# Observing at TNG today.
# Perspectives for the future.

*Ennio Poretti*

| Instrument | Date |
|---|---|
| TNG | June, $9^{th}$ 1998 |
| OIG | Dec, $10^{th}$ 1998 |
| ARNICA | Dec, $18^{th}$ 1998 |
| AdOpt | Dec, $18^{th}$ 1998 |
| DOLORES | May, $20^{th}$ 2000 |
| SARG | June, $9^{th}$ 2000 |
| NICS | September, $17^{th}$ 2000 |
| HARPS-N | March, $21^{st}$ 2012 |
| GIANO | July, $27^{th}$ 2012 |
| GIANO-B | Oct, $27^{th}$ 2016 |
| GIARPS | March, $14^{th}$ 2017 |

| | |
|---|---|
| M1 diameter | 3.58 m |
| Focal length | 38.5 m (f/11) |
| M2 diameter | 0.875 m |
| M2 baffle diam. | 1.165 m |
| Scale | 5.36 arcsec/mm |
| Vignetting-free field | 25 arcmin diameter |

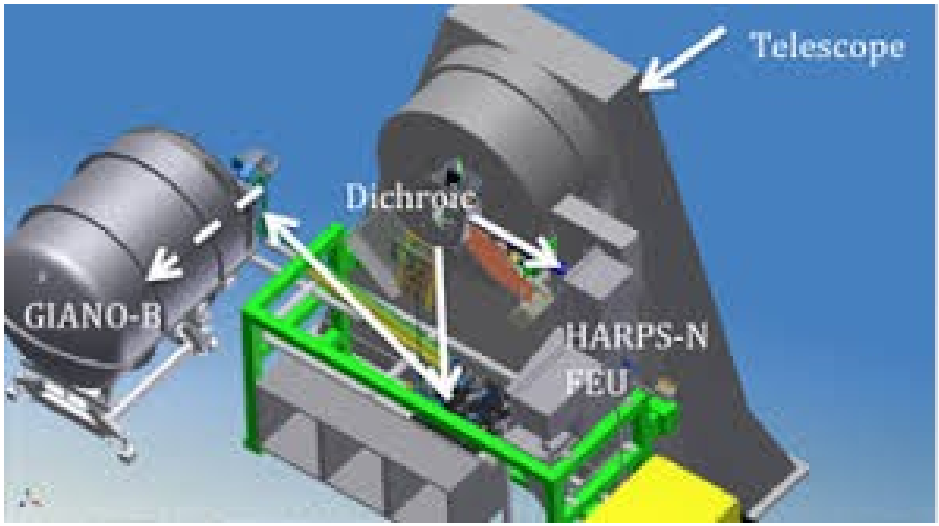
# Four interchangeable instruments

- **HARPS-N**, high-resolution spectrograph (R=115000) operating in the visible.
- **GIANO-B**, high-resolution spectrograph (R=50000) operating in the near infrared.
- **DOLORES**, low-resolution spectrograph (R<6000) and imaging.
- **NICS**, near-infrared instrument, low-resolution spectroscopy (R<2500), imaging.

**and**

- **SiFAP2,** ultrarapid photometer (time resolution 8 ns), PI instrument.

GIANO-B and HARPS-N combined in the **GIARPS** observing mode. Simultaneous visible and infrared spectra of the same target.



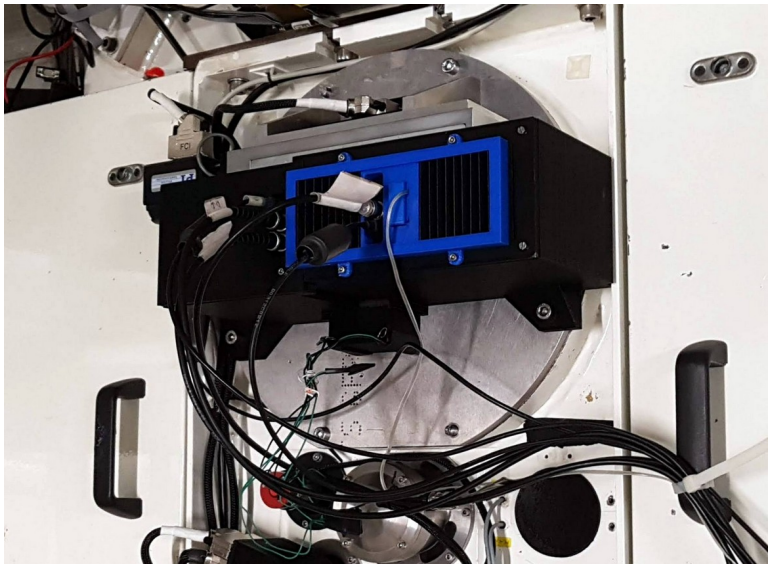

**Action taken by the Italian Community : GAPS, GIANO Team, and TNG staff. Funded by own budget.**

# ENTERING TIME DOMAIN ASTRONOMY WITH EXCELLENCE

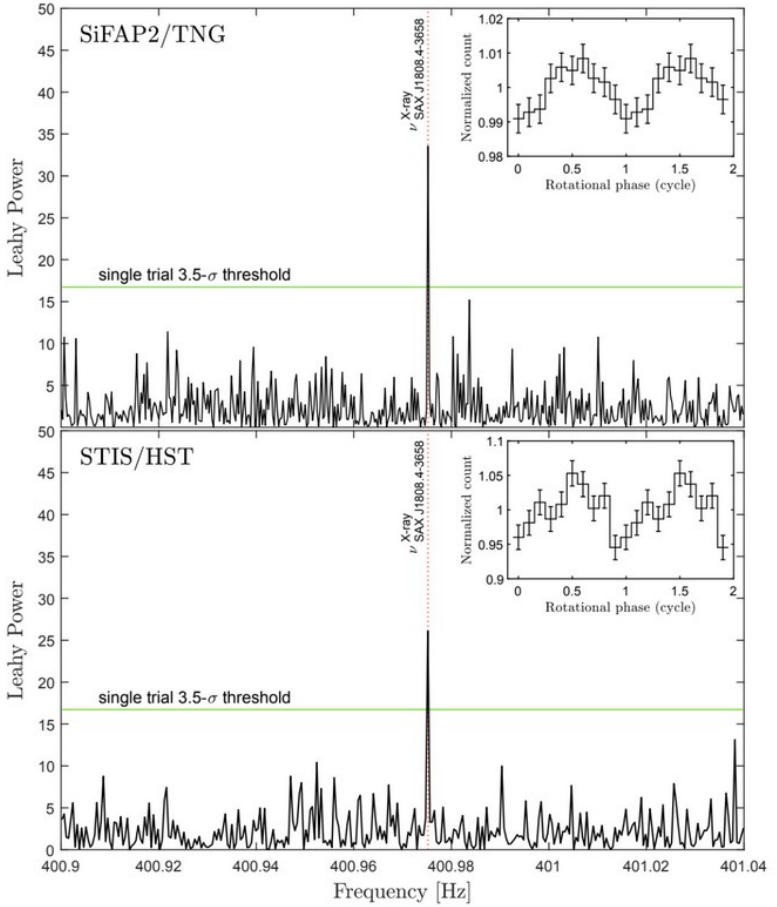
## *Silicon Fast optical Astronomical Photometer (SiFAP2) offered as a visitor instrument*

**Pulses of visible light from a millisecond pulsar**

***(Ambrosino et al. 2017, Nature Astronomy)***



First light of SiFAP2 on November 14, 2018



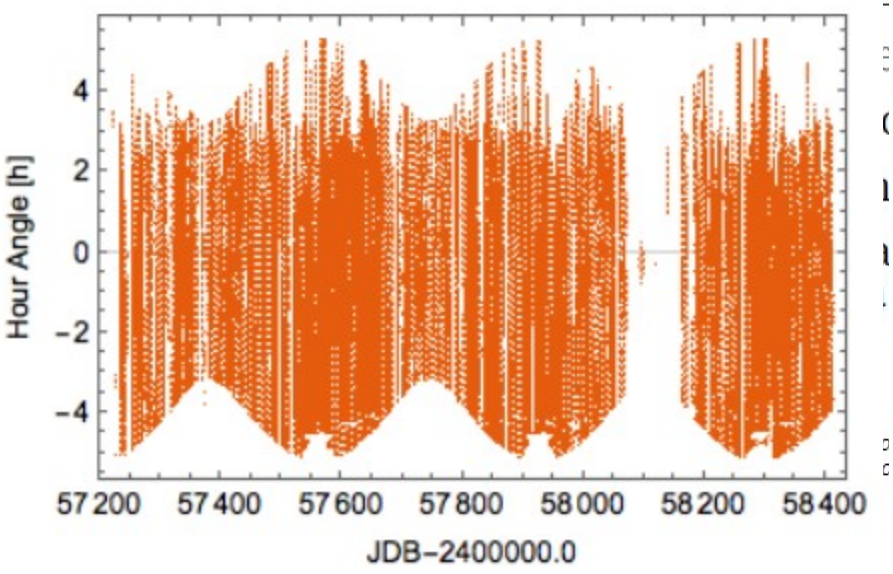

*Ambrosino et al. 2020, Nature Astronomy*

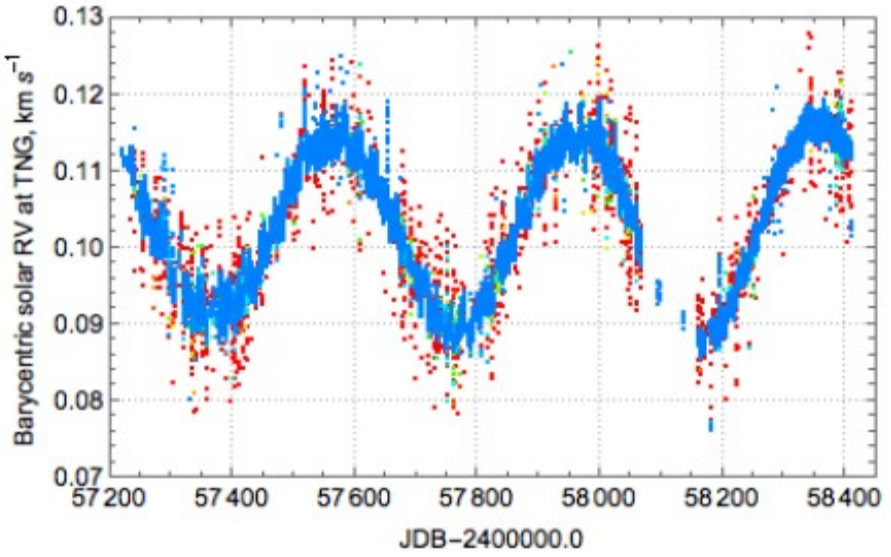
# *The Sun as a star*

David Phillips, Xavier Dumusque, TNG staff, et al.

**LCST** (Low Cost Solar Telescope) operating daytime.
It feeds HARPS-N spectrograph.

**Three years of Sun-as-a-star radial-velocity observations on the approach to solar minimum.**



# LOCNES: Low Cost NIR Extended Solar Telescope

Claudi R.[a], Ghedina A.[b], Pace E.[c], Gallorini L.[c], Di Giorgio A.–M.[d], Liu S.–J.[d], Tozzi A.[e], Carleo I.[a], Lanza A.F.[f], Micela G.[g], Molinari E.[h], Poretti E.[b], Phillips D.[g], and Tripodo G.[i]

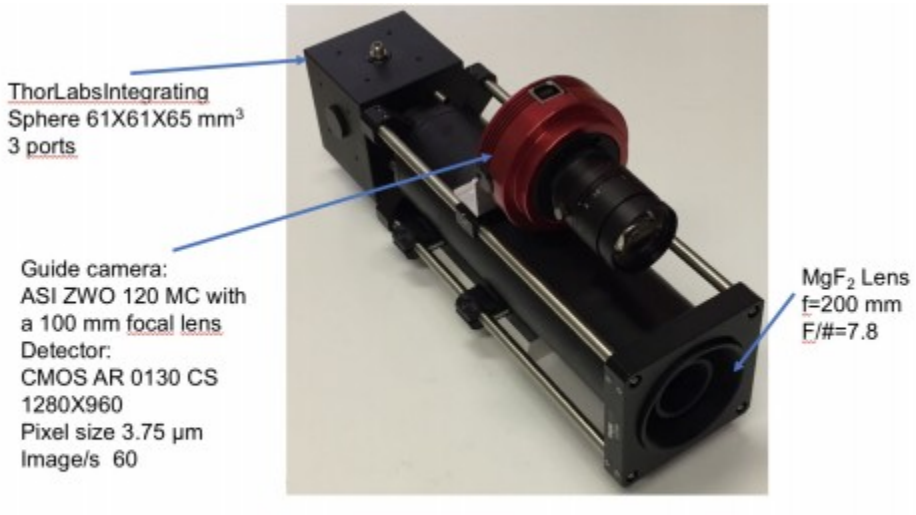
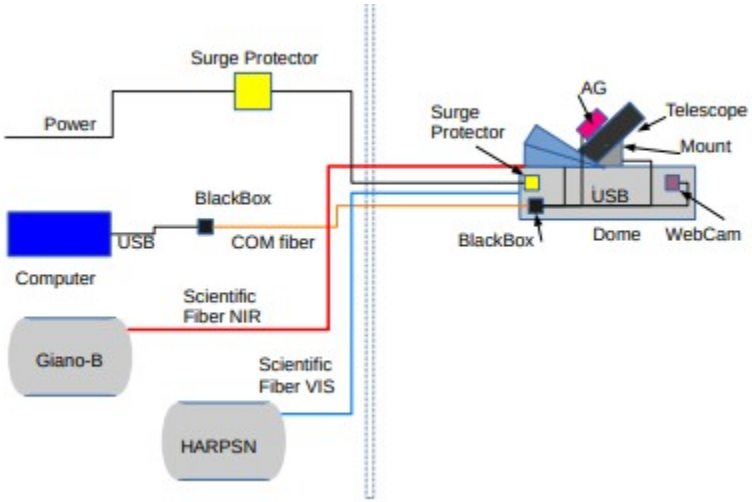



Figure 3. The LOCNES telescope.




The Fundación Galileo Galilei-INAF (FGG-INAF) is a Spanish non-profit institution. The FGG's main aim is to promote astrophysical research by managing the Telescopio Nazionale Galileo (TNG), located at the Roque de Los Muchachos Observatory in La Palma, and developing INAF activities in the Canary Islands.

The financial support is ensured by the Italian Istituto Nazionale di Astrofisica (INAF). Decisional Board : ***PATRONATO,*** composed of 5 members: INAF President, INAF General Director, INAF Scientific Director, and two experts.

On the island: TNG Director. Also acting as *Gerente* FGG.
31 personnel units contracted by FGG.

4 INAF astronomers.

Administration (1+2), Technology (11), Informatics (4), Astronomy (8), Telescope Operators (5), Safety Manager (1), **ASTRI (2)**

# QUESTIONS

Q1 HOW ARE NIGHTS AT TNG ?
Q2 WHO USES TNG TIME ?
Q3 IS IT DIFFICULT TO GET OBS.TIME ?
Q4 CAN I GET ENOUGH DATA ?
Q5 WHAT DOES TNG OBSERVE ?
Q6 ARE THE RESULTS PUBLISHED?
Q7 WHO PUBLISHES BY USING HR ?

# Q1 : HOW ARE THE NIGHTS AT TNG ?

## Night Statistics

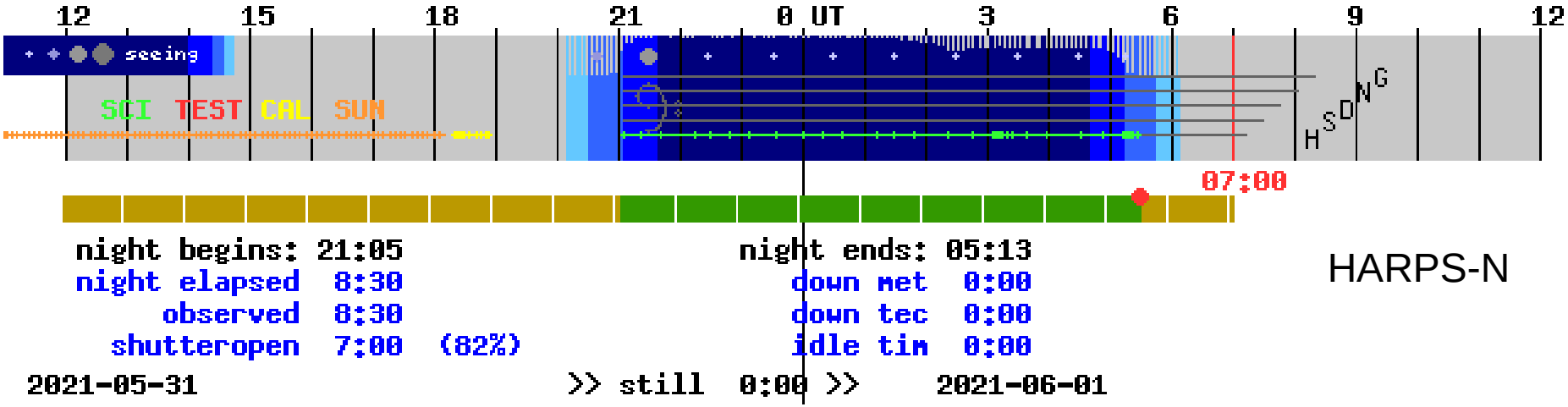
| | **2020** [%] | 2019 [%] | 2018 [%] | 2017 [%] | 2016 [%] | 2015 [%] |
|---|---|---|---|---|---|---|
| Down meteo | **26.5** | 14.4 | 27.0 | 22.7 | 25.3 | 23.3 |
| Technical failures | **2.7** | 3.1 | 2.8 | 2.0 | 1.4 | 2.2 |
| Engineering time | **2.2** | 5.9 | 5.3 | 5.6 | 4.9 | 2.7 |
| Idle time | **0.5** | 0.6 | 0.5 | 0.6 | 1.0 | 0.4 |
| Observed time | **68.1** | 76.0 | 64.6 | 68.9 | 67.3 | 71.4 |
| Open Shutter | **74.6** | 71.9 | 76.2 | 72.8 | 74.1 | 72.7 |

Answers :

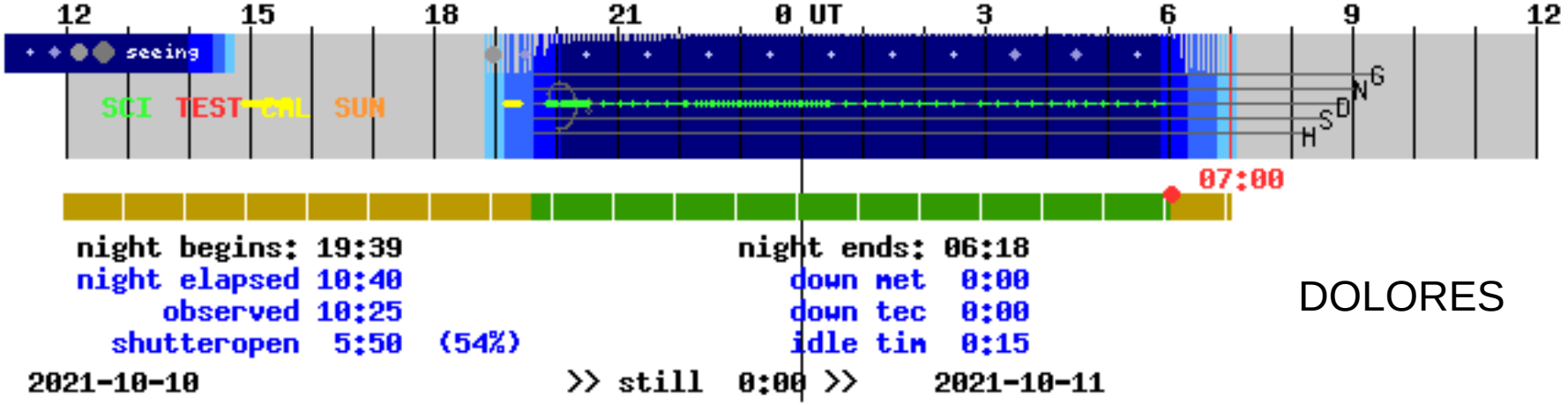
2.5 nights out of 10 lost for bad weather

You observe 7 nights out of 10

Open shutter 5.25 nights out of 10




HARPS-N




DOLORES

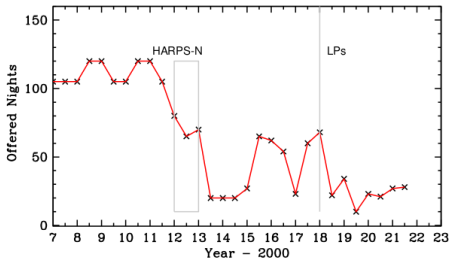
E. Molinari & N. Hernandez, SPIE 2012

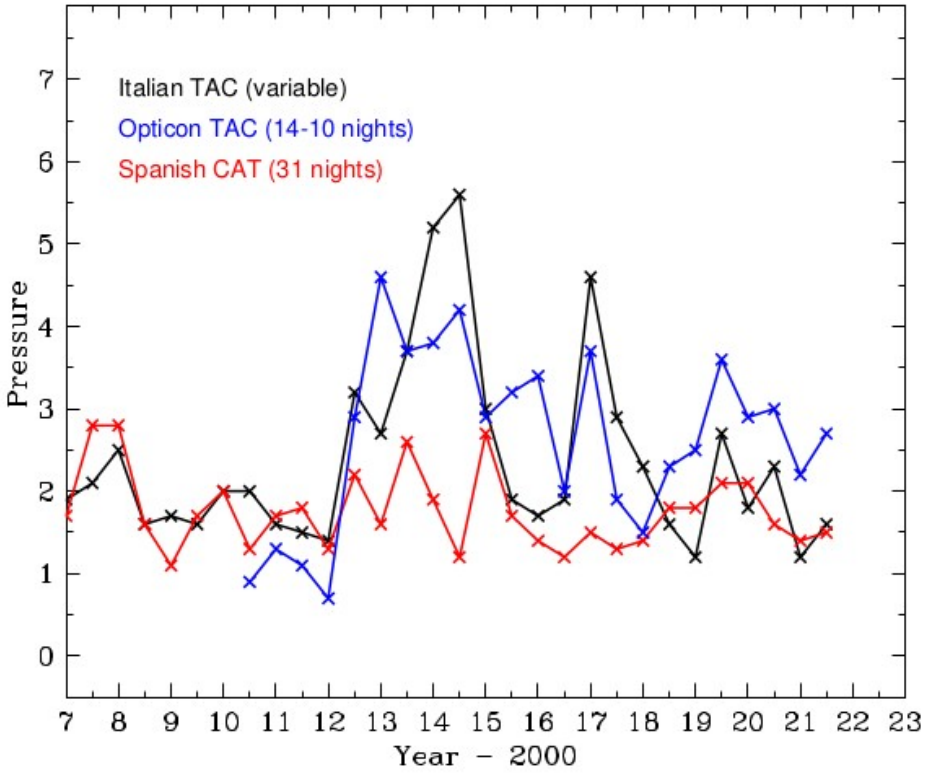
| Q2: WHO USES TNG TIME ? | AOT 38 | AOT 39 | AOT 40 | AOT 41 | AOT 42 | AOT 43 | AOT 44 | Typical Semester |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **NIGHTS** |
| INAF OPEN TIME | 12 | 12 | 10 | 18 | 16 | 26 | 28 | 20 |
| INAF Large Prog. | 47 | 47 | 39 | 43 | 43 | 34 | 36 | 40 |
| INAF Long Term | - | 4 | 3 | - | 6 | 6 | - | 3 |
| GTO (INAF-GTO agr.) | 40 | 40 | 33 | 40 | 40 | 40 | 40 | 40 |
| Spanish CAT (Intl. protocol) | 31 | 31 | 26 | 31 | 31 | 31 | 31 | 31 |
| CCI ITP (Intl. protocol) | 8 | 7 | 7 | 8 | 7 | 7 | 8 | 8 |
| OPTICON | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| TNG-NOT (Agreement) | 10 | 10 | 8 | 5 | 5 | 5 | 5 | 5 |
| Technical nights (DDT, payback,...) | 24 | 22 | 42 Alum. | 28 PAO | 24 | 24 | 24 | 24 |

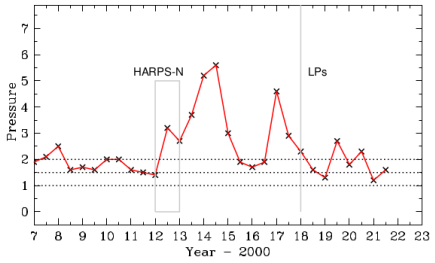
**ANSWERS :**

63 nights INAF
40 nights GTO
31 nights Spain
23 nights Rest-of-world
24 nights “Technical”

# Q3 : IS IT DIFFICULT TO GET OBSERVING TIME ?
# HOW MUCH PRESSURE ?




**Answer : Enough pressure to guarantee “good science”**

# Q4: CAN I GET ENOUGH DAT ?

According to the official table with the status of SPA observations made available to us by the TNG Director, 596 hrs of open telescope was recorded out to the 612 hrs nominally scheduled.

During the 596 hrs of observations in the six semesters from Period 37 to Period 42, we secured spectra for 520 stars in the disk field and associated star clusters, spreading a wide range of Galactocentric distances and divided in three main age groups, as shown in Figure 1 and detailed below .

Other cases : programs requesting <20-30 hours of observations mostly fully-excuted
MINCE (Cescutti), C-MetaLL (Ripepi), WD (Silvotti), TESS subgiants (Montalto), ARIEL (Rainer, Benatti)

More difficult to be fully executed: comets, asteroids and NEO due to high proper motion

Flexible schedule.

**ANSWER : Yes, for sure**

# Q5: WHAT DOES TNG OBSERVE ?

GHOsT
GIARPS High-resolution Observations of T Tauri Stars

# OBSERVING PROGRAMS:
# INAF (63 nights/semester)

GraWITA

JEDI JEts and Disks @Inaf

## HIGH-RESOLUTION (GIARPS)

EXOPLANETS : GAPS and a few related PIs

STELLAR ASTROPHYSICS : ABUNDANCES MW DISK (SPA), METAL POOR (MINCE, Cescutti), T TAURI (GHOST Antoniucci, JEDI Alcala'), GAIA CEPHEIDS (Ripepi), WD (Silvotti)

## LOW RESOLUTION, IMAGING (DOLORES, NICS)

EXTRAGALACTIC : GW (GRAWITA), GRB (Swift), QSO (Trieste), SN (Padova), GALAXY CLUSTERS

SOLAR SYSTEMS : COMETS (Lazzarin), NEO (Perna), ASTEROIDS (IAPS, ESA/NASA preparatory work)

## TIME DOMAIN ASTRONOMY (SiFAP2)

PULSARS (Ambrosino, Papitto, Casella,...), BURSTS, LUNAR AND ASTEROIDAL OCCULTATIONS


GAPS
GLOBAL ARCHITECTURE OF PLANETARY SYSTEMS

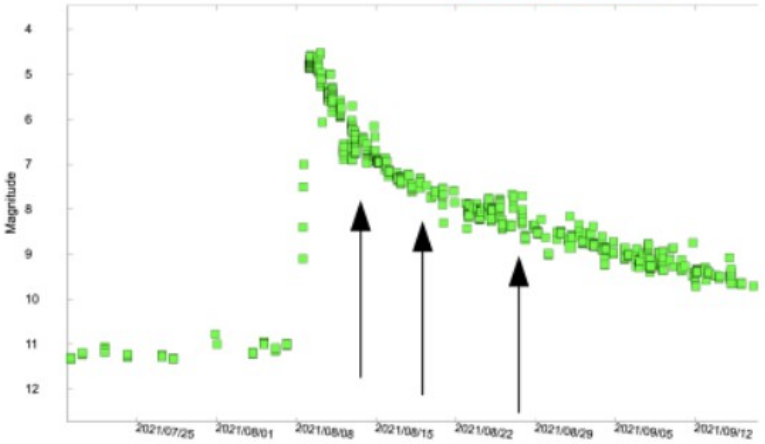
# RS Oph & HARPS-N

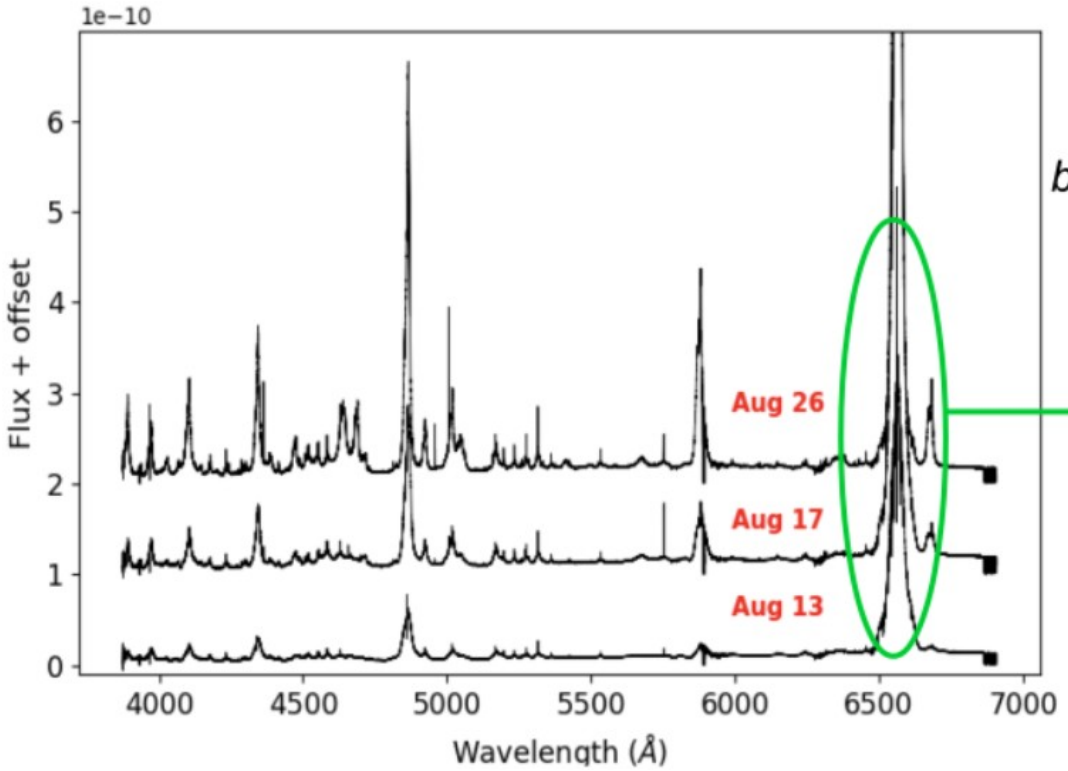
(Luca Izzo)

Recurrent nova – last outburst 2006

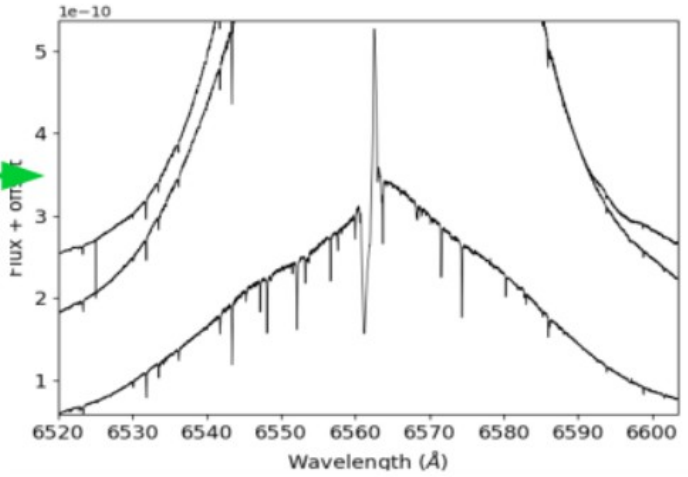
3 spectra obtained in August 2021

Within a larger high-res monitoring program:
**UVES+TNG+NOT**



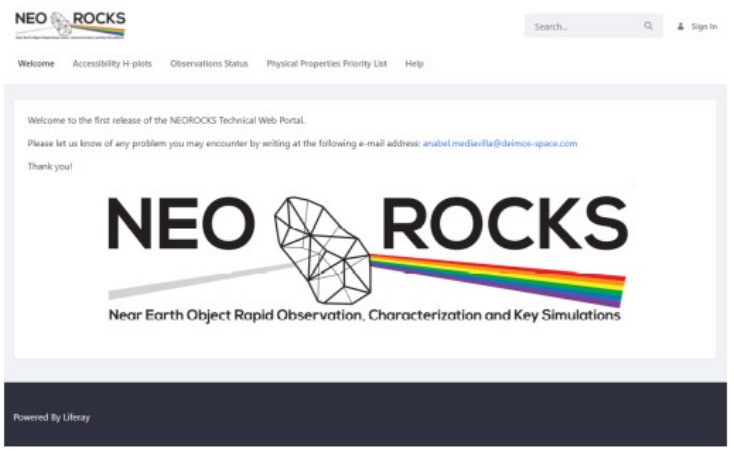

**Shock interaction**
nova ejecta – red giant wind
*broad -> nova ejecta; narrow -> RG wind*



# International commitments:

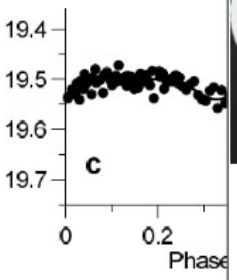
Horizon 2020
European Union funding
for Research & Innovation

EU H2020 projects


Space missions

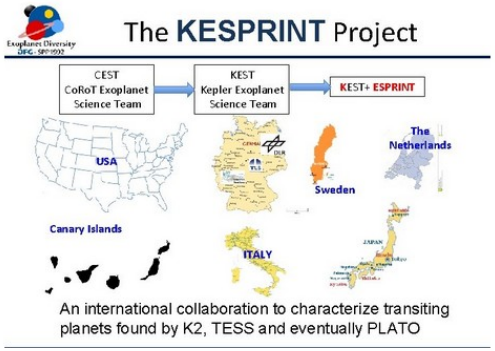
LICIA
Light Italian Cubesat for Imaging of Asteroids



About 50 papers in 15 years: observations, interpretation, models, “big picture”

# OBSERVING PROGRAMS:
# SPAIN (31 nights/semester)




## HIGH-RESOLUTION (GIARPS)

EXOPLANETS : MS STARS (IAC, KESPRINT), TRANSMISSION SPECTROSCOPY (IAC, Palle'), M-STARS (IAC Rebolo, HADES, GAPS coll.)

STELLAR ASTROPHYSICS & EXOPLANETS: TAPAS (CSIC)

## LOW RESOLUTION, IMAGING (DOLORES, NICS)

EXTRAGALACTIC : BLAZARS (Madrid), GALAXY CLUSTERS (IAC)

SOLAR SYSTEMS : –

# OBSERVING PROGRAMS: INTERNATIONAL (CCI, OPTICON, and now NORDIC time)


**HIGH-RESOLUTION (GIARPS)**

EXOPLANETS : TRANSITING, TRANSMISSION SPECTROSCOPY

STELLAR ASTROPHYSICS: T TAURI, RCB

**LOW RESOLUTION, IMAGING (DOLORES, NICS)**

EXTRAGALACTIC : SN (ZTF, Icecube, Lensed…), AGN (eROSITA)

SOLAR SYSTEMS : COMETS, ASTEROIDS

## PARTIAL RENEWAL OF THE BILATERAL AGREEMENT IN 2022

(*CCI President Welcome speech*)

## Answers:

**Exoplanets** (masses, transmission spectroscopy) by different groups, with a large INAF involvment.

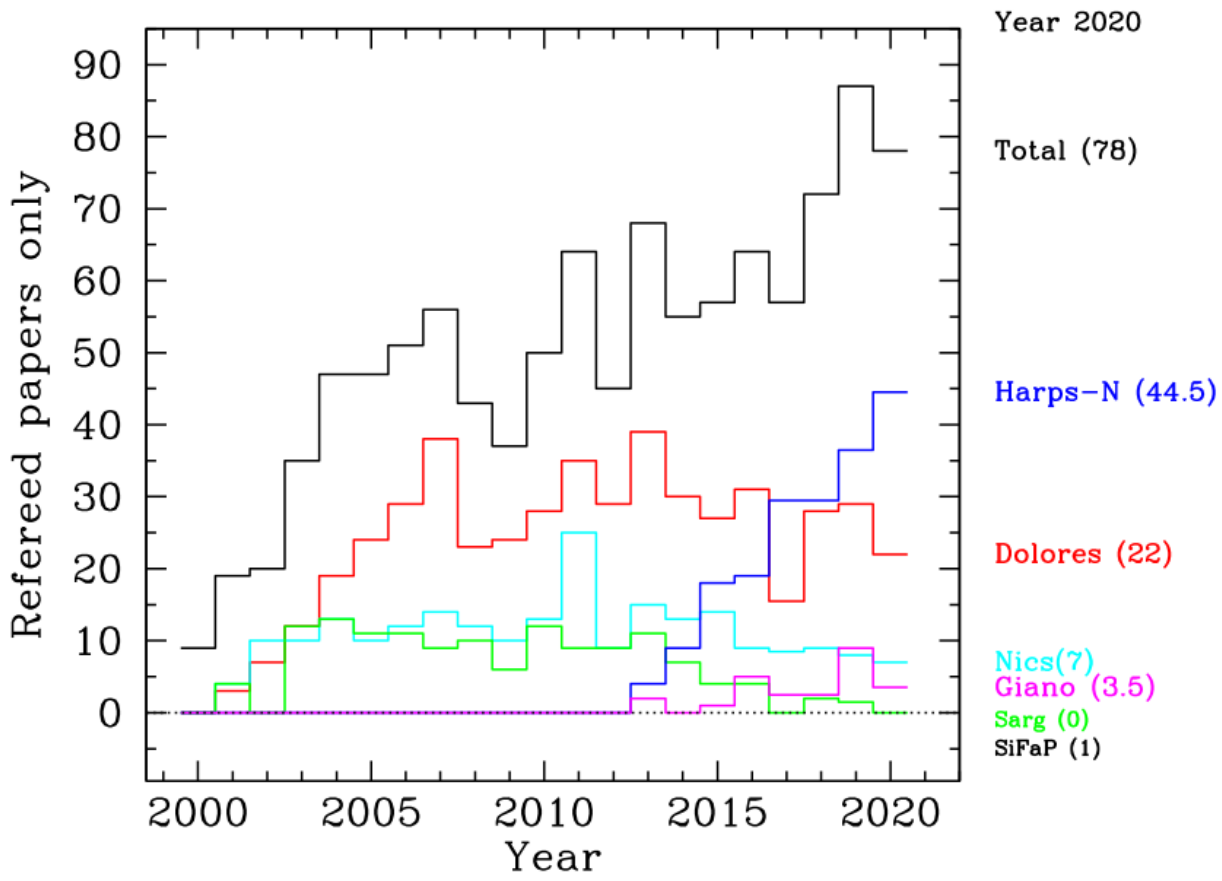
Stellar astrophysics, Solar System, TDA and extragalactic researches are adequately covered.

**High-resolution spectroscopy.** But also imaging, LR spectroscopy, fast photometry are powerful available tools.

## Q6 : ARE THE RESULTS PUBLISHED ?

**Publication record** *(source TNG webpage)*

Peer-review journals only




Answers : Increasing after a long-standstill.
Large-Program (GAPS,GTO,SPA) effect since Dolores/Nics stable over the years

# Q7: WHO PUBLISHES BY USING HR ?

**Publication record** *(source TNG webpage)*

Peer-review journals only

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|
| HARPS-N | 4 | 9 | 22.5 | 22 | 31 | 29 | 33 | 40 |
| High Resolution | 6 | 9 | 24.5 | 27 | 35 | 32 | 45 | 48 |
| INAF | 4 | 2 | 11 | 9.5 | 9 | 9 | 14 | 17.5 |
| GTO | 1 | 3 | 5 | 6 | 6 | 5 | 11 | 9 |
| SPAIN | 0 | 1 | 3.5 | 7.5 | 8 | 9 | 10 | 12.5 |
| Rest of World (archival data!) | 1 | 3 | 5 | 4 | 12 | 9 | 10 | 9 |

ANSWER : INAF HOLDS THE LEAD

# Q & A

| | | |
|---|---|---|
| Q1 | HOW ARE NIGHTS AT TNG ? | It sounds reasonable to apply |
| Q2 | WHO USES TNG TIME ? | Italy, but not only |
| Q3 | IS IT DIFFICULT TO GET OBS.TIME ? | No, easy for good science |
| Q4 | CAN I GET ENOUGH DATA ? | For sure |
| Q5 | WHAT DOES TNG OBSERVE ? | Mostly Exoplanets in HR mode, but not only |
| Q6 | ARE THE RESULTS PUBLISHED? | Yes, ever increasing |
| Q7 | WHO PUBLISHES BY USING HR ? | INAF holds the lead |

| | |
|---|---|
| Padova meeting on TNG | March 2017 |
| HARPS-N agreeement renewed | August 2017 |
| Call for Large Programs (80-85% of available nights) | October 2017 |
| Two LPs using HR selected | March 2018 |

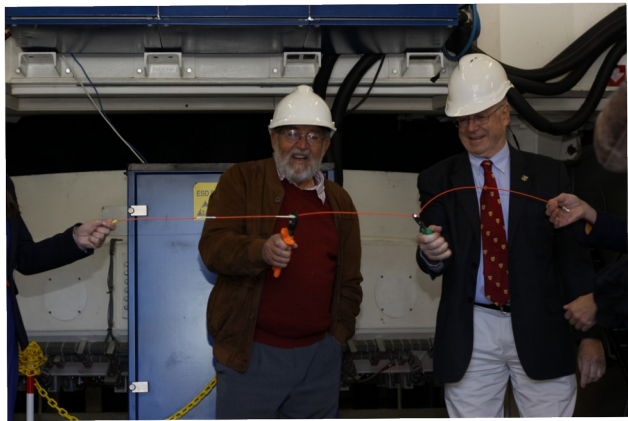
**This strategy is keeping TNG at the top in the HR field.**


Date : December 7, 2018

Harps-N

Collaboration Agreement

for the maintenance and operation of the HARPS-N spectrograph and its scientific use



# CRITICALITIES AND FUTURE ACTIVITIES

**HARPS-N: excellence in the exoplanet science in the Northern Hemisphere. Space missions on exoplanets (TESS, CHEOPS, ARIEL, PLATO,…) ensure a bright future.**


**GIANO-B: infrared spectrograph to characterize stars and exoplanets.**

**DOLORES and NICS are playing the game of transients follow-up and chasing the optical counterpart of a gravitational wave event. Small improvements possible**

*New instruments: SiFAP2, LOCNES, waiting for a third generation?*

**GIANO-B** : Unable to reach high-precision RV measurements.
Instrument instability. Few lines in the IR.
Possible solution to alleviate the problem: absorption cells