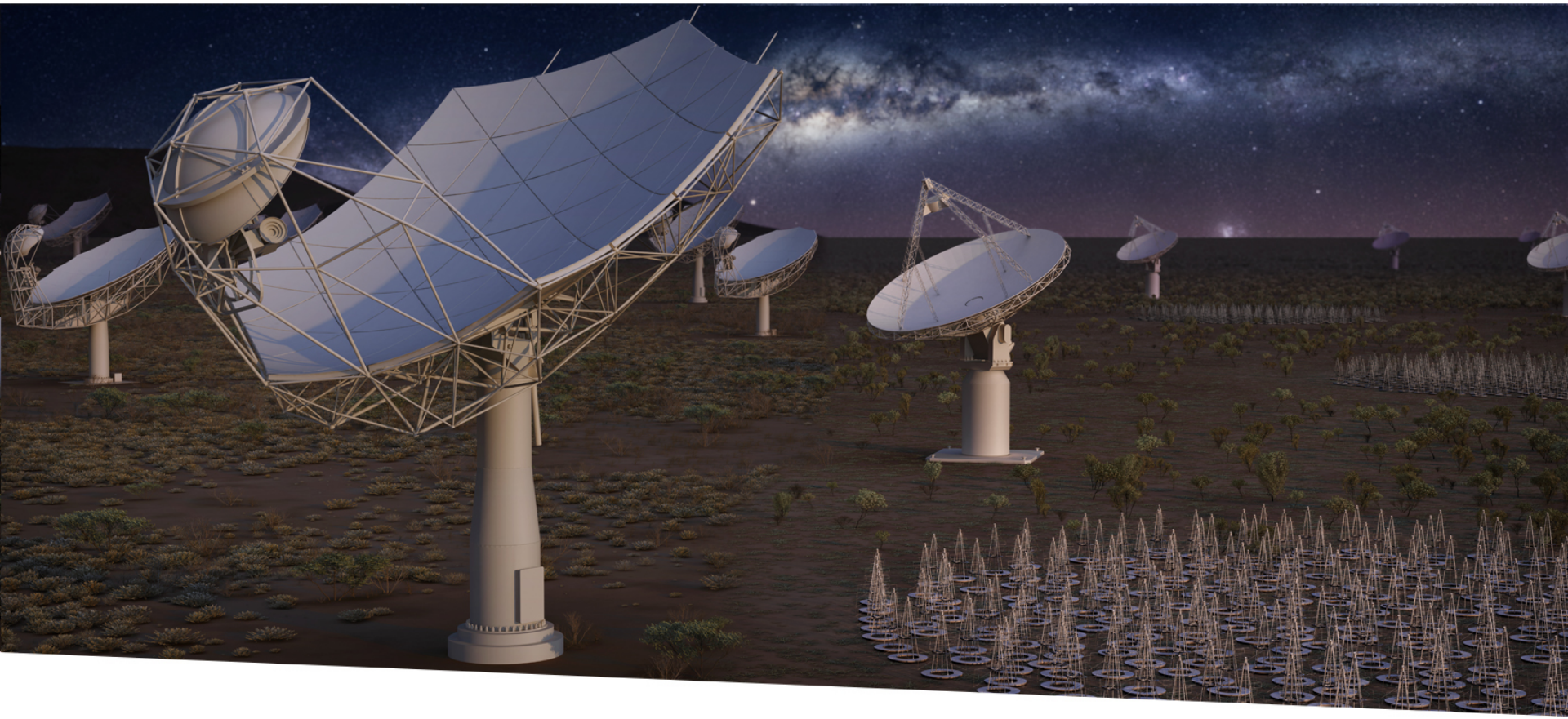
Advanced Instrumentation Programme



SQUARE KILOMETRE ARRAY

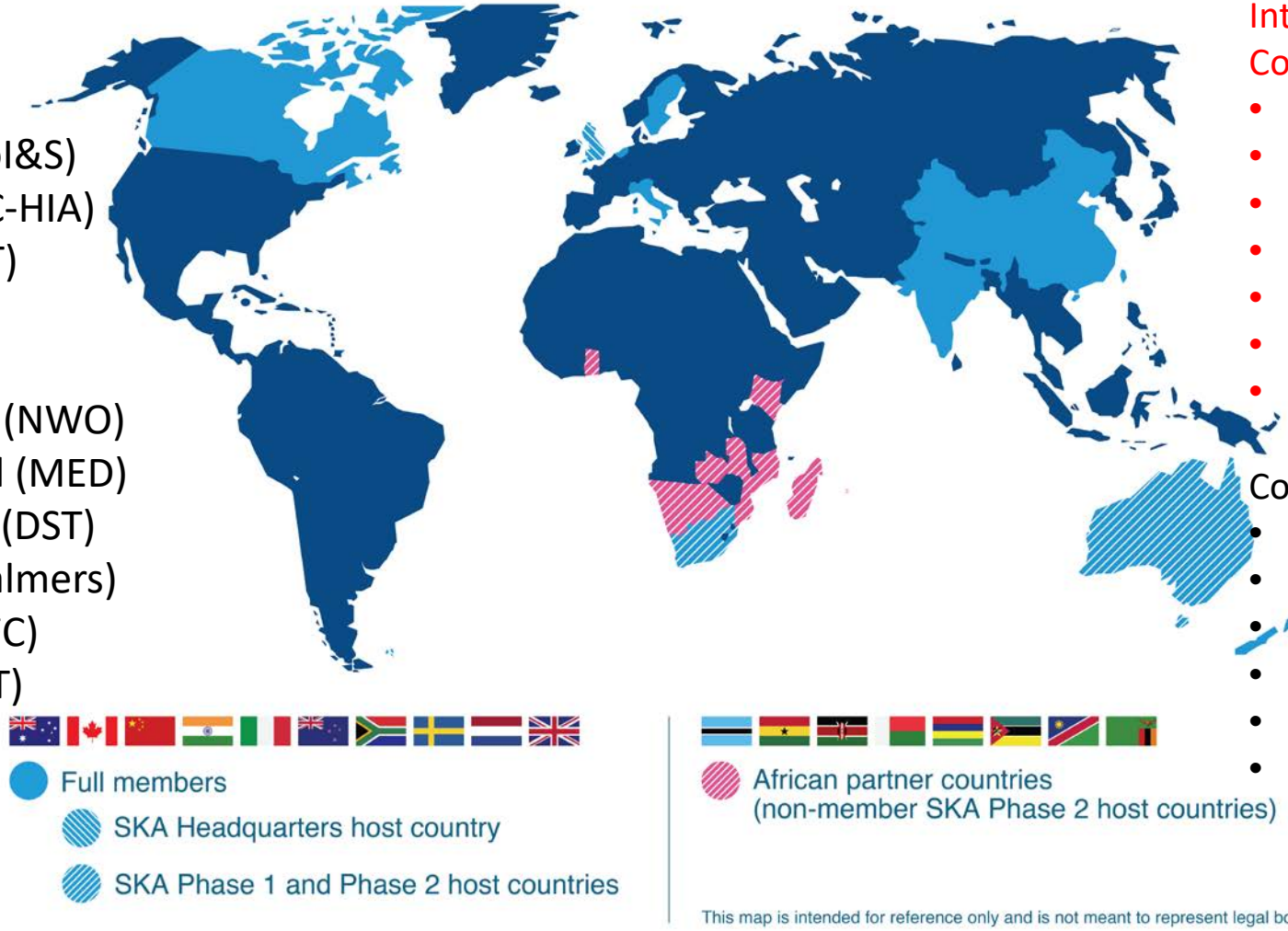
Exploring the Universe with the world's largest radio telescope

Alistair McPherson

8th June 2017

SKA Organisation: 10 countries, more to join

Australia (DoI&S)
Canada (NRC-HIA)
China (MOST)
India (DAE)
Italy (INAF)
Netherlands (NWO)
New Zealand (MED)
South Africa (DST)
Sweden (Chalmers)
UK (BEIS/STFC)
Portugal (FCT)



Interested Countries:

- Germany
- France
- Portugal
- Spain
- Switzerland
- Japan
- Korea

Contacts:

- USA
- Malta
- Mexico
- Brazil
- Ireland
- Russia

Square Kilometre Array

3 sites; 2 telescopes + HQ

1 Observatory

Design Phase: ~ €200M; 600 scientists+engineers

Phase 1

Construction: 2019 – 2024

Construction cost cap: €674.1M (inflation-adjusted)

Operations cost: under development (see below)

MeerKat integrated

Observatory Development Programme (€20M/year planned)

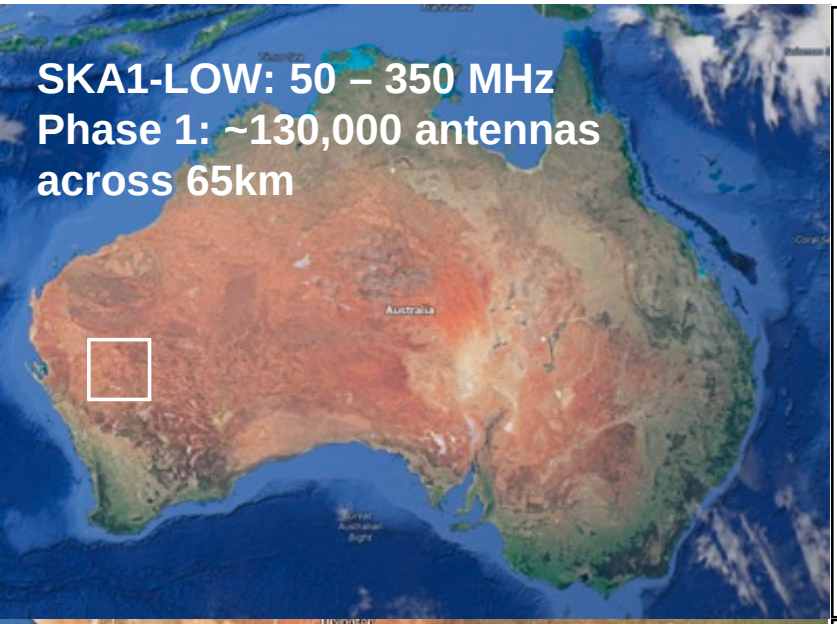
SKA Regional centres out of scope of centrally-funded SKAO.

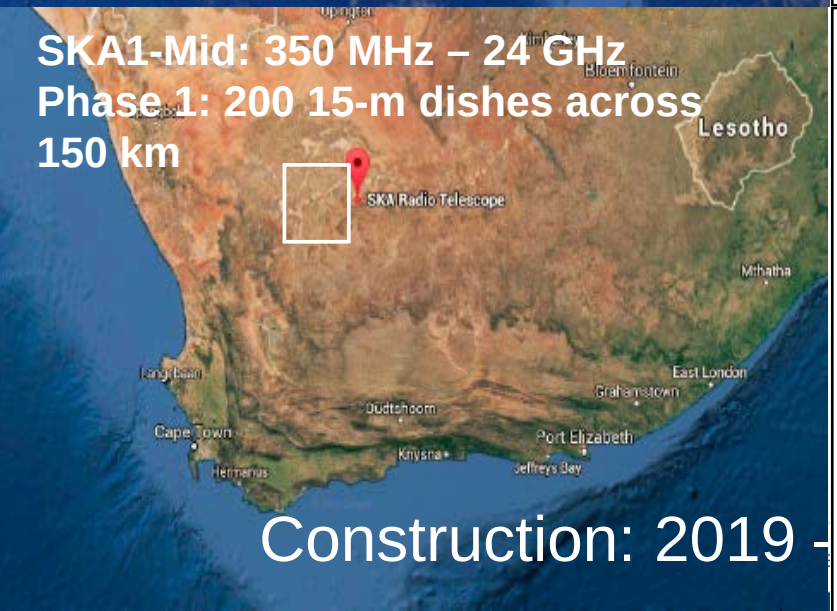
Phase 2: start mid-2020s

~2000 dishes across 3500km of Southern Africa

Major expansion of SKA1-Low across Western Australia

SKA: HQ in UK; telescopes in AUS & RSA





International Design Teams

- Project Management and System Engineering based at Jodrell Bank, Manchester, UK
- >600 scientists & engineers in institutes and industry in Member countries of the SKA


WIDE BAND SINGLE PIXEL FEEDS


TELESCOPE MANAGER

CENTRAL SIGNAL PROCESSOR


SIGNAL AND DATA TRANSPORT

SCIENCE DATA PROCESSOR


DISH


MID-FREQUENCY APERTURE ARRAY


LOW-FREQUENCY APERTURE ARRAY

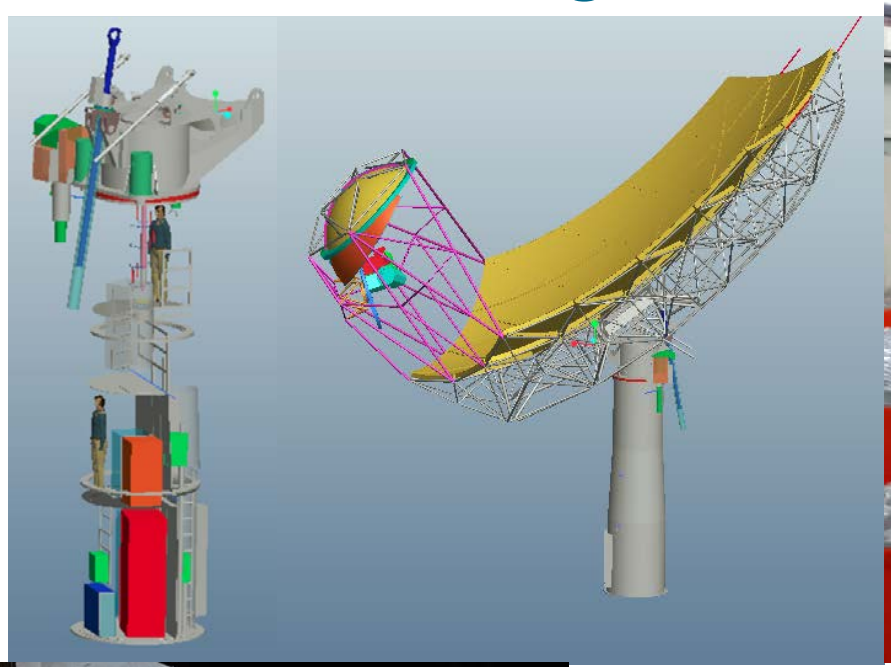

ASSEMBLY, INTEGRATION & VERIFICATION

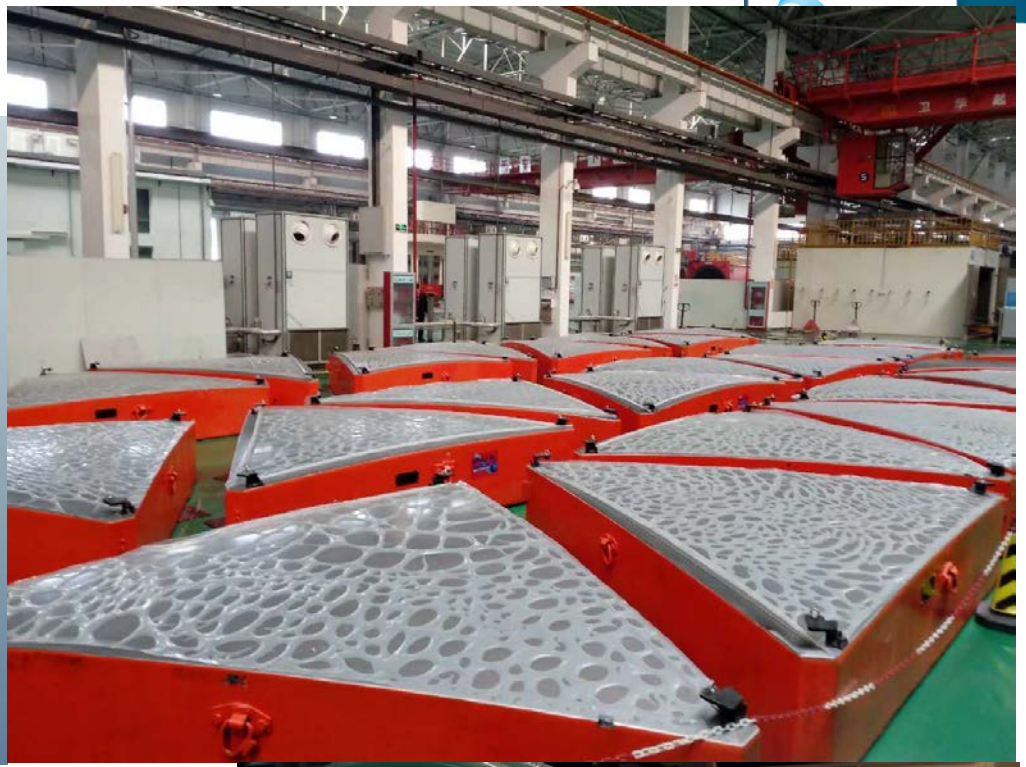

INFRASTRUCTURE AUSTRALIA

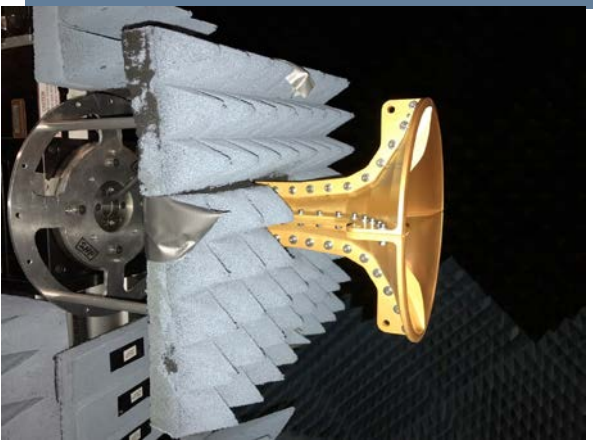

INFRASTRUCTURE SOUTH AFRICA

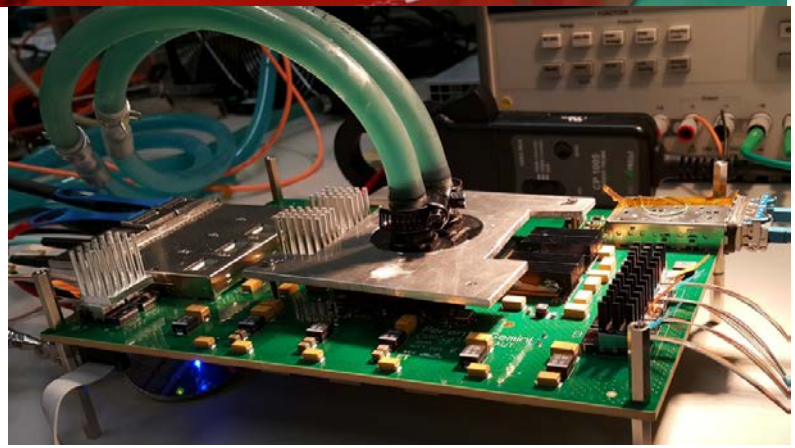
Status

Technical Progress

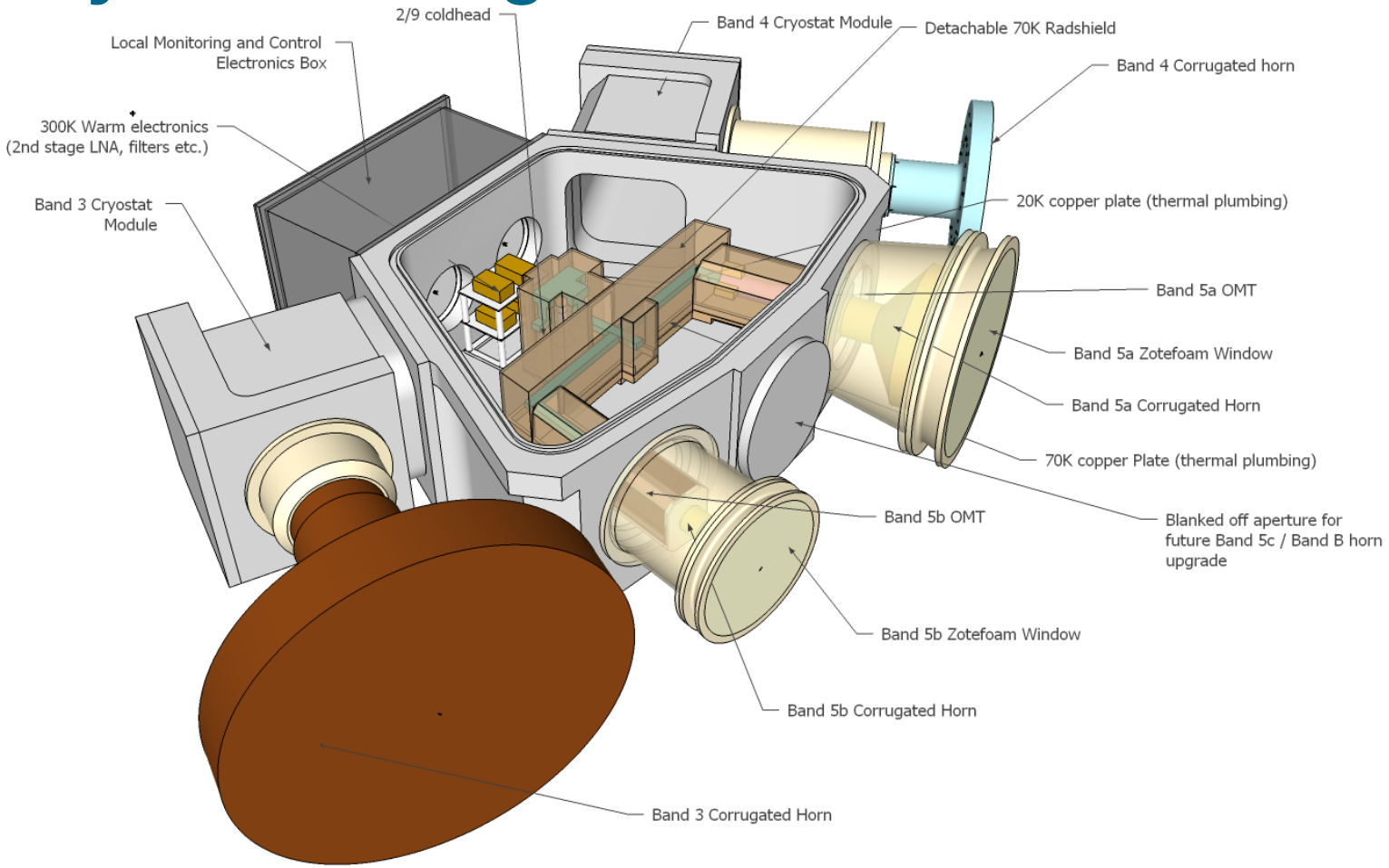








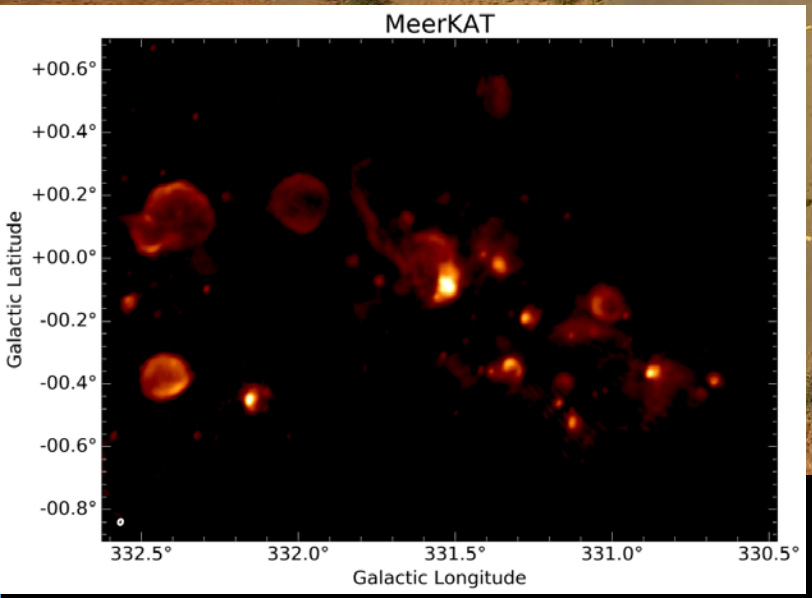
New Cryostat Design SPF 3/4/5abc/5B



- Band 5 ECP160022 ECP approved
- (4.6 – 13.8 GHz) => eg. (5.0 – 9.25) & (9.0 – 16.7) GHz

SKA-LOW prototype antenna station deployed

MeerKAT



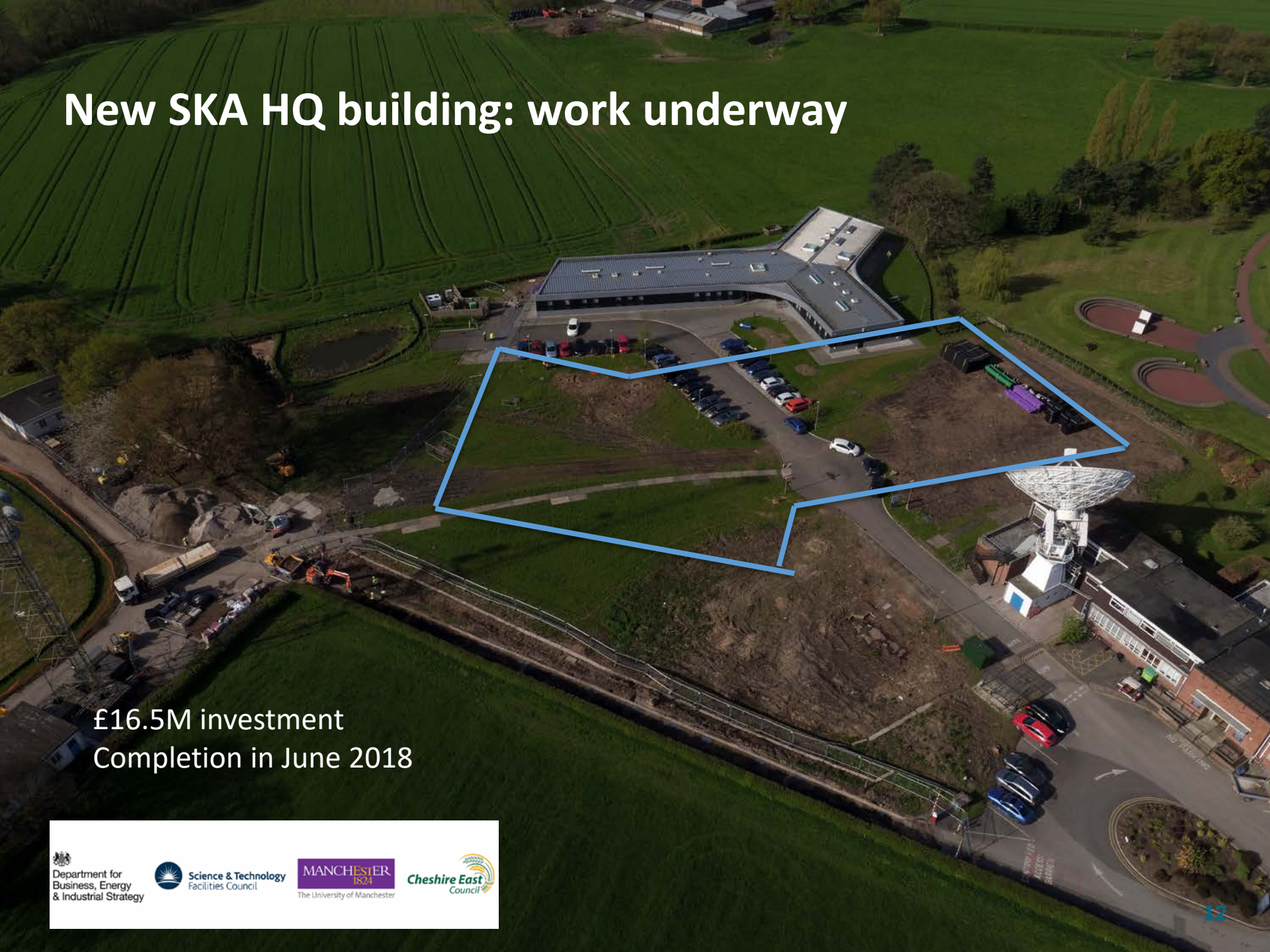
Picture: SKA-SA

SKA Cost Control Project

- Initiated following recommendation of the SKA Board in Nov 2016
- Solutions to **meet the Cost Cap** of €674M
- Two scenarios brought forward:
  1. Sequential **minimisation of science impact**
     - A sequence of **reinstatable** (via extra funding) measures to achieve the cost cap
     - Ordered **by** increasing **science impact**
  2. Re-use of **precursor technologies**

- **Science assessment teams**: low freq. range, pulsar timing req., low maximum baseline
- **Detailed Technical studies**: Low: beamforming, antenna; Mid: correlator, timing, Meerkat-based, SDP staged deployment
- SKA Science "**Town Hall meeting**" to review with science community

New SKA HQ building: work underway

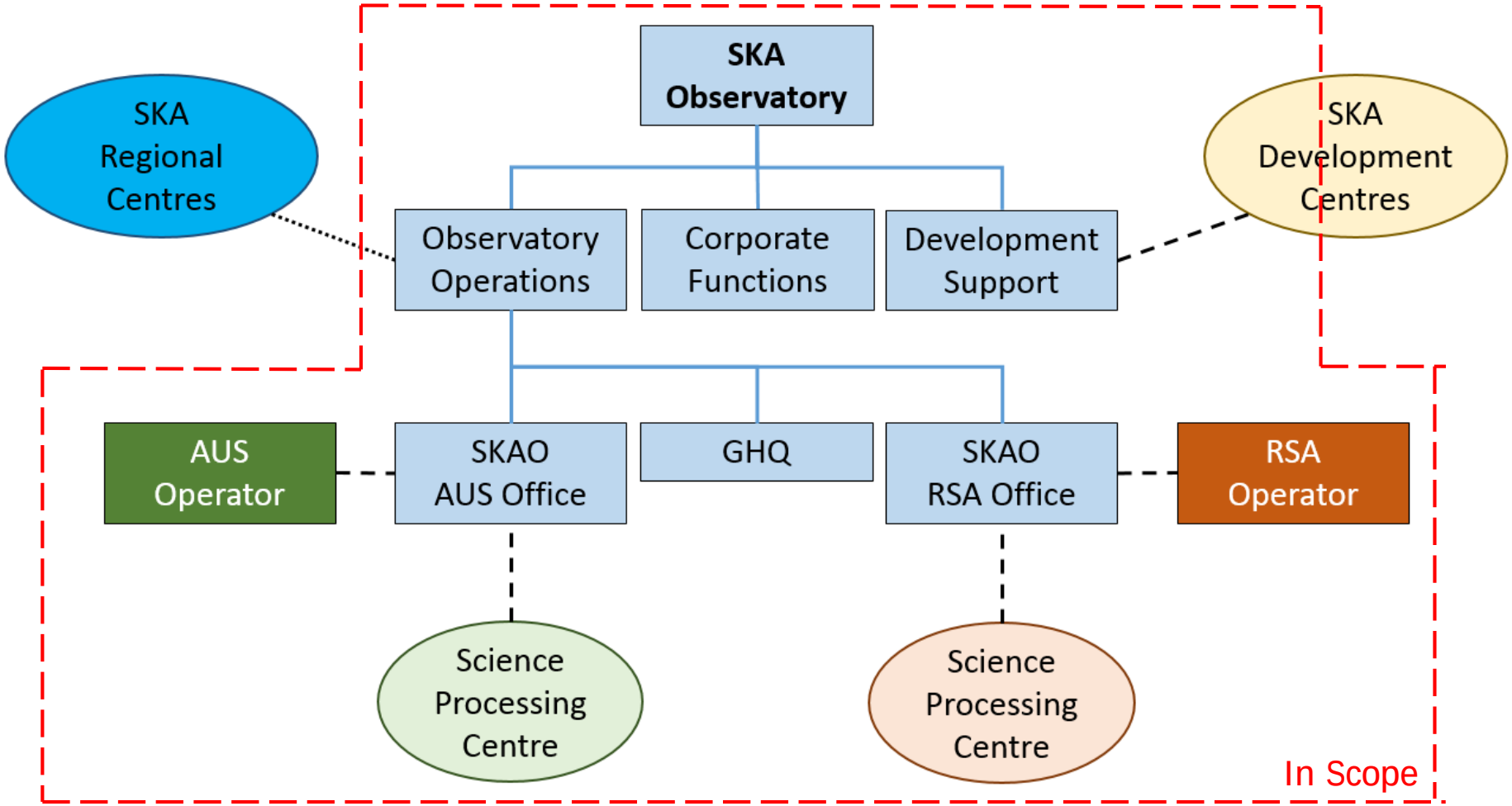


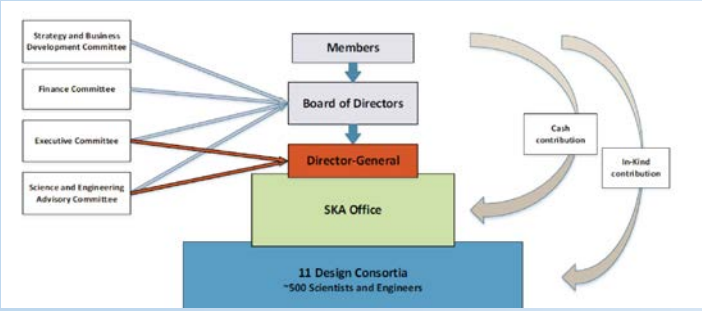
£16.5M investment
Completion in June 2018

Department for Business, Energy & Industrial Strategy
Science & Technology Facilities Council
MANCHESTER 1824 The University of Manchester
Cheshire East Council

Future Governance

Eventual scope





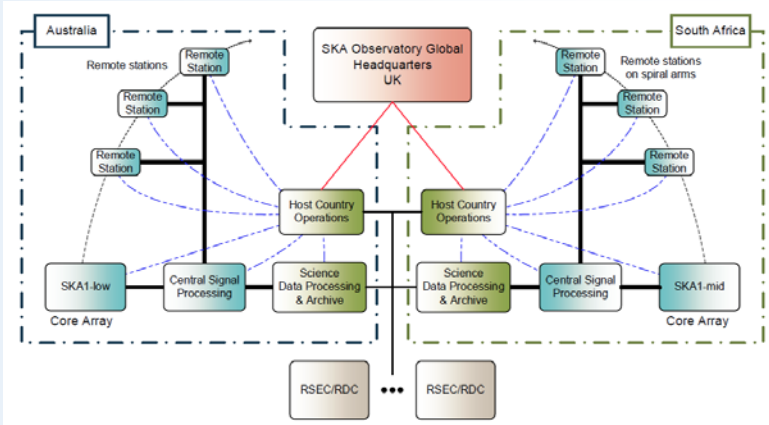
Design Phase

Construction/Ops Phase

2016

SKA Organisation Ltd

UK company structure



SKA Observatory IGO

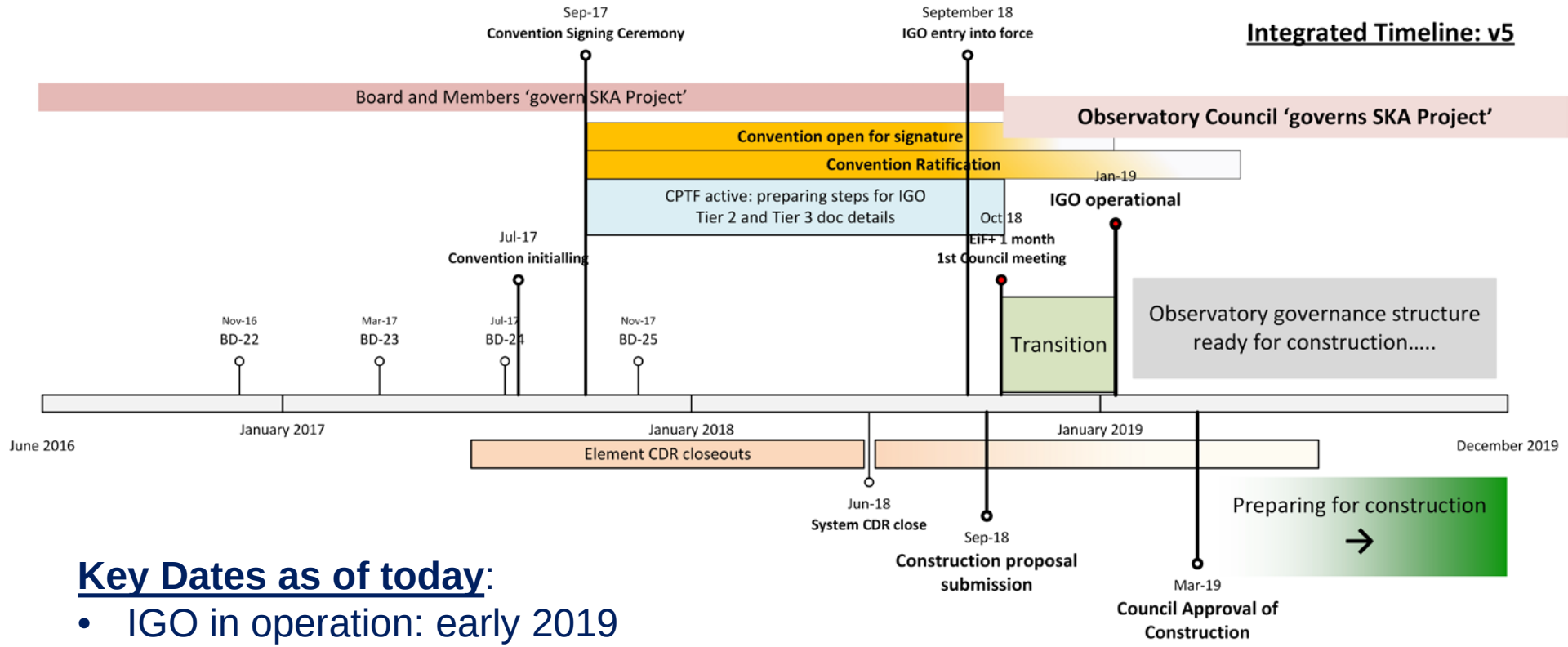
IGO Negotiation process

- 4 plenary meetings:
  - 14-16 October 2015
  - Jan 2016, April 2016, then September 2016
- Participation from all current SKAO members:
  - Majority as ‘negotiating parties’ – triggered by mandate being provided by a Member’s government (RSA, AUS, UK, IT, NL, CN, IN, NZ, SE)
  - ‘Observer’ status for those without that mandate (Canada, Germany)
- Aim:
  - Negotiation of core texts of agreements
  - Negotiation on supporting concepts that input to agreements or supporting policies
- Working Groups dealing with financial models, procurement approach, telescope access, IP etc: now focused on ‘Task Force’ to finalise issues

High-level IGO timeline

- **Now to July:**
  - Finalising the Convention text and other ‘treaty-level’ documents
  - High-level discussions on procurement principles, access etc
  - Governments preparing to ‘initial’ the documents
  - Discussions about initial phases of funding the IGO (not SKA1 construction…)
- **~July:**
  - Documents ‘initialled’ to mark end of negotiation process; governments prepare to sign the Convention
- **Best guess – September:**
  - Signing event for negotiating governments – most sign in one go, others when ready
  - Ratification of Convention by governments begins
  - ‘Proto IGO Council’ starts work preparing for IGO – policies, the transition from the company etc

The full picture…



Key Dates as of today:

- IGO in operation: early 2019
- Design process 'complete' ~mid/late 2018
- IGO Council approves construction: early/mid 2019
- SKA1 construction procurement begins: ~late 2019

AIP STATUS

Components of AIP

- Wide Band Single Pixel Feed
  - Output PDR
- Medium Frequency Aperture Array
  - Output Scoping of Prototype
- Phased Array Feeds
  - Technology Development

Principles of SODP

- Significant enhancements to scientific capability
- Clear path of development on or for the SKA
- Undertaken by international teams led by a Full Member
- SKAO funding limited to SKA Members
- Industry should be integral to development

Operations Budget – March 2017

Organisational Unit	Paper	Update
	€M/yr	*€M/yr*
AUS Operator	17.1	15.1
RSA Operator	19.7	19.7
AUS SPC	3.6	3.6
RSA SPC	3.5	3.5
SKAO GHQ	23.2	22.3
SKAO AUS	4.1	4.1
SKAO RSA	3.8	3.8
Reserve	6.0	6.0
Contingency	13.0	15.1
CURRENT ESTIMATE	**94.1**	**93.2**

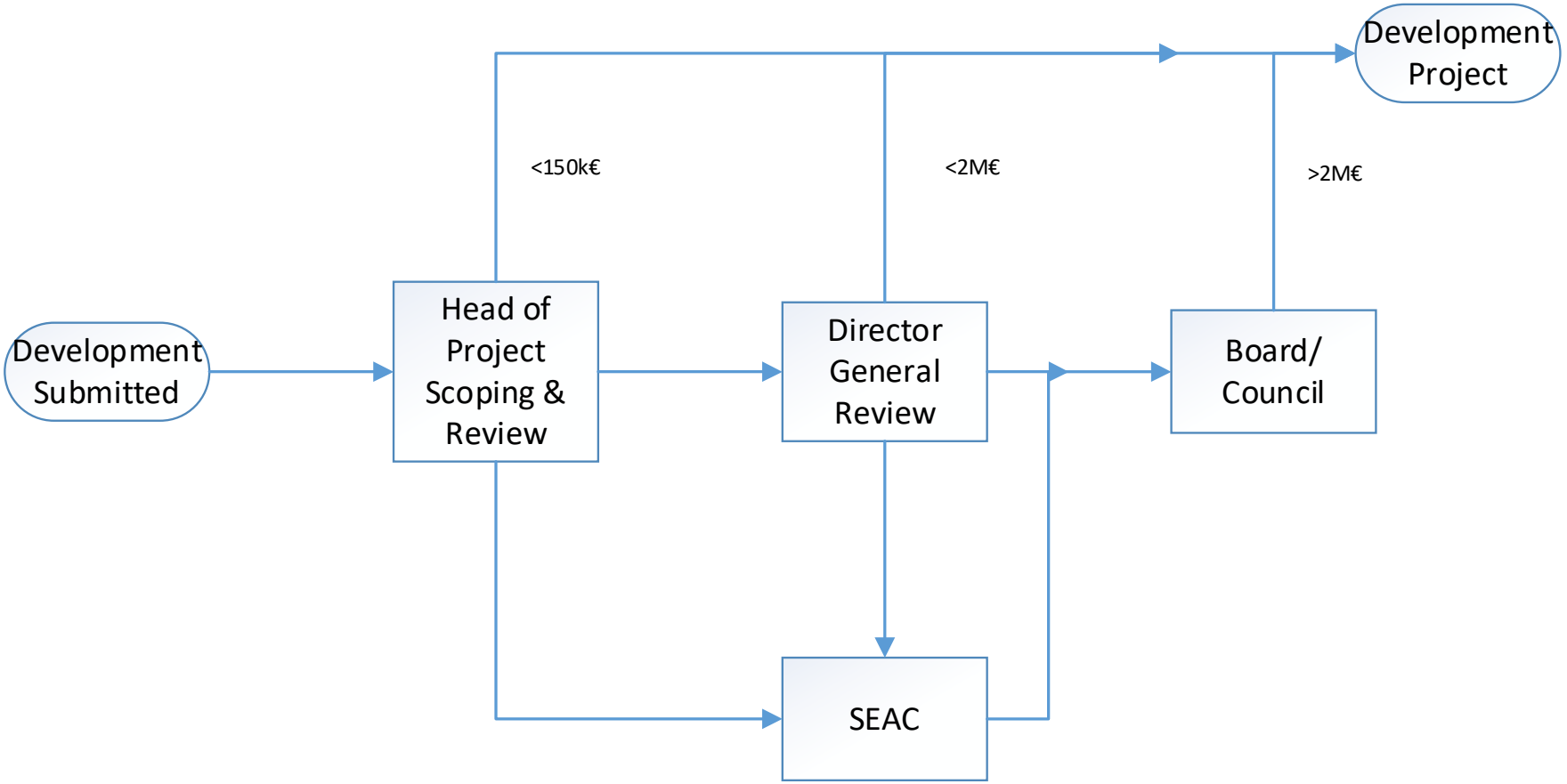
now 19%

(plus SKA Observatory Development Programme €20M/yr)

Development

- Blue Skies
  - Base development of technology
- Prototype Development
  - Developing technology to prototype
- Product Development
  - Developing actual product using developed technology

Process


Development Project
<150k€
<2M€
>2M€
Development Submitted
Head of Project Scoping & Review
Director General Review
Board/ Council
SEAC

Technology Roadmap

- Science Roadmap
- Overseen by SEAC or equivalent
- Technology Roadmap
- Development based on Road Map
  - Techniques
  - Solutions
  - Prototypes
- Technology Readiness Levels

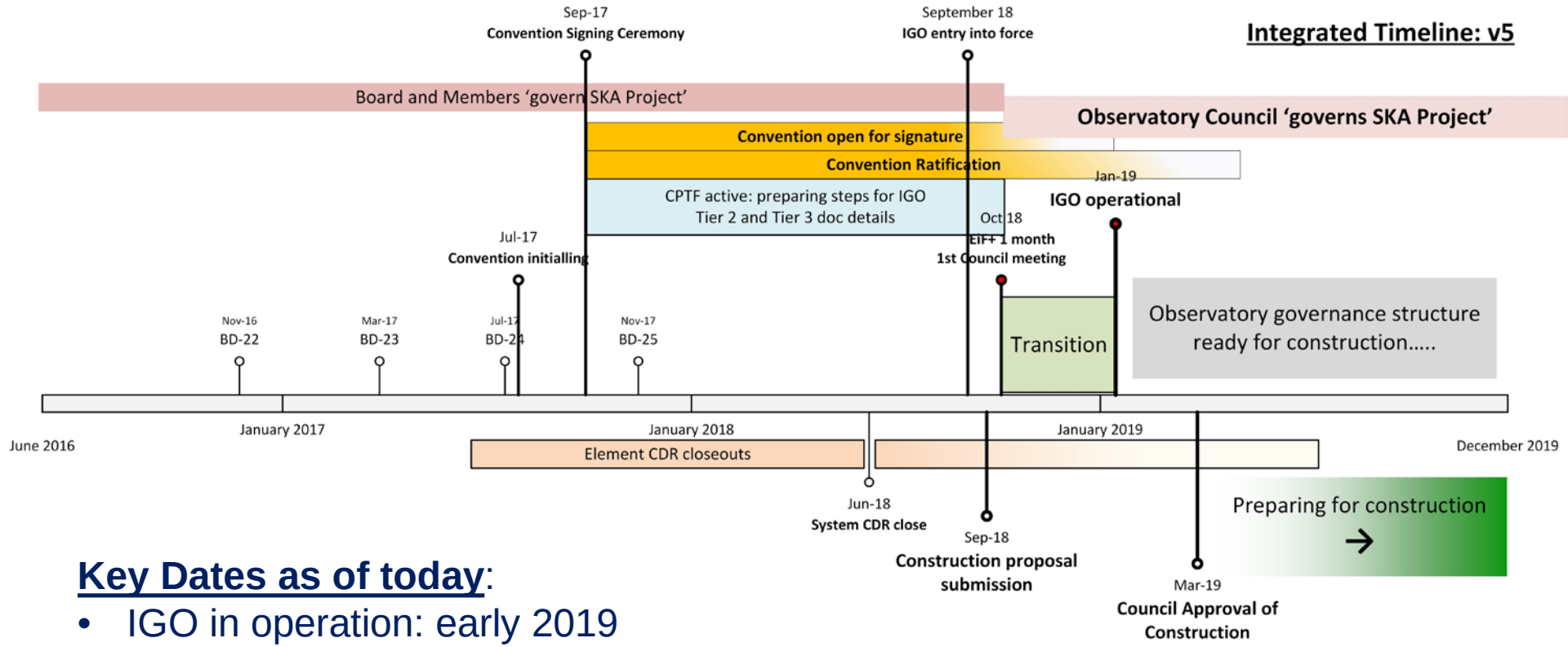
Development options

- Phase A studies
- Selection of solution(s)
- Development of prototype
- Development of instrument
- Roll-Out

Areas of work

- Technologies
  - MFAA
  - PAF
- Solutions – prototypes
  - MFAA
  - PAF
  - WBSPF

Timeline…



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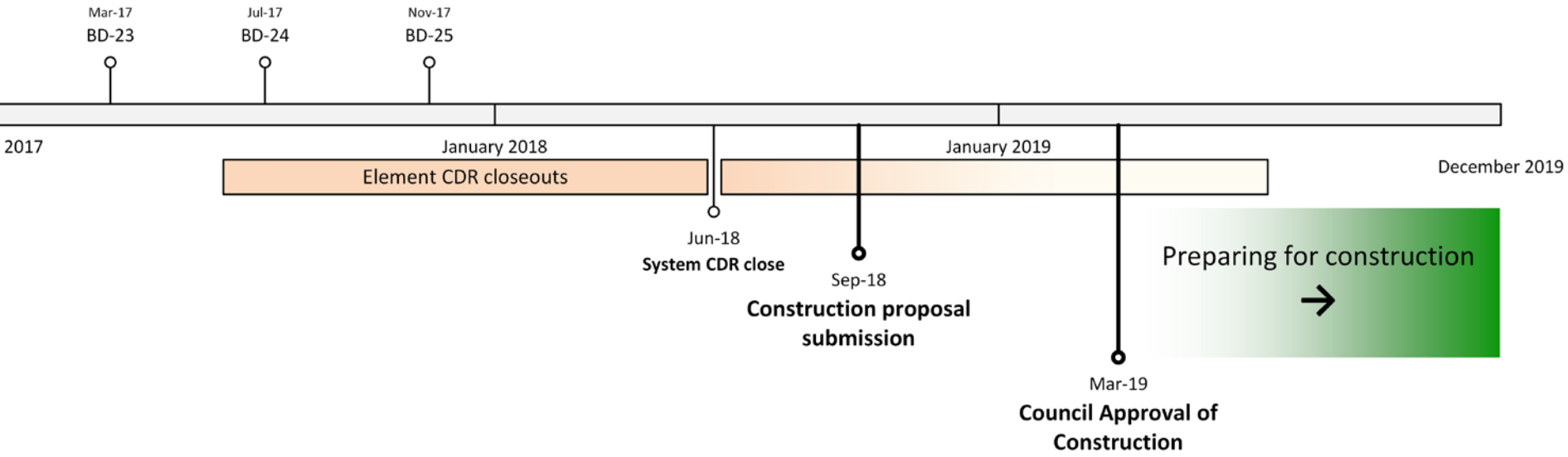
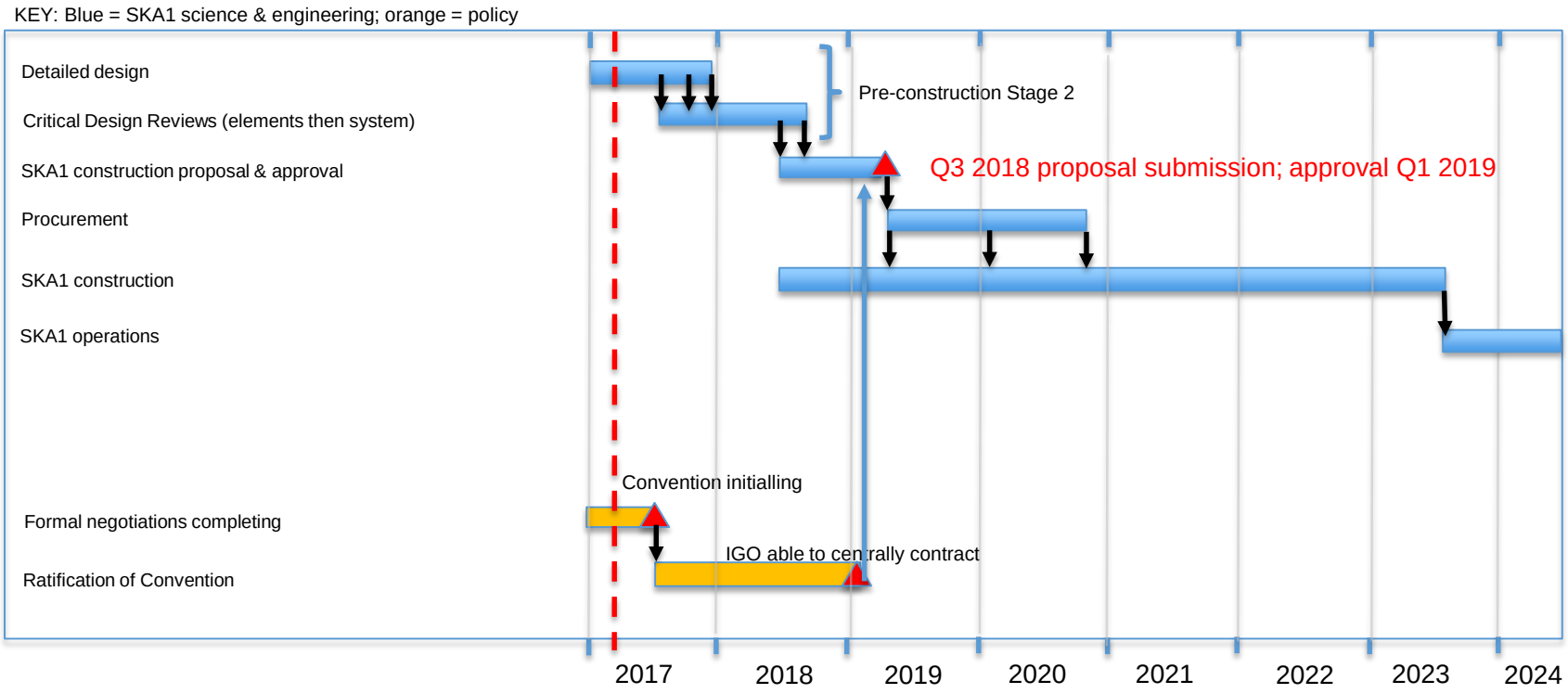
Engineering timeline



Key points and caveats:

- Current timeline through CDR to construction proposal…..but:
- Schedule under close scrutiny at present:
  - Office and Board examining cost control options for SKA1
  - Considerable work underway in Office and design consortia (including SDP)
  - Expect updated view of programme schedule post July Board meeting….
  - For now: assume SKA1 approval in 2019 – move to procurement phase thereafter

High-level SKA1 Roadmap



The Advanced Instrumentation Programme also continues, with an MFAA Demonstrator planned and the consortium extended until Dec '18; WBSPF consortium seeking extension to 2018; PAF consortium being created.

Future of Existing AIP

- Transfer into SODP
- Move to Production of Prototypes
- Technology Development

- Medium Term
  - Continue through funding streams
  - Input to transformation process

Potential Schedule

- IGO In Place - 2018
- SKA-1 Construction Starts – 2019
- SKA-1 Construction Completes – 2025
- *SKA-2 Pre-Construction – 2020*
- *SKA-2 Construction - 2027*

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Square Kilometre Array @SKA_telescope The Square Kilometre Array www.skatelescope.org