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Assessing the Fringe Detectability of the Africa Millimetre Telescope for Event Horizon Telescope Observations

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The AMT and the Fringe-Detectability Question

- A 14 m-class millimetre telescope planned for Namibia, designed to join the EHT at 230 GHz.
- Two candidate sites are being characterised: the H.E.S.S. site and Gamsberg Mountain.
- We test when the AMT–ALMA and AMT–NOEMA baselines can detect useful fringes from Sgr A* and M87*.

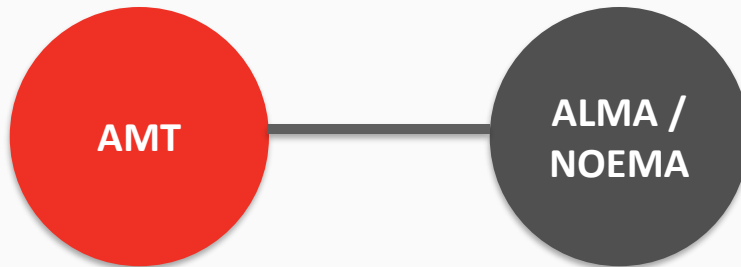
Main question: How often can these AMT baselines detect useful fringes from these sources?



Gamsberg Mountain (top) and H.E.S.S. observatory (bottom)

What do we mean by “fringe detectable”?

Two stations see the same source



A useful fringe needs:

- simultaneous visibility
- low enough SEFD at both stations
- enough coherent integration time
- enough correlated source flux

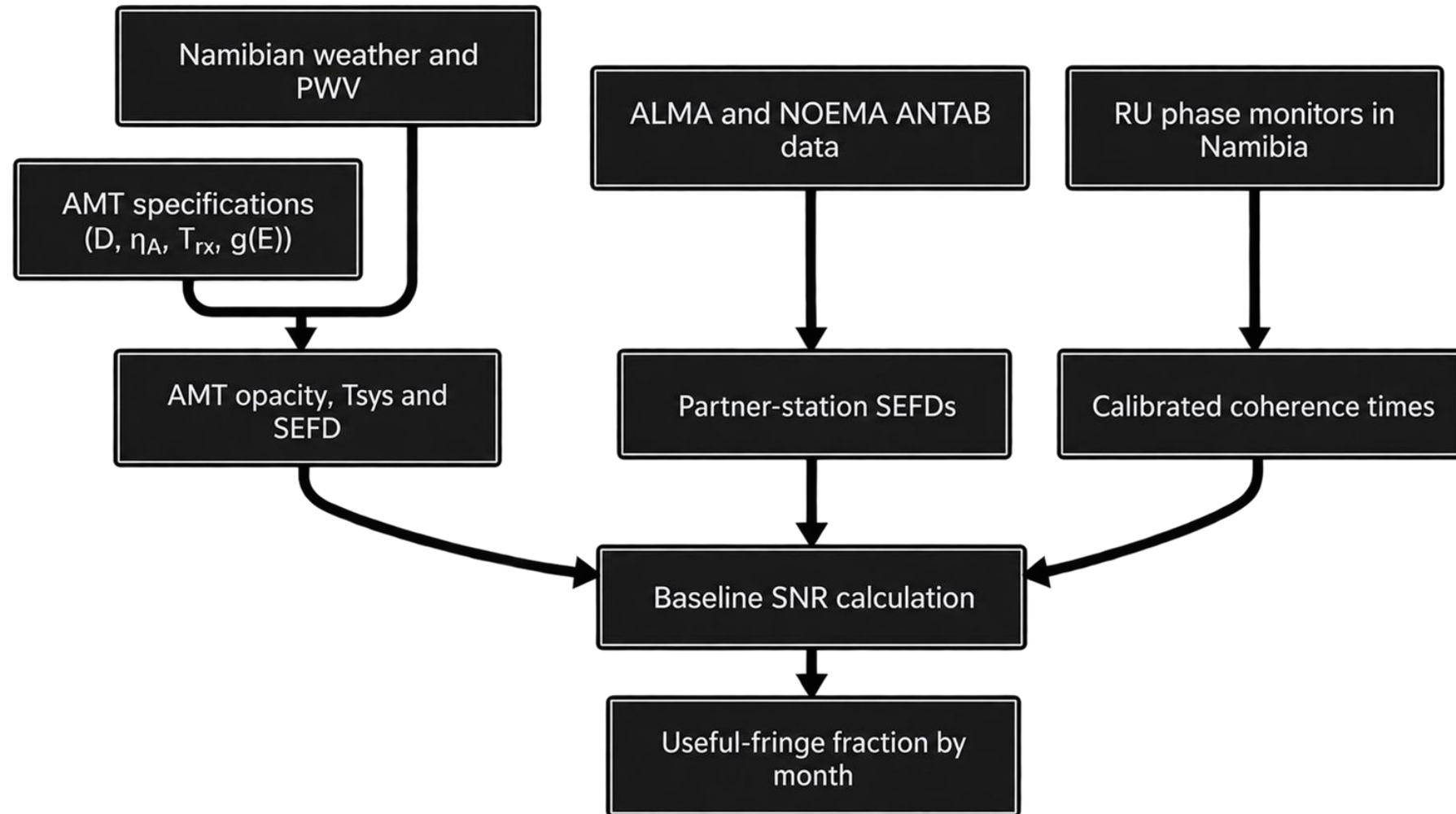
$$\text{SNR} = \eta_Q R_{\text{coh}} S_{\text{cor}} \sqrt{\frac{2 \Delta \nu t_{90}}{\text{SEFD}_{\text{AMT}} \text{SEFD}_{\text{partner}}}}$$

$$S_{\text{min}} = \frac{\text{SNR}_{\text{th}}}{\eta_Q R_{\text{coh}}} \sqrt{\frac{\text{SEFD}_{\text{AMT}} \text{SEFD}_{\text{partner}}}{2 \Delta \nu t_{90}}}$$

Useful fringe: $\text{SNR} \geq 4 \Leftrightarrow \text{correlated signal} \geq \text{detection limit}$

Lower SEFD and longer coherence time reduce the minimum correlated signal that can be detected.

From site measurements to a useful-fringe fraction

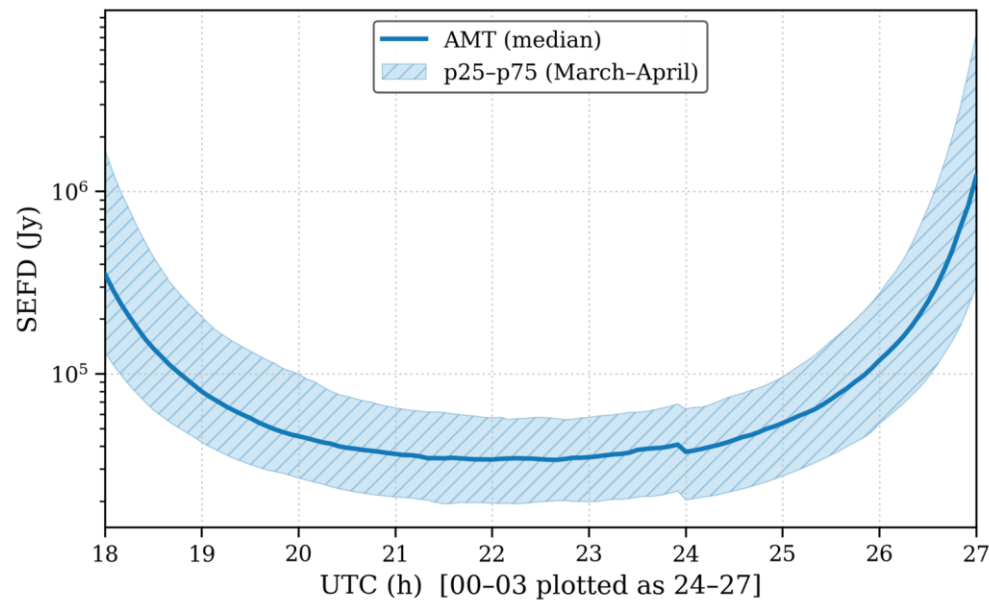


AMT sensitivity from Namibia site conditions

$$\text{PWV} \rightarrow \tau_0(230 \text{ GHz}) \rightarrow \tau_{\text{los}}(E) \rightarrow T_{\text{sys}} \rightarrow \text{SEFD}$$

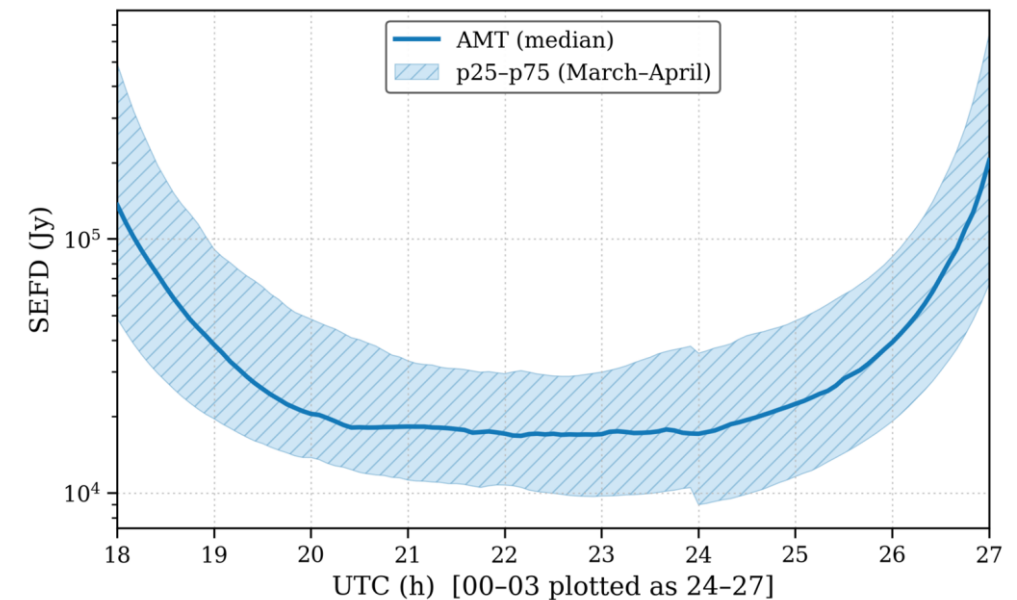
GNSS PWV + ground temperature are converted to 230 GHz opacity, then to a source-elevation-dependent AMT SEFD.

HESS AMT SEFD for M87*
(March–April)



H.E.S.S. median SEFD ≈ 44.9 kJy

GAMS AMT SEFD for M87*
(March–April)

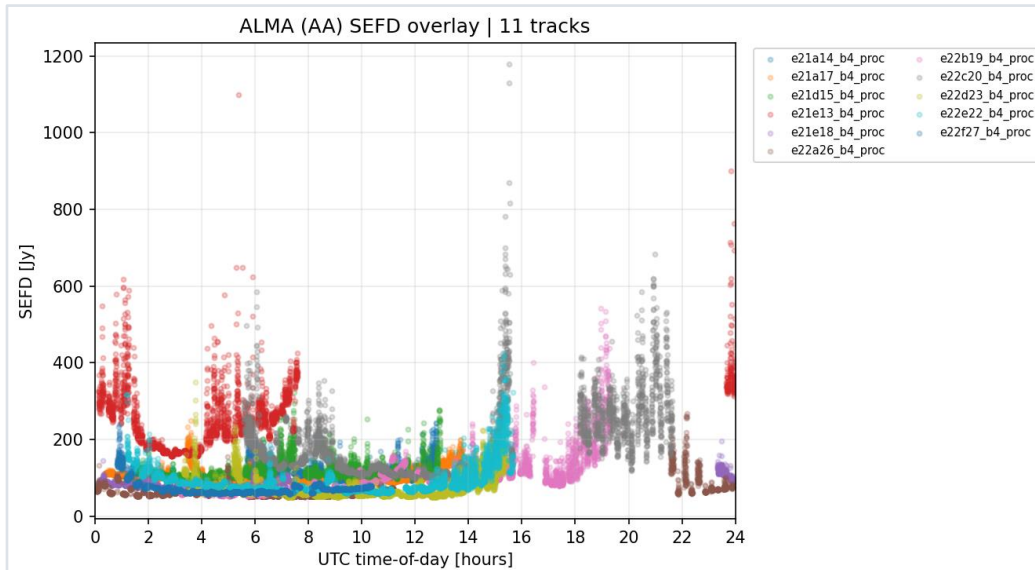


Gamsberg median SEFD ≈ 20.3 kJy

Partner-station SEFDs from real EHT ANTAB data

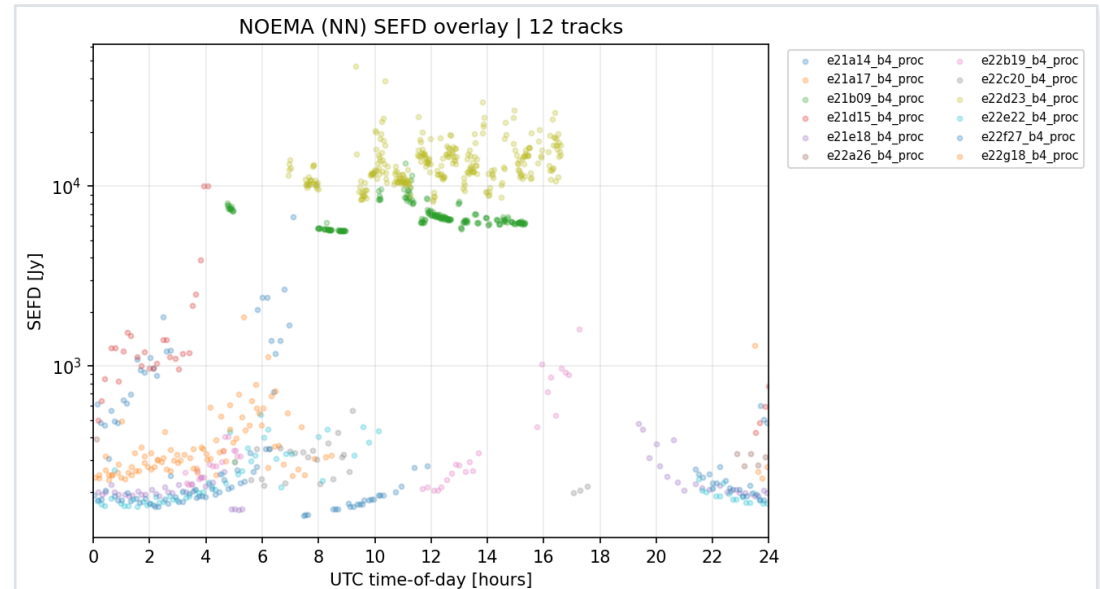
Observed partner-station sensitivity distributions used in the AMT fringe simulations

ALMA (AA) • 11 independent tracks



ALMA: $SEFD = \langle T_{sys} \rangle / DPFU$

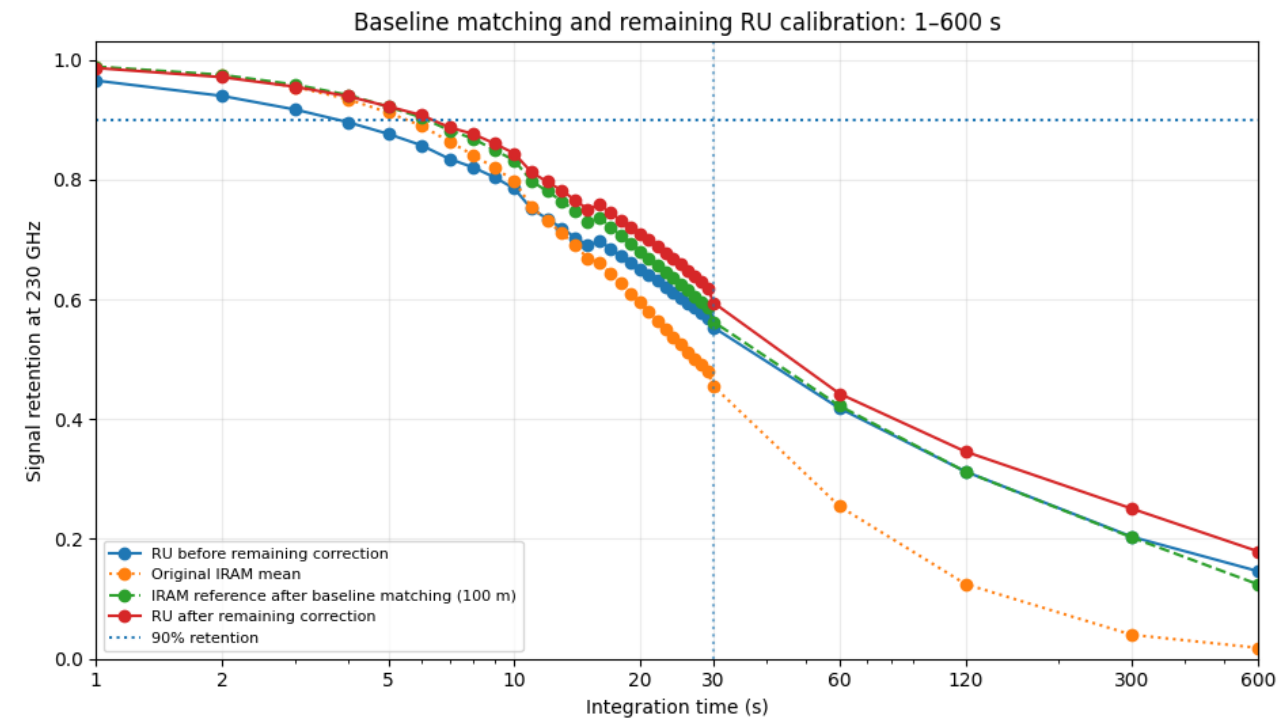
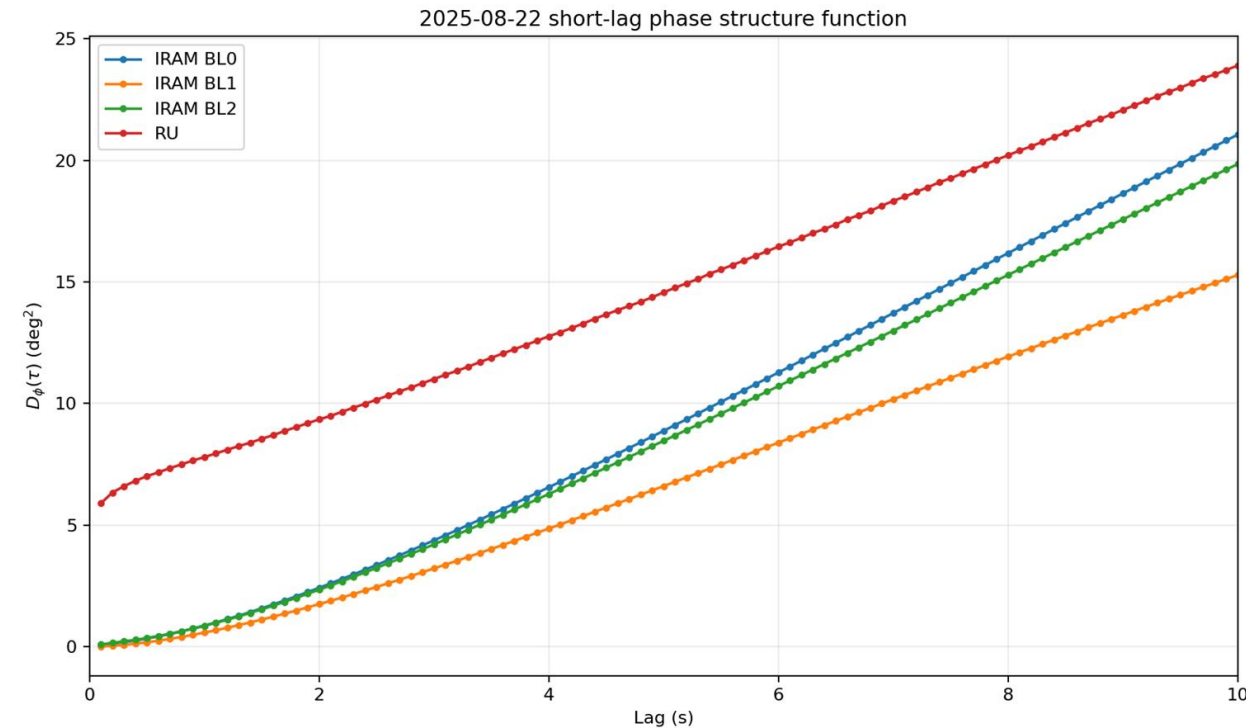
NOEMA (NN) • 12 independent tracks



NOEMA: processed T_{SYS_NN} values are already SEFD-equivalent

Monte Carlo sampling: track first → measurement second, so a densely sampled day does not receive extra weight.

Calibrating the low-cost RU phase monitor against IRAM



1 Noise floor

RU has a non-zero short-lag floor;
subtract instrumental variance.

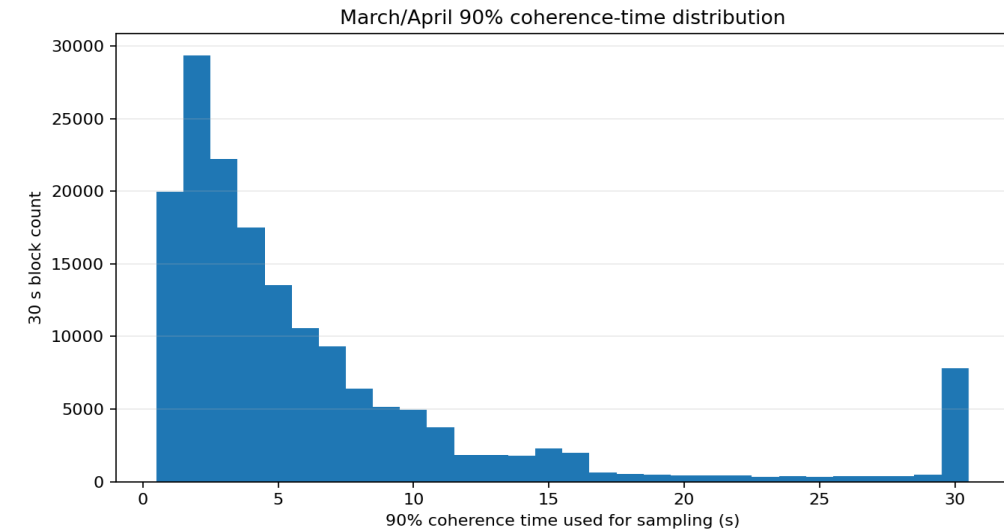
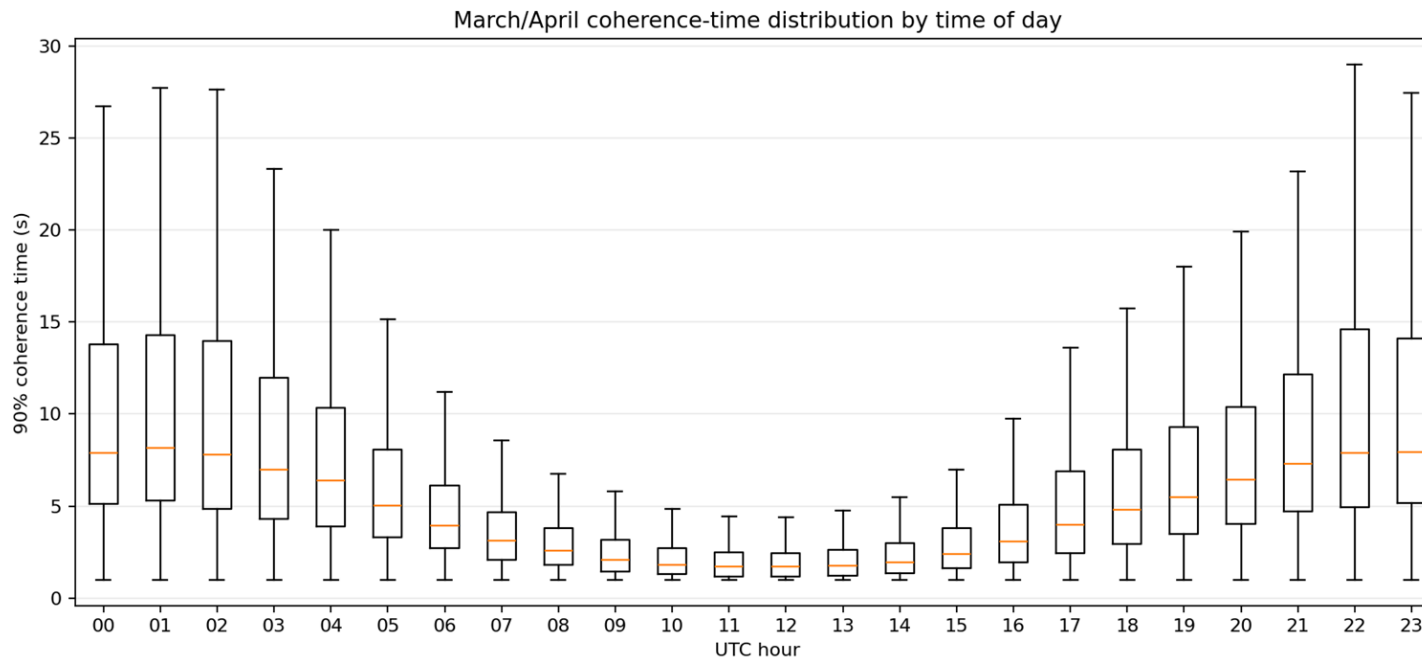
2 Baseline length

Match IRAM to the ~100 m RU baseline;
baseline effects grow at long T.

3 Remaining factor

Transfer the residual 1–30 s
correction to Namibia; validated with
held-out dates.

Measured H.E.S.S. coherence times are strongly time-dependent



165,692

accepted 30 s
atmospheric blocks

60

independent observing
dates

4.1 s

overall median τ_{90}

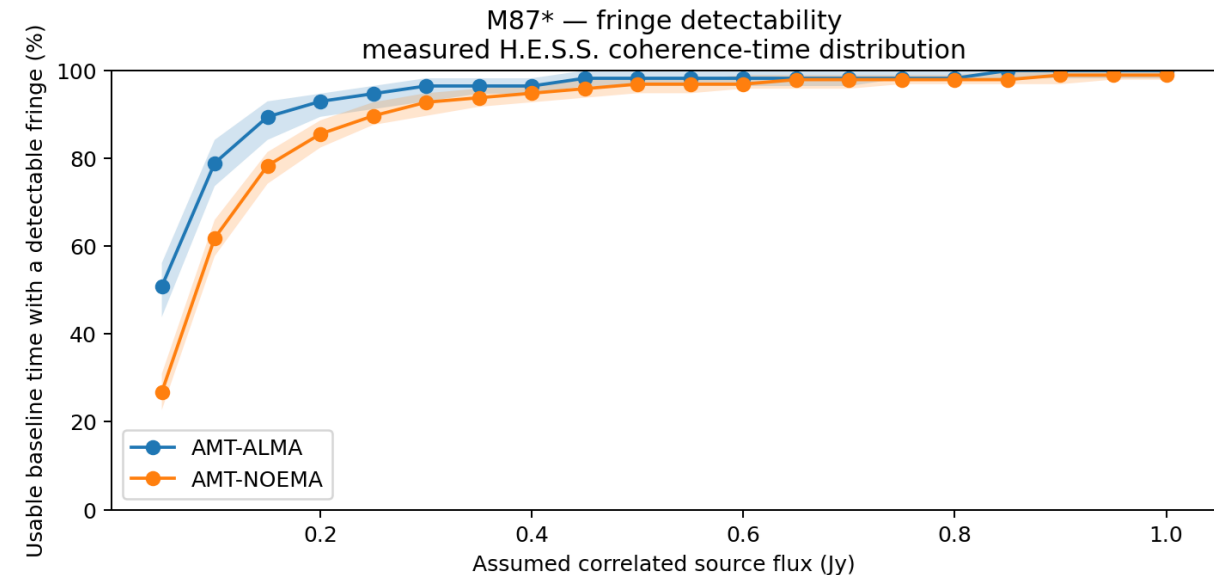
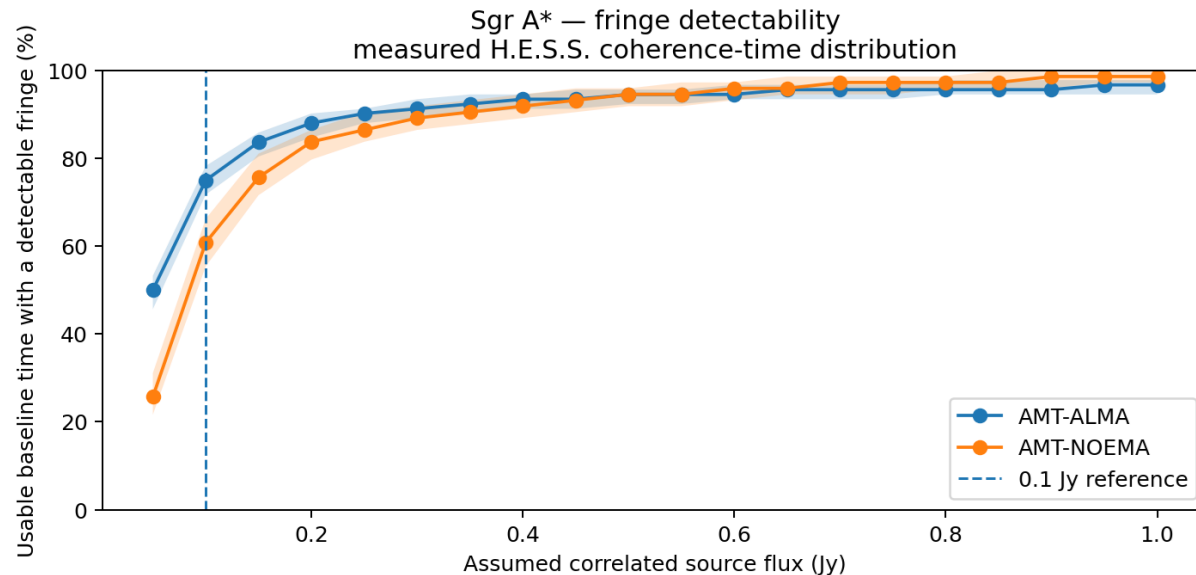
1.7–10.5 s

middle 68%

Monte Carlo sampling follows the measured τ_{90} distribution for the current UTC hour, not one fixed coherence time.

Preliminary fringe detectability with measured H.E.S.S. coherence times

5,000 Monte Carlo realisations per source–baseline combination.



Reference case for the percentages below: 0.1 Jy correlated signal

73.8%

Sgr A* · AMT-ALMA
16–84 percentile: 70.2–77.4%

68.7%

Sgr A* · AMT-NOEMA
16–84 percentile: 62.8–73.1%

71.4%

M87* · AMT-ALMA
16–84 percentile: 66.1–76.8%

57.6%

M87* · AMT-NOEMA
16–84 percentile: 53.8–61.3%

What we can say now — and what comes next

Preliminary takeaways

Measured atmosphere matters

The H.E.S.S. median t_{90} is ~ 4.1 s, but the distribution changes strongly with UTC time.

AMT–ALMA is more sensitive

For the 0.1 Jy reference, AMT–ALMA gives median detection fractions of 73.8% for Sgr A and 71.4% for M87, compared with 68.7% and 57.6% for AMT–NOEMA.

Gamsberg looks promising

Its weather-based AMT SEFD is lower than H.E.S.S., but Gamsberg coherence times are not yet included.

Next steps

- 1 Apply the calibrated coherence-time method to Gamsberg and the remaining Namibia phase monitors.
- 2 Replace the fixed 0.1 Jy reference with source-model correlated flux as a function of baseline and time.
- 3 Apply the same fringe-detectability analysis to selected existing EHT baselines to provide a direct benchmark for the AMT results.



Thank you

Questions and discussion

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