

# Spanish participation in the Square Kilometer Array (SKA)

Lourdes Verdes-Montenegro  
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(Instituto de Astrofísica de Andalucía-CSIC)



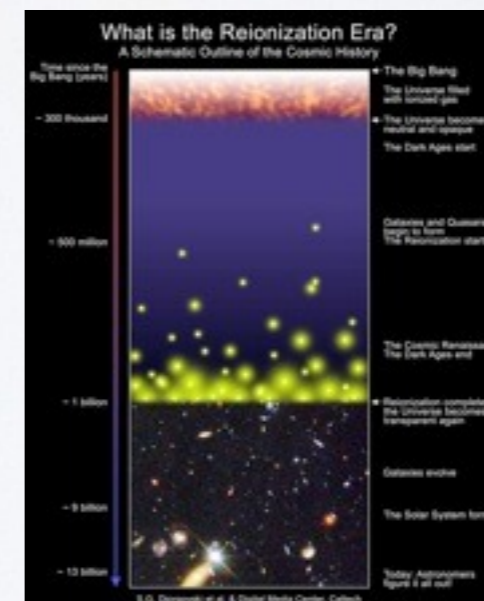
**Reunión abierta de la RIA: Spanish SKA day, 23 Oct. 2014**

# OUTLINE

- The road of Spain to SKA Pre-construction



- Spanish involvement in SKA during Pre-construction phase



# **The road of Spain to SKA pre-construction**



# SKA - SPAIN

- **MINECO-funded Scientific Network**

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

- **May 2011**: “Reunión abierta de la RIA: Science and technical opportunities in the SKA era”: Meeting in CSIC showed broad and strong scientific interest of Spanish researchers in SKA

- **September 2011**: MICINN requests Spain to participate in SKA as an Observer





## November 2011: MINECO funds

**“Feasibility study of the Spanish technological participation in SKA”** (Lead by IAA-CSIC; 75.000€)

*Subprograma Infraestructuras Científicas Internacionales*

--> extended until 31-1-2014, to support participation in consortia

**Participants:** 7 research institutions (4 from CSIC) + 8 Universities

- ▶ CSIC: **IAA**, CAB, ICE, IFCA
- ▶ IGN - OAN
- ▶ Instituto de Astrofísica de Canarias
- ▶ Universities of Granada, Barcelona, Cantabria, Valencia, Jaén, Carlos III, and Politécnica de Cartagena
- ▶ National Institute for Aerospace Technology (INTA)

**In collaboration with**

- ▶ FRACTAL SLNE
- ▶ CTAER (Advanced Technological Center for Renewable Energies)
- ▶ CIEMAT (Plataforma Solar de Almería)







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The following form allows obtaining very easily the list of public and/or private organizations that have expressed their interest in a particular Work Package and/or could be interested in a particular expertise domain.

The list of Work Packages includes the Work Packages, as defined by the SKA Project.


The list of expertise domains includes all the capacities that shall be required for carrying out the Work Packages.

Each organization registered in the VIA-SKA web portal has identified their interests and their technical capabilities, providing also an overview about previous projects that this organization has carried out. All provided information has been reviewed before being registered. This form facilitates the access to the registered data, filtering organizations by Work Packages and/or areas of expertise in order to quickly map the capabilities of the registered organizations.

Form allowing an easy search of public and/or private organizations registered in VIA-SKA filtering by Working Package or Expertise domains

### Capacity map form

<b>Name</b>	<input type="text"/>
<b>Institution type</b>	<input type="text"/>
<b>SKA Work Package of interest</b>	<input type="text"/>
<b>Expertise domains</b>	<ul style="list-style-type: none"><li>Dish-array element</li><li><input checked="" type="checkbox"/> Low Frequency Aperture Array</li><li>Signal and Data Transport / Sync and Timing</li><li>Central Signal Processor</li><li>Science Data Processor</li><li>Telescope Manager</li><li>Power</li><li>Site and Infrastructure</li><li>Science</li><li>Management and Engineering</li></ul>



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### Capacity map form

Name

Institution type

SKA Work Package of interest

Expertise domains



- Analog ASIC design
- Analog beamforming hardware
- Analog beamforming software
- Analog filterbank design
- Analog sensors
- Analog signal processing
- Antenna system beam profile measurement
- Antenna system sensitivity measurement
- Cabling
- Civil engineering
- Control system design
- Cooling: Cryogenics
- Cooling: Heat recovery
- Cooling: Thermal insulation
- Cost modelling
- Cryogenic LNAs (450MHz-2GHz)
- Digital ASIC design
- Digital beamforming
- Digital Fieldbuses
- Digital filterbank design
- Digital sensors
- Digital signal processing
- Digital signal transport networks
- Dipole antenna array construction
- Dipole antenna array design
- Dish antenna construction
- Dish antenna design
- Electro-magnetic compatibility design
- FFT digital signal processing
- FPGA computing
- FPGA design
- High Performance Computing: event-based computing
- High Performance Computing: GPU computing
- High Performance Computing: grid computing
- High-accuracy timing systems
- High-voltage electrical engineering
- Logistics engineering
- Low-RFI Power conversion
- Mechatronics
- Mechanical engineering
- Mechanical tooling
- Monitoring software and systems
- Non-cryogenic LNAs (70MHz-450MHz)
- Photovoltaic solar thermal energy
- Power engineering
- Power engineering: budgeting
- Project management

n VIA-SKA

: capacity

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Packages

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## VIA-SKA Workshop

### *SKA: Strategic Position & Future Opportunities for Spanish Industry*



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



Jesús Ricote (Deputy Vicepresident for Internationalization, CSIC)

*15 presentations from companies*



## Interaction with international consortia/groups for strategic alliances

- ▶ Active presence in virtually all SKA events
- ▶ **Membership to the European SKA Consortium (ESKAC)**
- ▶ Membership to African-European Radio Astronomy Platform (AERAP)
- ▶ Contacts with Technapoli (Italy) consortium
- ▶ **Spanish participation in SKACON, named SKACON-ES**
  - ▶ **Led by IAA-CSIC Outreach Unit Head: Emilio García + Obs Valencia**
- ▶ Positioning of Spanish industry at international level
  - ▶ Telescope manager, Dishes, Central Signal Processor, Signal & Data Transport

- ▶ Positioning of Spanish industry at international level: Power

- ▶ Visits to Sevilla: SKA Office (May 2012)

Co-organizers of the workshop (June 2012)

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

- ▶ BIOSTIRLING4SKA. FP7-ENERGY-2012-1 Collaborative Project

- ▶ Invitation to present BIOSTIRLING4SKA in **AERAP** events + **European Parliament**

- ▶ End May 2013:

- ▶ started collaboration with Plataforma Solar Almería (CIEMAT)

- ▶ **contact with Australia+ SouthAfrica Consortium**

- ▶ **Involving 8 companies**



## ▶ Latest activities

- ▶ Participation in SKA engineering meeting, Fremantle (Australia), 2014
- ▶ Membership of IAA-CSIC to SDP consortium.
- ▶ Linking Spanish groups/companies in AERAP





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## ▶ Reports

- ▶ Estimation of the Spanish contribution to the SKA (2014-2020) (November 2012)
- ▶ Feasibility study of the Spanish technological participation in SKA (April 2013)
- ▶ Participation of Spanish groups and companies in the SKA Request for Proposals: requested and provided resources (April 2013)
- ▶ Spanish participation in SKA. Budget for the activities between PDR and CDR (July 2014)
  - ▶ Spanish groups and companies need co-funding 1.5M€ that corresponds to the 35% of the amount that is already provided and the additional amount that they are willing to compromise
- ▶ Work in progress: Study the potential industrial return during SKA construction



# INTERNATIONAL SKA CONTEXT

## **2008-2013 Preparatory Phase: system design and costing**

- ▶ SKA I Definition, and Project Execution Plan (PEP)
- ▶ New legal entity: the SKA Organisation (incorporated in the UK)
- ▶ Transition from SPDO towards SKA Org
- ▶ Work Breakdown Structure & Statements of Work **Jan 2012**
- ▶ Call for Expressions of Interest **May 2012**
- ▶ Site decision
- ▶ Request for Proposals & Evaluation **(Released March 2013 - 10th June)**

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

- ▶ (Pre-construction Phase) Stage 1 - Preliminary Design
- ▶ Stage 2 : Detailed design

## **~2017-20 Phase I construction**

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- SKA Project Office accepted to include **9 VIA-SKA** members in the **WBS Working Groups**

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  - Dishes: IFCA/DICOM+NTE-SENER
  - AAs: IFCA/DICOM+UC3M
  - SDP: IAA-CSIC
  - Power: Spain, + Portugal, Netherlands, Germany
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Each WWP in pre-construction went to an International Consortium

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# SKA WORKING PACKAGES

## Spanish Participation in bidding consortia

- ▶ Management 
- ▶ System Engineering & Requirements 
- ▶ Dish Arrays 
- ▶ Aperture Arrays 
- ▶ Signal & Data Transport 
- ▶ Sync & Timing 
- ▶ Central Signal Processor 
- ▶ Science Data Processor 
- ▶ Telescope Manager 
- ▶ Site & Infrastructure  
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# **Spanish involvement in SKA during Pre-construcion phase**

- ▶ Science
- ▶ Outreach and communications
- ▶ Technology
- ▶ Contact with SKA Organisation

# OFFICIAL TIMELINE

## SKA RfP Proposal Evaluation

junio 2013 – agosto 2013

### SKAO Governance Development

enero 2014 – diciembre 2016

### Seek SKA1 Funding

enero 2014 – diciembre 2016

SKA Cost Ceiling Established  
julio 2013

RfP Consortia Negotiations  
agosto 2013 – octubre 2013

### Pre-construction Stage 1

noviembre 2013 – marzo 2015

### Pre-construction Stage 2

marzo 2015 – octubre 2016

### SKA1 Prototype Systems

enero 2016 – marzo 2016

SKA1 Construction Approval  
noviembre 2016

SKA1 Tender & Construction Procurement  
enero 2017 – octubre 2017

### SKA1 Construction

enero 2018 – diciembre 2023

### SKA2 Detailed Design

enero 2018 – diciembre 2021

SKA Request for Proposals  
marzo 2013 – junio 2013

PDR (Preliminary Design Review)  
noviembre 2014

CDR (Critical Design Review)  
junio 2016

SKA1 Early Science  
enero 2020

2014

2015

2016

2017

2018

2019

2020

2021



# ADVANCING ASTROPHYSICS WITH THE SQUARE KILOMETRE ARRAY

to be published by early 2015

- **Chapters with Spanish contribution (non-complete list):**

- **Core-collapse and Type Ia supernovae with the Square Kilometre Array.** [M.A. Pérez-Torres](#), [A. Alberdi](#), R. J. Beswick, P. Lundqvist, R. Herrero-Illana, C. Romero-Cañizales, S. Ryder, M. della Valle, J. Conway, J.M. Marcaide, S. Mattila, T. Murphy, E. Ros
- **The connection between radio and high energy emission in black hole powered systems.** M. Giroletti, [I. Agudo](#), [A. Alberdi](#), et al.
- **The Neutral Interstellar Medium in Galaxies.** W.J.G. de Blok et al. (including [L. Verdes-Montenegro](#))
- **Broadband Polarimetry with the Square Kilometre Array: A Unique Astrophysical Probe.** Brian. M. Gaensler; [Iván Agudo](#) et al

**Advancing Astrophysics with the Square Kilometre Array**  
9-13 June 2014, Giardini Naxos, Italy  
#skascicon14

2014 marks 10 years since the publication of the comprehensive 'Science with the Square Kilometre Array' book and 10 years since the first radio galaxy discovered in 1950. In that time numerous and ground-breaking advances have been made in the fields of astronomy and physics related to the capabilities of the Square Kilometre Array (SKA). This meeting will facilitate the publication of a new, updated science book, which will be relevant to the current astrophysical context.

**Scientific Organizing Committee**  
Robert Braun (SKA) - co-Chair  
Greta Jones (MNF/CRIC) - co-Chair  
Tyler Bourke (SKA)  
Rob Fender (Zentrum)  
Federica Gaston (MNF - UK/England)  
Jim Green (SKA)  
Marian Herra (Lund)  
Maurice Janssen (MNF) (Victoria Univ. Wellington)  
Luis Rodriguez (Instituto Astrofísica de Canarias)

**Michael Kramer (MNF)**  
**Rita Maartens (EPRC, Western Dept)**  
**Tom Oosterloo (ASTRON)**  
**Robi Penzias (MNF - USA)**  
**Michael Seymour (MNF)**  
**Ben Briggs (Manchester)**  
**Carolee Ricketts (South Africa)**  
**Yue Wu Yan (MNF)**  
**Jeff Hogg (SKA)**

Enquiries: [ska-june14@skatelescope.org](mailto:ska-june14@skatelescope.org)  
or visit: [indico.skatelescope.org/event/AdvancingAstrophysics2014](http://indico.skatelescope.org/event/AdvancingAstrophysics2014)

RadioNet | INAF | SKA

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to be published by early 2015

- Chapters with Spanish contribution:
  - **Radio Jets in Young Stellar Objects.** [Guillem Anglada](#), Luis F. Rodriguez , Carlos Carrasco-Gonzalez
  - **Relativistic Jets in Active Galactic Nuclei.** [Iván Agudo](#) et al.
  - **SKA studies of nearby galaxies: star-formation, accretion processes and molecular gas across all environments.** R. J. Beswick, E. Brinks, [M.A. Pérez-Torres](#), A. M. S. Richards, S. Aalto, [A. Alberdi](#), M. K. Argo, I. van Bemmel, J. E. Conway, C. Dickinson, D. M. Fenech, M. D. Gray, H-R Klöckner, E. J. Murphy, T.W. B. Muxlow, M. Peel, A. Rushton, E. Stinger
  - **Neutral Hydrogen and Galaxy Evolution.** S. -L. Blyth et al. (including [L.Verdes-Montenegro](#))

**Advancing Astrophysics with the Square Kilometre Array**  
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Jim Green (SKA)  
Maurice Hearn (Lund)  
Maurice Jahnke-Hardt (Victoria Univ. Wellington)  
Luis Rodríguez (Instituto Astrofísica de Canarias)

Michael Kramer (MPIA)  
Ilyse Marston (Ohio Western Univ)  
Sue Osborne (JSTEC)  
Isabella Prandoni (INAF-IFG)  
Nicholas Seymour (CSIRO)  
Ben Stappers (Mannheim)  
Cristian Stanculescu (ICRAR)  
Yue Wu Yan (NANOGrav)  
Jill Riegg (SKA)

Enquiries: [ska-june14@skatelescope.org](mailto:ska-june14@skatelescope.org)  
or visit: [indico.skatelescope.org/event/AdvancingAstrophysics2014](http://indico.skatelescope.org/event/AdvancingAstrophysics2014)

RadioNet | INAF | SKA



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to be published by early 2015

- Chapters with Spanish contribution:
  - **Cool Outflows and HI absorbers.** Raffaella Morganti et al. (including [L.Verdes-Montenegro](#))
  - **SKA Deep Field and Cosmic Magnetism.** Russ Taylor, [Iván Agudo](#) et al
  - **The Intergalactic Medium and the Cosmic Web.** A. Popping et al. (including L.Verdes-Montenegro)
  - **Very Long Baseline Interferometry with the SKA.** Zsolt Paragi, [J.L. Gómez](#), F. Colomer, [María Rioja](#), Mar Mezcua, [Eduardo Ros](#), Javier Moldón, [Iván Martí](#), [A.Alberdi](#), [Miguel Pérez-Torres](#), et al.
  - **Studies of Anomalous Microwave Emission (AME) with the SKA.** Clive Dickinson et al, including [R. Genova-Santos](#), [J.A. Rubiño](#)



# SKACON-ES



Media



National and Local media

- Participation in first face-to-face SKACON meeting at SouthAfrica
- Press releases
- Translations of press releases SKA Office Communication





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- Videos and documentaries



*Screenplay checked by SKAO*

- **“Deconstructing the light: SKA, the world’s largest radio telescope”**

- Radioscopio





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- Videos and documentaries
- Radioscopio
- Distribution through social media.
- LOC Spanish SKA day





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# PARTICIPATION IN CONSORTIA



- ▶ 9 Spanish research centres and 11 companies participate in 6 SKA Pre-construction Consortia
- ▶ Great opportunity for Spanish industry with proved technological excellence



# PARTICIPATION IN CONSORTIA



11:30 Spanish participation in the SKA Telescope Manager. Eduard Díez.

12:15 Spanish participation in the SKA Science Data Processor Consortium. Rosa Badia.

13:00 Spanish participation in the SKA Synchronization and data transport Consortium. Javier Díaz.

13:15 Spanish participation in the SKA Central Signal Processor. Juan Antonio López

15:45 Spanish Activity in the development of cryogenic LNAs for the bands 4 and 5 of the SKA-mid telescopes



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# Participation in Pre-construction



- 2014 update
  - Renewable energies are considered in SKA1.
  - Contact with Adriaan Schutte (Power System Engineer): new working group within SKAO to study solutions based on renewable energies for SKA2 and remote stations for SKA1.
  - Contact with Abengoa AUS and the Senior Systems Technology Engineer of Horizon Power



# PRE-CONSTRUCTION PARTICIPATION

Most consortia have accepted Spanish members as Associate Members in their consortia;  
CSP only accepts participants from SKA member states

	Lead Org.	Spanish Partners (Companies)	Person- years	Funds (k€)	
Dishes		IFCA-CSIC, DICOM-UC, UPNA, OAN-IGN (TTI Norte, Anteral)	4,71	341,0	
Signal & Data Transport		UGR (7Solutions, DAS Photonics)	2,16	130,0	
Central Signal Processor		UPM → U. Berkeley → RSA (INSA/ISDEFE)	2,13	255,0	
Science Data Processor		FCSCCL, BSC	5,00	914,3	
Telescope Manager		GTD	1,50	90,0	
Infrastructure		CIEMAT, IAA-CSIC → CSIRO/SKA-SA	1,60	168,0	
		<b>Power Companies?</b>	Total	17,10	1.898,3



Work Package	Partner	Total Person-years	Financial value	Broad description of work
Dishes	IFCA-CSIC / DICOM-UC	0,40	60.000,00 €	Cryogenic Low-Noise Amplifier (LNA) design, modelling, testing for Single Pixel Feeds and analogue circuitry for receivers.
Dishes	UPNA	2,13	132.000,00 €	Single feed design and performance simulation.
Dishes	IGN	1,68	79.000,00 €	Cryogenic Low-Noise Amplifier (LNA) design, modelling, and testing for SPF amplifiers, bands 4 and 5.
Dishes	TTI norte	0,00	30.000,00 €	Support to IFCA/DICOM work.
Dishes	Anteral	0,50	40.000,00 €	Support to UPNA in feed design and feed manufacture.
Signal & Data Transport	UGR	1,58	90.000,00 €	UGR is mostly involved in the Synchronisation & Timing (SKA.TEL.SADT.SAT.*) packages, including (but not limited to) active phase compensation, & Performance modelling.
Signal & Data Transport	DAS Photonics	0,29	20.000,00 €	Technology consultancy on timing pulse generation and stability.
Signal & Data Transport	7Solutions	0,29	20.000,00 €	Technology consultancy on time distribution and White-Rabbit technology.
Central Signal Processor	UPM	1,50	165.598,08 €	Prototyping of FPGA-based signal processing on Uniboard and CASPER boards
Central Signal Processor	ISDEFE	0,63	89.410,72 €	Support to UPM work
✓ Science Data Processor	BSC	2,50	288.500,00 €	Contribution to SDP prototype design, design of pipelines, and code optimization.
✓ Science Data Processor	FCSCCL	2,50	625.825,00 €	Integrated SDP system prototyping in FCSCCL infrastructure, and participation in the Open Architecture Lab.
Telescope Manager	GTD	1,50	90.000,00 €	GTD provides expertise in dynamic scheduling SW development and restrictions for astronomical observatories through its wholly-owned German subsidiary.
✓ Infrastructure (Power)	CIEMAT	1,00	98.342,88 €	Expertise in power modelling and budgeting, including market and technology knowledge, and support to IAA-CSIC on dealing with Spanish industry.
✓ Infrastructure (Power)	IAA-CSIC	0,60	69.612,87 €	Interface with Spanish industry and research facilities on behalf of the RSA and AU Infra consortia, in coordination with PSA (CIEMAT).
<b>Total</b>		<b>17,1</b>	<b>1.898.289,55 €</b>	



18<sup>th</sup> February 2014

**SKA Organisation**  
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 e: enquiries@skatelescope.org  
 w: www.skatelescope.org

Mr Fernando Ballesterro  
 Deputy Director for International Relations and European Affairs  
 MINECO

Dear Mr Ballesterro,

I am writing in my capacity as the Director-General of the Square Kilometre Array (SKA).

The SKA is the next-generation radio-telescope. It will be, once complete, the largest scientific facility on Earth, with antennas spread across several thousand kilometres on two continents (Africa and Australia) and generating data volumes greater than ten times that produced by the entire internet traffic of the planet.

The SKA is being designed as a physics machine for the 21<sup>st</sup> Century and will address scientific questions such as the nature of gravity, the origins of the Universe and the origins of life.

The SKA Organisation (SKAO) currently has 11 members (Australia, South Africa, United Kingdom, Germany, Italy, the Netherlands, Sweden, Canada, China, India and New Zealand), who between them fund the €120M detailed design process. The detailed design is due to be complete in 2016 at which point, assuming funding has been approved, Phase 1 of the SKA will move to construction.

The SKAO is open to new members at any time. I am extremely encouraged and impressed by the interest in the SKA shown by scientists, engineers and industry in Spain. As the attached list demonstrates, Spanish organisations and institutes are currently contributing 17.1 person-years to the SKA design efforts; this has an estimated financial value of ~€1.9M. I understand that additional resources may also be available. The SKA Board welcomes these contributions from our Spanish colleagues and hopes that they can be translated at some point into a more formal membership of the SKA Organisation.

In order to provide more information the SKA Board is very pleased to invite you as a guest at the next SKA Board meeting as a representative of the Spanish government. The Board meeting will take place on March 11-12 at Jodrell Bank, near Manchester, UK. Mr Colin Greenwood, SKAO Company Secretary, will issue a formal invitation shortly.

Sincerely,

SKA Director-General

Cc: Ms Inmaculada Figueroa;  
 Dr Lourdes Verdes-Montenegro;  
 Mr Colin Greenwood

Company Number: 07881918  
 Company Limited by Guarantee  
 Registered in England & Wales

# SPAIN AND SKA ORGANISATION

**SKA TELESCOPE**  
**SQUARE KILOMETRE ARRAY**  
Exploring the Universe with the world's largest radio telescope

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## SKA Organisation Staff

**Miles Deegan**

**Juande Santander-Vela**  
System Engineer (SDP & TM)

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# SKA BOARD MEETINGS

- **22/07/2013:** MINECO sends e-mail to John Womersley (SKA Board Chair) stating the amount of Spanish participation, and availability for clarifications
- **27/07/2013:** John Womersley acknowledges message, invites MINECO to send delegate to October Board meeting, suggests LVM
- **2014:** Spain is regularly invited to Board meetings.



Jodrell Bank Observatory. March 2014

# SPANISH SKA DAY: GOALS

- Facilitating the Spanish **researchers** to **identify their niche among SKA scientific goals**, as well as making the Spanish community present in SKA Science Working Groups, in order to favour an **active role** in the preparation and exploitation of the SKA.
- To present to the Spanish research community the **status of the participation** of the Spanish technological groups and companies **in the SKA design**.
- **Making the engineers** participating in the SKA pre-construction consortia **aware of the scientific interest of SKA for our community**
- **Informing industry** on the potential areas of involvement for the PDR to CDR phase as well as for Construction

Registered participants from 18 academic institutions and 17 companies