DARB: An Automated System for Diagnostic handling, Analysis, Review and Backup of Laser Plasma Experimental Data

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Introduction

The data generated from intense laser-plasma experiments is in many ways an extremely valuable commodity. A single shot on a CLF laser system is the culmination of years of work from facility staff, months of planning by experimenters and weeks of work setting up the experiment. Good experimental results can confirm or transform our understanding of laser-plasma interactions and lead to wide reaching scientific and societal impact. With this also naturally follows a pressure for quality, for novelty and for efficiency that comes with any significant investment of capital and people. We therefore have a responsibility to ensure that experimental data is stored and analysed efficiently and backed up safely. In addition, if labour-intensive data handling methodologies are replaced by automated methods then more time is made available for researchers to conduct analysis during experimental campaigns, which would ideally lead to improved outcomes. Furthermore, recent policy changes by major UK funding councils places an expectation that UK-funded research data be publically accessible. To meet both the letter and spirit of this obligation a more standardized approach to data handling which includes for example a naming convention should be taken.

In an effort to address each of these concerns a software package called DARB (Diagnostics, Analysis, Review and Backup) was developed at Strathclyde in collaboration with the Central Laser Facility.

Overview of DARB

DARB consists of three main components (1) a target area client (2) a control room user interface and server, and (3) a data visualization package. These components are primarily programmed in C#, python (also a C# version available) and

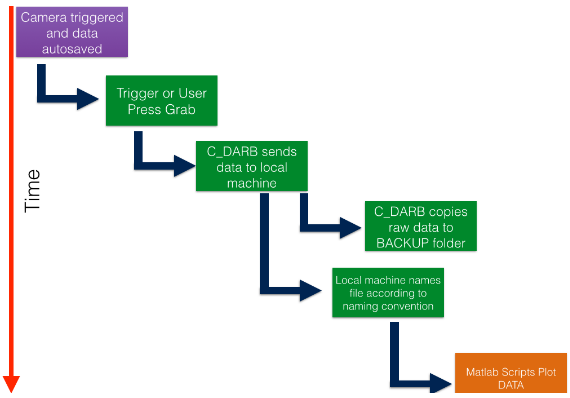

Figure 1: Simple waterfall model of data flow through DARB.

MATLAB, respectively. The flow of data through DARB occurs in the following way (also shown in Figure 1). Immediately after a laser shot the user (or a trigger if it is in the fully automated mode) instructs DARB via the user interface (UI) layer to grab data from the target area diagnostics. In sequential order the server then contacts each of the DARB clients which are running on diagnostic PCs connected to detectors in the target area (CCD cameras, spectrometers etc.). The DARB client then checks the predefined data directory (to which a given detector will autosave data) for the latest file. This file is then transferred to the DARB server. Based on the current data and overall shot number for the experiment the DARB server creates a shot folder using a “ddmmyyyy_shot” format. Likewise, each transferred file is renamed with a “ddmmyyy_shot_diagnostic” format where the “diagnostic” is a predefined diagnostic name. For data integrity all file transfers are checked against a list of previously transferred files to avoid duplication and users are warned if any duplication is found. Actions including transfers, folder creation and file renaming are logged and dated.

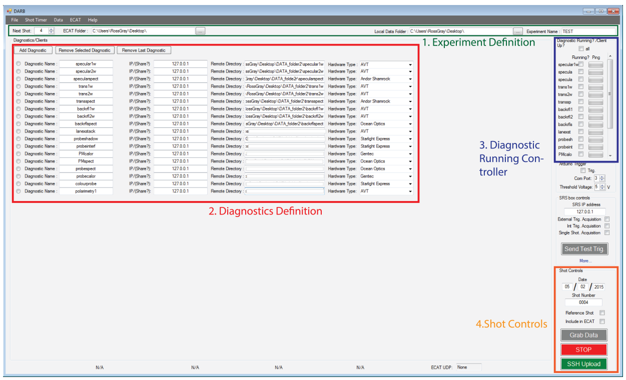

Figure 2: DARB user interface. (1) Definition of the experiment name and data folder (2) Definition of diagnostic name, client IP address, and remote data directory (3) Activation of diagnostic and ping of remote client (4) Grab data command.

Once the file transfer process is completed a script running in MATLAB listening for changes in the main data directory is initiated. Based on the contents of data in the latest shot folder user defined analysis scripts are applied to the data and this is displayed. Files and analysis scripts are associated with each other via the plain text “_diagnostic” section of the data file name. Finally, the analysis is displayed on screen and is also automatically saved into the data folder for inclusion in basic data summaries. In addition to basic steps covered here there are a large number of sub-processes, which are covered in the user manual.

Advanced & Future Features of DARB

As DARB has developed, in addition to the core server-client data transfer system some useful subsystems have been added and more are in development. One of the subsystems currently included with the code is a control interface for remote control of an SRS-DG645 delay generator. This enables the user, over a local network, to command and control the delay generator to send test triggers to diagnostics inside the target area and also automatically trigger (post shot) DARB to grab data. For similar purposes, an interface for an Arduino controller has been included as a subsystem in the code. On the Arduino side a laser trigger is connected, the trigger signal voltage is measured by the board and communicated to DARB. If the measured voltage is above a user set threshold voltage DARB will trigger and grab data. Both of these subsystems enable a fully hands-off automation of data collection and analysis during long runs of experiment laser shots.

There are a number of future developments scheduled for DARB, driven by the collaboration with the CLF. In particular, a subsystem that will interact closely with ECAT is under development. This will explicitly associate user entered diagnostic and shot metadata with experimental data and transfer to an ECAT standard format and upload to the ECAT system. This will be in place for end of financial year 2015/16.

Conclusions

In summary, through a collaboration between the University of Strathclyde and the CLF an automated system for storing, analyzing, visualizing and backing up data produced during laser-plasma experiments has been developed. This current version is able to operate in a fully hands-off mode enabling researchers to transfer effort from labour intensive data registration to data analysis, ideally improving scientific outcomes for laser-plasma experiments. This project is an ongoing development with further features to be added in the future.

Acknowledgements

We acknowledge the support of Central Laser Facility staff.
This work is supported by EPSRC grant EP/J003832/1.