

# Köln Array AOS (AOS5)

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## 1 About Array AOS

Köln 4 GHz Array AOS, with Caltech 4–8 GHz IF processor as its frontend, can be used either with existing 1–2 GHz IF narrowband receivers (Side Cabin and 850 GHz receivers) or with new generation 4–8 GHz IF wideband receivers (“Frank Rice’s” receiver and “Barney”).

The 4 GHz AOS (AOS5) consists of an array of four 1 GHz AOSs, or “subbands,” centered at 2.1 GHz. Each 1 GHz ( $1300 \text{ km s}^{-1}$  at 230 GHz and  $370 \text{ km s}^{-1}$  at 805 GHz) AOS is equipped with a 2048 channel CCD, of which about 1600 channels are illuminated, resulting in the channel separation of about 0.65 MHz and the true resolution of about 1 MHz ( $0.85 \text{ km s}^{-1}$  and  $1.3 \text{ km s}^{-1}$  at 230 GHz and  $0.24 \text{ km s}^{-1}$  and  $0.37 \text{ km s}^{-1}$  at 805 GHz, respectively).

When one of the wideband receivers is in use, the IF processor splits the 4–8 GHz IF into four subbands of 1 GHz wide, centered at  $4.5 \pm 0.1$ ,  $5.5 \pm 0.1$ ,  $6.5 \pm 0.1$  and  $7.5 \pm 0.1$  GHz. Internal mixers and LO synthesizers mix those IF subbands with  $6.6 \pm 0.1$ ,  $7.6 \pm 0.1$ ,  $8.6 \pm 0.1$  and  $9.6 \pm 0.1$  GHz, respectively, to down-convert to the second IFs centered at 2.1 GHz.

When either one of the Side Cabin receivers or the 850 GHz receiver is in use, the 1–2 GHz IF is up-converted to 6–7 GHz and fed to the third subband of the AOS5 by the IF processor.

The IF processor has two input ports for the 4–8 GHz IF receivers (A and B) and one for the 1–2 GHz IF receiver. It provides IF matrix switches to select one of three receivers, dark frame switches and 100 MHz comb signals for each input, and output power amplifiers and attenuators for each of four second IF output ports.

## 2 Taking Data

### 2.1 Turning IF Processor On

First turn on the main power supply unit near the top of the rack. Output voltages of the main power supply must be verified through test points on the

front panel. If any one of the voltages reads significantly lower than what it should be, the power supplies must be restarted. If the problem persists, shut down the system and contact CSO staff.

## 2.2 (Turning Computer On)

Synthesizers, attenuators, and RF switches in the IF processor are controlled by a computer called “rtlinux,” colocated inside the rack, which also handles the AOS5 and chopping secondary mirror. This computer must be kept running all the time.

## 2.3 Starting IF Processor Monitor Program

Optionally, start a program called “ifpmon,” which remotely monitors the status of the IF processor, either on kilauea or puuoo:

```
kilauea% ifpmon
```

## 2.4 Selecting Receiver

The second parameter of the LO command, the receiver number or the IF/LO channel number, determines which receiver and which IF system are to be used. The receiver number 1, 2, 3 and 4 correspond to the 1–2 GHz IF channel 1, 2, 3 and 4. They are normally connected to the Side Cabin 230, 345, 492 and 650 GHz receiver, respectively. The IF channel 3 is also used for the 850 GHz receiver, by swapping an input to the IF amplifier 3 manually in the Side Cabin. The receiver number 5 and 6 correspond to the 4–8 GHz IF channel A and B, respectively, of the IF processor.

In most cases the receiver number can be omitted. If it is not given, the UIP automatically determines which IF channel to use. If the IF is set above 2.0 GHz, the receiver number 5 (the 4–8 GHz IF channel A) is selected. Otherwise one of the Side Cabin receivers or the 850 GHz receiver is selected based on the line frequency. To override the default selection, the receiver number must be given.

For example, the following command selects the Side Cabin 230 GHz receiver explicitly:

```
UIP> LO 12C02-1 /RECEIVER RX230
```

The same receiver is implicitly selected by the following command:

```
UIP> LO 12C02-1 /IF_FREQUENCY 1.5
```

or alternatively by the following (most familiar) command, if the IF has been set somewhere between 1 and 2 GHz already:

```
UIP> LO 12C02-1
```

The following command selects the Side Cabin 230 GHz receiver, overriding UIP’s default selection of the 345 GHz receiver for this frequency:

```
UIP> LO H28ALPHA /FREQUENCY 284.25059 /SIDEBAND U /RECEIVER RX230
```

The command below selects the 230 GHz wideband receiver (“Frank Rice’s” receiver), connected to the channel A of the IF processor:

```
UIP> LO 12C02-1 /IF.FREQUENCY 5.5
```

and the following selects the 345 GHz wideband receiver (“Barney”), regardless of the current IF setting, connected to the channel A of the IF processor:

```
UIP> LO 12C03-2 /RECEIVER RX345X
```

The reconfiguration of the IF switch matrix can be forced by the following command:

```
UIP> LO /FORCE_RX_CHANGE NOMIRRORS
```

The receiver to be used will be redetermined based on the current line frequency and the IF. To override the default, the receiver name must be specified. For example, if the 850 GHz receiver is connected to the IF channel 4, a command like the following must be used:

```
UIP> LO /RECEIVER RX805,4 /FORCE_RX_CHANGE NOMIRRORS
```

Otherwise the receiver/IF/LO channel number defaults back to 3, assuming that the IF is set to 2 GHz or below.

## 2.5 Restarting AOS Client

When the AOS5 is selected for the first time (for any receivers), or when switching between narrowband receivers and wideband receivers, the AOS5 client has to be (re)started using the SPECTROMETER command:

```
UIP> SPECTROMETER /AOS5 /RESTART
```

This initializes the synthesizers and the attenuators in the IF processor. When one of the wideband receivers is in use, all four 1 GHz subbands become active and displayed in the AOS5 window. When any of the narrowband receivers is in use, only the third 1 GHz subband becomes active.

## 2.6 Really Taking Data

Observe in the same way as other AOSs, but note some differences explained in “Quirks and Workarounds.”

## 2.7 Shutting Down

Turn off the main power supply unit of the IF processor. Leave the “rtlinux” computer running.

## 3 Quirks and Workarounds

### 3.1 Attenuators

RF inputs of the AOS5 may be cut off when a very strong signal is present. This causes an automatic adjustment of the attenuators to fail to reach proper level. To workaround, manually set the attenuators to their maximum value (63 dB) prior to the ADJUST\_ATTEN command, or any other commands that try to adjust the attenuators automatically, e.g., the CALIBRATE command. For example:

```
UIP> DB 63  
UIP> ADJUST_ATTEN
```

### 3.2 CHOP\_SLEWY

Logical CCD readout rate of the AOS5 is much slower compared to other AOSs. Consequently, there is a short delay of 1-2 seconds when each CHOP\_SLEWY cycle is started.

### 3.3 OTF\_MAP

For the similar reason, the choice of integration time (determined by cell size and scan speed) for the AOS5 is more restrictive compared to other AOSs.