Antenna Sets, Subbands and RCU Bands (Modes)

Antenna Sets

In international mode, we recommend using either the `LBA_OUTER` or `HBA_JOINED` antenna sets, depending on the part of the instrument you intend to use. The remaining antenna sets are mostly used in the core and remote stations depending on the needs of observers to full out different parts of the UV-plane when observing with multiple stations

`LBA_OUTER` can be used with bands 10_90 or 30_90, while `HBA_JOINED` can be used with 110_190, 170_230, 210_250. The properties of each of these bands are described below.

The choice of antenna-set and band in your `beamctl` command, with the `--antennaset` and `--band` flags will chose how the station operates.

RCU Band	RCU Clock (MHz)	Lower Frequency (MHz)	Upper Frequency (MHz)	Subband Width (MHz)
10_90	200	0	100	0.1953125
30_90	200	0	100	0.1953125
110_190	200	100	200	0.1953125
170_230	160	160	240	0.15625
210_250	200	200	300 (~260 effective)	0.1953125

RCU Bands (Modes)

The RCU band (formally known as RCU mode, now referred to as 'bands', configured via the --band flag) allows you to set the observing window for a given set of RCUs. While the band of each antenna polarisation can be configured to be independent on any other antenna (allowing for configurations such as KAIRA's Mode 3-5-7), we recommend only using a single observing band and use multiple observing epochs to see a source over multiple modes to allow for the use of the entire antenna set to maximise the sensitivity and keep a reasonable and predictable beam shape for each observation.

The name of each band roughly describes the frequencies at which the electronics will have a negligible effect on the observed data. Outside of these ranges, the Nyquist zone or other filters may suppress emission at certain frequencies, even if they are available at specific subbands.

Mode 0, 1, 2

These modes are the OFF, Low-band Low (200MHz) and Low-Band Low (160MHz) observation modes, they should not be be used on international stations and are meant to selectively use different parts of the array in the core and remote stations.

Mode 3 (Band '10_90')

Mode 3 is the standard LBA observing mode, using the entire set of LBA antenna and the 200MHz clock, covering 0MHz to 100MHz.

Mode 4 (Band '30_90')

Mode 4 enables observation with the entire set of LBA antenna and the 200MHz clock, with an additional high-pass filter to reduce the effects of bright signals below 30MHz, but allowing for observations from 0MHz to 100MHz.

Mode 5 (Band '110_190', "HBALo")

Mode 5 is the standard HBA observing mode, enables observing with the HBA tiles and the 200MHz clock covering 100MHz to 200MHz.

Mode 6 (Band '170_230')

Mode 6 enables observing with the HBA tiles and the 160MHz clock, covering 160MHz - 240MHz.

Mode 7 (Band '210_250', "HBAHi")

Mode 7 enables observing with the HBA tiles and the 200MHz clock. It has a reduced bandwidth compared to the other modes as a result of significant amounts of RFI and antenna attenuation being present above ~240MHz, but allows for observations from 200MHz to 250MHz.

Subbands

A subband is 1 out of 512 slices created by the polyphase filterbank out of the total bandwidth available to a given observing band. The total bandwidth available is either 100MHz or 80MHz depending on your use of the 200MHz or 160MHz clock (refer to the table above or text below).

When trying to calculate the subbands you are interested in,you will need to consider the frequencies of interest and the chosen observing band. For example, while only 0-100 MHz is available to the LBAs, the HBA can observe either 100-200, 160-240, or 200-260MHz at one point in time. As a result, you should

- Chose your RCU band based on the frequencies of interest, and determine the lowest frequency available to you
- Find the difference between the lowest frequency and your target frequency, and divide the resulting value by the subband width (the RCU clock value divided by 1024), rounded downwards to encapsulate the target frequency, and you have one of your subband limits.
- Repeat for a chosen upper frequency, and ensure that your bitmode allows you to allocate enough beamlets (see previous chapter)

Overall, the subband calculation roughly follows this equation

```
target_subband = (target_frequency - band_base_frequency) / (band_rcu_clock / 1024)
target_subband = round_down(target_subband)
```

As some example calculations,

Frequency (MHz)	Band	Base Frequency (MHz)	RSP Clock (MHz)	Sub-band Calculation	Subband
25	10_90	0	200	(25 - 0) / (200 / 1024)	128
125	110_190	100	200	(125 - 100) / (200 / 1024)	128
185	170_230	160	160	(185 - 160) / (160 / 1024)	160
225	210_250	200	200	(225 - 200) / (200 / 1024)	128

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