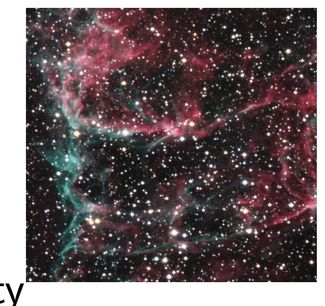
THELI - A pipeline for UV to mid-IR imaging data reduction

Mischa Schirmer[1], Thomas Erben[2]

[1]Isaac Newton Group of Telescopes, [2]Argelander Institute for Astronomy, Bonn University



THELI was initially developped for the reduction of the 20 square degree Garching-Bonn Deep Survey, conducted with the Wide Field Imager at the 2.2m MPG/ESO telescope in La Silla.

We collected available stand-alone software packages such as *SExtractor*, *Swarp*, *WIFIX*, *Eclipse* etc, wrapped them into shell scripts and wrote interfaces so that the various modules would allow for a continuous data flow. Most of these packages were slightly modified to better suit our purposes, of others (e.g. *Eclipse*) we took only basic functionality or ideas and developed own programmes. The code is mostly based on C/C++, and runs in principle on any up-to-date UNIX/Linux machines. Parallelisation is fully supported for multi-core CPUs and for cluster architectures.

THELI has many advantages, amongst others:

- It is entirely instrument-independent. All camera-specific parametres are contained in an instrument configuration file. The reduction steps are very similar, independent of what kind of data one reduces. In particular, this extends from optical to mid-IR wavelengths, and from single- to multi-chip instruments.
- It is fully parallelised. On multi-processor PCs the user only selects the number of CPUs he wants to use, where ideally one CPU is selected per CCD for a multi-chip instrument.
- A fully documented graphical user interface is available, which allows easy access to all parametres and functions. It makes the reduction process very convenient and preserves full transparency. Yet, *THELI* wants to be learnt as any other reduction software.
- The modular principle of *THELI* allows us to quickly include new routines or to implement improvements suggested by the end user.

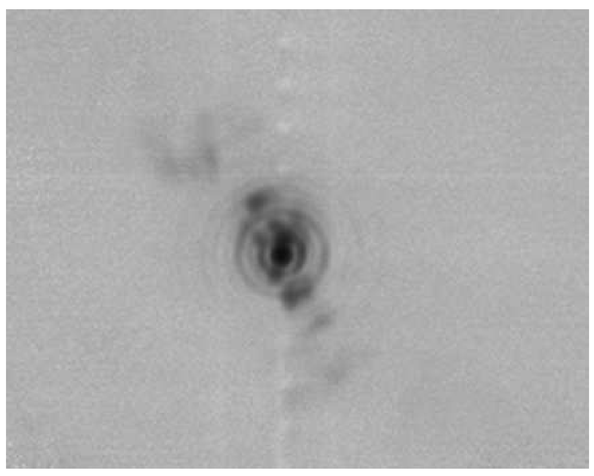


Fig. 1: Core of the starburst galaxy NGC 1068, as seen with VISIR in NeII (12.8μm). The nucleus is stellar and shows diffraction rings (ESO archive; PI Lagage, VISIR commissioning).

The development of *THELI* was based on WFI@2.2m MPG/ESO data, hence all code is already generalised for the particular structure of multi-chip camera data. Major differences in the reduction of different data types appear only at a higher level, for example in the choice of optimal parametres or strategies for sky background modelling.
The *THELI* GUI takes this into account, having all parametres not more than a mouse-click away, and by offering various methods for a particular task. In this way *THELI* could be extended to the near-IR, delivering as good or even better results than with other standard reduction packages. Recently, *THELI* has seen a very successful extension to the mid-IR based on VISIR data sets.

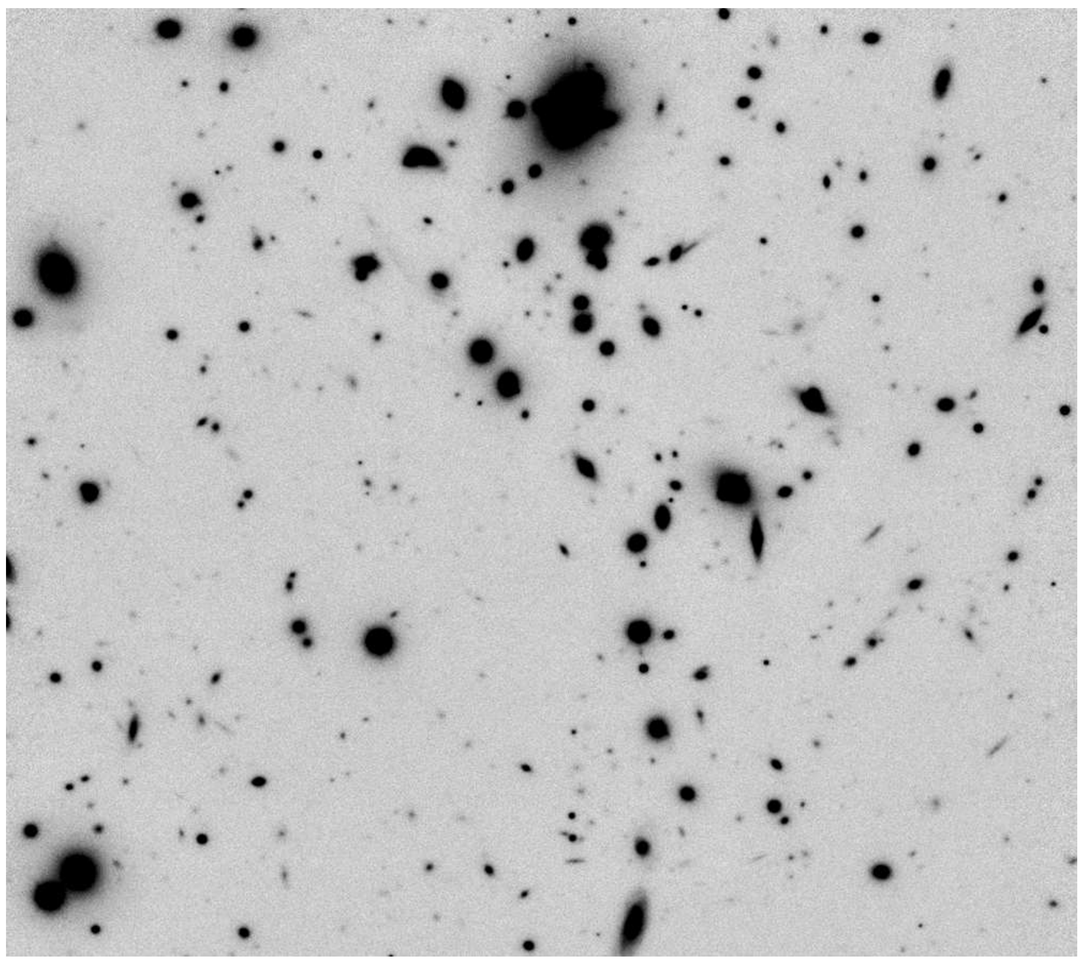


Fig. 2: An 11 ksec ISAAC J-band image of the lensing cluster Abell 1835 (ESO archive; PI: Pelló, high-z lensed galaxies).

Fig. 3: Deep exposure of the central region of the dwarf galaxy NGC 300, taken in BVR and Hα with WFI@2.2m MPG/ESO. Exposure times in these filters were 40, 38, 15, 18 ksec, respectively, totalling in 277 exposures taken in 36 different nights (ESO archive; PI: Gieren, the ARAUCARIA cepheid project)

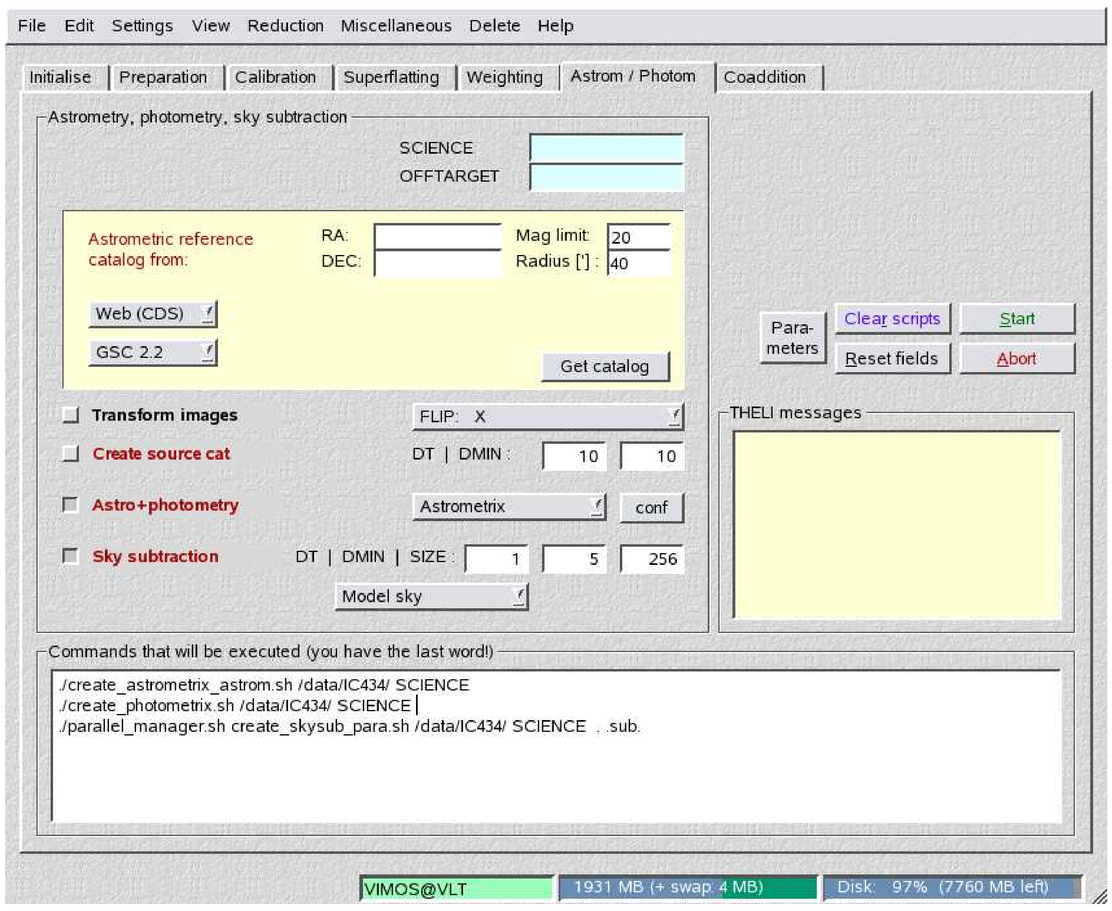


Fig. 4: The graphical user interface for THELI. The user simply marks the tasks he wants to execute, and then clicks the *Start* button.

Apart from the already mentioned general features, *THELI* offers much more such as

- Static and dynamic superflats (= sky models in the IR), full support of chop-nod techniques and blank sky fields, everything fully configurable
- Various sky background subtraction methods: modelling, constant estimates, estimates from a particular chip representative for the mosaic, etc
- Full astrometric correction for mosaics, including de-rotation and distortion correction, based on automatically created object catalogues. Registration better than 1/10th of a pixel. Works on very sparse and very crowded fields, using *Astrometrix* or *Scamp*; relative flux scaling included
- Statistically optimised weighted coaddition, using different resampling kernels. Coadded mosaiced images have a global astrometric solution and the same photometric zeropoint for all pixels
- Full documentation with step-by-step processing examples for multi-chip cameras, near-IR and mid-IR imagers; online help; detailed installation instructions; a user forum run by the authors

---

Contact: Mischa Schirmer, mischa@ing.iac.es
A fully functional pre-release of THELI is available from **ftp://ftp.ing.iac.es/mischa/THELI/**
The user forum can be found at **http://marvin.astro.uni-bonn.de/forums**

2007 ESO Instrument Calibration Workshop, Garching