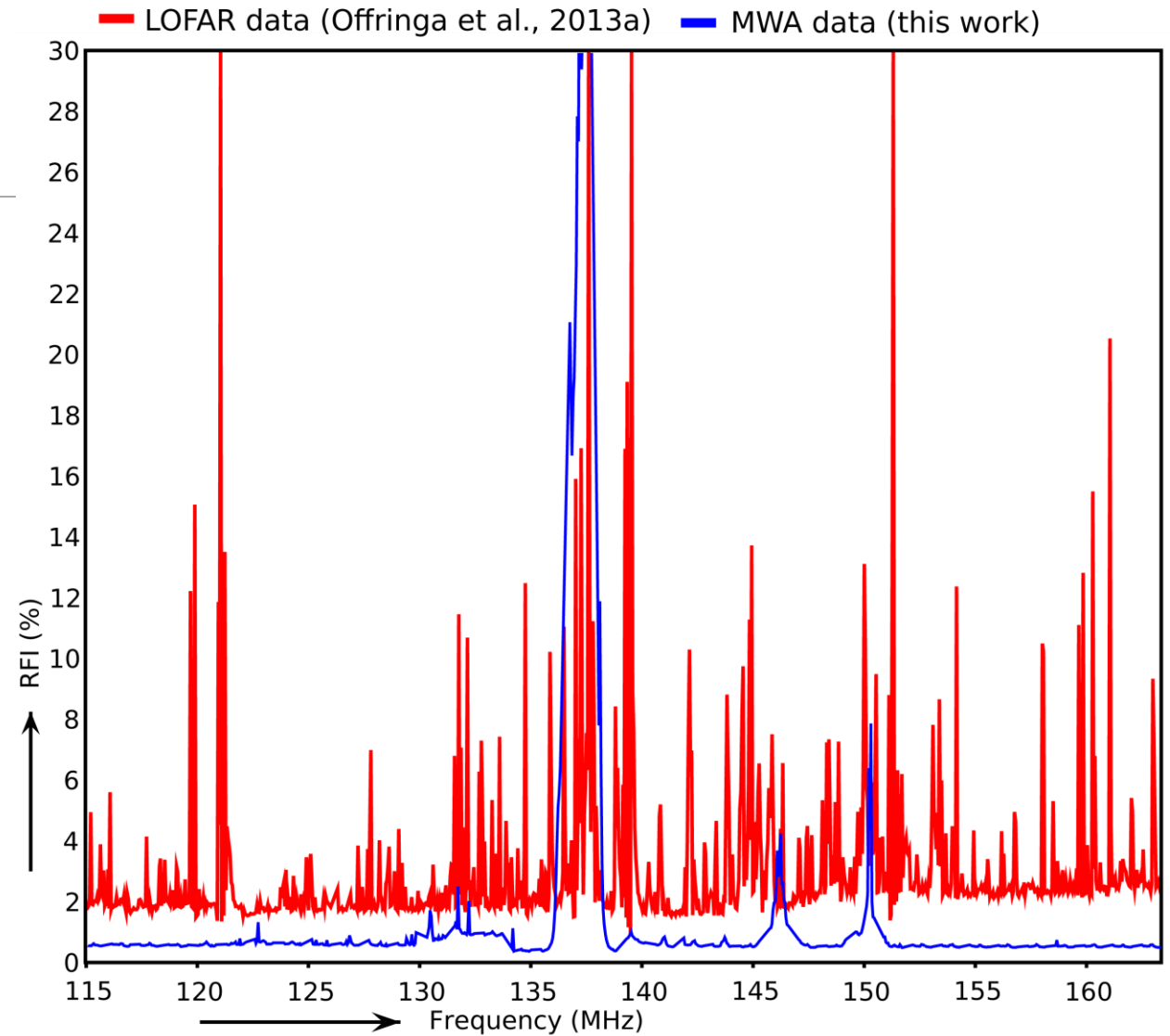


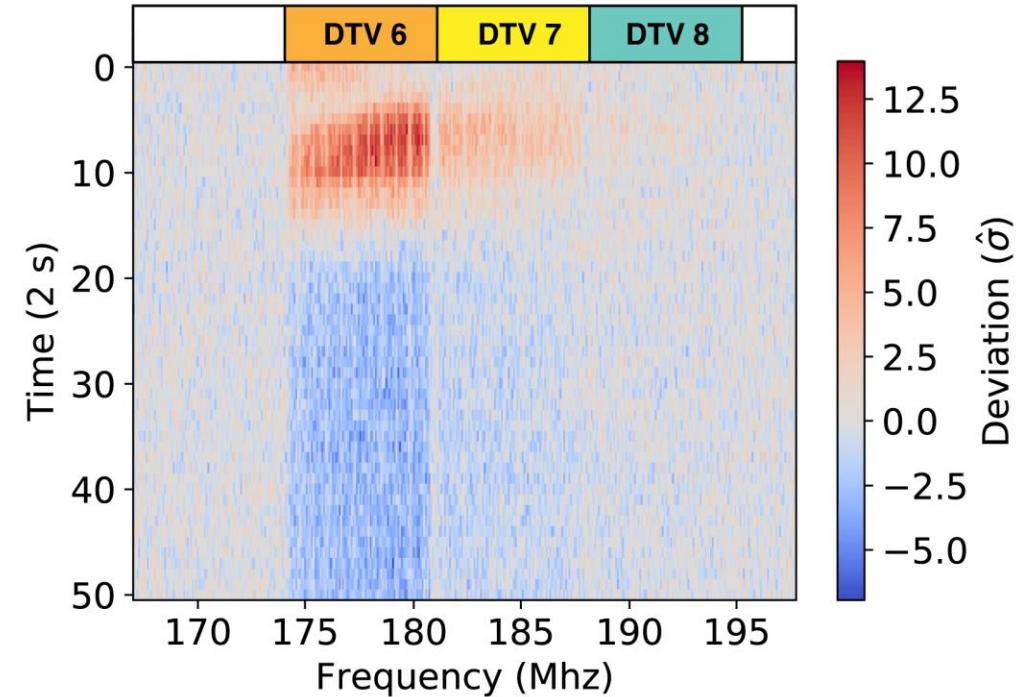
10 years ago...

- RFI was a solved problem
 - *AOFlagger* was really good
 - Remote sites drastically reduced RFI
 - We could focus on the “real” physics!



5 years ago...

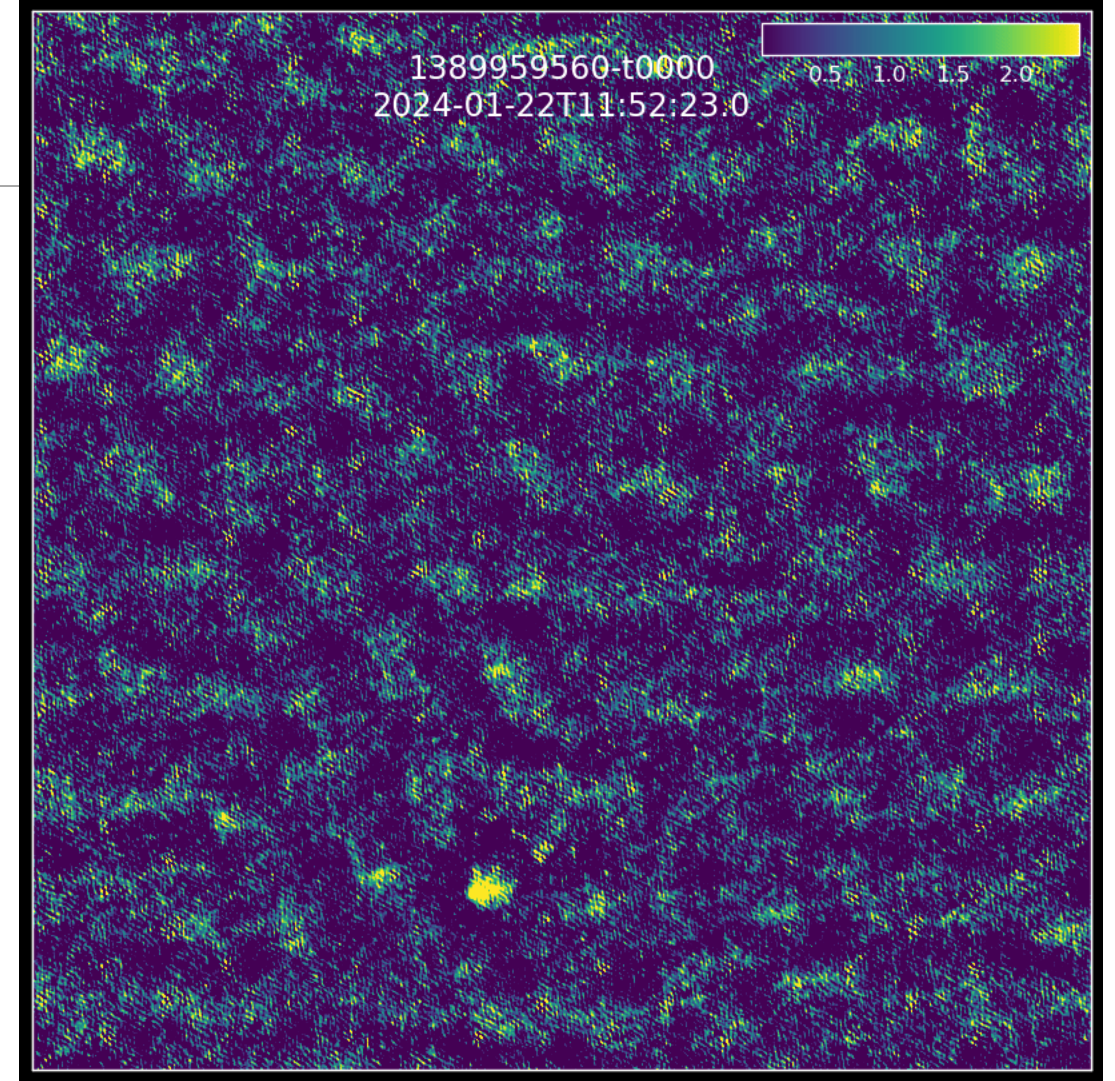
- RFI lurks in the data, below the noise level of an individual visibility, but well above the 21 cm signal (Wilensky et al. 2019)
- SSINS and other data quality metrics improved power spectrum results (Barry et al. 2019b, Li et al. 2019, Trott et al. 2020)
- RFI *flagging* is itself a problem: missing data creates a complicated PSF in frequency (Offringa et al. 2019, Wilensky et al. 2022)



adapted from Wilensky et al. (2019)

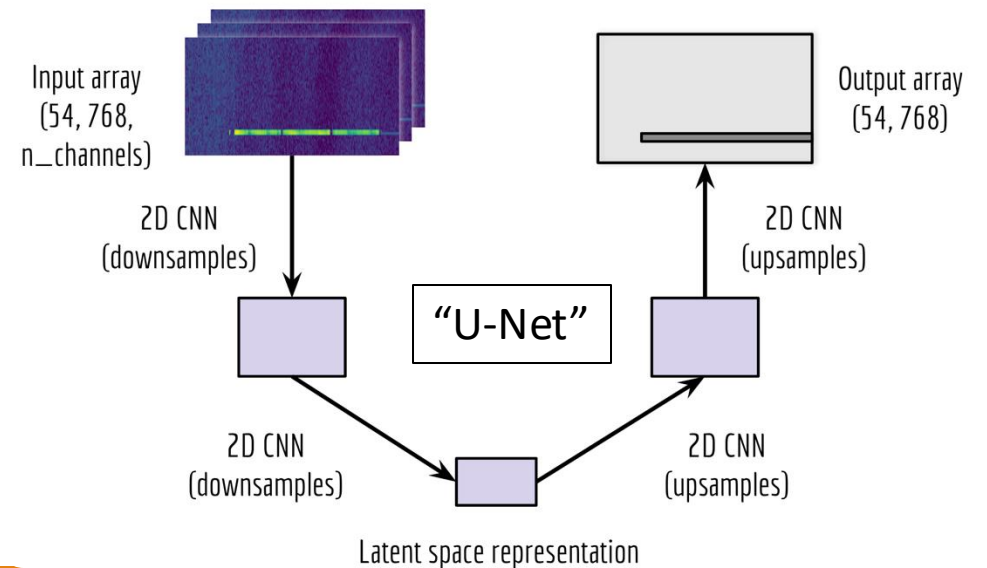
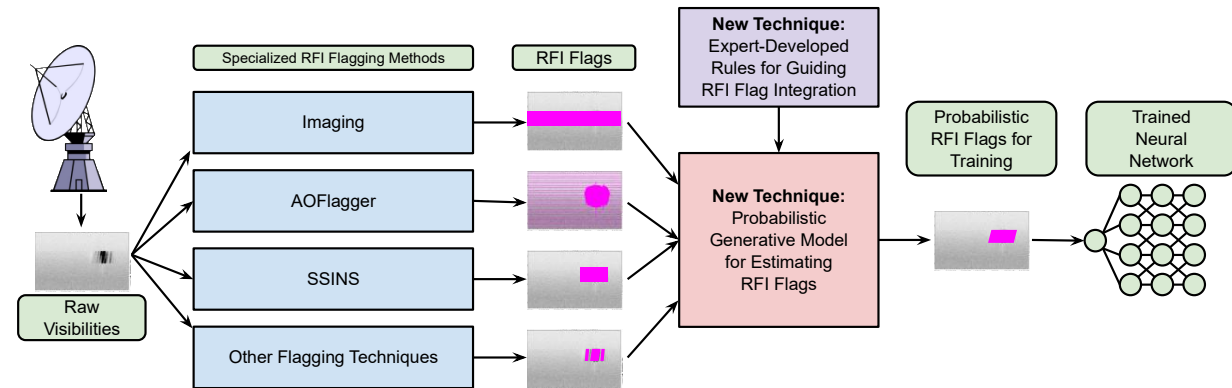
Now...

- Statistical analyses show “ultrafaint” contamination still lurks in the data (Wilensky et al. 2023)
 - Best limit comes from using only 15% of the initial data set
- RFI environment appears to be getting worse
 - 2023 – 2025 MWA observations see *significant* uptick in RFI occupancy
 - StarLink is quite visible in narrow bands — even after recent “fix” (di Vruno et al. 2023, Grigg et al. 2023, Bassa et al. 2024)



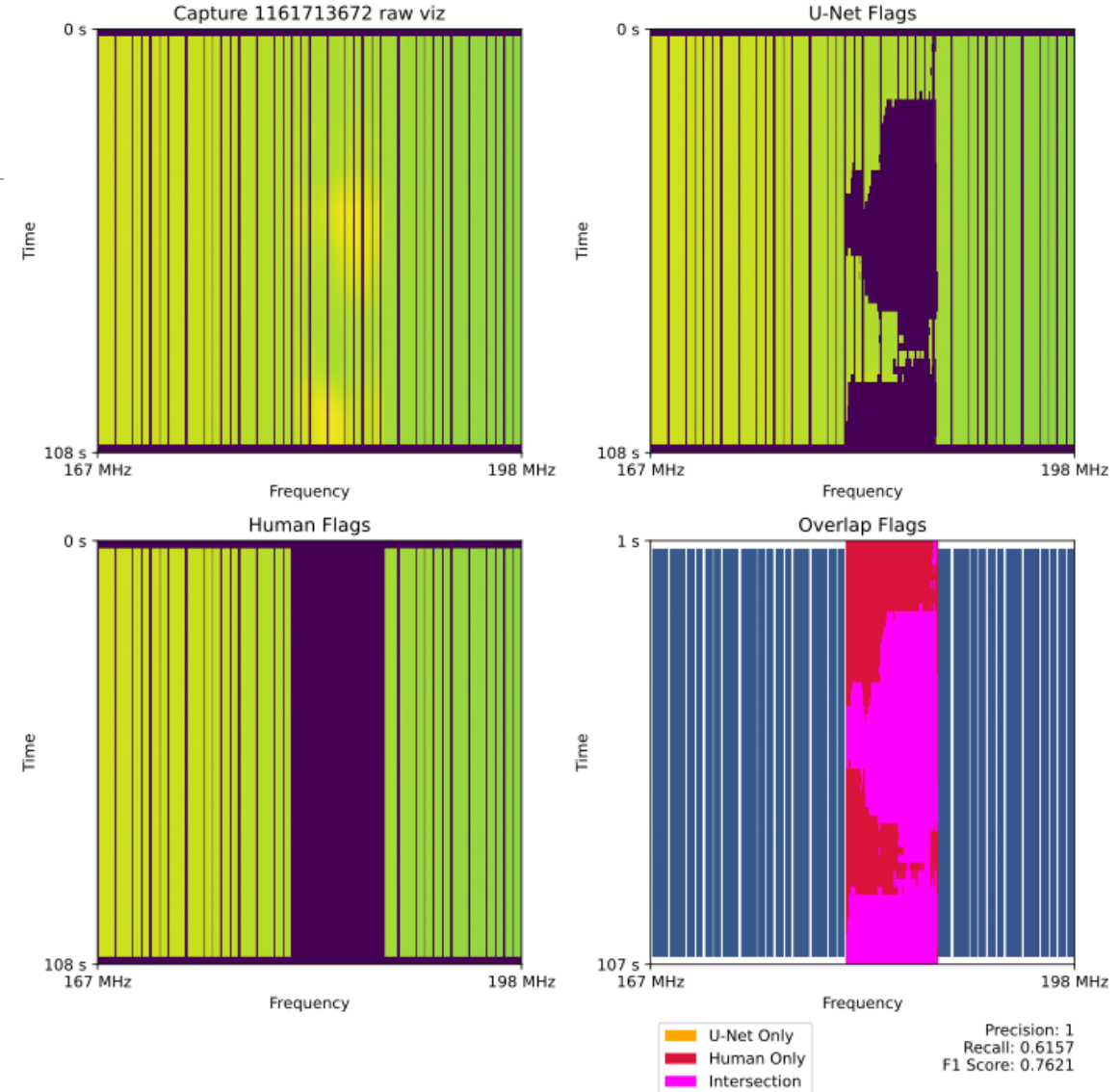
SWIFT-Sat Project: Using ML to Find RFI

- Machine learning can be used to accelerate detection algorithms to keep pace with increasing data rates (Kerrigan et al. 2019, Mesarcik et al. 2020, Alireza et al. 2020)... but can it actually help us go deeper and find “ultrafaint” RFI?
- SWIFT approach focuses of “weak supervision” – using the flags from existing techniques as noisy labels instead of having a “ground truth”

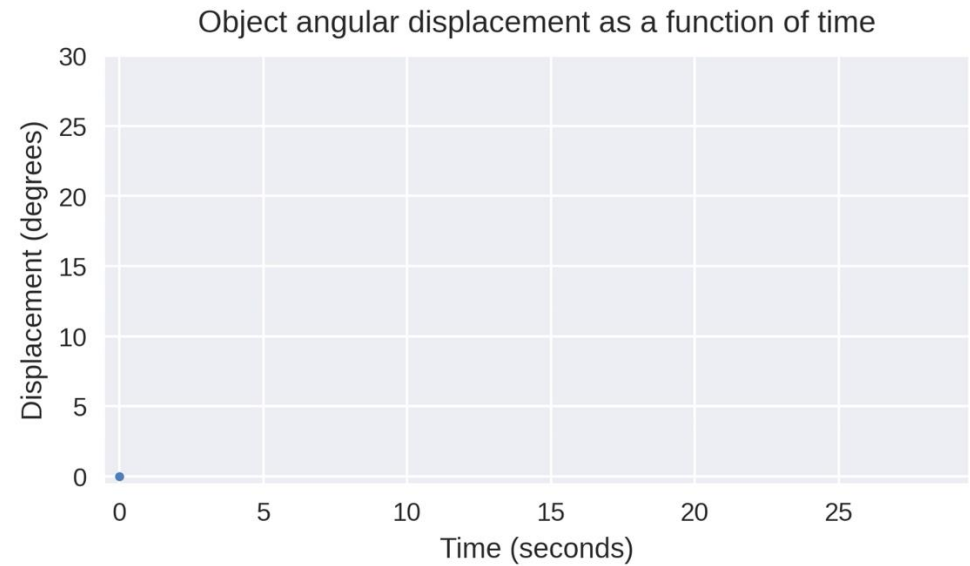
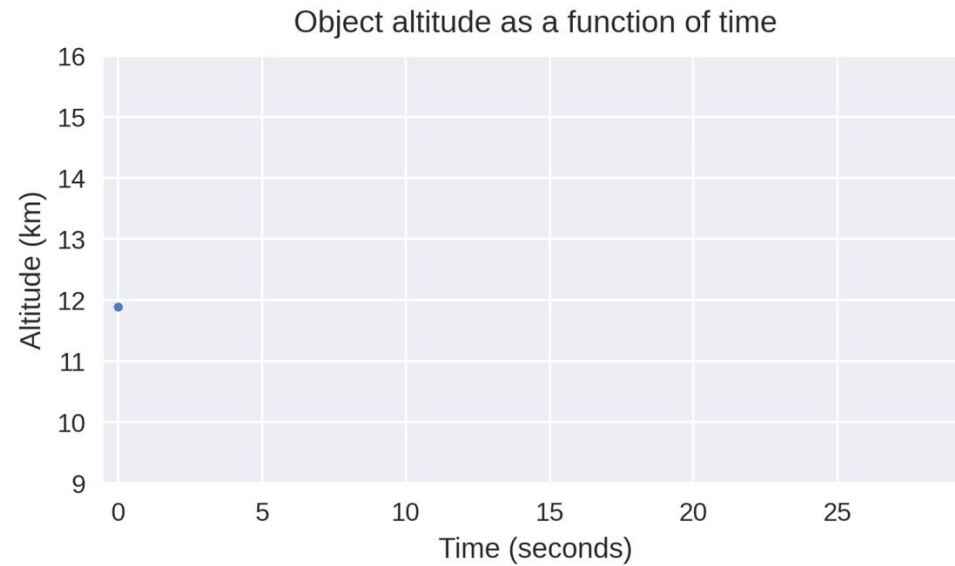
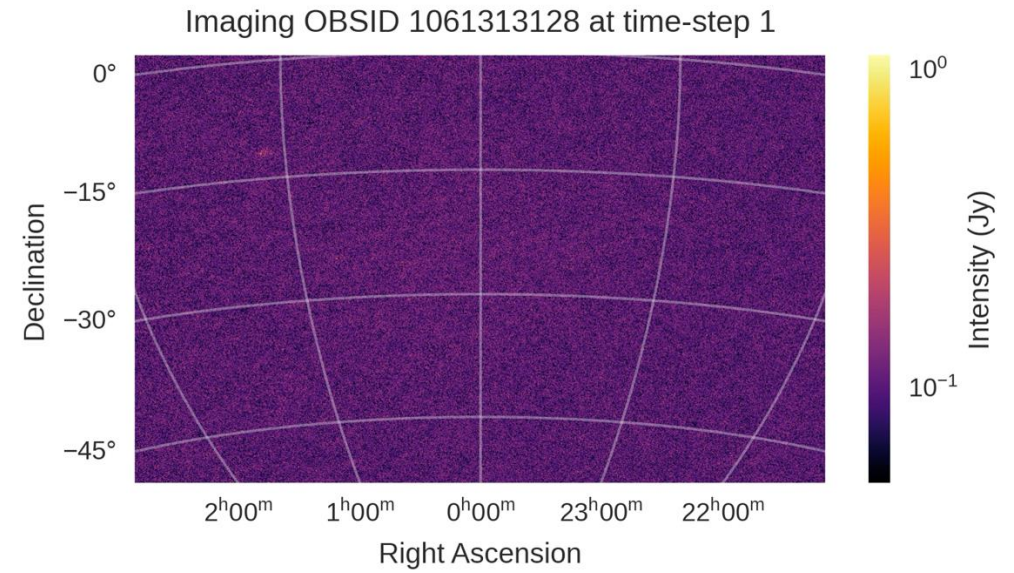
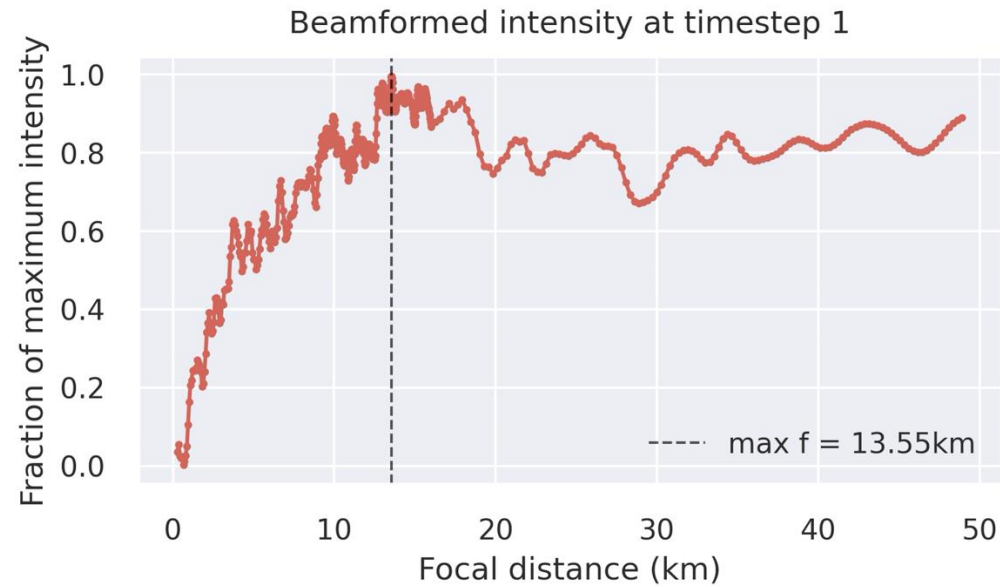


Results

- Built a custom hand-annotation tool to provide a validation set (i.e. *not* training data, but something to compare our weakly supervised approach against)
- U-Net learns better when fed summary statistics (e.g. mean, z-score, etc.) than scores of individual visibilities
- Performs well on bright RFI, but can struggle when presented with unique events that only one flagger is good at detecting



Looking closely at SSINS



10-19-2016-EOR1, pointing: 1

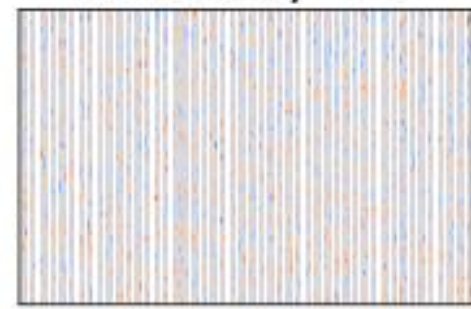
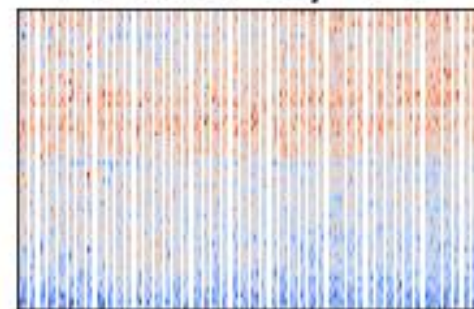
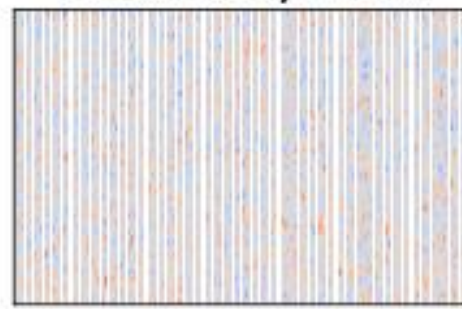
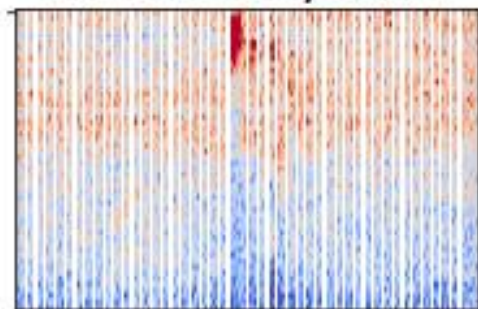
EAVILS, XX

SSINS, XX

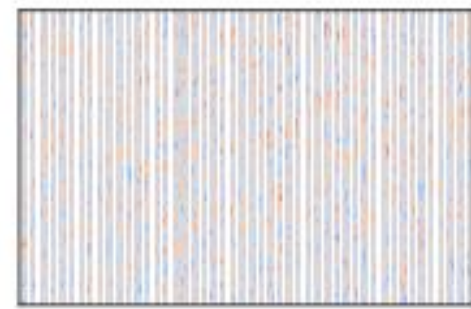
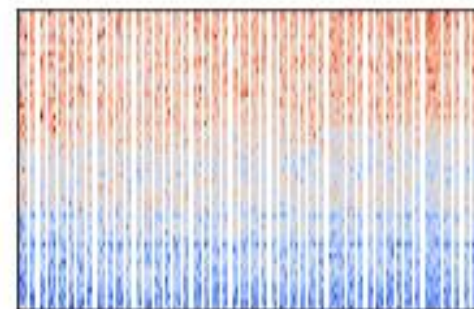
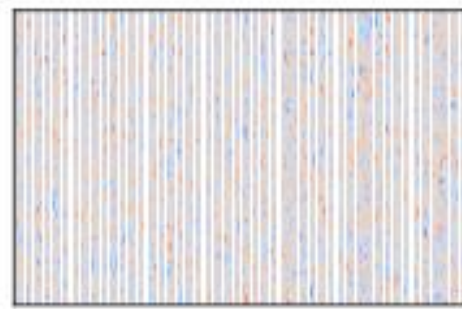
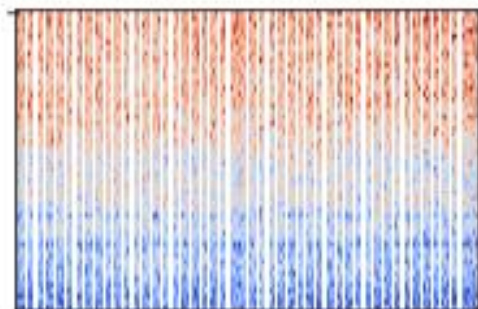
EAVILS, YY

SSINS, YY

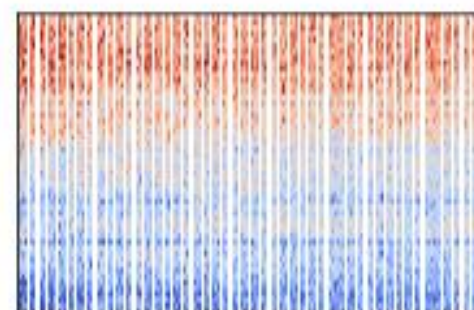
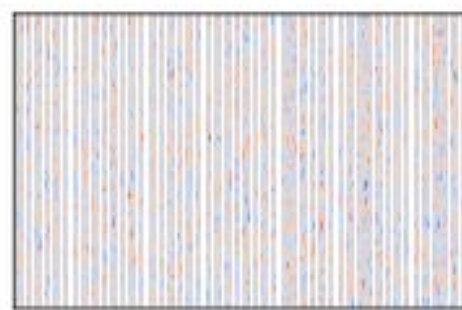
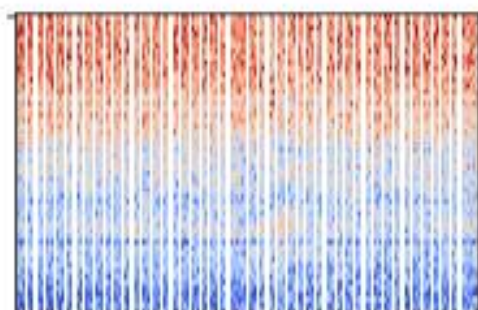
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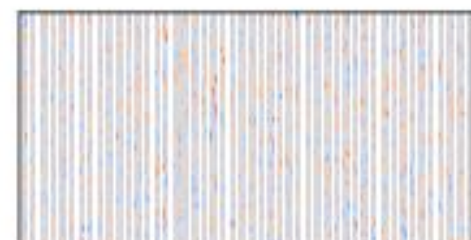
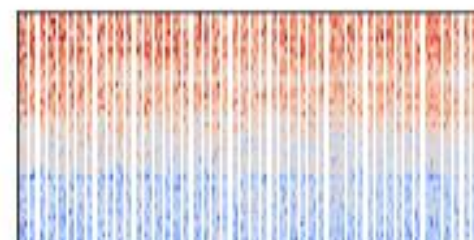
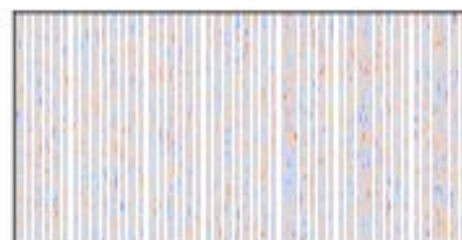
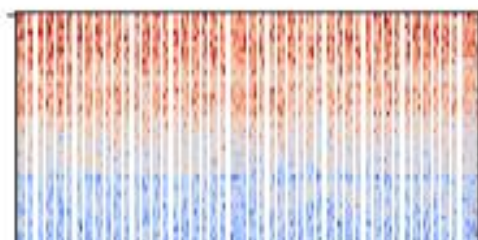
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Providing second ultra-faint RFI detector

