

The PHENIX Experiment in the RHIC Run 7

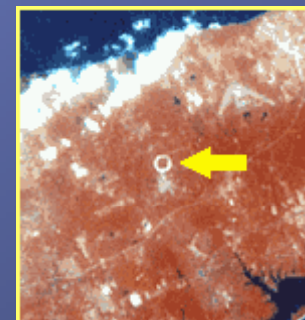
(with some references to Run 6...)

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RHIC from space



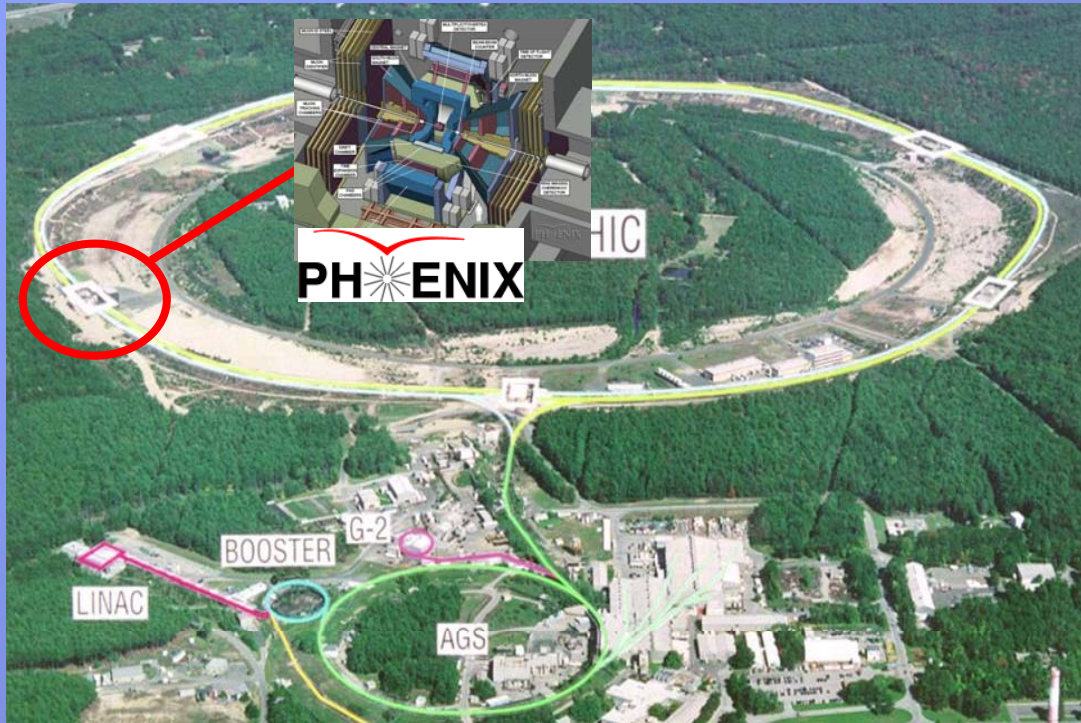
Long Island, NY



Or, much simpler:

Our best run ever!

RHIC/PHENIX at a glance



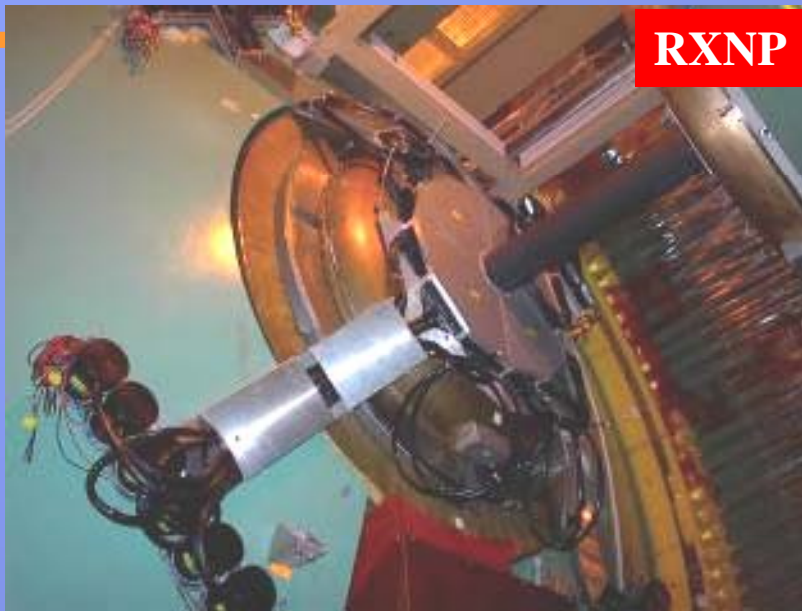
RHIC:

2 independent rings, one beam clockwise,
the other counterclockwise
 $\sqrt{s_{NN}} = 500 \text{ GeV} * Z/A$
~200 GeV for Heavy Ions
~500 GeV for proton-proton (polarized)

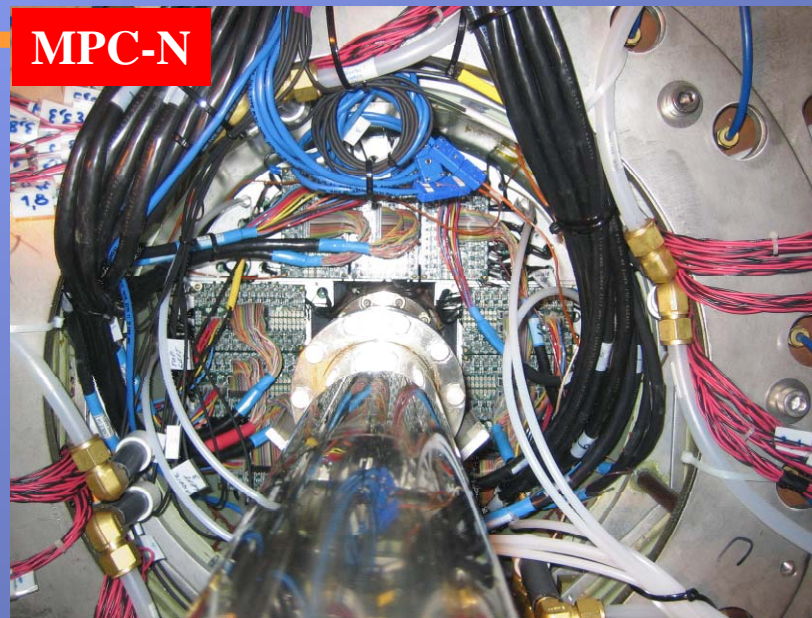
PHENIX:

4 spectrometer arms
15 Detector subsystems
500,000 detector channels
Lots of readout electronics
Uncompressed Event size
typically 280 -220 - 110 KB for
AuAu, CuCu, pp
Data rate ~5KHz (Au+Au)
Front-end data rate 0.5 - 1.1
GB/s
Data Logging rate ~400MB/s,
700 MB/s max

...and 4 new Detector Systems in Run 7



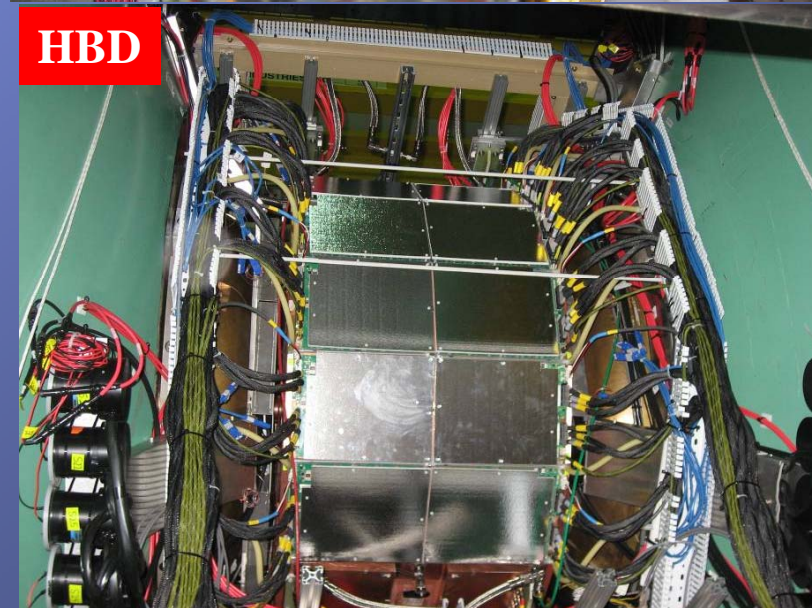
RXNP



MPC-N



TOF-W



HBD

Building up to record speed

- Over the previous runs we have been adding improvements
- Had lighter systems, d+Au, p-p, Cu-Cu in the last runs, less of a challenge than 200GeV Au+Au

Ingredients:

- Distributed data compression (run 4)
- Multi-Event buffering (run 5)
- Mostly consolidating the achievements/tuning/etc in run 6, also lots of improvements in operations (increased uptime)
- 10G Network upgrade in run 7, added Lvl2 filtering

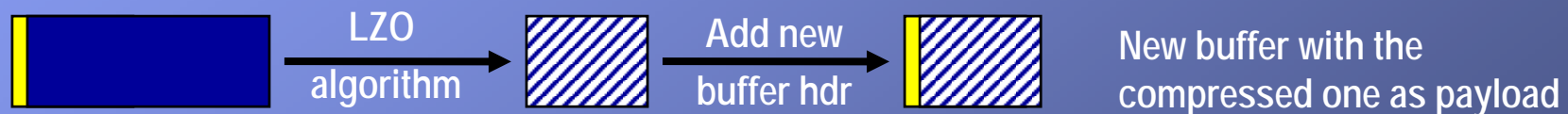
With increased luminosity, we saw the previously demonstrated 600++MB/s data rate in earnest for the first time.

Data Compression

Found that the raw data are still gzip-compressible after zero-suppression and other data *reduction* techniques

Introduced a compressed raw data format that supports a late-stage compression

This is what a file normally looks like



On readback:

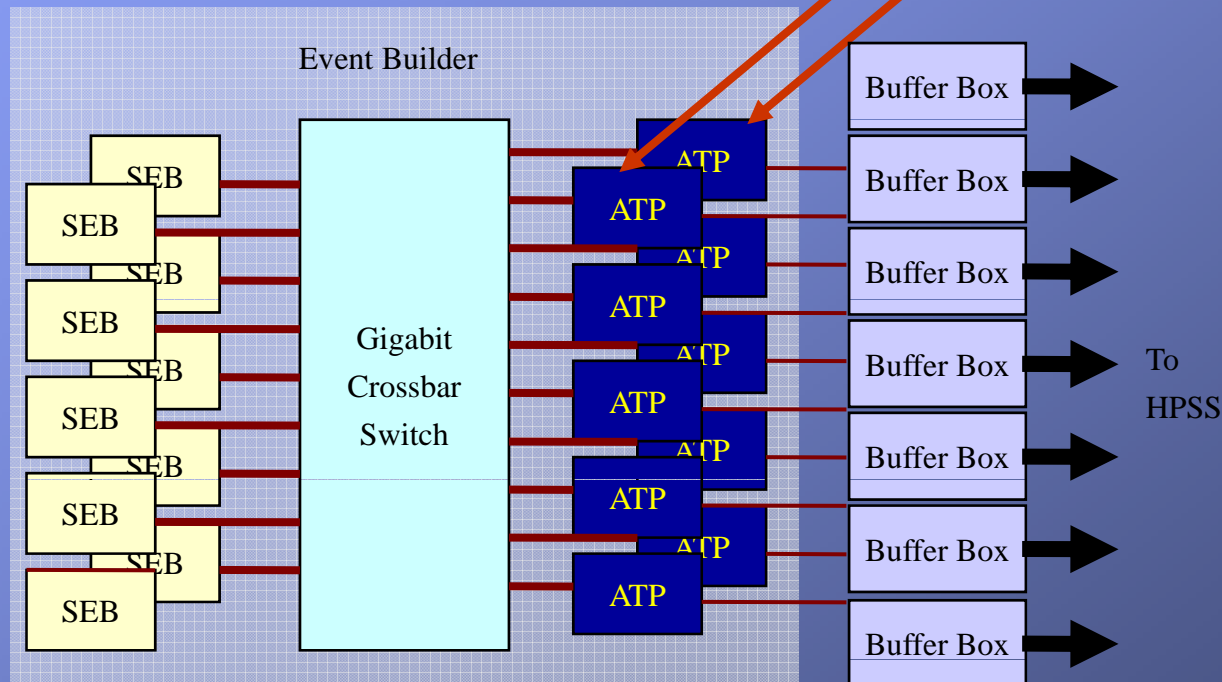


All this is handled completely in the I/O layer, the higher-level routines just receive a buffer as before.

Distributed Compression

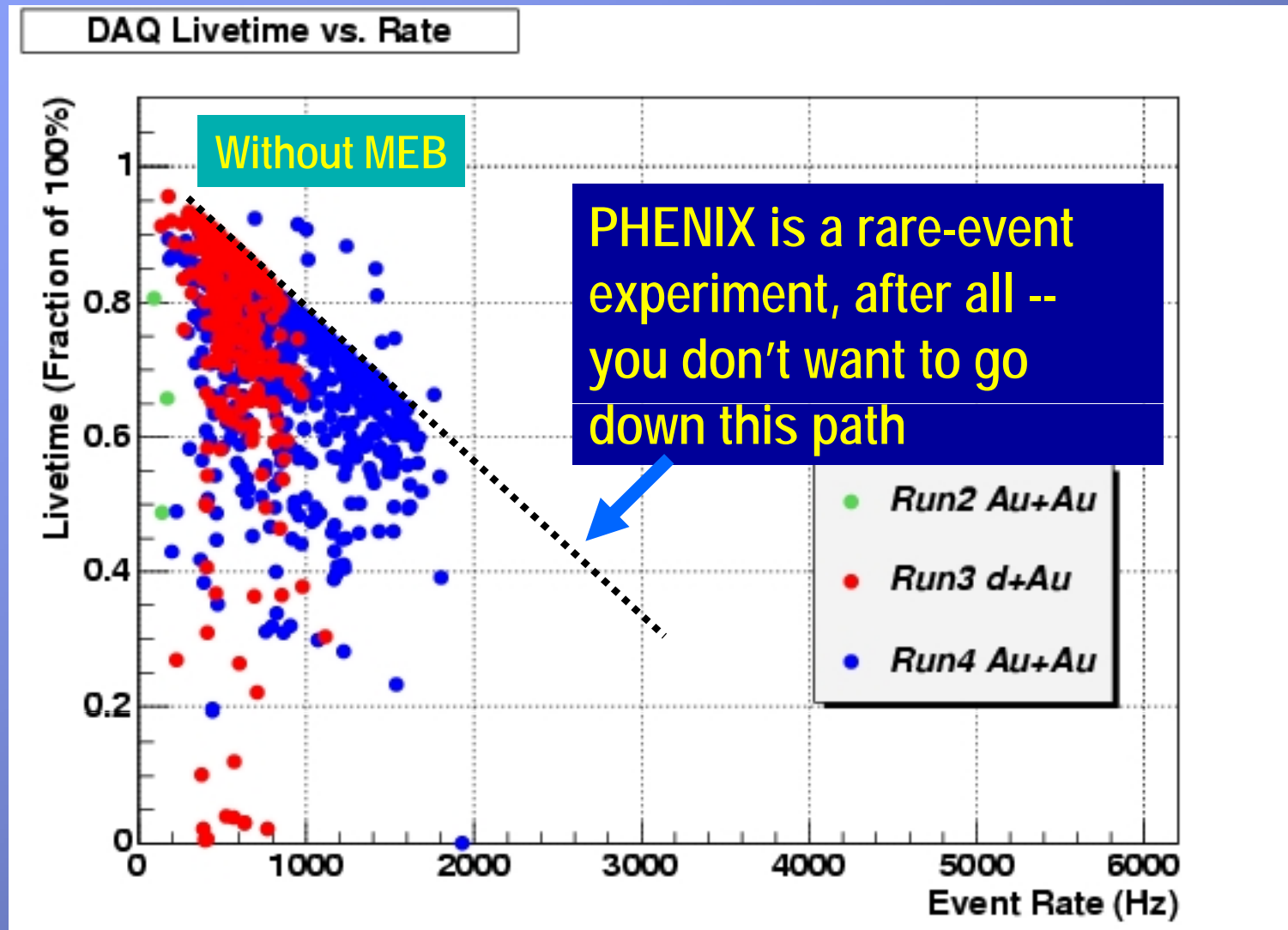
The Event builder has to cope with the uncompressed data flow, e.g. 600MB/s ... 1200MB/s

The compression is handled in the "Assembly and Trigger Processors" (ATP's) and can so be distributed over many CPU's -- that was the breakthrough



The buffer boxes and storage system see the compressed data stream, 350MB/s ... 650MB/s

Multi-Event Buffering: DAQ Evolution



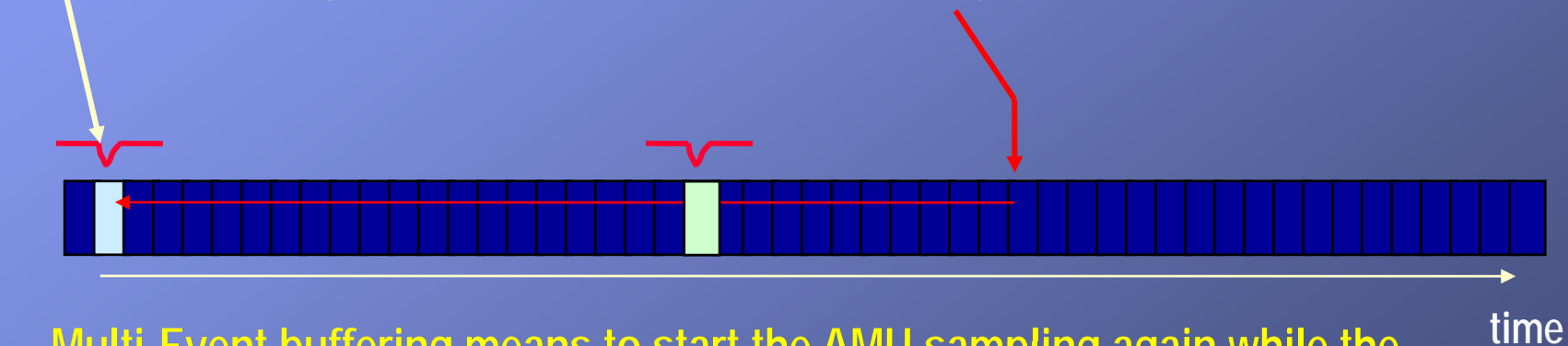
MEB: trigger delays by analog Memory

trigger electronics needs to buy some time to make its decision

done by storing the signal charge in an analog memory (AMU)

Memory keeps the state of some 40us worth of bunch crossings

Trigger decision arrives. FEM goes back a given number of analog memory cells and digitizes the contents of that memory location

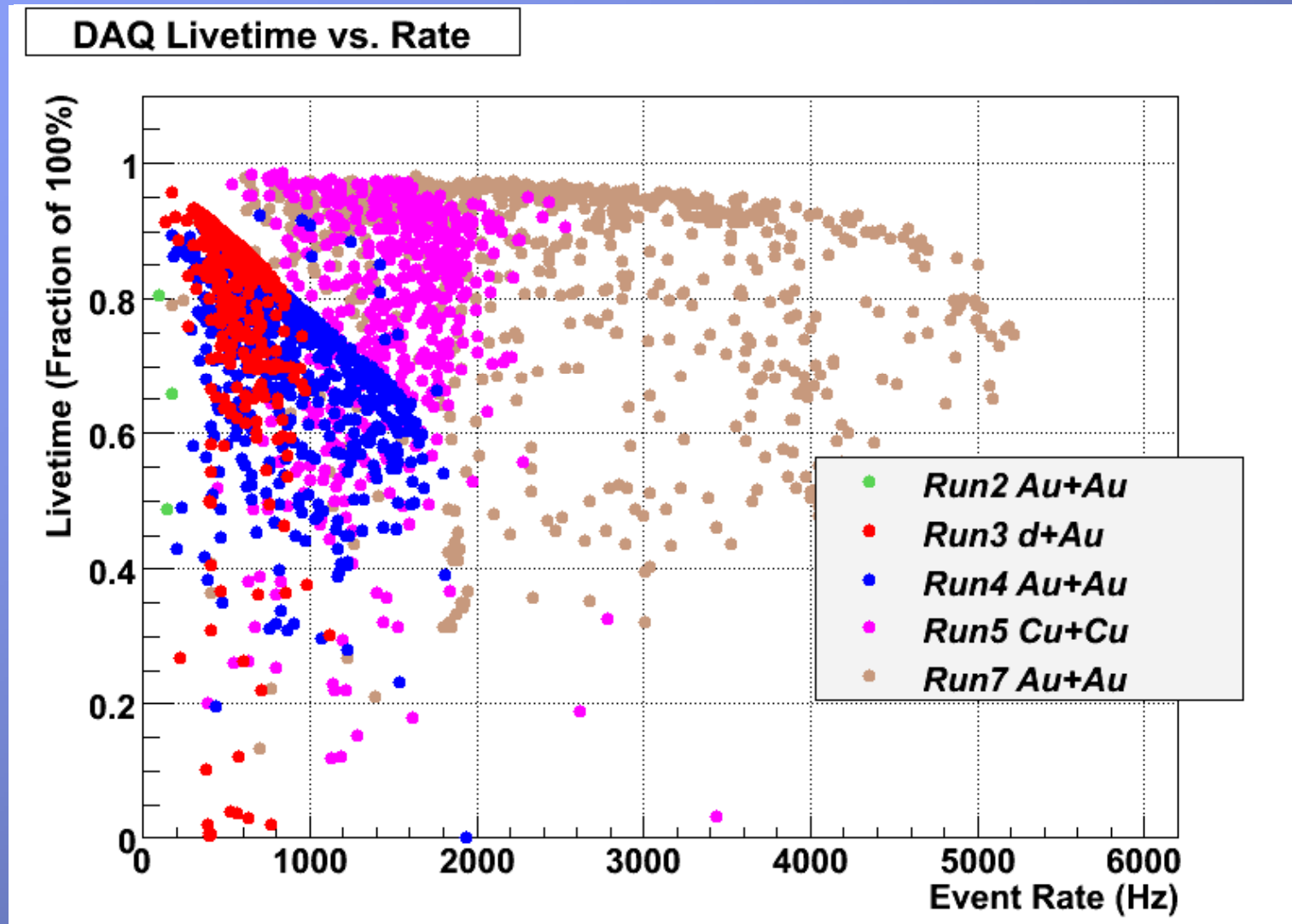


Multi-Event buffering means to start the AMU sampling again while the current sample is still being digitized.

Trigger busy released *much* earlier

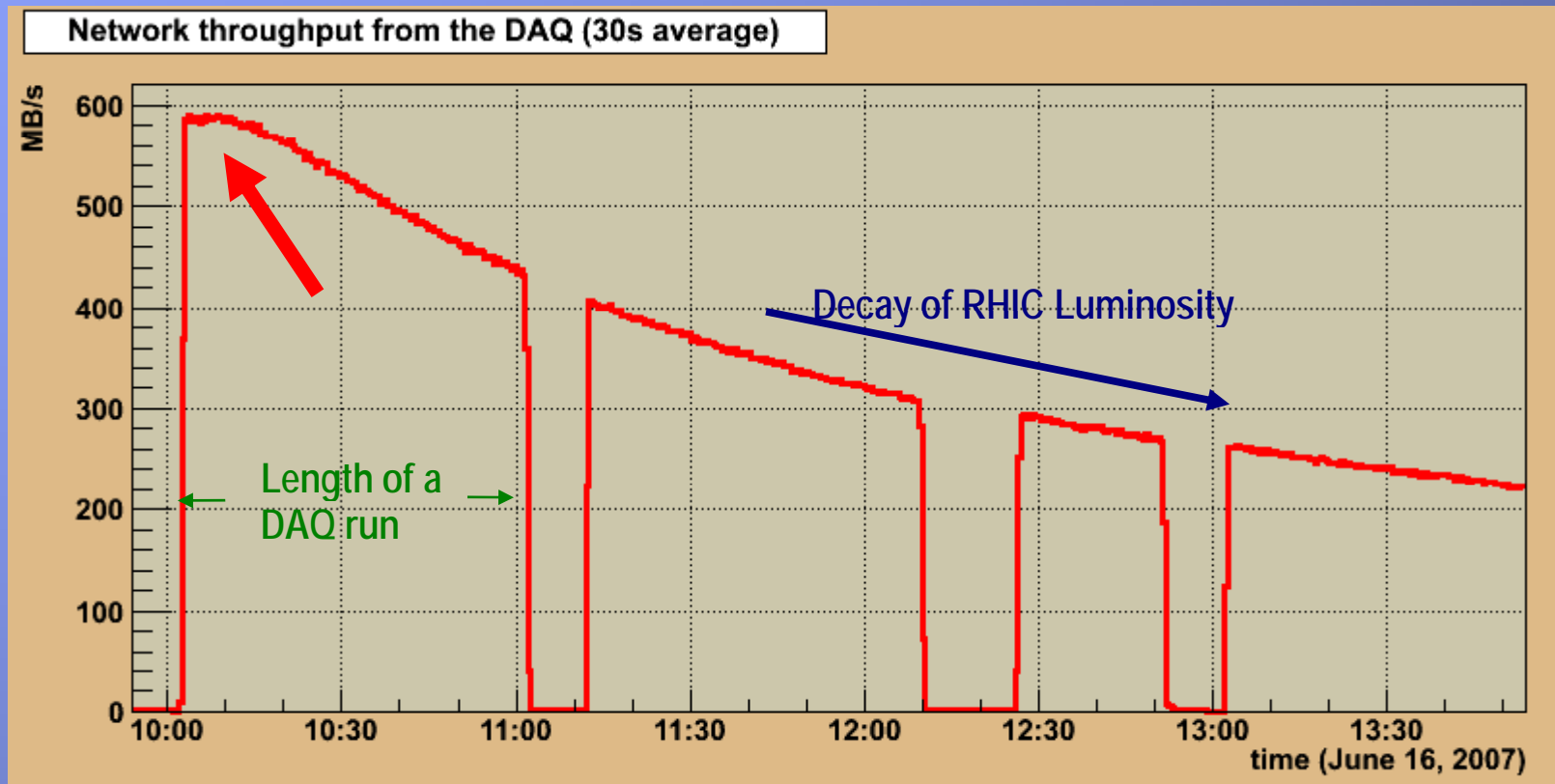
deadtime greatly reduced

The Multi-Event Buffering Effect



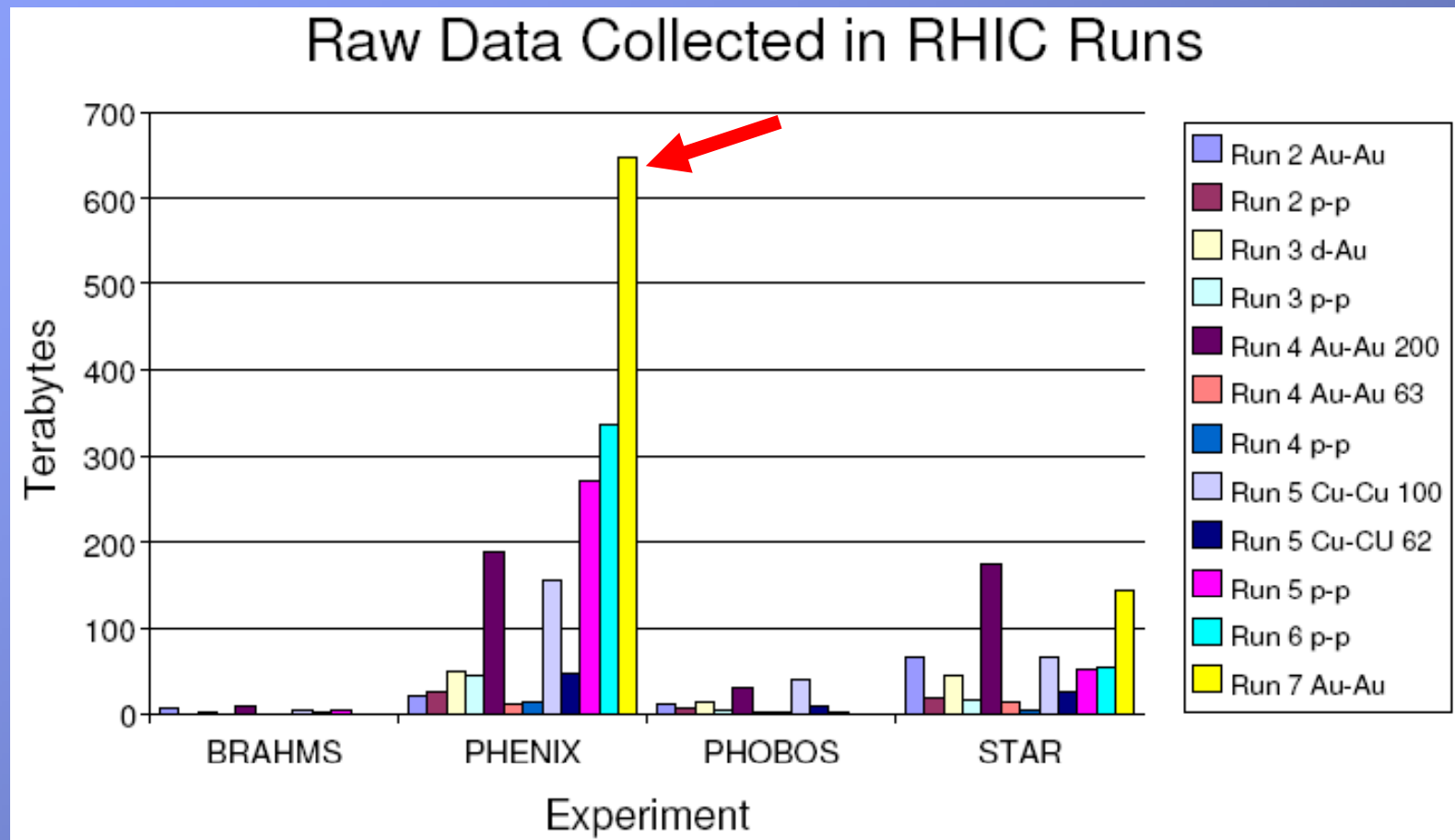
~600 MB/s

This shows the aggregated data rate from the DAQ to disk in a RHIC fill
We are very proud of this performance...



It's not the best, it's one where I was there...
best went up to 650MB/s

Event statistics



5.7 Billion Events in ~650TB of data

Run 6 pp – 6.8 Billion @200GeV
1 Billion @62GeV

Online Filtering and Reconstruction

We ran Level-2 triggers in the ATP's in so-called filter mode

lvl2 triggers don't reject but fish out interesting events for priority reconstruction

Filtered data were sent to IN2P3 in France where resources were available AND where the people most interested in the filtered dataset are

~10% of min bias data were sent to Vanderbilt University where Computing resources were available to reconstruct the data set, find problems in reconstruction, new detectors' software, make early DST's available, gear up for "real" production

Valuable tool to get a reading how you are doing, as well as preliminary physics signals to check calibrations etc

Used to refine our GRID file transfer procedures to "new" remote sites (not that much data volume transferred during this run, ~70TB – Run6 - 300TB)

Summary

- Very successful run, 650TB of data on tape despite short run due to DOE budget woes
- Can do > 600MB/s
- 4 new detector systems which still needed some “shakedown”
- Reached 5KHz event rate in Au-Au with larger event size
- successful filtering effort for priority reconstruction
- First iterations of min bias data production at a remote site (Vanderbilt University)

Where we are w.r.t. others

