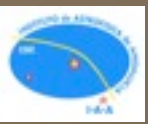


NUEVAS APLICACIONES: EL SQUARE KILOMETRE ARRAY

LOURDES VERDES-MONTENEGRO

JUAN DE DIOS SANTANDER

INSTITUTO DE ASTROFÍSICA DE ANDALUCÍA (CSIC)
GRANADA



QUICK OVERVIEW OF SKA

WHAT WILL SKA BE?

A revolutionary radio telescope made of 1000s of receivers
Linked together across an area the size of a continent.

Total combined collecting area: **1 KM²**



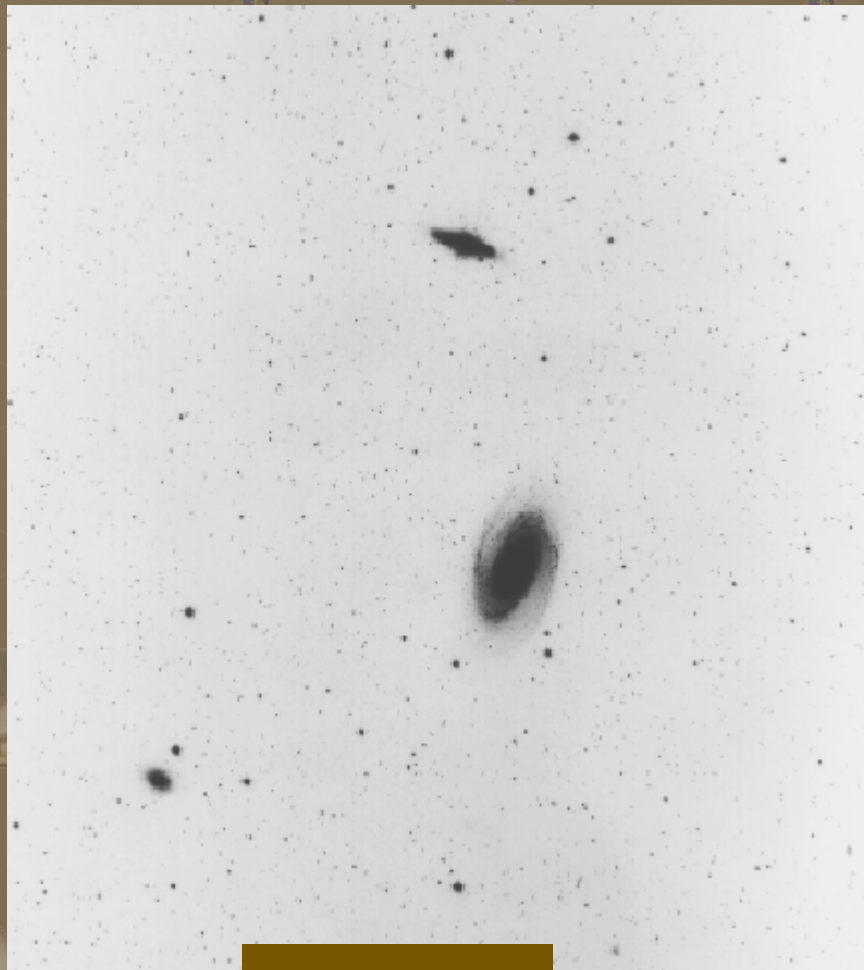
**THE LARGEST AND MOST SENSITIVE RADIOTELESCOPE
EVER BUILT**



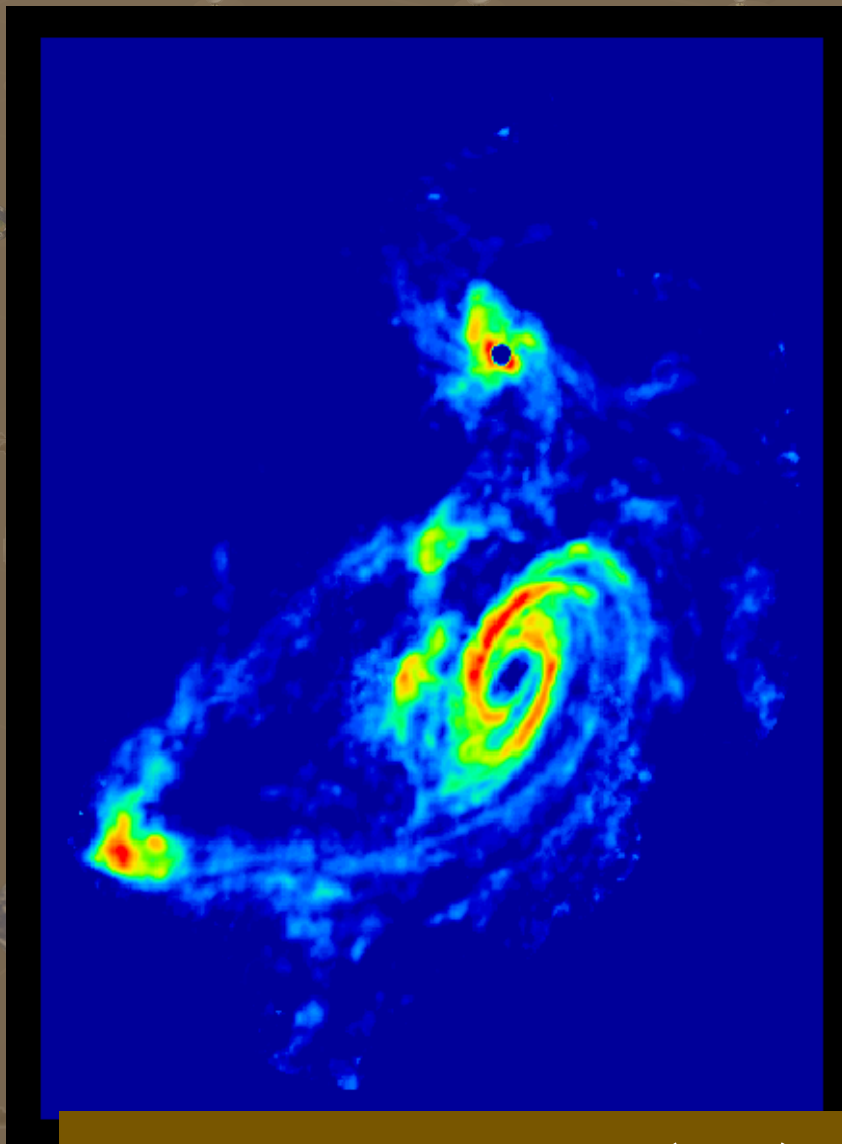
WHAT FOR?: KEY SCIENCE

- HISTORY OF HI (ATOMIC GAS): REIONIZATION - TODAY
 - GRAVITY TEST
 - ORIGIN & EVOLUTION OF COSMIC MAGNETISM
 - PROTOPLANETARY DISKS
- 
- The background features a large, glowing galaxy with a prominent central bar and a surrounding spiral structure. In the foreground, a grid of Earth-like planets is shown, each with a radio dish antenna pointing towards the galaxy. The overall color palette is a mix of brown, tan, and blue.

- HISTORY OF HI (ATOMIC GAS): REONIZATION - TODAY



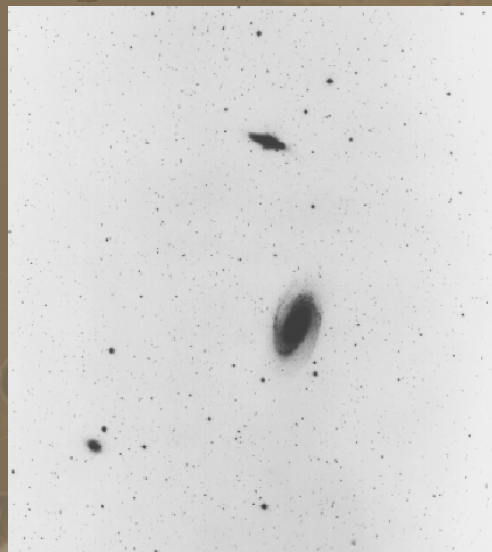
STARS



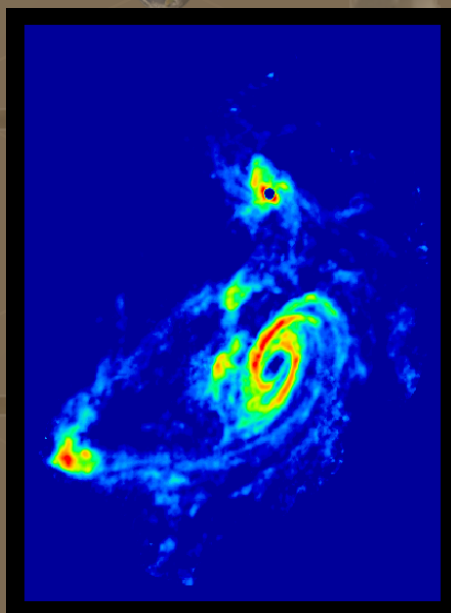
ATOMIC GAS (HI)

WHAT FOR?: KEY SCIENCE

- HISTORY OF HI (ATOMIC GAS): REONIZATION - TODAY



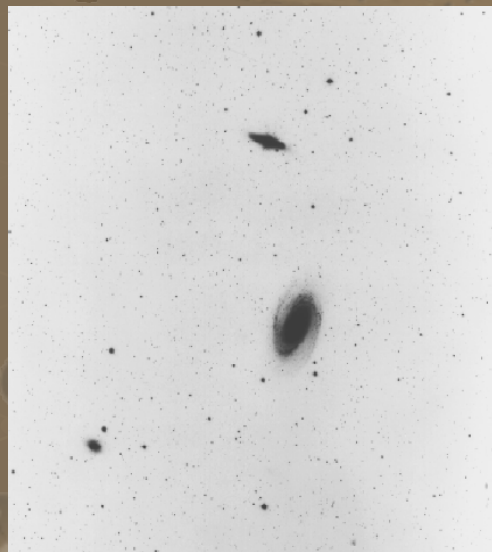
Estrellas



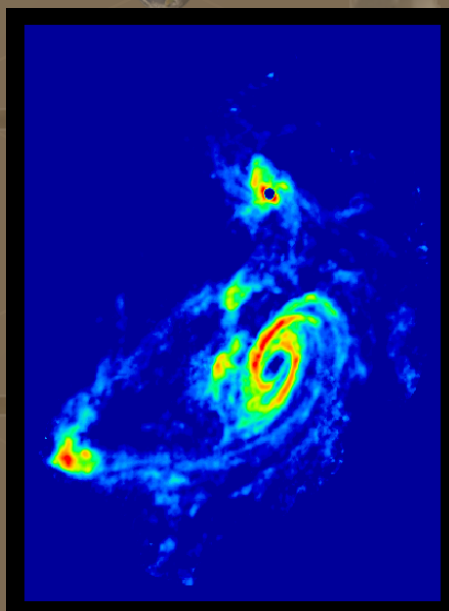
Gas atómico

WHAT FOR?: KEY SCIENCE

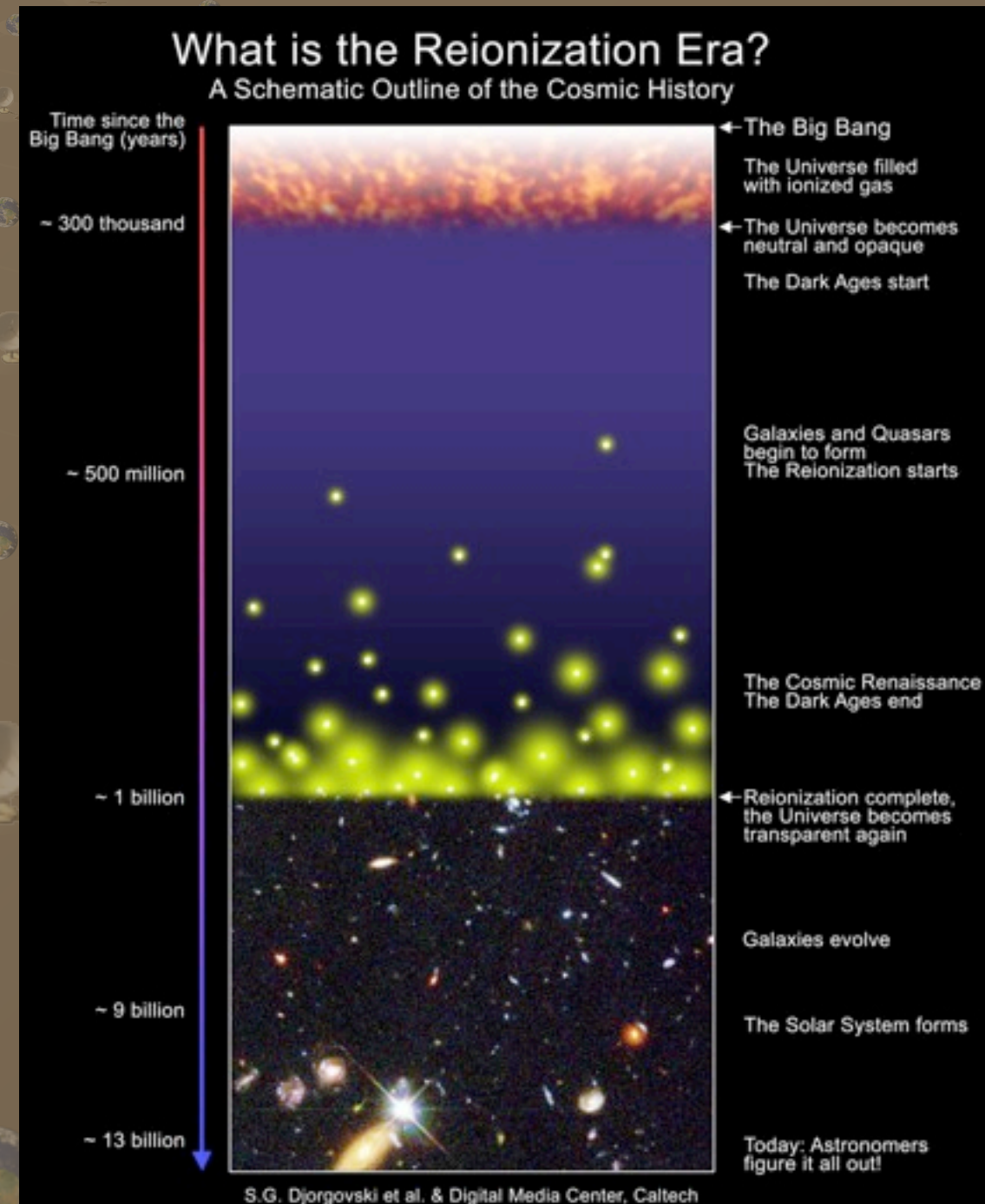
• HISTORY OF HI (ATOMIC GAS): REIONIZATION - TODAY



Estrellas

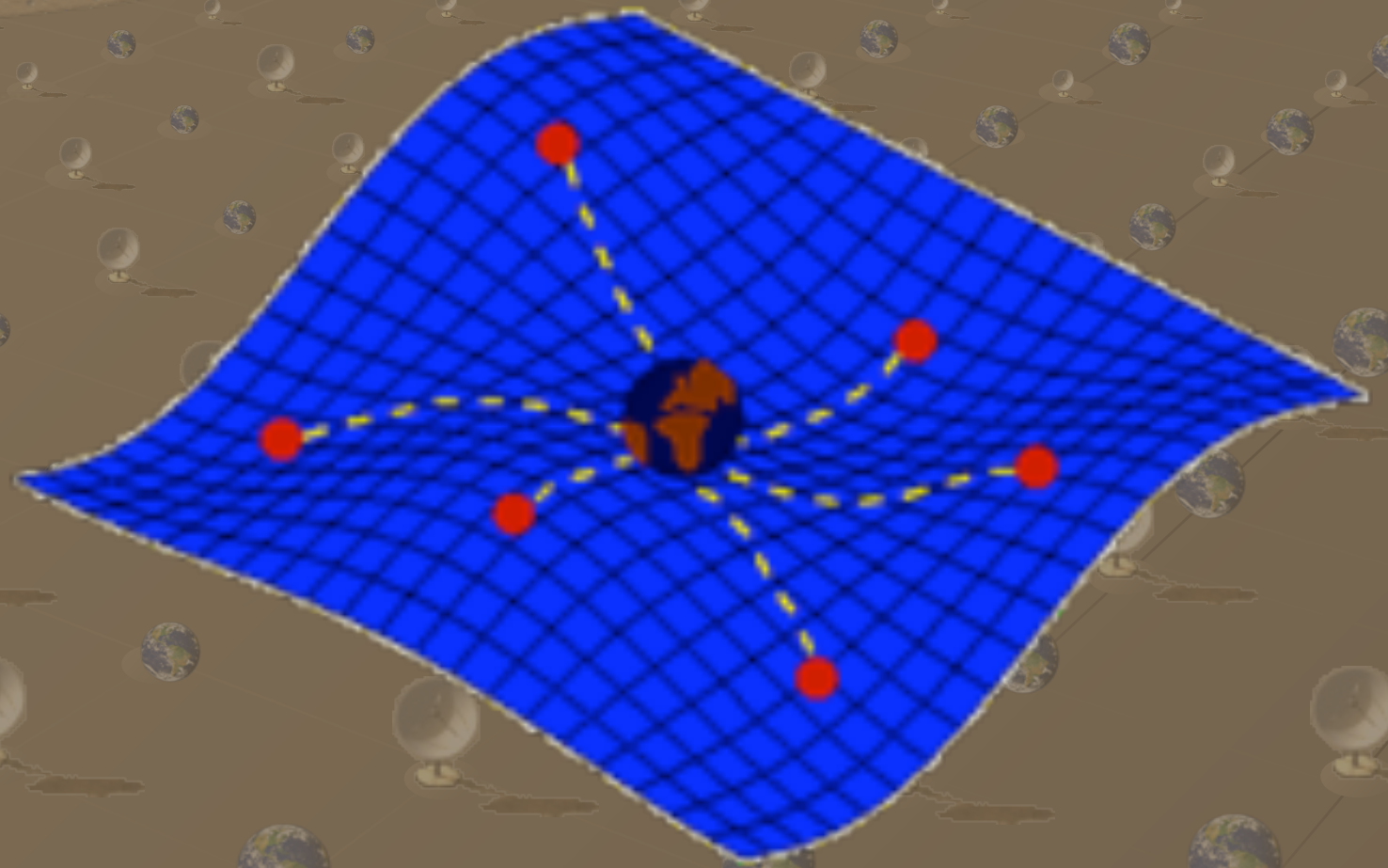
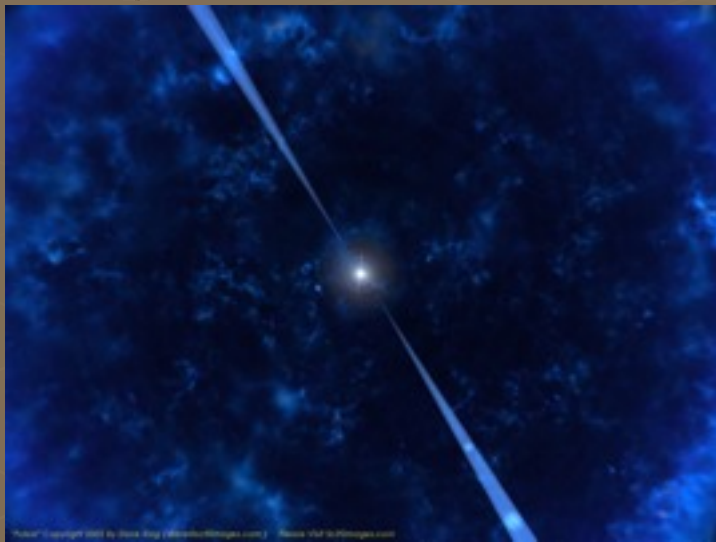


Gas atómico



WHAT FOR?: KEY SCIENCE

● GRAVITY TEST



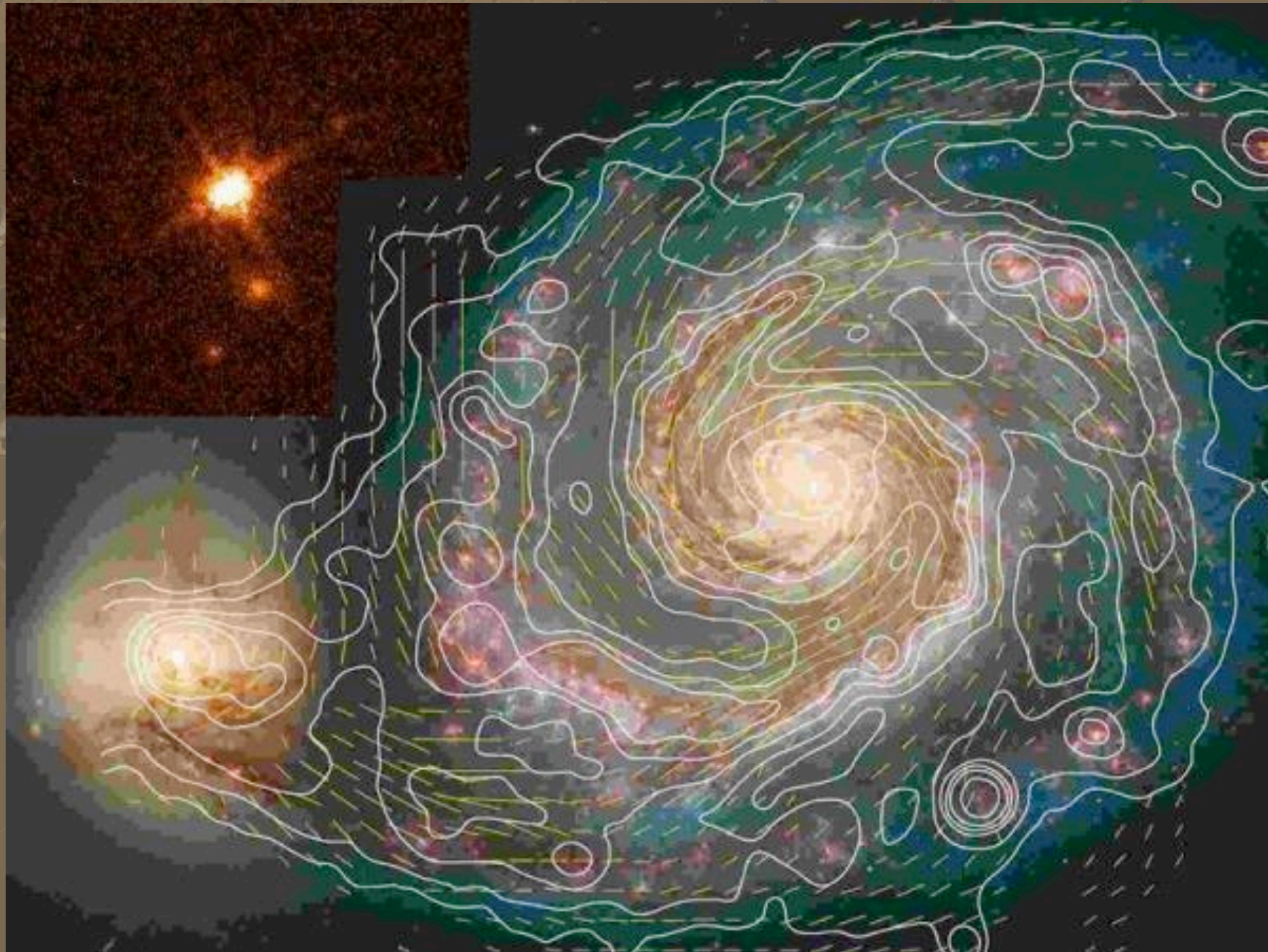
LISA : FREE-FALLING MASSES IN SPACECRAFT

LIGO: SUSPENDED MIRRORS

SKA: FREE FALLING MILLISEC PULSARS

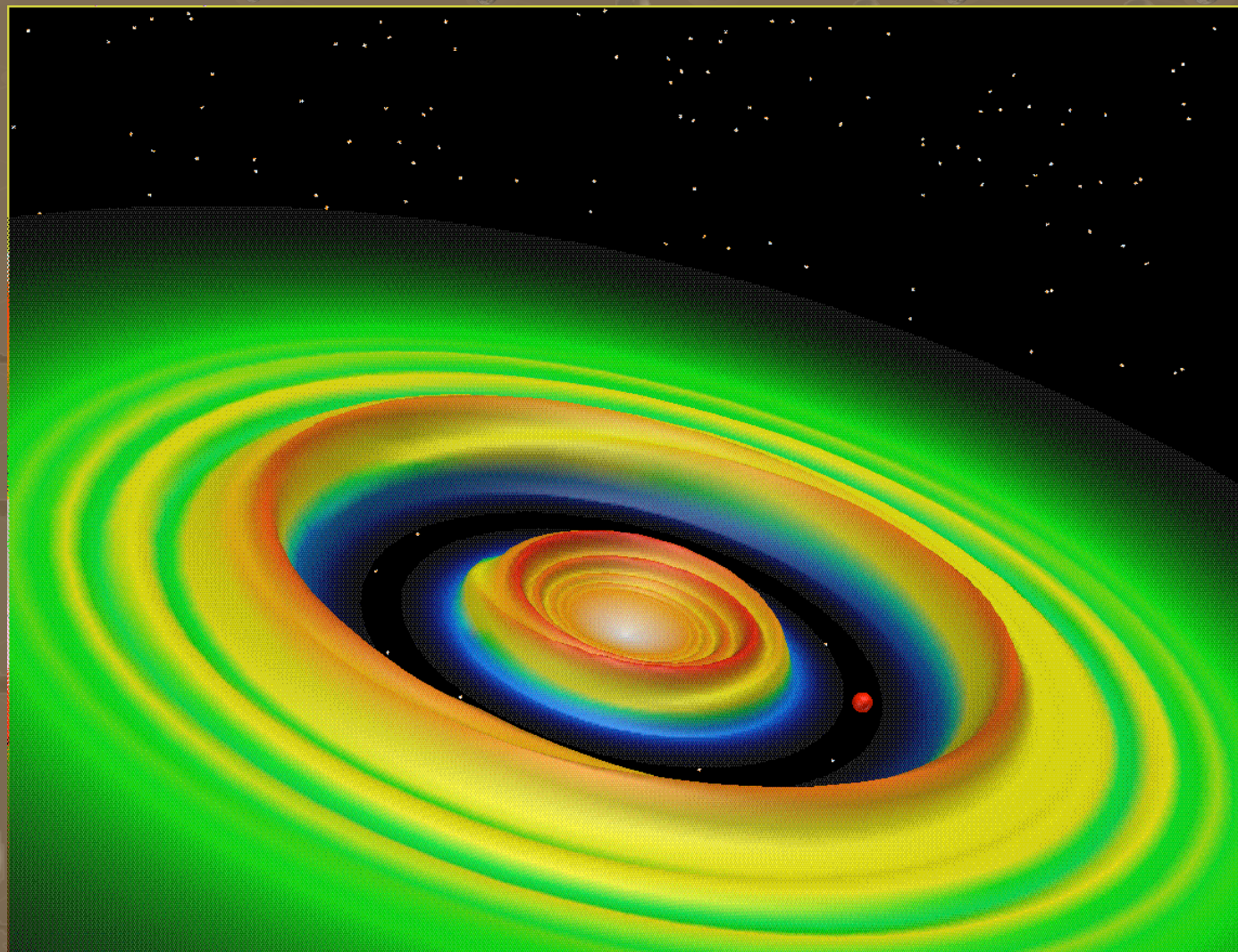
WHAT FOR?: KEY SCIENCE

- **ORIGIN & EVOLUTION OF COSMIC MAGNETISM**



WHAT FOR?: KEY SCIENCE

- **PROTOPLANETARY DISKS**



QUICK OVERVIEW OF SKA

- 1000 -1500 antennas x15m in 5km
- 1000 -1500 antennas x15m up to 3000 km

70 MHz - ≥ 25 GHz
4-3m - 1.2 cm

200 - 1 SQ² FOV
0.1'' - 0.001'' resolution

INTERFEROMETER CAN BE BUILT INCREMENTALLY

- **SKA1** = 10% collecting area, 70 Mhz - 3 GHz , 350 M€, 2016 -2019
- **SKA2** = 100% collecting area, 70 - 100 GHz, ~1100 M€, 2018 -2023
- **SKA3** High frequencies: ≥ 25 GHz. No defined dates
- Operational costs 100 M€/yr, European contribution ~ 40%

QUICK OVERVIEW OF SKA

EVOLVING QUICKLY (20 countries involved) **2010-2012-2015**

- Organizational structure defined, SPO Jodrell Bank
- Preparatory Phase:
 - **Definition - March 2012**
- Pre-Construction Phase 1:
 - Stage 1: **Preliminary Design 2012**
 - Stage 2: **Detailed Design 2013-2015**

QUICK OVERVIEW OF SKA

Preparatory Phase:

- Approval of funding for completion of Preparatory Phase and Pre-Construction activities
 - Establishment of a **legal entity** for the SKA Organisation
 - **Selection of the SKA site: Australia vs South Africa**
- 
- The background of the slide features a repeating pattern of SKA radio telescope dishes and Earth globes. The dishes are arranged in a grid-like pattern, and the globes are interspersed between them. The overall color scheme is a muted, brownish-grey.

QUICK OVERVIEW OF SKA

Preparatory Phase:

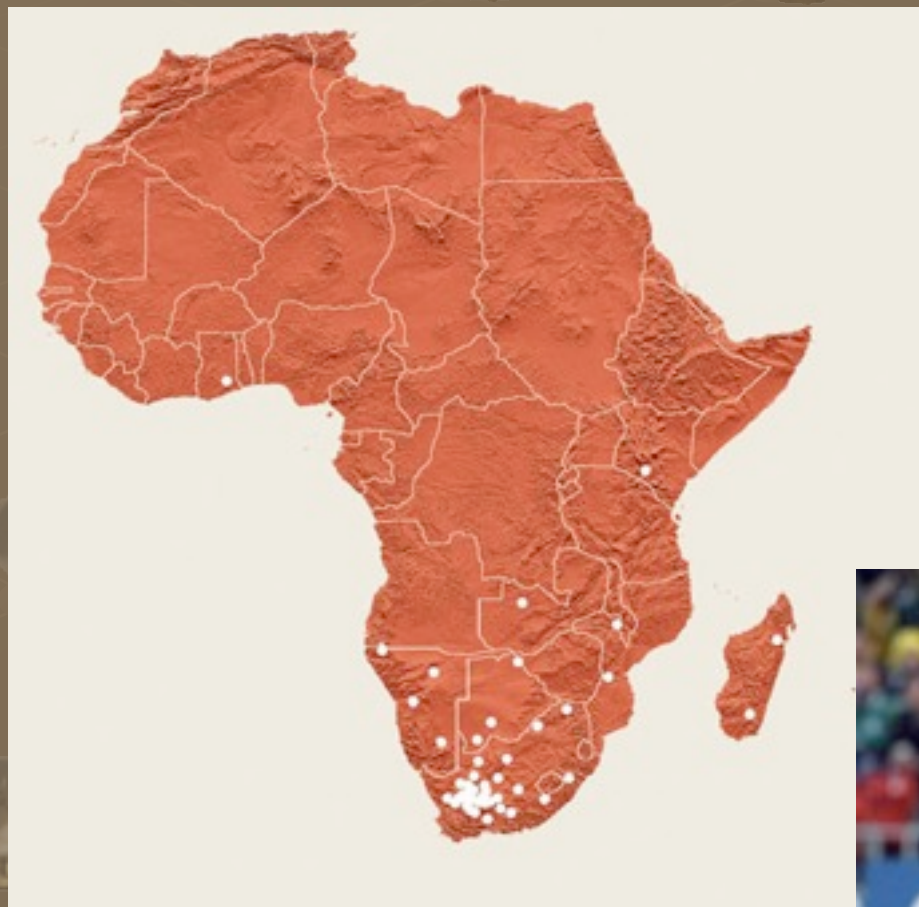
- Approval of funding for completion of Preparatory Phase and Pre-Construction activities
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- **Selection of the SKA site: Australia vs South Africa**



QUICK OVERVIEW OF SKA

Preparatory Phase:

- Approval of funding for completion of Preparatory Phase and Pre-Construction activities
- Establishment of a **legal entity** for the SKA Organisation
- **Selection of the SKA site: Australia vs South Africa**



QUICK OVERVIEW OF SKA

Preparatory Phase:

- Approval of funding for completion of Preparatory Phase and Pre-Construction activities
- Establishment of a legal entity for the SKA Organisation
- Selection of the SKA site: Australia vs South Africa
- **Work Breakdown Structure + Statement of Work for end of March 2012**



- Overview of scope of work for Pre-Construction Stage 1
- Overview of deliverables
- Design studies, prototypes, analysis, trade-offs, etc

International Consortia and Industry clusters forming now

Each WP in pre-construction Phase will go to a Consortium (2012)

A **GLOBAL** challenge:

- Antennas
- Power supply: towards a *GREEN SKA*
- Massive data transport, storage and processing
- Science extraction
- Outreach

A GLOBAL CHALLENGE



A GLOBAL CHALLENGE



The Square Kilometre Array

SWINBURNE ASTRONOMY PRODUCTIONS

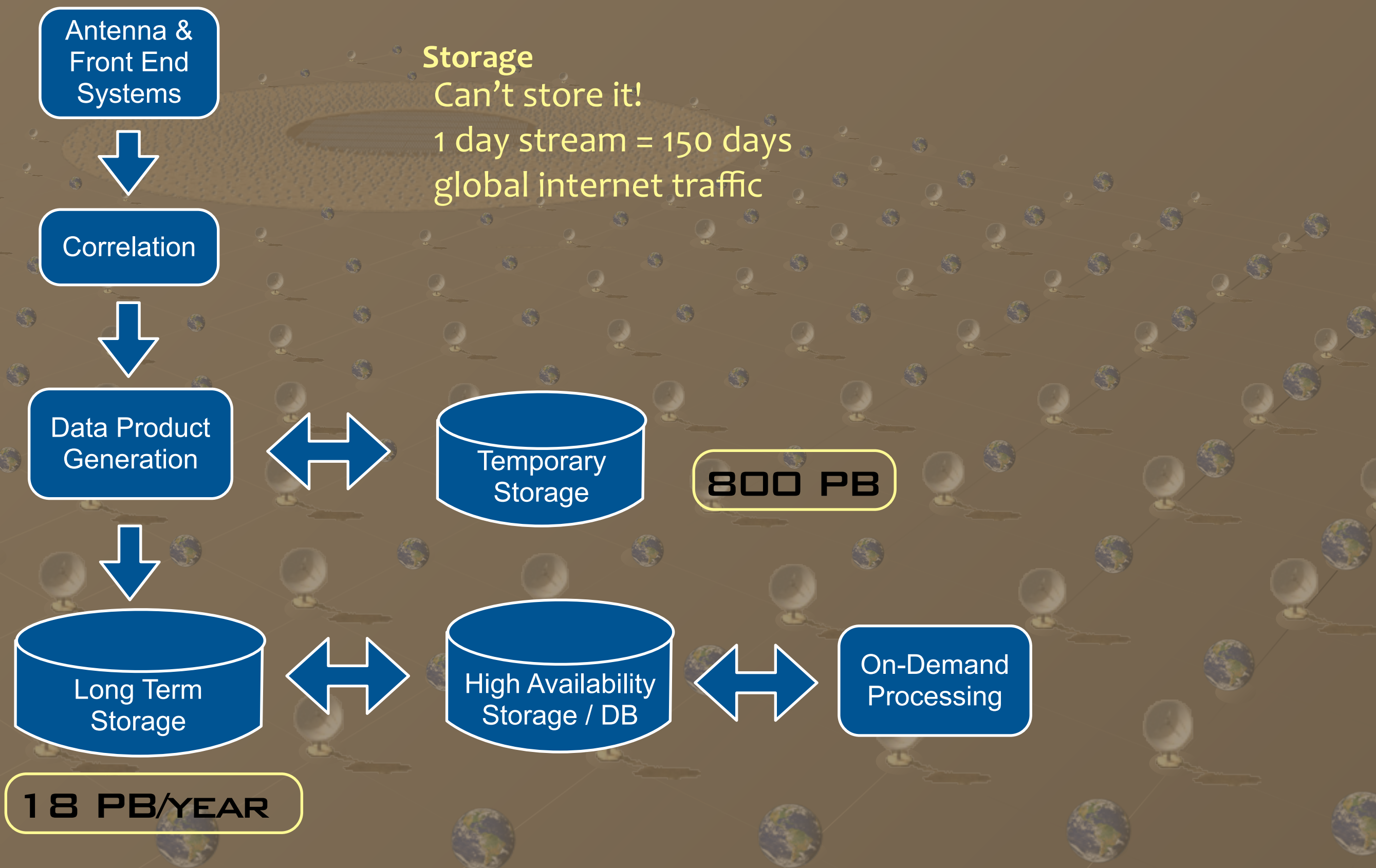
POSSIBLE NICHEs FOR SPANISH PARTICIPATION

- Outreach (WP1)
 - Scientific definition (WP2)
 - Antenna Design & Assembly (WP5)
 - Receivers (WP5/6)
 - LNAs (WP6)
 - Design FPGAs/ASICs (WP6/8)
 - Control Systems 8P99
 - e-Science for petabyte scales (WP2/9)

- **Renewable Energies (WP10)**

Spain + Portugal, in position to be major players

MASSIVE DATA TRANSPORT, STORAGE & PROCESSING

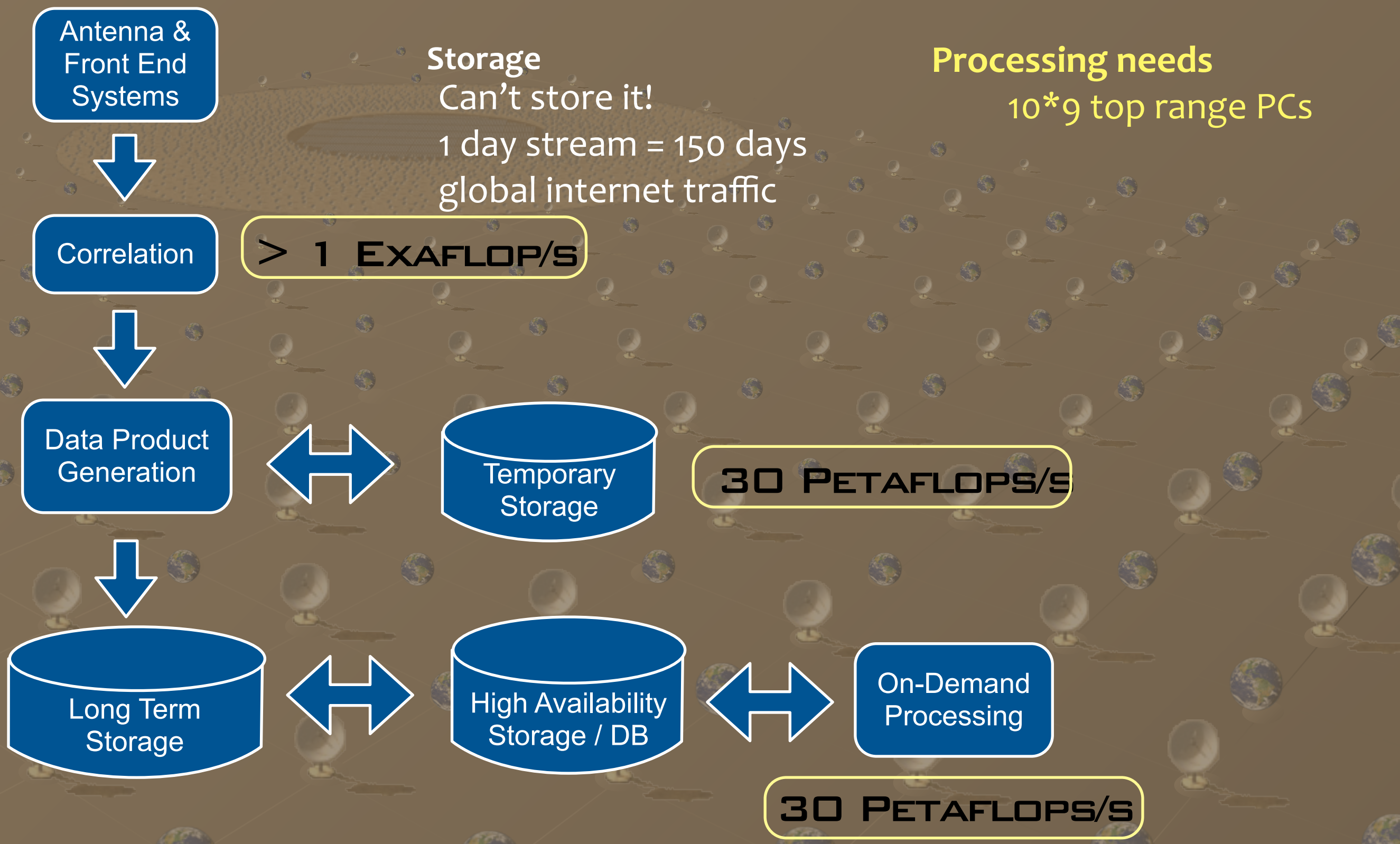


Storage
Can't store it!
1 day stream = 150 days
global internet traffic

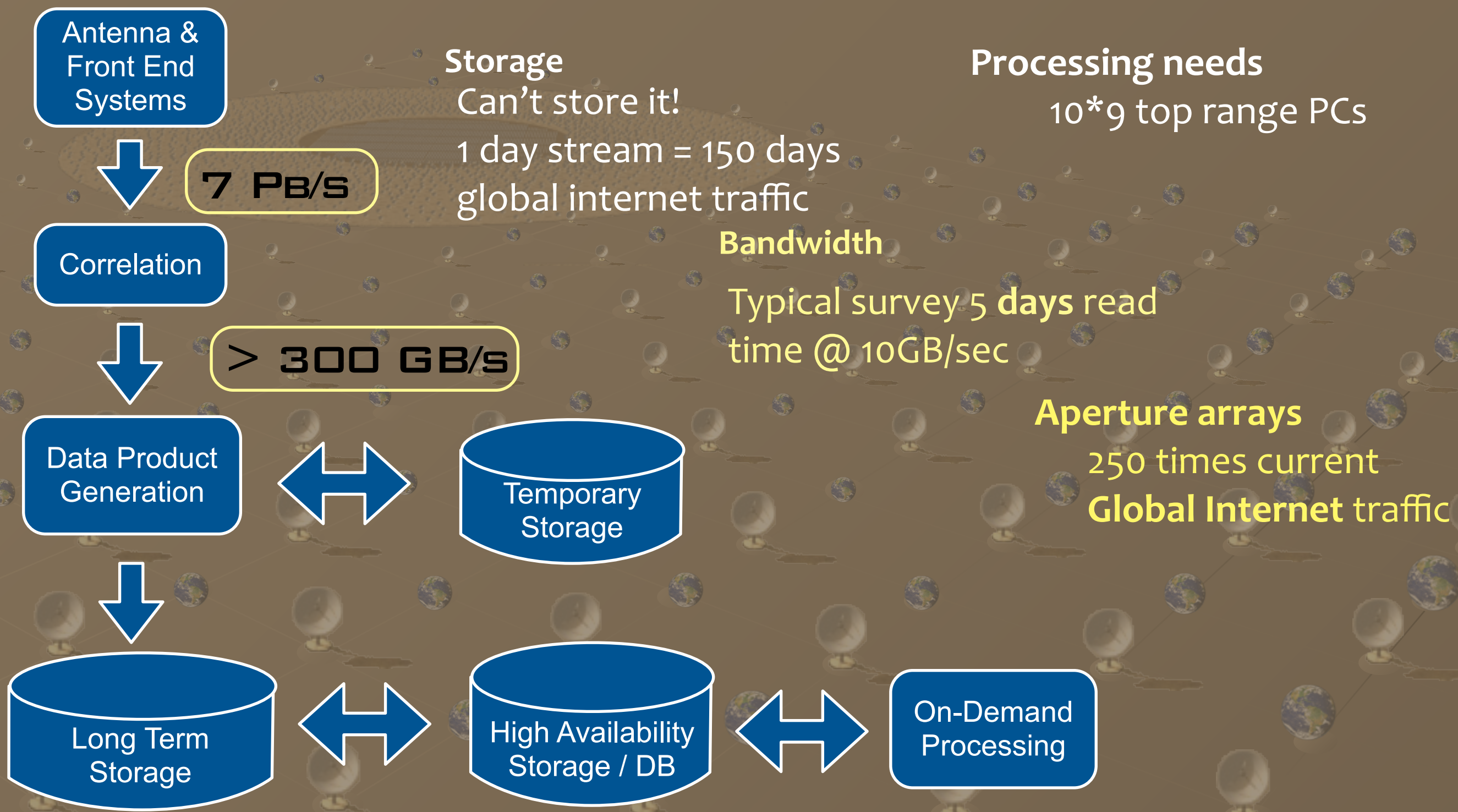
800 PB

18 PB/YEAR

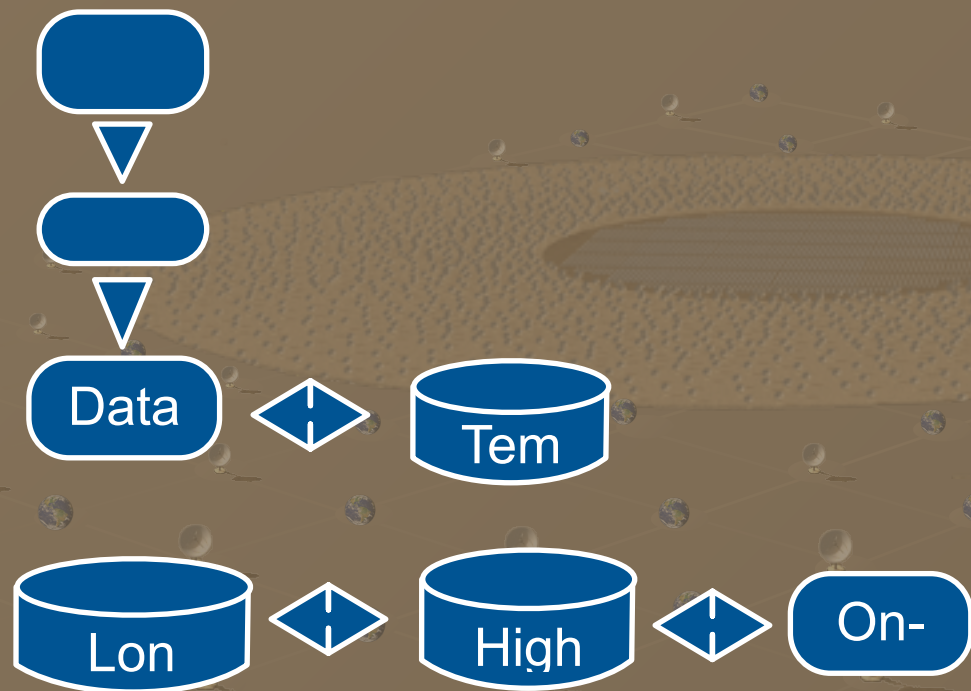
MASSIVE DATA TRANSPORT, STORAGE & PROCESSING



MASSIVE DATA TRANSPORT, STORAGE & PROCESSING



MASSIVE DATA TRANSPORT, STORAGE & PROCESSING



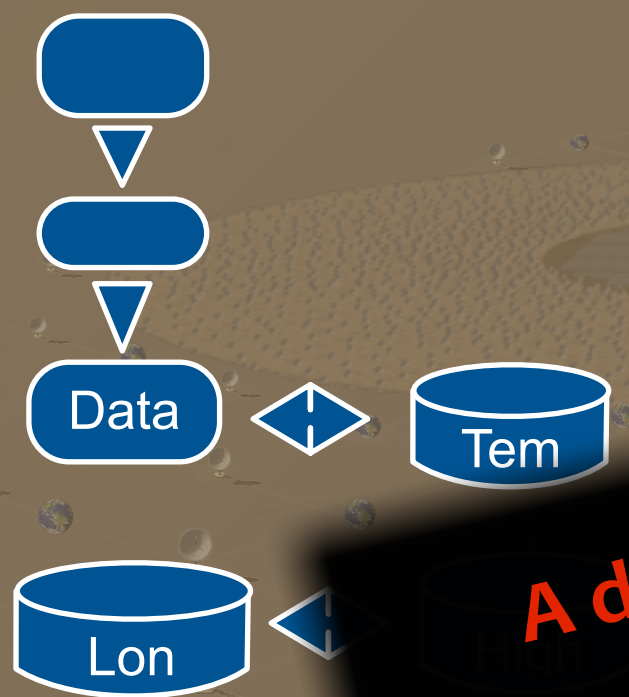
**BUT A NEW
CHALLENGE STARTS
HERE**

Extraction of scientifically relevant information from huge data volumes

- Visualization of enormous multiD catalogs
- Efficient packaging of scientific methodology
- Collaborative science

Transfer of knowledge to society

MASSIVE DATA TRANSPORT, STORAGE & PROCESSING



Extraction of scientifically relevant information from large data

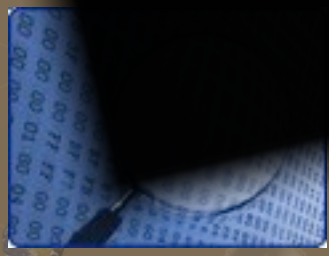
A disruptive change in the methodology required e-Science

ormous

- Efficient packaging of scientific methodology
- Collaborative science

Transfer of knowledge to society

BUT A NEW CHALLENGE STARTS HERE



MASSIVE DATA TRANSPORT, STORAGE & PROCESSING

TARGET+LOFAR as pathfinder for GRID computing +SKA



Real time multiple sensor array
Streaming processing: processing
real time data streams

MASSIVE DATA TRANSPORT, STORAGE & PROCESSING

TARGET+LOFAR as pathfinder for GRID computing +SKA



GRID as:
off-line processing
data storage

POWER CONSUMPTION

HUGE Data Volumes!

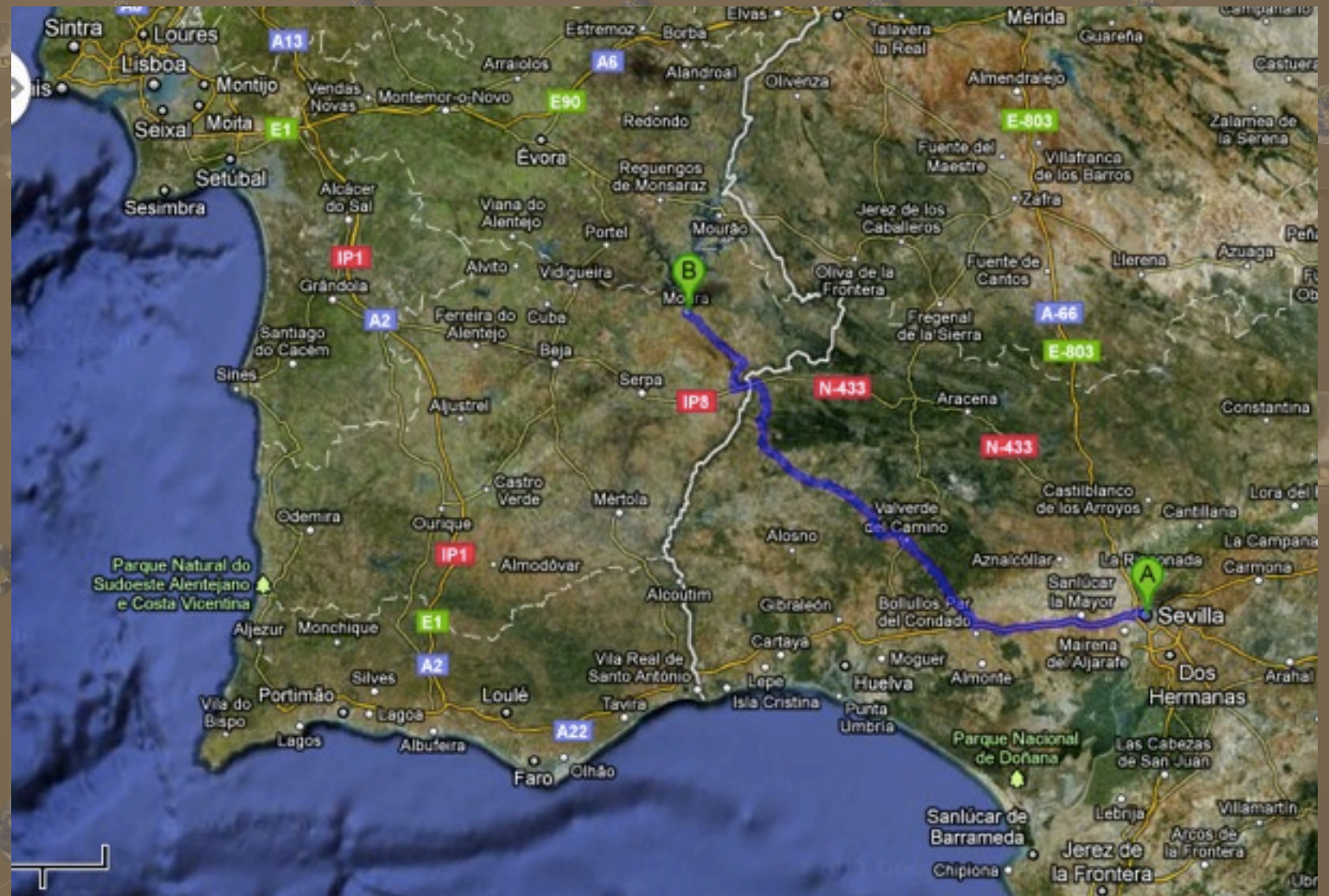
- Can't Download Data
- Processing must be done in situ: Remote Analysis
- Visualization Techniques for Multi-D parameter spaces

**COMPUTING/COOLING IS
MOST OF THE ENERGY
BUDGET!**

POWER CONSUMPTION

SKA Site emulator in Moura

- Possibilities for INTEREG funding and cross-cooperation between borders.
- Excellent collaborations even for testing in/with spanish ground.



POWER CONSUMPTION

Major issue:

SKA performance maybe power limited

- cooling in the desert
 - concentrated loads
 - distributed loads
-
- 100 MW for 1 exaflop/s
 - to remote stations (thousands of kms)

Sustainable energies developments are key for SKA

ONGOING INITIATIVES

Scientific Network (J. C. Guirado, Univ. Valencia)

Acción Complementaria para Red Española SKA

UV, IAA, CAB, OAN, UB, IEEC, UGR, UJ, IAC, IFCA, UPTC

Industry Participation (L. Verdes-M., IAA-CSIC)

Estudio de Viabilidad de Participación Industrial Española
en SKA (VIA-SKA)

(Subprograma Actuaciones Infraestructuras Científicas Internacionales)

IAA, IGN, UGR, UB, UV, CAB-CSIC, UC3M, IFCA-UNICAN, IAC

**MICINN requested to participate as an Observer in SKA
Founding Board**

DO YOU TAKE THE CHALLENGE...?

... To provide the means for powering the SKA with Green Energies?

THEN YOU CAN GET INVOLVED IN

- VIA-SKA
- SKA WBS/SOW definition

HOW: contact

lourdes@iaa.es

Gonzalo Lobo & Manuel Silva CTAER