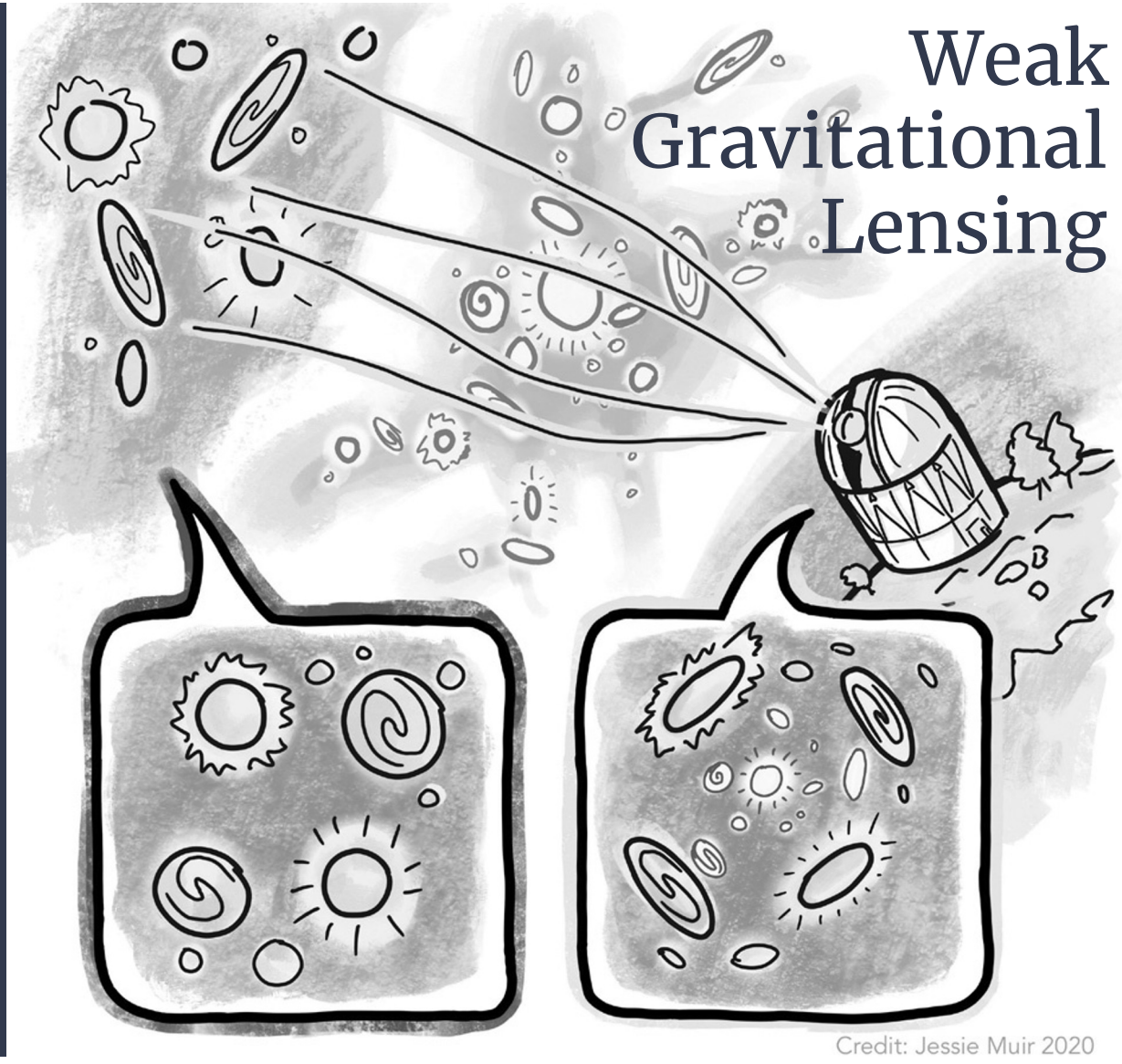
roman-hlis-cosmology.caltech.edu

github.com/Roman-HLIS-Cosmology-PIT

Hot-wiring the Roman Sky: Resolving the Undersampling Crisis with Fast IMCOM for Real-Time Discovery

Presenter: Kaili Cao (The Ohio State University → University of Michigan)

Our Project Infrastructure Team: Maximizing Cosmological Science with the Roman High Latitude Imaging Survey



Why do we coadd images? – “Oversample, we must!”

- Roman point spread functions (PSFs)
  - = Airy disk (~λ/D) + linear obscuration + diffraction spikes + detector effects
  - An example in Y106 band shown below

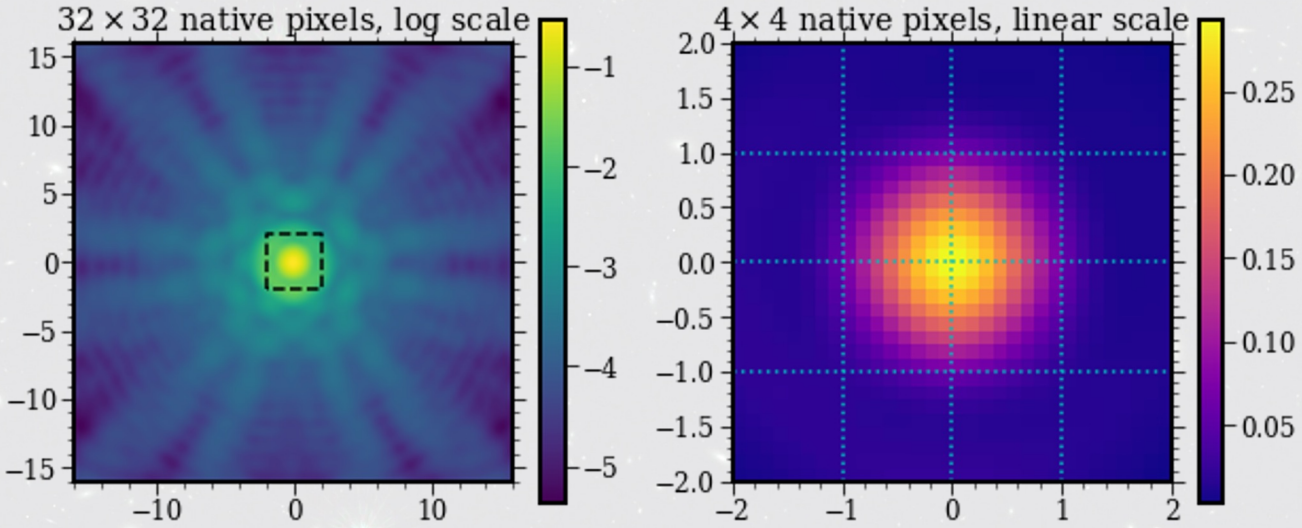
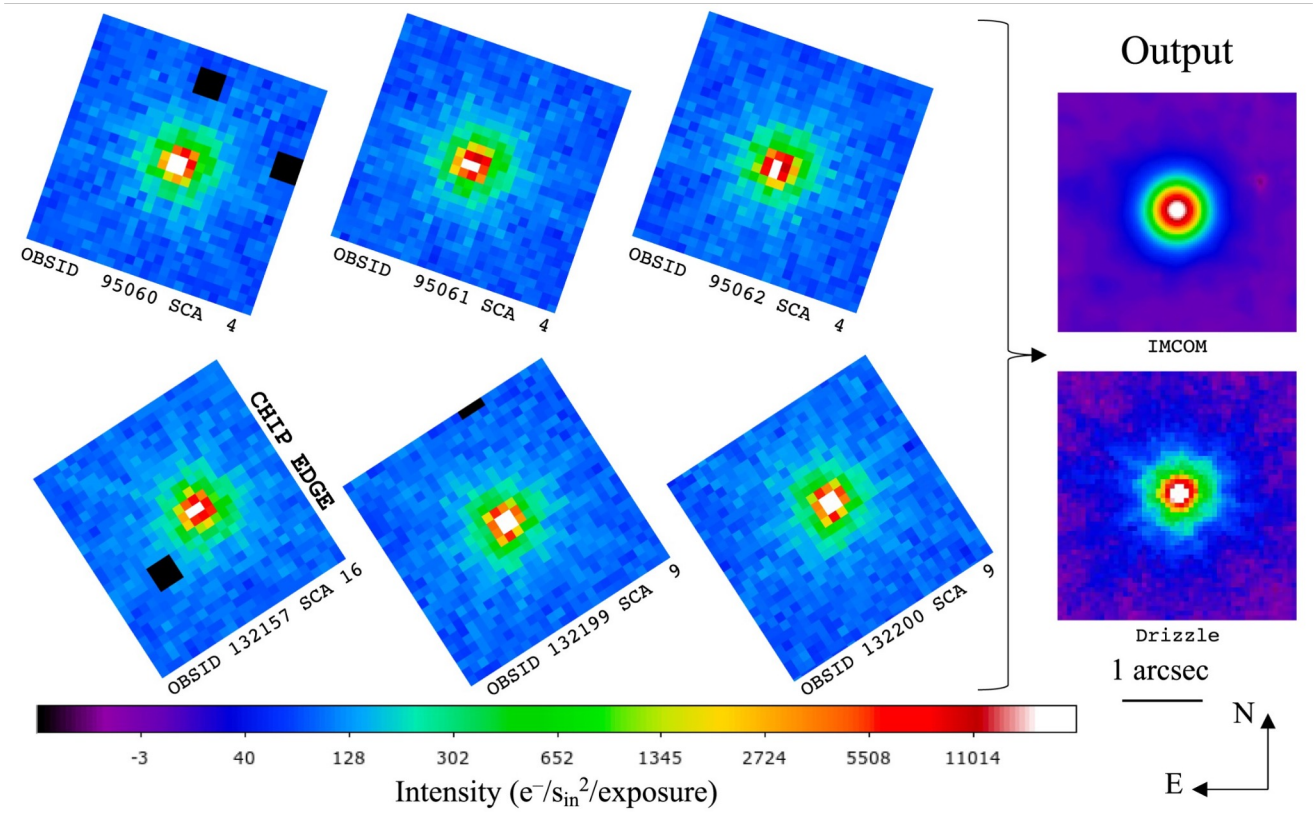


Image credits: Lucasfilm Ltd., Janson_G

IMCOM (B. Rowe et al. 2011): Image Coaddition with Control over Output Point Spread Function



←: 3 dithers × 2 passes (typical for Medium and Wide Tiers of HLWAS)

↗️: IMCOM (IMage COMbination) – **optimal** image coaddition

↘️: Drizzle – **efficient** image coaddition

Credit: Figure 9 from C. Hirata et al. 2024

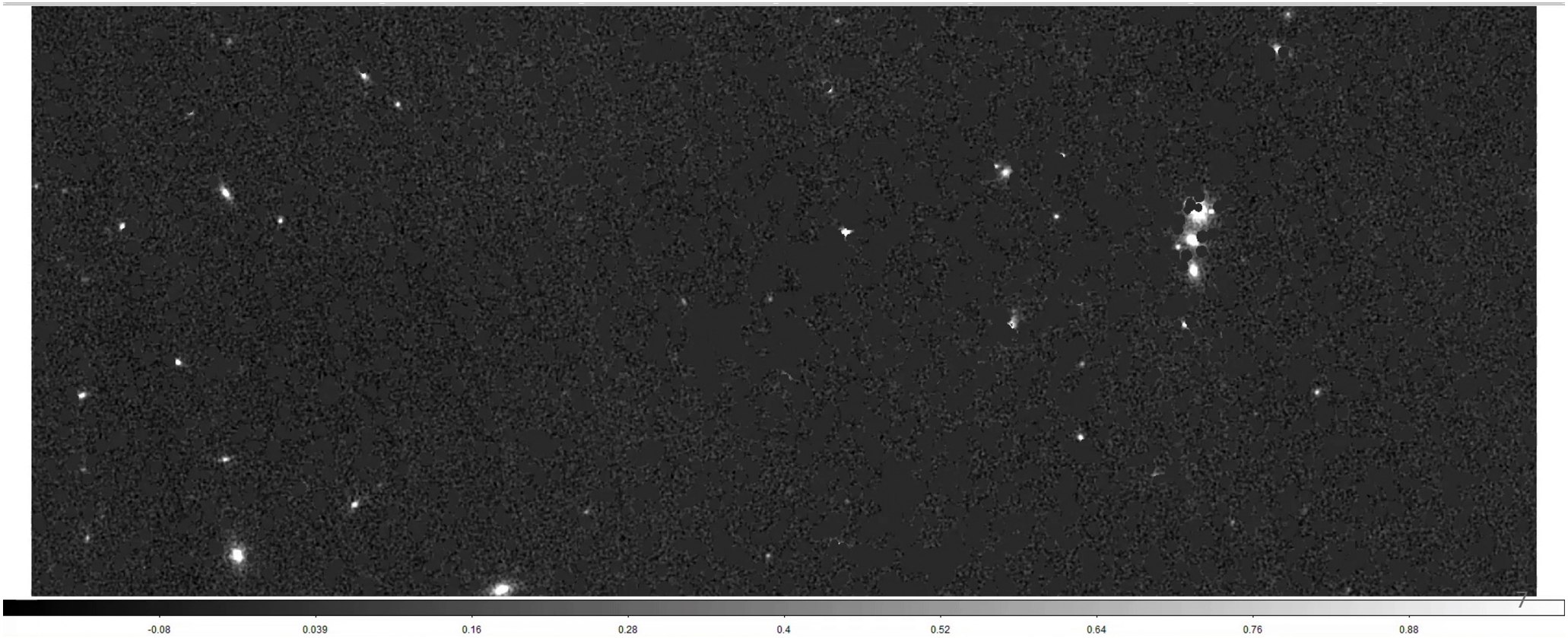
One day

Time to reconstruct a Roman WFI image [$(7.5\ \mathrm{arcmin})^2$] with a single CPU core using IMCOM.

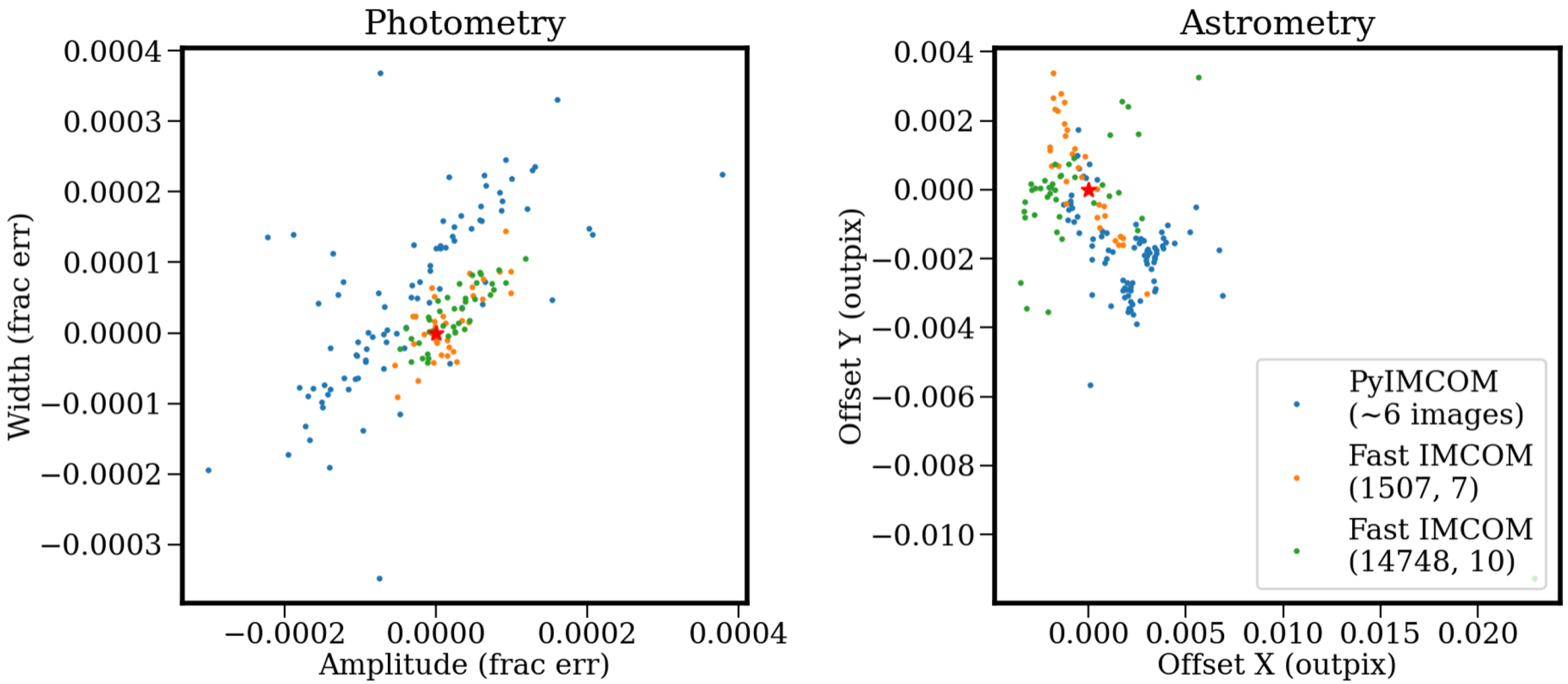
One day → Half an hour

Time to reconstruct a Roman WFI image [$(7.5\ \mathrm{arcmin})^2$] with a single CPU core using IMCOM → Fast IMCOM.

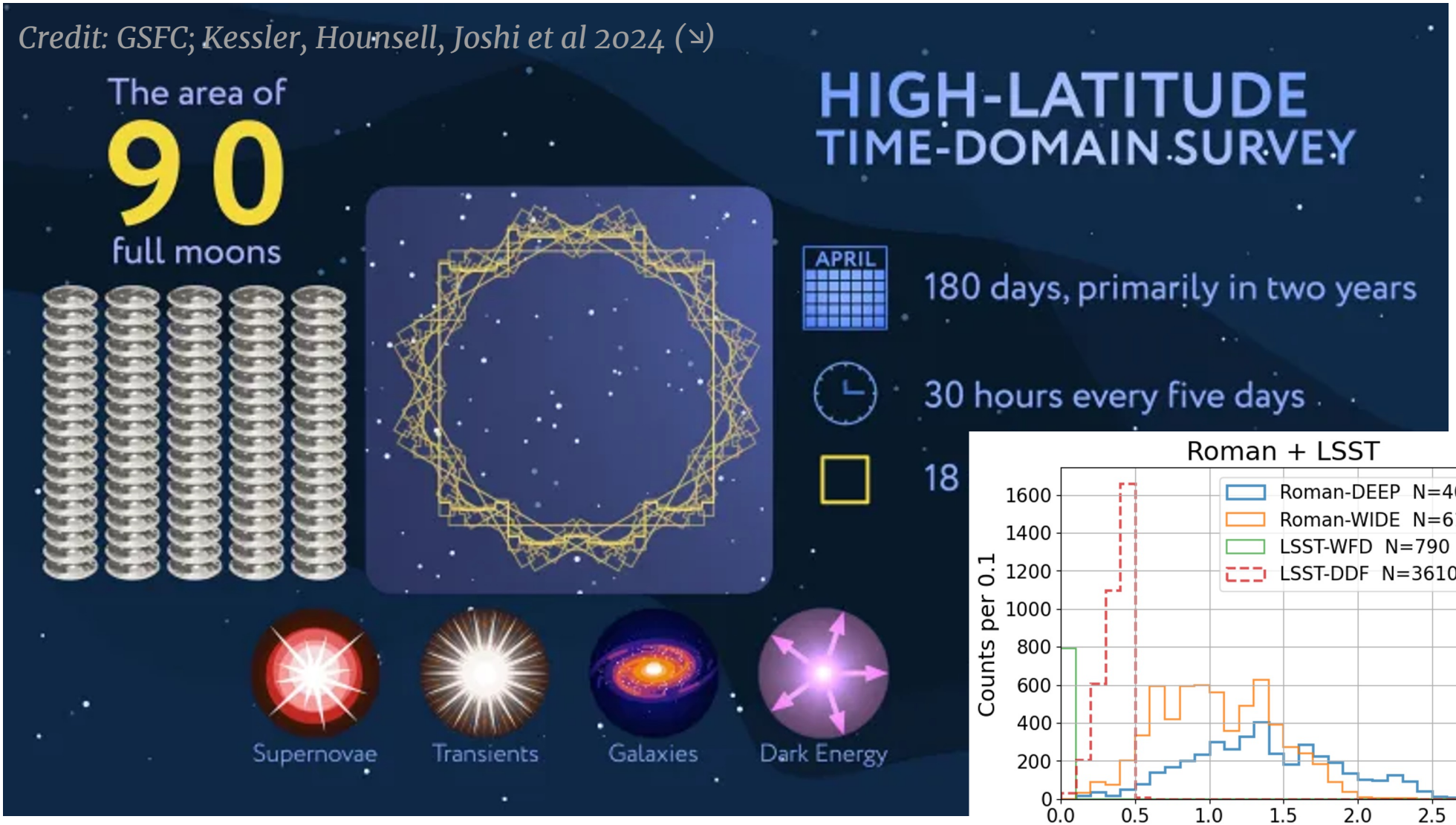
Foreseeable Future: Efficient Optimal Image Reconstruction with Fast IMCOM (Cao 2026*)



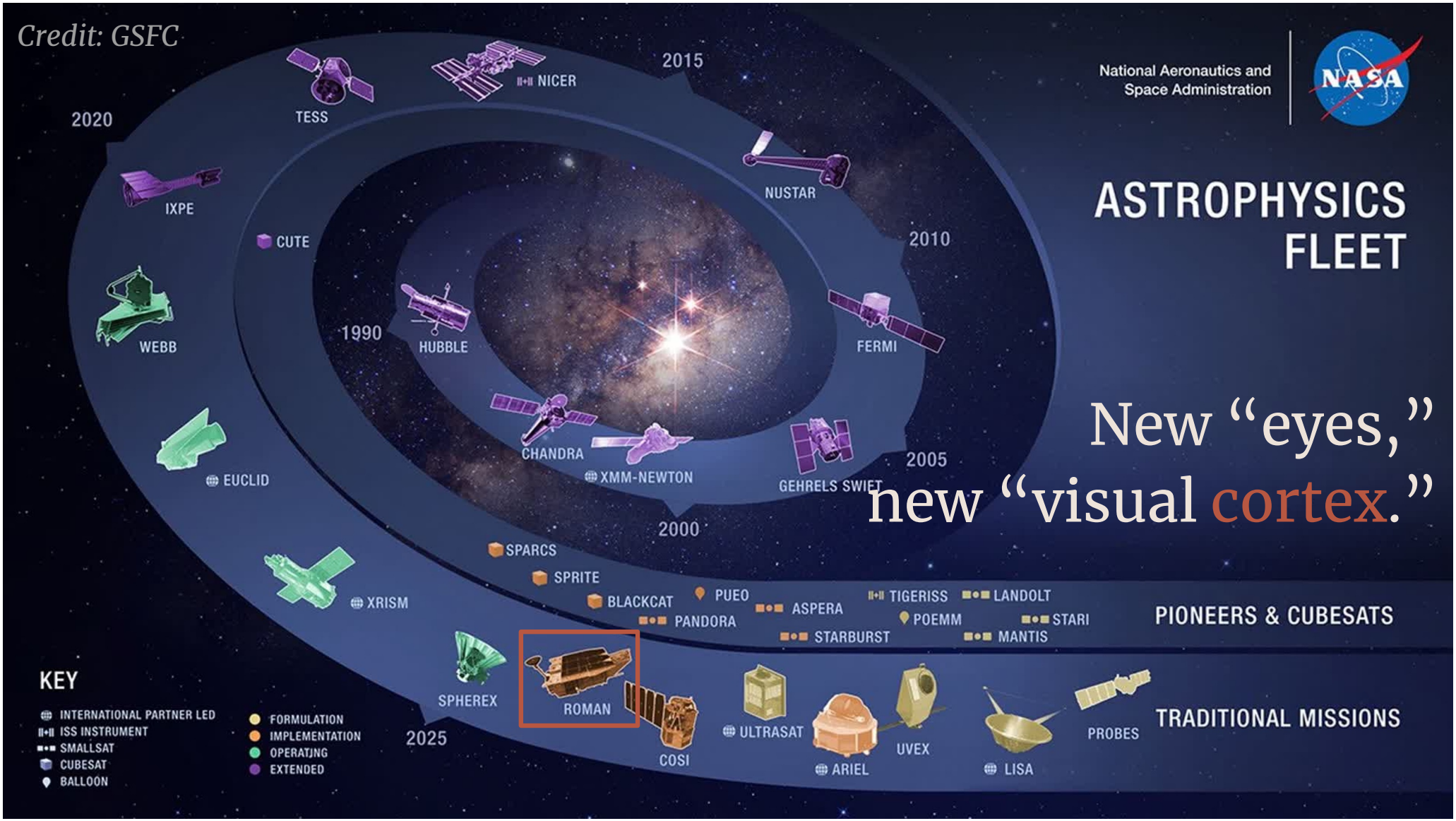
Measurements with Fast IMCOM (Cao 2026*)



For noiseless point sources. The output pixel scale is currently ~46.3 mas.


Credit: GSFC; Kessler, Hounsell, Joshi et al 2024 (↘)
The area of
90
full moons
HIGH-LATITUDE
TIME-DOMAIN SURVEY
APRIL
180 days, primarily in two years
30 hours every five days
18
Supernovae
Transients
Galaxies
Dark Energy

Roman + LSST
Roman-DEEP N=4007
Roman-WIDE N=6180
LSST-WFD N=790
LSST-DDF N=3610
Counts per 0.1
Redshift
0
200
400
600
800
1000
1200
1400
1600
0.0
0.5
1.0
1.5
2.0
2.5
3.0



New “eyes,”
new “visual cortex.”

How do we optimize transient discovery with multi-wavelength and multi-messenger alert streams?

Is it worth projecting single-epoch images onto a common pixel grid and unifying the point spread functions?

Necessary inputs: calibrated single-epoch images (“Level-2”), world coordinate systems, point spread functions

Configurable outputs: pixel grid, point spread function

Formalism paper published in AJ; methods papers underway.

roman-hlis-cosmology.caltech.edu

github.com/Roman-HLIS-Cosmology-PIT

Hot-wiring the Roman Sky: Resolving the Undersampling Crisis with Fast IMCOM for Real-Time Discovery

Presenter: Kaili Cao (The Ohio State University → University of Michigan)