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10GHZ SKY SURVEY PROJECT, WASEDA FFT INTERFEROMETER

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INTRODUCTION

Large-field radio interferometer at 10.65GHz have been developed to search for transient radio objects such as radio supernovae and radio bursts in stellar systems (Daishido et al. 1984). This is a spatial fast-fourier transform (FFT) type radio interferometer, being an equally-spaced, maximum redundant, two-dimensional (2D) array in an 8×8 configuration. Sixty-four identically-designed frontend elements are comprised of 2.4 m diameter cassegrain antennas and 200K HEMT receivers. These are steerable in elevetion and are fixed in azimuth. Although it is only partially operating, the completed system having 64 beams in the northern hemisphere is expected to provide maps having 0.1° angular resolution and a sensitivity of 50 mJy. The beams are formed by a newly-developed "Digital Lens" (complex amplitude equalizer + 2D FFT pipelined processor), with the array's overall size being 20×20 m.

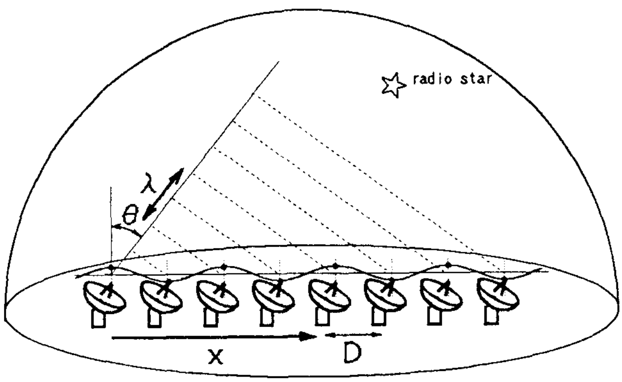

FIGURE I An east-west one-dimensional FFT interferometer.

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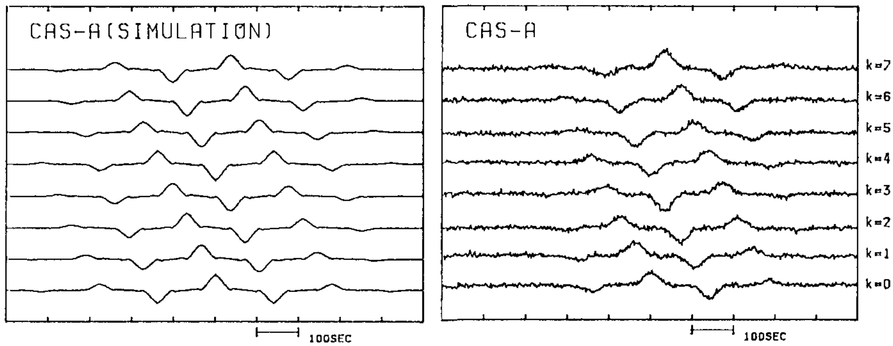

FIGURE II Simulation and result of simultaneous 8-direction observation

ONE-DIMENSIONAL BEAM FORMING

Previous to the 2D beam forming, we report a result of an east-west one-dimensional (1D) expriment (Figure I). In order to measure the instrumental phase error of each element, time-domain fringes of far field sources were used (Nakajima et al. 1992). After the phase equalization, eight 1D beams were formed. To obtain a 2D image of N×N pixels of the sky, N×N equally-spaced elements sample the electric field of $E(m\Delta x, n\Delta y)$. Fourier transform of

$$\tilde{E}(k,l) = \frac{1}{N^2}\sum_{m=0}^{N-1}\sum_{n=0}^{N-1} E(m\Delta x, n\Delta y)e^{-i2\pi\frac{k}{N}m}e^{-i2\pi\frac{l}{N}n} \quad (1)$$

gives information of radio source direction. In the presented experiment, $N = 8$ in the k direction and 180° phase switching were used. Under the 2ms phase switching, only astronomical signals are correlated. Finally the 1D images are obtained by

$$P(k) = G(k)[\tilde{E}(k)\tilde{E}^*(k) - \tilde{E}_\pi(k)\tilde{E}^*_\pi(k)] \ , \quad (2)$$

where $G(k)$ is 8-element antenna pattern and the suffix -π indicate the applied phase gradient. We fabricated high cost-performance frontend element and observed strong radio sources in Dec., 1991. The simulation and the observed result are shown in Figure II. With the 8-elements, 8-directions differential images were obtained simulataneously. Nakajima et al. 1993 gives the details of this observation. We plan to start the 2D operation and the mapping in 1993.

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