# EVE Link Budget Recommendations

18 March 2025 Review

Open Research Institute https://openresearch.institute

# Where to find this document?

https://github.com/OpenResearchInstitute/documents/blob/master/Engineering/Link_Budget/Link_Budget_Modeling.ipynb

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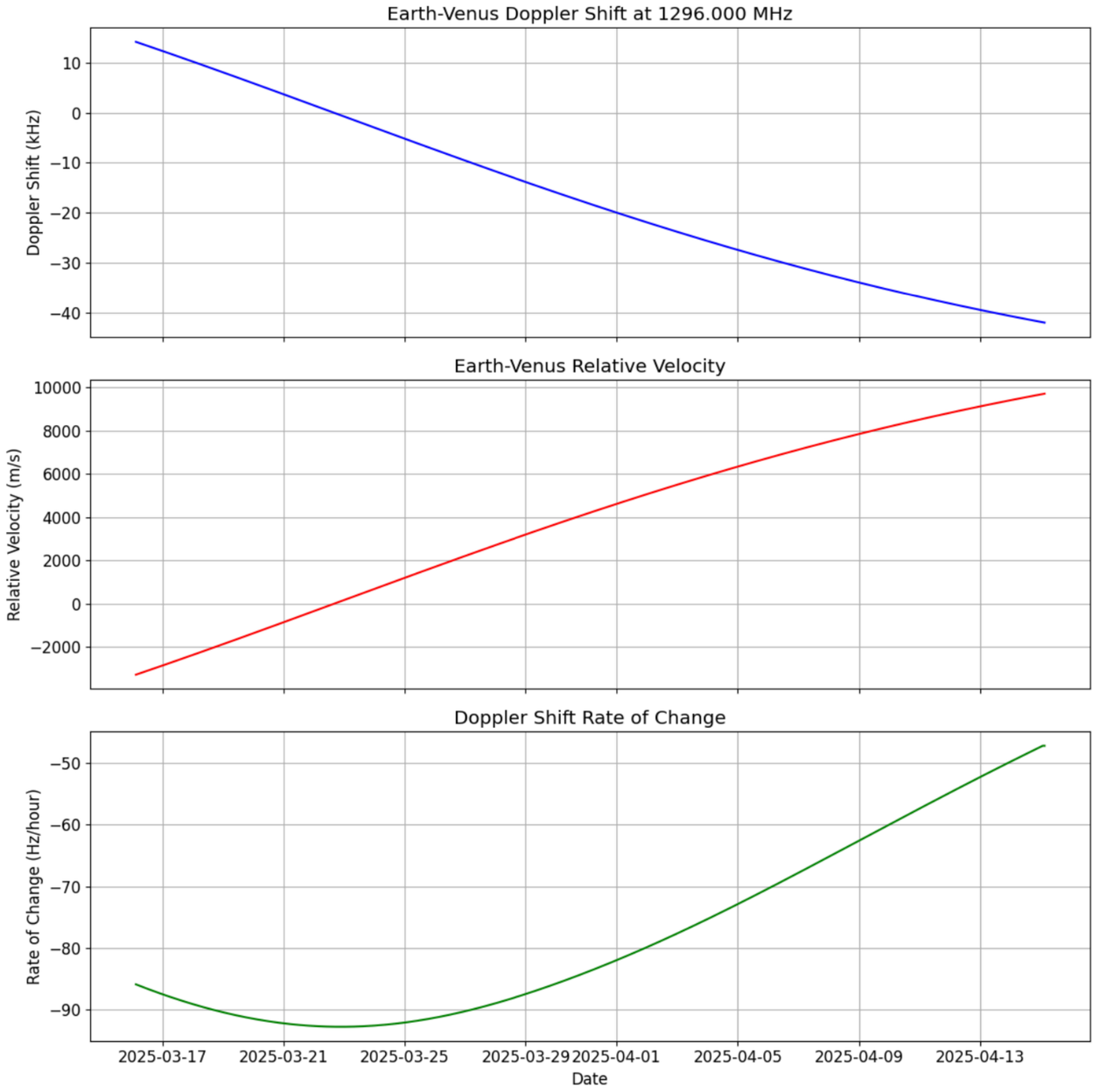
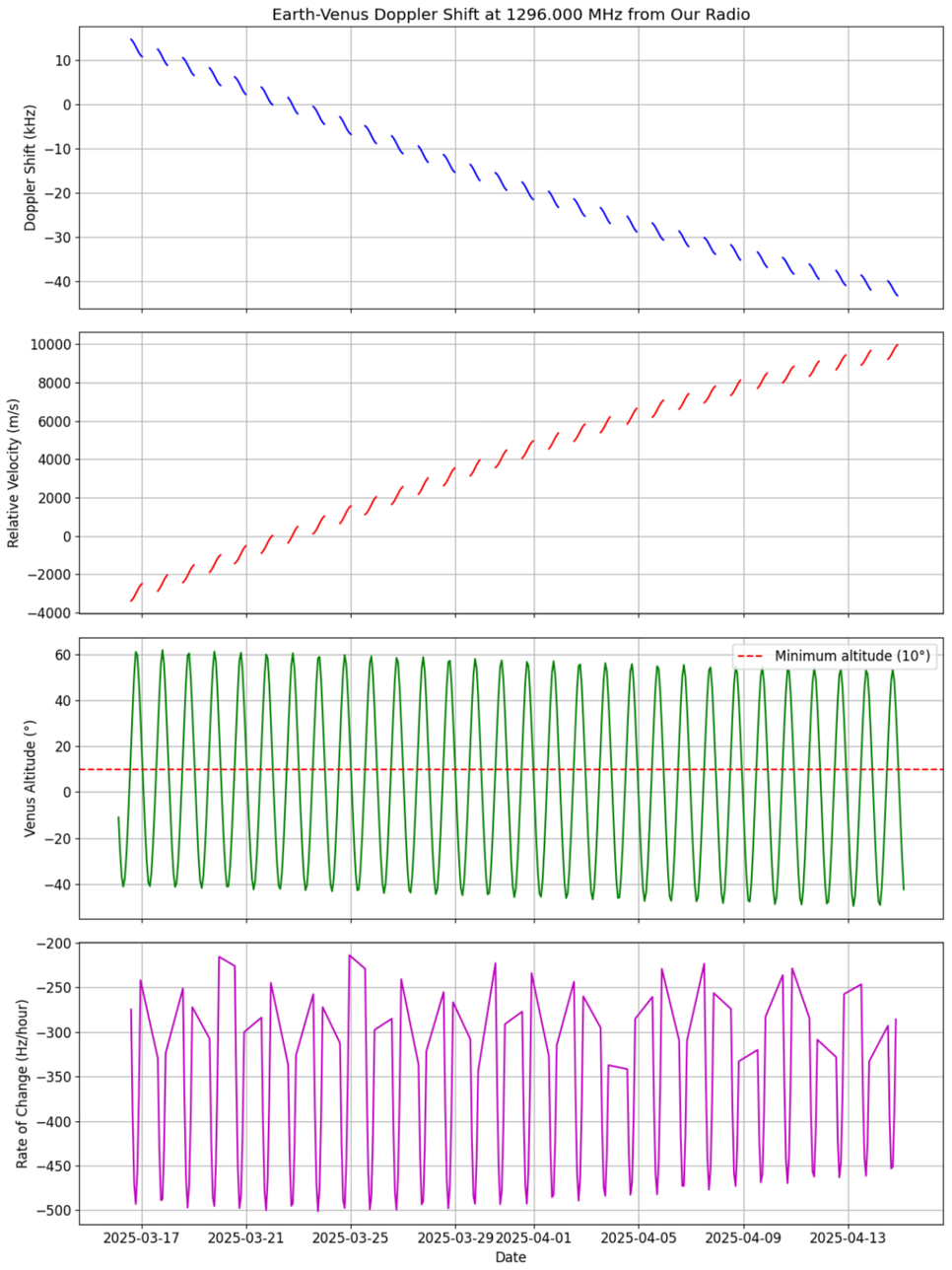
Link_Budget_Modeling




Link_Budget_Modeling



# Recommendations

## Based on current math in the link budget

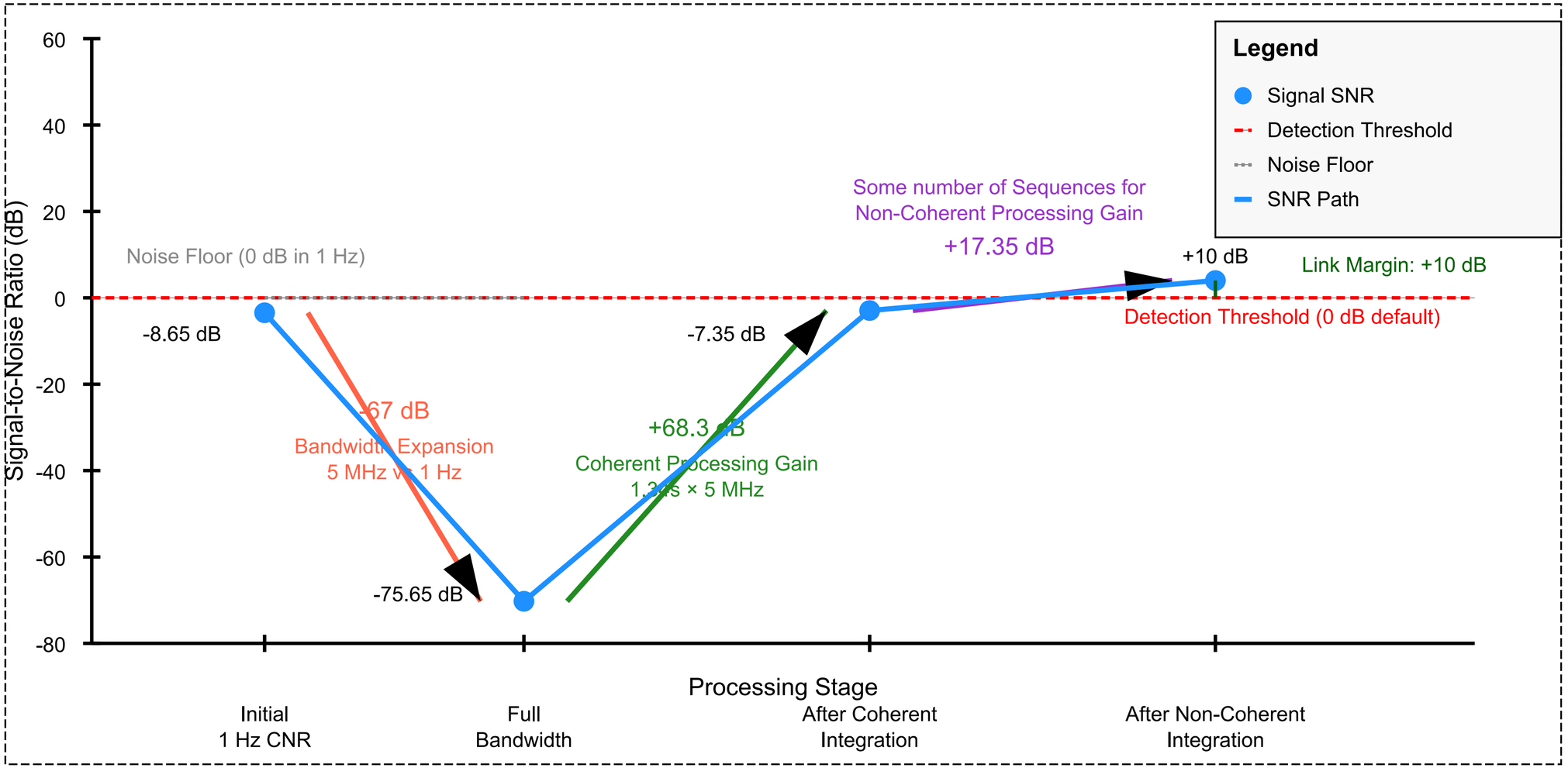
- March 2025 inferior conjunction is essentially “now”.
- We were asked to get involved in mid-February 2025. We’ve done a lot in a very short amount of time, we have raised awareness, and we can make some recommendations.
- To ORI board: ORI should remain involved, continue developing and using the link budget, and produce candidate EVE transmissions for the October 2026 inferior conjunction for cooperative amateur sites.

# Recommendations

## What are the characteristics of a cooperating site?

- Supports Open Source publication
- Open to digital signal processing techniques and experimentation
- Demonstrates inclusive collaboration that draws on the diverse expertise from across the amateur and citizen science community

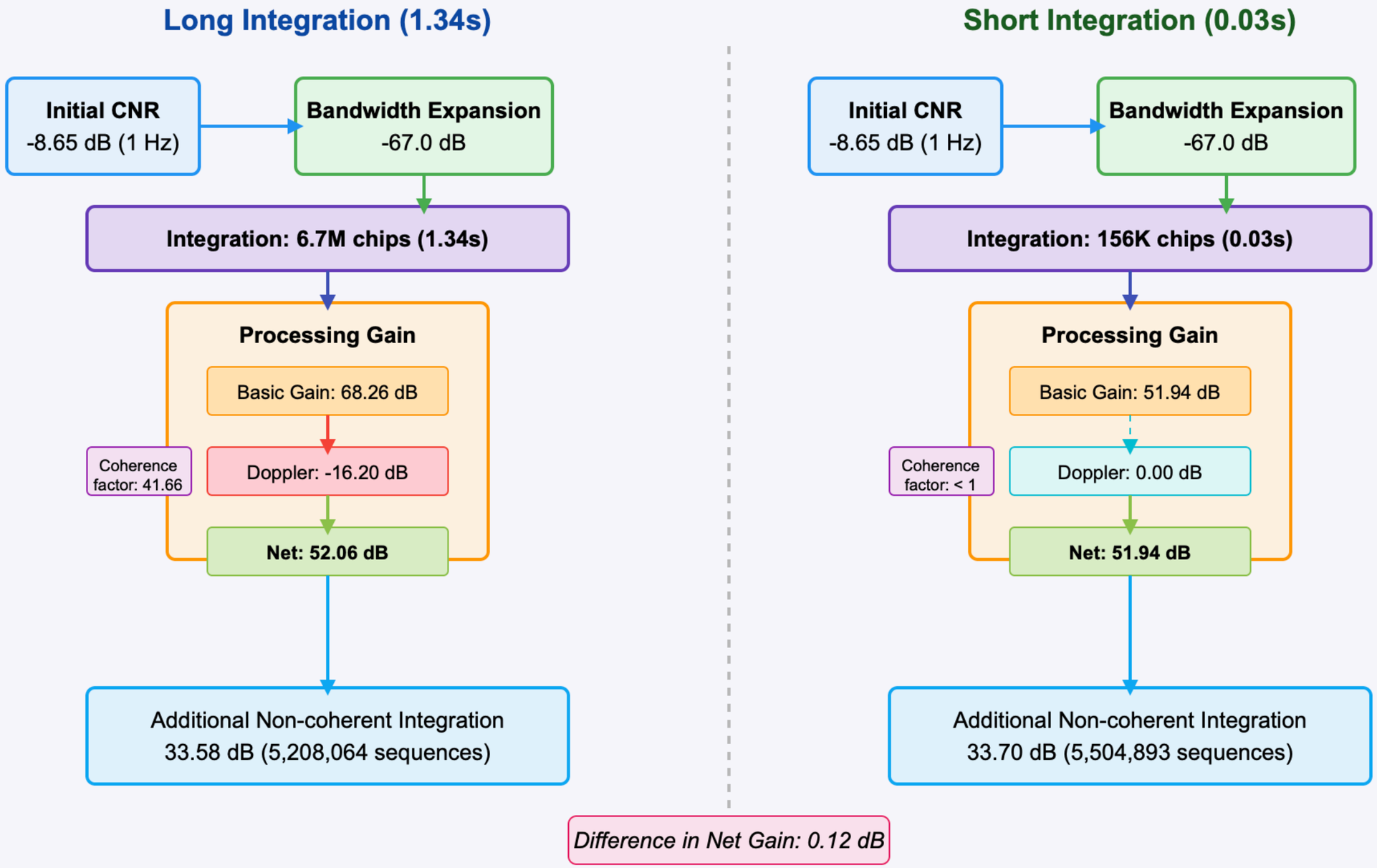
# Earth-Venus-Earth Signal Processing and SNR Improvement




**Zadoff-Chu Sequence Parameters:**

- Coherent Integration: 1.34s (Doppler limited)
- Perfect Auto-Correlation Properties
- Non-Coherent Integration: as many sequences as required to achieve Link Margin
- Constant Envelope for Maximum Power Efficiency

# Doppler Effect Comparison: Long vs. Short Integration



# Question

## Is there a chip rate/bandwidth recommendation for Zadoff-Chu?

- Given that integration time is somewhat of a wash, can we show the effect of varying the chip rate? Yes
- Can we increase the chip rate to make basic processing gain go back up? No, because the bandwidth expansion puts you further away.

# Recommendations

## Based on math in the link budget

- Traditional modes, with the exception of a very loud very narrow carrier, don’t close the link.
- Coherent integration modes get you closer. Coherent integrations will need to be followed by non-coherent integrations. Nothing so far closes the link. Doppler Spread is much larger than previously calculated (needs review)
- Clearly state that the goal is communication, not just detection.
- SigMF file format is the preferred way to package transmission data files