



SKA: Strategic Position & Future Opportunities for Spanish Industry

Instituto de Química Física Rocasolano, CSIC
Madrid
23/11/2012



The Square Kilometre Array

SWINBURNE ASTRONOMY PRODUCTIONS

ORIGINAL MUSIC REPLACED BY
JAMAICA SKA - BYRON LEE/THE DRAGONARIES



**Feasibility study of the Spanish Technological
Participation in the SKA**

(Subprograma Actuaciones Infraestructuras Científicas Internacionales)

Pl. Lourdes Verdes-Montenegro

PM. Juande Santander-Vela

(IAA-CSIC)

CTAER, Fractal

23/11/2012

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**

SKA, a Green ICT machine



- Its core: a city!
- Remote stations: spread villages
- The Universe camera, after an Exabyte and an Exaflop

QUICK OVERVIEW OF SKA

- 1000 - 1500 antennas \times 15m in \sim 100 km
- 1000 - 1500 antennas \times 15m up to 3000 km

70 MHz - \geq 25 GHz
4-3m - 1.2 cm

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

interferometer: escalable

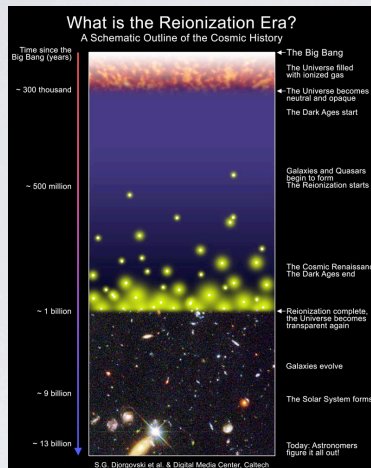
SKA1 = 10% collecting area, 70 Mhz - 3 GHz , 350 M€, 2016 -2019

SKA2= 100% collecting area, 70MHz - 10 GHz, \sim 1500 M€, 2018 -2023

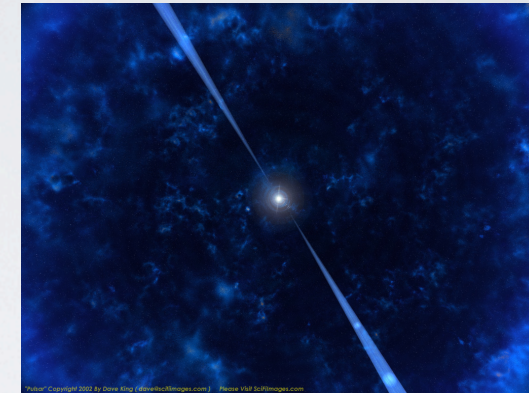
SKA3 High frequencies: \geq 25 GHz. No defined dates

WHAT FOR?: KEY SCIENCE

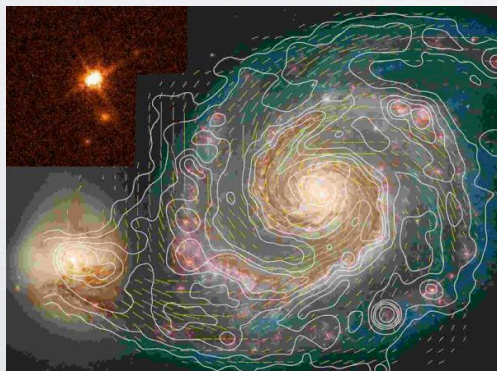
- HISTORY OF ATOMIC GAS (HI):
REIONIZATION - TODAY



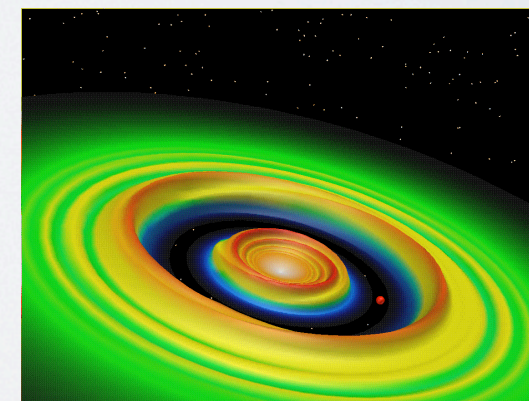
- GRAVITY TEST



- ORIGIN & EVOLUTION OF COSMIC MAGNETISM



- PROTOPLANETARY DISKS



ANTENNAS

- Frequency range $>$ two decades:
- Combination of different types of antennas



Can observe towards several directions simultaneously

Aperture Array

70 - 450 MHz

Baselines 100 km

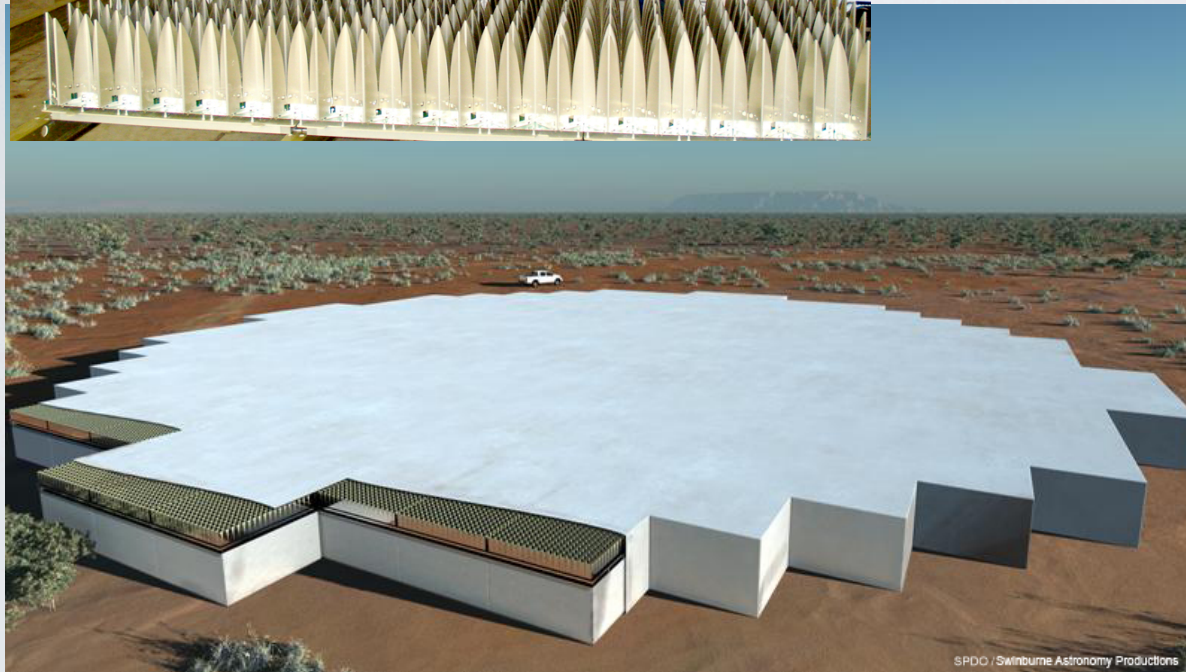
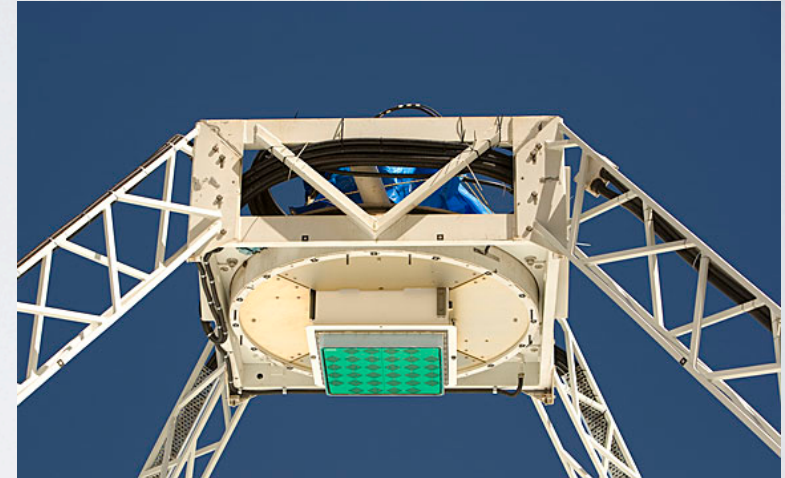
2016 - 2019

SKA1

single pixel feed
450 MHz - 3GHz
baselines 100 km



Enhancing FOV



+ focal
plane array

dense
aperture
array

200 - 500 MHz
200 deg²

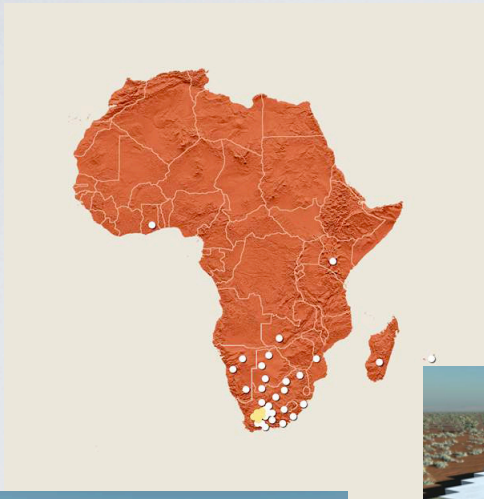
SKA₂

2018 - 2023

A Distributed Sensor Network at the Scale of Two Continents

DUAL SITE

South-Africa & Australia/
New Zealand Joint Site



SKA2 AAs



SKA2 Mid

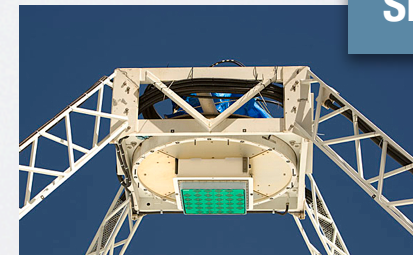


SKA1 Low



SKA1&2 Mid

SKA1 SURVEY



SKA I

SKA2

SKA I_LOW



SKA2_LOW



SKA I_MID



SKA2_MID



SKA I_SURVEY



SKA2_AA



PARTICIPATION SCHEME

SKA Project Development Office: Jan 2008 - Dec 2011

The SKA Organization: Dec 2011

Non-for-profit limited liability company, incorporated in the UK

Associate Member: no downright payment, but firm intention to become a Full Member in the future.

Full member: 250k€/año x 4 años

Member contributions fund directly the SKA Office

Countries fund the (Pre-)Construction tasks of their institutions/companies

PARTICIPANTS

Full Members:

- Australia: Department of Innovation, Industry, Science and Research
- Canada: National Research Council
- China: National Astronomical Observatories, Chinese Academy of Sciences
- Italia: National Institute for Astrophysics
- Nueva Zelanda: Ministry of Economic Development
- Republica de Sudáfrica: National Research Foundation
- Holanda: Netherlands Organisation for Scientific Research
- Reino Unido: Science and Technology Facilities Council
- Sweden: Chalmers University/Onsala

Associate member:

- India: National Centre for Radio Astrophysics
- Germany joining soon

STRATEGIC VALUE

- SKA only global project on ESFRI list:
 - 67 institutes in 20 countries participating (and increasing)
 - Highest priority in EU ASTRONET roadmap together with ELT
 - High-priority in MICINN document

“Construyendo la Ciencia del Siglo XXI”

STRATEGIC VALUE

- European Parliament Written Declaration 45/2011 on Science Capacity Building in Africa: promoting European-African radio astronomy partnerships.

- Launch of African-European Radio Astronomy Platform (AERAP).

Response to Written Declaration 45/2011:

Researchers, industry, public sector contribute to definition of funding plans in areas of collaboration between Africa and Europe

- **Aligned with H2020**

- Better society (green power/sustainability, TIC)
- European industry + cutting edge science, Internet of the Future technologies
- Union for innovation: industry + basic research for commercial solutions

SCHEDULE

- **2008-13 Preparatory Phase: system design and costing**

- SKAI definition and PEP
- Work Breakdown Structure and Statements of Work Dic12 - May12
- Expressions of Interest 30 April 2012-14th May 2013
- Request for Proposals & Evaluation February 2013

Juande Santander's talk

- **~2013-16 Detailed design & pre-construction phase**

- Stage 1 of Pre-construction Phase - Preliminary Design
- Stage 2 : Detailed design, ready for construction

- **~2016-19 Phase I construction**

International Consortia forming now

Each WWP in pre-construction Phase will go to a Consortium

SKA WORKING PACKAGES

- Science 
- Management
- System Engineering & Requirements
- Dish Arrays 
- Aperture Arrays 
- Signal & Data Transport 
- Sync & Timing 
- Central Signal Processor
- Science Data Processor 
- Telescope Manager 
- Power 
- Site & Infrastructure

CHALLENGES

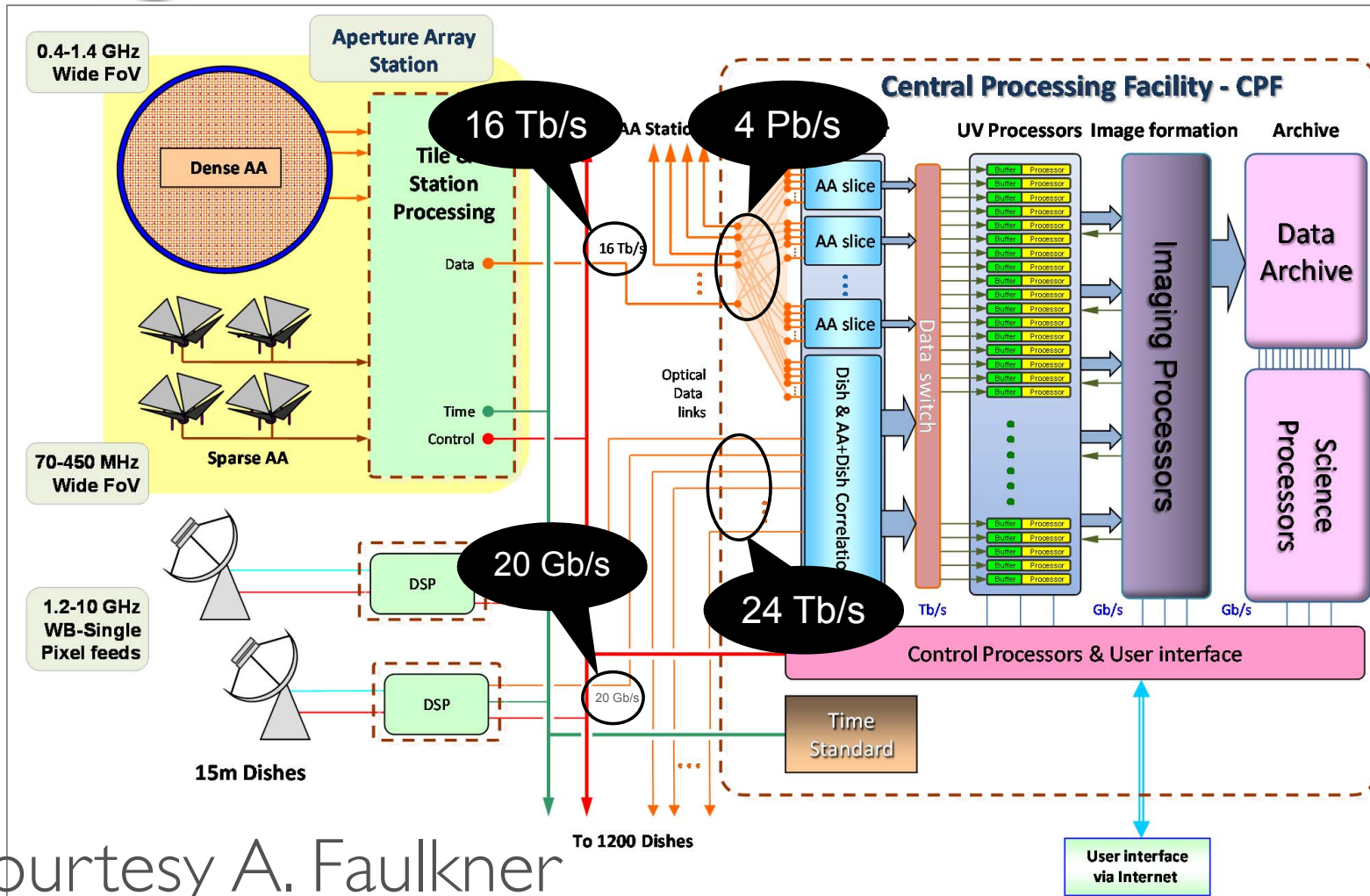
A GLOBAL challenge:

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

Massive Data Flow, Storage & Processing



SKA₂ wide area data flow



Courtesy A. Faulkner

1 Gigaflops = 0,5W

1 Exaflops = 500MW

Target: 100MW

NOT ONLY HOW MUCH, BUT HOW

1 Gigaflops = 0,5W

1 Exaflops = 500MW

Target: 100MW

NOT ONLY HOW MUCH, BUT HOW

- Far from man-made radio frequency emission (hence power supplies)
- Geographically distributed
- 24/7 operation
- Cooling of digital electronic
- Sustainable
- Reliable
- Affordable
- Projections from pathfinders and precursors: SKA will be power limited

With Renewable Energy

SKA-SPAIN

SKA - SPAIN

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)



<http://www.via-ska.es/ska/>

- Participants

CSIC: IAA, CAB, IEEC, IFCA

IGN - OAN, Instituto de Astrofísica de Canarias

Universidad de Granada, Barcelona, Cantabria, Valencia, Jaén, Carlos III, and Politécnica de Cartagena

Instituto Nacional de Técnica Aeroespacial (INTA)

- In collaboration with

CTAER (Centro Tecnológico Avanzado de Energías Renovables)

FRACTAL SLNE

MoU for SKA-Spain in preparation:


OTRI of Universidad de Valencia

Servicio de Programas Europeos de la Vicepresidencia Adjunta de Programación Científica de Vicyt (CSIC)

To identify technological niches for Spanish Contributions to SKA WPs.

Capacity map form

Name	<input type="text"/>
Institution type	Private company ▾
SKA Work Package of interest	Low Frequency Aperture Array ▾
Expertise domains	FPGA design ▾



Cancel Search

Ana Pérez's talk

Interaction with international consortia for strategic alliances

Promotion of participation/leadership in WPs

Identification of areas of interest for Spanish Sci&T

- Participation in preparation of WBS/SoW: the SKA Project Office accepted to include **9 VIA-SKA members in the Working Groups**
- **Membership to ESKAC** (European SKA Consortium):
Netherlands, UK, France, Italy, Germany, Portugal, Sweden, Radionet,
now Spain
- **Membership to AERAP**
- SKA Day in Lisbonne 30th November

Expression of Interest (Eol)

Date	Description
10 to 27 April	SKA Office prepare Expression of Interest (Eol) documentation, review and update.
30 April	SKA Office issue Eol
14 May	SKA Office receives Eol responses
25 May	Report the results of Eol process to the Interim Director General and the Board of the SKA Organisation for consideration
June	SKA Office facilitates consortium forming and addresses gaps that have been identified from the results of the Eol process.

SKA.TEL.DSH (Dish Arrays)

IFCA-CSIC/DICOM-UC, NTE-SENER

CSIRO + South Africa, INAF, ASTRON et al

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SKA.TEL.LFAA (Low Frequency Aperture Arrays)	IFCA-CSIC/DICOM-UC, UC3M
SKA.AI.MFAA (Medium Frequency Aperture Arrays)	IFCA-CSIC/DICOM-UC, UC3M
SKA.AI.PAF (Phased Array Feeds)	IFCA-CSIC/DICOM-UC
SKA.AI.WBSPF (Wide-Band Single Pixel Feeds)	IFCA-CSIC/DICOM-UC

ASTRON et al

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SKA.AI.PAF (Phased Array Feeds)	IFCA-CSIC/DICOM-UC, INTA
SKA.AI.WBSPF (Wide-Band Single Pixel Feeds)	IFCA-CSIC/DICOM-UC
SKA.TEL.SDP (Science Data Processor)	IAA-CSIC, IFCA-CSIC/DICOM-UC

Univ. Cambridge et al

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SKA.AI.MFAA (Medium Frequency Aperture Arrays)	IFCA-CSIC/DICOM-UC, UC3M
SKA.AI.PAF (Phased Array Feeds)	+ ASTRON, Fraunhofer, IT (Portugal), MPIfR (Germany)
SKA.AI.WBSPF (Wide-Band Single Pixel Feeds)	
SKA.TEL.SDP (Science Data Processor)	
SKA.TEL.PWR (Power)	CTAER, IAA-CSIC

Support letter from Abengoa, Isofotón, Ariema

POWER

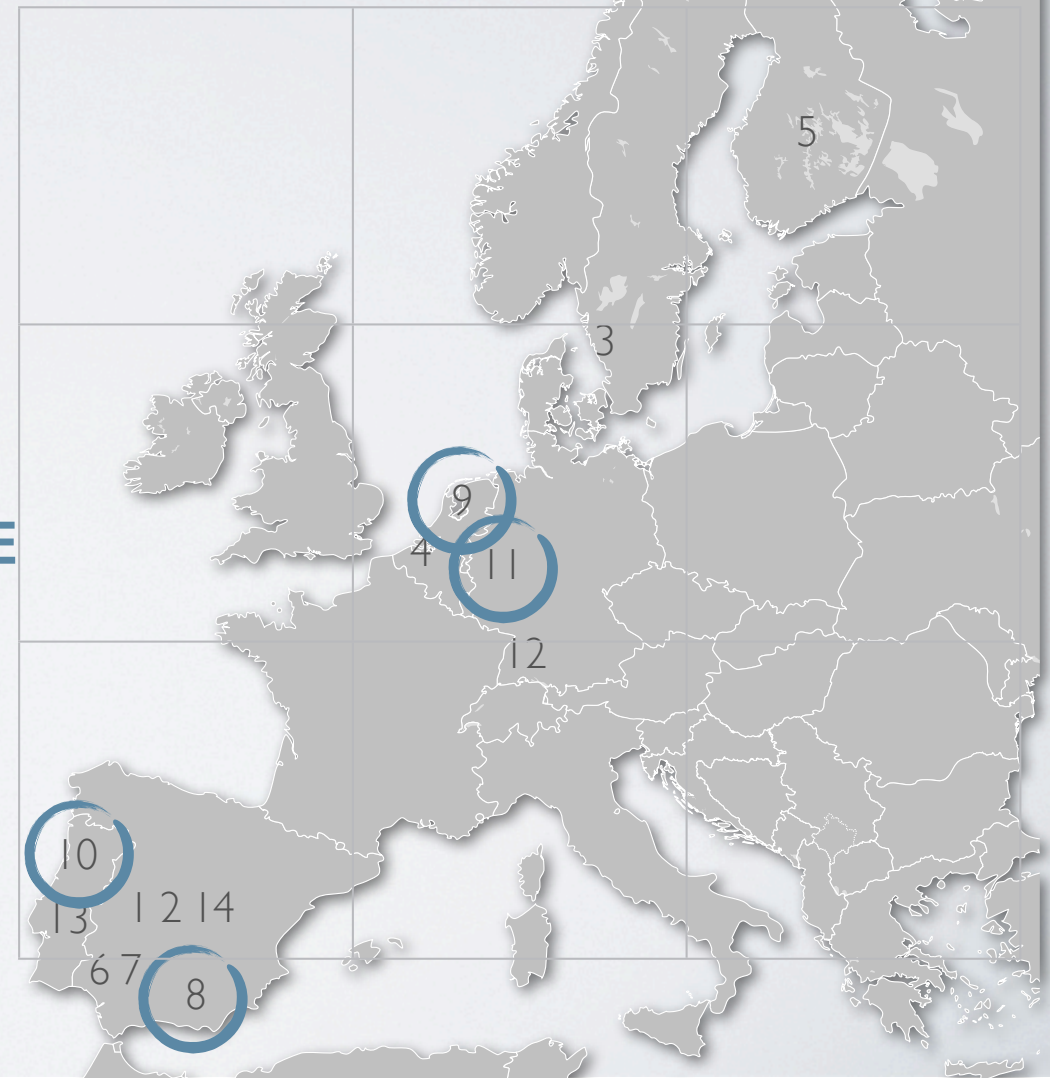
• Positioning of Spanish industry at international level

Link of BIOSHIRLING proposal to SKA

BIOSHIRLING4SKA

Dish Stirling systems for SKA. FP7-ENERGY-2012-1 Collaborative Project

- | | |
|--|--------------------------------------|
| 1. GESTAMP RENEWABLE INDUSTRIES (GRI) | 7. U. SEVILLE (US) |
| 2. ALENER SOLAR | 8. CSIC-IAA |
| 3. CLEANERGY | 9. ASTRON |
| 4. AGC GLASSEUROPE | 10. IT AVEIRO |
| 5. UNIVERSITY OF JYVÄSKYLÄ (JYU) | 11. MPIfR |
| 6. CENTRO TECNOLÓGICO AVANZADO DE ENERGÍAS RENOVABLES (CTAER) | 12. FRAUNHOFER-ISE |
| | 13. LÓGICA |
| | 14. GESTAMP SOLAR STEEL (GSS) |



- **Positioning of Spanish industry at international level**

- Link of BIOSTIRLING proposal to SKA **BIOSTIRLING4SKA**

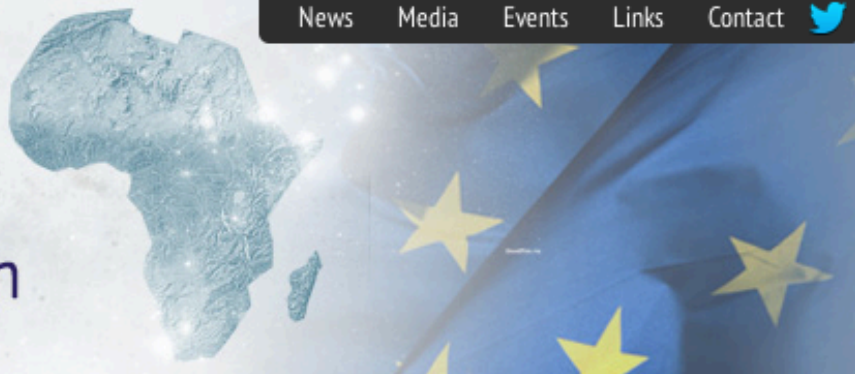
- Invitation to present BIOSTIRLING (before end of negotiation phase) to

Eurodeputies:

- attracted interest of Britta Thomsen, Eurodeputy, Vice-chair of the European Parliament's Committee on Industry, Research and Energy



African - European Radio Astronomy Platform



[About AERAP](#) | [African Radio Astronomy](#) | [Partnerships](#) | [Funding](#) | [Science Capacity Building](#)



"The most incomprehensible thing about our universe is that it can be comprehended."
Albert Einstein (1879-1955) U. S. physicist, born in Germany.



Event

AERAP workshop on "Renewable Energy Solutions for Radio Astronomy: Opportunities for African-European cooperation" - 09-10-2012

News

19-10-2012 - Interview with Ian Jones, CEO of Goonhilly Earth...

News

Announcement: Symposium on "Astronomy, Radio Sources and Society:..."

- **Positioning of Spanish industry at international level**

- Visits to Sevilla
 - SKA Project Office (May2012)
 - Co-organizers of Workshop

The Power Challenges of Mega-Science Infrastructures: the example of SKA

Moura, Portugal and Sevilla, Spain
20th-21st June 2012

SKA PROJECT OFFICE VISIT TO ABENGOA SOLAR FACILITIES (PS 10, PS20) IN SEVILLA

28th May 2012

- Representatives of the SKA Project Office: Georgina Harris and Robert Millenaar



- Jose Ramón Sánchez (MINECO)
- Maria Luisa Revilla y Borja Izquierdo (CDTI)
- Representantes de ABENGOA
- Miguel Ángel Vázquez (ISOFOTON)
- Rafael Luque (ARIEMA)
- Domingos Barbosa (IT Aveiro)
- André van És (ASTRON)
- Matilde Fernández (IAA - CSIC)
- Lourdes Verdes-Montenegro Atalaya (VIA-SKA, IAA-CSIC)
- Ana Pérez (VIA-SKA; FRACTAL)
- Valeriano Ruiz, Gonzalo Lobo, Manuel Silva, Sol Luca de Tena (CTAER)



- **Positioning of Spanish industry at international level**

- Germany, Netherlands, Portugal, support Spain
- CSIRO (Australia) will not bid for Power
- SA has not shown interest to bid for Power to SKA-Org
- Offers for discussions on collaborations with:
 - Australia
 - UK
 - SA

- **Direct transfer of technology**

- Computational resources consume 1.5% of power in the World
- 1.6 billion people with no access to electric power

- **Demonstrator for Sustainable Mega Science Infrastructures with 0% carbon footprint**

- **Options for funding**

- Policy EC H2020
- INTEREG funds with Portugal (Moura SKA demonstrator 200 km from Sevilla)
- AERAP provides tools, contacts, partners, interviews with stakeholders

CURRENT SITUATION

- Participation in proto-consortia:

MeerKAT

- Dishes (IFCA/DICOM-CSIC, SENER?) ----- Lead by Australia
- Aperture Arrays Low and Mid (UC3M and IFCA-CSIC/DICOM) ----- Holanda
- Science Data Processor (IAA-CSIC) ----- UK (Univ. Cambridge)
- Signal and Data Transport (Univ. Granada, 7 Solutions) ----- UK (UMan)
- Synchronization & Timing (Univ. Granada, 7 Solutions) ----- UK (UMan)
- Telescope Manager (GTD) ----- India (working on that)
- POWER EoI

Several talks

**SKA CAN NOT BE BUILT
WITHOUT INDUSTRY
INVOLVEMENT**

