What can VLBI do for your research? The EVN and JIVE

By

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Joint Institute for VLBI ERIC (JIVE)

EAVN @ PyonengChang (Korea), 4-7 September 2018

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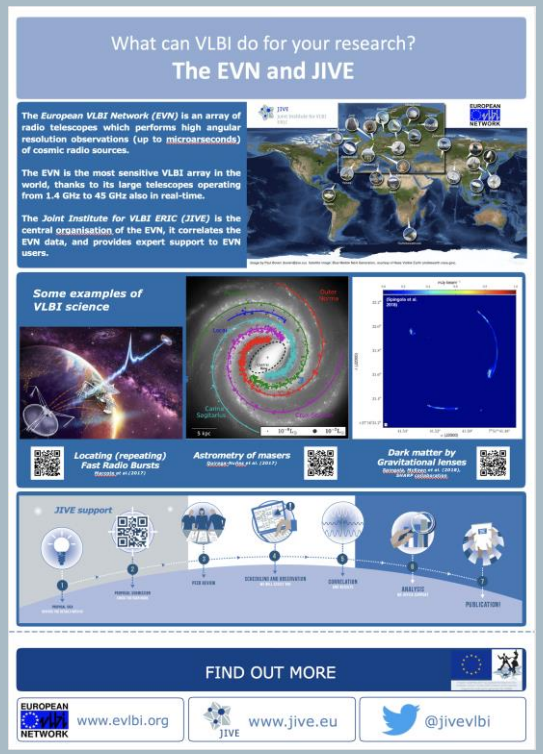
- The European VLBI Network (EVN)
- The Joint Institute for VLBI ERIC (JIVE)
- (A few) recent VLBI results
- Globalization of VLBI

See also poster:



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European VLBI Network (EVN)

- The EVN is a network of radio telescopes located primarily in Europe and Asia, with additional antennas in South Africa and Puerto Rico, which performs high angular resolution observations of cosmic radio sources.
- It is **the most sensitive VLBI array in the world**, thanks to the collection of extremely large telescopes that contribute to the network, operating from 1.4 GHz to 45 GHz (some up to 90 GHz), also in **real-time** (*e*EVN).
- The **Joint Institute for VLBI ERIC (JIVE)** correlates the EVN data and **provides expert support to EVN users**.

http://www.evlbi.org/

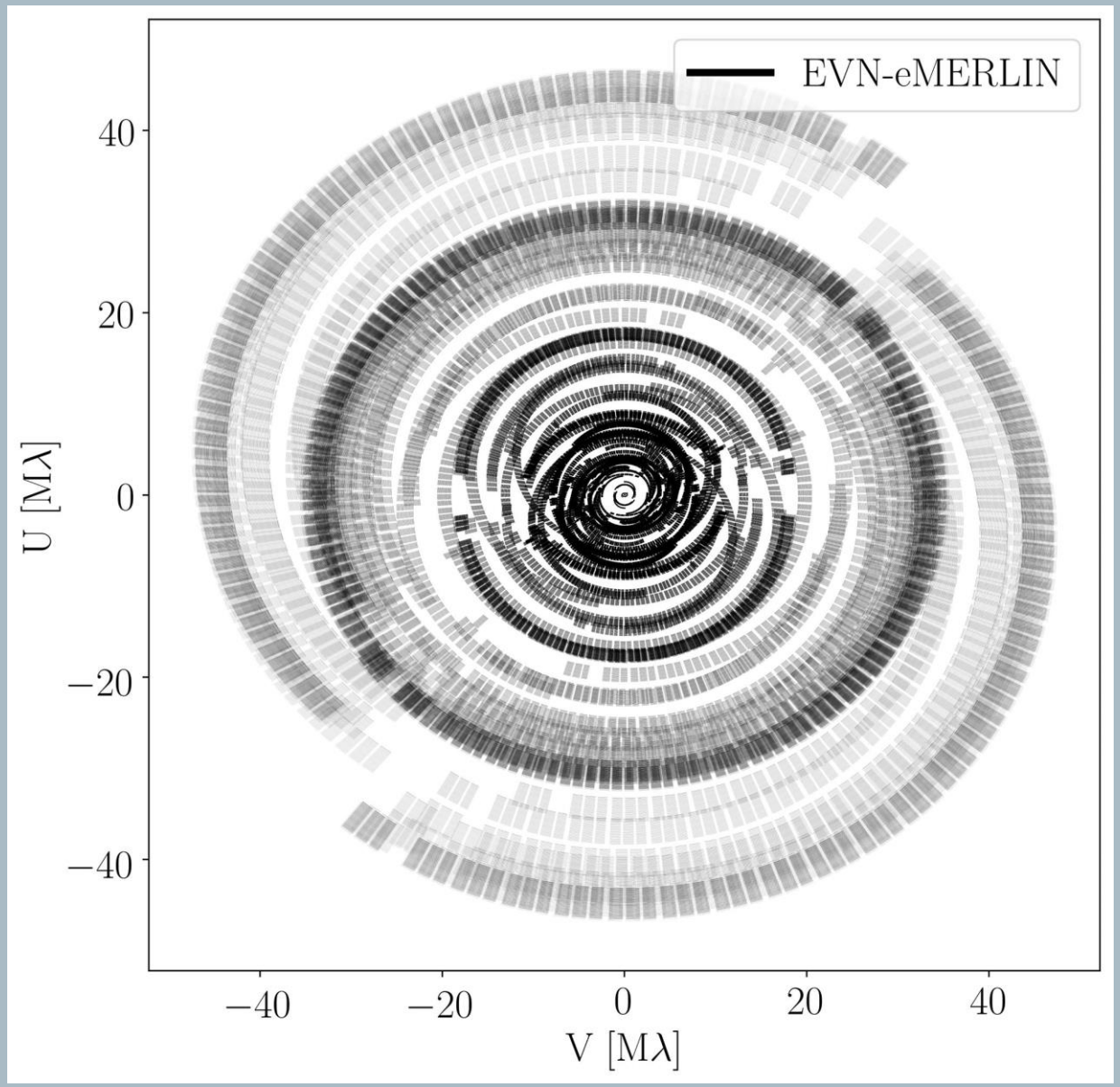
JIVE

JIVE
Joint Institute for VLBI ERIC

EUROPEAN vlbi NETWORK

www.jive.eu / www.evlbi.org

EVN+MERLIN



Joint Institute for VLBI ERIC (JIVE)

An **European Research Infrastructure Consortium (ERIC)**

- 6 partner countries: NL (host), FR, ES, UK, SE, LV
- 4 associated institutions: INAF (IT), NRF (SA), MPIfR (DE), NAOC (Cn)

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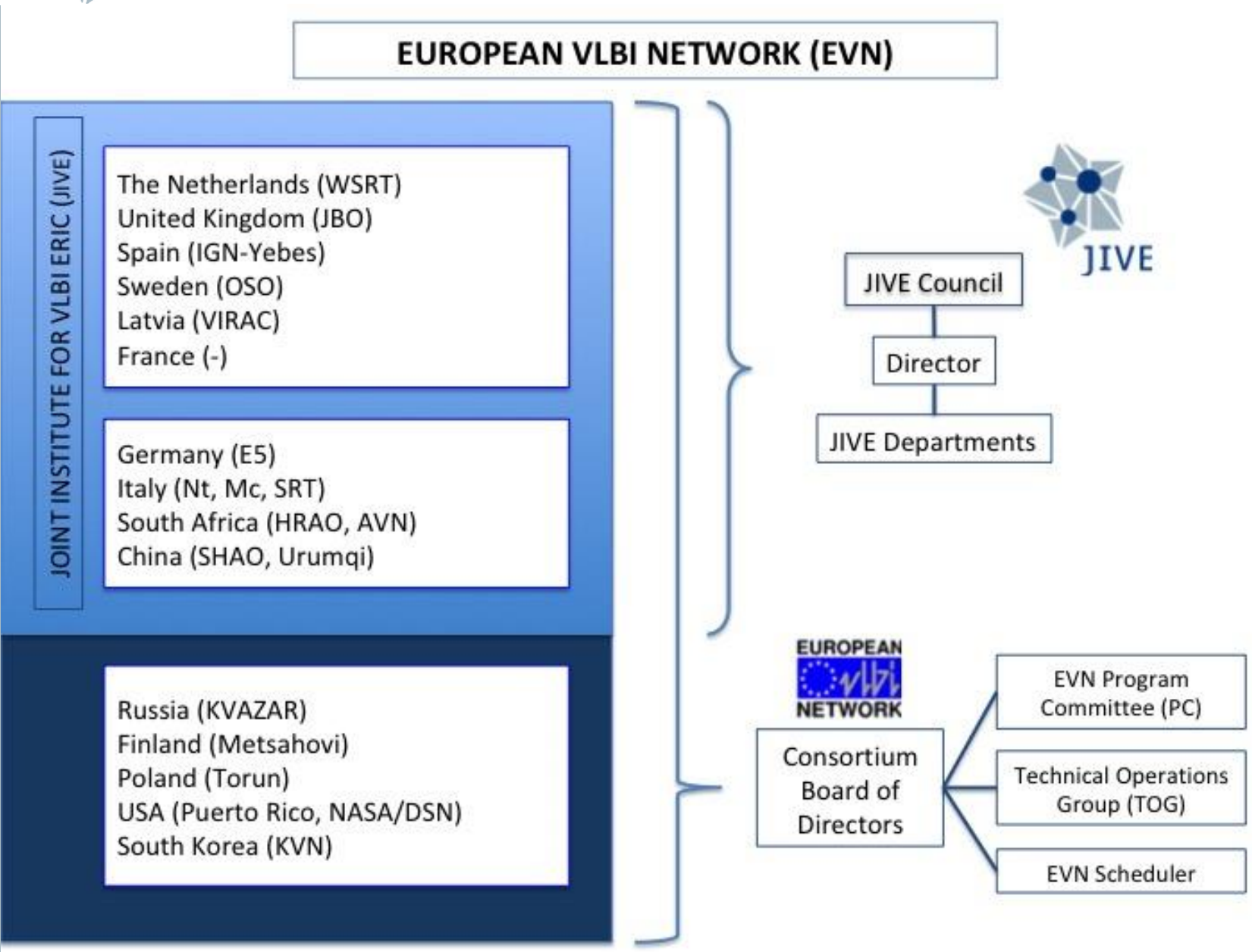
JIVE and EVN



JIVE

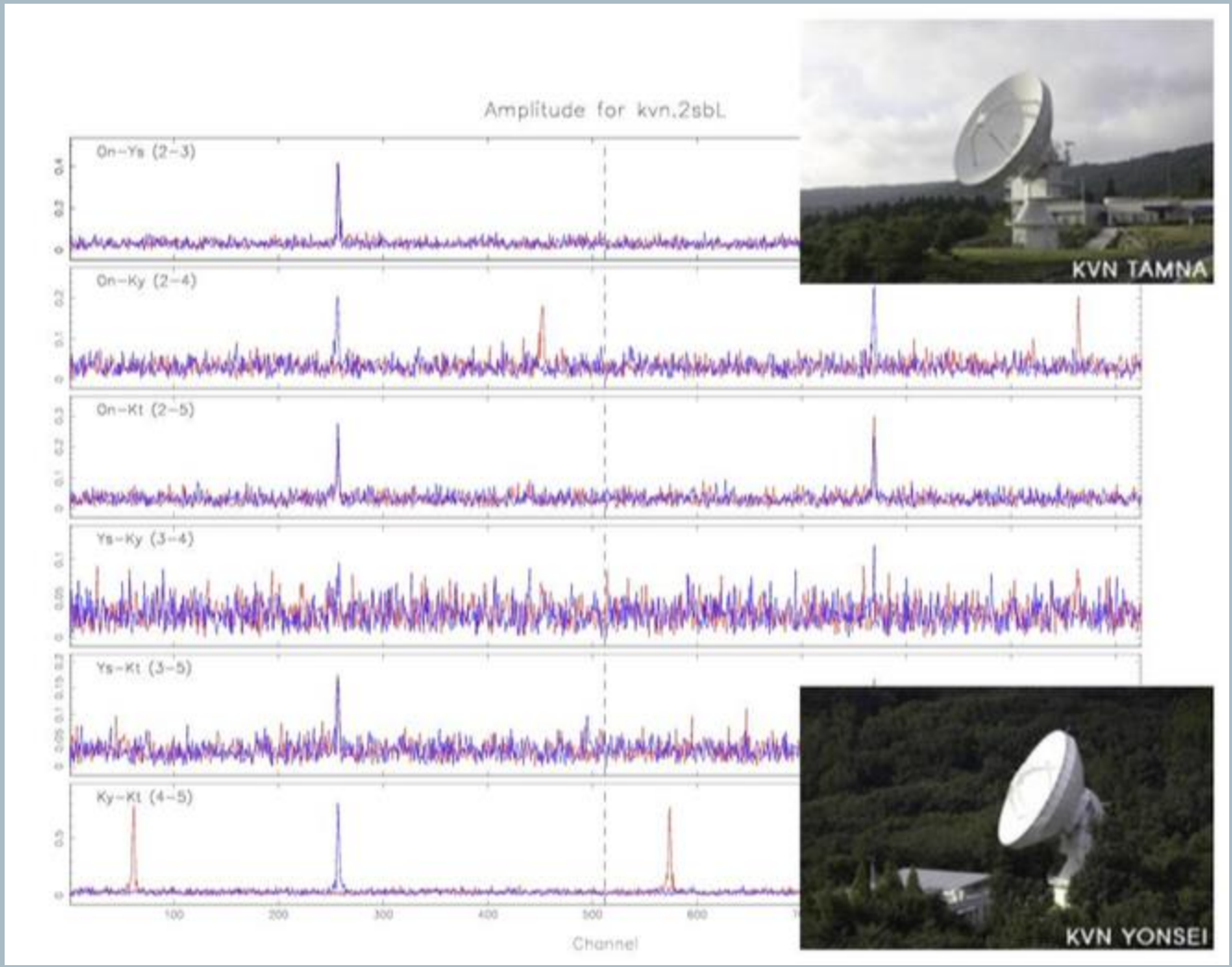
Joint Institute for VLBI ERIC (JIVE)

- **Supports the European VLBI Network**
  - Radio astronomy at its highest angular resolution
  - operations
  - correlation
  - data acquisition
- **Research & development**
  - Software (CASA 5.3)
  - hardware
  - e-VLBI
- **Science support**
- **Training**

JIVE headquarters in Dwingeloo, the Netherlands.

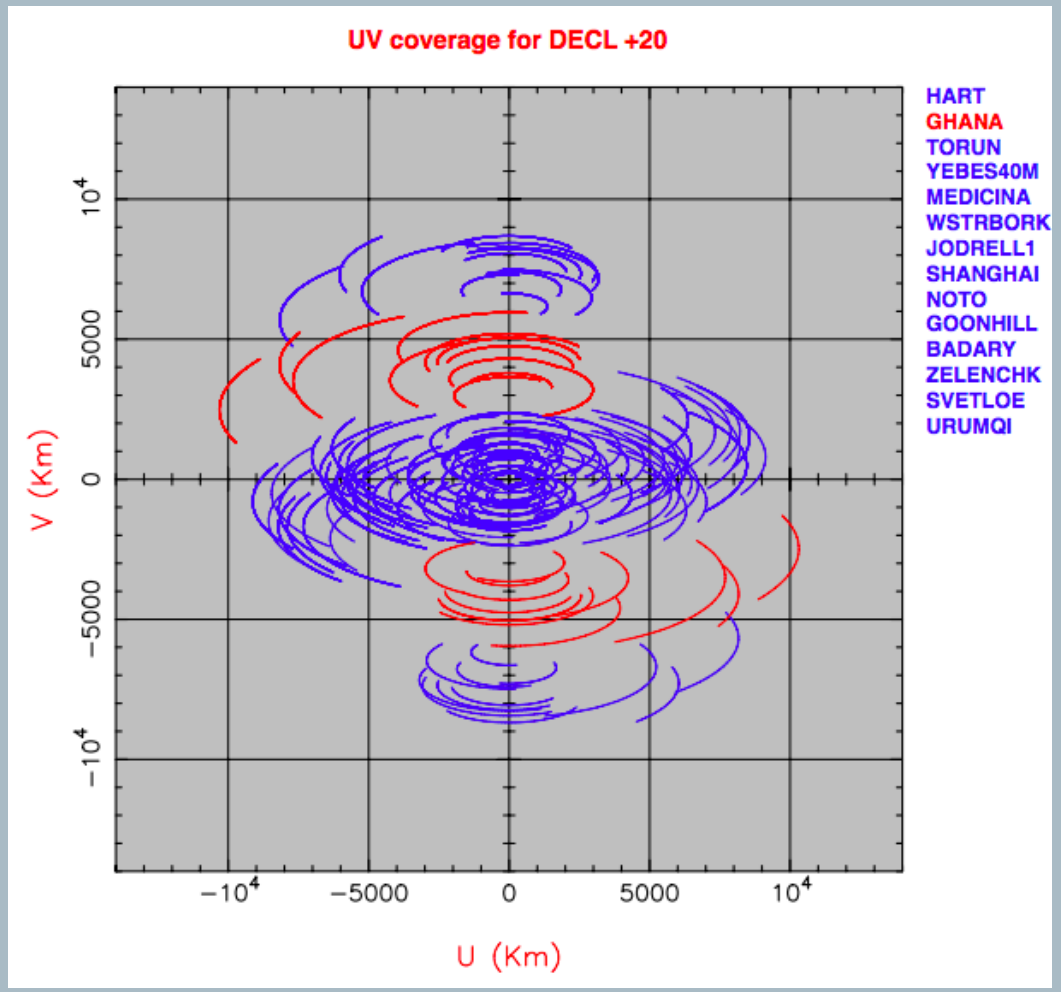
http://www.jive.eu/

EVN/JIVE collaboration with KVN



First e-VLBI fringes between EVN antennas (Onsala and Yebes) and two stations of the Korean VLBI Network at 22 GHz.

New VLBI station in Kutunse (Ghana)



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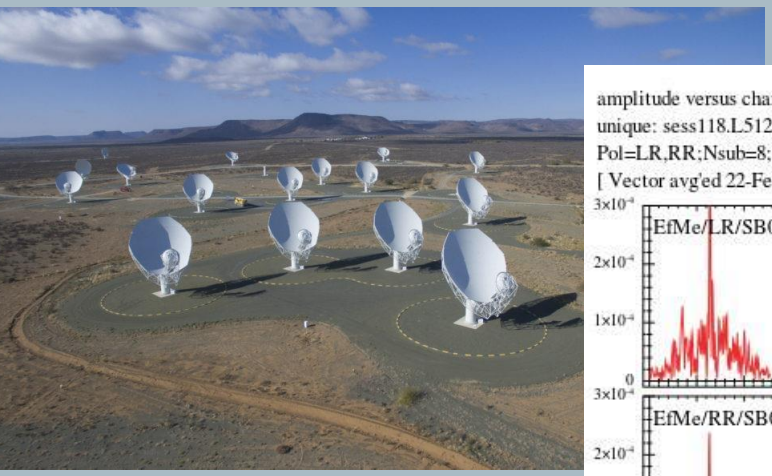
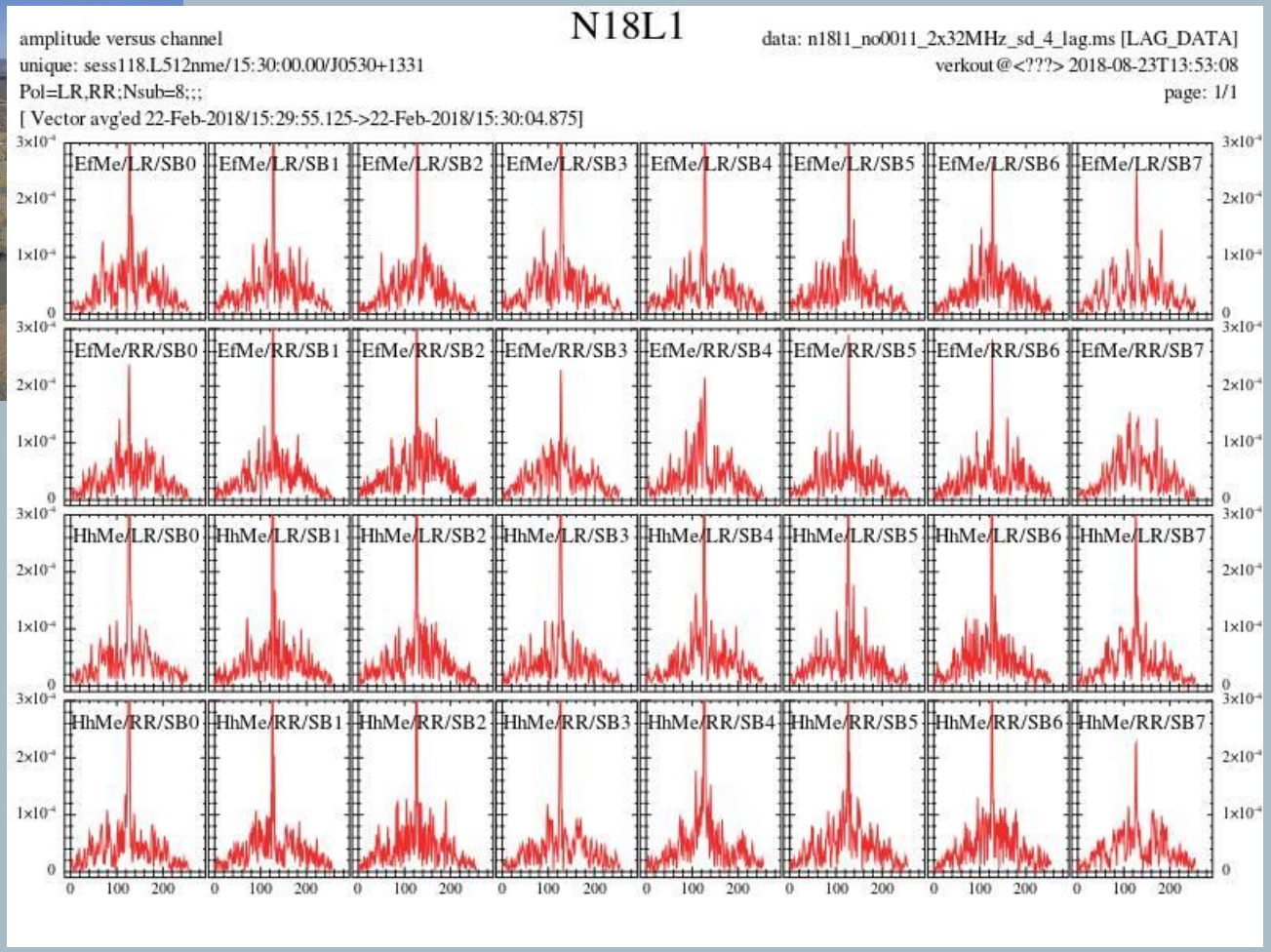
First VLBI fringes with MeerKAT !





http://www.astron.nl/dailyimage/index.html?main.php?date=20180828

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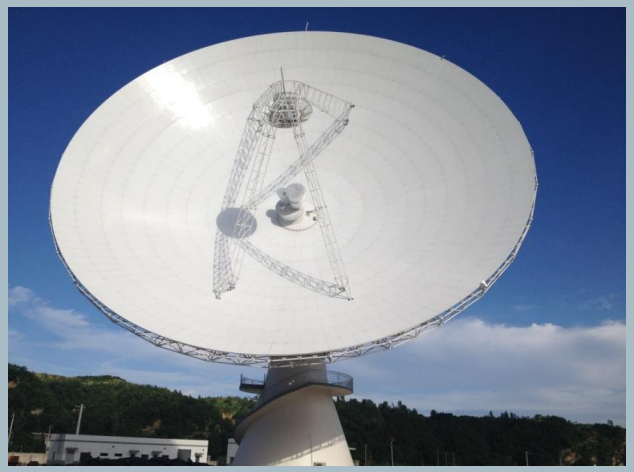
New potential EVN partners



Haopin, 40 m, China

Zolochiv, 32 m, Ukraine

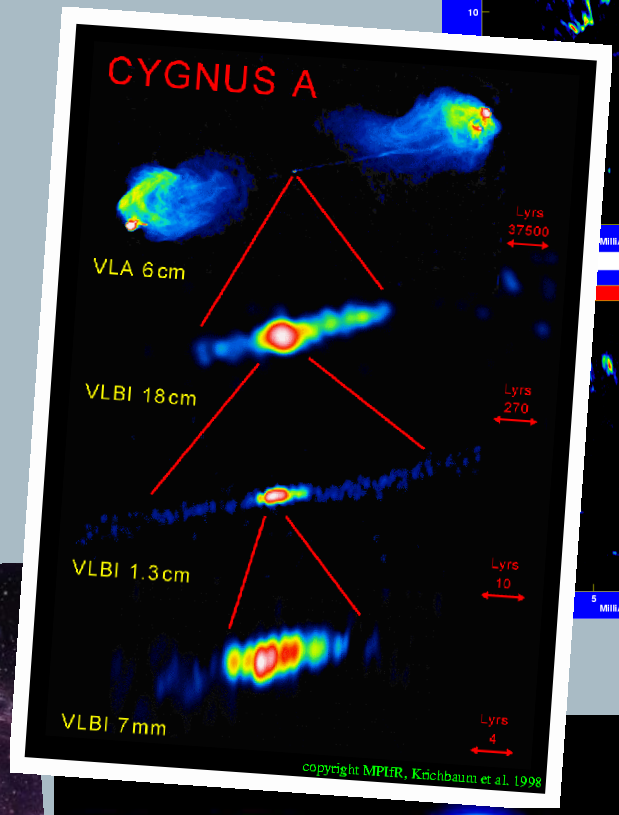
Azores, 32 m, Portugal

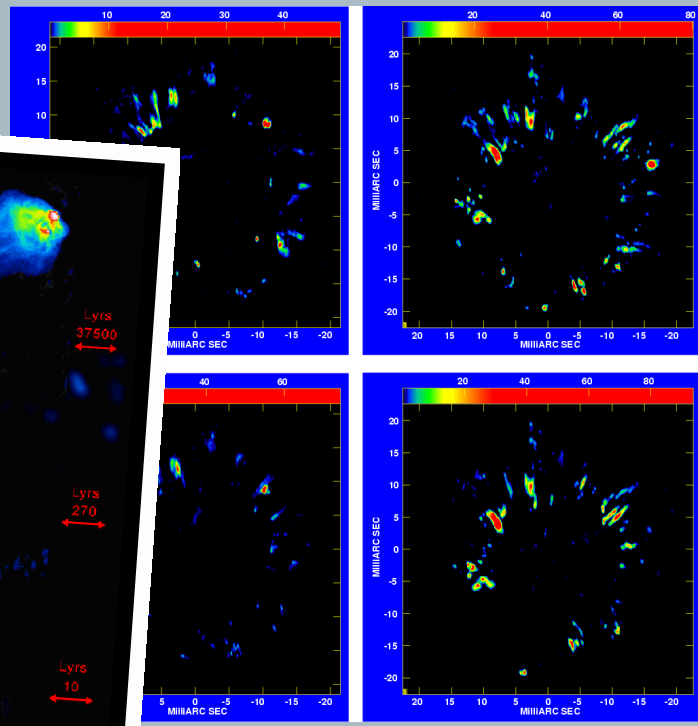
Usuda, 64 m, Japan

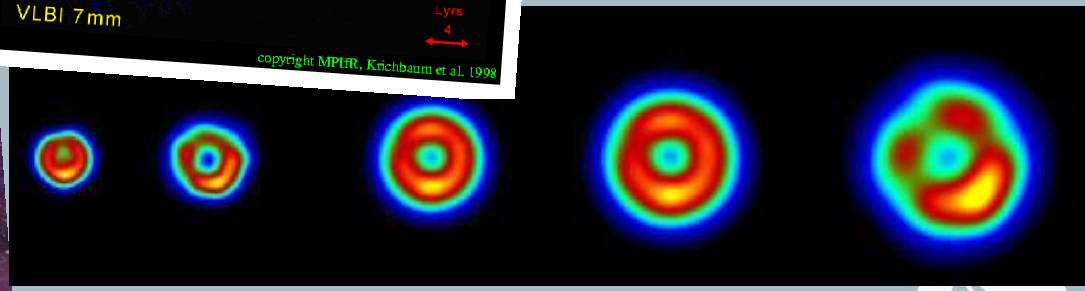
Aragats,50 m, Armenia

VLBI science highlights

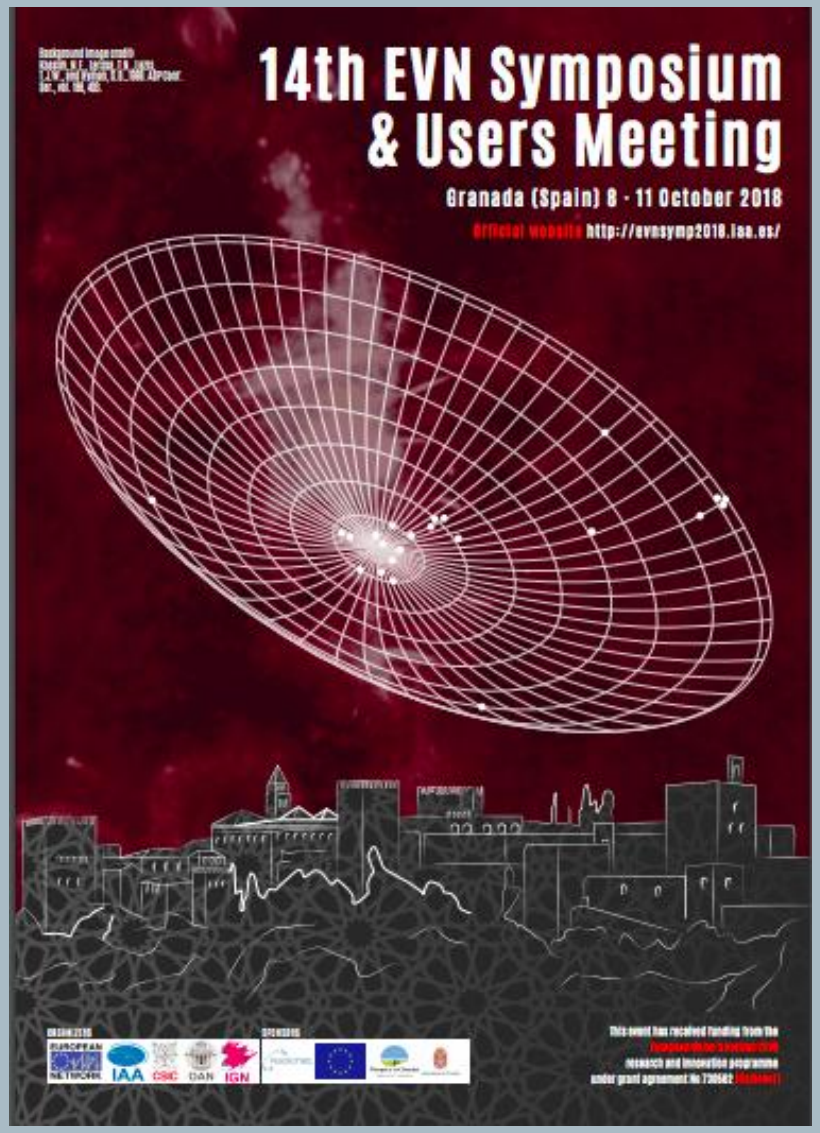
- AGN, galaxies
- Star formation
- Evolved stars
- The transient Universe
- Astrometry
- Reference frames …







EVN Symposium 2018



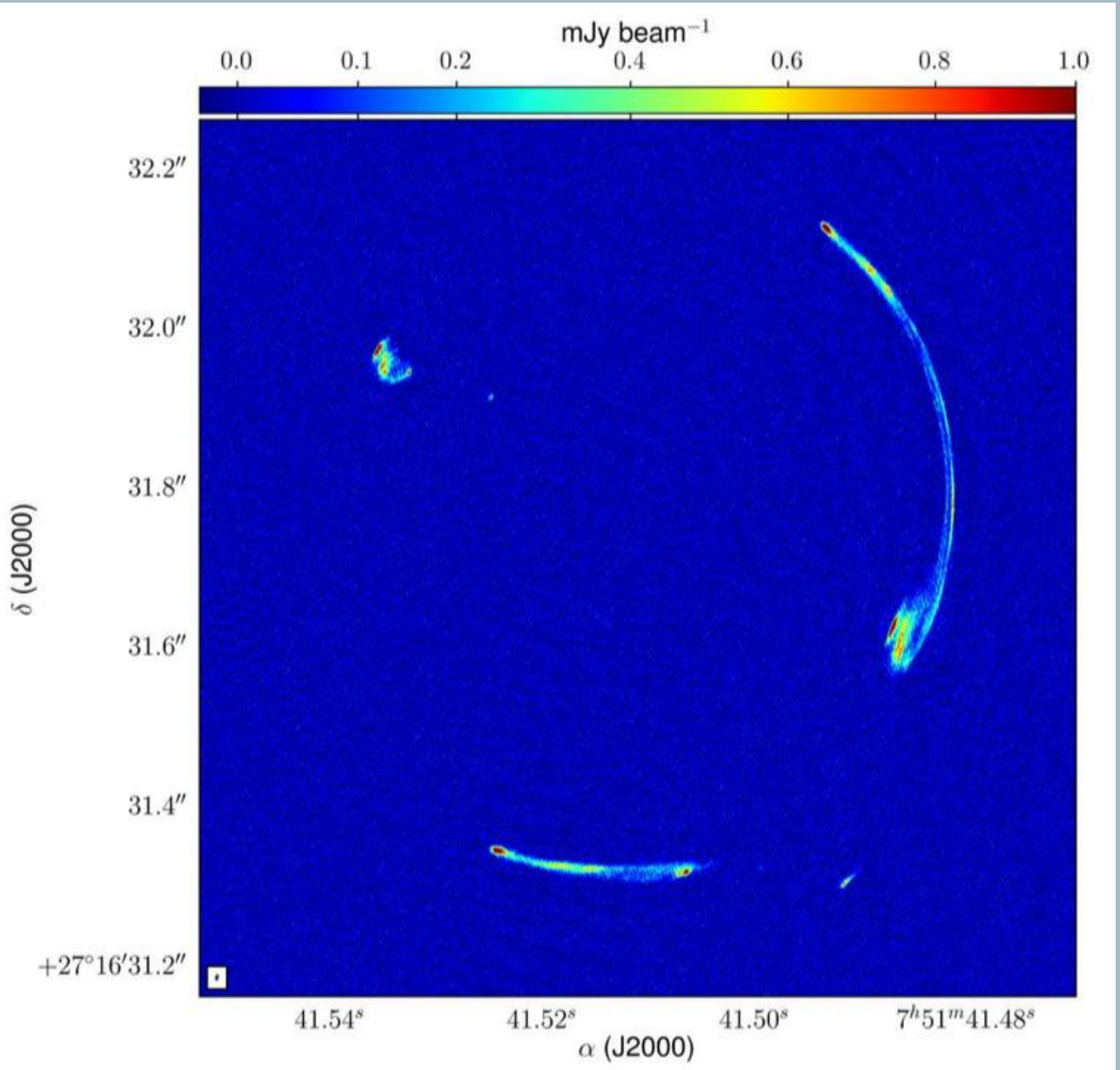
In Granada (Spain),

October 8-11 2018

http://evnsymp2018.iaa.es/

JIVE

Gravitational lenses and dark matter



"SHARP – V. Modelling gravitationally-lensed radio arcs imaged with global VLBI observations".

C. Spingola et al.

Monthly Notices of the Royal Astronomical Society, Volume 478, Issue 4, 21 August 2018, Pages 4816–4829, https://doi.org/10.1093/mnras/sty1326

JIVE PR:

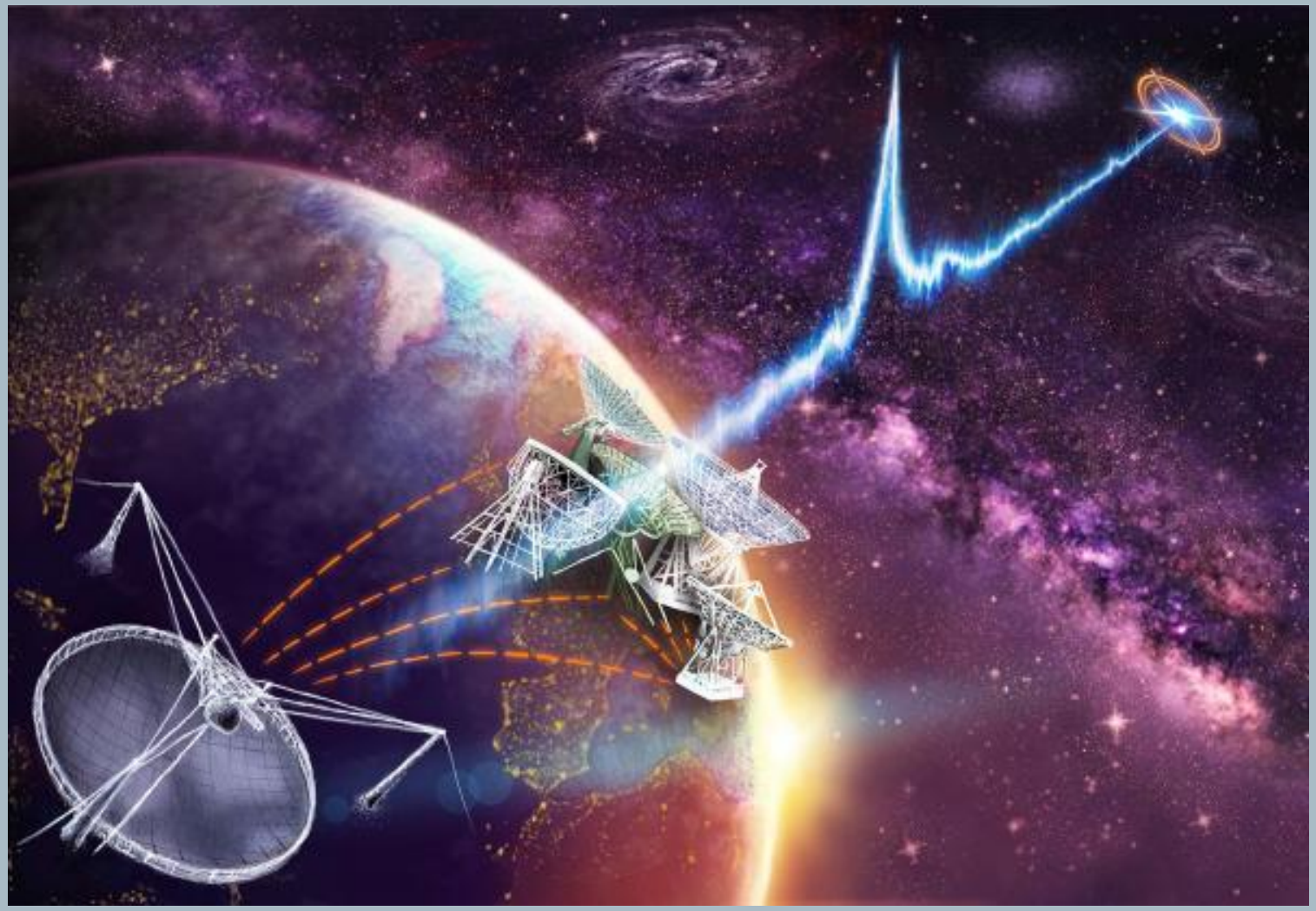
http://www.jive.eu/new-images-super-telescope-bring-astronomers-step-closer-understanding-dark-matter

JIVE

Locating mysterious Fast Radio Bursts

EVN enables the identification of the host galaxy.

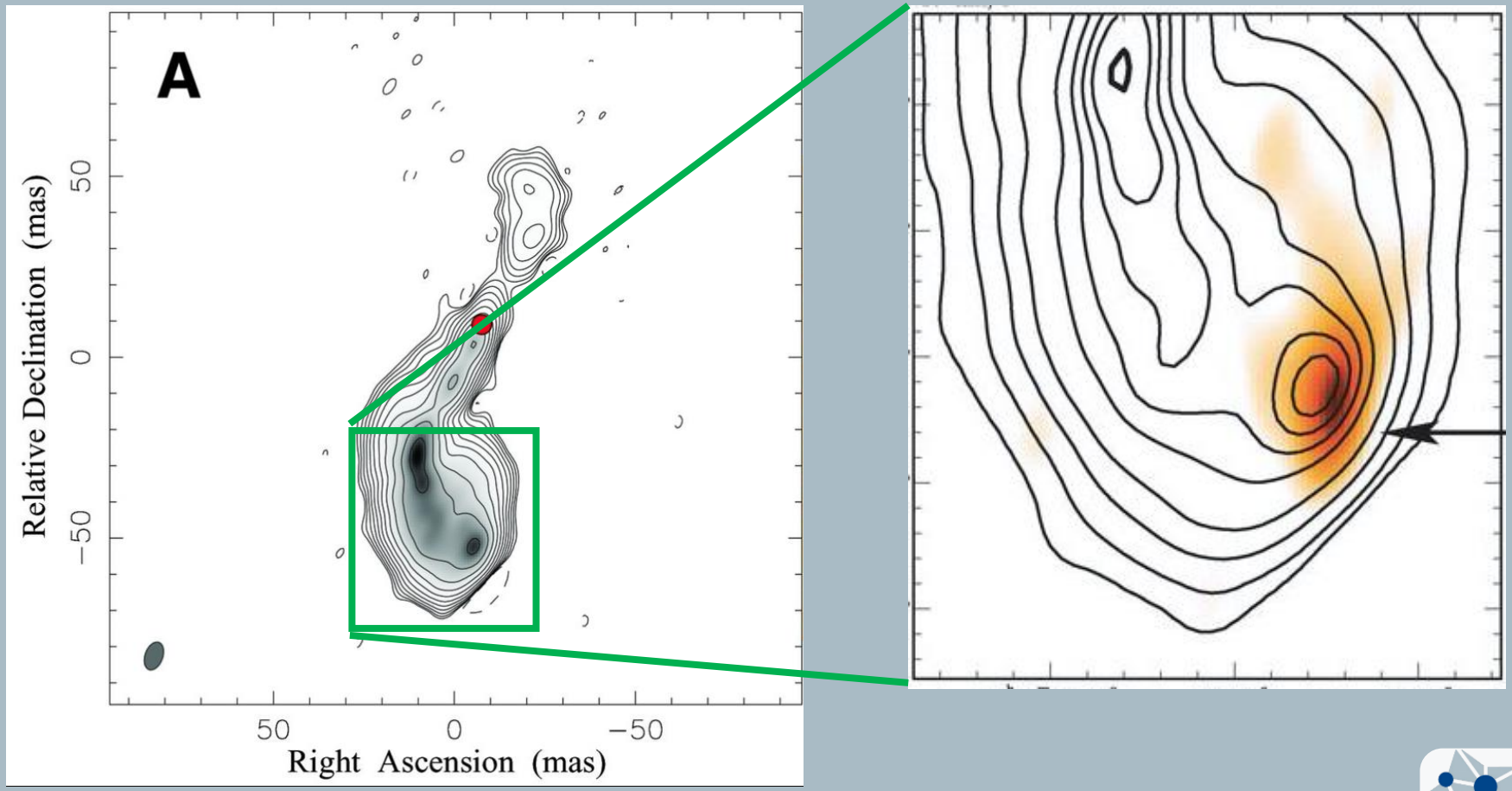
http://jive.eu/astronomers-pinpoint-radio-flashes-long-long-ago-galaxy-far-far-away



Feeding monsters

Material ejected from (or falling into) black holes.

http://science.sciencemag.org/content/341/6150/1082



Tidal Disruption Event (TDE)

A supernova explosion was actually a star being pulled apart by a supermassive black hole: the powerful gravity of SMBH rips apart a star that has wandered too close.

Mattila, S., Pérez-Torres, M., et al. 2018. A dust enshrouded tidal disruption event with a resolved radio jet in a galaxy merger. Science. DOI: 10.1126/science.aao4669

http://www.jive.eu/surprise-discovery-provides-new-insights-stellar-deaths

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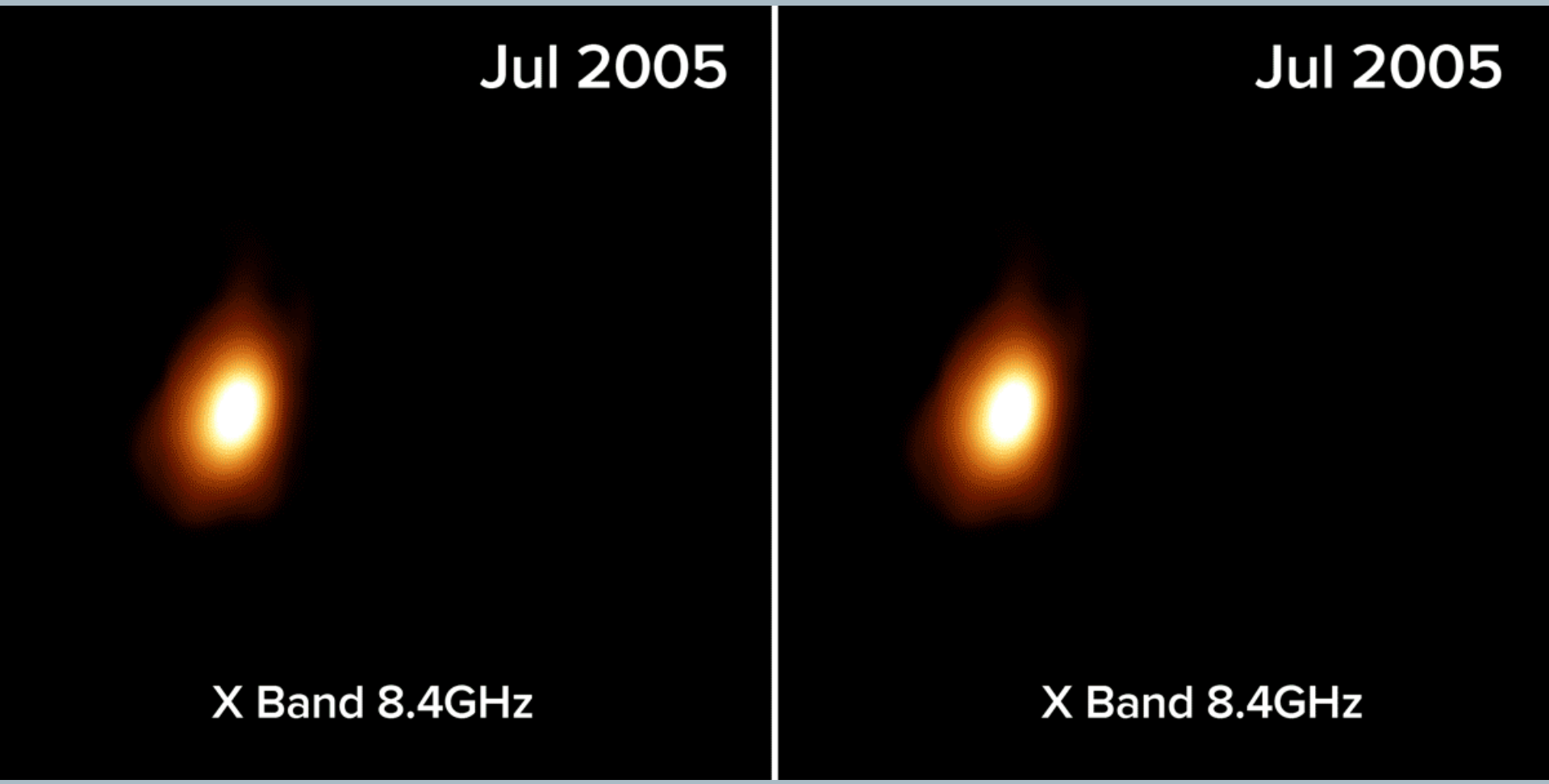
Tidal Disruption Event (TDE)



http://www.jive.eu/surprise-discovery-provides-new-insights-stellar-deaths

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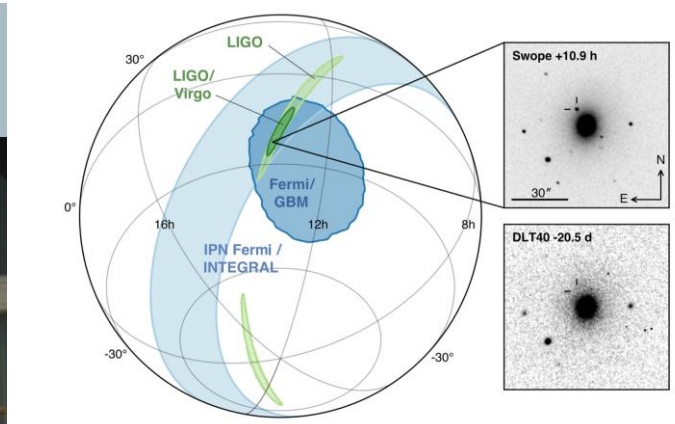
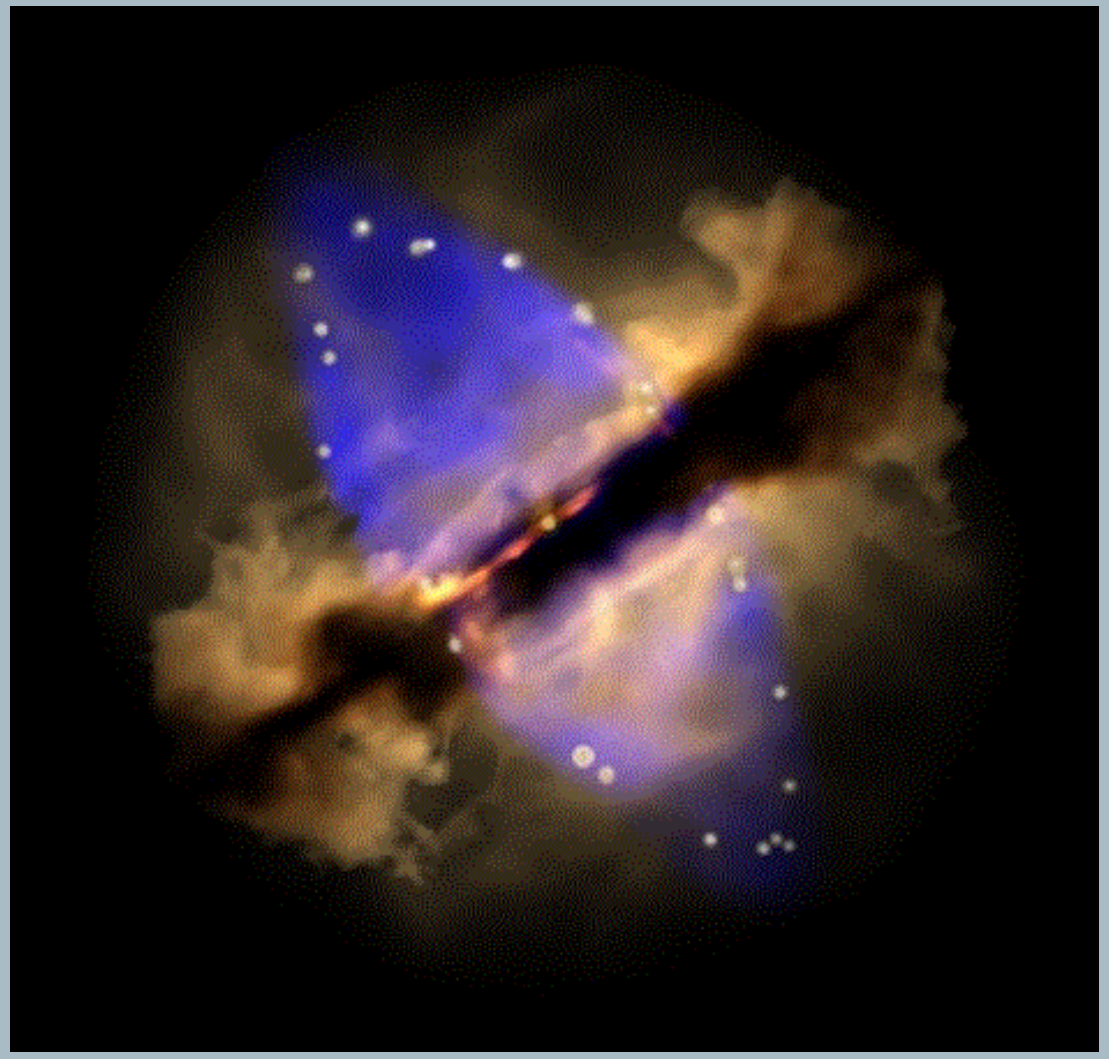
First EVN observation of a Gravitational Wave counterpart



Birth of massive stars

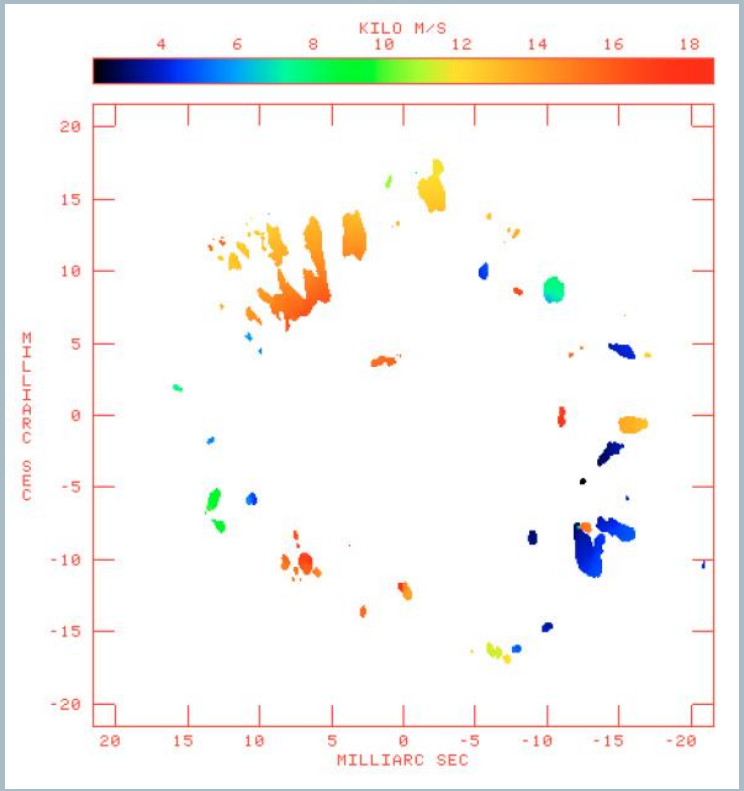
EVN can trace gas motions around birth place.

http://jive.eu/w75n-outflow-onset

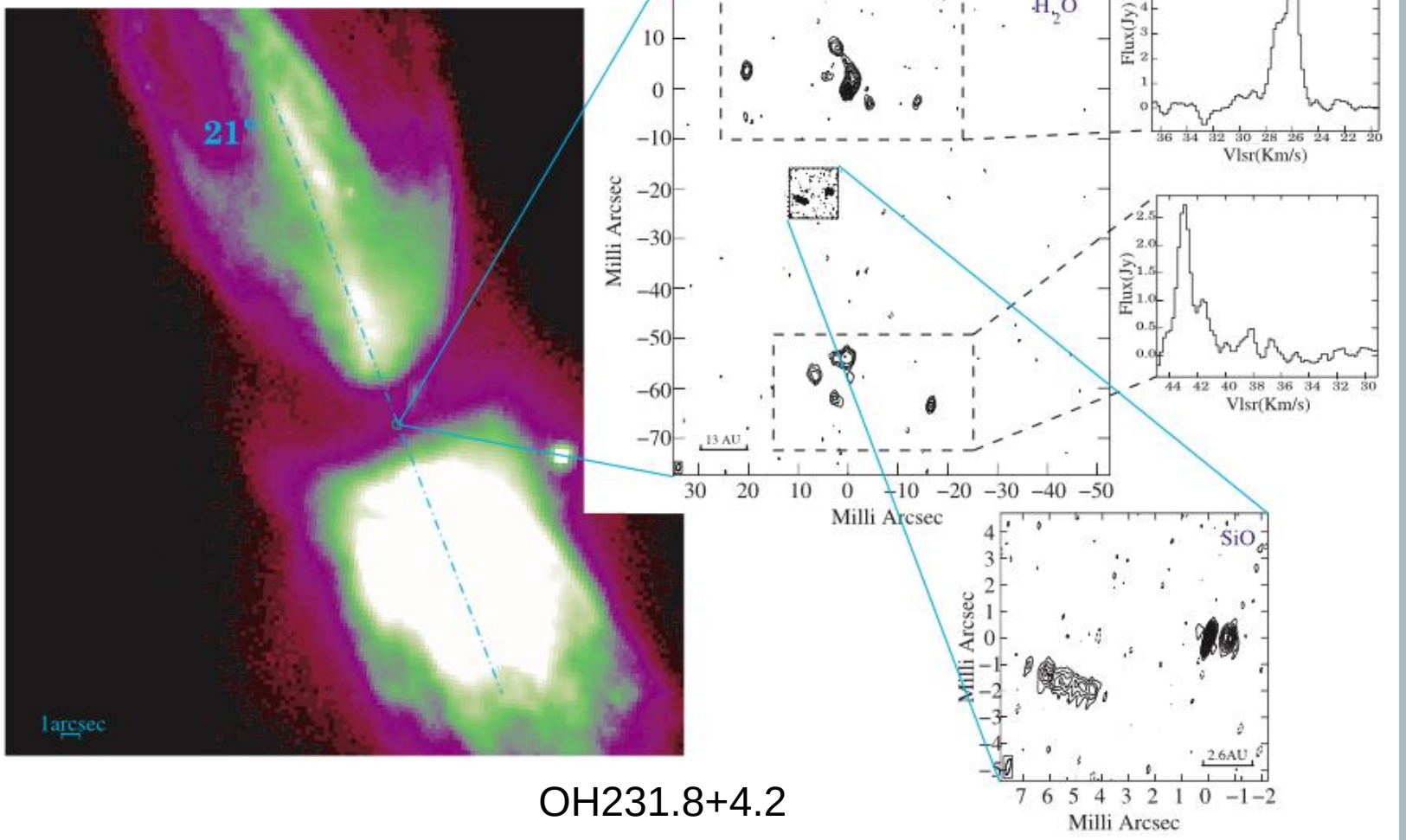


Envelopes of evolved stars

VLBI displays the star CSE evolution in real time.



How does axial asymmetry appears?



OH231.8+4.2

Desmurs et al. (2007), A&A 468, 189

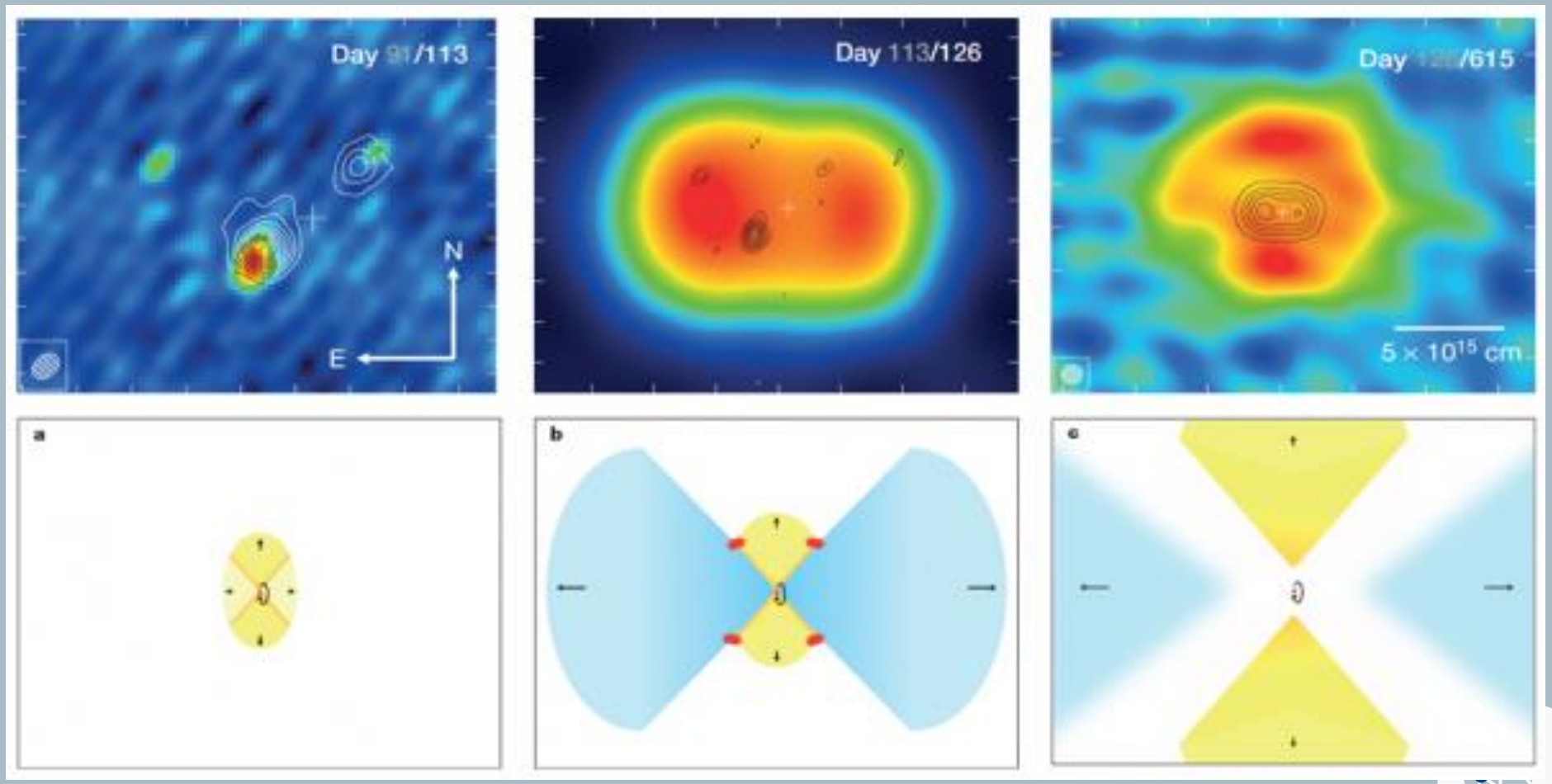
Absolute positions are needed !

JIVE

Nova Mon: stellar evolution

EVN solves riddle on gamma ray production.

http://jive.eu/sharp-radio-images-unravel-mystery-gamma-rays-stellar-explosions

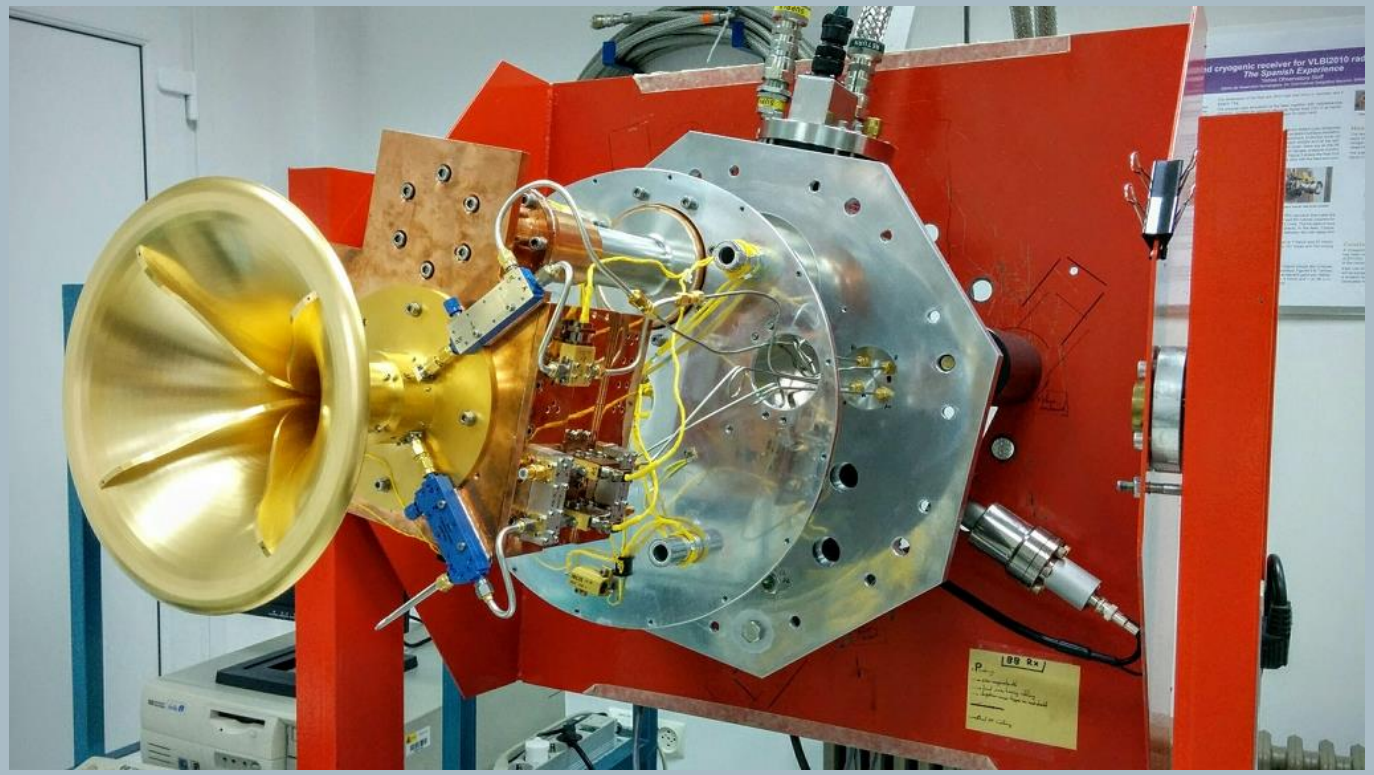


What can VLBI do for you?

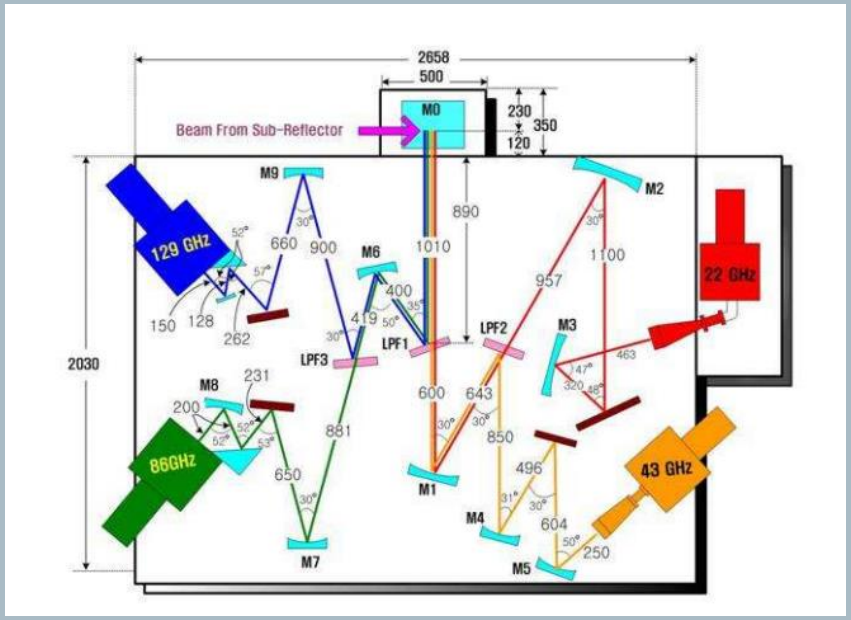
FUTURE PROSPECTS

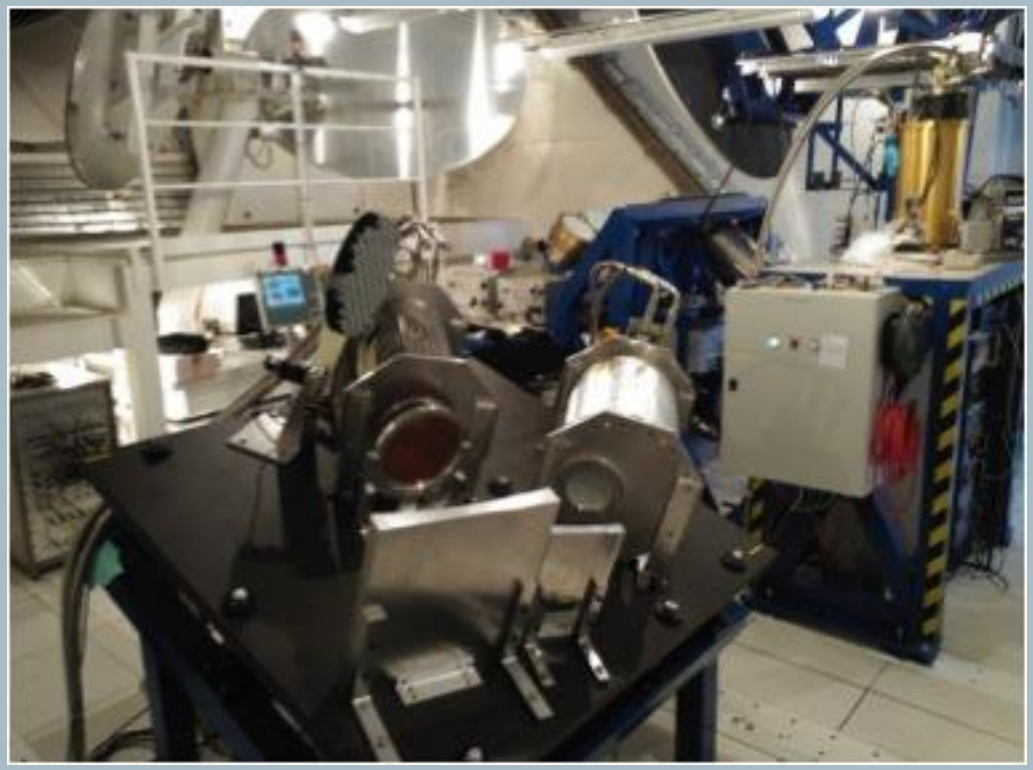
RADIONET BRAND receiver for EVN

- Broadband receiver to cover 1.5-15.5 GHz.
- Allows simultaneous registration of masers of OH (1.6, 1.7, 4.7 and 6.0 GHz), and CH_3OH (6.7 and 12.2 GHz).



Simultaneous multi-frequency observations





K band (21-26 GHz)
Q band (41-49 GHz)
W band (76-100 GHz)

Water masers
SiO masers
HCN masers
Some methanol masers

Allows alignment of maser maps !

K/Q/W at IGN-Yebes 40-m RT

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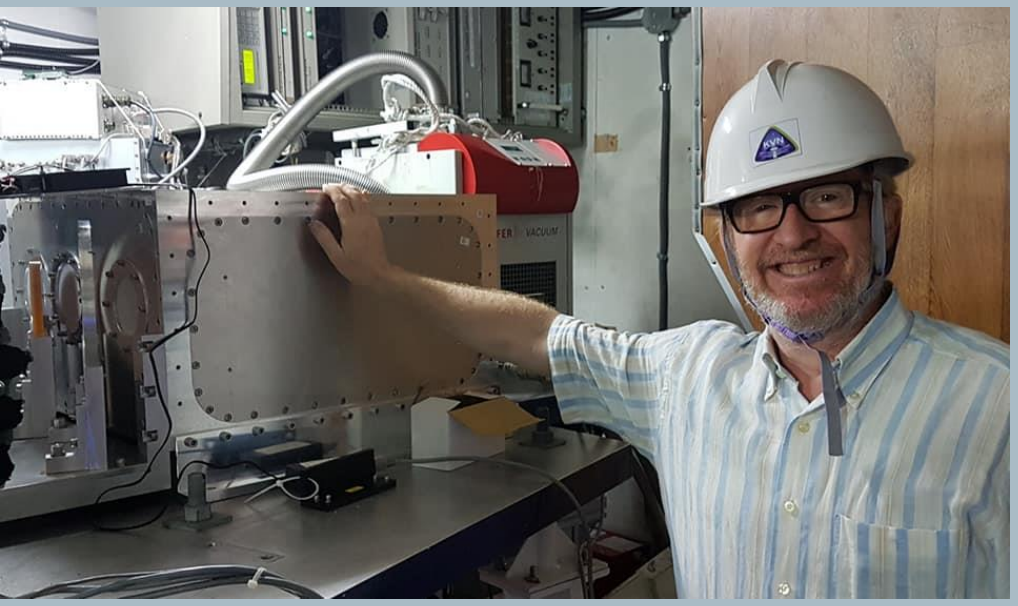
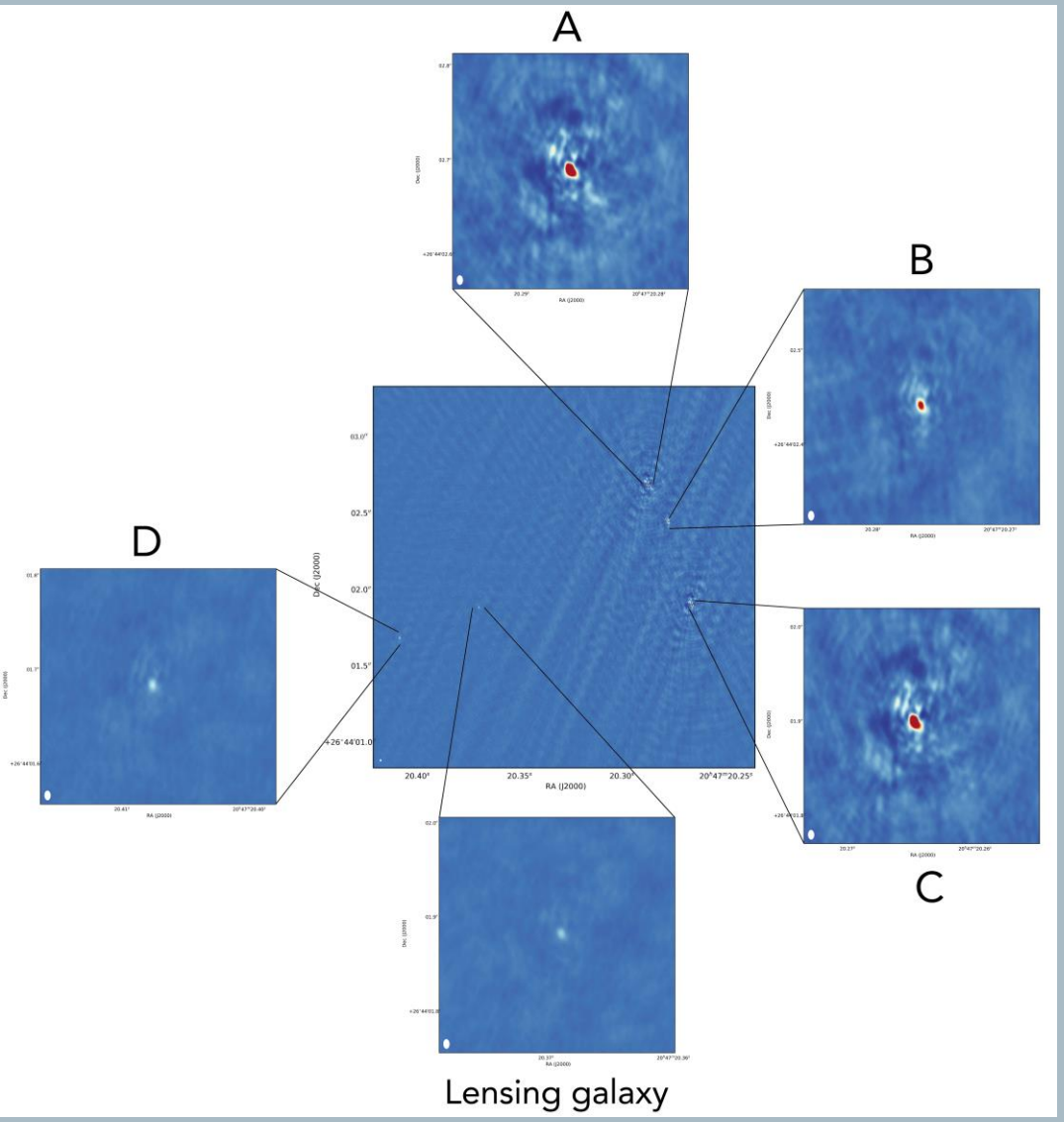
Compact K/Q/W bands receiver



Also allows calibration of high frequency data (up to W band) using lower frequency (Q, K) simultaneous observations

See talks by Dr. Han, and by Maria Rioja !

Software highlights



Fringe Fitting for VLBI in CASA reaches maturity

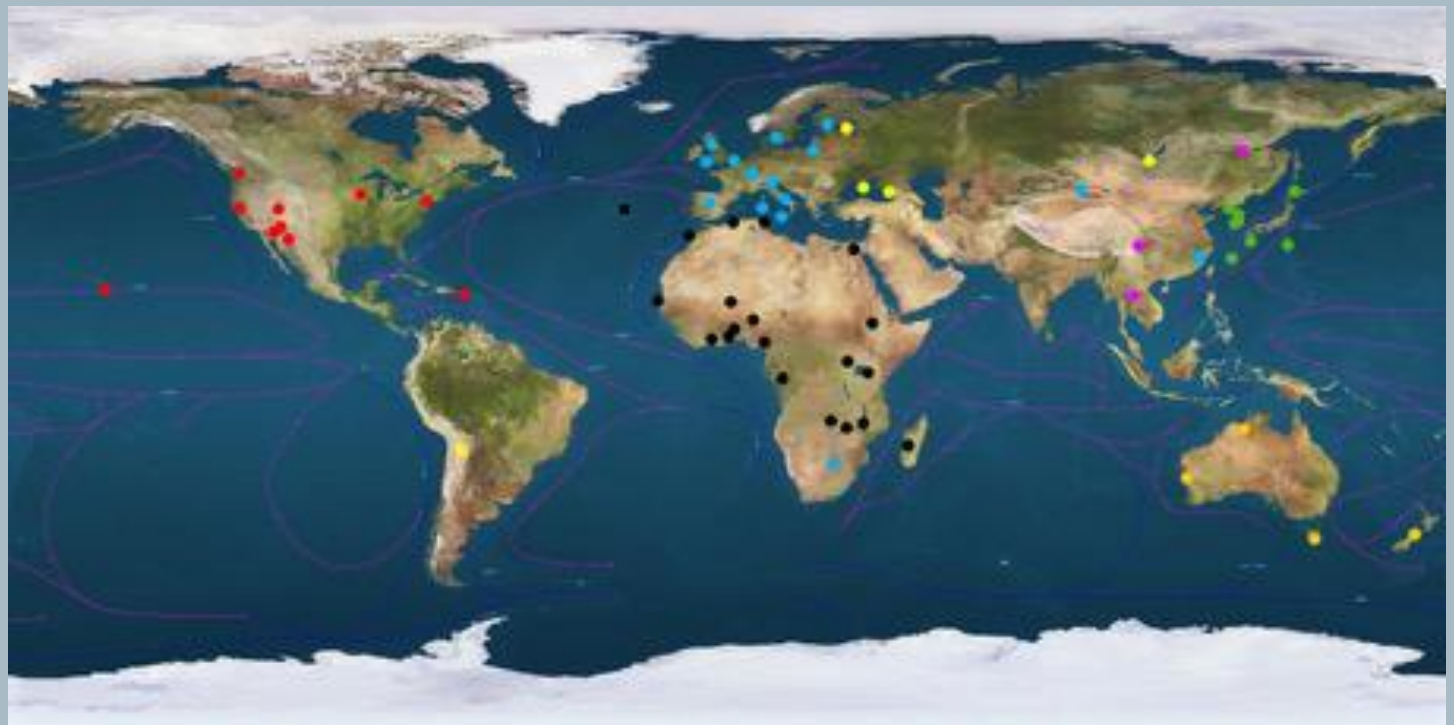
- Two very successful workshops to exercise new capability
- First image of a VLBI science target fully processed with the new CASA tools

Cristiana Spingola (Kapteyn Institute, University of Groningen)

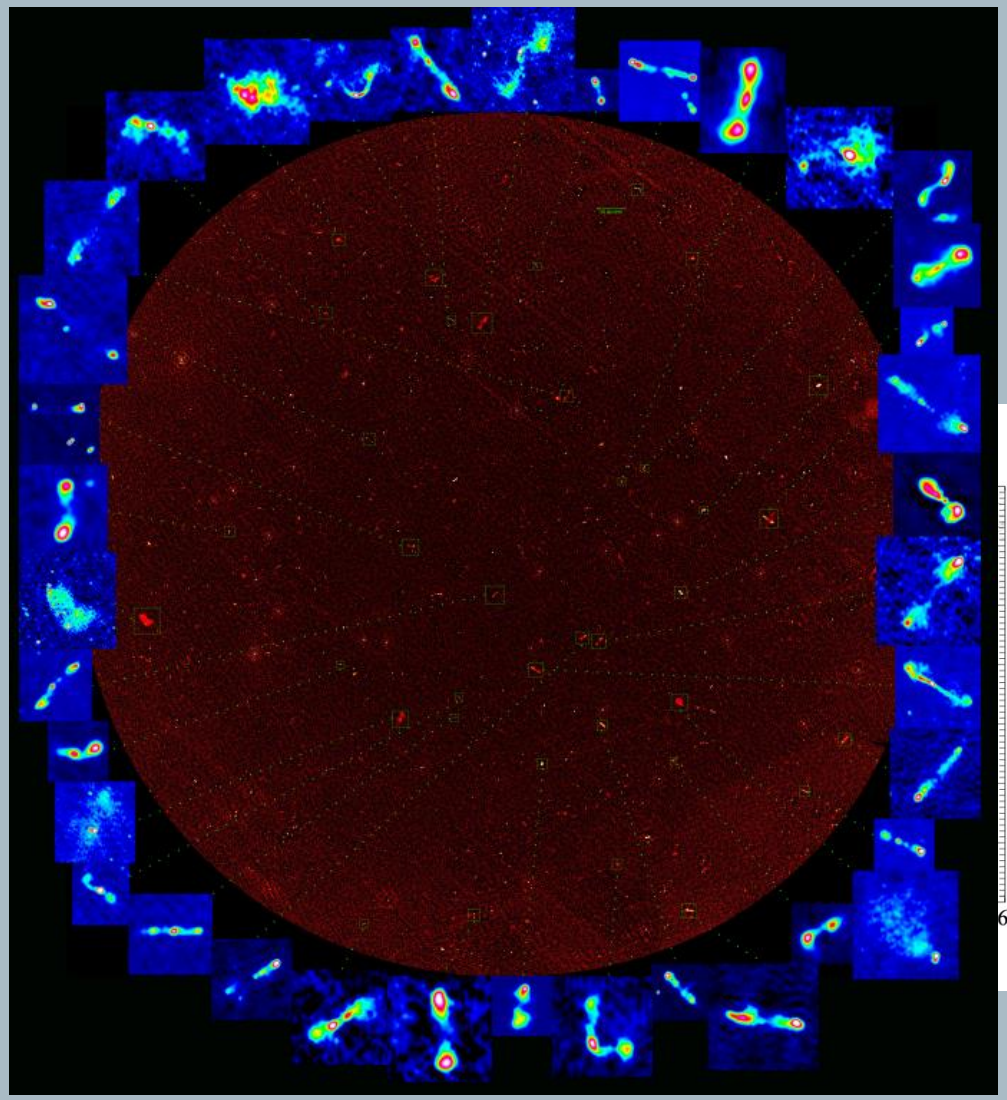
JIVE

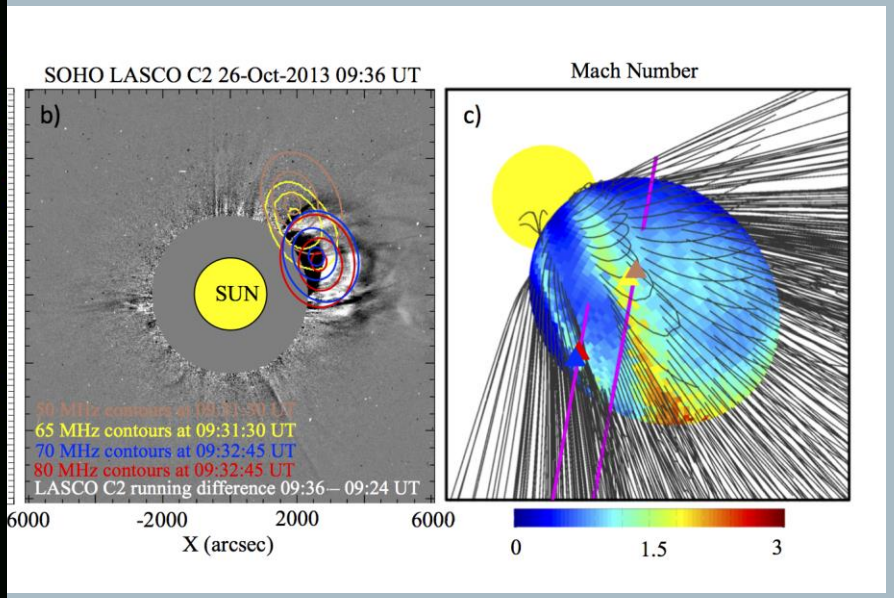
Towards global VLBI

- "Earth VLBI alliance" concept being developed
  - EVN, VLBA, LBA, GMVA, EAVN, KVN, VERA, AVN…
  - Need to set a Global VLBI Working Group (GVWG) for coordination
- When SKA_1 is built, long baselines and northern hemisphere sky coverage will be needed!



EVN/JIVE - LOFAR/ILT synergies





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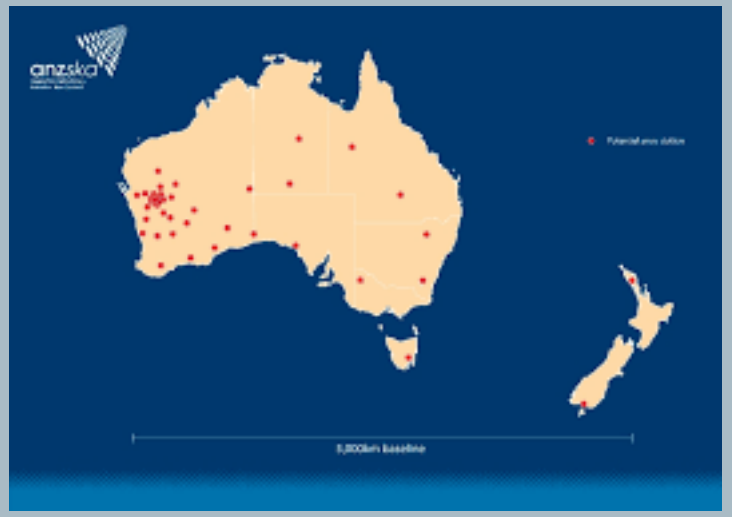
VLBI in the era of SKA

- The Square Kilometer Array (SKA) will be built in two phases.
- SKA-1 is 10% of the full SKA, and will lack very long baselines, which are provided by VLBI.



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EC H2020 JUMPING JIVE

WP10: SKA-VLBI

- Explores the synergies between VLBI and SKA
- **SKA1-MID shares frequencies with EVN**; combined observations will provide unprecedented sensitivity.
- To develop a **global VLBI** Science Case including precision astrometry, large field-of-view VLBI, VLBI surveys and transients, etc.

https://www.skatelescope.org/precursors-pathfinders-design-studies/

Summary

- VLBI is the astronomical technique with **highest angular resolution**
- VLBI provides a huge add-on value to national RA facilities
- EVN is the **most sensitive** VLBI network in the world, **open** to all astronomers
- Members of EVN/JIVE are involved in **cutting-edge research and development**
- Development of **new VLBI stations** will improve image quality, and create local expert communities
- JUMPING JIVE fosters **global VLBI** – need to set a *Global VLBI Working Group (GVWG)*
- e-VLBI networks are **pathfinders to SKA**

JIVE

Thank you!

Francisco Colomer

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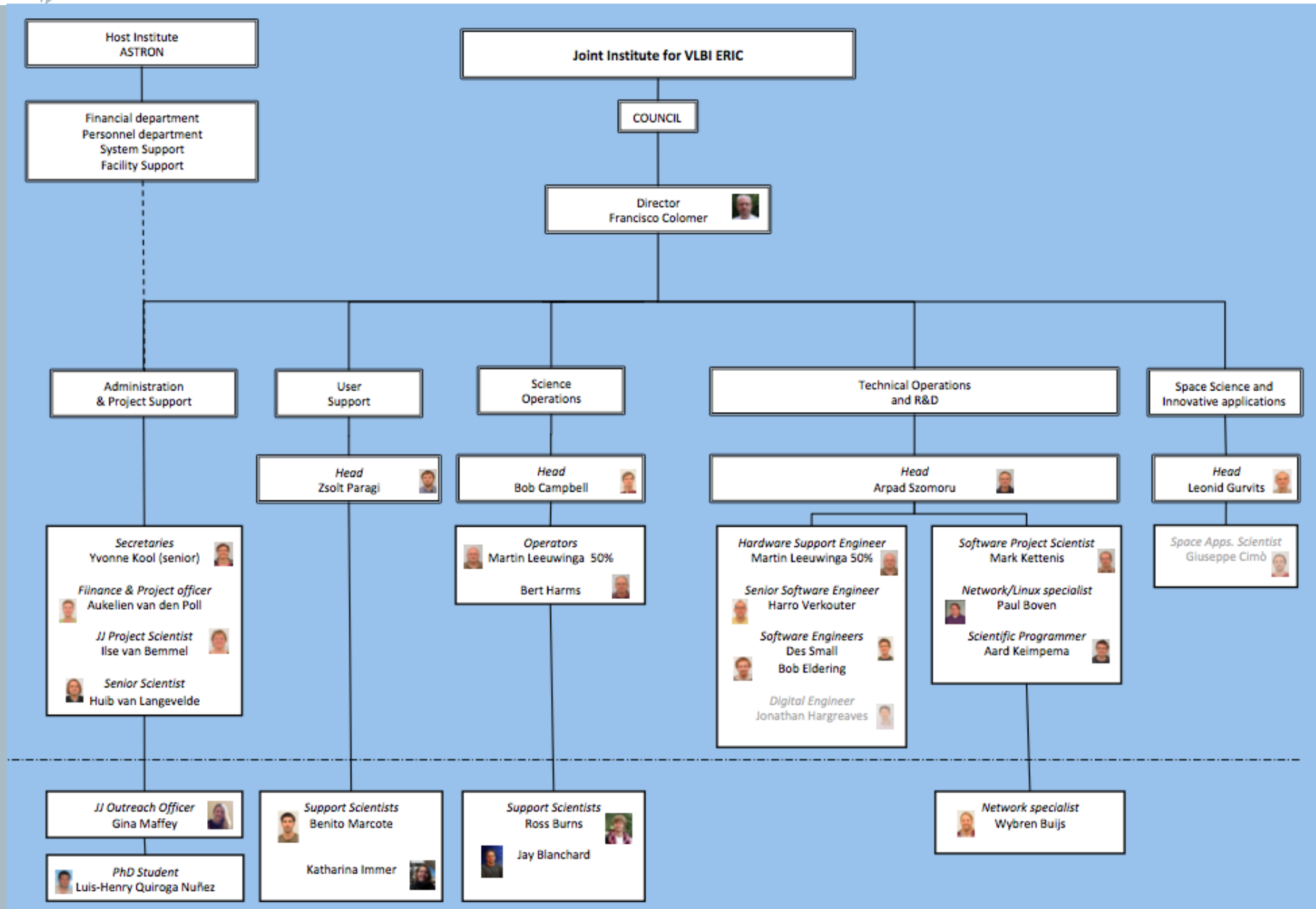
www.jive.eu

@jivevlbi

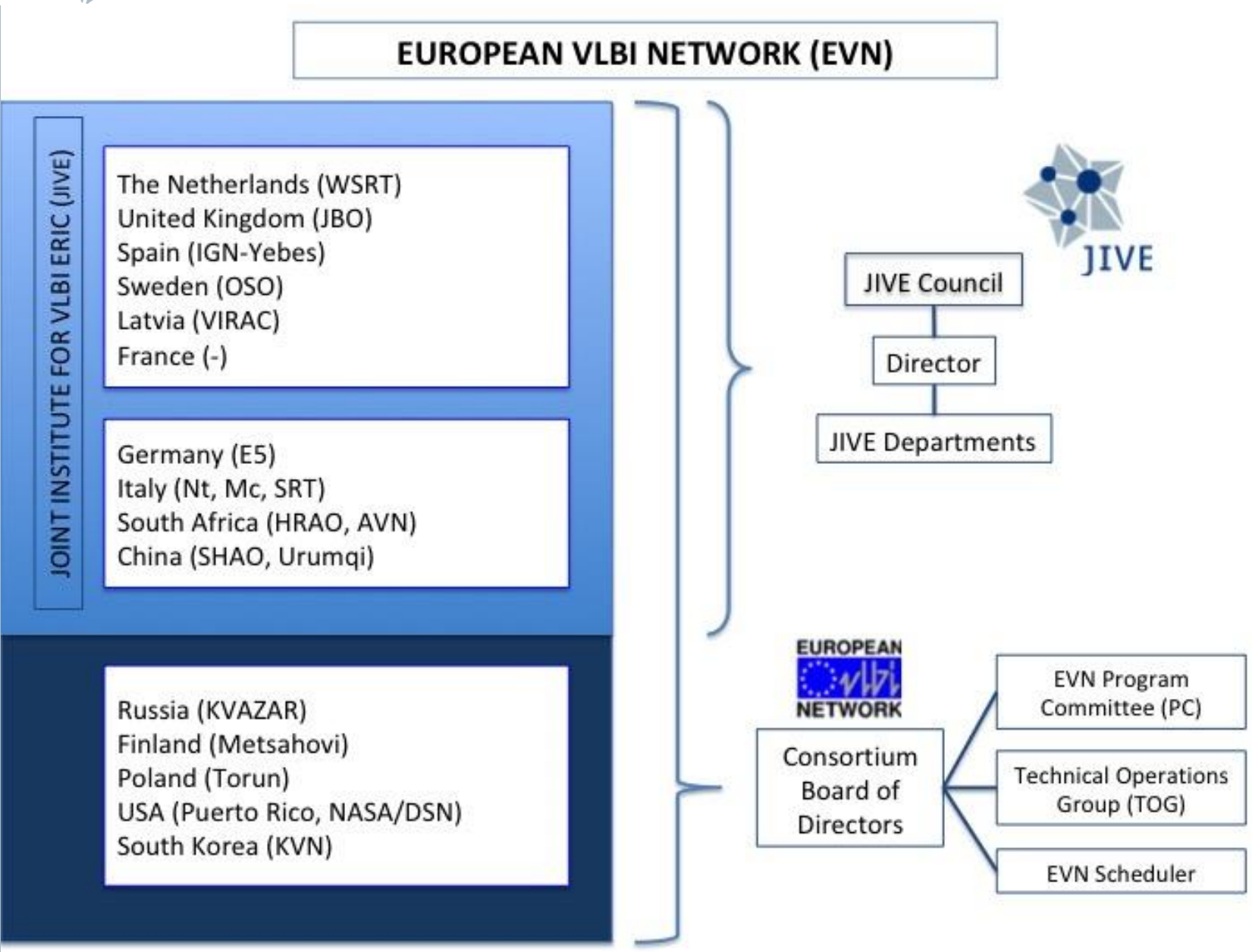
@JIVERIC

EXTRA SLIDES

Who is who at JIVE

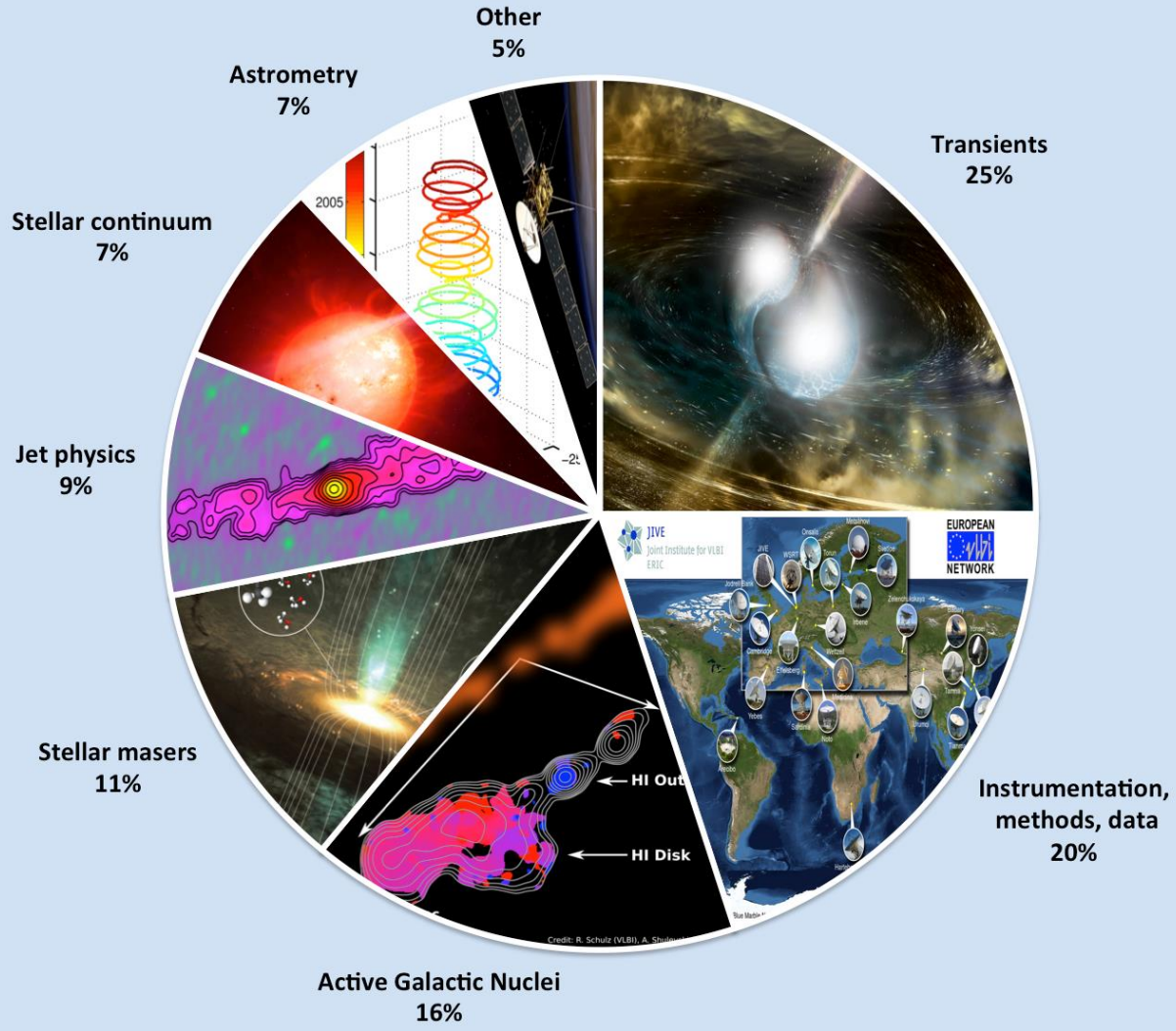


JIVE and EVN



JIVE

EVN scientific output (2017)



EC Projects

- **JUMPING JIVE:**
  - "Joining up Users for Maximizing the Profile, the Innovation and Necessary Globalization of JIVE".
  - Coordinated by JIVE
  - 3 MEuro in 2017-2020.

- **RadioNet (EVN TNA, RINGS):**
  - A new 10 MEuro, 4-year program started in 2017
  - TNA provides access to EVN and JIVE.
  - RINGS for analysis of wideband data.

RadioNet

- **ASTERICS:**
  - JIVE coordinates CLEOPATRA and participates in OBELIX

Asterics
Astronomy ESFRI & Research Infrastructure Cluster

Aeneas
Advanced European Network of E-infrastructures for Astronomy with the SKA

BLACK HOLE CAM

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JIVE