Variable Star Section

BAA

British Astronomical Association

Spectroscopy Workshop
N.L.O. 10th October 2015

Download from dropbox at http://tinyurl.com/NLO-workshop

Low Resolution Slit Spectroscopy

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The slit spectrograph

Advantages

Collimating the beam at the grating eliminates aberrations
at higher dispersion, allowing potentially much higher resolutions

Fixed sampled width of target means extended objects can be measured
and the resolution is constant and controlled

Excludes sky background improving SNR and eliminating interference

Provides a fixed reference point for wavelength calibration

Diffuse lamps can be used as calibration sources

Flat correction simpler (flats will also remove small scale instrument
sensitivity variations)

The slit spectrograph

Disadvantages

Increased cost and complexity over a simple non-objective slitless grating setup

Need to acquire, focus and guide the star on the slit (key to success and not trivial)

Proportion of light through slit not controlled, preventing absolute flux measurement

Transmission grating slit spectrograph

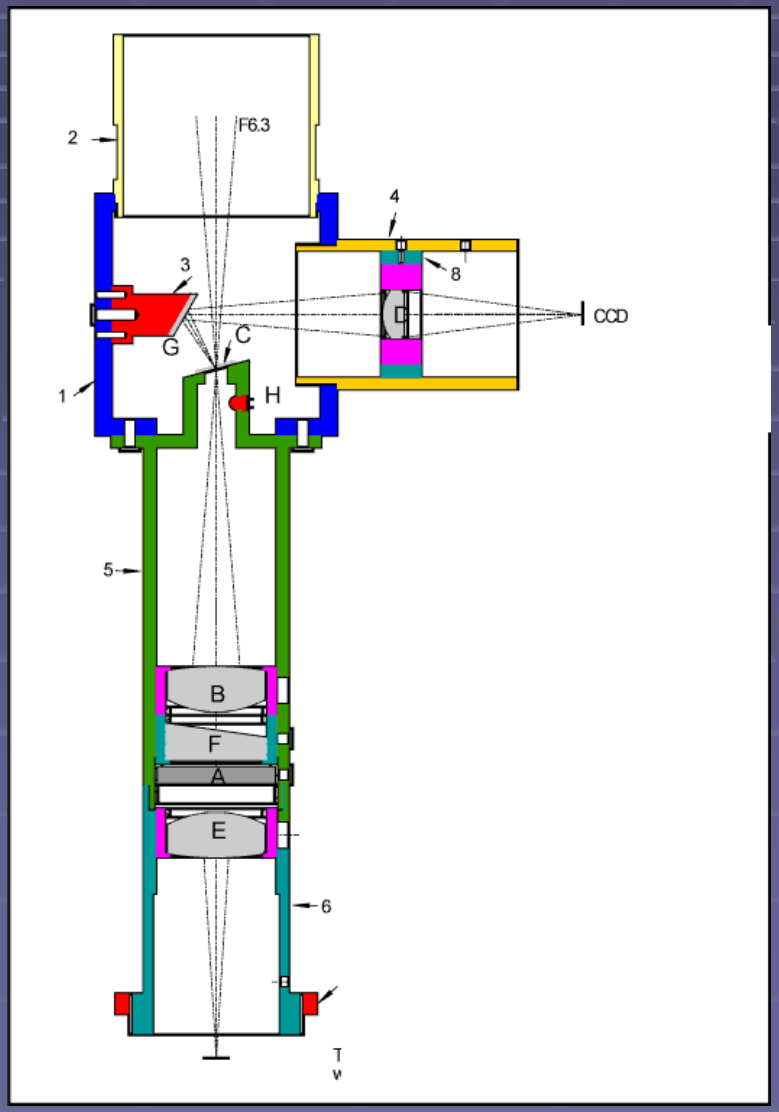
Open University TRAGOS (Vadim Burwitz 2004)

Mirror slit guider

Collimator lens

Grism

Camera lens

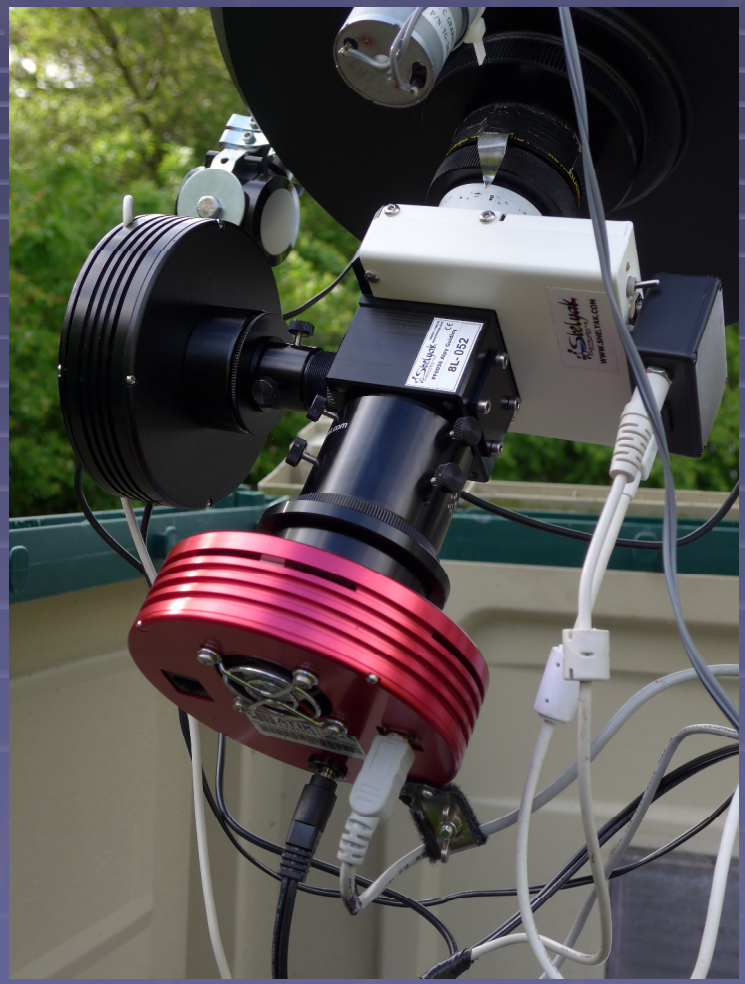


ALPY 600 at Three Hills Observatory

Celestron C11

Guider camera

Imaging camera



.63 focal reducer

Calibration module

Guider module

ALPY core module

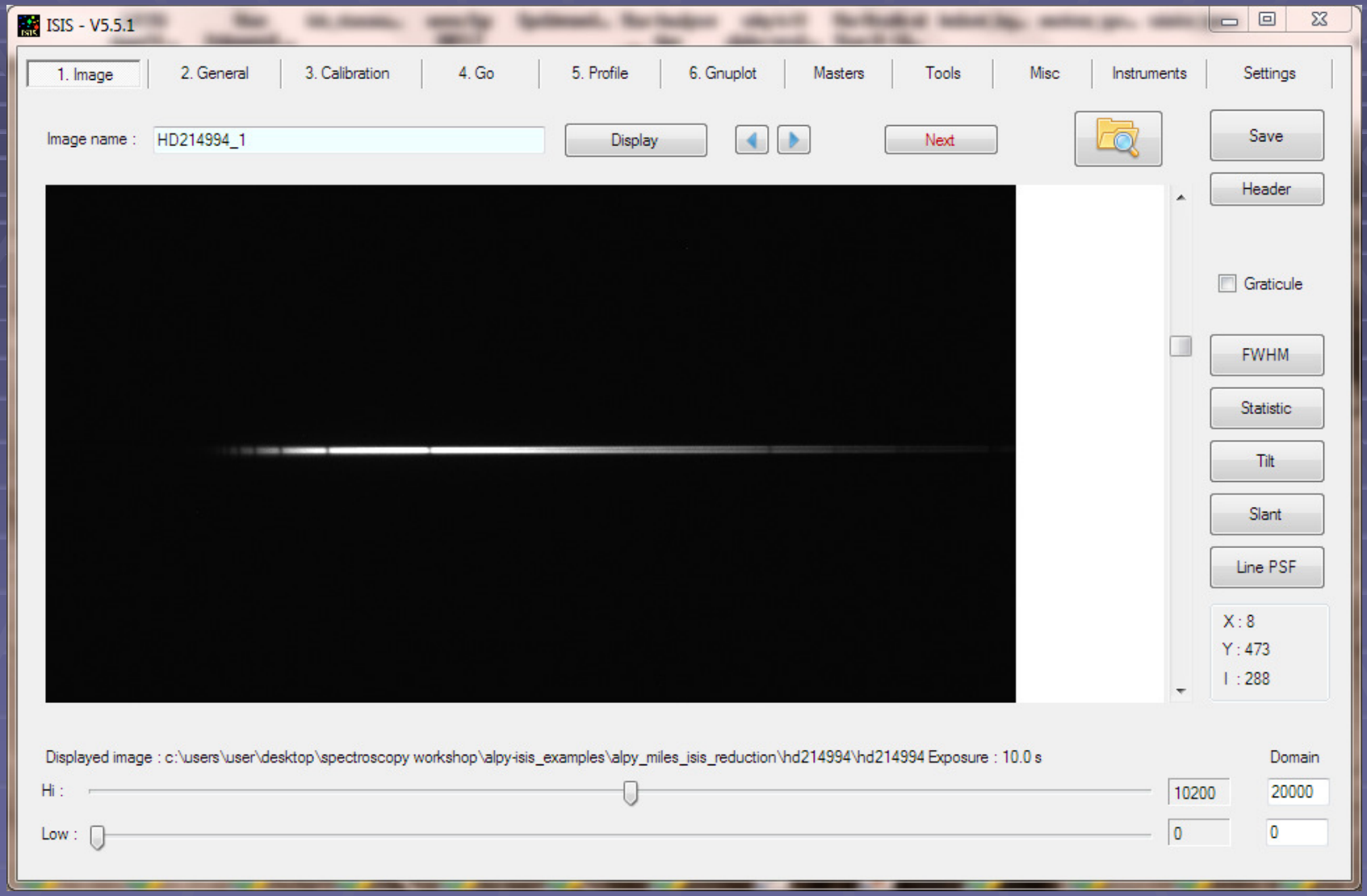
Measuring the spectra of MILES stars of various spectral types using an ALPY 600 2013-08-02

The Targets and observation details

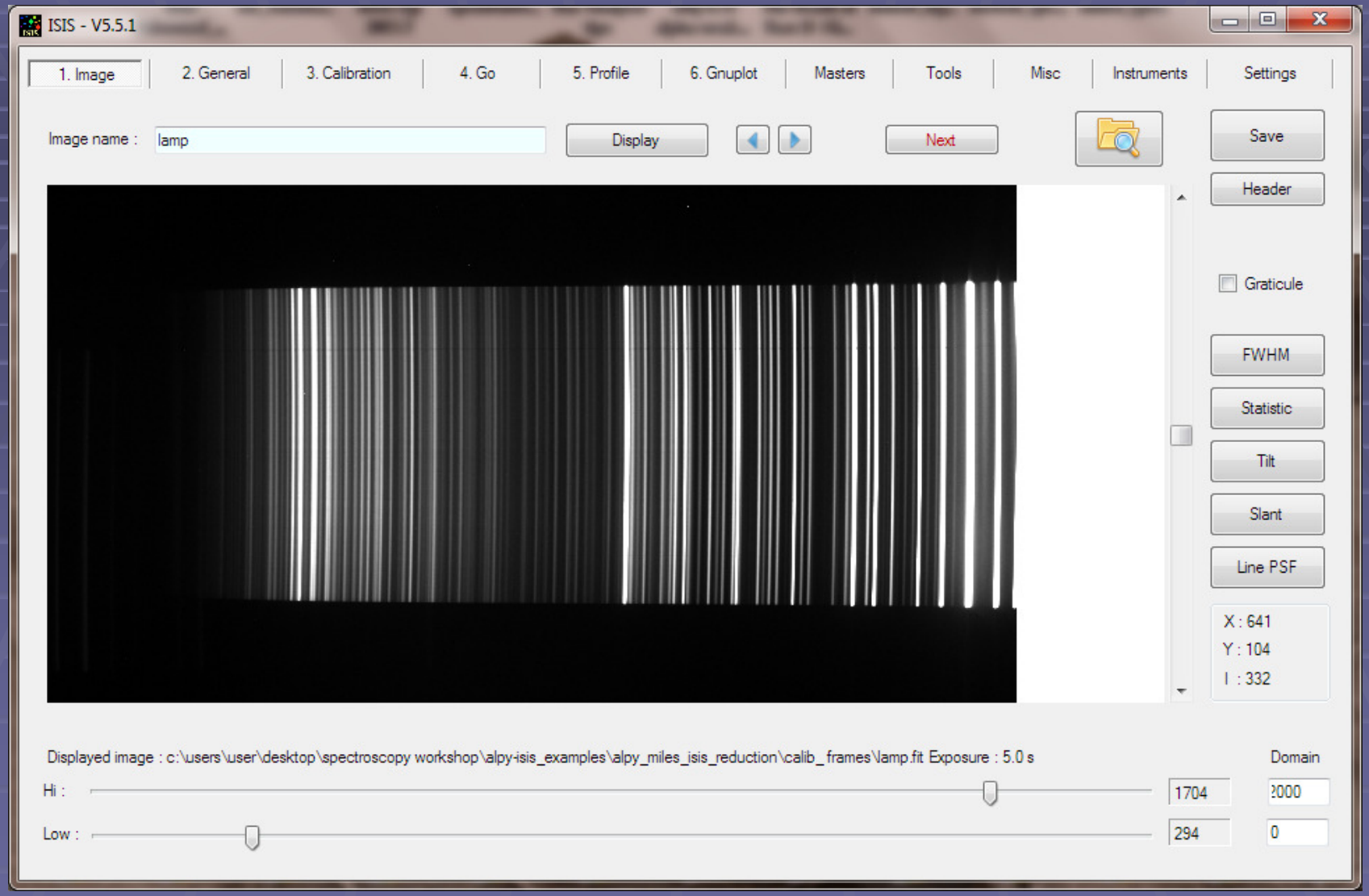
star	spec type	Vmag	time	az	alt	air mass	exposure
HD214994	A1v	4.8	22:05	93	40	1.6	20x10s
HD217014	G5v	5.4	22:20	100	34	1.8	10x10s
HD218031	K0iii	4.6	22:39	72	55	1.2	13x10s
			refocused				
HD218031	K0iii	4.6	22:43	73	55	1.2	10x10s
HD183324	A0v	5.8	22:56	179	38	1.6	20x 5s

(Intermittent thin cloud)

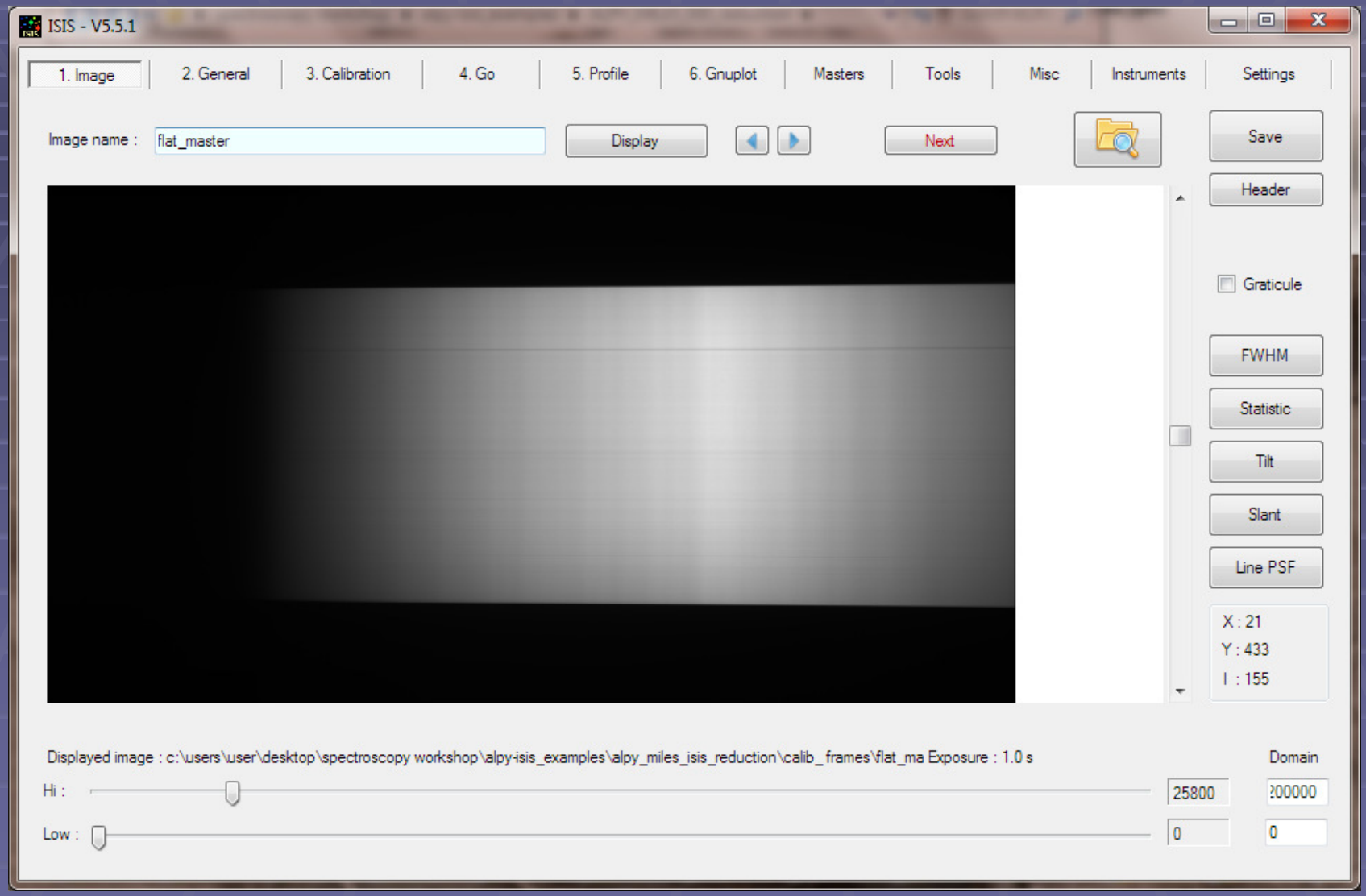
raw reference star spectrum HD214994 A0v



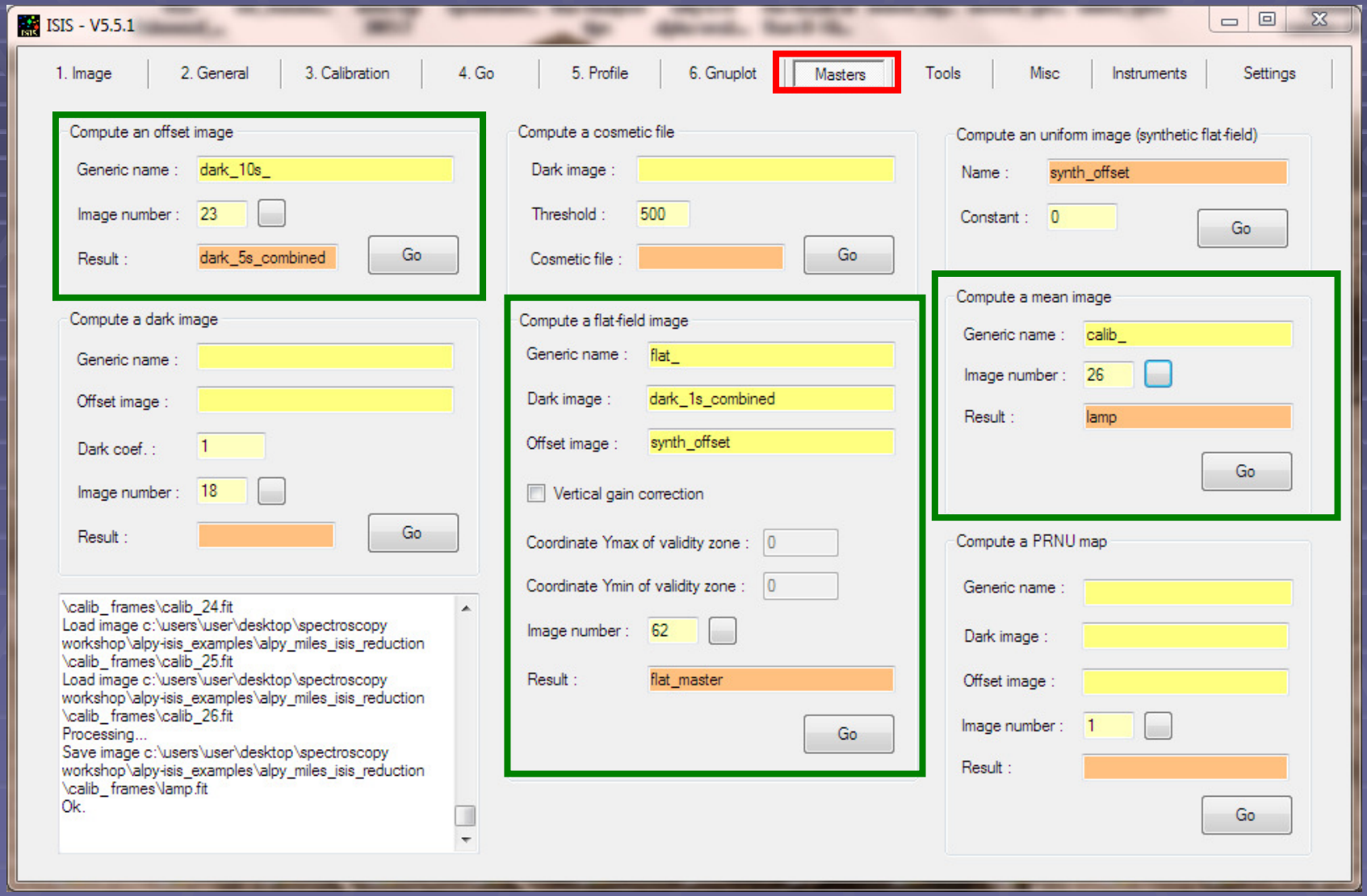
Neon / Argon lamp spectrum



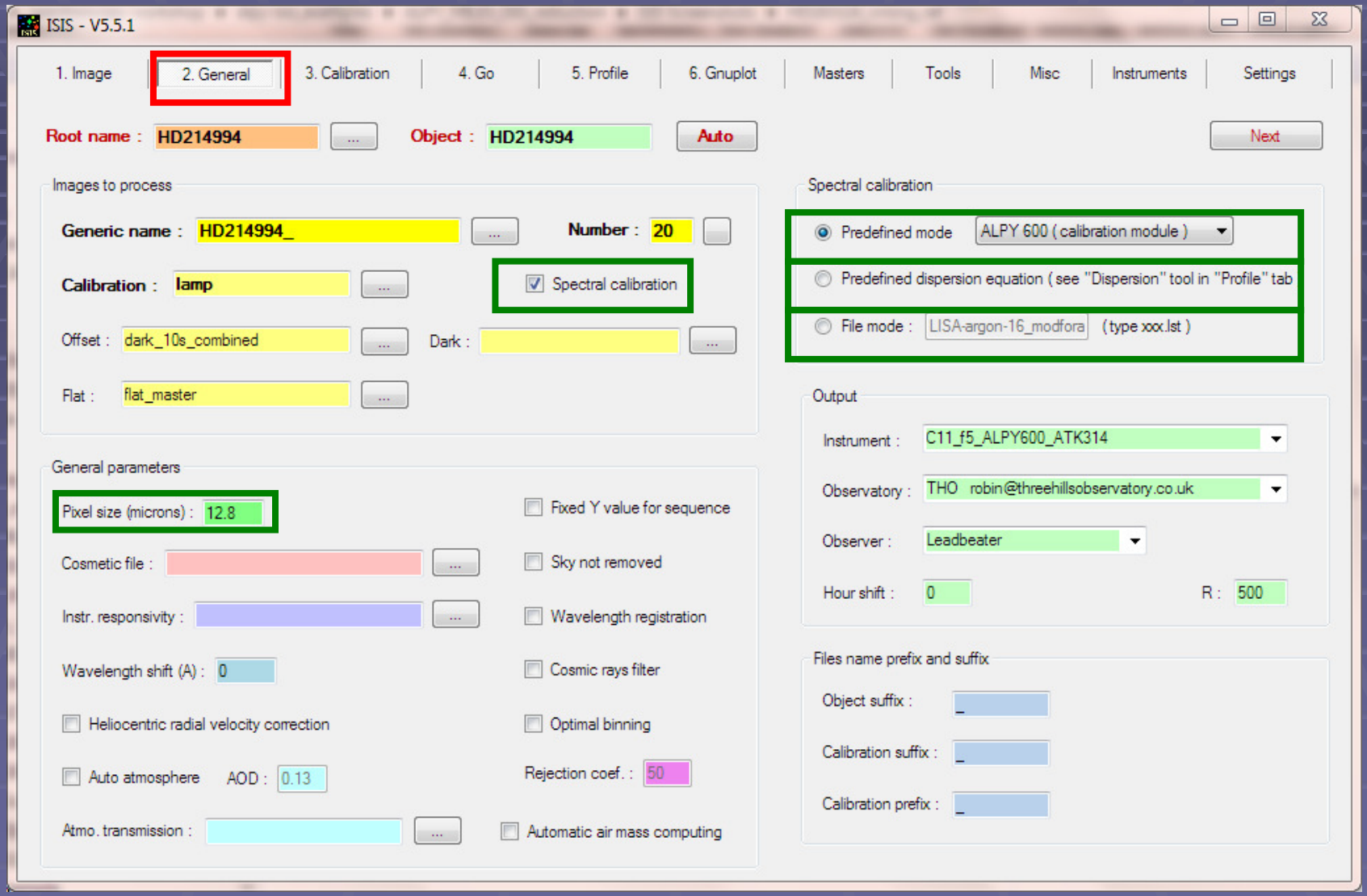
Tungsten Halogen lamp flat



Prepare master flat and offset images

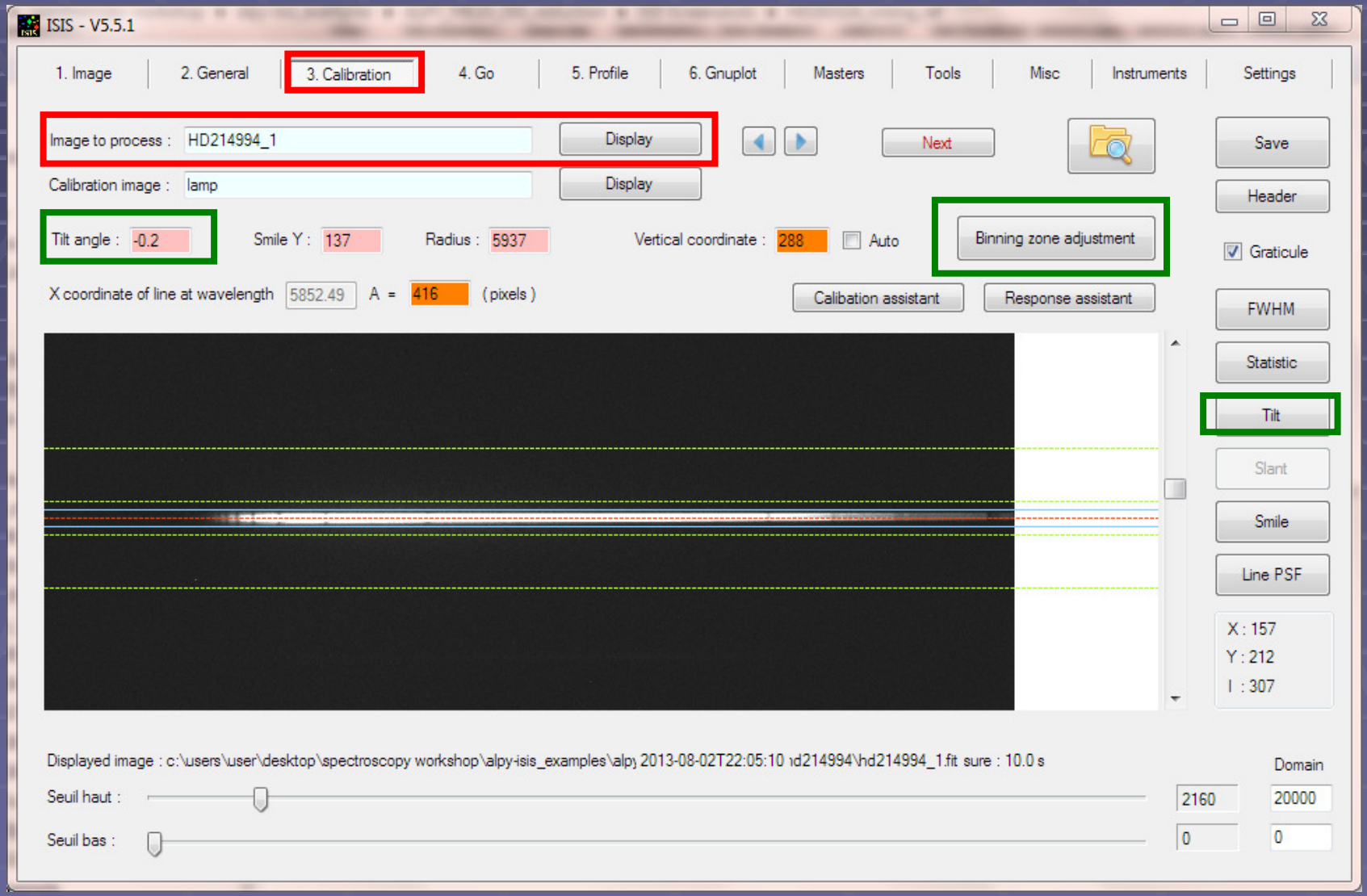


Wavelength calibration options

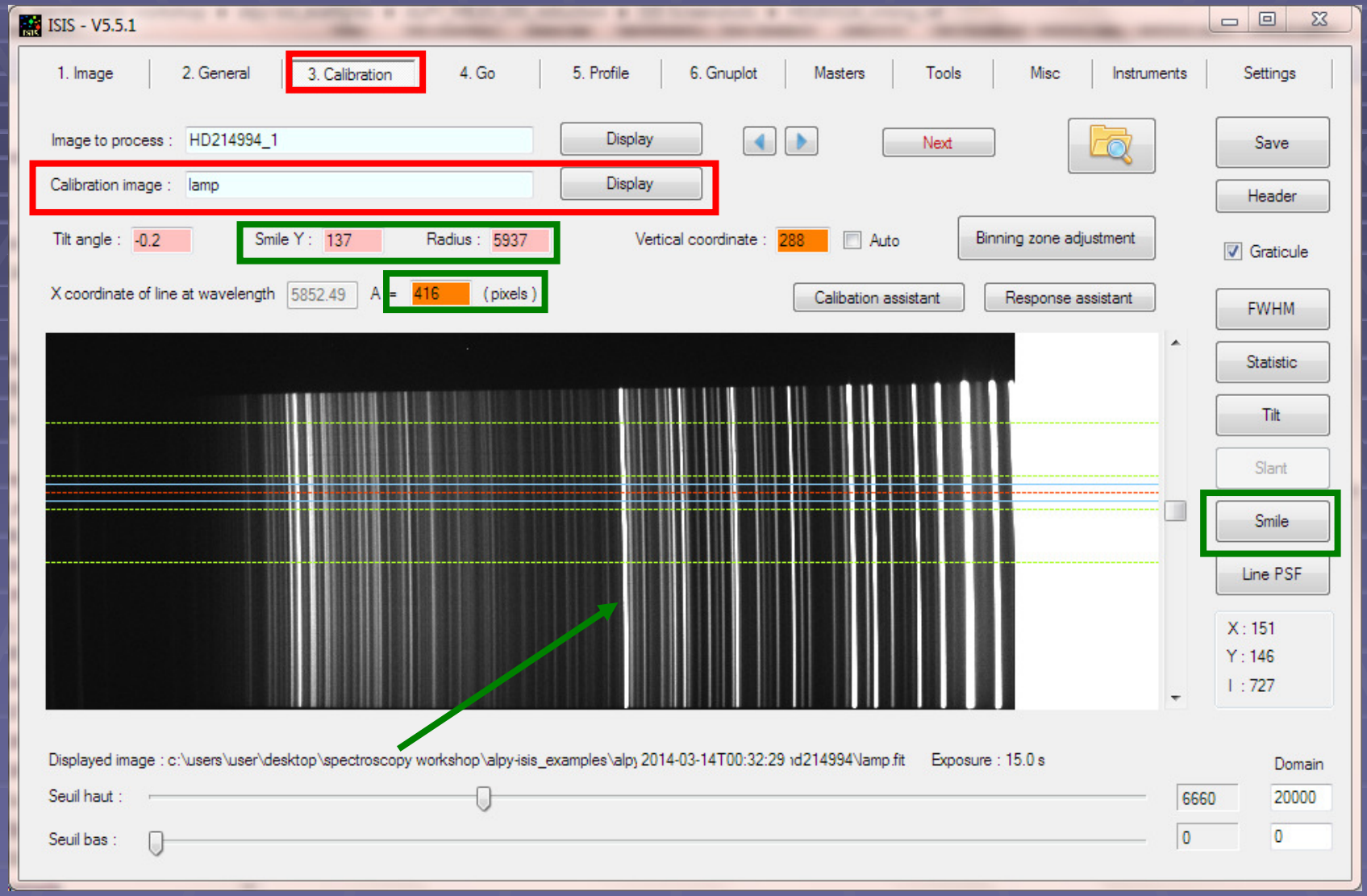


For this example use predefined mode

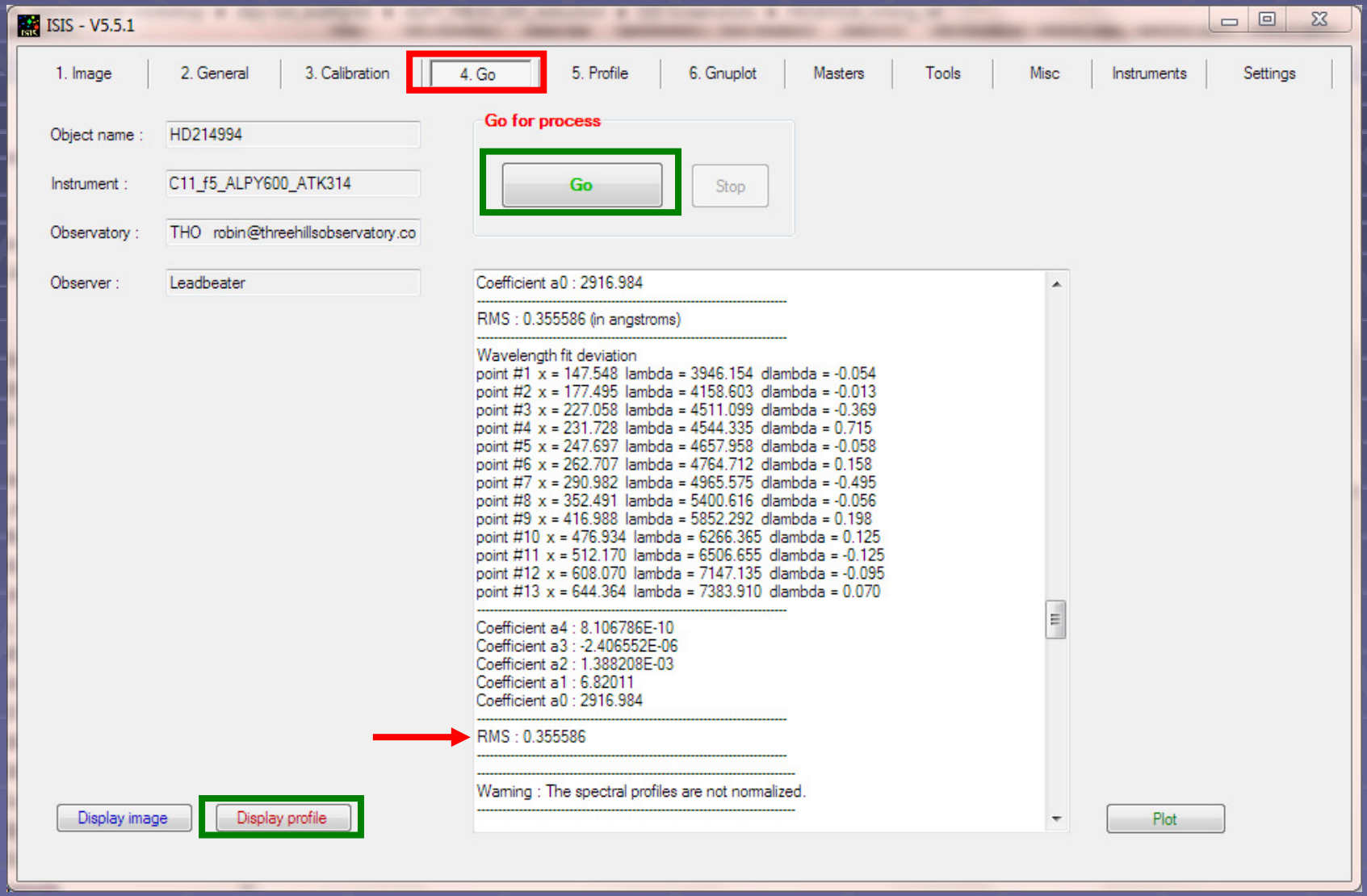
Correct spectrum tilt and select binning and sky background zones



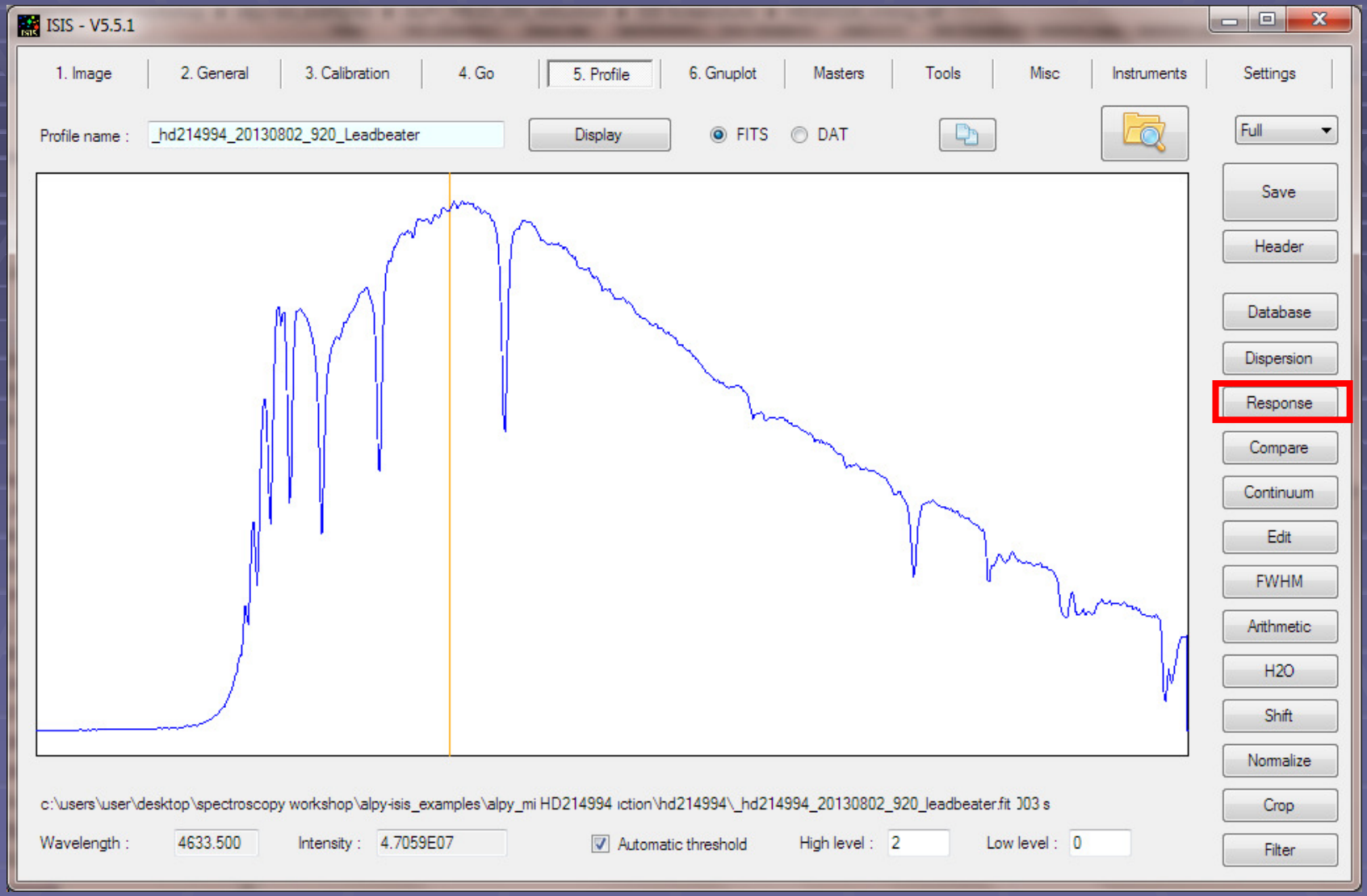
Correct for smile/slant of lines and enter location of reference line



Run the spectrum processing from raw images to wavelength calibrated profile

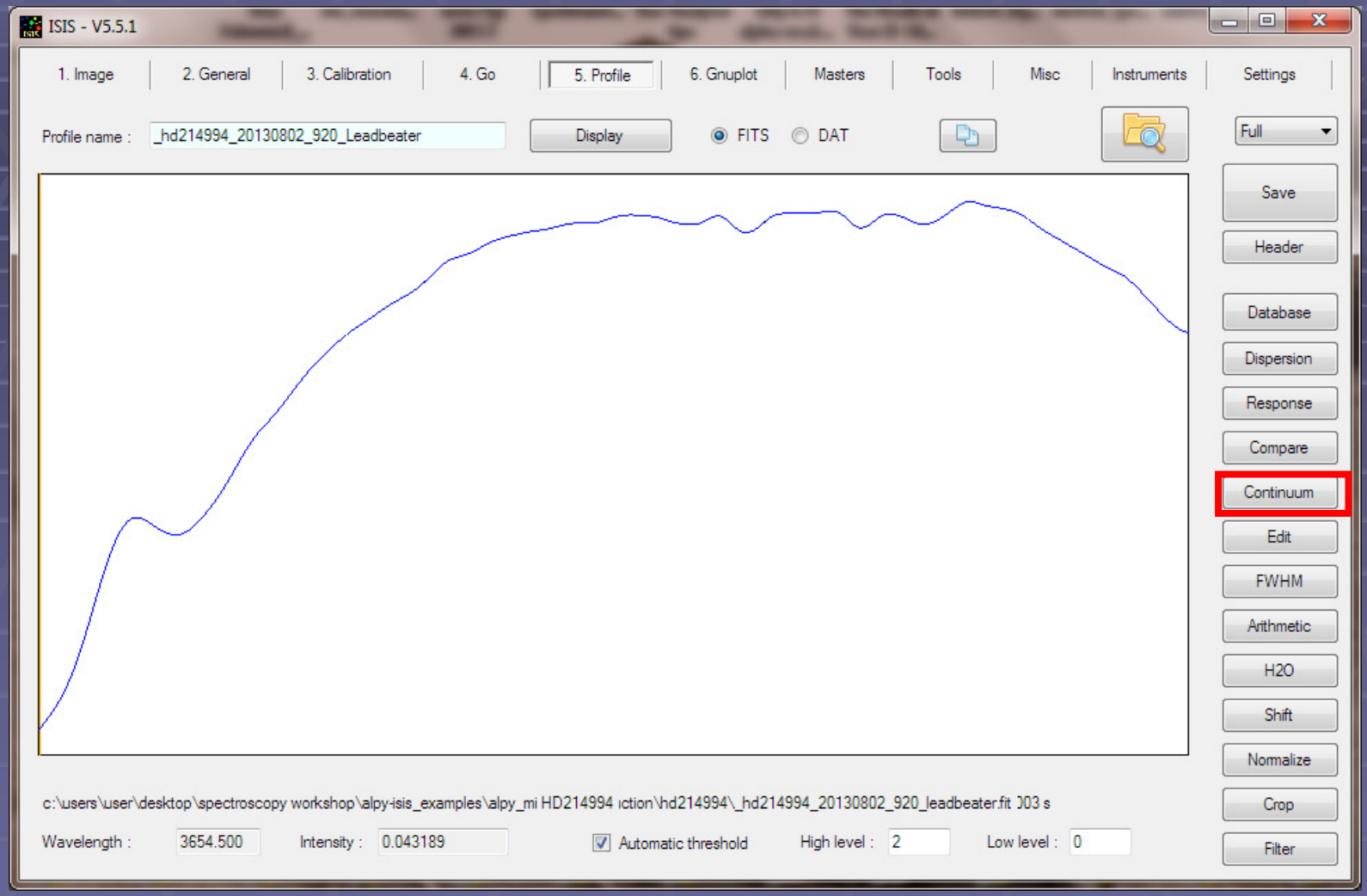


The wavelength calibrated profile



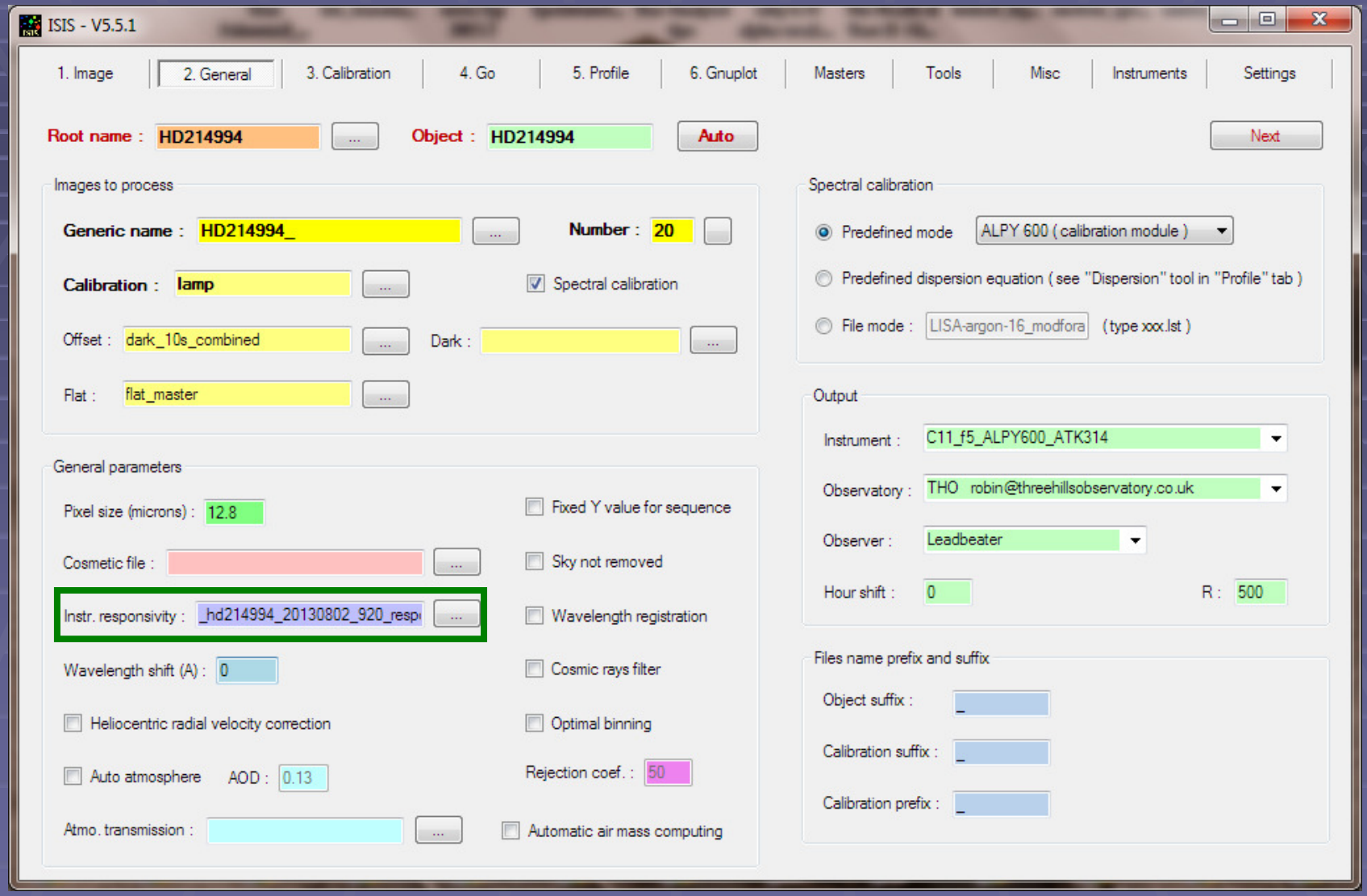
Calculate raw instrument response

Final instrument response curve

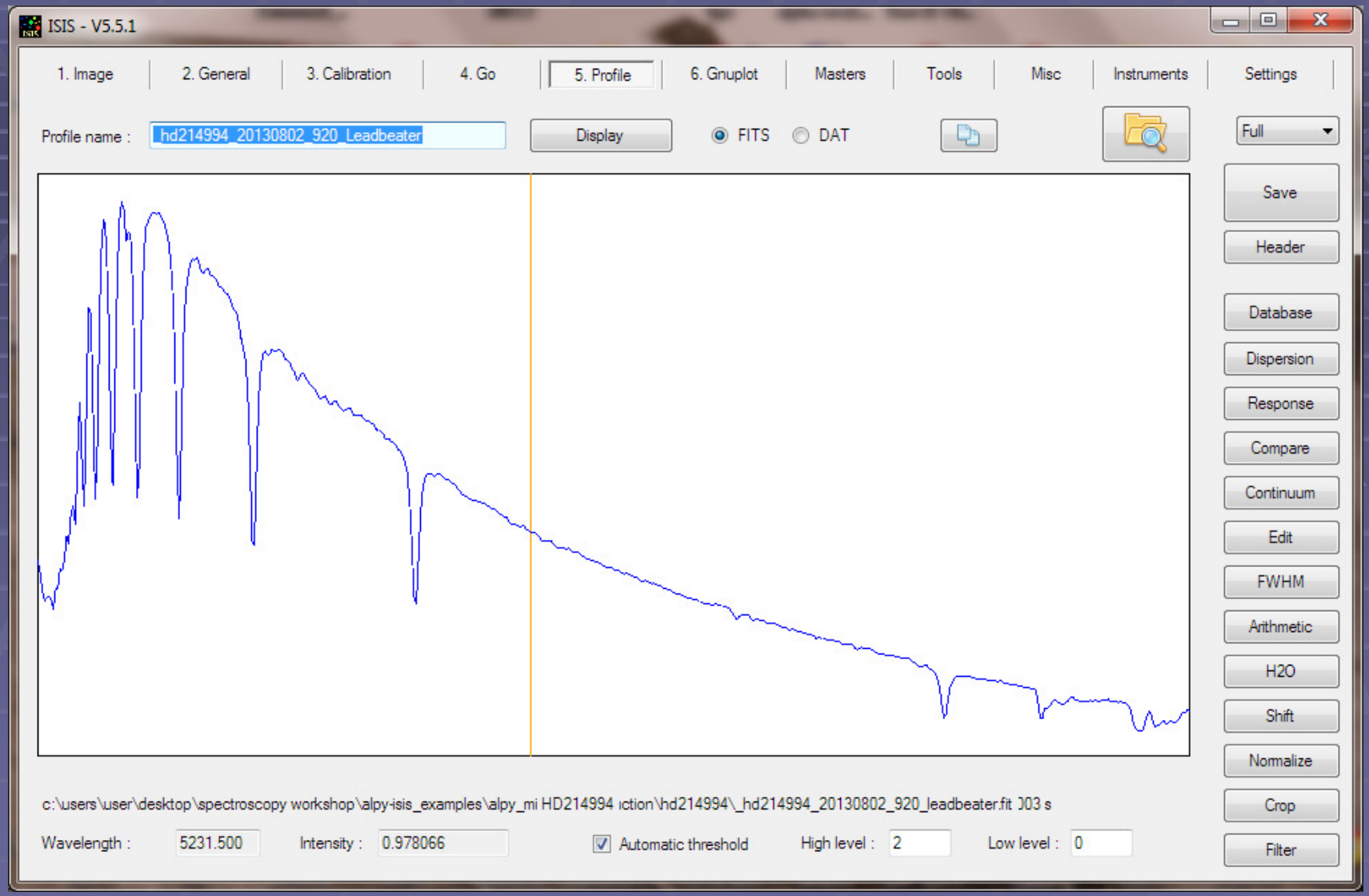


Save it!

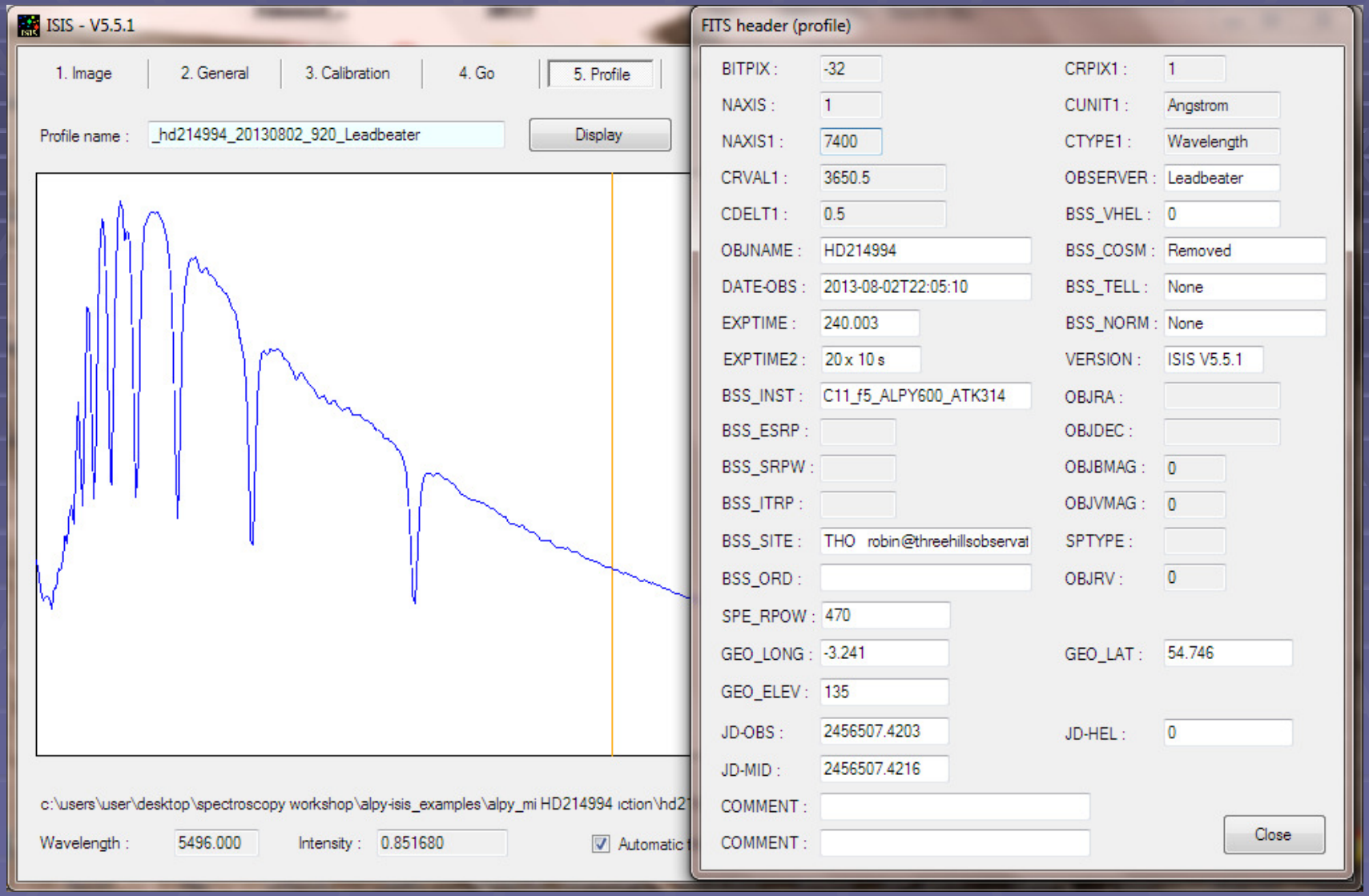
Re-run processing including instrument response correction



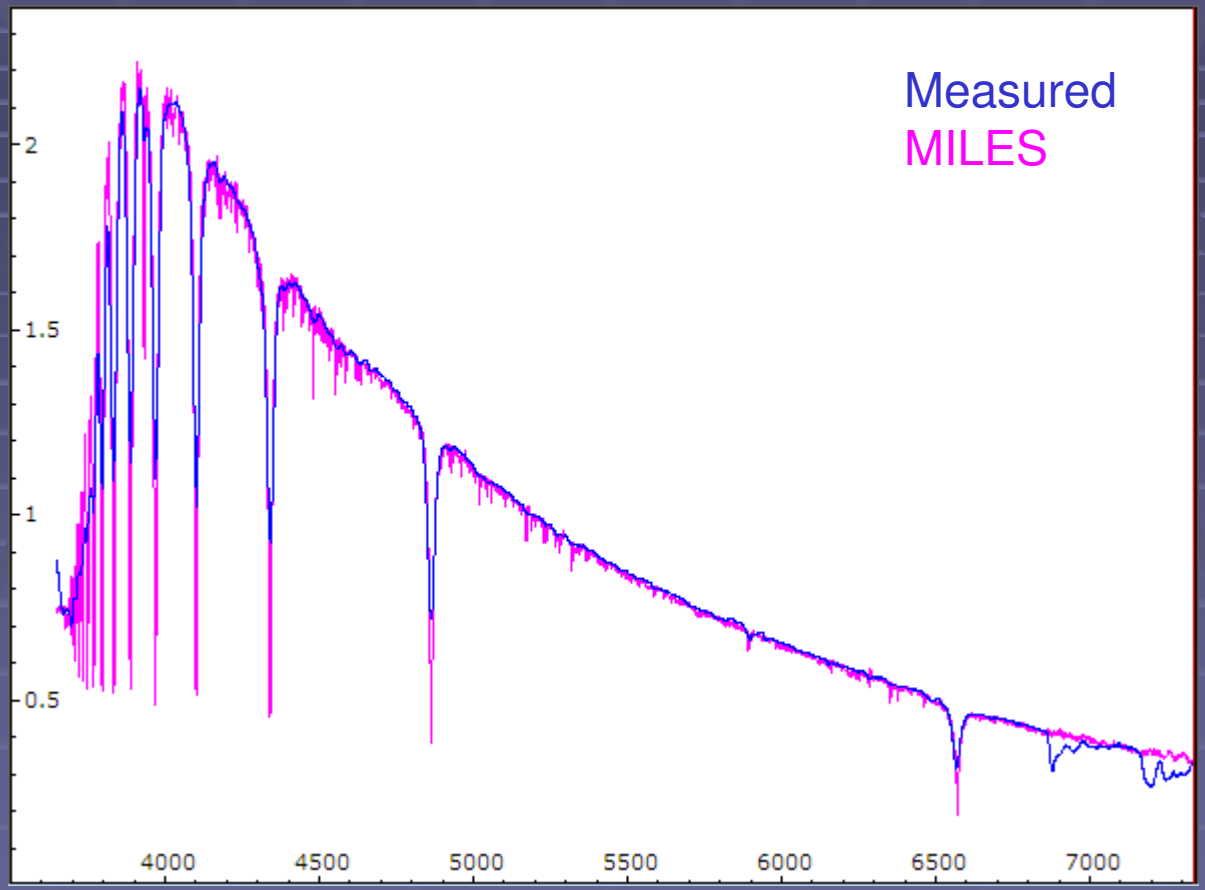
The final result calibrated in wavelength and relative flux



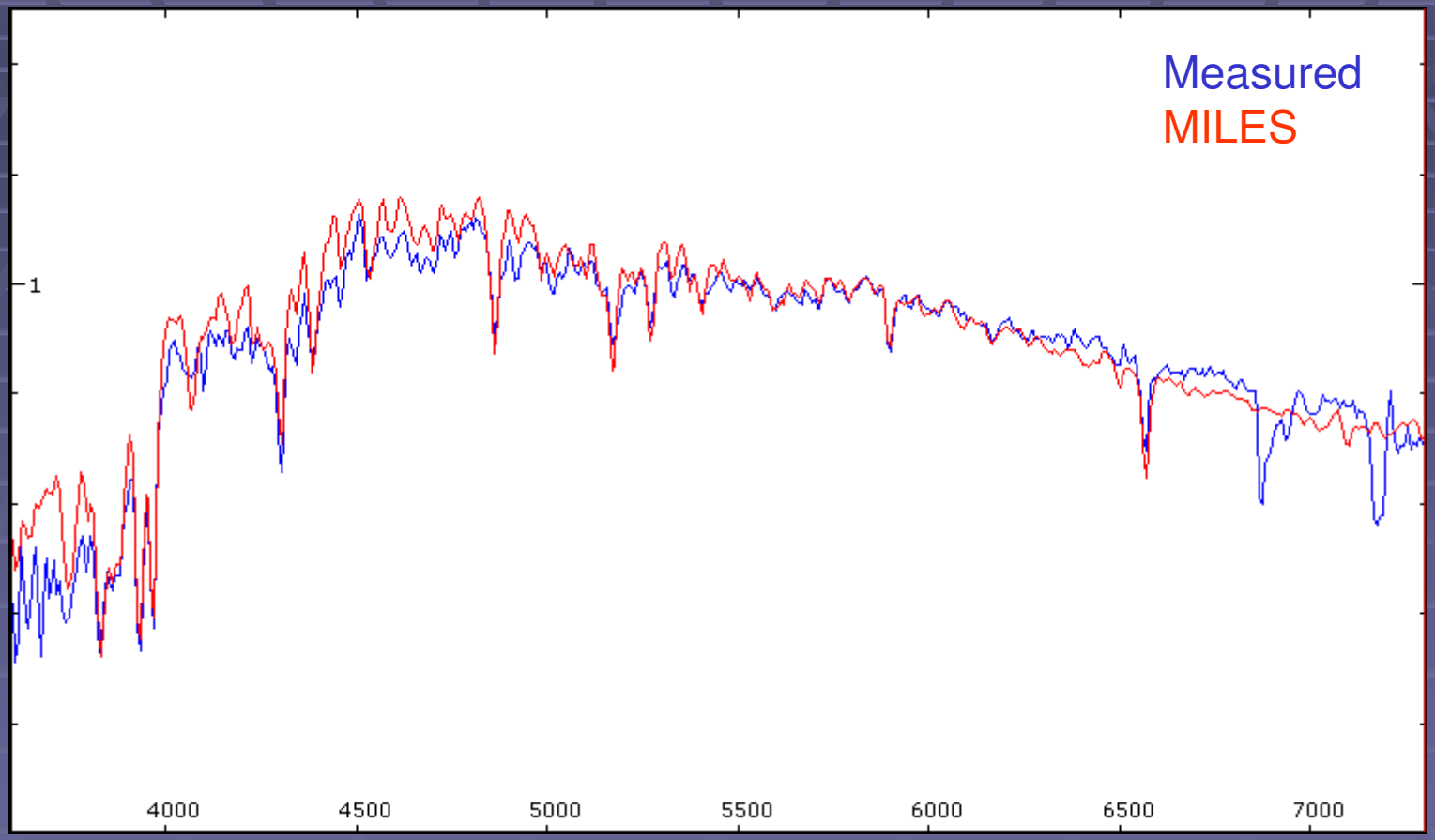
ISIS enters information about the observation in the FITS header



HD214994 A1v

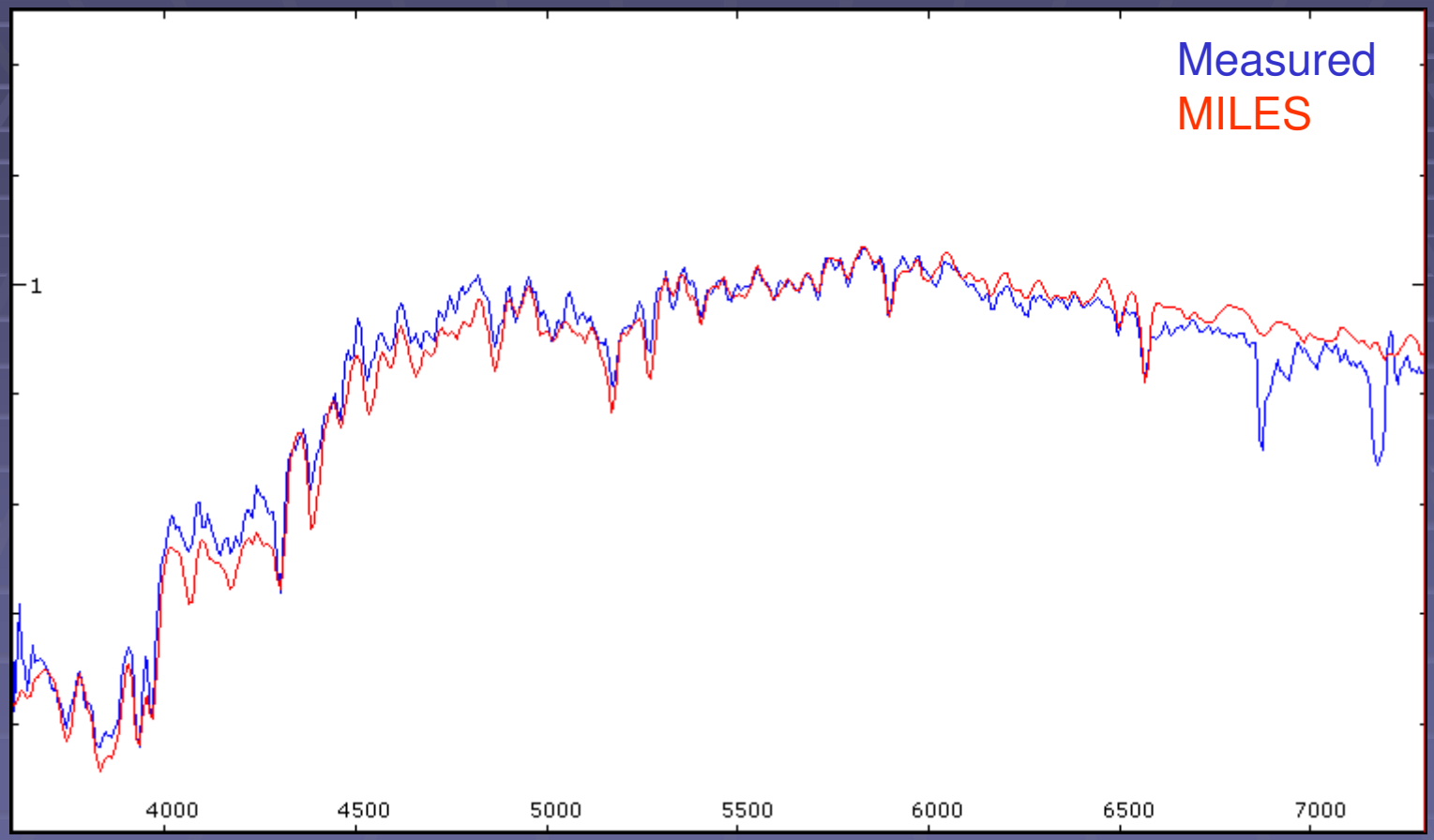


HD217014 G5v



Note slight error in continuum (high air mass 1.8 v 1.6 for ref star ?)

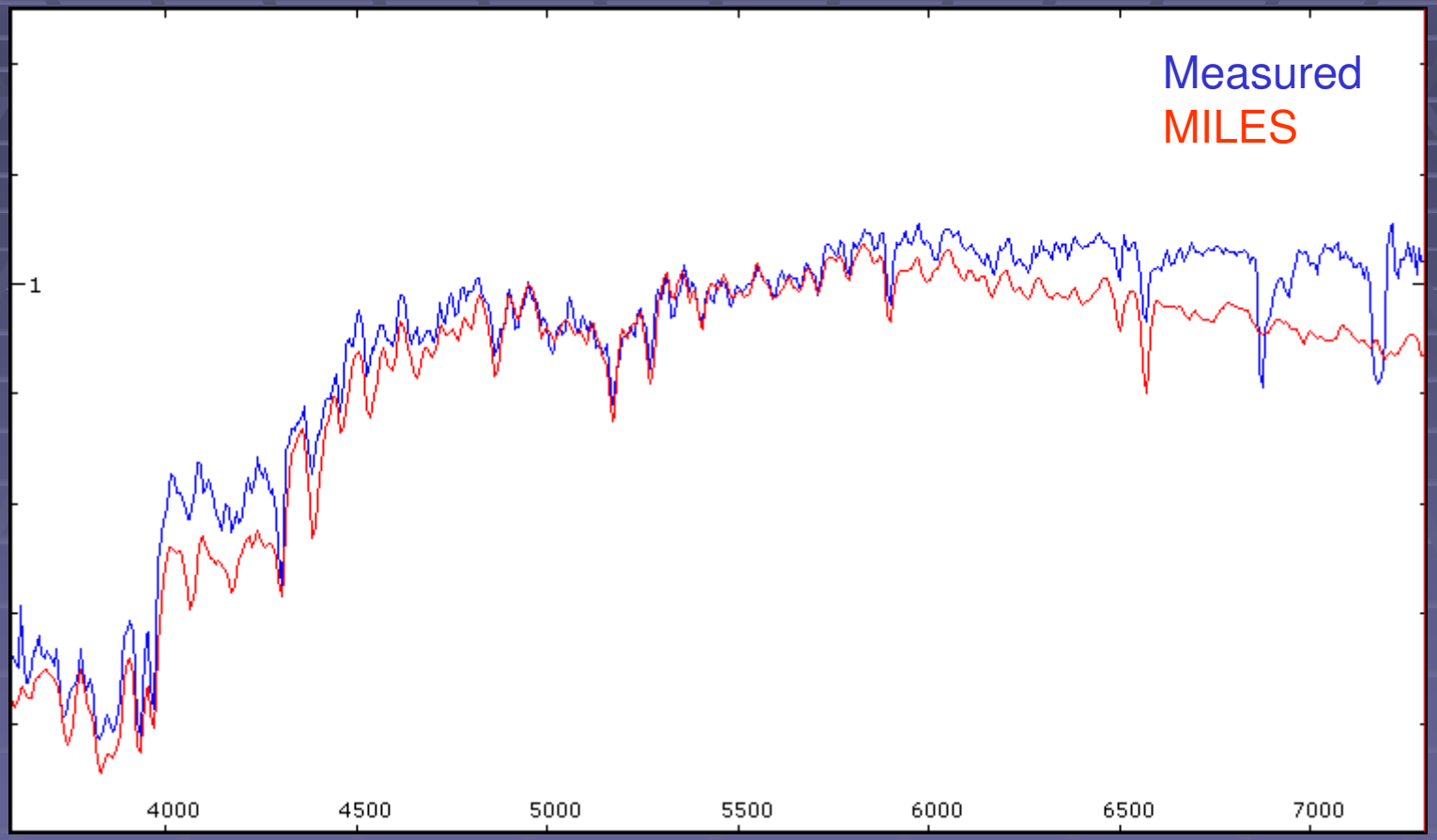
HD218031 K0iii



Small error in continuum (low air mass 1.2 v 1.6 ?)

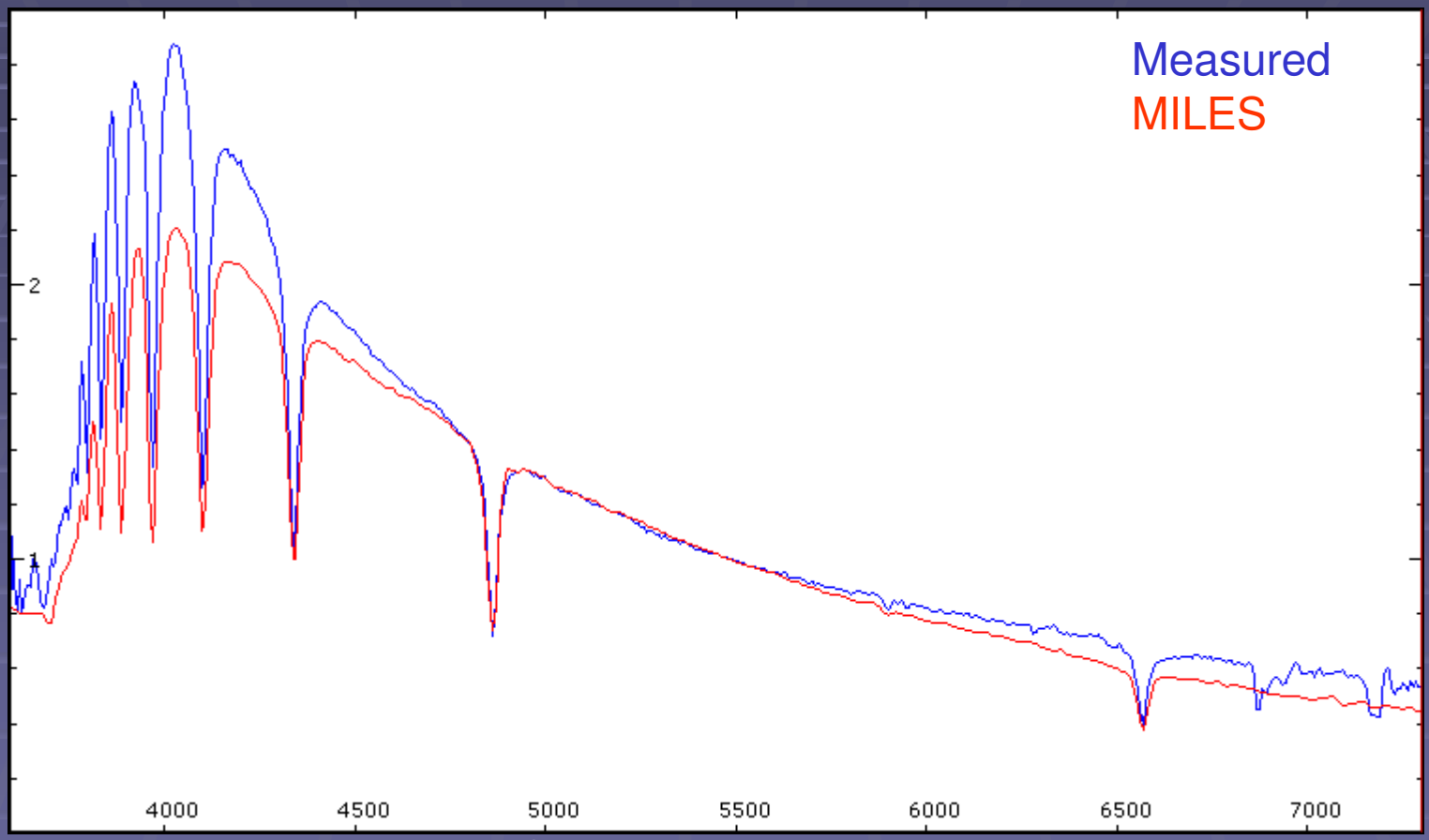
HD218031 K0iii

Refocused



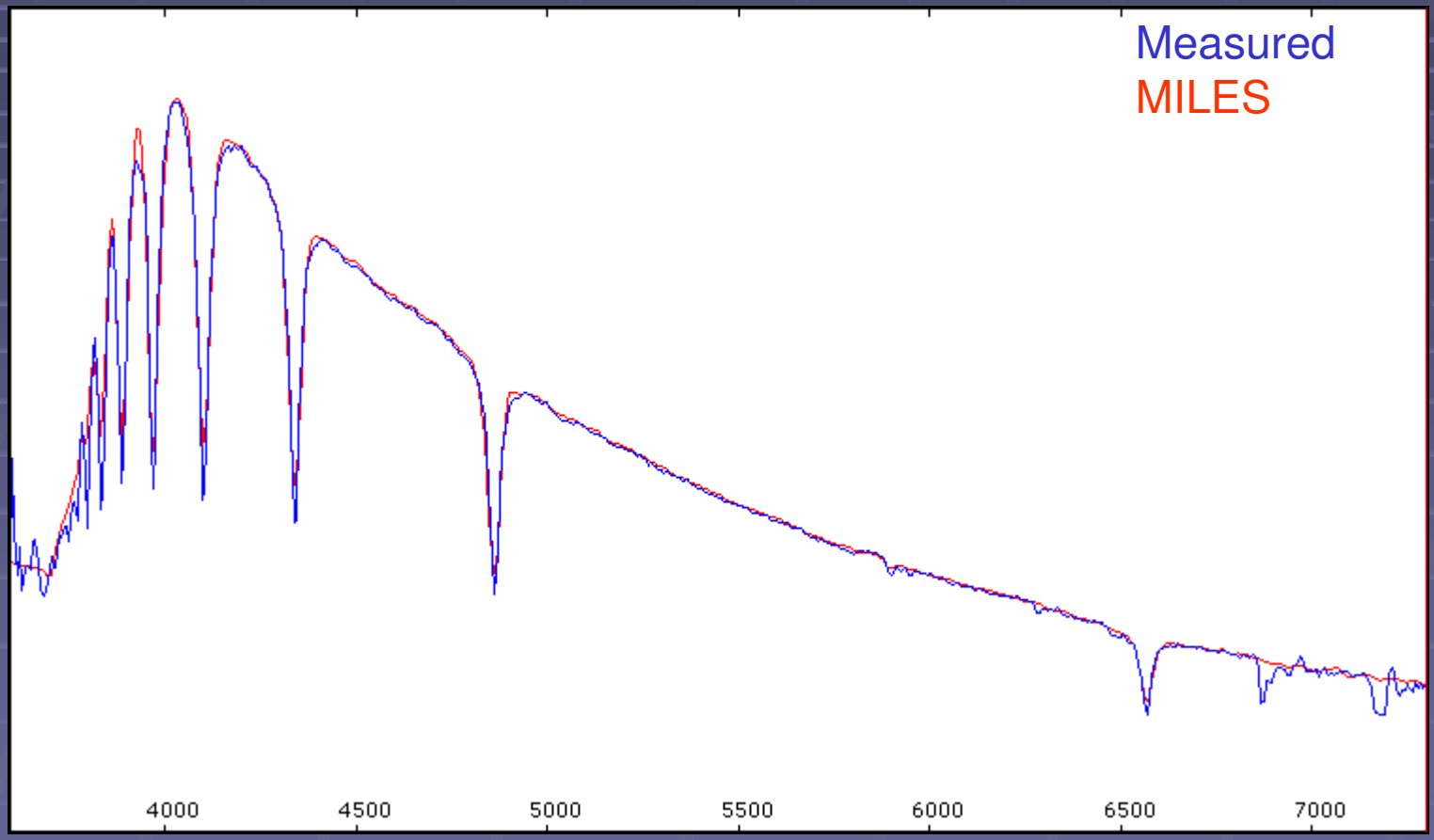
Note the significant change in continuum shape with focus change

HD183324 A0v

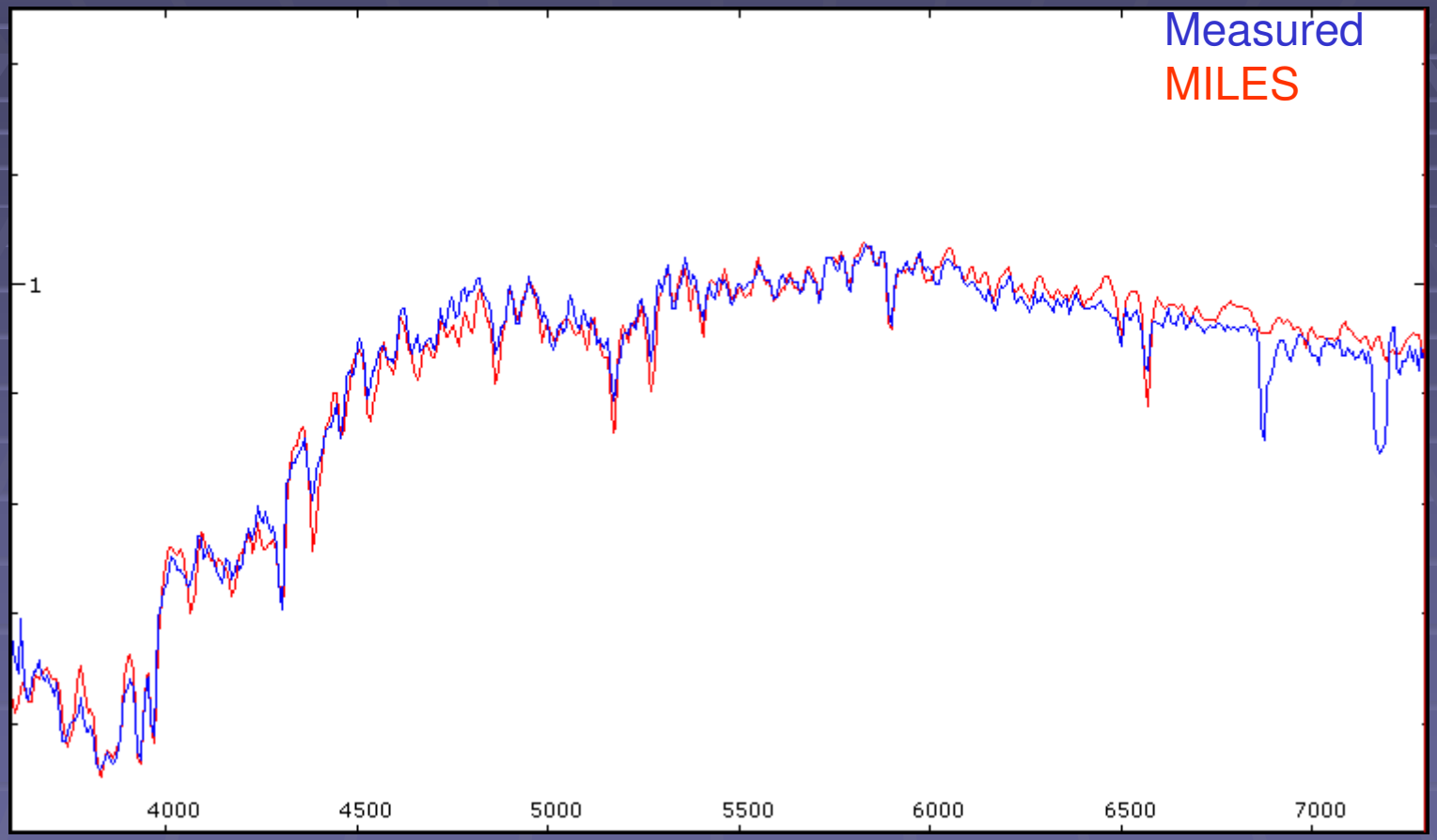


The error due to refocusing is clearly seen here too

HD183324 used to generate a new response



Refocused HD218031 spectrum corrected using new response



The continuum correction is now good

Using a modified ALPY spectrograph for Supernova identification

Potential Supernovae, once discovered need spectroscopic follow up for confirmation and identification of type

With the increased use of automated surveys to detect transients, the emphasis for the amateur is shifting from discovery to follow up.

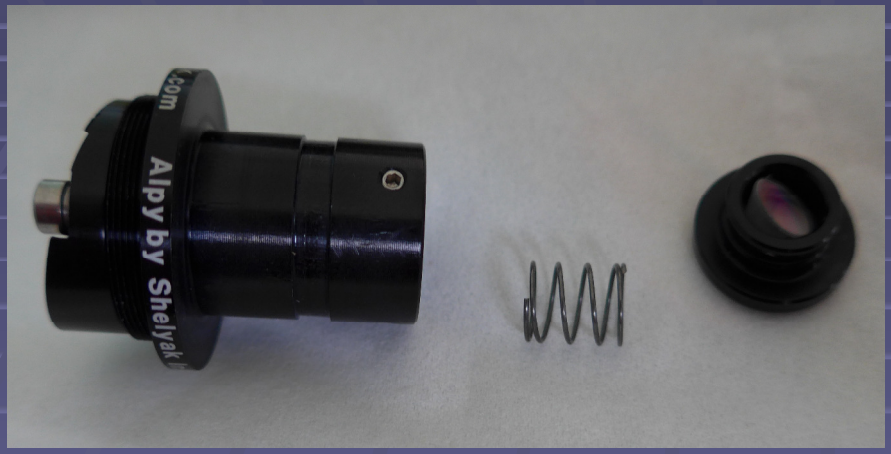
Except for a few bright examples, Supernova spectroscopy has proved tough for the typical amateur.
(To be useful, magnitudes fainter than mag 16 need to be reached)

Low resolution R~100 is sufficient to confirm and produce a preliminary classification so within range of the Star Analyser but getting results below ~mag 15 has proved difficult

A potential alternative approach is to use a slit spectrograph designed for the minimum resolution required

An ALPY 600 spectrograph was therefore modified to reduce its resolution to ~130

MODIFYING THE ALPY SPECTROGRAPH (ALPY 200)



Removing the the Grism from the ALPY Core Module

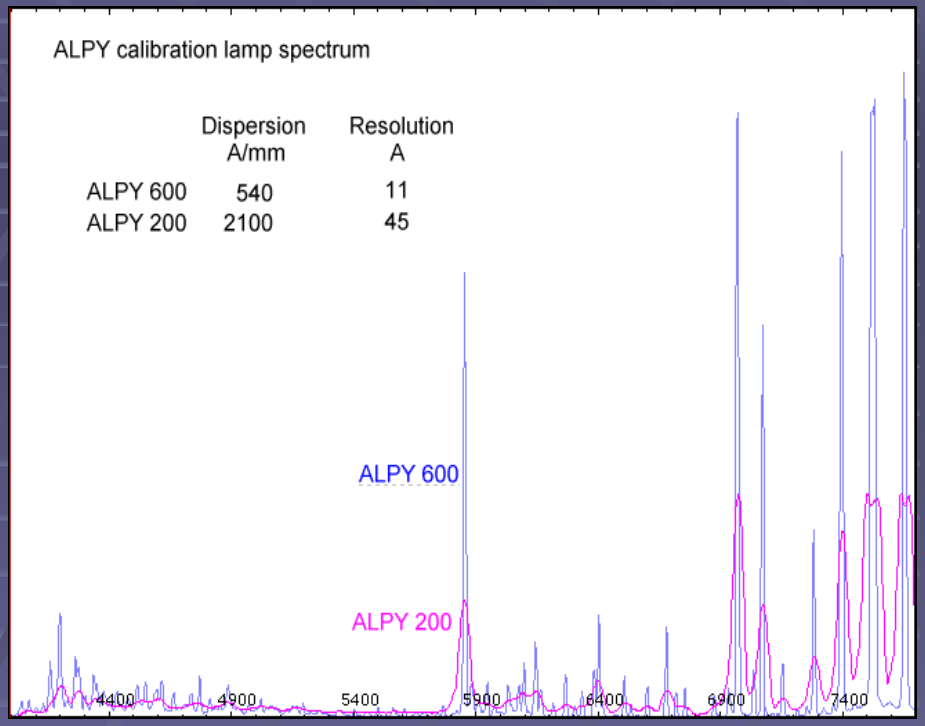
Taking care that the collimator lens does not fall out!

Standard 600 l/mm Grism

Modified 200 l/mm Grism (Made using the Star Analyser 200 master grating)

BENCH TESTS - ALPY 200 v 600

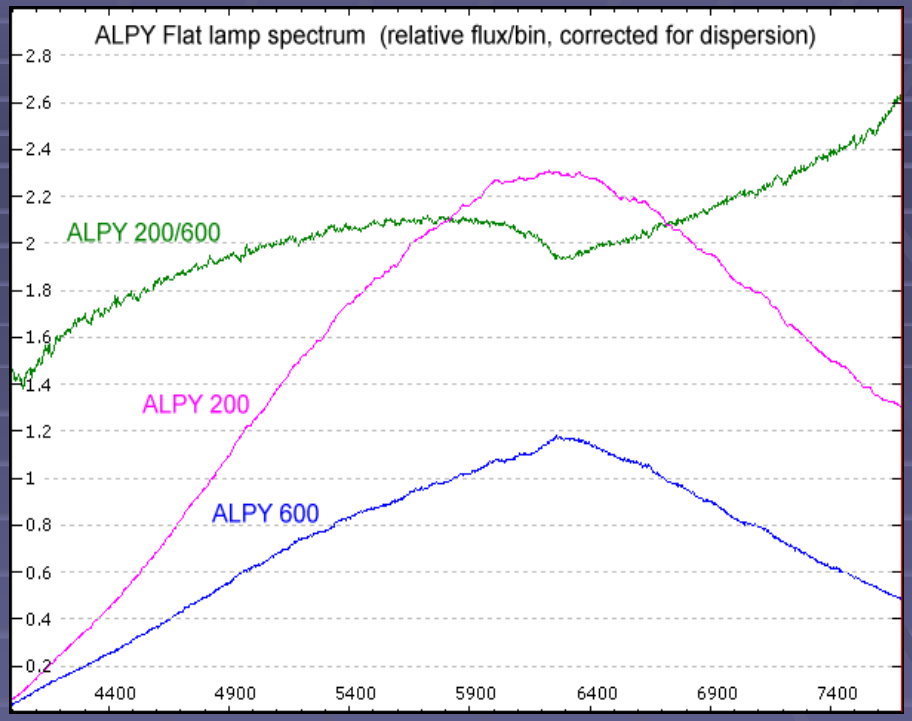
Resolution



The dispersion and resolution of the ALPY200 are ~ 4 lower compared with the ALPY 600

R = 130 at 6000 A is sufficient for supernova identification for example

Efficiency



The efficiency of the 200 l/mm grism is ~ 2x that of the 600 l/mm grism

Combining this with the 4x reduction in dispersion results in an **8x brighter spectrum**

ADVANTAGES OF THE ALPY 200

Compared with the Star Analyser

The slit reduces the sky background level by a factor of ~100, reducing sky noise and eliminating interference from field stars and their spectra.

The mirror slit guider allows longer individual exposures, reducing the total camera read noise contribution.

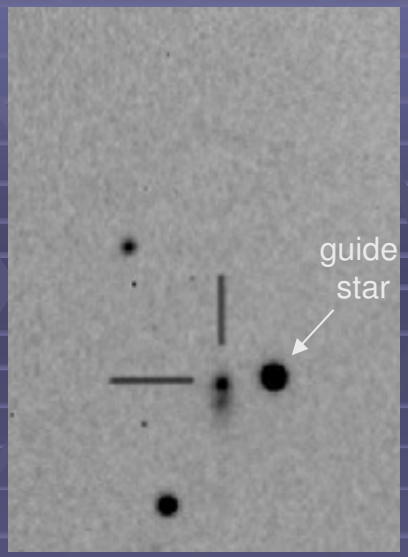
The fully collimated optics produce a sharp spectrum over the full wavelength range, allowing a lower dispersion to be used for the same resolution.

Compared with the ALPY 600

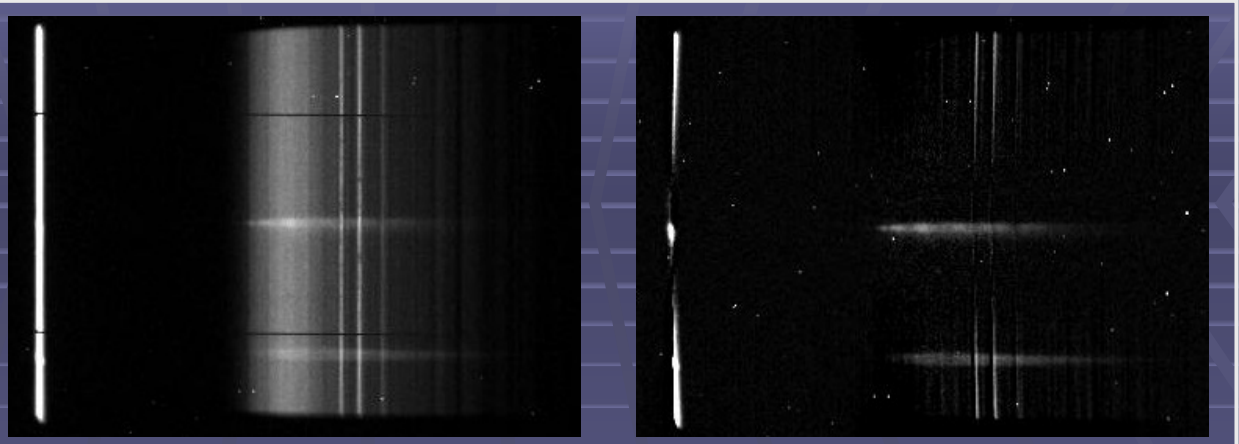
The higher efficiency of the 200 l/mm grism increases the flux in the spectrum.

The reduced dispersion minimises the camera thermal noise contribution compared with increasing the effective pixel size by in camera binning

PSNJ15024996+4847062_20140521 in PGC 2325560 (mag ~16)
discovered amateurs R. Gagliano, J. Newton T. Puckett 2014-05-13

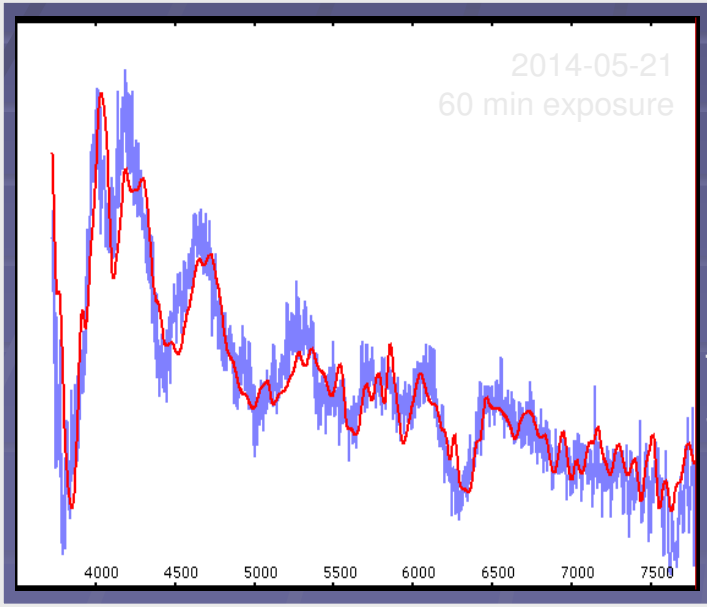


Discovery image



Spectrum image before and after sky subtraction

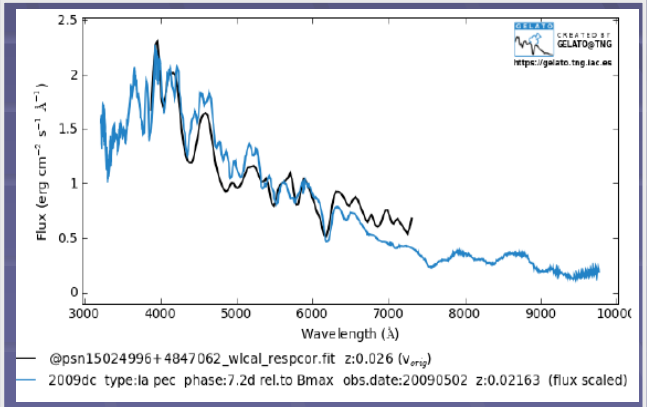
Spectrum of the supernova (centre).
The lower spectrum is a field star caught in the slit



Reduced spectrum (red)

overlaid on professional spectrum (blue) taken 6 days earlier (ATel 6140)

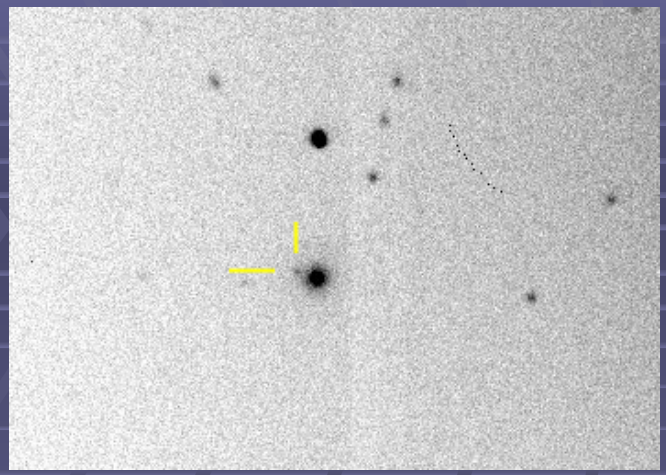
The spectrum shows a strong Si II 6150 absorption feature redshifted to 6300 A (characteristic of type Ia)



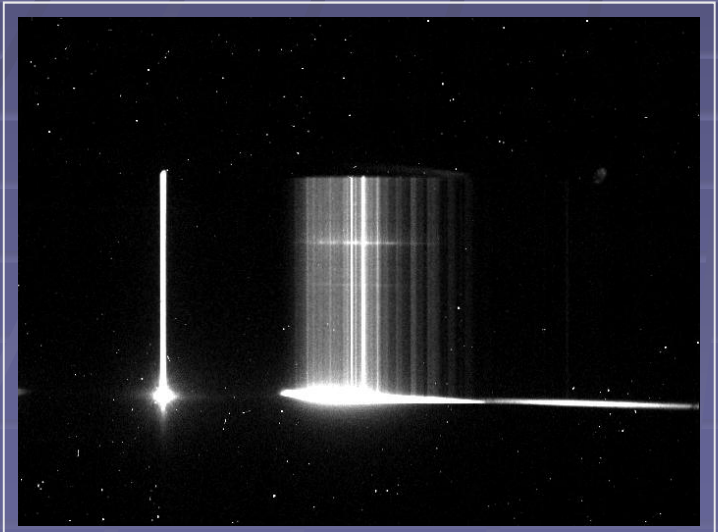
GELATO

supernova identification program gives an excellent fit to type Ia a few days after maximum

ASASSN 15fa in NGC 6319 29 days after discovery at mag ~17.5

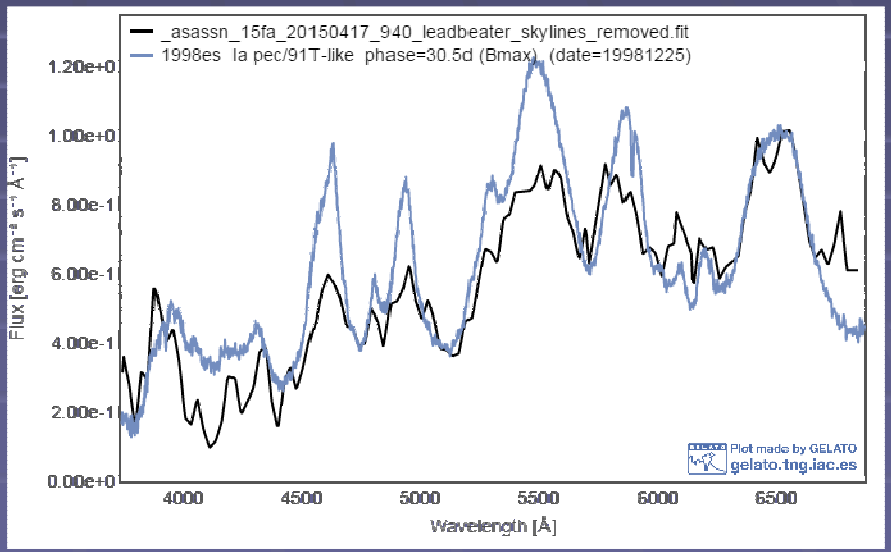


guider image (15x 20s)



raw spectrum
(bright star below is mag 11)

ASASSN 15fa was discovered by the All Sky Automated Survey for Supernovae on 2015-03-17 (ATel 7245) and identified from a spectrum taken by the Asiago Transient Classification Program as a type 1a supernova (ATel 7253).



ALPY 200 spectrum (black) compared
With best fit GELATO spectrum at 30 days