

Muon Lifetime Experiment MATLAB Script Documentation

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This contains a brief set of instructions for using `LeCroy_Muon_Recorder.m` to automatically collect data for the Muon Lifetime experiment.

I. INTRODUCTION

The MATLAB script `LeCroy_Muon_Recorder.m` has been provided to aid in data collection for the Muon Lifetime experiment. The LeCroy 9310 oscilloscope, photomultiplier power supply, and signal discriminator must be powered on and set to the desired settings before running `LeCroy_Muon_Recorder.m`. Be sure that the electronics are connected properly.

II. DESCRIPTION AND USAGE

The `LeCroy_Muon_Recorder.m` script is a self-contained file in `C:\Users\physics4life\Documents\MATLAB`. While running the script in MATLAB, the computer will periodically query the oscilloscope status and record the data for each new sweep as it arrives. `LeCroy_Muon_Recorder.m` will stop once the target number of sweeps has been reached or if the user chooses to terminate the script at any time by pressing `Ctrl+C`.

After collecting the data for each new sweep, MATLAB will save a `.csv` file containing the time and voltage signal for each sweep (for analysis and reconstructing the oscilloscope display). In addition, a plot of each sweep (as it appears on the oscilloscope display) is generated and saved as a `.png` file. Furthermore, a record of the MATLAB console display will be saved as a text file using the `diary` function. These output files are saved in the following directories:

- Data `.csv` file
`[User-Directory]\YYYY-MM-DD-HHMMSS_Data`
- Plots `.png` file
`[User-Directory]\YYYY-MM-DD-HHMMSS_Plots`
- Console `.txt` file
`[User-Directory]\YYYY-MM-DD-HHMMSS_Data`

where `[User-Directory]` is a user-defined directory. If the above directories do not exist, then they will be automatically created when needed. Data and plot output files follow the naming convention `Data_%08d.csv` and `Plot_%08d.png`, respectively, where the `d` denotes the current sweep number.

A. General MATLAB Syntax

The only required input for `LeCroy_Muon_Recorder.m` is `TargetSweeps`, which is the total number of sweeps to collect in the run. To run the script in MATLAB, enter the following in the command window.

```
>> LeCroy_Muon_Recorder( TargetSweeps );
```

where `TargetSweeps` should be replaced by any user-defined number of sweeps to be collected. For instance, entering the following into the console will run `LeCroy_Muon_Recorder.m` with `TargetSweeps = 586`:

```
>> LeCroy_Muon_Recorder( 586 );
```

Name	Constraints	Default Value	Description
ClearSweeps	Logical (1 or 0)	1	Indicates if sweep counter should be zeroed before collecting data.
LogName	Char. Array	'Console_Display.txt'	Filename of console window text dump. The log file will only be saved if DataCode = 1.
DataCode	Logical	1	Indicates if collected data will be written to a text file and saved to disk. This also indicates if the console log file will be generated and saved to the same folder.
PlotCode	Logical	1	Indicates if plots of collected data will be saved to disk. If SaveFolder = 0, then the corresponding folder to store plots will not be created.
DebugCode	Logical	1	Indicates if "Debug Mode" will be entered. In this mode, the oscilloscope readout will be printed in the command window. This is useful for troubleshooting purposes.
SaveFolder	Char. Array	' ' (Empty string)	Name of output directory (usually the experimenters' names), which was denoted as [User-Directory] earlier. All output directories can be found in C:\Student_Directories. If SaveFolder = ' ' (an empty string, its default value), then a MATLAB UI window will prompt the user to pick a destination folder.
MaxChar	Positive Integer	1000	Maximum number of character entries to expect from each oscilloscope response (1000 is more than enough).
Pause	Positive Real	3	Amount of seconds to wait before each oscilloscope query.
OverTime	Positive Real	3600	Amount of seconds to wait before oscilloscope readouts are automatically displayed on screen. This is convenient for troubleshooting purposes in case the code hangs or oscilloscope malfunctions.

TABLE I. Summary of optional parameters for `LeCroy_Muon_Recorder.m`

B. Optional Name-Value Parameters

`LeCroy_Muon_Recorder.m` also admits a number of optional parameters in name-value pair format. These optional parameters can be set by using the following generalized syntax:

```
>> LeCroy_Muon_Recorder( TargetSweeps, <Optional Name-Value Parameters Here> );
```

All optional parameters that are not defined will adopt their indicated default values. Table I summarizes the various optional parameters and their purpose.

C. Example Syntax with Optional Parameters

The following examples illustrate the use of name-value optional parameters:

```
>> LeCroy_Muon_Recorder( 300, 'ClearSweeps', 0, 'SaveFolder', 'Somewhere294', 'Pause', 19 );
```

indicates the following:

- **TargetSweeps** = 300.
- **ClearSweeps** = 0, so the sweeps will not be cleared prior to starting data collection.
- **SaveFolder** = 'Somewhere294', so the complete path to the output directory is C:\Student_Directories\Somewhere294.

This implies that the data .csv files and plot .png files will be saved in the following directories:

```
C:\Student_Directories\Somewhere294\YYYY-MM-DD-HHMMSS_Data
C:\Student_Directories\Somewhere294\YYYY-MM-DD-HHMMSS_Plots
```

- Pause = 19, so the amount of delay time between consecutive oscilloscope queries is 19 seconds.
- All other parameters that are not explicitly defined will take on their default values.

Note that the optional parameters may be specified in any order, as long as they are written in name-value argument pairs. However, the first argument of `LeCroy_Muon_Recorder.m` *must* be the value for `TargetSweeps`.

```
>> LeCroy_Muon_Recorder( 1400, 'OverTime', 1800, 'MaxChar', 5000, 'SaveFolder', 'Folder912');
```

indicates the following:

- `TargetSweeps` = 1400.
- `OverTime` = 1800, so if more than 1800 seconds has elapsed since the last retrieved sweep, then the oscilloscope output will be printed on console.
- `MaxChar` = 5000, so the maximum number of characters to expect from the oscilloscope is 5000.
- `SaveFolder` = 'Folder912', so the complete path to the output directory is:
C:\Student_Directories\Folder912.

This implies that the data .csv files and plot .png files will be saved in the following directories:

```
C:\Student_Directories\Folder912\YYYY-MM-DD-HHMMSS_Data
C:\Student_Directories\Folder912\YYYY-MM-DD-HHMMSS_Plots
```

- All other parameters that are not explicitly defined will take on their default values.

D. Additional Comments

- Pressing `Ctrl`+`c` on the keyboard will prematurely terminate the script and safely disconnect the computer from the oscilloscope. Otherwise connection issues may arise, requiring a hard restart of the computer and/or oscilloscope. In the event that there is a communication error between the devices, try any of the following:
 - Abort the script with `Ctrl`+`c` and rerun the script
 - Restart MATLAB (make sure all MATLAB-related processes are killed) and rerun the script.
 - Restart MATLAB and power-cycle (power off and on) the oscilloscope. Then rerun the script.
 - Restart the computer and power-cycle the oscilloscope. Then rerun the script.
- `LeCroy_Muon_Recorder.m` uses methods/commands from the `inputParser` class, and will not work in MATLAB versions before R2007a. The code was written and tested in MATLAB R2014a.
- If the figure that is plotting the current sweep is closed before or during the saving process (being minimized, docked, or behind the active window is OK), then `LeCroy_Muon_Recorder.m` will throw a print error and attempt to safely exit.
- An informal log of changes in the script and known errors can be found in the comments embedded in the script. To view this, either open `LeCroy_Muon_Recorder.m` with any text editor or type `help LeCroy_Muon_Recorder` in the MATLAB console.

E. Additional Resources

The communication between the computer and the oscilloscope is made possible by ActiveDSO control drivers from Teledyne LeCroy. Refer to the following for details about the communication process:

- ActiveDSO Drivers and example scripts:
 - Local Install: C:\Program Files (x86)\LeCroy\ActiveDSO

- Web Drivers: <http://teledynelecroy.com/support/softwaredownload/activedso.aspx?capid=106>
- Remote Control Manual for LeCroy 9300 & LC Oscilloscopes
 - Local: C:\Users\physics4life\Documents\LeCroy_Documentation\lc_rcm_rev.pd
 - Web: http://cdn.teledynelecroy.com/files/manuals/lc_rcm_rev.pd
- LeCroy 9300C Series Digital Oscilloscope Operator's Manual:
 - Local: C:\Users\physics4life\Documents\LeCroy_Documentation\9300_om_reva.pd
 - Web: http://cdn.teledynelecroy.com/files/manuals/9300_om_reva.pd

III. FINAL REMARKS

LeCroy_Muon_Recorder.m is still a work in progress. The oscilloscope has a quirky behavior at times, leading to minute-long delays between communication or appending extraneous characters and/or symbols in its message to the computer. Many instances of these issues have been accounted for in the code, although new ones sporadically arise. Inform the TA or instructor if you suspect that something strange is happening while the script is running.

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