

Netherlands Institute for Radio Astronomy

Renewable radio astronomy

Ilse van Bemmel Aperture Array Verification Scientist

ASTRON is part of the Netherlands Organisation for Scientific Research (NWO)

Aperture arrays



Large field-of-view

Multi-directional

Flexible

SKA technology



Aperture arrays



Large field-of-view

Multi-directional

Flexible

SKA technology



EMBRACE: AA-mid technical demonstrator



A/T ~ 1 m²/K
400-1500MHz
TWO analogue beams
~200 digital beams (195.3kHz wide)
~40MHz bandwidth
single pol Nança



EMBRACE results: WSRT





EMBRACE results: Nançay



5

EMBRACE results: Nançay

<u>AST</u>RON



Breaking news!



EMBRACE WSRT, Benthem et al 2012

Limits for EMBRACE



imaging dynamic range

- polarization
- bandwidth
- (post-)processing
- big gap towards SKA

Limits for EMBRACE



imaging dynamic range

polarization

bandwidth

Need for science capable instrument

(post-)processing

big gap towards SKA

AAVS2-mid frequency demonstrator

Renewable aperture array radio telescope

Science capable interferometer

Green energy







Renewable aperture array radio telescope

Science capable interferometer

Green energy



EMMA main goals



Measure BAO signal (science)

Demonstrate imaging capability (technology)



EMMA specs



- $-2000m^2$ (A/T ~ 40 m²/K)
- multiple stations
- full Stokes
- 2 FoV, 64 digital beams
- ~80 deg² per FoV
- 450-1450 MHz
- T_{sys} ~50K
- bandwidth 500MHz
 - SKA single station



EMMA specs





EMMA configuration

- 14 stations
- 13.5m diameter
- central core: >50%
- Iongest baseline between 300-1000m







SKA site

EU site

12

Location



E-90 de Ródão P1 O Ourém 0 Brozas Casar de Nazaré Batalha o Porto 0 Cáceres SKA site Mação Alcobaca O Torres Tomar A23 Nisa de Mós Novas Abrantes **A8** 0 o Cáceres Trujili Valencia de IP2 Gavião 0 Arroyo Golegã Alcántara 0 Alcanena 0 0 de la Luz Marvãoo Madroñera Peniche o San Vicente Caldas da o Chamusca de Alcántara O Rio Major Ponte Portalegr Rainha EU site -de Sor o Crato C Santarém Alburquerque Lourinhã O 0 0 Cadaval Cartaxo o Almeirim Torres Miajadas Vedras 0 A-66 Madrigalejo Alenquer Avis Campo Santa o 0 Amalia Maior E-803 IP2 Vila Franca 0 Mora E802 Mérida Don Benito O de Xira Coruche Montijo O Mafra Badajoz 0 Campana Estremoz Elvas 0 A-5 0 Sintra Guareña A13 Talavera Loures Borba o Vila Viçosa 0 la Real Lisboa o Alcochete Arraiolos Cast Vendas o Montijo Almendralejo 0 Redondo o Alandroal Olivenza Novas 0 0 o Montemor o-Novo 0 Cascais 0 A6 0 Aceuchal Zalamea de Seixal Lisboa • Palmela Villafranca 0 la Serena Fuente del o Évora de los Barros Setúbal Barcarrota O Reguengos Maestre Sesimbra de Monsaraz 0 Zafra Viana do 0 Jerez de los Alentejo Caballeros Portel Alcácer Alvito Azuaga do Sal Llerena Oliva de la Fregenal E-803 Grândola ontera de la Sierra 0 Ferreira do Cuba 0 A-66 Alentejo Santiago do Cacém 0 Beja Sines A2 Serpa 0 1 IP8 Aracena Constanti 0 Aljustrel 201 Castro Nerva Castilblanco Lora Verde Mértola Valverde 0 Odemira Ourig del Camino nodôvar Alosno Azn 0 Sanlúcar la Mayor Bollullos Par del Condado o A-49 Gibraleón Sevilla 0 Aljezur Monchique 0 Mairena Huelva IP1 Lepe 0 del Aljarafe 0 0 Dos Silves Almonte A2 Olsla Cristina Punta Portimão Loulé o Umbría Hermanas Vila do O OLagoa Bispo 0 0 0 A22 Albufeira Parque Nacional Lagos Las Cabezas Faro Olhão de Doñana de San Juan * Lebrija O E-5 Villamarti Sanlúcar de 0 Arcos de Barrameda Jerez de la Frontera 0 0 Chipiona Q la Frontera 0 Cádiz Medina Rattendaten @2

Location



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Planning



AA-mid pathfinder

Single SKA station



Participants



Technical development:

- ASTRON
- Observatoire de Paris
- IRA/INAF
- UK
- Spain & Portugal: green energy
- Science team in the making

EC funding opportunities being explored



based on online information late 2011



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based on online information late 2011

based on online information late 2011

EMMA: additional science

low column density HI: few x 10¹⁹ cm⁻²

pulsars: survey and timing

polarization in local Universe

transient follow-up

local cosmology

Movie credits: Swinburne Astronomy Productions