Multi-messenger astronomy

LIGO / Virgo example: GW170817

LIGO Scientific and Virgo Collaborations,
Astroph. J. Lett. 848:L12 (2017)

Host galaxy:
NGC 4993
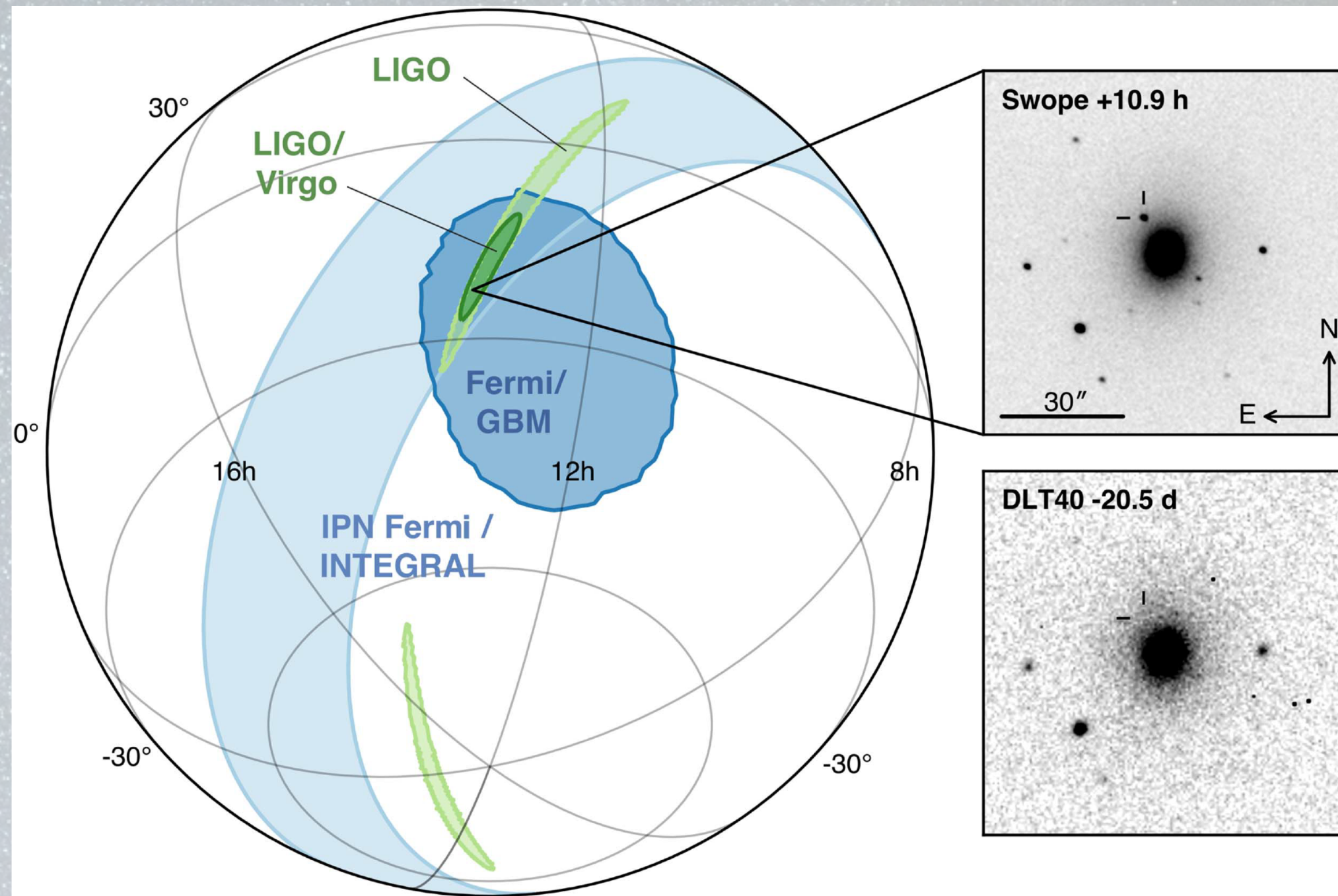
Two main ingredients for a successful followup campaign

- Accurate sky localization
- Release of candidate information

More precise sky localization expected for some LISA sources.
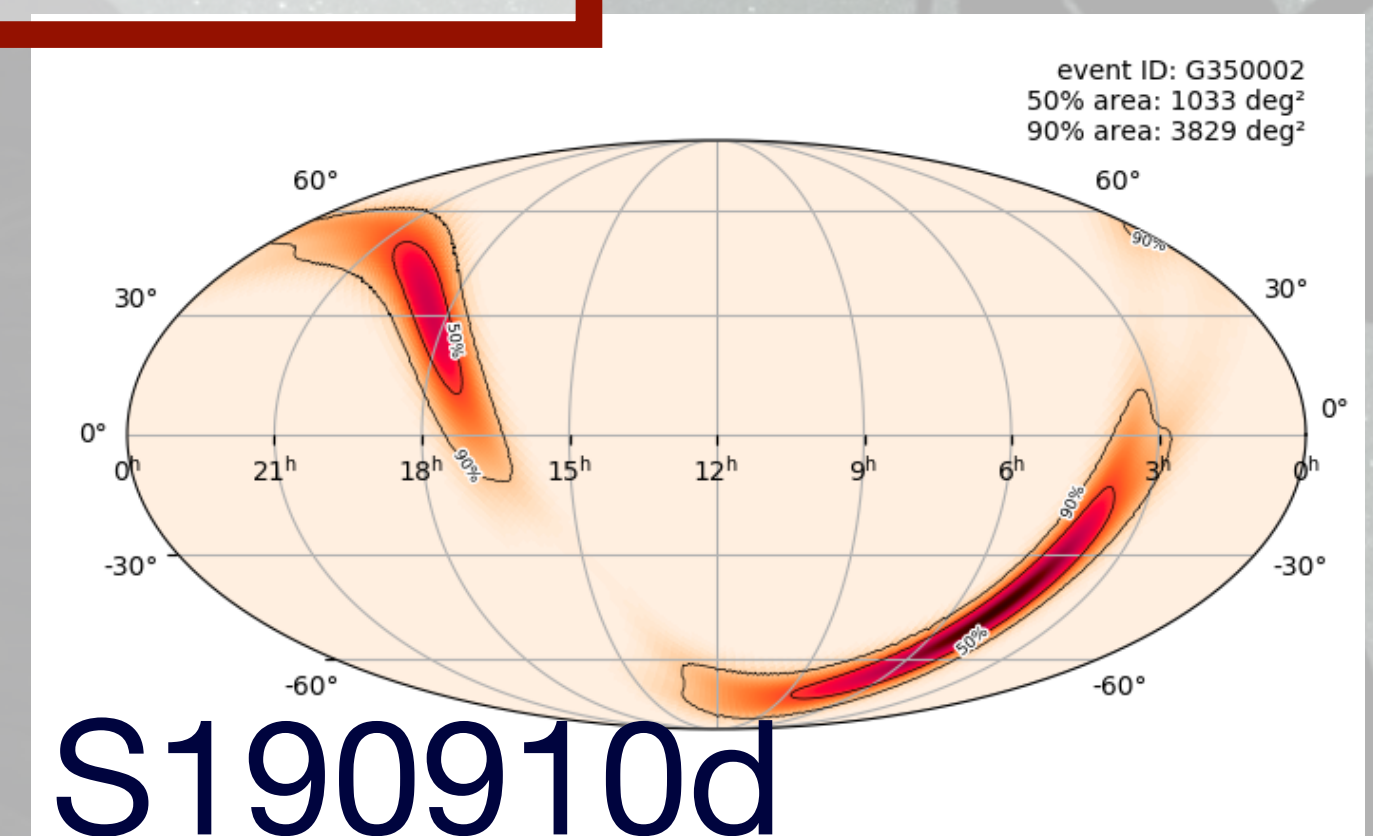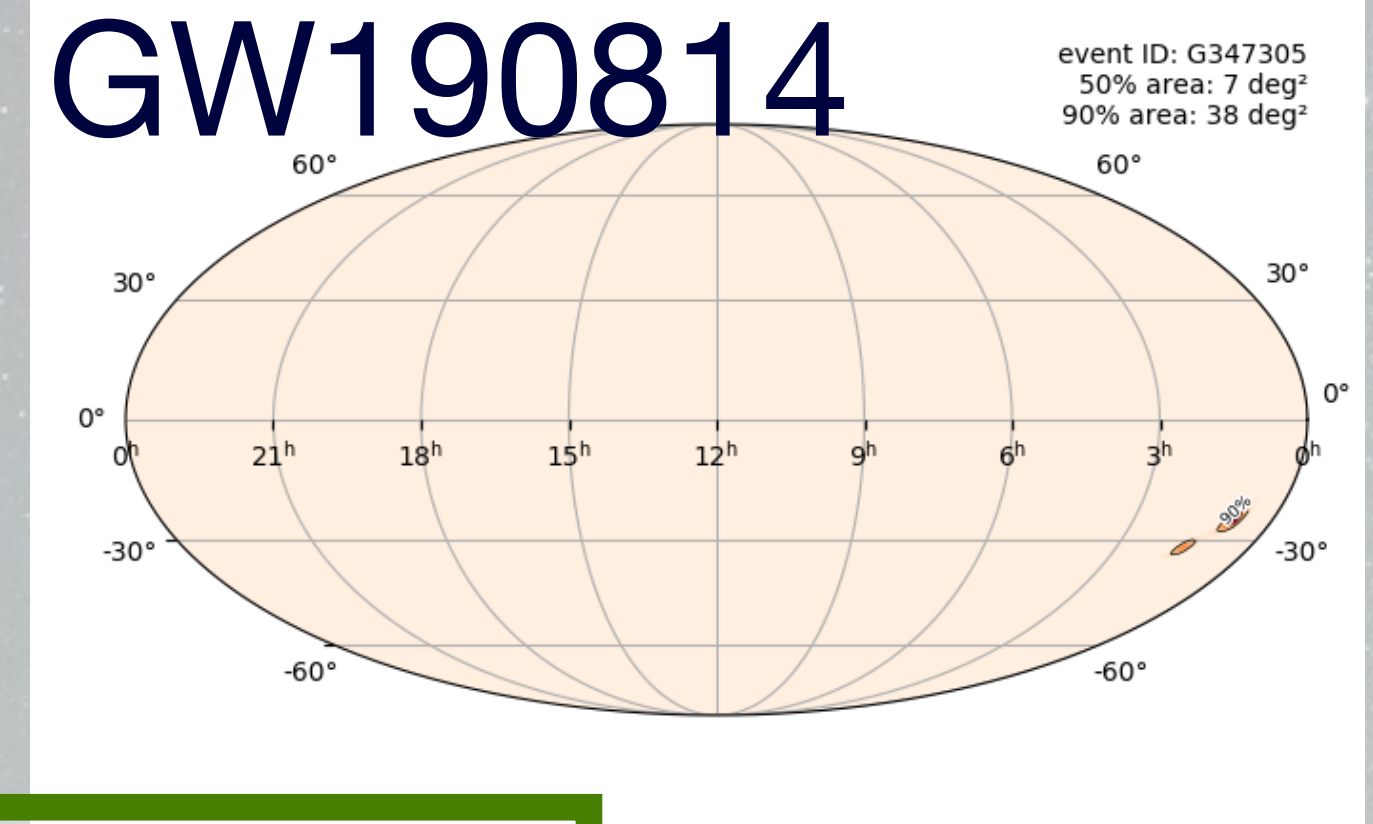
Machine learning with sky maps

GWSkyNet

Convolutional neural network
- 2D sky map image
- 3D volume image
- Detector network
- Estimated distance

Astrophysical

Not astrophysical

GW190814

event ID: G347305
50% area: 7 deg²
90% area: 38 deg²

S190910d

event ID: G350002
50% area: 1033 deg²
90% area: 3829 deg²

GraceDB

Performance on GWTC-2

GWTC-2: GW discoveries between
1 April and 1 October 2019

$\longrightarrow$

29 non-retracted & unpublished
candidates in this period

	Astrophysical	Not astrophysical
Results (GWTC-2)	22	7
Prediction (GWSkyNet)	23	6

Correctly rejected most
non-astrophysical events
(except S190923y)

Accuracy: How often is the model correct?

$$A = \frac{\text{Correct predictions}}{\text{All predictions}} = 96.5\,\%$$

Recall: How many astrophysical events are
predicted correctly?

$$R = \frac{\text{Predicted astro}}{\text{Actual astro}} = 100\,\%$$

GWSkyNet

for multi-messenger astronomy

UBC DEPARTMENT OF
PHYSICS ASTRONOMY

UBC

GWSkyNet is a classifier that uses GW sky maps to identify non-astrophysical events

Results look promising: GWSkyNet can help astronomers decide which candidates to follow up

Can be applied to LISA sources once a training set with LISA data has been constructed

Thank you