BRAND EVN

(BR*oad-b*AND EVN)

Joint Research Activity in RadioNet4

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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

Switching time from seconds to hours depending on the station (EVN)

Different physical receivers imply:

Mechanical different positions in the antenna focus

Cryogenic cooling of all systems in the antenna

Different pointing models - have to load software for different receivers

NO MULTI-BAND SIMULTANEOUS OBSERVATIONS

EVN has fast frequency switching as high priority goal for > 15 years

New Opportunities

- **can develop multi-wavelength VLBI now!**
- backends with very high data rates (see JRA DIVA: DBBC3 with up to 128 Gbps; 4x 4GHz dual pol - 32Gbps)
- High bit-rate recorders: Mark 6 (64 Gbps w. 4 units @EHT)
- Broad-band LNAs and feeds
- **Scientific opportunities:**
  - multi-wavelength VLBI mapping
  - multi-wavelength spectroscopy
  - multi-wavelength polarimetry
  - multi-wavelenght single-dish
  - geodetic VGOS compatibility
- **New: no different LOs and huge sky frequency range**

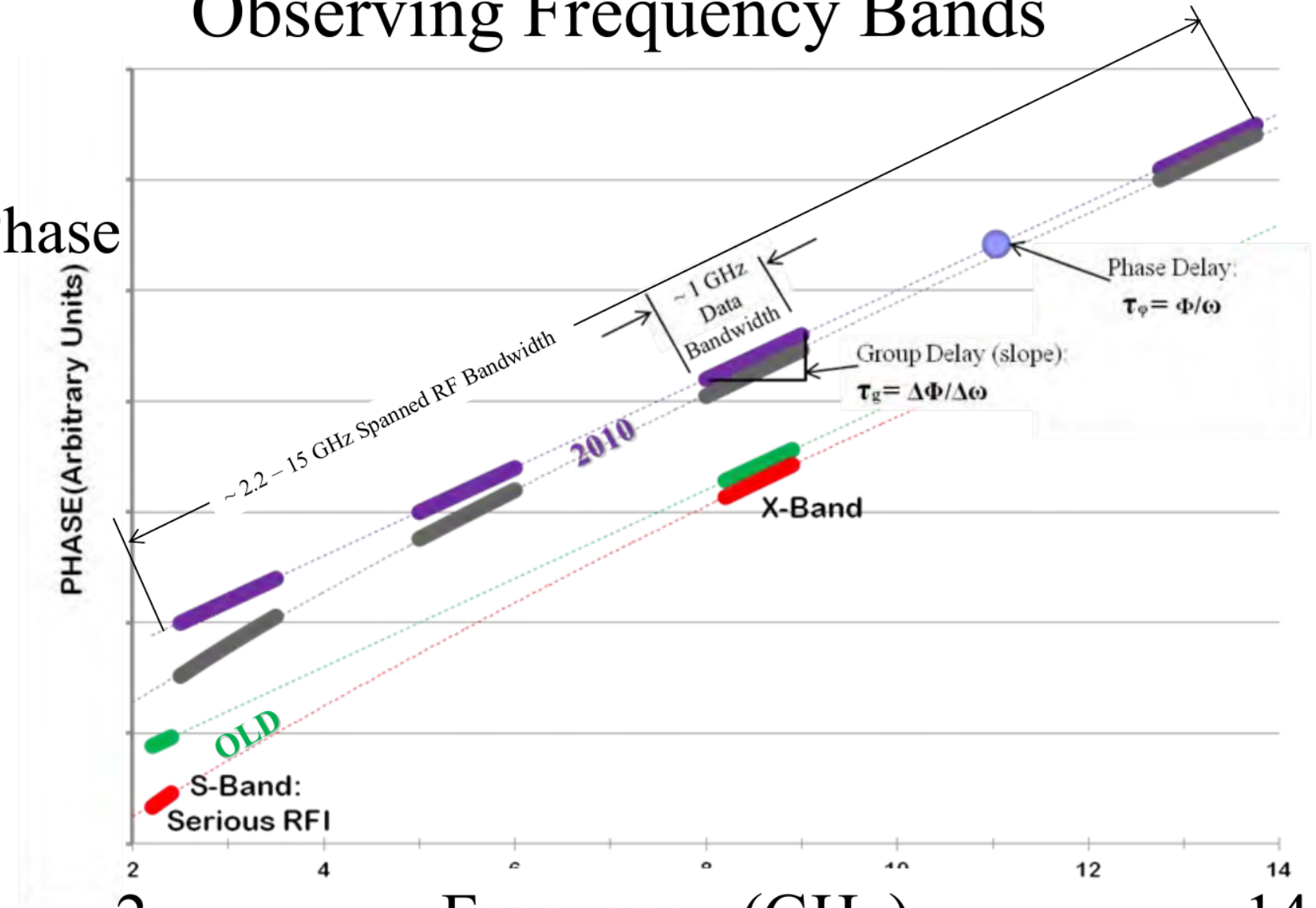
Scientific motivation - fast frequency switching

- 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

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

PROPOSAL

Single cooled receiver covering the broad-band for astronomy with linear polarization feed

Starting from the ten years VGOS developed technology (feeds, backends, recorders)

New: Analogue signal processing without any frequency conversion

Analogue signal process only LNA and amplification chain, plus filtering of strong RFI

BROAD BAND 1.5-15 GHz

PROPOSAL (continue)

Fully digital broad-band sampling and data processing

Broad-band digital receiver (= back-end)

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 GHz

PROPOSAL (continue)

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

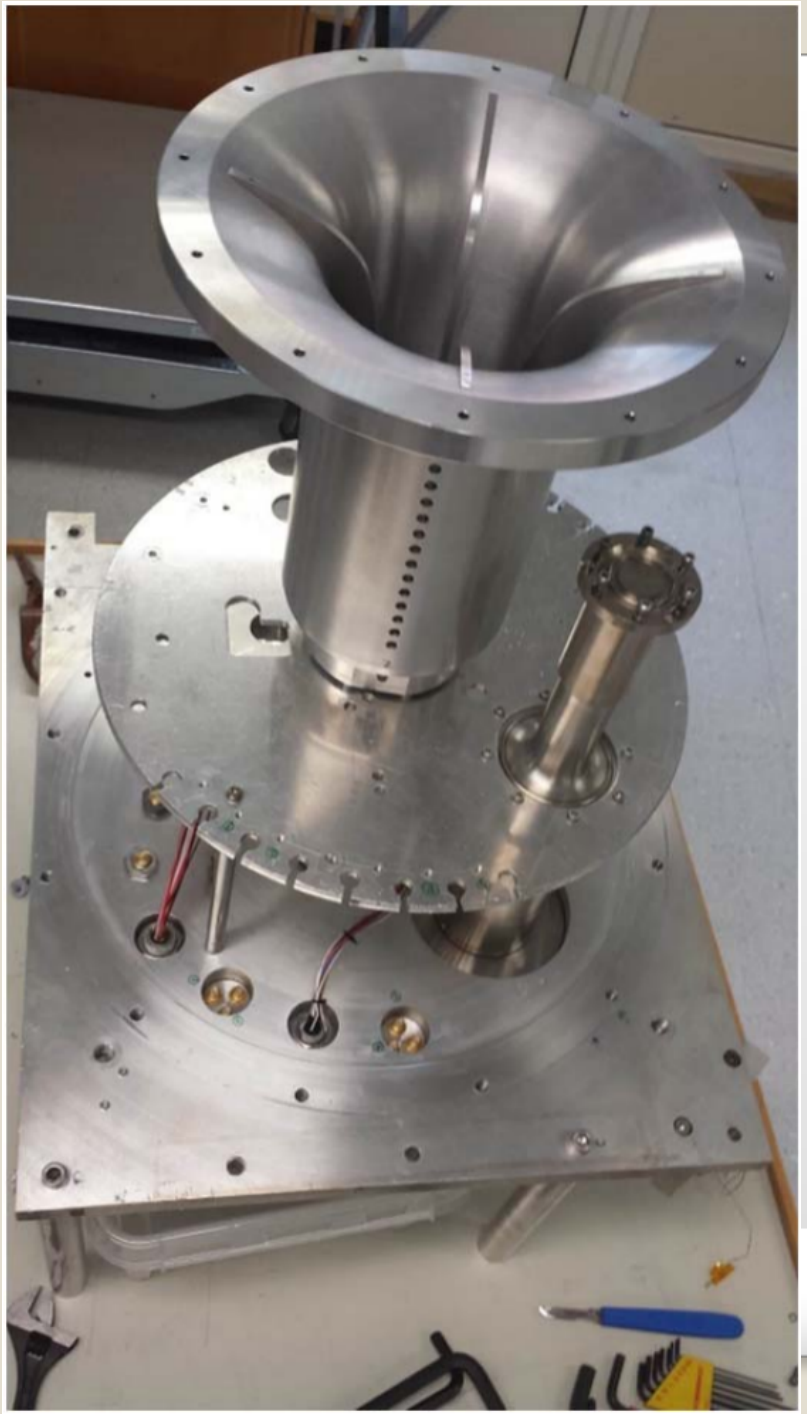
- (and spectrometer...)

Existing (or under development) 2-14 GHz analogue VGOS technology to start from

QRFH feed from Onsala (e.g. JRA DIVA)
DYQSA feed from Yebes
ELEVEN feed from Onsala

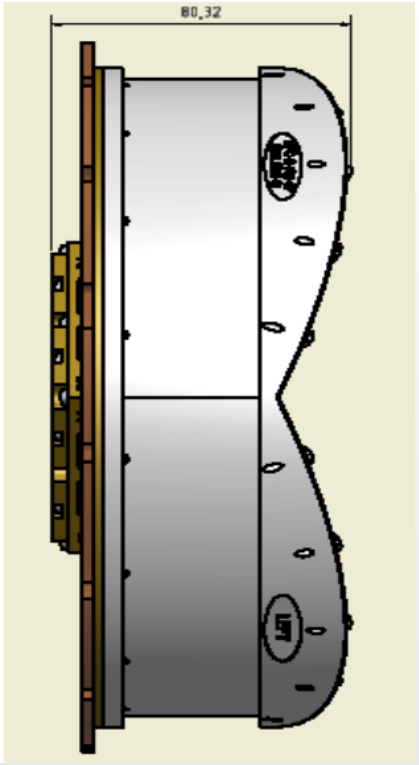
Broad-band LNA (MPI & IAF or Yebes?)

Cryogenic HTS (High Temperature Superconductor) filters (Noto-Effelsberg)



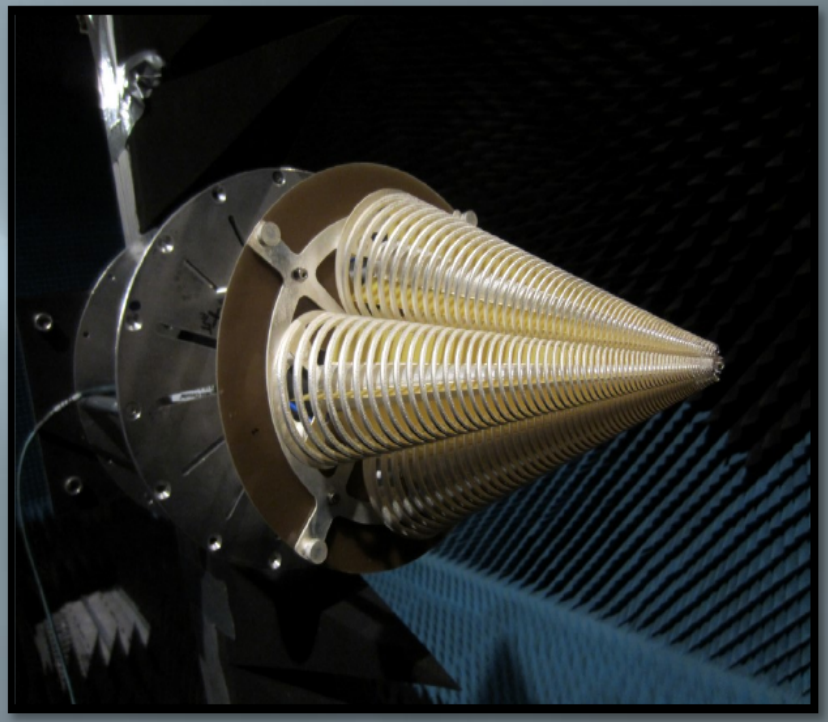
Quad-ridge feed horn as tested by Onsala

Feed horn ready to be placed into dewar


80,32

DYQSA

- Band: 2-14 GHz
- Dual circular polarization
- Gain < 10 dB
- Beamwidth (-16dB): 130°



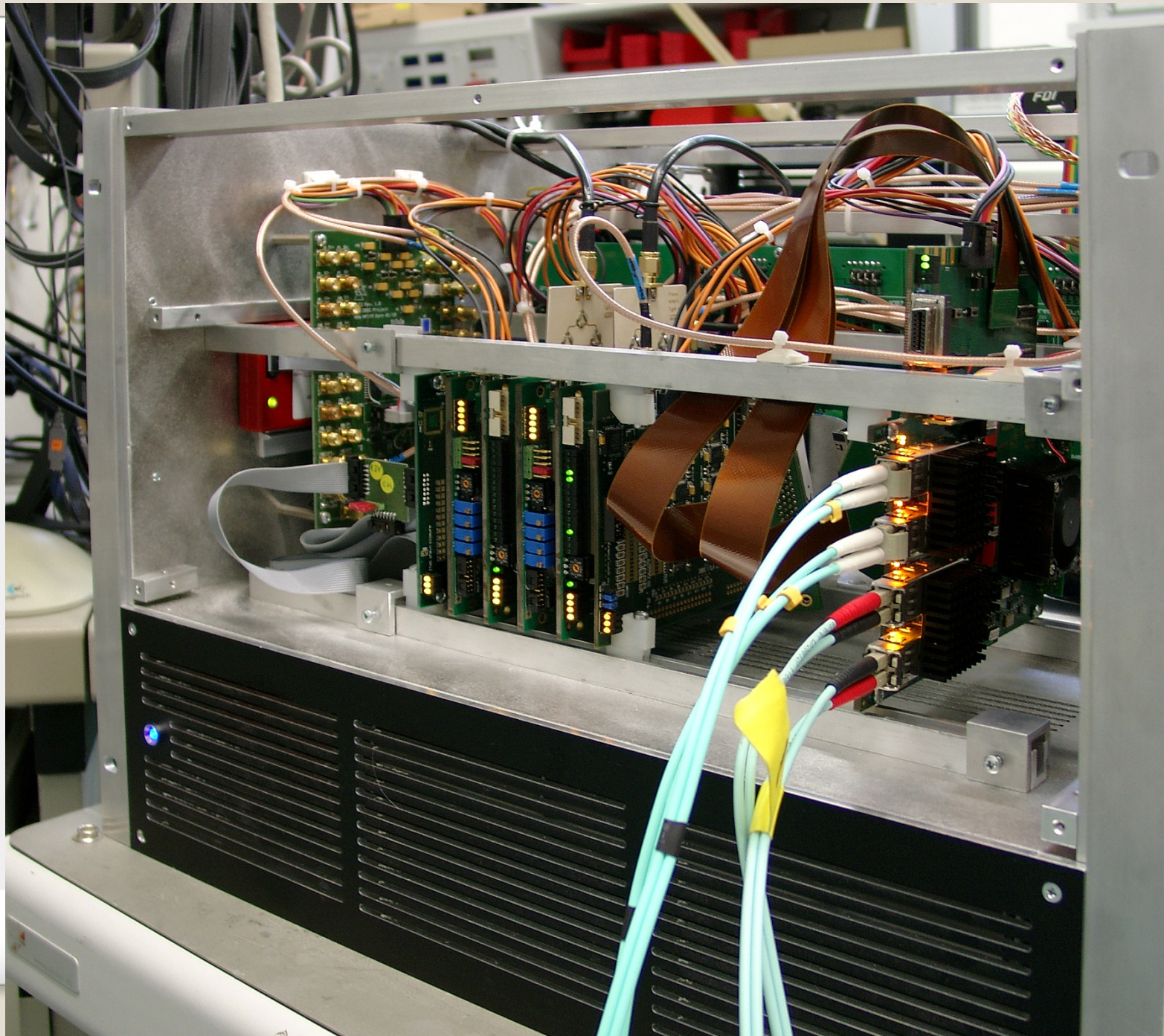
Existing (or under development) 2-14 GHz analogue VGOS technology to start from

DBBC3H backend with data-rates up to 128 Gbps
(~<64 Gbps needed for 2x full band)

data recorders with rates up to 32 Gbps
e.g. ALMA 4 x 16 Gbps recorders (Mark 6)


DBBC 3
EUROPEAN
NETWORK
HAT Lab

DBBC3L-2L2L



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

- Determine suitable and interested EVN telescopes
- Determine boundary conditions for EVN telescopes (Interfaces, focus, RFI ...)
- Develop feed for prime focus and investigate feed for secondary focus
- Develop prototype receiver for selected antenna and the analogue part (prime focus)
- Develop digital sampler, adapt processing unit
- Adapt existing/write new firmware and control software
- Integration and test

PARTNERS

- MPI
- INAF
- OSO
- YEBES
- IAF
- ASTRON