IMP12

December 17, 2020

Contents

1 IMP12 - Equilibrium, MHD, and Disruptions

1.1 Scientific Rationale and Main Objectives of the Task

The goal of the IMP12 activity is to provide the ITM-TF with a comprehensive set of **equilibrium, linear stability, and non-linear MHD modelling tools** as well as the tools for a consistent free boundary equilibrium evolution with application to the study of plasma disruptions. The project aims at providing ITER relevant modelling capabilities covering essential areas in an MHD simulation chain, starting from equilibrium reconstruction and free boundary evolution under feedback control via linear and non-linear MHD stability to non-linear MHD stability and plasma disruptions.

1.2 Scope and Long Term Perspective

The mature consolidation of a substantial part of the tools developped by IMP1 (equilibrium reconstruction and linear MHD stability) prompts for continued maintenance and integration.
Because of the synergy between equilibrium/linear stability and non-linear MHD modelling integration, IMP1 and IMP2 have been merged as off 2010.
Adopting a unifying strategy, the project therefore now consolidates the coverage of essential MHD numerical tools. Validation [1] of the *full chain of equilibrium reconstruction* and *linear stability* codes has started in 2009 and will proceed in collaboration with the MHD Topical Group, addressing relevant experimental scenarios (disruptive limits, edge stability limits,...). Collaborations with additional experiments is planned.
Extension of the equilibrium and linear stability codes as well as the data structures to include *plasma flow* and *3D effects* will consolidate the scope of the present tools.
Validation of the existing modules for modelling of a *free boundary equilibrium on experiments* and *integration with the ETS* , mediated by *feedback control schemes* , will enhance the whole device modelling capabilities of ITM tools.
Interfacing with *non-linear stability modules* dedicated to *sawtooth, NTM, ELMs, error fields* , and *beta limit pertinent modules* , such as the *RWM* will be facilitated.
Alongside such efforts, both *2D and 3D MHD non-linear stability modules* will be integrated in the platform, with privileged application to further development for *VDE/disruption* capability, including work towards a "real time" disruption predictor for ideal MHD limits.

1.3 Project Leadership

Edmondo Giovannozzi - Project Leader - edmondo.giovannozzi@enea.it

Dmitriy Yadykin - Deputy Project Leader - dimitriy@chalmers.se

2 Tasks

Until 2012, the ITM-TF defines its projects in terms of tasks with the associations and outreach collaborations. The official tasks are agreed upon with the associations in form of task agreements.

2.1 Tasks in 2010

The list of IMP12 related tasks for 2010 is given below:

2.1.1 WP10-ITM-IMP12-ACT1: Maintenance of Equilibrium and linear MHD Stability

Table 1: Members

Name	**Association**	**e-mail**
Christian Konz	IPP	cjk@ipp.mpg.de
Blaise Faugeras	CEA	Blaise.Faugeras@unice.fr
Olivier Sauter	Swiss Confederation	olivier.sauter@epfl.ch
Sergei Medvedev	Swiss Confederation	medvedev@crppsun.epfl.ch

2.1.2 WP10-ITM-IMP12-ACT2: Free Boundary Equilibrium Codes and Feedback Control

[1] `https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_validation`

Table 2: Members

Name	Association	e-mail
Massimiliano Mattei	ENEA Frascati	massimiliano.mattei@unina2.it
Raffaele Albanese	ENEA Frascati	raffaele.albanese@unina.it
Giuseppe Calabrò	ENEA Frascati	calabro@frascati.enea.it
Giuseppe Ramogida	ENEA Frascati	giuseppe.ramogida@enea.it
Francesco Maviglia	ENEA Frascati	francesco.maviglia@unirc.it
Carmelo Labate	ENEA Frascati	carmelenzo.labate@unirc.it
Katia Calabrò	ENEA Frascati	caterina.calabro@unirc.it
Sylvain Brémond	CEA	sylvain.bremond@cea.fr
Eric Nardon	CEA	eric.nardon@cea.fr
Patrick Hertout	CEA	patrick.hertout@cea.fr
Jacques Blum	CEA	jblum@math.unice.fr
Cédric Boulbe	CEA	cedric.boulbe@unice.fr
Blaise Faugeras	CEA	Blaise.Faugeras@unice.fr
Afeintou Sangam	CEA	sangam@unice.fr

Minutes of the meeting on control in March 2010 [2]
Gantt Chart [3]

2.1.3 WP10-ITM-IMP12-ACT3: Development of Equilibrium Reconstruction Codes

Table 3: Members

Name	Association	e-mail
Giuseppe Calabrò	ENEA Frascati	calabro@frascati.enea.it
Edmondo Giovannozzi	ENEA Frascati	edmondo.giovannozzi@enea.it
Giuseppe Ramogida	ENEA Frascati	giuseppe.ramogida@enea.it
Christian Konz	IPP	cjk@ipp.mpg.de
Silvio Gori	IPP	silvio.gori@ipp.mpg.de
Gerhard Strohmayer	IPP	strohmg@ipp.mpg.de
Peter Martin	IPP	peter.martin@ipp.mpg.de
Josef Havlíček	IPP CR	havlicek@ipp.cas.cz

2.1.4 WP10-ITM-IMP12-ACT4: Flow Extension of Equilibrium and MHD Stability Codes

Table 4: Members

Name	Association	e-mail
Roberto Paccagnella	ENEA RFX	roberto.paccagnella@igi.cnr.it

2.1.5 WP10-ITM-IMP12-ACT5: Validation of the Equilibrium Reconstruction Codes in Kepler

Table 5: Members

Name	Association	e-mail
Blaise Faugeras	CEA	Blaise.Faugeras@unice.fr
Peter de Vries	FOM Rijnhuizen	Peter.de.Vries@jet.efda.org
David Taylor	CCFE	david.taylor@ccfe.ac.uk
Vladimir Drozdov	CCFE	vladimir.drozdov@ccfe.ac.uk
Mathias Brix	CCFE	mathias.brix@ccfe.ac.uk

2.1.6 WP10-ITM-IMP12-ACT6: Definition of 3D Data Structures for the Equilibrium and Implementation in 3D Equilibrium Codes

[2] https://www.efda-itm.eu/ITM/imports/imp12/public/imp12_ITM_meeting_on_control_23_03_2010.pdf
[3] https://www.efda-itm.eu/ITM/imports/imp12/public/imp12_Control_gantt_chart.pdf

Table 6: Members

Name	Association	e-mail
Joachim Geiger	IPP	joachim.geiger@ipp.mpg.de
Tony Cooper	Swiss Confederation	wilfred.cooper@epfl.ch

2.1.7 WP10-ITM-IMP12-ACT7: Sawtooth Crash Module

Table 7: Members

Name	Association	e-mail
Olivier Sauter	Swiss Confederation	olivier.sauter@epfl.ch

2.1.8 WP10-ITM-IMP12-ACT8: ELM Module

Table 8: Members

Name	Association	e-mail

2.1.9 WP10-ITM-IMP12-ACT9: Resistive Wall Modes

Table 9: Members

Name	Association	e-mail
Fabio Villone	ENEA Frascati	villone@unicas.it
Guglielmo Rubinacci	ENEA Frascati	rubinacci@unina.it
Salvatore Ventre	ENEA Frascati	ventre@unicas.it
Maurizio Fumo Palumbo	ENEA Frascati	maurizio.fumopalumbo@unicas.it
Raffaele Fresa	ENEA Frascati	fresa@unibas.it
Bruno Viola	ENEA Frascati	bruno.viola@unibas.it
Yuequiang Liu	CCFE	yuequiang.liu@ccfe.ac.uk
Roberto Paccagnella	ENEA RFX	roberto.paccagnella@igi.cnr.it
Calin Vlad Atanasiu	MEdC	cva@ipp.mpg.de

2.1.10 WP10-ITM-IMP12-ACT10: NTM Module

Table 10: Members

Name	Association	e-mail
Diego De Lazzari	FOM Rijnhuizen	D.DeLazzari@rijnhuizen.nl
Egbert Westerhof	FOM Rijnhuizen	E.Westerhof@rijnhuizen.nl
Silvana Nowak	ENEA CNR	nowak@ifp.cnr.it
Enzo Lazzaro	ENEA CNR	lazzaro@ifp.cnr.it
Christopher Ham	CCFE	chris.ham@ccfe.ac.uk
Olivier Sauter	Swiss Confederation	olivier.sauter@epfl.ch

2.1.11 WP10-ITM-IMP12-ACT11: 3D MHD Code

Table 11: Members

Name	Association	e-mail
Joan Decker	CEA	joan.decker@cea.fr

2.1.12 WP10-ITM-IMP12-ACT12: Error Field Module

Table 12: Members

Name	Association	e-mail
Christopher Ham	CCFE	chris.ham@ccfe.ac.uk

2.1.13 WP10-ITM-IMP12-ACT13: 2D MHD Code

Table 13: Members

Name	Association	e-mail
Daniela Grasso	ENEA Frascati	daniela.grasso@infm.polio.it
Dario Borgogno	ENEA Frascati	dario.borgogno@polio.it
Anna Perona	ENEA Frascati	anna.perona@polio.it
Fulvio Militello	CCFE	fulvio.militello@ccfe.ac.uk
Olivier Agullo	CEA	olivier.agullo@univ-provence.fr
Sadruddin Benkadda	CEA	sadruddin.benkadda@univ-provence.fr
Magali Muraglia	CEA	magali.muraglia@univ-provence.fr
Maurizio Ottaviani	CEA	maurizio.ottaviani@cea.fr
Chiara Marchetto	ENEA CNR	marchetto@ifp.cnr.it

2.1.14 WP10-ITM-IMP12-ACT14: Disruption Workbench

Table 14: Members

Name	Association	e-mail
Fabio Villone	ENEA Frascati	villone@unicas.it
Guglielmo Rubinacci	ENEA Frascati	rubinacci@unina.it
Raffaele Albanese	ENEA Frascati	raffaele.albanese@unina.it
Raffaele Fresa	ENEA Frascati	fresa@unibas.it
Salvatore Ventre	ENEA Frascati	ventre@unicas.it
Maurizio Fumo Palumbo	ENEA Frascati	maurizio.fumopalumbo@unicas.it
Bruno Viola	ENEA Frascati	bruno.viola@unibas.it
Joan Decker	CEA	joan.decker@cea.fr

2.1.15 WP10-ITM-IMP12-ACT15: Numerical Tools

Table 15: Members

Name	Association	e-mail
George Georghiou	Greece Cyprus	geg@ucy.ac.cy
Lymperis Papgeorgiou	Greece Cyprus	liberis@teemail.gr
Olivier Sauter	Swiss Confederation	olivier.sauter@epfl.ch
Silvio Gori	IPP	silvio.gori@ipp.mpg.de
Gerhard Strohmayer	IPP	strohmg@ipp.mpg.de

---

last update: 2011-05-13 by konz

2.2 Tasks in 2011

The list of IMP12 related tasks for 2011 is given below:

2.2.1 WP11-ITM-IMP12-ACT1: Integration, support and maintenance

Description

This activity concerns all the IMP12 codes, modules or packages at a mature stage. As a minimum, a working Kepler actor (or a suite of Kepler actors) must have been made available during WP10, i.e. corresponding to Phase III (K) of the release cycle (see Appendix A).

Scope of this activity is integration of IMP12 modules and support for code integration in selected workflows, in conjunction with other IMPs. The activity also covers continued maintenance of mature IMP12 codes.

As a guideline, it is foreseen that IMP12 codes under this activity will participate in the construction of the following workflows:

- A workflow coupling ETS, a fixed boundary equilibrium code, and physics modules from several IMPs, aimed at plasma core simulations.
- A prototype workflow coupling the ETS with a free boundary equilibrium code.

- A prototype workflow coupling a free boundary equilibrium code with a feedback controller.

Participants under priority support are expected to provide the code and user documentation, as an integral part of the code release.

The deliverables for 2011 are:

- integration of mature codes into workflows, especially into ETS workflow
- code documentation (phase IV(N))
- physics description of code (phase IV (O))

Table 16: Members

Name	Association	e-mail
Lynton Appel	CCFE	lynton.appel@ccfe.ac.uk
Sylvain Brémond	CEA	sylvain.bremond@cea.fr
Eric Nardon	CEA	eric.nardon@cea.fr
Cédric Boulbe	CEA	cedric.boulbe@unice.fr
Blaise Faugeras	CEA	Blaise.Faugeras@unice.fr
Jacques Blum	CEA	jblum@math.unice.fr
Oliviero Barana	CEA	oliviero.barana@cea.fr
Pablo García-Müller	CIEMAT	pabloluis.garcia@ciemat.es
Rafael Mayo	CIEMAT	rafael.mayo@ciemat.es
Silvana Nowak	ENEA CNR	nowak@ifp.cnr.it
Christian Konz	IPP	christian.konz@ipp.mpg.de
Olivier Sauter	Swiss Confederation	olivier.sauter@epfl.ch
Laurent Villard	Swiss Confederation	laurent.villard@epfl.ch
Enzo Lazzaro	ENEA CNR	lazzaro@ifp.cnr.it
Silvio Gori	IPP	silvio.gori@ipp.mpg.de
Gerhard Strohmayer	IPP	strohmg@ipp.mpg.de

2.2.2 WP11-ITM-IMP12-ACT2: Adaptation of IMP12 modules and standalone packages

Description

This activity concerns the adaptation up to the stage of tested Kepler actors (phase III(K) of the release cycle of all the IMP12 codes, modules or packages still at a development stage. In most cases, it involves continuation of WP10 work. It may include newly proposed work matching the TF remit.

The deliverables for 2011 are:

- porting of code to the ITM Gateway, test runs and report
- adaptation of code to ITM standard, with use of relevant CPOs, in standalone form; test runs and report
- generation of Kepler actor of code; test on the ITM platform and report

Table 17: Members

Name	Association	e-mail
Yueqiang Liu	CCFE	yueqiang.liu@ccfe.ac.uk
Blaise Faugeras	CEA	Blaise.Faugeras@unice.fr
Jacques Blum	CEA	jblum@math.unice.fr
Sadri Benkadda	CEA	benkadda@up.univ-mrs.fr
Magalie Muraglia	CEA	magali.muraglia@univ-provence.fr
Olivier Agullo	CEA	olivier.agullo@univ-provence.fr
Alexandre Poyé	CEA	alexandre.poye@univ-provence.fr
Fabio Villone	ENEA Frascati	villone@unicas.it
Raffaele Albanese	ENEA Frascati	raffaele.albanese@unina.it
Guglielmo Rubinacci	ENEA Frascati	rubinacci@unina.it
Salvatore Ventre	ENEA Frascati	ventre@unicas.it
Andrea Chiariello	ENEA Frascati	chiariello@unicas.it

Table 17: Members

Name	Association	e-mail
Roberto Paccagnella	ENEA RFX	roberto.paccagnella@igi.cnr.it
George Poulipoulis	Hellenic Republic	gpoulipo@yahoo.com
George Throumoulopoulos	Hellenic Republic	gthroum@uoi.gr
Silvio Gori	IPP	silvio.gori@ipp.mpg.de
Gerhard Strohmayer	IPP	strohmg@ipp.mpg.de
Christian Konz	IPP	christian.konz@ipp.mpg.de
Josef Havlicek	IPP-CR	havlicek@ipp.cas.cz
Jakub Urban	IPP-CR	urban@ipp.cas.cz
Calin Vlad Atanasiu	MEdC	cva@ipp.mpg.de
Dmitriy Yadykin	VR	dimitriy@chalmers.se
Joachim Geiger	IPP	joachim.geiger@ipp.mpg.de
Pavel Cahyna	IPP-CR	cahyna@ipp.cas.cz

2.2.3 WP11-ITM-IMP12-ACT3: Verification and validation of IMP12 codes

Description

Verification and validation (V&V) is an essential part of the ITM TF code release cycle. This activity targets IMP12 codes qualifying for Phase III (K), to carry out V&V on the ITM platform, employing Kepler workflows. This is a cross-project activity targeting code developers as well as experimentalists to cooperate in the validation work.
The following are minimal objectives for WP11, although contribution to code validation is sought for all IMP12 codes qualifying for Phase III (K).

- Continued validation of the EQUAL equilibrium reconstruction code on JET data.
- Verification of equilibrium and MHD stability codes by code-code comparison within the equilibrium and stability chain and assessment of code inter-operability

The deliverables for 2011 are:

- Validation of code EQUAL on JET data. Report on validation conforming to the ITM validation procedure.
- cross verification of codes belonging to the equilibrium and MHD stability chain
- Report on benchmarking exercises: cross verification of the triplet of high resolution equilibrium codes (HELENA, CHEASE, CAXE), and cross verification of the (ILSA, KINX) pair of stability codes, by code replacement in the Kepler equilibrium and stability chain.

Table 18: Members

Name	Association	e-mail
Regis Masset	CEA	regis.masset@cea.fr
Philippe Lotte	CEA	philippe.lotte@cea.fr
Christian Konz	IPP	christian.konz@ipp.mpg.de
Christoph Fuchs	IPP	christoph.fuchs@ipp.mpg.de
Laurent Villard	Swiss Confederation	laurent.villard@epfl.ch
Holger Reimerdes	Swiss Confederation	holger.reimerdes@epfl.ch
Dmitriy Yadykin	VR	dimitriy@chalmers.se

2.2.4 WP11-ITM-IMP12-ACT4: Exploitation of mature workflows: from equilibrium reconstruction to MHD stability analysis

Description

The aim of this activity is the exploitation of the extended chain of equilibrium reconstruction to MHD stability analysis on data from selected experiments for which machine descriptions, data mappings and a suitable shot range is made available (EDRG-ACT1,2).
Specifically, the TF seeks a partnership with one or more Associations (providing suitable manpower) to adapt, when necessary, and to exploit the equilibrium reconstruction and stability chain to carry out an extensive

MHD analysis of a significant set of shots, of high relevance for the Association work programme.

The deliverables for 2011 are:

- Equilibrium reconstruction, MHD chain stability chain and public ITM database of relevant shots of device.
- MHD analysis of the selected data base. Report on study.

Table 19: Members

Name	Association	e-mail
Fréderic Imbeaux	CEA	frederic.imbeaux@cea.fr
Silvana Nowak	ENEA CNR	nowak@ifp.cnr.it
Christian Konz	IPP	christian.konz@ipp.mpg.de
Christoph Fuchs	IPP	christoph.fuchs@ipp.mpg.de
Andreas Burckhart	IPP	andreas.burckhart@ipp.mpg.de
Elisabeth Wolfrum	IPP	elisabeth.wolfrum@ipp.mpg.de

2.2.5 Work Breakdown

Work Description	*Associate*	*Manpower Baseline Support (ppy)*	*Manpower Priority Support (ppy)*	*Hardware, Cons., Other Expenditure Priority Support (kEuros)*
WP11-ITM-IMP12-ACT1-01/CCFE	CCFE	0.01	0.00	0.00
WP11-ITM-IMP12-ACT1-01/CEA	CEA	0.00	1.50	0.00
WP11-ITM-IMP12-ACT1-01/CEA/BS	CEA	0.30	0.00	0.00
WP11-ITM-IMP12-ACT1-01/CIEMAT/BS	CIEMAT	0.50	0.00	0.00
WP11-ITM-IMP12-ACT1-01/ENEA_CNR	ENEA_CNR	0.00	0.20	0.00
WP11-ITM-IMP12-ACT1-01/IPP	IPP	0.10	0.00	0.00
WP11-ITM-IMP12-ACT1-01/Swiss Confederation	Swiss Confederation	0.00	0.15	0.00
WP11-ITM-IMP12-ACT1-02/ENEA_CNR	ENEA_CNR	0.18	0.00	0.00
WP11-ITM-IMP12-ACT1-02/IPP	IPP	0.75	0.00	0.00
WP11-ITM-IMP12-ACT1-03/IPP	IPP	0.00	0.10	0.00
WP11-ITM-IMP12-ACT1-03/IPP/BS	IPP	0.10	0.00	0.00
WP11-ITM-IMP12-ACT2-01/CCFE	CCFE	0.10	0.00	0.00
WP11-ITM-IMP12-ACT2-01/CEA	CEA	0.70	0.00	0.00
WP11-ITM-IMP12-ACT2-01/ENEA_Frascati	ENEA_Frascati	0.50	0.00	0.00
WP11-ITM-IMP12-ACT2-01/ENEA_RFX	ENEA_RFX	0.20	0.00	0.00
WP11-ITM-IMP12-ACT2-01/Hellenic Republic/BS	Hellenic Republic	1.30	0.00	0.00
WP11-ITM-IMP12-ACT2-01/IPP	IPP	0.00	0.25	0.00
WP11-ITM-IMP12-ACT2-01/IPP.CR	IPP.CR	0.10	0.00	0.00
WP11-ITM-IMP12-ACT2-01/IPP/BS	IPP	0.25	0.00	0.00
WP11-ITM-IMP12-ACT2-01/MEdC	MEdC	1.00	0.00	0.00
WP11-ITM-IMP12-ACT2-01/VR	VR	0.12	0.00	0.00
WP11-ITM-IMP12-ACT2-02/ENEA_RFX	ENEA_RFX	0.10	0.00	0.00

Work Description	*Associate*	*Manpower Baseline Support (ppy)*	*Manpower Priority Support (ppy)*	*Hardware, Cons., Other Expenditure Priority Support (kEuros)*
WP11-ITM-IMP12-ACT2-02/IPP	IPP	0.00	0.10	0.00
WP11-ITM-IMP12-ACT2-02/IPP.CR	IPP.CR	0.10	0.00	0.00
WP11-ITM-IMP12-ACT2-03/ENEA_RFX	ENEA_RFX	0.50	0.00	0.00
WP11-ITM-IMP12-ACT3-01/CEA	CEA	0.00	0.20	0.00
WP11-ITM-IMP12-ACT3-01/IPP	IPP	0.00	0.25	0.00
WP11-ITM-IMP12-ACT3-01/Swiss Confederation/BS	Swiss Confederation	0.10	0.00	0.00
WP11-ITM-IMP12-ACT3-01/VR	VR	0.00	0.12	0.00
WP11-ITM-IMP12-ACT4-01/CEA	CEA	0.00	0.10	0.00
WP11-ITM-IMP12-ACT4-01/ENEA_CNR	ENEA_CNR	0.00	0.10	0.00
WP11-ITM-IMP12-ACT4-01/IPP	IPP	0.00	0.24	0.00
Total		7.01	3.31	0.00

last update: 2011-05-16 by konz

last update: 2011-05-16 by konz

3 List of IMP12 codes

The following list lists the codes and modules which are part of ITM-TF tasks and their responsible officers. A link takes you to the status page for each code.

A number of IMP12 codes have projects on gforge [4].

Update the code status here [5].

3.1 Free boundary equilibrium codes

CEDRES++, S. Brémond, CEA (code status [6], gforge [7])

CLISTE, P. Mc Carthy, DCU (code status [8])

CREATE-NL, M. Mattei, ENEA Frascati (code status [9])

EFIT++, L. Appel, CCFE (code status [10])

EQUAL, W. Zwingmann, EC (code status [11], gforge [12], actor (4.1.1.1))

EQUINOX, B. Faugeras, CEA (code status [13], gforge [14])

FIXFREE, E. Giovannozzi, ENEA Frascati (code status [15])

[4] https://gforge6.eufus.eu/project/
[5] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM
[6] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=CEDRES%2B%2B&SUBMIT=Submit+Query
[7] https://gforge6.eufus.eu/project/cedres/
[8] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=CLISTE&SUBMIT=Submit+Query
[9] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=CREATE_NL&SUBMIT=Submit+Query
[10] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=EFIT%2B%2B&SUBMIT=Submit+Query
[11] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=EQUAL&SUBMIT=Submit+Query
[12] https://gforge6.eufus.eu/project/equal/
[13] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=equinox&SUBMIT=Submit+Query
[14] https://gforge6.eufus.eu/project/equinox/
[15] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=FixFree&SUBMIT=Submit+

3.2 Fixed boundary equilibrium codes

CAXE, S. Medvedev, EPFL (code status [16])

CHEASE, O. Sauter, EPFL (code status [17], gforge [18])

HELENA, C. Konz, IPP (code status [19], actor (4.1.2.1))

3.3 Linear MHD stability codes

KINX, S. Medvedev, EPFL (code status [20])

ILSA, C. Konz, IPP (code status [21], actor (4.1.3.1))

MARS, G. Vlad, ENEA Frascati (code status [22], gforge [23])

MARS-F, D. Yadykin, Chalmers (code status [24], gforge [25])

3.4 Equilibrium codes with flow

FLOW, R. Paccagnella, ENEA RFX (code status [26])

3.5 3D Equilibrium Codes

3.6 Sawtooth Crash Modules

SAWTEETH, O. Sauter, CRPP (code status [27], gforge [28])

3.7 ELM Modules

3.8 RWM Modules

3.9 NTM Modules

3.10 3D MHD Codes

JOREK, G. Huysmans, CEA (code status [29])

3.11 Error Field Modules

3.12 2D MHD Codes

3.13 Disruption Modules

3.14 Numerical Tools

PROGEN, C. Konz, IPP (code status [30], actor (4.1.4.1))

JALPHA, C. Konz, IPP (code status [31], actor (4.1.4.2))

Query

[16] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=CAXE&SUBMIT=Submit+Query

[17] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=CHEASE&SUBMIT=Submit+Query

[18] https://gforge6.eufus.eu/project/chease/

[19] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=HELENA&SUBMIT=Submit+Query

[20] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=KINX&SUBMIT=Submit+Query

[21] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=ILSA&SUBMIT=Submit+Query

[22] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=MARS&SUBMIT=Submit+Query

[23] https://gforge6.eufus.eu/project/marsgw/

[24] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=MARS-F&SUBMIT=Submit+Query

[25] https://gforge6.eufus.eu/project/marsf/

[26] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=FLOW&SUBMIT=Submit+Query

[27] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=SAWTEETH&SUBMIT=Submit+Query

[28] https://gforge6.eufus.eu/project/sawteeth/

[29] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=JOREK&SUBMIT=Submit+Query

[30] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=PROGEN&SUBMIT=Submit+Query

[31] http://solps-mdsplus.aug.ipp.mpg.de:8080/ITM/specific_code_report?specific_codename=JALPHA&SUBMIT=Submit+Query

4 Kepler

4.1 Actors

IMP12 has provided a number of Kepler [32] actors [33] for testing and use on the ITM Gateway [34] . The list is constantly expanding and will regularly be updated.

The actors can be found in the KeplerActors [35]project under Gforge.

IMP12's actors are hosted in the following categories:

```
- fixed_boundary_equilibrium
- free_boundary_equilibrium
- linear_MHD
- NTM
- numerical_tools
- database_tools
- RWM
- sawtooth
```

4.1.1 Free Boundary Equilibrium Reconstruction

4.1.1.1 EQUALslice

The EQUALslice actor reads experimental signals from the data base and calculates a free boundary equilibrium for the given time slice.

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	magdiag pfsystems toroidfield limiter ironmodel msediag interfdiag polardiag coreprof	equilibrium	time iteration

The parameter time determines the time point at which the experimental signals will be sliced. The parameter iteration gives the number of iterations.

4.1.2 High Resolution Fixed Boundary Equilibrium Reconstruction

4.1.2.1 HELENA

The HELENA actor calculates a fixed boundary high resolution equilibrium in straight field line coordinates starting from plasma profiles like p', FF', p, $< j_{\mathrm{tor}} >$, the corresponding radial points like Ψ , ρ_{tor} , ρ_{vol} and the boundary curve for a fixed boundary equilibrium calculation.

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium	equilibrium	path

The parameter path is optional and allows you to redirect verbose output to the specific directory.

[32]https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_kepler
[33]https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_actor
[34]https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_gateway
[35]https://www.efda-itm.eu/ITM/html/isip_kepleractors.html#isip_kepleractors

4.1.3 Linear MHD Stability Analysis

4.1.3.1 ILSA

The ILSA actor performs a linear MHD stability for a fixed boundary high resolution equilibrium in straight fild line coordinates.

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium	mhd	path

The parameter path is optional and allows you to redirect verbose output to the specific directory.

4.1.4 Numerical Tools

4.1.4.1 PROGEN

The PROGEN actor either reads plasma profiles like p', FF', p, $< j_{\text{tor}} >$, the corresponding radial points like Ψ , ρ_{tor} , ρ_{vol} and the boundary curve for a fixed boundary equilibrium calculation from files or constructs them from analytic formulae.

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium (empty)	equilibrium	active path_tag path

The parameter active allows you to deactivate the PROGEN actor altogether if set to 0. The parameter path is optional and allows you to redirect verbose output to the specific directory. path_tag should remain empty.

4.1.4.2 JALPHA

The JALPHA actor takes the pressure and current density profile from an incoming equilibrium CPO [36] together with the radial positions ρ_{vol} and modifies them by scaling the edge pressure gradient and edge current density. Doing so, it maintains the total plasma energy W_{MHD} and the total plasma current I_{p} . It is designed to generate profiles for input to the HELENA actors for a j- α study. Recent extensions allow to scale the width of the pedestal as well as the normalized plasma beta.

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium	equilibrium	path scan_p scan_j

The parameter path is optional and allows you to redirect verbose output to the specific directory. The parameter scan_p allows you to specify the scaling factor for pedestal height, pedestal width, or plasma beta modifications for the pressure profile. The parameter scan_j allows you to specify the scaling factor for pedestal height and width for the flux surface averaged current density profile.

4.1.5 Database Tools

4.1.5.1 EQUILIBRIUM2UAL

The EQUILIBRIUM2UAL actor reads an equilibrium CPO [37] from the specified standardized ASCII file and feeds it to the output port. Currently, the ASCII file is supposed to contain a single time slice as a scalar.

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium (empty)	equilibrium	path

The path contains the path to the ASCII file including the name of the file.

[36] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo
[37] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo

4.1.5.2 MHD2UAL

The MHD2UAL actor reads an mhd CPO [38] from the specified standardized ASCII file and feeds it to the output port. Currently, the ASCII file is supposed to contain a single time slice as a 1D vector.

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium (empty)	mhd	path

The path contains the path to the ASCII file including the name of the file.

4.1.6 Fill Tables

The **fill tables** in this section provide a fast way to check which fields in the output CPOs [39] of the Kepler [40] actors [41] provided by IMP12 are filled and which should be filled.

The color coding is as follows:

- gray - data structure or field not filled
- **lightgreen** - data structure partially filled
- **purple** - data structure or field filled
- **red** - data structure or field not filled but should be (partially) filled

The numbers in parentheses indicate the number of substructures. For the entire CPO, the number in parentheses signals the total number of fields that can be filled in the CPO.

The data structure is broken down in blocks for the substructures directly below the CPO level (level 1 structures). They are evenly distributed in two columns. No special meaning is attached to this distribution.

The list is constantly expanding and will regularly be updated. Currently, only fill tables for the most recent versions of the actors are specified.

The actors can be found in the KeplerActors [42]project under Gforge.

IMP12's actors are hosted in the following categories:

```
- fixed_boundary_equilibrium
- free_boundary_equilibrium
- linear_MHD
- NTM
- numerical_tools
- RWM
- sawtooth
```

4.1.6.1 Free Boundary Equilibrium Reconstruction

4.1.6.1.1 EQUALslice

[38] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo
[39] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo
[40] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_kepler
[41] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_actor
[42] https://www.efda-itm.eu/ITM/html/isip_kepleractors.html#isip_kepleractors

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	magdiag pfsystems toroidfield limiter ironmodel msediag interfdiag polardiag coreprof	equilibrium	time iteration

fill table not yet available

4.1.6.2 High Resolution Fixed Boundary Equilibrium Reconstruction

At release status all high resolution fixed boundary equilibrium modules shall return an equilibrium CPO which fulfills the targeted fill status given below. Modules building on the equilibrium output from a fixed boundary equilibrium module may assume the existence of data in all filled fields. Caution need be applied though to ensure that the equilibrium geometric data are given in the desired coordinate system. Possibly, coordinate transformations need to be applied to the output CPO before feeding it to the next module.

4.1.6.2.1 Targeted fill status: equilibrium CPO

Table 29: equilibrium (299)

```
-> datainfo (7)
      |— dataprovider (0)
      |— putdate (0)
      |— source (0)
      |— comment (0)
      |— isref (0)
      |— whatref (5)
      |     |— user (0)
      |     |— machine (0)
      |     |— shot (0)
      |     |— run (0)
      |     |— occurrence (0)
      |— putinfo (4)
      |     |— putmethod (0)
      |     |— putaccess (0)
      |     |— putlocation (0)
      |     |— rights (0)
-> eqgeometry (14)
      |— source (0)
      |— boundarytype (0)
      |— boundary (3)
      |     |— r (0)
      |     |— z (0)
      |     |— npoints (0)
      |— geom_axis (2)
      |     |— r (0)
      |     |— z (0)
      |— a_minor (0)
      |— elongation (0)
      |— tria_upper (0)
      |— tria_lower (0)
      |— xpts (2)
      |     |— r (0)
      |     |— z (0)
      |— left_low_st (2)
      |     |— r (0)
      |     |— z (0)
      |— right_low_st (2)
-> eqconstraint (14)
      |— bpol (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— bvac_r (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— faraday (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— flux (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— i_plasma (8)
```

```
|       |— r (0)
|       |— z (0)
|— left_up_st (2)
|       |— r (0)
|       |— z (0)
|— right_up_st (2)
|       |— r (0)
|       |— z (0)
|— active_limit (2)
|       |— r (0)
|       |— z (0)
-> flush (4)
|— datainfo (7)
|       |— dataprovider (0)
|       |— putdate (0)
|       |— source (0)
|       |— comment (0)
|       |— isref (0)
|       |— whatref (5)
|       |       |— user (0)
|       |       |— machine (0)
|       |       |— shot (0)
|       |       |— run (0)
|       |       |— occurrence (0)
|       |— putinfo (4)
|       |       |— putmethod (0)
|       |       |— putaccess (0)
|       |       |— putlocation (0)
|       |       |— rights (0)
|— position (2)
|       |— r (0)
|       |— z (0)
|— coef (0)
|— codeparam (5)
|       |— codename (0)
|       |— codeversion (0)
|       |— parameters (0)
|       |— output_diag (0)
|       |— output_flag (0)
-> global_param (14)
|— beta_pol (0)
|— beta_tor (0)
|— beta_normal (0)
|— i_plasma (0)
|— li (0)
|— volume (0)
|— area (0)
|— psi_ax (0)
|— psi_bound (0)
|— mag_axis (3)
|       |— position (2)
|       |       |— r (0)
|       |       |— z (0)
|       |— bphi (0)
|       |— q (0)
|— q_95 (0)
|— q_min (0)
|— toroid_field (2)
|       |— r0 (0)
|       |— b0 (0)
|— w_mhd (0)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
|       |— exact (0)
|       |— weight (0)
|       |— sigma (0)
|       |— calculated (0)
|       |— chi2 (0)
|— isoflux (6)
|       |— position (2)
|       |       |— r (0)
|       |       |— z (0)
|       |— source (0)
|       |— weight (0)
|       |— sigma (0)
|       |— calculated (0)
|       |— chi2 (0)
|— jsurf (8)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
|       |— exact (0)
|       |— weight (0)
|       |— sigma (0)
|       |— calculated (0)
|       |— chi2 (0)
|— magnet_iron (2)
|       |— mr (8)
|       |       |— measured (0)
|       |       |— source (0)
|       |       |— time (0)
|       |       |— exact (0)
|       |       |— weight (0)
|       |       |— sigma (0)
|       |       |— calculated (0)
|       |       |— chi2 (0)
|       |— mz (8)
|       |       |— measured (0)
|       |       |— source (0)
|       |       |— time (0)
|       |       |— exact (0)
|       |       |— weight (0)
|       |       |— sigma (0)
|       |       |— calculated (0)
|       |       |— chi2 (0)
|— mse (8)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
|       |— exact (0)
|       |— weight (0)
|       |— sigma (0)
|       |— calculated (0)
|       |— chi2 (0)
|— ne (8)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
|       |— exact (0)
|       |— weight (0)
|       |— sigma (0)
```

```
-> profiles_1d (33)
        |— psi (0)
        |— phi (0)
        |— pressure (0)
        |— F_dia (0)
        |— pprime (0)
        |— ffprime (0)
        |— jphi (0)
        |— jparallel (0)
        |— q (0)
        |— r_inboard (0)
        |— r_outboard (0)
        |— rho_tor (0)
        |— rho_vol (0)
        |— beta_pol (0)
        |— li (0)
        |— elongation (0)
        |— tria_upper (0)
        |— tria_lower (0)
        |— volume (0)
        |— vprime (0)
        |— area (0)
        |— aprime (0)
        |— surface (0)
        |— ftrap (0)
        |— gm1 (0)
        |— gm2 (0)
        |— gm3 (0)
        |— gm4 (0)
        |— gm5 (0)
        |— gm6 (0)
        |— gm7 (0)
        |— gm8 (0)
        |— gm9 (0)
-> profiles_2d (9)
        |— grid_type (0)
        |— grid (3)
        |     |— dim1 (0)
        |     |— dim2 (0)
        |     |— connect (0)
        |— psi_grid (0)
        |— jphi_grid (0)
        |— jpar_grid (0)
        |— br (0)
        |— bz (0)
        |— bphi (0)
        |— position (2)
        |     |— r (0)
        |     |— z (0)
-> time (0)
-> codeparam (5)
        |— codename (0)
        |— codeversion (0)
        |— parameters (0)
        |— output_diag (0)
        |— output_flag (0)
        |     |— calculated (0)
        |     |— chi2 (0)
        |— pfcurrent (8)
        |     |— measured (0)
        |     |— source (0)
        |     |— time (0)
        |     |— exact (0)
        |     |— weight (0)
        |     |— sigma (0)
        |     |— calculated (0)
        |     |— chi2 (0)
        |— pressure (8)
        |     |— measured (0)
        |     |— source (0)
        |     |— time (0)
        |     |— exact (0)
        |     |— weight (0)
        |     |— sigma (0)
        |     |— calculated (0)
        |     |— chi2 (0)
        |— q (8)
        |     |— qvalue (0)
        |     |— position (2)
        |     |     |— r (0)
        |     |     |— z (0)
        |     |— source (0)
        |     |— exact (0)
        |     |— weight (0)
        |     |— sigma (0)
        |     |— calculated (0)
        |     |— chi2 (0)
        |— xpts (6)
        |     |— position (2)
        |     |     |— r (0)
        |     |     |— z (0)
        |     |— source (0)
        |     |— weight (0)
        |     |— sigma (0)
        |     |— calculated (0)
        |     |— chi2 (0)
-> coord_sys (10)
        |— grid_type (0)
        |— grid (2)
        |     |— dim1 (0)
        |     |— dim2 (0)
        |— jacobian (0)
        |— g_11 (0)
        |— g_12 (0)
        |— g_13 (0)
        |— g_22 (0)
        |— g_23 (0)
        |— g_33 (0)
        |— position (2)
        |     |— r (0)
        |     |— z (0)
```

last update: 2011-02-15 by konz

4.1.6.2.2 HELENA

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium	equilibrium (??)	path

4.1.6.2.3 Actual fill status: equilibrium CPO

Table 31: equilibrium (299)

```
-> datainfo (7)
      |— dataprovider (0)
      |— putdate (0)
      |— source (0)
      |— comment (0)
      |— isref (0)
      |— whatref (5)
      |     |— user (0)
      |     |— machine (0)
      |     |— shot (0)
      |     |— run (0)
      |     |— occurrence (0)
      |— putinfo (4)
      |     |— putmethod (0)
      |     |— putaccess (0)
      |     |— putlocation (0)
      |     |— rights (0)
-> eqgeometry (14)
      |— source (0)
      |— boundarytype (0)
      |— boundary (3)
      |     |— r (0)
      |     |— z (0)
      |     |— npoints (0)
      |— geom_axis (2)
      |     |— r (0)
      |     |— z (0)
      |— a_minor (0)
      |— elongation (0)
      |— tria_upper (0)
      |— tria_lower (0)
      |— xpts (2)
      |     |— r (0)
      |     |— z (0)
      |— left_low_st (2)
      |     |— r (0)
      |     |— z (0)
      |— right_low_st (2)
      |     |— r (0)
      |     |— z (0)
      |— left_up_st (2)
      |     |— r (0)
      |     |— z (0)
      |— right_up_st (2)
      |     |— r (0)
      |     |— z (0)
      |— active_limit (2)
      |     |— r (0)
      |     |— z (0)
-> flush (4)
      |— datainfo (7)
      |     |— dataprovider (0)
      |     |— putdate (0)
-> eqconstraint (14)
      |— bpol (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— bvac_r (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— faraday (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— flux (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— i_plasma (8)
      |     |— measured (0)
      |     |— source (0)
      |     |— time (0)
      |     |— exact (0)
      |     |— weight (0)
      |     |— sigma (0)
      |     |— calculated (0)
      |     |— chi2 (0)
      |— isoflux (6)
      |     |— position (2)
      |     |     |— r (0)
      |     |     |— z (0)
      |     |— source (0)
      |     |— weight (0)
      |     |— sigma (0)
```

```
|       |— source (0)
|       |— comment (0)
|       |— isref (0)
|       |— whatref (5)
|       |       |— user (0)
|       |       |— machine (0)
|       |       |— shot (0)
|       |       |— run (0)
|       |       |— occurrence (0)
|       |— putinfo (4)
|       |       |— putmethod (0)
|       |       |— putaccess (0)
|       |       |— putlocation (0)
|       |       |— rights (0)
|— position (2)
|       |— r (0)
|       |— z (0)
|— coef (0)
|— codeparam (5)
|       |— codename (0)
|       |— codeversion (0)
|       |— parameters (0)
|       |— output_diag (0)
|       |— output_flag (0)
-> global_param (14)
        |— beta_pol (0)
        |— beta_tor (0)
        |— beta_normal (0)
        |— i_plasma (0)
        |— li (0)
        |— volume (0)
        |— area (0)
        |— psi_ax (0)
        |— psi_bound (0)
        |— mag_axis (3)
        |       |— position (2)
        |       |       |— r (0)
        |       |       |— z (0)
        |       |— bphi (0)
        |       |— q (0)
        |— q_95 (0)
        |— q_min (0)
        |— toroid_field (2)
        |       |— r0 (0)
        |       |— b0 (0)
        |— w_mhd (0)
-> profiles_1d (33)
        |— psi (0)
        |— phi (0)
        |— pressure (0)
        |— F_dia (0)
        |— pprime (0)
        |— ffprime (0)
        |— jphi (0)
        |— jparallel (0)
        |— q (0)
        |— r_inboard (0)
        |— r_outboard (0)
        |— rho_tor (0)
        |— rho_vol (0)
        |— beta_pol (0)
|       |— calculated (0)
|       |— chi2 (0)
|— jsurf (8)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
|       |— exact (0)
|       |— weight (0)
|       |— sigma (0)
|       |— calculated (0)
|       |— chi2 (0)
|— magnet_iron (2)
|       |— mr (8)
|       |       |— measured (0)
|       |       |— source (0)
|       |       |— time (0)
|       |       |— exact (0)
|       |       |— weight (0)
|       |       |— sigma (0)
|       |       |— calculated (0)
|       |       |— chi2 (0)
|       |— mz (8)
|       |       |— measured (0)
|       |       |— source (0)
|       |       |— time (0)
|       |       |— exact (0)
|       |       |— weight (0)
|       |       |— sigma (0)
|       |       |— calculated (0)
|       |       |— chi2 (0)
|— mse (8)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
|       |— exact (0)
|       |— weight (0)
|       |— sigma (0)
|       |— calculated (0)
|       |— chi2 (0)
|— ne (8)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
|       |— exact (0)
|       |— weight (0)
|       |— sigma (0)
|       |— calculated (0)
|       |— chi2 (0)
|— pfcurrent (8)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
|       |— exact (0)
|       |— weight (0)
|       |— sigma (0)
|       |— calculated (0)
|       |— chi2 (0)
|— pressure (8)
|       |— measured (0)
|       |— source (0)
|       |— time (0)
```

|— li (0)
|— elongation (0)
|— tria_upper (0)
|— tria_lower (0)
|— volume (0)
|— vprime (0)
|— area (0)
|— aprime (0)
|— surface (0)
|— ftrap (0)
|— gm1 (0)
|— gm2 (0)
|— gm3 (0)
|— gm4 (0)
|— gm5 (0)
|— gm6 (0)
|— gm7 (0)
|— gm8 (0)
|— gm9 (0)
-> profiles_2d (9)
|— grid_type (0)
|— grid (3)
| |— dim1 (0)
| |— dim2 (0)
| |— connect (0)
|— psi_grid (0)
|— jphi_grid (0)
|— jpar_grid (0)
|— br (0)
|— bz (0)
|— bphi (0)
|— position (2)
| |— r (0)
| |— z (0)
-> time (0)
-> codeparam (5)
|— codename (0)
|— codeversion (0)
|— parameters (0)
|— output_diag (0)
|— output_flag (0)
| |— exact (0)
| |— weight (0)
| |— sigma (0)
| |— calculated (0)
| |— chi2 (0)
|— q (8)
| |— qvalue (0)
| |— position (2)
| | |— r (0)
| | |— z (0)
| |— source (0)
| |— exact (0)
| |— weight (0)
| |— sigma (0)
| |— calculated (0)
| |— chi2 (0)
|— xpts (6)
| |— position (2)
| | |— r (0)
| | |— z (0)
| |— source (0)
| |— weight (0)
| |— sigma (0)
| |— calculated (0)
| |— chi2 (0)
-> coord_sys (10)
|— grid_type (0)
|— grid (2)
| |— dim1 (0)
| |— dim2 (0)
|— jacobian (0)
|— g_11 (0)
|— g_12 (0)
|— g_13 (0)
|— g_22 (0)
|— g_23 (0)
|— g_33 (0)
|— position (2)
| |— r (0)
| |— z (0)

last update: 2011-02-15 by konz

4.1.6.3 Linear MHD Stability Analysis

At release status all linear MHD stability modules shall return an mhd CPO which fulfills the targeted fill status given below. Modules building on the mhd output from a linear MHD stability module may assume the existence of data in all filled fields.

4.1.6.3.1 Targeted fill status: mhd CPO

Table 32: mhd (21)

-> datainfo (7)
|— dataprovider (0)
|— putdate (0)
|— source (0)
|— comment (0)
|— isref (0)
-> n (0)
-> m (0)
-> psi (0)
-> frequency (0)
-> growthrate (0)
-> disp_perp (0)

|— whatref (5)	-> disp_par (0)
| |— user (0)	-> tau_alfven (0)
| |— machine (0)	-> tau_resistive (0)
| |— shot (0)	-> time (0)
| |— run (0)	-> codeparam (5)
| |— occurrence (0)	|— codename (0)
|— putinfo (4)	|— codeversion (0)
| |— putmethod (0)	|— parameters (0)
| |— putaccess (0)	|— output_diag (0)
| |— putlocation (0)	|— output_flag (0)
| |— rights (0)	

last update: 2011-02-15 by konz

4.1.6.3.2 ILSA

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium	mhd	path

4.1.6.3.3 Actual fill status: mhd CPO

Table 34: mhd (21)

-> datainfo (7)	-> n (0)
|— dataprovider (0)	-> m (0)
|— putdate (0)	-> psi (0)
|— source (0)	-> frequency (0)
|— comment (0)	-> growthrate (0)
|— isref (0)	-> disp_perp (0)
|— whatref (5)	-> disp_par (0)
| |— user (0)	-> tau_alfven (0)
| |— machine (0)	-> tau_resistive (0)
| |— shot (0)	-> time (0)
| |— run (0)	-> codeparam (5)
| |— occurrence (0)	|— codename (0)
|— putinfo (4)	|— codeversion (0)
| |— putmethod (0)	|— parameters (0)
| |— putaccess (0)	|— output_diag (0)
| |— putlocation (0)	|— output_flag (0)
| |— rights (0)	

last update: 2011-02-15 by konz

4.1.6.4 Numerical Tools

4.1.6.4.1 PROGEN

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium (empty)	equilibrium	active path_tag path

fill table not yet available

4.1.6.4.2 JALPHA

Type	Input CPOs	Output CPOs	Kepler parameters
single time slice	equilibrium	equilibrium	path

fill table not yet available

---

last update: 2011-02-15 by konz

---

last update: 2011-07-13 by konz

4.2 Workflows

The IMP12 project has provided a series of prebuilt Kepler [43] workflows around equilibrium reconstruction, linear MHD stability, non-linear MHD, and disruptions.
Below the prototype workflows are described as they are stored in the keplerworkflows [44] repository under Gforge [45] . Most prototypes come with several production versions which are also stored in the keplerworkflows [46] repository.
The list is constantly expanding.

IMP12's workflows are hosted in the following categories:

```
- fixed_boundary_equilibrium
- free_boundary_equilibrium
- linear_MHD
```

4.2.1 Prototype Workflows

Workflow	Description
equalslice.xml	free boundary equilibrium reconstruction based on magnetics data using EQUALslice (4.1.1.1).
helena_aug.xml	high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1).
ilsa_aug.xml	linear MHD stability analysis for a high resolution fixed boundary equilibrium using ILSA (4.1.2.1).
equal_helena.xml	Free boundary equilibrium reconstruction based on magnetics data using EQUALslice (4.1.1.1) and subsequent high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1).
equal_helena_ilsa.xml	Free boundary equilibrium reconstruction based on magnetics data using EQUALslice (4.1.1.1) and subsequent high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1). Resulting equilibrium analyzed for linear MHD stability using ILSA (4.1.3.1)
progen_helena_analytic.xml	Analytic profile and shape generation using PROGEN (4.1.4.1) and subsequent high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1).
progen_helena_aug.xml	ASDEX Upgrade profile and shape generation using PROGEN (4.1.4.1) and subsequent high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1).
progen_helena_ilsa_analytic.xml	Analytic profile and shape generation using PROGEN (4.1.4.1) and subsequent high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1). Resulting equilibrium analyzed for linear MHD stability using ILSA (4.1.3.1)
progen_helena_ilsa_aug.xml	ASDEX Upgrade profile and shape generation using PROGEN (4.1.4.1) and subsequent high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1). Resulting equilibrium analyzed for linear MHD stability using ILSA (4.1.3.1)
jalpha_helena_analytic.xml	$j - \alpha$ -modification of an existing fixed boundary equilibrium using JALPHA (4.1.4.2) and subsequent high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1).
jalpha_helena_ilsa_analytic.xml	$j - \alpha$ -modification of an existing fixed boundary equilibrium using JALPHA (4.1.4.2) and subsequent high resolution fixed boundary equilibrium calculation using HELENA (4.1.2.1). Resulting equilibrium analyzed for linear MHD stability using ILSA (4.1.3.1)

4.2.2 Production Workflows

Prototype	Production
progen_helena_aug.xml	progen_helena_aug_20116@2_25.xml
	progen_helena_aug_20116@3_59.xml
	progen_helena_aug_20116@5_09.xml
progen_helena_ilsa_aug.xml	progen_helena_ilsa_aug_20116@2_25.xml
	progen_helena_ilsa_aug_20116@3_59.xml
	progen_helena_ilsa_aug_20116@5_09.xml

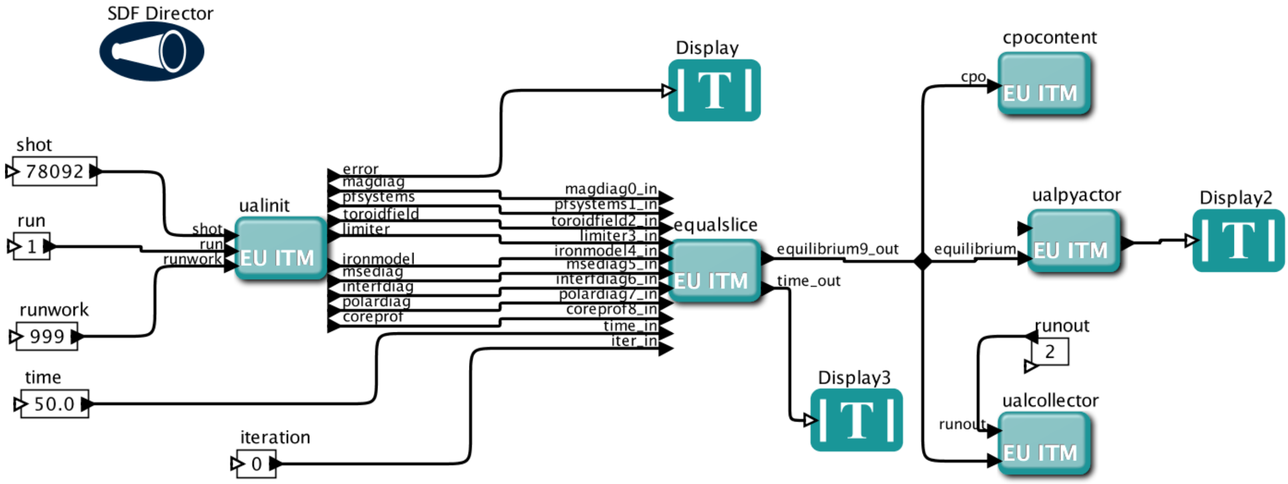
[43] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_kepler
[44] https://www.efda-itm.eu/ITM/html/isip_keplerworkflows.html#isip_keplerworkflows
[45] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_gforge
[46] https://www.efda-itm.eu/ITM/html/isip_keplerworkflows.html#isip_keplerworkflows

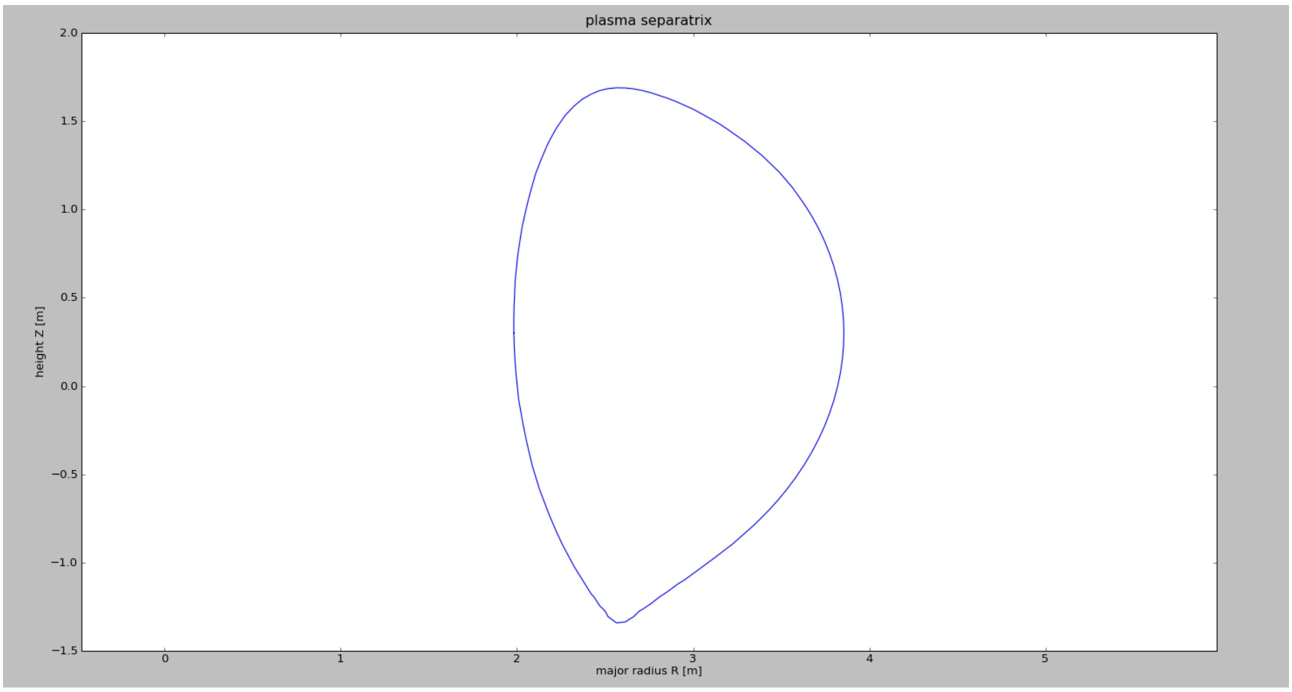
4.2.3 Free Boundary Equilibrium Reconstruction

4.2.3.1 EQUAL slice

The workflow **equalslice.xml** reads JET magnetics data from the ITM database and runs the EQUAL free boundary equilibrium reconstruction code to calculate the equilibrium. A Python actor [47] is included to visualize the resulting separatrix curve (see figure below).

Type	Actors	Input CPOs	Output CPOs
linear	ualinit equalslice ualpyactor ualcollector	magdiag pfsystems toroidfield limiter ironmodel msediag interfdiag polardiag coreprof	equilibrium





4.2.4 High Resolution Fixed Boundary Equilibrium Reconstruction

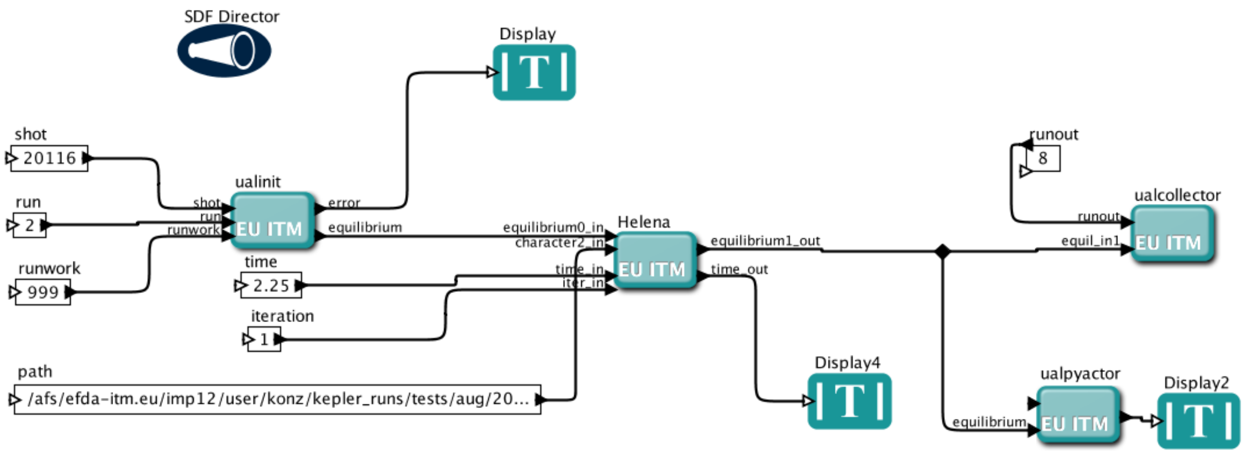
4.2.4.1 HELENA

The workflow **helena_aug.xml** reads an equilibrium CPO from the ITM database (which may contain as little as the input profiles and boundary curve) and calculates the high resolution fixed boundary equilibrium inside

[47] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_actor

the specified boundary curve using the HELENA actor. A Python actor is included to visualize the resulting equilibrium.

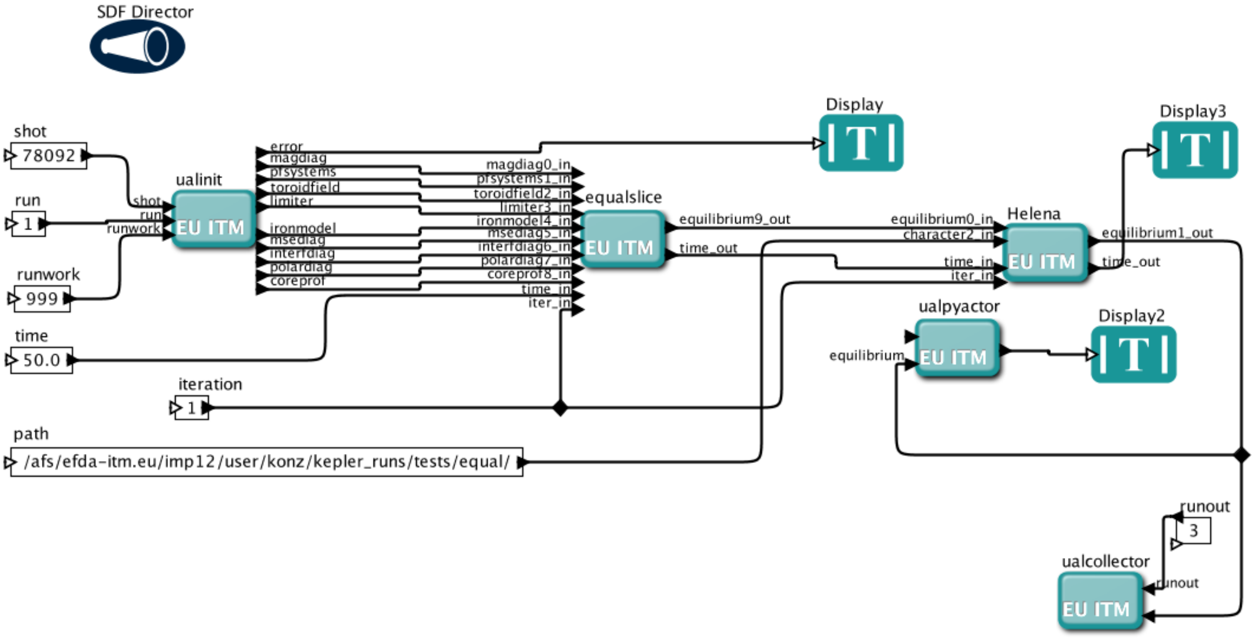
Type	Actors	Input CPOs	Output CPOs
linear	ualinit helena ualpyactor ualcollector	equilibrium	equilibrium

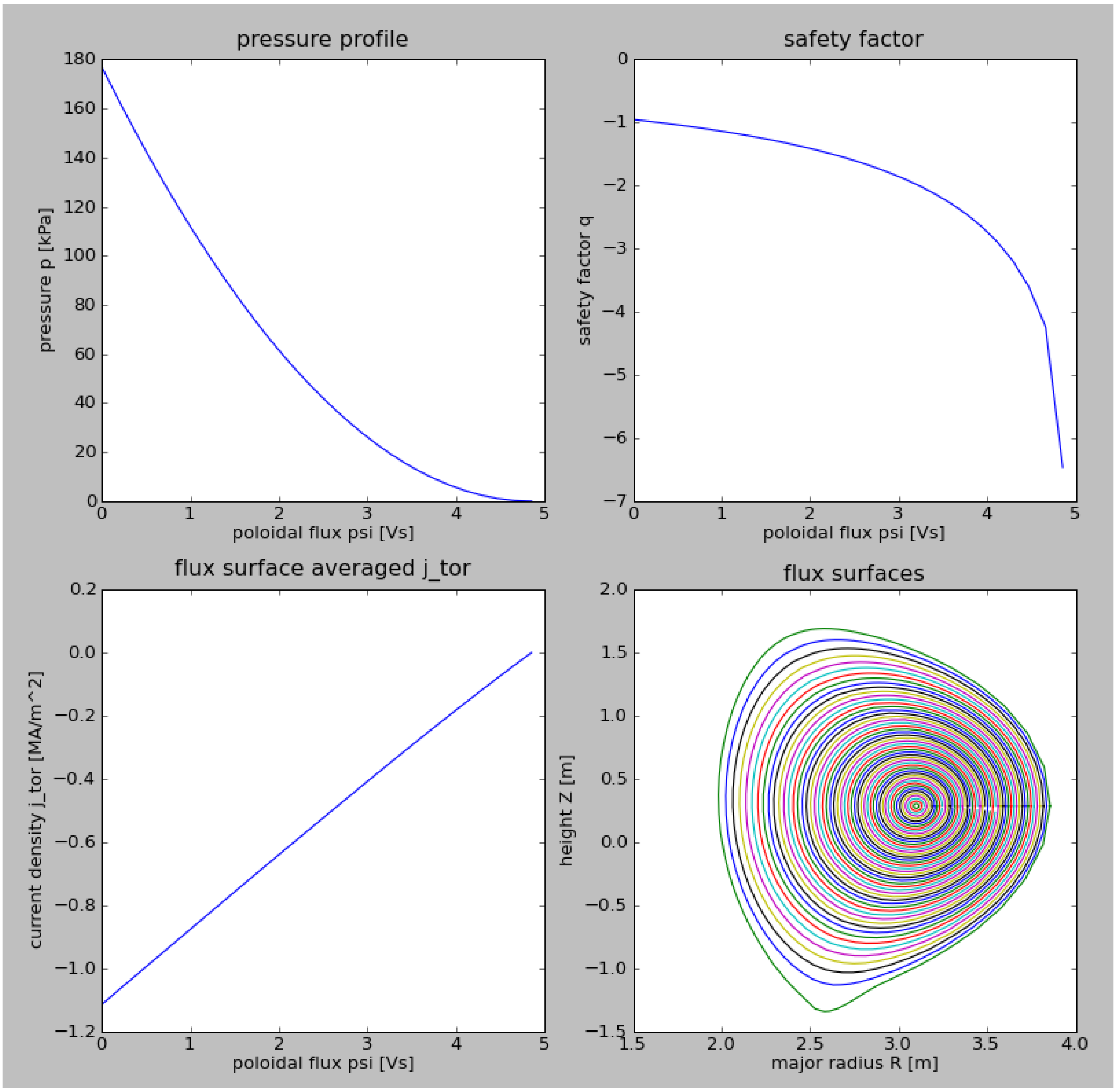


4.2.4.2 EQUAL-HELENA

The workflow **equal_helena.xml** reads JET magnetics data from the ITM database and runs the EQUAL free boundary equilibrium reconstruction code to calculate the equilibrium. The resulting equilibrium is then reconstructed within the separatrix with the high resolution equilibrium solver HELENA. A Python actor is included to visualize the pressure and current density profiles along with the safety factor q and a two-dimensional plot of the flux surfaces (see figure). The path parameter is optional and can be used to redirect verbose output to the specified directory.

Type	Actors	Input CPOs	Output CPOs
linear	ualinit equalslice helena ualpyactor ualcollector	magdiag pfsystems toroidfield limiter ironmodel msediag interfdiag polardiag coreprof	equilibrium


SDF Director
shot
78092
run
1
runwork
999
time
50.0
iteration
1
path
/afs/efda-itm.eu/imp12/user/konz/kepler_runs/tests/equal/
ualinit
EU ITM
equalslice
EU ITM
Helena
EU ITM
ualpyactor
EU ITM
ualcollector
EU ITM
Display
Display2
Display3
runout
3
equilibrium9_out
time_out
equilibrium0_in
character2_in
time_in
iter_in
equilibrium1_out
time_out
equilibrium


pressure profile
pressure p [kPa]
poloidal flux psi [Vs]
safety factor
safety factor q
poloidal flux psi [Vs]
flux surface averaged j_tor
current density j_tor [MA/m^2]
poloidal flux psi [Vs]
flux surfaces
height Z [m]
major radius R [m]

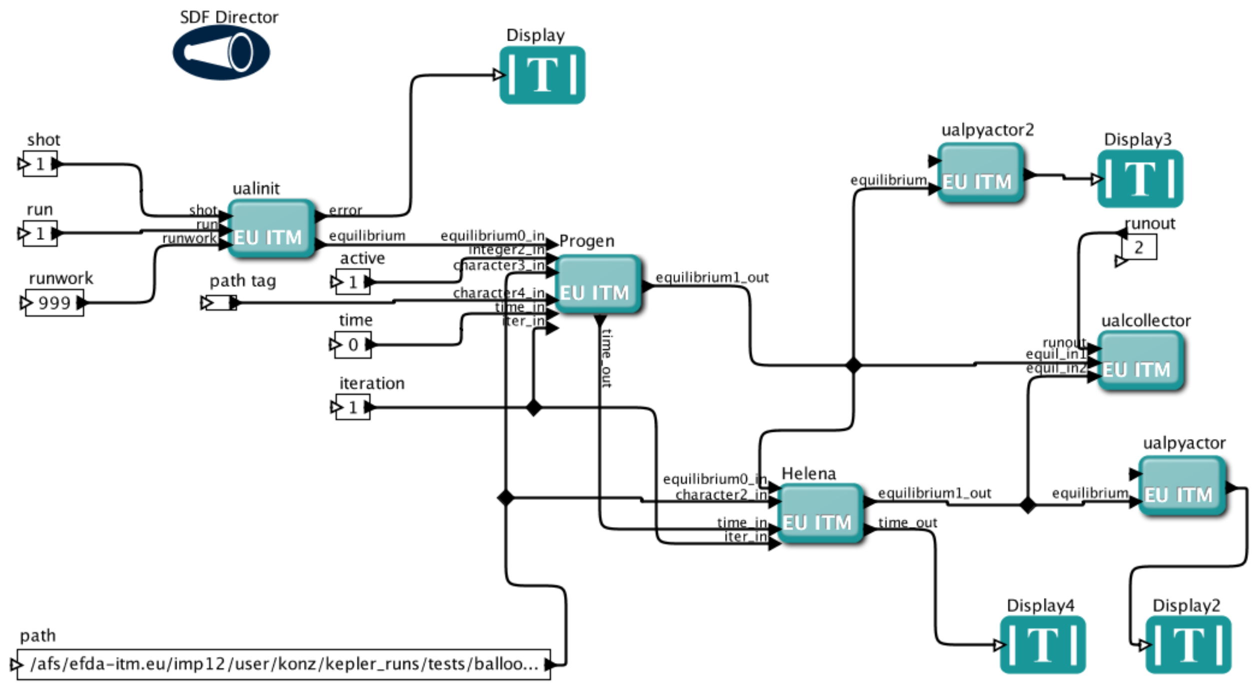
4.2.4.3 PROGEN-HELENA

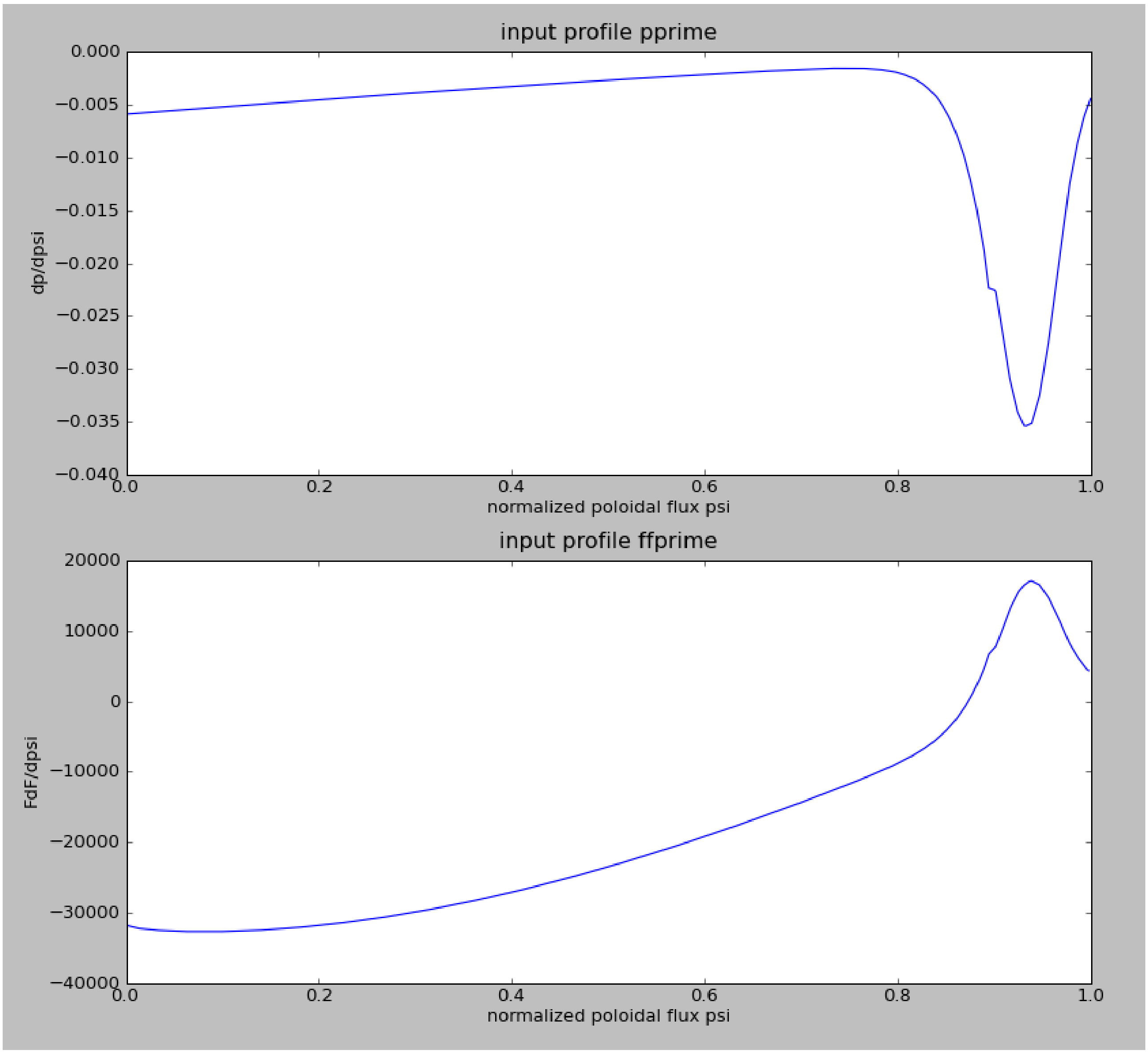
Two prototype workflows fall in this category: **progen_helena_analytic.xml** and **progen_helena_aug.xml** . The first of these generates an equilibrium from an analytic definition of the profiles and the shape. The second reads experimental profiles and generates an experimental equilibrium for ASDEX Upgrade.

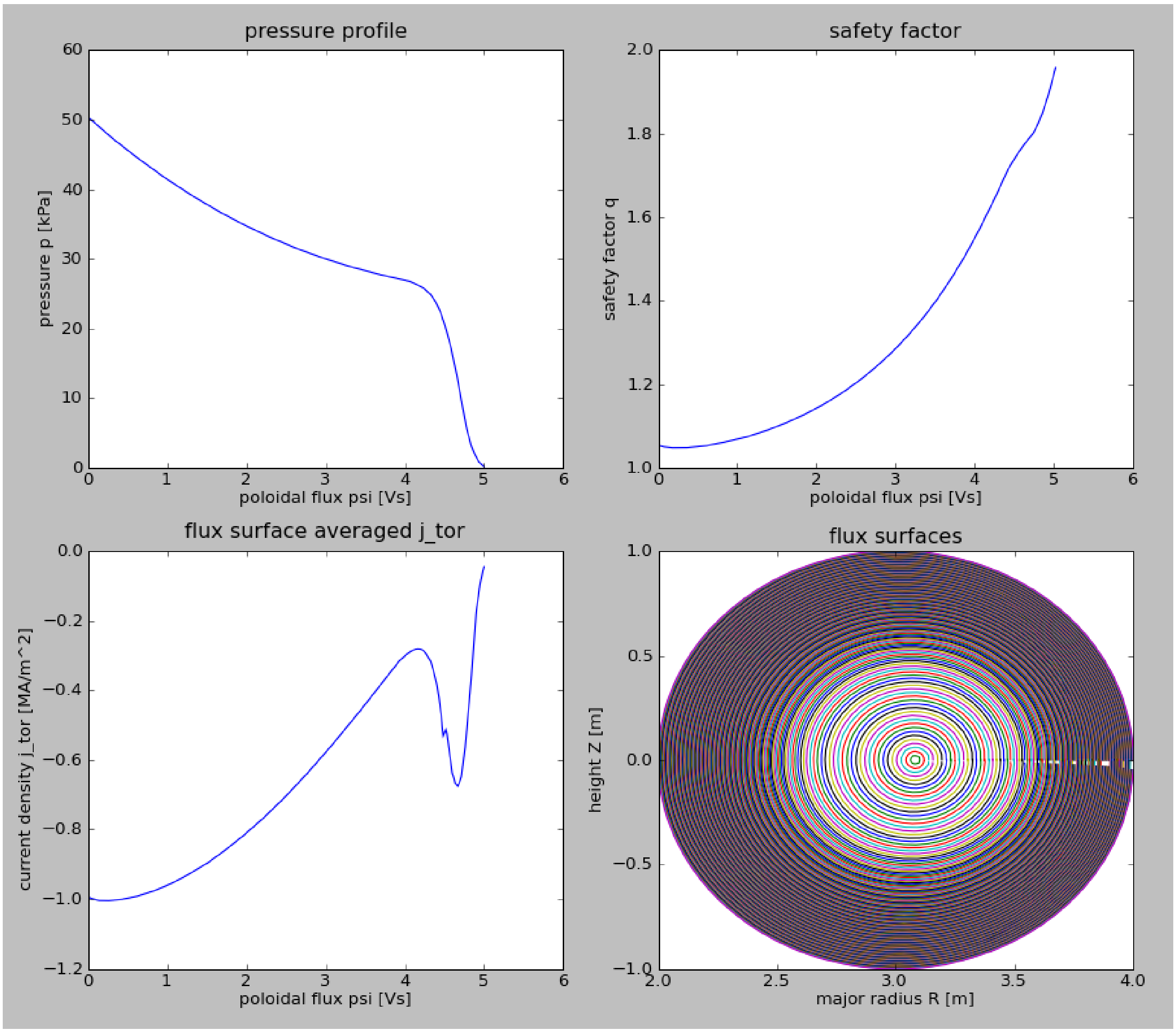
4.2.4.3.1 Analytic equilibrium

The workflow **progen_helena_analytic.xml** uses the simple tool PROGEN to generate analytic profiles for p′, FF′ and the plasma boundary which are fed to the high resolution fixed boundary equilibrium solver HELENA. One Python actor shows the incoming p′ and FF′ profiles while a second Python actor shows the resulting equilibrium (see figures). The path parameter is optional but can be used to read profiles from file and to redirect verbose output to the specified directory.

Type	Actors	Input CPOs	Output CPOs
linear	ualinit progen helena ualpyactor ualcollector	none	equilibrium



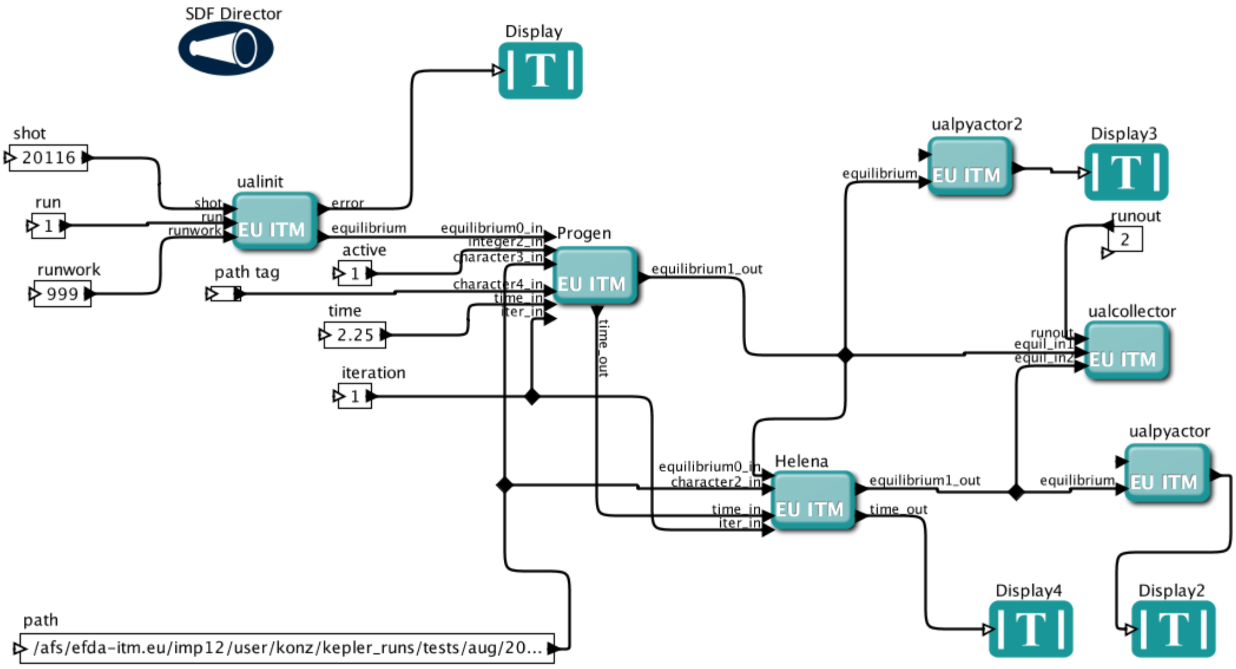

input profile pprime
dp/dpsi
normalized poloidal flux psi
input profile ffprime
FdF/dpsi
normalized poloidal flux psi

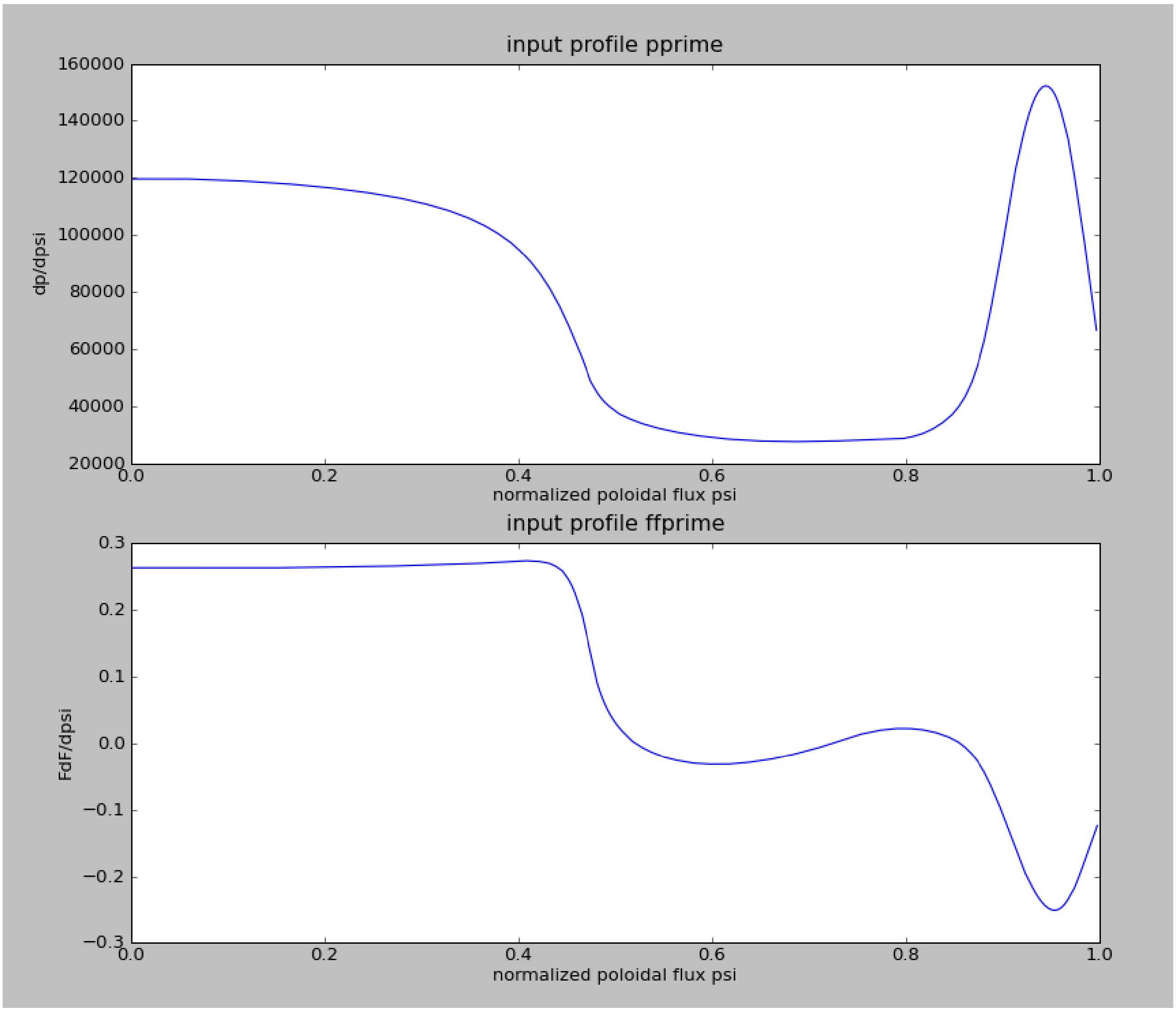


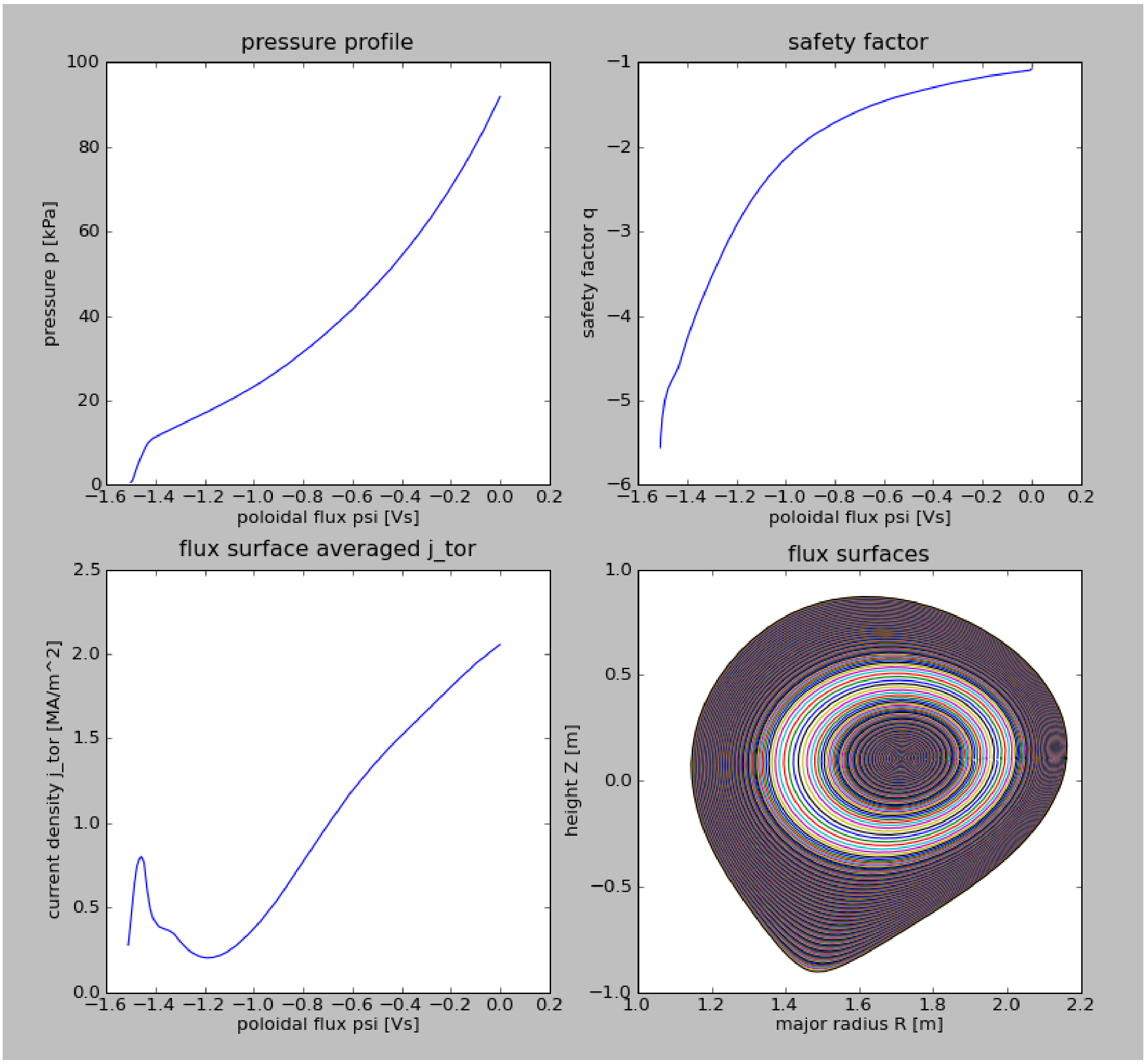
4.2.4.3.2 Experimental equilibrium

The workflow **progen_helena_aug.xml** uses the simple tool PROGEN to read the profiles for p′, FF′ and the plasma boundary from files. These are then fed to the high resolution fixed boundary equilibrium solver HELENA. One Python actor shows the incoming p′ and FF′ profiles while a second Python actor shows the resulting equilibrium (see figures). The path parameter is used to read the profiles from file and to redirect verbose output to the specified directory.

Type	Actors	Input CPOs	Output CPOs
linear	ualinit progen helena ualpyactor ualcollector	none	equilibrium


SDF Director
Display
shot
20116
run
1
runwork
999
ualinit
shot
run
runwork
EU ITM
error
equilibrium
active
1
path tag
time
2.25
iteration
1
equilibrium0_in
integer2_in
character3_in
character4_in
time_in
iter_in
Progen
EU ITM
equilibrium1_out
time_out
ualpyactor2
equilibrium
EU ITM
Display3
runout
2
ualcollector
runout
equil_in1
equil_in2
EU ITM
ualpyactor
equilibrium
EU ITM
equilibrium0_in
character2_in
time_in
iter_in
Helena
EU ITM
equilibrium1_out
time_out
Display4
Display2
path
/afs/efda-itm.eu/imp12/user/konz/kepler_runs/tests/aug/20...

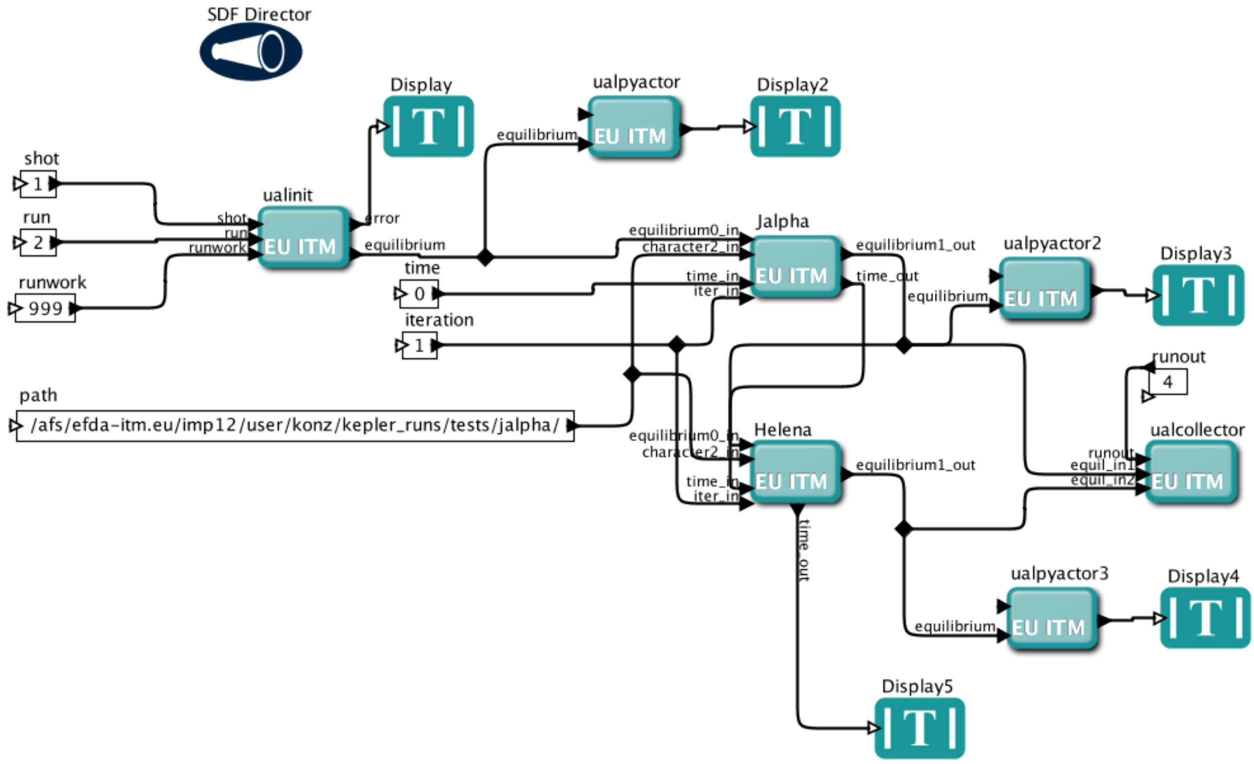

input profile pprime
dp/dpsi
normalized poloidal flux psi
input profile ffprime
FdF/dpsi
normalized poloidal flux psi

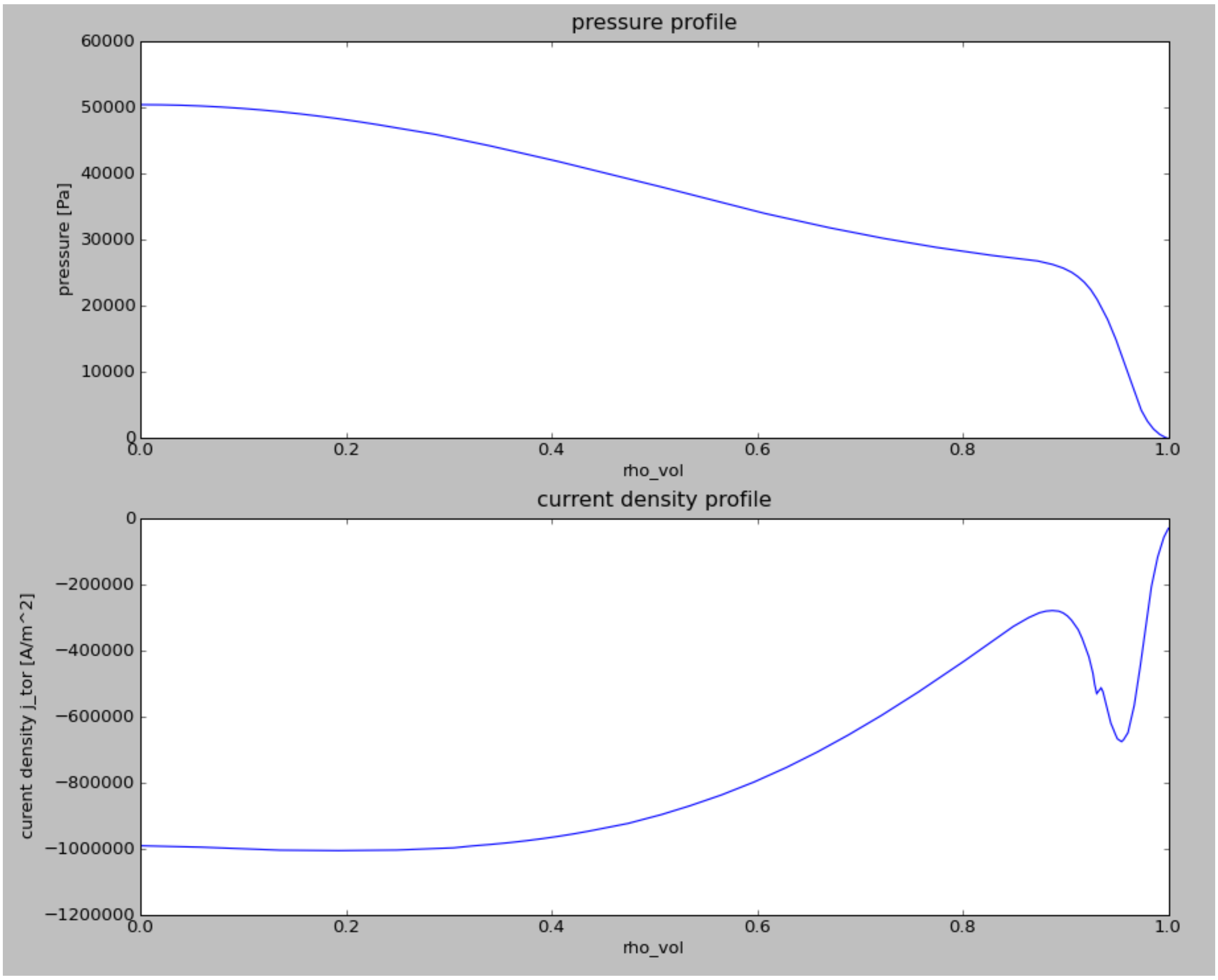


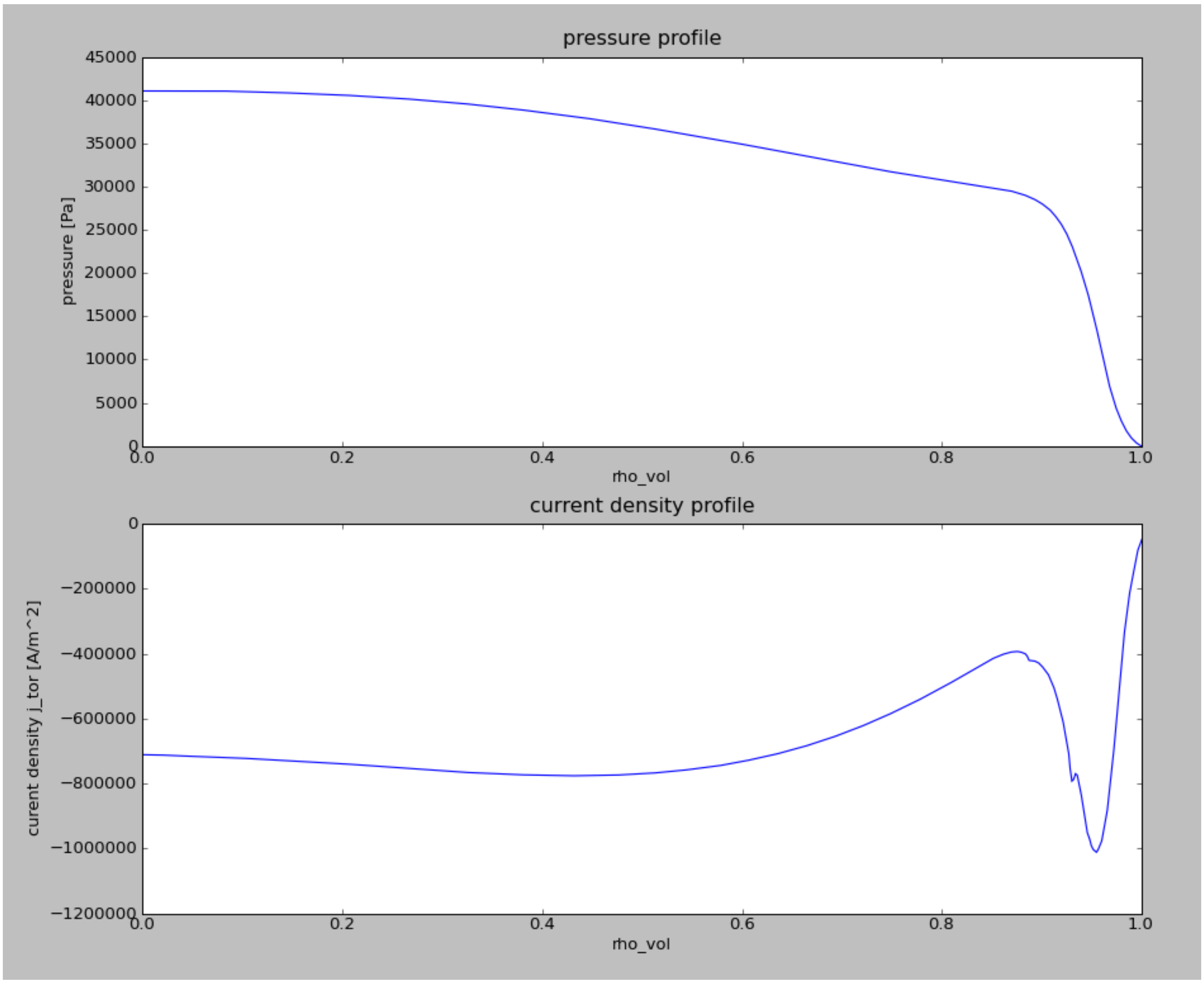
4.2.4.4 JALPHA-HELENA

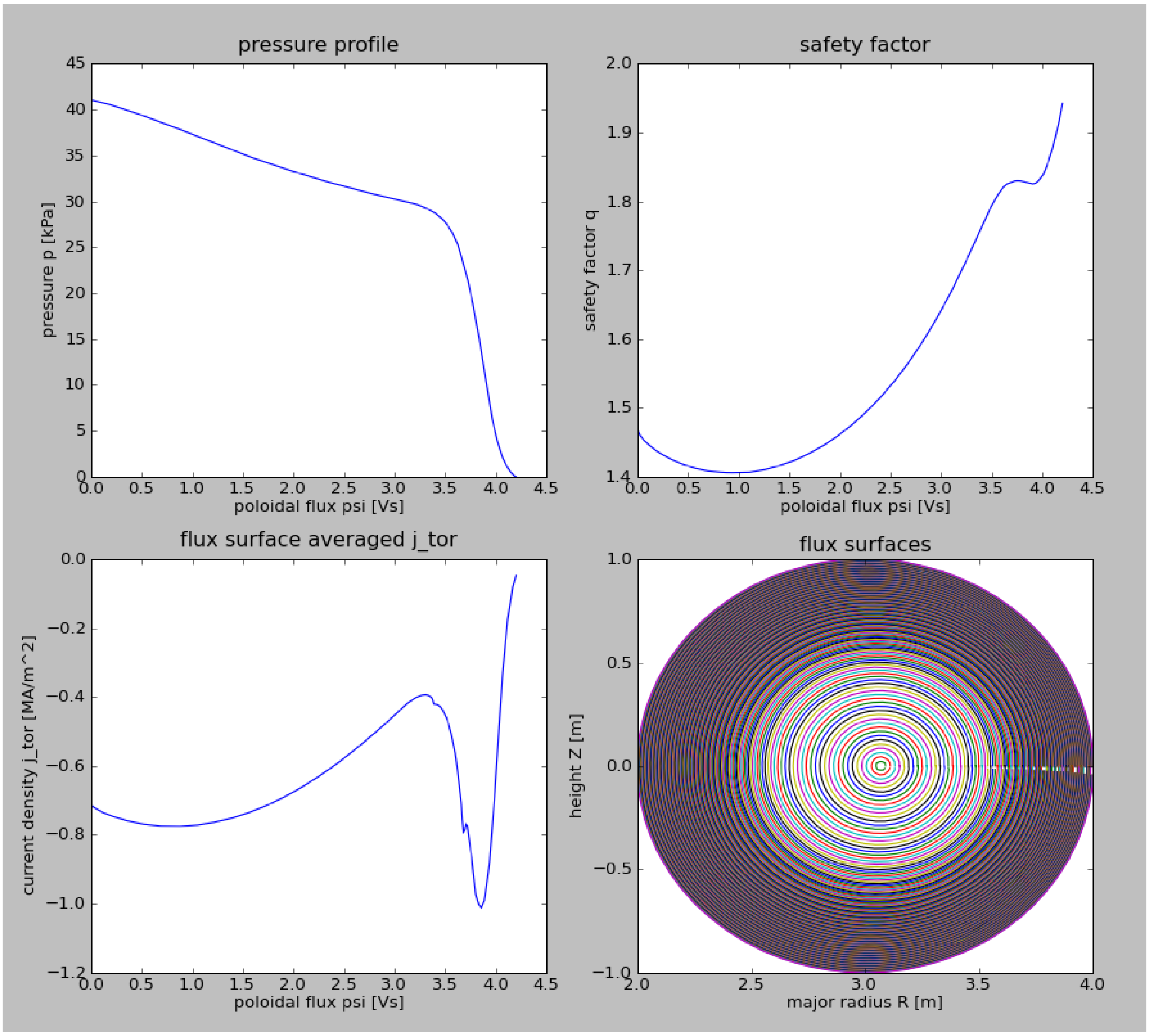
The workflow **jalpha_helena_analytic.xml** reads a precalculated equilibrium (for instance calculated with HELENA) from the data base, modifies the pressure and current density profiles with the module JALPHA and calculates the new equilibrium using the HELENA actor. The intention here is to modify an experimental equilibrium for edge stability analysis, so called j- α diagrams. A Python actor shows the pressure and current density profiles of the original equilibrium another the modified profiles while a third Python actor shows the new equilibrium (see figures). The path parameter is optional and can be used to redirect verbose output to the specified directory.

Type	Actors	Input CPOs	Output CPOs
linear	ualinit jalpha helena ualpyactor ualcollector	equilibrium	equilibrium


SDF Director
Display
ualpyactor
Display2
shot
1
run
2
runwork
999
ualinit
shot
run
runwork
EU ITM
error
equilibrium
equilibrium
time
0
iteration
1
equilibrium0_in
character2_in
Jalpha
time_in
iter_in
equilibrium1_out
time_out
ualpyactor2
equilibrium
Display3
runout
4
path
/afs/efda-itm.eu/imp12/user/konz/kepler_runs/tests/jalpha/
Helena
equilibrium1_out
time_out
ualcollector
runout
equil_in1
equil_in2
ualpyactor3
equilibrium
Display4
Display5


pressure profile
pressure [Pa]
60000
50000
40000
30000
20000
10000
0
0.0
0.2
0.4
0.6
0.8
1.0
rho_vol
current density profile
current density j_tor [A/m^2]
0
−200000
−400000
−600000
−800000
−1000000
−1200000
0.0
0.2
0.4
0.6
0.8
1.0
rho_vol


pressure profile
pressure [Pa]
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0.0
0.2
0.4
0.6
0.8
1.0
rho_vol
current density profile
curent density j_tor [A/m^2]
0
−200000
−400000
−600000
−800000
−1000000
−1200000
0.0
0.2
0.4
0.6
0.8
1.0
rho_vol

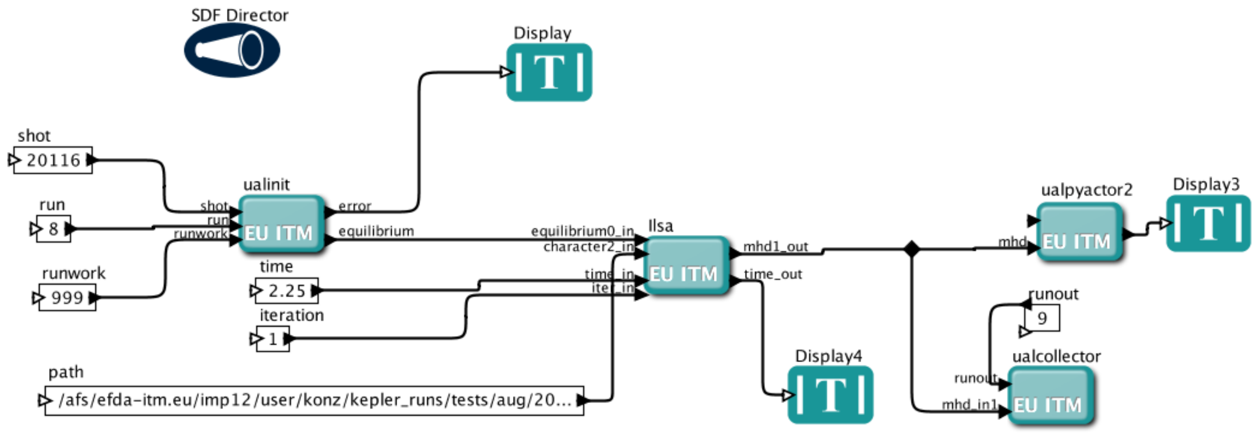


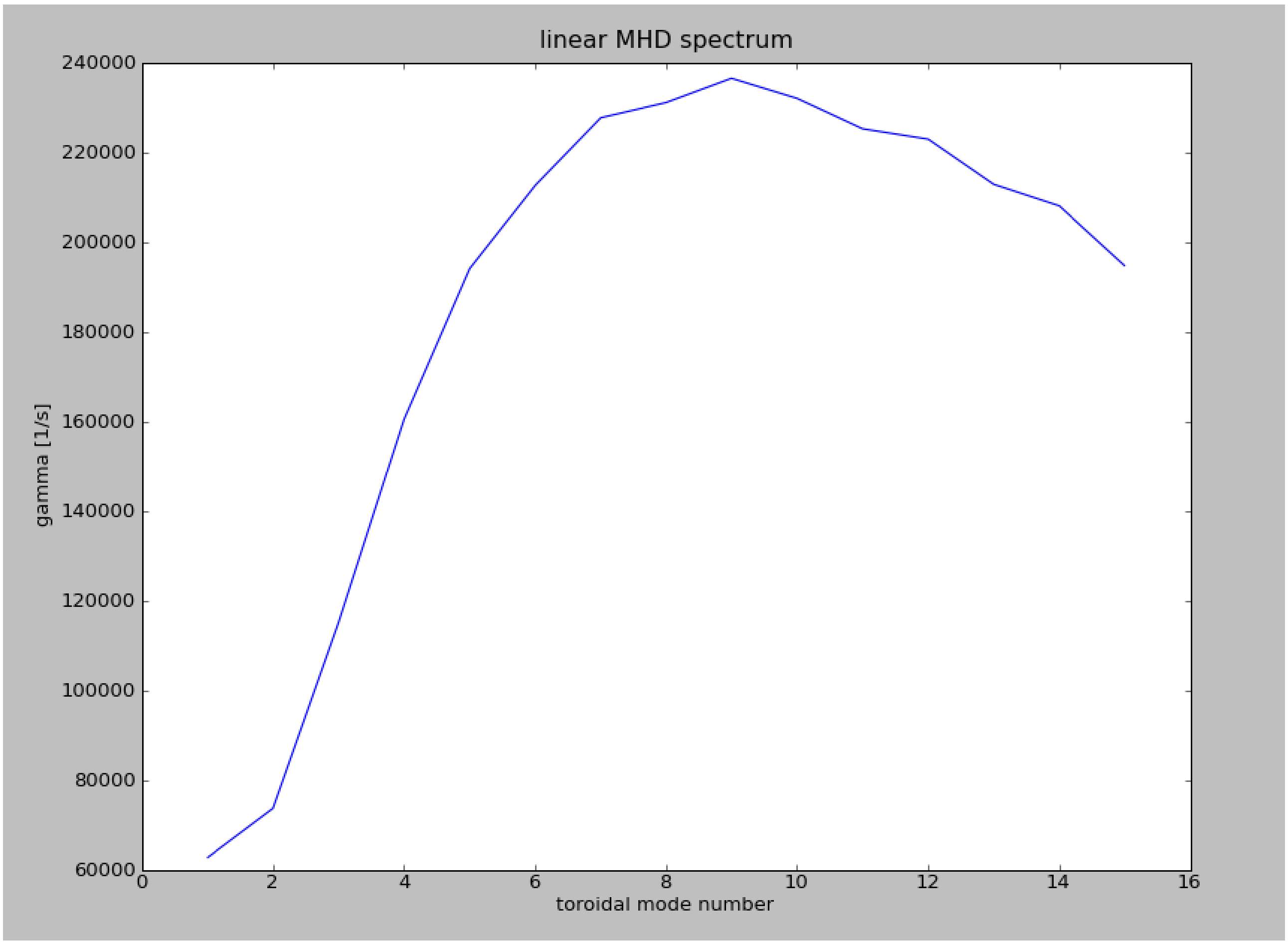
4.2.5 Linear MHD Stability Analysis

4.2.5.1 ILSA

The workflow **ilsa_aug.xml** reads an equilibrium CPO from the ITM database containing a high resolution fixed boundary equilibrium. It then analyzes the equilibrium for linear MHD stability and calculates a spectrum of growthrates and frequencies vs. toroidal mode numbers using the linear MHD stability actor ILSA. A Python actor is included to visualize the resulting spectrum (see figure below).

Type	Actors	Input CPOs	Output CPOs
linear	ualinit ilsa ualpyactor ualcollector	equilibrium	mhd





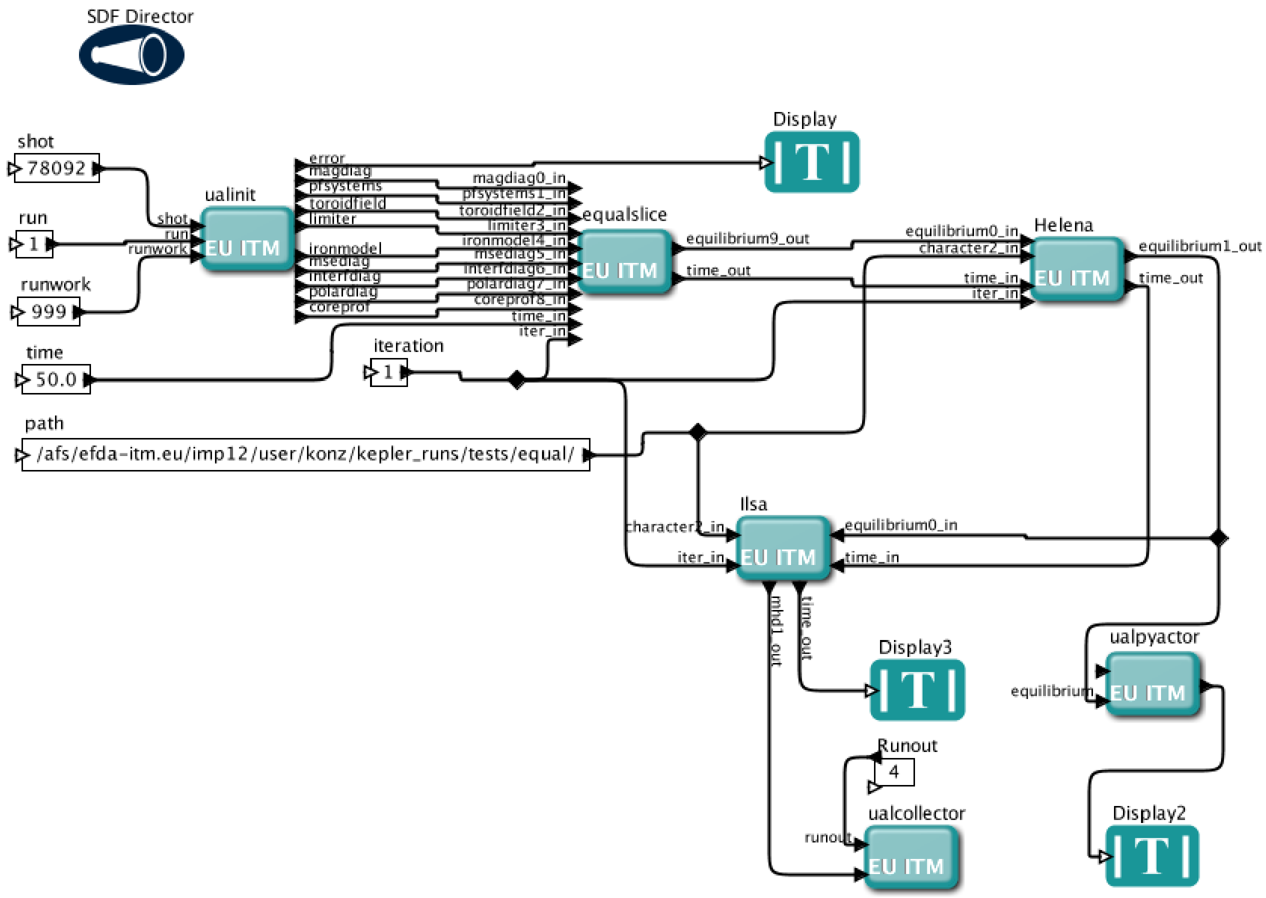
4.2.5.2 EQUAL-HELENA-ILSA

The workflow **equal_helena_ilsa.xml** reads JET magnetics data from the ITM database and runs the EQUAL free boundary equilibrium reconstruction code to calculate the equilibrium. The resulting equilibrium is then reconstructed within the separatrix with the high resolution equilibrium solver HELENA. Using this high resolution fixed boundary equilibrium, the linear MHD stability module ILSA determines the stability of the equilibrium.

A Python actor is included to visualize the pressure and current density profiles along with the safety factor q and a two-dimensional plot of the flux surfaces. The path parameter is optional and can be used to redirect verbose output to the specified directory. The resulting MHD CPO [48] is stored in the database using the `ualcollector` actor.

[48] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo

Type	Actors	Input CPOs	Output CPOs
linear	ualinit equalslice helena ilsa cpocontent ualpyactor	magdiag pfsystems toroidfield limiter ironmodel msediag interfdiag polardiag coreprof	mhd



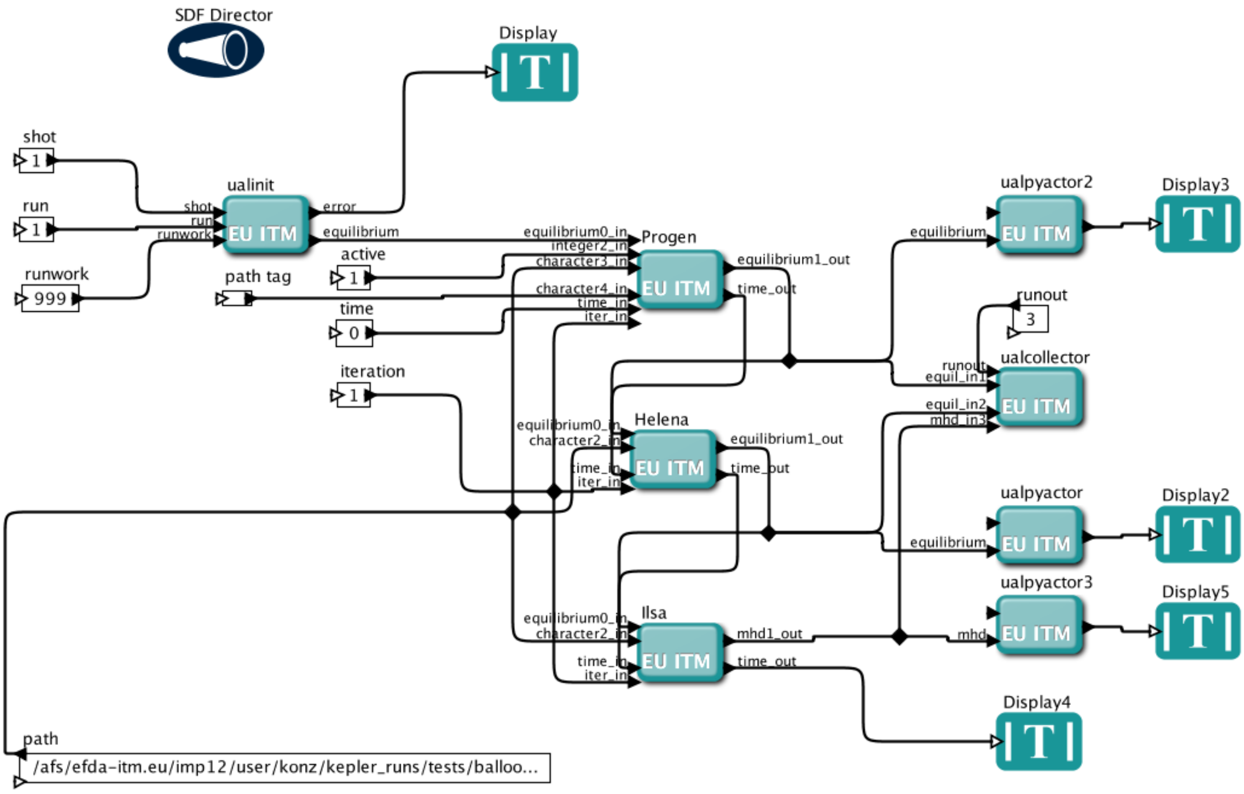
4.2.5.3 PROGEN-HELENA-ILSA

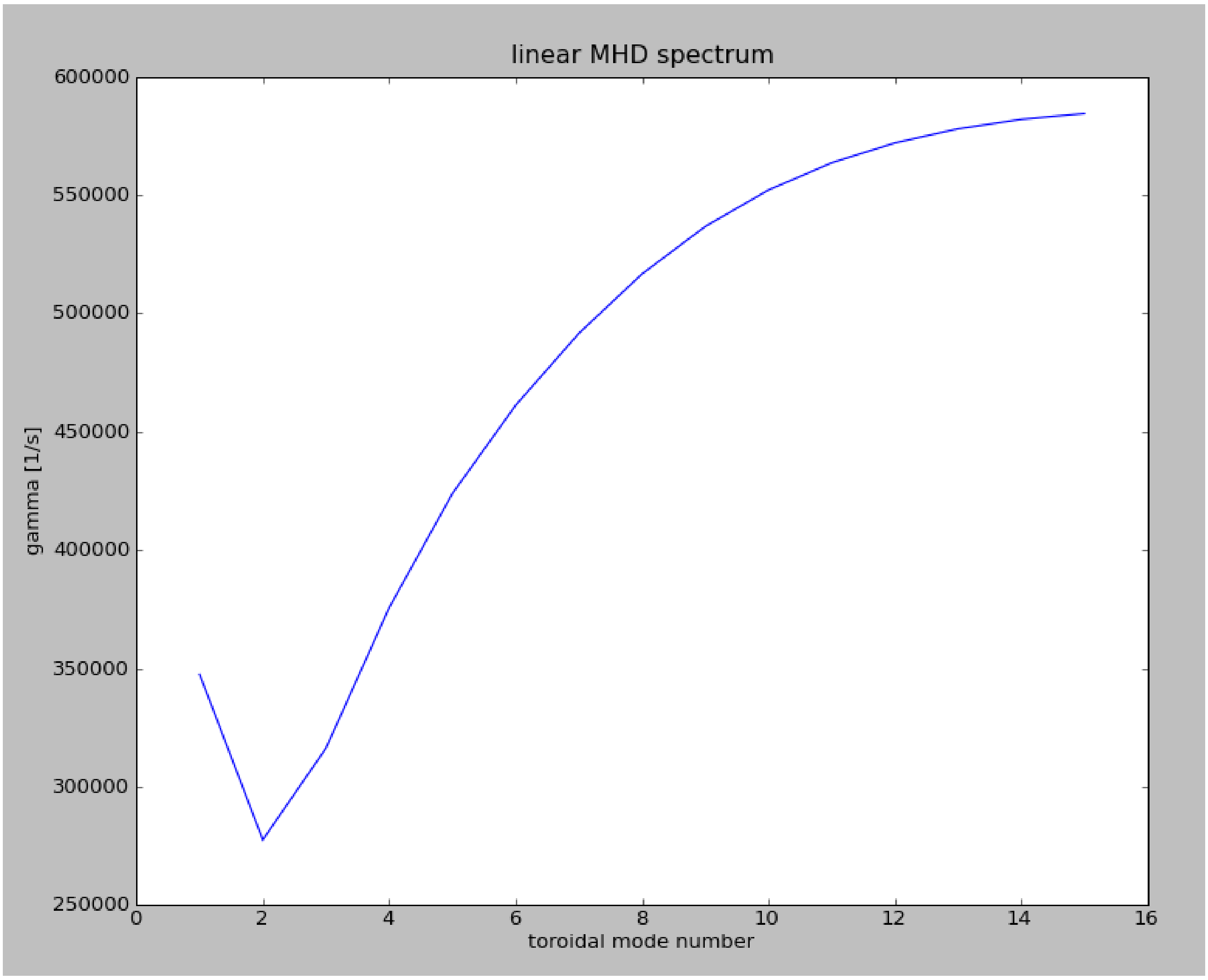
Two prototype workflows fall in this category: **progen_helena_ilsa_analytic.xml** and **progen_helena_ilsa_aug.xml**
.
The first of these generates an equilibrium from an analytic definition of the profiles and the shape. The second reads experimental profiles and generates an experimental equilibrium for ASDEX Upgrade. Both workflows then analyze the linear MHD stability of the resulting equilibria.

4.2.5.3.1 Analytic equilibrium

The workflow **progen_helena_ilsa_analytic.xml** uses the simple tool PROGEN to generate analytic profiles for p′, FF′ and the plasma boundary which are fed to the high resolution fixed boundary equilibrium solver HELENA. One Python actor shows the incoming p′ and FF′ profiles while a second Python actor shows the resulting equilibrium. Using this high resolution fixed boundary equilibrium, the linear MHD stability module ILSA determines the stability of the equilibrium. The path parameter is optional but can be used to read profiles from file and to redirect verbose output to the specified directory. A third Python actor shows the resulting linear MHD spectrum (see figure below).

Type	Actors	Input CPOs	Output CPOs
linear	ualinit progen helena ualpyactor ilsa cpocontent	none	equilibrium mhd

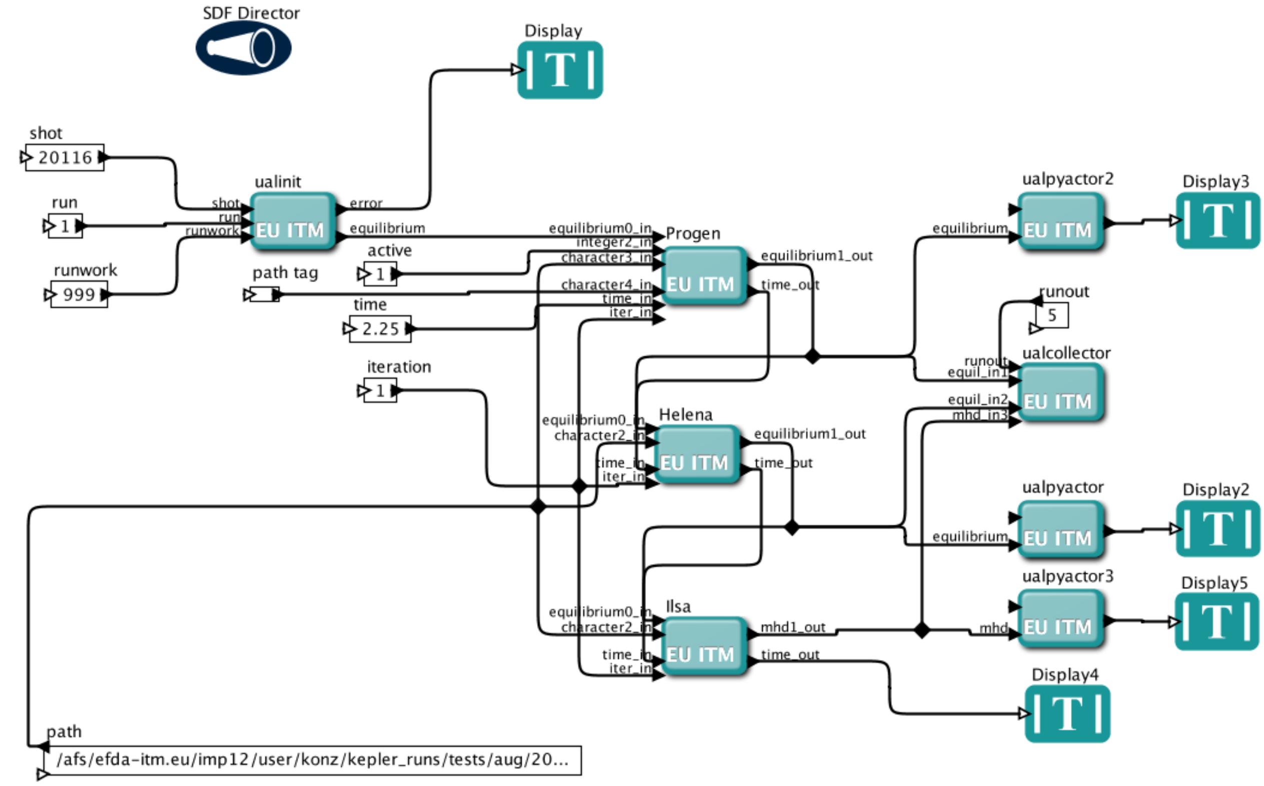




4.2.5.3.2 Experimental equilibrium

The workflow **progen_helena_ilsa_aug.xml** uses the simple tool PROGEN to read the profiles for p′, FF′ and the plasma boundary from files. These are then fed to the high resolution fixed boundary equilibrium solver HELENA. One Python actor shows the incoming p′ and FF′ profiles while a second Python actor shows the resulting equilibrium. Using this high resolution fixed boundary equilibrium, the linear MHD stability module ILSA determines the stability of the equilibrium. The path parameter is used to read profiles from file and to redirect verbose output to the specified directory. A third Python actor shows the resulting linear MHD spectrum.

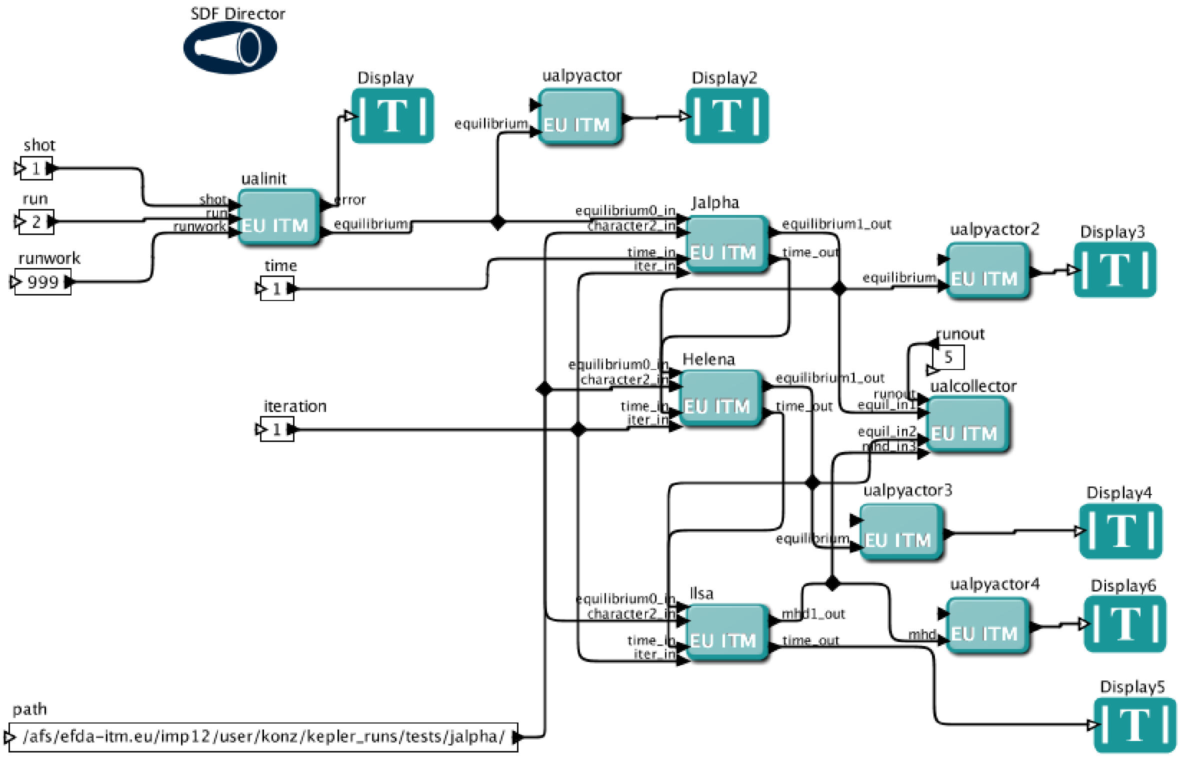
Type	**Actors**	**Input CPOs**	**Output CPOs**
linear	ualinit progen helena ualpyactor ilsa cpocontent	none	equilibrium mhd



4.2.5.4 JALPHA-HELENA-ILSA

The workflow jalpha_helena_analytic.xml reads a precalculated equilibrium (for instance calculated with HELENA) from the data base, modifies the pressure and current density profiles with the module JALPHA and calculates the new equilibrium using the HELENA actor. The modified high resolution fixed boundary equilibrium is then fed to the linear MHD stability module ILSA which determines the stability of the equilibrium. The intention here is to modify an experimental equilibrium for edge stability analysis, so called j- α diagrams. A Python actor shows the pressure and current density profiles of the original equilibrium another the modified profiles while a third Python actor shows the new equilibrium (see figures). The path parameter is optional and can be used to redirect verbose output to the specified directory. A cpocontent actor is included to show the content of the resulting MHD CPO.

Type	Actors	Input CPOs	Output CPOs
linear	ualinit jalpha helena ilsa ualpyactor ualcollector	equilibrium	equilibrium mhd



last update: 2010-12-17 by konz

last update: 2012-07-18 by coster

5 IMP12 Shots

Shots stored in the private data base of IMP12 members are generally not validated. Please do not publish without contacting the data provider.

5.1 ITER shots

The shots can be accessed by setting

```
TOKAMAKNAME = iter
```

5.1.1 UAL Version 4.08b

The shots can be accessed by setting

```
UAL = 4.08b
```

The following table lists the shot by shot number and run number together with the list of stored CPOs [49] , the user name of the data base, and a short description.

[49] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo

Shot	Run	CPOs	user	generated with	description
1	2	equilibrium mhd	konz	euforia2ual_j_alpha	j- α scan through modification of the pedestal height between 50% and 150% of the reference equilibrium together with linear MHD stability analysis The scan is done in 10% steps. The 121 different cases are stored in time slices starting from 0.0s with 1.0s steps where scale_p=0.5 and scale_j=0.5 is the first entry and scale_j is looped over faster (e.g., scale_p=0.6, scale_j=0.5 is stored in time slice t=0.0s+11s=11.0s).
	3	equilibrium mhd	konz	euforia2ual_j_alpha	β_N scan through modification of the entire pressure profile between 50% and 150% of the reference equilibrium together with linear MHD stability analysis The scan is done in 10% steps. The 11 different cases are stored in time slices starting from 0.0s with 1.0s steps where scale_beta=0.5 is the first entry (e.g., scale_beta=1.0 is stored in time slice t=0.0s+5s=5.0s).
	4	equilibrium mhd	konz	euforia2ual_j_alpha	β_N scan through modification of the core pressure profile only between 50% and 150% of the reference equilibrium together with linear MHD stability analysis The scan is done in 10% steps. The 11 different cases are stored in time slices starting from 0.0s with 1.0s steps where scale_beta=0.5 is the first entry (e.g., scale_beta=1.0 is stored in time slice t=0.0s+5s=5.0s).

5.2 JET shots

The shots can be accessed by setting

```
TOKAMAKNAME = jet
```

5.2.1 UAL Version 4.08a

The shots can be accessed by setting

```
UAL = 4.08a
```

The following table lists the shot by shot number and run number together with the list of stored CPOs [50] , the user name of the data base, and a short description.

Shot	Run	CPOs	user	generated with	description
78092	1	magdiag pfsystems toroidfield limiter ironmodel msediag	konz	exp2itm	time trace of experimental signals for equilibrium reconstruction
	2	equilibrium	konz	equalslice	free boundary equilibrium at t=50s
	3	equilibrium	konz	equal_helena	fixed boundary equilibrium up to separatrix at t=50s
	4	mhd	konz	equal_helena_ilsa	linear MHD stability for n=-3..-5 at t=50s (stable)

5.3 ASDEX Upgrade shots

The shots can be accessed by setting

```
TOKAMAKNAME = aug
```

5.3.1 UAL Version 4.08a

The shots can be accessed by setting

[50] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo

```
UAL = 4.08a
```

The following table lists the shot by shot number and run number together with the list of stored CPOs [51] , the user name of the data base, and a short description.

Shot	Run	CPOs	user	generated with	description
20116	2	equilibrium	konz	progen_helena_aug	**improved H-mode** (type-I ELMs) $I_p = 1\text{MA}$, $n_e = 6.25 \cdot 10^{19} m^{-3}$, $B_t = -2.392T$, $q_{95} = 4.522$ at t=2.25s with 5 MW NBI and 3.6 MW ICRH fixed boundary equilibrium cut at 99.3% of ψ_{bound}
	3	equilibrium	konz	progen_helena_aug	**improved H-mode** (type-I ELMs) $I_p = 1\text{MA}$, $n_e = 6.25 \cdot 10^{19} m^{-3}$, $B_t = -2.392T$, $q_{95} = 4.522$ at t=3.59s with 7.5 MW NBI and 3.6 MW ICRH fixed boundary equilibrium cut at 99.3% of ψ_{bound}
	4	equilibrium	konz	progen_helena_aug	**improved H-mode** (type-I ELMs) $I_p = 1\text{MA}$, $n_e = 6.25 \cdot 10^{19} m^{-3}$, $B_t = -2.392T$, $q_{95} = 4.522$ at t=5.09s with 10 MW NBI and 3.6 MW ICRH fixed boundary equilibrium cut at 99.3% of ψ_{bound}
	5	equilibrium mhd	konz	progen_helena_ilsa_aug	**improved H-mode** (type-I ELMs) $I_p = 1\text{MA}$, $n_e = 6.25 \cdot 10^{19} m^{-3}$, $B_t = -2.392T$, $q_{95} = 4.522$ at t=2.25s with 5 MW NBI and 3.6 MW ICRH fixed boundary equilibrium cut at 99.3% of ψ_{bound} and linear MHD stability spectrum (peeling-ballooning modes)
	6	equilibrium mhd	konz	progen_helena_ilsa_aug	**improved H-mode** (type-I ELMs) $I_p = 1\text{MA}$, $n_e = 6.25 \cdot 10^{19} m^{-3}$, $B_t = -2.392T$, $q_{95} = 4.522$ at t=3.59s with 7.5 MW NBI and 3.6 MW ICRH fixed boundary equilibrium cut at 99.3% of ψ_{bound} and linear MHD stability spectrum (peeling-ballooning modes)
	7	equilibrium mhd	konz	progen_helena_ilsa_aug	**improved H-mode** (type-I ELMs) $I_p = 1\text{MA}$, $n_e = 6.25 \cdot 10^{19} m^{-3}$, $B_t = -2.392T$, $q_{95} = 4.522$ at t=5.09s with 10 MW NBI and 3.6 MW ICRH fixed boundary equilibrium cut at 99.3% of ψ_{bound} and linear MHD stability spectrum (peeling-ballooning modes)
	8	equilibrium	konz	helena_aug	fixed boundary equilibrium (same as run 2)
	9	mhd	konz	ilsa_aug	linear MHD stability analysis for run 8 (toroidal mode number n = 1 - 15), peeling-ballooning mode

5.3.2 UAL Version 4.08b

The shots can be accessed by setting

```
UAL = 4.08b
```

The following table lists the shot by shot number and run number together with the list of stored CPOs [52] , the user name of the data base, and a short description.

Shot	Run	CPOs	user	generated with	description
20116	2	equilibrium	konz	progen_helena_aug	**improved H-mode** (type-I ELMs) $I_p = 1\text{MA}$, $n_e = 6.25 \cdot 10^{19} m^{-3}$, $B_t = -2.392T$, $q_{95} = 4.522$ at t=3.59s with 7.5 MW NBI and 3.6 MW ICRH fixed boundary equilibrium cut at 99.3% of ψ_{bound}
	3	equilibrium	konz	jalpha_helena	j- α modified equilibrium based on run 2 (scale_p=1.4, scale_j=1.5)
	6	mhd	konz	ilsa_aug	linear MHD stability analysis for run 2 (toroidal mode number n = 1 - 15), peeling-ballooning mode
	10	equilibrium mhd	konz	euforia2ual_j_alpha	j- α scan through modification of the pedestal height between 50% and 150% of the reference equilibrium from run 2 together with linear MHD stability analysis The scan is done in 10% steps. The 121 different cases are stored in time slices starting from 3.59s with 1.0s steps where scale_p=0.5 and scale_j=0.5 is the first entry and scale_j is looped over faster (e.g., scale_p=0.6, scale_j=0.5 is stored in time slice t=3.59s+11s=14.59s).

[51] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo
[52] https://www.efda-itm.eu/ITM/html/itm_glossary.html#g_cpo

Shot	Run	CPOs	user	generated with	description
	11	equilibrium mhd	konz	euforia2ual_j_alpha	j- α scan through modification of the pedestal width between 50% and 150% of the reference equilibrium from run 2 together with linear MHD stability analysis The scan is done in 10% steps. The 121 different cases are stored in time slices starting from 3.59s with 1.0s steps where scale_p=0.5 and scale_j=0.5 is the first entry and scale_j is looped over faster (e.g., scale_p=0.6, scale_j=0.5 is stored in time slice t=3.59s+11s=14.59s).
	12	equilibrium mhd	konz	euforia2ual_j_alpha	β_N scan through modification of the entire pressure profile between 50% and 150% of the reference equilibrium from run 2 together with linear MHD stability analysis The scan is done in 10% steps. The 11 different cases are stored in time slices starting from 3.59s with 1.0s steps where scale_beta=0.5 is the first entry (e.g., scale_beta=1.0 is stored in time slice t=3.59s+5s=8.59s).
	13	equilibrium mhd	konz	euforia2ual_j_alpha	β_N scan through modification of the core pressure profile only between 50% and 150% of the reference equilibrium from run 2 together with linear MHD stability analysis The scan is done in 10% steps. The 11 different cases are stored in time slices starting from 3.59s with 1.0s steps where scale_beta=0.5 is the first entry (e.g., scale_beta=1.0 is stored in time slice t=3.59s+5s=8.59s).
23223	3	equilibrium mhd	konz	euforia2ual_j_alpha	j- α scan through modification of the pedestal height between 50% and 150% of the reference equilibrium together with linear MHD stability analysis The scan is done in 10% steps. The 121 different cases are stored in time slices starting from 5.325s with 1.0s steps where scale_p=0.5 and scale_j=0.5 is the first entry and scale_j is looped over faster (e.g., scale_p=0.6, scale_j=0.5 is stored in time slice t=5.325s+11s=16.325s).
	4	equilibrium mhd	konz	euforia2ual_j_alpha	j- α scan through modification of the pedestal width between 50% and 150% of the reference equilibrium together with linear MHD stability analysis The scan is done in 10% steps. The 121 different cases are stored in time slices starting from 5.325s with 1.0s steps where scale_p=0.5 and scale_j=0.5 is the first entry and scale_j is looped over faster (e.g., scale_p=0.6, scale_j=0.5 is stored in time slice t=5.325s+11s=16.325s).

5.4 TEST shots

The shots can be accessed by setting

```
TOKAMAKNAME = test
```

5.4.1 UAL Version 4.08a

The shots can be accessed by setting

```
UAL = 4.08a
```

The following table lists the shot by shot number and run number together with the list of stored CPOs, the user name of the data base, and a short description.

Shot	Run	CPOs	user	generated with	description
1	2	equilibrium	konz	progen_helena_analytic	simple circular ballooning unstable equilibrium, high resolution fixed boundary equilibrium in straight field line coordinates
	3	equilibrium mhd	konz	progen_helena_ilsa_analytic	same as run 2
	4	equilibrium	konz	jalpha_helena_analytic	j- α modified equilibrium based on run 2 (p_modulator%c_2=1.1, j_modulator%c_2=1.5)
	5	equilibrium mhd	konz	jalpha_helena_ilsa_analytic	same as run 4

last update: 2011-07-12 by konz

6 Meetings

6.1 2010/09/13-17 ITM General Meeting in Lisbon

6.1.1 Posters

- *Modelling of FAST equilibrium configurations by a Toroidal Multipolar Expansion code using Kepler workflows* (pdf [53]), by G. Calabrò et al.
- *The New ITM Website* (pdf [54]), by C. Konz et al.
- *Sawteeth and Neoclassical Tearing Modes Workflows* (ppt [55]), by O. Sauter et al.
- *Validation Procedure of the Tokamak Equilibrium Reconstruction Code EQUAL with a Scientific Workflow System* (pdf [56]), by W. Zwingmann et al.
- *Free Boundary Equilibrium Code CEDRES++* (pdf [57]), by J. Blum et al.
- *Status of MARS-F and CarMa codes on ITM* (ppt [58]), by D. Yadykin et al.

6.1.2 Code overview talks

- *Influence of a Non-Uniform Resistive Wall on the External Kink Modes in a Tokamak* (ppt [59]), by C.V. Atanasiu et al.
- *Update on FIXFREE and CREATE-NL* (ppt [60]), by G. Calabrò et al.
- *Magnetohydrodynamic Properties of Nominally Axisymmetric Systems with 3D Helical Core* (pdf [61]), by W.A. Cooper

6.1.3 Talks on infrastructure and tools

- *XML2EQ (YAXFI)* (ppt [62]), by E. Giovannozzi
- *Interpos - Generic Code Params - Numerical Fit* (pdf [63]) (ppt [64]), by O. Sauter
- *Fitting to Scattered Data* (ppt [65]), by W. Zwingmann and L.-G. Eriksson

---

last update: 2011-02-10 by konz

6.2 2010/11/08 Coupling of FBE and Transport Codes

6.2.1 Agenda

Time	Presentation
10:00h - 10:15h	”ETS workflow with free boundary code” David Coster
10:15h - 10:35h	”Coupling between CREATE-NL and JINTRAC” Florian Koechl
10:35h - 11:35h	”Lessons learned from developing, running, and validating DINA-CH, including coupling to CRONOS” Jo Lister, Karim Besseghir

[53] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Poster_Calabro.pdf
[54] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Poster_Konz_website.pdf
[55] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Poster_Sauter_OS_and_SN_final.ppt
[56] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Poster_Zwingmann_eps2010_v2_8.pdf
[57] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Poster_Blum.pdf
[58] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Poster_Yadykin.ppt
[59] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Talk_Atanasiu_2.ppt
[60] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Talk_Calabro.ppt
[61] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Talk_Cooper_icpp2010_pres.pdf
[62] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Talk_Giovannozzi_XML2EG.ppt
[63] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Talk_Sauter_numerical_tools.pdf
[64] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Talk_Sauter_numerical_tools.ppt
[65] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20100913-17_Lisbon/Talk_Zwingmann_fife-fitting_gs04.ppt

Time	Presentation
11:35h - 12:00h	"CEDRES++" Cédric Boulbe
12:00h - 12:30h	"EQUAL in predictive mode" Wolfgang Zwingmann
12:30h - 14:00h	lunch break
14:00h - 17:00h	open discussion

6.2.2 Presentations

- *ETS - Free Boundary Equilibrium* (ppt [66]), by D. Coster
- *Movie: Psi evolution (shot 5 run 42)* (mpg [67]), by D. Coster
- *Movie: Ne/Te/q evolution (shot 5 run 42)* (mpg [68]), by D. Coster
- *Coupling between CREATE-NL and JINTRAC* (ppt [69]), by F. Koechl
- *DINA-CH full tokamak simulator* (pdf [70]), by J. Lister and K. Besseghir
- *Movie: DINA plasma boundary* (mpg [71]), by J. Lister and K. Besseghir
- *Free boundary equilibrium code CEDRES++* (pdf [72]), by J. Blum et al.
- *Movie: CEDRES++ isoflux* (mpg [73]), by J. Blum et al.
- *EQUAL in predictive mode* (ppt [74]), by W. Zwingmann

6.2.3 Additional Material

- *Minutes of the meeting* (pdf [75]), by C. Konz
- *DINA-CH workflow* (pdf [76]), by K. Besseghir
- *DINA-CH and CRONOS: Full tokamak discharge simulator* (pdf [77]), by S. H. Kim

---

last update: 2011-02-10 by konz

6.3 19-30 March 2012. Garching Code Camp

---

last update: 2012-02-08 by egiovan

7 Outreach

With the modules in IMP12 coming to a mature level, the project is starting outreach collaborations to promote the use of the ITM tools within EFDA.
A small list of existing outreach collaborations is given below. This list is not necessarily complete but should protocol the ongoing efforts to exploit ITM tools.

[66] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/ETS-FBE.ppt
[67] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/psi_5_42.mpg
[68] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/comb_psi_5_42.900x400.mpg
[69] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/Koechl_Coupling_between_CREATE-NL_and_JINTRAC.ppt
[70] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/FullTokamakSolvers_20101108_v2.pdf
[71] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/frontiere_DINA.mpg
[72] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/Cedres.pdf
[73] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/isoflux_ITER_T53000_5ms.mpg
[74] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/equal_pred_wz04.ppt
[75] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/Minutes_FBE_Transport_2010.pdf
[76] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/DINA-CH_workflow-Favez.pdf
[77] https://www.efda-itm.eu/ITM/imports/imp12/public/meetings/20101108_fbe_transport/DINA-CH_and_CRONOS_working_scheme_and_equations-Kim.pdf

7.1 Linear MHD Stability Chain at JET

The aim of this effort is to benchmark and verify the ITM modules HELENA and ILSA against the versions of HELENA and MISHKA_1 currently used at JET for linear MHD stability calculations. Replacing the JET tools by the corresponding ITM tools may be considered.

- **Main project contact:** Christian Perez von Thun
- **ITM Contact:** Christian Konz
- **Start Date:** 03/2010
- **Steps completed so far:**
  - Mapping from JET EFIT equilibrium reconstruction to ITM HELENA equilibrium CPO input
- **Current stage:** testing of ITM linear MHD stability workflow (4.2.5.3) using JET mapped data

7.2 EQUINOX at Tore Supra

The aim of this effort is to run the ITM tool EQUINOX on Tore Supra data.

- **Main project contact:** Didier Mazon
- **ITM Contact:** Blaise Faugeras
- **Start Date:** 12/2010
- **Steps completed so far:**
  - initial contact
- **Current stage:** project start

7.3 EQUAL at Tore Supra

The aim of this effort is to run the ITM tool EQUAL for intershot equilibrium reconstruction on Tore Supra.

- **Main project contact:** Fréderic Imbeaux
- **ITM Contact:** Wolfgang Zwingmann
- **Start Date:** 12/2010
- **Steps completed so far:**
  - initial contact
- **Current stage:** project start

7.4 Interfacing the Fixfree code to ETS

The aim of this effort is to use the Fixfree as a Free-Boundary code to be interfaced to the ETS transport solver

- **Main project contact:** Roberto Paccagnella
- **ITM Contact:** Edmondo Giovannozi
- **Start Date:** 4/2011

- **Steps completed so far:**
  - initial contact
- **Current stage:** project start

---

last update: 2011-04-15 by rpaccagn

8 Private IMP12 pages

To access the private IMP12 pages [78], an IMP12 password is needed.

---

last update: 2012-01-22 by yadykin

[78] https://www.efda-itm.eu/IMP12/html/index.html