV pp program are to sample 280 pb^{-1} of integrated luminosity.

When the dust finally settled, Run 17 turned out to be 21 Cryo weeks

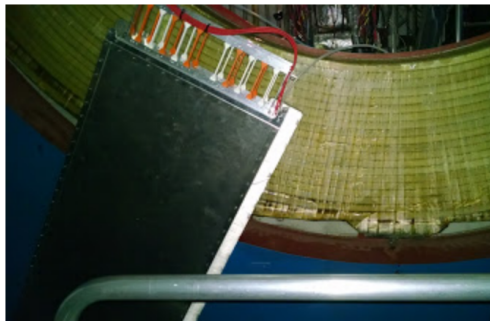
Additions to STAR for Run 17



FMS Post Shower

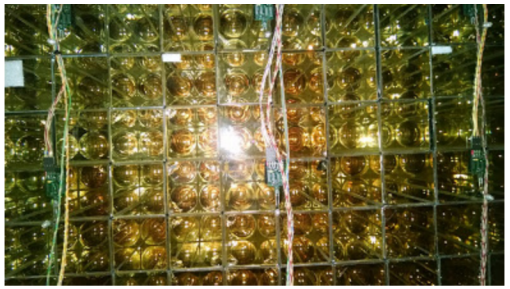


RHICf

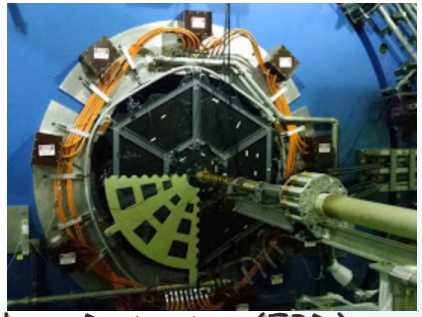


eTOF Prototype

* EIC Calorimeter R&D setup



FMS UV Curing system



Event Plane Detector (EPD) quadrant

Original (low mass) center cone

* iTPC proto type RDO and FEE
* Proto type Digital Electronics Platform (DEP)
* New QT with TAC built in
* Selectable trig crate readout

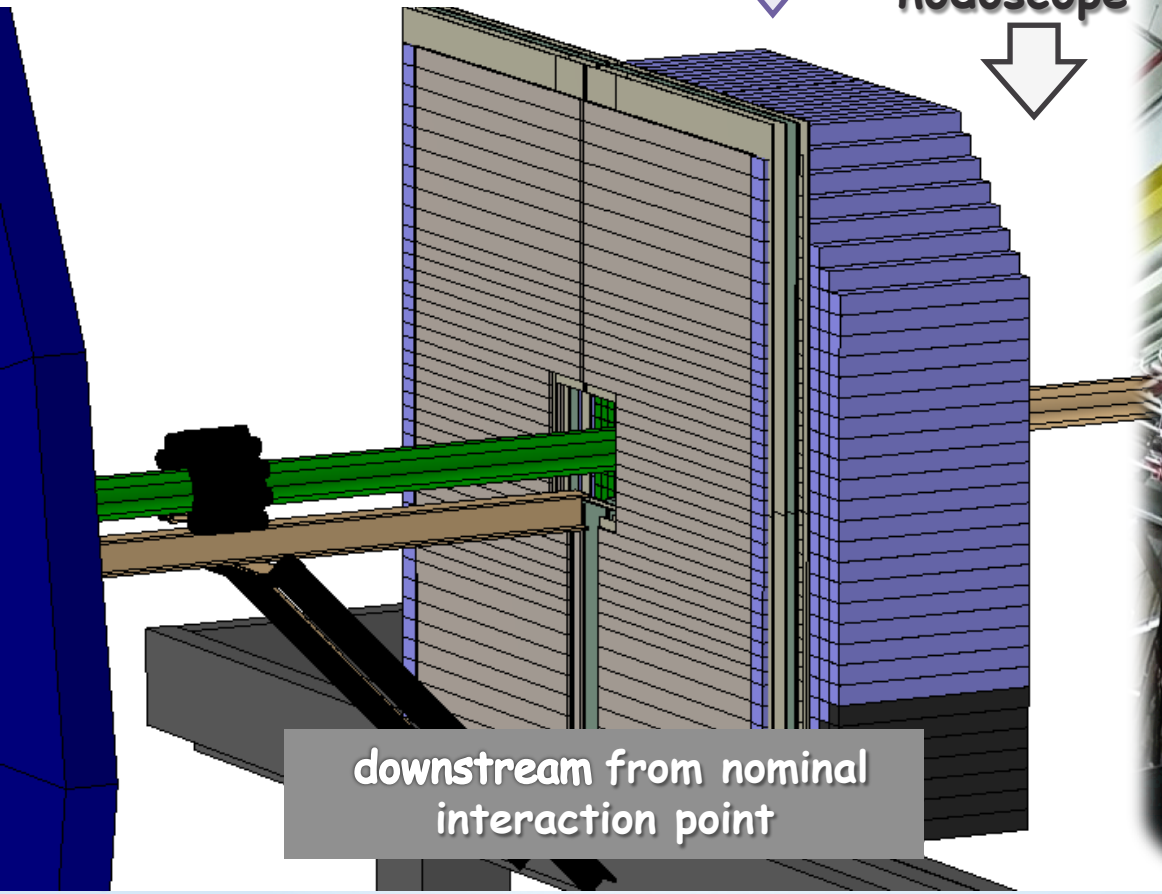
PRESHOWER AT FORWARD RAPIDITIES

Forward Meson Spectrometer

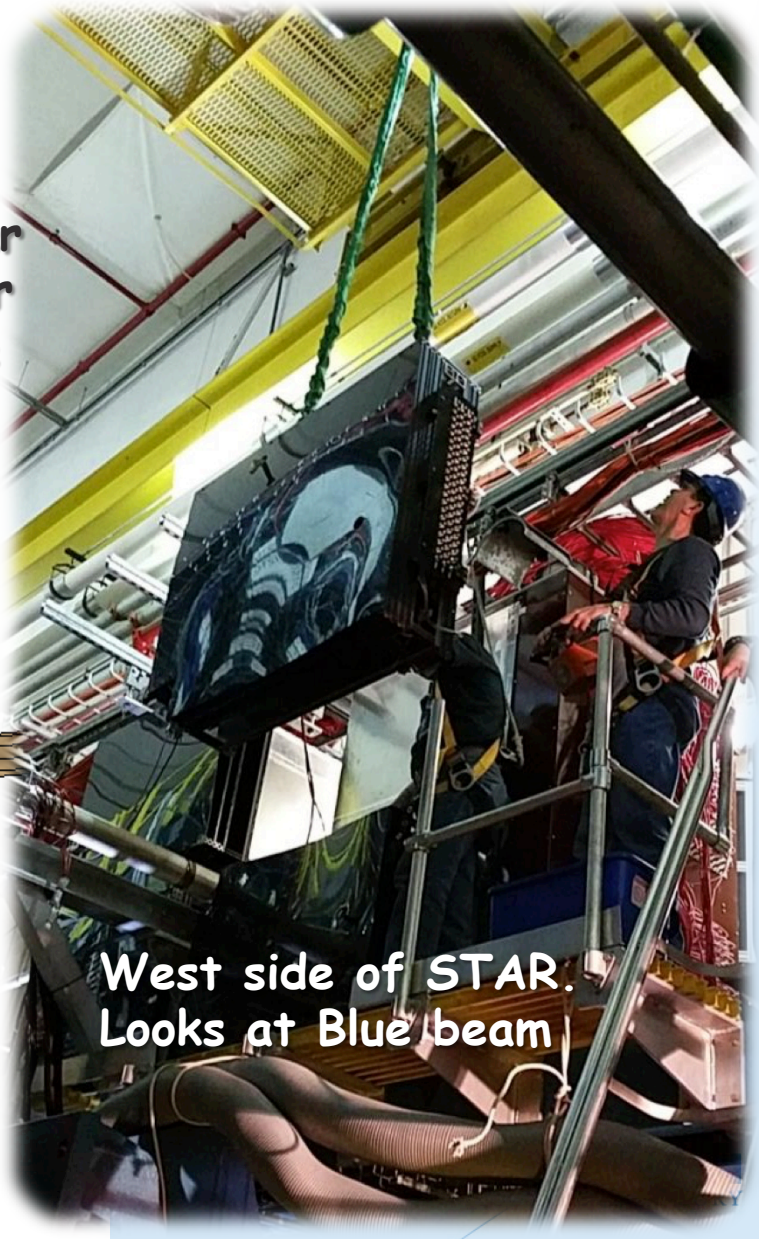
Preshower scintillator hodoscope

476+788 PbGl towers

Postshower scintillator hodoscope

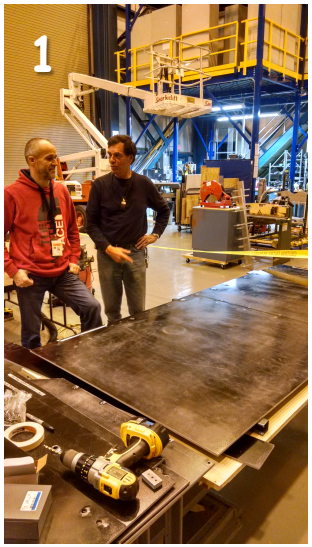


downstream from nominal interaction point



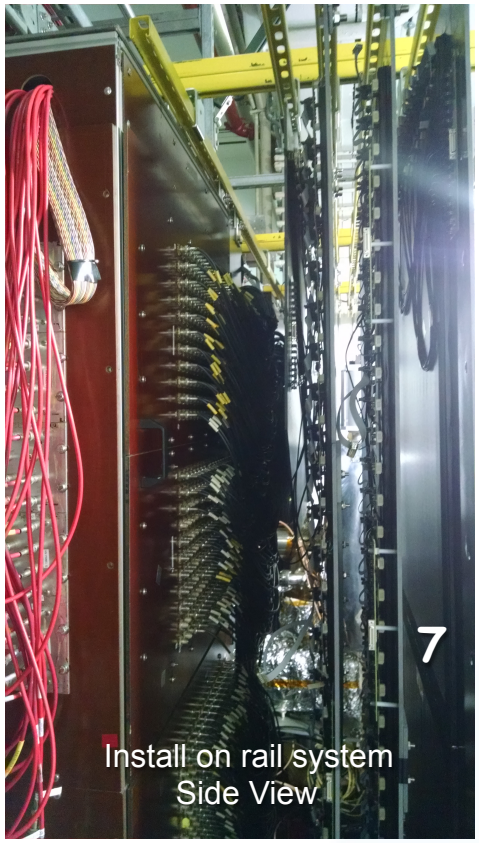
West side of STAR. Looks at Blue beam

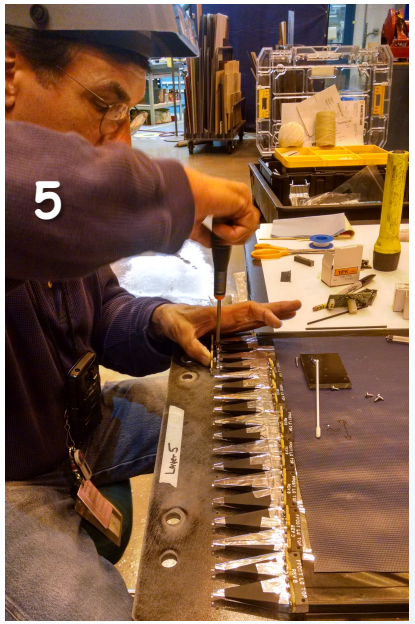
FMS Post Shower Detector



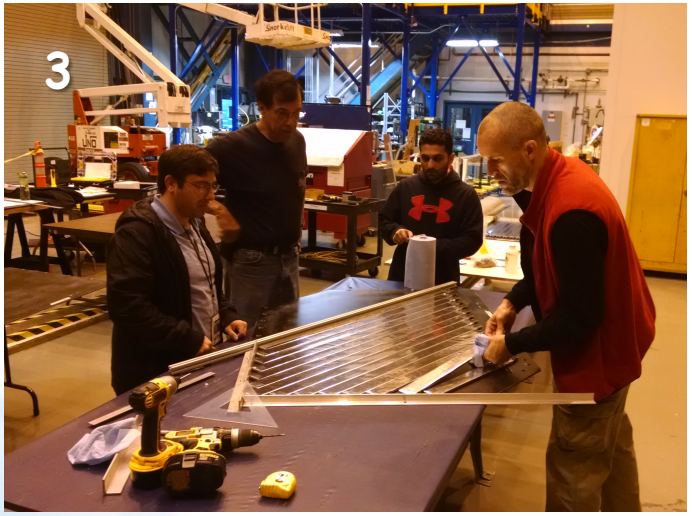
Start with pre-cut panels

Drill and tap for joining

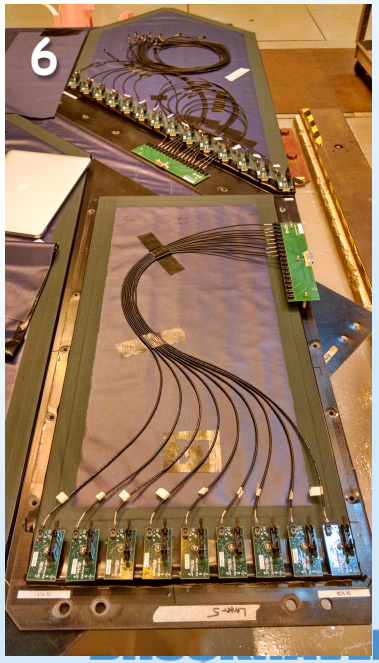




Attach SiPMT boards

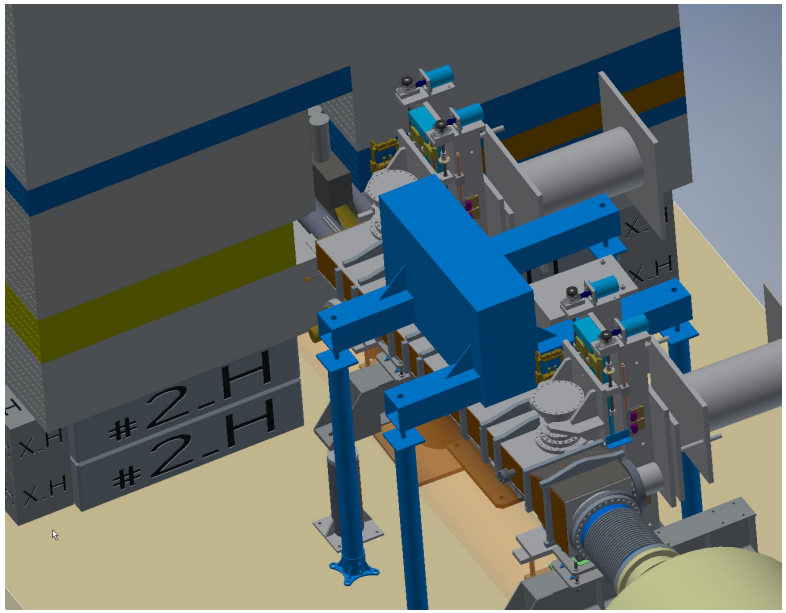


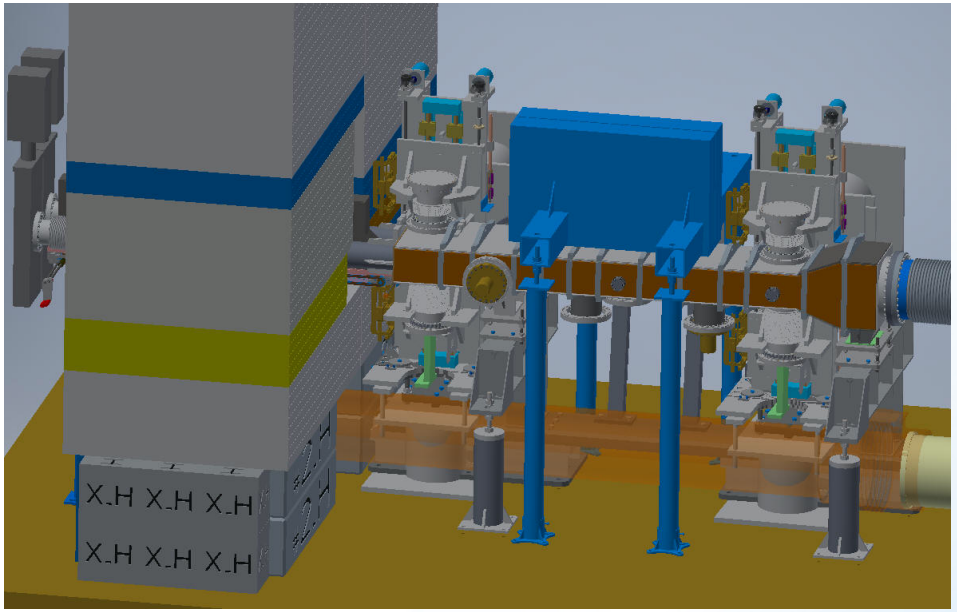
Glue on wrapped scintillators with light guides

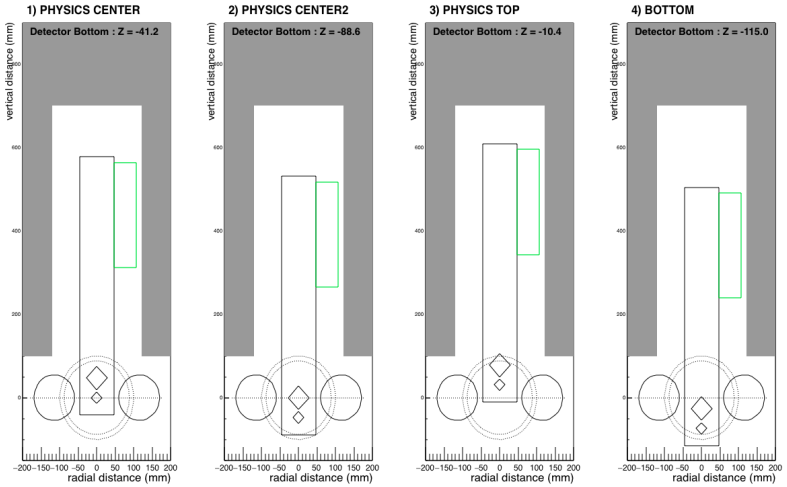


Install FEE boards & cables

RHICF INSTALLATION ON THE WEST SIDE OF STAR







The RHICf setup is a position sensitive calorimeter system to be positioned just in front of the ZDCs on the West side of STAR.

It will measure cross sections for particles traveling in the Blue beam direction.

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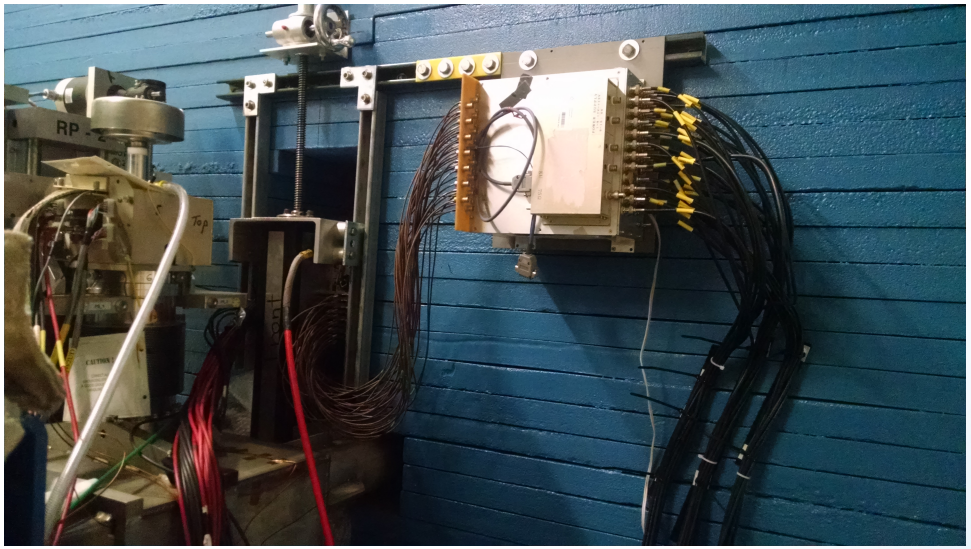
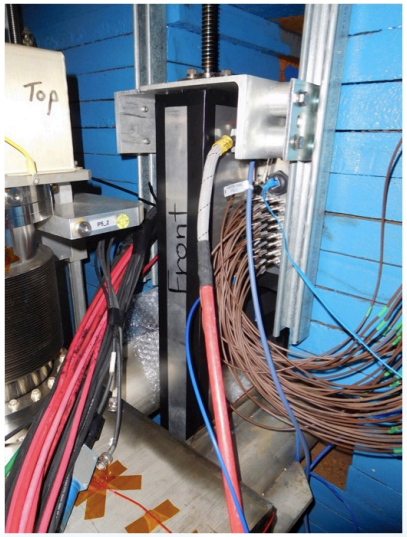
VERTICAL MOVEMENT DEVICE & RHICF

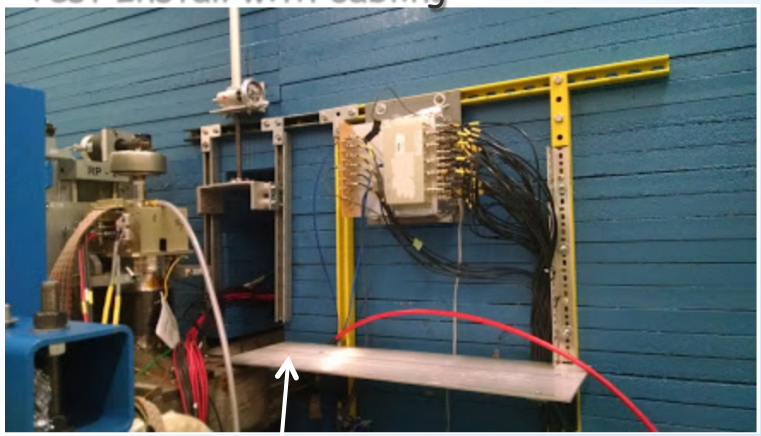
Rahul, Bob Soja, John Scheblein, and two High School student interns



Test Install with cabling



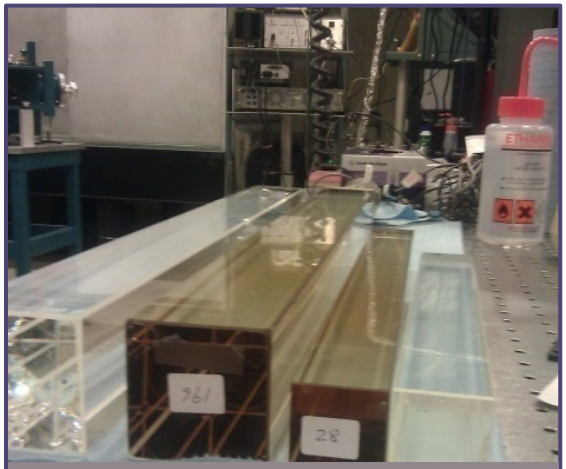
Close up of installed & cabled RHICf



Shelf where RHICf resided until their running period at end of Run 17

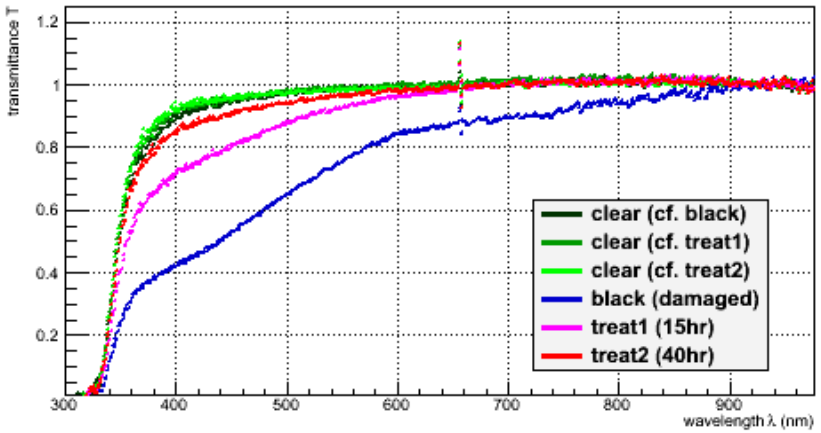
FMS IN SITU UV CURING SYSTEM

Pb-glass annealed in sunlight before, New system to anneal in place with UV LEDs

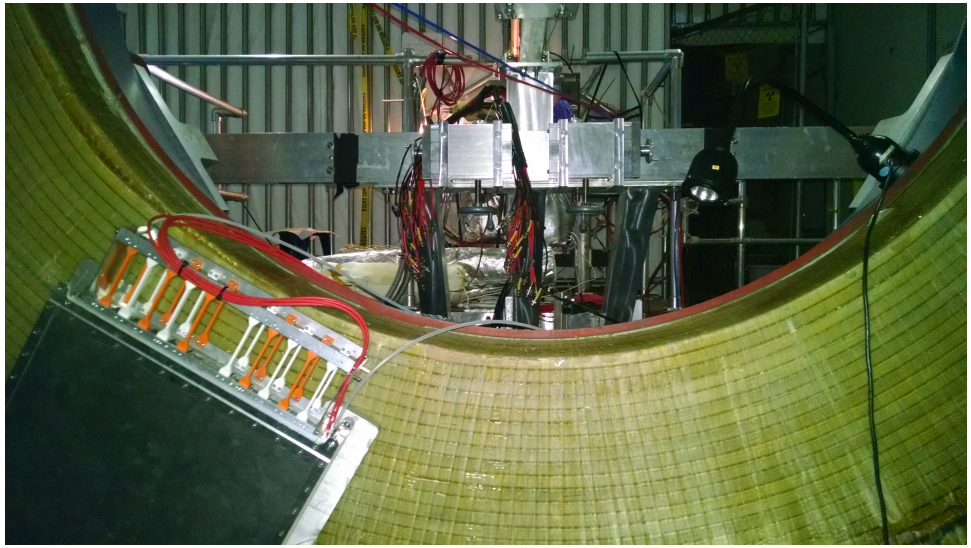


Curing of radiation damage

PbGl transparency after UV curing

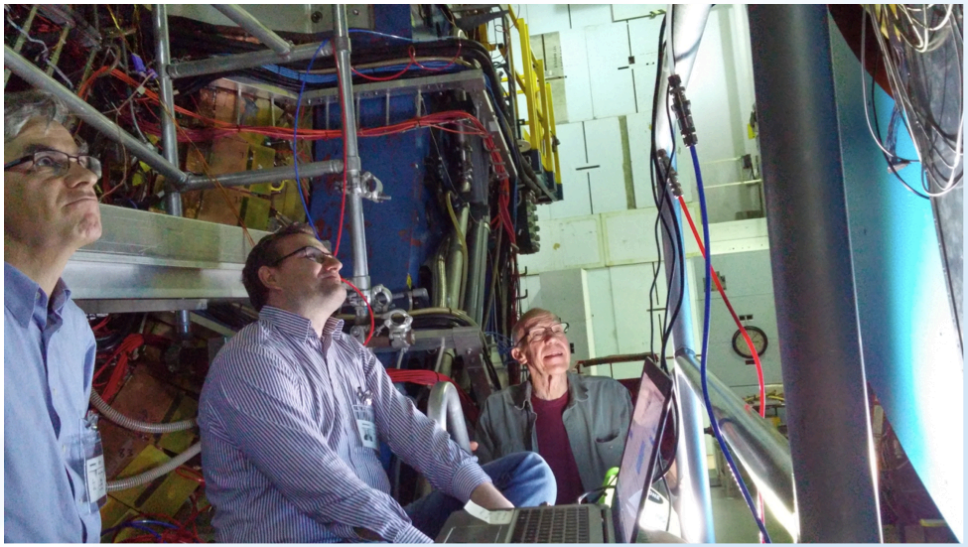


ENDCAP TOF (ETOF) PROTOTYPE



eTOF installed on inside surface of East Poletip

Three "final" design modules will be installed for Run 18. Entire installation prior to Run 19



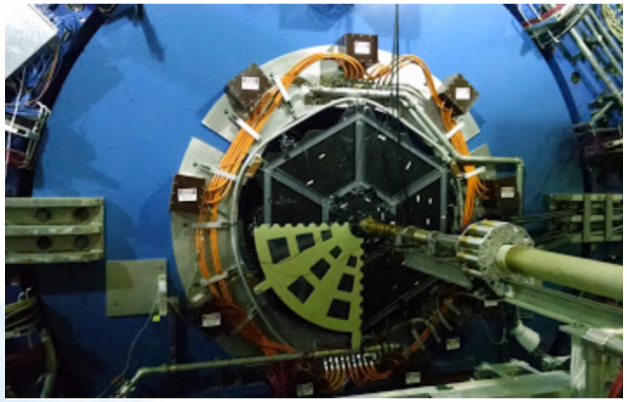
eTOF Colleagues looking at installed prototype

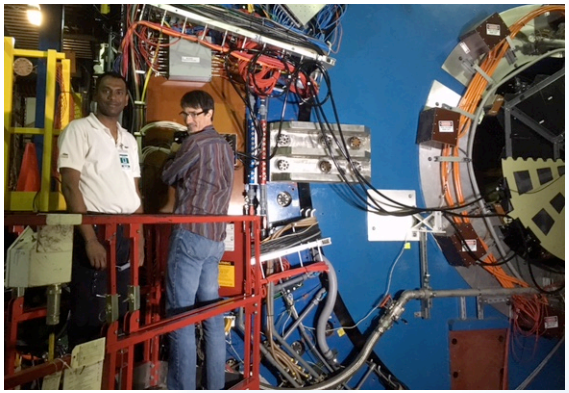
Prototype Event Plane Detector (EPD)

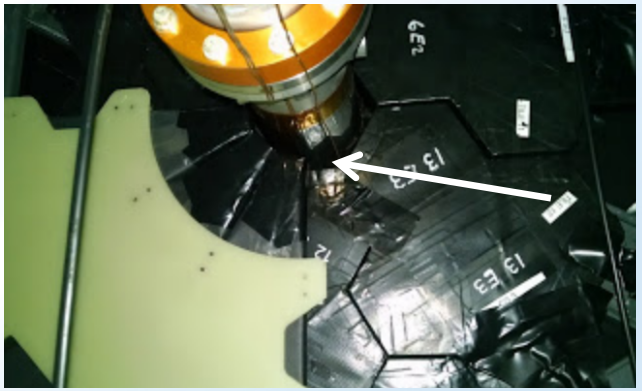

Test install frame


Final assembly in Clean Room


Transport to IR


Installed behind BBC on East side


Mike and Prasanth installing new FEE board during run


Within ~ 1 cm of beam pipe

PP510 OPERATION MODE FOR W-BOSON

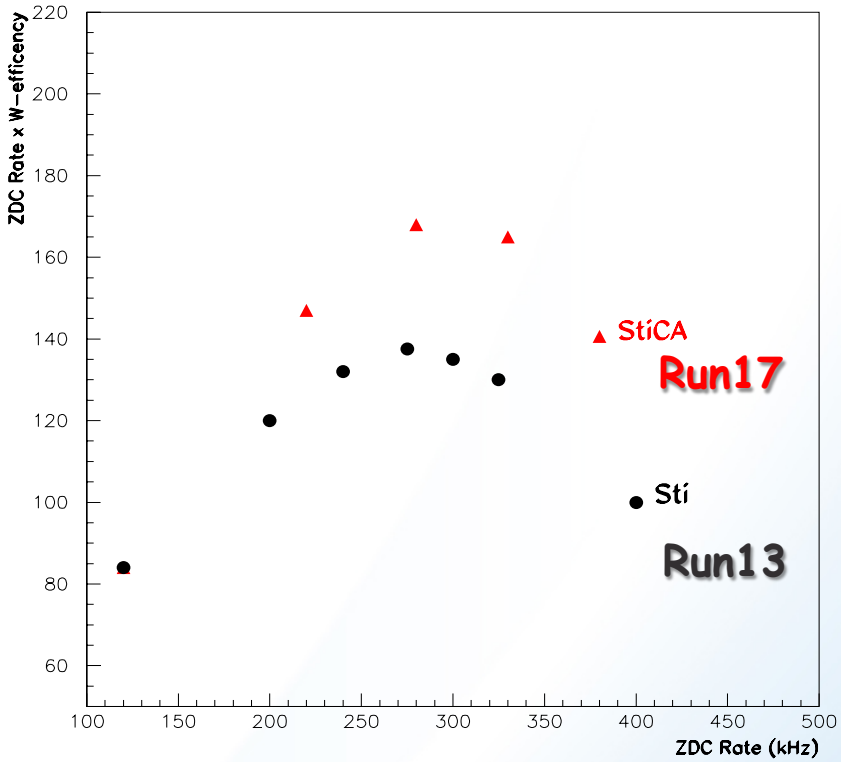
STAR TPC event pile-up affects tracking efficiency

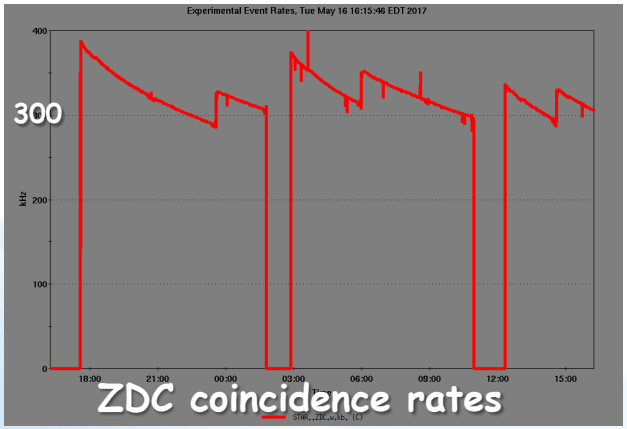
The W-boson reconstruction efficiency was obtained from the data measured in 2011 to 2013 and with an improved Tracking Algorithm.

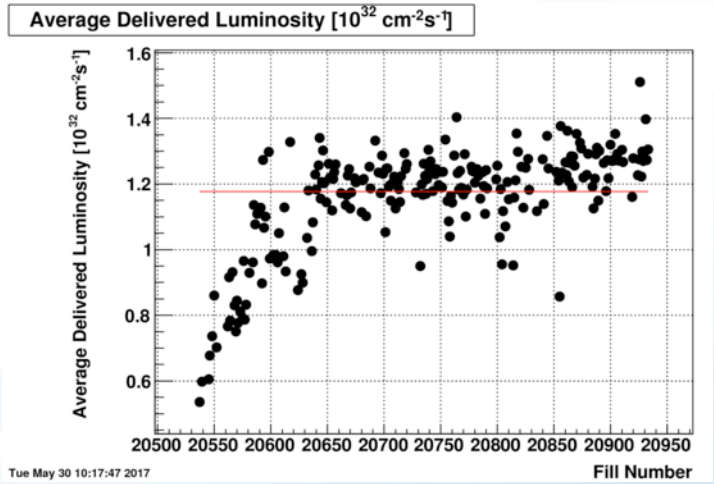
The highest FoM is reached at a ZDC rate of 330 kHz corresponding to a luminosity of 1.3 x 10^{32} $cm^{-2}s^{-1}$. (For 2017 calibrations 315 kHz)

Optimization of delivered luminosity with dynamic beta* squeeze.

Estimate ~13 weeks to reach 400pb^{-1} delivered (STAR Goal 280 sampled).







As the plot to the left shows, C-AD delivered almost exactly what was requested.

Excellent!

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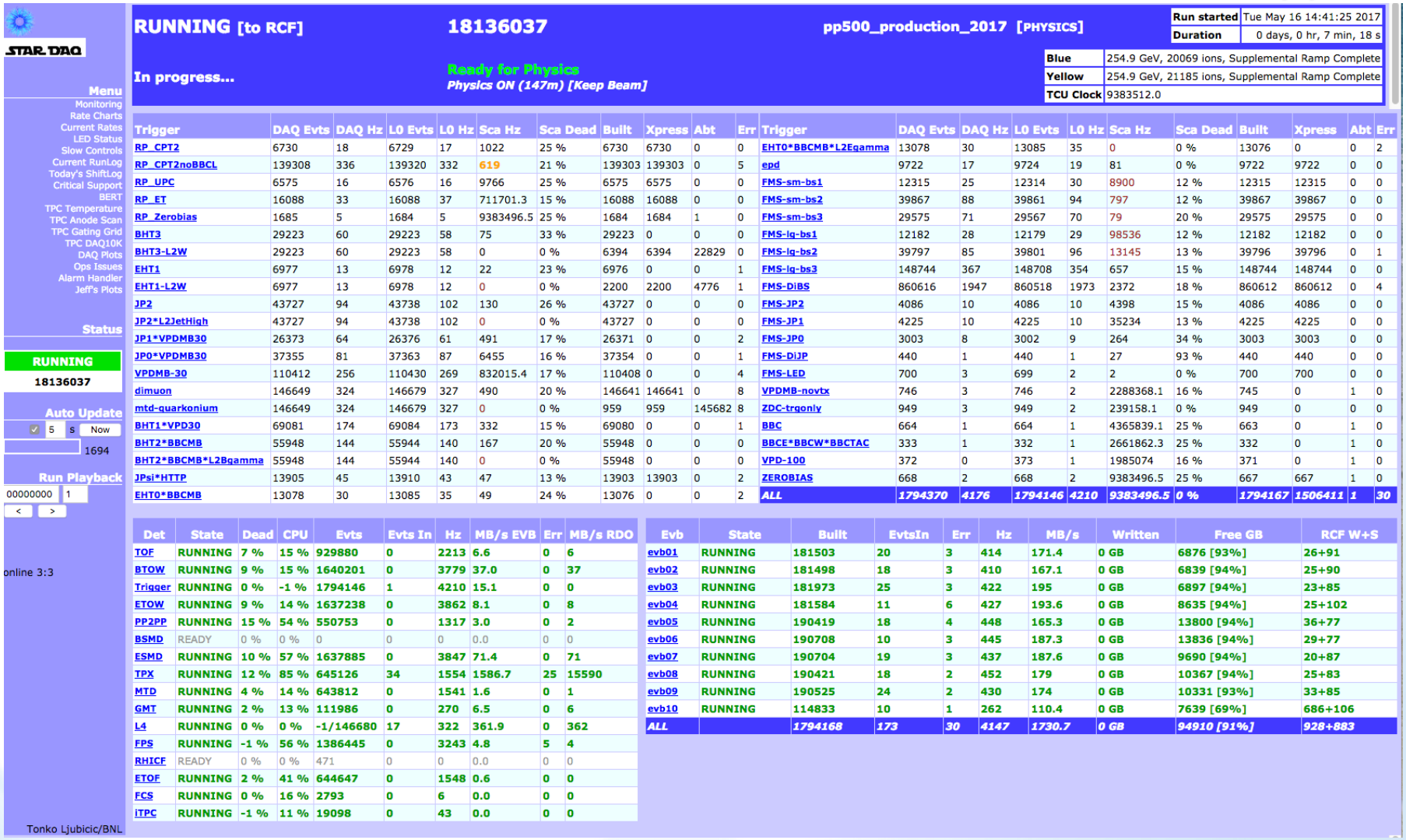
DAQ Monitor for Run 17 510 GeV Transverse pp



STAR DAQ

Menu
Monitoring
Rate Charts
Current Rates
LED Status
Slow Controls
Current RunLog
Today's ShiftLog
Critical Support
BERT
TPC Temperature
TPC Anode Scan
TPC Gating Grid
TPC DAQ10K
DAQ Plots
Ops Issues
Alarm Handler
Jeff's Plots

Status
RUNNING
18136037

Auto Update
5 s Now
1694

Run Playback
00000000 1
< >

online 3:3

Tonko Ljubicic/BNL

RUNNING [to RCF] **18136037** pp500_production_2017 [PHYSICS]

In progress...

Ready for Physics
Physics ON (147m) [Keep Beam]

Run started	Tue May 16 14:41:25 2017
Duration	0 days, 0 hr, 7 min, 18 s
Blue	254.9 GeV, 20069 ions, Supplemental Ramp Complete
Yellow	254.9 GeV, 21185 ions, Supplemental Ramp Complete
TCU Clock	9383512.0

Trigger	DAQ Evts	DAQ Hz	L0 Evts	L0 Hz	Sca Hz	Sca Dead	Built	Xpress	Abt	Err
RP_CPT2	6730	18	6729	17	1022	25 %	6730	6730	0	0
RP_CPT2noBBCL	139308	336	139320	332	619	21 %	139303	139303	0	5
RP_UPC	6575	16	6576	16	9766	25 %	6575	6575	0	0
RP_ET	16088	33	16088	37	711701.3	15 %	16088	16088	0	0
RP_Zerobias	1685	5	1684	5	9383496.5	25 %	1684	1684	1	0
BHT3	29223	60	29223	58	75	33 %	29223	0	0	0
BHT3-L2W	29223	60	29223	58	0	0 %	6394	6394	22829	0
EHT1	6977	13	6978	12	22	23 %	6976	0	0	1
EHT1-L2W	6977	13	6978	12	0	0 %	2200	2200	4776	1
JP2	43727	94	43738	102	130	26 %	43727	0	0	0
JP2*L2JetHigh	43727	94	43738	102	0	0 %	43727	0	0	0
JP1*VPDMB30	26373	64	26376	61	491	17 %	26371	0	0	2
JP0*VPDMB30	37355	81	37363	87	6455	16 %	37354	0	0	1
VPDMB-30	110412	256	110430	269	832015.4	17 %	110408	0	0	4
dimuon	146649	324	146679	327	490	20 %	146641	146641	0	8
mtd-quarkonium	146649	324	146679	327	0	0 %	959	959	145682	8
BHT1*VPD30	69081	174	69084	173	332	15 %	69080	0	0	1
BHT2*BBCMB	55948	144	55944	140	167	20 %	55948	0	0	0
BHT2*BBCMB*L2Bgamma	55948	144	55944	140	0	0 %	55948	0	0	0
JPsi*HTTP	13905	45	13910	43	47	13 %	13903	13903	0	2
EHT0*BBCMB	13078	30	13085	35	49	24 %	13076	0	0	2

Trigger	DAQ Evts	DAQ Hz	L0 Evts	L0 Hz	Sca Hz	Sca Dead	Built	Xpress	Abt	Err
EHT0*BBCMB*L2Egamma	13078	30	13085	35	0	0 %	13076	0	0	2
epd	9722	17	9724	19	81	0 %	9722	9722	0	0
FMS-sm-bs1	12315	25	12314	30	8900	12 %	12315	12315	0	0
FMS-sm-bs2	39867	88	39861	94	797	12 %	39867	39867	0	0
FMS-sm-bs3	29575	71	29567	70	79	20 %	29575	29575	0	0
FMS-lg-bs1	12182	28	12179	29	98536	12 %	12182	12182	0	0
FMS-lg-bs2	39797	85	39801	96	13145	13 %	39796	39796	0	1
FMS-lg-bs3	148744	367	148708	354	657	15 %	148744	148744	0	0
FMS-DiBS	860616	1947	860518	1973	2372	18 %	860612	860612	0	4
FMS-JP2	4086	10	4086	10	4398	15 %	4086	4086	0	0
FMS-JP1	4225	10	4225	10	35234	13 %	4225	4225	0	0
FMS-JP0	3003	8	3002	9	264	34 %	3003	3003	0	0
FMS-DiJP	440	1	440	1	27	93 %	440	440	0	0
FMS-LED	700	3	699	2	2	0 %	700	700	0	0
VPDMB-novtx	746	3	746	2	2288368.1	16 %	745	0	1	0
ZDC-trgonly	949	3	949	2	239158.1	0 %	949	0	0	0
BBC	664	1	664	1	4365839.1	25 %	663	0	1	0
BBCE*BBCW*BBCTAC	333	1	332	1	2661862.3	25 %	332	0	1	0
VPD-100	372	0	373	1	1985074	16 %	371	0	1	0
ZEROBIAS	668	2	668	2	9383496.5	25 %	667	667	1	0
ALL	*1794370*	*4176*	*1794146*	*4210*	*9383496.5*	*0 %*	*1794167*	*1506411*	*1*	*30*

Det	State	Dead	CPU	Evts	Evts In	Hz	MB/s EVB	Err	MB/s RDO
TOF	RUNNING	7 %	15 %	929880	0	2213	6.6	0	6
BTOW	RUNNING	9 %	15 %	1640201	0	3779	37.0	0	37
Trigger	RUNNING	0 %	-1 %	1794146	1	4210	15.1	0	0
ETOW	RUNNING	9 %	14 %	1637238	0	3862	8.1	0	8
PP2PP	RUNNING	15 %	54 %	550753	0	1317	3.0	0	2
BSMD	READY	0 %	0 %	0	0	0	0.0	0	0
ESMD	RUNNING	10 %	57 %	1637885	0	3847	71.4	0	71
TPX	RUNNING	12 %	85 %	645126	34	1554	1586.7	25	15590
MTD	RUNNING	4 %	14 %	643812	0	1541	1.6	0	1
GMT	RUNNING	2 %	13 %	111986	0	270	6.5	0	6
L4	RUNNING	0 %	0 %	-1/146680	17	322	361.9	0	362
FPS	RUNNING	-1 %	56 %	1386445	0	3243	4.8	5	4
RHICF	READY	0 %	0 %	471	0	0	0.0	0	0
ETOF	RUNNING	2 %	41 %	644647	0	1548	0.6	0	0
FCS	RUNNING	0 %	16 %	2793	0	6	0.0	0	0
iTPC	RUNNING	-1 %	11 %	19098	0	43	0.0	0	0

Evb	State	Built	EvtsIn	Err	Hz	MB/s	Written	Free GB	RCF W+S
evb01	RUNNING	181503	20	3	414	171.4	0 GB	6876 [93%]	26+91
evb02	RUNNING	181498	18	3	410	167.1	0 GB	6839 [94%]	25+90
evb03	RUNNING	181973	25	3	422	195	0 GB	6897 [94%]	23+85
evb04	RUNNING	181584	11	6	427	193.6	0 GB	8635 [94%]	25+102
evb05	RUNNING	190419	18	4	448	165.3	0 GB	13800 [94%]	36+77
evb06	RUNNING	190708	10	3	445	187.3	0 GB	13836 [94%]	29+77
evb07	RUNNING	190704	19	3	437	187.6	0 GB	9690 [94%]	20+87
evb08	RUNNING	190421	18	2	452	179	0 GB	10367 [94%]	25+83
evb09	RUNNING	190525	24	2	430	174	0 GB	10331 [93%]	33+85
evb10	RUNNING	114833	10	1	262	110.4	0 GB	7639 [69%]	686+106
ALL		*1794168*	*173*	*30*	*4147*	*1730.7*	*0 GB*	*94910 [91%]*	*928+883*

41 Triggers Running at a total of about 4200 Hz, accumulating ~ 1.7 GB/sec!

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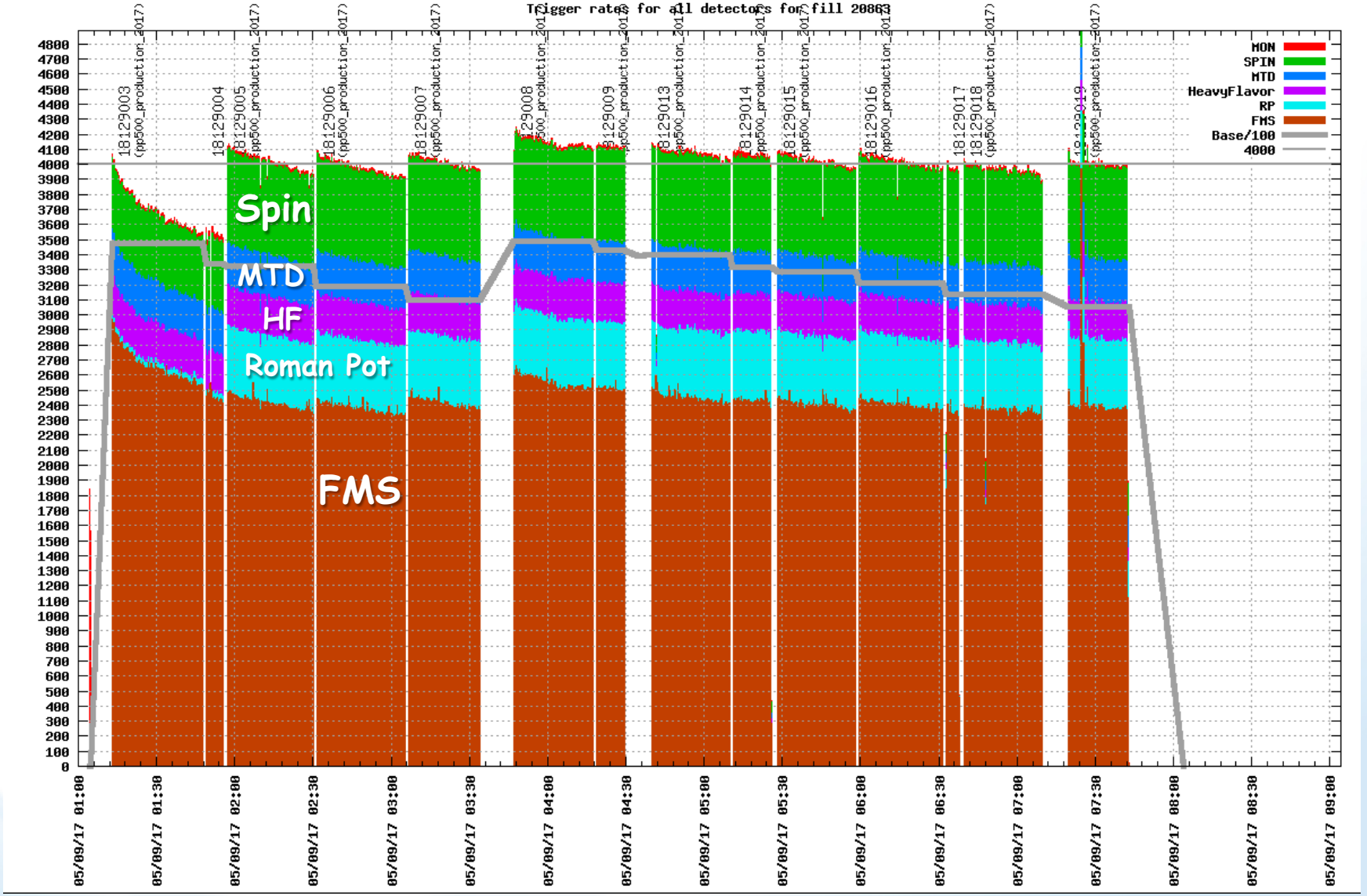
Store from May 9th showing Bandwidth allocation



Accessed Jeff Landgraf's Trigger Versioning page
https://online.star.bnl.gov/RTS/plotdata/storedPlots2017.php

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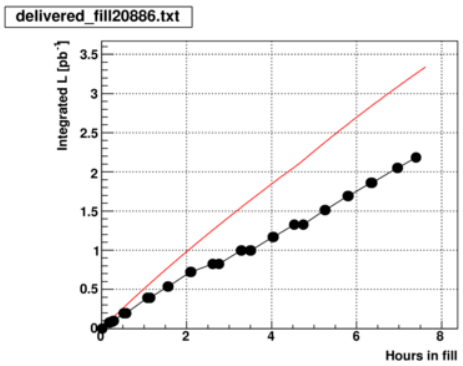
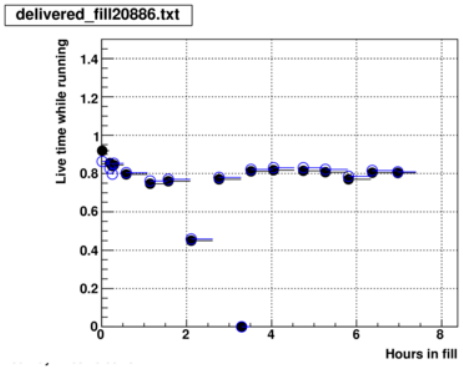
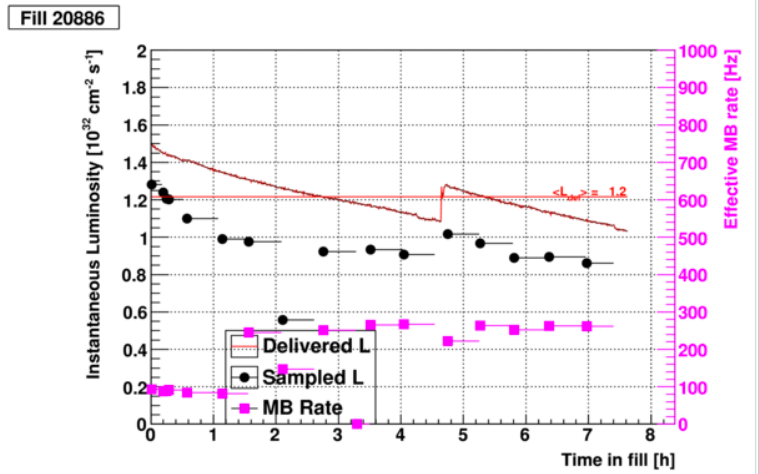
STARs Running Efficiency for Run 17

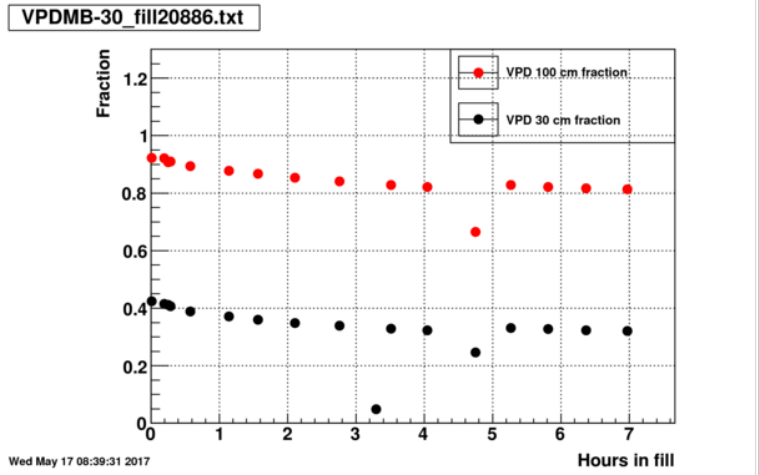
Efficiency metrics for one Store

Fill 20886
Started Mon May 15 06:56:41 2017
Ended Mon May 15 14:34:02 2017
7.6 Hours
1.0 Hours since last fill
Total delivered: 3.338 pb^-1
Average delivered: 1.216x10^32 cm^-2s^-1
Sampled Fraction: 0.692
after correction by average TCULive/Live: 1.059
Fraction of L delivered while taking data: 0.875
Fraction of hours delivered while taking data: 0.874
Minutes lost before first run: 0.8 Frac: 0.002
Minutes lost after last run: 13.3 Frac: 0.029
Luminosity fraction lost before first run: 0.001
Luminosity fraction lost after last run: 0.025
Average Live Time while taking data: 0.747
Live Time from TCU Counters while taking data: 0.791





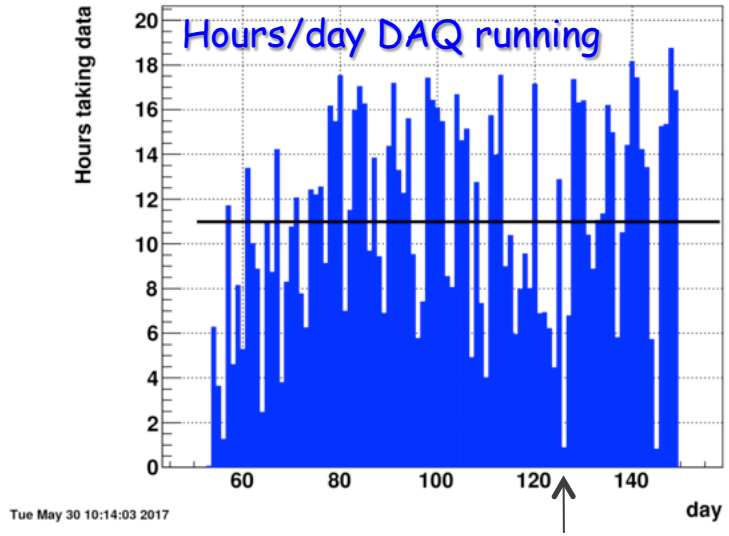




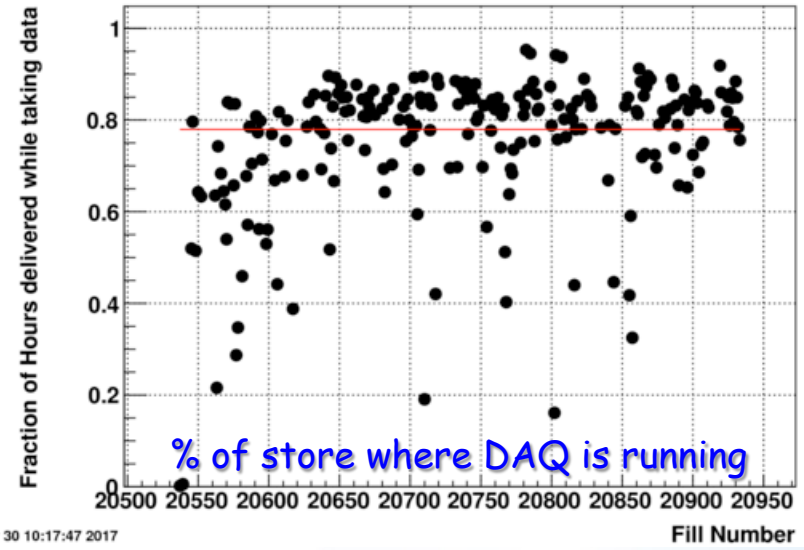
Jamie Dunlop maintains a Web page with various links where one can see how the run is going through various metrics. The link to this page, found on the STAR -> Experiment -> Online page is: https://www.star.bnl.gov/protected/common/triggerPages.html

STARs Running Efficiency for Run 17

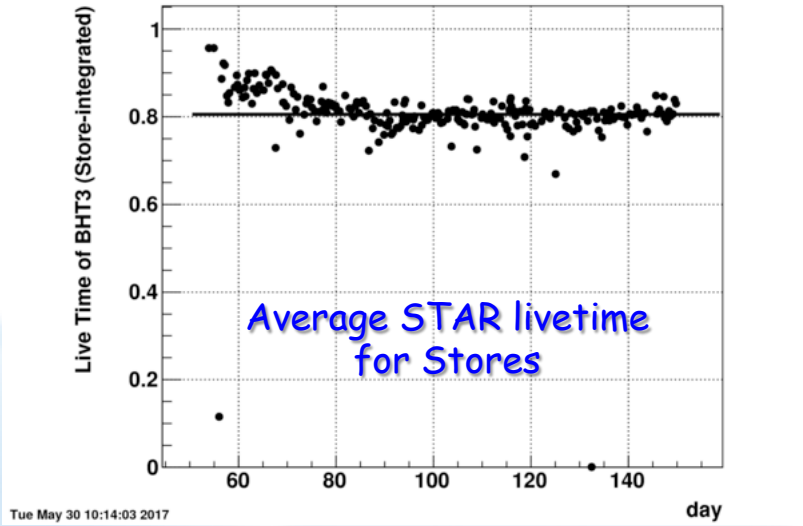
hours_perday.txt



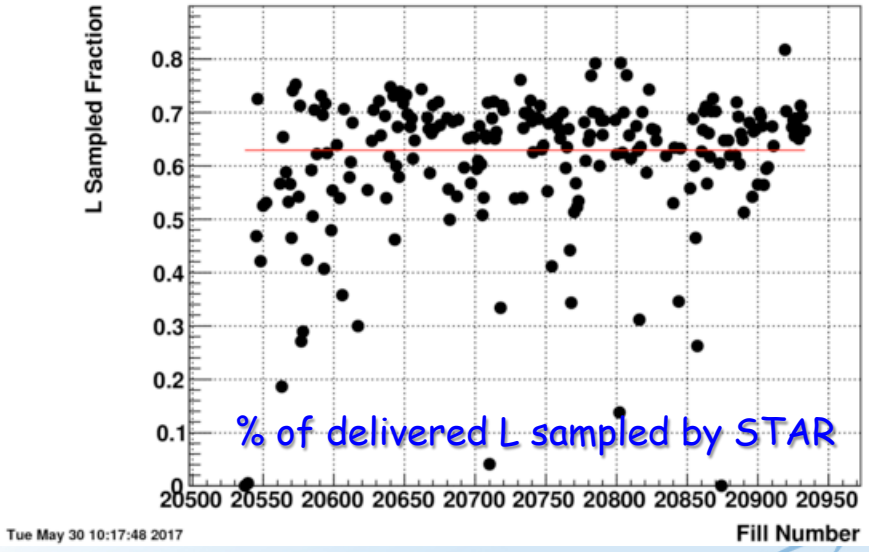
Fraction of Hours delivered while taking data



tculive_perday_fill.txt



L Sampled Fraction



STAR Performed Extremely Well

SUMMARY OF DATA SETS ACCUMULATED

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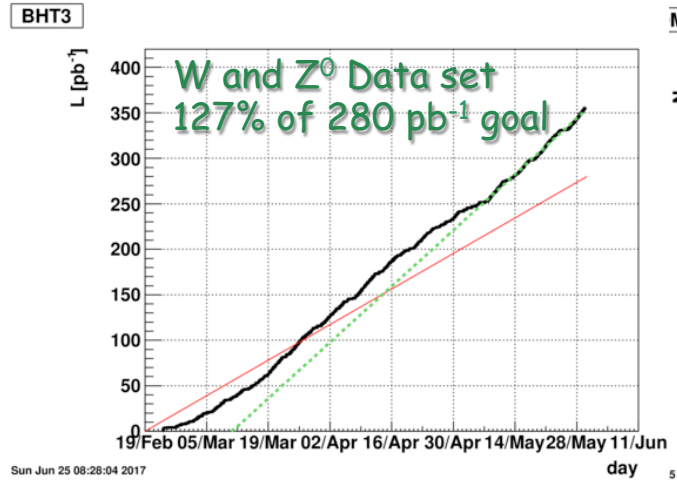
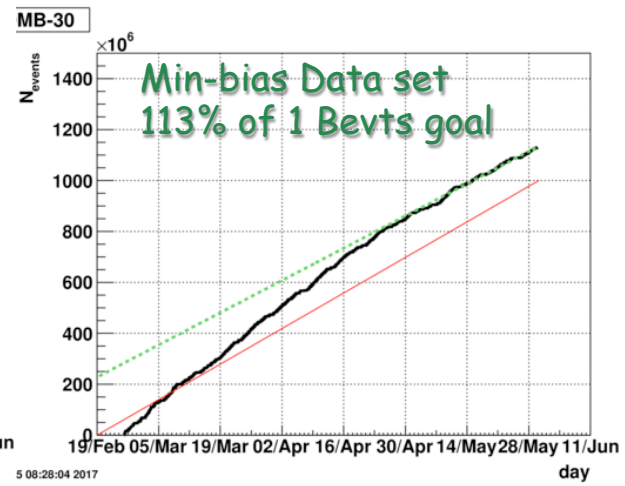
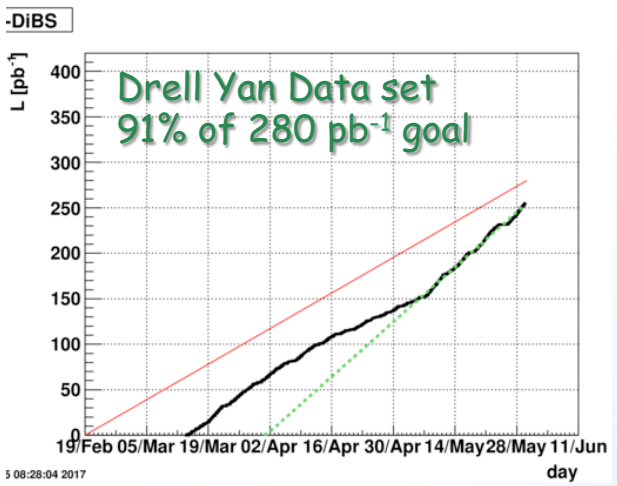
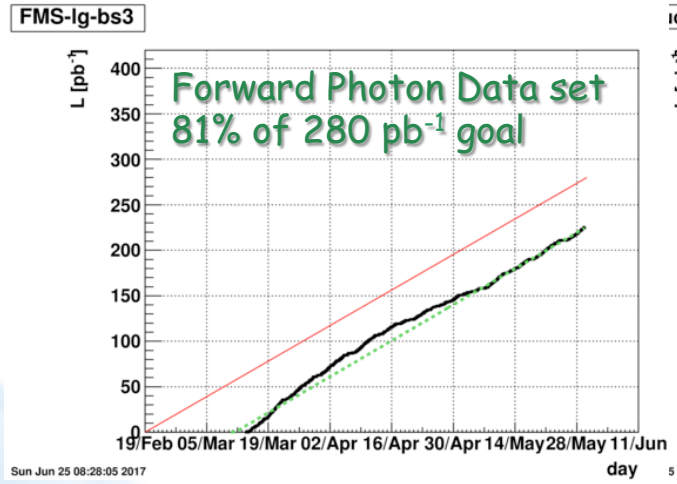
510 GEV TRANSVERSE PP

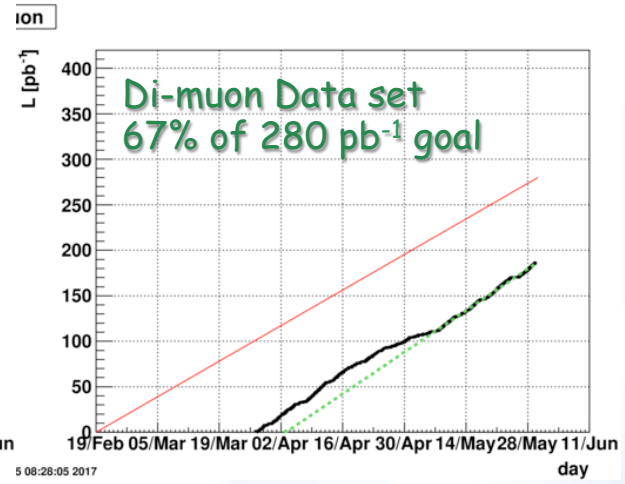


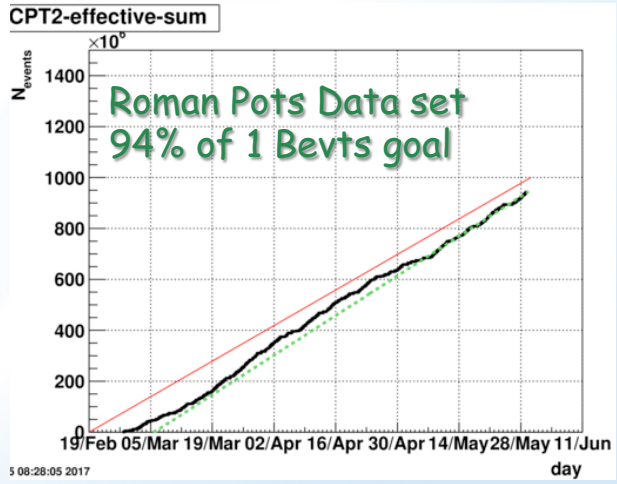




Key: ——— = Goal ——— = Acculated Data ····· = Projection





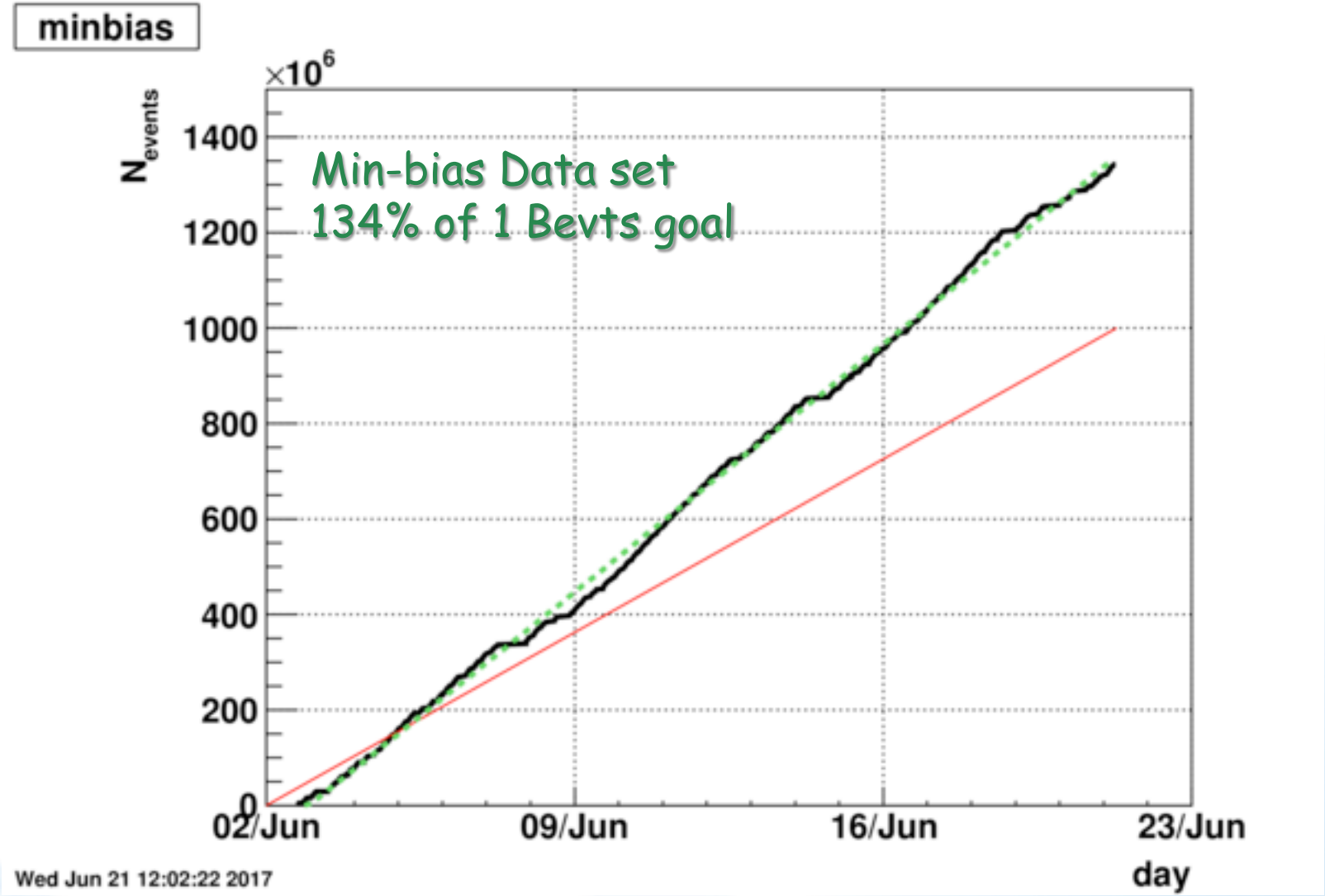


Run went very well.

FMS program got a later start due to need to commission and calibrate,

Di-muons got a much later start waiting for machine protection (MPS) that did not come.

54 GEV AU+AU



Very Successful Au+Au Physics Run

STAR SUMMARY

- Run 17 went very well. The Spin data sets for the sign change via the W's and Z^0's, as well as the min-bias data, exceeded goals. Forward Drell Yan, direct photon, and Roman pot data sets were just slightly below their goals. For the Di-muons we reached about 70% of the goal. It will be important that the MPS system is ready for Run 18.

- We installed, commissioned, and successfully ran a number of new systems this year. This went very well.

- The $\sqrt{s}$ = 54.4 GeV AuAu run also went very well. We accumulated 134% of the 1 Bevts min-bias data set goal in a short (17 day) run.

- We ended the run by going back to $\sqrt{s}$ = 510 GeV radially polarized pp for the RHICf program. There were some RHIC issues that made this effort a challenge, but in the end we accumulated a data set that the RHICf group was satisfied with.

- STAR had ambitious goals for Run 17 with a number of new systems and challenging data set goals. It was another very successful run!

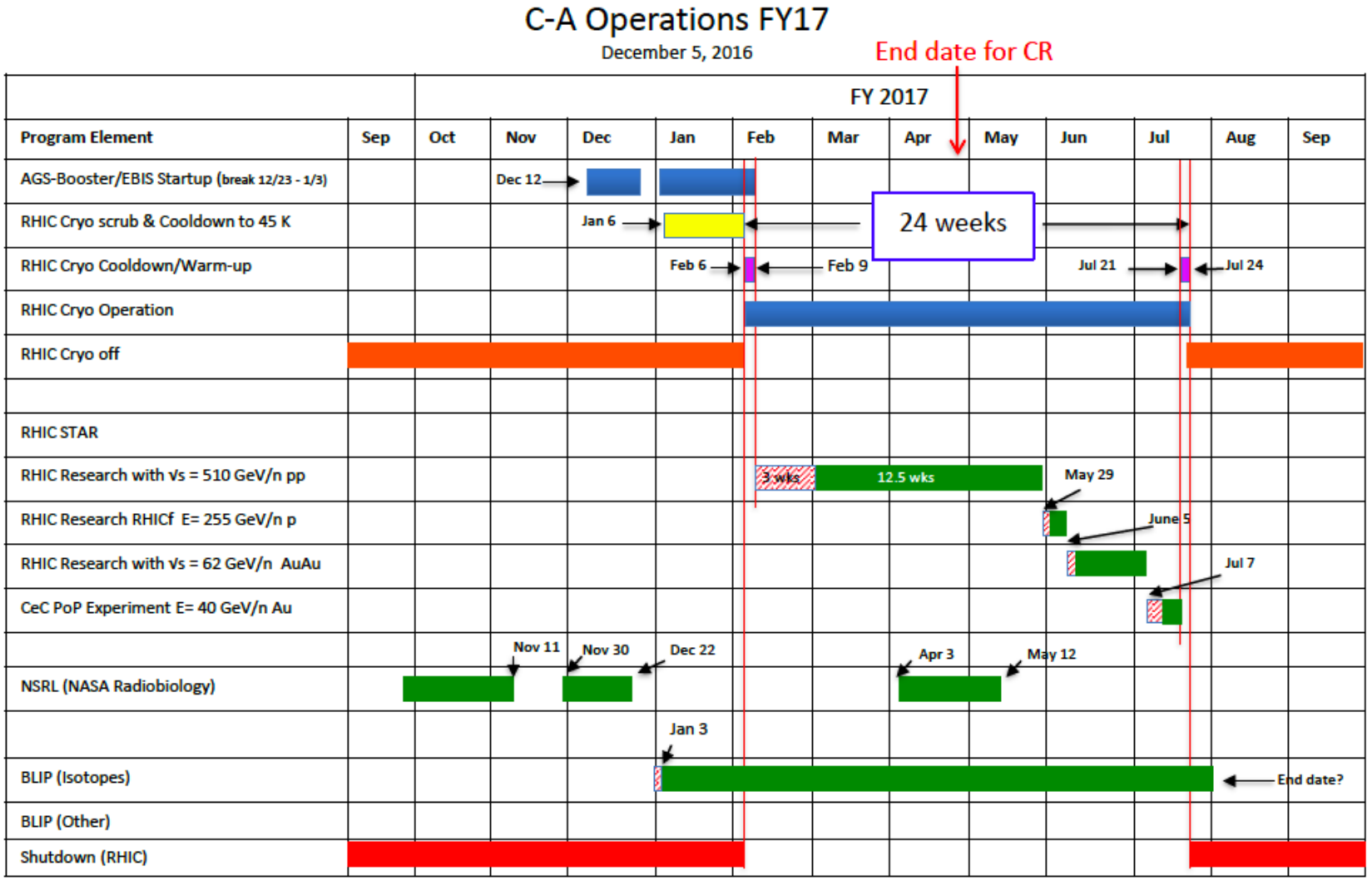
Thank you to C-AD for all your efforts in Run 17

COMMENTS AS C-AD SCHEDULING PHYSICIST

Some General Considerations/Complications with Scheduling for Run 17

- No Federal Budget, hence uncertainty in length of the run
- To achieve STAR's data set goals required a significant amount of Physics running time.
- Ongoing installation and commissioning for LeREC during run
- Ongoing installation and commissioning for CEC during run
- Linac failure which required splitting the 510 GeV pp running into two periods, separated by Heavy Ion running.
- Need/desire for significant polarized pp APEX time, and need to delay (to move Linac repair forward) much of this APEX to the second pp running period.
- Need/desire for multi day diode testing while cold

Schedule we started the Run with. Revised once Budget for year set about May 5th



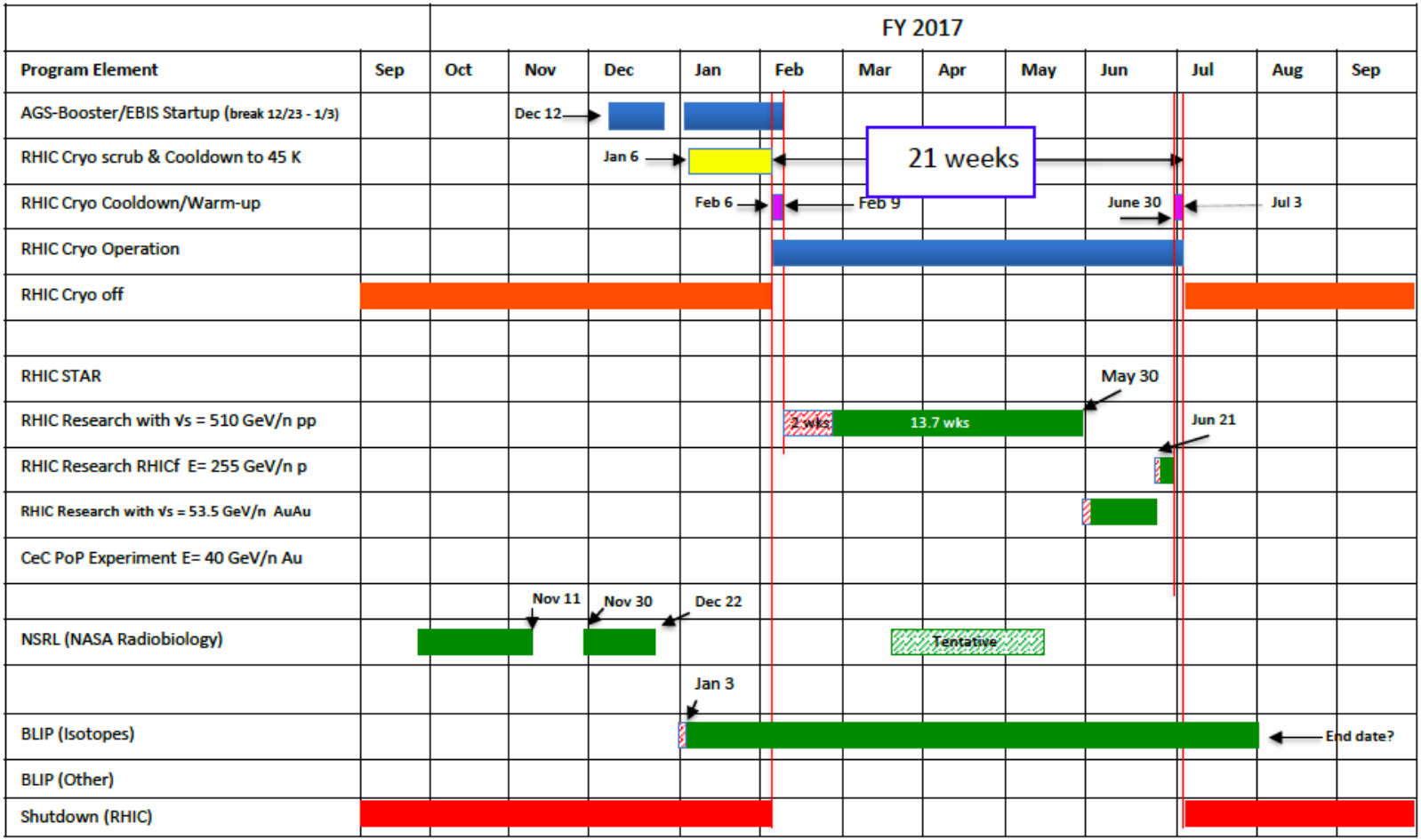
Please note: This Run length is based on the FY 2017 budget put forth by President Obama. We are currently operating under a Continuing Resolution that expires on April 28th. The length of the run may well change once the FY 2017 budget is known.

CR was eventually extended from April 28th to May 5th

With the budget for the year known, and need for diode repair also known, the global schedule for remainder of the run was revised May 5th

C-A Operations FY17

May 8, 2017



To allow for timely LINAC repair, plan is to switch fro pp running to AuAu running on May 30th, and then come back to pp running on June 21st.

With the budget known and run length set, a detailed plan for the remainder of Run 17 was iterated and agreed to by ~ May 6th

May

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3 Access 8 am - noon APEX noon to midnight	4 Physics to 7:45 am CeC 8 am to midnight	5 Physics	6 Physics
7 Physics	8 Physics	9 Physics	10 Physics	11 Physics	12 Physics	13 Physics
14 Physics	15 Physics	16 Physics	17 Access 8 am – 4 pm CeC 4 pm to 8 am (16 hrs)	18 Physics 8 am on	19 Physics	20 Physics
21 Physics	22 Physics	23 Physics	24 Physics to 7:45 am APEX 8 am to midnight	25 Physics	26 Physics	27 Physics
28 Physics	29 Physics	30 Physics to 7:45 am Access 8 am – 4 pm 4 pm – 4 pm AuAu 53.5 GeV Setup/tune (24 hrs) LINAC repair commences	31 Detector setup noon to 4 pm (28 hrs) CEC			

Tally
(from 8 a May 3rd)

4 hrs maintanance
12 hrs APEX
16 hrs CeC
2.3 days Physics

0 hrs maintanance
0 hrs APEX
0 hrs CeC
7 days Physics

8 hrs maintanance
0 hrs APEX
16 hrs CeC
6 days Physics

0 hrs maintanance
16 hrs APEX
0 hrs CeC
6.3 days Physics

8 hrs maintanance
0 hrs APEX
1 day CeC
2.3 days Physics

Totals
20 hrs maintanance
28 hrs APEX
56 hrs CeC
23.9 days Physics

This detailed schedule was designed to try to accommodate all of the various needs and constraints

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A downside of this detailed schedule for the remainder of the run was the concentration of pp APEX at the end of the run

June

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1 CeC Trigger setup to 4 pm Physics 4 pm on	2 Physics & CeC	3 Physics & CeC
4 Physics & CeC	5 Physics & CeC	6 Physics & CeC	7 Physics & CeC to 7:45 am APEX 8 am – midnight	8 Physics & CeC	9 Physics & CeC	10 Physics & CeC
11 Physics & CeC	12 Physics & CeC	13 Physics & CeC	14 Dump 7:45 am Access 8 am – 4 pm 4 pm -Physics & CeC	15 Physics & CeC	16 Physics & CeC	17 Physics & CeC
18 Physics & CeC	19 Physics & CeC	20 Physics & CeC	21 Physics & CeC till 8 am RHICf pp 510 setup 8 am to 8 am (24 hrs)	22 RHICf Physics 8 am	23 RHICf Physics	24 RHICf Physics
25 RHICf Physics 2 Cryo warm-up	26 RHICf Physics to 8 am 18 hrs STAR Calibration 3 Cryo warm-up Complete End of 21 Cryo wk Run	27 STAR Calibrations to 8 am APEX 8 pm to 8 am Diode testing 8 am – 8 pm	28 APEX 8 pm to 8 am Diode testing 8 am – 8 pm	29 APEX 8 pm to 8 am Diode testing 8 am – 8 pm	30 APEX 8 pm to 8 am Diode testing 8 am – noon Noon, Start Cryo warm-up	July 1 Cryo warm-up

Tally

0 hrs maintanance
16 hrs Trigger Setup
0 hrs APEX
3 days CeC
2.3 days Physics

16 hrs APEX
6.3 days CeC
6.3 days Physics

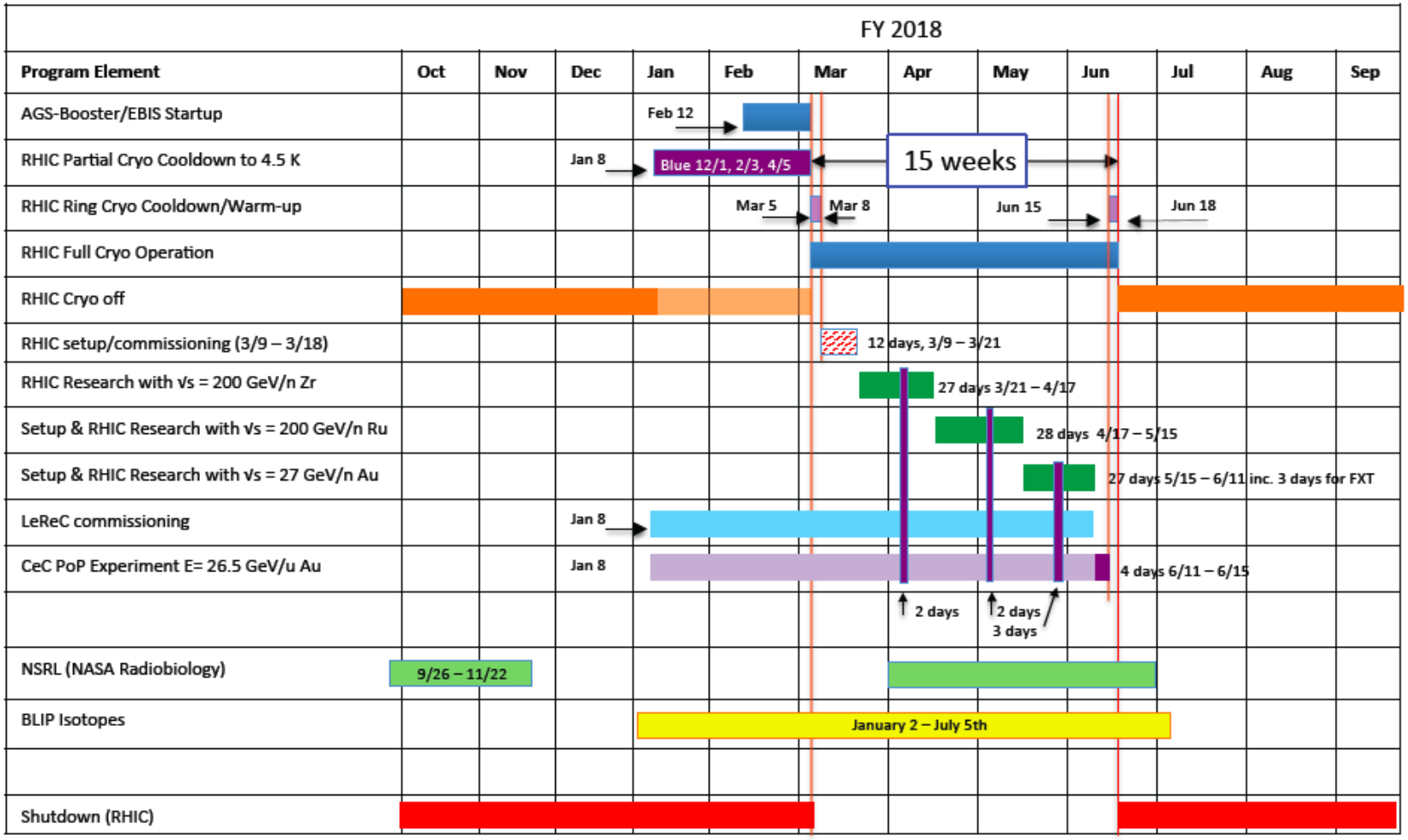
6.6 days CeC
6.6 days Physics
8 hrs maintanance

3.3 days CeC
3.3 days Physics
24 hrs RHICf setup
2.6 days RHICf phys.

Totals (June & July)
24 hrs Setup
4 days RHICf Phy.
8 hrs maintanance
24 hrs STAR Calib.
16 + 48(pp) hrs APEX
19.2 days CeC
18.5 days Physics
40 hrs Diode testing
2.8 days Cryo warm

C-A Operations FY18

Last revision: July 21, 2017



Zr run = 27 days (24.5 "physics" + 2 CeC + .5 float)
Ru run = 28 days (1.5 setup + 24.5 "physics" + 2 CeC)
Au run = 27 days (1 setup + 20 "physics" + 3 FXT + 3 CeC)
"physics" = physics + APEX + maintenance

Dates for first three CeC periods are approximate (early April, early and late May)
CeC commissioning in background =
CeC Dedicated running = (Total of 11 days)

Please note the "early" start to commissioning for LeReC and CeC

Summary for Scheduling Physicist Comments

- It is important/helpful that groups anticipating making requests at the Monday weekly RHIC scheduling meeting meet internally and agree on their request prior to the meeting.
- With all of the access needs for CeC and LeRec early in the run it was hard for RHIC & STAR to hit their stride (i.e. efficiency suffered a bit), but I don't think we could avoid this.
- Once we transitioned to the detailed schedule, and reduced the number of mode transitions/week, the efficiency of the entire program improved quantitatively (e.g. slide 16).
- Deciding to match the low energy STAR AuAu energy to the CeC requirement was a big relief on the schedule constraints, allowing these two programs to run in parallel.
- With the early start to CeC and LeREC commissioning, ~ 2 months prior to the start of Run 18, the perhaps optimistic expectation is that scheduling will be much less complicated for Run 18.
- Any and all comments or suggestions on how to improve the scheduling process, or to increase the utility of the schedules, is welcome either at this Retreat, or at any time.