

Work package number ⁹	WP10	Lead beneficiary ¹⁰	1 - JIV-ERIC
Work package title	VLBI with the SKA		
Start month	1	End month	48

Objectives

The driver for this Work Package is to pursue the globalisation of VLBI in the advent of SKA, to dramatically enhance VLBI observations by providing significantly increased sensitivity and access to a broad range of spatial resolutions. With this Work Package, we will support this unique opportunity to explore the synergies between VLBI and the SKA.

Description of work and role of partners

WP10 - VLBI with the SKA [Months: 1-48]
JIV-ERIC, SKAO

Background. SKA1-MID, phase 1 of the mid-frequency telescope of the Square Kilometre Array (SKA), will be built in South Africa (with the low-frequency counterpart to be constructed in Australia). SKA1-MID is capable of providing very long and ultra-sensitive North-South baselines to the European VLBI Network (EVN), enabling exciting VLBI science to be achieved with this unique, global array. The SKA Organisation has initiated a number of international science working groups in order to inform and constrain the detailed design with high profile science cases. The SKA-VLBI Working Group was initiated in the summer of 2015 and has strong representation from JIVE/EVN, with the goal of identifying key science areas where SKA-VLBI will deliver breakthrough astrophysics.

Through the cooperation and coordination of work with the SKA, new and exciting opportunities will arise for global VLBI and JIVE. This Work Package is designed to achieve this through two well-defined tasks: to develop the operational model and the global science cases for SKA-VLBI.

Task 1. SKA-VLBI Operational Model. It is recognised that the development of SKA-VLBI requires a person with VLBI expertise to work closely with the SKA. This person will need to be located in the SKA office to ensure smooth communication channels between all stakeholders, namely, the SKA Office, the construction consortia, and JIVE. We identify a number of key outcomes to emerge from this task.

- Operational model for SKA-VLBI: Given that SKA construction is due to commence in 2018, it is important to ensure that science case developments are in line with existing SKA-VLBI requirements. Investigating this through a series of use cases and operational scenarios would ensure conformity with the SKA design. Commensal observing will be a common operational mode for the SKA. However, it is not clear whether this is also true for SKA-VLBI, and so it will be important to identify whether any technical or operational limitations exist to implementing this operational mode for SKA-VLBI and to increasing the observing efficiency and scientific throughput of VLBI.
- Interfaces: The interfaces between the VLBI and SKA require that there is someone identified to act as a liaison, or point-of-contact, between the SKA office, the construction teams and the global VLBI centres. This will occur at different levels of interaction, for example with the consortia responsible for the correlator or telescope managers. It will deal with data transport, and ensuring that the beam-formed data is in the correct format before being sent for correlation at the VLBI correlation centres. In addition, this work includes laying the foundations for establishing agreements between the SKA and the VLBI networks on issues such as proposal handling, time allocation, data rights and observation management. For instance, the SKA will expect to receive schedule blocks that conform with their telescope and observation management systems.
- Commissioning, test procedures and calibration strategy: Recognising that there is limited scope for SKA support of VLBI during the telescopes construction phase, there is a need to develop a commissioning and test plan for integrating the SKA into the VLBI network. This necessarily includes developing a calibration strategy.

In addition, in the course of much of this work it will be important to consider an upgrade path for SKA-VLBI commensurate with the development path of the SKA. The justification for this, and the requirements that would flow from there, will need to be documented and reviewed.

Task 2. Developing global VLBI science cases. The SKA1-MID will be a phased array with the capability of providing multiple beams over the field of view of individual dishes to observe multiple sources, and at the same time aid precision astrometry. The local interferometer data will complement the high-resolution VLBI results, providing simultaneous images of the sky at a broad range of angular resolutions. The unique combination of high-sensitivity and high-resolution capabilities have not been possible with traditional VLBI arrays. As such VLBI with the SKA is a fundamental tool providing for a wide range of SKA key science including maser astrometry, proto-planetary disks, Galactic and

extragalactic structure, mapping stellar magnetic fields, pulsar astrometry and the localisation of transients on all timescales. SKA1-MID will also be capable of providing triggers to the EVN for following-up transient phenomena.

Our aim is to bring together VLBI experts to work on new research projects in the field of precision astrometry, large field-of-view VLBI, VLBI surveys and transients, in order to prepare for scientific exploration of SKA-VLBI. This will result in custom-designed use cases and possible science projects, as well as surveys with traditional VLBI, or other (pathfinder) facilities in preparation for possible SKA-VLBI Key Science Programmes. Involvement of experts as well as promising young scientists is important at this stage.

The aim of this task is to bring together VLBI experts to work on new science cases under the umbrella of the high precision astrometry provided by SKA-VLBI. This will allow the optimal preparation for the full scientific exploration of the science that will be enabled by SKA-VLBI, resulting in custom-designed use cases and science projects in the many VLBI-related science areas identified in the SKA Science Book (2015), as well as surveys with traditional VLBI, SKA pathfinder facilities in preparation for possible SKA-VLBI Key Science Programmes. Involvement of established experts, as well as talented young scientists, is vital at this stage. This task will support the SKA Science and Operations Teams, the SKA VLBI Working Group (core and associated members), as well as other VLBI experts. Besides workshops, we propose to support a number of working visits.

WP Lead: JIVE (Zsolt Paragi) and SKAO (Antonio Chrysostomou)

Participation per Partner

Partner number and short name	WP10 effort
7 - SKAO	24.00
Total	24.00

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D10.1	Details on VLBI interfaces to SKA consortia	7 - SKAO	Report	Public	24
D10.2	Operational plan for inclusion of SKA in Global VLBI	7 - SKAO	Report	Public	36
D10.3	Portfolio of SKA-VLBI Science cases	1 - JIV-ERIC	Report	Public	30
D10.4	Report on SKA-VLBI Key Science Projects	1 - JIV-ERIC	Report	Public	42

Description of deliverables

D10.1 : Details on VLBI interfaces to SKA consortia [24]
 Details on VLBI interfaces to SKA consortia

D10.2 : Operational plan for inclusion of SKA in Global VLBI [36]
 Detailed operational plan for inclusion of SKA in Global VLBI

D10.3 : Portfolio of SKA-VLBI Science cases [30]
 Portfolio of SKA-VLBI Science cases with details on science requirements

D10.4 : Report on SKA-VLBI Key Science Projects [42]

Report on SKA-VLBI Key Science Projects

Schedule of relevant Milestones

Milestone number¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS33	Details on VLBI interfaces to SKA consortia	7 - SKAO	24	Details on VLBI interfaces to SKA consortia, noted by SKA VLBI working group
MS34	Operational plan for inclusion of SKA in Global VLBI	7 - SKAO	36	Operational plan for inclusion of SKA in Global VLBI, noted by SKA VLBI working group
MS35	Portfolio of SKA-VLBI Science cases	1 - JIV-ERIC	30	Portfolio of SKA-VLBI Science cases, approved by SKA VLBI working group
MS36	Report on SKA-VLBI key science projects	1 - JIV-ERIC	42	Report on SKA-VLBI key science projects, noted by SKA VLBI working group