



WISE Calibration Peer Review

WISE Science Data Processing Overview

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WISE Will Release Three Primary Data Products



- WISE Image Atlas
 - FITS format, all exposures registered and combined, resampled to 1/2 raw pixel scale (1.375"/pix), 4 bands registered
 - Photometrically and astrometrically calibrated
 - ~300,000 2048x2048 images covering entire sky in four WISE bands
- WISE Source Catalog
 - Calibrated positions (J2000 with respect to 2MASS) and photometry in the four WISE bands for ~300 million objects detected on the combined (Atlas) images
 - Source detection and measurement quality flags and parameters (*e.g.* detection statistics, reliability estimate, photometric quality, confusion and contamination)
 - Additional information to enhance usability (*e.g.* association with 2MASS)
- Explanatory Supplement
 - Mission and data product descriptions
 - User's guide (*e.g.* data formats, access modes)
 - Cautionary notes describing limitations of data and known idiosyncrasies





MOS Architecture



WSDC Overview

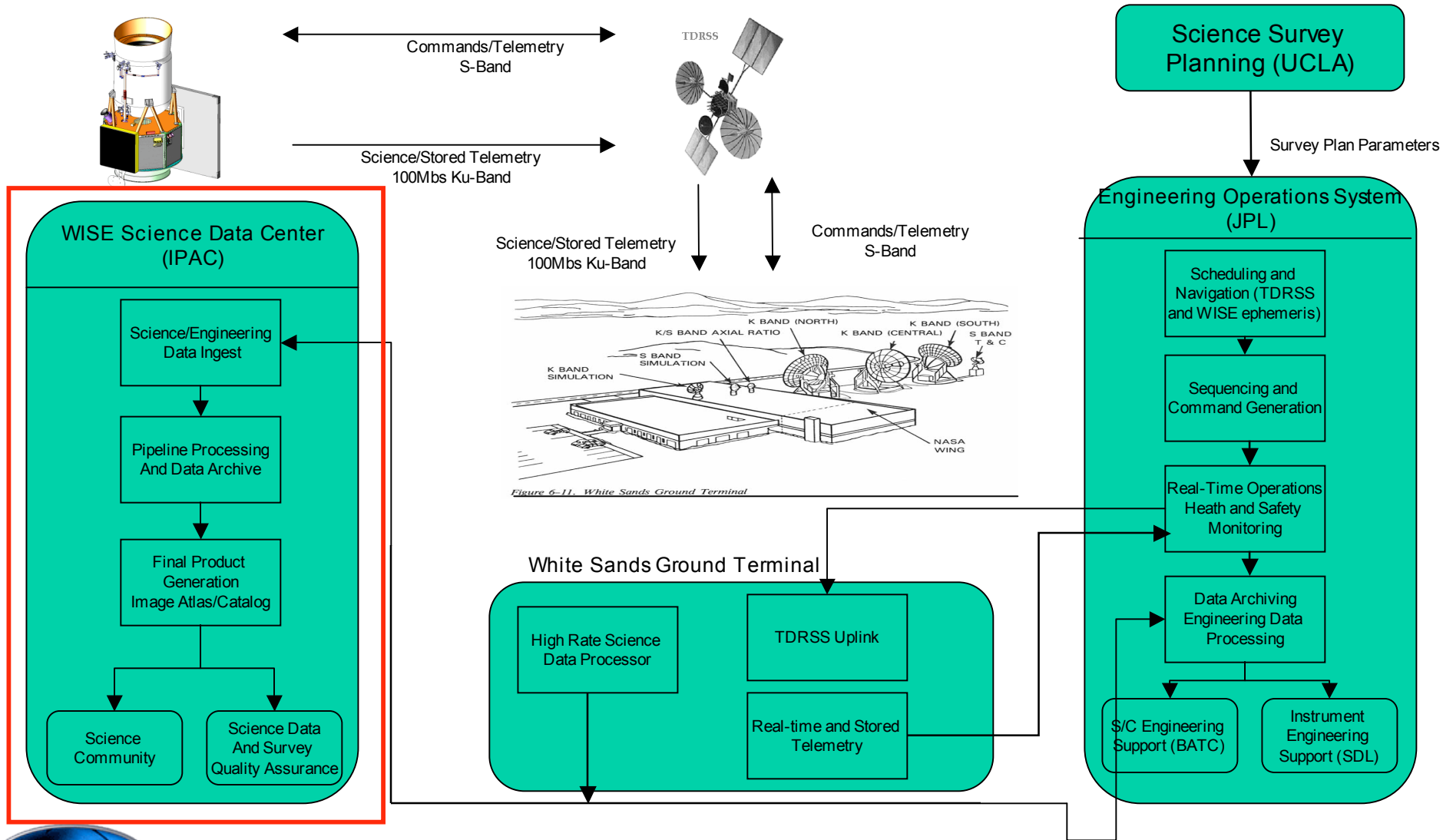


Figure 6-11. White Sands Ground Terminal





IPAC is the WISE Science Data Center (WSDC)



- **Science Data Processing**
 - Convert raw imaging and engineering data into a photometrically and astrometrically calibrated Image Atlas and extracted Source Catalog
 - Compile Explanatory Supplement to the WISE Data Products
 - Generate ancillary data products to support mission requirements
- **Science Data Quality Assurance**
 - Quicklook QA feedback for on-orbit performance (i.e. scan mirror synch)
 - Overall science data QA for survey planning and data product generation
- **Science Data Archiving and Distribution**
 - Raw data (Level 0) archive during mission
 - Long-term “living” archive for primary and intermediate data products
 - Serve WISE science data products to project team, astronomical community and general public along with user’s guide documentation and descriptive analysis (in collaboration with the NASA/Infrared Science Archive (IRSA))





WISE Data Will Be Processed Two Complete Times

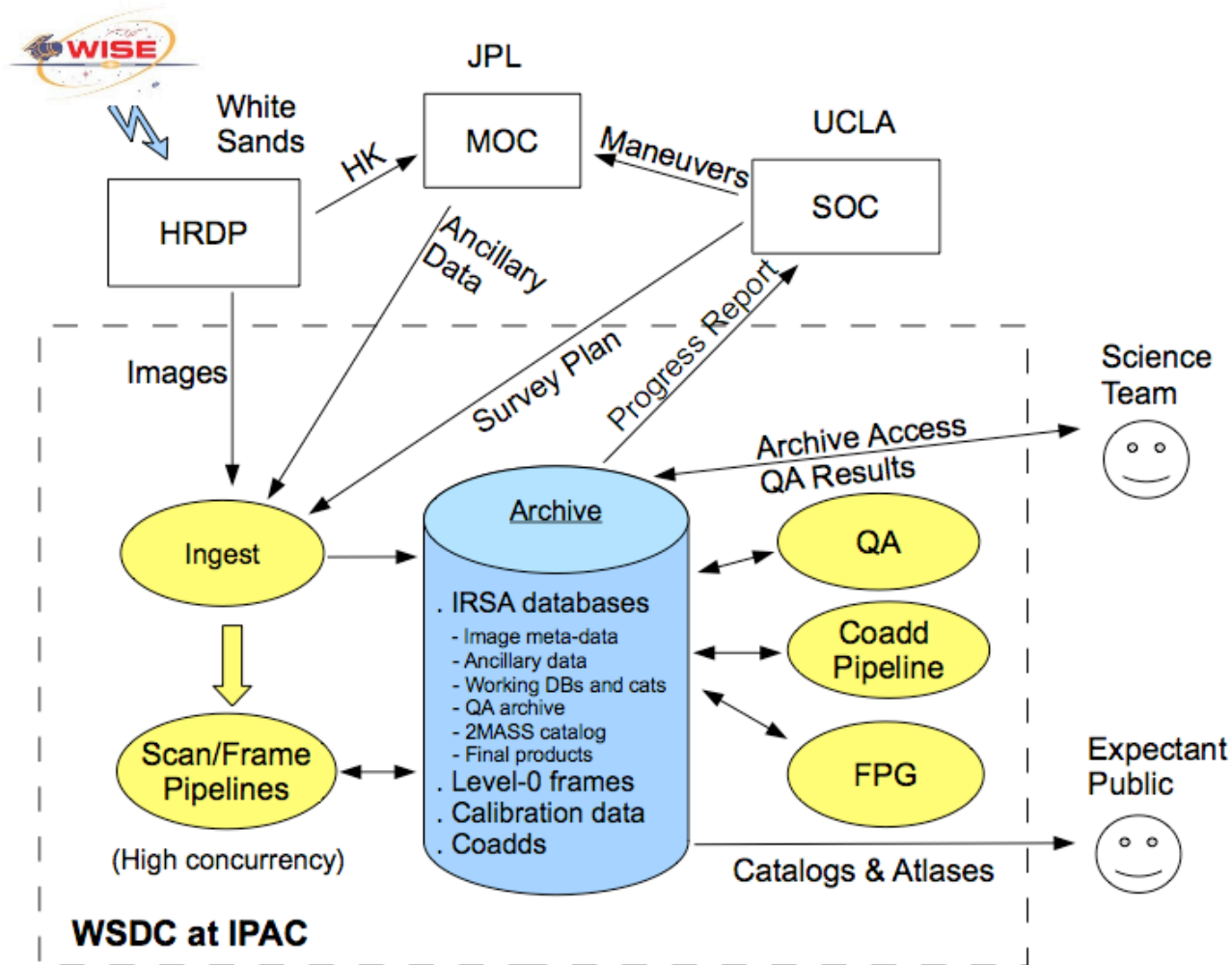


- Same strategy that was used successfully for 2MASS
- First Pass Processing
 - Performed during on-orbit ops -> Supports Quicklook QA, Survey operations
 - Use ground and updated calibrations from IOC; generate dynamic on-orbit calibrations and optimize windows/parameters (desired accuracy, anneals, SAA passages, stability, transients, bright source avoidance etc..)
 - Preliminary reduction algorithms based on pre-launch simulation and IOC tuning
 - Yields Preliminary Image Atlas and Source Catalog (release 6 months after end of on-orbit data acquisition)
- Second Pass Processing
 - Performed following the end of on-orbit operations after analysis of full data set
 - Incorporates best knowledge of actual flight system performance, properties of the infrared sky, data processing algorithms
 - Best available calibration using full data-set time history, and optimal “interval matching” to survey data
 - Yields Final Image Atlas and Source Catalog (release 17 months after end of on-orbit data acquisition)





WISE Science Data System (WSDS) Functional Block Diagram





WSDS Key Subsystems

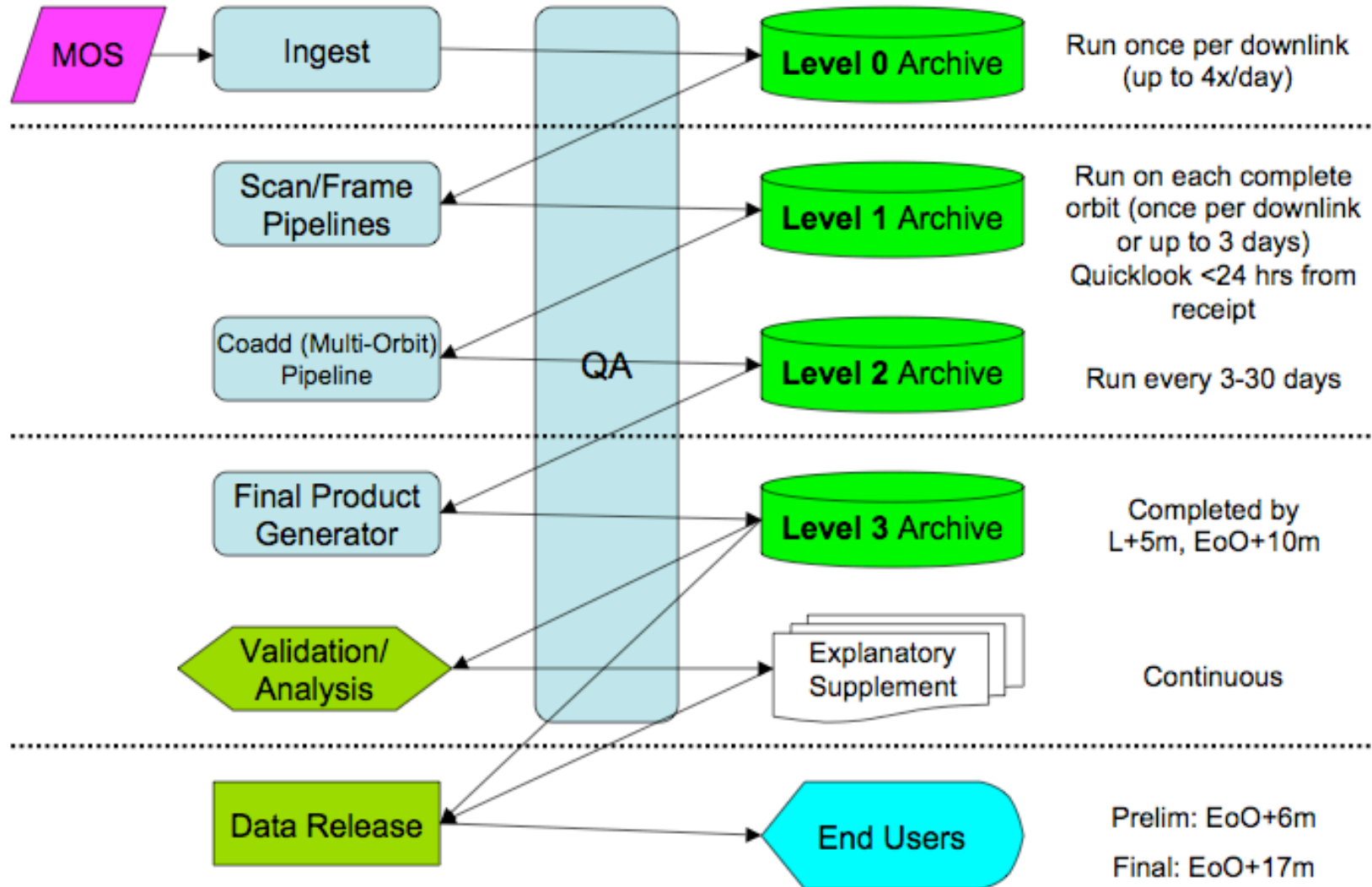


- **INGEST**
 - Receives science data packets and engineering telemetry from MOS and assembles Level 0 FITS-format files. Stages Level 0 images and metadata for pipeline processing.
- **Data Reduction PIPELINES**
 - Converts Level 0 imaging data into calibrated images and extracted source *Working Databases*
 - **Frame/Scan pipeline** operates on individual frames within one “scan” (=1/2 orbit)
 - **Coadd pipeline** operates on data from multiple orbits
- **Quality Assurance (QA)**
 - Generates concise reports summarizing science data quality using summary outputs from other subsystems. Web-based report, with capability to drill-down to detailed image, graphical and tabular data
 - Reports reviewed by QA scientists at WSDC. Final quality assignment approved by PI or designee
- **ARCHIVE/Distribution System**
 - Archives raw and processed mission data and metadata. Serves Image Atlas, Source Catalog and mission metadata to WISE project team and astronomical community. Integrated into Infrared Science Archive (IRSA) at IPAC
- **Final Product Generator (FPG)**
 - Constructs WISE Preliminary and Final Image Atlas and Source Catalog from *Combined* image and source *Working Databases*. Includes validation, characterization and documentation



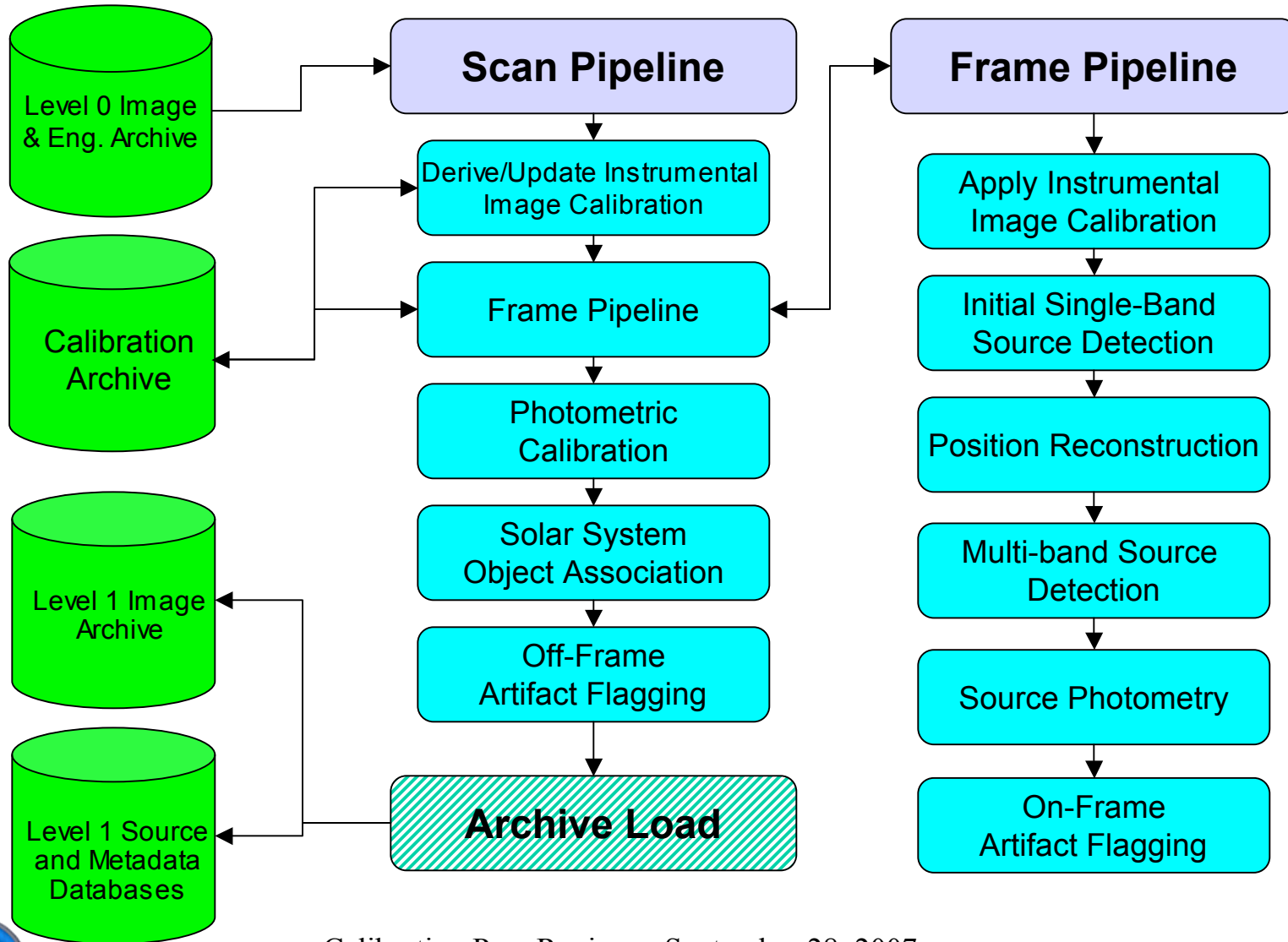


WSDS Data Flow and Operational Cycle



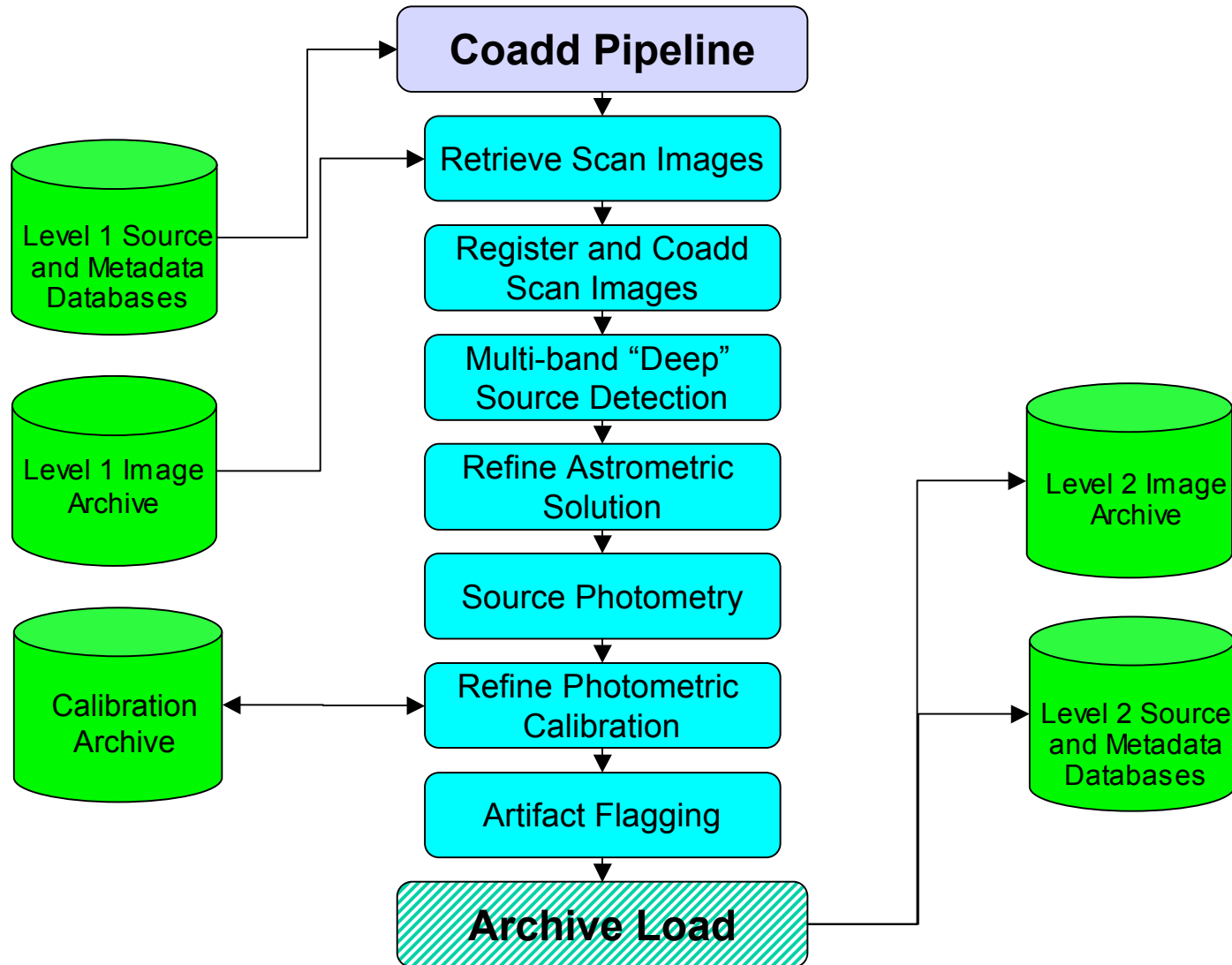


Scan/Frame Pipeline Reduces Data From Each Half-Orbit



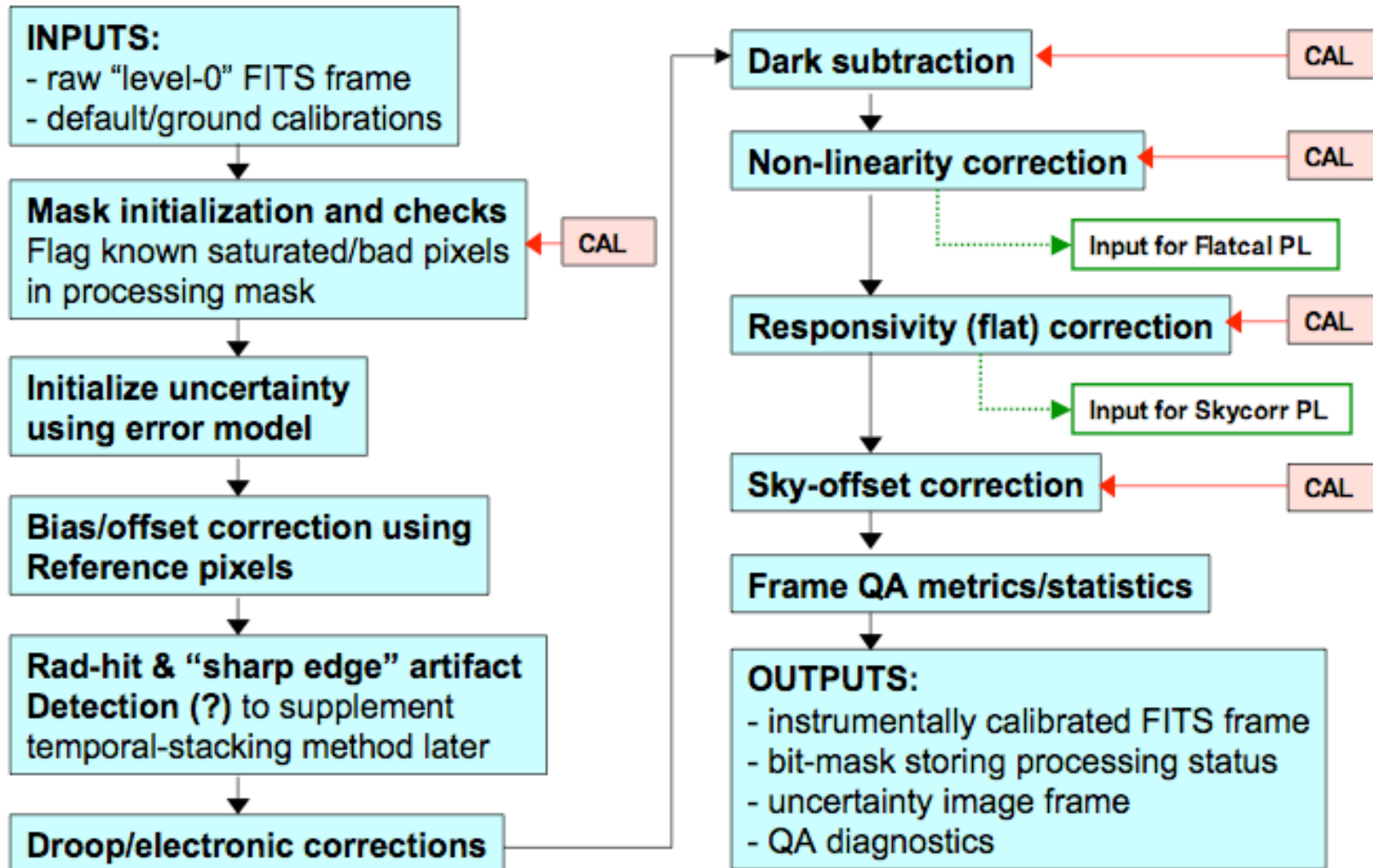


Coadd Pipeline Combines Data From Multiple Scans/Frames





Frame Instrumental Calibration Process Flow





Source of Frame Instrumental Calibration Corrections - 1



- A processing bit-mask denotes pixels to be excluded from processing operations
 - Masks initialized using ground characterization to identify pixels with: excessive dark current; excessive read noise; low and high responsivity (dead and hot pixels); reach and stay saturated in their A/D ramps during a nominal exposure; strong inter-pixel capacitance (IPC)
 - The mask will also be updated for conditions flagged by on-board DEB processing and recorded in actual down-linked frames: e.g., ramp saturation, broken pixels, DEB -> MUB transfer losses, and overflow.
 - Masks are further updated dynamically downstream to record: pixels that cannot be calibrated (e.g., dark subtracted, linearized, flattended...); new (transient) low/high responsive pixels using stacking analyses from the sky-offset estimation step; more “bad” pixels subject to IPC effects and energy leakage from photons hitting dead pixels/regions;
- Reference pixels (4 pixel boundary) may be used to subtract bias levels to correct for time-varying DC-offsets across each read-out channel in the active region
- Droop corrections derived from ground characterization may be necessary to compensate for erroneous signal added to the output of a pixel that depends on the total counts on the array (*i.e.* a global coupling between the readout channels and/or amplifiers). Droop is seen in some of the *Spitzer* arrays (most notably MIPS Si:As).





Source of Frame Instrumental Calibration Corrections - 2

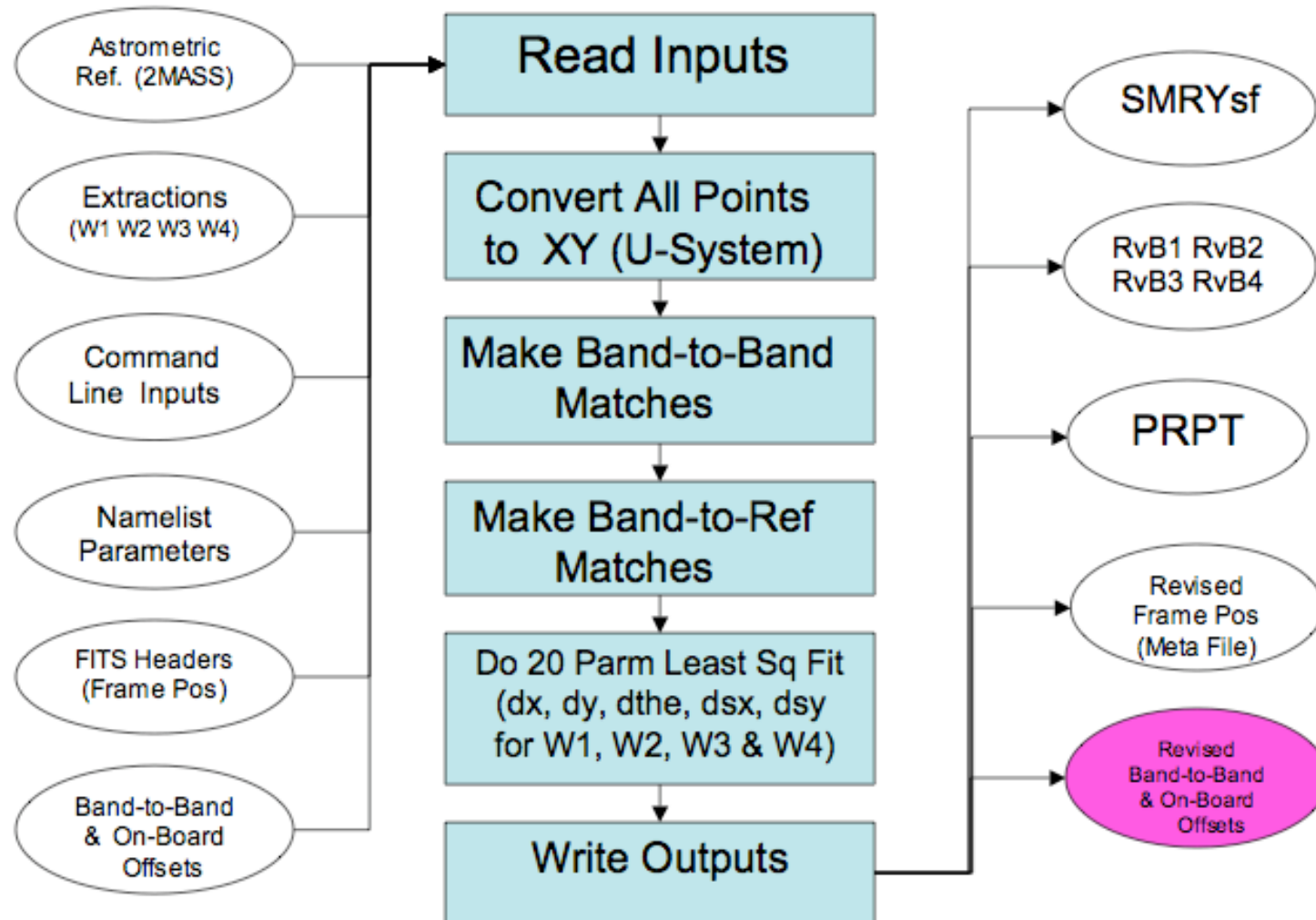


- Dark current/structure corrections to be derived from ground characterization
- Sky-offset (illumination) corrections compensate for variations in bias and dark structure over an array not captured by ground (or long term) calibrations
 - Generated by median combination of running median of 50-100 consecutive frames
- Non-linearity corrections to be derived from ground and IOC measurements made by toggling SUR coefficients to vary effective exposure time
- Flat-field (responsivity) corrections to be derived from:
 - Ground characterization
 - On-orbit measurements of the varying relative response to changes in zodiacal background illumination (Bands 3 & 4)
 - Medianed “dark-sky” measurements (Bands 1 & 2)
 - Focal-plane position-dependent star photometric residuals measured on-orbit in adjacent scans





Scan/Frame Position Reconstruction Process Flow





Scan/Frame Position Reconstruction (SFPrex)

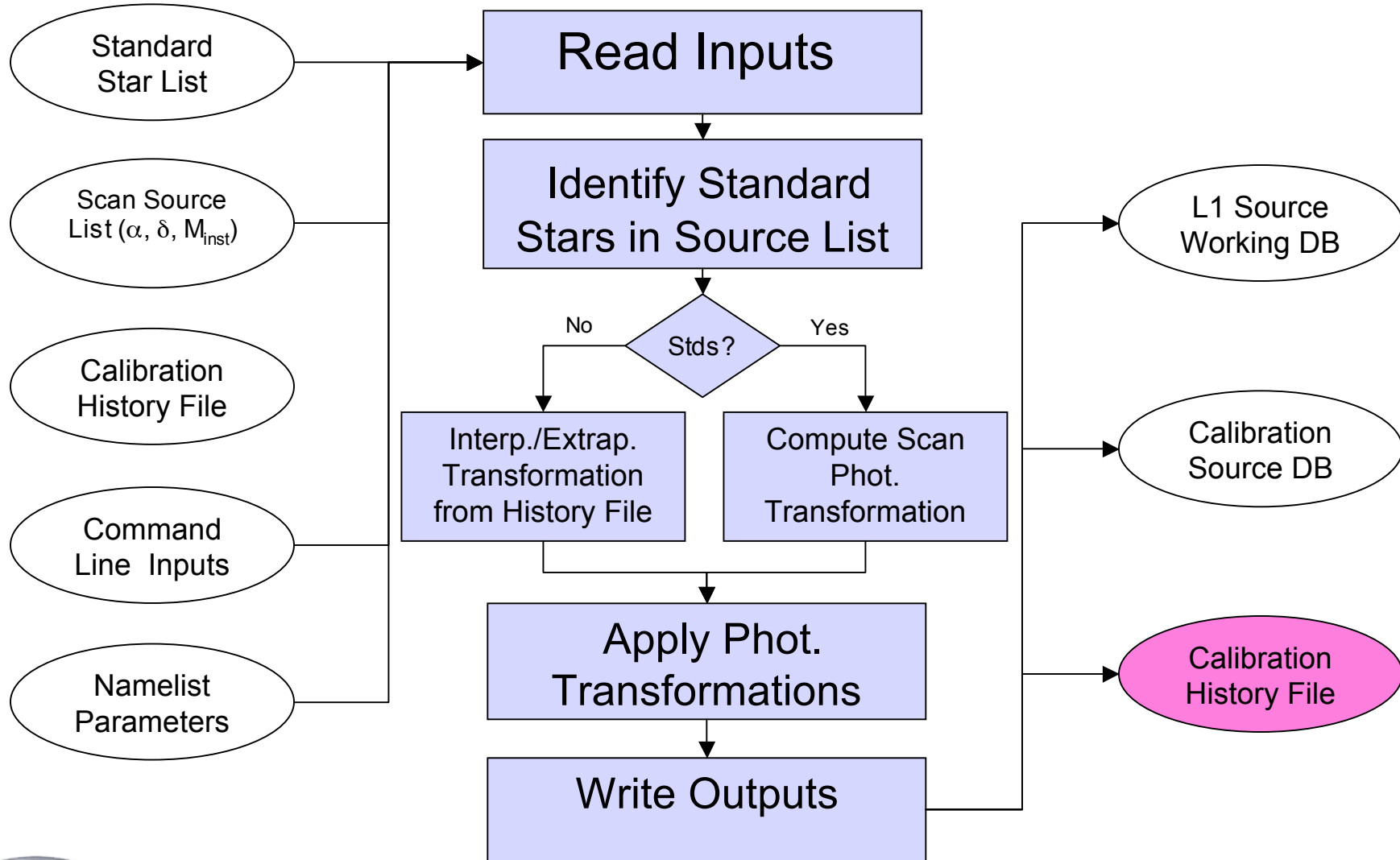


- Astrometric reference catalog (2MRef) is a subset of the 2MASS All-Sky PSC selected for astrometric accuracy
- Band-to-Reference catalog matching requires a pattern matcher which can handle large offsets (up to several arcminutes) between on-board position and true boresight
- **SMRYsf** is a cumulative file of most of the parameters generated by SFPrex
- **RvB** (Reference vs Band) files used to fit distortion
- **PRPT** is file of SFPrex band-merged & position reconstructed point sources useful for Quality Assessment
- Revised band-to-band & on-board offsets most useful during IOC





Scan Photometric Calibration Process Flow





Photometric Calibration Derived from Measurements of Standard Stars



- Primary standard stars located within 1 FOV of the north and south ecliptic poles
 - Measured during every pole passage if WISE is not performing downlink maneuver or other engineering activity
 - Typically ~20 times/day
- Photometric zero point offset (and optional color terms) derived from each set of standard star measurements
- Photometric transformations applied to source instrumental photometry and images
 - For preliminary processing: Calibration measurement made closest in time
 - For final processing: Calibration interpolated in time between
- Optional improvements
 - Calibrate network of secondary standard stars in each polar region
 - Monitor calibration stability between pole passages using photometric residuals of sources in orbit-to-orbit overlap regions





WSDC Activity is Ramping Up in Preparation for CDR (1/29-30/08)



- Phase B design work was focused on the requirements flow-down, top-level system design, and data and operational interface definition
- Selected prototyping was conducted in conjunction with MOS
 - Science data INGEST capability was developed to support spacecraft MUB testing
 - Scan synchronization monitor component of Quicklook Quality Assurance subsystem has been demonstrated
- WSDS subsystem detailed design/prototyping is now underway
 - Ingest system, instrumental calibration, source detection, position reconstruction, source photometry, image coadding in advanced design and/or prototypes delivered
 - Artifact detection, photometric calibration, quality assessment, archive interfaces/tools planned for 2008
- Version 0 of WSDS to be delivered in October 2007
 - Basic pipeline framework to test data handling and flow
 - Prototypes of several scan/frame pipeline subsystems
- Functionality and fidelity added through future staged WSDS deliveries

