VESPA users's guide (Draft)

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Warning

Please note that this document is in its early draft stages, and may even be completely wrong in some places. Note also that polarimetry modes are not yet offered to external observers, and that the receiver phase-lock reference connections have to be modified in order to achieve the required phase coherence.

1 Introduction

In the following the capabilities of VESPA are described for each of the main modes of operation. As time goes, more information will be added on how to best use VESPA capabilities.

2 HERA (multi-beam receiver) modes

The possible combinations of resolution and bandwidth available for HERA are shown in table 1. The **OBS** command to configure them is:

```
VESPA part resolution bandwidh offset /RECEIVER name
```

allowing up to 4 independent parts to be defined. The only limitation is that the sum of the resource usages does not exceed 100%.

Bandwidth(MHz)		Resolution (Channel spacing in kHz)				
Theoretical	Actual	20	40	80	320	1250
20	17.5	50.0	25.0	–	–	–
40	35	100.0	50.0	25.0	–	–
60	52.5	–	75.0	–	–	–
80	70	–	100.0	50.0	25.0	–
120	105	–	–	75.0	–	–
160	140	–	–	100.0	50.0	25.0
240	210	–	–	–	75.0	–
320	280	–	–	–	100.0	50.0
480	420	–	–	–	–	75.0
640	512	–	–	–	–	100.0

Table 1: Resource usage (in %) for HERA (multi-beam receiver) modes

Bandwidth(MHz)		Resolution (Channel spacing in kHz)				
Theoretical	Actual	20	40	80	320	1250
20	17.5	8.3	–	–	–	–
40	35.0	16.7	8.3	8.3	–	–
60	52.5	25.0	–	–	–	–
80	70.0	33.3	16.7	16.7	8.3	–
100	87.5	41.7	–	–	–	–
120	105.0	50.0	25.0	25.0	–	–
140	122.5	58.7	–	–	–	–
160	140.0	66.7	33.3	33.3	16.7	8.3
180	157.5	75.0	–	–	–	–
200	157.5	83.3	41.7	41.7	–	–
220	157.5	91.7	–	–	–	–
240	210.0	100.0	50.0	50.0	25.0	–
280	245.0	–	58.7	58.7	–	–
320	280.0	–	66.7	66.7	33.3	16.7
360	315.0	–	75.0	75.0	–	–
400	350.0	–	83.3	83.3	41,7	–
440	385.0	–	91.7	91.7	–	–
480	420.0	–	100.0	100.0	50.0	25.0
560	490.0	–	–	–	58.3	–
640	512.0	–	–	–	66.7	33.3

Table 2: Resource usage (in %) for basic single pixel receiver modes

3 Single pixel receiver modes

When using single pixel receivers, there are four classes of VESPA modes described in the following sections: basic, ultra-high resolution, polarimetry and parallel. Basic modes can be categorized as simple and a simple carry-over of the modes available with the previous correlator[1] , while the other ones provide new capabilities, and can be categorized as complex since understanding how to configure VESPA using them to optimaly suit the needs of an observation can take quite some work.

Note that, barign bugs, the software does not enforce any limitation on mixing up bands from different classes other than the ones imposed by hardware.

3.1 Basic modes

The possible combinations of resolution and bandwidth available for basic single pixel receivers are shown in table 2. The command to configure them is the same as for HERA with the exception that up to 12 independent part can be defined.

The other detail which distinguishes these modes from the HERA modes is that the basic bandwidth for 40 kHZ resolution is a 40 MHz instead of 20. This is done by using both sidebands of an image-rejection mixer, the possible drawback being that a spike can appear right in the center of each 40 MHz band (for example at 1/3 and 3/4 of the spectrum for 80 MHz bandwidth).

[1] with the exception that 10 kHz resolution is classified as ultra-high resolution

Bandwidth(MHz)		Resolution (Channel spacing in kHz)		
Theoretical	Actual	3.3	6.6	10(min–max)
10	8.75	16.7	–	–
20	17.50	33.3	16.7	8.3– 16.7
30	26.25	50.0	–	–
40	35.00	66.7	33.3	16.7– 33.3
50	43.75	83.3	–	–
60	52.50	100.0	50.0	25.0– 50.0
80	70.00	–	66.6	33.3– 66.7
100	87.50	–	83.3	41.7– 83.3
120	105.00	–	100.0	50.0–100.0

Table 3: Resource usage (in %) for ultra-high resolution modes. See text for detailed explanations.

While the spike is unavoidable, it can be easily shifted away from the interesting frequency by specifying a frequency offset. In the important case of frequency-switching with 40 MHz bandwidth, the spike will not be such a nuisance since it will appear between the frequency ranges of interest and move away after folding.

These modes should be sufficient for most needs, they at least provide a 50% improvement in capabilities over the earlier correlator[2]. The advantage is that they are simple, and that as long as they are not mixed up with modes defined in the following sections, the rule of the game is again that the sum of the resource usages does not exceed 100%.

3.2 Ultra high resolution modes

This section and the following two describe the most esoteric modes of VESPA, what makes these modes complex is that their resource usage cannot be described as a single number like the preceding modes. Some additional constraints imposed by the limitations of the distribution make it rather hard to predict whether a given combination of modes can be realized or not. The best way to check whether a configuration is possible is to use the program `vespaconf.py` available on several computers at the telescope and for download at `http://iram.fr/PV/vespaconf.py`.

As an example of this complexity, the ultra-high resolution modes, described in table 3, can often, but not always, be combined with basic modes defines in the previous section.

In this respect, the 10 kHz resolution case is especially complex since it uses only one part of a chassis but seriously restricts the capabilities of the other part, for this reason the resource usage is given as a range of percentages.

For the 3.3 and 6.6 kHz columns, the given figures are valid for a best case scenario, when the limitations of the distribution do not restrict the combinations with other modes.

The **OBS** command for the ultra-high resolution modes has exactly the same syntax as the basic modes.

[2] For 10 kHz resolution, see the next section

Bandwidth(MHz)		Resolution (Channel spacing in kHz)				
Theoretical	Actual	40	80	160	625	2500
20	17.5	16.7	8.3	8.3	–	–
40	35.0	33.3	16.7	16.7	8.3	–
60	52.5	50.0	25.0	25.0	–	–
80	70.0	66.7	33.3	33.3	16.7	8.3
100	87.5	83.3	41.7	41.7	–	–
120	105.0	100.0	50.0	50.0	25.0	–
140	122.5	–	58.7	58.7	–	–
160	140.0	–	66.7	66.7	33.3	16.7
180	157.5	–	75.0	75.0	–	–
200	157.5	–	83.3	83.3	41.7	–
220	157.5	–	91.7	91.7	–	–
240	210.0	–	100.0	100.0	50.0	25.0
280	245.0	–	–	–	58.7	–
320	280.0	–	–	–	66.7	33.3
360	315.0	–	–	–	75.0	–
400	350.0	–	–	–	83.3	41.7
440	385.0	–	–	–	91.7	–
480	420.0	–	–	–	100.0	50.0
560	490.0	–	–	–	–	58.3
640	500.0	–	–	–	–	66.7

Table 4: Resource usage (in %) for polarimetry modes

3.3 Polarimetry modes

Table 4 summarize the capabilities of the polarimetry modes, whose channel spacing is twice the values of basic modes.

The **OBS** syntax for setting up a polarimetry band is:

```
VESPA part resolution bandwidh offset /POLARIMETRY name1 name2
```

the only difference besides the option name is that 2 receivers have to be specified, and that the two receivers have to be tuned at the same frequency with the same sideband setting (USB or LSB).

3.4 Parallel modes

One way to look at the parallel modes is to consider them as polarimetry modes without cross-correlation, allowing to reallocate the resources towards higher resolution, but still sharing the synthesizers between two receivers. However the restrictions on receiver setup are relaxed.

Table 5 summarize the capabilities of the parallel modes, which offer exactly the same resolution choices as the basic modes. Note that for two highest resolutions the resource usage can only be approximately given.

The **OBS** syntax for setting up a parallel band is:

```
VESPA part resolution bandwidh offset /PARALLEL name1 name2
```

Bandwidth(MHz)		Resolution (Channel spacing in kHz)				
Theoretical	Actual	20	40	80	320	1250
20	17.5	≈ 11.1	–	–	–	–
40	35.0	≈ 22.2	≈ 11.1	8.3	–	–
60	52.5	≈ 33.3	–	–	–	–
80	70.0	≈ 44.4	≈ 22.2	16.7	8.3	–
100	87.5	≈ 55.6	–	–	–	–
120	105.0	≈ 66.7	≈ 33.3	25.0	–	–
140	122.5	≈ 77.8	–	–	–	–
160	140.0	≈ 88.9	≈ 44.4	33.3	16.7	8.3
180	157.5	100.0	–	–	–	–
200	157.5	–	≈ 55.6	41.7	–	–
240	210.0	–	≈ 66.7	50.0	25.0	–
280	245.0	–	≈ 77.8	58.7	25.0	–
320	280.0	–	≈ 88.9	66.7	33.3	16.7
360	315.0	–	100.0	75.0	–	–
400	350.0	–		83.3	41,7	–
440	385.0	–		91.7	–	–
480	420.0	–		100.0	50.0	25.0
560	490.0	–	–	–	58.3	–
640	512.0	–	–	–	66.7	33.3

Table 5: Resource usage (in %) for parallel modes

as for polarimetry, two receivers have to be specified, but there is no restriction as long as both receivers use the same sideband[3]

[3]The check for identical sideband is skipped for the frequent case of a centered band