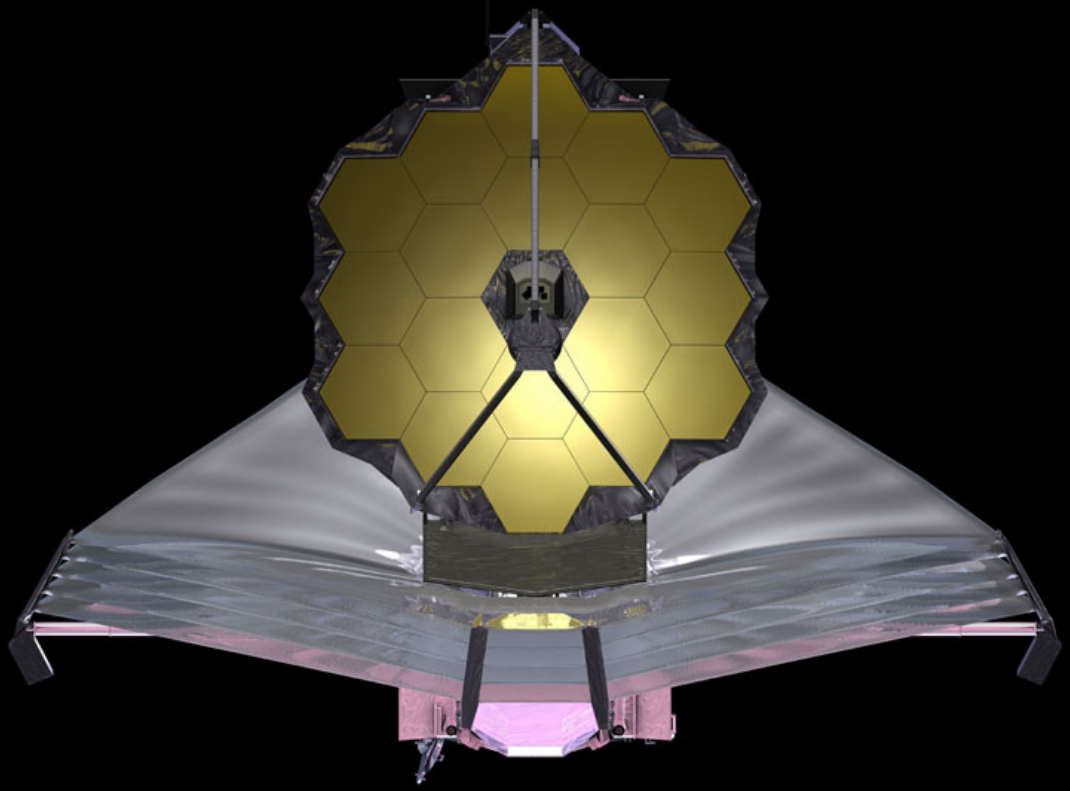
Mastering the JWST proposal tools

CSA webinar #2

Nov. 22th 2017



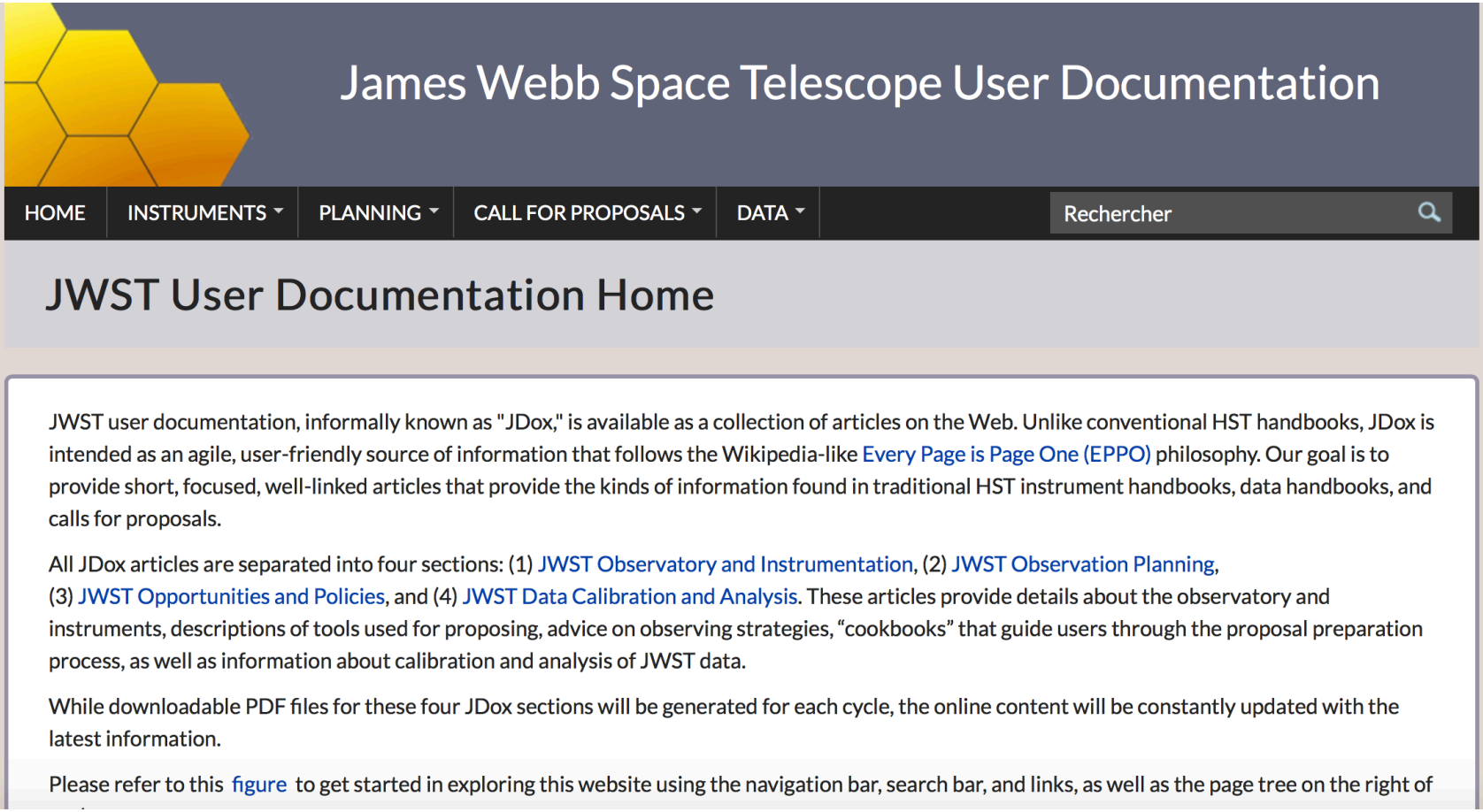
Université de Montréal

NASA esa CSA ASC James Webb Space Telescope JWST NASA • ESA • CSA iREx CRAQ Comprendre l'Univers OBSERVATOIRE DU MONT-MÉGANTIC

The number one tool - JDox

https://jwst-docs.stsci.edu/display/HOM/JWST+User+Documentation+Home

"When all else fails, read the manual..."



Outline

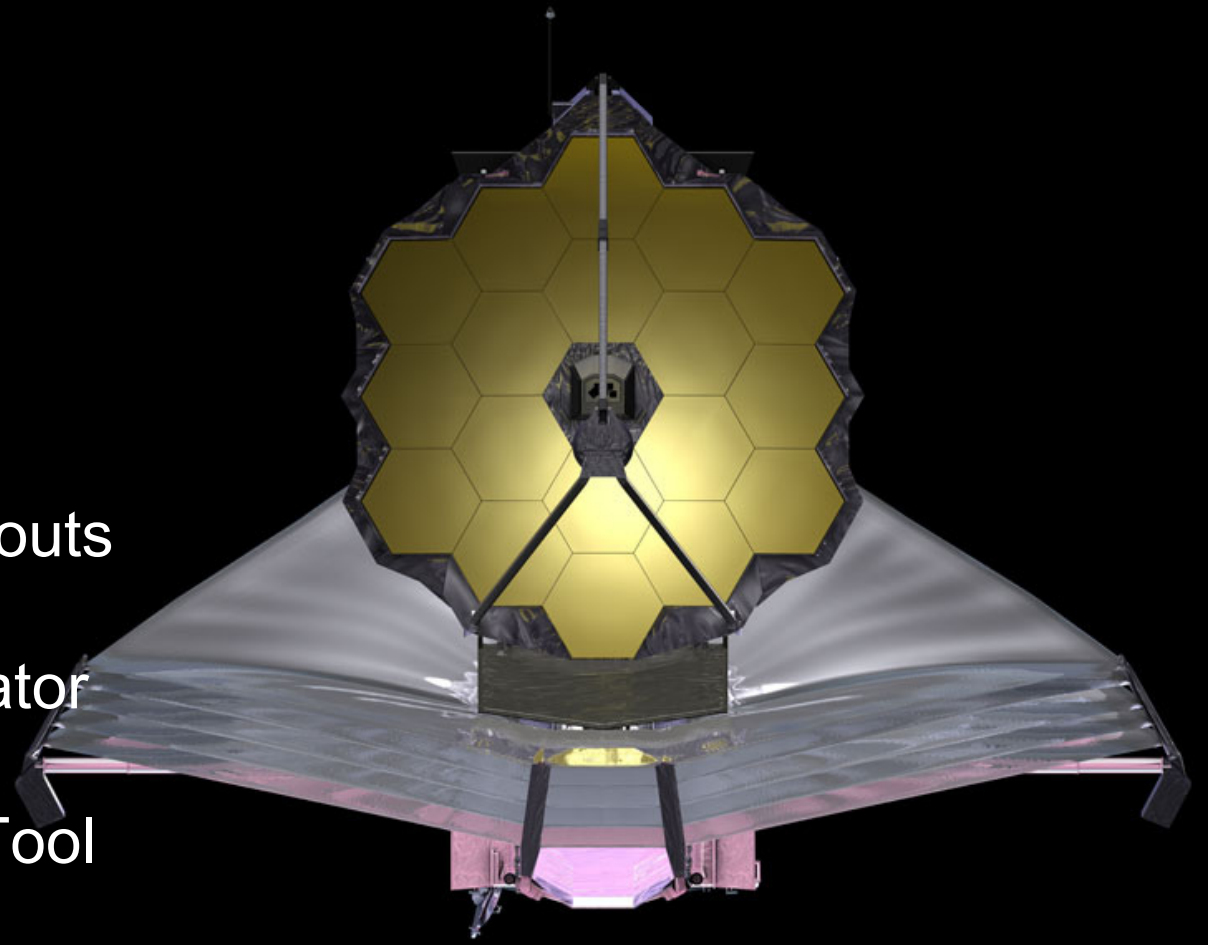
JWST field of regard

(ESASky)
Visibility Tool

Infrared detector Readouts

Exposure Time Calculator

Astronomer Proposal Tool



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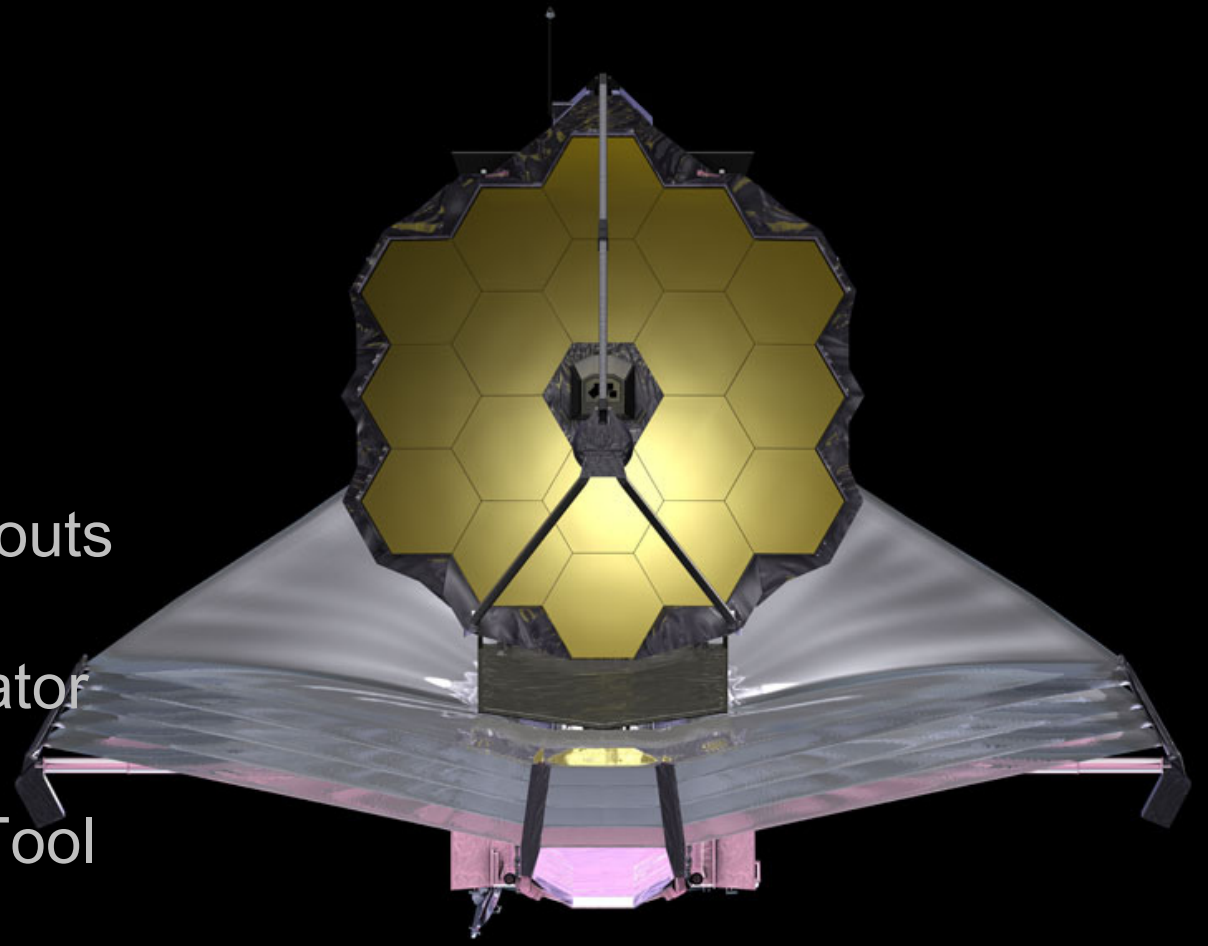
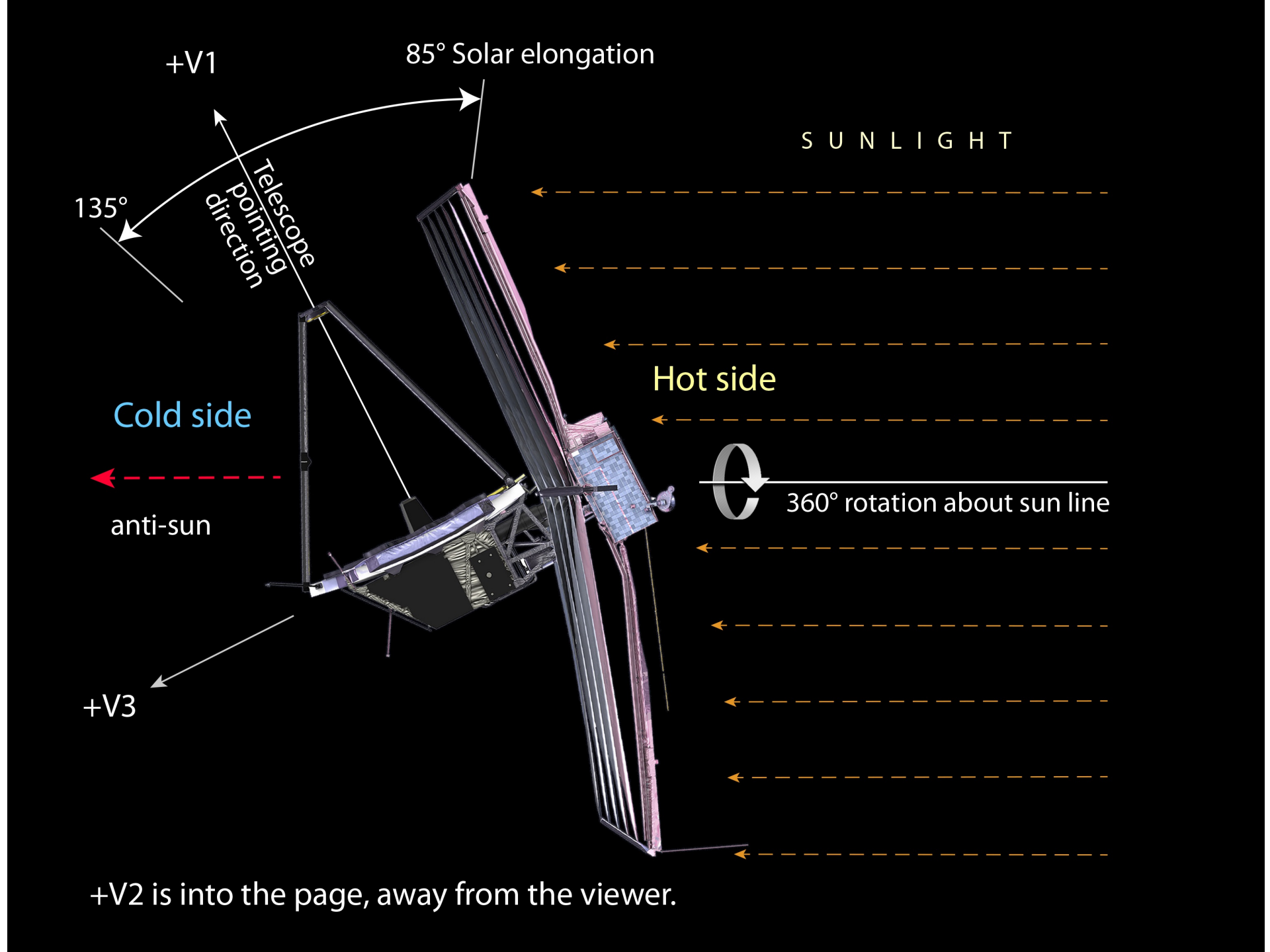
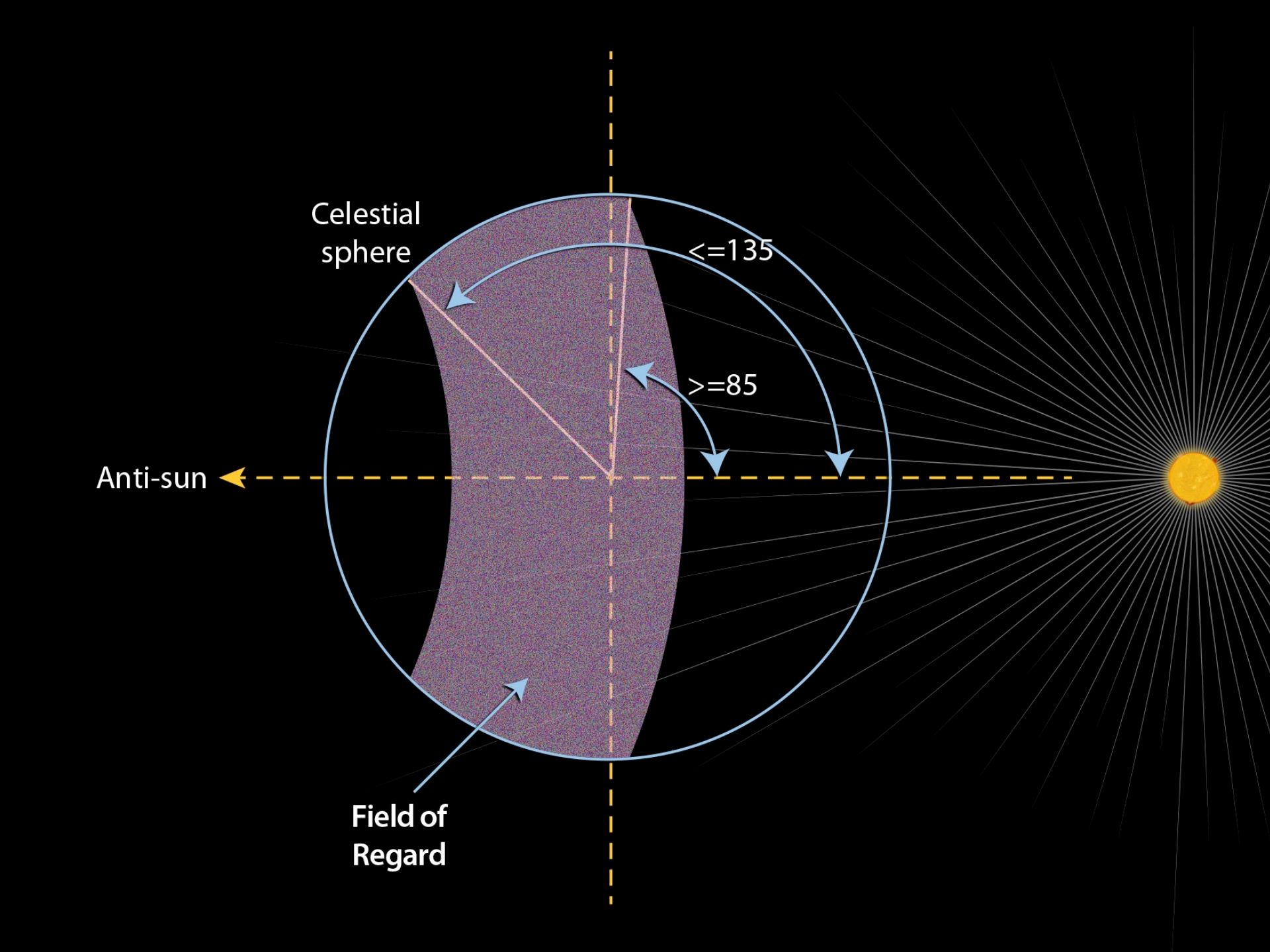
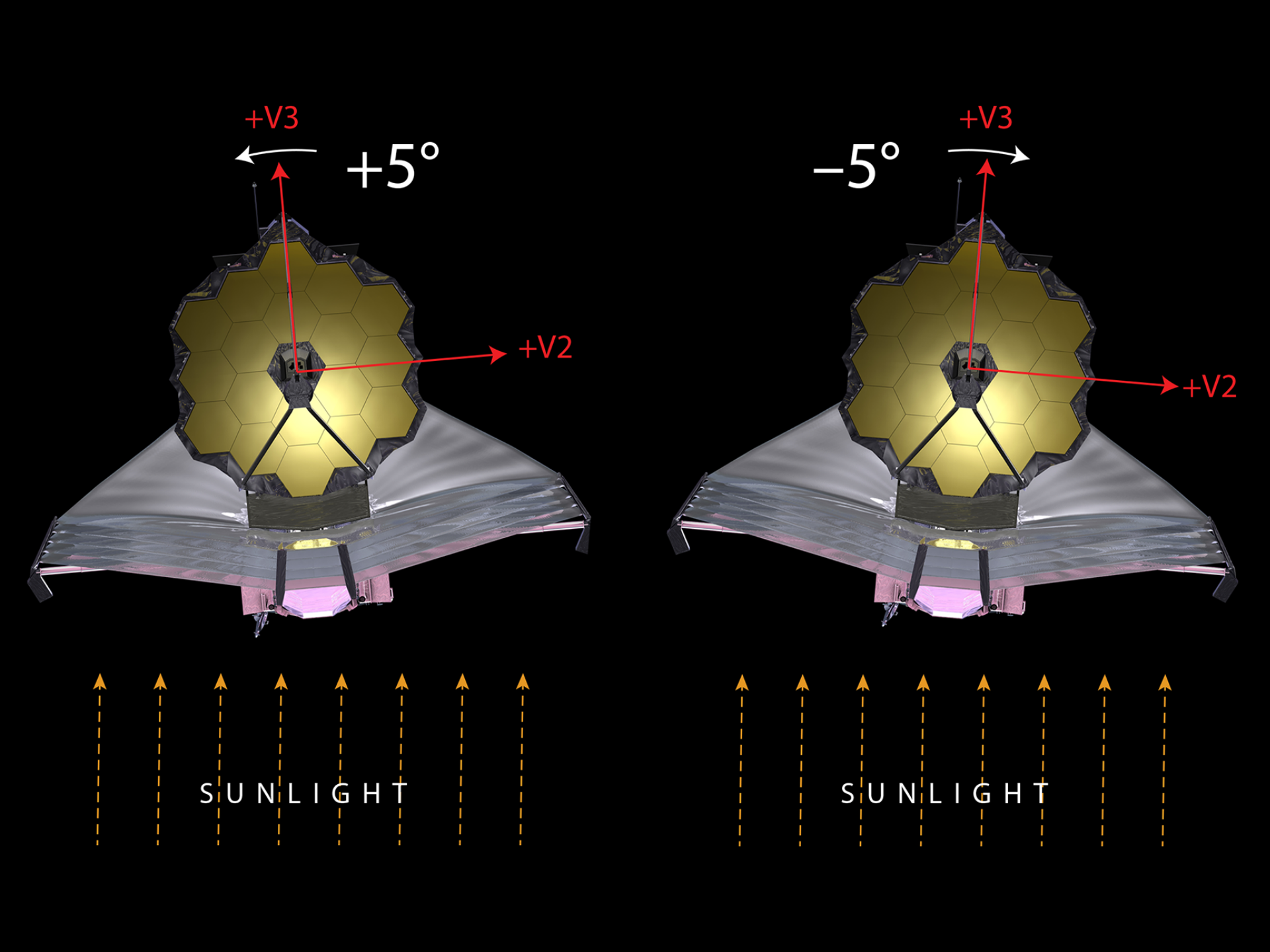



+V1
85° Solar elongation
SUNLIGHT
135°
Telescope pointing direction
Hot side
Cold side
anti-sun
360° rotation about sun line
+V3
+V2 is into the page, away from the viewer.


Celestial sphere
<=135
>=85
Anti-sun
Field of Regard


+V3
+5°
+V2
SUNLIGHT
+V3
−5°
+V2
SUNLIGHT

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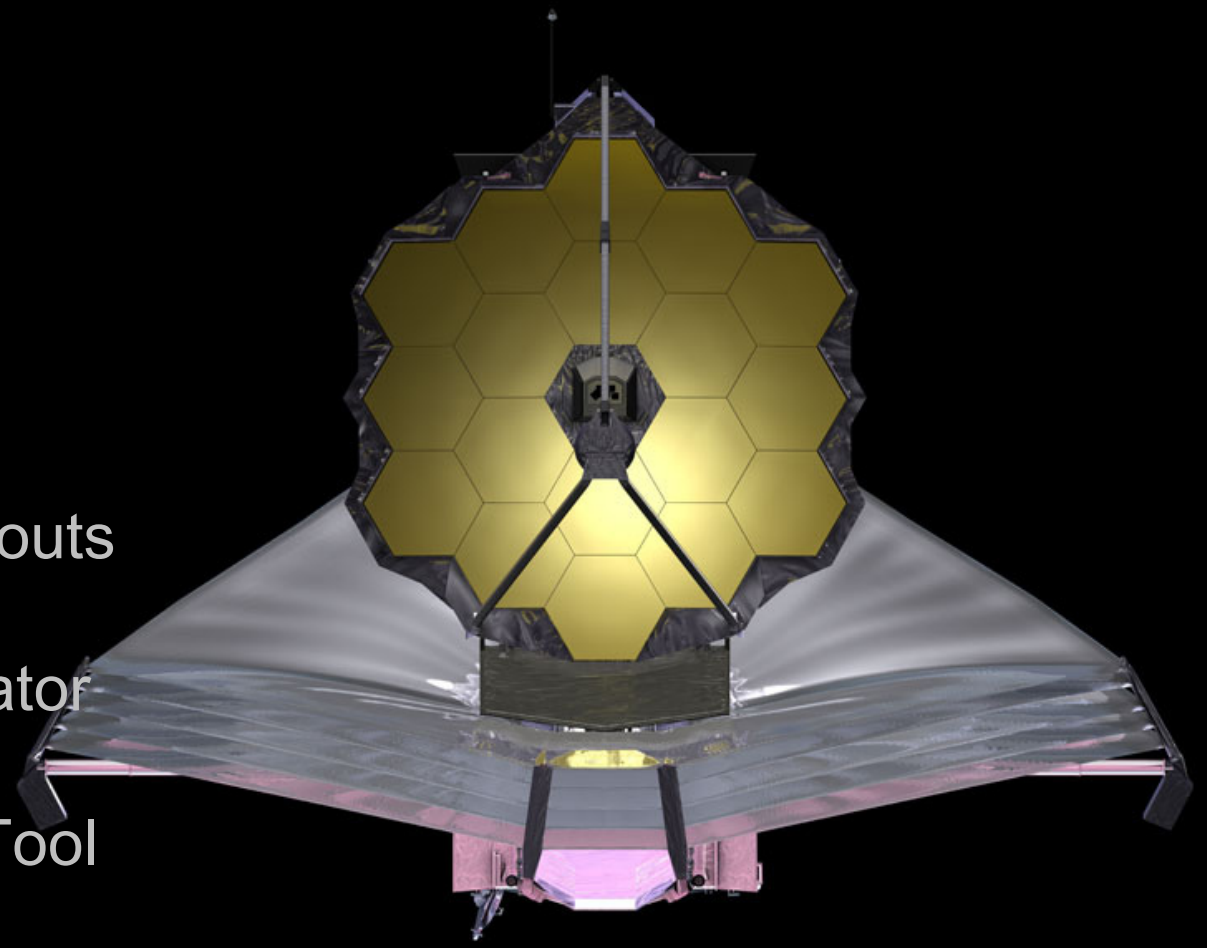


Target Visibility Tool

- The Astronomer Proposal Tool (APT) includes calculations of the visibility and it has the final say.
- For simply assessing a target's visibility, APT is a bit heavy as one must enters various fields before being able to assess visibility.

- An independent, python based tool is provided: jwst_gtvt, distributed in the astroconda package

Target Visibility tool

- The TVT returns both
  - the days in the year when a target is visible with JWST AND
  - the position angle of the "aperture" (read detector) on the sky.

- A second python-based tool, jwst-coronagraph-visibility-gui, handles the special case of visibilities for the JWST coronagraph modes (see webinar #8).

TVT installation

- Install python. We recommend installing anaconda
  https://www.anaconda.com/download/

  and use the conda package manager to install the

  astroconda python distribution:
  http://astroconda.readthedocs.io/en/latest/

- Or follow these instructions provided by STScI:
  https://jwst-docs.stsci.edu/display/JPP/JWST+General+Target+Visibility+Tool+Help

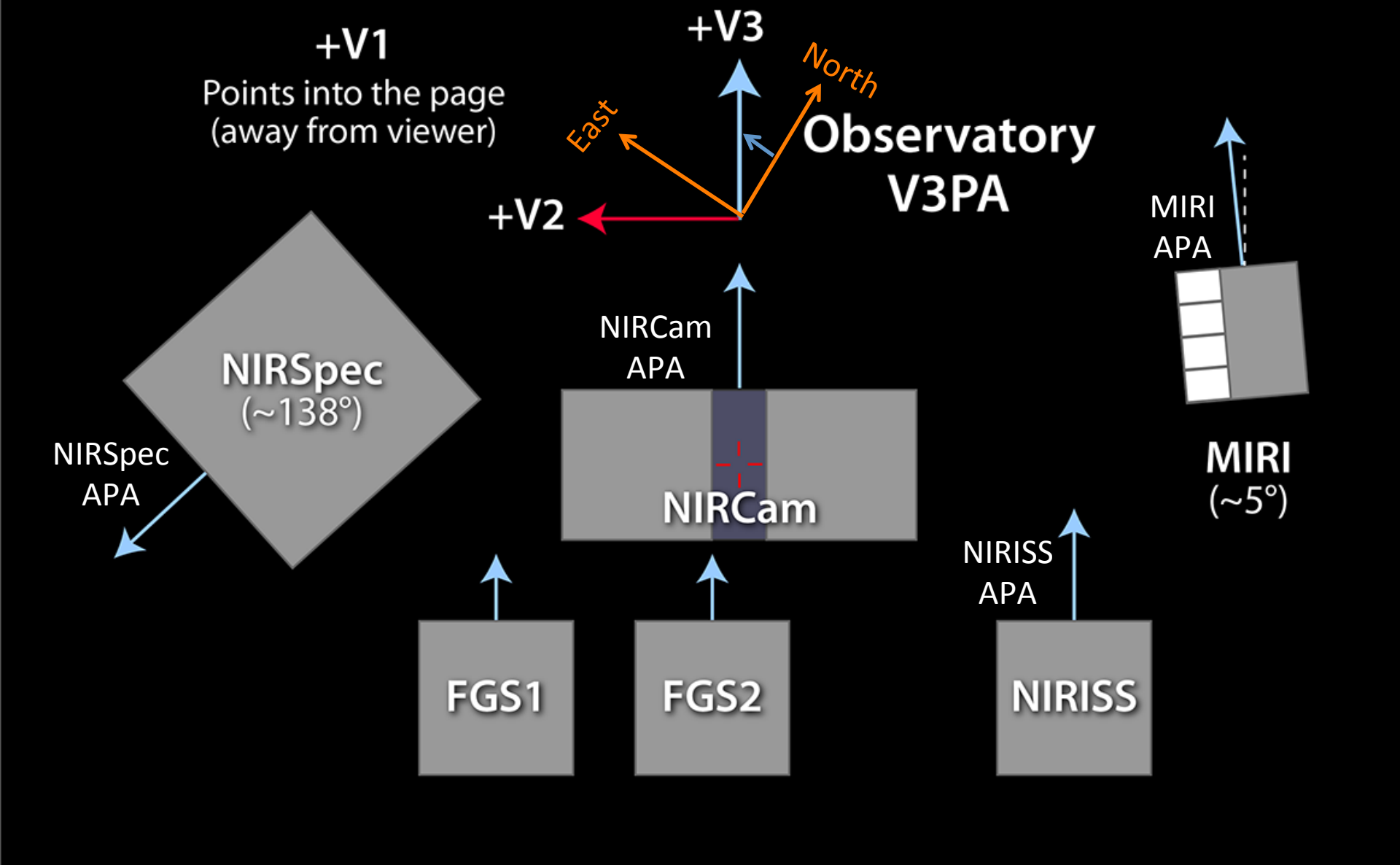
- Launch:

  $ source activate astroconda (bypassed if in conda env)

  (astroconda)$ conda install jwst_gtvt

  (astroconda)$ jwst_gtvt 12:12:34.2 +40:12:59

JWST Position Angle (V3PA) vs. each instrument's Aperture Position Angle



TVT Demo

(+ ESASky for quick scene viewing)

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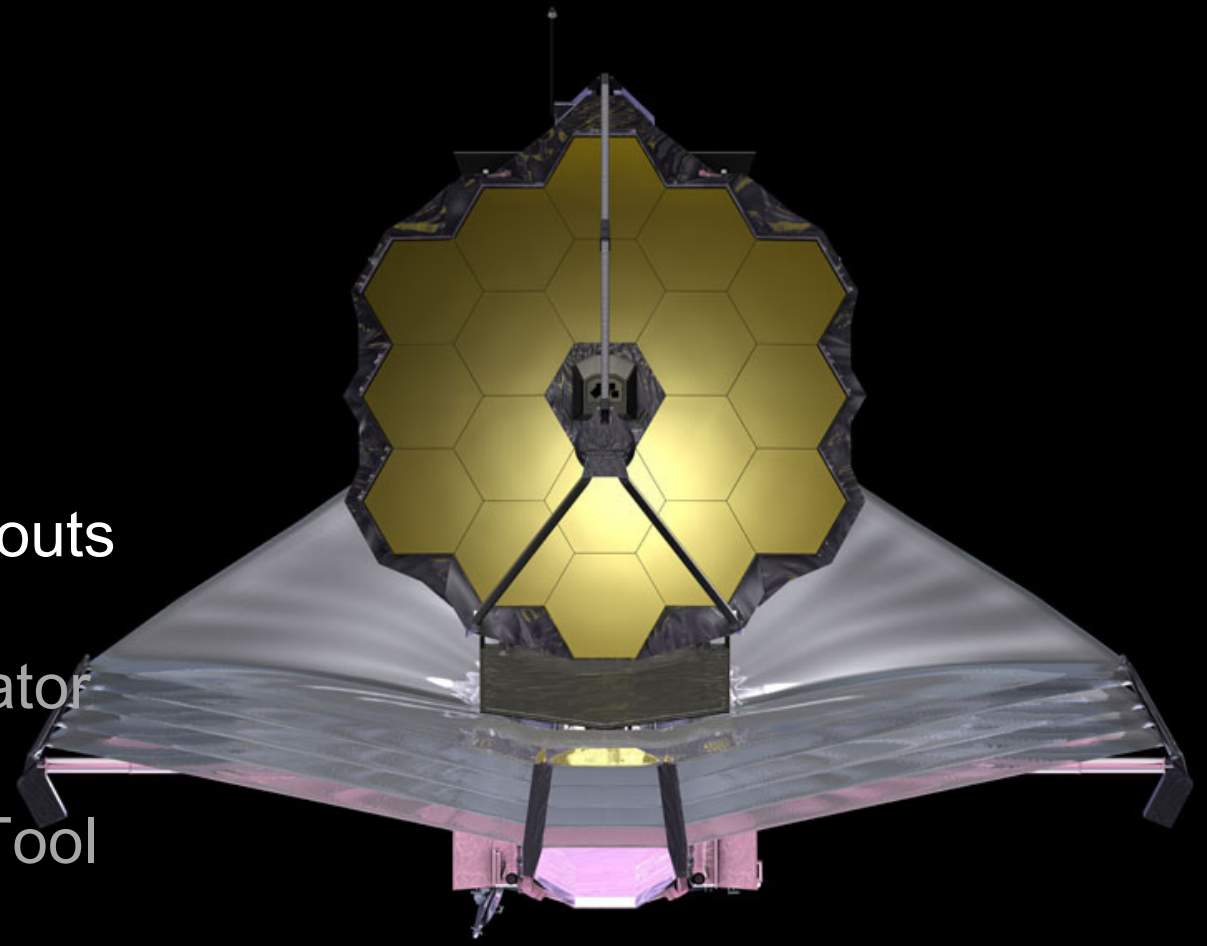
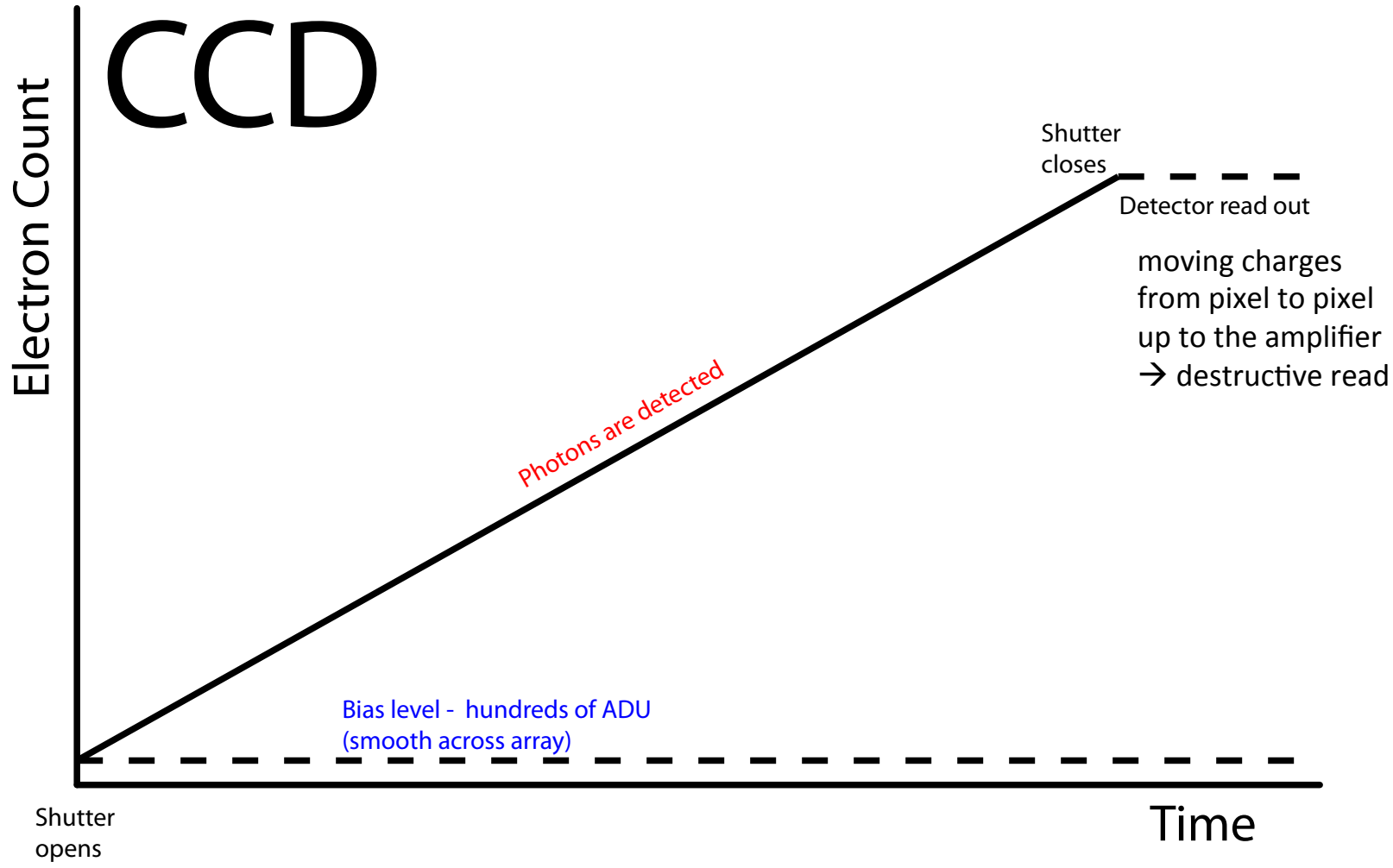
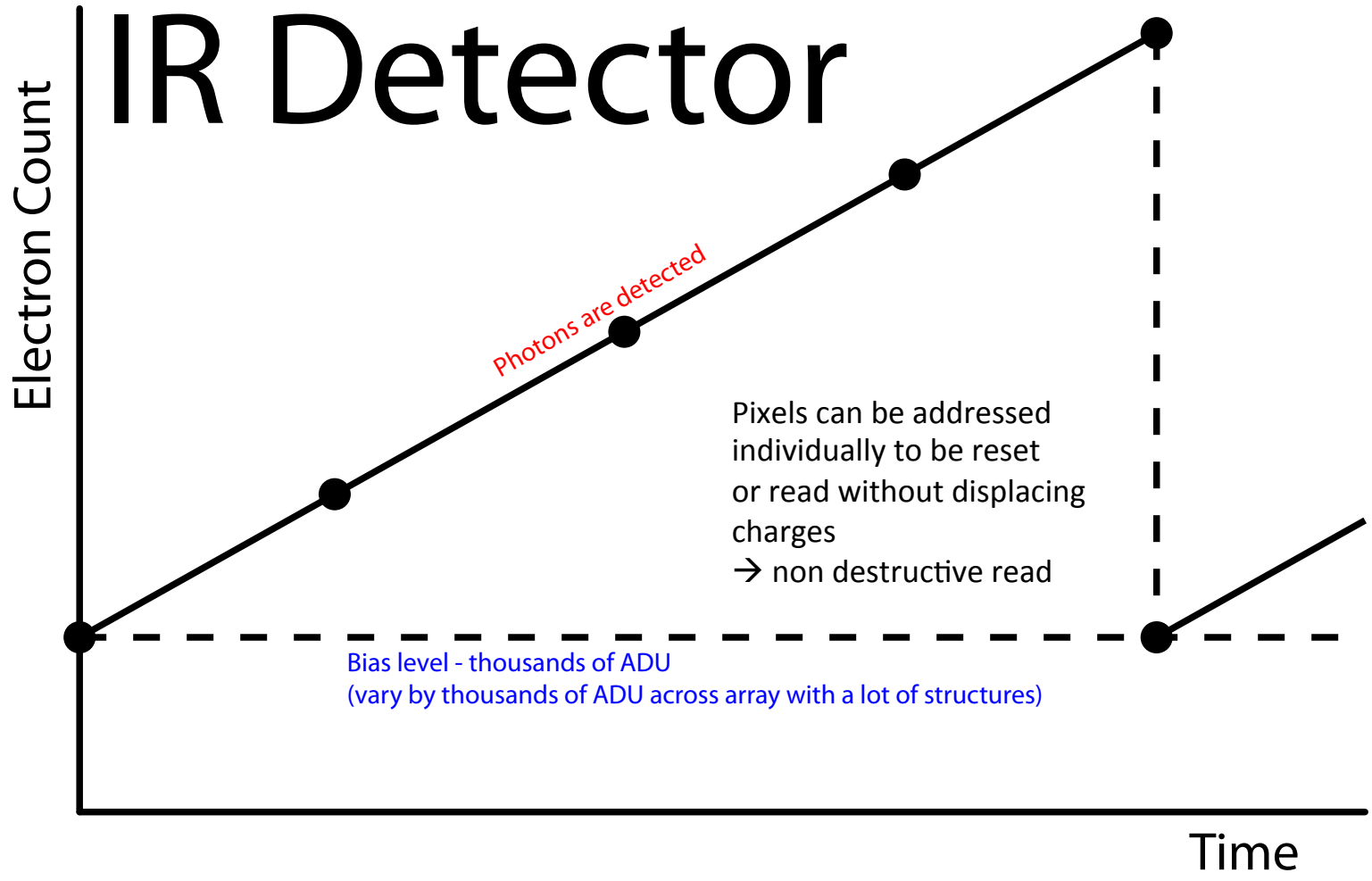
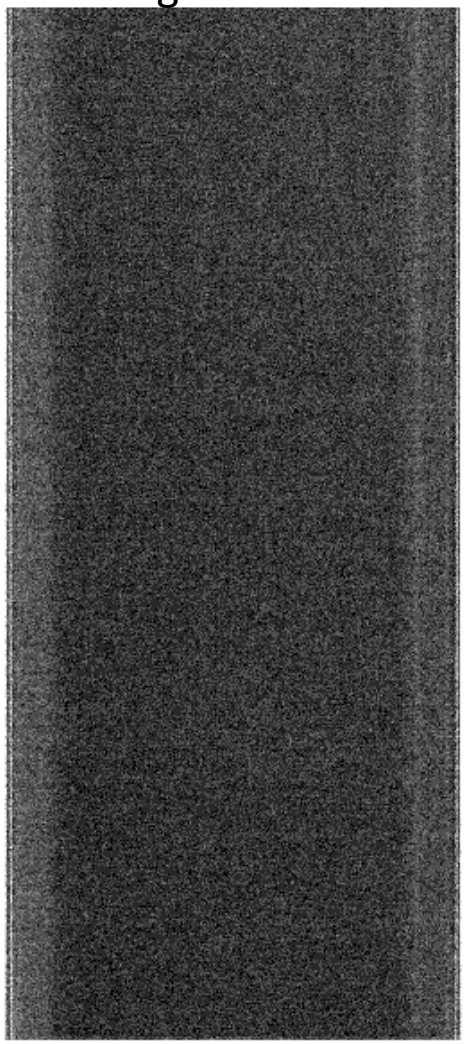



CCD
Electron Count
Shutter closes
Detector read out
moving charges from pixel to pixel up to the amplifier → destructive read
Photons are detected
Bias level - hundreds of ADU (smooth across array)
Shutter opens
Time

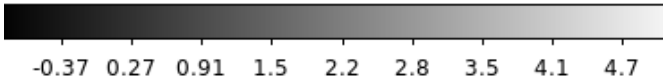

IR Detector
Electron Count
Photons are detected
Pixels can be addressed
individually to be reset
or read without displacing
charges
→ non destructive read
Bias level - thousands of ADU
(vary by thousands of ADU across array with a lot of structures)
Time

CCD vs. IR Array (Raw data)

Megacam bias

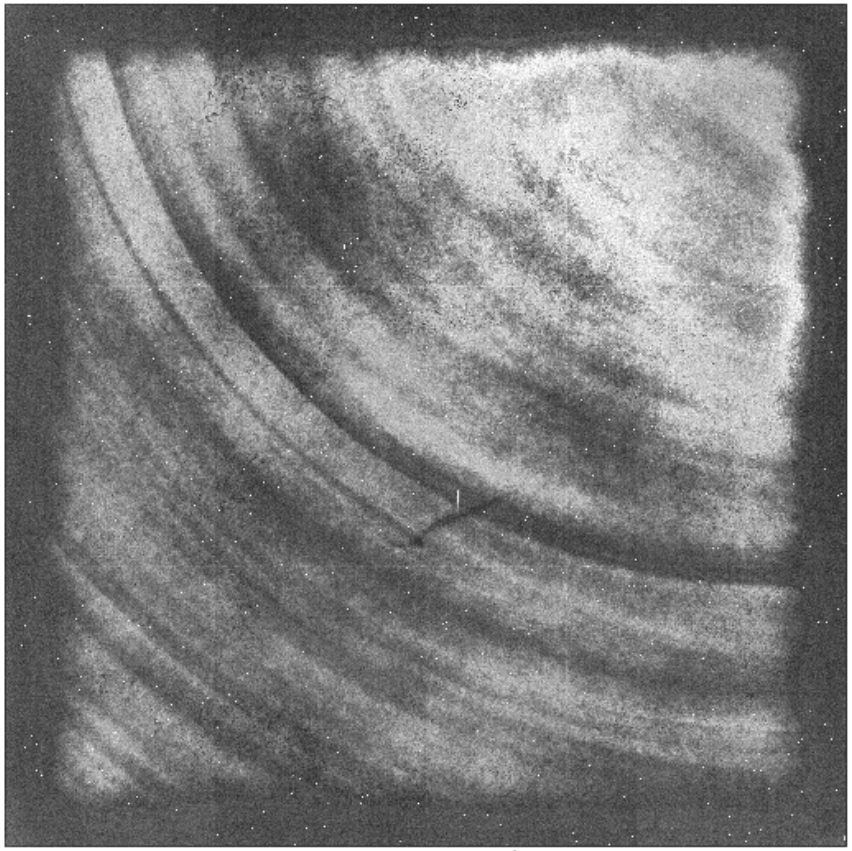


2112 pixels

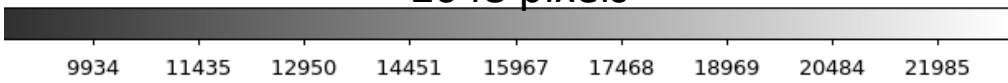


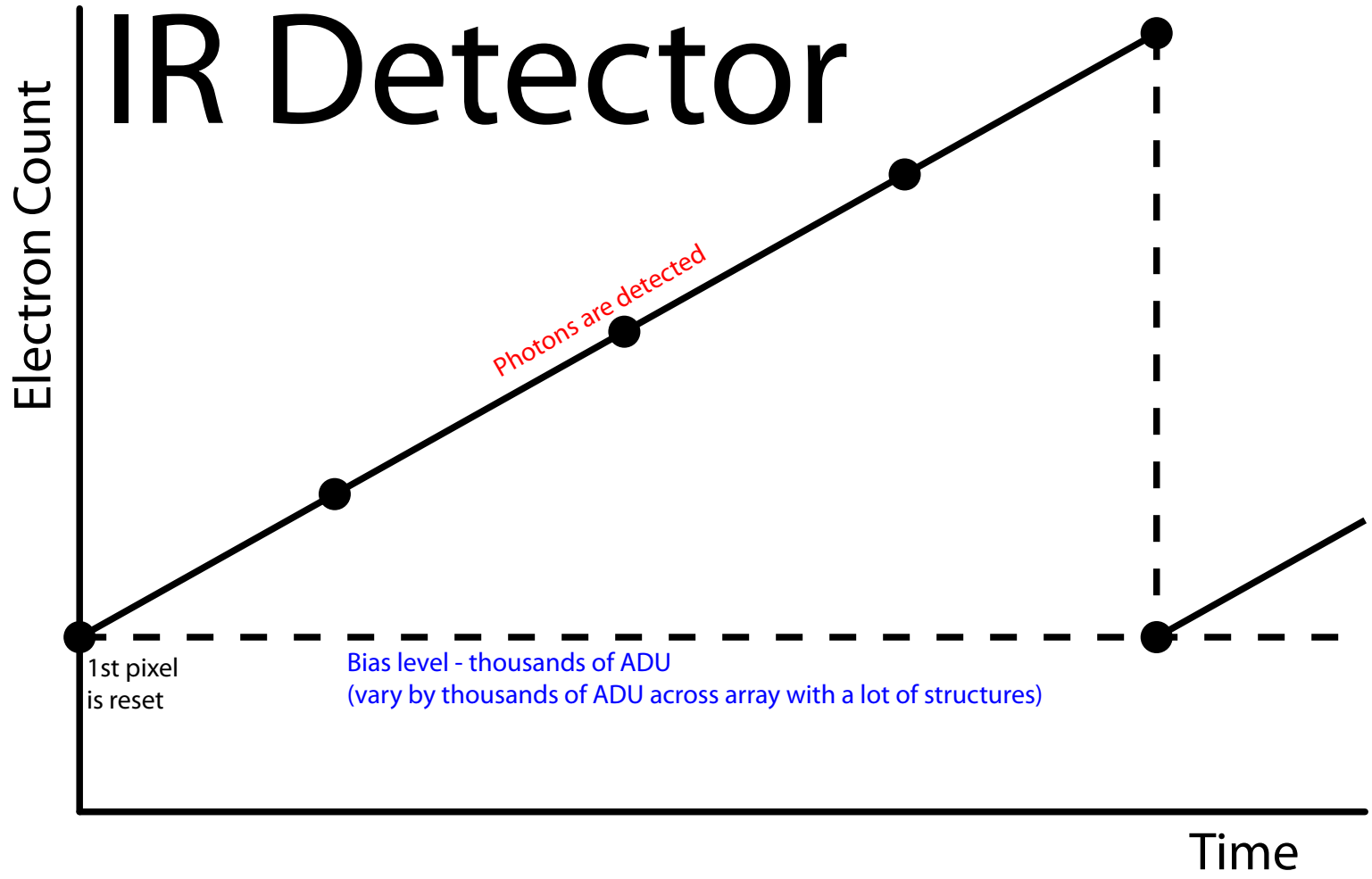
The structured pedestal disappears when subtracting the first read from the last read or when doing a slope fit of the ramp data.

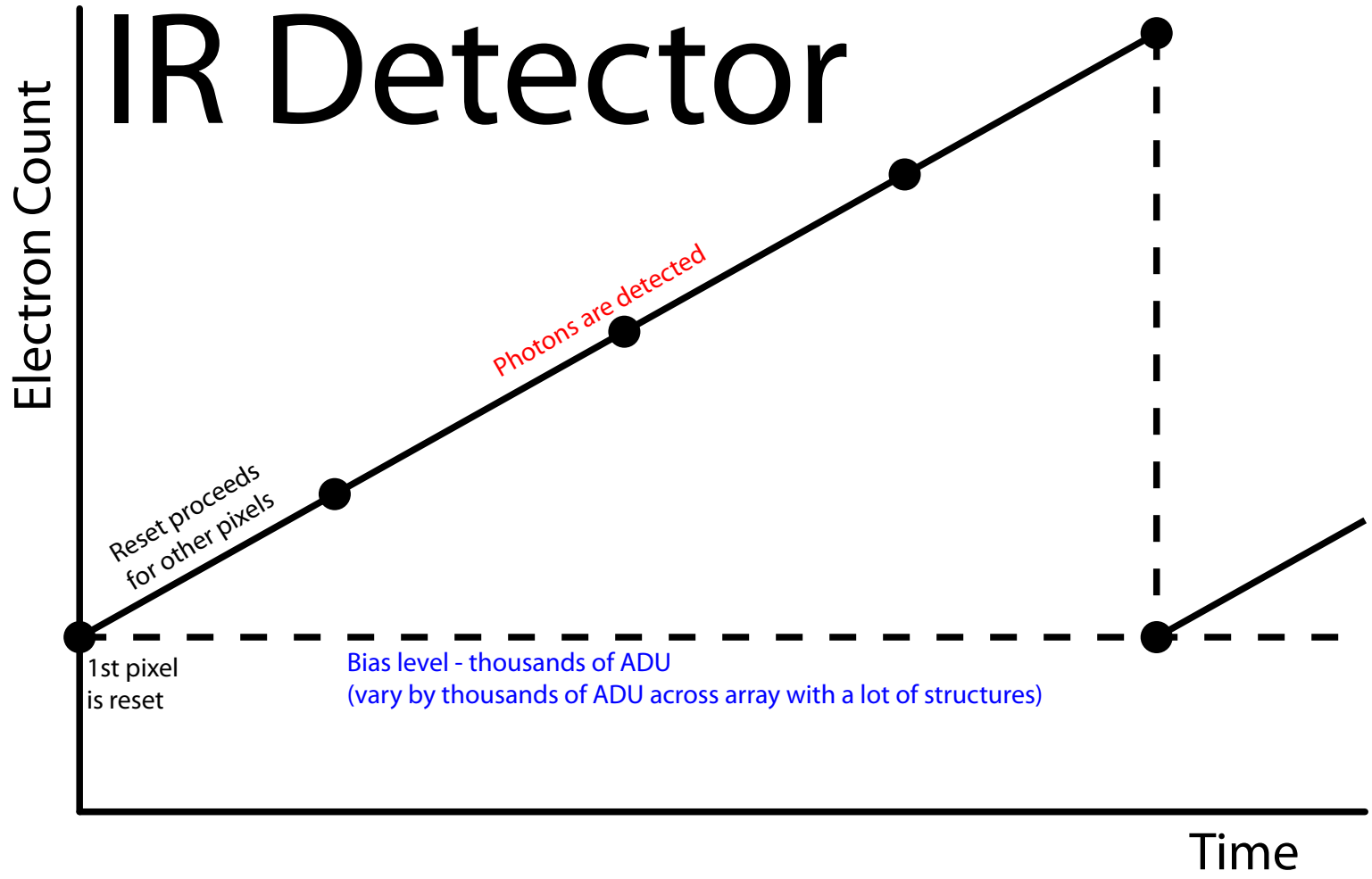
NIRISS – read 1

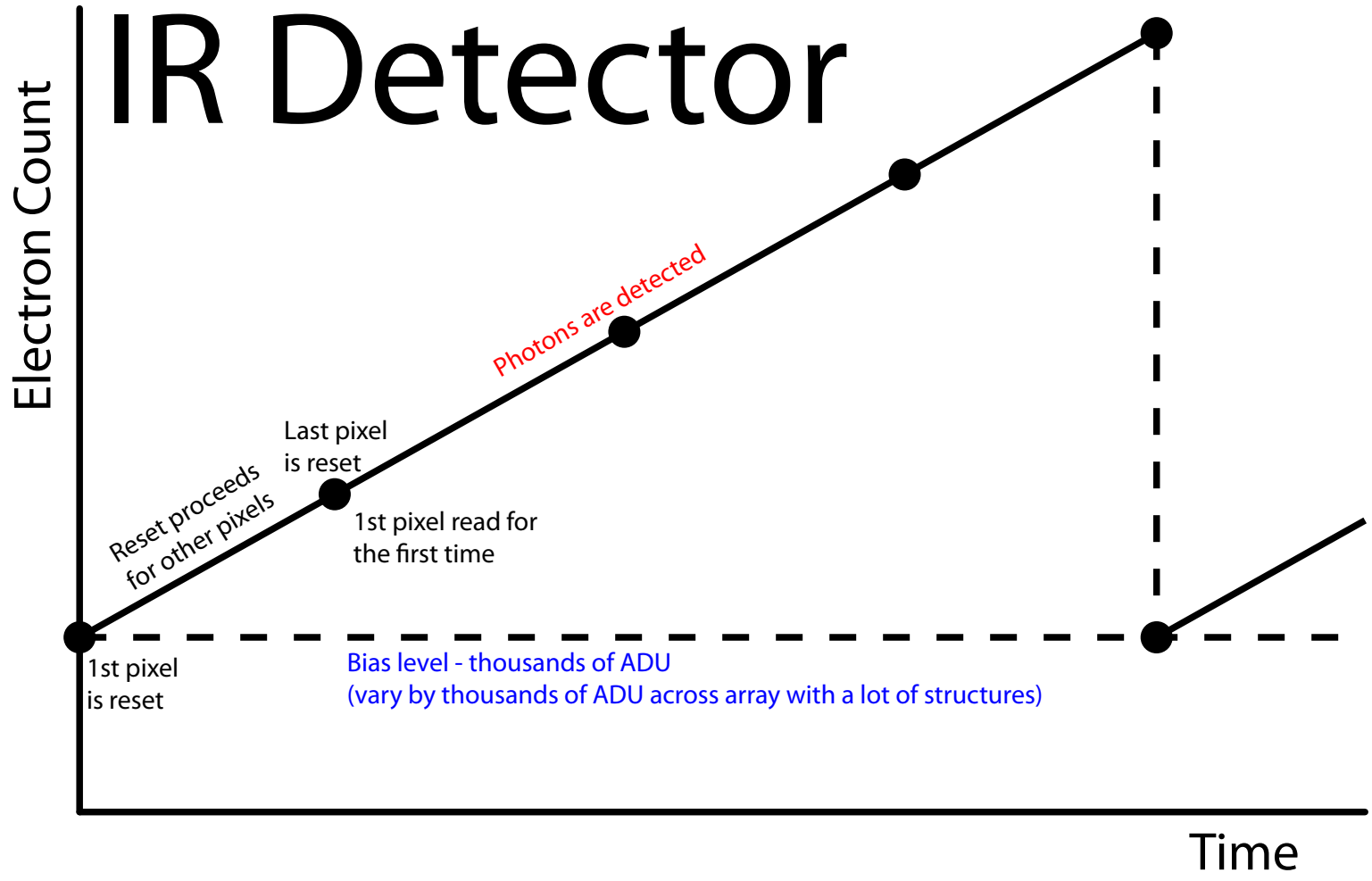


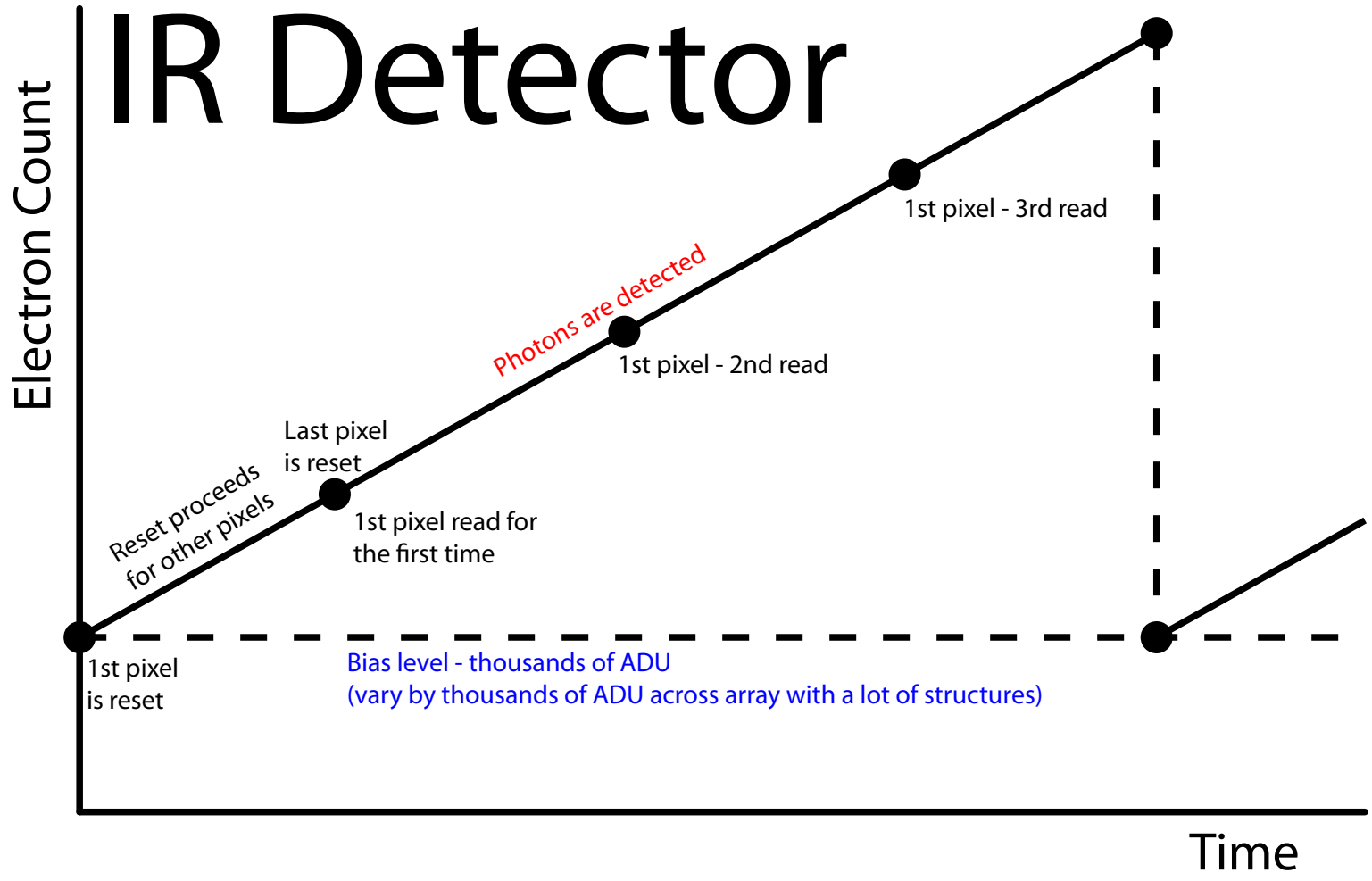
2048 pixels

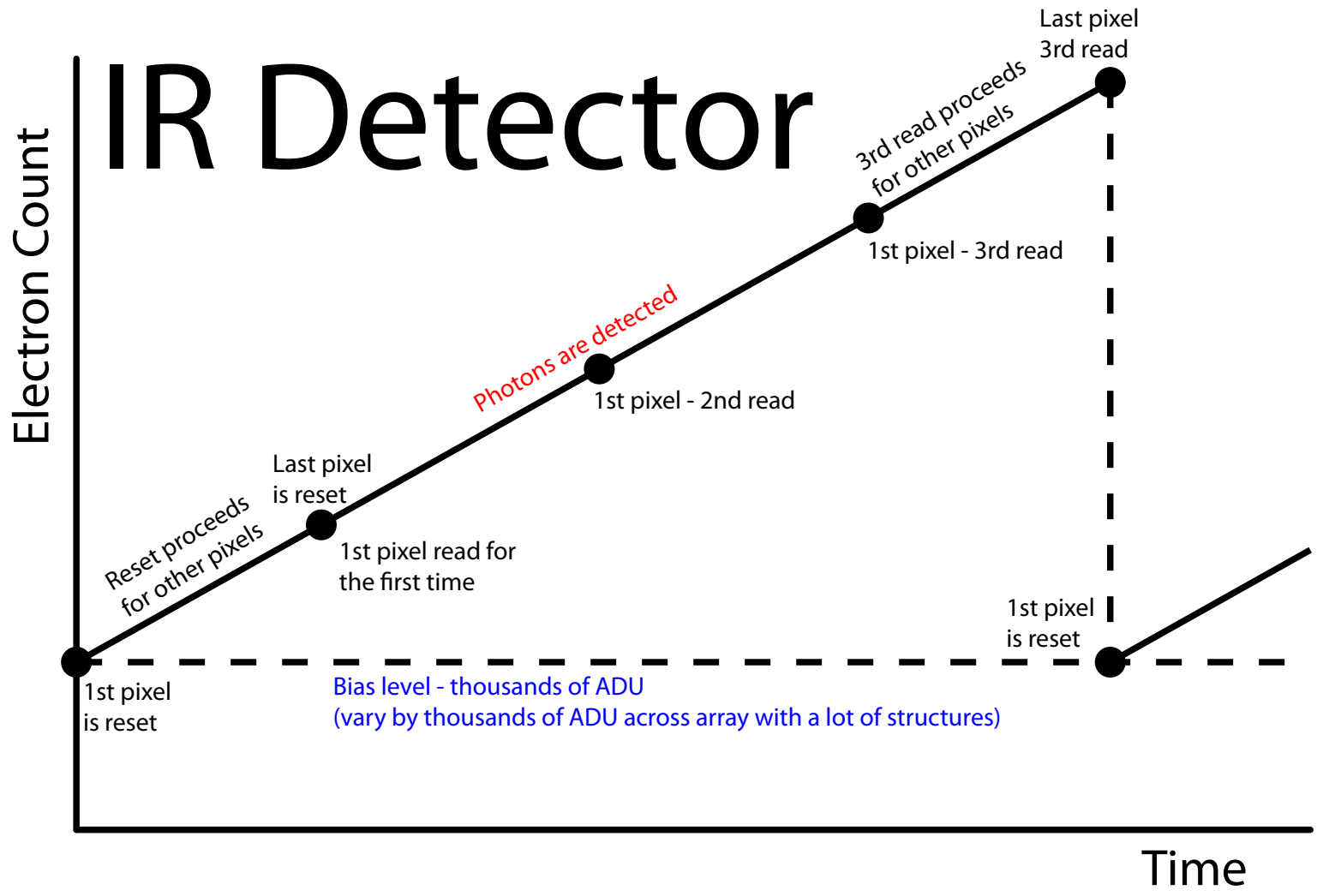


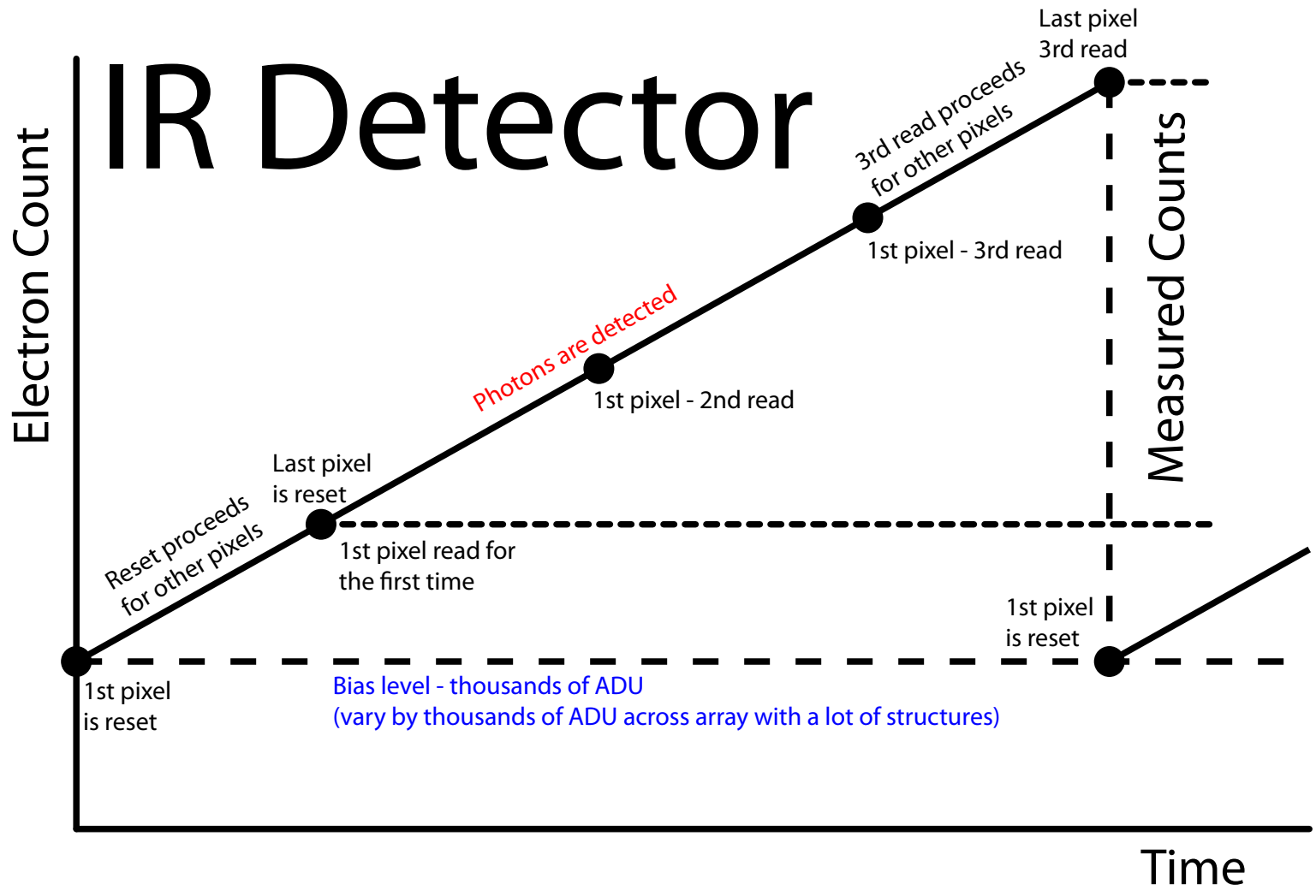

IR Detector
Electron Count
Photons are detected
1st pixel
is reset
Bias level - thousands of ADU
(vary by thousands of ADU across array with a lot of structures)
Time

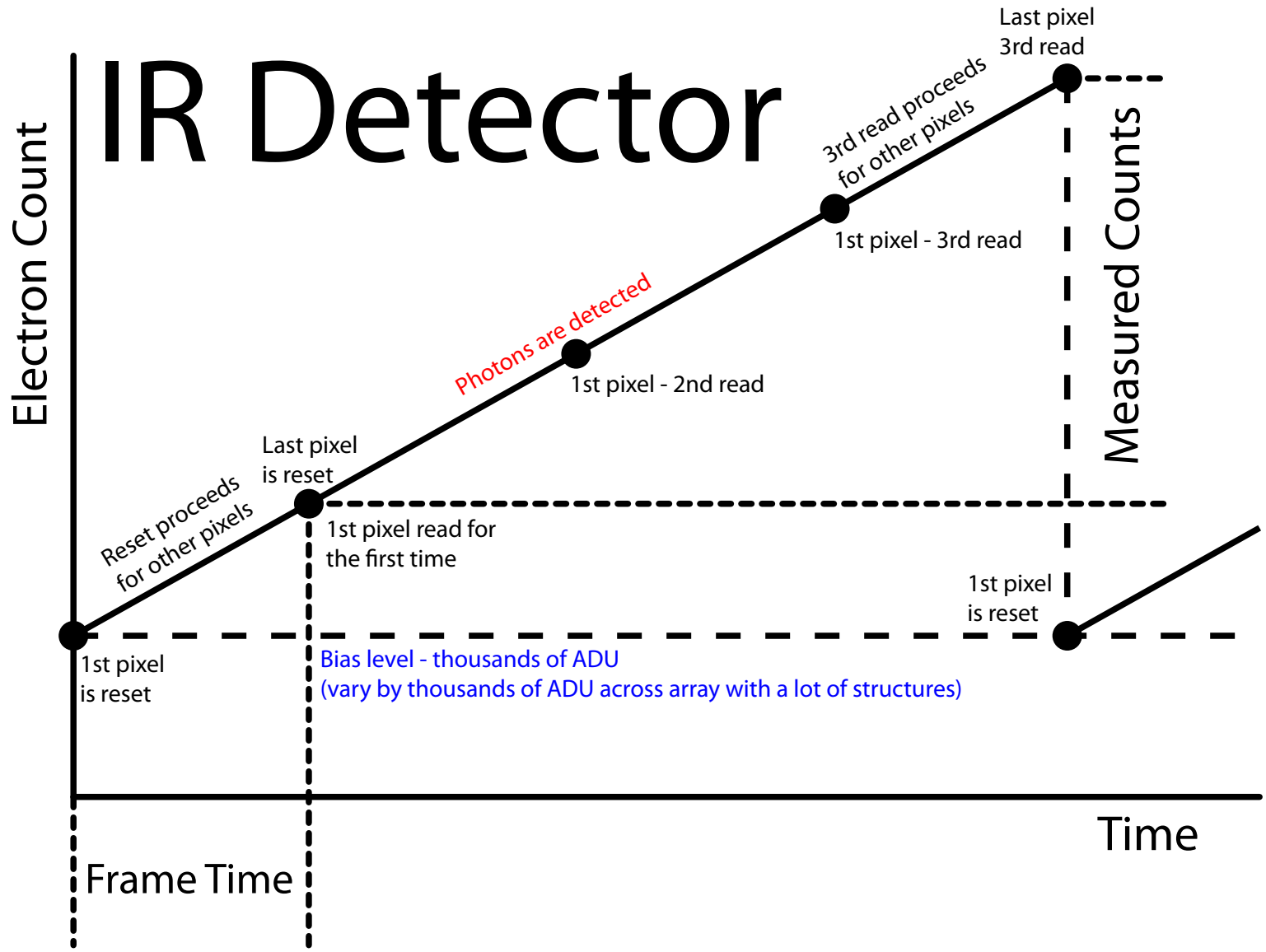

IR Detector
Electron Count
Photons are detected
Reset proceeds
for other pixels
1st pixel
is reset
Bias level - thousands of ADU
(vary by thousands of ADU across array with a lot of structures)
Time


IR Detector
Electron Count
Time
Photons are detected
Last pixel
is reset
Reset proceeds
for other pixels
1st pixel read for
the first time
1st pixel
is reset
Bias level - thousands of ADU
(vary by thousands of ADU across array with a lot of structures)


IR Detector
Electron Count
Time
1st pixel - 3rd read
Photons are detected
1st pixel - 2nd read
Last pixel
is reset
Reset proceeds
for other pixels
1st pixel read for
the first time
1st pixel
is reset
Bias level - thousands of ADU
(vary by thousands of ADU across array with a lot of structures)


IR Detector
Electron Count
Time
Last pixel
3rd read
3rd read proceeds
for other pixels
1st pixel - 3rd read
Photons are detected
1st pixel - 2nd read
Last pixel
is reset
Reset proceeds
for other pixels
1st pixel read for
the first time
1st pixel
is reset
1st pixel
is reset
Bias level - thousands of ADU
(vary by thousands of ADU across array with a lot of structures)


IR Detector
Electron Count
Time
Measured Counts
Last pixel
3rd read
3rd read proceeds
for other pixels
1st pixel - 3rd read
Photons are detected
1st pixel - 2nd read
Last pixel
is reset
Reset proceeds
for other pixels
1st pixel read for
the first time
1st pixel
is reset
1st pixel
is reset
Bias level - thousands of ADU
(vary by thousands of ADU across array with a lot of structures)



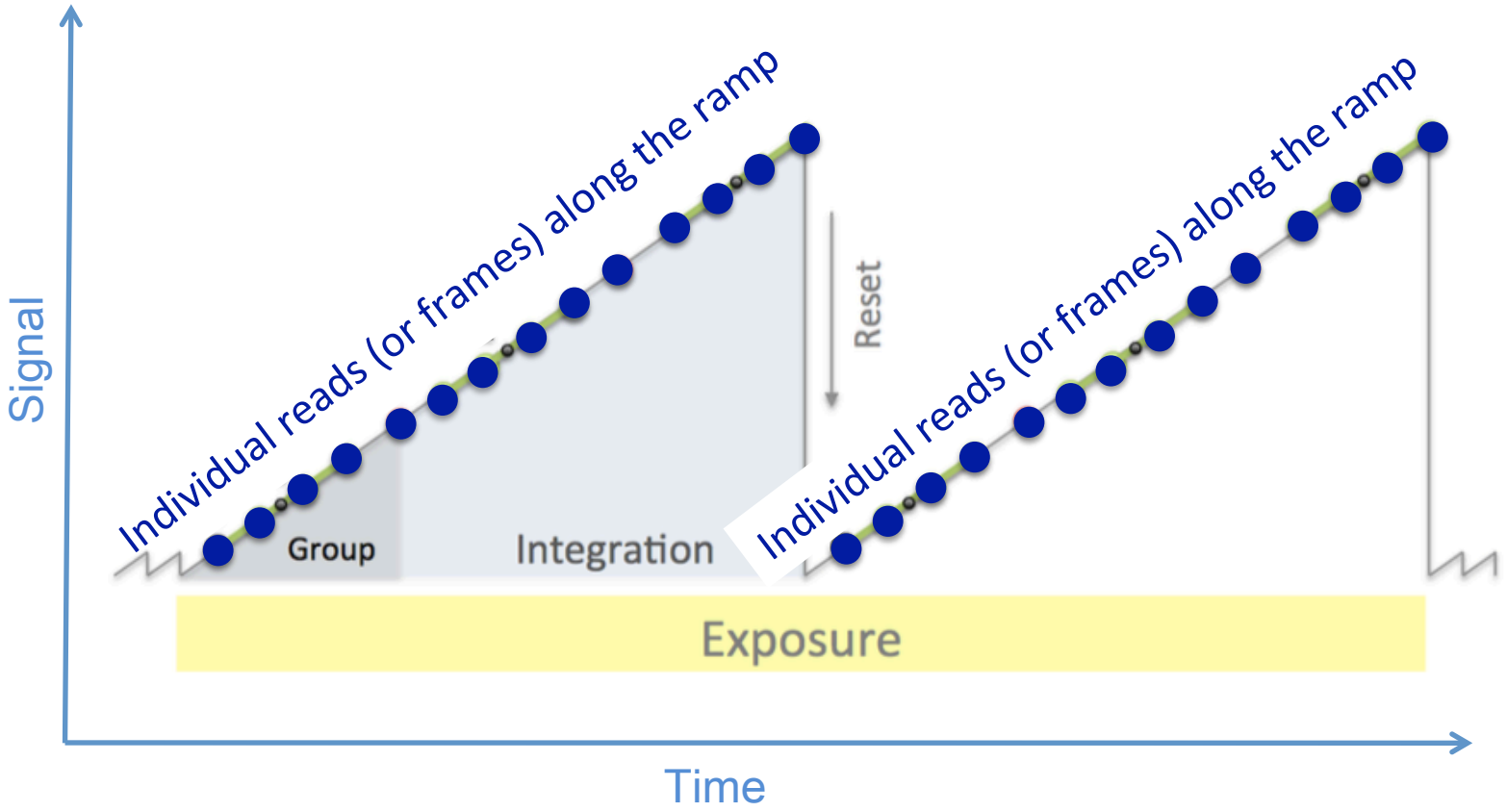
Frame Time = Npixel * 10 usec/pixel

--> 256 x 256 sub-array: Frame Time = 0.65 sec

--> 2048x2048 (Full-Frame): 10.7 sec

The following applies to Near IR detectors
(NIRCam, NIRSpec, NIRISS, FGS)
The Mid-IR detector of MIRI is slightly different
in the details although the principle is similar

Infrared Detector – JWST jargon



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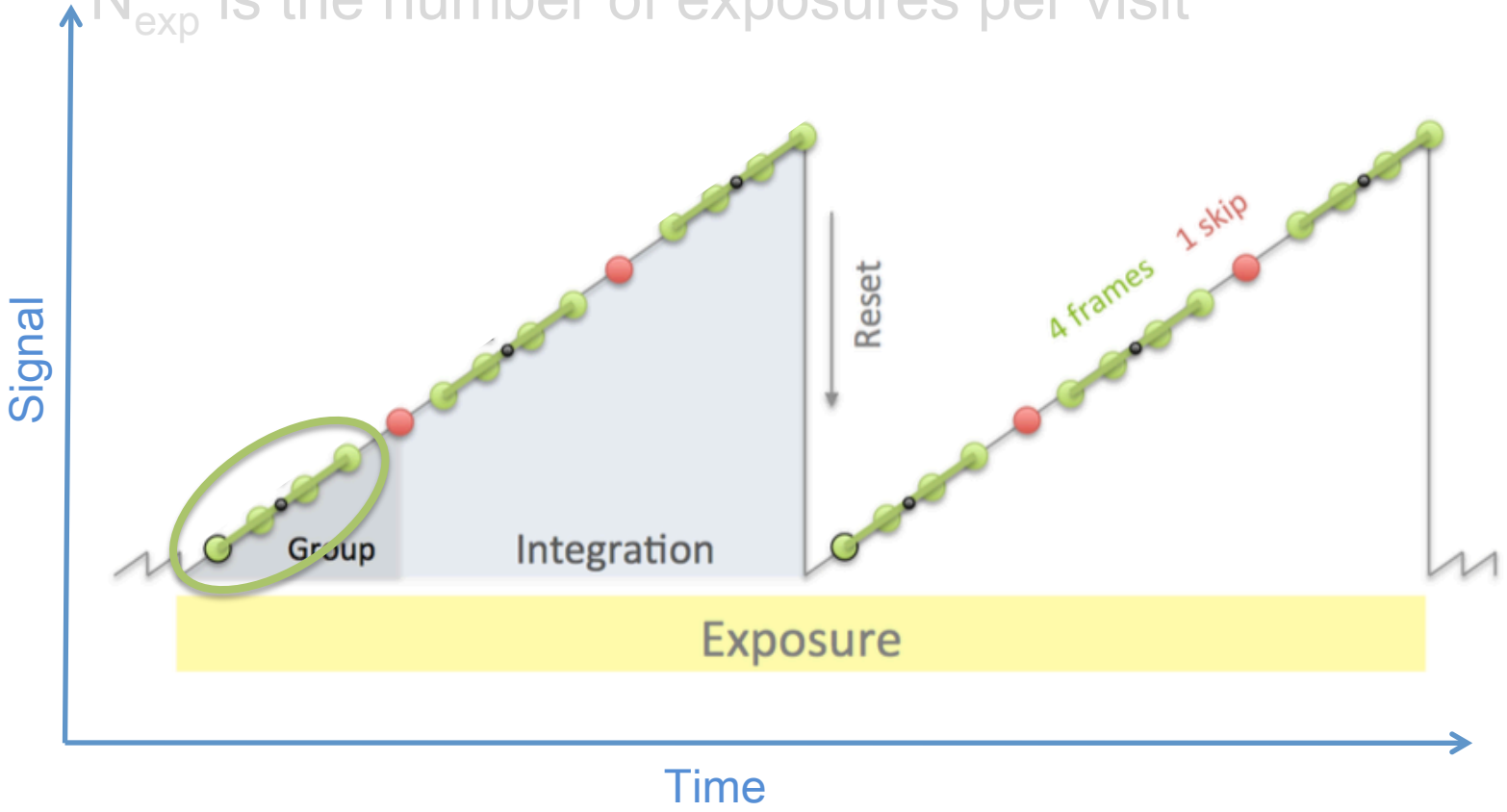
Infrared Detector – JWST jargon

N_f is the number of frames (or reads) averaged in a group

N_g is the number of groups in an integration (ramp)

N_{int} is the number of integrations (ramps)

N_{exp} is the number of exposures per visit



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Infrared Detector – JWST jargon

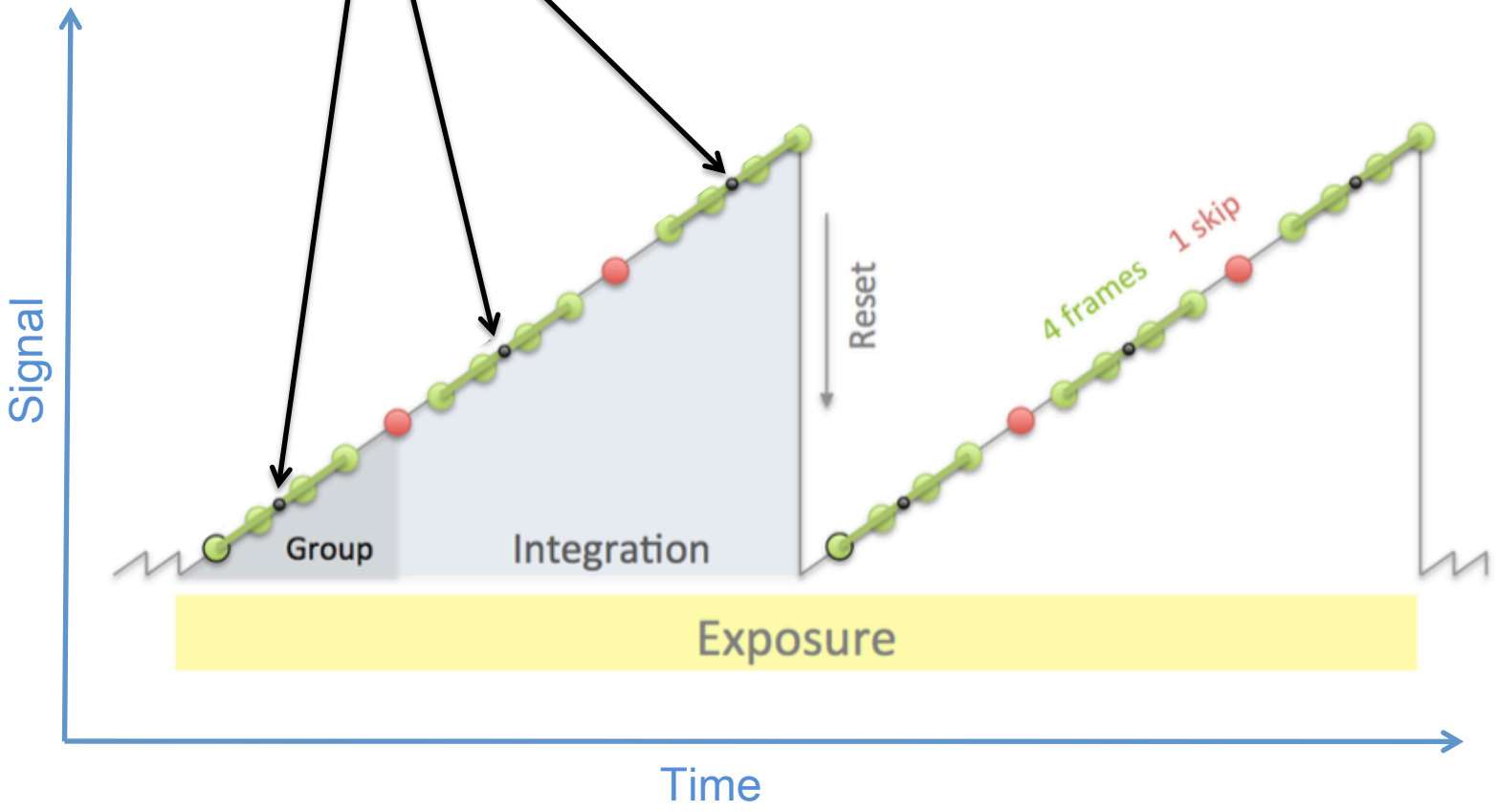
N_f is the number of frames averaged in a group

N_g is the number of groups in an integration (ramp)

N_{int} is the number of inte

N_{exp} is the number of exp

Downloaded to ground



©C. Chen

Infrared Detector – JWST jargon

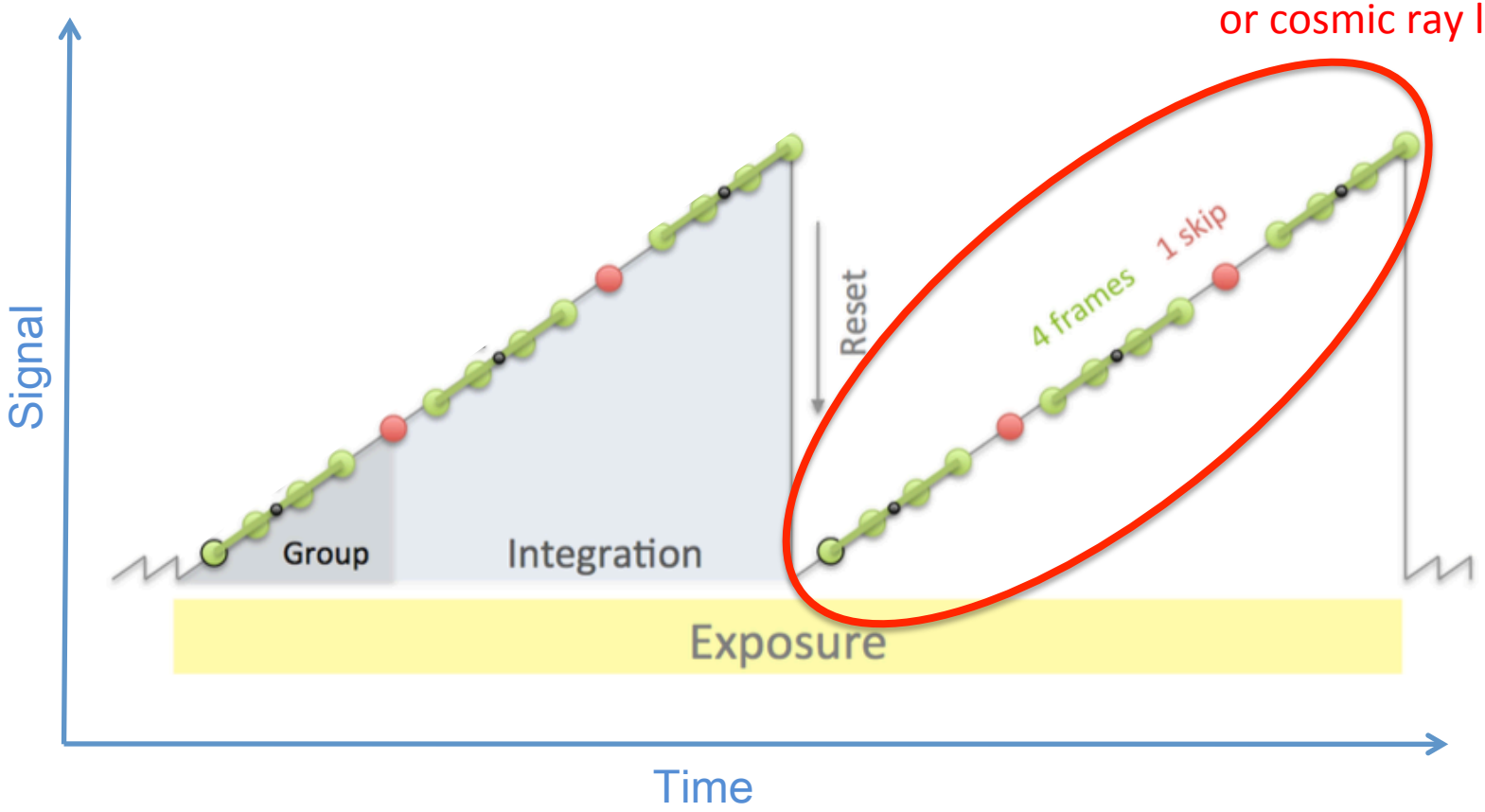
N_f is the number of frames averaged in a group

N_g is the number of groups in an integration (ramp)

N_{int} is the number of integrations (ramps)

N_{exp} is the number of exposures per visit

INTEGRATION = RAMP
= set by saturation
or cosmic ray limit



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Infrared Detector – JWST jargon

N_f is the number of frames averaged in a group

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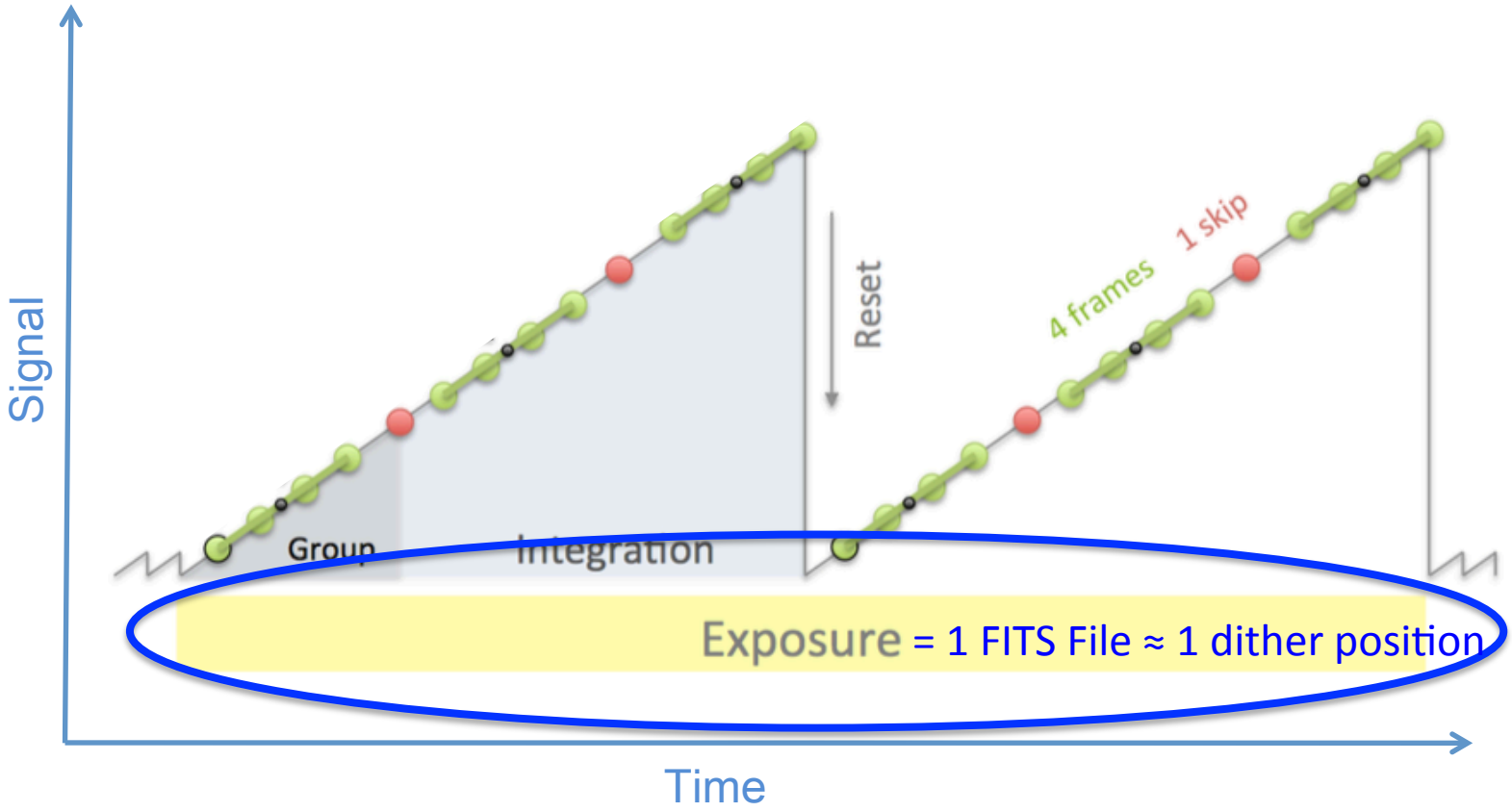

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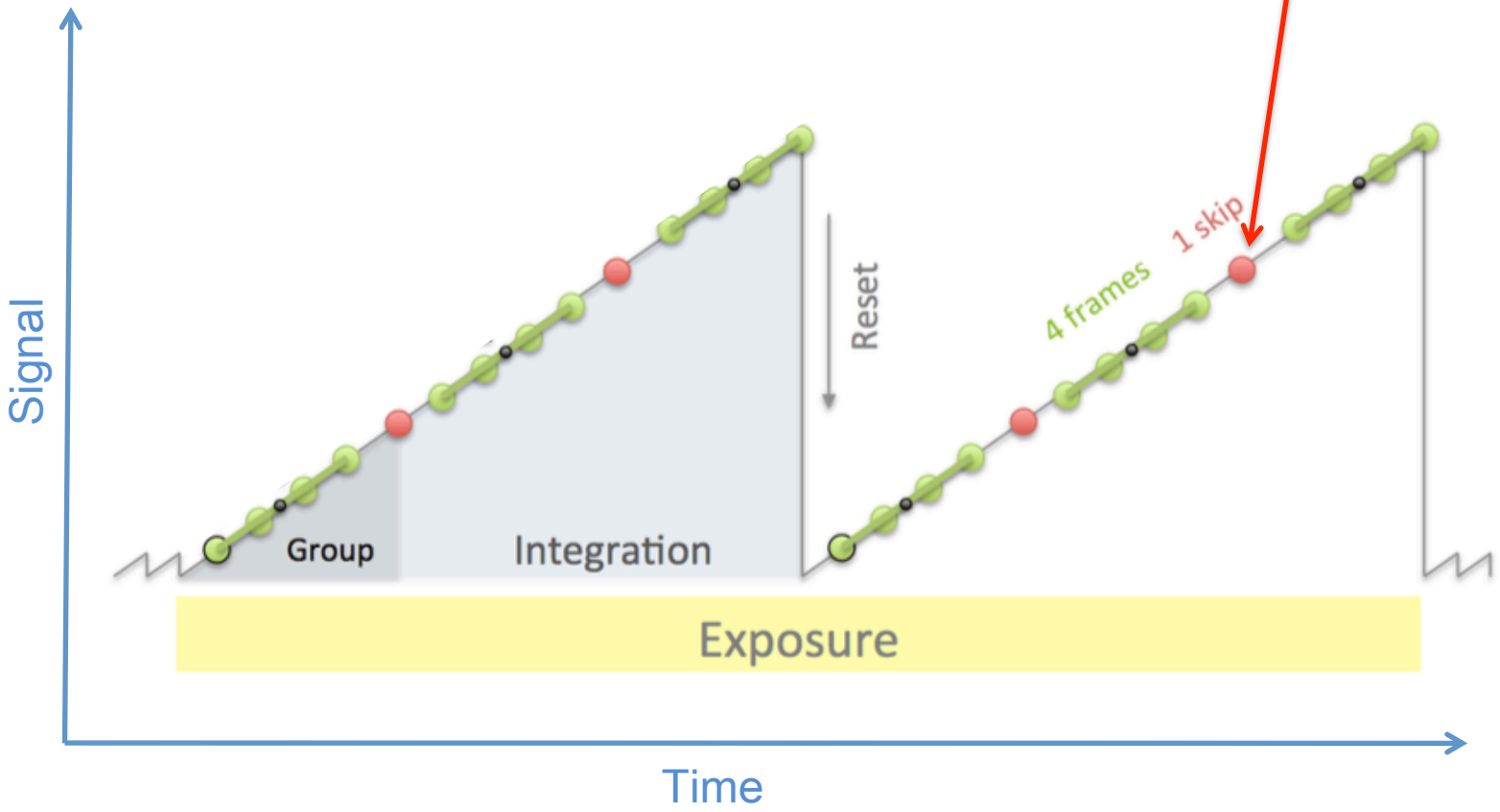
Infrared Detector – JWST jargon

N_f is the number of frames averaged in a group
N_g is the number of groups in an integration (ramp)
N_{int} is the number of integrations (ramps)
N_{exp} is the number of exposures per visit

For NIRCam, some reads are simply skipped, not even averaged



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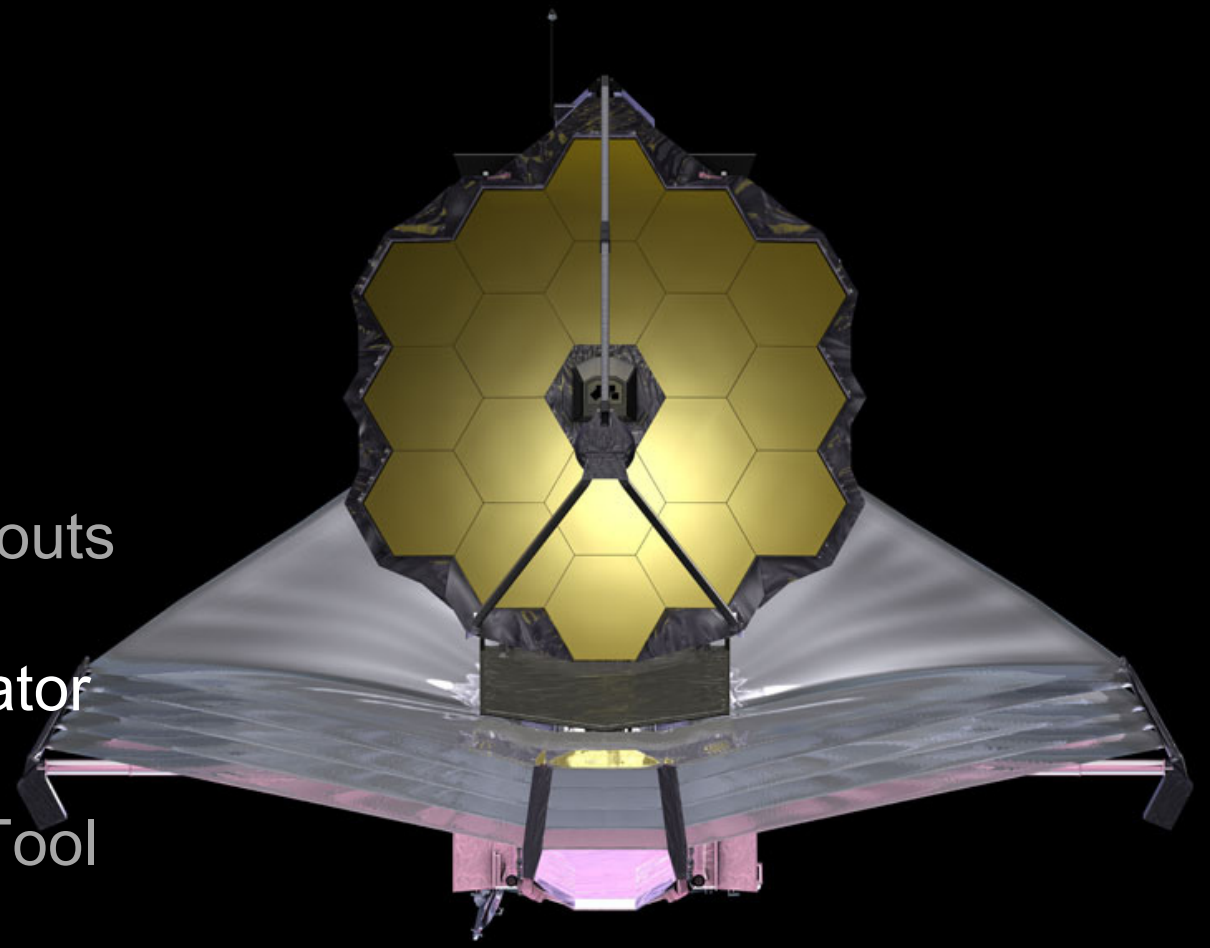


Exposure Time Calculator: what is it?

Real-time simulation of an observation: exp. time => SNR

3D approach: spatial and spectral

Creates complex astrophysical scenes
- small postage stamp (few arsec) of the sky
- can contain multiple sources (point source/extended)
- convolved with monochromatic WebbPSF

Handles correlated noise and background emission:
- background (zodi, ISM, straylight, thermal) is time-dependant
- standalone tool:

https://github.com/janerigby/jwst_backgrounds

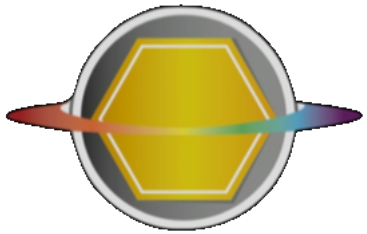
Exposure Time Calculator: tools

Documentation:
https://jwst-docs.stsci.edu/display/JPP/JWST+Exposure+Time+Calculator%2C+ETC

Web interface:
https://jwst.etc.stsci.edu
- have a MyST account to save and share works

Python engine:
https://github.com/spacetelescope/pandeia-tutorials/blob/master/notebooks/Quickstart.ipynb
advanced scripting and options

ETC demo



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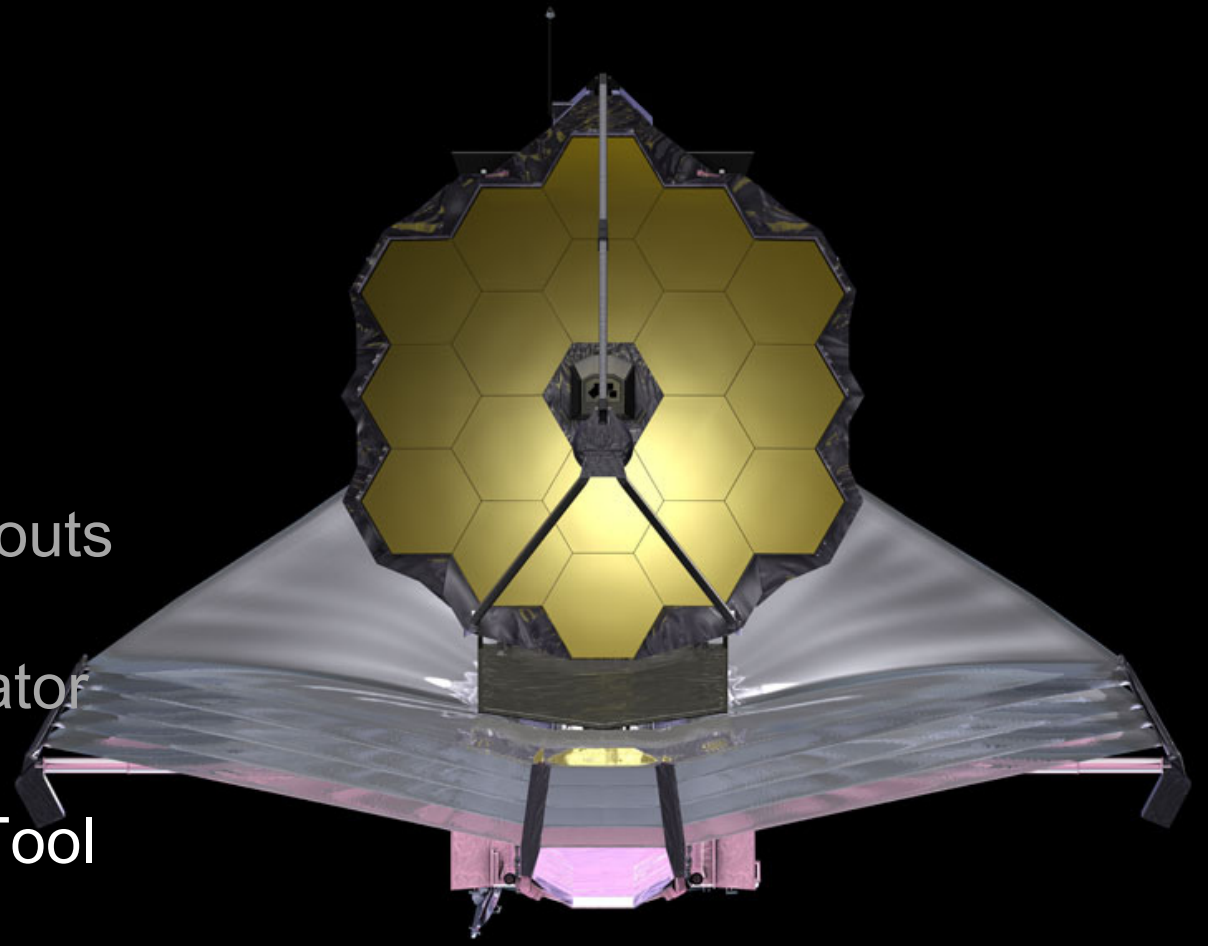

APT: a template-based proposal software

- THE tool to prepare (phase 1) and submit a proposal with JWST
- Uses templates to design an observation (17 exist)
- Calculates the exposure time
- Calculates schedulability (date of observation)
- Computes charged time in wall clock time (including overheads)
- APT has the final say
- Link for local installation:
  http://www.stsci.edu/hst/proposing/apt
- Make sure to always use the latest version
- Documentation:
  https://jwst-docs.stsci.edu/display/JPP/JWST+Astronomers+Proposal+Tool+Overview

APT demo

Next webinar: Imaging, Dec. 6th, 2017

Real-time design of a proposal

Have the tools installed and ready to be used on your laptop:

- TVT
- myST account for the ETC
- APT v25.4.0.1 (or later)