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
  soon up to 128 Gbps

- High bit-rate recorders: Mark 6 (64 Gbps w. 4 units @EHT)

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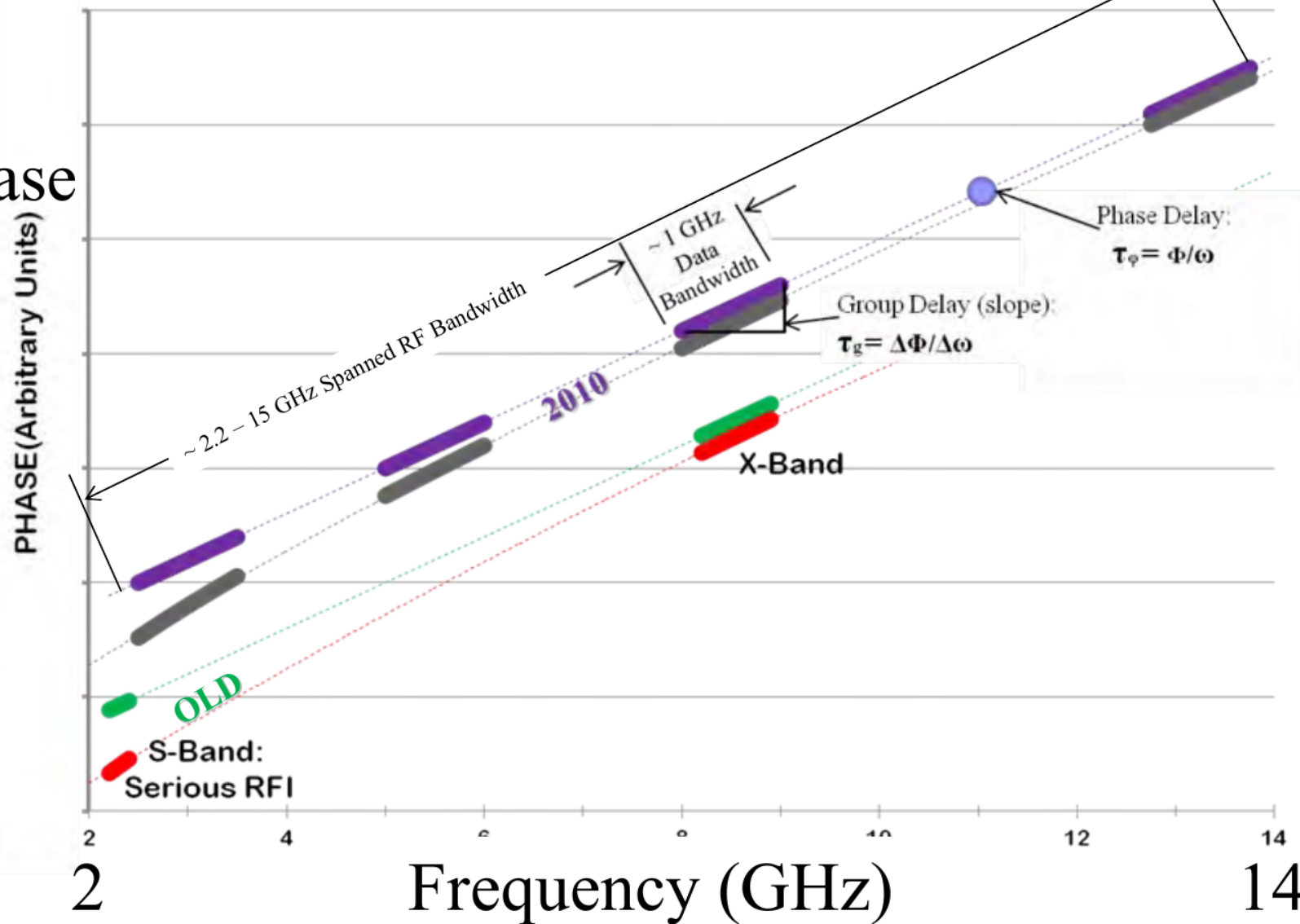
- VLBA offers fast frequency switching (~7 s) between 2 or 3 frequencies
  - high user demand
  - saves valuable observing time
  - spectral index maps
  - if phase-referencing is used: precise registration of source positions
    - precise measurement of core-shift
- is wanted for the EVN for more than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

Phase

PHASE(Arbitrary Units)

~ 1 GHz Data Bandwidth

~ 2.2 – 15 GHz Spanned RF Bandwidth

2010

Phase Delay:
$\tau_\varphi = \Phi/\omega$

Group Delay (slope):
$\tau_g = \Delta\Phi/\Delta\omega$

X-Band

OLD

S-Band:
Serious RFI

2

Frequency (GHz)

14

Scientific motivation - multiwavelength VLBI

- simultaneous multi-frequency observations - a la VGOS
  - with fringe-fitting over very wide frequency range (cf. VGOS)
  - will determine ionosphere (JRA RINGS)
  - **precise registration of simultaneous images at different frequencies**
- But superior to VGOS due to continuous freq. coverage (RFI filters !!)

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 <u>without</u> any frequency conversion **and huge sky frequency range + extremely high bit-rate**

BROAD BAND 1.5-15.5 GHz

PROPOSAL

- 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: <u>only</u> LNA and amplification chain

BROAD BAND 1.5-15.5 GHz

PROPOSAL (digital, firmware)

- Fully digital broad-band sampling and data processing
  - next version of DBBC3 with: sampling 0 GHz - 15.5 GHz
  - output data-rate up to 128 Gbps

- Broad-band digital receiver together with frontend
  - but also universal back-end for VGOS, other receivers

- Fully digital down-conversion and/or band selection: DSC/PFB/DDC
  - Output channel selection means also <u>selection of the observing band</u>

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

BROAD BAND 1.5-15.5 GHz

PROPOSAL (firmware)

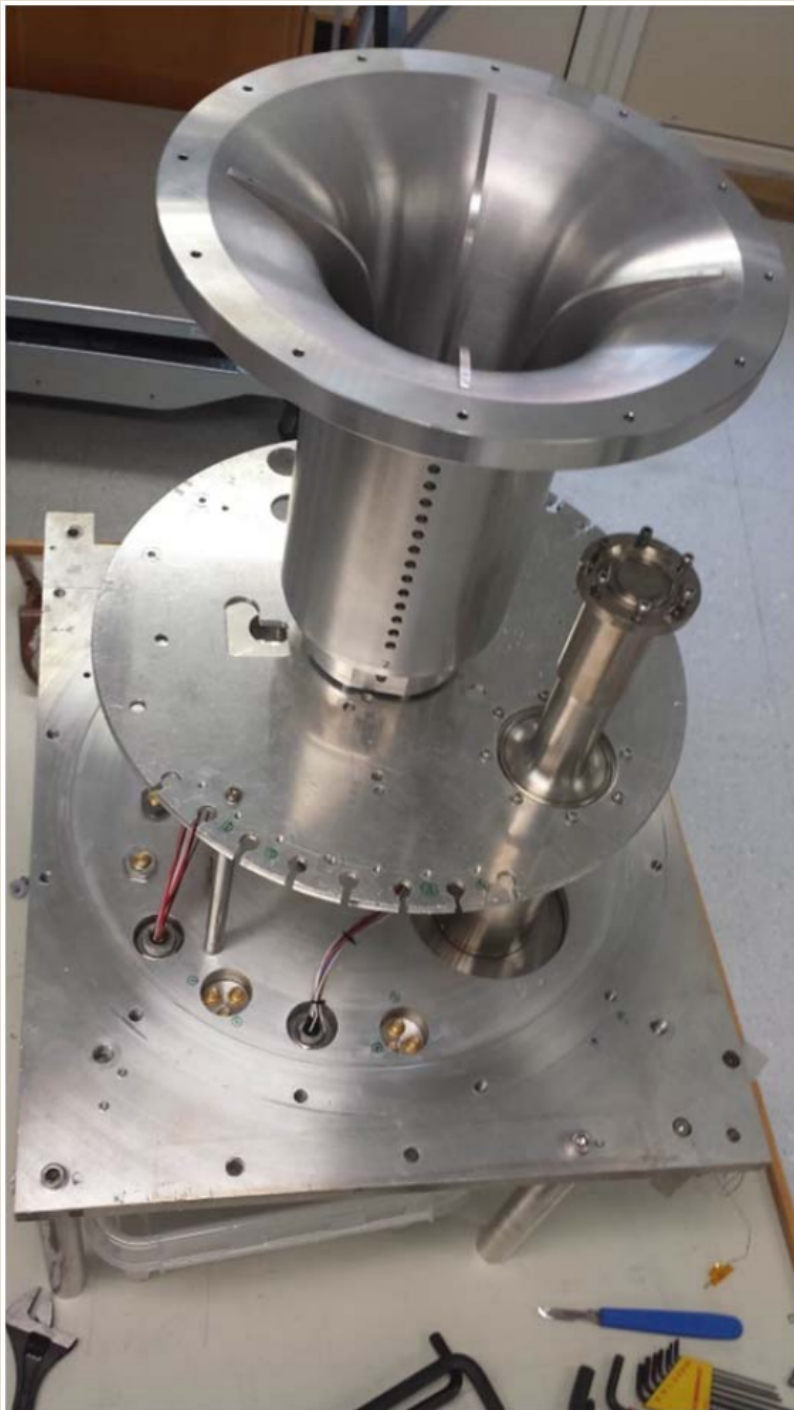Digital polarization conversion from linear to circular

Additional digital RFI mitigation

    - Local RFI 'fingerprint' determination at stations

Multi-band total power detector

Multi-band polarimeter
      - (and spectrometer...)

Quad-ridge feed horn as tested by Onsala

Feed horn ready to be placed into dewar

Advantages for EVN

User:
- new improved science
- "more" observing time

Telescopes
- fewer receivers to maintain (2 with SEVN)
- "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 (no cost)