

October 3, 2018

Abstract

Every RHIC physics store is analyzed, with key components updated to a spreadsheet, to identify and monitor any improvements or degradations of performance. With physics stores lasting between 50 minutes (optimal store length of 7.3 GeV Au in Run14) and 20 hours (store length of 100 GeV Zr and Ru stores in Run18), manual analysis becomes tedious and time consuming. To reduce the time required by operators to update the spreadsheet data, a program was written in Python to automatically analyze every store. An overview of the data analyzed is given, and the programs used to analyze each store are discussed.

What data is collected and what it is used for

- Total intensity in blue and yellow ring; before ramp, after ramp, at physics.
 - Used for monitoring:
 - ramp efficiency;
 - total ring intensity;
 - lifetime:
 - a double exponential and a single exponential fitted to the first several hours of total intensity. The decay process that provides the most accurate fit is used to determine the decay rate.
- Number of bunches in blue and yellow ring.
- Peak, integrated and lifetime of luminosity.
 - a double exponential and a single exponential fitted to the first several hours of luminosity. The decay process that provides the most accurate fit is used to determine the lifetime.
- Start and End times for physics and luminosity.
 - Used to determine:
 - the length of a store and the duration of physics provided to experiments;
 - the time from the end of ramp to physics turning on;
 - the time from one Store to the next.
- Bunch Length at start and end of store.
 - Used to calculate:
 - the hour glass factor;
 - the emittance from: luminosity, per bunch intensity, number of bunches, hour glass factor.

StoreAnalysis Program

- The StoreAnalysis program
 - Reads archived data for select stores and calculates the luminosity, and has the capabilities of calculating much more.
 - Can perform single and double exponential fits to the luminosity and beam intensity.
 - Has a configuration file as an input that includes cross-section, ion species, and energy.

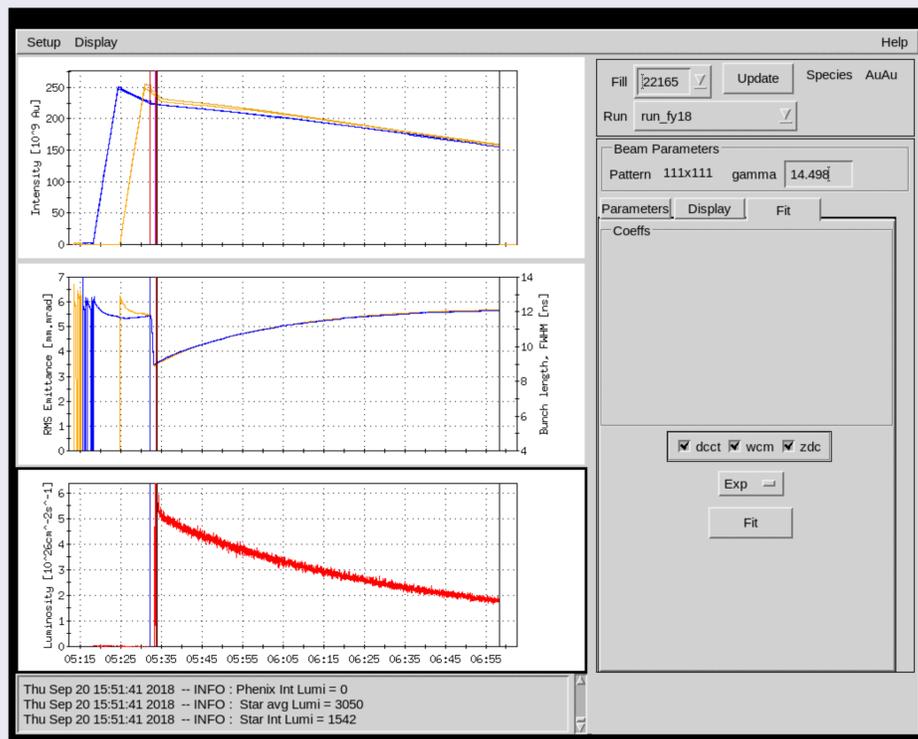


Figure 1: Analysis of Store 22165 using the StoreAnalysis program.

Automating Analysis

- First Steps
- Choose a language that can read .sdds archives and update excel spreadsheets (python).
 - Write the program for reading and analyzing archived data.
 - Fits were performed using a maximum entropy model and the Nelder-Mead simplex algorithm for parameter optimization.
 - Benchmark results from python program with results from StoreAnalysis application.
 - Write the program for updating and formatting the spreadsheet.
 - Certain logic was added for formatting different fields, i.e. stores that are shorter than the fit duration are marked in red, and do not have a fit performed.

StoreAnalysis Spreadsheet

Figure 4: Example spreadsheet and data from 13.5 GeV Au run.

Example outputs from automated analysis shown below.

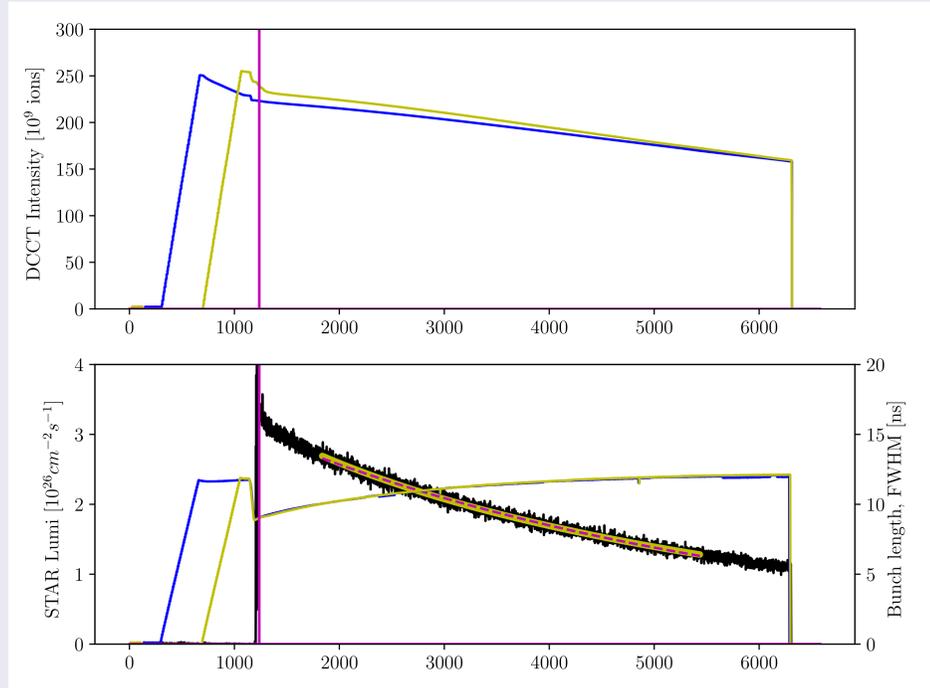


Figure 2: Plot generated from automated analysis.

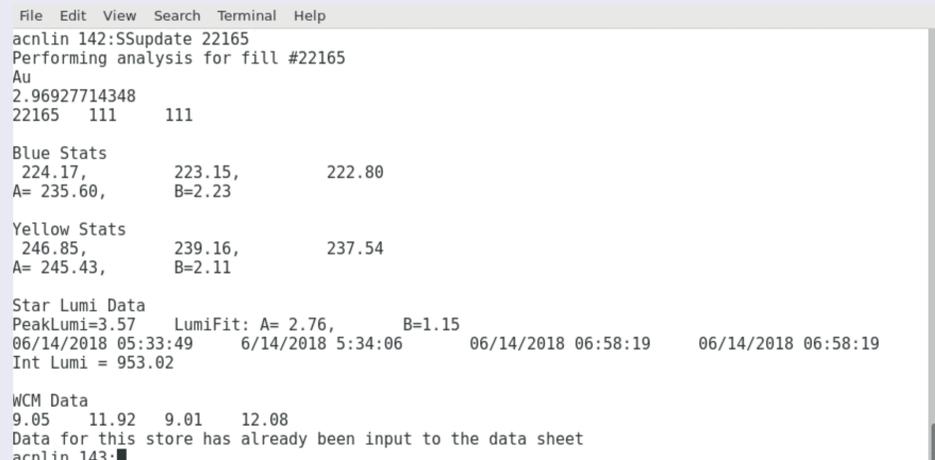


Figure 3: Output from automated analysis with relevant parameters.

Fully automating analysis and data updating:

- Created an infinite loop to check when a new Store was generated.
- Upon generation of a new Store, the previous Store was checked if physics occurred.
- If the previous Store was for physics, it would be analyzed and data would be updated to the spreadsheet.
- Operator would occasionally check quality of data, and correct where necessary.

Pros

- For Zr and Ru, stores would alternate between species, each had a separate spreadsheets.
 - Was able to read the ion species in RHIC and update the corresponding data set.
- Over the course of the 13.5 GeV Au run, automation saved the operator ~20 hours of time from updating the spreadsheet in a 3 week period (assuming ~5 minutes per store to update, and 232 Stores that were analyzed).

Cons

- Occasionally misses bunch length at end of store in cases where one ring is dumped but the other remains.
- Initially double exponential fits would provide optimal results with fast decay lifetimes being within 1% and slow decay lifetimes. This was updated so the fast decay would need to be 10x less than the slow decay lifetime or otherwise use the single decay fit model.

Conclusion

- Through automation, time required by operators to input data has been greatly mitigated.
- Ended years of operators needing to update data to spreadsheet.
- Despite data errors, the pros greatly outweigh the cons.

Acknowledgements

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