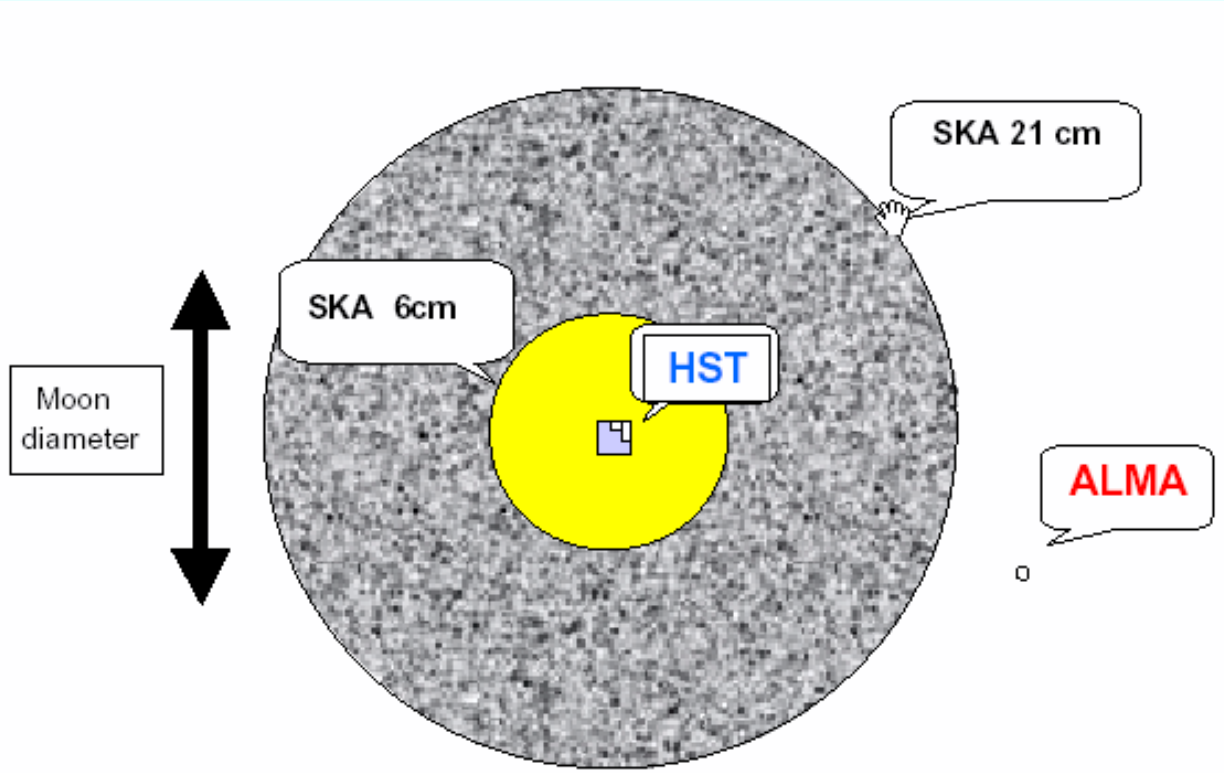

SKA
SQUARE KILOMETRE ARRAY
Square Kilometer Array
Design Study
100 SKA stations (2020)

Telescope

Point source sensitivity of 10 nano-Jy in 8hours

- frequencies: 0.15 – 25 GHz (λ 1.2cm – 2m)
- field of view: 1 (→ 100?) square degrees at λ 21 cm / 1.4 GHz
  8 independent fields of view
- angular resolution: 0.01 arcsec at λ 21 cm / 1.4 GHz

→ 100 ‘stations’ of 100m diameter, baselines up to ~ 3000 km



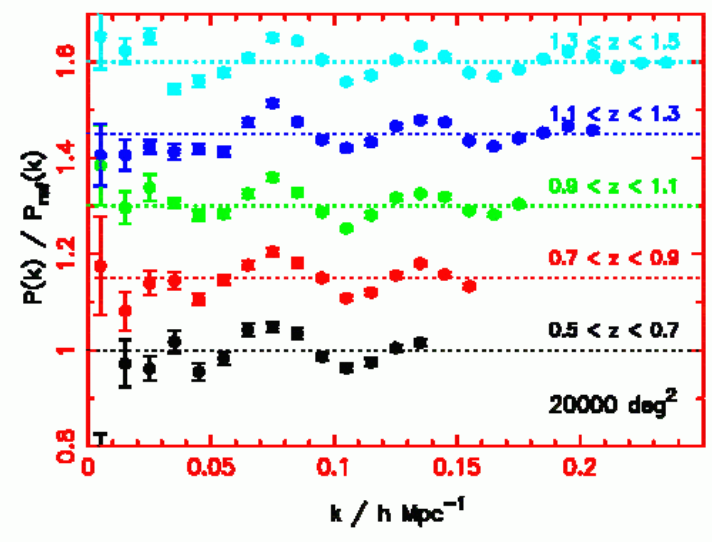
Extra-galactic Key Projects

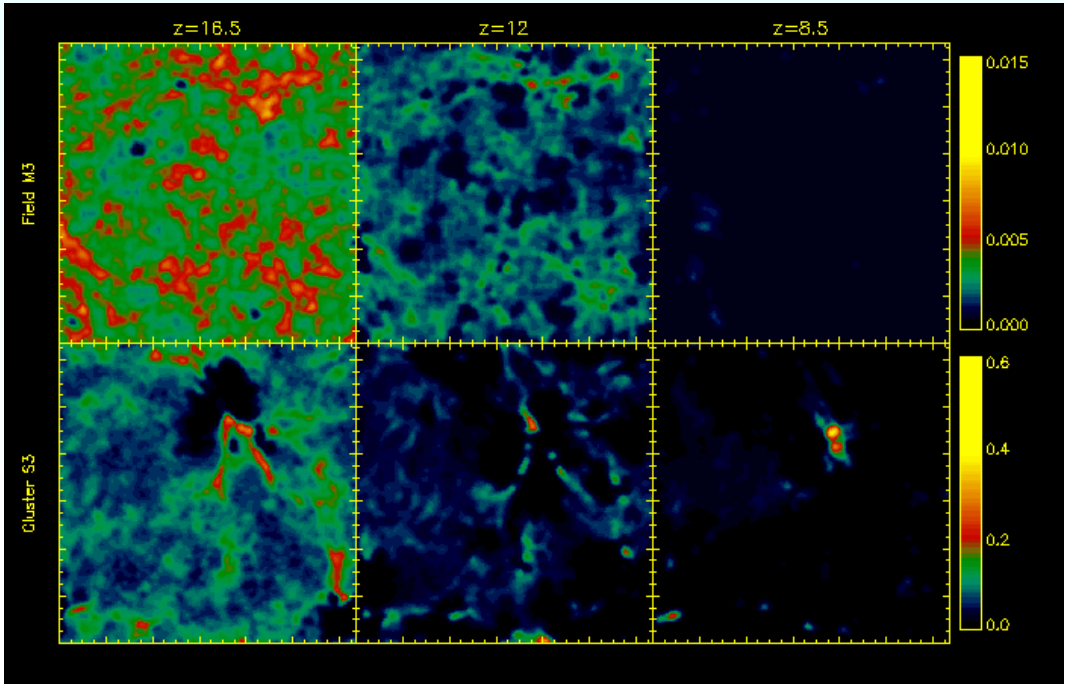
➔KP-4 Galaxy evolution and cosmology
(surveys in HI at z up to 2, CO and continuum; nature of dark energy)

➔KP-5 Probing the dark ages (Epoch of Reionisation)
(HI in emission/absorption, CO, continuum)

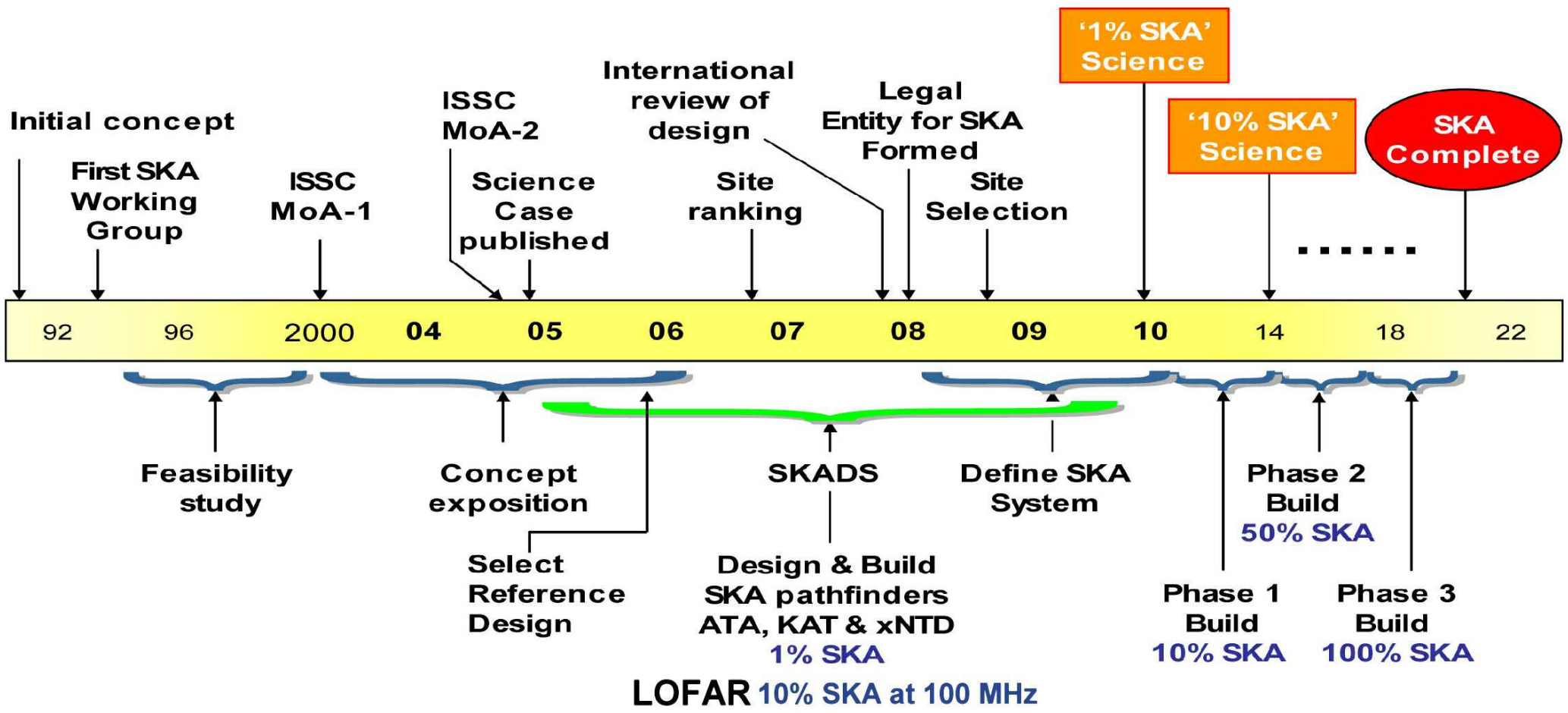
reionization

Wiggles, for tackling dark energy





Timeline


Initial concept
First SKA Working Group
ISSC MoA-1
ISSC MoA-2
Science Case published
International review of design
Site ranking
Legal Entity for SKA Formed
Site Selection
'1% SKA' Science
'10% SKA' Science
SKA Complete
92
96
2000
04
05
06
07
08
09
10
14
18
22
Feasibility study
Concept exposition
Select Reference Design
SKADS
Design & Build SKA pathfinders ATA, KAT & xNTD
1% SKA
Define SKA System
Phase 1 Build
10% SKA
Phase 2 Build
50% SKA
Phase 3 Build
100% SKA
LOFAR 10% SKA at 100 MHz

Project Time-line

➔Proposed sites: Australia & South Africa

➔Proposed concepts: phased array, large parabolas/cylinders, LNSD tiles.. Concept selection: 2009

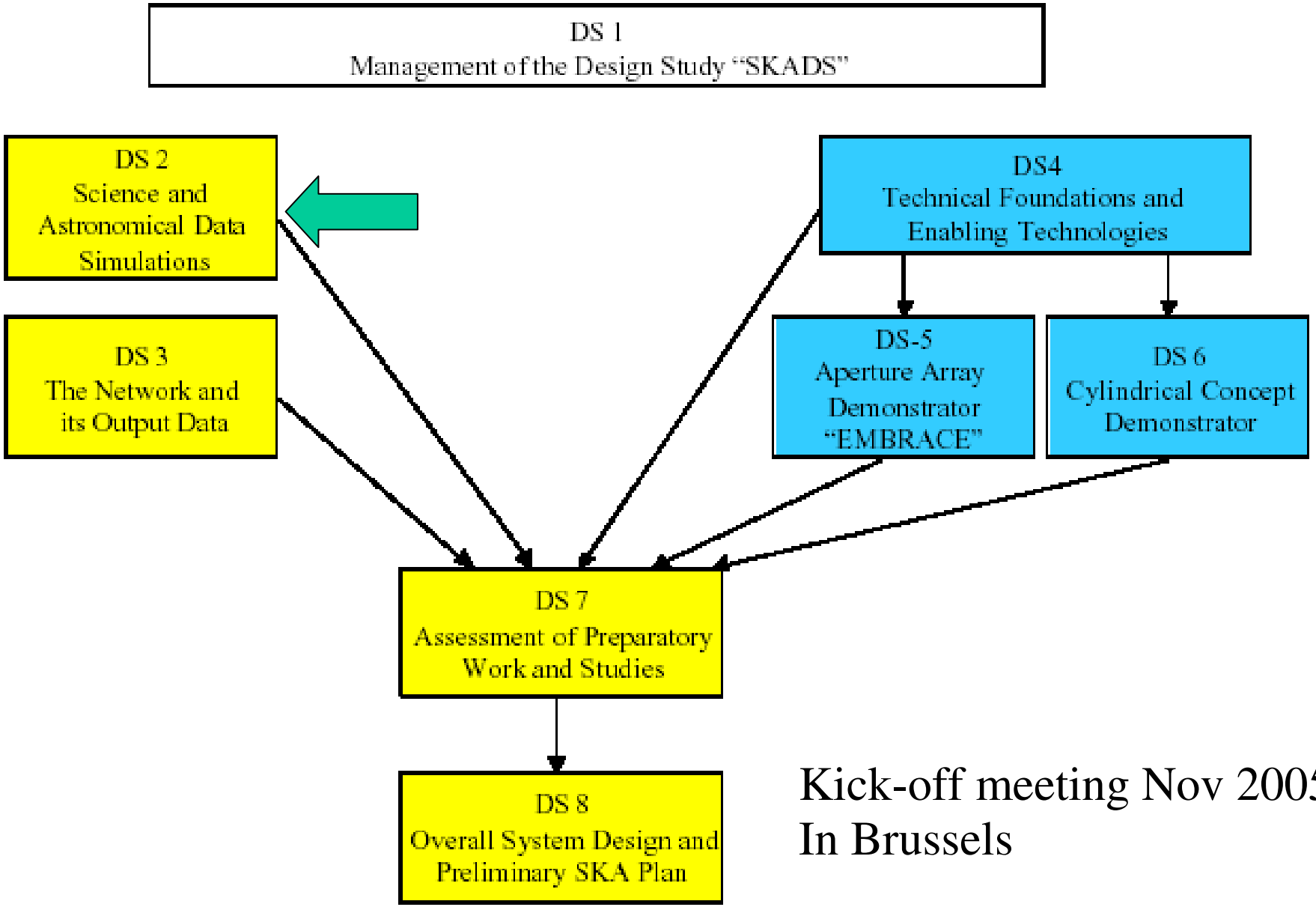
➔Design studies under way: AUS, RSA; CAN, CHN; USA;
Europe (EC FP6 SKA Design Study; 10 MEUR EC)

In Europe:

- Construction of EMBRACE, a demonstrator of the european phased array SKA concept (at Westerbork and Nançay in 2007)
- R&D towards the choice of this concept for the SKA
- Scientific modeling (cosmology – Horizon team)

➔ Start construction 100,000 m2 SKA *pathfinder* on the site: 2010
Construction of full-scale SKA : 2014-2020

Organisation



Kick-off meeting Nov 2005
In Brussels

SKA Design Study (FP6: 2005-2009)

DS1 Management *Arnold van Ardenne ASTRON*

DS2 Simulations *Mike Garrett JIVE*

Ds2T1 Science Simulations *Steve Rawlings Oxford*

Ds2T2 Astronomical Data Simulations *Cormac Reynolds JIVE*

DS3 The Network and its output data *Paul Alexander Cambridge*

Ds3T1 Network Infrastructure & Data Transmission *Simon Garrington Manchester*

Ds3T2 Data Handling, Control & Distributed Computing *Kjeld van der Schaaf ASTRON*

Ds3T3 Architecture and the Network Simulator *Paul Alexander Cambridge*

Ds3T4 A study of siting and related issues *Wim van Driel Obs de Paris*

Ds3T5 SKA for the user *Paul Alexander Cambridge*

Ds3T6 Scalable design and implementation *Martijn van Veelen ASTRON*

SKA Design Study (2)

DS4 Technical foundations and Enabling Technologies *Andy Faulkner Manch*

- Ds4T1 Front End technologies *Mo Missous Manchester*
- Ds4T2 Signal Control & digitisation *Stelio Montebugnoli INAF-IRA*
- Ds4T3 RFI mitigation techniques *Pierre Colom Obs de Paris*
- Ds4T4 Wideband integrated antennas *Jan Geraltbij de Vaate ASTRON*
- Ds4T5 Beam forming at patch level *Mike Jones Oxford*
- Ds4T6 The 2-PAD demonstrator *Anthony Brown Manchester*

DS5 EMBRACE *Parbhu Patel ASTRON*

- Ds5T1 Design of EMBRACE *Dion Kant ASTRON*
- Ds5T2 Development of EMBRACE as a system *Dion Kant ASTRON*
- Ds5T3 EMBRACE assesment of performance *Steve Torchinsky Obs de Paris*

DS6 BEST *Stelio Montebugnoli INAF-IRA*

- Ds6T1 Design of sub-systems *Stelio Montebugnoli INAF-IRA*
- Ds6T2 Development and demonstration *Stelio Montebugnoli INAF-IRA*
- Ds6T3 Assessment of performance *Stelio Montebugnoli INAF-IRA*
- Ds6T4 Phased arrays on concentrators *Jan Geraltbij de Vaate ASTRON*

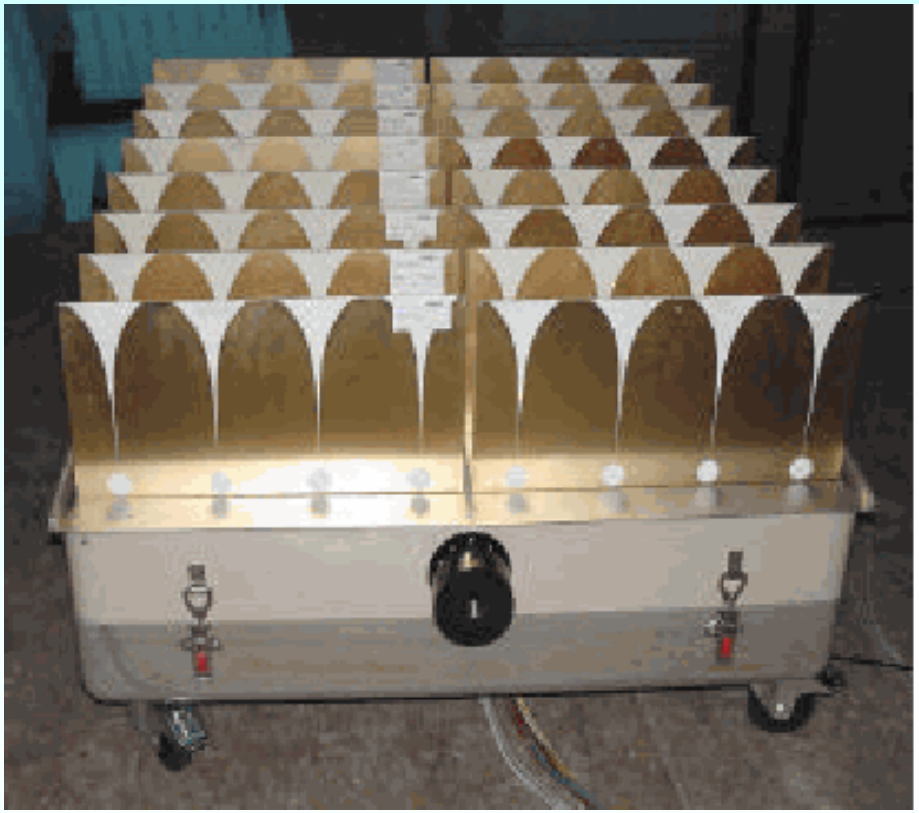
DS7 Continuous assesment and critical reviews *Wim van Driel Obs de Paris*

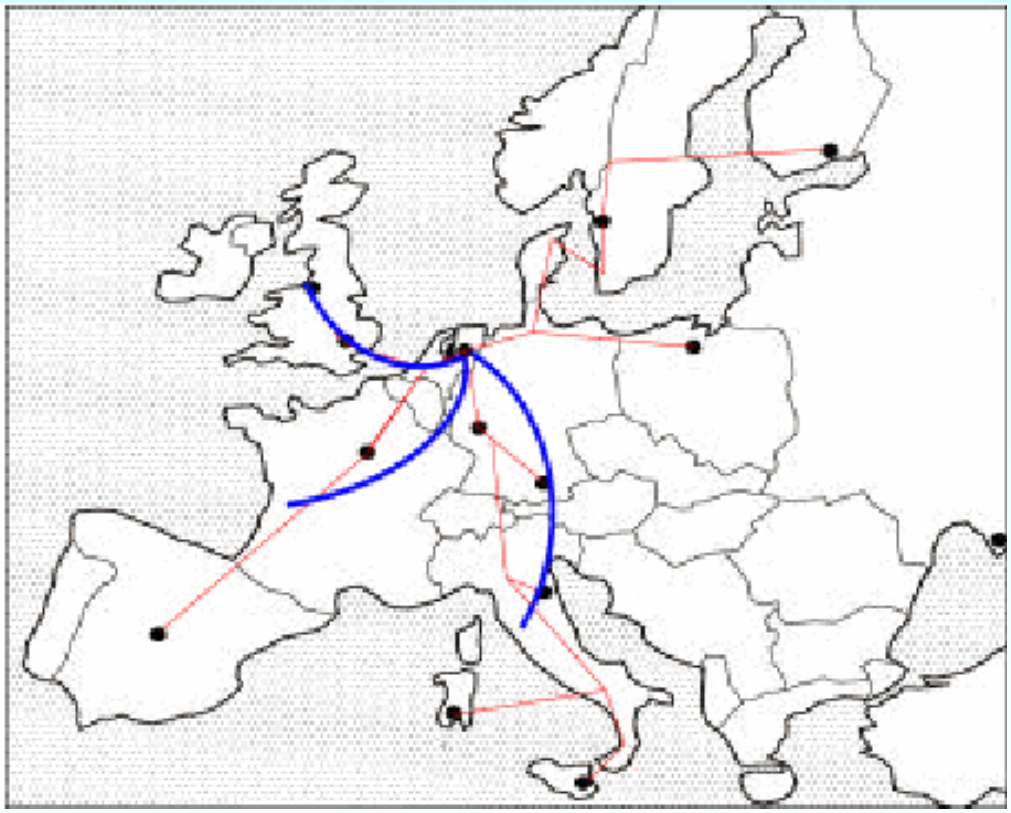
DS8 Overall System Design and Preliminary SKA Plan

Peter Wilkinson Manchester

EMBRACE

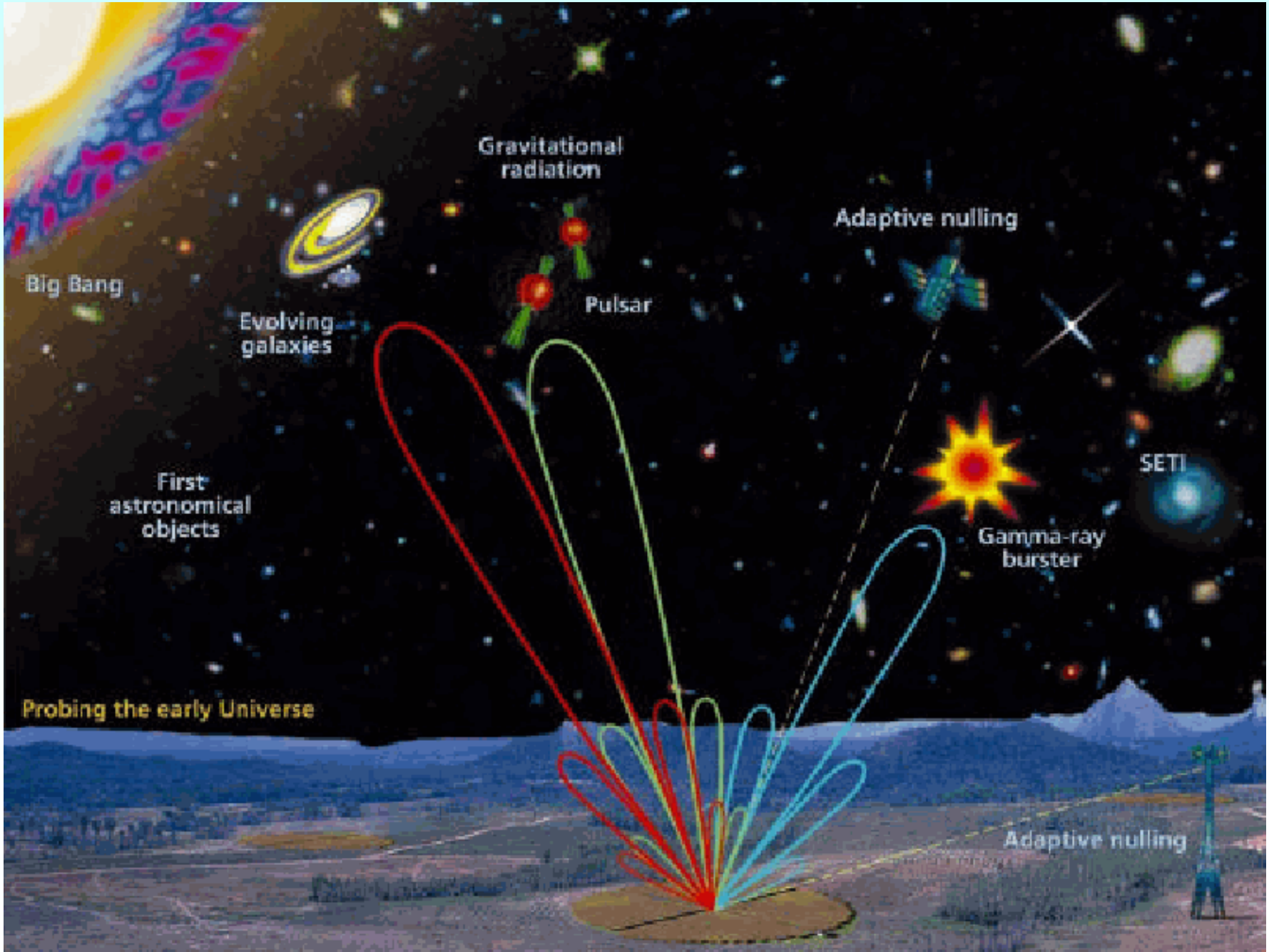
Electronic MultiBeam Radio Astronomy ConcEpt





➔THEA array of 1 sq m, built at ASTRON
Beamforming system below, to form 2 fields of view
➔Schematic view of EMBRACE demonstrator (fibre network) 100 m^2

Multi-Beam


Gravitational radiation
Adaptive nulling
Big Bang
Evolving galaxies
Pulsar
First astronomical objects
SETI
Gamma-ray burster
Probing the early Universe
Adaptive nulling

DS2-T1: Science Simulations

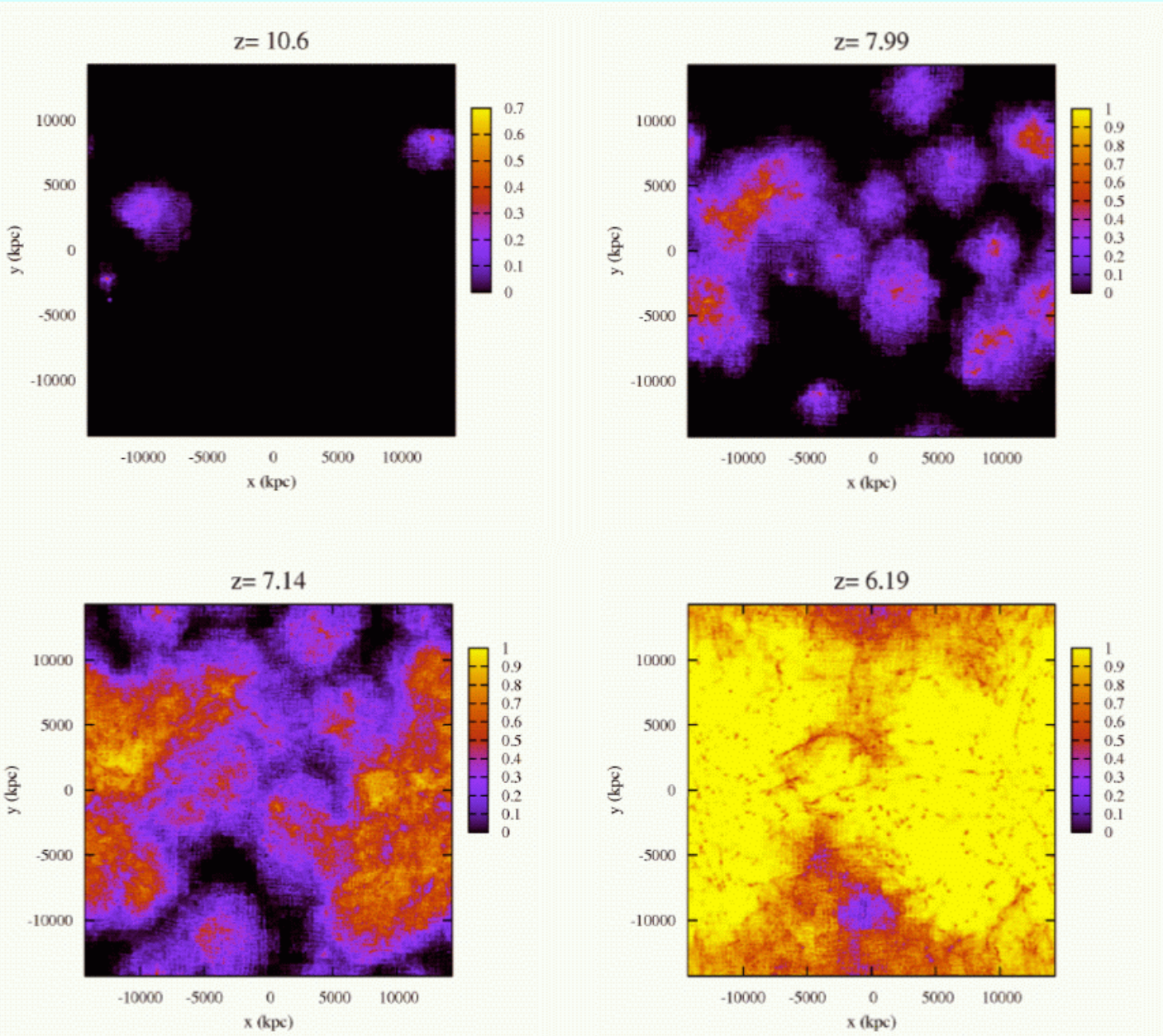
Continuum surveys	Oxford/ Hertfordshire/ Leiden/ Lisbon
Line surveys	Oxford/ Groningen/ Hertfords
Pulsars	Manchester
Epoch of Reionisation	Paris/ Lisbon/ Oxford
Magnetic Fields	MPIfR/ U Cambridge

Maps of the ionisation fraction

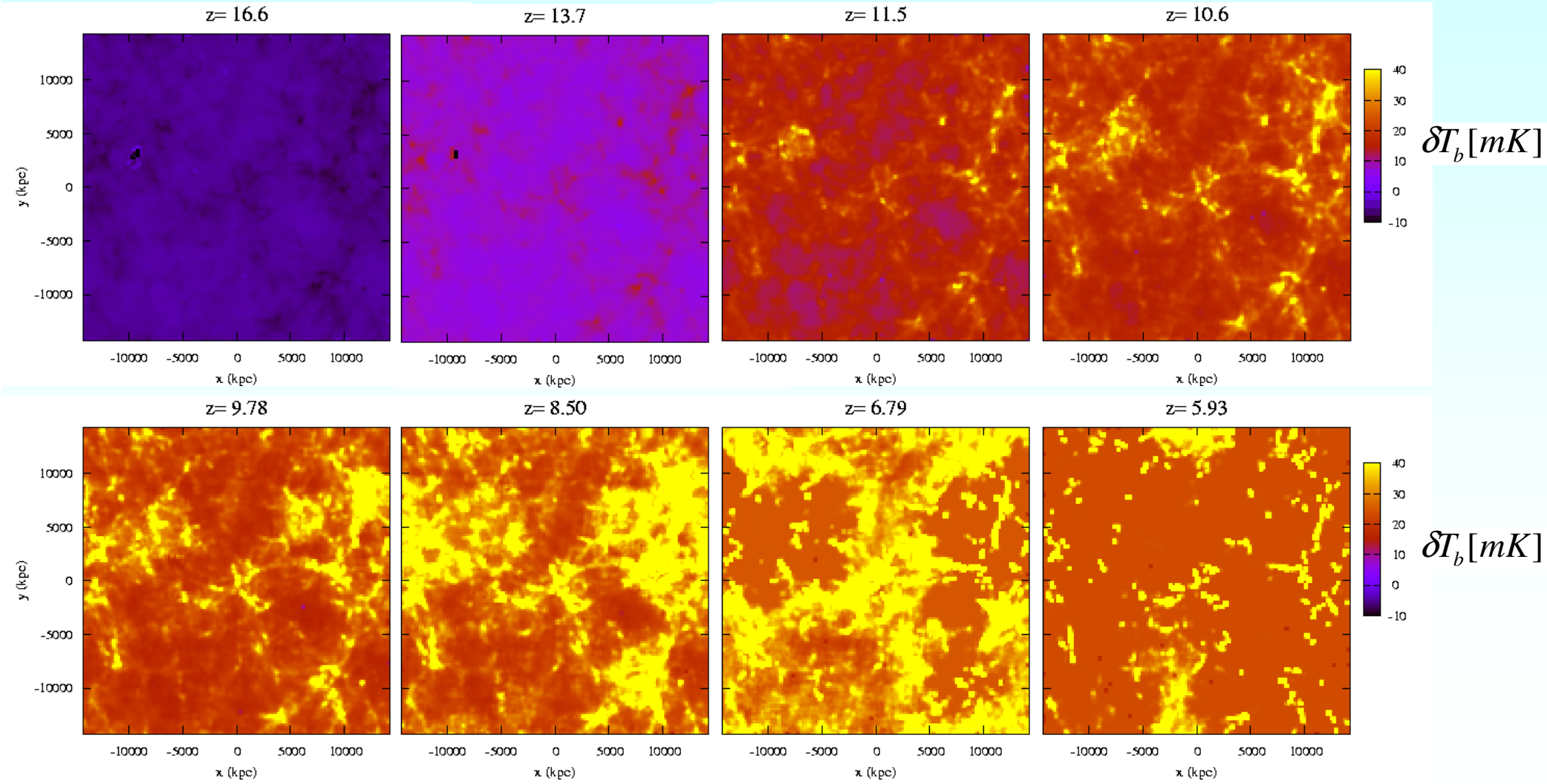
RT code: LICORICE

Monte-Carlo radiative transfer code, with adaptive resolution based on SPH particles.

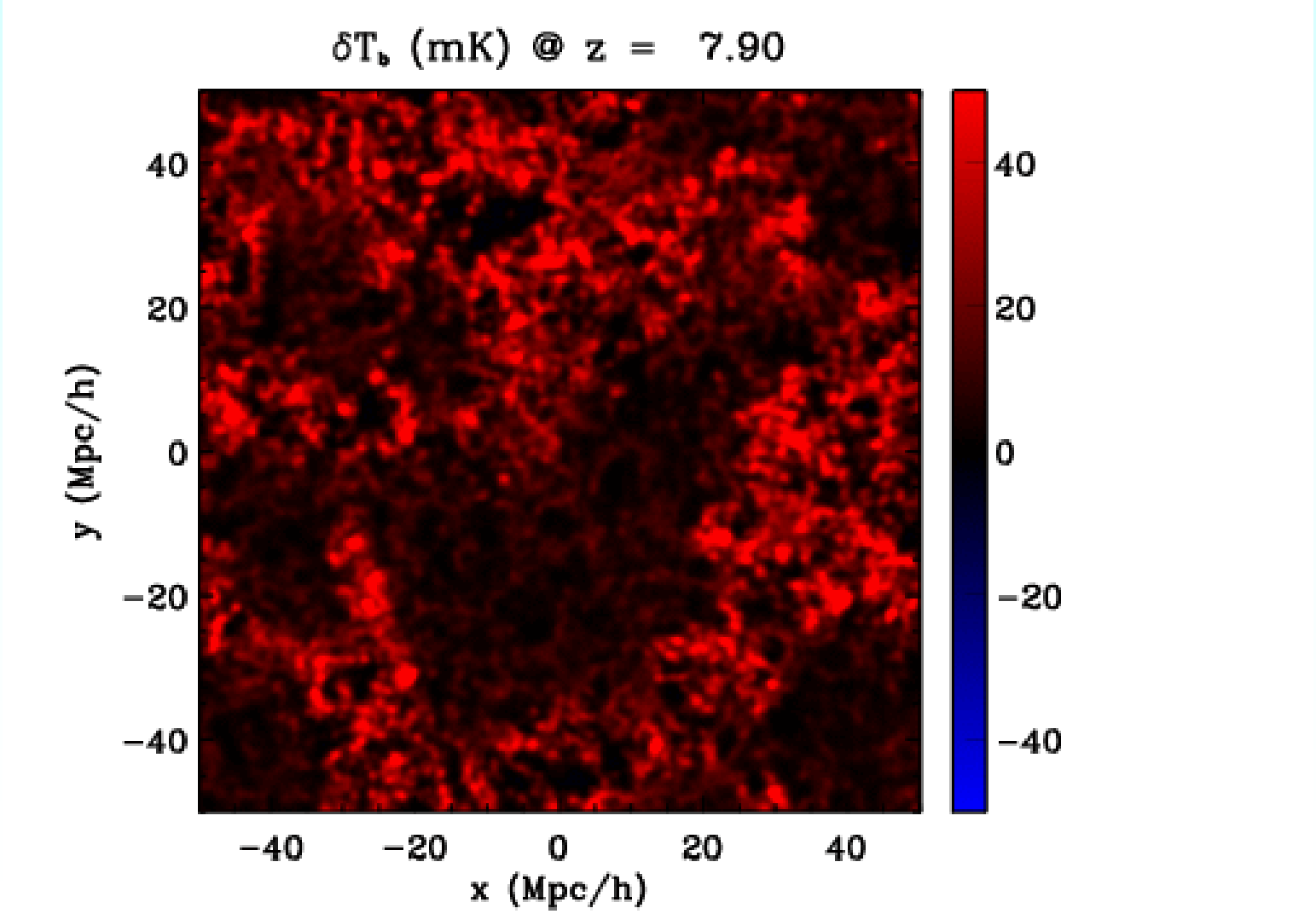
Semelin et al



Differential brightness temperature



Brightness temperature maps



Maps from Lisbon team

Santos et al

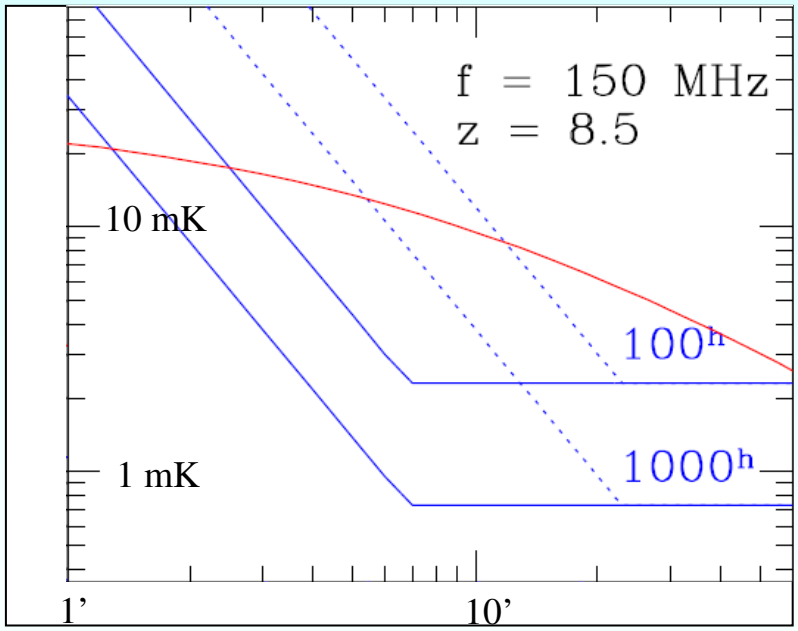
Observation of the 21 cm signal with SKA

SKA will deliver a complete tomography of the 21-cm emission

Difficulty at low frequency
beginning of reionisation
z=15

Necessity to extend to low frequency

- LOFAR: $6 < z < 20$
- **SKA: $z < 13$ (23)**

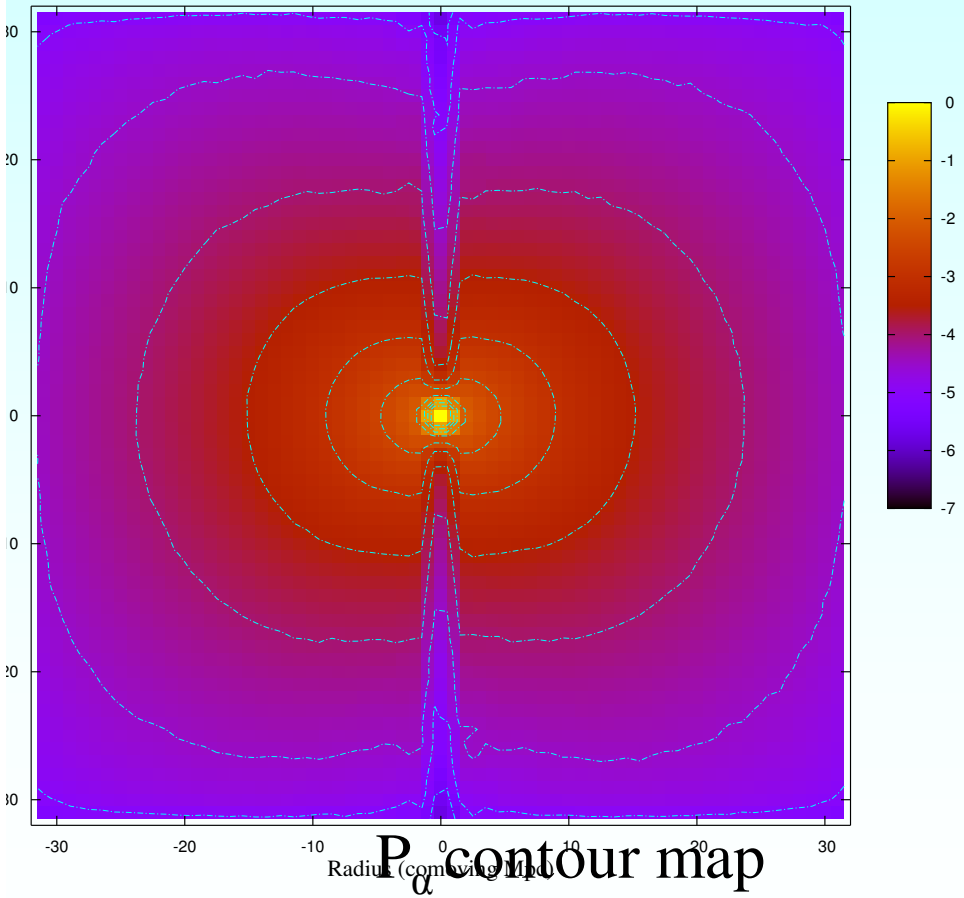


Furlanetto et al. 2004

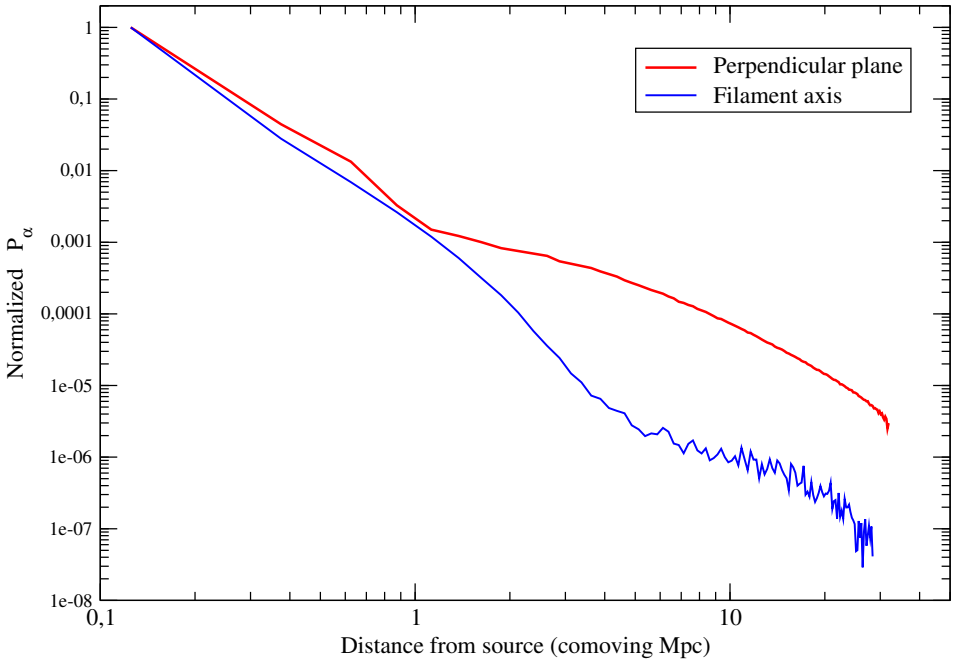
- LOFAR: 6' cluster size
- **SKA: 1'.**

Lyman-alpha simulations: Examples of new fluctuations

(Semelin et al. 2007)



P_α contour map



P_α profiles ∥ and ⊥ to the filament

- Density: vertical cylindrical filament 64 times denser than homogeneous background
- Central source: flat spectrum