Fast identification of GW signals for Einstein Telescope

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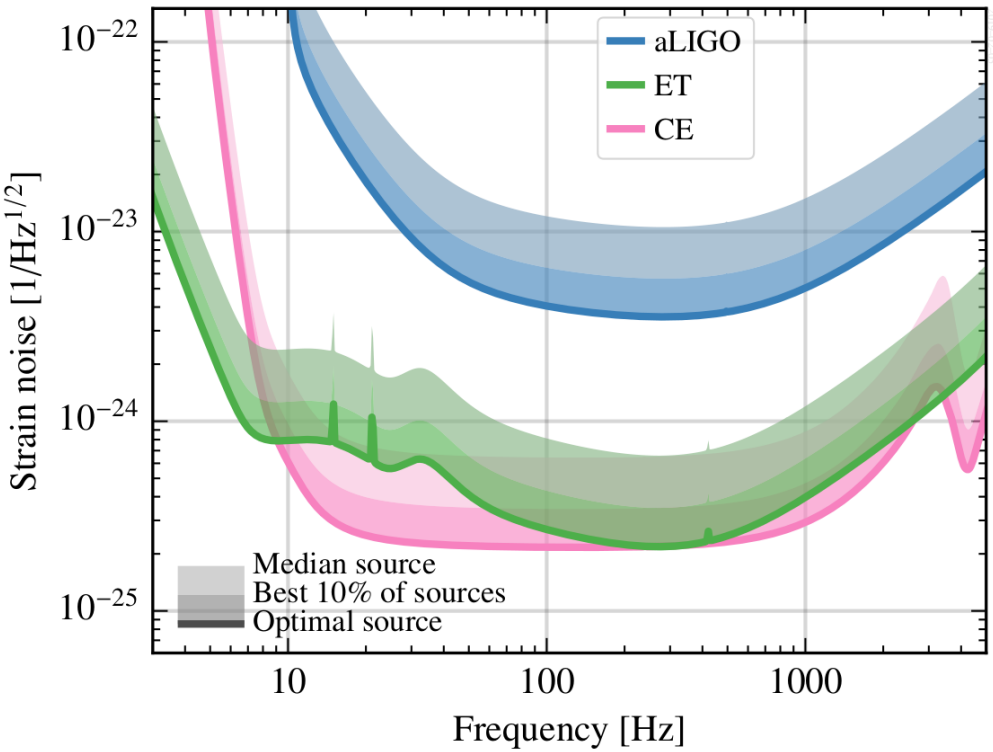
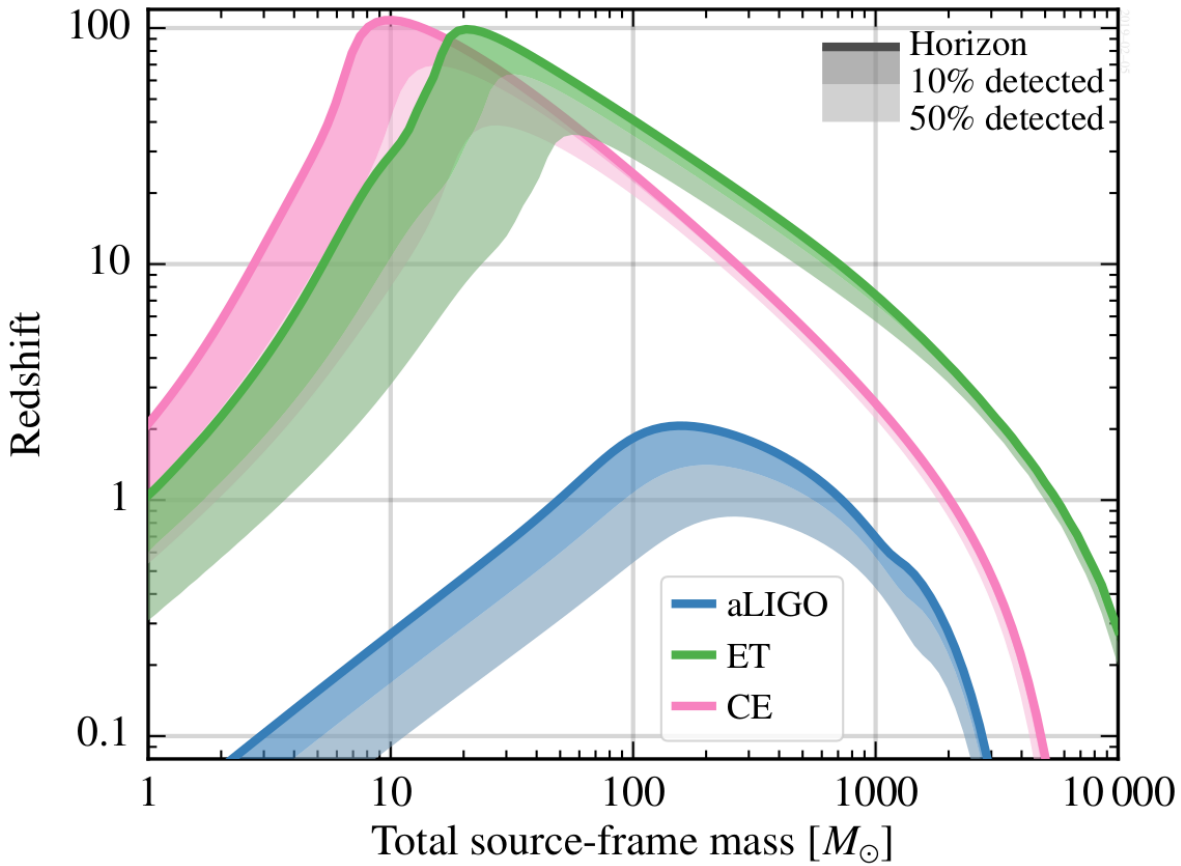
Einstein Telescope: the next generation GW observatory

-Relocated underground
-Extended the arm length
  -3 km to 10 - 15 km
-Separated high- and low-frequency interferometers
    -LF interferometer adopted cryogenic technology

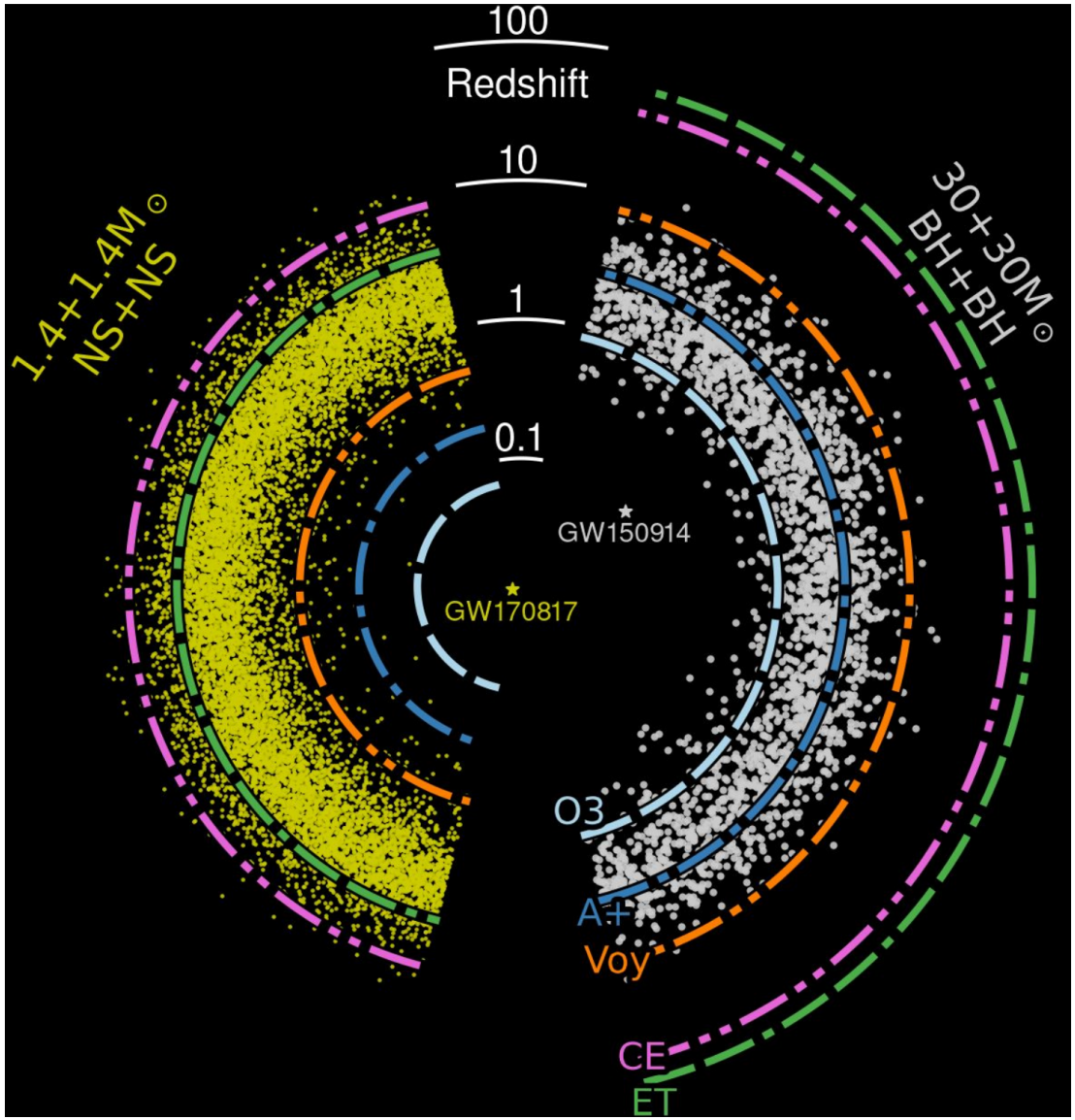


Unprecedented precision

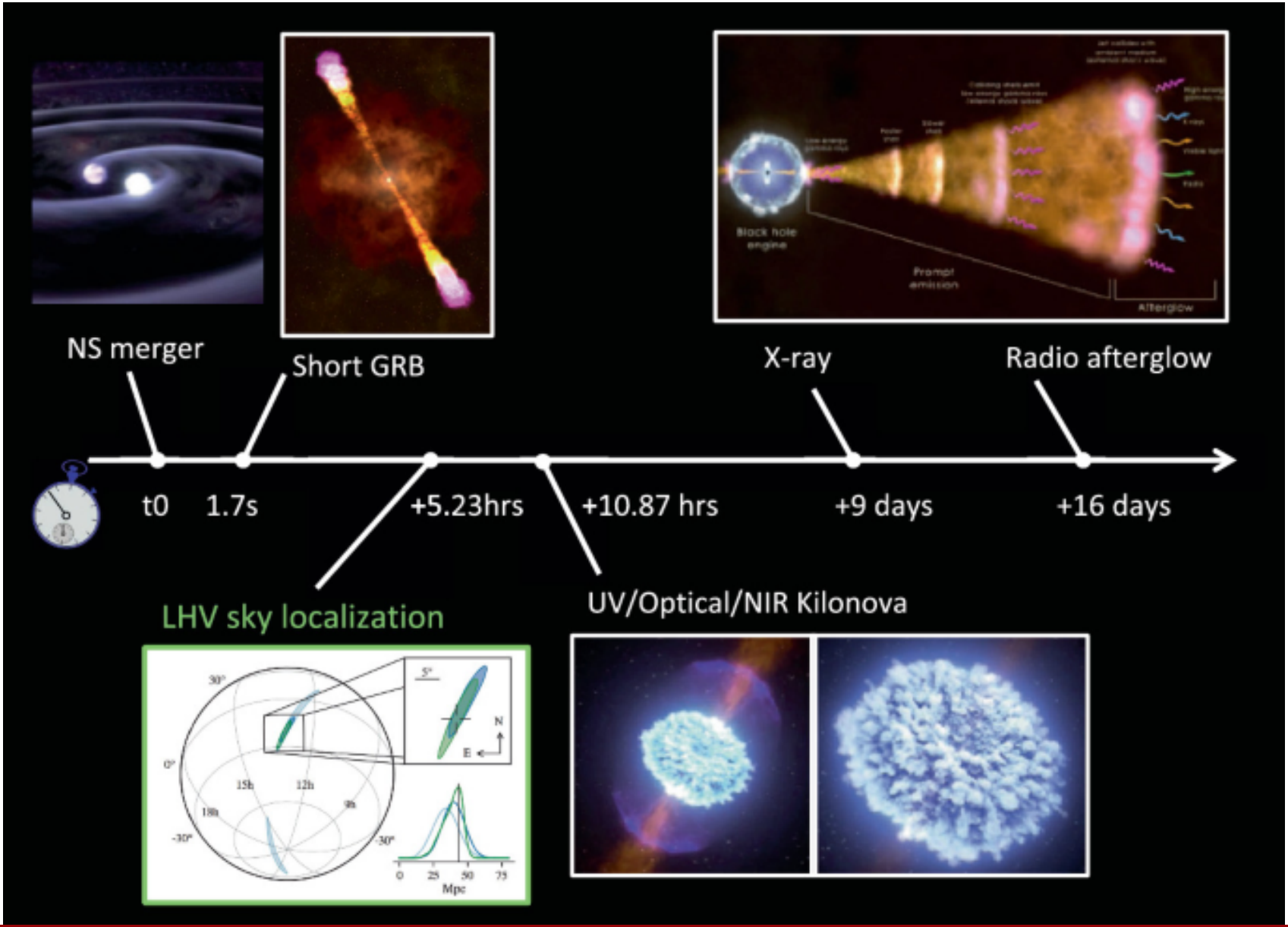
- Observing 10^5 – 10^6 BBH mergers per year
- $6 \cdot 10^4$ BNS mergers per year
- Extending the range of observed sources



Unprecedented precision

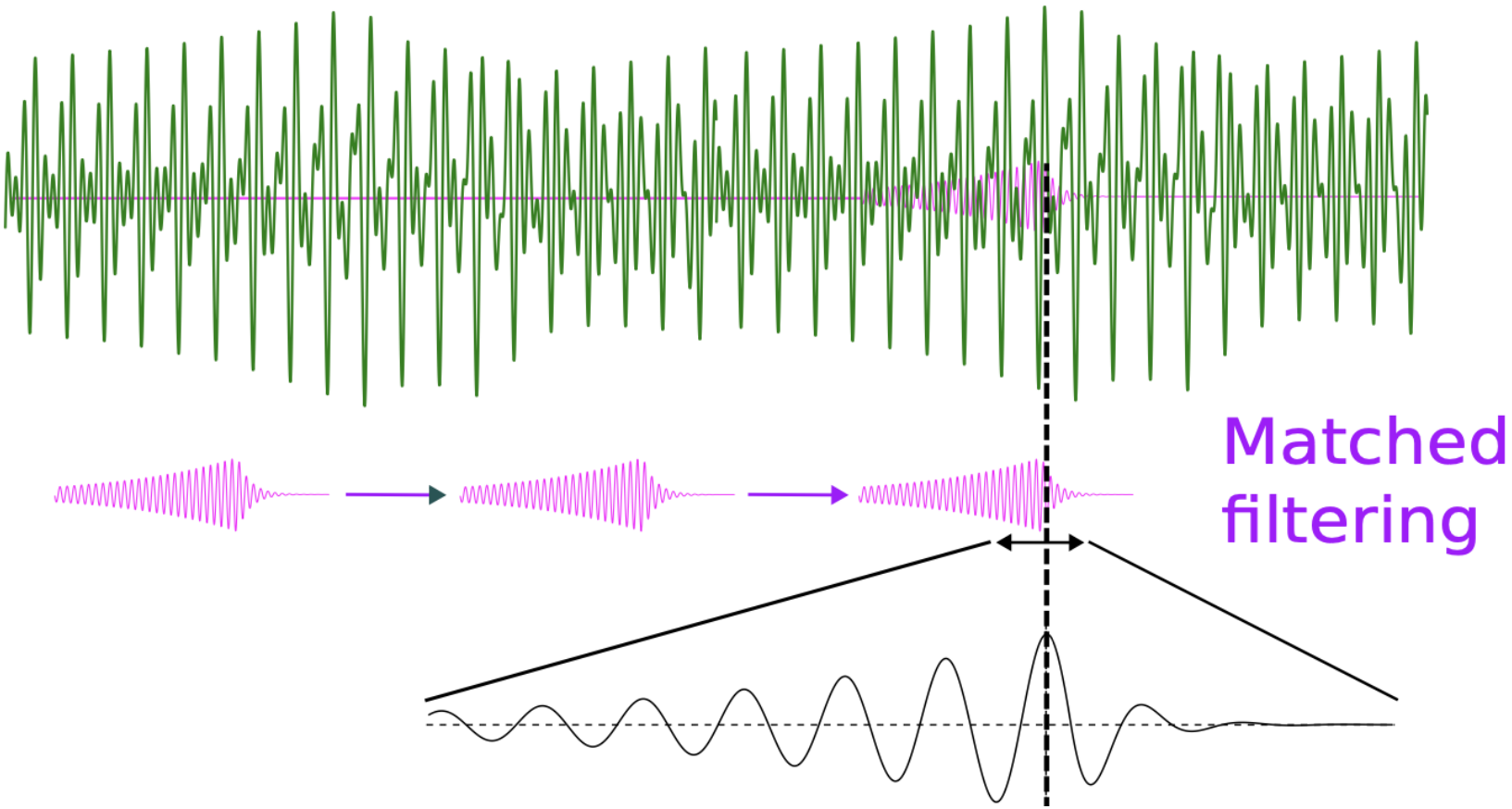


Multi-Messenger Astrophysics with GW170817



Drawbacks of current solutions in the early inspiral

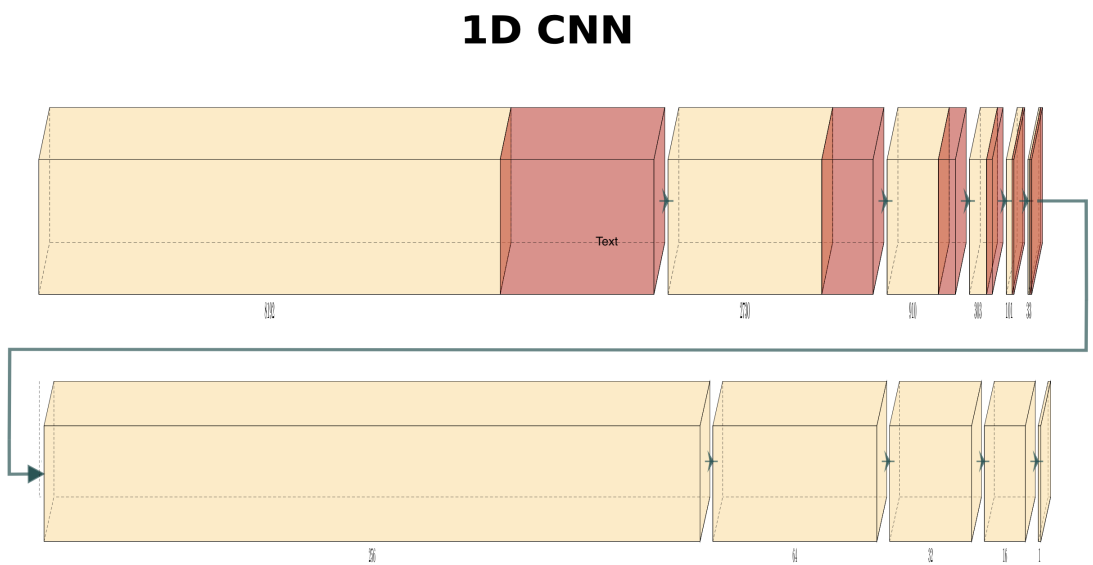
- Template bank generation
- Struggle to disentangle overlapping signals
- Long execution times



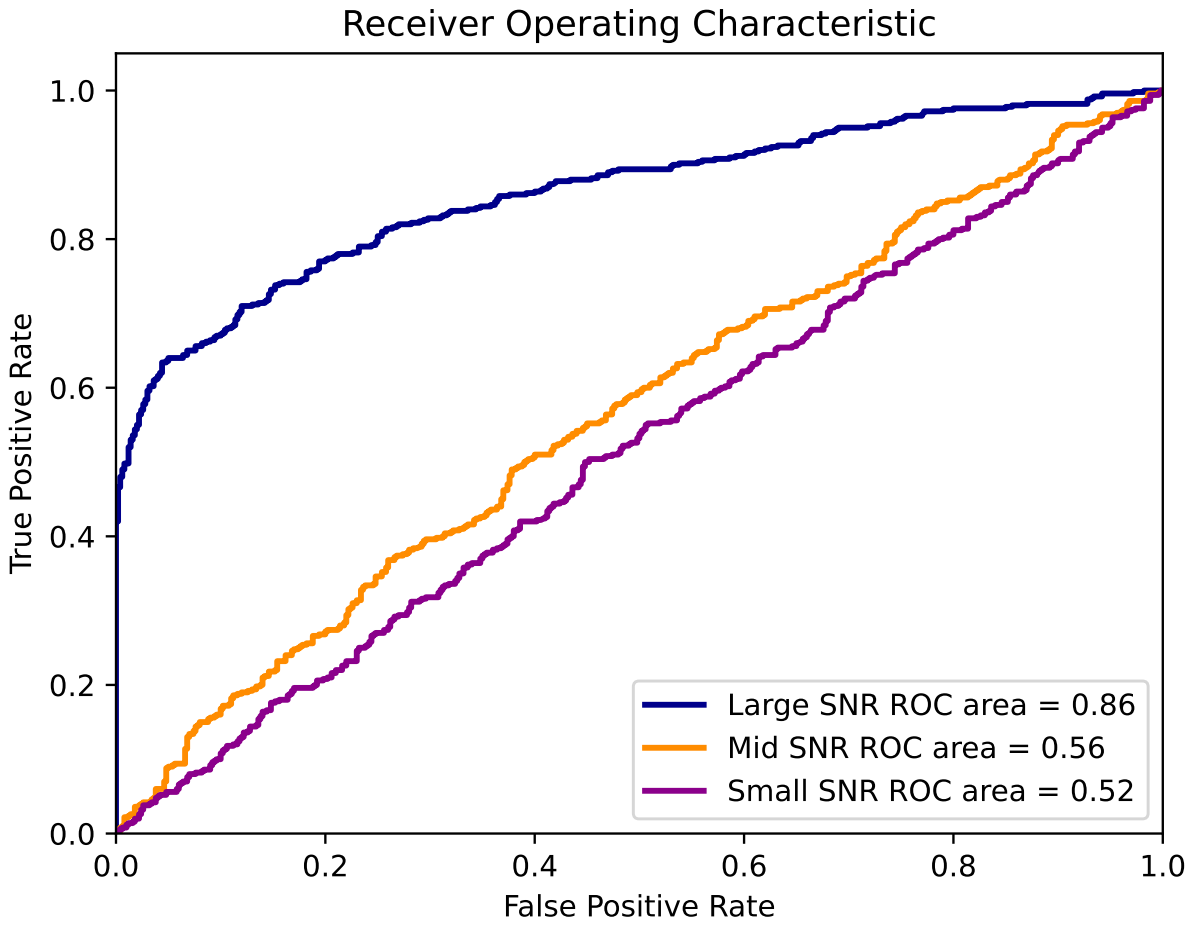
Issuing early alerts with ML algorithms

Simulated data:

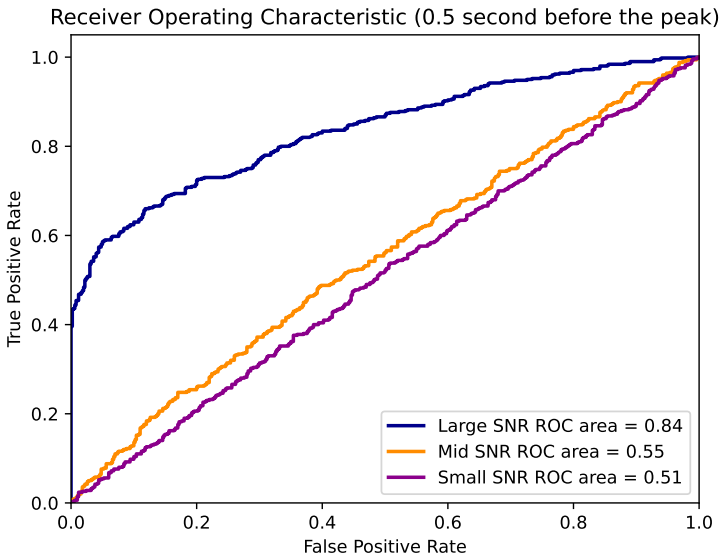
- 1s samples of 4096 sample rate
- 150, 000 samples
- $4 - 50 M_{\odot}$

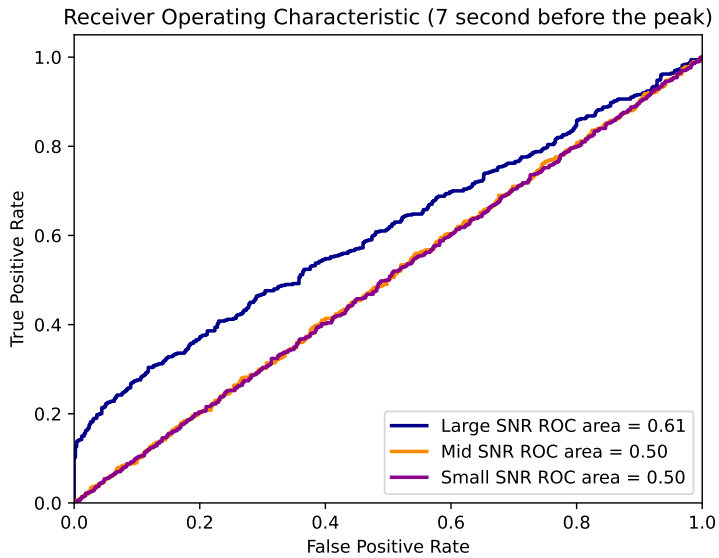


Evaluating performance of the CNN on synthetic data

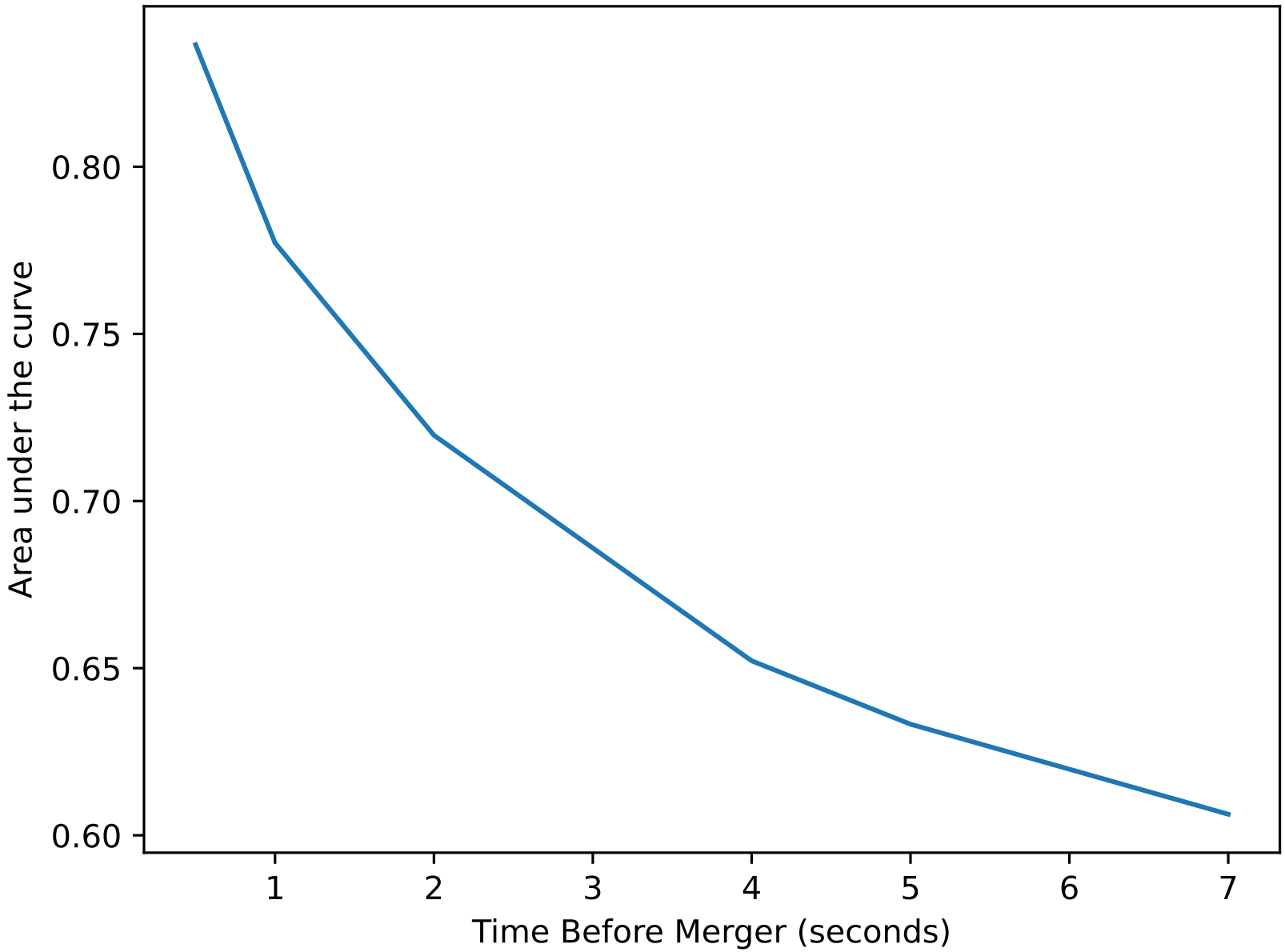


ROC in pre-merger stage (0.5 and 7 seconds)

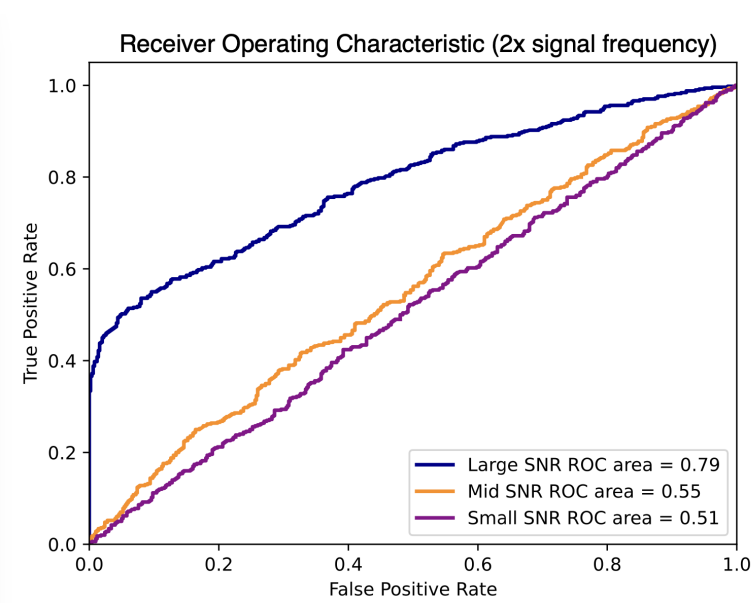


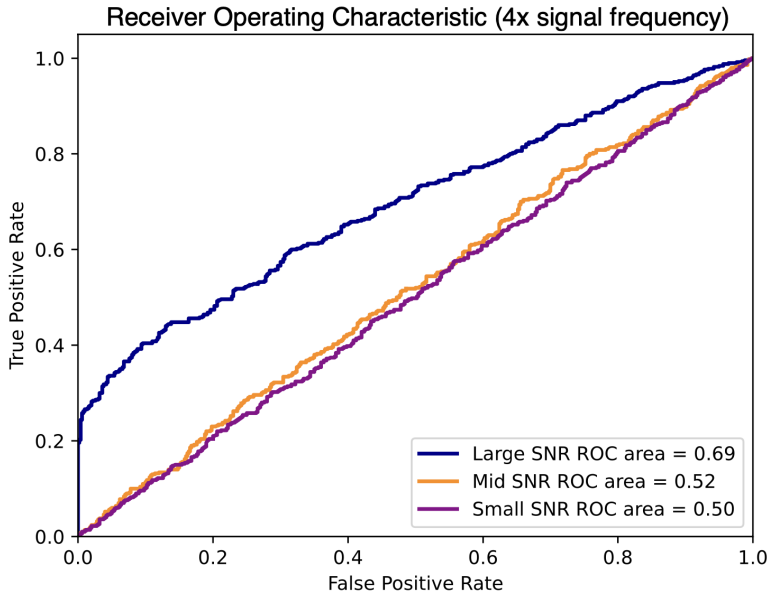


AUC vs Time before merger plot



ROC in signal frequency modified case (2x and 4x)





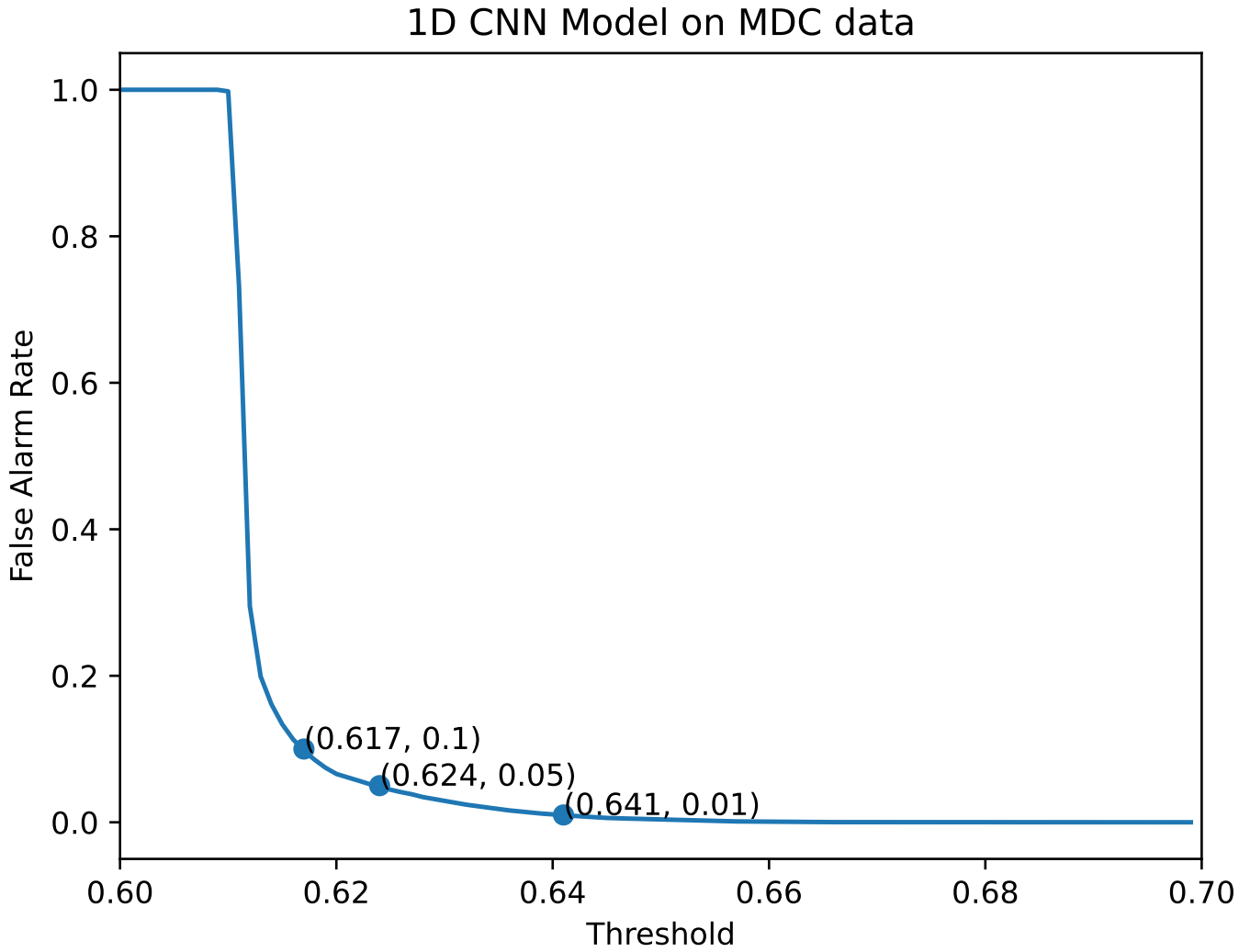
Testing the ability to detect signals under a lower mass hypothesis

Next Steps

- Increase the sample size
- Enhance the network architecture
- Broaden the temporal window of input data to increase performance on the pre-merger stage
- Investigate the BNS signals

Thank you for your attention

”Real life” applications of 1D CNN Model



$$SNR_{high} \geq 20$$

$$10 \leq SNR_{mid} < 20$$

$$SNR_{small} < 10$$

Calculation of localized SNR

$$SNR = \frac{noise_{PSD}}{sqrt(signal_{PSD})} \tag{1}$$