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# **Fusion Data Framework Documentation**

*Release 0.2.3*

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**Apr 26, 2017**

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## Contents

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<b>1</b>	<b>Fusion Data Platform</b>	<b>1</b>
<b>2</b>	<b>User Guide</b>	<b>3</b>
<b>3</b>	<b>Developer Guide</b>	<b>6</b>
<b>4</b>	<b>Project Documents</b>	<b>11</b>
<b>5</b>	<b>How to contribute</b>	<b>12</b>
<b>6</b>	<b>Changelog</b>	<b>14</b>
<b>7</b>	<b>Authors</b>	<b>16</b>
<b>8</b>	<b>License</b>	<b>17</b>

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## Fusion Data Platform

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Fusion Data Platform (FDP) is a data framework in Python for magnetic fusion experiments. FDP streamlines data discovery, management, analysis methods, and visualization.

- Github: <https://github.com/Fusion-Data-Platform/fdp>
- Documentation: <http://fdp.readthedocs.io/>
- Google group: <https://groups.google.com/forum/#!forum/fusion-data-platform>

### Description and features

- An extensible software layer that unites data access, management, analysis, and visualization
- A descriptive data object that users can query to find data and analysis methods
- Data access tasks (servers, trees, nodes, queries) are handled behind the scenes
- A collaborative development platform for data analysis tools
- Built with popular, open-source packages like Numpy and Matplotlib

### Example usage

```
import fdp
nstxu = fdp.nstxu()
nstxu.s204551.logbook()
nstxu.s204551.mpts.te.plot()
nstxu.s204551.equilibria.efit02.kappa.plot()
```

`nstxu` is a data object that abstracts the NSTX-U device with easy access to shots, diagnostics, signals, and data methods. The typical heirarchy is:

```
<machine>.<shot>.<diagnostic container>.[<possible sub-containers>].<signal>.  
↳<method>
```

Users can discover data containers like `mpts`, data signals like `te`, and data methods like `plot()` with Python's tab-complete functionality.

### **Contributing**

To contribute to the FDP project, see `CONTRIBUTING.rst` in the top-level directory or `Contributing` in the docs.

### **Lead developers**

- David R. Smith, U. Wisconsin-Madison
- Kevin Tritz, The Johns Hopkins U.
- Howard Yuh, Nova Photonics

### Getting started

This guide is for people who want to use FDP on the PPPL Linux cluster. If you wish to contribute to the FDP project as a developer, see the developer guide.

To use FDP on the PPPL Linux cluster, load the module `nstx/fdp` (you may need to unload other `nstx` modules):

```
[sunfire06:~] % module load nstx/fdp

[sunfire06:~] % module list
Currently Loaded Modulefiles:
 1) torque/2.5.2          5) idl/8.2              9) java/v1.6
 2) moab/5.4.0           6) nstx/treedefs       10) nstx/mdsplus5
 3) ppplcluster/1.1     7) nstx/epics          11) nstx/fdp
 4) freetds/0.91        8) nstx/idldirs
```

Verify that `python` points to `/p/fdp/anaconda/bin/python`:

```
[sunfire06:~] % which python
/p/fdp/anaconda/bin/python
```

If `python` does not point to `/p/fdp/anaconda/bin/python`, then `PATH` contains to a different python distribution. In this case, you need to modify `PATH` so `/p/fdp/anaconda/bin` is the first python distribution in `PATH`.

Finally, you can launch `python` and import the FDP package:

```
[sunfire06:~] % python
Python 2.7.10 |Anaconda 2.3.0 (64-bit)| (default, Sep 15 2015, 14:50:01)
```

```
[GCC 4.4.7 20120313 (Red Hat 4.4.7-1)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
Anaconda is brought to you by Continuum Analytics.
Please check out: http://continuum.io/thanks and https://anaconda.org
>>> import fdp
>>>
```

See Usage Examples to learn about the capabilities of FDP.

## Usage examples

First, import the FDP module:

```
>>> import fdp
```

### Initiate a machine instance

**Define** a NSTX machine instance:

```
>>> nstxu = fdp.nstxu
```

Shots are added as referenced. For instance, without previous reference to 139980, you can enter:

```
>>> nstxu.s139980.chers.plot()
```

**Add shots** to the NSTX instance:

```
>>> nstxu.addshot(140000)
```

or a shotlist:

```
>>> nstxu.addshot([141400, 141401, 141402])
```

or by XP:

```
>>> nstxu.addshot(xp=1048)
```

or by date (string or int YYYYMMDD):

```
>>> nstxu.addshot(date=20100817)
```

**List shots** presently loaded:

```
>>> dir(nstxu)
```

or:

```
>>> nstxu.listshot()
```

Get a custom **shotlist**:

```
>>> my_shotlist = nstxu.get_shotlist(xp=1032) # returns numpy.ndarray
```

## Getting started

This guide is for developers who want to contribute to the FDP project, and this guide describes the development workflow on the PPPL Linux cluster. If you simply want to use FDP on the PPPL Linux cluster, see the user guide.

The FDP code repository is hosted on GitHub: <https://github.com/Fusion-Data-Platform/fdp>

To participate in the FDP project as a developer, you must create a GitHub account. The FDP project uses GitHub and Git for collaborative development and version control.

## Configure Git

On the PPPL Linux cluster, load the module `git/1.8.0.2` (on Red Hat 6 systems, use `git/2.4.2`):

```
[sunfire08:~] % module avail git
----- /usr/pppl/Modules/modulefiles -----
git/1.7.4.1(default)      git/1.8.0.2      git/2.4.2

[sunfire08:~] % module load git/1.8.0.2

[sunfire08:~] % module list
Currently Loaded Modulefiles:
1) torque/2.5.2          3) ppplcluster/1.1
2) moab/5.4.0           4) git/1.8.0.2
```

You may want to add the module load command to your shell start-up files: `~/.cshrc` for `csh/tcsh` or `~/.bash_profile` for `bash`.



Next, you must configure Git with your name and email (the same email associated with your GitHub account):

```
[sunfire08:~] % git config --global user.name "John Doe"
[sunfire08:~] % git config --global user.email "JohnDoe@email.com"
```

Also, you may want to set a default editor (e.g. vi, emacs, nedit) for Git comments:

```
[sunfire08:~] % git config --global core.editor nedit
```

You can inspect your Git configuration in the file `~/.gitconfig`. For more information about Git configuration, see <https://help.github.com/articles/set-up-git/> or <https://git-scm.com/book/en/v2/Getting-Started-First-Time-Git-Setup>

## Clone the FDP repository

Git clones repositories into a new directory in your current directory. In the right column of the FDP repo page (<https://github.com/Fusion-Data-Framework/fdp>), you can find the HTTPS URL (<https://github.com/Fusion-Data-Framework/fdp.git>) to clone FDP to your local directory

```
[sunfire08:~] % ls -d fdp
ls: fdp: No such file or directory

[sunfire08:~] % git clone https://github.com/Fusion-Data-Framework/fdp.git
Cloning into 'fdp'...
remote: Counting objects: 619, done.
remote: Total 619 (delta 0), reused 0 (delta 0), pack-reused 619
Receiving objects: 100% (619/619), 783.01 KiB, done.
Resolving deltas: 100% (279/279), done.

[sunfire08:~] % ls -d fdp
fdp/
```

Cloning via SSH is also feasible: <https://help.github.com/articles/set-up-git/#next-steps-authenticating-with-github-from-git>

Finally, add your new FDP directory to the PYTHONPATH environment variable:

```
[sunfire08:~] % setenv PYTHONPATH ${HOME}/fdp:$PYTHONPATH

[sunfire08:~] % echo $PYTHONPATH
/u/drsmith/fdp:<other directories>
```

You may want to add this action to your shell start-up files, as described above. In bash, use the export command to set PYTHONPATH.

## Git workflow for FDP development

(1) Create a development branch (here, we call it devbranch) and checkout the new branch:

```
[sunfire08:~] % cd fdp

[sunfire08:~/fdp] % git branch
* master

[sunfire08:~/fdp] % git branch devbranch

[sunfire08:~/fdp] % git branch
devbranch
* master

[sunfire08:~/fdp] % git checkout devbranch
Switched to branch 'devbranch'

[sunfire08:~/fdp] % git branch
* devbranch
master
```

Devbranch initializes as a copy of master. `git branch` lists branches in your local repository, and the asterisk denotes the active branch. You can switch between local branches with `git checkout <LocalBranchName>`.

(2) Push devbranch to the remote FDP repository at GitHub (you may need to enter your GitHub username and password):

```
[sunfire08:~/fdp] % git push origin devbranch
Total 0 (delta 0), reused 0 (delta 0)
To https://github.com/Fusion-Data-Framework/fdp.git
 * [new branch]      devbranch -> devbranch
```

devbranch is now listed in the FDP repository at GitHub. `origin` is the alias for the remote GitHub repository. You can view your remote repositories and aliases with `git remote -v`.

(3) Proceed with FDP development within devbranch: commit changes, add/delete files, and push updates to GitHub.

As you complete small tasks, you should commit changes to your local repository with `git commit -a -m '<mymessage>'`. Also, each commit requires a short message describing the changes:

```
[sunfire02:~/fdp] % git commit -a -m 'added dictionary rows in logbook.py'
[devbranch bb6c58a] added dictionary rows in logbook.py
1 file changed, 16 insertions(+), 21 deletions(-)
```

If you do not specify a commit message with `-m` option, then Git will open your default editor and ask for a commit message (see Configure Git above). The `-a` option commits all file changes throughout the branch index, not simply your current directory. The branch index is the list of files Git tracks in the branch. `git commit -a` tracks changes to files in the branch index, so you must add new files to the index and remove deleted files from the index. You can view the branch index with `git ls-files`, and you can add new files to the index and remove deleted files from the index with `git add -A`:

```
[sunfire02:~/fdp] % touch temp.py
```

```
[sunfire02:~/fdp] % ls temp.py
temp.py

[sunfire02:~/fdp] % git ls-files temp.py

[sunfire02:~/fdp] % git add -A

[sunfire02:~/fdp] % git ls-files temp.py
temp.py
```

Note that `temp.py` appeared in the index only after the command `git add -A`. Similarly, deleted files stay in the index until the `git add -A` is given.

When you complete a large task, you should “push” changes to the devbranch on GitHub with `git push`:

```
[sunfire05:~/fdp] % git push origin devbranch
Counting objects: 10, done.
Delta compression using up to 8 threads.
Compressing objects: 100% (6/6), done.
Writing objects: 100% (6/6), 1.30 KiB, done.
Total 6 (delta 3), reused 0 (delta 0)
To https://github.com/Fusion-Data-Framework/fdp.git
 129c5d9..a166825 devbranch -> devbranch
```

Again, “origin” signifies the branches on the remote GitHub repo.

(4) While you are working locally in `devbranch`, others may be modifying `master` at GitHub. When you are ready to merge `devbranch` into `master`, you should first merge the latest version of `master` from GitHub into your local `devbranch`. To retrieve the latest version of `master` from GitHub, use `git fetch`:

```
[sunfire05:~/fdp] % git fetch origin master
From https://github.com/Fusion-Data-Framework/fdp
* branch          master      -> FETCH_HEAD
```

Next, verify that you are in `devbranch` and merge `origin/master` into `devbranch`:

```
[sunfire08:~/fdp] % git branch
* devbranch
master

[sunfire05:~/fdp] % git merge origin/master
```

Next, push your local `devbranch` to `devbranch` on GitHub:

```
[sunfire05:~/fdp] % git push origin devbranch
```

Finally, on the GitHub website, in the `devbranch` area, submit a *pull request* to pull `devbranch` into `master`.

## Package reference

Subpackage `fdp.classes`

Subpackage `fdp.methods`

Class `Fdp`

Class `Machine`

Class `Logbook`

Class `Shot`

Class `Container`

Class `Signal`

Class `Node`

Module `fdp.classes.globals`

Module `fdp.classes.factory`

## CHAPTER 4

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### Project Documents

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#### **October 9, 2015 meeting**

[http://nstx.pppl.gov/DragNDrop/Working\\_Groups/FusionDataFramework/Meeting\\_2015-10-09/](http://nstx.pppl.gov/DragNDrop/Working_Groups/FusionDataFramework/Meeting_2015-10-09/)

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## How to contribute

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- Github repository: <https://github.com/Fusion-Data-Platform/fdp>
- Bugs and feature requests: <https://github.com/Fusion-Data-Platform/fdp/issues>
- Google group: <https://groups.google.com/forum/#!forum/fusion-data-platform>

**Workflow:** Thank you for your interest in the FDP project. To contribute to the FDP code base, please follow the “forking workflow”:

1. Fork the main FDP repo at Github to create your personal repo
2. Clone your personal repo to your local work area
3. (Regularly pull updates from the main FDP repo to your local repo)
4. Push commits to your personal repo at Github
5. Submit pull requests to the main FDP repo at Github

Read more:

- <https://guides.github.com/activities/forking/>
- <https://help.github.com/articles/fork-a-repo/>

**Style:** Try to follow the [PEP8 style guide](#). FDP uses `flake8` to scan for PEP8 conformance and static code analysis. To perform the scans, run `make lint` in the top-level directory.

**Testing:** FDP uses `pytest` for testing and `coverage` for test coverage. You can run the test suite with `make test` or `pytest` in the top-level directory, and you can run the test coverage scan with `make coverage` in the top-level directory. See `test/README.rst` for more information about testing in FDP.

**Makefile recipes:** The top-level `Makefile` contains several recipes for generating docs, code style/quality reviews, and versioning. Run `make help` to see a summary of recipes:

```
$ make help
help          show this help message
docs         build HTML and PDF documents
docs-html    build HTML documents
docs-pdf     build PDF documents
test        run pytest in current Python environment
coverage     check test coverage and show report in terminal
coverage-html check test coverage and show report in browser
lint        run flake8 for code quality review
autopep     run autopep8 to fix minor pep8 violations
authors     update AUTHORS.txt
changelog   internal use only
bumpversion internal use only
bump-major  update AUTHORS and CHANGELOG; bump major version and
↳commit
bump-minor  update AUTHORS and CHANGELOG; bump minor version and
↳commit
bump-patch  update AUTHORS and CHANGELOG; bump patch version and
↳commit
clean       remove all build, docs, and Python artifacts
clean-docs  remove docs/build
clean-pyc   remove Python file artifacts
```

# CHAPTER 6

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## Changelog

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### Release v0.2.3 – 2017-04-20

```
00e03db bumpversion, AUTHORS, and Makefile
28119ae Bump version: 0.2.1 → 0.2.2
64ee3f5 updated CHANGELOG.rst and AUTHORS.txt
c93f1c4 bumpversion and Makefile
```

### Release v0.2.2 – 2017-04-20

```
c93f1c4 bumpversion and Makefile
```

### Release v0.2.1 – 2017-04-20

```
4745b51 CHANGELOG generation in Makefile
f5a0585 changed CHANGELOG to .rst
40cdcfa implemented doc hosting at readthedocs.io
c2de060 Merge pull request #55 from drsmith48/drs-dev
```

### Release v0.2.0 – 2017-04-19



```
4abf46b tests
6564d4c changed 'fdp_globals' to 'globals' throughout repo
dea305b changed fdp_globals import
ea12a72 tests
54cb3a7 Merge branch 'drs-dev' of github.com:drsmith48/fdp into drs-dev
74c271f tests
ff08bd2 tests
63ce140 tests
af97cda testing for logbook.py and machine.py
8fbaf30 pytest setup
534f00a created new test directory and configured for pytest; run 'pytest' or
↪ 'make test'
3f59f74 minor
be1449c minor
a8e38e3 fixed axis removal from multi-dim signals
9400ca8 Merge branch 'master' into drs-dev
8e2d471 Merge pull request #54 from drsmith48/plotpsirz
33c025e debugging eq.plotrz.plot()
7adfae2 bfield() method for equilibria
ddd16a5 minor fixes
ea8852b changed 'zero level' indices to floats
09f779a changed iteritems to iter()
7d32fd6 docs
bab6bbc docs
fala1fb docs
17e9578 removed pushes from bumps in Makefile
a06ac9b run 'authors' recipe prior to 'bump-*' recipes in Makefile
```

## Release v0.1.4 – 2017-04-07

```
a2842c8 added automatic CHANGELOG.txt updates with 'bump-*' recipes in
↪ Makefile
```

## CHAPTER 7

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### Authors

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Lead developers:

David R. Smith  
Kevin Tritz  
Howard Yuh

Commits from authors:

289 David R. Smith  
37 ktritz  
22 dmkriete  
2 hyyuh  
1 Howard Yuh

Commits from obsolete FDF repository:

261 David R. Smith  
41 Kevin Tritz  
17 ktritz  
10 Howard Yuh  
7 John Schmitt  
4 hyyuh  
2 jcschmitt

## CHAPTER 8

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### License

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