広帯域記録装置を用いたVERA K帯 測地実験

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測地解推定精度を向上するためのアプローチと手段とは？

2-3mmの確からしさを持ってアンテナの座標の推定を行うことは実現可能か？

1. 観測と遅延時間観測値取得の時間密度を上げる
2. より高性能なモデルを解析に採用，そして，よりシンプルな構造の天体を使う
3. VLBI観測システムの安定性の向上
4. より高精度で遅延時間観測値を取得する事．遅延の誤差は数mm（時間で平均10ピコ秒より短い）を目指す．

遅延観測値を高精度にするための広帯域データ取得装置として

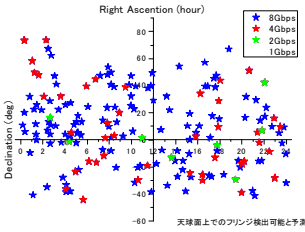
← OCTAD (High speed sampler and DBBC)

Specifications
Maximum sampling rate:　10384Mbps
Quantifying bit number:　2bit or 3bit
Output:　10GbE
10GbE channel number:　4 stream (max)
10GbE application layer protocol:　VDIF

Digital BBC mode: 8MHz-32ch, 16MHz-32ch, 512MHz-4ch, and more mode....., correspondence also in VGOS is possible.

記録帯域幅の広帯域化とフリンジ検出能力の予測

Sampling mode Recording rate	Minimum SNR	Minimum flux density (Jy) necessary to fringe detection with Minimum SNR	Number of fringe-detectable radio sources (Even if EL = 6 degree)
512MHz-2bit 1 Gigabit/sec	280	4.54	0
1024MHz-2bit 2 Gigabit/sec	170	2.02	8
2048MHz-2bit 4 Gigabit/sec	65	0.80	44
4096MHz-2bit 8 Gigabit/sec	45	0.28	170



天球面上でのフリンジ検出可能と予測される電波源の分布

Simulation Setting:

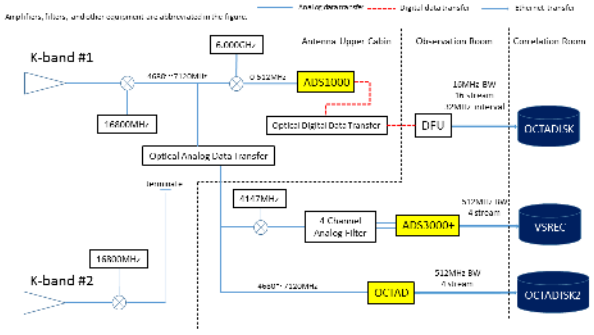
Four VERA stations observe a radio source simultaneously.
Used Frequency Band is K-band.
Maximum Theoretical Observed Delay Error = 10 Pico sec
Cutoff Maximum Duration Length = 120 sec
Structure Effect: 0 <= variation of delay < 10 Pico sec
　　structure index = (always 1) or (1 and sometime 2)
Cutoff Lower Angle of Elevation = 6 degree

3種の記録モードを用いた試験観測

観測概要
日時: 06:00 Jan.27－06:06 Jan.28 (UT), 2016. 天候 : Mizusawa 晴, but Ishigakijima 雨.
総scan数: 490 times/baseline/24hour (VERA+KVN session), 最小SNR設定値/scan: 38
基線, 基線長: Mizusawa-Ishigakijima, 2280Km, 周波数帯: K-band,
使用天体リスト: : P. Charlot, et.al: The celestial reference frame at 24 and 43GHz. Ⅱ. Imaging, Astronomical Journal, 139:1713-1770, 2010 May, doi:10.1088/0004-6256/139/5/1713
有効データ時間長 : 06:00～19:00, 有効scan回数: 255
3種のデータ取得システムに同時に記録

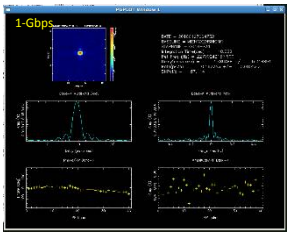
Mode	Sampler	Filter Mode (MHzBW-bit-stream)	Recorder	Minimum Frequency (MHz)	Recording Bandwidth (MHz) & Recording Rate (Mbps)	Effective Bandwidth (MHz)
1G-bps	ADS1000	16-2-16	OCTADISK	22700	256 & 1024	147.51
2G-bps	ADS3000+	512-2-1	VSREC	21971	512 & 2048	147.80
8G-bps	OCTAD	512-2-4	OCTADISK2	21459	2048 & 8196	591.21

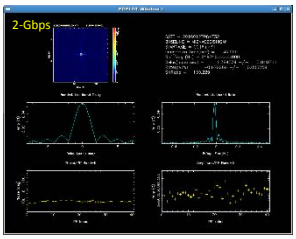
The System Configuration of the Test Observation in Mizusawa

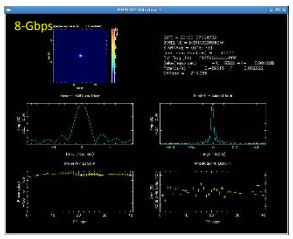


同一scanのフリンジサーチ結果

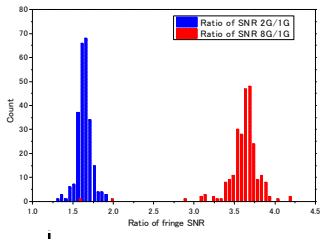
RecRate	Delay Error (Pico second)	SNR
1-Gbps	18.8	57.1
2-Gbps	10.7	100.2
8-Gbps	1.2	219.3

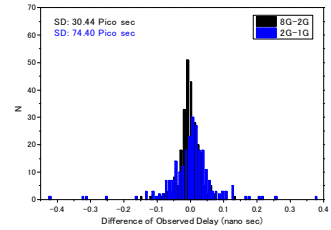






SNRの比，遅延観測値差の分布

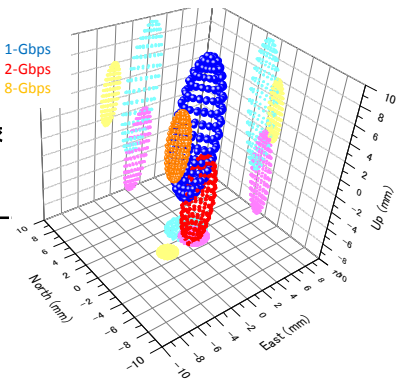




	2-Gbps/1-Gbps	8-Gbps/1-Gbps
Theoretical Ratio of SNR	1.64	3.27

Result of delay search	2-Gbps/1-Gbps	8-Gbps/1-Gbps
Ratio of averaged SNR	1.77	3.72

局位置解析結果，各3モードでの推定値差と誤差の比較



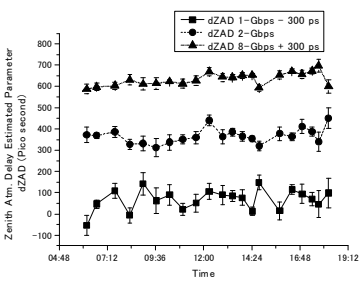
Unit=mm	U-D	E-W	N-S
1-Gbps	2.1	1.5	1.0
2-Gbps	-5.3	1.4	-0.4
8-Gbps	2.6	-2.3	-0.8

	1-Gbps	2-Gbps	8-Gbps	2G/1G	8G/1G
R.M.S. of Post-fit-residuals (Pico second)	32.2	23.0	14.0	0.71	0.43
Sample Standard Deviation (Pico second)	2.4	1.7	1.0	0.70	0.42
Degree of Freedom	177	185	186		
Error of Baseline Length (mm)	8.6	6.0	4.1	0.69	0.48
R.M.S. of Observed Delay Error (Pico second)	34.7	21.0	3.3	0.61	0.10
Delay Rejection Criterion (Pico second)	159.6	115.3	71.5		

The ability of delay estimation is not used effectively for analysis. What are the causes?

- The instability of the observation system?, Time variation of inter-band phase characteristic?
- Fitting function (Quadratic) of fringe peak search processing?, Skewness of the delay resolution function?
- Precision of the physical models, correction of tau_ion, etc are not enough to the magnitude of delay error?

大気遅延推定への効果



	Average (Pico second)	Standard Deviation (Pico second)
1-Gbps	367.17	38.25
2-Gbps	366.89	26.86
8-Gbps	334.20	18.73