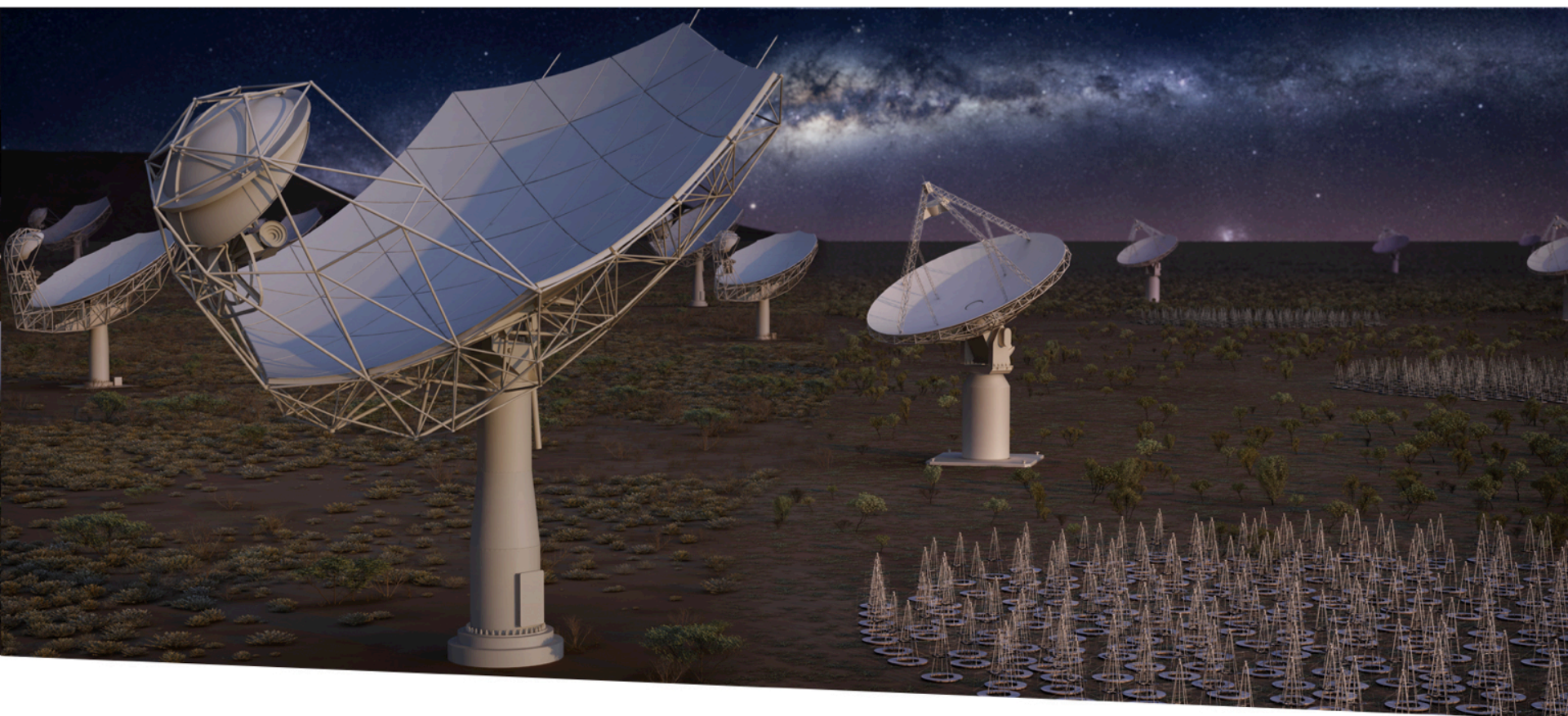


# Square Kilometre Array



**SQUARE KILOMETRE ARRAY**

Exploring the Universe with the world's largest radio telescope

**Philip Diamond, Director-General**

**SKA France: 16 October 2017**

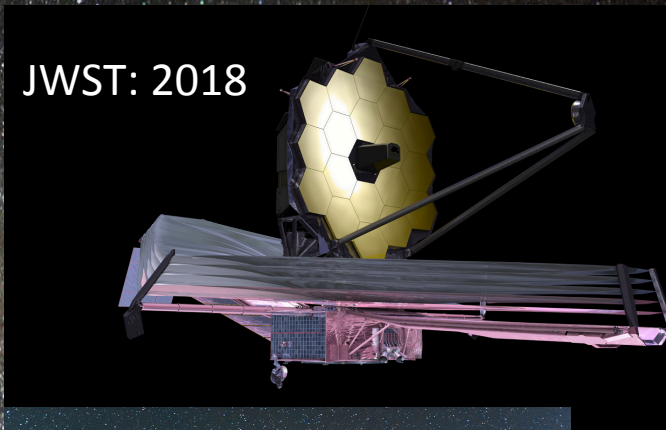


# 21<sup>st</sup> Century Observatories

LIGO: operational



JWST: 2018



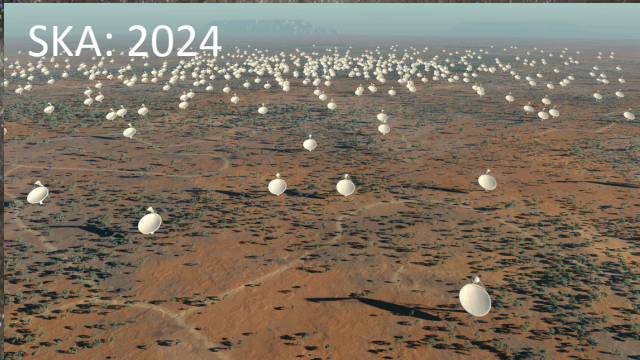
ALMA: operational



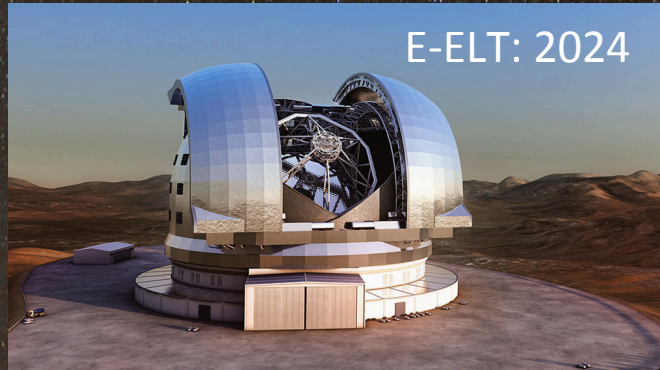
ATHENA: 202



SKA: 2024



E-ELT: 2024



CTA: 2024



Radio waves

Microwaves

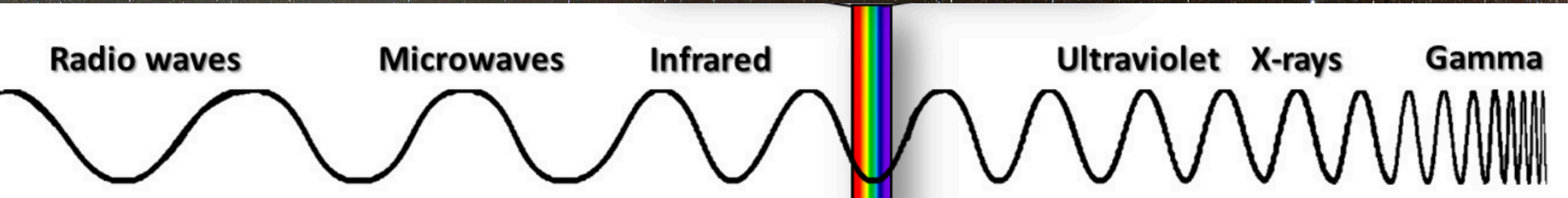
Infrared



Ultraviolet

X-rays

Gamma

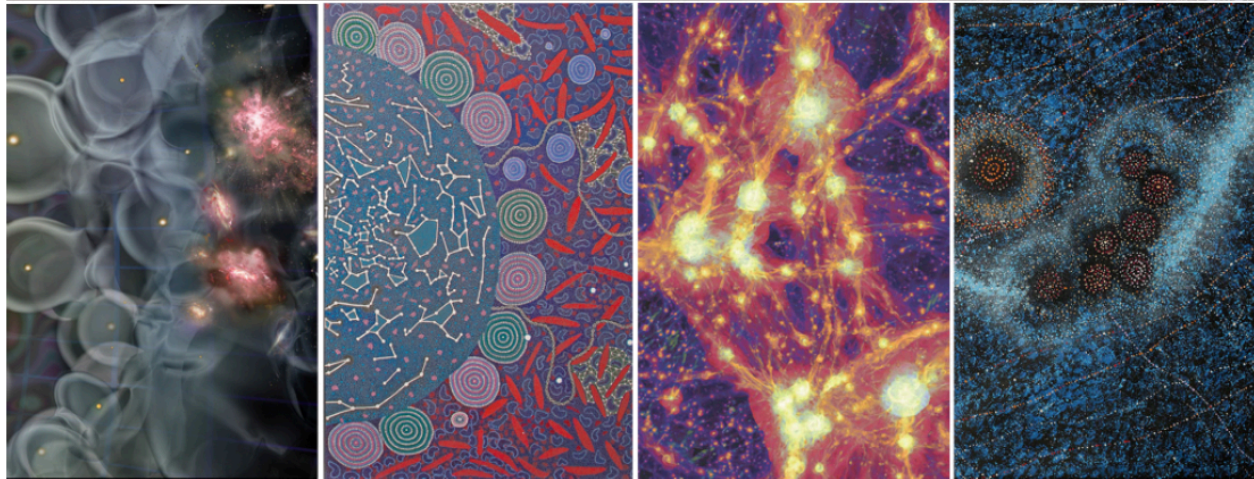
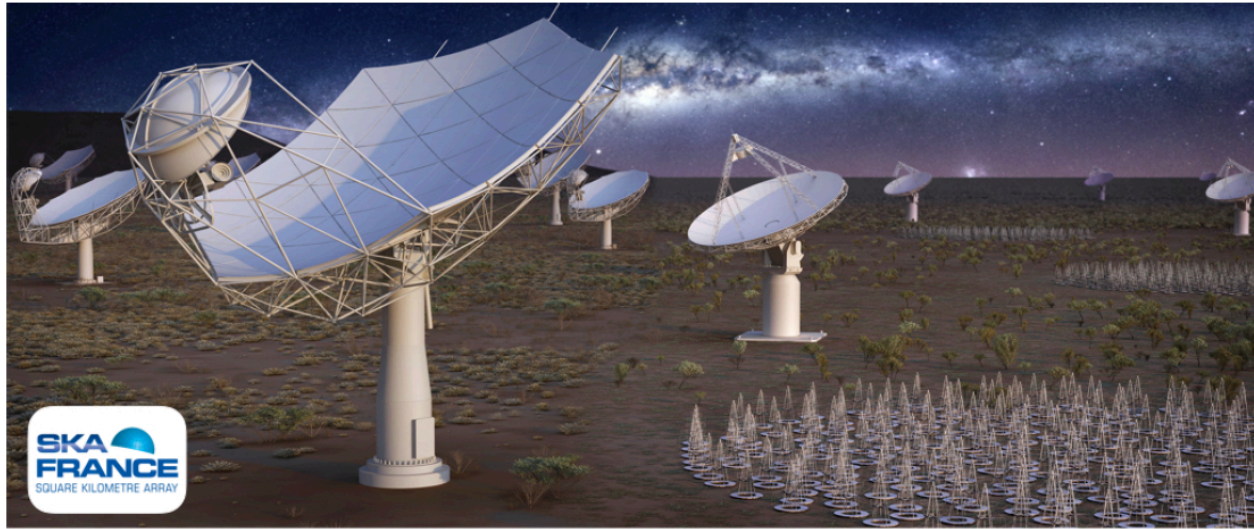




# SKA – Key Science Drivers:

## French SKA White Book

The French community towards the Square Kilometre Array



axies)

ution  
es  $z \sim 2-3$ )

structure)

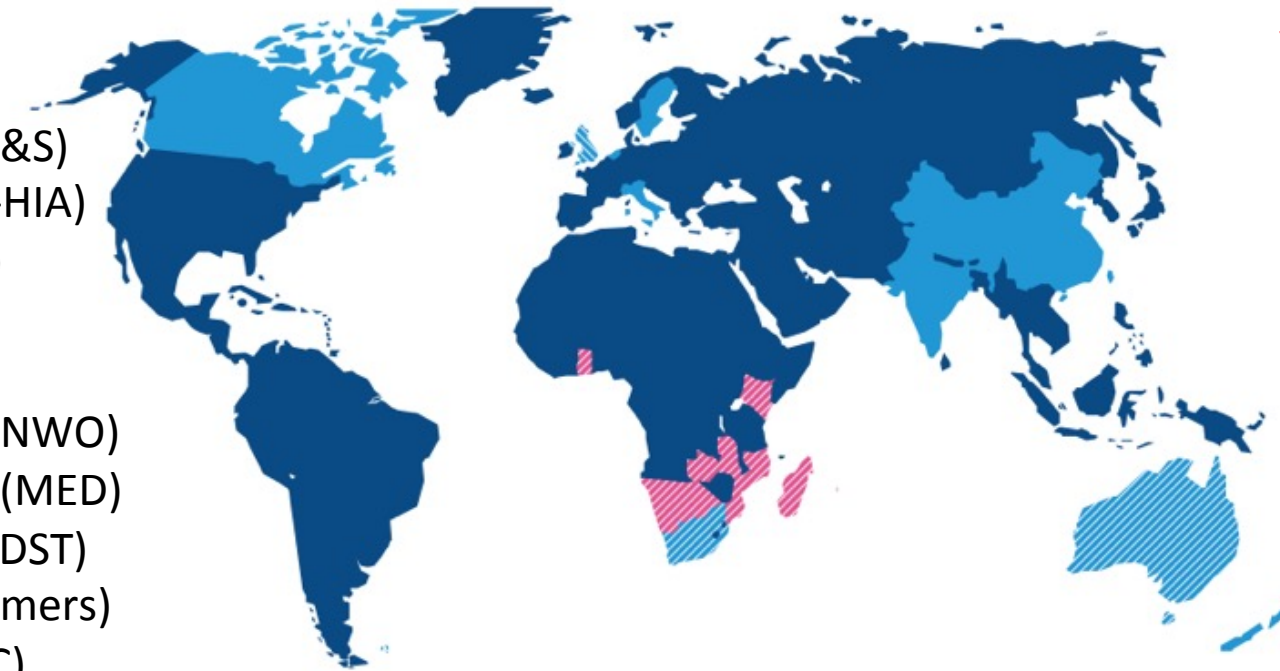
Broadest range of science of any facility, worldwide



# 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)



- Full members
- SKA Headquarters host country
- SKA Phase 1 and Phase 2 host countries



- African partner countries  
(non-member SKA Phase 2 host countries)

This map is intended for reference only and is not meant to represent legal borders

In discussion  
with :

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



# New Chair of the Board



Giovanni (Nanni) Bignami  
1944 - 2017

Catherine Cesarsky





# Square Kilometre Array

3 sites; 2 telescopes + HQ  
1 Observatory

Design Phase: ~ €200M; 600 scientists+engineers,  
Now 75% complete

Phase 1

Construction: 2019 – 2024

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

Operations cost: current estimate €89M/yr

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

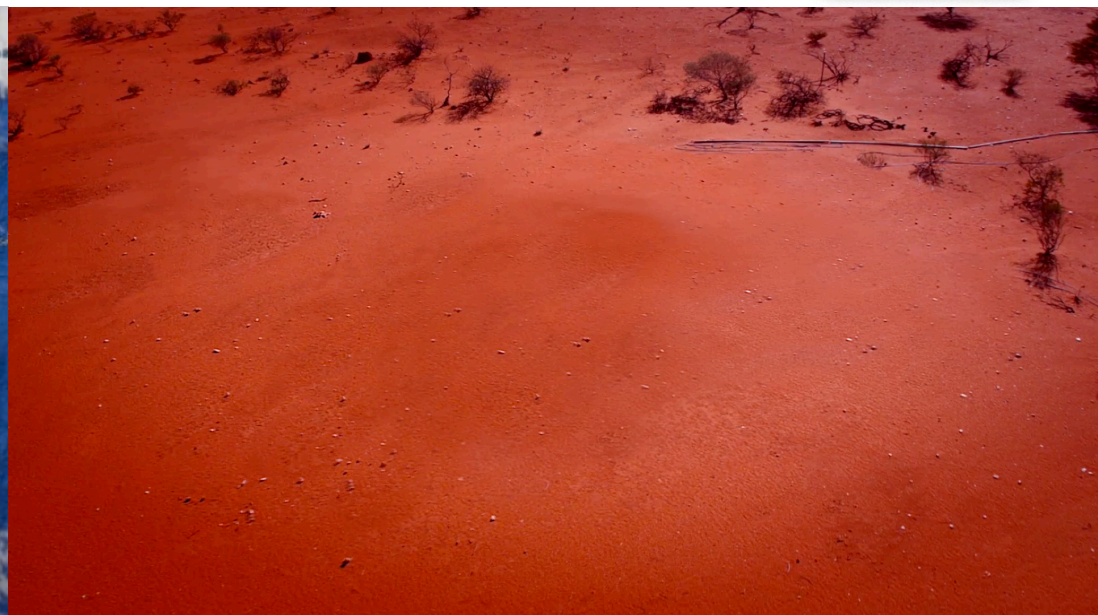
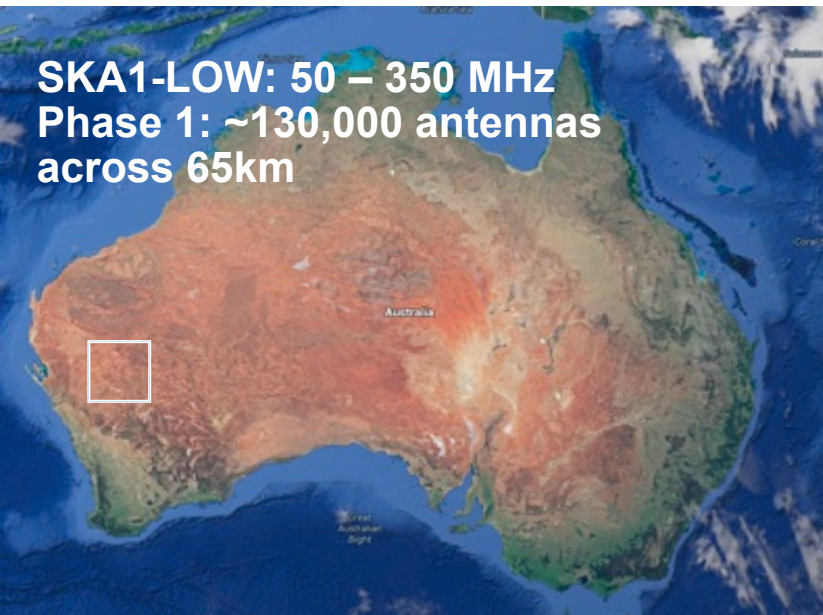
Major expansion of SKA1-Low across Western Australia



# SKA: HQ in UK; telescopes in AUS & RSA



**SKA1-LOW: 50 – 350 MHz**  
**Phase 1: ~130,000 antennas**  
**across 65km**



**SKA1-Mid: 350 MHz – 24 GHz**  
**Phase 1: 200 15-m dishes across**  
**150 km**



Construction: 2019 – 2024; Cost cap: €674M



SKA HQ: ~150 staff: SKA Observatory: ~440 staff



€20M project.

Complete June 2018

A 'nexus for radio astronomy'





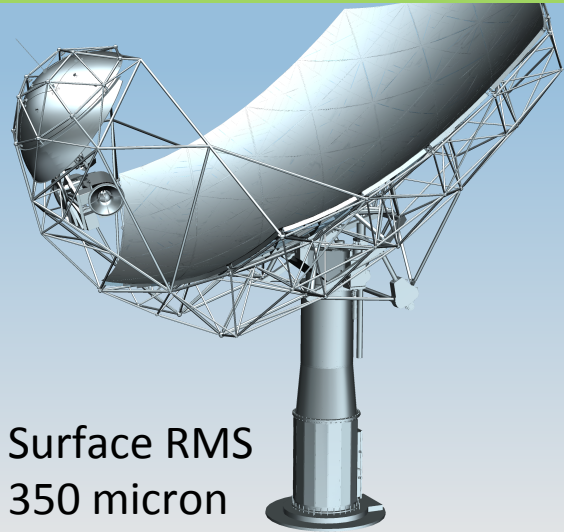
# Current status



# Technical Progress



Chinese (CETC54)/German (MTM)  
Design.

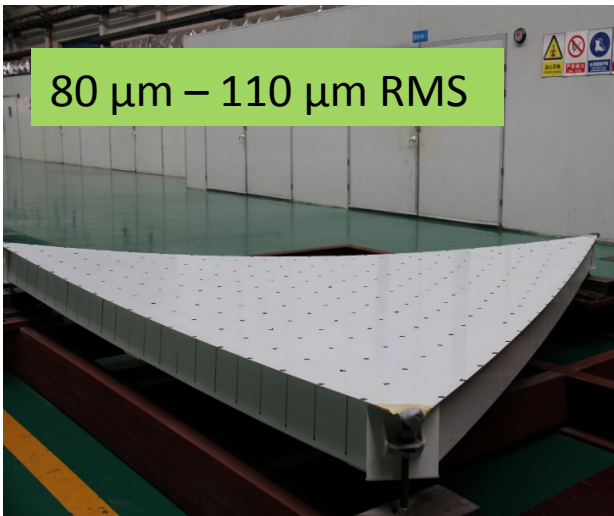


Surface RMS  
350 micron

Foundation: South Africa



80  $\mu\text{m}$  – 110  $\mu\text{m}$  RMS



Subreflector Mould: China

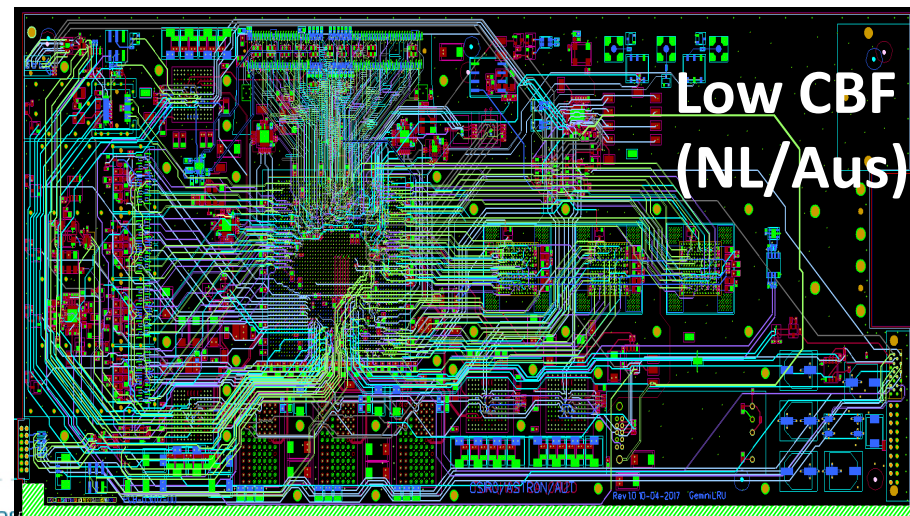
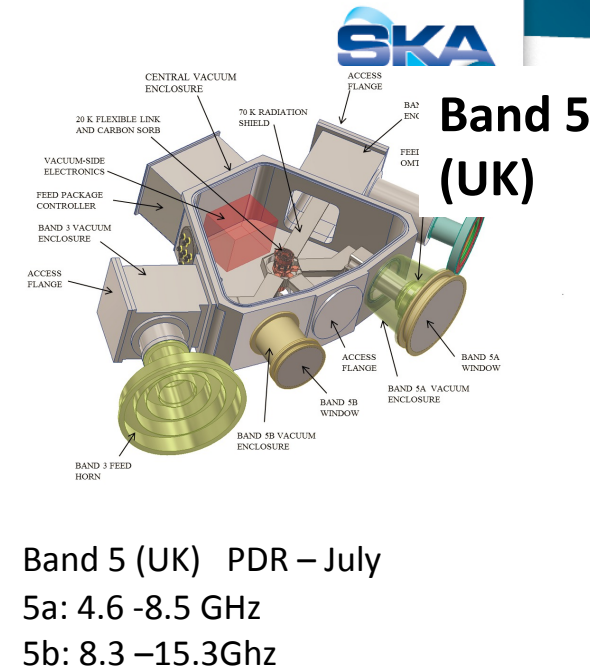
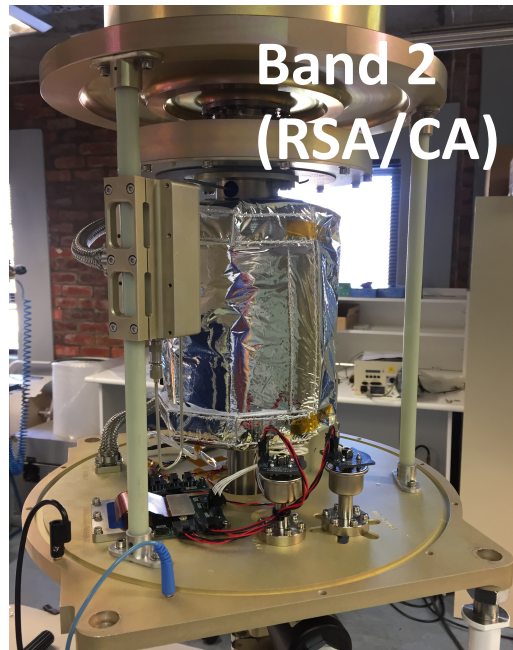
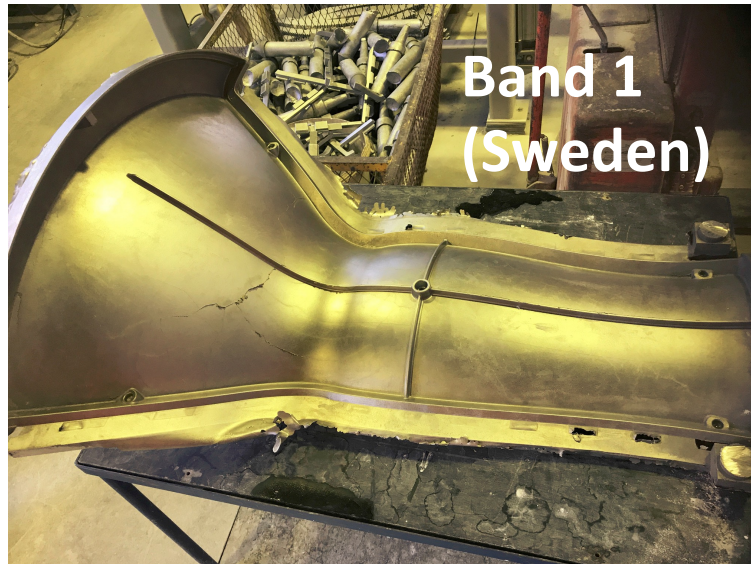


Feed Indexer: Italy





# Technical Progress









# Design Baseline / Deployment Baseline



	Design Baseline	Deployment Baseline	Re-instatement '+' means add to system
<b>SKA1-Mid</b>			
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
<b>SKA1-Low</b>			
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
<b>Common</b>			
Compute Power	260 PFLOPs	50 PFLOPs	+210 PFLOPs

- Outcome of July SKA Board Meeting
  - Design Baseline for which CDRs will be undertaken is unchanged
  - Deployment Baseline is scoped for cost-capped Construction budget
  - Further analysis of Low  $B_{\text{Max}}$  underway
  - Re-instatement of HPC and PSS already part of Operational budget
  - Re-instatement commitment for **all items** as soon as funding permits

**Cost:**  
**Design baseline: €806M**  
**Deployment: €675M**  
**Ops costs ~ €89M/yr**



# Data Flow



## SKA1-LOW



Antennae Corporation © 2016

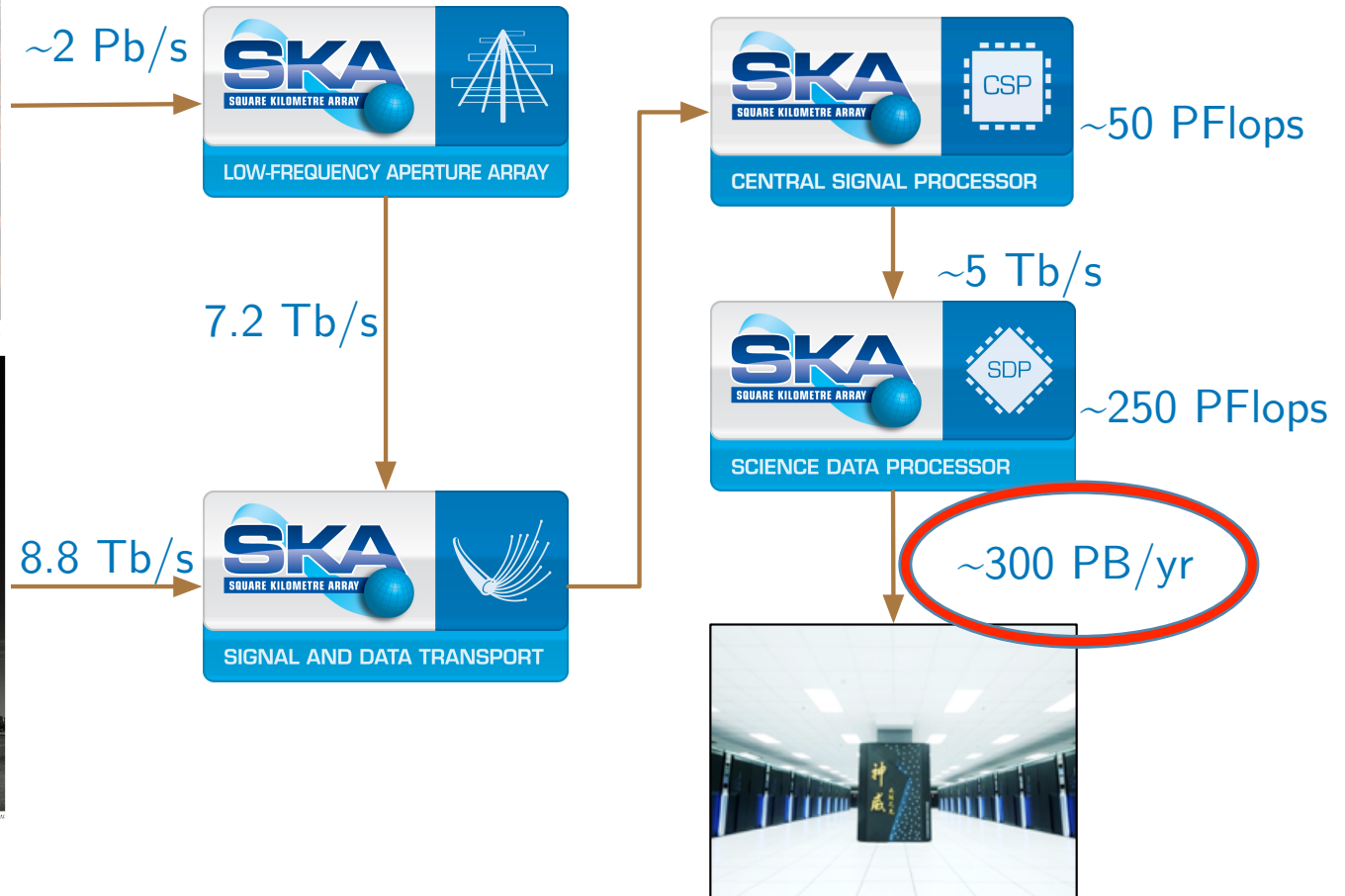


© Antennae Corporation 2016

## SKA1-MID

# Global internet traffic ~360 Tb/s

(Cisco: 2016)



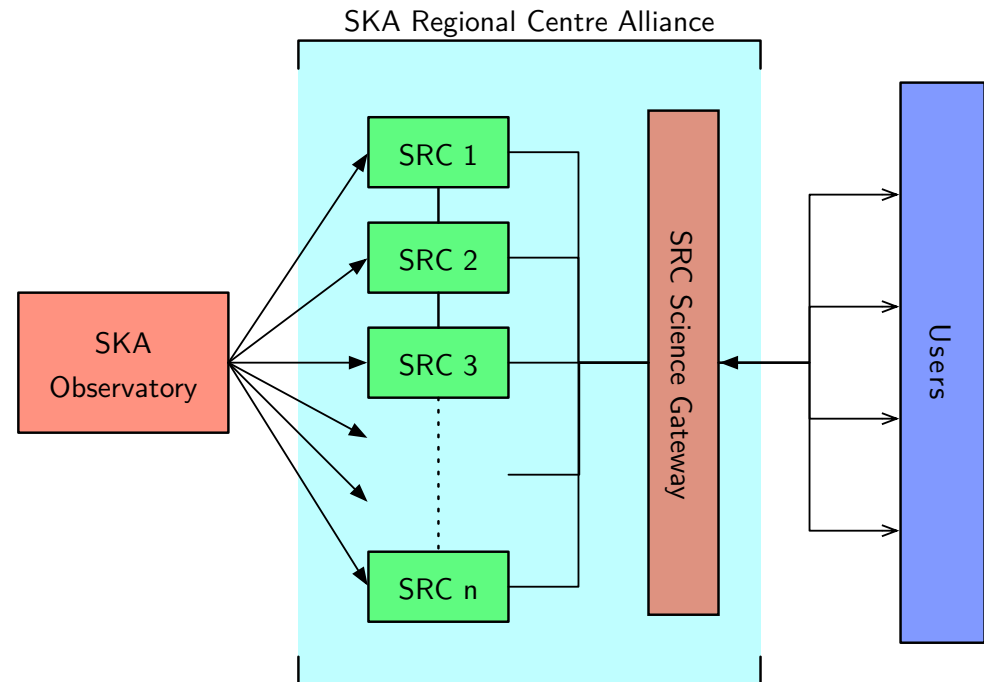


# Planning for SKA Regional Centres



- a collaborative alliance
- transparent and location agnostic interface to SRCs for users

- no SKA user should care where their data products are
- all SKA users should be able to access their data products, irrespective of whether their country or region hosts a regional



- 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 & user support
- Multiple regional SRCs, locally resourced and staffed



# Collaboration Agreement with CERN





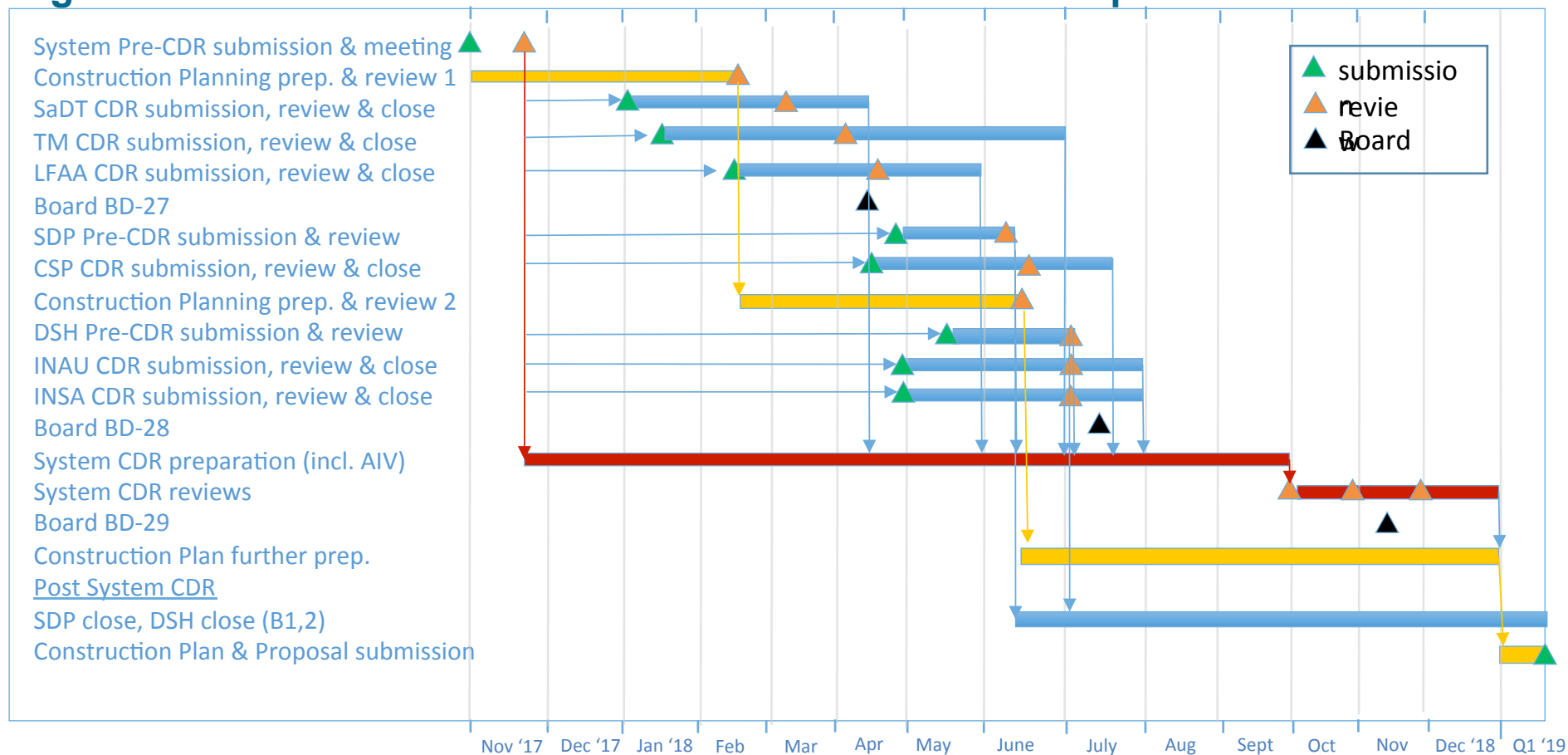
# Establishing SKA as a Treaty Organisation

- SKA Organisation member governments agreed to develop an Intergovernmental Organisation in 2015
- Rationale:
  - Appropriate for a genuinely global research infrastructure of SKA's scale
  - Government commitment: political stability, funding stability
  - A level of independence in structure
  - Availability of 'supporting processes' through Privileges and Immunities from members: functional support for project
  - 'Freedom to operate', specifically through procurement process, employment rules etc
- Negotiations started October 2015 – four Plenary meetings led by Italian government;
- Expect Convention to be signed February 2018, ratified 12 months later





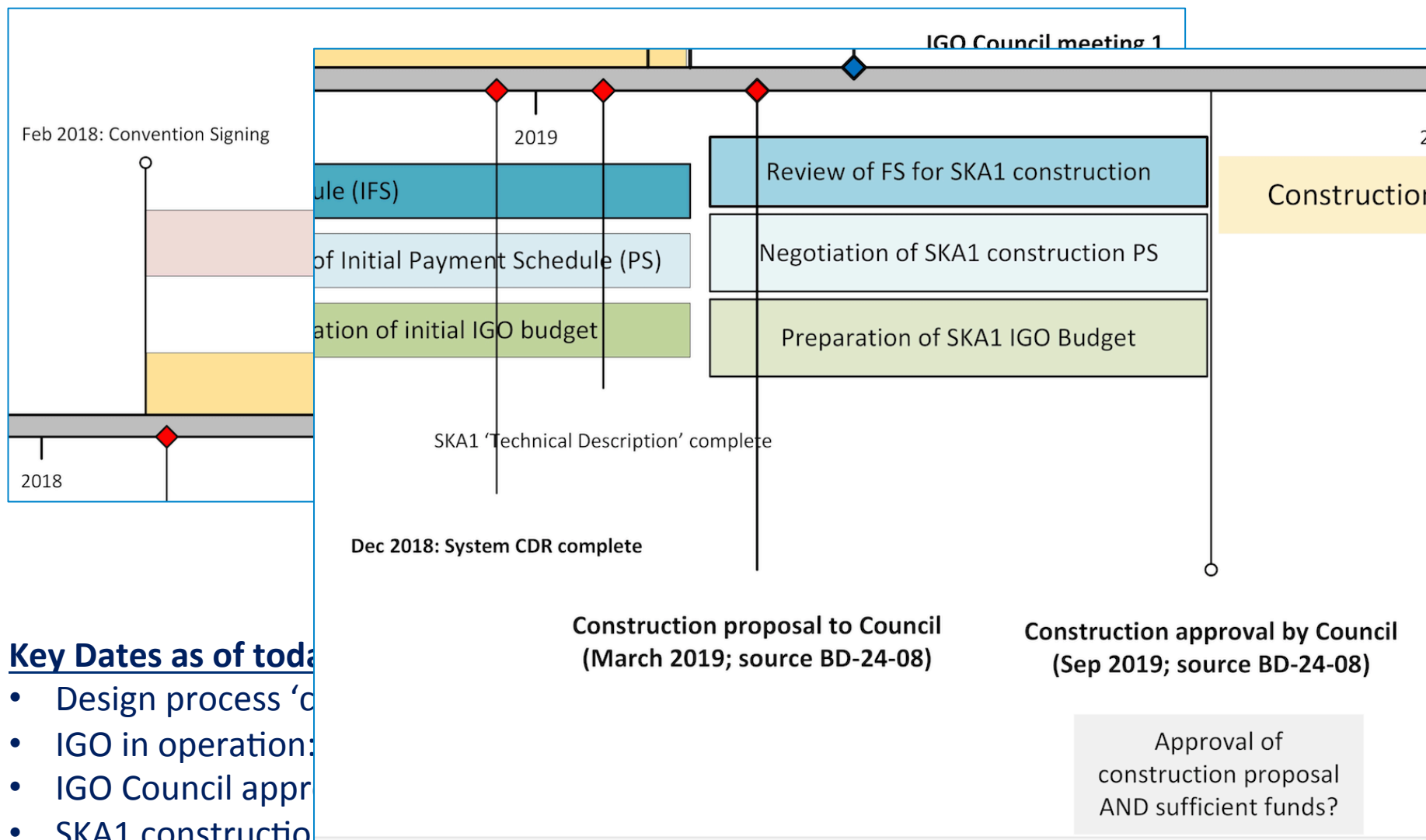
## High-level Pre-Construction Schedule to Construction Proposal



Andrea Casson, Sept 2017



# The overall project schedule.....





# Current activities



- Preparing for CDR – major effort, across all engineering teams
- Working with consortia to ensure they are prepared for successful CDR.
- Adopting SAFe approach for all software development, and hardware activities where appropriate
- Drafting “Call for Expressions of Interest” for construction activities – expect to release Q1 2018
- Preparing for Nov Board meeting:
  - Cost update
  - Engineering report focus on 2 telescopes
  - Planning for consortia transition to construction: access to expertise
  - Personnel planning for construction and steady-state operations
  - Overall project schedule
  - IGO, transition planning





# Summary



- SKA maintaining and building momentum
- Entering CDR 'season', culminating in System CDR in mid-2018
- IGO: convention initialing imminent, signing in February 2018
- Construction activities begin in Q3/4 2019
- SKA partners welcome French interest; joining SKA in near future allows participation in all key decisions and ability to influence the programme
- Acknowledge huge efforts of SKA France team

