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Hybrid Installation Project in Nobeyama, Triple-band Oriented -HINOTORI-

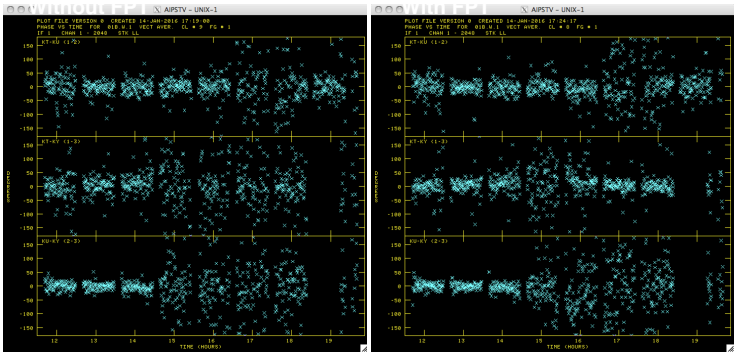
Motivations

VLBI observations at mm bands have been challenging because of the lower sensitivity of the instruments, intrinsically lower source fluxes, and shorter coherence times imposed by the rapid variations of the water vapor content in the troposphere, compared with the observations at cm bands. Simultaneous multi-frequency VLBI observations have the potential to overcome the fundamental limitations imposed by the atmospheric propagation at mm bands. Since the multi-frequency receiving system of the Korean VLBI Network (KVN) employed the new phase referencing techniques, like frequency phase transfer (FPT; Middelberg+ 2005) and source-frequency phase referencing (Rioja & Dodson 2011), the KVN has continued to produce successful results of VLBI imaging and astrometry at mm bands (e.g. Dodson+ 2014; Rioja+ 2015; Sawada-Satoh+ 2016a).

Our project, Hybrid Installation Project in Nobeyama, Triple-band Oriented (HINOTORI) aims at the multiple-frequency (K/Q/W-bands) observations in single-dish and VLBI observations, installing a new quasi optics to the NRO 45m telescope. It will allow us to carry out accurate multi-line observations, and to get closure amplitudes to calibrate antenna gains more accurately.

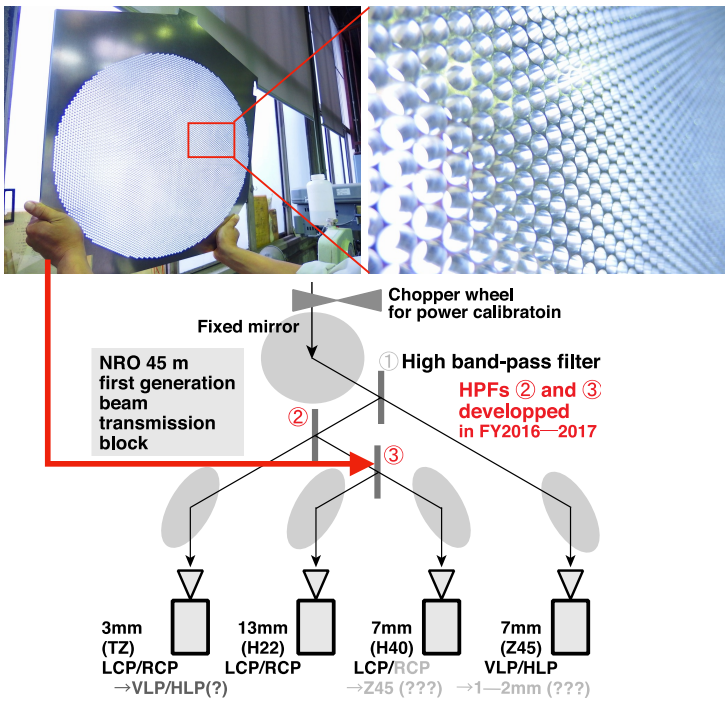
Demonstrations

We here present the observational demonstrations of the FPT method, using double-frequency KVN observations at 22 and 88 GHz. Two IFs were tuned to 21700-21828 and 88643-88871 MHz. We derived phase solutions of fringe fitting at 22 GHz, and transferred the 22 GHz solutions to 88 GHz, by scaling by their frequency ratio 88/22. The scaled phase solutions were applied to the 88 GHz uvdata, to track a rapid phase time variation at 88 GHz. Our FPT demonstrations achieved a longer effective coherence time and yielded a sensitivity improvement of 40% (Sawada-Satoh 2016b).

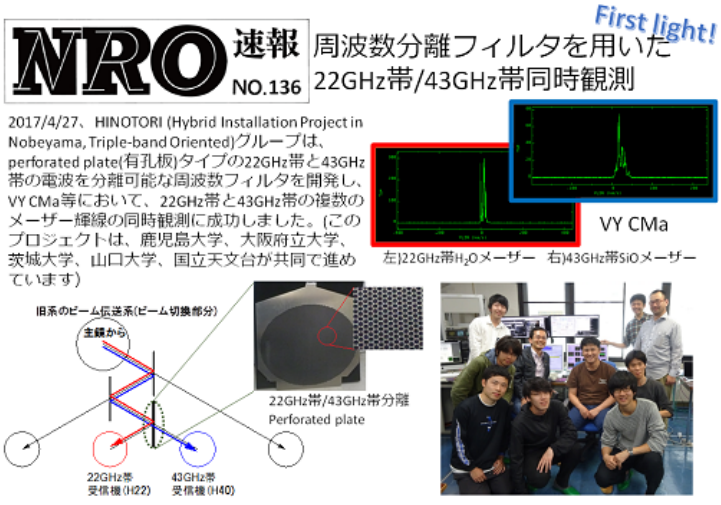


Comparison of visibility phases with/without FPT at 88 GHz, using the KVN (Yonsei, Ulsan and Tamna). (Left) Without FPT. (Right) With FPT.

Installation design



A K/Q dichroic filter was developed and installed at the mirror position (3) to switch K (13mm) and Q (7mm) bands in the NRO 45m telescope optics part. A test observation using the filter at NRO was carried out on April 27 2017, and succeeded to detect H2O and SiO maser emission lines of a red super giant star VY CMa simultaneously.



Dodson+ 2014, AJ, 148, 97
Middelberg+ 2005, A&A, 433, 897
Rioja & Dodson 2011, AJ, 141, 114
Rioja+ 2015, AJ, 150, 202
Sawada-Satoh+ 2016a, ApJL, 830, L3
Sawada-Satoh 2016b, NARIT-KaVA Science WS
http://www.nro.nao.ac.jp/astronomer/NRO-sokuhou/136.html