Multi-messenger Panel PAX

Jess Broderick, ASTRON, LOFAR EM follow-up co-lead

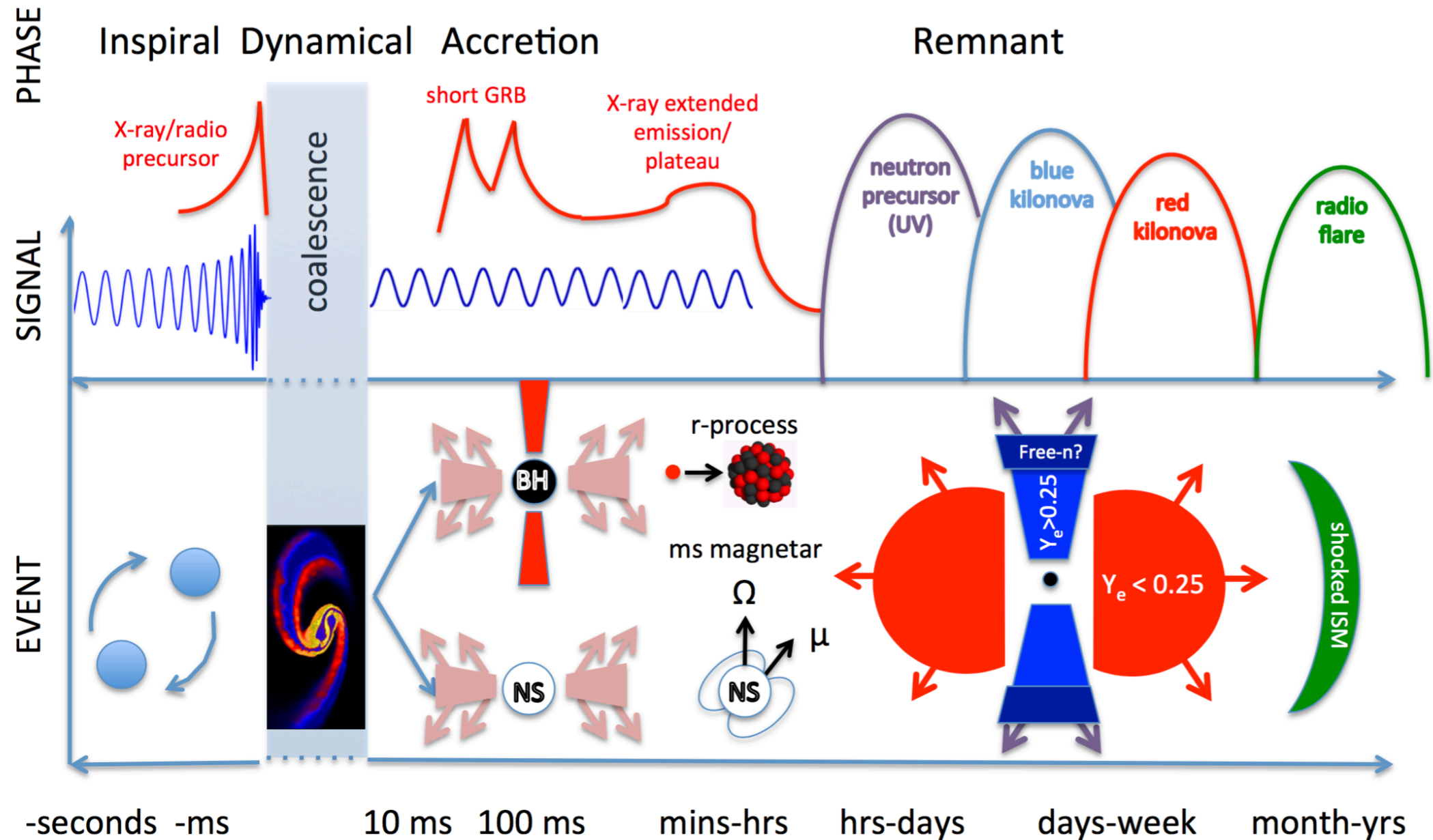Jason Hessels, University of Amsterdam & ASTRON

Gijs Nelemans, Radboud University, Nijmegen

Elena Rossi, Leiden University

Nial Tanvir, University of Leicester

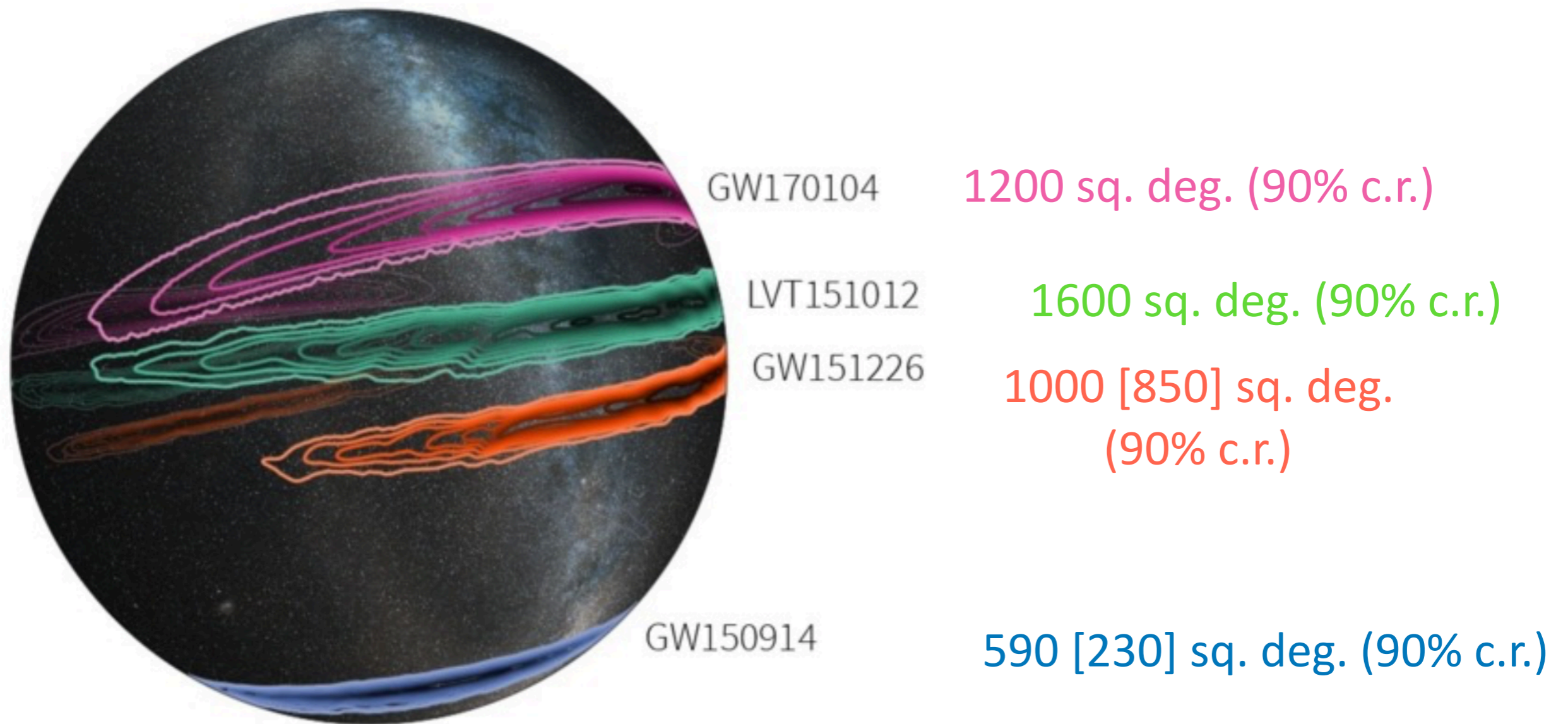Andrew Williamson, RIT $\Rightarrow$ Radboud University, Nijmegen

Two types of outflows ⇒ Plethora of EM counterparts

[Fernandez and Metzger, 1512.05435, and references therein]

[see also Tsang et al. 2011, Metzger et al., Siegel et al. 2016,17, Gottlieb et al., 2017]
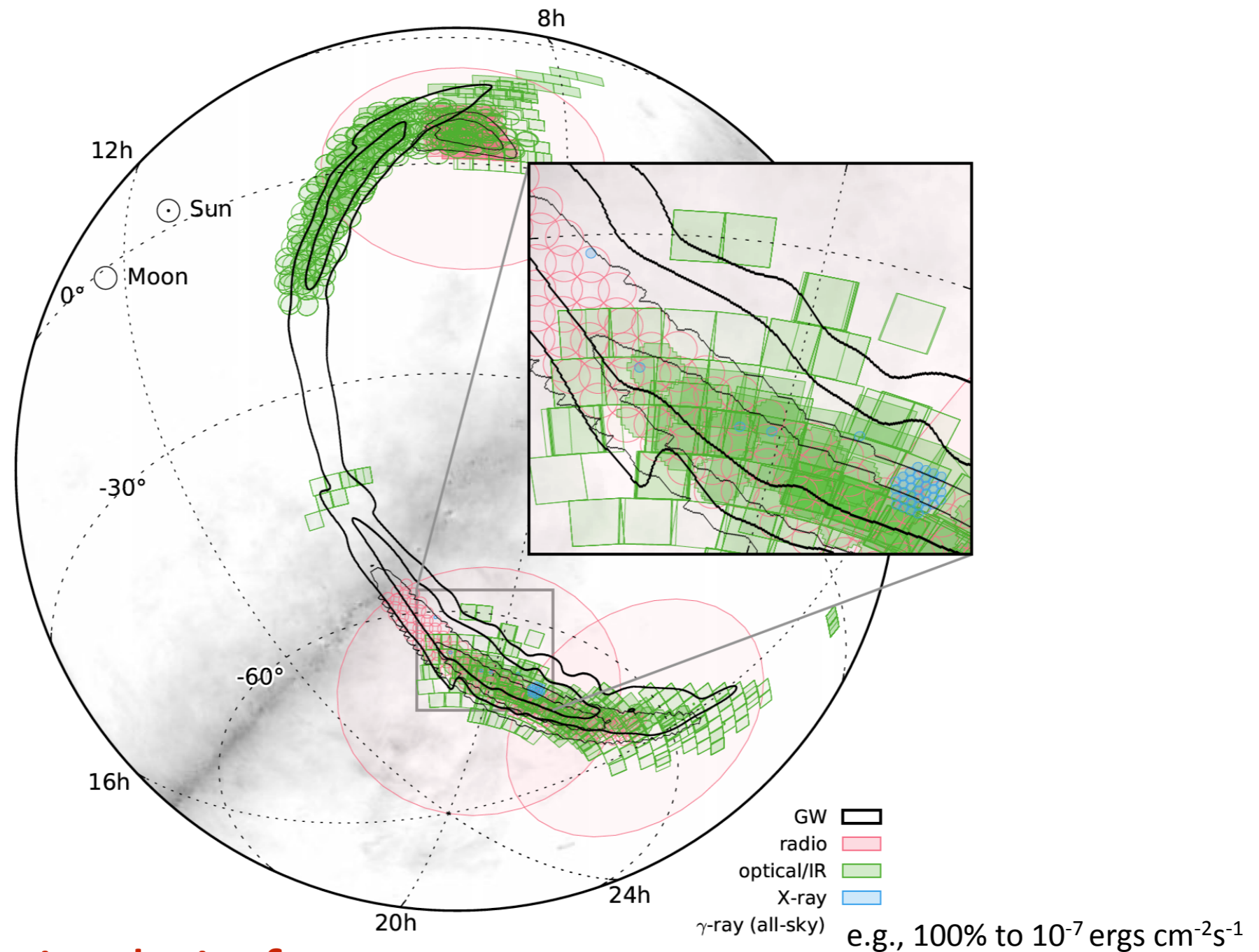
How well can we localise the source on the sky?

GW170104 1200 sq. deg. (90% c.r.)

LVT151012 1600 sq. deg. (90% c.r.)

GW151226 1000 [850] sq. deg. (90% c.r.)

GW150914 590 [230] sq. deg. (90% c.r.)

[Image credit: LIGO/L. Singer/A. Messinger]

10^5-10^7 galaxies in these volumes

2015: EM follow-up by 24 observatories for GW150914

19 orders of magnitude in frequency space

Also, high-energy neutrino search with IceCube/Antares (+/- 500s)

Next step: combine & interpret GW + EM

h(t): 9-16 parameters

+ Redshifted Masses (several to tens %)

+ Redshifted Spins (tens of %)

+ NS radii (tens of %)

+ Geometric properties: (tens of %)
    - Inclination angle
    - Source Position
    - Luminosity distance

$F_\lambda(t)$: 5-10 parameters

+ Energetics and beaming
+ R-process nucleosynthesis
+ Mass ejecta and velocity
+ Environment
+ Redshift, Accurate Position (1")
+ Stellar populations
+ Magnetic field strength
+ Previous binary evolution & mass loss

Discussion Points

1) What do GW sources look like in EM radiation? What is the best strategy to find them?

2) Can EM signals help to distinguish source classes

3) Do EM detections help to determine source population properties (relative occurrences, mass distributions, redshift dependence of rates/distributions etc)?

4) How complete can EM follow-up be and how does incompleteness influence the previous points?

Discussion Points II

5) Can any thing more be done from GW side to help EM prospects?

6) Do we want to get in to issues such as "what would
it take to make a good candidate counterpart?", "what would take
to make a compelling/convincing counterpart?"

7)similarly, what are prospects for joint statistics e.g.
sub-threshold detections in either EM or GW or both?

8) Can we identify possible EM signal precursors to a GW merger?
what do the timescales prior to merger would be? Could we use
them to plan an observational campaign ?