
# ESO Reflex

## A graphical workflow engine for running recipes

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# Outline

- The ESO data reduction context
- The Sampo project
- ESO Reflex overview
- ESO Reflex in action
- Future plans

# The Data Reduction Challenge

- As the volume and complexity of astronomical data increase, astronomers are faced with the challenge of a timely and accurate reduction of their own data.

- Archival research, data mining and Virtual Observatories allow easy access to a vast amounts of diverse data, an in-depth knowledge of which may be challenging for the average user.

- Two possible (and non conflicting) approaches:
  - Provide the user with reduced data
  - Provide the user with a (powerful, flexible and user-friendly) data reduction system

# Reduced data at ESO

- QC processing of all pipeline-supported modes for VLT/VLTI Service Mode stream (virtually 100% of the data volume). These data are distributed to Pis.
- Similarly for HARPS and FEROS on La Silla and APEX.
- Advanced Data Products for selected datasets (eg, GOODS IR imaging and optical spectroscopy) are produced at ESO and ingested in the archive.
- Advanced Data Products are returned to ESO from the community (eg, Public Surveys, Large Programmes, etc.) and ingested in the archive.

# Data reduction by individual users: the context

- ESO provides pipeline “recipes” for all VLT instruments
- They remove the instrumental signature and are used for quality control at ESO and distributed to the community
- All newer recipes are compiled C code using the CPL library and tools to run them offline are available (Gasgano and EsoRex)
- Many older general purpose reduction and analysis systems remain in wide use (MIDAS/IRAF etc)
- Many instrument-specific packages have been developed in the community (eg, Euro3D tools)
- Future developments will lead to enhanced data complexity

So - what is the best way forward for ESO in this area?

# Sampo - background and organisation

- As part of Finland's joining fee a contribution "in kind" of 6 people for three years (18 FTE) was made available. Sampo started in January 2005.
- Aim: to assess the requirements for ESO data reduction and analysis software **infrastructure** over the next decade and beyond and perform a series of to assess different options and produce useful tools.

- Project Organisation:
  - Project Manager: Richard Hook (ESO/ST-ECF/DMD)
  - Project Scientist: Martino Romaniello (since January 2006)
  - Project Team (Finland):
    - Finnish National Coordinator (Ville Savolainen, CSC, 50%)
    - VO Specialist (Johan Lindroos, CSC)
    - Software Engineer (Pekka Jarvelainen,CSC, 50%)
    - System Architect (Marko Ullgren, Helsinki Observatory)
    - Two Software Engineers (Sami Maisala, Tero Oittinen, Helsinki Observatory)
    - One Consultant (Otto, Solin, Space Systems Finland)

- Project Oversight:
  - A Finnish Astronomical Advisory Group (FAAG) chaired by Juhani Huovelin.
  - An ESO Science Advisory Committee (SAC), chaired by the Project Scientist, representing the ESO Faculty.

# Data reduction by individual users: the Sampo approach

- A data reduction system for the end user requires:
  - Modular recipes to provide access to intermediate products
  - Interactive tools, defined or customized by the user, to analyze intermediate and final data products
  - A user-friendly, intuitive and flexible interface

- Sampo, and specifically the ESO Reflex tool, tries to address the interface issue, with a focus on the use case of ESO data:
  - Common front-end interface to cope with the potentially large number of ESO instruments in a uniform and maintainable way (à la p2pp)
  - General invoker for CPL-based recipes
  - General invoker for Python scripts (hence PyRAF & PyMidas)

# ESO Reflex? Taverna?

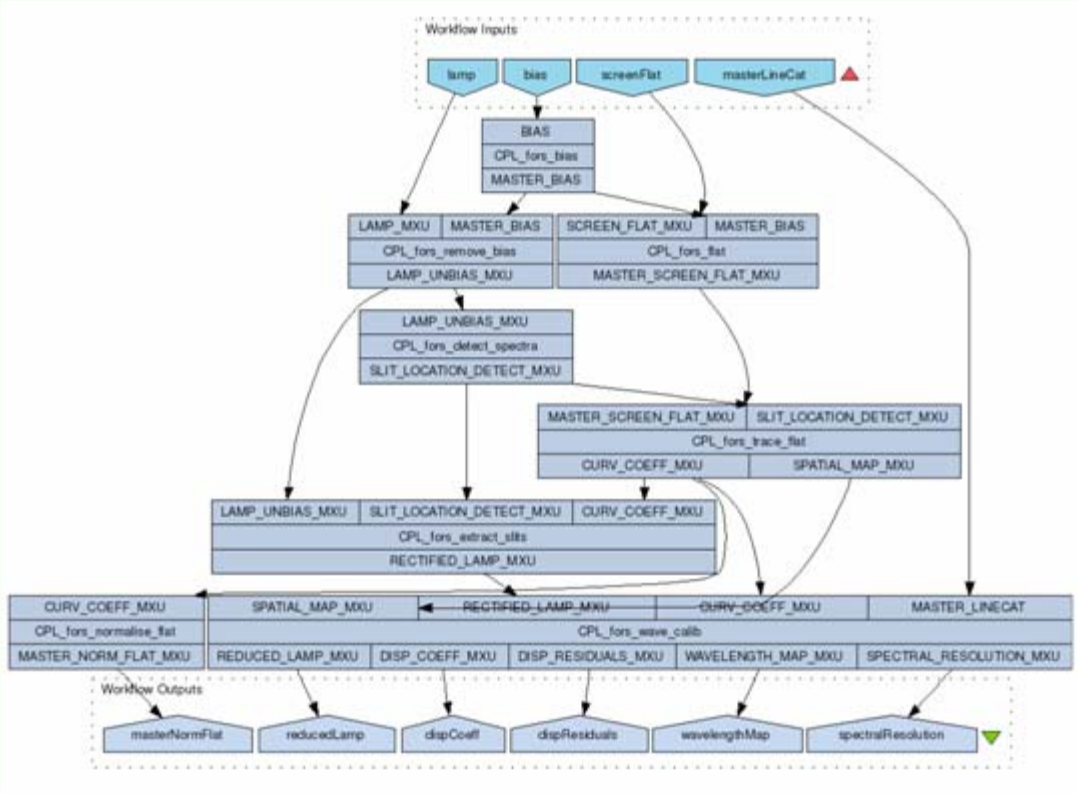
- ESO Reflex is a graphical ***workflow engine*** for executing CPL Recipes and other tools□
  - not instrument specific
  - easy inclusion of external tools and scripts
  - allows user interaction during execution
- ESO Reflex is based on Taverna
  - an open source Java workflow system developed for the molecular biology community in the UK
  - easy to use and adapt
  - suitable for science (rather than business applications)
- ESO Reflex is a pilot project to assess in detail the concept

# From Taverna to ESO Reflex

- The Sampo project has developed Taverna further
  - to allow the execution of  CPL Recipes
    - the recipe invocation mechanism
  - to ease the running of astronomical workflows
    - a completely new graphical user interface for launching the workflows
    - FITS file handling functionality
      - data classification
      - FITS viewing
  - to allow the incorporation of external tools
    - Python invoking mechanism, DS9, FV, Plastic...
    - also Web services (e.g. VO) at some stage

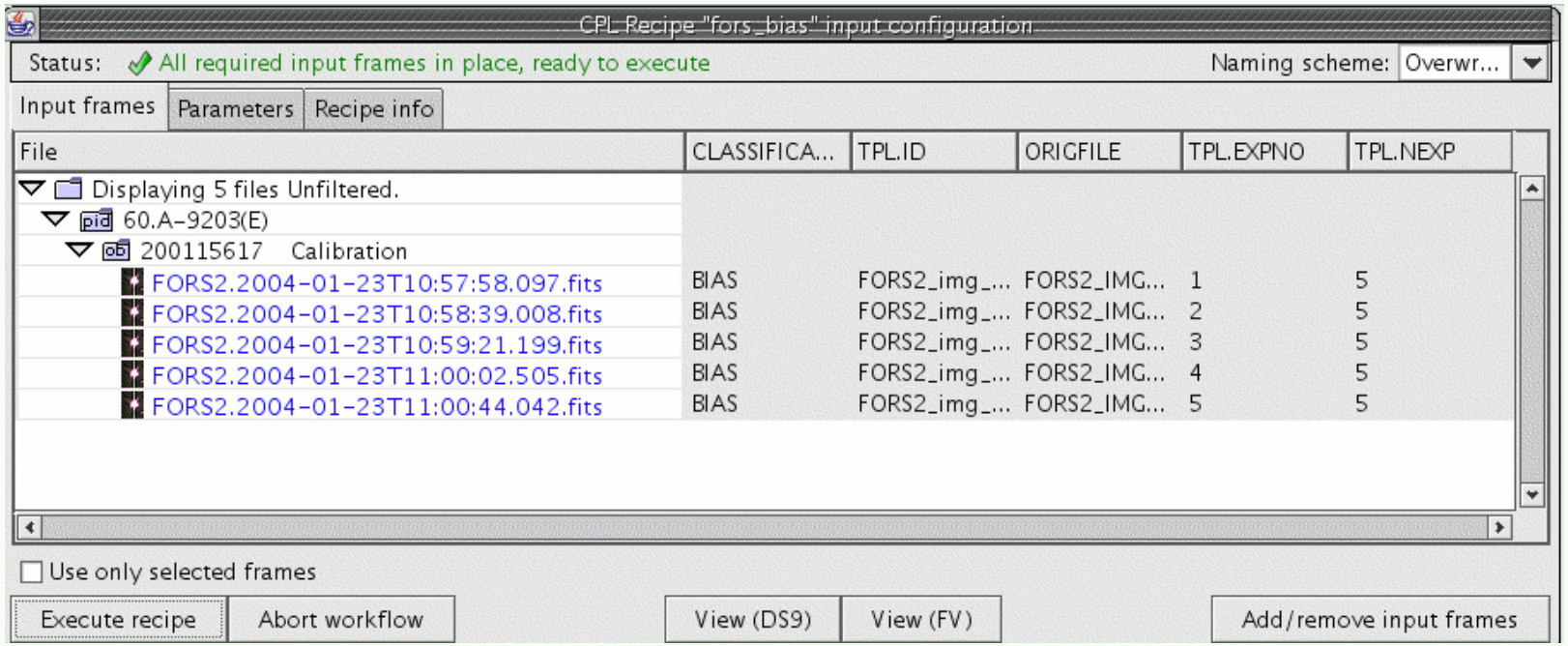
# Advantages of Reflex: The Workflow Approach

- Modular sub-recipes are run in a sequence



# Advantages of Reflex: Step-by-step execution

- In interactive mode the user can make changes to input data and parameters during execution



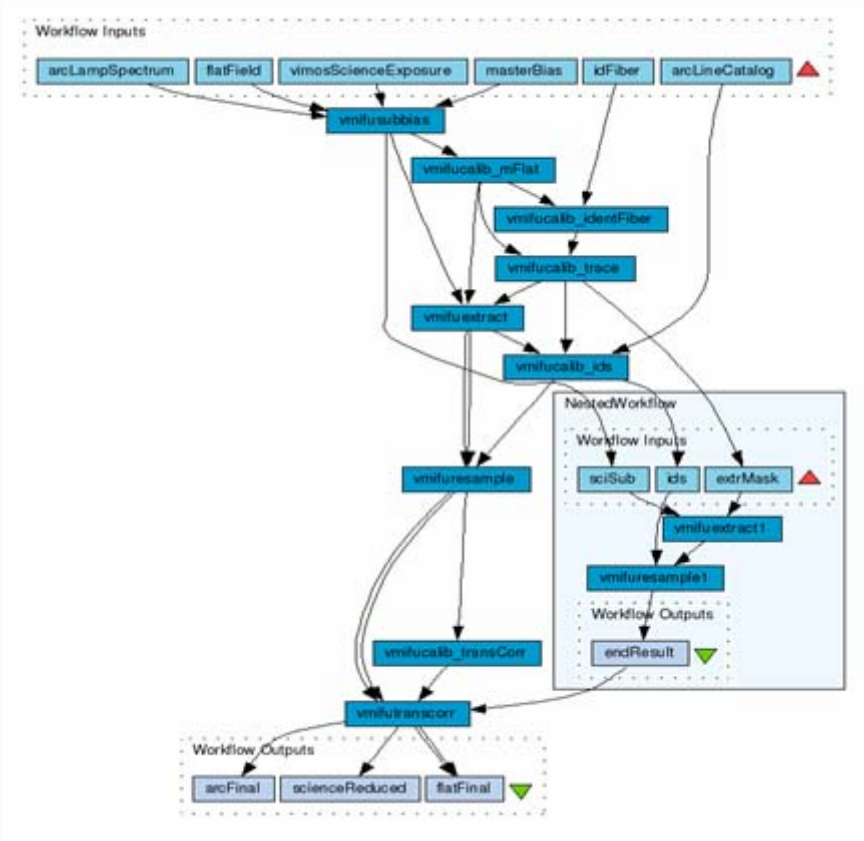
# Advantages of Reflex: Error detection and recovery

- Errors on during recipe execution are detected by Reflex


- Appropriate action can be taken by the user

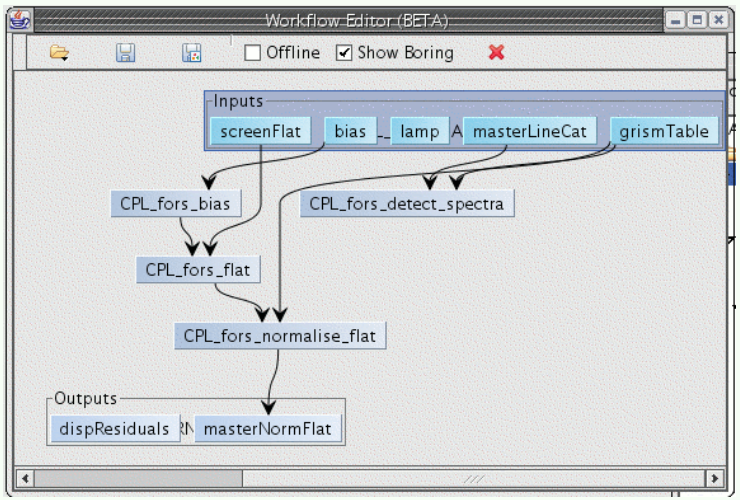
# Advantages of Reflex: Parallel Execution

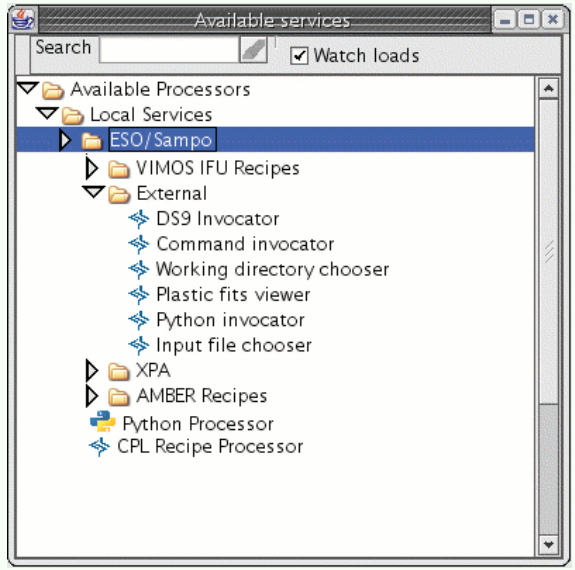
- The recipes on a parallel workflow execute in parallel
- Full advantage on multi-processor or multi-core machines



# Advantages of Reflex: Customisability

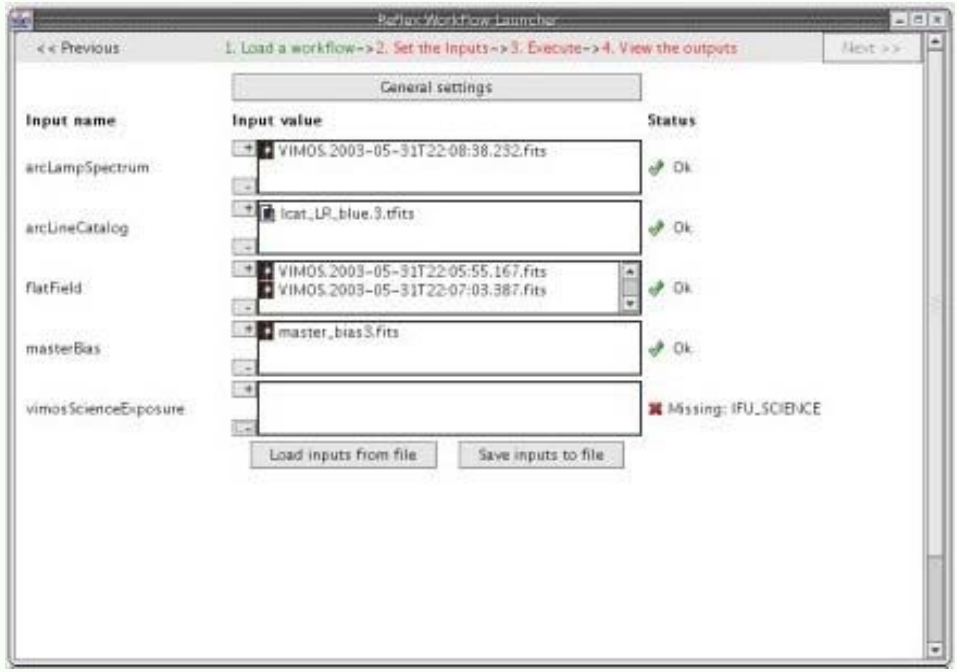
- The user can easily modify the workflows
- Python scripts can be included in the workflows
- Any system command can also be invoked from the workflows

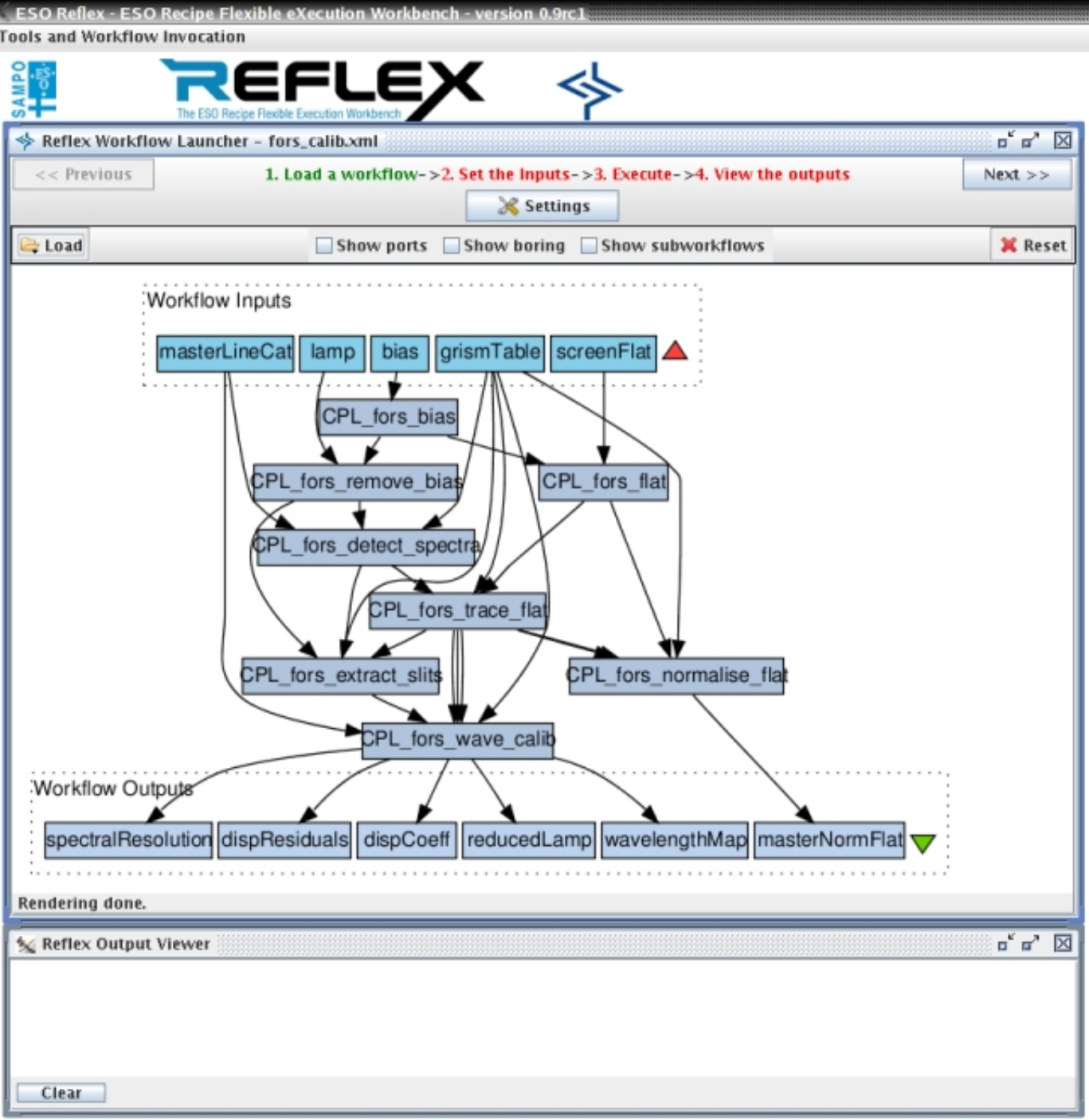


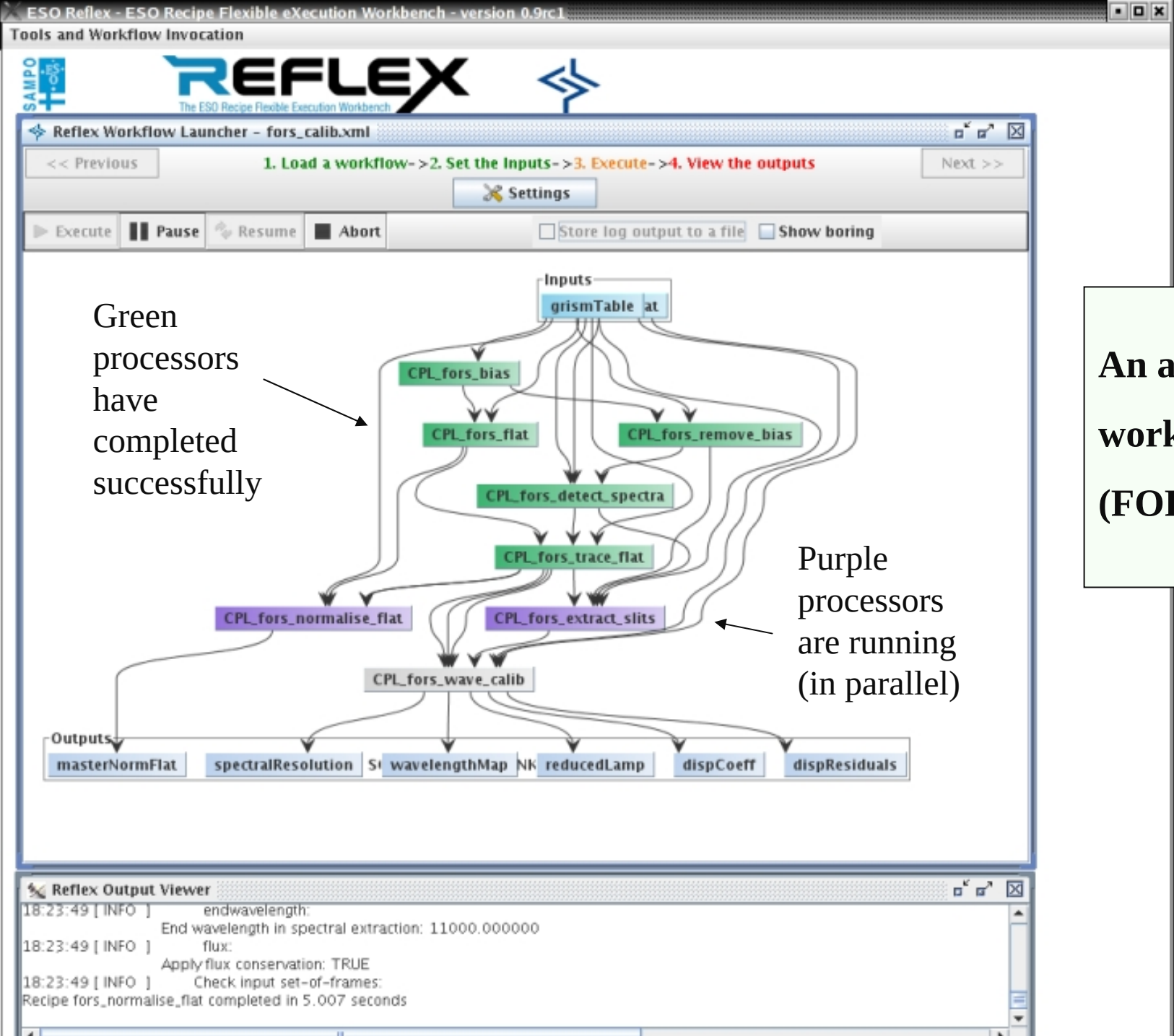
# Advantages of Reflex: FITS-file handling (using Gasgano code)

- The instrument-specific *tags* of the FITS-files are automatically extracted from the FITS-headers
- Tag-checking: only compatible FITS-files are allowed in inputs






**An example workflow - FORS/MXU calibration**




Green processors have completed successfully

Purple processors are running (in parallel)

**An active workflow (FORS/MXU)**

# Current and Future Activities

- ESO Reflex is just being released to beta testers for a more detailed assessment
  - The release includes FORS/MXU and AMBER recipes
  - Interactive tools, featuring complex Python-based GUIs, are also included
- Based on the users's feedback ESO will decide the future course of action.