Using machine learning to classify GW event alerts

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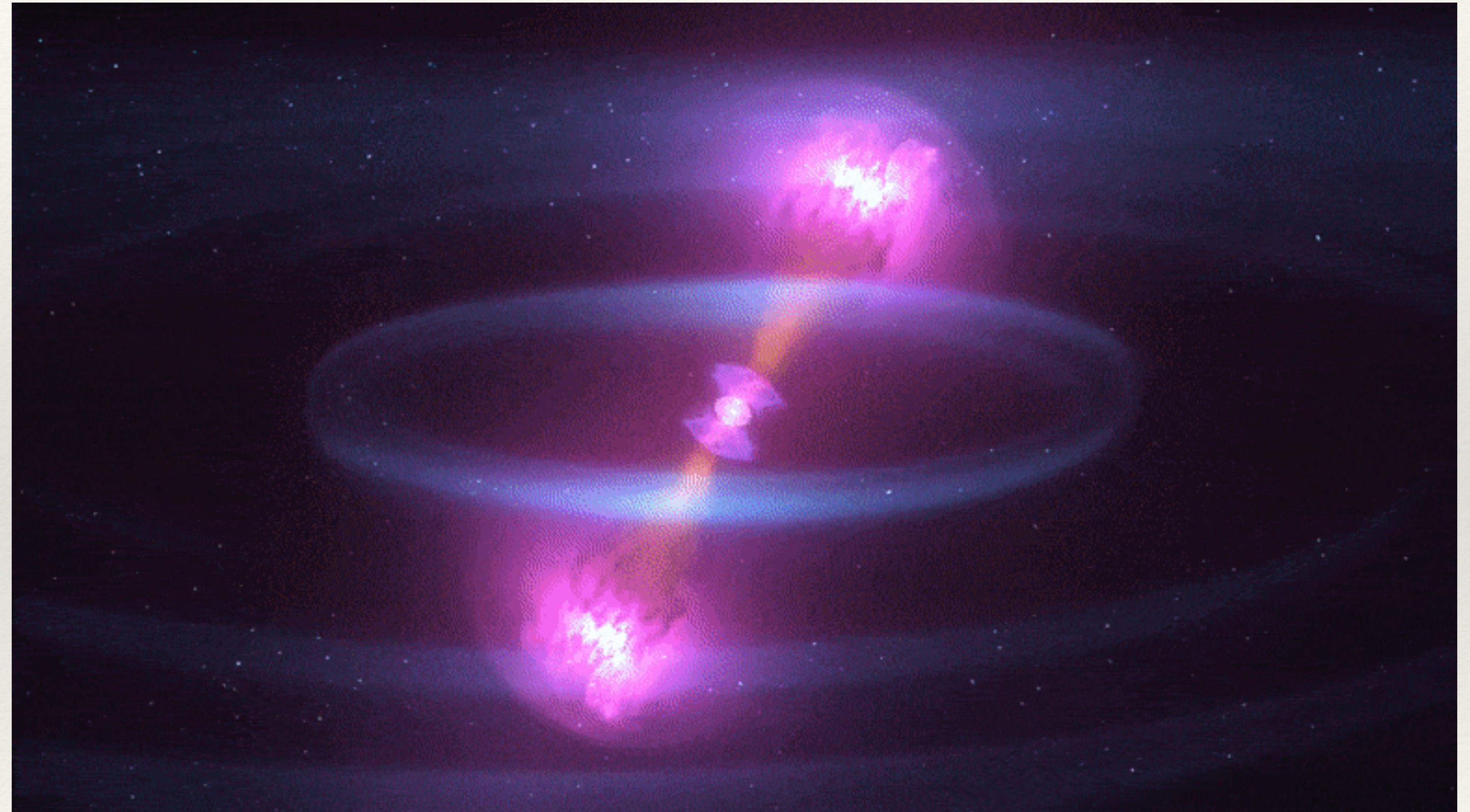
LISA Canada Workshop 2022

Multimessenger astronomy with GWs

❖ **LIGO detected sources: NS mergers (GW170817)**

❖ **LISA potential sources:**

   - Stellar compact binaries

   - Massive black hole binaries

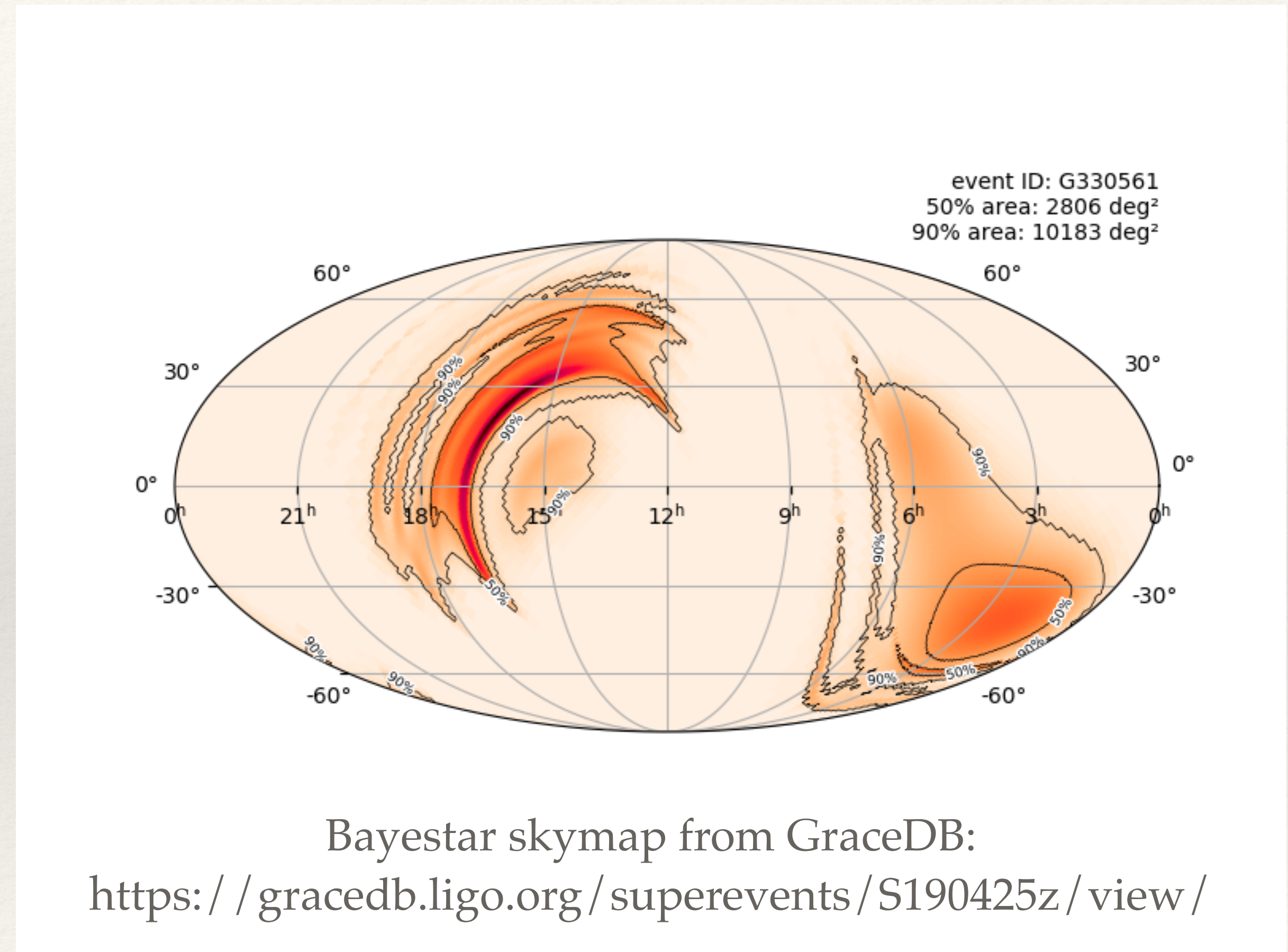   **- Extreme and intermediate mass ratio inspirals**

Credit: NASA/Goddard/CI Lab

LVK alerts and EM follow-up

❖ **Since O3: LIGO-Virgo release public alerts for <u>candidate</u> GW event detections**

❖ **Real and worth following up? 32/77 alerts in O3 were glitches!**

❖ **Follow-up is time sensitive: need a tool that is fast and helps classify nature of event**

event ID: G330561
50% area: 2806 deg²
90% area: 10183 deg²

Bayestar skymap from GraceDB:
https://gracedb.ligo.org/superevents/S190425z/view/

GWSkyNet as a fast classifier

❖ **A machine learning classifier of LIGO-Virgo public alerts**

❖ **V1: binary classifier - astrophysical or glitch? (Cabero et al. 2020)**

❖ **V2: multi-class classifier (Abbott & Buffaz et al. 2022)**

❖ **64/77 O3 alerts correctly classified (83%)**
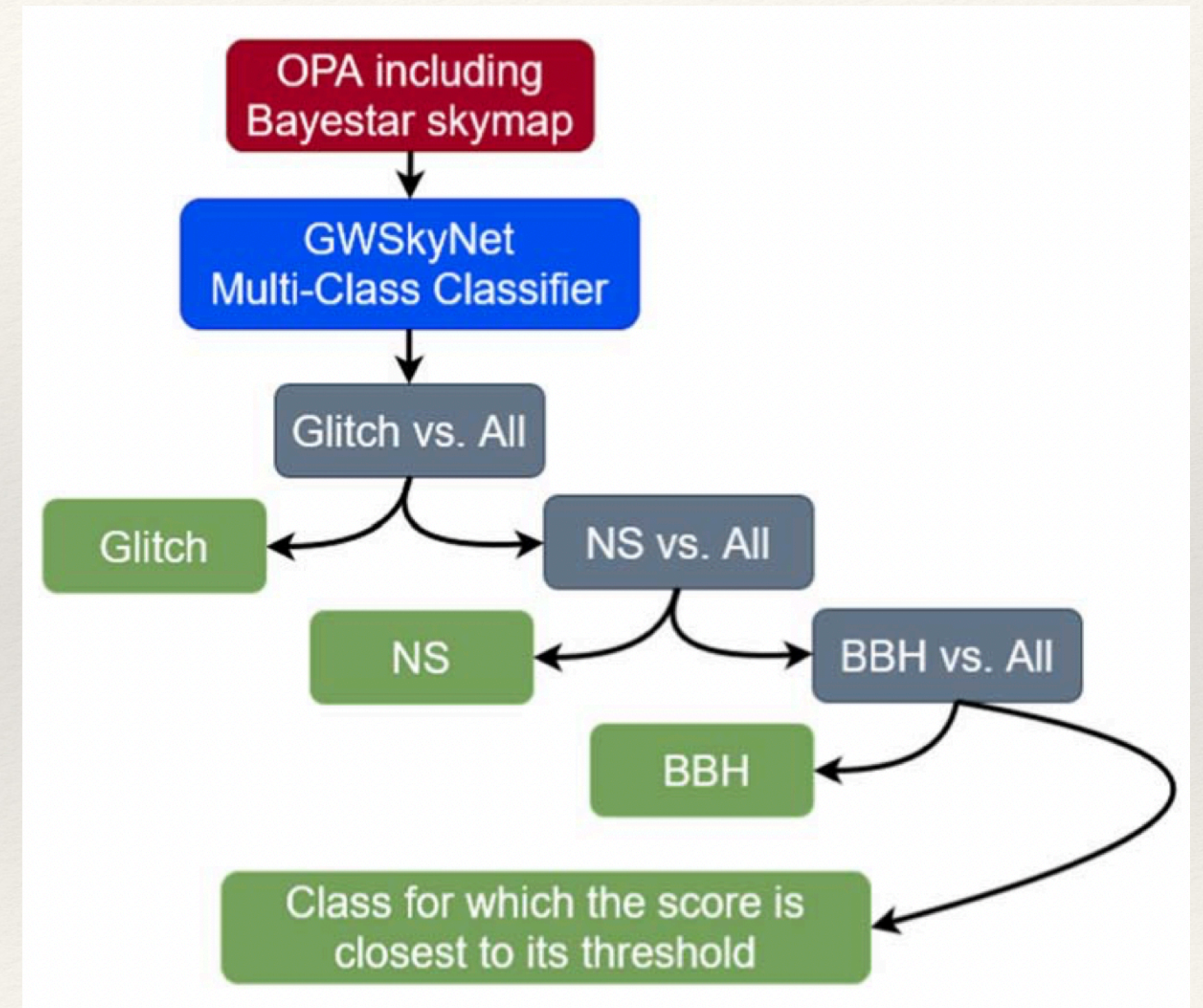

Abbott & Buffaz et al. (2022)

LISA event alerts

❖ **LISA will produce event notices for EM community follow-up**

❖ **Can expect some of the same data products as we get from LIGO-Virgo alerts e.g. sky localization maps**

❖ **Glitches also present in LISA (Pathfinder) - possibility of some false alerts!**

❖ **Could a GWSkyNet-like ML classifier be trained on LISA alerts data?**

Danzmann et al. (2017)
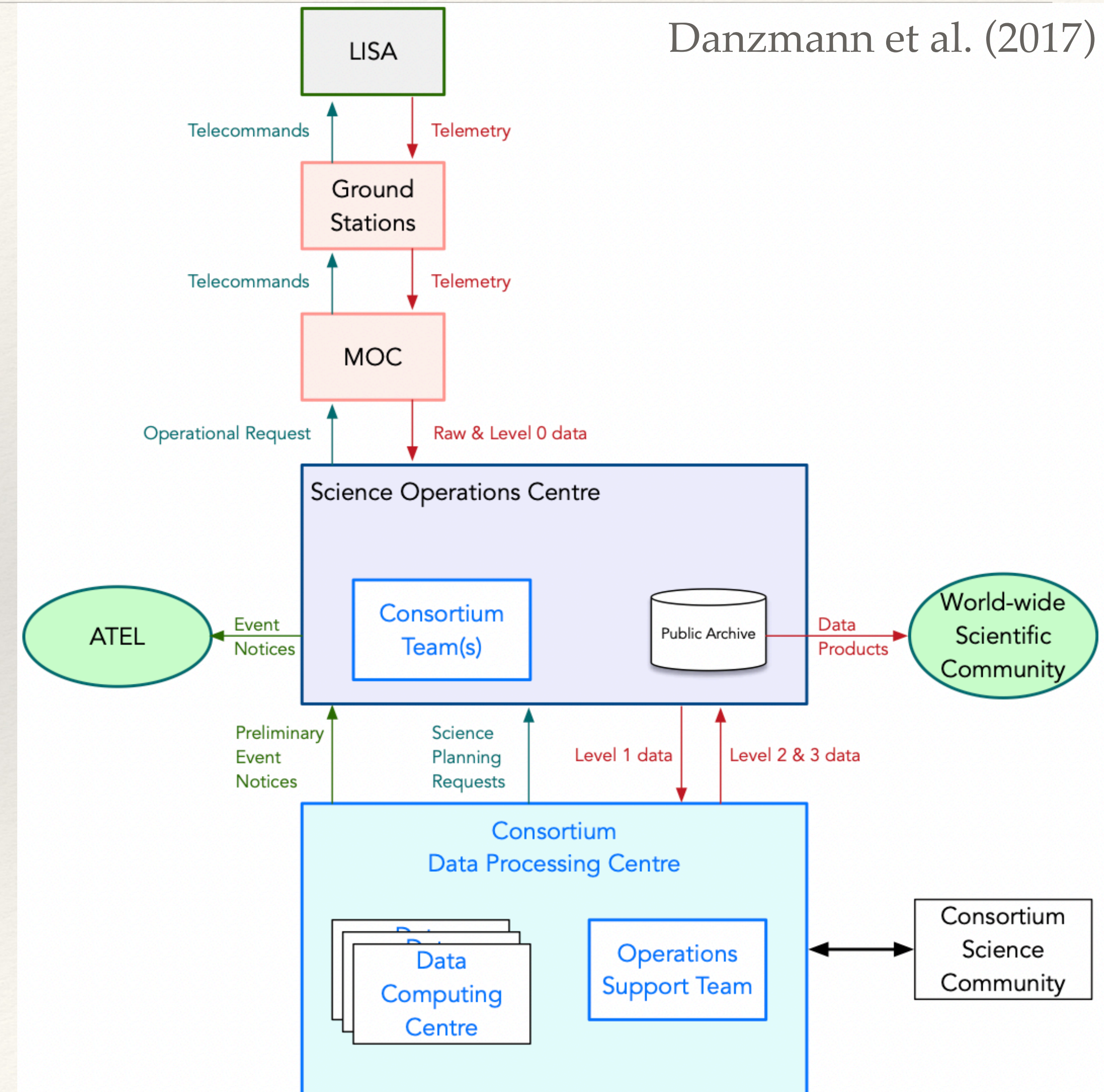
Towards an ML classifier for LISA alerts?

❖ **First step: simulated event timeseries data + Pathfinder glitches from LISA data challenges**

❖ **Foreseen challenges:**

- many more types of real events to learn

- vastly varying timescales - from months to near real-time!

- possibly evolving alerts as SNR accumulates
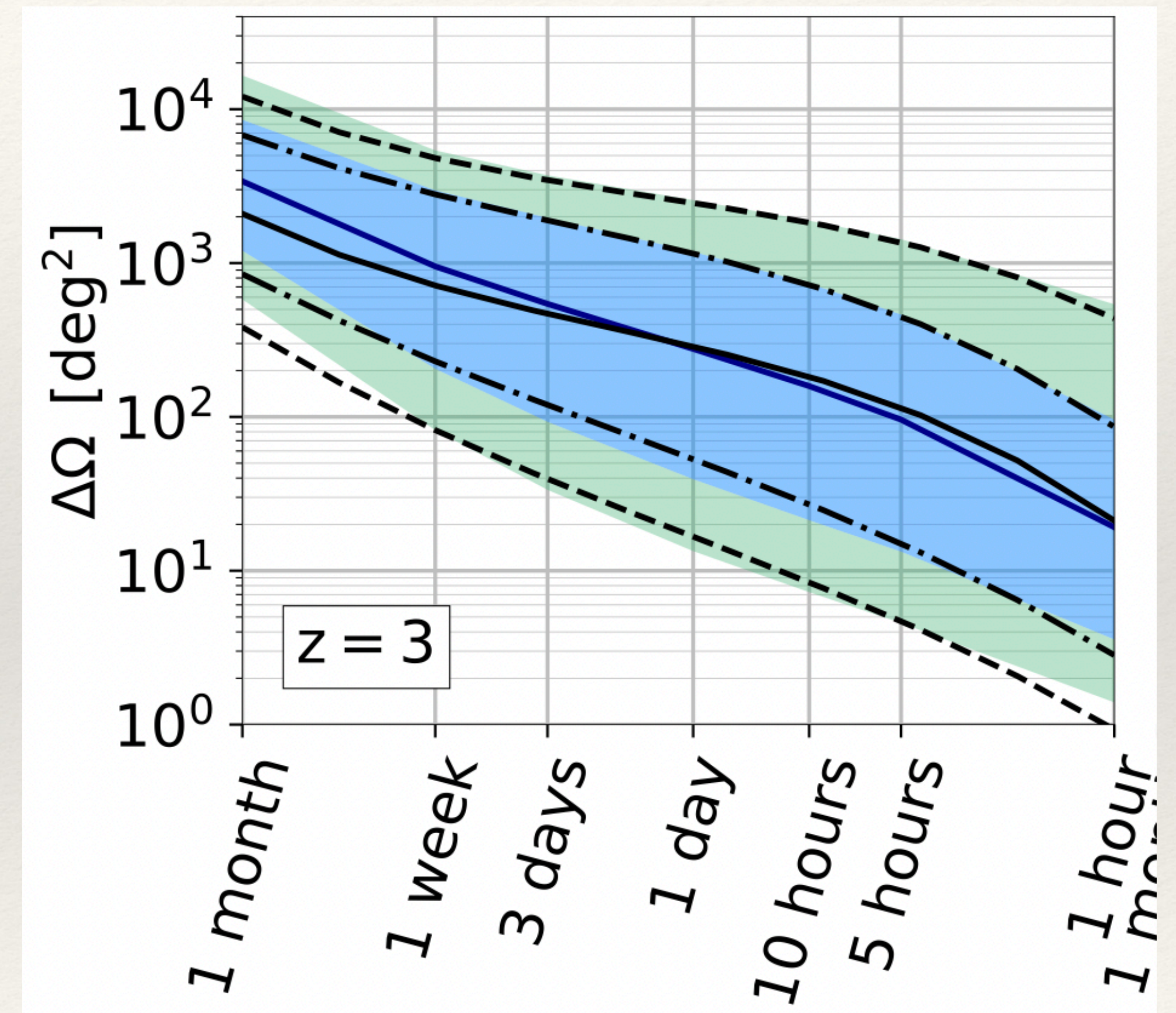
Mangiagli et al. (2020)

Summary

❖ **GWSkyNet is a ML classifier for LIGO-Virgo public alerts that helps astronomers make EM follow-up decisions**

❖ **There is potential to train a similar tool for future LISA alerts, but the process poses its own unique challenges that require careful consideration**