

Introducing FRACTAL SLNE

Services and Capabilities

A Technological company for scientific projects

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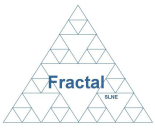
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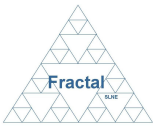
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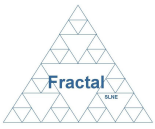


Introduction to FRACTAL SLNE: Services and capabilities.



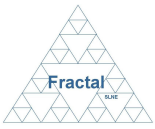
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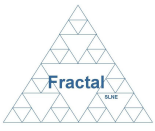
List of Acronyms and Abbreviations used

AOR	Astronomical Observing Request
AT	Auxiliary Telescope
CFC	Continuous Flow Cryostat
CNIG	Centro Nacional de Información Geográfica (National Centre for Geographic Information)
CS	Control Software
CV	Curriculum Vitae
DDL	Differential Delay Line
ESA	European Space Agency
ESAC	European Space Astronomy Center
ESO	European Southern Observatory / European Organization for Astronomical Research in the Southern Hemisphere
ESOC	European Space Operations Center
GTC	Gran Telescopio CANARIAS
HIFI	Heterodyne Instrument for the Far Infrared
IA	Instituto de Astronomía
IAA	Instituto de Astrofísica de Andalucía
IAC	Instituto de Astrofísica de Canarias
ISO	Infrared Space Observatory
ISS	Interferometer Supervisor Software
ITA	Instituto Tecnológico de Aragón
IUE	Internacional Ultraviolet Explorer
JPL	Jet Propulsión Laboratory
OAN	Observatorio Astronómico Nacional (National Astronomical Observatory)
OPD	Optical Path Difference
PD	Preliminary Design
PDR	Preliminary Design Review
PPARC	Particle Physics and Astronomy Research Council
SOW	Statement Of Work

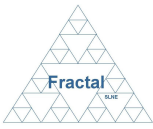


Introduction to FRACTAL SLNE: Services and capabilities.

TCS	Telescope Control System
UAM	Universidad Autónoma de Madrid
UC	Universidad de Cantabria
UCM	Universidad Complutense de Madrid
ULL	Universidad de La Laguna
UNAM	Universidad Nacional Autónoma de México
US	Universidad de Salamanca
VLT	Very Large Telescope
VLTI	Very Large Telescope Interferometer
VO	Virtual Observatory
WBS	Work Breakdown Structure
WP	Work Package



Introduction to FRACTAL SLNE: Services and capabilities.



1. SUMMARY

This document presents an introduction of the company GARCIA VARGAS, MARIA LUISA 000852081X SLNE (hereafter FRACTAL S.L.N.E.), a technological company for engineering services, operations and development of scientific projects. The document contains a summary of its services and capabilities as well as a list of the contracts already done for some of our customers.

2. INTRODUCTION

FRACTAL SLNE is a private company belonging to the technological activities sector. FRACTAL started founded in August, 2005, being now almost 12 years old. We provide consultancy services in different engineering areas. Our main goals are to consolidate ourselves as a company specialized in engineering services for scientific projects, to focus our services mainly to the research and operation centers and universities, which sometimes need additional engineering or managing manpower; and to collaborate with other companies, universities and research centers in Research & Development Projects for scientific applications.

Our main area of expertise is the development of professional astronomical instrumentation and software. Most of FRACTAL's consultants worked at GRANTECAN Company, in charge of the development of the 10-m telescope, the GTC. FRACTAL's General Manager was for more than 9 years the Head of the Instrumentation Group at the GTC Project Office. FRACTAL people mainly come from three areas of expertise: (1) Astronomical Instrumentation (including Optics, Mechanics, Electronics, Detectors, Cryogenics, etc.); (2) Control and Software Development (Real Time Control, including astronomical software for telescope operations, active Optics loops, mechanisms control, Data bases and Data management and processing) and (3) Management and System Engineering.

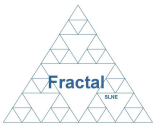
This specific expertise allows us to participate in large project's developments, like the instrumentation for the GTC 10-m telescope, as well as international projects, like the 6.5 large telescope in Mexico, the HEXA 6.5m in CAHA, the GTC 10m telescope and the giant 42-m diameter ELT segmented telescope. Also, we can provide services to Space projects (at the level of instrumentation development, software, management and quality control) as well as engineering and scientific services.

2.1 Contractual Data and Company identification

The commercial name of the company is FRACTAL SLNE.

The "legal" name is: GARCIA VARGAS, MARIA LUISA 000852081X S.L.N.E.

, where SLNE is the acronym for Sociedad Limitada Nueva Empresa, New Company Limited Society, a legal form for small companies in Spain promoted by the Spanish Industry Ministry where the name comes from the surname of the main partner plus a combination of numbers and letters getting from the name and combined by an automatic algorithm. The company was



registered in the *Registro Mercantil de Madrid, Tomo 53 Libro 0 Folio 46 Sección: SLNE Hoja: M.1250 Inscripción 3ª el 10/06/2009* (data from the Commercial Register in Madrid).

The identification code for the company is CIF: ES-B38829107.

In summary:

Formal / Legal Name: GARCIA VARGAS, MARIA LUISA 000852081X S.L.N.E.

CIF: ES-B38829107

Commercial Name: FRACTAL SLNE

Company address:

C/ Tulipán nº 2, portal 13, 1ªA. E-28231 Las Rozas de Madrid. Madrid (Spain)

Phone: +34 916379640 / +34 630737981 FAX: +34 917917113

Company Partners:

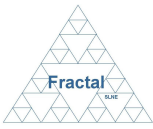
- Dr. María Luisa García Vargas (pH in Astrophysics). Director & Head of the Instrumentation Area
- Pedro Gómez-Cambronero Álvarez (Msc. Physics). Head of the Software Area

We will provide the official document for the company constitution and the formal document with the CIF number or any other administrative document under request. The company pays regularly all the taxes to the Treasury Agency and to the Social Security. We can provide official and updated certificates from these institutions if required.

2.2 Technical capability

The current FRACTAL team is composed by highly qualified people, all of them with university studies in scientific and engineering disciplines: Engineering, Mathematics, Physics, etc. We develop the projects with a multidisciplinary approach. Our professional experience includes not only private industry but also the universities and science operations centers. FRACTAL's value is the sum of the ability and imagination of FRACTAL people. We have been working together for many years and we do each project by combining our forces to produce the best results. We are a group of 16 people (mostly senior with more than 15 years of expertise) covering the following areas:

- Management
- System Engineering
- Software for Data Bases
- Control Software (Real Time, CORBA, Distributed Systems, Mechanism control, etc.)
- Data Reduction. Pipelines
- Telescope Control Systems



- Optics (Optics, opto-mechanics and Adaptive Optics)
- Mechanics
- Electro-mechanics and Electronics
- Cryogenics, CCDs and Data Acquisition System
- Astronomy

To show the company's capability we can provide CV of the partners and the engineers of our company, under request.

A detailed list of the relevant contracts already done with scientific customers by our company is given in the next section.

We think this documentation proves the technical capability of our company. We can deliver under request any other document that can be considered relevant to show our capabilities. We list below the contracts (training courses and grating delivery contracts have not been included) we have developed for our customers and a list of references.

3. FRACTAL CONTRACTS

3.1 Management and System Engineering Consultancy and services

[1] **Management and System Engineering services for MEGARA**

Customer: UCM (Universidad Complutense de Madrid)

Description: Management and System Engineering services for MEGARA instrument (an IFU wide field instrument for the GTC 10-m telescope) in the whole instrument life-time [2010-2017], according to the customer requirements and constraints taken into account the interface constraints imposed by GTC and the scientific requirements and managerial constraints coming from the different scientific partners of the project: UCM, INAOE (Mexico), UPM and IAA. FRACTAL consultants María Luisa García Vargas and Ana Pérez Calpena have been the Project manager and the System Engineer of CARMENES project.

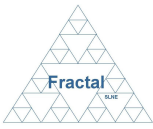
Reference: Dr Armando Gil de Paz, (agil@fis.ucm.es)

Astronomy Department of the Universidad Complutense de Madrid.

[2] **Management services for The Two Towers Project**

Customer: INTA (Instituto Nacional de Técnica Aeroespacial)

Description: Management support services to INTA in the framework of the Preliminary Design of the Two Towers project for SEOSAT Ingenio.



Reference: Dr. Héctor Guerrero Padrón, (guerreroph@inta.es)

Instrumentation Department. Opto-electronics laboratory. Spatial Programs and Spatial Science, INTA

[3] **Management Plan for the design and construction of San Pedro Mártir 6.5m Twin Telescopes (early project 2007)**

Customer: **IA-UNAM** (Institute of Astronomy. Universidad Nacional Autónoma de México)

Description: Management Plan according to the customer requirements and constraints and in order to produce a fair distribution, industrial return and task responsibility for the partners. We produced the WP definition and distribution, described the Project Organization issues, established the schedule and milestones, gave estimations of cost and related cash flow, and discussed the industrial return and other partnership-related issues.

We have had several contracts since the beginning of the proposal. The reference for the Management contracts have been:

Reference: Dr José Franco, (pepe@astrocu.unam.mx)

Ex - Head of the Astronomy Department of the Universidad Nacional Autónoma de México.

Reference: Dr. William Lee (wlee@astro.unam.mx). Head of the Astronomy Department of the Universidad Nacional Autónoma de México

[4] **Management and System Engineering Plan for HEXA 6.5m telescope at CAHA**

Customer: CAHA

Description: Management and System engineering services for developing the HEXA 6.5m telescope and its instrumentation for CAHA Observatory.

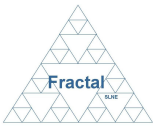
Reference: Dr. David Barrado, (barrado@caha.es)

CAHA Director

[5] **Consultancy for the market study of VIA-SKA**

Customer: IAA

Description: Consultancy services for studying the feasibility of the Spanish Industrial Participation in the Square Kilometer Array (SKA). This work is part of the actions carried out by the VIA-SKA project, which has been funded by the Ministerio de Ciencia e Innovación (MICINN) and includes researchers and engineers from the



Instituto Geográfico Nacional, Universidad de Granada, Universidad de Barcelona, Universidad Carlos III, Instituto de Física de Cantabria / Universidad de Cantabria, Universidad de Valencia, Centro de Astrobiología and Instituto Astrofísico de Canarias

Reference: Lourdes Verdes-Montenegro (lourdes@iaa.es)

IAA Researcher

[6] **Management and System Engineering services for CARMENES project at CAHA**

Customers:

LWS (Landessternwarte Königstuhl-ZAH (Heidelberg, Germany)

IAA (Instituto de Astrofísica de Andalucía, Granada, Spain)

CAHA Observatory

Description: Management and System engineering services for CARMENES instrument, a new double arm echelle spectrograph for the 3.5m CAHA telescope. FRACTAL consultants María Luisa García Vargas and Ana Pérez Calpena have been the Project manager and the System Engineer of CARMENES project.

Reference: Dr. Andreas Quirrenbach (aquirren@lsw.uni-heidelberg.de)

Dr. Pedro J. Amado González, (pja@iaa.es)

PI and co-PI of CARMENES project

Also Dr. Jesús Aceituno (aceitun@caha.es) Director of CAHA and the two former directors Dr. David Barrado and Dr. José María Quintana.

[7] **Management and System Engineering Plan for the design and construction of San Pedro Mártir 6.5 Telescope (2014 – 2015)**

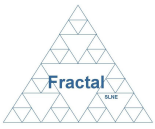
Customer: **IA-UNAM** (Institute of Astronomy. Universidad Nacional Autónoma de México)

Description: Management and System Engineering Plans for the design and construction of a new 6,5m aperture telescope in San Pedro Mártir. Our services included also the production of requirements, specifications and interface control documents.

References:

Beatriz Sánchez y Sánchez beatriz@astro.unam.mx

William Lee wlee@astro.unam.mx Head of IA-UNAM



Michael Richer

richer@astro.unam.mx Director OSPM

[8] **Management and System Engineering Plan for the design and construction of San Pedro Mártir 6.5 Telescope (2015 – future)**

Customer: **IA-UNAM** (Institute of Astronomy. Universidad Nacional Autónoma de México)

Description: Management and System Engineering services for the 6.5m aperture telescope in San Pedro Mártir, being FRACTAL's consultants María Luisa García Vargas and Ana Pérez Calpena respectively. The work implies communication with the different partners (IA-UNAM, University of Arizona (Steward Observatory, INAOE and Smithsonian Astronomical Observatory, Center for Astronomy, Harvard (SAO, CfA) and the participant companies (M3) and technological centers (CIDESI).

References:

William Lee

wlee@astro.unam.mx Head of IA-UNAM

Michael Richer

richer@astro.unam.mx Director OSPM

[9] **Safety and maintenance plan for the LST of the CTA project**

Customer: **UCM** (High Energy Department)

Description: Development of a Safety and Maintenance Plan for the LST of the CTA project, the largest Cherenkov radiation telescope currently under construction.

Reference: Dr. José Miguel Miranda miranda@fis.ucm.es

We have been collaborating in some internal meeting and workshops

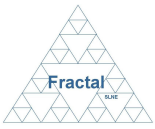
3.2 Scientific Support and Operations services at customer

[10] **Astronomical support for the Spanish National Observatory (Radioastronomy) in the development of a user support platform for the HIFI instrument (Herschel mission, ESA).**

Customer: **Centro Nacional de Información Geográfica, CNIG**

Reference: Dr. Pere Planesas (p.planesas@oan.es)

CNIG researcher and contract responsible



[11] **Pre-launch Operational support for the Spanish National Observatory (Radioastronomy) for the HIFI instrument (Herschel mission, ESA).**

Customer: **Centro Nacional de Información Geográfica, CNIG**

Reference: Dr. Pere Planesas (p.planesas@oan.es)

CNIG researcher and contract responsible

Description: The two former contracts for scientific operations implied that two people were working at customer's offices to develop the agreed contract scope. In particular they had the following associated tasks for the support to the users granted with OAN Guaranteed Time Key Program for HIFI

Scientific tasks

- Simulations
- Data reduction
- Milimetric observations proposal submission from the Ground

Support tasks

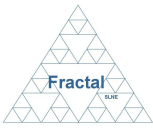
- Installation and updates of HSPOT ESA software
- Support to OAN astronomers in the HSPOT use
- Meetings with ESA HIFI/HSPOT responsible
- Preparation of the AOR, Astronomical Observing
- Request for the OAN Key-Program
- Meetings and talks at OAN
- HIFI/OAN User Support Web Page
- Twiki, Distribution Lists, internal and outreaching (public) web pages
- Documentation

3.3 Software services at customer

[12] **Software consultancy for the development of an astronomical database to store and handle the data from the HIFI/Herschel mission (ESA)**

Customer: **Centro Nacional de Información Geográfica, CNIG**

Reference: Dr. Pere Planesas (p.planesas@oan.es)



CNIG researcher and contract responsible

Description: A consultant was working at customer during 1.5 years to develop customized applications to manage a database of final products resulting from scientific astronomical observations. The database (on MySQL) is managed by a Java application local-based. Users (with different profiles) can connect to this database through Internet. From Internet, a user can interact with the database according to their permissions and with a basic tool for quick look and analysis of the calibrated images and spectra. The main functionalities are the management of:

- Herschel/HIFI (spectra) Data - Radiosources Catalogue (from SIMBAD)
- Spectral Lines Catalogue (from JPL Molecular Spectroscopy).
- Users and Groups Management
- Permissions according to the data property policy

Through Internet it shall be possible to:

- Make queries to the database
- Many search criteria available
- Visualize and/or Download the spectra (with the adequate permissions)
- The applet for the Calibrated Spectra allows:
 - Smoothing / Unit change / Zoom

[13] **Software consultancy (part-time) for the development and maintenance of an astronomical database and other software facilities for the HIFI/Herschel (ESA)**

Customer: **Instituto Geográfico Nacional / National Astronomical Observatory.**
OAN

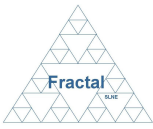
Reference: Dr. Valentín Bujarrabal (v.bujarrabal@oan.es)

OAN researcher and contract responsible

Description: A consultant worked at customer during 2 years (July 2008 –June 2010) to develop customized applications to manage a database of final products resulting from scientific astronomical observations and other software developments and facilities related to HIFI/Herschel project.

[14] **Software Development for the pipelines of VLT instruments.**

Customer: **European Southern Observatory, ESO**



Service Contract No. 20147/ESO/08/18366/GWIE

Reference: Gerd Wieland (gwieland@eso.org) and Pascal Ballester (pballest@eso.org)

Head of Contract procurement department and Head of Pipelines Department

Description: A consultant worked at customer's offices in Garching (Munich) during 2 years (April 2008 – April 2010) to develop customized software for reduction and analysis of data taken with the instruments of the VLT telescopes (4 telescopes of 8m diameter placed at Cerro Paranal in Chile). Among his tasks, he has contributed to the development of the pipeline for instrument HAWK-I and for SINFONI.

[15] **Preparation of data reduction procedures for the ESO VLT pipelines, and the implementation of these parts in ANSI-C with the ESO-CPL library**

Customer: **European Southern Observatory, ESO**

Service Contract No. 32518/ESO/10/32982/YWE

Reference: Pascal Ballester (pballest@eso.org)

Head of Pipelines Department

Description: A consultant worked at customer's offices in Garching (Munich) during 2 years (April 2010 – April 2012) to develop customized software for ESO VLT pipelines.

3.4 Astronomical Instrumentation Development

[16] **Acam Conceptual Design (future instrument for the 4.2 WHT at ORM)**

Customer: **PPARC / Isaac Newton Group of telescopes, ING**

Reference: Dr. René Rutten (rgmr@ing.iac.es), currently at GTC Project Office

Director of Isaac Newton Group of telescopes

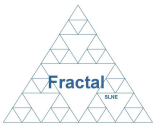
Description: We carried out the feasibility study and the optical conceptual design of a new camera and spectrograph for the 4.2m William Herschel Telescope.

[17] **OASIS enlarger Preliminary Design (existing instrument at 4.2 WHT)**

Customer: **PPARC / ING**

Reference: Olivier Martin (olivier@ing.iac.es)

Instrumentation engineer at ING and contract responsible



Description: We developed an upgrade of the entrance Optics of the OASIS instrument in order to enlarge the FOV. Also, the study will include a detailed analysis about stray light to improve the instrument performance.

[18] **Specification and manufacturing tracking of z-filters for Elmer (GTC)**

Customer: **IAC**

Reference: Dr. José Alfonso López Aguerri (jalfonso@iac.es)

IAC Researcher and contract responsible

Description: We made final manufacturing specifications for a set of narrow band filters for the instrument Elmer from the high level user requirements (pure scientific requirements)

[19] **Design, Specification and manufacturing tracking of filter mounts and masks for Elmer**

Customer: **Instituto de Astrofísica de Canarias, IAC**

Reference: Dr. José Alfonso López Aguerri (jalfonso@iac.es)

IAC Researcher and contract responsible

Description: We made final the design (including manufacturing drawings, manufacturing tracking, integration and tests of the mounts for the new set of narrow band filters for the instrument Elmer (previous contract)

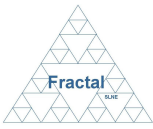
[20] **IACAT Preliminary Design: Telescope and Atmosphere simulator for Adaptive Optics systems**

Customer: **Instituto de Astrofísica de Canarias, IAC**

Reference: D. Luis Fernando Rodríguez (lrr@iac.es)

Head of the IAC Electronics Department

Description: We made the optical, mechanical and control preliminary design of the IACAT system: an atmosphere and telescope simulator to test instruments for AO system at the laboratory. Three telescopes were simulated: OGS, WHT and GTC. This system included a wavefront sensor and a complete star simulator system able to provide a single star, double stars and a star cluster.



[21] **Mechanical Conceptual Design for the instrument NAHUAL for the GTC**

Customer: **Instituto de Astrofísica de Canarias, IAC**

Reference: Dr. Eduardo Martín (ege@iac.es)

IAC Researcher and contract responsible

Description: We carried out the conceptual mechanical design of NAHUAL instrument: an echelle spectrograph ($R = 130.000$) in the near IR (1 to 2.5 microns) for the GTC.

[22] **Optical Conceptual Design for ACTUEL, a 2.5m survey telescope at Javalambre**

Customer: **ITA (Instituto Tecnológico de Aragón)**

Reference: Emilio Esco (eesco@aragon.es)

Description: We carried out the conceptual optical design of a 2.5m telescope with a FOV of 10 squared degrees optimized for survey programs.

[23] **Mechanical Conceptual Design for ACTUEL, a 2.5m survey telescope at Javalambre**

Customer: **ITA**

Reference: Emilio Esco (eesco@aragon.es)

Description: We carried out the conceptual mechanical design of a 2.5m telescope with a FOV of 10 squared degrees optimized for survey programs.

[24] **Coronagraph for CAHA**

Customer: **University of Cantabria**

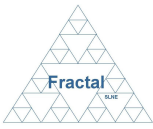
Reference: Dr. Manuel Pérez Cagigal (perezcm@unican.es)

Professor/ Researcher and contract responsible

Description: We carried out the whole system design, specification, manufacturing tracking, system integration and tests of a visible coronagraph.

[25] **Infrared Spectrograph and camera for the Antarctic (new instruments)**

Customer: **University Autónoma of Madrid, UAM**



Reference: Dr. Carlos Eiroa de San Francisco (carlos.eiroa@uam.es)

Professor/ Researcher and contract responsible

Description: We carried out the conceptual optical design of two IR instruments: a near IR spectrograph and camera (1.0 μ m to 2.5 μ m), PNIRC, and a mid-IR spectrograph and camera in the extended range 8 μ m to 40 μ m, PMIRC. Both instruments are being designed for the 2.5m telescope, PILOT, to be in operation at Dome C, Antarctic.

[26] **Design of a high resolution grating for the Instrument Elmer**

Customer: **Instituto de Astrofísica de Canarias, IAC**

Reference: Dra. Casiana Muñoz Tuñón (cmt@iac.es)

IAC Researcher and contract responsible

Description: We carried out the complete and detailed design of a novel VPH grating able to produce relatively high resolution (10.000 to 15.000) with high throughput and in Littrow configuration. The element will be a prototype manufactured for the instrument Elmer.

[27] **Tunable Filter Unit (to be used in an existing instrument, upgrade)**

Customer: **University Complutense of Madrid, UCM**

Reference: Dr. Jesús Gallego Maestro (j.gallego@fis.ucm.es)

Professor/ UCM Researcher and contract responsible

Description: We carried out a design of a Tunable filter in the near-IR (in particular in the K band) to be installed at CIRCE and/or EMIR instruments at the GTC 10m telescope.

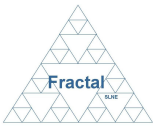
[28] **Feasibility study for the spectrograph MSIX for the 3.5m telescope at CAHA**

Customer: **University Complutense of Madrid, UCM**

Reference: Dr. Jesús Gallego Maestro (j.gallego@fis.ucm.es) / Armando Gil de Paz

Professor/ UCM Researcher and contract responsible

Description: We carried out a feasibility study of the instrument MSIX, a grid of 6 - 9 spectrographs fed by an Integral Field Unit design in the visible range for the CAHA 3.5m telescope.



[29] **Feasibility study for the echelle high resolution spectrograph XHAIRS for the 3.5m telescope at CAHA**

Customer: **Institute of Spatial Studies, IEEC-CSIC, Barcelona**

Reference: Dr. Ignasi Ribas (iribas@aliga.ieec.uab.es)

IEEC Researcher and contract responsible

Description: We carried out the feasibility study of the instrument X-HAIRS, an echelle very high resolution spectrograph in the near-infrared range for the CAHA 3.5m telescope.

[30] **Cryostats for very low temperatures experiments**

Customer: **Universidad de Salamanca**

Reference: Dr. Enrique Díez (enrisa@usal.es)

University of Salamanca Researcher and contract responsible

Description: We carried out the detailed design and the corresponding manufacturing specification and tracking of two cryostats optimized for very low temperature experiments.

[31] **Conceptual Design for MEGARA, a mid-resolution intermediate spectrograph for the GTC**

Customer: **Universidad Complutense de Madrid**

Reference: Dr. Armando Gil de Paz (agil@fis.ucm.es)

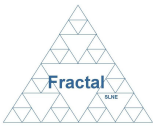
Professor/ UCM Researcher and contract responsible

Description: We carried out the conceptual design of MEGARA: a spectrograph for the GTC. FRACTAL was in charge of the Optics, Mechanics and Detector of the spectrograph, as well as the Management and System Engineering WP.

[32] **Conceptual Design for NIRINTS, a high-resolution intermediate spectrograph for the GTC**

Customer: **Centro de Astrobiología**

Reference: Dr. Eduardo Martín (ege@iac.es)



Professor/ IAC Researcher and contract responsible

Description: We have carried out the conceptual design of NIRINTS: a near-IR spectrograph for the GTC. FRACTAL was in charge of the Optical Design.

[33] **Design and development of ARES spectrograph and Fiber Link**

Customer: **Instituto de Estudios Espaciales de Cataluña (IEEC)**

Reference: Dr. Ignasi Ribas (iribas@ice.csic.es)

IEEC Researcher and contract responsible

Description: Design and development of the fiber-fed spectrograph, ARES for the IEEC at R=12000. The project started at the level of requirements and finished with the installation at the telescope.

[34] **Design and development of LICA laboratory for Universidad Complutense**

Customer: Grupo GUAIX, Departamento de Astrofísica, UCM

Reference: Dr. Jaime Zamorano (jzamorano@fis.ucm.es)

Professor/ UCM Researcher and contract responsible

Description: We have developed the design of the for Laboratory for Scientific Advanced Instrumentation of GUAIX group at UCM (Astrophysics department)

[35] **Diagnostics of TROBAR camera for ARAS de los Olmos Observatory**

Customer: Valencia University

Reference: Dra. Julia Suso (julia.suso@uv.es)

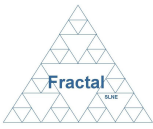
Professor/ UV Researcher and contract responsible

Description: We developed a diagnostics of the CCD camera of the TROBAR telescope at the Aras de los Olmos Observatory (belonging to University of Valencia – Spain)

[36] **Wasatch Photonics Orders**

Partner: Wasatch Photonics

Customer: Several customers / only authorized distributor for whole Europe



We specify and provide VPH holographic gratings to different customers to be used in their applications for ground-based and space instrumentation projects. In particular these gratings have been also produced for large ground-based observatories (like the ones for MEGARA for the GTC 10m telescope and ARES for Observatory of Montsec) and for Space in the framework of Exo-Mars RAMAN spectrograph under contract with INTA.

[37] **MEGARA, a mid-resolution intermediate spectrograph for the GTC**

Customer: **Universidad Complutense de Madrid**

Reference: Dr. Armando Gil de Paz (agil@fis.ucm.es)

Professor/ UCM Researcher and contract responsible

Description: Services and products to design and develop MEGARA: a spectrograph for the GTC. These services have been agreed for the whole project duration [2010-2017] and include: Optical Fiber Bundles design and integration; Optics, Mechanics and Detector design of the spectrograph, final integration and tests as well as the Management and System Engineering WP. Also FRACTAL is in charge of specifying and procuring the whole set of VPH-based elements and of the MEGARA Control System architecture.

[38] **Design and development of ESTRANGIS Fiber Link**

Customer: **Instituto de Astrofísica de Canarias (IAC)**

Reference: Dr. Enric Pallé (epalle@iac.es)

IAC Researcher and contract responsible

Description: Design and development of the two arms fiber link spectrograph, ESTRANGIS for solar observations.

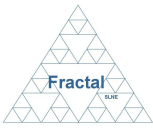
[39] **Design and development of the optical conceptual design of a new telescope for CAHA**

Customer: CAHA

Description: Conceptual design of a new telescope for CAHA Observatory.

Reference: Dr. David Barrado, (barrado@caha.es)

CAHA Director



[40] **Design and development of HECATE: a Fiber-Fed spectrograph for HEXA telescope at CAHA**

Customer: CAHA

Description: Conceptual design of a high spectral resolution spectrograph for HEXA telescope, the next 6.5m telescope at CAHA Observatory.

Reference: Dr. David Barrado, (barrado@caha.es)

CAHA Director

[41] **Optical Design and Filter specifications for the PAU camera for the 4.2m WHT**

Customer: **Instituto de Estudios Espaciales de Cataluña (IEEC)**

Reference: Ricard Casas (casas@ieec.uab.es)

IEEC Researcher and contract responsible

Description: Optical design and filter specification for the PAU camera, a wide FOV imager for the 4.2m William Herschel Telescope at La Palma

[42] **Digital Ophthalmoscope Prototype**

Customer: **R+D project**

Description: Development of a functional prototype of a digital ophthalmoscope for glaucoma early diagnosis.

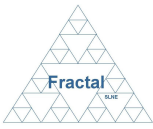
[43] **Holographic Gratings for the RAMAN spectrograph on board of the Rover of the ExoMars mission**

Customer: **INTA**

Reference: María Colombo Bueno (colombobm@inta.es)

Spectrograph Project Manager (INTA)

Description: Design and provision of 37 VPH gratings to be qualified and finally fly in the ExoMars mission.



[44] **ALBIREO refurbishment for the Observatorio de Sierra Nevada**

Customer: **IAA**

Reference:

José Manuel Vílchez (jmv@iaa.es) Director IAA

Olga Muñoz (olga@iaa.es) Sub-Director (IAA)

Description: Complete refurbishing of the spectrograph ALBIREO for the Observatory of Sierra Nevada (Granada, Spain) under contract with the IAA. The project includes design, manufacturing, new gratings and observing modes and a new module of A&G and calibration as well as several software developments.

[45] **Optics, Mechanics and Cryogenics Conceptual Design for OCTOCAM (Gemini)**

Customer: **IAA**

Reference: Antonio de Ugarte Postigo (adeugartepostigo@gmail.com)

Description: Conceptual design of the optics, mechanics and cryogenics of the 8-channel mid-resolution spectrograph for Gemini Observatory.

The project has been selected by Gemini. Contract's signature between SwRI and FRACTAL is in process.

[46] **Preliminary Optical Design of Telescopio San Pedro Mártir**

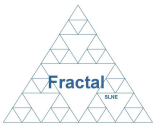
Customer: **IA-UNAM**

Description: Preliminary Design of the Telescopio San Pedro Mártir

References:

Dr. Michael Richer (richer@astro.unam.mx) Director OSPM

Dr. Jesús González (jesus@astrocu.unam.mx) IA-UNAM



3.5 Software analysis and development

[47] **Web Services for the Project “Estallidos”**

Customer: **Instituto de Astrofísica de Canarias, IAC**

Reference: Dra. Casiana Muñoz Tuñón (cmt@iac.es)

IAC Researcher and contract responsible

Description: we developed a complete web services kit for a scientific project

[48] **Database for GTC 10m telescope observations**

Customer: **Instituto de Astrofísica de Canarias, IAC**

Reference: Dra. Casiana Muñoz Tuñón (cmt@iac.es)

IAC Researcher and contract responsible

Description: we developed a complete a complete database and the corresponding web services for user support to manage the GTC observations of the “Starburst” project of the IAC.

[49] **Web services for ISCAI and GTC-Consolider projects and market study for ISCAI**

Customer: **Instituto de Astrofísica de Canarias, IAC**

Reference: Dr. Rafael Guzmán (guzman@astro.ufl.edu)

Professor at University of Florida, and contract responsible

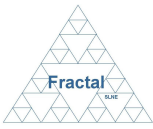
Description: we developed web services (internal and external) of the International School of Advanced Instrumentation, ISCAI, as well as a market study of education services through Internet. ISCAI is an initiative of the IAC, the University of Florida, the University Complutense of Madrid and UNAM at Mexico.

[50] **Study of the requirements for the definition of the data reduction systems (pipelines) for the E-ELT (ESO)**

Customer: **Universidad Complutense de Madrid**

Reference: Dr. Jesús Gallego (j.gallego@fis.ucm.es)

Professor at University Complutense de Madrid, and contract responsible



Description: we have carried out a study of the requirements for the definition of the data reduction systems (pipelines) of the E-ELT (ESO) instruments.

[51] **Study of the requirements for the implementation of the data from E-ELT (ESO) instruments in the Virtual Observatory**

Customer: **LAEFF / Centro de Astrobiología (CAB)**

Reference: Dr. Miguel Mas-Hesse (mm@cab.inta-csic.es)

Researcher at LAEFF/CAB and contract responsible

Description: we have carried out a study of the requirements needed for the implementation of the E-ELT data coming from the instruments in the Virtual Observatory.

[52] **Web services for MEGARA**

Customer: **Universidad Complutense de Madrid**

Reference: Dr. Armando Gil de Paz (agil@fis.ucm.es)

Professor/ UCM Researcher and contract responsible

Description: we developed web services (internal and external) of the MEGARA project, see webpage by FRACTAL <http://guaix.fis.ucm.es/megara>

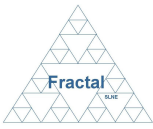
[53] **Web services for SECPhO**

Customer: **SECPhO Cluster in Optics and Photonics**

Reference: Sergio Sáez (sergio.saez@secpho.org)

Cluster Manager

Description: we developed web services (internal and external) of the SECPhO, Southern Cluster in Photonics and Optics, see webpage by FRACTAL <http://www.secpho.org/>.



[54] **Web services for VIA-SKA**

Customer: **IAA**

Reference: Lourdes Verdes-Montenegro (lourdes@iaa.es)

Cluster Manager

Description: we developed web services (internal and external) of the VIA-SKA project, see webpage by FRACTAL <http://www.via-ska.es/>.

[55] **Web interface for CALIFA database observations**

Customer: **CAHA Observatory**

Reference: Dr. Sebastián Sánchez (sanchez@caha.es)

Ramón & Cajal Researcher at IAA/CAHA

Description: we developed a complete a web interface for the CALIFA project database.

http://www.caha.es/CALIFA/public_html/

[56] **FMAT (Fiber MOS Assignment Tool) for MEGARA**

Customer: **IAA**

Reference: Dr. Jorge Iglesias (jiglesia@iaa.es)

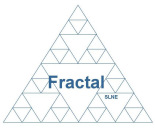
Researcher at IAA and representative of IAA in the MEGARA Consortium

Description: Development of an S/W Tool for allow the astronomers to prepare and optimize the Multi-Object mode observations with MEGARA instrument for the GTC.

[57] **Hosting FRACTAL Suite services**

Customers and users: **UCM, IAA, UPM, CSIC, CNRS, LSW, MPIA, IAG, HS, TLS, INAOE, IA-UNAM**

Description: We provide our S/W tools (GECO, DOCMA, MANATEE, SUMO, LLAMA) in hosting mode in our servers to different customers.



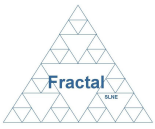
[58] **Quick Look and Cube viewer for MEGARA**

Customer: **UCM**

Reference: Dr. Armando Gil de Paz (agil@fis.ucm.es)

Researcher at UCM and PI in the MEGARA Consortium

Description: Development of an S/W Tool for Quick Look of MEGARA products and MEGARA spectra-cube viewer.



3.6 Technology Transfer

Continuous Flow cryostat Technology from ESO

Partner: **ESO**

Description: FRACTAL signed with ESO an agreement to license the cooling system technology (from ESO to FRACTAL). Continuous flow cooling systems were first developed at ESO for the cooling of instruments and detectors for the Very Large Telescope (VLT). The photo (Credit: ESO) shows The MUSE instrument on the VLT equipped with 24 continuous flow cooling systems.

Continuous flow systems are more compact than traditional systems that use a bath of very cold liquid, but share the advantage of being vibration free. The continuous flow system allows the temperature within an instrument to be changed from room temperature to -193 degrees Celsius and is not affected by the loss of electrical power. As a result, the instrument can be kept very close to its operating temperature and the vacuum within the instrument can be retained.

This agreement includes the licensing of the well-proven cryostats (which regulate the low temperatures) that are used to cool individual detectors from room temperature down to -193 degrees Celsius and the more sophisticated version that is used for the cooling of the ultra-stable detectors used in more sensitive measurements.

News from ESO here <http://www.eso.org/public/announcements/ann15041/>

3.7 Collaboration in Research + Development Projects (only funded projects listed here)

- *Estudio de viabilidad para el diseño y caracterización de redes de alta resolución (Feasibility study for the design and characterization of high resolution gratings).*

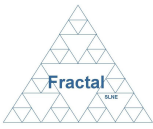
Leader: FRACTAL SLNE, with the partnership of University Complutense of Madrid

Program: Ayudas para el sector aeroespacial de la Comunidad de Madrid (2009)

Reference 04-AEC-0913-000022/2009

Budget: 60% by CAM + 40% by Fractal

- *Estudio de viabilidad de sistemas de pupila novedosos para su incorporación en la nueva generación de instrumentos de los grandes telescopios, VIENTOS, IDC-20101106 (Feasibility study of innovative pupil systems to be implemented in the new generation instruments for large telescopes)*



Leader: FRACTAL SLNE, with the partnership of University Complutense of Madrid

Program: Industria de la Ciencia (2010-2012)

Reference *IDC-20101106*

Funded: 85% by CDTI (119.936,40 euros) + 15% by FRACTAL/UCM

- *AstroMadrid, Astrofísica y desarrollos tecnológicos en la Comunidad de Madrid*

Leader: Consejo Superior de Investigaciones Científicas, CSIC

Reference: Dr José Miguel Mas-Hesse (mm@cab.inta-csic.es). Principal Investigator.

- *ASTRID, "Project for development and exploitation of astronomical instrumentation"*, supported by Madrid Government.

Leader: Universidad Complutense de Madrid, UCM

Reference: Dr Jesús Gallego (j.gallego@fis.ucm.es). Principal Investigator.

- *Consolider Ingenio 2010 "First Light with the GTC telescope"*, funded by the Spanish Ministry for Science and Education.

Leader: Instituto de Astrofísica de Canarias, IAC

Reference: Dr. José Miguel Rodríguez Espinosa. (jre@iac.es). Principal Investigator

- *Project for the detection of telluric exoplanets with very high spectral resolution instruments in very large aperture telescopes*, funded by the Spanish Ministry for Science and Education.

Leader: Instituto de Astrofísica de Canarias, IAC

Reference: Dr. Eduardo Martín (ege@iac.es). Principal Investigator

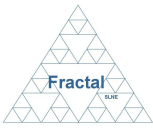
- *"Herschel: Contribution to the Science and Instrument Control Centres of SPIRE and PACS"* funded by the Spanish Ministry for Science and Education.

Leader: Instituto de Astrofísica de Canarias

Reference: Dr. Ismael Pérez Fournón (ipf@iac.es). Principal Investigator.

- *"Star Formation Bursts"*

Leader: Instituto de Astrofísica de Canarias



Reference: Dr. Casiana Muñoz-Tuñón (casiana@iac.es). Principal Investigator

- *“Design and development of a coronagraph”*

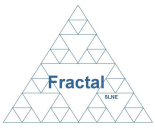
Leader: Universidad de Cantabria

Reference: Dr. Manuel Pérez Cagigal (perezcm@unican.es). Principal Investigator

We also has participated in infrastructure projects with U. Complutense and U. Salamanca

Personal References for María Luisa García Vargas (General Manager and main partner)

- Dr. Armando Gil de Paz (agil@fis.ucm.es, principal Investigator of MEGARA, UCM Professor)
- Dr. Pedro Amado (pja@iaa.csic.es co-principal Investigator of CARMENES, IAA Researcher)
- Dr. José Manuel Vilchez (jvm@iaa.es), IAA Director
- Dra. Beatriz Sánchez (beatriz@astro.unam.mx , Institute of Astronomy, UNAM)
- Dra. Esperanza Carrasco (bec@inaoep.mx, senior researcher INAOE, México)
- Dr. Roberto Terlevich (rjt@inaoep.mx), Professor at INAOE (México) and of Institute of Astronomy (Cambridge)
- Dr. José Miguel Rodríguez Espinosa (jre@iac.es), IAC-CSIC, GTC Project Scientist
- D. Félix Kábana (fkabana@iies.es), GTC Project Manager



4. FRACTAL SERVICES

The services we provide to our customers are:

- Engineering and Scientific Support services at customer's site
- Management, and Development of multidisciplinary scientific projects
- Consultancy in Management, Optics, Detectors, Data Acquisition Systems, Software and Systems Engineering.
- Volume Phase holographic gratings and related projects
- System Engineering
- Systems Engineering Software Tools
- Software Development for scientific applications
- Professional Training
- Web services and hosting for scientific projects

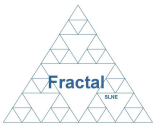
4.1 Engineering and Scientific Support Services at customer's site

FRACTAL S.L.N.E. can send highly qualified staff (PhD. in Science, Degree in Science and Engineers) to the customer offices to develop projects in-situ. This gives our customers the opportunity of counting on excellent engineers and scientists but only for the required time and without the problems and time-consuming efforts of finding, contracting and training new staff. This service can give the projects the needed dynamism to make them highly competitive.

FRACTAL staff is especially trained on the operation and exploitation of scientific facilities, and in particular, astrophysical observatories at both, Ground and Space.

4.2 Management and Development of multidisciplinary scientific projects

The FRACTAL team is specialized in managing and developing multidisciplinary projects with scientific goals. Starting from the basic scientific requirements of our customers, FRACTAL can do feasibility studies, design studies (at different levels) or even the whole project, including the manufacturing and test phases, with the help in some areas of other companies (mainly for manufacturing) with which FRACTAL has previously worked.



In FRACTAL we offer an ad-hoc management service to complement the academic and scientific capital in hands of the universities and research centers, with our professional and highly qualified engineering team. This will lead to a science-driven project, well managed and executed by people with many years of professional experience developing and participating in scientific projects.

We offer a solution focused on our customer's needs. We can help them to review their scientific requirements and to find a feasible solution that can be executed in a competitive schedule.

We specifically offer Project Management and System Engineering services for scientific projects that are developed by (in general) an International Consortium. Under the Principal Investigator, we provide project management of the project and coordinate the effort of the different institutions. We also provide web services such as documentation, management and configuration database, through Fractal Suite and a web portal for the collaboration, given also the necessary SW support.

4.3 Consultancy

Consultancy service is nowadays one of the most efficient tools used in the Industry for the quality control of its own work. FRACTAL offers consultancy services for bid revisions, project planning, technical specifications, design, acceptance and test plans, etc. in the areas of Management, System Engineering, Optics, Mechanics, Electro-mechanics, Detectors and Acquisition systems, Software and Control systems.

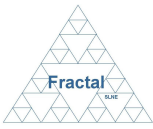
We offer different consultancy solutions according to our customer's needs:

- By e-mail: Sending the report with the revision of the documentation provided by the customer.
- In person: at customer's offices for design reviews or technical meetings.
- Organization and management of Project Design Reviews: FRACTAL can select and manage the professional services of a panel of experts (Fractal's consultants or external consultants) for Design Reviews at customer's offices.

In particular we have developed two specific areas:

Optics

We provide design, specification, manufacturing and tests of optical systems. We can carry out the development of any optical system. Starting from the basic scientific requirements, we can produce feasibility studies, designs (at different levels) or even the development of the whole project, including the manufacturing, which we would subcontract to companies with which FRACTAL has previous working experience. In particular we do specification, design,



acquisition and tests of filters, prisms, grisms, and Volume holographic gratings (VPHs) (especially for Astronomy applications).

CCDs and Acquisition Systems

We provide specification, design, acquisition and tests of detectors, CCDs, head electronics, cryostats, cryogenics system, pressure, temperature systems, H/W and SW for data acquisition and control (oriented to applications in Astronomy).

4.4 Volume Phase holographic gratings and related projects

We are exclusive distributor for Europe of Wasatch Photonics. This American company is specialized in high performance Volume Phase Holographic Gratings (VPHGs) and Volume Phase Holographic Optical Elements (VHOEs). <http://www.wasatchphotonics.com/index.html>

The partnership between Wasatch and FRACTAL is beyond a simple distribution but to make projects together for our customers at both sides of the Atlantic. We have provided VPHs to different Astronomy projects in Spain (UCM, IAA, INTA, CAB).

4.5 System Engineering

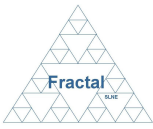
Systems Engineering is essential for the success of projects, especially the more complex ones, which include different professional disciplines and whose partners and working groups are often geographically distributed.

In addition, Systems Engineering also includes the Operation and Maintenance plans for the facilities, once the project construction is finished. A good Operation and Maintenance Plan guarantees the expected return, optimizes the human and economic resources and eases, thanks to the use of specific software tools, the facility management. Part of the FRACTAL team has been working in Systems Engineering for frontline scientific projects.

The services in Systems Engineering we can provide to our customers are:

4.5.1 Systems Engineering Consultancy

- Systems Engineering Plan Definition
- RAMS Plan
 - Reliability and Availability Plan
 - Operation and Maintenance Plan
 - Safety Program Plan



4.5.2 Systems Engineering Plan Definition

The success of every project in terms of both, the performance specifications and the schedule and budget fulfillment, strongly depends on a good organization. One of the bases of this organization is the definition and the implementation of a Systems Engineering Plan. The Systems Engineering is the interdisciplinary effort that governs the global technical effort done in the project framework to transform the initial requirements into a final system. A Systems Engineering Plan has to describe the approach, techniques, tools, organization and plan of the technical effort needed to reach the project goals. The Systems Engineering Plan functions include:

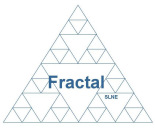
- To assure the integration of the different project disciplines.
- To implement the requirements engineering, whose goals are: to assure that the user needs are being correctly translated; to generate, control and keep a coherent set of specifications at the different system levels; and to assure the traceability between the system requirements and the subsystems specifications.
- To develop the analysis, needed to solve the conflicts among requirements, to study the different design alternatives and to study the project risks and their effects on the cost and the schedule.
- To define the configuration: the System Product Tree.
- To probe the System functionality and performance, by producing the verification matrix and by designing and carrying out the test plans.

4.5.3 RAMS Plan

The Reliability, Availability, Maintenance and Safety Plan, RAMS, includes all the considerations to take into account in the different project phases, to fulfill the requirements of Reliability, Availability, Maintenance and Safety.

Reliability and Availability Plan

The ILS (Integrated Logistic Support) is an important plan of the Systems Engineering Plan. The ILS has to assure that the reliability and availability requirements of the systems are taken into account in the design. This plan includes the distribution of these requirements among the different subsystems; the definition and development of the analysis to evaluate the requirements fulfillment and the execution of the actions to assure the reliability and availability requirements (e.g. component selections, redundancy decisions, etc). These analyses include:



- Feasibility Analysis to study the failure probability of a subsystem and its parts. This includes the determination of the MTBF (Mean Time Between Failures) and the MTTRs (Mean Time to Repair) of the different components.
- FMECA (Failure Modes Effect and Criticality Analysis) identifies and offers solutions to potential failures. The FMECA identifies the hazardous event, the cause, the method of control, and the corrective action. The failure probability analysis, its severity, the possible solutions, detection methods and prevention should be done for each of the critical system components.

Operation and Maintenance Plan

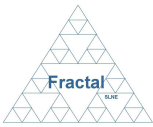
In parallel to the Systems Engineering Plan, a project has to define from the beginning the basis of the Operation and Maintenance Plan, which has to include the following aspects:

- Goal definition and Operation and Maintenance Policy.
- Operation tasks definition and operation restrictions.
- Maintenance tasks definition and maintenance restrictions including both predictive and corrective maintenance.
- Definition of the needed resources (personnel, workshops, tools, spares, supplies, external services and documentation) to carry out the operation and maintenance tasks.

From this Plan, the Systems Engineering will distribute requirements and restrictions to each subsystem that will have to be taken into account during the des

Safety Program Plan

The project has to include a Safety Program and to track its fulfillment through all the project phases. This plan has to control the risks associated to both, the design and the final use of the system. This safety plan will include the safety policy and the risk levels definitions. The plan will also include the necessary analysis to study the safety of people, the facility and the equipments. The results of these analyses will provide an input for the design and for the final use.



4.6 System Engineering Software Tools

We provide customized development of software tools for System Configuration Management and for the Management of the tasks and activities carried out during the Operation Phase of a given facility. Both tools contain a Database and a user interface adapted to the requirements of each customer. The Database is implemented in MySQL and the user interface is developed in JAVA, in order to offer a Platform-independent product based on free distribution software.

GECO: System Configuration Management Tool (already available)

We provide a customized software tool for System Configuration Management. This tool would be an essential part of the System Engineering Plan in order to control and to maintain the requirements, specifications and interfaces of a System.

To illustrate the advantages of this tool, the main utilities would be:

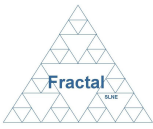
- Configuration Archive
- Documentation Archive
- Interface and Requirements Archive
- Product Tree Tool
- System Traceability Tool
- Analysis Traceability Tool
- Verification / Accomplishment Matrix Control Tool
- Configuration Changes Control Tool

DOCMA: Document Management Tool (already available)

We provide a customized software tool for Document Management on a web interface. This tool allows the users authorized in the system to follow the documents life flow and participating in the process according to their roles (authors, reviewers, approvers, etc.). There are different user's profiles and privileges. The system includes an updated list of warnings with the homework due by the users.

The documentation is linked to the projects. This tool also allows building and tracking the documentation associated to a given project.

The tool allows to consult the database and to interact with the system from any PC (only the Internet connection is needed).



This tool is oriented to help organizations or companies whose personnel travel a lot or it is geographically distributed

SUMO: System Use Management Tool

We provide a software tool for System Use Management. This tool allows the planning, tracking and control of the activities and tasks that have to be carried out during the Operation and Maintenance Phase of a facility. This tool also includes the inventory of system elements and their spares, as well as the support elements for the task execution. The tool allows the person in charge of running the facility, to schedule and prioritize the tasks and to organize the work for the Maintenance and Operation team.

To illustrate the advantages of this tool, the main utilities would be:

- Operation and Maintenance Task Archive
- Facility Inventory
- Spares and supplies Management Tool
- Operation and Maintenance tasks schedule Tool
- Executed tasks Archive.
- Failures Archive

MANATEE: MANAgement Tool for Effective Engineering (already available)

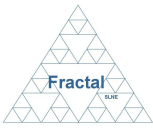
We provide a customized software tool for Project Management on a web interface. This tool allows the users authorized in the system to follow the project management's flow and participating in the process according to their roles (project managers, WP managers, engineers, etc). There are different user's profiles and privileges. The system includes an updated list of warnings with the homework due by the users.

The WP and WBS chain for a given project are linked also with the human resources in charge, the milestones, the deliverables, etc. This tool also allows building and tracking the progress of a Management Plan of given project. Some graphics and report tools complete the application.

The tool allows to consult the database and to interact with the system from any PC (only the Internet connection is needed).

This tool is oriented to help organizations or companies whose personnel travel a lot or it is geographically distributed.

MANATEE is running alone or in combination with DOCMA.



LLAMA: Laboratory MANAgement (already available)

We provide a customized tool for laboratory management (inventory, material, personnel, documentation, etc.)

4.7 Scientific Software Development

The technological challenge of the different scientific and engineering subjects has evolved from the need of improving the detection instruments (to produce better CCDs in Astronomy, better sequencing methods in Biotechnology, better particle detectors in High Energy Physics, etc.) to the current status, in which the most critical issue is the management of the large amount of data produced by the faster, more powerful and more capable instruments.

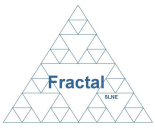
The current development status of scientific instrumentation reached the past 20 years has been possible thanks to the technological advances in Optics, Electronics and Material Physics. However, this progress has produced a new need: the development of powerful software tools able to process, reduce, analyze, archive and distribute the huge amount of data produced by the instruments.

This evolution has led to the growth of the intrinsic complexity of the scientific facilities, transferring the complexity of the parts to the System Control. This implies the use of the most advanced techniques in Software Engineering.

The FRACTAL team has experience in the Development and Operation of Complex Control Software Systems for Data Reduction and Analysis of scientific projects and also in the Definition and Implementation of Distributed Control Systems.

As examples of the software which our company can develop for scientific applications:

- Reduction and Visualization of data for:
 - Astronomy, both ground-based (optical, infrared and radio telescopes) and from Space
 - High Energy Physics
 - Material Analysis
 - Teledetection (Earth Observation Satellites)
 - Radio diagnosis (TAC, PET, Nuclear Magnetic Resonance)
 - Biotechnology (Sequencing)
- User interfaces (GUIs)



- Distributed Control systems
- Mechanism Control
- Real Time Control

4.8 Professional Training

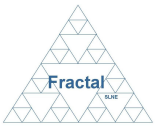
We offer general courses given in Madrid. At the moment the general courses are given in Spanish and in English. The courses last 8, 15 or 18 hours and are given over 1, 2 or 3 days. The calendar for the courses can be found in our Course schedule.

We also offer ad-hoc courses, to be given at our customer's offices at different levels, oriented to each particular need. Courses cover Project Management, System Engineering, Optics, Mechanics and Software. The current available courses are:

- Three views on Project Management
- System Engineering: Application and Development
- Optical principles and Instrumentation
- Opto-mechanical Systems Projects
- Introduction to Mechanical Design for Infrared Instrumentation
- Adaptive Optics
- Scientific Imaging in the visible and near-IR
- Remote sensing
- Software Projects Engineering with Object-Oriented Techniques
- Java software projects implementation
- C++ Object-Oriented Software
- CAN/CANOpen Field Bus Integration

Also, we impart:

- The course on opto-mechanics for instrumentation developers for SPIE org.
- The course on Management and Opto-mechanics at the International School of Advanced Instrumentation (an initiative of the Instituto de Astrofísica de Canarias, Universidad



Complutense de Madrid, Universidad Nacional Autónoma de México and University of Florida. Courses 2008, 2009, 2010, 2011, 2012.

- The courses on Optics, Optomechanics, Adaptive Optics and Management for the master in Spatial Instrumentation and Technologies at the University of País Vasco (Bilbao, Spain). Courses 2010, 2011 and 2012.

4.9 Web services and hosting for scientific projects

We provide different type of web services for our customers: web pages, web applications with public and private parts for the scientific projects, web services for astronomical data handling, also with a VO layer (astronomical databases on line, spectra and images visualization).

We also offer hosting for those web applications in case of our customer prefer that we also do the maintenance and update of the servers and the applications, providing also ftp facilities, documentation database, etc. for their projects.