**Experiment Automator Documentation**

**Usage Summary**

Experiment Automator is intended for use as an experiment automation tool. The user loads previously prepared text files into the application. The one required input is a *Scan Table.* Optional documents include a *PV Acquisition List*, a *Probe Acquisition List* and a *Bound Monitor Table*.

Once the documents are chosen, the user must click initialize to load and parse them; this marks the beginning of an experiment. The user may then start the program, which will iterate through the Scan Table, setting values and recording data according to the Acquisition Lists.

Optionally, the user can select to use the machine model to simulate the beam. If either *Record Model Probe* or *Probe Scan* is selected, Experiment Automator will initialize a machine model based on the selected accelerator sequence (more details on accelerator models and sequences can be found in ???).

The program operates by iterating through a number of steps. Each step consists of 3 phases: In the set phase, the values in the current line of the scan table are sent to their respective PVs through XAL’s Java Channel Access (JCA). In the case of a Probe Scan, the new beam parameters are applied to the model and the model is re-synchronized and run. In the threshold phase, Experiment Automator checks thresholds (section ???) and absolute bounds (section ???). In the acquisition phase, each PV in the acquisition list is read through JCA. If probe acquisition is used, the machine model will be re-synchronized and the Twiss parameters will be recorded at the nodes specified in the probe acquisition file.

The acquired data can be saved to a CSV file at any point in the experiment.

**Scans**

A scan table is the text-based document that dictates the machine settings to be used at each step in the experiment. In an *Element Scan*, the settings are PV values. In a *Probe Scan*, the settings are initial beam parameters used in the model. Each of the scan tables must be prepared according to a specific format described below.

 **Element scan**

The element scan table is contains 4 initial lines of PV and Threshold information. Lines 5 and onwards dictate the actual machine settings.

Line 1: PV names in the format “EGUN:SOL1:CUR”

Line 2: The name of the PV to be compared to before allowing the experiment to progress. For example “EGUN:SOL1:RDCUR”. If no checking is desired, use EMPTY.

Line 3: The quantity used to compare the set and comparison channels.

Line 4: The method used to compare the set and comparison channels. One of either DIFFERENCE or RATIO.

Line 5+: Values as integers (5), decimals(5.5), or exponential notation (5e+10). If it is desired that no new setting be sent to the machine, use the string “SKIP”.

**Threshold Checking**

To enable threshold checking, the user must include the lines 2-4 described above. Currently these lines must always be included, even if threshold checking is not desired. If this is the case enter EMPTY as the PV name on line 2. As a step of the program is executed, the values will be applied to the machine. Once the setpoint values are applied, the readback values are acquired. These readback values are compared to the setpoint values, each either by an absolute comparison ((set – read) > threshold) or by a relative comparison ((set – read)/set > threshold). If all the conditions are not met, the program pauses for a user-set delay time, then reads and checks again (see section “delay time”???). Only when all conditions are met does the program record the readback values and continue executing.

 **Probe Scan**

In progress

 **Acquisition**

 **PV Acquisition**

In the acquisition phase of each step, Experiment Automator will read the values of all PVs listed in the PV Acquisition List. PVs are listed in the form “EGUN:SOL1:RDCUR” separated by any whitespace. At each step the acquired values are stored n a table. When the “Save Data” button is pressed, the table is stored to a file. (Data display in progress).

EXAMPLE

 **Probe Acquisition**

In progress

 **Bound Monitoring**

At the threshold checking phase of each step, it is also possible to ensure a PV value is within a certain range by including a Bound Monitor Table. Each column contains the PV name to check in the form “EGUN:SOL1:RDCUR”, an upper bound, and a lower bound.

EXAMPLE

 **Delay Time**

To execute a step, the Automator uses three delay times, each set by the user.

1. Set values from element scan table

2. Delay #1

3. Check threshold and bound

 If fail, delay #2, repeat phase 3

If pass, delay #3, continue

5. Record values from readback PVs and end step

If the threshold values are re-checked many times in a row (defined by the user) without converging, the experiment is paused and an alert is shown.

 **Buttons**

The functionality of each button is described below. The tooltips give a brief description as well.

*Initialize*

 This begins an experiment. The scan and acquisition documents are read from their files and stored in memory. Any changes to the documents are ignored until re-initialization. The connections to the element scan PVs are checked and their initial values are recorded.

*Start*

This begins the experiment and executes sequential steps. Once the program is paused it can be resumed with this button.

*Pause*

This interrupts the experiment temporarily. A signal is sent to the program which will pause at the end of the currently executing step.

*Step Forward*

This executes a single step and then pauses the program.

*Skip Step*

This skips the current step. Useful for a non-convergent threshold if the user decides to allow the program continue.

*Save Data*

This writes the currently recorded data to the disc in the form of a csv file. The file is stored in the same location as the scan table, and the filename is based off the scan table name and the time the experiment was initialized.

*Save State & Load State*

Save State records all the current values of the setpoints in the element scan table. Load State sets the machine to these saved values. This can be used if the user wishes to return to the pre-experiment state of the machine.

Selecting a Sequence

 Experiment Automator inherits the behavior of an Accelerator Document as well as its accelerator sequence selection. A sequence must be selected to initialize an experiment.

 Reference to XAL

TODO:

Updated columns information for element scan table