The Quick Look Analysis (QLA) software for the ESA Euclid mission

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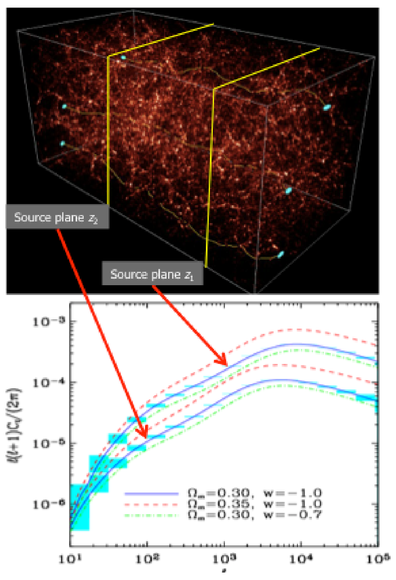
Abstract

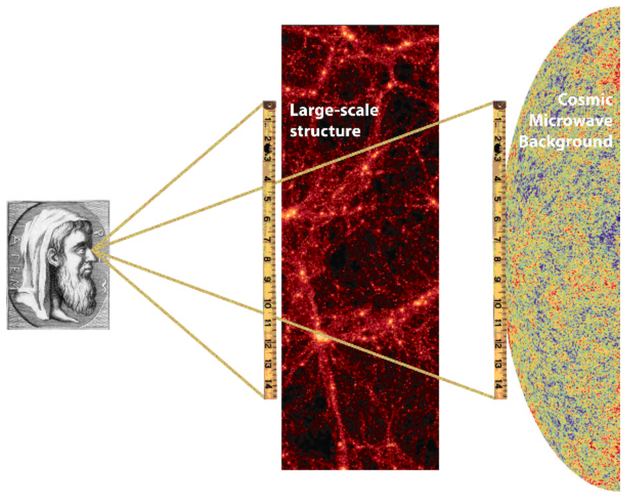
Euclid is an ESA mission due to launch in 2020 that aims at mapping the geometry of the dark Universe in the optical/near-infrared domain. The Science Operations Centre (SOC), located in Madrid, is responsible, among other things, for the development and execution of the Quick Look Analysis (QLA) software, the system in charge of pre-assessing - within 48 hours of data reception- the quality of the data in order to react as soon as possible in case of spacecraft problems (bad configurations, instrumental problems...). It consists of two main parts, 1- the QLA Processing Framework (QPF) provides the processing framework to execute system functionalities and 2-the QLA Diagnostic Tools (QDT) implementing different diagnostic functions to check the quality of all the data.

Science with Euclid

The primary goal is to map the geometry of the Universe in the optical/near-infrared domain, investigating the distance-redshift relationship and the evolution of cosmic structures out to redshifts $\sim$2 using a 1.2 m telescope with two instruments: VIS (the VISible instrument) and NISP (the Near Infrared Spectrometer and Photometer). Euclid will use mainly two cosmological probes: the **Weak Gravitational Lensing** and the **Baryon Acoustic Oscillations.** The nominal duration of the mission will be 6 years.



Weak gravitational lensing. Euclid will analyze shapes, gravitational shear and photometric redshifts of 1.5 billion galaxies with an accuracy of δz=0.05(1+z) over 15.000 deg^2 . Credits: Euclid Consortium.



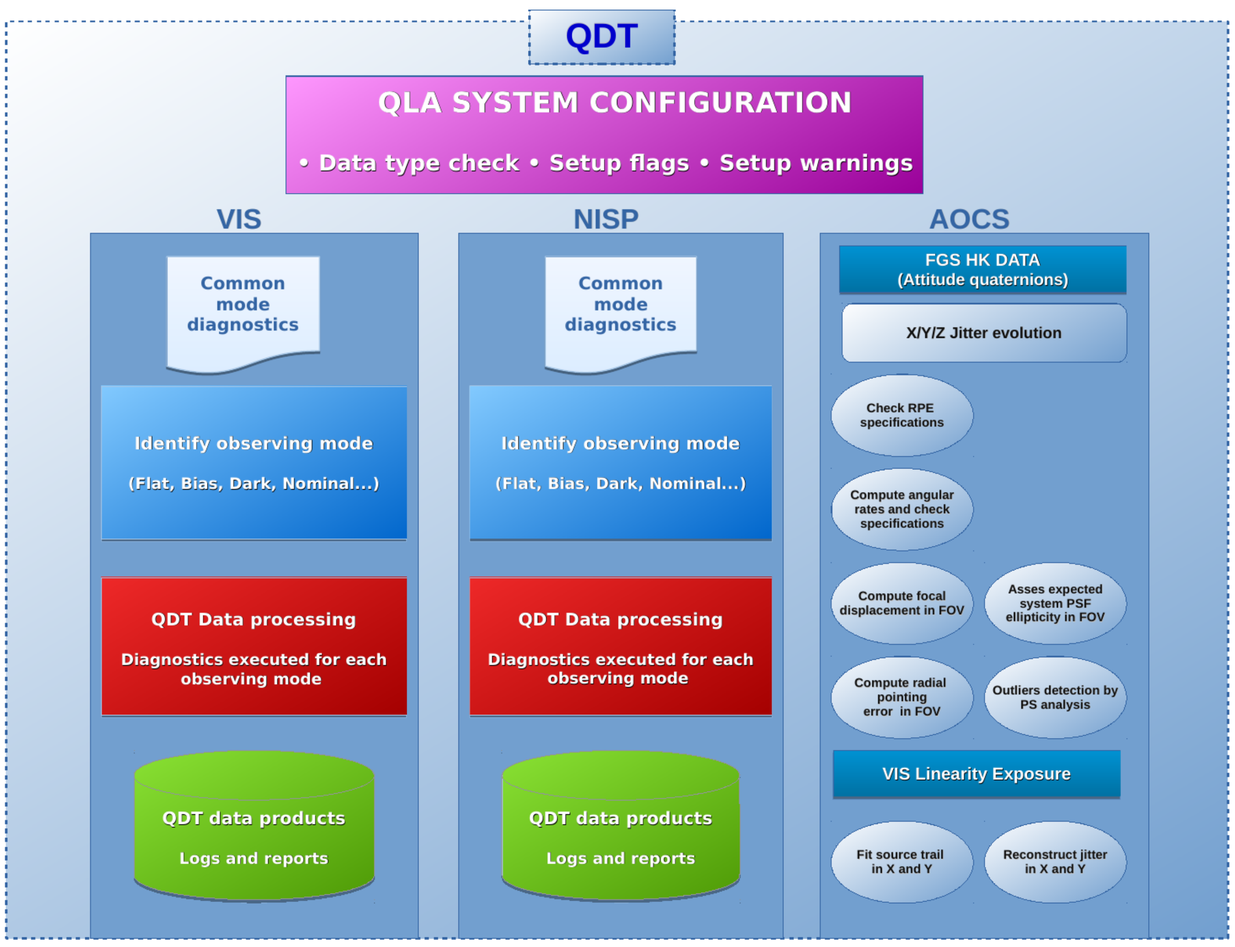
Galaxy clustering as a probe of the geometry of the Universe. The same acoustic features (Baryonic Acoustic Oscillations) seen in the cosmic microwave background (CMB) can be observed in the spatial distribution of galaxies, providing a standard cosmological ruler.Credits: NASA, ESA, and R. Massey

QLA Architecture

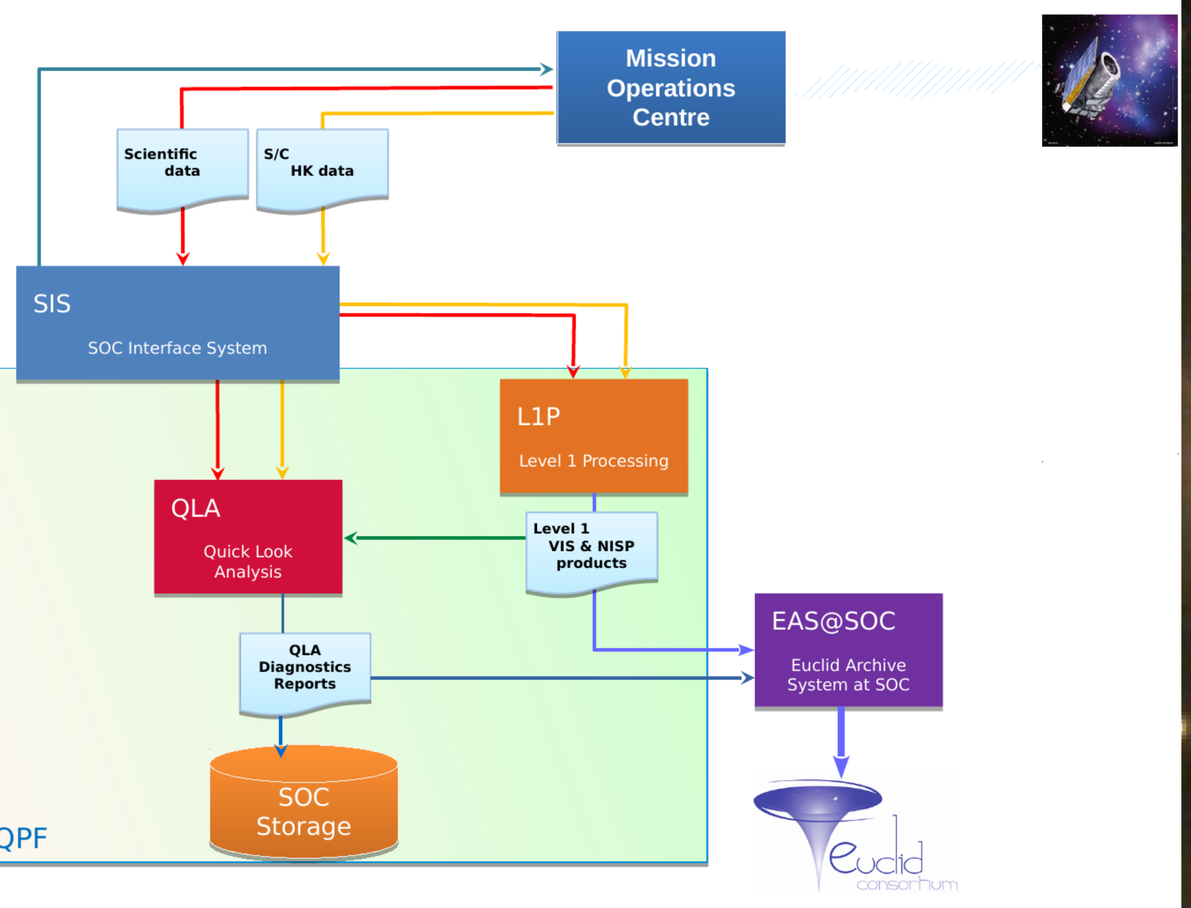
QLA Processing Framework (QPF): developed in QTk/C++, provides the processing framework to execute system functionalities, implements the main HMI, the data access and persistence mechanisms, the logging and the management of the tasks, as well as the gathering and collection of reports. The QPF also runs the LE1 Processor to generate LE1 data products.

QLA Diagnostic Tools (QDT): developed in python, they implement different algorithms and functions to perform over the data. They encompass data extraction (HKTM and parametric data), data processing and reporting:

- Common (including HKTM extraction and processing)
- VIS functions
- NISP functions
- AOCS functions



(Data processing) Science Operations Centre (SOC) components



Big data from space, fast reaction from Earth: the QLA software

Main objectives. The QLA diagnostics have three main objectives:

- Checks on correctness of on board operations versus the commanded ones
- Assessments of data content and anomalies, mainly at pixel and instrumental level, but it will not asses the data quality from the scientific point of view
- Quick feedback on survey execution and image quality

Fast check. The QLA needs to check the quality of the data as soon as possible (**within 48 hours of data reception**) in order to react quickly in case of instrumental problems (bad configurations, impacts...).

Automatic check. Huge amount of data: 850 Gbit per day of raw data, 1 Pbit per year of higher processed data. All the checks need to be executed **automatically** over all the level 1 data (VIS, NISP-P, NISP-S science data, i.e. including calibration exposures, housekeeping and pointings data).

Outputs & Report. The system is based on a pass/fail structure, setting quality flags and raising alerts. "Level 1.5" data produced on the fly (eventually stored only in a local buffer archive). If needed, QLA will facilitate ad hoc **visual data inspection** (through external tools like DS9) and processes to be conducted by the user (instrument scientist). Extracted parameters and results will be uploaded into the a database which will fed the health monitoring system (HMS).

QLA current status

- The QLA was released as part of the SOC V1.2 software release in May 2017
- The QPF component is very advanced, implementing:
  - HMI (System Start, Stop, Log, Monitor, Partial Configuration)
  - Task registration, configuration and connection
  - Execution of processing
  - Access to EAS/DSS
  - Internal DB for local persistence of products
- The QDT was released for VIS, allowing a subset of checks to be implemented over raw data sets as produced by the VIS simulated data as well as lab data (some reformatting needed), and for NISP, with the basic structure developed and the statistics checks implemented, just to allow basic testing.
- Tested successfully on V1 release
- AOCS diagnostic tools developed in MatLab code to port to python

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Acronyms: AOCS (Attitude and Orbit Control System), **HK** (HouseKeeping), **HMS** (Health Monitoring System), **HMI** (Human Machine Interface), **NISP** (Near Infrared Spectrometer and Photometer), **QLA** (Quick Look Analysis), **QPF** (QLA Processing Framework), **QDT** (QLA Diagnostic Tool), **VIS** (VISible instrument)