

# RadioAstronomy @ Pt

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## **Key Science Projects**

astrophysics

astrobiology

fundamental physics

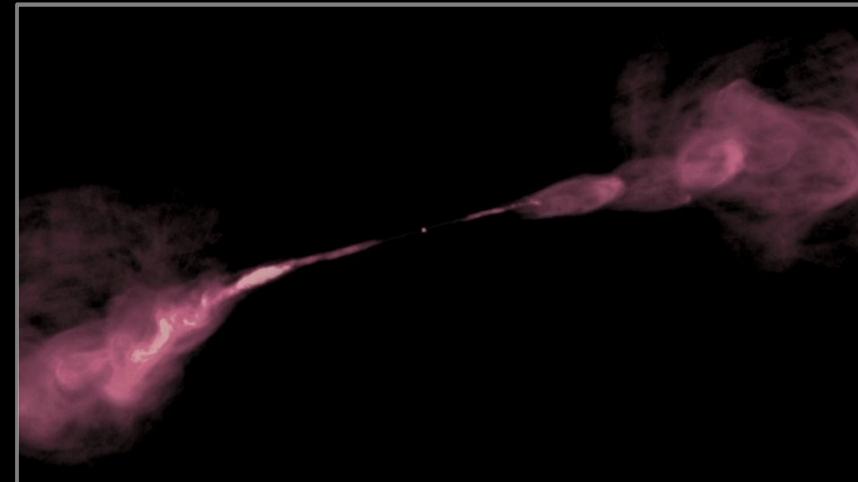
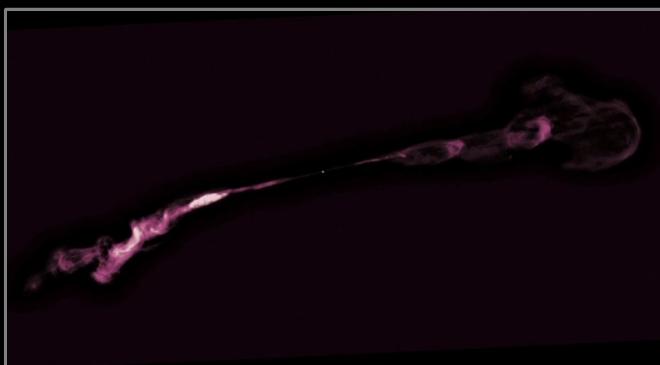
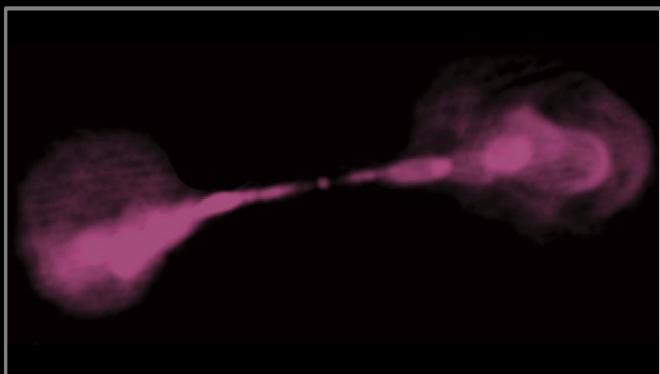
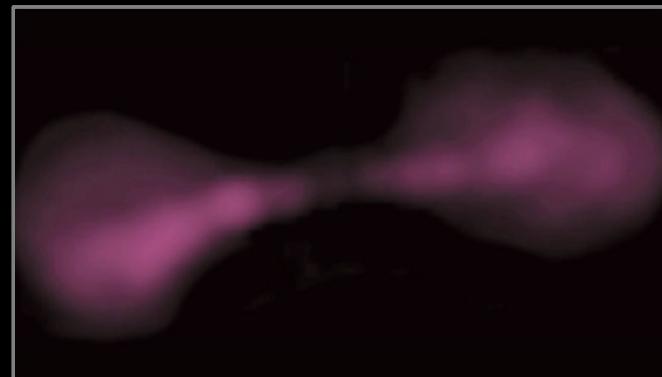
The History of the Universe through neutral hydrogen  
First Stars & Galaxies  
Galaxy Evolution  
Dark Energy & Dark Matter  
  
Cradle of Life

General Relativity & Gravitational Waves  
Origin & cosmic magnetism evolution



BIG questions → need BIG infrastructures → need HIGH technology →  
HIGH impact in society → economic wealth; training scientists & engineers; innovation

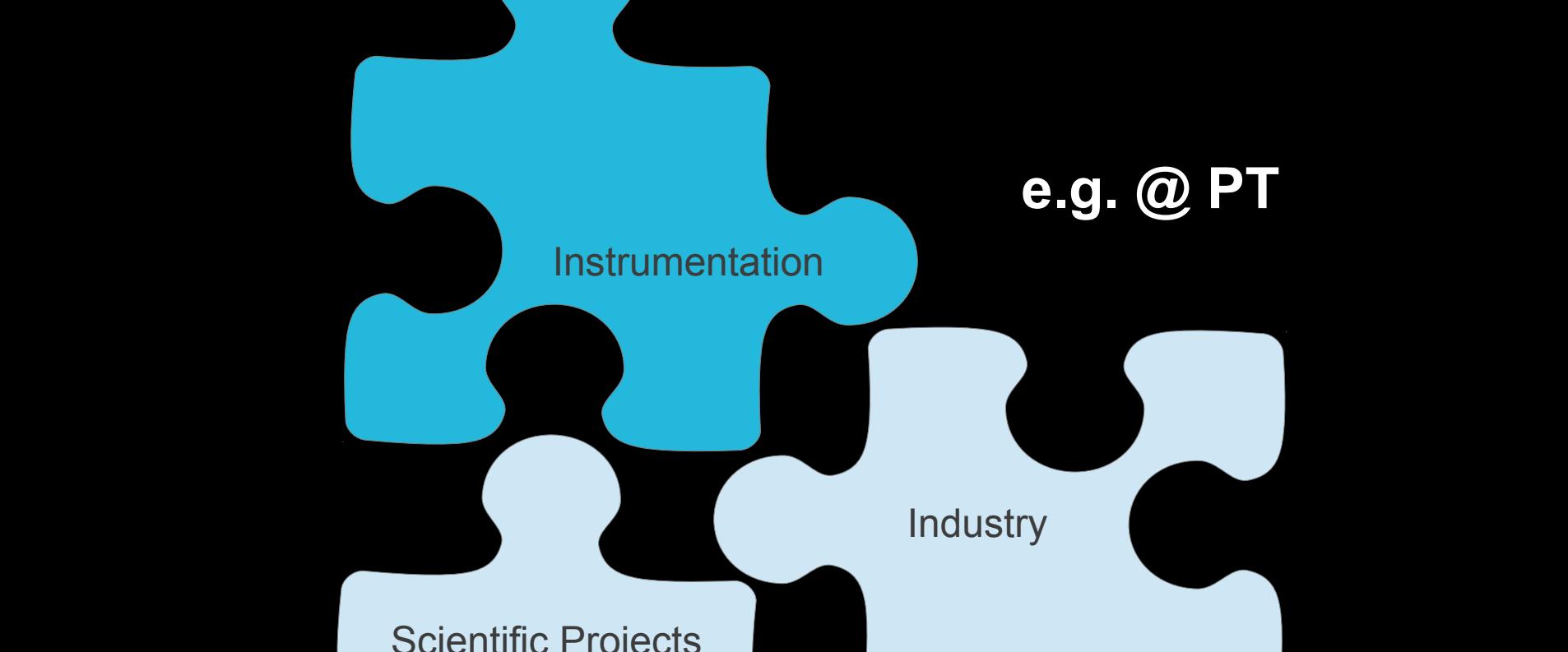




+ optical image



Hercules A – VLA NRAO



e.g. @ PT

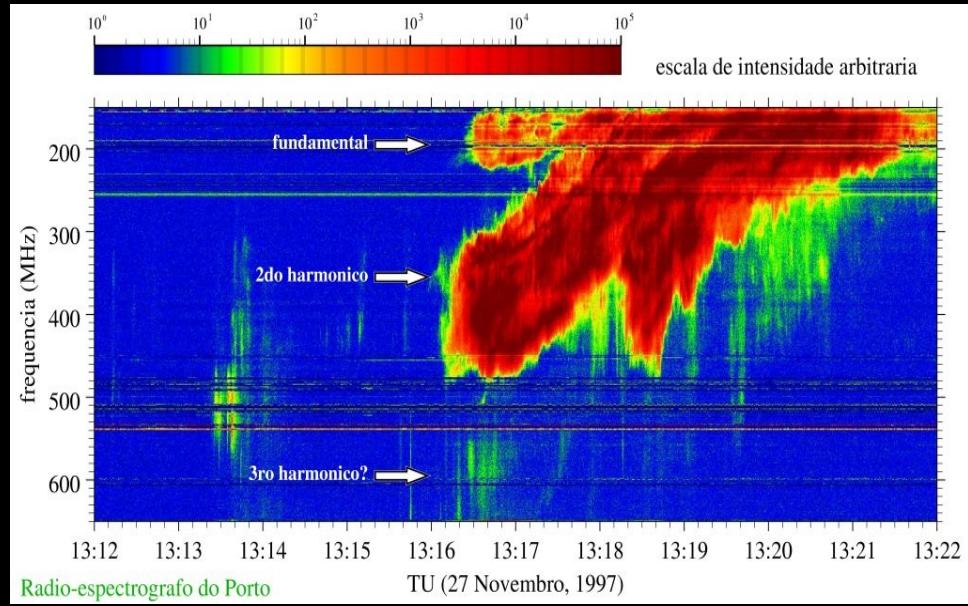
Instrumentation

Industry

Scientific Projects

Large International  
Collaboration

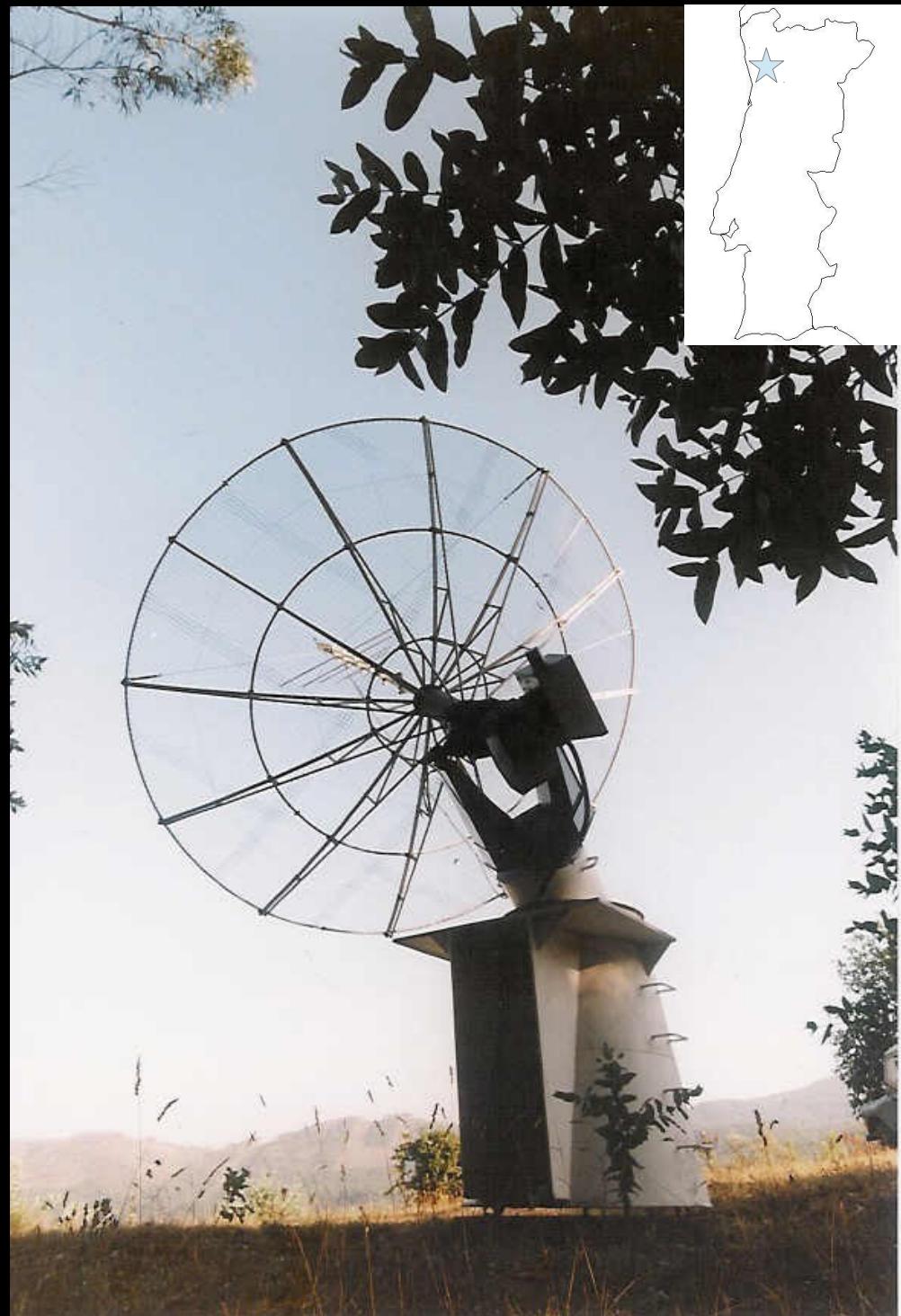




shock wave in solar corona, vel  $\sim$ 1000 km/s,  
emission mechanism: plasma

**Maia et al**  
**University of Porto**

## Solar Radio Spectrograph





9-m Cassegrain antenna for C-band observations

University of Aveiro

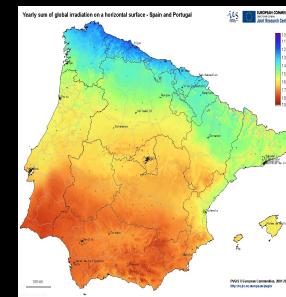
Pampilhosa da Serra



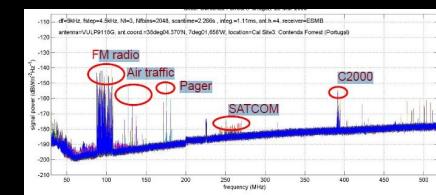
BIOSTIRLING-4SKA

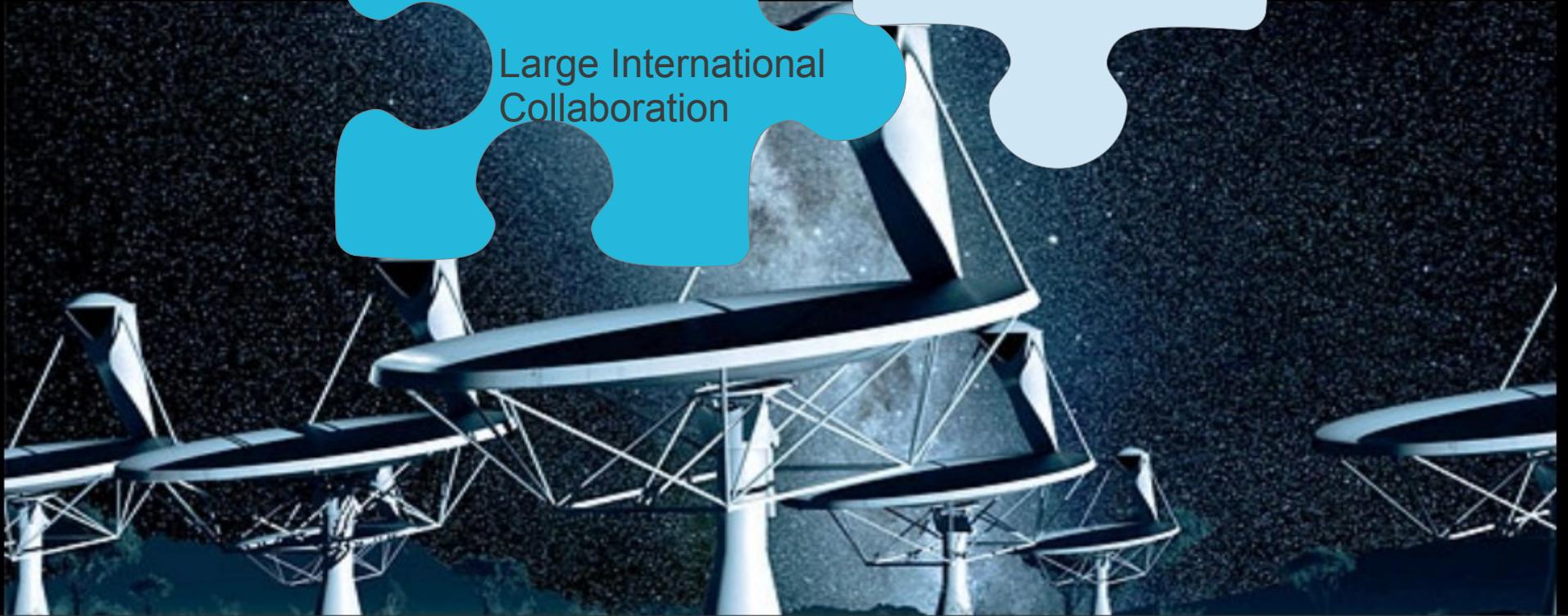
Lourdes Montenegro talk

## Test -site @ Moura Herdade da Contenda



+





Software

Instrumentation

e.g. @ PT

Industry

Scientific Projects

Large International  
Collaboration

# relatively young scientific community



International flavour at Postgraduate Bursary

28 November 2012 - The annual Conference isn't just about presenting projects. It also provides a chance for the world to meet up again, for valuable friendships to be strengthened. »

Workshop

The SKA: a large scale ESFRI infrastructure, from the cosmos to the cities of the future

30 November 2012, Portugal

An event to present the SKA and radioastronomy to the European community, policy makers and African collaborators.

**SKA AFRICA**  
SQUARE KILOMETRE ARRAY

29-Nov-2012



relatively young scientific community ... but quite active

**XXXIX Young European Radio Astronomers Conference**

Faculty of Sciences -- University of Porto -- Portugal

**YERAC - 2009**



Astrophysics and Space Science Proceedings

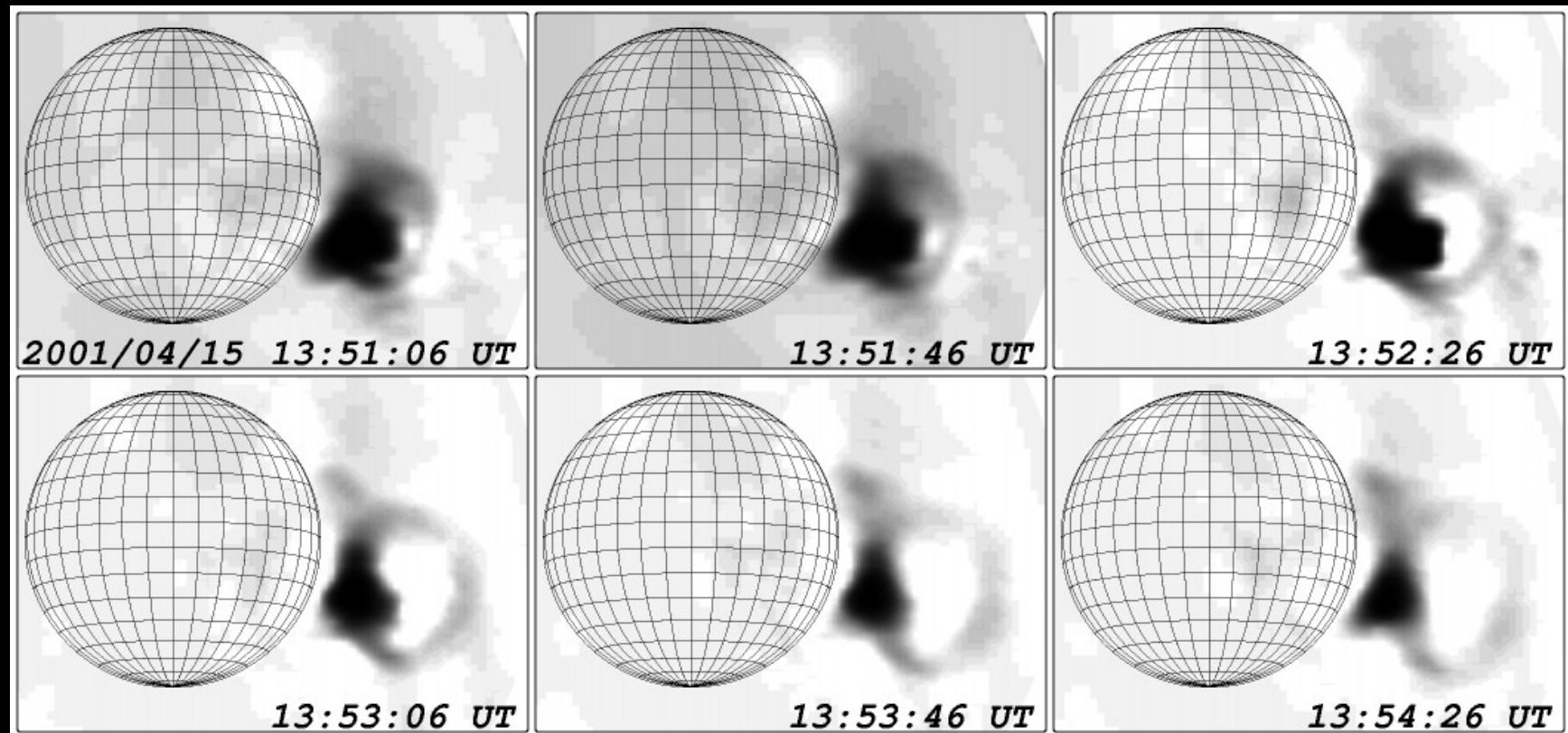
Domingos Barbosa  
Sonia Anton  
Leonid Gurvits  
Dalmiro Maia *Editors*

**The Square Kilometre Array: Paving the way for the new 21st century radio astronomy paradigm**

Proceedings of Symposium 7  
of JENAM 2010

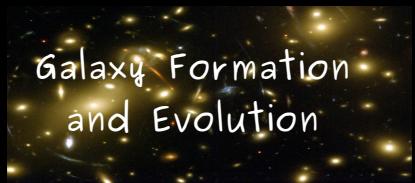
Springer





410 MHz – Nançay radioheliograph  
radio loop propagating outwards in the solar corona at  $\sim$ 1700 km/s. emission mechanism:  
giro-synchrotron/synchrotron, with strong razin suppression, peak at  $\sim$ 800MHz

Maia et al 2007

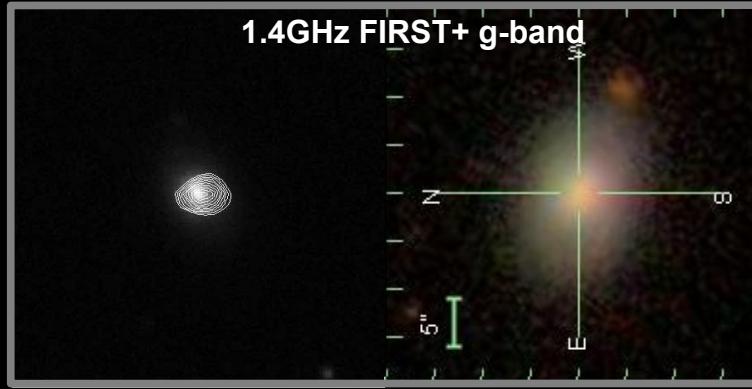


Galaxy Formation  
and Evolution



The Very Large Array (VLA)

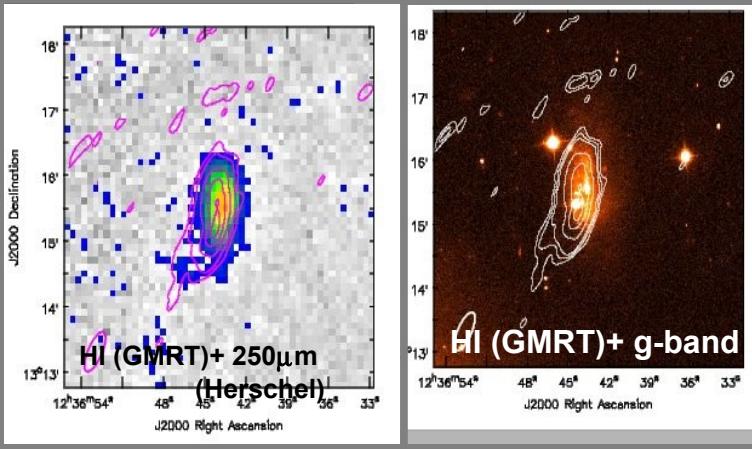
Photo courtesy NRAO



Bulgeless Galaxies - AGN content  
Lobo, Anton, Coelho, 2012



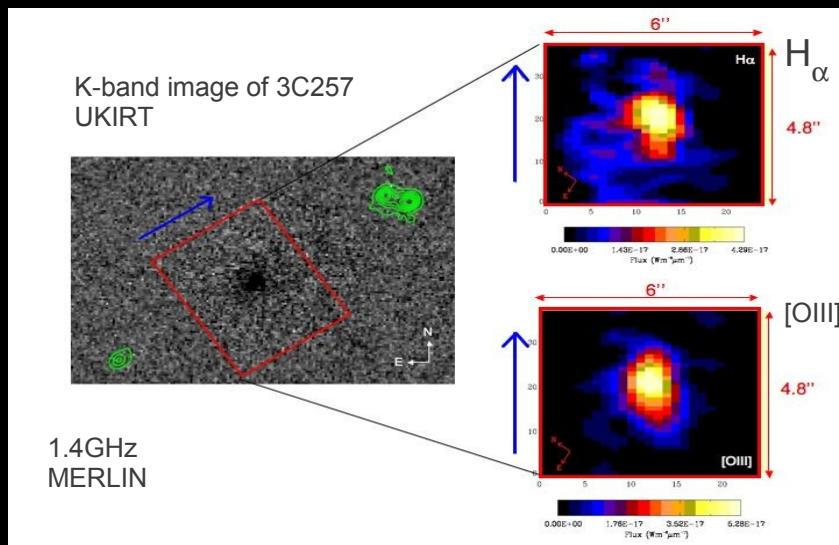
GMRT – Giant Metrewave Radio  
Telescopes --India



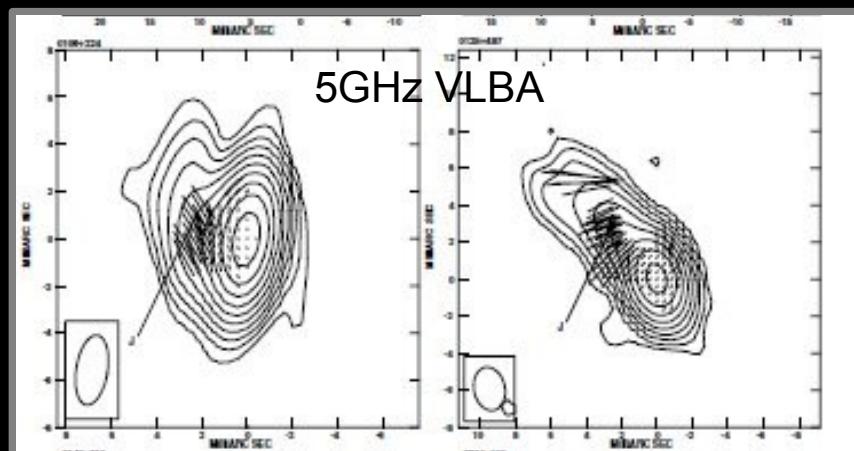
Dwarf Galaxies – Dust and HI content  
Grossi, Coelho, 2013



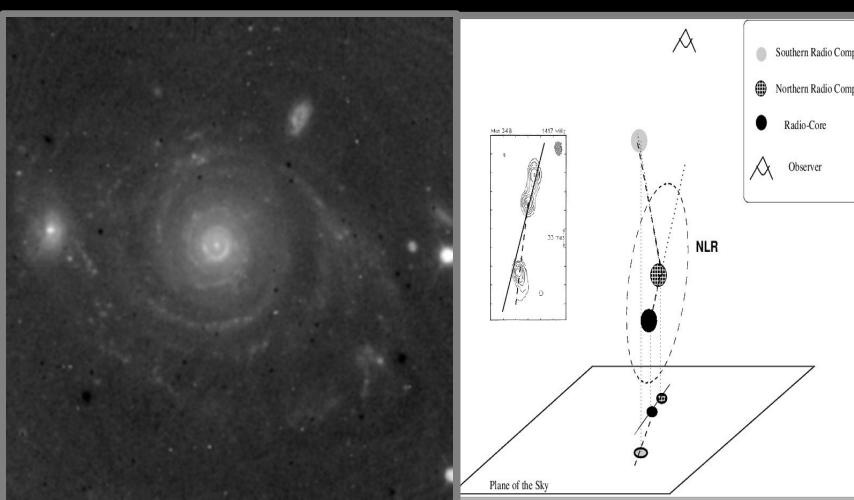
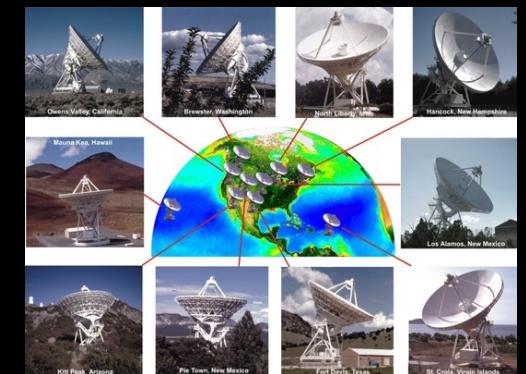
Sky deep survey @ ASKAP  
Norris, Hopkins, Afonso et al 2011



Radio Galaxies  
Fernandes et al 2012

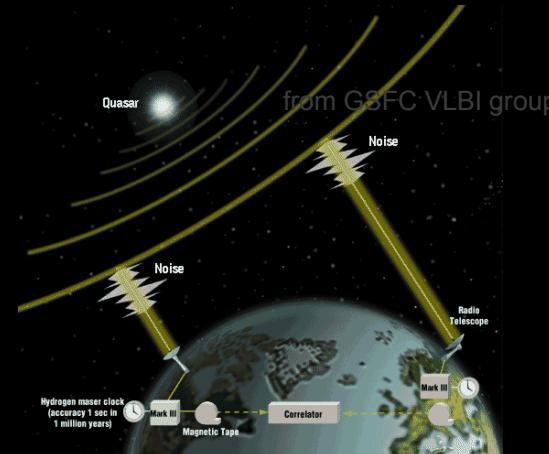


Blazars and passive elliptical  
galaxies  
Bondi, Marchā, et al 2004

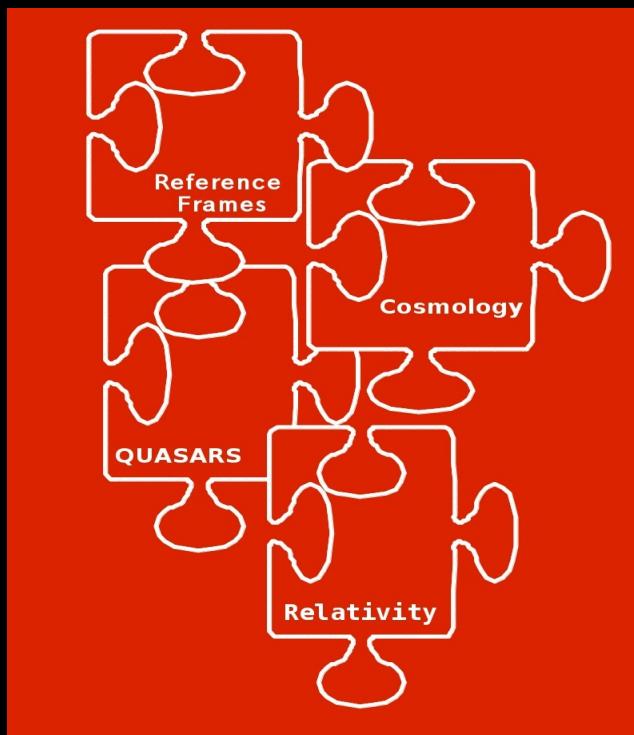


Radio Intermediate objects  
Antón et al 2002

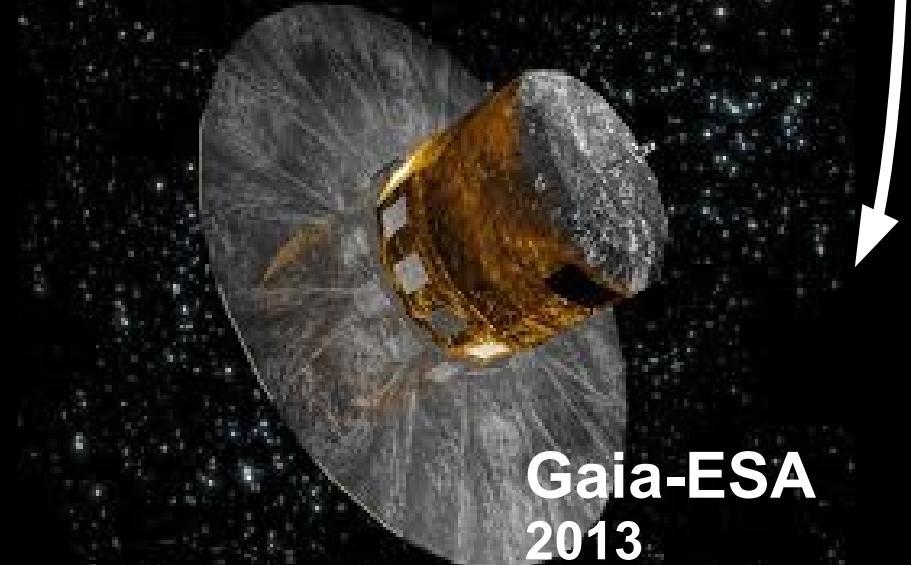


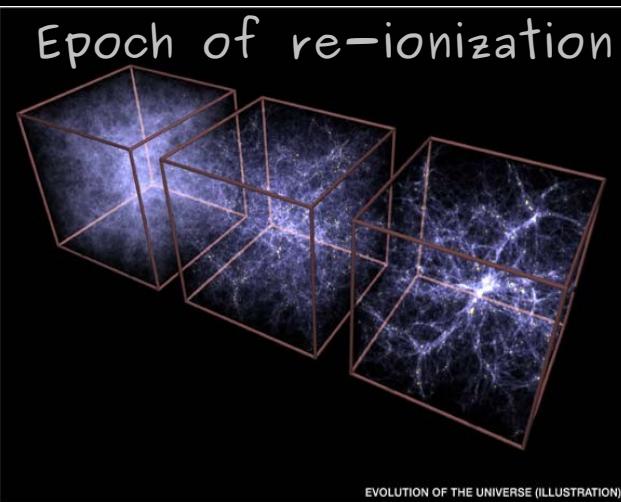


International Celestial Reference Frame



Gaia Celestial Reference Frame

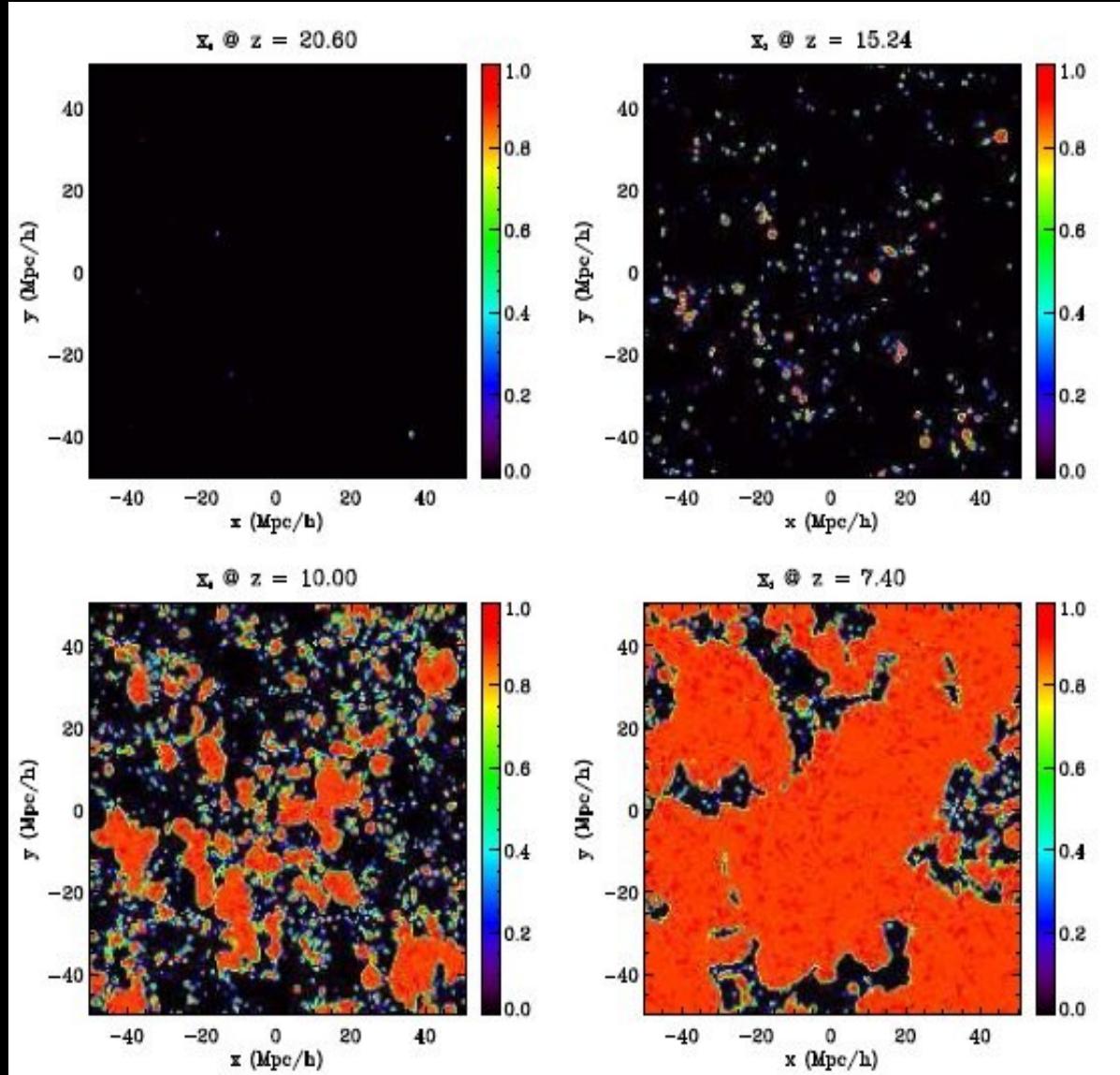




## SimFast21

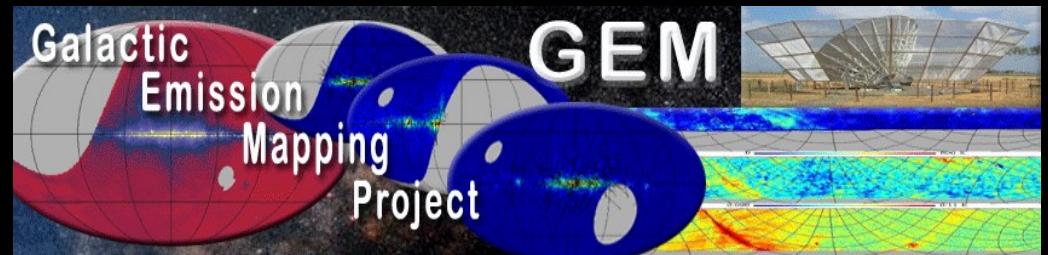
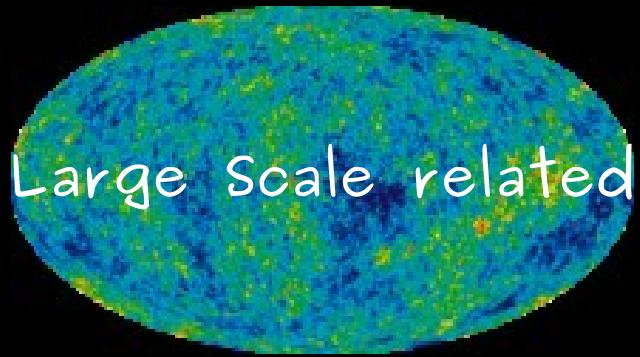
generate simulations of the  
high redshift 21cm signal

Copyright 2010 Mario Santos, Luis  
Ferramacho, Marta Silva, Alexandre  
Amblard, Asantha Cooray

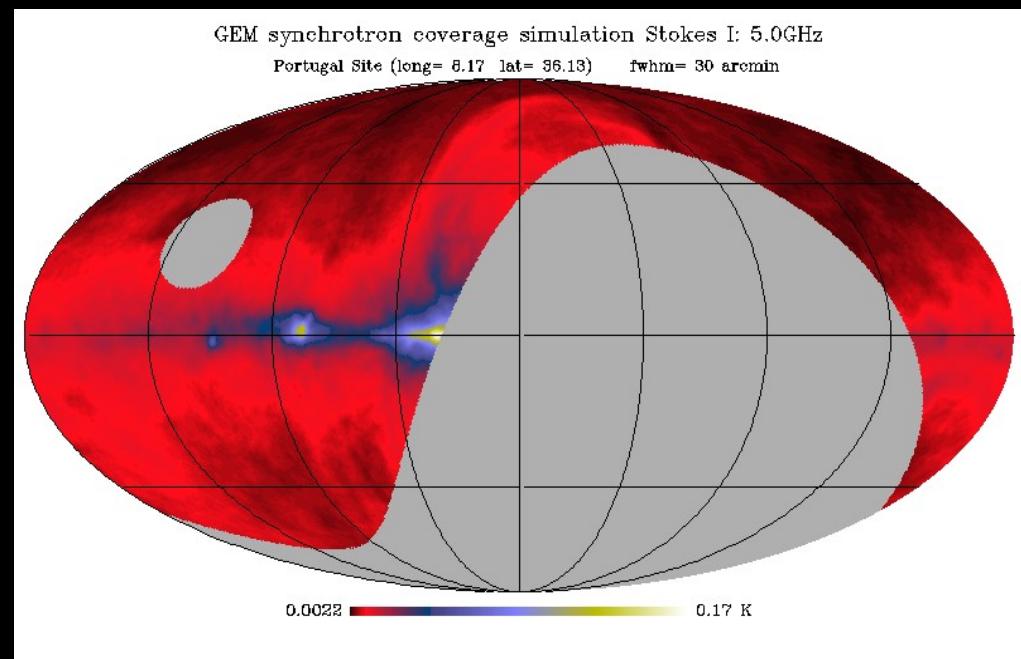


Maps of the ionization fraction from the simulation at  
 $z = 20.60, 15.24, 10.00, 7.40$

Santos et al 2008



5GHz total and in polarisation radiation emitted by the Milky Way galaxy and by the unresolved blend of external galaxies.



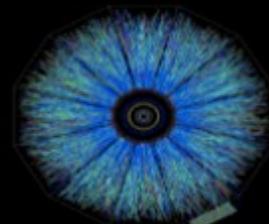
Barbosa et al  
IT, Aveiro



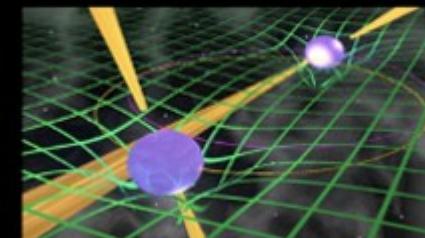
Square Kilometre Array Design Studies

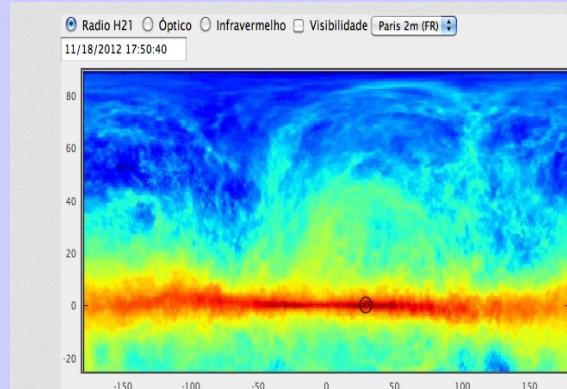


Preparatory phase Proposal for the Square Kilometre Array



BLACK HOLES IN A VIOLENT UNIVERSE  
ACTION MP0905





## Connecting Classrooms to the Milky Way

A “Hands on the Universe” project funded by Comenius –  
Europe in the classroom – see Doran's talk

**First European network of radiotelescopes for education  
students explore the Milky Way through Internet**



e.g.



Pulsar Discovery, 2010 Science

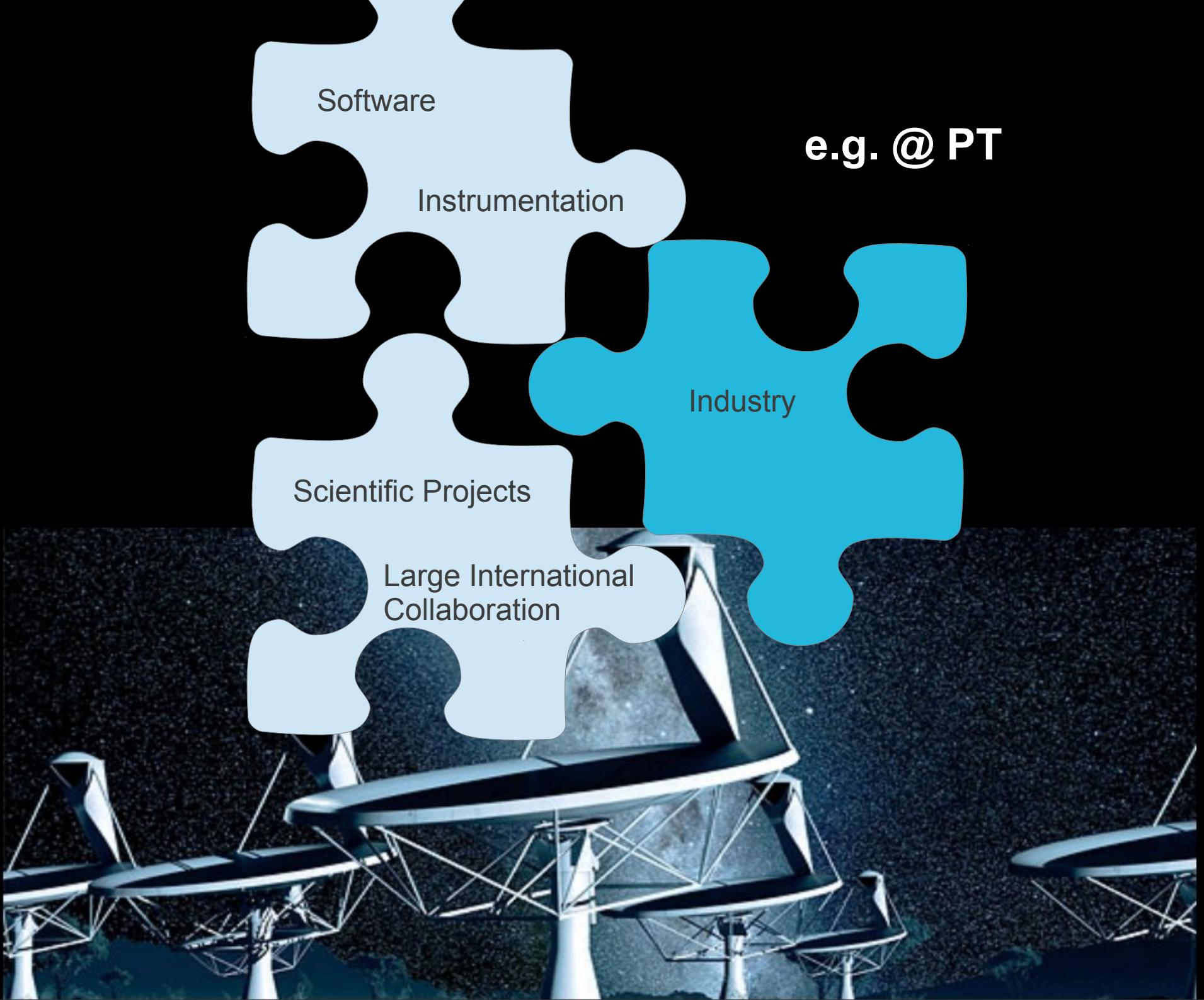


Search for Extraterrestrial Intelligence



**Computer power of hundreds of thousands of volunteers from 192 countries to mine large data sets**





Software

e.g. @ PT

Instrumentation

Industry

Scientific Projects

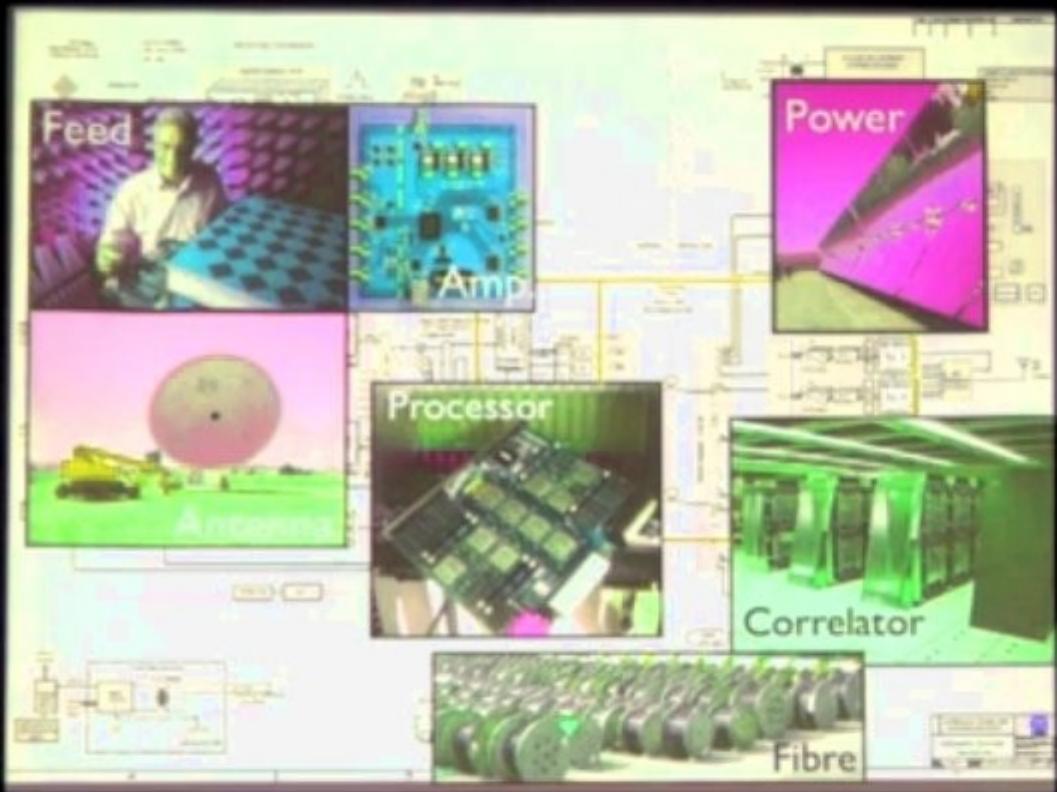
Large International  
Collaboration

# SKA == multi-parameter space infrastructure

engineering, electronics, telecommunications, power-supply, software development, ....

Competence and Convergence in  
Instrumentation, Software, Future Internet, Space technologies and Green Energies

e.g.



Brian Boyle – SKA presentation @ ICRAR

## Nokia Siemens networks

Exabyte technology - Large data transmission;  
Beam forming technologies

## Martifer

Power Investigation Task Force

## Logica – BIOSTIRLING 4SKA

efficiency and reduction of costs of solar dish systems



ENERGYIN

PÓLO DE COMPETITIVIDADE  
E TECNOLOGIA DA ENERGIA

# Radio Astronomers



What society thinks we do



What optical astronomers  
think we do

-  The Nobel Prize in Physics 1974  
Martin Ryle, Antony Hewish
-  The Nobel Prize in Physics 1978  
Pyotr Kapitsa, Arno Penzias, Robert Woodrow Wilson
-  The Nobel Prize in Physics 1993  
Russell A. Hulse, Joseph H. Taylor Jr.
-  The Nobel Prize in Physics 2006  
John C. Mather, George F. Smoot

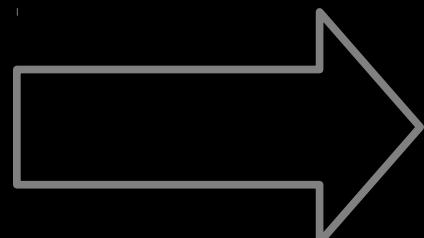
What we think we do



What governments think we do



What we'd like to do



**Portugal**



**South-Africa**



**Australia**



thank you