

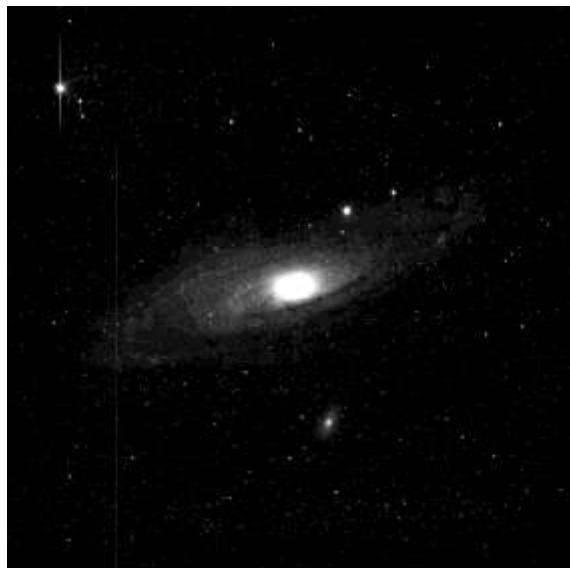


Your best ally



Test-Bed Telescopes

First European Asteroid
Observers Meeting



Test-Bed telescopes overview

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ESRIN, 1st February 2016

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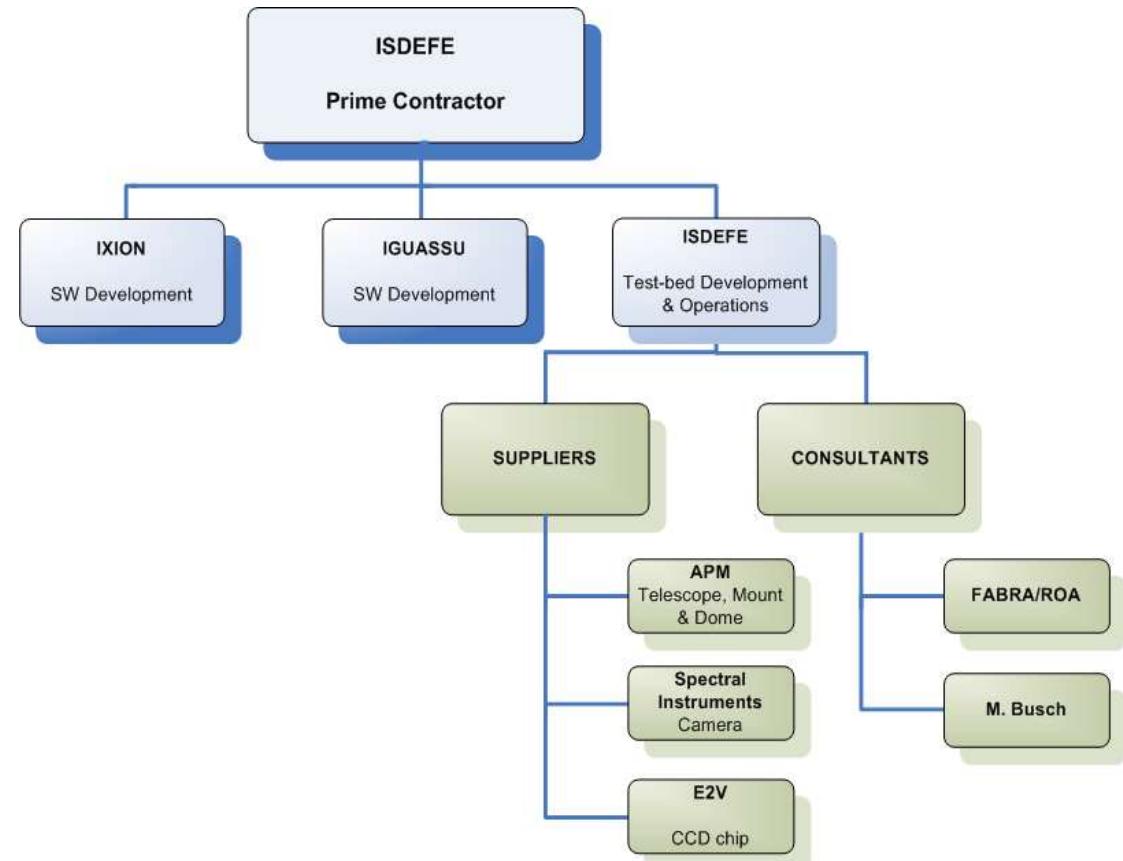
Test-Bed Telescopes

The Project

- “Demonstration Test-Bed for the Remote Control of an Automated Follow-Up Telescope” (**TBT, Test-Bed Telescopes**)
- Precursor service of the autonomous optical sensor network to be used as test-bed to demonstrate the capabilities to detect and follow-up near Earth (natural and man-made) objects
- Two telescopes of moderate size (> 400mm aperture) deployed at locations in Northern and Southern hemispheres
 - Cebreros DSS, Spain
 - Southern Hemisphere Site
- Evaluation and validation of the prototype software:
 - Automatic scheduling,
 - Robotic Real-time control and
 - Autonomous data processing

Project Consortium

- General Support Technology Programme (GSTP), ESA – optional programme
- Open to companies in Czech Republic, Germany and Spain
- Budget allocation:
 - Czech Republic 12,5 %
 - Germany 37,5 %
 - Spain 55 %

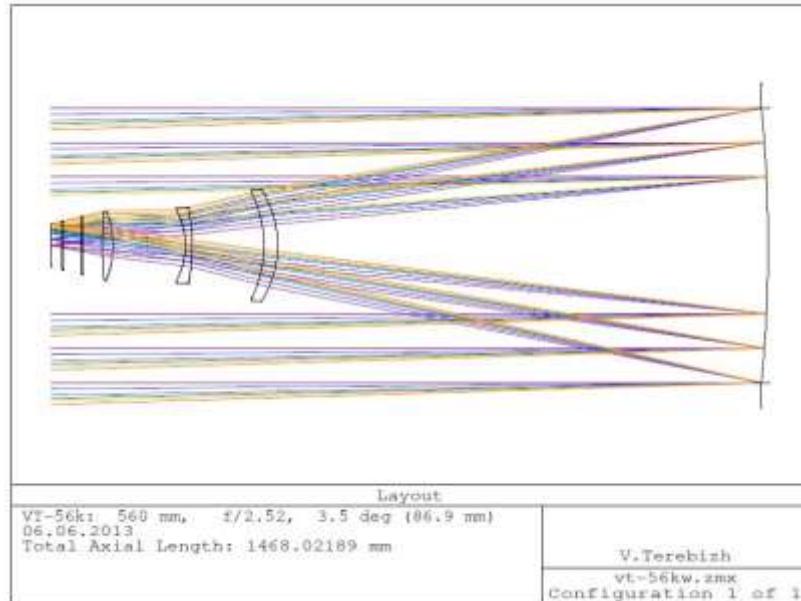


APM-Telescopes Prime Focus Astrograph



D560mm f2.52 TBT Wynne astrograph

Optical Designer: Dr. V. Yu Terebikh



D = 560mm

f-number = f/2.52

F = 1410mm

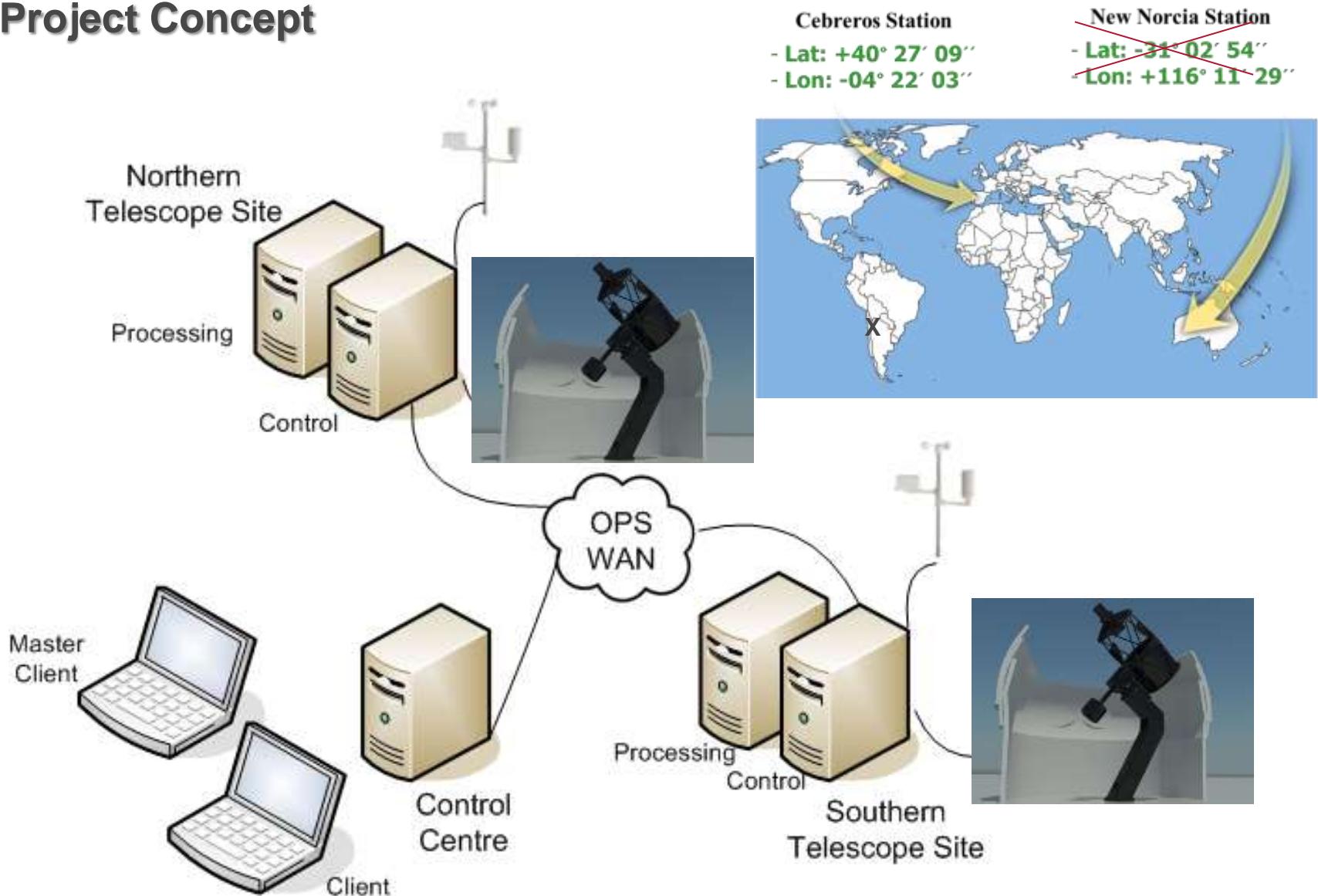
FoV = 2.5°x2.5°

Plate Scale = 2.2"/pix

Central Obstruction = 25%



Project Concept

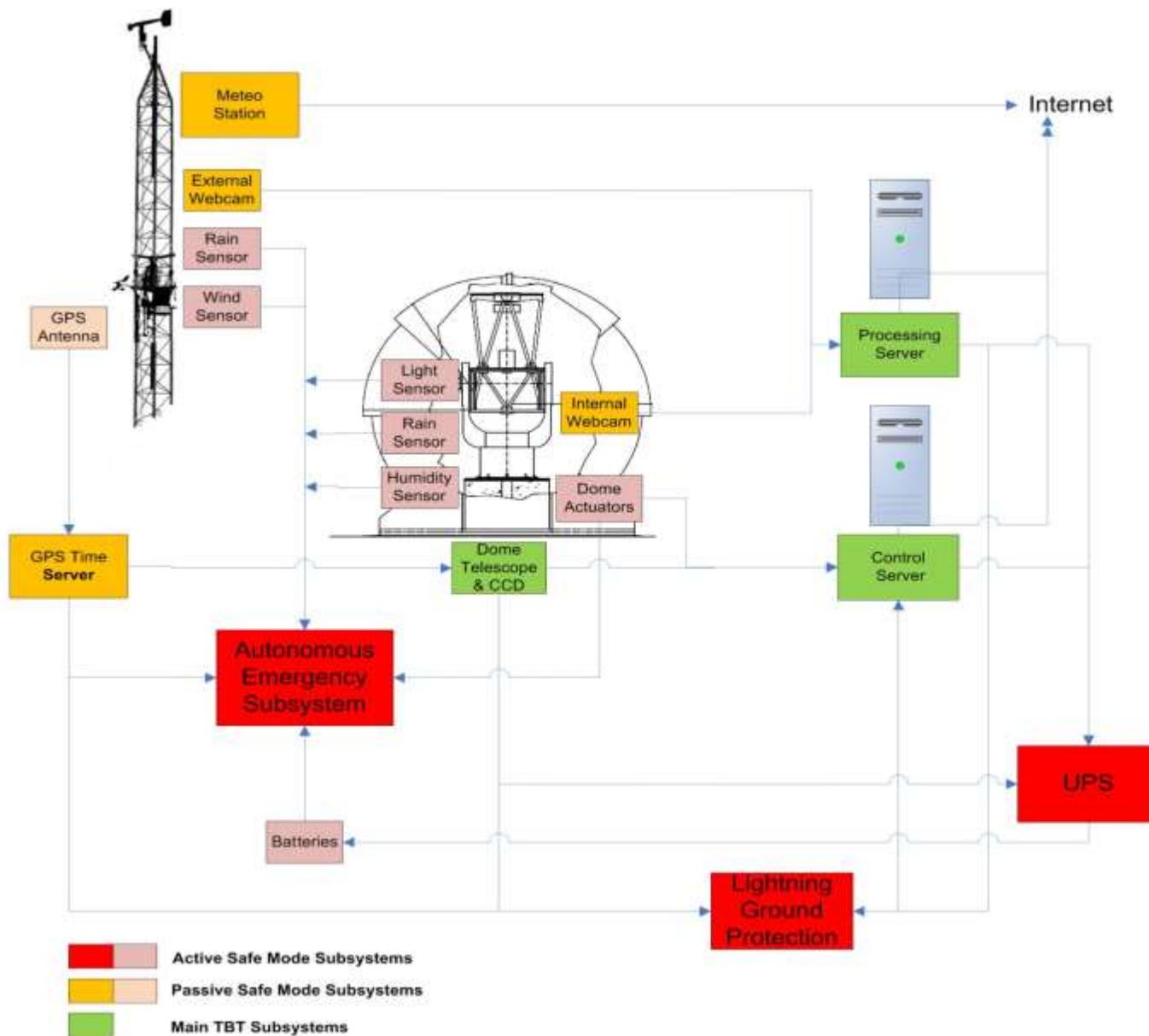


Spectral Instruments 800S Camera



Customer provided e2V 230-84 BI

800S Camera Performance	
Digitalization Precision	16 Bit
Number of Readout Ports	1-2
Cooling	Thermoelectric
Operating Temperature	-20°C
Typical Dark Current @-20°C	<1.0e-/pixel/s
Read speeds	100kHz, 500kHz, 800kHz
Typical Readout Noise @100kHz	4e-
Maximum Readout Noise @100kHz	<4.5e-
Typical Readout Noise @800kHz	11e-
Maximum Readout Noise @800kHz	<12e-
Linearity	<1% deviation from 150e- to 100ke-
Single pixel full well	>100ke-



Main Features

The objective is to cope with the existing ~~available~~ SW and make a feasible solution covering the SSA-TBT requirements. The main features of the proposed integrated solution are:

- Based on proven and mature SW (no COTS available. Big development effort mainly in drivers and scheduler)
- Implementing know-how of experts (M&C and Observatory management)
- In line with ESA policies
- Abstraction layer for HW communication
- Ensured Maintenance
- High modularity and re-usability
- Fully configurable
- Standard data format support
- New observation strategies easy implementation

→ Goal: implementation and testing different strategies and observing modes both for Follow-Up and Survey strategies and for different target populations + autonomous operations without user interaction.

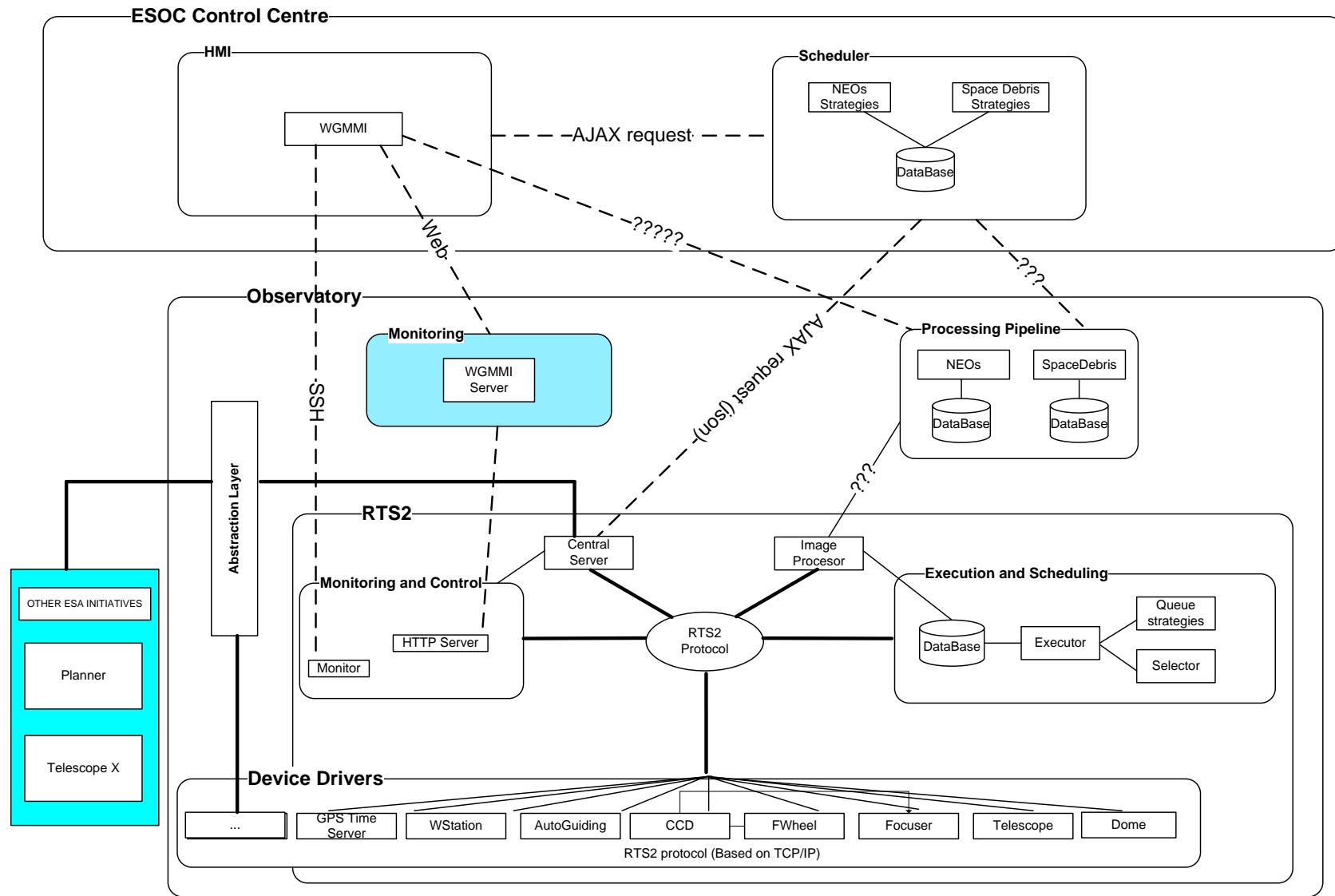
1. User interaction with scheduling tool

- **Manual GUI** for end-user.
- robust interface to allow **external input** for new strategies.

2. Autonomous operations:

- Software tool to allow automatic planning and scheduling of an observing night
- Automatic rescheduling to update the scheduling to real-time needs.
- Flexibility to allow real-time response to changes (ground observatories!!): queue system

TBT Architectural Design



TBT Scheduler

Web application tool for planning observing nights in optical observatories.
 Observations are structured in Observing Blocks, containing several exposures
 Two strategies are currently implemented to perform

- Survey
- Follow-up



RTS-2 Real-Time Control

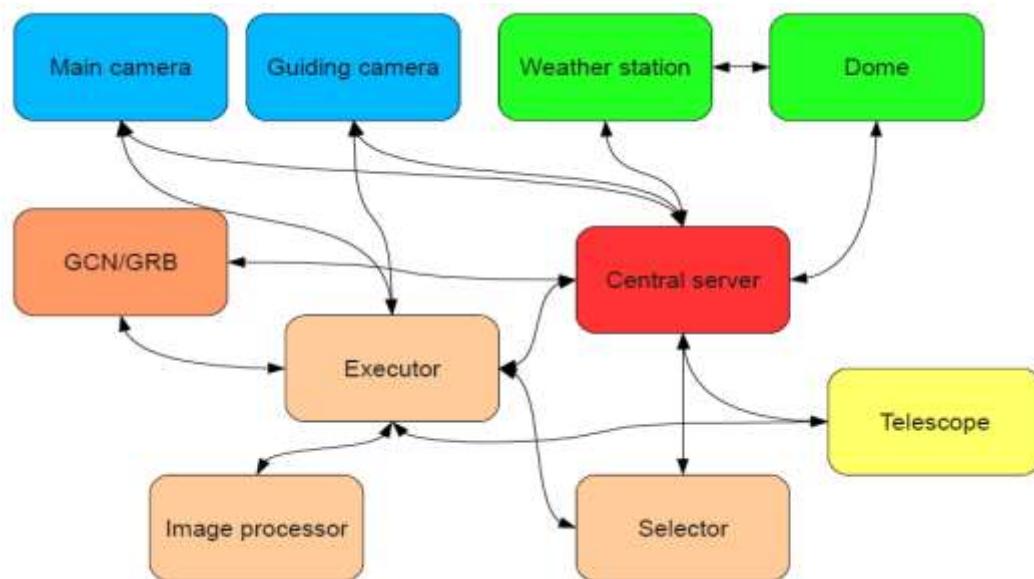
The Remote Telescope System version 2 (RTS-2) is an open source environment for telescope control and monitoring functions, including

- Mount pointing control
- Camera
- Focus
- Weather sensors
- Filter-Wheel
- Dome
- Mirror cover

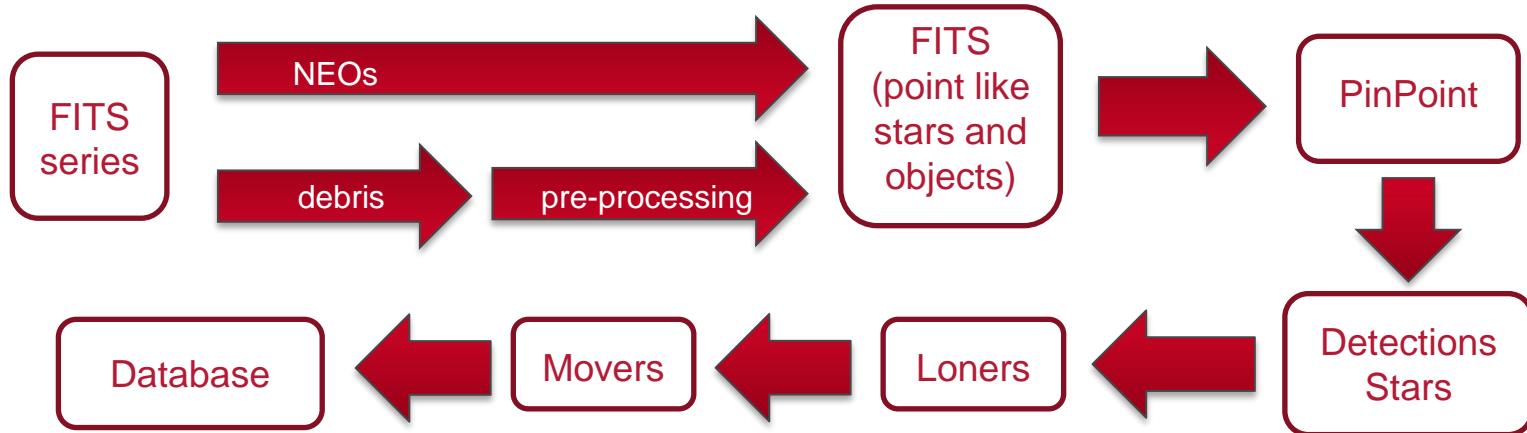
Night targets are executed through a database queue system

RTS-2 is currently implemented in more than 20 observatories worldwide

RTS-2 has a modular, object oriented design, implemented in C++, with GUI and scripting implemented in Python



TBT-TOTAS Data Processing

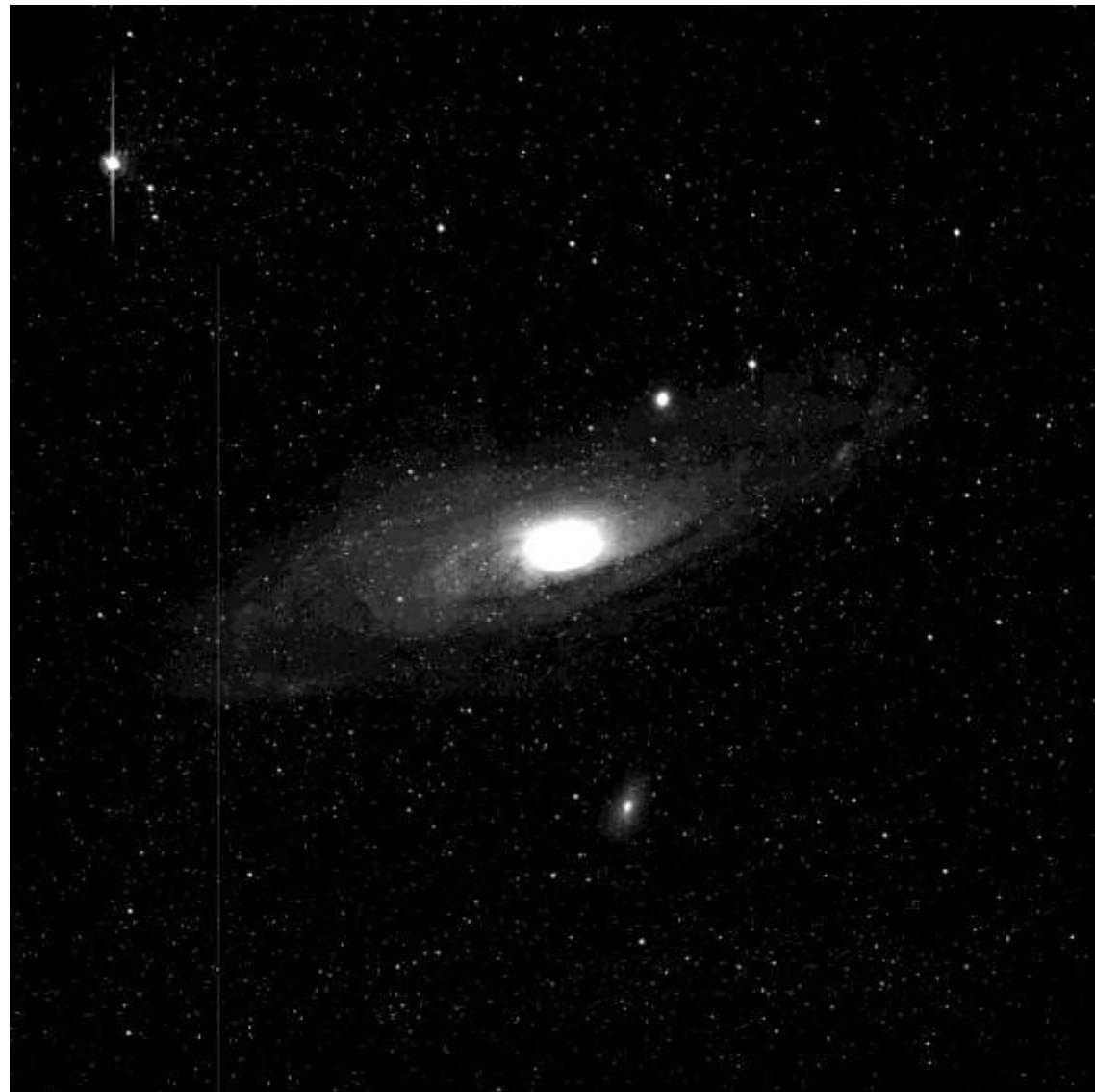


- FITS series
 - Images of the same field (RA/Dec)
- PinPoint
 - Non-sidereal tracking for space debris → stars exposed as streaks → pre-processing of images needed before passing them to PinPoint
- TOTAS
 - Use PinPoint output to find loners and movers

- Telescope #1 **installed** in the last week of **July**
- Integration of the system during the first half of August
- September and October bad weather
- From New Year running every other night



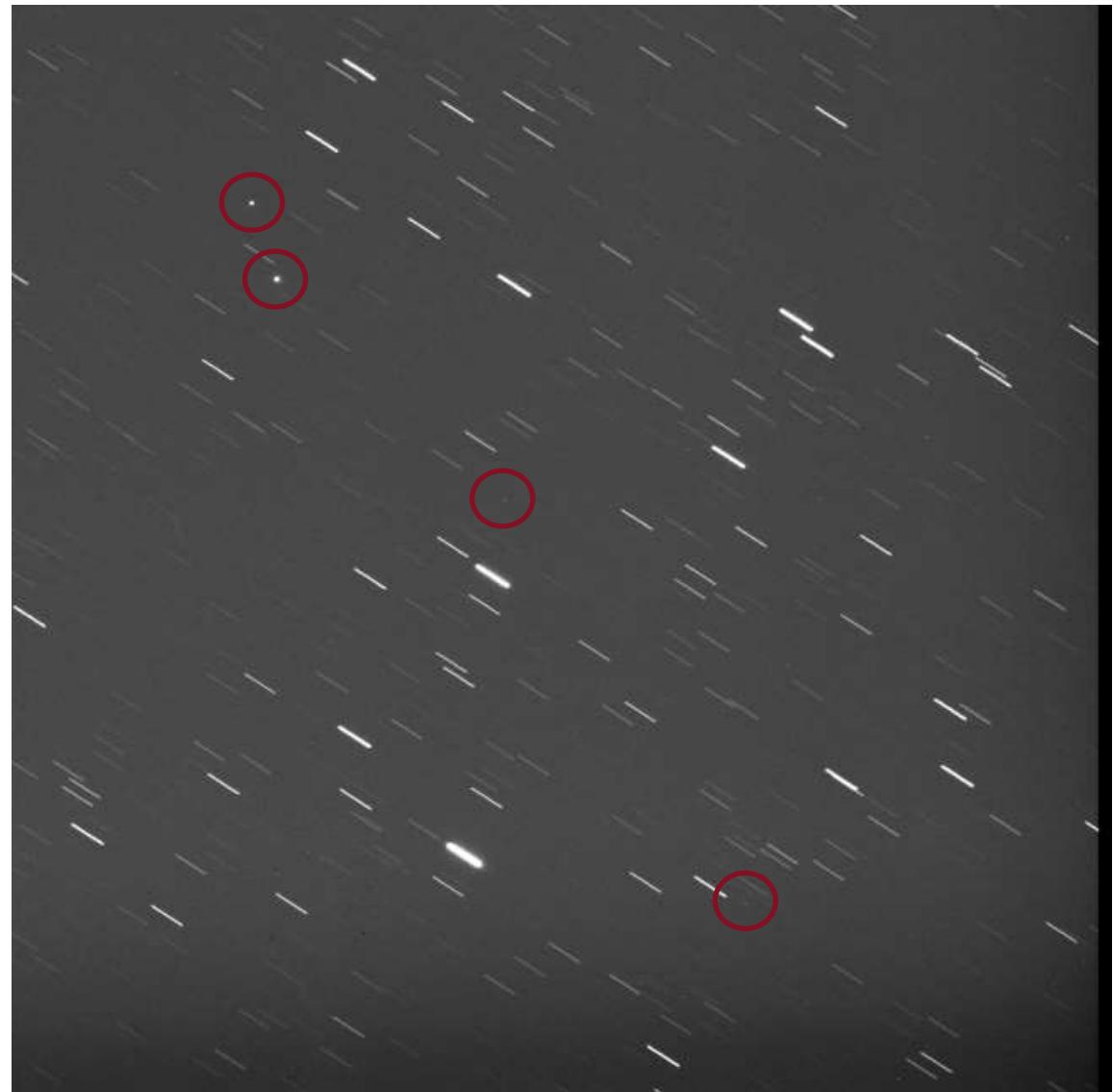
- Fine tune of the drivers software on-going
- Commissioning on-going
 - Testing driver robustness
 - Robotic system.
- Autonomous system under development
- Testing scheduler
- Last hardware items arriving
- Producing manuals (technical description, installation, operation, maintenance) and protocols



M31 – Andromeda Galaxy

- Mount

- Polar alignment 2'
- Pointing better than req.
- Perfect sidereal tracking
- Tracking satellites down to 8000-10000km high

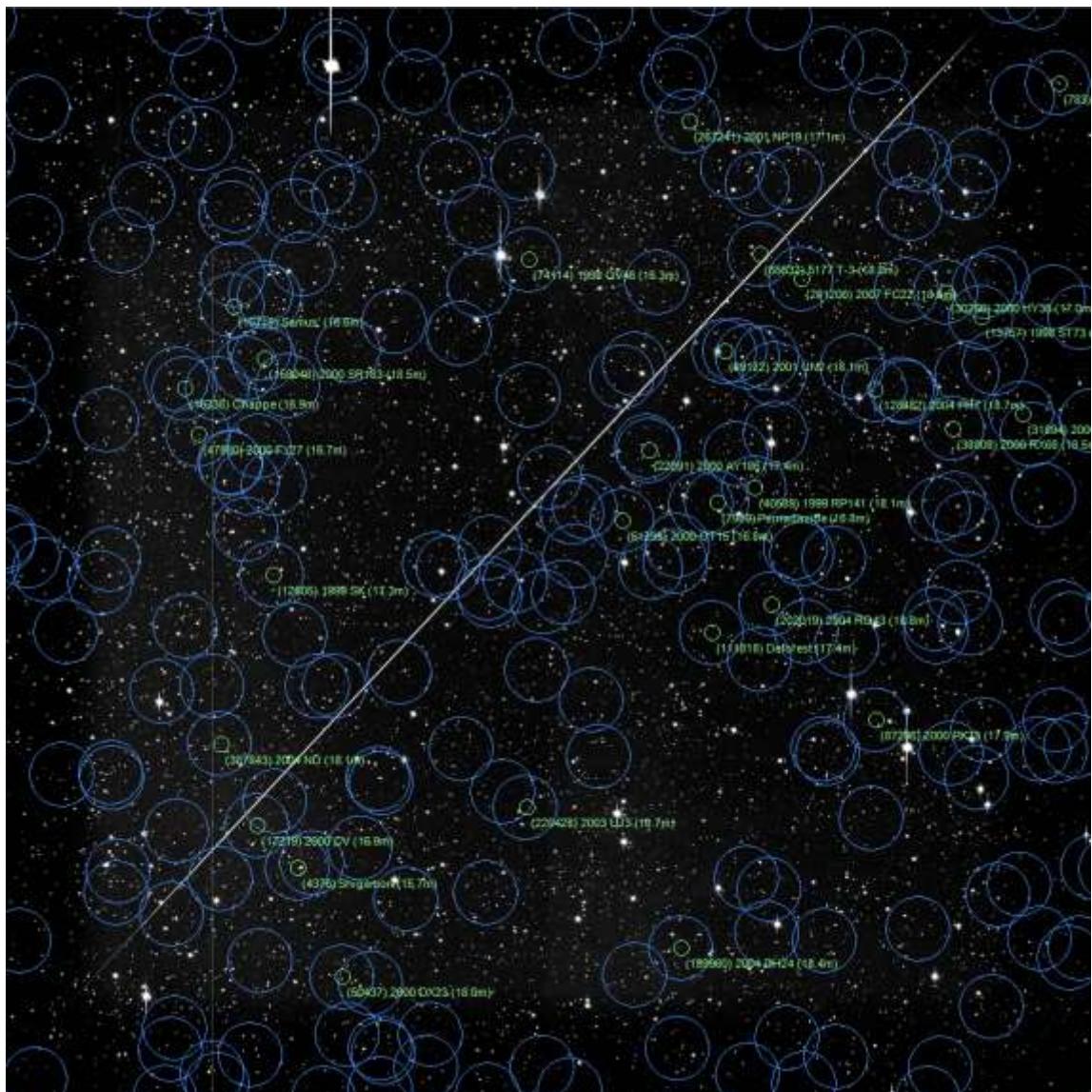


- First TOTAS based results

Field 1040_WQ39346: 38 known asteroids, 0 new asteroids

known asteroids:

(89122) 2001 UN2 (18.1m)
 (22091) 2000 AY186 (17.4m)
 (65632) 5177 T-3 (18.0m)
 (38808) 2000 RX68 (18.5m)
 (87296) 2000 PK23 (17.9m)
 (13757) 1998 ST73 (17.3m)
 (30260) 2000 HY35 (17.0m)
 (128482) 2004 PH7 (18.7m)
 (111818) Deforest (17.4m)
 (783) Nora (12.2m)
 (189980) 2004 DH24 (18.4m)
 (31894) 2000 FD44 (16.3m)
 (40589) 1999 RP141 (18.1m)
(220428) 2003 UJ3 (18.7m)
 (7989) Pernadavide (16.8m)
 (17219) 2000 CV (16.9m)
 (50437) 2000 DX23 (18.0m)
(267241) 2001 NP19 (17.1m)
 (61235) 2000 OT15 (16.8m)
 (74114) 1998 QV46 (16.3m)
 (158048) 2000 SR183 (18.5m)
 (47880) 2000 FY27 (16.7m)
 (16238) Chappe (16.9m)
 (10718) Samus' (16.6m)
 (387843) 2004 ND (18.1m)
 (41173) 1999 VP180 (18.6m)
 (150937) 2001 TJ83 (18.6m)
 (47180) 1999 TV119 (18.1m)
 (54107) 2000 HM9 (18.1m)
 (21942) Subramanian (18.7m)
 (39103) 2000 WQ17 (18.3m)
 (242926) 2006 QA21 (18.9m)
 (80537) 2000 AA75 (18.2m)
 (33077) 1997 WG25 (17.8m)
 (12605) 1999 SK (17.3m)
 (4376) Shigemori (15.7m)
(281200) 2007 FC22 (18.6m)
 (202019) 2004 RO43 (18.8m)



Astronomy and Space Consulting Engineering S.L.

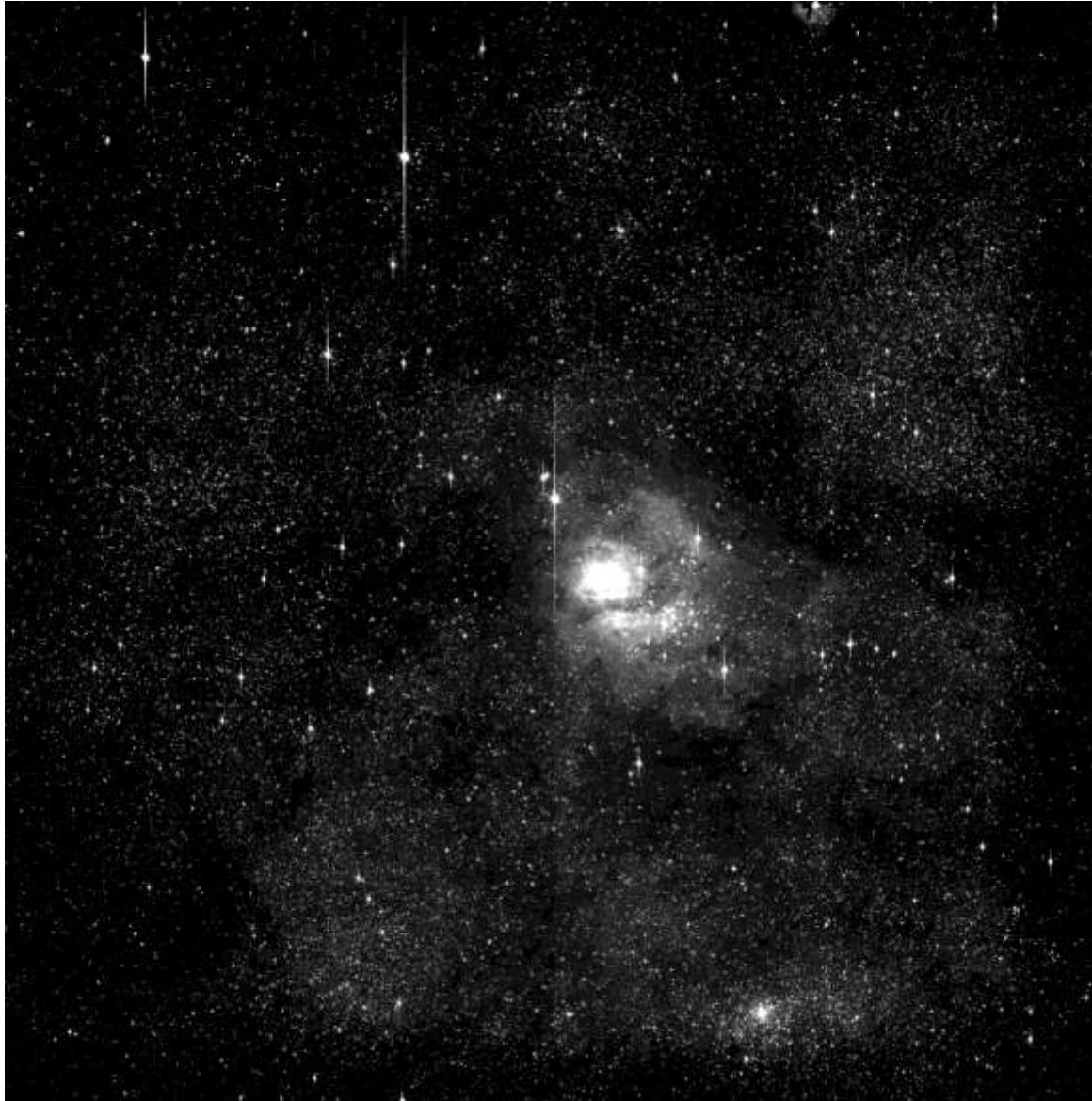


■ Services

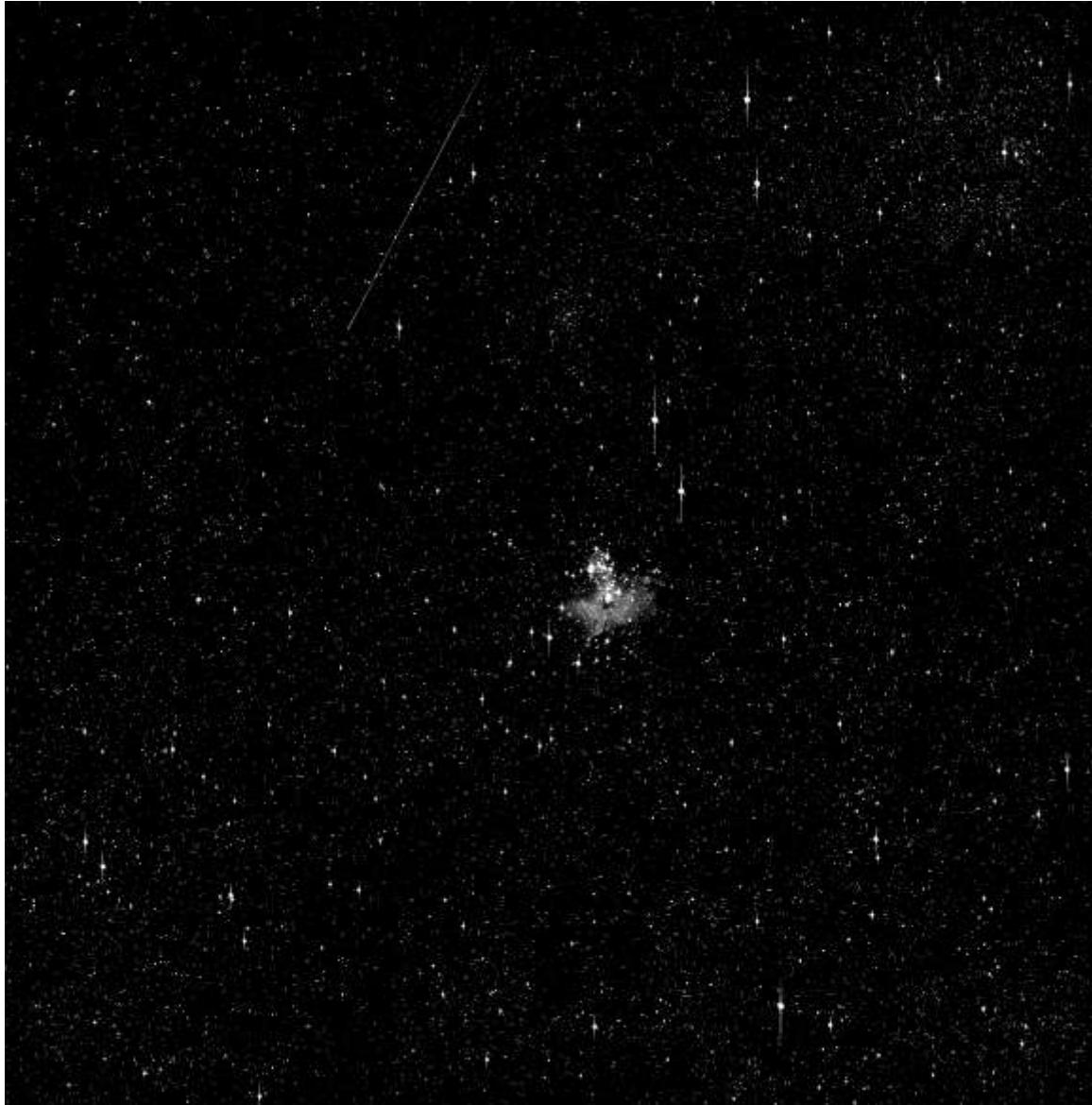
- Support for proposal and document writing (ESA tenders, grants, H2020 projects, ECSS standards...)
- Observations, campaign design
- Project management
- Software and System Engineering

www.ascen-engineering.com

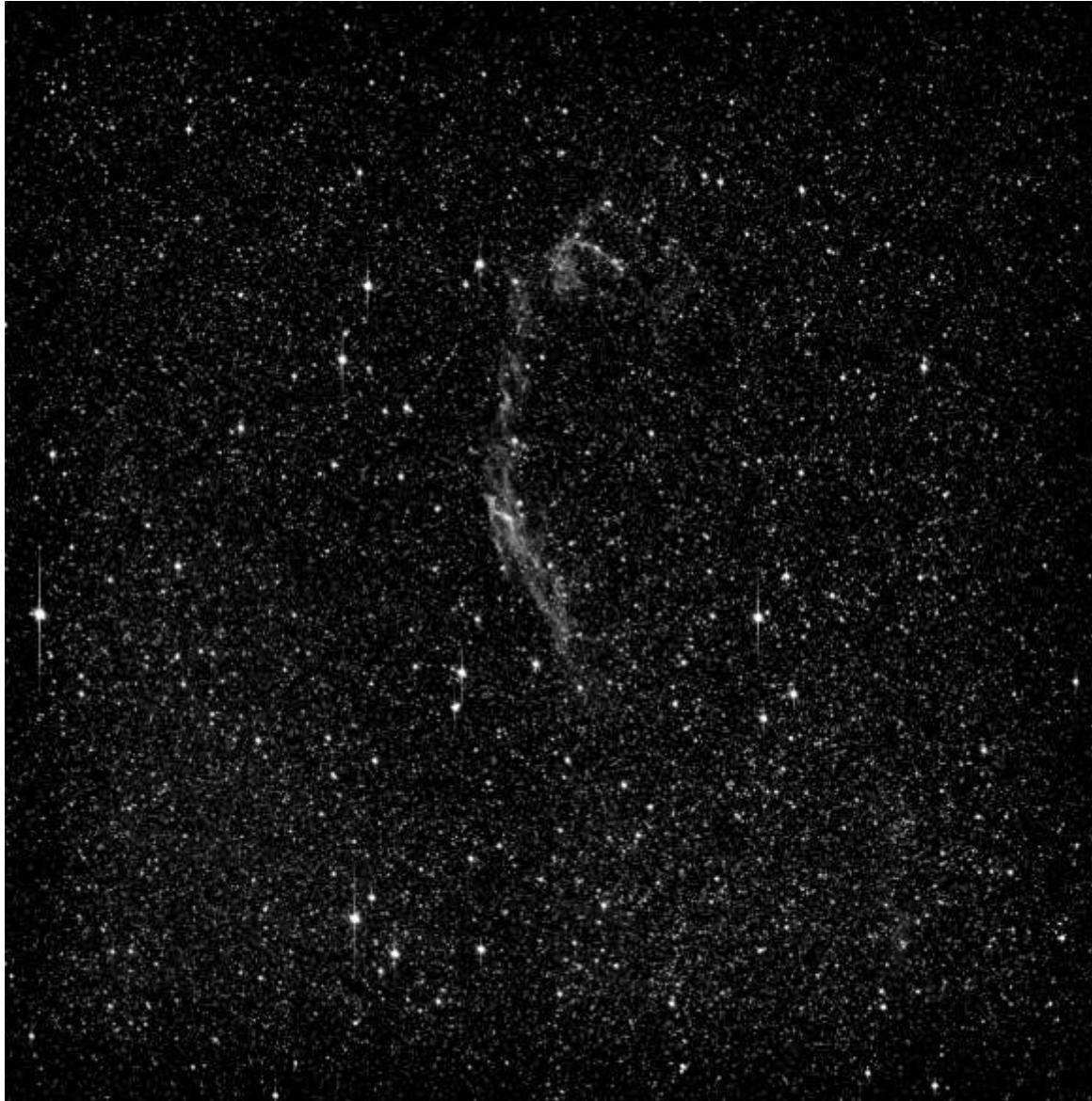




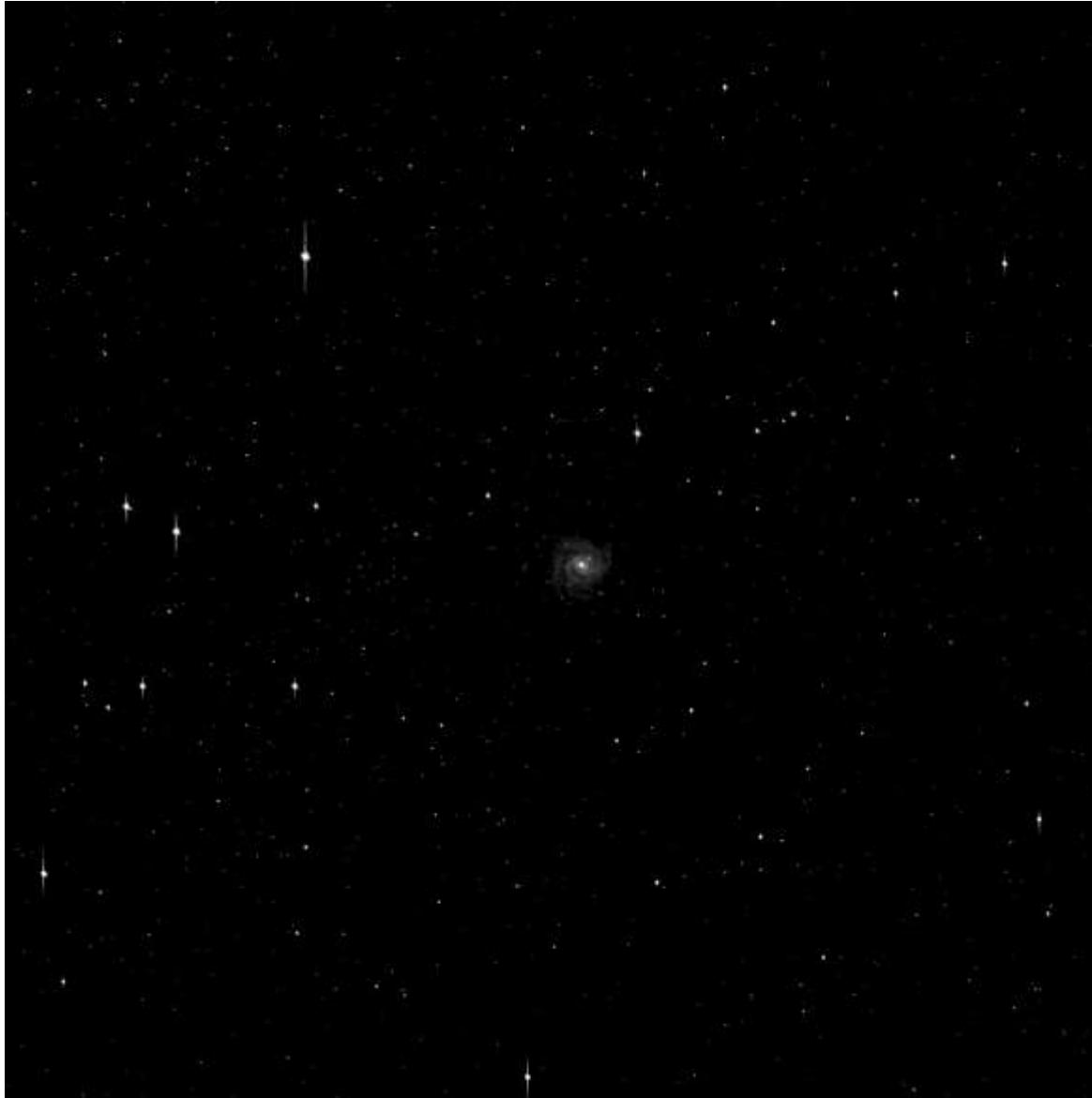
M8 Galaxy



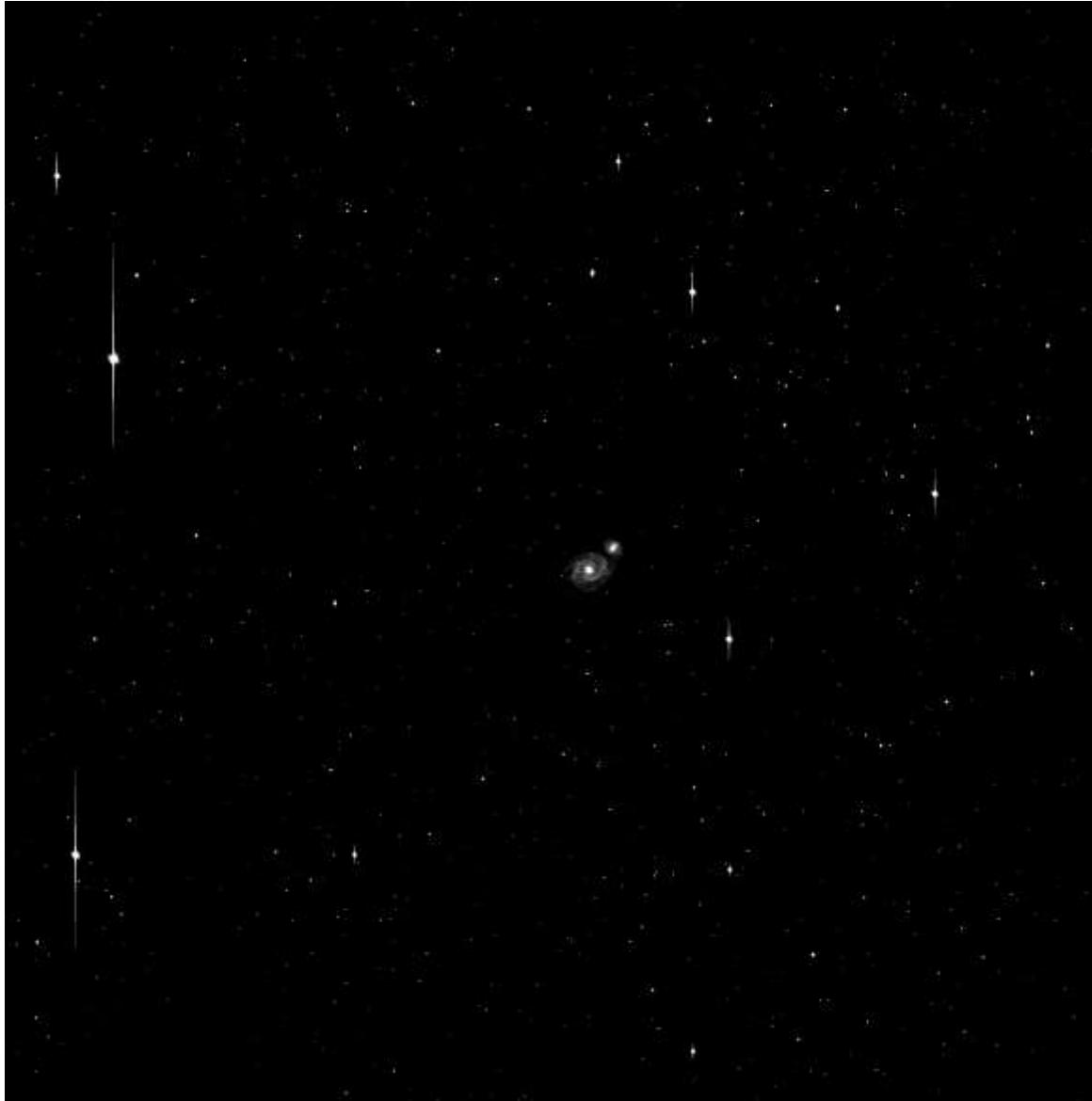
M16 Galaxy



Veil Nebula



M101 Galaxy



M51 Galaxy



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