EVN – A status report

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Onsala Space Observatory, Sweden

Outline

- Description of the EVN
- Science with the EVN
- RadioNet3
- Summary

Description of the EVN

- The European VLBI Network (EVN) was formed in 1980
  - MPIfR (Germany), IRA (Italy), ASTRON (The Netherlands), OSO (Sweden), JBO (UK)
- Today it includes 15 major institutes, including the Joint Institute for VLBI in Europe (JIVE)
  - The primary mission of JIVE is to operate and further develop the EVN correlator. JIVE is also involved in supporting EVN users and operations of EVN as a facility
- EVN has no central funding
  - Some institutes contribute to the operation of JIVE.
  - European Research Infrastructure Consortium (ERIC).
  - On 30 July 2013 the Dutch Ministry of Education, Culture and Science, submitted an application to set up the JIV-ERIC that will encompass the current activities of the JIVE

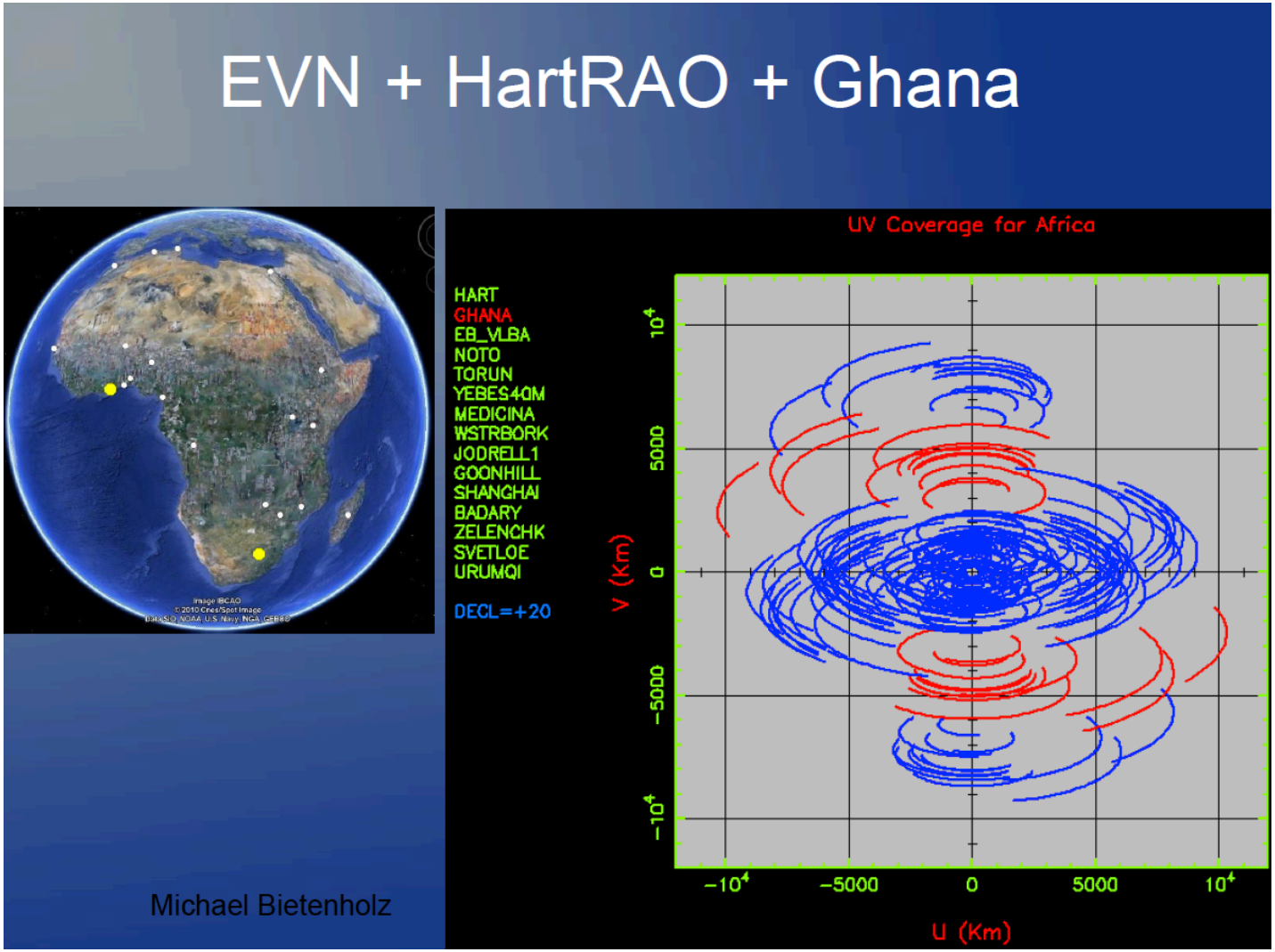
EUROPEAN VLBI NETWORK

JIVE
JOINT INSTITUTE FOR VLBI IN EUROPE

EUROPEAN VLBI NETWORK

JIVE JOINT INSTITUTE FOR VLBI IN EUROPE

AVN


EVN + HartRAO + Ghana
HART
GHANA
EB_VLBA
NOTO
TORUN
YEBES40M
MEDICINA
WSTRBORK
JODRELL1
GOONHILL
SHANGHAI
BADARY
ZELENCHK
SVETLOE
URUMQI
DECL=+20
UV Coverage for Africa
V (Km)
U (Km)
10^4
5000
0
-5000
-10^4
Michael Bietenholz

EUROPEAN
NETWORK
JIVE
JOINT INSTITUTE FOR VLBI IN EUROPE
Metsähovi
Onsala
JIVE
WSRT
Torun
Svetloe
Jodrell Bank
Wettzell
Zelenchukskaya
Badary
Cambridge
Effelsberg
Medicina
Yebes
Sardinia
Noto
Urumqi
Sheshan
Arecibo
Hartebeesthoek

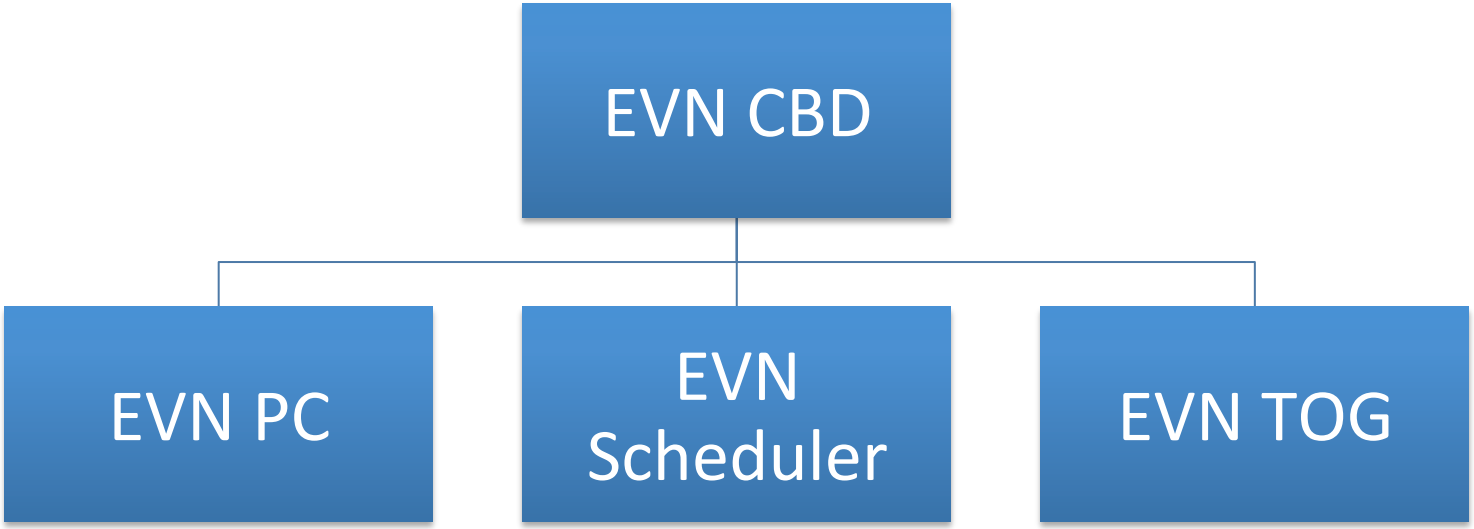
Description of the EVN

- The overall policy of the EVN is set by the EVN Consortium Board of Directors (CBD)
- Technical aspects of EVN operations are considered by the Technical and Operations Group (TOG)
- The EVN is an open facility and encourages proposals from the entire astronomical community
- Proposals are submitted to the EVN Programme Committee (EVN PC) 3 times/year

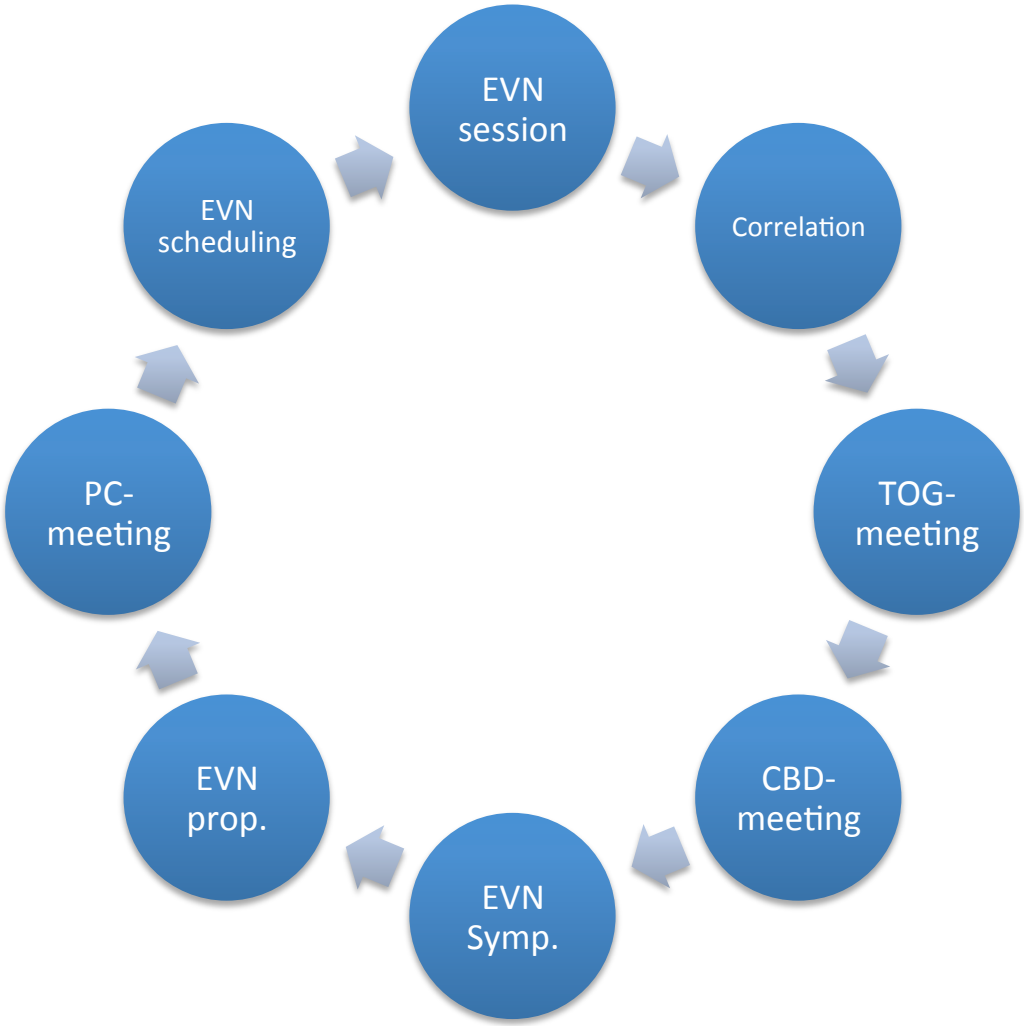
Description of the EVN

- The EVN observes during:
  - 3 EVN sessions (3x3 weeks)
  - 10 e-VLBI sessions (10x24 hours)
  - Target of Opportunity
  - Out of Session (RadioAstron)
- The scheduling is done by the EVN Scheduler
- The VLBI friends performs the observations

Description of the EVN



Description of the EVN



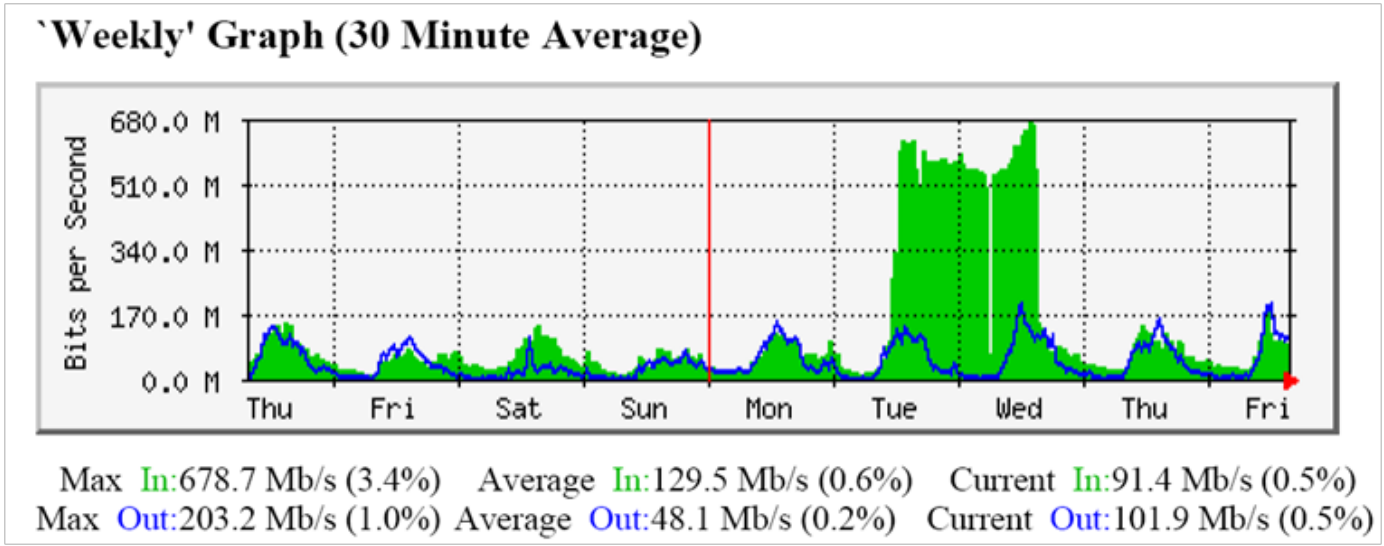
Description of the EVN

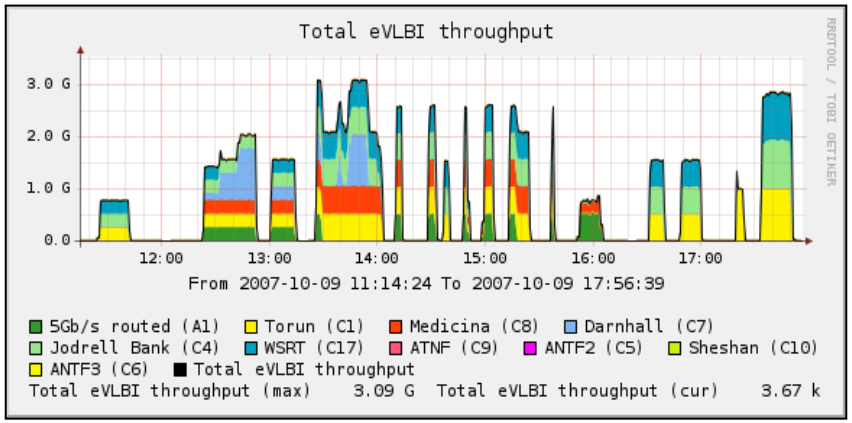
Maximum Angular Resolution in milliarcseconds

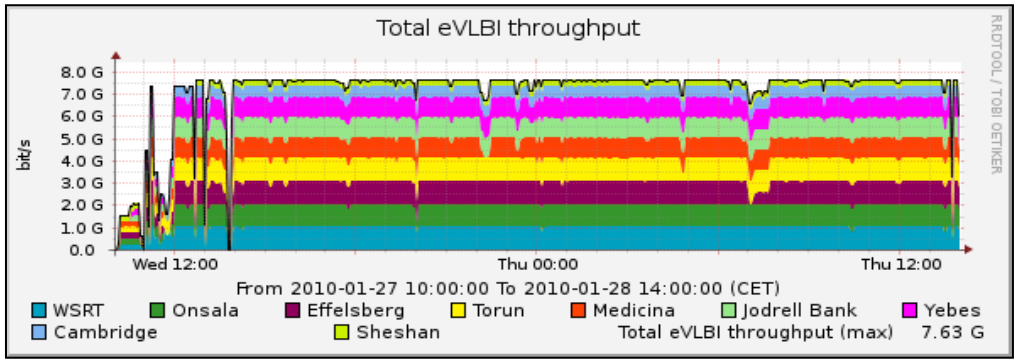
Array	90 cm	18 cm	6 cm	3.6 cm	1.3 cm	0.7 cm
EVN	-	15	5	3	1	0.6
EVN (inc. SH/Ur)	30	5	1.5	1	0.3	0.15
EVN+VLBA	19	3	1	0.7	0.25	0.13

- Telescopes, 14 – 305 m
- Data rate 1 Gbps (2x128 MHz, 2-bit sampling)
- Different types of digital backends, recorders

eVLBI

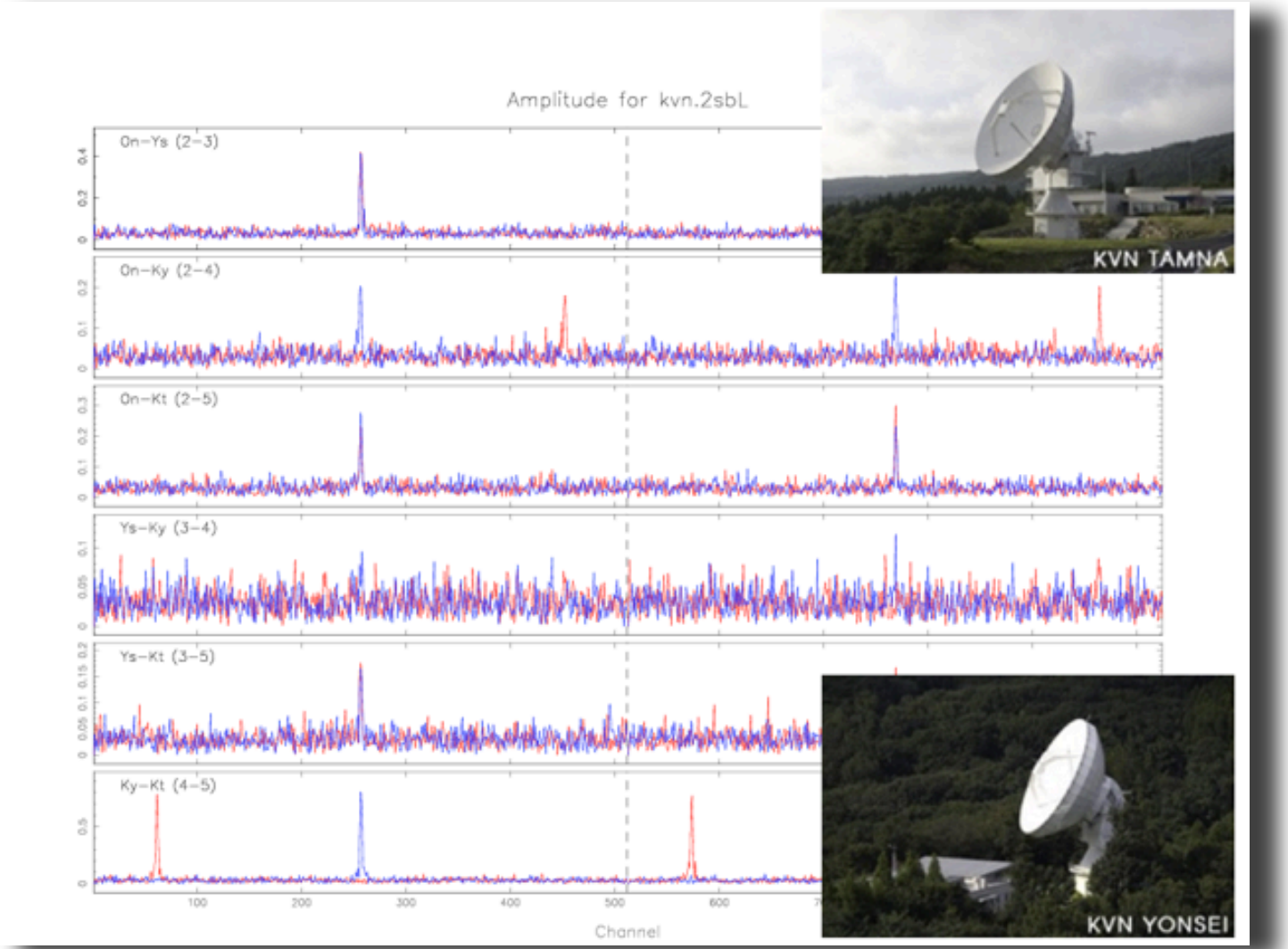






EXPReS/NEXPRES, 2 EC-projects

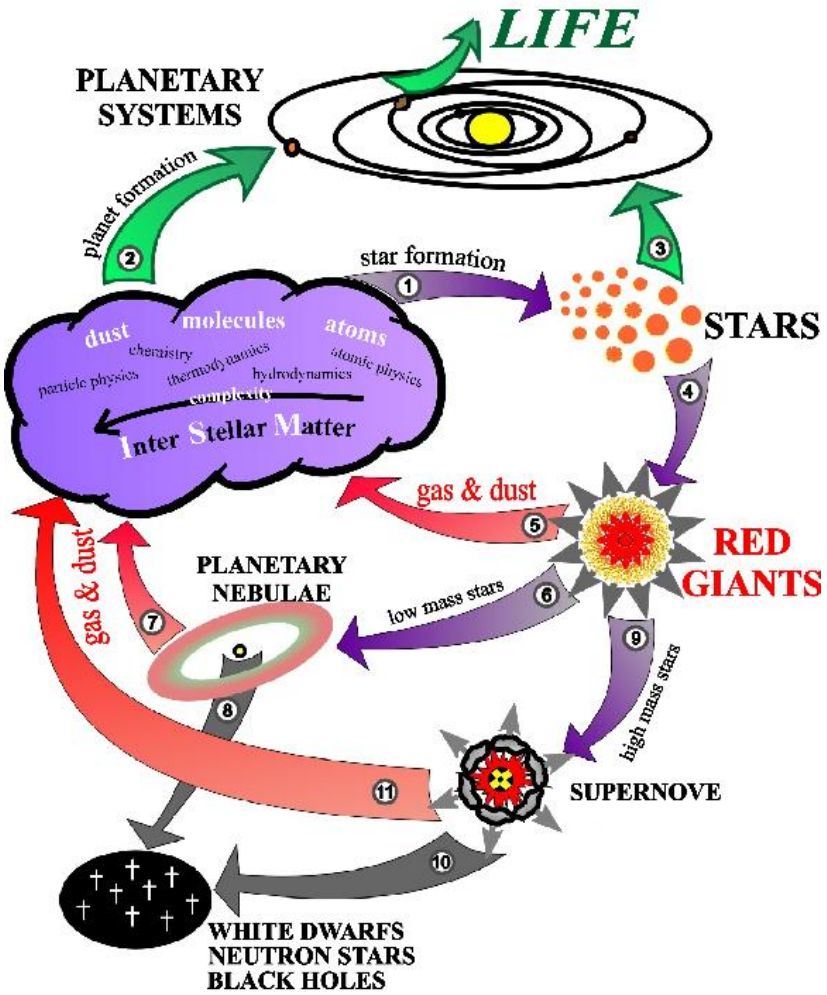
eVLBI


Amplitude for kvn.2sbL
On-Ys (2-3)
On-Ky (2-4)
On-Kt (2-5)
Ys-Ky (3-4)
Ys-Kt (3-5)
Ky-Kt (4-5)
100
200
300
400
500
600
Channel
KVN TAMNA
KVN YONSEI

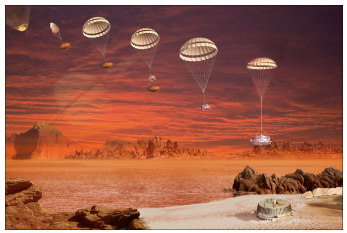
e-VLBI

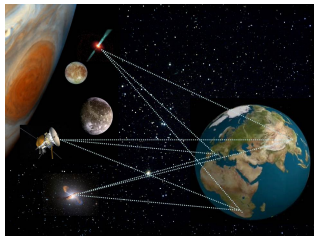
- "Most" EVN-stations can do 1024 Mbps
- Disk-less operations in the EVN?
  - Almost all proposals ask for KVAZAR, China
  - VLBA+EVN (Global)
- Disk recording and e-VLBI simultaneously (NEXPReS)

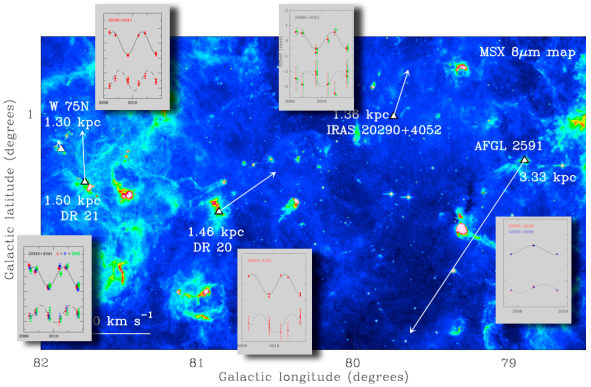
Cosmic evolution

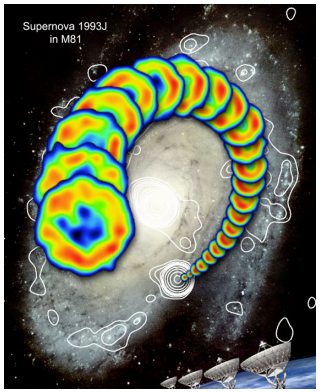


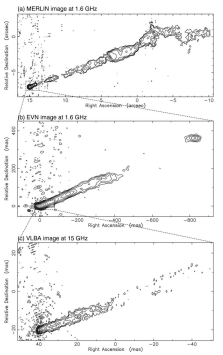
Science with the EVN

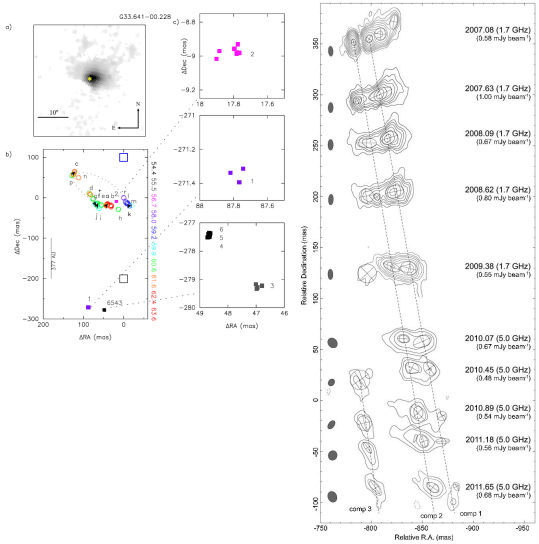


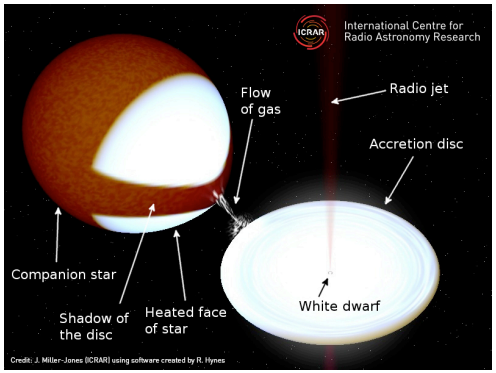


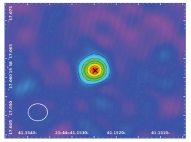


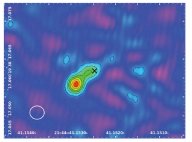


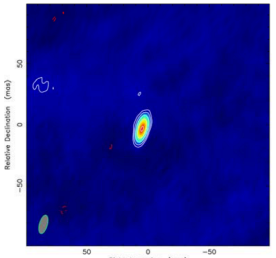


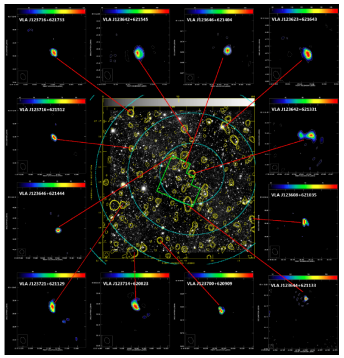


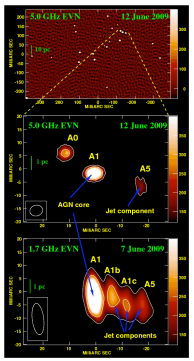


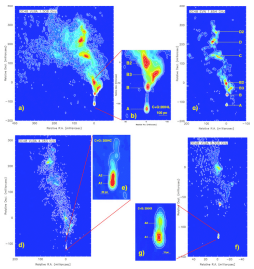












RadioNet3

- RadioNet3
  - project supported by the European Commission under FP7
  - includes 27 partners
  - Total EC contribution is 9.5 million Euro
  - 3 types of activities
    - Networking Activities (7)
    - Transnational Access (8 telescopes/arrays)
    - Joint Research Activities (4)

Science & Technology Facilities Council
CSIRO
SKA AFRICA SQUARE KILOMETRE ARRAY
LOFAR
UNIVERSITE D'ORLEANS
jive JOINT INSTITUTE FOR VLBI IN EUROPE
iram Institut de Radioastronomie Millimétrique
ESO
INAF ISTITUTO NAZIONALE DI ASTROFISICA
ASTRON Netherlands Institute for Radio Astronomy
Max-Planck-Institut für Radioastronomie
UNIVERSITY OF OXFORD
ONSALA RYMDOBSERVATORIUM CHALMERS TEKNISKA HÖGSKOLA
RadioNet
SRON Netherlands Institute for Space Research
UNIVERSITÉ BORDEAUX 1 Sciences Technologies
TU Delft Delft University of Technology
l'Observatoire de Paris
UNIVERSITAS NICOLAI COPERNICI TORUN
Turun yliopisto University of Turku
Fraunhofer IAF
KASI Korea Astronomy and Space Science Institute
ph1 Universität zu Köln
MANCHESTER 1824
UNIVERSITY OF CAMBRIDGE
Universidad de Alcalá
VENTSPILS AUGSTSKOLA
Aalto University
GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO
INSTITUTO GEOGRÁFICO NACIONAL

Network Activity - ERATec

The main activity of the RadioNet3 European Radio Astronomy Technical Forum (ERATec) is to organise and support meetings and workshops of European radio astronomical staff, directly involved in the technical development of the observing facilities and their application.

- Task 1: Technical Workshops - Karl-Heinz Mack (INAF)
  - Radio Interference in Large Bandwidth Observations, Bonn, April 2013
  - Calibration of Multi-Beam Receivers, Bologna, October 2013
- Task 2: European Radio Astronomy Engineering Spcial Sessions and Joint Workshops - Reinhard Keller (MPIfR)
  - The Power Challenges of Mega-Science Infrastructures: The example of SKA, June 2012
  - Large Scale Science Projects: Europa-Africa Connects, Mauritius, September 2013
  - Science Operations, SCIOPS, Madrid, 2013
- Task 3: EVN Technical Operation Group (TOG) - Michael Lindqvist (OSO)

Transnational Access – EVN

- The objectives of the Transnational Access portion of RadioNet3 are
  - to draw together all of the European radio facilities under one umbrella;
  - to enable the European user community to have easy and transparent access to the entire range of facilities;
  - to offer the European user community an integrated, professional and consistent level of user support;

Joint Research Activities

- DIVA
- Uniboard^2
  - will focus on the development of a generic high-performance computing platform for radio astronomy, along with the implementation of several different applications (correlator, digital receiver, aperture antenna beam former)
- Hilado
  - will create optimized libraries and software components that enable high performance processing of the data from existing and new facilities (LOFAR, ALMA, e-MERLIN, EVLA, EVN)

Developments in VLBI Astronomy (DIVA)

"DIVA will develop key technology building blocks to consolidate the role of European VLBI and European radio astronomy in general as a leading competitor with respect to developments in the USA and Asia." ☺

- Task 1: Low-noise wide-band integrated amplifiers for VLBI antennas
- Task 2: Development of a 32 Gbps digital backend (DBBC3)

Low-noise wide-band integrated amplifiers for VLBI antennas

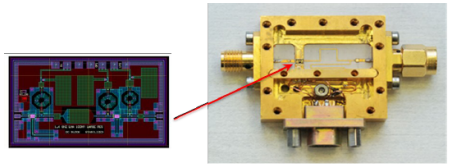
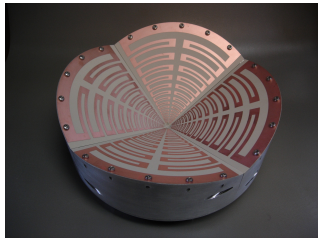


photo of the chip and LNA

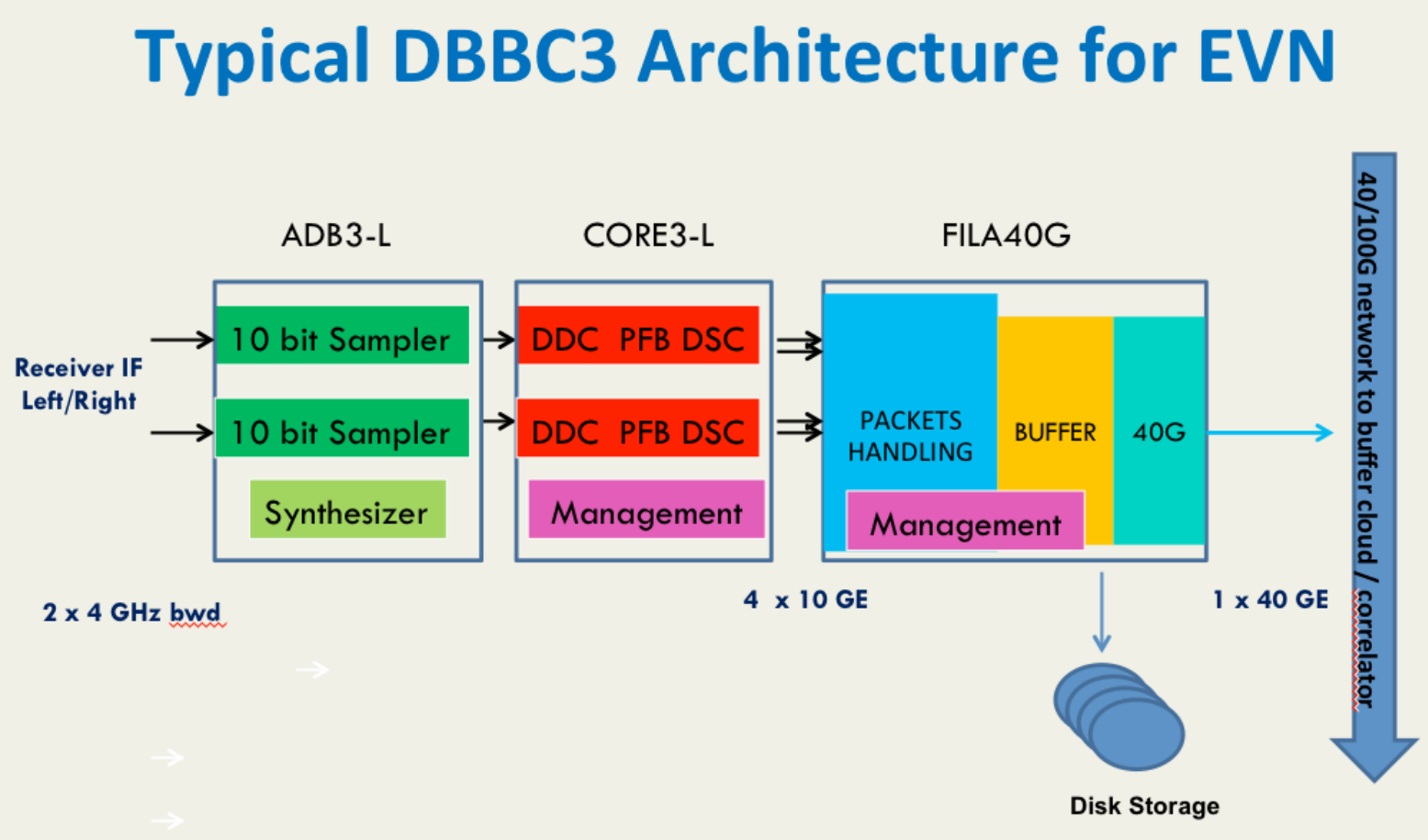


Eleven feed for 1.2-10 GHz

- Partners: MPIfR, ASTRON, OSO
- DIVA will develop a high performance integrated LNA Monolithic MIC (MMIC) providing the wide bandwidth 1 - 4 GHz
- The LNAs will be integrated with wide band feed and tests will be done by the end of 2014
- The target group of users for this project highly sensitive VLBI astronomy in the dm/cm-range and SKA Advanced Instrumentation Program

Development of a 32 Gbps digital backend

- Partners: INAF, MPIfR, OSO



What do the user want?

Average rank	In which direction should the EVN develop?
2.73	Improved uv-coverage (more telescopes, more short spacings)
3.50	Increased bandwidth to improve sensitivity
4.57	Improved calibration in general (phase, amplitude, bandpass, polarization)
4.60	Improved resolution (more long baselines)
4.73	Frequency agility for spectral index imaging
6.06	Real-time e-VLBI capabilities for more telescopes
6.34	Extended observing time to be able to carry out big surveys
6.42	Real-time e-VLBI capabilities for a larger fraction of observing time
6.71	Improved astrometry
6.89	Larger field of view

Enhancing EVN capabilities

- Observations at 4 Gbps (and beyond)
- DBBC3, Mark 6, disk-less operation, Harrobox, Flexbuff
- New telescopes and collaborations (SRT, AVN, KVN, China)
- High speed connectivity to, KVAZAR, China, …
- Better frequency agility
- Improve flexibility (transients, ToO)
- eMERLIN + EVN at 1 Gbps
- Sub-arrays, more observing time with smaller telescopes
- Next generation correlators, new possibilities

Summary

- EVN is producing excellent science
- EVN will complement the SKA
- Looking forward to see the first EVN proposal which asks for KVN!