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First e-VLBI observations of GRS 1915+105

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ABSTRACT

We present results from the first successful open call electronic very-long-baseline interferometry (e-VLBI) science run, observing the X-ray binary GRS 1915+105. e-VLBI science allows the rapid production of VLBI radio maps, within hours of an observation rather than weeks, facilitating a decision for follow-up observations. A total of six telescopes observing at 5 GHz across the European VLBI Network (EVN) were correlated in real time at the Joint Institute for VLBI in Europe (JIVE). Constant data rates of 128 Mbps were transferred from each telescope, giving 4 TB of raw sampled data over the 12 hours of the whole experiment. Throughout this, GRS 1915+105 was observed for a total of 5.5 h, producing 2.8 GB of visibilities of correlated data. A weak flare occurred during our observations, and we detected a slightly resolved component of 2.7 × 1.2 ms with a position angle of 140° ± 2°. The peak brightness was 10.2 mJy per beam, with a total integrated radio flux of 11.1 mJy.

Key words: ISM: jets and outflows – X-ray binaries: individual: GRS 1915+105.

1 INTRODUCTION

The use of the Internet for electronic very-long-baseline interferometry (e-VLBI) data transfer offers a number of advantages over conventional recorded VLBI, including improved reliability due to real-time operation and the possibility of a rapid response to new and transient phenomena. Decisions on follow-up observations can be made immediately after the observation rather than delayed by potentially weeks due to problems in shipment of tapes/discs to the correlator. The first open call with a suitable Greenwich Sidereal Time range for observations of GRS 1915+105 using the e-EVN (electronic European VLBI Network)[1] gave us the opportunity to test e-VLBI under operational conditions. A number of recent test runs have shown that 128 Mbps data rates can be obtained reliably for the six European telescopes; Cambridge, Jodrell Mk2, Medicina, Onsala, Torun and Westerbork, currently connected via national and international research networks to the EVN correlator at Joint Institute for VLBI in Europe (JIVE). Steps are currently being taken to improve the reliability of 256 and 512 Mbps connections, and also to develop 1 Gbps transmission as part of the EXPReS[2] project.

Microquasars are ideally suited for study by e-VLBI as they often have flares associated with the ejection of radio-emitting clouds in the form of jets. Time-scales of this emission are in the range of hours to days at cm wavelengths, and decisions about subsequent observations need to be taken quickly.

The X-ray binary GRS 1915+105 was first discovered in 1992 (Castro-Tirado, Brandt & Lund 1992) by the WATCH instrument on the *Granat* satellite. The system comprises a low mass, K-M III star (Greiner, Cuby & McCaughrean 2001b) companion and a 14 ± 4 $M_\odot$ black hole (Greiner, Cuby & McCaughrean 2001a). It was the first Galactic source observed to display superluminal motion, and is well known for its rapid variability and strong variable radio flux. It spends the majority of its time in relative radio-quiescence, with low radio and X-ray brightness, and with a characteristic low/hard state X-ray spectrum. In such a state the source is thought to be 'jet-dominated' (Fender, Gallo & Jonker 2003), with a ∼50 au scale inner radio jet (Dhawan, Mirabel & Rodríguez 2000) present. Transitions to the soft state are often accompanied by strong radio flares with the ejection of a high velocity component out to distances of

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[1] http://www.evlbi.org/evlbi

[2] http://www.expres-eu.org