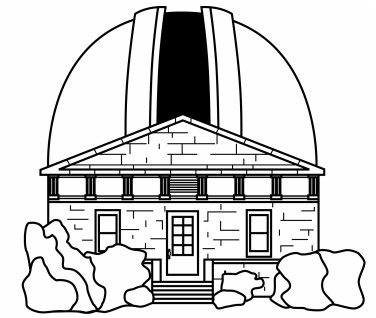

United States Naval Observatory

DRAFT

FAME Science Operations Center

Data Analysis System Requirements

DRAFT

4 September 2001

USNO-FAME-SOC-REQ
Version 0.2

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1. Scope

1.1. Identification

This specification applies to the United States Naval Observatory's (USNO) Science Operations Center's (SOC) FAME data analysis and processing system.

1.2. System Overview

FAME is an astrometric satellite designed to determine with unprecedented accuracy the positions, distances, and motions of 40 million stars within our galactic neighborhood. It is a collaborative effort between the USNO and several other institutions.

FAME Mission and Science Requirement documents and the FAME Calibration Plan levy specific requirements on the SOC system. The SOC is responsible for receiving, archiving and reducing all science and engineering data from the FAME spacecraft along with tracking information from the FAME ground tracking system. The SOC Concept of Operations document describes the conceptual design for a system that meets these requirements. The Concept of Operations document, in turn, is the basis for deriving the requirements contained in this document.

The SOC-Automated Data Processing (ADP) system is divided into five major subsystems: Data Ingestion (DI), Data Archiving (DA), Quicklook (QL), Data Analysis Trending (TR) and Data Analysis (DA). Figure 1 shows the conceptual design of the system.

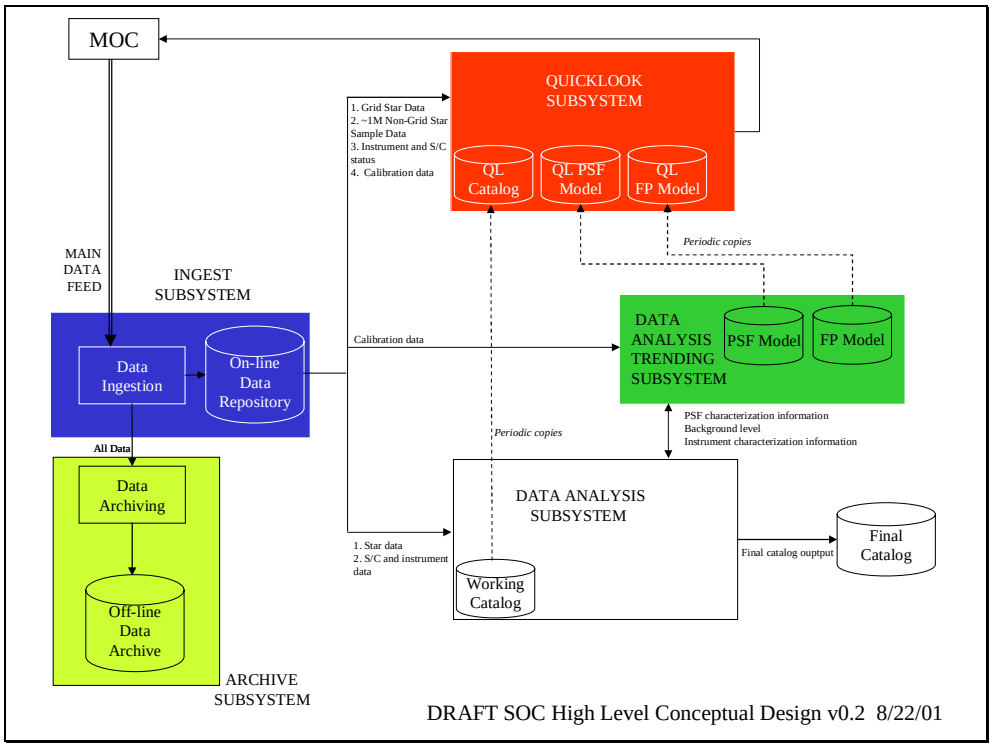

Fig. 1. SOC-ADP Conceptual Design

DI receives all data products from the Mission Operations Center (MOC) and makes them available to the other subsystems. DA copies all received data products to off-line storage media and records location and other relevant metadata in an accessible database. QL processes various data products in order to monitor instrument and spacecraft performance, and to determine when anomalies arise. Calibration measurement data and DA instrument parameter data are fed into TR which uses the information to maintain Point Spread Function (PSF), Focal Plane (FP) and Sky Background models used by DA. DA performs the data reduction that takes observations and converts these into astrometric and photometric results. More overview information can be found in the *SOC Concept of Operations* document.

The SOC operations portion of the SOC system will be described in a later release of the document.

1.3. Document Overview

This document generally follows the MIL-STD-498 Data Item Description (DID) for a System/Subsystem Specification (SSS). Section one gives an overview of the system and this document. Section two is a listing of referenced documents. Section three contains all system and subsystem requirements. This section includes subsections for system states and modes (section 3.1), system capabilities (3.2), external interfaces (3.3), internal (i.e., subsystem-to-subsystem) interfaces (3.4), internal data storage (3.5), security and privacy (3.8), system environment (3.9), computer resource requirements (3.11), system quality (3.12), personnel (3.13), training (3.14), logistics (3.15), and precedence and criticality of the requirements (3.16). Section four describes the qualification provisions for demonstrating that the system has met this specification. Section five provides requirements traceability to the Mission Requirements Document, the Science Requirements Document and the Calibration Plan. Section six contains notes to this document and section seven contains all appendices.

2. Referenced Documents

This specification references the following documents:

2.1. FAME Mission Documents

Table 1. FAME Mission Documents

Document Number	Description
NCST-D-FM001	FAME Science Requirements Document
NCST-D-FM002	FAME Mission Requirements Document
TBD	FAME Calibration Plan
USNO-FAME-SOC-CONOPS	SOC System Concept of Operations
USNO-FAME-SOC-MOC ICD	MOC-SOC Interface Control Document (ICD)
USNO-FAME-SOC-DI/DA Internal ICD	Data Ingest-Data Analysis Internal ICD

USNO-FAME-SOC-STD	SOC Software Test Description

2.2. Military and Industrial Standards

Table 2. Military and Industrial Standards Documents

Document Number	Description
MIL-STD-498	Software Development and Documentation
DI-IPSC-81431	System/Subsystem Specification
DI-IPSC-81434	Interface Requirements Specification

3. Requirements
   3.1. Required states and modes (omitted)

   3.2. System capability requirements
      3.2.1. Data Ingestion (DI) Subsystem
         3.2.1.1.Staging area and new files
            3.2.1.1.1. DI shall provide a staging area for the MOC to write files to.
               3.2.1.1.1.1.The staging area shall provide total storage space for one week of nominal data flow
               3.2.1.1.1.2.The filled portion shall never exceed 6/7^{ths} of the total storage area without operator approval.
            3.2.1.1.2. DI shall receive the following data products from the MOC (*N.b.: file types, formats, and frequency of receipts are defined in the MOC-SOC ICD*):
               3.2.1.1.2.1.Science Data files
               3.2.1.1.2.2.Full Frame CCD Readout files
               3.2.1.1.2.3.Acquisition file
               3.2.1.1.2.4.Charge Injection Test file
               3.2.1.1.2.5.Catalog Dump file
               3.2.1.1.2.6.Focus Test file
               3.2.1.1.2.7.Instrument Attitude file
               3.2.1.1.2.8.SOH file
               3.2.1.1.2.9.Ground Station Tracking file
               3.2.1.1.2.10. Time Conversion file
            3.2.1.1.3. DI shall check the staging area at least once every ten seconds (TBR) to determine what new files have been received from the MOC
            3.2.1.1.4. DI shall classify any newly detected file either as one of the ones listed in 3.2.1.1.2. or as an “unknown” file type.
            3.2.1.1.5. DI shall copy any file identified as “unknown” to an “unknown” file storage area and remove the file from the staging area.
            3.2.1.1.6. DI shall notify the MOC and SOC operators when any unknown file types are received.
            3.2.1.1.7. DI shall remove all properly classified (i.e., not unknown) file types from the staging area once they have been processed.
         3.2.1.2.DI shall make a copy of each identified file “as is” available to DA for archive.
         3.2.1.3.DI shall parse all recognized file types and extract the information and/or data listed in table 1:

Table 1. Data Ingest File Types and Extracted Data and Information

File Type	Information/Data
Science Data	2-D Grid Star profiles, 2-D Science Star profiles, 1-D Program Star profiles, background data, overscan data, time stamp, star ID, gain setting, aperture number, CCD number
Full Frame CCD Readout	Data, time stamp, gain setting, CCD number
Acquisition Window	Data, time stamp, star ID, gain setting, aperture number, CCD number
Charge Injection test	Test data, time stamp, gain setting, CCD number, input waveform number
Catalog Dump	Time stamp, catalog data
Focus Test	Test data, time stamp, gain setting, CCD number, input waveform number
Instrument Attitude	Instrument generated quaternion, time stamp
SOH	Power levels, temperature readings, time stamp
Ground Station Tracking	Position, velocity vectors, time stamp
Time Conversion	Conversion coefficients, time validity range

3.2.1.4.DI shall write this information to the On-Line Repository (OLR)

3.2.1.5.All the information in the OLR shall be made available to the other subsystems.

3.2.1.6.DI shall notify subsystems when appropriate data has been received as listed in table 2.

Table 2. Data/Subsystem Notification

Data Received	*QL*	*TR*	*DA*
2-D Grid Star profile	x		x
2-D Science Star profile			x
1-D Program Star			x
Background (sky) observation	x	x	
Overscan data	x	x	
Charge Injection test	x	x	
Focus test	x	x	
Instrument Attitude	x		
SOH	x		
Ground Station Tracking	x		
Certain flags result in these additional notifications:			
QL reference star profile	x		
PSF reference star profile		x	

3.2.1.7.DI shall process all data at real-time speed or faster.

3.2.2. Data Archiving (DA) Subsystem
- 3.2.2.1. DA shall copy all files made available from DI onto DVD disks.
  - 3.2.2.1.1. DA shall make these copies in the order in which the files have been received.
  - 3.2.2.1.2. DA shall fill each DVD before proceeding to the next one.
  - 3.2.2.1.3. Each DVD shall be uniquely numbered.
- 3.2.2.2. DA shall record the following information in a DA database to allow access to archived files:
  - 3.2.2.2.1. File name
  - 3.2.2.2.2. File type
  - 3.2.2.2.3. Target DVD number
  - 3.2.2.2.4. Time and date of transfer.
- 3.2.2.3. DVDs shall be stored in order of their ID number.
- 3.2.2.4. DVDs shall be stored:
  - 3.2.2.4.1. In individual cases
  - 3.2.2.4.2. On shelving system that can be locked
  - 3.2.2.4.3. In an area that can be locked.
- 3.2.2.5. DA shall process all archiving at real time speed or faster.

3.2.3. Quicklook (QL) Subsystem
- 3.2.3.1. QL PSF Model
  - 3.2.3.1.1. QL shall maintain a model of the instrument PSF to TBD accuracy with TBD parameters
  - 3.2.3.1.2. This model shall be periodically updated by copying the TR PSF model at TBD lower resolution.
- 3.2.3.2. QL Focal Plane Model
  - 3.2.3.2.1. QL shall maintain a model of the instrument Focal Plane parameters to TBD accuracy with TBD parameters
  - 3.2.3.2.2. This model shall be periodically updated by copying the TR PSF model at TBD lower resolution.
- 3.2.3.3. QL Catalog Copy
  - 3.2.3.3.1. QL shall maintain a copy of the astrometric and photometric catalog.
  - 3.2.3.3.2. This catalog shall be periodically updated by copying the DA working catalog.
- 3.2.3.4. QL Centroiding and Photometry
  - 3.2.3.4.1. For each new QL star profile received (see table 2), QL Centroiding and Photometry shall calculate the following parameters:
    - 3.2.3.4.1.1. Centroid in local pixel coordinates (in-scan for 1-D or in-scan and cross-scan for 2-D profiles), accurate to $1/20^{th}$ (TBR) pixel.
    - 3.2.3.4.1.2. Standard deviation in local pixel coordinates in one or two dimensions (as appropriate)
    - 3.2.3.4.1.3. Skewness in local pixel coordinates in one or two dimensions (as appropriate)

3.2.3.4.1.4.Source brightness and uncertainty in instrumental magnitude (TBR), accurate to $1/10^{th}$ mag.

3.2.3.4.2. QL Centroiding and Photometry shall write this information to the QL Centroid/Photometry Database.

3.2.3.5. QL Calibration Data Reduction

3.2.3.5.1. The Calibration Data Reduction process shall start whenever any of the following data products are ingested by DI:

3.2.3.5.1.1.Focus test
3.2.3.5.1.2.Flatfield observation
3.2.3.5.1.3.Charge Injection Test
3.2.3.5.1.4.Overscan data
3.2.3.5.1.5.Sky background data

3.2.3.5.2. The Calibration Data Reduction process shall use this input data to calculate the following parameters:

3.2.3.5.2.1.Pixel responsivity
3.2.3.5.2.2.Column responsivity
3.2.3.5.2.3.Column Charge Transfer Efficiency (CTE)
3.2.3.5.2.4.CCD bias level
3.2.3.5.2.5.CCD electronics and readout noise
3.2.3.5.2.6.Dark Current
3.2.3.5.2.7.TBD focus metrics
3.2.3.5.2.8.TBD other calibration information

3.2.3.5.3. The Calibration Data Reduction process shall write this information to the QL Calibration DB.

3.2.3.6.QL Attitude Solution O-C Calculation

3.2.3.6.1. QL Attitude Solution process shall calculate one minute (TBR) attitude solutions for the instrument using calculated grid star centroids. This attitude solution will include:

3.2.3.6.1.1.Spin rate and axis
3.2.3.6.1.2.Precession rate and axis
3.2.3.6.1.3.Nutation rate and axis

3.2.3.6.2. QL Attitude Solution process shall calculate the difference between the attitude solution and the reported instrument attitude.

3.2.3.6.3. QL Attitude Solution shall write this attitude O-C to the Attitude O-C database.

3.2.3.7.Profile Width O-C Calculation

3.2.3.7.1. Upon receipt of profile data for TBD stars, QL Profile Width O-C process will calculate the predict in-scan and cross scan profile widths.

3.2.3.7.2. The Profile Width O-C process shall calculate the difference between the observed profile width and the predicted profile width.

3.2.3.7.3. This profile width O-C shall be written to the Profile Width O-C database.

3.2.3.8.Anomaly Detection

3.2.3.8.1. The Anomaly Detection process shall continuously analyze data in the OLR and the QL databases.

3.2.3.8.2. The Anomaly Detection process shall examine the indicators listed in table 3 in order to determine if an anomaly condition has arisen:

Table 3. Anomaly Indicators

Indicator	Anomaly condition flag
Star in observation window	No star in window
Star centroid distance from nominal window center	TBD
Profile standard deviation	TBD
Profile skewness	TBD
TBD profile bimodality metric	TBD
O-C profile width	TBD
Total counts for CCD channels integrated over TBD time span are compared	TBD
Total counts for TBD selected stars are compared between CCD channels	TBD
Total counts for TBD selected stars are compared for single CCDs at different epochs	TBD
TBD focus metric(s)	TBD
Power levels	TBD
Temperature	TBD
Instrument reported spin rate and axis	TBD
Instrument reported precession rate and axis	TBD
Instrument reported nutation rate and axis	TBD
Attitude O-C	TBD
TDI rate	TBD
TDI rate-spin rate mismatch	TBD
Pixel responsivity	TBD
Column responsivity	TBD
CCD bias level	TBD
Electronic and readout noise	TBD
Dark current	TBD
CTE	TBD

3.2.3.8.3. The QL Anomaly Detection process shall initiate anomaly recovery whenever an anomalous condition arises.

3.2.3.8.4. The QL Anomaly Detection process shall generate operator notification messages whenever an anomalous condition arises.

3.2.3.8.5. The QL Anomaly Detection process shall maintain a log of all anomalous conditions that arise.

3.2.3.8.6. The QL Anomaly Detection process shall provide visual display and printout capabilities of trends and bounds for all of the parameters that are monitored in section 3.2.3.8.2.

3.2.3.9. Anomaly Resolution

3.2.3.9.1. The Anomaly Resolution process shall be initiated upon receipt of an anomaly detection notice from the Anomaly Detection process.

3.2.3.9.2. The Anomaly Resolution process shall identify the type of anomaly. Anomaly types and the related indicators are:

Table 4. Anomaly Types and Related Indicators

Anomaly Type	Related Indicator (all TBR)
On-board catalog error	• Star in observation window
Attitude problem	• Star in observation window • Star centroid distance from nominal window center • Profile standard deviation • Profile skewness • TBD profile bimodality metric • O-C profile width • Instrument reported spin rate and axis • Instrument reported precession rate and axis • Instrument reported nutation rate and axis • Attitude O-C • TDI rate • TDI rate-spin rate mismatch
On-board attitude calculation error	• Star in observation window • Star centroid distance from nominal window center • Profile standard deviation • Profile skewness • TBD profile bimodality metric • O-C profile width • Instrument reported spin rate and axis • Instrument reported precession rate and axis • Instrument reported nutation rate and axis • Attitude O-C • TDI rate • TDI rate-spin rate mismatch
TDI rate calculation error	• Star in observation window

	• Star centroid distance from nominal window center • Profile standard deviation • Profile skewness • TBD profile bimodality metric • O-C profile width • Instrument reported spin rate and axis • Attitude O-C • TDI rate • TDI rate-spin rate mismatch
Out of focus/alignment error	• Star centroid distance from nominal window center • Profile standard deviation • Profile skewness • TBD profile bimodality metric • O-C profile width • TBD focus metric(s)
Optics transmission degradation	• Total counts for TBD selected stars are compared for single CCDs at different epochs • Dark current
Filter transmission degradation	• Total counts for TBD selected stars are compared for single CCDs at different epochs • Dark current
CCD responsivity degradation	• Total counts for CCD channels integrated over TBD time span are compared • Total counts for TBD selected stars are compared between CCD channels • Total counts for TBD selected stars are compared for single CCDs at different epochs • Pixel responsivity • Column responsivity
Dark current variation	• Total counts for CCD channels integrated over TBD time span are compared • Total counts for TBD selected stars are compared between CCD channels • Total counts for TBD selected stars are compared for single CCDs at different epochs • Dark current
CCD FPA position variation	• Star centroid distance from nominal window center
Bias level variation	• Total counts for CCD channels integrated over TBD time span are compared

	• Total counts for TBD selected stars are compared between CCD channels • Total counts for TBD selected stars are compared for single CCDs at different epochs • CCD bias level
Electronics and readout noise variation	• Total counts for CCD channels integrated over TBD time span are compared • Total counts for TBD selected stars are compared between CCD channels • Total counts for TBD selected stars are compared for single CCDs at different epochs • Electronic and readout noise
CTE variation	• Total counts for CCD channels integrated over TBD time span are compared • Total counts for TBD selected stars are compared between CCD channels • Total counts for TBD selected stars are compared for single CCDs at different epochs • CTE • Pixel responsivity • Column responsivity
Temperature variation	• Total counts for CCD channels integrated over TBD time span are compared • Total counts for TBD selected stars are compared between CCD channels • Total counts for TBD selected stars are compared for single CCDs at different epochs • Temperature • Dark current
Power variation	• Power

3.2.3.9.3. Anomaly Resolution process shall initiate TBD recovery actions based on the identified type of anomaly.

3.2.3.10. QL shall process all data at real-time speed or faster.

3.2.4. Trending (TR) Subsystem

3.2.4.1.Sky Background

3.2.4.1.1. The Sky Background process shall use sky observations and feedback input from the data analysis process to develop a model of the sky background brightness level.

3.2.4.1.2. This model shall describe the following TBR background level brightness parameters:

- Background constant
- Background slope

3.2.4.1.3. This background level shall be a function of the following TBR variables:
- RA
- DEC
- Earth-instrument angle
- Day of the year

3.2.4.1.4. This background level model shall be accessible to DA

3.2.4.2.Focal Plane Characterization

3.2.4.2.1. The Focal Plane Characterization process shall use the following measurements as inputs to modeling the focal plane:
- Attitude
- Sky observations
- Flatfield observations
- Charge injection test observations
- Overscan data
- Feedback from the Data Analysis subsystem

3.2.4.2.2. This model shall describe the following TBR focal plane parameters:
- CCD bias
- CCD readout and electronics noise
- CCD dark current
- CCD position in focal plane
- Column sensitivity
- Column CTE
- Pixel sensitivity
- Optics throughput

3.2.4.2.3. This model shall be a function of the following TBR parameters:
- CCD
- Channel
- Column
- Pixel
- Mission Elapsed Time (MET)

3.2.4.2.4. This focal plane model shall be accessible to DA

3.2.4.3.PSF Characterization

3.2.4.3.1. The PSF Characterization process shall use the following TBR measurements as inputs to model the PSF:
- Attitude
- PSF reference star profiles
- Focus test
- TDI rate
- Color data from catalog
- Feedback input from Data Analysis subsystem

3.2.4.3.2. The PSF model shall characterize the PSF using TBD characterization parameters

3.2.4.3.3. The PSF model shall be a function of the following TBR parameters:

- Position in focal plane
- TBD Color indices
- MET

3.2.4.3.4. This PSF model shall be accessible to DA

3.2.5. Data Analysis (DA) Subsystem

3.2.5.1.DA shall maintain a Working Catalog database

3.2.5.1.1. The Working Catalog shall include the following values for each FAME target:

3.2.5.1.1.1.Position
3.2.5.1.1.2.Proper motion
3.2.5.1.1.3.Acceleration
3.2.5.1.1.4.Parallax
3.2.5.1.1.5.Magnitude
3.2.5.1.1.6.TBD Color indices
3.2.5.1.1.7.TBD anomaly flags

3.2.5.1.2. The Working Catalog shall be read-accessible to all DA processes

3.2.5.1.3. Astrometric parameters in the Working Catalog shall be write-accessible to the global solution and Astrometric Parameter Calculation

3.2.5.1.4. Photometric parameters in the Working Catalog shall be write-accessible to the photometric calibration and the photometric parameter calculation processes.

3.2.5.2.Centroiding and Photometry process

3.2.5.2.1. The Centroiding and Photometry process shall be initiated upon:

3.2.5.2.1.1.receipt of a new star profile by DI
3.2.5.2.1.2.manual command, along with a list of observations to be reprocessed

3.2.5.2.2. The Centroiding and Photometry process shall calculate the following information for each input star profile:

3.2.5.2.2.1.Centroid in local pixel coordinates, accurate to $1/350^{th}$ pixel (TBR)
3.2.5.2.2.2.Profile standard deviation in local pixel coordinates
3.2.5.2.2.3.Profile skewness in local pixel coordinates
3.2.5.2.2.4.Profile kurtosis in local pixel coordinates
3.2.5.2.2.5.TBD goodness-of-fit metric
3.2.5.2.2.6.TBD bimodality metric
3.2.5.2.2.7.Total in-band source brightness and uncertainty, in instrumental magnitudes

3.2.5.2.3. This information shall be written to the centroiding and photometry database
3.2.5.2.4. If any of these parameters are outside of TBD bounds, an anomaly shall be recorded in the centroiding and photometry database
3.2.5.3.Global Solution
3.2.5.3.1. The Global Solution process shall be run on command.
3.2.5.3.2. The Global Solution process shall provide the capability to specify the following TBR data input selection criteria:
3.2.5.3.2.1.Time span
3.2.5.3.2.2.Star Ids
3.2.5.3.2.3.Anomaly exclusion
3.2.5.4.The Global Solution shall use the centroiding information produced in the centroiding process for grid stars and the instrument attitude to calculate the following values:
3.2.5.4.1. Instrument pointing solution over valid observing period
3.2.5.4.2. Astrometric parameters of grid stars used in the global solution calculation. This consists of:
3.2.5.4.2.1.Position
3.2.5.4.2.2.Proper motion and acceleration
3.2.5.4.2.3.Parallax
3.2.5.4.3. TBD photometric information
3.2.5.4.4. Output TBD focal plane parameters
3.2.5.4.5. Output TBD sky background parameters
3.2.5.4.6. Output TBD PSF parameters
3.2.5.5.The instrument pointing solution shall be written to the global pointing database.
3.2.5.6.The astrometric and photometric parameters of grid stars used in the calculation shall be written to the working catalog
3.2.5.7.Output focal plane, sky background and PSF parameters will all be sent to TR for further processing.
3.2.6. Astrometric Parameter Calculation
3.2.6.1.The Astrometric Parameter Calculation Process shall be run on command.
3.2.6.2.Astrometric Parameter Calculation shall provide the capability to specify the following TBR data input selection criteria:
3.2.6.2.1. Time span
3.2.6.2.2. Star Ids
3.2.6.2.3. Anomaly exclusion criterion
3.2.6.3.Astrometric Parameter Calculation shall use the centroiding information produced in the centroiding process and the global pointing solution to calculate the following values:
3.2.6.3.1. Astrometric parameters of science and program stars. This consists of:
3.2.6.3.1.1.Position
3.2.6.3.1.2.Proper motion and acceleration

3.2.6.3.1.3.Parallax
3.2.6.3.2. TBD photometric information
3.2.6.3.3. Output TBD focal plane parameters
3.2.6.3.4. Output TBD sky background parameters
3.2.6.3.5. Output TBD PSF parameters
3.2.6.4.The astrometric and photometric parameters produced in this calculation shall be written to the working catalog
3.2.6.5.Output focal plane, sky background and PSF parameters will all be sent to TR for further processing.

3.2.7. Photometric Calibration Process
3.2.7.1.The Photometric Calibration process shall be run on command.
3.2.7.2.Photometric Calibration shall provide the capability to specify the following TBR data input selection criteria:
3.2.7.2.1. Time span
3.2.7.2.2. Star Ids
3.2.7.2.3. Anomaly exclusion criterion
3.2.7.3.The Photometric Calibration process shall use the photometric information produced in the Centroiding and Photometry process for photometric reference stars to calculate the following:
3.2.7.3.1. Calibration coefficients to transform instrumental magnitudes to TBD photometric reference system.
3.2.7.3.2. TBD photometric parameters for the photometric reference stars.
3.2.7.4.The calibration coefficients shall be written to the Photometric Calibration database.
3.2.7.5. The photometric reference star photometry shall be written to the working catalog.

3.2.8. Photometric Parameter Calculation Process
3.2.8.1.The Photometric Parameter Calculation process shall be run on command.
3.2.8.2.Photometric Parameter Calculation shall provide the capability to specify the following TBR data input selection criteria:
3.2.8.2.1. Time span
3.2.8.2.2. Star Ids
3.2.8.2.3. Anomaly exclusion criterion
3.2.8.3.The Photometric Parameter Calculation process shall use the photometric information produced in the Centroiding and Photometry process and the calibration coefficients in the Photometric Calibration database to calculate TBD photometric parameters for the non-photometric reference stars.
3.2.8.4.The photometry results shall be written to the working catalog.

3.3. External interface requirements

The Interface requirements between the MOC and the SOC shall be specified in the *MOC-SOC ICD*.

3.4. Internal interface requirements

Interface between the DI subsystem on the one hand and the DA and TR subsystems on the other shall be specified in the *Data Ingest-Data Analysis Internal ICD* document.

3.5. (omitted)

3.6. (omitted)

3.7. (omitted)

3.8. Security and Privacy requirements

3.8.1. The SOC system shall not permit access to any MOC system by any user outside of the SOC.

3.9. (omitted)

3.10. Computer resource requirements

3.10.1. (omitted/left to design)

3.10.2. (omitted/left to design)

3.10.3. (omitted/left to design)

3.10.4. Computer communications requirements

3.10.4.1. The system shall support download from the MOC on a 24 hr per day/7 day per week/365 days per year basis during science phase.

3.10.4.2. The system shall support a nominal peak rate of 5 GB (TBR) of data from the MOC per day

3.11. System quality factors

3.11.1. reliability requirements

3.11.1.1. The system shall provide sufficient recovery throughput to allow processing of one day's worth of data every two days in addition to the nominal data received from the MOC

3.11.2. availability requirements

3.11.2.1. The SOC ADP system shall operate on a 24 hr per day/7 day per week/365 days per year basis during science phase

3.12. (omitted)

3.13. (omitted)

3.14. (omitted)

3.15. (omitted)

3.16. Other requirements

TBD

3.17. (omitted)

3.18. Precedence and criticality of requirements

The SOC system is divided into two criticality levels:

- Launch critical
- Non-launch critical

Launch critical systems are defined as those systems that must meet all requirements prior to launch. Non-launch systems do not need to meet all requirements prior to launch. The following list categorizes the subsystems in terms of launch criticality:

3.18.1. The following SOC subsystems shall be launch critical:

3.18.1.1. Data Ingestion

3.18.1.2. Data Archive

3.18.1.3. Quicklook

3.18.2. The following SOC subsystems shall be non-launch critical:

3.18.2.1. Data Analysis Trending

3.18.2.2. Data Analysis

3.18.3. SOC System Initial Operating Capability (IOC) shall be declared upon acceptance of all launch critical subsystems.

3.18.4. SOC System Full Operating Capability (FOC) shall be declared upon acceptance of all launch critical and non-launch critical subsystems.

4. Qualification provisions

4.1. Each SOC subsystems shall be qualified as per table 5:

Table 5. Qualification Provisions

SOC Subsystem	Qualification Provision
DI	Test with Simulator generated data
AR	Test with Simulator generated data
QL	Test with Simulator generated data
TR	Test with Simulator generated data
DA	Test with Simulator generated data

4.2. The detailed test plan and test cases shall be listed in the *SOC System Test Description* document.

5. Requirements traceability

5.1. Traceability and Allocation of System Level Requirements

MRD, SRD and Calibration Plan system-level requirements on the SOC are shown in Table 6. Each one is allocated to one or more SOC systems and subsystems.

Table 6. Traceability and Allocation of System Level Requirements

Source	*Source Requirement*	SOC-ADP					SOC-OPS	SIM	*Notes*
		DI	AR	QL	TR	DA			
MRD	3.2.1.2.1.a	x	x	x	x	x	x		*general description of the system*
	3.2.1.2.1.b	x	x	x			x		
	3.2.1.2.1.c	x	x	x	x	x	x		
	3.2.1.2.2.1.b7	(x)					(x)		*weekly MOC status reports->SOC*
	3.2.1.2.2.1.b8			x			x		*MOC receipt of instrument commands from SOC*
	3.2.1.3	x	x	x	x	x	x		*general SOC requirements*
	3.7.2.1	x	x	x	x	x	x		*operations concept*
	3.7.2.2.b	(x)							*network req.*
	3.7.2.2.c	x	x	x	x	x	x		*network security*
	3.7.2.3.1.n	x	x	x	x	x	x	x	*Mission simulations and rehearsals*
	3.7.2.3.1.o	(x)							*MOC data storage and transfer to SOC*
	3.7.2.3.3.a			x					*near real time assessment of science data quality*
	3.7.2.3.3.b							x	*astrometric/photometric simulator*
	3.7.2.3.3.c				x	x			*astrometric/photometric data analysis pipeline*
	3.7.2.3.3.d		x						*data archive*
	3.7.2.3.3.e				x	x	x		*input catalog, science (output) catalog*
	3.7.2.4.3	x	x	x	x	x		x	*COTS use*

Source	*Source Requirement*	SOC-ADP					SOC-OPS	SIM	*Notes*
		DI	AR	QL	TR	DA			
SRD	2.1.1				x	x			*Astrometric reqs*
	2.1.2				x	x			*Photometric reqs*
	2.1.3					x	x		*Completeness reqs*
	2.3.1				x	x			*Detailed astrometric reqs*
	2.3.2				x	x			*Detailed photometric reqs*
CP	D.a.1						x		*blank sky stars for input catalog*
	D.a.2						x		*calibration reference stars for input catalog*
	D.a.3				x				*Calibration measurement data processing*
	D.a.4				x				
	D.a.5				x				
	D.a.6				x				
	D.a.7				x				
	D.a.8				x				
	D.a.9				x				
	D.b.1				x				
	D.b.2				x				
	D.b.3				x				
	D.b.4				x				
	D.b.5				x				
	D.b.6				x				

Notes:
MRD – Mission Requirements Document
SRD – Science Requirements Document
CP – Calibration Plan

x – Allocated requirement
(x) – Allocated implied requirement

6. Notes

7 Appendices

7.1 Appendix A: Glossary

Full frame	½ of a CCD—1024 x 4096 pixels. Also referred to as a "CCD channel".
Grid Star	A star with well known astrometric properties used during the global solution process to establish a pointing solution for the instrument.
Photometric Reference Star	A star with well-known photometric properties used to perform photometric calibration of the system. Frequently shortened to "reference star".
Profile	1-D or 2-D raster consisting of electrons recorded as a function of row or row and column.
Time	Refers to time according to the spacecraft. Ground reference time is specifically called out when referenced.
Science Star	A non-grid star whose data profiles will remain 2-D rather than be binned to 1-D
Program Star	A non-grid star whose data profiles will be binned to 1-D

7.2 Appendix B: Acronyms and Abbreviations

ADP	Automated Data Processing
DA	Data Analysis (subsystem)
CCD	Charged Coupled Device
CTE	Charge Transfer Efficiency
DA	Data Analysis
DEC	Declination
DI	Data Ingestion (subsystem)
DVD	Digital Versatile Disk (also, Digital Video Disk)
ECR	Earth Centered Rotational (coordinate system)
EDF	Engineering Data Formatting (process)
FAME	Full Sky Astrometric Mapping Explorer
FOC	Full Operating Capability
FOV	Field of View
FP	Focal Plane
ID	Identification number
IOC	Initial Operating Capability
MET	Mission Elapsed Time
MOC	Mission Operations Center
NRL	Naval Research Laboratory
O-C	Observed minus Computed, the difference between simulation results and observed measurements
OCD	Operations Concept Document
OLR	On-Line Repository
PSF	Point Spread Function
QL	Quicklook (subsystem)
RA	Right Ascension
SNR	Signal to Noise Ratio
SOC	Science Operations Center
SOH	State Of Health
TBD	To be determined (typically used in place of a parameter)
TBR	To be resolved (typically used to denote when a parameter is provisional)
TDI	Time Delay Integration
TR	Trending (subsystem)
USNO	United States Naval Observatory