SKAVLBIバックエンド

国立天文台水沢VLBI観測所　河野裕介 SKA-JP EWG

Based on SKA CSP Mid Correlator and Beamformer
Sub-element Detailed Design Document
SKA-TEL-CSP-0000066

CSP (Central Signal Processer)

CSP-MID　VLBI Beam former

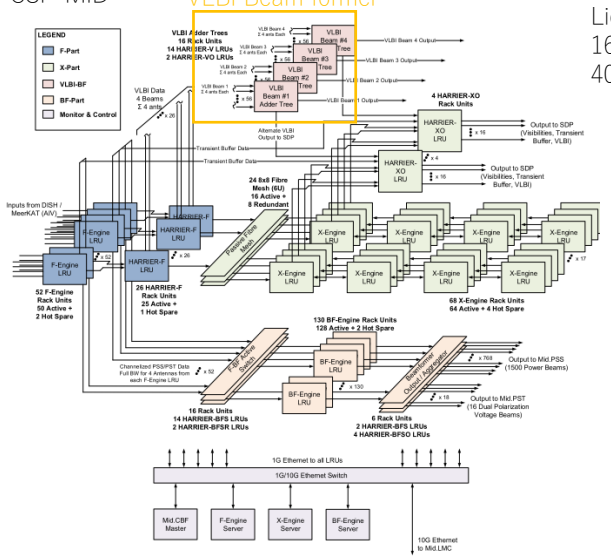


Figure 5-14　Mid.CBF Top Level Physical Architecture

1U / board, total 300 boards
Altera　Stratix 10　FPGAs
Liquid　cooling
16ラック
400kW　power

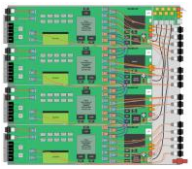


Table 5-2　The observation bands and other key parameters of SKA1 Mid and MeerKAT.

Band	Frequency Range (GHz)	Bandwidth to be delivered to the SDP (MHz) as visibilities	Sample Word-Length input to Mid.CBF	Common Sample Rate (GSPS) input to Mid.CBF
SKA1 Band 1	0.35 – 1.05	700	8-bit	4
SKA1 Band 2	0.95 – 1.76	810	8-bit	4
SKA1 Band 3	1.65 – 3.05	1400	8-bit	3.2
SKA1 Band 4	2.80 – 5.18	2380	4-bit (TBC)	12
SKA1 Band 5	4.60 – 13.80	2 × 2500	4-bit	2 × 6
MeerKat UHF-Band	0.58 – 1.015	435	TBD	TBD
MeerKat L-Band	0.9 – 1.67	720	10-bit	TBD
MeerKat S-Band	TBD	TBD	TBD	1.712
MeerKat X-Band	TBD	TBD	TBD	TBD

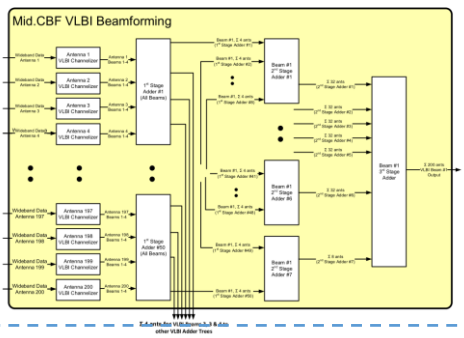
主な仕様

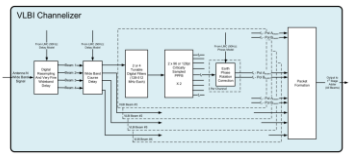
REQ-366	Within the bandwidth claimed to be spectrally pure, CSP_Mid.CBF shall induce no spectral distortion in the VLBI data above -40dB TBC in amplitude and 1e-2 radians TBC in phase after calibration.
REQ-358	Upon command from CSP_Mid.LMC, CSP_Mid.CBF shall re-configure the centre frequency, frequency band, and/or bandwidth for each tied-array VLBI beam, in less than 20 seconds (TBC).
REQ-1647	CSP_Mid.CBF shall send tied-array beam data to pulsar search and timing, and VLBI outputs, with a maximum latency of 0.1 seconds (TBC).

REQ-349	When performing VLBI beamforming, the CSP_Mid.CBF shall achieve a Signal to Noise ratio better than 98% compared to an ideal analogue beamformer, given the same digitized inputs and calibration.
REQ-353	CSP_Mid.CBF shall be able to output VLBI beams with a sampling rate selectable between Nyquist and at least factor 2 oversampled rates for the selected bandwidth.
REQ-352	CSP_Mid.CBF shall be able to generate data from the VLBI beams with samples traceable to a timestamp with an accuracy of 1 nsec or better.

VLBI ビームフォーマー構成

局数：200 (SKA1+MeerKAT)
帯域：Max 80Gbps/局
同時出力ビーム数：4
DBBC　Tunable 10kHz
BW: 1, 4, 16, 32, 64, 128, 256, 512 MHz
記録帯域：　80Gbps x 4beams





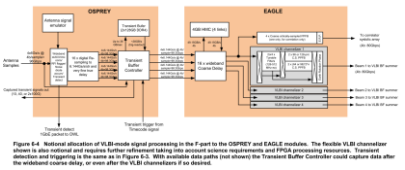


Figure 6-4　Notional allocation of VLBI-mode signal processing in the F-part to the OSPREY and EAGLE modules. The flexible VLBI channelizer shown is also notional and requires further refinement taking into account science requirements and FPGA processing resources. Transient detection and triggering is the same as in Figure 6-3. With available data paths (not shown) the Transient Buffer Controller could capture data after the wideband coarse delay, or even after the VLBI channelizers if so desired.

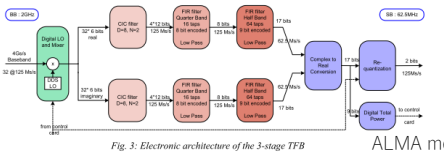
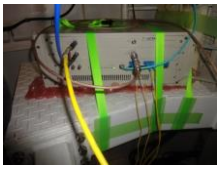


Fig. 3: Electronic architecture of the 3-stage TFB

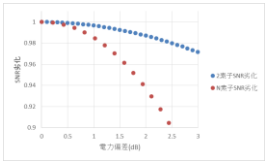
ALMA memo 579

NAOJ開発

DBBC：OCTAD同等であり着実な開発が可能
REC：　OCTADISK2を40GbE化する
スケジュール
2018　概念設計、2019～PM



ビーム合成帯域内振幅特性偏差によるSNRの劣化



SKA2に向けた基礎開発テーマ

1. 分散計算機＋低消費電力IO

～Post Mooreの計算機技術～

MIDではFIREFLYを採用
1.5W/28Gpbs=50mW/Gbps
↓
光IOコア（PETRA）　5mW/Gbps

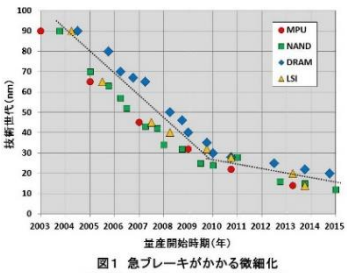
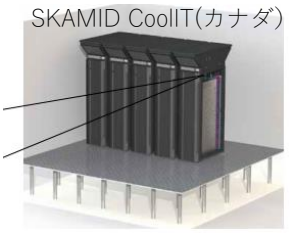


図1　急ブレーキがかかる微細化
出所：日経エレクトロニクス、2015年4月号、39ページの図30

http://www.nedo.go.jp/news/press/AA5_100367.html

2. 低消費電力冷却

SKAMID CoolIT(カナダ)



液没計算機
東工大　TSUBAME KFC
KEK　SUIREN
RIKEN

http://www.el.gsic.titech.ac.jp/~endo/publication/endo-hokke13-slides.pdf