



I N A F



Max-Planck-Institut
für
Radioastronomie



BRAND EVN

(BRoad-bAND EVN)

Joint Research Activity in RadioNet4

Gino Tuccari & Walter Alef plus partners



ASTRON

Netherlands Institute for Radio Astronomy



“digital” VLBI-receiver:

~1.5 - 15.5 GHz

for the EVN

and other telescopes

**Prototype for prime focus
+ research for secondary focus**

Background: EVN Observing Bands

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

(21 cm; 1.3 cm; 7mm only globals; 50 cm)

In each EVN session ~3 freqs. observed in succession

No multi-band simultaneous observations

New technical Opportunities

- Broad-band LNAs and feeds
 - e.g. VGOS, **VINA** 1.5 GHz - 5.5 GHz
- backends with very high data rates
 - see JRA **VINA**: DBBC3 with 2x 4GHz dual pol - 32Gbps soon up to 128 Gbps
- High bit-rate recorders:
 - Mark 6 (64 Gbps w. 4 units @EHT)
 - Flexbuff

can develop multi-wavelength VLBI now!

Scientific motivation - fast frequency switching

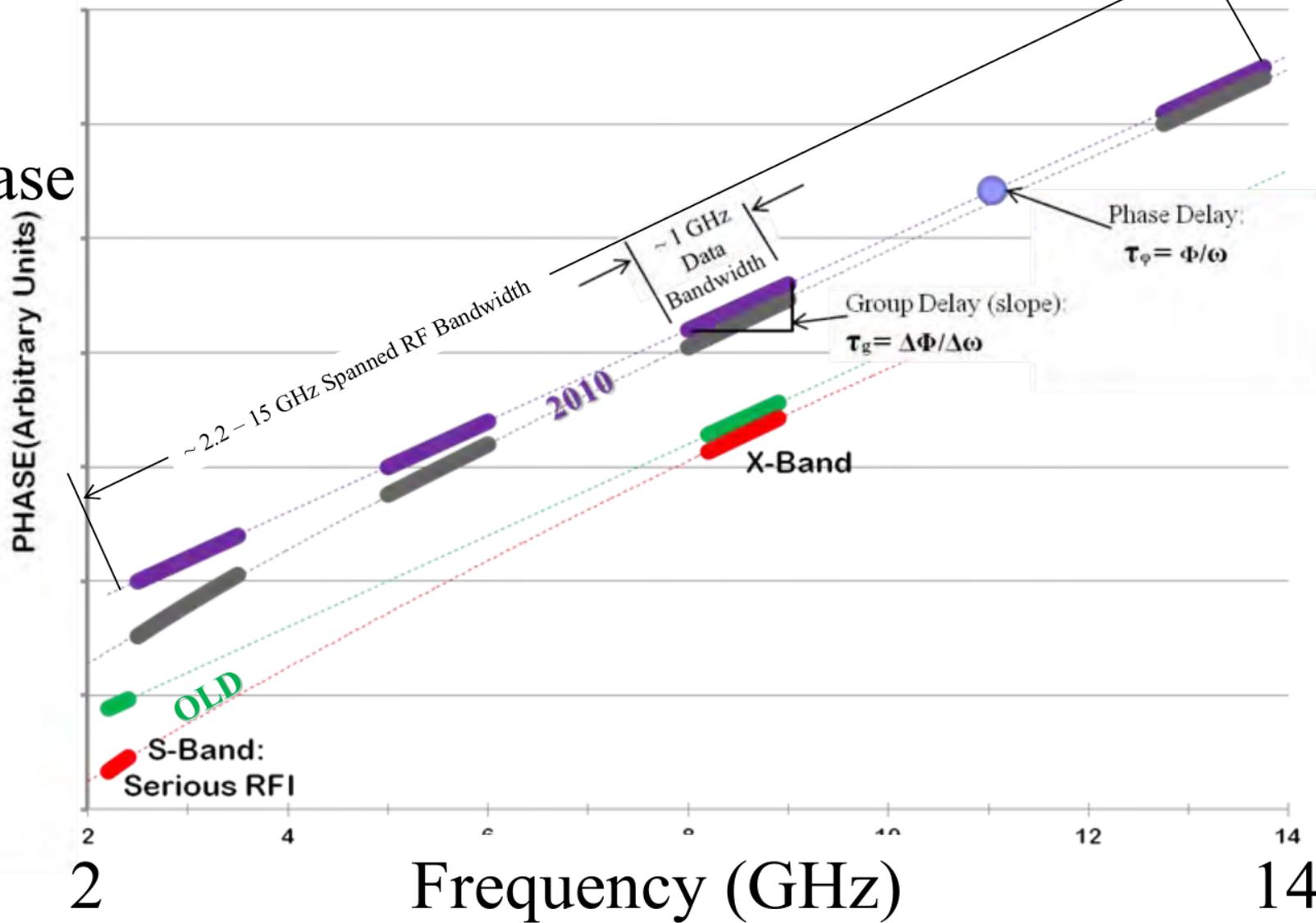
- VLBA offers fast frequency switching (~ 7 s) between 2 or 3 frequencies
 - high user demand
 - saves valuable observing time
 - spectral index maps
 - if phase-referencing is used: precise registration of source positions
 - precise measurement of core-shift
- is wanted for the EVN for more than 15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



Scientific motivation - multiwavelength VLBI

- simultaneous multi-frequency observations - a la VGOS
 - with fringe-fitting over very wide frequency range (cf. VGOS)
 - will determine ionosphere (RN4 JRA-RINGS)
 - **precise registration of simultaneous images at different frequencies**
- But superior to VGOS due to continuous freq. coverage (RFI filters !!)

Scientific motivation - multiwavelength VLBI (cont)

- superior to fast switching!
- UV-coverage vastly improved due to wide frequency band
 - multi-frequency imaging software available
- Compatible with VGOS
 - joint observations
 - Antenna positions & ICRF

Scientific motivation (cont.)

- Spectroscopy of several different maser types in different frequency bands simultaneously
- Variations of polarised emission as a function of frequency over a very wide frequency range
- Single dish:
 - flux variation studies (many bands)
 - rotation measures over large bandwidths
 - pulsar observations over a wide frequency range

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

- 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**

BROAD BAND 1.5-15.5 GHz

PROPOSAL (feed)

Prime focus:

- QRFH feed from Onsala (e.g. JRA **DINA**)
- DYQSA feed from Yebes
- ELEVEN feed from Onsala

Scoundary focus (only study)

- Ninja feed (Japan)

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 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 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

PARTNERS

- MPI
- INAF
- OSO
- YEBES
- ASTRON
- VIRAC (no cost)