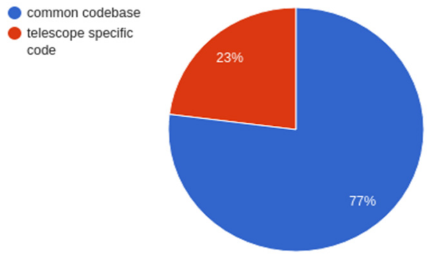
DISCOS UPDATES

Sergio Poppi on behalf of the DISCOS TEAM
INAF OA Cagliari

DISCOS

- DISCOS is a common control software for the Sardinia Radio Telescope and the other Italian radio telescopes
- 2004 Development SRT Control Software - NURAGHE started
    - Provide the Sardinia Radio Telescope of a control software with enhanced performances.
    - Build a common infrastructure for the three radio telescopes.
- 2007 ESCS Enhanced Single-dish Control System (Medicina and Noto)
- 2015 **D**evelopment of **I**talian Single-dish **CO**ntrol **S**ystem(**DISCOS**) unifies the control software for the three Italian radio telescopes.

- common monolithic codebase (77%):
    - management (scheduling, observing modes)
    - subsystem bosses
    - user interfaces
    - libraries
- Specific code coping differences among telescopes



Italian Radio Telescopes

INAF manages three dish radio telescopes:

- Sardinia Radio Telescope (64m)
- Medicina Radio Telescope (32m)
- Noto Radio Telescope (32m)

Observations can be run both in single-dish mode and in networks for very long baseline interferometry (VLBI).

The Italian radio telescopes are part of the following networks:

- European VLBI EVN
- Italian VLBI
- East Asia to Italy Near Global VLBI (EATING VLBI)

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Telescopes Configurations

SRT SARDINIA RADIO TELESCOPE

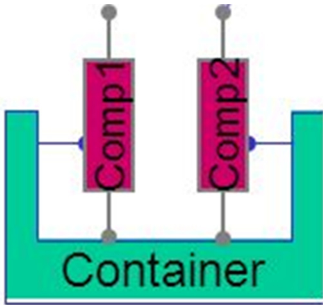
	SRT	Medicina	Noto
Main mirror	64 m	32 m	32 m
Optical configuration	Gregorian	Cassegrain	Cassegrain
Mount	Alt-azimuth, fully steerable 12 motors + cable wrap	Alt-azimuth, fully steerable 4 motors	Alt-azimuth, fully steerable 4 motors
Antenna Control Unit (main servo system)	Beckhoff PLC ethernet vendor protocol	VxWorks based PC ethernet vendor protocol	VxWorks based PC ethernet vendor protocol
Primary Focus	three degrees of freedom INAF defined protocol	three degrees of freedom INAF defines protocol	
Secondary Focus	six degrees of freedom ethernet INAF protocol	five degrees of freedom ethernet INAF protocol	five degrees of freedom RS232 vendor protocol
Active Surface	1008 aluminium panels 1116 actuators rs485/ethernet vendor protocol	To be installed in 2023	240 aluminium panels 244 actuators rs232 vendor protocol

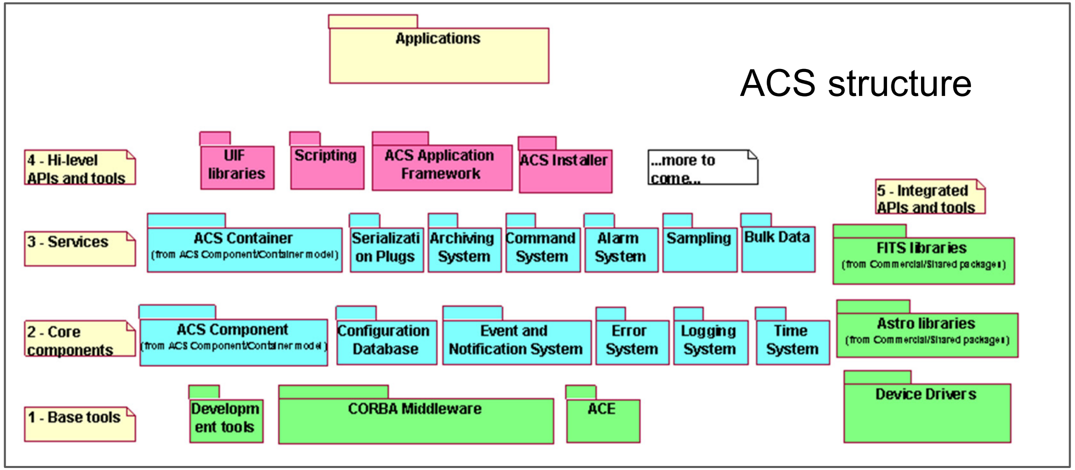
Telescopes Configurations

	SRT	Medicina	Noto
Main mirror	64 m	32 m	32 m
Receivers *	0.305-0.410 1.3-1.8 5.7-7.7 18.0-26.0, 7 feeds GPIB and ethernet INAF protocol	1.35-1.45 1.595-1.715 2.2-2.36 4.30-5.80 5.90-7.10 8.18-8.98 18.0-26.0, 2 feeds GPIB and ethernet and RS232 various protocols	0.317-0.320 1.40-1.72 2.20-2.36 4.70-5.05 8.18-8.58 22.18-22.46 39.0-43.3 GPIB and RS232 various protocols
Backends*	TotalPower (continuum) 0.1-2.1, 1-1000 ms, 14 inputs XARCOS (spectro-polarimetry) 0.0005-0.125, 10 s, 2048 bins, 14 inputs SARDARA(spectro-polarimetry) 1500MHz , 10-1000 ms,16384 bins, up to 14 inputs DFB3(pulsar) 1.024, 1-4000 ms, 8192 bins, 4 inputs DBBC	TotalPower (continuum) 0.1-2.1, 1-1000 ms, 4 inputs XARCOS (spectro-polarimetry) 0.0005-0.125, 10 s, 2048 bins, 14 inputs	TotalPower (continuum) 0.1-2.1, 1 ms, 4 inputs DBBC

DISCOS architecture

- Based on ALMA **Common** Software
  - Distributed objects architecture
  - ACS component as the basic unit that performs tasks
  - Components expose interfaces to other components.





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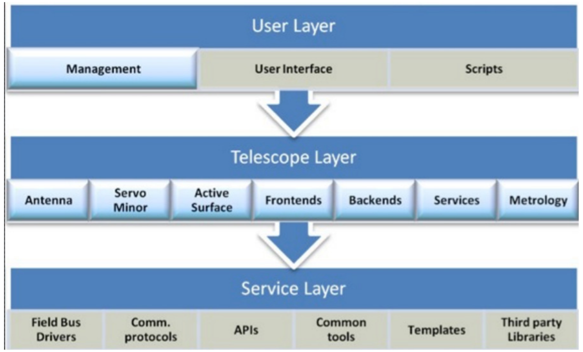
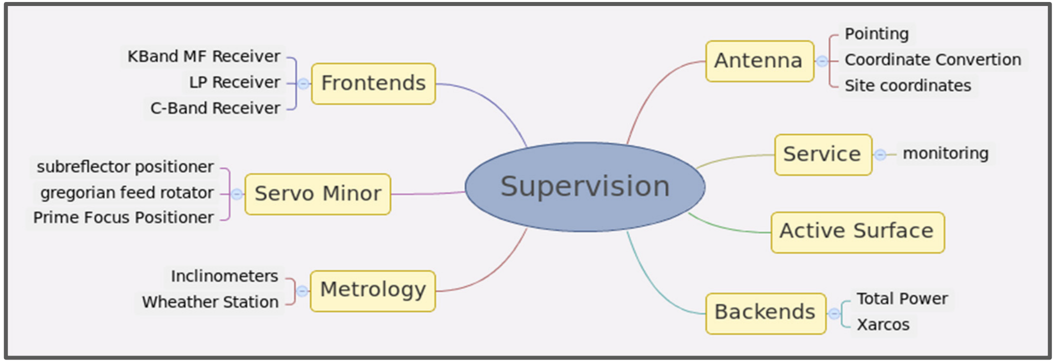
DISCOS Design

SRT SARDINIA RADIO TELESCOPE

- **Common** interfaces design for the three telescopes
- Components organised in subsystems (Containers)
- Each subsystem has a “boss” component, which is in charge of the communications inward and outward the subsystem.
- Three layers: User, Telescope, Service.





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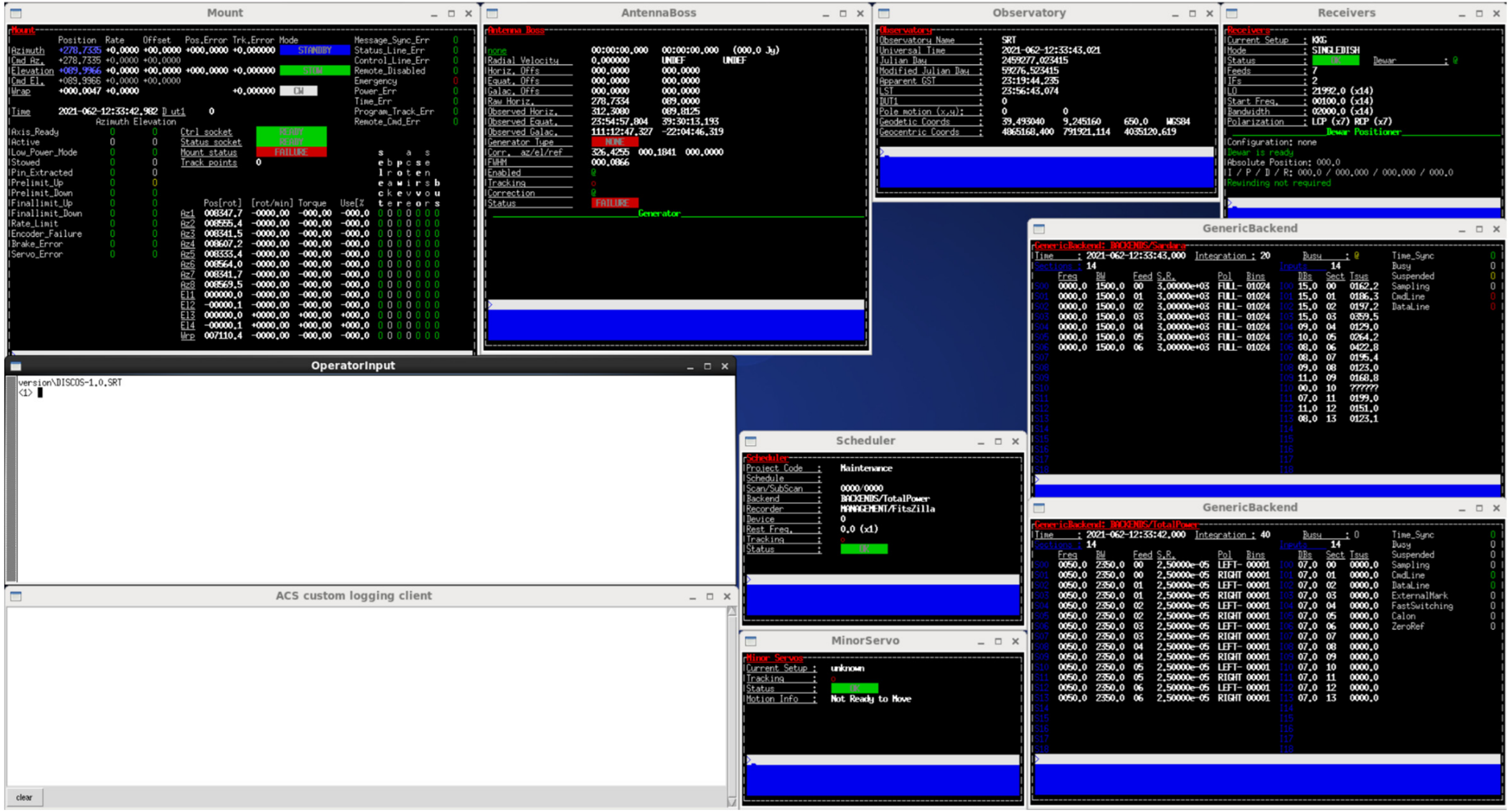
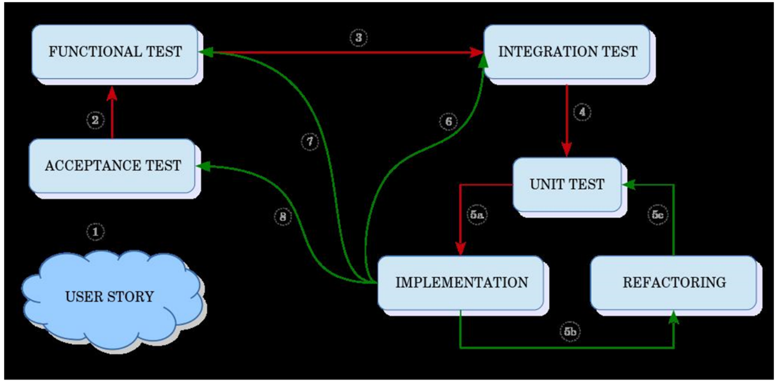
DISCOS User Interface

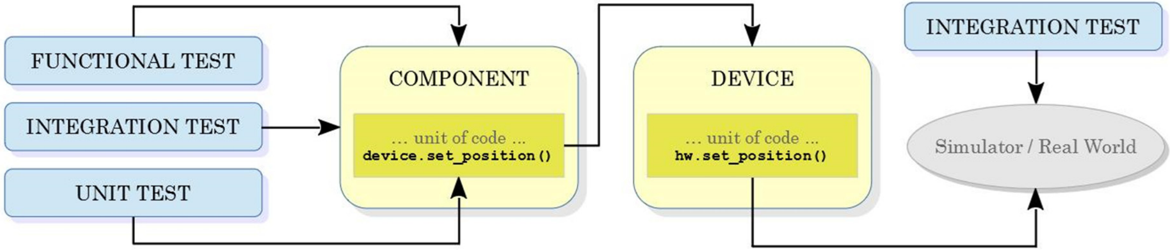
SRT SARDINIA RADIO TELESCOPE



Testing with Simulators



- Development of new functionality will be test driven

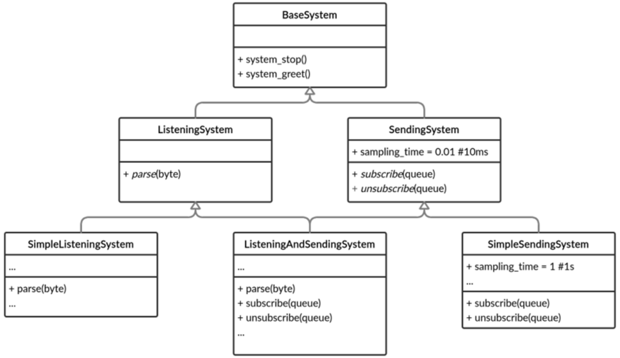


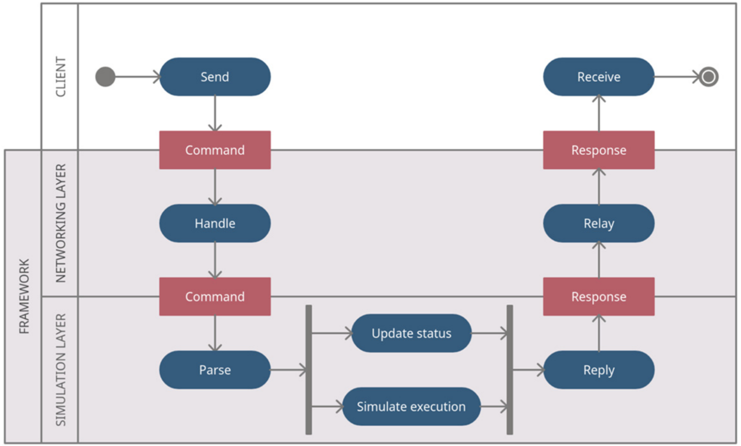
- Simulators provide a means to perform both high and low level offline tests
- Same tests should yield the same results with both simulators and hardware
- We can verify that the real hardware APIs behave as expected

DISCOS Simulators framework

The hardware is simulated at subsystem level:

- Antenna Control Unit
- Active Surface
- Backends
- Receivers



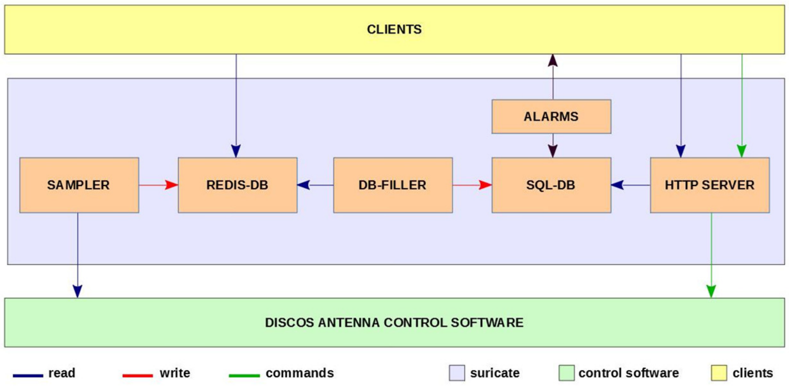


Simulators allow dry run of DISCOS.
Without simulators, telescope time would be needed to test software behaviour.

Simulators allow bug fixing and testing also without telescope. https://github.com/discos/simulators

DISCOS Suricate

- Handle communication inward and outward the CS
- Clients do not depend on the framework.
- Abstraction from the framework and the operating sistem.

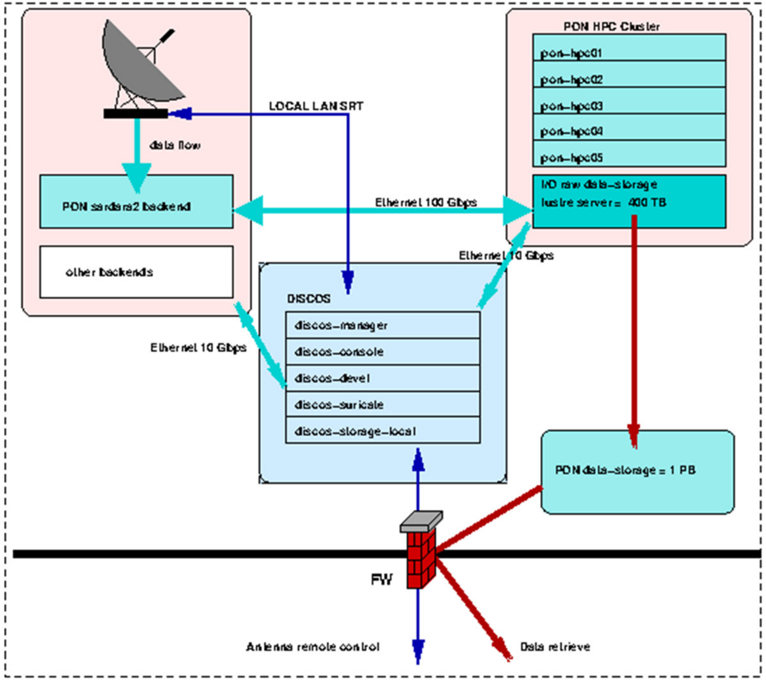


Grafana client

Automatic Deployment

Ansible

- Network setup
- shared file system setup
- Users creation
- dependencies installation (e.g. ACS)
- observing tools installation
- DISCOS installation



New receivers integration

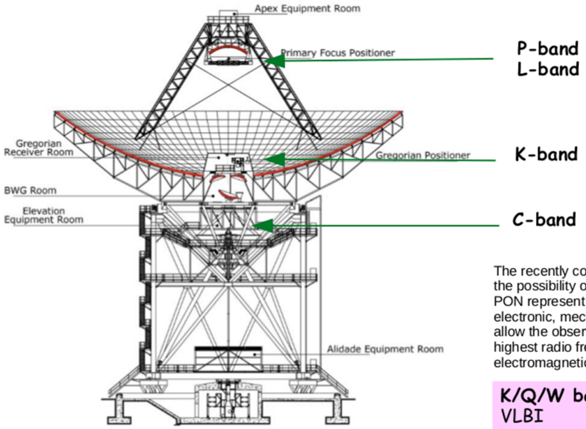
In 2019 INAF was granted a PON (National Operational Program) for the **Enhancement of the Sardinia Radio Telescope for the study of the Universe at high radio frequencies**

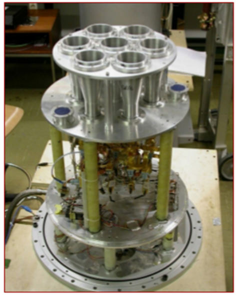
The enhancement involves:

- New receivers up to 116 GHz for SRT, Noto and Medicina radio telescopes
- New data acquisition backends
- Metrology system to measure optics attitude and position

Started June 2019
To be completed July 2022

Sardinia Radio Telescope - RECEIVERS





The recently completed upgrade of the active surface and the possibility of upgrading the infrastructure provided by this PON represent a great opportunity to equip SRT with all the electronic, mechanical and software systems necessary to allow the observation of radioastronomical sources at the highest radio frequencies, opening a window of the electromagnetic spectrum not yet explored by SRT.

P-band 305-425 MHz
L-band 1.3-1.8 GHz
C-band 5.7-7.7 GHz
S-band 3.0-4.5 GHz
Clow-band 4.2-5.6 GHz

K/Q/W band VLBI
W-band Camera 80-116 GHz
K-band multibeam 18-26 GHz
Q-band multibeam 33-50 GHz
W-band multibeam 75-116 GHz

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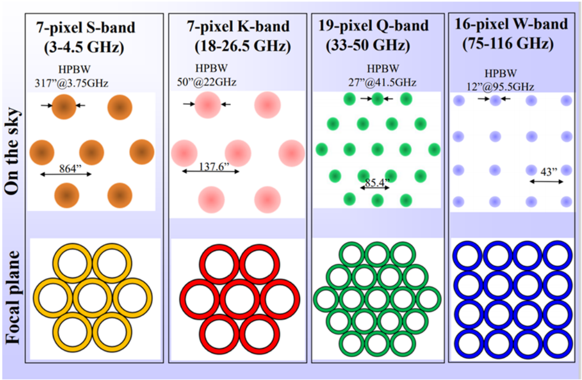
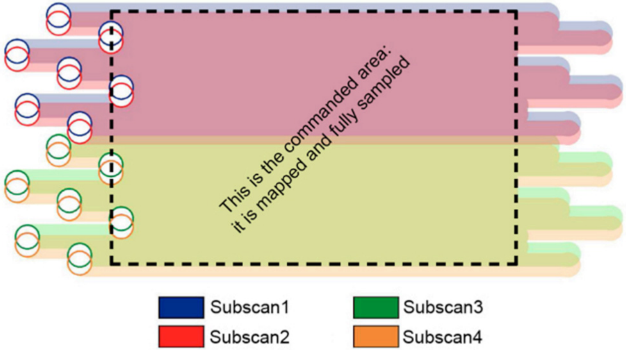
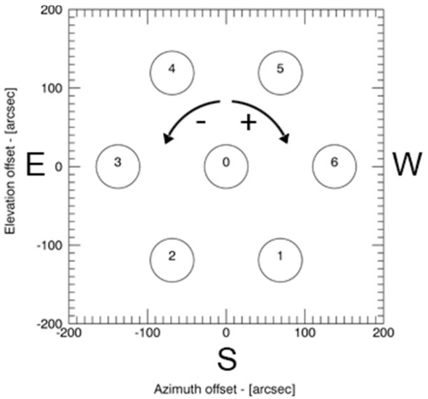
New receivers integration

- Most of the new receiver host a hardware derotator to track the parallactic angle
- In on-the-fly mapping a proper rotation angle can optimize scanning







Summarizing DISCOS updates

- Test driven development supported by full hardware simulation
- Automatic deployment for production and development.
- Suricate: a middleware to abstract from the operating system and the framework
- Integration of new receivers
  - cryogenic receiver in W Band for SRT (75-116 GHz)
  - cryogenic receiver in Q Band for SRT (33-50 GHz)
  - Millimetre camera for SRT (80-116 GHz)
  - triple-band receiving system for the three Italian radio telescopes (18-26 ; 35-50; 85-116 GHz)

Thank you for your attention!

1 Useful links

https://github.com/discos/discos
https://github.com/discos/suricate
https://github.com/discos/deployment
https://github.com/discos/simulators
https://www.radiotelescopes.inaf.it/
https://discos.readthedocs.io/

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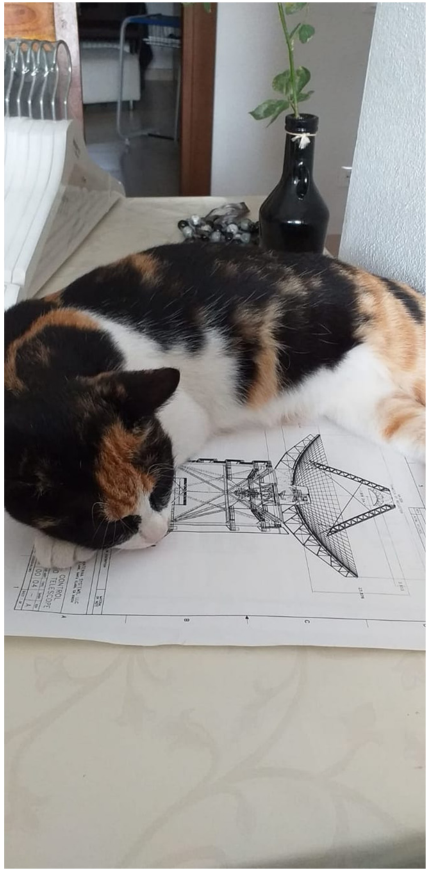
- M.Landoni (INAF - Brera and Cagliari)



Slide 16

1 potresti aggiungere il link a redthedoc, vedi te.

Andrea Orlati, 20/10/2021

1 Fatto

Sergio Poppi, 20/10/2021