Development of Seven BEam Equipment (7BEE) for the Nobeyama 45-m Telescope

Atsushi Nishimura*(1), Yutaka Hasegawa(2), Yasumasa Yamasaki(2), Sho Yoneyama(2), Sho Masui(2), Sana Kawashita(2), Shimpei Nishimoto(2), Tsubasa Chinen(2), Chiaki Nosohara(2), Heyang Sun(2), Ikko Fujitomo(2), Yuma Nishikawa(2), Ryo Nakagawa(2), Takeru Matsumoto(2), Toshikazu Onishi(2), Hideo Ogawa(2), Chieko Miyazawa(1), Toshikazu Takahashi(1), Jun Maekawa(1), Alvaro Gonzalez(1,3), Takafumi Kojima(1,3), Takeshi Sakai(4), and Ken'ichi Tatematsu(1,2)

(1) National Astronomical Observatory of Japan, Nagano, Japan; e-mail: atsushi.nishimura@nao.ac.jp
(2) Osaka Metropolitan University, Osaka, Japan
(3) The Graduate University for Advanced Studies, SOKENDAI, Tokyo, Japan
(4) The University of Electro-Communications, Tokyo, Japan

To understand how stars form, it is essential to investigate the process of mass accretion from diffuse molecular clouds to dense cores. Deuterium compounds, promising measures of the chemical evolutionary stage for starless cores [e.g., 1], will open new sight on the star formation, and thus we developed the new receiver Seven Beam Equipment (7BEE) for the Nobeyama 45-m radio telescope covering frequency bands of 70 GHz (Deuterium compounds), 80-90 GHz (molecules tracing dense gas) and 100-115 GHz (molecules tracing diffuse gas).

The main target lines of 7BEE are J=1-0 transition of deuterated molecules N_2D^+ (77.11 GHz), DCO^+ (72.04 GHz), DNC (76.31 GHz), and DCN (72.41 GHz), reference molecules for the measurements of deuterium fraction (D/H) N_2H^+ (93.17 GHz), $H^{13}CO^+$ (86.75 GHz), HNC (90.66 GHz), and HCN (88.63 GHz), and diffuse gas tracers ^{12}CO (115.27 GHz), ^{13}CO (110.20 GHz), and $C^{18}O$ (109.78 GHz). In order to realize simultaneous observations of these lines, wideband CLNAs (cold low noise amplifiers) are adopted for the receiver frontend. Wideband double-ridge-boifot-junction type OMTs (ortho-mode transducer) are developed for 7BEE, and therefore the number of RF channels observed is 14. For the optics, wideband corrugated horns designed for the ALMA Band 2 receiver [2] are employed with dielectric lenses developed in-house [3]. The RF signals amplified in the cooled part of the receiver are introduced to triplexers at room temperature which output three RF bands (72-77, 86-93, and 109-116 GHz) separately. Then, signals of each RF band are down-converted to the IFs for backends. At this moment, the SAM45 spectrometer having 16 IF channels for inputs are used. Updating the backend to allow simultaneous observations of all 42 IFs is required for the future development. The 7BEE receiver was installed to the Nobeyama 45-m telescope on Aug. 2022, and its first light was achieved on Sep. The typical system noise temperature Tsys are measured to be ~200, 160, and 200 K for 75, 90, and 110 GHz band, respectively, and these performances are equal or better than existing other receivers on the telescope.

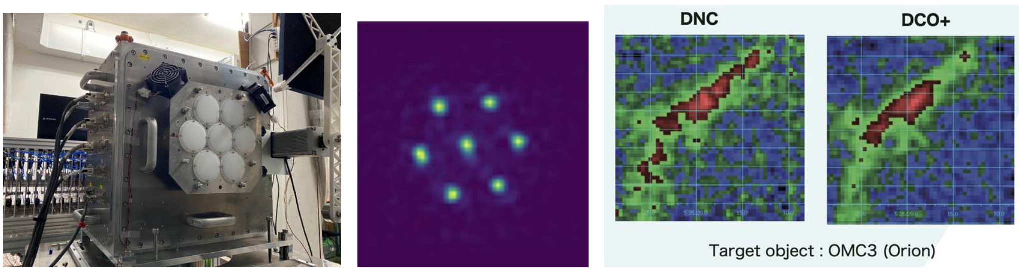

Figure 1. (left) photo of 7BEE, (center) observed beam pattern of 7BEE, (right) test observation results.

References

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