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SPHERE TDB : Catalogue management, observation planification and detection visualisation

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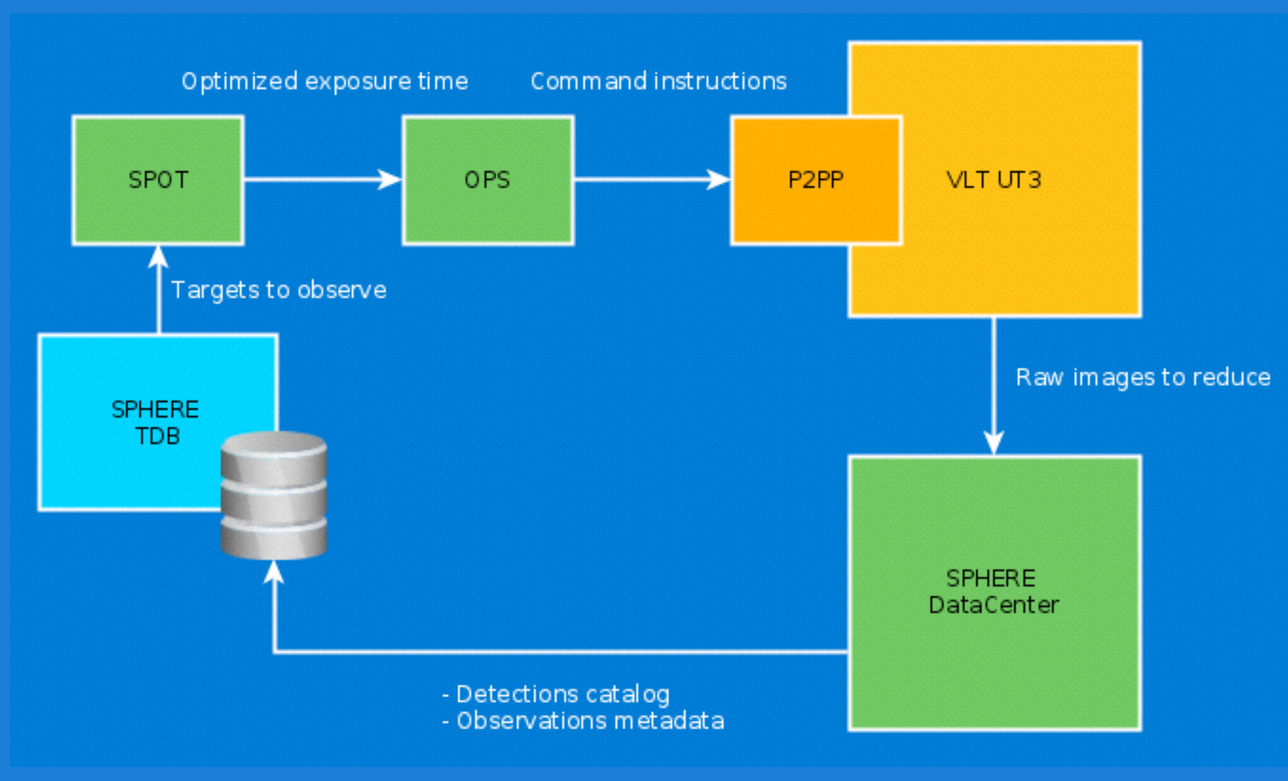
Abstract

SPHERE is the extreme adaptive optics system and coronagraphic facility at the VLT. Its goal is imaging, low-resolution spectroscopic, and polarimetric characterization of extra-solar planetary systems. We developped at CeSAM (Centre de Données Astrophysiques de Marseille) the SPHERE Target DataBase (TDB), it is a web based information system aiming at the management of the catalogue of NIRSUR guaranteed time survey dedicated to the search and the characterization of Giant Planets. For the observation preparation, the TDB makes it possible to select targets with multiple criteria. Results are formatted and sent to the set of tools in order to optimize the observation plan. TDB also keeps track of all NIRSUR observations and resulting detections. In the second step, TDB offers the possibility to visualize detections and to ease the determination of false positives.

CeSAM

Laboratoire d'Astrophysique de Marseille (LAM) gathered their forces working in computing for Astrophysics in the Astrophysical Data Center of Marseille (Centre de données Astrophysique de Marseille -CeSAM). CeSAM is developping softwares, WEB based applications, databases, numerical simulations and Image processing modules. The developments are made with respect to the Virtual Observatory standard.



Technical aspects

Python Django

Django is a high level Python Web framework that encourages rapid development and clean, pragmatic design without needing to reinvent the wheel. It's free and open source.

ANIS Framework

ANIS is a web generic tool to facilitate and standardize the implementation of astromical data.

Aladin Lite

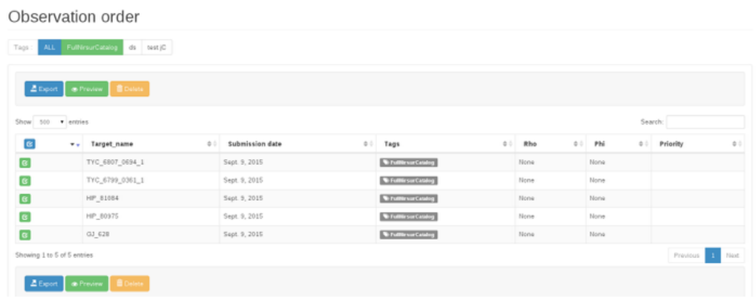
It is a lightweight version of the Aladin Sky Atlas. It allows to visualize image survey and footsprints data powered by the HTML5 canvas technology.

- Development : Python Django, ANIS Framework
- Embedded libraries : Numpy, Aladin Lite, pIDLy
- Deployment : Web Application.
- Tested on Safari, Firefox, Chrome

Functionalities

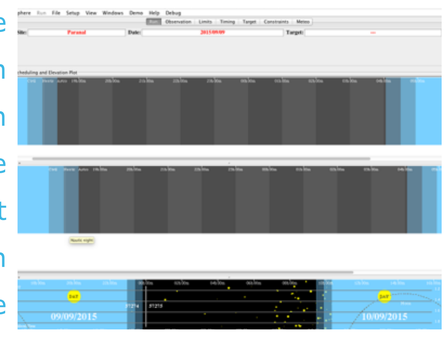
Targets selection

Regularly, the Sphere team updates the new targets priorities for the next session of observation. Then, astronomers prepare observations by searching targets in TDB (Target DataBase) and generate an output file (RDB Remote DataBase format) sent to the next tool. This file includes the star's identifier, coordinates, magnitude R all required for the pointing and the Adaptative Optics (AO) system and exposure time computed by TDB and other information for the configuration of the instrument.



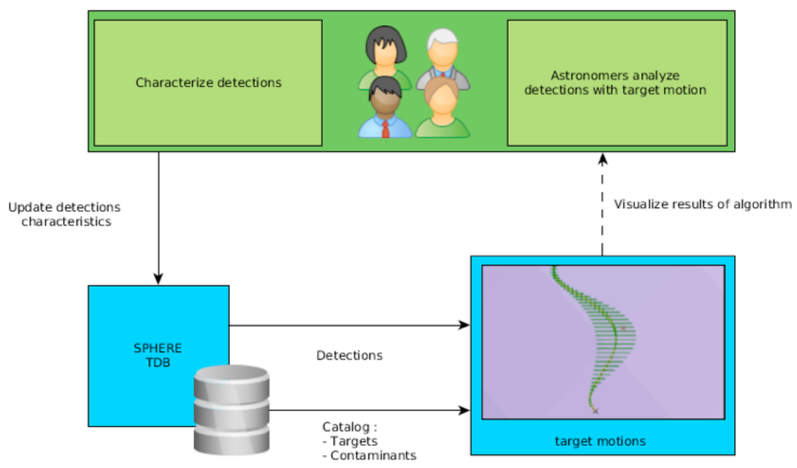
Optimization & observation

The SPOT Software (Lagrange, Rubini, and al 2015, poster of Montreal's Lyot meeting) aims to optimize the observations session (several nights). It reads the exported RDB file and determines the optimum observation time and the best total exposure time for each star, it also improves the exposure time given by TDB. In fact, stars must be observed at the moment where the rotation of the field (of view) is the fastest in order to apply the ADI method to reduce the data and achieve the highest possible contrast (10^-6). Then, the OPS (Observation Preparation Software) finalizes observations preparation for each night and exports the resulting file into P2PP (Phase 2 Proposal Preparation tool) which controls the telescope.



Data reduction

Data are reduced afterward with the SPHERE Data Center facilities and resulting metadata are retrieved by the TDB which updates the observation characteristics (date, instrumental mode, performance, etc). Thereafter acute analysis is carried out and poduces detections of possible companions, also stored in the database.



Reduced Data analysis

The TDB implements an astrometric algorithm that displays the motion of background stars in the target's reference frame. This allows to distinguish objects linked with the star (planet, companion star) from background stars when the detection is observed at different dates. It could also be useful to determine the best date to observe again the target in order to resolve the ambiguity of the nature of the detection.

Conclusion and perspectives

- Suggestion :
  - Astrometric validation could be used for other surveys.
  - Computation of orbital parameters (eccentricity, semi major axis, etc.) from the planet motion using several observations.
- Still to come
  - VO compliant
  - Up to you …

References and Special thanks

This work has been performed thanks to T. BOCH (Aladin Lite) and R. GALICHER (astrometric algorithm).

- OPS : https://plone.unige.ch/SphereOps
- Contact : jean-charles.meunier@lam.fr
- SPHERE TDB : http://cesam.lam.fr/spheretools/