Evaluation of a Collaborative Networking Environment for Experimental Configurations

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1. Abstract

A three-dimensional model of the OMEGA Target Chamber that was developed for web-based services to emulate interaction with large-scale laser facilities, specifically the OMEGA laser facility, has been improved upon to incorporate more collaborative options for the users. This design was created with the purpose of allowing users of the OMEGA laser system to collaborate in an interactive and visually intuitive environment to set up experimental configurations. Work has been done to increase the network collaborative capabilities of the web-based service to include tools that allow users to directly interact with one another in a real-time situation. Users can interact with the Target Chamber, by toggling diagnostics and Ten-Inch Manipulators. Users can also interact with other online users by sending messages or even watching the actions of another user in real-time. The three-dimensional virtual model of the OMEGA Target Chamber was expanded upon for use as an interactive platform for configuration creation and display as an alternative to the traditional text-based proposal tools.

2. Introduction

At the Laboratory for Laser Energetics (LLE) research proposals and setups are designed to be used for testing on the OMEGA laser system. Currently, scientists use a text-based method of campaign management and design proposal. This poses a few problems: first, the users cannot easily access information relevant to the laser system or current setup or quickly communicate with each other and relevant specialists, and second, the researchers can't easily and visually view the current setups to evaluate additional options. Additionally, researchers from facilities other than LLE who wish to use the laser facility for their own purposes have to use a system that isn't the most user friendly. To help solve these problems, a sophisticated three-dimensional (3D) diagnostic, a laser semantic model of the 60-beam OMEGA laser system, has been created[1] and developed since. It aims to provide a straightforward and easier way to set up and communicate work and projects that use the laser system. This program's functionality isn't just in the third dimension; it has many visually hidden aspects that make up the heart of the program. In addition to showing what the laser system looks like, the program can relate information from projects and setups to a user's preference. Users can therefore work on experimental setups by viewing and adjusting settings for diagnostics, the target chamber's tools for data gathering and analysis [Figure 1]. This program, named SILICON (simulation of laser operations through collaborative networking), has been improved upon to work better with the collaborative aspects of shot design and discussion.

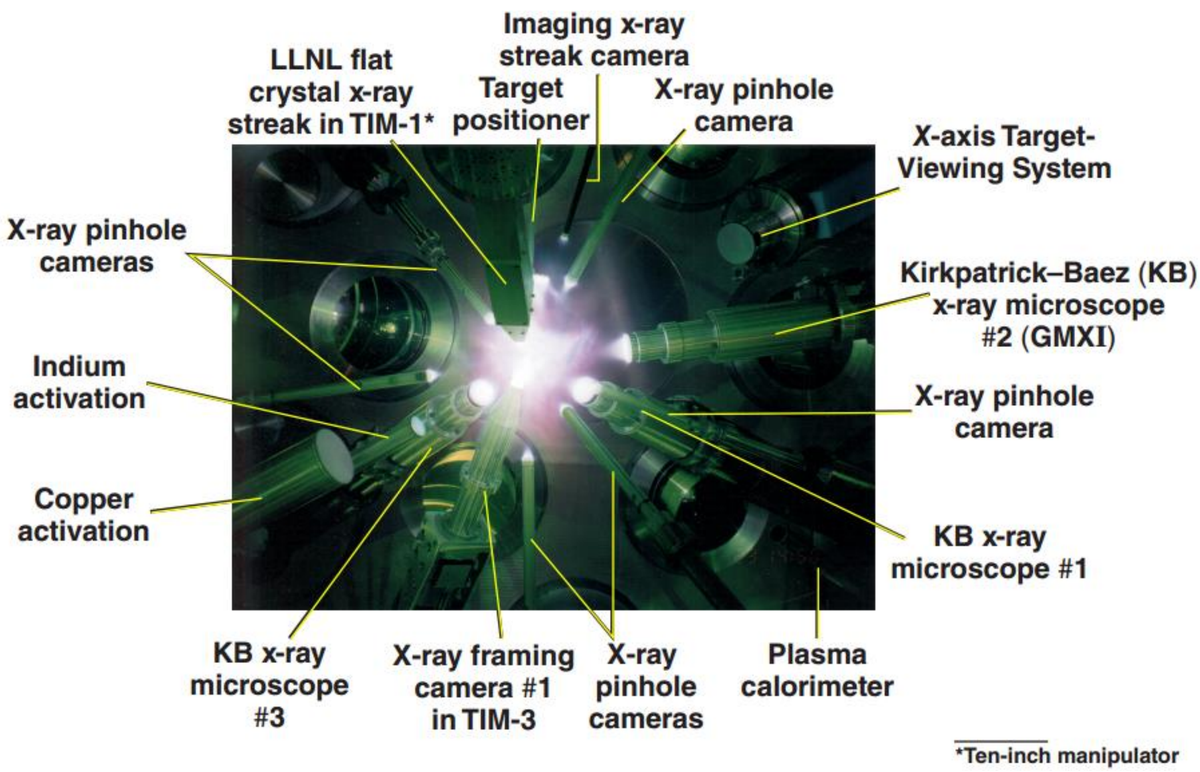

Figure 1: Typical selection of diagnostics on the 60-beam OMEGA target chamber. The target chamber also uses Ten-Inch Manipulators (TIMs), which allow for the insertion of a variety of different diagnostics in the vacuum chamber that are specific to certain shots and research aims.

3. SILICON

The interactive model of the target chamber has been created using JavaScript APIs (application program interfaces) including WebGL and three.js. These allow the rendering of 3D graphics, specifically interactive ones, in common internet browsers. This allows the creation of a more user-friendly program that doesn't require installation or setup by the user while remaining freely expandable. Since WebGL is based on OpenGL, which is a cross-platform API that implements shaders to generate 3D graphics, better looking and performing 3D environments can be created for the program.[2] WebGL differs from Canvas (another browser-based renderer) in that it is more focused on and optimized for 3D rendering instead of 2D rendering.

The usage of an ontology also allows for an expanded range of possible features. An ontology is essentially a web of data that is based on the properties of and relationships between objects. An ontology uses subjects and predicates, which are the objects and the links between them[3] [Figure 2]. Because an ontology can relate many properties together, this web-like data can be used to

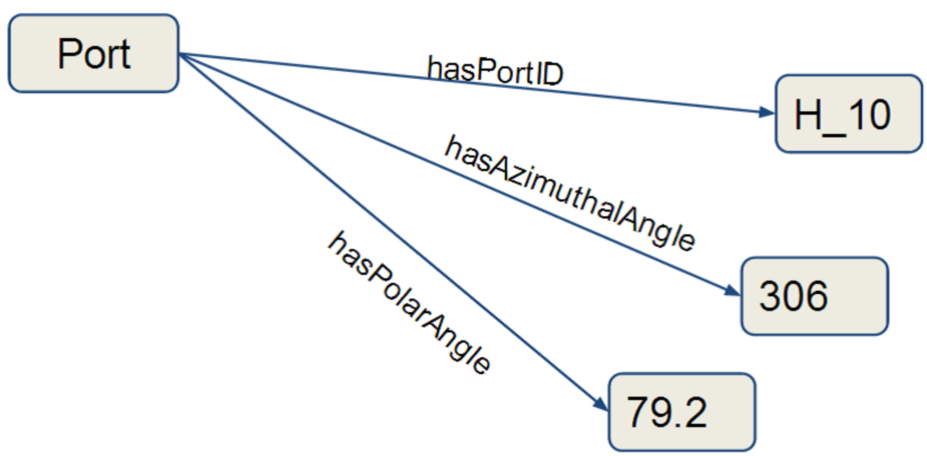

Figure 2: Illustration of how data is linked in an ontology by properties. Relationships are represented by the subject and predicate system. Shown here, the "Port" object has three properties: hasPortID, hasAzimuthalAngle, and hasPolarAngle. These properties contain values which can be used by the program to render, process, or obtain information.

infer relationships to gather relevant data more easily. Inferencing can be done based on a set of predefined rules; in SILICON's ontology OWL rules (the standards of languages for ontology mapping) are used. For example, the identification of a user could be used to find his or her relevant campaigns and the research proposals associated with them, which, in turn, could be used to find the specifics of that setup and other people who are either associated with it or that person (who could then be used to access more setups, and so on).

4. Node.js

Since the target chamber model had to be able to support multiple users connected at the same time with communication between both other users and the program itself, Node.js was selected as the base for the collaborative aspects. Node.js is an event-driven JavaScript API that has included extension support. It was selected because it is able to process multiple inputs simultaneously and separately from each other in a way that allows for unrestricted communication (that is, without causing the inputs to impede the function of other inputs both from the same user and others) and future expandability. Node.js was also selected because it is based on JavaScript, which was what much of the program was written in, allowing for an easier integration with the existing code. Node.js is event-driven [Figure 3], which means

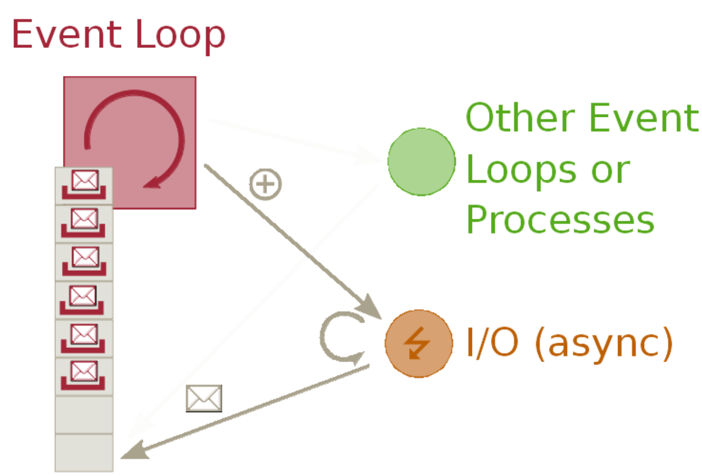

Figure 3: Visual example of how Node.js operates with an event loop. This allows inputs and output to be processed separately from the rest of execution while still allowing other processes to be dealt with.
Source: http://bert.github.io/

that when an input is received it is processed separately from the rest of the code execution, which allows for decreased hang-up in requests from multiple sources and also allows those same requests to be processed more quickly. Node.js also has its own built-in extension support so, since it is already part of the community of JavaScript APIs, it has a large range of future possibilities.[4] Of Node.js's many extensions, socket.io was chosen as the main network interface for Node.js, which, using Node.js's event-driven approach, allows for a real-time communication to be set up between multiple clients and a server. Using both Node.js and socket.io, the program was modified to allow real-time communication and collaboration so users could both chat with each other and view, load, and modify configurations.

5. Capabilities

The creation of a program such as SILICON requires certain capabilities to be met, such as an easy to use interface and the ability to view configurations. The configuration information is retrieved for each user, so someone can easily log in and see the current available projects that he or she is associated with. The interactive model has been constructed so that users can interact with campaigns and the selected diagnostics, as well as the current beam layouts [Figure 4]. The ability to visualize the beam layouts of the current configuration is one of the core functionalities in SILICON, providing users with visual feedback before

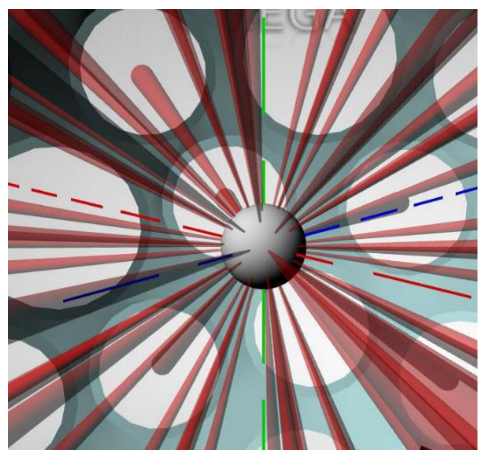

Figure 4: Laser beam pointings seen focused on a center target, which allows for users to more easily see and predict how the target will be hit by the lasers and how it may react.

extensive testing is done. This allows researchers to visualize their setups and is intended to assist in the reviewing of those setups before shots are done on the laser system itself. The diagnostics that are selected for use and the ports of the target chamber are also noted in the program so users can see which ones are used in the current configuration [Figure 5]. This can help them see where a diagnostic will be pointing on a target, especially with the usage of the three dimensional models of the diagnostics and other instrumentation associated with the OMEGA laser system. The application also provides a way for users to modify the current setup, allowing for the toggling of active diagnostics on and off [Figure 6]. In addition, a chat interface has been provided to allow people who are working together on the same setup to discuss options for the configuration of shots while looking at the setup itself. This chat feature also allows for users to view the temporary, or unsaved, setups of other users on the same configuration before decisions are made for the final

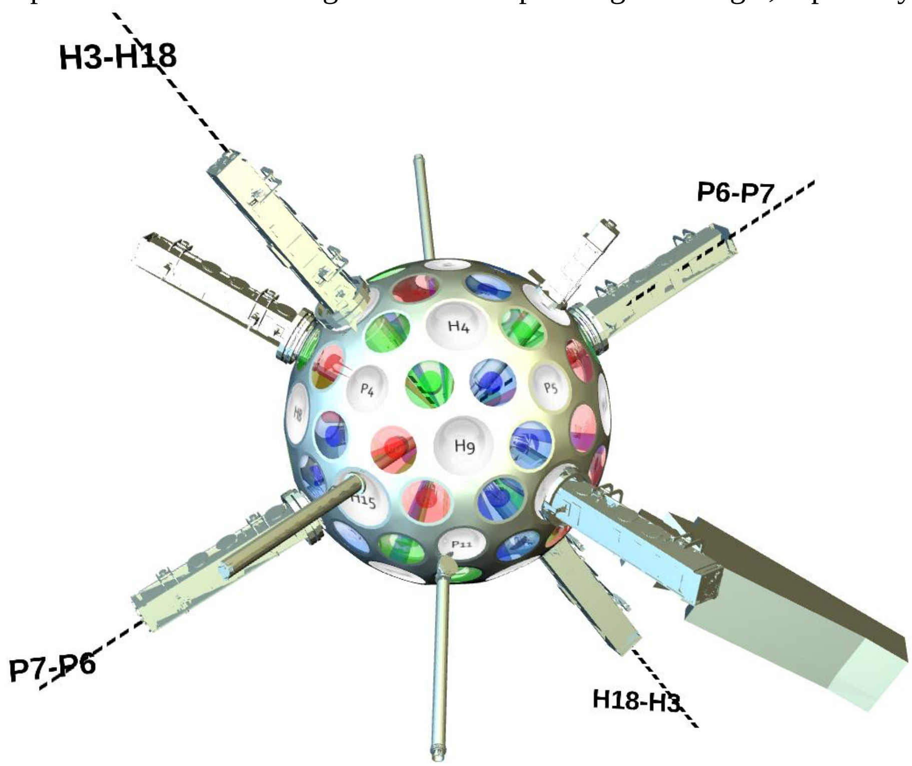

Figure 5: Sample view of SILICON. The 3D models of the target chamber and the diagnostics allow the visualization of the ones that are active and where they are pointing. The ports of both the diagnostics and lasers are labeled (although in this figure, the laser ports have been set transparent, which is another feature available to researchers using the program).

setup or to specify a certain area or subject, since the viewers can also see the current camera location and other aesthetic options in the application of the person being viewed.

6. Future Plans

Because of the need to have an easier to use configuration creation tool, the 60-beam OMEGA laser target chamber model has been developed. The program is planned to be used alongside, and eventually instead of, the current system of campaign creation and modification [Figure 7]. Work is also planned to fully integrate the program with the ontology database of configuration data so that it will become a useful tool for people who wish to use the OMEGA laser facility. The program will be able to load and save temporary files, that is, setups that a user creates before a version is finalized and then used for research. It is intended for this program to provide visual feedback and collaboration between users so that experiments can be set up more quickly in an easier and more user-friendly manner. The program also aims to provide an easy method of communication between instrument specialists (people who work with certain diagnostics or the laser system in general) and those who use the OMEGA system for research.

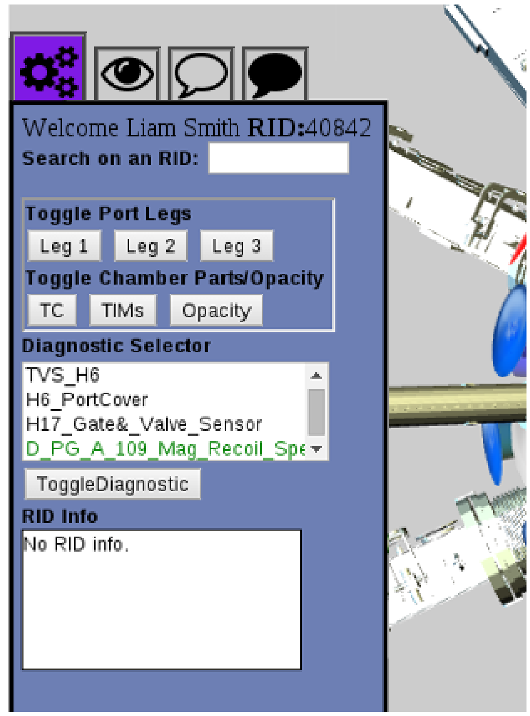

Figure 6: The current user interface of SILICON. The program allows users to turn diagnostics on and off as well as make aesthetic changes that make it easier to see parts of the target chamber. Additional options are available to allow users to select setups and chat with others.

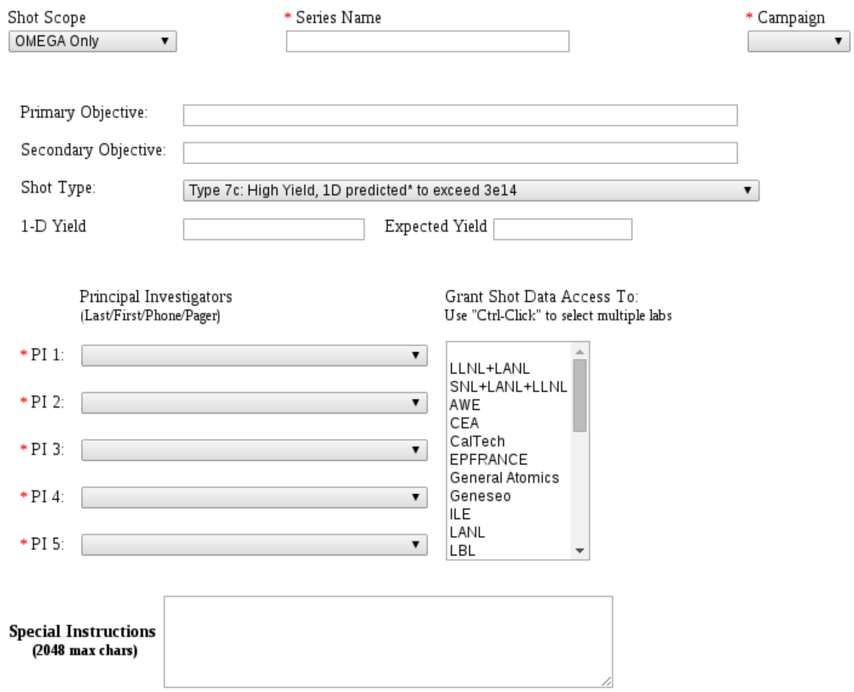

Figure 7: Currently, text-based shot request forms (SRFs) are used to set up or create plans for shots on the OMEGA laser system.

7. Conclusion

Work has been done on the 3D interactive model of the 60-beam OMEGA target chamber to create a better collaborative work environment at LLE. Visual interfaces with collaborative tools, like the one discussed here, are very helpful for researchers because they provide a research-oriented and specialized approach with an easy to use structure. This interactive model has multiple advantages when compared to the typical text-based forms of setup and data manipulation. The interactive environment developed further by this work increases the collaborative opportunities provided. SILICON is now able to establish and process both peer-to-peer and peer-to-server network connections for real-time communication. This allows the program to have both direct communication between users, such as messaging through a chat system, and data transfer between a central entity and the users, such as configuration retrieval. Additionally, SILICON's new collaborative networking capabilities have been designed as a base for future network communication of varying degrees. This means that it has been set up so that new types of information can be sent through pre-established connections by using existing code. This research demonstrates not only a simpler and more efficient way of OMEGA shot planning and coordination but also a more accurate and informed one, as it aims to provide communication between instrument specialists and those who may be new to the OMEGA system.

6. Acknowledgements

This work could not have been completed without the help of Mr. Richard Kidder and some of his fellow workers, especially Randy Holderried and Raul Pasols. Mr. Kidder helped organize the project and gave guidance towards the intended functionality of the program while giving me the freedom to develop my own ideas. Randy Holderried assisted me in setting up my work and helping me get to know the program's functionalities and preexisting state and Raul Pasols taught me the details of the ontology and database systems.

7. References

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