
felapps Documentation

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felapps Python package

felapps: FEL High-level Applications.

Install: pip install felapps

PDF documentation: [Download](#)

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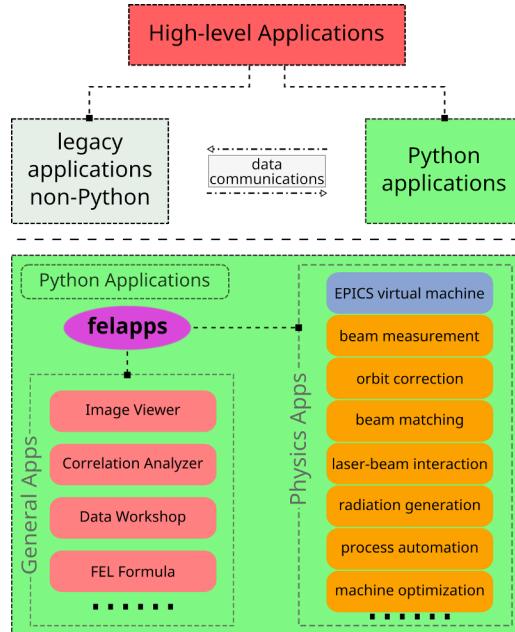
CHAPTER ONE

INTRODUCTION

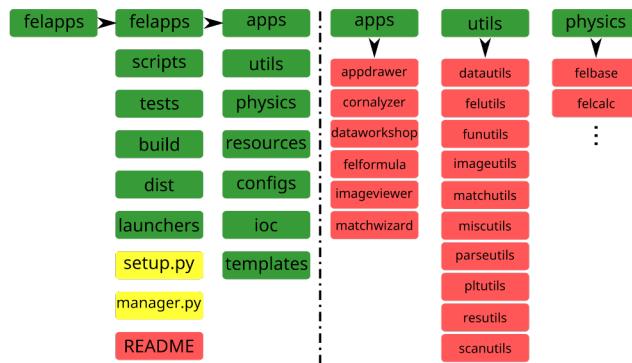
`felapps` is a Python package developed for the commissioning of free-electron laser facility, with the intention of providing useful tools for the high-level applications, both command line interface (CLI) and graphical user interface (GUI) are developed/under development.

The package name stands for “FEL High-level Applications”, the core building language is Python, of the version of 2.7.x. Since Python is a dynamic interpreted high-level language, pure object-oriented, various powerful third-party packages support, all of these great features make it possible to build software system in a real efficient way.

Below is the basic framework of `felapps`, general-purpose applications and specific-purpose applications are both included, specific-purpose applications mean physics-related, both LINAC and FEL physics.



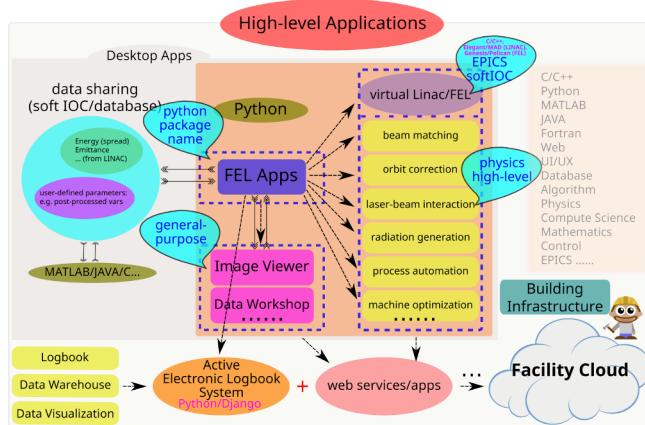
To make the package be well-organized, the source code is structured by the following style:



Building such Python-based software system requires much more effort to understanding the following key points (including but not limited to):

- potentially demandings of the FEL facility commissioning;
- software architecture of the system to be alike;
- comprehensive relationship between the lower-level control system and the high-level applications system;
- interfaces between various different layers;
- deployment of the entire software system;
- documentations;
- etc.

Picture of felapps



This the incubated picture of felapps package, which including *Desktop Apps* and *Web Apps* categories, also indicating the developing orientation, i.e. to take the advantages of Python, to build desktop apps to be an eco-system with bundle of well-defined APIs , to serve the web apps as service infrastructures, the ultimate goal should be a facility cloud with plenty of services that could be utilized by the facility, e.g. free-electron laser facility.

Specifically, in the beginning of such vision, Desktop Apps should be built, into which general-purpose and physics-related apps/classes/functions/methods should be integrated, just as the picture illustrates. As for the user, the deployment of felapps should be easy and robust. The future developing phase should

be web-based apps, to achieve such goal, the suggested beginning point should be the web-based log book, i.e. to develop an e-log web system by Python, incorporating the power from Python web-development community.

Progress of felapps

Up to now (2016.8), the ready-to-deploy/use apps from felapps are:

Graphical User Interface Apps

- appdrawer¹: alias: runfelapps, portal to reach other GUI apps;
- cornalyzer: parameters correlation analysis app;
- dataworkshop: data post-processing app, feeding the data generated by imageviewer's Auto Save operation module;
- felformula: efficient calculator for FEL physics;
- imageviewer: general-purpose profile/CCD monitor/DAQ app;
- latticeviewer²: lattice online modeling framework;
- wxmpv: (to be) general data plotting & processing app.

Command Line Interface Apps

- lte2json²: standardize the .lte file for Elegant simulation, i.e. convert .lte file to JSON string file;
- json2lte²: convert (valid) JSON string file to .lte file;
- update-felapps-menu: script of integrating felapps into system menu, as well as the reversed operation, i.e. uninstalling.

¹ App name that could be treated as the command name in the command line interface, to get the app running, the same rule applies to other apps.

² Python package beamline is required.

DEPLOYMENT

Deploy felapps to different operating systems is quite simple, both online and offline approaches are provided. Before installing this package into system, there may be packages/libraries dependence issues to be resolved first.

Prerequisites

Required Python packages: numpy, scipy, matplotlib, pyepics, h5py, pyrpn, beamline, lmfit, wxPython.

Packages with version information:

```
numpy      : 1.11.1
scipy      : 0.17.1
matplotlib : 1.5.1
pyepics    : 3.2.6
h5py       : 2.6.0
pyrpn      : 1.0.3
beamline   : 1.3.5
lmfit      : 0.9.3
wxPython   : 3.0.2.0
```

Note:

- wxPython should be built with unicode support
 - Install them by pip install <package_name> (recommended)
-

Installation

Online approach

```
pip install felapps --prefix=/opt/high-level-apps -i https://pypi.python.org/pypi
```

or precisely define the version number:

```
pip install felapps==1.5.13 --prefix=/opt/high-level-apps -i https://pypi.python.org/pypi
```

Offline approach

Download felapps from PyPI.

```
pip install felapps-1.5.13-py2.py3-none-any.whl --prefix=/opt/high-level-apps
```

Note:

- root privilege may be asked.
-

Warning: After installing felapps, the following command may need to be executed: su -c 'sed -i "s|/usr/bin/python|/usr/local/bin/python|" /opt/high-level-apps/bin/*'

Configurations

Environmental Variables

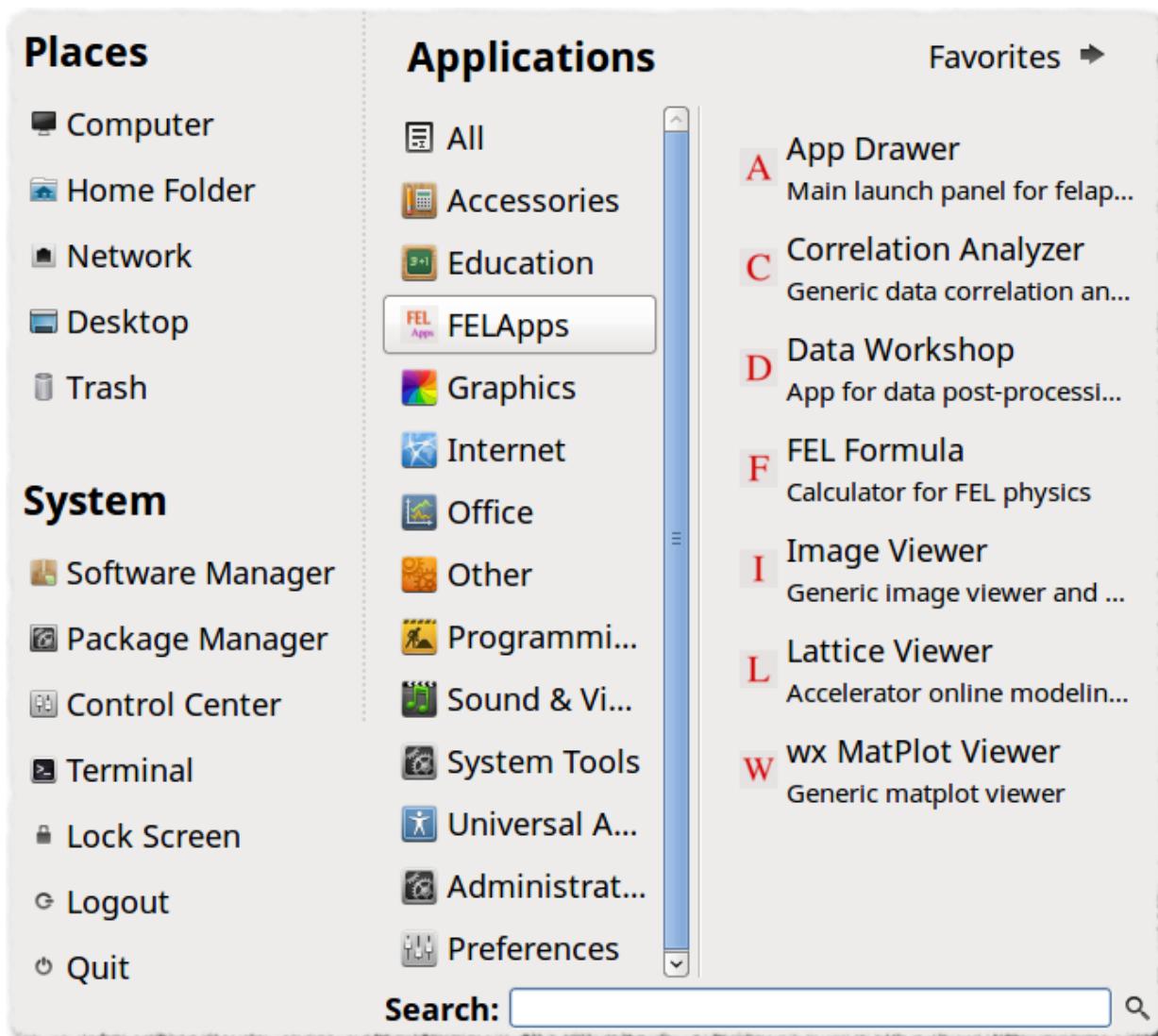
After installing felapps, system-wide environment variables should be configured correctly, say save the following shell script to a file named felapps.sh, put it into folder: /etc/profile.d, or append them into the bash configuration files.

```
HLAPATH=/opt/high-level-apps
HLAPYLIB=${HLAPATH}/lib/python2.7/site-packages
HLAPYBIN=${HLAPATH}/bin/
export PYTHONPATH=${HLAPYLIB}
export PATH=${PATH}: ${HLAPYBIN}
```

System-menu Integration

To integrate the available apps into system menu would greatly improve the user experience, just like the following image shows ¹: all the apps are categorized into FEL Apps menu, through which you can reach different apps to accomplish different tasks.

¹ The menu screenshot may differ from other operating systems.



felapps distributes a script called: update-felapps-menu to handle the system-menu integration issues, here is the usage:

- Install felapps into system-menu:

```
update-felapps-menu --appdir /opt/high-level-apps/
```

- Uninstall felapps from system-menu:

```
update-felapps-menu --appdir /opt/high-level-apps/ --operation uninstall
```

Warning: If executing the above command with the root privilege, all the users would see the menu, or only the current user could see them.

EXAMPLES AND DEMONSTRATIONS

Here goes through the main features that felapps provides, among which latticeviewer is an app based on beamline package.

Warning: The operating system is Linux (64 bit), distributions that have been tested: *Scientific Linux 6.4, CentOS 6.4, Linux Mint 17.x, 18 (Ubuntu 15.x, 16.x)*, other distros should work provided proper configurations. Part of features should work in Windows OS, but not has been fully tested.

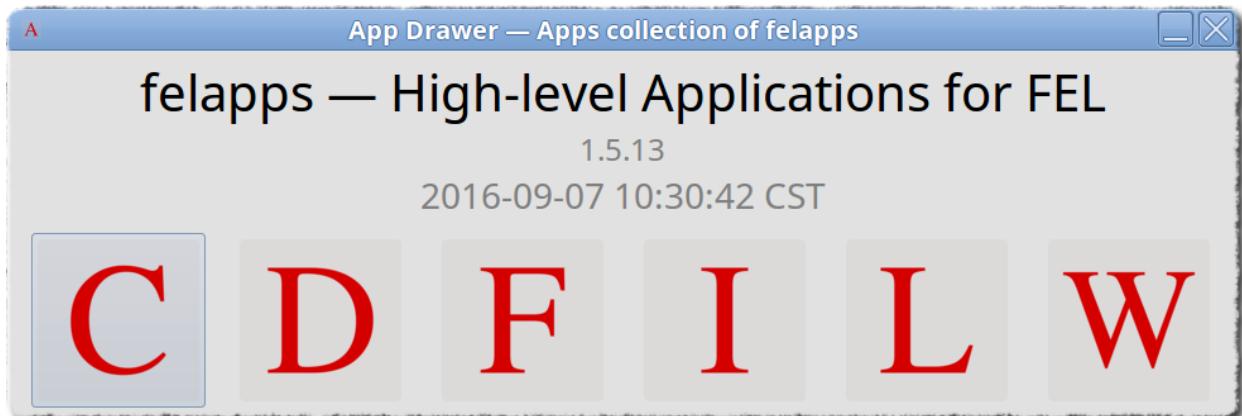
In the following examples, the invocation of the apps could be one of these approaches:

1. Type <app name> in the terminal;
2. Browse <app name> from FELApps system menu;
3. Invoke runfelapps or appdrawer, click <app name> from the app's panel (see the following image).
4. Run <app> in the python terminal: <app> could be one of imageviewer, cornalyzer, dataworkshop, felformula, wxmpv

For instance:

```
import felapps
felapps.imageviewer.run()
```

or python -c "import felapps;felapps.imageviewer.run()"

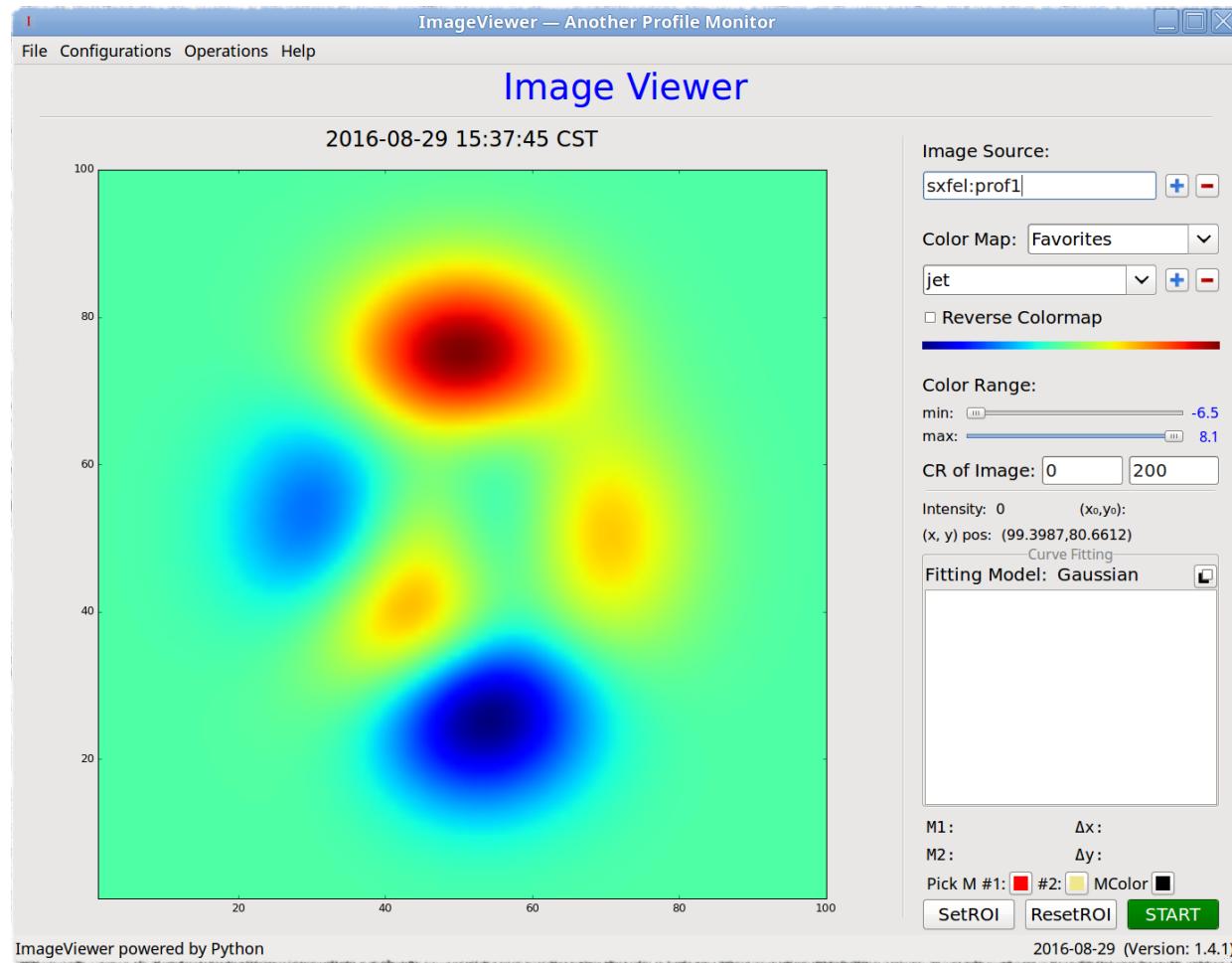


Example 1

`imageviewer` – Image figure DAQ app.

Start DAQ

If it is the first time to start `imageviewer`, windows may be poped up to ask for the configuration file¹. After loading the configuration file, the GUI style, e.g. background colour, font could be tunned, as well as other options, e.g. the data/image format that to be saved, the DAQ rate, image data source, EPICS control configurations, etc.



Some basic operations:

- Put the EPICS PV string name in the Image Source: box, press ENTER to retrieve the data (1D array), the +/- button is used to add/remove input PV string name to/from the internal favorite PV name array;
- Change the color map style of the obtained image, from Color Map: control field, select the grouped style from the combo list, add/remove current style to Favorites group;
- Reverse the color map, and change the color range, all these color options are of the goal to discriminate the interested signal from the big picture, i.e. to increase visibility;

¹ Configuration file that `imageviewer` requires is a .xml formated file, a sample file could be downloaded [here](#).

- To the figure plot region, there are operations:
 - Place up to two (2) markers with selected color;
 - Track the (x,y) coordinate when mouse is moving;
 - Show the figure intensity and Gaussian fit indicated radius sizes in x and y;
- Choose and reset Region-of-Interest, i.e. ROI.

Other operations that could be reached through menu:

- Save figure as some formated image ², shortcut: CTRL+S;
- Save figure as some formated data, shortcut: CTRL+D;
- Quit app: shortcut: CTRL+W ³;
- Save configurations: SHIFT+CTRL+S, load configurations: SHIFT+CTRL+L;
- Show profile along x-axis: ALT+X;
- Show profile along y-axis: ALT+Y;
- Show intensity monitor window: SHIFT+CTRL+V, the figure could also be saved;
- Save fetched image data automatically: ALT+S ⁴;

The following image is captured when `imageviewer` successfully fetch image data from PV named `sxfel:prof1` ⁵, which is a 50 x 50 array after reshaping operation, push START will trig the DAQ procedure with the configured rate Preferences > Control > Monitor Frequency ⁶.

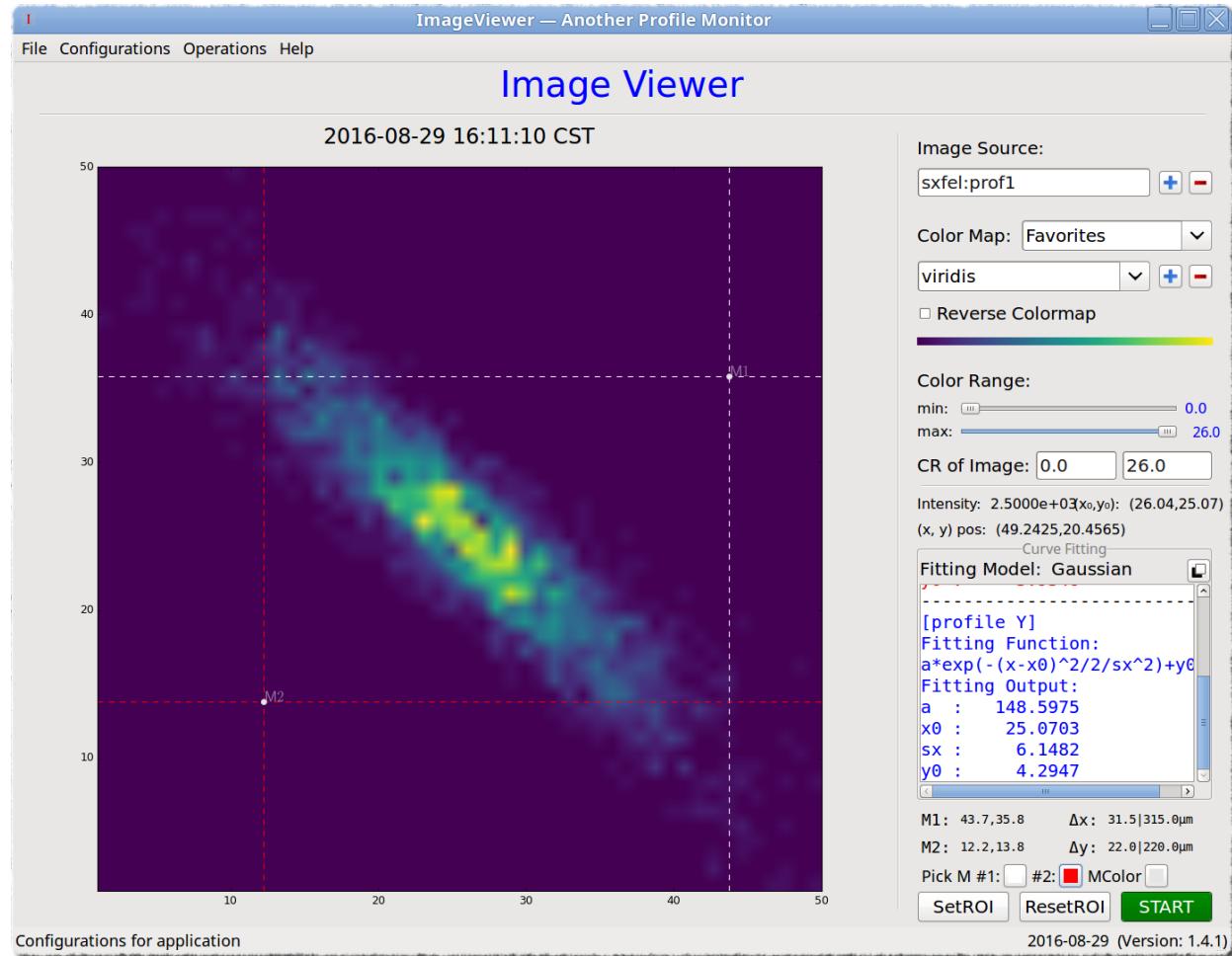
² The default image format could be set from menu: Configurations > Preferences > Image Name Extension or SHIFT+CTRL+I to open Preferences window, same rule applies to save figure data.

³ CTRL+W is a common shortcut to close the app for all apps in felapps.

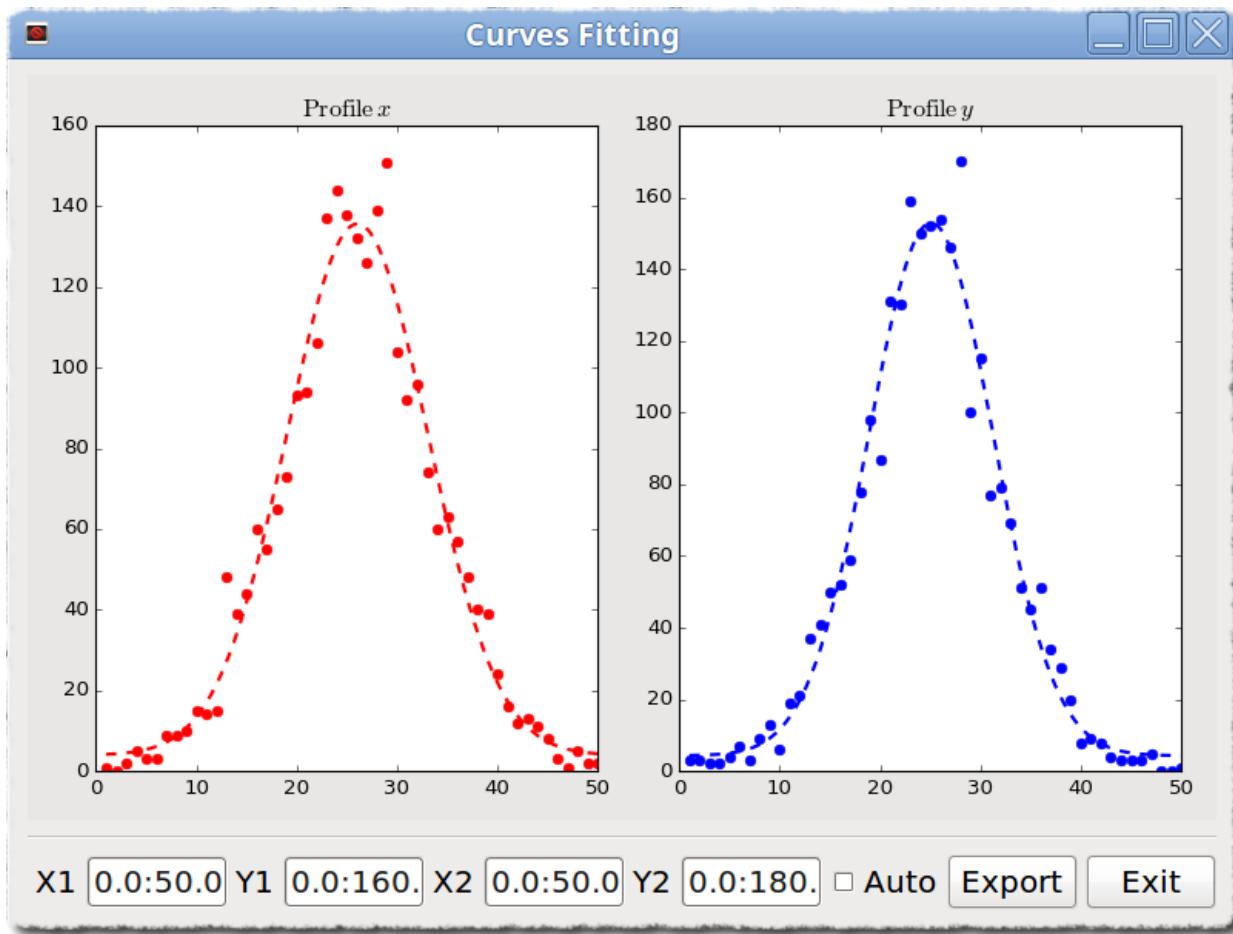
⁴ Auto saved data files could be used as the input data files of app: `dataworkshop`, which serves as a simple data post-processor.

⁵ `sxfel:prof1` is a waveform record of an soft-IOC that is used to simulate the EPICS control environment.

⁶ It is suggested that increasing this value gradually, e.g. by step of 0.5, e.g. 1 Hz for large image, and 5 Hz for small image.



Presently, imageviewer has been integrated Gaussian fitting model to show the x/y profiles of the image, click the pop up button right aside of ... Gaussian ... in the Curve Fitting panel of the main window, e.g. the following image shows the profiles.



The raw data and fitting data could be saved by Export button.

Note: Gaussian fitting model should be frequently used in the searching for radius size, central position of the light/beam spot, if other models should be applied, the imageviewer app needs to be extended.

Warning: Attention should be paid to the following configuration items:

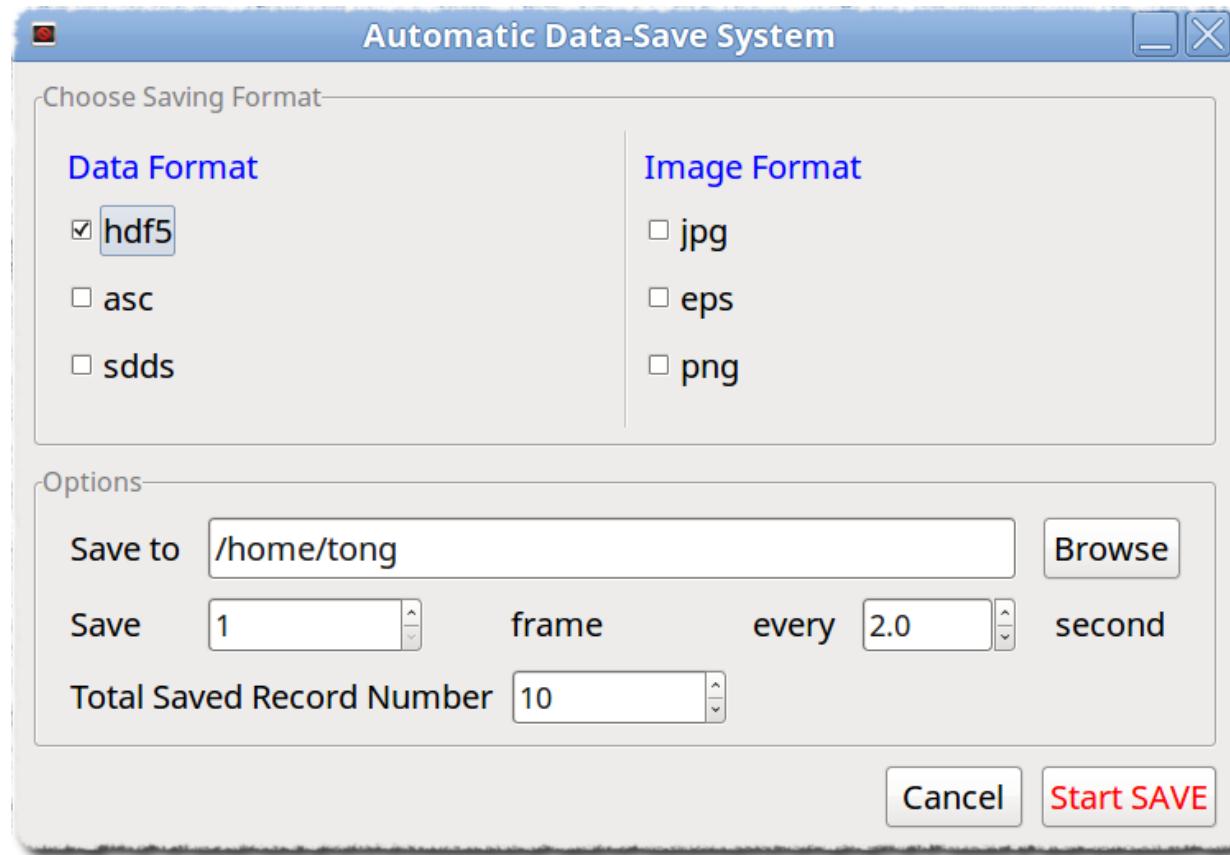
1. Image Width and Image Height, which is the dimension (2D array) to reshape;
2. CA Library Path, CA Max Array Bytes and Auto CA Address, which is the control specific parameters, proper tuning is required so as to fetch the image data from soft-IOC.

Auto Save

Here take the Auto save operation as example. Auto save is one of the operation modules in the Operations menu, future extended operation modules should be inserted into this menu. The shortcut for Auto save is ALT+S. Auto save is designed for the following scenario:

- The facility (e.g. FEL) finally has been properly configured;
- DAQ procedure should be activated to get bundle of data, e.g. for some kind of analysis.

Pop up Auto save window, in which, tick the interested data and image format to be saved⁷, as well as the full path to save files and the save frequency and save counter, etc. Push Start SAVE to trig the auto save procedure, the saving status could be found in the highlighted status bar in imageviewer app.



Warning: When utilizing Auto save operation, remember imageviewer should be in the DAQ mode, i.e. START button should be pushed.

Data Example

The data files generated by imageviewer can be classified into two categories, i.e. *figure* and *data*, while *figure* could be saved as png, jpeg, svg, tiff, ps, eps, pdf, etc.; *data* could be saved as txt and hdf5, of which only hdf5 could be self-explained, it is recommended to use hdf5.

hdf5 files could be generated in the following scenarios:

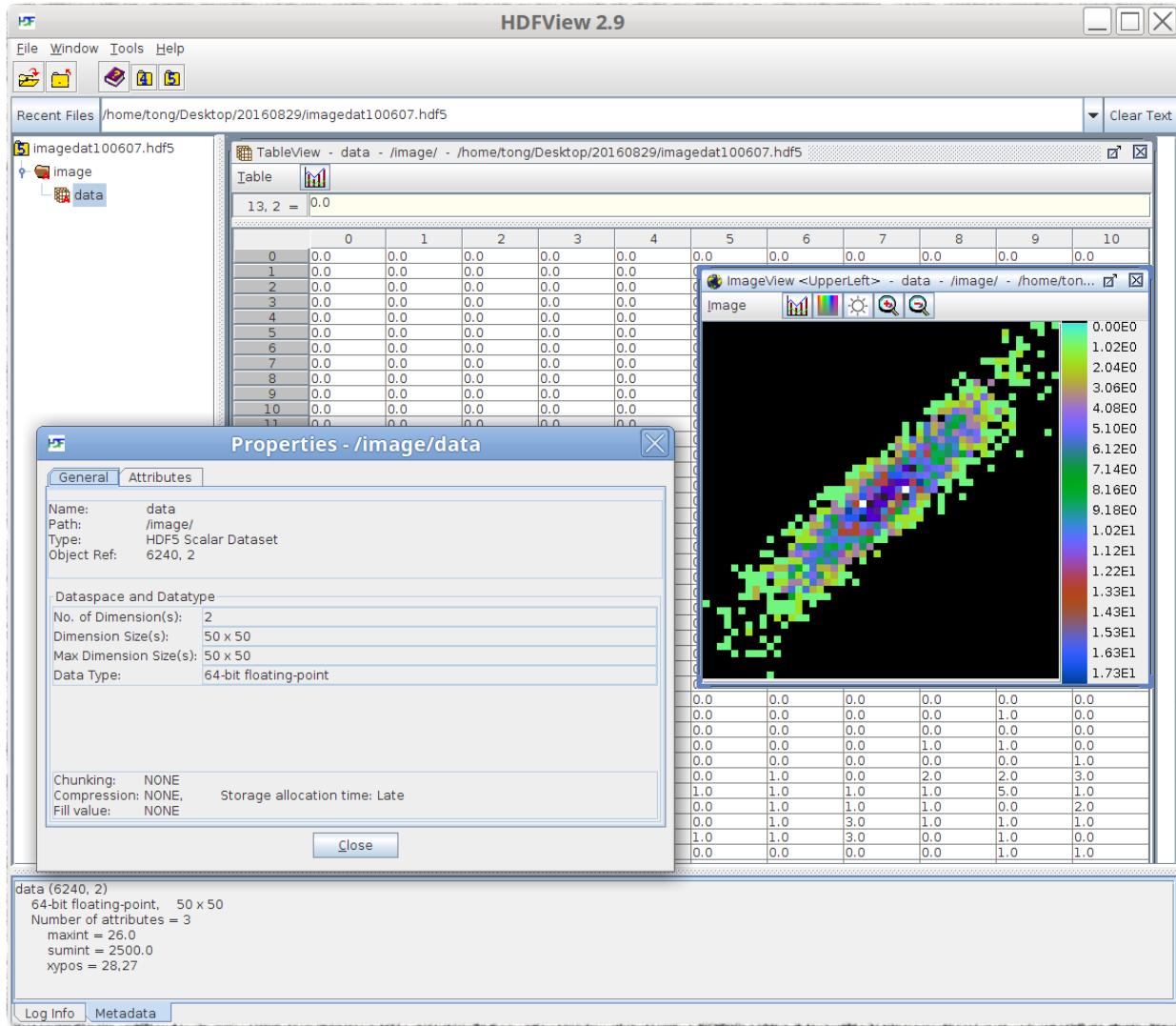
1. Image Data

Click File > Save Image Data, or by shortcut CTRL+D, raw data of the figure with trivial properties will be saved into a hdf5 file, by default, the full path filename will be save root directory + <folder name like '20160830'> + save filename head + <time stamp (hour,min,sec) like '100607'>⁸.

⁷ Since saving data, especially hdf5 is always more efficient than saving other format, it is suggested that only tick hdf5 options when cares more about efficient, especially for image with large pixels.

⁸ All these meta information could be set and get in the Preferences > Image panel.

Any hdf5 file could be opened by a program that distributed by HDF5 official group, named `hdfview`⁹. Also, in the CLI, command `h5ls` could be used for inspection, below are the illustrations for the two approaches:



⁹ <https://www.hdfgroup.org/products/java/hdfview/>

```
tong@walkstation 20160829]$ h5ls -lvr imagedat100607.hdf5
Opened "imagedat100607.hdf5" with sec2 driver.
/
    Group
        Location: 1:96
        Links: 1
    /image           Group
        Attribute: app scalar
            Type: variable-length null-terminated ASCII string
            Data: "imageviewer"
        Attribute: timestamp scalar
            Type: variable-length null-terminated ASCII string
            Data: "2016-08-30 10:06:07 CST"
        Location: 1:800
        Links: 1
    /image/data      Dataset {50/50, 50/50}
        Attribute: maxint scalar
            Type: native double
            Data: 26
        Attribute: sumint scalar
            Type: native double
            Data: 2500
        Attribute: xypos {2}
            Type: native long
            Data: 28, 27
        Location: 1:6240
        Links: 1
        Storage: 20000 logical bytes, 20000 allocated bytes, 100.00% utilization
        Type: native double
```

2. Curve Fitting Data

When curve fitting is enabled, in the pop up fitting panel, Export button will generate the hdf5 data, saving path should be informed through the pop up dialog. Use h5ls to inspect the exported file:

```
$ h5ls -lvr fitdata104332.hdf5
Opened "fitdata104332.hdf5" with sec2 driver.
/
    Group
        Location: 1:96
        Links: 1
    /data           Group
        Attribute: timestamp scalar
            Type: variable-length null-terminated ASCII string
            Data: "2016-08-30 10:43:32 CST"
        Location: 1:800
        Links: 1
    /data/fit       Group
        Attribute: x0 scalar
            Type: native double
            Data: 26.041
        Attribute: xstd scalar
            Type: native double
            Data: 6.99682
        Attribute: y0 scalar
            Type: native double
            Data: 26.041
        Attribute: ystd scalar
            Type: native double
            Data: 6.99682
        Location: 1:10608
        Links: 1
    /data/fit/x     Dataset {200/200}
        Location: 1:14432
        Links: 1
```

```

Storage: 1600 logical bytes, 1600 allocated bytes, 100.00% utilization
Type: native double
/data/fit/xdata          Dataset {200/200}
  Location: 1:14976
  Links: 1
  Storage: 1600 logical bytes, 1600 allocated bytes, 100.00% utilization
  Type: native double
/data/fit/y          Dataset {200/200}
  Location: 1:11624
  Links: 1
  Storage: 1600 logical bytes, 1600 allocated bytes, 100.00% utilization
  Type: native double
/data/fit/ydata          Dataset {200/200}
  Location: 1:14704
  Links: 1
  Storage: 1600 logical bytes, 1600 allocated bytes, 100.00% utilization
  Type: native double
/data/raw           Group
  Location: 1:1960
  Links: 1
/data/raw/x          Dataset {50/50}
  Location: 1:7712
  Links: 1
  Storage: 400 logical bytes, 400 allocated bytes, 100.00% utilization
  Type: native long
/data/raw/xdata          Dataset {50/50}
  Location: 1:10336
  Links: 1
  Storage: 400 logical bytes, 400 allocated bytes, 100.00% utilization
  Type: native double
/data/raw/y          Dataset {50/50}
  Location: 1:6240
  Links: 1
  Storage: 400 logical bytes, 400 allocated bytes, 100.00% utilization
  Type: native long
/data/raw/ydata          Dataset {50/50}
  Location: 1:7984
  Links: 1
  Storage: 400 logical bytes, 400 allocated bytes, 100.00% utilization
  Type: native double

```

The grouped data set: `raw` and `fit`, other metadata like `timestamp`, central point coordinate (`x0, y0`), radius size (`xstd, ystd`) could be retrieved according to the string names.

3. Auto Saved Data

Data generated by `Auto save` operation could be `hdf5` (recommended the exclusive choice), is similar as `Image Data`, besides `timestamp` property, but with only one property: `app`, which value is `imageviewer`, indicating that the file is generated by app named `imageviewer`. These `hdf5` data files could be imported into `dataworkshop` for post-processing, see [Example 2](#).

Example 2

`dataworkshop` – Data post-processing app.

Introduction

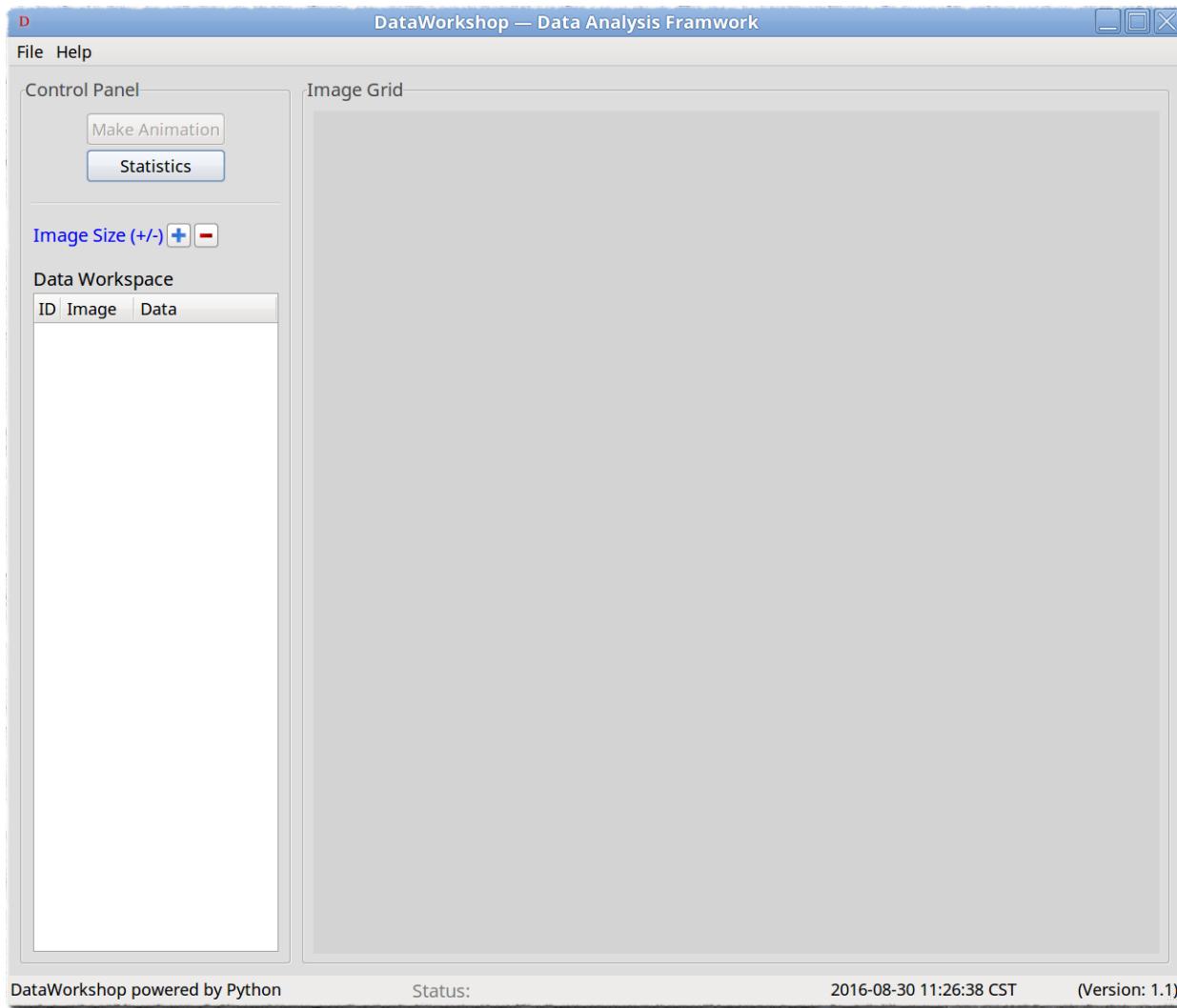
Initially, `dataworkshop` is created for the data processing tasks, since not all of the tasks, especially those demanding heavy computing resources are not required to be processed simultaneously, so we first get all the data that may need, then filter/process by another app, that is `dataworkshop`'s job.

Usage Guide

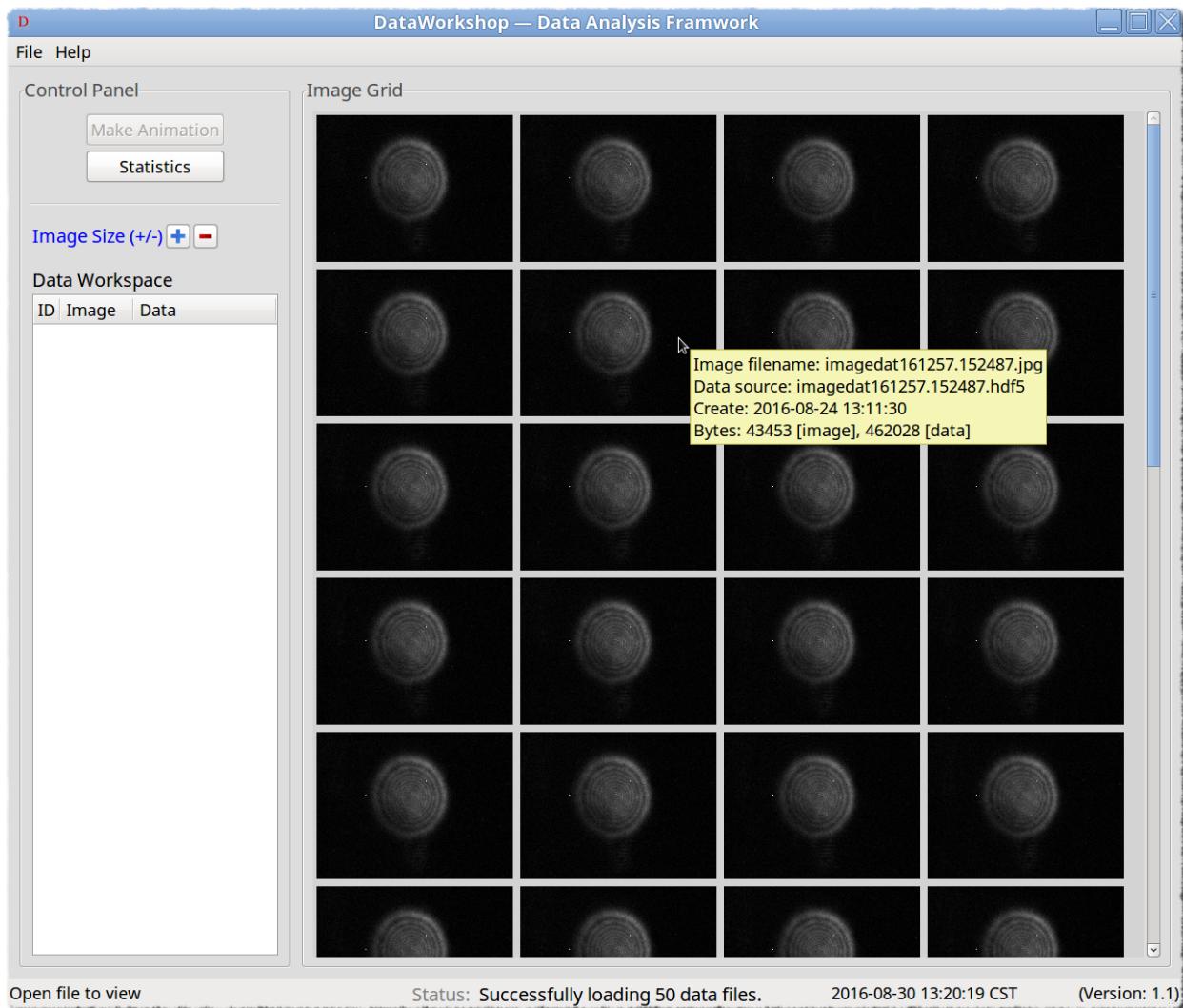
3.2. Example 2

Import Data Files

Open dataworkshop as the following image shows, Image Grid panel is the place where imported data file generated image should be put into, in the Control Panel, operations like Make Animation (not enabled), Statistics will take the data files that selected into Data Workspace as the input, to do specific post-processing procedures.



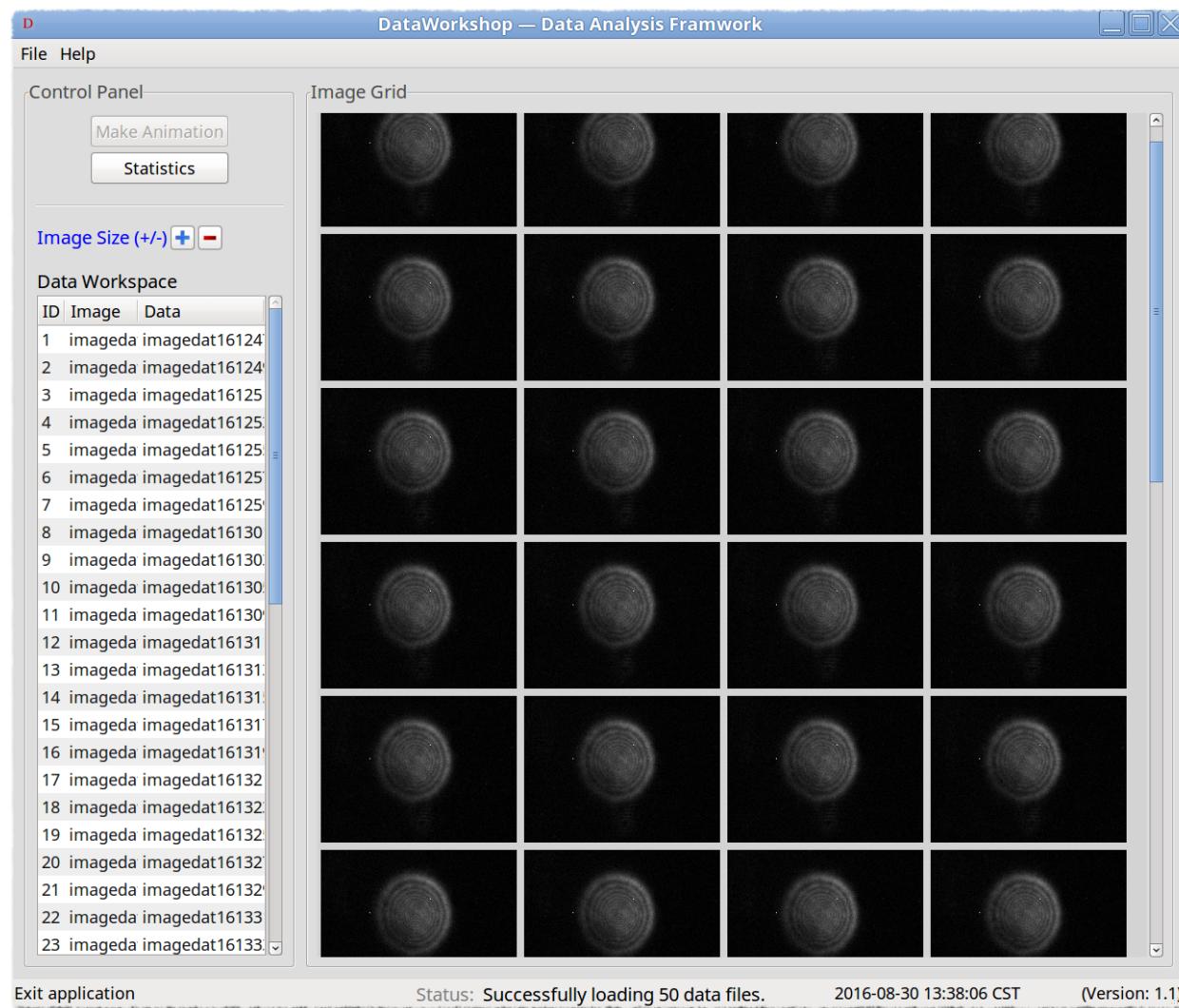
For example, click File > Open files or shortcut CTRL+O to import hdf5 files that generated by Auto save operations of imageviewer app. In order to show the data files in a more informative way, the import/open operation will first transform the data files into images, then show in grid style, the image size could be adjusted by the Image Size(+-) buttons, i.e. increase (+) or shrink (-); when the mouse is hovering over the image, information will show as a tooltip, including metadata like filename, timestamp, filesize, etc.



Note: File > Add files (CTRL+A) can be used to continue to add data files into the current Image Grid.

There are two approaches to add/remove data files into Data Workspace:

1. Right click the image files in Image Grid, choose To Workspace menu item to add the selected file into Data Workspace;
2. Right click the blank space of Image Grid panel, i.e. any space that is not occupied by the images, Add all to workspace and Remove all to workspace actions could be applied;
3. Once the file is already added into Data Workspace, then right click on the image should pop up Out Workspace action which would remove added file out of Data Workspace.

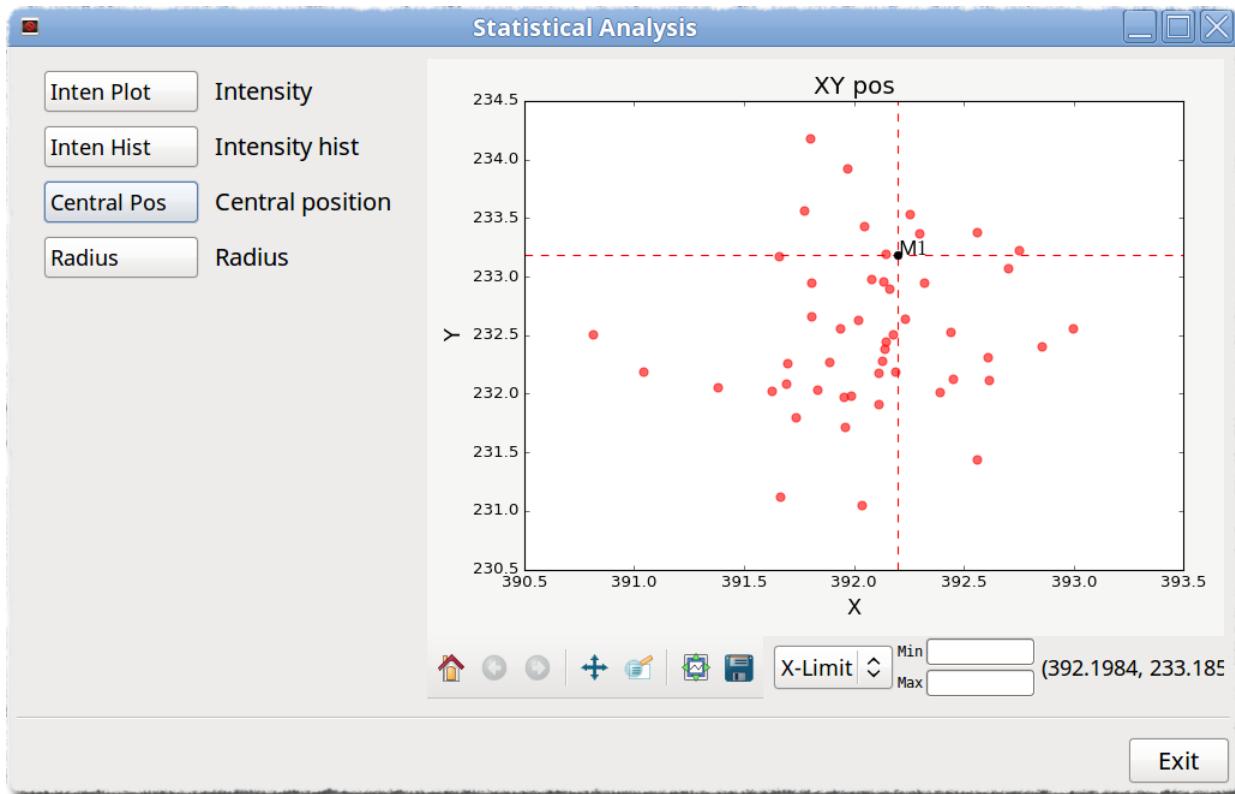


Note: When right clicking the image, another available action is Pop up Analysis, which will show the selected image in a more vivid way, details see [Example 6](#).

Post-processing

All the operations to the data files should be implemented in the Control Panel, up to now, there is Statistics button available to do post-processing operations.

Push Statistics button to open the pop up window, in which, push Radius, will plot the distribution of the central positions of all the files that in Data Workspace, other methods also could be developed to help the user to quickly understand the data, so as to make the next step decision.



Example 3

cornalyzer – Parameter correlation analysis app.

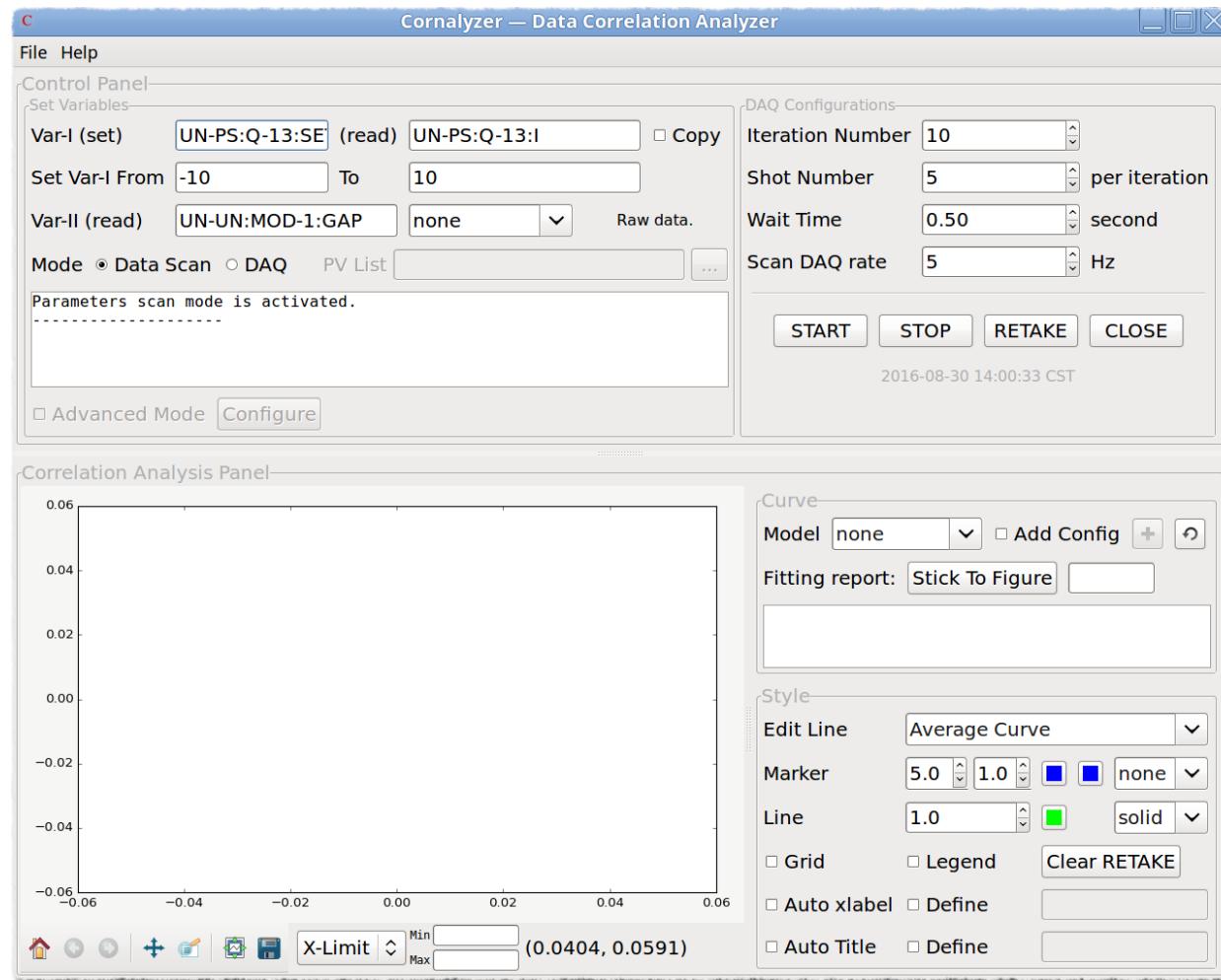
Introduction

If the user wanna analysis the correlation between parameters, cornalyzer could help. Presently, main features that cornalyzer provides are:

- **Two dimensional parameters correlation analysis;**
 - post-processor could be applied to the second dimension
- Data plot with x/y errorbars;
- **Curve fitting, support both polynomial and gaussian;**
 - additional fitting paramters
- **Plenty of operations on the figure:**
 - Line/marker/errorbar style
 - Labels, title, legend, text of fitted information
 - Data range control
- Re-take the selected variable points for correction by RETAKE button;
- Save the analysis result.

Usage Guide

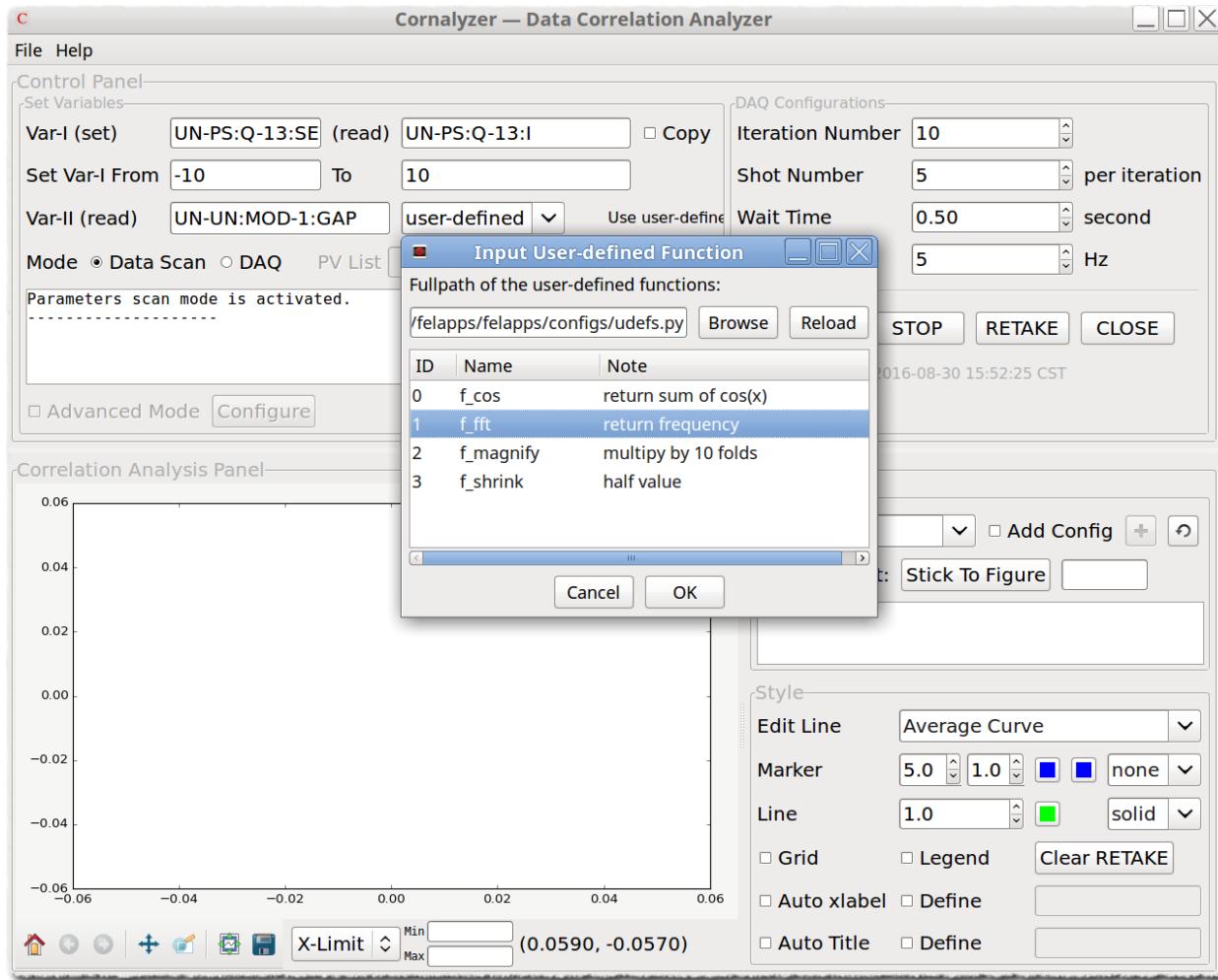
Open the cornalyzer app, like the following image shows, currently only Data Scan mode is supported.



Data Scan Guide

Input the EPICS PV string names in the Set Variables panel, Var-I should be treated as the first dimension of the analysis, i.e. the parameter to be altered, since the set and read of Var-I usually are controlled by two different PV strings, so two input boxes should be filled correctly¹. The Var-II is the parameter that to be monitored as Var-I is tuning, post-processing operations could be applied to the raw data that read from the EPICS PV string of Var-II, click the combobox right next the input box of Var-II, choice could be one of none, sum, max, min and user-defined, the meaning could be found on the right side hint text.

¹ copy checkbox could be used to quickly copy set value into read field.



Click user-defined option will pop up a window, browse the Python module that contains user-defined functions to load², below is the example of user-defined Python module:

```
"""
user-defined functions to process A, where
A could be any type of:

1. array, 1D or 2D,
3. scalar, float, integer,

Usually, the raw value of A could be retrieved by caget(PV_string)

This script/module is potentially be used by 'cornalyzer',
i.e. correlation analyzer application, to apply post-processing
procedure on the scan dependent variable.

Created: 2016-07-14 14:59:11 PM CST
"""

import numpy as np

def f_fft(x):
    """
    return frequency
    """
    f = abs(np.fft.fft(x))
    idx = np.where(f==f.max())[0][0]
    return idx

def f_magnify(x):
```

² The Python module file is a normal Python script that has function definitions, it is the user's liability to manage this file.

```
    """ multiply by 10 folds
    """
    a = 10
    return x * a

def f_shrink(x):
    """ half value
    """
    a = 0.5
    return x * a

def f_cos(x):
    """ return sum of cos(x)
    """
    return np.sum(np.cos(x))
```

Choose the function to be applied on Var-II, push OK to return to the main window.

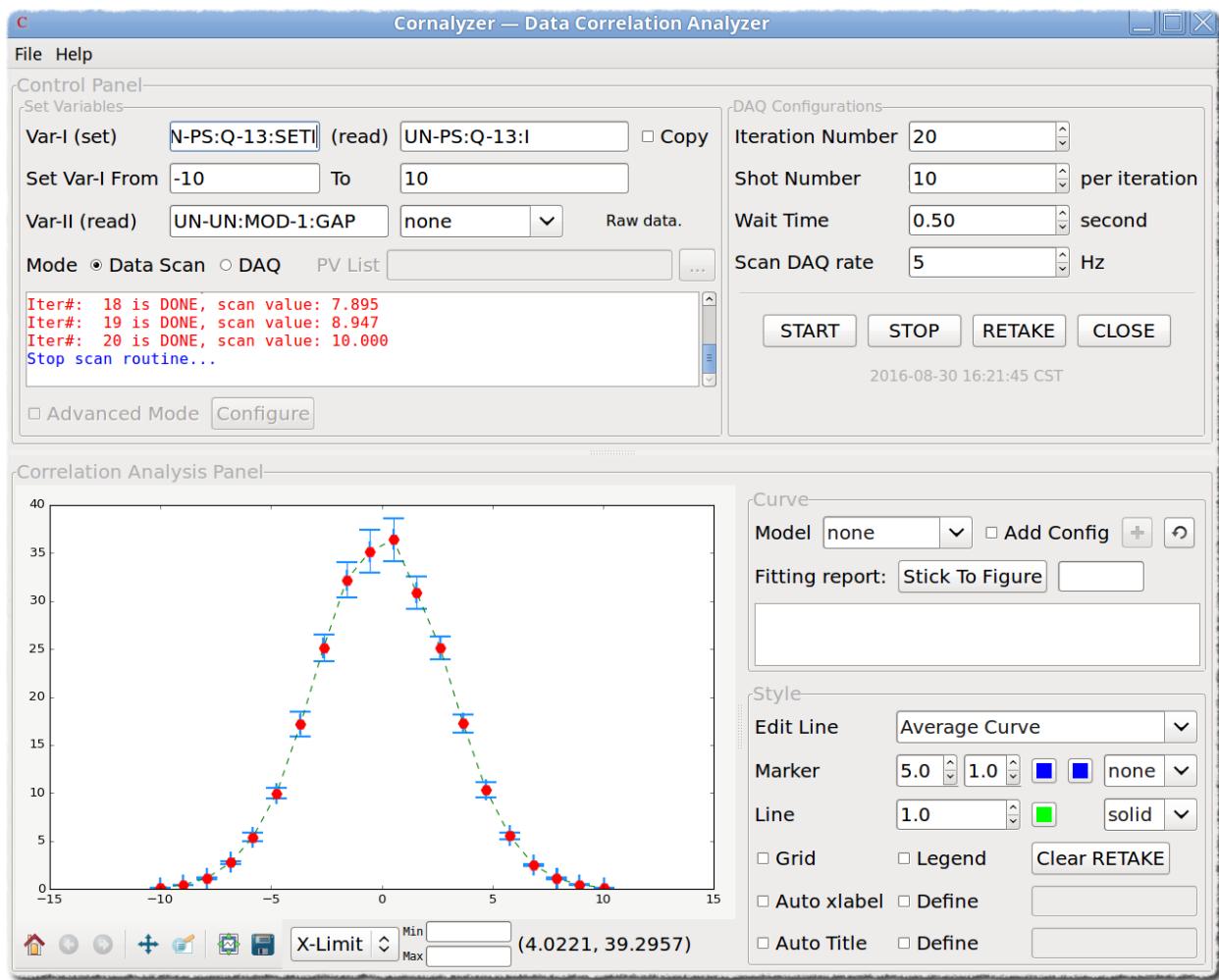
Note: Tips to write the user-defined functions:

1. Naming the function with meaningful strings;
 2. Keep function as simple as possible;
 3. Always write *doc string* (strings wrapped by "'''"), which will appear as the Note field to help understanding.
-

The meanings of other scan parameters could be get hint from the tool tips when the mouse hovers over the controls, e.g. Iteration Number is the total counter of Var-I scan array (equally spaced) that to be altered, Shot Number is the total counter of the fetched data for every iteration, and Scan DAQ rate is the DAQ frequency, e.g. scan configurations like: Iteration = 20, Shot Number = 10, Wait Time = 0.5 and Scan DAQ rate = 5 Hz tell the app that alter the Var-I parameter from the min (-10) to max (10) with equal step, until the step counter reaches 20, and for each variable update procedure, the global timer should wait 0.5 second³, in each step, the DAQ system should be working to retrieve the data (Var-II with proper operation) with the speed of 0.2 second per shot, until get 10 shot in total, this is one iteration.

Click START to start the scan procedure, and STOP to stop any time, scan log will show in the textbox, beginning with Iter#... for each iteration.

³ The data that used by example shown here is provided by a soft-IOC, with the scan frequency of 5 Hz, while for the real machine, e.g. Dalian Coherent Light Source (DCLS), tests show that 10-20 second may require so as to get valid signals.



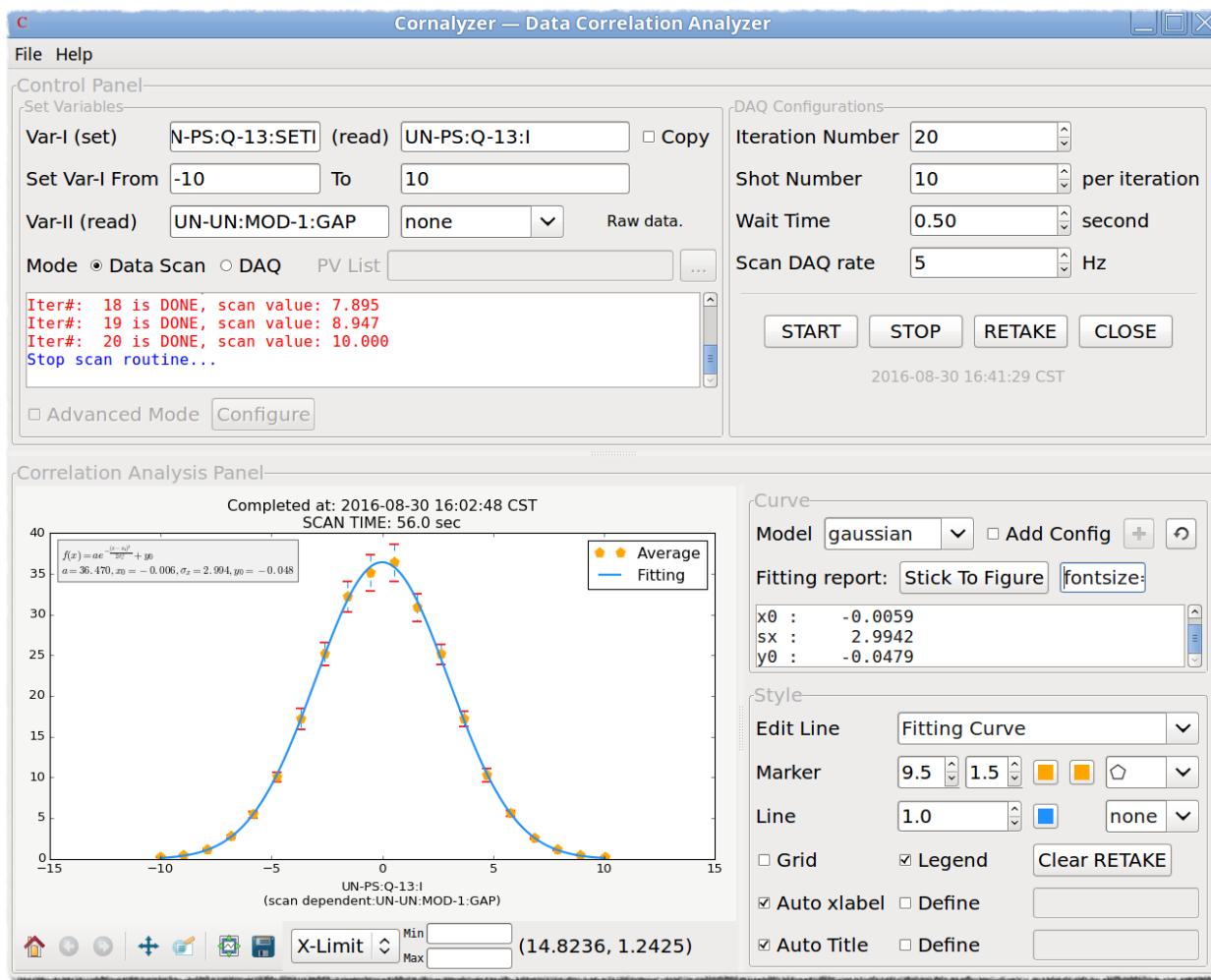
Curve Plot Tunning

cornalyzer is designed with the intention of generating publish-quality artwork for the data sharing and distributing.

Curve Fitting

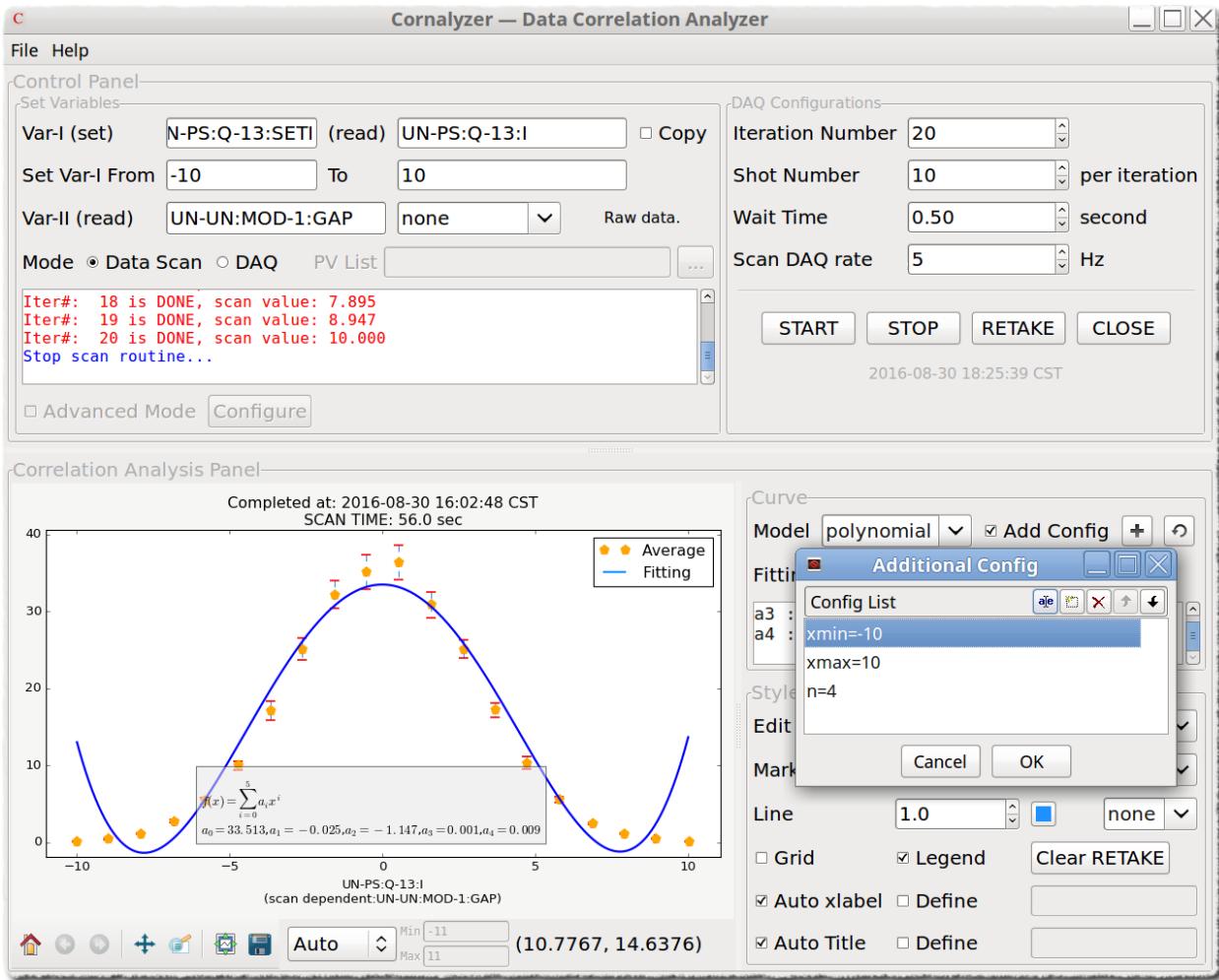
When the scan procedure is done, pop up dialog will show the warning that the scanned data could be saved by CTRL+S, while it is recommended that trig saving action when proper fitting model be applied.

In the Curve panel, choose Model to apply proper fitting model, e.g. gaussian, polynomial, the option none means not fitting the curve. In this example gaussian should be selected, blue gaussian shaped line (fitted average every iteration line) will be drawn onto the figure.



Note: Additional parameters are also provided to make the curve fitting module more flexible, follow the steps to do this:

1. Check Add Config, click + button to add parameters, just like the following image shows;
2. Valid parameters: n, the highest order for the polynomial fitting model; xmin and xmax, to fix the fitting range along x-axis.



Todo

user-defined option should be added into the Model combobox, such that to handle more curve fitting scenarios.

Curve Style

To adjust the style of the curves is of significance to make high-quality artworks, fortunately, Python package — matplotlib is dedicated to accomplish such mission.

There are three options in Edit Line combobox, choose any one of them to apply proper style configurations below, e.g. line style, line color, line thickness, marker style, marker color, marker size, etc., as well as putting legend, title, labels onto figure, moreover the fitting functions with fitting parameters could be annotated, which supports mouse dragging to reposition ⁴.

If Auto xlabel is checked, the xlabel will be assigned with the PV strings of Var-I and Var-II, and if the user wanna assign with other string, just check the Define option, and write the user-defined xlabel in the

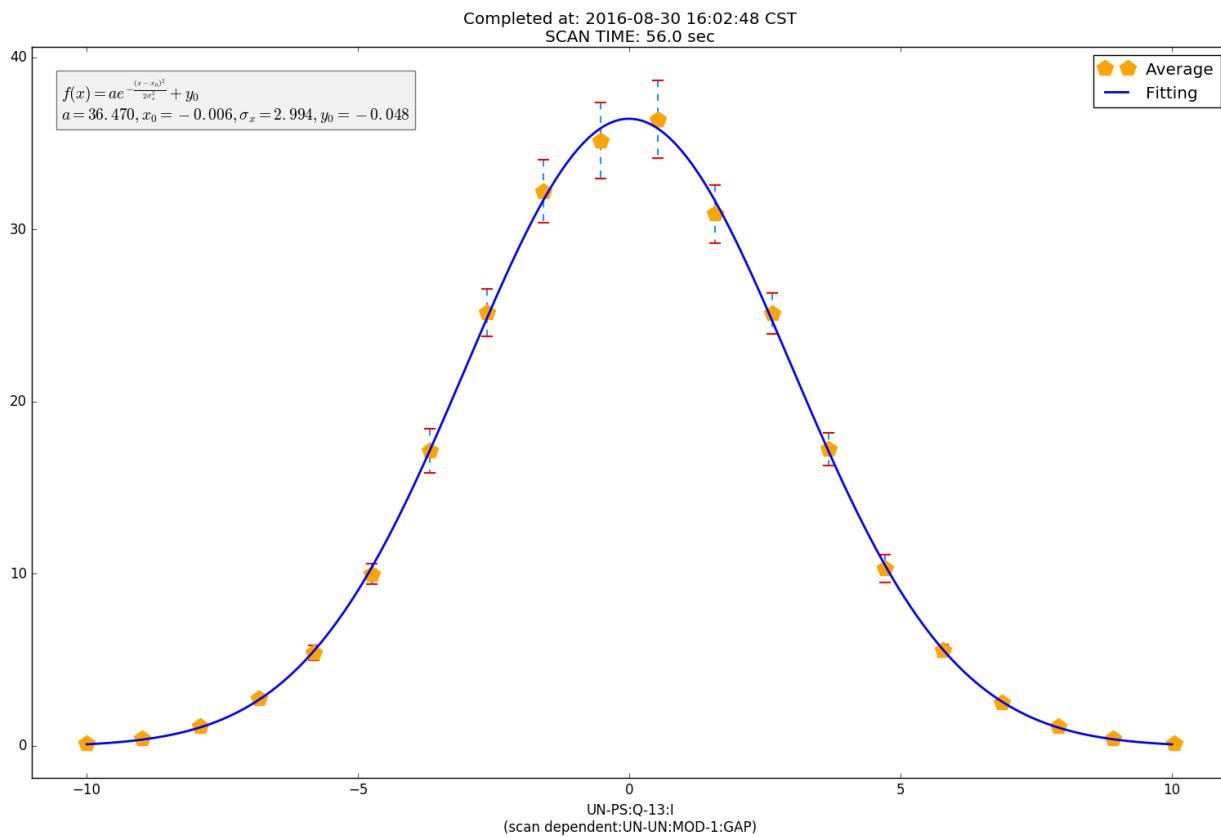
⁴ Push Stick To Figure button will draw the fitting function onto figure (the grey box in the above image), control the position could be by mouse dragging or input proper parameters, e.g. input x=0; y=0 in the textbox right aside of Stick To Figure button will move the grey box to (0,0), another valid parameter is fontsize, which could be used to control the text font size, details could be reached when the mouse hovers over the textbox.

right aside textbox, Auto xlabel may be rechecked to show the new xlabel; the same rule applies to the Auto Title options⁵.

Scan Plot

Main features of the scan plot region:

1. Save figure;
2. x/y data limit tunning;
3. Operations that toolbar provides: *zoom in/out, panning, reset*, etc.



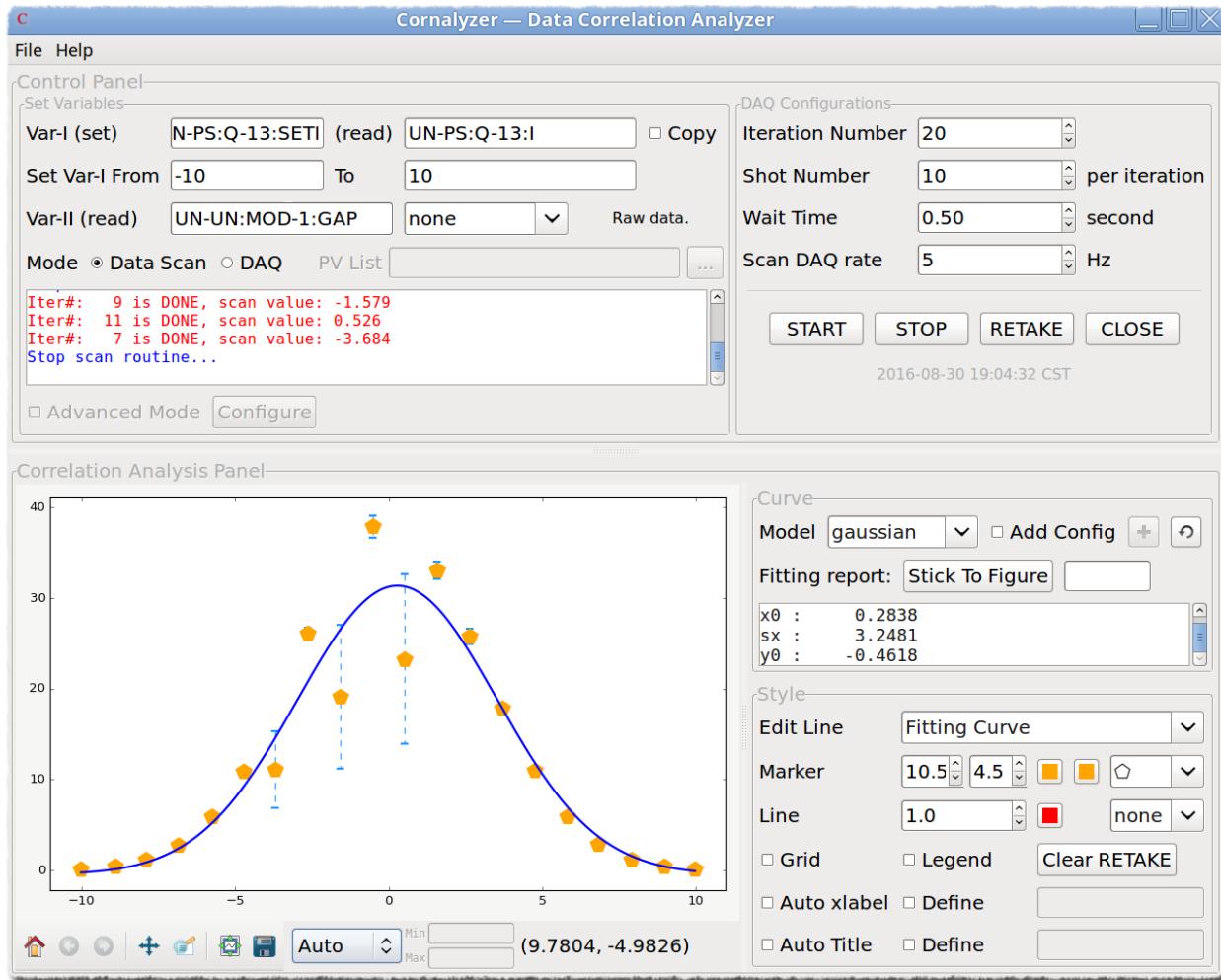
Bonus Feature

Sometimes, the user may demand that some iterations should be processed again, that means the data point should be retaken, no matter what reasons should be relied on, there should be some feature to accomplish such task, then the RETAKE button is created.

Warning: Only RETAKE when you have every reason that the data point(s) to be replaced is(are) wrong or flawed, e.g. then the machine was not that stable, believed the large jitter was caused by some malfunction of some power sources, etc., In a word, let the SCIENTIFIC DATA be more convinced.

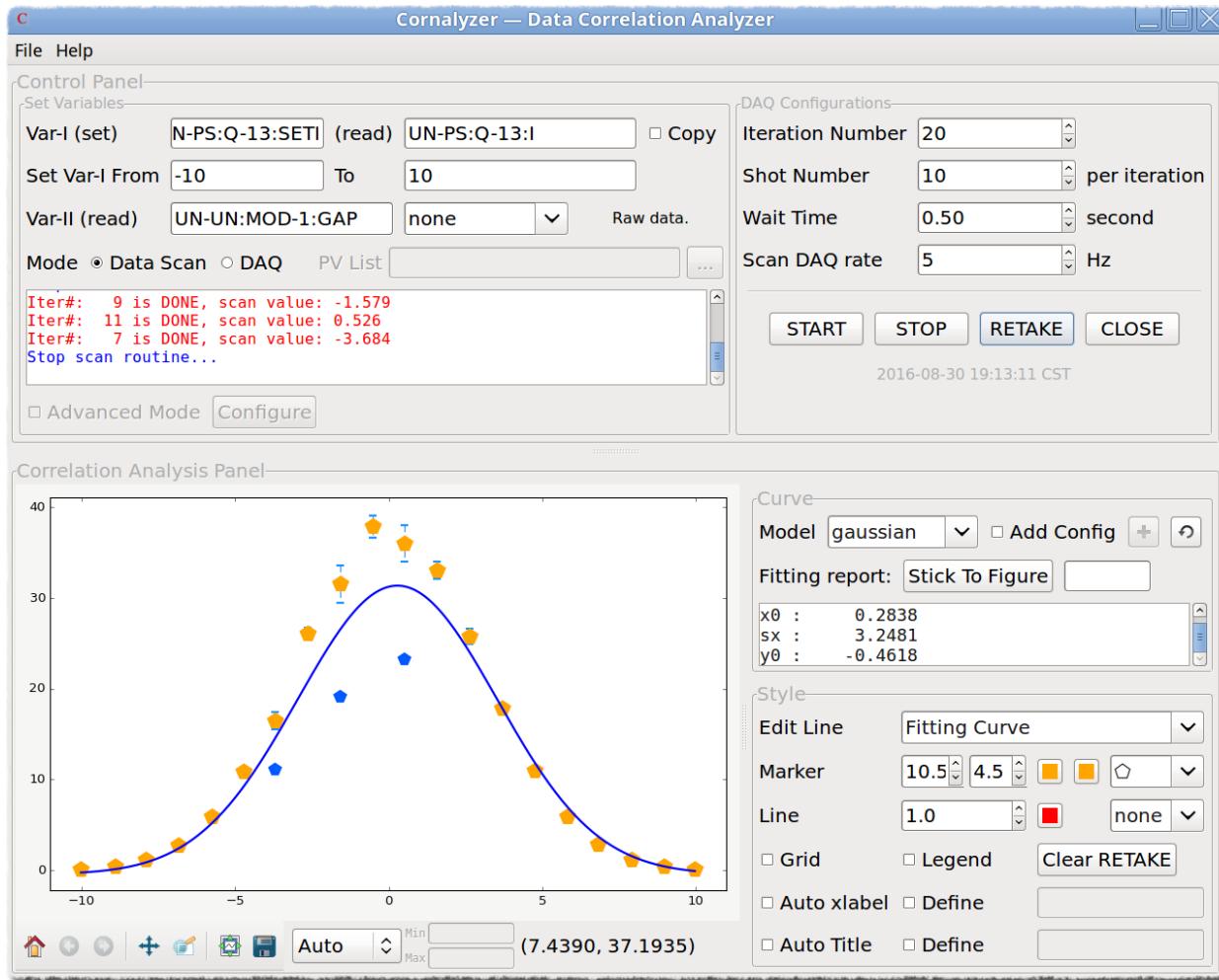
⁵ When the Define checkbox right aside of Auto Title is checked, in the user-defined title string, macro \$TITLE could be used to substitute the default title string that Auto Title uses.

In order to demonstrate the RETAKE feature, the data generator has been changed little, e.g. add more noise, just like the following image shows, three evident points with relatively large errorbar could be treated as wrong points, and need to be fixed⁶. To RETAKE, first select the point(s) to be retaken by clicking mouse onto the point(s), the selected point(s) should be highlighted, then push RETAKE button to start retaken procedure.

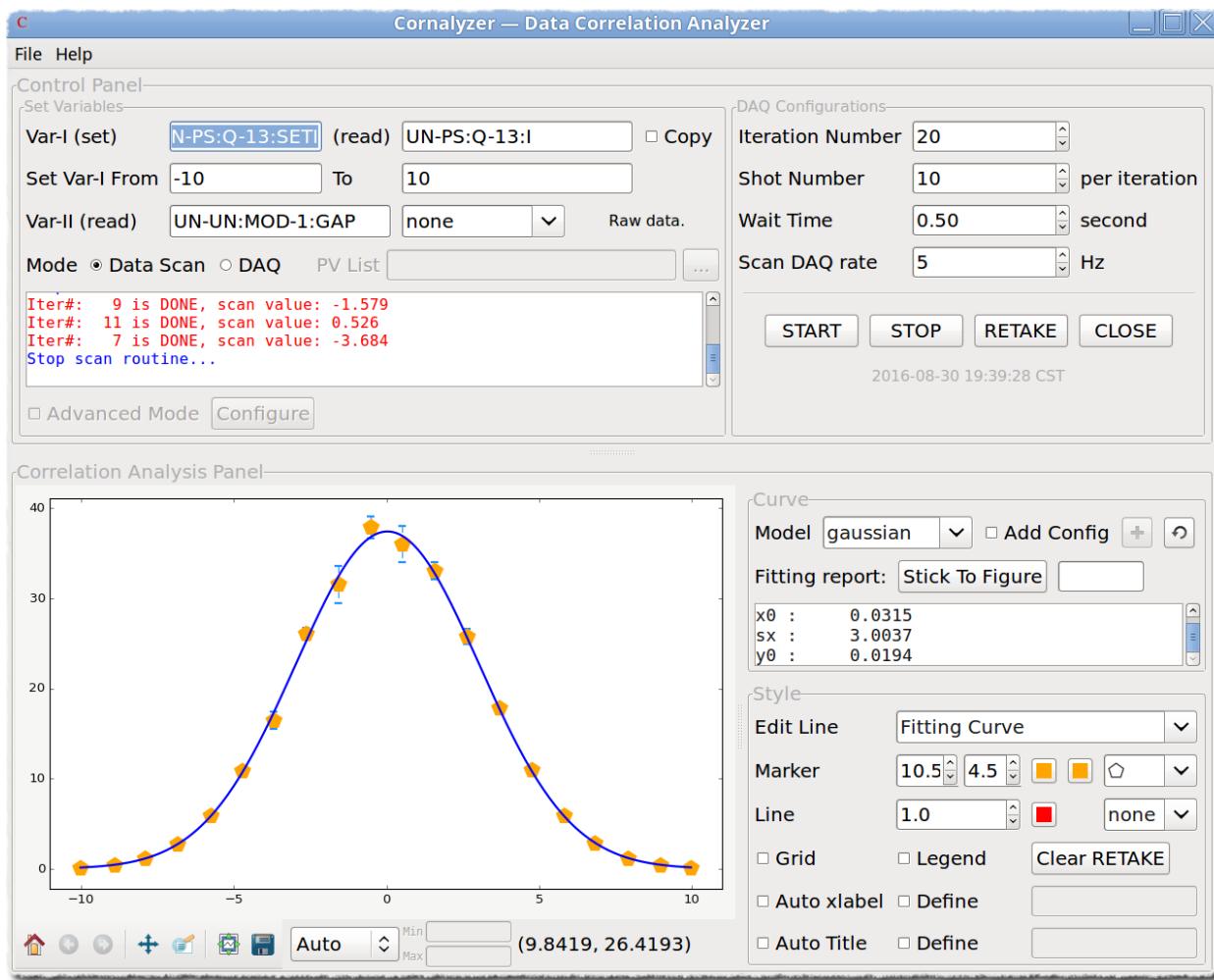


The wrong points have been pushed back.

⁶ Just increase the noise level in the data generating process (soft-IOC side) to magnify this effect; decrease noise level before RETAKE is performed, to mimic that machine status is back to stable or acceptable.

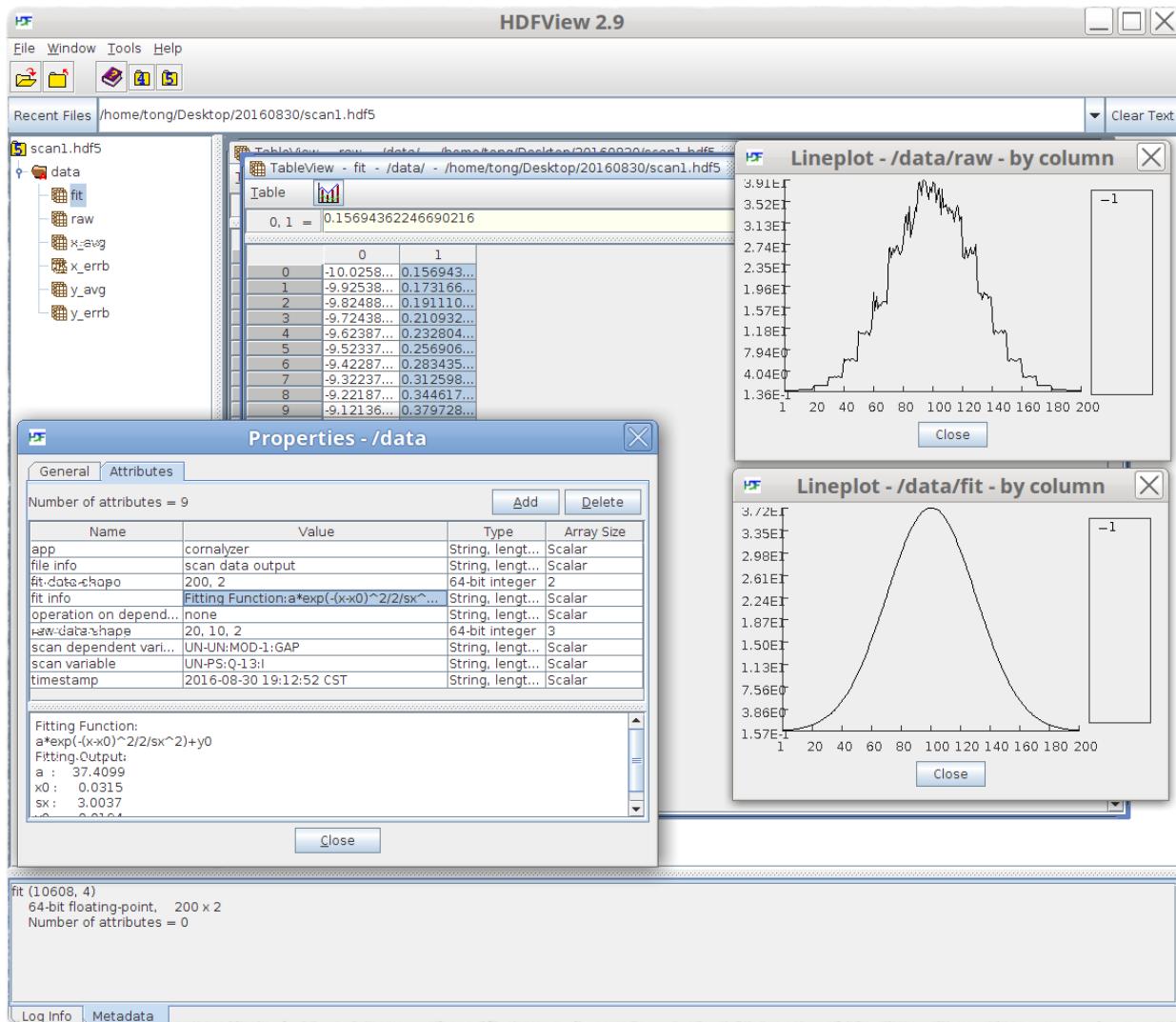


Apply fitting function by refresh button, right aside of +, to get final figure.



Scan Data

CTRL+S could save all the data into defined file, including *raw* and *fit* data, e.g. see below image:



Example 4

felformula – Basic FEL physics calculator app.

Introduction

Help users/operators or other non-FEL physics specialists to understand the FEL facility performance under certain machine configurations should be significant, this app is created for such mission that not only providing the staright-forward FEL calculation results, but also showing the clues for the FEL specialists to turning the machine.

The main features of felformula are:

- FEL parameters calculations based on analytical formulae;
- Parameters scan studies, valid parameters:
 - Beam energy, E_b , unit: MeV

- Energy spread, σ_γ
- Transverse emittance, ϵ_n , unit: m
- Peak current, I_p , unit: A
- Undulator period, λ_u , unit: m
- FEL wavelength, λ_s , unit: m
- Average beta function, β , unit: m
- Bunch charge, Q , unit: C
- Interactive scan results figure plot;
- Data saving/exporting and loading/importing.

Todo

Comprehensive FEL physics studies could be extended to `felformula`, e.g. integrate numerical simulations into Advanced menu (should be created first into the menubar), into which modules could be built to implement various FEL simulation modes, like SASE, HGHG, EEHG, PEHG, and mixtures of them, etc., as well as the algorithms like Twiss-matching, multi-parameters optimization, post-processing for data analysis, etc. Note that every single module should be built with clean and clear APIs, so as to communicate with other modules or apps.

Usage Guide

FEL Calculation

Open `felformula` as the previous examples demonstrated. Fill the Beam Parameters panel to setup the main parameters of an FEL facility, e.g. Dalian Coherent Light Source, the physics meaning of every input parameter should be explained by the name itself. Push Calculate button in the Operations > Command panel to calculate/update the output parameters that listed in FEL Calculations panel, where all the available parameters are grouped into Undulator and E-beam and FEL radiation categories, note that these calculated results are only for reference.

FEL Formula — Calculator for FEL physics

File Help

Cheat Sheet for FEL Physics

Beam Parameters

Beam Energy [MeV]	300
Energy Spread	0.0001
Norm. Emittance [m]	2e-6
Avg. Beta Func. [m]	10
Peak Current [A]	300
Undulator Period [m]	0.025
FEL Wavelength [m]	50e-9
Bunch Charge [C]	0.5e-9
Undulator Length [m]	12
Undulator Type	planar
Bunch Shape	gaussian

FEL Calculations

Undulator and E-beam

Field [T]:	0.373	Gap [mm]:	11.861
K:	0.870	au:	0.615
Bunch length (fs):	664.9	gaussian: rms	
Bunch length (um):	199.5	flattop: full width	
Beam size (um):	184.6		

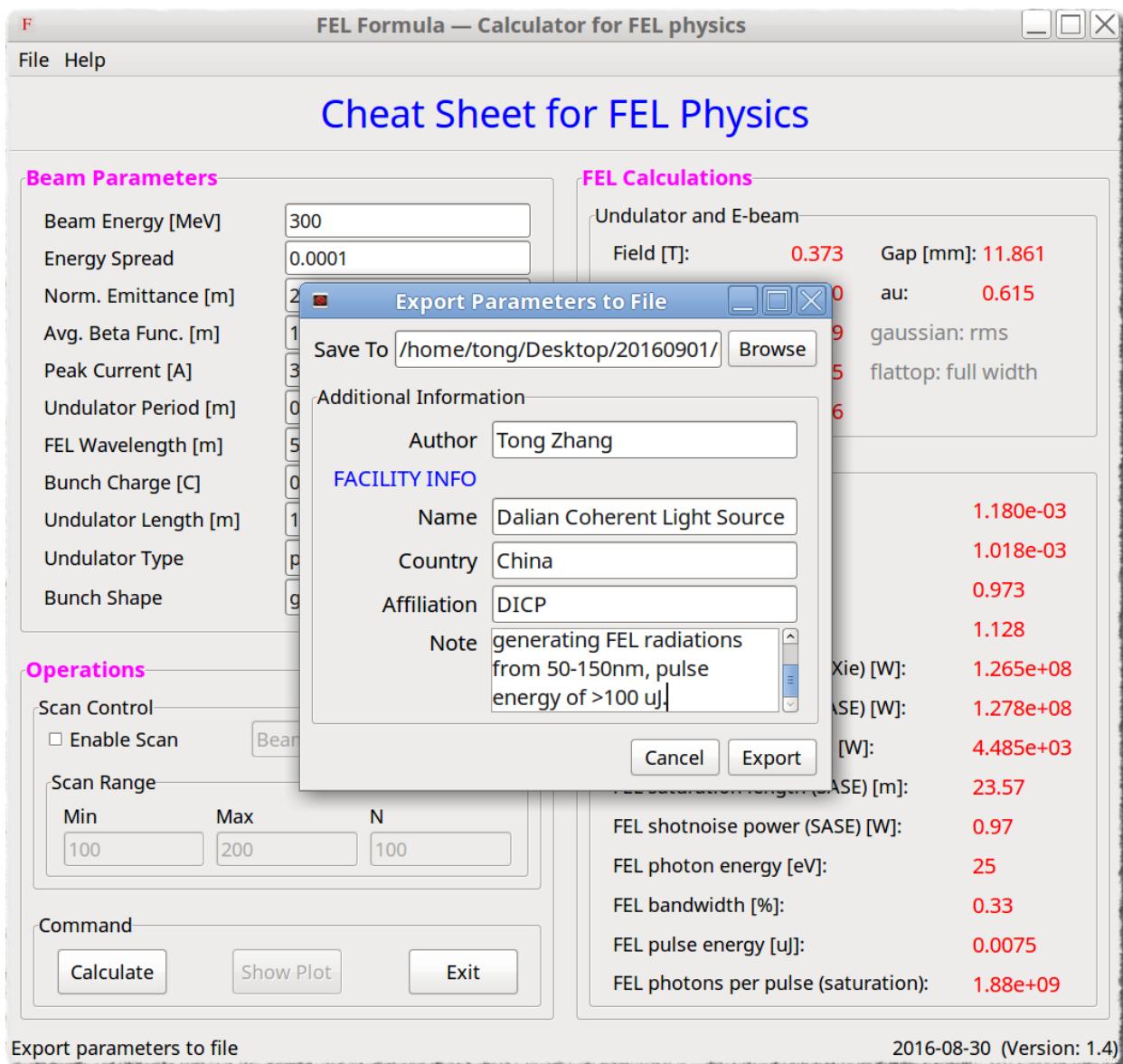
FEL Radiation

FEL parameter (1D):	1.180e-03
FEL parameter (3D):	1.018e-03
FEL gainlength (1D) [m]:	0.973
FEL gainlength (3D) [m]:	1.128
FEL saturation power (MXie) [W]:	1.265e+08
FEL saturation power (SASE) [W]:	1.278e+08
FEL output power (SASE) [W]:	4.485e+03
FEL saturation length (SASE) [m]:	23.57
FEL shotnoise power (SASE) [W]:	0.97
FEL photon energy [eV]:	25
FEL bandwidth [%]:	0.33
FEL pulse energy [uJ]:	0.0075
FEL photons per pulse (saturation):	1.88e+09

FEL formula powered by Python

2016-08-30 (Version: 1.4)

All the data could be exported by File > Export (SHIFT+CTRL+E), additional meta information could be appended into saved file, see the following image.



While the exported data file could also be imported by **File > Import** (SHIFT+CTRL+I), here is the exported file example,

```
[00-info]
author = Tong Zhang
created_time = 2016-09-01 07:20:38 CST
note = note = FEL user facility based on HGHG principle, generating FEL radiations from 50-150nm, pulse energy of >100 uJ.

[01-facility]
affiliation = DICP
country = China
name = Dalian Coherent Light Source

[02-electron_beam]
average_beta_function(m) = 10
bunch_charge(C) = 0.5e-9
bunch_length_t(fs) = 664.9
bunch_length_z(um) = 199.5
bunch_shape = gaussian
central_energy(MeV) = 300
energy_spread = 0.0001
normalized_emittance(m) = 2e-6
peak_current(A) = 300
```

```
transverse_beam_size(m) = 184.6

[03-undulator]
K = 0.870
au = 0.615
gap(mm) = 11.861
peak_field(T) = 0.373
period_length(m) = 0.025
total_length(m) = 12
type = planar

[04-FEL_radiation]
FEL_parameter_1D = 1.180e-03
FEL_parameter_3D = 1.018e-03
bandwidth(%) = 0.33
gainlength_1D(m) = 0.973
gainlength_3D(m) = 1.128
output_power(W) = 4.485e+03
photon_energy(eV) = 25
photon_per_pulse = 1.88e+09
pulse_energy(uJ) = 0.0075
saturation_length_SASE(m) = 23.57
saturation_power_MXie(W) = 1.265e+08
saturation_power_SASE(W) = 1.278e+08
shotnoise_power_SASE(W) = 0.97
wavelength(m) = 50e-9
```

Parameters Scan

Parameters scan feature is supported by checking the `Enable Scan` box, and selecting the parameter to be altered, e.g. average beta function.

FEL Formula — Calculator for FEL physics

Cheat Sheet for FEL Physics

Beam Parameters		FEL Calculations	
Beam Energy [MeV]	300	Undulator and E-beam	
Energy Spread	0.0001	Field [T]:	0.373
Norm. Emittance [m]	2e-6	Gap [mm]:	11.861
Avg. Beta Func. [m]	10	K:	0.870
Peak Current [A]	300	au:	0.615
Undulator Period [m]	0.025	Bunch length (fs):	664.9
FEL Wavelength [m]	50e-9	gaussian: rms	
Bunch Charge [C]	0.5e-9	Bunch length (um):	199.5
Undulator Length [m]	12	flattop: full width	
Undulator Type	planar	Beam size (um):	184.6
Bunch Shape	gaussian		

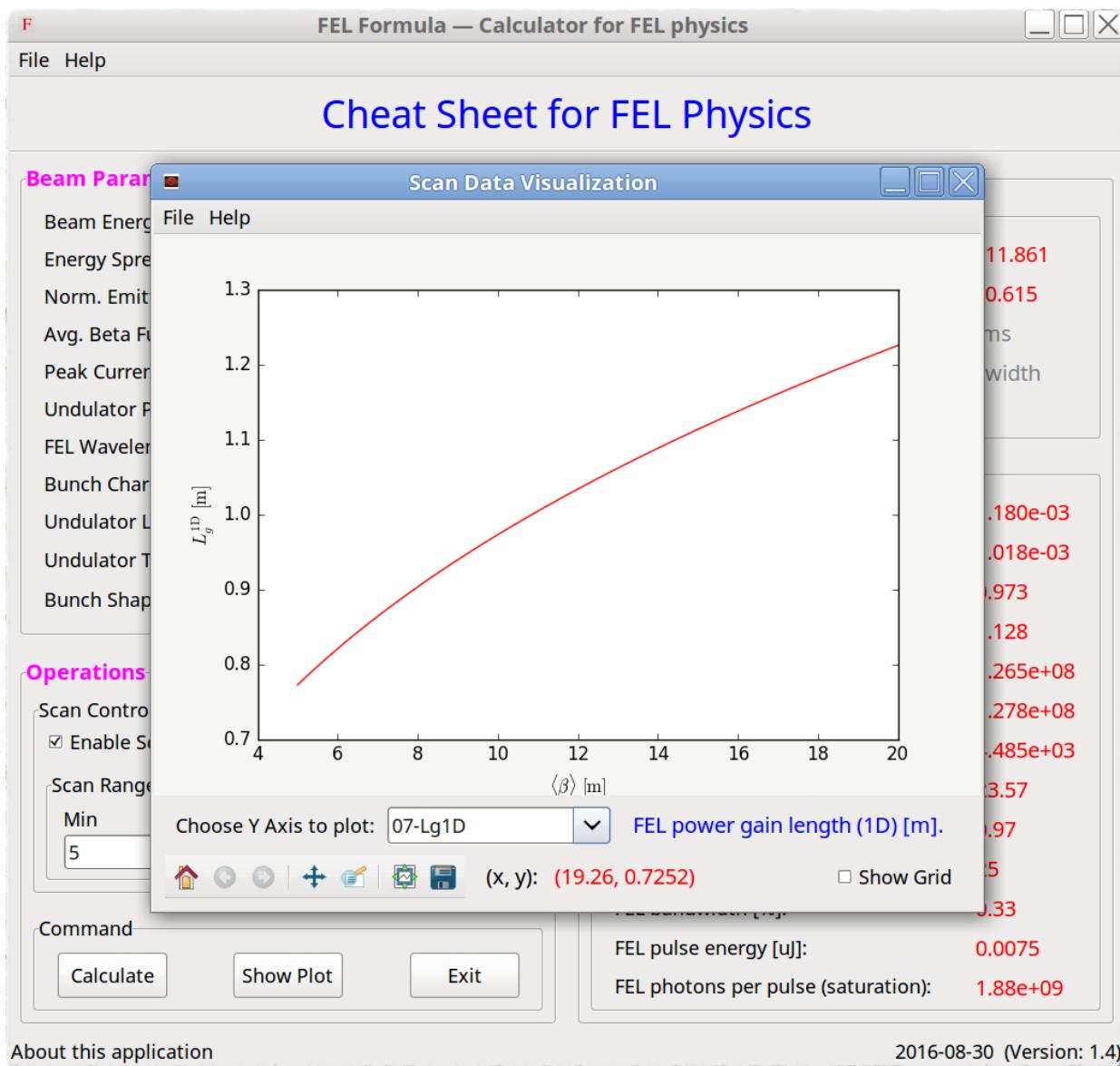
Operations		
Scan Control		
<input checked="" type="checkbox"/> Enable Scan	Avg. Beta Func.	<input type="button" value="▼"/>
Scan Range		
Min	Max	N
5	20	100
Command		
<input type="button" value="Calculate"/>	<input type="button" value="Show Plot"/>	<input type="button" value="Exit"/>

About this application

2016-08-30 (Version: 1.4)

Click Calculate first, then Show Plot to open the figure plot window, where the data for Y-axis could be selected from the following table:

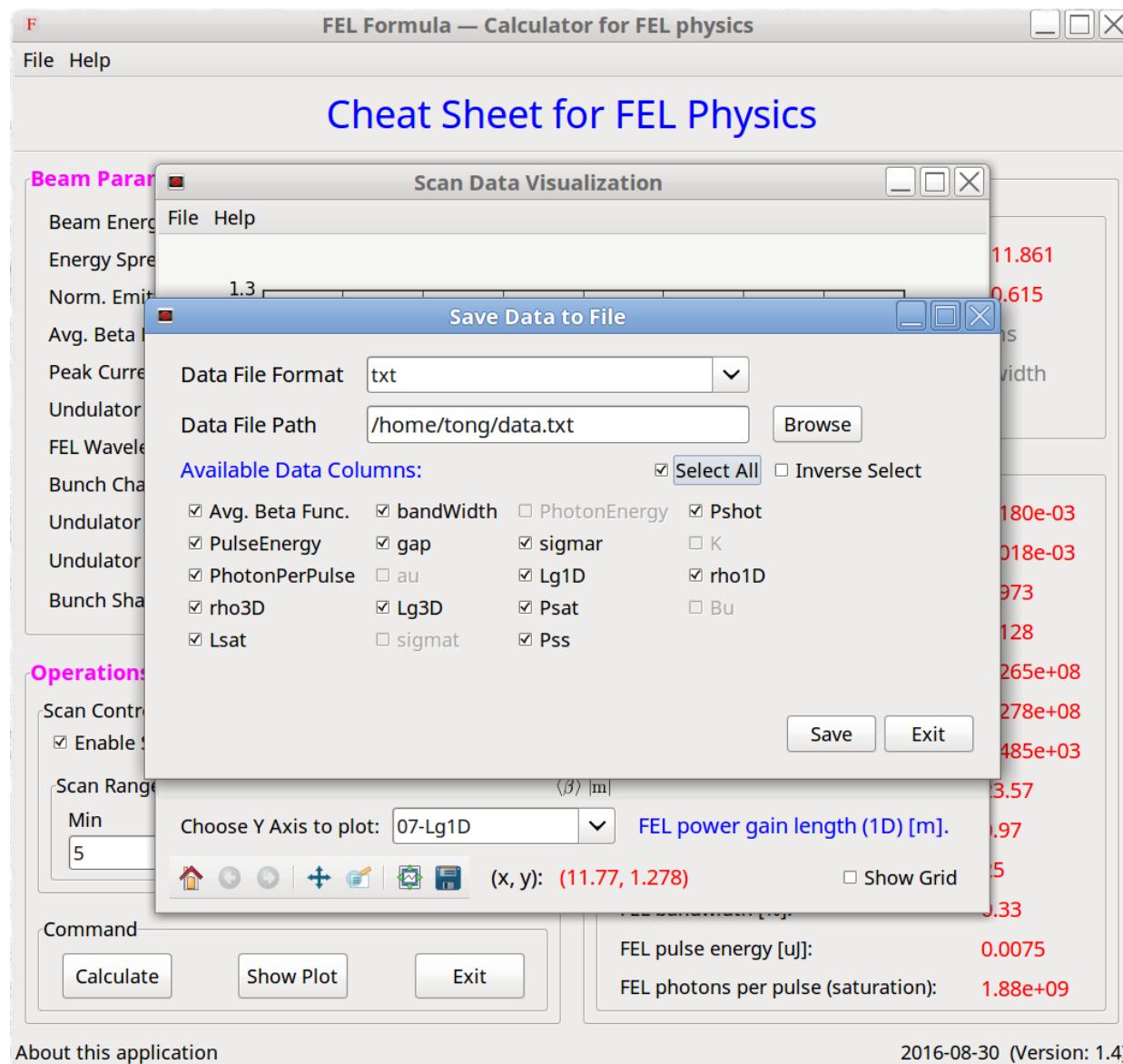
Choice	Symbol	Literal explanations
01-au	a_u	Normalized undulator parameter
02-K	K	Undulator parameter
03-Bu	B_u [T]	Undulator magnetic peak field [T]
04-gap	Gap [mm]	Permanent undulator gap [mm]
05-rho1D	ρ^{1D}	FEL parameter or Pierce parameter (1D)
06-rho3D	ρ^{3D}	FEL parameter or Pierce parameter (3D)
07-Lg1D	L_g^{1D} [m]	FEL power gain length (1D) [m]
08-Lg3D	L_g^{3D} [m]	FEL power gain length (3D) [m]
09-Psat	P_{sat} [W]	FEL saturation power (M.Xie formulae) [W]
10-Pshot	P_{shot} [W]	FEL initial shotnoise power [W]
11-Pss	P_{ss} [W]	FEL saturation power (SASE) [W]
12-Lsat	L_{sat} [m]	FEL saturation length (SASE) [m]
13-sigmar	σ_r [μm]	Transverse e-beam radius size (rms) [micro m]
14-sigmat	σ_t [fs]	Temporal bunch length (rms) [fs]
15-bandWidth	$\Delta\lambda/\lambda$ [%]	FEL bandwidth [%]
16-PhotonEnergy	E_p [eV]	FEL photon energy [eV]
17-PulseEnergy	W [μJ]	FEL pulse energy [micro J]
18-PhotonPerPulse	Photon #/pulse	FEL photon number per pulse



About this application

2016-08-30 (Version: 1.4)

The figure will be automatically updated when selected valid parameters.



The data could also be saved by SHIFT+CTRL+S, or CTRL+S to save the figure. Select the data columns that to be saved, the grey ones are invalid, example file see here.

Example 5

latticeviewer – Accelerator online modeling app.

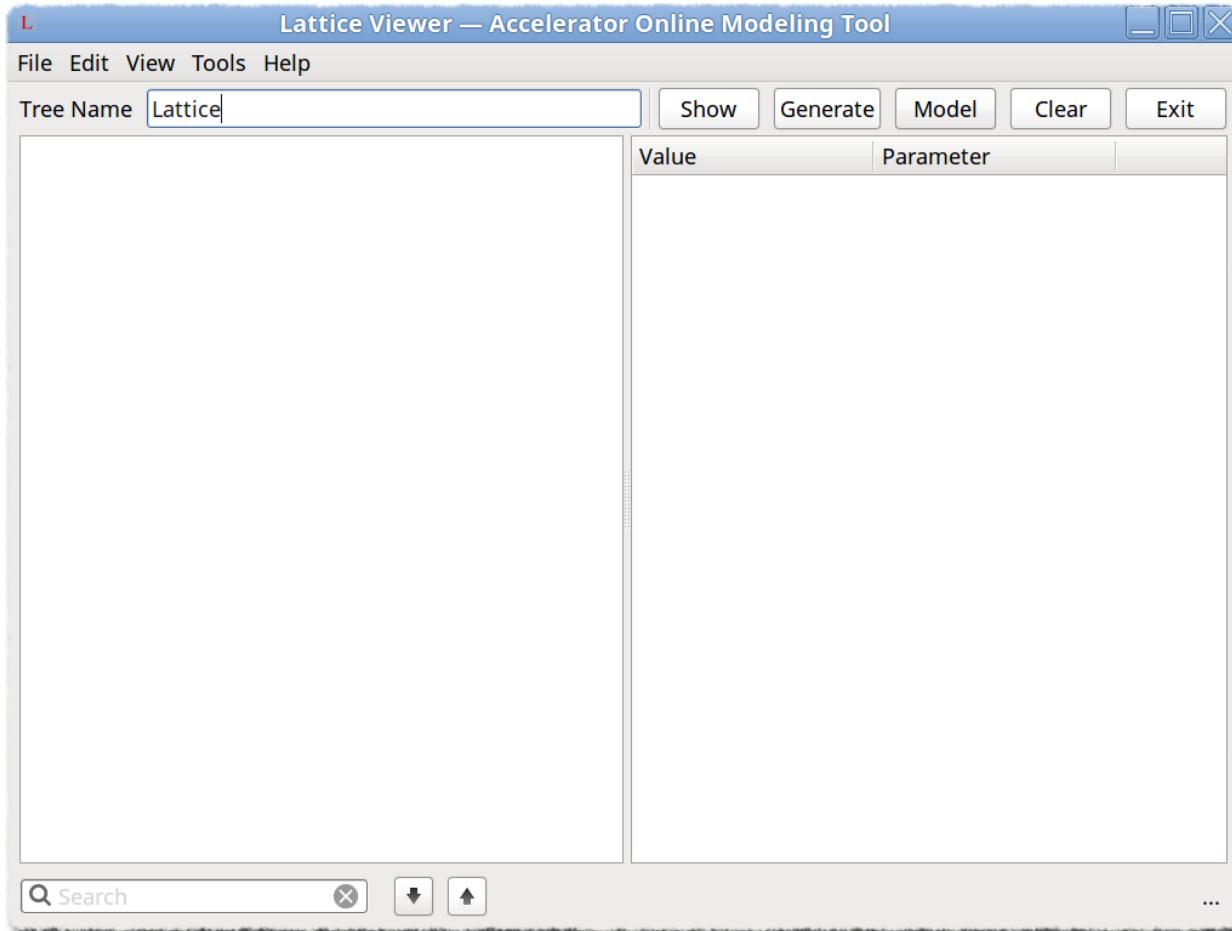
Note: latticeviewer is an app based on package beamline, and is wrapped by felapps to present the GUI to the users, either in the main panel of runfelapps or appdrawer, or the script named latticeviewer or lv.

Introduction

This app is built upon the console environment of accelerator online-model, which provides the basic toolkits to translate the real accelerator machine (as well as free-electron laser facility) into computer-recognized objects, such that manipulation to the real machine should be operated on the software level, so intuitively, this app should be the base on which physics-related procedures/extensions could be built. In this example, the basic online-model procedure will be presented, contrasted to the CLI approach demonstrated [here](#).

Usage Guide

Open app by `lv` or `latticeviewer`, just like the following image shows:



The acceptable file should be either valid `lte` file (which is lattice file that could be used by Elegant) or `JSON` file (which is converted from valid `lte` file).

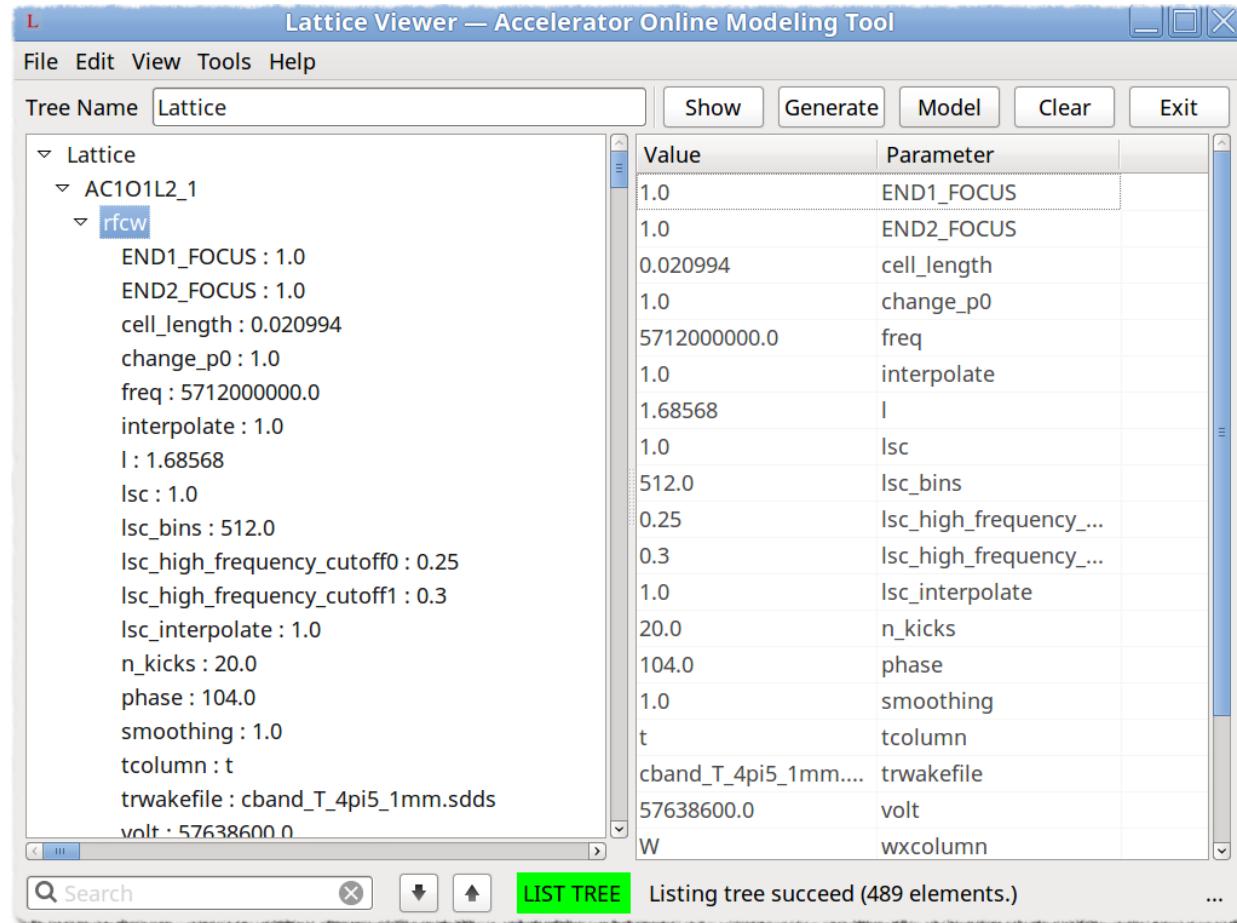
Note: `lte` file could be converted to `JSON` file and vice versa, see commands' [doc: lte2json](#) and [json2lte](#).

Open File

Click `File > Open` (`CTRL+O`) to import the lattice file (`lte` or `JSON`), here take the lattice of Shanghai soft x-ray free-electron laser (SXFEL) as example, here is the `lte` file, which covers injector, LINAC, linac-to-undulator

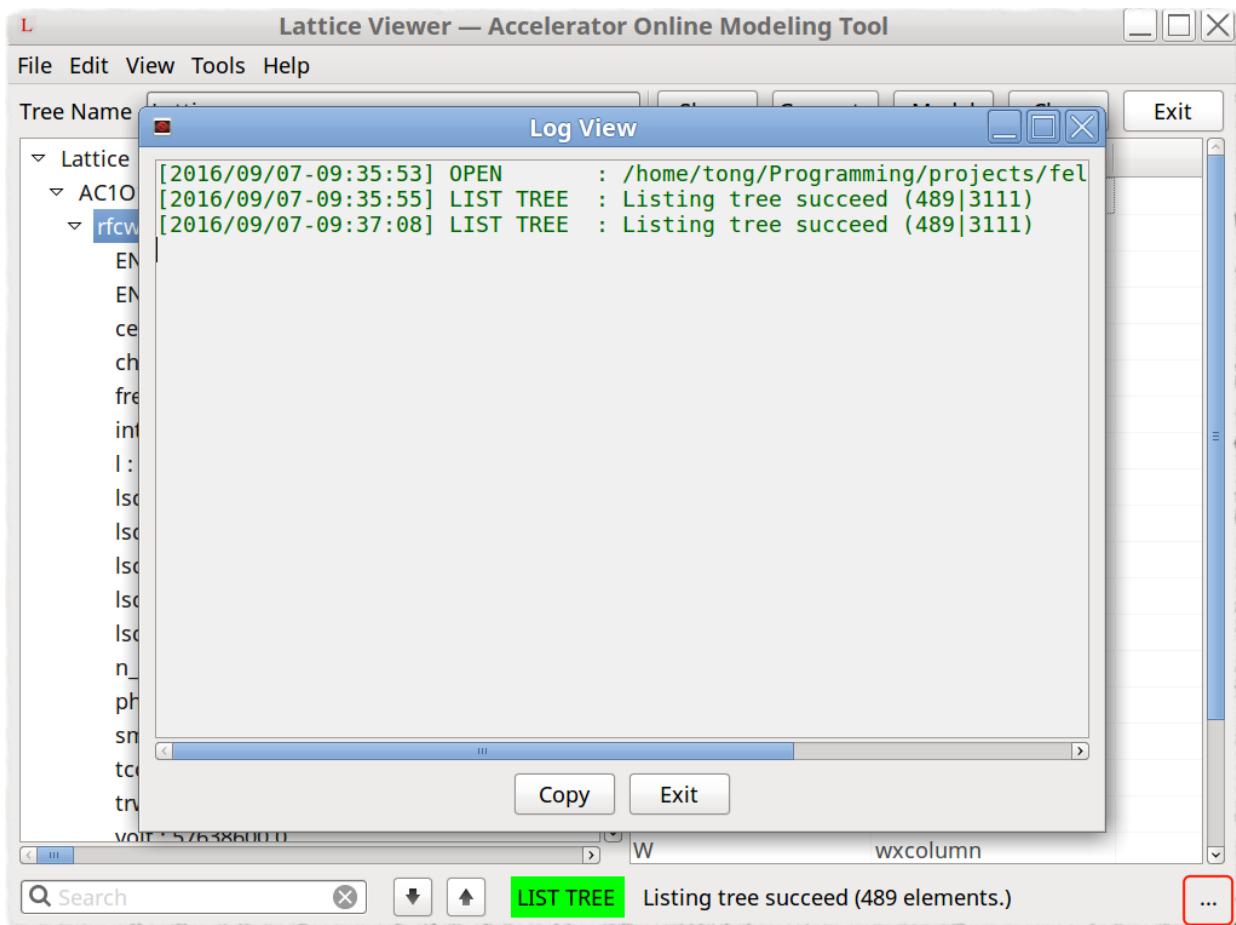
sections, while possible ele file and other required files that could be used to accomplish Elegant tracking could be download here and injector data if needed.

After the file is opened, the lattice would be parsed into tree list as shown in the left panel of latticeviewer, with the tree rootname of Lattice (which could be changed in Tree Name box¹). All elements could be reached either by clicking the items or by searching the keywords in the left bottom search box. When element is selected, e.g. rfcw is selected, the right panel will list all the properties of selected item, just like the following image shows.



In the right bottom, push red squared button, the brief operation log will pop up, from which one can grab basic information about the loaded lattice file, e.g. here indicates that 489 elements and 3111 properties have been parsed, if operation fails, the green boxed LIST TREE status should turn red.

¹ When the tree name is changed, Reopen (CTRL+R) is needed.



Currently, the operations of the properties listing panel only support `Highlight` and `Edit`, it is envisioned that more functionality should be extended.

Operations

`latticeviewer` is designed to be an online-modeling app, other high-level operations should be based on the fundamental lattice parsing feature, below is the main operations:

Show

If lattice file is not opened by Open menu, push Show button should give guideline to locate the valid lattice file to show.

Generate

This button if the first step of online-modeling, heavy tasks about the element/beamline modeling will be done if Generate is pushed, dialog will pop up if some other operation trigs this operation.

Model

This button is required by the online-modeling, another approach implemented on the GUI app².

Clear

Clear the lattice tree.

² The CLI approach could be found in beamline's doc.

Exit

Quit the app.

Menu operations

- Save, CTRL+S;
- Save AS, SHIFT+CTRL+S;
- Choose beamline, SHIFT+CTRL+B;
- Lattice visualization, SHIFT+CTRL+V.
- View lattice in three format: raw string, JSON string, dict.

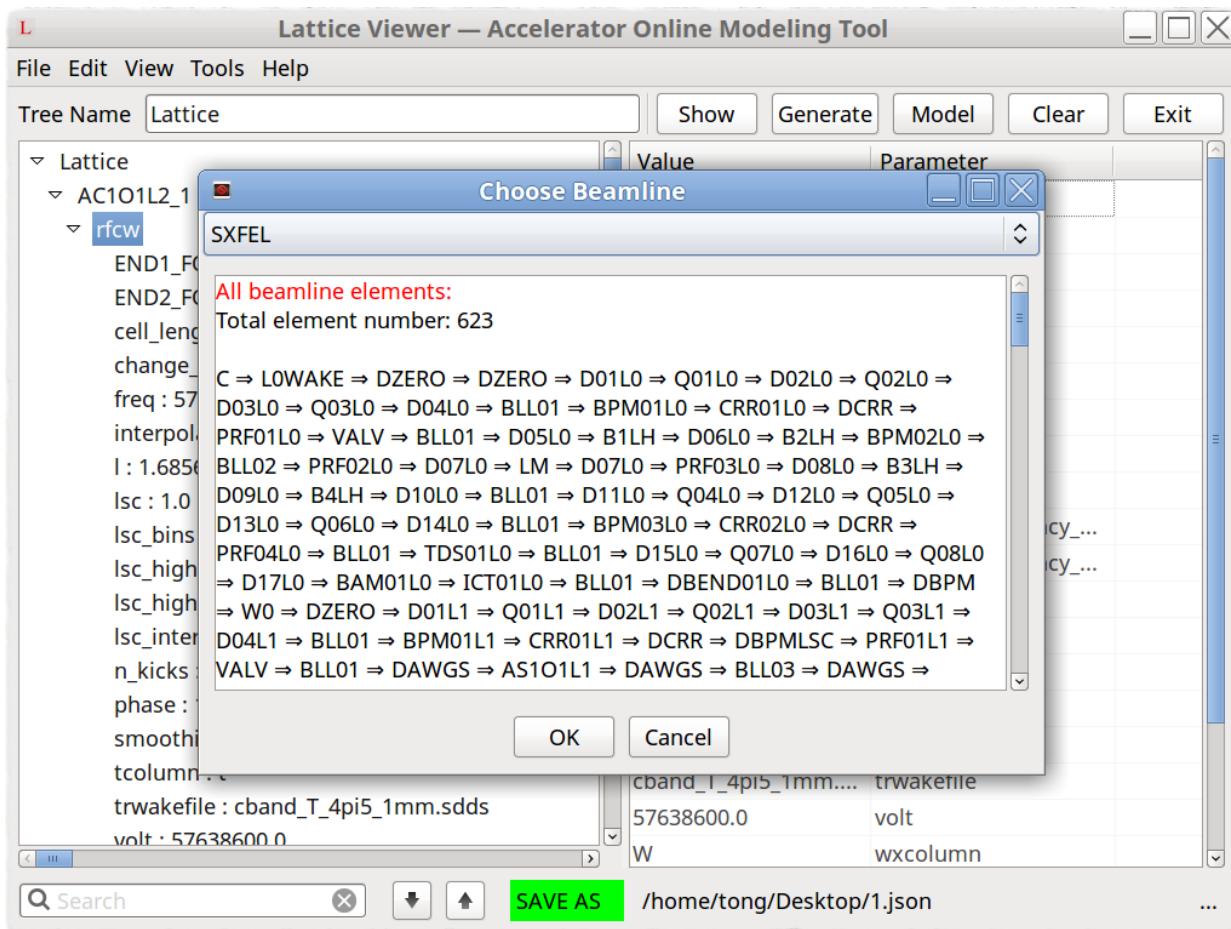
Examples

Save AS

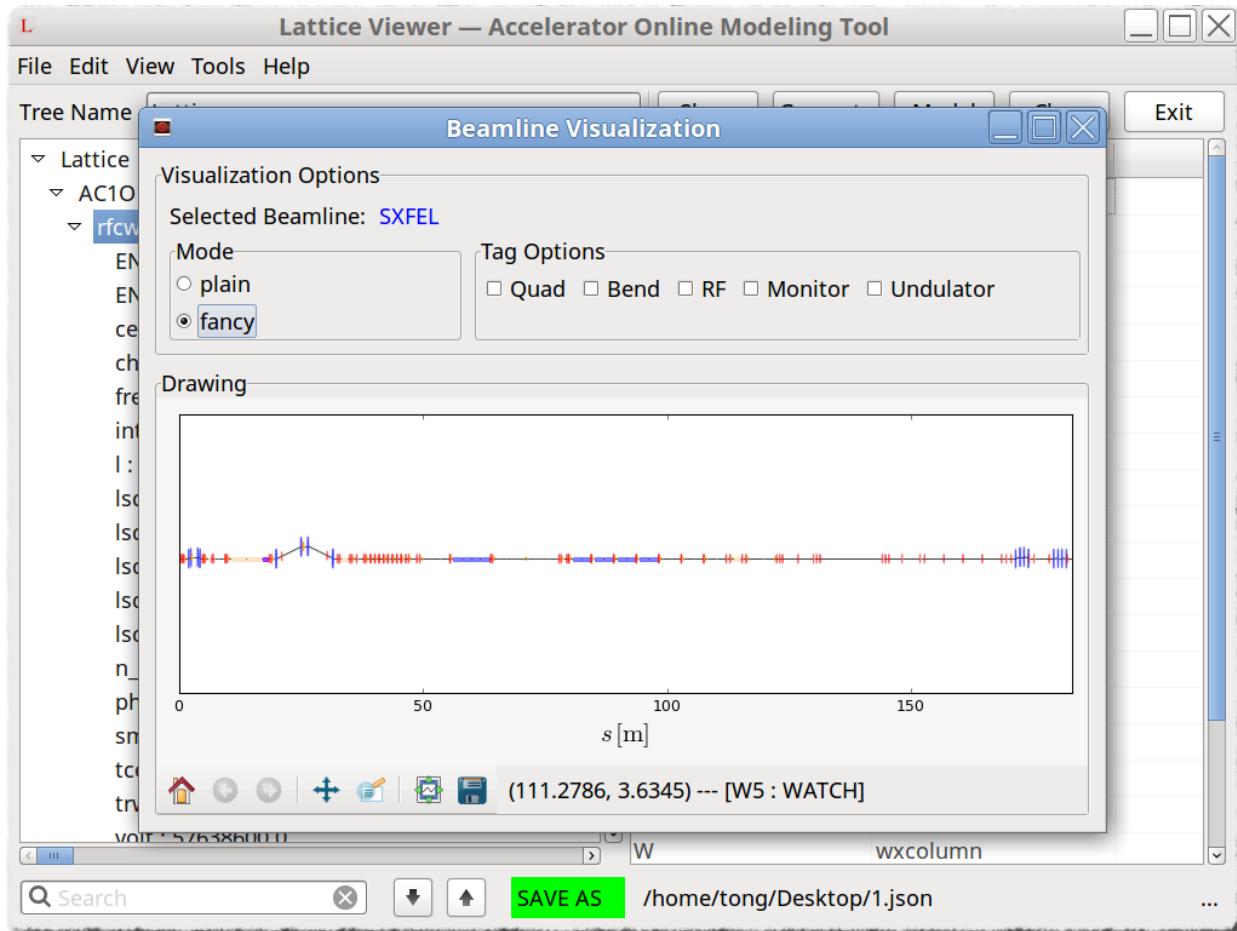
Push Generate, and SHIFT+CTRL+S to save lattice as JSON format.

Model Selected Beamline

Push SHIFT+CTRL+B to select the beamline name that to be modeled, e.g. SXFEL here is the beamline defined in 1te file that including elements from LINAC and LTU. Click OK to confirm.



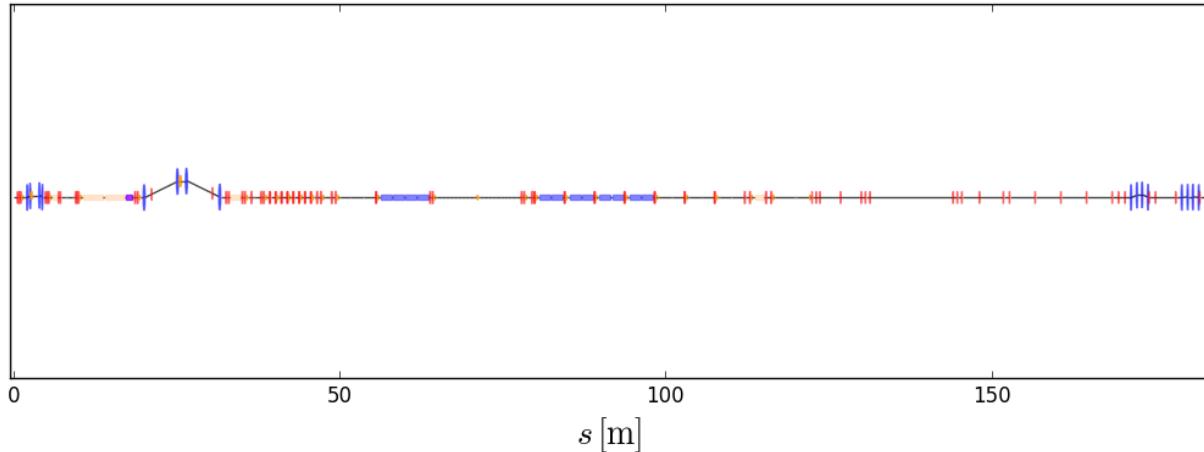
Click Model button to finish the modeling procedure, then push SHIFT+CTRL+V to open Tools > Visualization window.



In this window, the artist view of the selected beamline is firstly shown in the Drawing panel, which support features like:

- Operations provides by the bottom toolbar, e.g. *panning, zooming, save as*, etc.
- Element name tooltips, i.e. show the element name and type in the right of toolbar when mouse move onto the element, as well as the s position along the beamline.

Also, type name annotation feature is supported, by checking in Tag Options panel.



Todo

Note that `latticeviewer` is just a GUI app that only facilitate part of online-modeling operations, all the infrastructure features that make this possible are built into CLI, thus more features that would be implemented in the GUI framework should require much more effort. The ideal development cycle is to built high-level operations to the lattice into Tools menu, after all the algorithms have been well tested in the CLI framework.

Example 6

`wxmpv` – General matplotlib viewer app.

Introduction

`wxmpv` is the brief of `wx[Python] matplotlib[lib] viewer` or `wx[Python] mat[lab] plot viewer`, is designed with the intention of to provide the universal interface to manipulate the data files in the plot analysis stage, basic features should be included, such as:

- data loading/saving
- figure plot
- figure style tuning
- curve fitting
- etc.

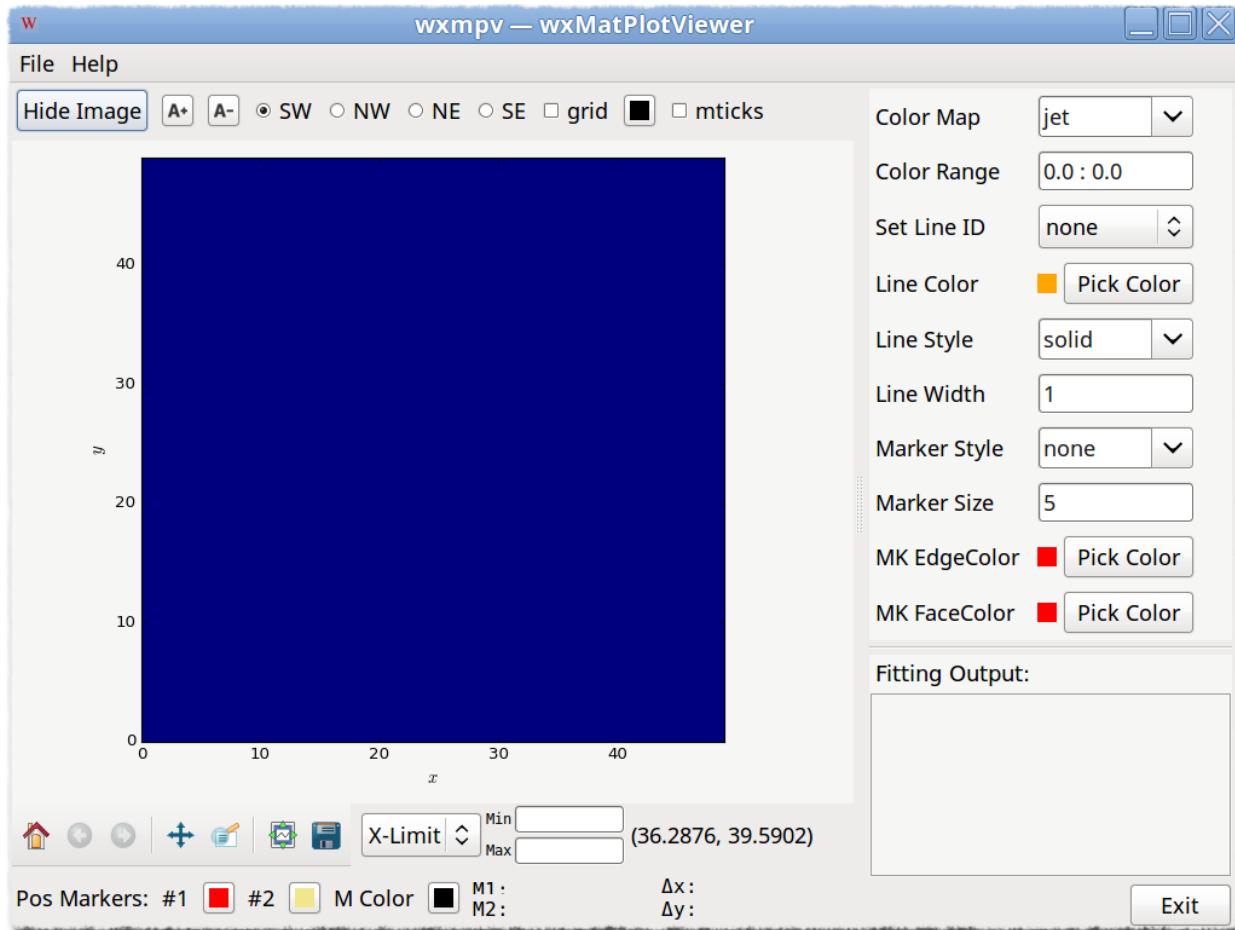
Currently, `wxmpv` could be used to operate these two (2) kinds of hdf5 data that generated from `imageviewer`¹:

- data saved by CTRL+D in `imageviewer`
- data generated from Autosave operation of `imageviewer`

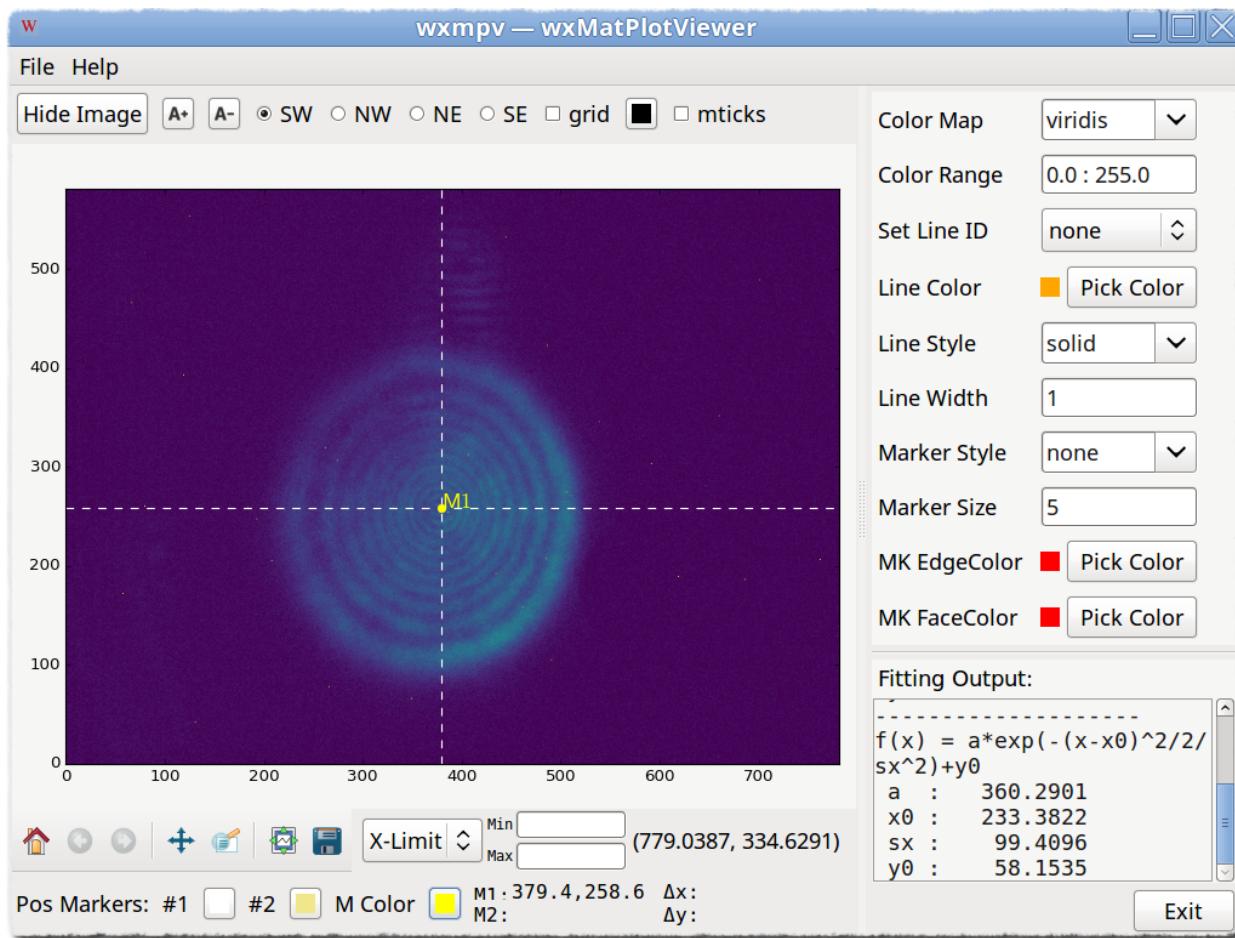
¹ hdf5 data format should be first set in Configurations menu, Image Data Name Extension and choose hdf5 in Auto save window.

Usage Guide

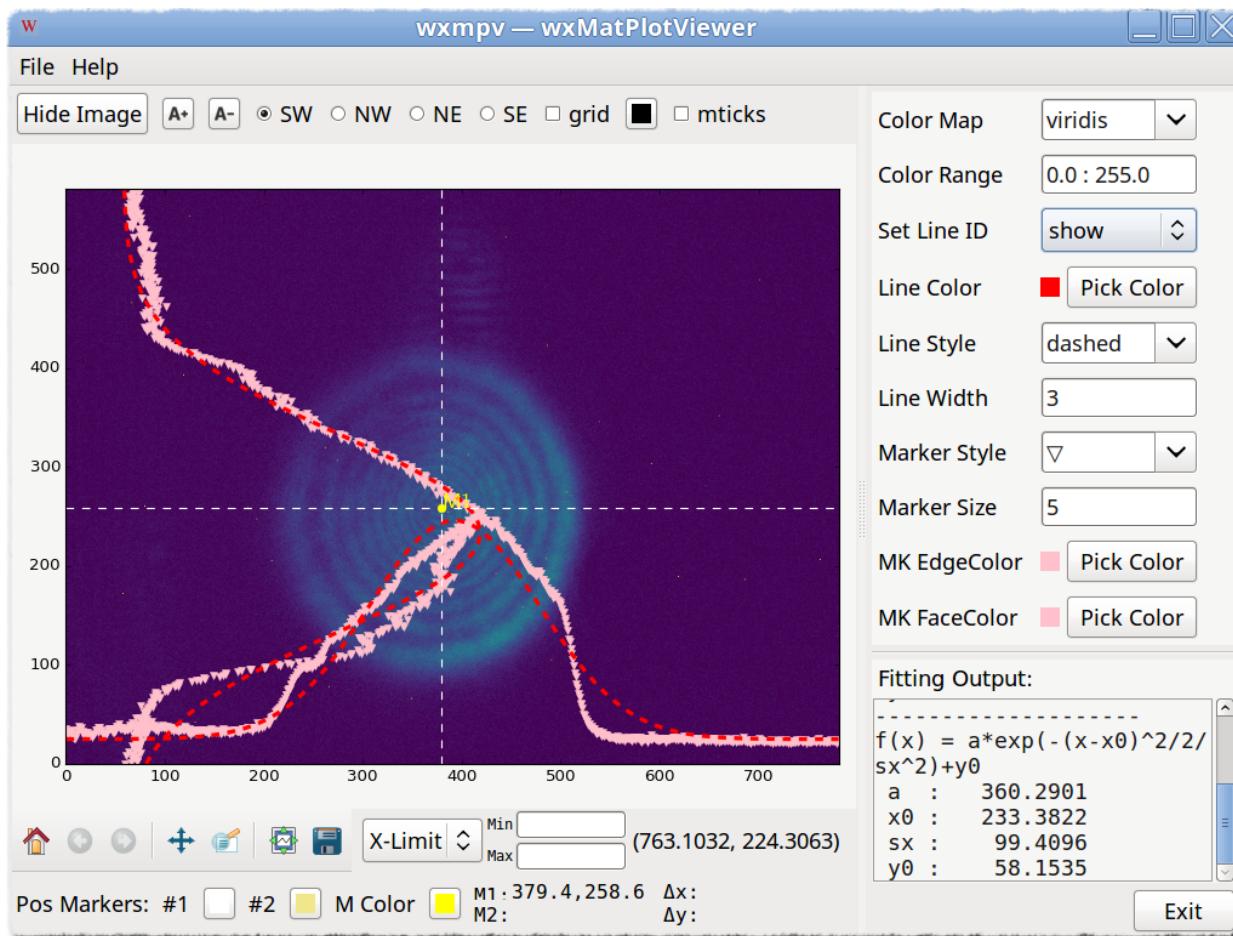
Open wxmpv, just like the following image shows, there are mainly two operation sections, the top and bottom region of figure and the style configuration panel in the right, as well as the curve fitting panel.

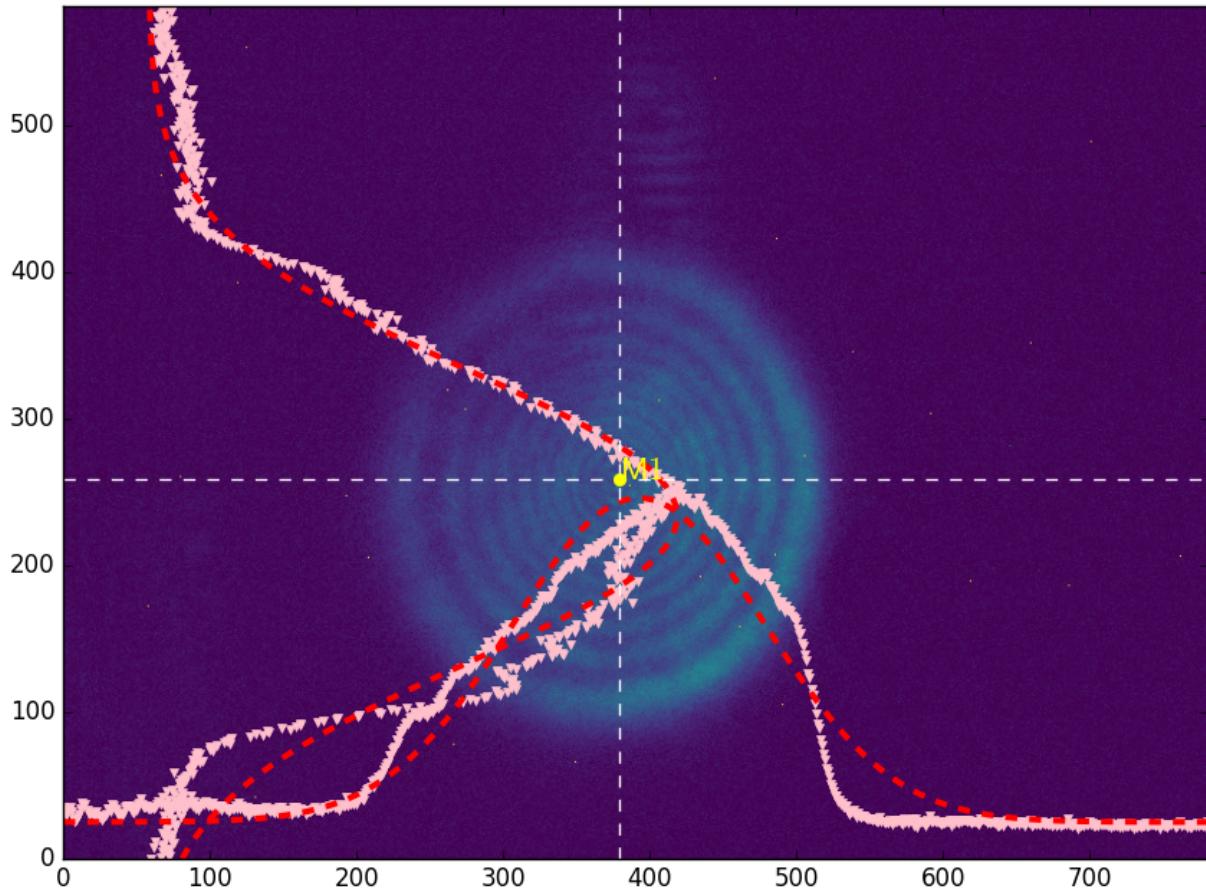


Click File > Open (CTRL+O) to open supported hdf5 data file, both image and data curve should be plotted onto the figure, style adjustment to the image and curve is possible.



For example, when tuning the curve styles, push Hide Image to hide the image temporarily, and click Set Line ID to select the line to adjust the style, valid options: line color, line width, line style, marker color, marker size, marker style, etc.; while the image could be adjusted with different type of color maps and color ranges, to meet the users' demanding.





The figure could be saved as eps, ps, png, etc. Other options could be tried by the users.

Todo

wxmpv should be extended to support more data plotting functionality, so as to serve as the general-purpose data plotting and manipulation app.

Shortcut: CTRL+S would save all the data into hdf5 format, sample file could be downloaded [here](#).

felapps package

Python package created for the commissioning of free-electron laser facilities, providing general-purpose graphical user interface applications to fulfill various tasks, such as image DAQ, data post-processing, data correlation analysis and FEL physics calculations, etc. Friendly user interactive approaches are subtly designed, as well as the straight-forward distribution manner.

felapps is the beginning phase to the world of python-powered software ecosystem that could be served as the infrastructure for the future versatile large-scale scientific facilities.

Warning: Before installing felapps, another python package beamline is required, so install that package first, see [the documentation](#).

Brief guide to the users:

1. type `runfelapps` or `appdrawer` in the terminal to open the main app portal of felapps;
2. in [i]python terminal, first import `felapps`, then call `felapps.imageviewer.run()` to open `imageviewer` app, the same rule applies to other apps:
 - `dataworkshop`
 - `cornalyzer`
 - `felformula`
 - `wxmpv`

Version 1.5.13

Author Tong Zhang (zhangtong@sinap.ac.cn)

Subpackages

felapps.apps package

This subpackage is designed for the interfaces of ready-to-use GUI applications that built from other sub-packages, such as `utils`, `physics`, etc.

These are the applications available:

- `appdrawer`
- `cornalyzer`

- dataworkshop
- felformula
- imageviewer
- latticeviewer¹
- wxmpv

Subpackages

felapps.apps.appdrawer package

Submodules

felapps.apps.appdrawer.appdrawer module

main launcher panel for all available apps from felapps

Author: Tong Zhang Created: Oct. 8, 2015

```
class AppDrawerFrame(parent, appversion='1.0', icon_set=None, **kwargs)
    Bases: wx._windows.Frame

    createMenubar()
    createPanel()
    createStatusBar()
    createToolbar()
    exitApp()
    initUI()
    onExit(event)
    postInit()
    preInit()

class AppDrawerPanel(parent, version, icon_set, *args, **kwargs)
    Bases: wx._windows.Panel

    createPanel()
    onClickAppC(event)
    onClickAppD(event)
    onClickAppF(event)
    onClickAppI(event)
    onClickAppL(event)
    onClickAppM(event)
    onClickAppW(event)
    onTickTime(event)
```

¹ Implement in package beamline, only integrate into appdrawer.

```
class InspectApp(redirect=False, filename=None, useBestVisual=False, clearSigInt=True)
    Bases: wx._core.App, wx.lib.mixins.inspection.InspectionMixin

    OnInit()

run(maximize=True, logon=False, debug=True, **kws)
    function to make appdrawer app run.
```

Module contents

[felapps.apps.cornalyzer package](#)

Submodules

[felapps.apps.cornalyzer.cornalyzer module](#)

cornalyzer: correlation analyzer, study the relation between parameters

Author: Tong Zhang Created: May. 27, 2015

```
class InspectApp(redirect=False, filename=None, useBestVisual=False, clearSigInt=True)
    Bases: wx._core.App, wx.lib.mixins.inspection.InspectionMixin

    OnInit()

run(maximize=True, logon=False, debug=True)
    function to call cornalyzer
```

Module contents

[felapps.apps.dataworkshop package](#)

Submodules

[felapps.apps.dataworkshop.dataworkshop module](#)

DataWorkshop: application to handle data, e.g. generated from imageviewer

Author: Tong Zhang Created: Sep. 23rd, 2015

```
class InspectApp(redirect=False, filename=None, useBestVisual=False, clearSigInt=True)
    Bases: wx._core.App, wx.lib.mixins.inspection.InspectionMixin

    OnInit()

run(maximize=True, logon=False, debug=True)
    function to make dataworkshop app run.
```

Module contents

[felapps.apps.felformula package](#)

Submodules

felapps.apps.felformula.felformula module

FelFormula: calculation cheat sheet for free-electron laser physics

Author: Tong Zhang Created: May. 28, 2015 (re-organized)

class InspectApp(*redirect=False, filename=None, useBestVisual=False, clearSigInt=True*)

Bases: wx._core.App, wx.lib.mixins.inspection.InspectionMixin

OnInit()

run(*maximize=True, logon=False, debug=False*)

function to call felformula GUI

Module contents

felapps.apps.imageviewer package

Submodules

felapps.apps.imageviewer.imageviewer module

ImageViewer: universal application for image viewing and data post-processing.

Author: Tong Zhang Created: Feb. 3rd, 2015

class InspectApp(*redirect=False, filename=None, useBestVisual=False, clearSigInt=True*)

Bases: wx._core.App, wx.lib.mixins.inspection.InspectionMixin

OnInit()

run(*maximize=True, logon=False, debug=False*)

function to make imageviewer app run.

Module contents

felapps.apps.wxmpv package

Submodules

felapps.apps.wxmpv.wxmpv module

General matplotlib plot panel developed by wxPython (UI) and Python

Author : Tong Zhang Created: 2016-07-05 21:20:05 PM CST

class InspectApp(*redirect=False, filename=None, useBestVisual=False, clearSigInt=True*)

Bases: wx._core.App, wx.lib.mixins.inspection.InspectionMixin

OnInit()

class MainFrame(*parent, appversion='0.2'*)

Bases: felapps.utils.analysisframe.AnalysisFrame

on_about(*event*)

on_exit(*event*)

```
on_info(event)
on_open(event)
on_save(event)
save_data(fname, data)

run(logon=False, debug=False)
    function to make app run.
```

Module contents

felapps.physics package

This subpackage is designed for the purpose of including physics-related modules, both accelerator physics and FEL physics.

Submodules

felapps.physics.felbase module

Python module for the basis of free-electron laser calculation.

```
class FELcalc(_beamEnergy=6000.0, _relativeEnergySpread=0.0001, _unduPeriodLength=0.015, _avgBetaFunc=20.0, _radWavelength=1e-10, _normEmittance=4e-07, _peakCurrent=3500.0, _bunchCharge=5e-10, _undulatorLength=10.0, _bunchShape='gaussian', _undulatorType='planar')
```

Bases: `felapps.physics.felbase.PhysicalConstants`

Analytical calculation for Free-electron Laser physics

Usage: `res = FELcalc(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10)`

Parameters

- **p1** – beamEnergy, [MeV]
- **p2** – relative energy spread
- **p3** – undulator period length, [m]
- **p4** – average beta function, [m]
- **p5** – radiation wavelength, [m]
- **p6** – normalized transverse emittance, [m]
- **p7** – peak current, [A]
- **p8** – bunchCharge [C]
- **p9** – undulatorLength [m]
- **p10** – bunchShape, 'gaussian' or 'flattop'

Return `res` dict, keys: "au", "bu", "gap", "sigmar", "rho1D", "rho3D", "Lg1D", "Lg3D", "Psat", "Pshot", "Pss"

findSatFactor(nl, l3, xlamd, factor0=20)

Calculator saturation length in the unit of 3D power gainlength

Parameters

- **factor0** – initial saturation factor, saturation length over power gain length
- **n1** – electron count within one unit of FEL wavelength
- **l3** – power gain length (3D)
- **xlamd** – undulator period

onFELAnalyse()

Apply M. Xie formulae for FEL analytical estimation

class HalbachPerm(_a=3.33, _b=-5.47, _c=1.8, _lambdaU=20, _Bu=1.0)
Bases: `object`

Input parameters:

Parameters

- **_a** – first Halbach parameter
- **_b** – second Halbach parameter
- **_lambdaU** – undulator period length, [mm]

Parma _c third Halbach parameter

Parma _Bu undulator magnetic field, [T]

findGap(*gap0*=10)

Solve undulator gap value

Parameters **gap0** – initial gap value vector, [mm]

Returns gap value in [mm]

class PhysicalConstants

Bases: `object`

Physical constants

Parameters

- **c0** – c_0 , velocity of light in vacuum
- **epsilon0** – ϵ_0 , permittivity in vacuum
- **mu0** – μ_0 , permeability in vacuum
- **e0** – e , electron charge, [C]
- **m0** – m_e , electron mass, [kg]
- **h0** – h , Plank constant
- **currentA** – I_A , Alven current, [A]

c0 = 299792458.0

currentA = 17045

e0 = 1.60218e-19

epsilon0 = 8.85418781762039e-12

h0 = 6.62607e-34

m0 = 9.10938e-31

```
mu0 = 1.2566370614359173e-06

test1()
test2()
test3()
```

felapps.physics.felcalc module

Author: Tong Zhang Create Time: 15:22, Jan. 15, 2015 first version is written in MATLAB on Dec. 25th, 2014.

```
class DataSaveFrame(parent, dataparent, title, **kwargs)
    Bases: wx._windows.Frame

        InitUI()
        onCheckCols1(event)
        onCheckCols2(event)
        onChooseFmt(event)
        onChoosePth(event)
        onExit(event)
        onSave(event)

class ExportFrame(parent, title, **kwargs)
    Bases: wx._windows.Frame

        InitUI()
        onCancel(event)
        onChoose(event)
        onExport(event)

class InfoFrame(parent, title, **kwargs)
    Bases: wx._windows.Frame

        InitUI()

class LogFrame(parent, title, **kwargs)
    Bases: wx._windows.Frame

        InitUI()
        onShowCLog(event)

class MainFrame(parent, size=(800, 600), appversion='1.0', **kwargs)
    Bases: wx._windows.Frame

        collectAllParams()
        createMenu()
        createPanel()
        createStatusbar()
        initUI()
        onAbout(event)
```

```
onCalc(event)
onChangelog(event)
onEnableScan(event)
onExit(event)
onExport(event)
    Export input parameters and output results into file (for next import or archive)
onExportJ(event)
    Export input parameters and output results as a json string to file
onImport(event)
    Import parameters from external configuration file
onInfo(event)
onMenuHL(event)
onPlot(event)
onSetInitialScanRange(event)
onTextEnter(event)
updateUI(paramsdict)
    update UI with import parameters from .conf file

class PlotFrame(parent, title, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    createMenu()
    createPanel()
    createToolbar()
    onAboutPlot(event)
    onExitPlot(event)
    onGridCheck(event)
    onMotion(event)
    onPlotChoice(event)
    onSaveData(event)
    onSavePlot(event)
    repaint()
    setColor(rgbtuple=None)

run()
```

felapps.utils package

This subpackage is designed for providing essential modules, classes, functions that felapps needs to accomplish various different tasks, basically all the modules are grouped by the type of the task.

Submodules

`felapps.utils.analysisframe module`

Subclass of PlotFrame, which is generated by wxFormBuilder.

```
class AnalysisFrame(parent, datasrc)
Bases: felapps.utils.myui.PlotFrame

    cmap_cbOnCombobox(event)
    crange_tcOnTextEnter(event)
    direct_xyaxis(x_direction, y_direction)
    exitApp()
    exit_btnOnButtonClick(event)
    get_data(datasrc=None)
    grid_ckbOnCheckBox(event)
    imhide_tgbtnOnToggleButton(event)
    lc_btnOnButtonClick(event)
    lineid_choiceOnChoice(event)
    ll_originOnRadioButton(event)
        set origin lower left
    lr_originOnRadioButton(event)
        set origin lower right
    ls_cbOnCombobox(event)
    lw_tcOnTextEnter(event)
    mec_btnOnButtonClick(event)
    mfc_btnOnButtonClick(event)
    mk_cbOnCombobox(event)
    ms_tcOnTextEnter(event)
    mticks_ckbOnCheckBox(event)
    onDecFontSize(event)
    onExit(event)
    onIncFontSize(event)
    onPickGridc(event)
    onPickMK1c(event)
    onPickMK2c(event)
    onPickPcc(event)
    pick_color()
    post_init()
    set_fit_output()
```

```
set_staticbmp_color(obj, color)
ul_originOnRadioButton(event)
    set origin upper left
ur_originOnRadioButton(event)
    set origin upper right
```

felapps.utils.datascanapp module

New App for data correlation analysis

Tong Zhang 2016-07-12 10:11:05 AM CST

```
class MainFrame(parent, appversion='0.1')
    Bases: felapps.utils.datascanframe.DataScanFrame
    about_mitemOnMenuSelection(event)
    close_btnOnButtonClick(event)
    exit_app()
    exit_mitemOnMenuSelection(event)
    on_exit(event)
    save_mitemOnMenuSelection(event)
```

felapps.utils.datascanframe module

Subclass of DataScanFrame, which is generated by wxFormBuilder.

```
class DataScanFrame(parent)
    Bases: felapps.utils.datascanframe_ui.DataScanFrame
    about_mitemOnMenuSelection(event)
    adv_mode_ckbOnCheckBox(event)
    auto_title_ckbOnCheckBox(event)
    auto_xlabel_ckbOnCheckBox(event)
    clr_retake_btnOnButtonClick(event)
    daq_flag_rbOnRadioButton(event)
    daq_pv_list_btnOnButtonClick(event)
    daqrate_scOnSpinCtrl(event)
    ds_flag_rbOnRadioButton(event)
    exit_mitemOnMenuSelection(event)
    fit_config_btnOnButtonClick(event)
    fit_config_ckbOnCheckBox(event)
    fit_curve(model='gaussian')
    fit_model_cbOnCombobox(event)
```

```
fit_refresh_btnOnButtonClick(event)
    refresh fit

fit_report(fm)
    fill fit_report_tc with curve fitting report

fit_to_fig_btnOnButtonClick(event)
    stick fit result onto scan figure

grid_ckbOnCheckBox(event)

iternum_scOnSpinCtrl(event)

lc_btnOnButtonClick(event)

legend_ckbOnCheckBox(event)

lineid_cbOnCombobox(event)

ls_cbOnCombobox(event)

lw_scOnSpinCtrl(event)

mec_btnOnButtonClick(event)

mew_scOnSpinCtrl(event)

mfc_btnOnButtonClick(event)

mks_scOnSpinCtrl(event)

mkstyle_cbOnCombobox(event)

retake_btnOnButtonClick(event)

save_mitemOnMenuSelection(event)

scan_ctrl_timerOnTimer(event)
    scan procedure control timer

scan_daq_timerOnTimer(event)
    timer to control every scan iteration

set_retake_flag()
    set retake process flag

set_scan_params()
    set up scan parameters, var1(x) and var2(y)

shotperiter_scOnSpinCtrl(event)

show_scandiag()
    show dialog when scan is done

start_btnOnButtonClick(event)

start_scan_daq_timer(ms, scanidx)

stick_pos_tcOnTextEnter(event)

stop_btnOnButtonClick(event)

tick_timerOnTimer(event)

unset_retake_flag()

update_scanfigure()
    update figure plot
```

```
user_title_ckbOnCheckBox(event)
user_xlabel_ckbOnCheckBox(event)
var1_from_tcOnTextEnter(event)
var1_pv_flag_ckbOnCheckBox(event)
var1_pv_tcOnTextEnter(event)
var1_to_tcOnTextEnter(event)
var2_op_comboBoxOnCombobox(event)
var2_pv_tcOnTextEnter(event)
waittime_scOnSpinCtrl(event)

class MyEditConfigFrame(parent, string_list=None, label=None)
    Bases: felapps.utils.uiutils.EditListFrame

    on_ok(event)

class MyEditFrame(parent, string_list=None, label=None)
    Bases: felapps.utils.uiutils.EditListFrame

    on_ok(event)

class MyEditListFrame(parent, string_list=None, label=None)
    Bases: felapps.utils.uiutils.EditListFrame

    on_ok(event)
```

felapps.utils.datascanframe_ui module

```
class DataScanFrame(parent)
    Bases: wx._windows.Frame

    about_mitemOnMenuItemSelection(event)
    adv_mode_btnOnButtonClick(event)
    adv_mode_ckbOnCheckBox(event)
    auto_title_ckbOnCheckBox(event)
    auto_xlabel_ckbOnCheckBox(event)
    close_btnOnButtonClick(event)
    clr_retake_btnOnButtonClick(event)
    daq_flag_rbOnRadioButton(event)
    daq_pv_list_btnOnButtonClick(event)
    daqrate_scOnSpinCtrl(event)
    ds_flag_rbOnRadioButton(event)
    exit_mitemOnMenuItemSelection(event)
    fit_config_btnOnButtonClick(event)
    fit_config_ckbOnCheckBox(event)
    fit_model_cbOnCombobox(event)
```

```

fit_refresh_btnOnButtonClick(event)
fit_to_fig_btnOnButtonClick(event)
grid_ckbOnCheckBox(event)
iternum_scOnSpinCtrl(event)
legend_ckbOnCheckBox(event)
lineid_cbOnCombobox(event)
ls_cbOnCombobox(event)
m_splitterOnIdle(event)
m_splitter_downOnIdle(event)
mkstyle_cbOnCombobox(event)
retake_btnOnButtonClick(event)
save_mitemOnMenuSelection(event)
shotperiter_scOnSpinCtrl(event)
start_btnOnButtonClick(event)
stick_pos_tcOnTextEnter(event)
stop_btnOnButtonClick(event)
user_title_ckbOnCheckBox(event)
user_xlabel_ckbOnCheckBox(event)
var1_from_tcOnTextEnter(event)
var1_pv_flag_ckbOnCheckBox(event)
var1_pv_tcOnTextEnter(event)
var1_to_tcOnTextEnter(event)
var2_op_comboboxOnCombobox(event)
var2_pv_tcOnTextEnter(event)

class FuncListFrame(parent)
    Bases: wx._windows.Frame

    cancel_btnOnButtonClick(event)
    ok_btnOnButtonClick(event)
    path_btnOnButtonClick(event)
    reload_btnOnButtonClick(event)
    udefs_lcOnListItemSelected(event)

```

felapps.utils.datautils module

python modules for data processing utilities: dataworkshop: main GUI framework for data post-processing

Author: Tong Zhang Created: Sep. 23rd, 2015

```
class DataImportThread(parent, target, datafiles)
Bases: threading.Thread

    run()
    stop()

class DataWorkshop(parent, config='config.xml', size=(1000, 750), appversion='1.0', **kwargs)
Bases: wx._windows.Frame

    createMenubar()
    createPanel()
    createStatusBar()
    createToolbar()
    exitApp()
    initUI()
    onAbout(event)
    onAdd(event)
        Add datafiles
    onAnalysis(event)
    onAnimate(event)
    onConfigApps(event)
    onConfigLoad(event)
    onConfigSave(event)
    onExit(event)
    onMenuHL(event)
    onOpen(event)
        select data files to be visualized in imagegrid panel Tasks:
            •clear two attributes: image_list and fdata_list
            •clear image grid panel to be ready for new data and image files
    fdata_list: put loaded data files via open operation image_list: put generated image files from
    fdata_list

    onSave(event)
    onScaleDec(event)
    onScaleInc(event)
    onStatistics(event)
    onStopWorker(file_num)
    onTickTime(event)
    postInit()
    preInit()
    updateImageGrid(image_file_list, fdir, filetype)
```

```

vizData(datafiles)
    read data file and show images on right panel :param datafiles: list of data filenames, ext: hdf5 | dat | asc

class ImageGrid(parent, figsize, dpi, bgcolor, **kwargs)
    Bases: felapps.utils.pltutils.ImagePanel

        doPlot()
        onGetData()
        onMotion(event)
        onPress(event)
        repaint()

class PlotPanel(parent, **kwargs)
    Bases: felapps.utils.funutils.AnalysisPlotPanel

        clear()
        doHist()
        doScatter()
        doXY2plot()
        doXYplot()
        on_motion(event)
        refresh()

class StatPanel(parent, datafiles, **kwargs)
    Bases: wx._windows.Frame

        InitUI()
        createPanel()
        gaussian_fit_all()
        onCentralPosStat(event)
        onExit(event)
        onIntensityStat(event)
        onIntensityStatHist(event)
        onRadiusStat(event)
        postInit()

```

felapps.utils.felutils module

Author: Tong Zhang Created Time: 20:14, Jan. 28, 2015

FEL utilities: 1 Three functional sections for HGHG: 1.1: ModdsPanel 1.2: MatchPanel 1.3: RadisPanel

```

class ChiConfigPanel(parent, **kwargs)
    Bases: wx._windows.Frame

        InitUI()
        OnHelp(event)

```

```
    OnInter(event)
    OnUpdateParams(event)
    createMenu()
    createPanel()
    createStatusBar()

class EbeamConfigPanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    OnCalc(event)
    OnDAQ(event)
    OnHelp(event)
    OnSingleShot(event)
    OnTextEnter(event)
    OnUpdate(event)
    OnUpdateParams(event)
    createMenu()
    createPanel()
    createStatusBar()

class LaserConfigPanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    OnDAQ(event)
    OnLaserHelp(event)
    OnLaserLoad(event)
    OnSingleShot(event)
    OnTextEnter(event)
    OnUpdate(event)
    OnUpdateParams(event)
    createMenu()
    createPanel()
    createStatusBar()

class MatchPanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    createMenu()
    createPanel()
    createStatusBar()
```

```
onAbout(event)
onExit(event)
onLoad(event)
onSave(event)

class ModConfigPanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    OnHelp(event)
    OnInter(event)
    OnUpdateParams(event)
    createMenu()
    createPanel()
    createStatusbar()

class ModdsPanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    OnConfigChicane(event)
    OnConfigEbeam(event)
    OnConfigLaser(event)
    OnConfigModulator(event)
    OnUpdatePS(psid='mod', newval=0)
    createMenu()
    createPanel()
    createStatusbar()
    onAbout(event)
    onExit(event)
    onLoad(event)
    onSave(event)

class RadisPanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    createMenu()
    createPanel()
    createStatusbar()
    onAbout(event)
    onExit(event)
    onLoad(event)
```

```
    onSave(event)
main(ClassName=<class 'felapps.utils.felutils.ModdsPanel'>)
```

felapps.utils.funclistframe module

```
class FuncListFrame(parent, fullpath='.')
Bases: felapps.utils.datascanframe_ui.FuncListFrame
cancel_btnOnButtonClick(event)
ok_btnOnButtonClick(event)
path_btnOnButtonClick(event)
reload_btnOnButtonClick(event)
udefs_lcOnListItemSelected(event)
```

felapps.utils.funutils module

Author: Tong Zhang Created Time: 11:09, Jan. 29, 2015

utilities/functions for convenience

```
class AnalysisPlotPanel(parent, data=None, **kwargs)
Bases: felapps.utils.uiutils.MyPlotPanel
clear()
direct_xaxis(x_direction, y_direction)
draw_hvlines(x0, y0)
get_clim()
get_data()
    return data: image, raw data, fit data
get_fit_report(xoy='x')
    return fitting report if success, else return None
hide_image(hide_flag)
on_press(event)
on_release(event)
set_clim(cr)
set_color(rgb_tuple)
    set figure and canvas with the same color. :param rgb_tuple: rgb color tuple,
        e.g. (255, 255, 255) for white color
set_colormap(cmap)
set_figure_data(data, fit=True)
set_fontsize(fontsize)
set_grids(color, b=None, which='major')
```

```

set_line_id(line='raw')
    selected current editable line, 'raw': raw data 'fitted': fitted lines 'none': hide all lines 'show':
    show all lines

set_linecolor(color)

set_lines()

set_linestyle(ls)

set_linewidth(lw)

set_marker(mk)

set_markersize(ms)

set_markflags(mk1=False, mk2=False)

set_mec(c)

set_mfc(c)

set_mkc1(color)

set_mkc2(color)

set_mticks(flag='off')

set_origin(ll=False, ul=False, ur=False, lr=False)

set_pcc(color)

set_ticks(flag='half')

update_deltxy()

class ExportData(data_raw, data_fit, model_x, model_y, fname)
    Bases: object

    onProcess()

    onSave()

class FitModels(model='gaussian', params=None, **kws)
    Bases: object

    calc_p0()
        return p0 from input x, y

    fit()

    fit_report()

    get_data()
        return raw data

    get_fit_result()

    get_fitfunc(p0=None)

    method

    mode

    model

    set_data(data=None, x=None, y=None)
        set raw data to fit

```

```
set_params(**p0)
    p0: initial parameters dict

class FloatSlider(parent, id=-1, value=0, minValue=0, maxValue=10, increment=0.1, size=wx.Size(-1, -1),
                  style=4, *args, **kws)
    Bases: wx._controls.Slider

    GetInc()
    GetMax()
    GetMin()
    GetRange()
    GetValue()
    SetInc(inc)
    SetMax(maxval)
    SetMin(minval)
    SetRange(minval, maxval)
    SetValue(value)

class ImageDataFactor(z)
    Bases: object

    getData()
    getInt()
    setData(z)

class MyButton(parent, font=None, fontsize=10, fontcolor='black', *args, **kws)
    Bases: wx._controls.Button

    setFont(font)
    setFontColor(fontcolor)
    setFontFaceName(facename)
    setFontSize(fontsize)

class MyCheckBox(parent, font=None, fontsize=10, fontcolor='black', *args, **kws)
    Bases: wx._controls.CheckBox

    setFont(font)
    setFontColor(fontcolor)
    setFontFaceName(facename)
    setFontSize(fontsize)

class MyComboBox(parent, font=None, fontsize=12, fontcolor='black', fontweight=90, *args, **kws)
    Bases: wx._controls.ComboBox

    setFont(font)
    setFontColor(fontcolor)
    setFontFaceName(facename)
    setFontSize(fontsize)
```

```
class MyListCtrl(parent, ID, pos=wx.Point(-1, -1), size=wx.Size(-1, -1), style=0)
    Bases: wx._controls.ListCtrl, wx.lib.mixins.listctrl.ListCtrlAutoWidthMixin

class MySpinCtrl(parent, font=None, fontsize=10, fontcolor='black', fontweight=90, *args, **kws)
    Bases: wx._controls.SpinCtrl

    font: wx.Font()

    setFont(font)
    setFontColor(fontcolor)
    setFontFaceName(facename)
    setFontSize(fontsize)

class MyStaticText(parent, font=None, fontsize=10, fontcolor='black', fontweight=90, *args, **kws)
    Bases: wx._controls.StaticText

    setFont(font)
    setFontColor(fontcolor)
    setFontFaceName(facename)
    setFontSize(fontsize)

class MyTextCtrl(parent, font=None, fontsize=10, fontcolor='black', *args, **kws)
    Bases: wx._controls.TextCtrl

    setFont(font)
    setFontColor(fontcolor)
    setFontFaceName(facename)
    setFontSize(fontsize)

class ProgressBarFrame(parent, title, range=100, *args, **kws)
    Bases: wx._windows.Frame

    createProgressbar()
    onTickTimer(event)

class SaveData(data, fname, type, app='imageviewer')
    Bases: object

    onDataProcess()
    onSaveASC()
    onSaveHDF5()
    onSaveSDDS()

class ScanDataFactor(z, scannum, shotnum, ndim=2)
    Bases: object

    getXavg()
    getXerrbar()
    getYavg()
    getYerrbar()
    setData(z)
```

```
show()

class ScanPlotPanel(parent, data=None, **kws)
    Bases: felapps.utils.funutils.AnalysisPlotPanel

    adjustErrbar(err, x, y, x_error, y_error)

    clear_pick_pt()
        clear picked points (which are picked for retaking)

    get_edit_obj()

    get_errorbar_line()

    get_errorbar_mks()

    get_fit_line()

    get_fit_model()

    get_fit_result()

    get_mean_line()

    get_pick_pt()
        return picked points dict {k:v}, k: index, v: drawing artist

    hide_fit_line()

    on_motion(event)

    on_pick(event)

    on_press(event)

    on_release(event)

    repaint()

    set_fit_line(point_num=200, **kws)
        apply fitting model to average curve

    set_fit_model(model='gaussian', **kws)

    set_grid()

    set_legend(**kws)

    set_line_id(line='Average Curve')
        selected current editable line, 'Average Curve': curve of mean value of every iteration 'Errorbars'
        : errorbars, x and y 'Fitting Curve': fitting curve of average curve

    set_linecolor(color)

    set_linestyle(ls)

    set linewidth(lw)

    set_marker(mk)

    set_mec(color)

    set_mew(mew)

    set_mfc(color)

    set_mks(mks)
```

```

set_text(text, **kws)
    set fitting result output as a Text object :param text: fitting result text from FitModels class available keys of kws: x, y, fontsize

set_title(**kws)

set_xlabel(**kws)

update_text(**kws)
    available keys of kws: x, y, fontsize

aupmu(gap, xlamd, a=3.44, b=-5.0, c=1.54)
    gap, xlamd: [mm]

color_to_hex(c)
    convert matplotlib colors into hex string format, e.g. 1 color_to_hex('r') = '#FF0000' 2 color_to_hex('red') = '#FF0000' 3 color_to_hex('#FF0000') = '#FF0000'

createwxButton(parent, label, fontname=17, fontsize=10, fontweight=90, fontcolor='black', size=wx.Size(-1, -1))

createwxPanel(parent, backgroundcolor=None, id=-1)

createwxStaticBox(parent, label='', style=0, fontname=17, fontsize=10, fontweight=90, fontcolor='black')

createwxStaticText(parent, label, size=wx.Size(-1, -1), style=0, fontname=17, fontsize=10, fontweight=90, fontcolor='black')

createwxTextCtrl(parent, value='', style=0, fontname=17, fontsize=10, fontweight=90, fontcolor='black')

findObj(objroot, objclass)
    Find all the objects that is instance of objclass belongs to objroot. obj

func_peaks(x, y)

func_sinc(x, y)

gaussian_fit(x, xdata, mode='full')
    return fit result and fitmodels :param x: data to fit, x col, numpy array :param xdata: data to fit, y col, numpy array

getFileToLoad(parent, ext='*', flag='single')

getFileToSave(parent, ext='*')

getResPath(filename, cwd='.', resdir='./resources')
    return absolute path for resources, e.g. images, data :param reshead : the relative path for resources dir :param filename: filename for images or data

get_file_info(filepath)
    return file information :param filepath: file full path name

get_randstr(length=1)
    return string of random picked up chars :param length: string length to return

get_range(x, xmin, xmax)
    find array range, :param x: original numpy array, 1d :param xmin: x min of range :param xmax: x max of range return range_index and array

handleConfig(config_name='imageviewer.xml')

handle configuration files issues: 1 load configuration files from app data 2 create user specific configuration files

```

Parameters config_name – configuration file name, by default is ‘imageviewer.xml’ (for app Image Viewer)

reutrn valid configuration file at default user location

hex2rgb(hex_string)
convert hexadecimal color into rgb form. :param hex_string: hex color string, e.g. white color: '#FFFFFF'

Example: >>> hex2rgb('#FFAABB') (255, 170, 187)

importCheck(moduleName)
check could import moduleName or not

invert_color_hex(hex_color_str)
invert hex colors, e.g. invert_color_hex('#FFFFFF') = '#000000'

pick_color()

r56chi(gam0, ibfield, imagl=0.15, idril=0.285)
return r56 of chicane, ibfield: [T]

readfld(filename, ncar=121)

rescaleImage(image0, scaledFac)
Jan. 28, 2105 rescale image, given the image full path on disk

rgb2hex(rgb_tuple)
convert color rgb into hex form. :param rgb_tuple: tuple of rgb color, e.g. white color: (255, 255, 255)

Example: >>> rgb2hex((255, 170, 187)) u'ffaabb'

setPath(pathstr)

set_staticbmp_color(obj, color)
obj: staticbitmap, bitmapbutton color: could be returned by pick_color()

felapps.utils.imageutils module

classes and functions for image processing data2Image: generate image from data file, hdf5, asc, dat

Author: Tong Zhang Created: Sep. 28, 2015

class ImageGalleryPanel(parent, *args, **kwargs)
Bases: wx.lib.scrolledpanel.ScrolledPanel

Panel for image gallery show

genImage(imagelist, fdir, ftype)

get_workspace(fmt='dvc')
_workspace_list element format: “image_file_full_path;;data_file_fullpath”

initUI()

onClear()
clear all objs on panel

onLeftClick(event)
when left click image, select corresponding item on workspace panel

onPopAdd(event, obj)

onPopAddAll(event, obj)

```

onPopAnalysis(event, obj)
onPopRemove(event, obj)
onPopRemoveAll(event, obj)
onRightClick(event)
onRightPopup(event)
onScaleDec(percent, fdata_list, image_list)
    shrink image by percent
onScaleImageSize(fdata_list, image_list)
    just rescale image size to show on image grid :param fdata_list: data file list, fullpath :param
    image_list: image file list, fullpath
onScaleInc(percent, fdata_list, image_list)
    enlarge image by percent
onUpdate(image_list=None, fdir=None, ftype=None)
    update image grid panel :param image_list: image file list, jpg :param fdir: dirname of data files
    :param ftype: ext of data format, which generate image_list

class ProgressBarFrame(parent, title, range=100)
    Bases: wx._windows.Frame
        createProgressbar()
        onTickTimer(event)

class WorkspacePanel(parent, data=None)
    Bases: wx._windows.Panel
        clear()
        set_data(data)
        update(data)

data2Image(filename, datatype='hdf5', figtype='jpg', wdir=None, width=None, height=None, whflag='h', cm-
    type='hot', *args, **kwargs)
    generate image thumbnails from data file, by default from hdf5 array.

```

Parameters

- **filename** – data filename, f.
- **datatype** – data format, ‘hdf5’ or ‘h5’: image data could be extracted by fid = h5py.File(f); fid[‘image’][‘data’]. ‘asc’ or ‘dat’: image data could be extracted by np.loadtxt(f).
- **figtype** – ‘jpg’, ‘png’ or others.
- **wdir** – working directory, to put generated jpg figures, if None, use cwd.
- **width** – image size in w, if None, take original values.
- **height** – image size in h, if None, take original values.
- **whflag** – ‘w’ (h prop with w) or ‘h’ (w prop with h) or ‘None’ (take size as w x h).
- **cmtyp**e – colormap type, hot by default.

```
main()
```

```
resizeImage(imagepath, height, width=None, whflag='h', quality=0)
    resize image read from file, return wx.Image obj :param imagepath: jpg image file path :param height:
        height in pixel after resizing :param width: width in pixel after resizing :param whflag: w.r.t. height
        ('h') or width ('w')
test_data2Image()
    test function Hdf2Image
```

felapps.utils.matchutils module

python modules for beamline matching utilities: matchwizard: main GUI framework for beamline matching

Author: Tong Zhang Created: Sep. 23rd, 2015

```
class LatVisPanel(parent, figsize, dpi, bgcolor, **kwargs)
    Bases: felapps.utils.pltutils.ImagePanelxy

    clear()
    refresh()
    visBeamline(zoomfac=1.5)

class MatchWizard(parent, config='config.xml', size=(1000, 750), appversion='1.0', **kwargs)
    Bases: wx._windows.Frame

    createMenubar()
    createPanel()
    createStatusbar()
    exitApp()
    initUI()
    onAbout(event)
    onCheckUserDefinedBL(event)
    onChooseBL(event)
    onConfigApps(event)
    onConfigLoad(event)
    onConfigSave(event)
    onExit(event)
    onMenuHL(event)
    onOpen(event)
    onSave(event)
    onTickTime(event)
    onVisLattice(event)
    postInit()
    preInit()
```

felapps.utils.miscutils module

```
class AppVersions
```

```
    getVersion(appName='imageviewer')
    setVersion(verNum, appName='imageviewer')
```

felapps.utils.myui module

```
class PlotFrame(parent)
```

```
    Bases: wx._windows.Frame
```

```
    cmap_cbOnCombobox(event)
```

```
    crange_tcOnTextEnter(event)
```

```
    exit_btnOnButtonClick(event)
```

```
    grid_ckbOnCheckBox(event)
```

```
    imhide_tgbtnOnToggleButton(event)
```

```
    lc_btnOnButtonClick(event)
```

```
    lineid_choiceOnChoice(event)
```

```
    ll_originOnRadioButton(event)
```

```
    lr_originOnRadioButton(event)
```

```
    ls_cbOnCombobox(event)
```

```
    lw_tcOnTextEnter(event)
```

```
    m_splitterOnIdle(event)
```

```
    mec_btnOnButtonClick(event)
```

```
    mfc_btnOnButtonClick(event)
```

```
    mk_cbOnCombobox(event)
```

```
    ms_tcOnTextEnter(event)
```

```
    mticks_ckbOnCheckBox(event)
```

```
    ul_originOnRadioButton(event)
```

```
    ur_originOnRadioButton(event)
```

felapps.utils.parseutils module

Author: Tong Zhang Created Time: 10:22, Sep. 17, 2015

```
class ConfigFile(infilename='config.xml', *args, **kwargs)
```

```
    Bases: object
```

Class to resolve parameters parsing by applying xmlparser approach.

```
    getConfigs()
```

```
    parseConfigs()
```

```
updateConfigs(params_dict, savetofile=None)
class ParamParser(inifilename='config.ini', *args, **kws)
    Bases: object

    Class to resolve parameters parsing by applying ConfigParser approach.

    createTemplate(configfilename='config_sample.conf')
    dumpDictToConfig(newhierdict, configfilename)

    makeFlatDict()
        return dict with key,value pairs

    makeHierDict()
        return dict with hierarch structure

    readConfig()
    saveConfig(filetosave=None)
    setAllParams(newhierdict)
    setOneParam(section_name, option_name, newvalue)

loadtest()
savetest()
```

felapps.utils.pltutils module

python modules for plot utilities: ImageViewer: main GUI framework for an universal image viewer

Author: Tong Zhang Created: Feb. 3rd, 2015

```
class AppConfigPanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    createMenu()
    createNotebooks()
    createStatusBar()
    onApplyData(event)
    onCancelData(event)
    onUpdateData(event)
    setParams()

class AutoSavePanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    createPanel()
    onCancel(event)
    onChoosePath(event)
    onStart(event)
```

```
postInit()

class ChooseROIFrame(parent, imgsrcptn, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    createMenu()
    createPanel(imgsrcptn)
    createStatusbar()
    onCancel(event)
    onGetROI(event)
    onMotion(event)
    onPress(event)
    onRelease(event)

class ChooseROIPanel(parent, figsize, dpi, **kwargs)
    Bases: wx._windows.Panel

    doPlot(imgsrcptn)
    onSize(event)
    setColor(rgbtuple=None)
        Set figure and canvas colours to be the same.

class ConfigNoteBook(parent, style=64, *args, **kws)
    Bases: wx._controls.Notebook

    MakePages()

class ControlConfigPanel(parent, **kwargs)
    Bases: wx._windows.Panel

    createPanel()
    initConfig()
    initUI()
    onCheckAuto(event)
    onChooseLib(event)
    onUpdateParams1(event)
    onUpdateParams2(event)

class DebugPanel(parent, **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    createPanel()

class FitPlotFrame(parent, model_x, model_y, **kwargs)
    Bases: wx._windows.Frame

    onAutoScale(event)
    onExit(event)
```

```
onExport(event)
onSetRange(event)
set_datalim(nid, range_list)
class FitPlotPanel(parent, figsize, dpi, bgcolor, fitmodel_x, fitmodel_y, **kwargs)
    Bases: felapps.utils.pltutils.ImagePanelxy
        doPlot()
        onGetData()
        refresh_draw()
        repaint(new_fitmodel_x, new_fitmodel_y)
        update_figure()
        update_fit_modules(new_fitmodel_x, new_fitmodel_y)
class HistPlotConfigPanel(parent, **kwargs)
    Bases: wx._windows.Panel
        createPanel()
        initConfig()
        initUI()
class ImageColorMap(parent, figsize, dpi, bgcolor, **kwargs)
    Bases: wx._windows.Panel
        doPlot()
        fitCanvas()
        onGetData()
        onSetCr(crange)
        onSetcm(cmap)
        onSize(event)
        repaint()
        setColor(rgbtuple=None)
            Set figure and canvas colours to be the same.
class ImageConfigFile(filename='config.xml', *args, **kwargs)
    Bases: felapps.utils.parseutils.ConfigFile
        parseConfigs()
class ImageConfigPanel(parent, **kwargs)
    Bases: wx._windows.Panel
        createPanel()
        initConfig()
        initUI()
        onChooseDirpath(event)
        onUpdateParams(event)
```

```
class ImagePanel(parent, figsize, dpi, bgcolor, heightratio=0.4, func='peaks', **kwargs)
Bases: wx._windows.Panel

    doPlot()
    draw_hvlines(x0, y0)
    fitCanvas()
    onConfigPlot()
    onGetData()
    onMotion(event)
    onPress(event)
    onRelease(event)
    onSetCr(crange)
    onSetHist()
    onSetcm(cmap)
    onSize(event)
    refresh()
    repaint()

    setColor(rgbtuple=None)
        Set figure and canvas colours to be the same.

    setHratio(hratio)
    set_markflags(mk1=False, mk2=False)
    set_mkc1(color)
    set_mkc2(color)
    set_pcc(color)
    update_deltxy()

class ImagePanelxy(parent, figsize, dpi, bgcolor, **kwargs)
Bases: wx._windows.Panel

    doPlot()
    fitCanvas()
    onConfigPlot()
    onGetData()
    onMotion(event)
    onPress(event)
    onRelease(event)
    onSize(event)
    onUpdatePlot()
    repaint()
```

```
    setColor(rgbtuple=None)
        Set figure and canvas colours to be the same.

class ImageViewer(parent, config='config.xml', size=(800, 600), appversion='1.0', **kwargs)
    Bases: wx._windows.Frame

    InitUI()
    createMenubar()
    createPanel()
    createStatusBar()
        self.statusbar = self.CreateStatusBar(2)    self.statusbar.SetStatusWidths([-4, -1])
        self.statusbar.SetStatusText(u'ImageViewer powered by Python', 0) versionfield = 15*' '
        + time.strftime('%Y-%m-%d', time.localtime()) + ' ' + '(Version: ' + self.appversion + ')'
        self.statusbar.SetStatusText(versionfield, 1)

    loadConfig(configfilename)
    onAbout(event)
    onAddPV(event)
    onAutoSave(event)
    onBookmark(event)
    onCheckRCM(event)
    onChooseROI(event)
    onConfigApps(event)
    onConfigLoad(event)
    onConfigSave(event)
    onDAQbtn(event)
    onDebug(event)
    onExit(event)
    onFitPopup(event)
    onMenuHL(event)
    onOpen(event)
    onPickMK1c(event)
    onPickMK2c(event)
    onPickPcc(event)
    onResetROI(event)
    onRmPV(event)
    onSaveDat(event)
    onSaveImg(event)
    onSaveTimer(event)
    onSetCmcclass(event)
    onSetColorRange(event)
```

```

onSetColormap(event)
onSetImgSrc(event)
    set image data source and show in the image panel
onShowInt(event)
onShowXhist(event)
onShowYhist(event)
onTickTime(event)
onUnBookmark(event)
onUpdate(event)
onUpdateUI()
onUpdateUIInit()
printConfig()
setEnvvars()
updateFont()

class ShowIntPanel(parent, **kwargs)
    Bases: wx._windows.Frame
        InitUI()
        createMenu()
        createPanel()
        createStatusbar()
        onSaveFigure(event)
        onTimerControl(event)
        onUpdate(event)

class StyleConfigPanel(parent, **kwargs)
    Bases: wx._windows.Panel
        createPanel()
        initConfig()
        initUI()
        onChooseColor(event)
        onChooseFont(event)

main()

```

[felapps.utils.resutils module](#)

[felapps.utils.scanutils module](#)

Author: Tong Zhang Created Time: 09:26, Jun. 29, 2015

Scan utilities: (p.s.) separated from felutils.py 1 correlation analyzer: 1.1: ScanAnalyzer

```
class ImagePanel(parent, figsize, dpi, bgcolor, **kwargs)
Bases: felapps.utils.pltutils.ImagePanel

    doPlot()
    onGetData()
    onMotion(event)
    onPress(event)
    repaint()

class ImagePanelxy(parent, figsize, dpi, bgcolor, **kwargs)
Bases: felapps.utils.pltutils.ImagePanelxy

    adjustErrbar(err, x, y, x_error, y_error)
    doPlot()
    onConfigPlot()
    onGetData()
    onMotion(event)
    onPress(event)
    repaint()

class ScanAnalyzer(parent, size=(800, 600), appversion='1.0', **kwargs)
Bases: wx._windows.Frame

    createMenubar()
    createPanel()
    createStatusbar()
    exitApp()
    initUI()
    onAbout(event)
    onCheckFitting(event)
    onCheckScan(event)
    onCheckScan2(event)
    onChooseFont(event)
    onChoosePath(event)
    onConfigApps(event)
    onConfigLoad(event)
    onConfigSave(event)
    onDEBUG1(event)
    onExit(event)
    onMenuHL(event)
    onOpen(event)
    onProfDAQ(event)
```

```
onPushClose(event)
onPushPause(event)
onPushProfDAQ(event)
onPushRetake(event)
onPushStart(event)
onSave(event)
onScanDAQ(event)
onScanfigClear(event)
onScanlogClear(event)
onSetDaqFreq(event)
onSetImgCM(event)
onSetImgCMR(event)
onSetImgCR(event)
onSetImgPV(event)
onSetProFreq(event)
onSetShotNum(event)
onSetWaitTime(event)
onTickTime(event)
onUpdateScan(event)
postInit()
postSetImage()
postSetScan()
preInit()
setScanParams()
startScanDAQ(ms, scanidx)
updateFont(font)
updateImage()
updateScanfig()

class ScanConfigFile(infilename='.cornalyzer.conf', *args, **kwargs)
    Bases: felapps.utils.parseutils.ConfigFile
        parseConfigs()

class ScanThread(target)
    Bases: threading.Thread

    Thread do scan routine, as well as show the progress bar.

    Dated: Jul. 1, 2015

    run()
```

felapps.utils.uiutils module

custom GUI controls

Tong Zhang 2016-06-19 12:37:40 PM CST

```
class CheckListCtrl(parent, log)
    Bases: wx._controls.ListCtrl,wx.lib.mixins.listctrl.CheckListCtrlMixin
    OnItemActivated(event)

class EditFrame(parent, init_string=None)
    Bases: wx._windows.Frame
    on_cancel(event)
    on_ok(event)

class EditListFrame(parent, string_list=None, label=None)
    Bases: wx._windows.Frame
    on_cancel(event)
    on_ok(event)

class LatticePlotPanel(parent, **kwargs)
    Bases: felapps.utils.uiutils.MyPlotPanel
    identify_obj(x)
    on_motion(event)

class MyPlotPanel(parent, figsize=None, dpi=None, bgcolor=None, type=None, toolbar=None, aspect='auto',
                  **kwargs)
    Bases: wx._windows.Panel
    fit_canvas()
        tight fit canvas layout
    maxlim_tcOnTextEnter(event)
    minlim_tcOnTextEnter(event)
    on_motion(event)
    on_pick(event)
    on_press(event)
    on_release(event)
    on_size(event)
    refresh()
    set_color(rgb_tuple)
        set figure and canvas with the same color. :param rgb_tuple: rgb color tuple,
        e.g. (255, 255, 255) for white color
    set_layout()
        set panel layout
    xlim_choiceOnChoice(event)

class MyToolbar(canvas)
    Bases: matplotlib.backends.backend_wxagg.NavigationToolbar2WxAgg
```

```
class TestFrame(parent, **kwargs)
    Bases: wx._windows.Frame

    test()
```

CHAPTER

FIVE

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