A photograph of a space station in orbit over Earth, with the planet's surface and atmosphere visible in the background. The station's structure, including a large cylindrical module and various external components, is partially visible on the right side of the frame.

# **GOP WP 141: Tools to optimize observations**

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and the IEEC PLATO Team

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# Tools to optimise observations

Updated WBS (summer 2022)

## Focus on WP 141xxx:

- 100: GCDH

(**GOP Comms & Data Handling**)

- 110: REP

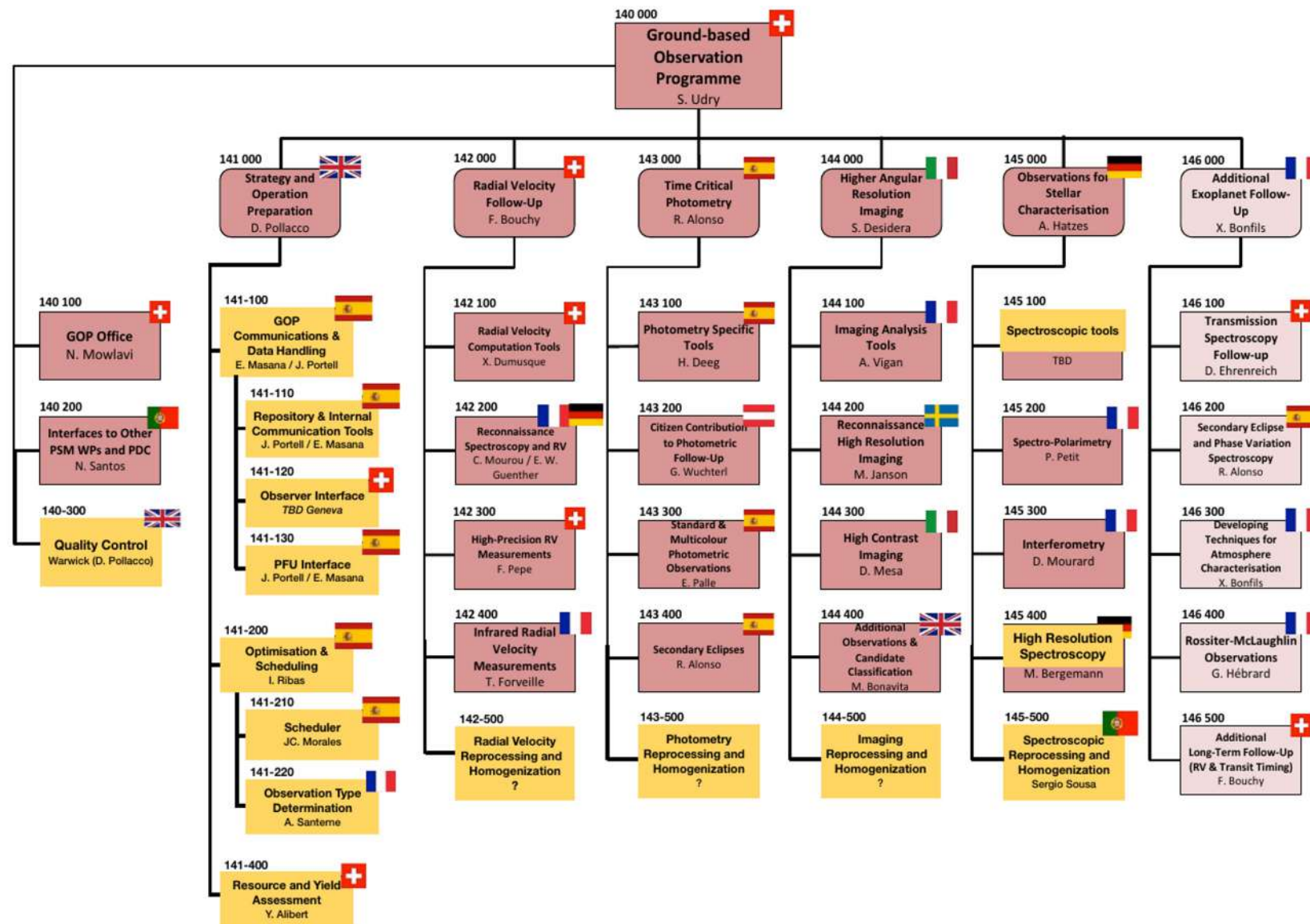
(**REPOSITORY & internal comms**)

- 130: PFI

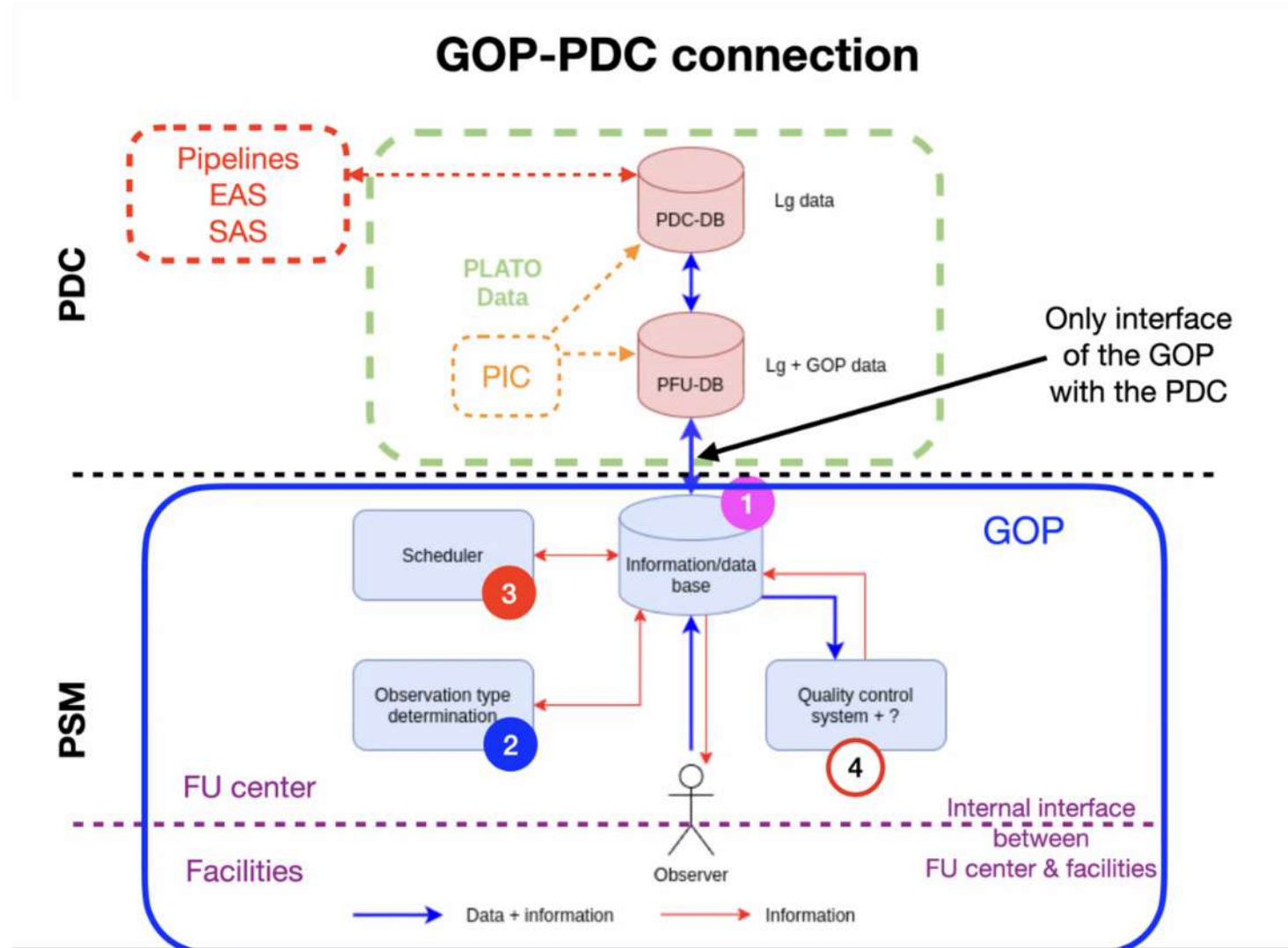
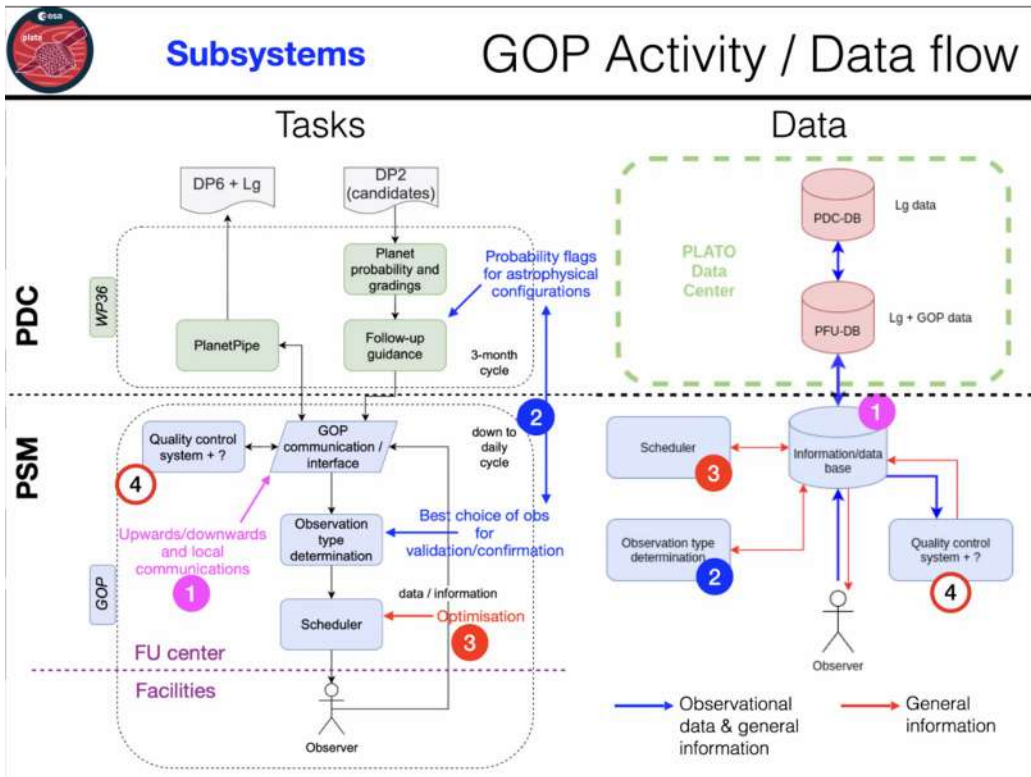
(**PFU-DB Interface**)

- 200+210: OPS+SCH

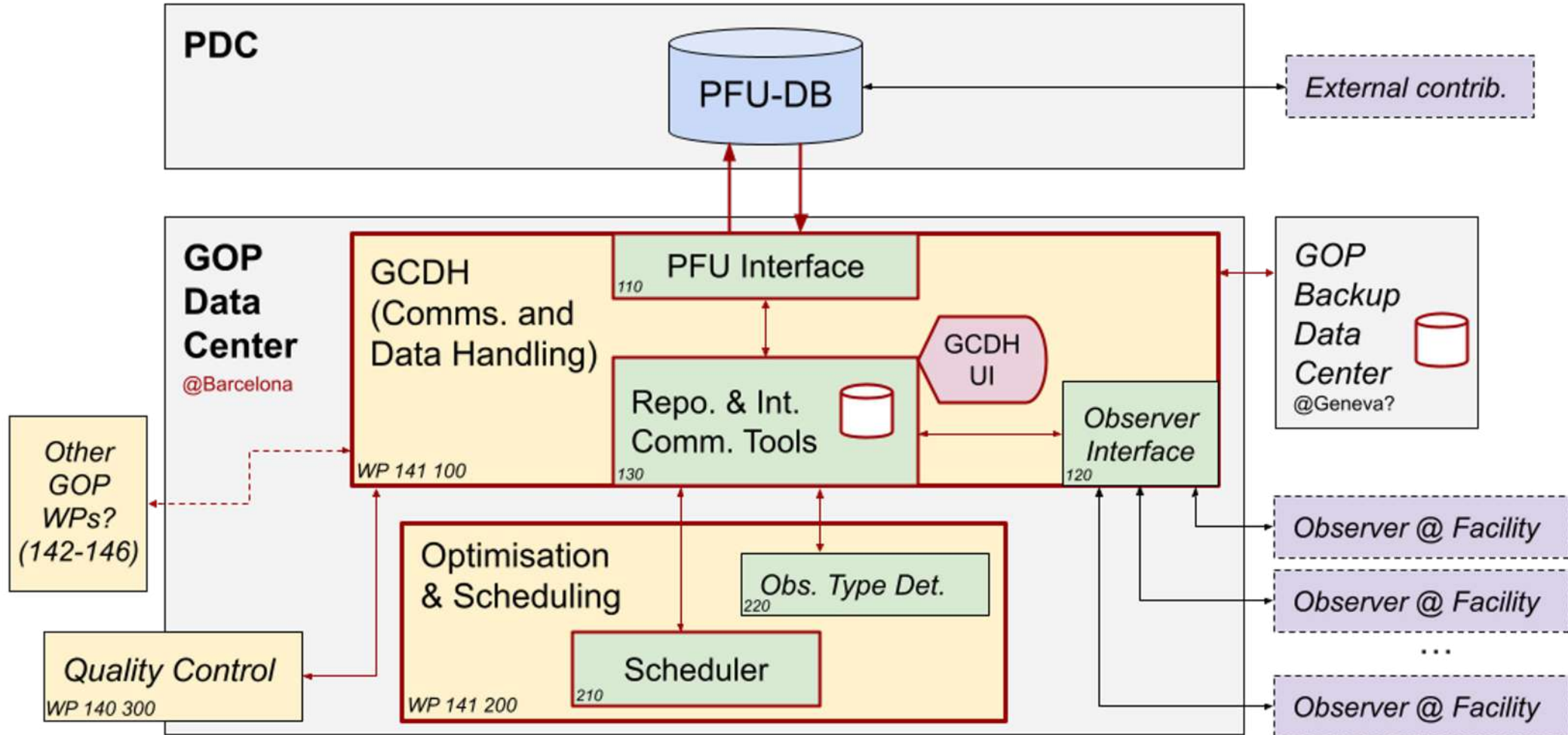
(**Optimisation + Scheduler**)



# Reminder on GOP and WP141 context



# Overview of relevant (sub)systems



# 141-100: Overall coordination and monitoring

- Interfaces:
  - PFU-DB, observers/facilities, schedule optimisation, quality control, other GOP WPs
- **Collect and provide all the information needed for an optimum follow-up**
- **User Interface** (for GOP operators, not observers):
  - Overall FU progress and status
  - Visualizations at global and individual level
- Programming language and guidelines?

**PFU-DB:** [Ping OK] [List recent exchanges]

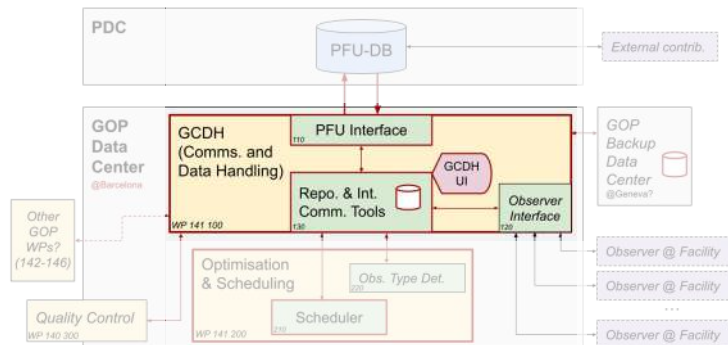
**Facilities:** [31 Online last 24h] [XX Active] [YY Done] [ZZ Failed]

**Targets:** [196 Pending] [XX Ongoing] [YY Done] [ZZ Failed] ...

**Repository:** [Status OK] [Details] ...

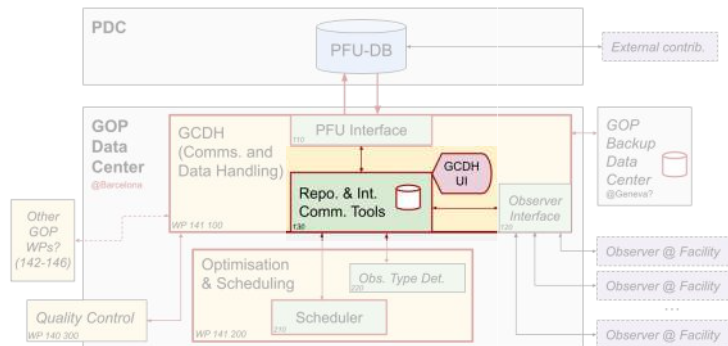
**Scheduler:** [Running] [Latest schedules] ...

...



# 141-110: GOP Repository & internal interfaces

- **Repository** based on files (format?) or DB (engine?)
- Tables / databases:
  - **Targets:**  
ID, active/inactive, priority, follow-up progress, decision tree, comments from observers, periodogram, fit, ...
  - **Facilities:**  
ID, status, performance, progress of the several targets followed up...
  - **Observer** (i.e., the “operator” at the facility), for e.g. credentials/permissions control
  - **Observations**, for the scheduling + history/log of observations done:  
ID, facility, target, obs type, time, GOP/external, accepted/discarded, quality, ...



## “Internal” interfaces with:

- Scheduler
- Quality control
- Obs type determination

**Web-based UI** for the several visualizations, incl. status of the repository

# 141-130: PFU-DB Interface

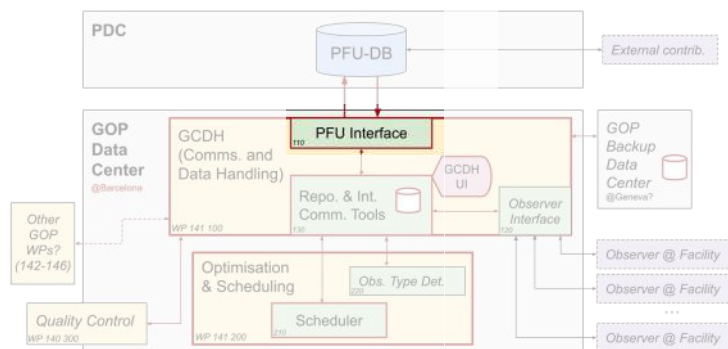
- “Event-driven” (asynchronous) approach
  - Simple, message-based, low-latency notifications to trigger actions
  - Actions = data transfers, always as “get” (never “put”), can be done when receiver is ready, reusing existing/preferred technologies (in agreement with the PDC)
- Example: PFU-DB has some target updates (e.g. new targets to be observed)
  - PFU-DB prepares the data: e.g. files with target details, on a given “outbox” folder
  - PFU-DB sends “push” notification to GOP PFU-Interface
  - When ready, PFU-Interface retrieves data from PFU-DB, and sends a “Done OK” message

We may have a “whiteboard” with the list of messages sent/received, processed/failed, information on the data/action, etc.

Just “high-level” data are considered (e.g. light curves), not raw data?

This approach could also be used for the **Observer Interface**:

No need to have the facility always online or quickly reacting



# 141-200/210: Scheduler inputs

- **From Observatories:**

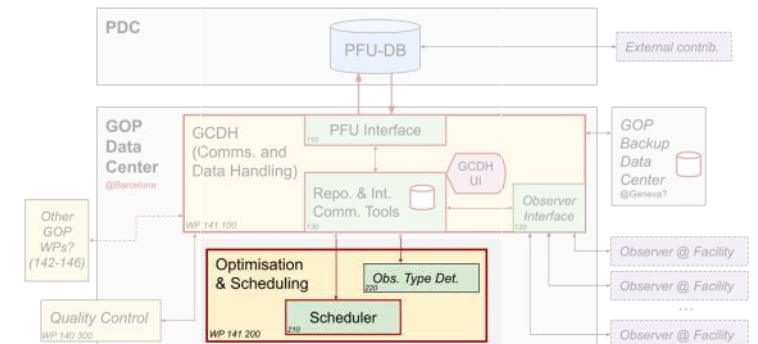
- **Location** and altitude
- **Telescope/Instrumentation**
  - Imaging, photometry, spectroscopy...
  - Capabilities (diameter, precision, resolution, bands...)
- **Dedication**
  - Fully dedicated
  - Fixed window observatories
  - Non-fixed window observatories
  - Limited involvement observatories
- **Protocols** and standards of communication
  - Task upload: long-term plan, short-term plan, dynamic, target dispatcher...
  - Data transfer: format, standards...



Observational constraints  
Reference precision  
Exposure time calculator



Plan length  
Optimization goals  
Target dispatcher





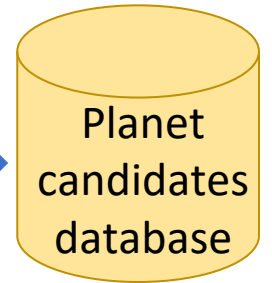
# 141-200/210: Scheduler inputs

- From Obs. Type Determination & other WGs:

- Planet candidates requesting FU (RA/DEC, mag, ephemerides, transit depth, RV amp...)
- FU type of observation (low/high-res. spectra, imaging, photometry...)
- Observational **setup** (spectral band, resolution...)
- Observational **strategy** (single obs., transit/occultation, RV FU, cadence,  $N_{\text{obs}}$ ...)
- Target and observation **priorities** (observational sequence...)

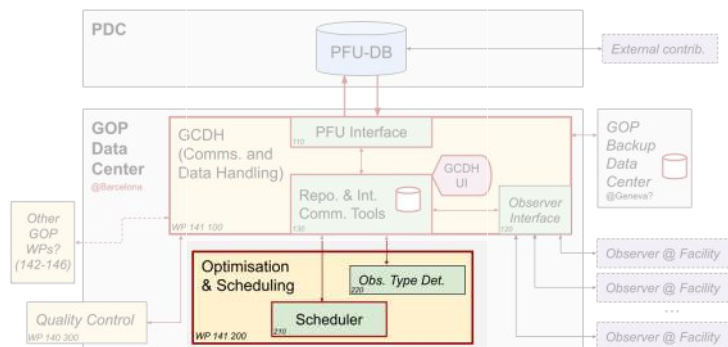
*Observatory selection*

Detailed list of parameters for each target, to populate the DB  
Different parameters depending on FU type, e.g.  $v \sin i$  (affecting precision),  $P_{\text{rot}}$  (affecting sampling)...



Different effect on the **Figure of merit (FoM)** for the scheduling optimization

*Plan optimization*



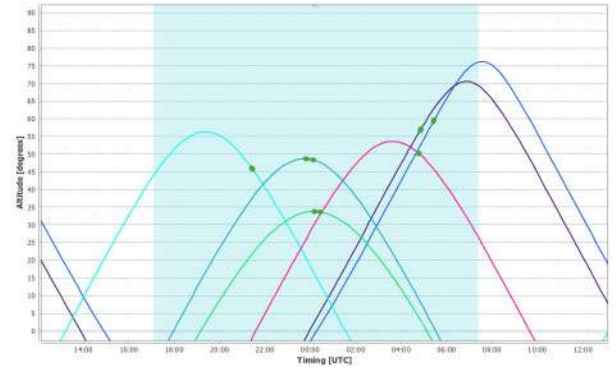
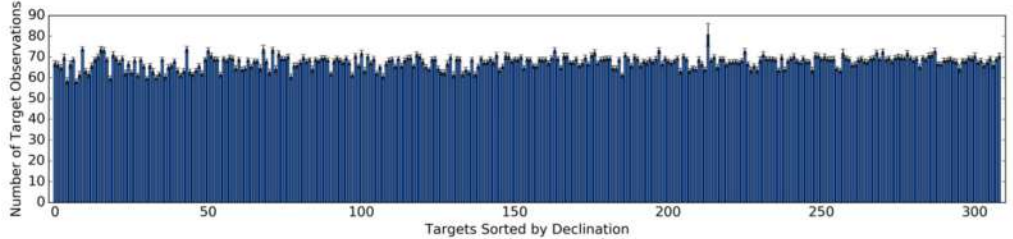
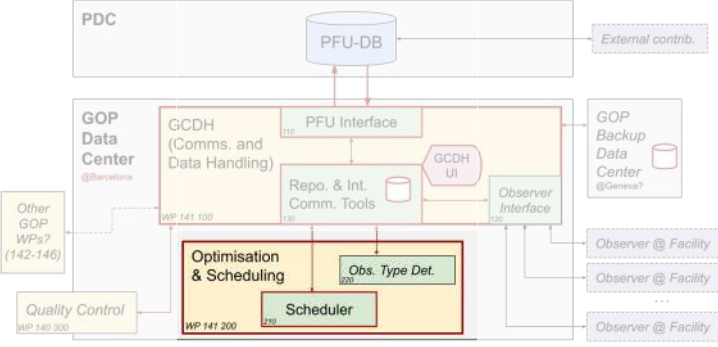
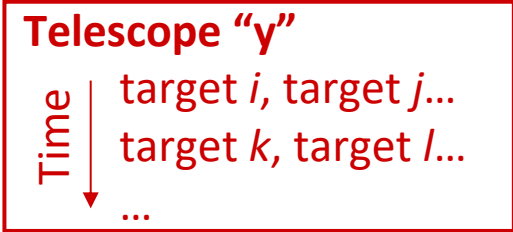
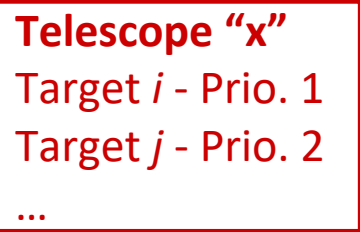
# 141-200/210: Scheduler Figure of Merit

## Parameters

- $mag \rightarrow$  SNR, RV precision, feasibility...
- $v \sin i \rightarrow$  RV precision
- $X \rightarrow$  preference to low air mass
- **Sp. Type/mass**  $\rightarrow K_{RV}$ , instrument
- **orbital period**  $\rightarrow$  phase sampling
- ...

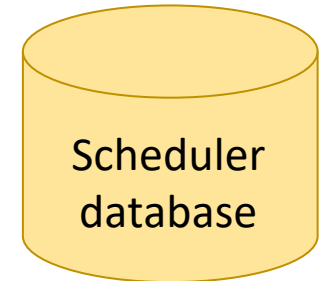
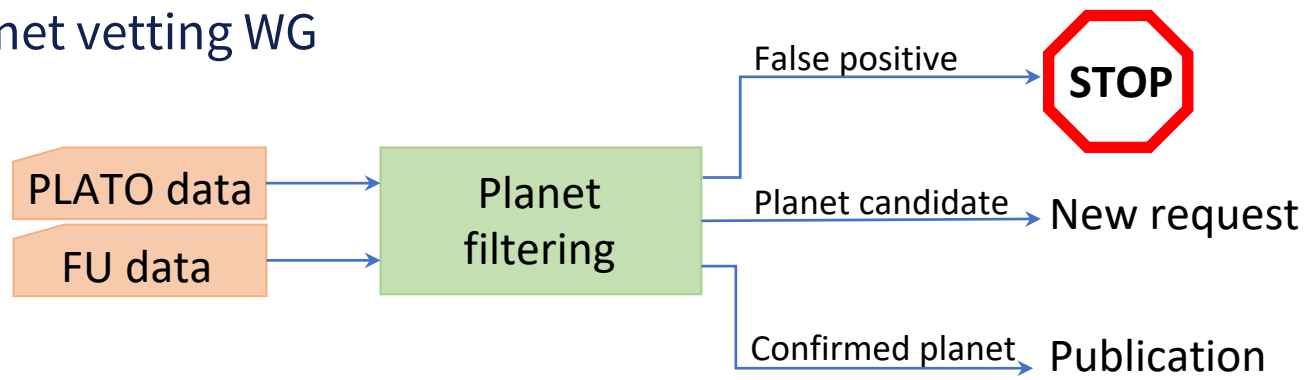
## Optimization goals

- Maximize confirmed targets
- Distribute obs. between targets
- Optimize time usage
- ...



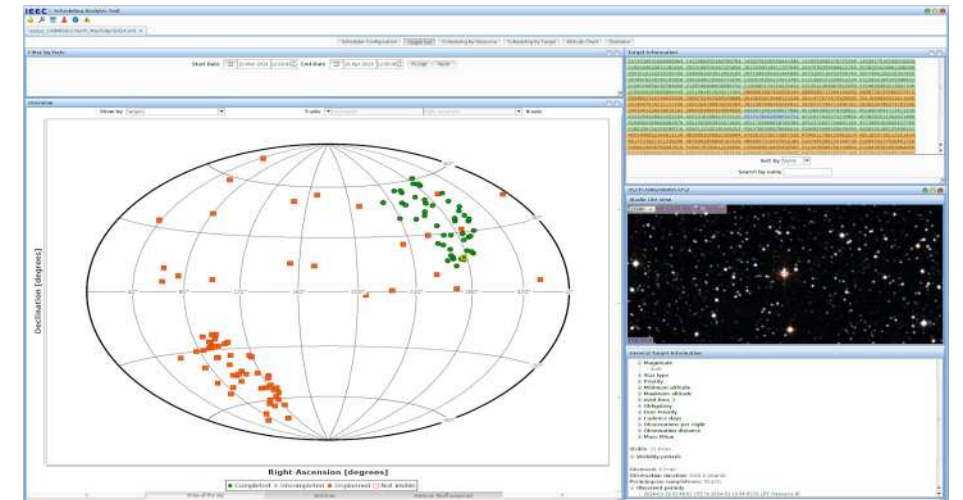
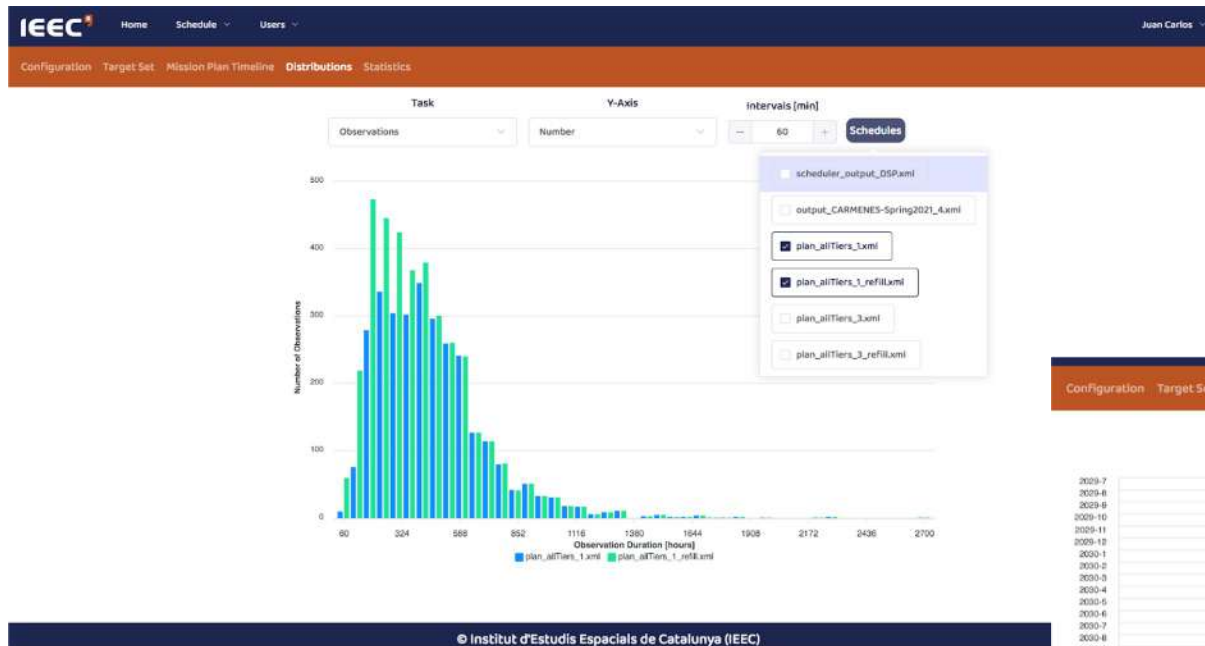
# 141-200/210: Scheduler feedback

- Feedback from quality control/planet filtering:
  - “Automatic” Quality Control
    - Valid observation → remove request from scheduler
    - Invalid observation → reactivate request in the scheduler
  - “Human” Quality Control
    - Valid observation → remove request from the scheduler
    - Invalid observation → update observational setup (if needed)  
→ send new request to scheduler
  - Planet vetting WG



# 141-200/210: Scheduler monitoring

- ATP (Automatic Tool for Planning)
  - Graphical User Interface to access observation planning generated by the Scheduler
  - Stable version available in Java (used by CHEOPS)
  - New version being developed with Web technologies



# Conclusions

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- 141-100, GOP Comms & Data Handling
  - Top-level “orchestrator” and interfaces
- 141-110, REPOSITORY & internal comms
  - Internal GOP database for targets, observations, facilities and observers
- 141-130, PFU-DB Interface
  - The one and only interface with the PDC / PFU-DB
- 141-200/210, Optimisation + Scheduler
  - Main machinery in charge of optimizing the follow-up plans
- WPs 100+110+130 quite well understood, some preliminary specifications available, heritage from Gaia
- WP 210: Heritage from already ongoing projects: CARMENES, Ariel, CHEOPS, ground observatories