The Relativistic Heavy Ion Collider

STAR

Breakout Session

James Dunlop

RHIC Facility Operations Review
August 6 – 8, 2013

BROOKHAVEN NATIONAL LABORATORY
a passion for discovery
Office of Science
U.S. DEPARTMENT OF ENERGY

STAR Organizational Chart

STAR Council
59 institutions,
12 countries
582 collaborators
Chair; G. Westfall
BNL Rep: F. Videbaek

STAR Spokesperson
N. Xu
Deputy Spokespeople
Mohanty, Z.Xu, Wissink

Talks Committee
Evdokimov (Chair), Bielcik,
Nasim, Sichtermann,
Wang, Q.Xu, Z.Xu

STAR Upgrades

Leader	Videbaek/H.Huang
HFT	Ritter/Videbaek
FGT	Surrow
pp2pp	Guryn
GMT	Majka/Van Buren
MTD	Ruan , B. Huang
HLT:	Ljubicic, Lauret, Tang
EIC TF	Ullrich, Lamont, Lee
iTPC:	Z. Xu/Q. Xu/Anderson
FCS R&D	Huang/Tsai/Gagliardi
eSTAR:	Sichtermann/Z. Xu

STAR Physics Working Groups
Physics Analysis Coordinator: Dong

Bulk Correlations:	Cebra,Shi, H. Wang
Heavy Flavor:	Kikola,Xie, Zhang
Jet-like Correlations:	Mioduszewski, Wang
Light Flavor Spectra:	Geurts,Kumar,Zhu
Spin:	Fatemi, Djawotho
UPC:	Seger, Guryn

BES Focus Group: Sorensen, Keane, Odyniec

STAR Group Leader: Z. Xu

Administrative: Mogavero, Nieves

STAR Operations

Detector Support Group

Leader:	Christie
DAQ:	Ljubicic, Landgraf
TPC:	Thomas, Lebedev
Trigger:	Crawford
HLT:	Tang, Ljubicic
Magnet:	C-AD, Christie
Slow Crls:	Cherney
BEMC:	Tsai
EEMC:	Jacobs
Laser:	Lebedev
ZDC:	Xu, Tang
BBC:	Bland, Ogawa
TOF :	Ruan, , Eppley, Llope
FMS:	Trentalange

Technical Support Group

vacant	Head EE
Soja	MT
Scheblein	Designer
Kuzcewski	ET
Camerada	ET
Tkatchev	ET
Scheetz	EE, DAQ1000
Hammond	ET

Software & Computing

Lauret	Leader
Van Buren	Co-Leader
Didenko	Production
Webb	Simulation Support
Perevotchikov	Simulation
Fisyak	Reco Leader
Vacant	Infrastructure
Arkhipkin	Online/Database
Betts, Poat	Real Time Support
Witt/Thomas	TPC calibration
Hajdu	Grid Development
Lauret,Webb	Upgrades

BNL Scientific Staff;
BNL Professional Staff;
Non-BNL Staff

BNL-STAR: Responsibilities for Technical and Professional Staff

- DAQ systems support — 1.8 FTE's
- Electronics system support and development — 6.5 FTE's
  - Including repair of electronics for all STAR subsystems during the run, and refurbishment during summer shutdowns
- TPC Hardware support — 1.2 FTE's

- Data Production and Online Systems Support — 4.5 FTE's
- Software infrastructure and development — 3.5 FTE's
- Simulations infrastructure and development — 2.0 FTE's

- Management, Coordination, Work Planning — 2.0 FTE's
- Collaborator and visitor support — 1.0 FTE's
- Design for modifications/upgrades — 1.5 FTE's

Total — 24 FTE's

+**2.5 FTE's** from Scientists on specific tasks

BNL-STAR: Hardware Operational Responsibilities

BNL Scientific Staff
BNL Professional Staff

TPC Hardware: Lebedev

Magnet: Christie

DAQ (DAQ+ run control): Ljubicic, Landgraf

Zero Degree Calorimeters/Trigger: Xu, Tang

Time of Flight, Muon Telescope Detector: Ruan, B. Huang

High Level Trigger: Tang, Ljubicic, Ke

Key experimental support in the STAR Technical Support Group

Leader: Christie

Electronics support and repair for all STAR subsystems

Electronics Engineers: Vacant (head), Scheetz

Electronics Technician: Camarada, Hammond, Kuzcewski, Tkatchev

Design for mods/new detectors: Scheblein, Sexton

Facilities Manager and Mechanical Technician: Soja

BNL-STAR: Software Operational Responsibilities

Core team: repository for technical expertise critical for timely and correct physics results and to ensure data quality as it is recorded

BNL Scientific Staff
BNL Professional Staff

Leader: Lauret

Co-leader: Van Buren

Data production coordinator and software librarian: Didenko

Distributed production support: Hajdu

Database administration and support: Arkhipkin

Reconstruction leader: Fisyak

Simulation leader: Perevotchikov

Simulation support specialist: Webb

Reconstruction, and software architect: vacant

Real time systems support: Betts, Poat

Grid operation coordinator and distributed facility point of contact: Betts

Grid technology support: Hajdu

Detector subsystem software: DAQ: Landgraf

STAR: Scientific Staff Supporting Upgrades

Upgrades Managers	Videbaek/Huang
HFT	Ritter / Videbaek
FGT	Surrow
GMT	Majka/Van Buren
pp2pp	Guryn
High Level Trigger	Tang, Ke, Ljubicic
MTD	Ruan, Huang
iTPC	Z.Xu/Q.Xu/Anderson
Forward Cal R&D	Huang/Tsai/Gagliardi
EIC TF	Ullrich/Lamont/Lee
eSTAR	Sichtermann/Z.Xu/Lauret/Webb

Non-BNL Scientists
BNL Scientific Staff
BNL Professional Staff

An **essential** contribution in addition to basic research, rather unique because of the group's location at BNL, is development of new techniques and detector instrumentation to extend scientific reach. This contribution has been central to 6 of the 7 STAR upgrades developed thus far (FMS, TOF, DAQ1000, HFT, MTD, HLT), to upgrades currently in the planning stage (Roman Pots Phase 2, iTPC), and the EIC R&D efforts (EIC Task Force, eSTAR R&D and LoI).

STAR OPS Manpower and Budget

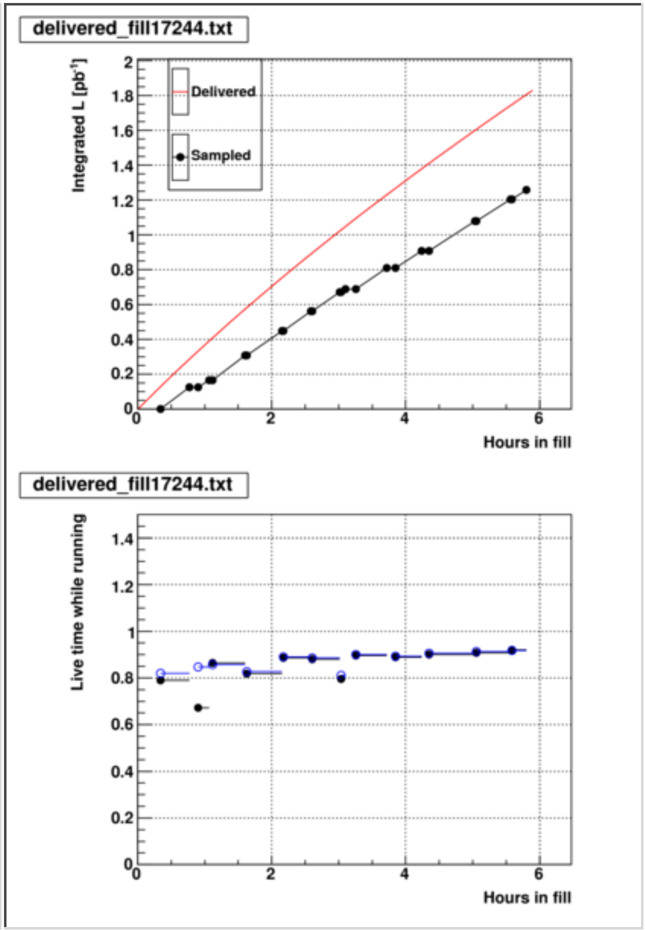
	Manpower			
	2010	2011	2012	2013*
MGTAD	1.70	1.70	1.80	1.50
PROF	12.50	13.00	11.70	10.30
SCIEN	6.90	7.30	8.60	7.10
TECH	6.30	6.20	5.80	6.20
UNION				
Grand Total	27.40	28.20	27.90	25.10

	(Dollars in Thousands)			
	2010	2011	2012	2013*
Salaries	3,552.9	3,799.8	3,707.3	3,515.4
Research Collaborators	153.0	154.3	165.9	167.5
Trade Labor	19.3	17.3	27.4	39.9
Purchases	654.6	661.9	719.8	608.1
Housing	240.9	258.2	288.7	307.8
High Value Procurements	314.6	502.1	301.7	538.8
Overhead Exempt Contracts	-	-	-	-
Equipment	32.9	23.9	24.6	-
Power	74.6	74.4	71.2	54.8
Communications and Other	57.5	71.2	77.4	85.7
Government Fleet Expense	6.6	6.9	7.2	6.1
Organizational Burden	404.3	421.2	414.7	489.0
Total Programmatic Cost	5,511.2	5,991.2	5,805.9	5,813.1
Material Handling Burden	60.1	79.4	79.6	86.0
ITD	169.0	-	-	-
Space	261.5	268.9	274.5	282.9
G&A	2,019.0	2,304.3	2,318.0	2,284.5
Total Laboratory Support Cost	2,509.6	2,652.6	2,672.1	2,653.4
Total STAR Operations Cost	8,020.8	8,643.8	8,478.0	8,466.5

*Estimated Annual Cost

Sampling efficiency

Fill 17244
Started Mon Mar 18 15:03:23 2013
Ended Mon Mar 18 20:56:46 2013
5.9 Hours
Total delivered: 1.828 pb^-1
Sampled Fraction: 0.700
after correction by average TCULive/Live: 1.017
Fraction of L delivered while taking data: 0.799
Fraction of hours delivered while taking data: 0.809
Minutes lost before first run: 20.5 Frac: 0.058
Minutes lost after last run: 5.2 Frac: 0.015
Luminosity fraction lost before first run: 0.070
Luminosity fraction lost after last run: 0.012
Average Live Time while taking data: 0.861
Live Time from TCU Counters while taking data: 0.876
Luminosity fraction lost in lasers: 0.000
Hours lost in lasers: 0.0 Frac: 0.000

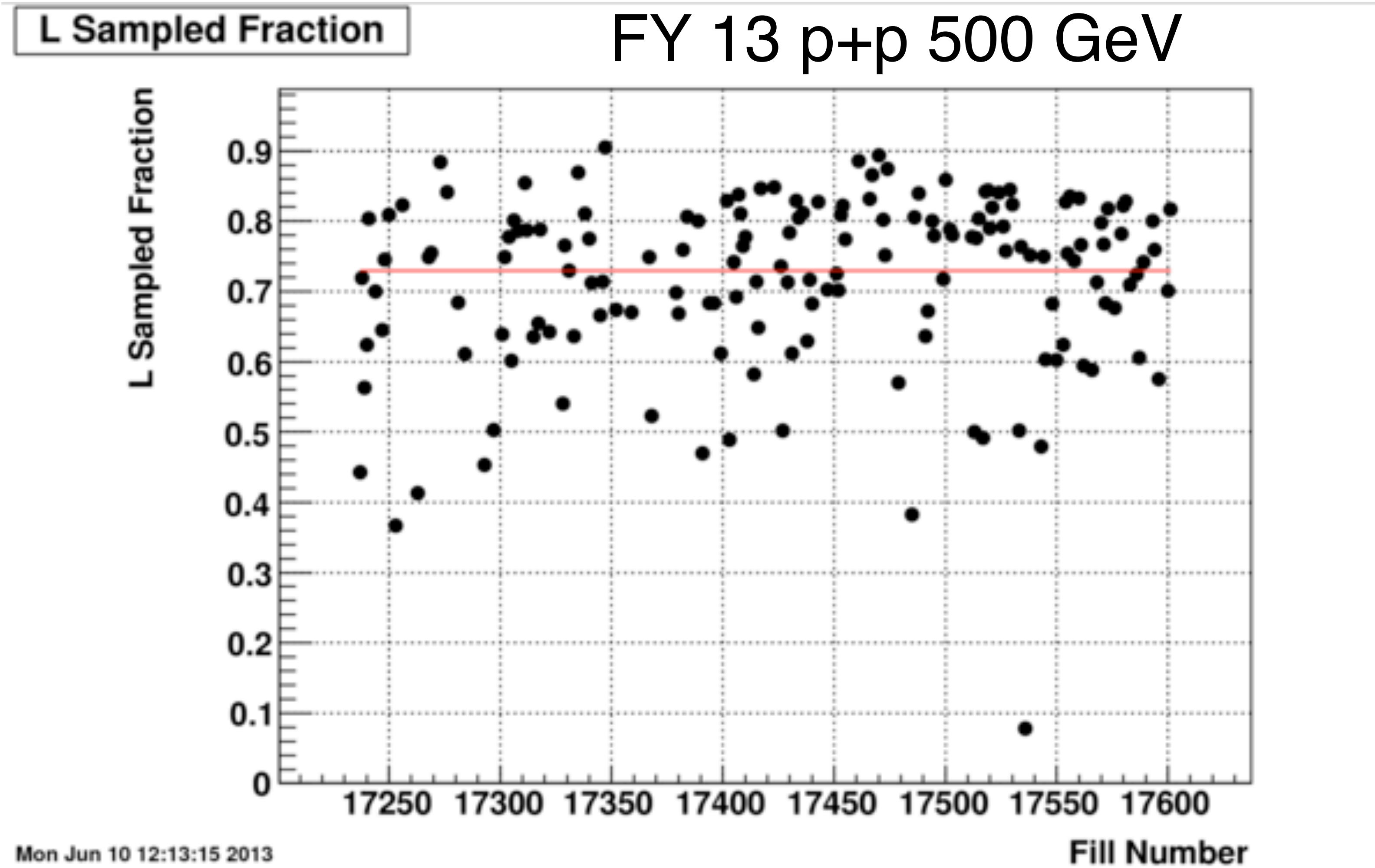


Tracked fill-by-fill as fraction of delivered luminosity actually recorded

Detailed statistics on losses

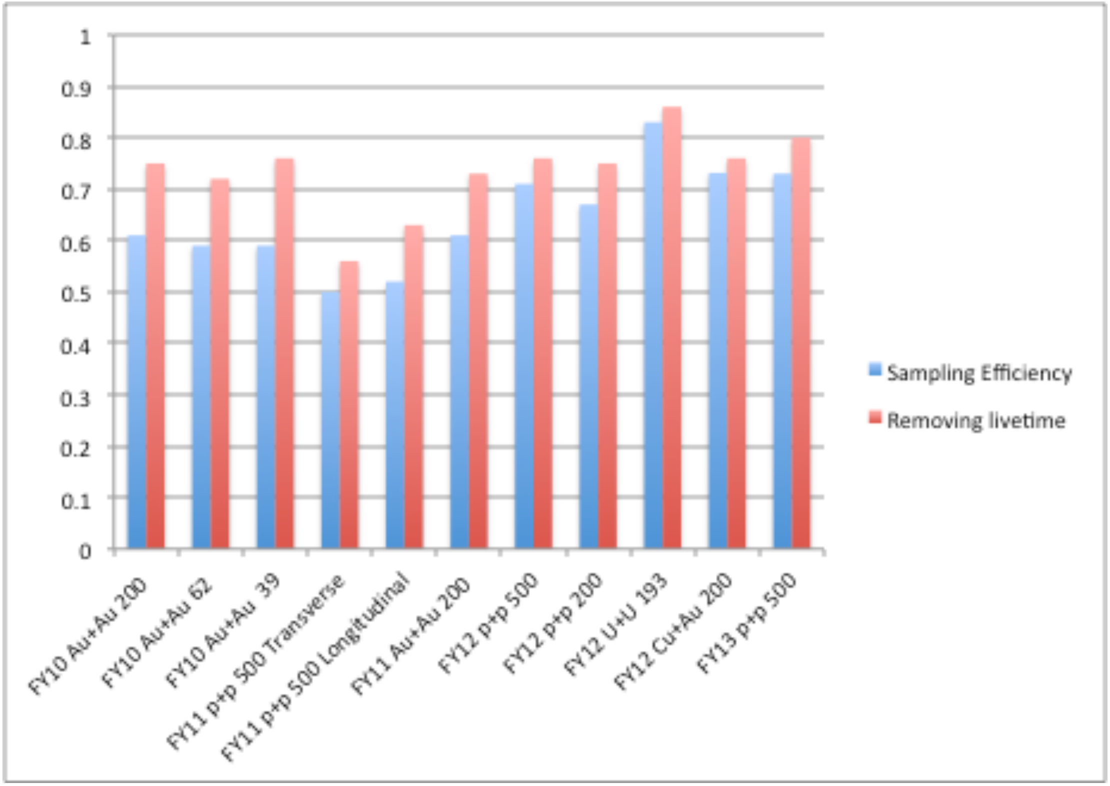
e.g. This fill: started late, too aggressive with data rate at beginning of fill (livetime), a few short detector failures

Sampling Efficiency: Stability



- Relatively large fluctuations in sampling efficiency
  - Driven by detector failures, operational issues (e.g. long downtime = low efficiency after starting back up; new detector = time lost to commissioning)
- Optimizing to hit best case scenario more often: ~90%

Sampling efficiency history



- Concerted effort over the years to increase sampling efficiency
  - Lasers interspersed during physics runs
  - Replaced Scaler system with one with rapid readout
  - Optimized and automated sub system electronics configuration
  - Optimized HV ramping and other startup items at beginning of fill, while still protecting systems
  - Automated DAQ recovery from SEU and other issues (most difficult for high radiation, e.g. pp500)
  - Stochastic cooling helps (e.g. U+U): less fractional luminosity lost at beginning of store
  - Standardization of Readout/DAQ interface for all sub systems
- Limited now by reliability of systems (HV, trigger stability, etc.)

Data QA

- Runs QA'd online: note that previous sampling efficiency does not include runs marked "BAD" by shiftleaders.
- All other data is processed, except those for which calibrations fail
  - Typically < few %, with some exceptions for specific difficult datasets
- QA of data quality done by analyzers afterwards
  - Different analyses have different levels to which they accept problems, e.g. SPIN lumps runs into Platinum, Gold, Silver, …
  - Not strictly monitored or kept track of
- Usability of data set depends on needs
  - E.g. Jet analyses can accept wider vertex cuts
  - Luminosity- and event-hungry analyses work harder to overcome variations in detector performance. Other analyses can afford to only accept nearly-perfect performance.

Subdetectors

Are sub-detectors working well together? are there some sub-detectors that for example slow down the data taking, are there any important physics analyses that are slowed down? Is there sufficient strength in the management to make tough decisions. Are there any examples of overall physics output optimization along these lines?

Each of the 64 possible triggers has different sub-detector components; inclusion into a given trigger is discussed in the Trigger Board, and optimized relative to live time

Capability to run through trips of some sub-detectors (e.g. FTPC), but only used for detectors not critical to main physics program. Often have fallback setups which can be run should one or more of the systems giving input into a trigger fail (e.g. calorimeters). Some unavoidable loss of time in switching to these setups, plus avoidable human error.

Example Trigger Mix by Subdetector

Trigger Definitions:

	Detector bits (detector live / detector fired)																Condition 1		
	SS2	*PP2PP*	*ETOW*	*BTOW*	*BSMD*	*TOF*	*ESMD*	*TPX*	*PXL*	*FGT*	*IST*	*RPII*	*unknown*	*unknown*	*GMT*	*MTD*			
JP0	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	+/+	+/+	+/+	+/+	+/+	+/+	+/+	JP0(63) Laser-protection(96)	+ -	Accept
JP1	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	+/+	+/+	+/+	+/+	+/+	+/+	+/+	JP1(54) Laser-protection(96)	+ -	Accept
JP2	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	0/-	+/+	+/+	+/+	+/+	+/+	+/+	JP2(55) Laser-protection(96)	+ -	Accept
BAJP	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	0/-	+/+	+/+	+/+	+/+	0/-	+/+	BAJP(61) Laser-protection(96)	+ -	Accept
JP0*DiJet	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	+/+	+/+	+/+	+/+	+/+	+/+	+/+	JP0-dijet(60) JP0(63) Laser-protection(96)	+ + -	l2-jet
JP1*DiJet	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	+/+	+/+	+/+	+/+	+/+	0/-	+/+	JP1(54) JP1-dijet(59) Laser-protection(96)	+ + -	Accept
BHT0*BBCMB*TOF0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	0/-	0/-	+/+	+/+	+/+	+/+	0/-	+/+	TOFmult0(4) BBC-TAC(16) BemcHiTwr-th0(48) Laser-protection(96)	+ + + -	Accept
BHT0*VPD	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	0/-	0/-	+/+	+/+	+/+	+/+	0/-	+/+	VPD-TAC(29) VPD-E(30) VPD-W(31) BemcHiTwr-th0(48) Laser-protection(96)	+ + + + -	Accept
BHT2	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	0/-	+/+	+/+	+/+	+/+	0/-	+/+	BemcHiTwr-th2(50) Laser-protection(96)	+ -	Accept
BHT2*BJP1	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	0/-	0/-	+/+	+/+	+/+	+/+	0/-	+/+	BemcHiTwr-th2(50) BJP1(56) Laser-protection(96)	+ + -	Accept
BHT2*BBCMB	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	0/-	0/-	+/+	+/+	+/+	+/+	0/-	+/+	BBC-TAC(16) BemcHiTwr-th2(50) Laser-protection(96)	+ + -	Accept
BHT3	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	0/-	+/+	+/+	+/+	+/+	+/+	+/+	BemcHiTwr-th3(51) Laser-protection(96)	+ -	Accept
EHT0	+/+	+/+	+/+	+/+	0/-	+/+	+/+	+/+	0/-	+/+	+/+	+/+	+/+	+/+	0/-	+/+	EemcHiTwr-th0(52) Laser-protection(96)	+ -	Accept

Triggers can require or not various subsystems, to optimize livetime vs. breadth of the trigger

Operational Manpower

- Are there any issues in balancing the manpower for data operations, data processing, physics analysis? How is this organized within the collaboration? Is there a monitoring system for sharing of service work and physics analysis? Do you see some changes/modifications to the organization that could improve data taking efficiency? Do you have visible manpower shortages in certain areas related to data taking?

Yes, there are visible manpower shortages, identified and communicated to DOE in 2011. Single-point-failure in operation of certain detectors. Support for manpower external to BNL STAR Operations group continues to decrease.

Service work in STAR is not currently monitored in detail.

Plan going forward, agreed to by the STAR Council, to gather additional manpower from the collaboration on operational tasks. Will require significant additional monitoring by the BNL STAR operations group; brainstorming ways to reduce this additional burden.

Calibrations

- What is the status of calibrations, their availability for data analysis? How long does it take for collected data to be usable for detailed physics studies? Are there areas that can and should be improved? Are there any activities towards optimization of data processing?

Timeline for calibrations: 3-4 months

Increasing challenges for TPC with increasing luminosity due to dynamic luminosity-induced distortions (multiple cm)

Timeline for full production: additional ~8 months or more, but certain datasets available earlier

Example: FY12 not yet fully completed, but W was fully analyzed by last fall

Optimization by dataset and trigger category

Each trigger can be split into one of multiple higher priority streams

e.g. W for p+p 500 GeV, can be produced in days

Continually improving high level triggering

e.g. rapid publication of anti-alpha in Nature before full dataset even available for analysis

Trigger efficiency

Can the event triggers be improved to increase the trigger efficiency of interesting events?

At Level 0, current limitation is in the Data Storage and Manipulation (DSM) boards, in which the basic trigger logic resides. These boards have been around since the beginning of STAR; they are technology from the late 1990's. Plan is to replace this with new boards (DSM-2) with diverse interconnects, allowing correlations earlier between detectors. Allows for walking jet patch triggers, for example.

Another initiative currently at the R&D stage is to improve resolution of z vertex from timing in vertex positioning detectors, in order to better select at Level 0 events under the HFT

High Level Trigger, helped with funds from China, is investigating using CA tracking technology and massively multicore chips to increase throughput and do secondary vertexing. This is to pre-select events for rapid processing offline from the ~2 kHz available at Level 0.

Questions 7 and 8

7) Are some RHIC running configurations less expensive than other configurations? If so, how should the running configurations be optimized to maximize the physics output?

From the STAR standpoint, no real savings in one configuration vs. another. Small differences in bandwidth and detectors that are most important to the physics program, but no major cost savings available.

8) Are there cost-effective detector upgrades that can be made to improve detector performance and physics output while RHIC operates with less running time?

FY14: finish MTD and HFT.

Beyond: trigger upgrades (DSM-2), along with some low-cost but high-impact throughput advances in the DAQ configuration.

Small-scale investments in forward upgrades (Roman Pots, preshower) for Run 15 p+A run.

Major next project, currently in R&D but planned to be ready by BES Phase 2, is the inner sector TPC upgrade (iTPC). This will extend the pseudorapidity coverage and dE/dx resolution by fully instrumenting the inner sectors, currently only instrumented to 20% coverage. Current idea is to leverage international investment to keep project as Capital Equipment.