Data Quality: Online Luminosity Monitoring Overview

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Luminosity Taskforce

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Outline

- Luminosity Basics
- Online Luminosity Responsibilities
- Online Luminosity Infrastructure
- Goals for M9

Actual shifter instructions: DQ session tomorrow!

What All Analysts Learn About Luminosity

From an arbitrary process $pp_{\text{inel}} \to Y$ at the LHC:

How many $pp_{\text{inel}} \to Y$ events were produced during a run of duration T?

$$N_{pp_{\text{inel}} \to Y} = \int_0^T \mathcal{L}(t)\,dt \times \sigma_{pp_{\text{inel}} \to Y}$$

where the instantaneous luminosity ($\mathcal{L}$) is time-dependent, accounting for the varying LHC conditions during the run (proton burn-off, etc.).

- Fundamental for cross-section measurements ($pp \to W/Z$, $pp \to t\bar{t}$, $pp \to H$, ...)
- Crucial for estimating sensitivity of model-dependent searches.
- Needed to normalize MC samples.

Other Uses for Luminosity Information

- LHC operators use $\mathcal{L}(t)$ measured by the experiments to optimize collisions at the interaction points.
- The luminosity signals (along with other indicators) when LHC conditions are adequate for physics data-taking.
- Forms the basis for the adjustment of the triggers during data-taking (prescales, etc.).
- The time-evolution of the luminosity together with the beam-spot parameters provide accelerator diagnostics that cannot be obtained by any other means:
  - Often needed during LHC development even if no ATLAS data is taken.

Luminosity: Which One?

- **Instantaneous Luminosity**:
  - $\mathcal{L}$ as previously defined.
  - Calculated by the Online Luminosity Calculator (OLC) for the shortest time interval possible for a particular detector.
  - Updates typically every 1-2 seconds for BCM and LUCID.
- **Luminosity Block (LB)**:
  - A short time period (Δt_{LB}, order ~ 1 min) defined by TDAQ during which LHC and ATLAS conditions are assumed constant, for which the average luminosity is calculated.
  - Smallest time granularity with which luminosity data is stored in COOL.
- **LB-averaged Instantaneous Luminosity**:
  - Instantaneous luminosity averaged over the duration of a LB ($\mathcal{L}_{\mathrm{LB}}$).
  - ***_all:** summed over all Bunch-Crossing IDentifiers (BCIDs).
  - ***_phys:** restricted to colliding bunches used for physics.
- **Integrated Luminosity**:

$$\int \mathcal{L} dt = \sum_{i}^{N} \mathcal{L}_{\mathrm{LB}_i} \Delta t_{\mathrm{LB}_i}, \qquad i \in \{\mathrm{run/fill}\}$$

Online Luminosity Monitoring Responsibilities

- **Detector Desks**:
  - Monitor the performance of the detectors up to and including the raw luminosity data they publish on the Information Service (IS).
    - Calorimeters Desk: LUCID, FCal, Tile.
    - Inner Detector Desk: BCM, DBM, (Pixel, SCT and IBL for offline).
    - Trigger Desk: MBTS.
- **Run Control Desk**:
  - Monitors the luminosity infrastructure:
    - Luminosity data flow from detectors to luminosity online tools (OLC).
    - Archiving in COOL database for offline use (OLC2COOL).
- **Data Quality Desk**:
  - Monitors the content of the luminosity publications from the luminosity infrastructure and their internal consistency.

Online Luminosity Monitoring Infrastructure

- **Online Luminosity Calculator (OLC)**:
  - Software that lives in the TDAQ online environment under the partition called OLC which hosts the OLC Application.
  - Collects raw data from the ATLAS sub-detectors (via IS) and LHC beam instrumentation (via the Data Interchange Protocol (DIP)).
  - Calculates calibrated instantaneous and integrated luminosities.
  - Publishes the information for online usage and permanent storage.

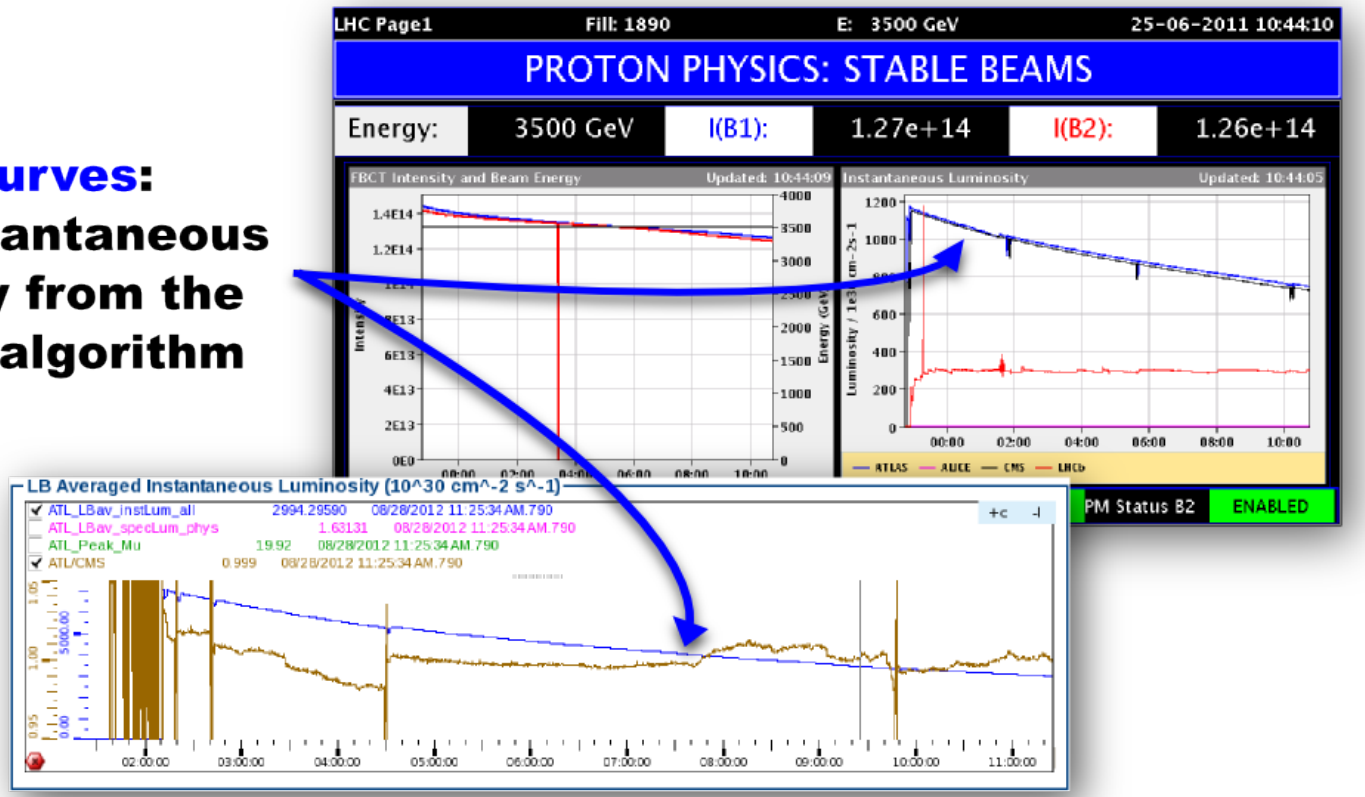
- **OLC2COOL**:
  - Archives the online luminosity values from OLC in the COOL database for offline use.

- **Luminosity diagnostics**:
  - **Data Quality Desk:**
    - DCS displays: time histories of $\mathcal{L}$ or ratios of $\mathcal{L}$.
    - OHP: bunch-by-bunch luminosities (for experts only).
  - **Run Control Desk:**
    - Shifter Assistant rules will be developed for 2015.

- **Preferred Algorithm**: **The one luminosity value that is:**
  - distributed to ATLAS as a whole (public plots, trigger prescales, etc.),
  - sent to LHC page 1,
  - Typically used for a first pass of physics analysis,
  - The focus of the DQ shifter.

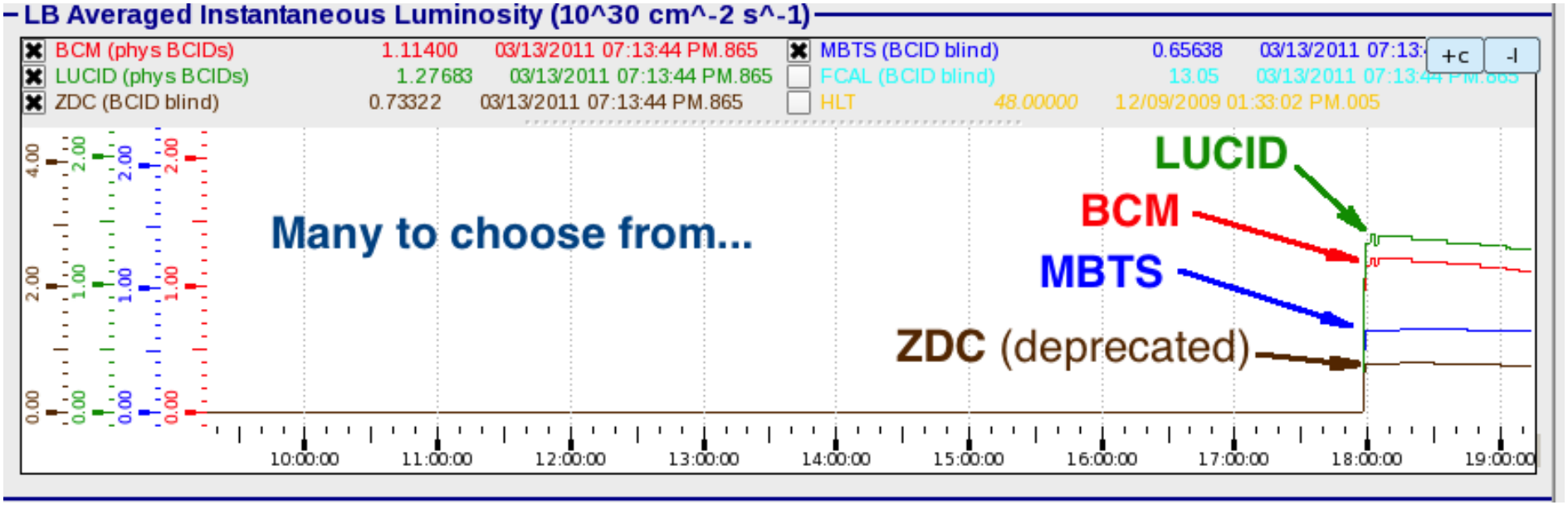
LHC Page 1

Blue curves:
ATLAS instantaneous luminosity from the preferred algorithm



ATLAS DCS Display

Preferred Algorithm for M9



- **The preferred algorithm for M9 is BCMVOR.**
  - It uses the vertical sensors of the BCM on both sides of ATLAS.
  - It counts all events firing either the A side or the C side, or both.

- **During M9:**
  - The BCM will issue simulated luminosity data.
  - We do not know yet what other system may begin publishing sensible values.
  - We may exercise changing the preferred algorithm.

Luminosity Monitoring Goals for M9

- **Exercise the online $\mathcal{L}$: stability? problems?**
  - Let OLC partition run throughout M9.
  - Clean-up deprecated IS publications and displays: the DCS display may change in the course of M9.
- **Develop/exercise the shifter tasks:**
  - Do DQ shifters have comments on the training material and reference twiki pages?

What We Want From the DQ Shifter in M9

- We want to gather **information** and **feedback**:
  - Is the current training/documentation helpful/useful?
  - Keep an eye on anything deviating from expectations:
    - This task is rather limited since we don't have beams: no real luminosity.
    - The correct operation of OLC and OLC2COOL can still be fully monitored
- Keep an eye on the **luminosity infrastructure monitoring plots**.
- Keep an eye on the **luminosity values coming from the preferred algorithm**.
- **Be aware of interventions by experts:** elogs, phone calls, drop-in visits in the control room, etc.