PHLAG – the Pipeline for Hubble Legacy Archive Grism data

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Overview

1. Why do we need a Hubble Legacy Archive?
2. Why slitless spectroscopy as ST-ECF contribution?
3. HST slitless spectroscopy
4. Method of reducing slitless spectroscopic data
5. PHLAG
6. The Modules of PHLAG
7. Status

1. Why do we need a Hubble Legacy Archive?

- HST is getting old
- HST scientists are getting older
- Knowledge is drifting away
- Pixel archive → archive with high level data products
- See also:
  - Talk by B. Whitmore
  - Poster by R. Albrecht
  - BOF session

2. Why slitless spectroscopy as ST-ECF contribution?

- Large experience with HST spectroscopy
- Development of NICMOSlook
- ST-ECF is responsible for ACS slitless spectroscopy (calibration and aXe software)
- Experience in the production of high level science products (UDF HRC Parallels, GOODS, GRAPES, PEARS)
- VO and archive expertise

➔ All premises are there

3. HST slitless spectroscopy

- **Main data sources:**

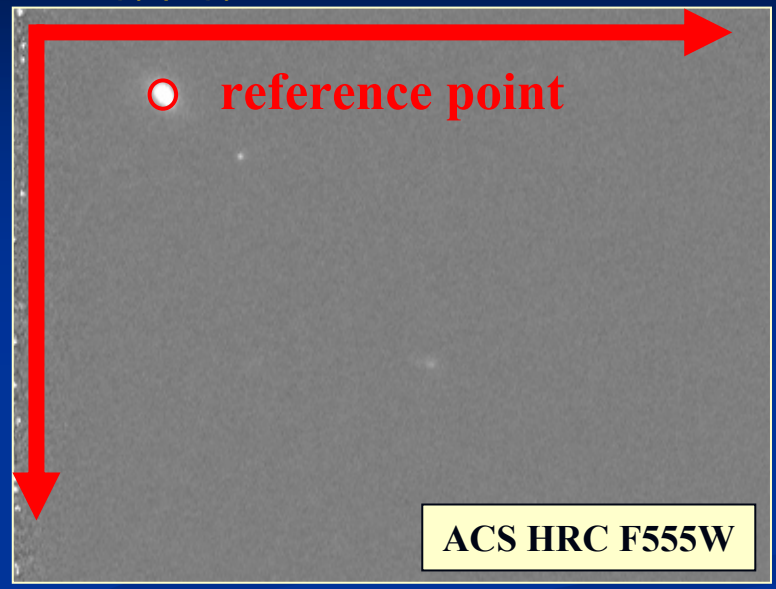
Channel	Disperser	Wavelength Range [Å]	Resolution [Å/pixel]	FOV ["]
ACS/WFC	G800L	5500 – 10500	38.5	202x202
ACS/HRC	G800L	5500 – 10500	23.5	29x26
ACS/HRC	PR200L	1600 – 3900	20 [@2500Å]	29x26
ACS/SBC	PR130L	1250 – 1800	7 [@1500Å]	35x31
ACS/SBC	PR110L	1150 – 1800	10 [@1500Å]	35x31
NIC3	G141	11000 – 19000	80	51x51

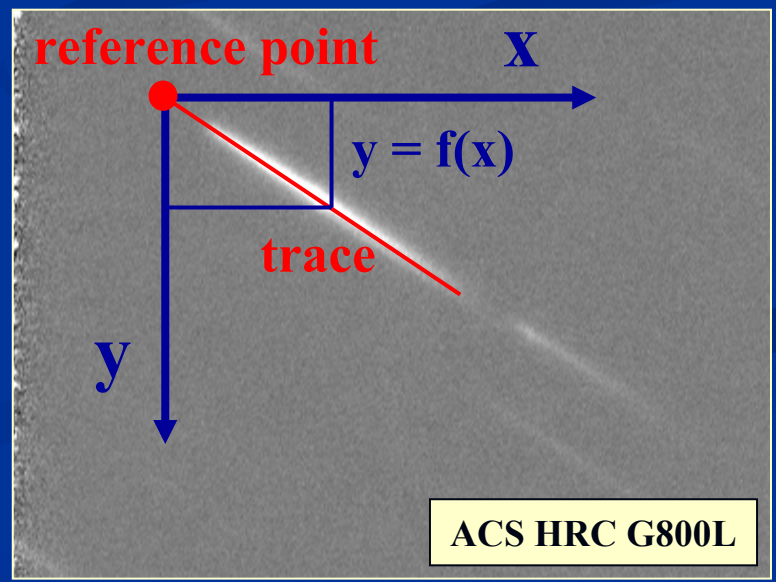
- **Further available:** NIC3/G096, NIC3/G206, STIS/G750L, STIS/PRISM, WFPC1/GRISM
- **After SM4: WFC3**

4. Method of reducing slitless spectroscopic data

- Spectroscopy with slits: aperture (slit/mask) defines a framework for trace definition and wavelength calibration
- Slitless spectroscopy: no such framework ⇒ objects and their position unknown
- Need for a 'reference position' to base framework for every object for spectral extraction

⇒ direct image to derive a reference position for every object

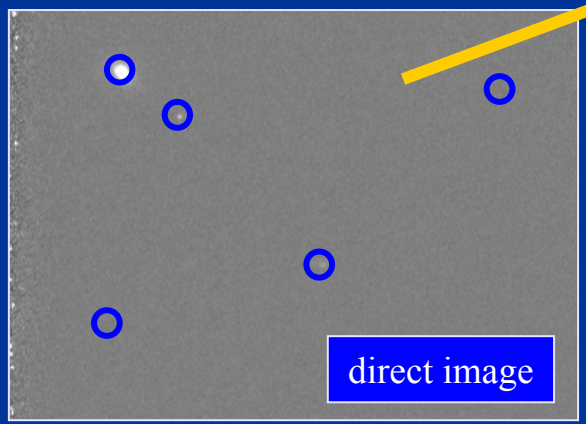




The aXe strategy

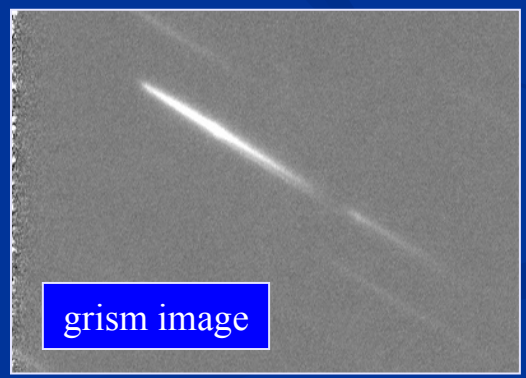
- Direct image ⇒ source list
- Association between one direct and one grism image
- Source list projected onto grism image
- Source list + calibration + grism image
  ⇒ spectral extraction

SExtractor



Input Object List

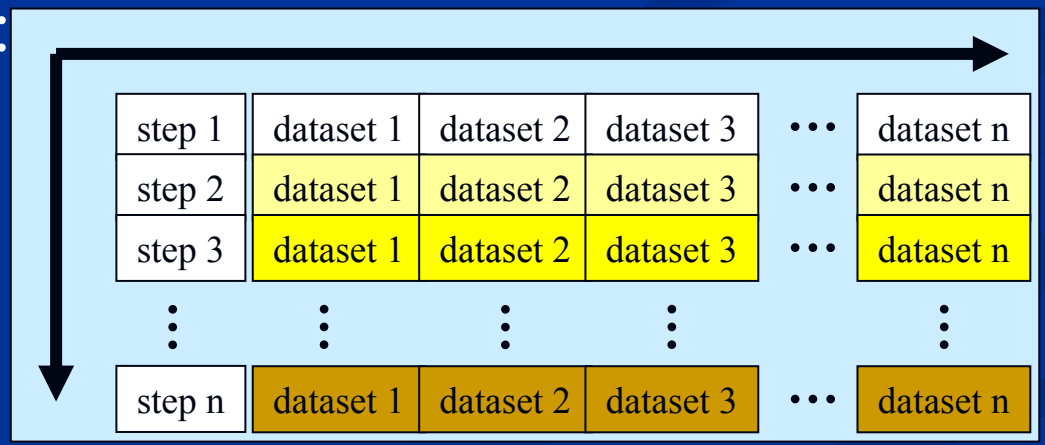
```
#   1 NUMBER          Running object number
#   2 X_IMAGE         Object position along x
#   3 Y_IMAGE         Object position along y
#   4 A_IMAGE         Profile RMS along major axis
#   5 B_IMAGE         Profile RMS along minor axis
#   6 THETA_IMAGE     Position angle (CCW/x)                  [deg]
#   7 X_WORLD         Barycenter position along world x axis  [deg]
#   8 Y_WORLD         Barycenter position along world y axis  [deg]
#   9 A_WORLD         Profile RMS along major axis (world units)  [deg]
#  10 B_WORLD         Profile RMS along minor axis (world units)  [deg]
#  11 THETA_WORLD     Position angle (CCW/world-x)            [deg]
#  12 MAG_AUTO        Kron-like elliptical aperture magnitude [mag]
   1 354.3 1788.0 1.38 0.93  -61.9 5.32227466e+01 -2.78269501e+01 1.15391e-05 7.81022e-06 -77.1 27.33
   2 430.8 1881.1 4.85 3.41  134.0 5.32222385e+01 -2.78263217e+01 4.04609e-05 2.84565e-05  84.8 22.77
   3 445.9 1745.3 1.50 1.32 -140.9 5.32223037e+01 -2.78259023e+01 1.25505e-05 1.10465e-05   6.7 26.60
   4 508.4 1417.7 1.09 0.73  -85.6 5.32249088e+01 -2.78258256e+01 9.13685e-06 6.09757e-06 -49.2 27.80
   5 550.3 1007.1 2.07 1.08  -81.1 5.32247112e+01 -2.78252172e+01 1.72606e-05 9.00725e-06 -54.4 26.86
```



aXe

5. PHLAG

- Developed for NICMOS G141 pilot project
- Modular, not monolithic; consists of a series of reduction steps
- Uses external software: SExtractor, pyraf, MultiDrizzle, aXe, aXe2web
- Implemented in Python
- Flexible:



6. The Modules of PHLAG

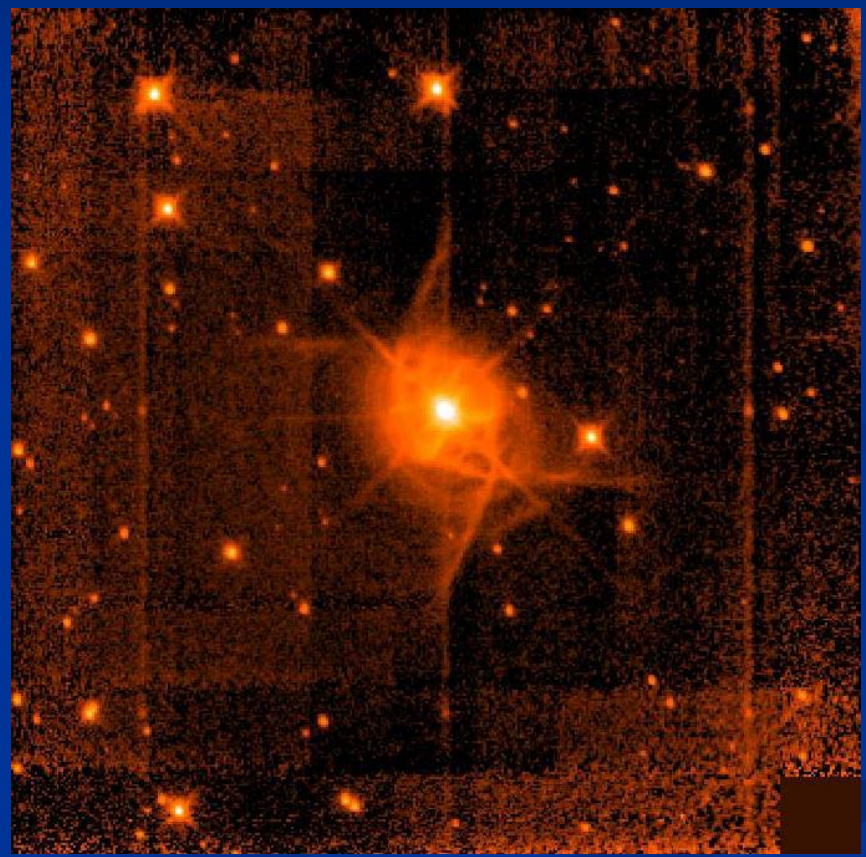
1. data preparation
2. data retrieval
3. background
4. image combination
5. object detection
6. spectral extraction
7. visualization
8. quality control
9. metadata
10. data ingestion

Data preparation/data retrieval/background

- Find a grism image association
- Find the corresponding association of direct images
- Select the “best” filter
- Find the association between grism images and direct images
- Determine the best strategy for grism image background

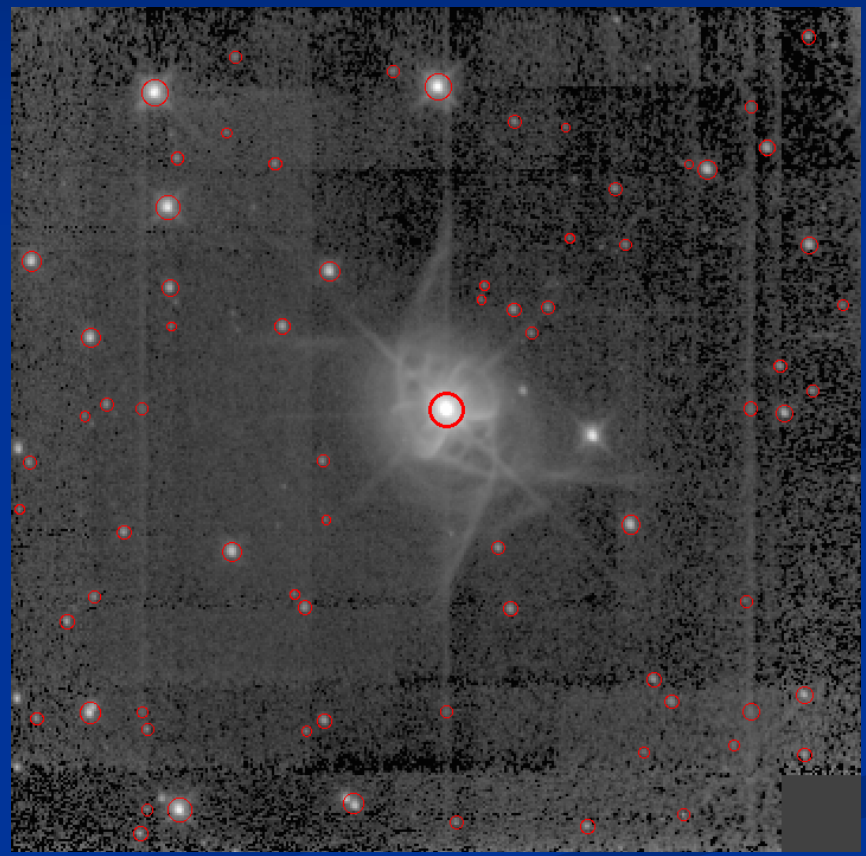
Image combination

- "Best" filter
- Using MultiDrizzle
- Standard settings

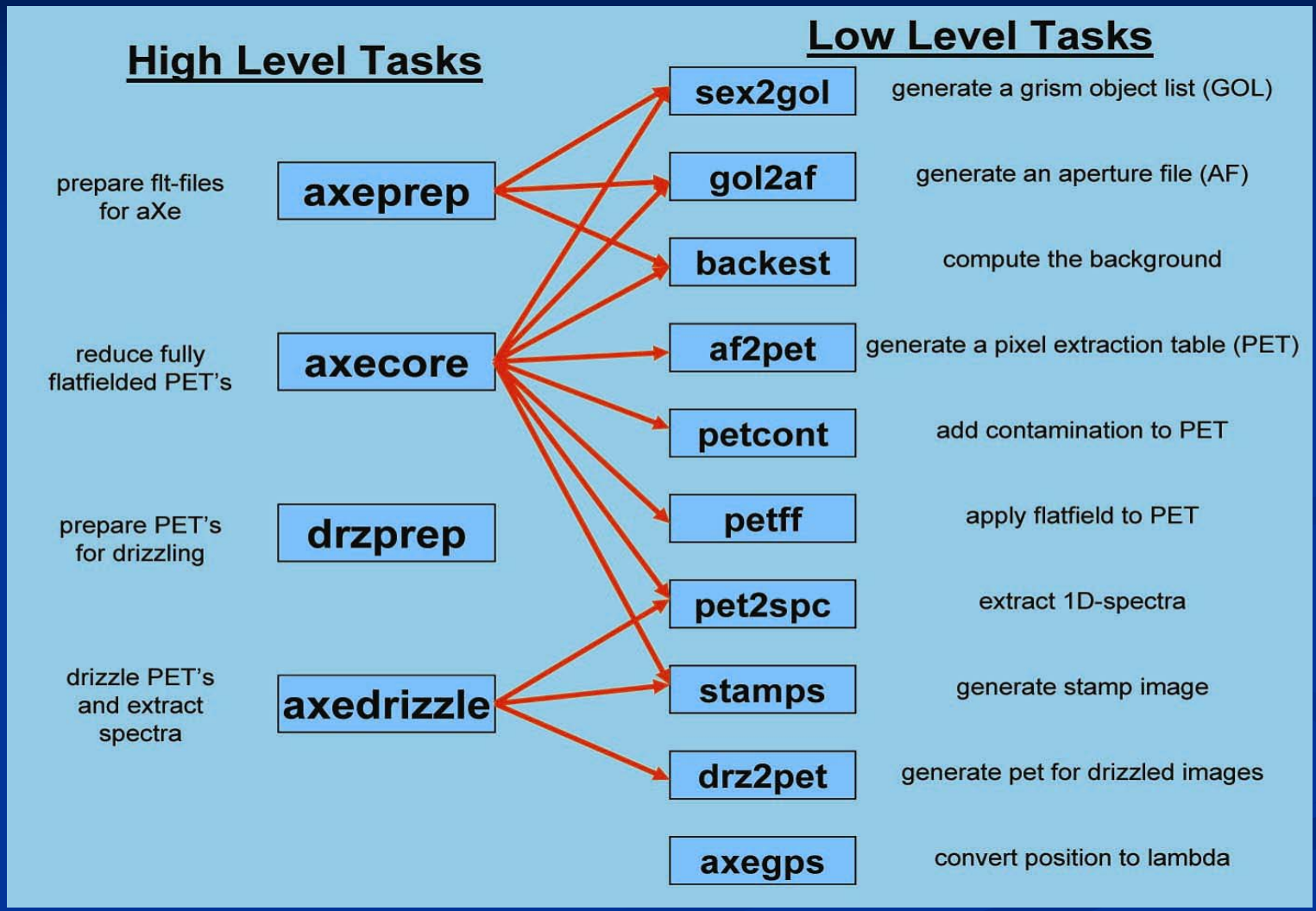


Object detection

- SExtractor
- Conservative settings
- Prime aim: get all objects for spectroscopy
- “Reasonable” photometry
- Boundary objects, splitting still problematic



Spectral extraction

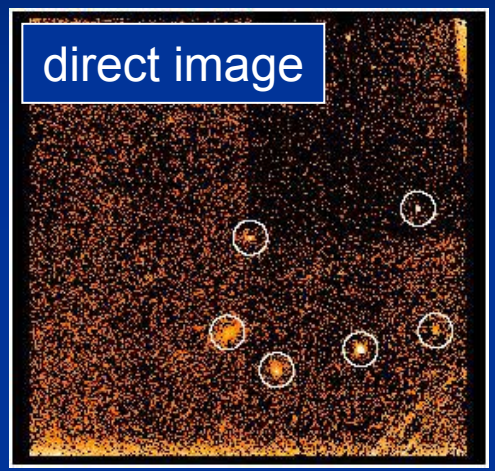


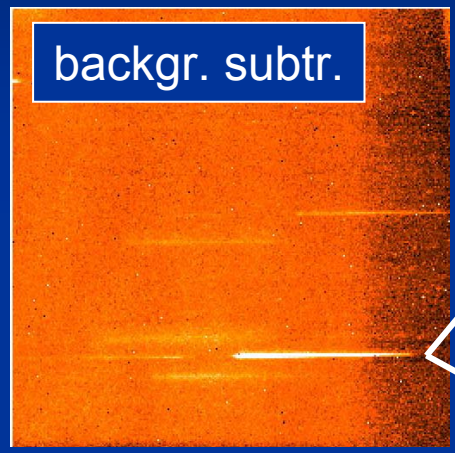
Example of a spectral extraction

input

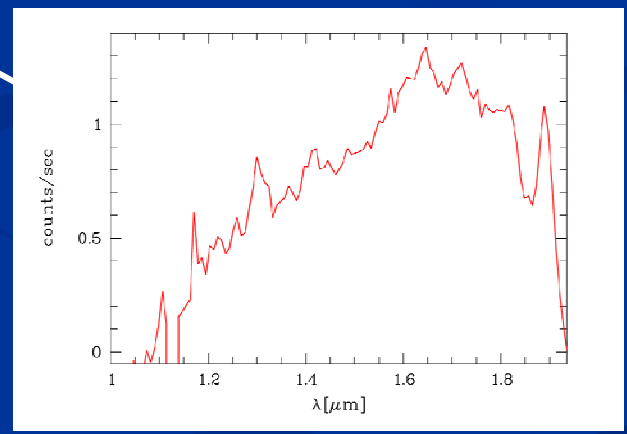
intermediate steps

result



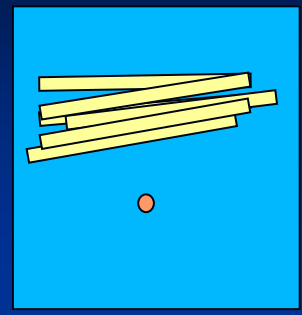


stamp image

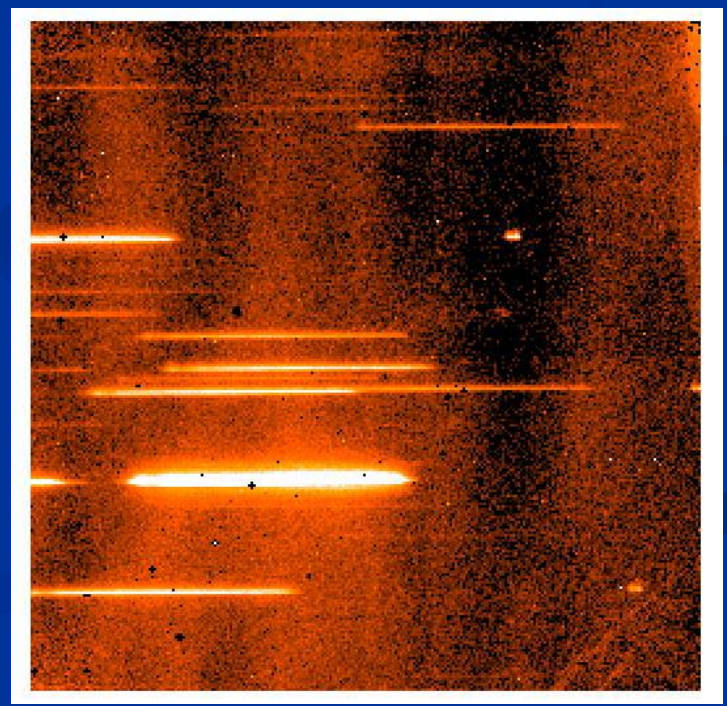


extracted spectrum

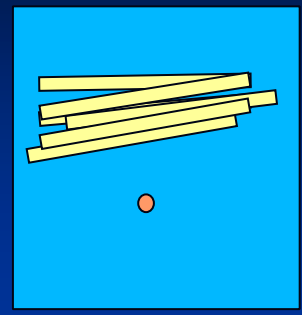
Readjustment of trace



- Filter wheel position is not reproducible
- Unstable trace
- Individual trace solution for every grism image
- Fitting of object traces



Readjustment of trace



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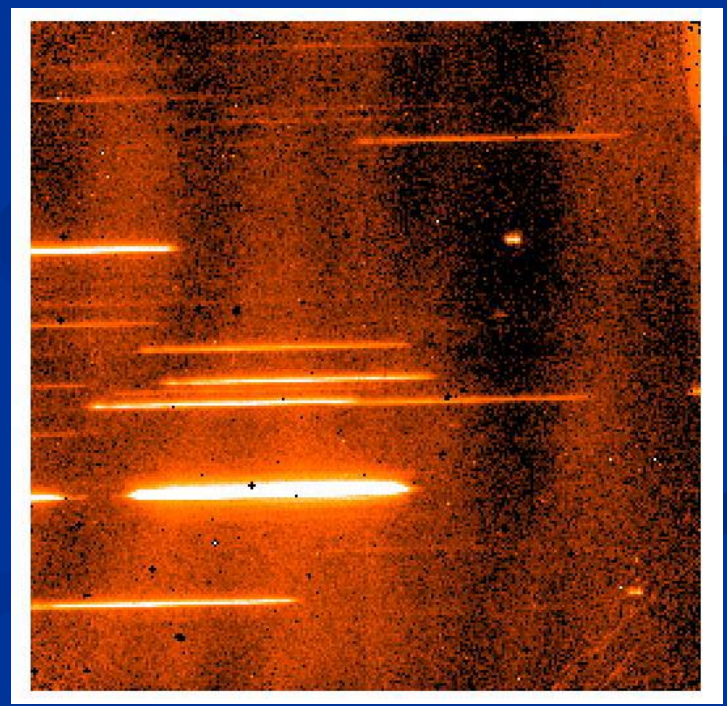
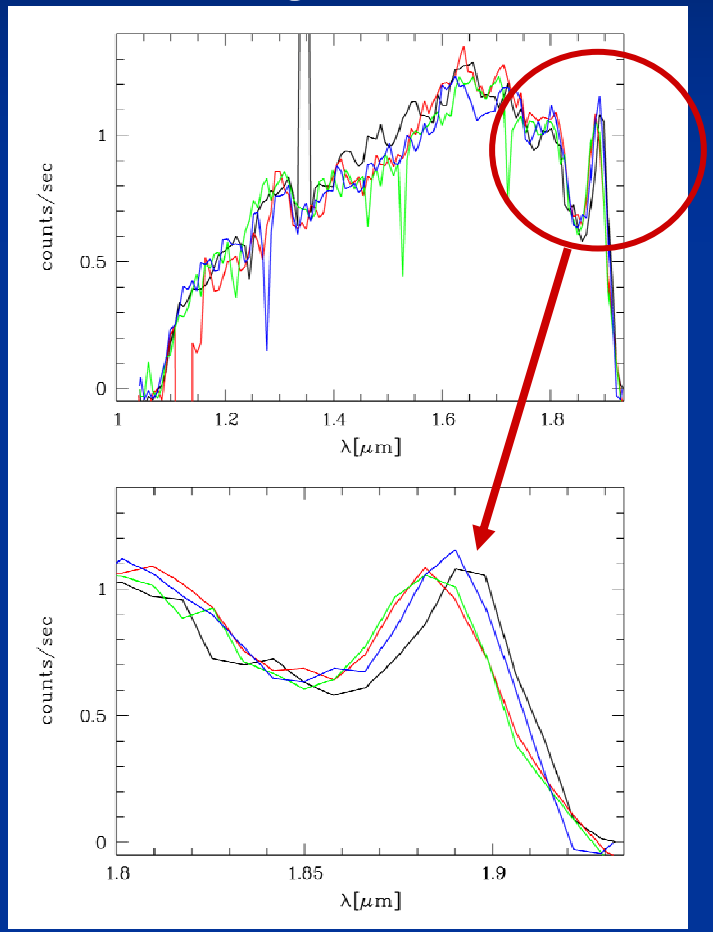
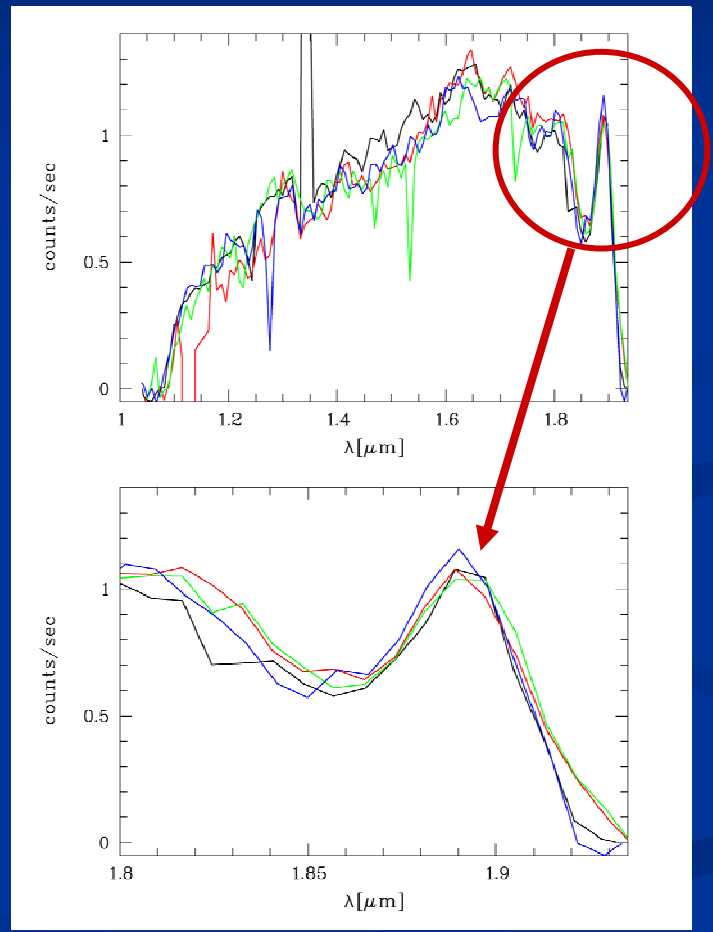


Readjustment of wavelength

original

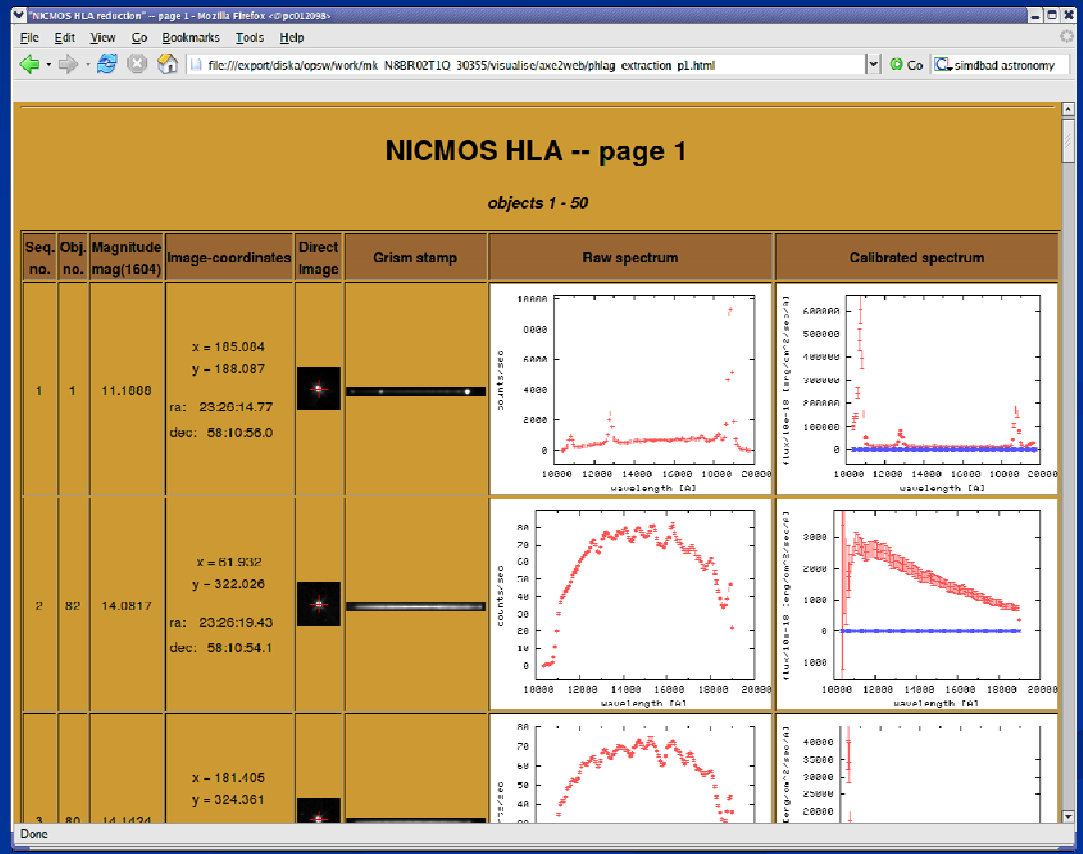


readjusted



Visualization

- Create browsable web pages using aXe2web
- For inspection purposes
- For better information handling
- Not part of the products for the HLA



Quality control

- Consistency checks (photometry ←→ spectroscopy)
- Flagging
- Selection of the pipeline products

Metadata

- Post-processing of the spectra
- Collect/compute metadata:
  - Positions from object catalogues
  - SNR-estimates derived from spectra
  - …
- VO compatibility: IVOA spectral model 0.98c

Data ingestion

- Store pipeline products in the HLA

7. Status

- Start in early 2006
- Now: most modules implemented
- To be done:
  - **quality control, metadata, ingestion**
  - finding best parameters, enhancing data quality
  - Improvements through **trending**