ASTRON

NWO

Netherlands Institute for Radio Astronomy

SKA NL Science Meeting

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ASTRON is part of the Netherlands Organisation for Scientific Research (NWO)

SKA Consortia

Pre-Construction Schedule

Milestone	Date	
Telescope Manager CDR	17-20 April 2018	✔
Signal and Data Transport CDR	15-18 May 2018	✔
Infrastructure Australia CDR	27-29 June 2018	
Infrastructure South Africa CDR	2-4 July 2018	
Central Signal Processor CDR	25-28 September 2018	
Low Frequency Aperture Array CDR	17-19 December 2018	
Signal & Data Transport CDR	17-19 December 2018	
Dish CDR	2019	
System CDR (incl. AIV)	March 2019	

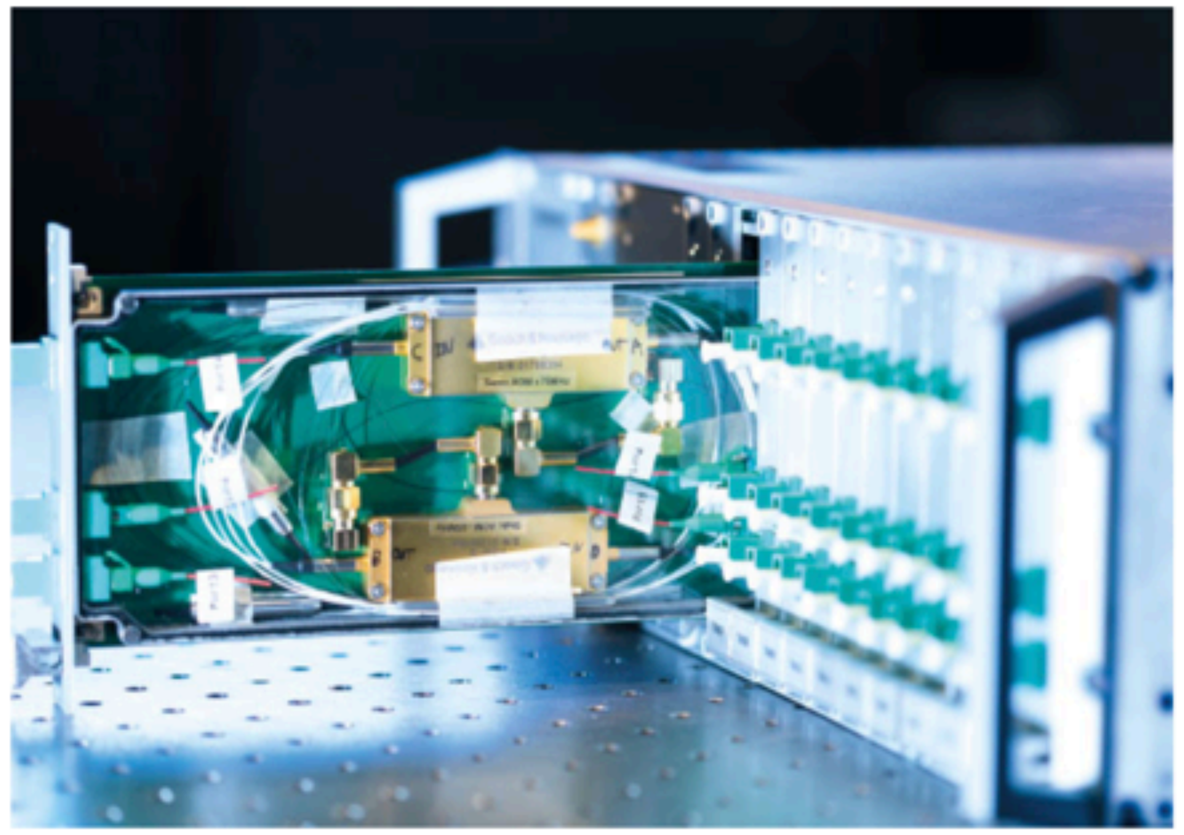
DESIGNING THE

Square Kilometre Array

Science Data Processor

The Science Data Processor (SDP) element will focus on the design of the computing hardware platforms, software, and algorithms needed to process science data from the correlator or non-imaging processor into science data products. The Science Data Processor will have to manage the vast amounts of data being generated by the telescopes. From spectral and continuum sky surveys, to more targeted observations of objects both near and far, the SDP will ingest the data, and move it through data reduction pipelines at staggering speeds, to then form data packages which will then be passed to the scientists, and in almost realtime, make decisions about noise that is not part of those delicate radio signals. The consortium is led by the University of Cambridge in the UK.

Signal and Data Transport



Signal and data transport is the backbone of the SKA telescope. The Signal and Data Transport (SaDT) Consortium is responsible for the design of three data transport networks. These include the Digital Data Backhaul (DDBH) that transports signals from the radio telescopes to the Central Signal Processor (CSP), and data products from the CSP to the Science Data Processor (SDP) and from the SDP to the regional SKA Data Centres. SaDT's work also includes the design of clocks and a custom-made frequency distribution system. The consortium is led by the University of Manchester in the UK.

https://cdr.skatelescope.org

DESIGNING THE

Square Kilometre Array

SKA Prototype Dish Assembled For The First Time

The fully assembled SKA dish prototype – SKA-P – at the CETC54 assembly workshop in Shijiazhuang, China. Credit: SKA Organisation

Shijiazhuang, China, Tuesday 6 February – The first fully assembled SKA dish was unveiled today at a ceremony in Shijiazhuang, China, by the Vice Minister of the Chinese Ministry of Science and Technology, in the presence of representatives from the countries involved and the SKA Organisation. The dish is one of two final prototypes that will be tested ahead of production of an early array.

In a major milestone for the SKA Project, the 54th Institute of China Electronics Technology Group Corporation (CETC54) has completed the structural assembly of the first SKA dish, bringing together components from China, Germany, and Italy.

https://cdr.skatelescope.org

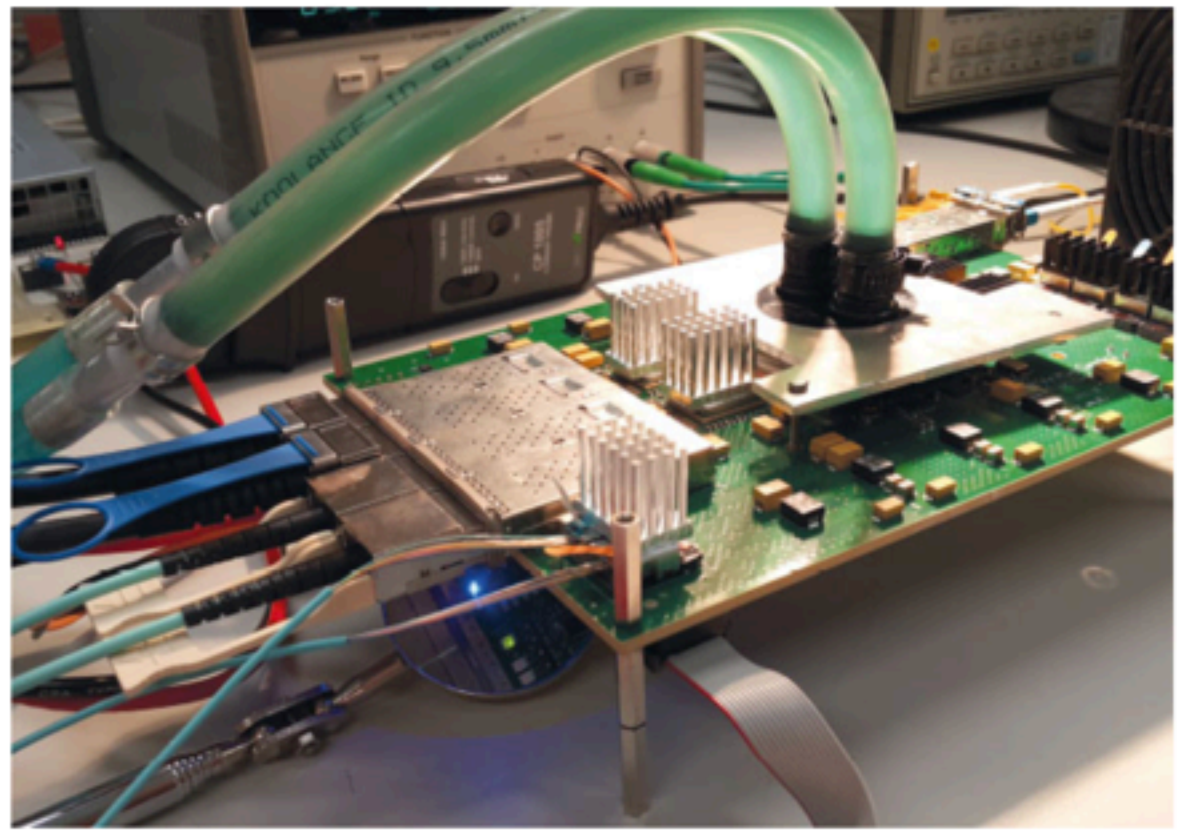
AAVS1 - prototype SKA_low station

The Aperture Array Verification System (AAVS) is an initiative of the Aperture Array Design and Construction (AADC) Consortium that supports SKA pre-construction.
AADC Consortium Lead: ASTRON
Netherlands Institute for Radio Astronomy
ICRAR International Centre for Radio Astronomy Research
INAF
UNIVERSITY OF CAMBRIDGE
UNIVERSITY OF OXFORD
JIVE Joint Institute for VLBI ERIC
MANCHESTER 1824 The University of Manchester
Science & Technology Facilities Council
Station de Radioastronomie de Nançay
Observatoire de la Côte d'Azur
MWA Murchison Widefield Array
KLAASA
From Lab To Outback: The Story Of AAVS1 So Far
Designing the SKA Telescopes
From lab to Outback: the story of AAVS1 so far
18 December 2017, SKA Global Headquarters, Jodrell Bank, UK – It is an understatement to say that designing and building a world-class scientific instrument comes with its challenges. The Aperture Array Verification System (AAVS1) is one of the major milestones in the journey towards delivering the final design for SKA1-low, the Australian arm of the first phase of the SKA telescope, that will eventually consist of 130,000 antennas observing low frequency signals emanating from the cosmos. The team delivering this project recently reported on the successful roll-out of a station made up of 256 antenna prototypes at the Murchison Radio-astronomy Observatory (MRO), located in Western Australia.
"The journey leading up to the deployment and installation of a full antenna station has been a fantastic experience and a steep learning

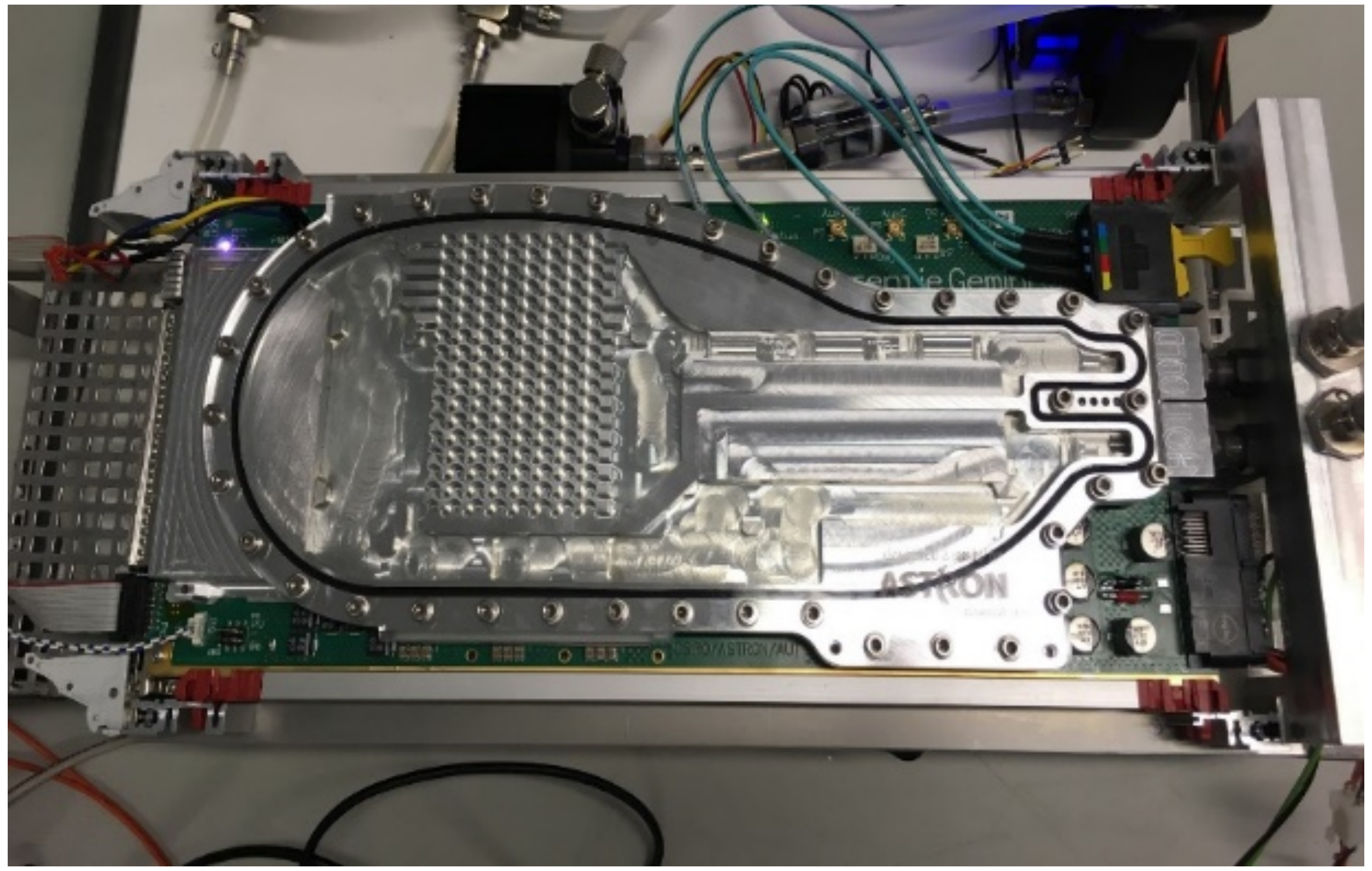
CSP - SKA_Low Correlator/Beamformer

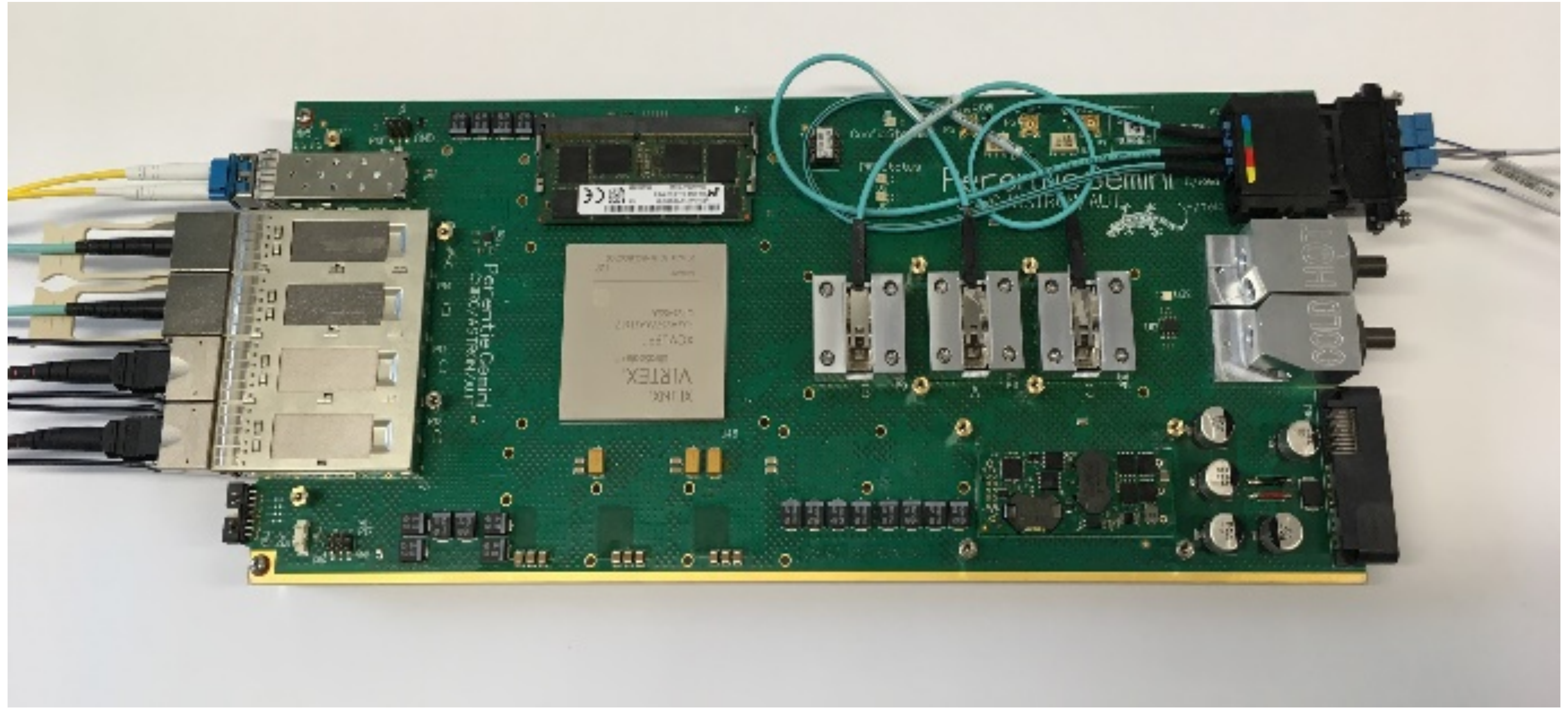
Central Signal Processor

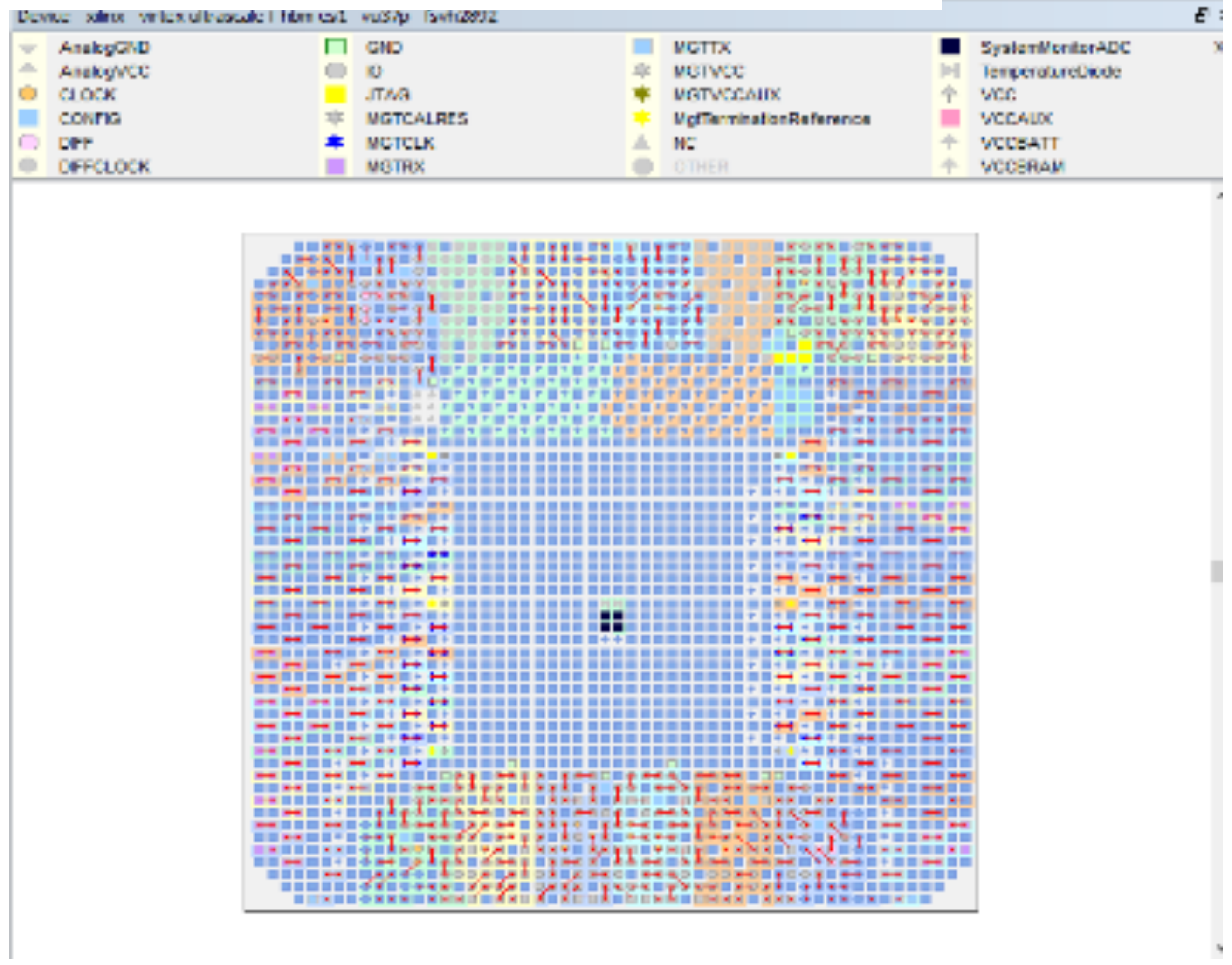
CSP



The Central Signal Processor or CSP is the central processing “brain” of the SKA. It converts digitised astronomical signals detected by SKA receivers into the vital information needed by the Science Data Processor to make detailed images of deep space astronomical phenomena that the SKA is observing. It will also design a “non-image processor” in order to facilitate the most comprehensive and ambitious survey yet to find new pulsars and precisely time known pulsars. The lead organisation of the Consortium is the National Research Council of Canada (NRC).







Collaboration between ASTRON, CSIRO & AUT

SKA1 Cost Control Project

WS / Origin	Description	LOW / MID / COMMON	Science Implication	Science Impact
5.39	INFRA_SA Renewable energy to outer dishes	MID	None	1
5.3	Maximise use of code produced during Pre-Construction	COMMON	None	1
5.38	Simplify DDBH LOW	LOW	None	1
5.38	Simplify DDBH MID	MID	None	1
5.25.2	Reduce PSS-MID: A, 750 nodes to 500 nodes	MID	Likely none, or small reduction of pulsar search parameter space.	1
5.25.2	Reduce PSS-LOW: A, 250 nodes to 167 nodes	LOW	Likely none, or small reduction of pulsar search parameter space.	1
5.35	Reduce CBF-MID: Freq. Slice variant of CSP design vs. MeerKAT-based design	MID	None	1
5.19	MID Frequency and Timing Standard: SaDT solution vs. MeerKAT-based solution	MID	None	1
5.36	MID SPF Digitisers: DSH solution vs. MeerKAT-based solution	MID	None	1
5.26 / 5.29	LOW RPF: Early Digital Beam Formation vs. Analogue Beam Formation	LOW	None	1
2	LOW Antenna: Log Periodic Design vs. Dipole Design	LOW	None of the current designs meet the L1 requirements	3
8	SDP- HPC: Deploy 200 Pflops (rather than 260 Pflops)	COMMON	Lower allowed duty cycle for HPC-intensive observations.	2
5.24.3	Reduce Bmax MID from 150 to 120 km: Case A, remove 3 dishes, but keep infra to 150km	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	3
5.24.2	Reduce Bmax MID from 150 to 120 km: Case B, remove infra, but add dishes to core	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	3
5.24.1	Reduce Bmax MID from 150 to 120 km: Case C, remove infra, remove dishes	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	3
5.5.2	Reduce MID Band 5 feeds: A, from 130 to 67	MID	Placement to be determined based on full community consultation.	3
5.25.2	Reduce PSS-LOW: B, 167 nodes to 125 nodes	LOW	Likely reduction in processed PSS beam number (1.3x) or pulsar search parameter space	2
5.25.2	Reduce PSS-MID: B, 500 nodes to 375 nodes	MID	Likely reduction in processed PSS beam number (1.3x) or pulsar search parameter space	2
8	SDP- HPC: Deploy 150 Pflops (from 200 Pflops)	COMMON	Lower allowed duty cycle for HPC-intensive observations.	3
5.30.0	Reduce Bmax LOW to 50km: A, remove infra, add 18 stations to core	LOW	Science Risk to EoR: Bmax.	3
5.30.0	Reduce Bmax LOW to 50km: B, remove 18 stations	LOW	Science Risk to EoR: Bmax	3
5.30b	Reduce Bmax LOW to 40km: C, remove next 18 stations	LOW	Science Risk to EoR: Bmax	3
8	SDP- HPC: Deploy 100 Pflops (from 150 Pflops)	COMMON	Lower allowed duty cycle for HPC-intensive observations.	4
8	SDP- HPC: Deploy 50 Pflops (from 100 Pflops)	COMMON	Lower allowed duty cycle for HPC-intensive observations.	4
5.31	Reduce CBF-LOW BW: A, 300 to 200 MHz	LOW	Longer observing times for continuum applications (1.5x)	4
5.25.2 / Deeper Savings	Reduce PSS-LOW: C, 125 nodes to 83 nodes	LOW	Likely reduction in processed PSS beam number (2x) or pulsar search parameter space	4
5.25.2 / Deeper Savings	Reduce PSS-MID: C, 375 nodes to 250 nodes	MID	Likely reduction in processed PSS beam number (2x) or pulsar search parameter space	4
5.13.2	Reduce Bandwidth output of band 5 to 2.5GHz	MID	Longer Band 5 observing times for some applications (2x)	4
5.35	Reduce MID CBF and DSH BW: 5 to 1.4 GHz	MID	Longer observing times to achieve continuum sensitivity in Band 5 (3.6x)	4
5.24 / Deeper Savings	Remove 11 MID Dishes from core	MID	10% Array sensitivity loss in core	4
5.30 / Deeper Savings	Remove 54 LOW stations from core	LOW	10% Array sensitivity loss in core	4
5.24 / Deeper Savings	Remove additional 11 MID Dishes from core	MID	20% Array sensitivity loss in core	4
5.30 / Deeper Savings	Remove additional 54 LOW stations from core	LOW	20% Array sensitivity loss in core	4
5.24.2	Reduce Bmax MID from 120 to 100 km: D, remove infra, remove next 3 dishes	MID	Lose Science (Planetary disks, High resolution Star Formation)	4
5.5.1	Remove MID Band 1 feeds: 105 to 0	MID	Lose Science (Cosmology, Galaxy Evolution)	4
5.5.2	Reduce MID Band 5 feeds: B, from 67 to 0	MID	Lose Science (Planetary disks, Star Formation)	4

- SKA1 Construction Cost Cap: 650 M€ (2013) = **674 M€** (2016)
- November 2016 cost estimate: 916.1 M€ (36% over)

- Cost Control project identified & ranked potential cost saving measures
- Defined Design Baseline & Deployment Baseline

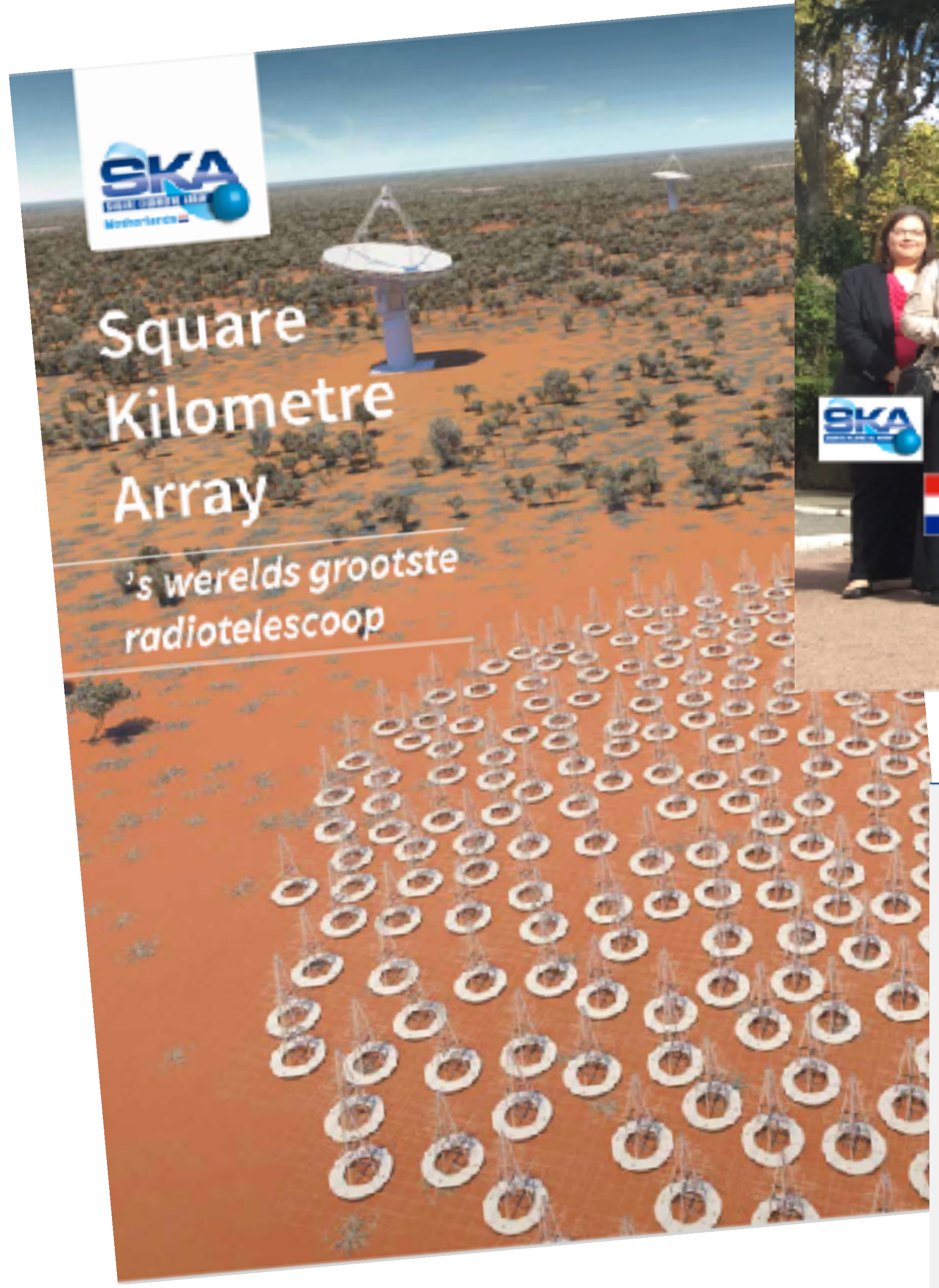
	Design Baseline	Deployment Baseline	Re-instatement '+' means add to system
SKA1-Mid			
No. dishes	133	130	+3 dishes at 150 km
Max. Baseline	150 km	120 km	+ infra to 150 km
Band 1 Feeds	133	130	+3 Band 1 Feeds for 3 dishes
Band 2 Feeds	133	130	+3 Band 2 Feeds for 3 dishes
Band 5 Feeds	133	67	+66 Band 5 feeds
Pulsar Search (PSS)	500 nodes	375 nodes	+125 nodes
SKA1-Low			
No. stations	512	476	+36 stations (18 stns at 49 & 65 km)
Max. Baseline	65 km	40 km	+infra to 65km
Pulsar Search	167 nodes	125 nodes	+42 nodes
Common			
Compute Power	260 PFLOPs	50 PFLOPs	+210 PFLOPs

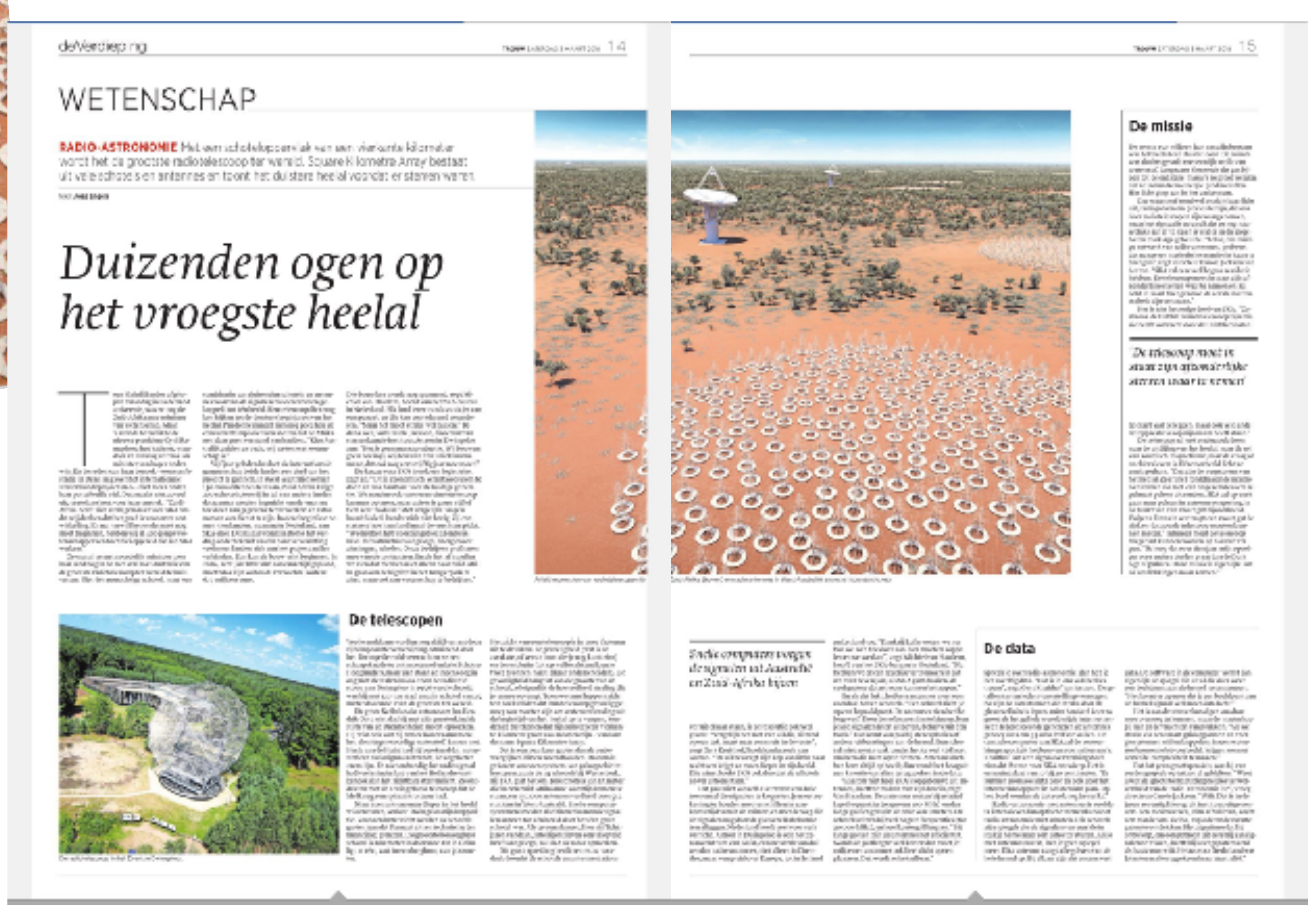
Design vs. Deployment Baseline June 2017 view

Setting up SKA Observatory

- Negotiations to set up SKA Intergovernmental Organisation (IGO)
- Convention now agreed
- Signing mid-September 2018
- SKA IGO active in 2020
- SKA Construction start: 2021

- Discussions on NL funding taking place
- Coalition agreement provides opportunities





Vertrouwen in de toekomst

Regeerakkoord 2017 – 2021

VVD, CDA, D66 en ChristenUnie

Nederland moet tekenen voor SKA

Deelname aan de bouw en beheer van 's werelds grootste radiotelescoop van 674 miljoen euro, de Square Kilometre Array, zal Nederland geen windeieren leggen en koploper maken op gebied van data science. Tenminste, als de nieuwe regering kiest voor de optie van minimaal vijf procent deelname en hiervoor 34 miljoen opzij zet. Zeventig procent van de investering vloeit sowieso direct terug in de vorm van contracten. Een optie van tien procent zou nog beter zijn, want die genereert 300 miljoen euro aan economische waarde.
Dit zegt hoogleraar Carole Jackson, algemeen en wetenschappelijk directeur van ASTRON. Na een paar jaar onderhandelen

SKA Project Schedule

Milestone	Date
Initialing SKA Convention	23 May - 20 July 2018
Signing SKA Convention	September 2018
Ratification Complete - SKA Observatory	early 2020
System CDR completed	mid 2019
Construction Proposal ready	late 2019-early 2020
SKA Council Approves Construction Plan	mid 2020
Start of Construction	early 2021

Other SKA Developments

- France, Spain set to join SKA Organisation
- Portugal to join when IGO is formed

- SKA KSP workshop & general science meeting
  - At the new SKA Headquarters
  - 8-12 April 2019

- MeerKAT inauguration - 13 July 2018

Themes for Today

- Updates from the Science Working Groups/Focus Groups
- What are the concerns or issues - important input to SKA Board

- Plans for Transition from SWG/FG to KSPs
  - How? When?
- How are pathfinders/precursors being used to prepare for SKA?

- Thoughts on SKA Regional Centres

Current Radio Astronomy Archives

LOFAR

Long Term Archive

36PB

NOAA

6PB

United States Census Bureau

4PB

NASDAQ

3PB

LIBRARY OF CONGRESS

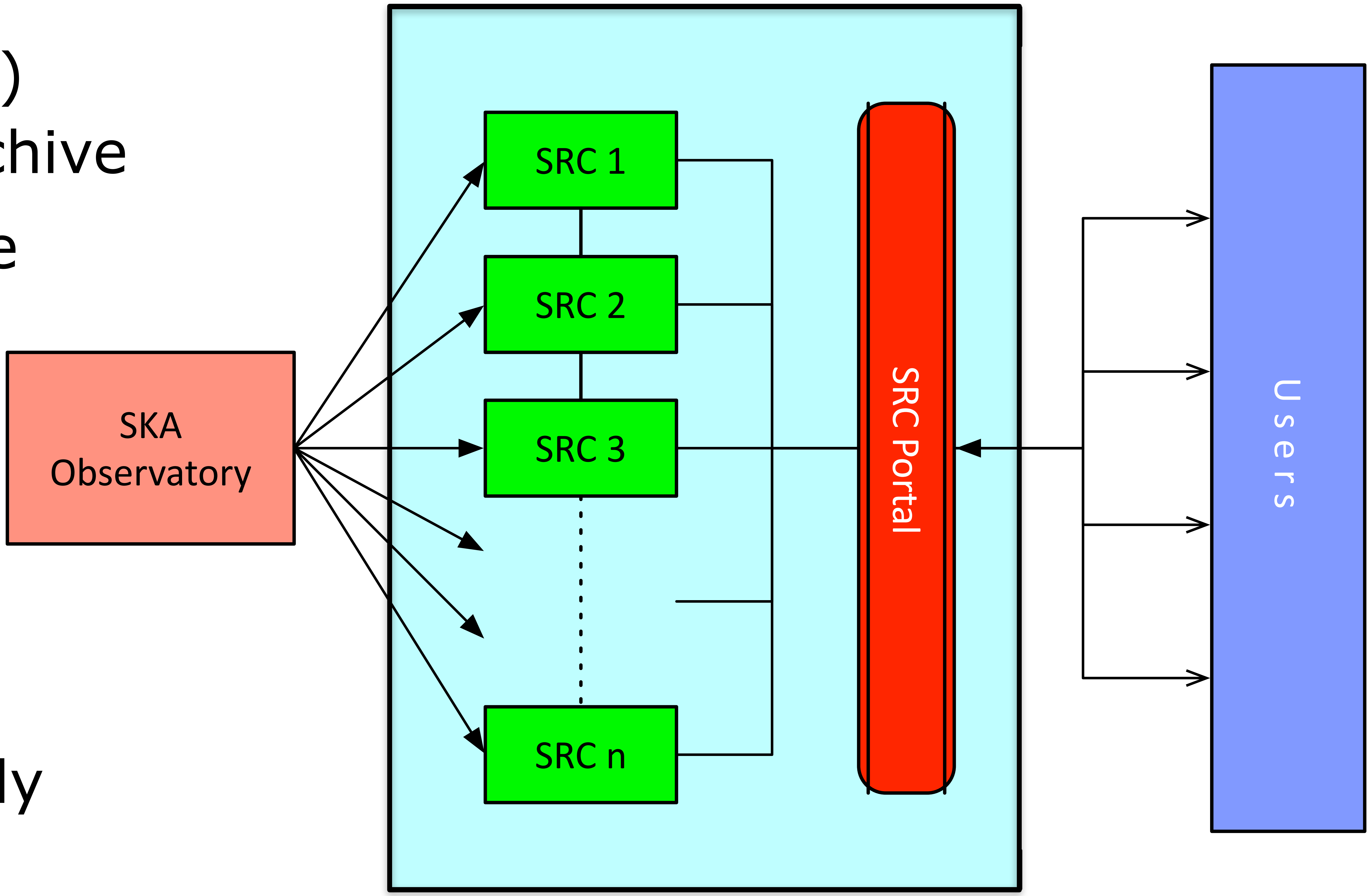
5PB

1 Petabyte (PB)

Future SKA Science Archive

SKA Regional Centres

- SKA Regional Centres (SRCs) will host the SKA science archive
- Provide access and distribute data products to users
- Provide access to compute and storage resources
- Provide analysis capabilities
- Provide user support
- Multiple regional SRCs, locally resourced and staffed

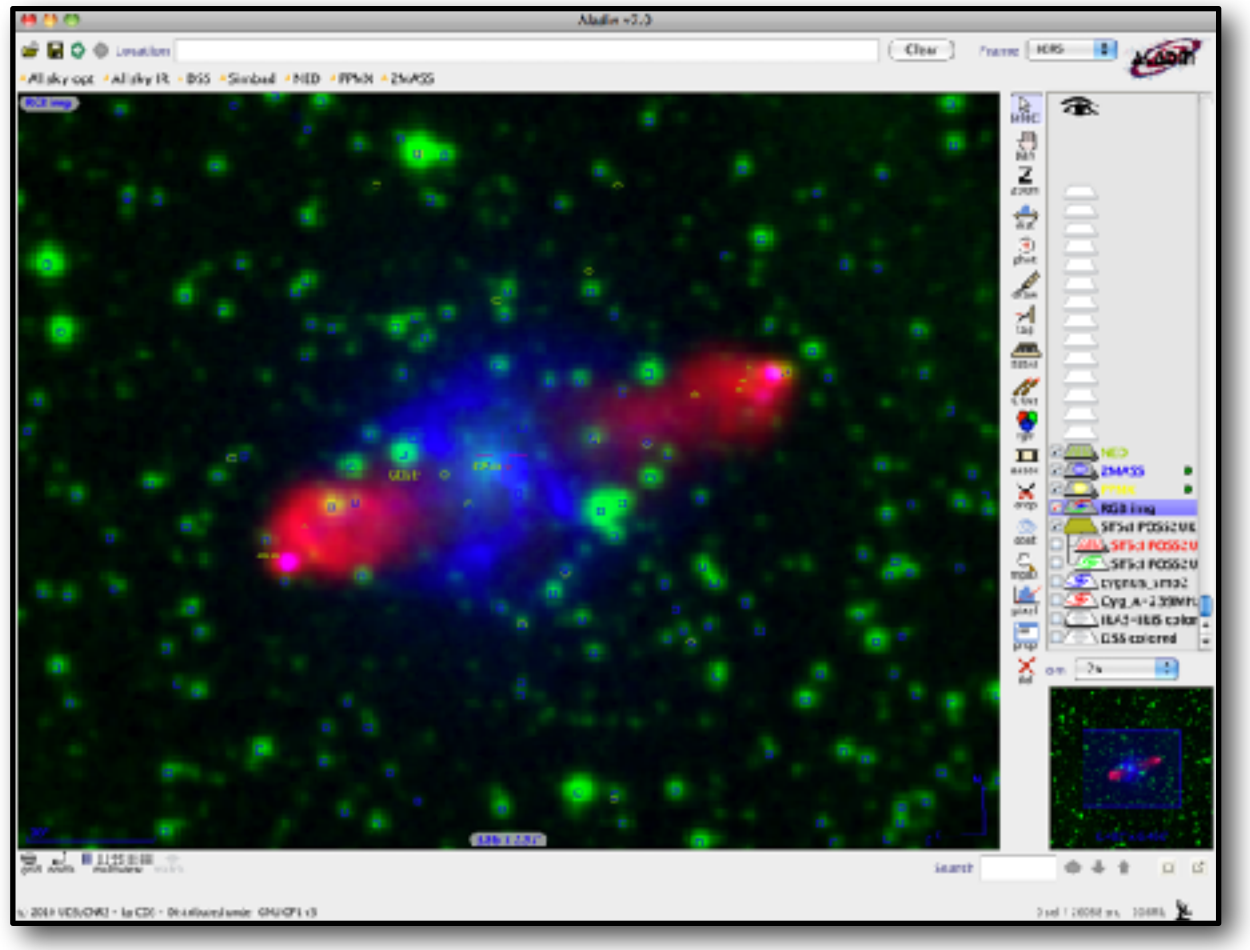


Primary interface for SKA data analysis

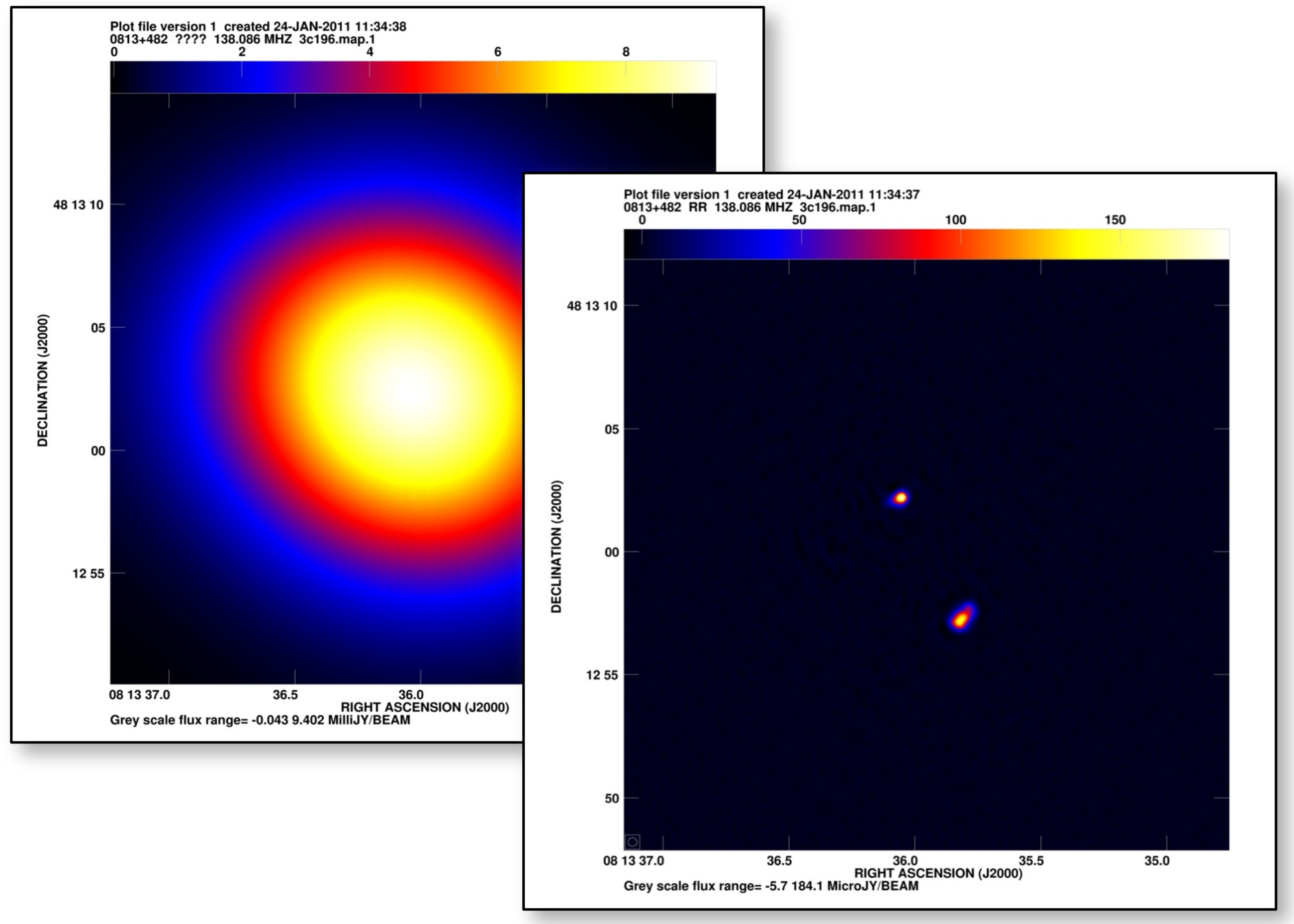
Regional Centre Functionality

Data Discovery

- Observation database
- Associated metadata
- Quick-look data products
- Flexible catalog queries
- Integration with VO tools
- Publish data to VO



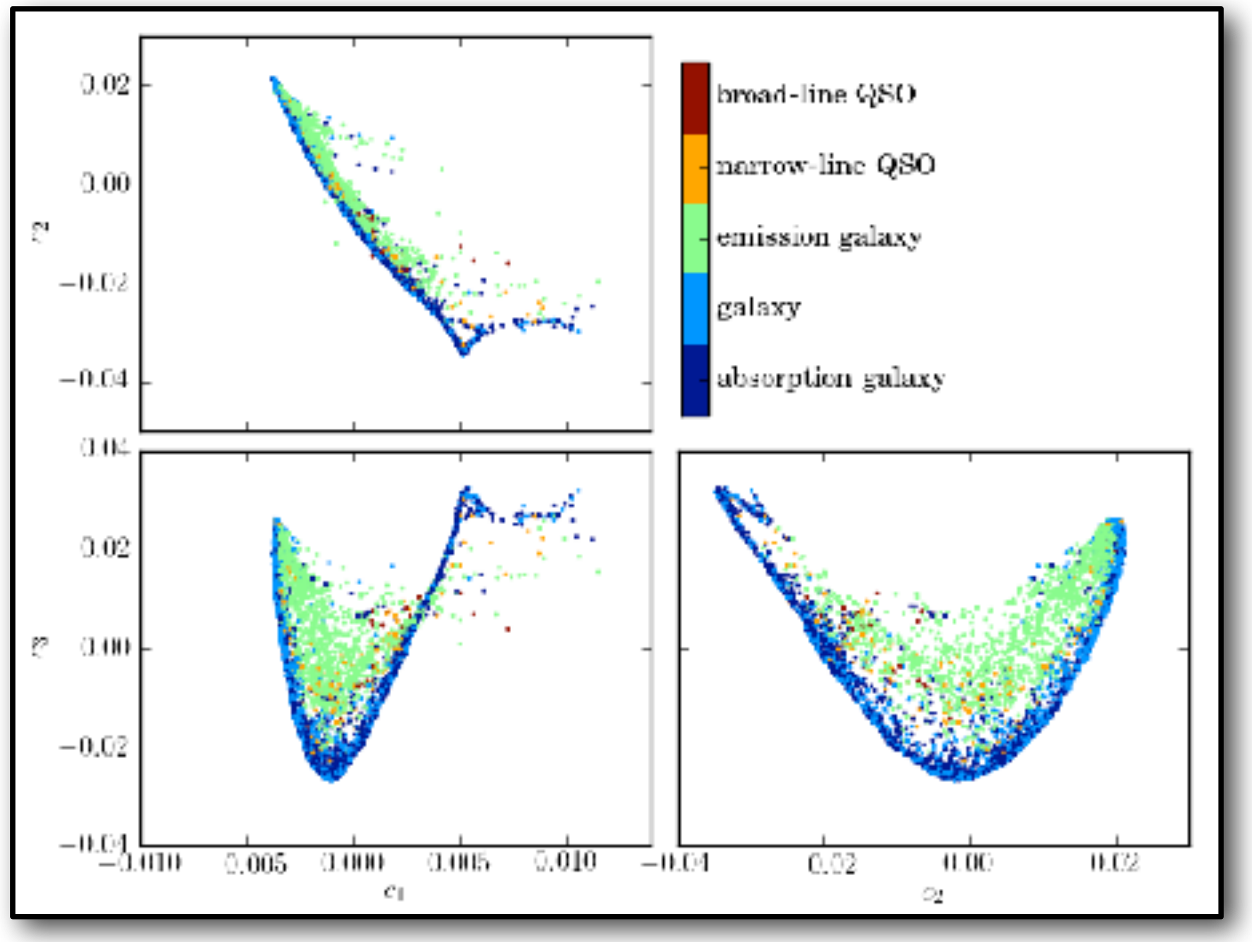
Data Processing



- Reprocessing and calibration
- High resolution imaging
- Mosaicing
- Source extraction
- Catalog re-creation
- DM searches

Data Analysis

- Multi-wavelength studies
- Catalog cross-matching
- Light-curve analysis
- Transient classification
- Feature detection
- Visualization



Aeneas

Advanced European Network of E-infrastructures for Astronomy with the SKA

Design and specification of a distributed, European SKA Regional Centre to support the astronomical community in achieving the scientific goals of the SKA

EC Horizon 2020 (€3 million)

13 countries, 28 partners, SKAO, host countries, e-infrastructures (EGI, GÉANT, RDA), NREN's

Three year project (2017-2019)

- We need input from SKA Science Working Groups & Focus Groups
- Regular Interactions to discuss use cases and functionality
- Test Regional Centre "Design" as it progresses using pathfinders & precursor data

Themes for Today

- Updates from the Science Working Groups/Focus Groups
- What are the concerns or issues - important input to SKA Board

- Plans for Transition from SWG/FG to KSPs
  - How? When?
- How are pathfinders/precursors being used to prepare for SKA?

- Thoughts on SKA Regional Centres
  - Science engagement with Regional Centre design process

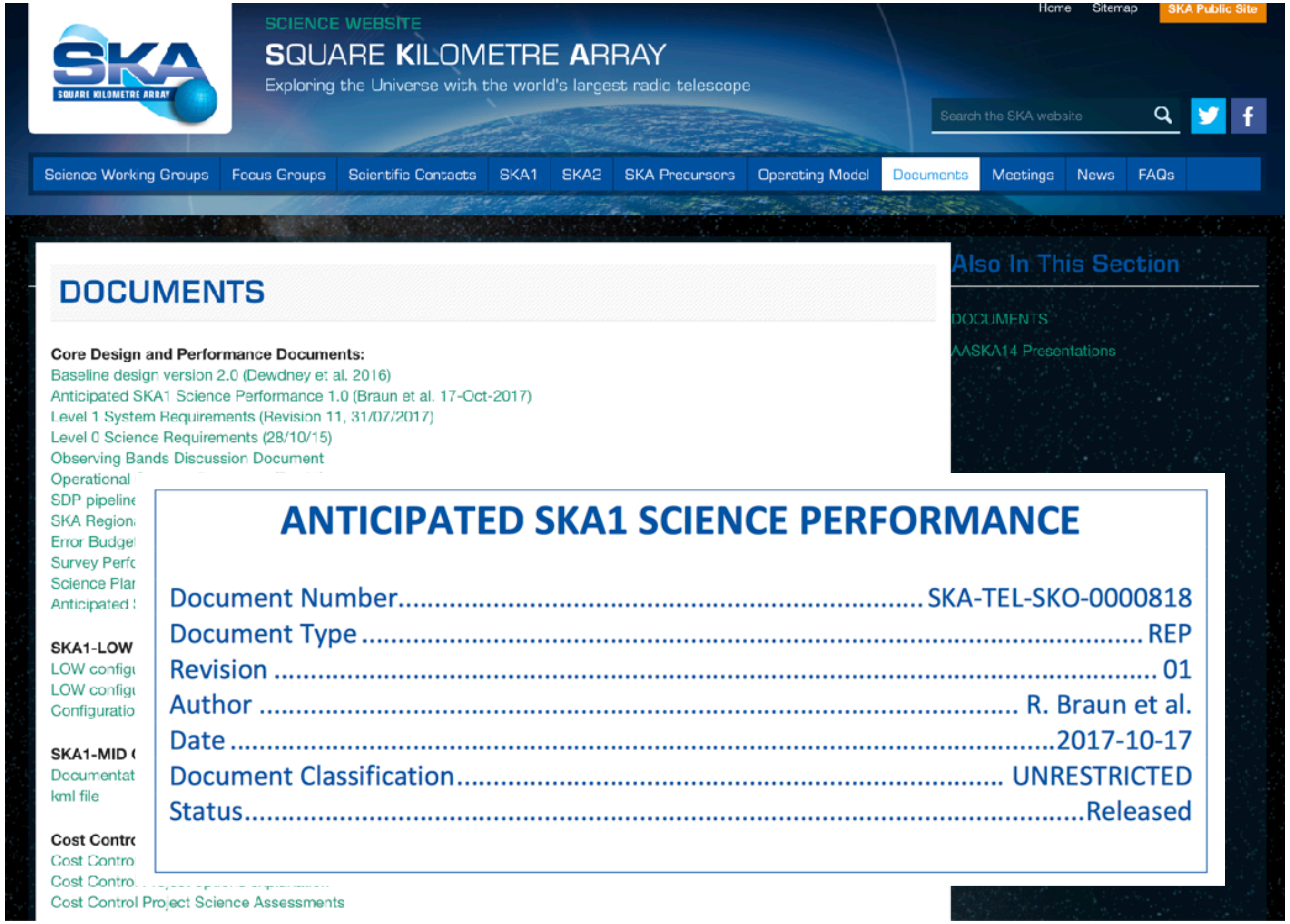
How to find relevant information

- https://astronomers.skatelescope.org/
- https://astronomers.skatelescope.org/documents/

- Check that documents aren't out of date
  - Through SWG/FG or SKA.org science team

Contact us:

- Jess Broderick
  NL SKA Project Scientist
  broderick@astron.nl
- or haarlem@astron.nl



SCIENCE AND OPERATIONS PLANNING

Document number... SKA-TEL-SKO-00000822
Document Type.. PLN
Revision..02
Author .... SKAO Science and Ops Teams
Date... 2017-11-14
Document Classification .... UNRESTRICTED
Status .... Released

Assembly, Integration & Verification Event	Low Stations	Date for Low	Mid Dishes SKA+MK	Date for Mid
AA1	18	C0+35	8 + 0	C0+34
AA2	64	C0+47	64 + 0	C0+44
AA3	256	C0+58	120 + 8	C0+58
AA4	512	C0+70	133+64	C0+67

C0 = the date for construction contracts to be awarded