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AEGORA Research Group
POLLUX Payload Workshop
4th April 2017

POLLUX/LUVOIR Simulations

Preparing the way for a POLLUX/LUVOIR simulator

UNIVERSIDAD COMPLUTENSE MADRID

Summary

1. WSO-Sim
2. WSO-UV Spectrograph simulations
3. POLLUX Simulations

1. WSO-Sim

AstroidSim

Astronomical Imaging multi-Detector Simulator

- An end-to-end simulation software-tool designed to be used in different space missions.

- Simulates photometric time-series of images by including realistic models of the noise sources.

1. WSO-Sim

PLATO Simulator

- An end-to-end simulation software-tool designed to be used in different space missions.

- Simulates photometric time-series of images by including realistic models of the noise sources.

1. WSO-Sim

WSO Simulator

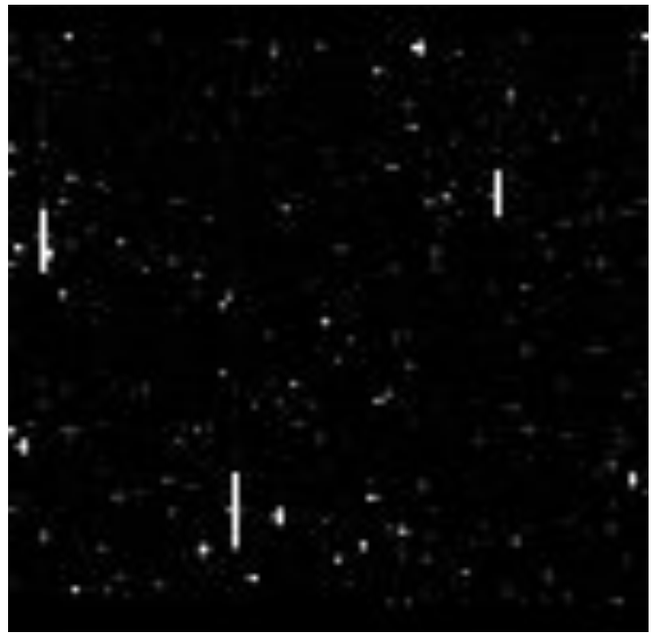
- An end-to-end simulation software-tool designed to be used in different space missions.

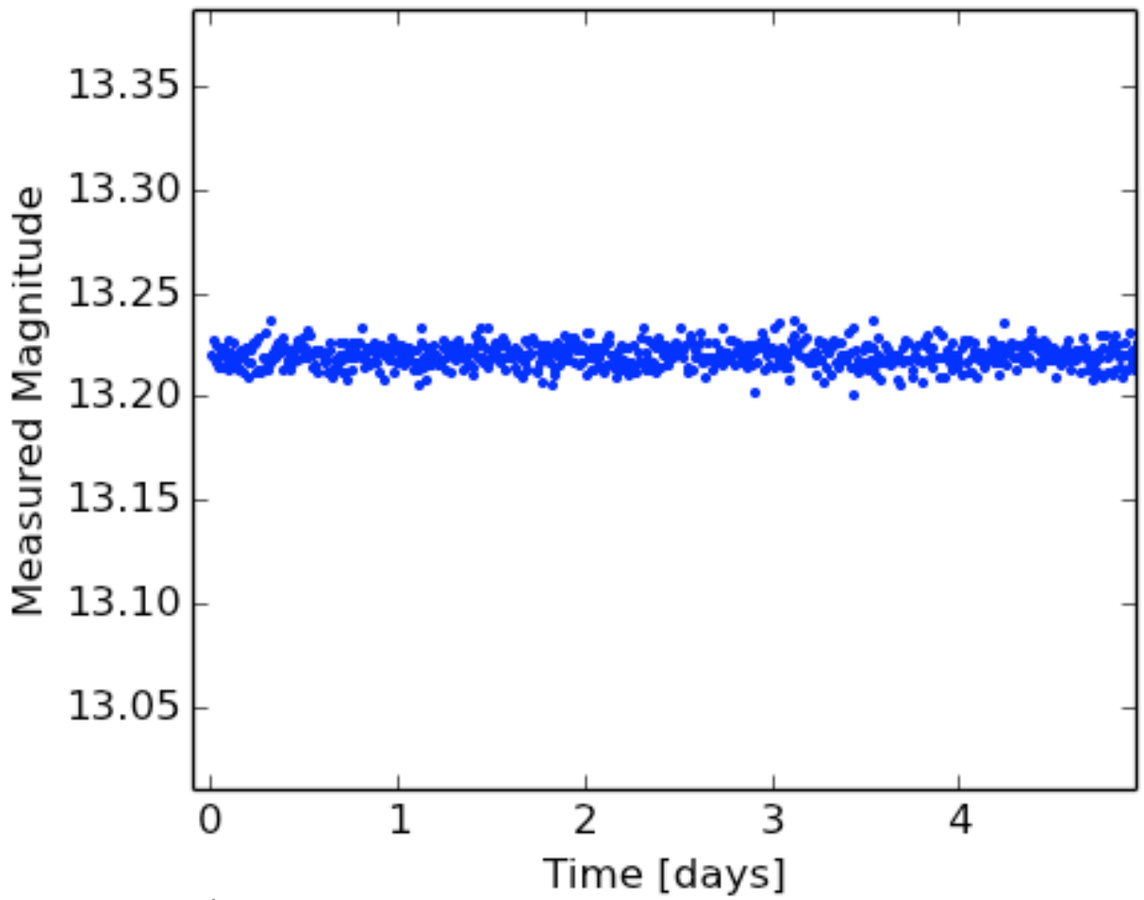
- Simulates photometric time-series of images by including realistic models of the noise sources.

WSO-Sim

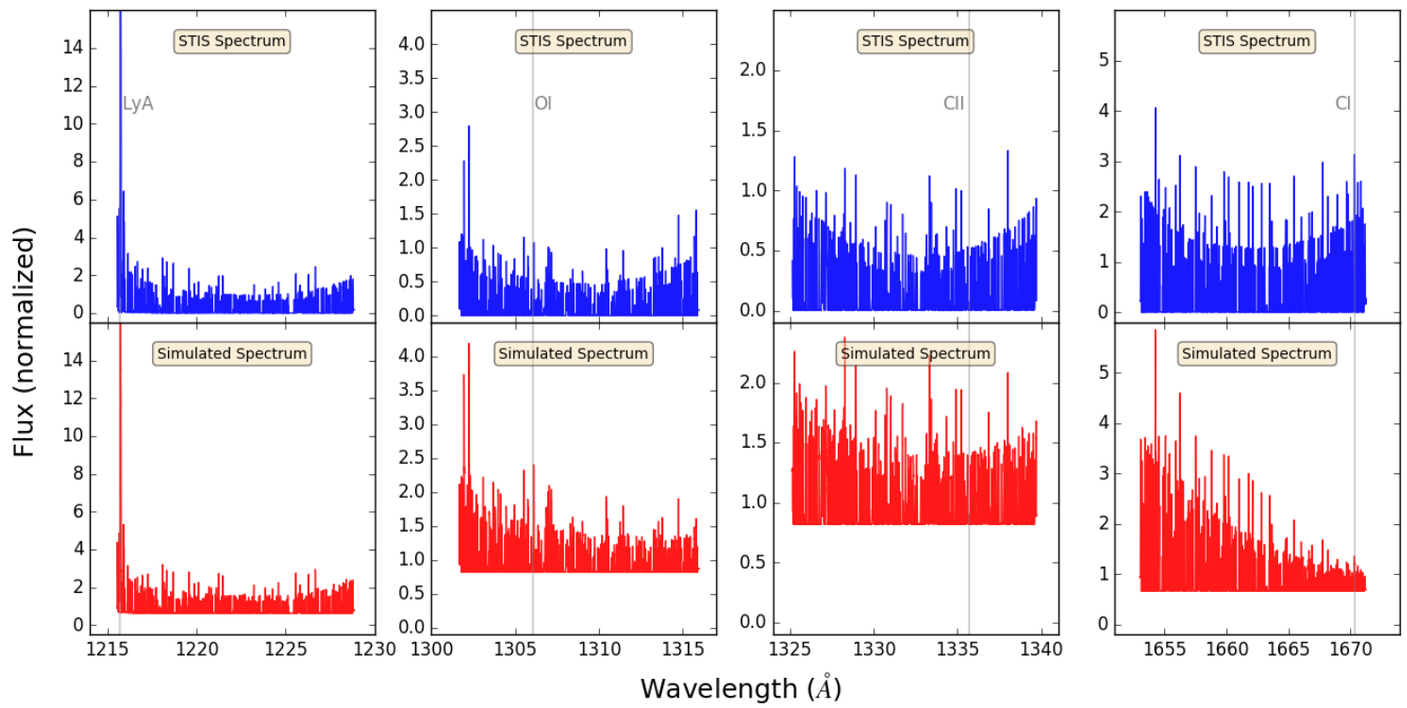
What kind of simulations?

- FITS Images generation
- Long time series
- Photometric algorithms on images
  - Measures the flux of each star in each image frame
  - Light curves for each star
  - Imager performance



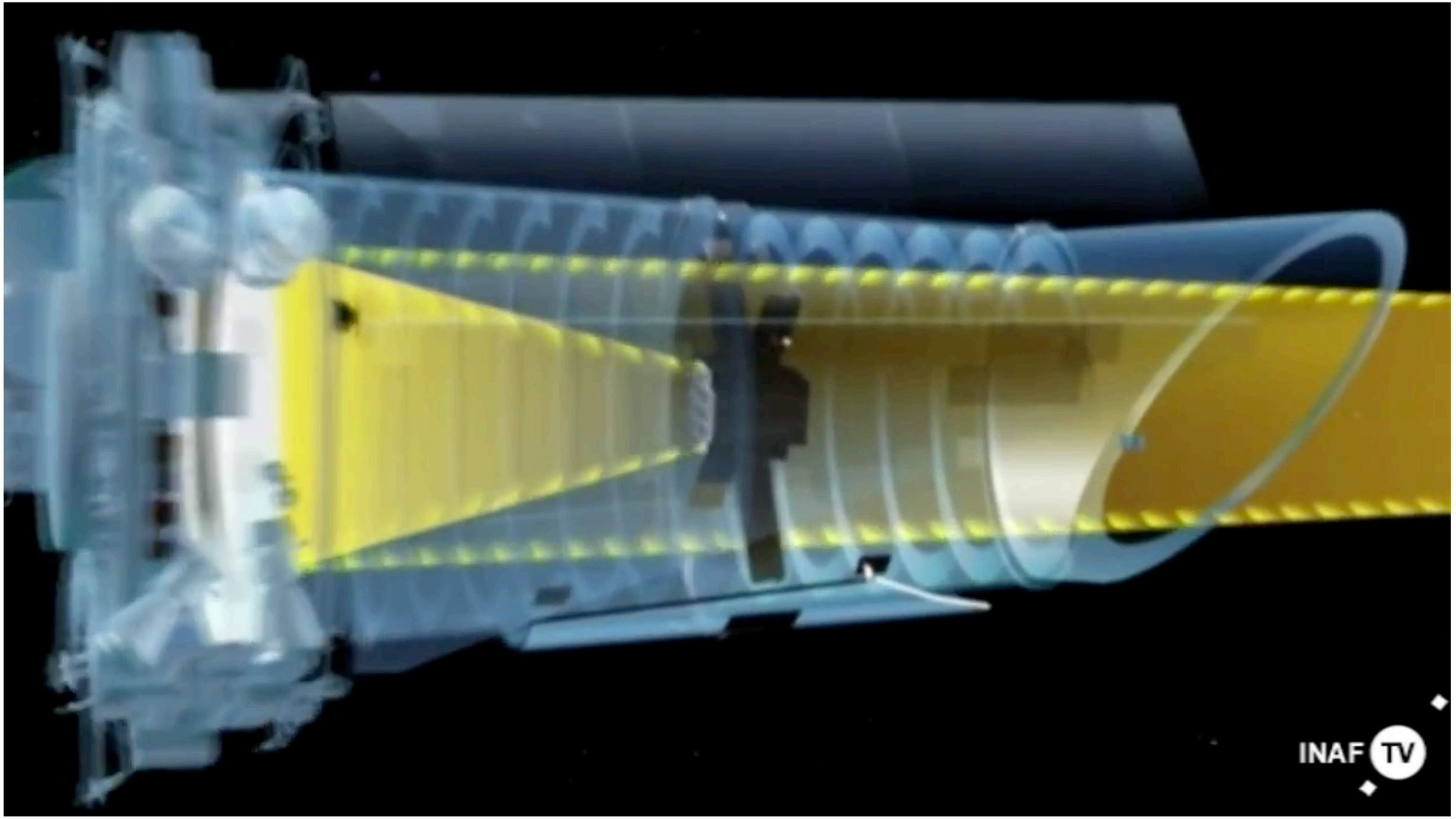


- FITS Images generation
- Long time series
- Photometric algorithms on images
  - Measures the flux of each star in each image frame
  - Light curves for each star
  - Imager performance
- Spectal analysis
  - Detectability of spectral lines
  - Spectrograph performance



WSO-Sim

What kind of simulations?



Courtesy of INAF

WSO-Sim

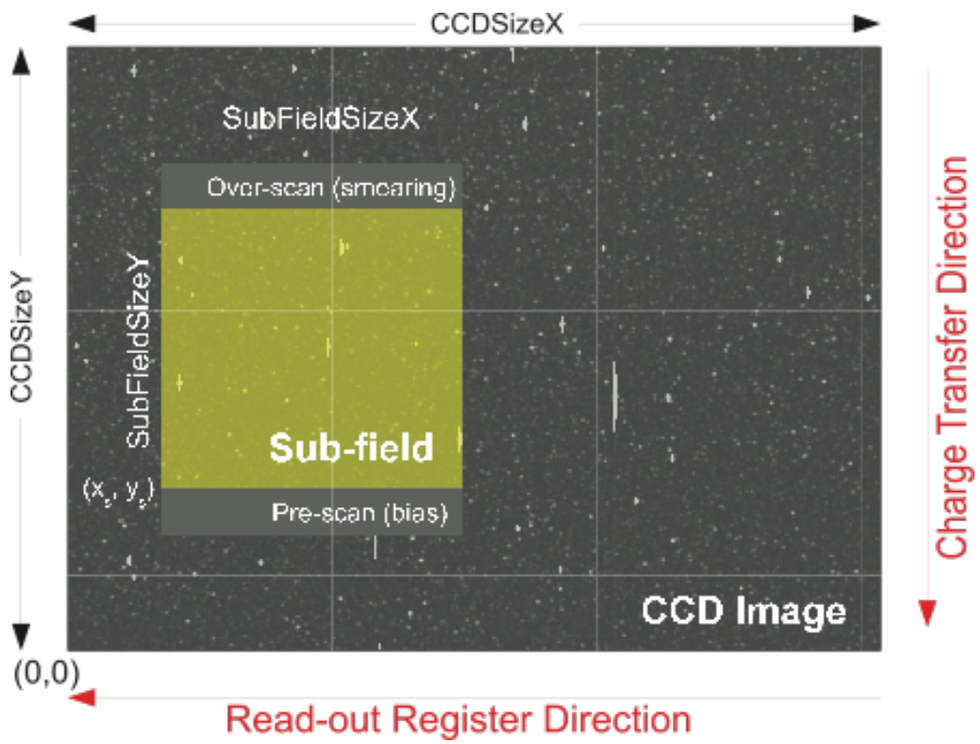
How does it work?

How does it work?

- Executable from command line, takes:
  - Simulation parameters
  - Star catalogue (α, δ, m_V)
  - Photometry parameters

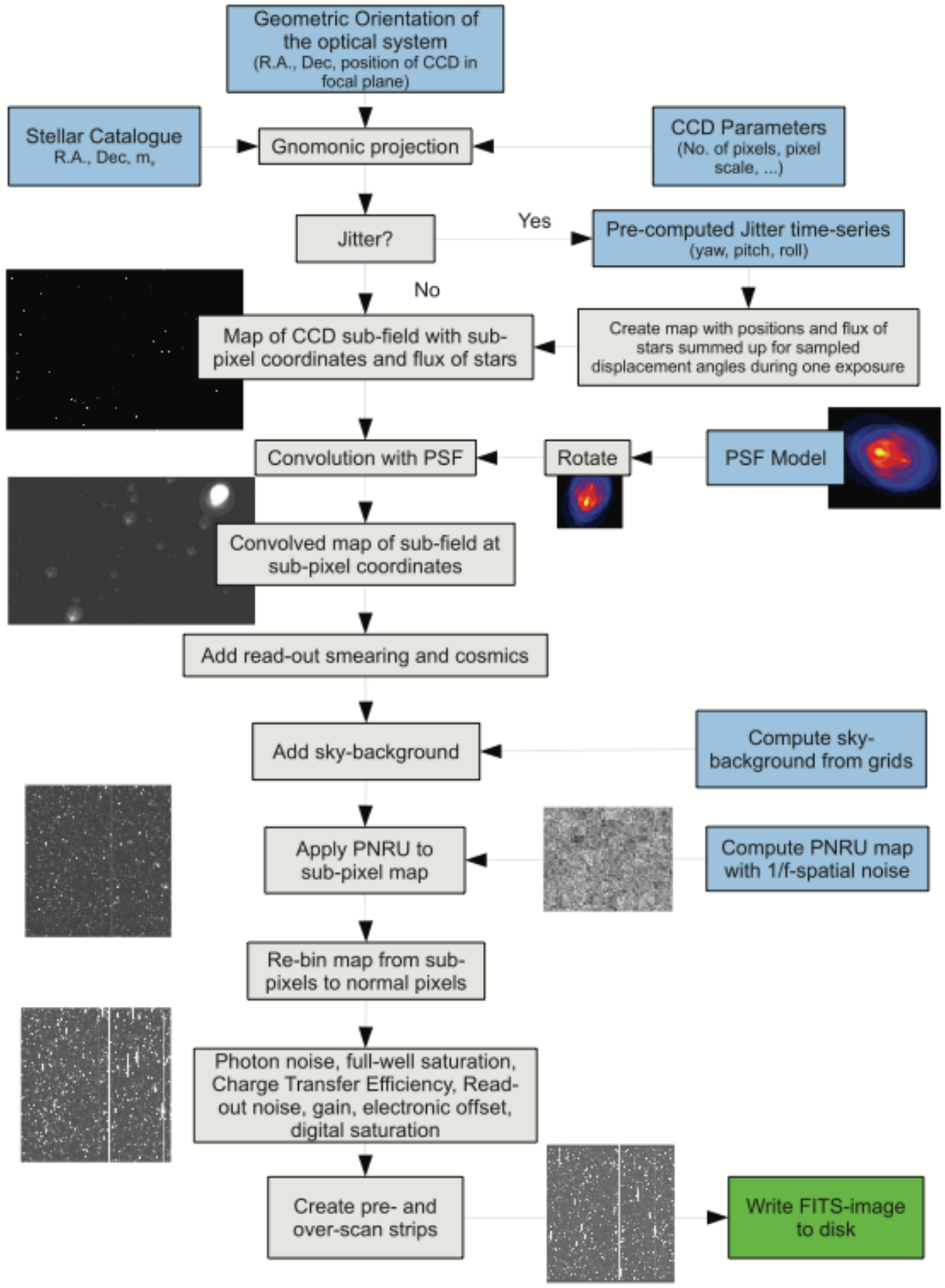
- Includes realistic models of:
  - the telescope optics,
  - stellar mapping on focal plane,
  - detector and its electronics,
  - the ACS jitter movements of the spacecraft,
  - and all important natural noise sources.

- Perform post-processing photometry of the images



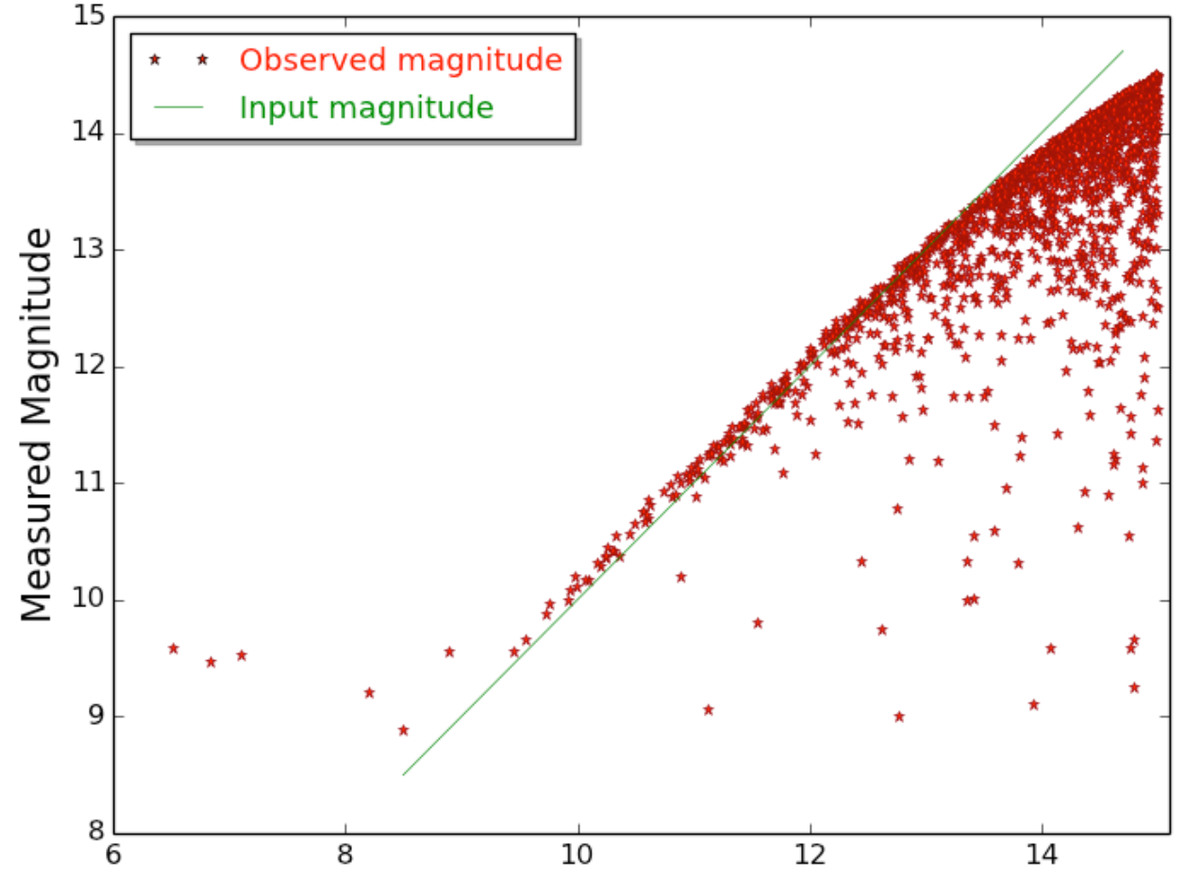
How does it work?

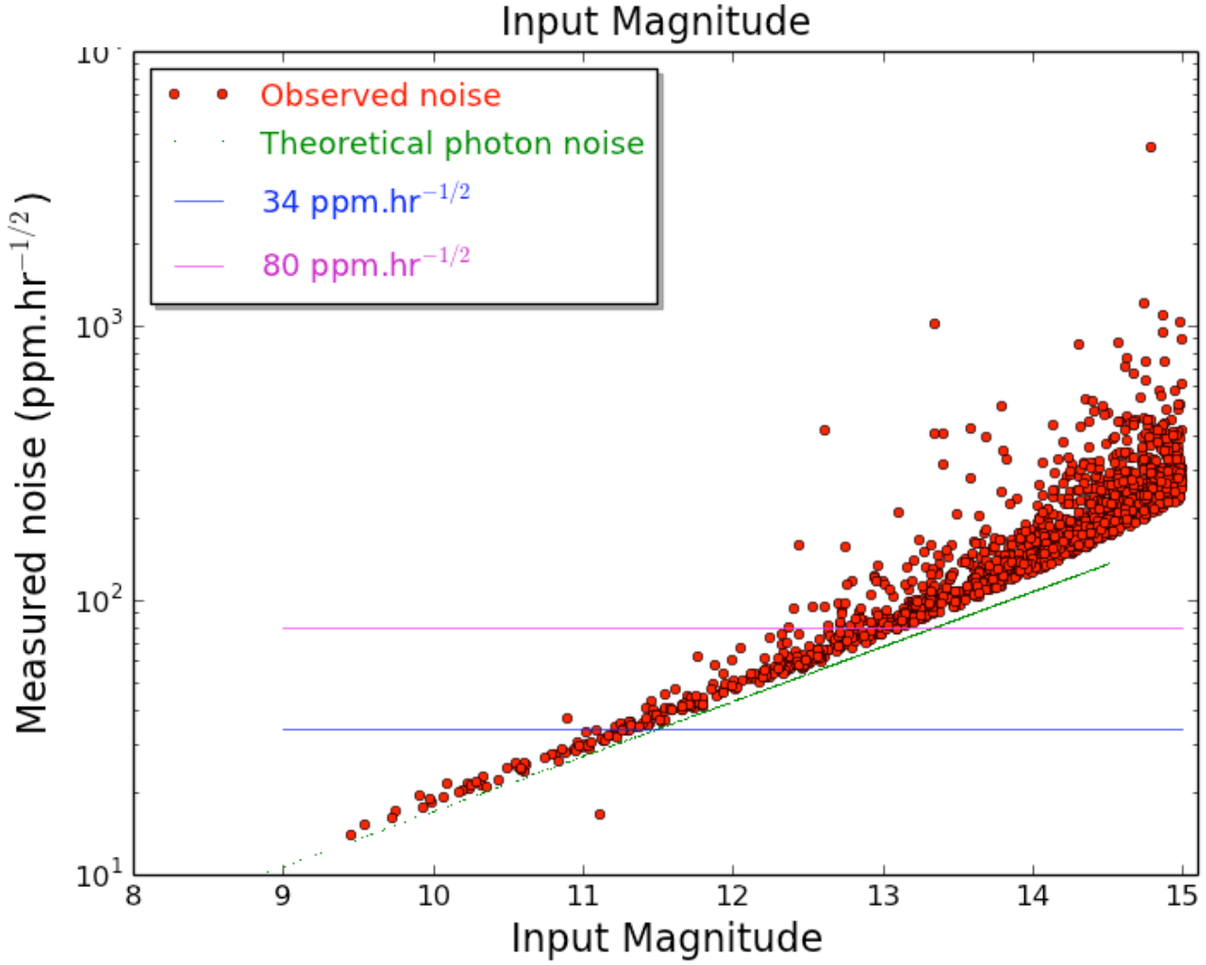
- Noise sources:
  - PSF Convolution;
  - High-energy particle hits;
  - Charge-transfer smearing;
  - Sky background;
  - CCD Sensitivity variations;
  - Quantum efficiency;
  - Photon noise;
  - Full-well saturation;
  - Charge-transfer efficiency;
  - Read-out noise;
  - Gain;
  - Electronic offset;
  - Digital saturation.



Applications

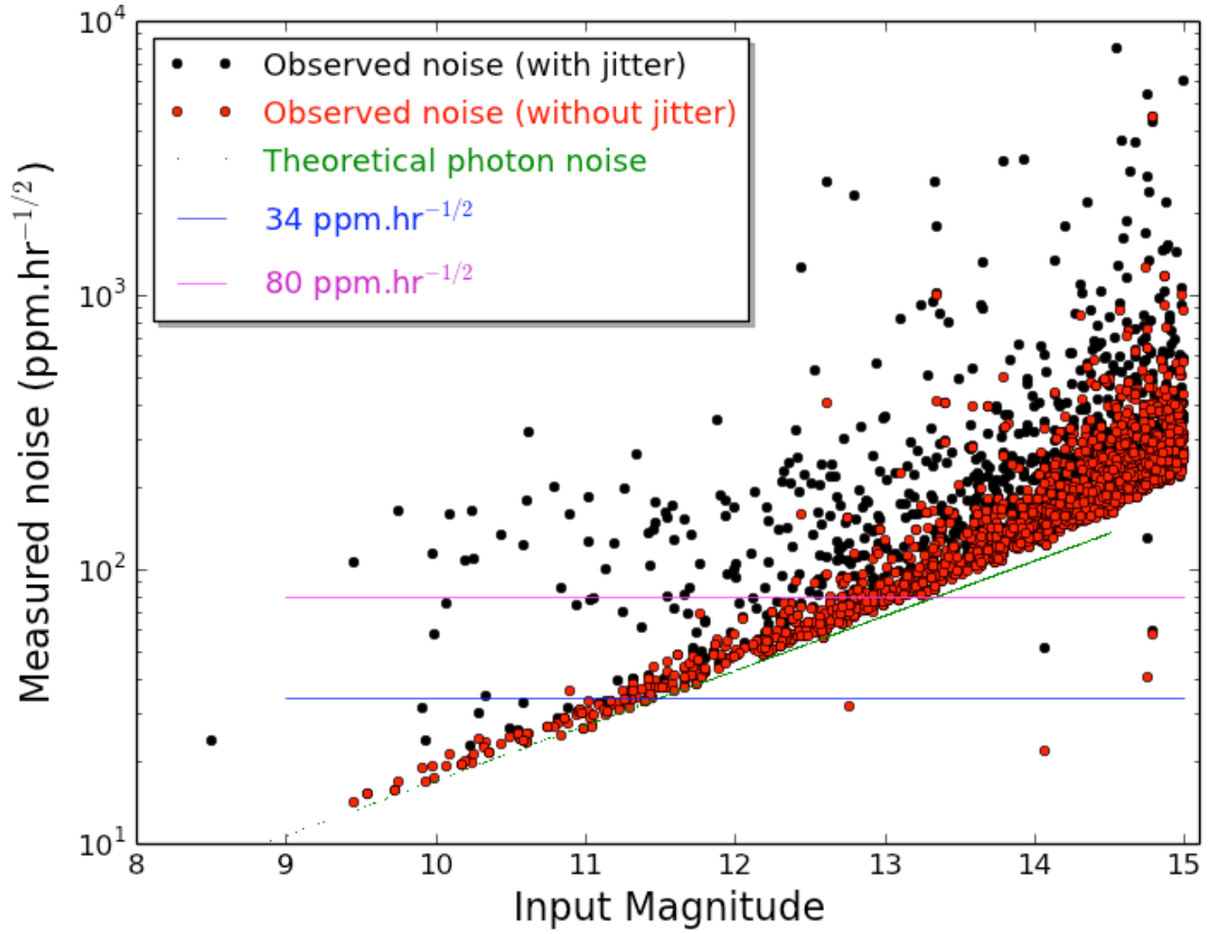
- Assessment of the PLATO science requirements
  - Effects of stellar crowding
  - Estimation of observable stars at specific noise levels

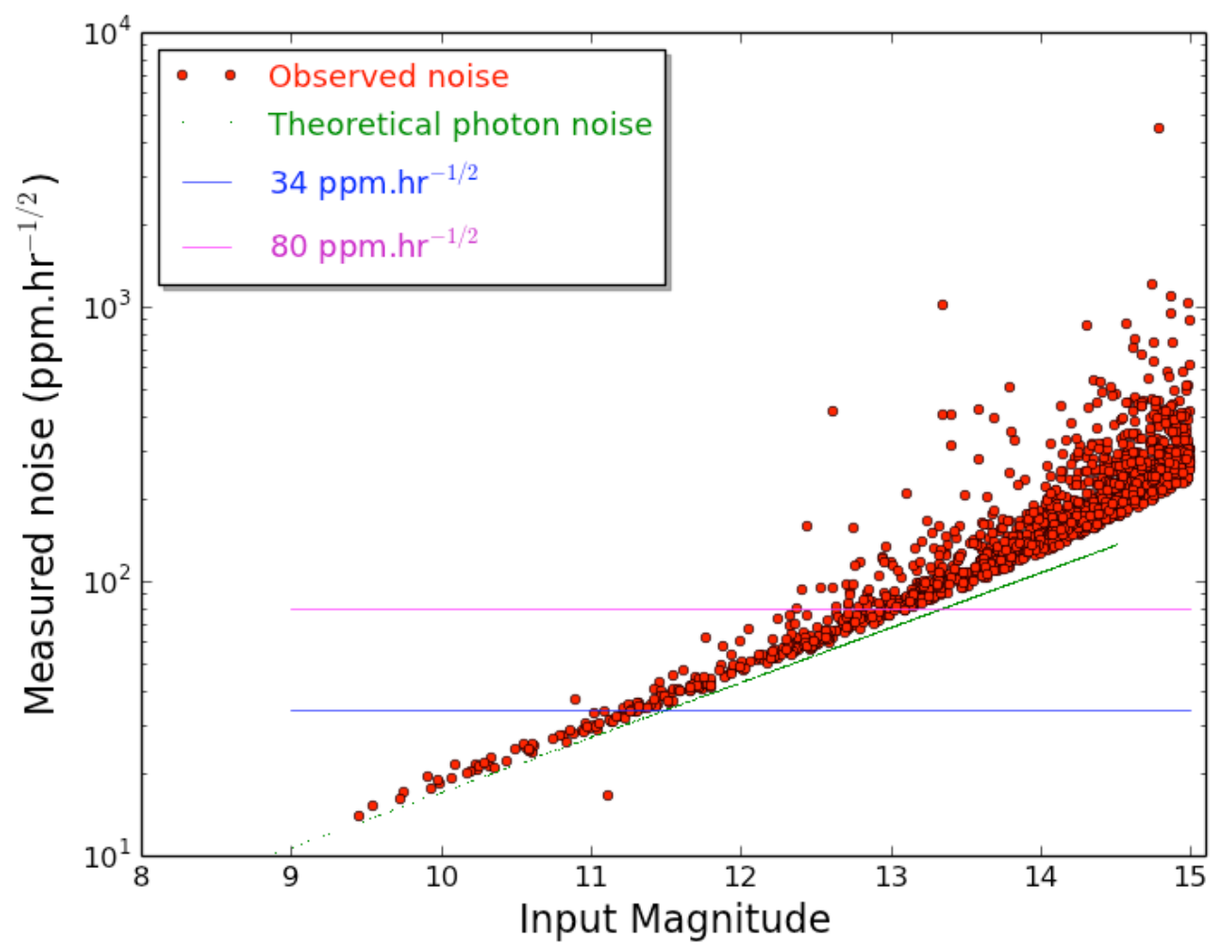




Applications

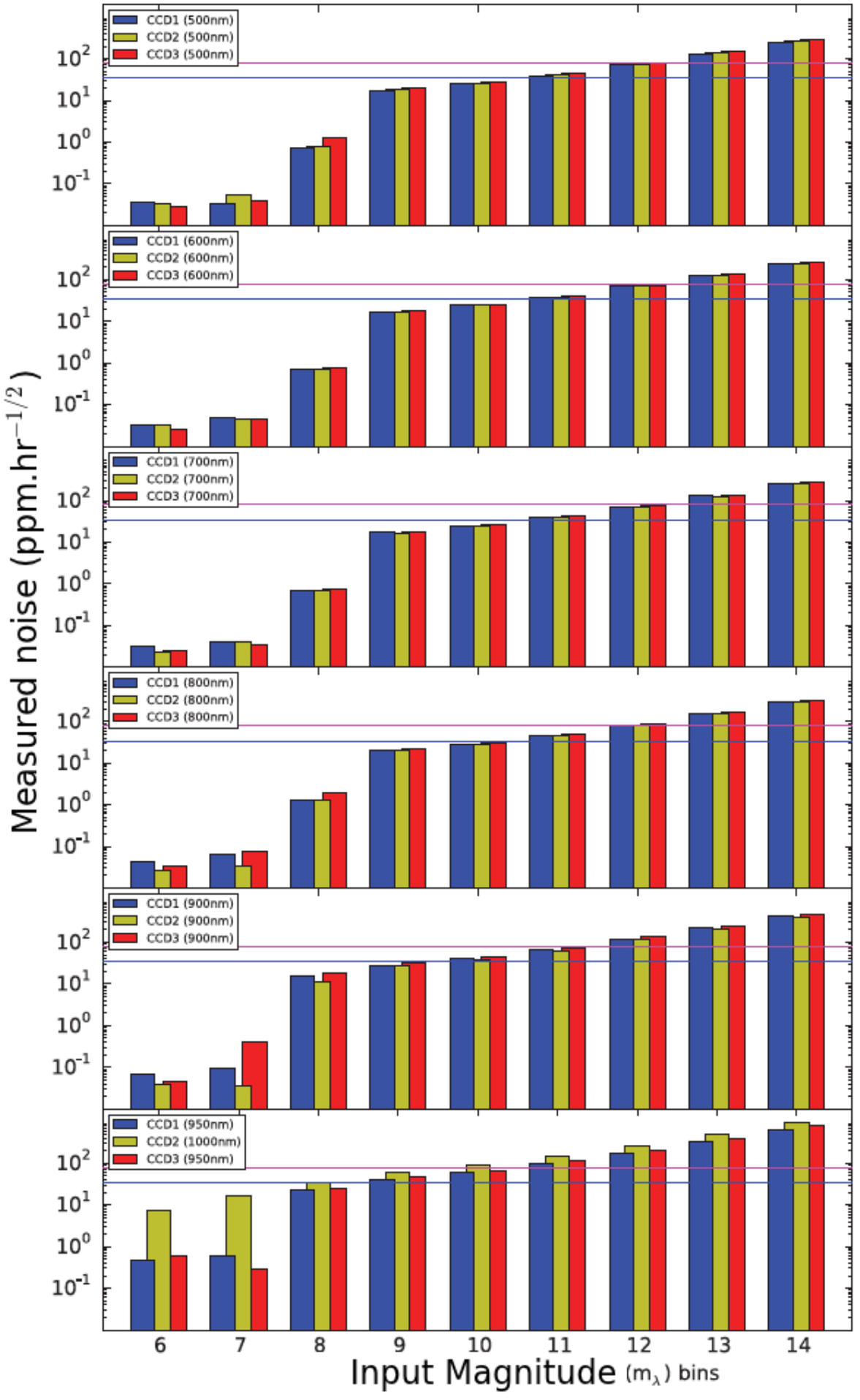
- Assessment of the PLATO science requirements
  - Effects of stellar crowding
  - Estimation of observable stars at specific noise levels
  - Jitter effect on the overall noise budget





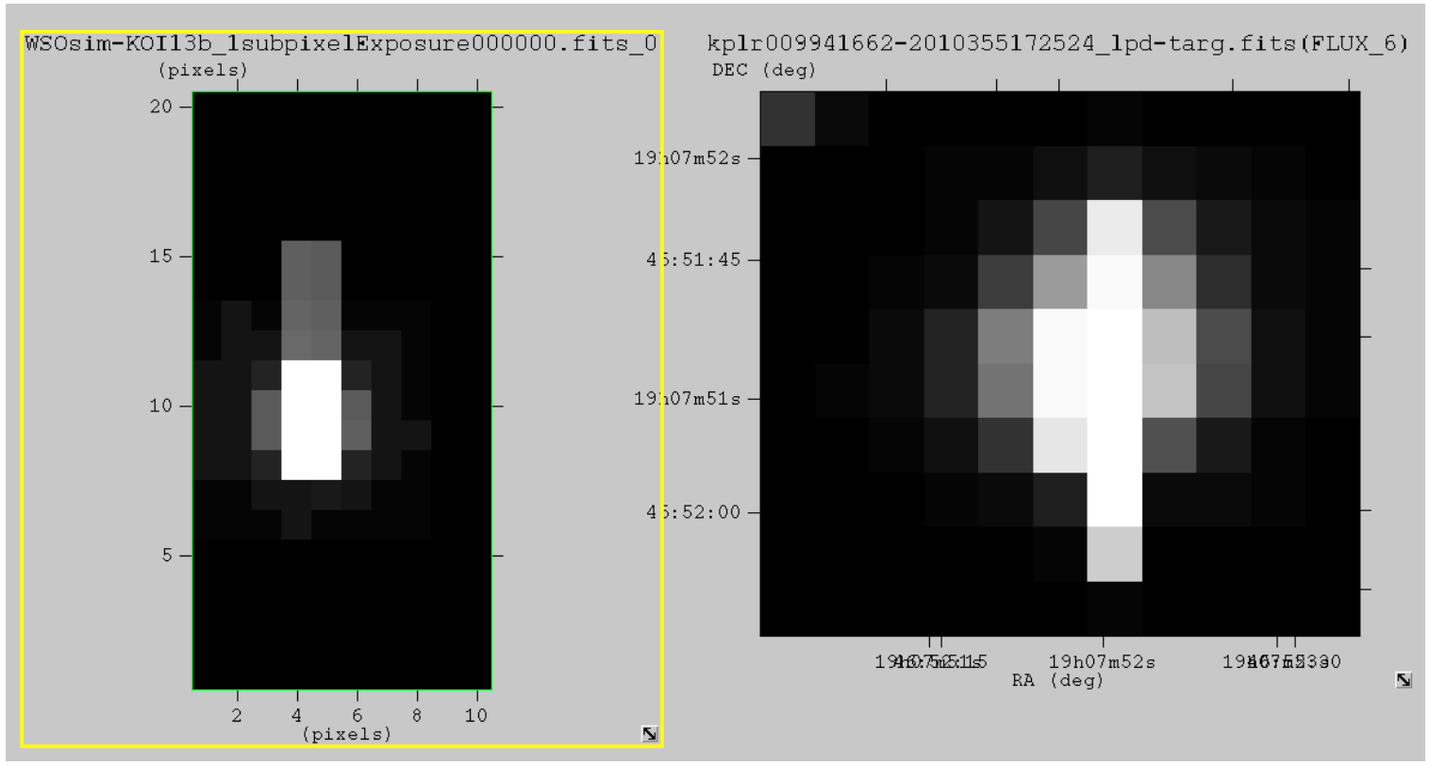
Applications

- Assessment of the PLATO science requirements
  - Effects of stellar crowding
  - Estimation of observable stars at specific noise levels
  - Jitter effect on the overall noise budget
  - Performance test of prototype detectors
  - Optical design performance



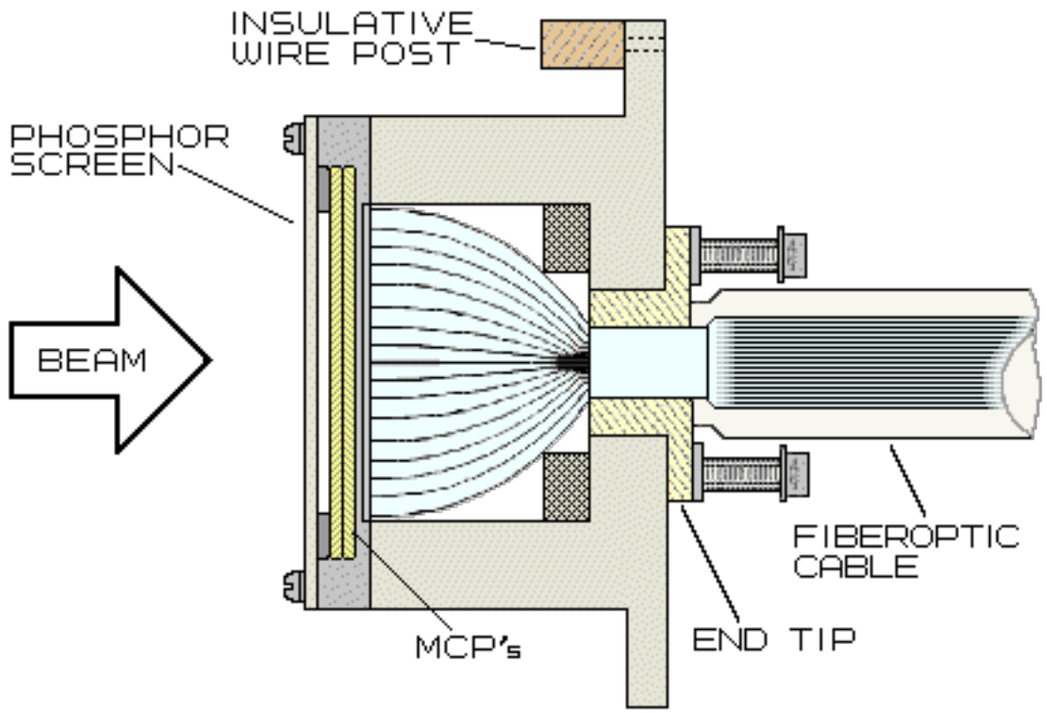
Applications

- Field Camera Unit (FCU) at WSO-UV
- UVO Channel implementation :
  - CCD Detector
  - Aperture pixels
  - Stack images
  - Exoplanets transits
  - Ad hoc photometry



Applications

- Field Camera Unit (FCU) at WSO-UV
- UVO Channel implementation:
  - CCD Detector
  - Aperture pixels
  - Stack images
  - Exoplanets transits
  - Ad hoc photometry
- FUV Channel implementation:
  - MCP Detector (work in progress)

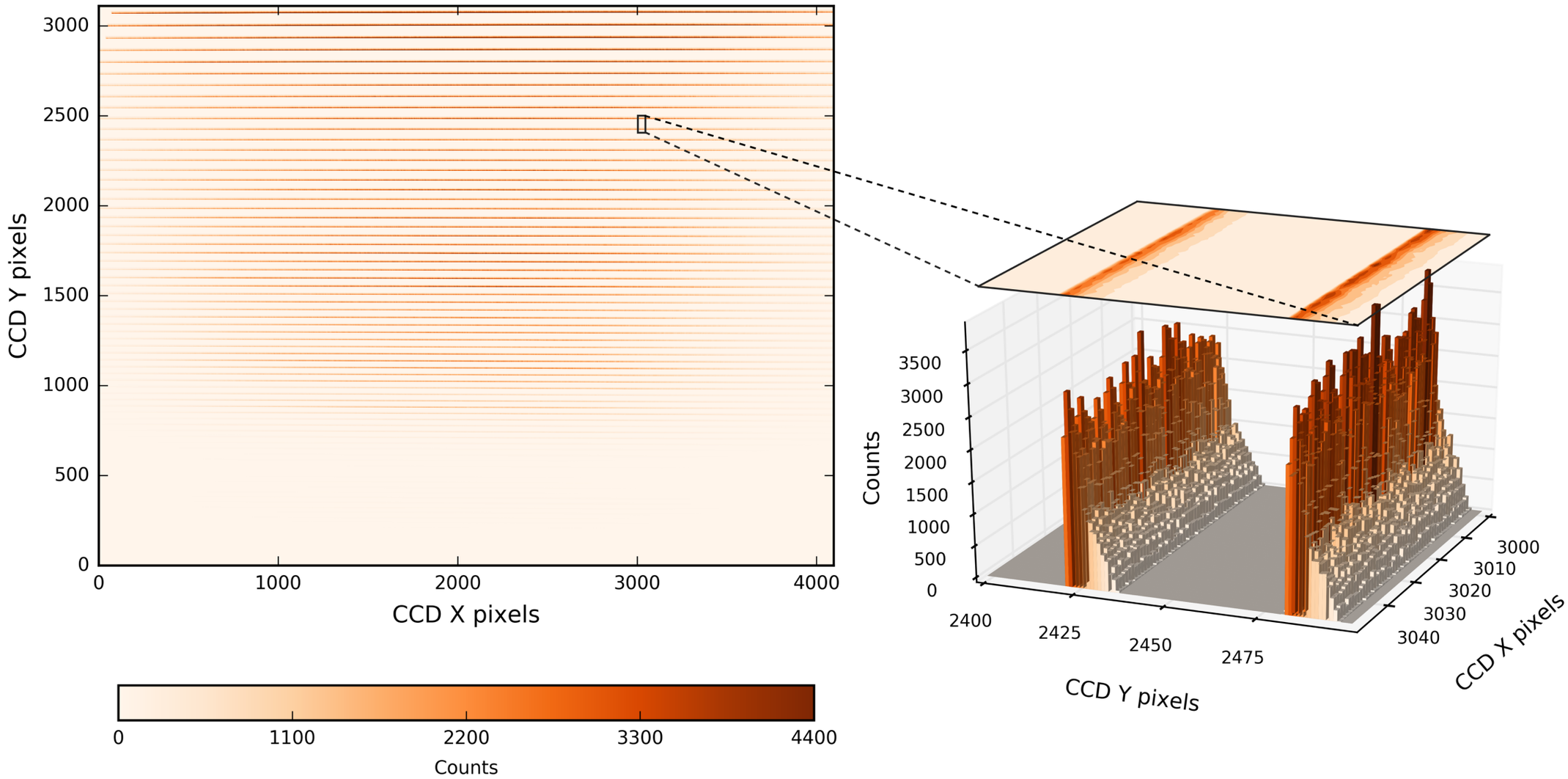


WSO-UV Spectrograph simulations

UV High-resolution échelle spectrograph

Input method

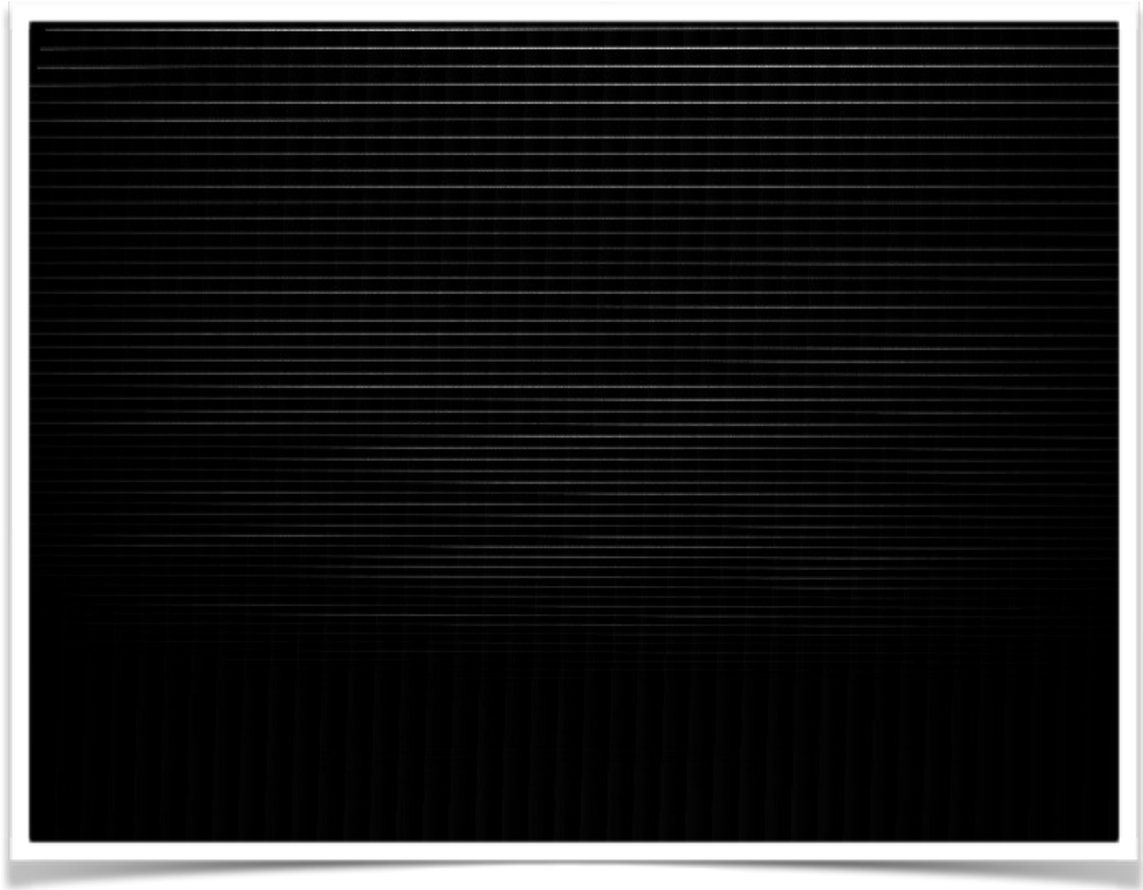
- WSO-UV Spectrograph (WUVS) team -> Flat energy distribution image



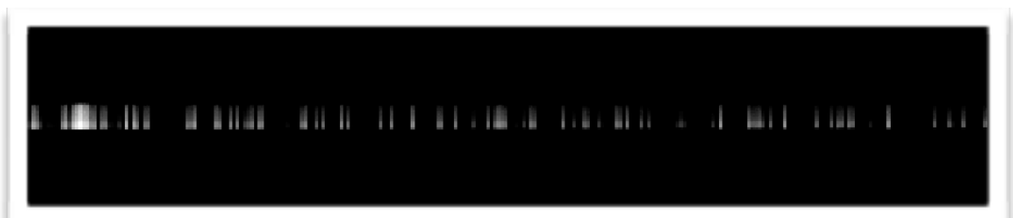
Simulations for the WSO-UV spectrographs

- Application: spectral lines detectability

- Select actual spectrum
  - STIS E140 grating similar spectral wavelength and resolution
  - Resampling STIS spectral resolution to WUVS spectral resolution
  - Setting the STIS orders into the WUVS pixel map



Input file: Flat spectrum

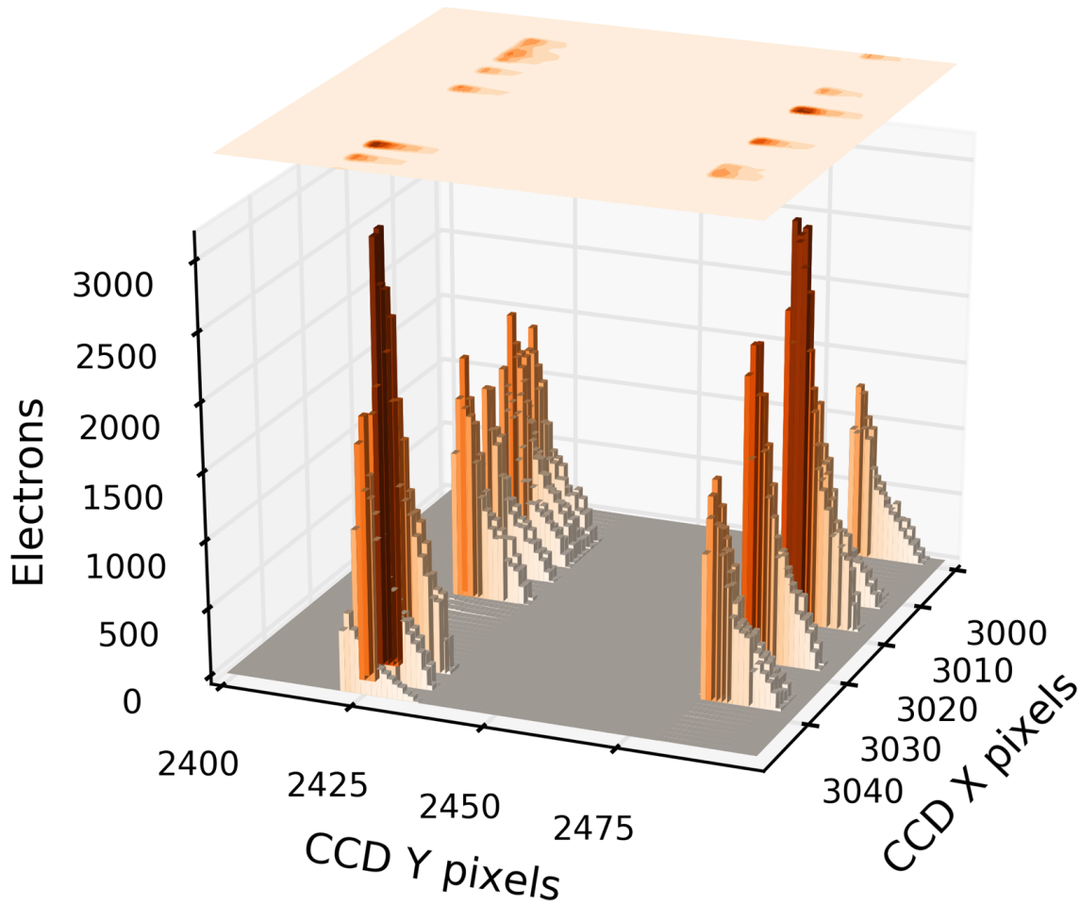


DG Tau spectrum from STIS in WUVS pixel map

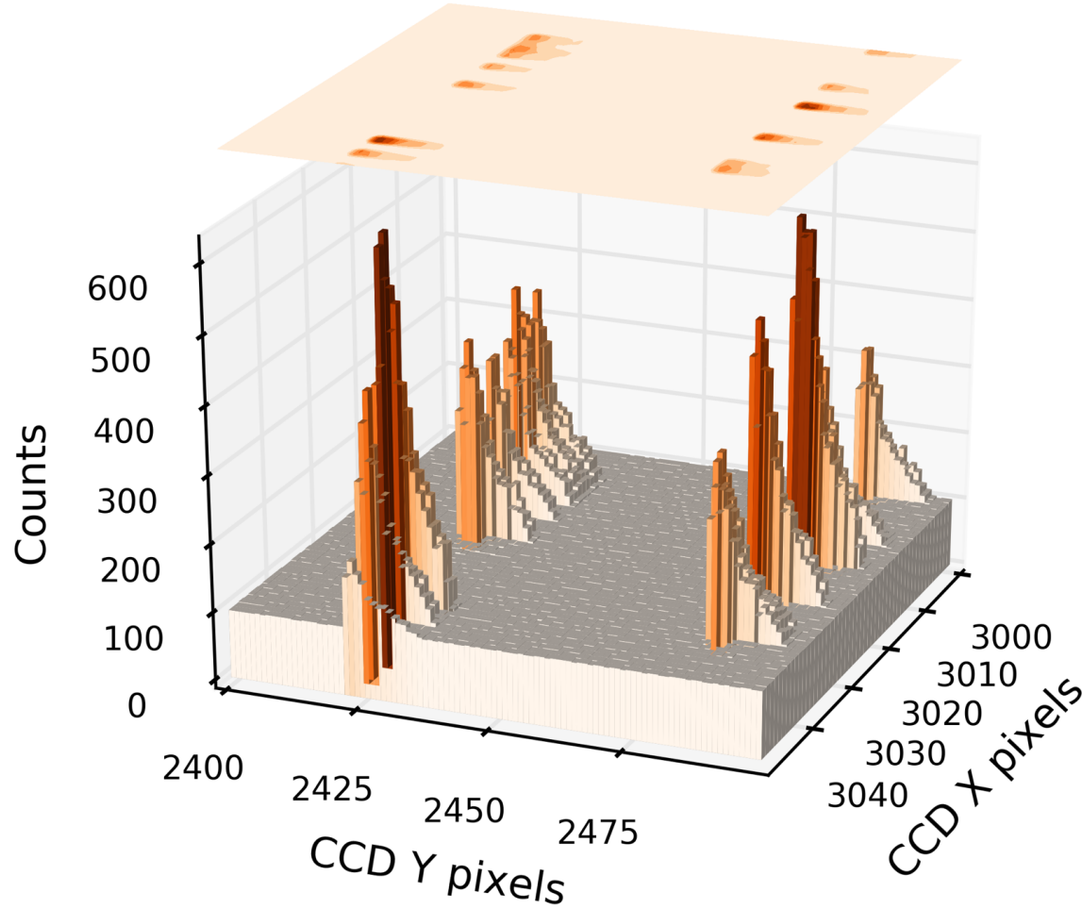
Simulation results

- Input image vs Simulated image

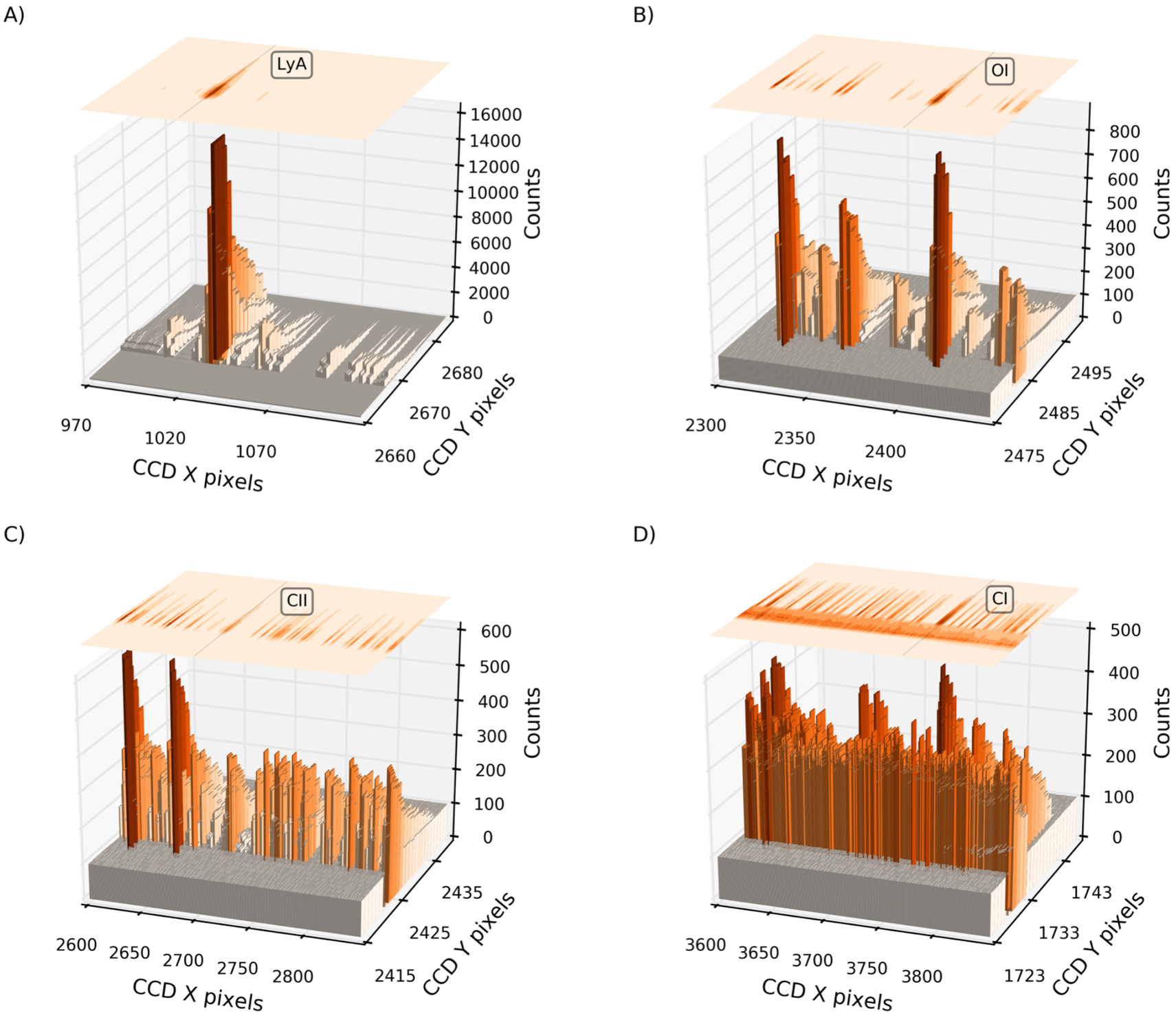
A)



B)

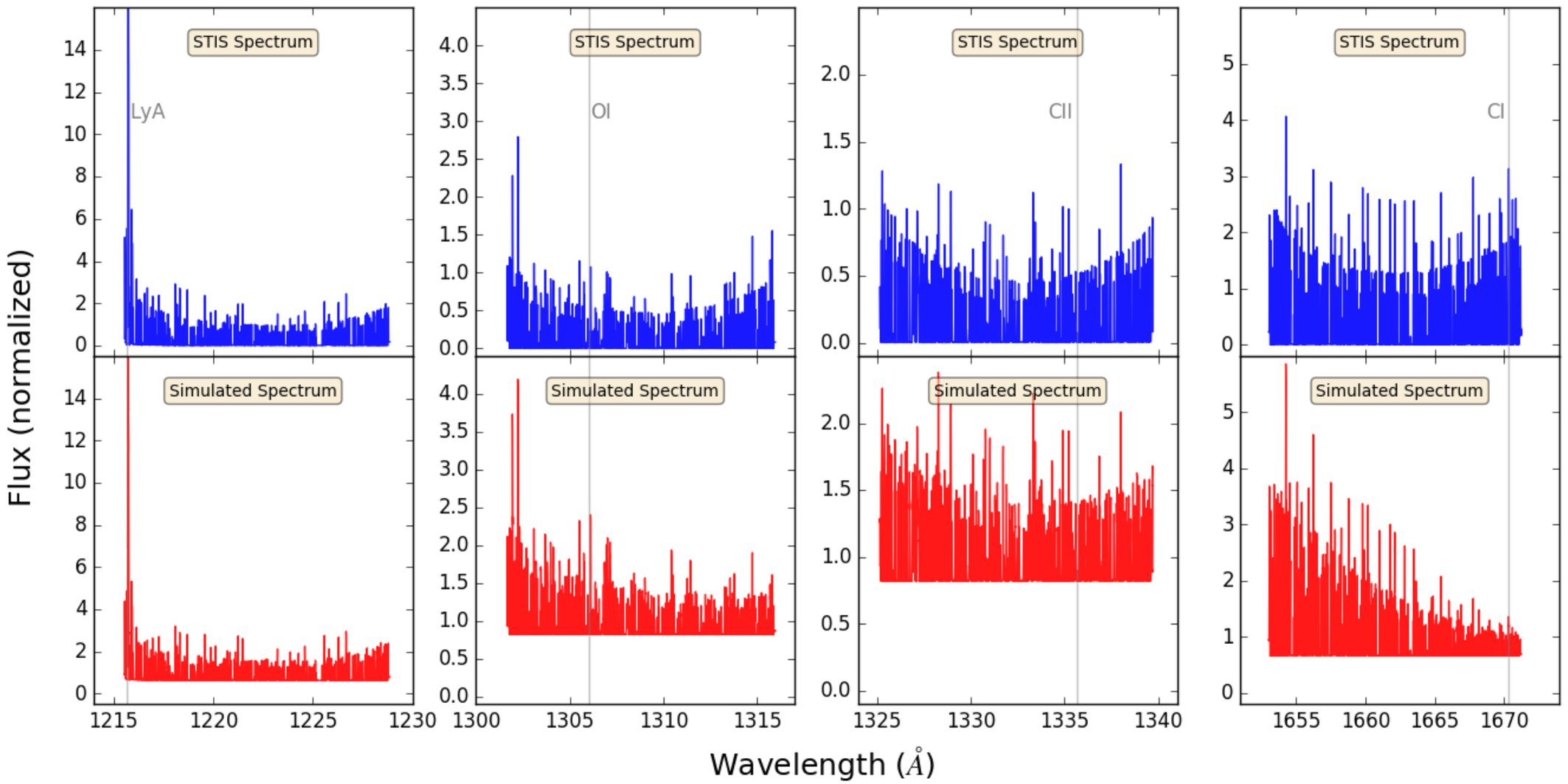


Simulation results



Simulation results: detectability of spectral lines

Original vs simulated spectra



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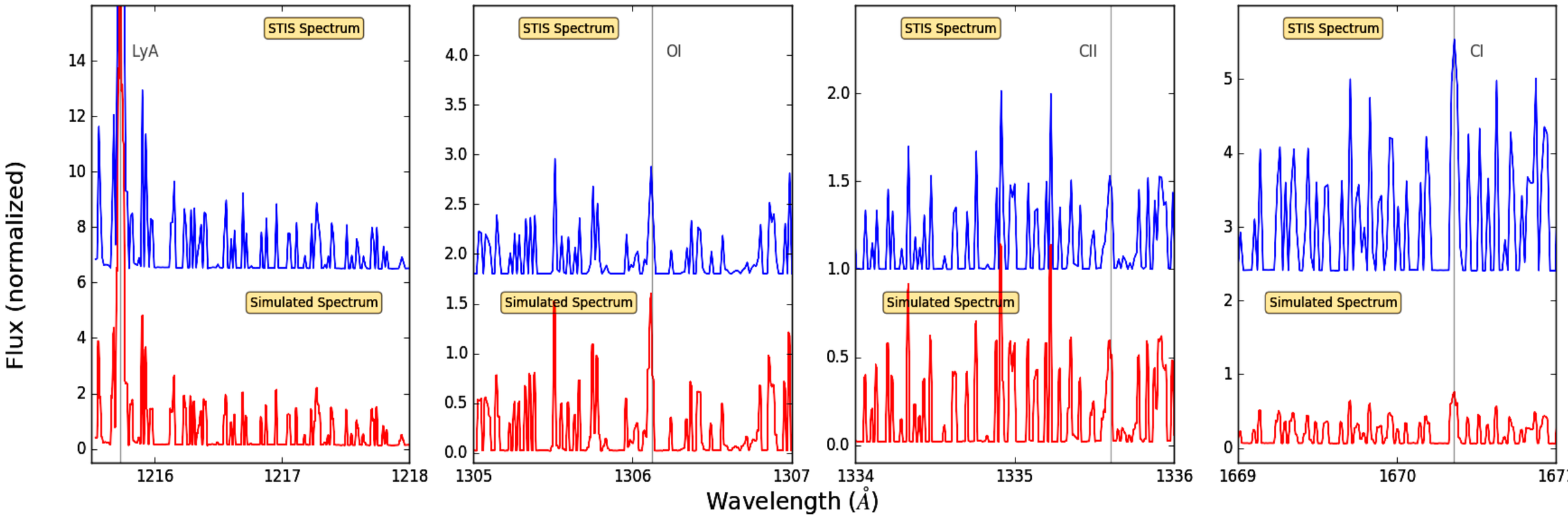
Original vs simulated spectra



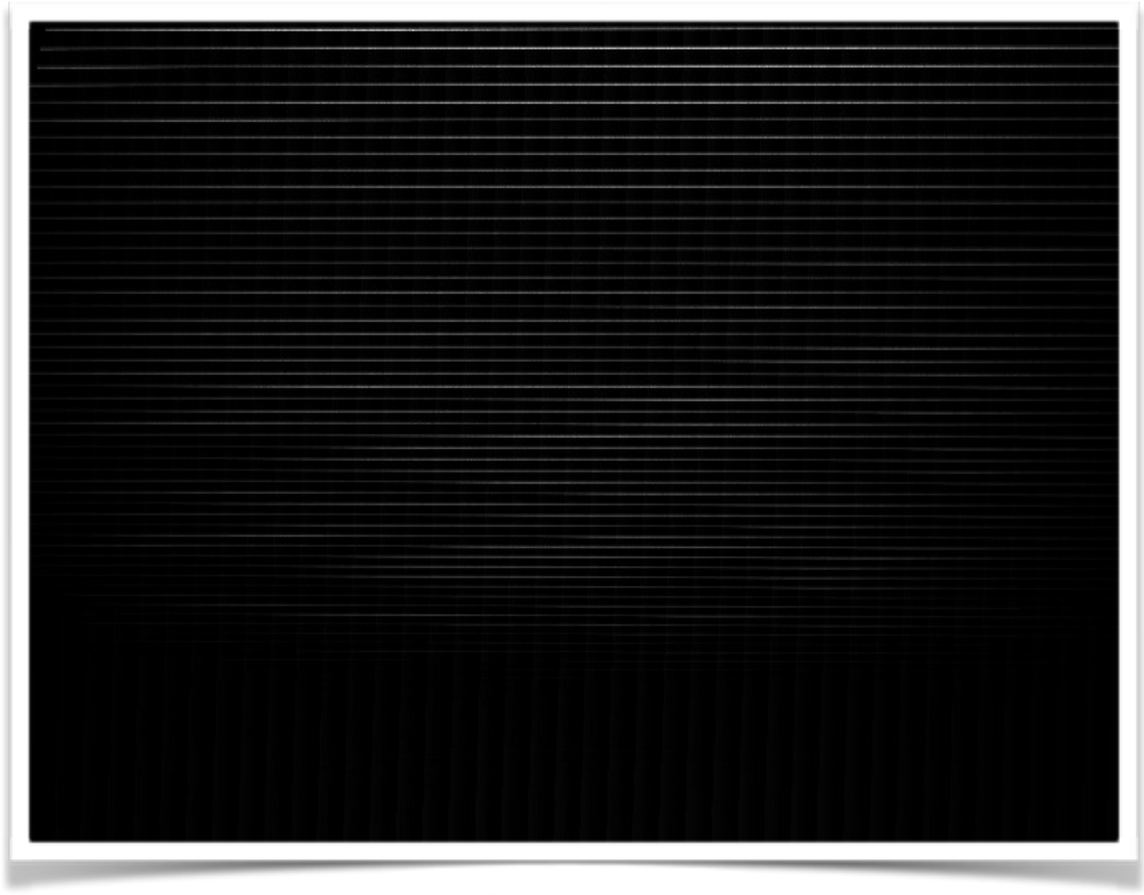
(Marcos-Arenal et al. 2017)

POLLUX Simulations

Adaptating the WSO Simulator

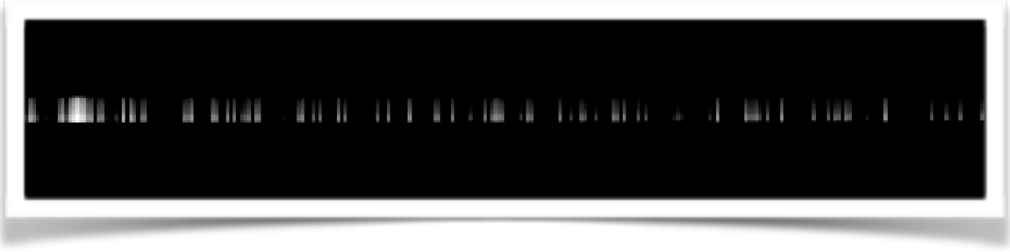
Input method

- 1st Option: Flat energy distribution image provided by instrumental team
  - Spectral model
  - Similar actual instrument for validation and comparison
  - Adapt grid to POLLUX spectral resolution



Input file: Flat spectrum

- 2nd Option: Reproduce échelle spectrograph and polarimeter optical path



DG Tau spectrum from STIS in WUVS pixel map

Input parameters for POLLUX/LUVOIR

Input Parameter	Value	Input Parameter	Value
CCD Size		Collecting area	
Sub-Field size		Digital saturation	
Pixel resolution		Full well pixel capacity	
Transmision efficiency		Gain	
Quantum efficiency		Electronic offset	
Number of exposures		Readout noise	
Exposure time		Flatfield pixel-to-pixel noise	
Charge transfer time		Mean Charge Transfer Efficiency	
Pixel scale		Pixel size	

Applications for POLLUX/LUVOIR

- Assesment of scientific requirements:
  - Observability of faintest targets
  - Degradation in spectral resolution
  - Signal to nose ratio
  - Pointing stability
  - …

Applications for POLLUX/LUVOIR

- Evaluation of the instrument's design performance
- Data quality
- Preparations for calibration and data processing
- Observation strategies
- …

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