

ALMA Cartridge IF Considerations

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Soon, the ARO will install a prototype ALMA Band-6 side-band separating cartridge into the 1.3 mm/2 mm SIS JT radiometer dewar. The IF frequency range of the mixers and cooled IF components is designed for an 8 GHz wide passband covering 4 GHz to 12 GHz. The ALMA requirements permit reduced sensitivity over a small portion of the band. The designers of this cartridge chose regions near both IF band edges where the performance would be lessened. Therefore, the noise temperature performance for this cartridge design is excellent between 5 and 11 GHz but worsens somewhat outside this region.

Currently, the total aggregate instantaneous IF coverage of all the ARO spectrometers is a little more than 4 GHz. Unfortunately, this coverage is scattered among a number of non-contiguous IF bandwidths and different spectrometer resolutions. To maximize the scientific benefit from the ALMA cartridge, both IF channels should be used and with the maximum frequency coverage.

There are two approaches that can be used to provide dual channel spectral coverage each with a 2 GHz wide bandwidth. One approach involves the heterogeneous concatenation of a 1 GHz wide spectrum from a filter bank with a 1 GHz wide spectrum from an acousto-optic spectrometer. The other, involves the homogeneous concatenation of two - 1 GHz wide spectrum from the two AOSs for one channel and the operation of the filter bank spectrometer in 2 GHz wide mode for the other channel.

The first scheme requires only minor changes to the AOS and employs the use of two in-house commercial frequency synthesizers. No changes are required to the filter banks. Each resulting 2 GHz wide spectra would have two slightly different spectral resolutions regions as determined by the AOS and the filter bank.

The 2 GHz wide spectrum would be produced by identical hardware in each IF channel. The contiguous IF frequency coverage for the heterogeneous configuration is limited by the high end of the filter bank. The highest possible operating frequency is 5 to 7 GHz.

The other scheme produces spectrum with identical characteristics within each 2 GHz wide band but with different spectral resolution between channels. In this homogeneous case, different hardware is used in each channel. Currently, the filter bank doesn't support tuning above 6 GHz so special hardware would be implemented. This would extend the input range of the filter bank to 8 GHz. The other channel uses the acousto-optic spectrometers and would be configured as above, with commercially available in-house test equipment with minor hardware modifications.

The special converter hardware would be modified 12-meter 8-beam IF processor modules that are currently excess to the needs at the 12-meter. By purchasing some additional

components, two - 1 GHz wide IF converter systems could be built as described in the "SMT IF System Considerations" note.

There are different types of costs involved with the heterogeneous and homogeneous spectrometers. In the heterogeneous case, each spectrum consists of two equal length regions of slightly different resolution. Only if uniform spectral resolution is desired across the full 2 GHz band is there a cost and it is incurred during data reduction. In the homogeneous case, the frequency resolution is constant across each contiguous spectra, but new hardware must be made. Also the spectral resolution is different for each channel. One benefit of the homogeneous approach is that the 2 GHz wide passband of either spectrometer can be located anywhere within the 4 GHz to 8 GHz band and the resulting modified hardware is fully compliant with the proposed IF standard.

Currently, there are no firm cost or schedule estimates for the homogeneous approach. A cost and schedule driver in this design may be a coaxial filter. To advance observations, both approaches could be taken. Early science could be obtained using the heterogeneous option during the time the hardware is being modified that supports the homogeneous solution. The new IF converters could then be installed as part of the SMT filter bank system to support the IF standard.

Costing of some components has begun, but a thorough cost estimate would not be started until sufficient interest is shown. A schedule with costs could be completed in a few weeks.