

Laser performance data analysis tool

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Introduction

eCAT, eScience based CLF Analysis Toolkit, is a new software application currently being developed as part of the eScience infrastructure for CLF (figure 1). It will support the analysis of Astra Gemini laser performance data initially and then be extended to Vulcan performance data analysis and possibly to user experiments in a third stage. eCAT is written in Java, making it portable across operating systems. The prototype version of the software is already deployed to selected laser scientists at CLF for testing and feedback and has been well received.

CLF Priorities

The basis for eCAT is the detailed set of prioritised requirements gathered from CLF scientists^[1]. The

requirements range from the ability to examine shot data as data sheets to being able to interactively query images from shot and trace data. Key functions include the ability to:-

- create, save and load sessions so individual users can customise the layout of the shot sheet to group variables that they view frequently,
- interact with images, extract statistics and compare,
- manipulate data using mathematical expressions,
- share data between eCAT and popular problem solving environments such as Matlab.

The full priority list contained over 100 requirements. These were then further prioritised to break the project into 5 roll-out phases, with additional features being implemented for each new version.

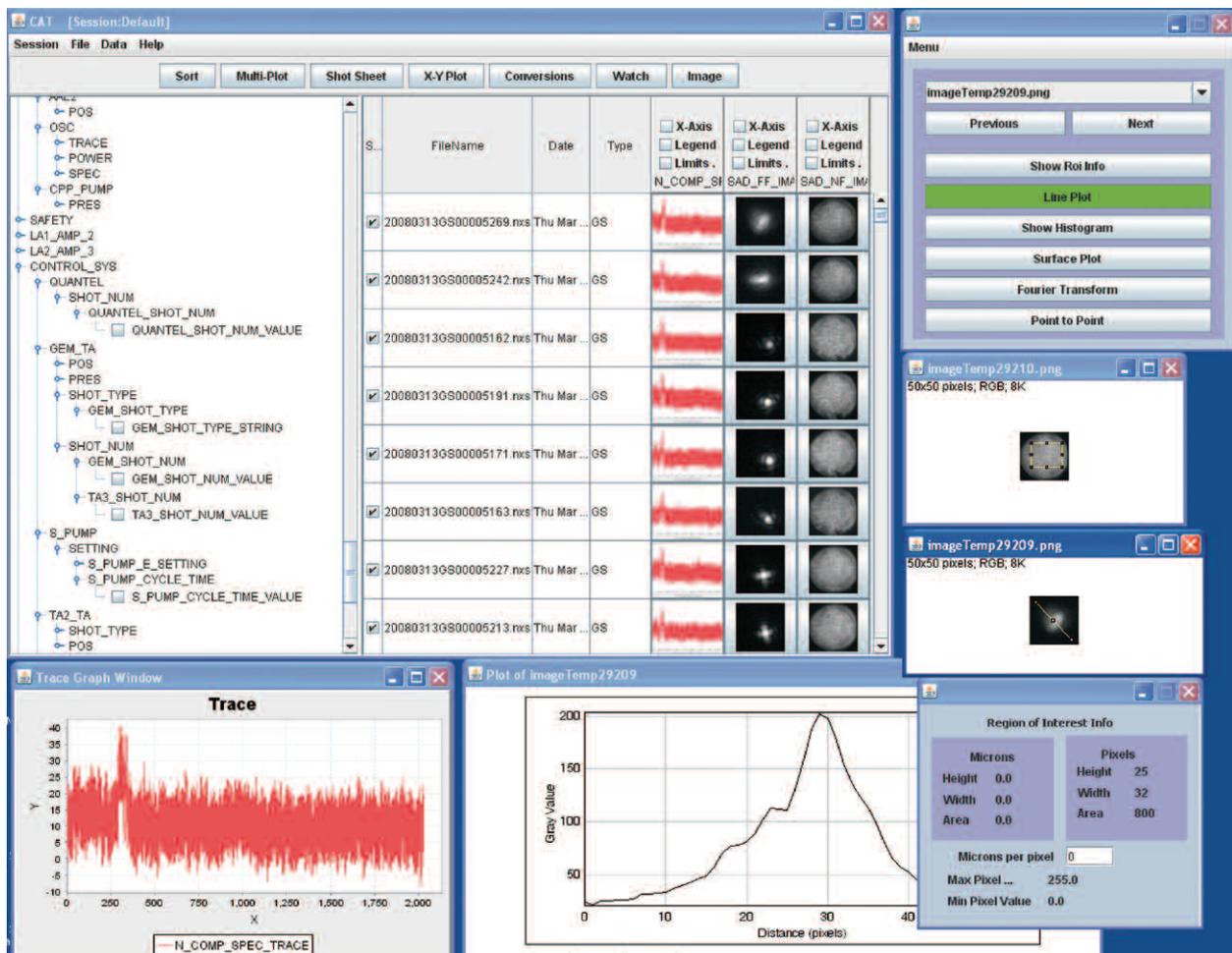


Figure 1. Screen shot of eCAT displaying many levels of functionality.

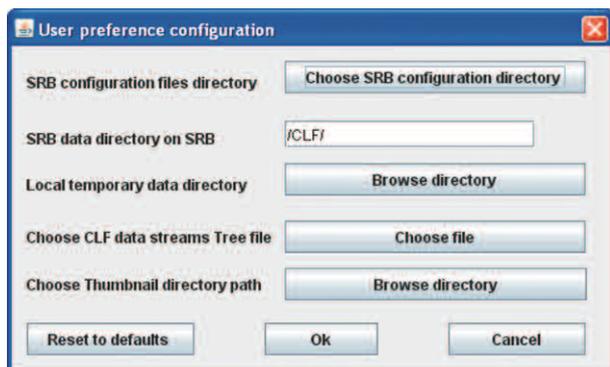


Figure 2a. eCAT interface for user customisation of configuration for data streams and directories.

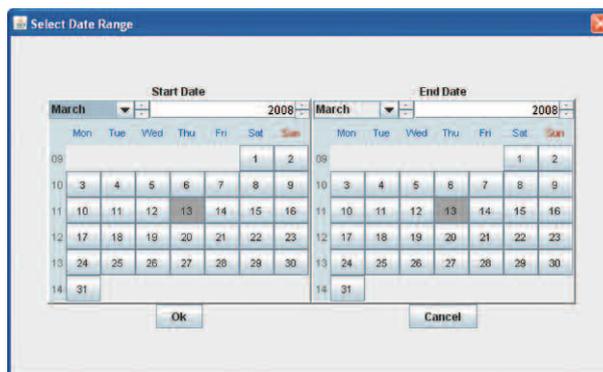


Figure 2b. Calendar widget to select start and end data for data analysis.

Software

Data gathered using the data acquisition software is converted to NeXus format which is the main input data format for eCAT. eCAT allows data access from the CLF Gateway Server (most recent 2 months data) and the CLF Storage Resource Broker (SRB) for older data. The user is able to customise the configuration module to specify the date and data directories to be used as shown in figure 2 and 3.

The list of data channels, also known as datastreams, are extracted from the Polar Bear^[2] repository as well as individual data files and displayed as a tree as shown in figure 1. The user is able to select specific data stream, fold or expand the tree and possibly insert new data stream as read from data set.

One advanced characteristic of eCAT is that all the data is processed closest to where it is gathered and stored. One such module is a standalone application that generates thumbnail images of trace and shot data. This application is automatically invoked when new dataset is written in NeXus format and a thumbnail is created and displayed if the user is viewing the data using eCAT. The most up to date data, as it arrives, will be updated within the eCAT browser. Another module will read NeXus files and create NeXus objects which are serialized and sent down the wire to the client desktop. The benefit of such a system is that the relatively slow processes of accessing disc files and reading the NeXus data files is assigned to the more powerful Linux server. This also removes the need for local copies of countless NeXus data files and the NeXus library. It is hoped that this implementation will mitigate well against particularly slow networks and make the system attractive to use even on modest client machines.

eCAT exploits public domain image processing software, in particular ImageJ and JFreeChart libraries with an integrated, new task specific interface as shown in figure 4. The strategy behind the decision is that when the development progresses to handling user data analysis, CLF user community will find their current software using these libraries and their knowledge of it transfer seamlessly to using eCAT.

Beta version of the software is currently being developed within the eScience Centre Scientific Applications Group.

We plan to migrate compute intensive components of the desktop version to be executed closer to where the data is and complete the full set of requirements gathered. The final stages of the development work will include components for data sharing with third party software, an interface to the metadata catalogue to browse all datasets and a fully operational distributed version to support scalability, easy maintenance, near real-time accessibility and interactivity from outside STFC and a thin client.

Functionality

On every Gemini laser shot many of the laser shot parameters are automatically saved to a NeXus database. The CLF Analysis Tool then retrieves the data and displays it as an interactive spreadsheet with one row given for each shot (figure 1). The columns hold individual pieces of laser data (i.e. images, traces etc) and can be added, removed, expanded and generally customized to suit the user. Once visible, individual columns of values can be selected and plotted against one another to display

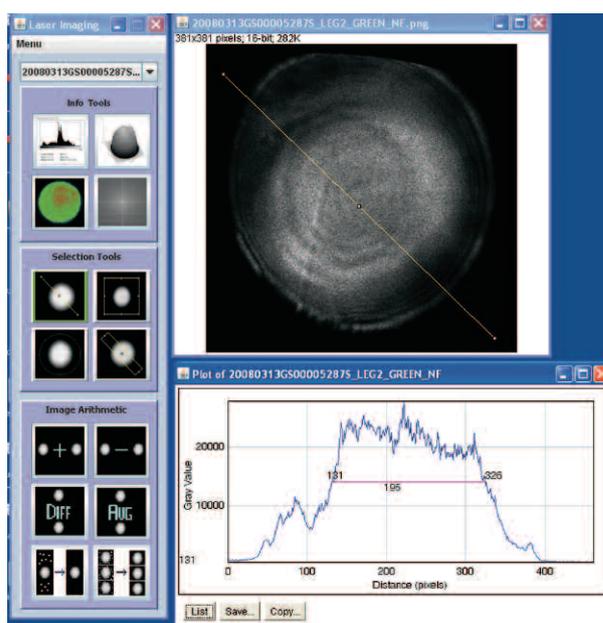


Figure 3. eCAT Image Analysis Interface showing angled line out and FWHM calculation on near field image.

shot trends and behaviour, e.g. energy vs. shot number or XY beam wander vs time. The small triangular icons at the top of each column allow the data to be sorted numerically by energy, shot number etc.

On the left-hand side is a hierarchy of possible data sources (datastreams) that can be selected to appear as columns of data. This is a three level hierarchy describing the location and type of data generated by each diagnostic^[2]. Knowing this greatly aids the selection of a specific datastream. The datastream names are automatically extracted from the Polar Bear^[2] repository as well as individual data files. This ensures that the hierarchy is always up to date. The user is thus able to select specific data stream, fold or expand the tree and possibly insert new data stream as read from data set. When selected the data stream appears as a new column in the shot sheet. Thumbnail images of trace and image data automatically appear.

Clicking on a thumbnail brings up an enlarged view of the image or trace. Basic distance and FWHM measurement are available on images, figure 4.

Additional functionality is due to be added including:-

- Allow data taken every few seconds through out the day to be plotted against shot data.
- Give statistical analysis of laser performance, beam wander etc.
- Improved image processing.
- Fully customizable displays for each user.
- Data extraction and Matlab compatibility.

The requirements were gathered across different laser facilities and Target Fabrication Unit and collated and hence applicable to Artemis, Vulcan and the Lasers for Science. It is expected that once the laser performance analysis and house-keeping is completed, components of user experiments data analysis such as interfaces to third party software packages and Storage Resource Broker (SRB), Polar Bear and ICAT, the data catalogue, will also be implemented, providing an integrated system for all CLF users.

For more information or if you wish to try the current system, please contact Edwin Divall (edwin.divall@stfc.ac.uk).

References

1. Laser Performance Analysis Requirements*
2. Managing Metadata for Astra Gemini. CLF Annual Report 2008, p216.
3. e-Infrastructure*
4. eCAT implementation plan*
5. eCLF Roadmap*

*Repository:- <http://www.e-science.stfc.ac.uk/projects/CLFeInfrastructure/>