

OMFIT M3D-C1 Tutorial

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This is a help document written in tutorial fashion that guides the user through the automated running of M3D-C1 using the autoC1 script through the OMFIT M3DC1 module.

[Introduction](#)

[Getting started](#)

[Setting up an equilibrium](#)

[Running from equilibrium files](#)

[Selecting equilibrium files](#)

[Extending profile data to open-field-line region](#)

[Running from an existing autoC1 directory](#)

[Setting up the input namelist](#)

[Selecting calculations to run](#)

[Starting the autoC1 run](#)

[Exploring an autoC1 directory](#)

[Examining M3D-C1 results](#)

Introduction

M3D-C1 is an implicit, three-dimensional, nonlinear simulation code that solves the two-fluid magnetohydrodynamics (MHD) equations in highly magnetized toroidal geometries. It also contains options to perform two-dimensional nonlinear or linear simulations, and to solve reduced sets of the MHD equations. The official users guide can be downloaded from <http://w3.pppl.gov/~jardin/M3DC1/NEWDOC-latest.pdf>.

This document outlines how to run M3D-C1 via OMFIT. It demonstrates how:

- to load and to preprocess a new equilibrium reconstruction for analysis,
- to load and to modify an M3D-C1 input namelist,
- to select types of calculations one wants to perform,
- and to start new calculations in an existing OMFIT M3D-C1 directory.

Running M3D-C1 through OMFIT is built on top of the autoC1 python utility, available for download from GitHub at <https://github.com/bclyons12/autoC1>.

Getting started

In order to perform automated M3D-C1 calculations, first launch OMFIT on your desired platform. From the menus, select File ---> Import Module, then load the M3DC1 module from the list of Module IDs. From the OMFIT tree, double click M3DC1 to launch the Automated M3D-C1 GUI. Note that the module name lack a hyphen compared to the name of the code. Detailed instructions for running OMFIT on various platforms can be found here: <http://gafusion.github.io/OMFIT-source/usage.html>.

Setting up an equilibrium

Under the Setup equilibrium tab, choose what Device you want to simulate from the dropdown menu. This will allow OMFIT to know what files it needs and autoC1 to know what templates to use. Next, choose what Setup type you want, [running from Equilibrium files](#) or [running from an Existing autoC1 directory](#). If necessary, click the Reset setup button to start the setup over. This can be done at any step.

Running from equilibrium files

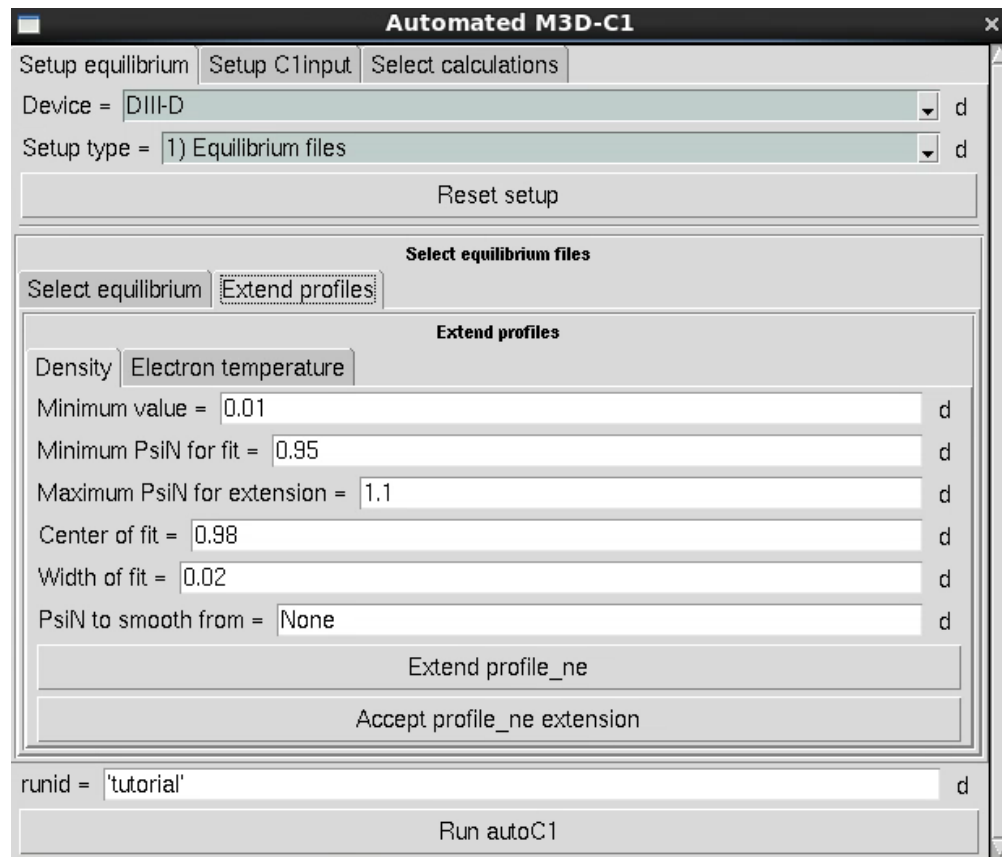
Selecting equilibrium files

The screenshot shows the 'Automated M3D-C1' window with the 'Setup equilibrium' tab selected. The 'Device' is set to 'DIII-D' and the 'Setup type' is '1) Equilibrium files'. A 'Reset setup' button is visible. Below, the 'Select equilibrium files' subtab is active, showing fields for 'Pick gEQDSK', 'Pick aEQDSK', 'Select profile type', and 'Pick pFILE', each with 'Tree', 'Local', and 'Remote' options. An 'Extract profiles' button is at the bottom of this section. The 'runid' field is set to 'tutorial', and a 'Run autoC1' button is at the very bottom.

Field	Value	Options
Device	DIII-D	d
Setup type	1) Equilibrium files	d
Pick gEQDSK	MFIT/DIII-D/158103/03796/done/efit/g158103.03796'	Tree Local Remote d
Pick aEQDSK	MFIT/DIII-D/158103/03796/done/efit/a158103.03796'	Tree Local Remote d
Select profile type	1) p-eqdsK file	d
Pick pFILE	ta/OMFIT/DIII-D/158103/03796/done/efit/p158103.03796'	Tree Local Remote d
runid	tutorial	d

If you choose Setup type = 1) Equilibrium files, you must select the appropriate equilibrium files under the Select equilibrium subtab. All files can be loaded from either the OMFIT Tree itself or a local or remote path. A gEQDSK file is always included in the required equilibrium inputs and is assumed to be named like g<shot>.<time>. The numbers <shot> and <time> are used to define the working directory for this M3D-C1 calculation. Next, select what type of kinetic profiles format to load from the Select profile type menu and load the appropriate file(s). Unless Select profile type = 0) M3D-C1 input files, you must click the Extract profiles button in order to generate the profile_ne, profile_te, and profile_omega files that M3D-C1 itself will read.

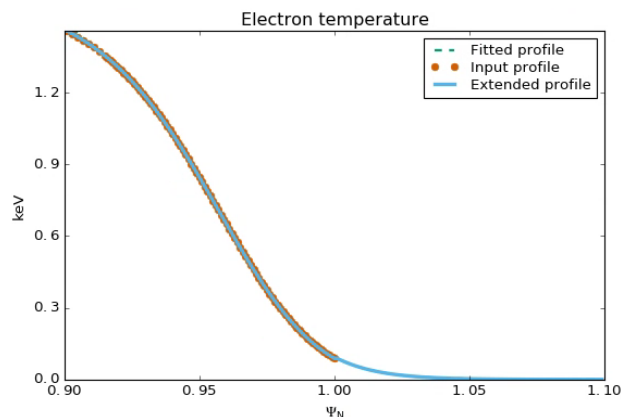
Extending profile data to open-field-line region



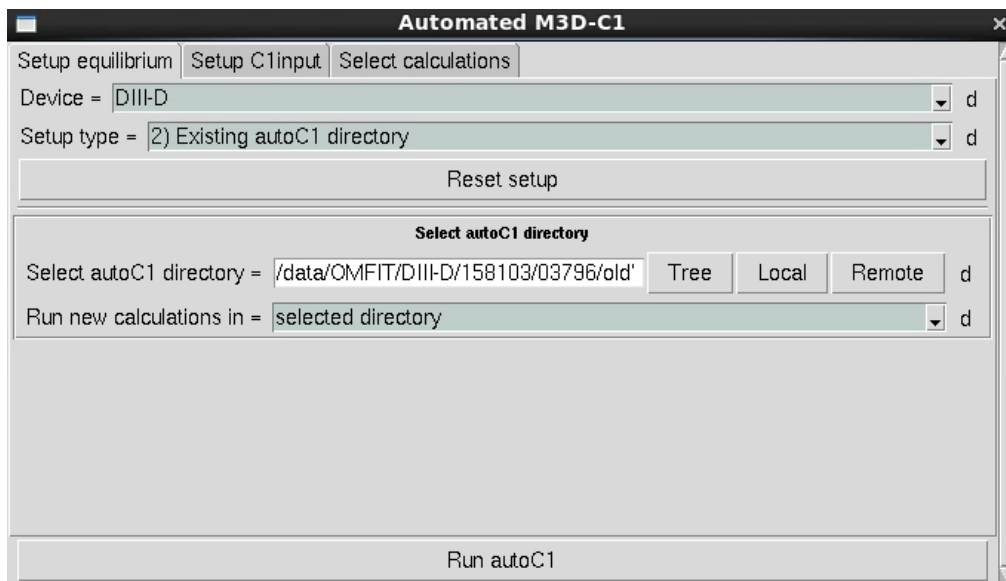
The screenshot shows the 'Automated M3D-C1' window with the 'Select calculations' tab active. The 'Device' is set to 'DIII-D' and the 'Setup type' is '1) Equilibrium files'. The 'Extend profiles' subtab is selected, showing parameters for extending the 'Density' and 'Electron temperature' profiles. The parameters are: Minimum value = 0.01, Minimum PsiN for fit = 0.95, Maximum PsiN for extension = 1.1, Center of fit = 0.98, Width of fit = 0.02, and PsiN to smooth from = None. The 'Extend profile_ne' button is highlighted.

Parameter	Value	Unit/Label
Device	DIII-D	d
Setup type	1) Equilibrium files	d
Minimum value	0.01	d
Minimum PsiN for fit	0.95	d
Maximum PsiN for extension	1.1	d
Center of fit	0.98	d
Width of fit	0.02	d
PsiN to smooth from	None	d
runid	'tutorial'	d

Next, the density and electron temperature profiles should be extended to small values in the open-field-line region using the Extend profiles subtab and the associated subsubtab. You can define initial parameters for the linear-tanh fit that will be used to extend that profile to the selected Minimum value at the selected Maximum PsiN for extension. Then, click the Extend profile_<name> button and examine the extended profile in the plot that appears. The final fit parameters are printed to the OMFIT Console, along with a warning if the fit has gone negative at any point. Keep modifying the initial fit parameters until the desired extension is achieved, then click the Accept profile_<name> extension button.



Running from an existing autoC1 directory



The screenshot shows the 'Automated M3D-C1' window with three tabs: 'Setup equilibrium', 'Setup C1 input', and 'Select calculations'. The 'Setup C1 input' tab is active. It contains the following fields and buttons:

- 'Device =' dropdown menu with 'DIII-D' selected and a 'd' icon.
- 'Setup type =' dropdown menu with '2) Existing autoC1 directory' selected and a 'd' icon.
- 'Reset setup' button.
- 'Select autoC1 directory' section with:
 - 'Select autoC1 directory =' text box containing '/data/OMFIT/DIII-D/158103/03796/old'.
 - 'Tree', 'Local', and 'Remote' buttons.
 - 'Run new calculations in =' dropdown menu with 'selected directory' selected and a 'd' icon.
- 'Run autoC1' button at the bottom.

If you choose Setup type = 2) Existing autoC1 directory, you must choose a directory created by a previous run of autoC1 through OMFIT in the Select autoC1 directory entry box. Once the directory is given, OMFIT will load appropriate files from it so that it knows how to launch new calculations efficiently. In addition, you can choose to Run new calculations in either the selected directory, or in a new directory. Either way, choosing these options will tell autoC1 that the appropriate setup (e.g., mesh adaptation) has already been completed and you will be able to more quickly run new calculations.

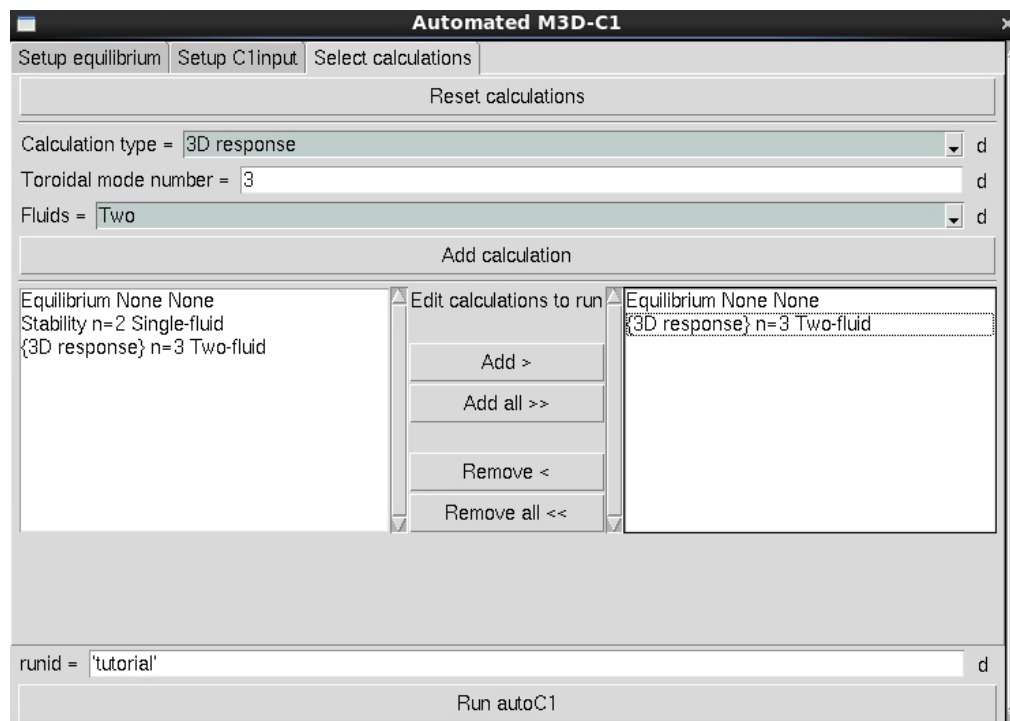
Setting up the input namelist

The screenshot shows the 'Automated M3D-C1' window with the 'Setup C1input' tab selected. The 'Setup C1input_base file' section contains a dropdown menu for 'Load =' set to '1) Default C1input_base' and a 'Load default C1input_base file' button. Below this, the 'Modify parameters =' dropdown is set to '1) Common'. The 'Physics Model' section has tabs for 'GS Solver', 'Stability', and '3D Response'. A list of parameters is shown with input fields and help icons: 'irot = -1', 'iread_omega = 0', 'iread_omega_ExB = 1', 'iread_omega_e = 0', 'amu = 1e-06', 'denm = 1e-06', 'kappat = 1e-06', 'ion_mass = 2.0', and 'zeff = 1.0'. At the bottom, the 'runid =' field is set to 'tutorial' and a 'Run autoC1' button is present.

The next step is to load a C1input_base namelist. While autoC1 will take care of the details about certain parameters that need to be set for different kinds of runs, the input parameters in this namelist will be used for all the runs. One can choose to load a Default C1input_base file from the autoC1 templates (recommended for new users) or an existing C1input_base file from a past automated M3D-C1 run. If you choose Load = 2) Existing C1input_base, another box will appear allowing you to pick the desired file. If [starting new calculations from an existing autoC1 directory](#), you'll also have a Load = 3) Last C1input_base used option.

After choosing the desired file and clicking the Load <type> C1input_base button, you will be able to modify the parameters loaded from that file. Choosing Modify parameters = 1) Common will give various commonly modified parameters, divided into subtabs depending on what those parameters are used for. Options are also given to modify any parameter already present in the C1input_base file and to add/modify/remove arbitrary parameters using a key-value pair.

Selecting calculations to run



The final step of the setup is to choose what types of calculations you want to run with the chosen equilibrium and C1input_base parameters. This is done under the Select calculations tab. Under the Calculation type menu, you can choose from

- Equilibrium: recalculate the equilibrium on the adapted M3D-C1 mesh,
- Stability: calculate the linear stability of the chosen Toroidal mode number for single- or two-fluid MHD,
- or 3D response: calculate the linear response to external, 3D magnetic perturbations for the chose Toroidal mode number for single- or two-fluid MHD.

After specifying the desired options for a run, click the Add calculation button. It will then appear in both columns of the list editor. The left side gives the list of all calculation types that you have added. The right side gives the list of calculation you actually intend to run. The buttons in the middle can be used to add or to remove calculations from the run list.

Starting the autoC1 run

Once the setup is complete, define an appropriate runid in the box at the bottom of the GUI, if that box is present. Along with the Device and the <shot> and <time> from the gEQDSK file selected under the Setup equilibrium tab, this runid will define the working directory for the run. The definition of this working directory can be found in the OMFIT tree in:

```
OMFIT[ 'M3DC1' ][ 'SETTINGS' ][ 'REMOTE_SETUP' ][ 'workDir' ]
```

Note that if you have the option to define a runid, this working directory will be overwritten if it already exists.

Once you're satisfied with all the options, click the Run autoC1 button to begin the calculations on the remote server.

Exploring an autoC1 directory

Under construction

Examining M3D-C1 results

At the moment, all examination of M3D-C1 results should be done through the existing IDL post-processing routines. Instructions for using those scripts can be found [here](#).

Python scripts for M3D-C1 post-processing are currently under development. This guide will be updated when they are usable through OMFIT.