ASTRON
The Netherlands Institute for Radio Astronomy & SKA

Prof Carole Jackson
General & Scientific Director, ASTRON

11 June 2018

Mission Statement:

“Making Discoveries in Radio Astronomy Happen”

- **Science leadership: World-leading astronomy**
- **Innovative R&D: Digital signal processing, photonics, antennas**
- **National Facility: Observatory operations delivering services and data to an international user community**

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Towards SKA

- **Science Drivers – the astronomical community's SKA ambitions**
- **Technology exploration (EU FP6 SKADS, FP7 PrepSKA and more)**
- **Year 2010 telescopes, precursors and pathfinders**
- **SKA pre-construction 2012-present**
- **ASTRON SKA futures**

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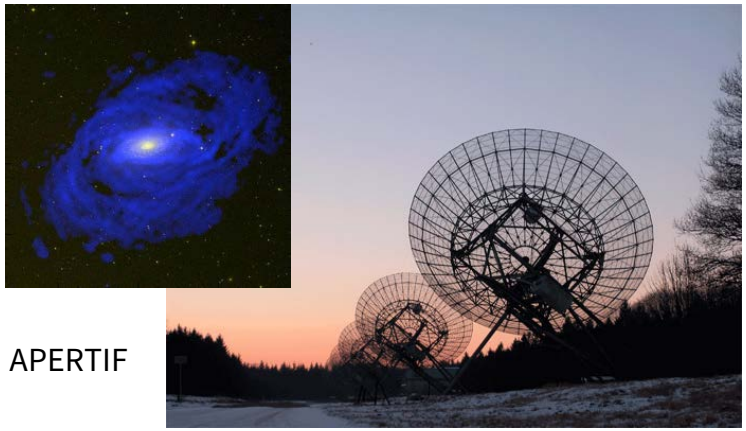
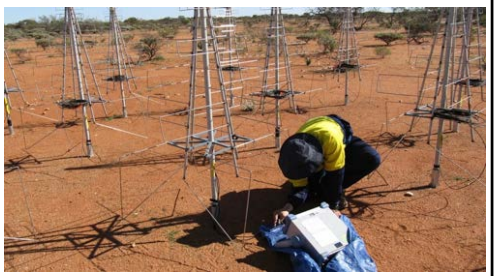
ASTRON's Portfolio 2017

Westerbork Synthesis Radio Telescope WRST



APERTIF

Pre-construction
2012-2019



LOFAR (Core)

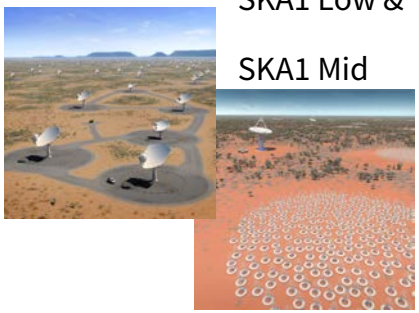
International LOFAR Telescope (ASTRON Share 75%)

ASTRON’s portfolio 2025 - 2030

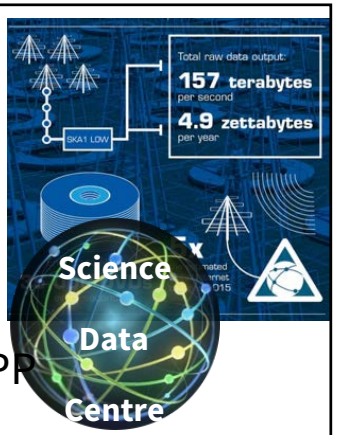
SKA1
Science operations
2024 onwards

SKA1 Low &

SKA1 Mid



NL Science Data Centre
A centre of excellence
EU focus
Collaborative, possible PPP



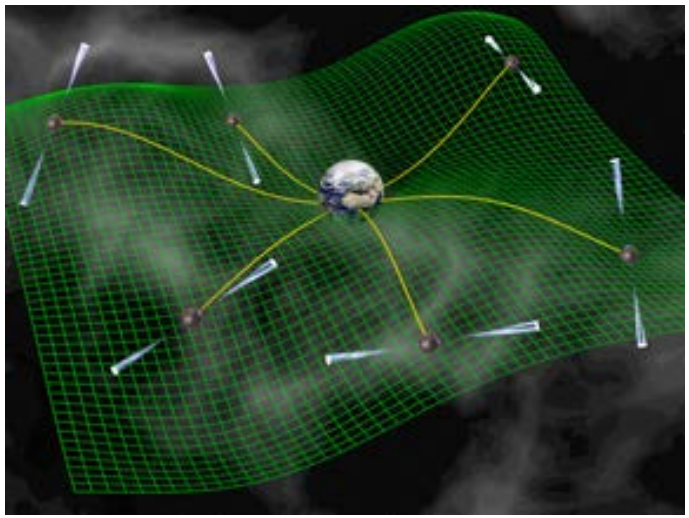
LOFAR 2.0 (Core - increased)

International LOFAR Telescope
additional partners
(ASTRON Share 75%)

ASTRON, NL and SKA science

- Testing General Relativity and the progenitors of gravitational waves

  pulsar, transients (FRB)s and time domain science



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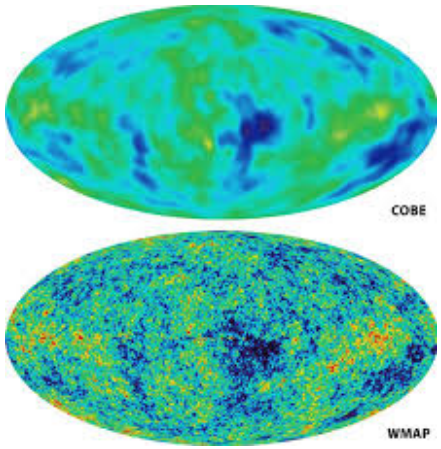
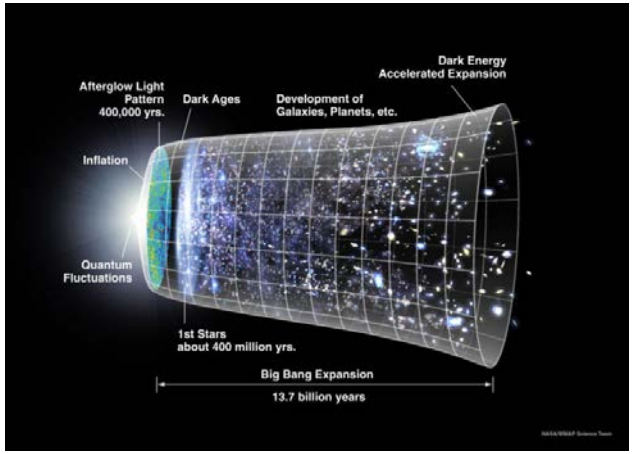
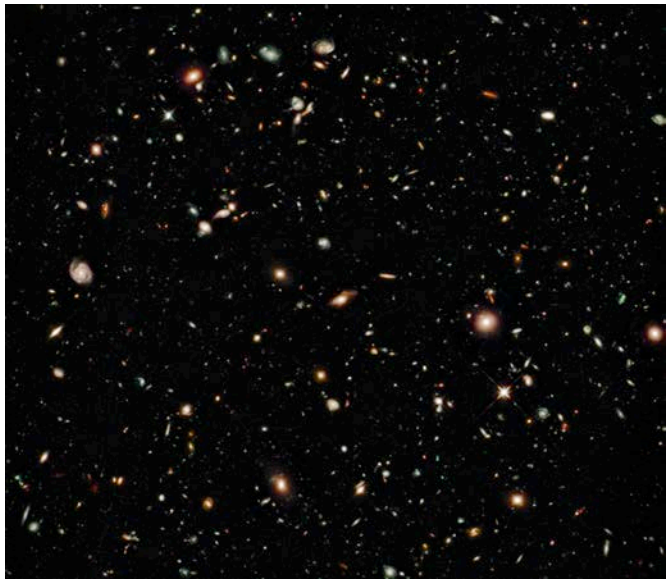
ASTRON, NL and SKA science

- Cosmic dawn, EOR & the birth of all stars & galaxies (HI)



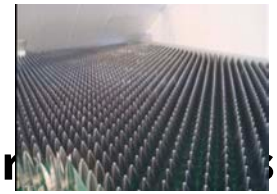




ASTRON and explorative SKA technologies

EU programmes FP6 & FP7 (SKADS and PrepSKA) explored SKA concepts (pre-2012)

- **Dense and sparse phased arrays (EMBRACE)**
- **Phased array feed receivers (PAFs) in dish antennas**
- **Advanced digital systems – rapidly advancing FPGA & GPU ar**
- **New low frequency (m-wavelength) telescopes enabled by ICT**



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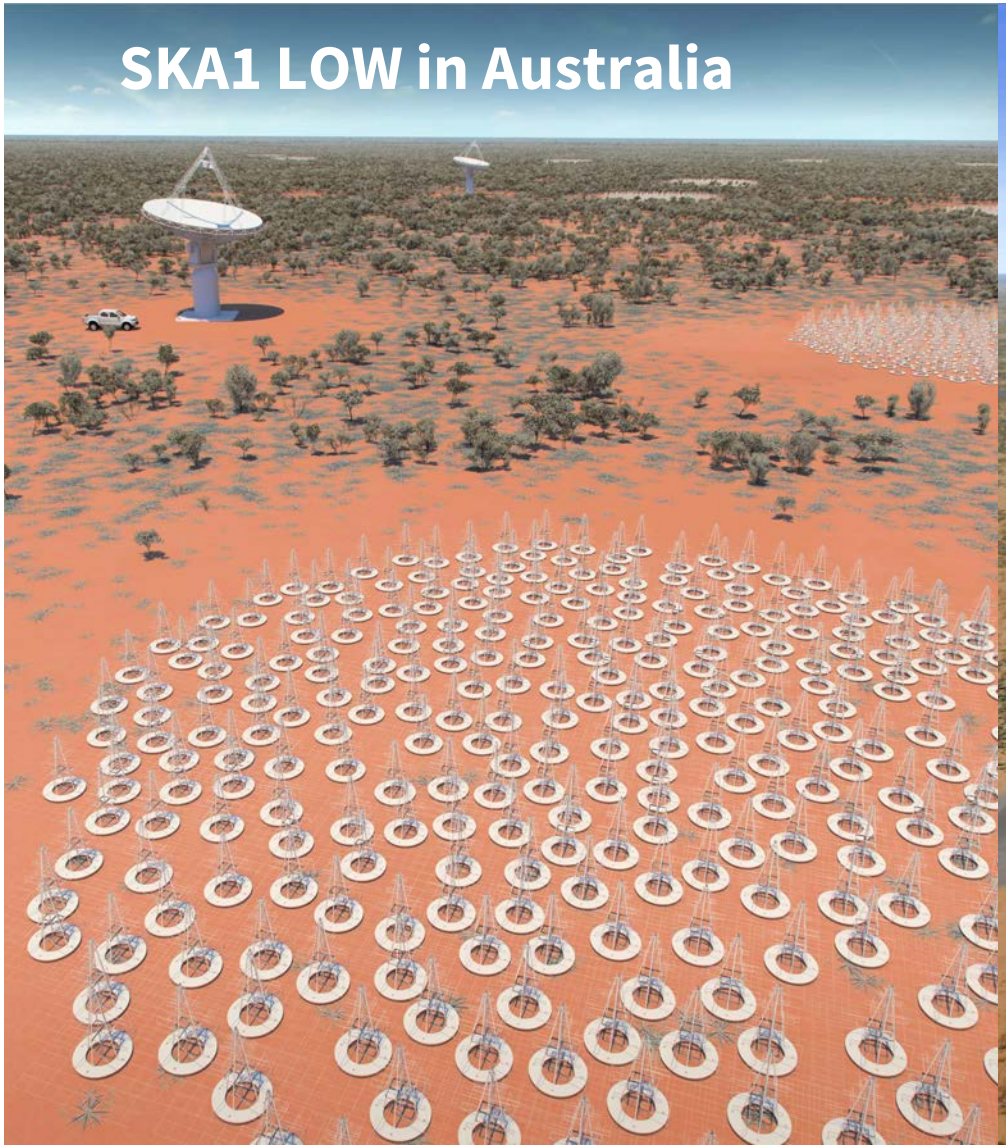
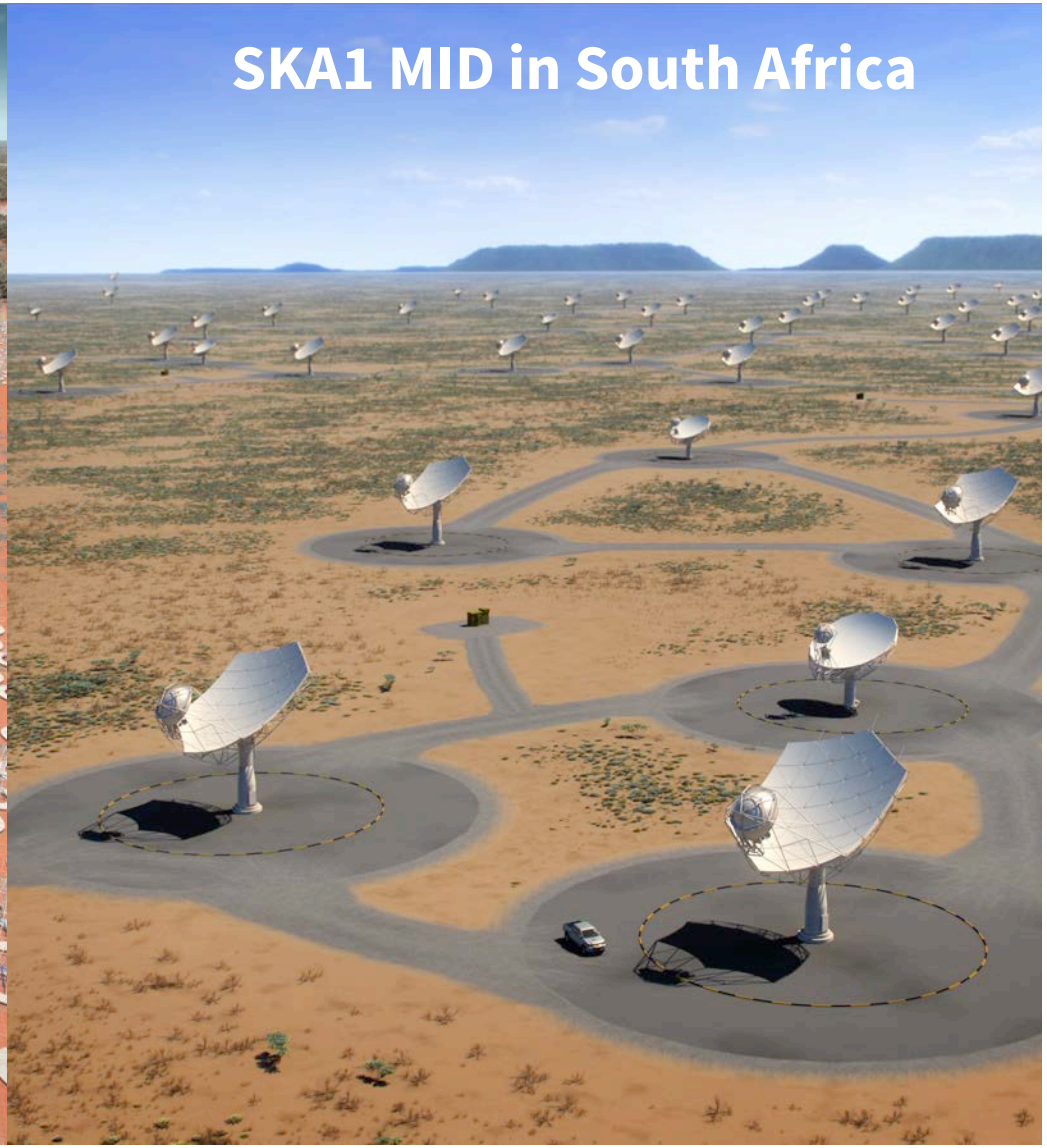

SKA1 LOW in Australia


SKA1 MID in South Africa

Year 2010 telescopes, SKA precursors and pathfinders

- LOFAR – design & build ~2008: Evolved as NL-funded ‘Sensor array’
- An SKA pathfinder - techniques, operations, design, training astronomers
  World-leading science now
- Growing number of international partners & stations

LOFAR

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Year 2010 telescopes, SKA precursors and pathfinders

- APERTIF – full WSRT systems upgrade
- In final commissioning (2018)
- An SKA pathfinder (AIP): PAF receivers
- Sister to ASKAP: whole sky HI surveys & transient detections (GW precursors)

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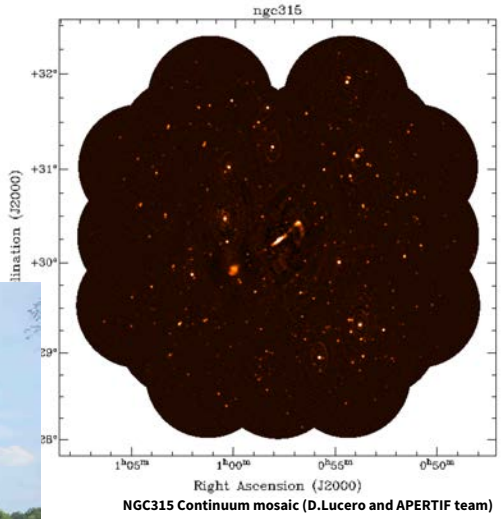
APERTIF – PAFs for SKA2?



NGC315 Continuum mosaic (D.Lucero and APERTIF team)

First imaging results from Apertif: Adams et al (2017)
Detection of a bright burstfrom FRB121102; Oostrum et al (2017)
ARTS – the Apertif radio transient system: van Leeuwen et al (2013)
Apertif – the focal plane array system for the WSRT: Oosterloo et al (200
HI surveys with APERTIF: Verheijen et al

https://www.astron.nl/astronomy-group/apertif/results-and-publications/apertif-results-and-publications

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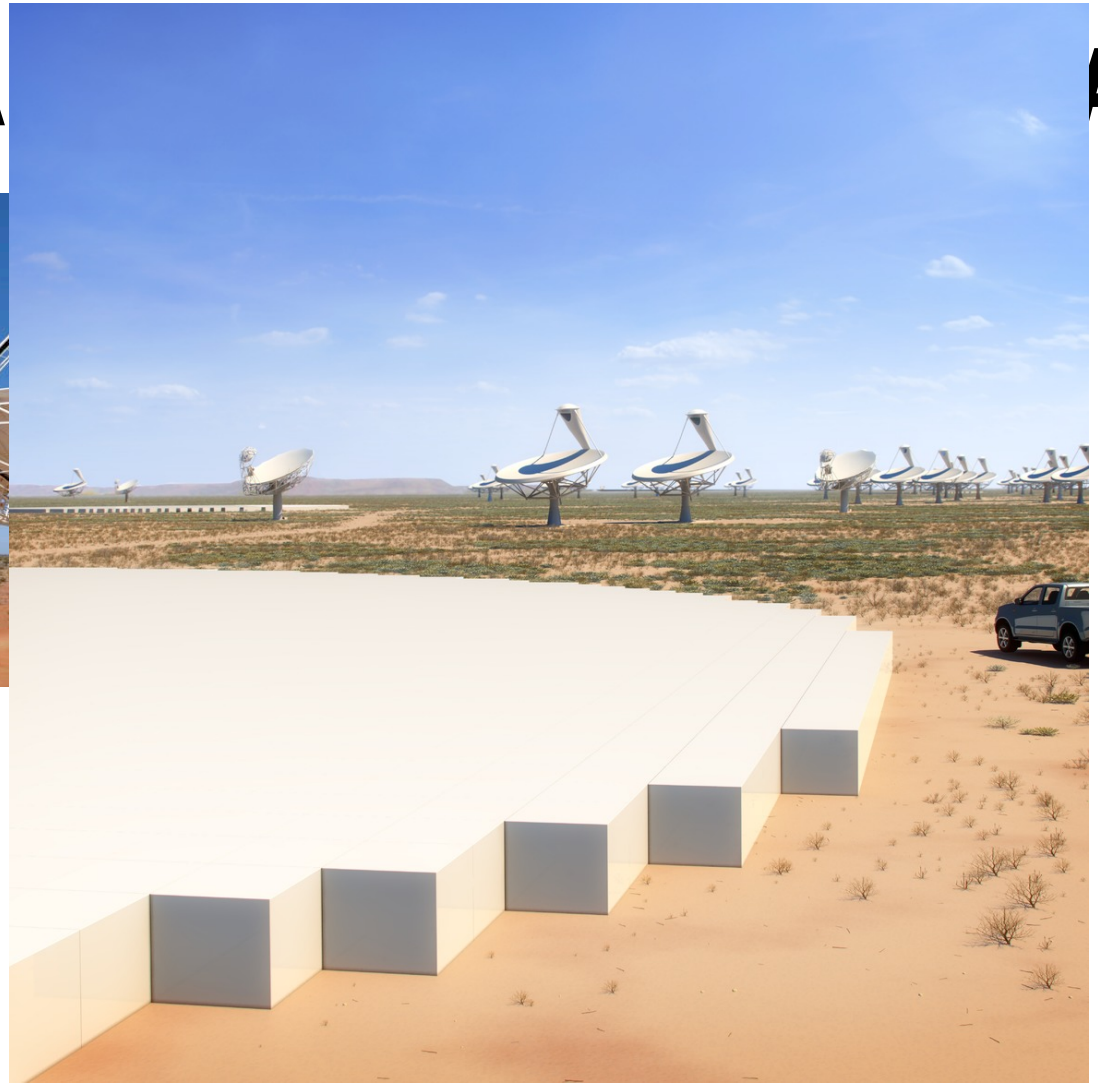
A A2?



Or are dense aperture arrays “MFAA” the way of the future SKA???

NGC315 Continuum mosaic (D.Lucero and APERTIF team)

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SKA pre-construction (2012 – 2018) – Design & Validation

Aperture Array (LFAA) design for SKA_Low

ICRAR International Centre for Radio Astronomy Research

UNIVERSITY OF MALTA L-Università ta' Malta

UNIVERSITY OF OXFORD

INAF ISTITUTO NAZIONALE DI ASTROFISICA NATIONAL INSTITUTE FOR ASTROPHYSICS

Observatoire de la CÔTE d'AZUR

Station de Radioastronomie de Nançay

Science & Technology Facilities Council

UNIVERSITY OF CAMBRIDGE

KLAASA Key Lab of Aperture Array and Space Application

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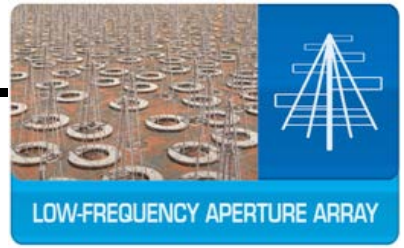
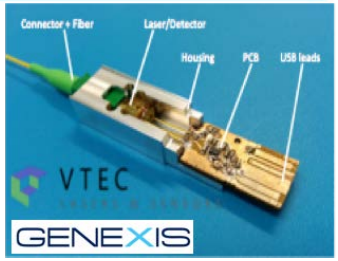
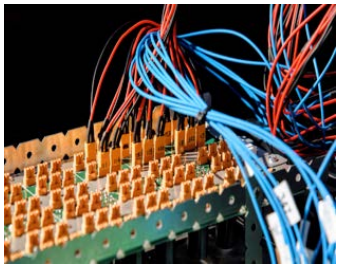
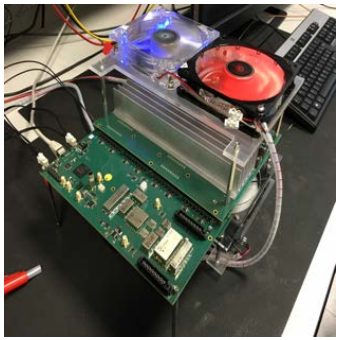
SKA pre-construction (2012 – 2018) – Design & Validation

- **"AAVS1" = First SKA1 Low test station in Western Australia**









SKA pre-construction (2012 – 2018) – Design & Validation

ASTRON also has

- **major contribution to CSP (Digital processing)**
- **SDP (science processing) and AIV (integration & verification)**
- **Reinvest ASTRON's aligned R&D efforts, including "LOFAR 2.0"* - and in reverse… SKA innovations assist our NF upgrades**
- **LOFAR 2.0 = digital upgrade – LBA+HBA; ionospheric calibration**

10 MHz+, full sensitivity & imaging; 10x resolution SKA1_low

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ASTRON leads major EU H2020 Projects

AENEAS: toward an EU SKA Science regional data centre

ASTERICS: deliver software tools and techniques for EU Research Infrastructures (ELT, SKA, KM3Net, CTA)

LOFAR4SW: investigate LOFAR/ILT's capabilities to deliver Space Weather Monitoring data (ESA, met offices …)

ASTRON in the SKA era

- **Balance National Facility vs IGO/SKA roles**
  Maintain & continue to host all-system R&D expertise

  ASTRON as a fast innovator delivering functionality and innovations to astronomy which major global facilities cannot

- Develop LOFAR 2.0 as complementarity to SKA with unique capabilities

- Contribute to AIP SKA – LOFAR 2.0 and aperture arrays of the future

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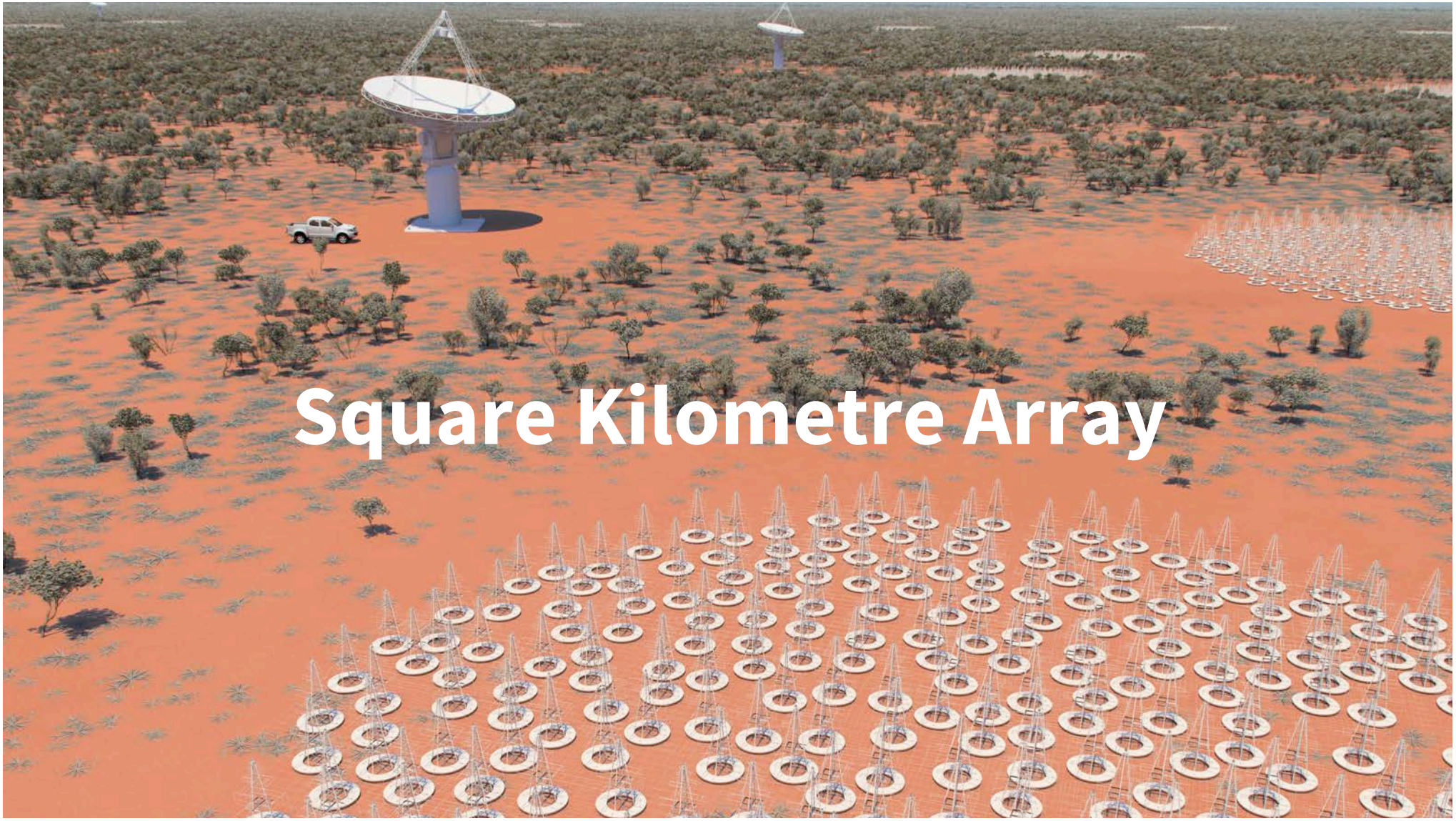
Square Kilometre Array