Final ADAS-EU Meeting; some introductory remarks

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Outline

- *A few remarks on the ADAS-EU project*
- *ADAS-EU contribution to the Integrated Tokamak Modelling Task Force (ITM-TF)*
- *Organisation of the EU fusion progrmme (outiside ITER) in Horizon 2020*
- *Conclusions*

A few words on the ADAS-EU project

- *The ADAS project, which has its origin at the JET Joint Undertaking and has grown to a project with global reach, was identified as an important support activity for the Fusion Programme in FP7.*

- *As a result, the Commission decided to contribute to the funding by awarding a "Coordination on and Support action" (an FP7 funding instrument) to the ADAS-EU project.*

- *Originally the CSA covered the period 2009 to 2012, but the end date was extended to 30/09/2013 by an amendment in 2012.*

- *The CSA was awarded to the University of Strathclyde, with Prof Hugh Summers as the Coordinator of the project.*

- *There was also four lead Associated EU labs linked to ADAS-EU*
  - **CCFE Cuham**
  - **CEA Cadarache**
  - **IPP Garching/Greifswald**
  - **TEC Juelich**

- *The objectives of the project included:*
  - support for efficient implementation of atomic data in:
    - diagnostics,
    - Modelling,
      - Transport,
      - Plasma wall interaction,
      - Heating and current drive,

    throughout European laboratories and in ITER
  - Management of databases
  - A number of science related objectives (see next slide)
  - Strong interaction with EFDA-JET and ITER was foreseen.

There were five main science themes in the ADAS-EU plan:

1. **Heavy element spectroscopy and models,**
2. **Charge exchange spectroscopy,**
3. **Beam stopping and emission,**
4. **Special features,**
5. **Diatomic spectra and collissional radiative models.**

The project objectives were largely to be achieved by:

- **Placement of staff in selected EU fusion laboratories**
- **Staff visits to EU fusion labs to interact with local programmes,**
- **Training courses in ADAS data techniques and modelling,**
- **A website (http://www.adas-fusion.eu).**

The CSA has allowed ADAS-EU to fund:

- **Six part-time ADAS-EU personnel (corresponding to almost 3 fulltime professionals per year),**
- **mission costs,**
- **subcontracts to a number of EU universities,**
- **IT equipment, software etc.,**
- **administration and logistics.**

- *The ADAS-EU project has involved 36 Work Packages,*
- *It has been monitored in terms of:*
  - **24 deliverables (all have been received, but some updates expected)**
  - **30 milestones (2/3 reached 31/12/12).**

- *The scientific achievements of ADAS-EU will not be discussed in this presentation.*
- *Nevertheless, it clear that ADAS-EU project has made substantial progress, not least for modelling of tungsten ions, which of course is very significant for JET with the ILW and for ITER.*
- *On a personal note I would like to say that I had very positive interaction with ADAS-EU (especially Hugh Summers and Martin O'Mullane) during my time as deputy leader of the ITM task force.*

A few words on integration of ADAS data into the ITM-TF* framework

ITM-TF philosophy and approach

Comprehensive integrated tokamak modelling:

- ✓ infrastructure describing both **the tokamak physics** and **the machine within a unique framework**
- ✓ strategy**:** divide the global problem into Elementary Physics Problems (equilibrium, transport, MHD, sources, diagnostic response, …)

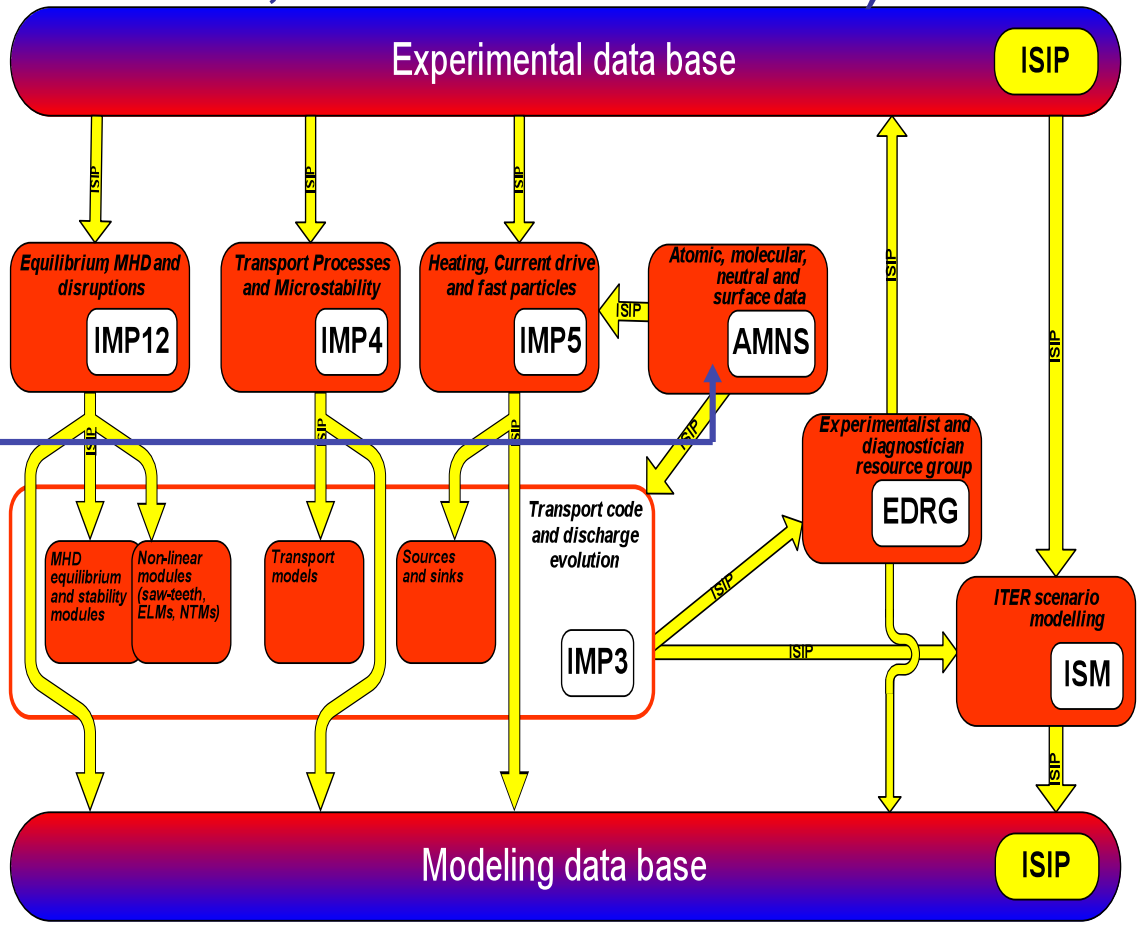
*TF Leaders: G Falchetto, D. Coster and R. Coelho
http://portal.efda-itm.eu/itm/portal/

- ✓ fully modular and flexible simulation platform
- ✓ standardized interfaces for physics and technology
  - ➢ Consistent Physical Objects (CPO)
  - ➢ This includes to atomic data
- ✓ completely generic workflow
- ✓ Verification and validation of codes and workflows should be an integral part of the process
  - ✓ **Version control of all codes and data (including atomic) going into simulations is therefore essential**

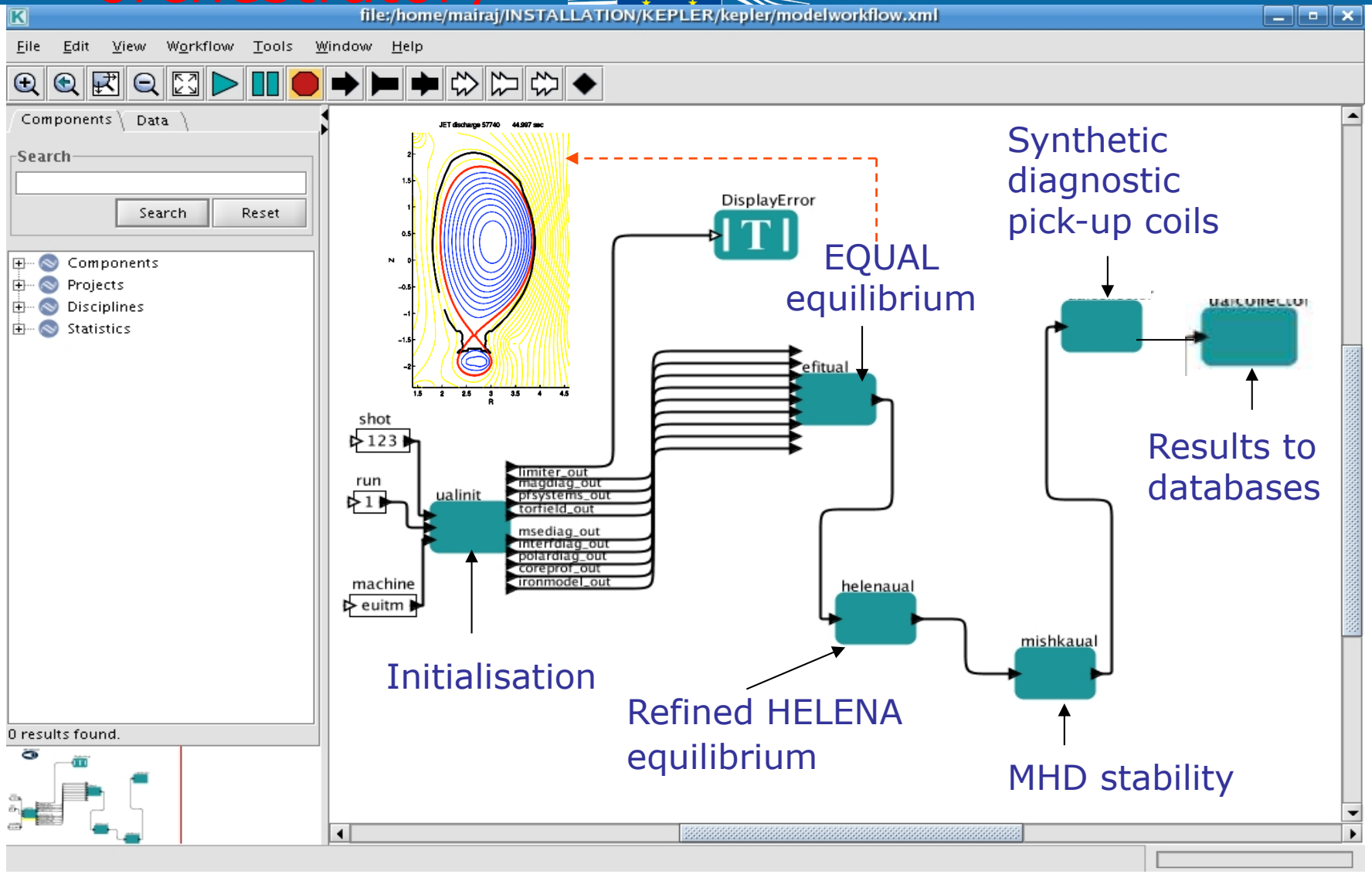
Schematic view of ITM-TF interlinking between models and AMNS (Atomic, Molecular, Nuclear Surface) data

Data from the ADAS database are read into an ITM database (AMNS) for standardised delivery to different ITM codes.

ITM-TF uses ADAS atomic data
e.g. for Transport and Heating & Current Drive modelling

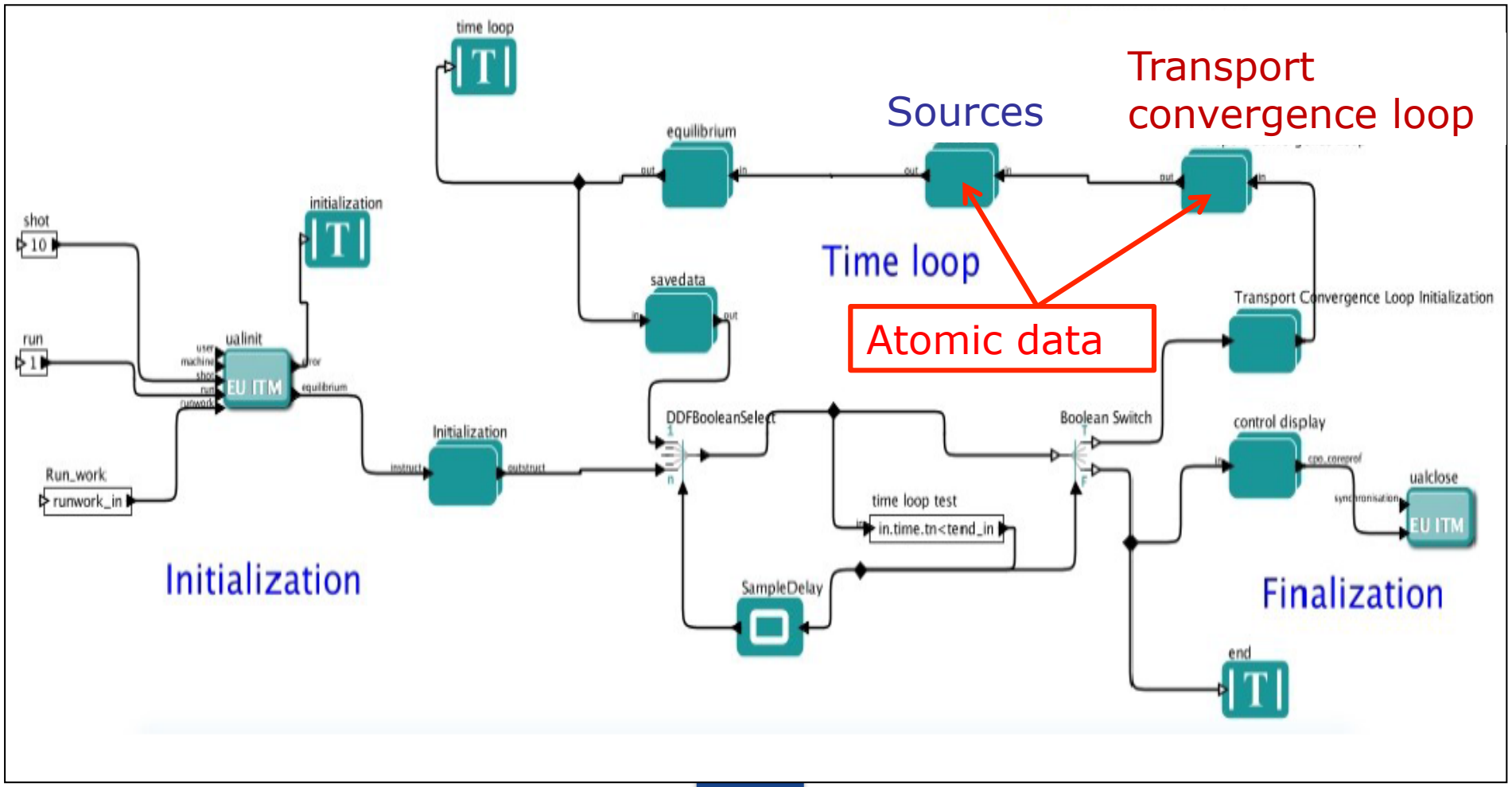


Kepler platform (workflow orchestrator)

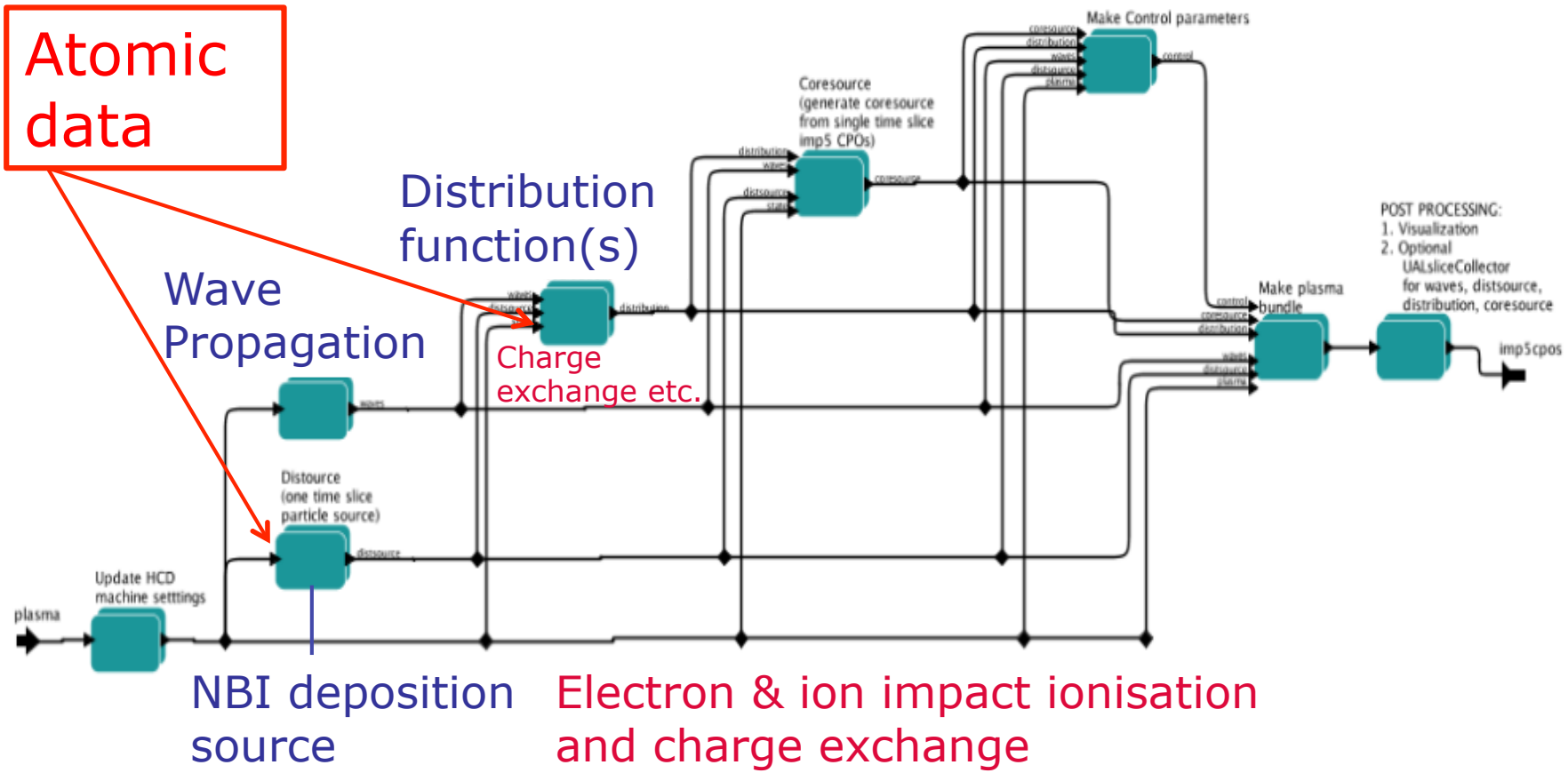


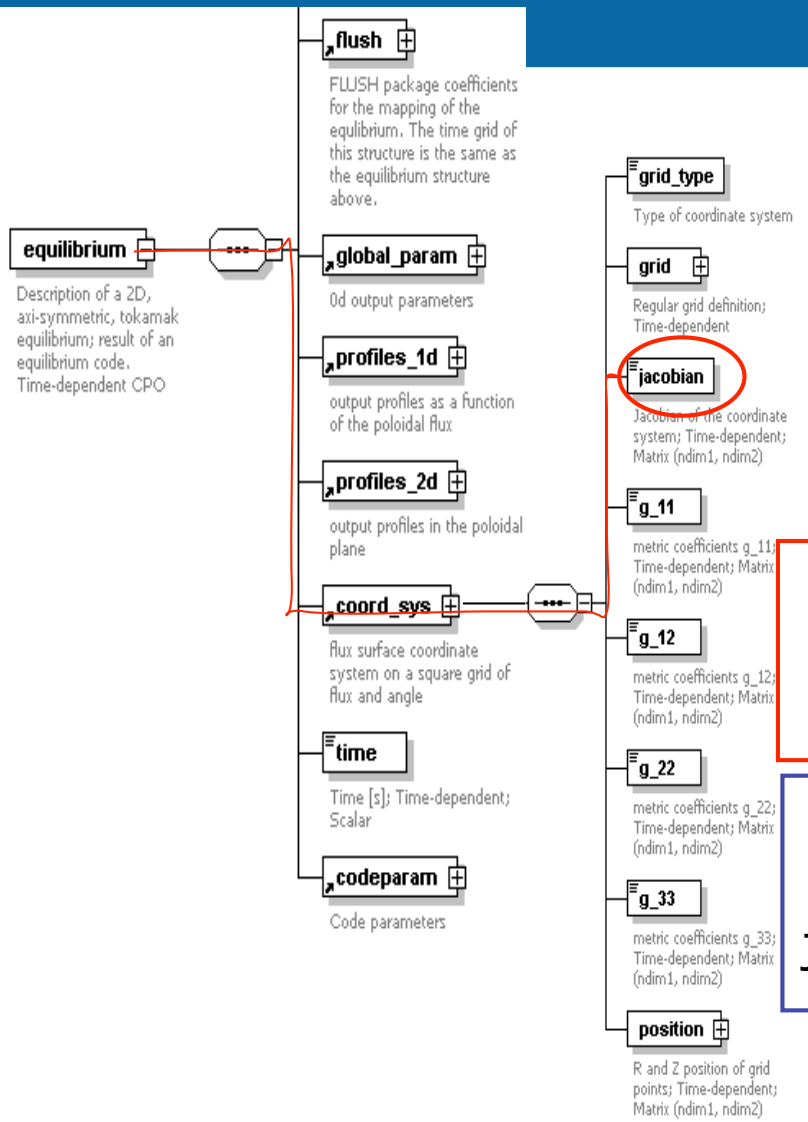
Data, in the form of CPOs, are transported between codes and finally stored by a dedicated software called the Universal Access Layer (UAL)

ETS (core transport) workflow



Auxiliary heating sources workflow





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Equilibrium data structure

Jacobian at gridpoint (5,6). In Fortran 90, matlab and C++ we simply write:

Fortran 90:

```
jac = equlibrium(1)%coord_sys%jacobian(5,6)
```

Matlab

```
jac = equlibrium(1).coord_sys.jacobian(5,6)
```

C++:

```
jac = itm._equilibriumArray.array(1).coord_sys.jacobian(5,6)
```

Purpose and principles of the AMNS project* within the ITM-TF

- Provide the ITM-TF with Atomic, Molecular, Nuclear and Surface (AMNS) data from appropriate sources.
- Develop modules which deliver AMNS data in a standardised way to ITM-TF codes.
- The system must be such that the provenance of the data used for a particular simulation is recorded to ensure that a simulation can be exactly replicated at a later date.

*Leader D. Coster

- *A key feature of the ITM-TF is the use of special data structures to communicate data between codes in a consistent manner (these are called CPOs)*
- *The simulation platform is adapted to CPOs and there is special software to communicate CPOs to the ITM database: the UAL (Universal Access Layer)*
- *It was therefore natural to also store AMNS data in the form of ITM data structures*

AMNS data structure released in the 4.08 version of the ITM data structures

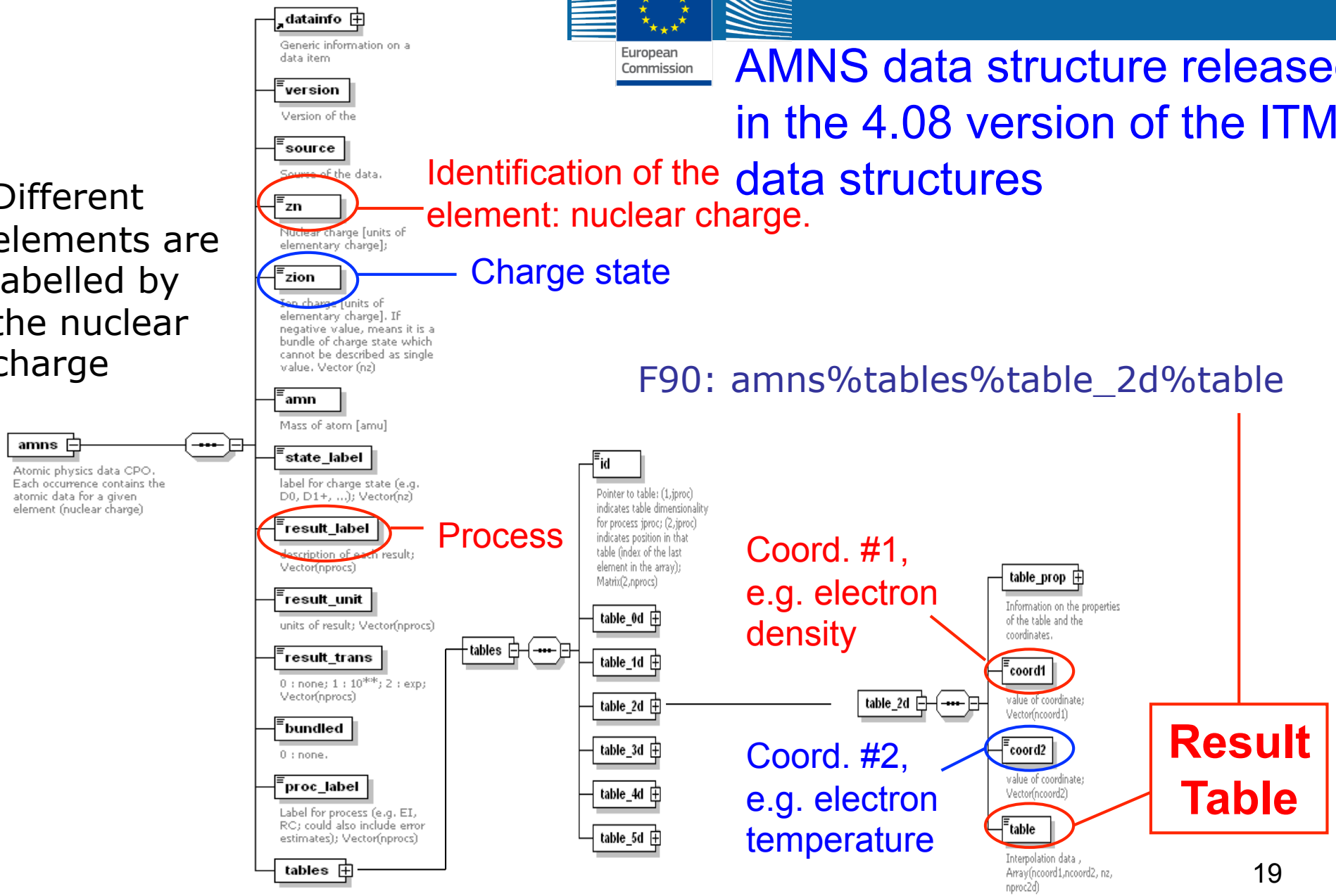
Different elements are labelled by the nuclear charge

Identification of the element: nuclear charge.

Charge state

Process

F90: amns%tables%table_2d%table



Coord. #1, e.g. electron density

Coord. #2, e.g. electron temperature

Result Table

ADAS involvement in ITM

- *Supplying data (obviously)*
- *Contributed to the development software for transferring data from the ADAS data base to the ITM database and storage of atomic data in the amns data structure.*
- *Contributed to routines for retrieving AMNS data from the ITM data base in a standardised fashion*

ADAS data currently used in ITM-TF

Release 11 [DEFAULT]

Data for H • Data for 2-H • Data for 3-H • Data for He • Data for 3-He • Data for Li • Data for Be • Data for B • Data for C • Data for N • Data for O • Data for F • Data for Ne • Data for Al • Data for Si • Data for S • Data for Cl • Data for Ar • Data for Cr • Data for Fe • Data for Ni • Data for Cu • Data for Ge • Data for Kr • Data for Mo • Data for Xe • Data for W

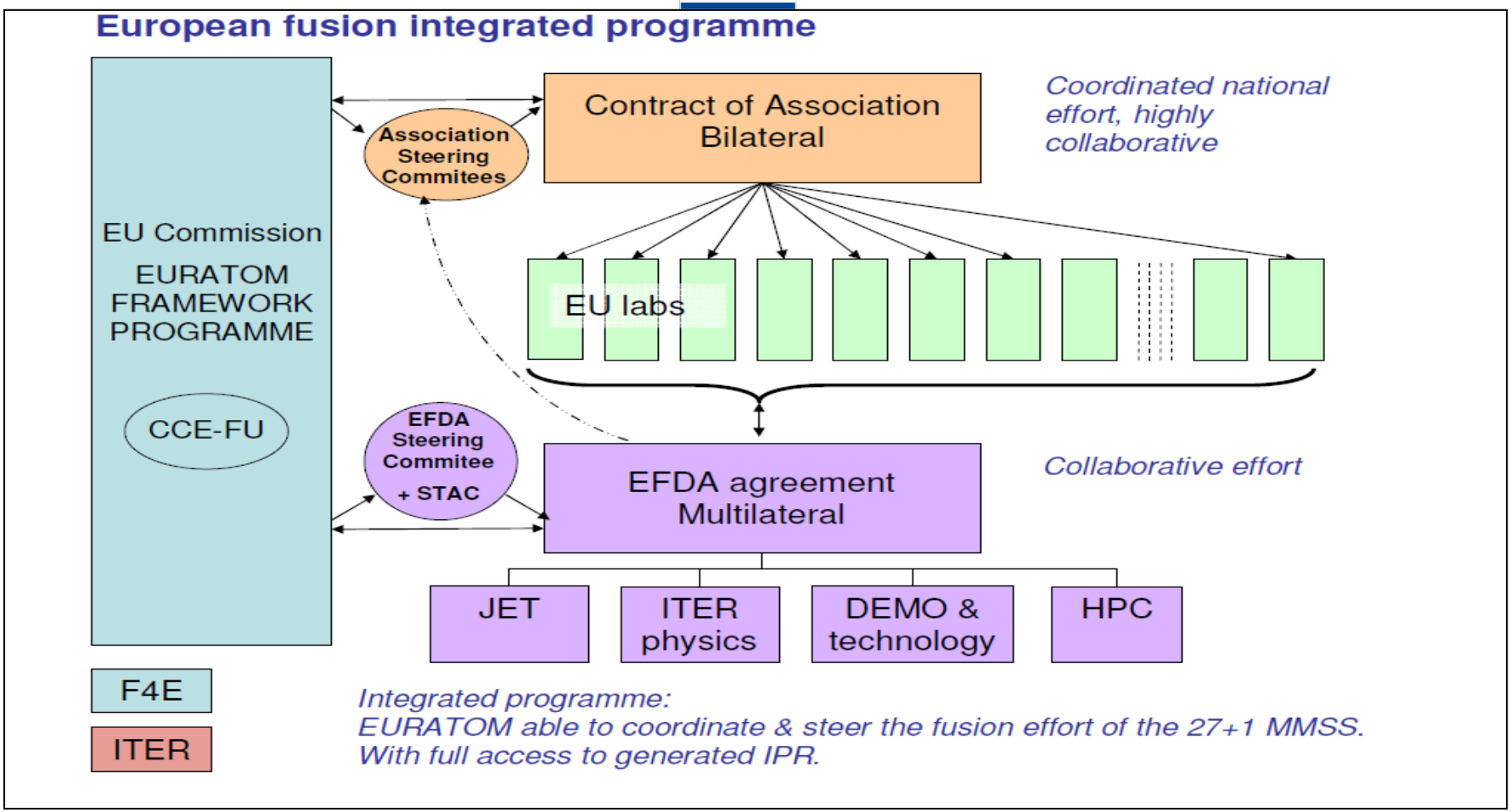
For H: (i) Recombination; (ii) Electron Impact Ionisation; (iii) CX recombination coeffts; (iv) Recomb/brems power coeffts; (v) Line radiation; (vi) Effective Charge; (vii) Effective Square Charge; (viii) Effective Ionisation Potential; (iX) Total Elastic Cross-Section; (x) Differential Elastic Cross-Section

Conclusion ADAS data have been well integrated into the ITM-TF framework

EU fusion programme outside ITER

Current organisation (FP7)

- *The European Commission (Euratom)*
  - Overall programme management (including funding), representation of the programme internationally (fusion co-operation Agreements)
- *Euratom Fusion Associations*
  - 26 bilateral "Contracts of Association" between Euratom and EU member states' fusion institutions (plus Switzerland)
- *EFDA (The European Fusion Development Agreement)*
  - An agreement between all the Associations and Euratom to support co-ordinated and collective activities



- *JET is linked to EFDA and operated under a bilateral contract, JOC, between the Commission and CCFE*

Structure of the Programme in Horizon 2020

- *The organisation of the EU fusion programme outside ITER will be radically restructured in Horizon 2020.*
- *The key aim is to make effective progress along the EFDA roadmap* while retaining the unity of the overall effort and the strengths of the current structure.*
- *The plan is to confer the implementation of the whole programme to a single Consortium made up of interested national fusion research institutions, with one national lab acting as a Consortium coordinator.*

*http://www.efda.org/wpcms/wp-content/uploads/2013/01/JG12.356-web.pdf

- *The Community funding of the Consortium should be via a so-called co-fund grant (a new Horizon 2020 funding instrument), i.e. the joint programming activities of the Consortium Members will be co-funded by the Community.*
- *JET is still planned to be operated under a bilateral contract between the Commission and CCFE in Horizon 2020.*
- *The scientific exploitation of JET will be entrusted to the consortium.*

- *As a result, the Commission will in Horizon 2020 have a much lesser role in the actual implementation of the fusion programme.*
- *It is in this context one must see how ADAS fits into the EU fusion programme in the future.*
- *The first port of call for discussions of how ADAS can continue to be well integrated to the EU fusion programme should be with the Consortium.*
- *The interim Programme Manager of the Consortium is Francesco Romanelli and meetings on the formation of the Consortium are chaired by Sibylle Günter.*

Conclusion

- *The ADAS-EU project has delivered on its objectives (scientifically, dispersal of knowledge, management of databases etc.).*
- *It is in the interest of fusion research that the built-up experience can be maintained.*
- *In the new structure of the EU fusion programme in Horizon 2020, the implementation of the fusion programme will be entrusted to a Consortium of EU fusion research institutions.*
- *It is principally this context one should consider the future of ADAS in the EU fusion programme.*