SKA EWG

VLBI & AIV

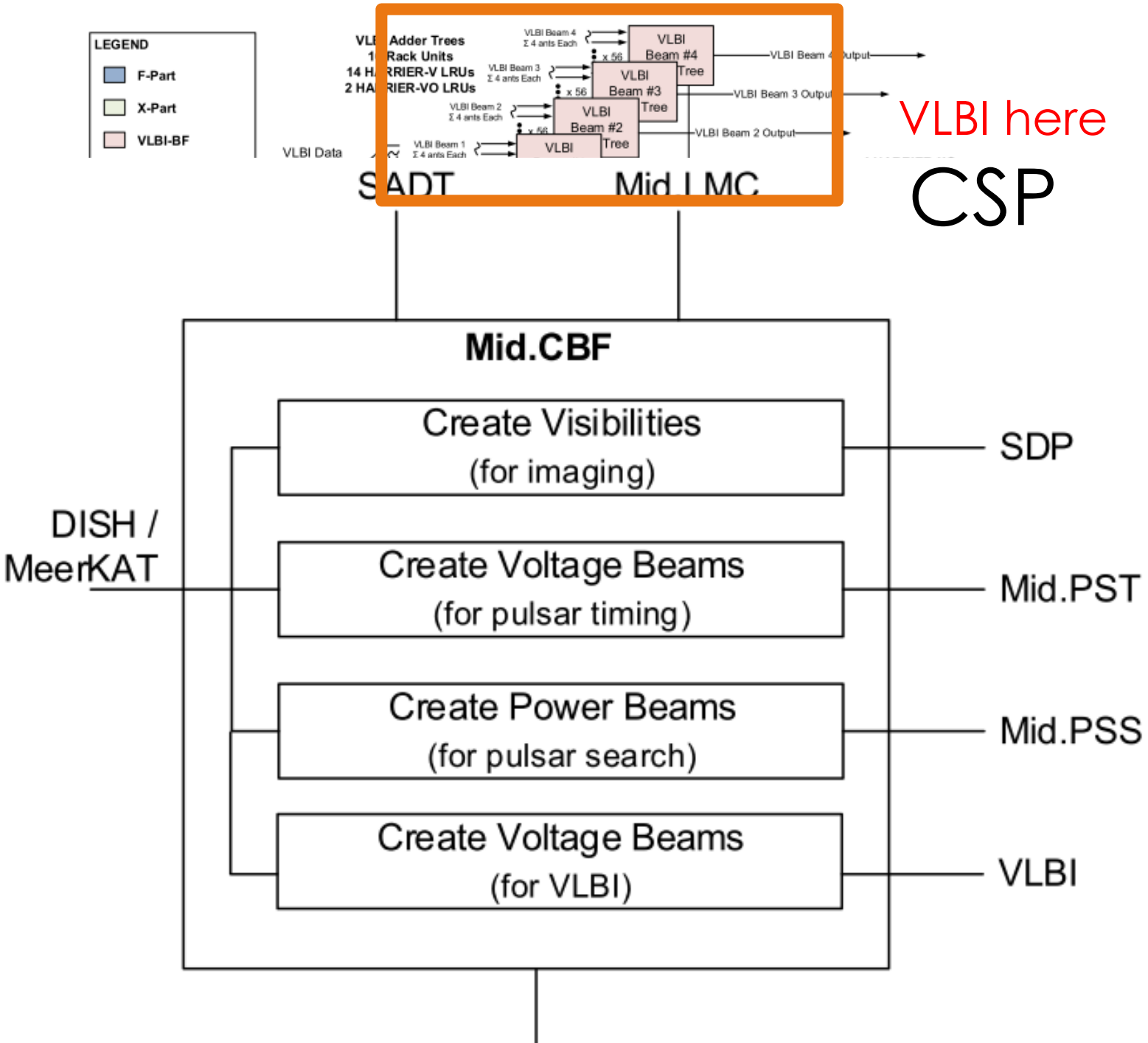
国立天文台　河野裕介

CONTENTS

- EWG
  - CSP (Central Signal Processor)
    - VLBI
  - AIV (Assembly, Integration, and Verification)

CENTRAL SIGNAL PROCESSOR

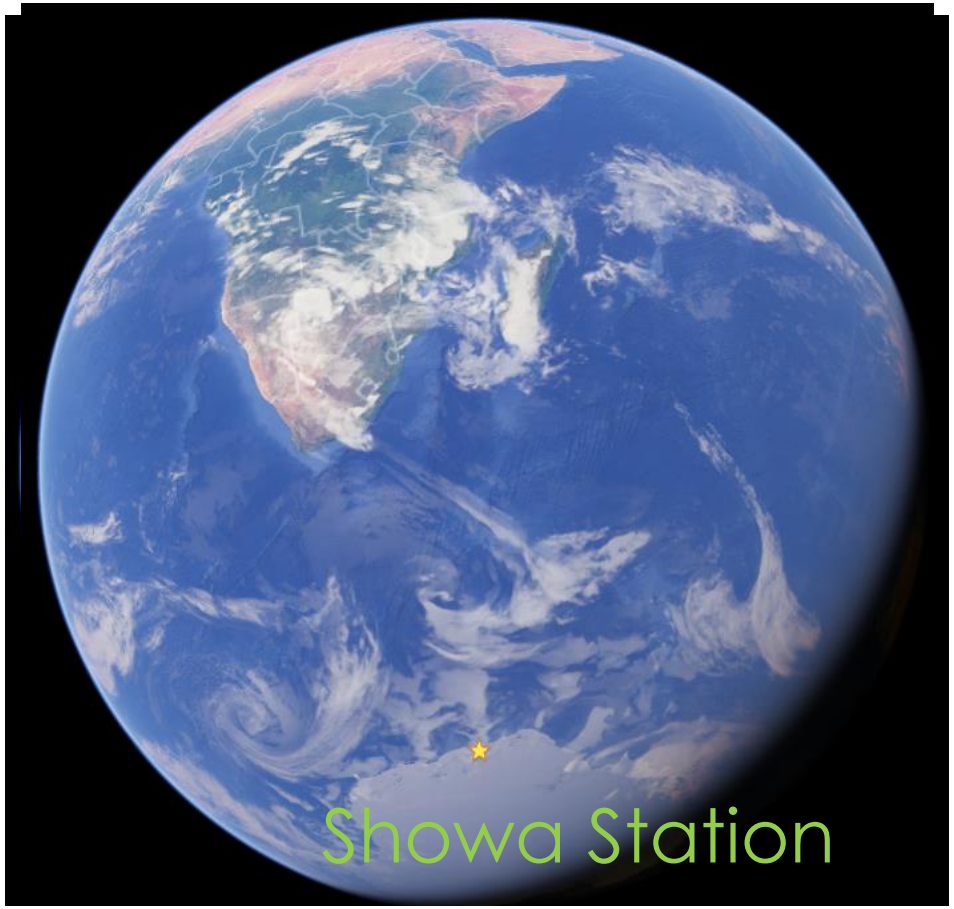
- 4つのビーム
- Lead: NRC(Canada)
- コスト€80M



VLBI CSP

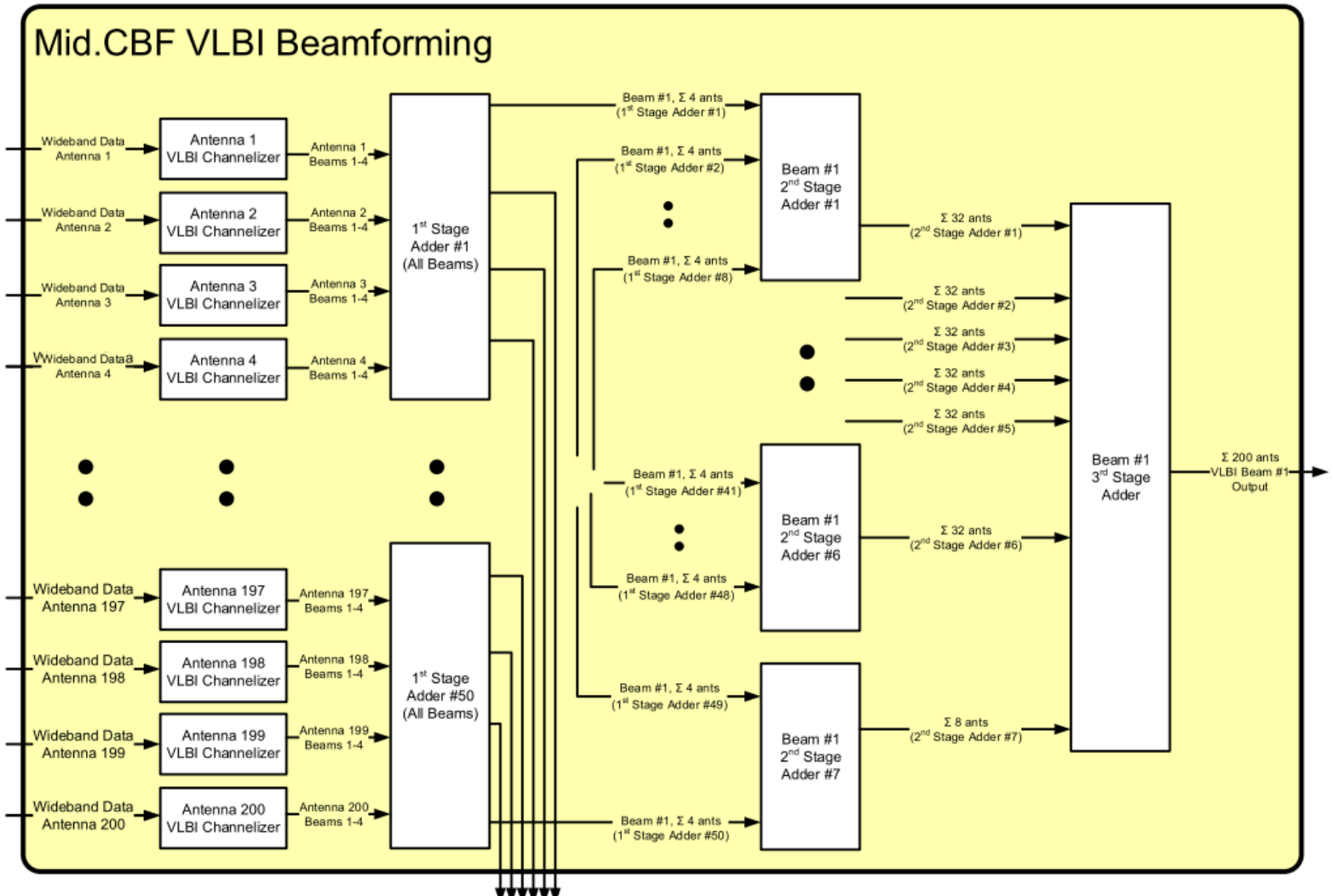
- No common sky
  - Complementary network to EAVN

- Contribute VLBI components to SKA1
  - Currently available component
    - Digital Signal Processing and Recording



VLBI BEAM FORMING

- Four beams
  - CBF produce cross corr. data for calib.
- DBBC
  - Tunable 10kHz
  - BW: 1, 4, 16, 32, 64, 128, 256, 512 MHz
- Adder 4 x 8 x 8
-
- Total 320 Gbps/4beams



REQUIREMENTS

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).

モード変更20秒以内

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).

バッファサイズ0.1秒以上

REQ-640	CBF components shall be capable of surviving pressures down to 11 kPa (equivalent altitude ~50,000 feet) during transport.

真空対応

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.

未知のタイムスタンプのずれ1n秒

REQ-350	The CSP_Mid CBF shall be a data source for VLBI data acquisition system. The interface between the CSP_Mid CBF and the external VLBI data acquisition system shall be compliant with the ICD SKA-TEL-SKO-0000116.

VLBIのIF

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.

オーバーサンプリング

REQ-652	CBF shall be fully operational and available 0.9991 (TBC) or more of the time.

運用時間率

Req ID	Req Text
REQ-157	CBF shall operate as specified in these requirements for at least 20 years after acceptance.

20年保証

KEY REQUIREMENTS

- Some prototyping needed
- 2018

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-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.	No	Section 6.1. Not easily possible due to bandwidth expansion. Can achieve 97%.

計画

- 2018
  - プロトタイプ
    - ソフトウェアシミュレーション
    - ハードウェア構成見積もり
    - OCTADISK2の40GE化
- 2019
  - プロトタイプ評価
  - PDR
- 2020～
  - CDR
  - インストール

JUMPING JIVE PROJECT

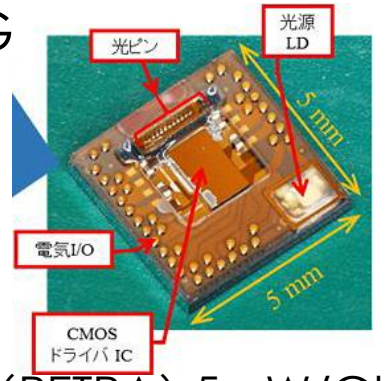
- EUのプロジェクト
  - 4年/3M euro
  - 8か国

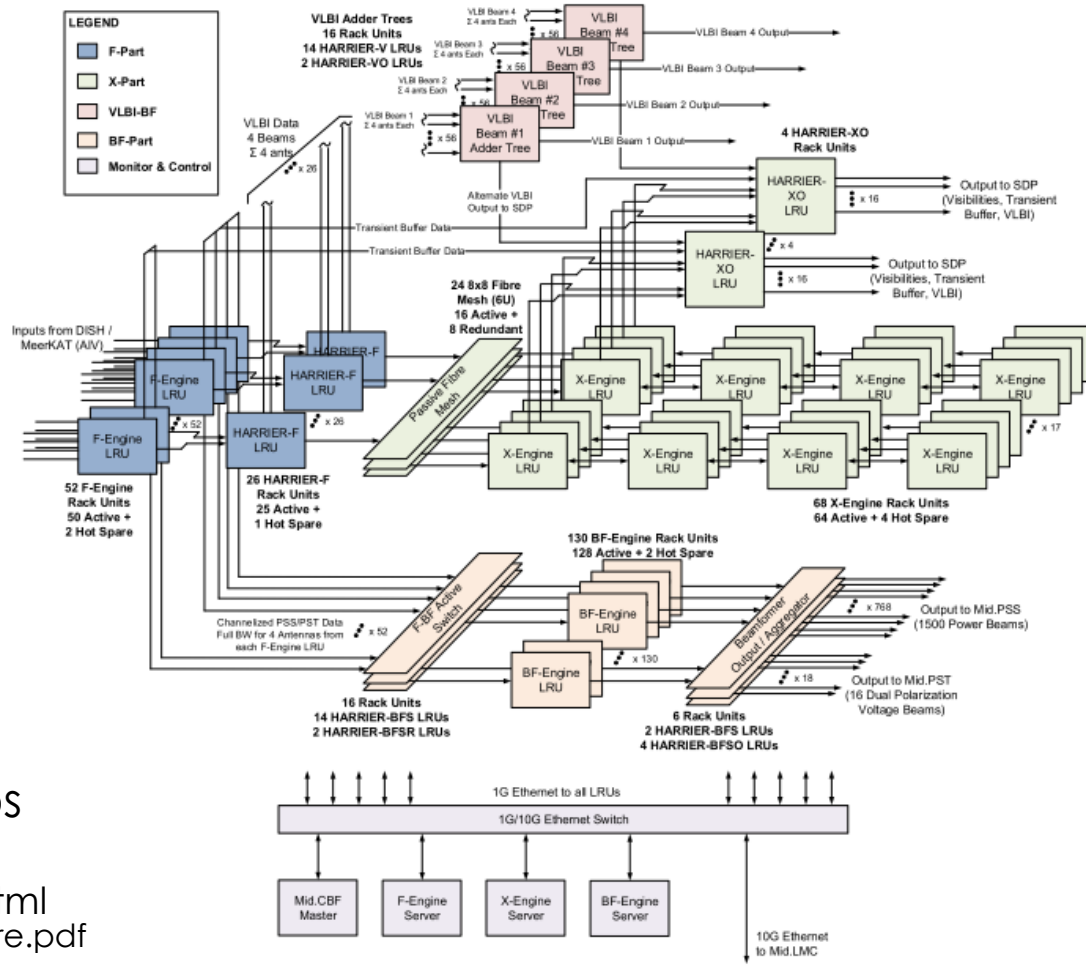
- Global VLBIとSKAとのIFを目的としている
  - SKAのCSPを分担するとは書いていない

- February 21 marks the official start of the project with a kick-off meeting in Leiden

SKA2への展望

- SKA2ではCSPコアを狙う
  - 演算∝N^2
- ムーアの法則の限界
  - 分散処理
- SKA1CSP ではFIREFLY
  - 1.5W/28Gpbs=50mW/G
  - Passive Opt. Switch



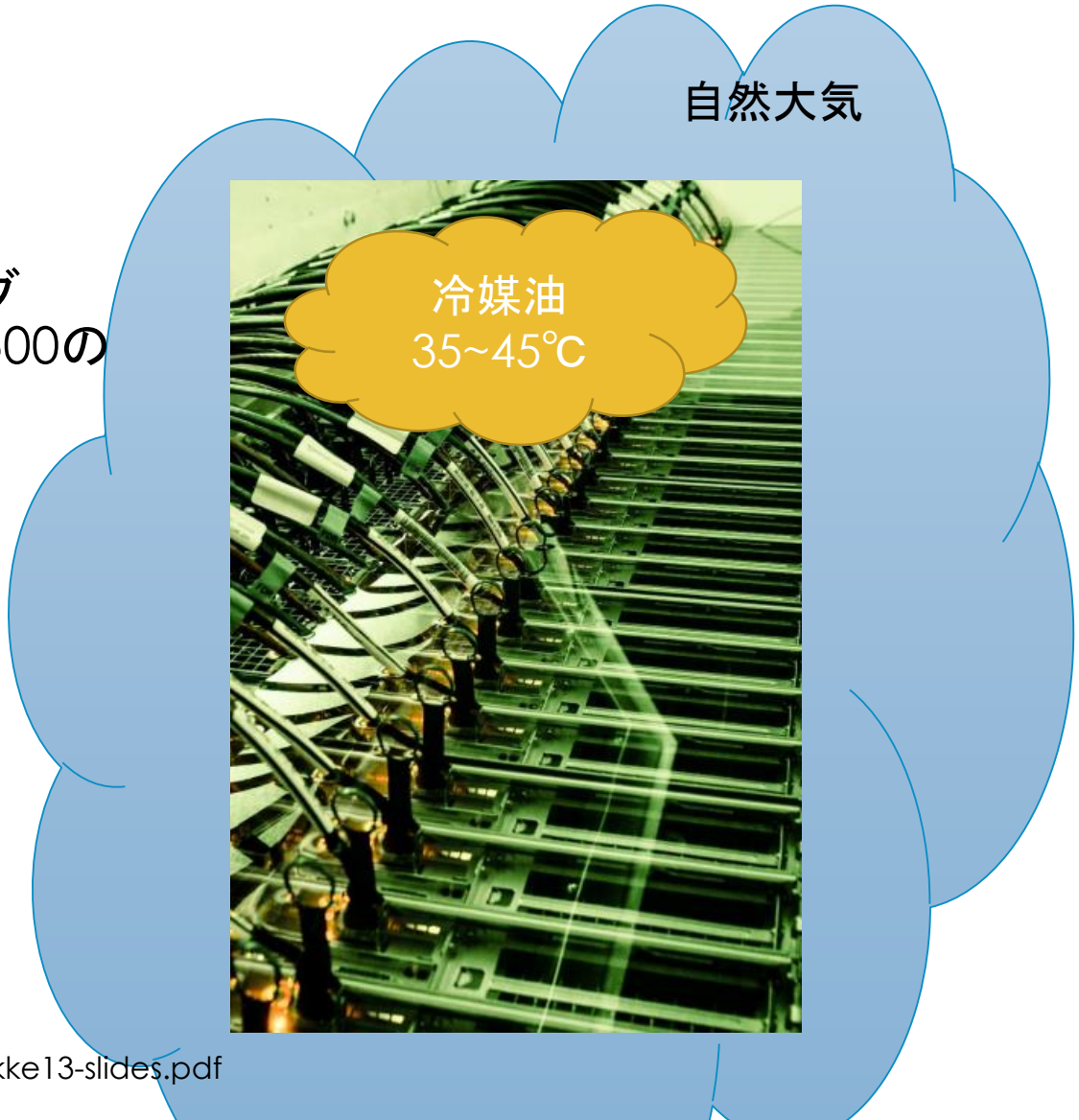


SKA2では超低消費電力の光IOコア（PETRA）5mW/Gbps

http://www.nedo.go.jp/news/press/AA5_100367.html
http://suddendocs.samtec.com/ebrochures/firefly-brochure.pdf

液没計算機

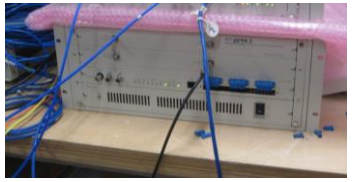
- 東工大　TSUBAME-KFC
  - スパコンの電力効率ランキング Green500, Green Graph 500の両方において世界一位
  - PUE＝1.15



http://www.el.gsic.titech.ac.jp/~endo/publication/endo-hokke13-slides.pdf
http://www.pc-master.jp/mainte/cleaning.html

実績

CPU Base (NiCT/NAOJ)
Oyama et al, 2012
Oyama et al, 2016



FPGA base(KASI/NAOJ)
Oh et al, 2011

HPC (NAOJ)

気球気密計算機　熱制御

CSP VLBIまとめ

- まずはVLBIバックエンドでSKA1に参入する
  - これまでのVLBIの技術開発の延長
    - NAOJ，CRL/NICT, ISAS, UNIVs

- SKA2で天文学史上最高集光力の集光部分（CSP)を狙う
  - グリーンコンピューティング

ASSEMBLY, INTEGRATION & VERIFICATION

AIV

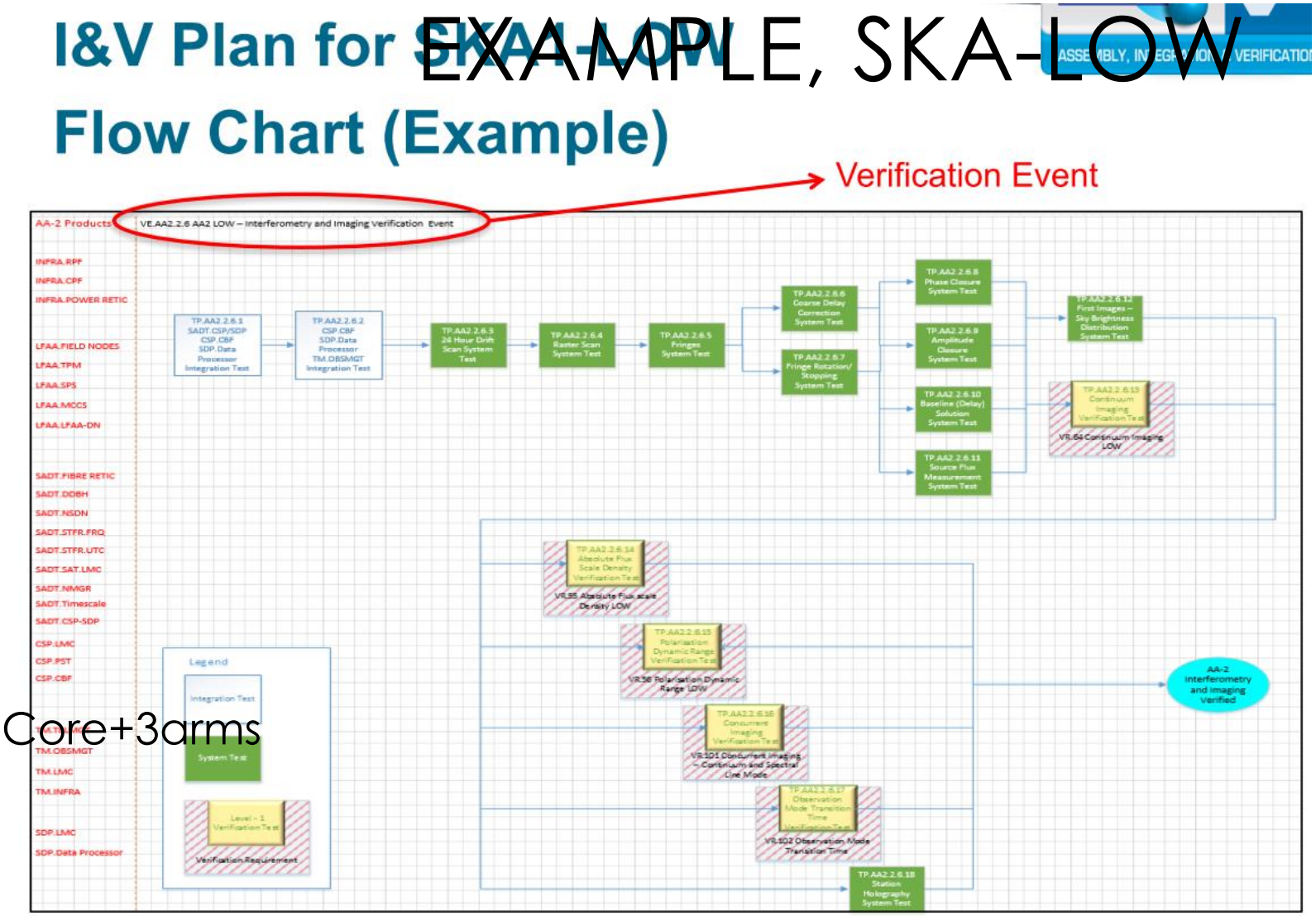
- Assembly, Integration & Verification
  - Lead: SKA SA
  - €20M

- タスク
  - ロールアウト計画立案
  - Detailed Integration and Verification Planを作成

- 納品検査の後、フルオペのサイエンスコミッションの前

EXAMPLE, SKA-LOW

- Station roll out
  - Station level tests
  - Station correlation tests
  - Weather condition tests
  - Station calibration tests
  - RFI mitigation tests
  - Clock accuracy tests
- Array roll out
  - 4 stations→20→Core→Core+3arms



CLARIFICATION OF ROLES AND RESPONSIBILITIES

- AIVだけが作業を行うのではない
  - どのメンバが必要かを検討
  - スケジュール・FTEを検討

		Subsystem team	Engineering Support team	SE team	Commissioning team	Operators	Maintenance team
Subsytems	Lab integration	execute	-	-	-	-	-
	Qualification testing	execute	-	observe	-	-	-
	Qualification review (QR)	execute	-	participate	participate	-	-
	Install on site	execute	-	-	-	-	-
	Site acceptance test	execute	-	observe	-	-	-
System	Lab Integration & fixing problems	support	execute	coordinate & execute	-	-	-
	Lab testing	support	support	execute	-	-	-
	Site integration and fixing problems	support	execute	coordinate & execute	-	-	support
	Acceptance testing	-	support	execute	support	-	support
	Acceptance Review	-	-	execute	participate	-	-
	Commissioning	-	support	-	execute	support	support
	Operation	-	-	-	-	execute	support
	Maintenance	-	support	-	-	-	execute

VERIFICATION EVENT

				FTE Days
	AA1 MID - Time and Frequency Reference		Non precision Time Stamping Accuracy	10
		Time Stamping Accuracy		20
		Coherence Loss		5
				35

- for example,
  - タイムスタンプの精度を20FTE days
  - コヒーレンスを5FTE days
- で求めないといけない。
  - どういう手法なのかは、資料にない。WPCに入れば見れる？

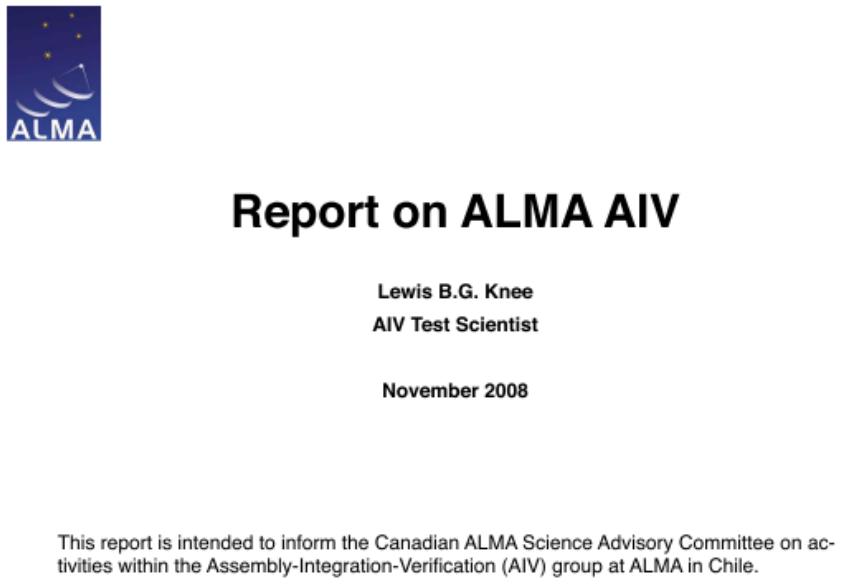
なぜAIVか

- Understaffed

AIV Consortium

- Achievements
  - Verification Requirements document is under Office review
  - Product Handover Checklist document is under Office review
  - Successful AIV workshops at Eng. Meeting
- Ongoing
  - Preparation of documentation pack for System Pre-CDR
  - Integration & Verification Plans for Mid and Low
  - Roll-Out Plans stable, minor refinements in version 6 expected
- Issues
  - AIV Consortium remains understaffed with no view on improvements
- AIV Consortium funding approved until end of 2018

ALMA AIV



Report on ALMA AIV

Lewis B.G. Knee
AIV Test Scientist

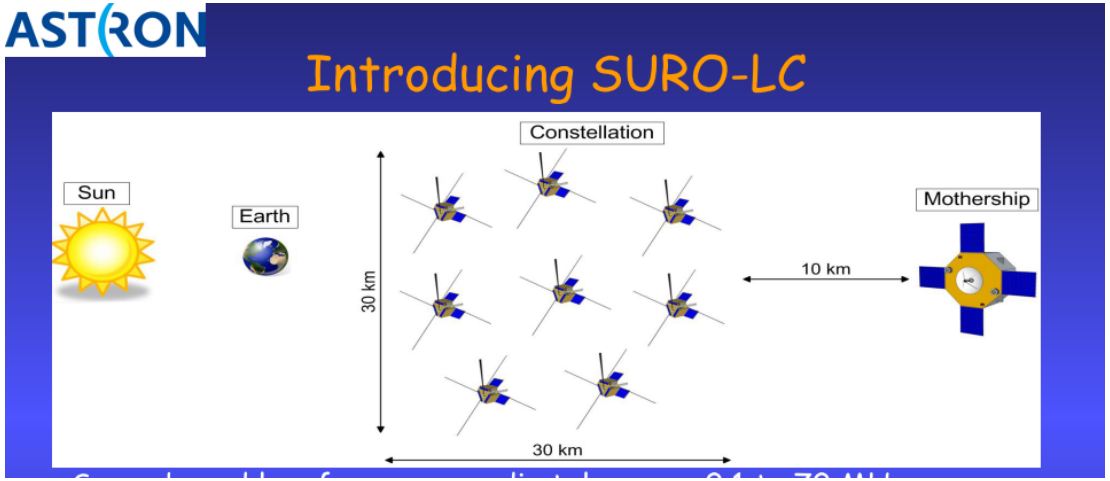
November 2008

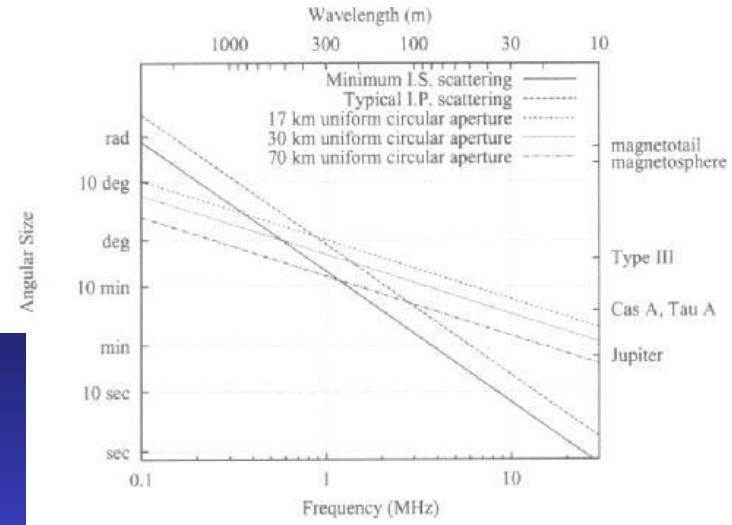
This report is intended to inform the Canadian ALMA Science Advisory Committee on activities within the Assembly-Integration-Verification (AIV) group at ALMA in Chile.

Report on ALMA AIV, Knee 2008

月面裏側　低周波電波望遠鏡

- 必要分解能0.1deg@3MHz
  - Baseline 60km程度
- Daedalus crater Lunar Far Side
  - 直径80km





http://www.ugcs.caltech.edu/~yukimoon/RALF/

AIV Stage 2 Milestonesスケジュール

#	Stage 2: Milestone Description	Due Date
1	Kick-off	Apr 2015
2	Telescope Preliminary I&V Plan	Jul 2015
3	SEMP and PMP Alignment	Jun 2015
4	Product Hand-Over Checklist	Jul 2015
5	Updated Cost Model	Aug 2015
6	MeerKAT Precursor ICDs	Aug 2015
7	Telescope Roll-Out Plan (Next Release)	Sep 2015
8	MeerKAT Precursor Integration Plan and ICDs	Oct 2016
9	Telescope Verification Requirements (Next Release)	Mar 2017
10	Product Hand-Over Checklist	Apr 2017
11	Telescope Detailed I&V Plan	May 2017
12	Telescope AIV Resource Plan	May 2017
13	Telescope Test Procedures (Draft)	Aug 2017
14	System Pre-CDR - Document Submission	Aug 2017
15	System Pre-CDR – Closure	Oct 2017
16	Telescope Test Procedures (Final)	Dec 2017
17	System CDR - Document Submission	Mar 2018
18	System CDR - Closure	System CDR + 4 weeks

ここまで終了
by SKA board2017 の
Engineering Report

AIV TEAM

Figure 1: AIV Team at the Engineering Meeting in Rotterdam, June 2017. Adam MacLeod, Richard Lord, Peter Hekman, Donald Gammon, Michael Hayes, Nico Ebbendorf, Marchel Gerbers

AIVまとめ

- AIV
  - 計画と評価設計などの人的貢献が中心

  - LOWでの参加がいいのでは？
    - LOWにも日本が正式参加
    - 20MEなので少額でコスト貢献インパクト大きい