

## ***REPORT ON THE RADIONET3 NETWORKING ACTIVITY***

**TITLE: TOWARDS THE RADIO-DETECTION OF COSMIC PARTICLES WITH THE SKA**

**DATE:** 5-7 MAY, 2015 **TIME:** WHOLE DAY

**LOCATION:** JODRELL BANK, UNITED KINGDOM

**MEETING WEBPAGE** <http://www.jb.man.ac.uk/meetings/cosmic2015/>

**HOST INSTITUTE:** UNIVERSITY OF MANCHESTER

**PARTICIPANTS NO:** 17

**MAIN LEADER:** UMAN

## REPORT:

### 1 Agenda of the meeting

The three days of this workshop consisted successively of a series of talks about the cosmic ray science possible with the Square Kilometre Array, discussion of the technical challenges involved, and discussion of the theoretical and analytic issues. A detailed listing of the meeting programme is attached.

### 2 Scientific Summary

The purpose of this workshop was to address the potential and technical requirements for cosmic particle science with the upcoming Square Kilometre Array (SKA), a radio telescope planned to begin construction in 2018. The design of the SKA is in an advanced state, so any changes required for this science must be determined in the near future, and this meeting brought engineers on this project together with scientists to discuss these. There are two possible techniques that may be employed with the SKA: detecting extensive air showers (EAS) from cosmic rays interacting in the atmosphere, as currently achieved by instruments such as LOFAR, to test their spectrum and composition; and detecting particles interacting in the moon, which the SKA has the potential to be the first instrument to achieve, and which would probe the origins of the most energetic particles. Both techniques were addressed at this workshop.

For the EAS project, various possibilities were considered for the co-located particle-detector array required triggering the storage of radio data, and a consensus was reached for a minimal array of simple scintillators aiming to measure only the electronic component of the shower, rather than a more ambitious array required to measure the associated muon flux. A potential show-stopper, the limited dynamic range of the SKA digitisers, was found to be less severe than feared, though it may still limit the reconstruction of cosmic ray events at higher energies; further simulations will be required to quantify this. The potential science goals of air-shower observations were discussed, including the prospects for discriminating between models of cosmic rays from Galactic or extragalactic sources based on their constituent particles.

For the lunar project, it was found that the low-frequency component of the SKA was strongly favoured, despite increased dedispersion requirements, due to the reduced beamforming requirements. The scope and interface for the signal-processing hardware required for this project was defined in some detail. The potential for this technique to verify the cosmic-ray hotspots detected by the Pierre Auger Observatory and Telescope Array was discussed, although this may be downgraded to a proof-of-concept detection experiment due to the decreased sensitivity of the SKA compared to earlier projections.

Plans were made to investigate both the scientific and technical points described above, with the latter to be codified into two engineering change proposals to be submitted to the SKA organisation some time in June.

The meeting included participants from Belgium, France, Germany, the Netherlands, Spain and the UK, of which Germany and the UK had the highest representation. The seventeen attendees included five postdocs and one student, and fifteen men and two women.





### **3 Attendance list**

The list of full participants is attached. The meeting was held on the site of an active radio observatory, and several astronomers attended informally for part of the meeting.

### **4 Financial Report / RadioNet3 contribution**

The financial support from RadioNet (2000€) was used for logistics and for conference material.

### **5 Conference Proceedings and Web page**

A report on the goals and outcomes of the meeting will be submitted to Astronomy & Geophysics. The presentations given during the meeting are available on the meeting web site <http://www.jb.man.ac.uk/meetings/cosmic2015/>.

# **Towards the radio-detection of cosmic particles with the SKA**

## **Meeting Programme**

### **Tuesday 5 May**

08:30 - Bus from hotel

09:00 - Registration

#### **Session 1: Cosmic rays and the SKA**

09:30 - Welcome (Ralph Spencer)

09:45 - Cosmic ray physics (Ralph Engel)

10:40 - Coffee

11:10 - [The lunar technique: history and current status](#) (Clancy James)

11:50 - [Radio EAS measurements: history and current status](#) (Frank Schroeder)

12:30 - Lunch (and conference photo)

13:30 - [SKA Phase 1 & 2](#) (Robert Braun)

14:30 - Coffee

#### **Session 2: SKA-EAS science and engineering**

14:45 - [SKA-EAS science chapter](#) (Tim Huege)

15:30 - SKA perspective on proposed engineering changes (Wallace Turner)

15:45 - Discussion

16:15 - Coffee

#### **Session 3: SKA-lunar science and engineering**

16:30 - [SKA-lunar science chapter](#) (Justin Bray)

17:15 - SKA perspective on proposed engineering changes (Wallace Turner)

17:30 - Discussion

18:00 - Bus to dinner

19:00 - Dinner, with talk on first radio cosmic-ray observations (Sir Francis Graham-Smith)

22:00 - Bus to hotel

### **Wednesday 6 May**



08:30 - Bus from hotel

## **Session 4: Workshop on SKA technical challenges**

(Workshop session: apart from the first talk, each item will consist of a slide or two about current issues followed by general discussion.)

Chairs: Olaf Scholten and Tim Huege

09:00 - SKA signal pipelines (Marco Caiazzo)

09:30 - Overview of SKA-EAS signal path (Tim Huege)

09:50 - Digitisation and buffering: dynamic range requirements, buffer size, readout window (Tim Huege)

10:10 - Triggering: radio self-triggering, particle detector trigger & interface (Tim Huege)

10:30 - Coffee

11:00 - Particle detectors: scintillator array design, RFI, space and power consumption (Stijn Buitink)

11:20 - Data: data transport & logistics, data products (Stijn Buitink)

11:40 - Calibration: antenna model, timing & amplitude calibration (Stijn Buitink)

12:00 - Overview of SKA-lunar signal path (Justin Bray)

12:15 - Beamformer: required capabilities, beam placement, array size, data output rate, commensality (Justin Bray)

12:30 - Lunch

13:30 - Dedispersion: source of ionospheric data (ionosonde, GPS, lunar polarisation), and implementation (Sander ter Veen for Maaijke Mevius)

13:50 - Detection: inversion of polyphase filterbank, interpolation, phase correction (Sander ter Veen for Maaijke Mevius)

14:10 - Triggering: anticoincidence scheme, beam overlap and self-veto, RFI environment (Sander ter Veen for Maaijke Mevius)

14:30 - Data: buffering, data transport & logistics, data products (Sander ter Veen)

15:00 - Coffee

## **Session 5: Strategic planning discussion**

15:30 - Discussion (chair: Clancy James)

- formal collaborations: Focus Group, Science Working Group, Key Science Project?
- expectations from Stockholm Key Science meeting
- funding opportunities
- papers to be written
- engineering change proposals
- timeline for all of the above
- define Session 7

18:00 - Bus to hotel

## Thursday 7 May

08:30 - Bus from hotel

### Session 6: Modeling and analysis workshop

(Workshop session: apart from the first talk, each item will consist of a slide or two about current issues followed by general discussion.)

Chair: Olaf Scholten

09:00 - [Lunar modeling and analysis overview](#) (Olaf Scholten)

09:10 - [Surface roughness and inhomogeneities at scales larger, smaller, and similar to observing wavelength](#) (Clancy James)

09:30 - [Shower length and LPM effect; charged- and neutral-current neutrino interactions](#) (Jaime Alvarez-Muniz)

09:50 - [Directional sensitivity; polarisation and frequency dependence](#) (Justin Bray)

10:10 - [Monte Carlo vs analytical models](#) (Justin Bray)

10:30 - Coffee

Chair: Tim Huege

11:00 - [Reconstruction \(incoherent\): energy, Xmax determination, limiting factors](#) (Stijn Buitink)

11:15 - Reconstruction (coherent): near-field imaging approaches (Tim Huege)

11:30 - [Preliminary SKA simulation study](#) (Anne Zilles)

11:45 - Particle detector motivation and options: muon detectors etc. (Stijn Buitink)

12:00 - Optimum band: higher frequencies? (Stijn Buitink)

12:10 - Plasma effects (Clancy James)

12:20 - [Thunderstorms](#) (Stijn Buitink)

12:30 - Lunch

### Session 7: Future plans and work allocation

13:30 - Discussion:

- probably in reference to the next ECP stage
- decide scope/priorities during the Wednesday 'strategic planning session'

15:00 - Coffee

15:15 - Further discussion

16:30 - Coffee

### Session 8: Wrap-up

16:45 - EAS wrap-up (Stijn Buitink)

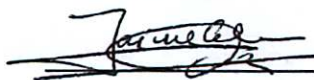
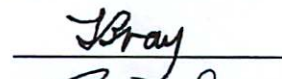

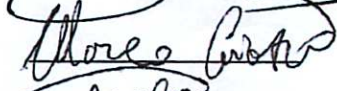
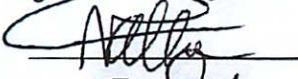

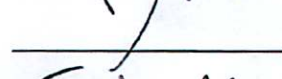
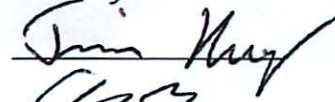
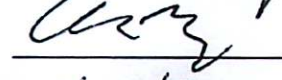
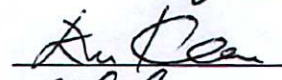
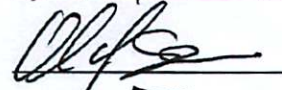
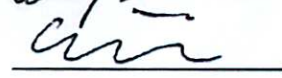
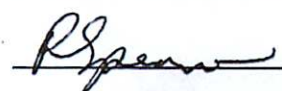
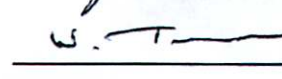
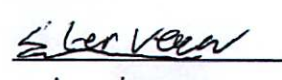
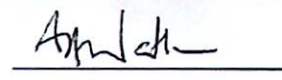
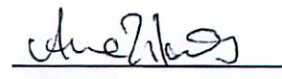

17:15 - Lunar wrap-up (Olaf Scholten)

17:45 - Goodbye (Ralph Spencer)

18:00 - Meeting ends; bus to hotel



**Towards the radio-detection of cosmic particles with the SKA**  
**Jodrell Bank Observatory, 5-7 May**

Name	Institution	Signature
Jaime Alvarez-Muniz	University of Santiago de Compostela	
Justin Bray	University of Manchester	
Stijn Buitink	Vrije Universiteit Brussel	
Marco Caiazzo	SKA Organisation	
Richard Dallier	SUBATECH France	
Ralph Engel	Karlsruhe Institute of Technology	
Jimi Green	SKA Organisation	
Tim Huege	Karlsruhe Institute of Technology	
Clancy James	ECAP, University of Erlangen-Nuremberg	
Evan Keane	SKA Organisation	
Olaf Scholten	KVI-CART, University of Groningen	
Frank Schroder	Karlsruhe Institute of Technology	
Ralph Spencer	University of Manchester	
Wallace Turner	SKA Organisation	
Sander ter Veen	ASTRON	
Alan Watson	University of Leeds	
Anne Zilles	Karlsruhe Institute of Technology	
Rebecca McFadden	—	

Attendees by country

Spain: 1

France: 1

UK: IIII II

Germany: IIII

Belgium: 1

Netherlands: II

