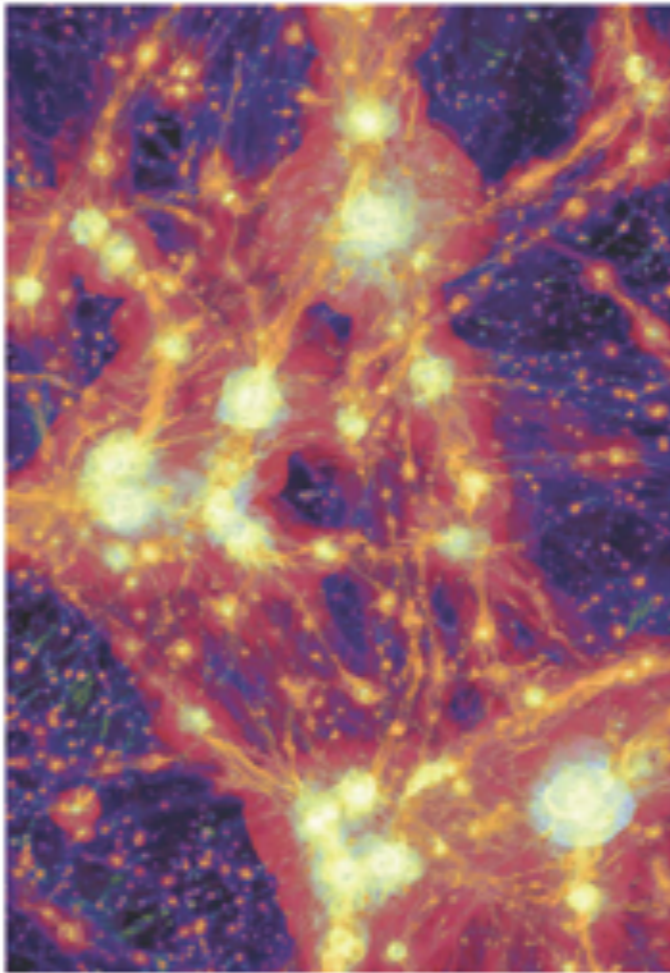


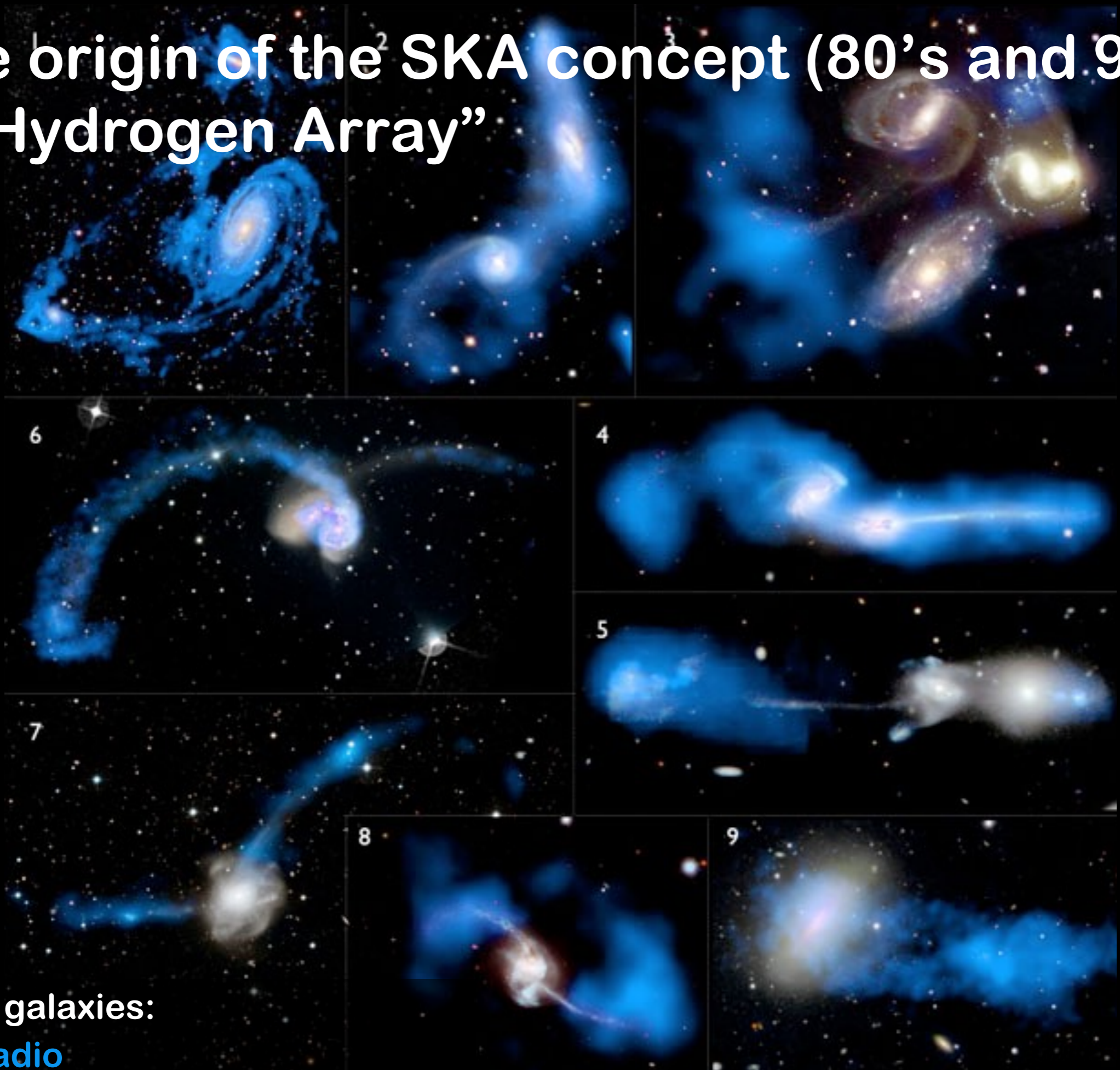
Le Square Kilometer Array (SKA) Un radiotélescope Exascale



Chiara Ferrari
Astronome (OCA)
SKA France Director

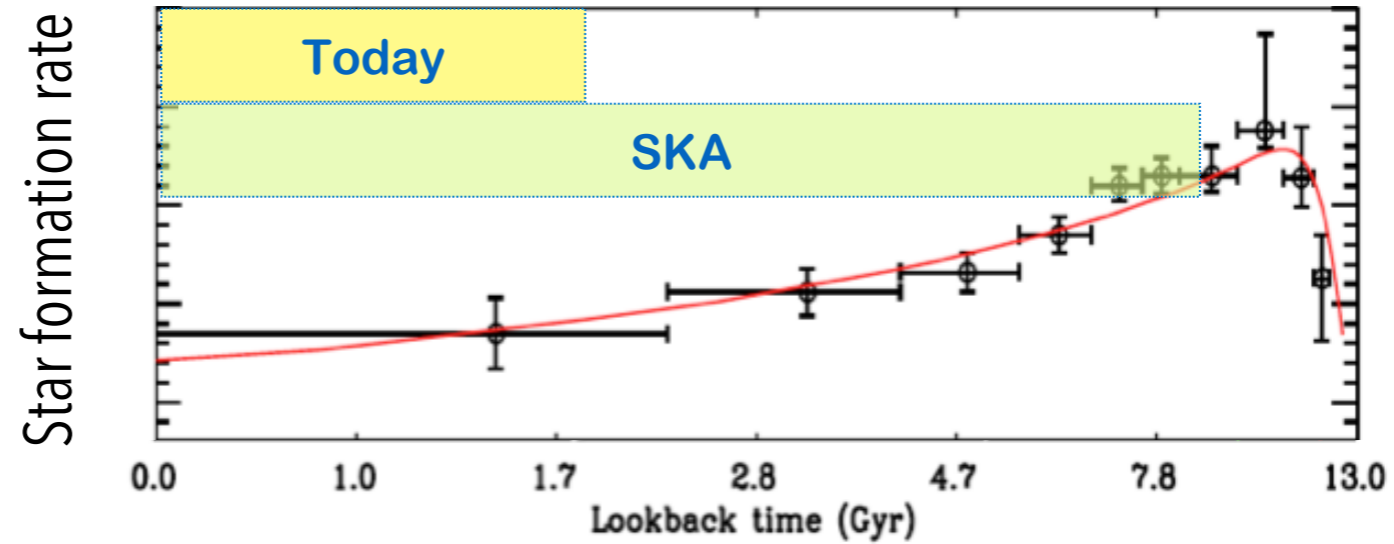


At the origin of the SKA concept (80's and 90's) The "Hydrogen Array"



Light from galaxies:
visible & radio

Changing our understanding of the Universe with the SKA



Galaxy evolution

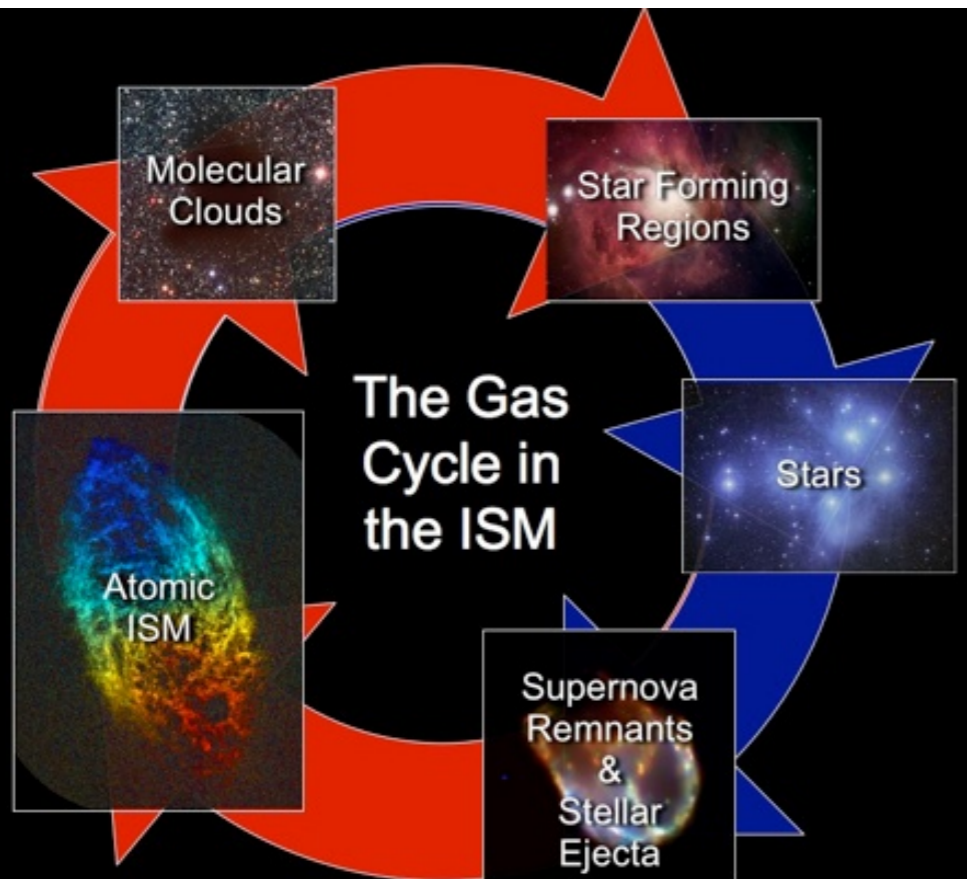
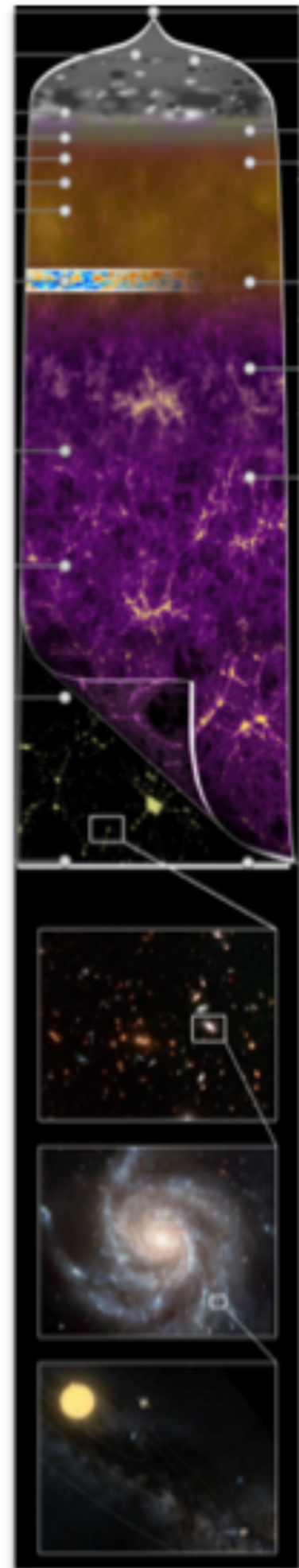


Photo Credits: R. Gendler, the FORS Team, D. Malin, SAO/Chandra, D. Thilker

Changing our understanding of the Universe with the SKA

Cosmic dawn & Epoch of Reionisation

Cosmology

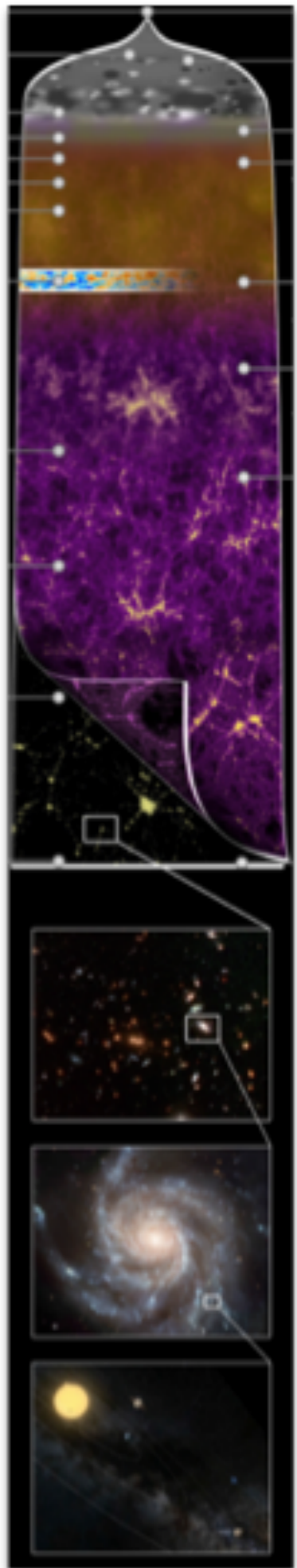
Galaxy evolution

Cosmic magnetism

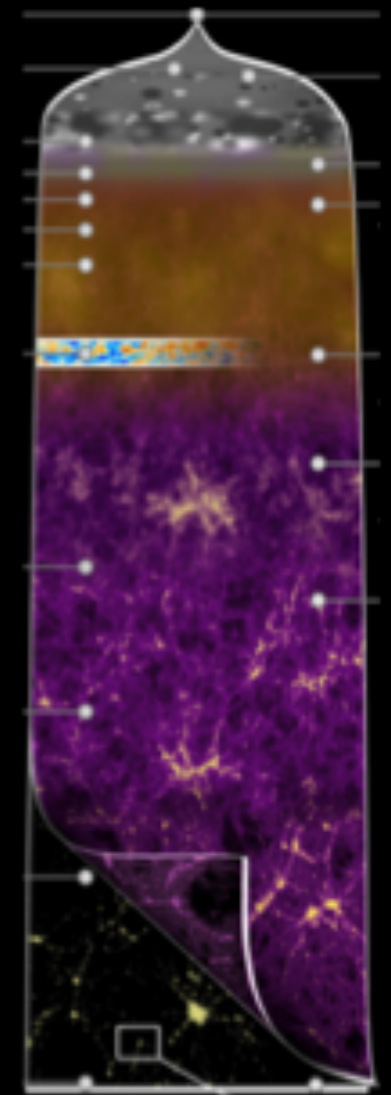
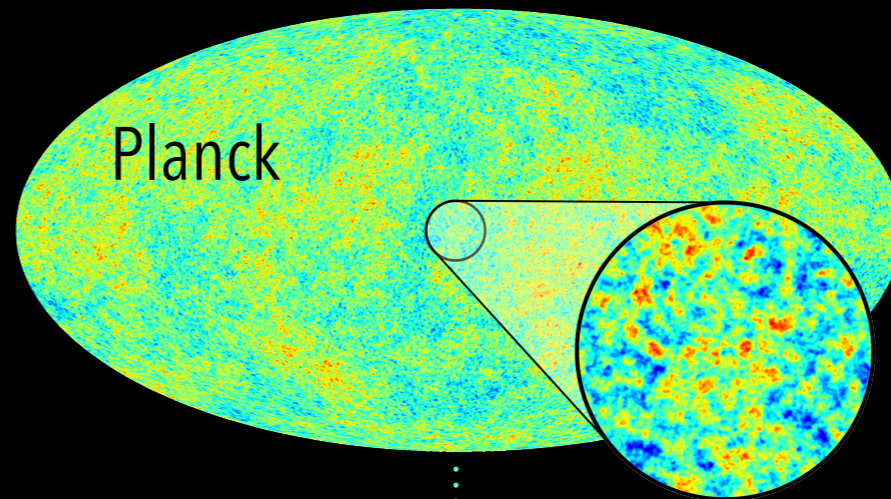
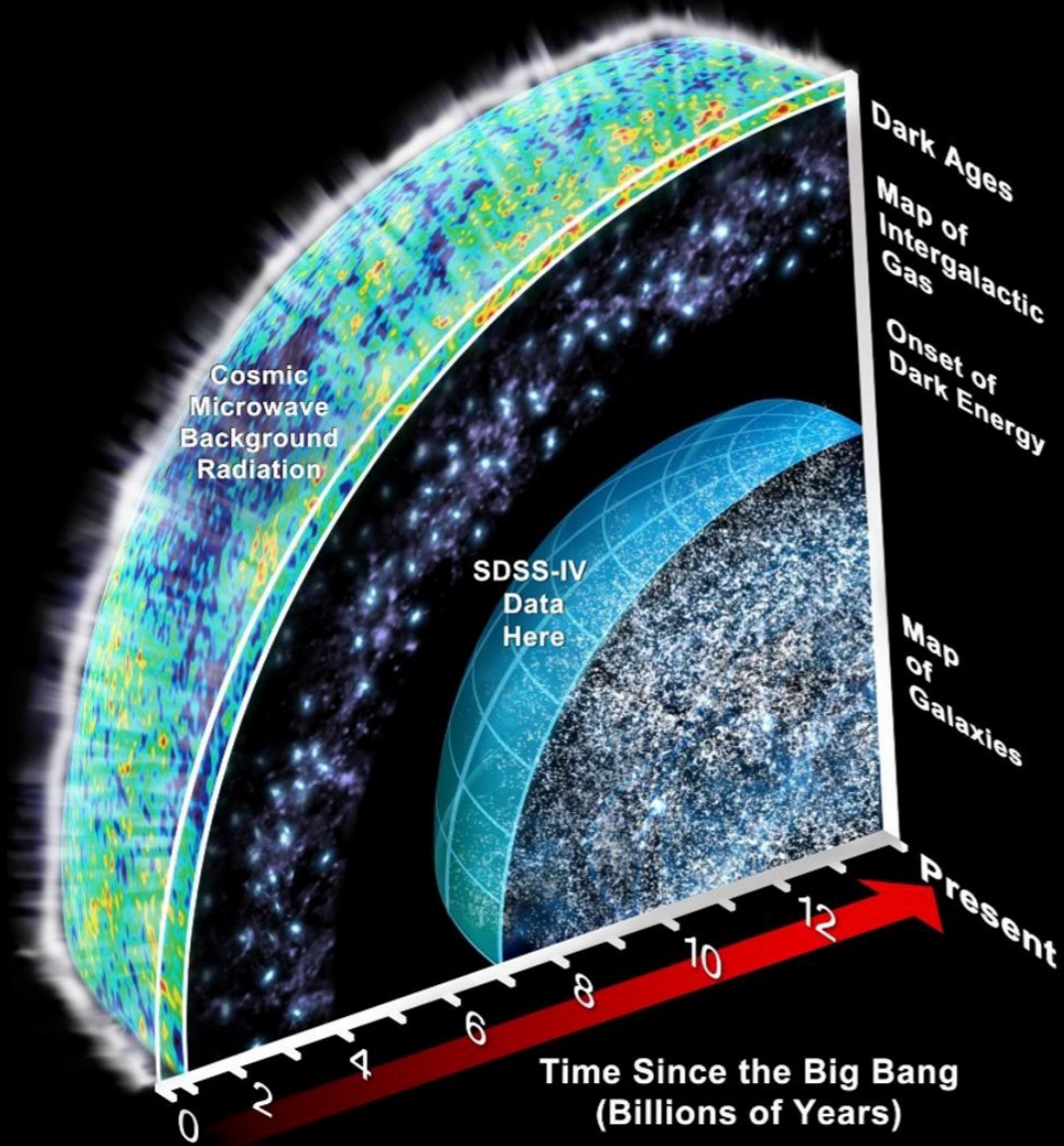
Fundamental physics

Transient sky

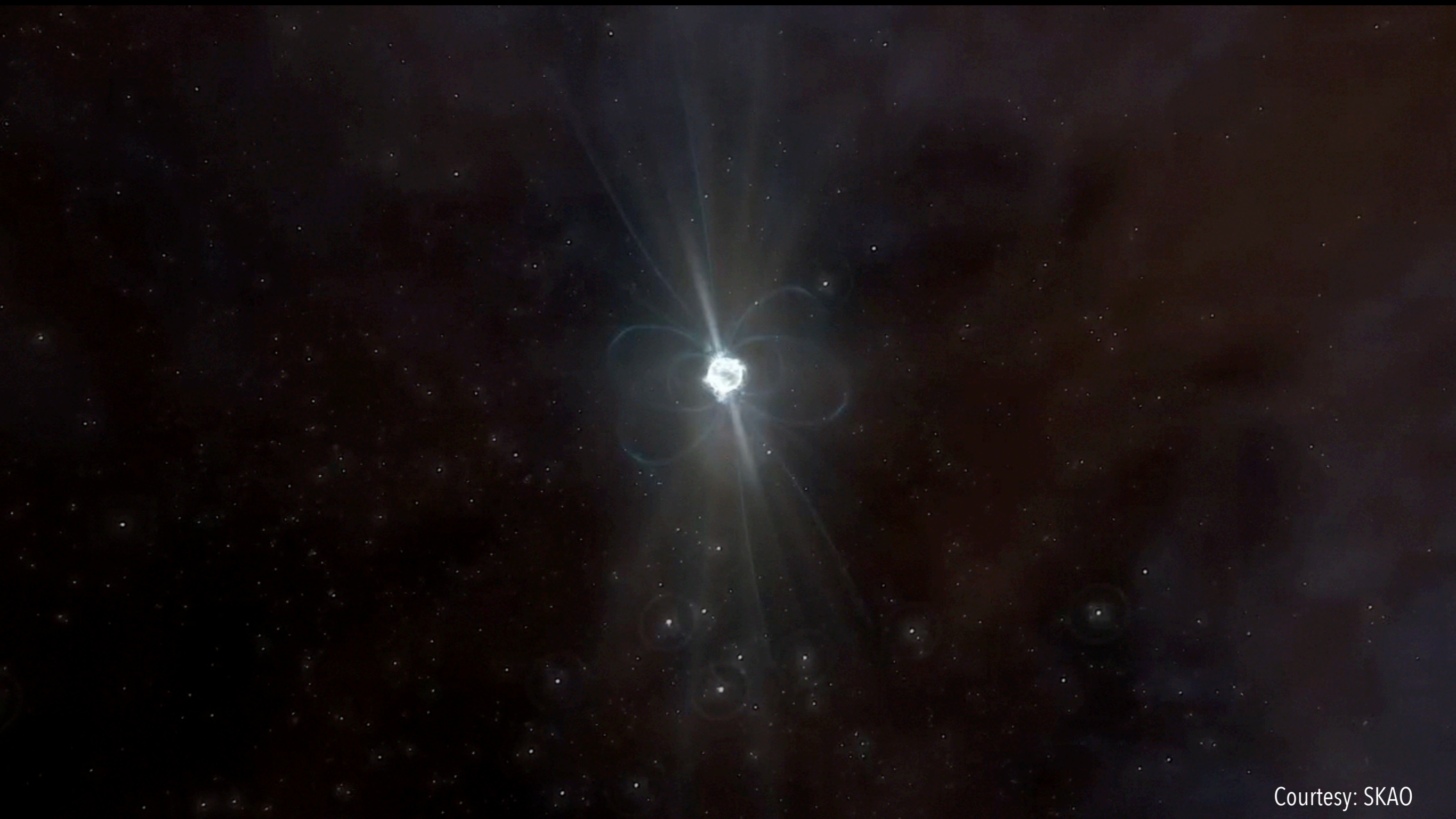
Cradle of life



Changing our understanding of the Universe with the SKA



Changing our understanding of the Universe with the SKA

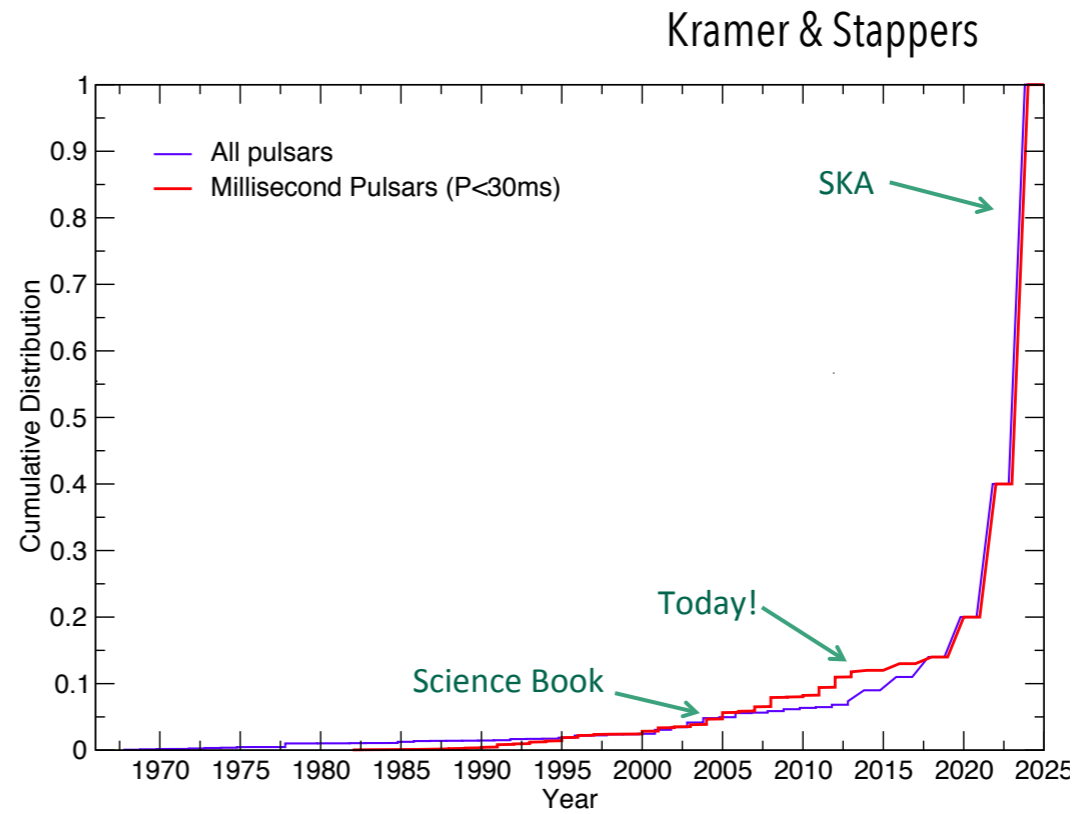
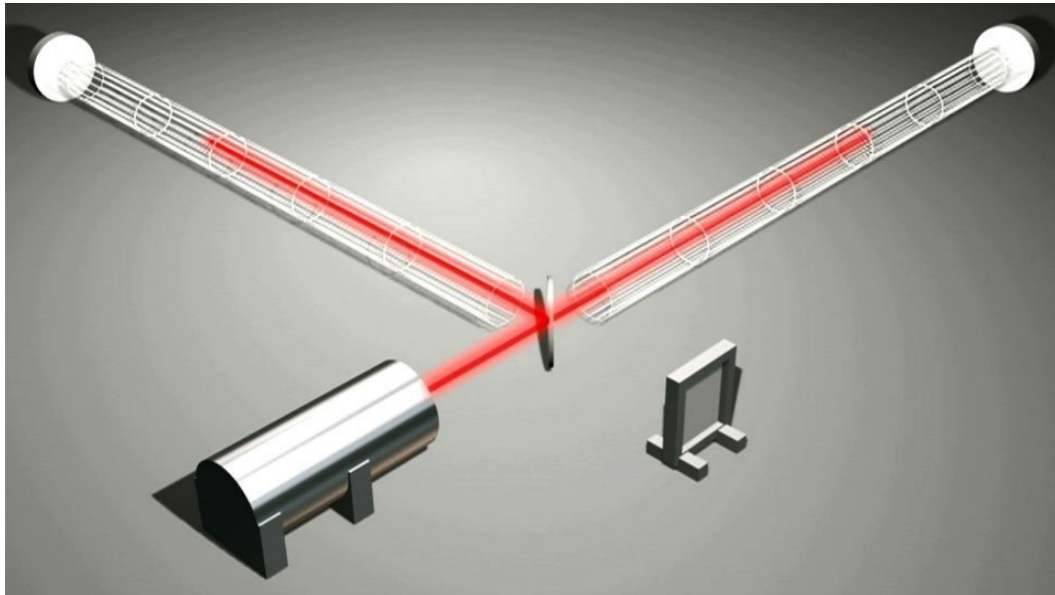
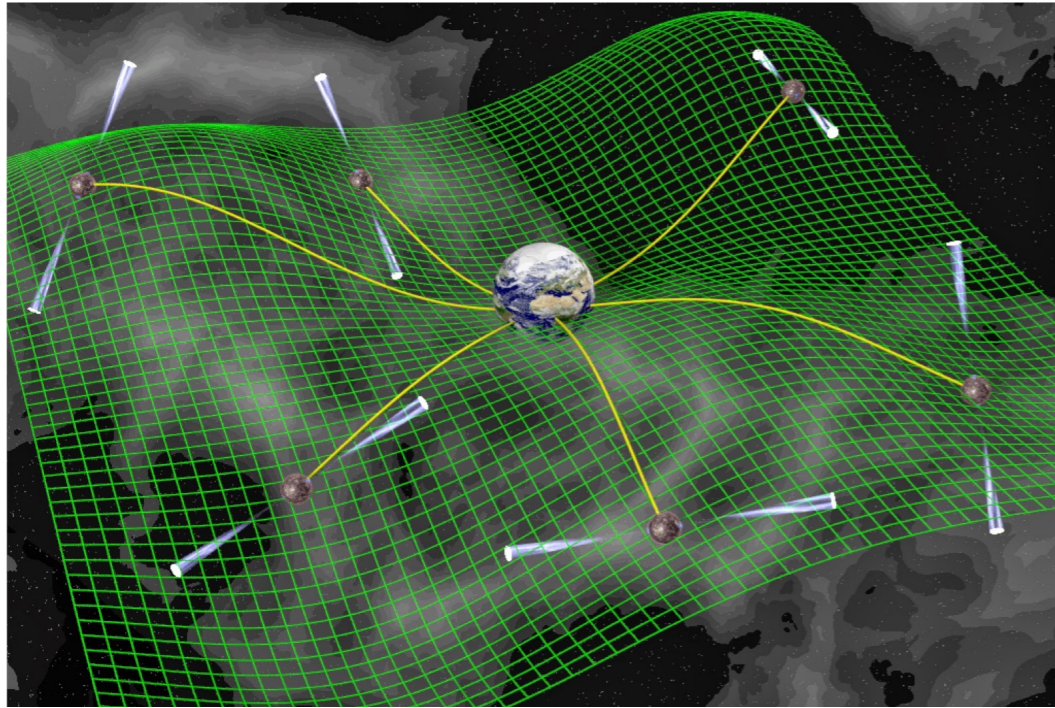


Courtesy: SKAO

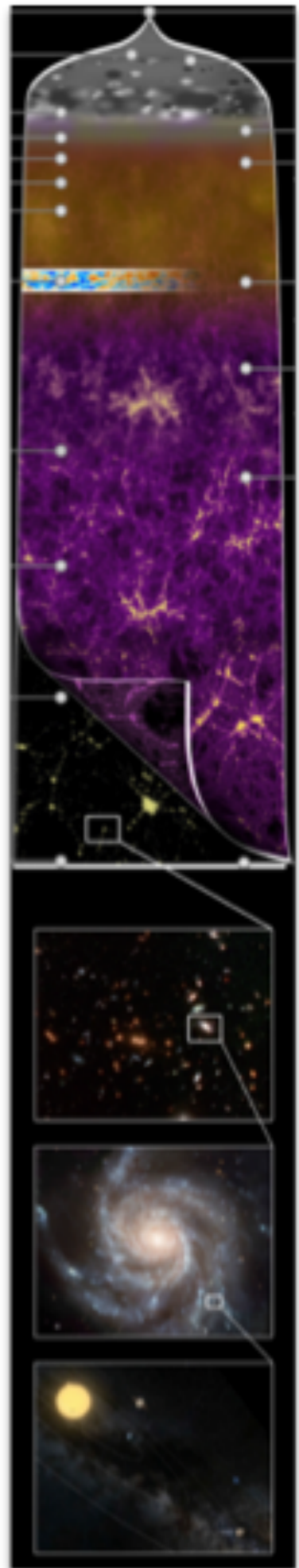


Courtesy: SKAO

Changing our understanding of the Universe with the SKA

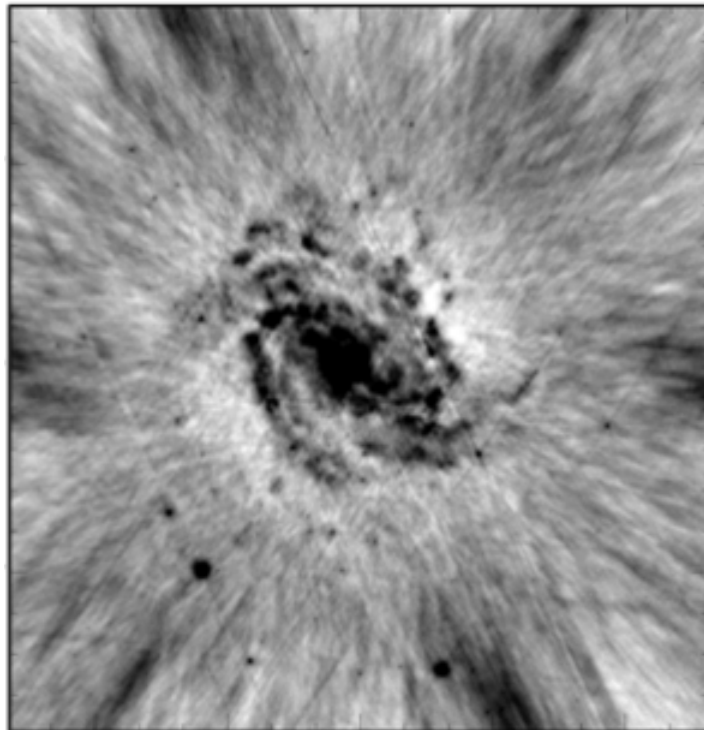


Fundamental physics

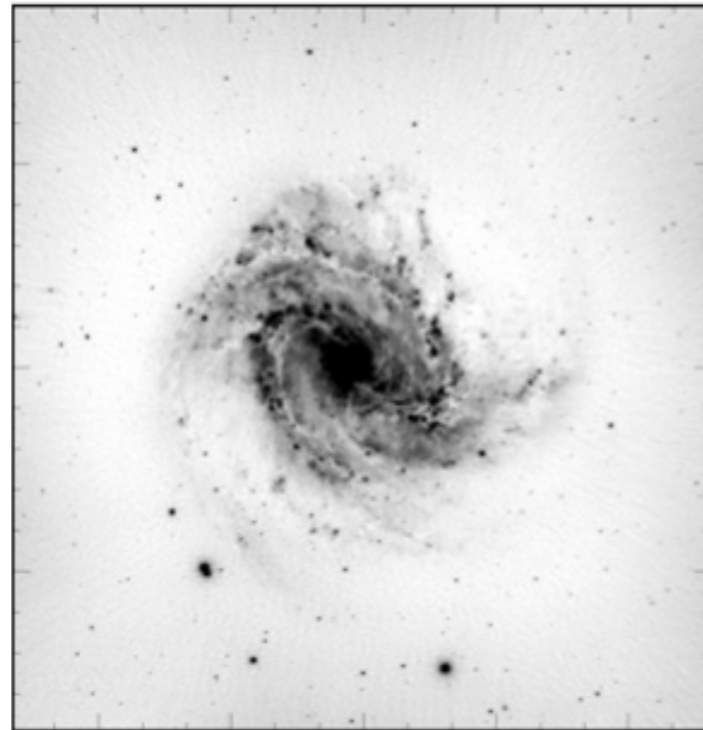


Why with the SKA?

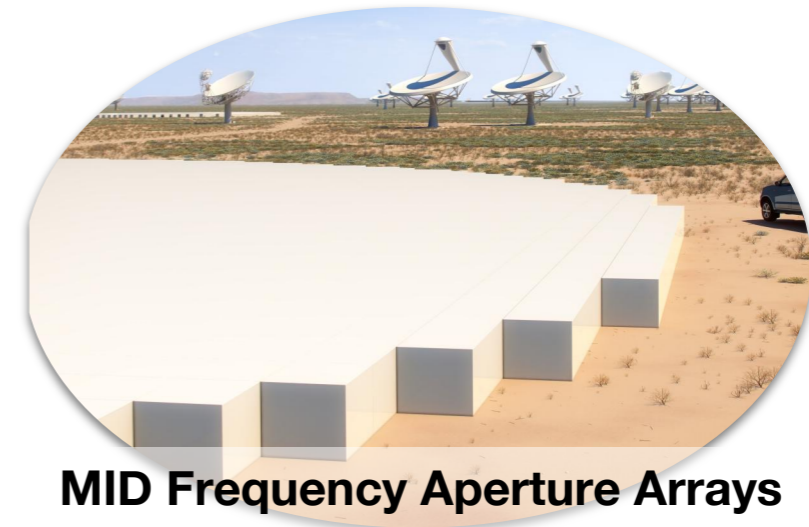
Today with JVLA



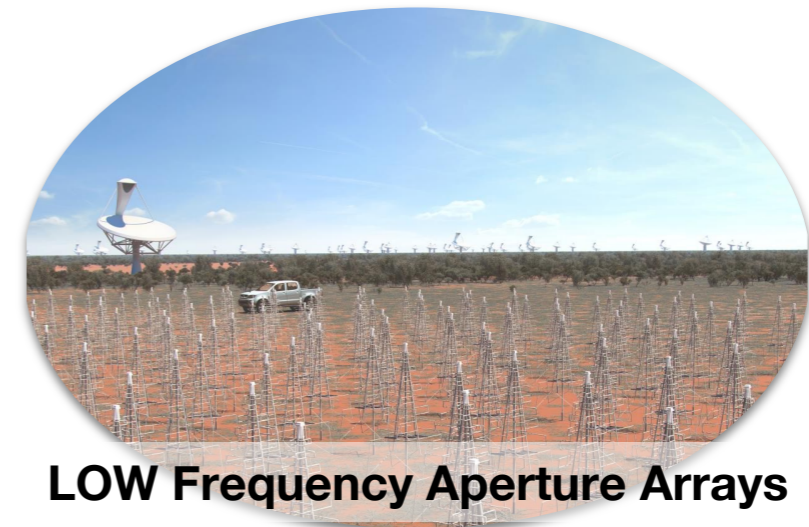
Tomorrow with SKA1



Dishes



MID Frequency Aperture Arrays



LOW Frequency Aperture Arrays

↑
>15 GHz

50 MHz

SKA Phase 1 (SKA1)

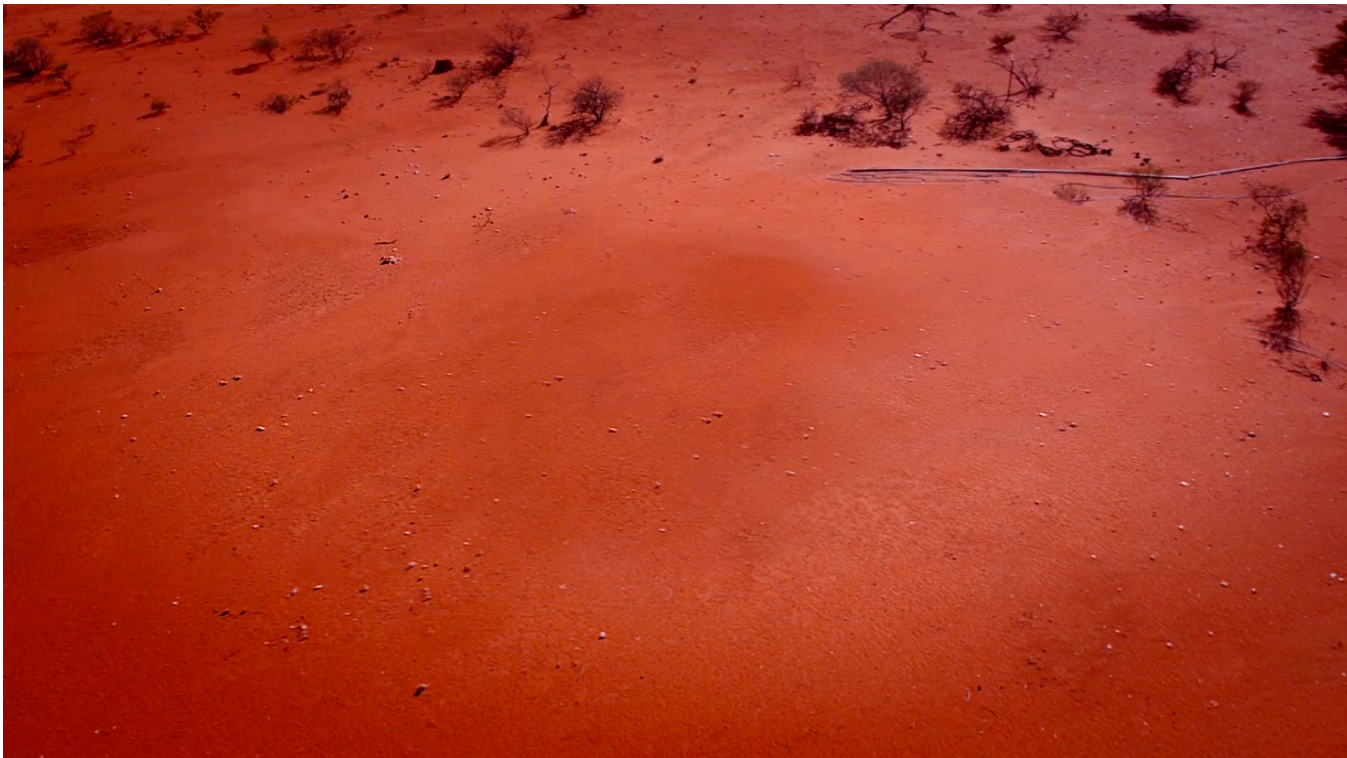


SKA1-LOW (AUS)
130,000 log periodic
antennas

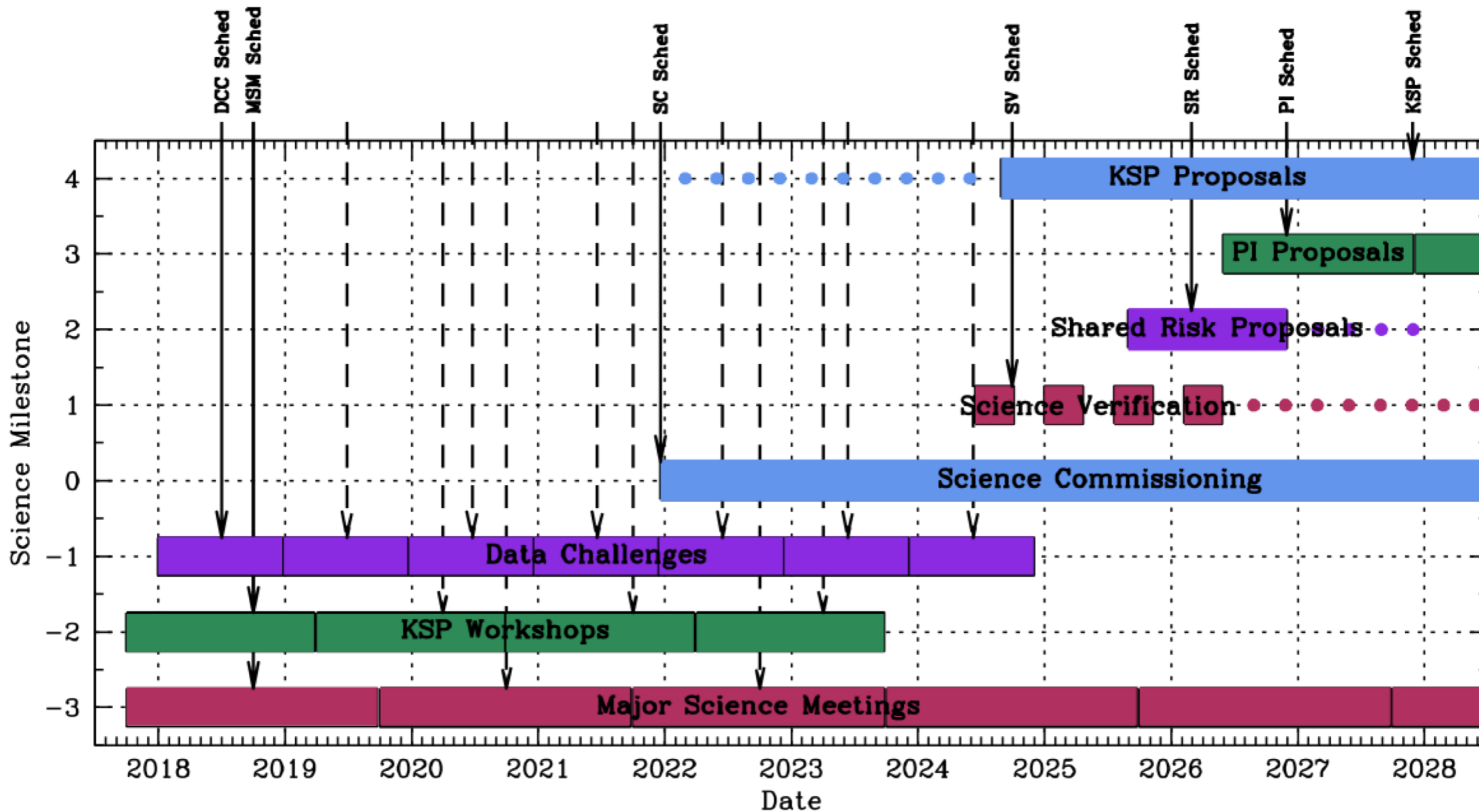


SKA1-MID (SA)
197 dishes (15m)

—50 MHz—————350 MHz—————15 GHz→



Schedule to SKA Science



SKA Organisation (SKAO)



Membres
Pays Hôtes: Australie, Afrique du Sud, Royaume Uni



Pays africains partenaires

Cette carte n'est à utiliser qu'à des fins d'illustration. Les frontières qui y sont représentées n'ont pas de valeur juridique.

Maison SKA France



- * A MoU, strong real equilibrated PPP, between research organisations and their industry partners
- * A science and technology roadmap
- * A forum to develop fundamental research and R&D projects
- * A precursor of a new business model for Large Research Infrastructures



SKA Design Consortia

DESIGNING THE

Square Kilometre Array



○ — Progress
○ — Completed

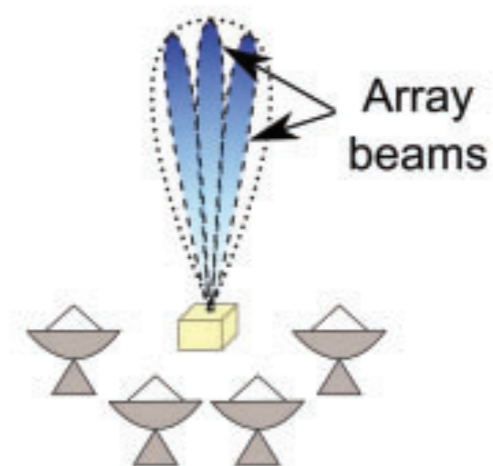
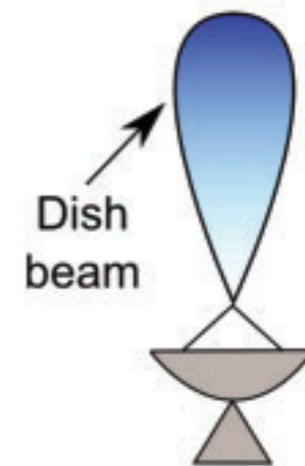
SKA Home

Website design in Manchester by Carbon Creative and SKA Communications team. Iteration Release v1.02

f
t
in

Observing modes

Non-imaging (Tide Array Beams)

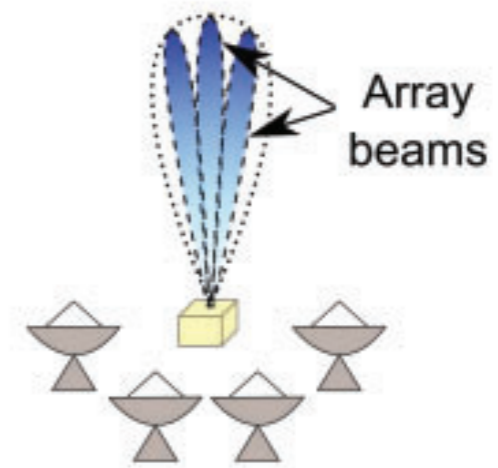
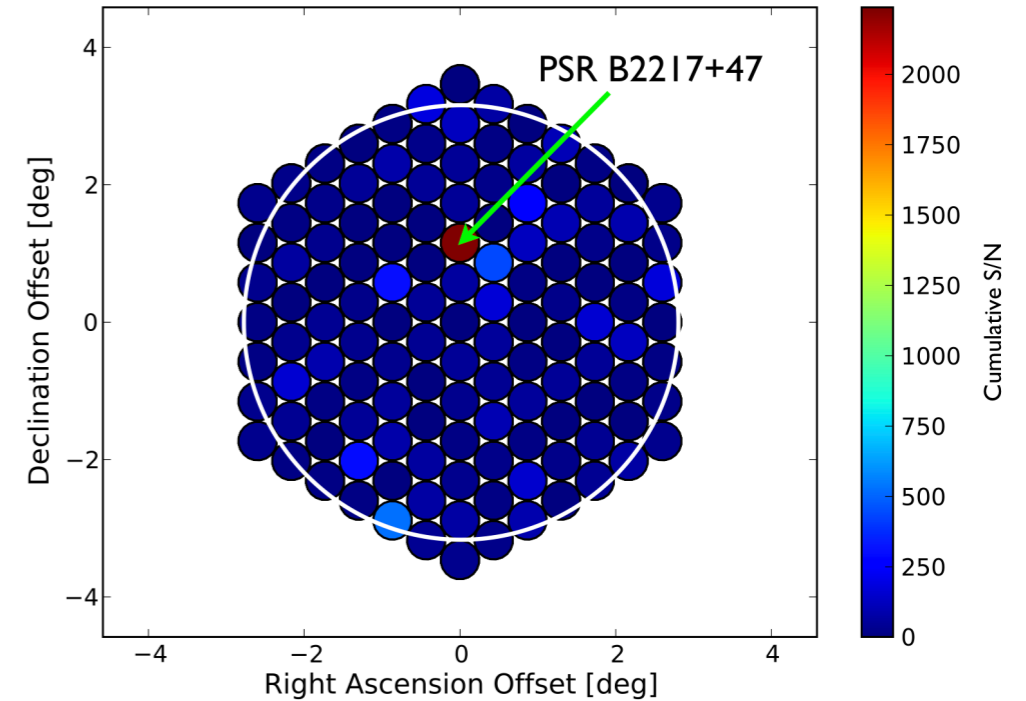


Observing modes

Non-imaging (Tide Array Beams)

Pulsar Search & Timing

- Forms hundreds of beams within the dish/station beam
- Time resolution $\sim 60\text{-}100 \mu\text{s}$
- Data rate $\sim 800 \text{ GB/s}$
- Archival $\sim \text{PB}$



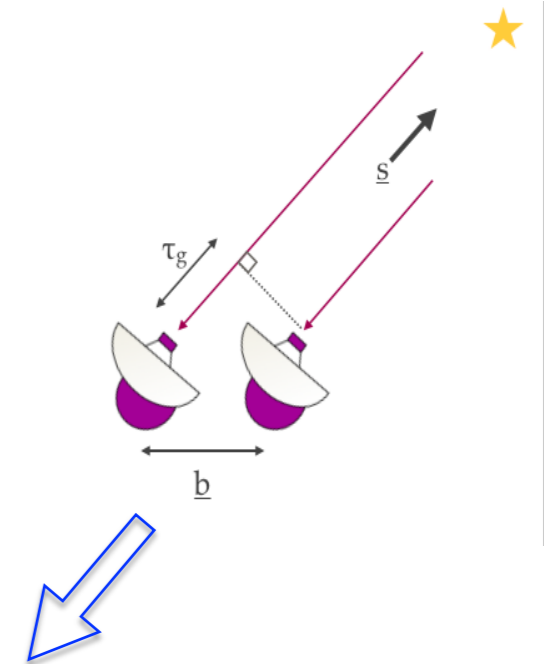
Observing modes

Non-imaging (Tide Array Beams)

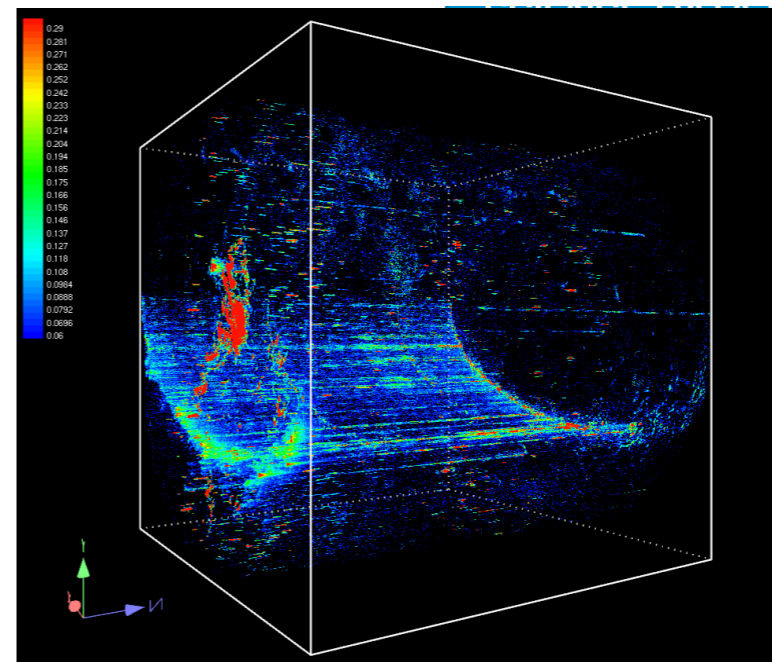
Pulsar Search & Timing

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- Data rate $\sim 800 \text{ GB/s}$
- Archival $\sim \text{PB}$

Imaging



$$T(x, y) = \int \int V(u, v) e^{-2\pi i(ux+vy)} du dv$$



Observing modes

Non-imaging (Tide Array Beams)

Pulsar Search & Timing

- Forms hundreds of beams within the dish/station beam
- Time resolution $\sim 60\text{-}100\ \mu\text{s}$
- Data rate $\sim 800\ \text{GB/s}$
- Archival $\sim \text{PB}$

Imaging

Most of the other Key Science Topics

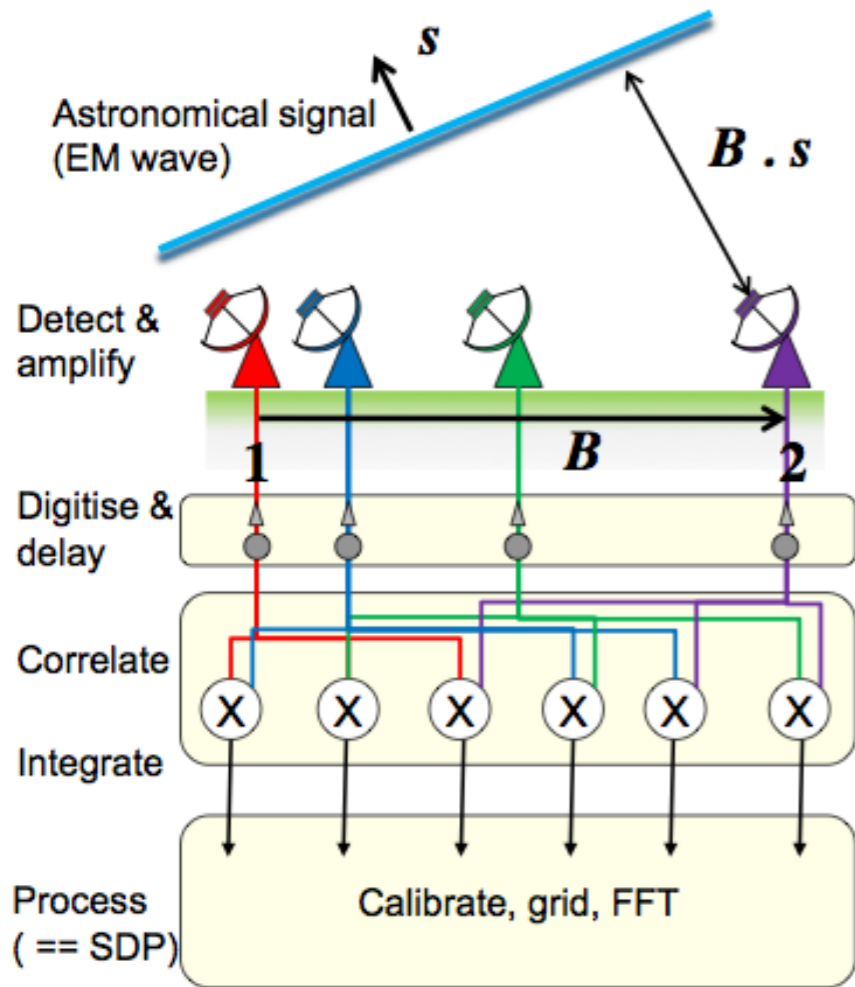
- 4D images (RA, Dec, Frequency, Polarization)
- Output image size $\sim 1\ \text{PB}$
- Archival $\sim 120\ \text{PB}$

Calibrated visibilities

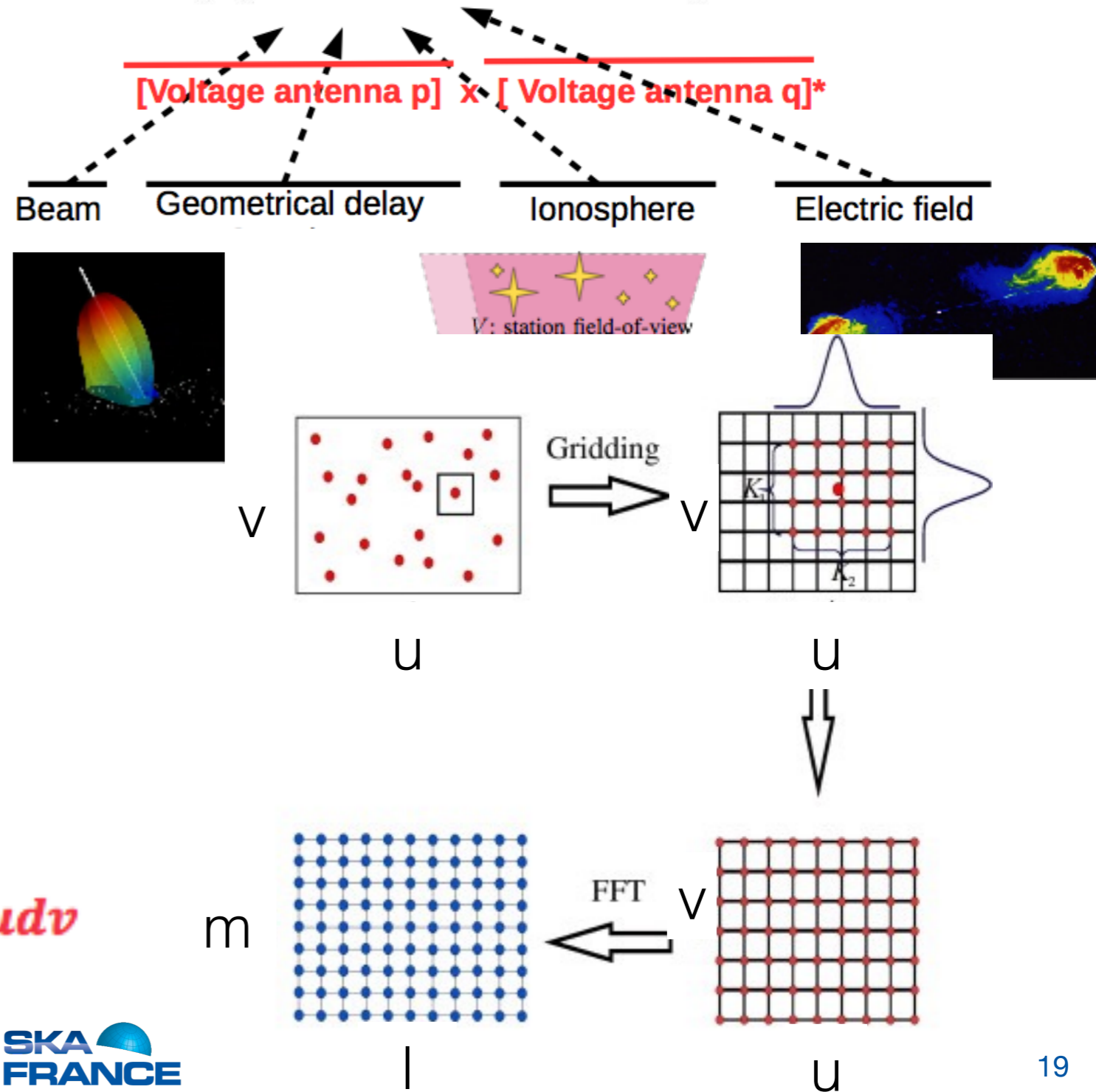
Epoch of Reionization

- Data archive of $> 200\ \text{PB}$
- Per observation $> 250\ \text{GB}$

Images for a radio interferometer



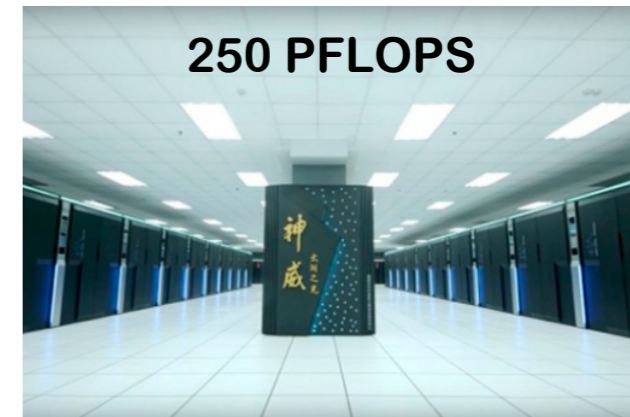
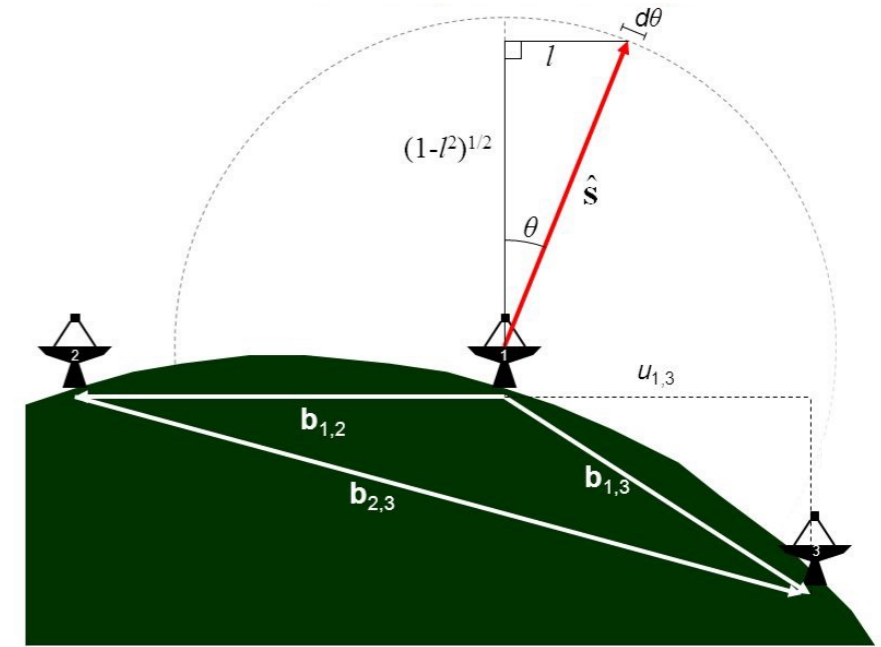
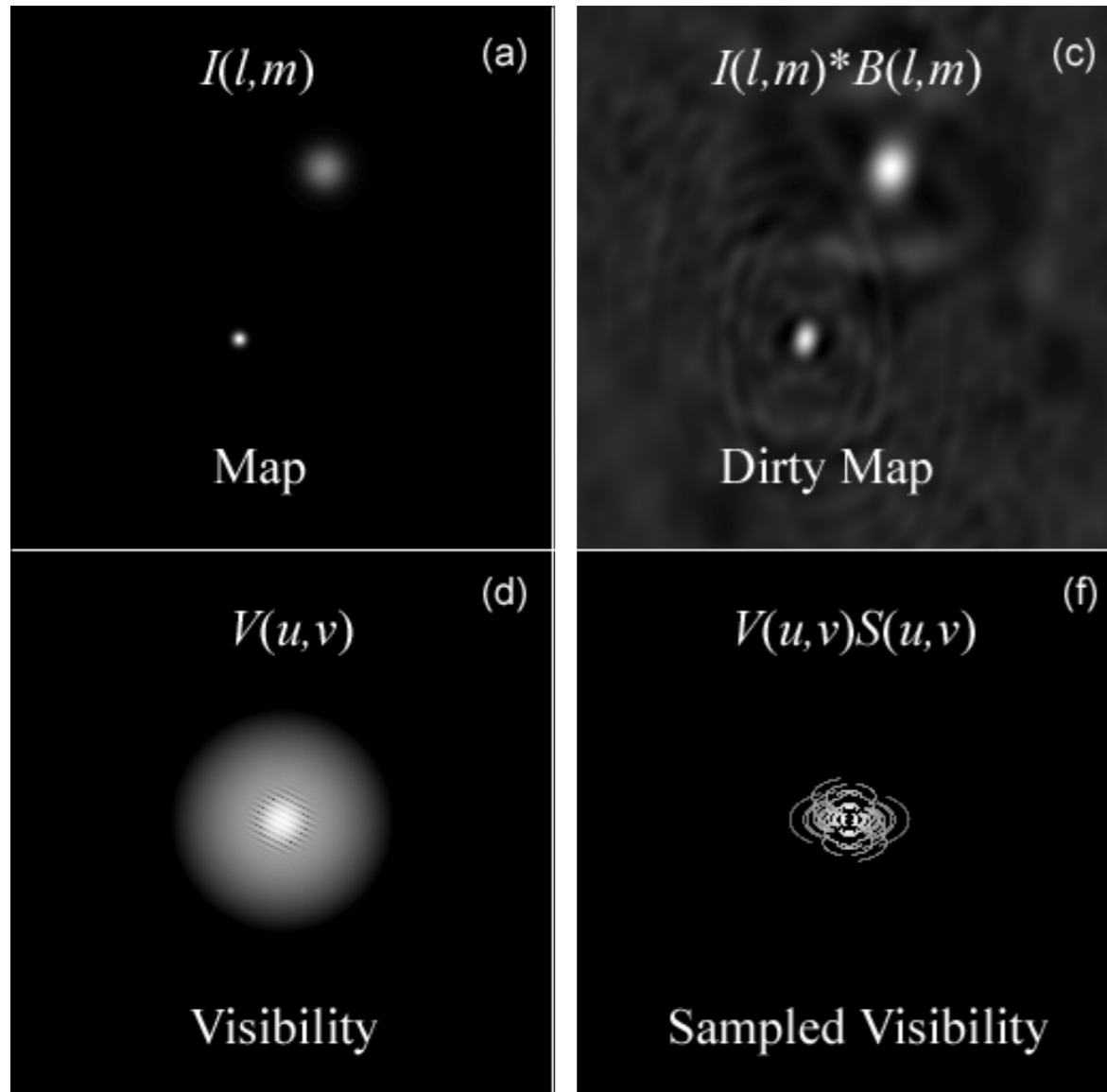
$$V_{pq} = \overbrace{G_p}^{\text{Direction independent}} \left(\sum_{i=1}^N \overbrace{B_{pi} K_{pi} I_{pi} F_i}^{\text{Direction dependent}} \cdot \overbrace{F_i^+ I_{qi}^+ K_{qi}^+ B_{qi}^+}^{\text{Source coherency}} \right) G_q^+$$



$$I(l, m) = \mathcal{F}^{-1}(V(u, v))$$

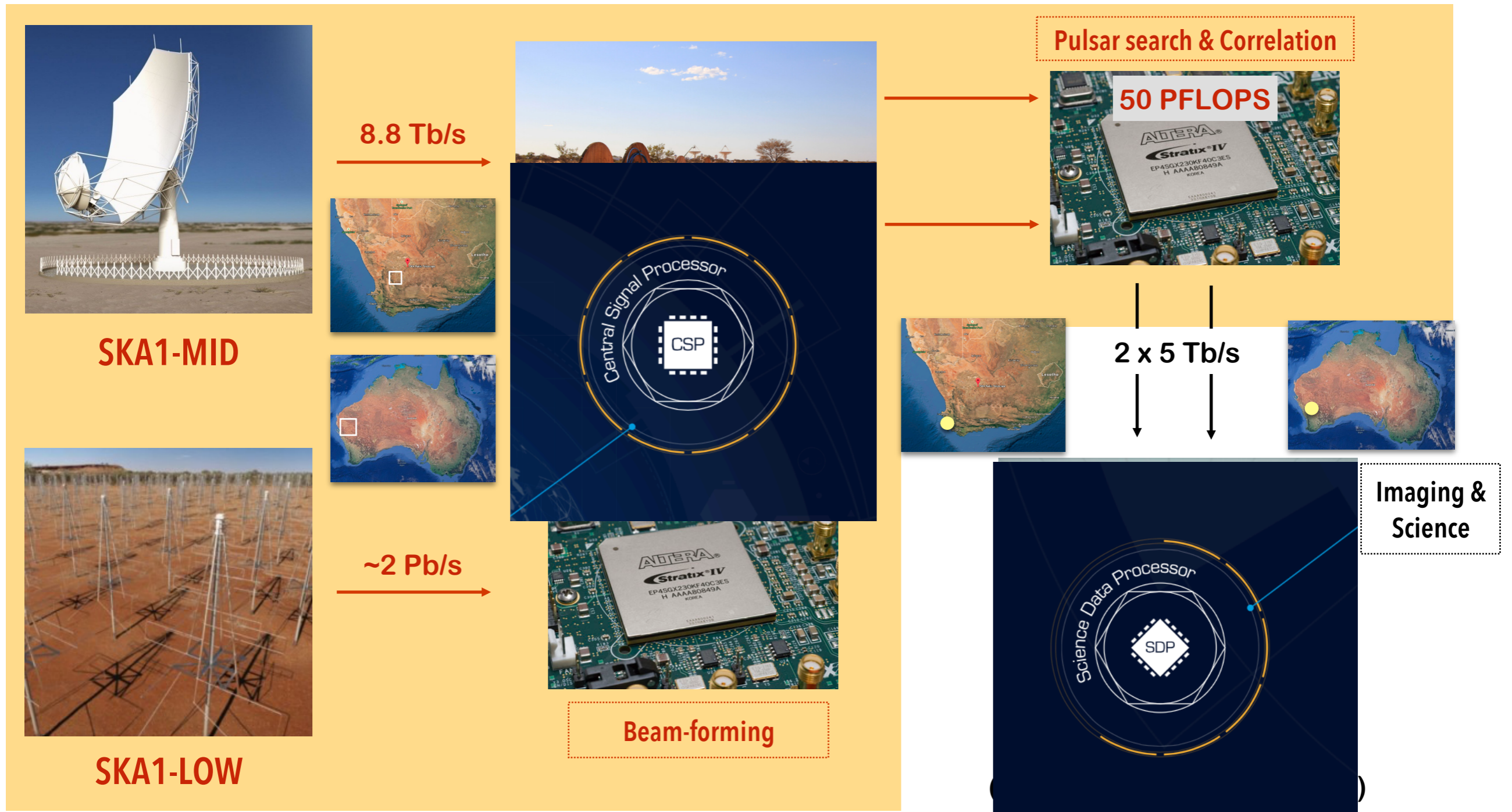
$$\equiv \iint_{-\infty}^{\infty} V(u, v) e^{i2\pi(ul+vm)} du dv$$

Finite number of antennas & Non-coplanar baselines

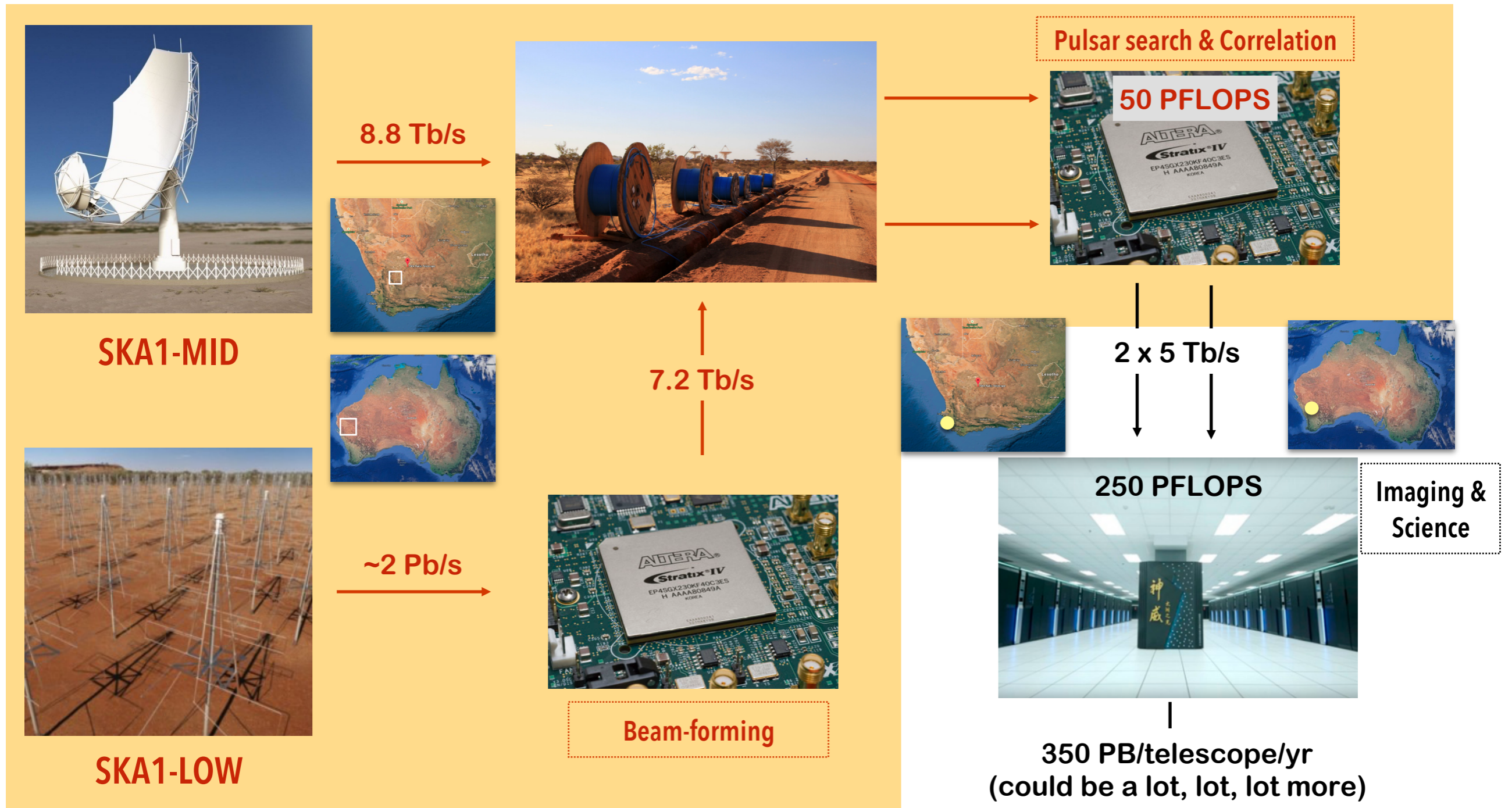


Imaging & Science

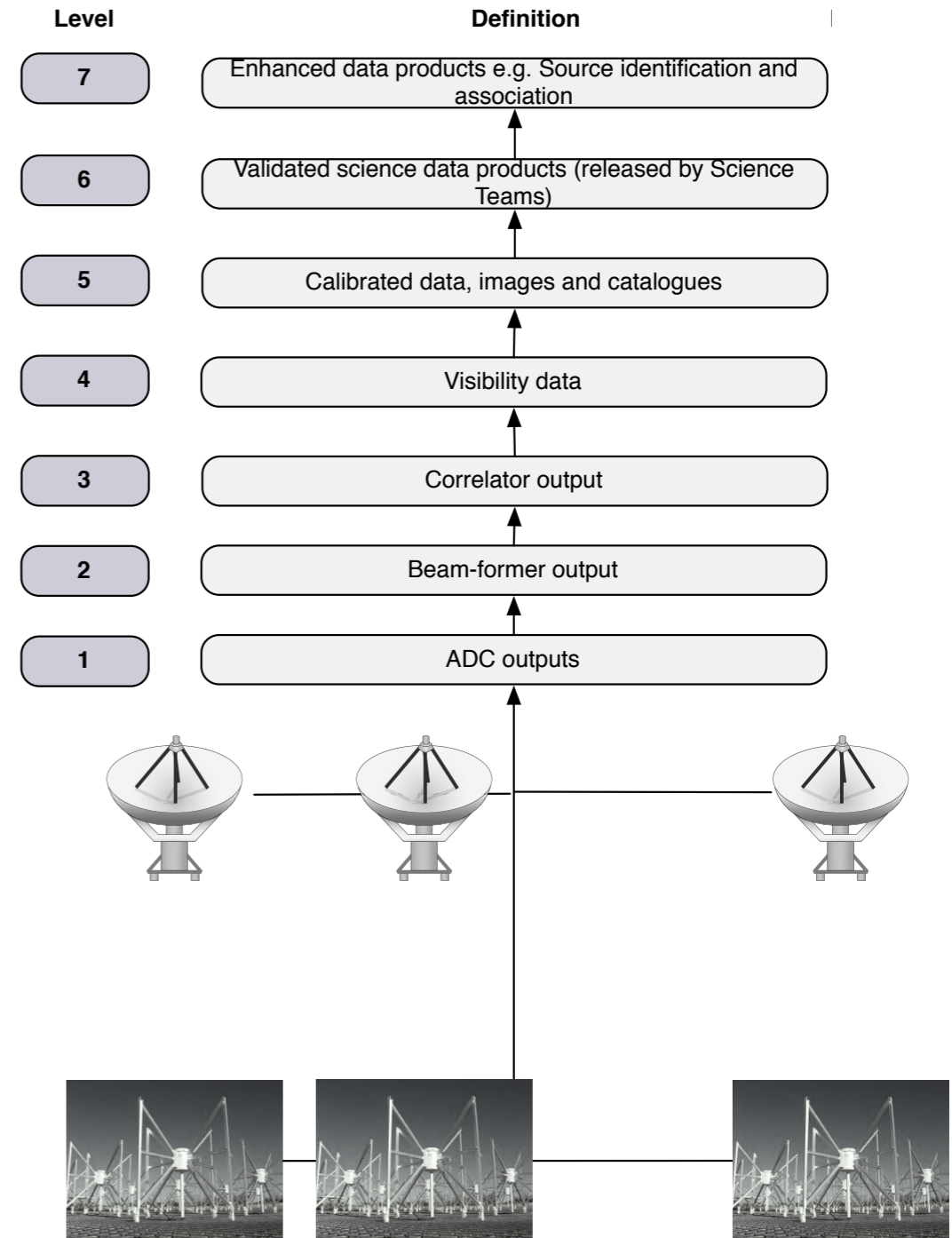
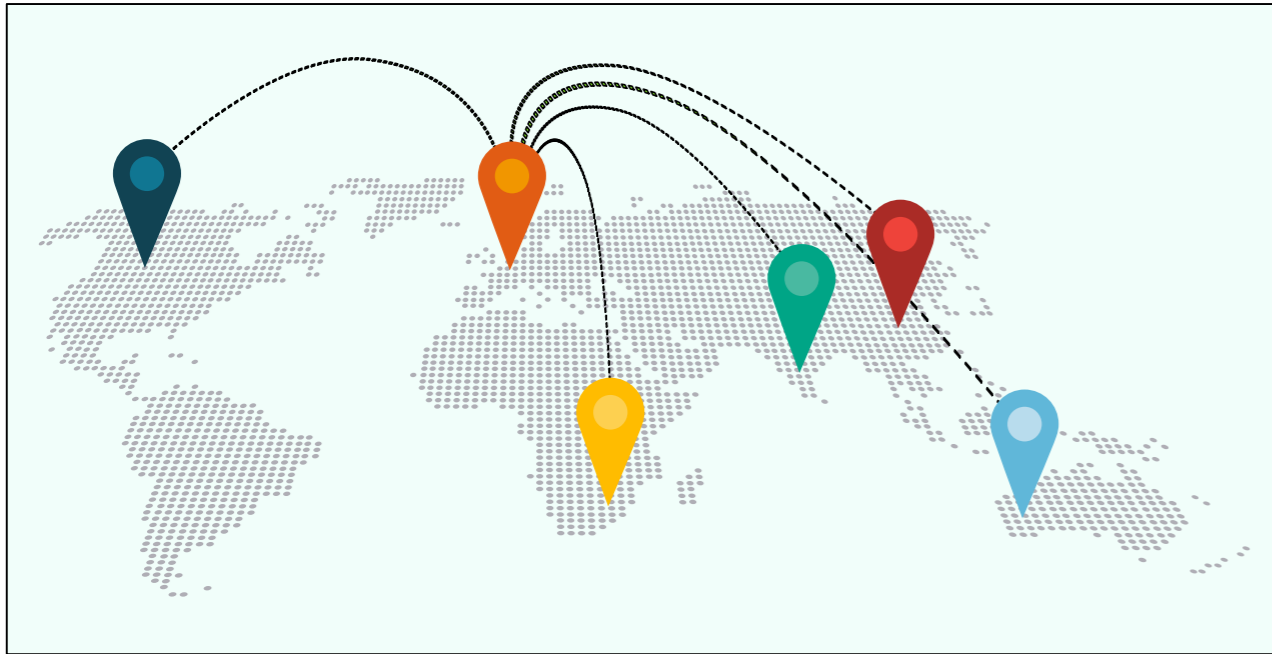
The SKA data challenge: a schematic view



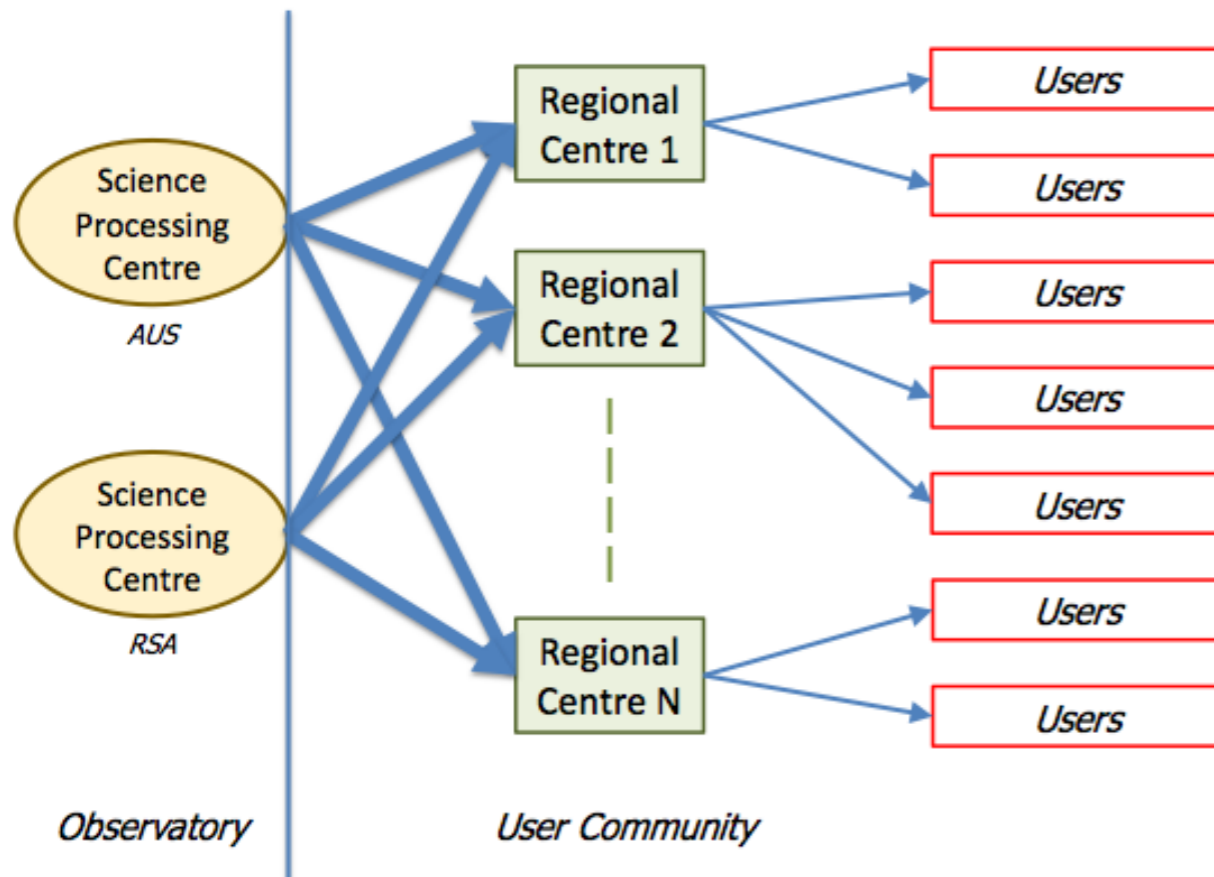
The SKA data challenge: a schematic view



SKA Regional Data Centers



The European Regional Data Center



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



European Commission

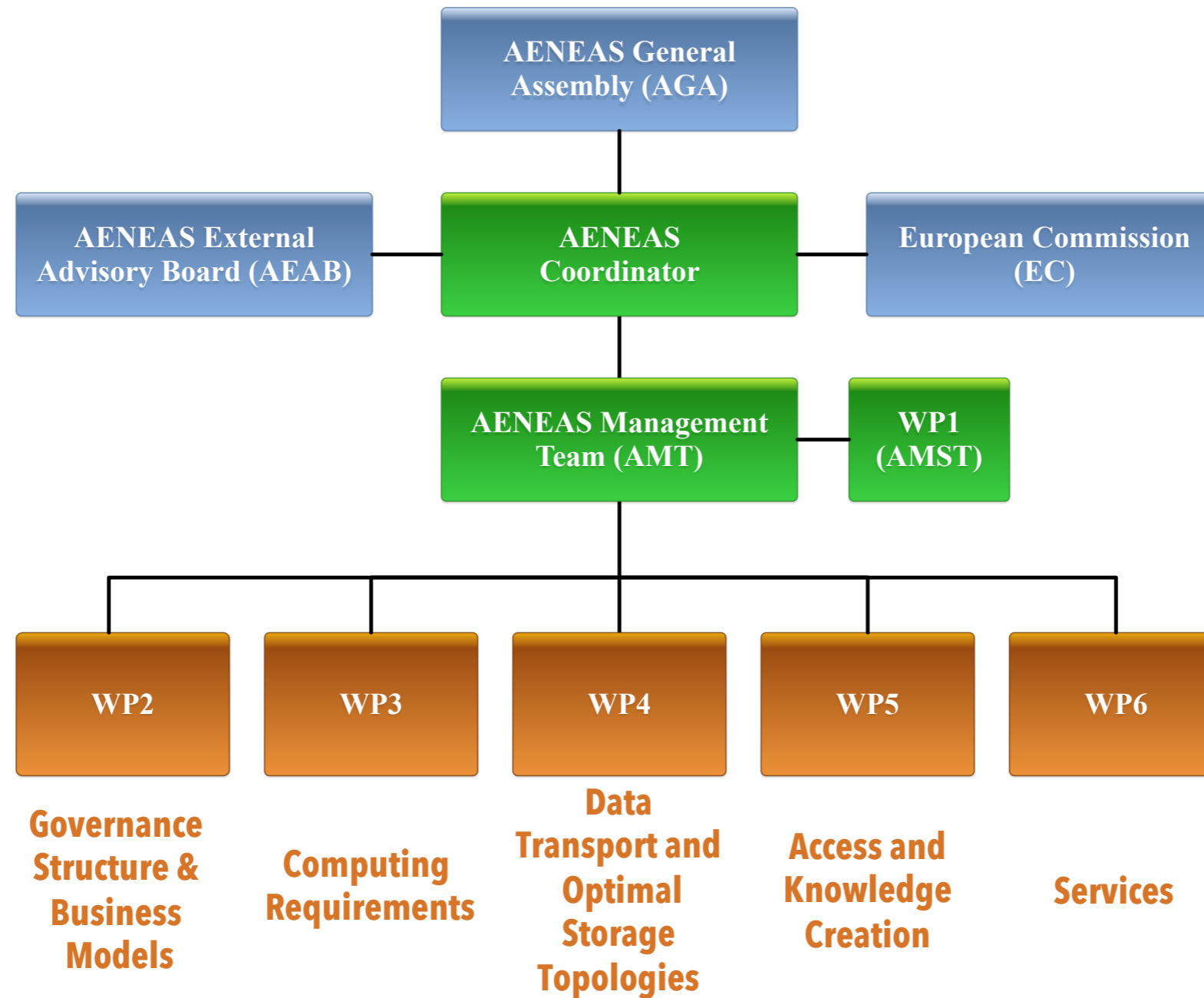
Horizon 2020
European Union funding
for Research & Innovation

ASTRON



- **J.-P. Vilotte (CNRS):**
member of the External Advisory Board
(with I. Bird @ CERN & M. Zwaan @ ESO)
- **C. Ferrari (OCA):**
chair of the General Assembly

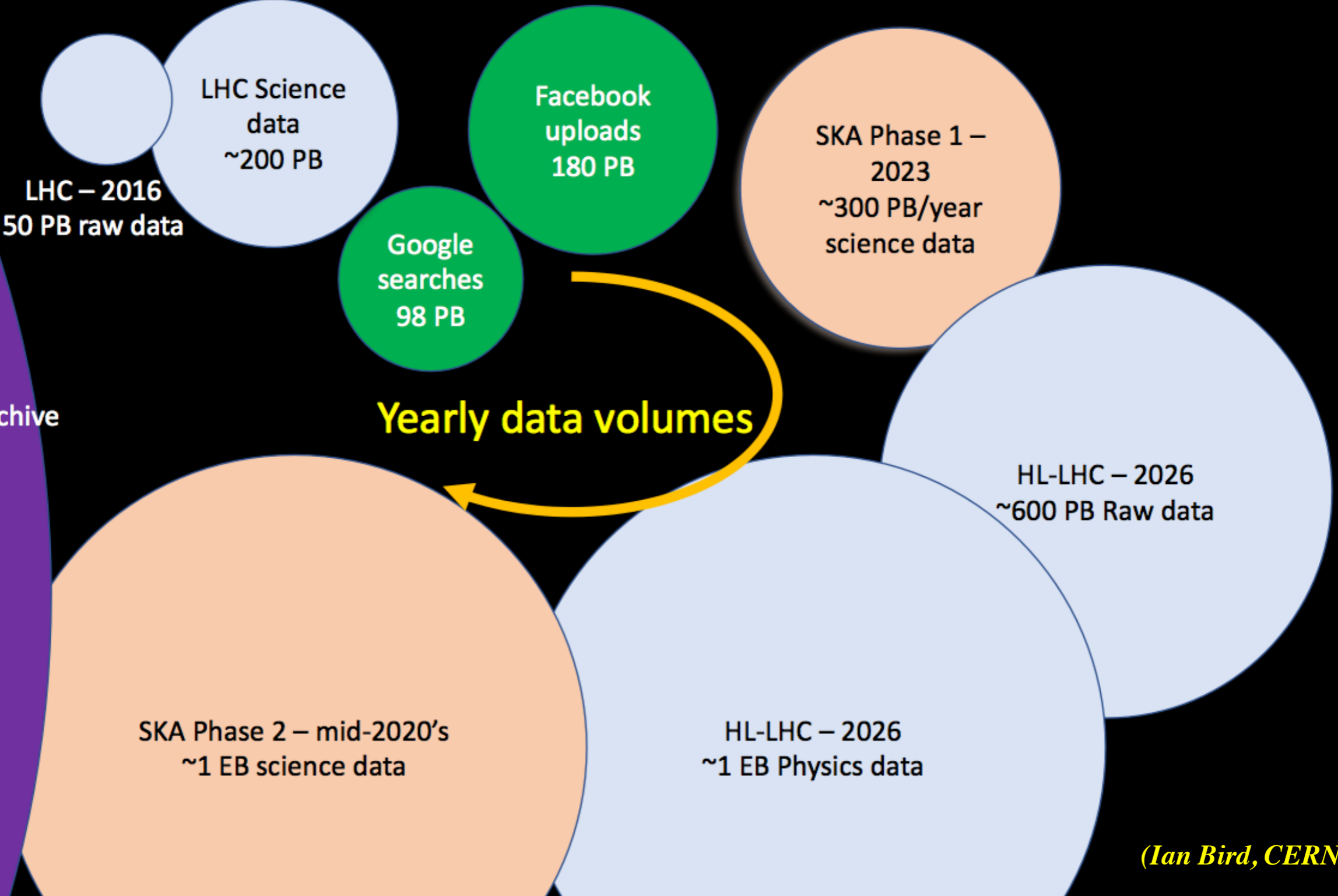
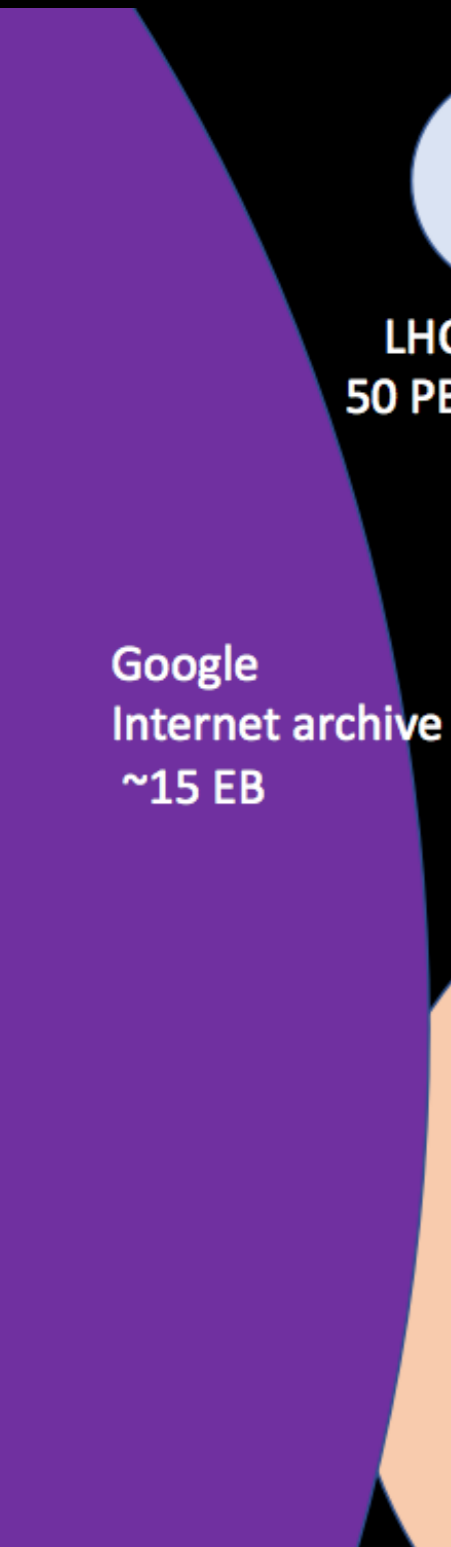
AENEAS Work Packages



Future SKA Science Archive



PER YEAR
1 Petabyte



(Ian Bird, CERN)

SKA-CERN Big Data cooperation agreement



July 14, 2017