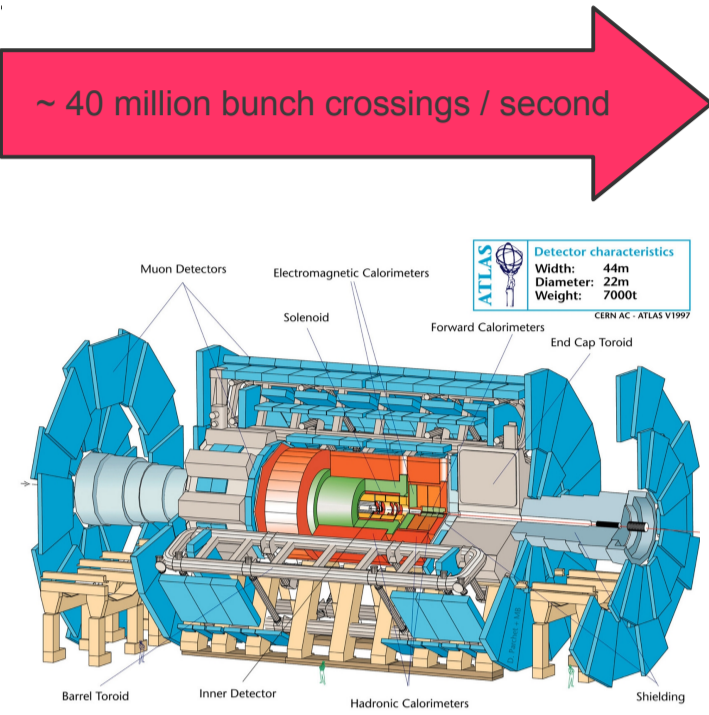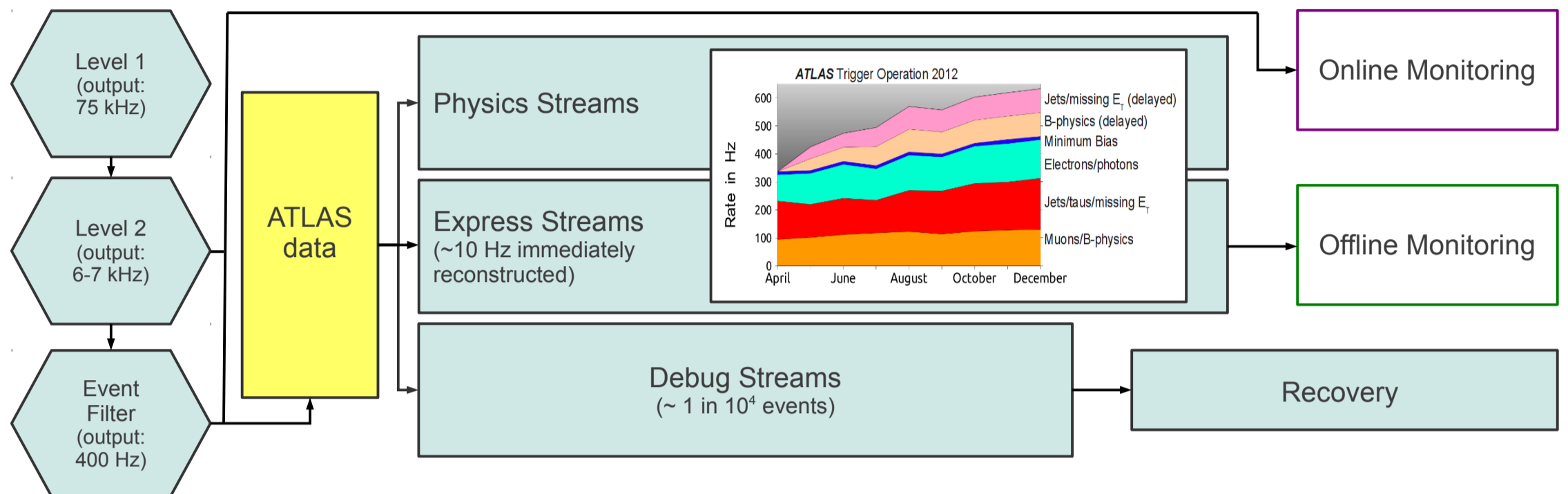# ATLAS Trigger Monitoring in 2012

The ATLAS data acquisition and trigger system is designed to reduce the LHC bunch crossing rate from 40 MHz to an output rate of a few hundred Hz to disk. The online and offline monitoring procedures ensure successful data-taking. The online monitoring infrastructure allows experts in the control room to monitor data during operation, so that they can identify and then respond to any defects in data quality or algorithm performance. After data-taking is complete, a subset of recorded events are quickly processed and select histograms are displayed in the offline monitoring framework for review by the trigger experts.
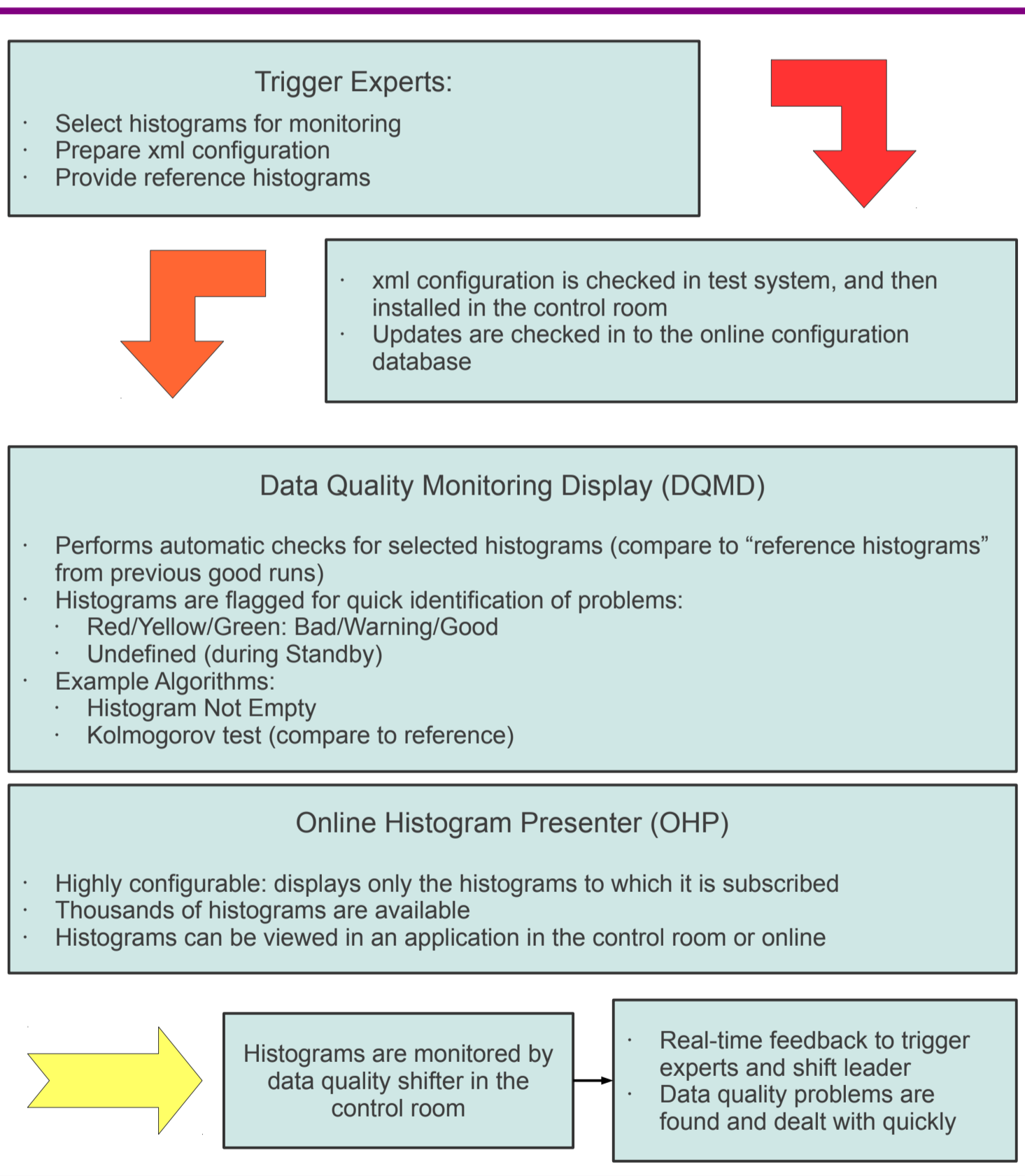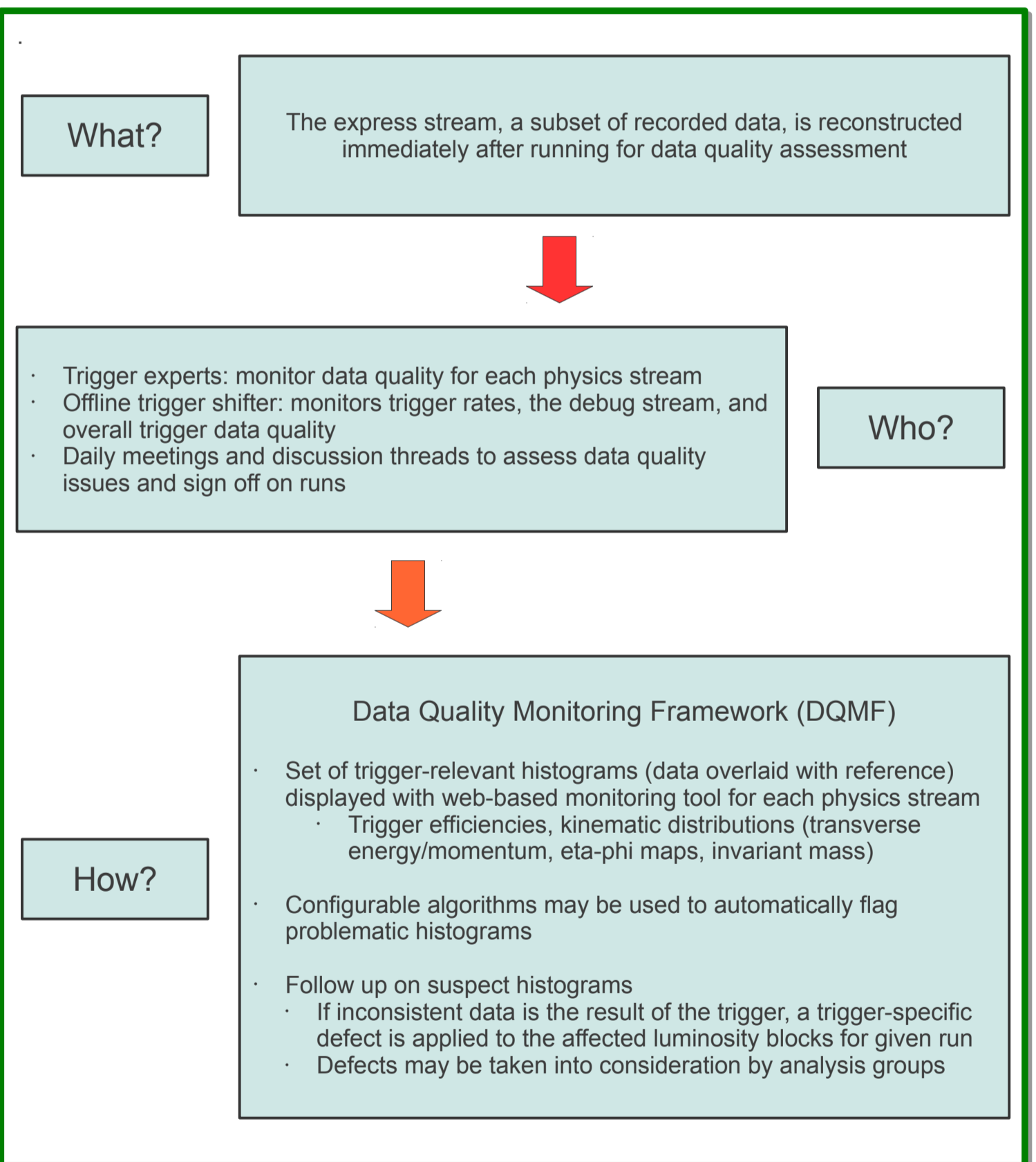
The ATLAS Detector

~ 40 million bunch crossings / second

Detector characteristics
Width: 44m
Diameter: 22m
Weight: 7000t
CERN AC - ATLAS V1997

Muon Detectors · Electromagnetic Calorimeters · Solenoid · Forward Calorimeters · End Cap Toroid · Barrel Toroid · Inner Detector · Hadronic Calorimeters · Shielding

The ATLAS Trigger System

Level 1 (output: 75 kHz)

Level 2 (output: 6-7 kHz)

Event Filter (output: 400 Hz)

ATLAS data

Physics Streams

Express Streams (~10 Hz immediately reconstructed)

Debug Streams (~ 1 in 10^4 events)

Online Monitoring

Offline Monitoring

Recovery

ATLAS Trigger Operation 2012 — Rate in Hz (600, 500, 400, 300, 200, 100) — April, June, August, October, December

Jets/missing E_T (delayed)
B-physics (delayed)
Minimum Bias
Electrons/photons
Jets/taus/missing E_T
Muons/B-physics

Online Monitoring

Trigger Experts:
· Select histograms for monitoring
· Prepare xml configuration
· Provide reference histograms

· xml configuration is checked in test system, and then installed in the control room
· Updates are checked in to the online configuration database

Data Quality Monitoring Display (DQMD)

· Performs automatic checks for selected histograms (compare to "reference histograms" from previous good runs)
· Histograms are flagged for quick identification of problems:
  · Red/Yellow/Green: Bad/Warning/Good
  · Undefined (during Standby)
· Example Algorithms:
  · Histogram Not Empty
  · Kolmogorov test (compare to reference)

Online Histogram Presenter (OHP)

· Highly configurable: displays only the histograms to which it is subscribed
· Thousands of histograms are available
· Histograms can be viewed in an application in the control room or online

Histograms are monitored by data quality shifter in the control room

· Real-time feedback to trigger experts and shift leader
· Data quality problems are found and dealt with quickly

Offline Monitoring

What? The express stream, a subset of recorded data, is reconstructed immediately after running for data quality assessment

Who?
· Trigger experts: monitor data quality for each physics stream
· Offline trigger shifter: monitors trigger rates, the debug stream, and overall trigger data quality
· Daily meetings and discussion threads to assess data quality issues and sign off on runs

How?

Data Quality Monitoring Framework (DQMF)

· Set of trigger-relevant histograms (data overlaid with reference) displayed with web-based monitoring tool for each physics stream
  · Trigger efficiencies, kinematic distributions (transverse energy/momentum, eta-phi maps, invariant mass)

· Configurable algorithms may be used to automatically flag problematic histograms

· Follow up on suspect histograms
  · If inconsistent data is the result of the trigger, a trigger-specific defect is applied to the affected luminosity blocks for given run
  · Defects may be taken into consideration by analysis groups

Reprocessing / Debug Stream

Debug Stream

· The debug stream collects events for which a timely trigger decision is not reached

· Quickly identify issues with trigger system:
  · misconfiguration, timeouts, errors, software crashes, missing data, network problems, etc.

· L2 and EF are re-run with the same configuration and conditions as online, but without any time limit
  · Event analysis to diagnose trigger indecision
  · Recovered events integrated into physics data streams

· Data are reprocessed to test and validate changes in:
  · Trigger menu
  · Software: thresholds, bug fixes, new algorithms, etc.
  · Conditions: alignment, calibration, etc.

· Data collected in the enhanced bias stream, in which only Level 1 trigger decisions are active, so that new L2 and EF configurations may be tested. Signal data (such as $Z \rightarrow ee$ skims) are used to validate the effect of changes on signal efficiencies.

· Trigger experts review monitoring and reconstruction output and sign off before deployment online

Reprocessing

Elizabeth Brost and Jane Cummings, for the ATLAS Collaboration

ATLAS EXPERIMENT