LBT Italy
Spectroscopic Reduction Center

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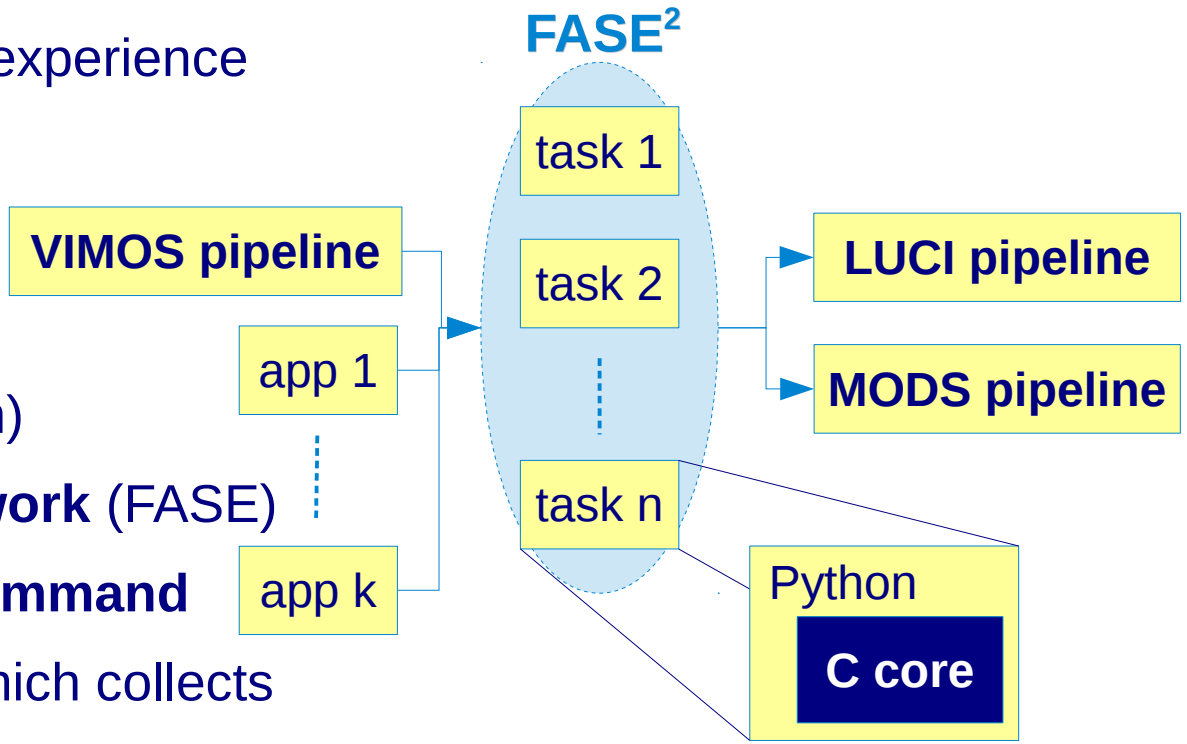
Pipelines software design

- LUCI and MODS pipelines development
- Inherits from **VIMOS**[1] pipeline experience
- Adaptation to **specific cases**

  (e.g. longslit mode)
- Plugged in **missing parts**

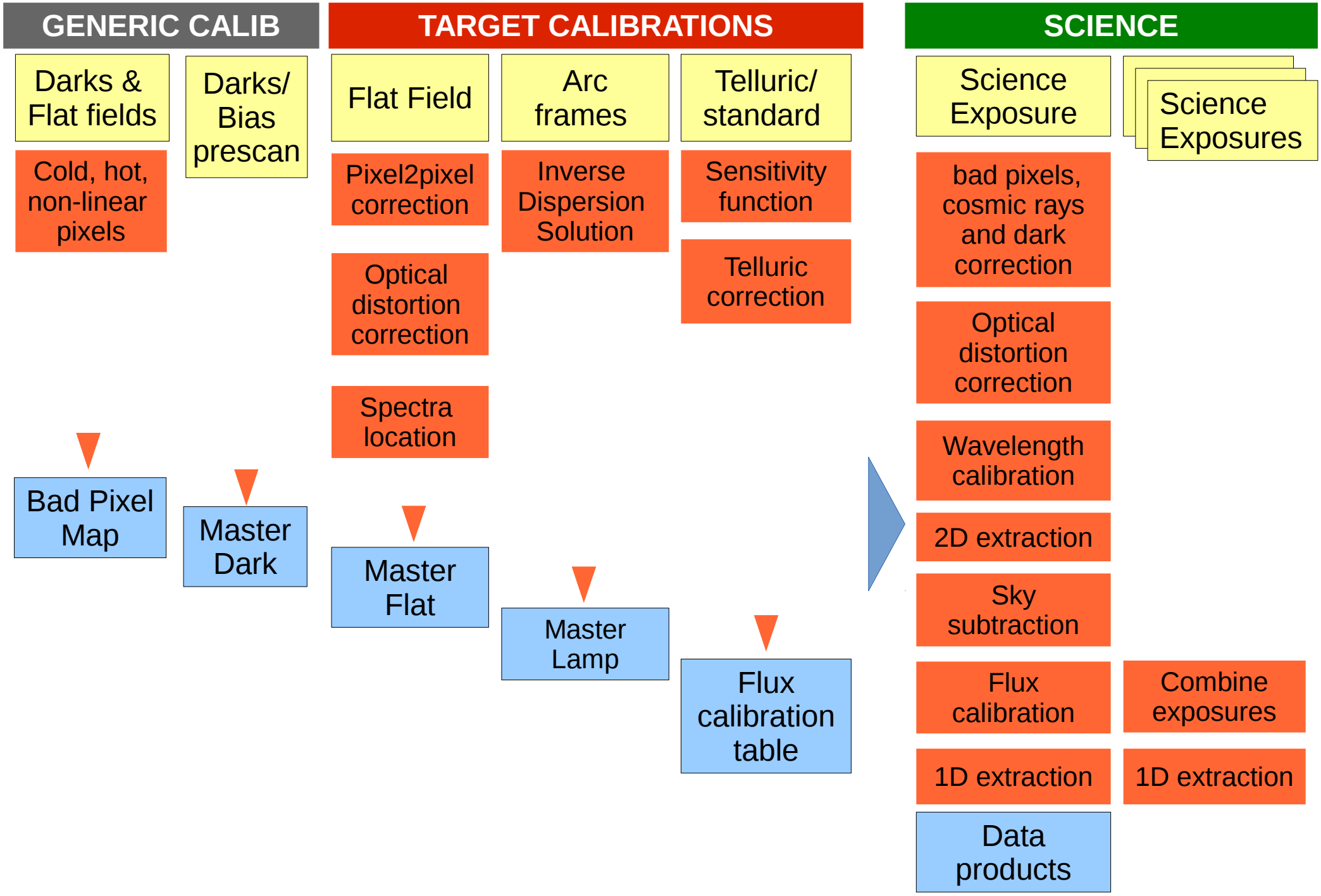
  (e.g. infrared sky subtraction)
- Plugged into **common framework** (FASE)
- Recipes can be run both by **command line** and by the **GUI** (**VIPGI**) which collects and organize data



1. “The VVDS Data-Reduction Pipeline: Introducing VIPGI, the VIMOS Interactive Pipeline and Graphical Interface”, Scodeggio at all 2005, PASP, 228, 1284

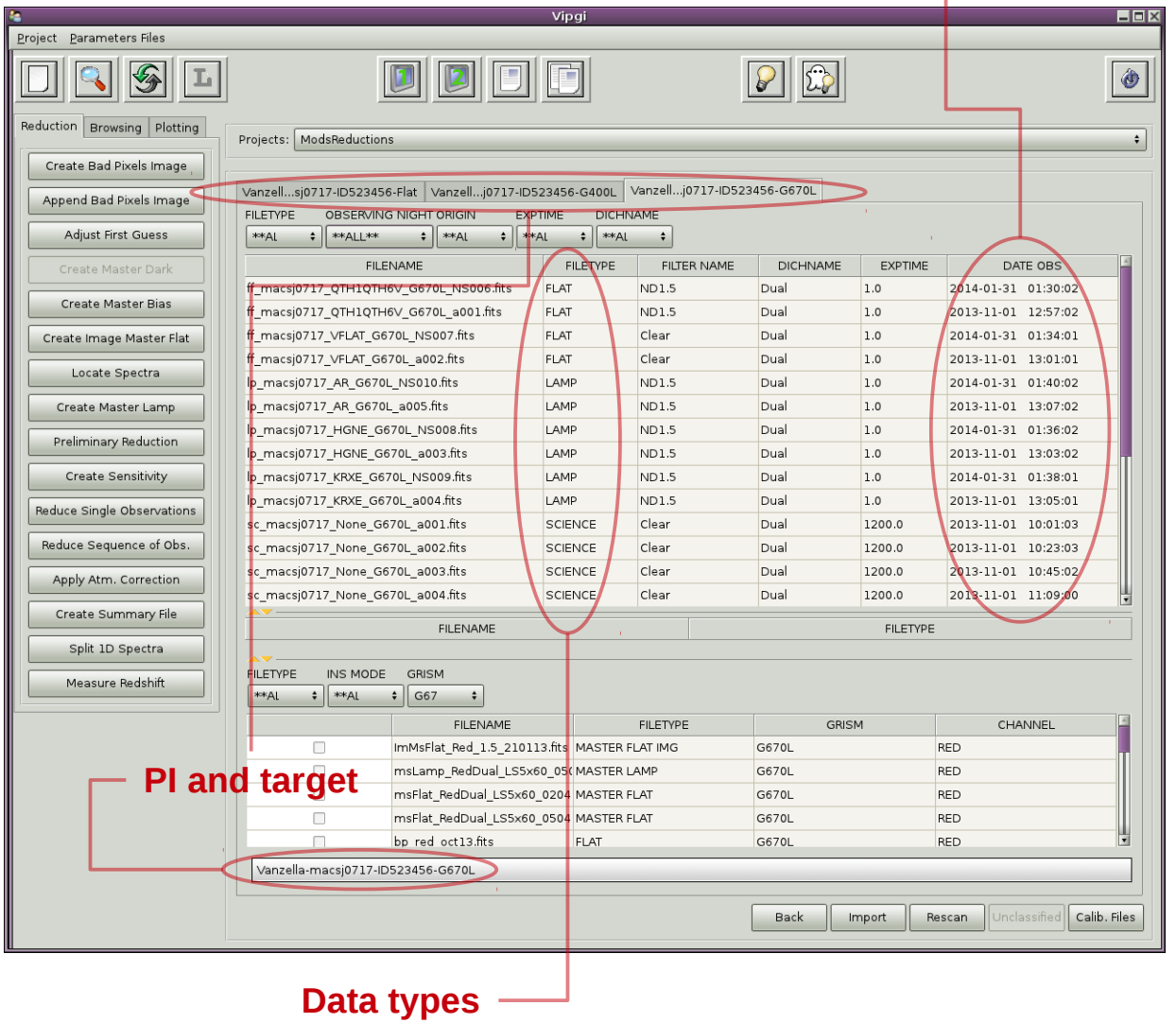
2. “A Future Astronomical Software Environment”, P. Grosbøl et all in ADASS XXI, vol. 461, 619

Pipelines workflow



Data unpacking and organizing

- **Trieste archive**[1] automatically send INAF data in Milan
- Data **unpacked**:
  - Mask info (LMS/MMS files)
  - Grism properties
  - **Mathematical models** used to describe the instrument configuration (**first guesses**)
- Data **automatically organized**:
  - collected according with PI, target and mask
  - Different nights/runs collected together
  - organized by data type and instrument mode

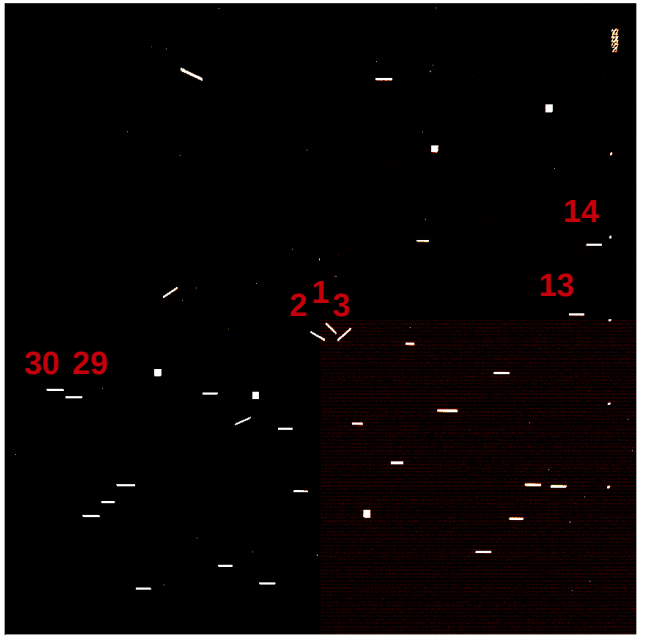


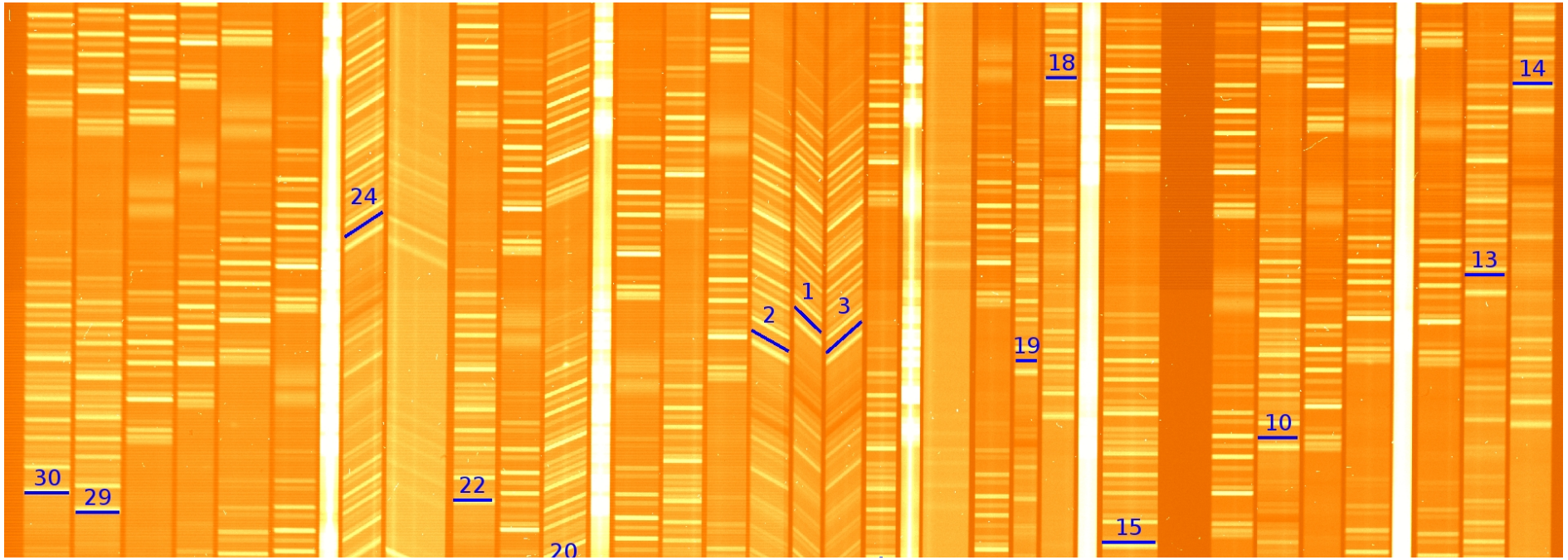
1. http://lbtarchive.as.arizona.edu/ powered by IA2 (see R. Smareglia talk)

Slits location

LMS/MMS information + mathematical model are used to roughly **locate slits**

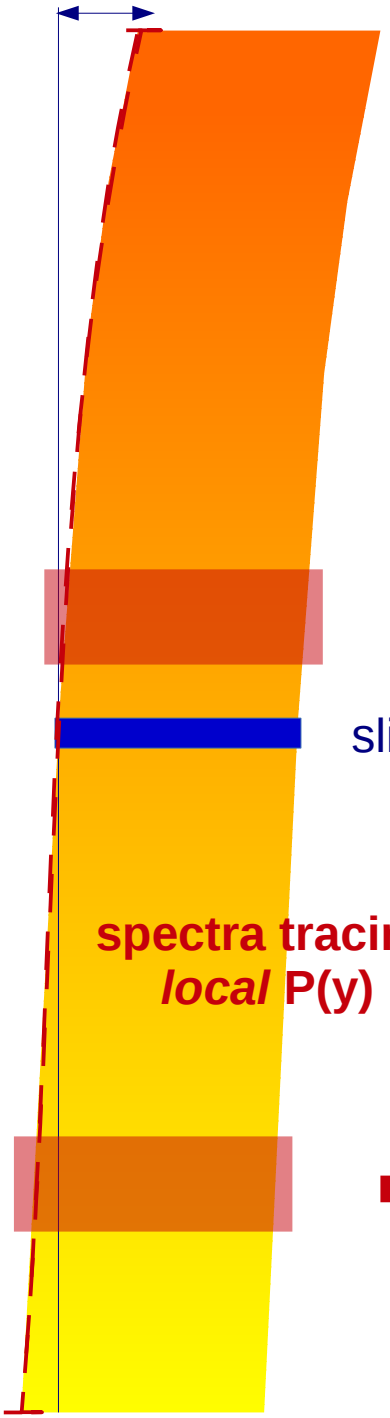
LMS/MMS
+
***global* P(x,y)**





Spectra location

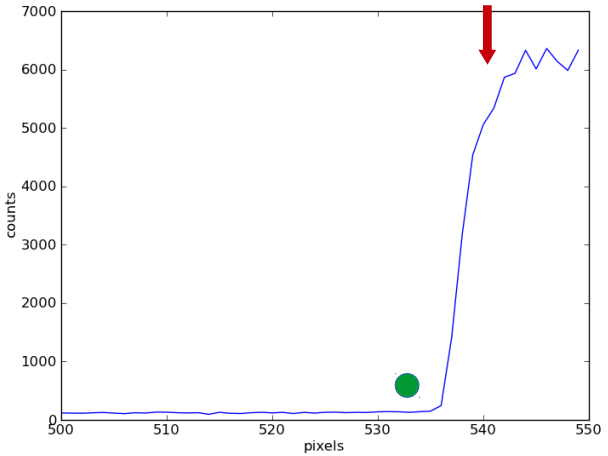
displacement

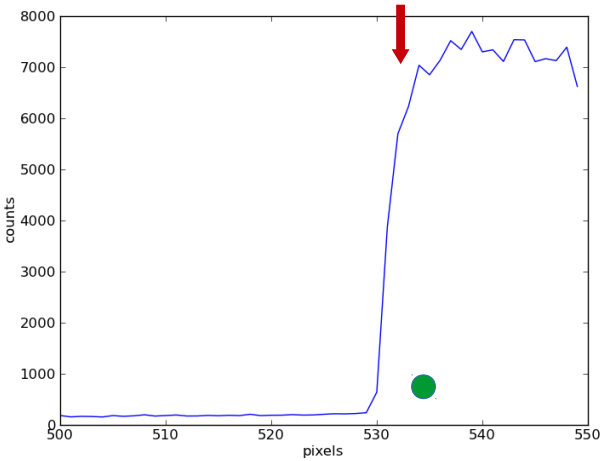


slit position

spectra tracing
***local* P(y)**

- Pipeline uses flats to trace spectra following the displacement from the **expected** position and the **real** position on frames
- Recipe **automatically finds flat edge** positions and fits new positions along dispersion direction



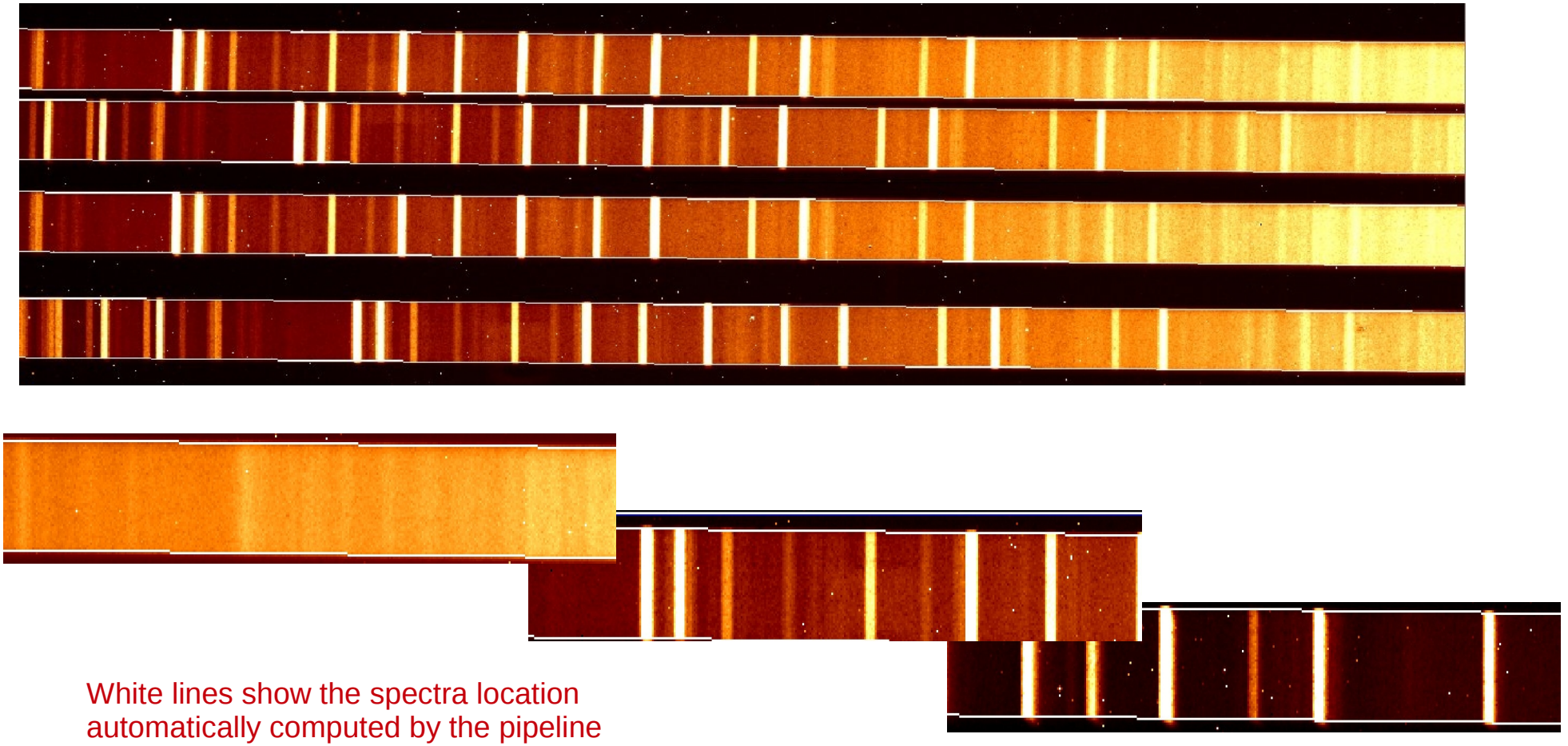


Expected spectra edge

Real edge on frame

Checks on Spectra location

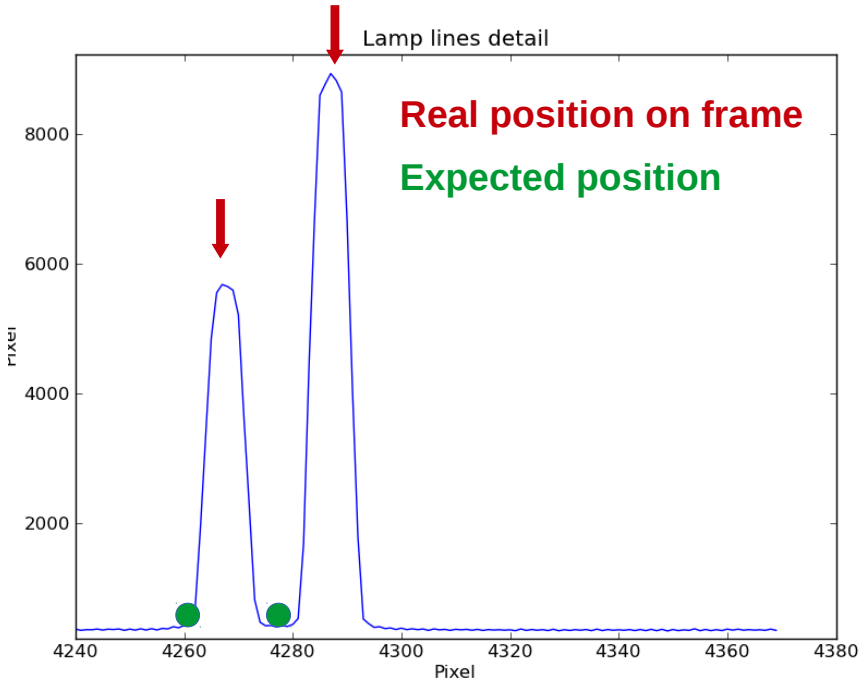
- **Quantitative check:** computes mean and maximum displacement between real and computed tracing solution
- **Visual check:** plots over frames computed solution



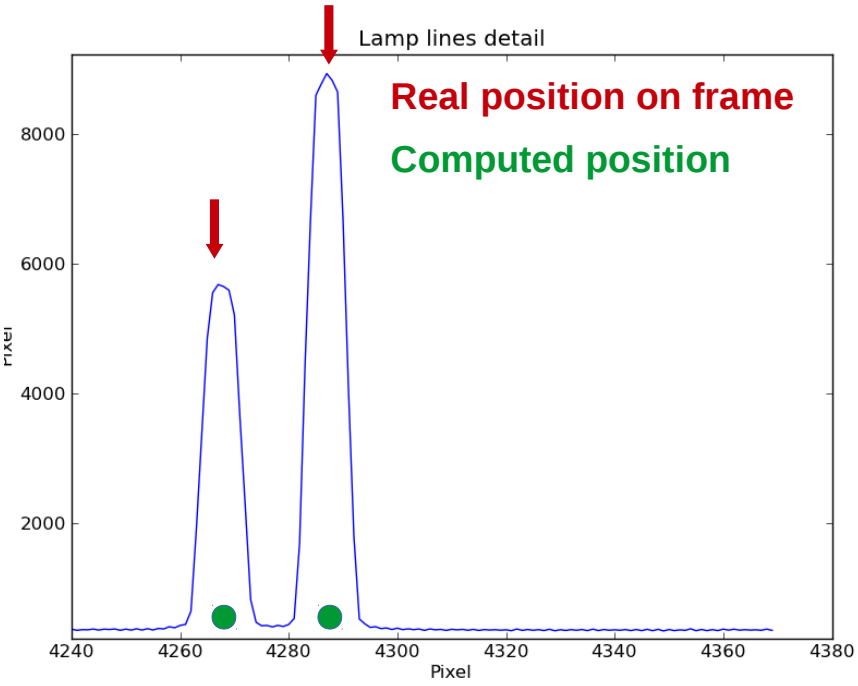
White lines show the spectra location automatically computed by the pipeline

2D Wavelength calibration

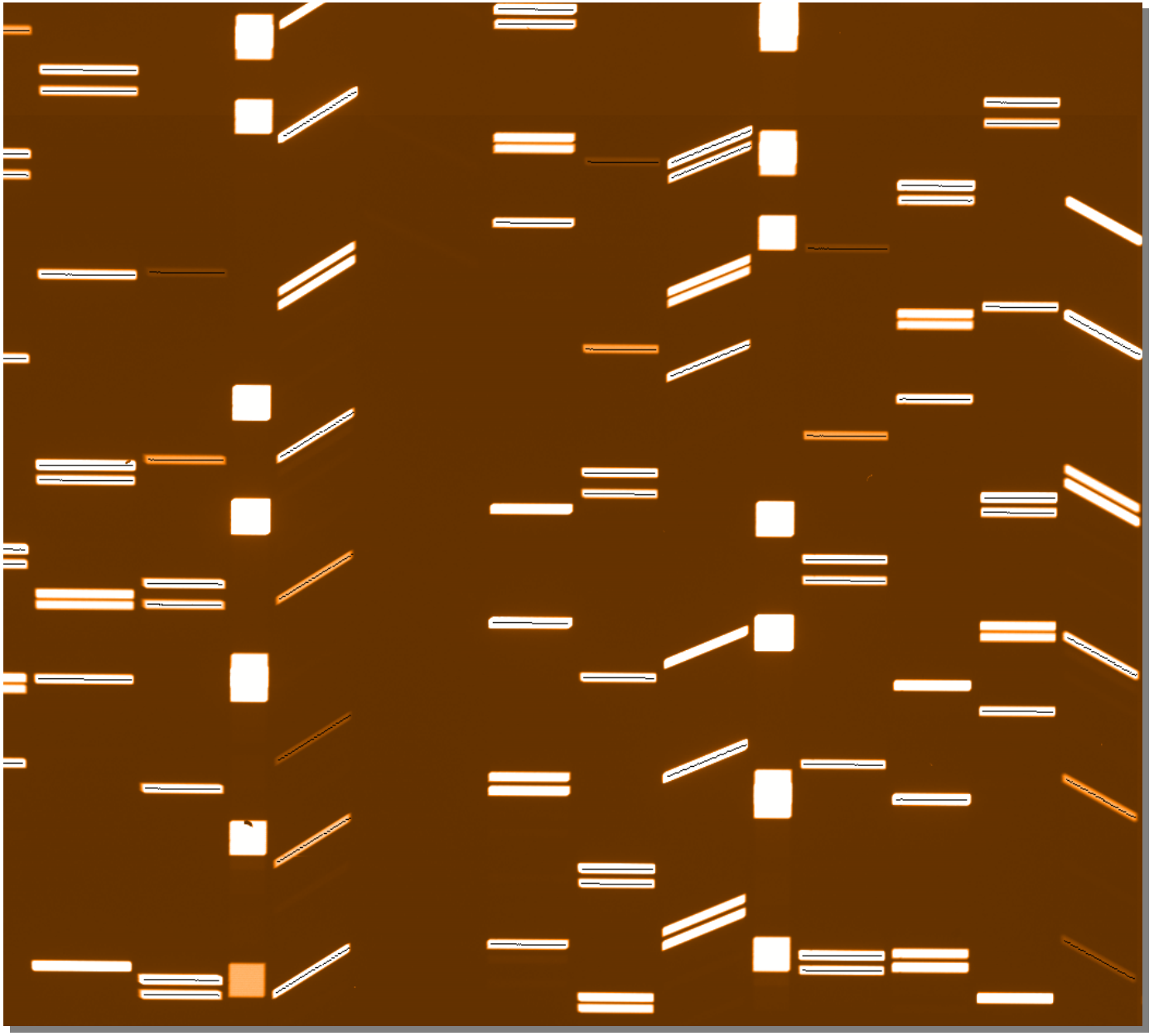
- First guesses model (global matrices) gives an **expected position**
- Pipeline **searches real lines** around expected positions (tabulated in a line catalog)
- Wavelength solution recomputed (local polynomial slit by slit)
- **Iteration** until a stable solution is obtained



Recipe computation



Wavelength calibration checks



The check tool overplots computed line positions (black lines) on lamp frame

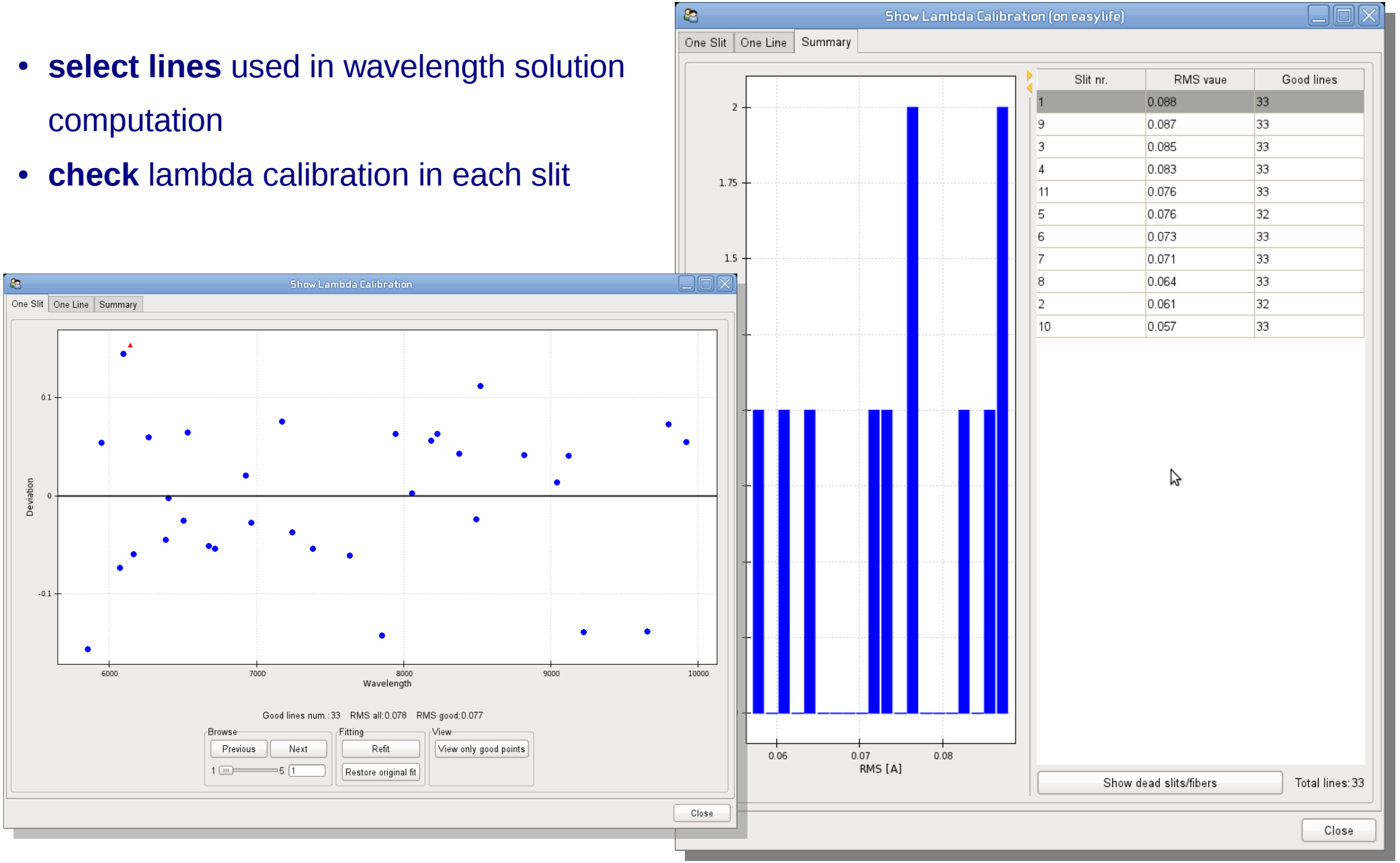
Quantitative check

Mean accuracy values:

- MODS red ~0.83Å
- MODS blue ~0.69Å
- LUCI 200HK (HK) ~0.57Å
- LUCI 200HK (zJ) ~0.29Å
- LUCI 210zJHK (K) ~0.26Å
- LUCI 210zJHK (H) ~0.15Å

Wavelength calibration check and refine

- **select lines** used in wavelength solution computation
- **check** lambda calibration in each slit

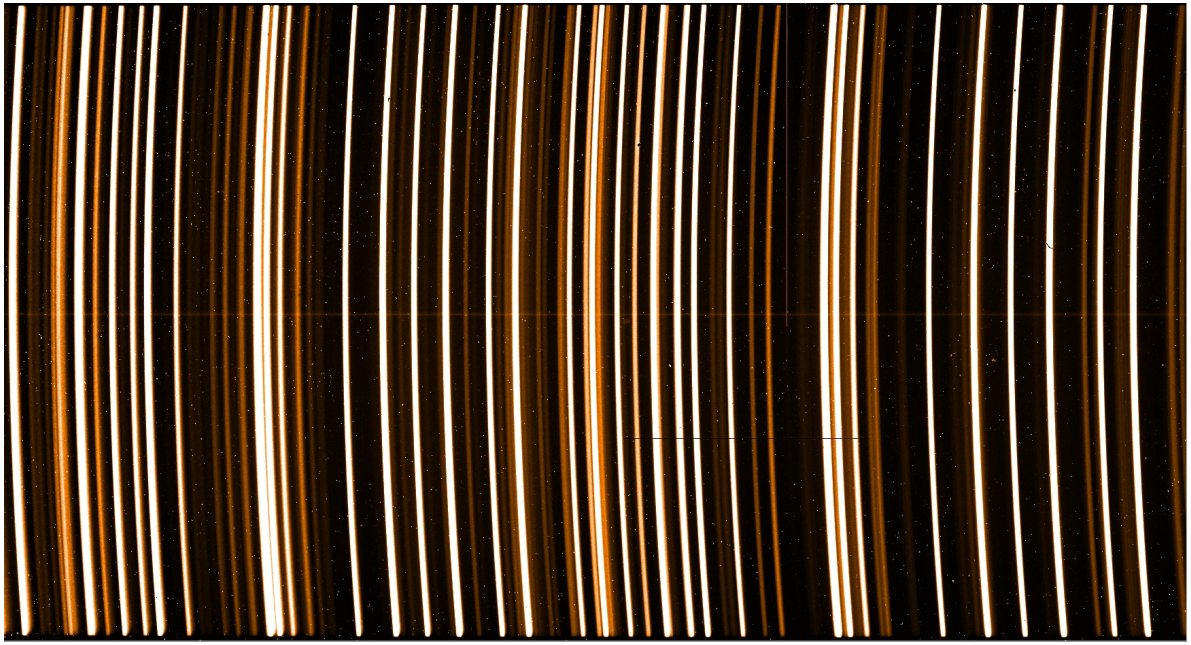


Spectra extraction and lambda calibration

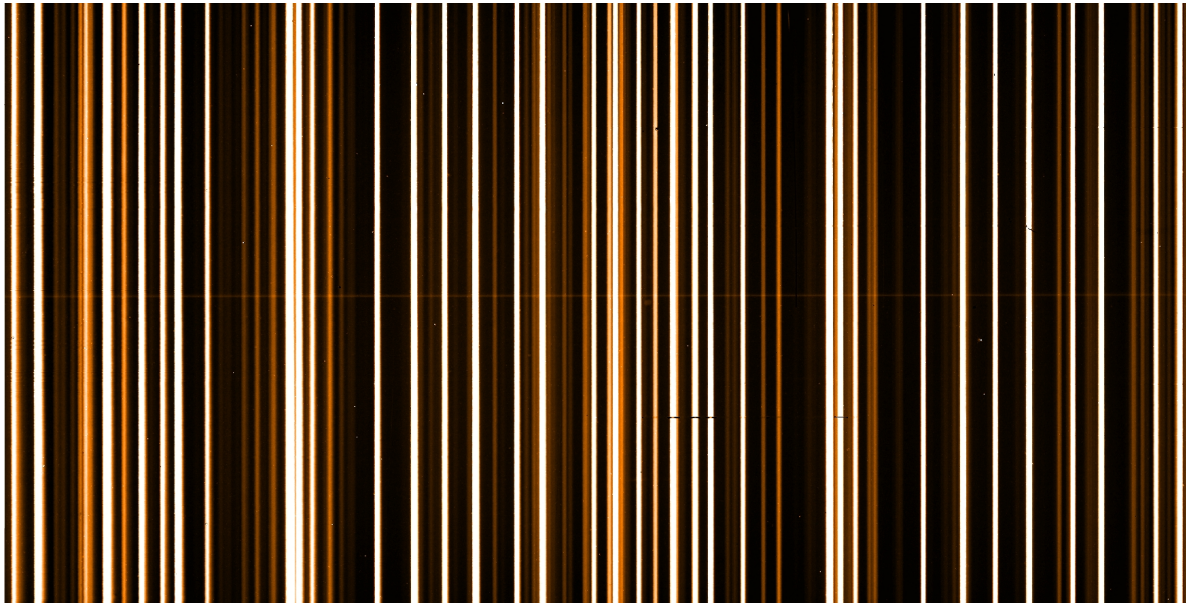
Spectra are **resampled** and extracted

(here LUCI longslit spectrum)

Raw frame



Extracted spectra lambda calibrated



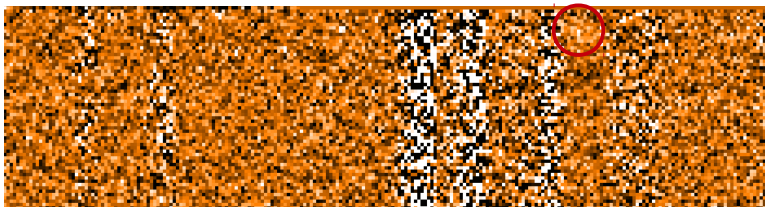
Lambda calibrated

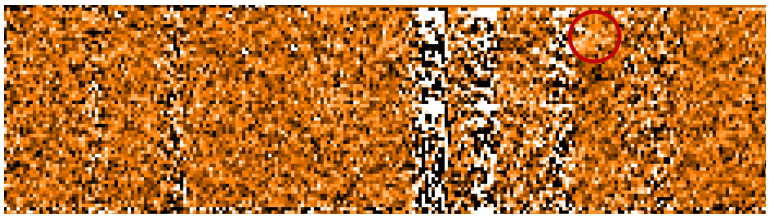
Background subtraction and slits combination

Background is removed in each exposure

- **MODS:** local estimation of the background slit by slit
- **LUCI:** Removed OH emission lines based on Davies algorithm[1]

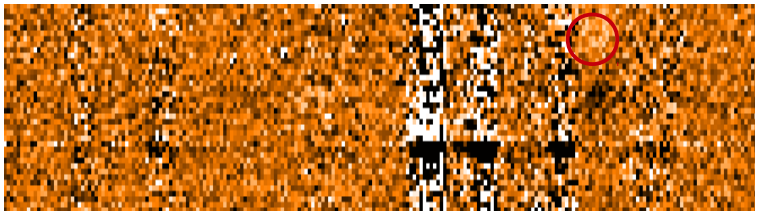
Frame 1

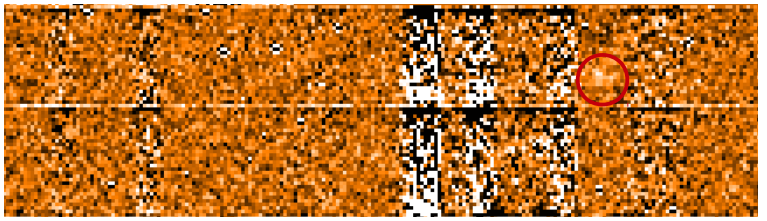




Frame 3

Frame 2





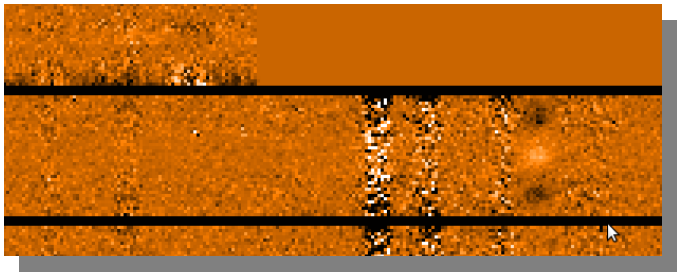
Frame 4

Frames are stacked, taking into account of **frame offsets.**

Offsets are computed using:

- **bright objects** on frame
- **header info** (if available)

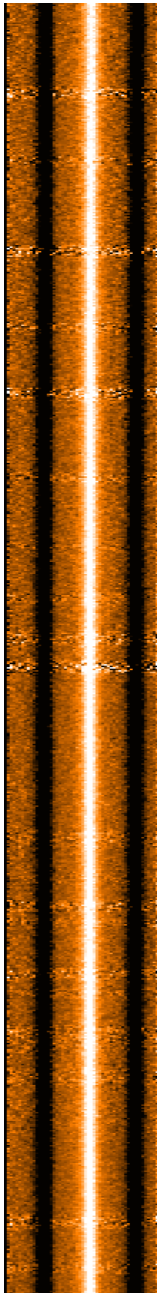
Combined frame



1. Porting (C code) of Davies R. and Cresci, G. algorithm implementation Davies 2007: MNRAS, 375, 1099

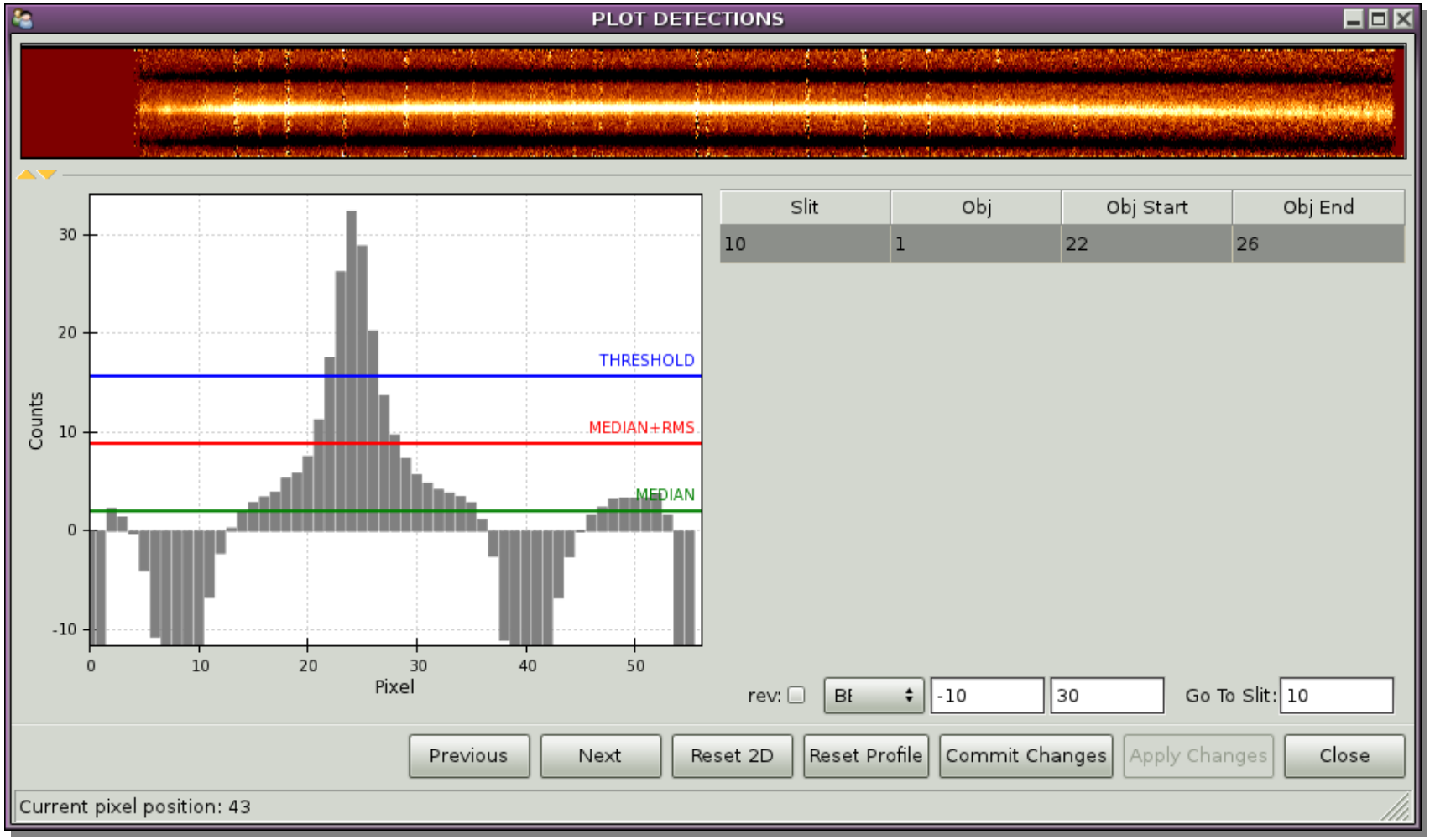
Automatic spectra extraction

- Create a **spectrum profile**: **collapse** 2D spectrum along spatial direction
- Detect objects using sigma clipping
- Perform optimal Horne extraction[1] to obtain 1D spectrum



Collapsing

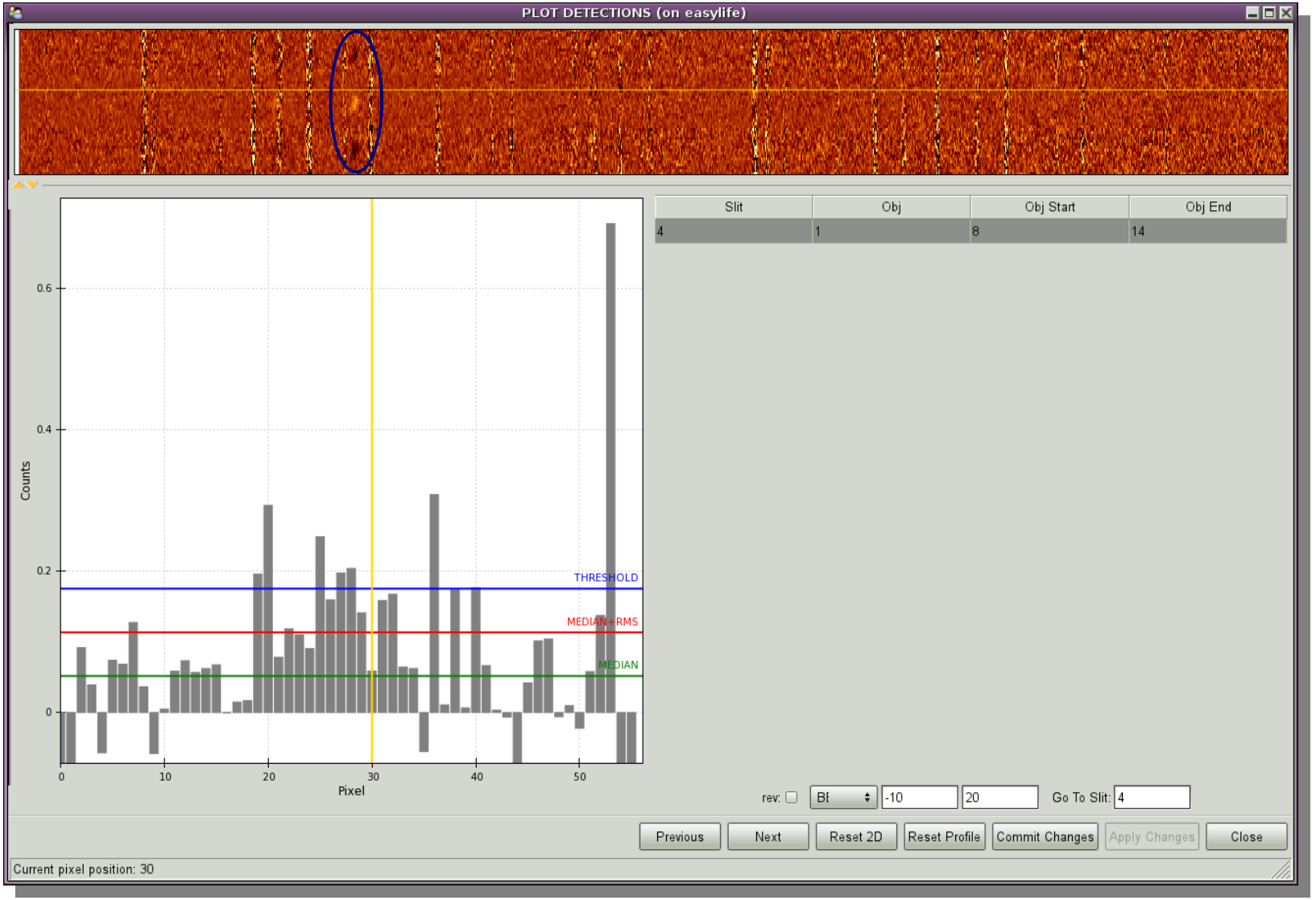
Spectra profile



[1] "An optimal extraction algorithm for CCD spectroscopy", Horne, K. 1986, 1986PASP...98..609H

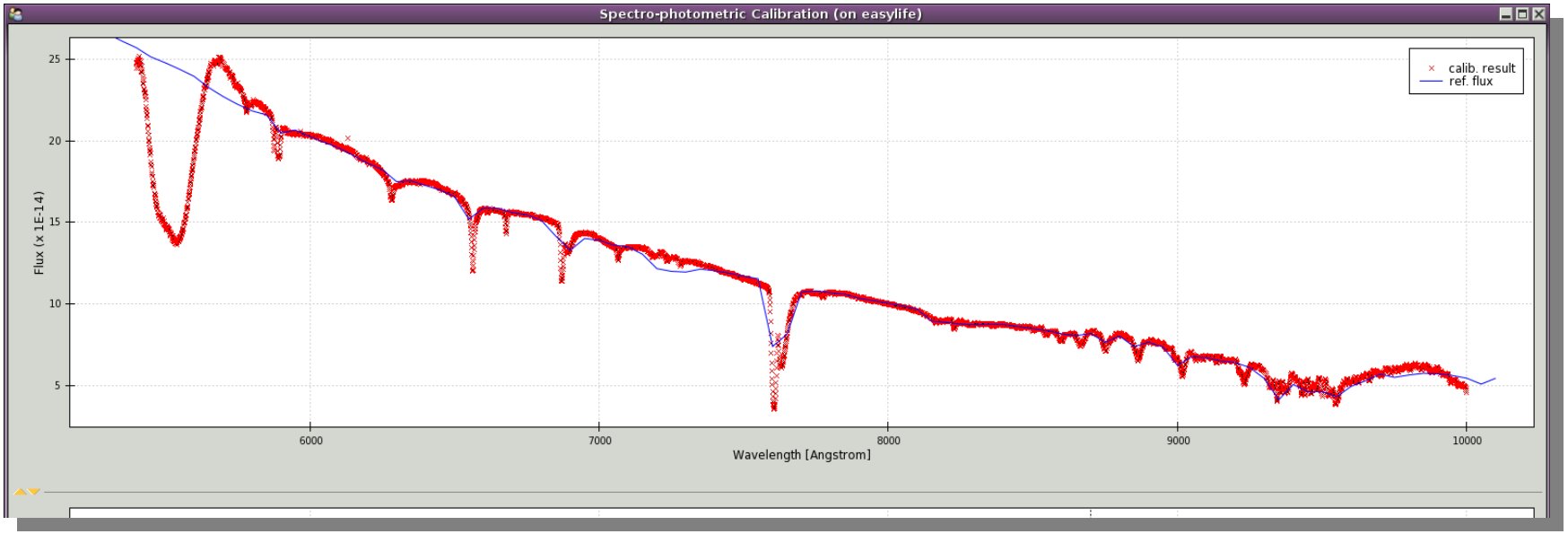
Manual spectra extraction

- Examine 2D spectra
- Looking for features
- Extract 1D spectra

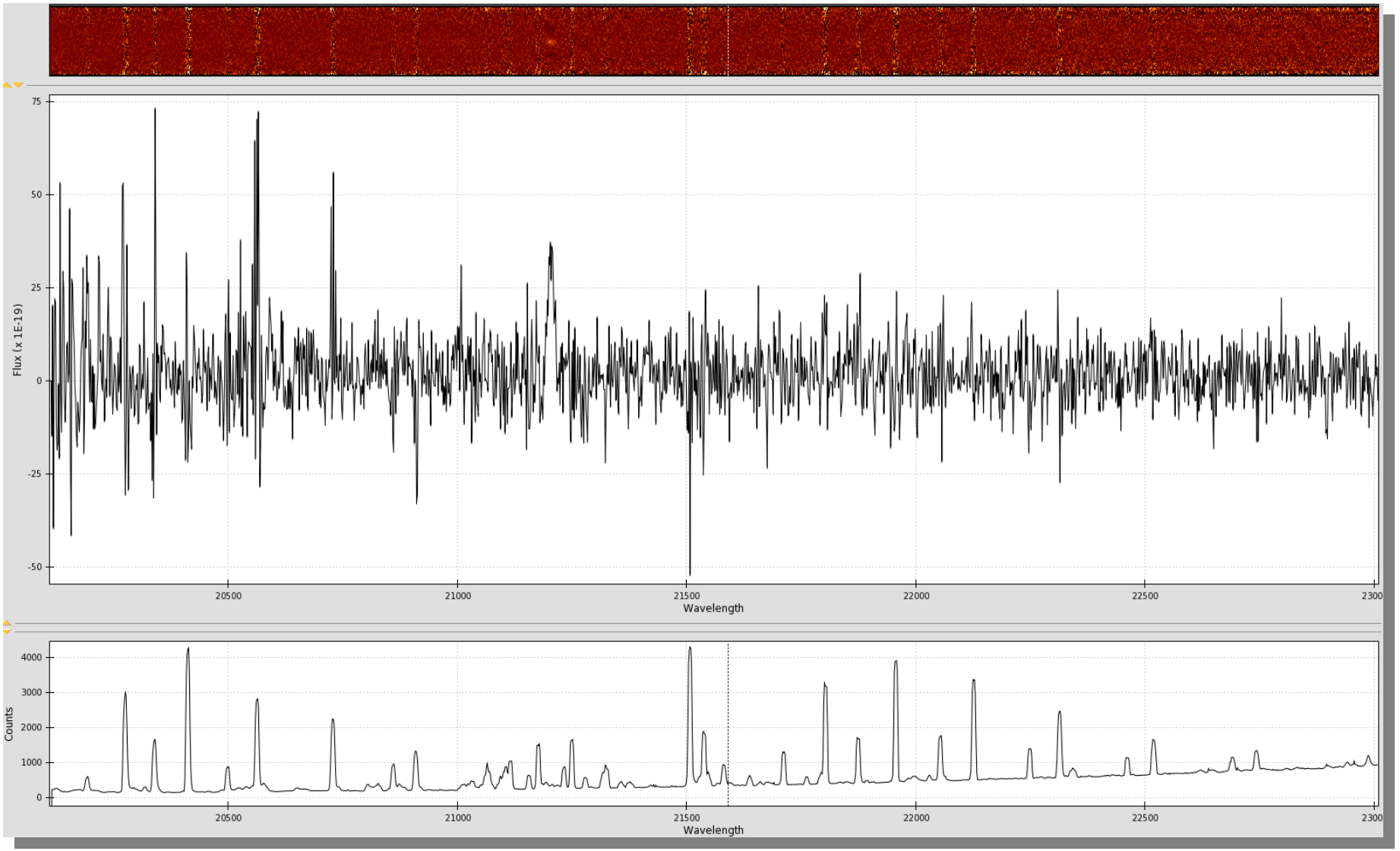


Spectra flux calibration

- Observed calibration star reduced by the pipeline
- Star spectrum is used to obtain a sensitivity function
- **MODS**:
  - reduced spectra is compared with **spectrophotometric standard**
- **LUCI**:
  - Stellar type, luminosity class and magnitude are retrieved (**Hipparcos catalog**)
  - **Pickles template** is rescaled
  - Reduced spectra is compared with the rescaled template



Distributed data products

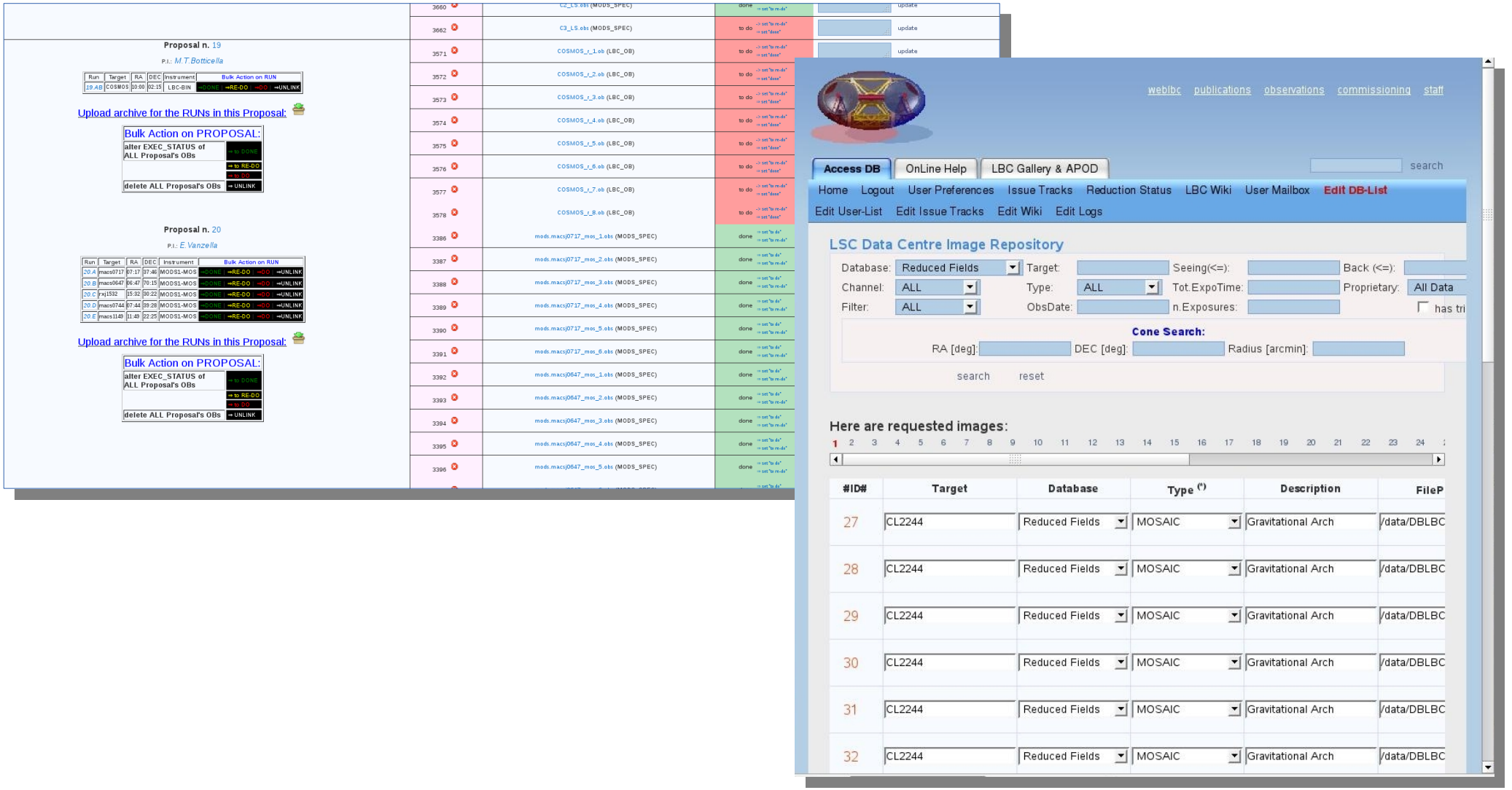


- **2D spectra** lambda calibrated
- Sky spectra lambda calibrated

- **1D spectra**, lambda and flux calibrated
- Others upon request

Data distribution

- Reduced data are uploaded on the **LSC**[1] database in Rome
- System sends a mail to the PI
- PI can retrieve data



1. http://lsc.oa-roma.inaf.it/index.html Powered by Stefano Gallozzi & LSC Team (see V.Testa talk)

Conclusions

- Pipelines provide good quality results which are being used by Italian community
- Data reduction is “**mostly automatic**”, with human intervention required for:
    - Quality checks
    - Calibrations
- Automatization could be **further improved** adding:
    - Integration of the quality checks in the reduction workflow
    - Handling of the various instrument configurations

Thanks