Photometric Data Reduction Pipeline for the Spectral Energy Distribution Machine Version 2 (SEDMv2)

Saarah Hall,[1] on behalf of the SEDMv2 Collaboration
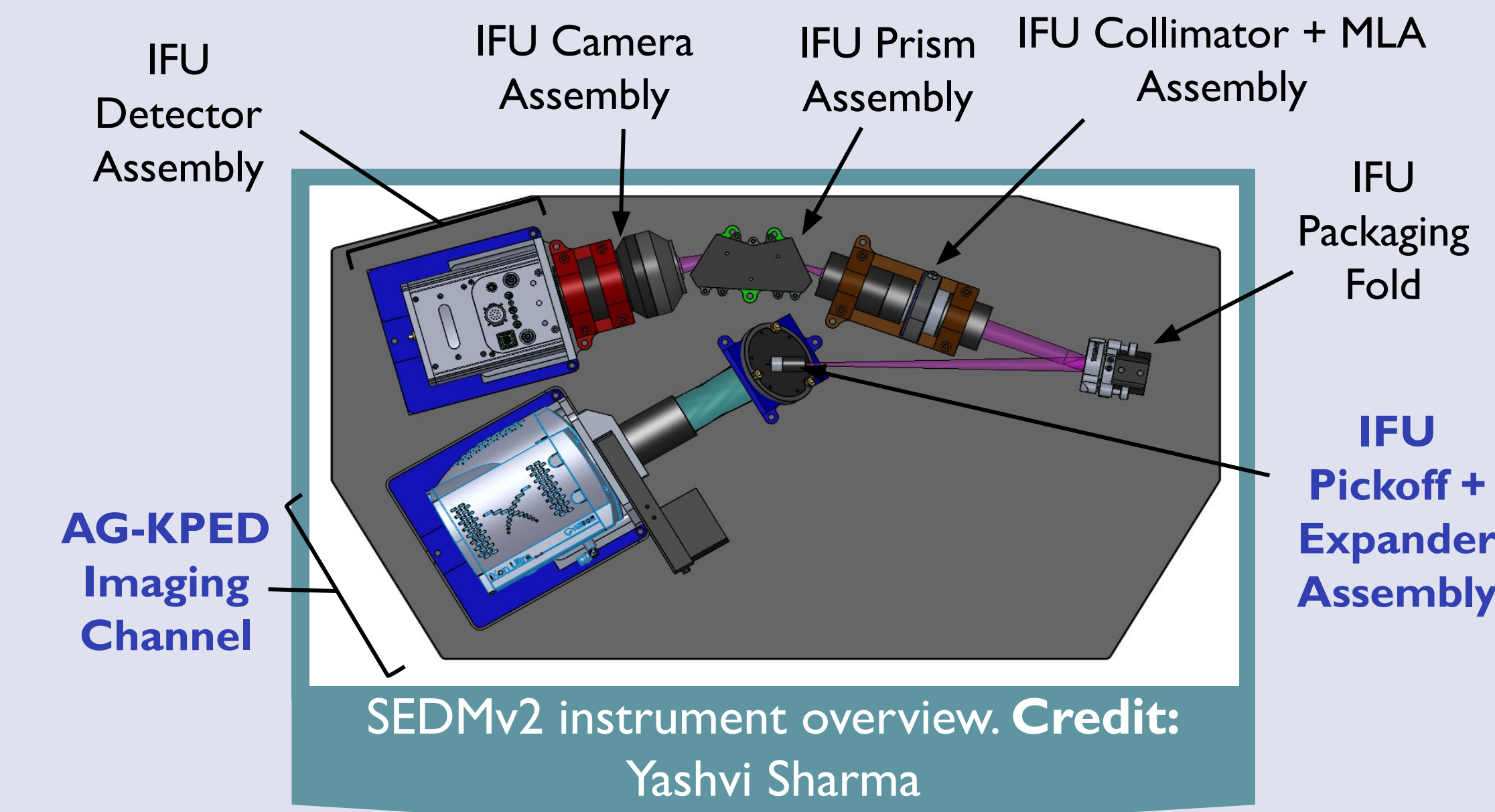
[1]Northwestern University
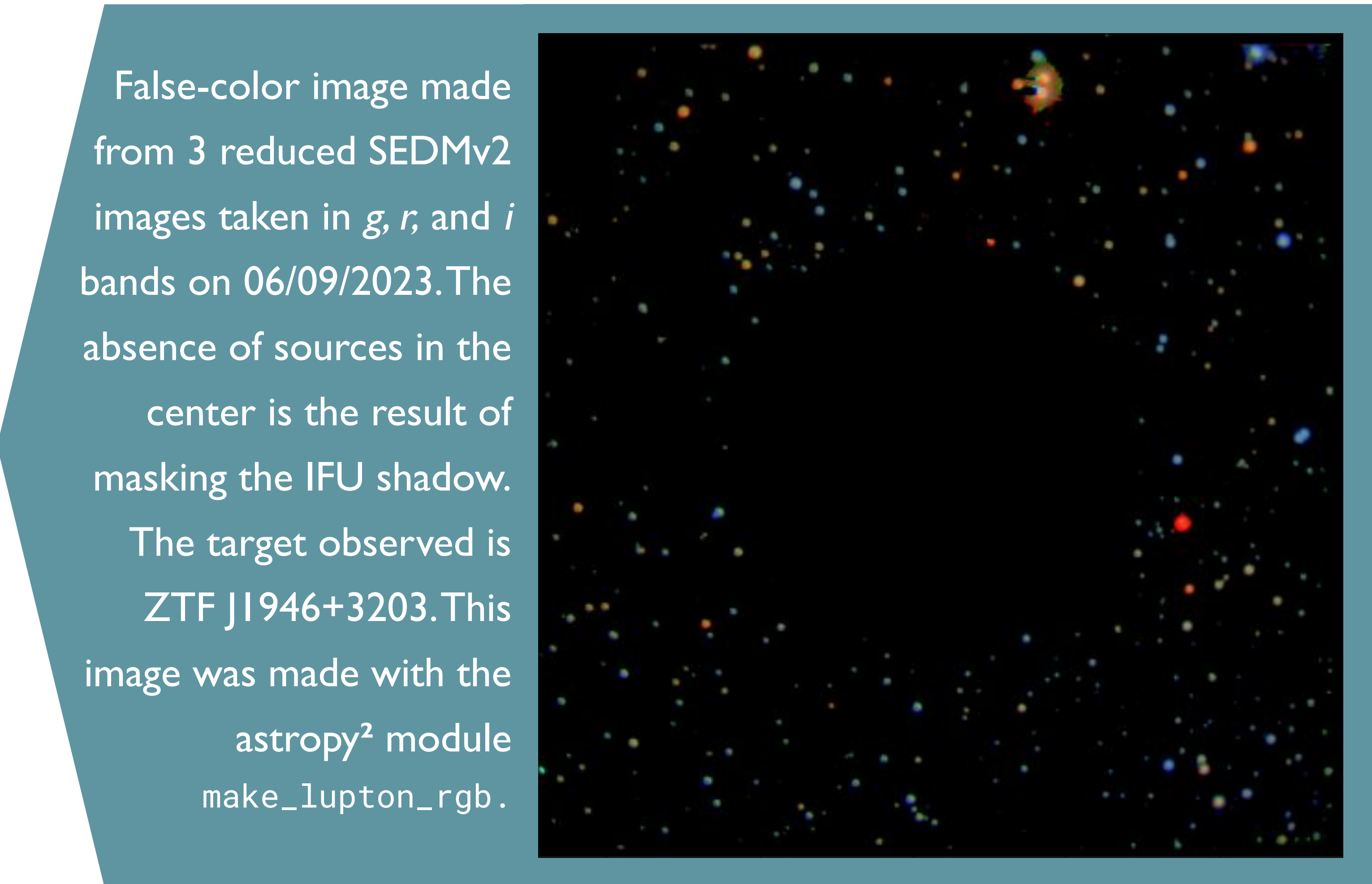
The Instrument

What is SEDMv2?

- 2nd generation robotic spectrograph designed for transient classification
- ultra-low resolution IFU CCD
- EMCCD for guiding and imaging in u, g, r, i, and z
- 2x more effective imaging area than SEDM[1]

Kitt Peak 84-inch telescope (KP84), the telescope that SEDMv2 is built on. **Credit:** NOIRLab/KPNO/NSF/AURA/P. Marenfeld

IFU Detector Assembly
IFU Camera Assembly
IFU Prism Assembly
IFU Collimator + MLA Assembly
IFU Packaging Fold
IFU Pickoff + Expander Assembly
AG-KPED Imaging Channel

SEDMv2 instrument overview. **Credit:** Yashvi Sharma

Quirky photometry: light in the center of the EMCCD is **obscured** and sent to the IFU channel

False-color image made from 3 reduced SEDMv2 images taken in g, r, and i bands on 06/09/2023. The absence of sources in the center is the result of masking the IFU shadow. The target observed is ZTF J1946+3203. This image was made with the astropy[2] module make_lupton_rgb.

The Pipeline

Modular Image Reduction and Analysis Resource (MIRAR)

MIRAR is an open source data reduction package created by **Robert Stein** and **Viraj Karambelkar.** The package makes it easy to construct a pipeline out of a series of pre-written processors. Install the package and apply it to your optical/IR instrument today!
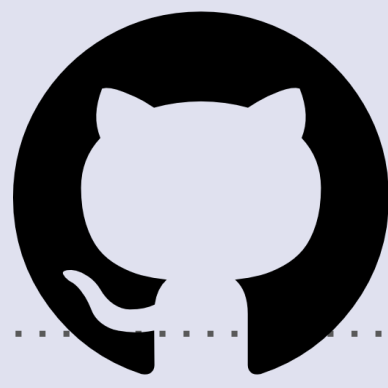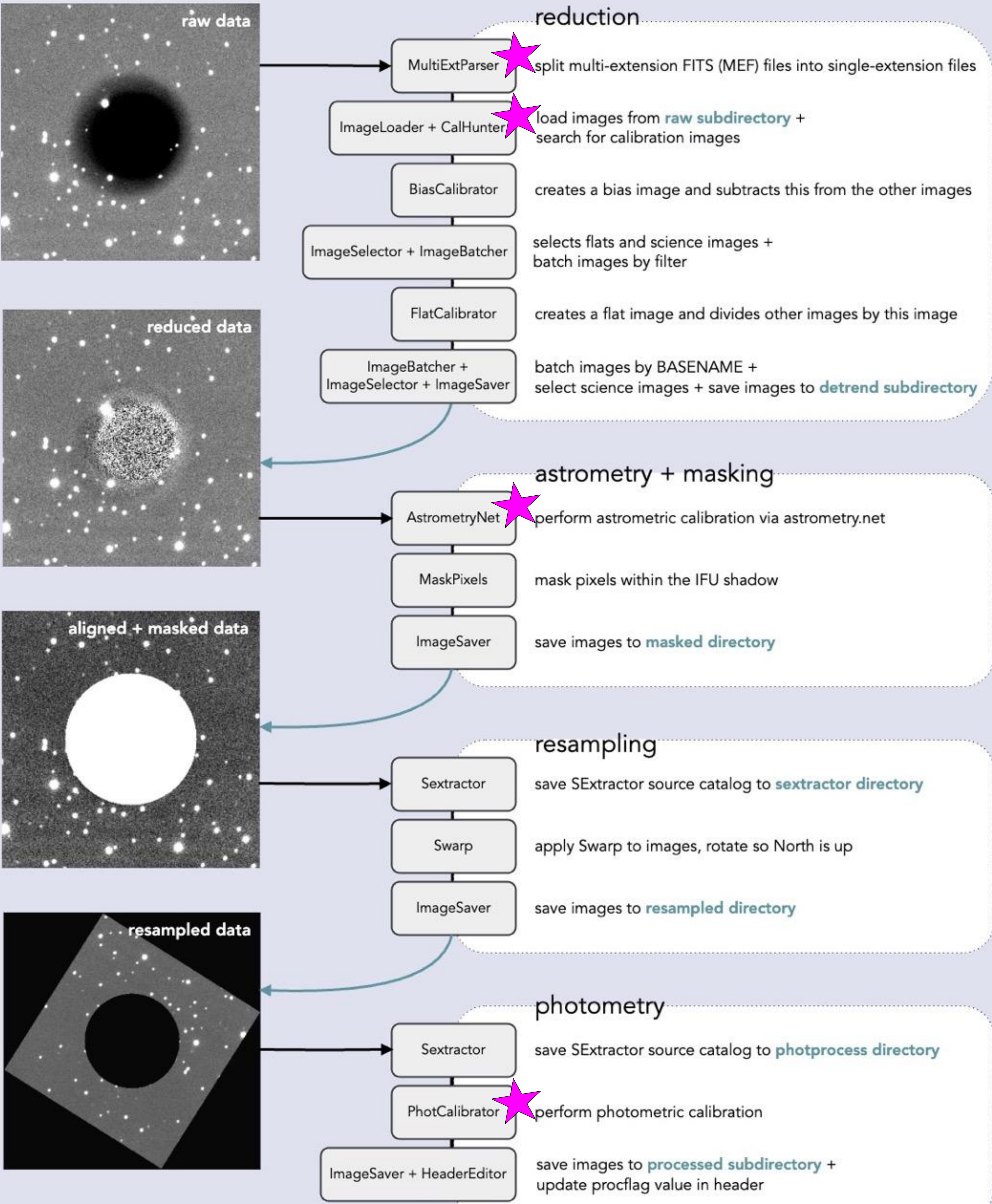
```
pip install mirar
```

Progress

⭐ = new/updated processors to benefit SEDMv2 and future MIRAR users

Next steps for MIRAR+SEDMv2:
- refine photometric calibration
- optimize image subtraction
- incorporate DarkCalibrator
- automate:
  - uploading to SkyPortal,[3] the SEDMv2 follow up portal
  - real-time reduction at Kitt Peak

github.com/winter-telescope/mirar
github.com/saarahhall

reduction

MultiExtParser ⭐	split multi-extension FITS (MEF) files into single-extension files
ImageLoader + CalHunter ⭐	load images from raw subdirectory + search for calibration images
BiasCalibrator	creates a bias image and subtracts this from the other images
ImageSelector + ImageBatcher	selects flats and science images + batch images by filter
FlatCalibrator	creates a flat image and divides other images by this image
ImageBatcher + ImageSelector + ImageSaver	batch images by BASENAME + select science images + save images to detrend subdirectory

raw data
reduced data

astrometry + masking

AstrometryNet ⭐	perform astrometric calibration via astrometry.net
MaskPixels	mask pixels within the IFU shadow
ImageSaver	save images to masked directory

aligned + masked data

resampling

Sextractor	save SExtractor source catalog to sextractor directory
Swarp	apply Swarp to images, rotate so North is up
ImageSaver	save images to resampled directory

resampled data

photometry

Sextractor	save SExtractor source catalog to photprocess directory
PhotCalibrator ⭐	perform photometric calibration
ImageSaver + HeaderEditor	save images to processed subdirectory + update procflag value in header

Flowchart of the "default" configuration for SEDMv2's MIRAR pipeline. Each MIRAR processor is denoted as a rectangle in grey. These and (any other unpictured) processors can be easily re-ordered and modified to benefit any optical or IR instrument. Raw and intermediate data products are visualized to the left, processor descriptions are on the right.

Northwestern
CIERA
CENTER FOR INTERDISCIPLINARY EXPLORATION AND RESEARCH IN ASTROPHYSICS
ZTF
MIRAR

1. Blagorodnova et al. 2018, The SED Machine: A Robotic Spectrograph for Fast Transient Classification. *Publications of the Astronomical Society of the Pacific*, 130, 035003.
2. Astropy Collaboration 2022, The Astropy Project: Sustaining and Growing a Community-oriented Open-source Project and the Latest Major Release (v5.0) of the Core Package. *The Astrophysical Journal*, 935, 2.
3. Coughlin et al. 2023, A data science platform to enable time-domain astronomy. arxiv:2305.00108v2 [astro-ph.IM]

MIRAR logo design: Benjamin Roulston