Getting your science!

Tips and advice for setting up Nāmakanui MSBs in the JCMTOT with the current ACSIS hardware fault.

April 30th 2021
Acronyms used

- **ACSI S**: the Auto-Correlation Spectrometer and Imaging System
- **DMC**: Down converter module - a maximum of 4 DCMs are fed from the same IF. Nāmakanui has 4 IF outputs (4 for ‘Ū‘ū at 230 GHz and 4 for ‘Āweoweo at 350 GHz), while there are 32 DCMs and correlator cards.
- **LO**: Local Oscillator (4.5-6.8GHz for Nāmakanui)
- **LO2**: second Local Oscillator used in ACSIS to down convert signal to the range 2-3GHz.
  - There are two LO2’s for each DCM: one working in the 6-8GHz range, the other working in the 8-10GHz range.
  - *It is the 8-10GHz synthesiser on the LO2 on DCM1 that is broken.*
- **NU0L**: Namakanui pixels are labeled using the following naming convention: Instrument-insert-polarization-sideband e.g. Nāmakanui – `Ū`ū – P0 – LSB (NU0L)
ACSIS: background

For notes on the ACSIS system see: HARP/ACSIS: a submillimetre spectral imaging system on the James Clerk Maxwell Telescope By Buckle et al. 2009

"A block diagram showing the IF signal path from the switching network (SWN) is given in Fig. 15. The input IF frequencies cover from 3.3 to 7.7 GHz. There are 16 IF signals feeding from HARP and eight feeds from additional receivers. Switching between these inputs is done by an IF switch. Each DCM extracts a nominal 1 or 0.25 GHz wide band from the 3.3–7.7 GHz ACSIS IF band. The frequency range extracted is determined by setting the appropriate second LO (LO2). Four tunable LO2s are fed to each set of four DCMs that can be connected to an IF input. A total of 32 DCMs are available. These two or four DCMs can be placed anywhere in the ACSIS IF band using the four LO2s. Due to the sharing of LO2s the positioning must be the same in all IF inputs. As described in Section 3.2 ACSIS can combine the correlators attached to adjacent DCMs doubling the number of frequency channels while halving the effective numbers of available DCMs."

https://www.eaobservatory.org/jcmt/instrumentation/heterodyne/acsis/

Figure 15. ACSIS overall system hardware block diagram. Only one of the 32 Down Convertor Sampler subsections is shown. The signal path is described in the text.
For notes on the ACSIS system see: HARP/ACSIS: a submillimetre spectral imaging system on the James Clerk Maxwell Telescope By Buckle et al. 2009

“In the DCM, each sub-band is amplified, filtered and converted to the sampler frequency range (baseband). The DCMs mix the IF with a tunable LO (LO2). A final LO (LO3) fixed at 2.0 GHz does the final downconversion to the baseband. Rather than having multiple system bandwidth/resolution combinations using many different IF filters, the philosophy is to have only two hardware options, and ensure that these cover most astronomical requirements. Each DCM can therefore switch between a wide-band (1 GHz) and a narrow-band (250 MHz) mode (see Table 1). In practice, the edges of the DCM filtering limit the bandwidth of each DCM to 930 and 220MHz”

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Figure 15. ACSIS overall system hardware block diagram. Only one of the 32 Down Convertor Sampler subsections is shown. The signal path is described in the text.
ACSIS: Broken Synthesiser issue (April/May 2021)

- ACSIS is the backend spectrometer used by HARP and Nāmakanui’s `Ū`ū and Āweoweo.
- Right now there is a broken synthesiser on one of the LO2’s DCM’s (DCM1). This means that there is a limitation on the IF that can be fed into DCM1.
- On DCM1 the broken LO2 synthesiser means that the system can only handle:
  - an IF < 5.5GHz (when combined with a backend of 1000MHz)
  - or an IF < 5.375GHz (with a backend of 250MHz)
  - this issue does not affect HARP (HARP uses an IF of 5GHz)
- As of April 30th 2021 the Observatory has shifted the order in which the DCMs are used in ACSIS so that this issue will not impact Nāmakanui users that are only using a single spectral region in their MSBs.
IF for ACSIS can range between ~3.3-7.5GHz, best noise performance for ‘Ū’ū is with an IF of 6GHz.

The JCMT Translator now switches the order in which it assigns wiring file entries to spectral windows. Entries from the file (which are ordered by DCM) for receptors with 4 entries (e.g. Namakanui) are assigned in the order 3, 4, 1, 2.

In these examples DCM4 can be used as we wish.

But… with DCM3 we must be careful.

Translator pushes issue onto DCM3 causing issues for any spectral set up requiring >1 spectral region (e.g. more than 2 DCMs - that can be chained together).

LO2 is selected based on the input IF to provide an output in the range 2-3GHz (1000MHz mode) or 2.5-2.75GHz (250MHz mode).

New order of DCM usage, denoted by numbering.

Actual DCM number
Changes to the JCMT Translator has shifted the LO2 issue from DCM1 onto DCM3. Thus users need to be careful if using 2, 3 or 4 spectral regions and hybrid modes.

The third DCM used in each case will need to be set such that the IF <5.5GHz when combined with a backend of 1000MHz or an IF <5.375GHz with a backend of 250MHz. Shown here is an example of a shifted IF.

For notes on the ACSIS system see: HARP/ACSIS: a submillimetre spectral imaging system on the James Clerk Maxwell Telescope By Buckle et al. 2009
Example 1: CO @ 230.538GHz IF 6

- 1 spectral region
- 1 backend @1000MHz
- 1 region with resolution 488kHz
- 1 region with 2048 channels

In this example two DCMs are being “chained” together to get the high resolution of 448kHz.
Example 1: CO @ 230.538GHz IF 6

Uses DCM1 & DCM2 in chain mode to get high resolution in single 1000MHz backend. DCM2 & DCM3 are not used.

In this instance user does not need to be concerned about the broken ACSIS synthesiser.
Example 2: CO @ 230.538GHz IF 6

- 2 spectral regions
- 2 backend @1000MHz
- 2 regions with resolution 488kHz
- 2 regions with 2048 channels

In this example we have two examples of two DCMs being “chained” together to get the high resolution of 448kHz.

Users will need to use the frequency editor to ensure the second spectral region an IF <5.5GHz (when combined with a backend of 1000MHz) or an IF <5.375GHz (with a backend of 250MHz).
Example 2: CO @ 230.538GHz IF 6

Uses DCM1 & DCM2 in chain mode for first 1000MHz backend and DCM3 & DCM4 in chain mode for second 1000MHz backend. Both obtain high resolution.

In this instance the user must select an IF <5.5GHz when combined with a backend of 1000MHz and an IF <5.375GHz with a backend of 250MHz in the second spectral region backend set up (Het set up: Region 1 - as zero based logic).

Uses DCM1 & DCM2 in chain mode for first 1000MHz backend and DCM3 & DCM4 in chain mode for second 1000MHz backend. Both obtain high resolution.

In this instance the user must select an IF <5.5GHz when combined with a backend of 1000MHz and an IF <5.375GHz with a backend of 250MHz in the second spectral region backend set up (Het set up: Region 1 - as zero based logic).
Example 3: CO @ 230.538GHz IF 6

- 3 spectral regions
- 3 backend @1000MHz
- 1 region with resolution 488kHz
- 2 regions with resolution 997kHz
- 1 region with 2048 channels
- 2 regions with 1024 channels

In this example we have four DCMs being used. Initially two DCMs are chained together to give the high 448kHz resolution. Then for the other two regions only a single DCM is used and so they have lower resolutions 977kHz.

Users will need to use the frequency editor to ensure the second spectral region an IF <5.5GHz (when combined with a backend of 1000MHz) or an IF <5.375GHz (with a backend of 250MHz).
Example 3: CO @ 230.538GHz IF 6

Uses DCM1 & DCM2 in chain mode for first 1000MHz backend the DCM3 for next 1000MHz backend and DCM4 for last 1000MHz backend. Only the first spectral region obtains high resolution.

In this instance the user must select an IF <5.5GHz when combined with a backend of 1000MHz and an IF <5.375GHz with a backend of 250MHz in the second spectral region backend set up (Het set up: Region 1 - as zero based logic).
Example 4: CO @ 230.538GHz IF 6

- 4 spectral regions
- 4 backend @1000MHz
- 4 regions with resolution 997kHz
- 4 regions with 1024 channels

In this example we have four DCMs being used. Each DCM must be used for the four spectral regions. No chaining can occur (as we have no spare DCMs) and so all four spectral regions have the same lower resolution of 977kHz.

Users will need to use the frequency editor to ensure the second spectral region an IF <5.5GHz (when combined with a backend of 1000MHz) or an IF <5.375GHz (with a backend of 250MHz).
Example 4: CO @ 230.538GHz IF 6

In this instance the user must select and IF <5.5GHz when combined with a backend of 1000MHz and an IF <5.375GHz with a backend of 250MHz in the third spectral region backend set up (Het setup: Region 2 - as zero based logic).

Each DCM is used separately for each 1000MHz backend. All spectral regions obtain same nominal resolution.
ACSIS: 250MHz examples in the OT

The same is true for the 250MHz (low resolution is 61kHz and 2096 channels, high resolution is 31kHz with 8192 channels). It is also possible to mix the bandwidths and IF selection. Reminder: it is the third DCM used in each case that will need to be set such that the IF <5.5GHz when combined with a backend of 1000MHz or an IF <5.375GHz with a backend of 250MHz.