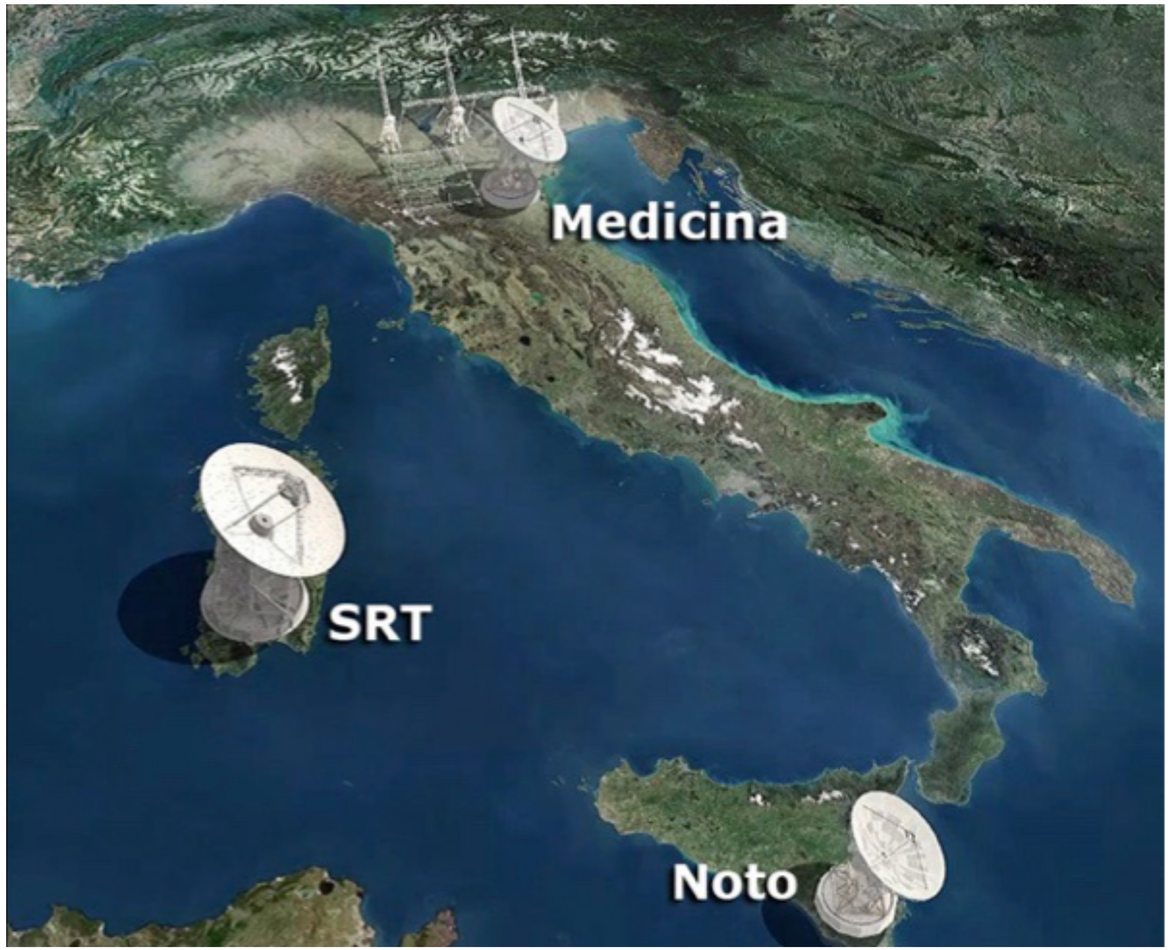
INAF radio telescopes: Project Status and RSN4 Involvement

Elise Egron
INAF-Observatory of Cagliari

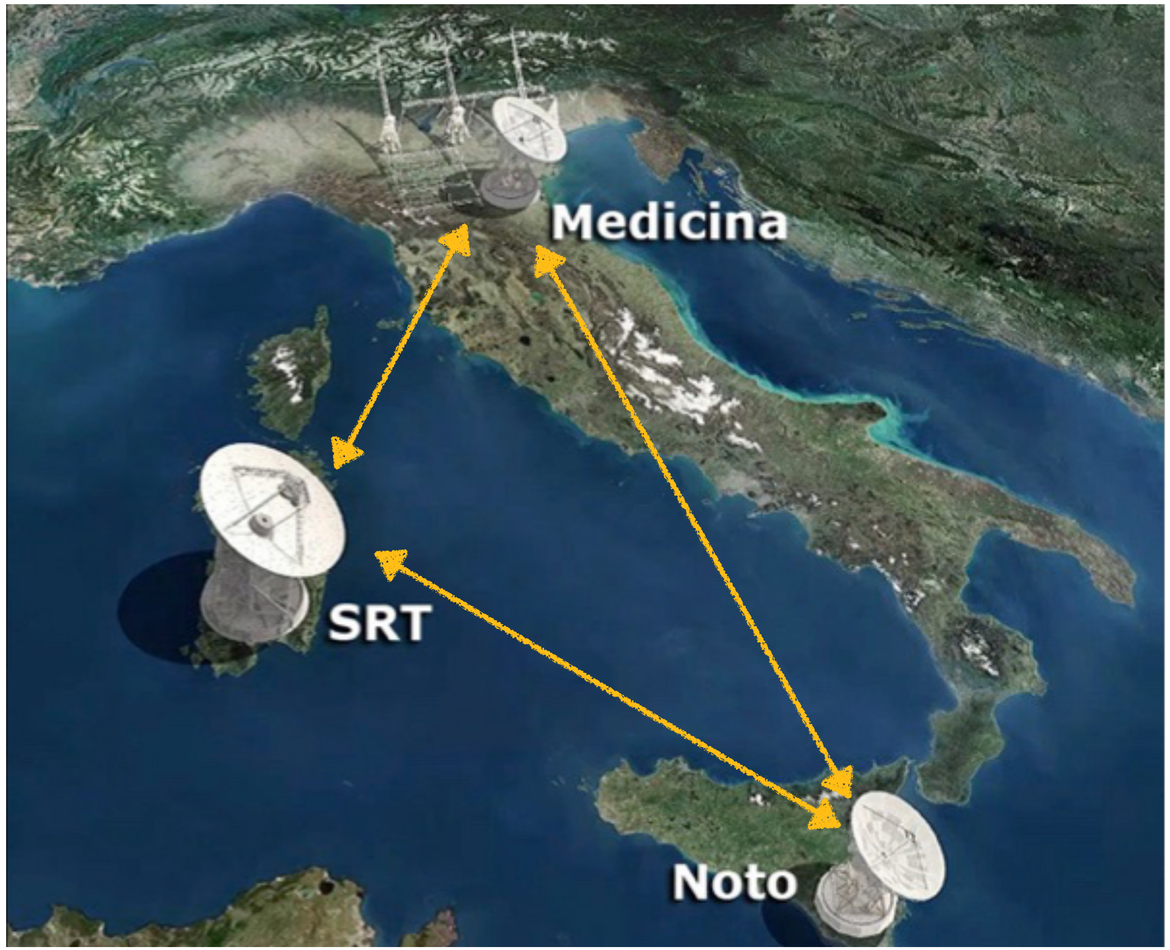
RSN4 - 29/01/2026

The INAF radio telescopes



Credits: MEDIA-INAF

Italian VLBI network (VITA)

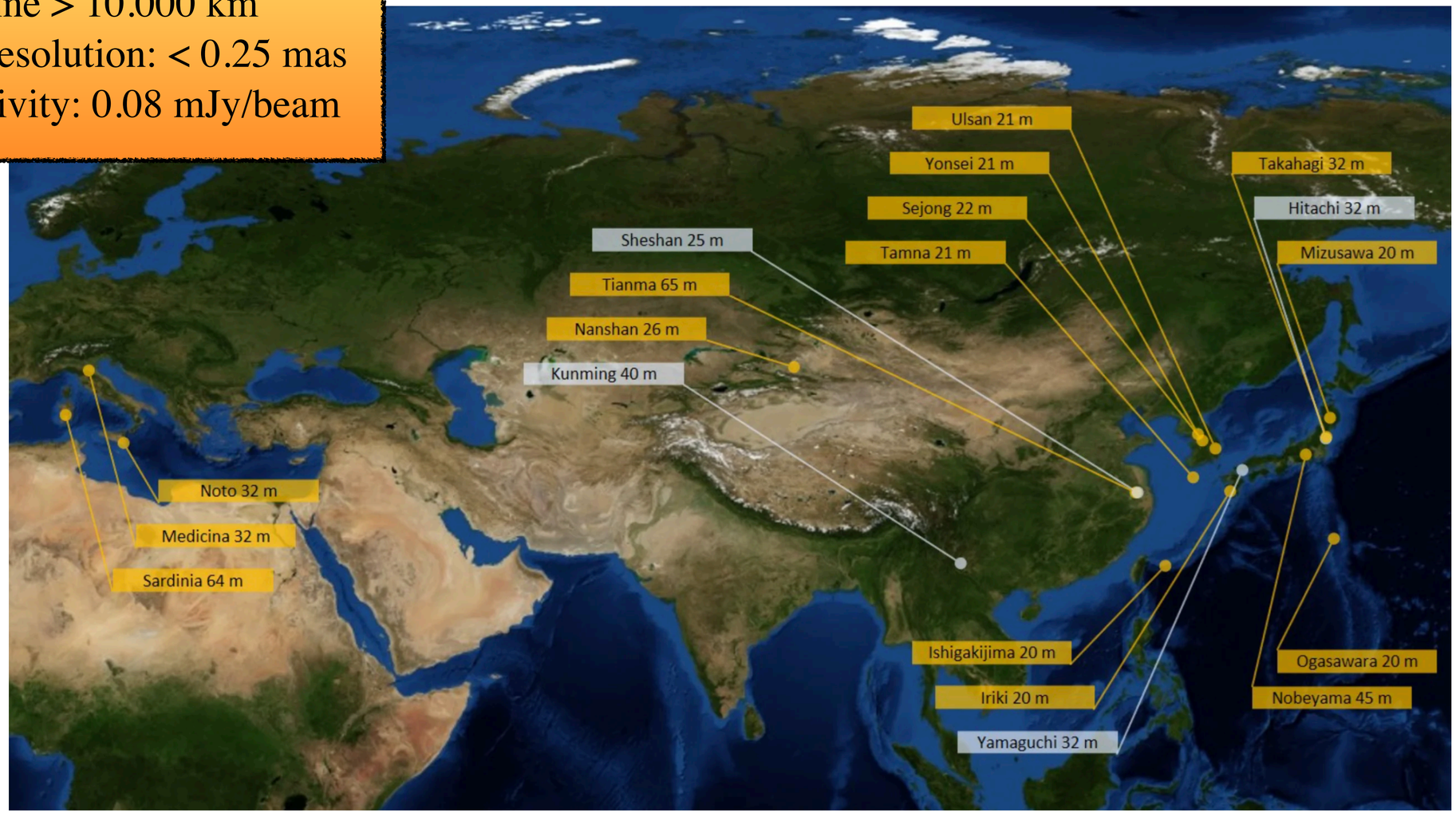


Credits: MEDIA-INAF

EVN: European VLBI Network

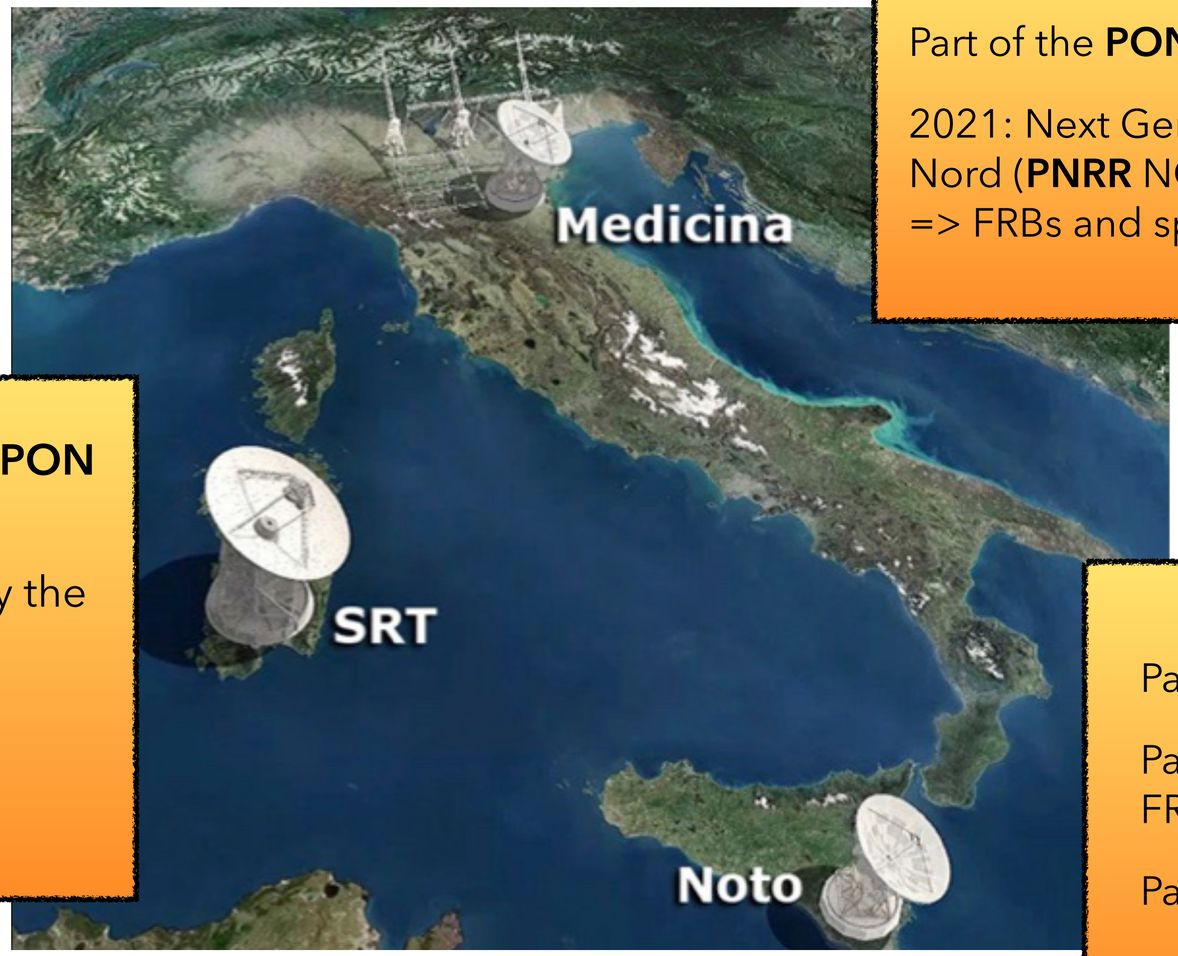
EATING VLBI:
East Asia to Italy Nearly Global VLBI

Frequency: 22 GHz
Baseline > 10.000 km
Angular resolution: < 0.25 mas
Image sentivity: 0.08 mJy/beam



Giovannini et al. 2023

Important upgrades



Part of the **PON** funding

2021: Next Generation – Croce del Nord (**PNRR** NG-CROCE) : **19 M€**
=> FRBs and space debris

2019: SRT: **18.7 M€ MIUR PON**

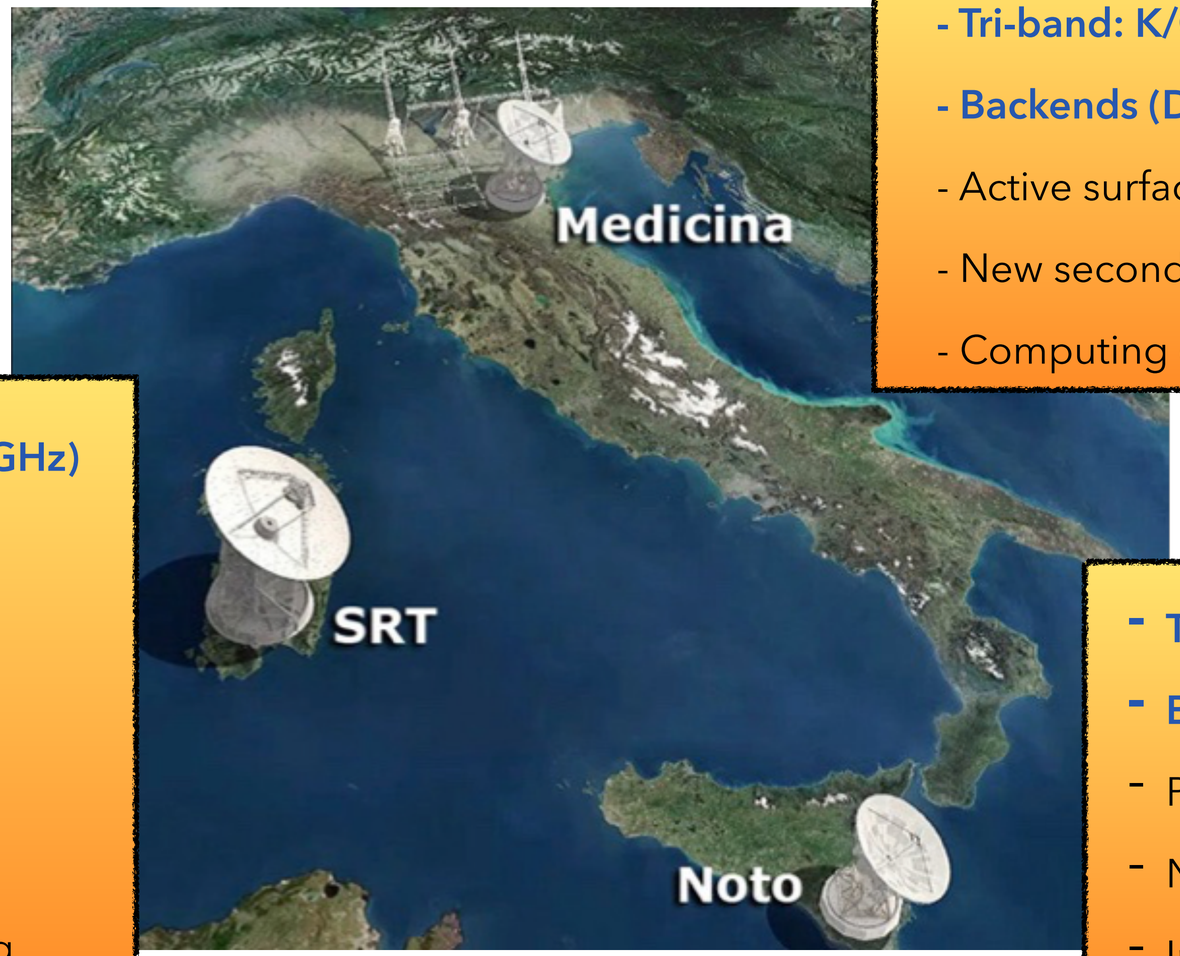
=> Major upgrade to study the Universe at high radio frequencies

Part of the **PON** funding

Part of the **PNRR** (NG-CROCE) : FRBs and space debris

Part of the **PNRR** KM3net

Towards the high radio frequencies



- **Tri-band: K/Q/W (22/43/86 GHz)**
- **Backends (DBBC3, SKARAB)**
- Q-band
- W-band: Caruso
- W-band camera: MISTRAL
- Metrology
- High Performance Computing

- **Tri-band: K/Q/W**
- **Backends (DBBC3, SKARAB)**
- Active surface
- New secondary mirror
- Computing center

- **Tri-band: K/Q/W**
- **Backends (DBBC3, SKARAB)**
- P-band
- New secondary mirror
- Important maintenance

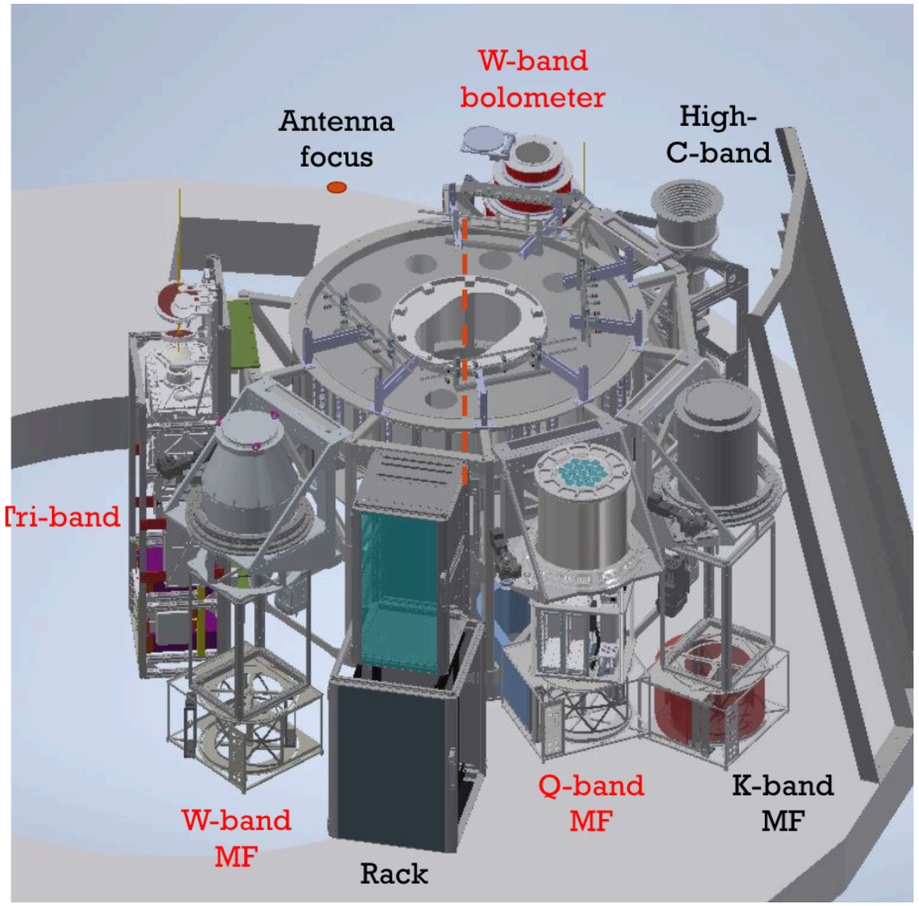
Credits: P. Soletta

New receivers

Receiver	Status	
Q-band	Installed	
Tri-band	Installed	
Bolometer (MISTRAL)	Installed	(now: upgrade cold head)

=> Performance verification started, some limitations; temporary limited bandwidth (700 MHz)

W-band (Caruso)	Not ready (UKRI)



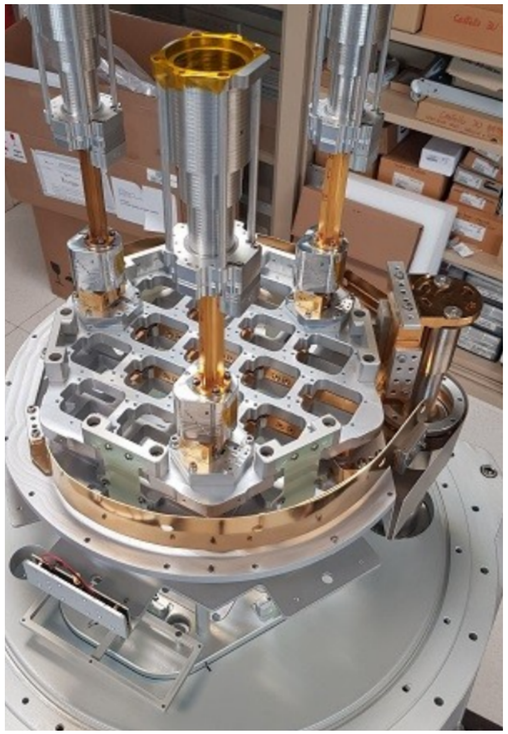
Operations suspended since Sept 2025 for ASI upgrades (PNRR-EMM), until April 2026.

Commissioning of the PON receivers

Q-band:

33-50 GHz

19 feeds



Tri-band:

18-26; 33-50; 80-116 GHz

MISTRAL:

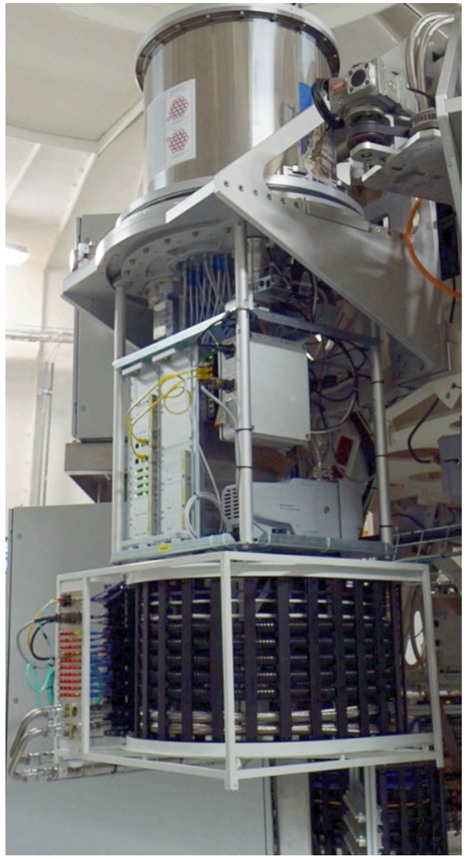
77-103 GHz

Commissioning of the PON receivers

Q-band:

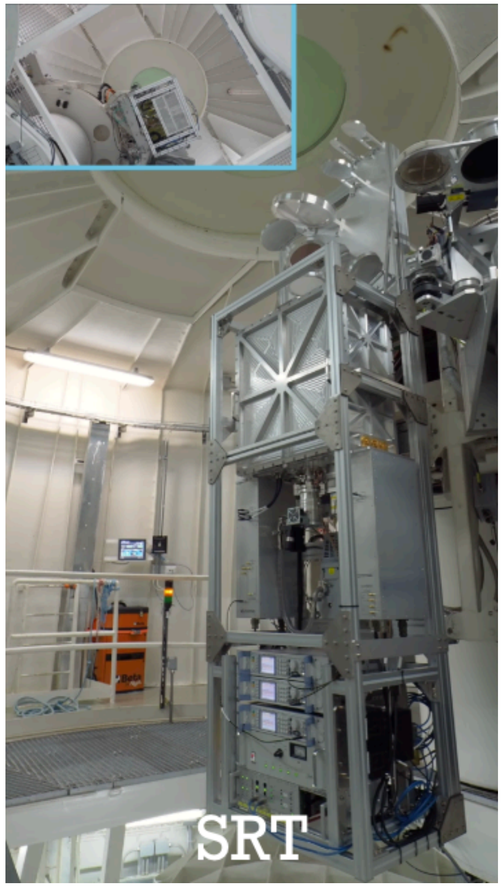
33-50 GHz

19 feeds



Tri-band:

18-26; 33-50; 80-116 GHz



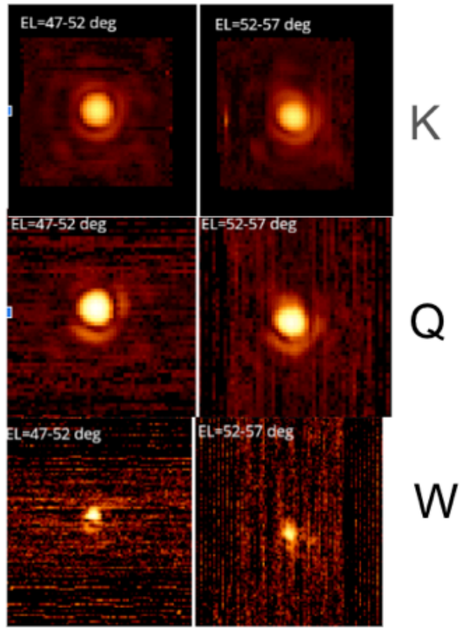
MISTRAL:

77-103 GHz

Commissioning of the PON receivers

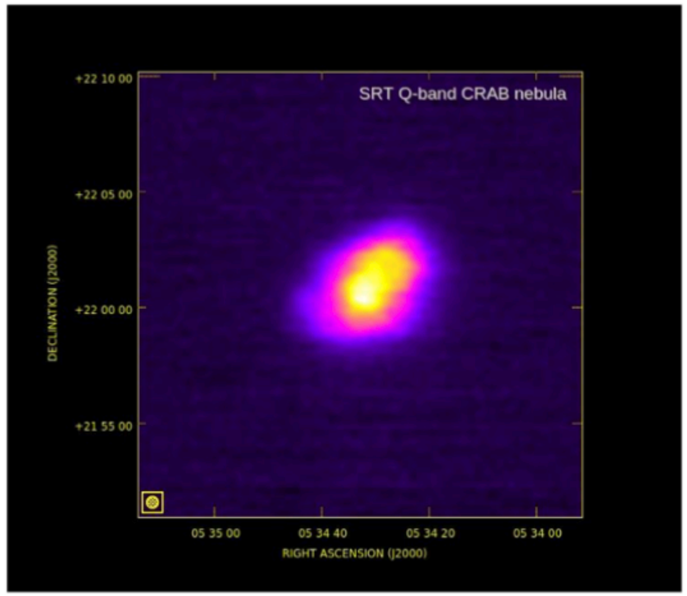
Tri-band

3C84



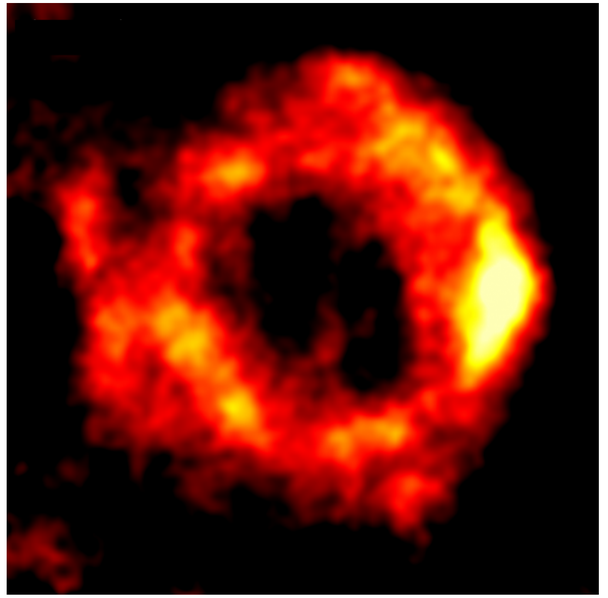
Q-band (Tri-band)

Crab Nebula



MISTRAL

Cas A at 90 GHz



PON commissioning team

Medicina

Credits: Fabio Cappelli

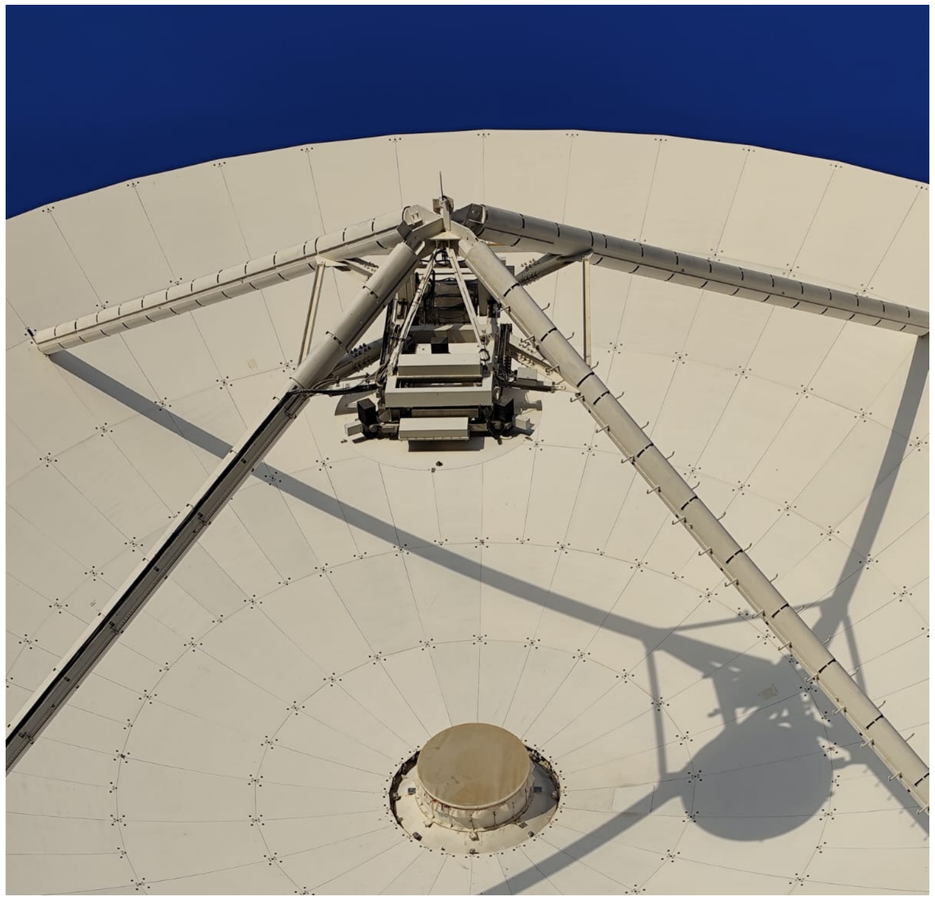
G. Grueff Radio Telescope (32m)

Active surface:

- 240 panels (>50% gain), 268 actuators
- installation: Oct 2024 - May 2025
- now in commissioning

Tri-band receiver: installed, in phase of commissioning

Antenna operative for the observations with the offered receivers.



Northern Cross

=> **Not offered for the call of the INAF radio proposals.**

- North–South arm: operational for space debris (BIRALES) and FRB experiments.

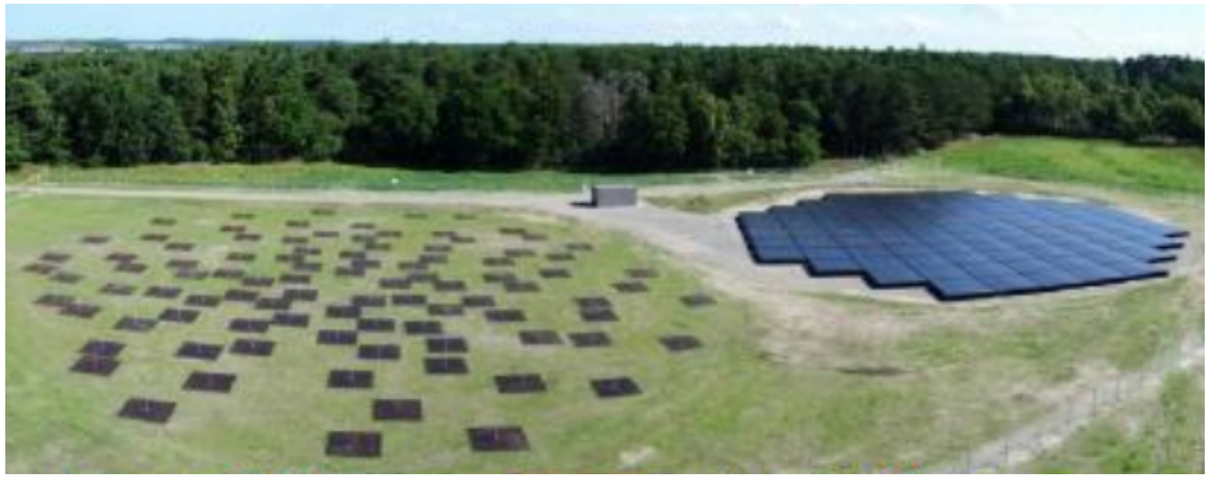
- East–West arm: upgrade ongoing (PNRR NG-Croce); new drive system and wide-field front-ends, completion expected by March 2026.

- Installation of a new data acquisition and processing system for space debris and FRBS, including a dedicated computing center for FRBs.

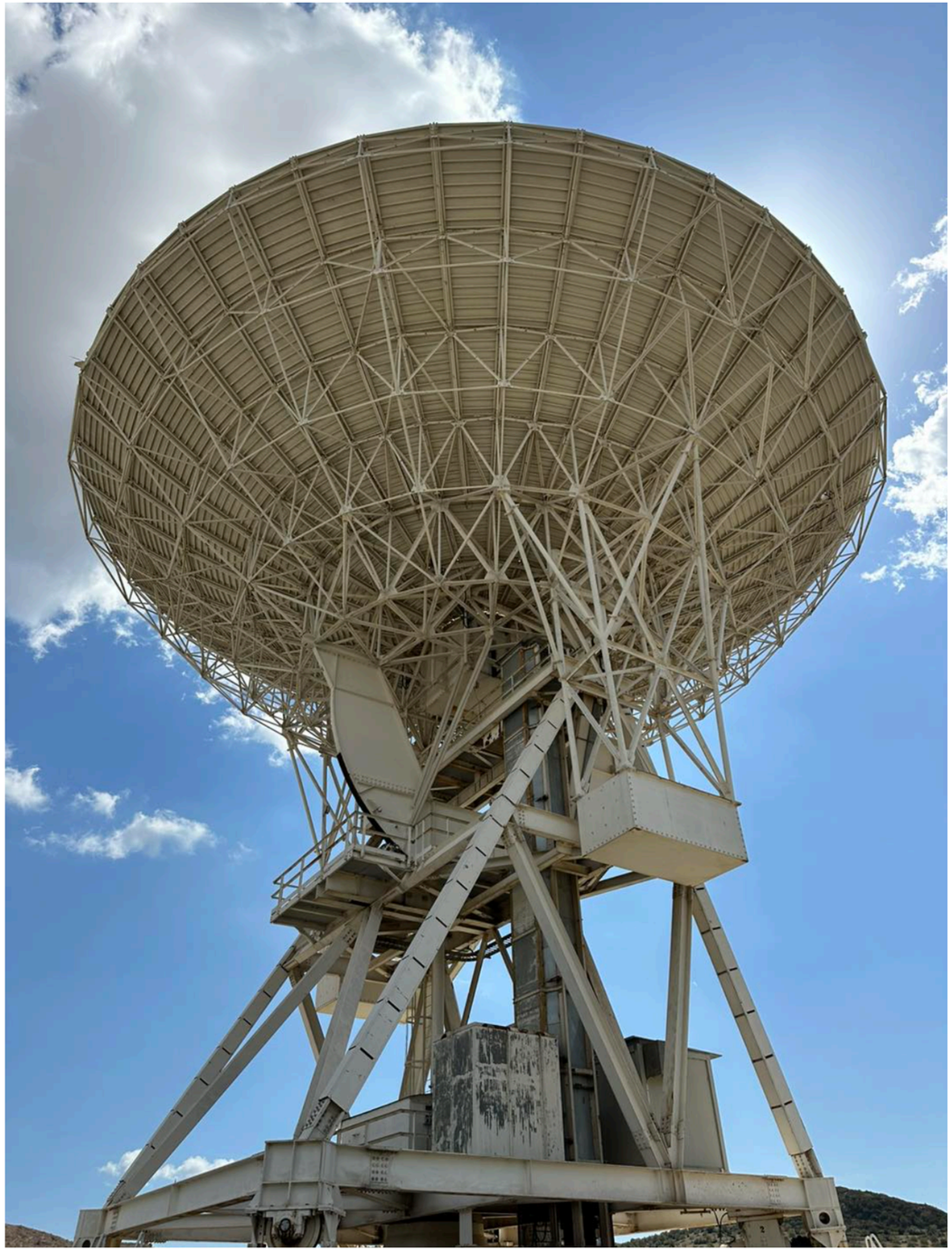
Credits: G. Bianchi

LOFAR

- Installation of a LOFAR 2.0 station, likely at the end of 2026.



Noto



Noto (32m)

Currently offline for upgrade and maintenance

- Primary mirror disassembly, cleaning, repainting, reassembly, plus active surface actuator maintenance

- New secondary mirror

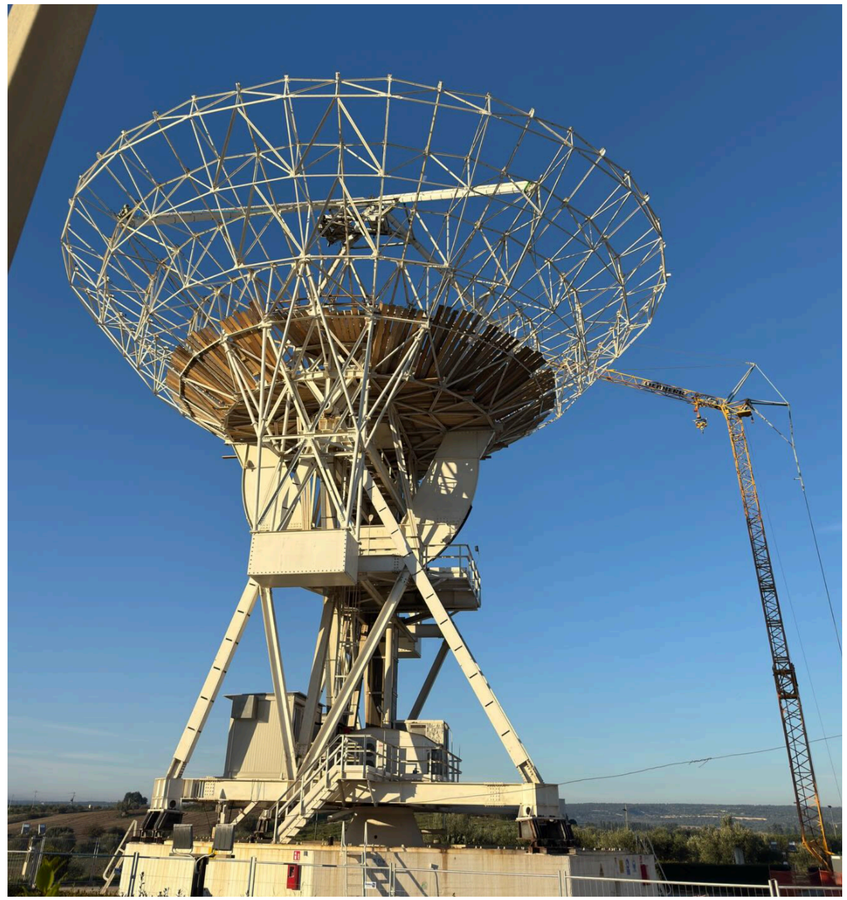
- Rail, rack, and auxiliary systems being refurbished

- Expected completion: **April 2026 → commissioning**

- **Tri-band K–Q–W** (PON) installation planned at end of works

- Data acquisition upgrade: 2 SKARAB (PNRR KM3NeT)

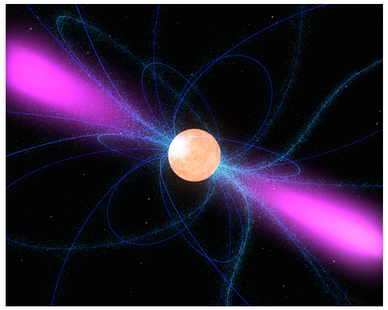
- **Frequency agility**



Involvement of the RSN4 community

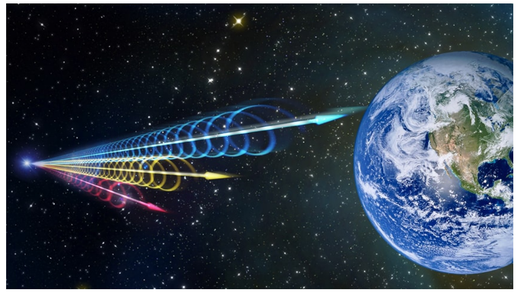
Italian radio telescopes: RSN4 science

Pulsars

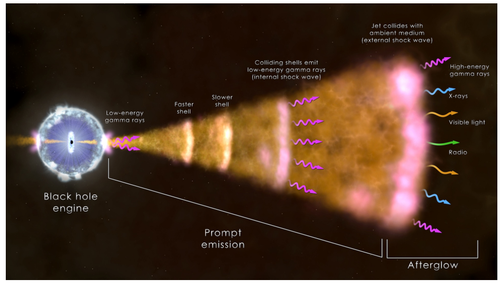


Gravitational waves

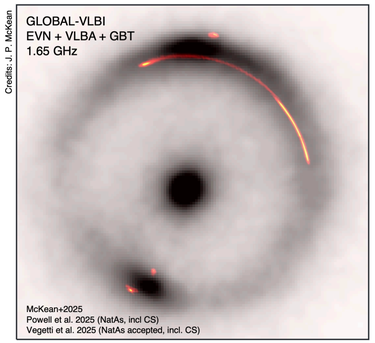
FRBs



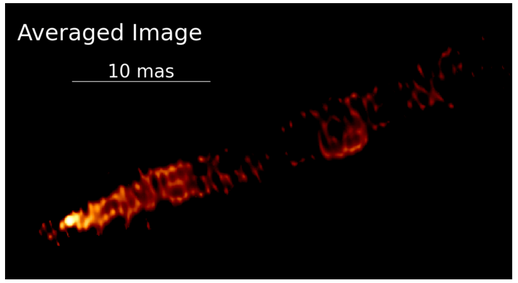
GRB afterglow



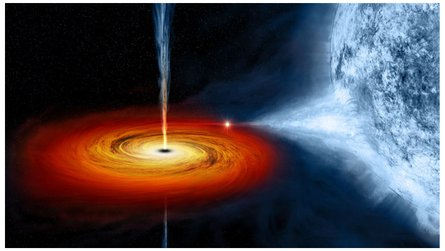
Dark matter



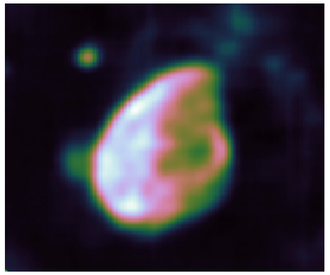
AGNs



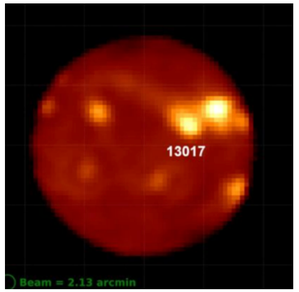
X-ray binaries



SNRs



Sun (RSN3)



Italian radio telescopes: single-dish/VLBI

Pulsars

Esposito +20

Mohan +20

Borghese +21

Miraval Zanon +21

Coti Zelati +21

Gravitational waves

Chen +21

Chalumeau + 22

FRBs

Giroletti +16

Pilia +20

Piro +21

Kirsten +22

Nimmo + 22

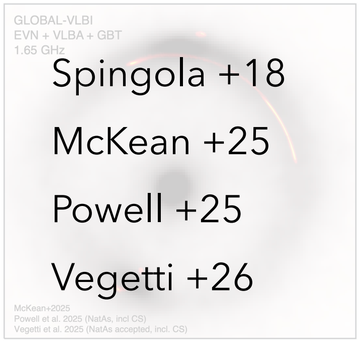
GRB afterglow

An +18

Ghirlanda +19

Marcote +19

Dark matter



Spingola +18

McKean +25

Powell +25

Vegetti +26

AGNs

Nesci +21

Cui +23

Vercellone +24

Marchili +25

X-ray binaries

Egron +17

Egron +21

Cao +22

Ingram + 24

SNRs

Egron +17

Loru +19

Loru +21

Loru +25

Sun

Pellizzoni +22

Marongiu + 24

Mulas +26

Italian radio telescopes: single-dish/VLBI

Pulsars

OACa: Possenti, Burgay, Pilia, Trudu, Corongiu

OA Roma: Israel, Papitto, Ambrosino

IASF Milano: Mereghetti

OA Brera: Coti Zelati, Illanio

Gravitational waves

OACa: Perrodin, Burgay, Possenti

FRBs

OACa: Pilia, Burgay, Trudu, Possenti, Corongiu

IRA: Bianchi, Giroletti, Bernardi, Pelliciari

GRB afterglow

OA Brera: Ghirlanda, Salafia

IRA: Giroletti, Giarratana

OACa: Marongiu, Bachetti

Dark matter

IRA: Spingola, Giroletti

AGNs

IRA: Giroletti, Marchili, D'Ammando, Orienti, Giovannini

OA Brera: Vercellone

OA Roma: Verecchia

OACa: Egron, Pellizzoni

X-ray binaries

OACa: Egron, Pellizzoni, Pilia

IRA: Giroletti

IASF Milano: Sidoli

IAPS: Soffitta, Muleri, Tavani

SNRs

OACa: Pellizzoni, Egron, Mulas, Marongiu

OACt: Loru, Ingallinera, Umana, Trigilio

Sun

OACa: Pellizzoni, Marongiu, Mulas, Egron

Tri-band receiver: SRT/Medicina/Noto

4 bands: K (18-26 GHz), Q (34-50 GHz), W-low (80-98 GHz) and W-high (98-116 GHz)

mm-VLBI: high angular resolution: advantage for compact sources and their localization

Frequency	Resolution (VLBI)
22 GHz	~2 mas
43 GHz	~1 mas
86 GHz	~0.5 mas

} Italian VLBI

Observations are more challenging as the wavelengths gets shorter (atmosphere)

Tri-band receiver: SRT/Medicina/Noto

4 bands: K (18-26 GHz), Q (34-50 GHz), W-low (80-98 GHz) and W-high (98-116 GHz)

mm-VLBI: high angular resolution: advantage for compact sources and their localization

Frequency	Resolution (VLBI)
22 GHz	~0.3–0.5 mas
43 GHz	~0.15–0.25 mas
86 GHz	~30–50 μas

} B ≈ 10 000–11 000 km

Observations are more challenging as the wavelengths gets shorter (atmosphere)

Tri-band receiver: SRT/Medicina/Noto

- mm-VLBI: high angular resolution => compact sources and their localization

=> AGN: vicinity of super-massive black holes (core, base of the jets)

=> Microquasars: structure (knots/blobs), geometry and kinematics of the jets (opening angle)

=> Dark matter and Hubble tension (extended gravitational arcs; DARKER FIS project PI Spingola)

=> Localization GRB afterglows

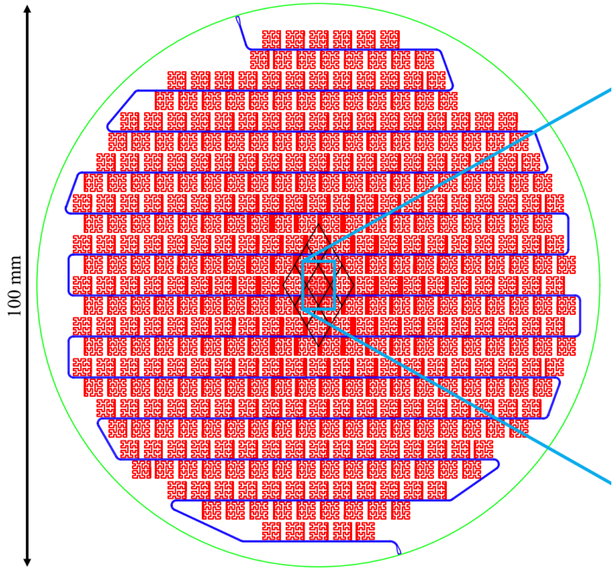
=> Transient sources

=> Follow-up of variable targets - Kilometer Cube Neutrino Telescope (PNRR KM3NeT PI Trigilio)

- mm-single-dish: simultaneous observations at different frequencies

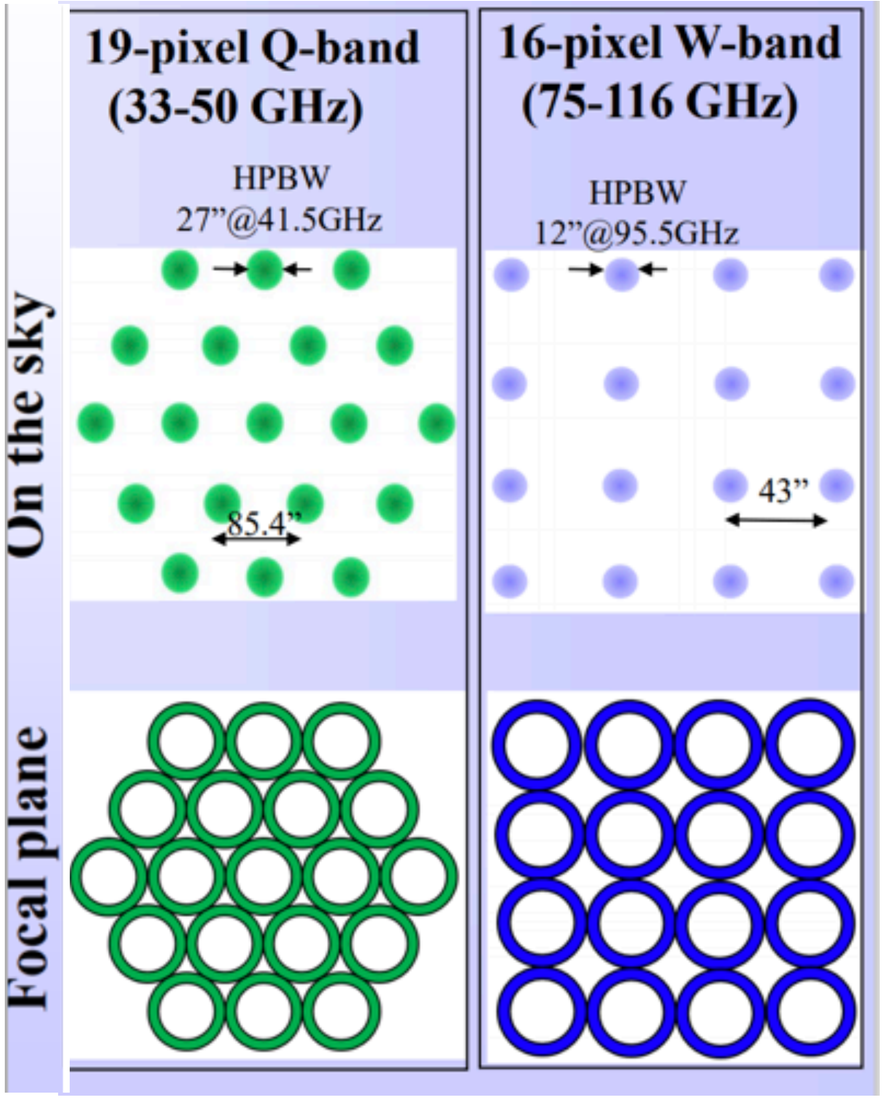
Q and W-band receivers

- **Fast mapping for extended sources**
- **Angular resolution**: 27″ (41 GHz) and 12″ (90 GHz)
- **Wide FoV** for MISTRAL: 4′
- **Targets**: SNRs, dark matter (galaxy clusters), Sun, …



MISTRAL

Kid array: 408 pixels



$$\sigma \propto \frac{T_{\mathrm{sys}}}{\sqrt{n_{\mathrm{pol}} \cdot \Delta\nu \cdot t_{\mathrm{int}}}}$$

Estimated Sensitivity

	Q-band	Caruso	Tri-band			MISTRAL
Frequency (GHz)	33 - 50	70 - 116	18 - 26	34 - 50	80 - 116	77 - 103
Beams x Pol.	19 x 2	16 x 2	1 x 2			408 pixels
Beam size (arcmin)	0.57	0.22	1	0.57	0.22	0.2
Tsys (K)	50 - 120	80	70 - 80	83 - 141	166 - 252	
* Sensitivity (mJy)	1 - 2.6	3	2	2.4 - 5.2	7.4 - 22	5 - 15

* Sensitivity (mJy) / BW=2 GHz, t=1sec, 2 channels

$$\sigma \propto \frac{T_{\mathrm{sys}}}{\sqrt{n_{\mathrm{pol}} \cdot \Delta\nu \cdot t_{\mathrm{int}}}}$$

Estimated Sensitivity

	Q-band	Caruso	Tri-band			MISTRAL
Frequency (GHz)	33 - 50	70 - 116	18 - 26	34 - 50	80 - 116	77 - 103
Beams x Pol.	19 x 2	16 x 2	1 x 2			408 pixels
Beam size (arcmin)	0.57	0.22	1	0.57	0.22	0.2
Tsys (K)	50 - 120	80	70 - 80	83 - 141	166 - 252	
* Sensitivity (mJy)	0.2 - 0.6	0.8	2	2.4 - 5.2	7.4 - 22	0.3

* Sensitivity (mJy) / BW=2 GHz, t=1sec, all channels

INAF radio antenna proposals

Observing with the Italian radio telescopes

Welcome to the Italian radio telescopes users' page
Here you can access all of the resources needed to achieve successful single-dish and extra-EVN interferometric observations

Contact us

Regular call is closed. Next deadline will be in April 2026.
Proposals for ToOs and DDT can be submitted anytime.
The offered instrumentation is listed here.

https://www.radiotelescopes.inaf.it/

Conclusions – INAF radio telescopes & RSN4

- **Major upgrades** opening new opportunities at **high radio frequencies (mm).**

- **Ongoing work**: commissioning, pointing refinement, metrology, dynamic scheduling (atmosphere)

- Strong contribution to **international radio astronomy**. Soon, our antennas could be part of the **GMVA (Global Millimeter VLBI array).**

- Versatile instruments: single-dish & VLBI, **important role for the RSN4,** supporting a wide variety of science cases.

- **Synergy with other facilities:** multi-wavelength and multi-messenger observations.

- **Do not hesitate to observe with our INAF antennas!**

Stay tuned!

On-going receiver development

SRT	Frequency Range (GHz)	T_sys (K)	HPBW (arcmin)	State
L-P band	0.310 - 0.410	50	47	
	1.3 - 1.8	35	11	
S-band	3 - 4.5			
C-band PAF	3 - 7.7			
Q-band	33 - 50	50 - 120	0.57	
Tri-band	18 - 26	80 - 110	1	
	34 - 50	83 - 141	0.57	
	80 - 116	166 - 252	0.22	
CARUSO	80 - 116	80	0.22	
MISTRAL	77 - 103			

Temporary unavailable | In commissioning phase | Under construction

Korea Astronomy and Space Science Institute

INAF ISTITUTO NAZIONALE DI ASTROFISICA NATIONAL INSTITUTE FOR ASTROPHYSICS

SENSITIVITY (EXPECTED)

SRT	K-band			Q-band			W-band		
Frequency (GHz)	**18**	**22**	**26**	**34**	**42**	**50**	**80**	**98**	**116**
(Total) Aperture efficiency (%)	69,8%	68,2%	69,1%	64,6%	63,4%	61,9%	53,7%	47,0%	39,7%
Antenna gain from (total) aperture efficiency (k /Jy)	0,81	0,80	0,81	0,75	0,74	0,72	0,63	0,55	0,46
Antenna gain with insertion loss and opacity (k /Jy)	0,55	0,52	0,54	0,51	0,50	0,43	0,35	0,31	0,18
Sky temperature (k)	25,4	35,6	25,4	25,4	25,4	66,5	66,5	66,5	147,7
Receiver noise temperature (k)	50,0	30,0	45,0	58,0	50,0	75,0	100,0	80,0	105,0
System noise temperature (k)	75,4	65,6	70,4	83,4	75,4	141,5	166,5	146,5	252,7
SEFD (Jy)	**137,2**	**125,8**	**129,4**	**162,5**	**149,6**	**330,6**	**469,8**	**472,0**	**1381,4**
Sensitivity (mJy) / BW=2 GHz, τ=1 sec, 2 channels	**2,2**	**2,0**	**2,0**	**2,6**	**2,4**	**5,2**	**7,4**	**7,5**	**21,8**

MED	K-band			Q-band			W-band		
Frequency (GHz)	**18**	**22**	**26**	**34**	**42**	**50**	**80**	**98**	**116**
(Total) Aperture efficiency (%)	67,2%	65,8%	65,9%	64,3%	63,1%	61,5%	52,6%	46,3%	39,3%
Antenna gain from (total) aperture efficiency (k /Jy)	0,20	0,19	0,19	0,19	0,18	0,18	0,15	0,13	0,11
Antenna gain with insertion loss and opacity (k /Jy)	0,14	0,13	0,13	0,13	0,12	0,11	0,09	0,07	0,04
Sky temperature (k)	18,4	35,6	22,0	25,4	25,4	66,5	66,5	93,4	154,4
Receiver noise temperature (k)	50,0	30,0	40,0	55,0	52,0	70,0	82,0	80,0	105,0
System noise temperature (k)	68,4	65,6	62,0	80,4	77,4	136,5	148,5	173,4	259,4
SEFD (Jy)	**506,9**	**521,7**	**472,5**	**635,6**	**623,8**	**1283,2**	**1710,6**	**2508,7**	**5957,4**
Sensitivity (mJy) / BW=2 GHz, τ=1 sec, 2 channels	**8,0**	**8,2**	**7,5**	**10,0**	**9,9**	**20,3**	**27,0**	**39,7**	**94,2**

INAF radio antenna proposals

Regular call for proposals twice a year (May and Oct)

- Single-dish proposals (continuum, full-stokes, timing, spectroscopy)
- VLBI proposals based on the Italian antennas
- EATING VLBI (East Asia to Italy Nearly Global VLBI): 22 GHz

DDT and ToO proposals can be submitted at any time

EATING VLBI

- International collaboration between **Korea, Japan, Cina and Italia** to study compact sources with VLBI observations at 22 GHz.

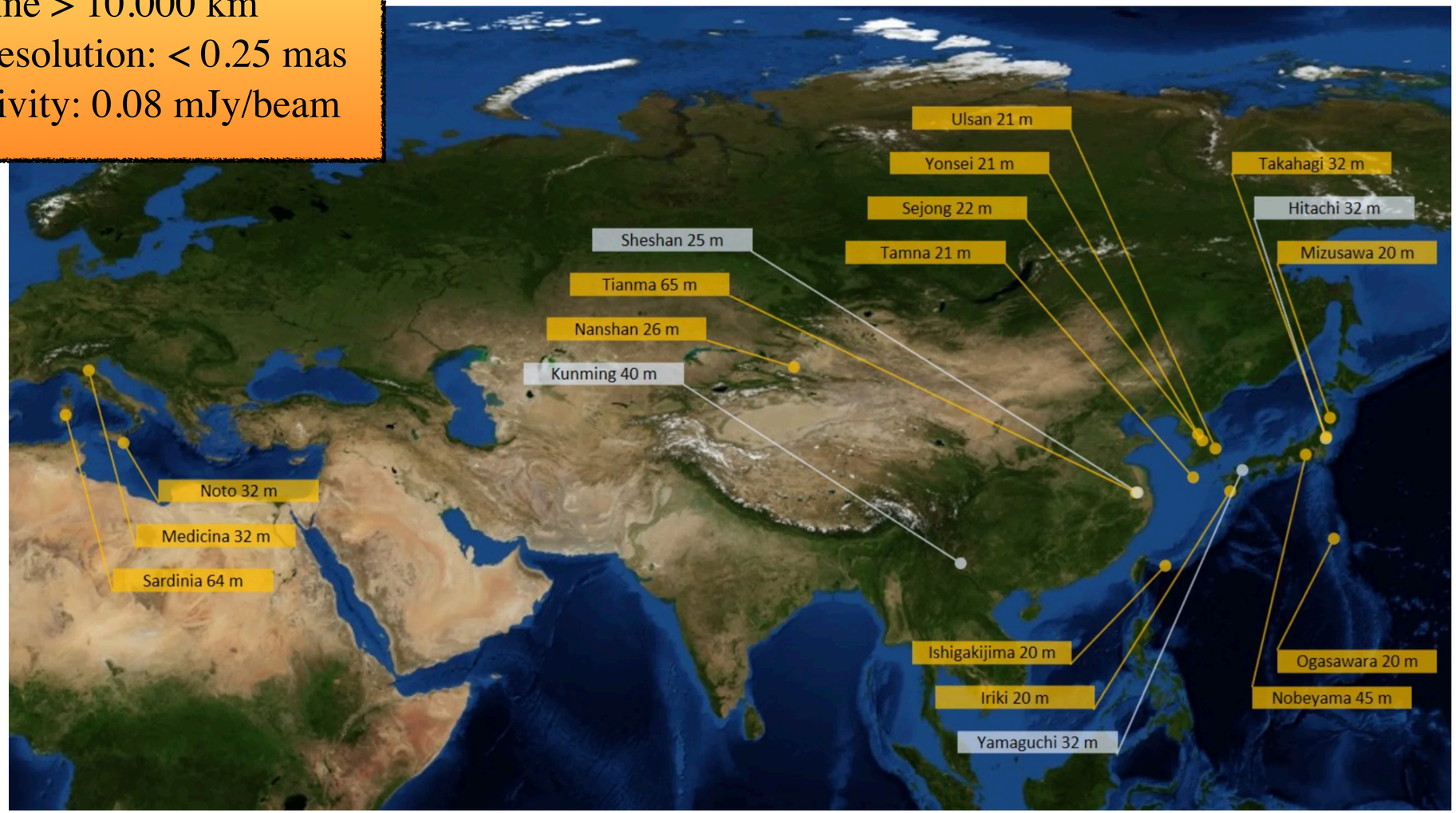
- Proposals submitted to each TAC .

- Approved projects: up to 30 hrs/semester.

- The last EATING VLBI meeting was in Oct 2025, in Bologna (tri-band receiver).

EATING VLBI

Frequency: 22 GHz
Baseline > 10.000 km
Angular resolution: < 0.25 mas
Image sentivity: 0.08 mJy/beam



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