Plans to improve STAR data-taking efficiency

W.B. Christie, BNL

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Outline

- Define an efficiency metric
- Discussion of tasks/issues that decrease efficiency
- Possible ways to improve efficiency
- Issues and concerns
- Summary

STAR Day Shift Crew, Last day of dAu Physics run January 27, 2008.

Definition of a metric for data taking efficiency

For the purposes of this discussion of STAR's data-taking efficiency I will define the efficiency in a perhaps overly simplistic manner.

Data-taking efficiency ≡ (Luminosity sampled by trigger) / (Delivered luminosity)

The Luminosity sampled by the trigger is defined as the delivered luminosity where:

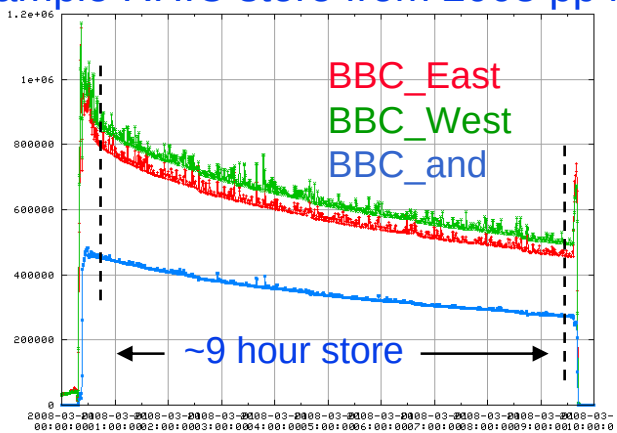
- the STAR system is on and taking ***Production Physics Triggers***
- the STAR system is "live" and able to take an event.

The Delivered luminosity is defined as the luminosity delivered to the STAR interaction region:

- after the collider tuning for a given store is complete
- prior to STAR being instructed to prepare for the dumping of the RHIC beam.

For this discussion, we assume that the RHIC store length is 6 hours (typical 4 to 10 hrs).

Example RHIC store from 2008 pp run



General Introduction of how STAR is Operated

- Shifts staffed by “generic” STAR Collaborators
  - Shift crew composed of four people, Shift Leader(SL), two Detector Operators(DO), Run Control/QA
  - Shift Leaders and Detector Operators get trained and certified
- Three crews/week
- Shift week is 8 days long
  - One full shift of overlap to instruct/retrain oncoming crew
- Detector Sub System Experts on Call
- Typically one or more people join Shifts for training (SL or DO)

All Sub systems provide documents for Shift Crews.

Concise instructions (step by step) on how to bring the detector online, calibration files to be taken, production triggers configurations to be run, etc. are provided to crew.

These instructions are modified throughout the run, based on operational experience, to improve clarity and efficiency.

Daily meetings to discuss issues/status/plans.

Tasks & issues that decrease data-taking efficiency (**Start-up**)

Bringing the Detector online after a RHIC Store:

- Reconfigure Calorimeter Electronics (~ 5 to 8 minutes)
- Ramp various sub systems to “pedestal” voltages (few minutes)
- Take pedestals for various sub systems (2 to 4 minutes)
- Ramp various sub systems up to operational voltages (3 to 5 minutes)

Take defined (run to run) calibration files: (5 to 8 minutes)

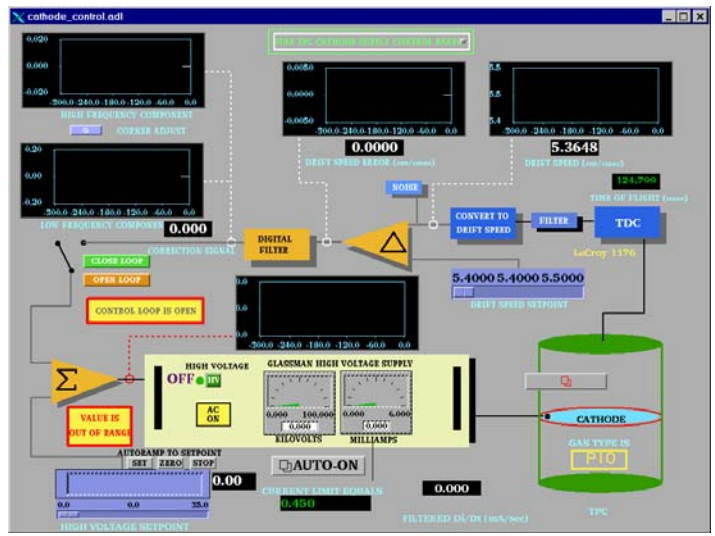
- e.g. Calorimeter status files, Calorimeter background files, etc.

This “start – up” process takes a minimum of ~ 15 to 20 minutes.

If the crew is inexperienced, or encounters problems, this time can double.

For a conscientious Shift Crew, the time to bring the detector online can drop significantly during the course of their week.

TPC Cathode HV Control GUI



Tasks & issues that decrease data-taking efficiency (Calibrations)

Various types of “Calibration” files taken, some vary run to run.

Pedestal files:

- Taken at beginning of store (accounted for in start-up)

Calorimeter Calibration files:

- Status table and Background files for B&E EMC (accounted for in start-up)

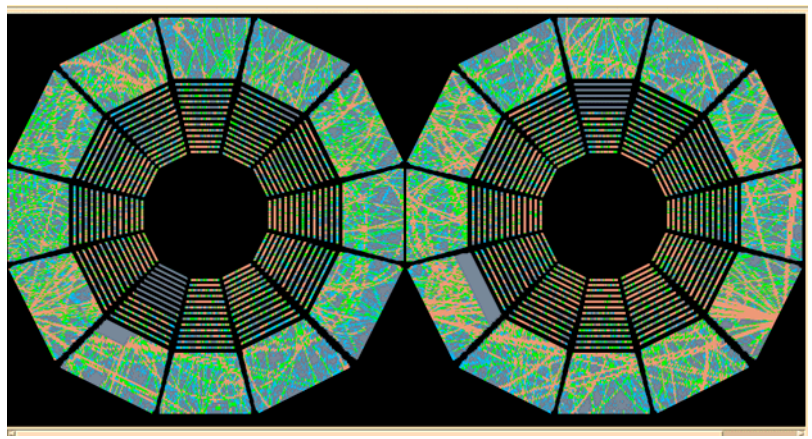
- FMS Calibration files (often taken in conjunction with Laser files)

TPC Laser Calibration files:

- Taken one hour into a store, and every two hours thereafter until end of store.

- Involves stopping physics run, turning on and warming Lasers, perhaps some Laser tuning/steering, take 2 kevts @ 10 Hz, turn off Lasers, reconfigure trigger.

- entire process takes 12 to 15 minutes



Tasks & issues that decrease data-taking efficiency (“Setup”)

As used here, “**Setup**” includes things such as:

- Debugging and commissioning/calibrating new detectors
- Commissioning triggers and Run Configurations
- Tuning trigger rates

To date, for essentially all RHIC runs we developed, commissioned, and put online new sets of triggers for each run.

- Most RHIC runs involve 2 (or more) different configurations of beam species and energy.

A rough estimate is that we spend about 25% of the “Physics” store time for the first two weeks of each beam species/energy combination performing this setup.

Preparing to dump a RHIC Fill (“Ramp down”)

- When we receive a message from the collider to prepare for a beam dump we put the detector sub systems into a safe state for this operation.
- Preparing the detector for a beam dump takes about 5 minutes.

Rough estimate of impacts on efficiency

Again,for purposes of this calculation we assume a store length of 6 hours.

Start/ramp up of detector	~ 20 to 25 minutes	(5 to 7%)
Calibration data sets	~ 40 minutes	(11%)
Shutdown/prepare for dump	~ 5 minutes	(1%)
Total	~ 65 to 70 minutes/360 minute fill	(~20%)

"Setup" (assume two 10 wk physics configurations):

(80% del. Lum. Available)[(10 wks - .25(2 wks)]/10 wks ~ 76% (i.e. ~ 4%)

Finally, account for typical running of TPC based physics program with a 50 Hz accepted event rate:

(76%)(.5) ~ 38% of Delivered physics luminosity sampled by STAR.

~ What STAR should achieve, ignoring any effect of vertex cuts.

N.B. This treatment of STAR's efficiency is a simplified presentation of the way we typically operate the STAR Detector. We typically run a few sets of triggers simultaneously, some of which don't require the readout of the "slow" detectors (e.g. TPC and FTPC).

Possible ways to improve “efficiency”

Biggest impact on this efficiency factor will be the DAQ1000 upgrade:

-The deadtime for reading out the TPC will fall from the current ~ 10 ms/evt (TPC 100% dead at 100 Hz) down to ~ 50 us/evt (drift time of electrons in the TPC volume).

- Thus, running at for example a TPC readout rate of 500 Hz the deadtime will only be about 2 - 3%

- This factor alone will ~ double our efficiency

- Some other “slow” sub systems will need some work to speed up.

Taking Laser Calibration files:

-Install pneumatic shutters in the Laser transfer lines.

- This would allow one to continue taking physics data while Laser is warmed up and tuned.

- This would save ~ 3 to 5 minutes for each Laser calibration file.

- For our 6 hour store this could save ~ 15 minutes ~ 4% increase in efficiency,

Possible ways to improve “efficiency”

Reducing time spent at “Startup” (~ 5 to 7% at present):

2 possibilities:

Increase Shift period from 8 days to 15 days

-Takes advantage of Shift crews getting faster with practice.

- Rough estimate is that the ~25 minutes could be dropped to ~15 minutes.

- Accounting for 4 to 5 days to reach this shortened time, the overall increase in efficiency could be ~ 2%.

Develop Automated “Sequencer” to bring detector online

- Rough estimate is that, if no problems, Detector could be brought up in ~10 minutes.

- Some decrease from this minimum average time likely as, if all doesn’t go smoothly, Shift crew will have to diagnose current state of sub systems, identify and remedy issue.

- To implement and maintain this system will take manpower resources.

- Maximum increase in efficiency possible ~ 4%.

- In practice one isn’t likely to achieve this maximum increase.

Plans for working on improvements to efficiency

TPC Deadtime:

- DAQ1000 project is progressing very well. We will have complete system installed and tested in time for next physics run (Run 9).

Start effort towards automated Startup sequencer:

- STAR has limited expert resources of the type required for this effort (Slow Controls, DAQ, and Trigger)

- Plan is to work on Slow Control system gathering necessary information to “recognize” various states of sub systems, Trigger, and DAQ.

- Once Slow Controls system can accurately and correctly determine the necessary status information, we’ll work on phasing in Sequencer.

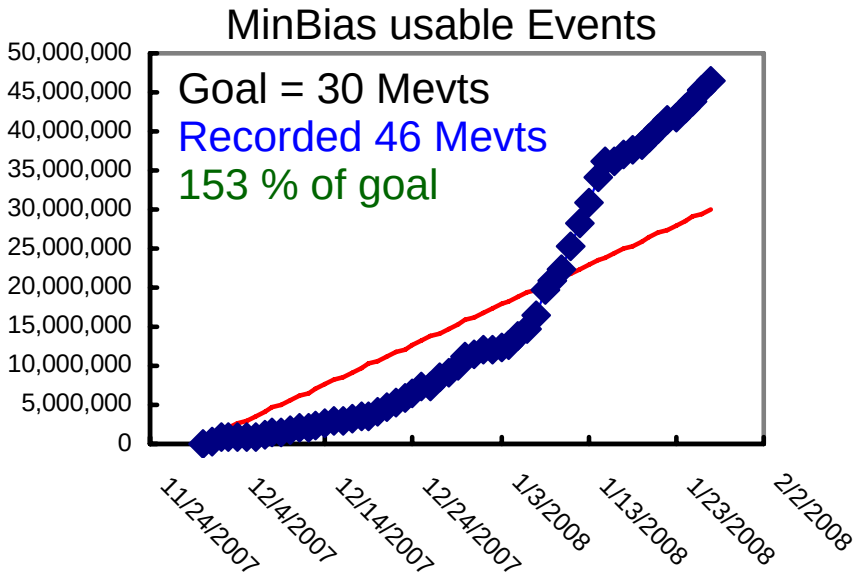
- Likely to be a couple year effort

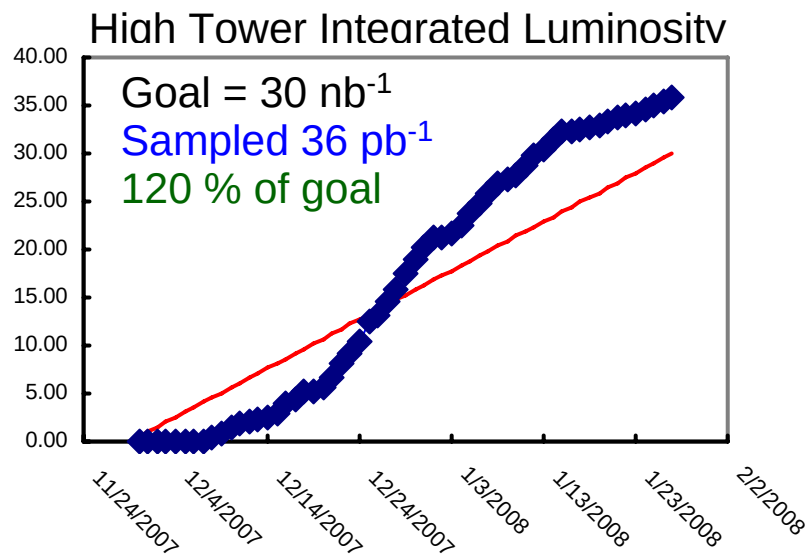
TPC Laser Calibration files:

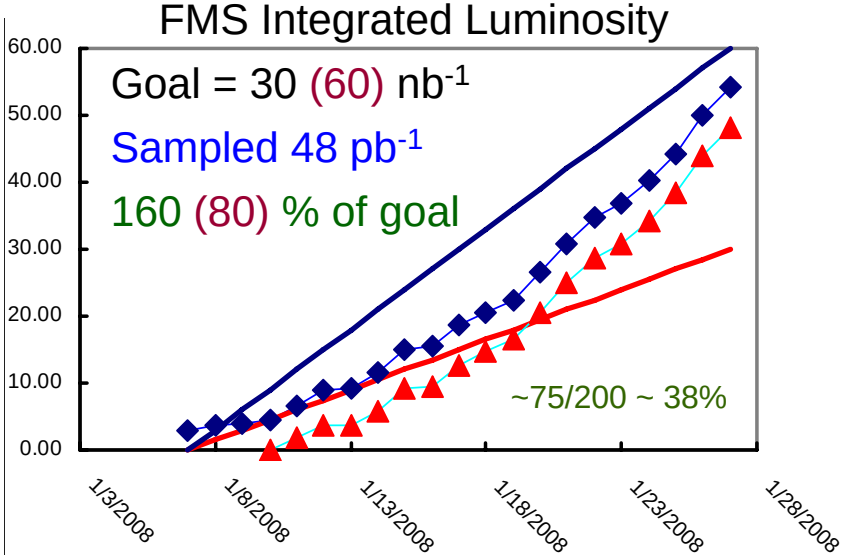
- We’ll procure necessary parts, and gain some further experience with pneumatic shutters during present shutdown.

- Depending on how this effort progresses (in particular reliability of shutters), we should be able to implement this, if not in time for Run 9, then for Run 10.

STAR Summary for the FY08 d-Au Run

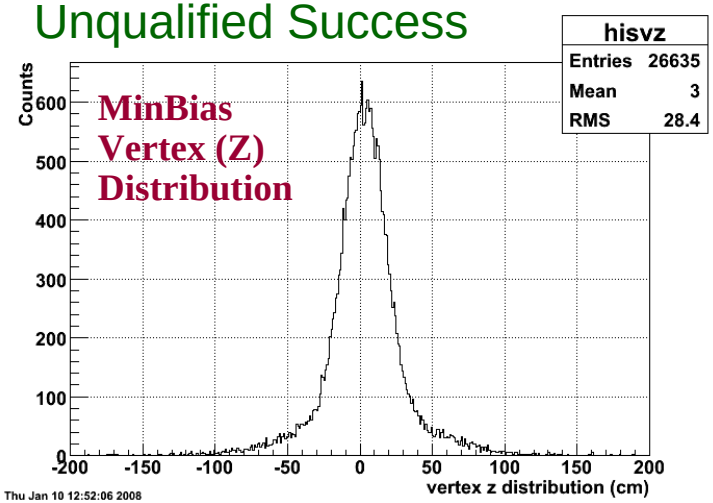






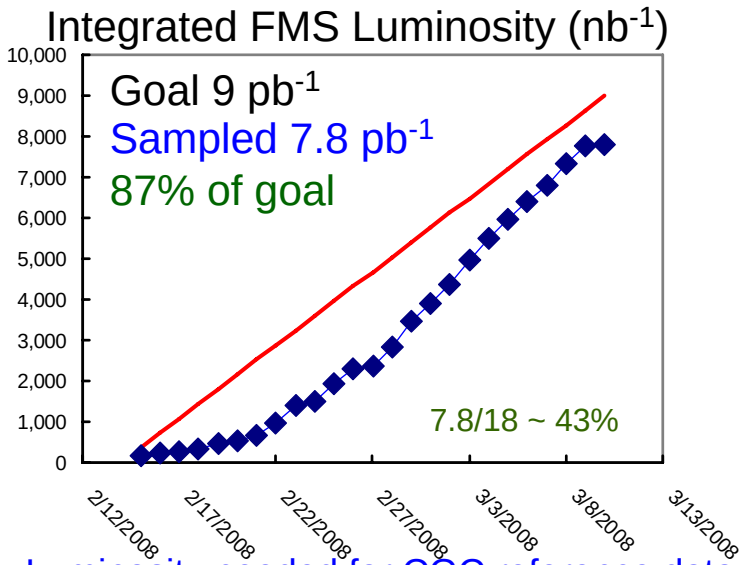
Summary of dAu Run

Unqualified Success

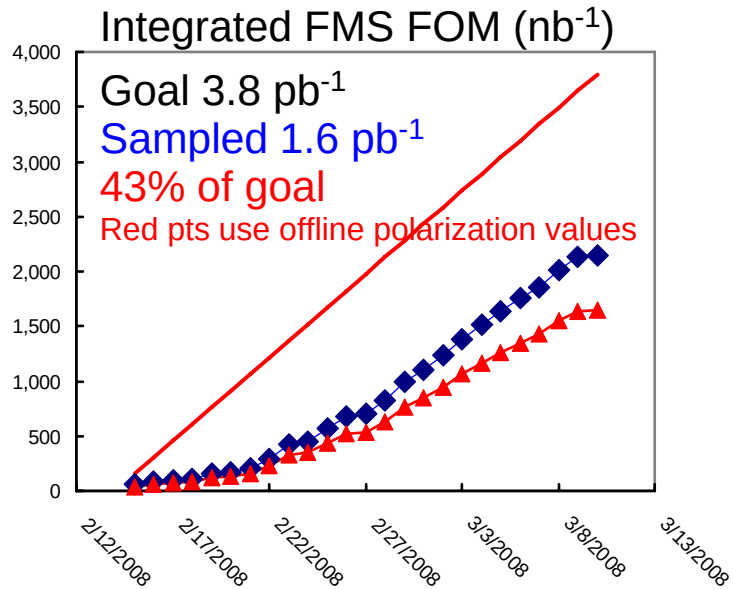


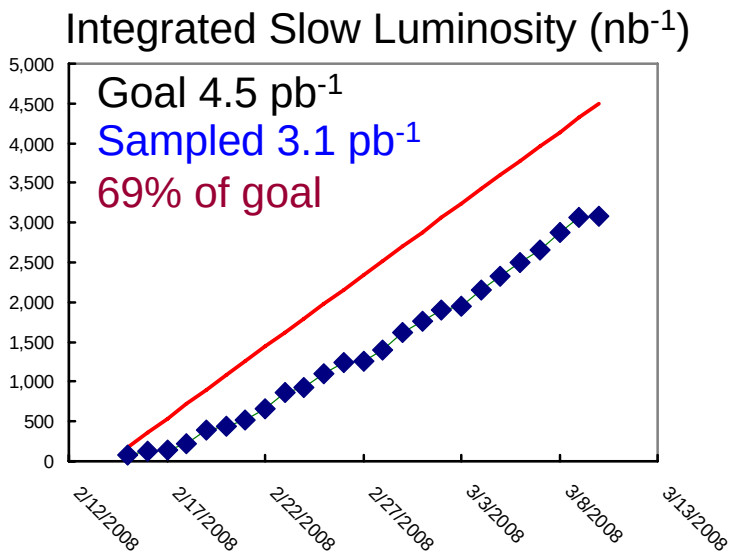
92% have Vz ≤ 50 cm

STAR Summary for the FY08 Polarized proton Run



Luminosity needed for CGC reference data





Summary of pp Run

- Comparison data for FMS CGC search
  - **Good shape**
- Extend x_F and p_T range for forward single-spin asymmetries
  - **Significant extension, but well short of what we had intended to achieve**
- Study direct photon asymmetries in forward direction
  - **Probably not practical with the current limited data set**
- Electrons from Charm and Bottom, with low material, to resolve STAR/PHENIX discrepancy
  - **Good shape**

The future is upon us, Blair Stringfellow retired this year

STAR Operations was very fortunate to have Blair not only using his considerable experience and skills to manage the TPC Sub system, but also for his assistance in looking after many other aspects of running STAR (Global interlocks Expert, Shift QA Board Chair, etc.). His retirement leaves a big hole for STAR to fill.

There is likely to be a decrease in STAR's operational efficiency for some period as we try to assimilate/acquire the necessary knowledge, and deal with the effects from the loss of Blair's considerable knowledge and experience.

BNL STAR Operations Group Issues/Concerns

- The BNL Operations group has had to pickup scope for sub-systems initially provided by Collaborating Institutions
- Budgets have been such that we haven't been able to replace key positions as people have left.
- In Key Positions we have minimum staffing
- We've operated with a small number of key people (myself, Jeff Landgraf, Blair Stringfellow, *R. Brown*)

  - Increased risk of loss in efficiency

- STAR Operations is (has been) concerned that to continue the quality operation to date, additional manpower from the Collaboration and within the STAR Operations group in key areas is needed.

  - With the additional responsibility for the TPC falling onto the BNL Ops group load, our challenge is increased.

- The maintenance, evolving needs, and age of many of the baseline STAR systems require annual capital equipment funds for refurbishment.

Summary

Summary of Possible increases in "efficiency"				
Task/Issue	**Current Time/fill**	**Possible Time/fill**	**% increase in efficiency**	**Comments**
Startup	**20 - 25 minutes**	**10 minutes**	**4 %**	
Calibration files	**40 minutes**	**25minutes**	**4 %**	
TPC Deadtime	**50%**	**1 – 15%**	**70 – 100 %**	**Reduced from 100% by next slowest det.**
Total			**~ 80 to 110%**	

- The BNL Operations group has been challenged to take on the support of sub systems that were previously supported by collaborating Institutions, without an accompanying increase in our resources. The addition of the TPC sub system is going to exacerbate this issue.
- We plan an Operations Workshop this Fall to revisit how our current resources are deployed, and decide how we'll redeploy these resources to pick up the responsibility for the TPC.