

# Accelerating ML for Gravitational Wave Signal Discovery

Ethan Marx, Alec Gunny, Will Benoit, Eric Moreno, Dylan Rankin,  
Deep Chatterjee, Ryan Raikman, Andy Chen, Philip Harris, Chia-Jui  
Chou, Michael Coughlin, Erik Katsavounidis

FastML for Science Workshop SMU

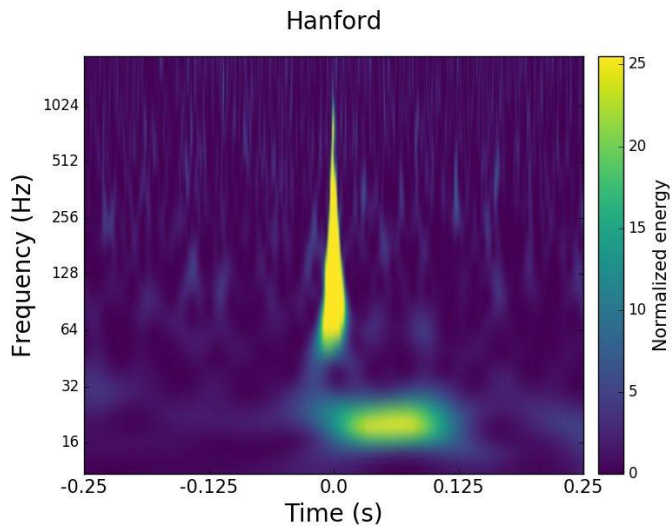
10/5/22

# Why ML for GW Detection

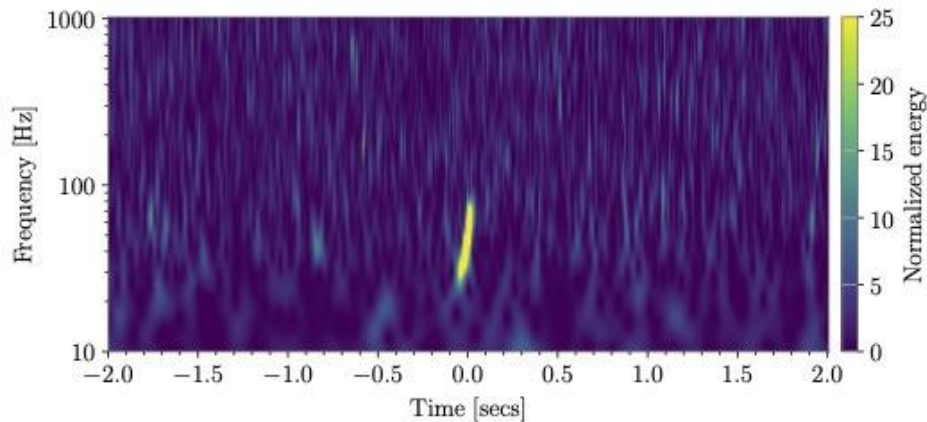
- **Online:** decreased inference latency for electromagnetic follow-up
- Template bank scalability
- **Offline:** smaller computational footprint, larger throughput
- Increased Sensitivity?

# Handling Glitches

- **Glitches:** Short duration, non-Gaussian noise transients originated from instrumental or environmental couplings
- Culprit of most significant false alarms

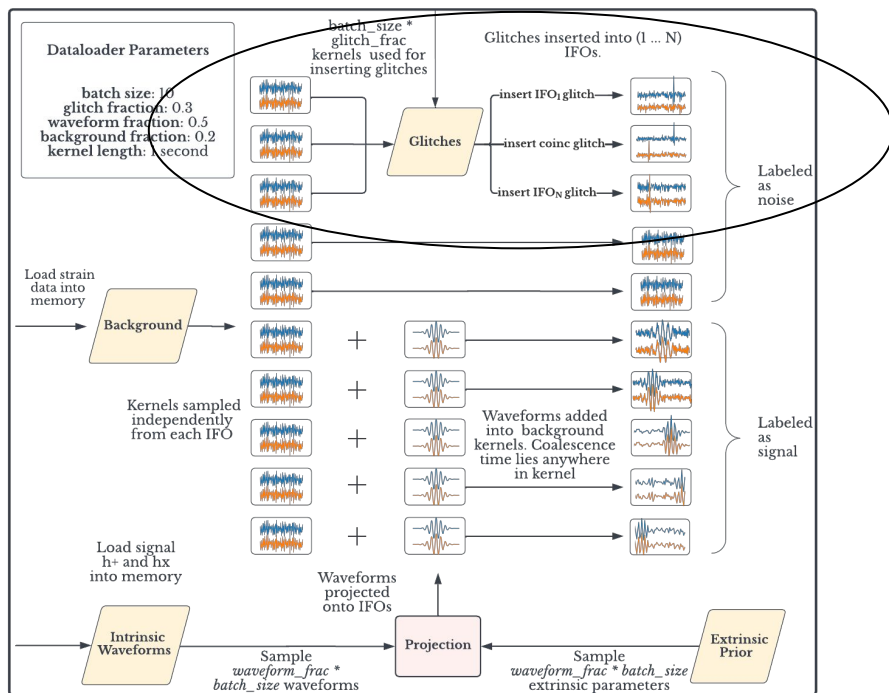


Blip glitch in Hanford data



Example binary black hole merger

# Data Augmentation: Glitches



Schematic of Dataloader

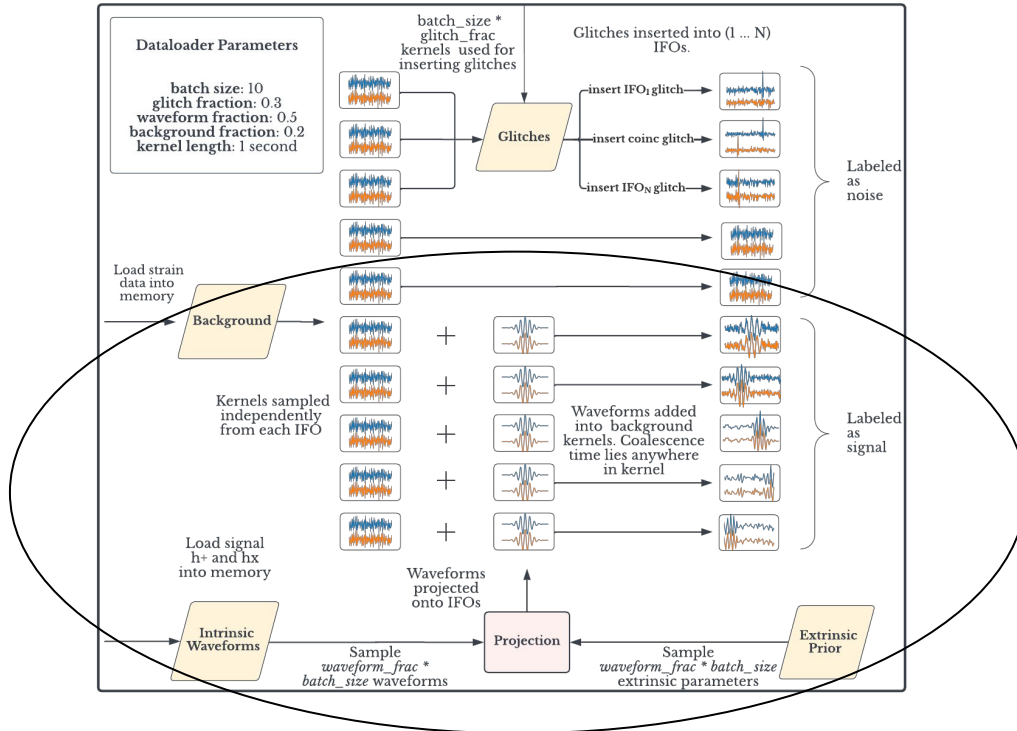
Excess power algorithm identifies glitches in training time series

During training, oversample glitches

Specify fraction of kernels with glitches in each training batch

# Data Augmentation: Waveforms

<https://github.com/ML4GW/ml4gw>



Schematic of Dataloader

Sample intrinsic parameters (masses, spins, tilts) and generate raw polarizations ( $h_+$  and  $h_x$ )

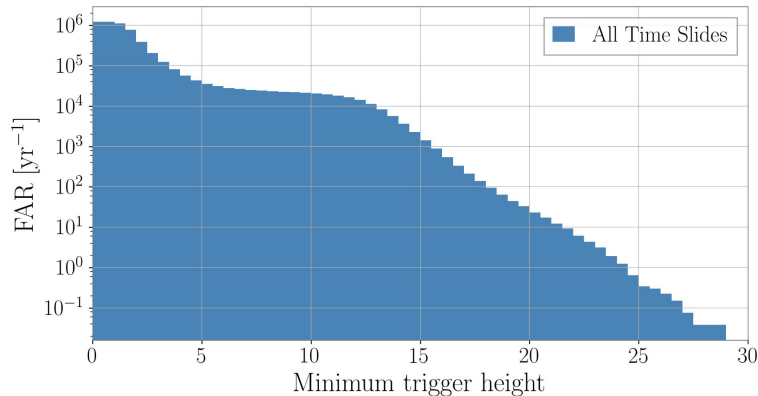
During training, sample extrinsic parameters (sky localization, distance) and project onto interferometers

Interferometer projection done on GPU: train time reduced from hours to 10s of mins

# Accelerating Model Evaluation

GW search sensitivity evaluated by comparing to background events generated through **timeslides**

Achieving high significance detections requires analyzing years of background - **computationally burdensome**

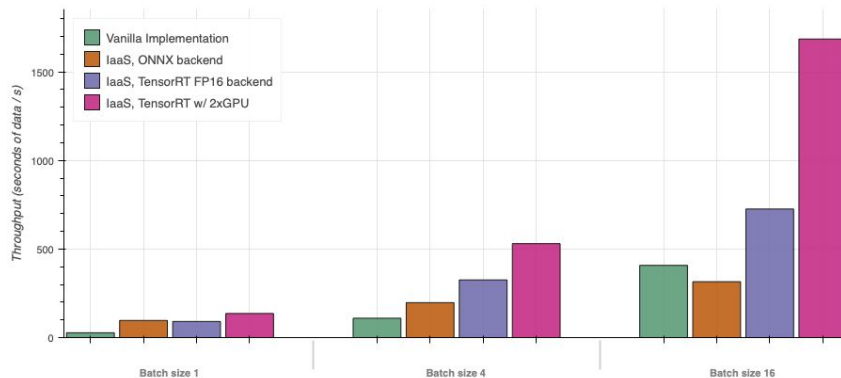


Trigger significance as a function of false alarm rate for timeslides

# Accelerating Model Evaluation

Host multiple model instances on GPU with Triton Inference Server (IaaS - [github.com/ML4GW/hermes](https://github.com/ML4GW/hermes))

Achieve throughput of 1600 seconds of data per second (lower bound)



**Thank You!**