

MMA: Our Three Pillars

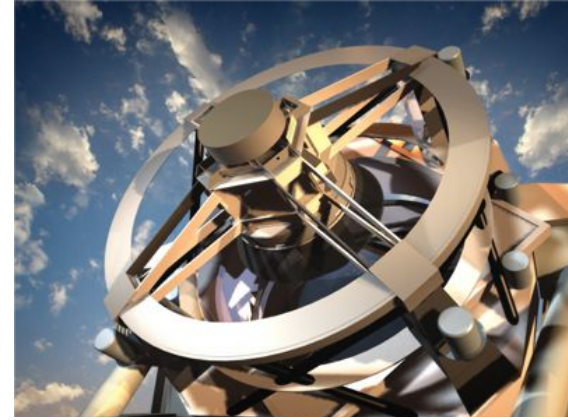
Gravitational waves



Neutrinos



Optical



MMA Organization

Major Challenges

- Data rights: building open source data sets that A3D3 can work on
- Internal connections: disparate science areas with very different data sets (connected by similar science goals)
- Problem formulation: wide variety of data sets and physical intuition
- Connection with stakeholders: useful algorithm development all the way to deployment requires connections outside of A3D3

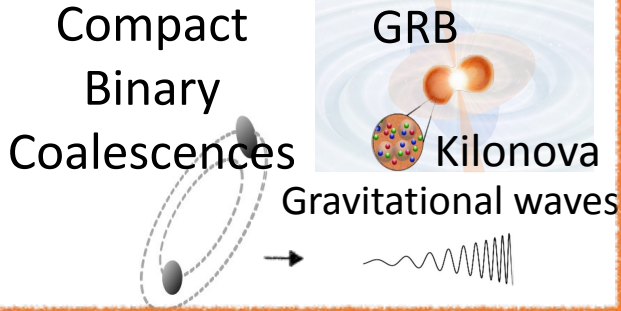
Organizational Discussion points

- How do we want to organize meetings (and balance internal collaboration ML meetings vs. A3D3 activities)?
- Do we need a regular “A3D3 MMA” meeting?
- How should we prioritize personpower? Relative to stakeholder deadlines presumably.

Scientific Discussion points

- What is the role of open data from experiments? Can we produce MMA Monte Carlo datasets for joint (end-to-end) analyses (example case studies: (1) CC-SN2023A in M31, (2) GW221109 at 100Mpc)?
- How can we work towards identifying off-the-shelf products/approaches that can be expanded to other areas: e.g., IaaS, image recognition?
- Can we identify a common conceptual path to establish the potential/merit for transition from traditional algorithms/computing to ML/HW acceleration? Establishing that path requires interaction with all groups in A3D3.

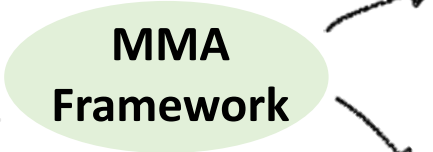
Global astrophysical modeling



Dedicated instrumentation



Online Platforms
Inference as a service



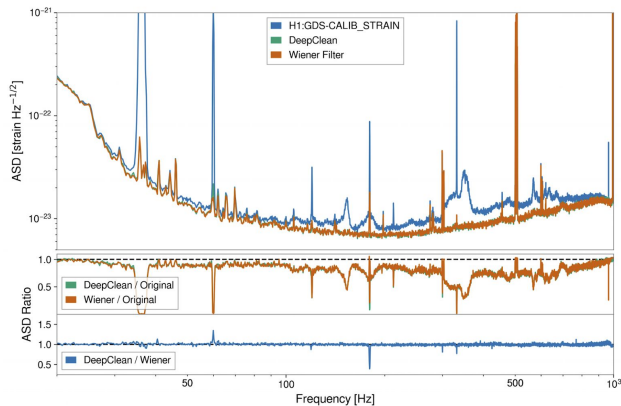
Machine Learning
Object Classification

Science!

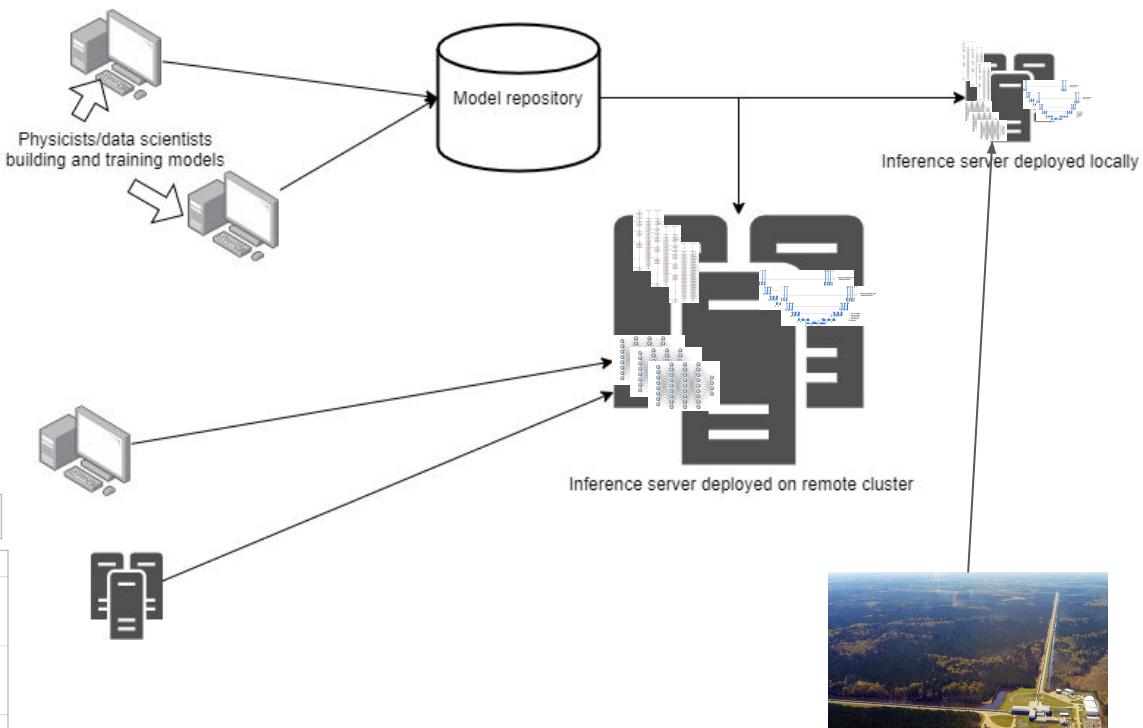
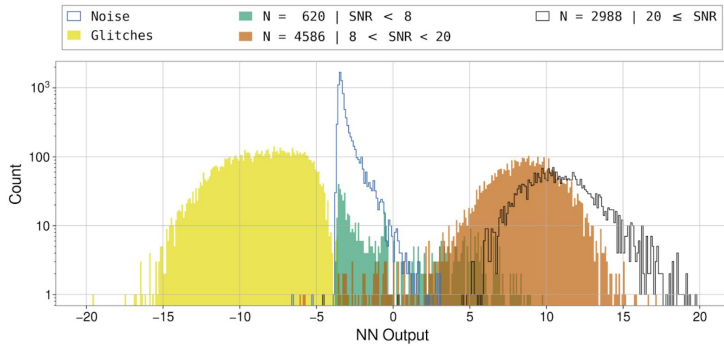
Multi-Messenger science includes representation from many of the most interesting experiments today.

Pillar 1 Project: Gravitational-wave Inference as a Service

Data Cleaning



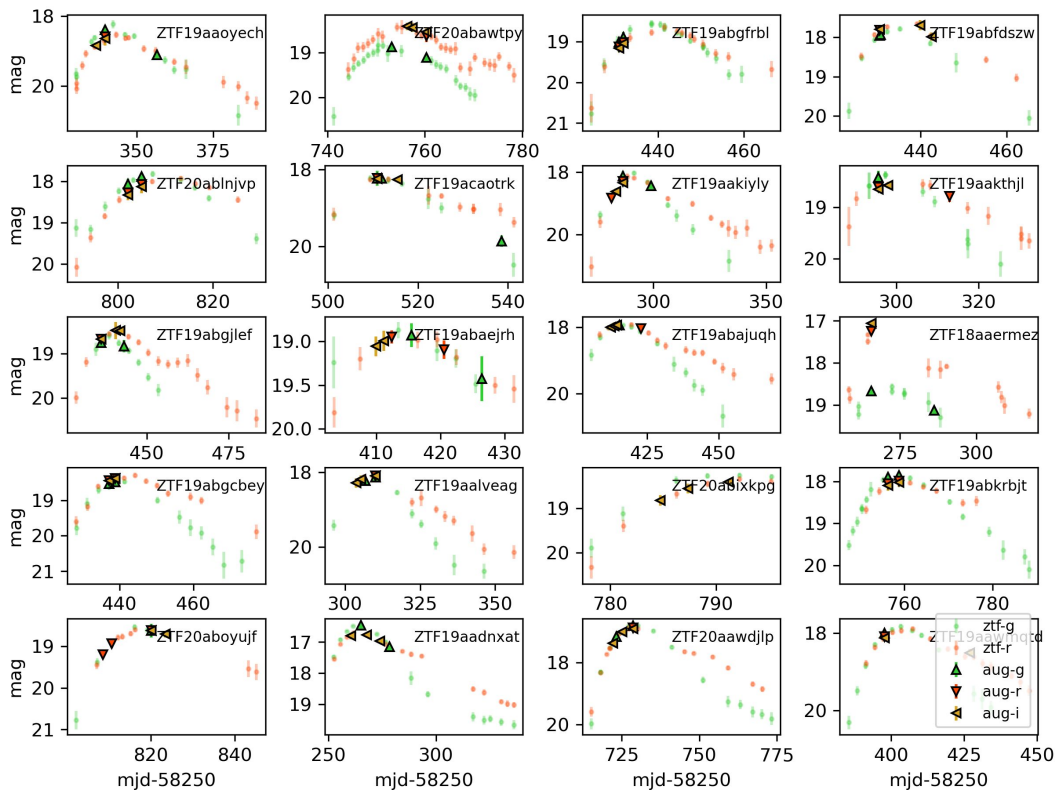
Detection



Gunny et al. (2021): 2108.12430

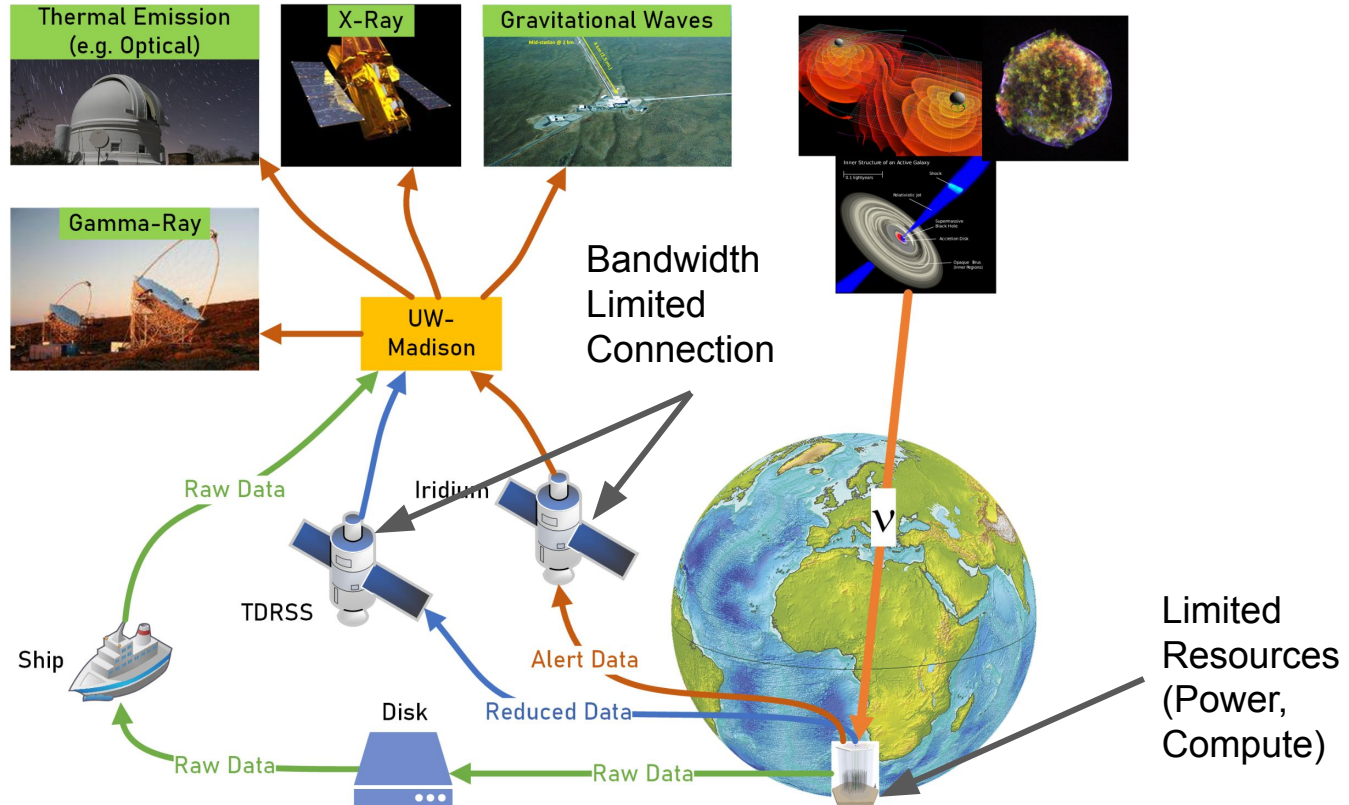
Pillar 2 Project: Optimal Light curve Augmentation

- Data will be insufficient for full science inference without additional follow-up
- Need to perform value-driven follow-up
- Broadly an optimal real-time resource allocation problem



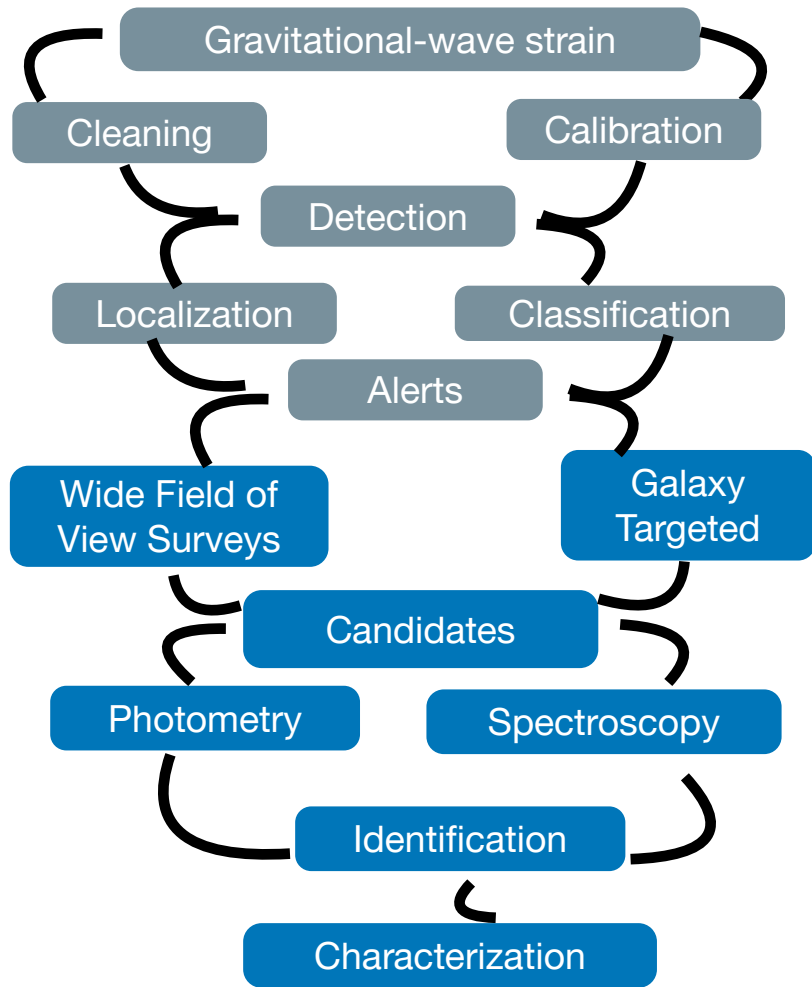
Pravraj et al. 2021: submitted

Pillar 3 Project: MMA at the Edge



Project 3: MMA at the Edge

- Want to send best results to community ASAP
- Resources limited at experiment
 - Bandwidth to Northern Hemisphere
 - Limited computational resources - Power constraint
 - Can not communicate with partners easily
 - Future detectors cannot transmit all their data to the surface
- Time critical and precise reconstruction
 - Need to transmit fast and accurate directional pointing
 - Data set needs to be analyzed on-site
 - ML recos $O(1s)$ vs. traditional recos $O(\text{hours} - \text{days})$ - FPGA or GPU acceleration - Goal 2024/25
 - Fast unfolding of ML inputs (waveforms) - FPGA or GPU acceleration - Goal 2023/4
 - Push waveform unfolding down to the sensors - FPGA - Goal 2025/6 (new detector design for Gen2 is ongoing)



- **HERMES (2108.12430):**
Saleem/Will, Alec/Dylan/Jeff
 - **DeepClean (2005.06534)**
 - **BBHNet**
- **Optimal Light curve augmentation:**
Tyler/Mouza, Ari
 - **NMMA (2002.11355)**
 - **ORACLEs (2003.08943)**
- **SkyPortal (skyportal.io)**

CIT

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