



Stellar Science data processing overview

- Background
- Preparatory pipeline
- Operational pipeline
- High-level operational concept
- Development schedule





Terminology

- Classical stellar parameters = not derived from asteroseismic data
 - T_{eff} , luminosity, $\log(g)$ from spectra, $[\text{Fe}/\text{H}]$, surface elemental abundances, projected rotational velocity
- Asteroseismic parameters = derived from asteroseismic data
 - Oscillation frequencies, large separation, max height in power spectrum
- Stellar properties = mass, radius, age



More information

	Ref: PLATO-LESIA-PSPM-DD-0021 Issue: 1 - Rev: 07 Date: 04/08/2023 Page: 1 / 23	
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Work and data flows of the stellar L1/L2 pipeline

Prepared by	Date
Christian Renié, LESIA, Paris Observatory Kévin Belkacem, LESIA, Paris Observatory	04/08/2023

Ref: PLATO-LESIA-PSPM-DRD-0009 Issue: 2 - Rev: 1 Date: 09/01/2023 Page: 1 / 96	
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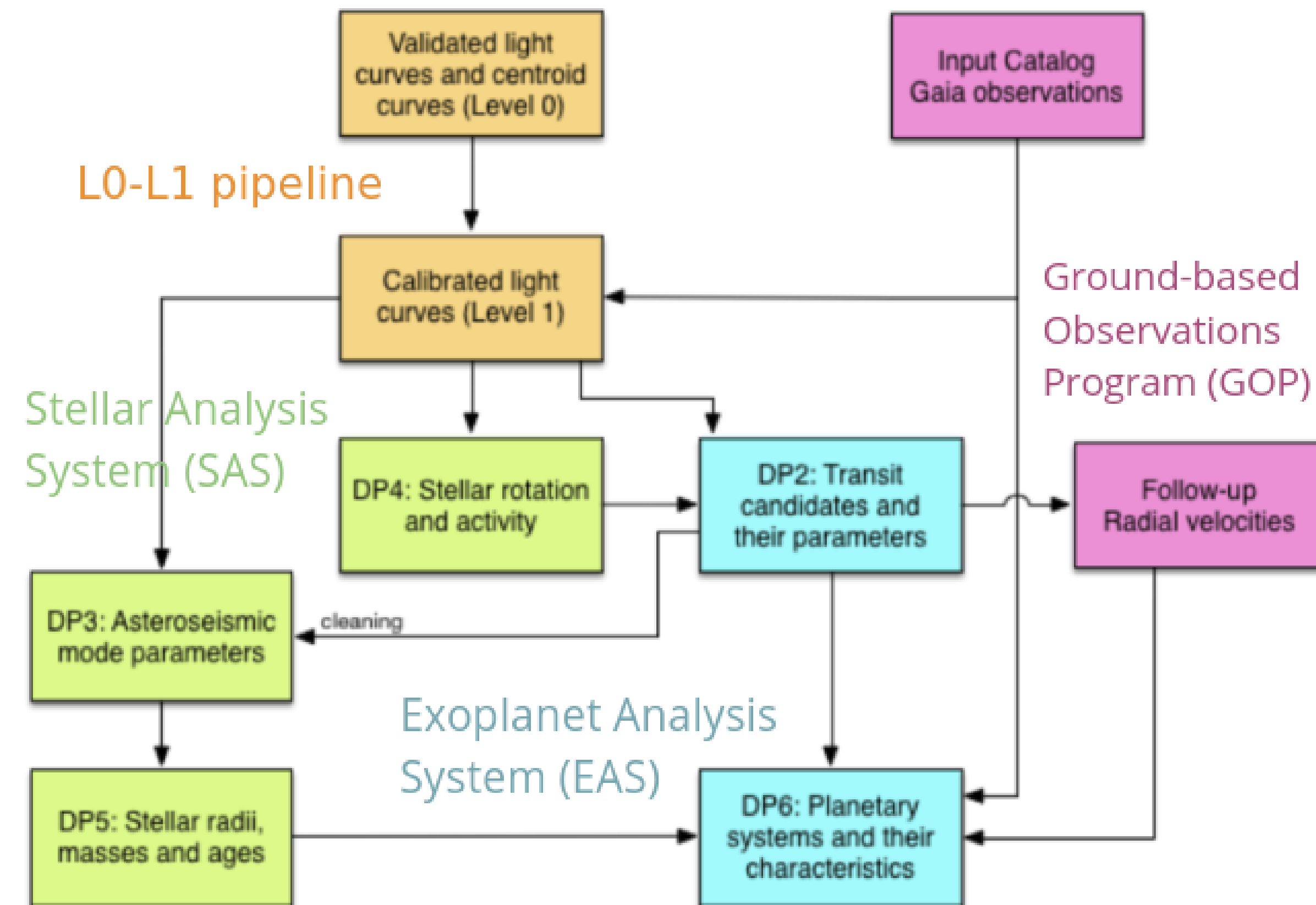
Data product description document of the stellar L1/L2 processing pipeline

Prepared by	Date
Rhita-Maria Ouazzani, LESIA, Paris Observatory Christian Renié, LESIA, Paris Observatory Kévin Belkacem, LESIA, Paris Observatory	09/01/2023



Data products

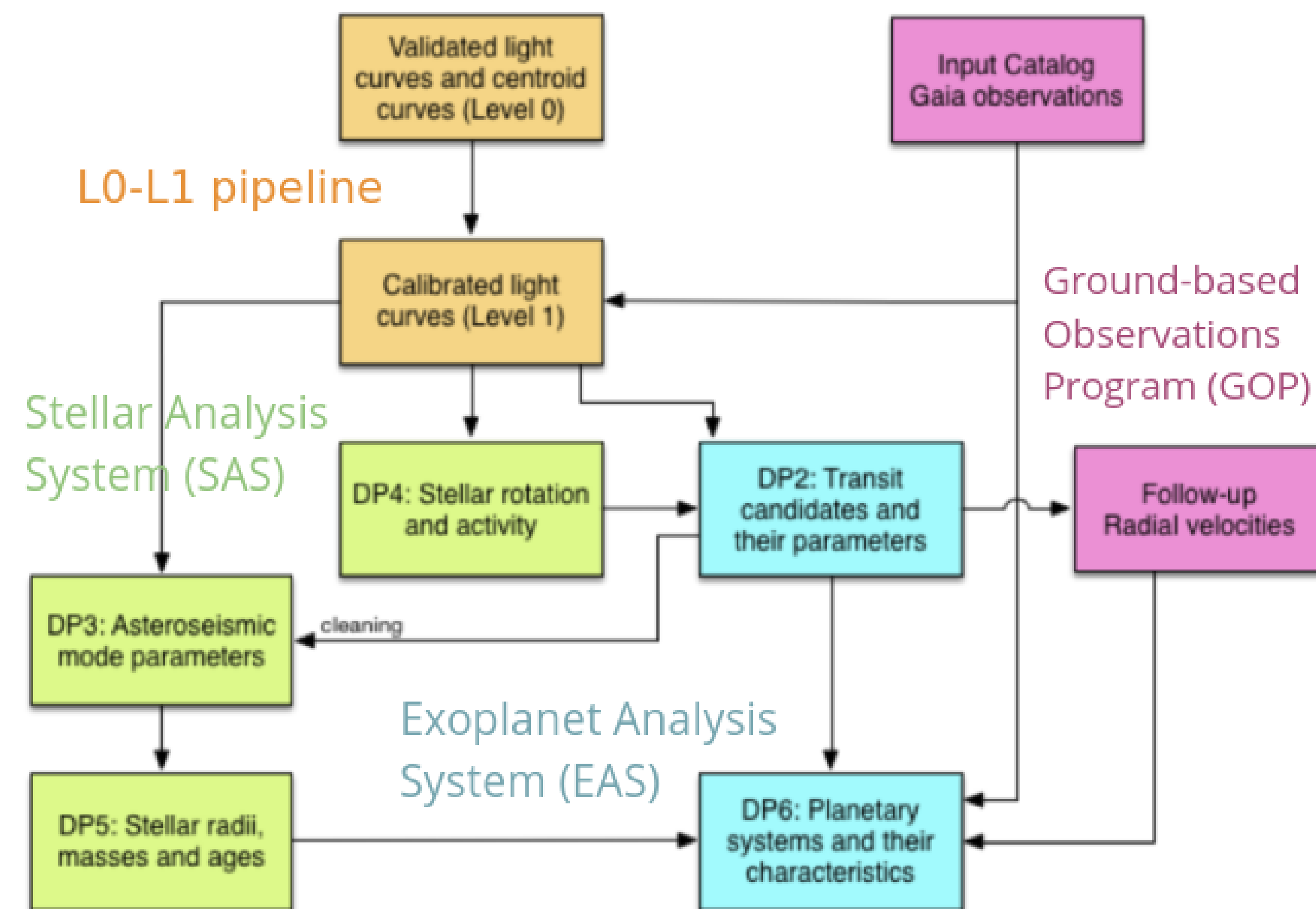
- Level 1 products:
 - Calibrated light curves, imagerettes, and centroid curves
 - Information on photometric contaminants
- Level 2 products:
 - Planetary candidates with transit parameters
 - Asteroseismic mode parameters
 - Stellar rotation periods & activity metrics
 - Stellar radii, masses, and ages
 - Living catalogue of planetary systems confirmed from PLATO data only, with parameters
- Level 3 products:
 - Living catalogue of planetary systems confirmed from PLATO data & follow-up data, with parameters





Data products

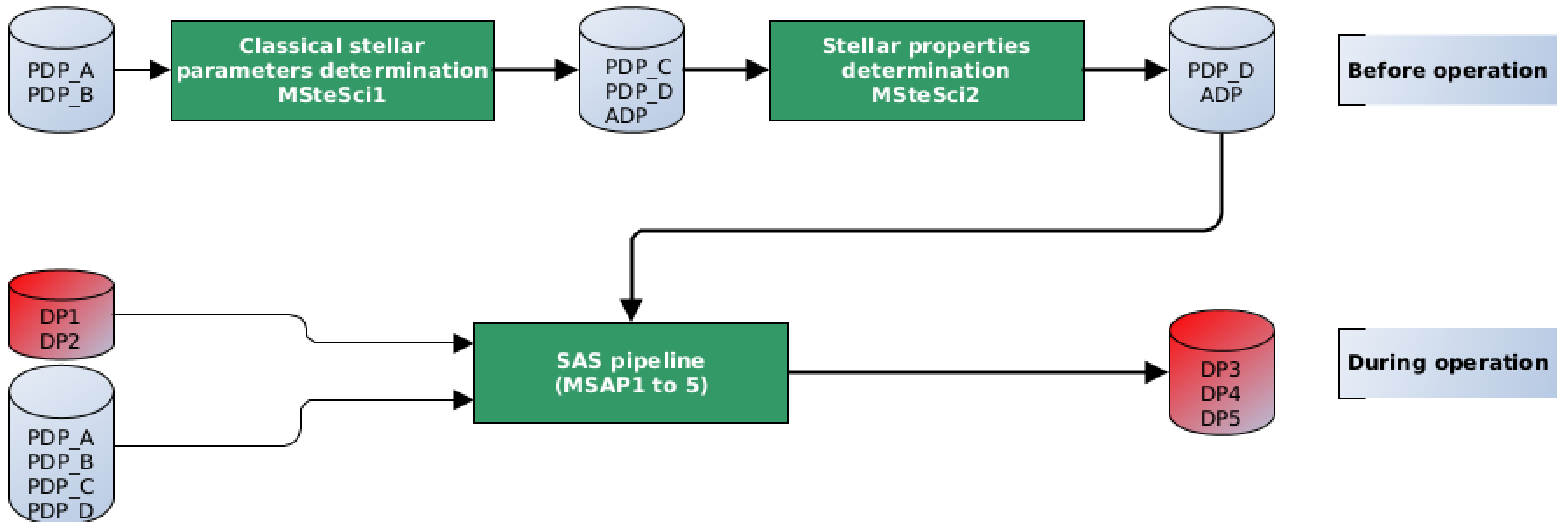
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Main scope and objectives

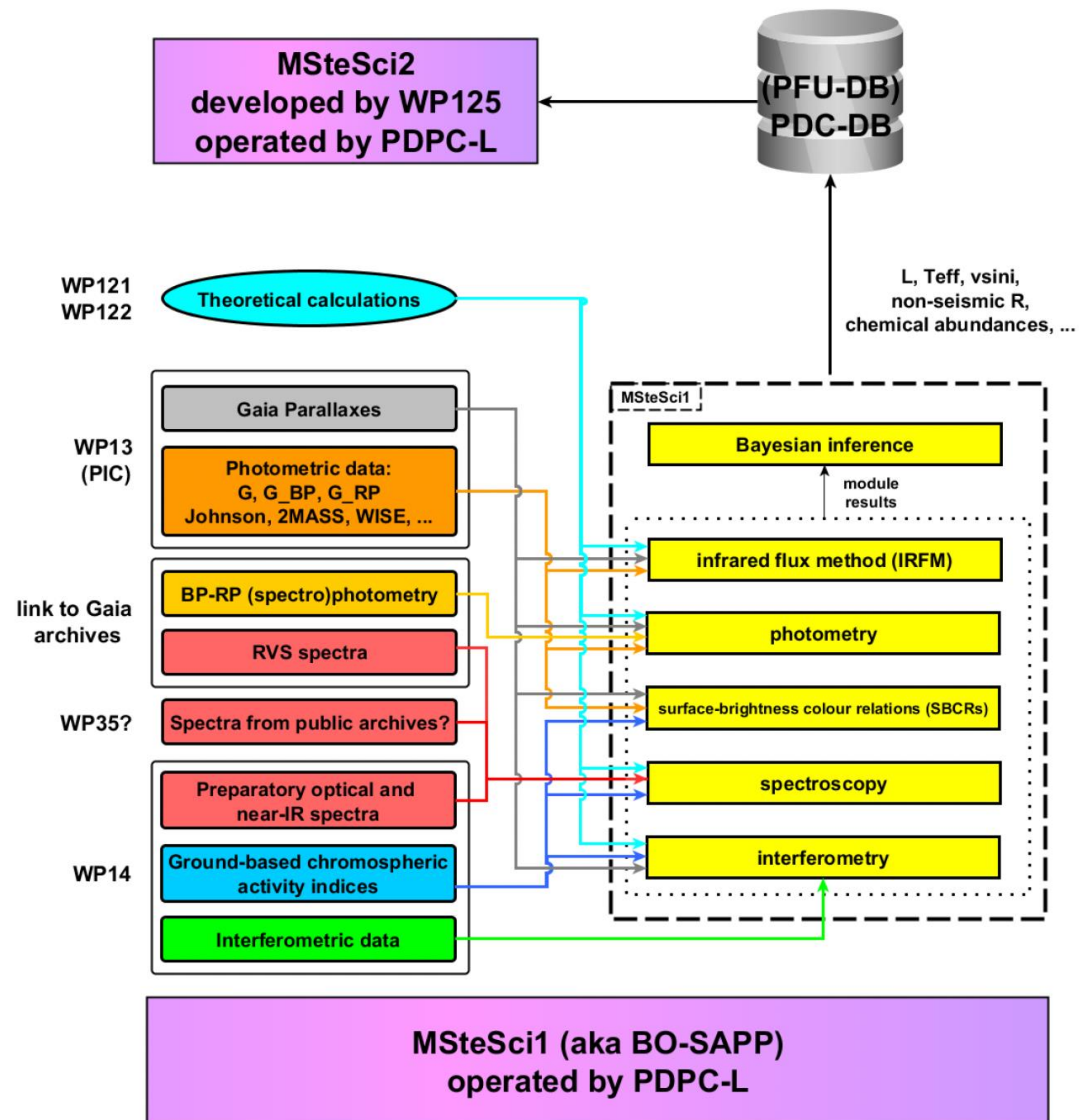
- Two phases of the data processing pipeline
 - Preparatory pipeline run before launch
 - Operational pipeline





Preparatory pipeline

- MSteSci1
 - Primarily computes “classical” stellar parameters based on preparatory data Applied to all core science samples (P1, P2, P4, P5) *with suitable preparatory data*
 - Two channels – FGK stars & M-dwarfs
- MSteSci2
 - Determines first guess stellar radius, mass, and age



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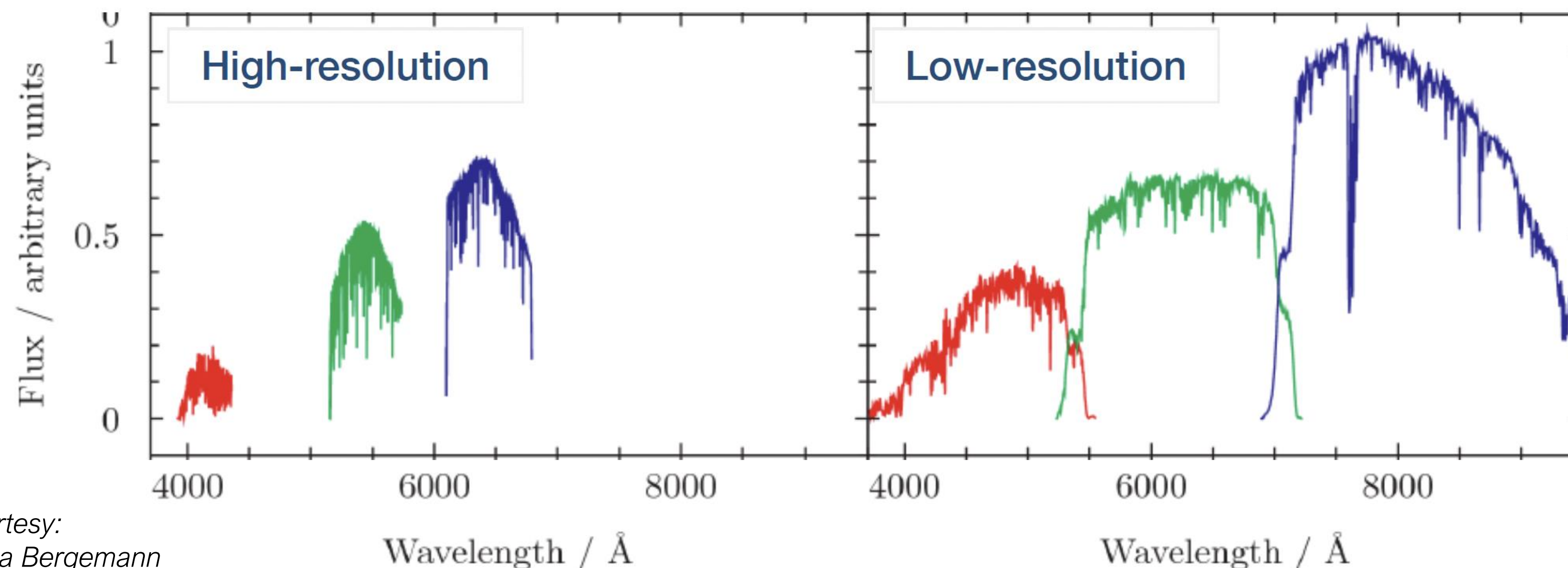
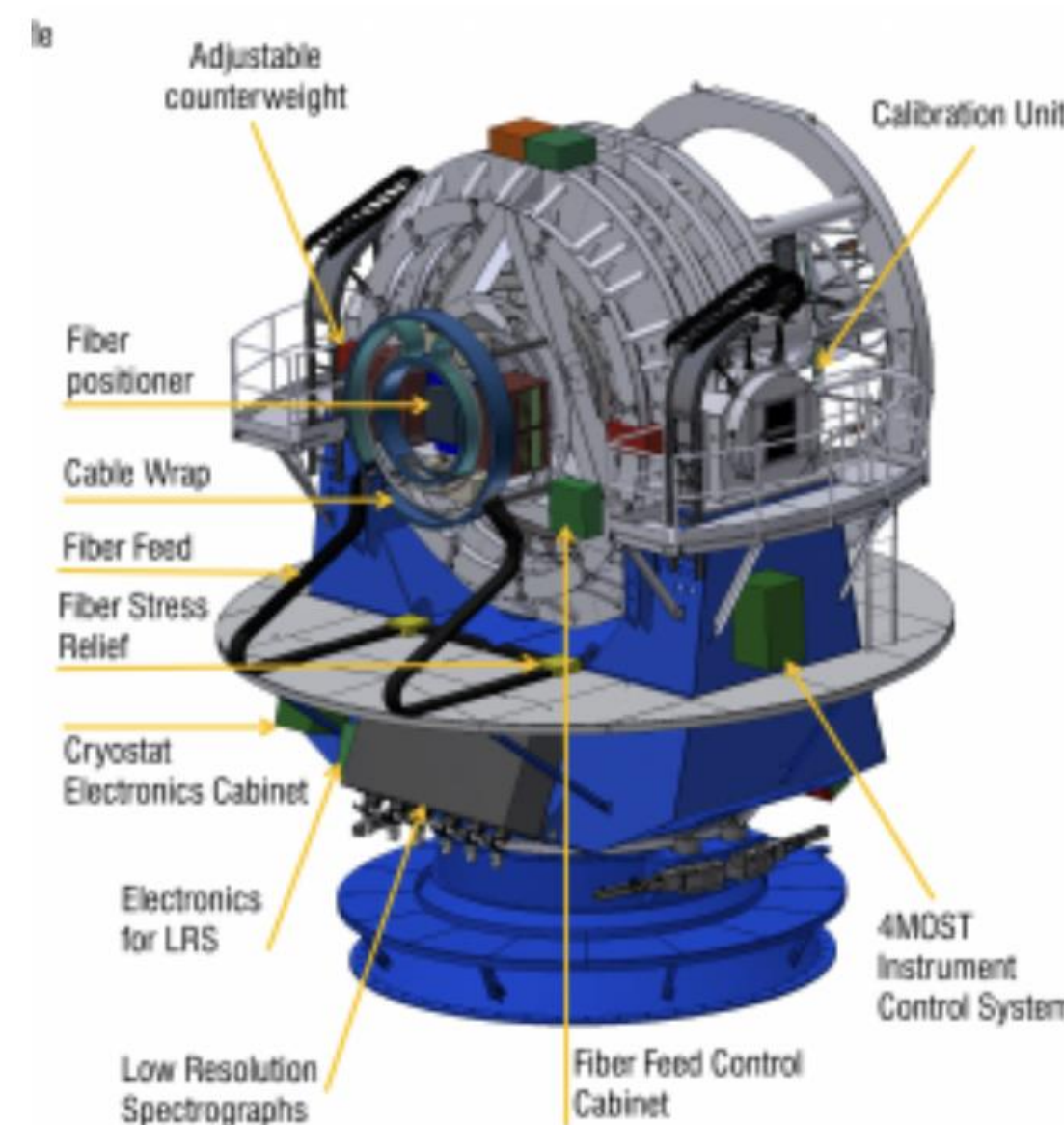
Description of MSteSci1 and MSAP2 pipelines

Prepared by	Date
Thierry Morel, AGO, Liège University, Belgium	07/08/2023



4MOST

Specification	Design value
Field-of-View (hexagon)	~4.1 degree ² ($\phi > 2.5^\circ$)
Multiplex fiber positioner	2436
Medium Resolution Spectrographs (2x)	R~4000–7500
# Fibres	812 fibres (2x)
Passband	370-950 nm
Velocity accuracy	< 1 km/s
High Resolution Spectrograph (1x)	R~20,000
# Fibres	812 fibres
Passband	392.6-435.5, 516-573, 610-679 nm
Velocity accuracy	< 1 km/s

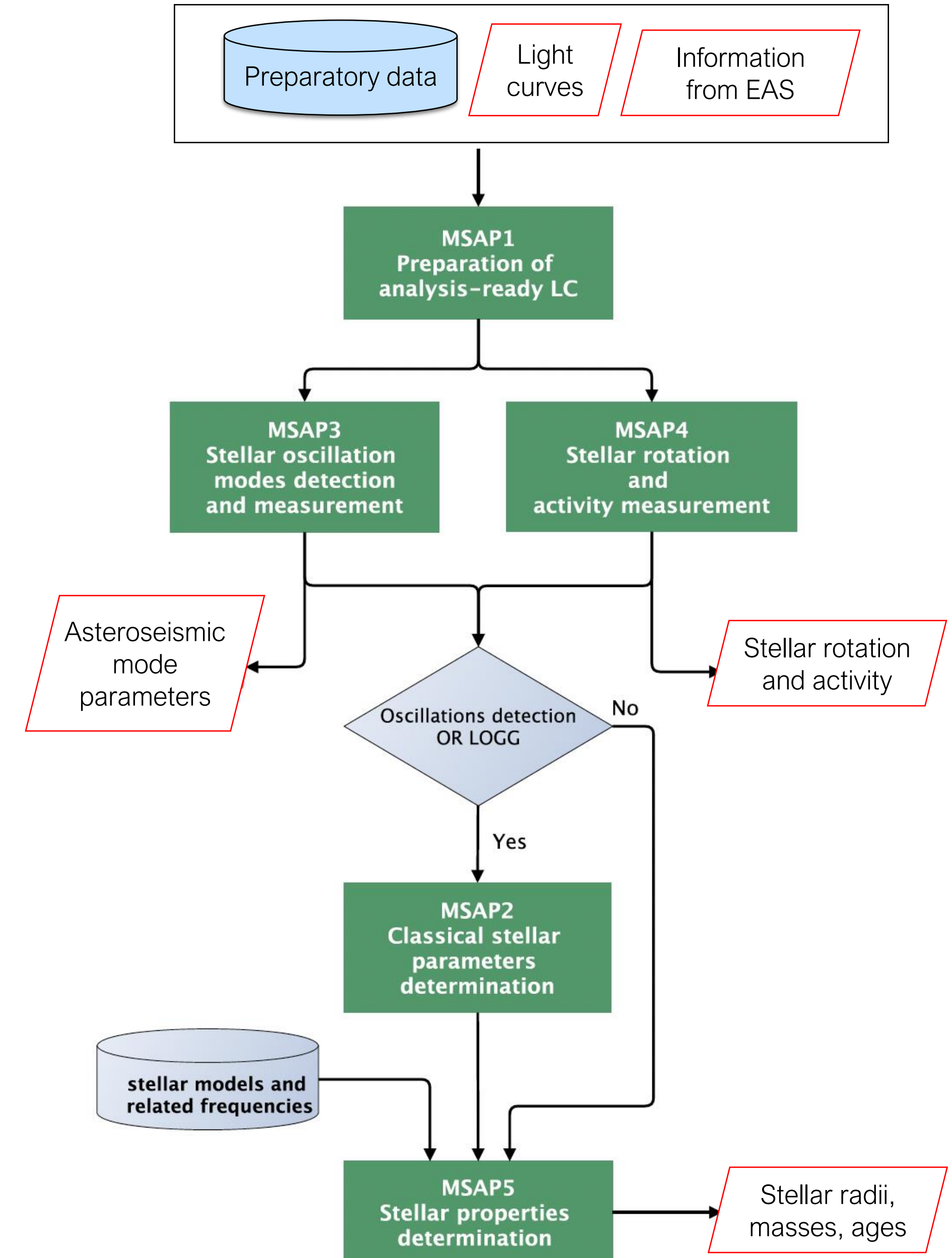


- Homogeneous stellar parameters and chemistry for P1, P2, P4, P5
- Li, C, N, O, Mg, Si, Ti, Fe, Mn, Co, Ni, Ba, Sr...
- activity indices (Ca H & K, H_{alpha}, near-IR Ca T)
- Vsin(I)
- up to 7 epochs



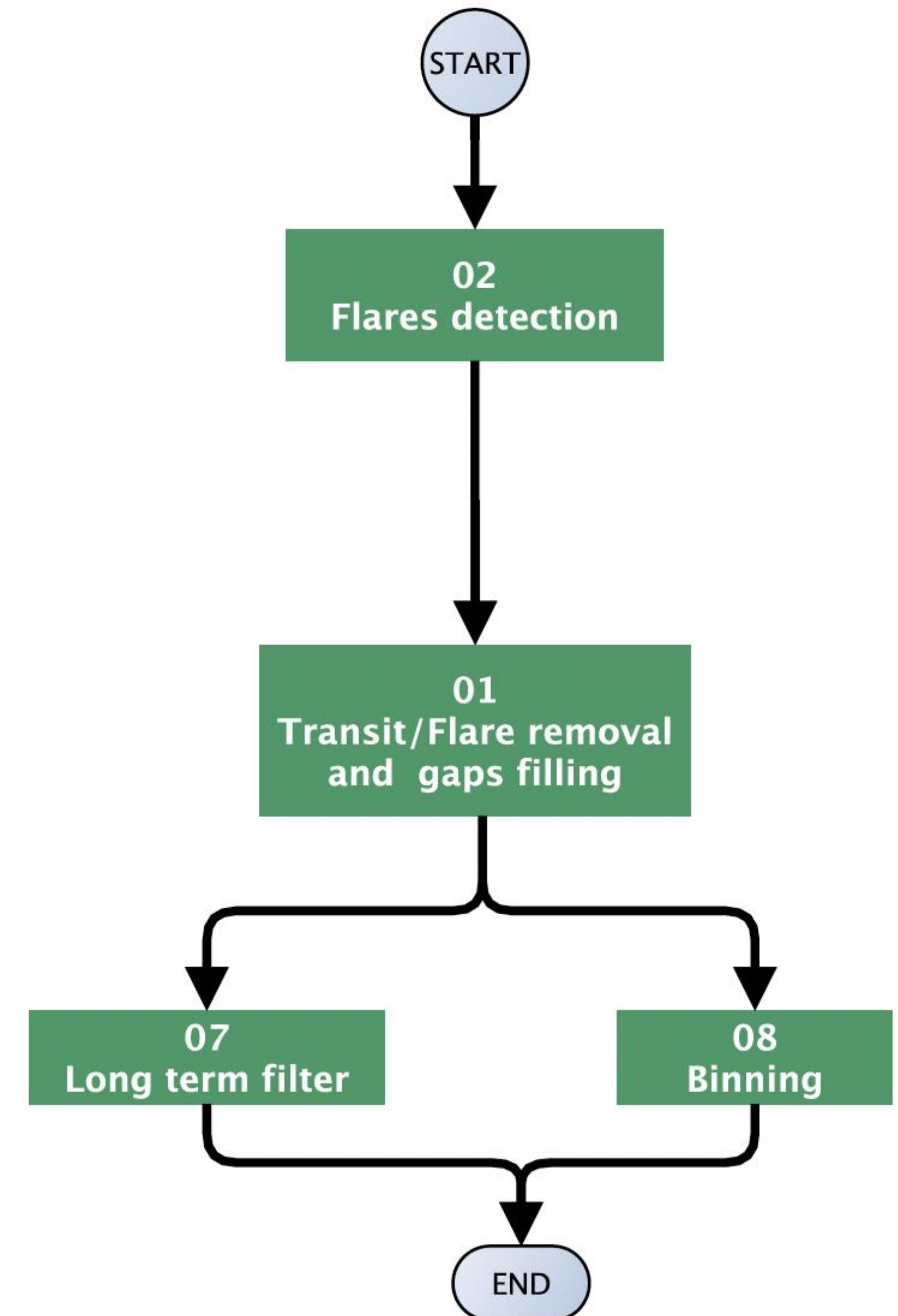
Main scope and objectives

- The operational pipeline is the "Stellar Analysis System (SAS)"
- Inputs:
 - PLATO light curves (DP1)
 - Information from Exoplanet pipeline
 - Preparatory data
- Outputs:
 - Asteroseismic mode parameters (DP3)
 - Stellar rotation periods & activity metrics (DP4)
 - Stellar radii, masses, and ages (DP5)



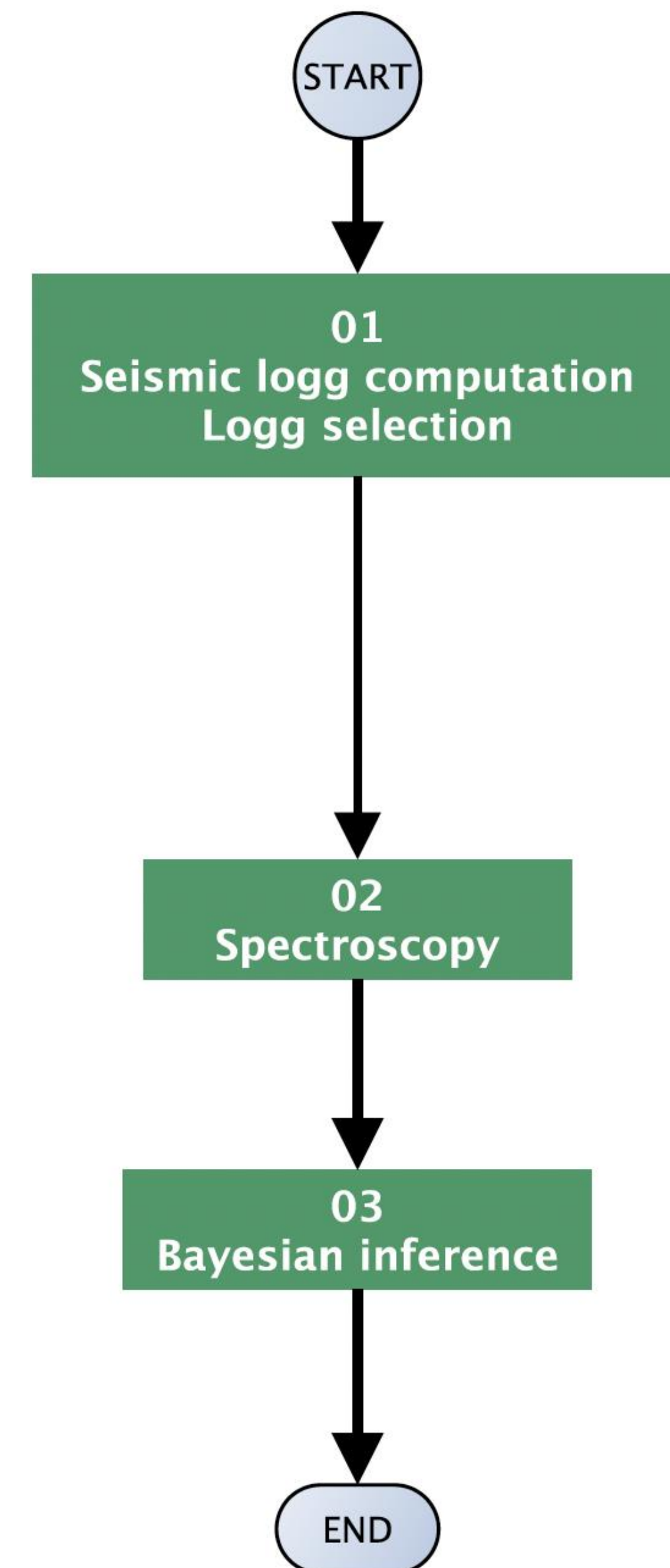
Preparation of analysis-ready light curves

- Prepare and calibrate merged and stitched Level 1 light curves ready for use in deriving stellar science data products.
 - *(detrending of residual instrumental systematics?)*
 - Detect and flag flares
 - Filter and model transits and eclipses
 - Remove flares
 - Compute power spectrum density
- Uses information from exoplanet pipeline to aid transit / eclipses treatment, but can do without.

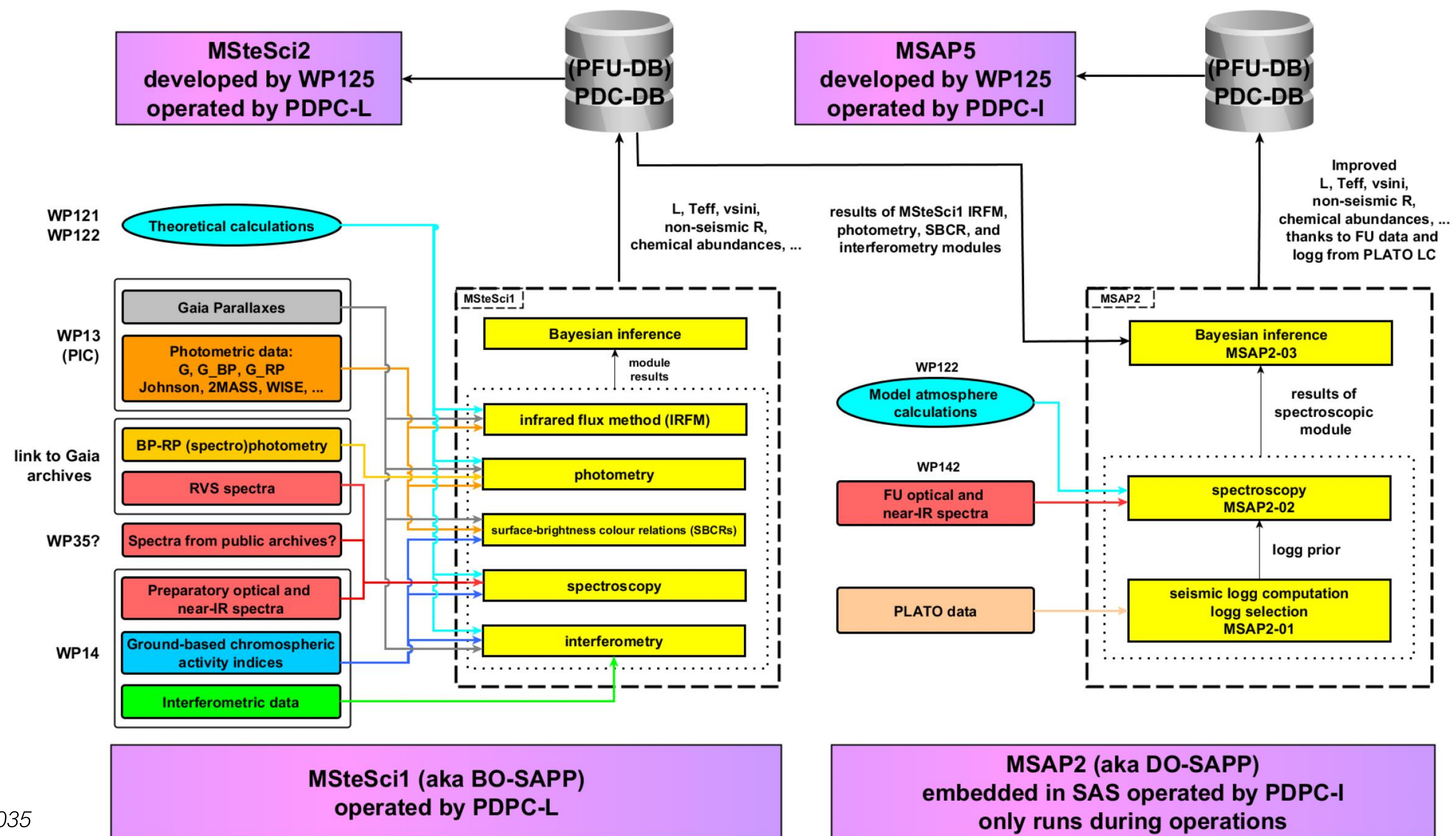


Classical stellar parameters determination

- Updating of results from preparatory pipeline using information inferred from PLATO light curves, e.g. precise $\log(g)$
- Some parameters will be determined by a variety of methods before and during operations.
 - Determine single 'best' value using Bayesian inference.

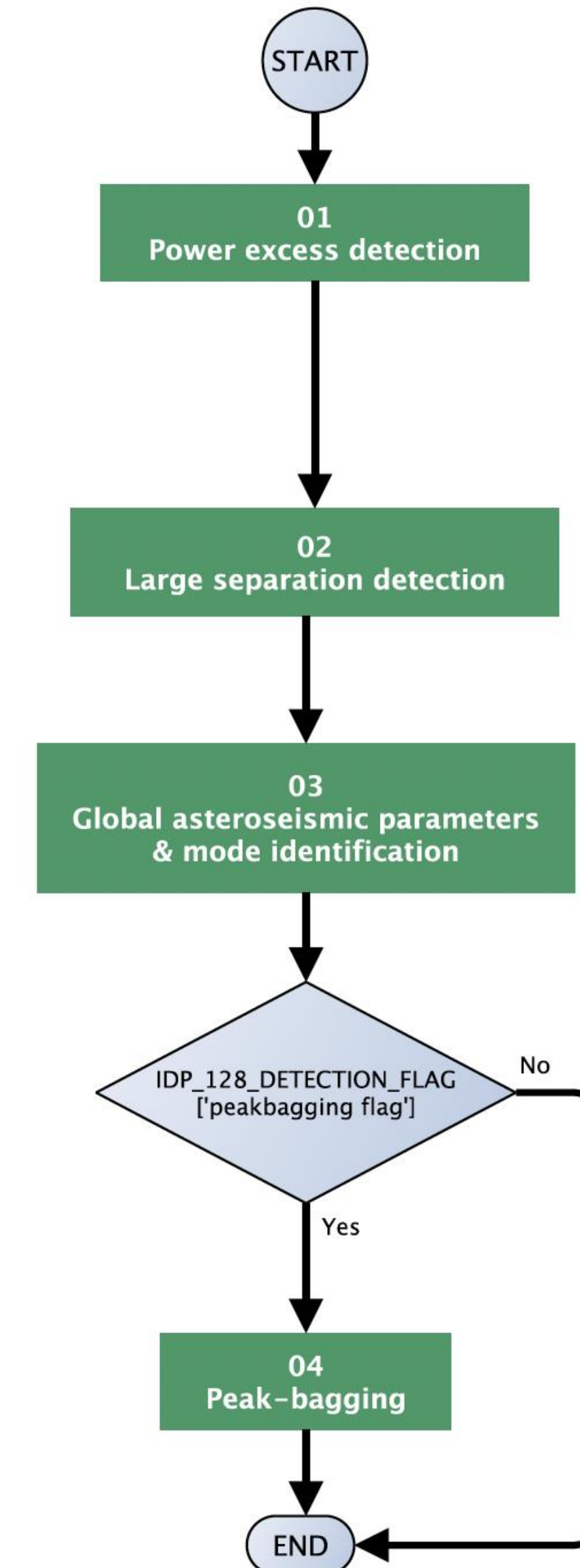


Classical stellar parameters determination



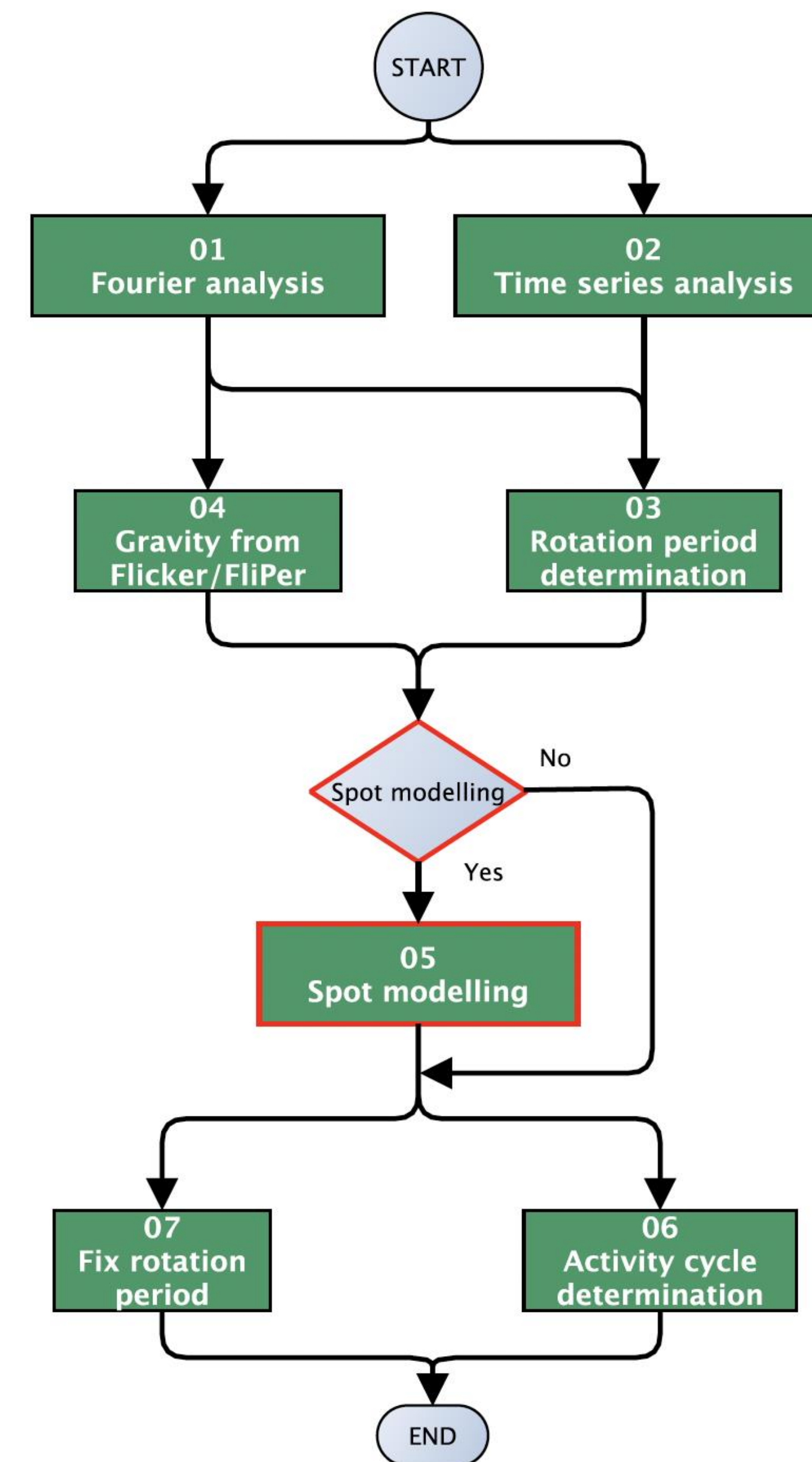
Stellar oscillation modes detection and measurement

- Detection and measurement of asteroseismic mode parameters with required precision.
 - Produces DP3.



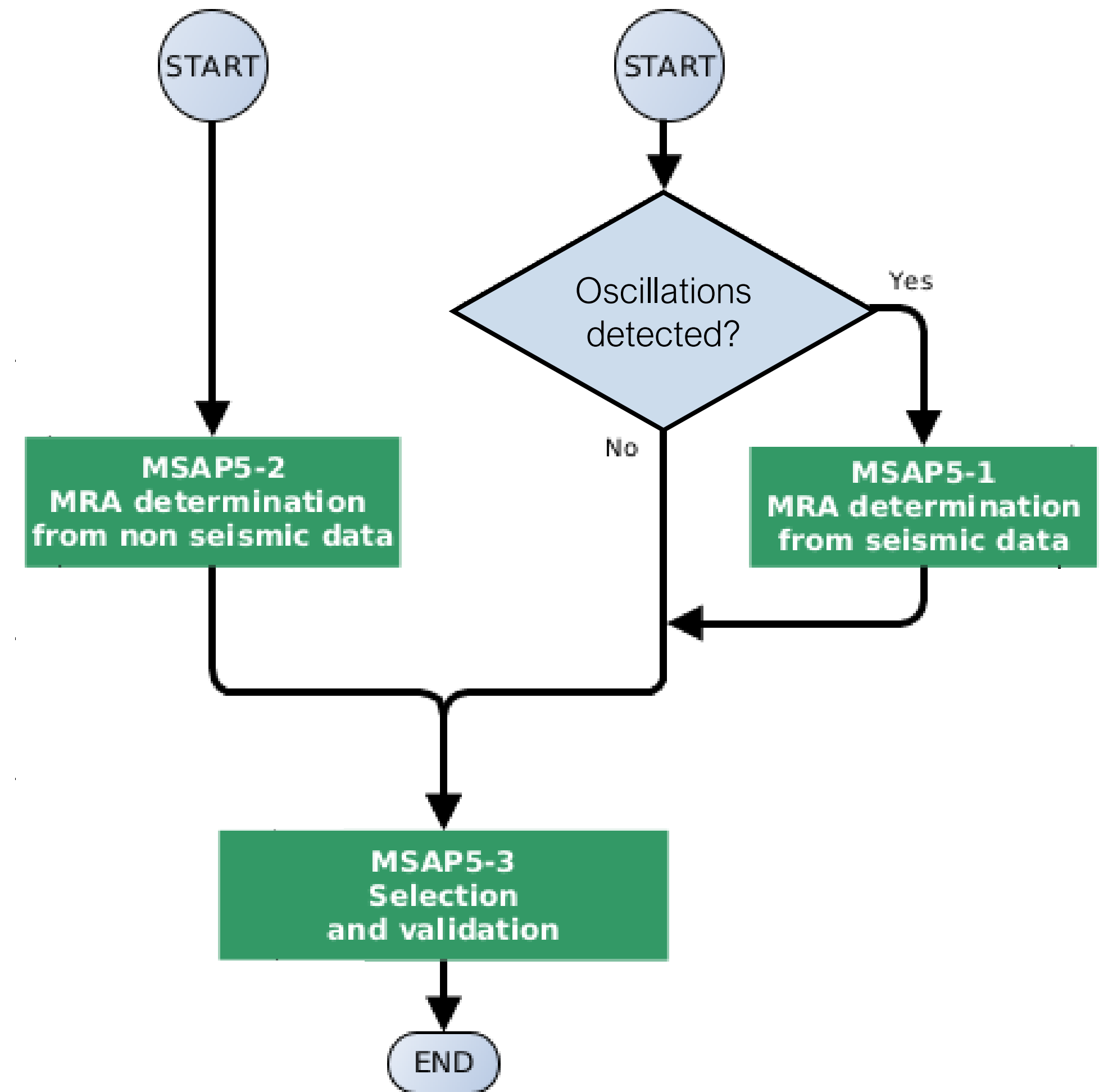
Stellar rotation and activity measurement

- Measurement of surface rotation periods and, when possible, information on the latitudinal differential rotation and activity level.
 - Produces DP4.
- Uses a range of standard approaches adapted to the characteristics of PLATO data.



Stellar properties determination

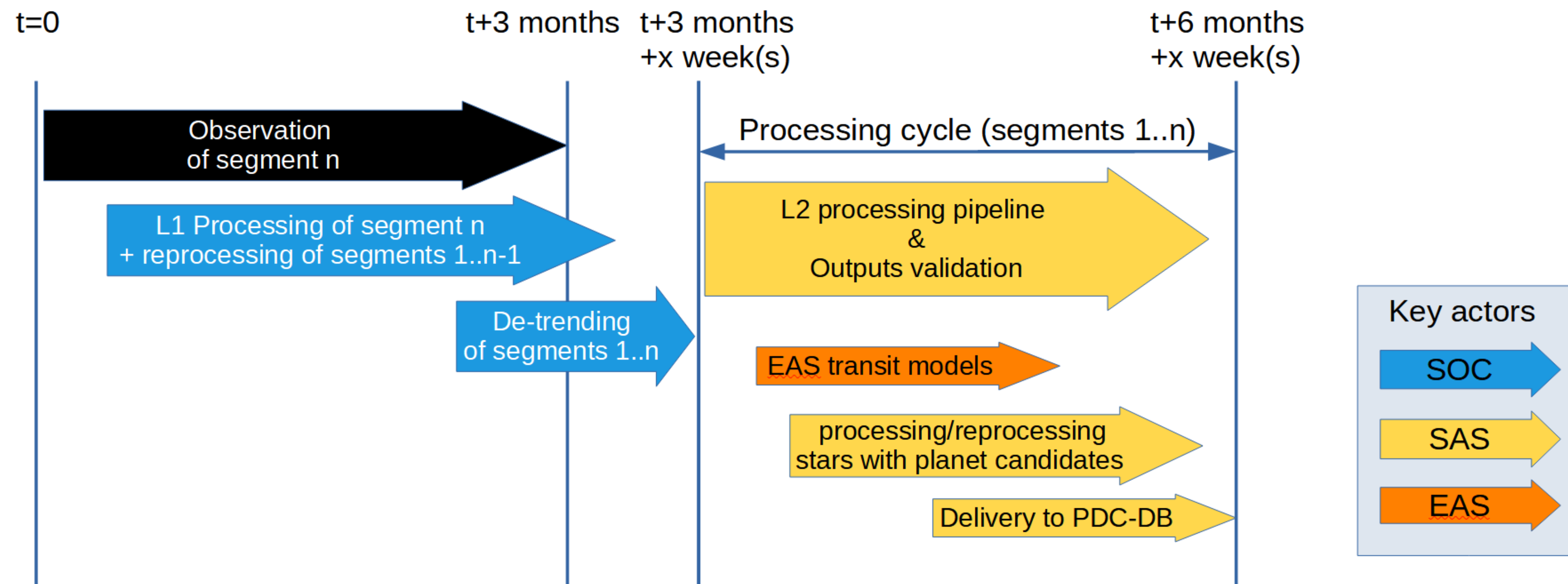
- Determine stellar radius, mass, and age (MRA) as precisely and accurately as possible.
 - Produces DP5.
- Use grid searches and optimisation methods to assess and remove systematics.
- Determine values from non-seismic and seismic data (if available)
 - Determine single ‘best’ values using Bayesian inference.





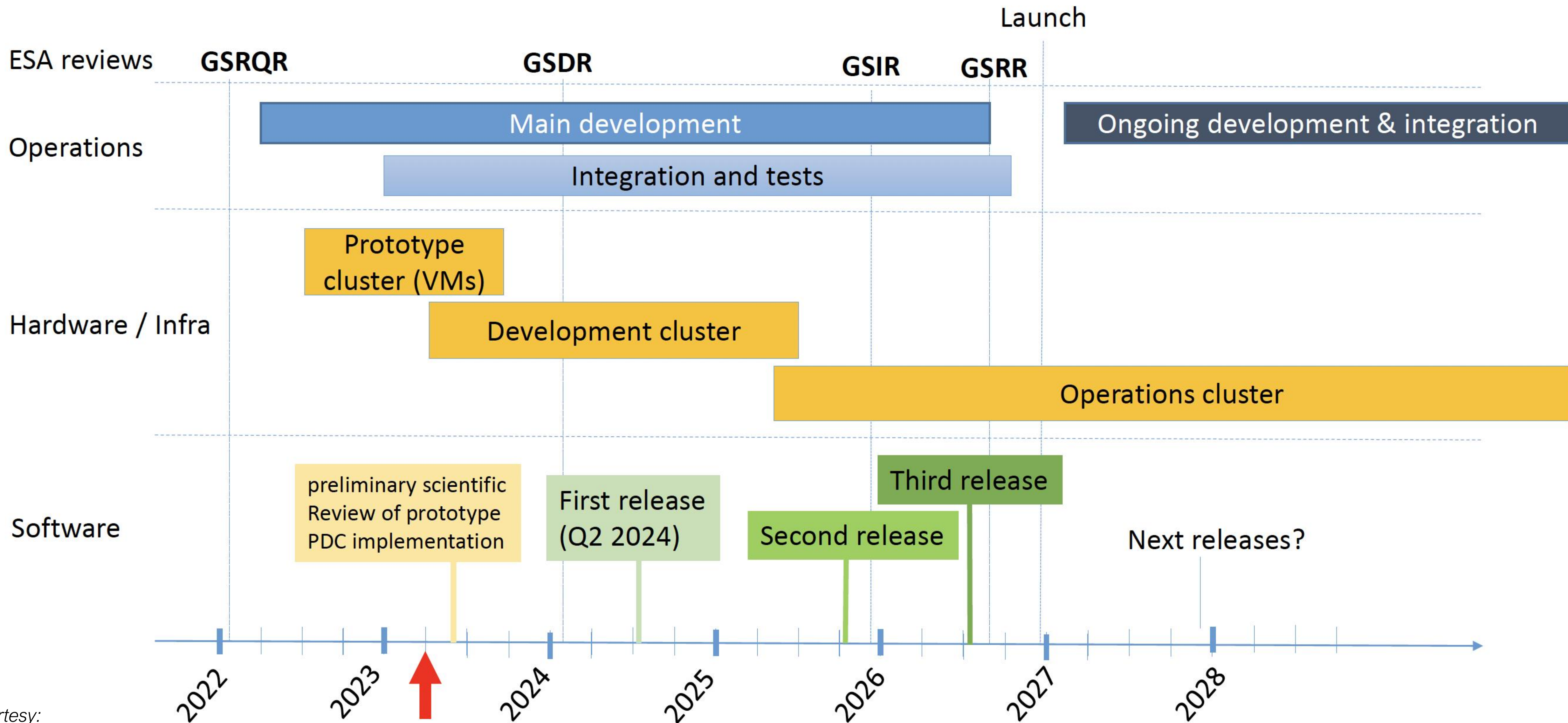
Operational concept

- SAS runs once per 'cycle' (defined by arrival of data for last quarter).
- The SAS can be triggered as soon as:
 - New merged & stitched light curve is available for a given star.
 - Status of transit flag has been set by EAS..
 - If flag is true, prefer to wait for corresponding transit removal kit before proceeding





Schedule





Thanks

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