Online Monitoring, Calibration and Reconstruction in the PHENIX experiment

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Outline

• The PHENIX experiment
• Monitoring
• Filtering
• Calibration
• Reconstruction
The PHENIX detector

Spectrometer, designed to measure Electrons Muons Photons and Hadrons

It targets rare Event Physics and is therefore designed to take the highest luminosities and make use of selective lvl1 triggers

Many many different detector types

So far no two Runs with the same configuration

➔ Whatever we do in terms of monitoring/calibration/reconstruction It better be flexible
Data Acquisition

Online Monitoring
HPSS, Filtering, Calibration

BufferBox

6 BufferBoxes, 6 TB each distributed over 4 filesystems COTS Hardware

5 kHz Event rate, 600MB/s Data rate, currently limited by frontend
Run 5 (2004-2005)
CuCu @ $\sqrt{s} = 62$GeV $\sim 0.8 \times 10^9$ Events
CuCu @ $\sqrt{s} = 200$GeV $\sim 2.2 \times 10^9$ Events
Pp @ $\sqrt{s} = 200$GeV $\sim 7.4 \times 10^9$ Events
Computing resources

Phenix Counting House:
~80 fast cpus, easy access to all data, ~10 TB local storage

Rhic Computing Facility (rcf):
~1000 cpus, hpss storage, much disk space, 200 MB/sec link

Computing Center Japan (CCJ):
~1000 cpus, hpss storage,
60 MB/sec link, Mickey Chiu, Dantong Yu

Herans Farm, ORNL:
~50 cpus, ~4 TB disk space, David Silvermyr
To keep it simple, the Online monitoring has a very limited scope:

- Making sure PHENIX subsystems are online and working to the best of their ability
- Fast feedback of problems (and a rough idea what to do)
- Data is reasonable (e.g. Vtx distributions)
- New subsystems should easily be included, it has to adapt constantly to deal with "the problem of the week"
- Archiving of plots and values for later cross checks
- It does not propagate values across run boundaries
Online Monitoring Dataflow

Simple client server architecture
Information is passed via Root histograms
Users only interact with the clients, no Pilot errors interfere with the monitoring
The monitoring code has to survive millions of events

DAQ
File

ET-Pool
C.Timmers
JLAB

Monitor 1
Monitor 2
Monitor 3
Monitor 4
Monitor 5
Monitor...

Draw Client 1
Draw Client 2
Draw Client ...

CHEP 06 13-17 February, Mumbai
The Server

Loops over registered Monitors
Manages Histograms
Ships Histograms to clients
Provides access to common variables (e.g. trigger)
Saves Histograms at end of Run
Sends messages to shift Crew via CORBA based Message system

Monitor 1:
Init();
Reset();
process_evt();
BeginRun();
EndRun();

vector<OnlMon *>

Provided by Subsystems

Histories

Events

Root
TSocket

Clients

Root File

Html
The shift crew uses this simple gui to monitor the all subsystems.

Internally it just executes small Root macros.

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Archiving on the Web

The output of the online monitoring is archived on the web for later reference. Subsystem can add additional plots which are not part of the standard shift crew monitoring.

This output is solely generated from the saved root histograms, enabling recovery of this in case of crashes/accidents.

Courtesy of L. Aphecetche

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Filtering

No one wants to wait for 6-12 months to start with Physics for which PHENIX was designed

We employ lvl2 trigger algorithms offline to select interesting events for priority reconstruction.

We ran 3 lvl2 algorithms:
- $J/\Psi \rightarrow \mu^+ \mu^-$
- $J/\Psi \rightarrow e^+ e^-$
- High pt Photon

And for convenience extracted the Laser events (1-2 Hz) which are needed for the calorimeter online calibration.

The algorithm rejections are in the order $\sim 500$

The resulting much smaller dataset can easily be transferred off site for processing.
Online Calibration

Like with the Online Monitoring, limited scope:

Provide **good enough** calibrations to run the global tracking, which is the main cpu consumer during reconstruction.

This reduces the required calibrations to provide **accurate enough hit positions** (but e.g. no fine tuned tof or emc timing).

These calibrations are applied in terms of **afterburners**, which run as part of our “**Analysis Train**”, their impact on cpu consumption is minimal.

Even though it is an overkill, we calibrate every run which makes the bookkeeping much simpler in terms of which run is ready for reconstruction.

→ That leaves drift chamber (drift velocity), pad chamber (noisy channels), emc (energy for clustering), tec (gain) All others are optional (but welcome to join)
Online Reconstruction

The filtered data set is small enough that it can be transferred to a small farm without mass storage for reconstruction like ORNL. Files were fetched by bbftp and reconstructed as soon as the online calibration was successful. All of this was done by scripts which were run by David Silvermyr when new filtered data became available, and the results were available on the web (for the collaboration).

The PHENIX counting house farm provided the reconstruction of minimum bias data which are needed to understand the biases introduced by the filtering.

Both farms use Condor as batch system with only minor glitches.
The Choreography

Guis are for show, the real work is done with scripts….

The start of the filtering, online calibration and production is initiated by the shift crew as soon as a file system is filled and becomes available for reading. The filtering and the calibration (using physics data) for the new runs are started simultaneously, only runs which contain a minimum number of events are processed (discard the "fizzled" ones which never got off the ground). The calibrations which use Laser events are started every 2 hours to process the new Laser events only files produced by the filtering. If the calibration was successful for a given run the reconstruction of the first 15GB of its raw data is started.

All processes write their status into postgreSQL tables and the shift crew supervises their status via php scripts.

Preliminary results were presented at QM05, 3 months after the run ended.
Summary

- Phenix processed 500TB of data in Run5
- Online Monitoring fairly mature and working reliably
- Calibrations for tracking done online
- First time (quasi) online Filtering of the complete data set
- First physics results 4 weeks after beam off
- Testing with Code Checkers (currently valgrind/insure anyone got others?) is essential for surviving millions of events – code which doesn’t pass this, doesn’t run – period
- It still required to many separate interventions by the shift crew, for this Run we’ll try to automatize the complete process, triggered by a file system switch

*Our code does so much more than just compile*