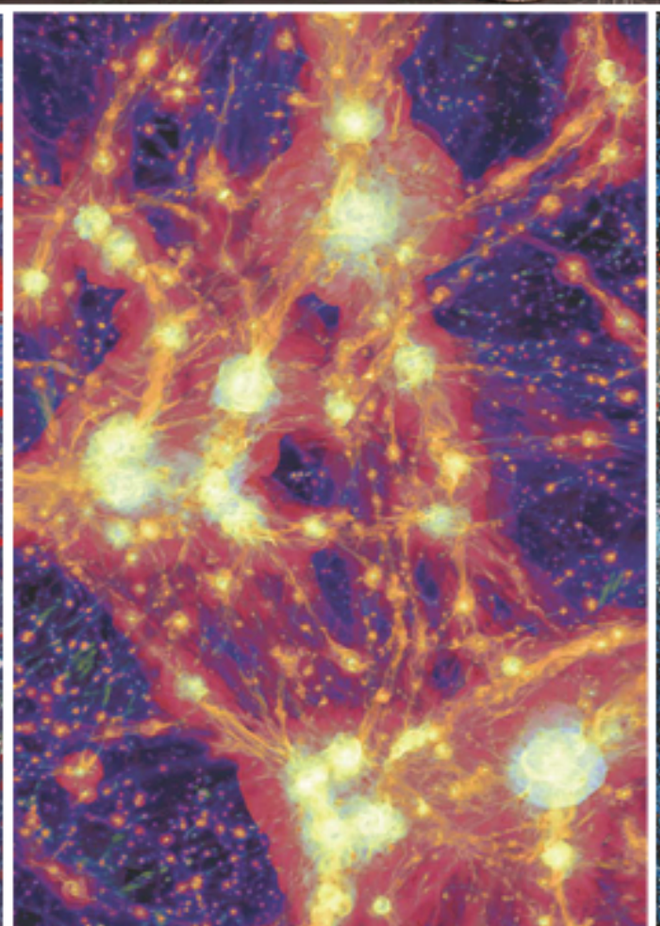
SKA France

The French community towards the Square Kilometre Array

Chiara Ferrari
Astronome (OCA)
SKA France Coordinator



Timeline of the SKA project

2010

ESFRI Project

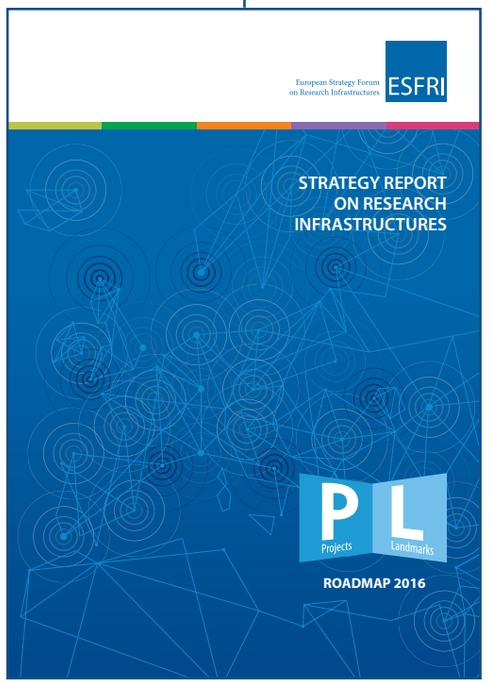
2012

Creation of the Project Office

2015

Beginning of negotiations for IGO

2016



ESFRI Landmark

2018

CDR closed

2019

IGO entry into force

Construction approval

Timeline of the SKA project

2009 — 2010 — 2011 — 2012 — 2015 — 2016 — 2017 — 2018 — 2019 →

Revision of French roadmap

AS SKA-LOFAR

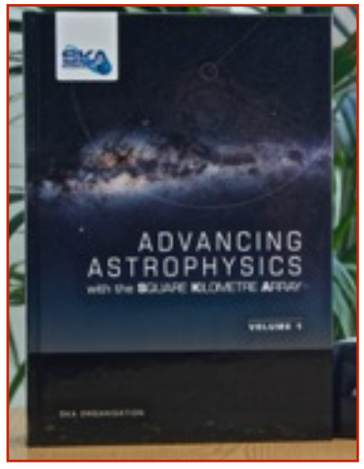
PrepSKA

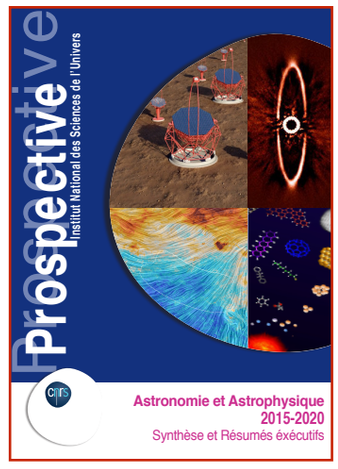
SKADS

BUT: French withdrawal from the SKA

SKA FRANCE
SQUARE KILOMETRE ARRAY

cnrs — l'Observatoire de Paris — Observatoire de la Côte d'Azur — université de BORDEAUX — UNIVERSITE D'ORLEANS





PO for France joining SKAO

NenuFAR

The SKA France coordination

Workshops

Web page

Big events

Seminars

Monthly bulletins

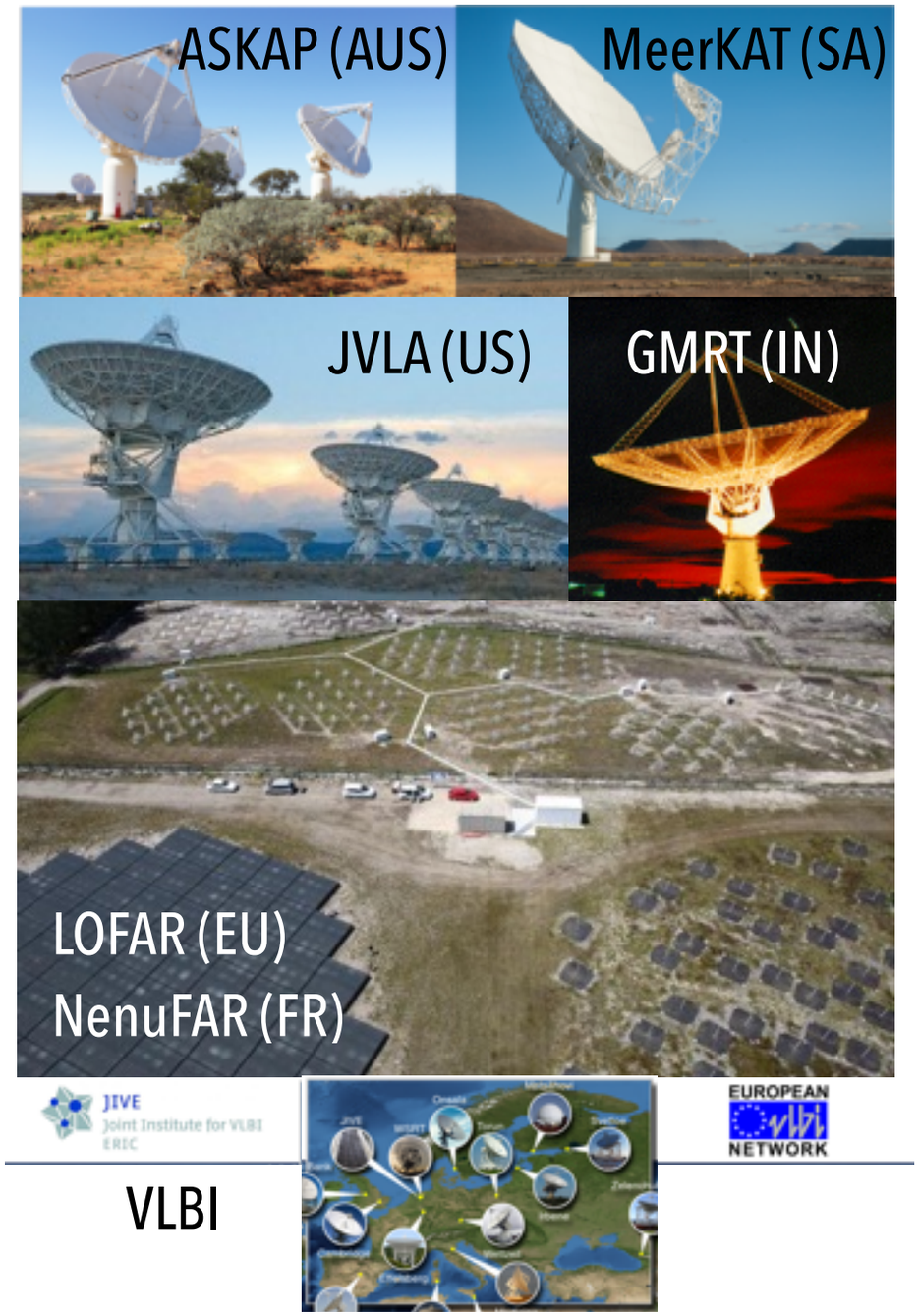
The French SKA White Book

176 authors from

* 40 French research institutes

* 6 private companies

A wider and wider community and strong interdisciplinary incentives

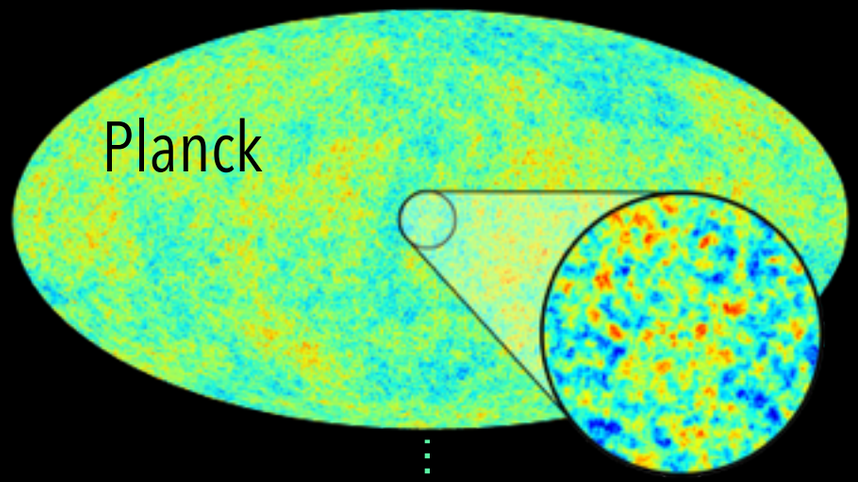


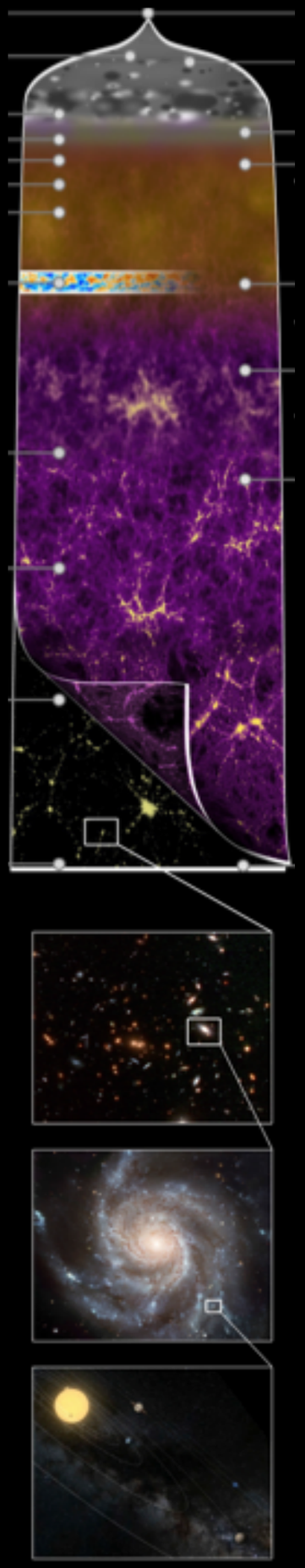
- All SKA Science Working Groups have French participants (55 researchers today - F. Combes co-chair of one SWG)
- Sixteen French researchers (co-)authors of more than 30 out of the 135 chapters of the SKA Science Book (published in 2015)

A wider and wider community and strong interdisciplinary incentives

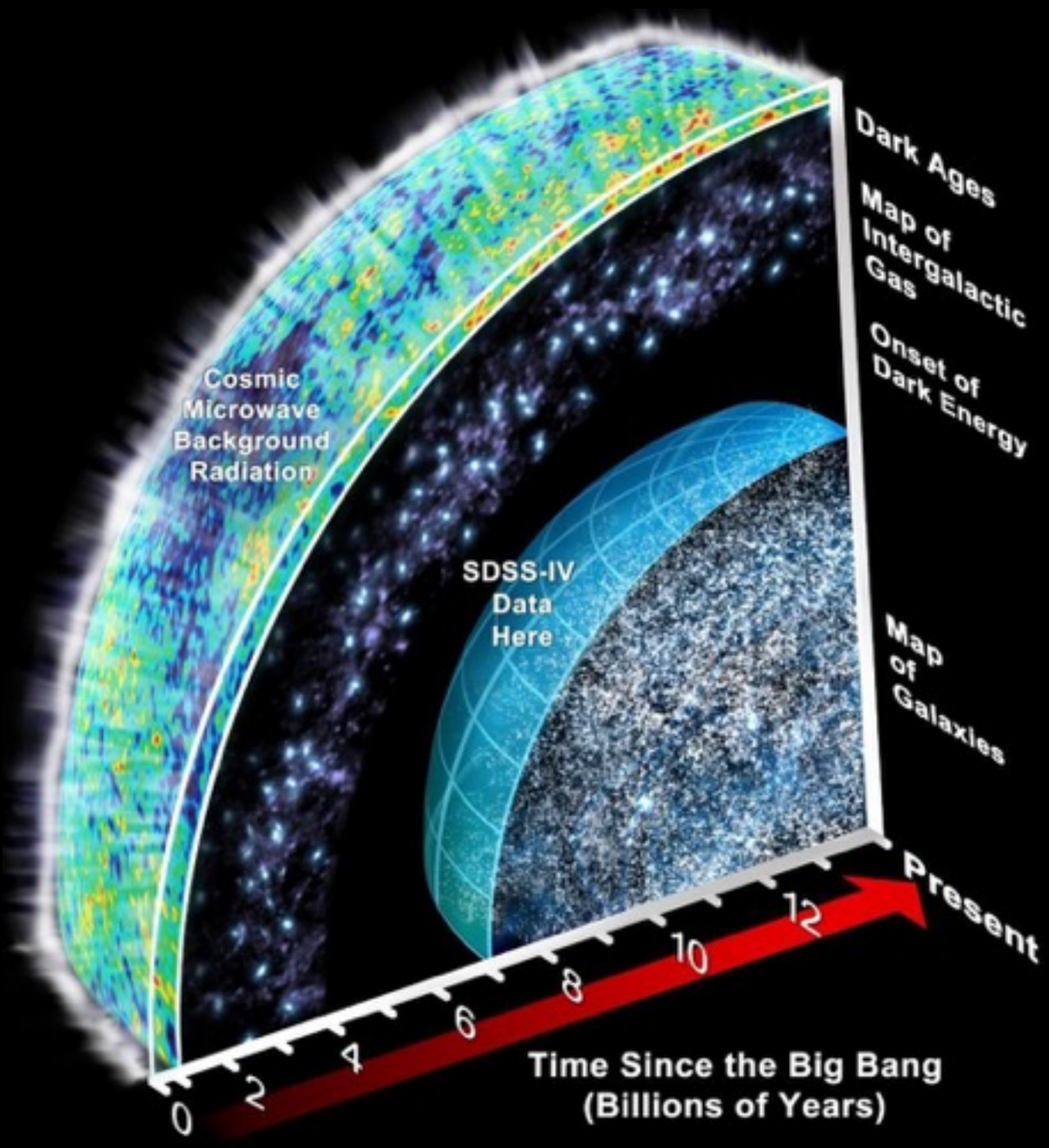
- The richest synergy chapter ever published about SKA vs. other projects, including:
  - instruments covering the whole electromagnetic spectrum
  - gravitational wave detectors
- Strong French implication in interoperability frameworks & design studies
- A wide variety of technical challenges
- A scientific project with a big expected impact on society

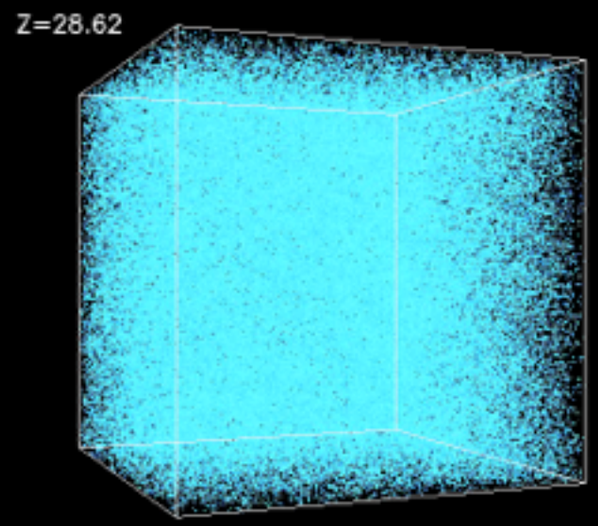
Changing our understanding of the Universe with the SKA

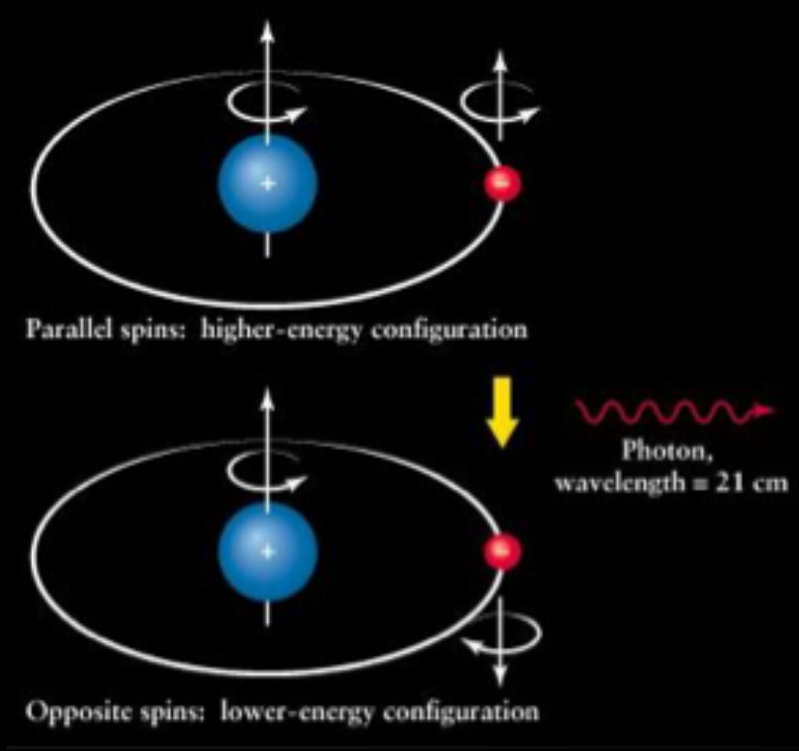


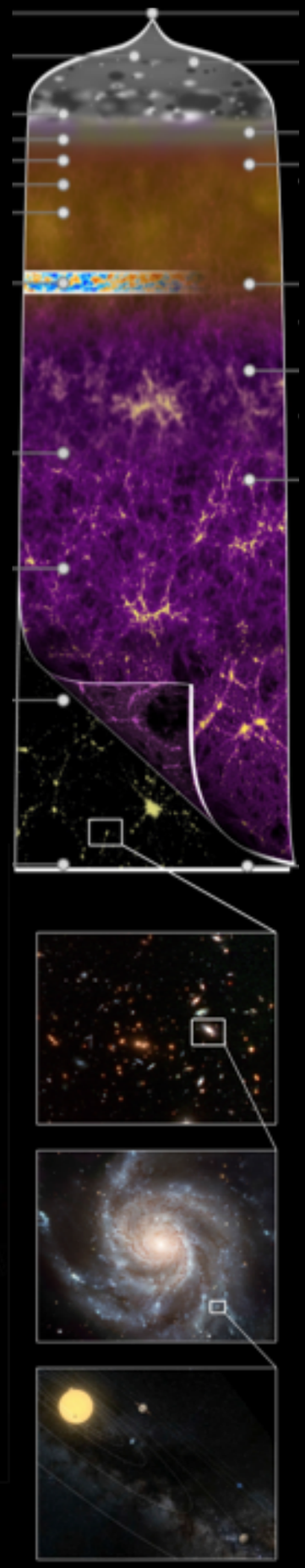


Changing our understanding of the Universe with the SKA

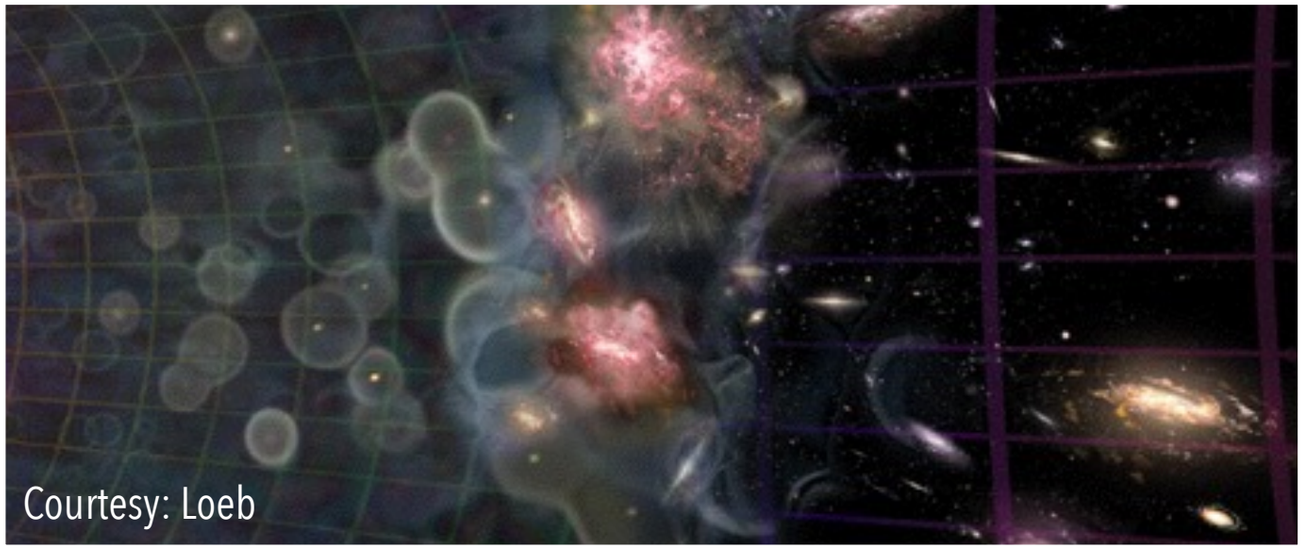


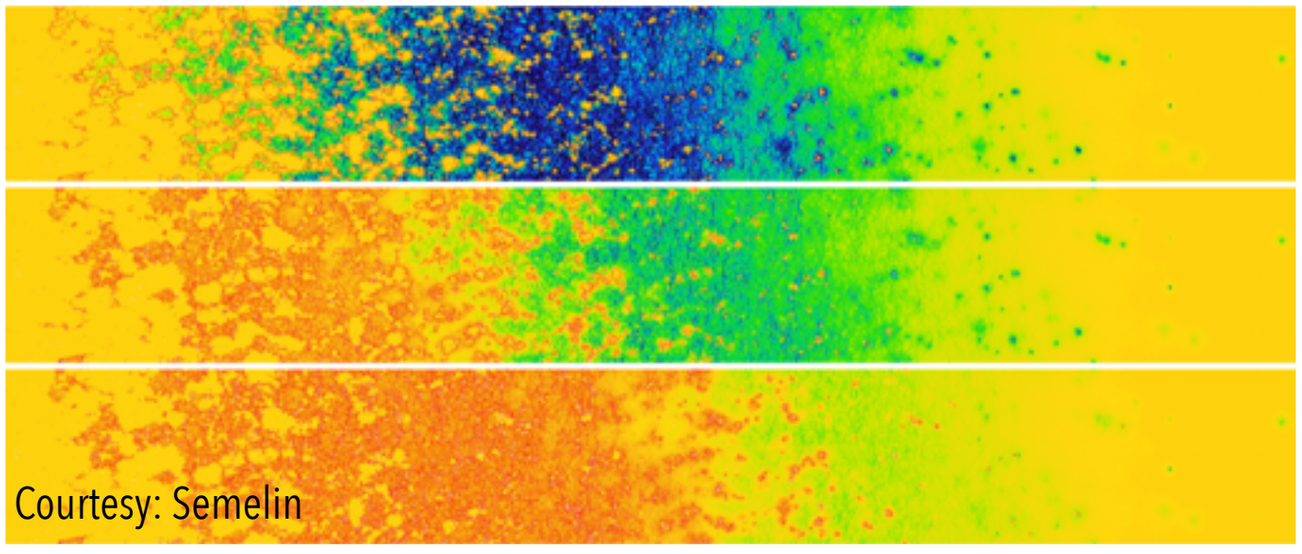






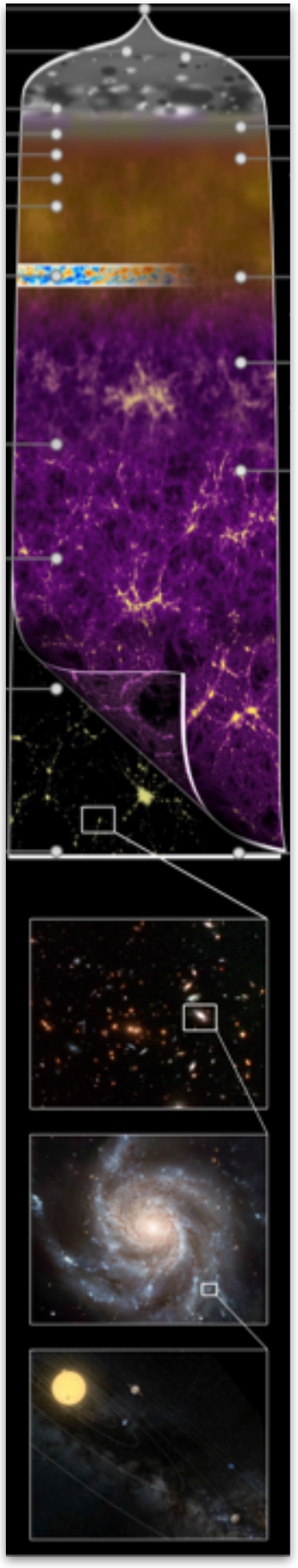
Changing our understanding of the Universe with the SKA





Cosmic dawn &
Epoch of Reionisation

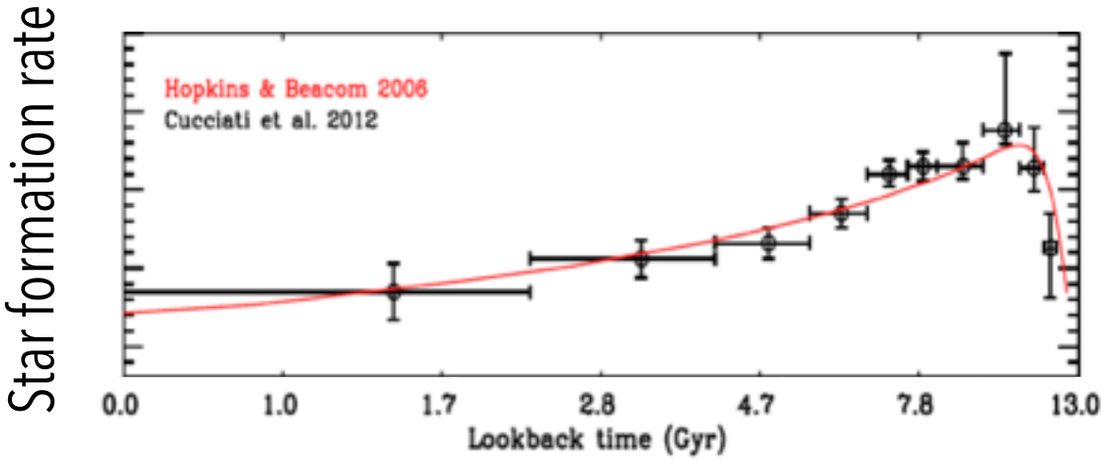
G. Lagache's talk

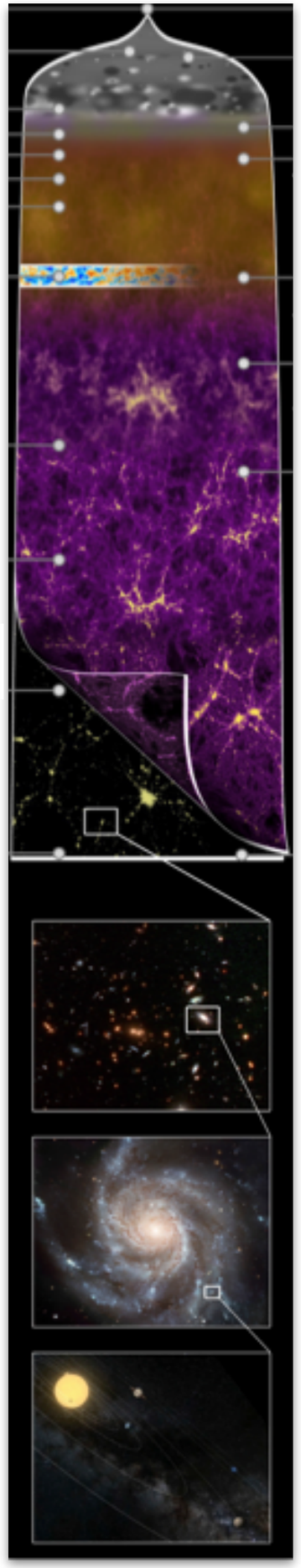


SKA FRANCE
SQUARE KILOMETRE ARRAY

Changing our understanding of the Universe with the SKA

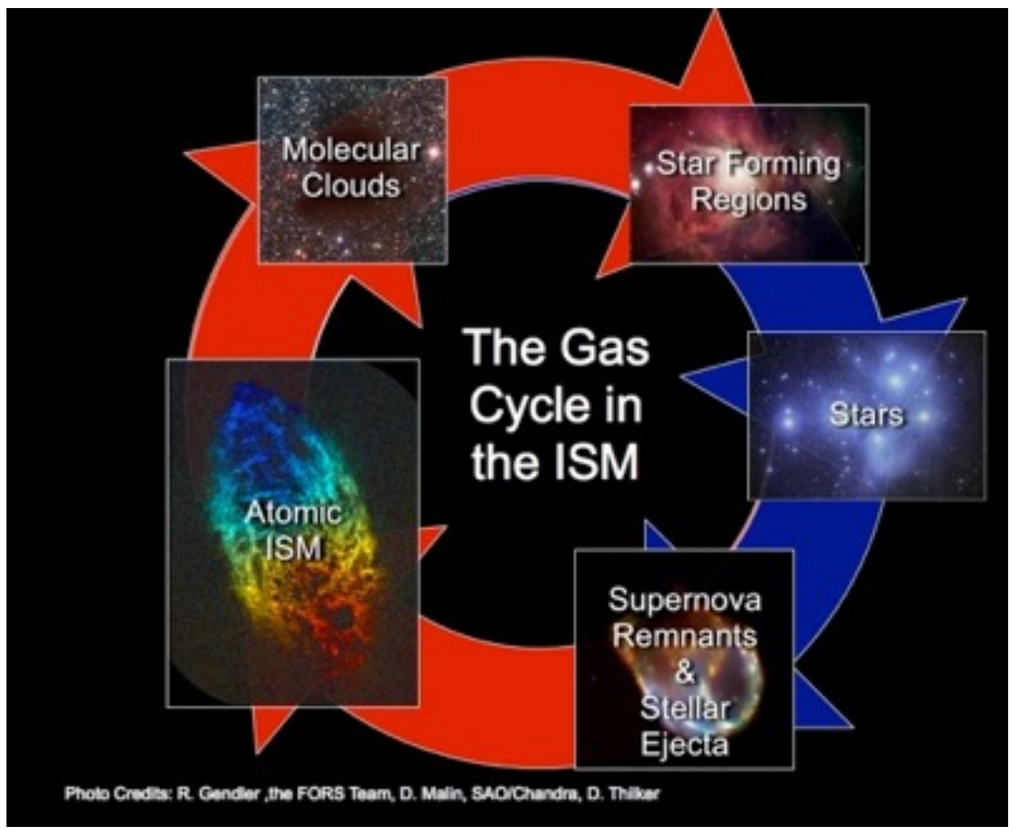
E. Daddi's talk



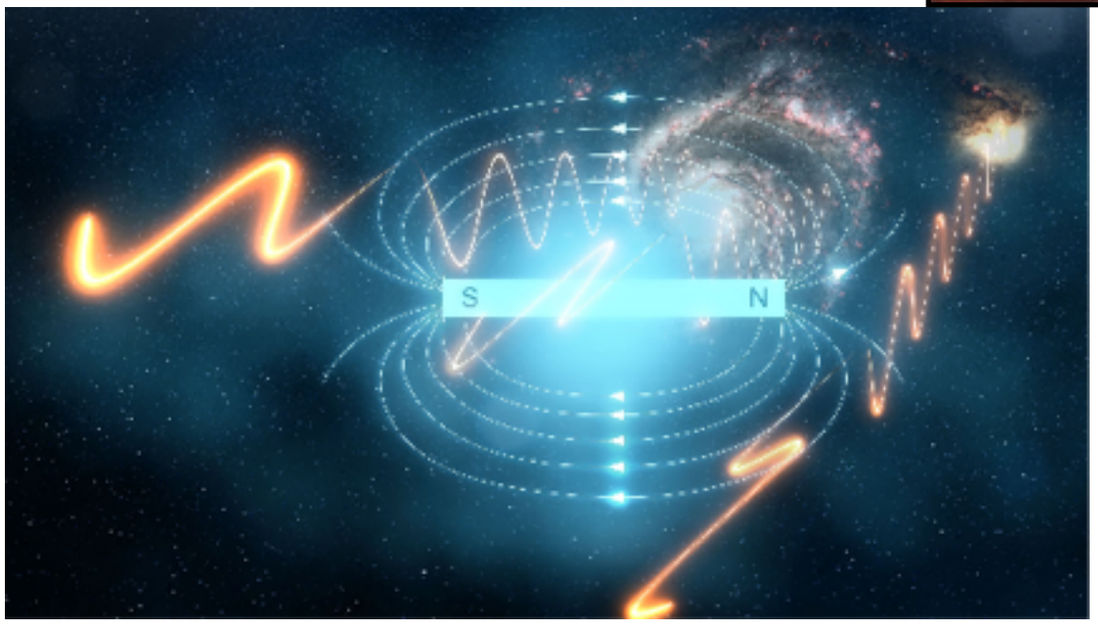


Duc & Renaud

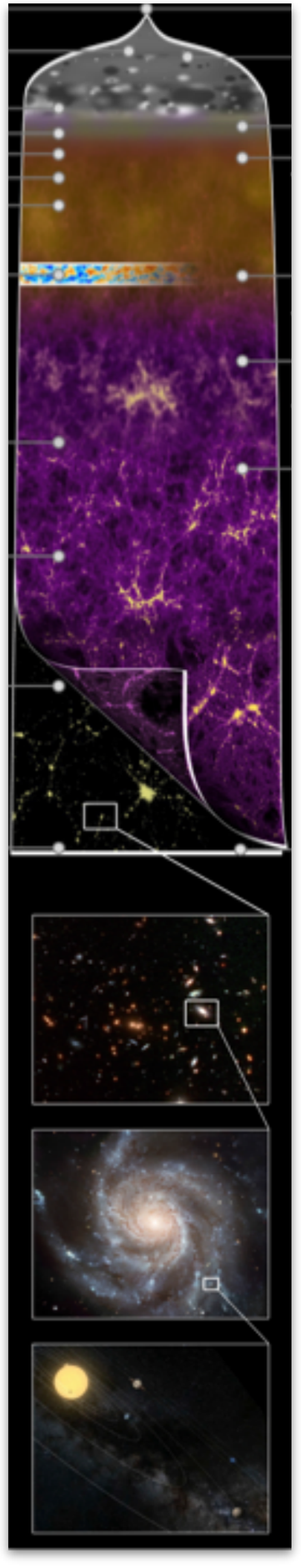
Galaxy evolution



Changing our understanding of the Universe with the SKA

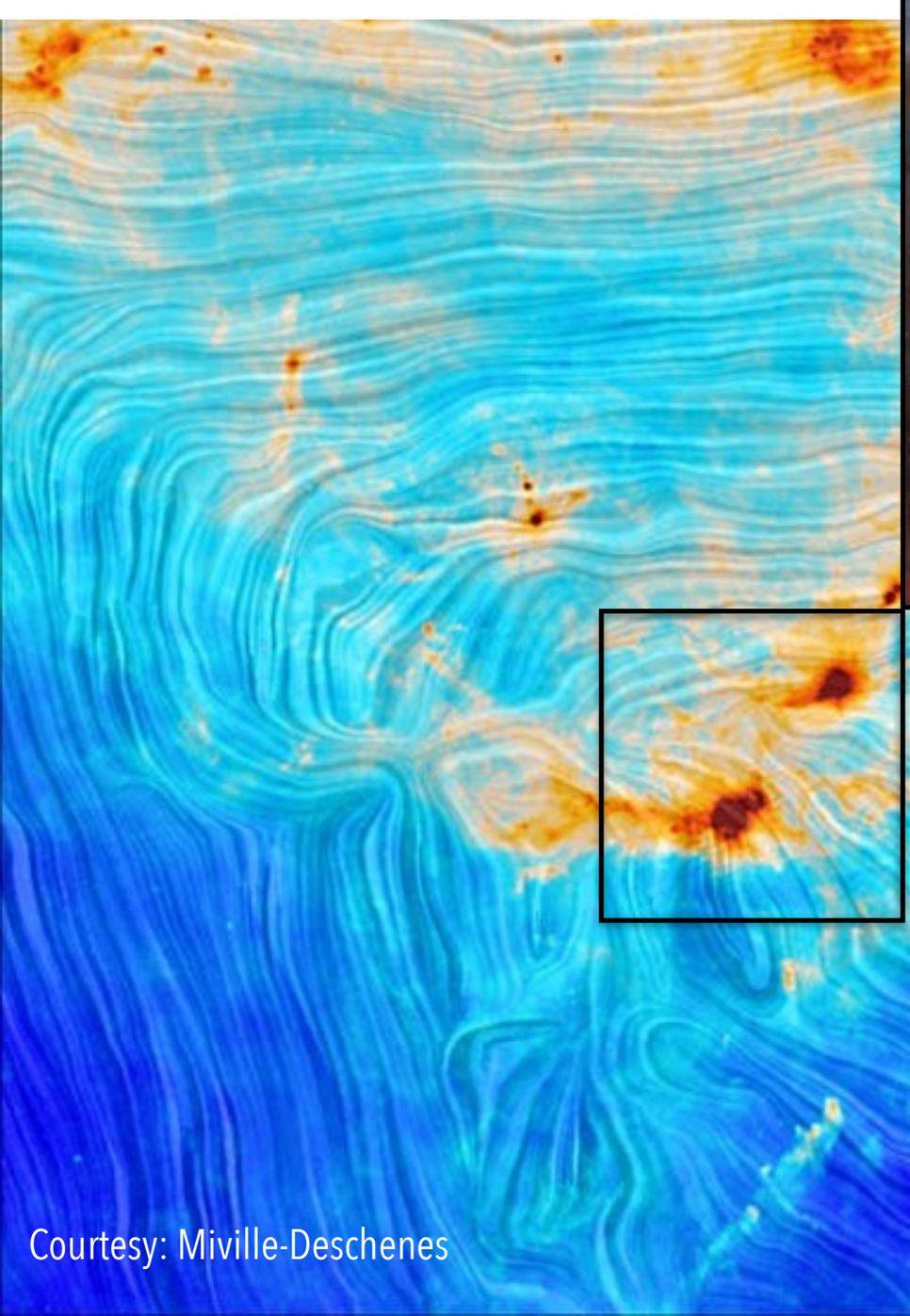


Cosmic magnetism



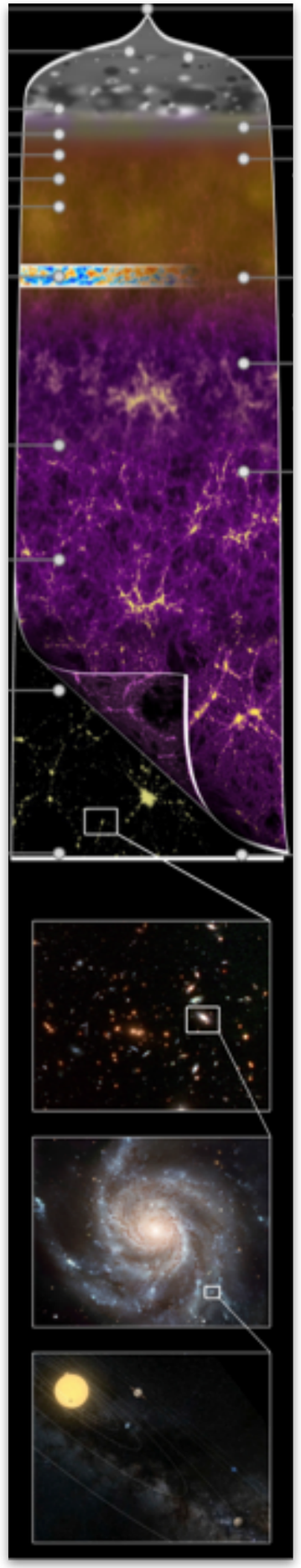
SKA FRANCE
SQUARE KILOMETRE ARRAY

Changing our understanding of the Universe with the SKA

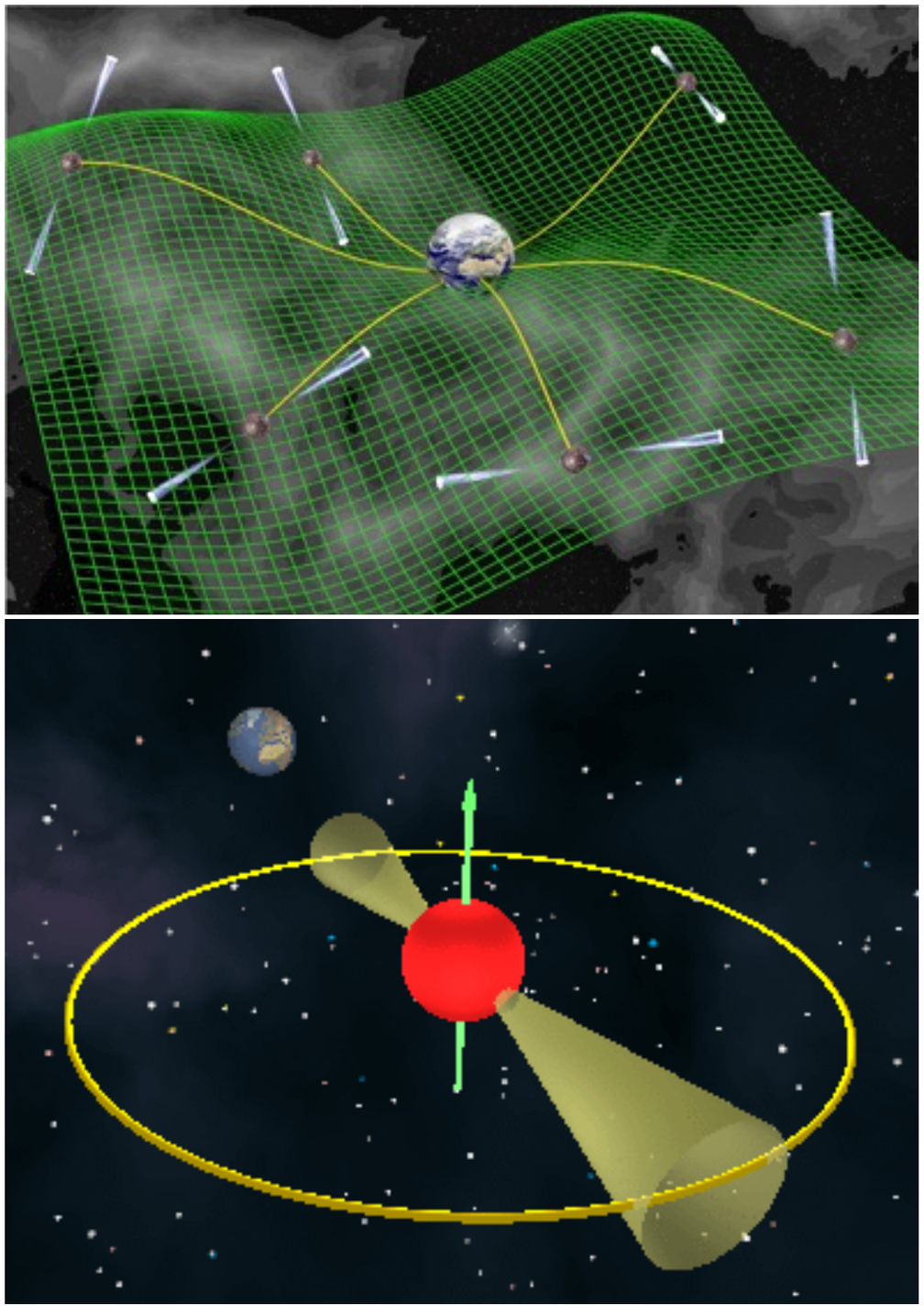


Cosmic magnetism

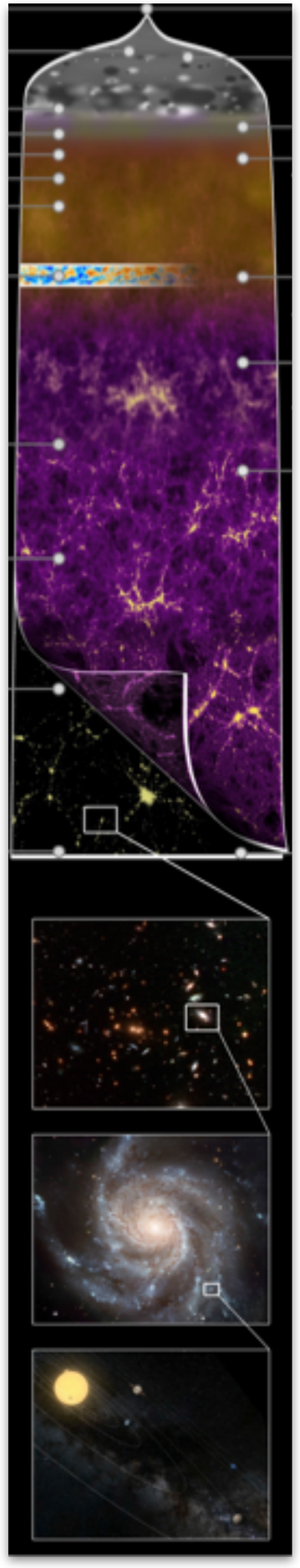
M.-A. Miville-Deschenes' talk



Changing our understanding of the Universe with the SKA

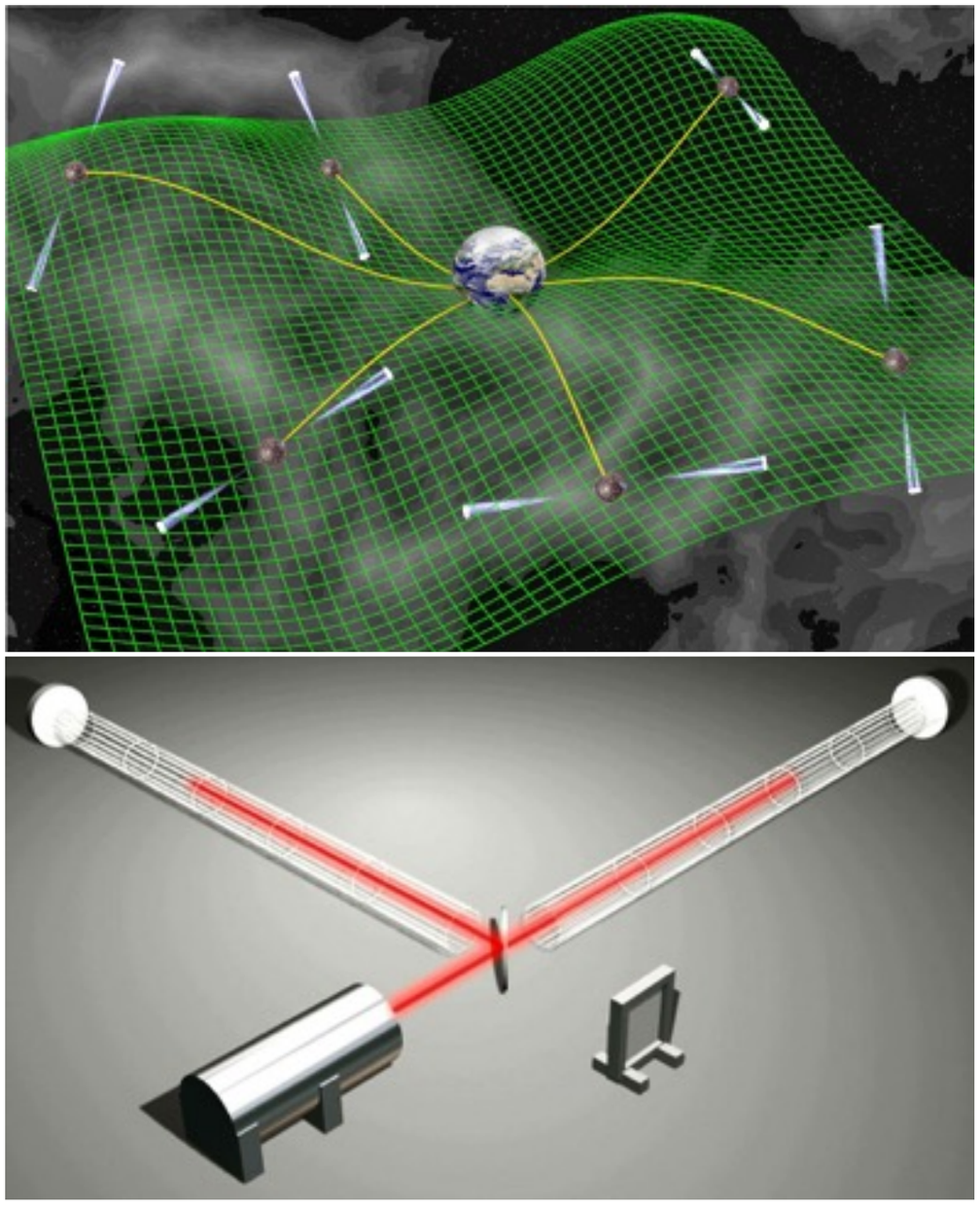


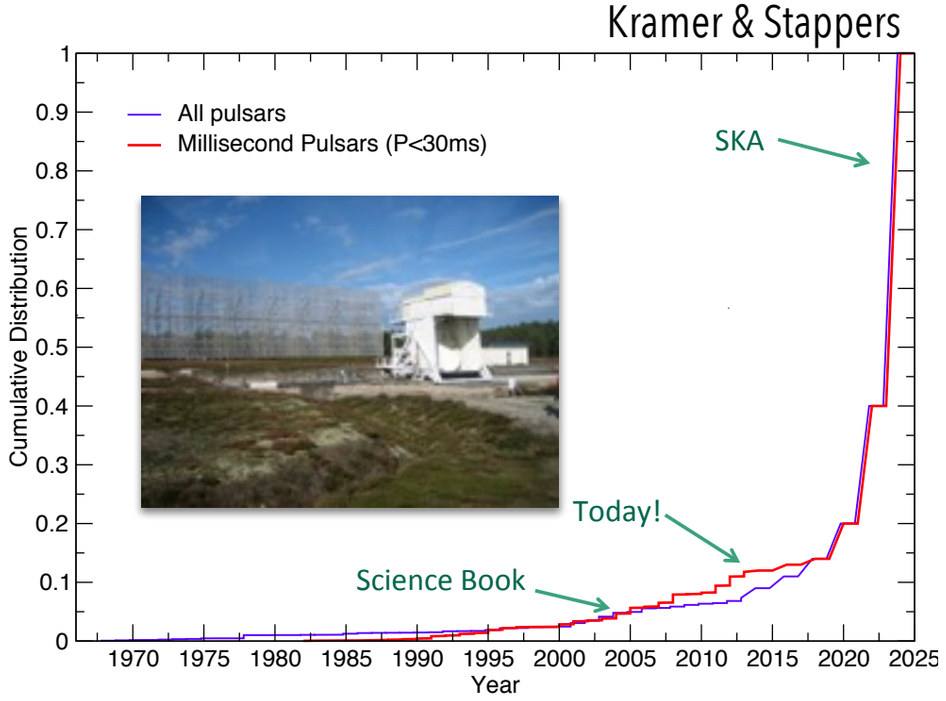
Fundamental physics



SKA FRANCE
SQUARE KILOMETRE ARRAY

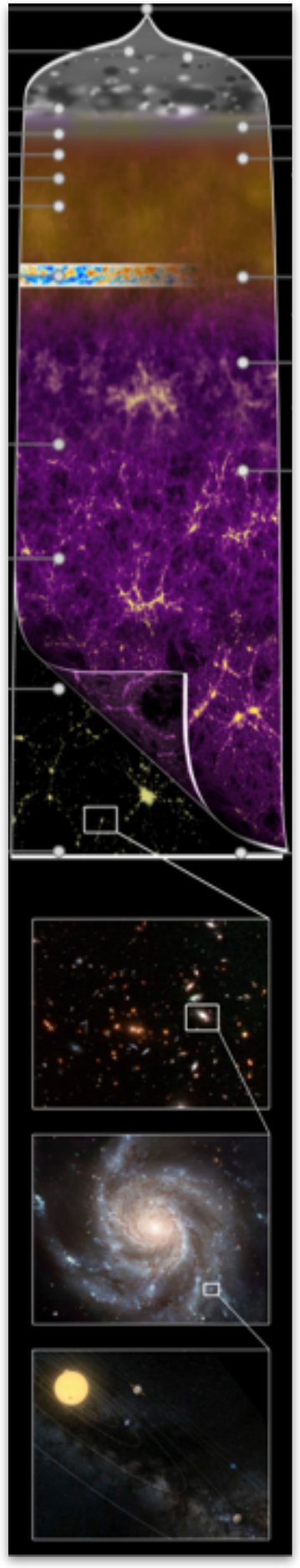
Changing our understanding of the Universe with the SKA





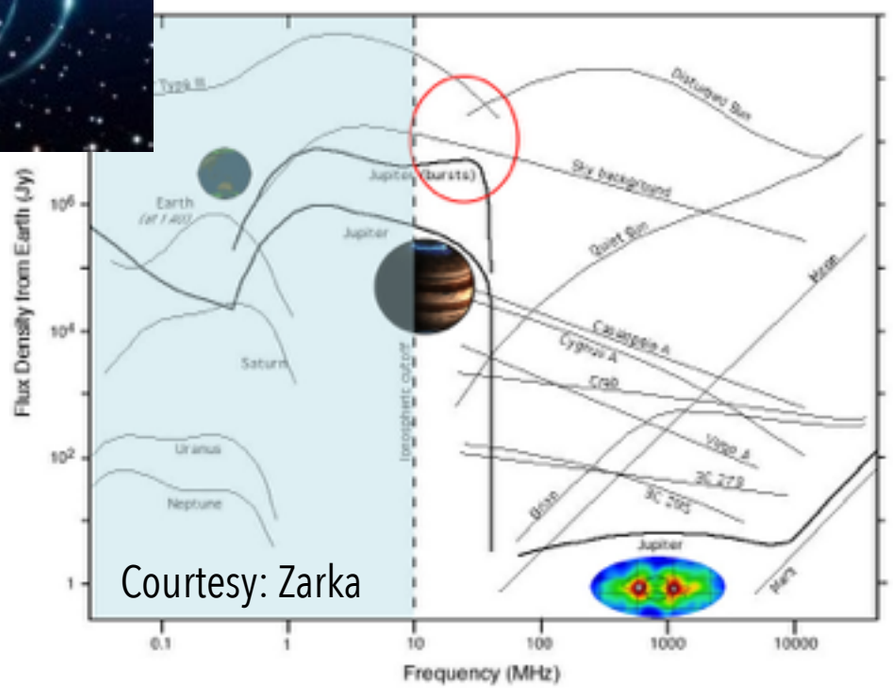
Fundamental physics

G. Theureau talk



SKA FRANCE
SQUARE KILOMETRE ARRAY

Changing our understanding of the Universe with the SKA



Cosmic dawn & Epoch of Reionisation

Cosmology

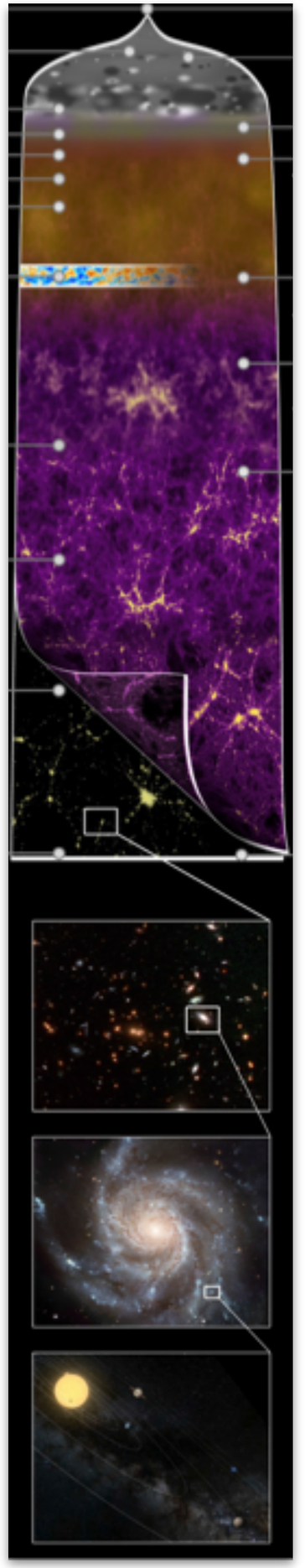
Galaxy evolution

Cosmic magnetism

Fundamental physics

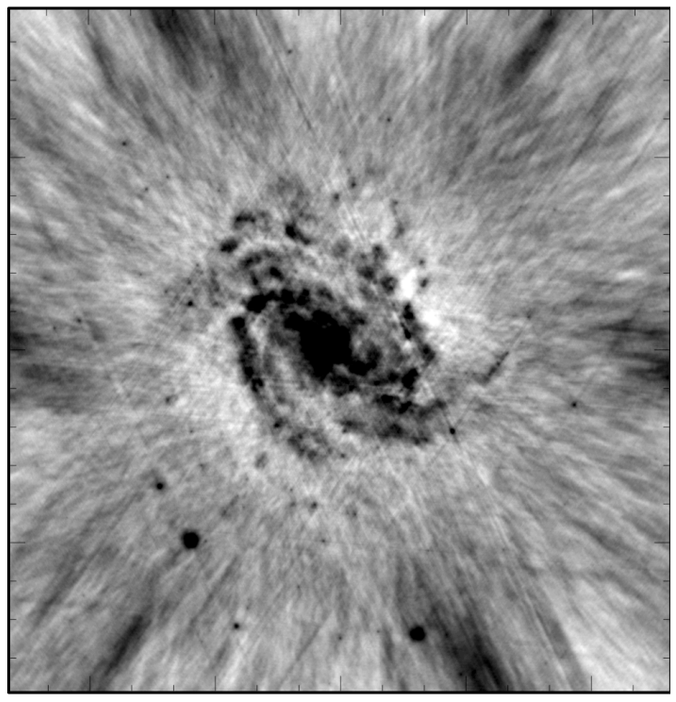
Transient sky

Cradle of life

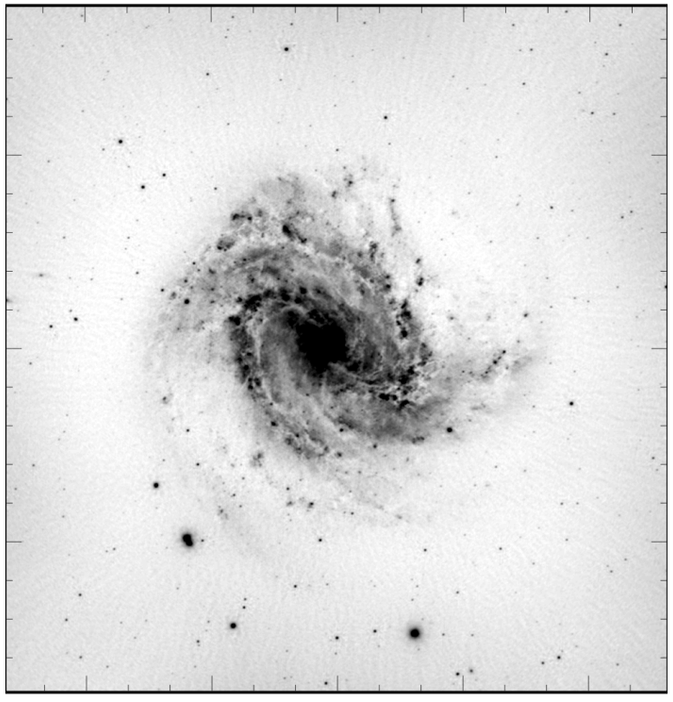


Why with the SKA?

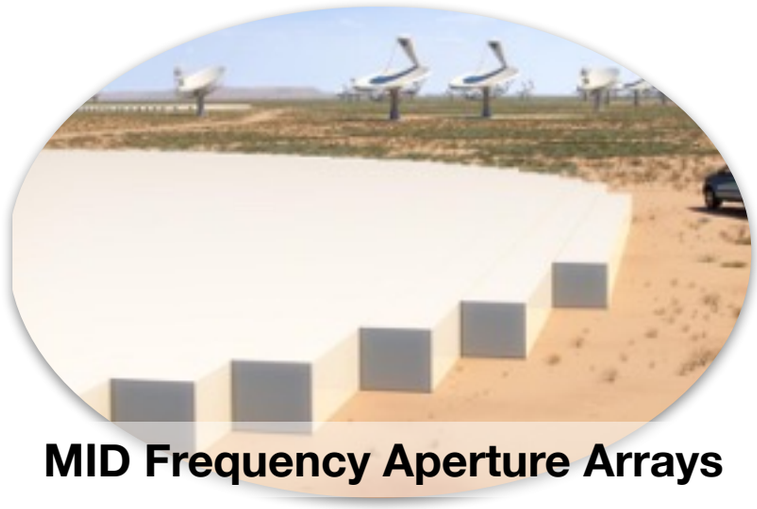
Today with **JVLA**



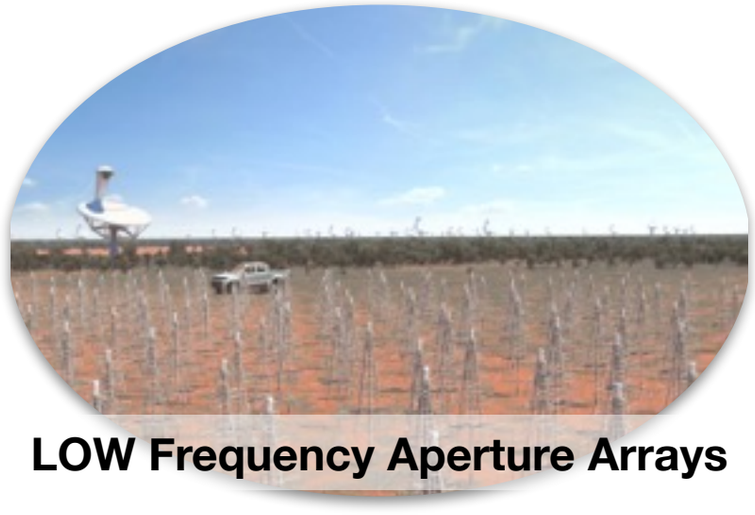
Tomorrow with **SKA1**



Dishes



MID Frequency Aperture Arrays



LOW Frequency Aperture Arrays

>15 GHz

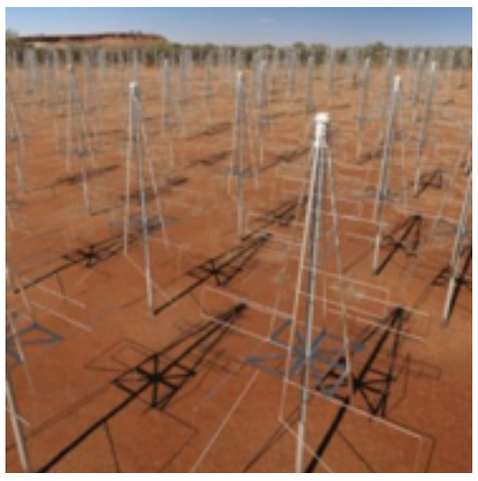
50 MHz

Building this fantastic machine: technological developments in France

Building this fantastic machine: technological developments in France

SKA1-MID

~2 Pb/s



SKA1-LOW

S. Gauffre's talk

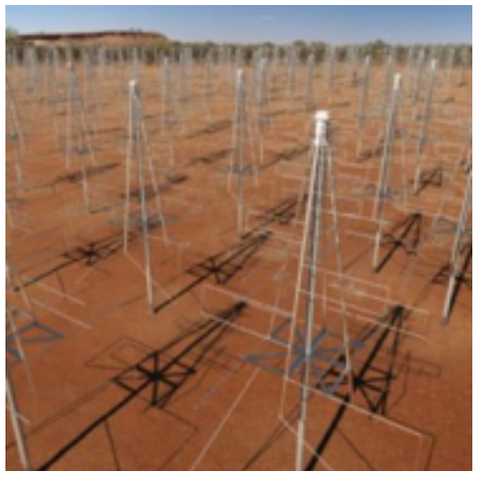
P. Zarka's talk

Building this fantastic machine: technological developments in France

SKA1-MID

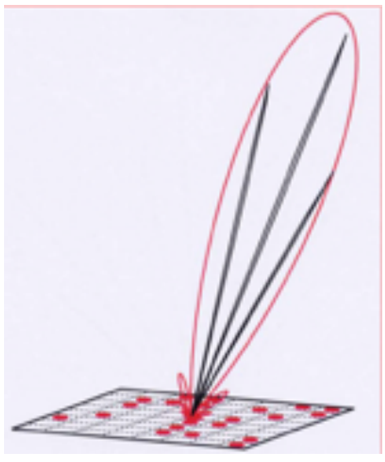
8.8 Tb/s

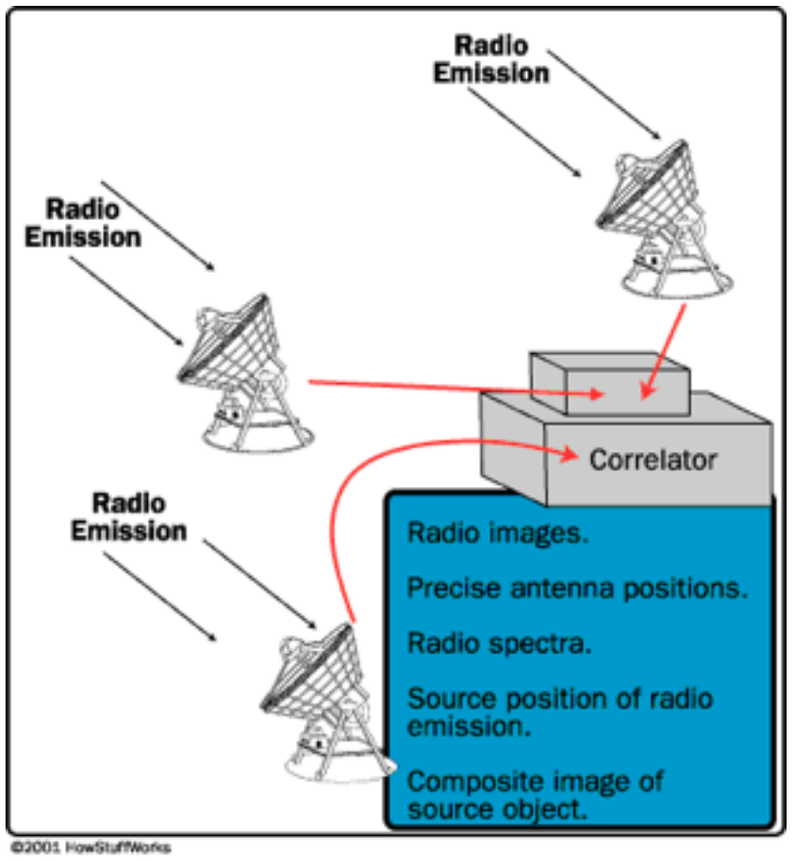
7.2 Tb/s



SKA1-LOW

~2 Pb/s





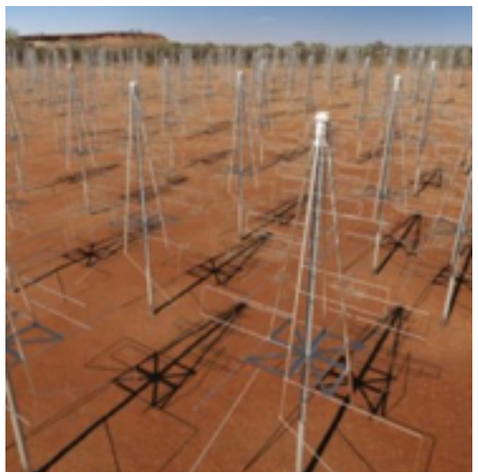
Building this fantastic machine: technological developments in France

SKA1-MID

8.8 Tb/s

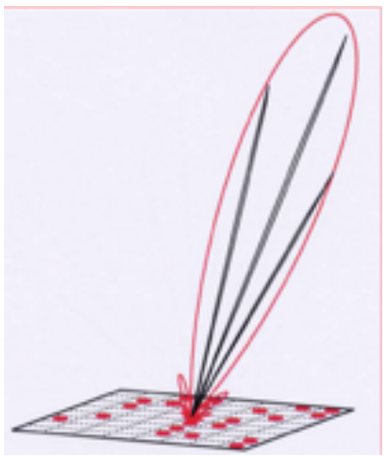
7.2 Tb/s

INSA RENNES



SKA1-LOW

~2 Pb/s



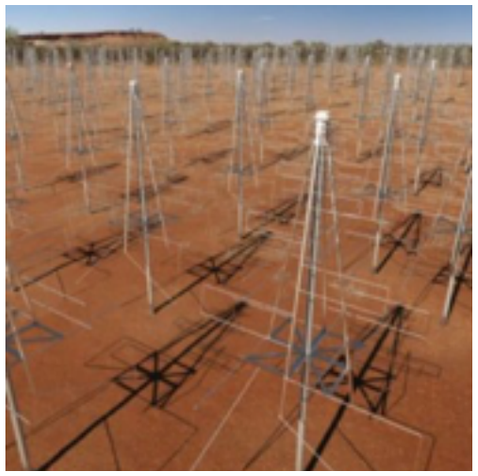
Building this fantastic machine: technological developments in France

SKA1-MID

8.8 Tb/s

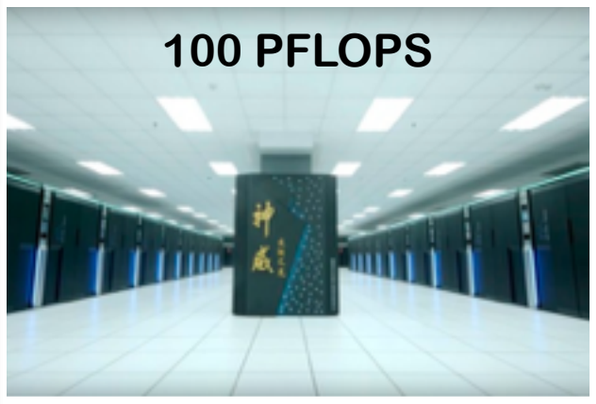
7.2 Tb/s

5 Tb/s



SKA1-LOW

~2 Pb/s



French researchers push forward radio image quality in view of the SKA telescope

Goa, India, Thursday 10 November - Novel image processing techniques have been discussed today at the 2016 SKA Science Conference in Goa, India, as French researchers have updated the international astronomy community on promising work being undertaken in France to develop new algorithms for radio astronomy, with potential applications beyond.

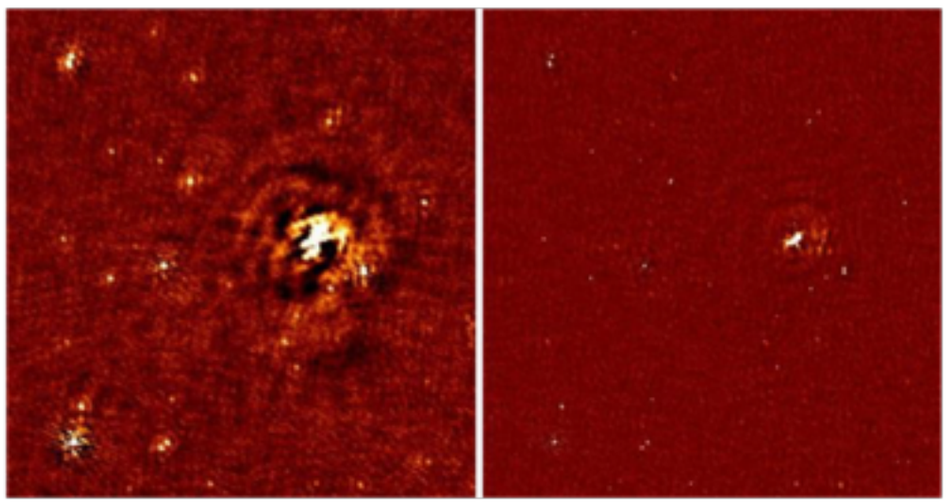
French teams from Observatoire de Paris, Observatoire de la Côte d'Azur, AIM Laboratory, ENS Cachan and Université Paris X are actively working on state-of-the-art algorithms for calibration and deconvolution – removal of artefacts in the images – of radio astronomy observations.

"Adaptive optics" for radio astronomy

A French team from Observatoire de Paris led by Dr Cyril Tasse is working on developing the equivalent of "adaptive optics" for radio astronomy. Adaptive optics systems – as used in world-class optical astronomy facilities such as ESO's VLT in Chile – measure how atmospheric turbulence affects known sources in the sky, to then deform active mirror surfaces and compensate for the turbulence, thus resulting in much sharper images. In effect, these systems almost correct the effects of the atmosphere.

"In optical astronomy, you apply this correction to the mirror. In radio-astronomy you apply the correction in the supercomputer doing the image processing", explains Dr Chiara Ferrari, Coordinator of SKA-France (*see note*).

While self-calibration tools already exist in radio astronomy, the French team has developed next-generation "direction-dependent" algorithms that cope with the changing nature of the ionosphere over the observed portion of the sky. These algorithms measure how the signal from known sources in the sky in the area of observation is affected by the turbulence from the ionosphere, and then apply a correction in post processing to cancel those effects. The team recently tested their algorithm on observations of the international LOFAR telescope (from the LOFAR Surveys project, led by Prof Röttgering), producing very promising results.



Results of classical (left) and next-generation calibration (right) on a small portion of the so-called « Bootes field » observed for 8 hours with the LOFAR telescope at 150MHz (data courtesy: LOFAR Surveys, Röttgering et al.)

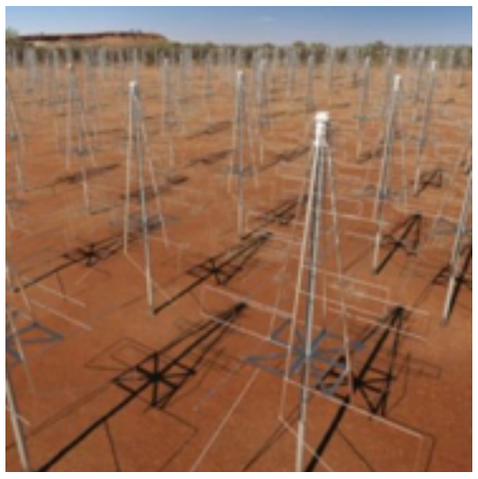
Building this fantastic machine: technological developments in France

SKA1-MID

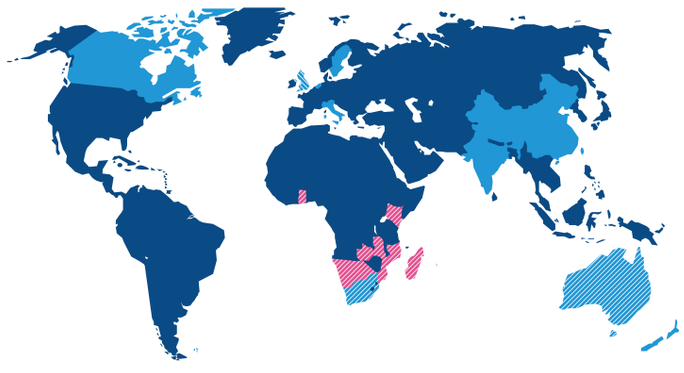
8.8 Tb/s

7.2 Tb/s

~2 Pb/s



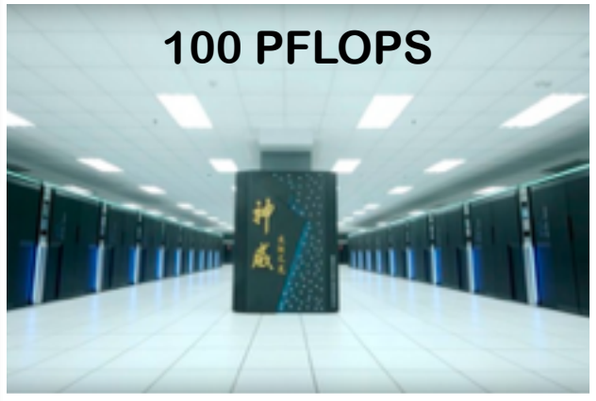
SKA1-LOW



50 PFLOPS

5 Tb/s

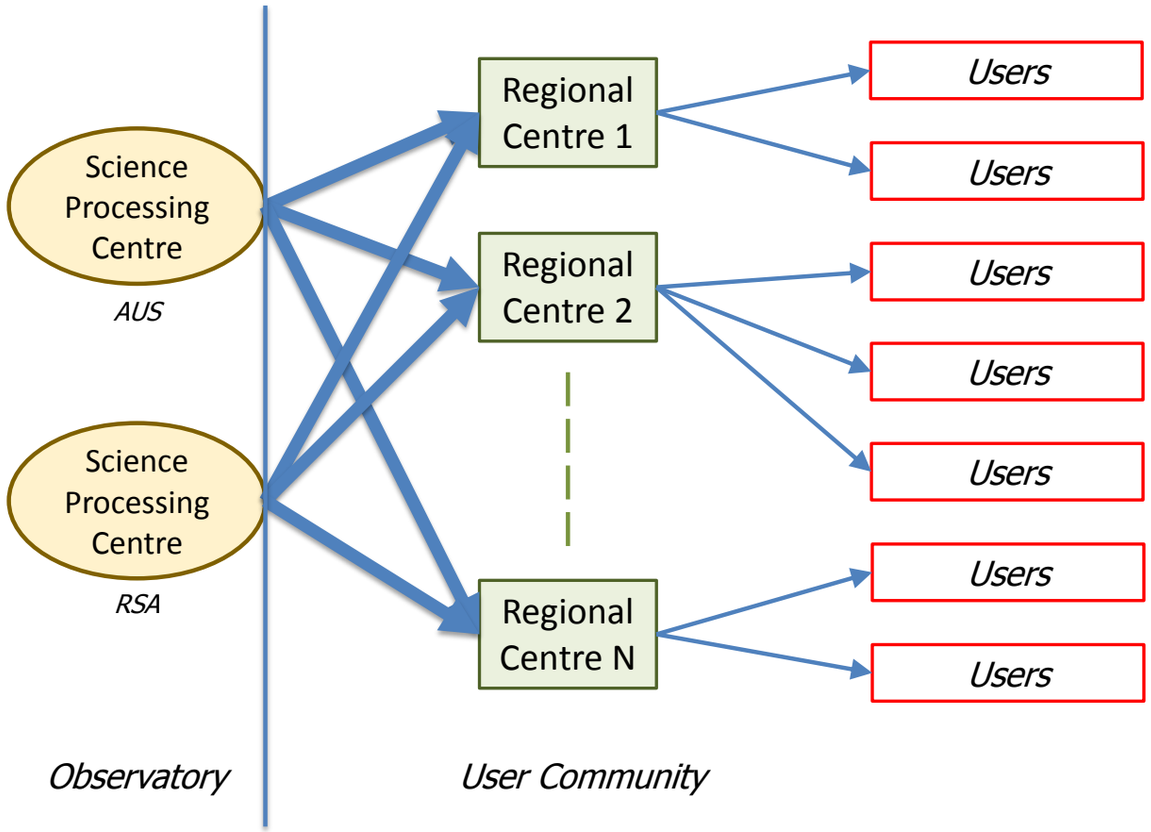
100 PFLOPS



~300 PB/yr

Users

France within the organisation of the SKA European Regional Data Centre



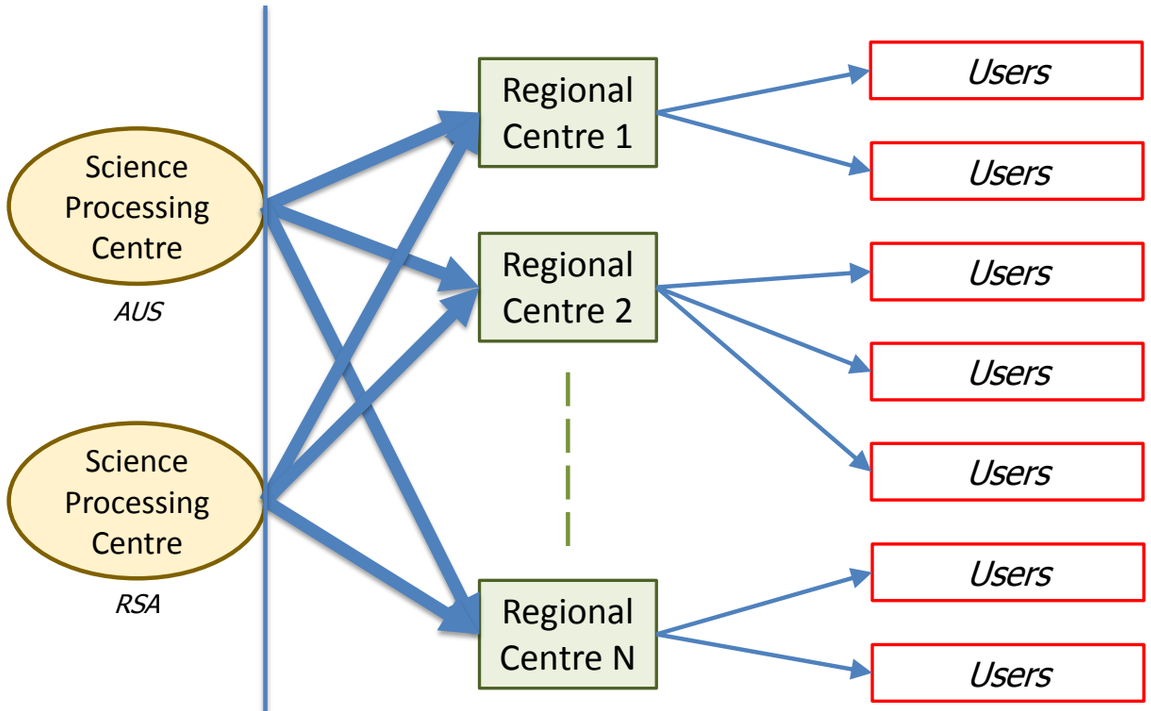
- **J.-P. Vilotte (CNRS):**
  member of the External Advisory Board
  (with I. Bird @ CERN & M. Zwaan @ ESO)
- **C. Ferrari (OCA):**
  chair of the General Assembly

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

European Commission

Horizon 2020
European Union funding
for Research & Innovation

France within the organisation of the SKA European Regional Data Centre

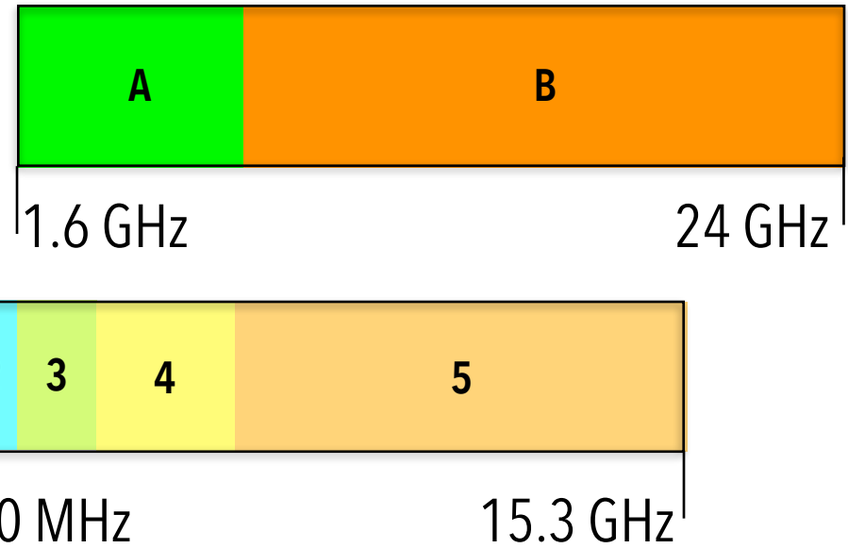


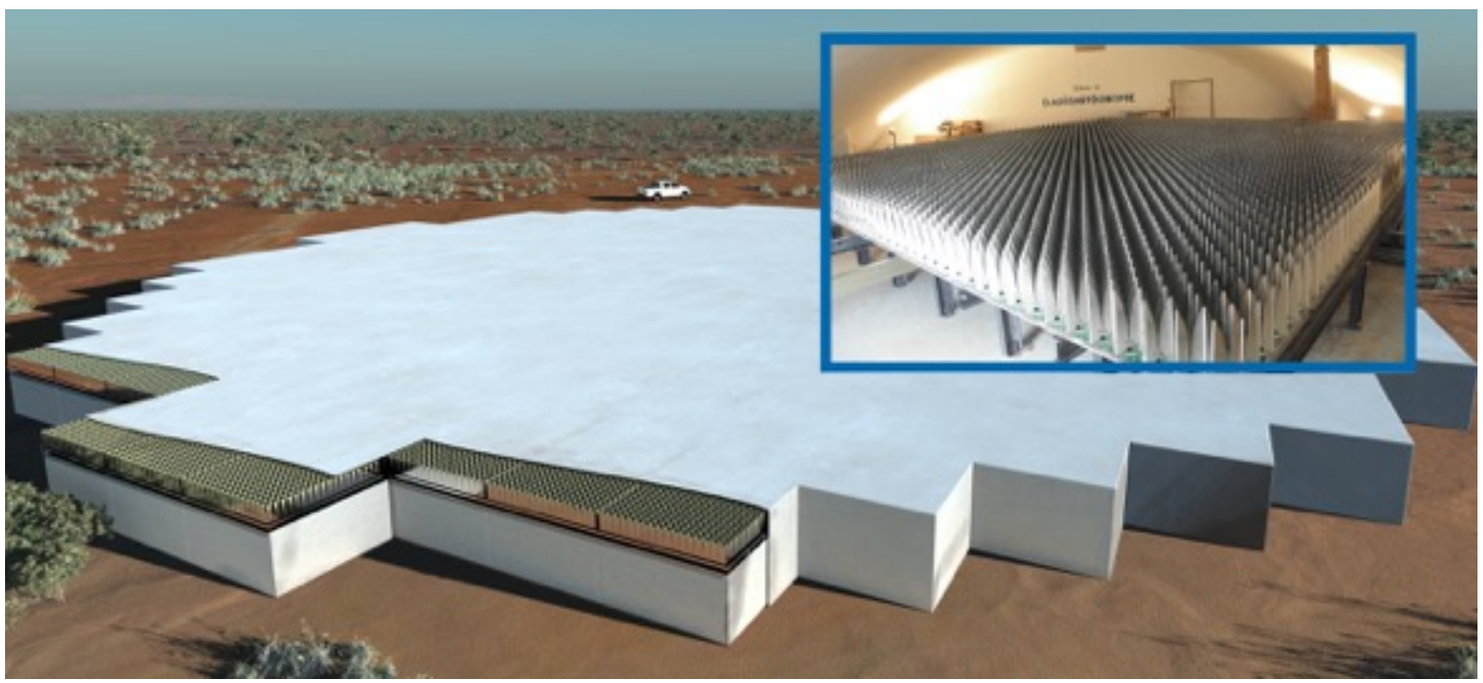
Aeneas
Advanced European Network of E-infrastructures for Astronomy with the SKA

European Commission
Horizon 2020
European Union funding for Research & Innovation

Advanced Instrumentation Programme

université de BORDEAUX





l'Observatoire de Paris

université de BORDEAUX

A wide variety of technical challenges

- Management of large data flows and complex problems of interferometric signal processing
  - *Interdisciplinarity through applications:* identify SKA signal processing and analysis issues that are in common with other application domains (geophysics, meteorology, particles physics, medical imaging, …)
  - *Interdisciplinarity within the SKA project:* identify how to respond to the challenges of the entire data processing and analysis chain by integrating the technological and methodological components
- Distribution of uninterrupted electrical energy under strong constraints in a desert environment
- Minimising the costs, whilst maximising the reliability and ease of maintenance of all hardware components
- Accurate real-time control of a many elements large-scale infrastructure

Industrial perspectives and solutions

THALES

AIRBUS SAFRAN LAUNCHERS

IBM

FABRICANT DE CARTES ET PRODUITS ÉLECTRONIQUES PROFESSIONNELS

ENGIE

NOKIA

Callisto

KALRAY

Alcatel·Lucent

life.augmented

DDN STORAGE

Schneider Electric

AEG

EDF

TOTAL

SAFT

NVIDIA.

intel

Alcatel·Lucent

Air Liquide creative oxygen

Bull atos technologies

Industrial perspectives and solutions

Callisto

Cryogenics systems

THALES

Receiving technologies

FABRICANT DE CARTES ET PRODUITS ÉLECTRONIQUES PROFESSIONNELS

Antenna design

ThalesAlenia Space

A. Julier's talk

5 Tb/s

7.2 Tb/s

~2 Pb/s

Industrial perspectives and solutions

SKA1-MID

8.8 Tb/s

Telecommunications

ThalesAlenia Space

50 PFLOPS

5 Tb/s

7.2 Tb/s

Air Liquide creative oxygen

Energy production and storage

~2 Pb/

ENGIE

100 PFLOPS

Y. Pennec's talk

SKA1-LOW

Industrial perspectives and solutions

SKA1-MID

8.8 Tb/s

Data science for monitoring

ThalesAlenia Space

Bull atos technologies

Hardware and application integration

KALRAY

J.M. Denis's talk

SKA1-LOW

~2 Pb/s

DDN STORAGE

Data storage, distribution, preservation

Industrial perspectives and solutions

ThalesAlenia Space

System engineering

arianeGROUP

A. Julier's & A. Ayoun's talks

SKA1-MID

8.8 Tb/s

7.2 Tb/s

5 Tb/s

SKA1-LOW

~2 Pb/s

100 PFLOPS

Industrial perspectives and solutions

ThalesAlenia Space

System engineering

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Cryogenics systems

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Receiving technologies

FABRICANT DE CARTES ET PRODUITS ÉLECTRONIQUES PROFESSIONNELS

Air Liquide creative oxygen

Energy production and storage

DDN STORAGE

Antenna design

ENGIE

Data storage, distribution, preservation

ThalesAlenia Space

Large systems – From engineering to integration and maintenance
*(*A. Julier – *Thales Alenia Space)*

SKA data processing, storage, distribution
(*J.-M. Denis – Bull-ATOS)*

SKA system engineering needs
(A. Ayoun – *Ariane Group)*

Hydrogen for Powering SKA: a Case for Storing Renewable Energy
(Y. Pennec – *Air Liquide)*

High-frequency receivers
(*S. Gauffre – LAB)*

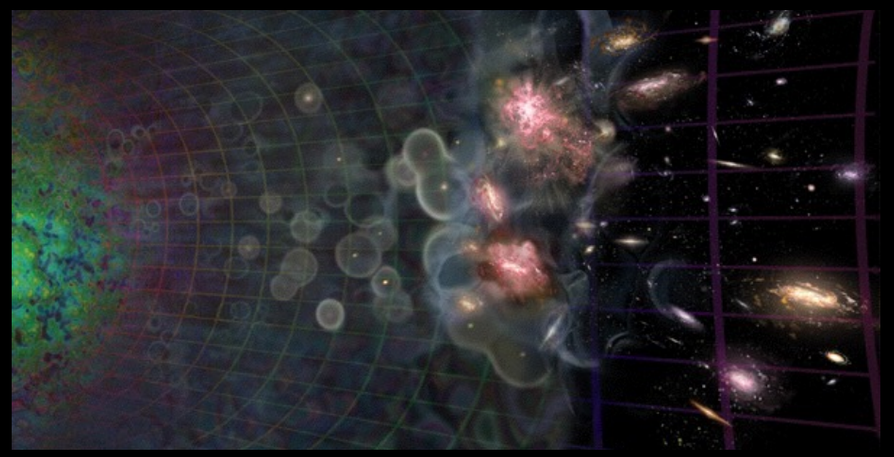
NenuFAR : a French pathfinder of SKA1-LOW
(*P. Zarka – Obs. Paris)*

The French Pulsar timing experience
(*G. Theureau – LPC2E)*

Cross-correlating cosmic fields in the Epoch of Reionisation
(*G. Lagache – LAM)*

Atomic and molecular lines with the SKA
(*E. Daddi – AIM)*

The SKA : a unique instrument to study the interstellar medium
(*M.A. Miville-Deschenes – IAS)*

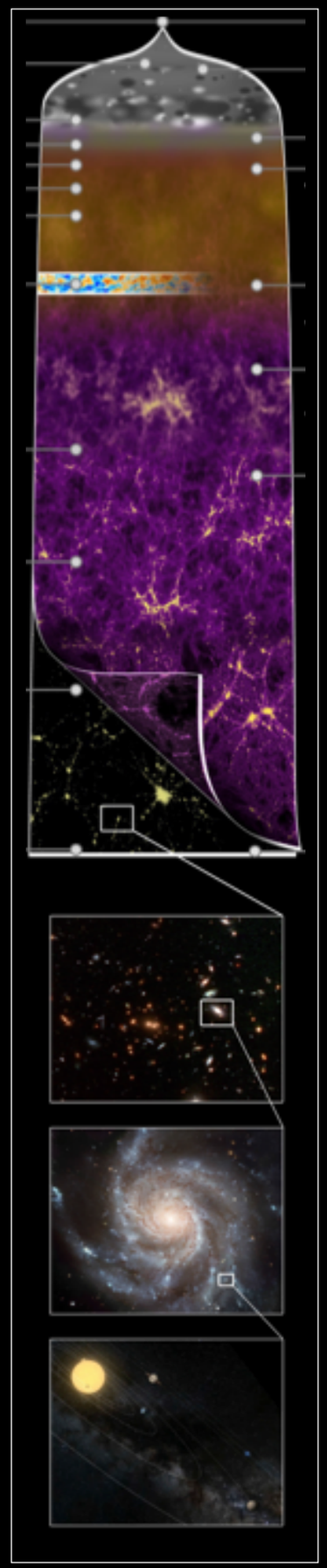


The « *Maison commune* » SKA-France
(*G. Marquette – Coordination SKA-France/CNRS)-INSU*

SKA FRANCE
SQUARE KILOMETRE ARRAY

Conclusions

- The French astronomical community has intensified its efforts in preparing a national contribution to the SKA project
- About 180 authors from 40 research institutes and 6 private companies involved in the French SKA White Book
- Multi-usage, transversal domain dimension of the SKA
  - A conservative estimate of at least 400 future users of SKA1 in France
  - Ongoing discussions with public research institutes & infrastructures
  - More potential partners identified within private companies
  - A scientific project with a big expected impact on society
- **Evolution towards a new structure :** « Maison SKA France »
  - Create an instrument in response to the necessity of an innovative financial approach
  - Enable France to participate to major scientific breakthroughs over the next 50 years



THANKS!

SKA FRANCE
SQUARE KILOMETRE ARRAY