The ATLAS Online Luminosity Software

Nicoletta Garelli (SLAC), Alex Kastanas (Stockholm University), Andy Salnikov (SLAC) for the ATLAS collaboration

At a collider the luminosity is a measurement of the interaction rate at a collision point. For a given process, with a certain cross-section, the event rate is the product of the luminosity and the cross-section.

Real-time luminosity determination is important for both ATLAS and the Large Hadron Collider (LHC). This has led to the development of software tools responsible for reading and calibrating inputs from luminometers, publishing the information in the control room as well as archiving the data for offline analysis.

**Online Luminosity Calculator (OLC)**

The ATLAS luminometers deliver inputs for $\tau(70)$ luminosity algorithms:
- averaged over all LHC bunches every $\tau(1)$ s.
- per-bunch data for every ATLAS luminosity block (LB) on a timescale of $\tau(1)$ minute.

The Online Luminosity Calculator (OLC) reads the data, calibrates and publishes it online in the control room. It was re-designed with a multithreaded architecture and updated for the LHC Run-II, with the goal of improving reliability and reducing latency in providing the luminosity data.

**OLC2COOL**

Archiving of luminosity and accelerator data from the OLC is done by the OLC2COOL application, redesigned for Run-II. Luminosity information is archived for every LB. When archiving the optimal online luminosity is also produced as well as a measure of the integrated luminosity.

A crucial deliverable is ensuring that in rapidly changing conditions all data are archived. This was achieved with a multithreaded architecture where data reading and calculations are performed independently in separate threads.

**Scan Controller**

The Scan Controller is responsible for automatically steering beam scans in ATLAS. Upon LHC request, the Scan Controller automatically prepares ATLAS for a scan:
- Adjust trigger (only for emittance scans).
- Aligns LBs with the LHC magnets movements.
- Increase number of data files in local storage.

Once done, the Scan Controller signals readiness for scans and LHC operators vary the beam separation in steps with a $10$ s pause per step so ATLAS can acquire data.

The luminosity data during the scans are sent to the LHC online.

At the end of a scan ATLAS is brought back to nominal physics configuration.

**Feedback and Monitoring**

The luminosity output is used for many purposes:
- Provide feedback on accelerator performance.
- Optimise collisions at ATLAS interaction point.
- "Level luminosity", keep the luminosity at ATLAS interaction point at a steady value.
- Used by the detectors and high level trigger to correct for luminosity dependent effects.

Multiple systems are used to monitor the luminosity:
- The Detector Control System provides a real time view as well as evolution with time.
- Summary web pages show the current status in a user-friendly manner for overview.
- Alerts provide feedback to the operators in case of serious problems.

**Summary**

The new ATLAS luminosity software for Run-II has proven successful and a reliable and flexible system:
- Greater stability and lower latency in delivering information online → all data read and archived.
- Improved configuration flexibility → an asset given the exceptional LHC performance.
- Possibility to change configuration on the fly.

Both accelerator and experiment conditions can change rapidly, robust monitoring proven to be crucial:
- Multiple tools giving a complete picture.
- Faster feedback to operators with respect to Run-I.

The Scan Controller allows performing emittance scans regularly during physics fills:
- Successfully automated.