

The Extremely Large Telescope: standing on the shoulder of Open Source and AlmaLinux

How open source will help the biggest telescope see the cosmos

Federico (fpellegr@eso.org), Piotr (pszubiak@eso.org)



About European Southern Observatory - ESO

- Intergovernmental organization providing facilities for ground based modern astronomy
- Founded in 1962
- 16 member states (+ Chile and Australia)
- Headquarters in Garching near Munich
- All astronomical facilities in Chile



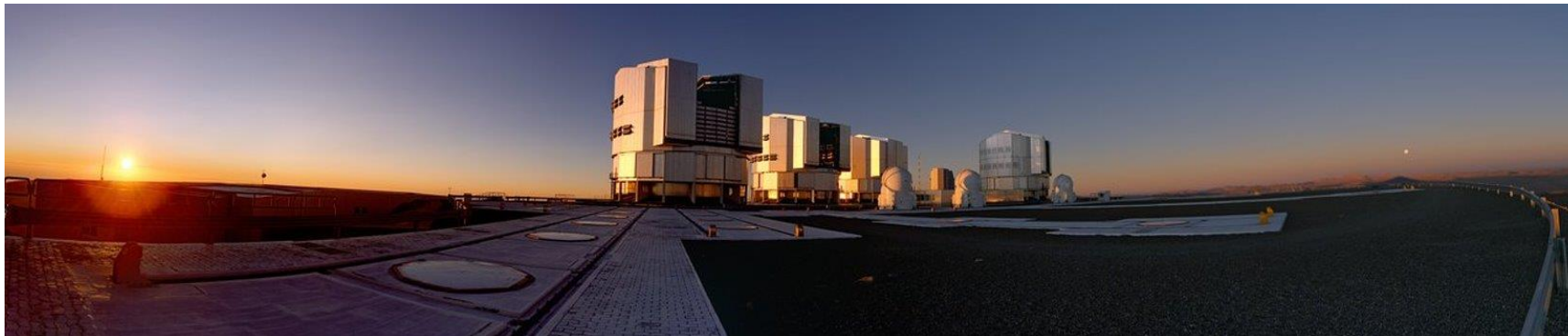
ESO Observatories – La Silla

- Operational since 1966 (and 1976 first light of 3.6m)
 - ~10 telescopes still in operation today
 - Some telescopes have software frozen for decades
- Still producing very important science
 - Nobel prize in 2019 with HARPS (+ESPRESSO)
 - Still some new instruments being deployed
- And we get visits from local fauna:
 - Guanacos, vicunas, foxes, rabbits....



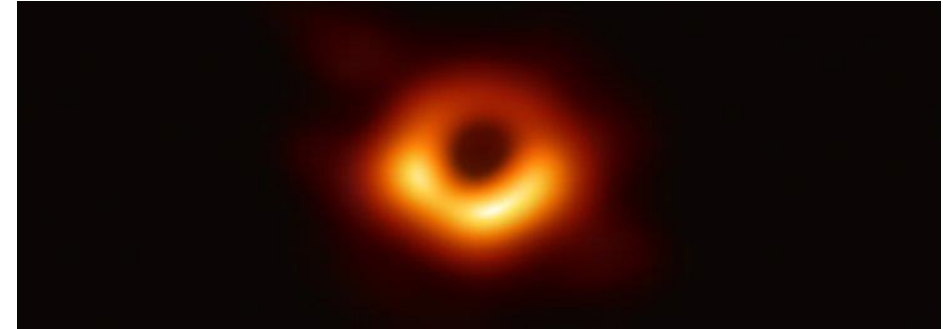
ESO Observatories – Paranal

- Operational since 1999 (first light of UT1)
- Very Large Telescope (4 x 8m visible)
 - Control Software runs on AlmaLinux 9
- VLT Interferometer (4 x 8m VLT + 4 x 1.8m AT)
 - Nobel price 2020 – black hole in centre of galaxy
- Other telescopes on site (VISTA, VST)
- Future home for Cherenkov Telescope Array



ESO Observatories – ALMA

- Joint project with NRAO and NAOJ
- Operational since 2011
- 66 moveable antennas at 5000m
- Part of Event Horizon Telescope (EHT)
- APEX nearby



ESO Observatories – ELT

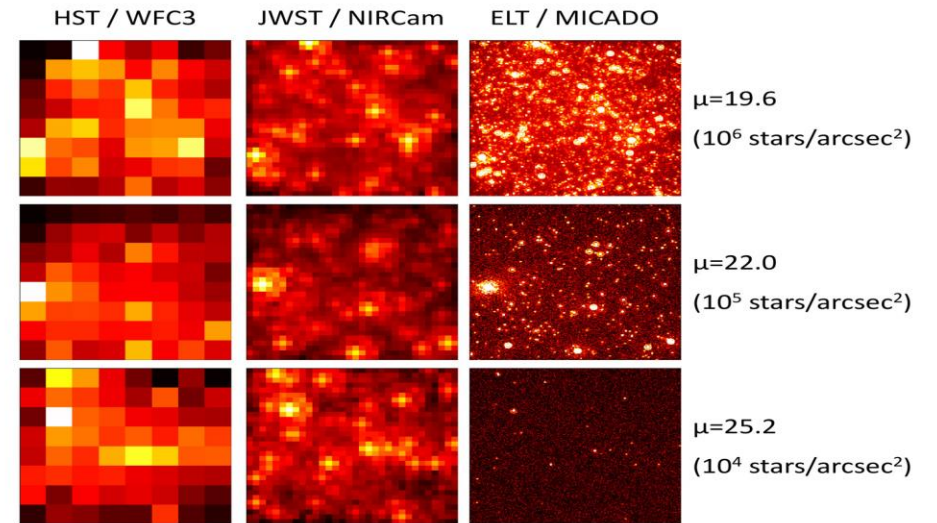
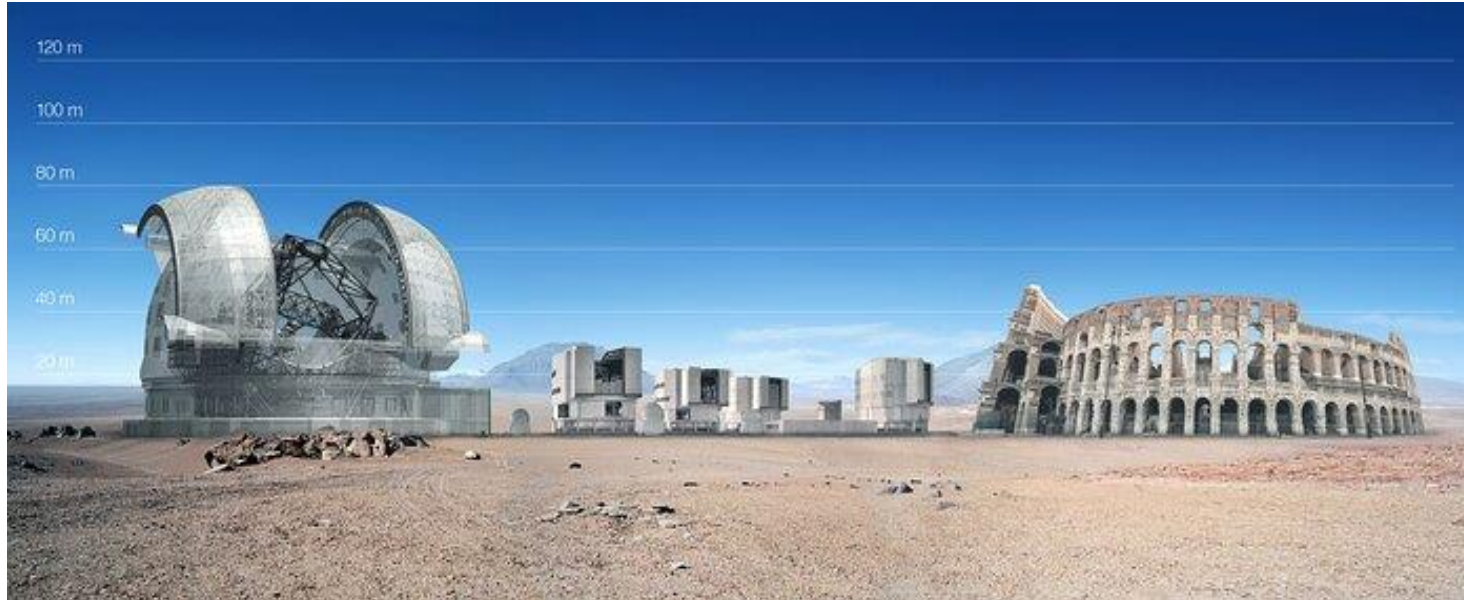


- 39m mirror at Cerro Armazones (3000m)
- First stone May 2017, First light expected 2029
- Exoplanets, star formations, protoplanetary systems
- Largest optical/near-IR telescope

- M1: 798 segments 1.4 meters wide 5cm thick
- Figure loop at 500Hz ~ 1Gbit/s traffic
- M4: 4 meters (~6000 actuators)

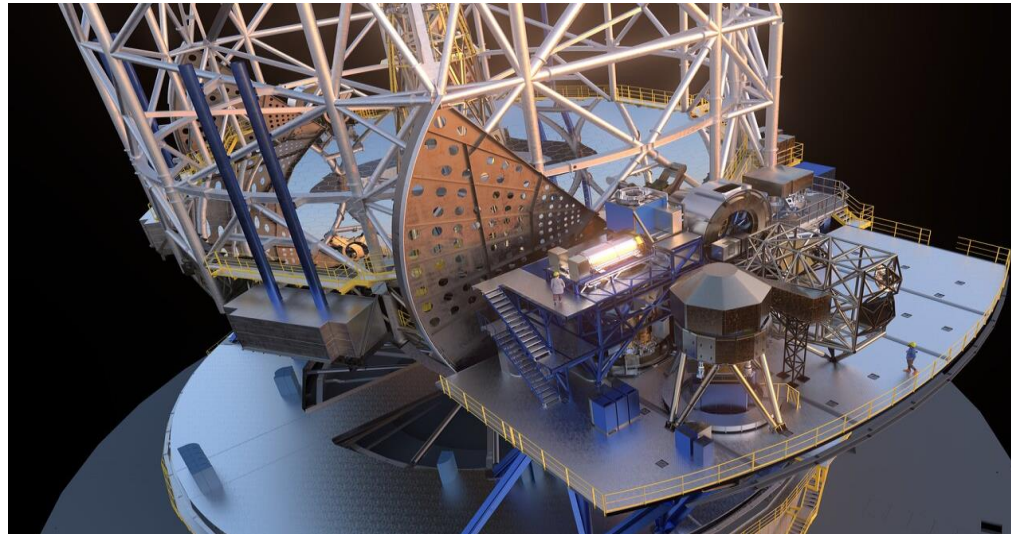


The ELT: size matters



ELT Control Software

- Real-Time system that coordinates all telescope subsystems
 - Active mirror alignment
 - Rotation of the Dome and Main Structure
 - Precise pointing and tracking
- Adaptive Optics – Laser Guide Stars and Deformable Mirrors
- Control of Instruments
 - Cryogenics
 - Motors
 - Shutters
 - Detectors



Why Open Source?

- Long lifespan of projects: 30+ years
 - Open Source, albeit not easy, guarantees maintainability
 - Cost is predictable
- Collaboration with consortia and other organizations is easier when based on Open Source
- One-off projects, no big market for big telescopes, resources available only during the construction
- Avoiding bureaucracy with acquisition and license management
- Easy access to the source makes debugging easier
- Developing on top of Open Source is fun!

ELT Development Environment



- Linux distribution for ELT Control Software
 - RPM based
 - ELT DevEnv is a customized base OS (CentOS, Fedora, AlmaLinux)
 - Our goal is to extend the base distribution instead of customizing
- We are close to be 100% Open Source
- Main technologies
 - C/C++ and Python, waf/wtools
 - Qt, KDE
 - OPC UA, DDS, Protobuffer

Challenges in Open Source-Based Projects

- The word "support" makes management slightly... uncomfortable
- Contribution back to upstream projects may require a major effort
- Unexpected changes in project licensing
 - Redis, Terraform
- Project get abandoned
 - Main contributor lost interest i.e., bumpversion and bump2version
 - Companies change their mind i.e., CentOS 8 (that was a hard punch for us)

Why AlmaLinux as Base OS for ELT?



- Predictable update policy
- Awesome AlmaLinux Team and community around!
- Super fast delivery of updates and releases
- Support for hardware removed from RHEL (including AlmaLinux 10 x86_64-v2 arch)
- ABI compatibility is more sustainable than 1:1 rebuild of RHEL
 - Some fixes land faster on AlmaLinux than the upstream

Building ELT Development Environment



- Tools for building our distribution are evolving
 - fpm and alien -> SPEC + rpmbuild -> SPEC + mock -> OBS -> ??
 - All software build in isolation from source
- Open Build Service from SUSE is our "Wunderwaffe"
 - OBS understands the dependency tree and triggers rebuilds automatically
 - Web UI - "Citizen packaging" via Request workflow
 - Possible to build against multiple distributions
 - Integration via hooks and REST API

Name	Changed
elt-mal	11 minutes ago
elt-wtools	43 minutes ago
reuse	3 days ago
python-debian	3 days ago
elt-trex-sw	6 days ago
elt-seq	6 days ago
elt-linetio	6 days ago
elt-devenv-repos	6 days ago
elt-ecos	7 days ago
elt-influx-archiver	7 days ago
elt-lcs-ifttest-common	7 days ago

Build Results	
containers	
x86_64	succeeded: 1, excluded: 299
elt_almalinux_10	
x86_64	succeeded: 215, unresolvable: 1, blocked: 69, building: 5, disabled: 9, excluded: 1
elt_almalinux_10_next	
x86_64	succeeded: 1

ESO Open Source Contributions

- Software:
 - Astronomical/scientific software under GPL: ACS, ESO-MIDAS, CPL, IAS
 - Most of ELT software is / will be mostly LGPLv3 licensed
- Fedora / EL / EPEL:
 - A few of us are Fedora/EPEL package maintainers
 - We try to contribute back also to CentOS Stream / AlmaLinux
- Many contributions upstream to used projects:
 - waf build system, buildroot, Nix, NixOS, Jenkins, kernel ...

ESO Open data and videos

- Science archive data:
 - All data is available to everyone after a period of exclusive usage by the PI (usually ~1 year)
 - <https://archive.eso.org/cms.html>
- Images and videos (including UltraHD, fulldome and VR 16k) released under CC 4.0
 - <https://www.eso.org/public/images/>
 - <https://www.eso.org/public/videos/>

FAQ



So when are you going to Mars?



FAQ



Is there life out there?



FAQ



How does my Moon sign influence my emotions?

How do transits affect my career path?

What does a Saturn return signify for me?



Come and visit us!

- Our observatories can be visited (guided visits on Saturdays) so come by if you are in Chile!
- Or you can visit our HQ and the nearby planetarium (Garching near Munich).

**Thank you AlmaLinux and
Open Source
Community!!**

