GaiaX – MeerLICHT Contemporaneous Observations

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In the Age of Multimessenger Astronomy...

The Main Goal:

Using Gaia for the Discovery of Electromagnetic Counterparts of Gravitational Waves (GW)

What We Need:

Improved sensitivity of the Gaia Photometric Science Alerts stream;

Method:

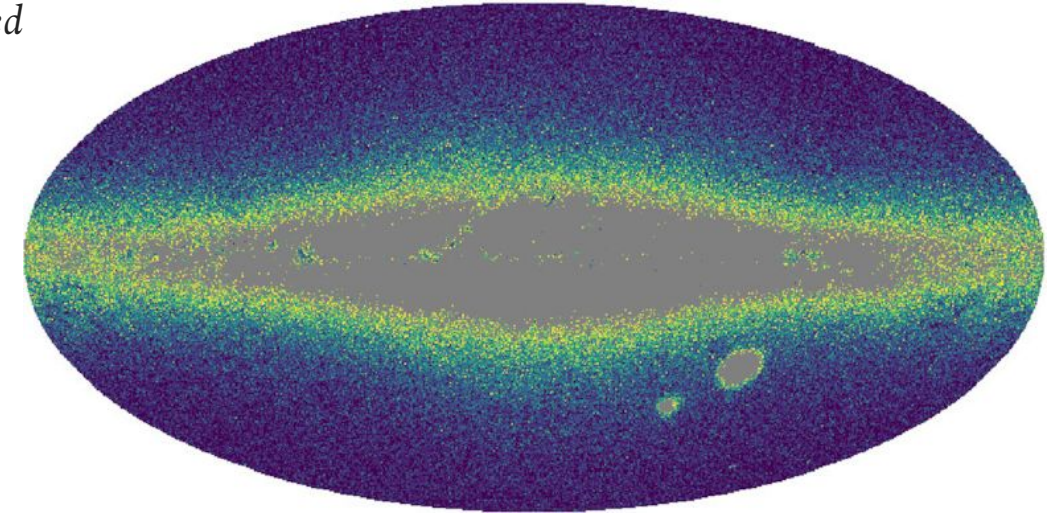
Publishing an extra (less pure) alert stream called *GaiaX* during O4 for active follow-up of GW events; *(Kostrzewa-Rutkowska et al 2020)*

GaiaX Alerts Stream

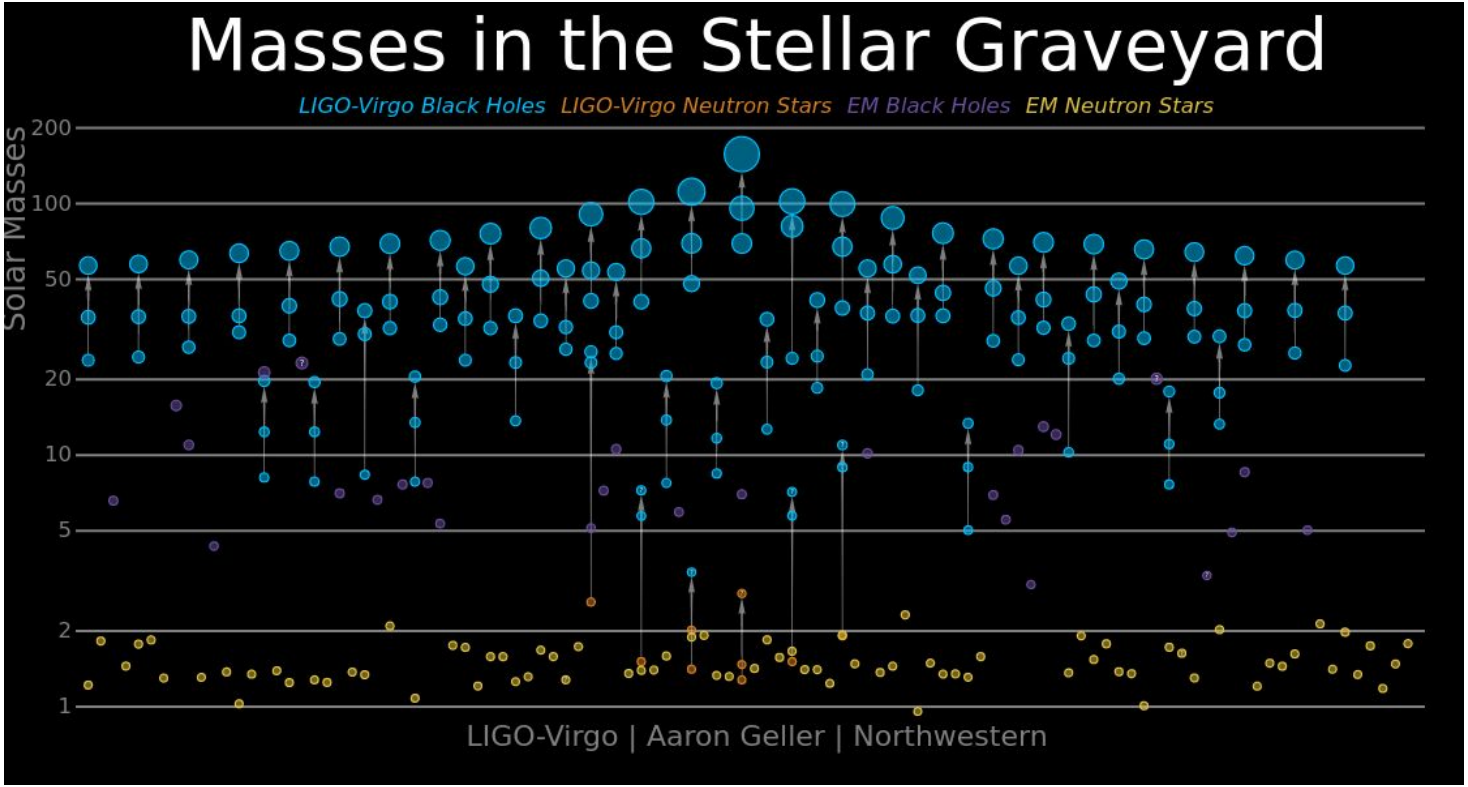
- Allowing a single detection to trigger an alert
  (for normal alerts, two transits are required for the detection)

- Fainter candidates are included as the threshold is around 20.7 mag
  (instead of 19 mag)

- Limited sky coverage
  (Milky Way bulge and disk, Magellanic Clouds, and other very dense regions are excluded - 21%)

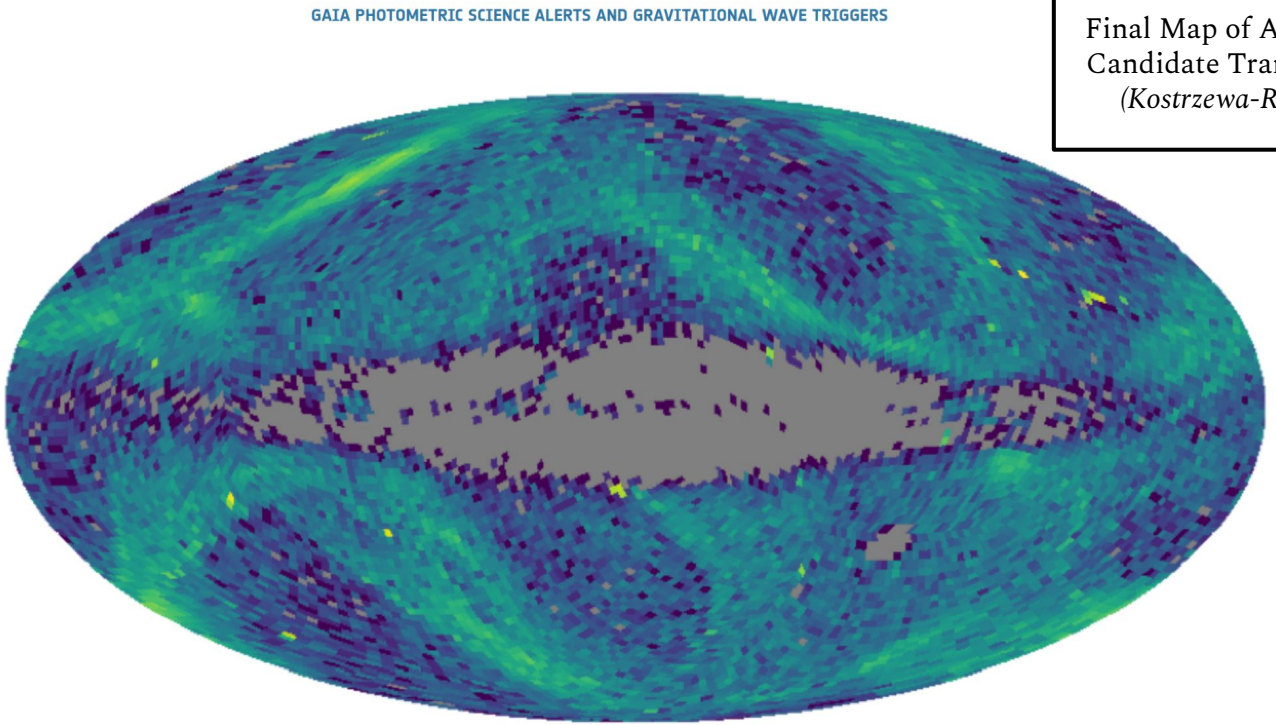


Density map of sources in GDR2 chosen for the new detector *(Kostrzewa-Rutkowska et al 2020)*



At least 50 EM candidates from Gaia (all published via GCN)

GaiaX - MeerLICHT Experiment



Final Map of All-Sky Distribution of Candidate Transients after Filtering *(Kostrzewa-Rutkowska et al 2020)*

Official Announcement: https://www.cosmos.esa.int/web/gaia/iow_20210825

MeerLICHT: Listening and Looking at the Sky at the Same Time

> “Certainly, if we can overlay radio with optical, we can start to do some source association, and really try to understand the correlations between these two different windows on the universe.”

- **Optical** view of the transient **radio** sky (observed by MeerKAT)
- Broad contemporaneous view of the southern skies
- At Sutherland, South Africa
- 0.65m telescope
- Wide field of view (2.7 square degrees)
- Prototype of BlackGEM (Chile)

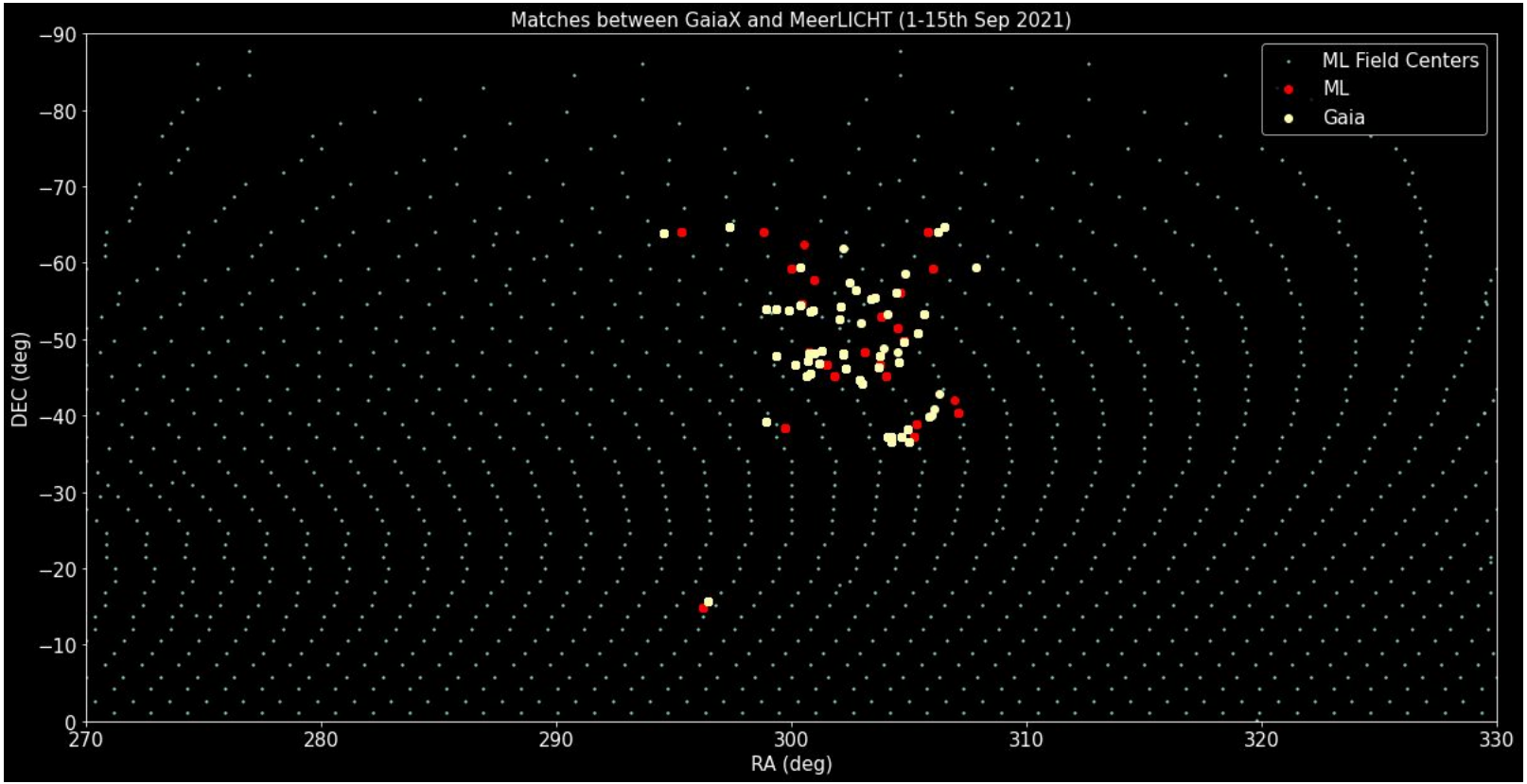
GaiaX - MeerLICHT Experiment (Sep - Oct 2021)

- MeerLICHT following Gaia
- GaiaX Alerts Stream published

What we're expecting...

GaiaX	MeerLICHT	Outcome
Yes	Yes	Possibility of interesting transient detections; Training ML machine learning algorithms;
Yes	No	Better GaiaX alerts filtering; Understanding the environment using ML images;
No	Yes	Improving bogus detections (e.g. asteroids);

Current Status of the Experiment



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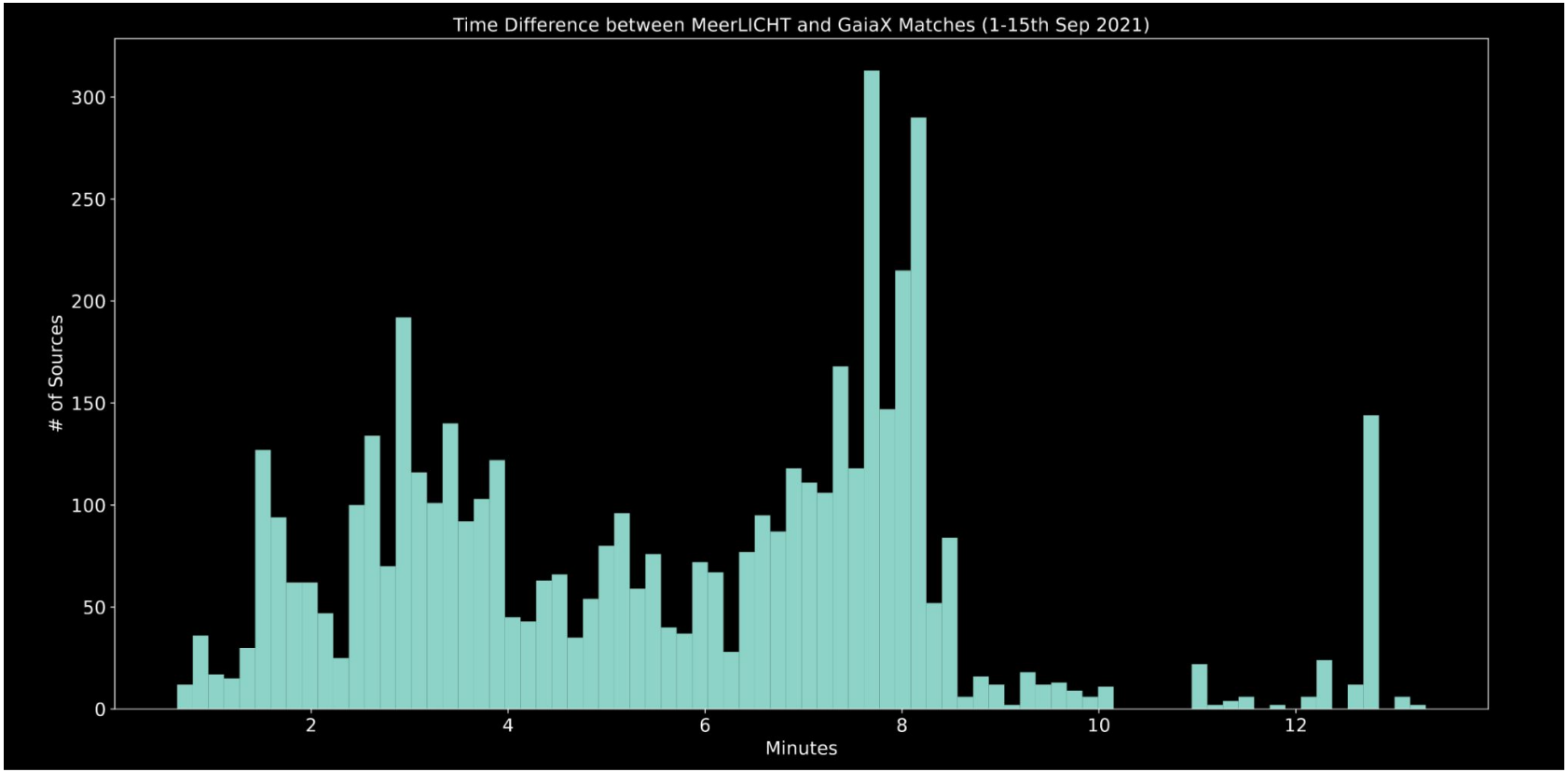


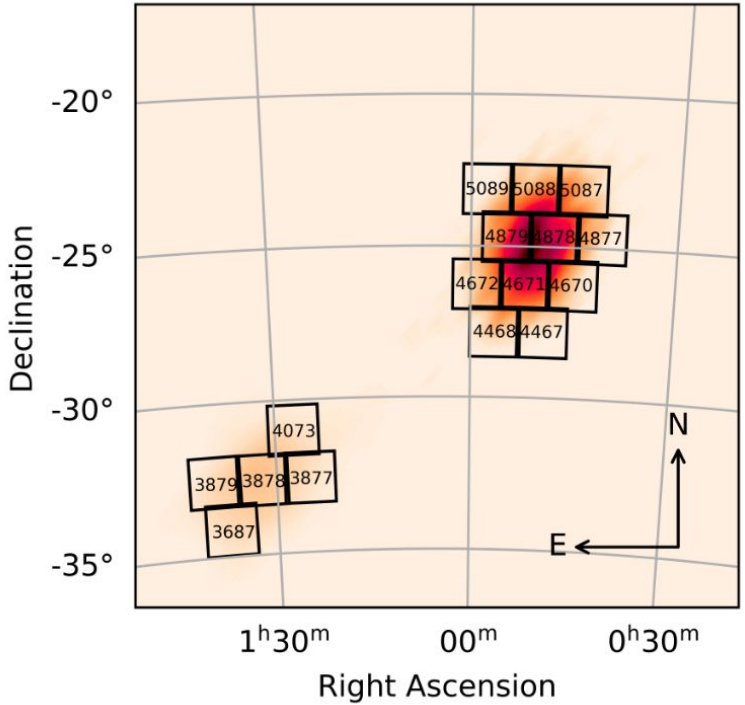
Conclusion & Final Remarks

- Goal is for Gaia to detect optical counterparts of GW events during O4
- Introduction of GaiaX alerts stream to achieve this
- Testing GaiaX by running a contemporaneous experiment with MeerLICHT
- Lots of promising data (and lots of analyzing left to do!)
- Get ready for O4!

Thanks for listening!

Extra Slides

Optical follow-up of GW190814 with MeerLICHT *(S. de Wet, 2021)*



- MeerLICHT/BlackGEM fields
- Sky positions of 16 fields with at least 95% probability

  (based on the LALInference skymap)

Table 1. A summary of the impact of each selection criterion applied during filtering on the sample size.

Criterion	Number of remaining candidates	Rejection ratio
(i)	38×10^6	0.74
(ii)	8.3×10^6	0.78
(iii)	7.0×10^6	0.16
(iv)	3.6×10^6	0.49
(v)	1.4×10^6	0.61
(vi)	1.2×10^6	0.14
(vii)	1.2×10^6	<0.01
(viii)	1.1×10^6	0.01
(ix)	2.5×10^5	0.78

(Kostrzewa-Rutkowska et al 2020)