Rapid follow-up of gravitational wave event with SVOM

Jean-Grégoire Ducoin

Frédéric Daigne
Nicolas Leroy

Institut d'Astrophysique de Paris

Introduction

gravitational waves follow-up challenge

Key points of the gravitational waves follow-up challenge

General objectives: multi-wavelength detection, highly sampled light curve, measure the redshift and spectral feature

Several difficulties:

Key points of the gravitational waves follow-up challenge

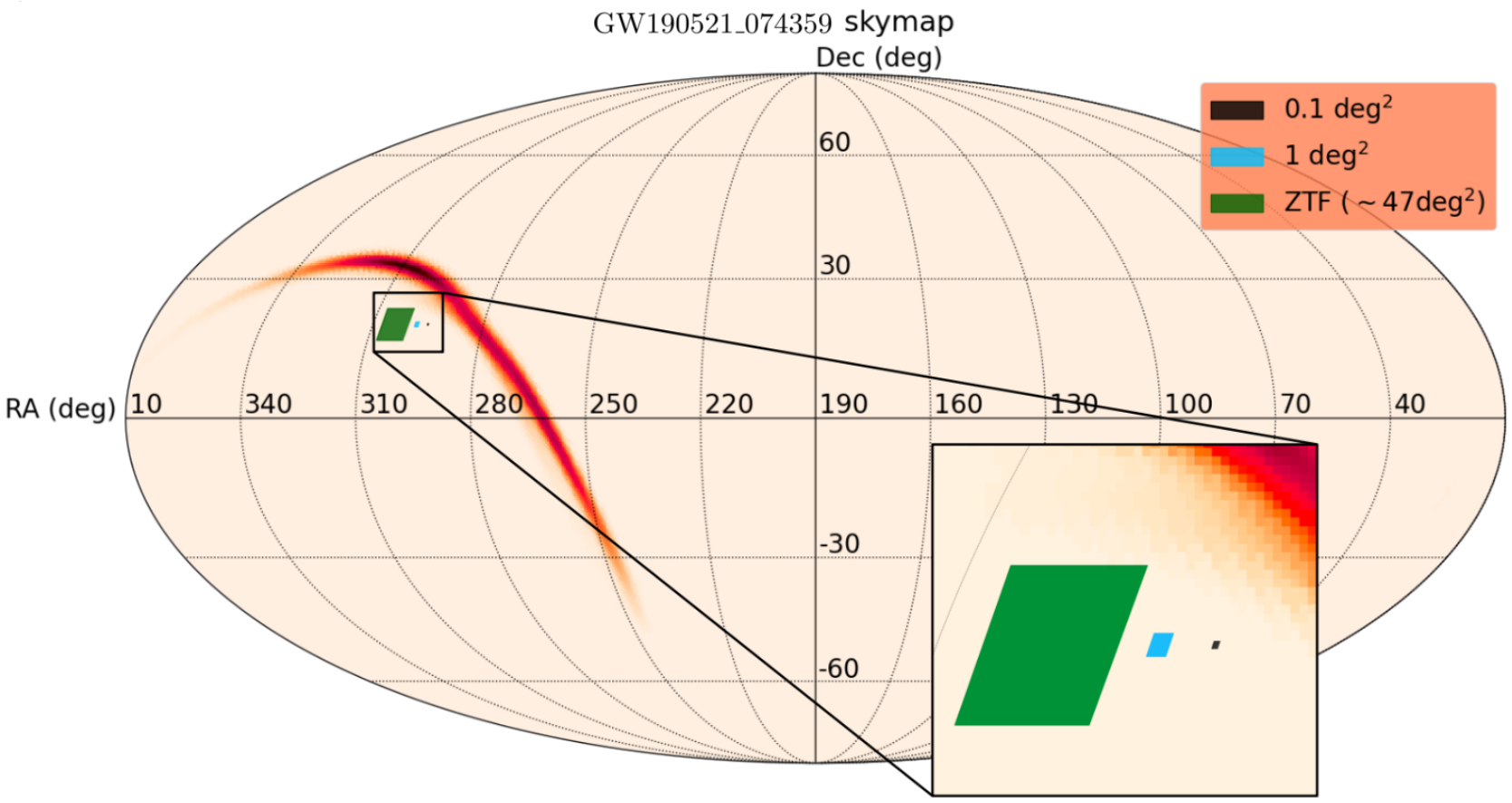
General objectives: multi-wavelength detection, highly sampled light curve, measure the redshift and spectral feature

Several difficulties:

- Large uncertainty on localisation

Large uncertainty on localisation

GW localisation from a few tens to more than 1000 square degrees $\sim 500\ \mathrm{deg}^2$



Key points of the gravitational waves follow-up challenge

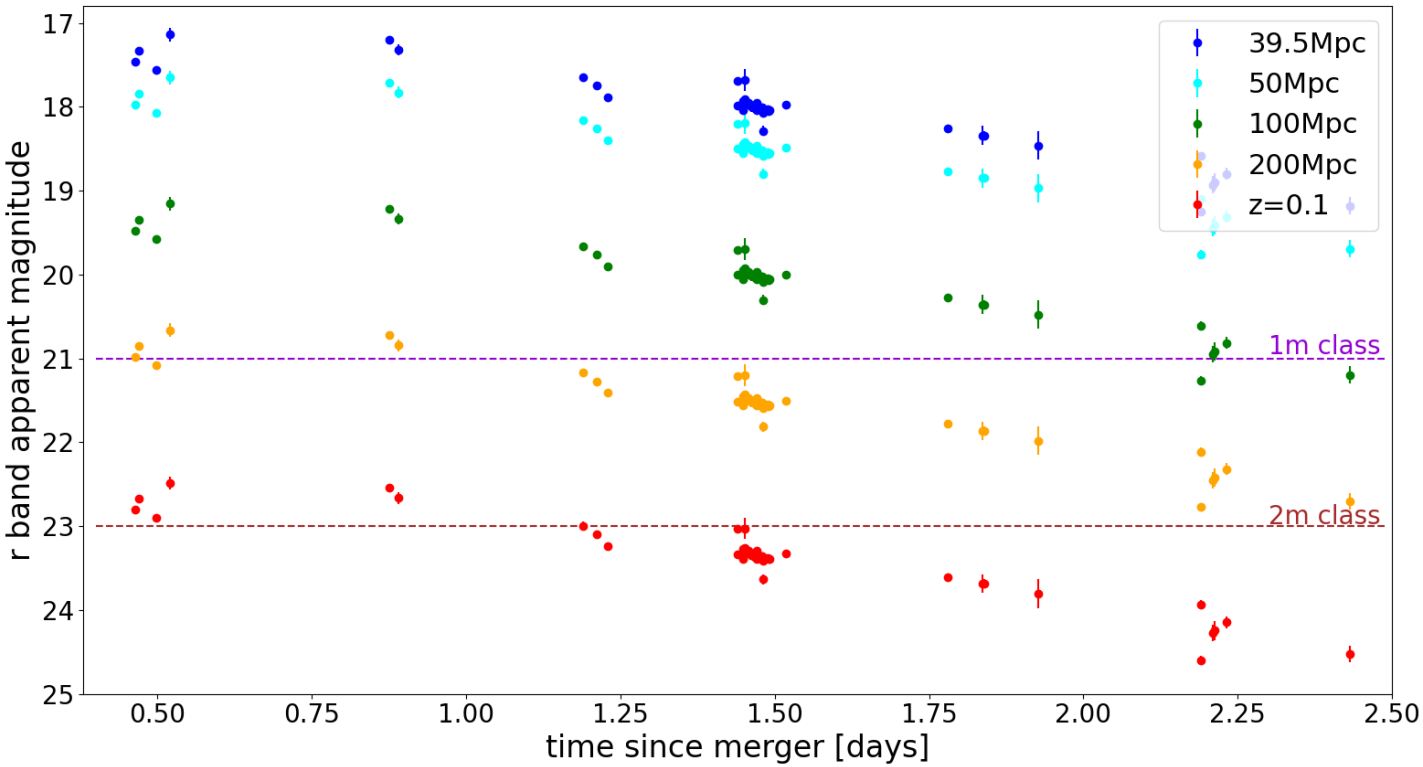
General objectives: multi-wavelength detection, highly sampled light curve, measure the redshift and spectral feature

Several difficulties:

- Large uncertainty on localisation $\Rightarrow$ Largest FoV possible
- Faint and fast decaying transient

Faint and fast decaying transient

kilonova emission: example of GW170817 kilonova, apparent magnitude peaked at ∼17 mag in r band



Key points of the gravitational waves follow-up challenge

General objectives: multi-wavelength detection, highly sampled light curve, measure the redshift and spectral feature

Several difficulties:

- Large uncertainty on localisation $\Rightarrow$ Largest FoV possible
- Faint and fast decaying transient $\Rightarrow$ Fast/deep observations
- Identification of candidates

Key points of the gravitational waves follow-up challenge

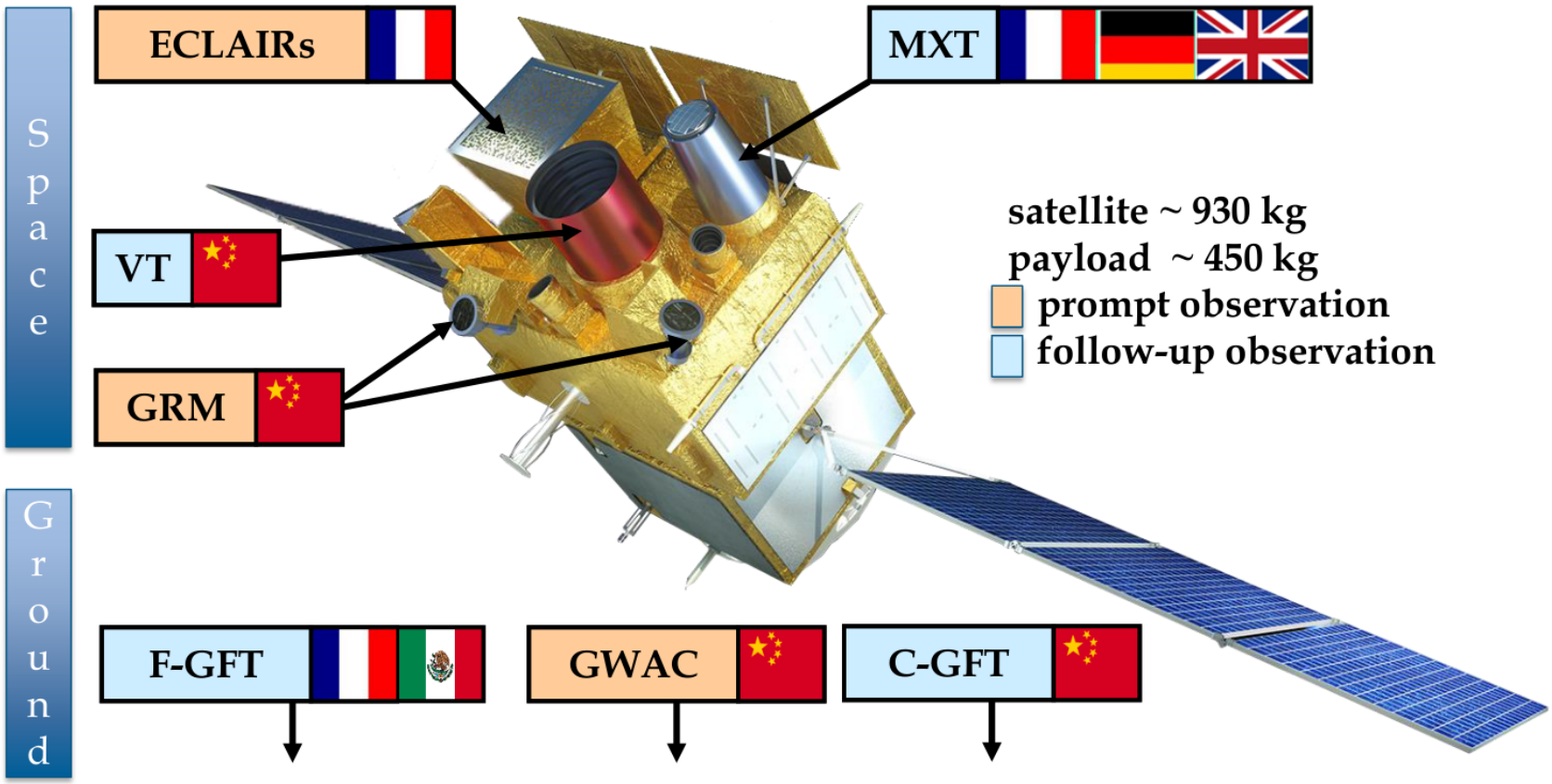
General objectives: multi-wavelength detection, highly sampled light curve, measure the redshift and spectral feature

Several difficulties:

- Large uncertainty on localisation $\Rightarrow$ Largest FoV possible
- Faint and fast decaying transient $\Rightarrow$ Fast/deep observations
- Identification of candidates $\Rightarrow$ Develop dedicated tools

SVOM

To be launched in early 2024

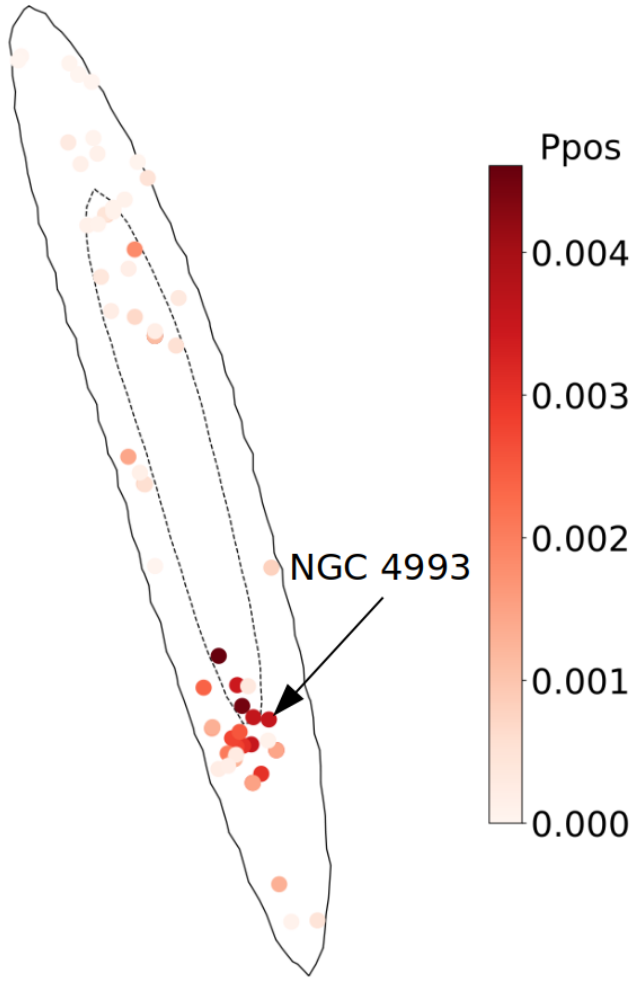


Multi-wavelength capabilities well adapted for the GW follow-up.

Recent development of the observation plan for SVOM :

General development:
(ducoin et al.,10.1093/mnras/staa114)

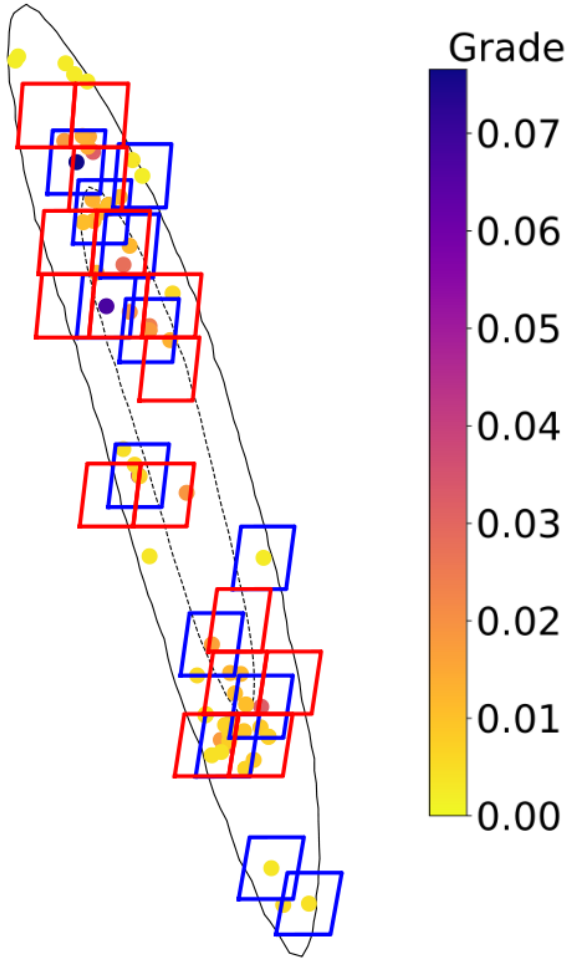
- Implementation of the galaxy targeting
- Construction of the MANGROVE catalog
- Use of the stellar mass of the galaxies



Recent development of the observation plan for SVOM :

Development for the spacecraft:
(ducoin et al.,10.48550/arXiv.2210.12120)

- galaxy targeting $>$ galaxy weighted tiling



Recent development of the observation plan for SVOM :

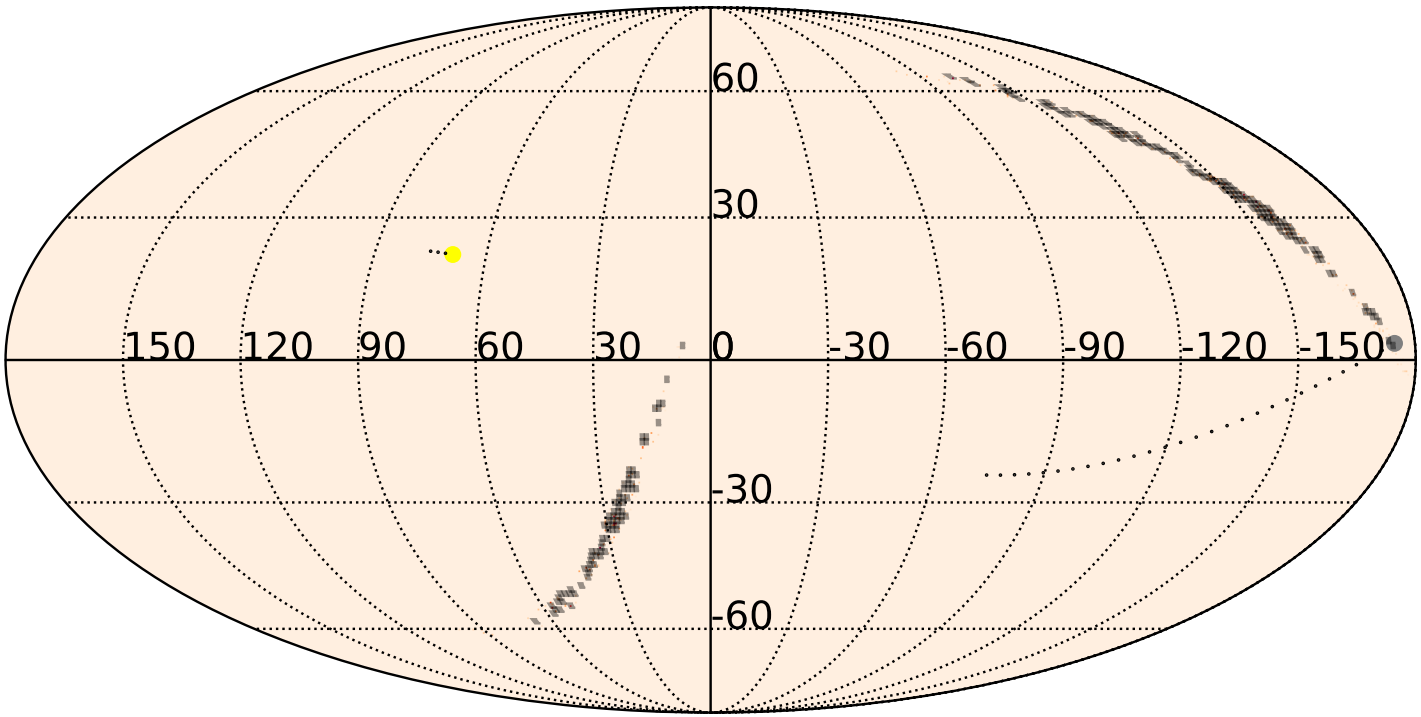
Development for the spacecraft:
(ducoin et al.,10.48550/arXiv.2210.12120)

- galaxy targeting $>$ galaxy weighted tiling
- Sun constraint

Recent development of the observation plan for SVOM :

Development for tl
(ducoin et al.,10.48

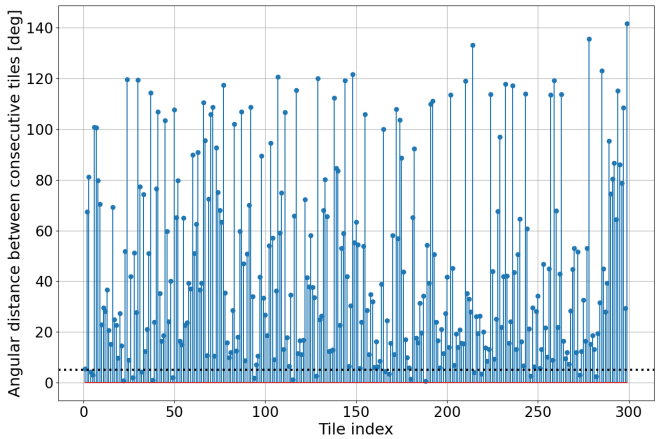
- galaxy targetin
- Sun constraint

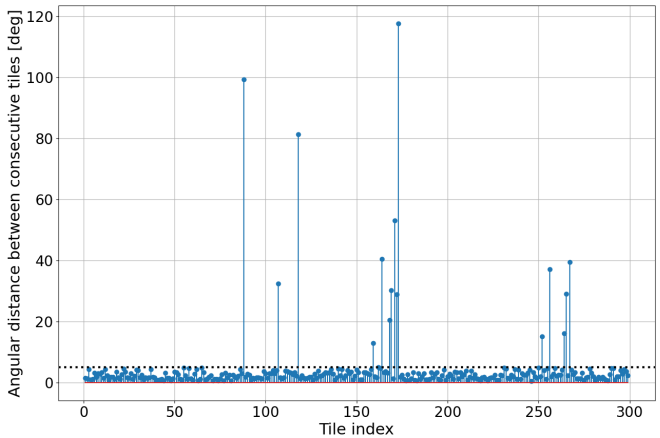


Recent development of the observation plan for SVOM :

Development for the spacecraft:
(ducoin et al.,10.48550/arXiv.2210.12120)

- galaxy targeting $>$ galaxy weighted tiling
- Sun constraint
- Slew constraint ($<$5 deg)

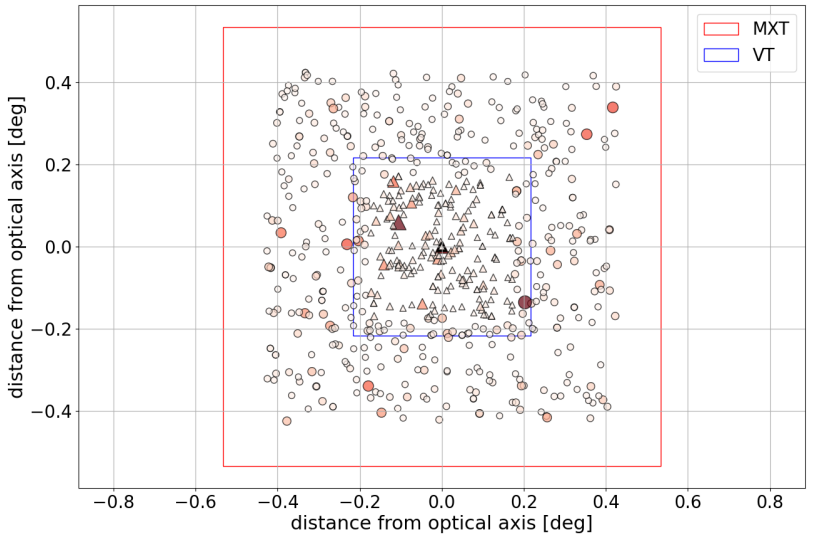




Recent development of the observation plan for SVOM :

Development for the spacecraft:
(ducoin et al.,10.48550/arXiv.2210.12120)

- galaxy targeting $>$ galaxy weighted tiling
- Sun constraint
- Slew constraint ($<$5 deg)
- VT observation



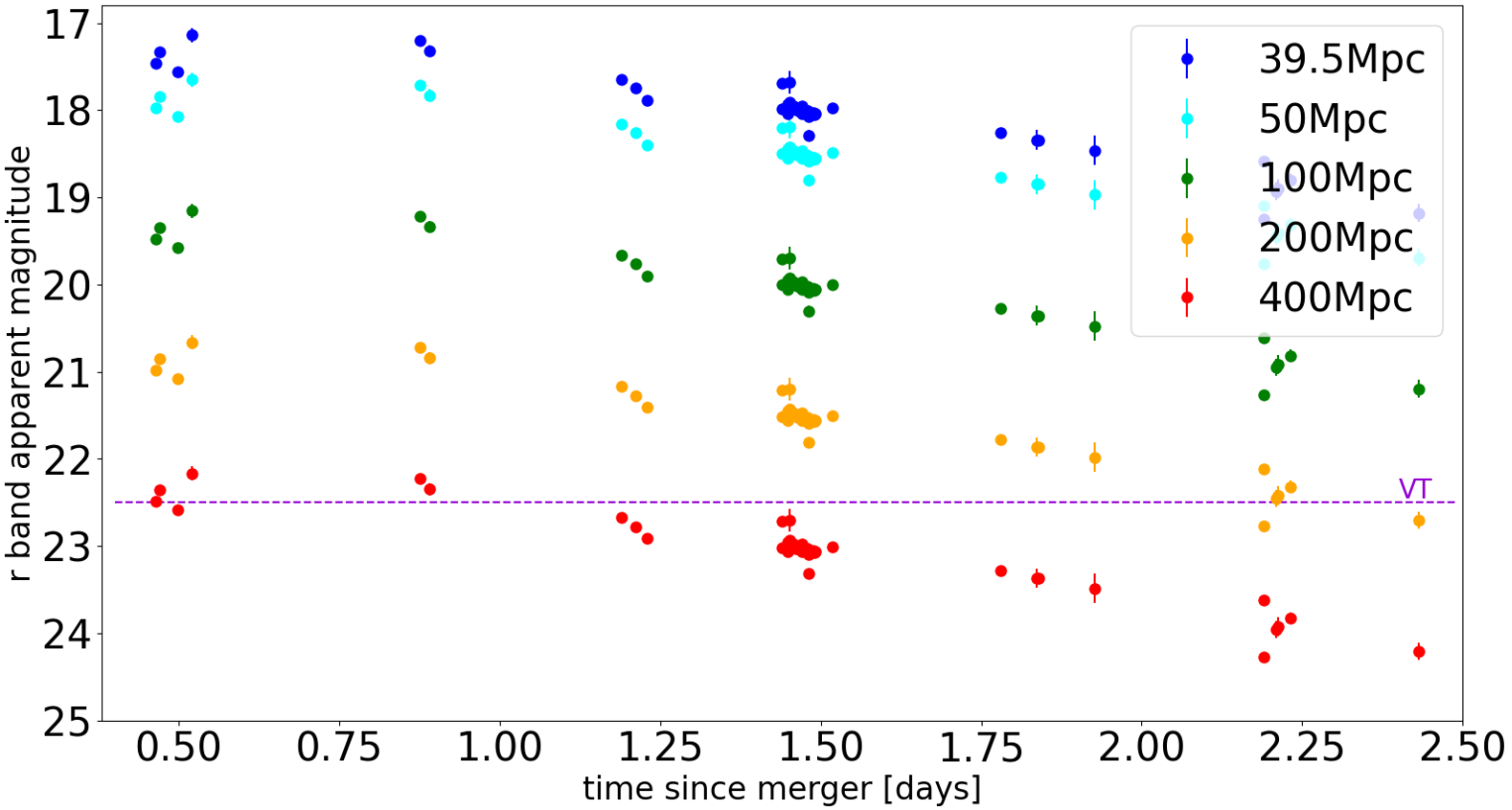
MERCI!

DALL·E : "A seal in space looking at a binary neutron star merger producing gravitational waves"

Very well adapted to the electromagnetic follow-up of gravitational wave events

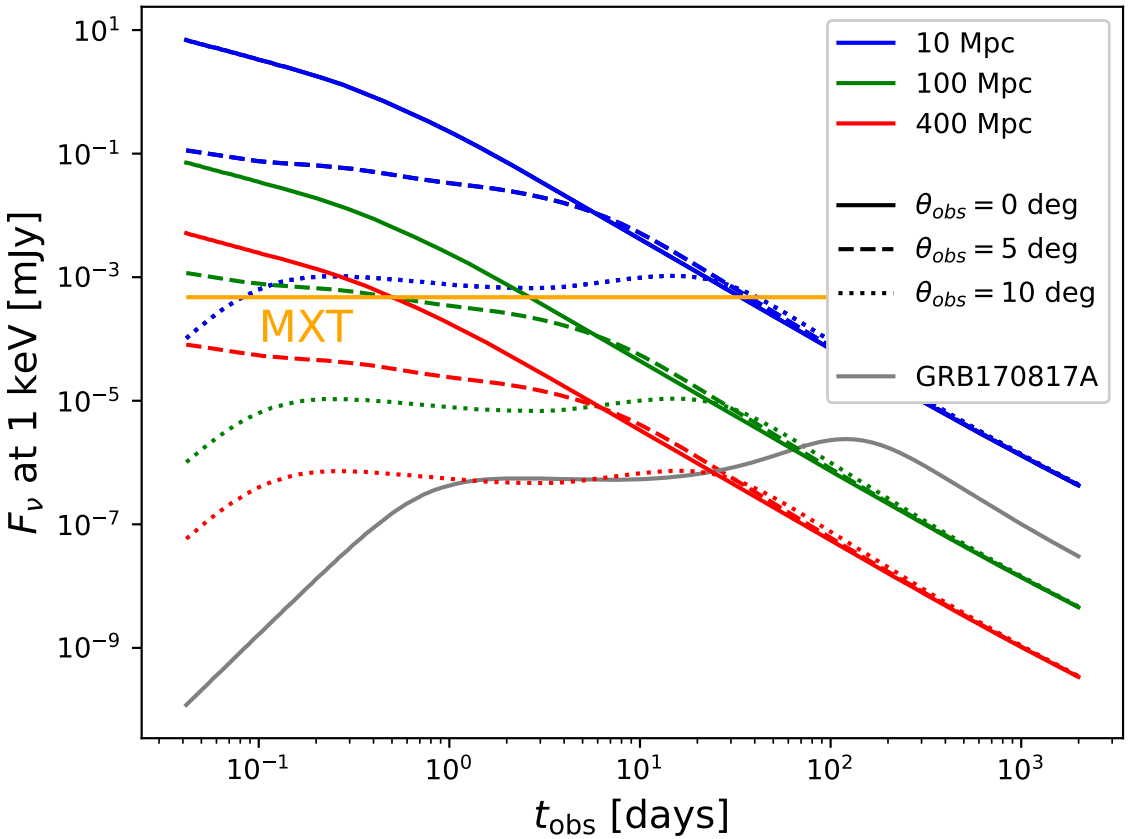
VT

Kilonova



Very well adapted to the electromagnetic follow-up of gravitational wave events

MXT
Afterglow



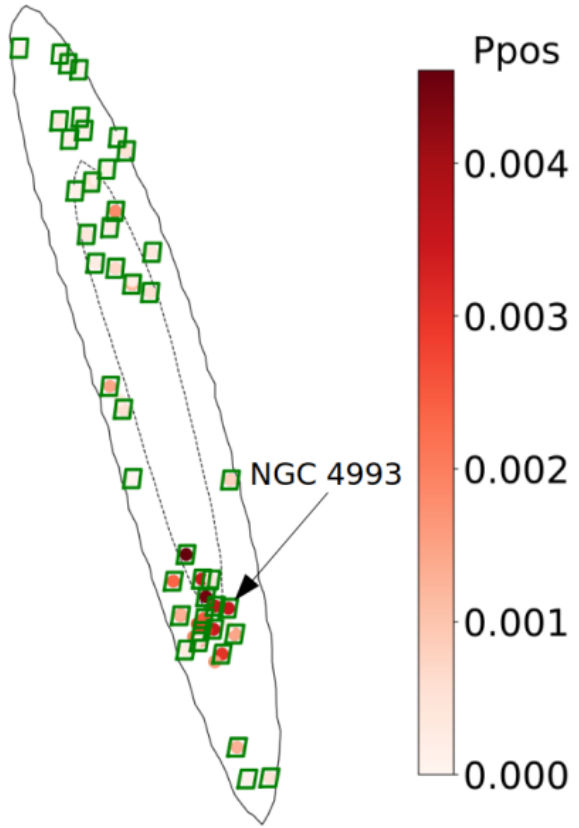
(ducoin et al.,10.1093/mnras/staa114)

General development for GW follow-up, mainly focusing on ground based observatories (GRANDMA, SVOM ground segment).

Main developments :

- Implementation of the galaxy targeting strategy (gwemopt)

$$P_{\rm pos} = P_{dV} = \frac{P_{\rm pixel}}{\text{Pixel area}} N_{\rm pixel}\, e^{-\frac{1}{2}\left(\frac{D_{\rm galaxy}-\mu_{\rm pixel}}{\sigma_{\rm pixel}}\right)^2}$$



(ducoin et al.,10.1093/mnras/staa114)

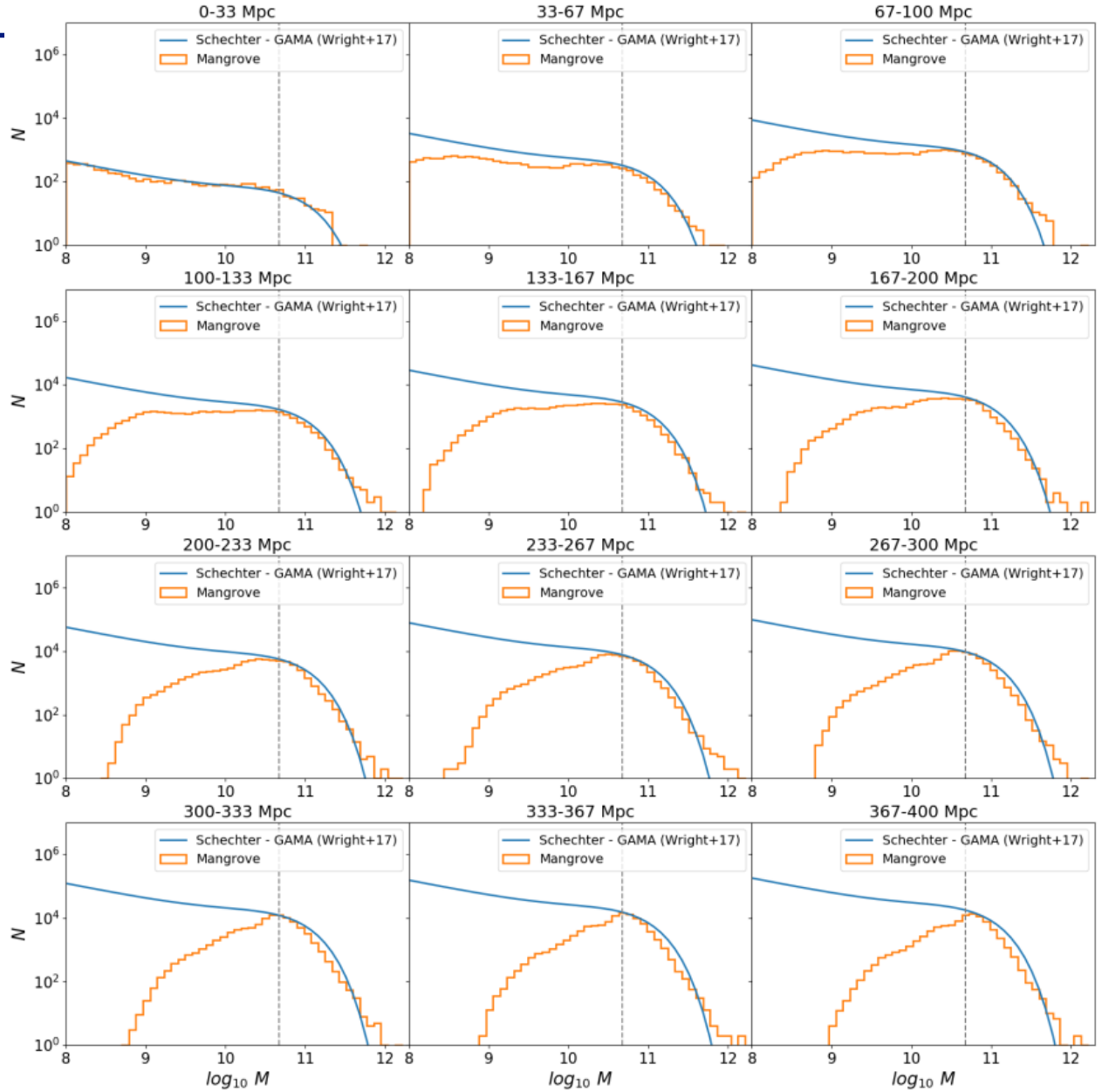
General development for GW follow-up, mainly focusing on ground based observatories (GRANDMA, SVOM ground segment).

Main developments :

- Implementation of the galaxy targeting strategy (gwemopt)
- Add the galaxies properties to the galaxy targeting (stellar mass)

$$G_{\mathrm{tot}} = P_{\mathrm{pos}} \left(1 + \alpha\beta G_{\mathrm{mass}}\right)$$

$$G_{\mathrm{mass}} = \frac{M_{*,\mathrm{galaxy}}}{\sum M_{*,\mathrm{galaxy}}}$$


0-33 Mpc
33-67 Mpc
67-100 Mpc
100-133 Mpc
133-167 Mpc
167-200 Mpc
200-233 Mpc
233-267 Mpc
267-300 Mpc
300-333 Mpc
333-367 Mpc
367-400 Mpc
Schechter - GAMA (Wright+17)
Mangrove
N
log10 M