FEL Performance Plots

NATIONAL ACCELERATOR LABORATORY

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Introduction

It is of great importance for LCLS users to be aware and informed of the free electron laser's performance when altering various parameters since these changes can affect their own runs. LCLS pulse intensity will vary week to week and can be affected by other beam parameters such as election energy, electron bunch length, and electron beam charge. Knowing the restrictions and bounds that are necessary for their own experiment, a user may ask for the expected pulse intensity given these three predetermined parameters. It would be useful to estimate the expected pulse intensity based on the other three parameters.

Keywords: free electron laser, performance, pulse intensity

Research

Background

Figure 1: A screenshot of the control room LCLS summary display. Here, one can see how the FEL performs when certain parameters are varied.

The FEL can operate within the energy ranges of 280 eV and 11.2 keV. Resulting pulse intensities vary accordingly between 1 - 3 mJ. Further details and technical capabilities of proposed experiments depend on the available LCSL instruments. Each instrument is unique in creating the necessary environment for a particular experiment.

While LCLS is in operation, data about the energy, peak current, electron bunch length, pulse intensity and electron beam charge at different time intervals is recorded.

Goal: Show FEL performance that is dependent on four parameters including time.

LCLS operates in "run" periods. In between runs it undergoes maintenance and upgrades, so it is reasonable to allow users to access data when it is grouped by runs. Furthermore, users request a certain electron beam charge during their laser beam time so data is then binned by this parameter.
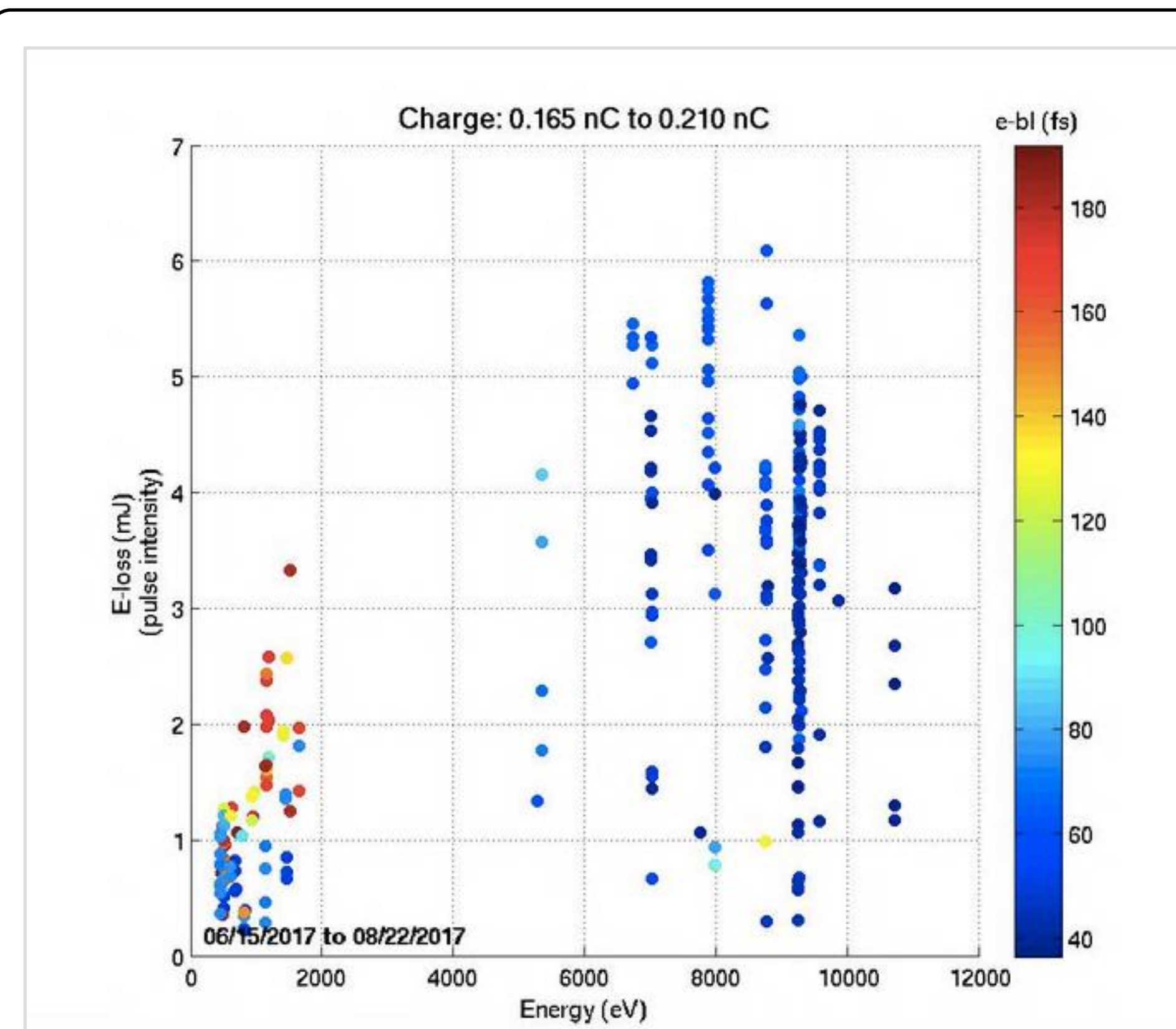

Figure 2: An example of data plotted from the current run, Run 15. Data is binned into four separate bins by charge (0.165 nC to 0.210 nC in this particular graph). The color of each point reflects the electron bunch length (fs) at a specific energy (eV) and intensity (mJ).
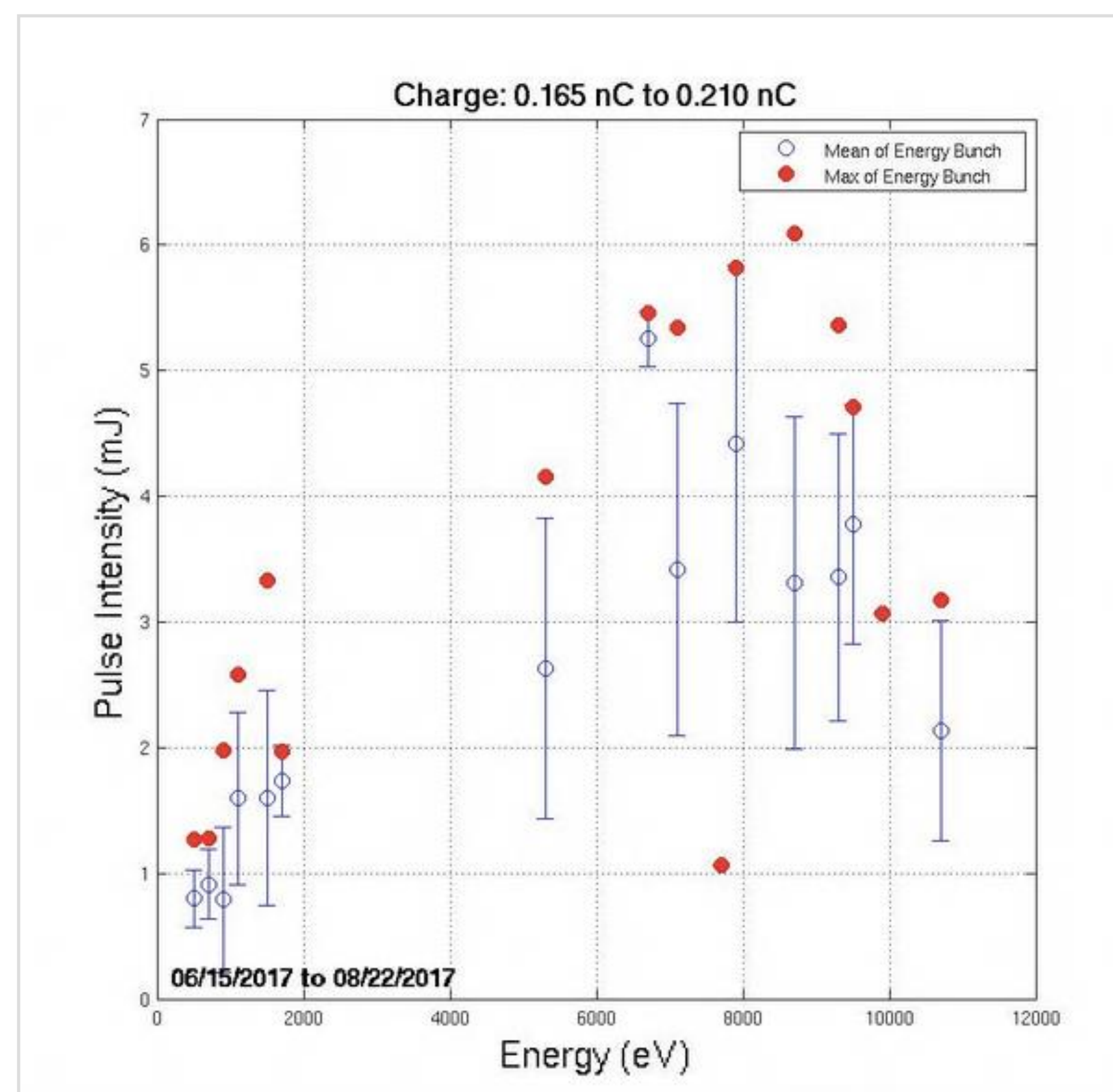

Figure 3: In the following plot, data is first binned by charge then energy (bin length is 200 eV). Users are shown the mean and maximum pulse intensity for each energy bunch. One standard deviation from the mean is also shown.

Figure 2 and Figure 3 allow users to observe the trend in pulse intensity when altering other parameters. Users are now able to access this information and go through all the data up to the very first run.
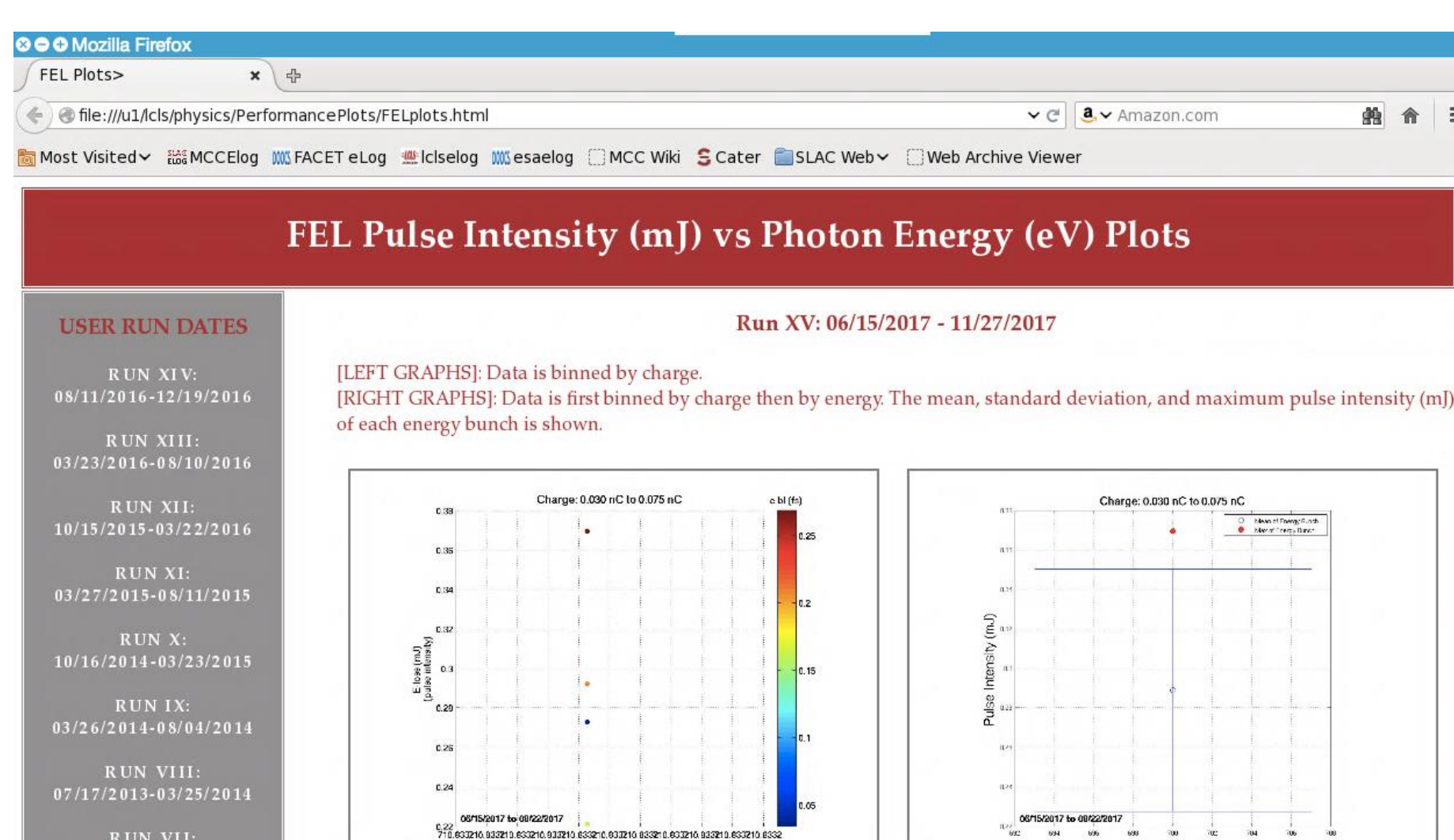

Figure 4: Screen shot of the web page presenting all plots, organized by successive run periods.

The second part of this project incorporates google charts to create plots with range sliders that the user can interact with. Users are able to select the ranges of parameters that interest them.
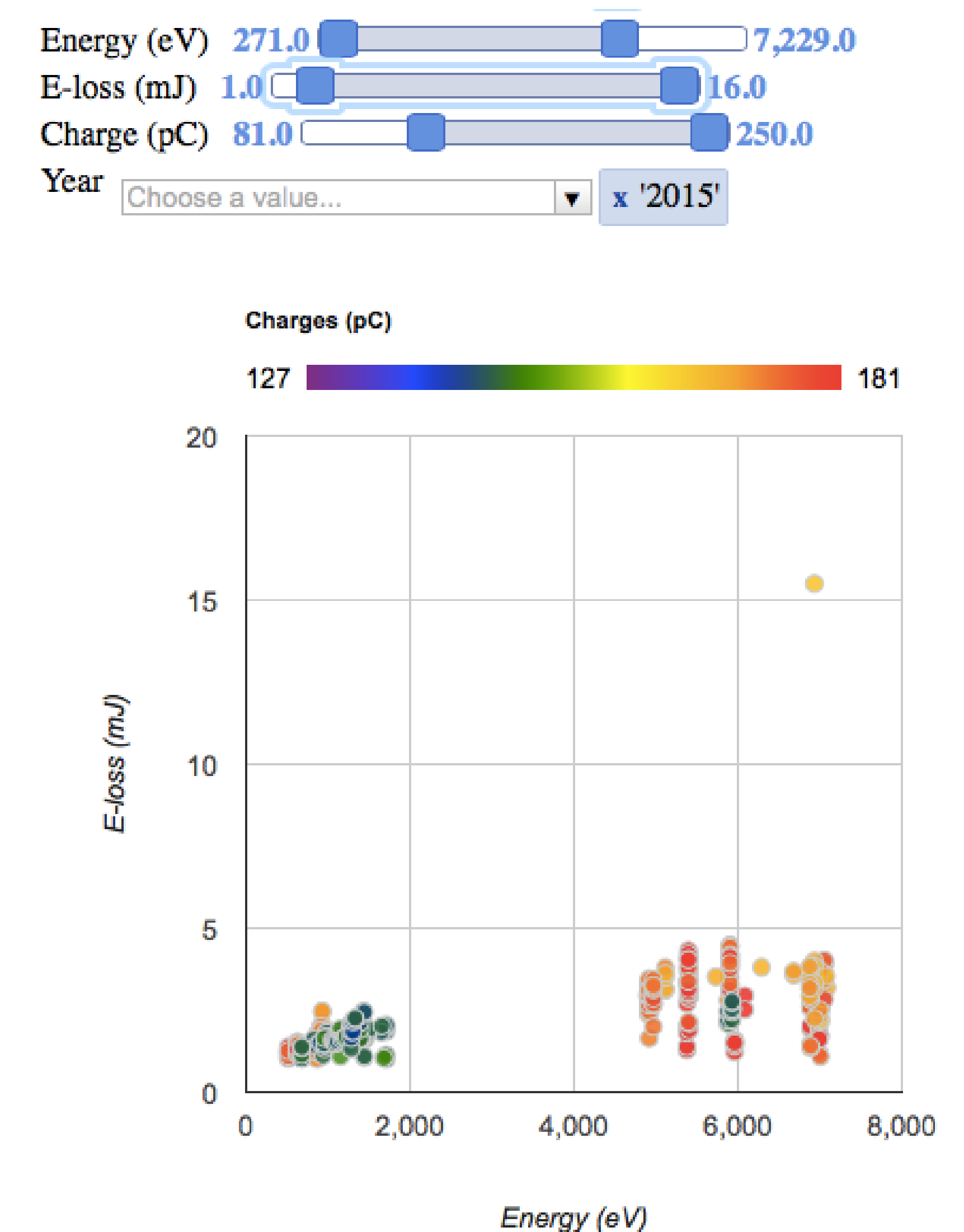

Figure 4: In the following plot, users are able to choose the range of energy, pulse intensity, charge, and year of the data they want to see plotted.

Conclusions

It is important for users to have access to information about the free electron laser's performance. This information may strongly affect how they choose to run their own experiments. The plots presented here are fairly specific and can certainly be altered. For instance the size of energy and charge bins can be changed. Furthermore, as there are multiple parameters to consider, different graphs can be created that present more (or less) parameters but give a better presentation of data depending on what users find most important to know.

In the future, it would be helpful if a similar analysis is done for experiments run on LCLS II when it begins operating.

Acknowledgments

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