Simulation of NIRSpec exposures

Bernhard Dorner, ESR CRAL

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This talk is brought to you by:

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Overview

- NIRSpec simulations: How and what?
- Electron rates for spectra: Spatial and spectral features
- Readout simulation: final data example

How: the Instrument Performance Simulator (IPS)

- Development of CRAL (Piqueras et al. 2010)
- Simulate JWST OTE + NIRSpec
- Modules for
  - Fourier propagation
  - Geometrical transforms
  - Radiometry
  - Detector readout

How: IPS model data and results

How: IPS model data and results

System data

Instrument model

How: IPS model data and results

System data

Source data

Instrument model

Electron rate maps

How: IPS model data and results

System data

Source data

Readout simulation

Instrument model

Electron rate maps

Realistic exposure

What: ground & space

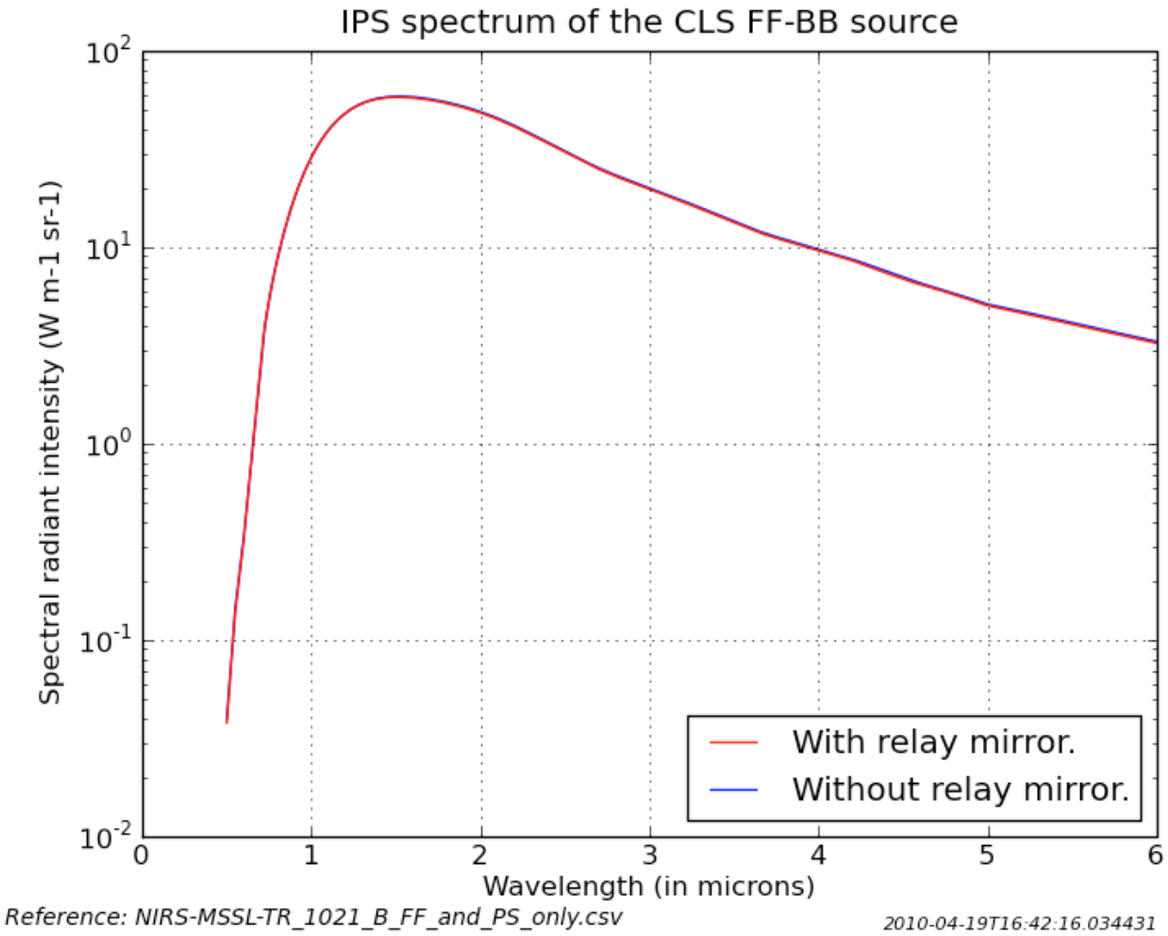
- Ground calibration (setup described by Xavier Gnata)
  - Prepare test campaign (simulations, fake data)
  - Verification of IPS and instrument
- In orbit
  - Observation preparation and verification
  - Possible input for data processing

Source: CLS
Broadband flatfield

NIRSpec optics:
Clear filter, prism

MSA:
Long slit

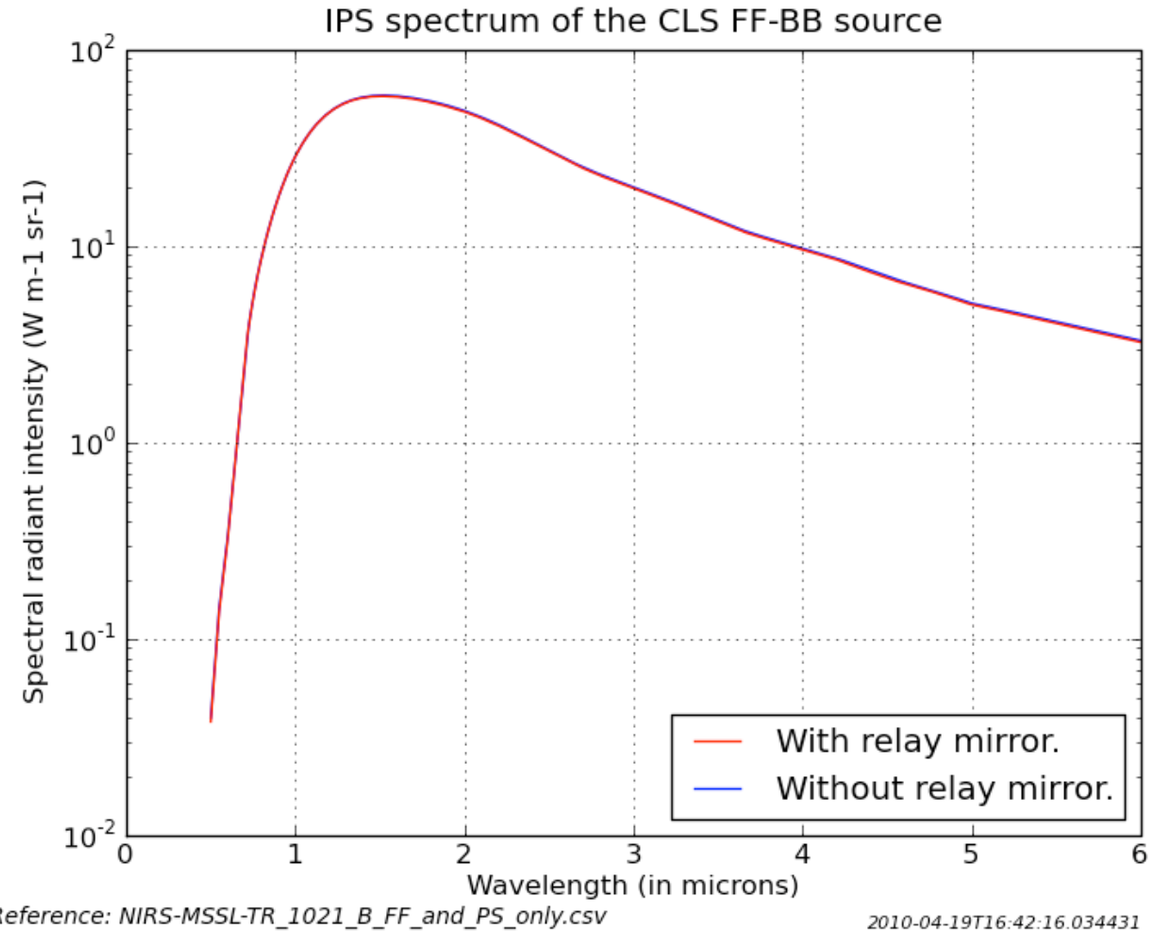
Dispersion

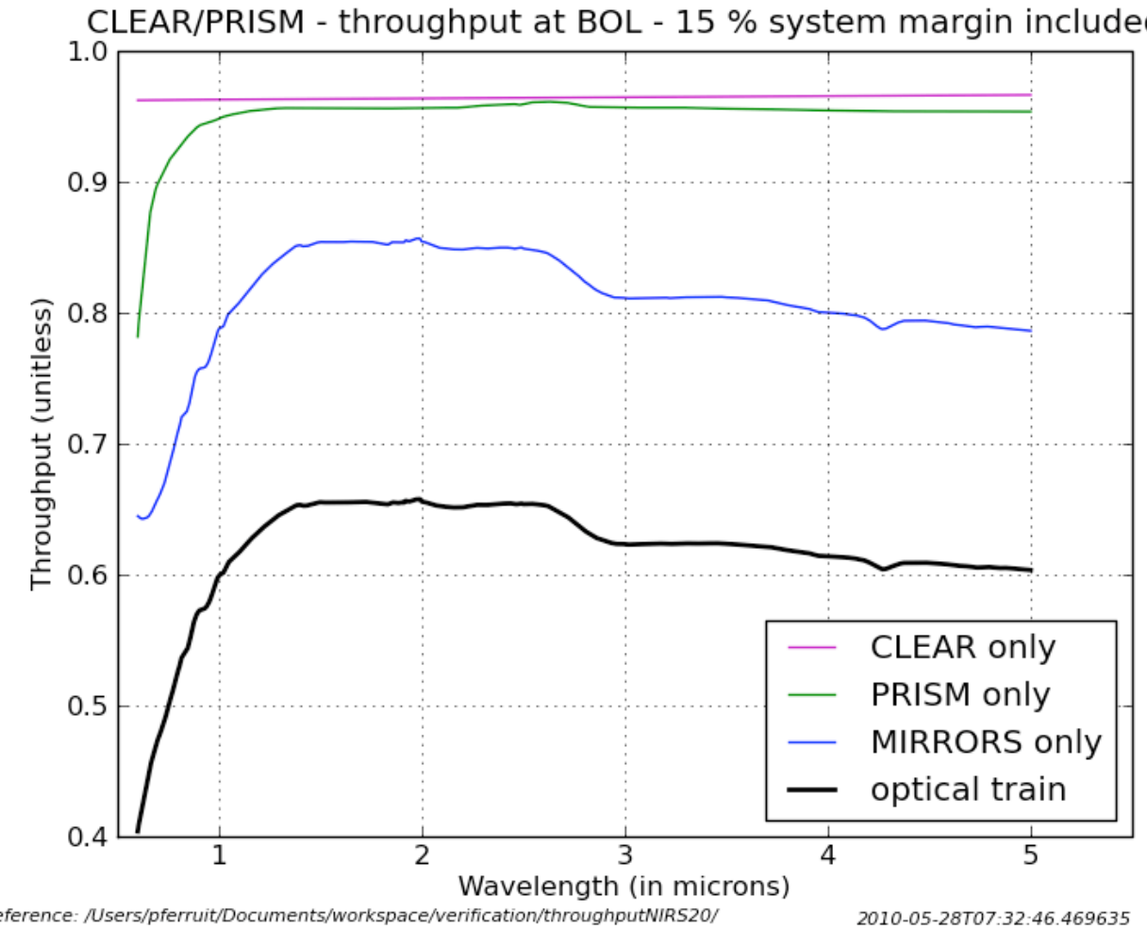


NIRSpec optics: Clear filter, prism

MSA: Long slit

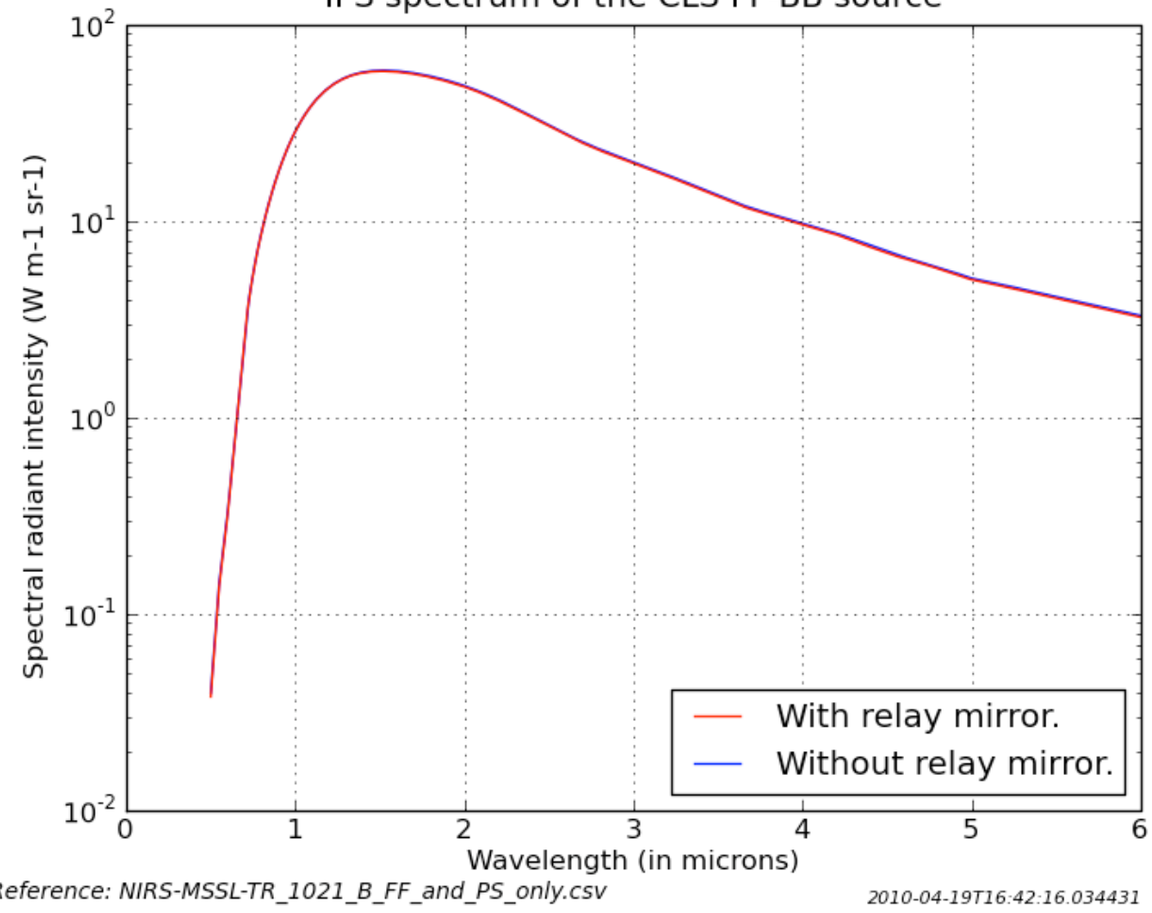
Dispersion

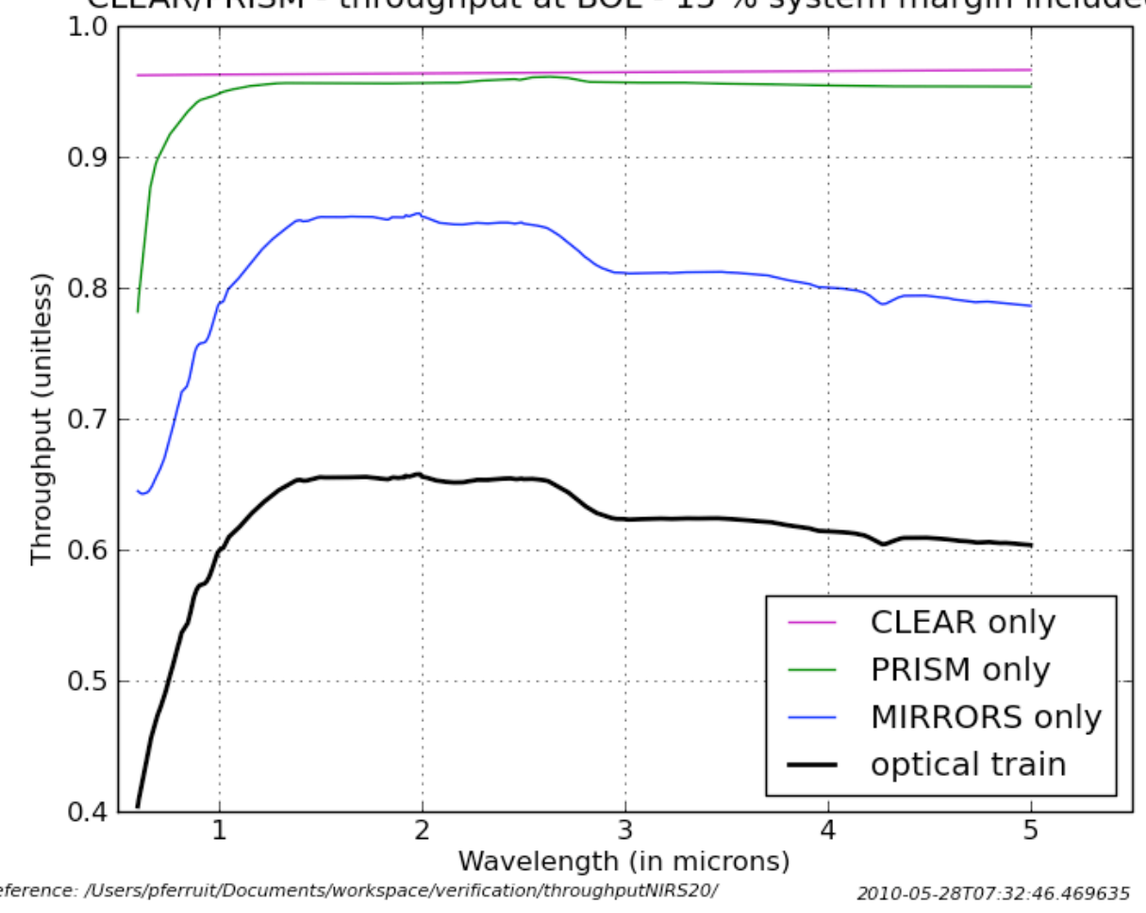




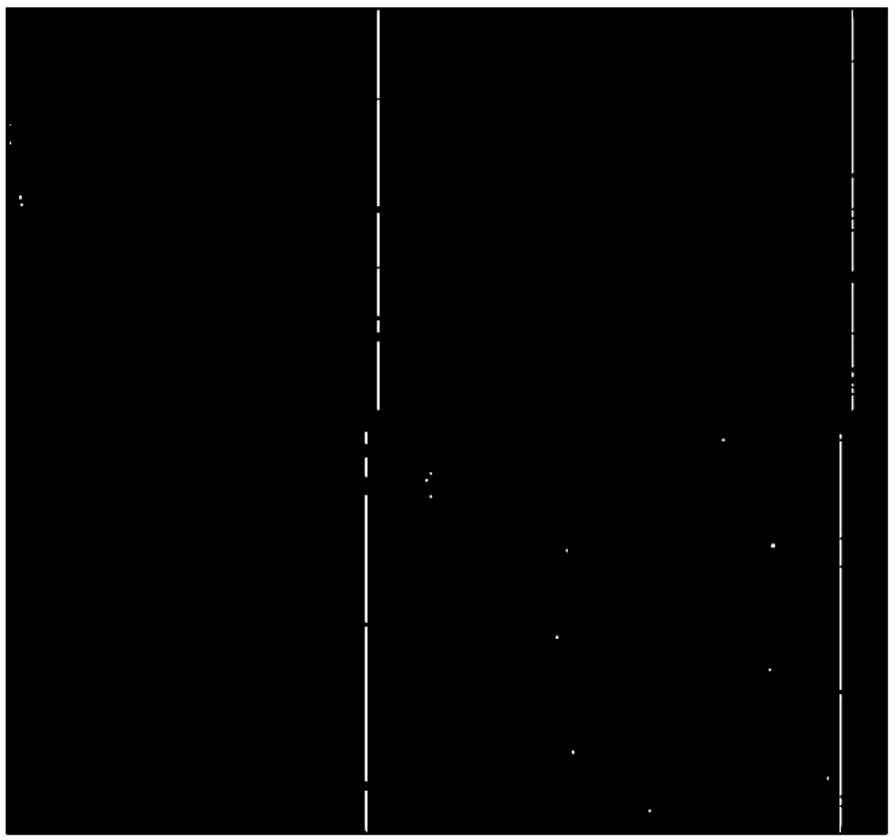
MSA:
Long slit

Dispersion

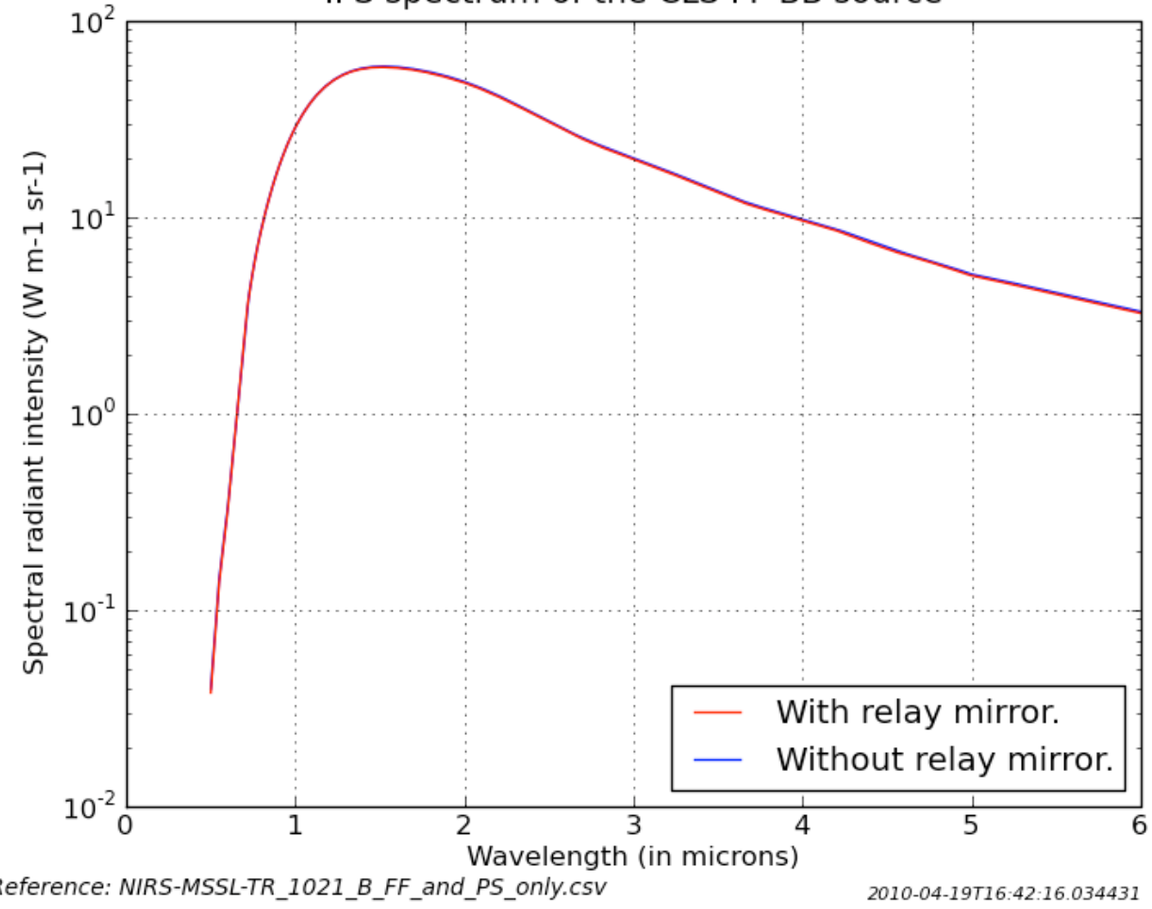


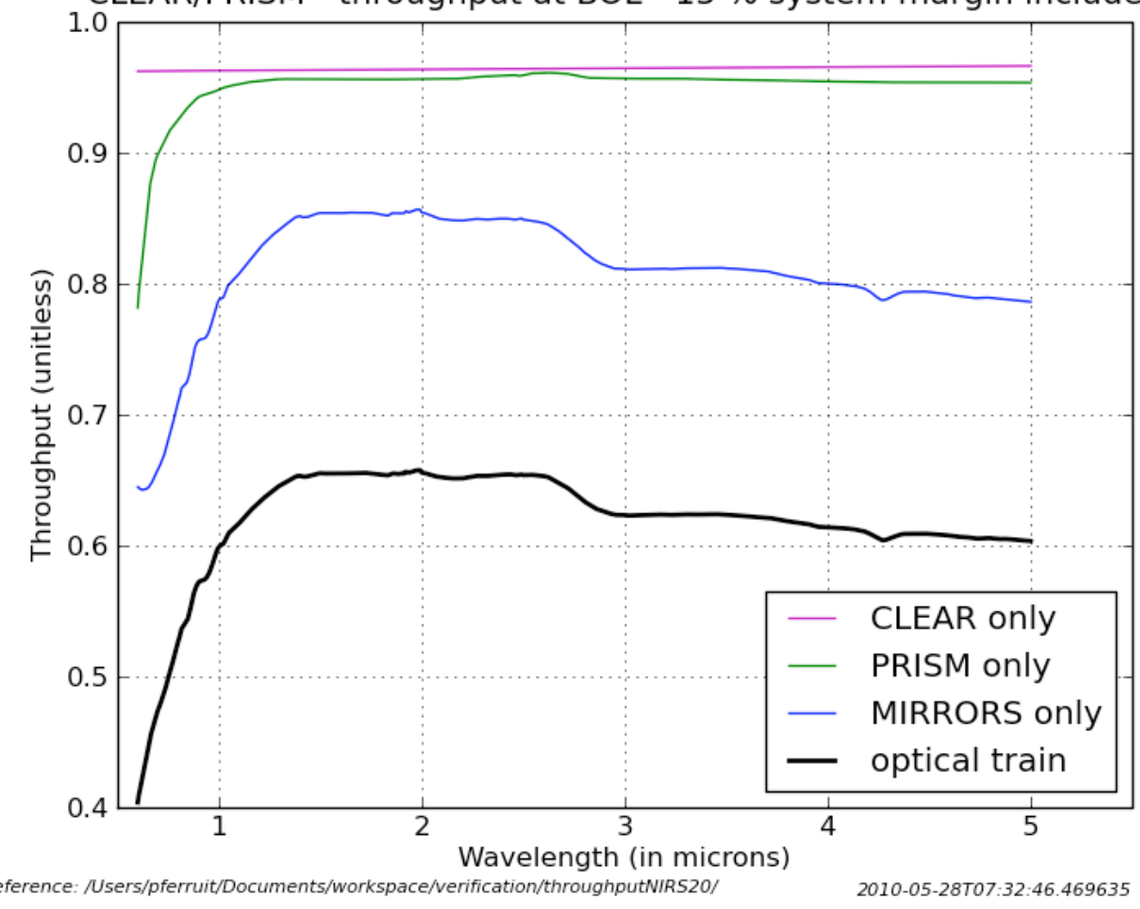


MSA pattern

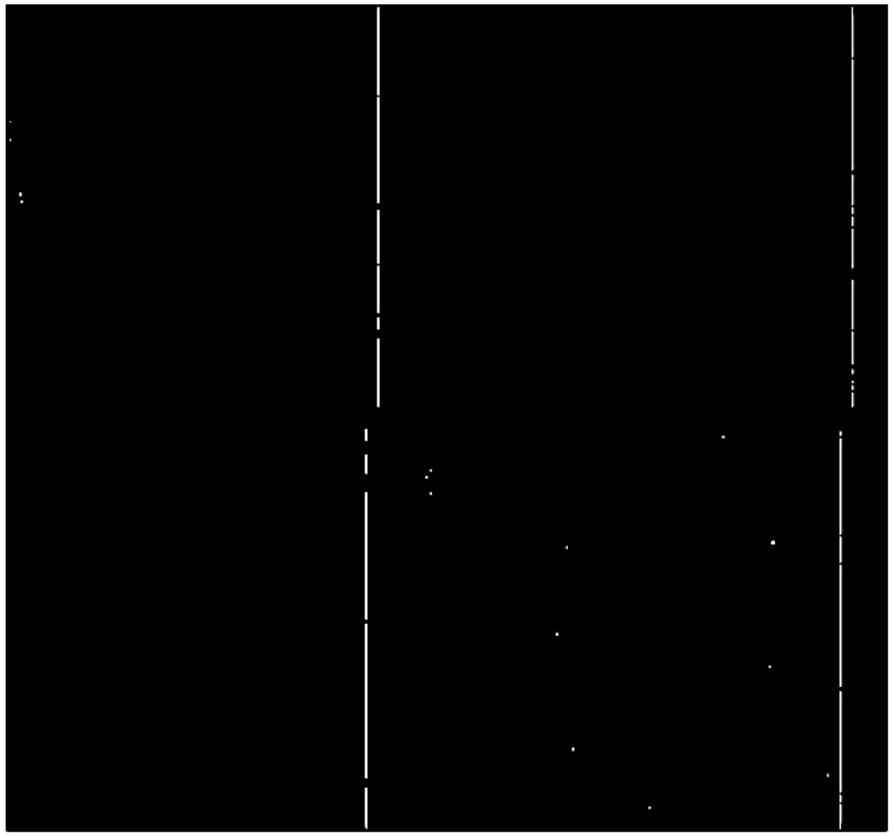


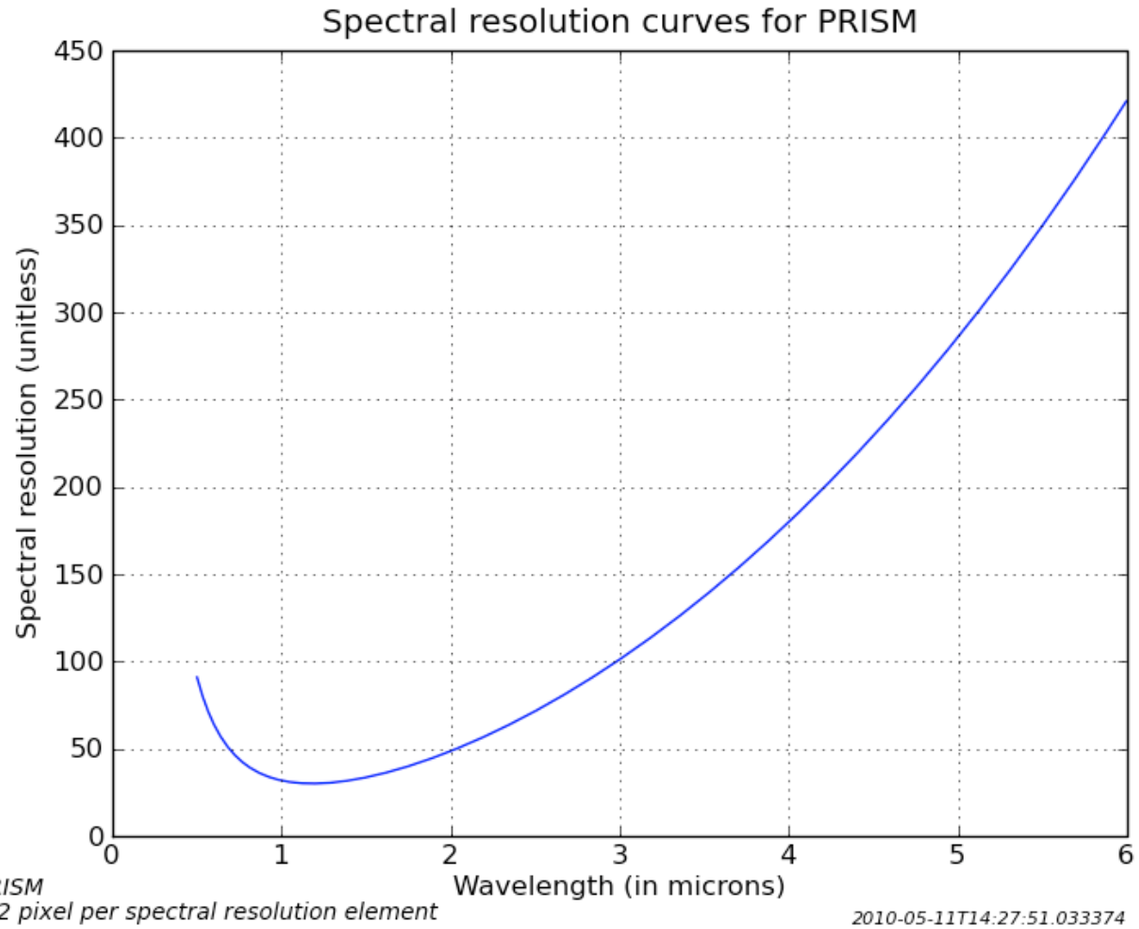
Dispersion


IPS spectrum of the CLS FF-BB source
Spectral radiant intensity (W m-1 sr-1)
Wavelength (in microns)
With relay mirror.
Without relay mirror.
Reference: NIRS-MSSL-TR_1021_B_FF_and_PS_only.csv
2010-04-19T16:42:16.034431

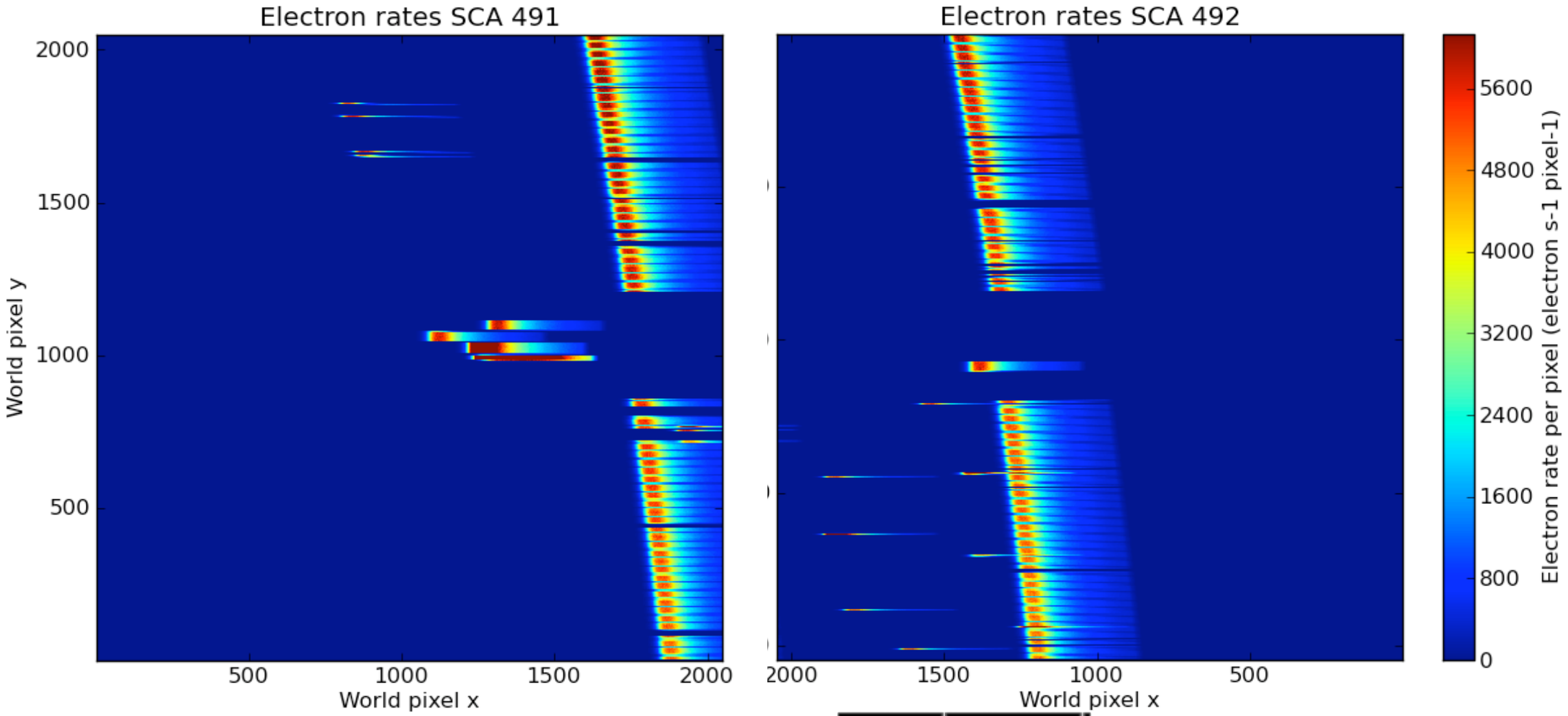

CLEAR/PRISM - throughput at BOL - 15 % system margin included
Throughput (unitless)
Wavelength (in microns)
CLEAR only
PRISM only
MIRRORS only
optical train
Reference: /Users/pferruit/Documents/workspace/verification/throughputNIRS20/
2010-05-28T07:32:46.469635

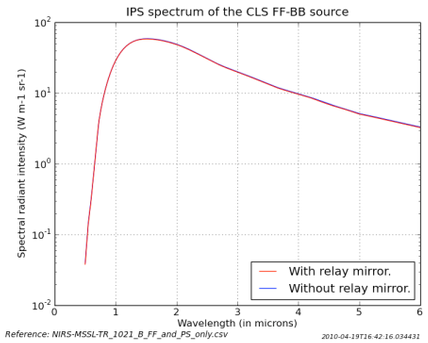
MSA pattern

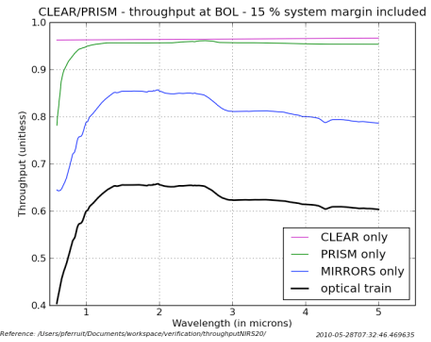


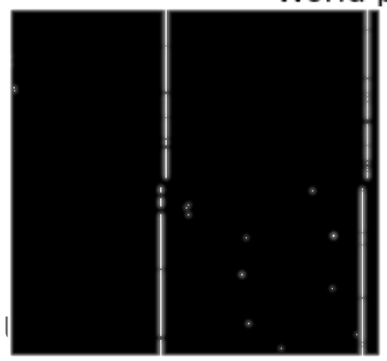

Spectral resolution curves for PRISM
Spectral resolution (unitless)
Wavelength (in microns)
PRISM
2.2 pixel per spectral resolution element
2010-05-11T14:27:51.033374

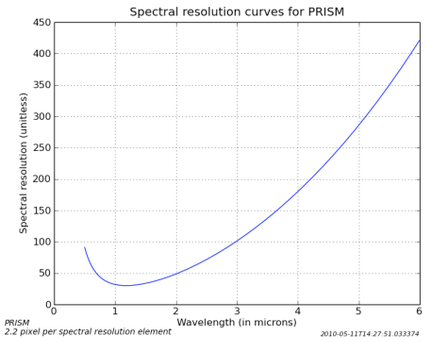
Flatfield, broadband, prism: overview



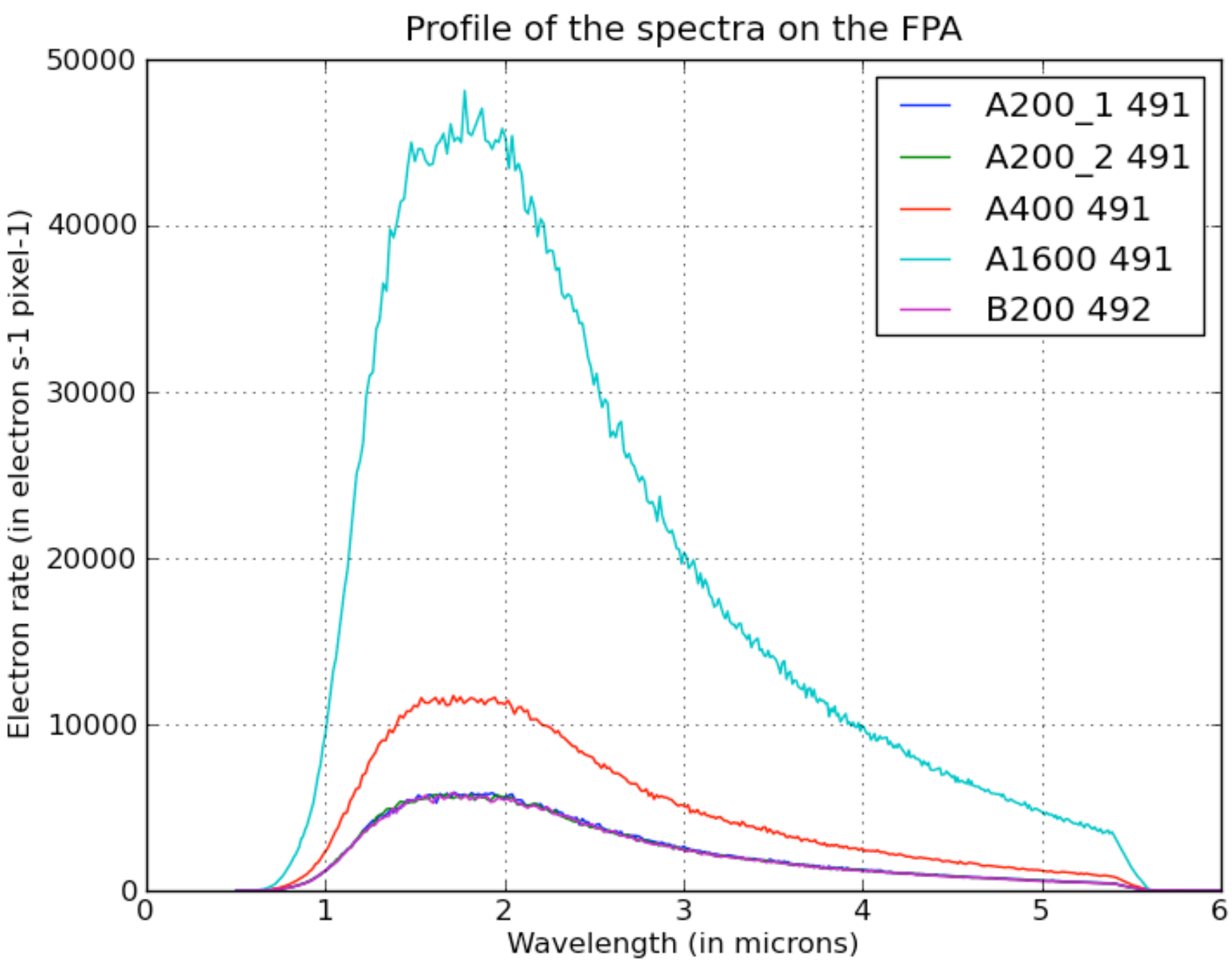


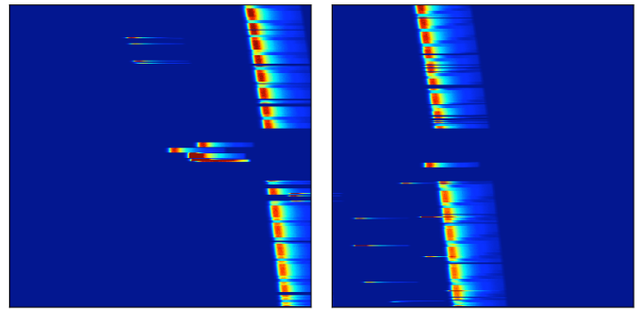


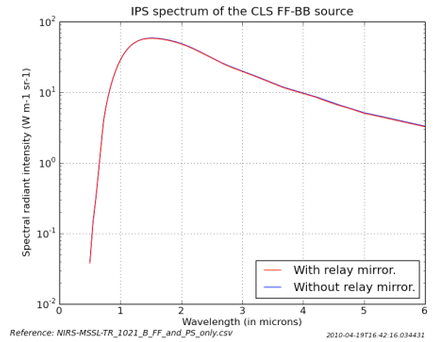


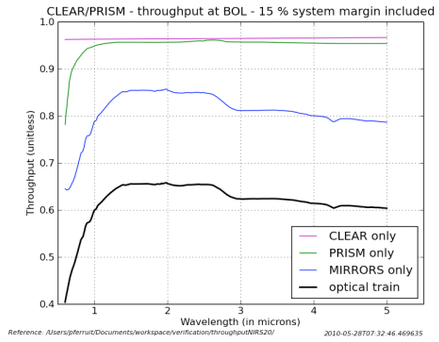


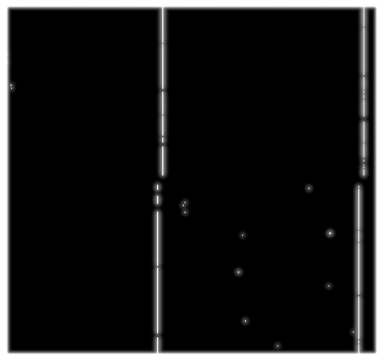
Flatfield, broadband, prism: spectrum trace

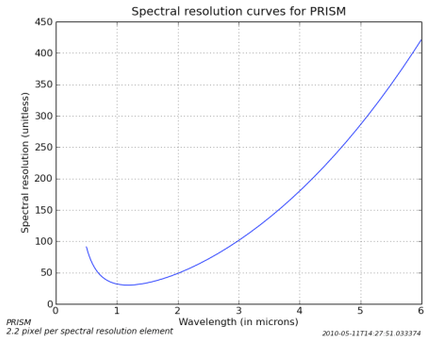












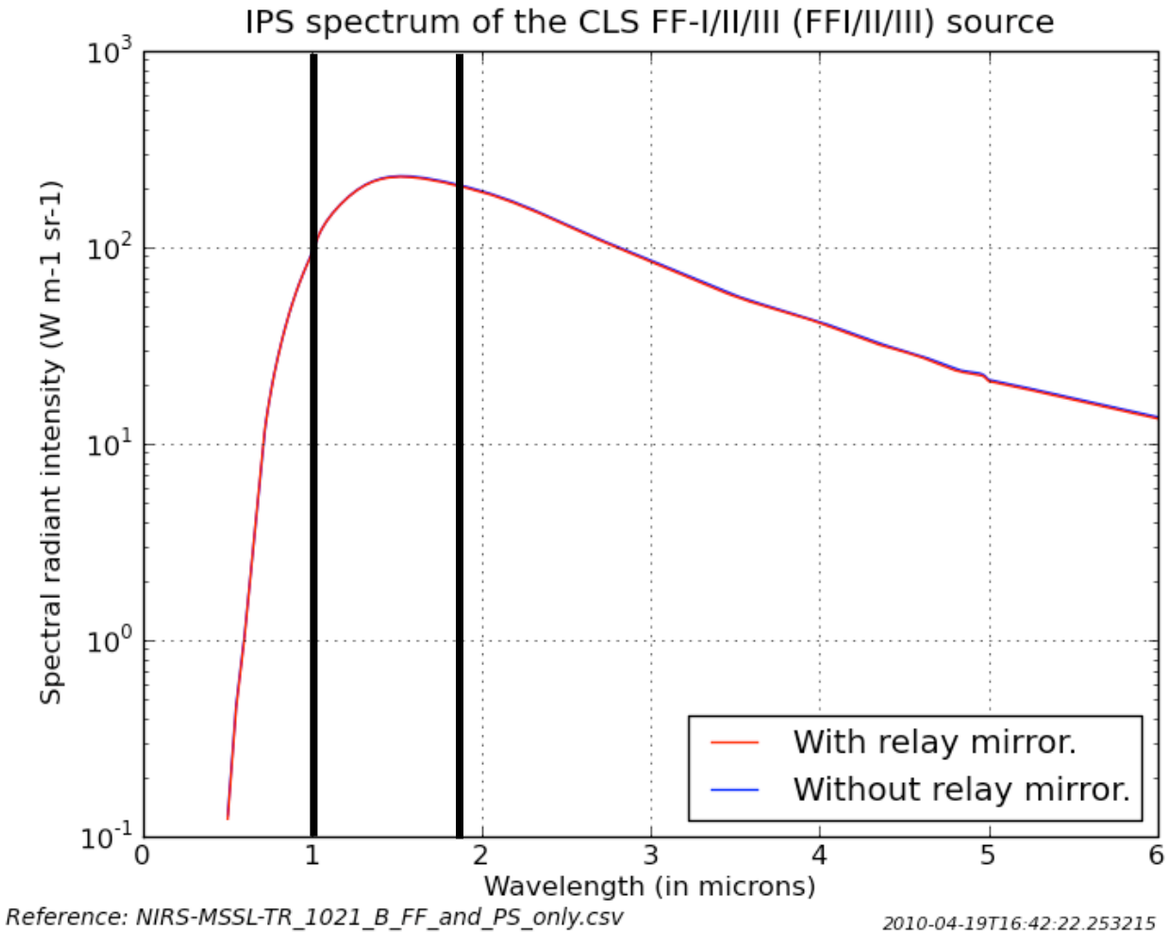
CRA Lyon

Source: CLS
Band 1 flatfield

NIRSpec optics:
LP100, G140M
(band 1 medium)

MSA:
Long slit

Dispersion



NIRSpec optics:
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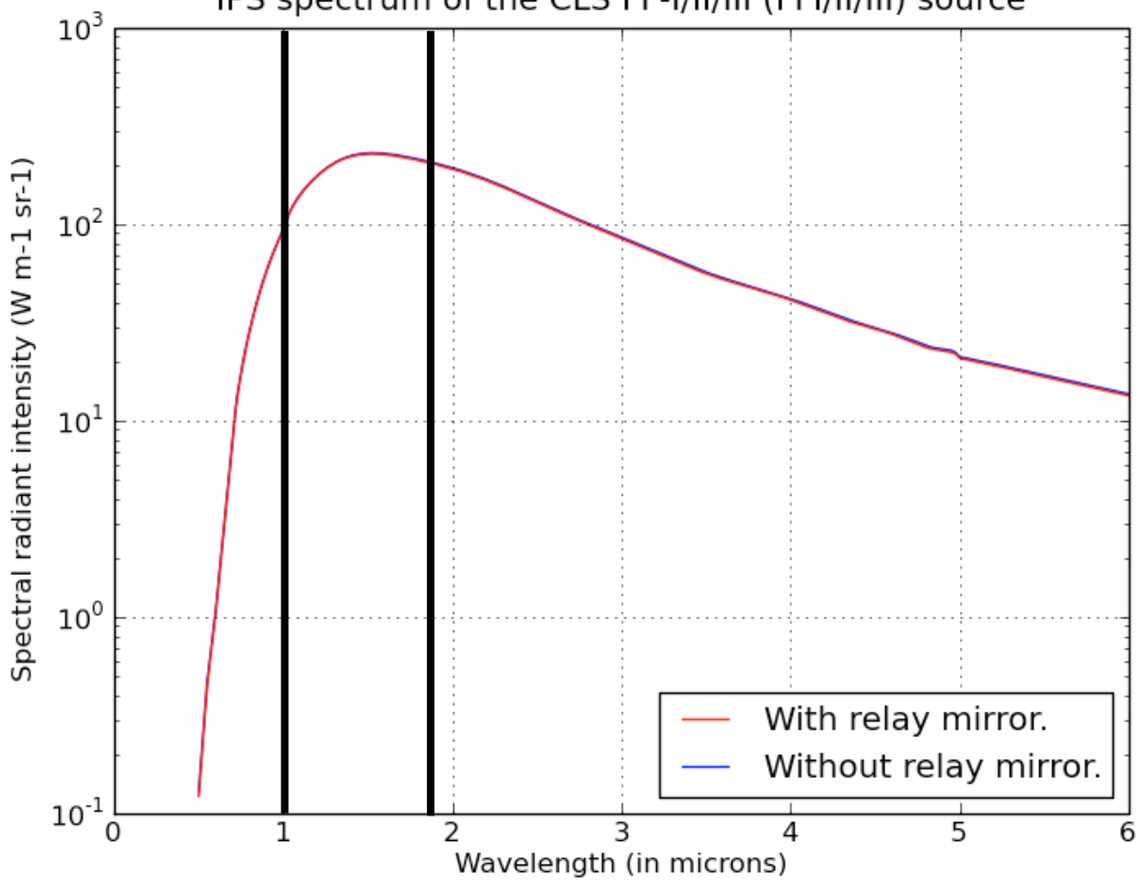
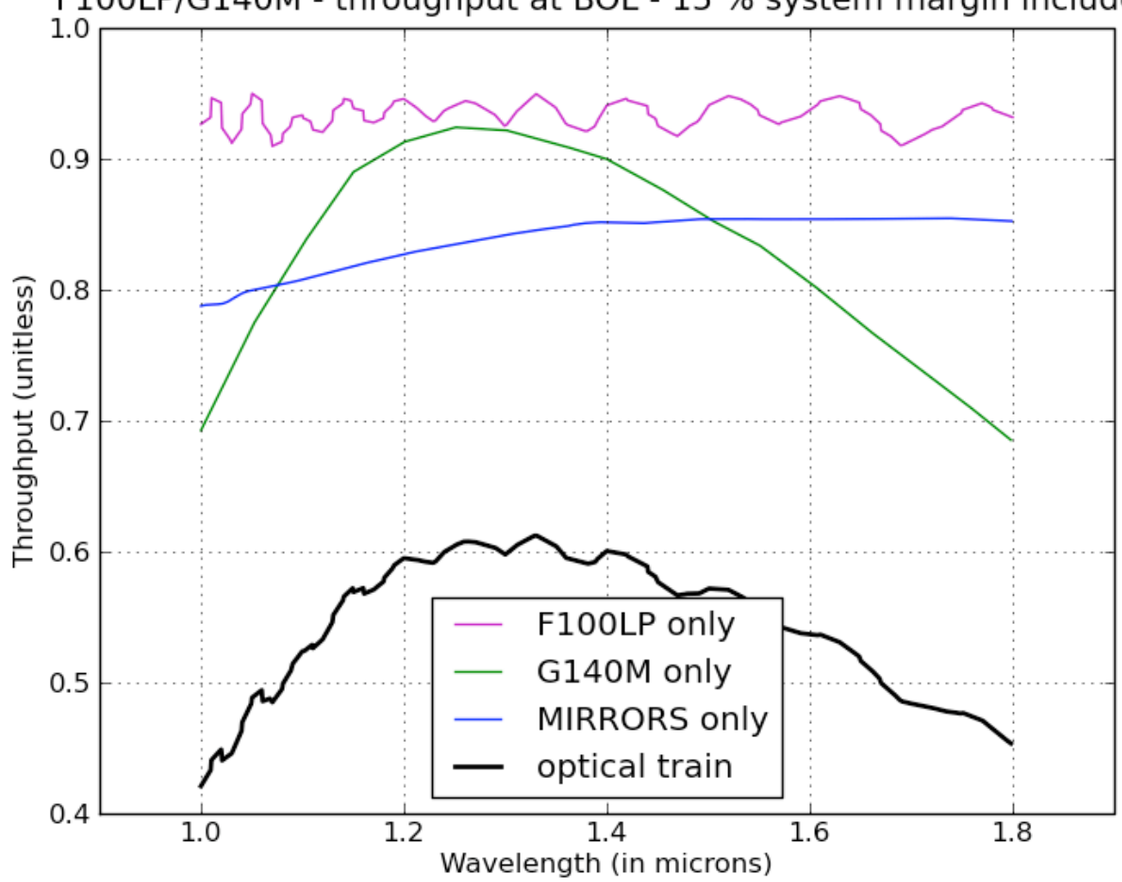
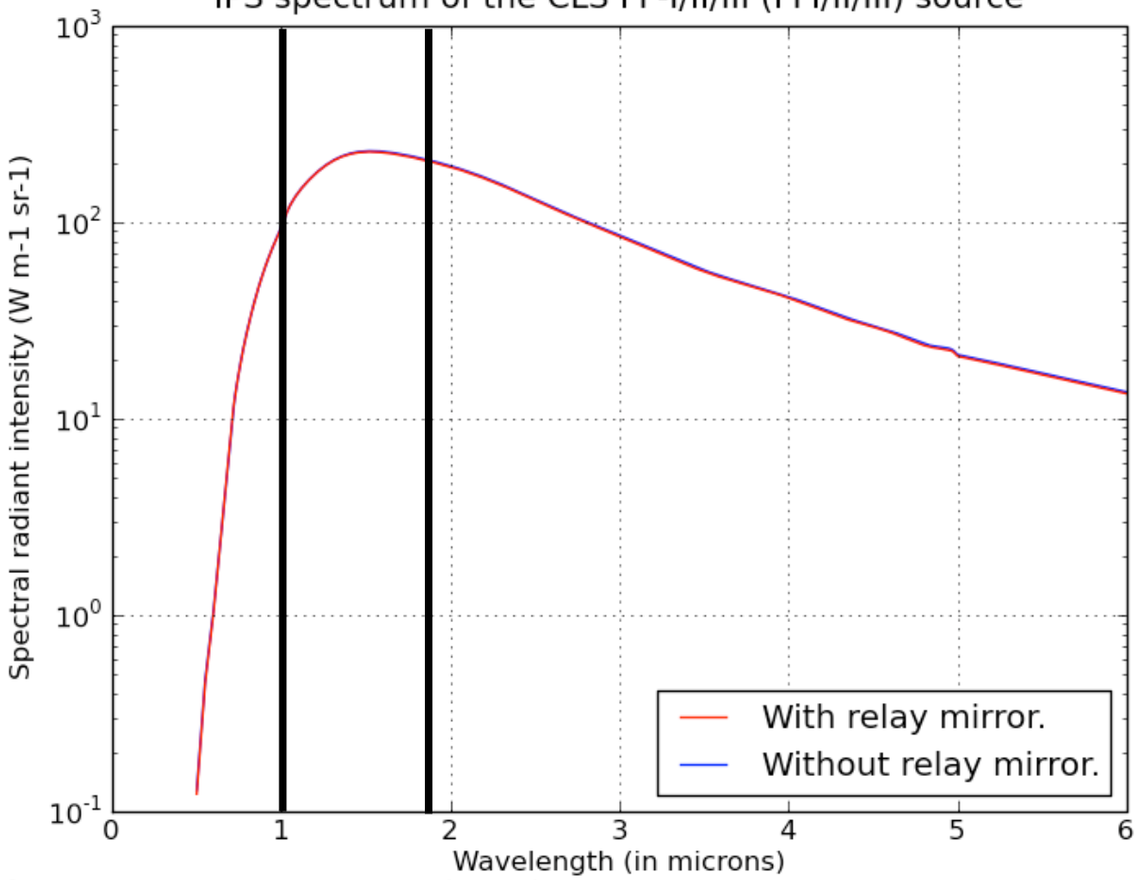
Dispersion

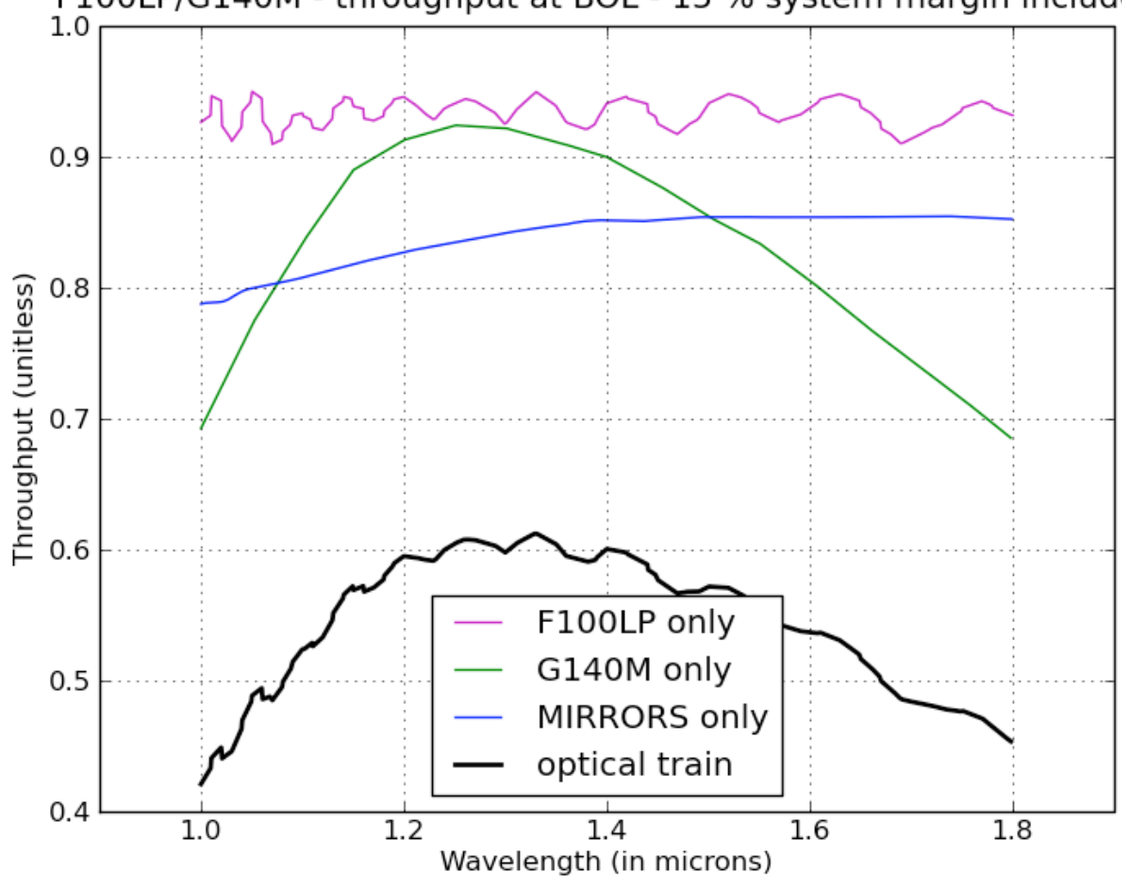




MSA:
Long slit

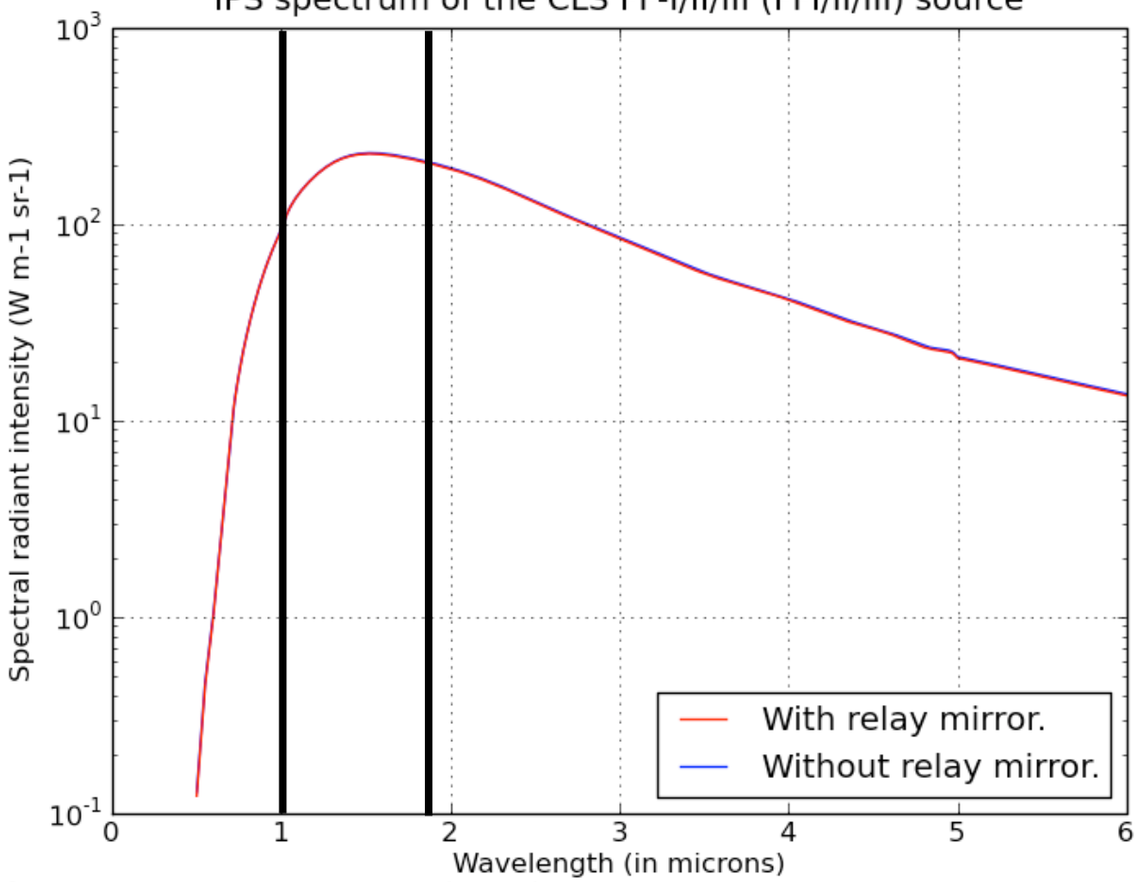
Dispersion





MSA pattern

Dispersion



Reference: NIRS-MSSL-TR_1021_B_FF_and_PS_only.csv

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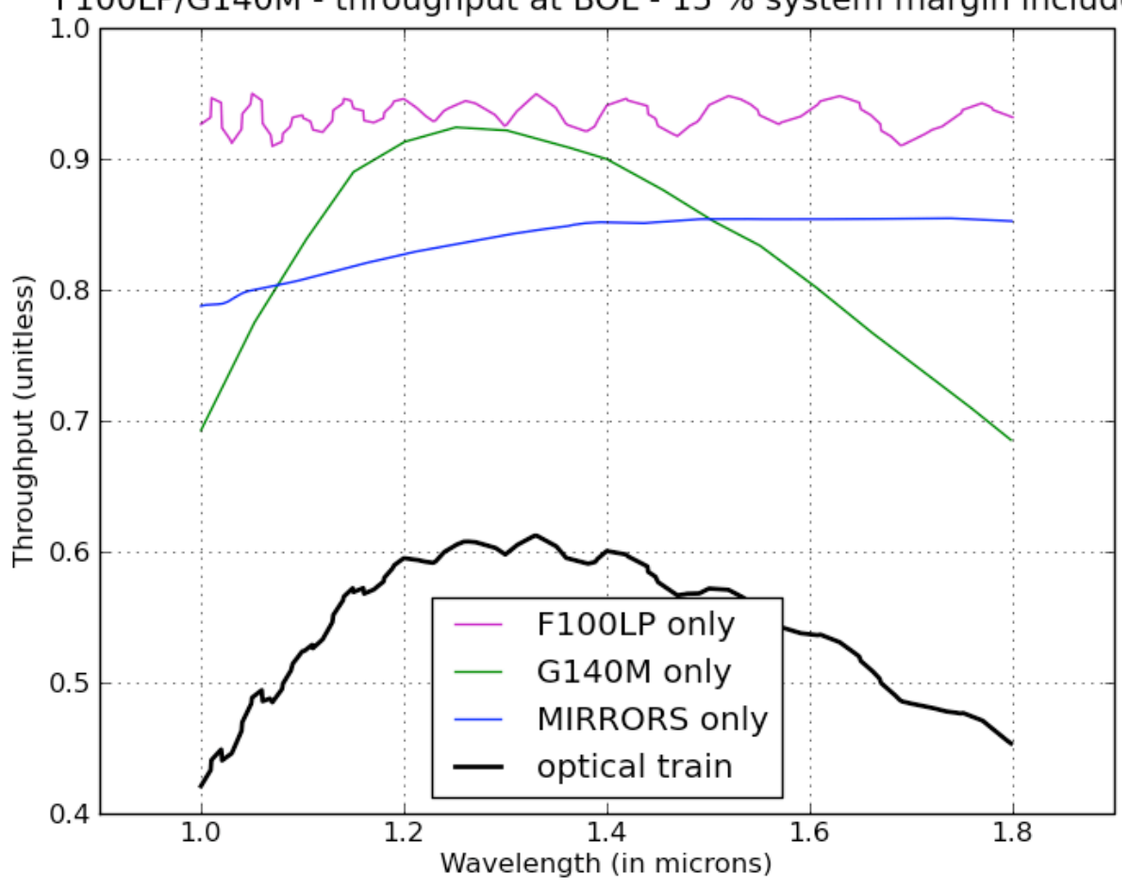

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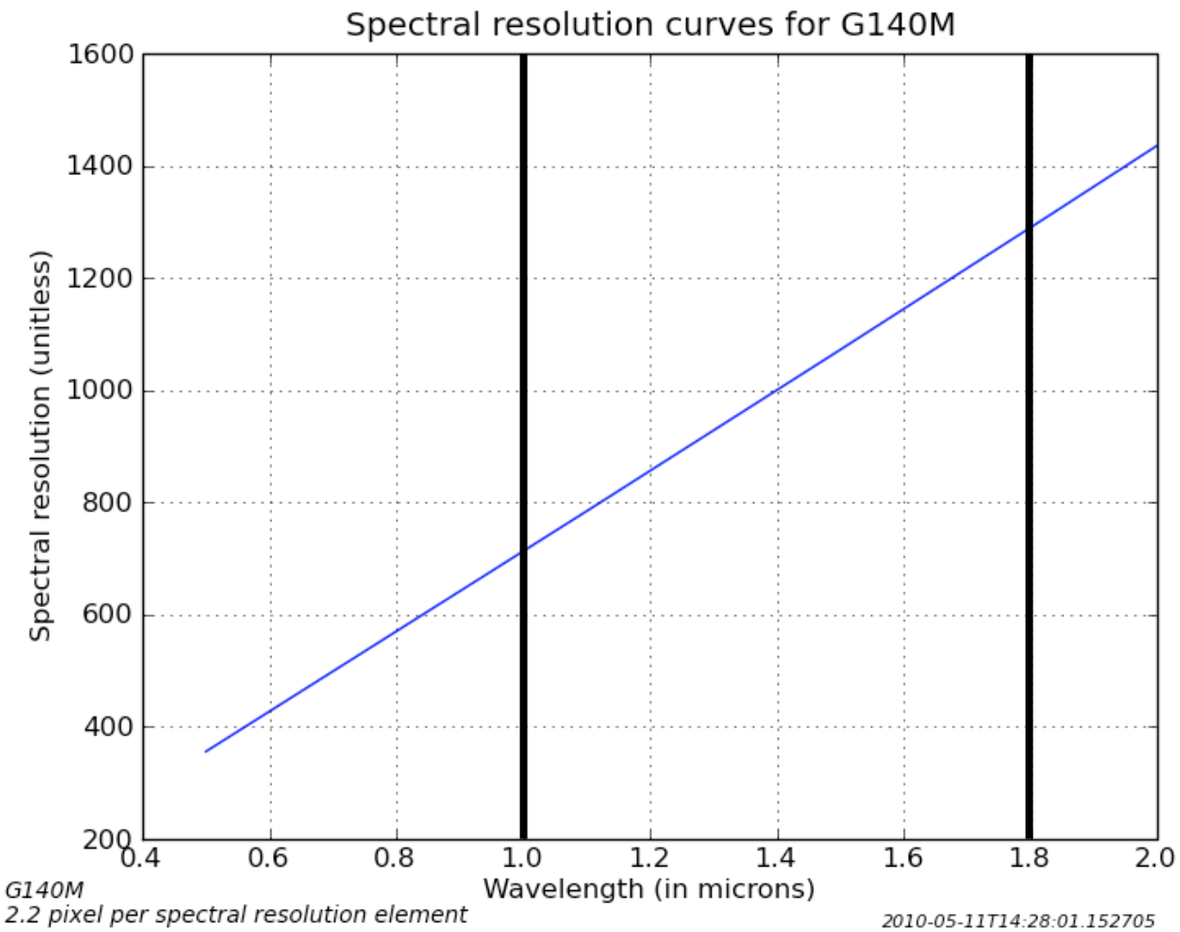
MSA pattern



G140M
2.2 pixel per spectral resolution element

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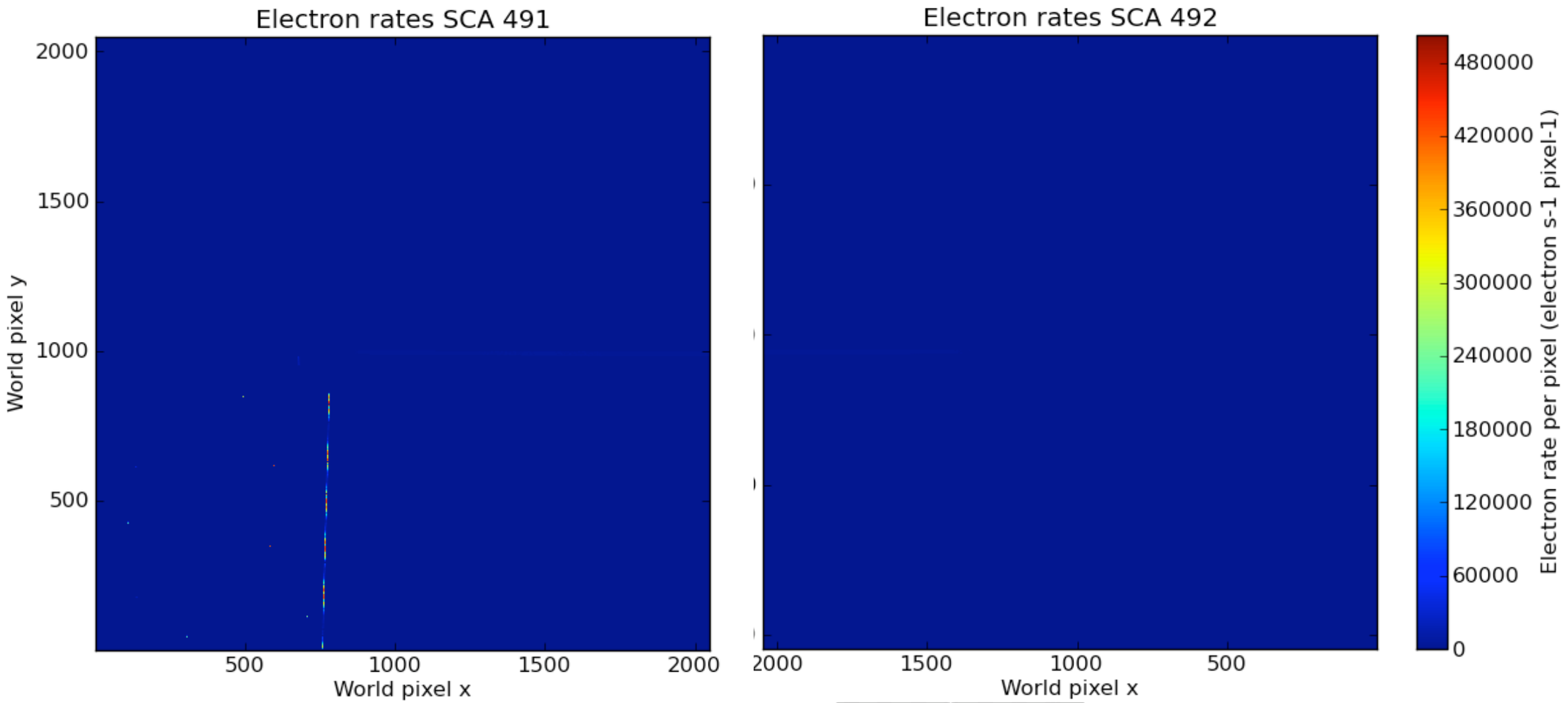
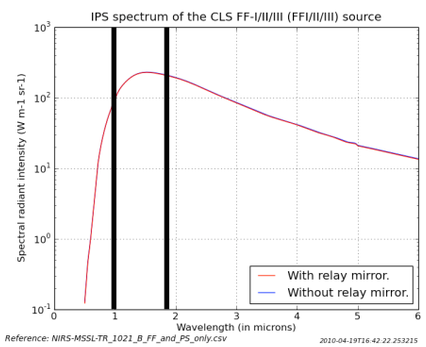
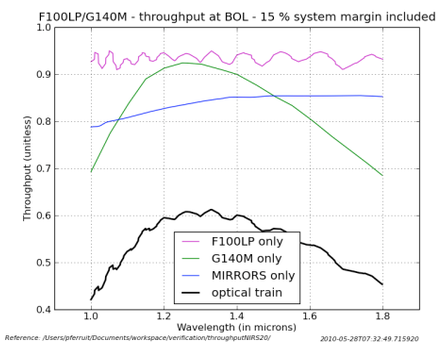
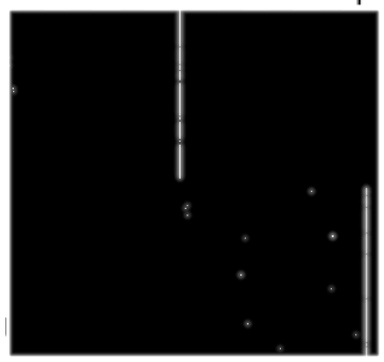
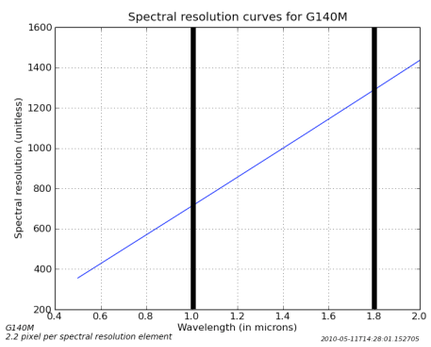
Flatfield, continuum, MR grating: I overview



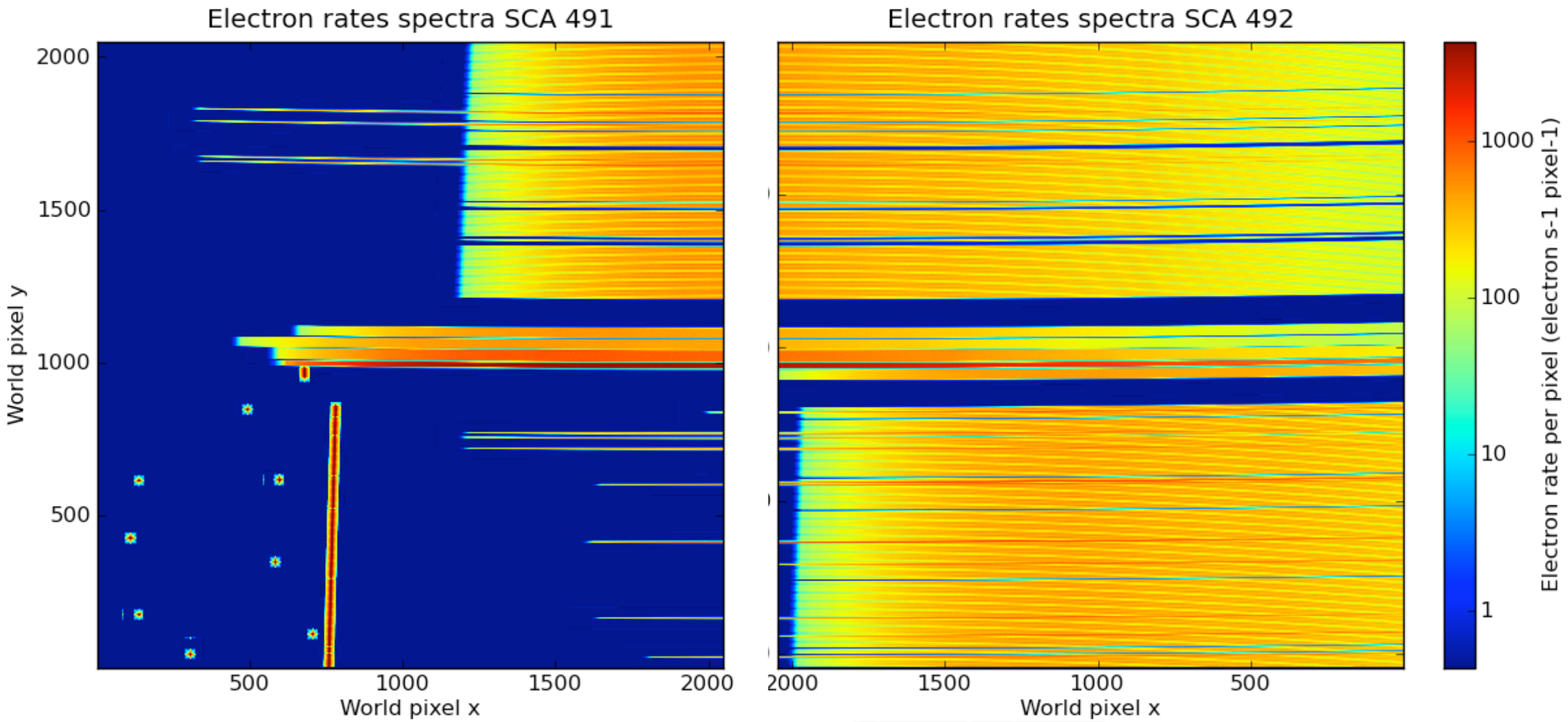


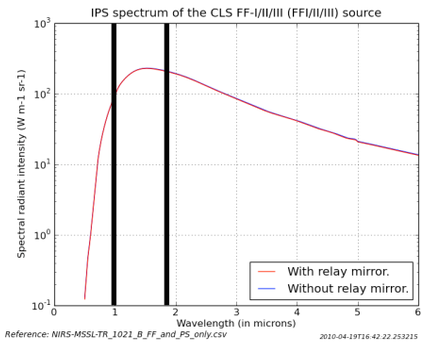


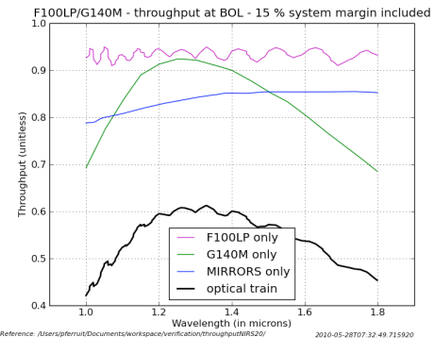


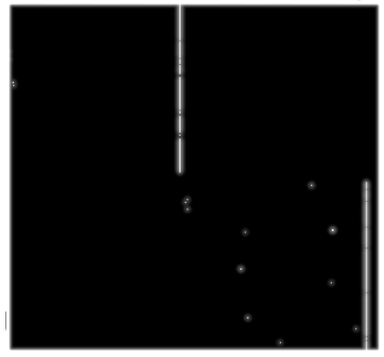


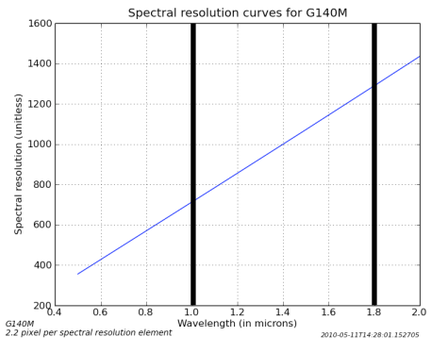
Flatfield, continuum, MR grating: I overview





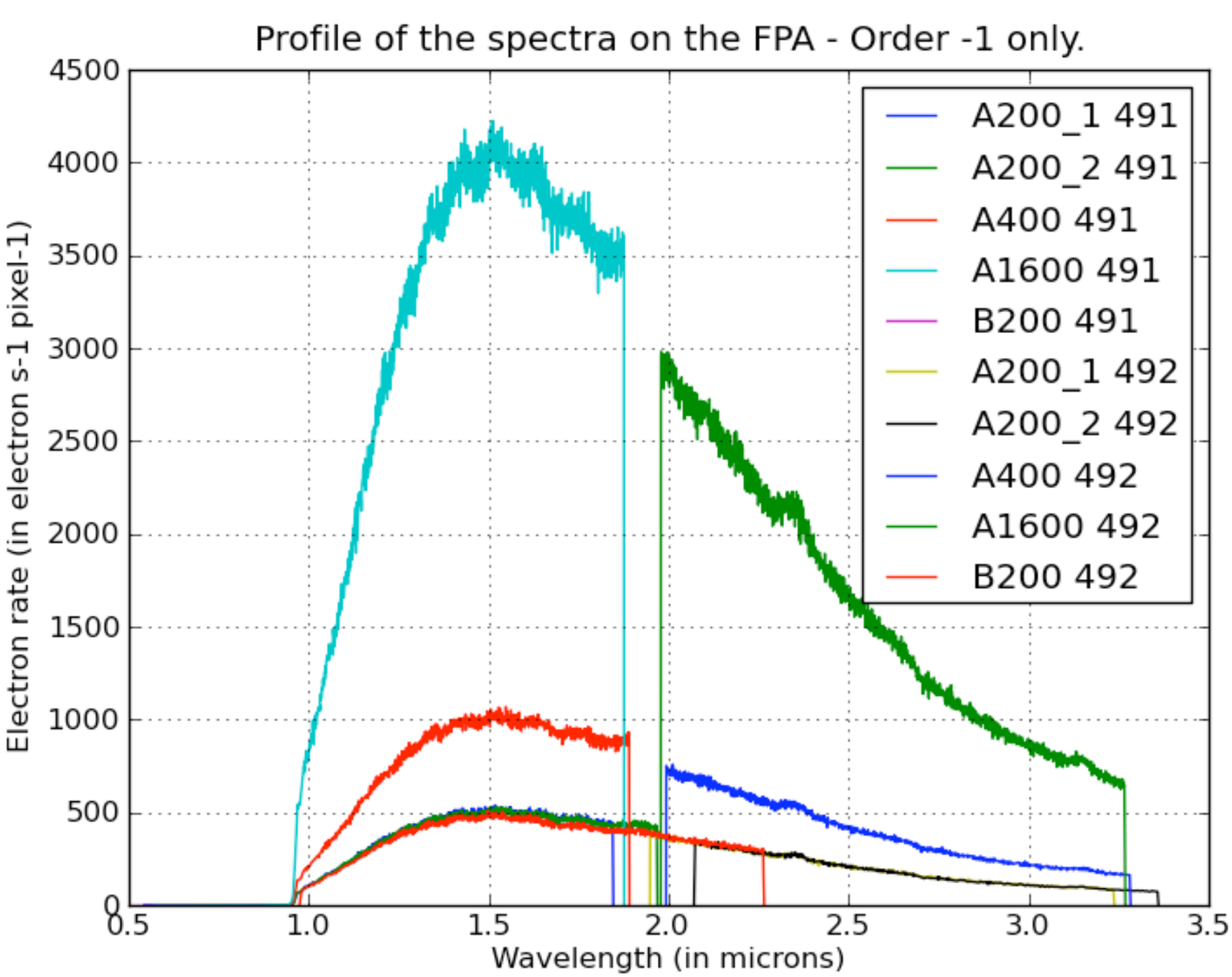


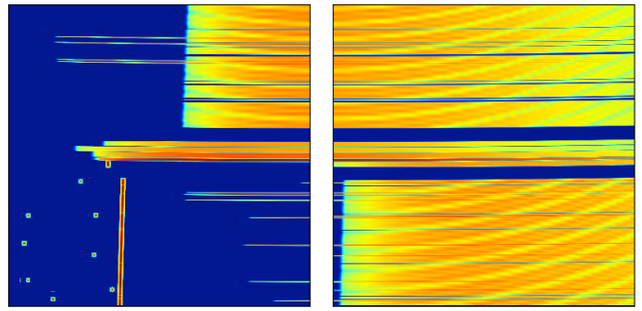


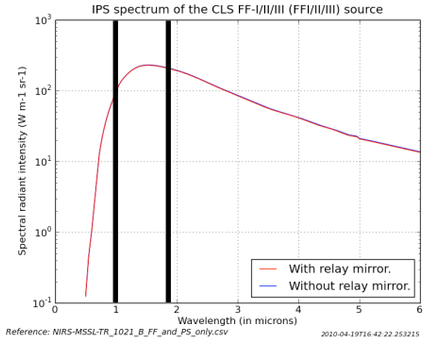


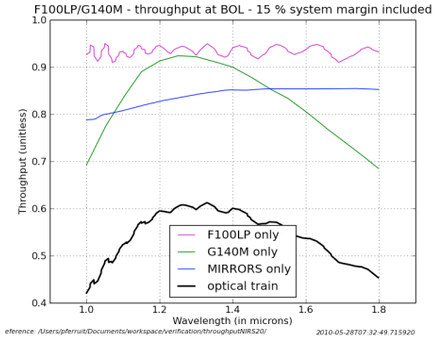
Astri

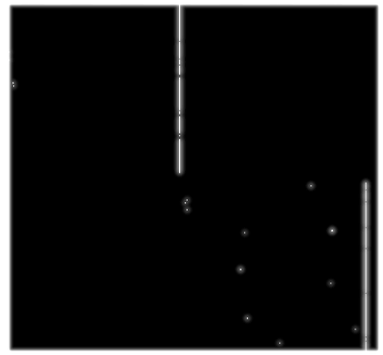
Flatfield, continuum, MR grating I: spectrum trace

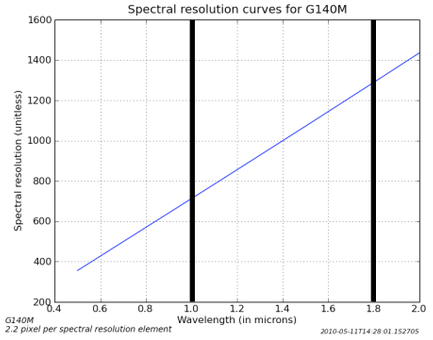






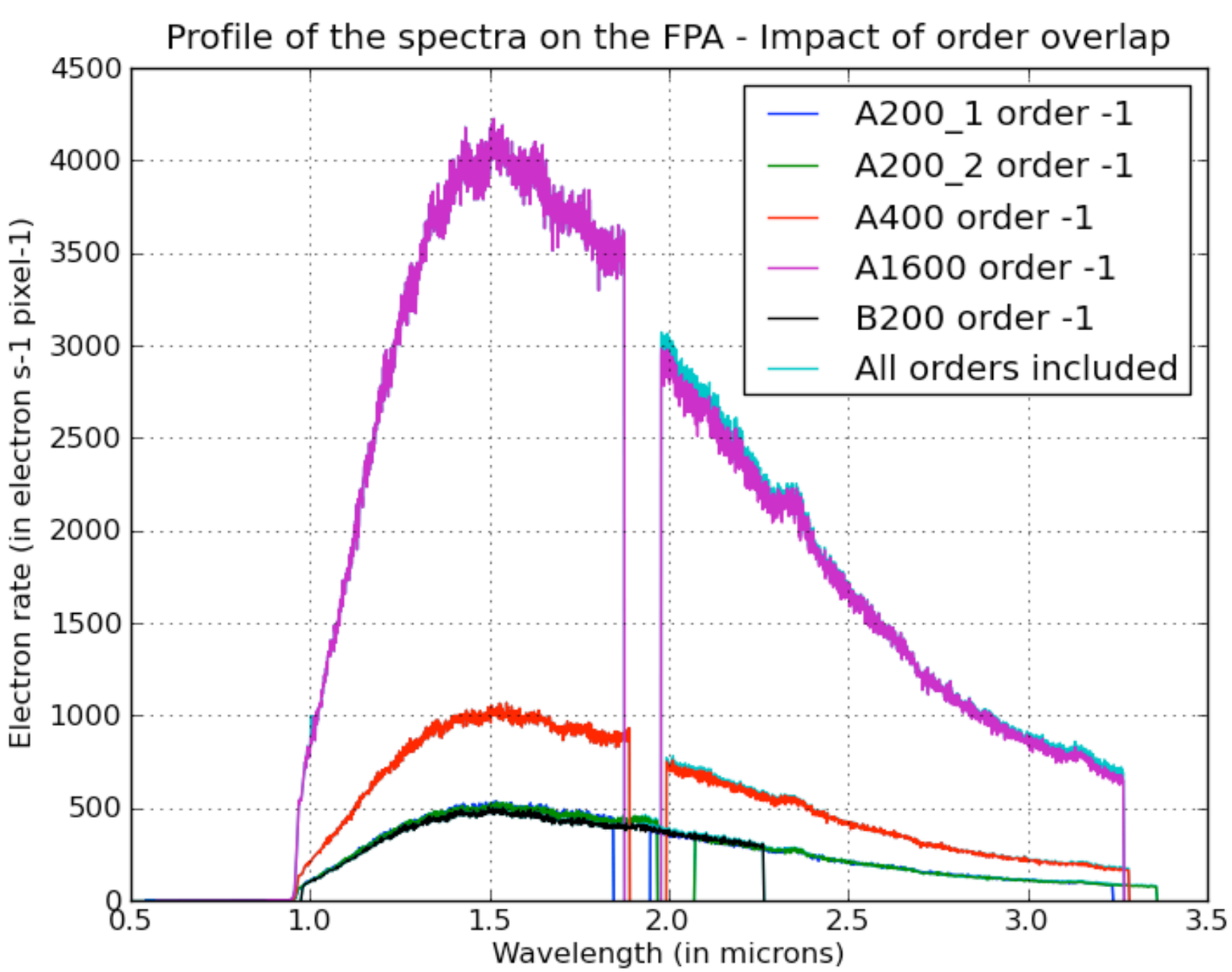


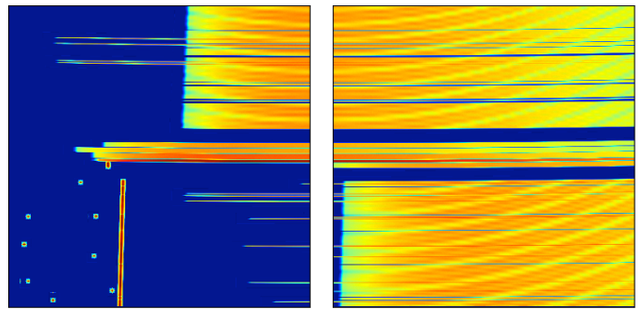


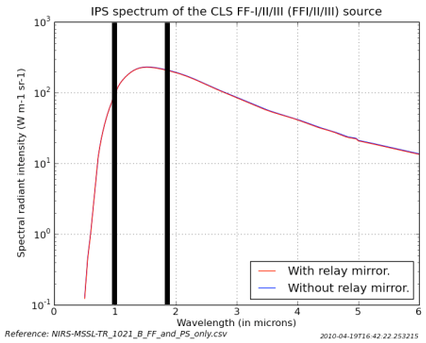


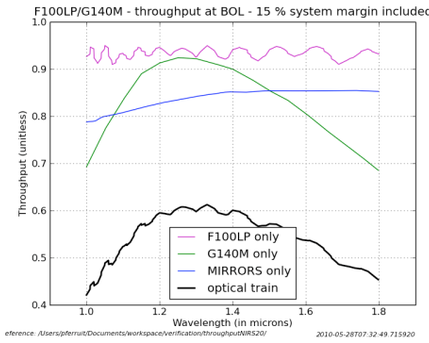
CRA Lyon

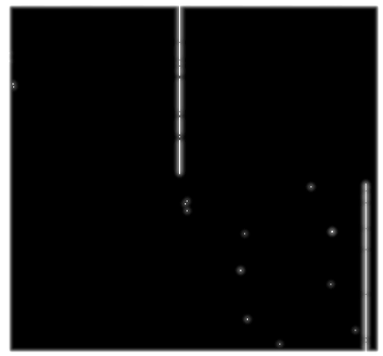
Flatfield, continuum, MR grating I: spectrum trace

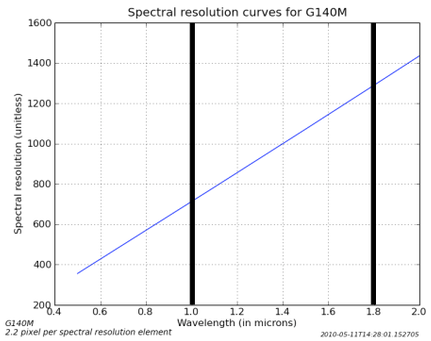










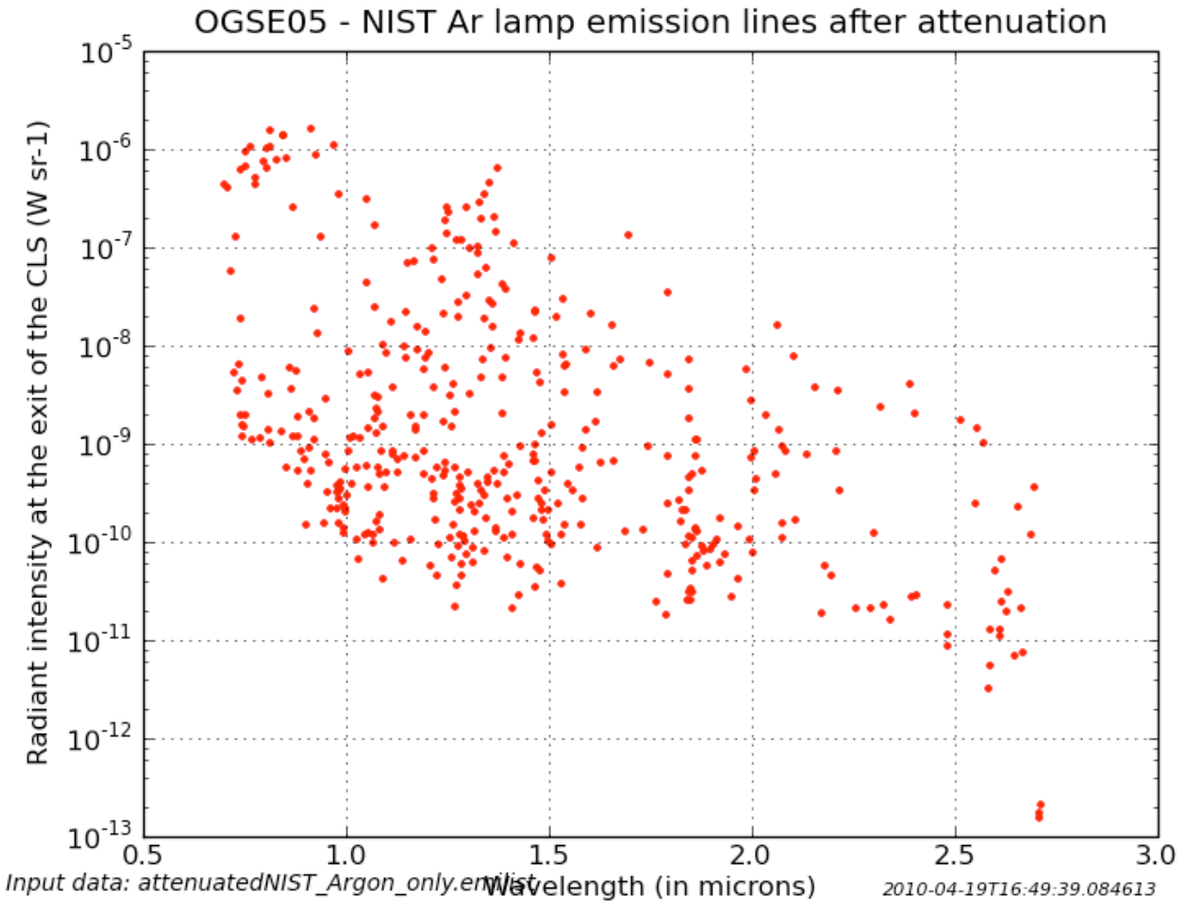


Source: CLS Argon
emission lines

NIRSpec optics:
LP100, G140H
(band 1 high)

MSA: Perfect
all closed

Dispersion



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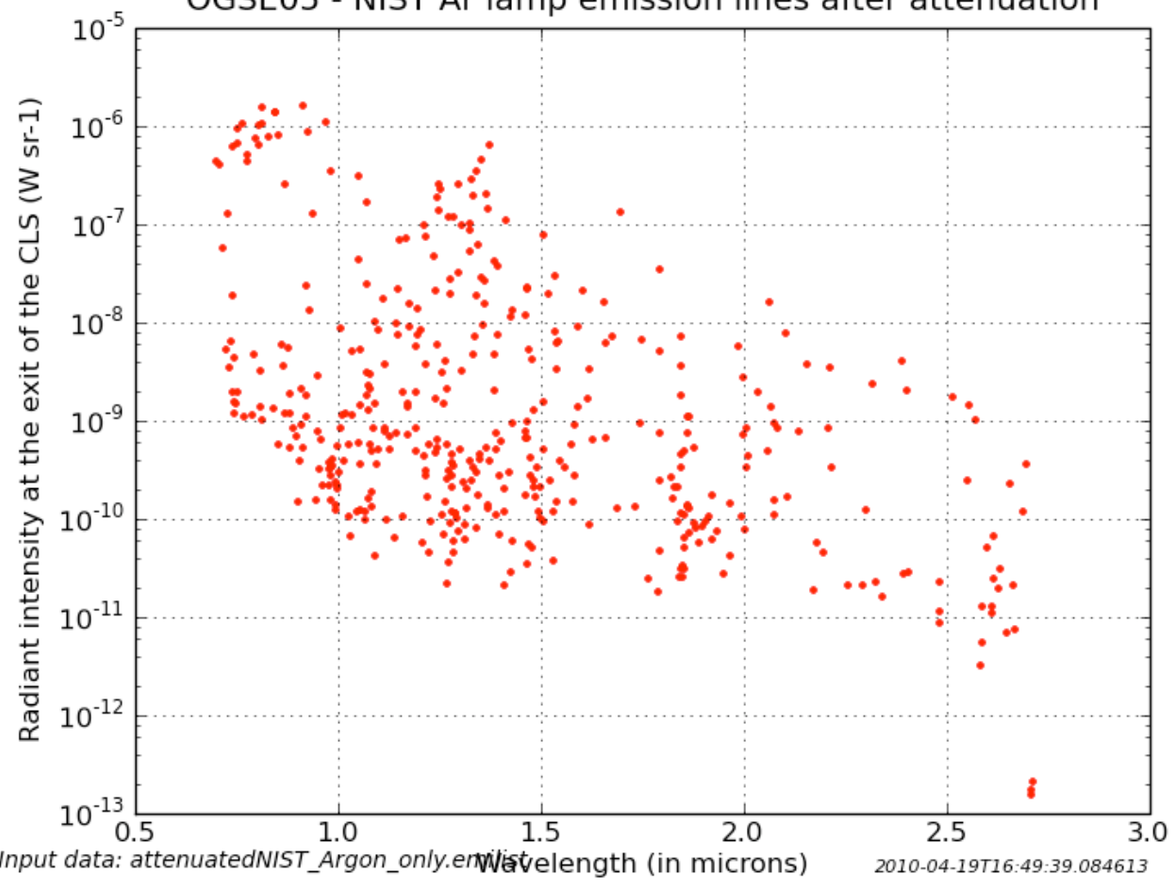

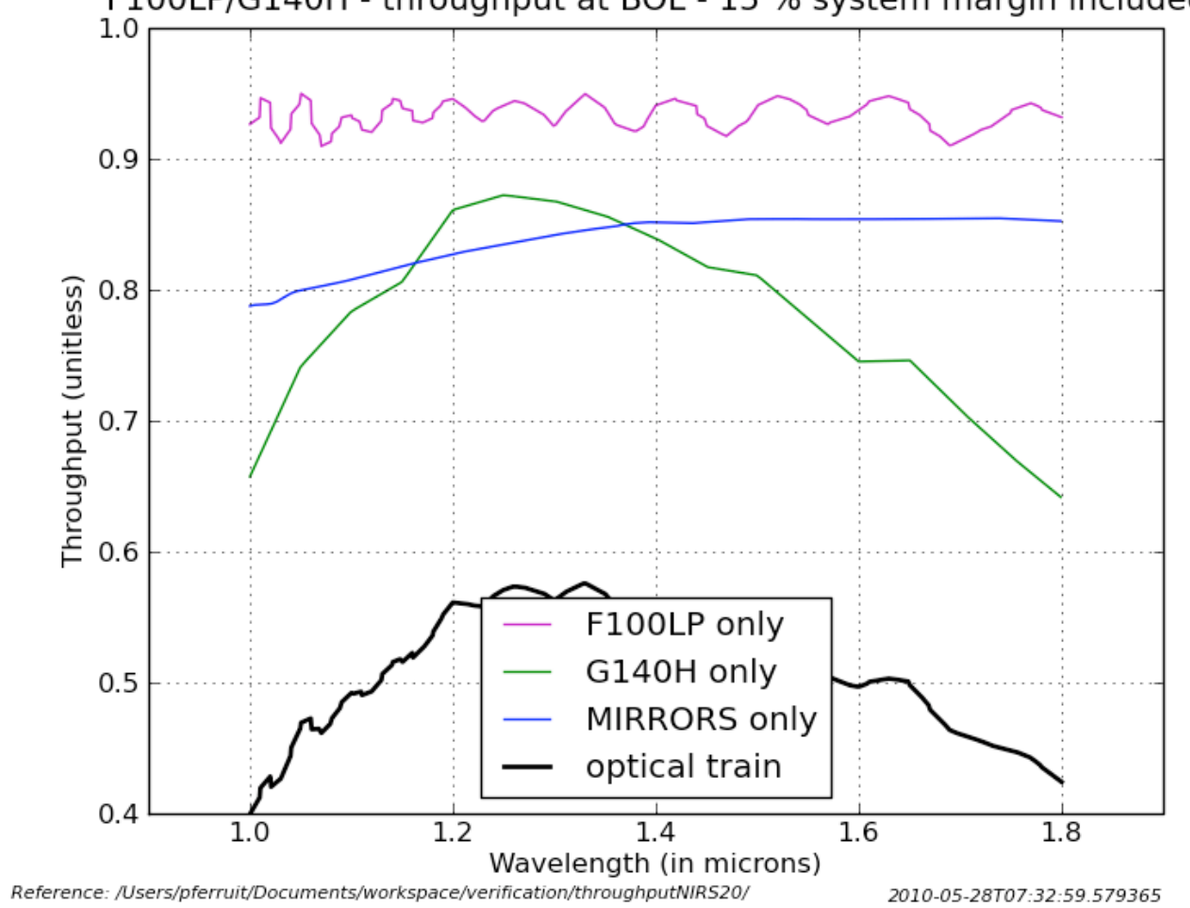

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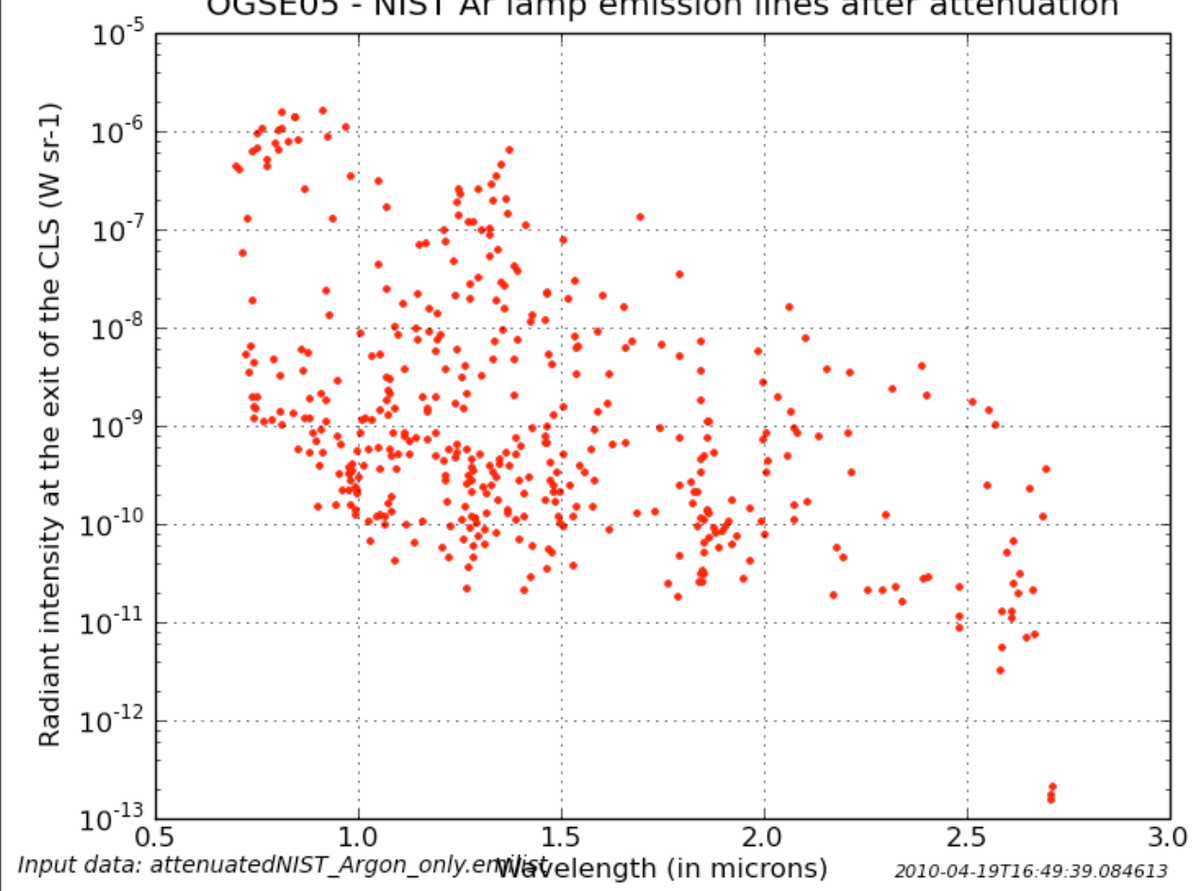
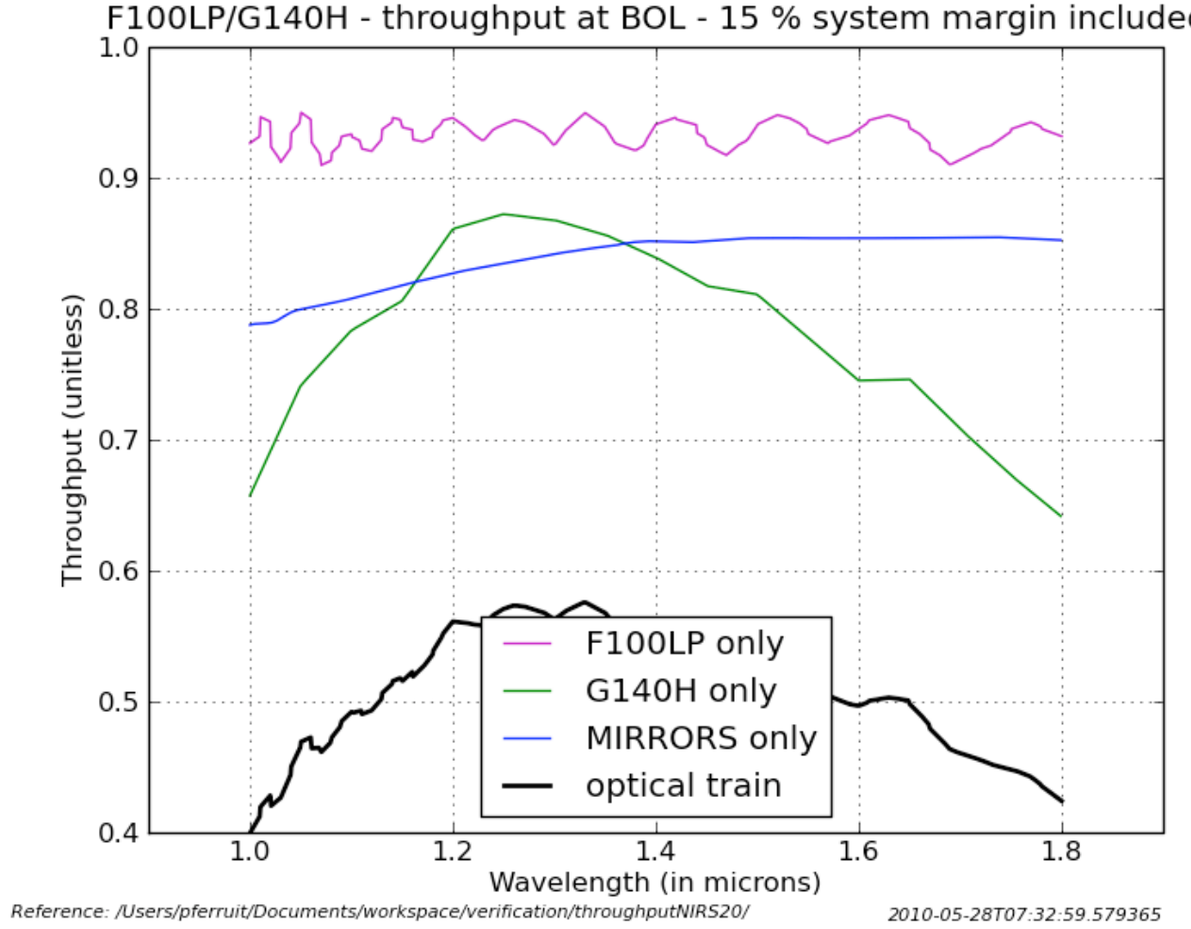
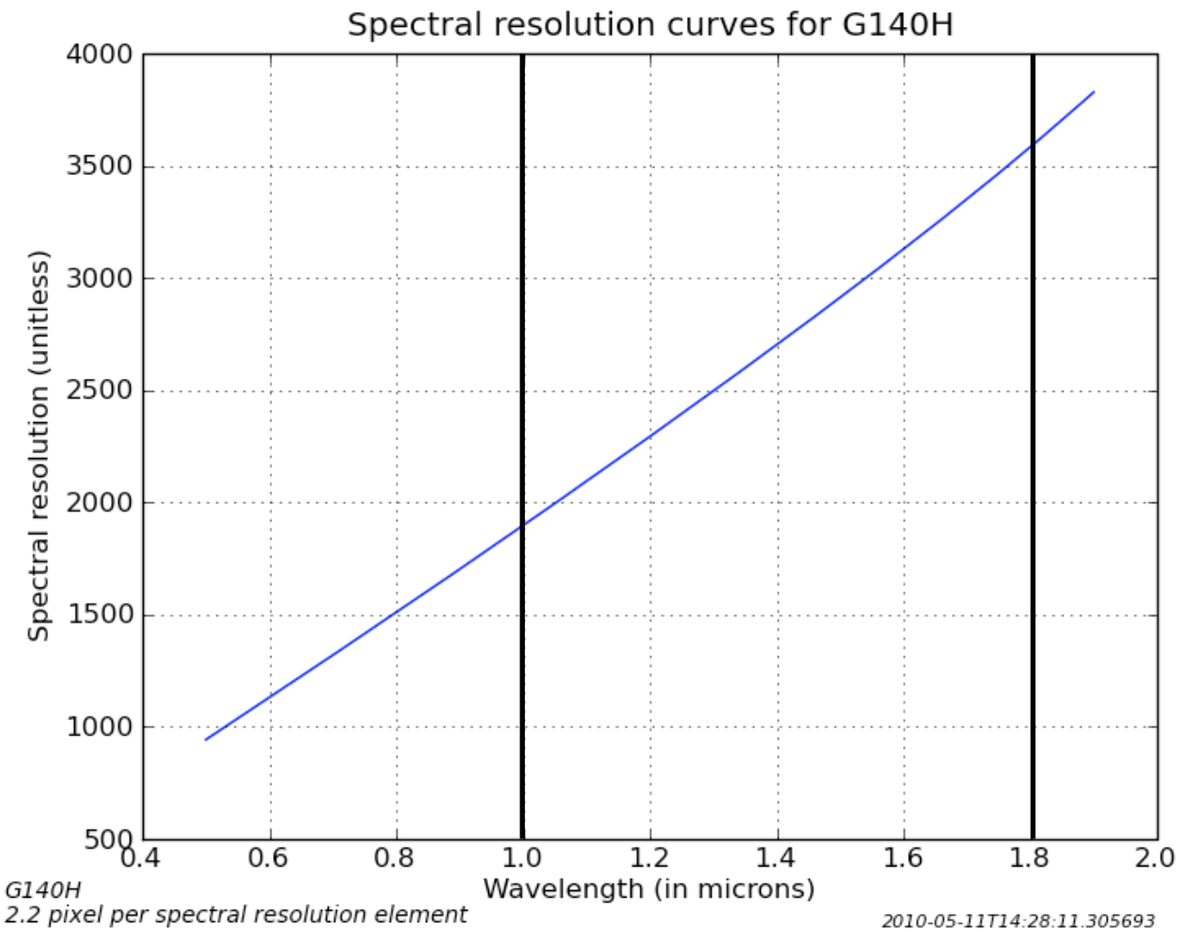
all closed

Dispersion

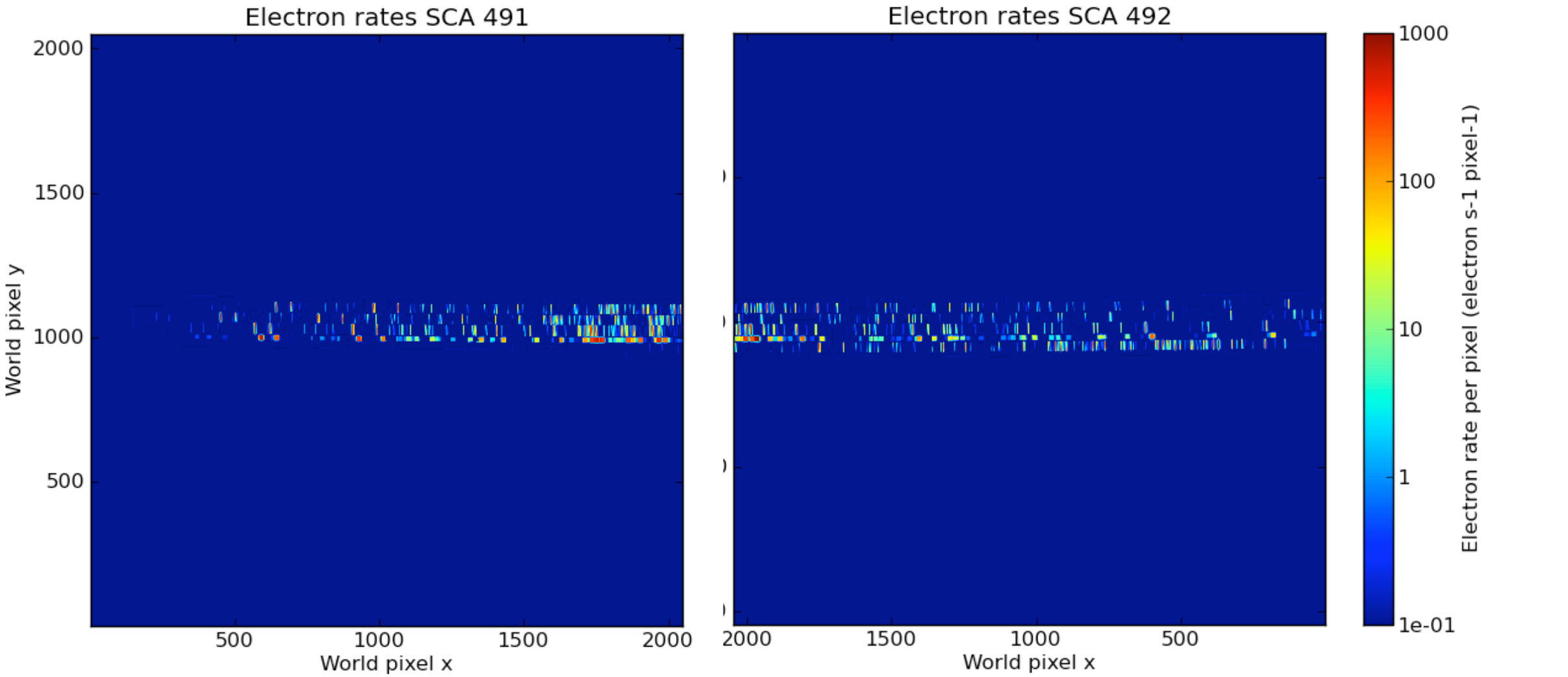


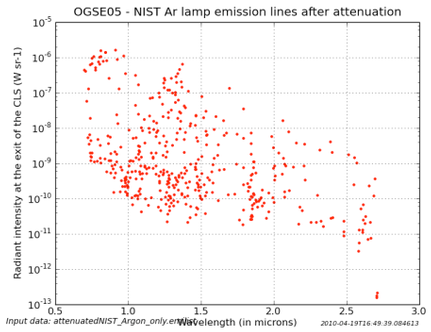


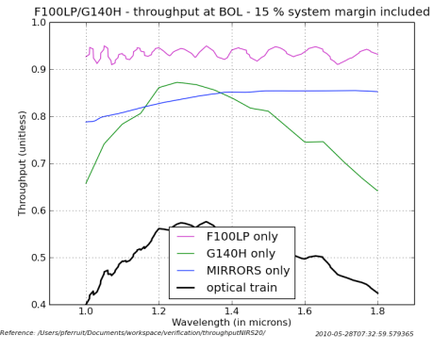
MSA: Perfect all closed

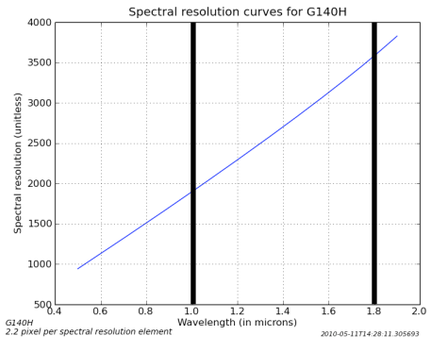


Flatfield, emission lines, HR grating I: overview









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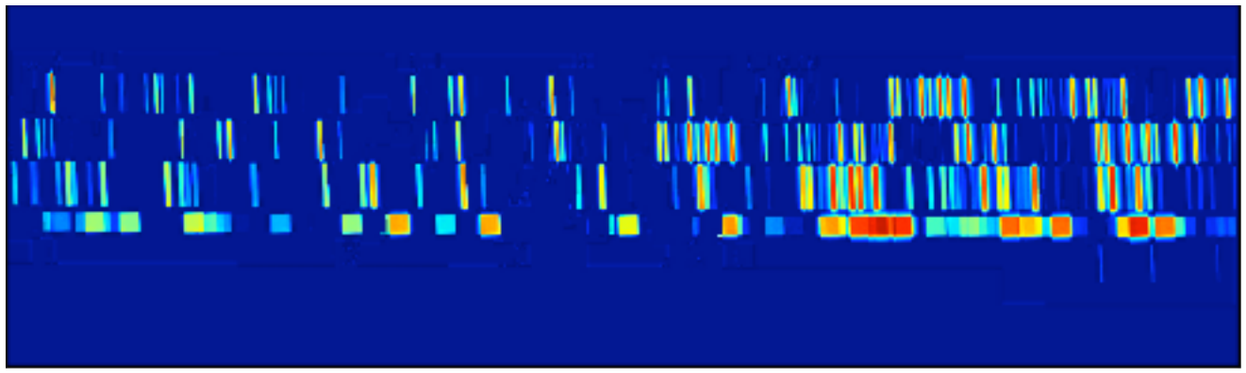
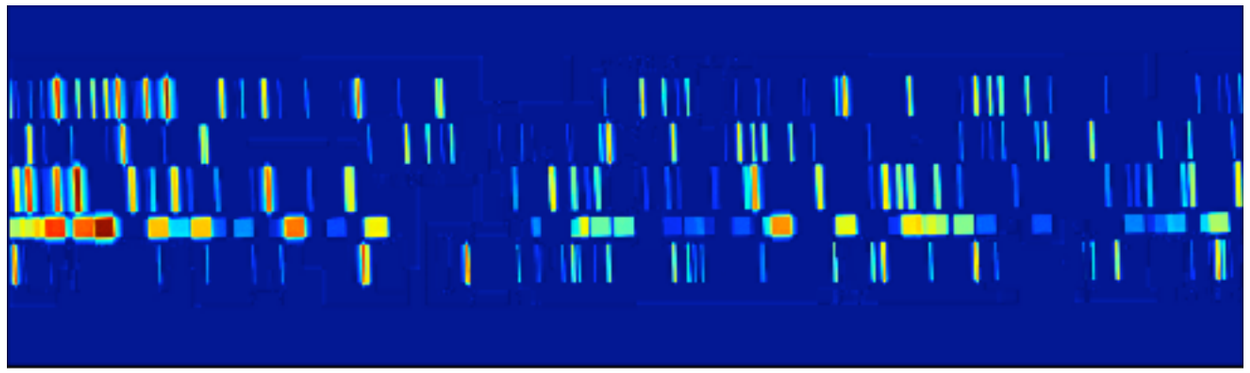
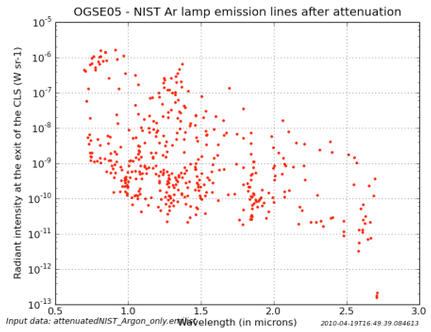
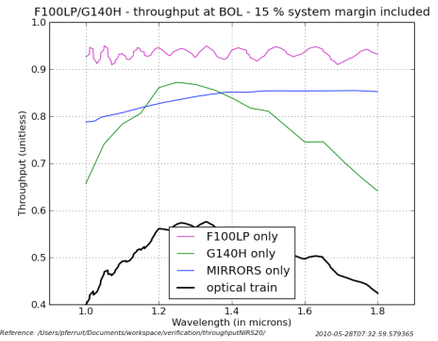
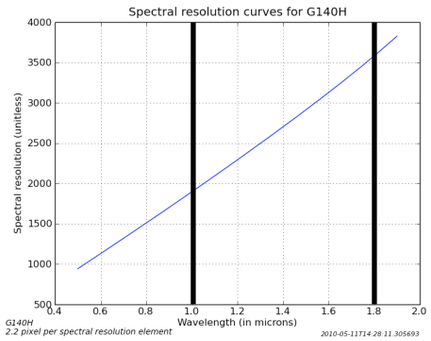
Flatfield, emission lines, HR grating I: overview



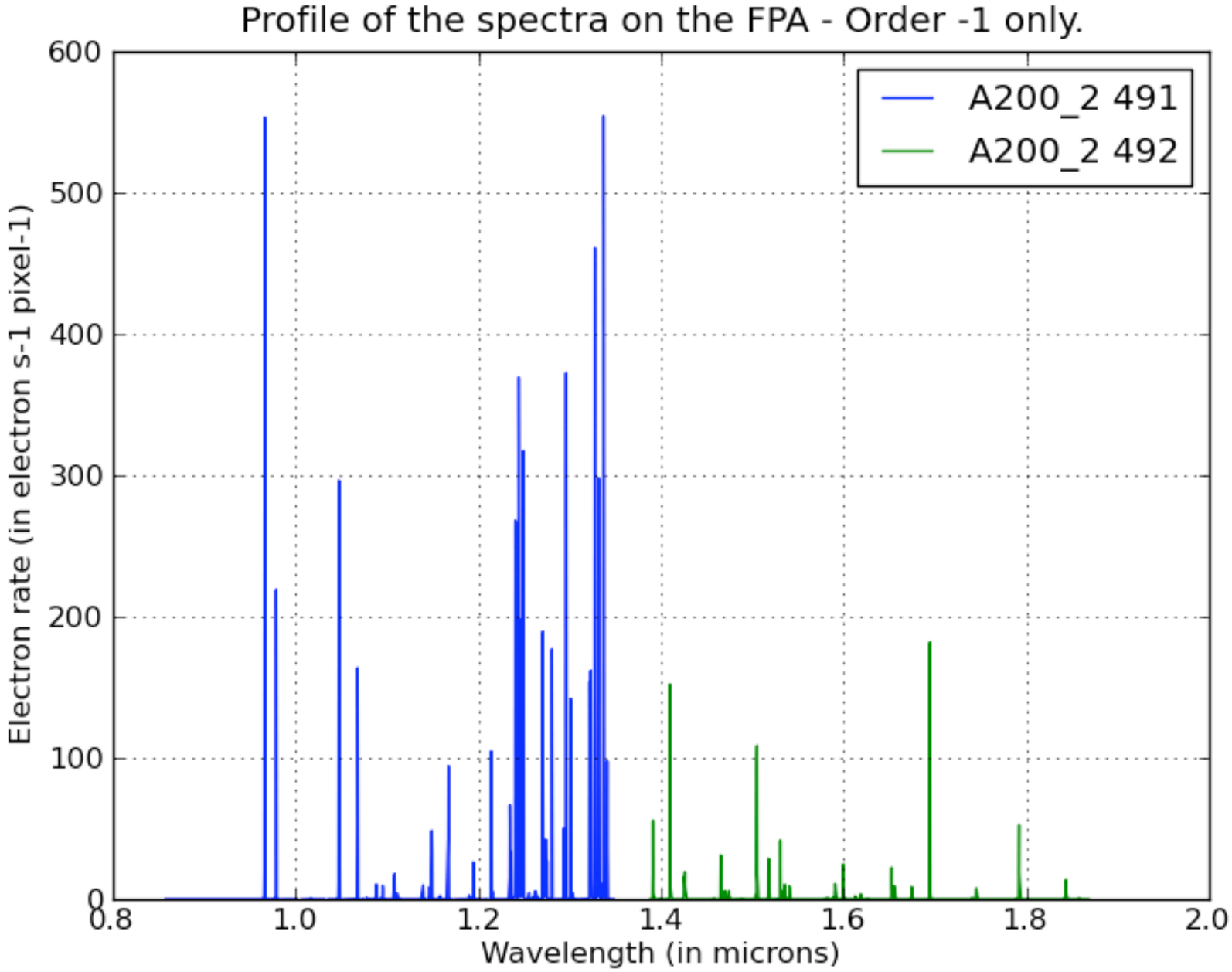


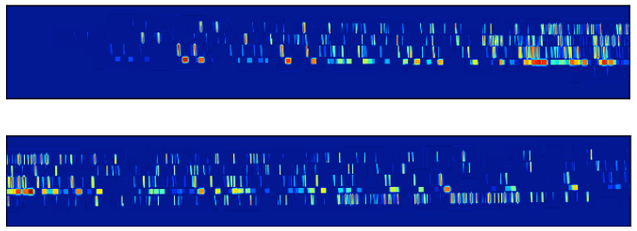


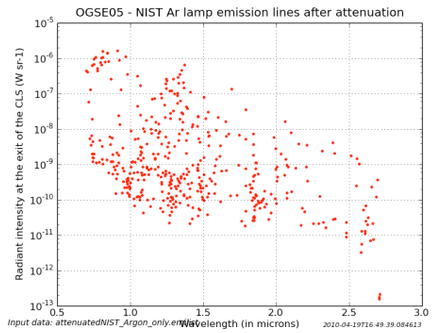


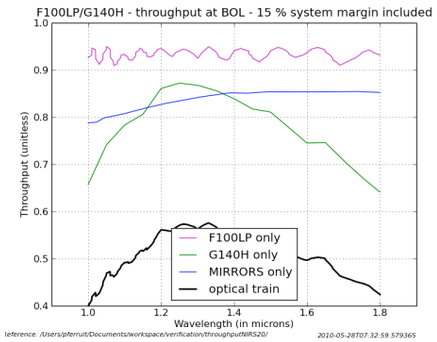


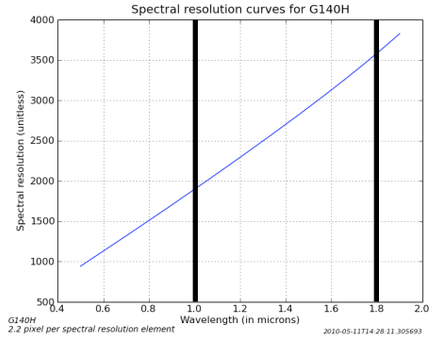
Flatfield, emission lines, HR grating I: spectrum trace









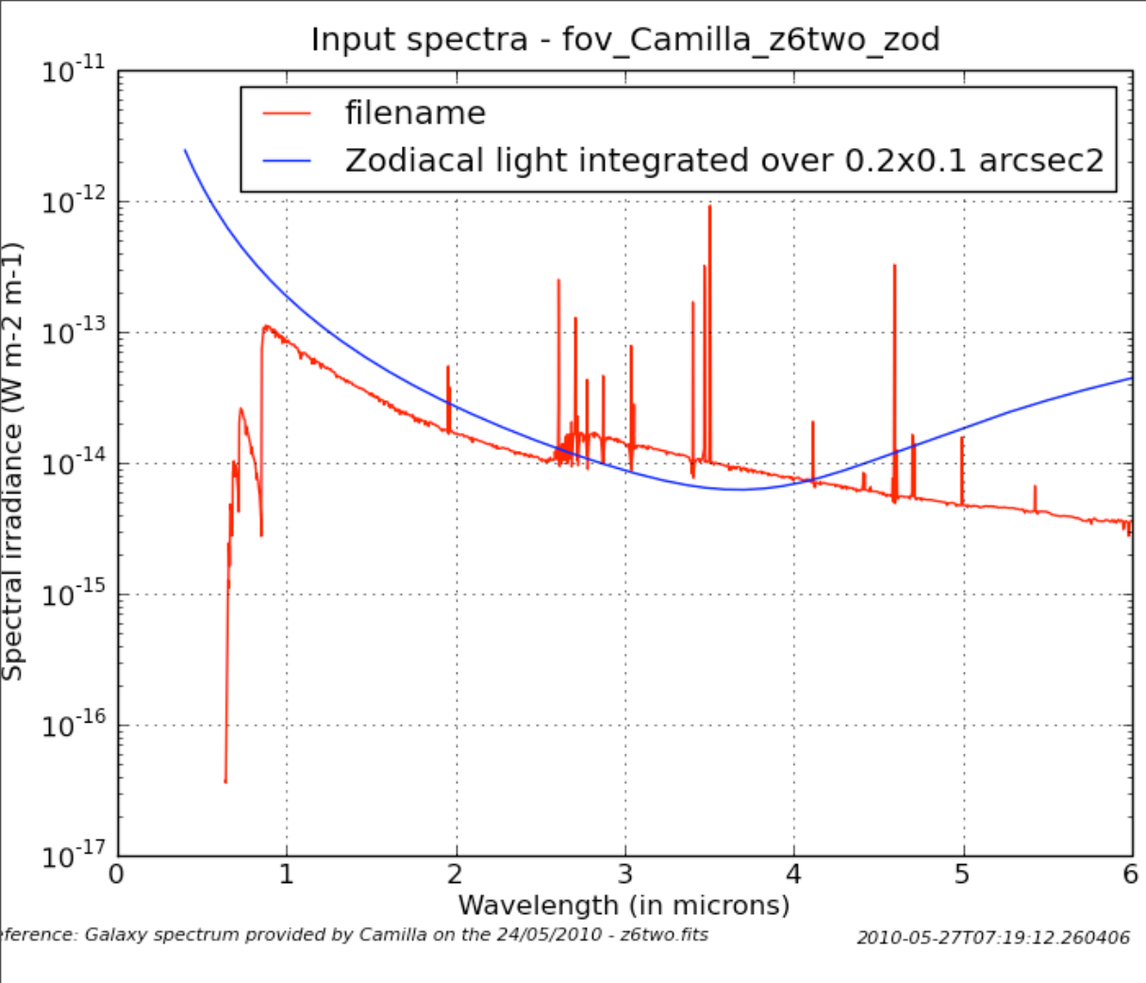


Source: Galaxy
spectrum at z=6

NIRSpec optics:
Clear filter, prism

MSA: Perfect
all closed

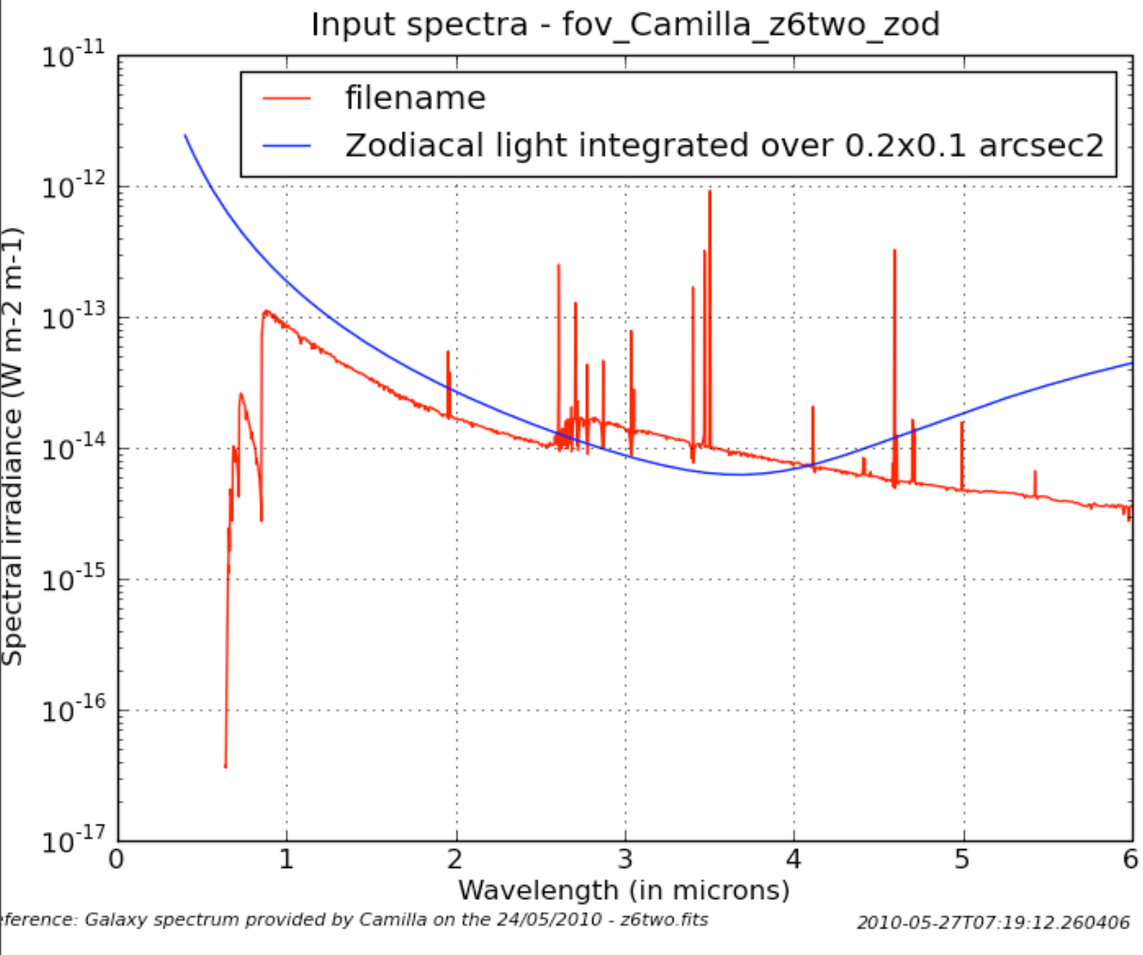
Dispersion

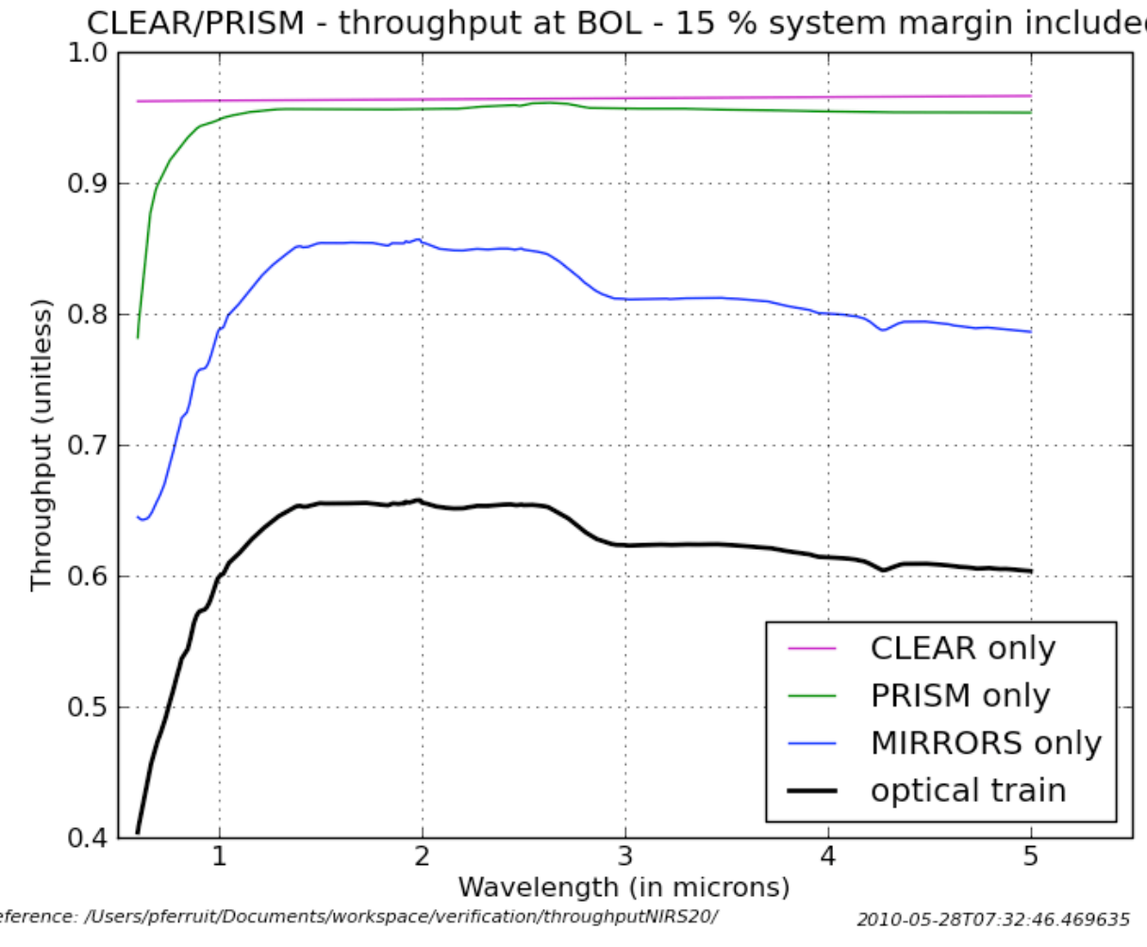


NIRSpec optics:
Clear filter, prism

MSA: Perfect
all closed

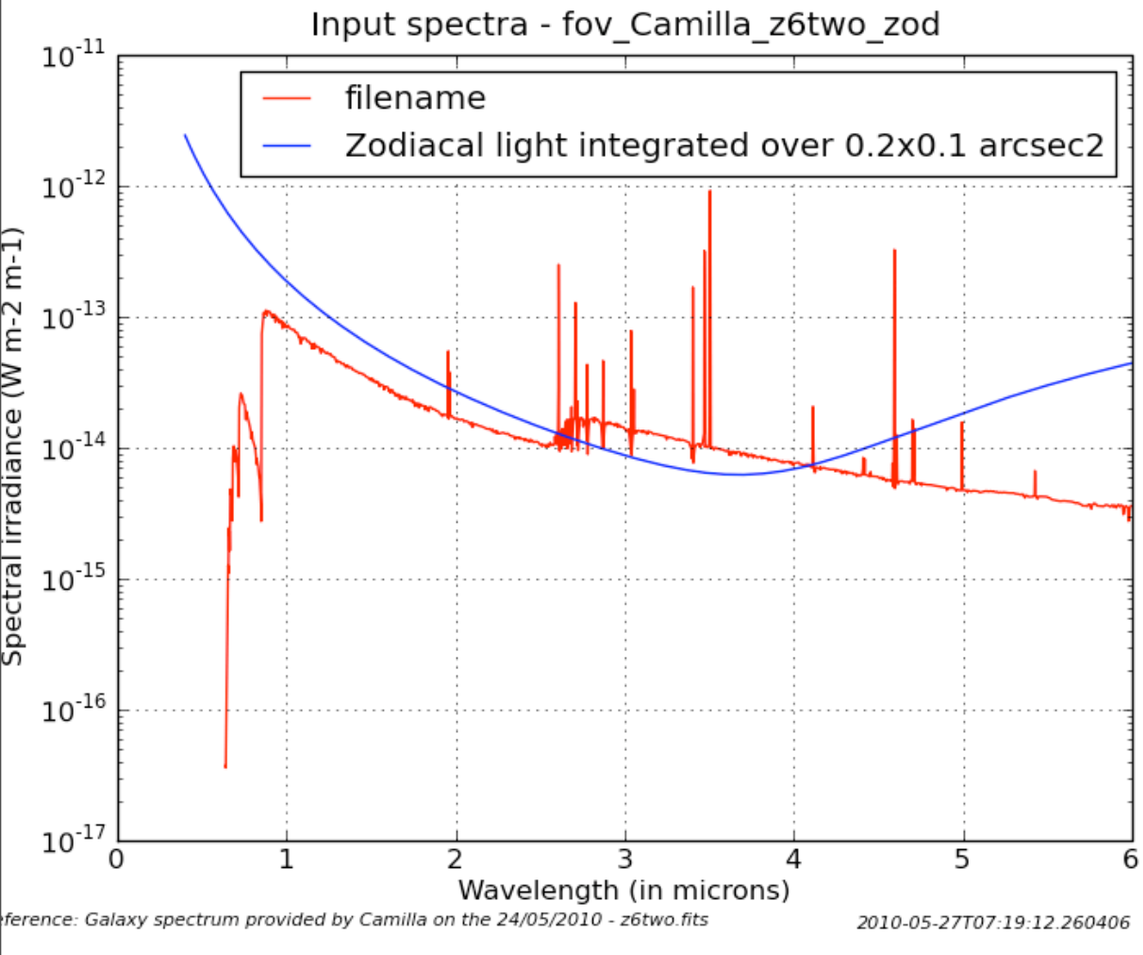
Dispersion

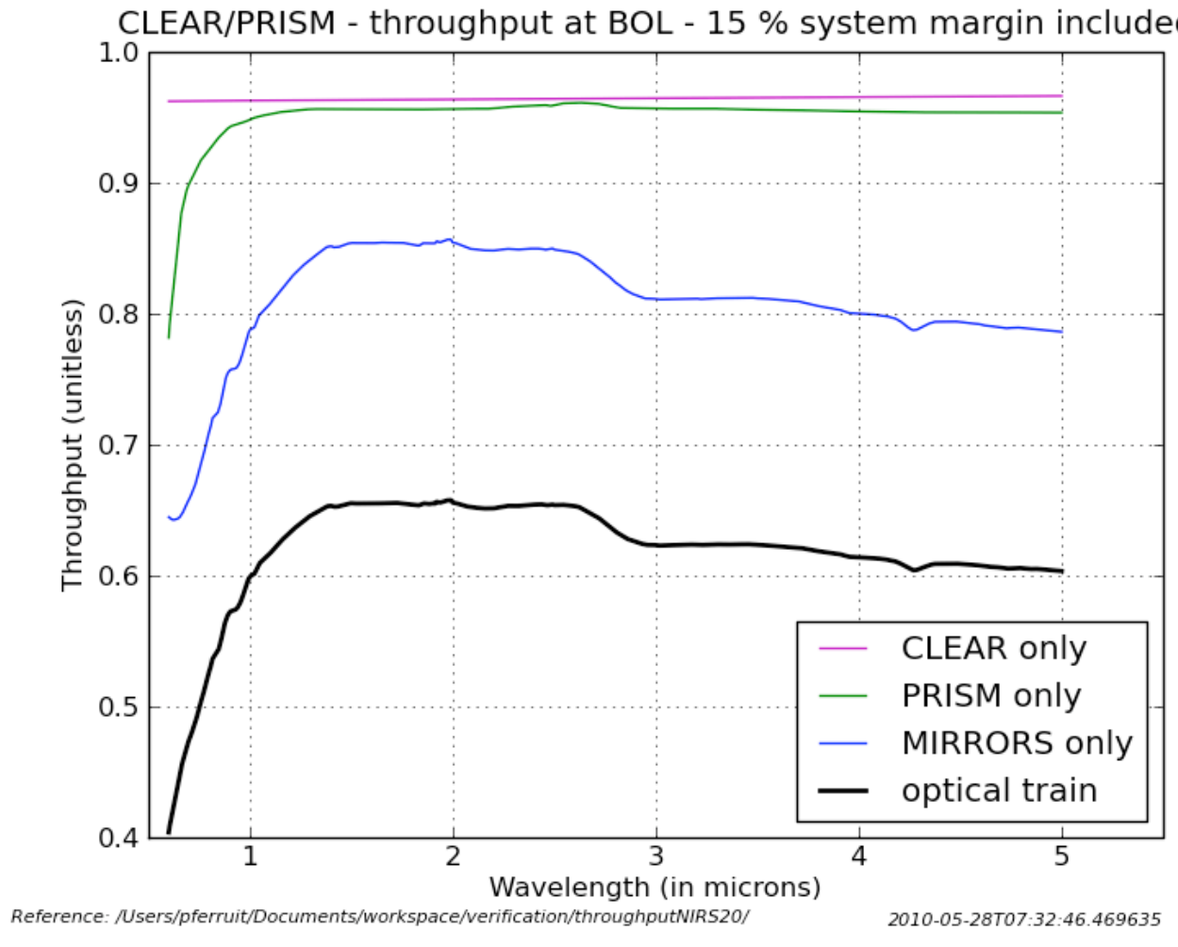




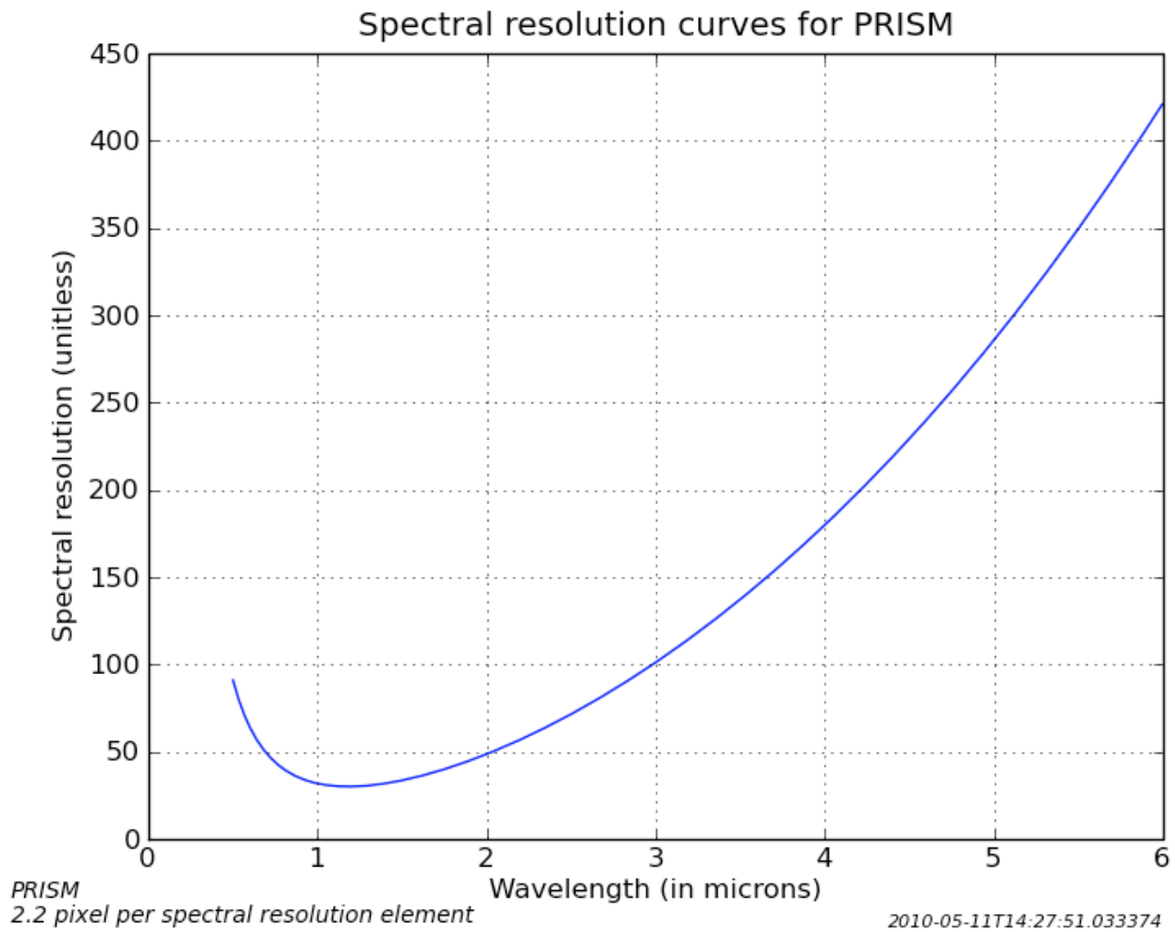
MSA: Perfect
all closed

Dispersion

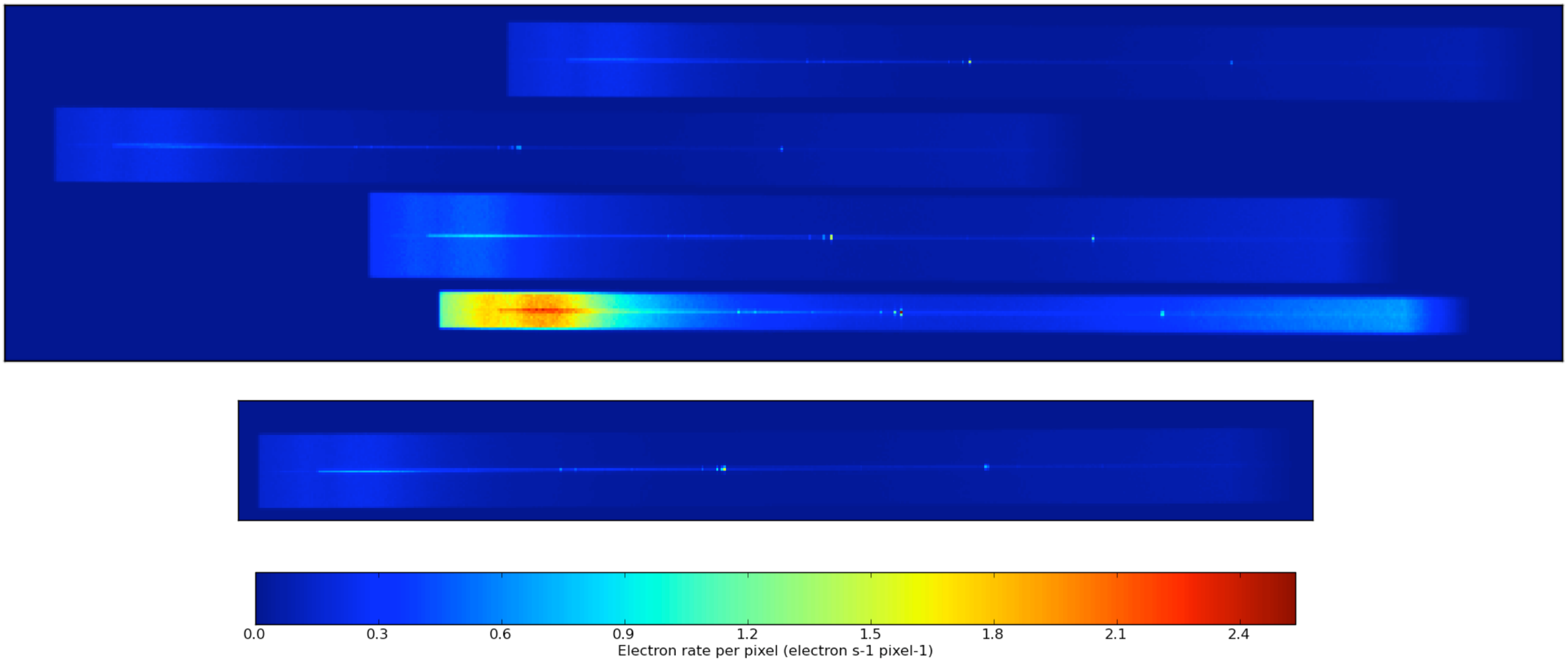


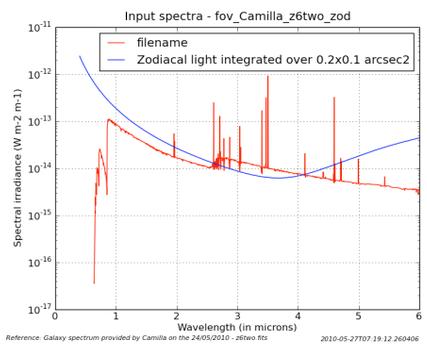


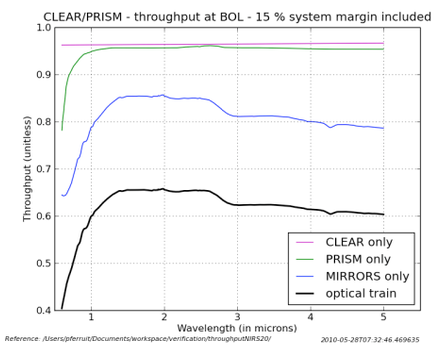
MSA: Perfect all closed



Point source, galaxy z=6, prism: overview







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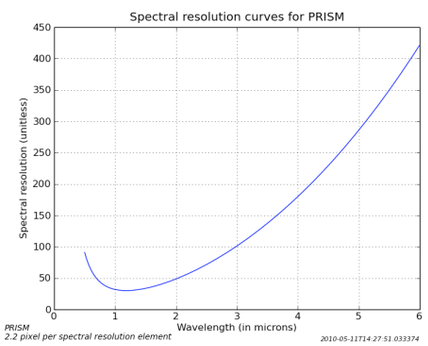
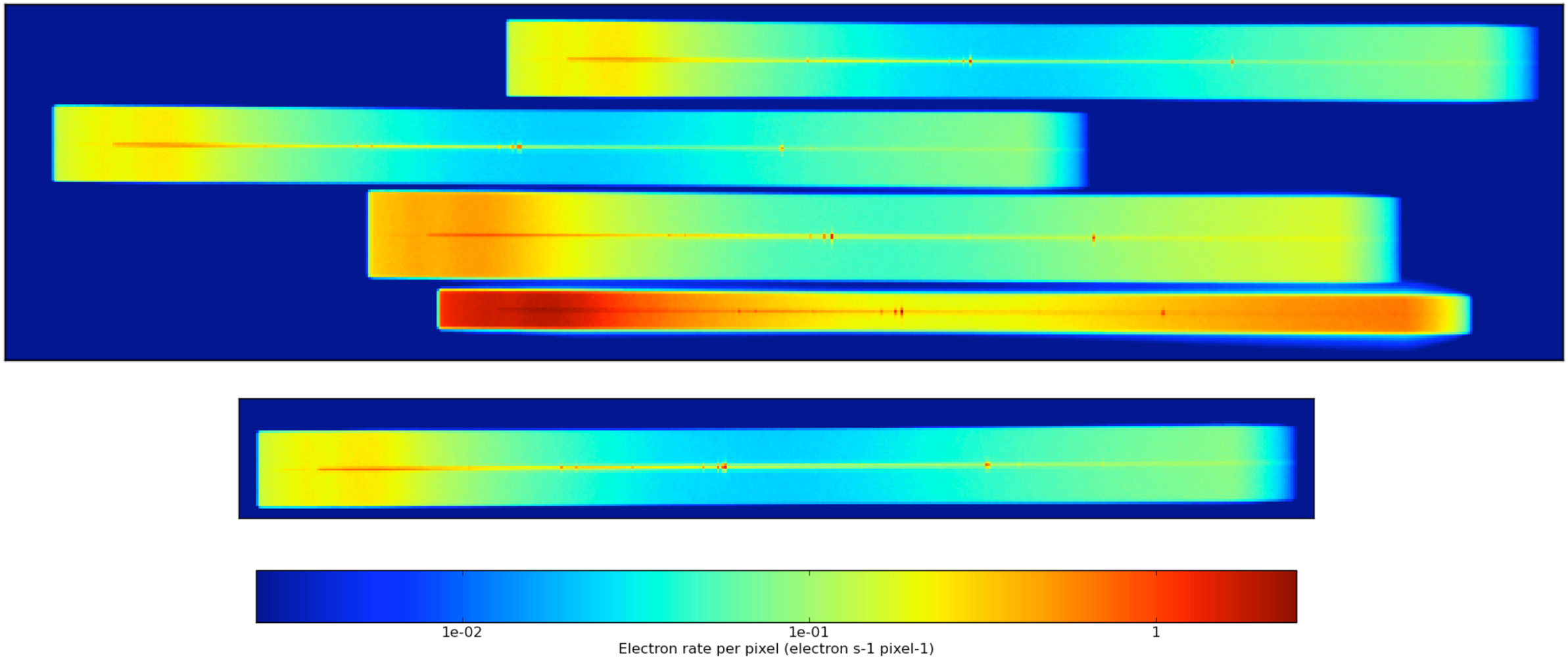
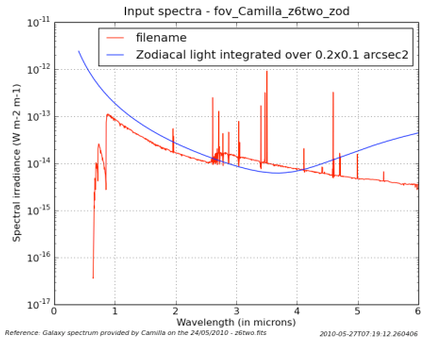
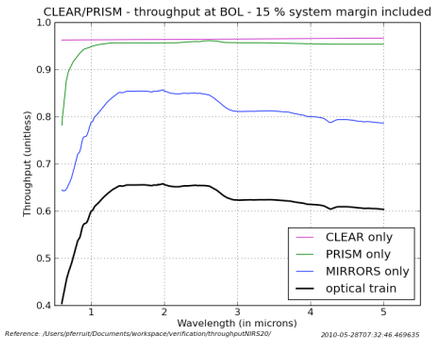
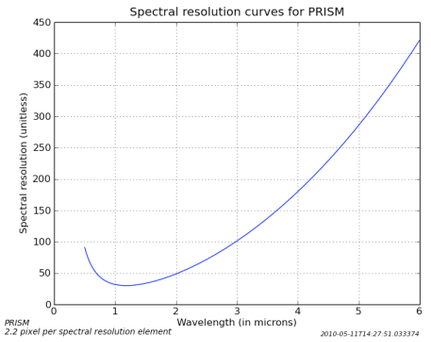


Point source, galaxy z=6, prism: overview









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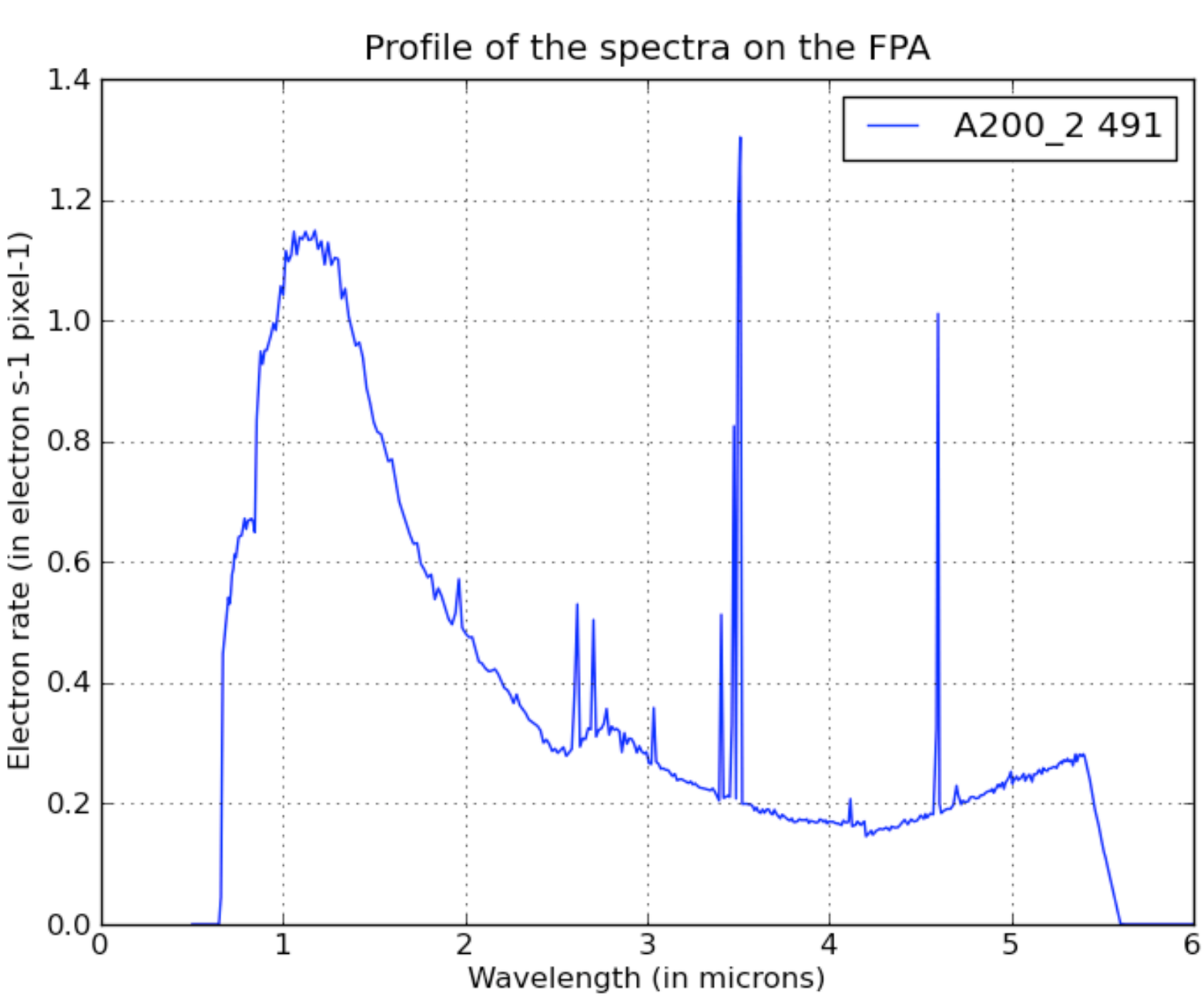
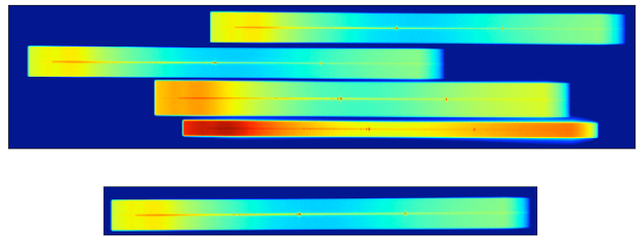
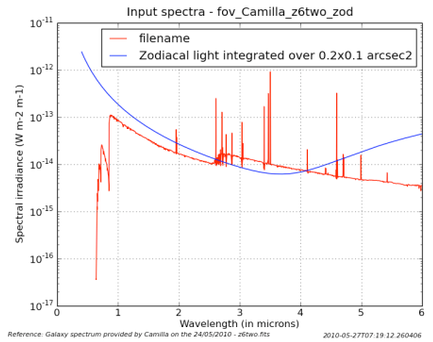
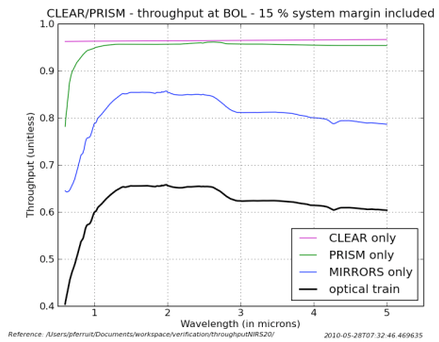
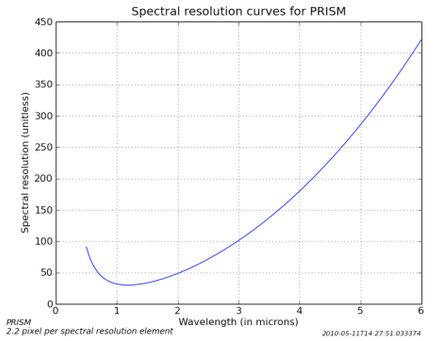
Point source, galaxy z=6, prism: spectrum collapsed











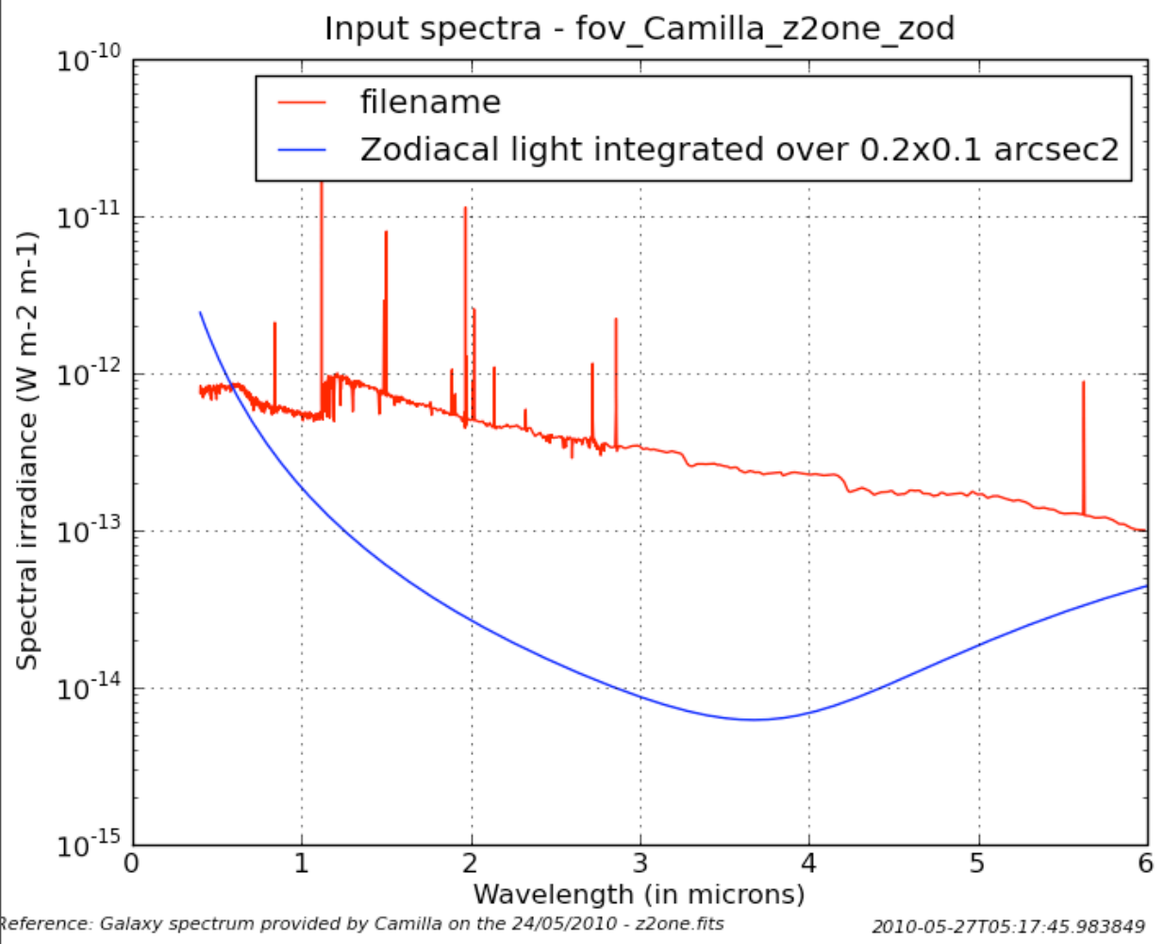
CRA Lyon

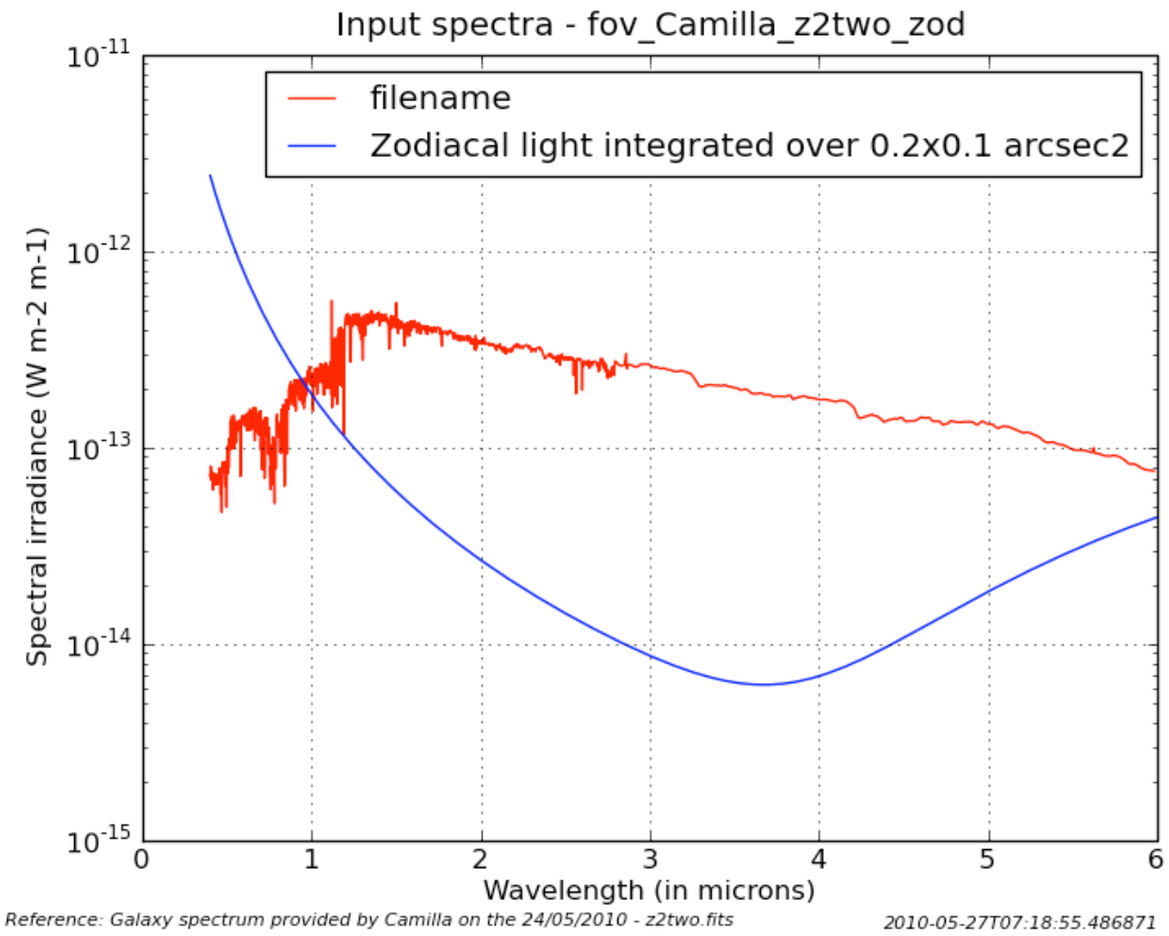
Source: Galaxy spectrum at z=2

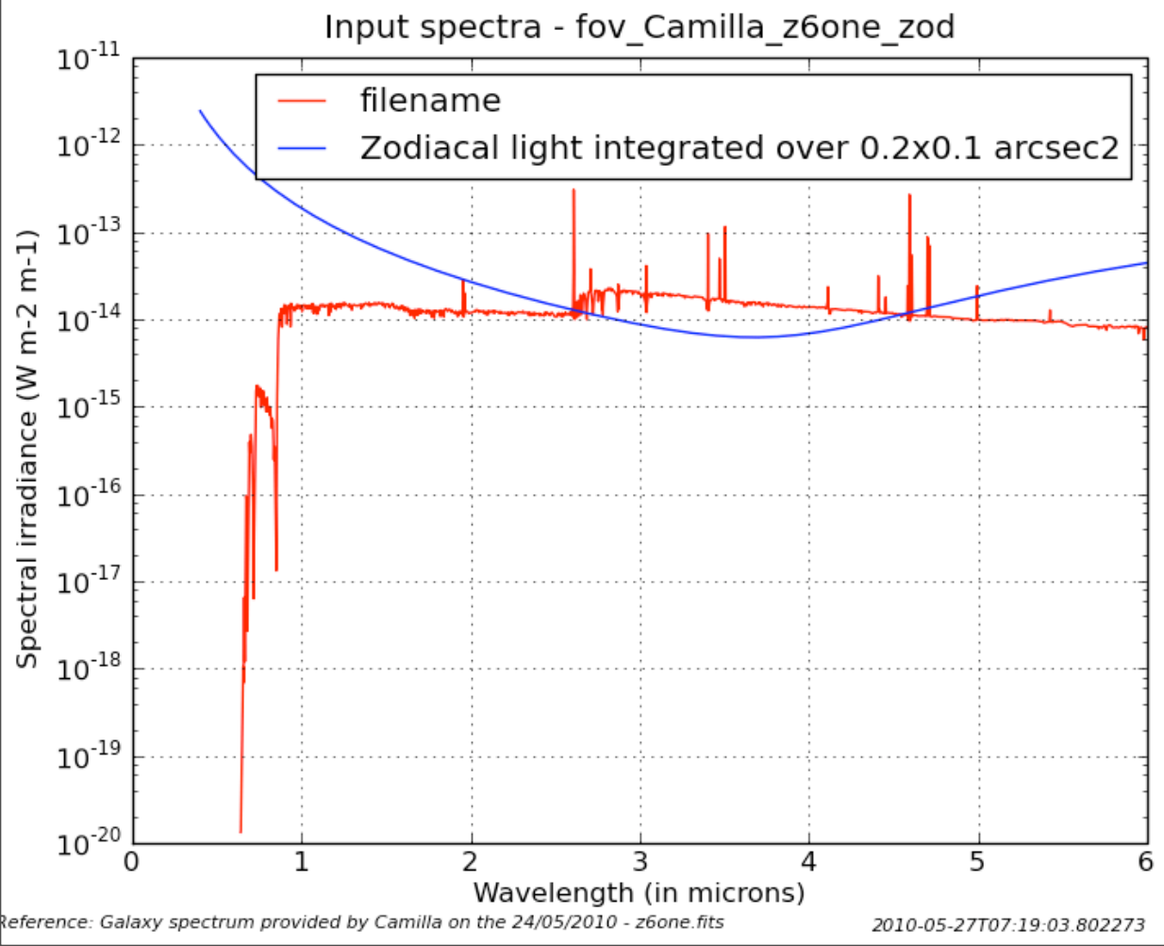
Source: Galaxy spectrum at z=2

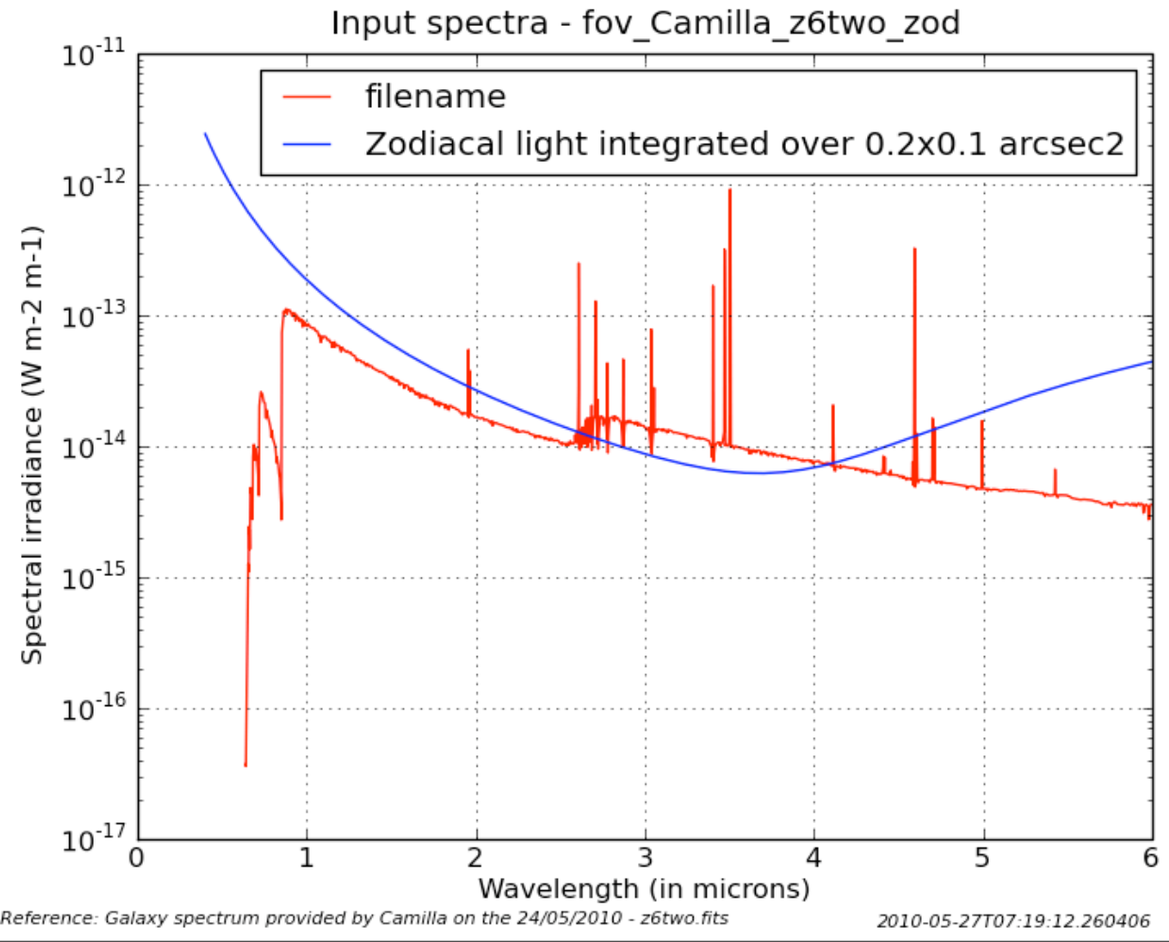
Source: Galaxy spectrum at z=6

Source: Galaxy spectrum at z=6

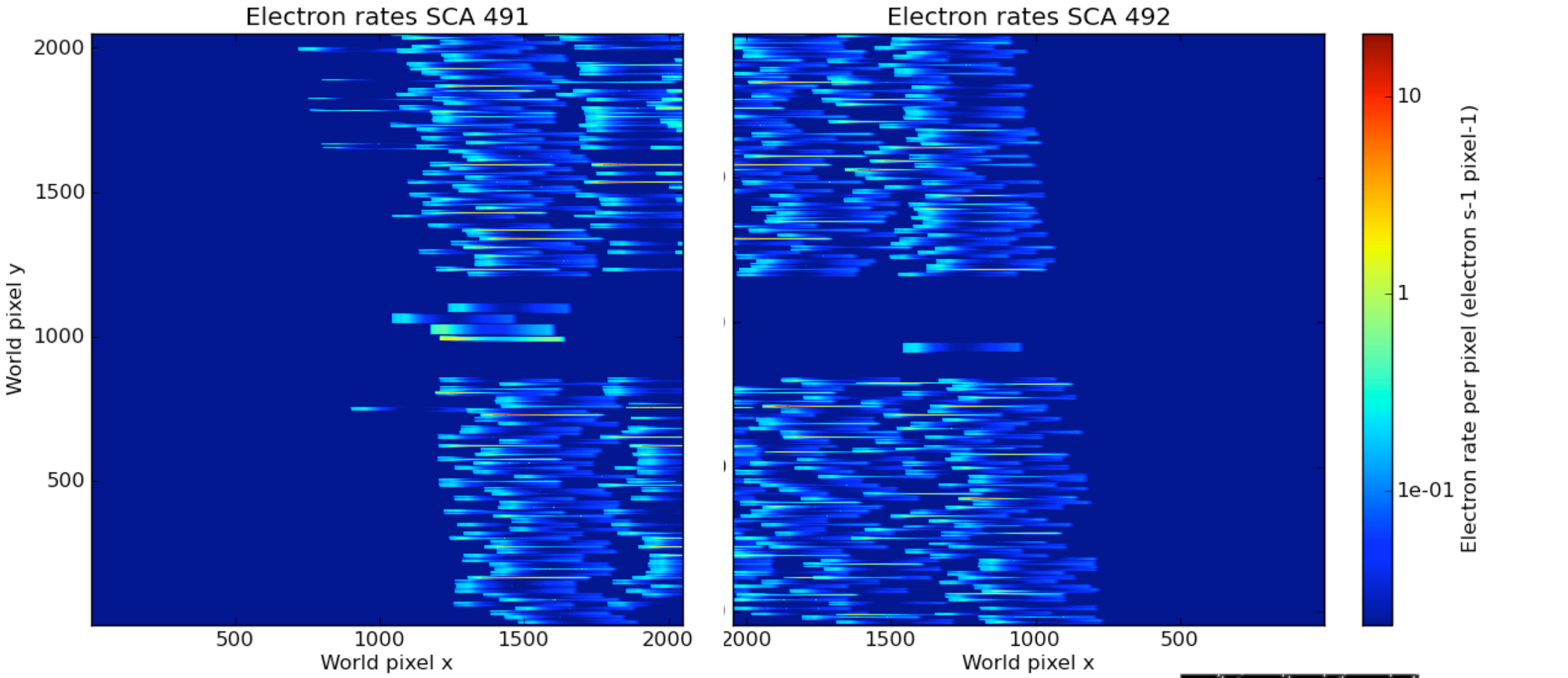

Input spectra - fov_Camilla_z2one_zod
filename
Zodiacal light integrated over 0.2x0.1 arcsec2
Spectral irradiance (W m-2 m-1)
Wavelength (in microns)
Reference: Galaxy spectrum provided by Camilla on the 24/05/2010 - z2one.fits
2010-05-27T05:17:45.983849

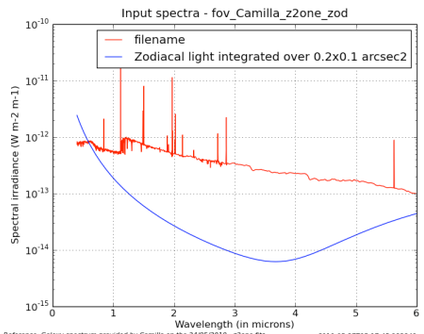

Input spectra - fov_Camilla_z2two_zod
filename
Zodiacal light integrated over 0.2x0.1 arcsec2
Spectral irradiance (W m-2 m-1)
Wavelength (in microns)
Reference: Galaxy spectrum provided by Camilla on the 24/05/2010 - z2two.fits
2010-05-27T07:18:55.486871

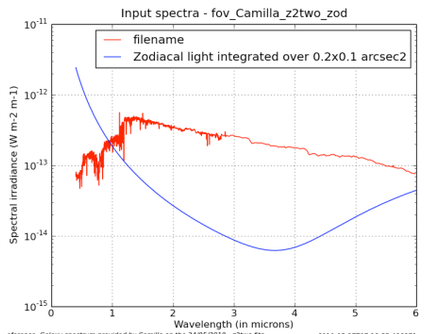

Input spectra - fov_Camilla_z6one_zod
filename
Zodiacal light integrated over 0.2x0.1 arcsec2
Spectral irradiance (W m-2 m-1)
Wavelength (in microns)
Reference: Galaxy spectrum provided by Camilla on the 24/05/2010 - z6one.fits
2010-05-27T07:19:03.802273

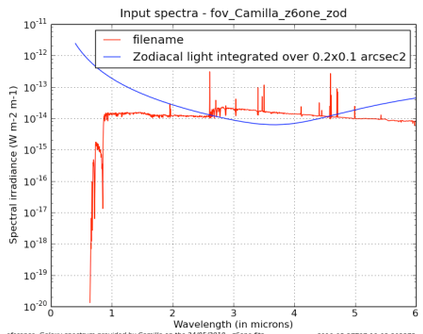

Input spectra - fov_Camilla_z6two_zod
filename
Zodiacal light integrated over 0.2x0.1 arcsec2
Spectral irradiance (W m-2 m-1)
Wavelength (in microns)
Reference: Galaxy spectrum provided by Camilla on the 24/05/2010 - z6two.fits
2010-05-27T07:19:12.260406

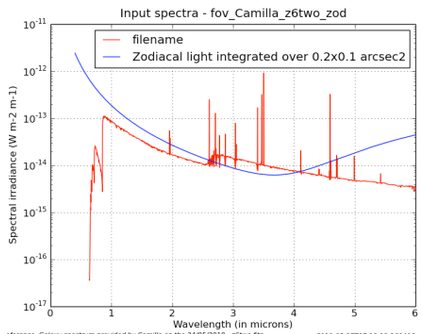
Point source, MOS sky scene, prism: overview

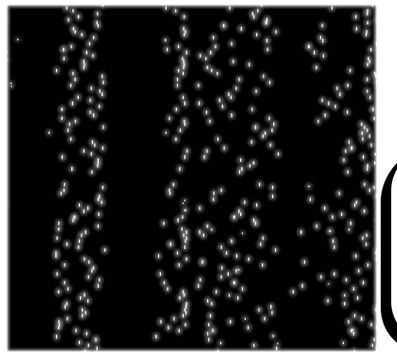




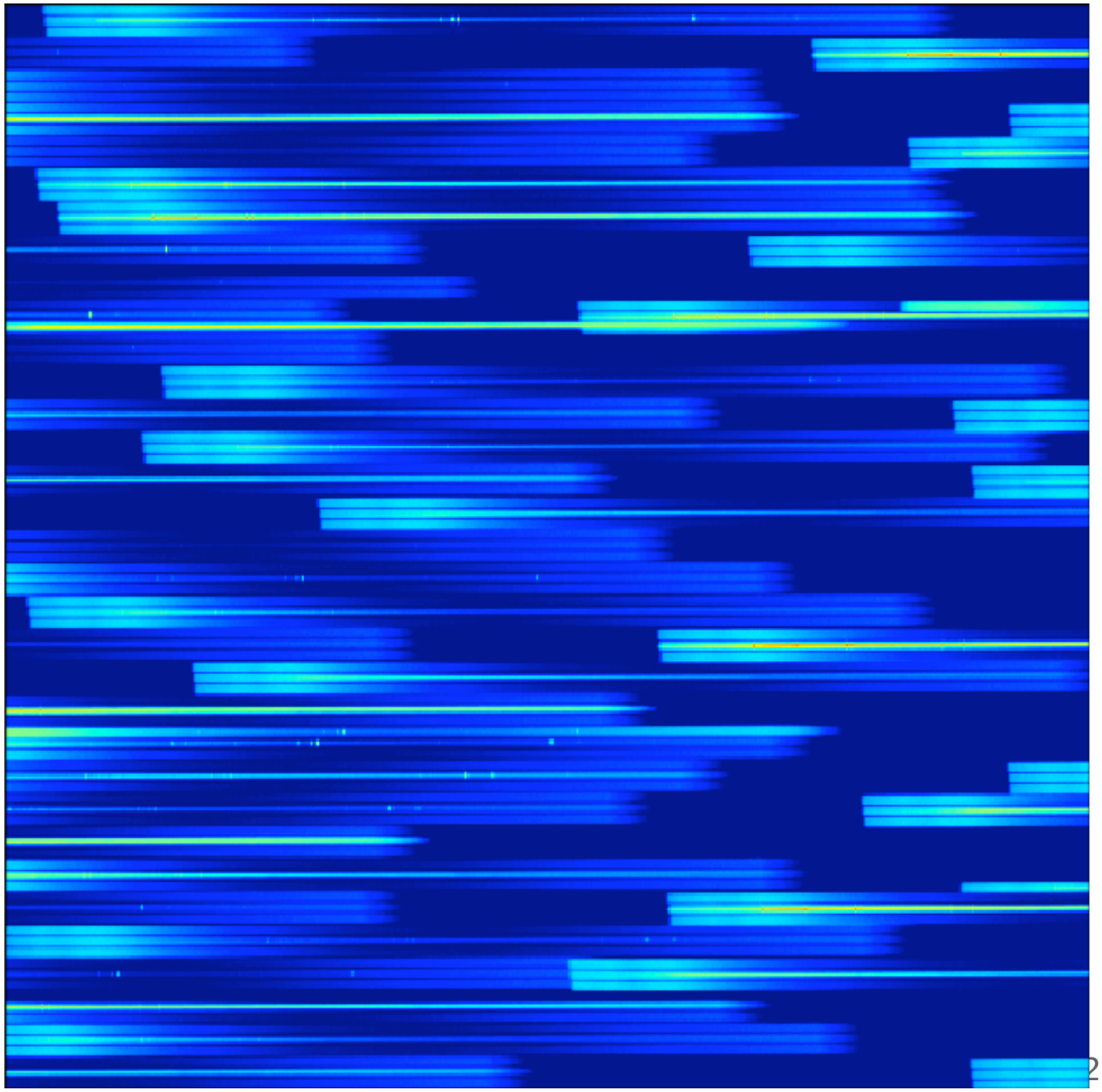


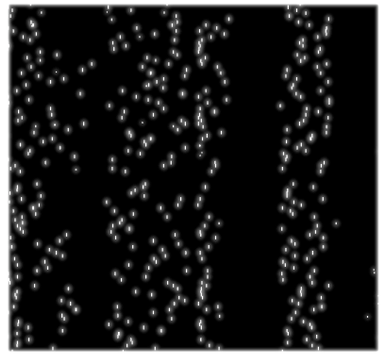


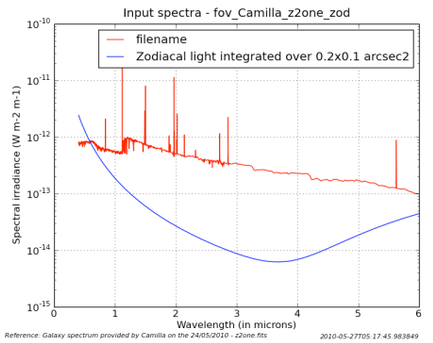


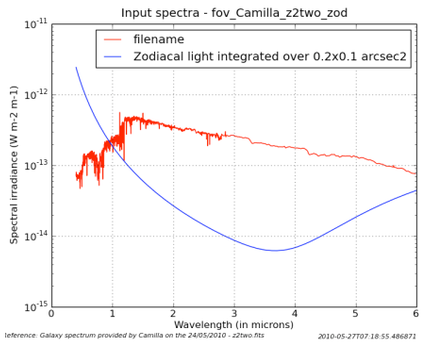


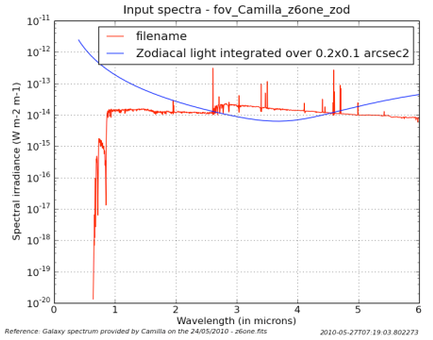
Point source, MOS sky scene, prism: zoom

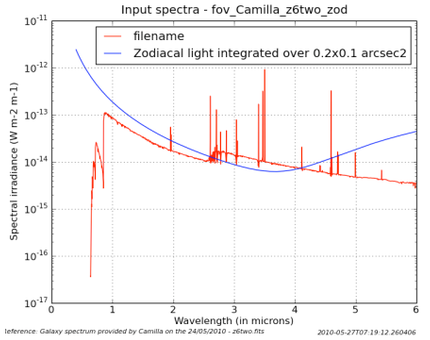




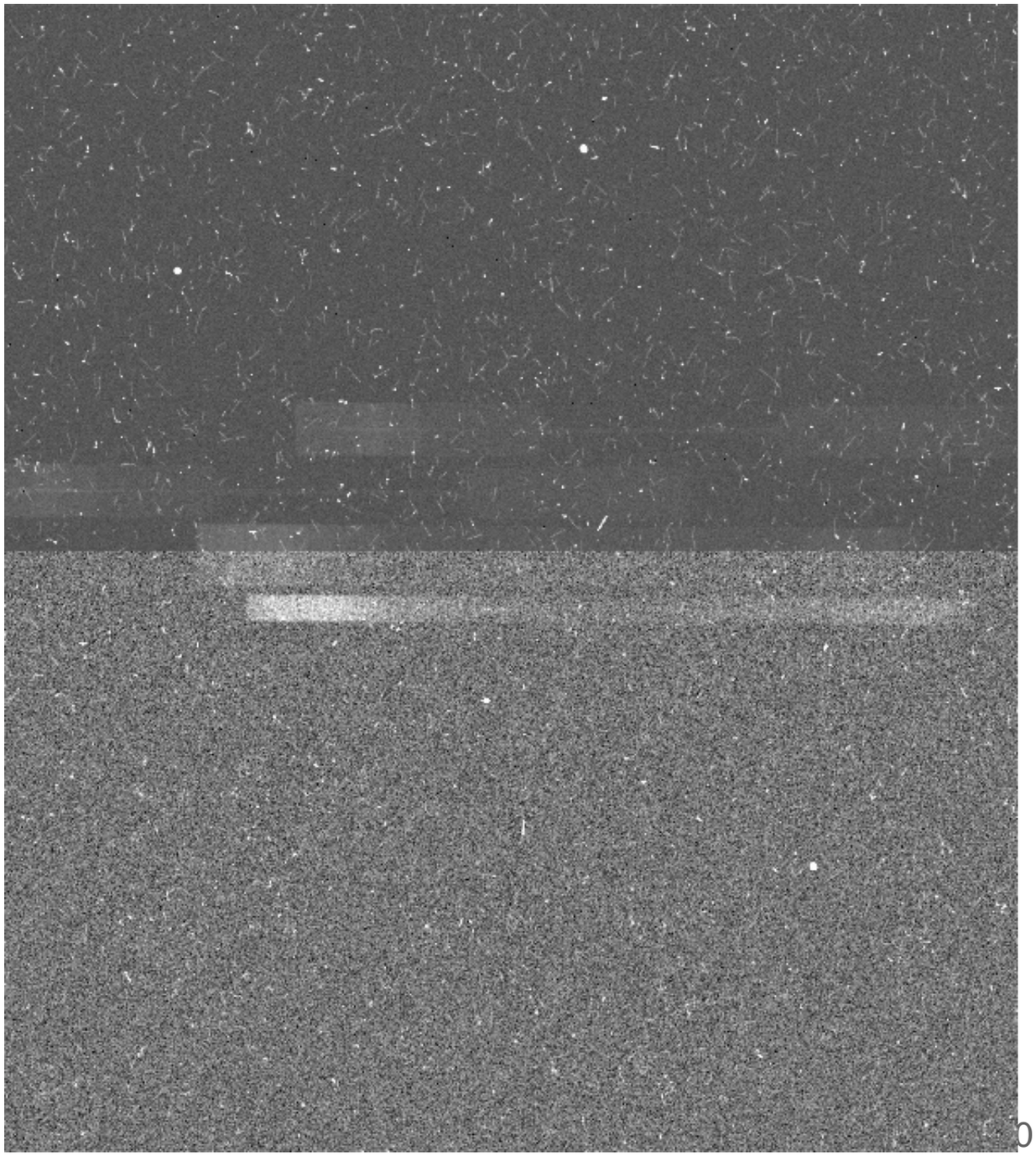


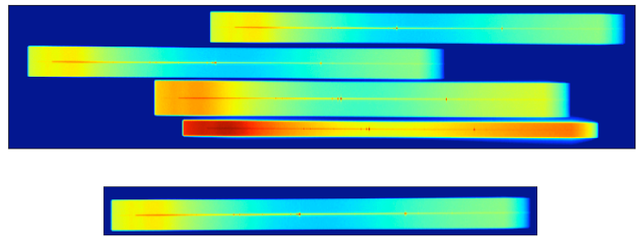


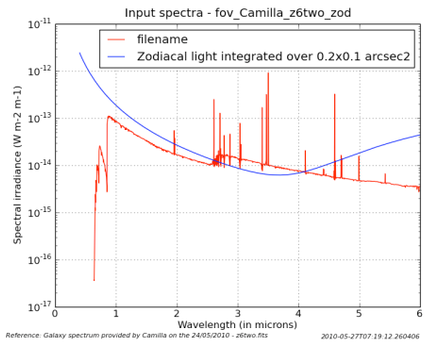


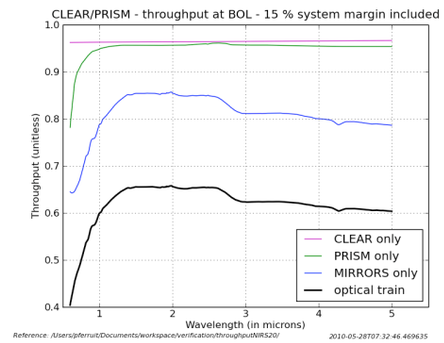


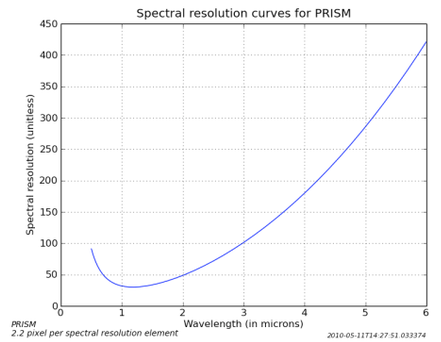
Point source, galaxy z=6, prism: 22x4 readout (902 s)











Conclusion

- IPS does realistic end-to-end simulation
- Separation of electron rates + readout allows study of different effects
- Prepare FM tests and start with science simulations