Advanced GW detectors design sensitivity at the time of LSST

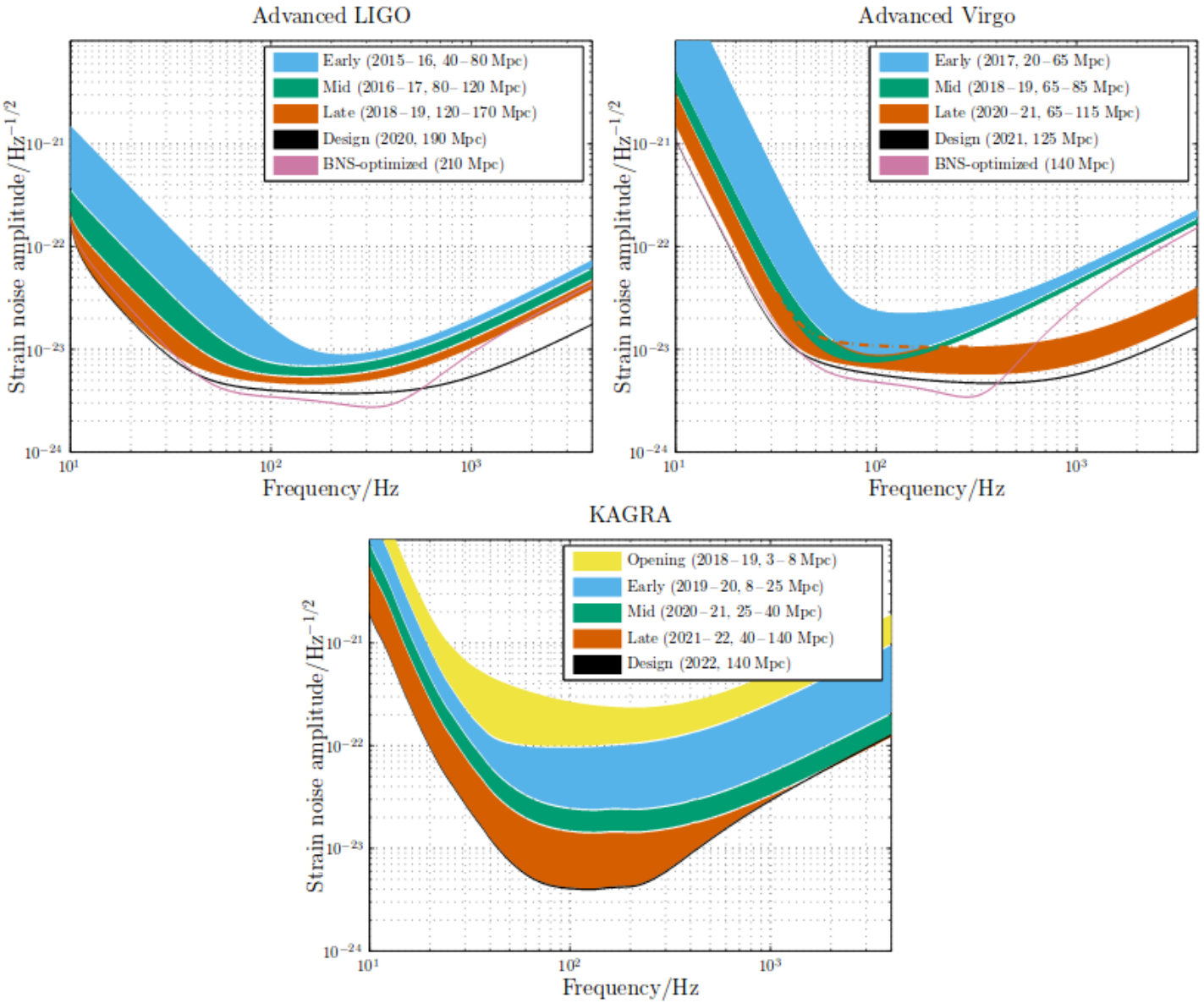
- Network :
  - ~2022 : 4 interferometers (2 LIGO, Virgo and KAGRA) at design.
  - ~2024 : a fifth one : LIGO India
- Sensitivity : likely an heterogen network. Maximal Binary Neutron Star range (horizon/2.6) : ~200 Mpc. > Gpc for Binary Black-Holes.

Table 1 Plausible target detector sensitivities. The different phases match those in Figure 1. We quote the range, the average distance to which a signal could be detected, for a $1.4M_{\odot}$+$1.4M_{\odot}$ binary neutron star (BNS) system and a $30M_{\odot}$+$30M_{\odot}$ binary black hole (BBH) system.

	LIGO		Virgo		KAGRA	
	BNS range/Mpc	BBH range/Mpc	BNS range/Mpc	BBH range/Mpc	BNS range/Mpc	BBH range/Mpc
Early	40 – 80	415 – 775	20 – 65	220 – 615	8 – 25	80 – 250
Mid	80 – 120	775 – 1110	65 – 85	615 – 790	25 – 40	250 – 405
Late	120 – 170	1110 – 1490	65 – 115	610 – 1030	40 – 140	405 – 1270
Design	190	1640	125	1130	140	1270

« Prospects for Observing and Localizing Gravitational-WaveTransients with Advanced LIGO, Advanced Virgo andKAGRA« Abbott, et al [gr-qc/1304.0670]

LIGO Virgo and KAGRA sensitivity evolution



GW network detectors observing strategy

- Follow-up mode :
  - The network will follow-up all LSST triggers associated to a potential source of GWs : Core collapse supernova (CCSN), GRB, magnetars, Soft Gamma Ray bursts, kilonova, … (Delta T0 < 1 jour)
  - 4/5 interferometers network : full sky almost covered at any time.
  - The GW detectors horizon for each of these sources will be very different :
    - BNS range : 200 Mpc
    - CCSN range : ~10 kpc (standard model of emission) → 20 Mpc (exotic models)
    - Magnetars : ~100 kpc
  - Sub-threshold analyzes (already performed with Fermi-GBM triggers).
- Alerts mode :
  - LIGO-Virgo will generate Open Public Alerts (will start during O3 in 2019)
  - OPA rate ? Not yet defined for O3.
  - OPA content ? Not yet defined for O3.
  - OPA media : Galactic Circular Network likely for O3 (email, téléphone…)

Advanced GW detectors sky localization performance

- Can use the BNS case as a proxy.
- Key factor : the number of interferometers and their localization in the network :
  - Median 90 % credible region : 9-12 deg² with 5 ifos (2024)

					4 ifos	5 ifos
Epoch		2015–2016	2016–2017	2018–2019	2020+	2024+
Planned run duration		4 months	9 months	12 months	(per year)	(per year)
Expected burst range/Mpc	LIGO	40–60	60–75	75–90	105	105
	Virgo	—	20–40	40–50	40–70	80
	KAGRA	—	—	—	—	100
Expected BNS range/Mpc	LIGO	40–80	80–120	120–170	190	190
	Virgo	—	20–65	65–85	65–115	125
	KAGRA	—	—	—	—	140
Achieved BNS range/Mpc	LIGO	60–80	60–100	—	—	—
	Virgo	—	25–30	—	—	—
	KAGRA	—	—	—	—	—
Estimated BNS detections		0.05–1	0.2–4.5	1–50	4–80	11–180
Actual BNS detections		0	1	—	—	—
90% CR	% within 5 deg²	< 1	1–5	1–4	3–7	23–30
	% within 20 deg²	< 1	7–14	12–21	14–22	65–73
	median/deg²	460–530	230–320	120–180	110–180	9–12

Factor 10 of improvement with 5 ifos (LIGO-India)

Joint observation

- GW detectors interested by source identification information
  Ex : type Ib/Ic supernova t_zero and prompt light curve
- GW triggers information ; we provide :
  - If binary system, probability the source contains a neutron star or not
  - Sky map : 90 % CR can still be large at the time of LSST (100 deg²). Can also be lower than 10deg². Case by case TO decision depending on GW source localization accuracy ?
    - more details very soon in gr-qc/1304.0670:v2
    - will be important to have discussions before LSST starts