JWST Pipeline & Data Products

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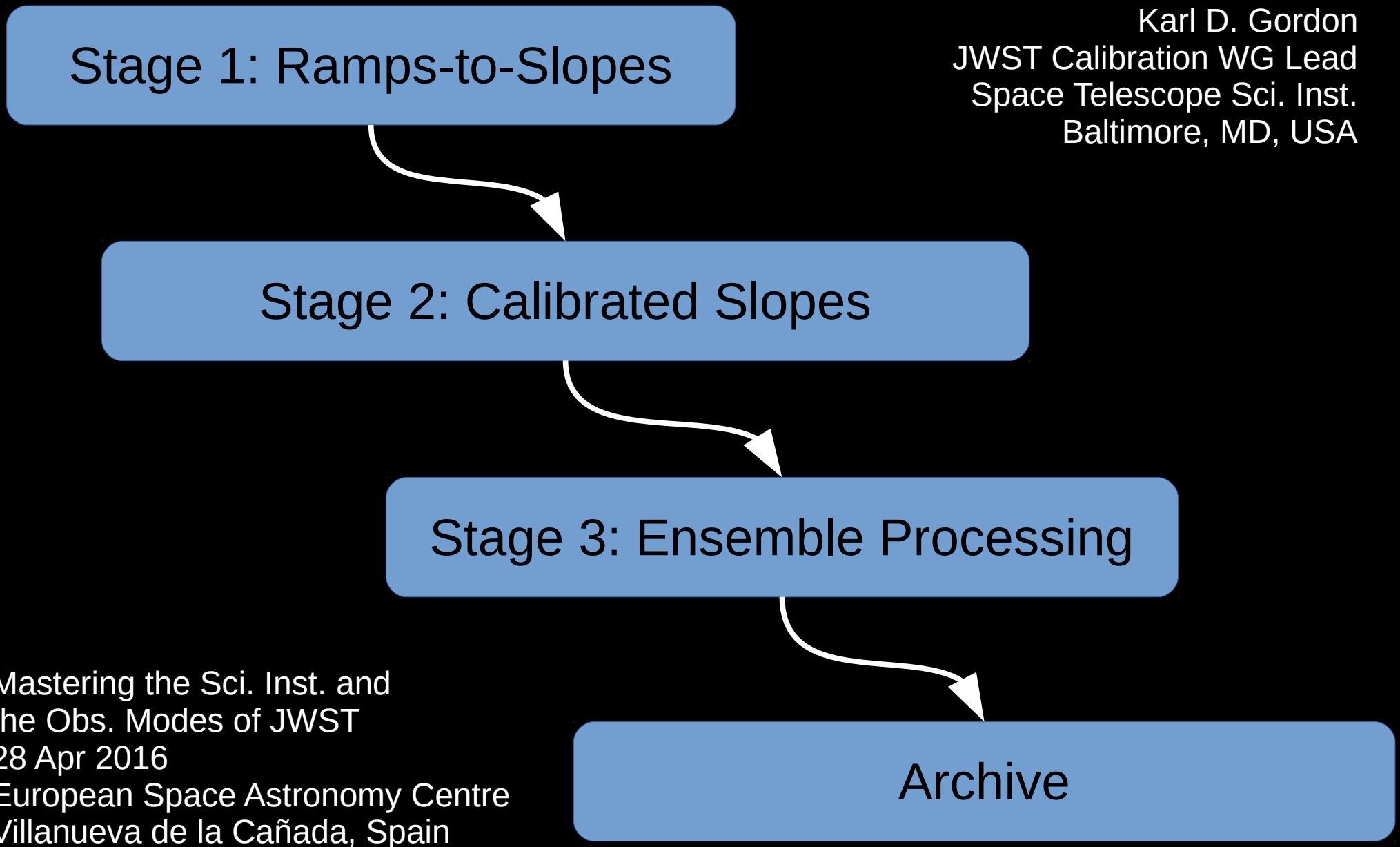
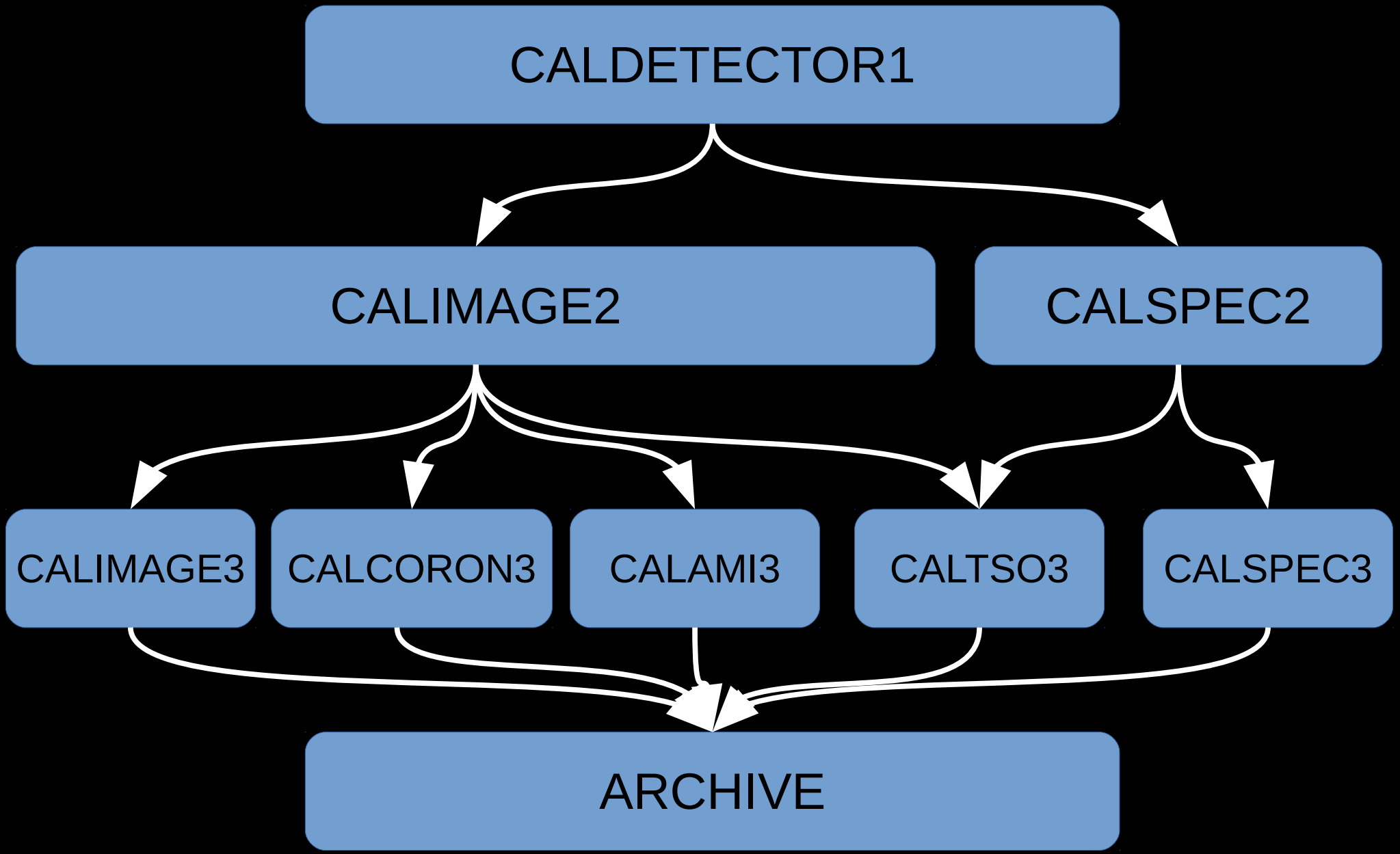


Mastering the Sci. Inst. and
the Obs. Modes of JWST
28 Apr 2016
European Space Astronomy Centre
Villanueva de la Cañada, Spain

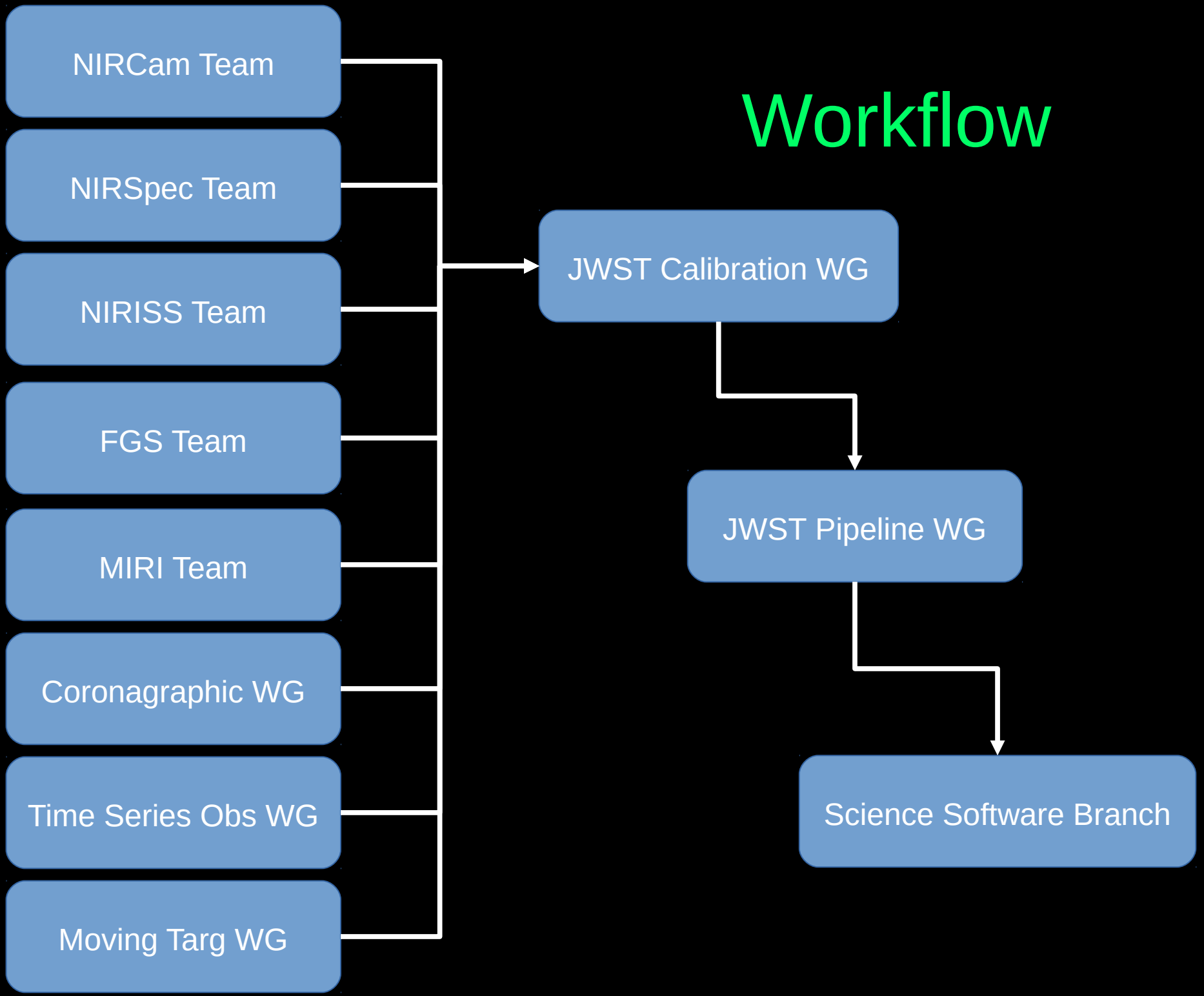
Standing on the Shoulders of Giants

- Previous Missions
  - Hubble, Spitzer, Herschel, etc.
  - Ground-based observatories/instruments
    - Especially important for IFU, coronagraphy, and MOS
- What to do
- What not to do

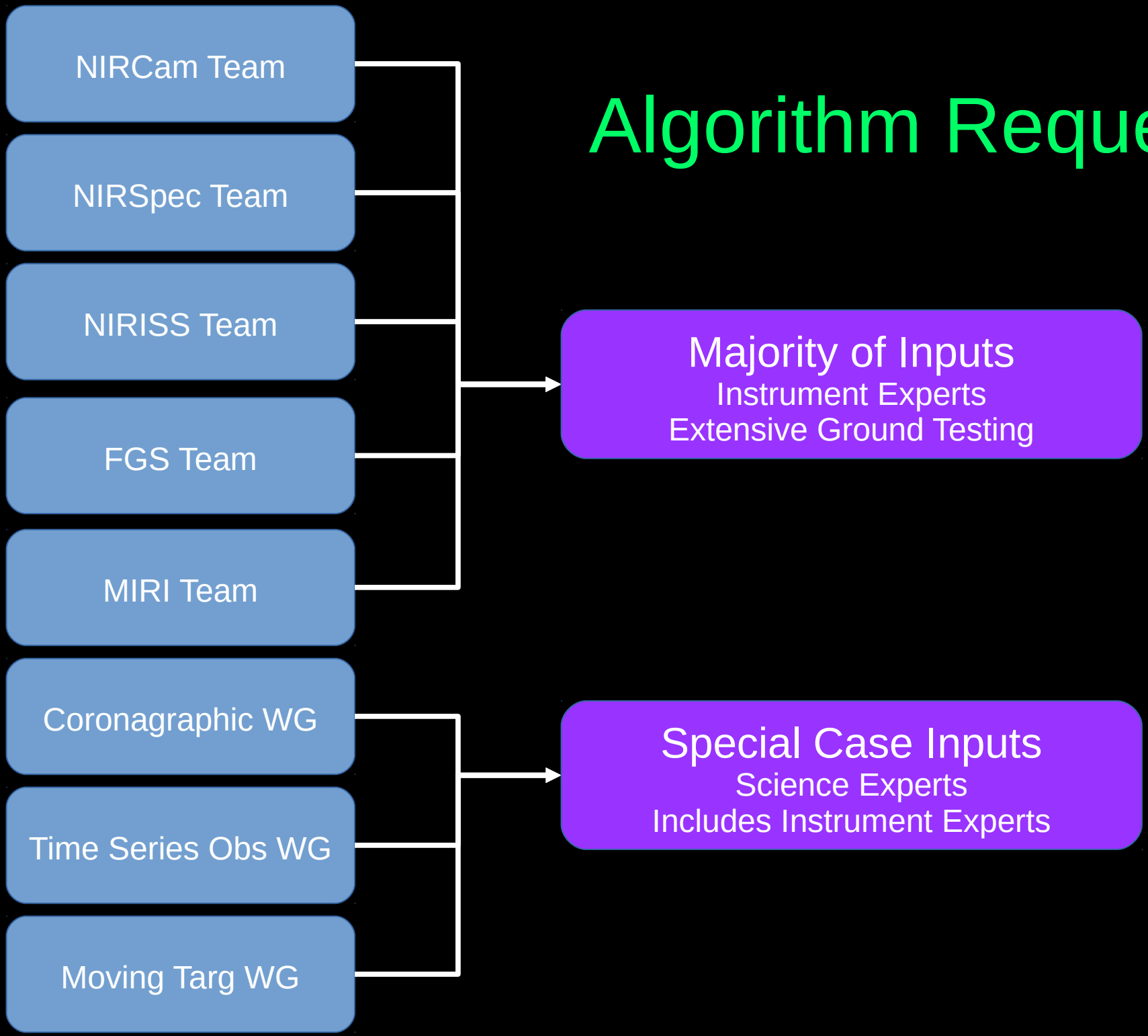
Overall Pipeline Architecture

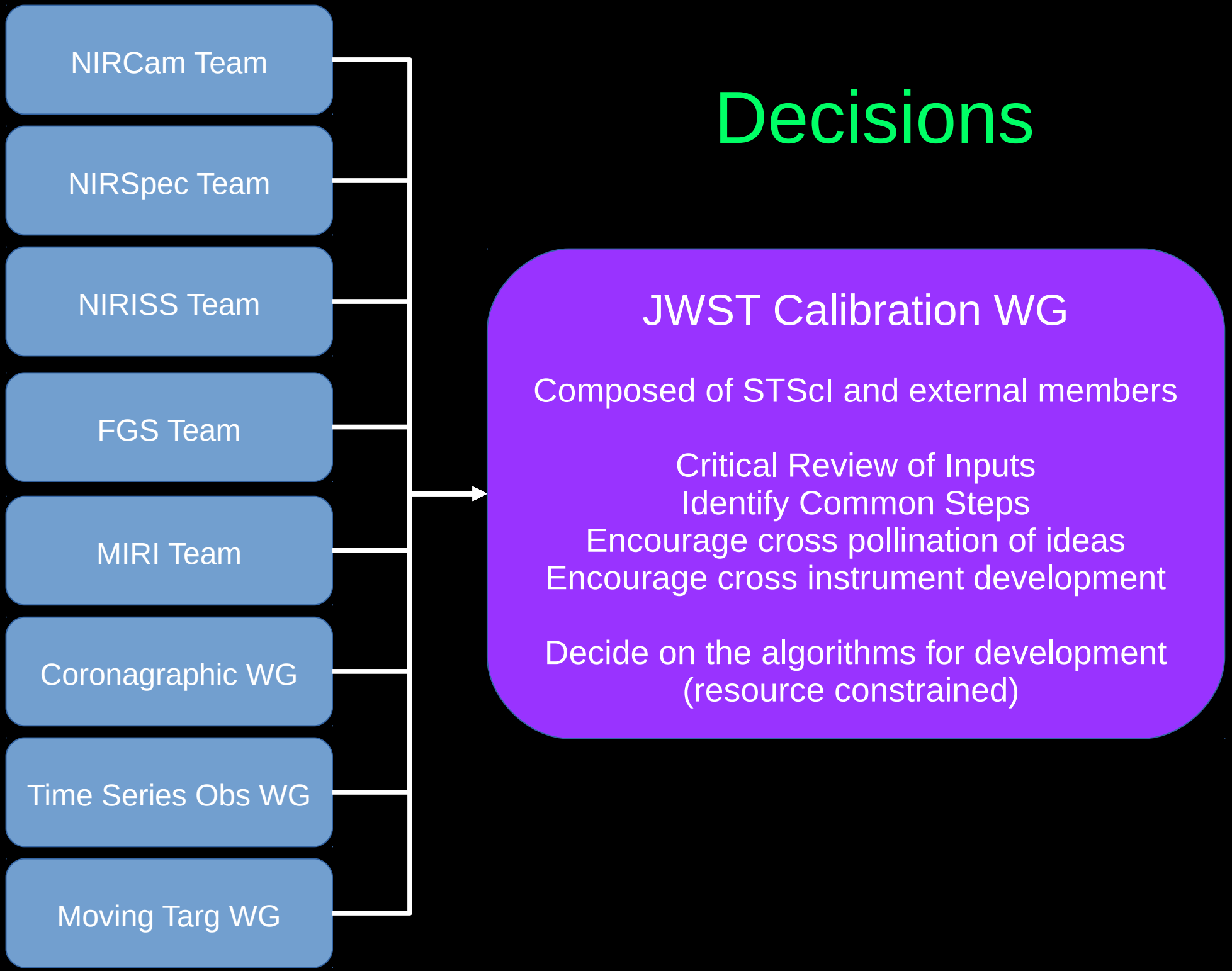


Workflow


NIRCam Team
NIRSpec Team
NIRISS Team
FGS Team
MIRI Team
Coronagraphic WG
Time Series Obs WG
Moving Targ WG
JWST Calibration WG
JWST Pipeline WG
Science Software Branch

Algorithm Requests




NIRCam Team
NIRSpec Team
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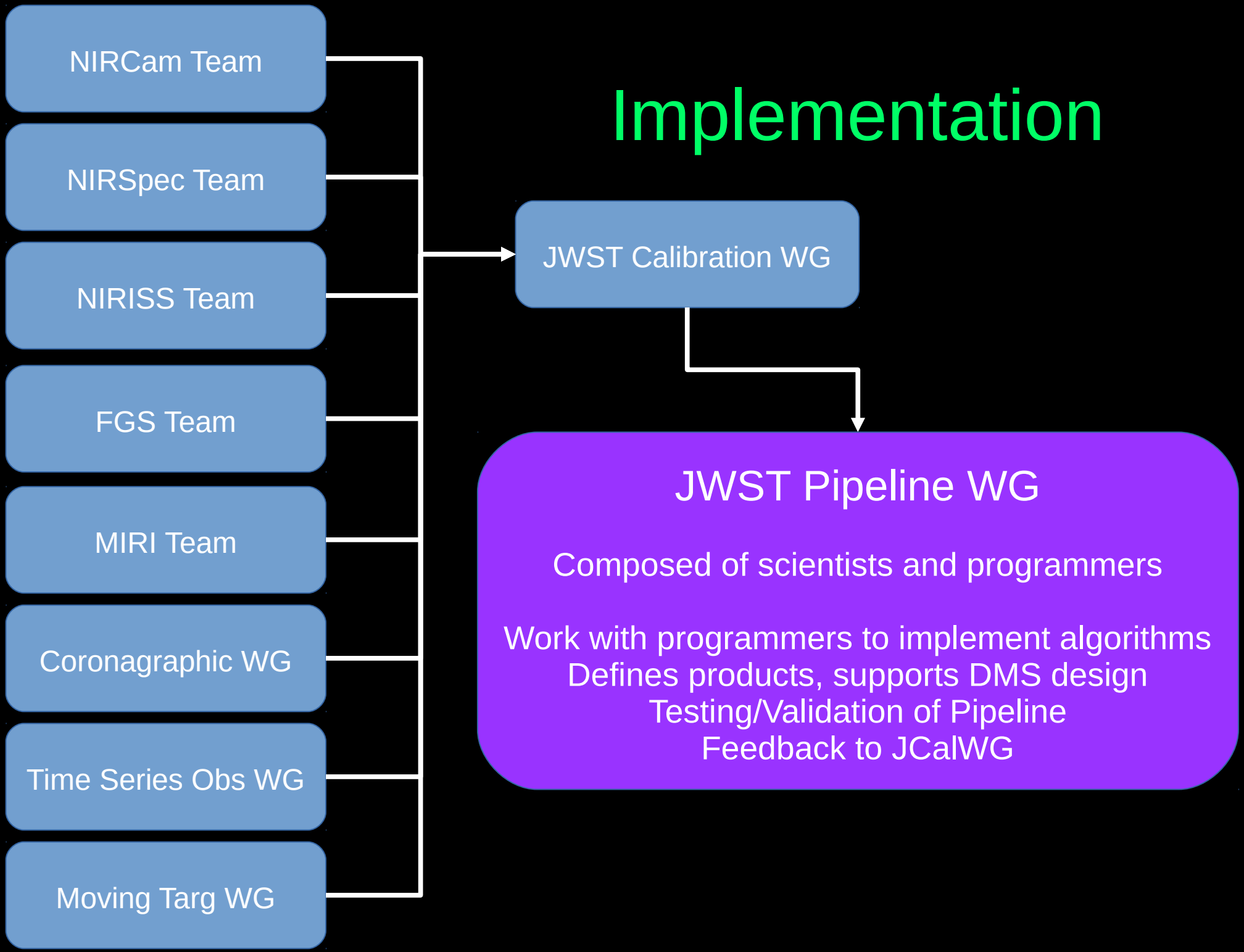
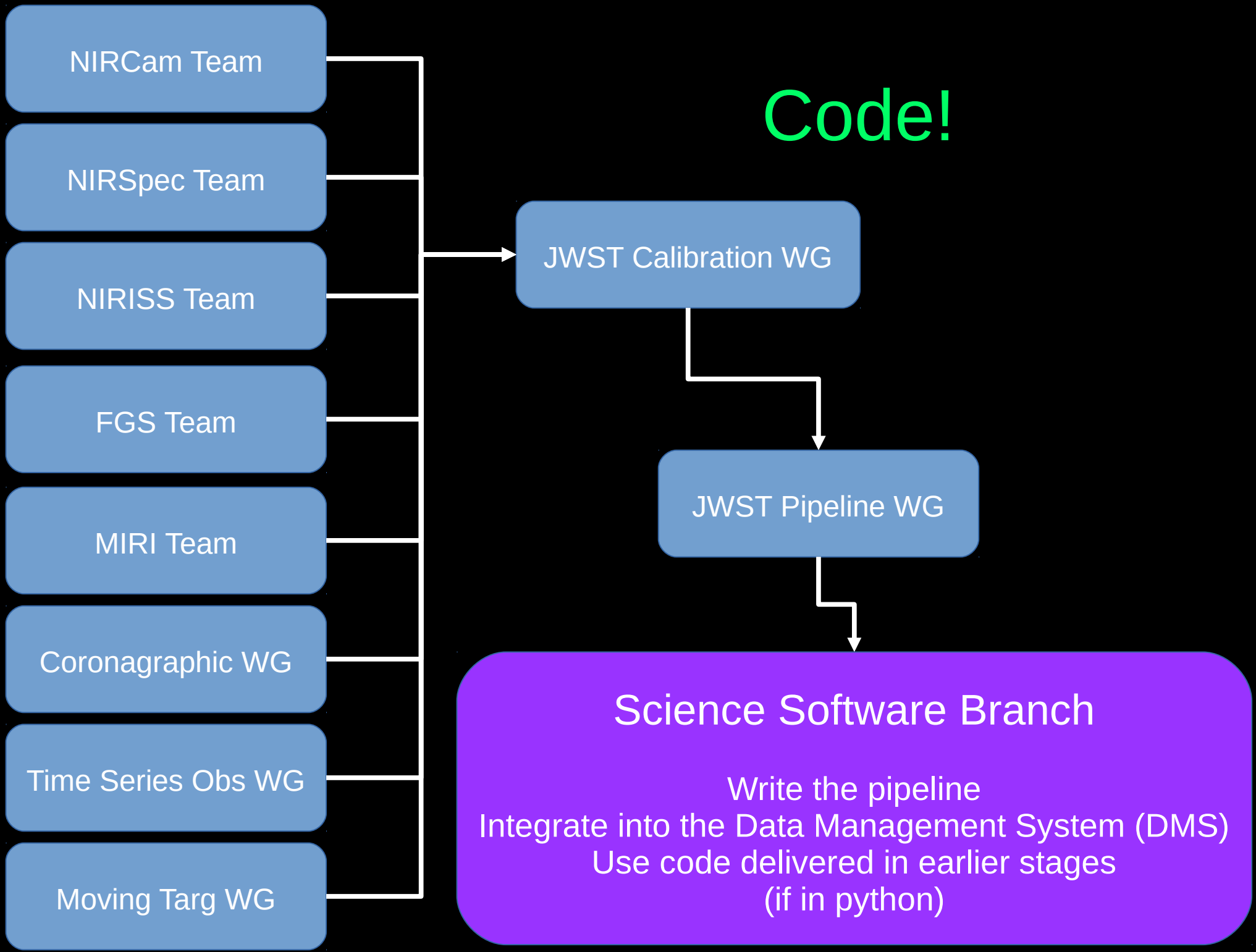
FGS Team
MIRI Team
Coronagraphic WG
Time Series Obs WG
Moving Targ WG
Decisions
JWST Calibration WG
Composed of STScI and external members
Critical Review of Inputs
Identify Common Steps
Encourage cross pollination of ideas
Encourage cross instrument development
Decide on the algorithms for development
(resource constrained)

Implementation

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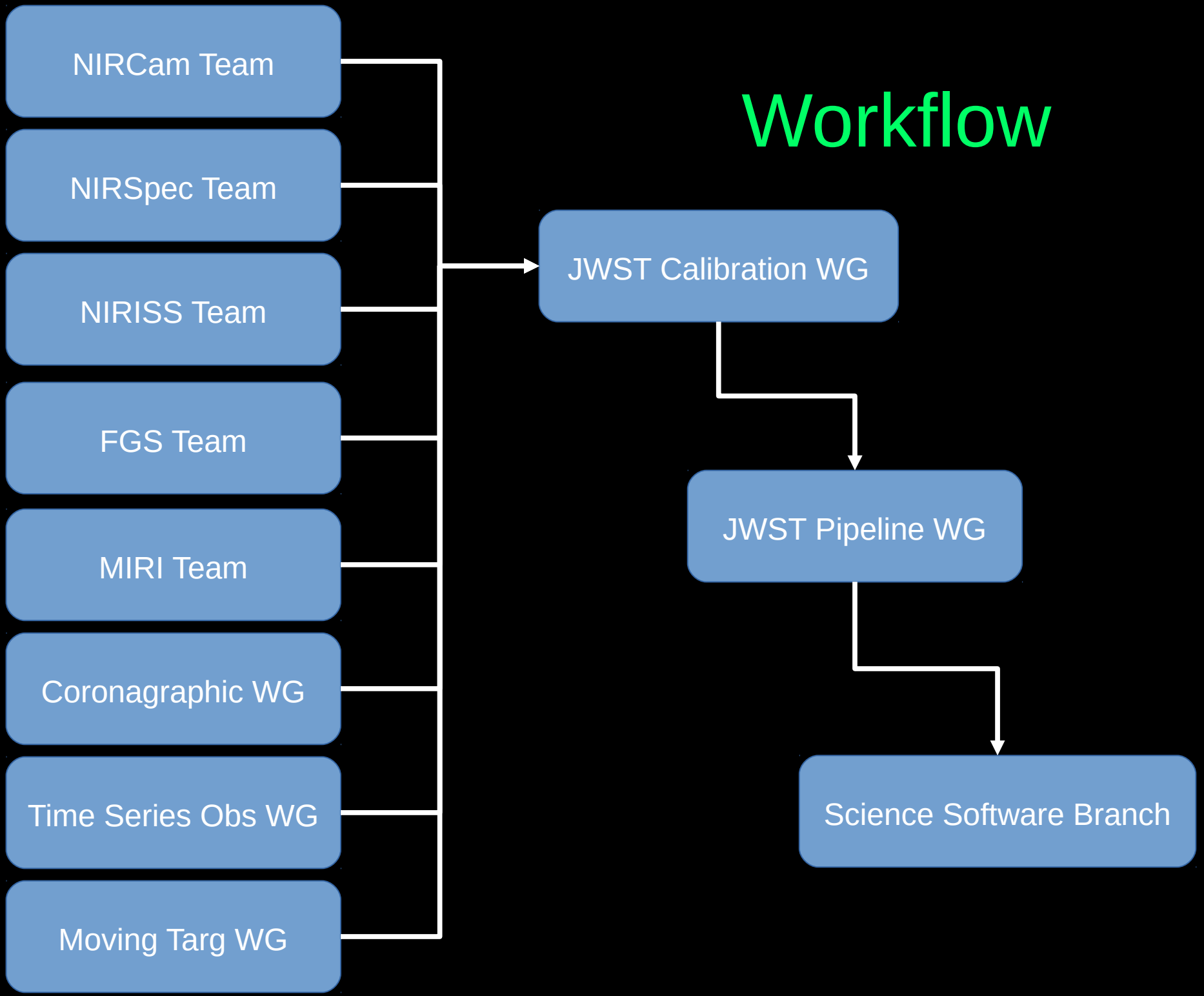
Time Series Obs WG
Moving Targ WG
Code!
JWST Calibration WG
JWST Pipeline WG
Science Software Branch
Write the pipeline
Integrate into the Data Management System (DMS)
Use code delivered in earlier stages
(if in python)

Workflow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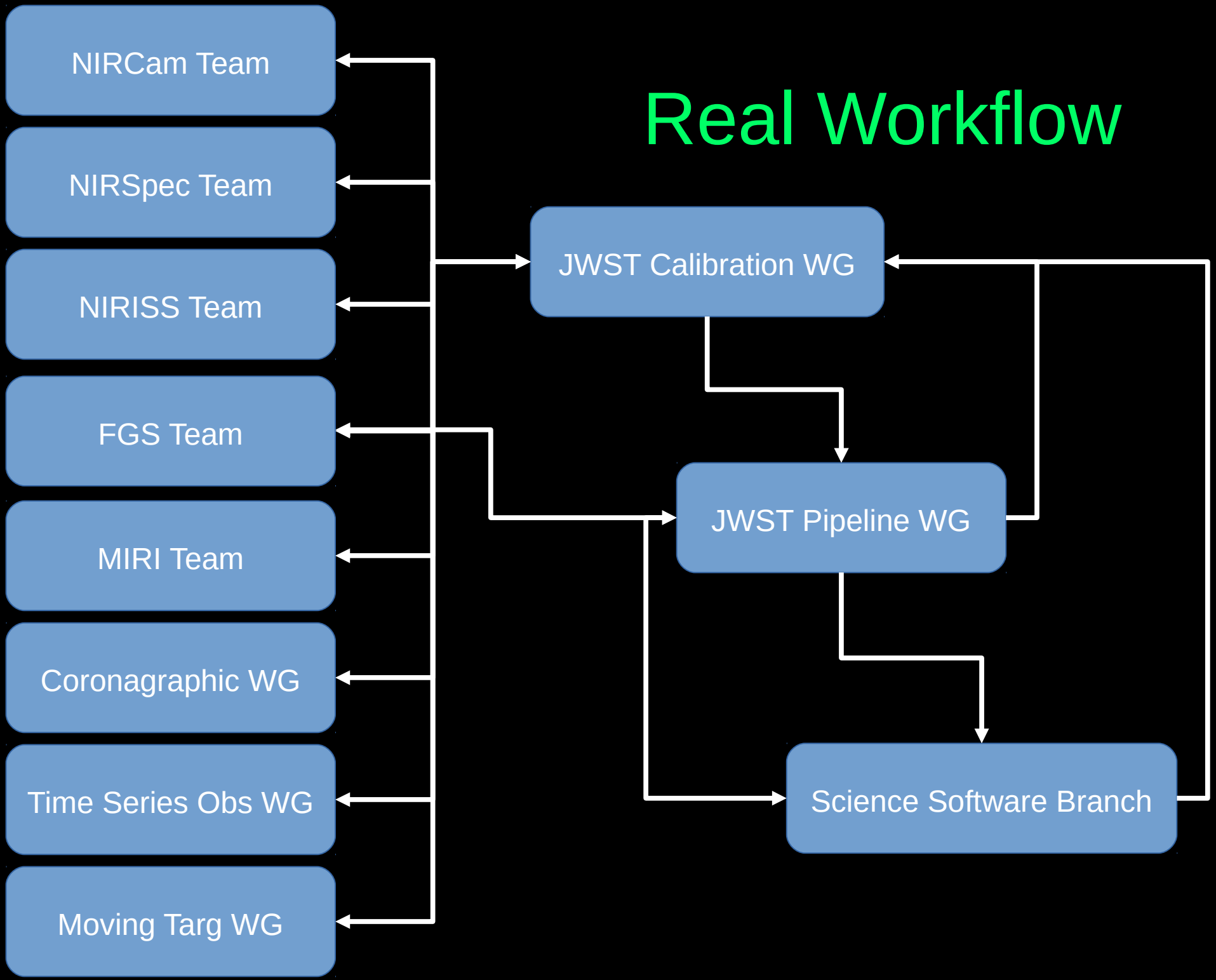
Real Workflow
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Science Software Branch

Development Plan

- Baseline Pipeline
  - All instruments and all modes
  - Provides good science
  - Meets requirements
  - Delivered by Dec 31, 2016
- Optimal Pipeline
  - Best possible reductions
  - Highest quality science data
  - This is the final goal (launch + many years)
  - Start work after baseline pipeline done and continue for the mission lifetime and beyond
    - Will need to prioritize effort

Potential Optimal Algorithms

- In development
- A few examples
- Upgrade for slope fitting
  - Weighted linear least squares to Generalized Least Squares
- “Optimal” Spectral Extraction
  - Use knowledge of spatial profile
- MIR self-calibration
  - Correct for small drift in MIR detectors using dithered data

Pipeline Availability

- Written in python
- Freely available
- Easily configurable
- Users can rerun all or part of the pipeline
- Users can replace specific modules
- Hosted on github
- Based on astropy

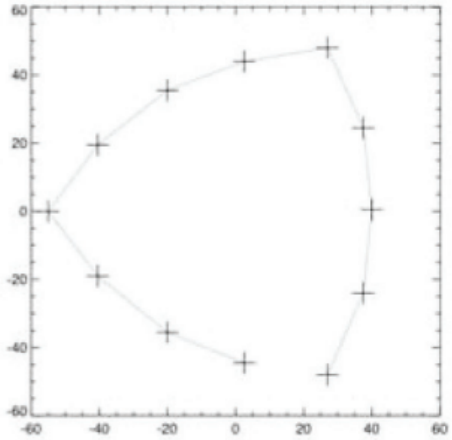
Data Products

- Raw data
- Intermediate stage data
- Final data
  - Best quality from an automated pipeline
  - “browse-quality” data in Spitzer-speak
  - Flux, wavelength, and position calibrated
- Any user can rerun the pipeline offline
  - Changed parameters to specific steps
  - Replace a step with a user written version

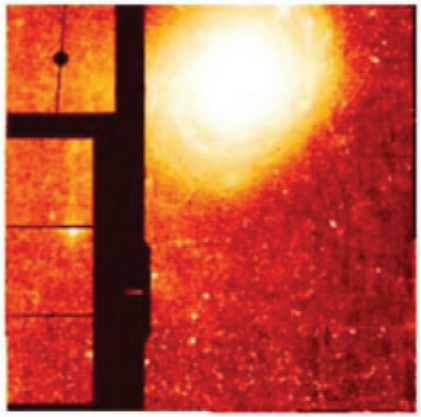
Imaging Data Products

- Mosaic of all images with the same filter
  - In sky coordinates (e.g., ra, dec)
- Catalog of sources
  - automated generation
- Integration level
  - All images fully corrected with flagging of CRs, etc.
    - In detector & sky(rectified) coordinates

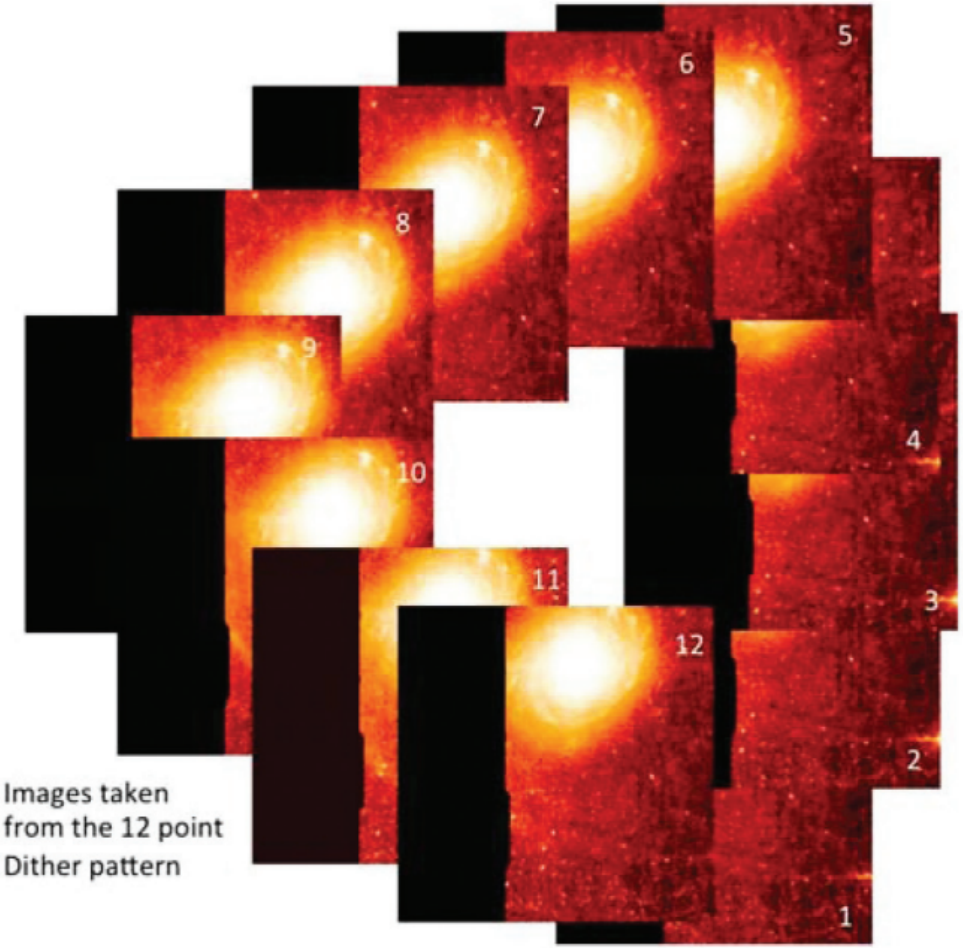
Imaging Data Products: Example



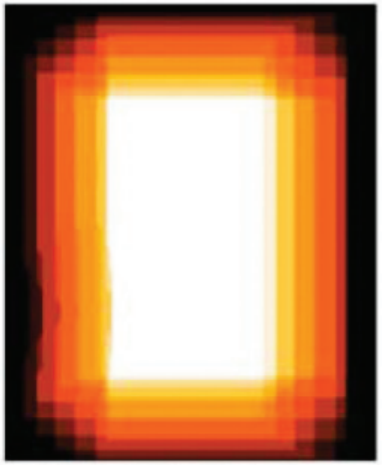
Reuleaux 12 point Dither pattern



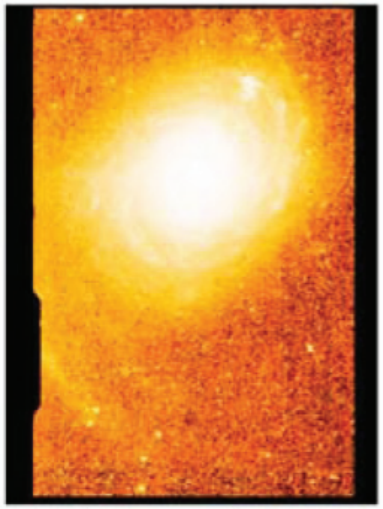
The MIRIM footprint



Images taken from the 12 point Dither pattern



Mosaic coverage map



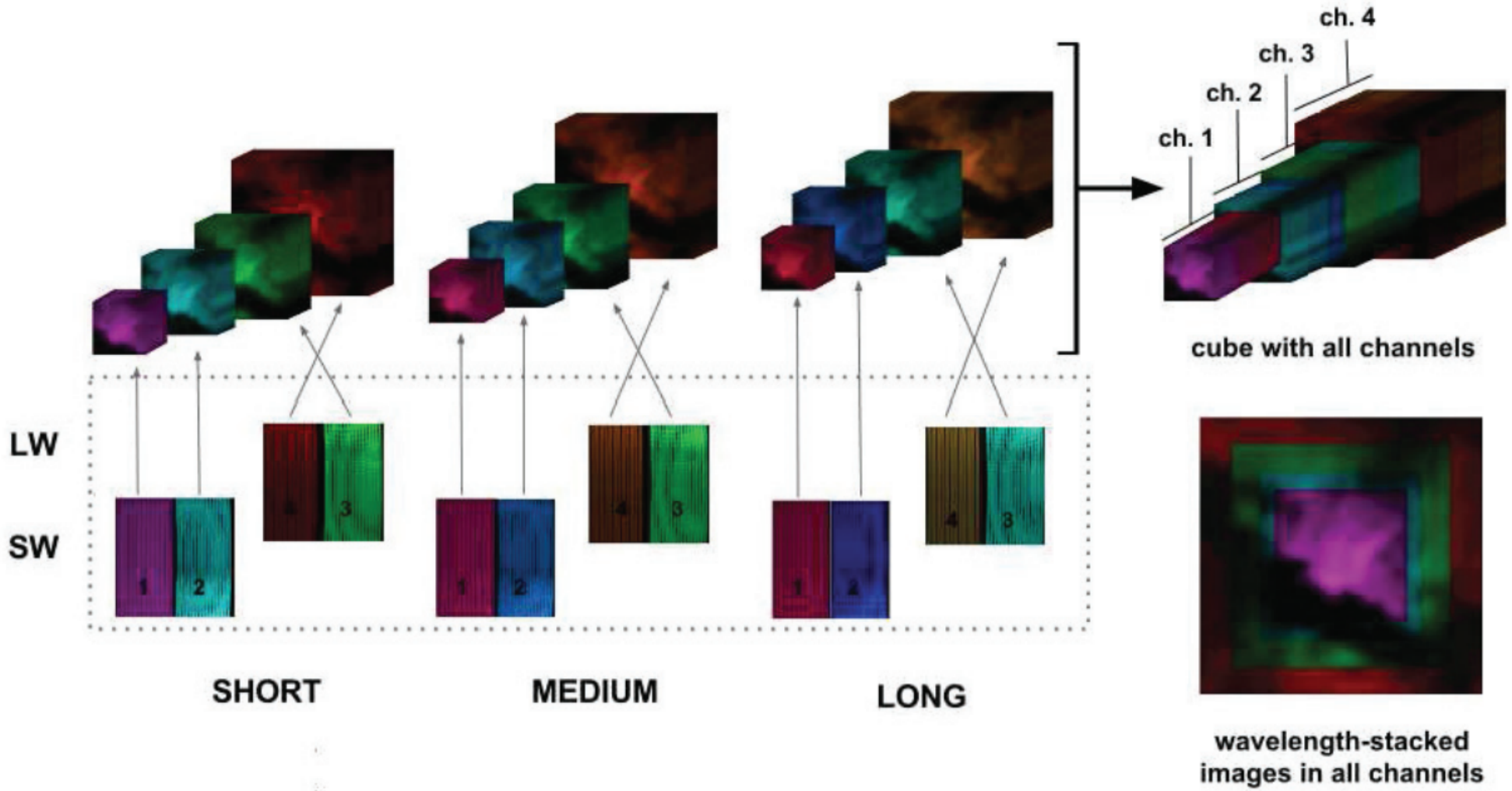
Resulting mosaicked image

Gordon et al. (2015, PASP, 127, 696) – MIRI PASP paper X

Spectroscopic Data Products

- Slit & Slitless: 2D spectral image
  - along-slit and wavelength
  - Includes MOS targets (each processed separately)
- IFU: 3D spectral cube
  - ra, dec, and wavelength
- Extracted spectrum for the target source
  - will be able to advise pipeline if source is point/extended via APT
- Integration level
  - All images fully corrected with flagging of CRs, etc.
    - In detector & sky(rectified) coordinates
  - 3D cubes or 2D images depending on observation type

Spectroscopic Data Products: IFU Example

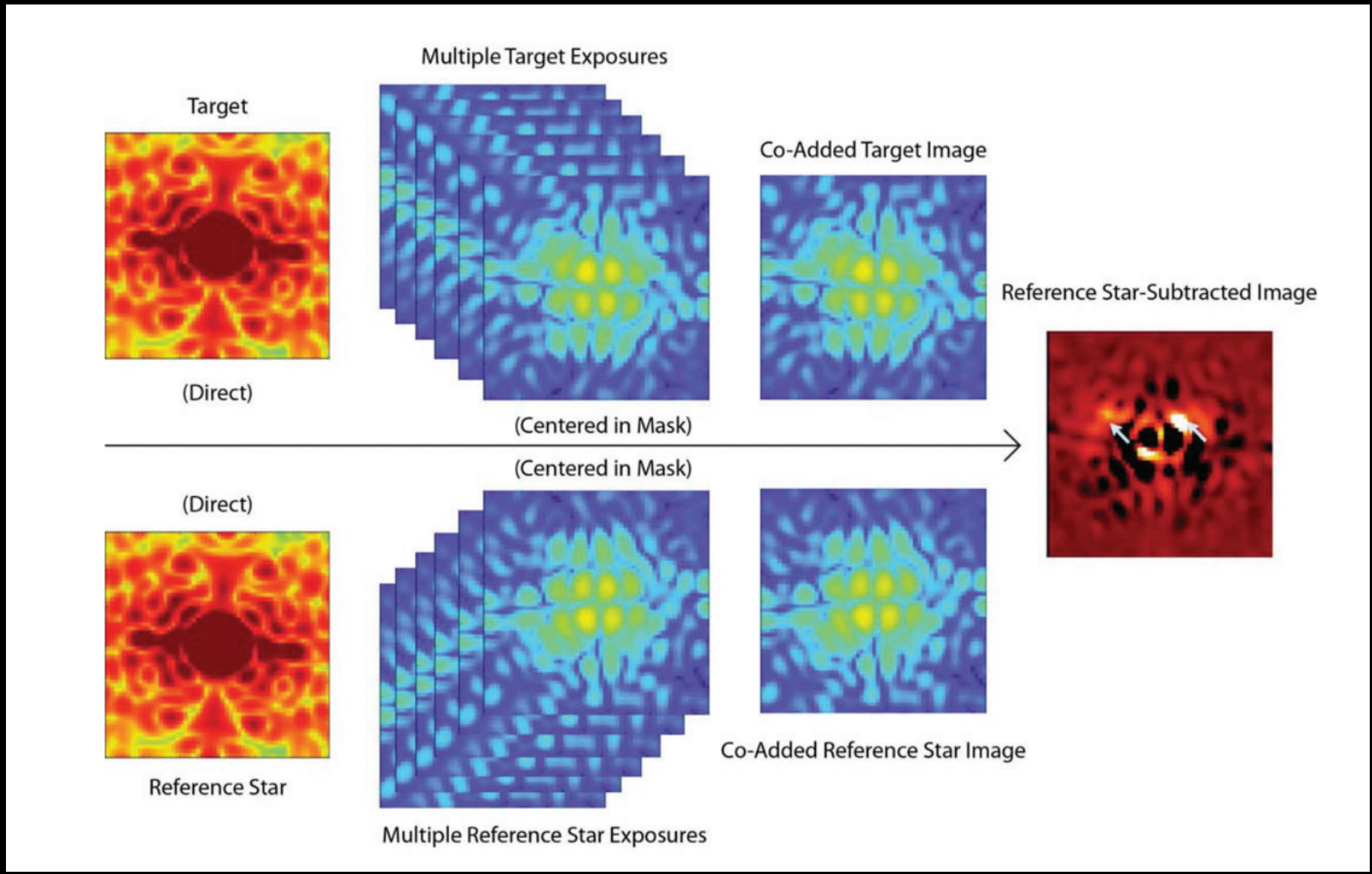


Gordon et al. (2015, PASP, 127, 696) – MIRI PASP paper X

Coronagraphic Data Products

- Coadded images
  - In detector coordinates
  - After PSF subtraction
- Integration level
  - All images fullly calibrated with flagging of CRs, etc.
    - In detector & sky(rectified) coordinates

Coronagraphic Data Products: MIRI 4QPM Example



Gordon et al. (2015, PASP, 127, 696) – MIRI PASP paper X

Aperture Masking Interferometry Data Products

- Fringe parameters
  - Closure phases and amplitudes
- Reconstructed images

Time Series Observation Data Products

- Photometry
  - Aperture photometry per integration
- Spectroscopy
  - Extracted spectrum per integration
  - White-light photometry per integration
- Integration level
  - Image or spectral image as appropriate
    - fully corrected with flagging of CRs, etc.
    - In detector & sky(rectified) coordinates

Want to contribute to defining the pipeline algorithms/data products?

- Especially improvements to make it more optimal
- Talk to me or any of the many members of the JWST CaI WG
  - Instrument team members both at STScI and external
- Really motivated
  - Join the JWST Calibration WG
  - details including discussions are on a set of confluence(wiki) pages
  - Can provide an account so you can view them and comment (full version control)
  - Which optimal steps to do first?