BRAND EVN

(BR*oad-b*AND EVN)

Joint Research Activity in RadioNet4

Gino Tuccari & Walter Alef plus partners

“digital” VLBI-receiver:

~1.5 - 15.5 GHz

for the EVN

and other telescopes

Prototype for prime focus

+ research for secondary focus

EVN Observing Bands < 22GHz

Today in the EVN separate receivers cover:

- 18 cm - L band
- 13 cm - S band
- 6 cm - C band
- 5 cm - C (Methanol-OH)
- 4 cm – X band
- In each EVN session ~3 freqs. observed in succession
- No multi-band simultaneous observations

New Opportunities

can develop multi-wavelength VLBI now!

- Broad-band LNAs and feeds (e.g. VGOS, DIVA)
- backends with very high data rates
  see JRA DIVA: DBBC3 with 2x 4GHz (dual pol) - 32Gbps
  for VGOS 32 up to 128 Gbps
- High bit-rate recorders: Mark 6
  Flexbuffer
  FILA40G

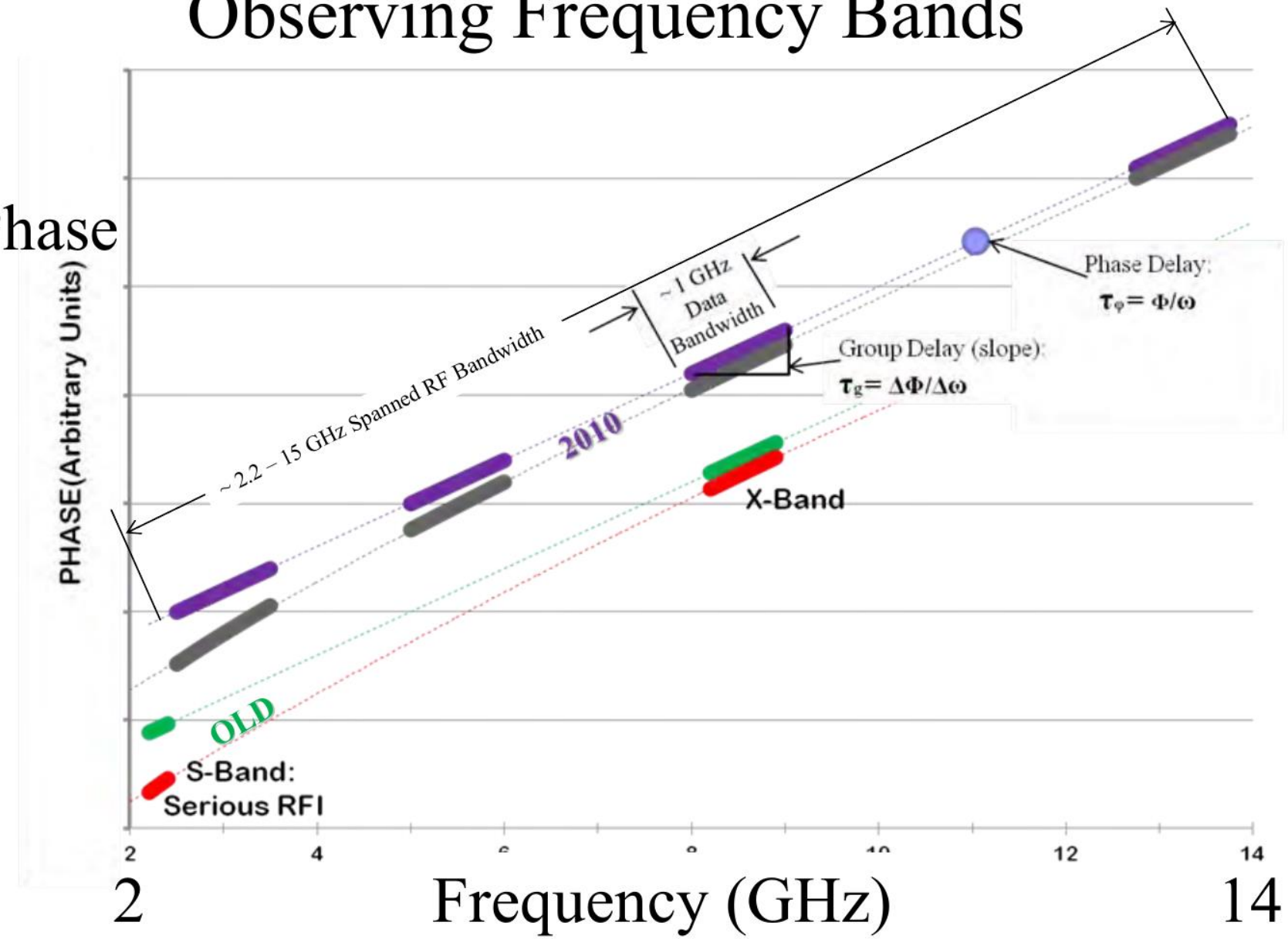
Scientific motivation - fast frequency switching

- VLBA offers fast frequency switching (~7 s) between 2 or 3 frequencies
  - high user demand
  - saves valuable observing time
  - spectral index maps
  - if phase-referencing is used: precise registration of source positions
  - precise measurement of core-shift
- is wanted for the EVN for more than 15 y!

Scientific motivation - multiwavelength VLBI

- simultaneous multi-frequency observations - a la VGOS
  - with fringe-fitting over very wide frequency range (cf. VGOS)
  - will determine ionosphere

Observing Frequency Bands



Scientific motivation - multiwavelength VLBI (cont)

- precise registration of simultaneous images at different frequencies
- UV-coverage greatly improved due to wide frequency band

multi-frequency imaging software available

superior to fast switching!

Scientific motivation - multiwavelength VLBI spectroscopy

- study several different maser types in different frequency bands simultaneously
- alignment of different maser species
  - e.g. determine conditions in complex flow patterns

Scientific motivation - multiwavelength VLBI polarimetry

- variations of polarised emission as a function of frequency over a very wide frequency range
- precise unambiguous rotation measures
- improve studies of physical conditions of various astronomical objects

Scientific motivation - multiwavelength single dish

- flux variation studies in several bands simultaneously
  - especially interesting for intraday variability
- pulsar observations over a wide frequency range
  - no timing ambiguities

Scientific motivation - compatibility with VGOS antennas

- joint observations with geodetic VGOS antennas would be possible
- precise positions of astronomical antennas
- celestial reference frame
- huge arrays for astronomical observations if needed

BROAD BAND 1.5-15.5 GHz

PROPOSAL

- **Single cooled receiver covering the broad-band for astronomy with linear polarization feed**
- Starting from e.g. the ten years VGOS developed technology (feeds, backends, recorders)
- **New**: Analogue signal processing without any frequency conversion **and huge sky frequency range + extremely high bit-rate**

BROAD BAND 1.5-15.5 GHz

PROPOSAL (analogue)

- Survey of individual EVN antennas!
  - Feed options (prime/secondary), RFI, interfaces
  - will select prime focus as demonstrator
  - research on options for secondary focus solutions
  - **aim is to install the BRAND receiver in the whole EVN**
- QRFH feed from Onsala (e.g. JRA DIVA)
- DYQSA feed from Yebes
- ELEVEN feed from Onsala

BROAD BAND 1.5-15.5 GHz

- **PROPOSAL** (analogue)
- Cryogenic HTS (High Temperature Superconductor) filters for strong RFI
- Wide-band LNA (e.g. Yebes)
- Analogue signal processing: only LNA and amplification chain

BROAD BAND 1.5-15.5 GHz

PROPOSAL (digital, firmware)

- Fully digital multi-bit (8) broad-band sampling and data processing
  - starting from the DBBC3H with: sampling 0 GHz - 15.5 GHz
  - output data-rate up to 128 Gbps
- Broad-band digital receiver together with frontend
  - also universal back-end for VGOS, other 'receivers' are included
- Fully digital down-conversion and/or band selection: DSC/PFB/DDC
  - Output channel selection means also selection of the observing band

=> **MULTI-BAND SIMULTANEOUS OBSERVATIONS !**

BROAD BAND 1.5-15.5 GHz

PROPOSAL (firmware)

- Digital polarization conversion from linear to circular
- Additional digital RFI mitigation
- - Local RFI ‘fingerprint’ determination at stations
- Multi-band total power detector
- Multi-band polarimeter
- - (and spectrometer...)

Advantages for EVN

User:

- new improved science
- “more” observing time

Telescopes

- fewer receivers to maintain
- “more” observing time

EVN could take lead in VLBI observing with novel capabilities

Aims / Work packages

- Survey: determine boundary conditions for EVN telescopes (interfaces, focus, RFI ...)
- Develop feed for prime focus
- Investigate feed solutions for secondary focus
- Develop prototype receiver for selected antenna including dewar etc. (prime focus)
- Develop digital sampler, adapt processing unit
- Adapt existing/write new firmware and control software
- Integration and test

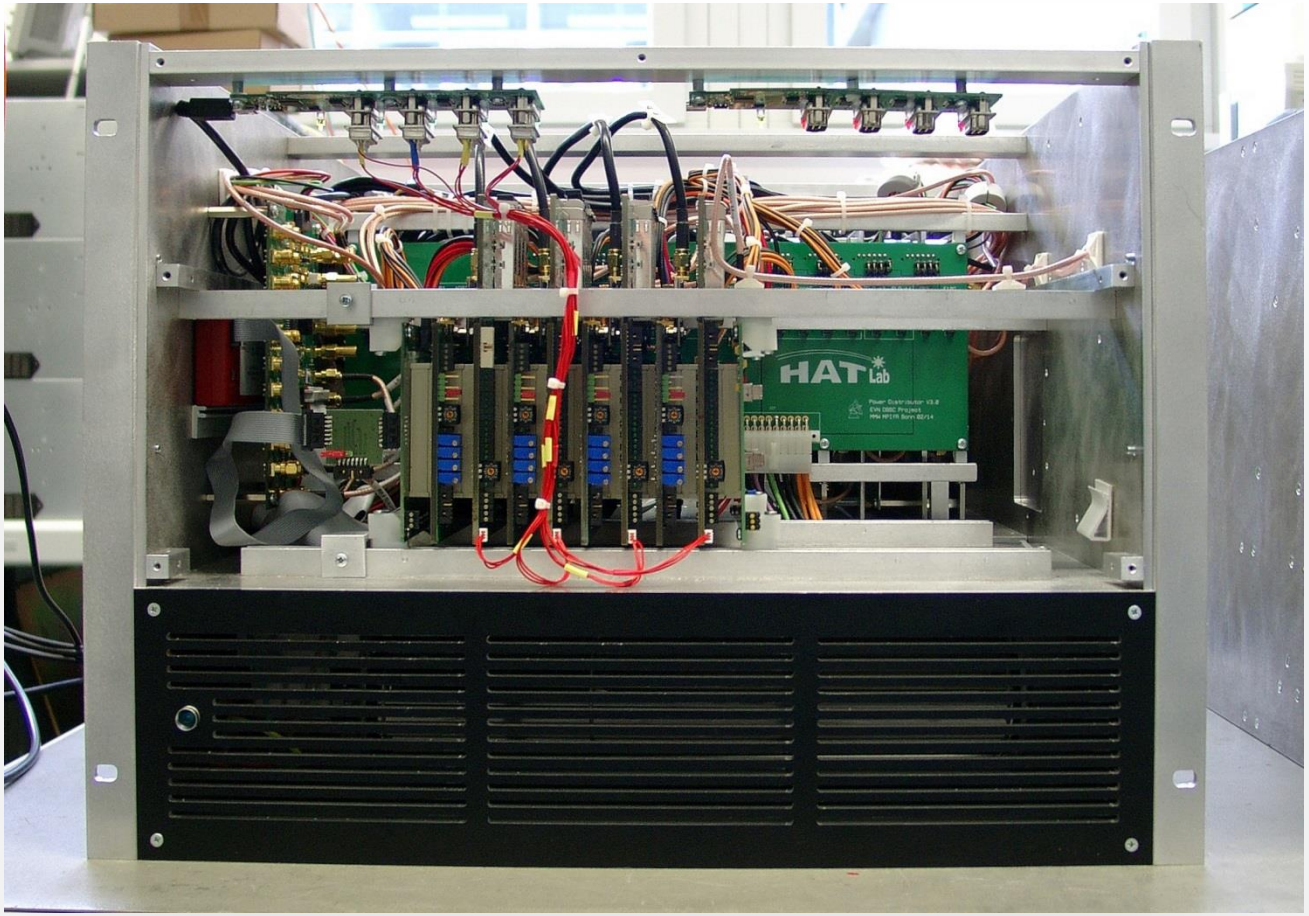
PARTNERS

- MPI
- INAF
- OSO
- YEBES
- ASTRON
- VIRAC

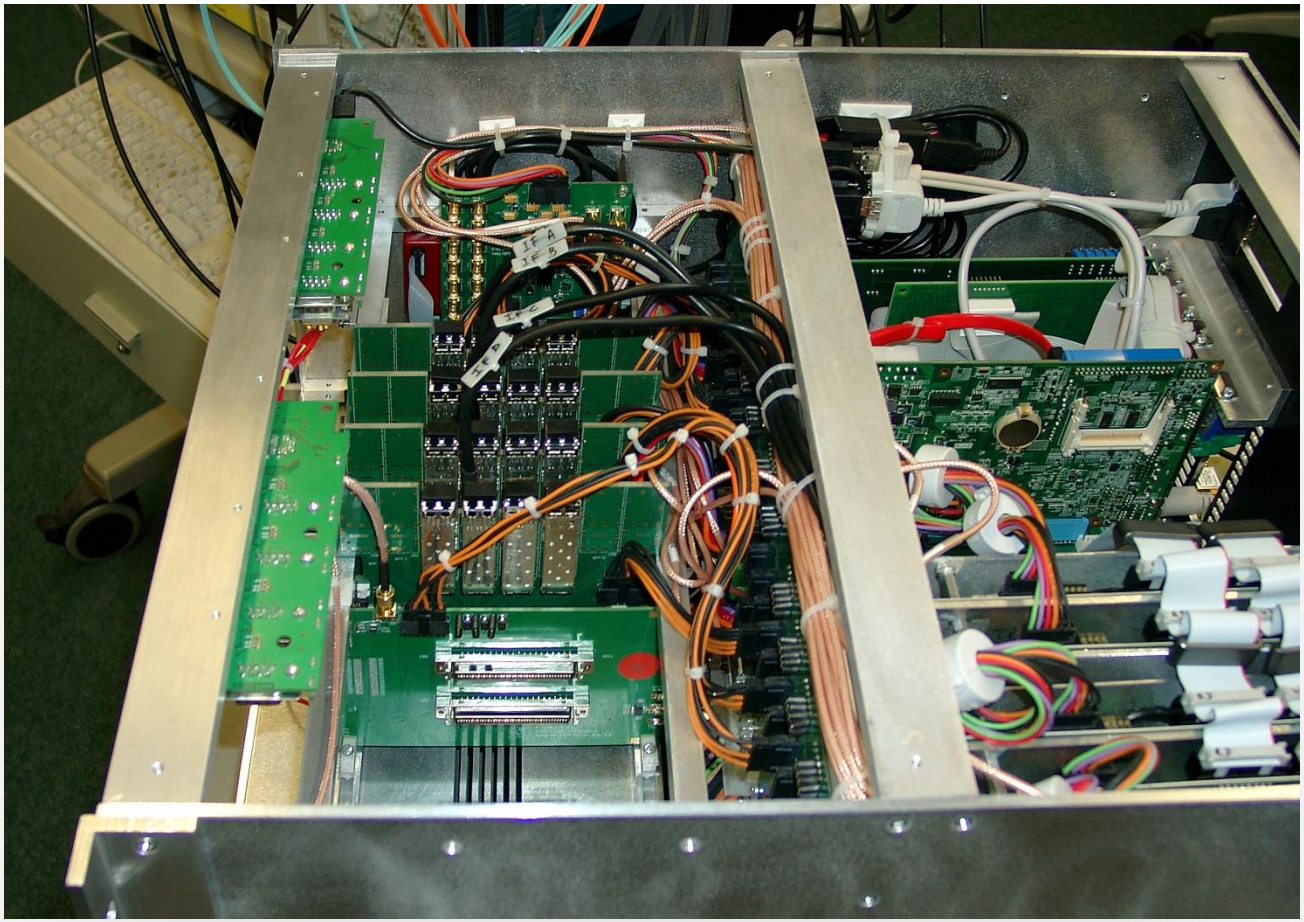
- Formal Radionet3 project ends in 2015
- 4 GHz IF each producing std 16Gbps@2-bit
  (max. 64 Gbps@8-bit)
- 1-8 IFs in a single system (max. 512 Gbps@8-bit)
  for EVN dual pol IF (<=32 Gbps)
  for full VGOS 8 IFs dual pol 2-14 GHz
  (<=128 Gbps)
- input 0-4 GHz / 4-15 GHz pre-filtered adapter
- different architectures possible with VSI-H interfaces and/or 10GE SFP+

DBBC3L current status

DBBC3L front view



DBBC3L front view



DBBC3L top view

DBBC3L rear view