Metis OBSW Functionality overview

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INAF-OAto

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OBSW Overview

The title says everithing…

Overview of the OBSW scientific functionality

No engineering modes

Not an guideline to operations

References:

- Metis User Manual: METIS-ATI-MA-001 Issue 9.0
- Metis OnBoard Data Processing Description: METIS-OATO-TNO-012 Issue 1.0
- TMTC ICD
- FDIR

OBSW Overview

Metis is a two channels coronagraph

VL channel [580-640 nm] with polarimetric capability

UV channel [H I Ly-α 121.6±10 nm]

The two channels can be operated together or one at time.

A scientific acquisition can be performed after selecting and configuring, for each channel, the suitable

ACQUISITION SCHEME

OBSW Overview

An ACQUISITION SCHEME is defined by a specific combination of:

- **Detector readout mode**
- **On board data processing**
- **Subsystems operations**
- **A set of available SCIENTIFIC DATA OBJECTS and FLAGS**

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SCIENTIFIC DATA OBJECTS
VL Images
UV Images
UV PCU Events Lists
UV PCU Accumul. matrices

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SCIENTIFIC DATA OBJECTS
VL Images
UV Images
UV PCU Events Lists
UV PCU Accumul. matrices
VL cosmic ray log matrices
UV cosmic ray log matrices
Visible Light Curves

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SCIENTIFIC DATA OBJECTS
VL Images
UV Images
UV PCU Events Lists
UV PCU Accumul. matrices
VL cosmic ray log matrices
UV cosmic ray log matrices
Visible Light Curves
VL Temporal Noise matrices
UV Temporal Noise matrices
UV PCU Test Events Lists

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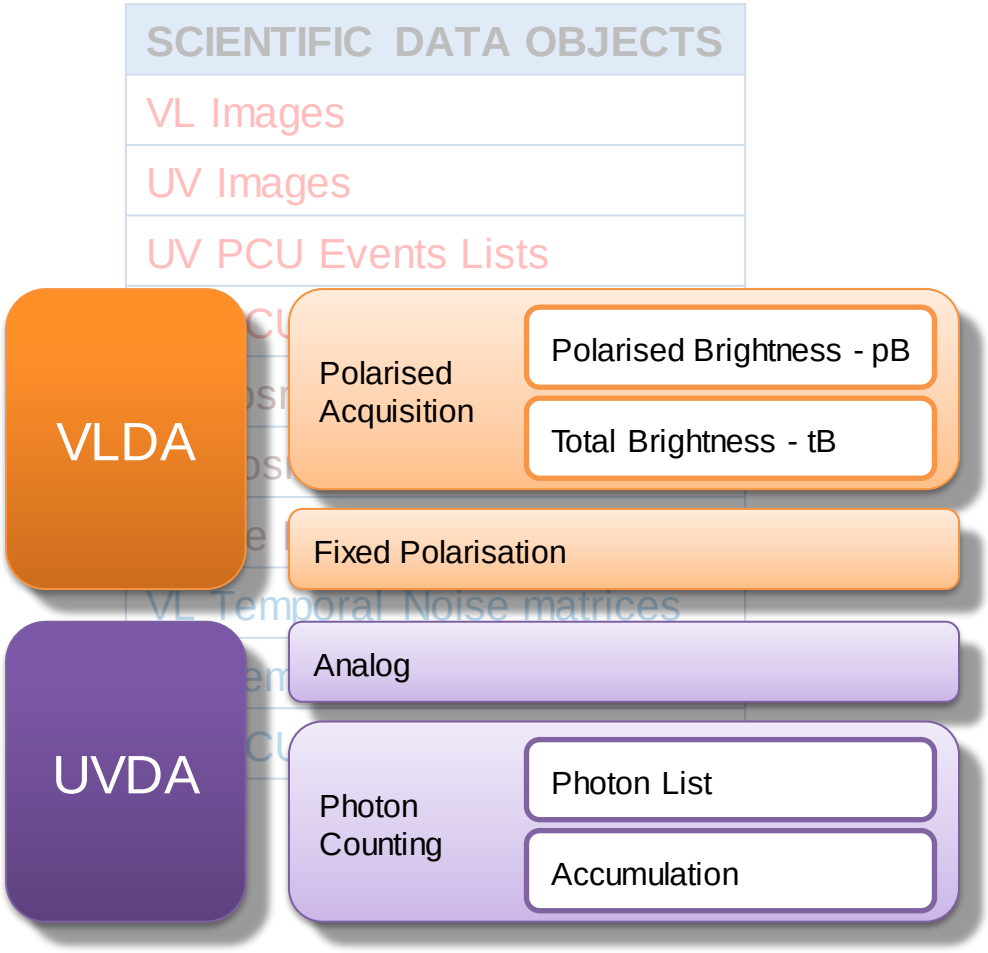
For each channel three scientific ACQUISITION SCHEMES are available:



OBSW Overview

Data processing flow and terminology common to both channels (*):

- Each detector produces continuosly FRAMES having the same integration time DIT
- The acquired FRAMES are averaged on board in order to obtain one IMAGE every CADENCE,
- IMAGES are compressed (including binning and masking), packetised and sent to ground.
- This process goes on for the DURATION of the acquisition, specified by the operator
- CADENCE and DURATION of the two channels can be the same or different.

(*) Not fully applicable to UV-Photon Counting

OBSW overview

Scientific Flags

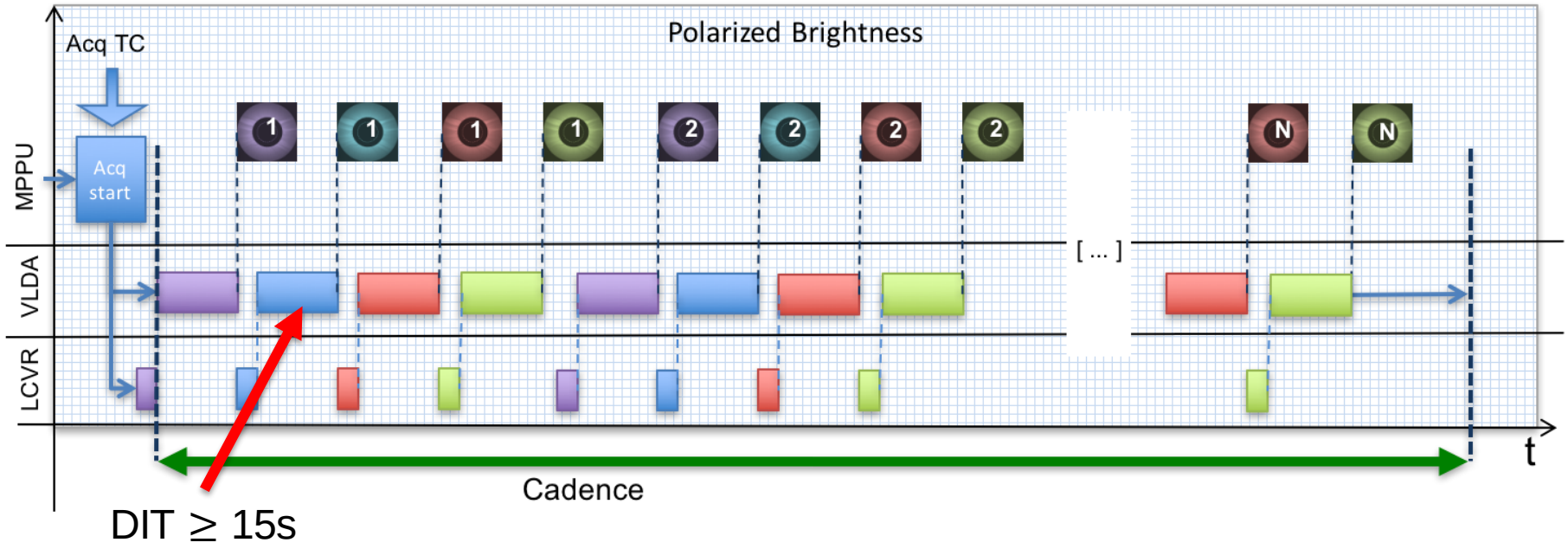
- CME

Safety monitoring

- SunDisk
- MCP overillumination

VL-pB

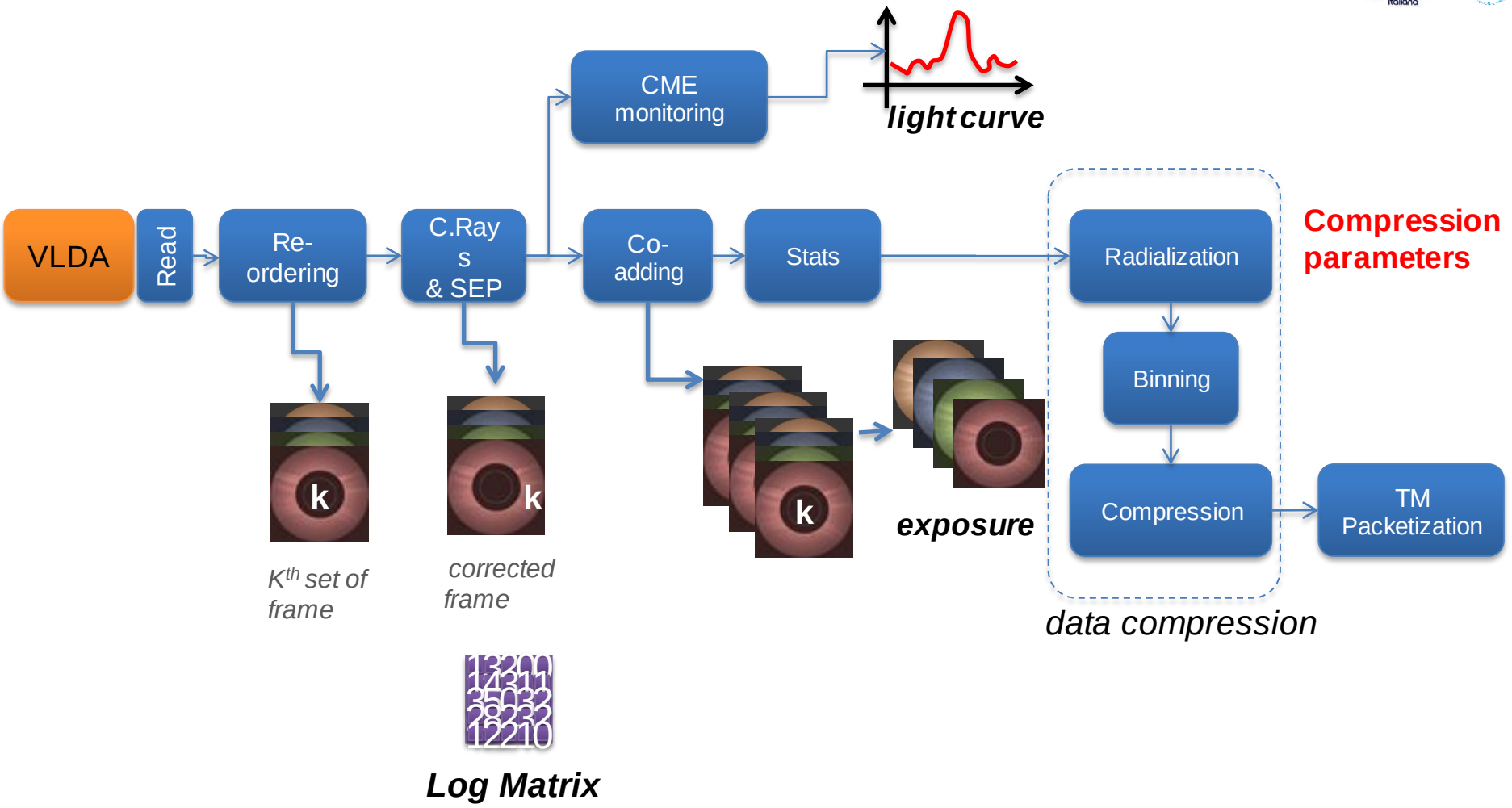
The VL-pB acquisition scheme allows to take coronal images at 3 or 4 different polarization.



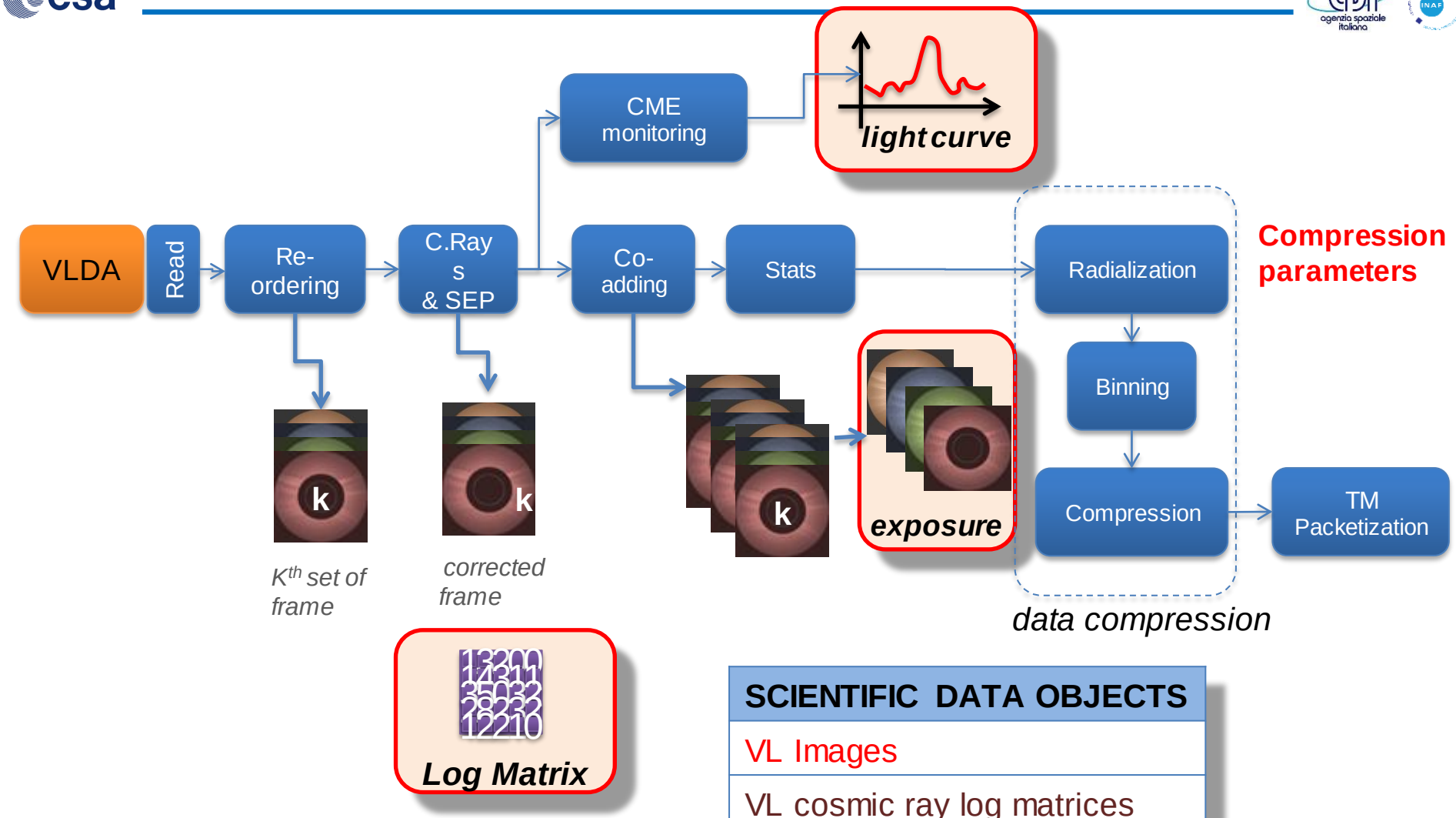
Each frame is acquired at a different known polarisation angle.

The measurement is carried out cycling over the NPOL specified polarization angles and thus producing an "interleaved" data stream - (where NPOL = 3 or 4)

VL-pB


CME monitoring
light curve
VLDA
Read
Re-ordering
C.Rays & SEP
Co-adding
Stats
Radialization
Compression parameters
Binning
Compression
TM Packetization
k
k
k
exposure
Kth set of frame
corrected frame
data compression
Log Matrix

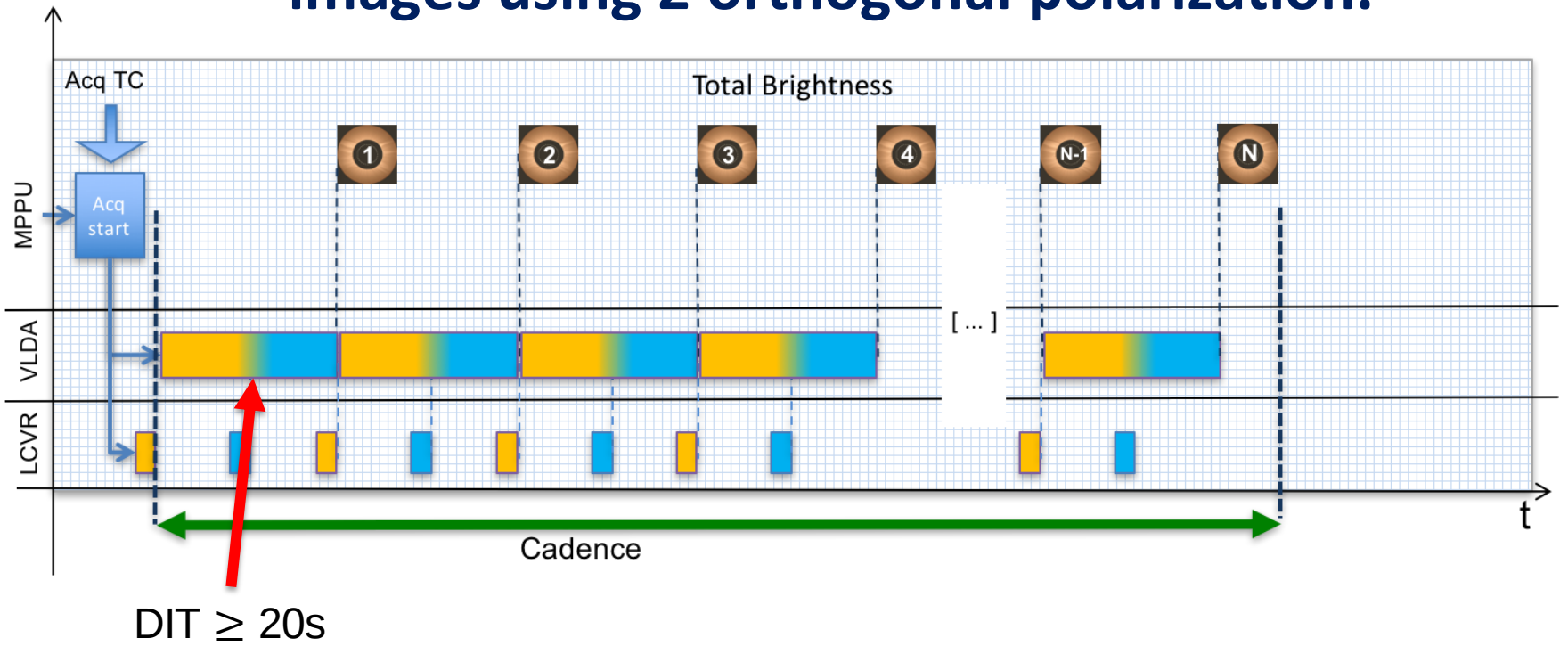
VL-pB



SCIENTIFIC DATA OBJECTS
VL Images
VL cosmic ray log matrices
Visible Light Curves

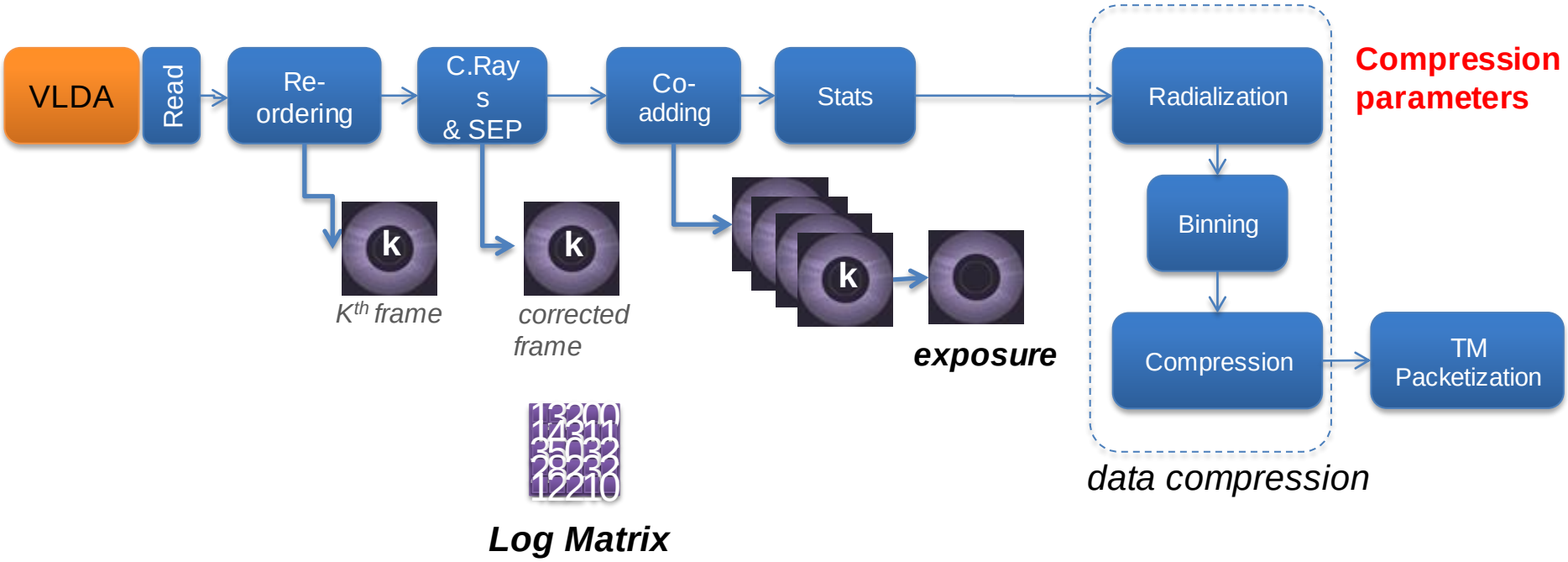
VL total Brightness

The VL-tB acquisition scheme allows to take tB coronal images using 2 orthogonal polarization.

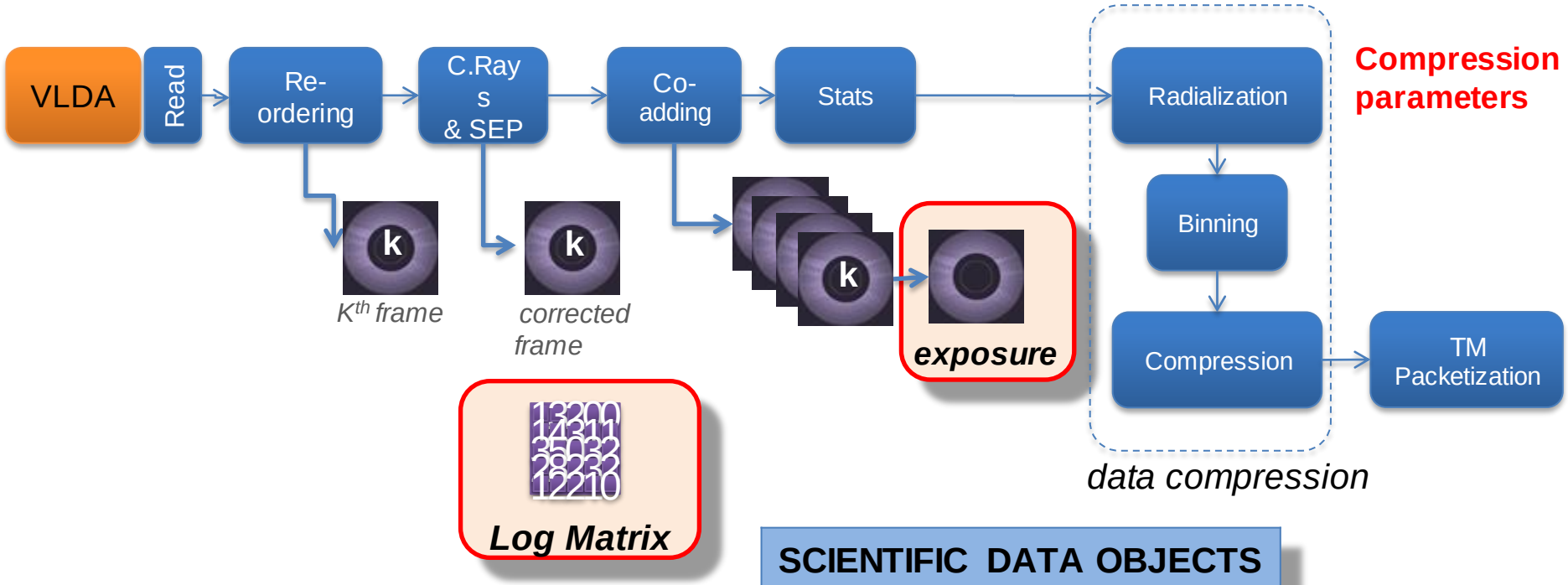


Each frame is acquired switching the polarization angle exactly in the middle of the detector integration time.

VL total Brightness



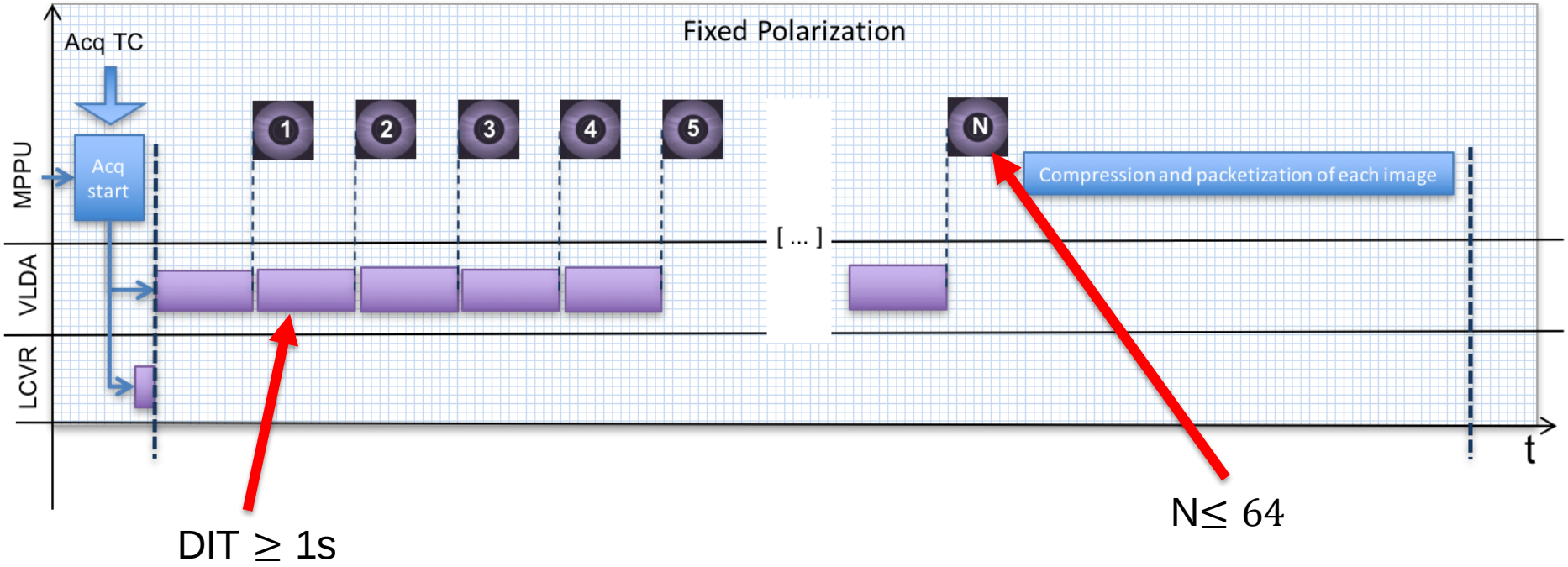
VL total Brightness



SCIENTIFIC DATA OBJECTS
VL Images
VL cosmic ray log matrices

VL Fixed Polarization

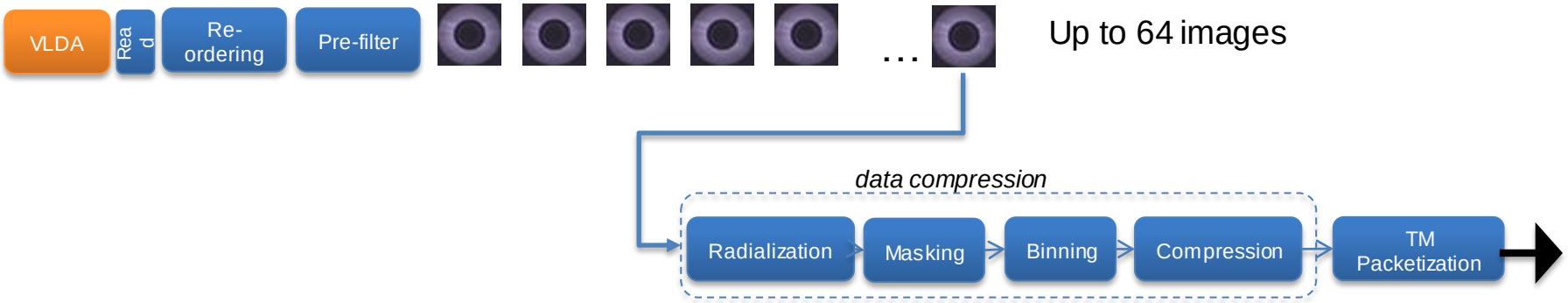
The VL-FP acquisition scheme allows to take a snapshot of up to 64 IMAGES with very short DIT ≥ 1s



All frames are acquired with the same fixed polarization angle selectable by the operator

VL Fixed Polarization

The data processig is performed at the end of the acquisition.



The total acquisition time is less than 11min, inclusive of processing, compression and delivery

VL Fixed Polarization

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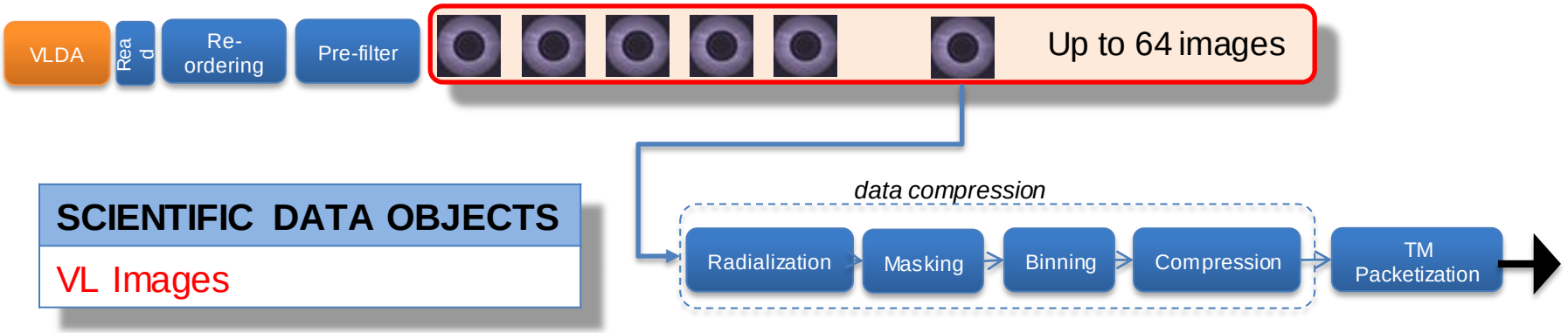

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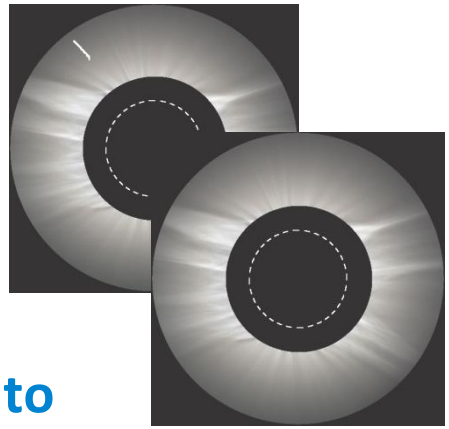
CR/SEP removal

A Cosmic Ray Scrub can be applied to remove cosmic rays from METIS images (VL-pB, VL-tB, UV-Analog);

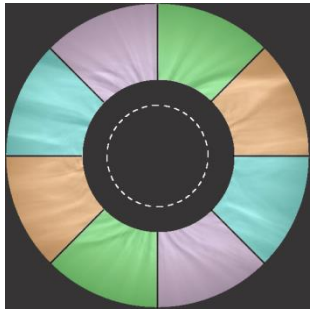
The algorithm compares pixels having the same coordinates belonging to 2 images sequentially acquired in the same configuration. If the pixels show very different signals, the pixel having the maximum value is replaced by the pixel with the minimum value.



The pixels that have been modified are recorded into a Log Matrix.

CME Monitoring/Light Curves/Sun Disk Monitor

The CME detection algorithm operates on the VL-pB frames. It computes the running difference of consecutive images and looks for abrupt changes caused by possible arising of transient bright events.

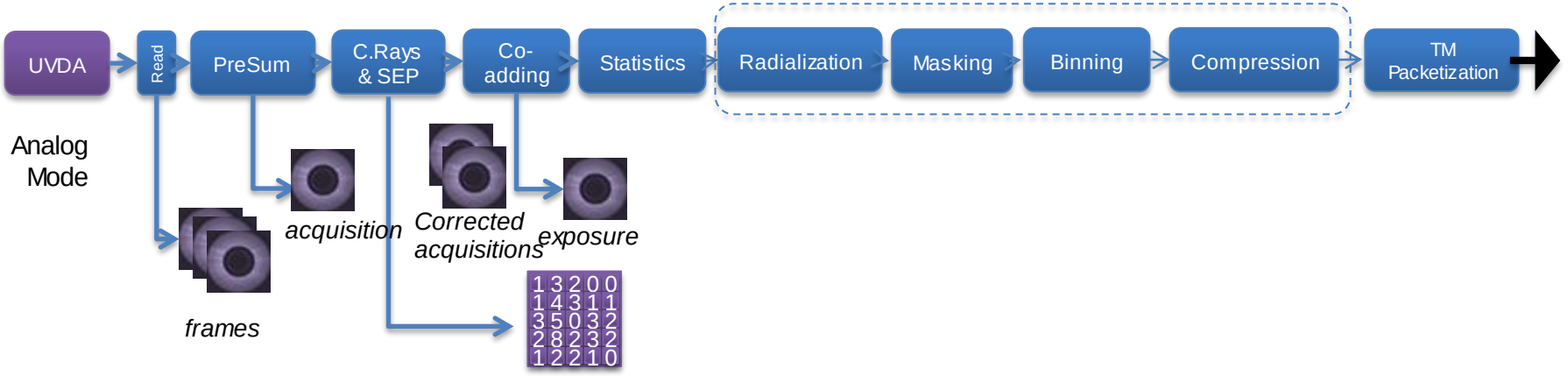


METIS field of view is split in 8 sectors; pixels of each sectors are summed together to produce 8 temporal series of intensity (Light Curves).
The differences between two consecutive frames (with the same polarization) is monitored against a threshold. In case of event a specific and predefined observation can be executed autonomously.

The same algorithm is used to monitor if the Sun disk is entering into the Metis FOV.

UV-Analog

While in this acquisitions scheme (Figure 4-5) the UV detector acquires and delivers frames at constant rate and detector integration time (DIT ≥ 1s).



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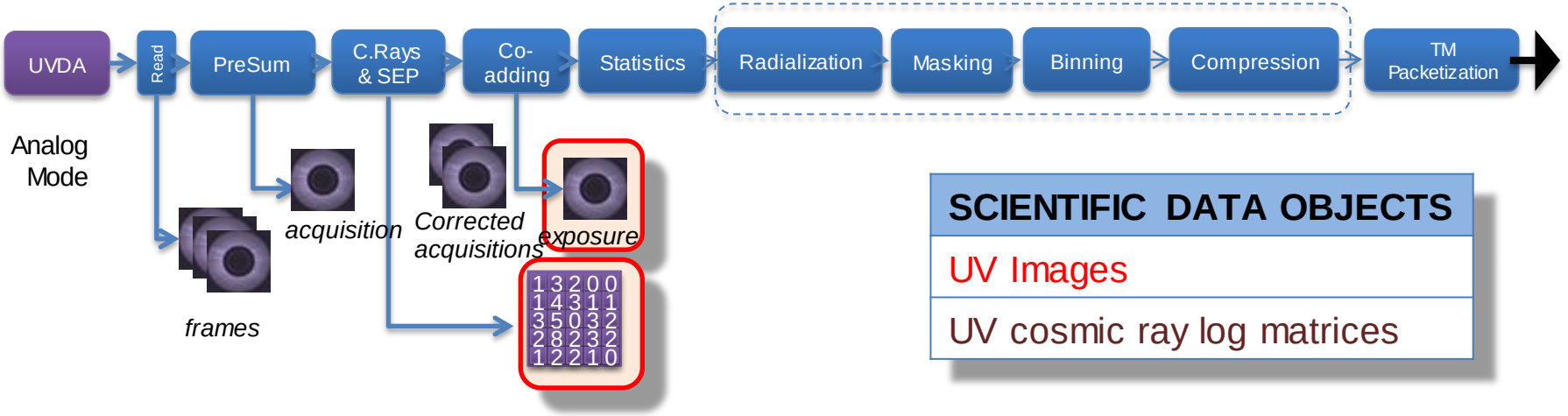
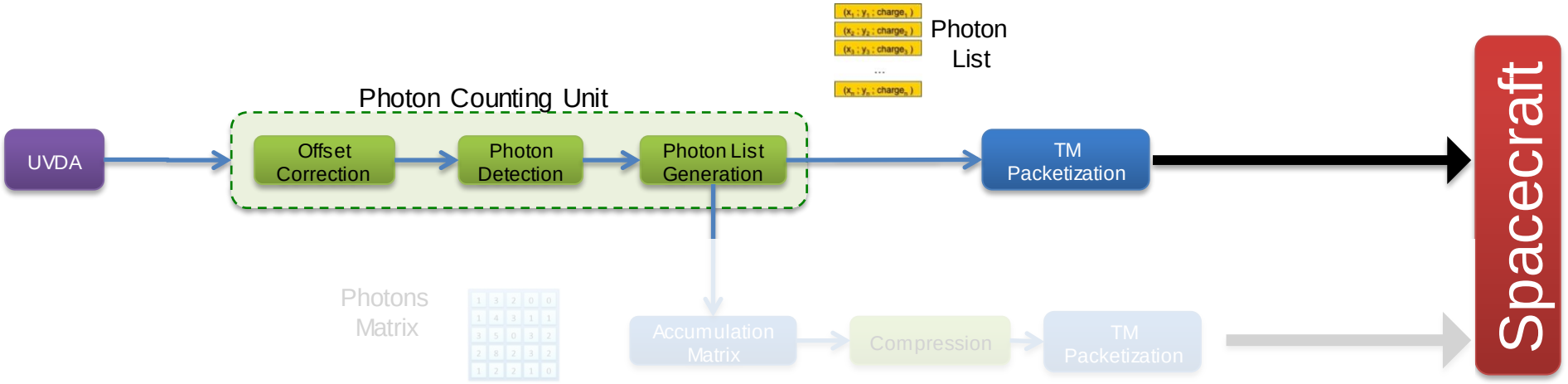


SCIENTIFIC DATA OBJECTS
UV Images
UV cosmic ray log matrices

UV-Photon Counting – List Mode

While in this acquisitions scheme the UV detector acquires and delivers frames at full speed (DIT = 98ms). The PCU analyses 3 detector rows at time and detects the events.



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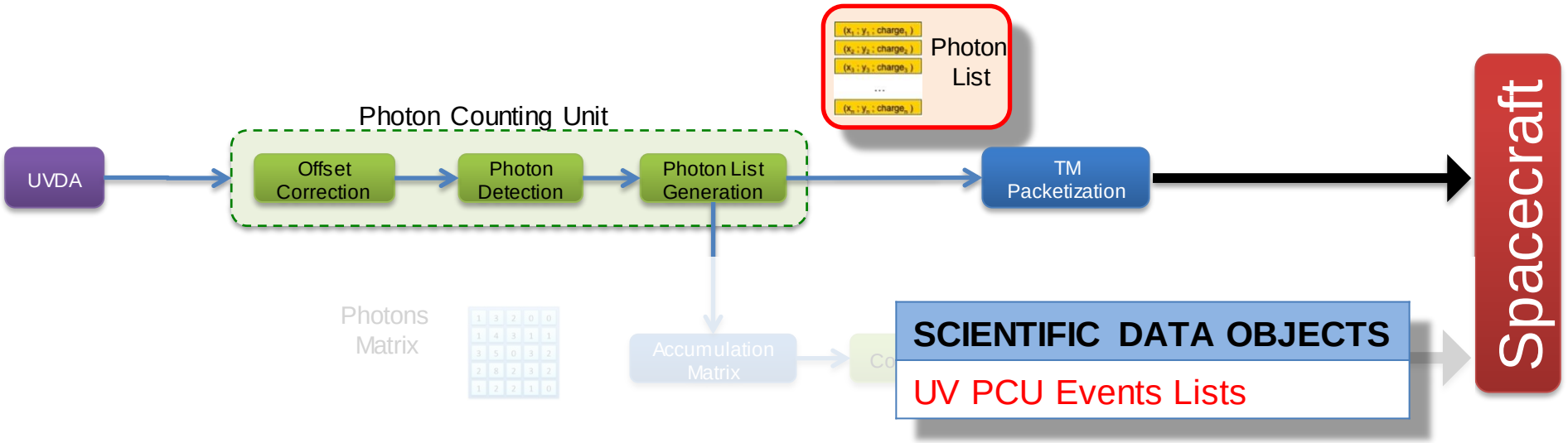
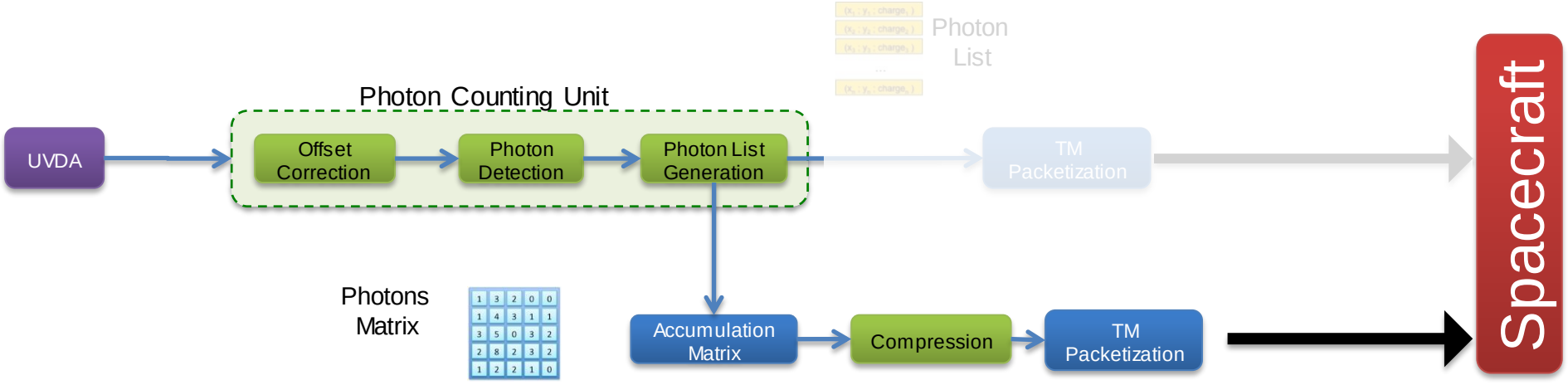


UV-Photon Counting – Accumulation Mode

While in this acquisitions scheme the UV detector acquires and delivers frames at full speed (DIT = 98ms). The PCU analyses 3 detector rows at time and detects the events.



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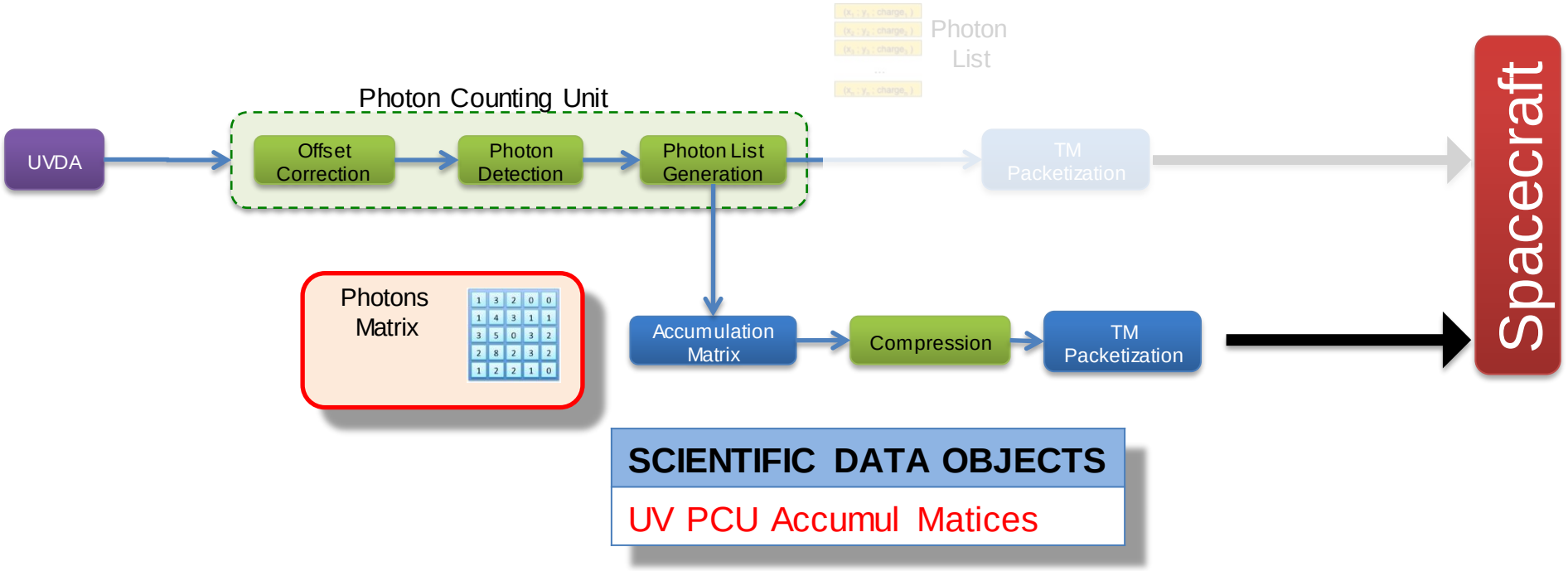

COMPRESSION ALGORITHM

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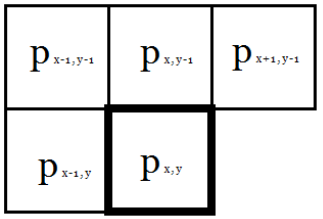
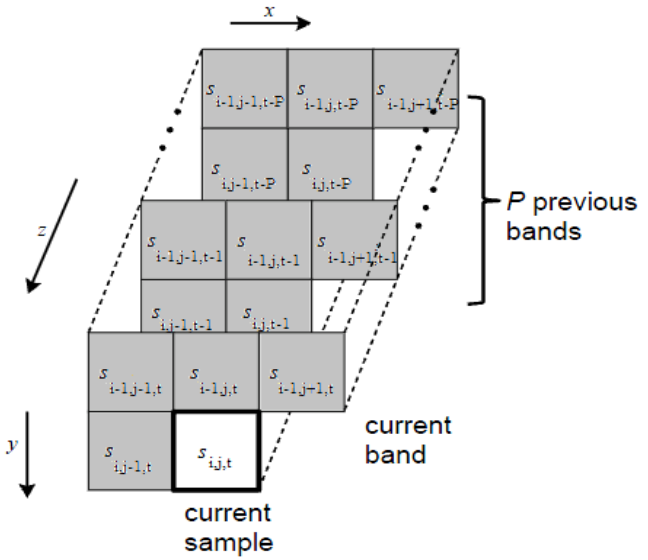
Proposed approach

Lossless compression typically employs prediction-based techniques. In particular, a mathematical model is used to predict a pixel given the knowledge of pixels in the current and previous bands that have already been processed

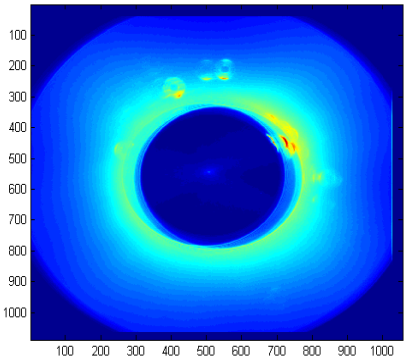


Algorithm based on CCSDS-123, optimized fo solar corona images:

- multi-temporal image compression
- lossless and lossy compression in one single package.
- lossy mode bounds maximum absolute error



Ad-hoc routine to tailor the compression process to the geometry of solar corona images
Off-line procedure: a non-adaptive mapping that is calculated just once, then applied to every acquired image

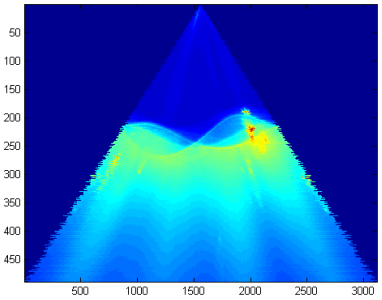


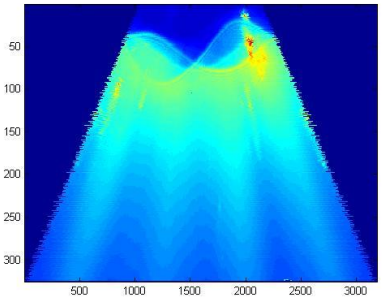
Test image - STEREO A

r = 0, R = 500

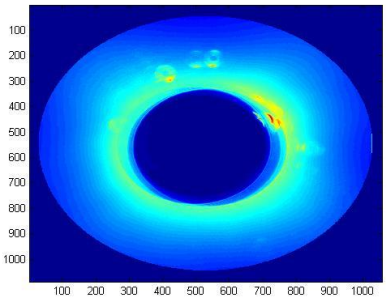
r = 170, R = 500

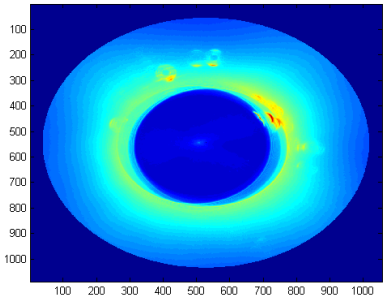
radialization





reconstruction





METIS con algorithm

Advantages of this approach:

- Gain in terms of compression ratio
- more natural way to exploit inter-pixel correlations
- Computationally light and off-line procedure
- Possibility to keep lossless property if desired (no interpolation performed)
- Enables radial binning
- Makes it easier to identify regions of interest

LOSSLESS COMPRESSION RATIO		
	COR 1 STEREO A	COR 1 STEREO B
Original image	2,3308	2,6822
Radialized image	2,5228	2,8556
Improved radialization	3,0956	3,5297

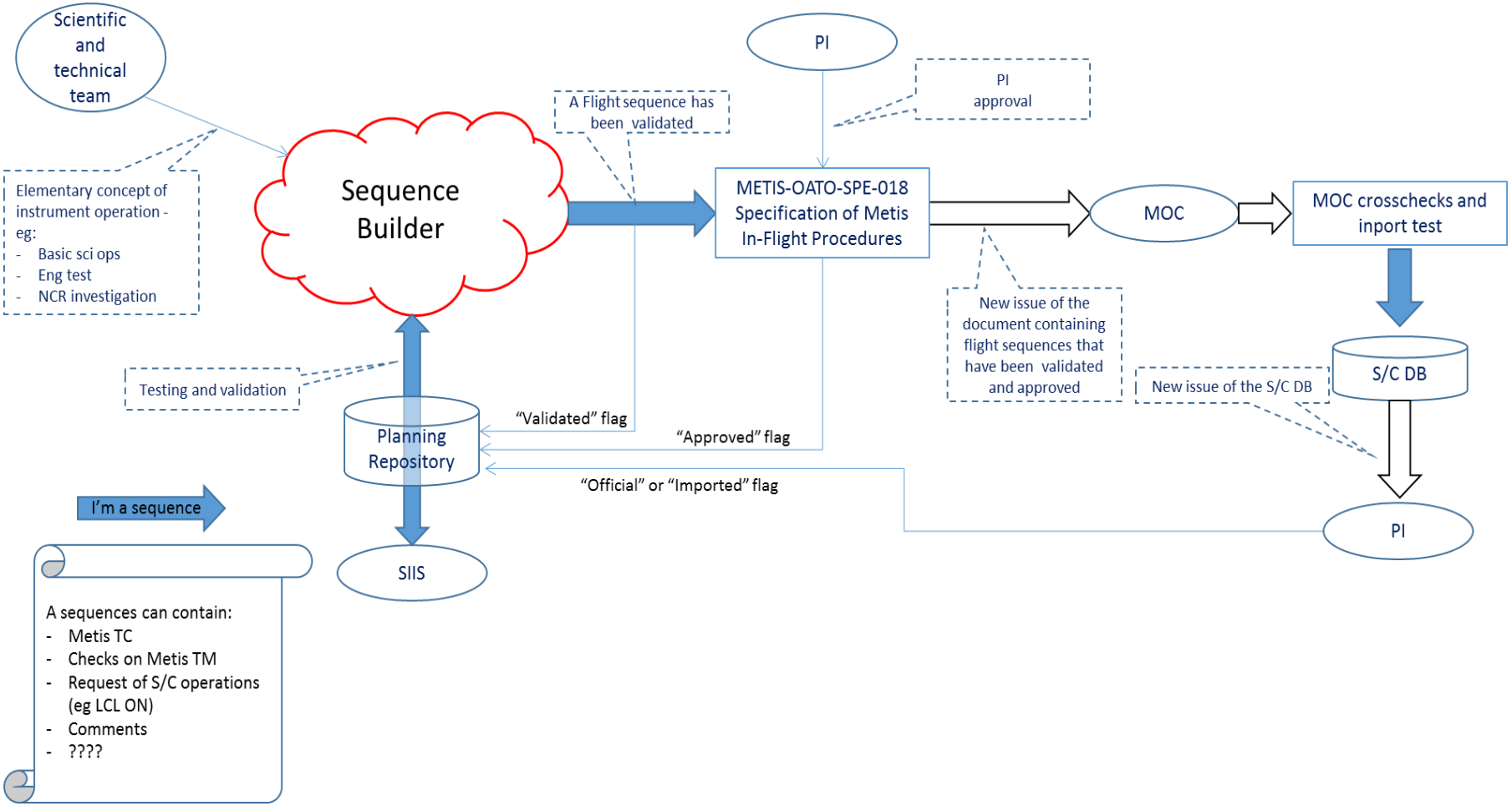
Planning Center Overview

The Planning Center infrastructure is based on three main elements...

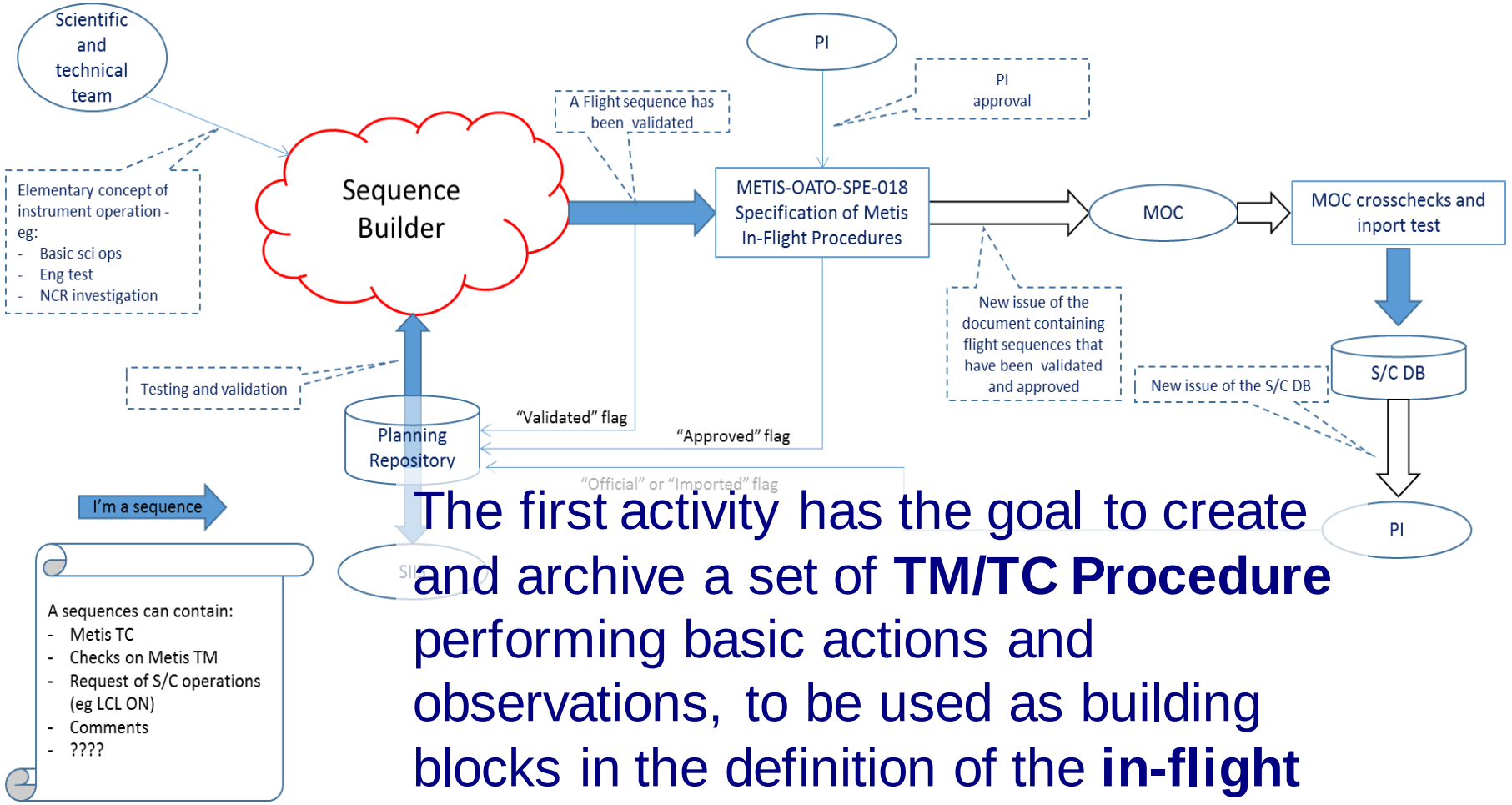
- **The Procedure Builder**
- **The Planning Repository**
- **The Timeline Editor**

… supporting two activity flows

First activity flow

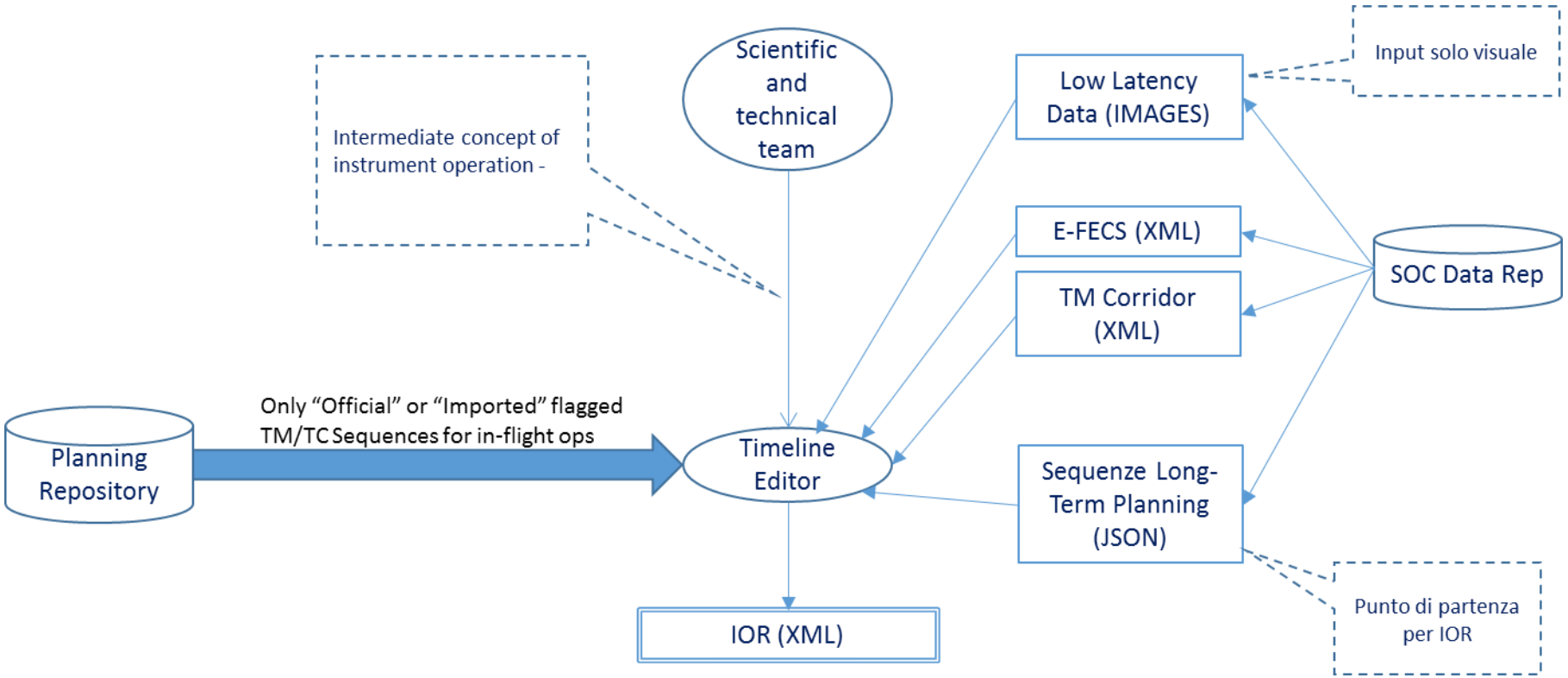


First activity flow

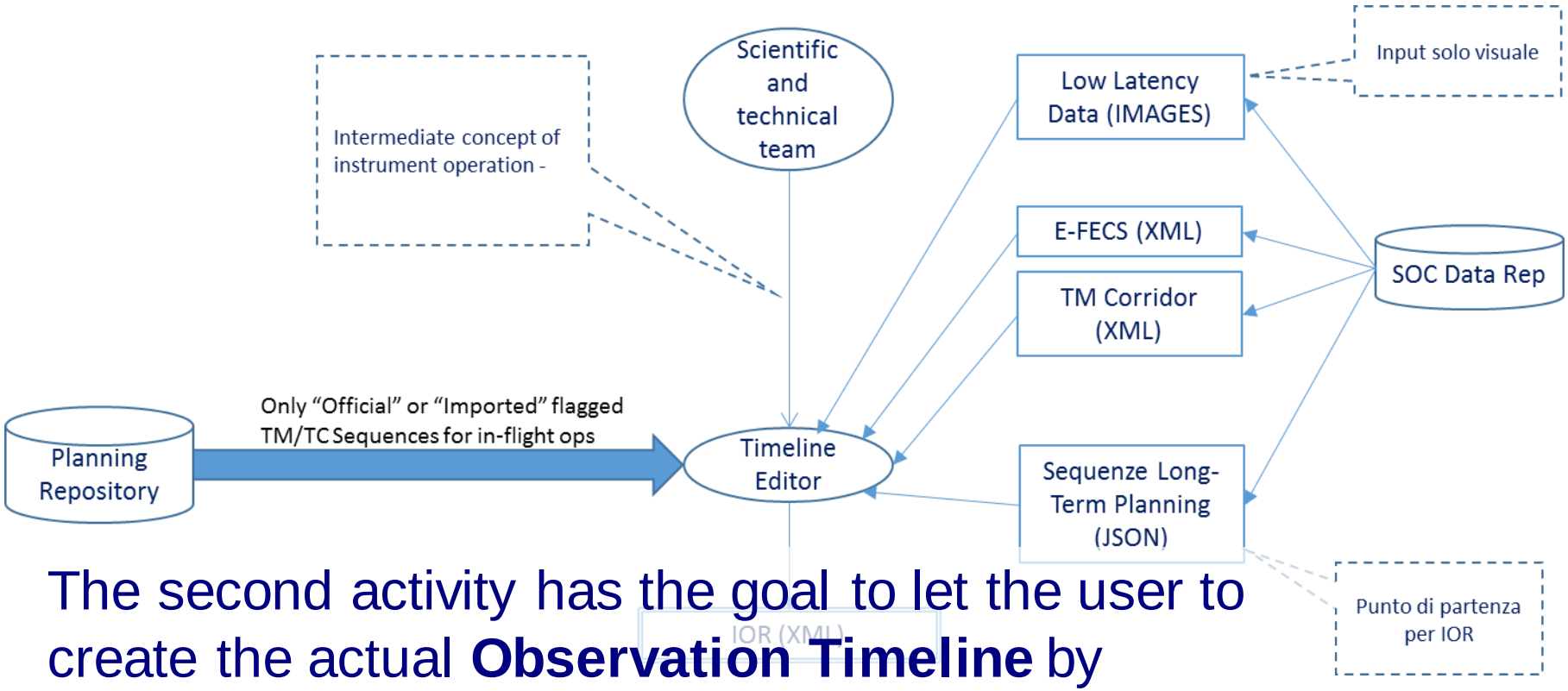


The first activity has the goal to create and archive a set of **TM/TC Procedure** performing basic actions and observations, to be used as building blocks in the definition of the **in-flight observing Timeline** or to run on-ground test/investigations.

Second activity flow



Second activity flow



The second activity has the goal to let the user to create the actual **Observation Timeline** by selecting the proper TM/TC Procedures present in the "Planning Repository", compatible with the observational goals and mission constrains, to be exported as IOR and to be passed to ESA.

Metis EMC test spec (proposal)

End

of

presentation