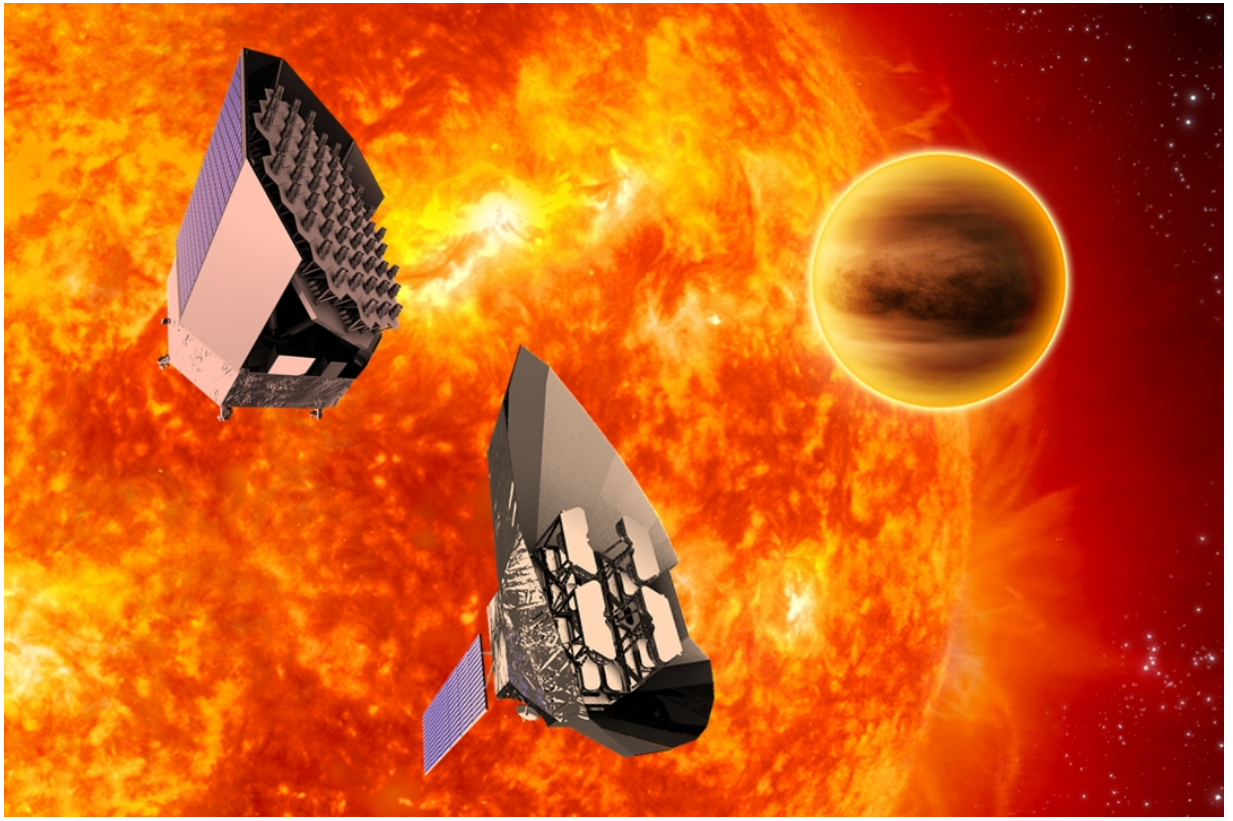
PDC WP360: Exoplanet Analysis



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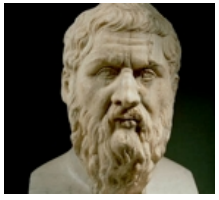
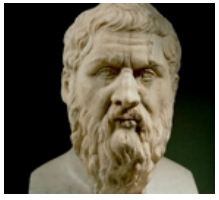


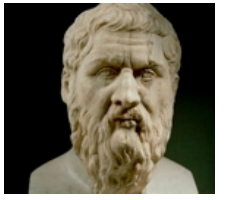
WP360: Delivering Key Plato Products

- The ultimate product of Plato is a catalogue of extra-solar planetary systems with associated characterisation information
- WP360 will deliver the software infrastructure and analysis modules required forming the Exoplanet Analysis System (ESA)
  - Integration of Ground Based observations
- DPC-C will be responsible for the operation of the exoplanet analysis processing system



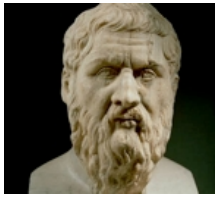
Building the Exoplanet Analysis System

- Development of data flow diagrams
  - Initial assessment of processing requirements
- Required inputs
  - core processing, supplemetary observations, simulations
- Assessment of key algorithms
  - Use of established algorithms
  - Those requiring further development
- Work Breakdown Structure
  - Initial assessment of development effort requirements
- Assessment of key 'risk' areas in the processing
  - Identification of key science/ technical challenges
- Work timelines
  - Draft study phase report required mid March 2011



Assessment of what is required from the L0, L1 processing chain

- Validated light curves (Level 0) for all stars:
  - validated light curves and centroid curves for the 32+2 telescopes
  - CCD in-flight calibration / radiation damage
- Flux calibrated light curves (Level 1) for all stars:
  - NT flux-calibrated light curves and the centroid curves for each star, averaged over all 32 telescopes and their associated errors
  - two FT calibrated light curves and centroid curves for each star
  - data quality parameters
  - improved environment analysis, specific for stars for which imagettes are available

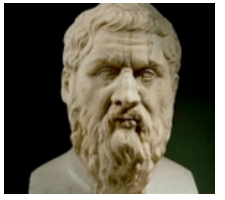


The Scale of the Problem

The Plato Science Samples

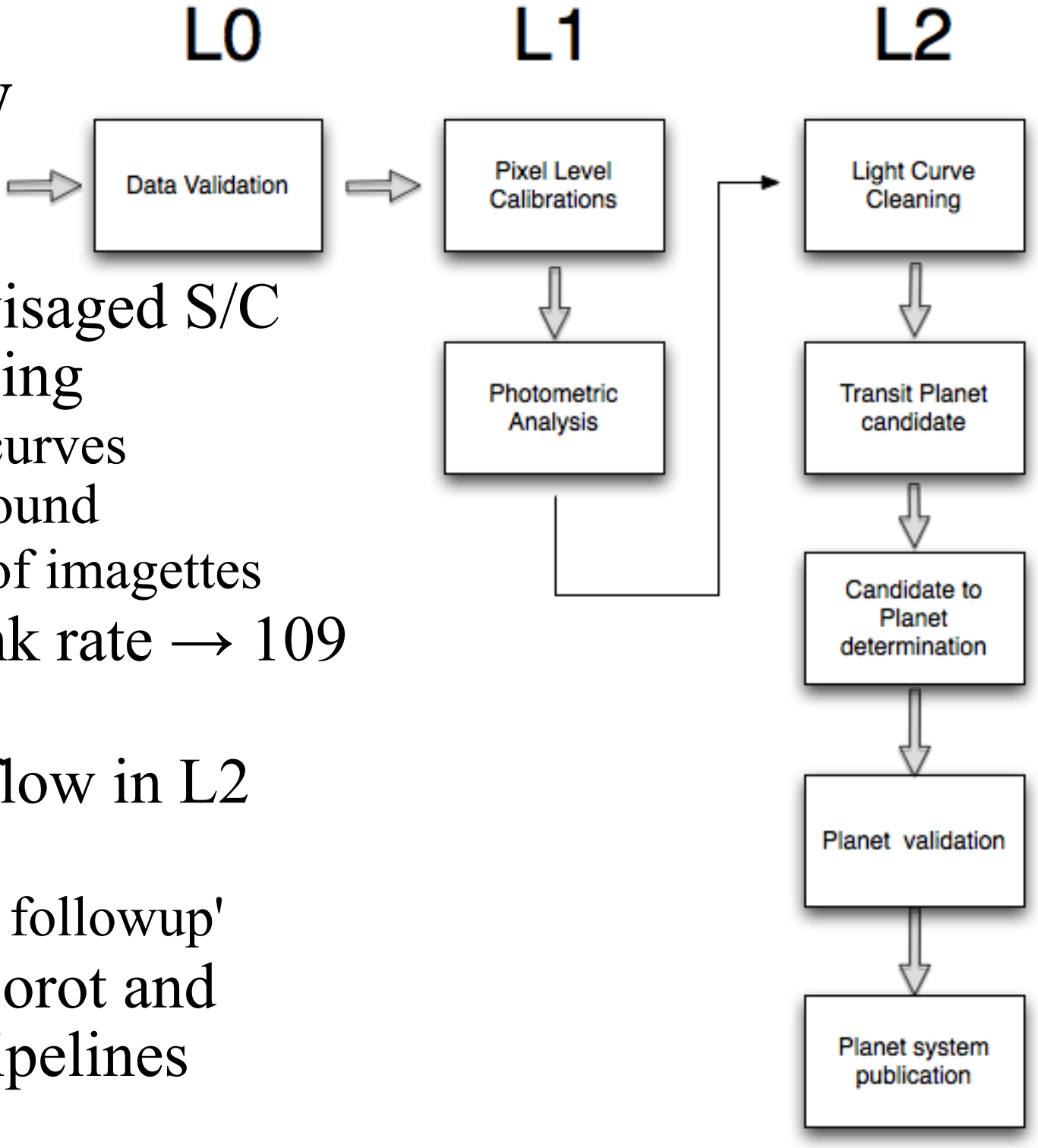
- P1: >20000 dwarfs & subgiants to 2.7x10-5/hr (V<11)
- P2/3: 4000 stars V<8
- P4: 10000 nearby M dwarfs 8x10-4/hr
- P5: >290000 stars to 8x10-5/hr (V=13-14)

- one field for 3 years
- one field for 2 years
- 1-2 year step and stare phase (months each)



Process Flow

- Definition of envisaged S/C on-board processing
  - Calibrated light curves transmitted to ground
  - Strategy for use of imagettes
- Baseline downlink rate → 109 Gb/day
- Processing data flow in L2
  - Iterative nature
  - Interfaces to 'GB followup'
- Advances over Corot and Kepler science pipelines



WP360 Process

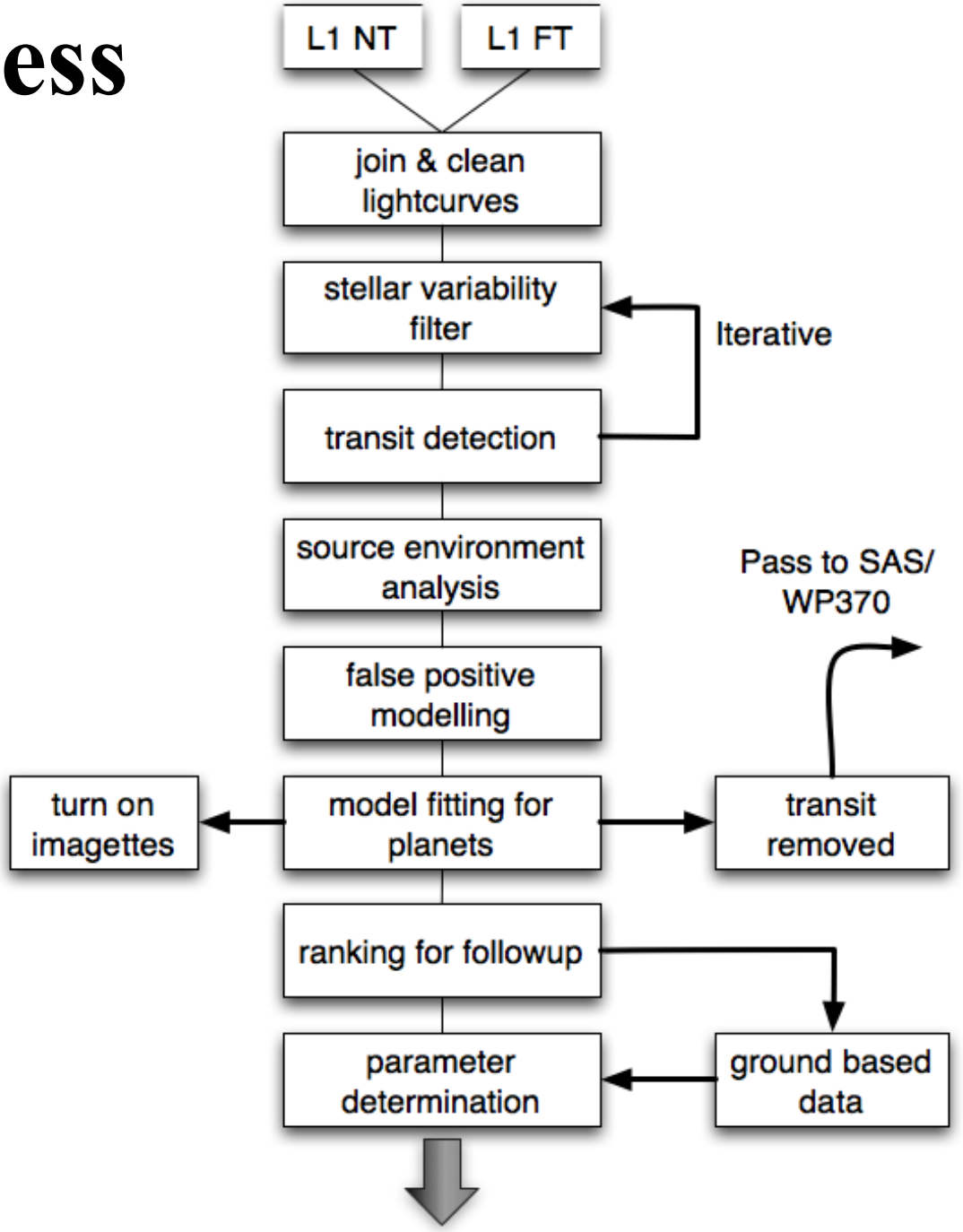
alertPipe

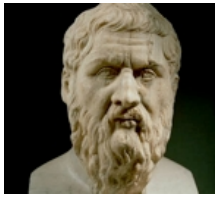
↓

transitPipe

↓

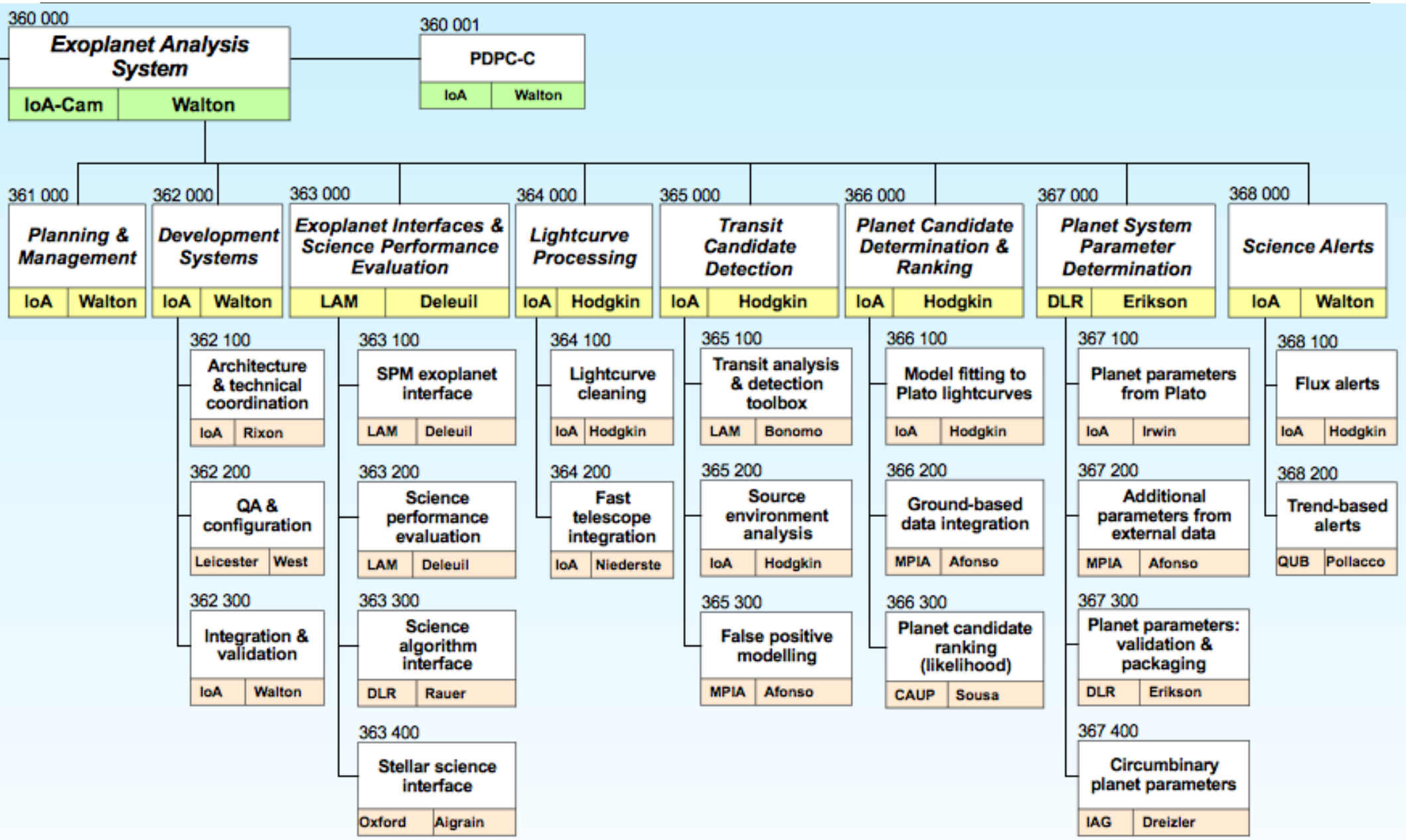
planetPipe





WP360 Work Breakdown Structure

definition phase leads identified



Processing Detail

Light curve Processing

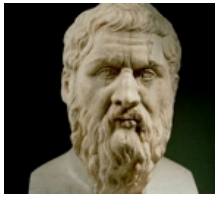
- join in the new L1 light curves, removing residual trends and jumps
- incorporate fast telescope data (colours)
- filter stellar variability (iteratively with transit detection)

Science Alerts

- Flux based – transients
- Trend based – additional science processing

Variability filtering

- successful strategies developed for space based surveys:
  - using a matched filter maximises the SNR in the component of interest
  - iteratively clipped non-linear filter to handle data gaps and separate out short duration events
- variability signal preserved (stellar activity level, rotation periods, add back on)



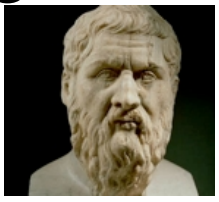
Transits and Source Environment

Transit detection

- run a number of transit detection algorithms hand-in-hand with the variability filtering, as input from PSPM, including:
  - wavelet-based adaptive matched filters
  - iterative non-linear filter

Source environment analysis + false positives

- Gaia sources in PSF: likelihood of an Eclipsing Binary
- Centroid curves (rules out contaminating binaries)
- Pixel LCs for the imagettes
- Ellipsoidal (out of eclipse) variation
- Transit shape and planet radius (stellar R from Gaia L and spectroscopic Teff)
- Lightcurve solution consistency with object photometry (Seager & Mallén-Ornelas 2003)



Prioritisation and Parameters

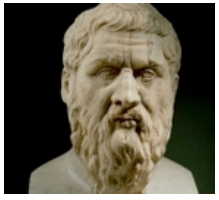
Modelling of the Transits

- will be done on the pre-filtered data, using a post-detection de-trending algorithm to preserve signal on time-scale of the transit (e.g. Alapini & Aigrain 2009)
- include Gaia radius
- light-curves with model transits removed fed into stellar analysis, and back into transit detection
- triggering of imagettes
- triggering of ground-based follow-up

Planet system parameters

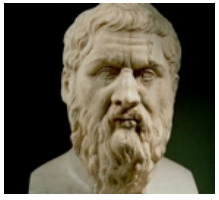
- Requires spectroscopy to measure mass function
- Asteroseismology gives M_* to 2-4%, Gaia gives R_* to 2%

CLOSE INTERACTION WITH SAS WP370

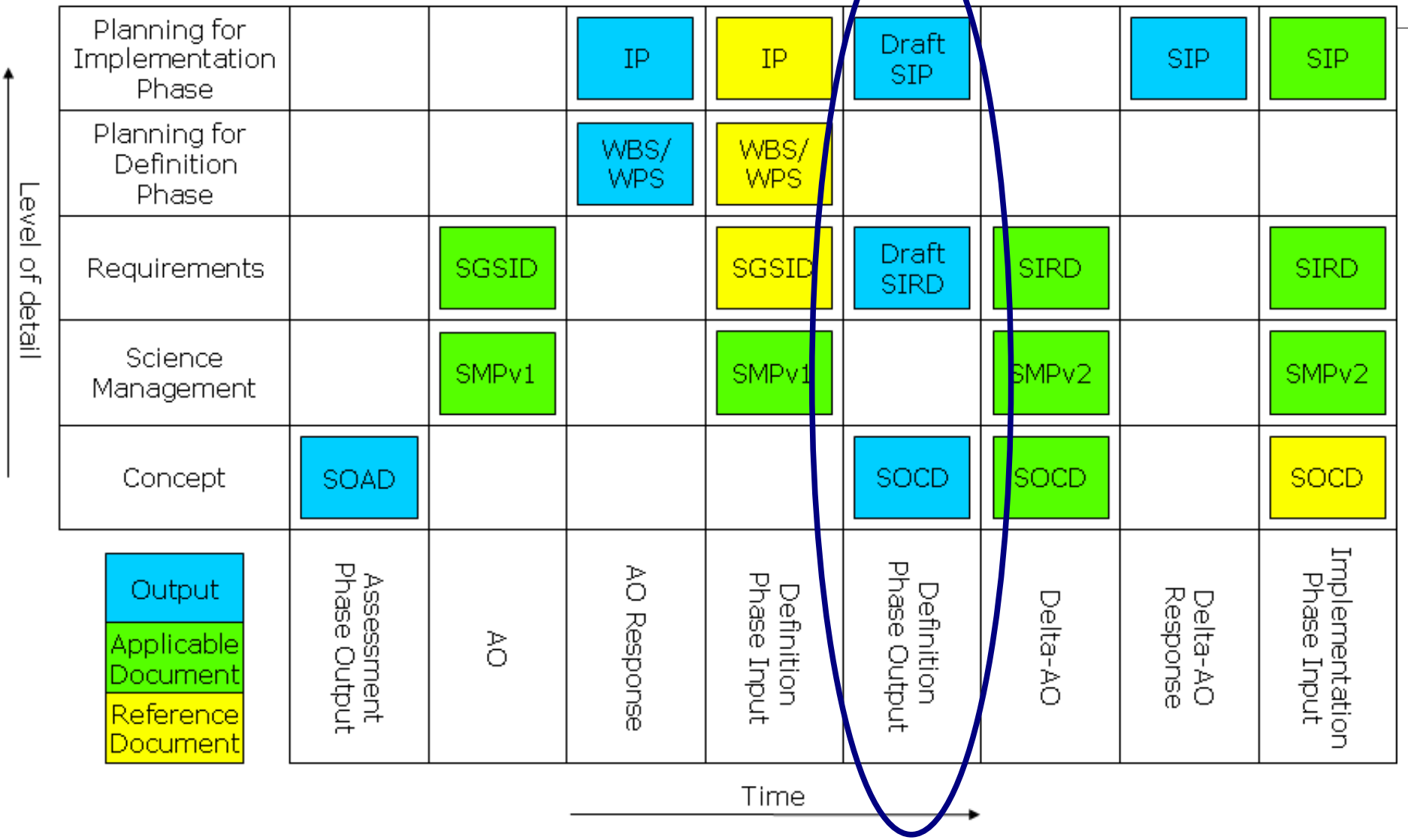


PDC WP360 Exoplanets: Outputs

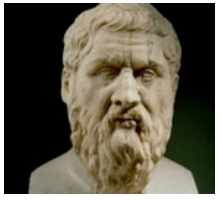
- Transit candidates and their basic parameters
  - Ranking indicating planetary likelihood
- Planetary systems and their characteristics
  - List of confirmed planets, using follow-up observations
  - Assessment of false alarm probability
  - Potentially several hundreds of planetary systems for which the seismology of the central stars is possible.
  - Determination of the planet parameters: orbital parameters, planet size, mass, density (average composition), age (from central stars)
  - Any additional characterization of planet properties from follow-up observations and light curves analysis



ESA AO/ Definition and the SGS



WP360 DEFINITION STUDY DELIVERS INPUTS TO SIP, SIRD, SOCD



Definition Phase WP360 Activities

- Plato Consortium Meeting
  - 9-10 Nov 2010: Paris
  - WP360 plenary presentation
  - WP360 breakout sessions – PDC/PSPM interfaces and definition phase activities
- WP360 team meeting
  - Mid Dec 2010 – videocon
  - Update on WP activities, milestones and deliverables
- Initial definition of key WP360 systems
  - Pipeline framework, common tools, processed
  - TransitPipe, planetPipe, alertPipe specification
- Planning to include PSPM requirements from Dec10