Metsähovi Compact Array

Finland's new radio interferometer

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With thanks to: Jere Raassina, Kjetil Holmberg, Christian Malino, Ari Mujunen, Juha Aatrokoski, Rick Åberg, Job Vorster, Demian Aaltonen, Sonny Holman, Joni Tammi, Tuomas Savolainen, Eki Oinas, Juha Kallunki, Petri Kirves, Axel Rautiainen, Ulla Kallio, Kaj Wiik

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Metsähovi, Finland

Site established by University of Helsinki in 1971
Optical observatory (w/ 0.6m-RC)

Helsinki Univ. of Technology (TKK),
built the 14m radio telescope on the site in 1974

TKK merged with TaiK (arts) and HKKK (econ.)
to form Aalto University in 2010

Ref: Urpo, “Hajatarinoita Kurpitsan Historiasta”, Metsähovi Radio Observatory, TKK, HUT-KURP-29, 2004

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Photo: (c) NLS/Gustafsson 2025-06-09, used with permission Map: Kartapiakka, MML McKay-0543 3 / 24

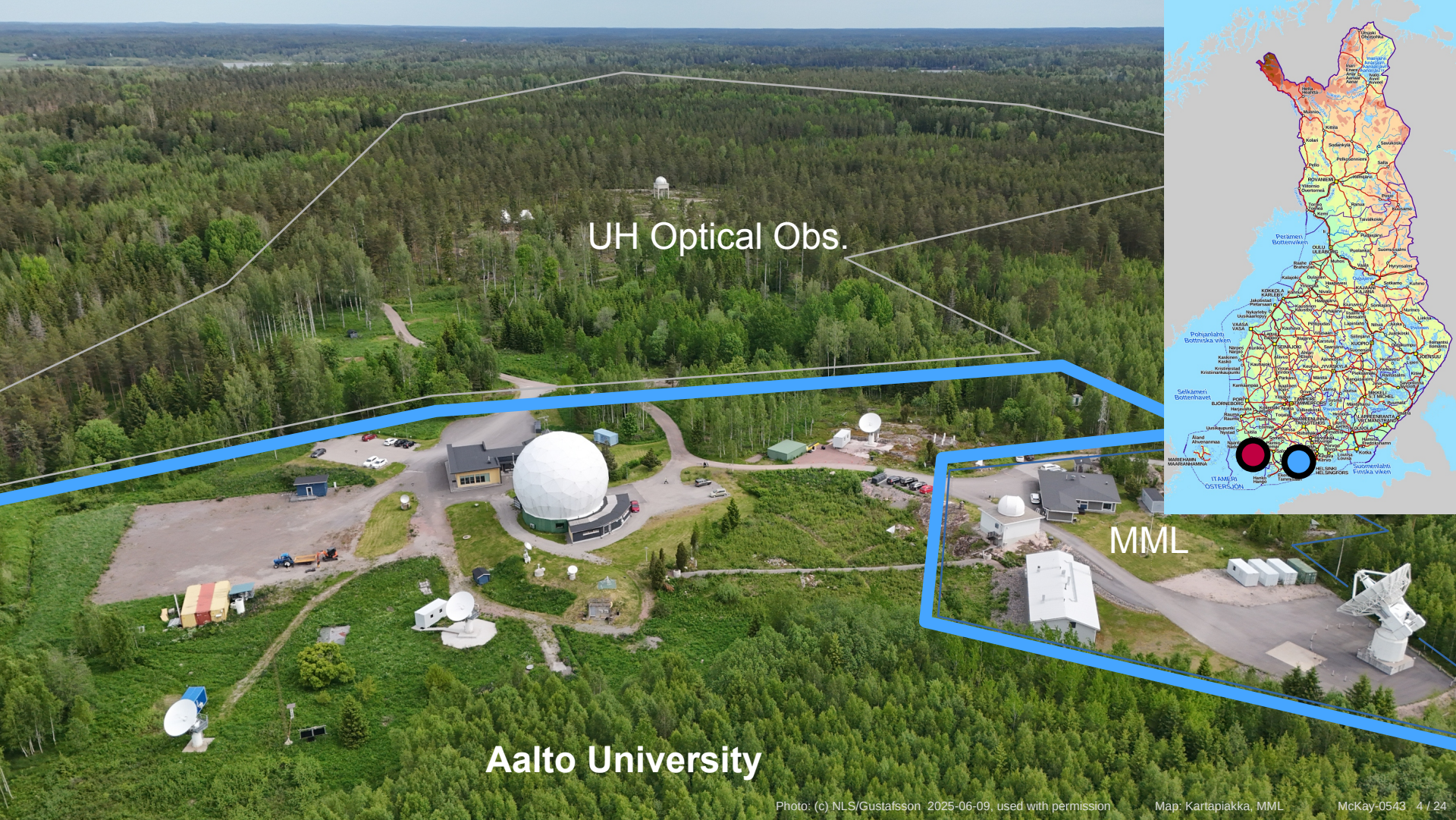
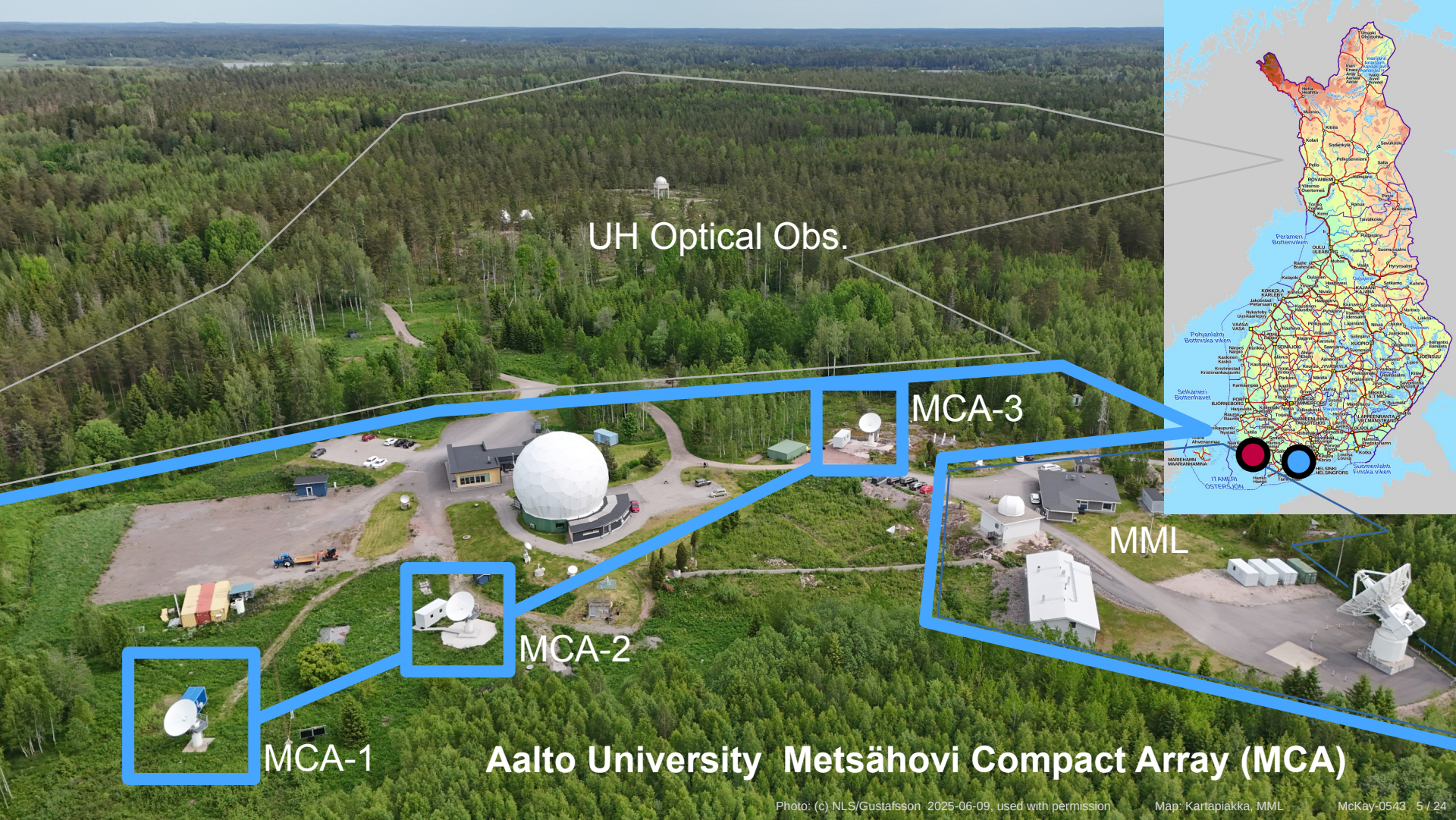


Photo: (c) NLS/Gustafsson 2025-06-09, used with permission Map: Kartapiakka, MML


UH Optical Obs.
MCA-3
MML
MCA-2
MCA-1
Aalto University Metsähovi Compact Array (MCA)
Photo: (c) NLS/Gustafsson 2025-06-09, used with permission
Map: Kartapiakka, MML

MCA overview and objectives

Metsähovi Compact Array

Scientific research facility

Technology development platform

Training and education facility

Cross-disciplinary interferometry

Three 5.5-m steerable parabolic antennas

Freq. range 4-8 GHz

Single-dish and interferometer modes

Photo: D. McKay, 2026

MCA history

2014 ex-Karkkila → MRO

2022 MCA-1 commissioned

2024 MCA-2 commissioned


Viisykkönen

Etusivu Uutiset

Viisykkönen.fi / Uutiset / Tässä viedään Kylmälän perukoille uusia antenneja

24.09.2014 08:56 (3) kommenttia

Tässä viedään Kylmälän perukoille uusia antenneja

Jaa tämä juttu:

Loppumatka Metsähovin tekee tiukkaa, mutta antenni saatiin erikoiskuljetuksella perille.

MCA history

2014 ex-Karkkila → MRO

2022 MCA-1 commissioned

2024 MCA-2 commissioned

· · · AD2024 · · ·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Images: Viisykkönen (delivery), Kallunk (MCA-1), McKay (MCA-2)

MCA history

2014 ex-Karkkila → MRO

2022 MCA-1 commissioned

2024 MCA-2 commissioned

· · · AD2024 · · ·

2024 First fringes

2025 Spectral correlator

2026 MCA-3 first light

} This talk :-)

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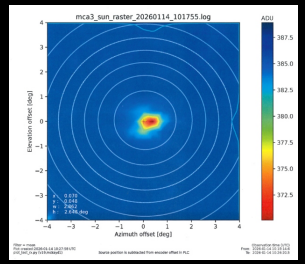
MCA-3 progress

↓ (At the time of AD2024, Vaasa)

Now built! →



“First-light” 14-Jan-2026

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Photo credits: D.McKay (2024, 2025).

MCA Antennas

Alcatel 9775 ex-Globalstar (Karkkila)

De-icing unit, all year operation

Approx. 5t gross-weight

5,5m diameter primary
0,8m secondary, Cassegrain focus

θ_{min} → Az ±255° El 2-89°

ω → Az 17°/s El 3°/s

Guaranteed on-source < 30s

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Photo: D.McKay, 2026

RF-systems

Dual-channel, circularly-polarised, OMT

Lower waveguide cut-off 4.1 GHz

Total Rx. BPF response 3.9 – 8.1 GHz

Transducers optimal for 4.7 – 7.0 GHz

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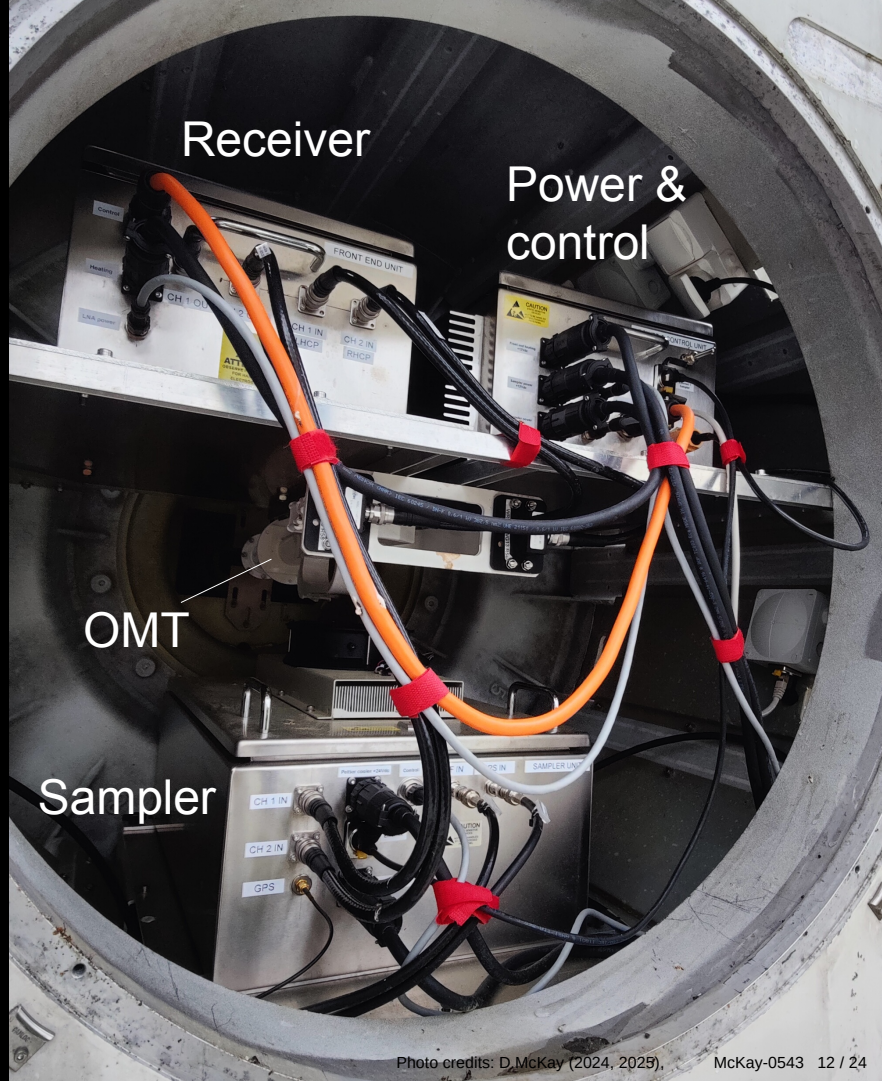
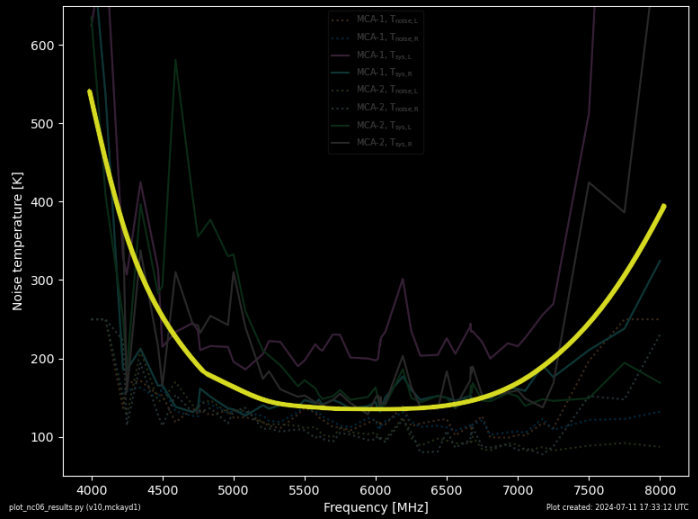


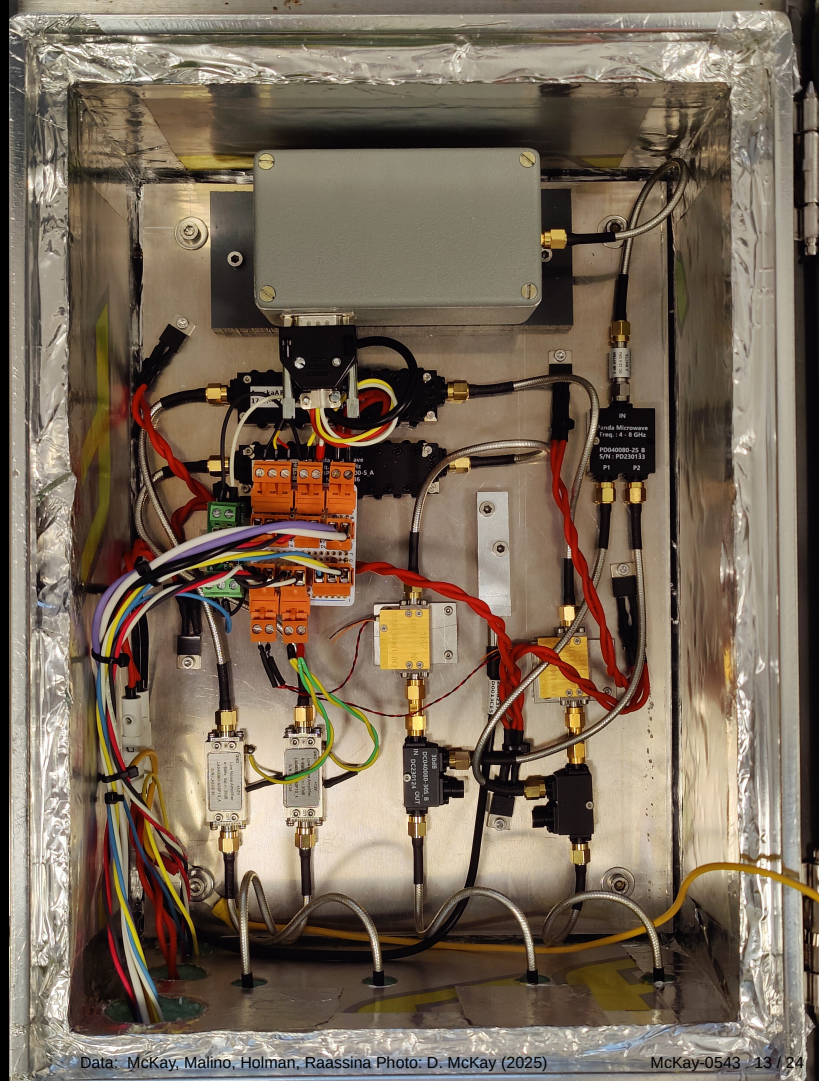
Photo credits: D.McKay (2024, 2025),

Receivers

Dual-channel, ambient receiver

Noise diode; T_{sys} ~150 - 170K





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Samplers and spectral capability

MCA-1 & MCA-2 → Ettus X410

Min. 0.512 MHz
Max. 6 MHz dual pol. Or 12 MHz single pol.

4096 spectral channels

→ ~1 m/s v_{LSRK}

Exp. w/ 122 MHz

To be replaced…

10 MHz & 1PPS references derived from observatory's hydrogen maser atomic clock

Photo: D.McKay (2024)

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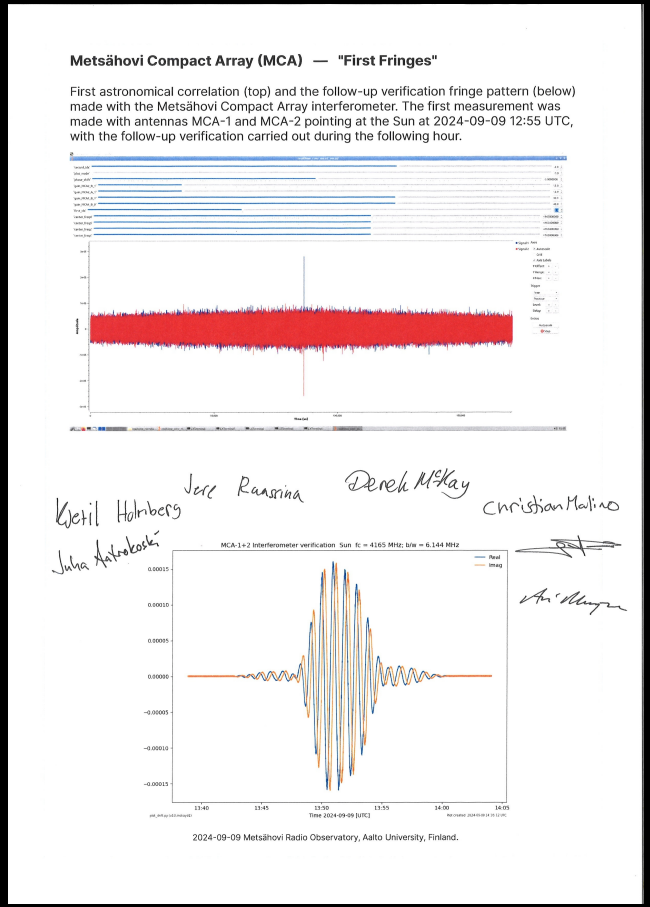
MCA Correlator

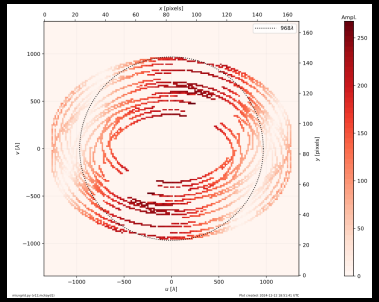
FXF / FX-correlator

12 MHz B/W | 2×6 MHz dual-polarisation

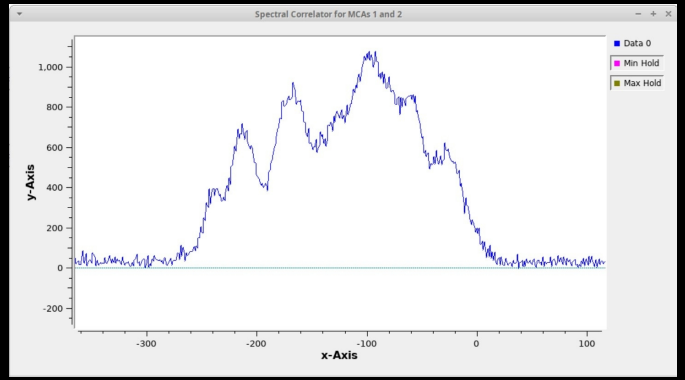
“First fringes” 09-Sep-2024 →



MFS ↓



Spectral mode ↓



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Site layout and uv-coverage

MCA-1-2 **47 m**

MCA-2-3 **116 m**

MCA-1-3 **163 m**

MCA-4 location TBD

Ref: McKay, D., et al. "Metsähovi Compact Array Finland's New Radio Interferometer", WSW2026

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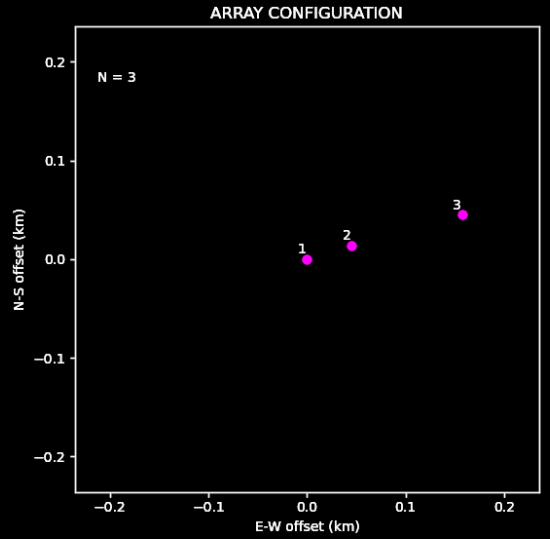
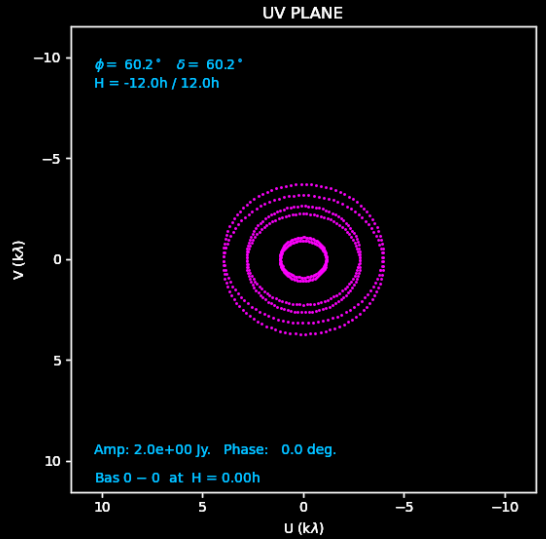
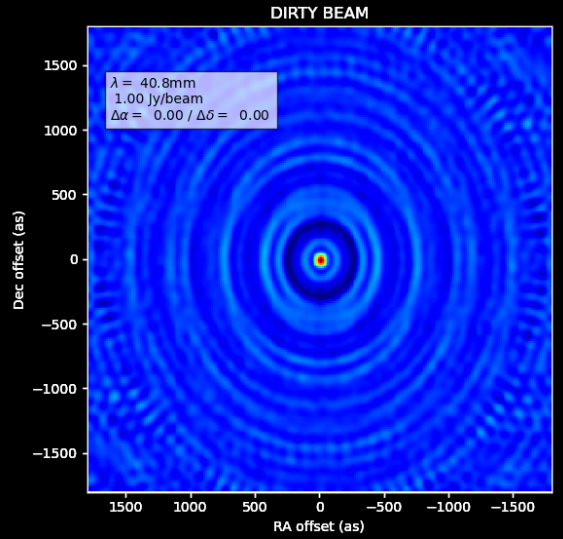
Site layout and uv-coverage

Array configuration, HA ±12h, δ = +60.2° (co-lat.).

MCA1+2+3 (=163m) will have approx. 30× resolution of MCA-1 (5.5m)







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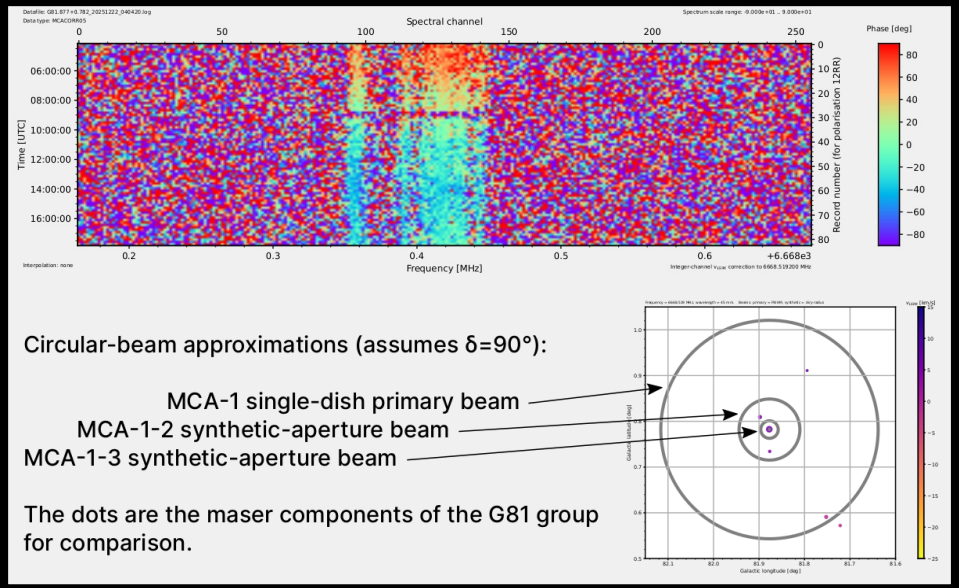
Example: @6.7 GHz MCA-1 only = 0.48 deg, MCA-1-2 = 56 mdeg, MCA-1-2-3 = 16 mdeg (~ 1 arcmin)

Simulations made using ApSynSim, (Marti-Vidal 2014),

Fringes and localisation

5.5m antennas
← low sensitivity
→ but a large primary beam

Can detect a maser flare in the primary beam, and then localise it using the interferometer



Refs: McKay, D. et al., "Metsähovi Compact Array – Finland's New Radio Interferometer", WSW2026
Nikkilä, N. & Laakkonen, V., "MCA Measurement Report", Aalto Geoinformatics, 2025

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MML MAANMITTAUSLAITOS

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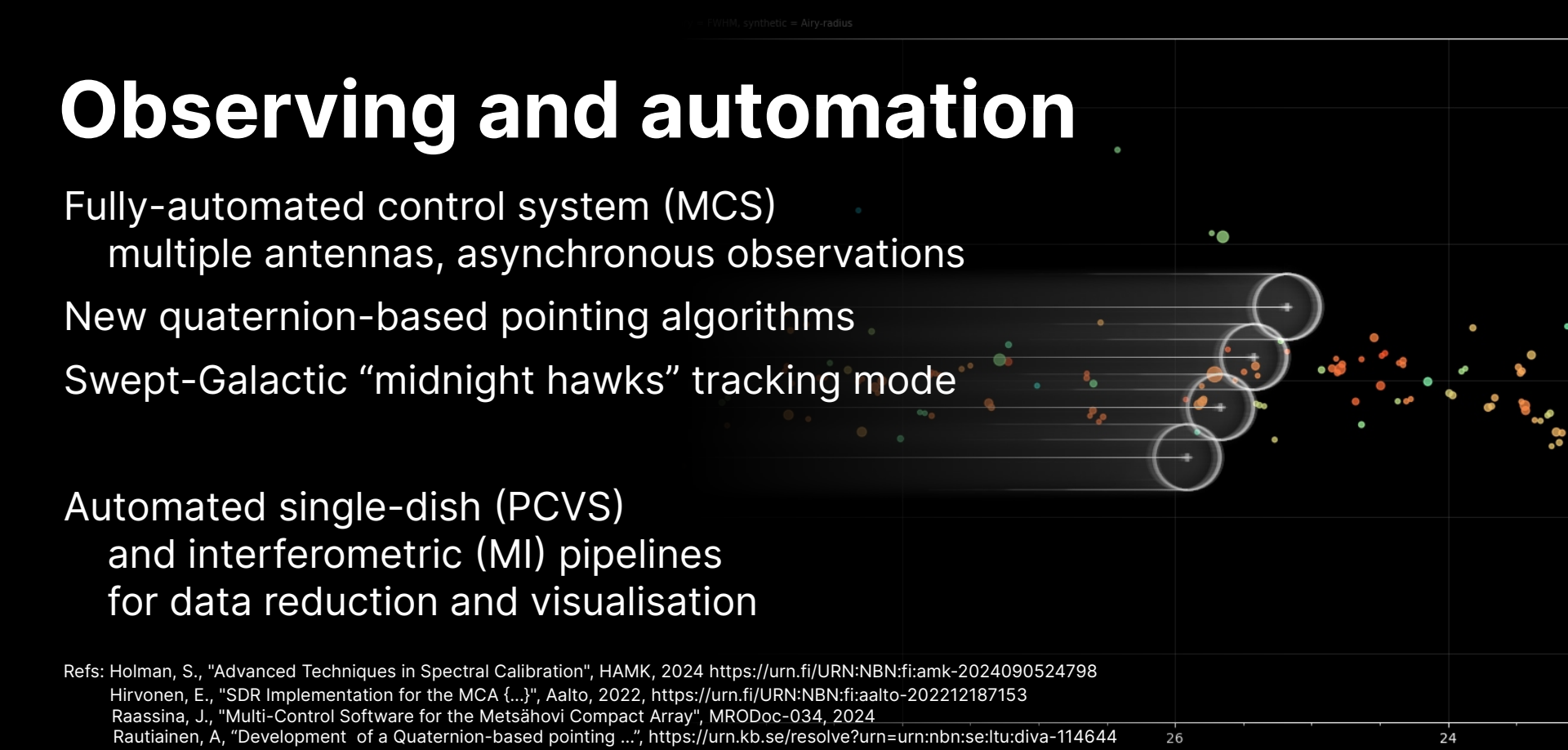
Observing and automation

Fully-automated control system (MCS)
multiple antennas, asynchronous observations

New quaternion-based pointing algorithms

Swept-Galactic “midnight hawks” tracking mode



Automated single-dish (PCVS)
and interferometric (MI) pipelines
for data reduction and visualisation

Refs: Holman, S., "Advanced Techniques in Spectral Calibration", HAMK, 2024 https://urn.fi/URN:NBN:fi:amk-2024090524798
Hirvonen, E., "SDR Implementation for the MCA {...}", Aalto, 2022, https://urn.fi/URN:NBN:fi:aalto-202212187153
Raassina, J., "Multi-Control Software for the Metsähovi Compact Array", MRODoc-034, 2024
Rautiainen, A, “Development of a Quaternion-based pointing ...”, https://urn.kb.se/resolve?urn=urn:nbn:se:ltu:diva-114644

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Science overview

Searching for accretion bursts
from young stellar objects → NEXT TALK !!!

(using targeted observing and
the new swept-Galactic continuous tracking)

High-resolution (~1 m/s) methanol-maser line study

Stellar flare induced stimulated emission

Solar flare target-of-opportunity

Ref: Vorster, J. et al., "Searching for accretion bursts from young stellar objects with the Metsähovi Compact Array", WSW2026

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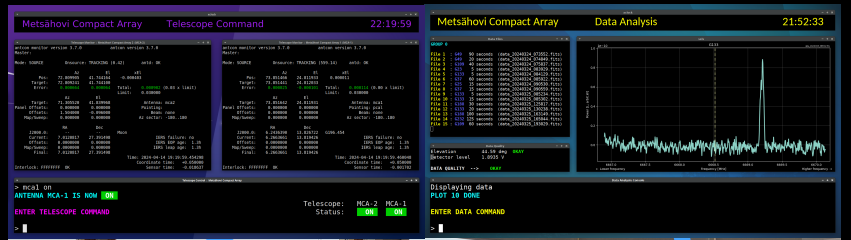
Education

Bridging the yawning gap between high-end facilities and introductory instrumentation

School students, hands-on multi-telescope control to measure Galactic rotation →



↓ Master's level Radio Astronomy: RF-measurement right at the telescope

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Future work

Spoiler alert for NBAD2028 !

Multi-band samplers

Hybrid-mode,
wide-band correlator

MCA-4 (~ 400m)

Photo: D.McKay, 2026

Conclusion

Making solid progress

Solid education

Solid science

If you want to
get involved,
get in touch!

:-)

Photo: D.McKay, 2026

Questions?

https://www.metsahovi.fi/mca

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