

# Updating the EVN Vision Document

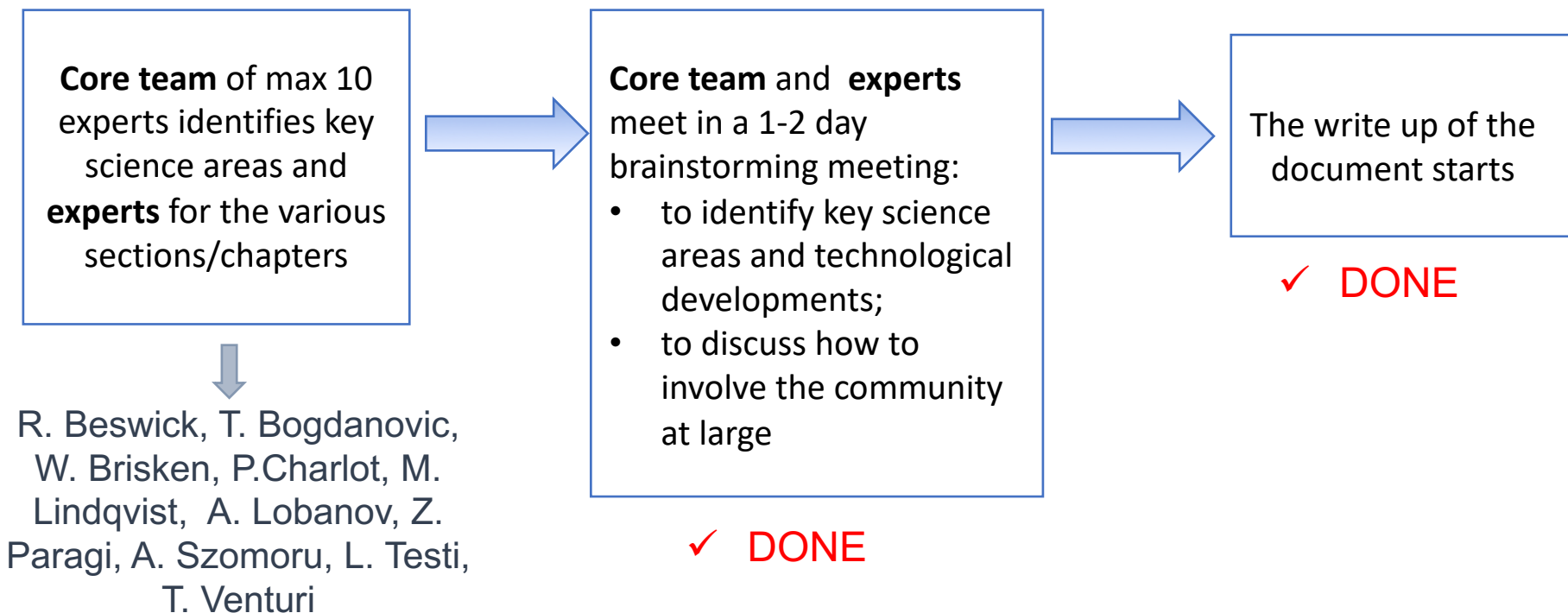
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- Overview
- Activity since the CBD in Dwingeloo
- Current status
- Input from the Directors
- Future deadlines

## IMPLEMENTATION PLAN AND STATUS



## NEXT STEPS AND DEADLINES

- ❖ Meeting of the WP leaders scheduled in January – Inspection of the material; matrix of requests vs science; selection of topics for «glossy version» of the vision document
- ❖ Meeting among WP leaders and co-writers in 2019, possibly connected with one of the SKA-VLBI science meetings
- ❖ Very advanced draft to be delivered in a year from now 

LAST SLIDE IN DWINGELOO



First version of the VLBI vision document delivered to the CBD (plus Mike Garrett and Huib van Langevelde) on April 3, 2019

## MEETINGS, CONFERENCES AND DISCUSSIONS IN PREPARATION OF THE DOCUMENT

- ✓ VLBI session at the meeting: **eMERLIN and EVN in the SKA era** (Jodrell Bank, 11-12 September 2017)
  - ✓ 1.5 days **F2F meeting** (Zaandam, 28 February – 1 March 2018)
  - ✓ Special Session SS11 @ EWASS 2018: **Exploring the Universe: a European vision for the future of VLBI** (Liverpool, 4 April 2018)
  - ✓ **Open discussion** on the EVN Vision Document at the **14<sup>th</sup> EVN Symposium** in Granada (8-11 October 2018)
  - ✓ **Meeting of the WP leaders** to assemble the first version of the document (Bologna, 21-23 January 2019)
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- First deadline to chapter coordinators to deliver their part: 3 September 2018
  - Second deadline for revision after the EVN Symposium: end of December
  - Third version for revision after reading the full document: 28 February 2019

# The VLBI Science Vision Document

## Suggestions given to the chapter coordinators and to the community

The document should not be a wishlist, but rather include:

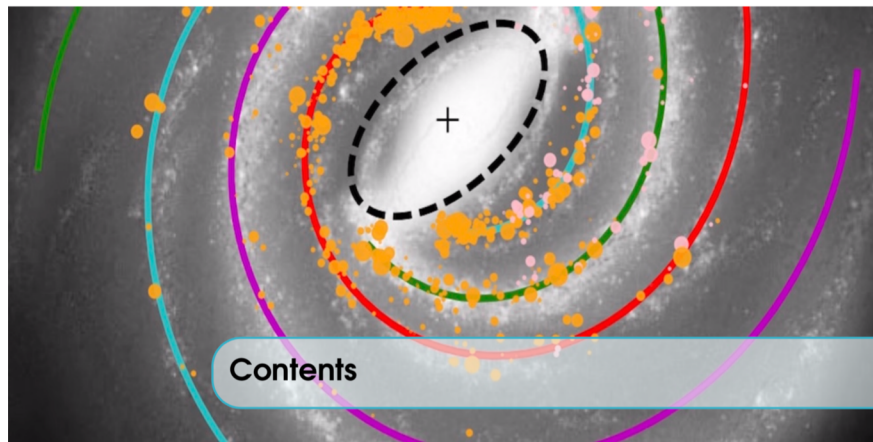
- ✓ a selection of open questions in astrophysics where VLBI can provide unique answers
- ✓ a selection of science areas which can make considerable progress thanks to VLBI
- ✓ envisaged accessible and feasible developments to address the science

# The VLBI Science Vision Document

The document consists of eight chapters:

- ✓ Chapter 1 includes an overview of the main present and upcoming facilities in the radio and other bands, and the prospects for the technological framework
- ✓ Chapters 2 to 7 are the science chapters, with a scientific coverage going from cosmology to Earth science, and space and planetary science applications
- ✓ Chapter 8 is meant to be a concluding summary





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## General Considerations

- Most missing topics at the CBD in Dwingeloo have been added
- Very good quality of the chapters
- Still not fully homogenous
  
- Difficult to derive a matrix of required developments for the EVN
  
- An executive summary is still to be drafted
  
- Glossy version still in progress – Zsolt Paragi will lead this effort, in coordination with WP2 in JUMPING JIVE

## Feedback request to the CBD

First version sent to the CBD on 3 April 2019

- Document still preliminary
- Scientific coverage
- Input and comments on the last chapter (so far **key questions** from each coordinator have been collected)
- Input/preferences for the glossy version



## 8. A new vision for European VLBI

## KEY QUESTIONS

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Chapter 8. A new vision for European VLBI

### Cosmology

- Q1
- Q2
- Q3

### Star formation, accretion and feedback over cosmic time

- What is the role of AGN in promoting and controlling star-formation activity at high redshifts?
- What links the co-evolution of SMBH growth with the assembly of galaxies in the early Universe?
- What are the fundamental signposts of accretion and feedback that can be studied at high linear resolution in the local Universe?

### Outflows and AGN feedback

- How do HI properties on sub-kpc-scales vary with radio power and type of AGN?
- What are characteristic differences for jet and wind driven HI outflows?
- Do the sub-kpc-scale jet properties differ for AGN with and without outflows (or inflows)?

### Physics of black holes and jet formation

- How the formation and initial propagation of relativistic jets in AGN are connected with the physical conditions in the accretion disk and magnetosphere of the central black hole?
- What factors are chiefly determining the "radio loudness" and the efficiency of jet formation in AGN?
- What is the total strength and three-dimensional structure of the magnetic field in the region within a thousand gravitational radii of the central black hole?

### The growth of supermassive black holes

- How did supermassive black hole form?
- When did the first radio AGN appear in the history of the Universe?
- What role did the jetted AGN play in the galaxy evolution in the earliest Universe?

### Incoherent (synchrotron) transients

- Can we detect GW counterparts at medium to high redshifts that may serve as VLBI probes for cosmology?
- Is there a hidden TDE population and, if so, will TDEs reveal a new population of massive BH (single or in binary/multiple systems)?
- Are there off-axis long GRBs and what does this imply for GRB theories?
- How jets are launched in NS(BH) binaries and how relativistic they can be? What is their supernova-kick distribution?
- What is the nature of thermonuclear SN progenitors (single-, double degenerate)?

### Coherent (fast) transients, pulsars and SETI

- What is the nature of FRBs and their environments (redshift, DM, RM distributions, possible progenitors as well as host properties) in the low-redshift universe ( $z < 0.1$ )? Can we detect them at higher redshifts?

### 8.1 VLBI and synergies in the next decade

*FIXME there is a lot to do still for this chapter. The content here will rely a lot on the information presented in the technical introduction and the science chapters*

#### 8.1.1 The EVN in the SKA era

*FIXME: this subsection should describe "Where do we fit in?", e.g. describe the synergies with radio instruments from the lowest [LOFAR] to the highest frequencies [ALMA/EHT; EHI], and specifically addressing the SKA and SKA-VLBI*

#### 8.1.2 Multi-messenger landscape

*FIXME: this part should place the future EVN to a broader context, considering its possible synergies with major MM facilities. Note it should not be a detailed description of these MM facilities (like the radio array in the intro chapter), rather, it should focus on the synergies, and should possibly highlight a few MM science cases (input from the Chapters)*

#### 8.1.3 Future of the EVN Archive

*FIXME: it is not clear where this part will be (intro chapter or here), or if it should address future of JIVE more broadly*

#### 8.1.4 Summary of "Key Questions"? and the technical requirements (MATRIX)

*FIXME: one could summarize the science objectives of the EVN in the coming decade in a few key questions, put together by the chapter working groups. And we would present the technical requirements to be able to address these questions.*

## KEY QUESTIONS

### 8.1 VLBI and synergies in the next decade

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- What are the properties (radius, mass, chemical composition) of companions to NS in binaries? (to aid precision tests of GR and nuclear physics)
- “Are we alone?”

#### Stars (continuum)

- How far are the farthest stars?
- How precise is our cosmological distance ladder?
- Do magnetic dynamo mechanisms operate to produce radio emission in substellar objects?
- How mass loss through stellar winds impacts the evolution of the stars and their surroundings?

#### Stellar masers

- What are the structure and kinematics of our Milky Way’s spiral arms and its inner region?
- How does the extraordinary growth of massive young stars happen, and how can we best use masers to pin-point the various evolutionary phases and study the role of the magnetic field in these objects?
- What are the fundamental properties of maser emission?
- What are the morphology and magnetic properties of the outflow from evolved stars at high angular resolution, how the wind escape?

#### Celestial reference frames

- Is the Solar System purely rotating around the Galactic center or does it have an off-plane motion?
- Is the overall AGN geometry confirmed by ultra-accurate multi-frequency astrometry?
- What is the main driver for the free core nutation and its variability?

#### Space and planetary science: main goals

- Achieve state-of-the art astrometric accuracy (at the sub-nanoradian level) for any spacecraft anywhere in the Solar system!
- Achieve ultra-precise VLBI-based Doppler tracking of radio emitting spacecraft for characterisation of planetary exosphere!
- Provide input into multi-disciplinary studies of origins of the Solar system, exoplanetary systems and cosmic life!

## Feedback request to the CBD

- Are all sections/chapters needed and developed enough?
- Are there missing topics?
- Comments/input for Chapter 8
- Comments/input for the glossy version of the document are welcome (i.e. format, key community/ies to address)
  
- Anything else?





# Updated version of the cover with eMERLIN antennas and their location (MAG)



**JIVE**  
Joint Institute for VLBI  
ERIC

**EUROPEAN**  
VLBI  
NETWORK

Image by Paul Boven (boven@jive.eu). Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

## NEXT STEPS

Participation in the *Radio/Millimetre astrophysical frontiers in the next decade*, Charlottesville, 25-27 June 2019 (poster presentation accepted)

Second very advanced version of the document to be delivered to the CBD at the meeting in November 2019

First version of the glossy document to be delivered to the CBD at the meeting in November 2019

The SKA-VLBI meeting in October will be another chance for at least part of the people involved to have a further discussion on the document

Possible final meeting with the community in 2020

THANK YOU  
FOR YOUR ATTENTION