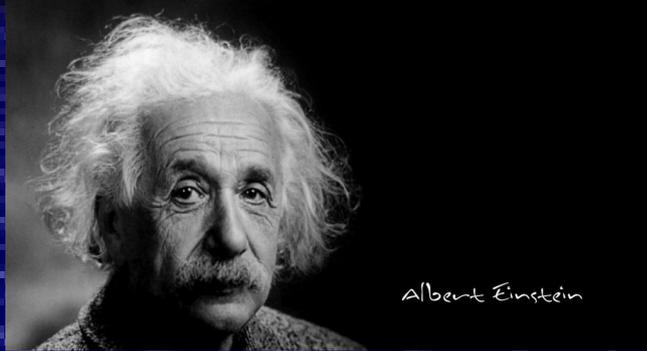


Gravitational Wave Detection

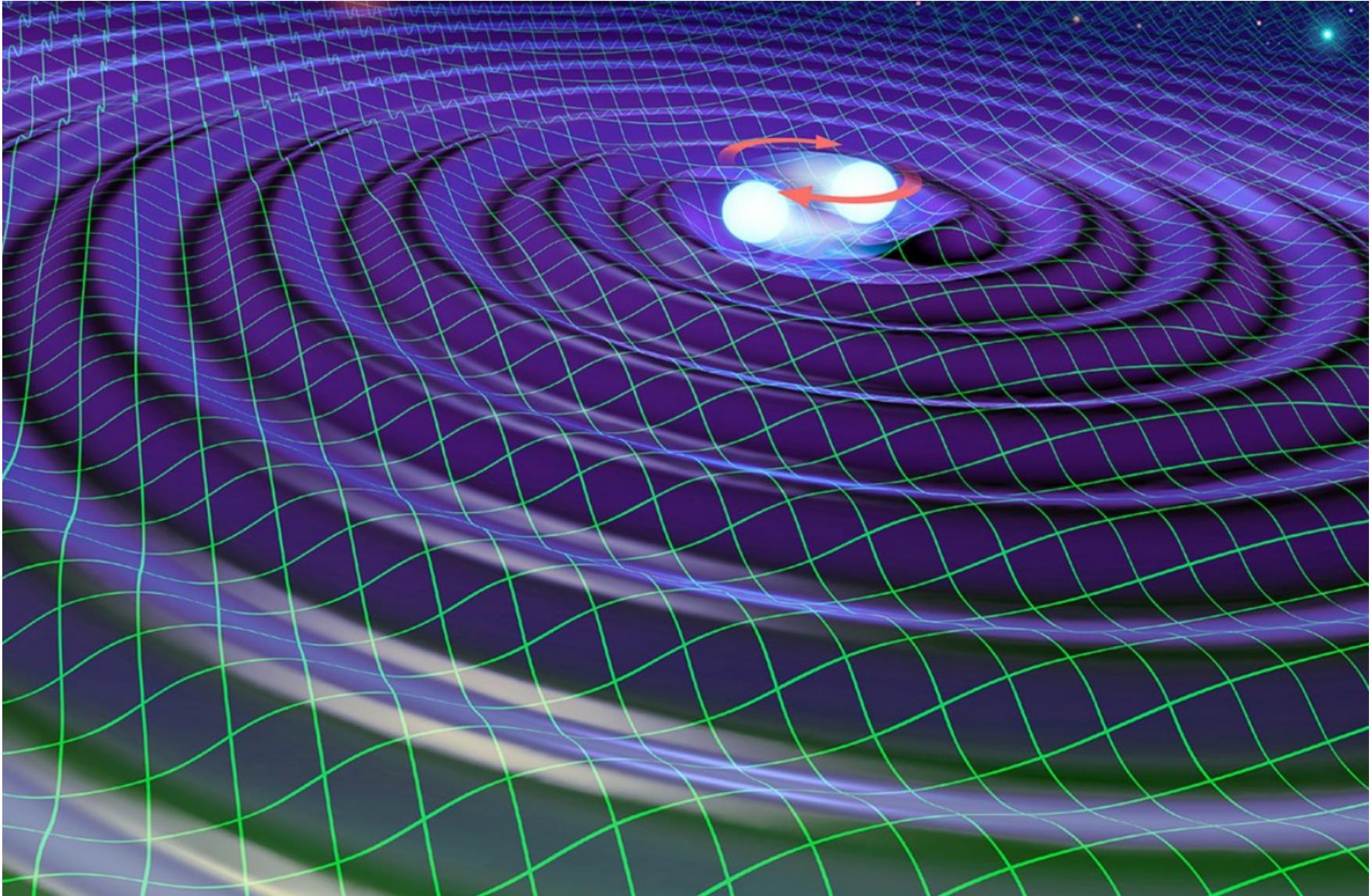
Kazuhiro Hayama
(KAGRA observatory, ICRR, U Tokyo)

General Relativity



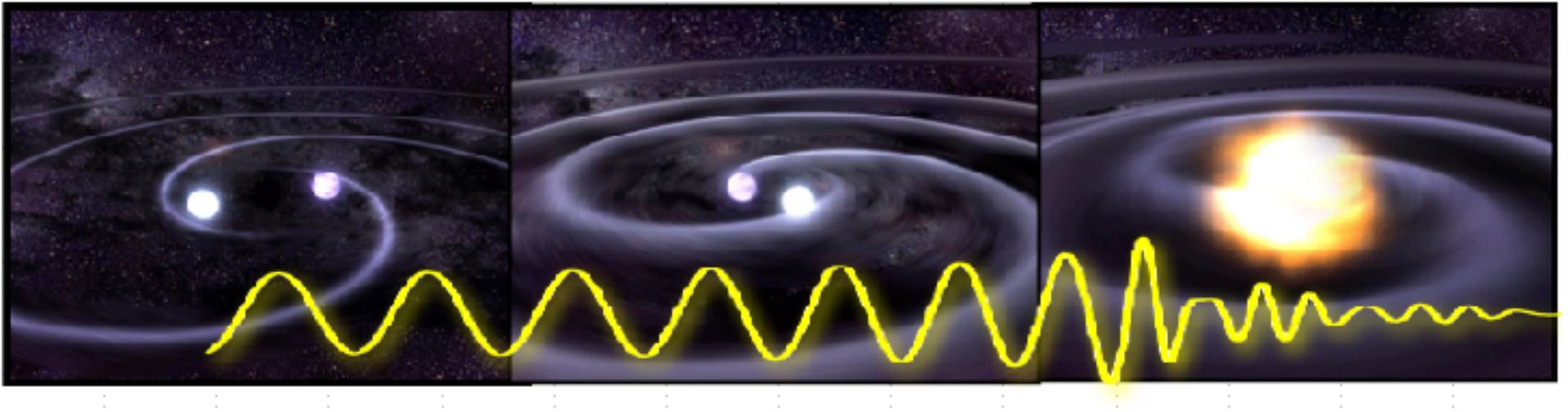
$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = \kappa T_{\mu\nu}$$

Gravitational wave : ripple of space-time



Binary NS-NS merger

- NS-NS merger in the Virgo cluster has $h \sim 1E-21$ near the earth



LIGO

Hanford



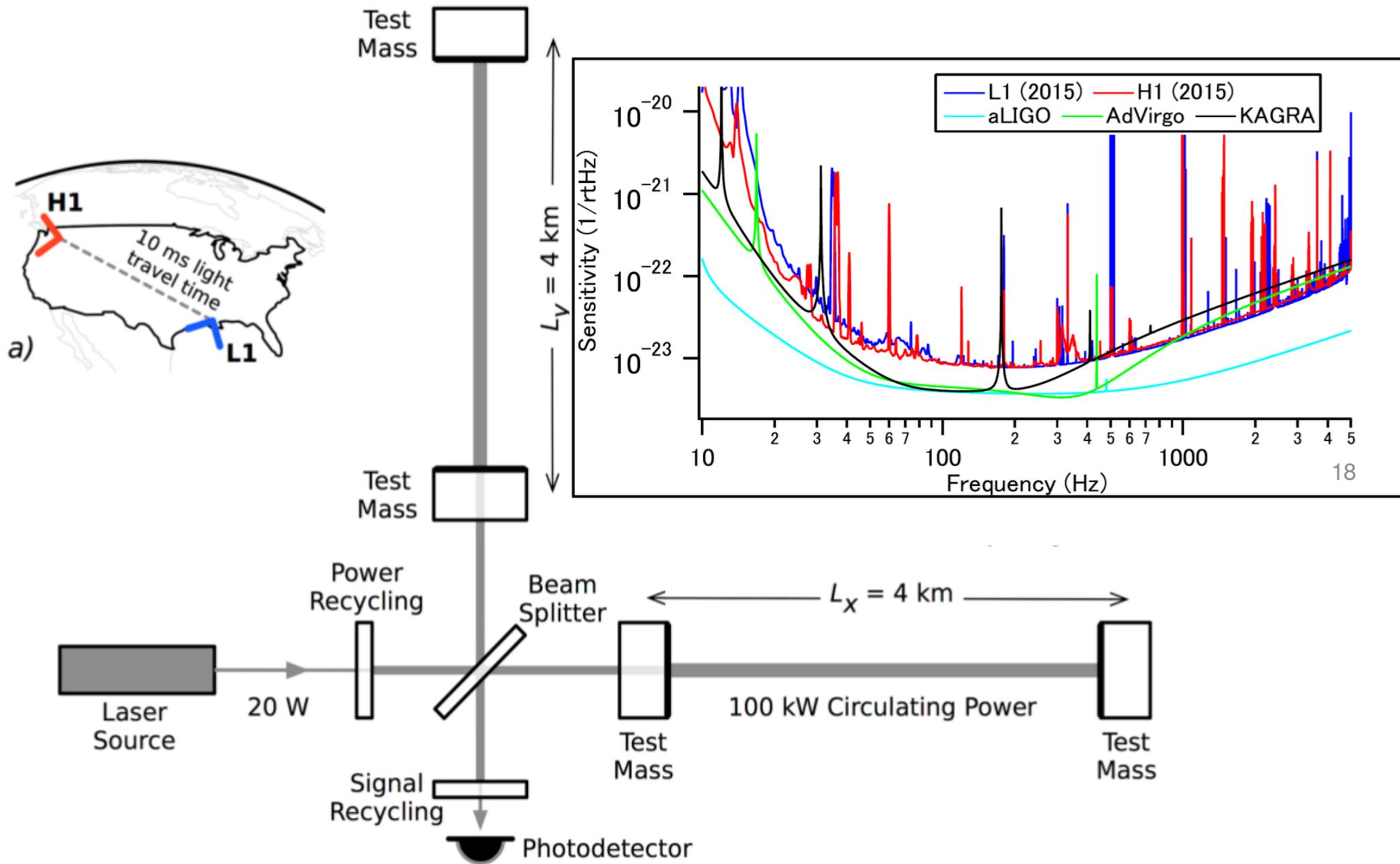
Livingston



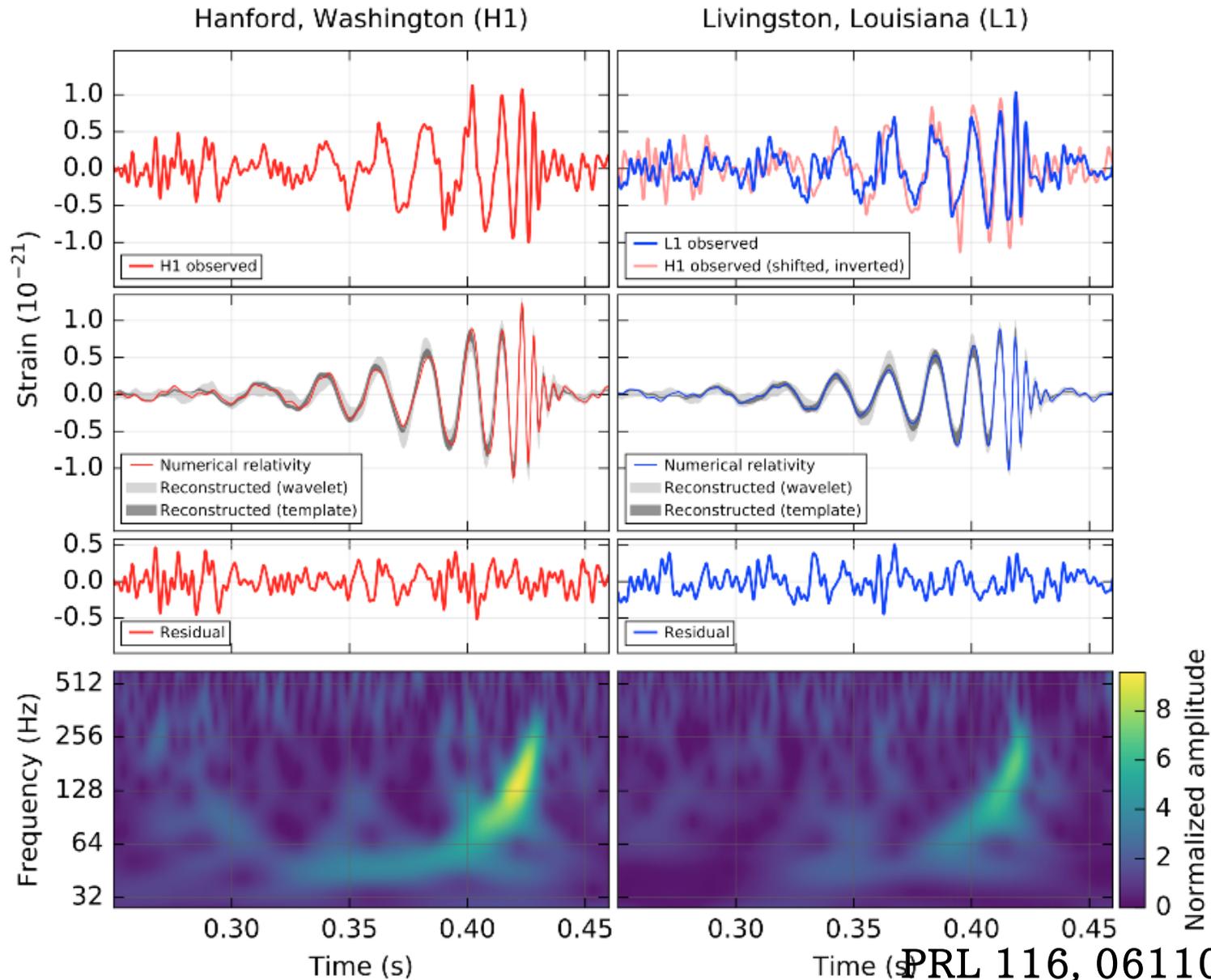
LIGO Scientific collaboration:

~1000 scientists, ~90 Institutions, 15 countries

Observation in 2015-2016



GW150914



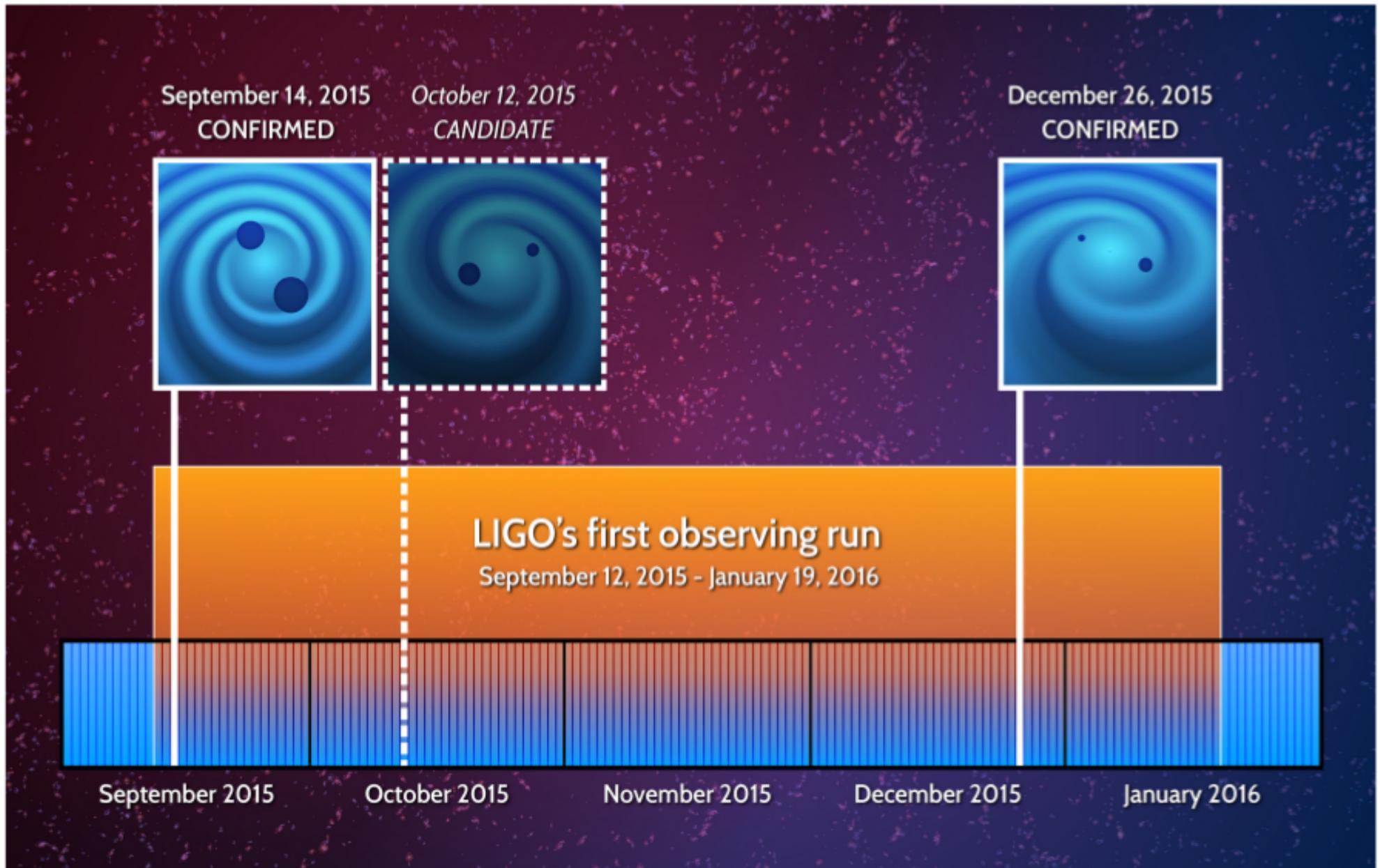
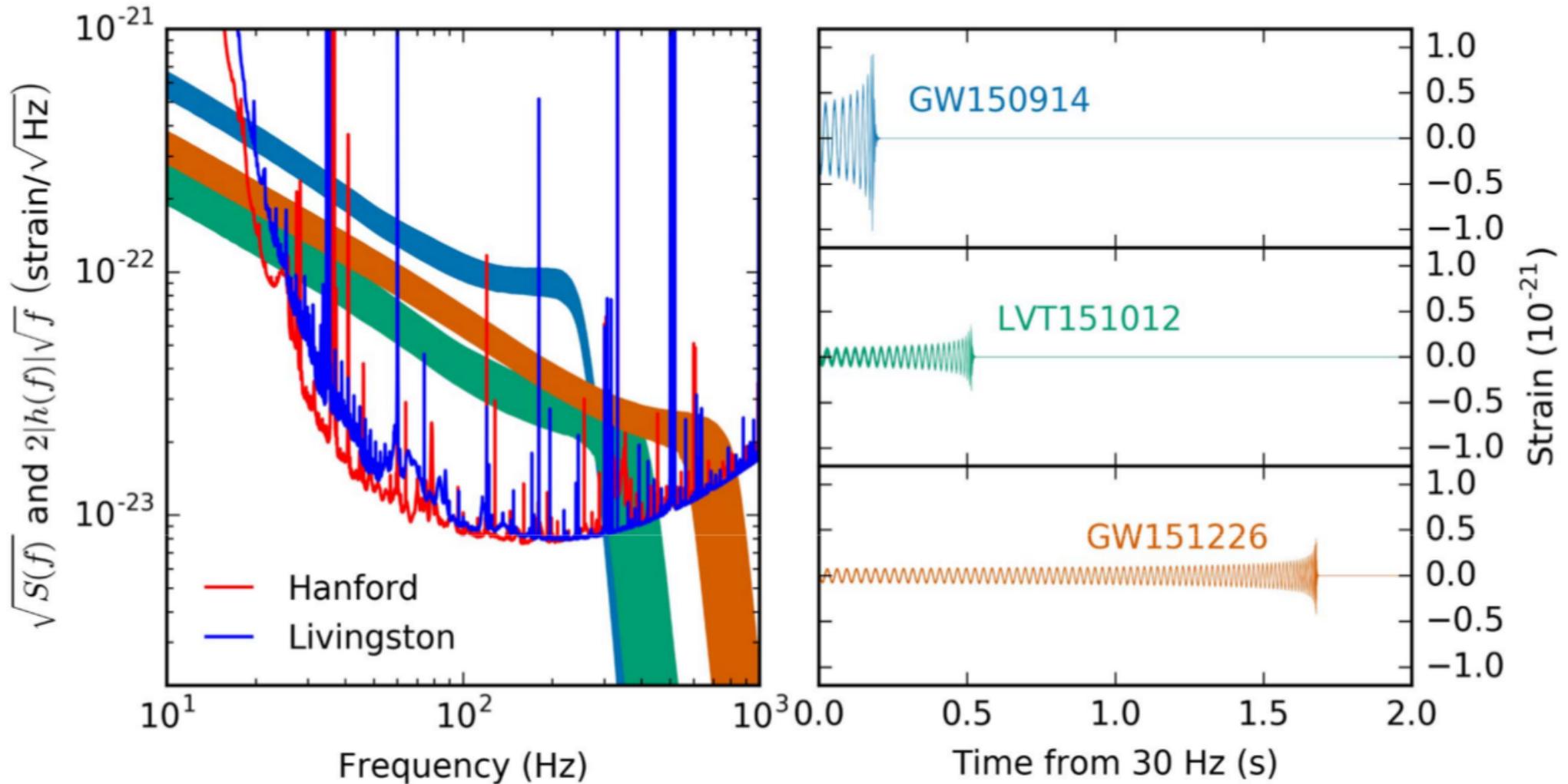
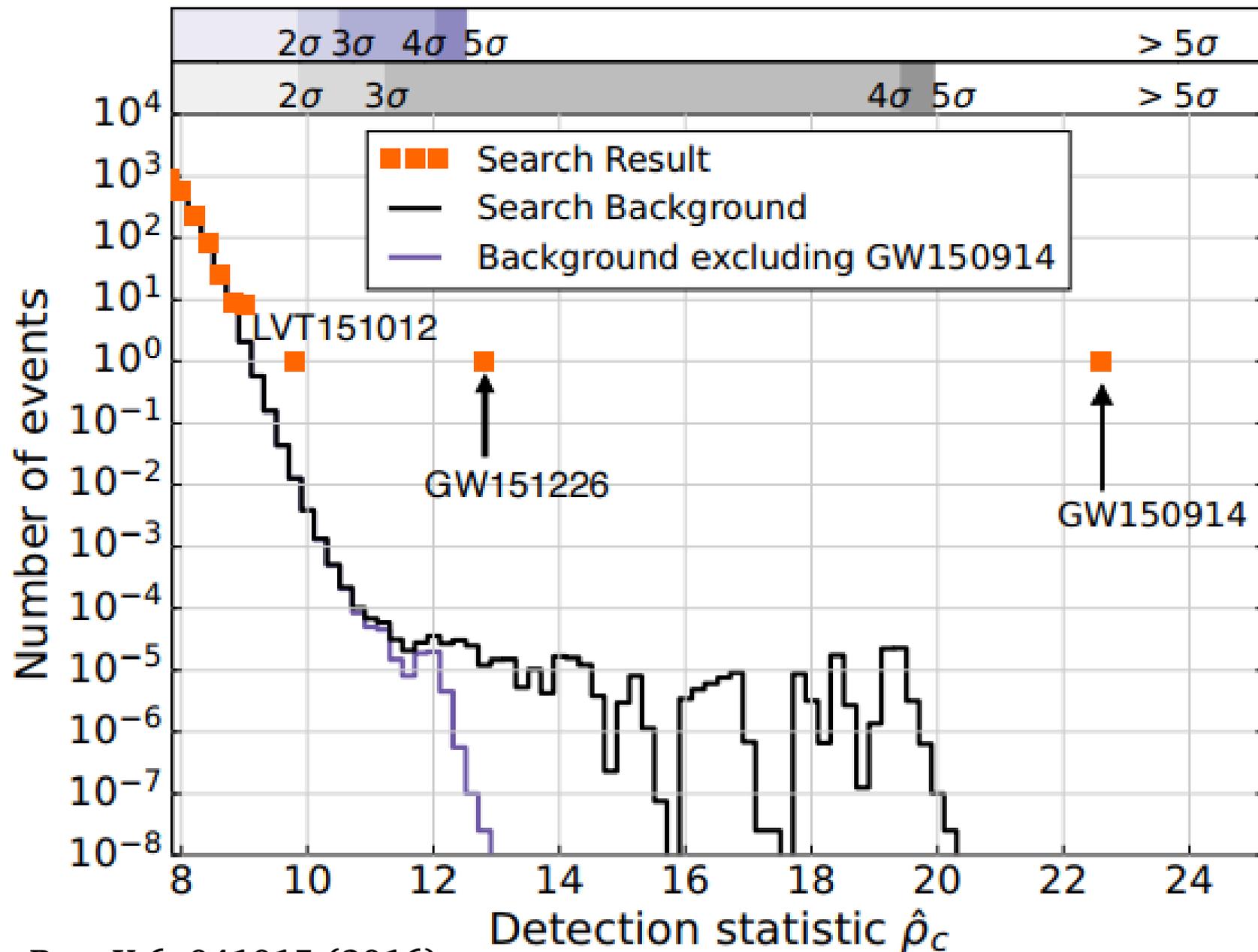


Image credit: LIGO

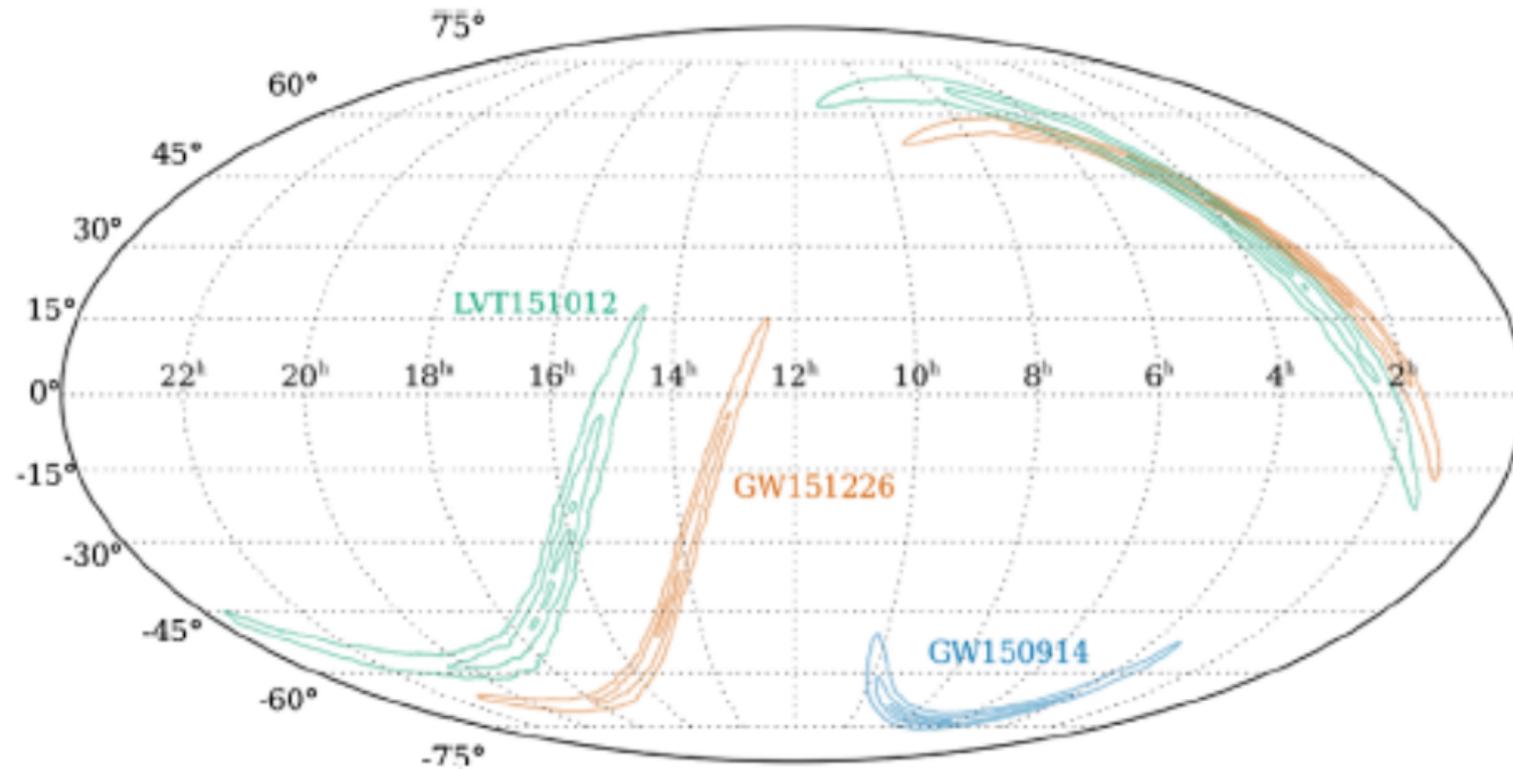
Spectrum of the events



Significance of the events



Localization

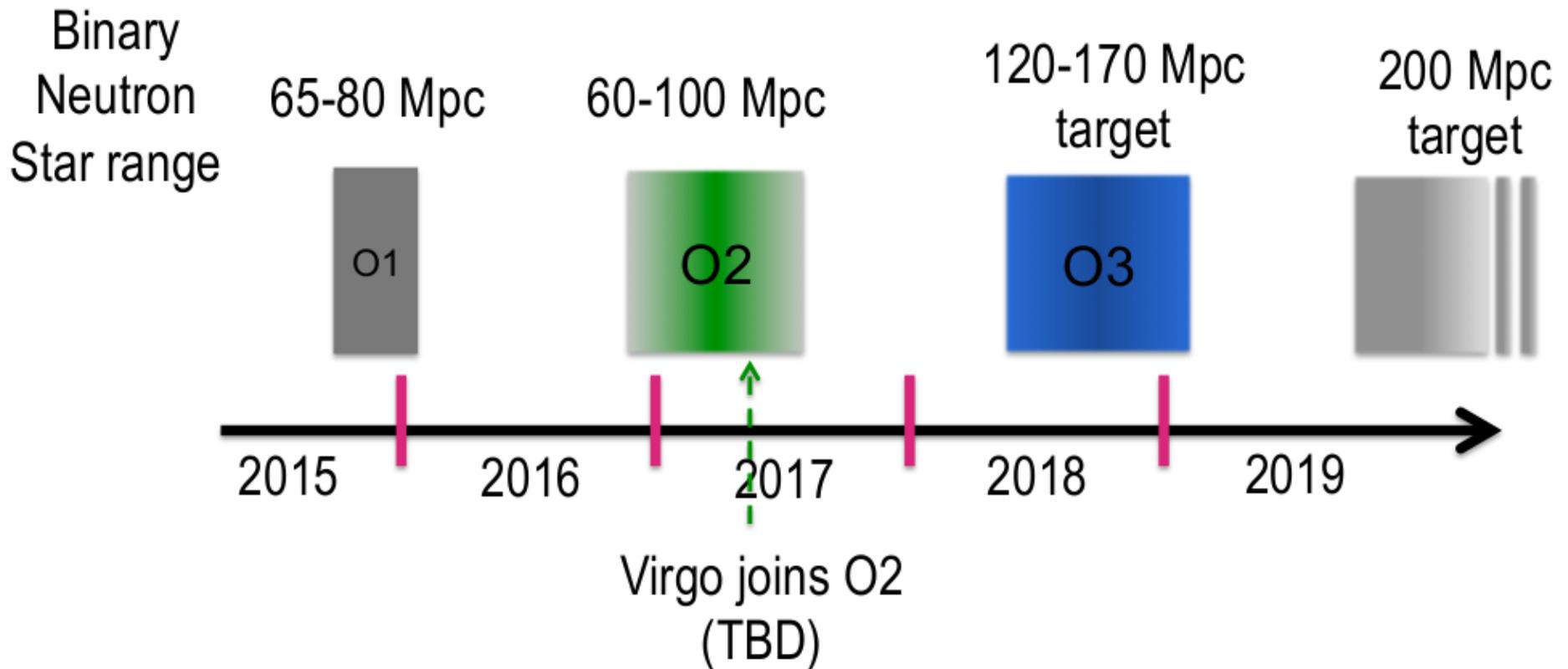


For GW150914

Error of position reconstruction $\sim 590 \text{ deg}^2$

Observing run timeline

(plans still under development within the LIGO and Virgo Collaborations)



G.Gonzalez (KIW3, 2017)

- **First detection has been made by LIGO in near future (2020s) event rate will be $\sim 1/\text{day}$**
- **Can perform statistical studies to understand steller evolution using GWs**
- **Detection of NS-BH, NS-NS mergers**
- **Test of gravity theory in strong G foelds**
- **Identification of GW sources with corporation of astronomical telescopes**
- **Detection of other type of GW sources s.t. Core collapse Supernovae, Pulser, ...**
- **Observing GWs with global network of GW telescopes, (Virgo, KAGRA, LIGO India, ...)**

KAGRA project

- 3km cryogenic interferometric gravitational wave telescope to observe gravitational wave.

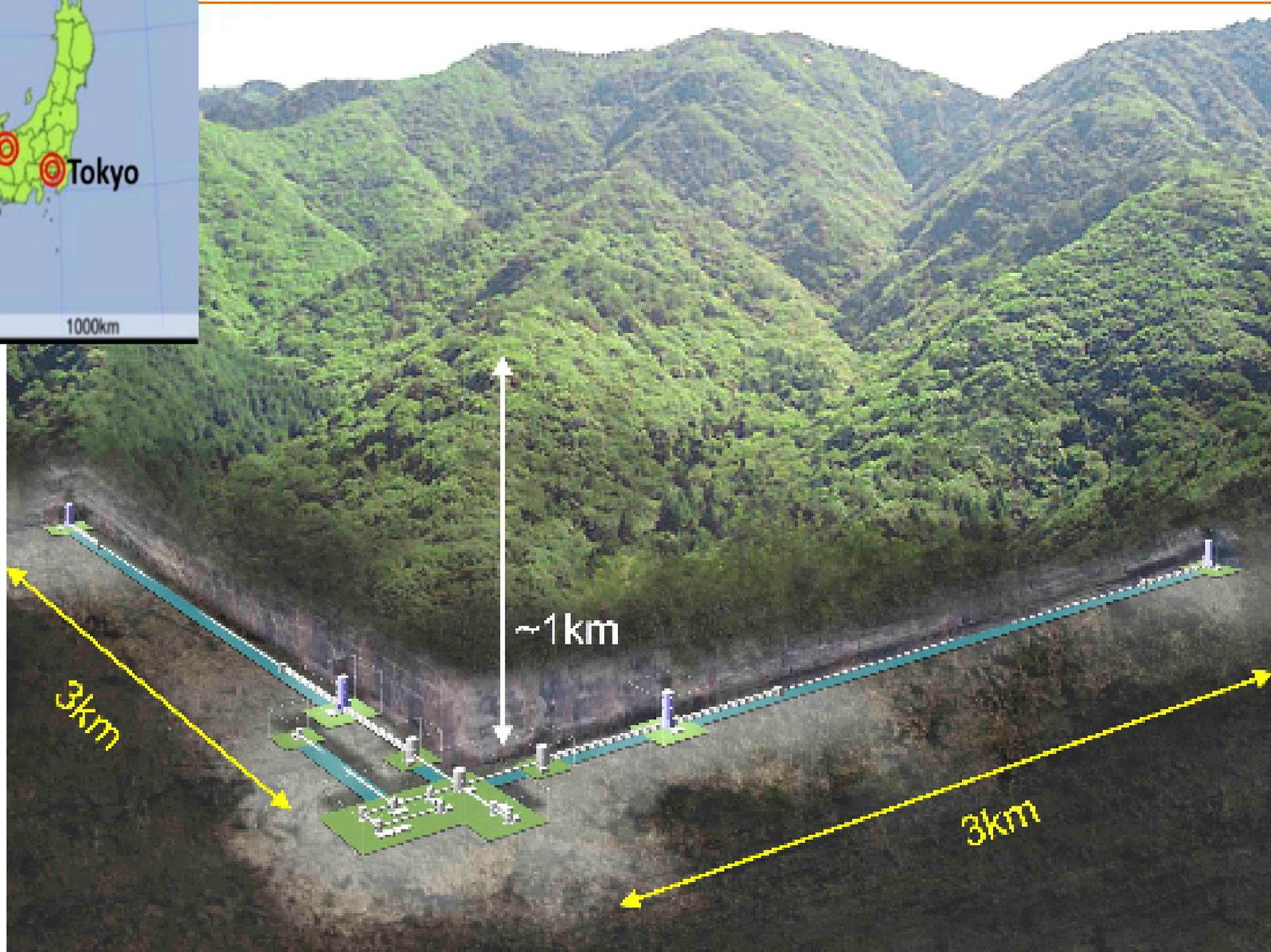


Caltech

+more...

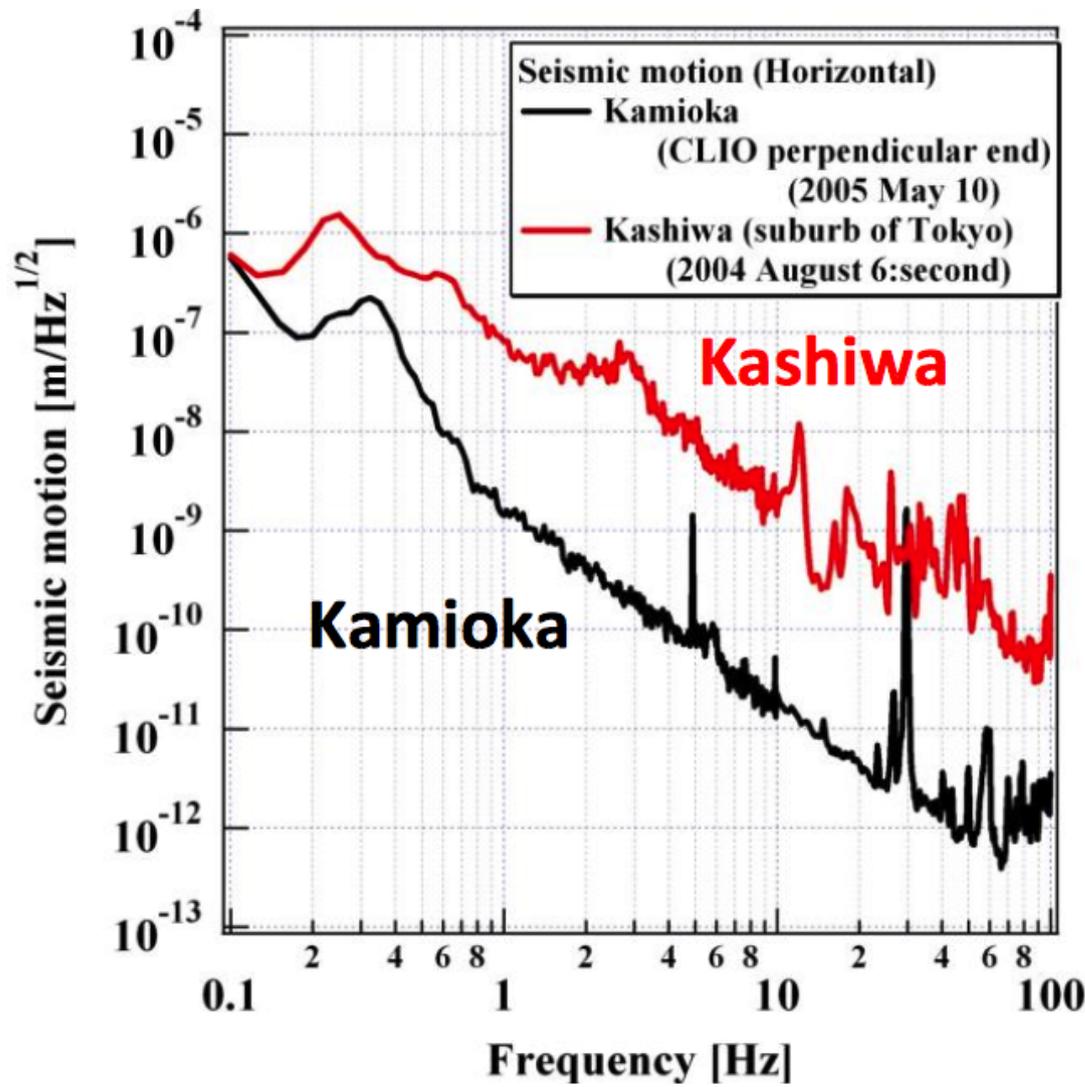
collaborators > 300, Institutes, universities >30 in Japan, >40 in Foreign

KAGRA project



KAGRA project

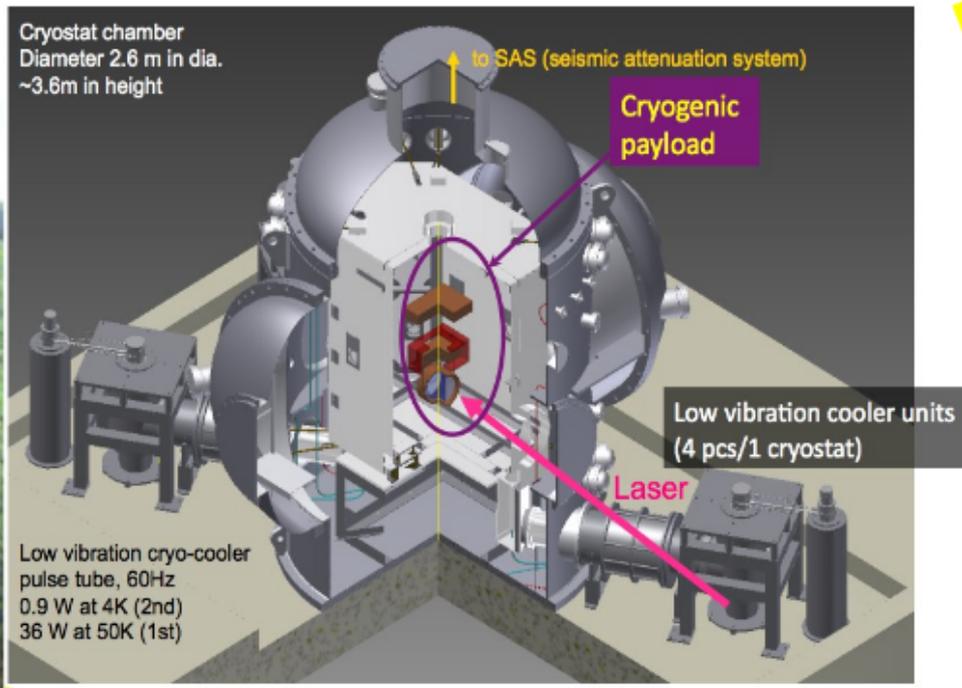
Feature 1:
underground for reduction of
seismic activities



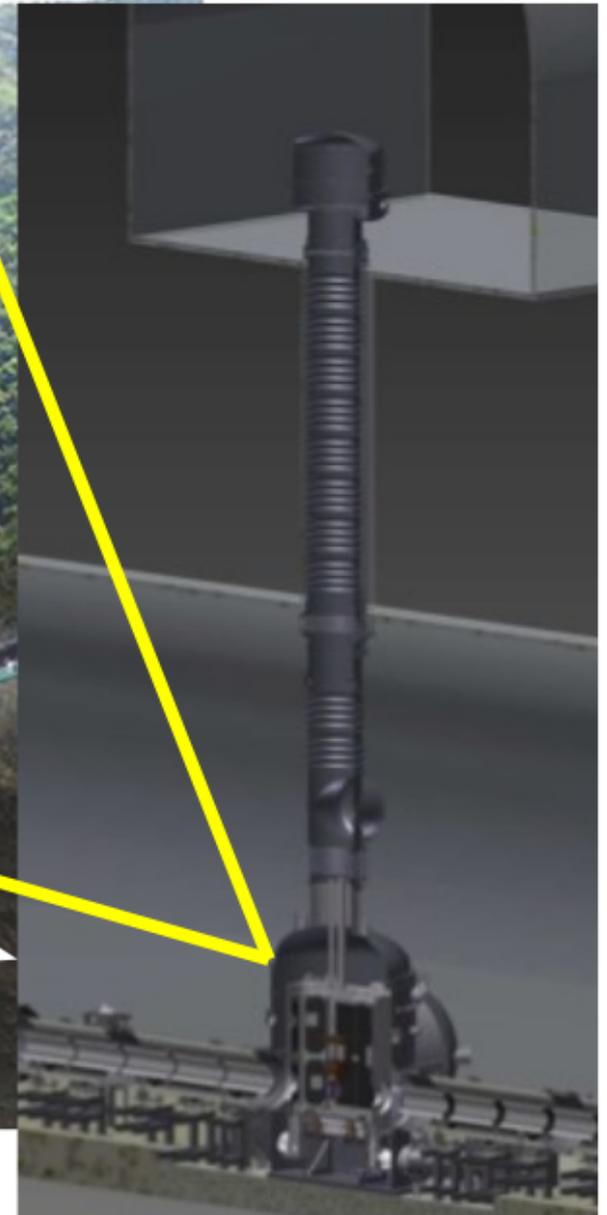
3km

3km

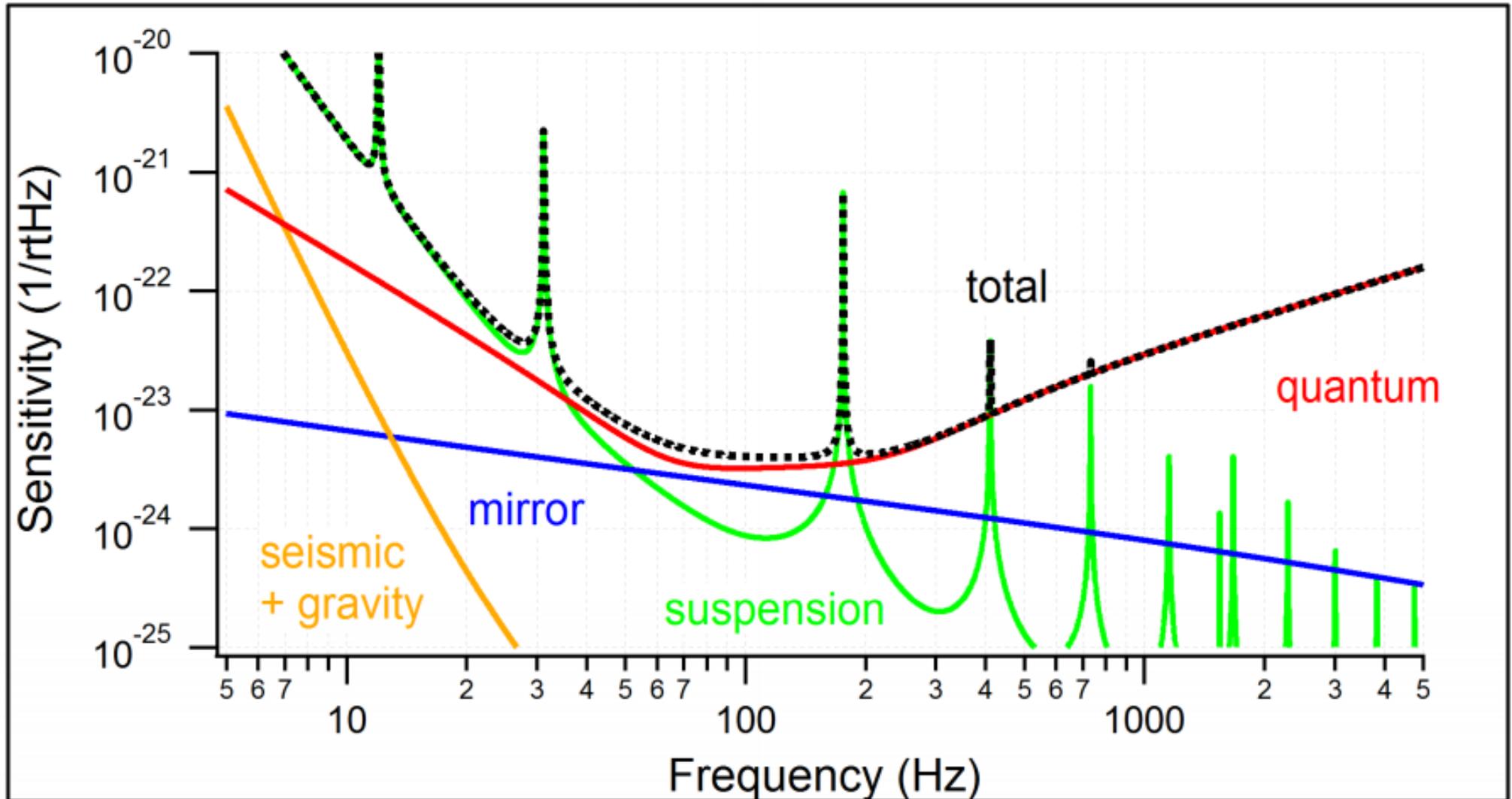
KAGRA project



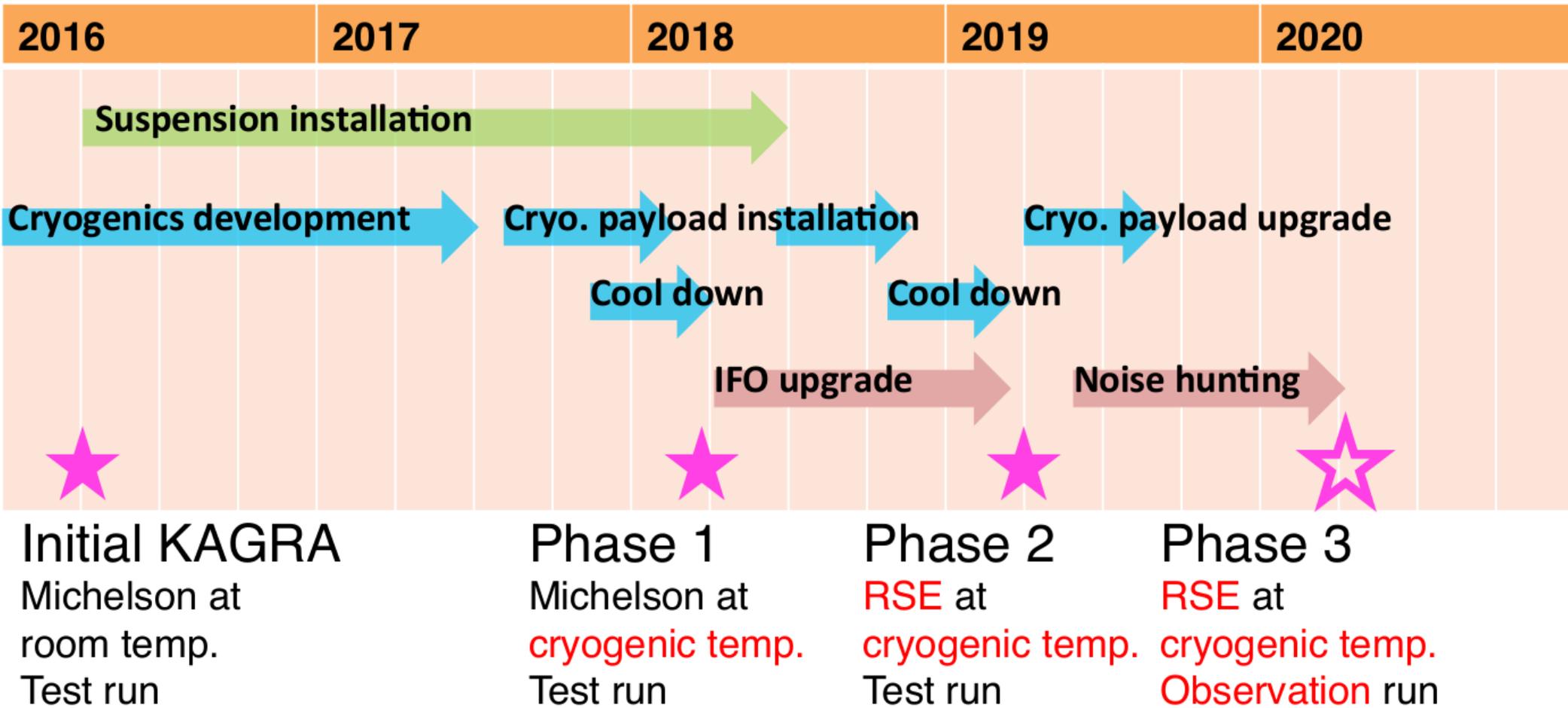
Feature2:
20K cryogenic sapphire mirror
and 14m high suspension



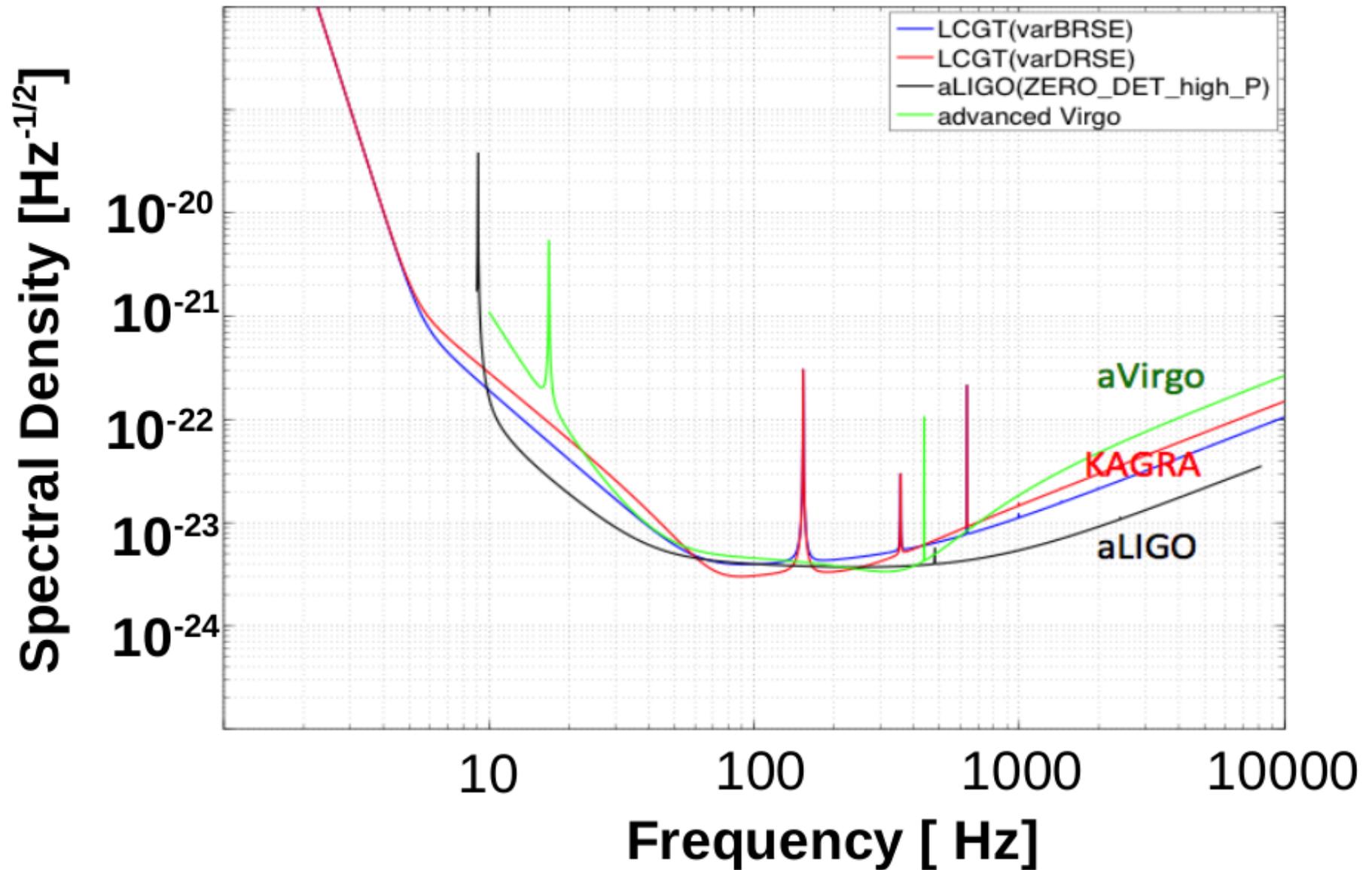
KAGRA design sensitivity to get in early 2020s



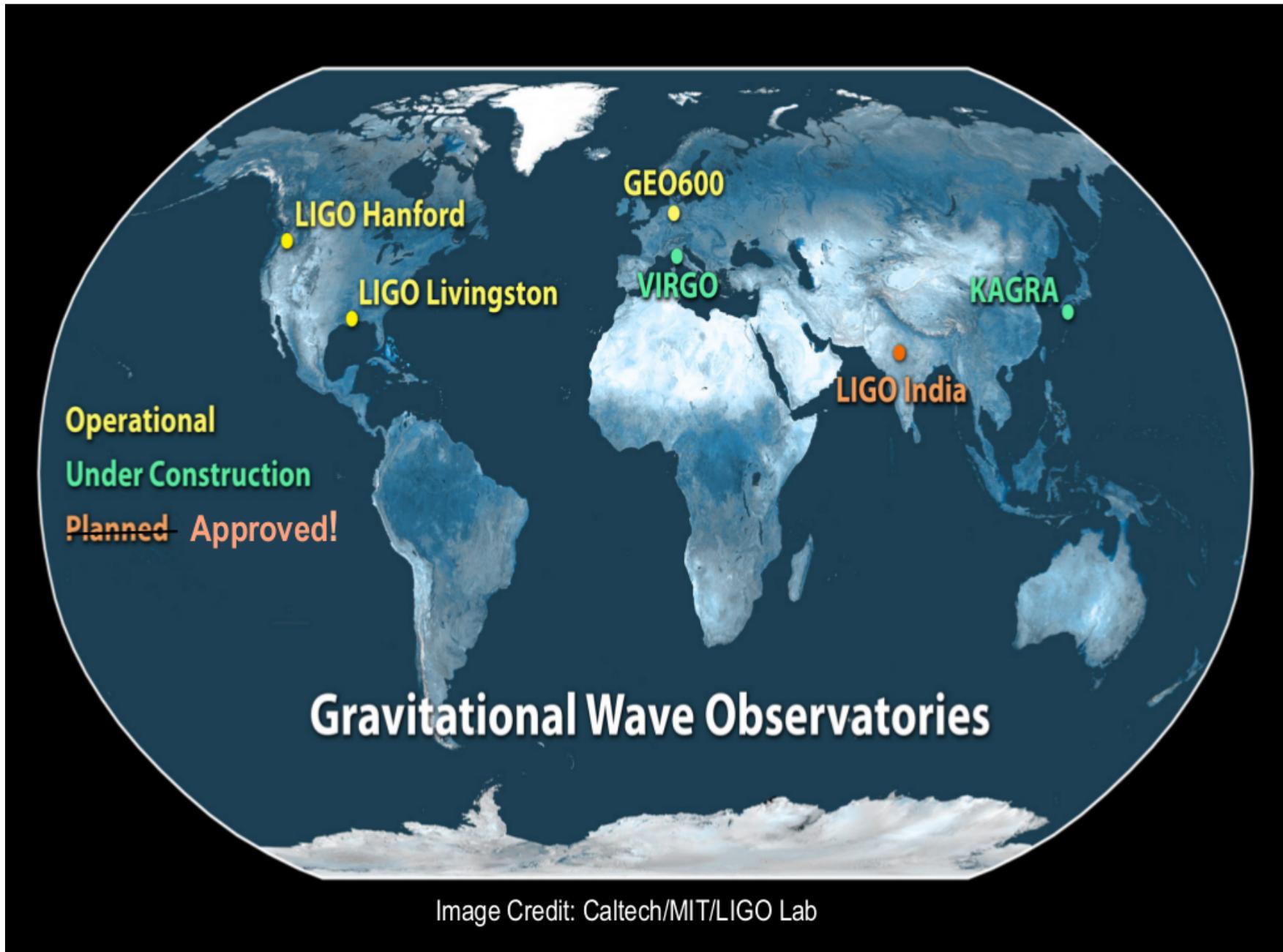
Schedule



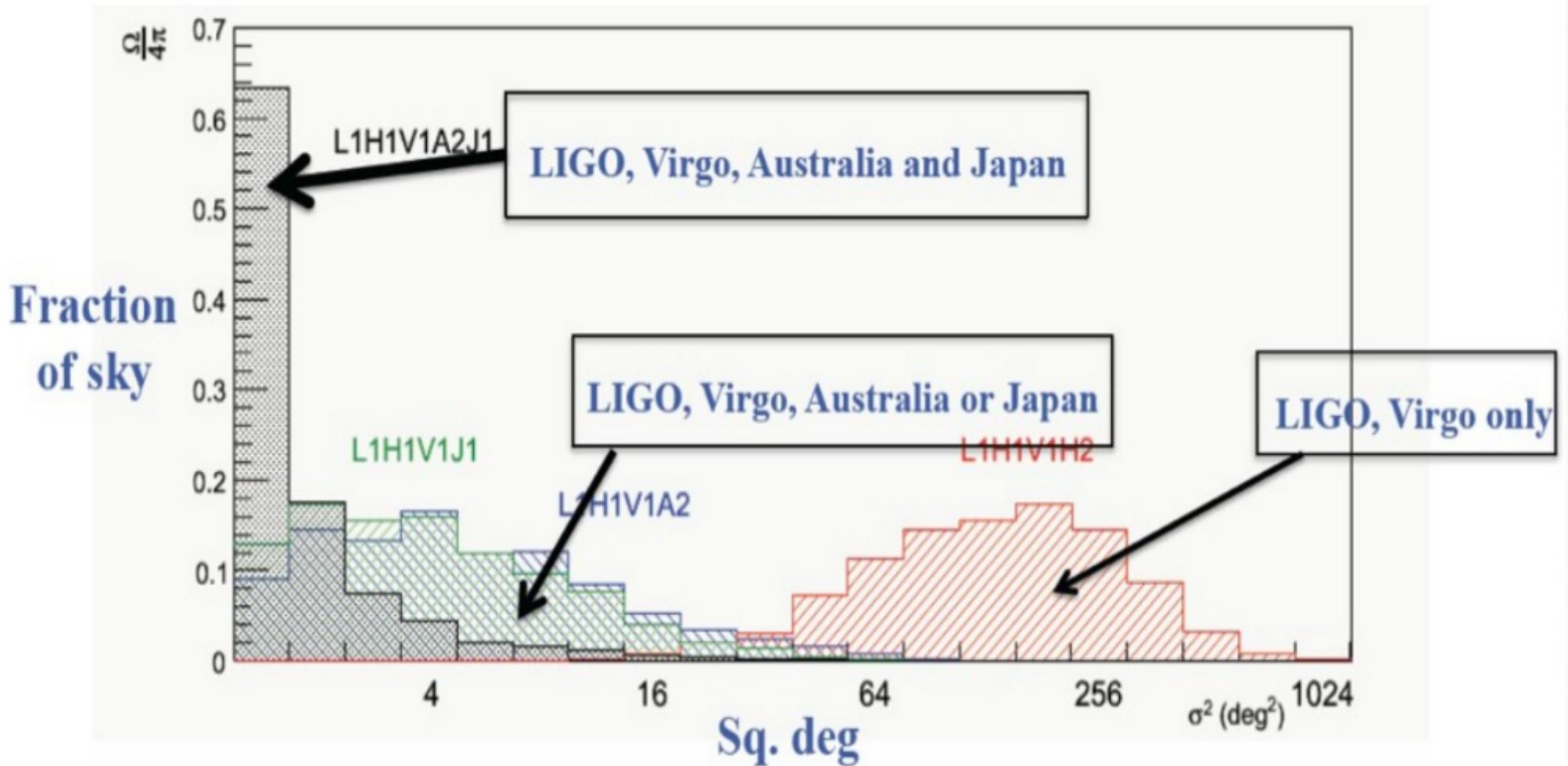
Sensitivities of advanced era



World-wide network of GW telescopes

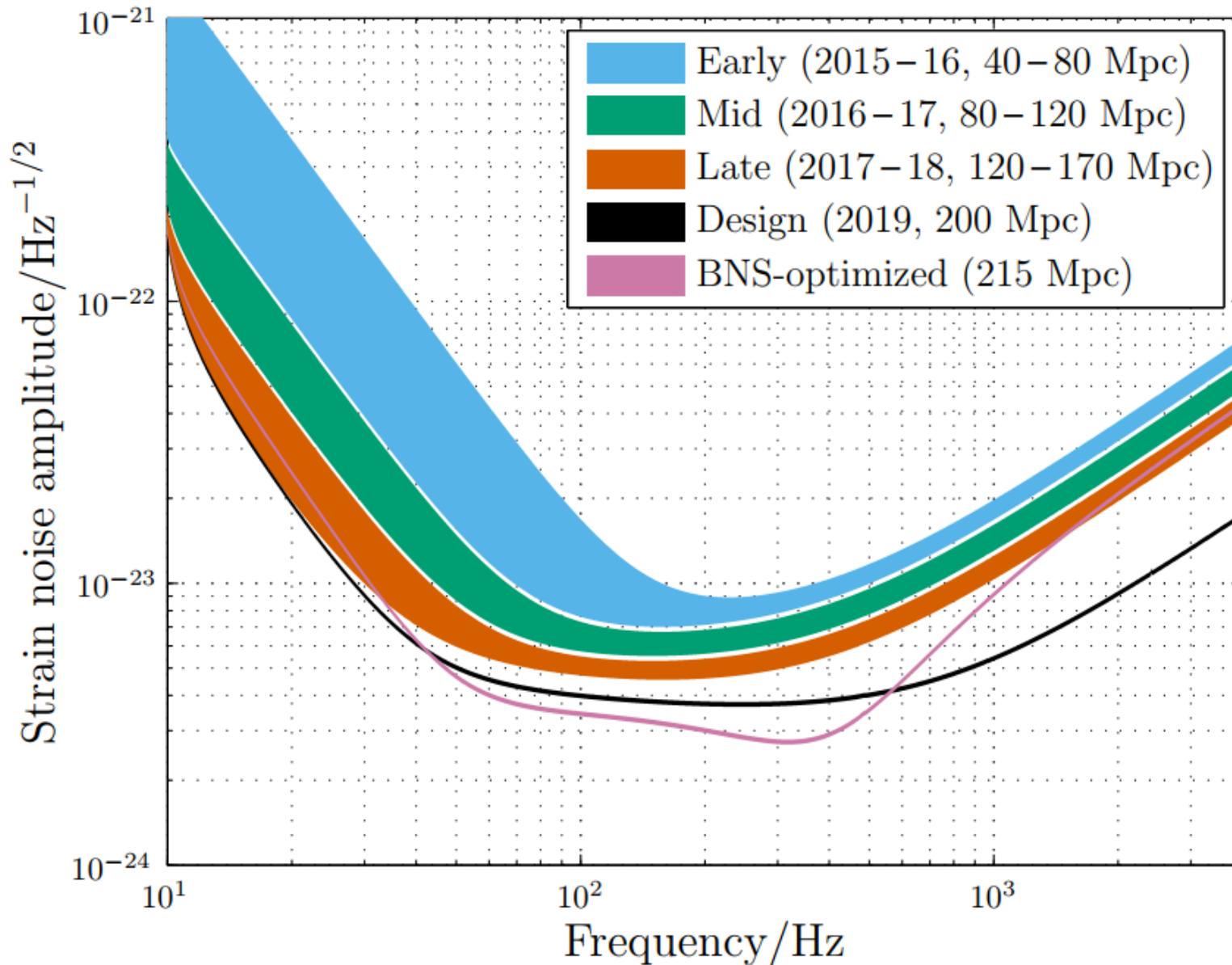


Sky localization



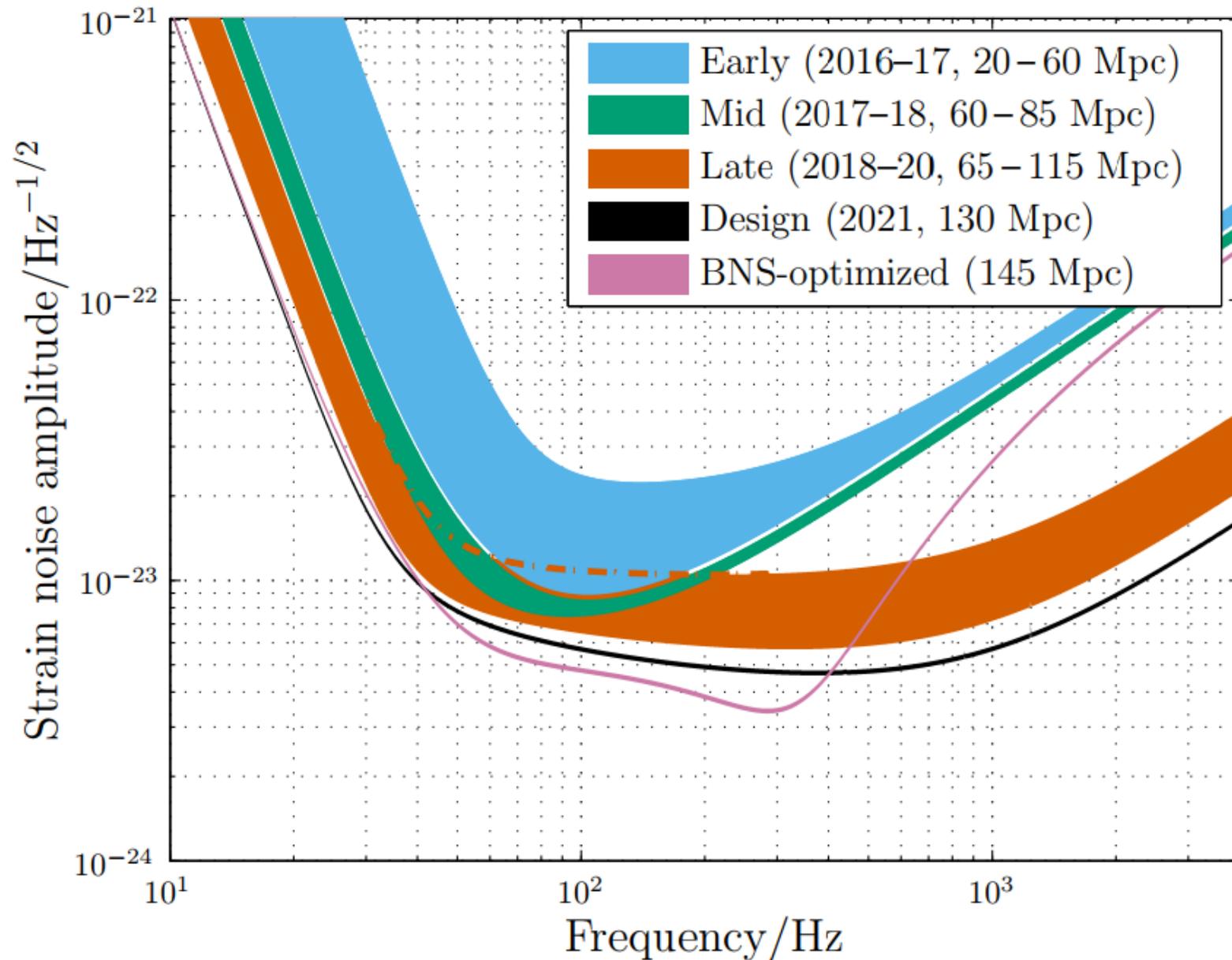
Observation scenario : LIGO

Advanced LIGO



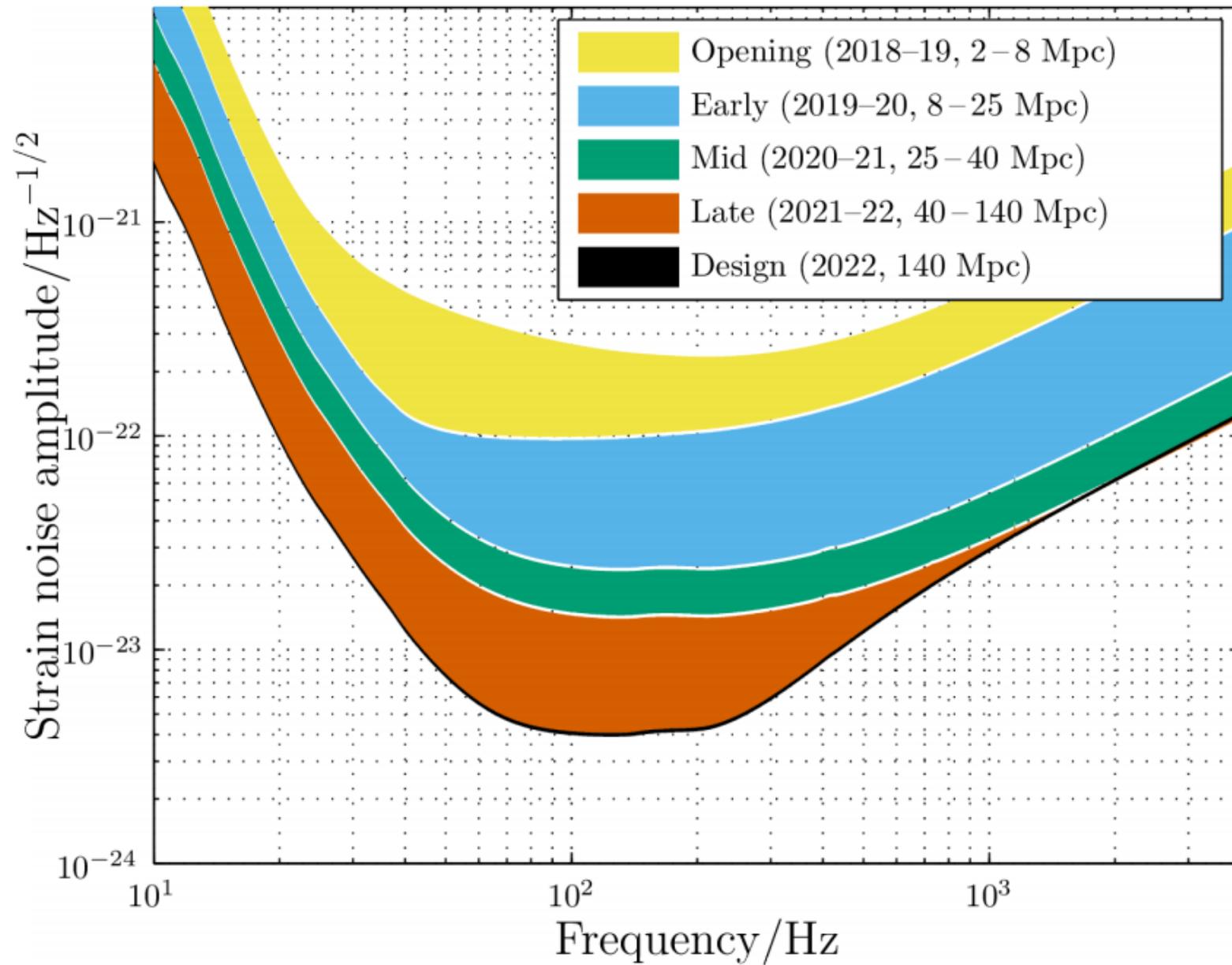
Observation scenario : Virgo

Advanced Virgo

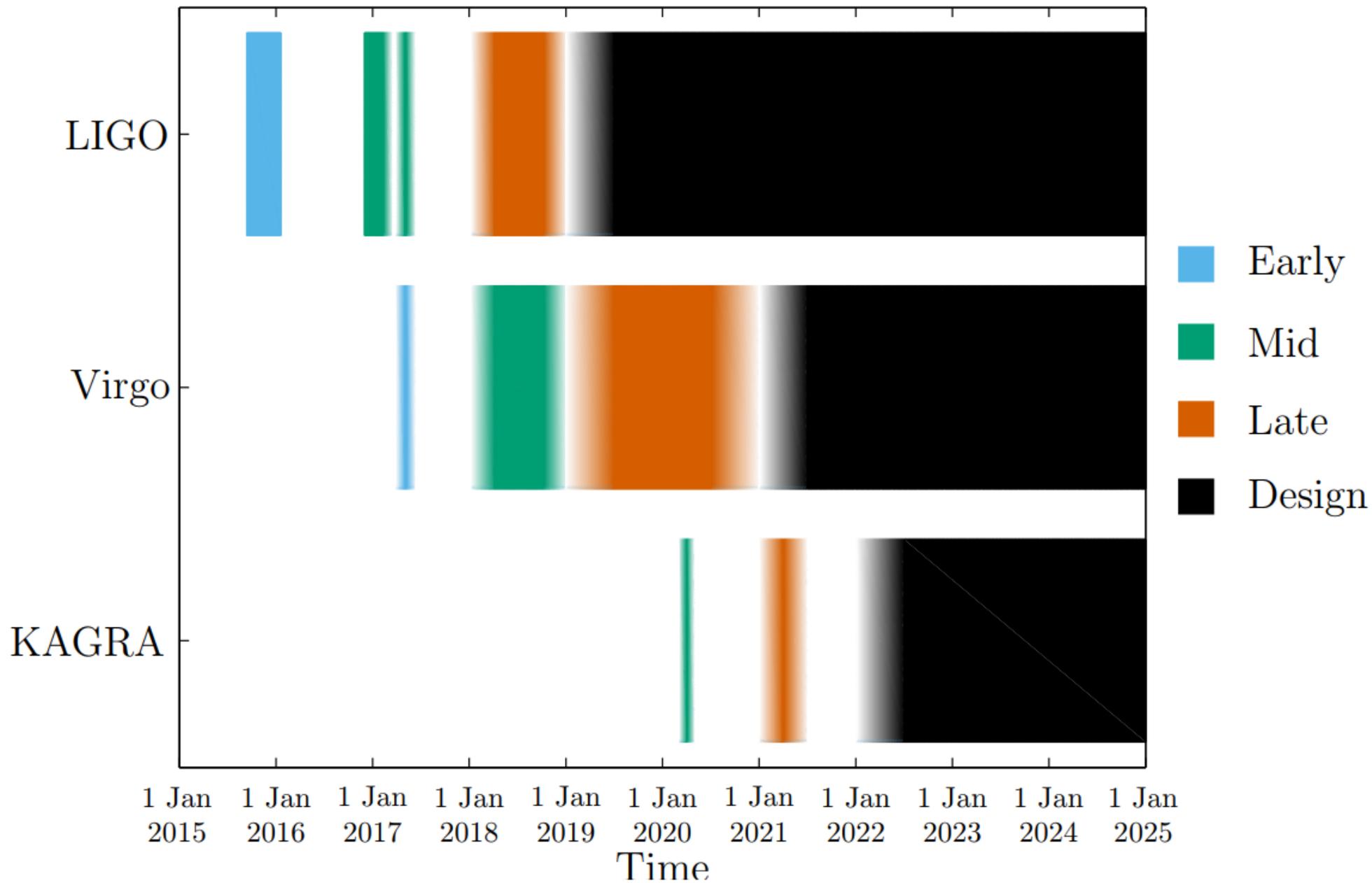


Observation scenario : KAGRA

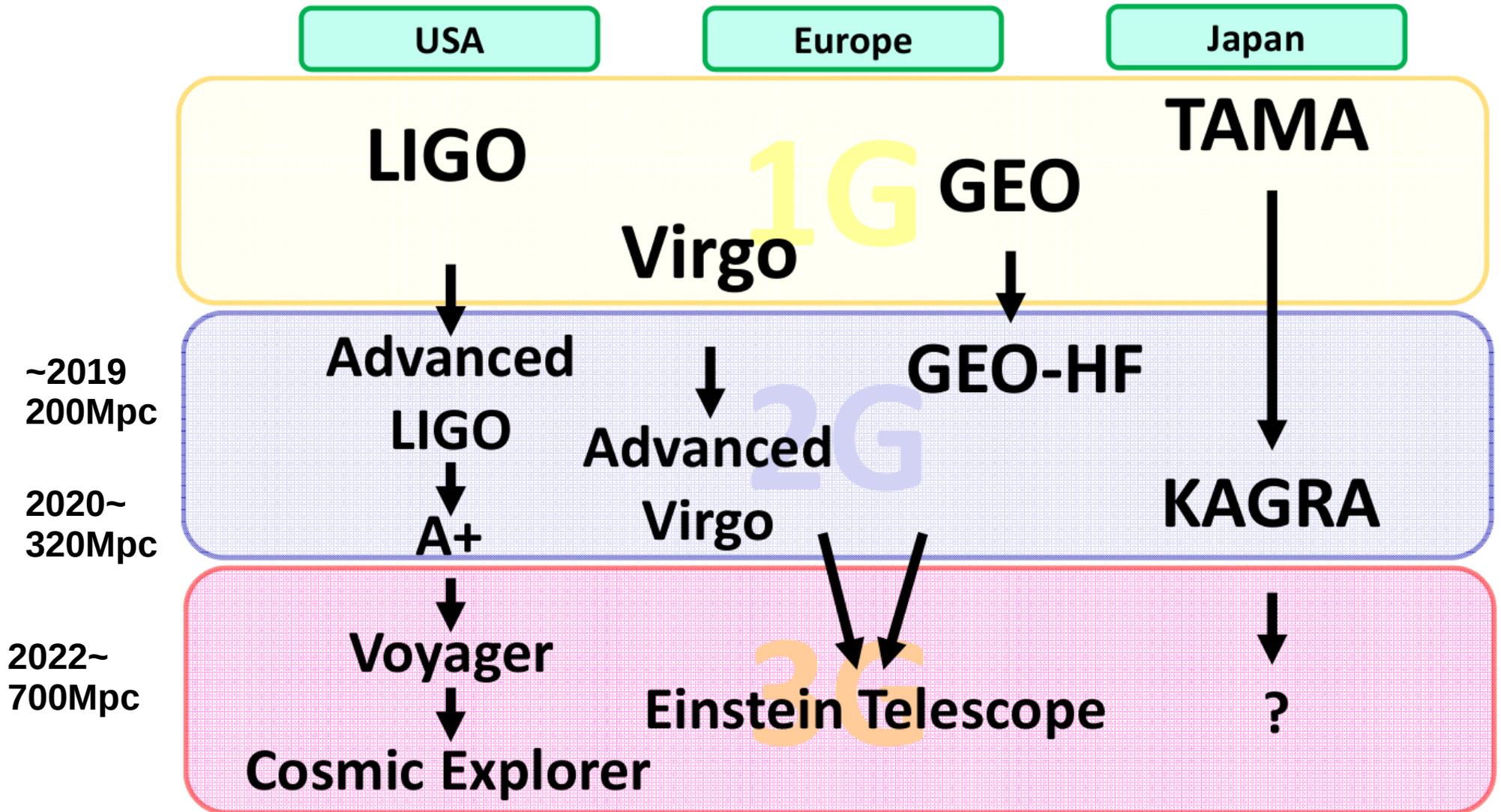
KAGRA



Observations



post-advanced generation

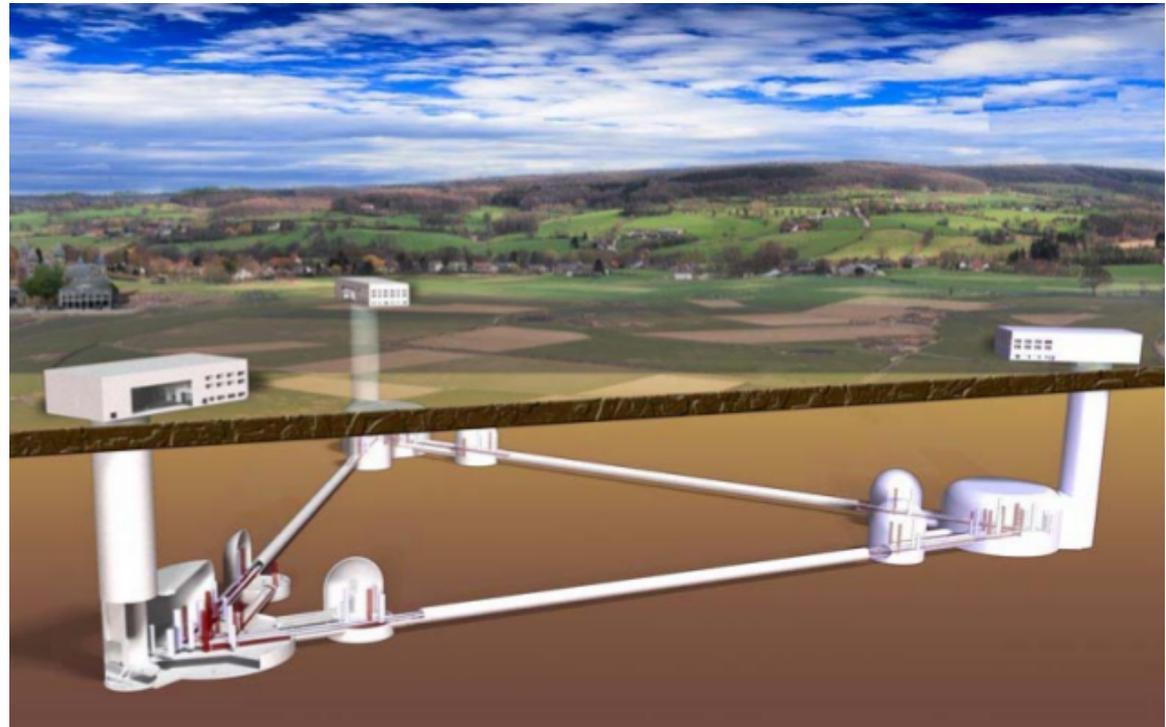


2025~

Cosmic Explorer

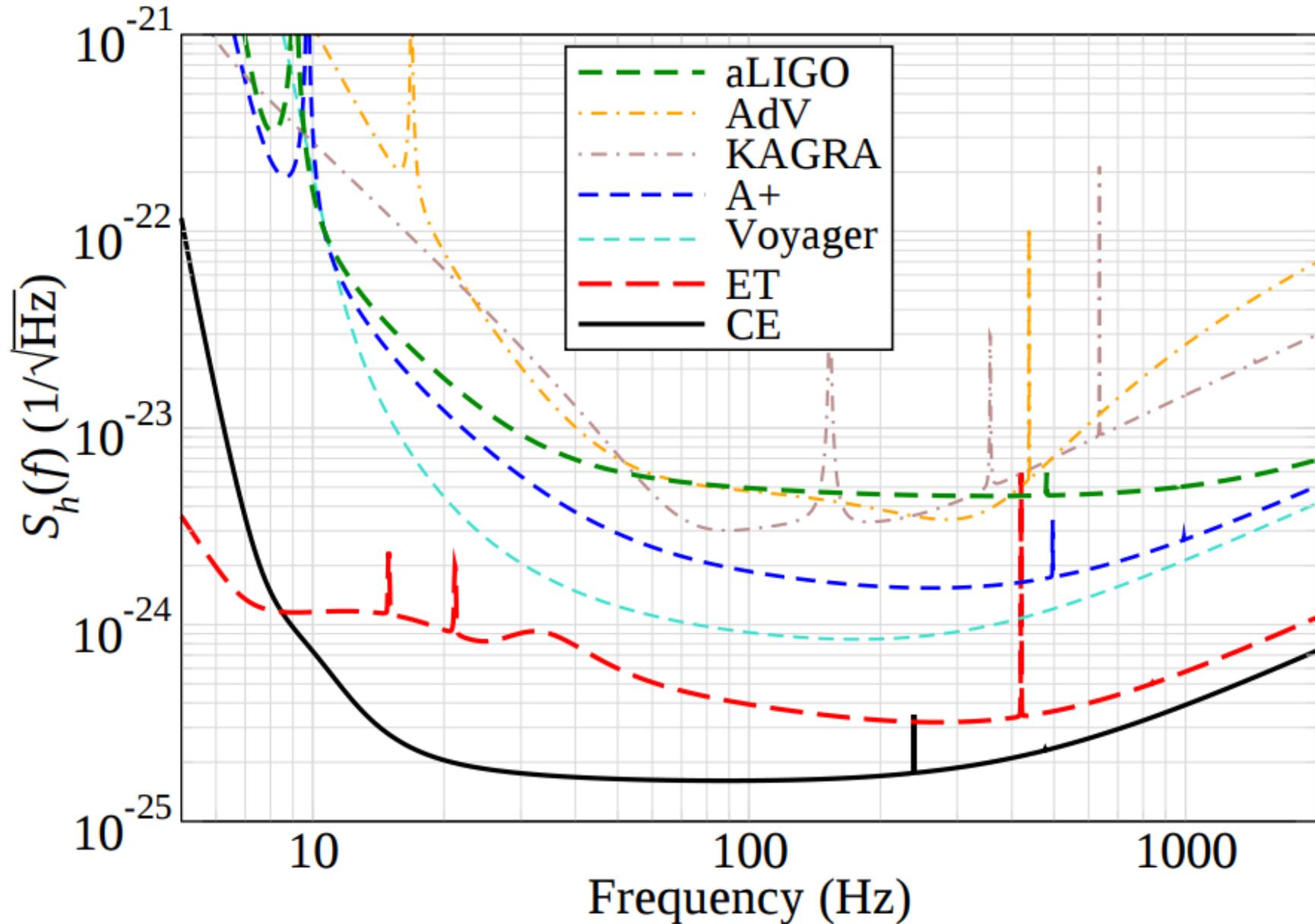
?

Einstein Telescope



<http://www.et-gw.eu/>

Einstein telescope, Cosmic explore



Sensitivity of Cosmic Explorer

