New Observing System of the 45-m Telescope at Nobeyama Radio Observatory

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Abstract

We developed a new observing system to improve the performance of the 45-m telescope at Nobeyama Radio Observatory (NRO). The system consists of new receivers, new IF converters, new A/D converters, and a new spectrometer. The technologies developed for ALMA (the Atacama Large Millimeter/Submillimeter Array) were used for many parts (e.g., receivers and spectrometers). With the new system, we are conducting surveys of distant primeval galaxies and line surveys of various targets.

1. Introduction

Recent progress on the technologies for radio astronomy is remarkable. Especially, many instruments with high performance have been developed for ALMA. It is possible to improve the performance of the present instruments by using the technologies for ALMA. We developed a new observing system for the NRO 45-m telescope which is one of the largest telescopes for mm observations. It is a very powerful observing system for observations which require high sensitivity and wide frequency coverage such as distant galaxy survey or line survey of various objects.

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2. New Receivers

For line observations of a point source with the 45-m telescope, position switch is used in general. In that case, on-source time is less than half of the total observing time, since the rest is used for off position and antenna threw time. On the other hand, for a two-beam receiver with a moderate beam separation, we can make the integration time for on-source twice by switching between two beam positions. Therefore, we have developed a two-beam SIS receiver (TZ) for 100 GHz band using sideband-separating technique (Figure 1).

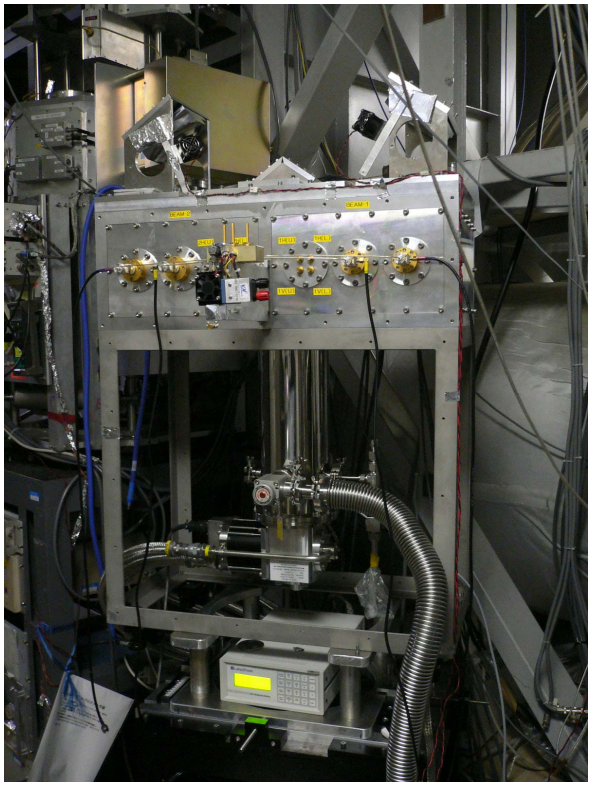

Figure 1. The sideband-separation receiver TZ mounted in the receiver cabin of the 45-m telescope.

The sideband-separating receiver has an advantage to cover wide frequency range, since it can observe both sidebands simultaneously. The composition of TZ is similar to T100 which is a single beam sideband-separating receiver for 100-GHz band [1]. The range of the operation frequency of TZ is 80-120 GHz. The beam separation is 45 arcsec. The IF bandwidth is 4 GHz (4-8 GHz) and the total bandwidth including both side band is 8 GHz. TZ can be used as a single beam receiver for an extended source of course. We will extend the IF range of one beam which is used for single-beam observations to 4-12 GHz.

A multi-beam receiver using the sideband-separation technique is also being developed. The receiver has 2 x 2 beams and dual polarizations for each beam. The range of the operation frequency is 80-120 GHz. The IF ranges

are 4-12 GHz for the upper side and 4-8 GHz for the lower side. The wide bandwidth makes us possible to observe ^{12}CO(1-0) and ^{13}CO(1-0) simultaneously in the upper side.

3. New Spectrometer

SAM45 (Spectral Analysis Machine for the 45m telescope) is a new spectrometer of the 45-m telescope which is a copy of a part of the FX correlator for the Atacama Compact Array (ACA) which covers short baseline for ALMA. SAM45 can process 16 signals. The frequency resolution is variable as 3.8 kHz x 2^N (N : integer) up to 490 kHz with the total channels of 4096. SAM45 can cover up to 2 GHz x 16.

We have developed a new A/D converter PANDA (Progressive Analog to Digital converter for Astronomy) for SAM45. PANDA basically has the same performance as the A/D converter for ACA correlator. The sampling speed per input is 4 Gsps and the number of bit per sample is 3 bits. The processing bandwidth per input is 2 GHz (2-4 GHz). We use the newly-developed IF converter to convert the IF from the receiver front end to 2-4 GHz for input of PANDA.

4. Test Observations with SAM45

We made test observations of SAM45 using single-beam receiver T100 toward IRC+10216. Figure 2 shows the spectra of IRC+10216 obtained with SAM45. We connected 14 spectrometers with some overlap. It is apparent that the combination of a wide band receiver and SAM45 is very powerful tool for observations which search lines over wide frequency range such as a blind survey of CO lines of distant galaxies or line survey of various objects.

5. References

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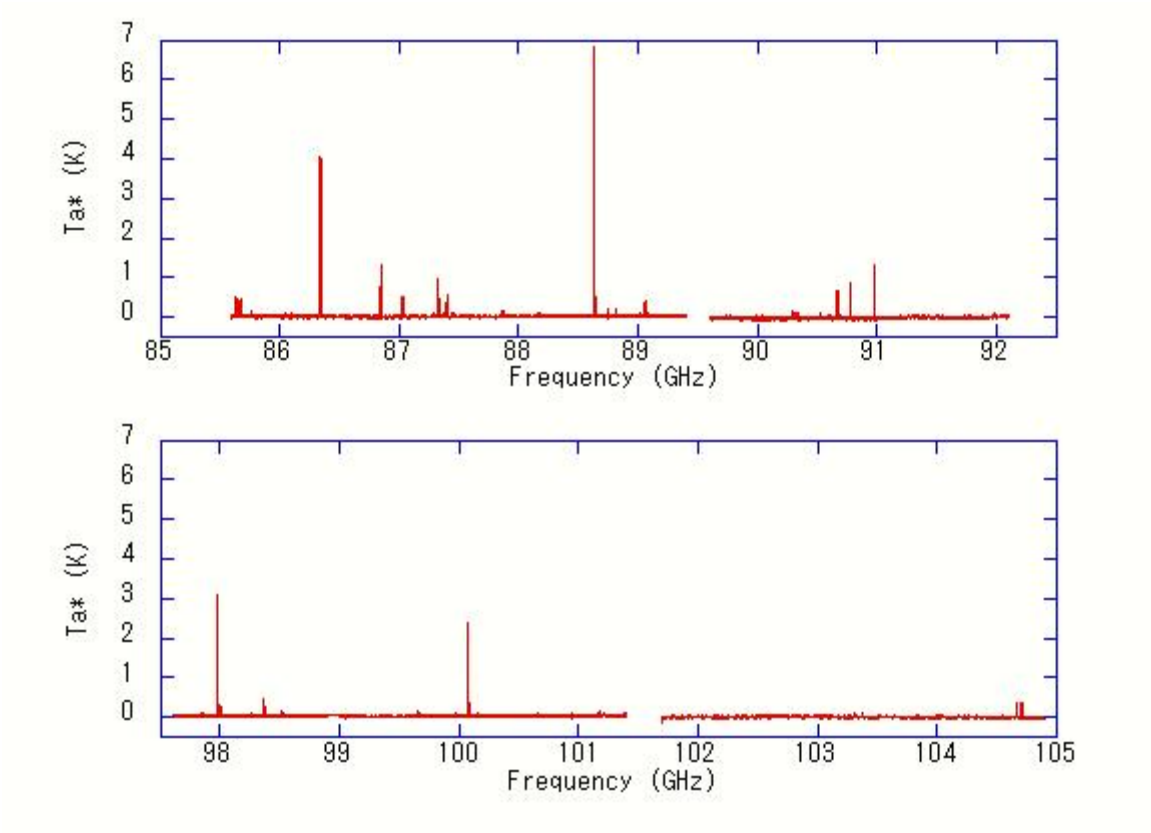

Figure 2. Spectra toward IRC+10216 obtained with T100 and SAM45.