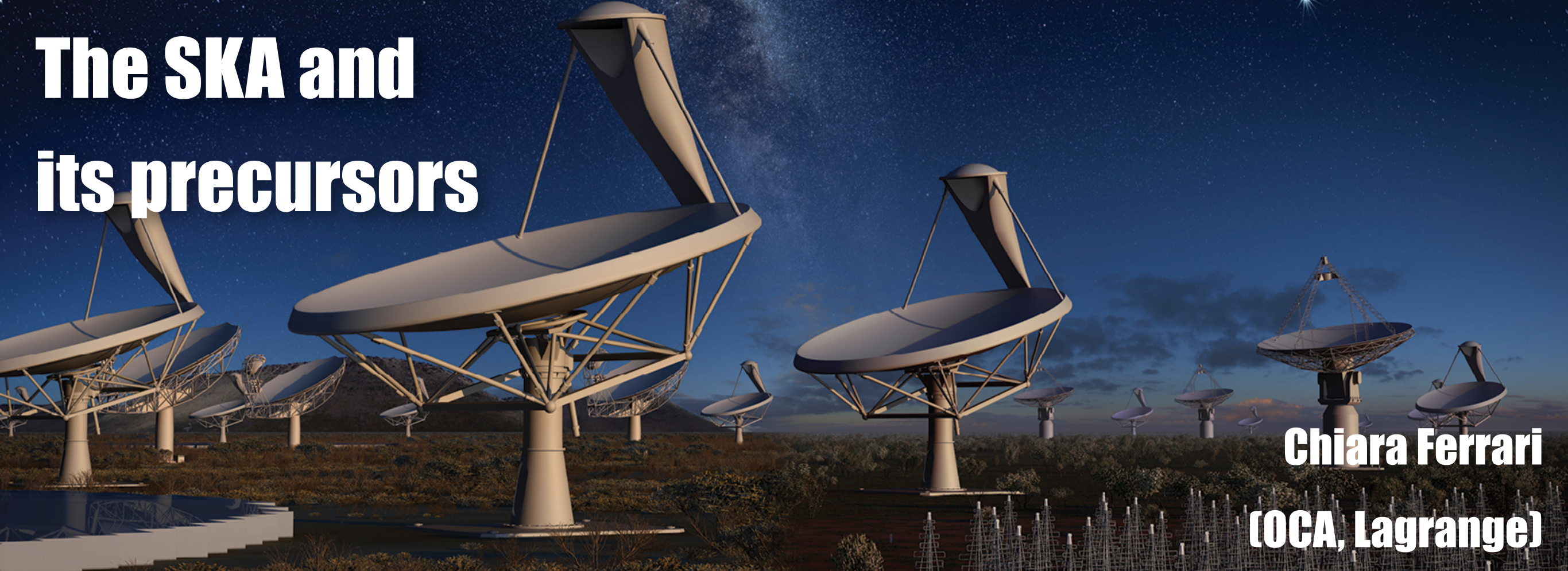


The SKA and its precursors



Chiara Ferrari
(OCA, Lagrange)



IMAGE COURTESY:
WWW.SKATELESCOPE.ORG



Overview of the talk



► **SKA and its precursors** : the telescopes

► **The role of the international community vs. :**

◆ **SKA precursors:** operational soon

◆ **SKA itself:** importance of being involved now

The Square Kilometre Array (SKA)

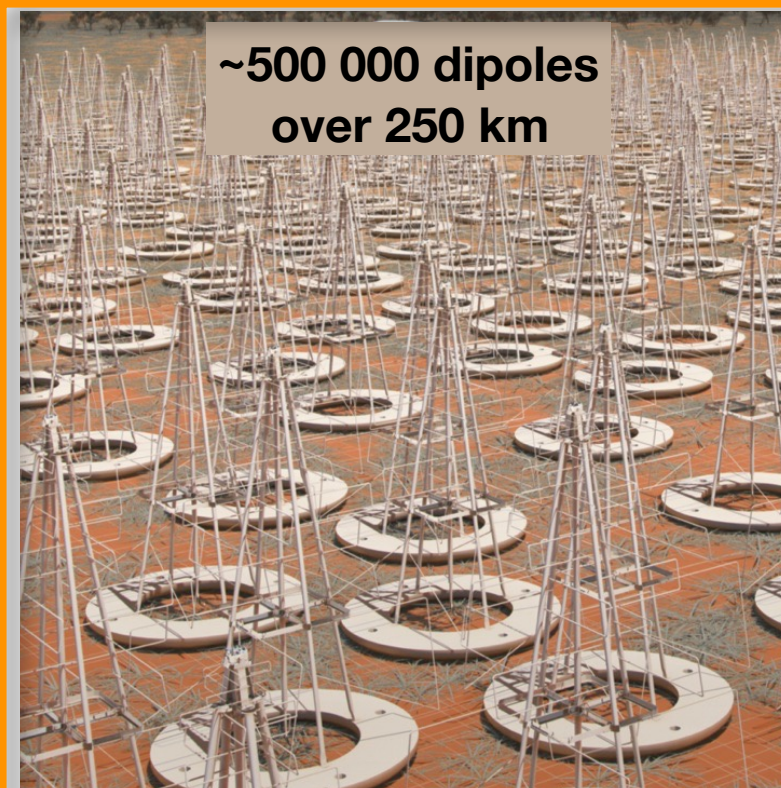
~2500 x 15m dishes
over 3500 km



~250 x 60m
MID Frequency Aperture Arrays



~500 000 dipoles
over 250 km



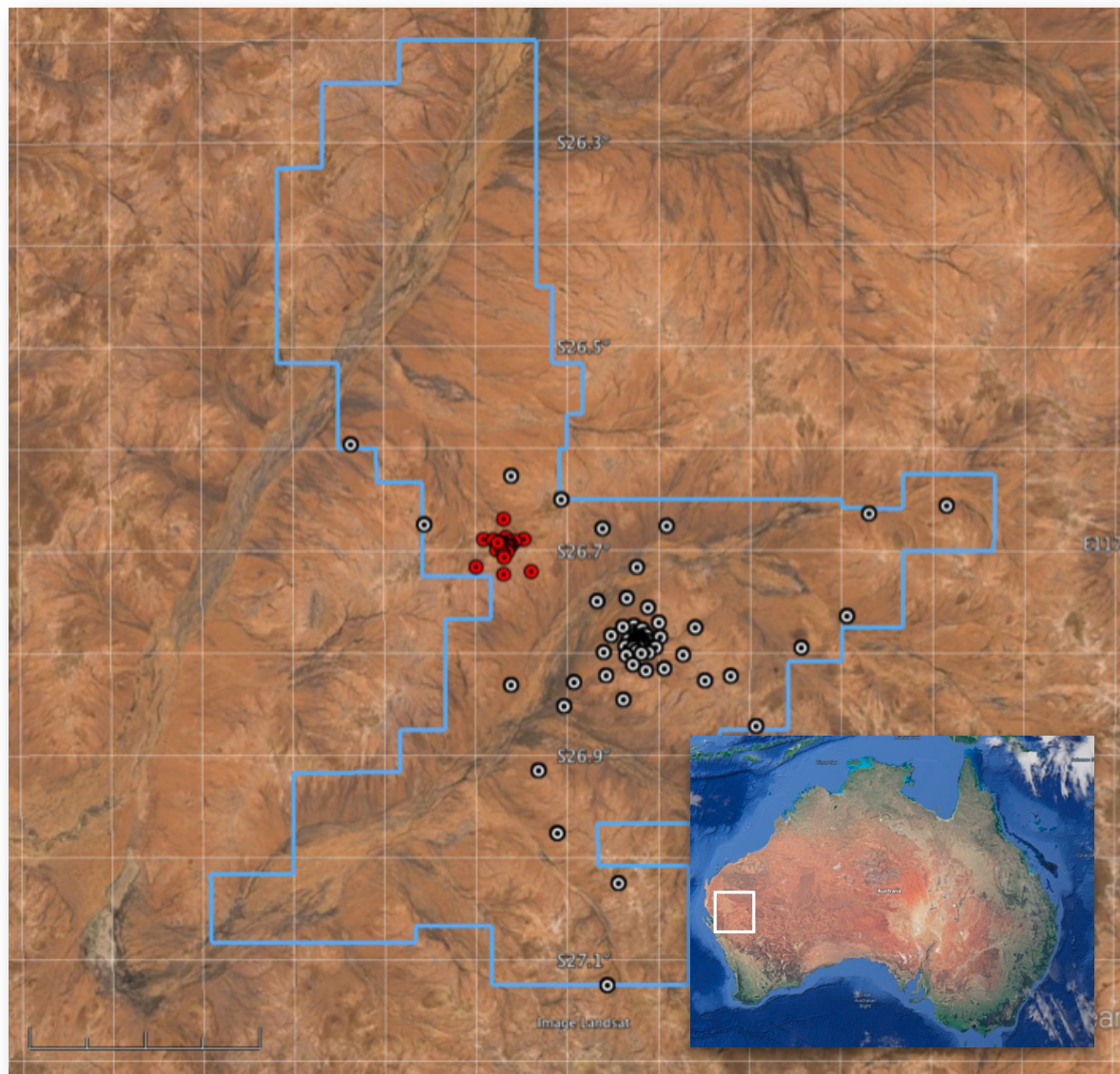
1 km² collecting area
50 MHz - ≥14 GHz
Sub-arcsec angular res.



SKA1: 2018-2013 with cost-cap 650 M€

SKA1-LOW (AUS)

- 130,000 dipoles
- Frequency coverage: 50 - 350 MHz
- Max baseline: 80 km



SKA1-MID (SA)

- 133 15m dishes + **MeerKAT**
- Frequency coverage: 0.350 - 1.8 GHz & 4.6 - 13.8 GHz
- Max baseline: 150 km

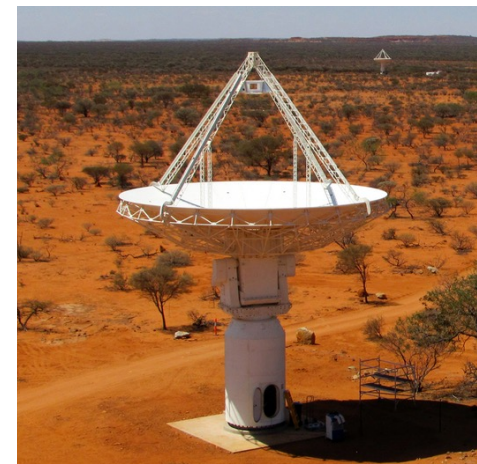


The SKA precursors



MeerKAT

- Location: South Africa
- Max baseline: 8 km
- Frequency coverage: 0.5 - 10 GHz
- Number of antennas: 64
- Diameter of antennas: 13.5 m
- **Fully operational from 2017**



ASKAP

- Location: Australia
- Max baseline: 6 km
- Frequency coverage: 0.7 - 8 GHz
- Number of antennas: 36
- Diameter of antennas: 12 m
- **Fully operational from 2017**



MWA

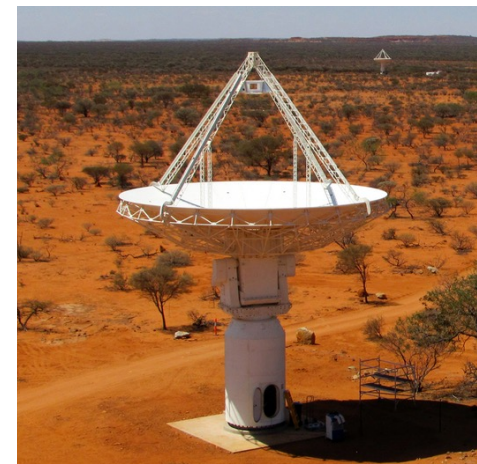
- Location: Australia
- Max baseline: 3 km
- Frequency coverage: 80 - 300 MHz
- Number of stations: 128
- Antennas per station: 16
- **Fully operational since 2012**

The SKA precursors



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- Location: South Africa
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Timeline for SKA and precursors



2016 2017 2018 ... 2020 ... 2023 ...

Timeline for SKA and precursors

2016

2017

2018

...

2020

...

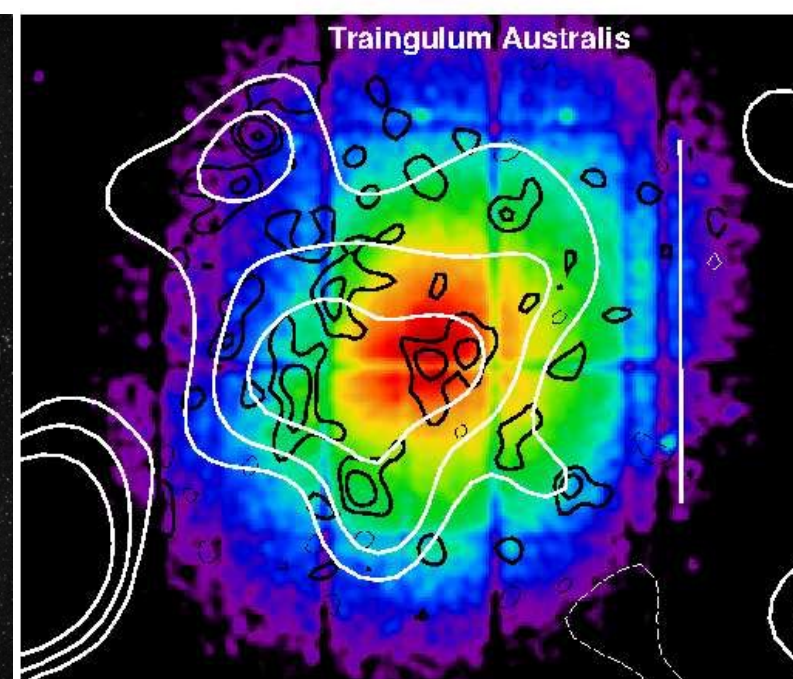
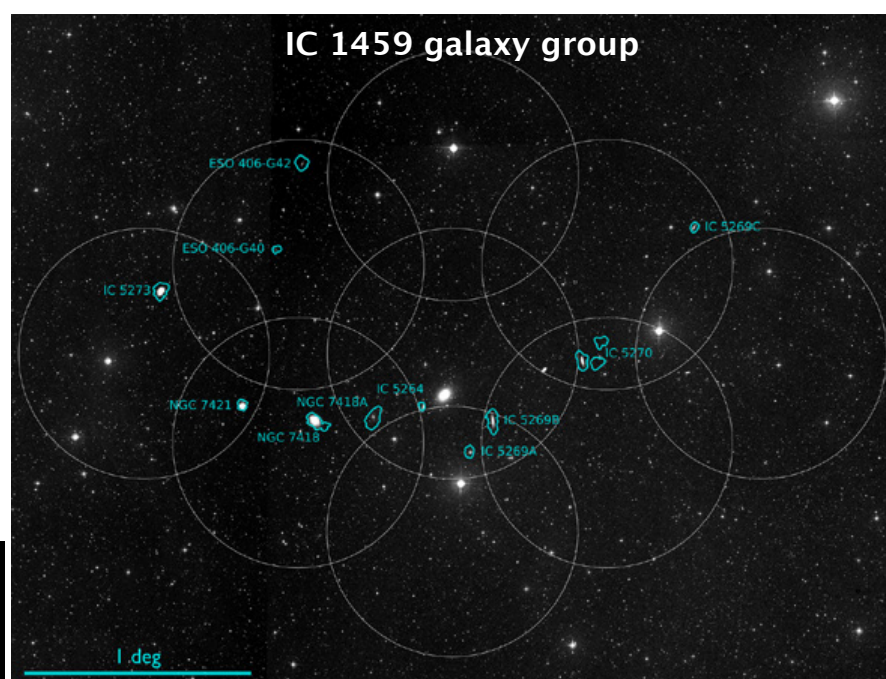
2023

...

Serra+ 15

Optical image

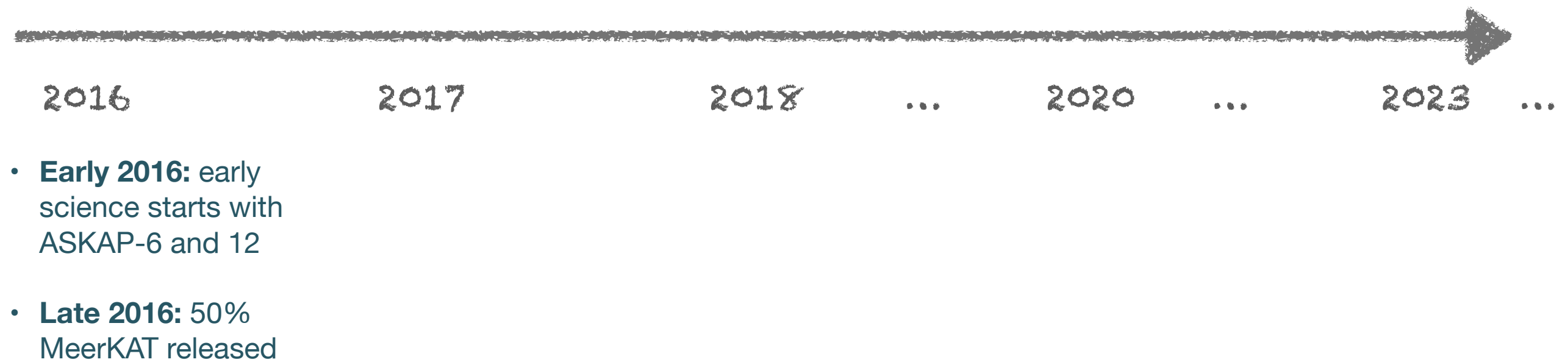
HI contours from
ASKAP-BETA



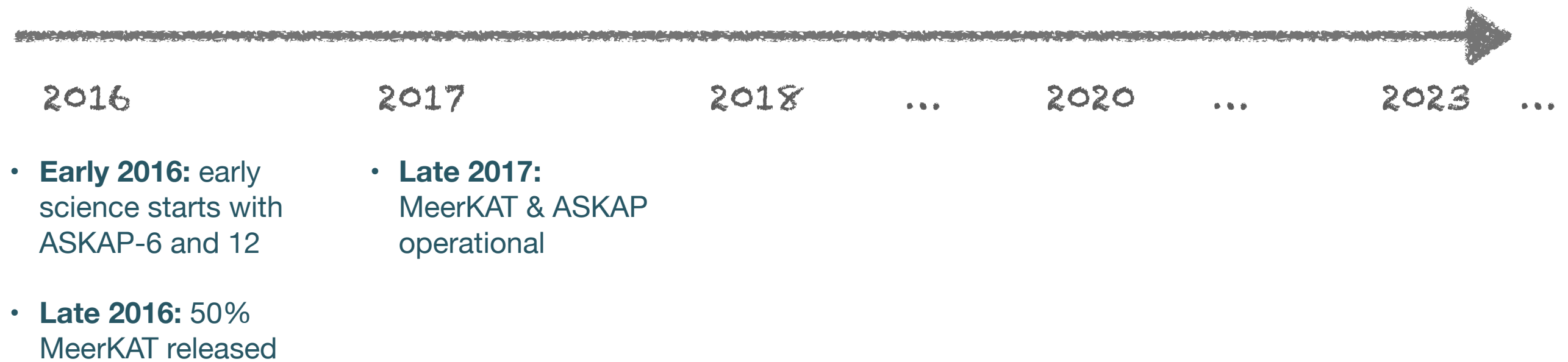
Bernardi+ 15

X-ray image
NVSS contours
KAT-7 contours

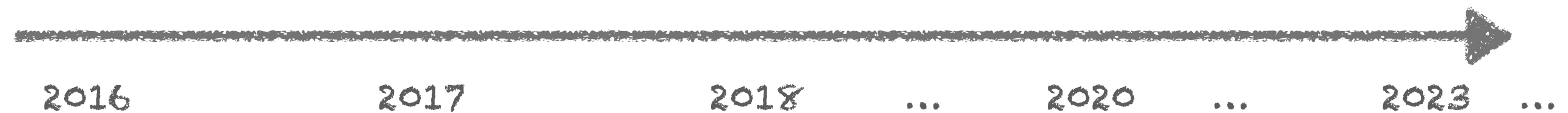
Timeline for SKA and precursors



Timeline for SKA and precursors



Timeline for SKA and precursors



- **Early 2016:** early science starts with ASKAP-6 and 12

- **Late 2016:** 50% MeerKAT released

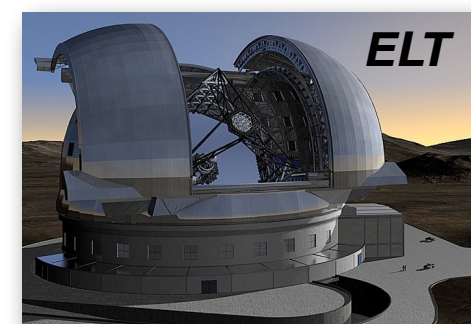
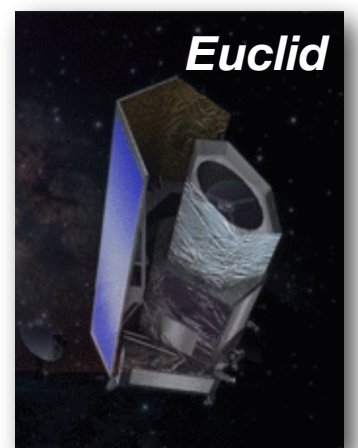
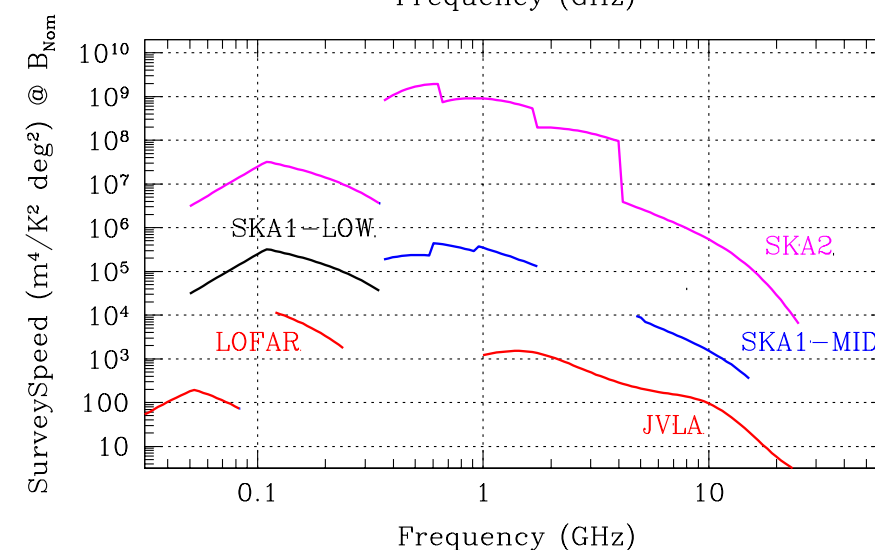
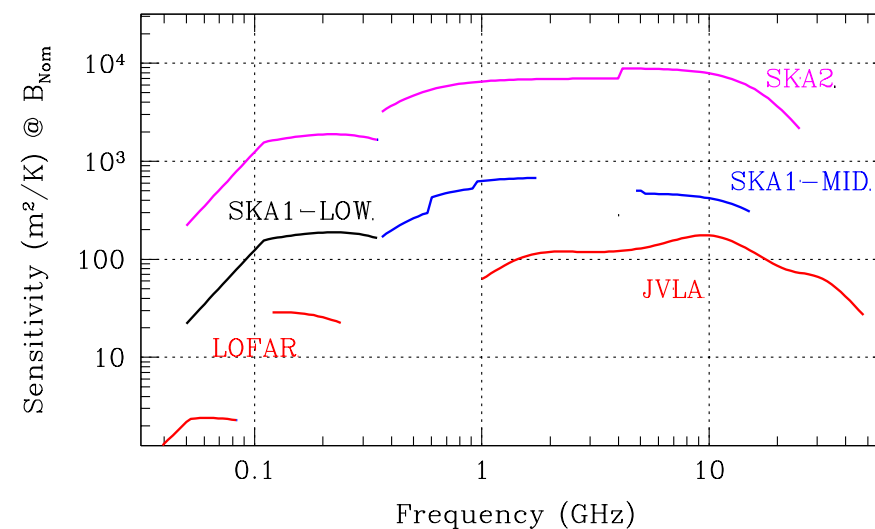


- **Late 2017:** MeerKAT & ASKAP operational

- **Late 2017:** Inter-governmental organisation for SKA operational



Timeline for SKA and precursors



ASKAP Surveys

During ASKAP's first five years of operation at least 75% of its time will be used for large Survey Science Projects

- ▶ **2008:** expressions of interest
- ▶ **2009:** submission and selection of proposals
→ ten successful projects invited to proceed to the design studies phase
- ▶ **2009:** prioritisation based on a committee of international experts
 - ◆ **EMU:** *Evolutionary Map of the Universe*
(PI: Norris)
 - ◆ **WALLABY:** *Widefield ASKAP L-Band Legacy All-Sky Blind Survey*
(PIs: Koribalski and Staveley-Smith)

ASKAP Surveys

During ASKAP's first five years of operation at least 75% of its time will be used for large Survey Science Projects

► 2008: expressions of interest

► 2009: submission and selection of proposals

→ ten surveys were selected



SKA-LABY: Widefield ASKAP L-Band

Legacy All-Sky Blind Survey

(PIs: Koribalski and Staveley-Smith)

► Discuss key aspects of the ASKAP science surveys with the user community

► Showcase new results from ASKAP Commissioning and Early Science

► Provide training in the use of Virtual Observatory tools

► **Discuss astronomical surveys at other wavelengths that will complement ASKAP**

► **Bring together international experts on large astronomical surveys and exploiting complex data sets**

ASKAP : opened to the community !

List of EMU Key Science Projects

Key Science Projects are primarily science-based and address the EMU key science goals. They develop science and techniques on data now, with the goal of producing papers before then. No individual can lead more than one key science project.

- Feel free to contact the project leader shown below if you would like to join a team.
- Email Ray Norris if you would like to propose a new key project or would like to volunteer to lead a key science project. Note also the [user-driven Team Science Projects](#).
- The "management contact" below is the person on the EMU management team who has been delegated to be a conduit of information to/from EMU management meeting:

Key project #	Title & link to wiki page	Project Leader	Current Status	Other participants	Management Contact	Description
KP5.	Clusters of Galaxies	Melanie Johnston-Hollitt & Chiara Ferrari		Heinz Andernach, Kaustuv Basu, Annalisa Bonafede, Shea Brown, Gianfranco Brunetti, Rossella Cassano, Tracy Clarke, Siamak Dehghan, Jose M Diego, Alastair Edge, Matthias Ehle, Luigina Feretti, Tom Franzen, Gabriele Giovannini, Tony Mroczkowski, Ray Norris, Paul Nulsen, Andrew O'Brien, Mamta Pandey-Pommier, Gabriel W. Pratt, Marco Regis, Thomas Reiprich, Larry Rudnick, Anna Scaife, Nick Seymour, Timothy Shimwell, Nick Tothill, Kurt van der Heyden, Tiziana Venturi, Michael Wise, Franco Vazza	Ian Heywood	X-ray surveys Numerical simulations

MeerKAT Surveys

The MeerKAT science program will consist of legacy-style, large survey projects (70% of time), plus open time (30%) available for new proposals

▶ **Early 2010:** submission of proposals

▶ **Late 2010:** prioritisation

◆ **Radio Pulsar Timing** (*PI: Bales*)

◆ **LADUMA:** *Looking at the Distant Universe with the MeerKAT Array*
(*PIs: Blyth, Holwerda and Baker*)

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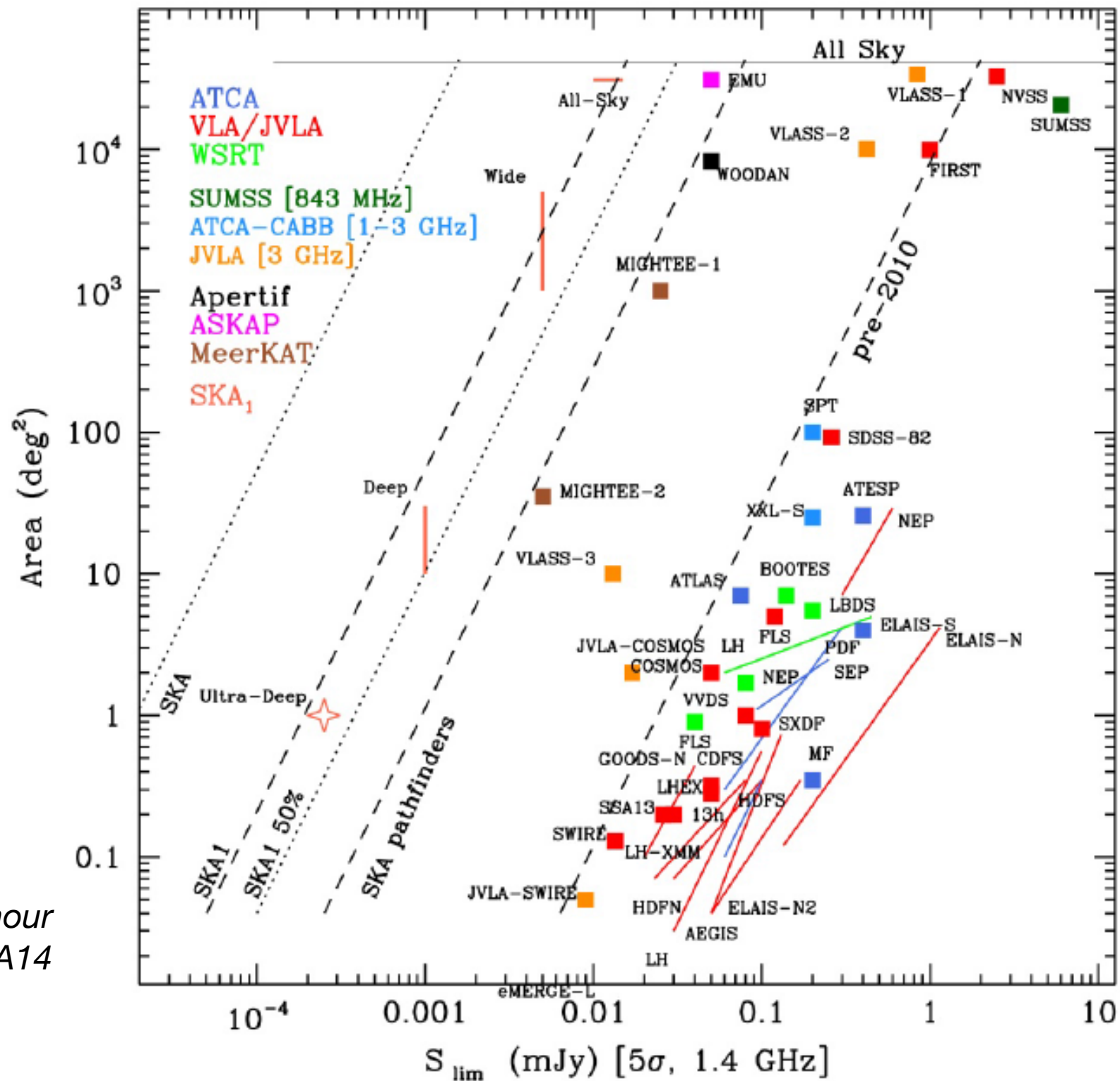
Workshop from May 25 to 27, 2016

▶ Updated technical specifications of MeerKAT

▶ New scientific results obtained since the time of the original proposals

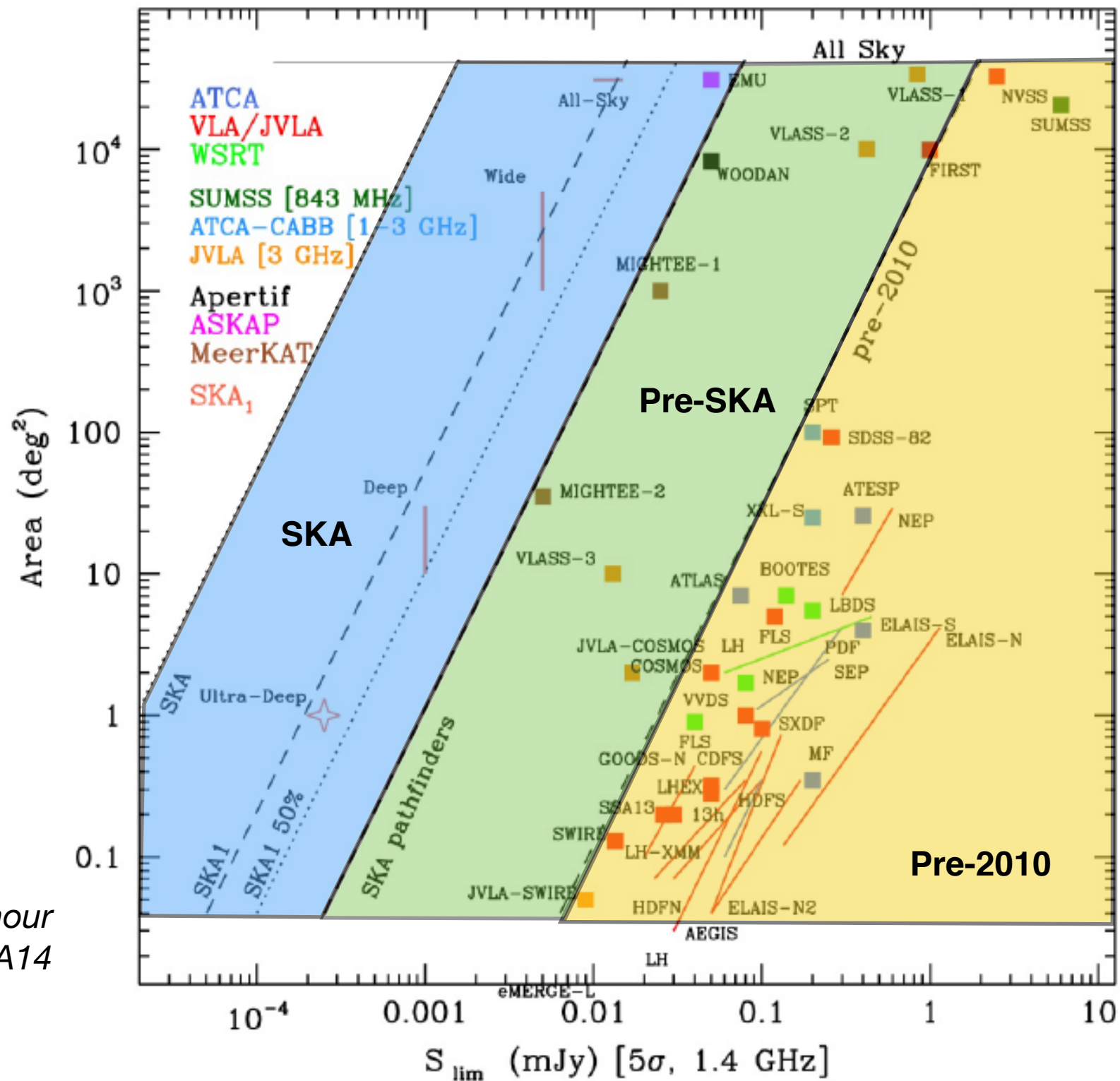
▶ **Current or planned large programs on other facilities that affect the international context of the project**

Summary plot for continuum surveys



Prandoni & Seymour
AASKA14

Summary plot for continuum surveys



Prandoni & Seymour
AASKA14

Participation to the SKA project

► SKA Science Working Groups

- ◆ **Epoch of Reionization**
- ◆ **H I Galaxy Science**
- ◆ **Extragalactic Spectral Line**
- ◆ **Extragalactic Continuum**
- ◆ **Cosmology**

- ◆ **Cosmic Magnetism**
- ◆ **Radio Transients**
- ◆ **Cradle of Life/AstroBiology**
- ◆ **Our Galaxy**
- ◆ **Solar & Heliospheric Physics**

► SKA Work Packages

- ◆ **Assembly, Integration and Verification**
- ◆ **Central Signal Processor**
- ◆ **Dish**
- ◆ **Infrastructure Australia and Africa**
- ◆ **Low-Frequency Aperture Array**

- ◆ **Mid-Frequency Aperture Array**
- ◆ **Signal and Data Transport**
- ◆ **Science Data Processor**
- ◆ **Telescope Manager**
- ◆ **Wideband Single Pixel Feeds**

Participation to the SKA project

► SKA Science Working Groups

◆ Epoch of Reionization

- Membership on Science Teams is open to **any** researcher with a science interest in SKA
- Science Team membership is open to researchers affiliated with both SKA-member and **non-member nations** (~30 French scientists already involved)
- Researchers can **nominate themselves** for membership by contacting the relevant Science Team Chair

► SKA

◆ Integration and Verification

◆ Central Signal Processor

◆ Dish

◆ Infrastructure Australia and Africa

◆ Low-Frequency Aperture Array

◆ Mid-Frequency Aperture Array

◆ Signal and Data Transport

◆ Science Data Processor

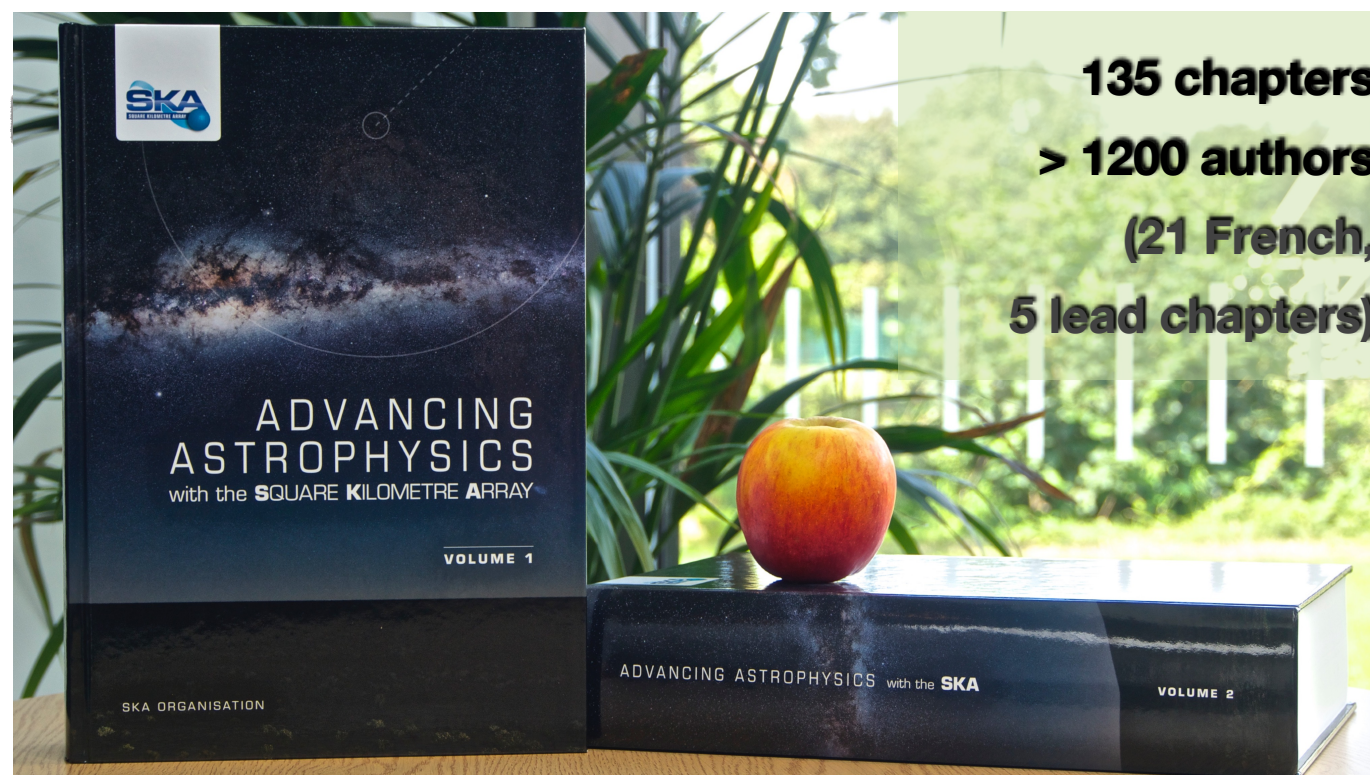
◆ Telescope Manager

◆ Wideband Single Pixel Feeds

Current activities

► SKA Science Working Groups

- ◆ **Science meetings opened to the whole community** (already involved or not in SKA)
- ◆ **Key Science Workshops** (restricted to actively involved participants)
- ◆ **Regular teleconferences within Science Working Groups**



Current activities

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► SKA Work Packages

- ◆ **Yearly engineering meetings**
- ◆ **Regular teleconferences**
- ◆ **Three French Institutes have already signed MoUs** (Obs. Paris, Obs. Bordeaux, Obs. Côte d'Azur)



Example of outcome of the Stockholm meeting

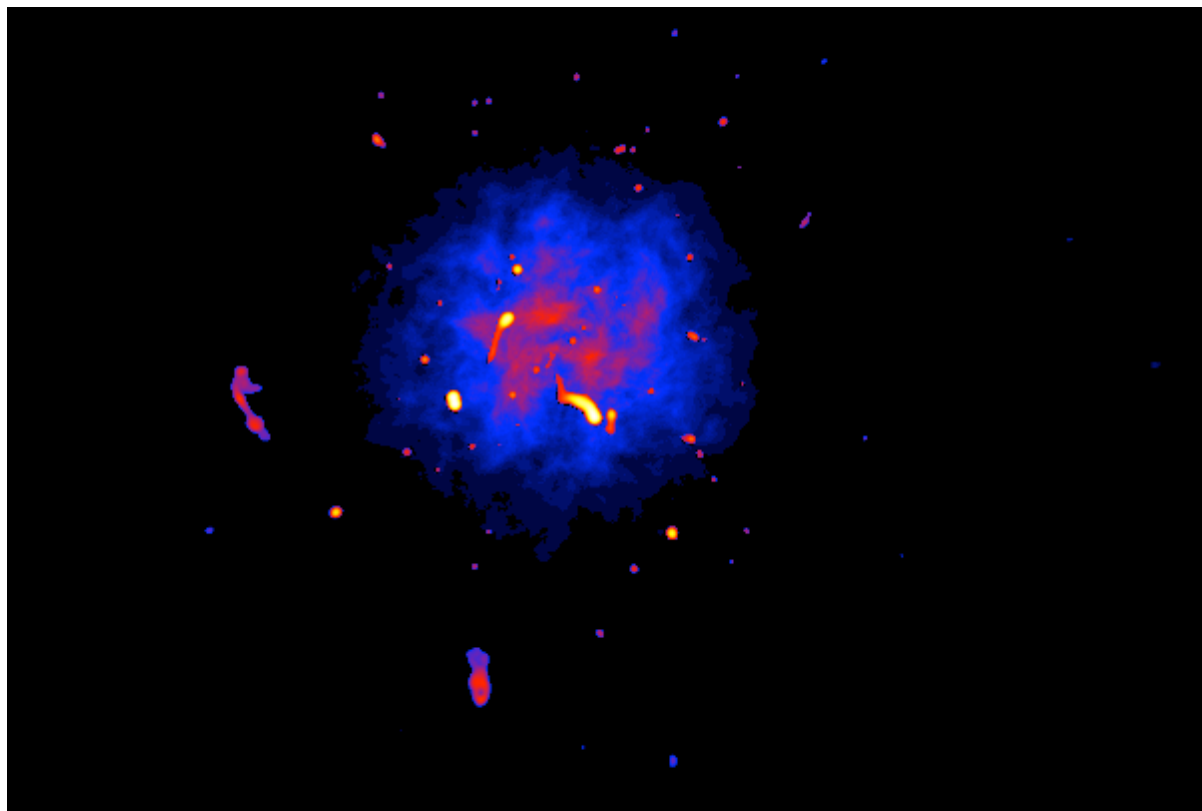
Survey	Area	Freq	T	Magnetism	Cosmology/	Continuum
	(deg ²)	MHz	(hrs)		EoR	
Medium wide	400	950-1420	2000		1000 sq deg 5000 hours weak lensing	similar strategy
Medium deep	20	950-1420	2000	100 deg2 tracing cosmic web, similar depth		similar strategy
Deep	1 pointing	600-1050	3000	compatible; magn. plans wider		useful only if in band 1
Targeted	30 targets	1400-1420	3000	good match in sample, res and depth		
Targeted (Accr)	(30 targets)	1400-1420	(3000)	fully commensal with ISM Accretion		
Galaxy/MS	500	1418-1422	4500	commensal with Galaxy + Magn WG to get optimum 1200 deg2 and 11500 hours		
Galaxy Abs	(5000)	1418-1422	(10000)	fully commensal with "Galaxy/MS", continuum, magnetism		
Absorption	1000+	350-1050	1,000+	all sky, optimum commensality if band 1		
	1000	200-350	1.000		fully commensal 5000 deg2 absorption survey	

Image Courtesy: E. de Blok & HI Science Working Group

and commensal with medium-wide HI band 2

Example of scientific & technical development for SKA

Radio galaxies +
Radio halo ($P_{1.4 \text{ GHz}} \sim 1 \times 10^{24} \text{ W/Hz}$)



Relativistic electron population

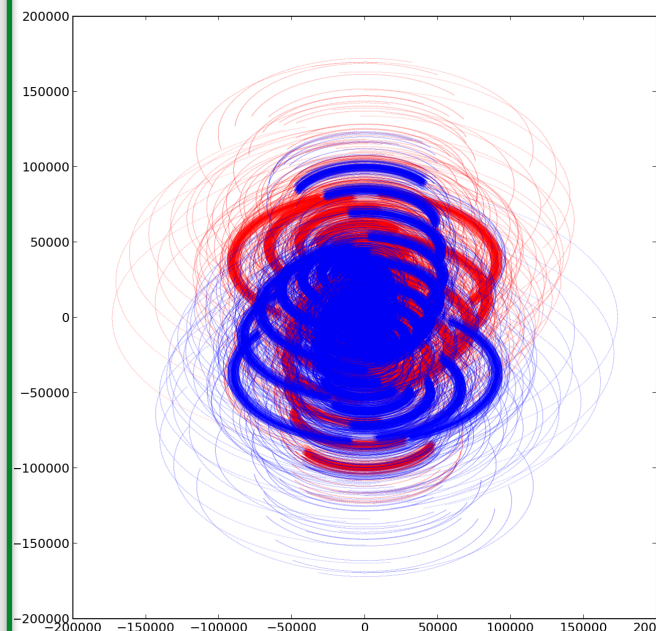
+ Magnetic field model

Faraday tool (Murgia+ 04)

8 hours observations

60 sec integration time

50 MHz BW starting @ 1415 MHz

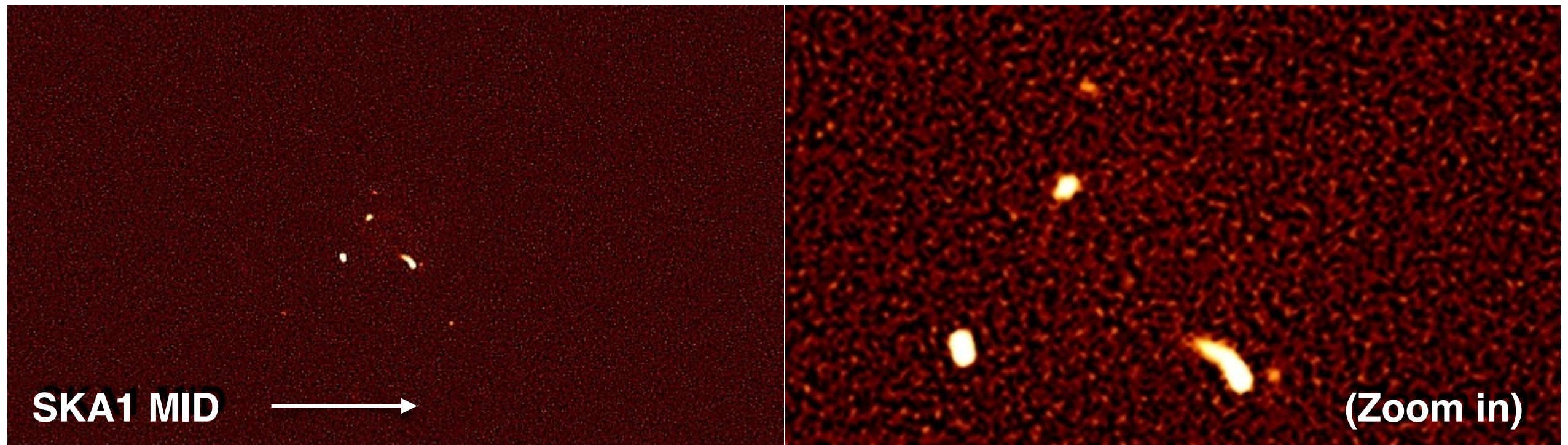


Simulations of SKA1 MID

observations

MeqTrees tool (Noordam & Smirnov 10)

Simulated SKA1 observations



Radio maps before deconvolution from the instrument PSF
1 arcsec resolution

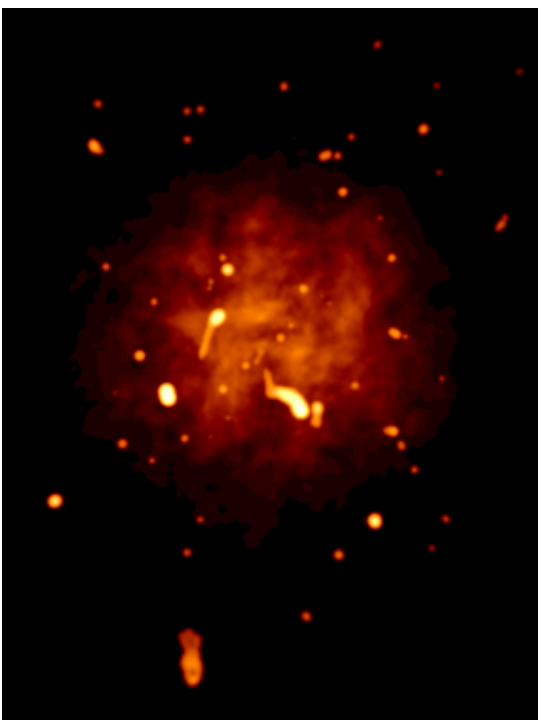
Ferrari+ 15

MORESANE algorithm :

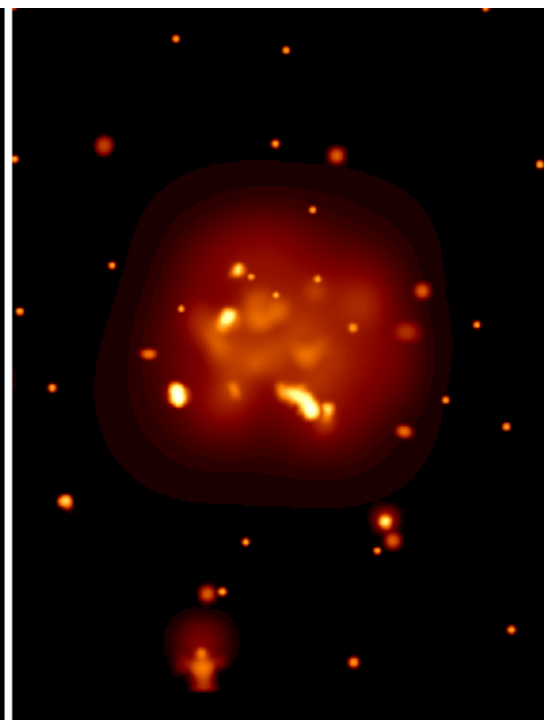
new deconvolution method based on sparse representations developed @ OCA, Nice (FR)

Dabbech+ 12; Dabbech+ 15

High-z galaxy cluster studies with SKA1



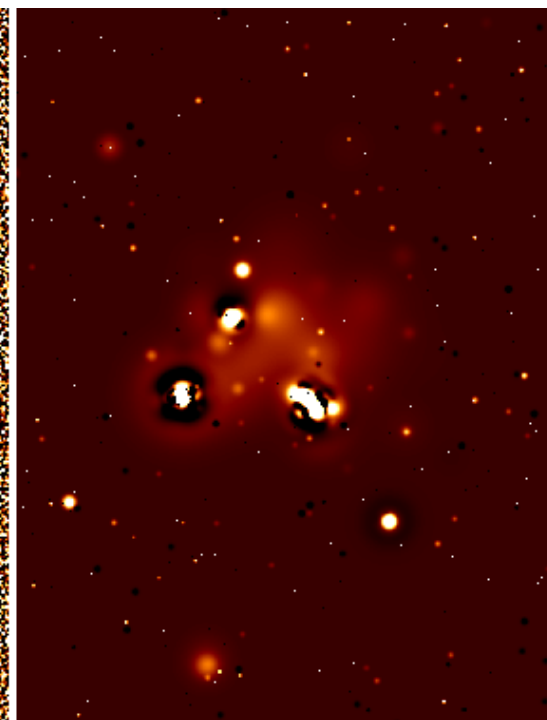
Simulated cluster



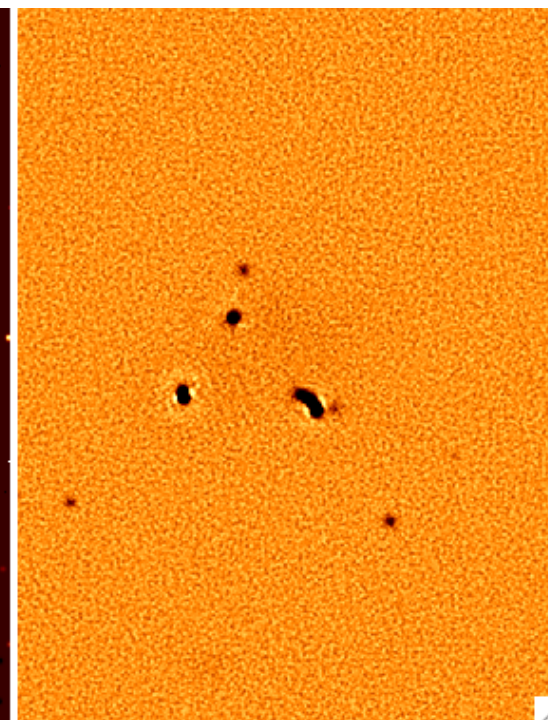
MORESANE
source model



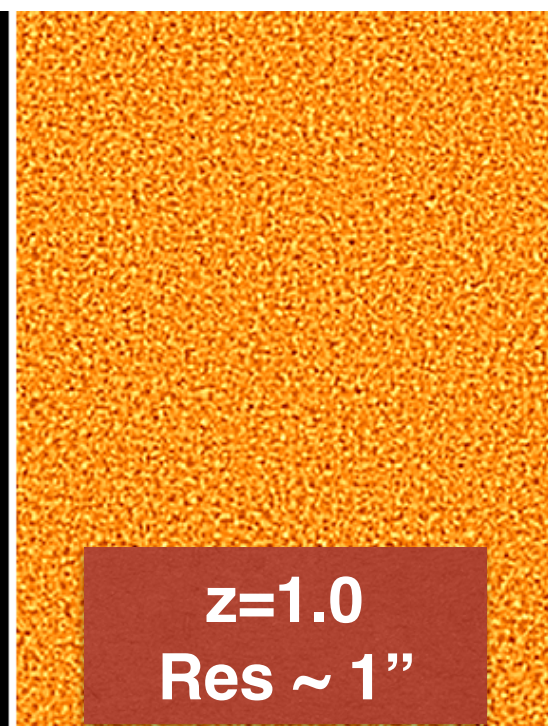
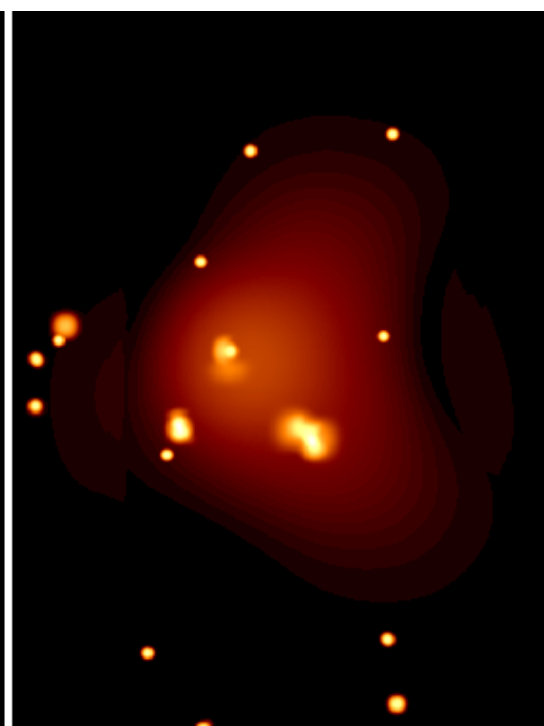
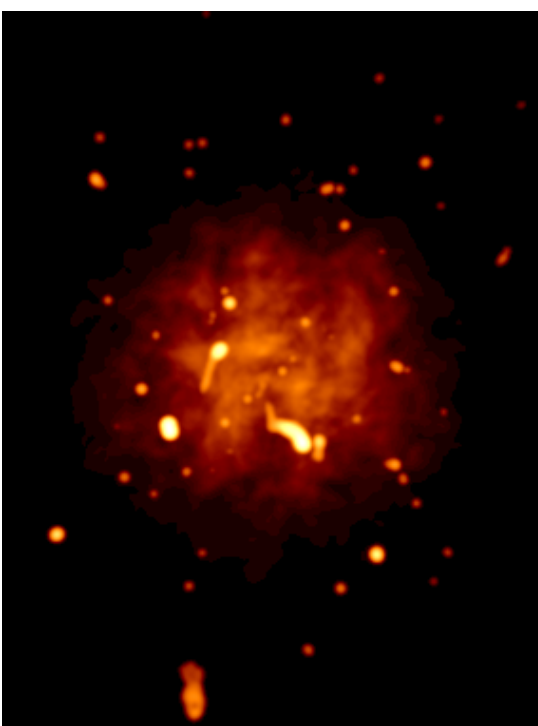
MORESANE
residuals



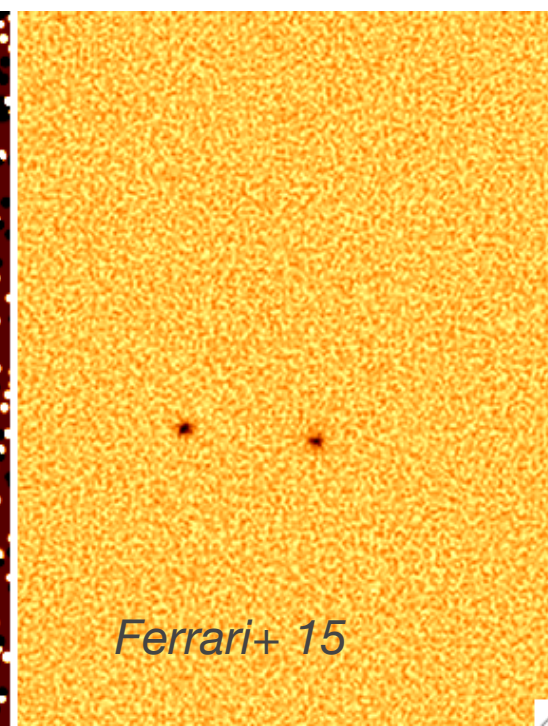
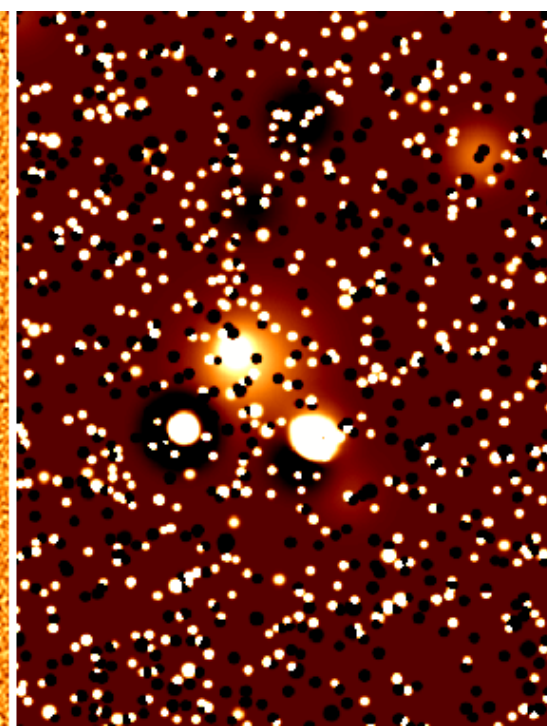
MS-CLEAN
source model



MS-CLEAN
residuals

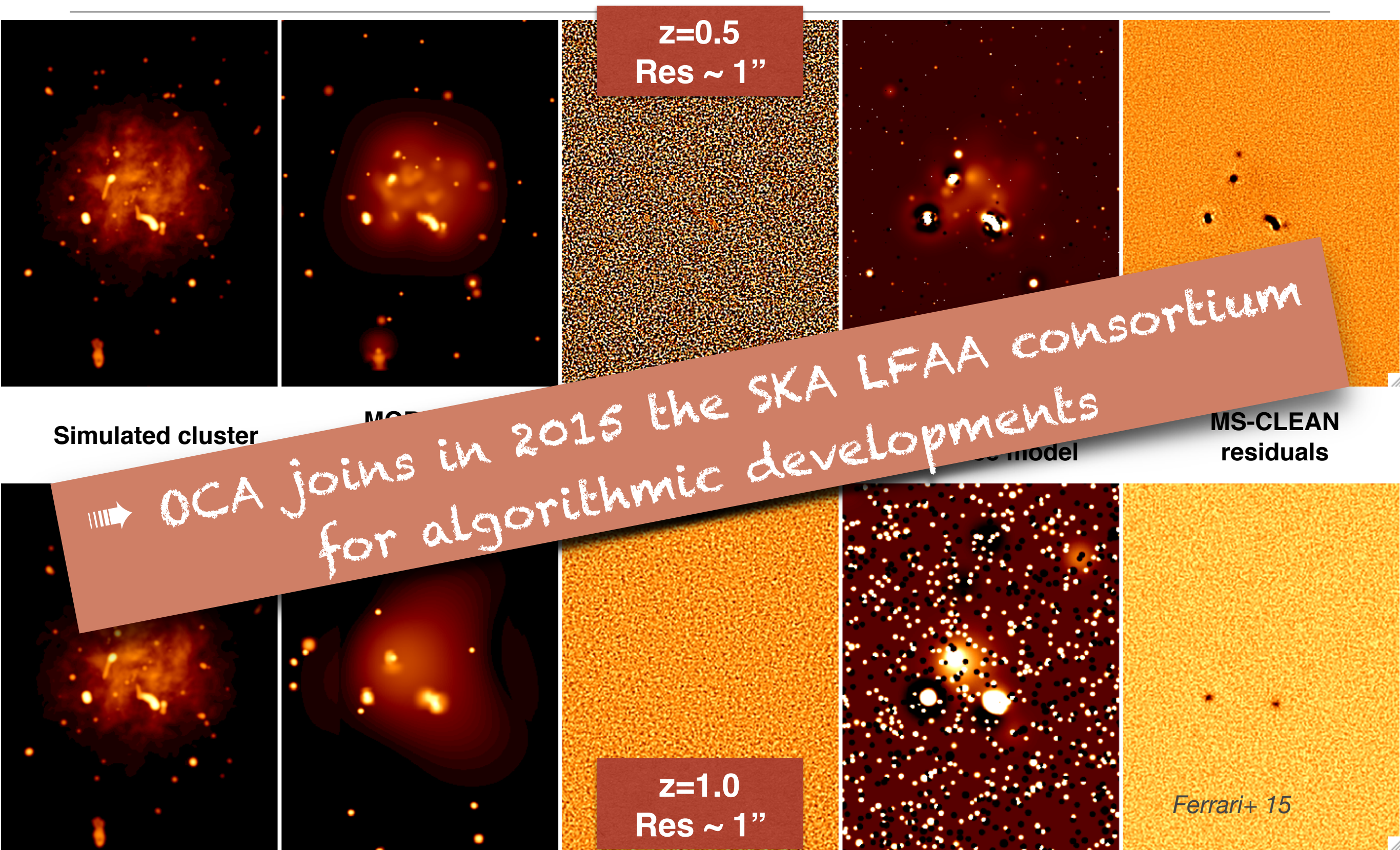


z=1.0
Res ~ 1''



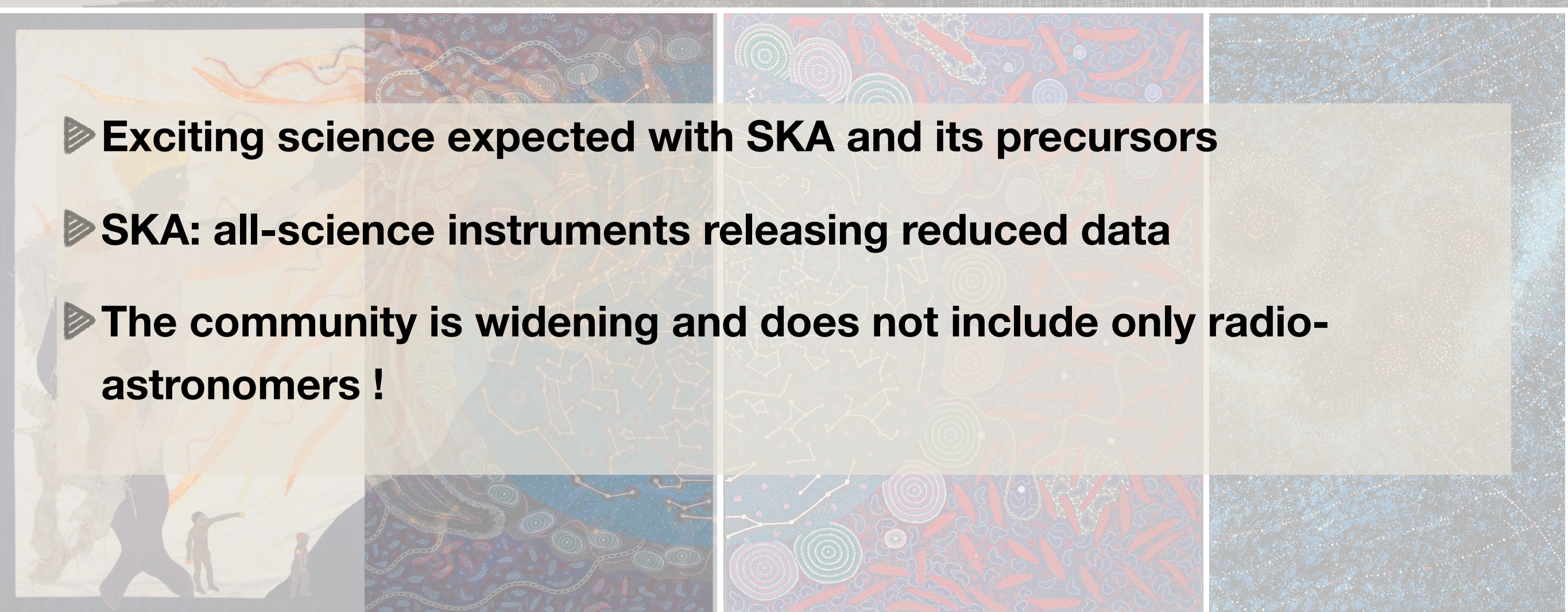
Ferrari+ 15

High-z galaxy cluster studies with SKA1





Conclusions

- 
- ▶ **Exciting science expected with SKA and its precursors**
 - ▶ **SKA: all-science instruments releasing reduced data**
 - ▶ **The community is widening and does not include only radio-astronomers !**

Thanks !!!

Chiara Ferrari

chiara.ferrari@oca.eu

PNCG Project (2014-2016)

Vers le SKA: première science avec ses précurseurs et préparation au plus grand radiotélescope du monde