The European Organisation for Astronomical Research in the Southern Hemisphere (ESO) is the foremost intergovernmental astronomy organisation in Europe and the world's most productive ground-based astronomical observatory. ESO carries out an ambitious programme focused on the design, construction and operation of powerful ground-based observing facilities enabling astronomers to make important scientific discoveries.

ESO operates three unique world-class observing sites in northern Chile: La Silla, Paranal and Chajnantor (home to ALMA and APEX), and the ESO Headquarters are located in Garching, near Munich, Germany.

At Paranal, ESO operates the Very Large Telescope, the world's most advanced visible-light astronomical observatory, and will host and operate the southern array of the Cherenkov Telescope Array, the world's largest and most sensitive high energy gamma-ray observatory. ESO is a major partner in ALMA, the largest astronomical project in existence. And on Cerro Armazones, ESO is building the 39-metre Extremely Large Telescope (ELT), which will become "the world's biggest eye on the sky" and whose operations will be fully integrated into the Paranal Observatory.

For its Paranal Observatory, ESO is inviting students from Chilean universities to participate in our program:

SUMMER STUDENTS CHILE 2023

The Maintenance, Support and Engineering department (MSE): provides technical support to the four VLT 8-m telescopes, to the VLT Interferometer with its auxiliary telescopes and to all instruments available for scientific observations. The MSE Department of Paranal has a total workforce of 80 engineers and technicians distributed in 6 engineering groups.
References for MSE Dpt. http://www.eso.org/sci/facilities/paranal/paranalenginternship.html

The Science Operations department (PSO): In the last years, major new systems have complemented our suite of instruments. This includes the VLTI 2nd generation instruments Gravity & Matisse, the Adaptive Optics Facility (AOF) on UT4 and the planet hunter ESPRESSO. ERIS and the MOS facilities MOONS & 4MOST are upcoming future systems at the VLT.

For the summer period 2023, ESO is offering five projects for the Maintenance and Engineering Department, and three projects for the Science Operations Department. These are the following:

Projects for the MSE Department:

I. Software/Instrumentation Project: "Web Application for telescope/instrument systems status and observation reports overview for corrective maintenance"

One of the most recurrent overheads during corrective maintenance happens in the recollection of information, which is a tedious task because many systems are working in parallel, and the information is dispersed throughout them. We propose to implement a central tool that:

- Collects information on demand of the any part of the observation chain through scripts and additional information (Atmospheric/Weather conditions).
- Adaptation of previous works to get observation information from BOB (observation context, target, magnitude, size, etc.)
- Create a Web Application using Django and DevOps practices compatible with software requirements to be maintainable and later transferable to ownership of the IT group

This study case will focus on the UT4 observation chain with MUSE + AOF. This chain includes systems like M1, DSM, M3, GALACSI, 4LGSF, UT positioning, atmosphere conditions, and others.

Objectives

The project aims to evaluate industrial grade hardware solutions for a future cooling upgrade keeping in mind the following main objectives:

- Get a good grasp of how observations are carried out and how the different systems are involved.
- Elaborate the scripts for data collection based on Instrumentation group requirements.
- Define a good strategy to implement the Web Application and how to integrate the data acquired by scripts, atmospheric telemetry, and data delivered by previous works.
- Produce a Web Application for the data visualization.
- Deliver the documentation as a project report, with a user manual for the maintenance.

Student Profile

- Student of Computational/Software Engineer or similar career
- Advanced programming experience and in particular, using Django.

Shift and duration

Shifts still to be defined. (Supervisor flexibility can be considered if operations allow it). The duration goes from two to three months.

II. Electronics Project: "Assembly and testing of electronic boards for the VLT and the Interferometer"

In the context of upgrading the Unit Telescope (UT) altitude and azimuth tachometers with a new and simpler system, a new device was designed, tested, and put into normal operation. The new tachometer includes a conditioning board that requires to be populated (i.e., solder several parts) and tested. While this is not a complicated task, it is a repetitive and time-consuming one. Also, to have tested and ready-to-use spare units, it is necessary to assemble all the required parts and test them together.

In addition, in the context of upgrading the beacon modules, four of them have been replaced in the UT but AT (Auxiliary Telescopes of the VLT interferometer) are still pending. We have the components to manufacture several new modules to get spares for UT, as well as the units needed to replace the old ones in the AT. The student will assemble those new beacon modules that also include the calibration of the intensity of the different laser sources, which is a challenging aspect of the work.

Student Profile

- Electronic technician or Electronic Engineer.
- Experience in soldering component on electronic boards

Shift and duration

8x6 shifts, for two months.

III. Instrumentation Project: "Monitoring System for Detector Lab"

The Detector Lab (DetLab) has 3 different test benches for detectors plus some housekeeping system (O2 detector, coolant distribution, LN2 distribution) that need to be monitored and forwarded to the Paranal datalake (aka DataLab) and/or the Azure Cloud.

These monitoring systems are very similar to those installed in our instruments, so the Detector lab will be used as a test bed to implement different approaches to monitor all the sensors that can help to assess the system state and, if possible, prevent future failures.

Objectives

- To develop drivers for the different sensor systems.
- Use Node Red, MQTT, OPC UA to concentrate data and send to Cloud servers.
- Develop a system running in a Raspberry Pi to concentrate all the sensors values gathered in the detlab and convey that information to cloud storage
- Prepare a dashboard with sensor information that can be accesses locally in the detlab.

Student Profile

- Student of electronic engineering career
- Solid knowledge of digital electronics
- Solid knowledge of python language
- Knowledge of Raspberry Pi microcomputer and ESP32, ESP8266 microcontrollers
- Knowledge of Linux (desirable)

Shift and duration

8x6 shifts for three months.

IV. Mechanical Project: "Improvements of practices at the anodizing room"

The Paranal mechanical workshop is equipped with a metal anodizing room for special parts. The quality of the anodizing process is directly related to the values of the main chemical parameters of the different stages/processes. Measuring these parameters, and doing corrections in case of detecting deviations, is not so trivial and requires fine-tuning.

Objectives

- Review concentrations, contamination and PHs of tanks, and making corrections and/or renovations if needed.
- Compare quality of anodized parts before and after corrections.
- Check if instruments available in anodizing room are most suitable for measuring the chemical parameters of the different dyes. If not, specify and look for parts in local market
- Define clear/simple procedures about how to measure chemical parameters in the different dyes (defining ranges of what is acceptable) and how to correct chemical parameters in case of detecting deviations.

Student Profile

- A degree on Industrial Chemistry.

Shift and duration

Four shifts of 8x6 for a period of two months.

V. Quality Assurance Project: "Wrench time calculation as a case study in astronomical observatories"

Wrench time studies are methods used to validate efficiencies gained from work management improvement projects. The practical aspects of performing a wrench time study will vary based on the type of industry studied. This activity will be an examination of the general concepts of wrench time studies and the development of a case study at the Paranal Observatory.

Objectives

- Study and understand the methodology for the wrench time calculation defined in Paranal.
- Collect data and promote a pilot application for a system of interest.
- Develop related documentation related to the group requirement.
- Deliver a report about what was done (problems, steps, benefits, recommendations)
- Provide a presentation to the MSE/SQA group and other stakeholders.

Student Profile

- Student of industrial, mechanical, or electrical engineering in the last semester of career (also an option to perform a graduating thesis).
- Good command of English.
- Knowledge of SQL database.
- Knowledge or previous experience on any CMMS (desirable)
- Knowledge of KPI and Dashboard (desirable)
- Knowledge of Maintenance Strategies (desirable)

Projects for the PSO Department:

I. Project: "SCUBA testing and factorization"

Service mode observations at ESO's Paranal Observatory relies on the ability to grade science observations. The grading criteria, as defined by the submitter of the program are based mainly on external conditions (e.g. sky transparency, atmospheric seeing) and the grading is done by the night crew immediately after the observations. One of the top-level requirements for operating the E-ELT is to improve observation grading scheme by including criteria based on pipeline-reduced science data. The implementation of a science data grading for a range of different instruments and data types requires the development of new versatile software tools. They would feature real time data visualization, the ability to measure a variety of data quality indicators and able to render the necessary information to the night operators in order to properly grade the science data. This is the role of the SCUBA software.

Objectives

SCUBA is separated in a GUI and independent instrument related modules. This internship is focused on the GUI part. In the spirit of creating a robust and low-maintenance tool, we need to have a code that is well written, documented, factorized, and fully tested. The intern will have the choice between two sub-projects:

- Factoring: A lot of the GUI-instrument source code are coded in a similar way. The goal of this subproject is to analyze the source code and factorize most of the common functionalities. This will reduce the size of the code and allow us to maintain is more easily.
- Testing: The GUI is the central part of the software, and it is crucial to have this part well tested to ensure that the software does not break. This project will focus on the unit testing of the graphical user interface.

Student Profile
Student in Natural Sciences or Computer Engineering with the following skills:

The ideal student profile will have an extended experience with the python programming language. We also seek an intern with hands-on experience in graphical user interface programming with the PyQt5 library and some knowledge of unit testing.

Shifts and duration
Shifts on site. January-February 2023.

II. Project: "VLTI vibration frequencies: Machine learning source identification"

Vibrations of elements of the telescopes and instruments reduce data quality or even prevents operation. Vibration diagnostic is a key element in modelling UT-VLTI system performance. The main goal of the project is to detect and identify the source of the anomalies. To achieve this task, it is necessary to detect vibration frequencies, quantify their impact on operations, and identify their origin. The end of project deliverable is to create an alert system for operations, indicating that an anomalous frequency has been detected and the probable source of the frequency.

Objectives

Relevant data sources have been collected. The student will be tasked with the cleaning and preprocessing of the data, exploratory data analysis, labelling by vibration frequency class, and source identification using machine learning techniques. The main tasks will be:

1. Data cleaning and preprocessing of the prepared dataset for analysis.
2. Exploratory statistical analysis.
3. Use two different techniques to obtain class definitions (nominal vs anomalous vibrations):
    I. Clustering
    II. Anomaly detection
4. Perform root-cause analysis using preferred method (*ex:* multivariate anomaly detection, mutual information.
5. Develop an interactive dashboard to visualize results.
6. Summarize work in a final report and presentation.

All code produced must be properly documented.

Student Profile

- Strong mathematics background
- Statistical analysis
- Python programming: pandas, scikit-learn
- Knowledge of machine learning models: supervised and unsupervised
- Experience with Azure ML Studio, desired but not required

Shifts and duration

Mix shifts on-site and Vitacura premises (remote working). January-February 2023.

III. Project: "Revision of the ESPRESSO calibration plan"

In this project we aim at revising the calibration plan of the ESPRESSO high-resolution spectrograph (https://www.eso.org/sci/facilities/paranal/instruments/espresso.html). In particular, we will re-assess the validity range of the short-term (e.g. bias, flat, Th-Ar lamps, etc) and long-term set of data (linearity, spectrophotometric and radial velocity standard stars, fibers relative efficiency, etc) that are used to calibrate the scientific data taken every night, and to monitor the instrument health with time. The goal of the project is to determine how 'old' a calibration can be used to produce high quality reduced data.

Objectives

- Download, reduce and analyze ESPRESSO data using the dedicated ESO pipeline (https://www.eso.org/sci/software/pipelines/espresso/espresso-pipe-recipes.html), installed at local machines here at ESO.
- Determine validity periods for each set of daily and long term calibrations
- Determine precise validity ranges for key performance indicators of the spectrograph, from health check.

Student profile

The student is expected to have experience on astronomical data reduction and its various steps. Knowledge of high resolution spectrographs would be also highly beneficial. The candidate should also have the ability to read and manipulate fits files and have a working knowledge of a programming language for data analysis (python, IDL, etc)

Duty station

Paranal Observatory located 120 km south of the city of Antofagasta, Chile, with accommodation provided on site. Some work in the Vitacura premises is also possible, and foreseen in some cases, depending on the nature of the project**.** Remote work is also considered for some of the projects.

Contract Allowance and Transportation

ESO offers a special allowance during the period of the internship; air and ground transportation between Santiago and the observatory site will be provided by ESO.

Application

We invite students from Chilean Universities in their last career year to apply. The apprenticeship should be supported by the University, and therefore, it shall be covered by the student accident insurance (Law 16.744).

If you are interested in working in areas of frontline technology and in a stimulating international environment, you are invited to apply online at **http://recruitment.eso.org/.** Applications must be completed in English and should include a CV and a motivational letter indicating the project(s) you are interested in. In order to provide further details, and learn about the general context and objectives of these internships, we will be holding a webinar on a date to be confirmed shortly, in this same posting.

Closing date for applications is 30 September 2022.

ESO has established diversity as an important value of the Organisation; it is committed to providing an equal opportunities environment and is actively seeking to promote a diverse and inclusive workforce. The post is equally open to suitably qualified candidates irrespective of nationality, gender, age, disability, ethnicity, or religion.