PhIAT Documentation -- Manual Fitting

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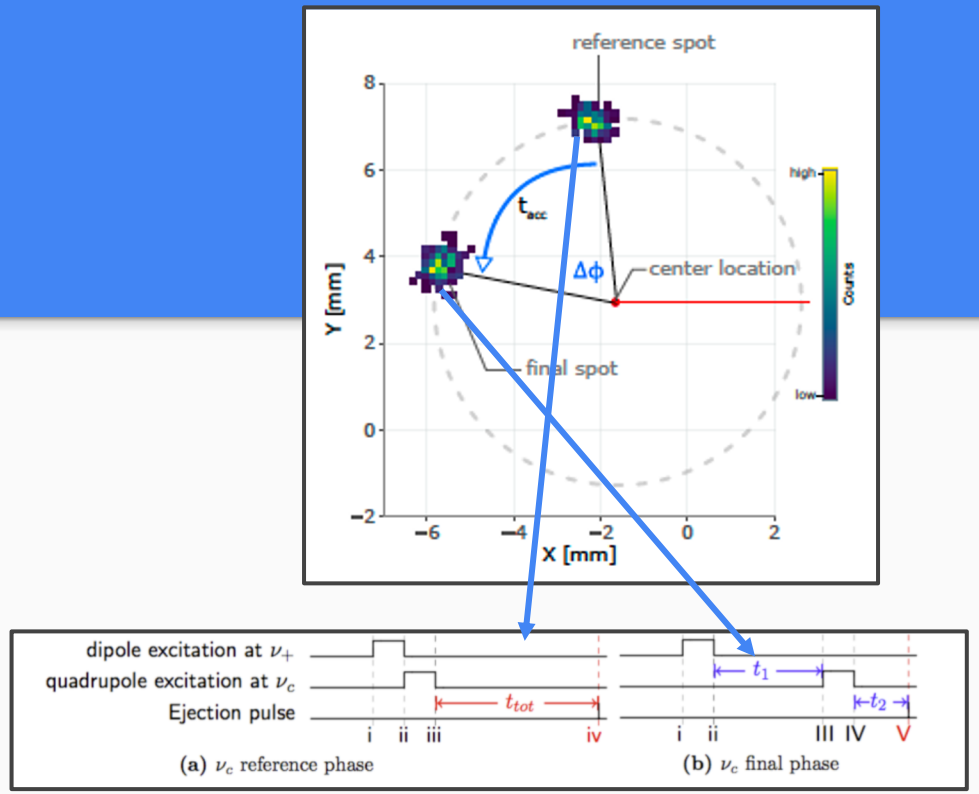
Overview

- **Language:** MATLAB (R2016a or newer)
- **Input:** A directory address (i.e. address to a folder) of MIDAS Files (ex: /Users/wsporter/Documents/Physics_Research/TITAN/PIICR_Analysis/Testing/Test_CAENOffset) OR a File List.csv (see midas_to_phiat Documentation for more)
- **Output:**
  - A .csv containing relevant info and potential cyclotron frequencies of spots in all files (if Create Freq ID checked)
  - A .xlsx containing relevant data fitting results (if Finish Analysis checked)
  - A .png of the sinusoidal fit of cyclotron frequency data (if Finish Analysis checked)
  - A .png of the sinusoidal fit of radius data (if Finish Analysis checked)

PI-ICR Basics

- The cyclotron frequency (ω_c) is determined via the phase difference (ϕ_c) between two spots with different **accumulation times (Tacc)**
  - Reference Spot: Tacc = 0
  - Final Spot: Tacc = Nonzero Value
- PhIAT determines the X/Y Positions of these spots to find each of their phases



$$\omega_c = \frac{\phi_c + 2\pi N(t_{acc})}{2\pi t_{acc}}$$

BEFORE YOU CONTINUE! -- titan_data

- PhIAT.m uses midas_to_phiat.py, which requires you download the **titan_data package**
  - This can be downloaded here: https://bitbucket.org/ttriumfdaq/titan_data/src/master/

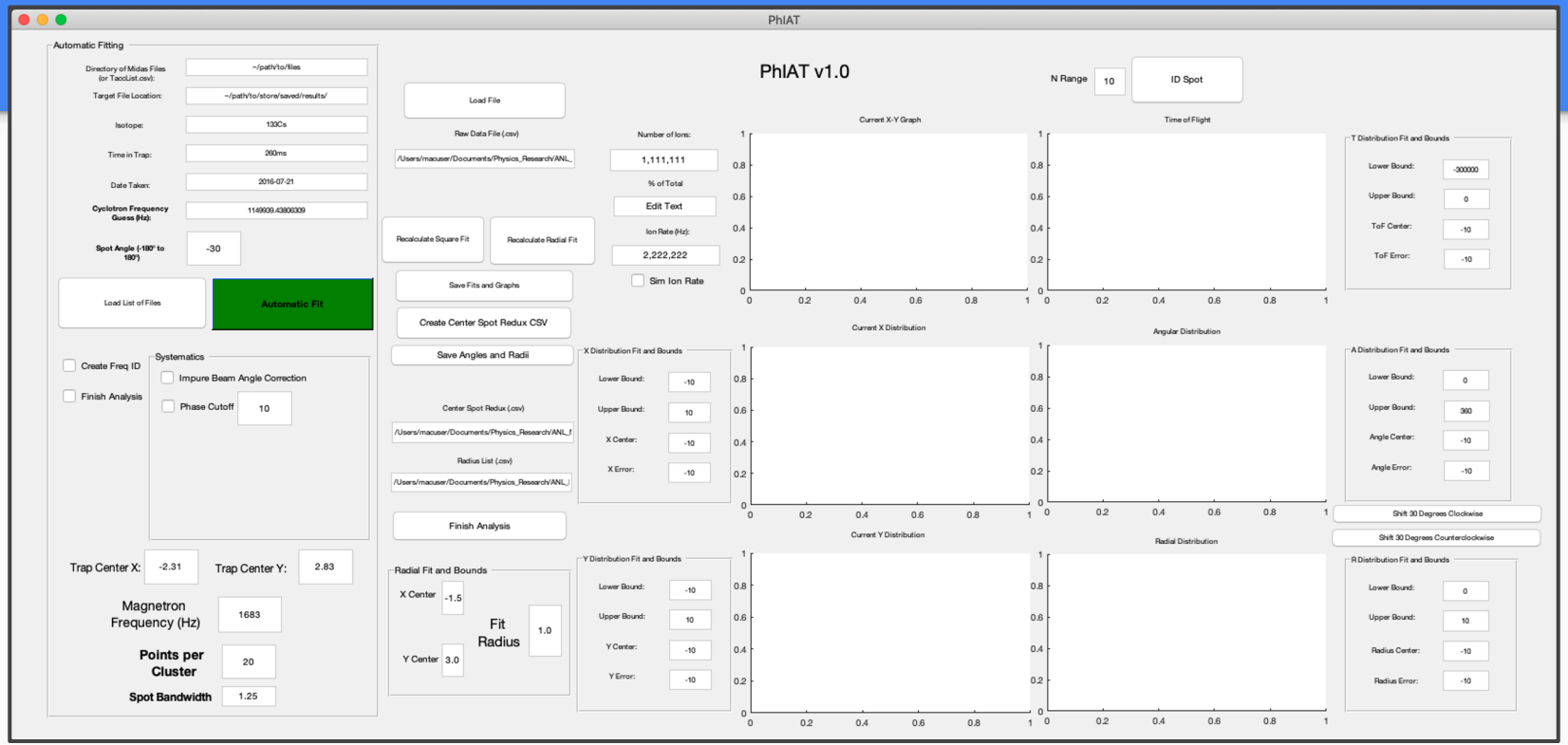
- On Line 20 in midas_to_phiat.py: Change the address in sys.path.append from '/Users/wsporter/Documents/Physics_Research/TITAN/PIICR_Analysis/titan_data' to the local address of titan_data on your computer (i.e. '/local/address/to/titan_data')

```
sys.path.append('/Users/wsporter/Documents/Physics_Research/TITAN/PIICR_Analysis/titan_data') # Address of titan_data module. NEW USERS NEED TO CHANGE THIS! #
```

NOTE!

- A large portion of this method of fitting is similar to Automatic Fitting, and therefore only differences are documented here. Please reference the Automatic Fitting documentation for a full description of the analysis suite

Getting Started - Press the Run Button to bring up the PhIAT GUI:



Loading a List of Files

- To start, input the address of the directory of MIDAS files (i.e. /Users/wsporter/Documents/Physics_Research/TITAN/PIICR_Analysis/Testing/Test_CAENOffset)
  - If you have already converted a directory of MIDAS files using midas_to_phiat.py, you can also input the address of the FileList.csv (see midas_to_phiat.py documentation)
- Click the Load List of Files button...

Loading a List of Files cont.

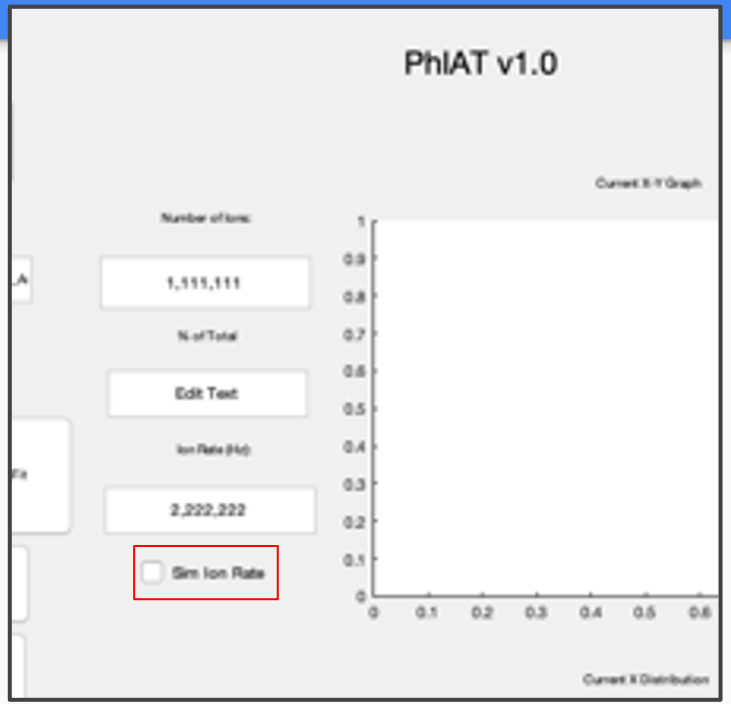
- Clicking Load List of Files runs midas_to_phiat.py and converts each MIDAS file into a readable .csv file containing (for each event):
  - X/Y Positions
  - Times of Flight from Ejection to MCP Contact
  - What trigger number of the TDC each event was recorded during
- midas_to_phiat.py also creates a FileList.csv, which contains a list of addresses of all data files

Loading a List of Files cont.

- The FileList.csv is used so PhIAT can navigate to each individual file and then load in that respective data

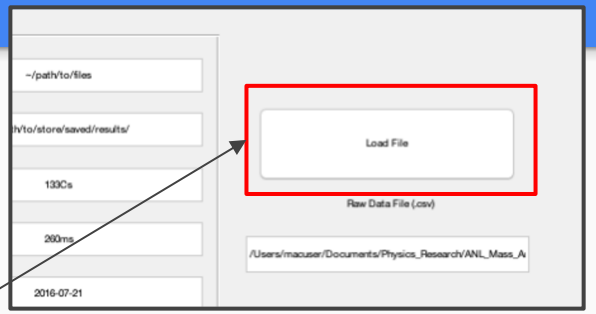
BEFORE YOU CONTINUE -- Simulated Data

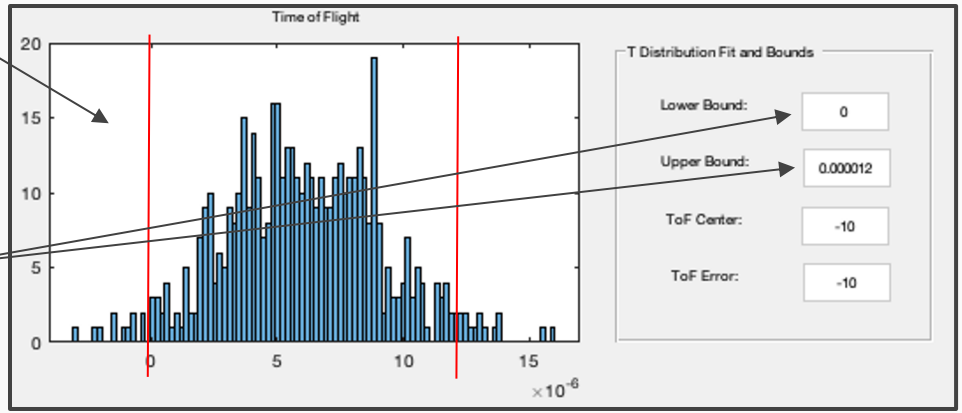
- If you are fitting any simulated data (i.e. data produced from PI_ICR_simulated_data.m), **make sure the Sim Ion Rate checkbox is checked**
  - Since there is no count timing information from simulated data, leaving this unchecked will cause an error otherwise...



Fitting -- ToF Cuts

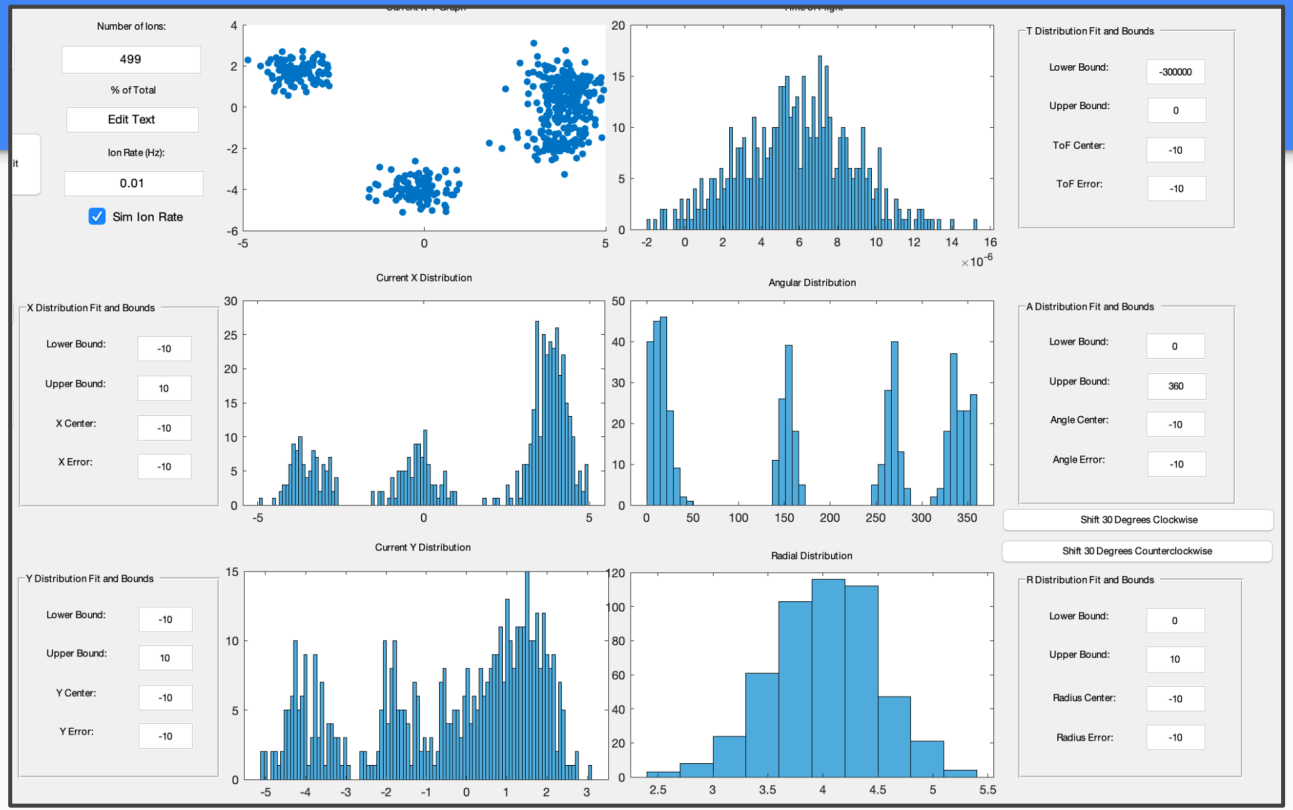
- It’s advised to apply a time of flight cut to throw away data outside of the expected times of flight (i.e. column 3 of each data .csv)
- Press Load File to load just the first file
  - Using the distribution seen in the ToF plot, determine bounds that cut out data outside of the counts majority
    - It’s expected the distribution is pseudo-Gaussian
  - Put these bounds in the Lower Bound and Upper Bound boxes next to the ToF plot





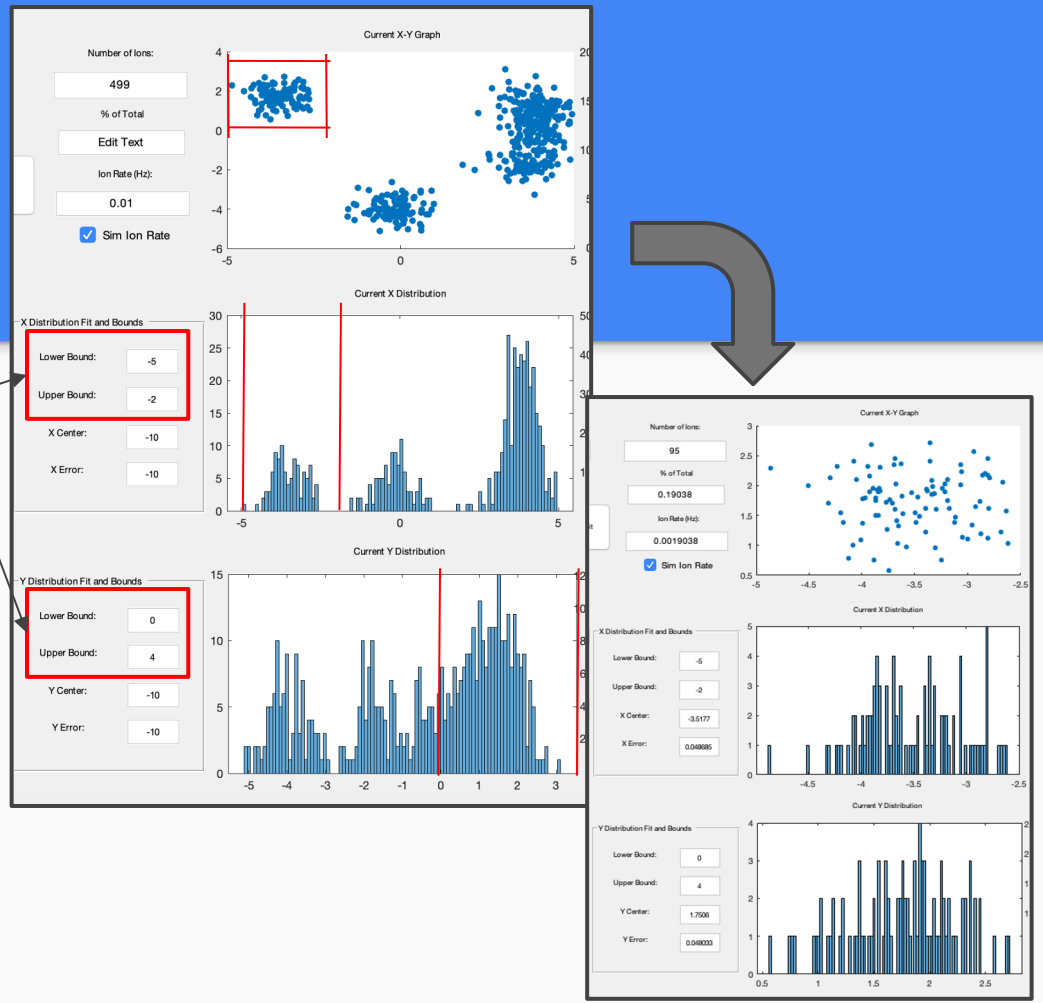
Fitting -- Other Cuts

- After pressing **Load File**, the data and relevant distribution will pop up:



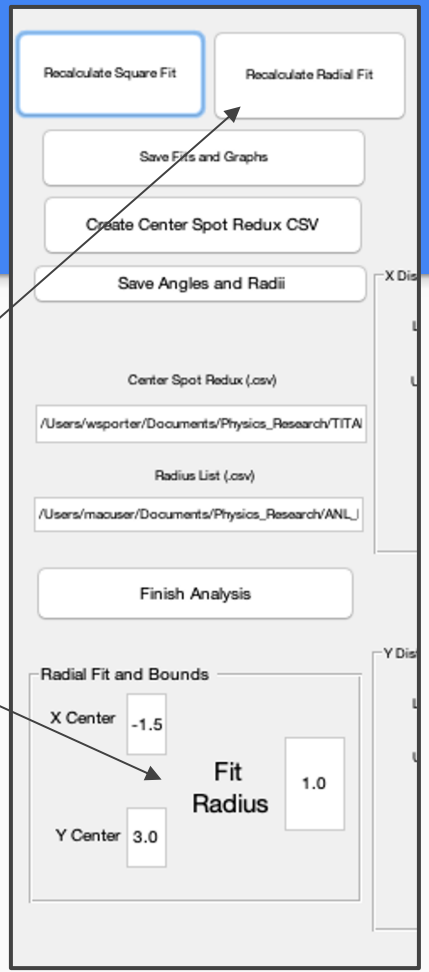
Fitting -- Other Cuts

- To fit a spot, input X and Y gates in the respective lower and upper bound boxes to center around a spot
- Pressing **Recalculate Square Fit** will cut out all data outside these bounds
- This can also be done to cut out data using the Radial and Angular distributions
- NOTE: If at any point you make a mistake while manually gating, you can simply press Load File to restart



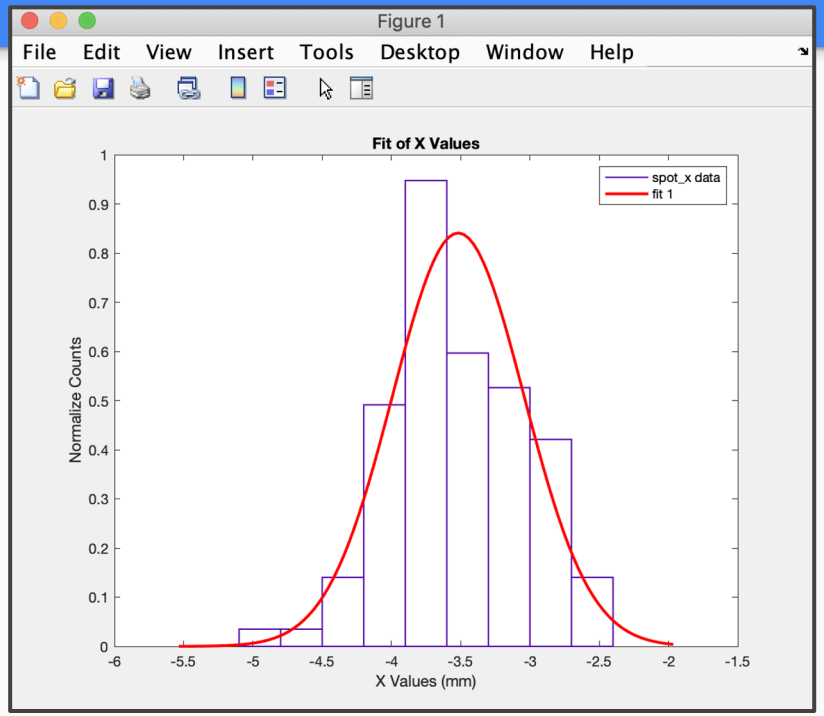
Fitting -- Recalculate Radial Fit

- Data can also be cut outside a radius of a specified point
- Choose X Center and Y Center to specify the point
  - Fit Radius: Data outside a radius of this value is cut away
- Pressing **Recalculate Radial Fit** does this cutting

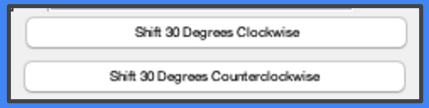


Fitting -- Save Fits and Graphs

- Once satisfied with cuts applied, click **Save Fits and Graphs**
  - X, Y, Angular, Radial and ToF distributions are fit with a Gaussian using a Maximum Likelihood estimator to determine the spot center
- These five fits are printed out, and screenshots are saved in a folder labeled by the Tacc
  - This folder also contains other Excel files that are used by the script automatically later in analysis
- Upon press, the script automatically cycles to the next file in the FileList, so simply press **Load File** again to load in the next file and continue



Fitting -- Angular Cuts



- Since the distribution of angles will be fit, Shift 30 Degrees Clockwise or Counterclockwise can be selected to shift the angular data 30 degrees forward or backwards
  - This is so the distribution isn't cut off at 360 and can still be fit reasonably

Finish Analysis

- Once all files are fit (when ‘No More Files Left’ appears in the Raw Data File (.csv) box), press **Save Angles and Radii** and **Create Center Spot Redux CSV**
  - This creates a few more Excel files to be used by the code when finishing fitting
- In the text box beneath Center Spot Redux (.csv), input the address for the CenterSpotRedux.csv file created (in the directory you specified in Target File Location)
- In the text box beneath Radius List (.csv), input the address for the Radii.csv file created (in same directory as above)

Finish Analysis

- Press **Finish Analysis** and the script will automatically finish the rest of the analysis for you!
  - This is the same as is outlined in Automatic Fitting

- Please contact Sam Porter (wporter@triumf.ca) if you have any questions
- Happy PI-ICRing!