NSTX kineticEFITtime Tutorial

DISCLAIMER:

This is an editable public document! When you make a change to it, it will be visible immediately from everyone! Feel free to edit it and help other OMFIT users!

Since this is an evolving document, there may be some small inconsistencies as different figures have been taken by different people with different versions of OMFIT for different analyses.

A prerequisite to using OMFIT is completing the first time users setup.

Introduction

This document and its companion workbook describes a typical workflow for producing plasma profile and transport analysis with the intention of a kinetically-constrained equilibrium reconstruction. The high level goal is to produce an EFIT that has P' and FF' constrained by additional information provided by the experimental thermal and model-based fast-ion pressure, and current constrained by a bootstrap current model.

Workflow overview

There are 8 major steps in this workflow

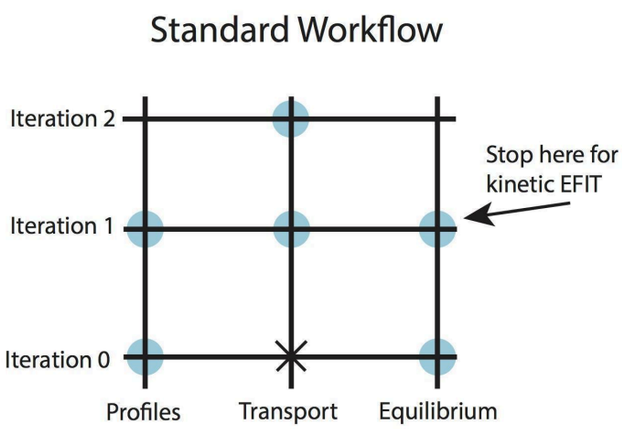
1. Select the discharge and timebase for the analysis
2. Select a snap file to produce the k-file that includes the basic constraints and switches for the desired final equilibrium reconstruction
3. Perform profile analysis on an existing MDSplus EFIT reconstruction to
   a. Constrain a refined equilibrium based on edge profile measurements
   b. Form inputs required for the transport code of choice

4. Produce refined equilibrium that satisfies #3.a.
5. Re-fit profiles on refined equilibrium from #4. Steps 3-5 be iterated as necessary until good equilibrium and profiles are achieved.
6. Run transport code evolving poloidal field diffusion equation
7. Produce kinetic constrained EFIT
8. Re-run transport code using kinetic EFIT without evolving current (poloidal field)

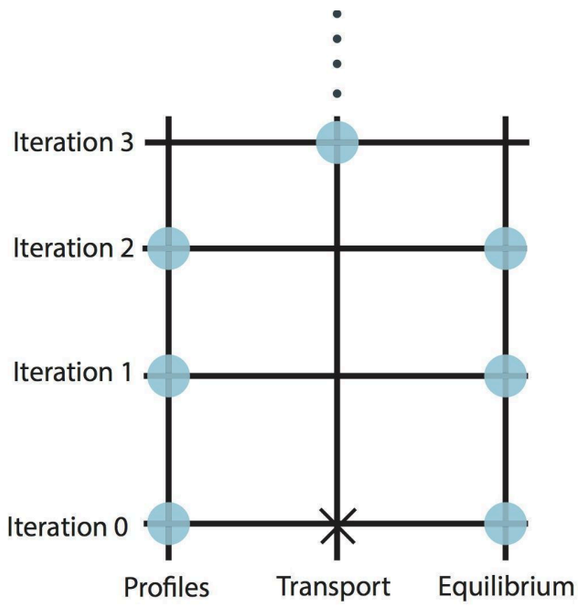
The last step can be skipped if the final result is an EFIT. If the final result is a self-consistent equilibrium+transport analysis for transport model validation then the final step is generally necessary.

Iteration overview

In OMFIT these steps are broken into iterations. A schematic of the standard workflow and various iterations is shown here.



However, OMFIT is designed to be modular and this standard workflow does not always need to be followed. An example of another workflow is shown below. In this example profiles and equilibrium are done in iteration 0. They are repeated in iteration 1 and iteration 2 until satisfactory inputs for transport are generated. When transport is run in iteration 3, the most recent iteration profiles and equilibrium are used (in this case iteration 2.) However, if it is later decided that the profiles and equilibrium in iteration 1 are better; you can jump back to iteration 1 and then delete the next iterations (2 and 3) to perform the transport step in iteration 2. It is a better practice to jump to the next iteration to improve profiles and equilibrium rather than to overwrite a previous iteration.



Tutorial Example

This tutorial uses NSTX discharge 140001 for the following steps because all of the diagnostics for a MSE-constrained EFIT with electron and ion profiles from axis to boundary are available. Please follow along with this tutorial /p/omfit/users/gavdeeva/projects/140001_tutorial.zip.

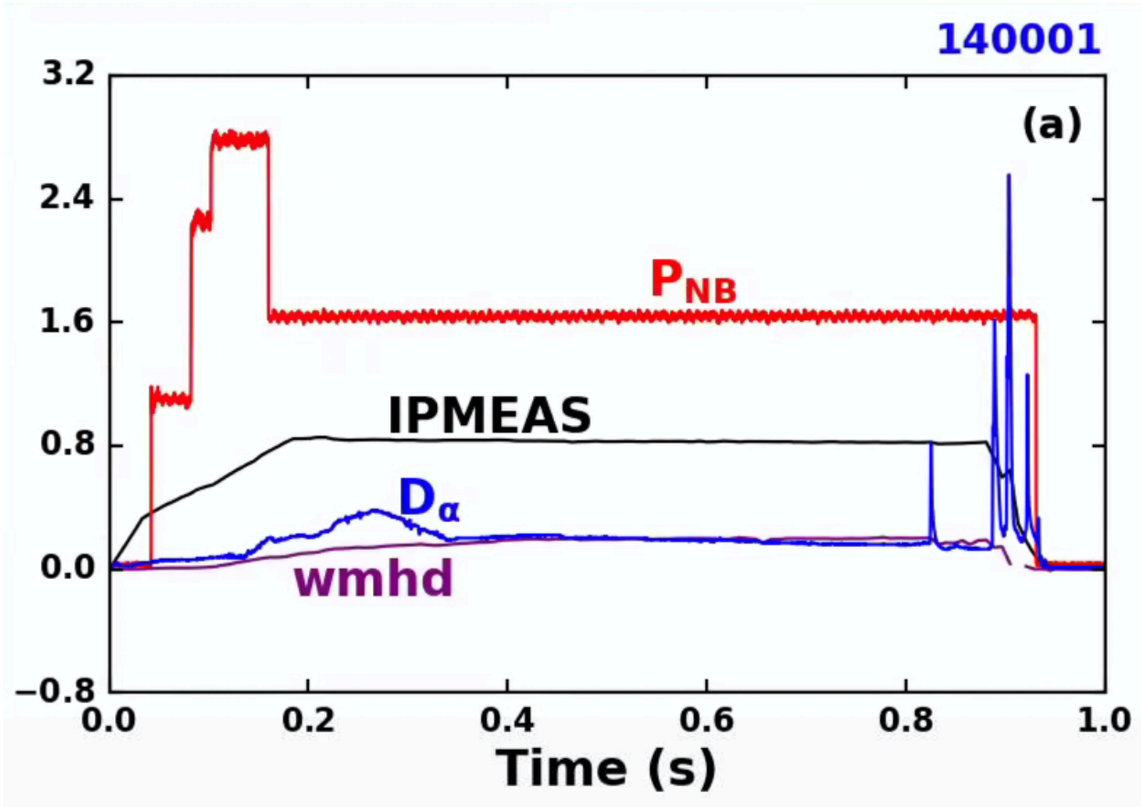
1. Select discharge and timebase for analysis

It is imperative that you are aware of the available diagnostics for the analysis you will be performing. For most analyses, availability of the following list needs to be confirmed

1. EFIT02 is valid for all times selected (can be viewed in IDL tool efitviewer)
2. Thomson scattering for ne, Te (can be processed considering the occurrence of ELMs)
3. Charge-exchange for Ti, rotation, Er and impurity density
4. MSE for internal pitch angles to constrain the core current profile
5. Radiated power for use in electron power balance

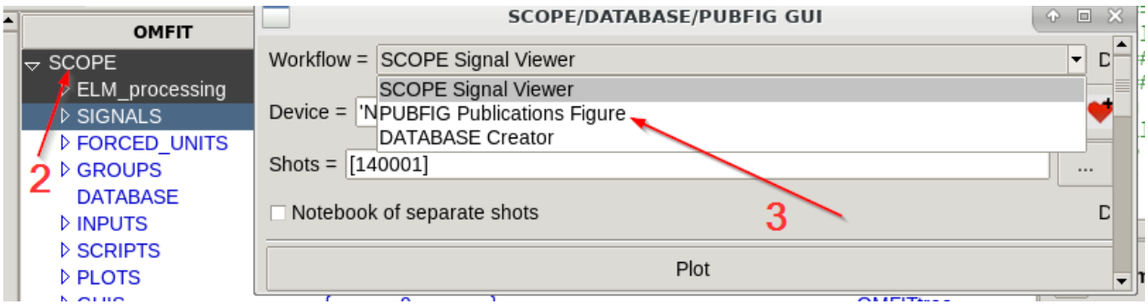
Please use the appropriate SCOPE to view the discharge history and think critically about what you will be accomplishing.

Discharge 140001 achieves Ip flat top at 0.2 seconds and H-mode at 0.215 seconds. Thomson scattering (ne, Te), core charge exchange (Ti, rotation, nZ) and MSE are available from very early <0.1 seconds until the end of the discharge. By 0.8 seconds the discharge is approaching termination, so this is where our analysis ends. We choose 16 ms as the timebase for our tutorial analysis because this is an integer multiple of the existing EFIT k-file timebase (8 ms).



To make this plot, perform the following:

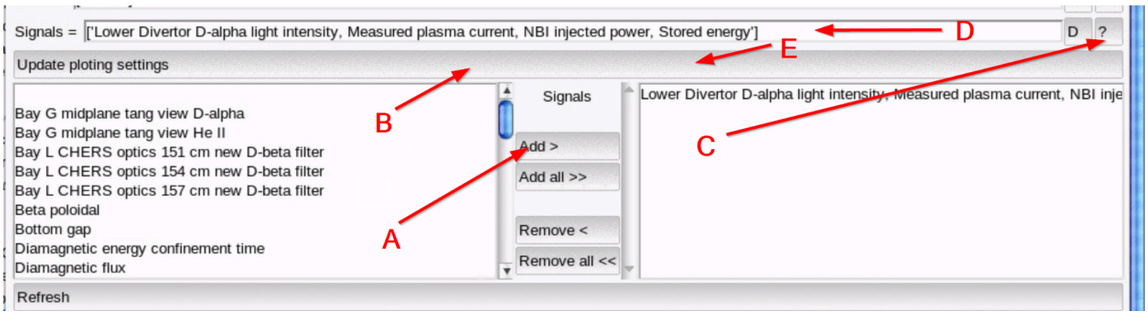
1. Import the SCOPE module
2. Launch the SCOPE GUI
3. Change the workflow to the PubFig workflow



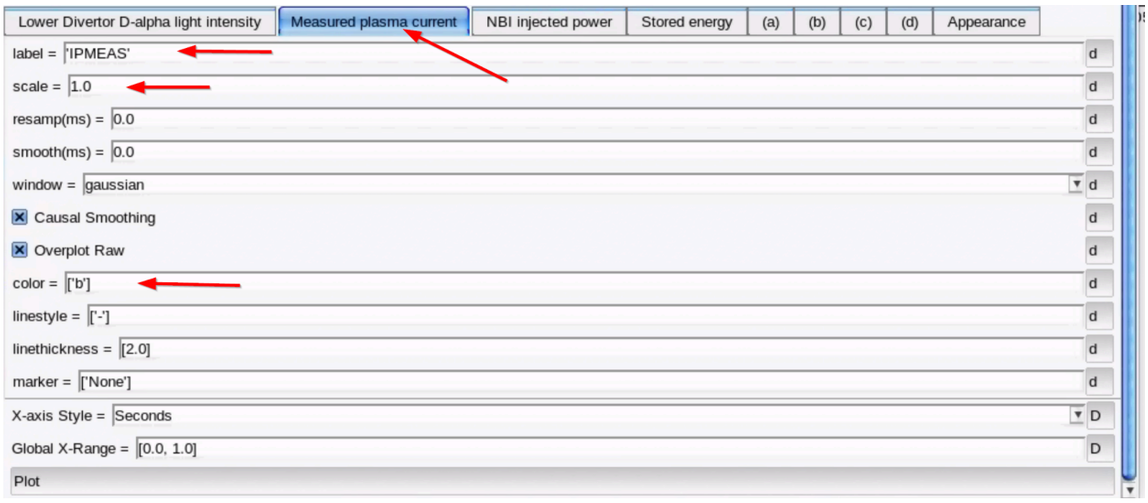
4. Change the device to NSTX (if the shot number starts from 2 change the device to NSTXU)

5. Change the shots to [140001]

6. Select signals to plot
    a. Update plotting settings (*to create a list of 'active' signals in the OMFIT tree and set initial settings for figure, e.g figure size, number of rows,columns, labels …*)
    b. Press '?' on the 'Signals' row to see how to modify the signals list to plot all signals on one plot
    c. Modify the list
    d. Update plotting settings again. (*It is necessary to update plotting setting each time after modifying the 'Signals' list*)



7. Change the label of Measured plasma current to IPMEAS, scale to `1e-6`, and the color to `'black'`

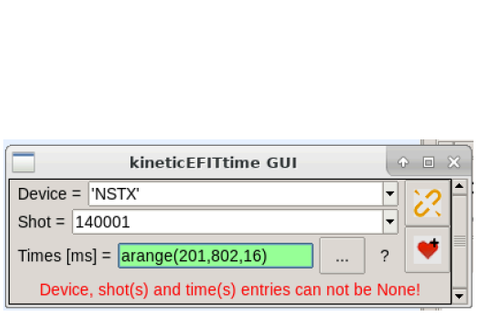


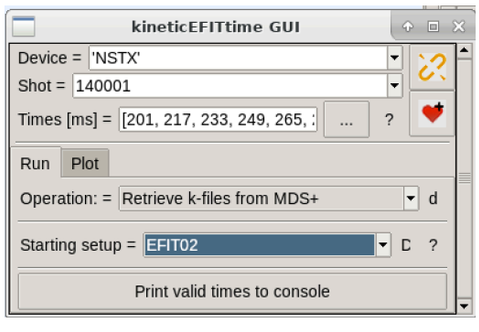
8. Change the label to wmhd, scale to `1e-6`, and the color to `'purple'` for stored energy
9. Change other labels and plotting settings if needed
10. Click the “Plot” button at the bottom of the GUI

2. Fetch k-files for EFIT

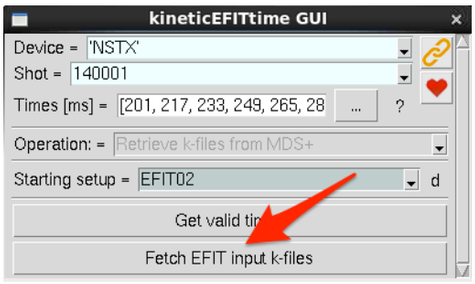
Start the OMFIT GUI, import the kineticEFITtime module and begin the module GUI by double-clicking kineticEFITtime in the OMFIT tree.
Enter shot 140001 [return]
Enter ‘NSTX’ in the Device combobox. Note: if the shot number starts from 2 change the device to **‘NSTXU’** by typing this in the combobox
Enter the time range using the python command `arange(201,802,16)` [return], which fills times from 201 to 793 in 16 ms steps, which is every other existing k-file.
Select EFIT tree in “Starting setup” dropdown , e.g. ‘EFIT02.

Then click, “Print valid times to console” to validate your EFIT time selection.” It also will print times nearest to times of Thompson scattering measurements.

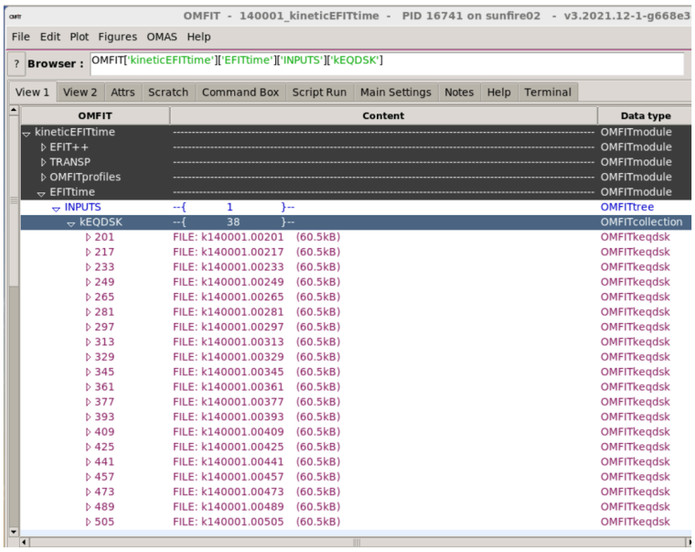




Now we will retrieve our k-files by clicking “Fetch EFIT input k-files”



We have now retrieved our k-files (as can be seen in OMFIT tree kineticEFITtime → EFITtime → INPUTS → kEQDSK for each time).



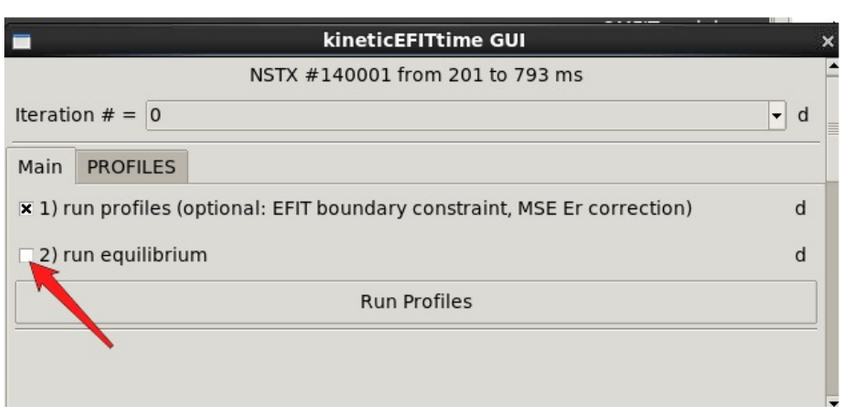
The next step is to fit profiles in preparation for making MSE-constrained EFITs.
After fetching the k-files the GUI re-draws and presents you with the option to run profiles and form the equilibria. For this tutorial we will go through each step.

Iteration 0

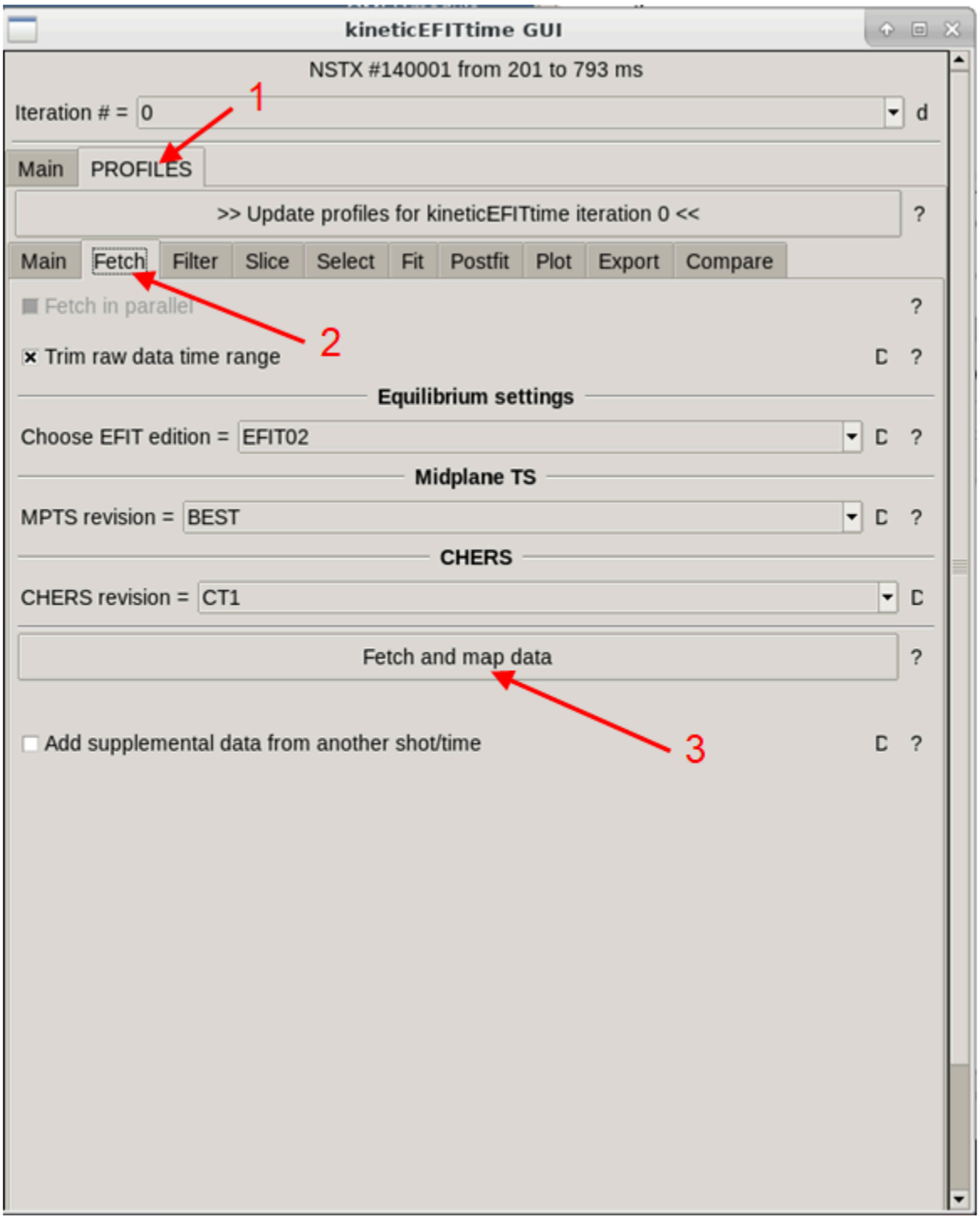
3. Fit Profiles (to map profiles into flux space)

kineticEFITtime module can load profiles from OMFITprofiles or from QUICKFIT module. QUICKFIT needs to be loaded as an extra module, OMFITprofiles is already a submodule of kineticEFITtime.

De-select 2) run equilibrium and then move to the “Profiles” tab, where we go through each step.



On Profiles → Fetch we want to “Fetch and map data”.



Then next step, is to “Slice” the data, which places all diagnostics on a common timebase. Description of the algorithms for time convolution in the OMFITprofiles tutorial.

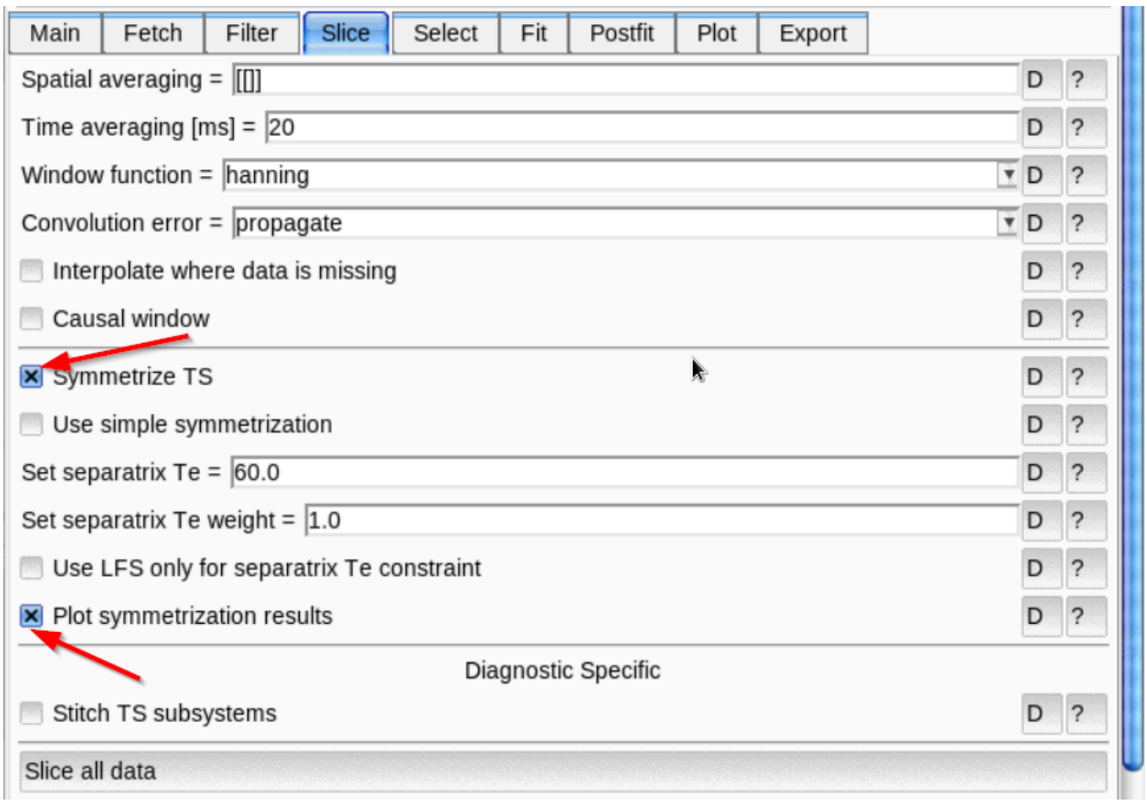
NSTX has full radial coverage for Thomson scattering and the high-field and low-field side profiles do not always align. When we slice the data we also symmetrize the Thomson scattering based on the Te data, identifying a value for the separatrix temperature.

Symmetrization of Thomson scattering

The ‘Symmetrize TS’ feature applies a radial shift function to the Thomson scattering data based on either trying to optimize the match between the LFS and HFS measurements or on the separatrix temperature. You can select the weighting to either the former or the latter (or a mix) by setting the ‘Set separatrix Te weight’ box. Values of the order 0.001 puts emphasis on the matching of HFS and LFS, while values of the order 100 puts emphasis on the separatrix temperature. To use only separatrix temperature constraints (in some cases symmetrization

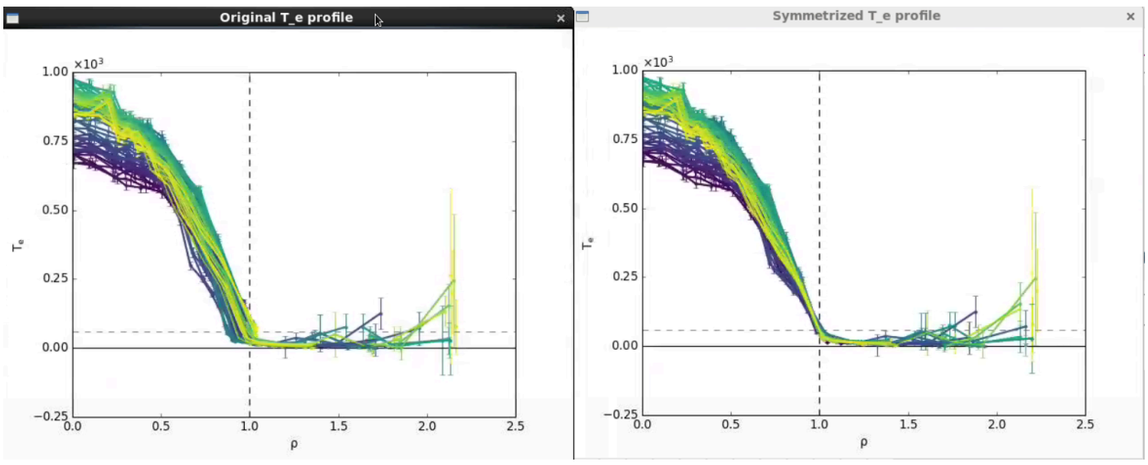
without matching of HFS and LFS at the core might work better) use the option “Use simple symmetrization”.

As default, the cost function associated with the separatrix temperature constraint is only applied to both the LFS and HFS data to avoid noisy data in the SOL biasing the shift. However, to only apply this cost function to the LFS data, click the ‘Use LFS only for separatrix Te constraint’ check box.



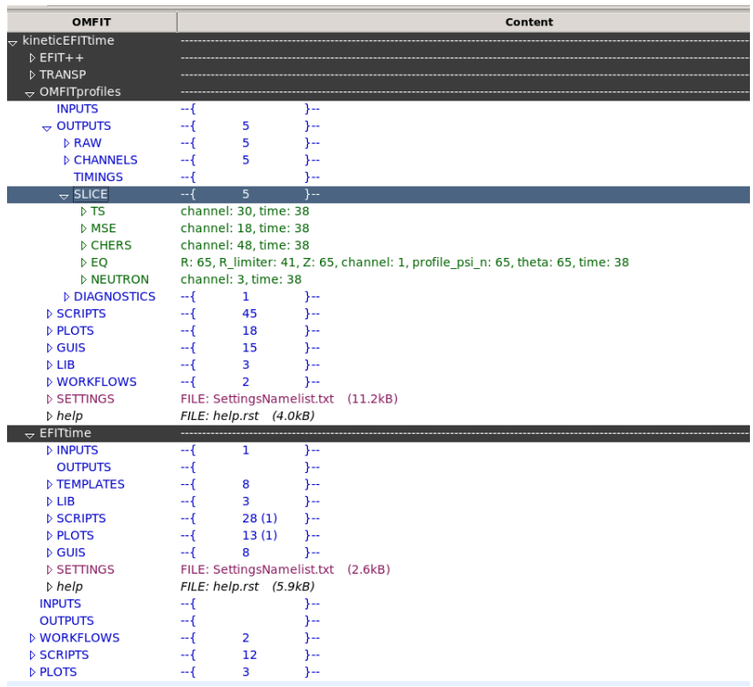
1) *Select “Symmetrize TS” and “Plot symmetrization results”.*
2) *Click “Slice all data”*

The procedure (*symmetrization of TS*) is automatic and illustrated below:

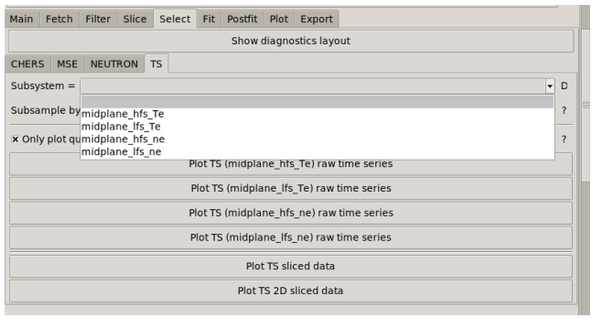


Note: TS symmetrisation is not necessary if you start with step 2, calculate EFIT equilibrium with isothermal constraint and then fit the kinetics profiles.

Now that we have sliced the data, we can view the raw profiles and time histories conveniently in the OMFIT tree (kineticEFITtime → *OMFITprofiles* → *OUTPUTS)*



Then move on to the "Select" tab, select Subsystem to see diagnostic channels (will pop up automatically) and plot the data to identify the bad channels.



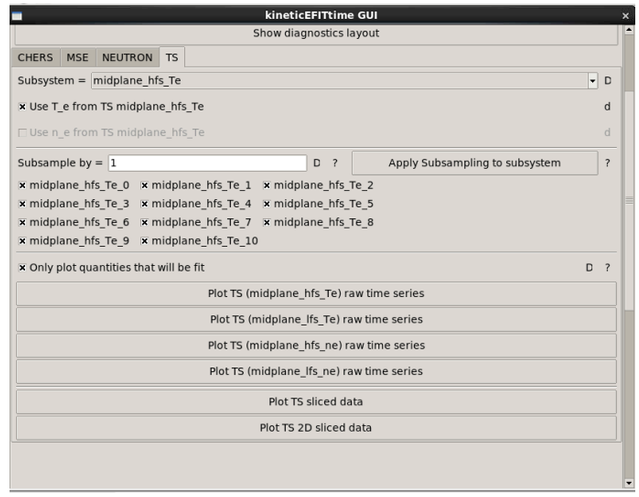


Illustration of "Plot TS (midplane_HFS_T_e) raw time series"

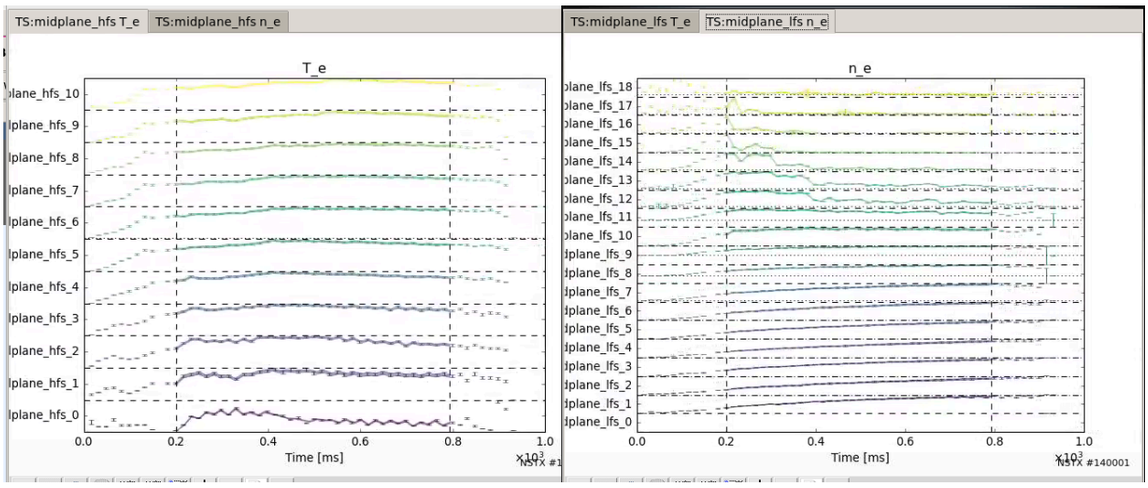
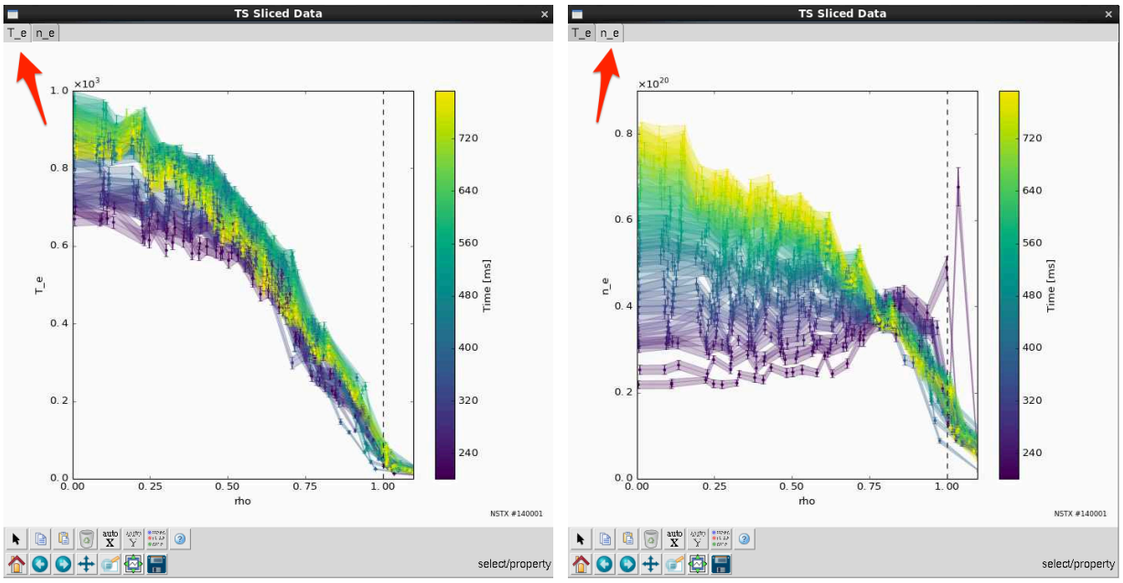
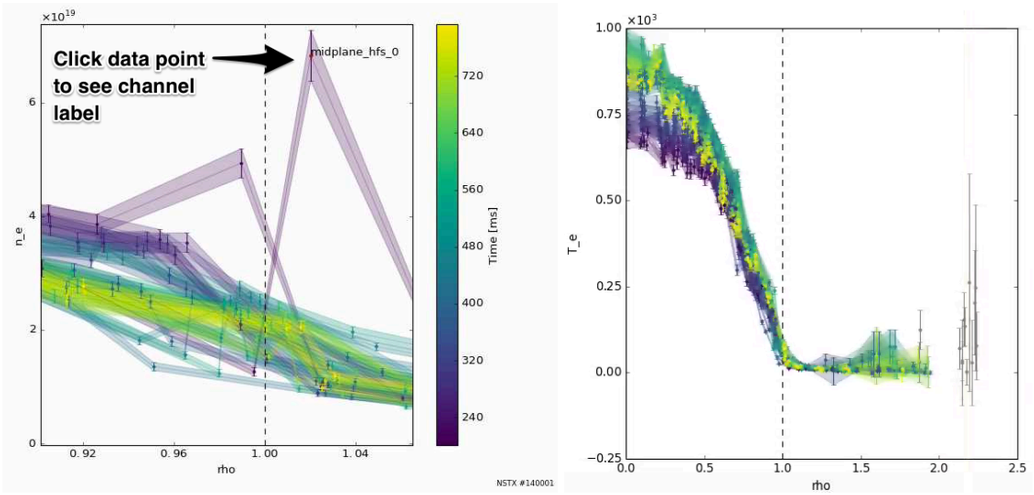

TS:midplane_hfs T_e
TS:midplane_hfs n_e
T_e
plane_hfs_10
plane_hfs_9
plane_hfs_8
plane_hfs_7
plane_hfs_6
plane_hfs_5
plane_hfs_4
plane_hfs_3
plane_hfs_2
plane_hfs_1
plane_hfs_0
0.0
0.2
0.4
0.6
0.8
1.0
Time [ms]
x10^3
NSTX #1
TS:midplane_lfs T_e
TS:midplane_lfs n_e
n_e
plane_lfs_18
plane_lfs_17
plane_lfs_16
plane_lfs_15
plane_lfs_14
plane_lfs_13
plane_lfs_12
plane_lfs_11
plane_lfs_10
plane_lfs_9
plane_lfs_8
plane_lfs_7
plane_lfs_6
plane_lfs_5
plane_lfs_4
plane_lfs_3
plane_lfs_2
plane_lfs_1
plane_lfs_0
0.0
0.2
0.4
0.6
0.8
1.0
Time [ms]
x10^3
NSTX #140001

Illustration of “Plot TS sliced data”

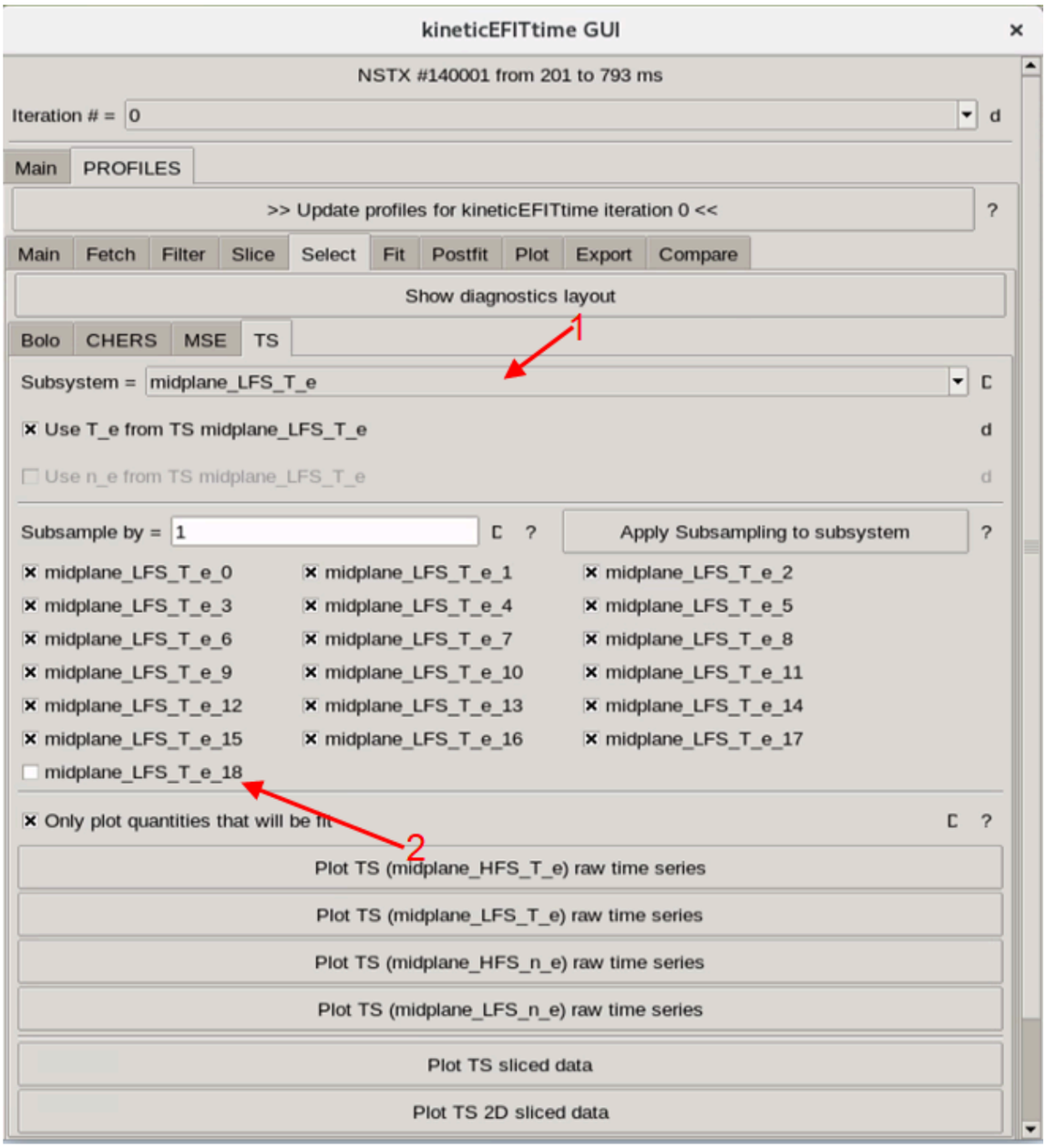


If a given channel is bad, then it can be de-selected in the GUI checkbox. *Data from de-selected channels will be shown in a grey color. Data will be removed for all timelices. Current OMFITprofiles does not have capability to remove single corrupted points.*



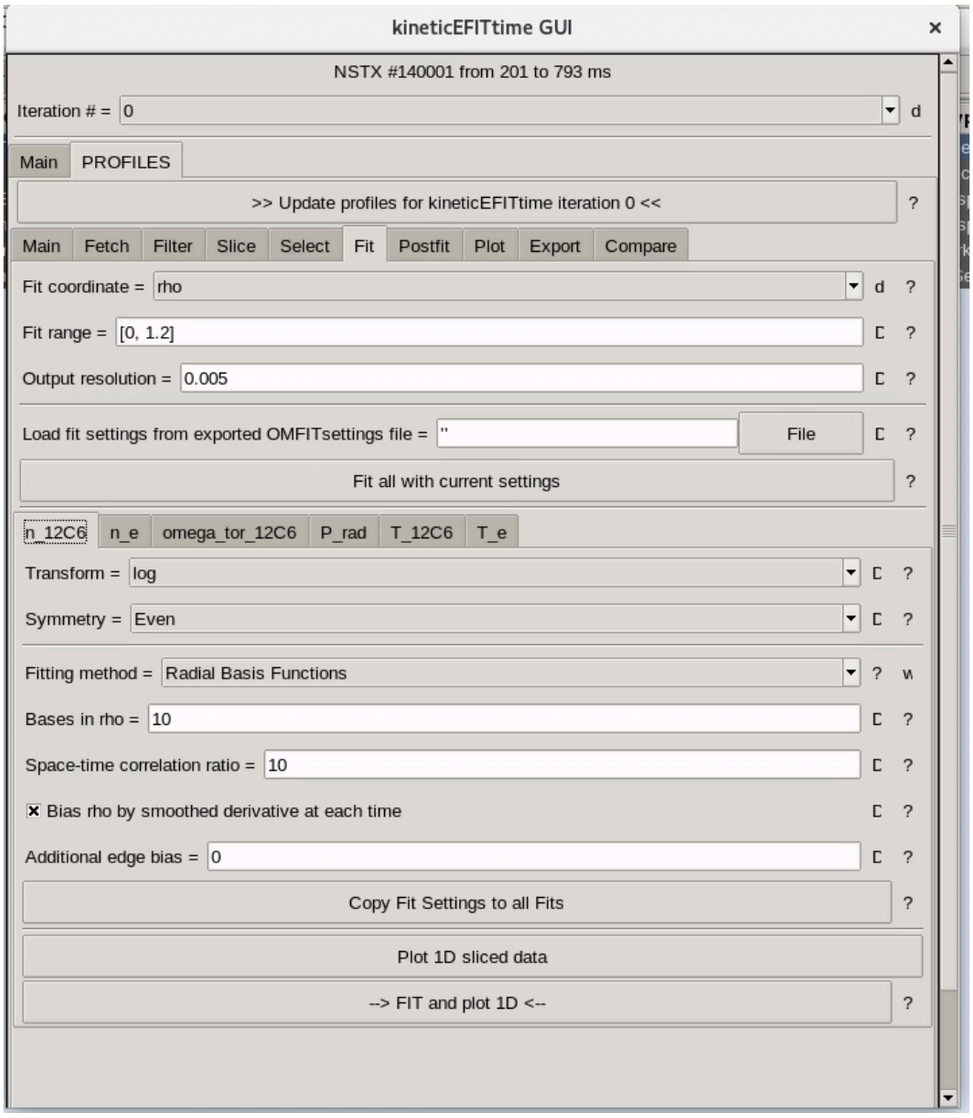
For this tutorial it is recommended to de-select midplane_LFS_T_e_18 and midplane_HFS_ne_0 channels. The steps to do this are as follows:

1) Return to the kineticEFITtime GUI (See Figure below)
2) Select ‘midplane_LFS_T_e’ from the ‘Subsystem’ dropdown menu
3) De-select ‘midplane_LFS_T_e_18
4) Repeat steps 2 and 3 for midplane HFS_n_e


kineticEFITtime GUI
NSTX #140001 from 201 to 793 ms
Iteration # = 0
Main
PROFILES
>> Update profiles for kineticEFITtime iteration 0 <<
Main
Fetch
Filter
Slice
Select
Fit
Postfit
Plot
Export
Compare
Show diagnostics layout
Bolo
CHERS
MSE
TS
1
Subsystem = midplane_LFS_T_e
Use T_e from TS midplane_LFS_T_e
Use n_e from TS midplane_LFS_T_e
Subsample by = 1
Apply Subsampling to subsystem
midplane_LFS_T_e_0
midplane_LFS_T_e_1
midplane_LFS_T_e_2
midplane_LFS_T_e_3
midplane_LFS_T_e_4
midplane_LFS_T_e_5
midplane_LFS_T_e_6
midplane_LFS_T_e_7
midplane_LFS_T_e_8
midplane_LFS_T_e_9
midplane_LFS_T_e_10
midplane_LFS_T_e_11
midplane_LFS_T_e_12
midplane_LFS_T_e_13
midplane_LFS_T_e_14
midplane_LFS_T_e_15
midplane_LFS_T_e_16
midplane_LFS_T_e_17
midplane_LFS_T_e_18
2
Only plot quantities that will be fit
Plot TS (midplane_HFS_T_e) raw time series
Plot TS (midplane_LFS_T_e) raw time series
Plot TS (midplane_HFS_n_e) raw time series
Plot TS (midplane_LFS_n_e) raw time series
Plot TS sliced data
Plot TS 2D sliced data

Selecting the Fit

Next, we will begin profile fitting. In the ‘PROFILES’ tab in kineticEFITtime GUI, select the ‘Fit’ tab.



Within the ‘Fit’ tab, there is a tab selector with the various measured parameters that require a fitting function definition (e.g. Carbon Density (n_12C6), Electron Density (n_e), Carbon Toroidal Frequency (omega_tor_12C6), Radiated Power (P_rad), Carbon Temperature (T_12C6), and Electron Temperature (T_e)). This set of parameters is specified in the ‘Fetch’ process, which was covered in the step Fetch k-files for EFIT. Note: this is the minimum set of parameters for a reasonable estimate of the power balance.

This step requires user discretion to determine what is reasonable given the data quality, and to some extent, the desired next steps for the analysis (core transport, pedestal stability, etc…). For this example, we will adopt the practice to obtain relatively smooth profiles without focusing on the detailed structure.

We begin the fits by selecting a reasonable fitting method for all times. Approaches to individual time slices can be defined later, after an initial fit has been performed.

1) *Select the Electron Temperature ‘T_e’ tab.*
2) *Select ‘Scale Length’ in the ‘Fitting method’ dropdown menu.*
   Note:tWhat constitutes the “best” fitting method is up to the user. The inverse scale length method gives consistent separatrix fit, good for electron temperature. If you are not satisfied with fit quality, try other fitting methods.
3) For the other parameters (n_12C6, n_e, T_12C6) select ‘Scale Length’ as was done for T_e.

Note: We could have made the changes to a single measurement, say T_e, and then used the "Copy Fit Settings to all Fits' to propagate that selection.

4) For the parameter omega_tor_12C6, select 'Radial Basis Functions' as the "Fitting Method"
   Note: The reason that radial basis functions are used for the toroidal rotation frequency rather than 'scale length' is that sometimes the frequency can have negative values, which radial basis functions can handle, but scale length fit methods cannot.
5) Select 'Fit all with current Settings' to perform a fit of all measured parameters for all time slices.
   Note: It is possible to conduct each fit individually, but often one begins with this global approach and refines the fits after reviewing.

The kineticEFITtime GUI (see Figure: kineticEFITtime GUI after initial fit) changed because the Fit data was added to the tree OMFIT['kineticEFITtime']['OMFITprofiles']['OUTPUTS']['FIT'] (shown here).

Figure: kineticEFITtime GUI after initial fit

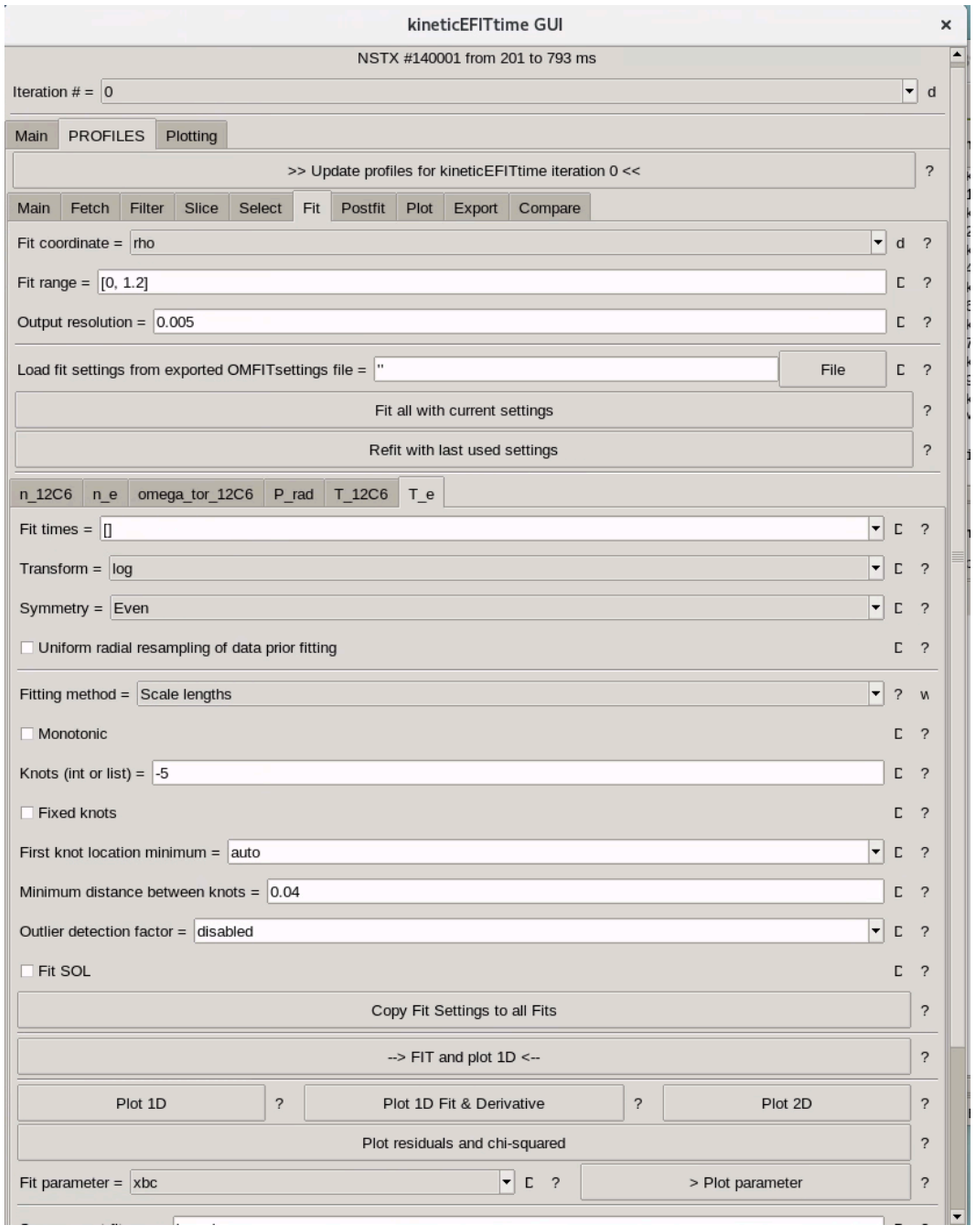
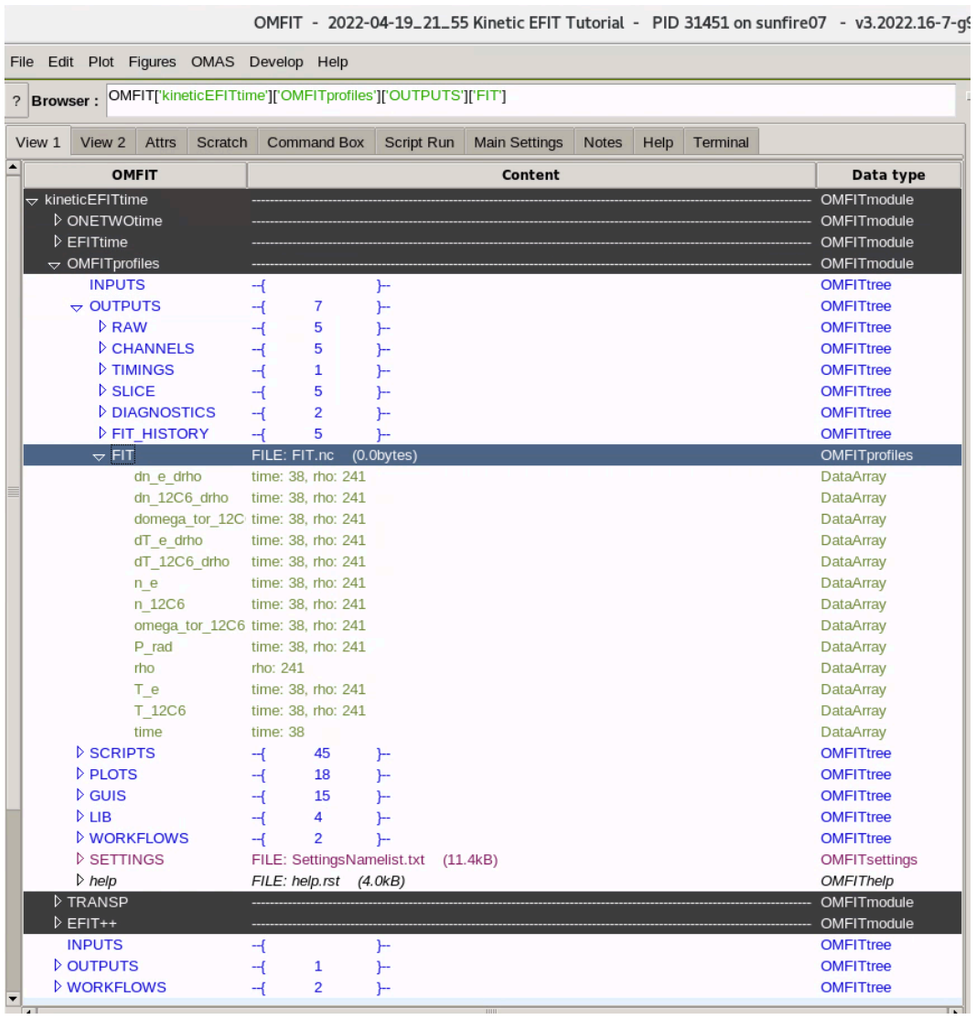
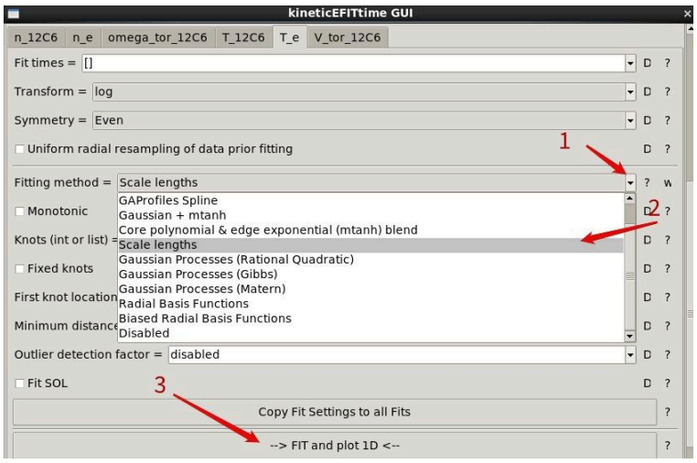
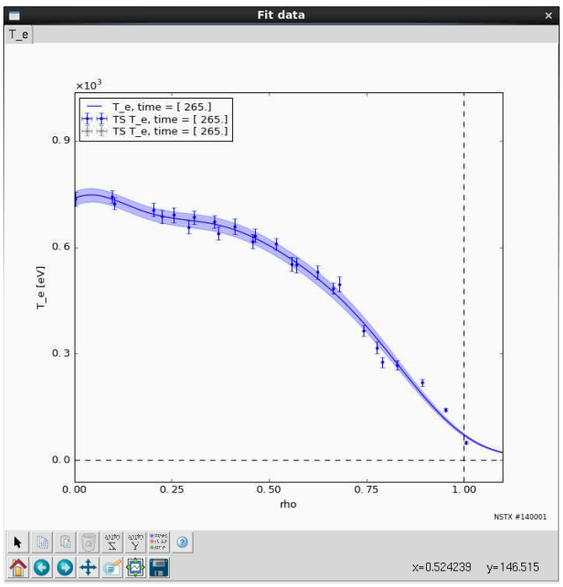


Figure: OMFIT['kineticEFITtime']['OMFITprofiles']['OUTPUTS']['FIT'] view



6) *Then click “Fit and plot 1D”. Use arrow keys →,← to page forward and backwards in time. Always carefully examine the fits.*

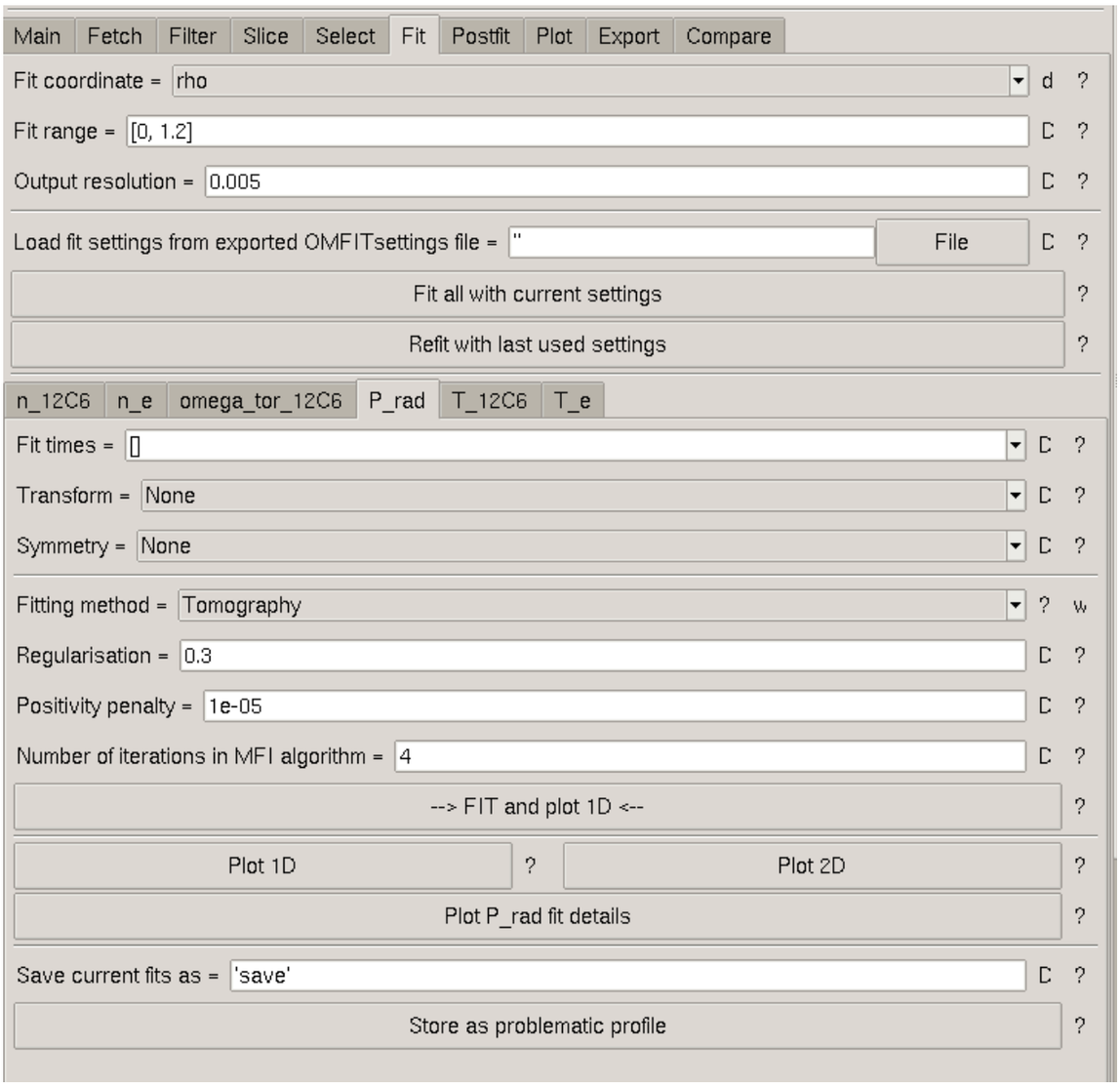




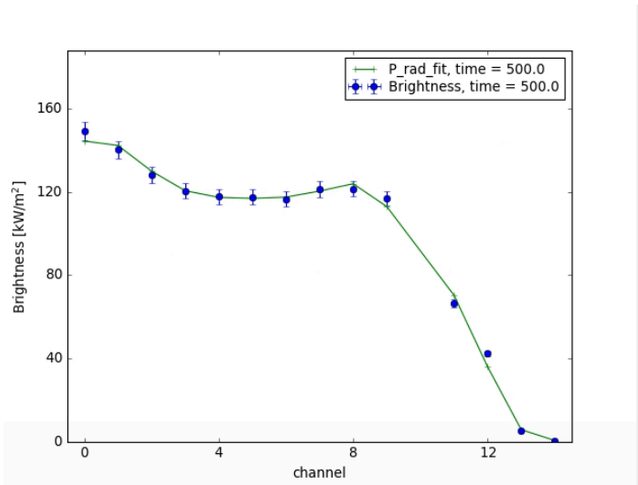
Bolometers

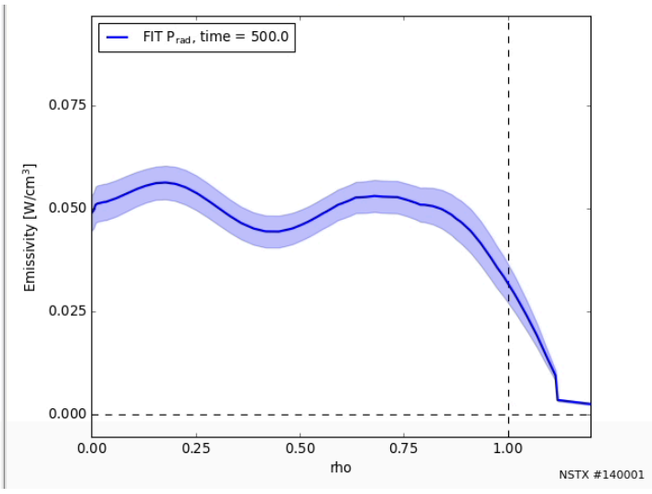
Because the bolometers provide line integrated data, they need to be interpreted differently than other profiles. Simple tangential midplane geometry of the bolometers allows to make a 1D inversions, sometimes incorrectly called Abel inversions. The tomographic inversion algorithm is based on Minimum Fisher regularised (MFI) Tikhonov method. Regularisation level is specified in the fit GUI by a number between 0 and 1. The higher number makes the regularisation bias stronger and profiles smoother, lower regularisaton better fits experimental data. Other two parameters, i.e. Positivity penalty and Number of MFI iterations shouldn't have a large effect on reconstruction quality and it is recommended to keep them at default values.
Once the fit is done, please check data by Plot Prad fit details. Sometimes a single corrupted channel can damage the whole reconstruction. In such case, return to Select panel, remove this channel and try to fit it again.

Because of the high Mach numbers in NSTX plasmas, the radiation profiles have very large centrifugal asymmetry. Therefore the midplane emissivity profile needs to be averaged before saving to OMFITprofiles FIT dataset. Currently the HFS and LFS profiles are only averaged and mapped on rho coordinate. Proper flux averaging would require application of model for centrifugal asymmetry and detailed knowledge of impurity content.



Here is an example of measured data and reconstructed radial profile. Plots are interactive,use left/right arrow key to move in time.





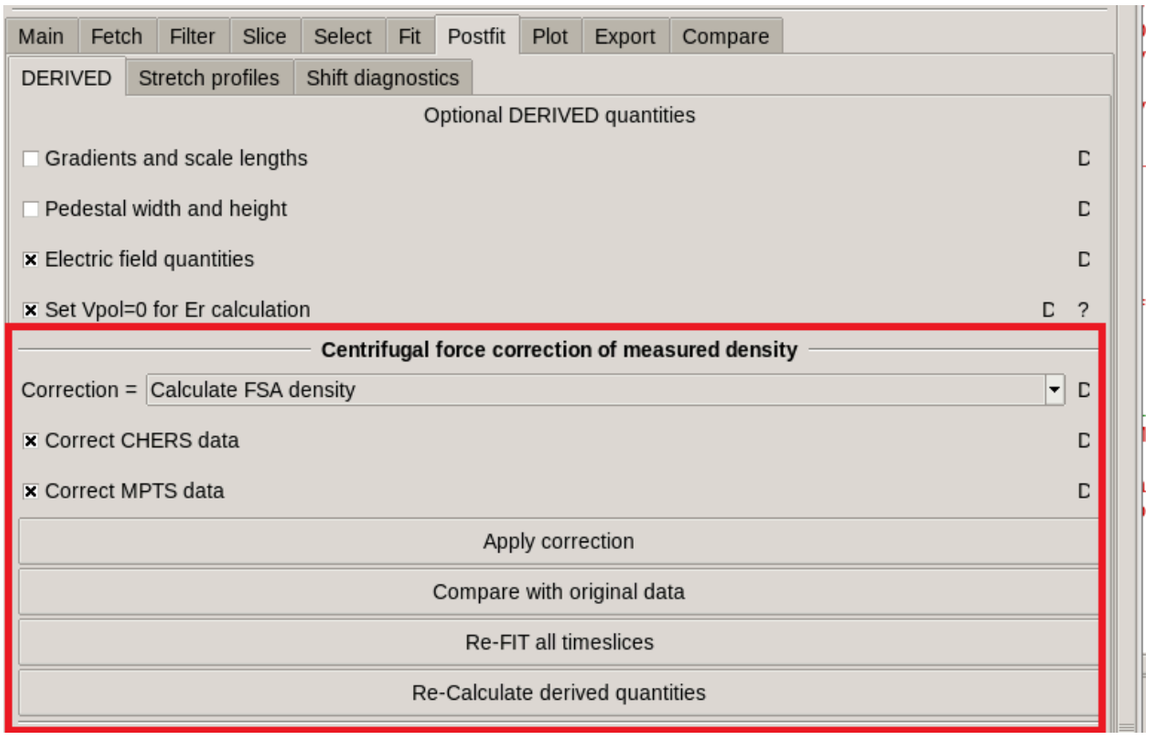
Postfit

When you have completed your profile fitting, *move to the Postfit tab and select "Calculate derived quantities",* which calculates quantities like quasi-neutrality, Zeff, various frequencies, pressures, etc…

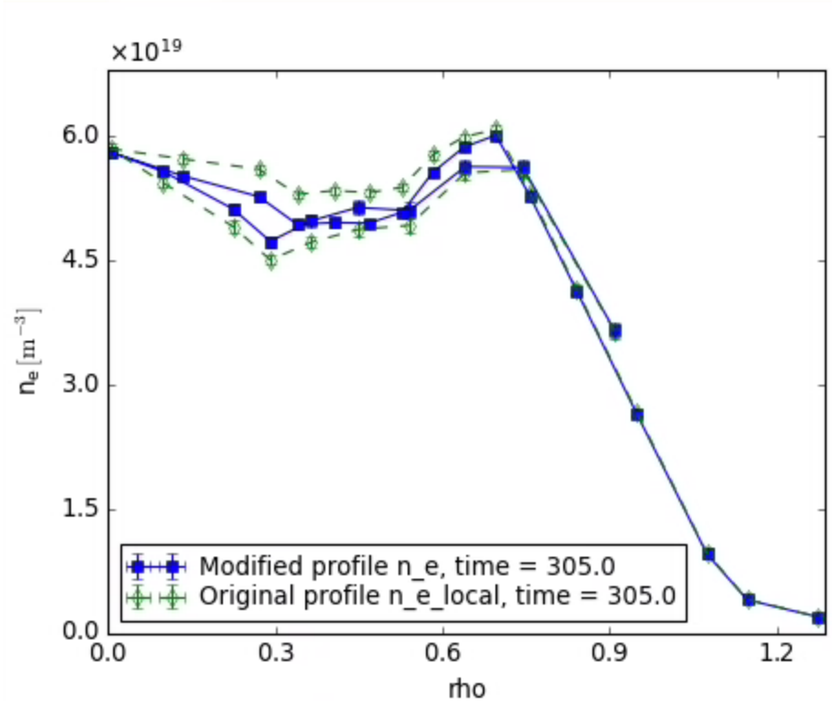
Centrifugal force correction of measured density

Very fast rotation and relatively low ion temperatures in NSTX imply that the deuterium Mach number is near unity, therefore compressibility effects should be considered. As a consequence of particle centrifugal trapping on the Low Field Side (LFS) of the plasma, we can observe an increase in LFS impurity and ion density and a commensurate increase of the electron density on the LFS to maintain quasineutrality of the plasma.

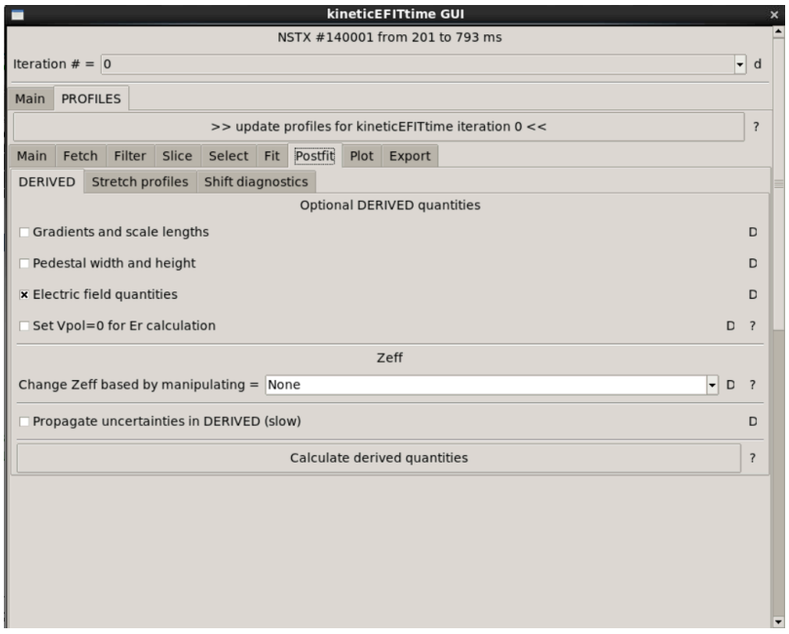
OMFITprofiles has an option to recalculate the measured density to either correspond to the LFS or flux surface averaged (FSA) density. FSA density is utilized by 1.5D codes like TRANSP, while LFS density with properly applied compressibility and rotation effects is expected by codes like NEO, CGYRO or GKW.



Calculation of the density using either of them (LFS of FSA) reduces discrepancy between measured LFS and LFS density profiles as is illustrated below:



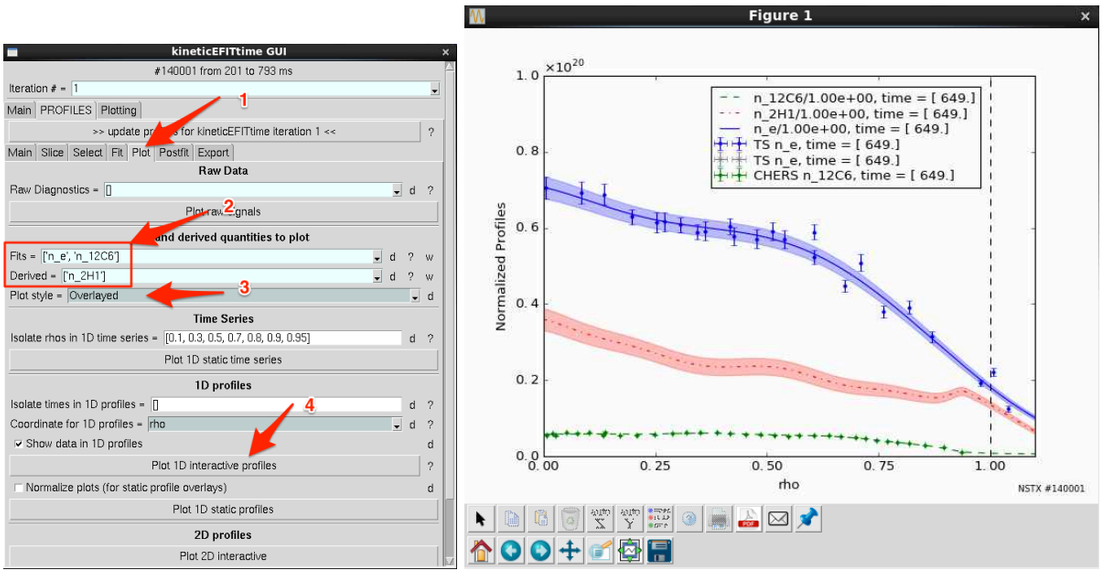
There are also options to stretch profiles or shift diagnostics (like for DIII-D .)



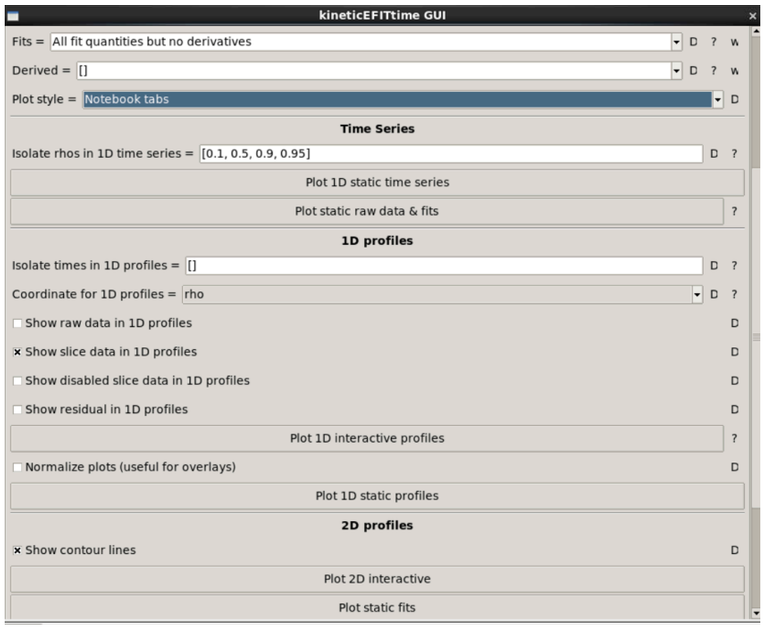
When you are satisfied with the profiles fit, press the button "Update profiles for kineticEFITtime iteration 0" and see them in the OUTPUT for iteration 0

Plot profiles

You can use the Plot tab to produce some powerful visualizations such as the following plot of quasi-neutrality that can be paged through in time, showing ne, nCarbon and nDeuterium profiles.



Another useful option is to select the plot style as notebook tabs and plot interactive profile (use → , ← to page in time). Or look for more options in the [OMFITprofiles tutorial](#).



4. Run Equilibrium

The next step is to create the first user EFIT on your timebase, permitting you to perform detailed pedestal alignments, change the EFIT switches from their defaults, etc.. Then, when this is done, we will fit the profiles again to make both the EFIT and the diagnostic mappings self-consistent for running TRANSP.

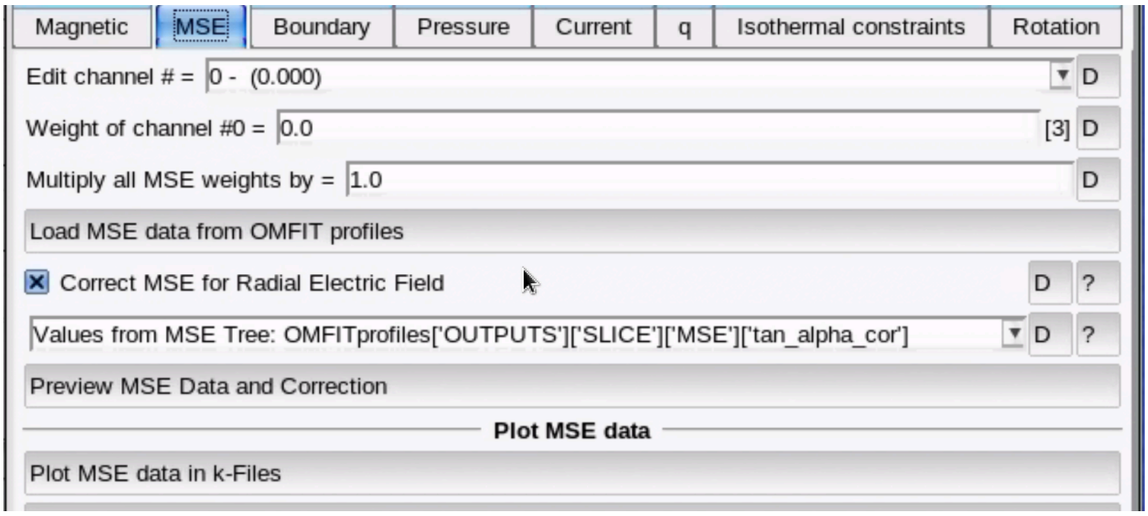
Disable 1) run profiles and enable 2) run equilibrium

Move to the EFIT tab and set up the EFIT constraints. Here we make sure that MSE is used. The default is to run EFIT for all times, but the OMFIT ListEditor allows you to select single times or a subset if you are focused on getting a setup optimized before applying to all times.

There are also options to modify convergence error, relaxation coefficient and number of iterations. The `solution relaxation` parameter controls how much of the EFIT solution at the previous iteration is retained. This parameter (defined between 0 and 1) trades off the speed of convergence for stability. Higher values will make convergence faster, but it can miss the global optimum.

On the Constraints → MSE tab
The first time EFIT is run, the MSE data from OMFITprofiles must be fetched from there. Then **click** the **"Load MSE data from OMFIT profiles"** button. This button should not be pressed in future, unless deselecting many channels in OMFITprofiles, and then updating here in EFIT will allow those weights to be set to 0 accordingly. If you find later that MSE data are poorly fitted, and you trust the MSE data, do not hesitate to increase the weight by an order of magnitude.

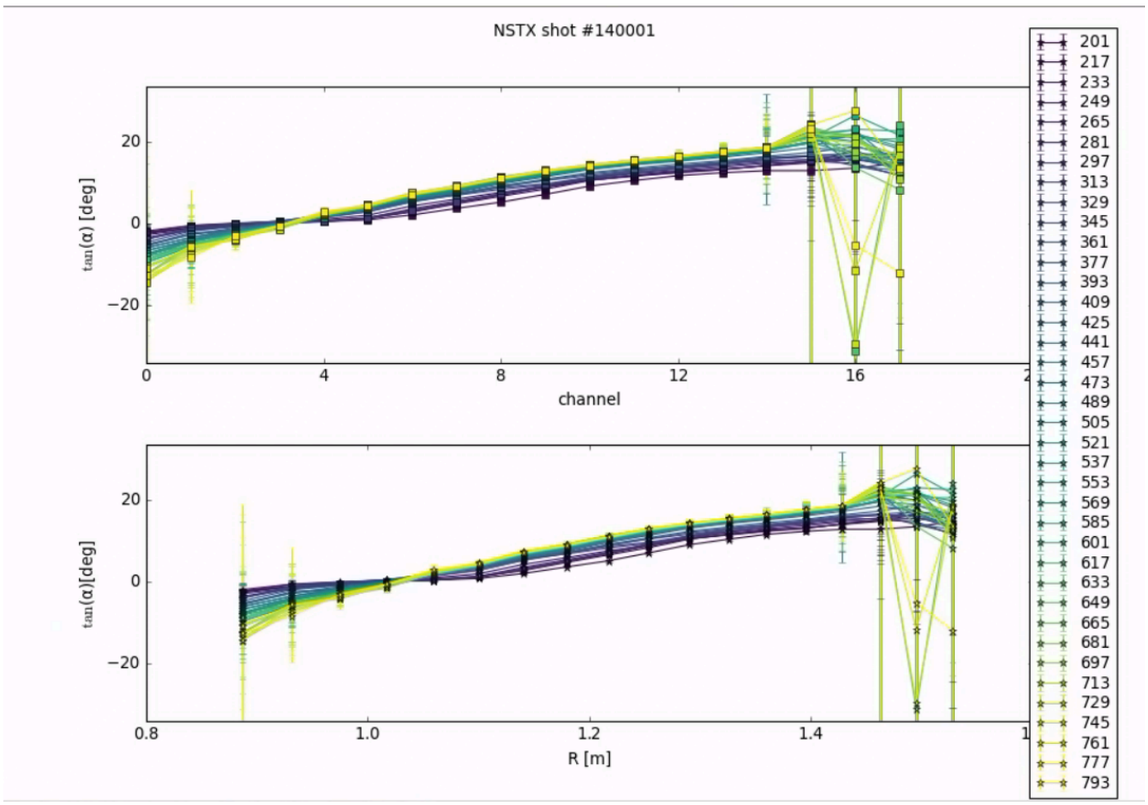
1) *Constraints → MSE tab*



We can view the MSE pitch angles with "Plot MSE measurements".

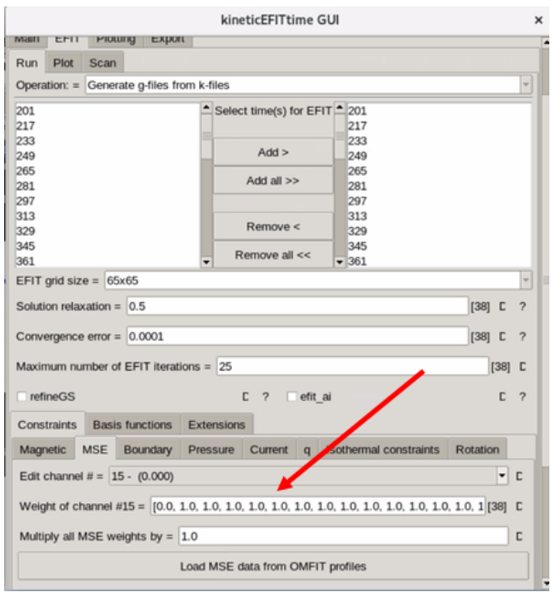
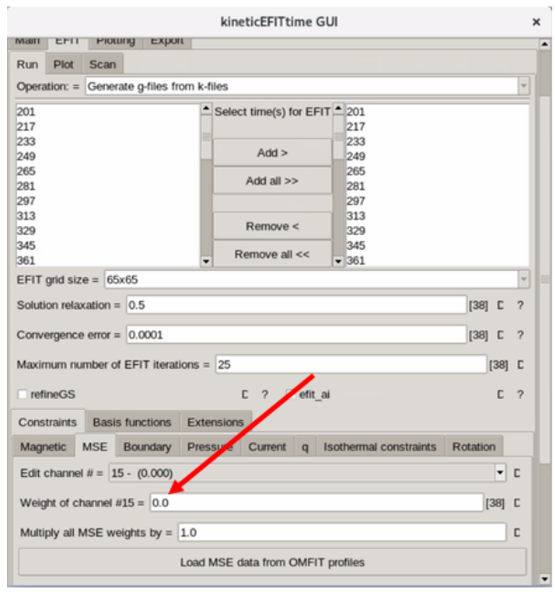
Here we show the measurements as a function of time (as color) vs index and vs R. It is apparent that there are some data concern.

If a given set of MSE channels are not desired then they can be disabled, by changing the weight of the channel. *For this particular example we* will *need to* ***de-select*** *some* ***channels (15-17)*** *to see the plot with a reasonable scale (y axis). Let's see how to do this.*



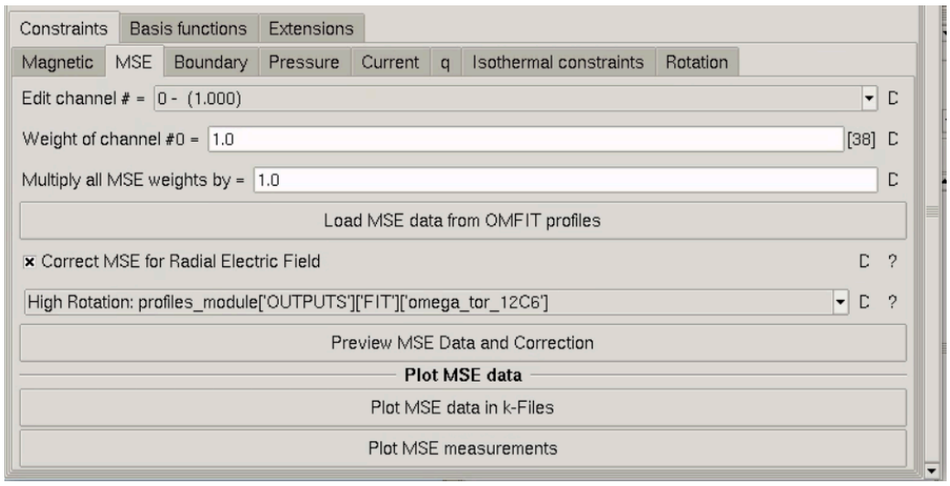
To remove channels 15-17:

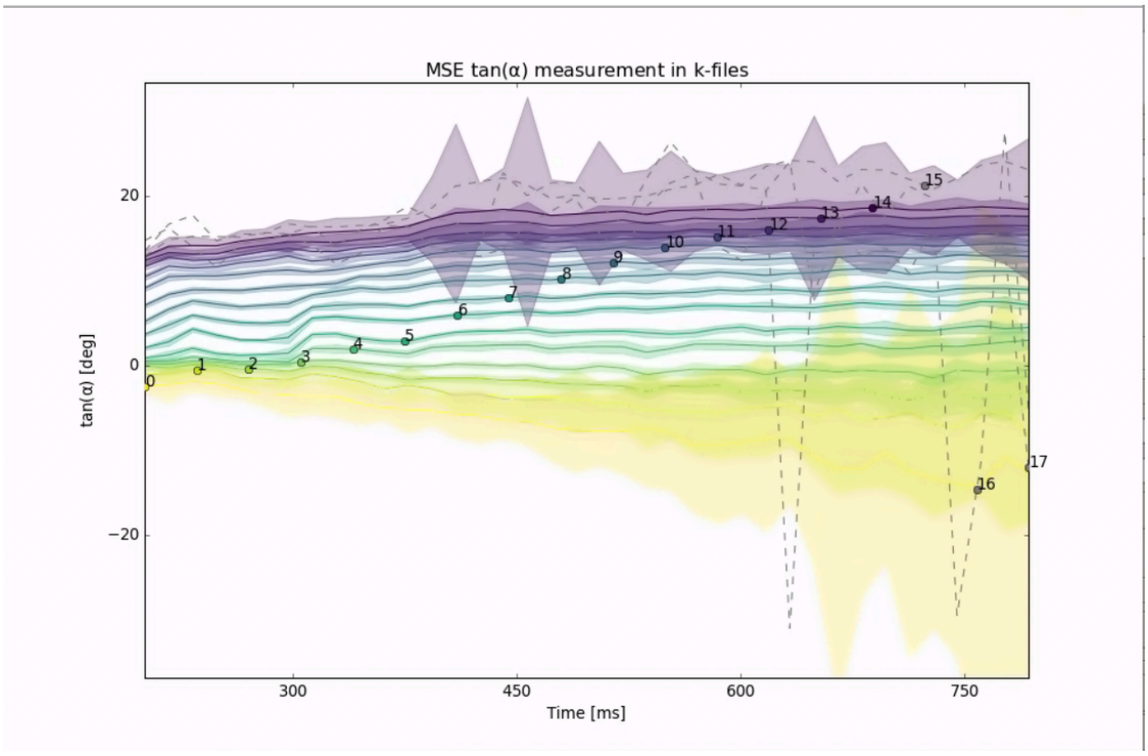
1) Select the tabs EFIT→Run→Constraints→MSE
2) From the “Edit channel #” dropdown, select “15 - (1.000)”
3) Set the “Weight of channel #15” to 0
4) Repeat steps 1-3 for channels 16 and 17.

Before	*After*
	

Next, let’s see what the MSE data in the k-files

1) From the tabs EFIT→Run→Constraints→MSE
2) Press “Plot MSE data in k-files”



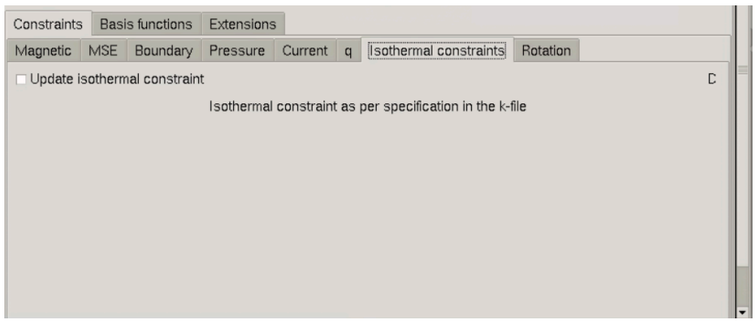


Isothermal constraint

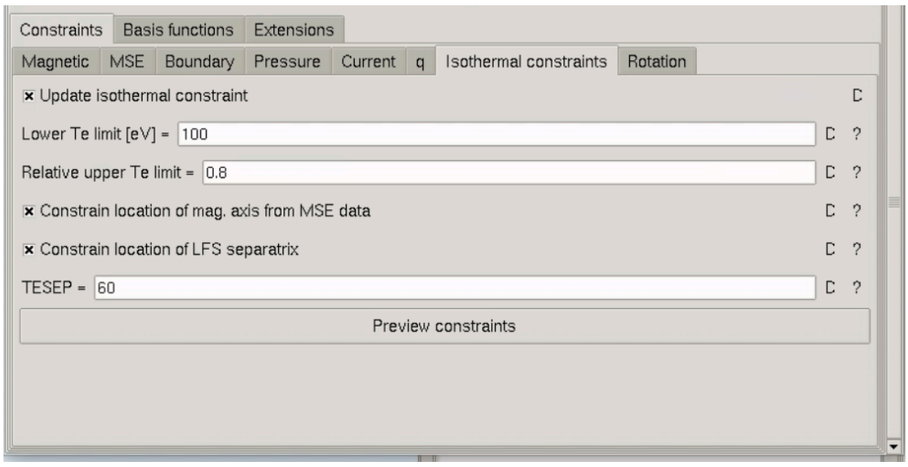
It is highly recommended to use isothermal constraints to properly shift HFS and LFS profiles. The physics behind the isothermal constraint is that the parallel heat conductivity is so high that the electron temperature should be constant on a flux surface.
Preview the constraint to check if the location of Te constraint was identified correctly.

To apply the isothermal constraint:

1) Navigate to EFIT→Run→Constraints→Isothermal constraints
2) Select the “Update isothermal constraint” checkbox.



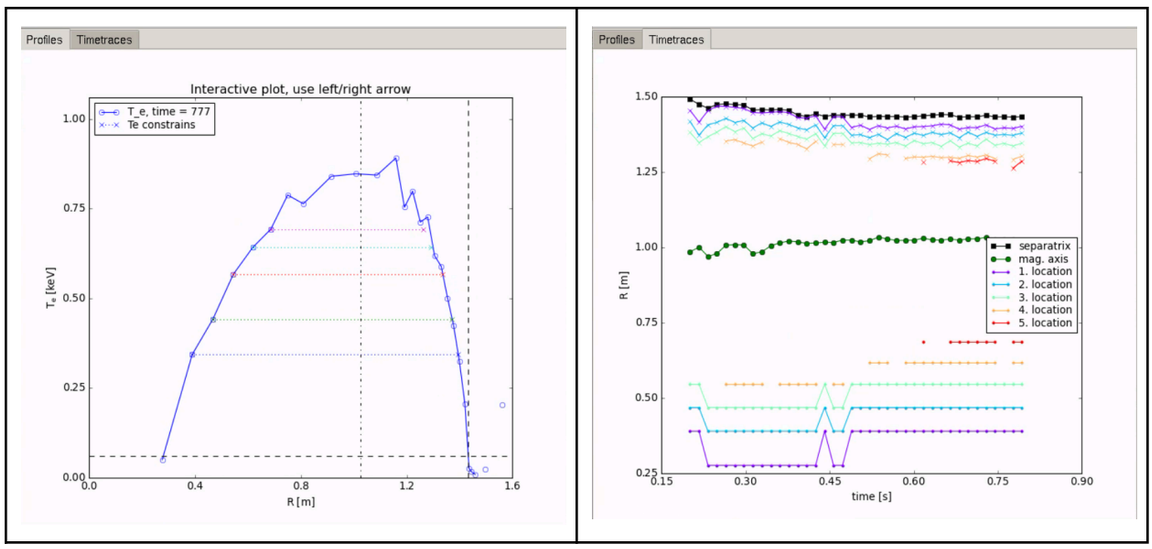
The “Isothermal constraints” tab will refresh

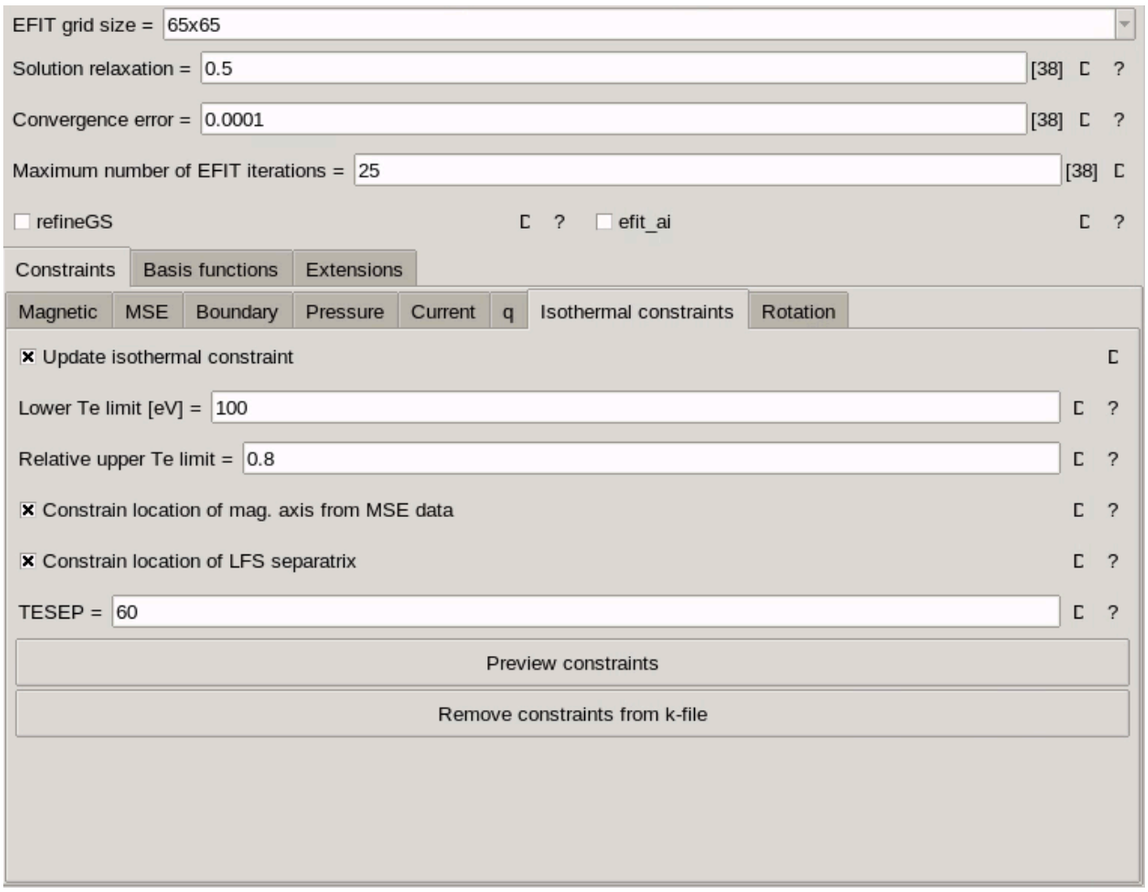


Let’s see what this does

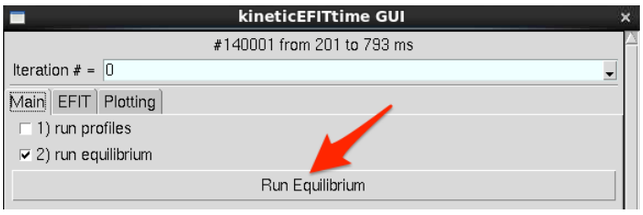
1) Select “Preview constraints”

One can view any of profiles for various times by navigating through them with the arrow key. Let’s look at time slice 777 ms. For the “Timetraces” there is only one view.

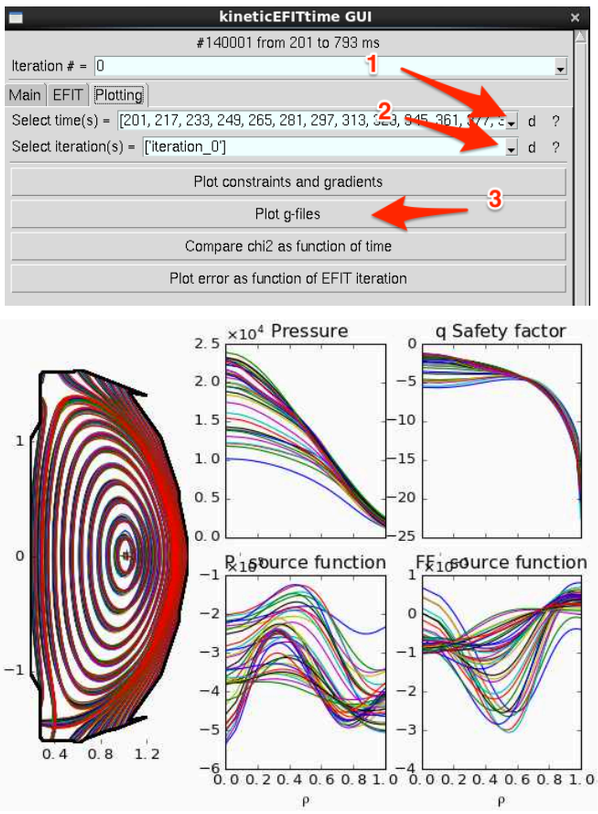




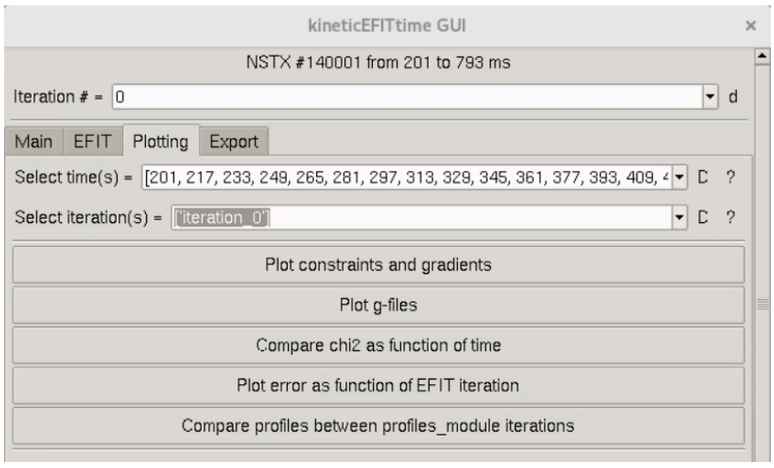
Now move on to running EFIT



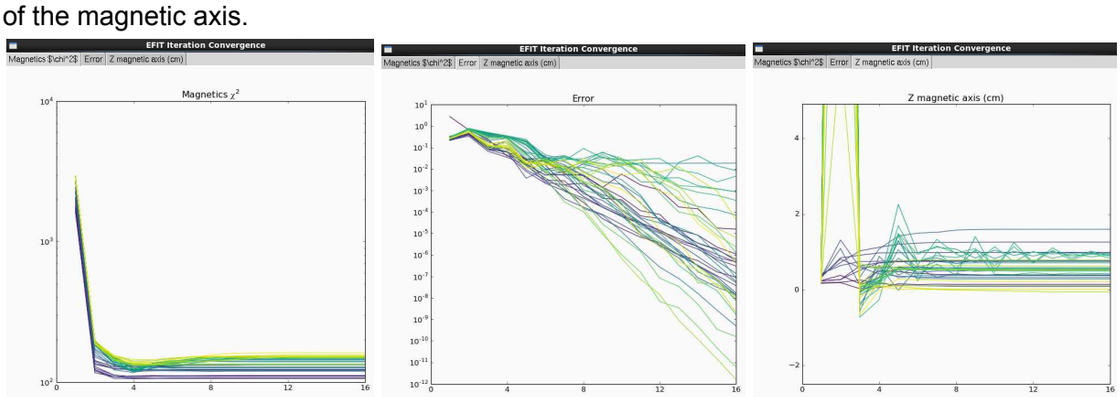
When the EFITs are all complete, we can plot them (*move on to the Plotting tab*)
Select that you want to plot all times, iteration_0 and then plot the g-files.



We can examine the fit quality by plotting the EFIT chi2, error, and magnetic axis location as a function of iteration. Plot GS error by **pressing the "Plot error as a function of EFIT iteration"** button.



Here some time slices converge more quickly than others, and a few EFITs have an oscillation of the magnetic axis.



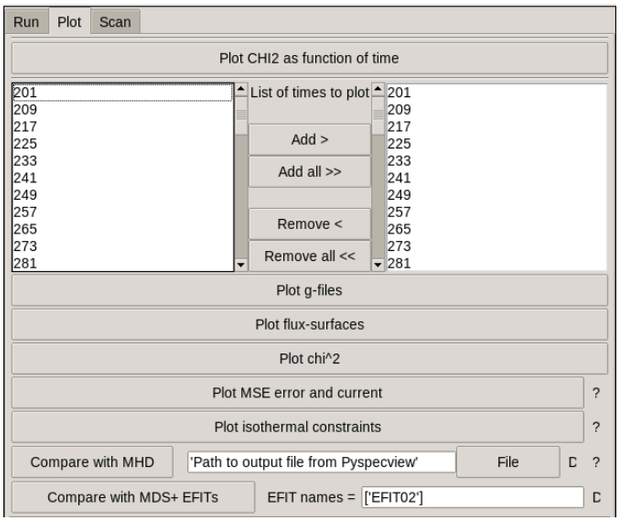
One key figure to examine is the agreement between the measured and reconstructed MSE pitch angles, which determines the q-profile.

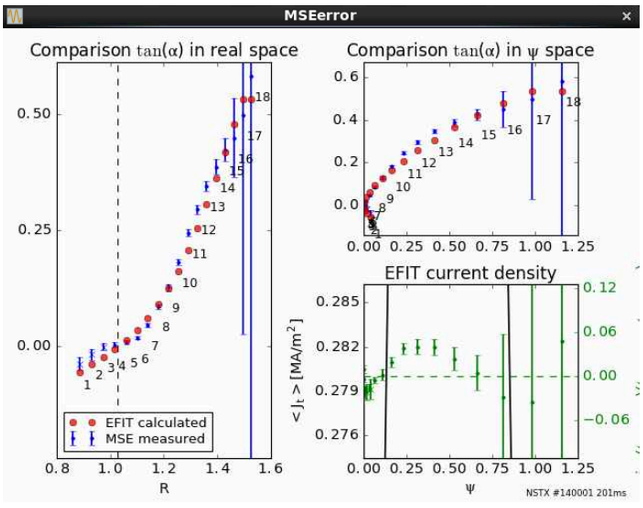
Let's look at the MSE error and current profile:

1) Navigate to EFIT→Plot
2) Press the "MSE error and current profile" button

Here we can see that the EFIT magnetic axis may be at a larger radius than the reconstruction, and that the current profile from a perfect MSE match will be lower on-axis and larger off-axis. However, the existing basis function selection does not allow this, and will be refined later.

More about basis functions, how to customize constraints and what to examine after EFIT runs can be found in the [kineticEFIT tutorial](#).



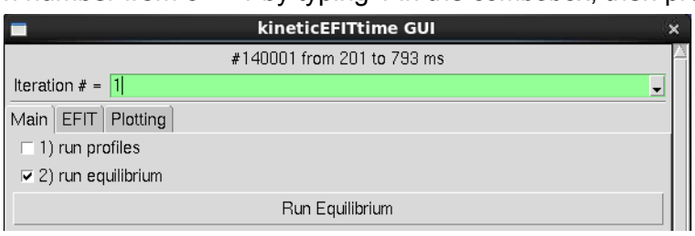


Iteration 1

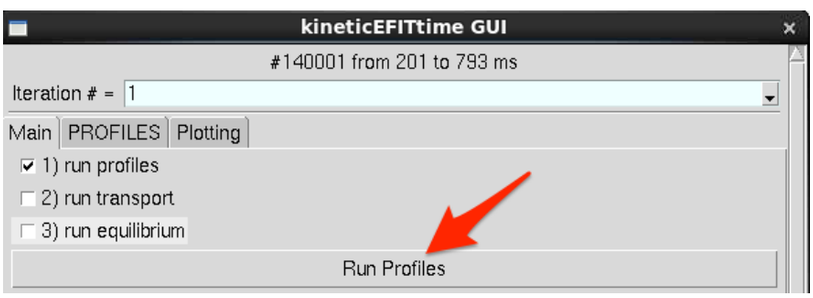
5. Re-fit the profiles on user EFITs

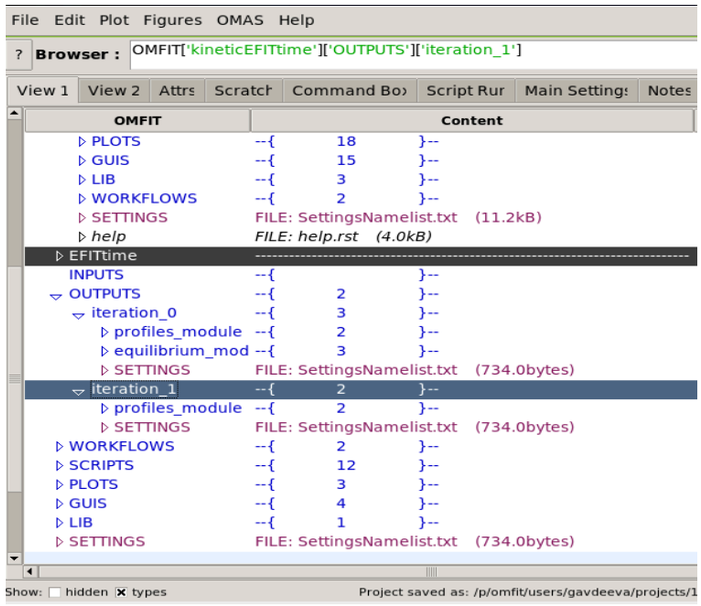
Next, to make the EFITs and profiles self consistent, we need to re-map the diagnostics from machine coordinates to flux coordinates using our user EFITs. Otherwise, the mapping used for our profile fits (based on MDS+ EFITs) may not be the same as the mapping from our user-defined EFITs, which are also exactly on our specified timebase.

Change the iteration number from 0 -> 1 by typing 1 in the combobox, then press [return].



Rather than view each profile again, we can simply "Run Profiles" and the scripts will run all of the way through each profile (n_e, T_e, etc…), update DERIVED and store the resulting profiles in the OMFIT tree.





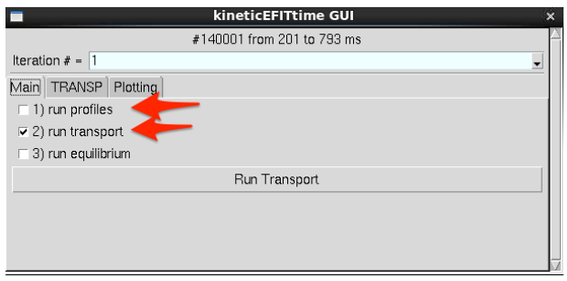
Check carefully the profile fits to avoid unpleasant surprises later.

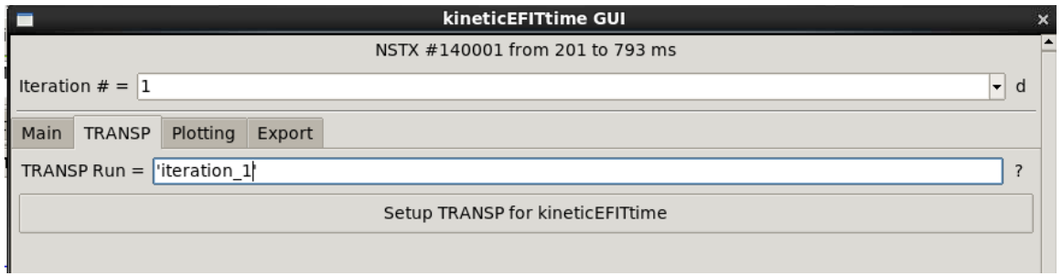
6. Run TRANSP

Note: It is possible to use ONETWO as well. For more details, check the DIII-D version of kineticEFITtime manual.

Back to the Main tab and change our workflow from 1) run profiles to 2) run transport. The TRANSP tab appears.

On the TRANSP tab click "SetupTRANSP for kineticEFITtime". (It may be necessary to change the TRANSP run number to something like 'iteration_1', and then press the button.)





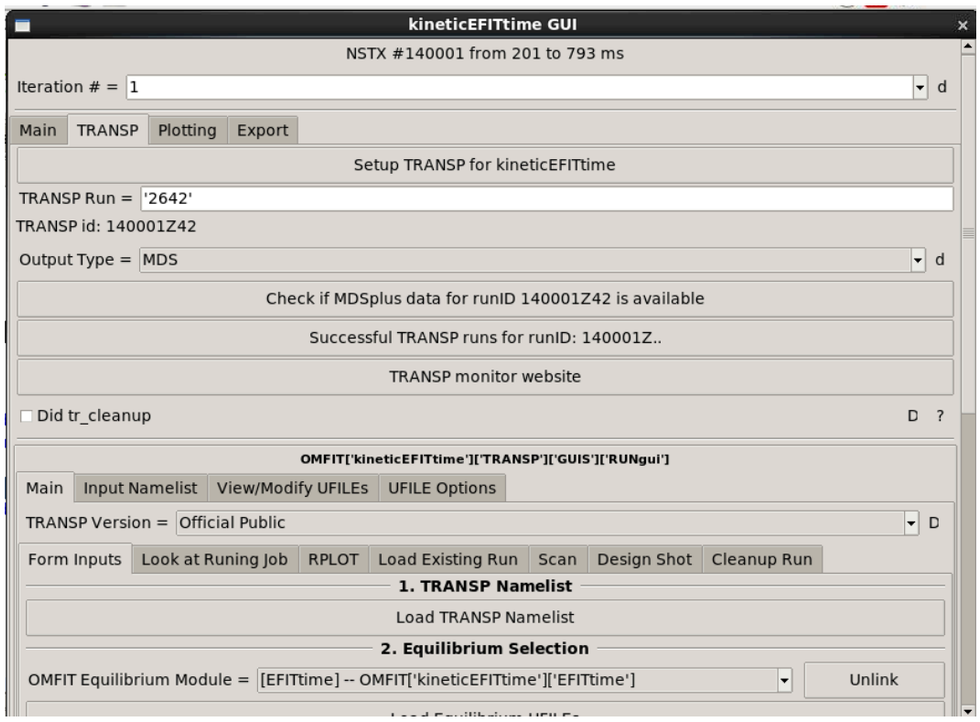
Initializing TRANSP will perform the following for you:

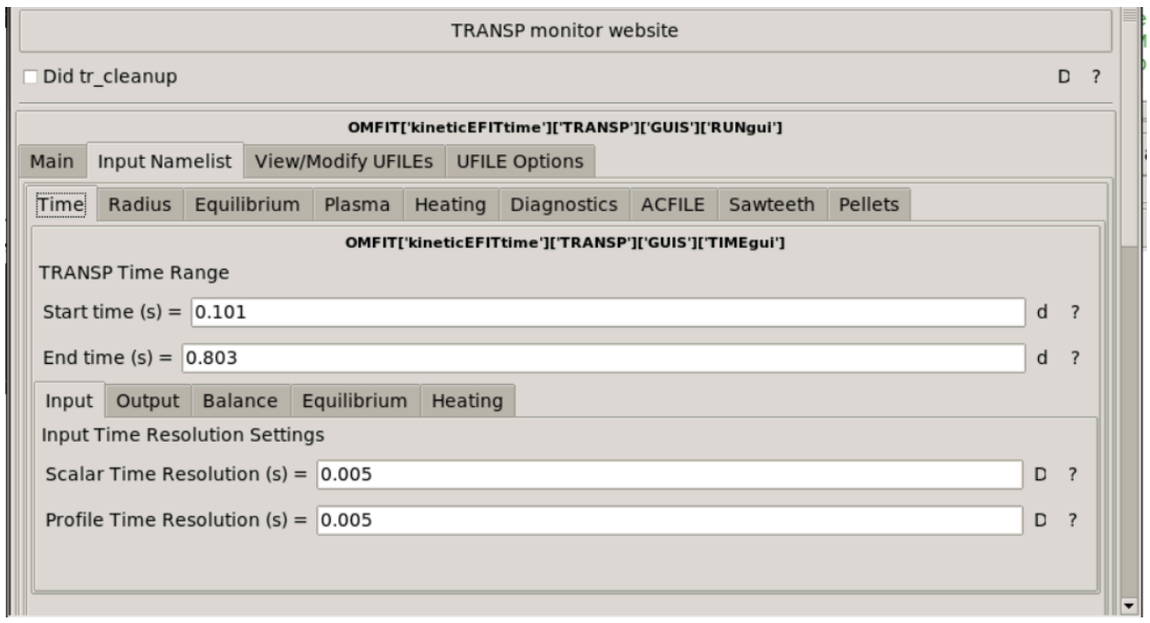
1. Create the TRANSP namelist with pre-defined defaults
2. Deploy the gEQDSK files to disk, run scrunch2, and pull the UFILEs back into OMFIT

a. In the console print out is written warning if some qEQDSK are skipped due to a high GS error. Sometimes SCRUNCH2 can skip most of them.

3. Create profile UFILEs for the plasma profiles you produced in iteration_1 “run profiles”
4. Set up machine specific inputs such as heating powers, recycling, neutron rates, etc...

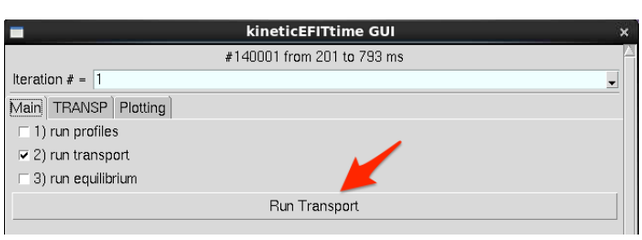
Once completed, you are presented with the TRANSP GUI, where you can change desired settings.





When you are happy with input settings click button “Setup TRANSP for kineticEFITtime”.

After successful finishing “Setup TRANSP for kineticEFITtime” return to the Main Tab and select “Run Transport”



The run will appear in the TRANSP Grid Monitor http://w3.pppl.gov/transp/transpgrid_monitor.

If the submission of the run failed with the following error

```
ssh_askpass: exec(/usr/libexec/openssh/ssh-askpass): No such file or directory
Permission denied, please try again.
ssh_askpass: exec(/usr/libexec/openssh/ssh-askpass): No such file or directory
Permission denied, please try again.
ssh_askpass: exec(/usr/libexec/openssh/ssh-askpass): No such file or directory
Permission denied (publickey,gssapi-keyex,gssapi-with-mic,password,hostbased).
tr_send_pppl.pl -E-  globus-job-submit failed
```

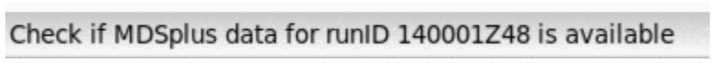
you should save the project (to be able to open and just continue later), open a new terminal, type `ssh -Y portal` and then start a new OMFIT session.

...	140001Z01	NSTX	10	bgriers	Mark	Restart mark set to: 0.1000000 / 0.1050000 (sec) - cpu time =2.1402E-03 (hrs)
					active	Running on mccune031.pppl.gov (R5)
					active	Since Thu Nov 17 16:03:27 EST 2016
					shot	Shot: 140001
					truser	tr_bgriers

(After the run is done, if you get this error:

```
   status=self.get("TreeOpen($,$)",tree,shot)
 File "/fusion/projects/codes/atom/omfit_v3.x/atom/miniconda3_3.2021.20.1
/lib/python3.7/site-packages/MDSplus/connection.py", line 254, in get
   ans = self.__getAnswer__()
 File "/fusion/projects/codes/atom/omfit_v3.x/atom/miniconda3_3.2021.20.1
/lib/python3.7/site-packages/MDSplus/connection.py", line 110, in __getAnsw
er__
   ans=Connection.dtype_to_scalar[dtype](_C.cast(ans,_C.POINTER(_dtypes.
mdsdtypes.ctypes[dtype])).contents.value)
KeyError: 0
```

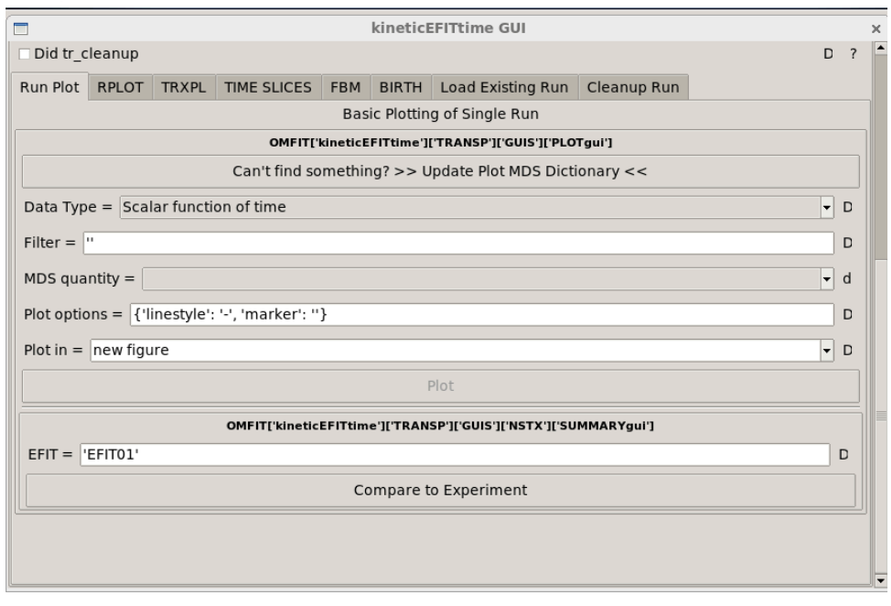
click on the button

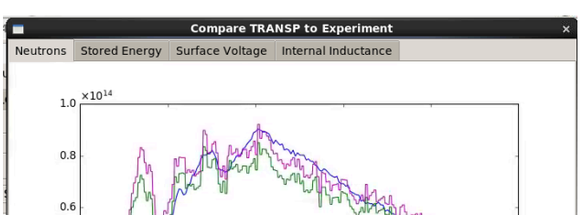


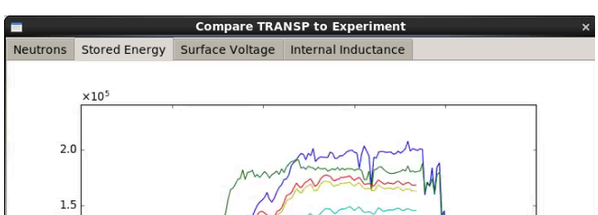
and hopefully your data will now be fetched.
)

Compare TRANSP to experiment

Upon completion of the run, we examine the self-consistency between the measured and predicted neutron rate, the comparison between the plasma stored energy from kinetic profiles (ne, nImp, Te, Ti, Pbeam) and magnetics (W_MHD), and the measured and simulated surface loop voltage that depends on the overall Zeff, beam-driven and bootstrap current by *clicking the "Compare to experiment" button on the bottom of the TRANSP tab.*



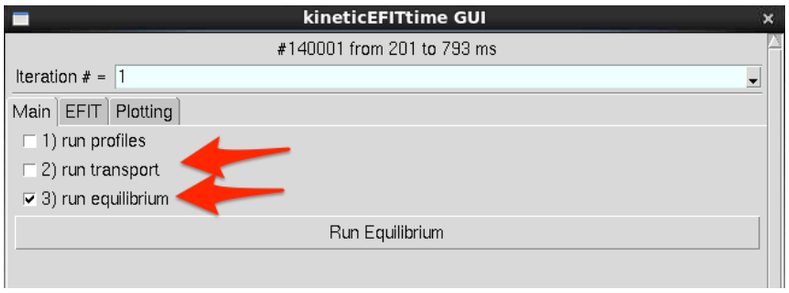




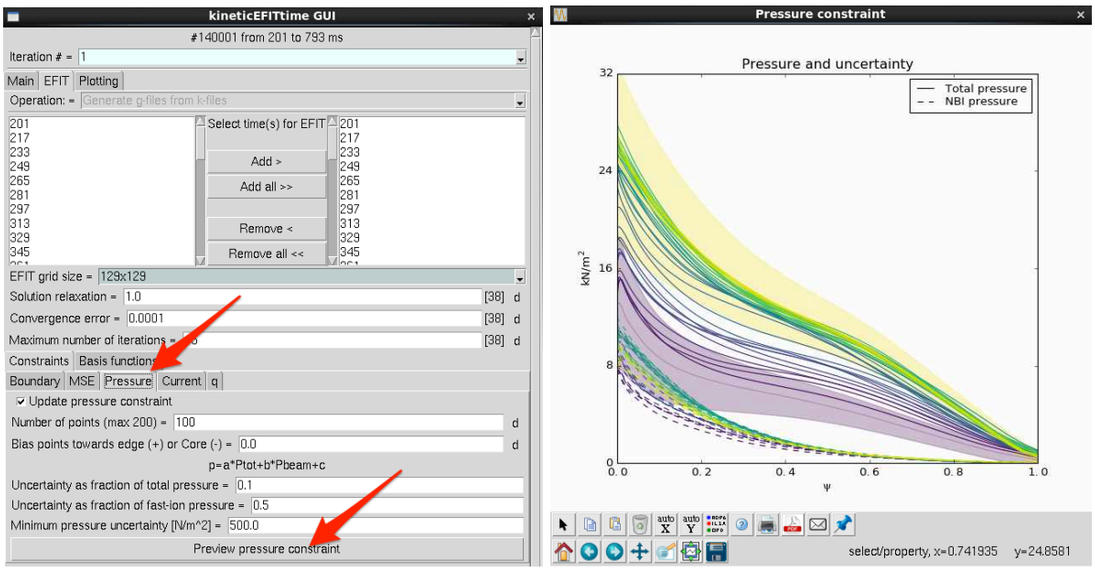
And you can view any TRANSP output with the TRANSP GUI's plotting capability or the RPLOT tool for comparing multiple TRANSP runs, creating new UFILEs, plotting fluxes, etc...

7. Create kinetic EFITs

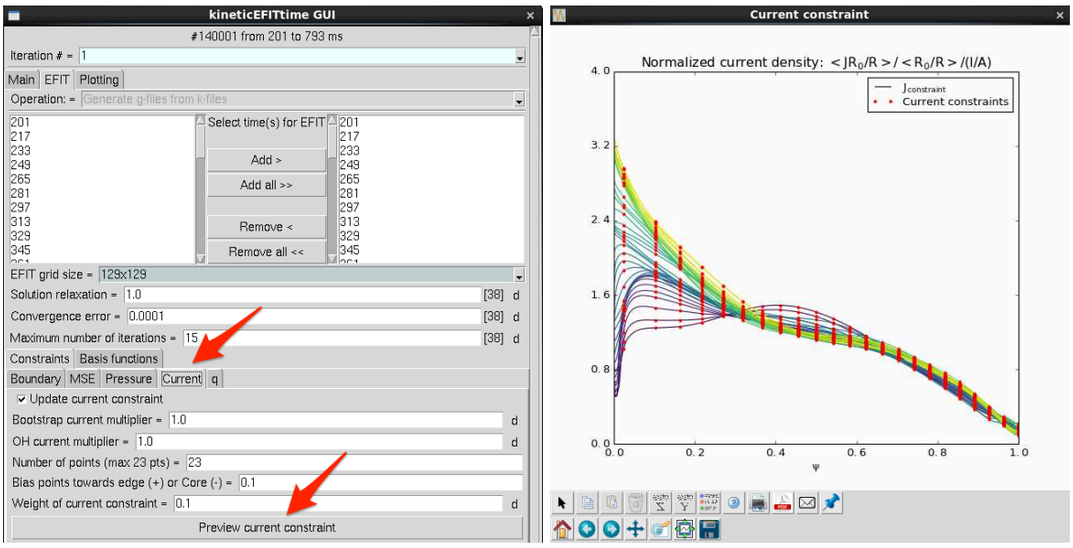
Now for the final step, which is to use the TRANSP output thermal and fast-ion pressures, and bootstrap current, to make a new "kinetic" EFIT.
On the Main tab change from "transport" to "equilibrium".



On the EFIT tab select "Constraints" and then "Pressure".
Here we view the thermal and fast-ion pressures for each timeslice.
Depending on the condition and data quality, you may want to change the default values for the pressure uncertainty or the number of radial points in the pressure profile constraint for EFIT.



Next we can view the current constraint, which defaults to prescribing the entire current profile from the TRANSP simulation with 23 radial points assigning a 10% weight.

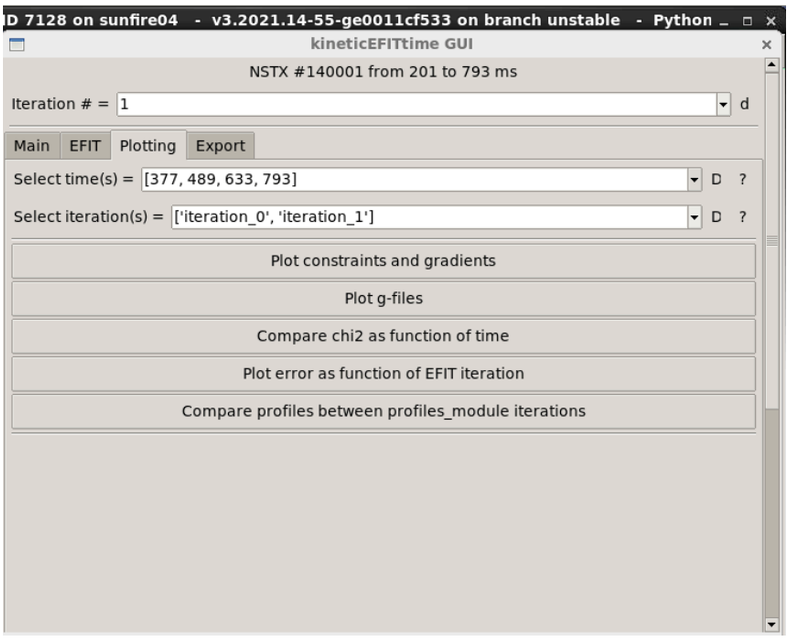


Finally, add also the Rotation constraint. It might be necessary to reduce the number of pressure constraints if the rotation constraint is included.

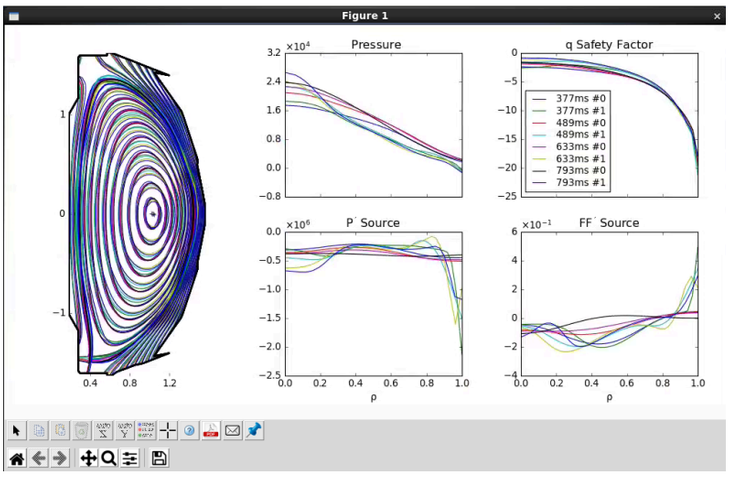
Having previewed the pressure, current, rotation and isothermal constraints, now go back to the main kineticEFITtime GUI and click the “Run Equilibrium” button.

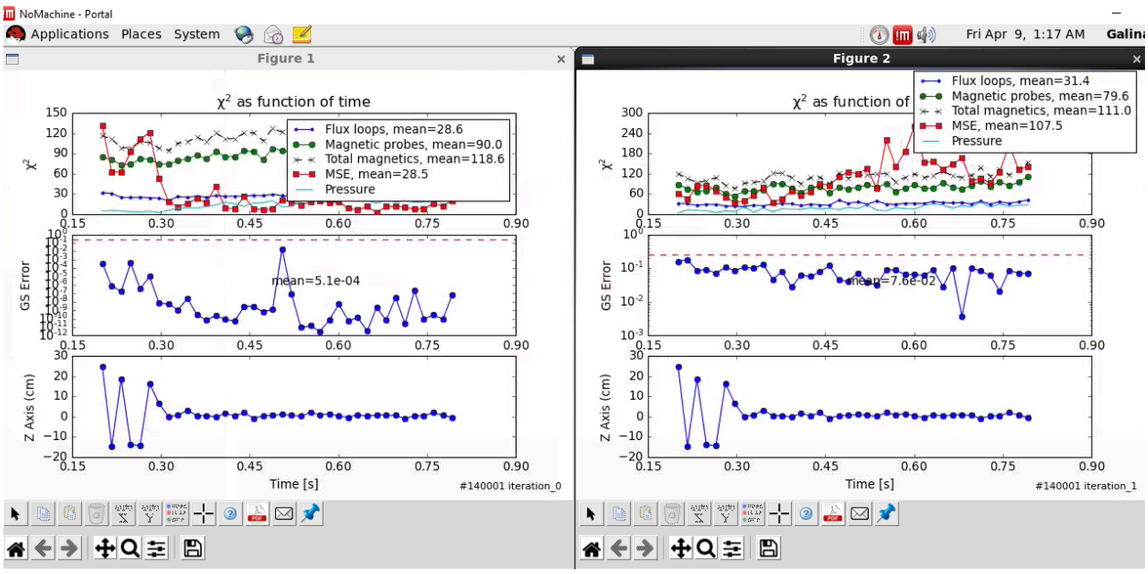
9. Compare iterations

Upon completion of the equilibrium reconstruction, we can compare results between two iterations. Move on to the Plot tab, select the time steps and iterations, then plot the desired quantities.

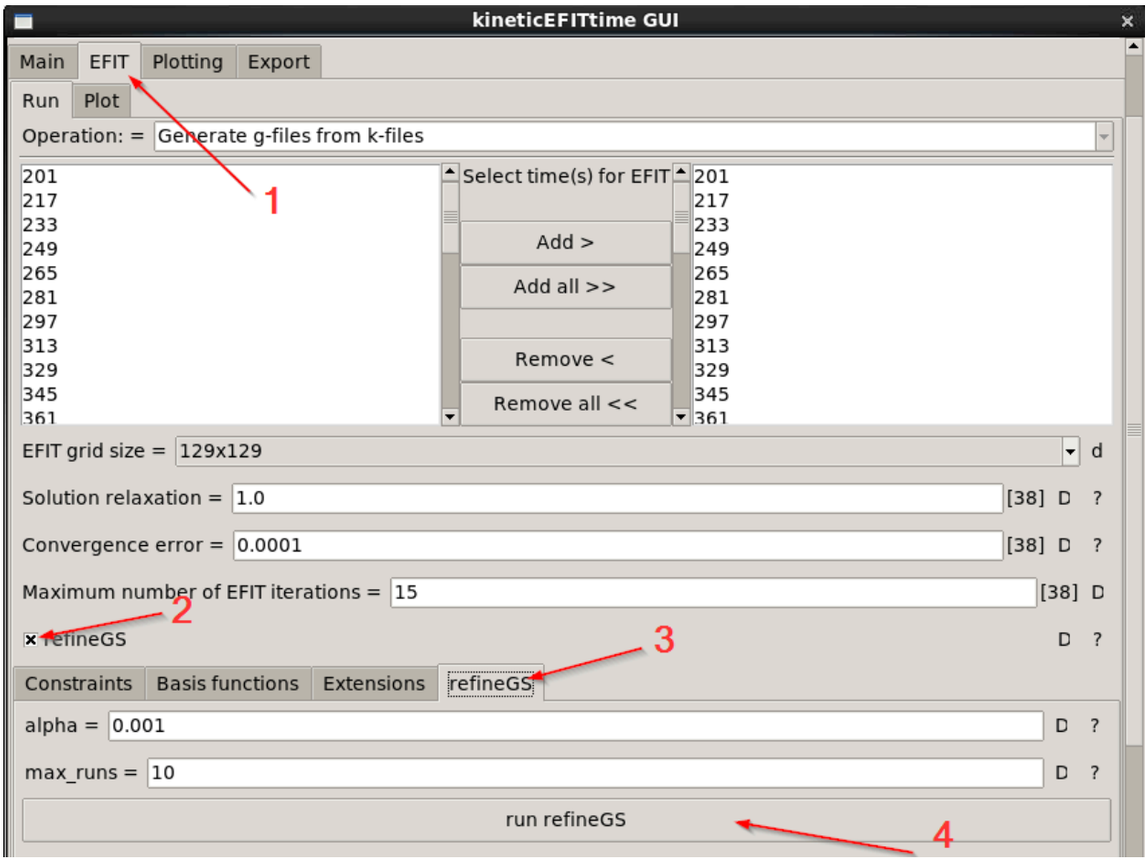


Below is the comparison between the EFIT02 (iteration 0) and the TRANSP-constrained kinetic EFIT (iteration 1)





In case of a high GS error, we can run the refineGS script. This script runs EFIT multiple times perturbing the P' and FF' spline knots and keeps the solutions with the lowest Grad Shafranov error.



Move on to the EFIT tab and find the refineGS tab with settings and “run refineGS " button.

If the error is still high, decreasing the solution relaxation parameter, or increasing the maximum number of EFIT iterations, alpha (perturbation amplitude), and max_runs should improve the solution.

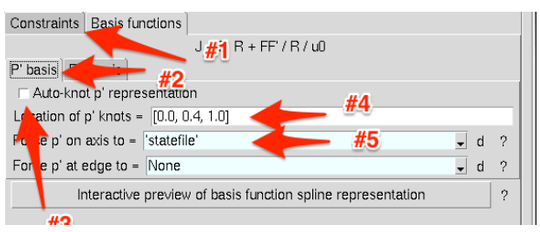
Q/A

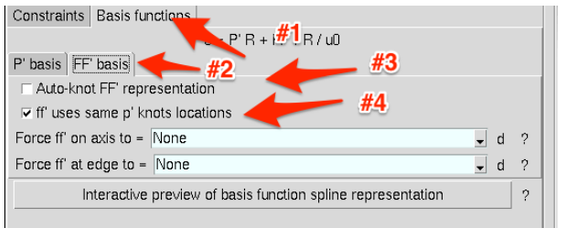
Basis functions

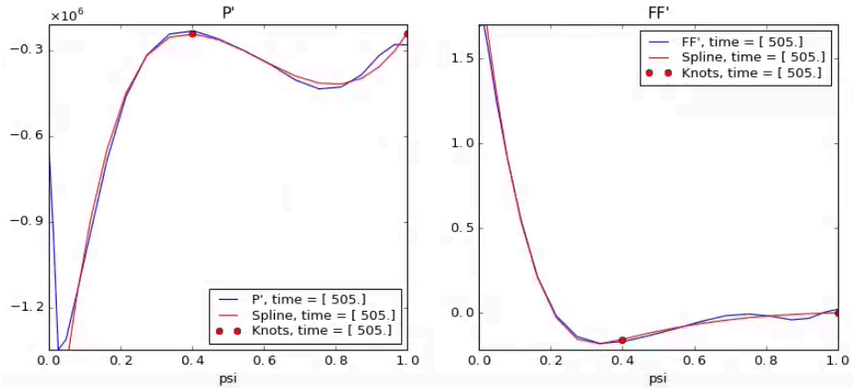
To modify the knots location for basis function spline

1. Go to EFIT→Run →Basis Functions → P' basis. De-select Auto-knot, enter [0.0, 0.4, 1.0] into the knot locations,select 'p on axis from 'statefile'
2. Go to Basis Functions → FF' basis. De-select Auto-knot, and select ff' uses same p' knot locations

Then you can preview the basis function splines







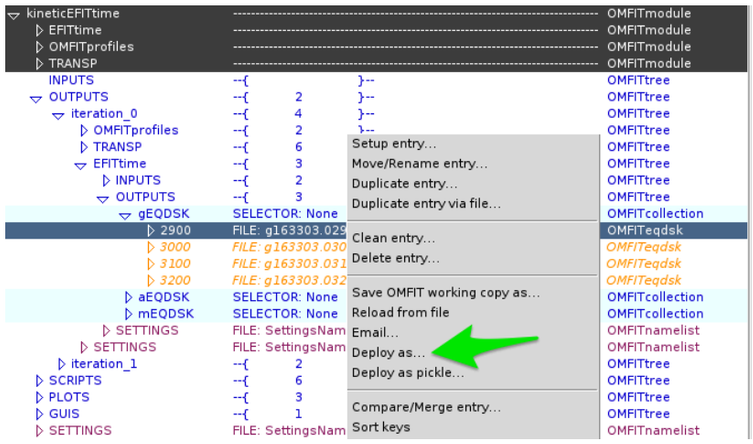
Data Output

Often the results you create will be needed by other computer codes.

One of the most common is outputting the EFIT quantities kEQDSK, gEQDSK, aEQDSK, mEQDSK, etc…

Browse to the iteration that you would like to export to a directory on your workstation.

Right-click on the entry and select "Deploy as..."



A pop-up dialog box will ask where you would like to save the file.
Then, it is up to you to copy or share with whomever you like.