Objectives

The main objective of BRAND EVN (BRoad bAND EVN) is to develop and build a **prototype broad-band digital receiver**, which will cover a **frequency range from 1.5 GHz to 15.5 GHz** (1:10 range, chosen to include the 2 cm VLBA band). The BRAND frontend can be adapted to different EVN antennas. The backend part can also be used for other receivers with a RF frequency or IF range between 0-16 GHz. The BRAND receiver when deployed at a majority of EVN telescopes will:

- Open a range of new scientific opportunities like multi-wavelength: VLBI mapping, spectroscopy, polarimetry, and single-dish, as well as geodetic VGOS (VLBI2010 Global Observing System) compatibility, due to its enormous simultaneous bandwidth.
- Catapult EVN to new levels of performance not achievable with any other astronomical VLBI network.
- Influence cost for maintenance and energy for cooling by replacing multiple VLBI receivers in the frequency range of 1.5-15 GHz.
- Increase the available observing time offered by EVN, as more than one frequency can be observed simultaneously.
- Offer even greater sensitivity, as the reduction in sensitivity of such a broad-band receiver compared to narrow-band receivers will be more than compensated by the enormous data-rate resulting from the wide bandwidth.
- Have an impact on the design of new telescopes, which could be optimized for a BRAND receiver, and would profit from a smaller number of required receivers.

Project plan

projet management

Feasibility survey of EVN antennas

The specifications for the installation of a BRAND receiver at the EVN antennas will be collected.

BRAND receiver frontend

Primary focus feed including RFI filters

Different broad-band feeds for prime focus will be evaluated (e.g. Quad-ridge feed horn - QRFH, Eleven-feed, Dyson conical quad-spiral array - DYQSA). Possibilities for injecting noise-calibration signals at the feed level will be investigated. An optimal feed for the prototype Effelsberg system will be chosen. Appropriate filters for suppressing the strongest RFI, which would saturate the amplification chain, will be identified and the corresponding low-pass, high-pass and notch high-temperature superconductor (HTS) bandpass filters will be manufactured.

Low Noise Amplifier (LNA)

An Indium Phosphide (InP) MMIC single broad-band LNA optimized for the 1.5–15.5 GHz frequency range will be designed and manufactured.

Cryostat and integration and testing of receiver frontend

A dewar for the prototype frontend system to be installed at the Effelsberg antenna will be manufactured. All frontend components will be integrated. Characterization and testing in the laboratory will be done.

Solutions for secondary focus

Feed solutions for EVN telescopes, which will not be able to mount a BRAND receiver at their primary focus will be investigated. Results and recommendations will be summarized in a report that will be available to all interested partners/observatories.

BRAND receiver backend

Sampling board

Before the wide-band frontend signal can be sampled, it has to be amplified and equalized; an analogue board for this task has to be built. The BRAND backend will require sampling devices, which transfer the analogue signal to the numeric domain for a very wide band. Sampling boards making use of the sampling chips will be designed and manufactured. Additionally firmware for configuration and control of the boards will be developed.

High data rate processing board

A board with a single FPGA processor will be developed including the hardware platform with its firmware engine. The board will have an input data rate of 896 Gbps and 128 Gbps as output.

FPGA firmware

For processing linearly polarized feeds, digital linear to circular polarization conversion will be realized in firmware. Additional firmware will
be developed for the various VLBI modes like direct sampling conversion (DSC), digital down-conversion (DDC), polyphase filterbank (PFB), etc.

Backend integration and tests

All backend components will be integrated and tested in the laboratory.

Control, recording and correlation software

Control software for the BRAND frontend and backend systems will be developed, which will allow users to perform various setup and configuration tasks.

This task will provide a software layer that will distribute the data stream and control and monitor the data recorders.

The correlator software will be extended to allow unpacking of the data format delivered by the BRAND backend. In addition, the data products delivered by the correlator will need to be compatible with the post-processing software. In particular, post-processing of broad-band data as produced by BRAND will require special fringe-fitting capabilities as the ones, which will be provided by the RadioNet RINGS project.

Integration at telescope and test observation

Effelsberg

[Effelsberg integration](#)