Gravitational-wave detectors in the next decade(s)

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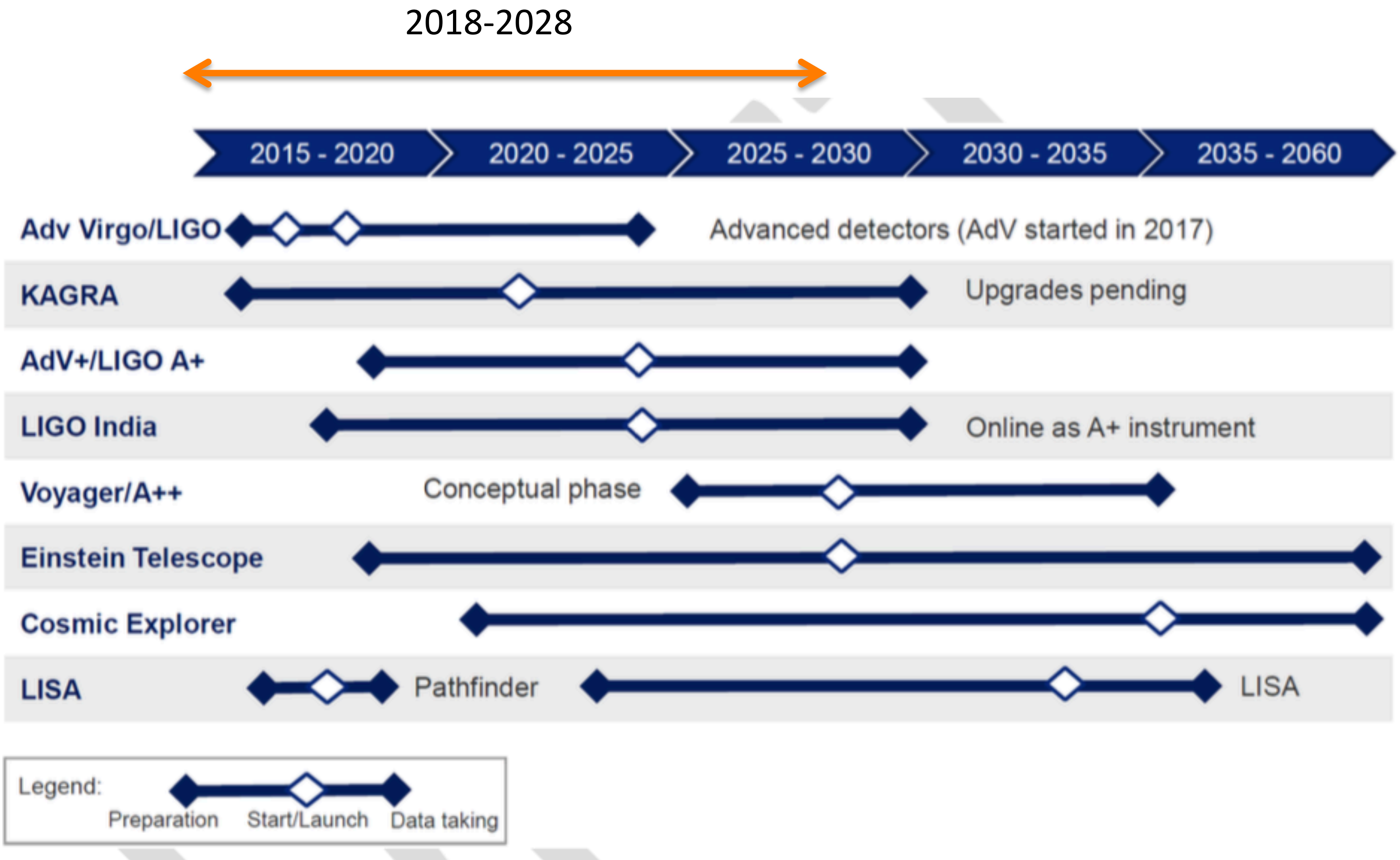
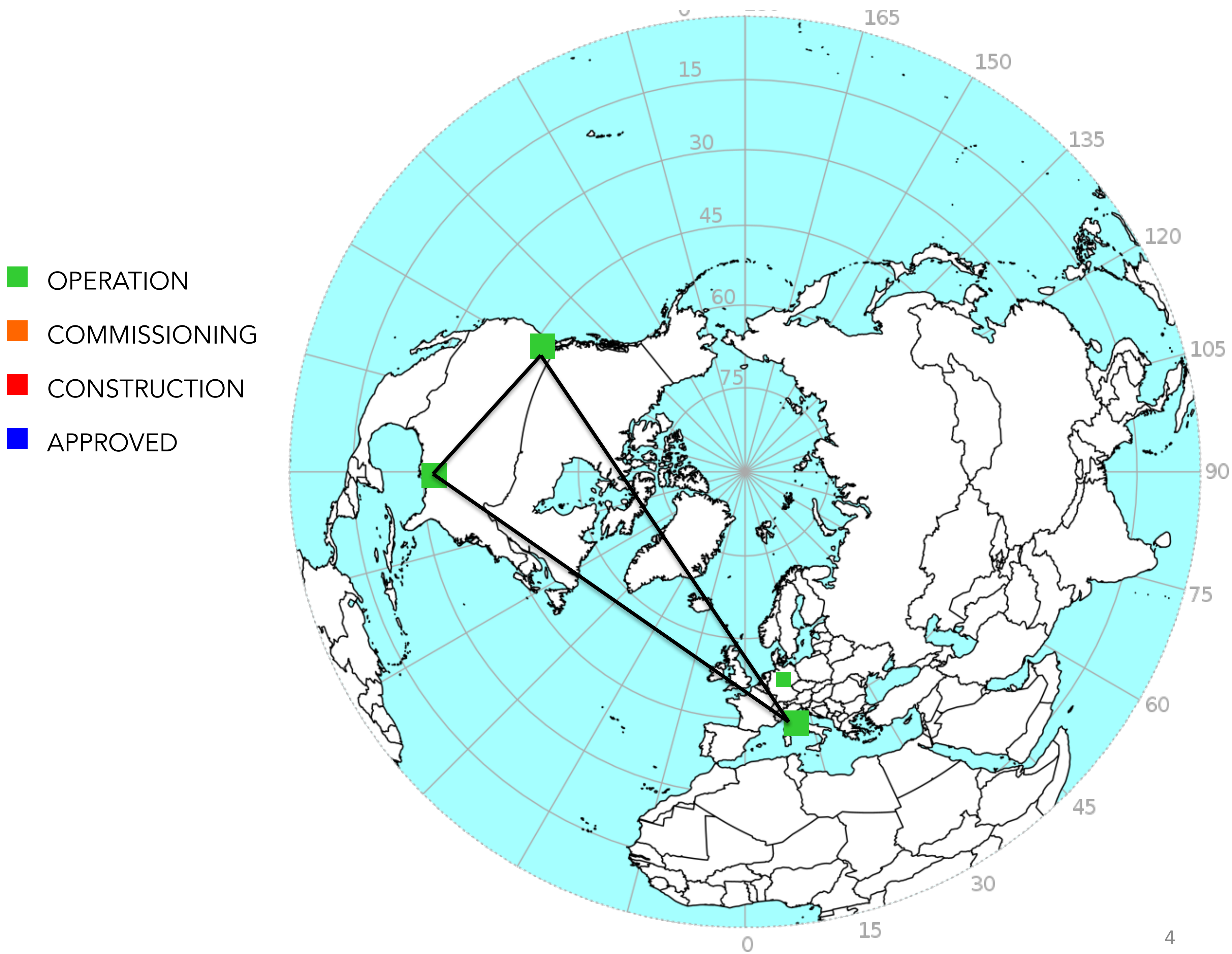
The big picture



The status during 02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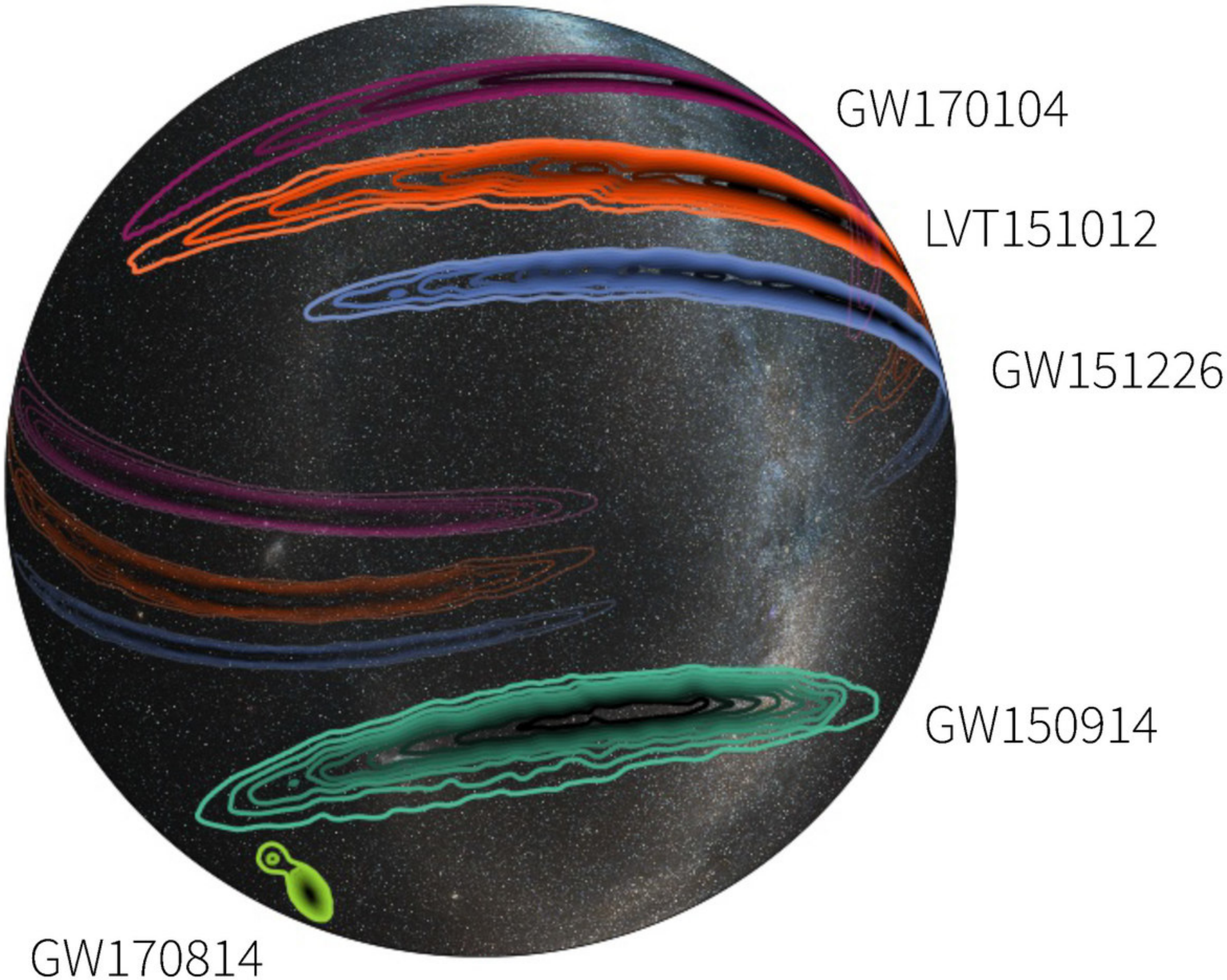
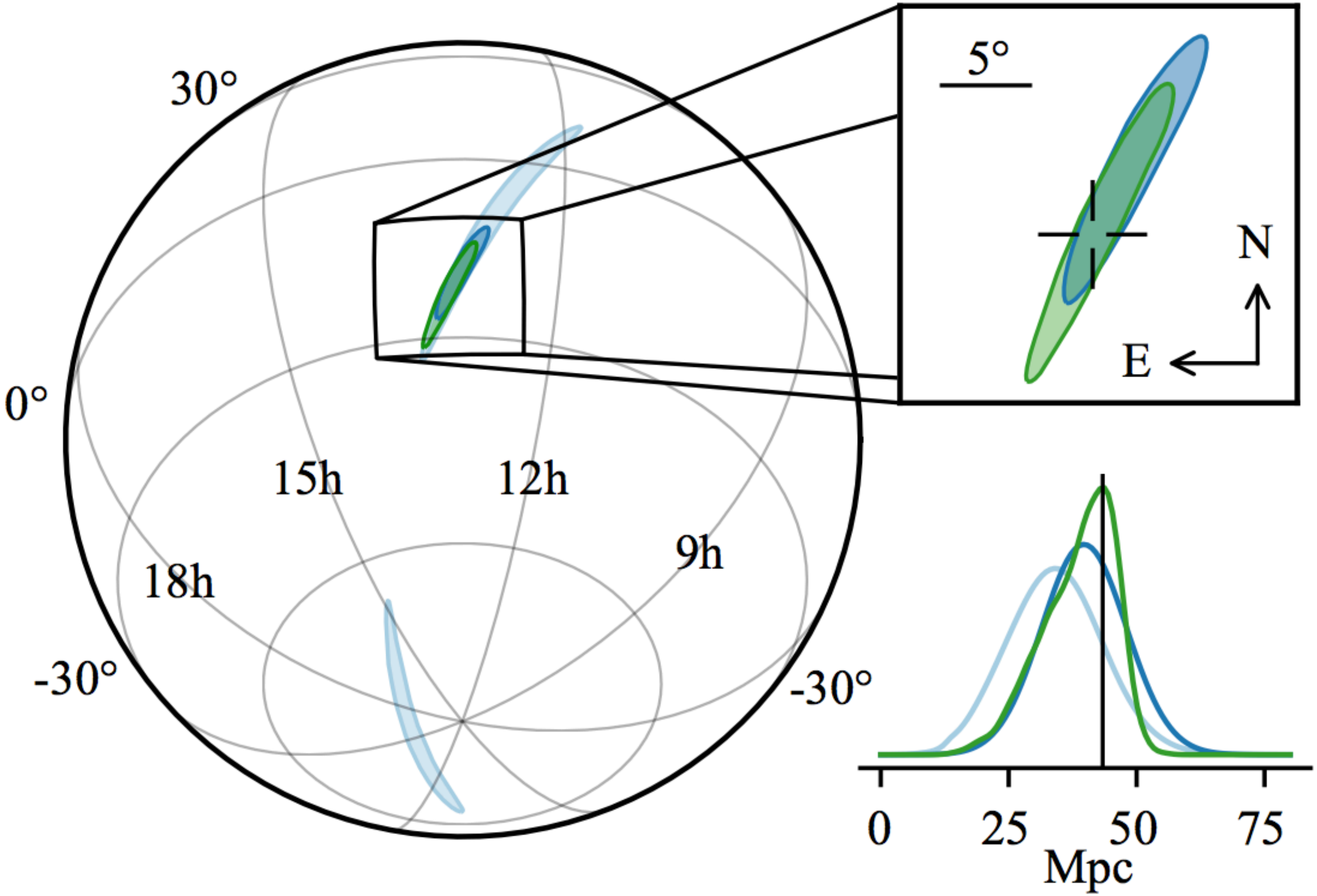
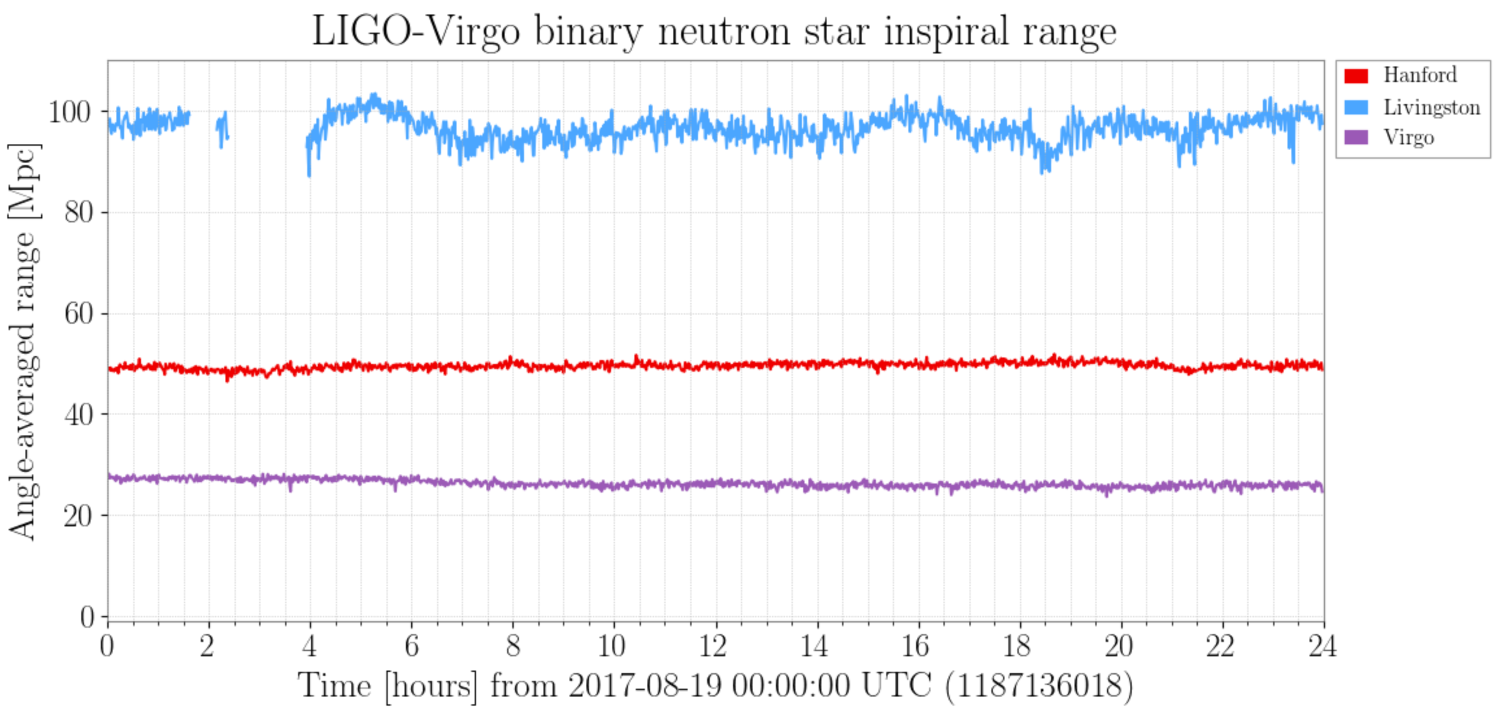
Localization: GW140817 – Binary black hole



Localization: GW170817– Binary neutron star



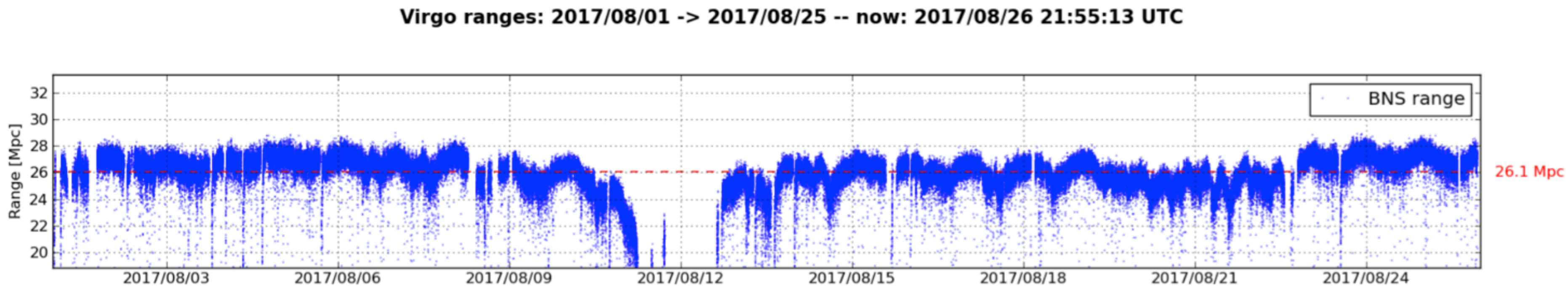
O2 sensitivities

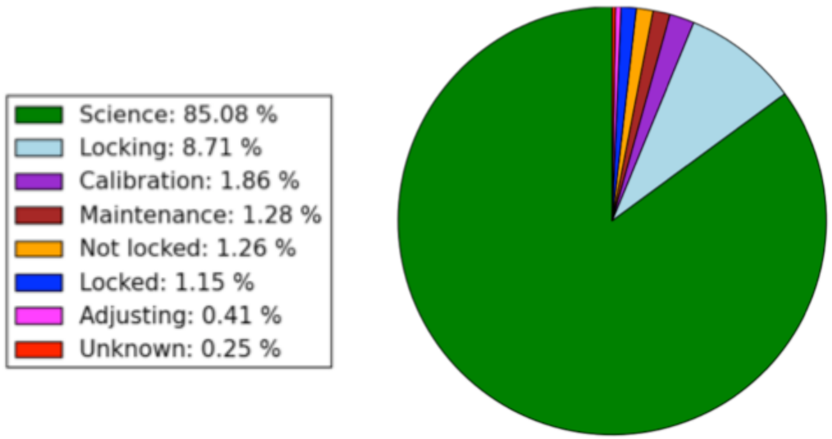


« Horizon » = 2.3 x « range »

Virgo ~ 60 Mpc
Livingston ~ 220 Mpc
Hanford ~ 110 Mpc

Virgo performances





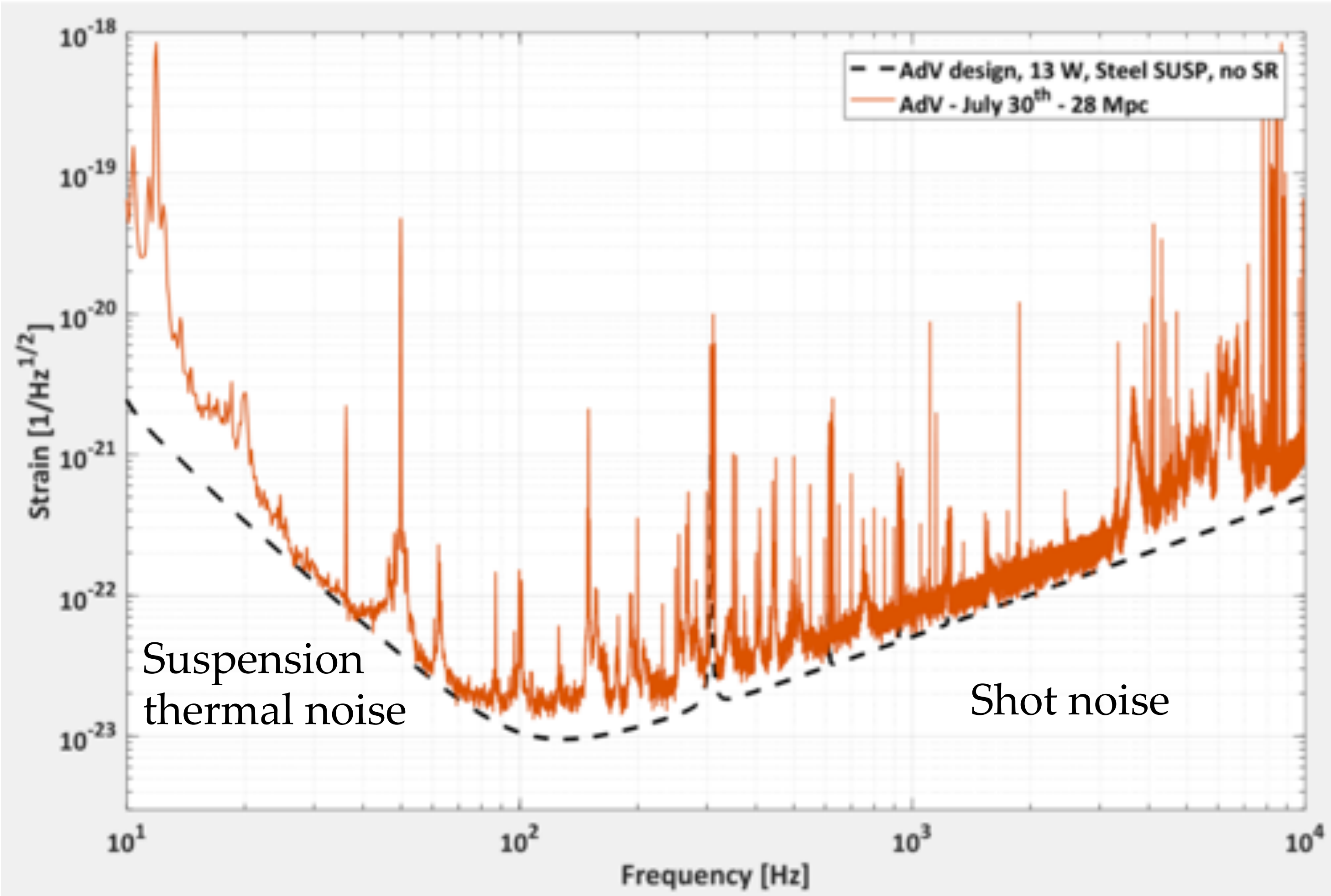
DUTY CYCLE: 85%

LONGEST LOCK STRETCH: 69 hours

HIGHEST BNS RANGE: 28.2 Mpc

AVERAGE RANGE: BNS 26 - BBH_{10} 134 - BBH_{30} 314 Mpc

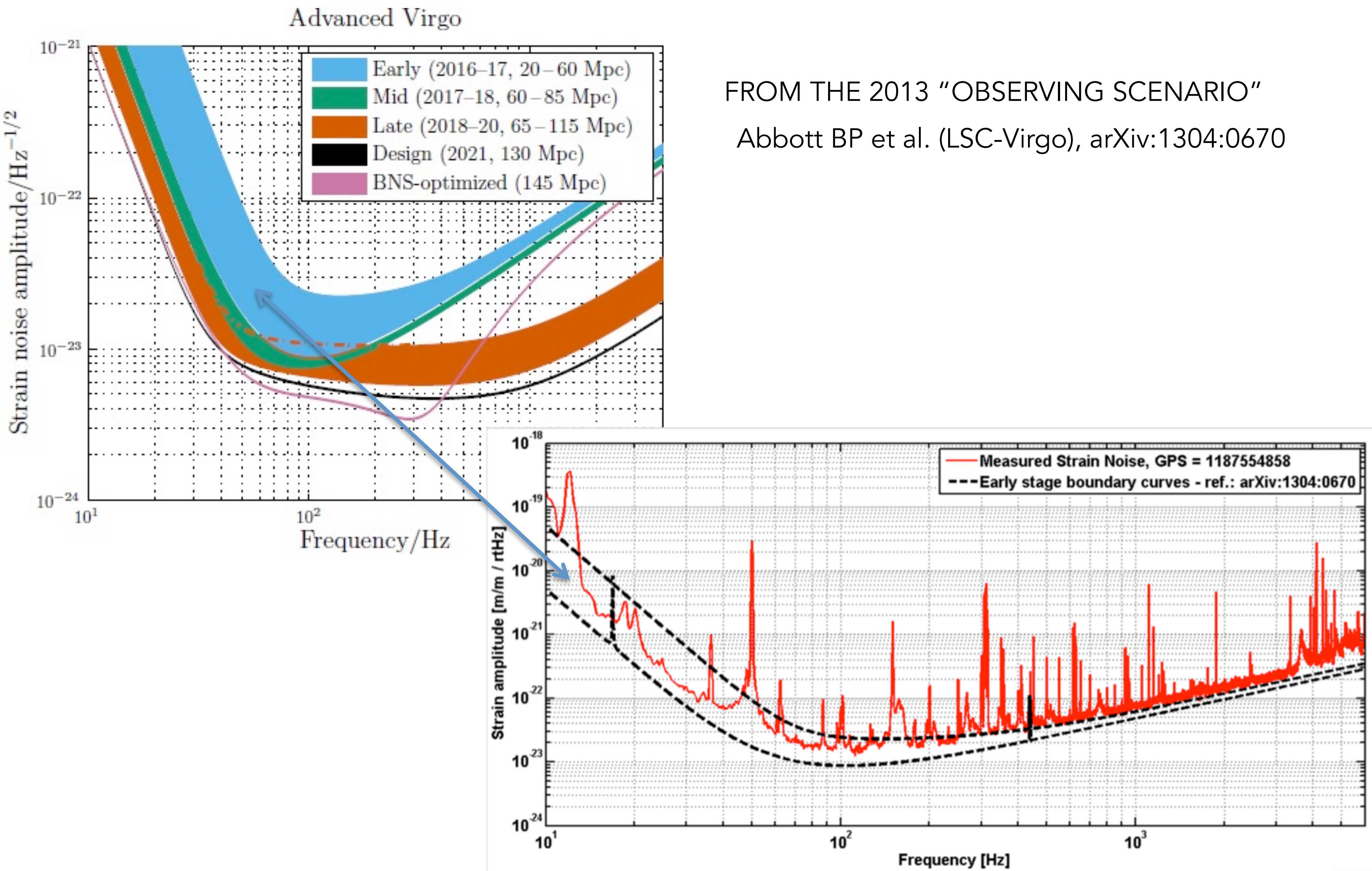
Virgo sensitivity



Virgo sensitivity

FROM THE 2013 "OBSERVING SCENARIO"

Abbott BP et al. (LSC-Virgo), arXiv:1304:0670



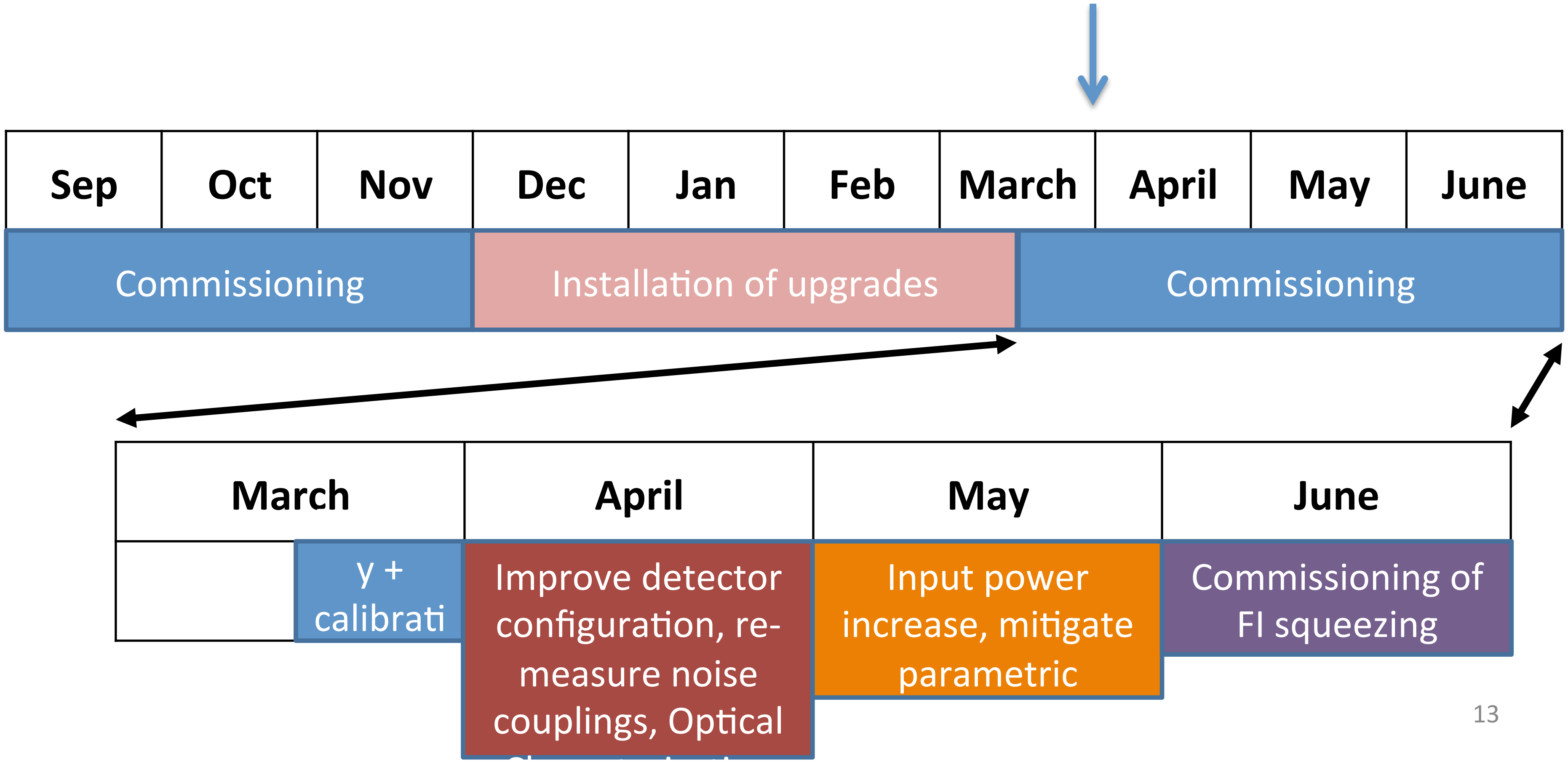
03 preparation

Three phases in the detector life

- "Construction": detector lock for hours
  - LIGO: march 2015
  - Virgo: end 2016
  - KAGRA: early 2019

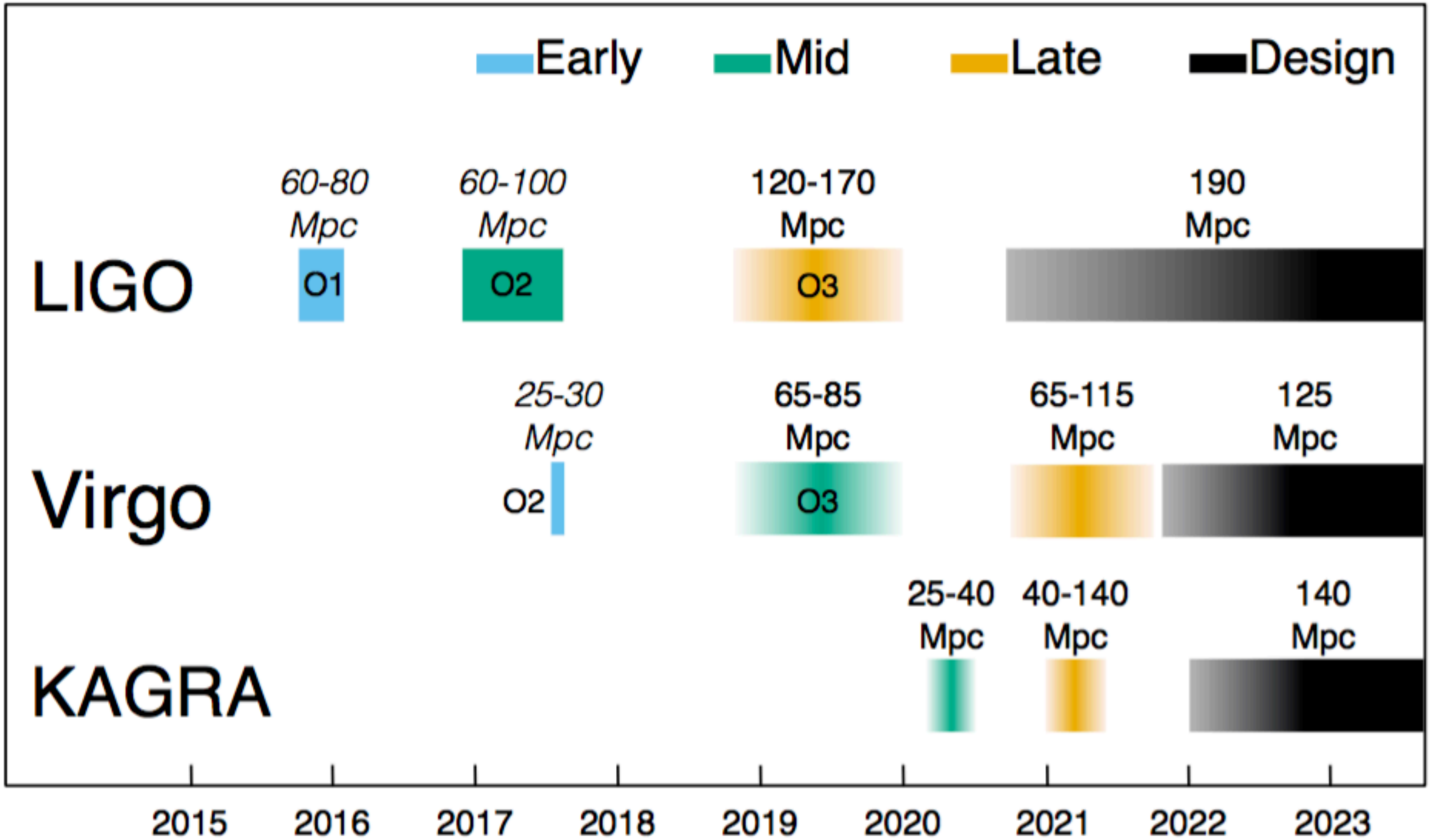
  (LIGO India not operational before 2024)
- "Commissioning": improvement of the sensitivity
  - Scheduled improvements
  - Tackling unexpected problems
- "Observing run(s)": scientific data
  - Cost-benefit commissioning/Observing

Commissioning/installation plans



Credit: Alessio Rocchi

Observing runs and sensitivities



Living Rev Relativ manuscript No.
(will be inserted by the editor)

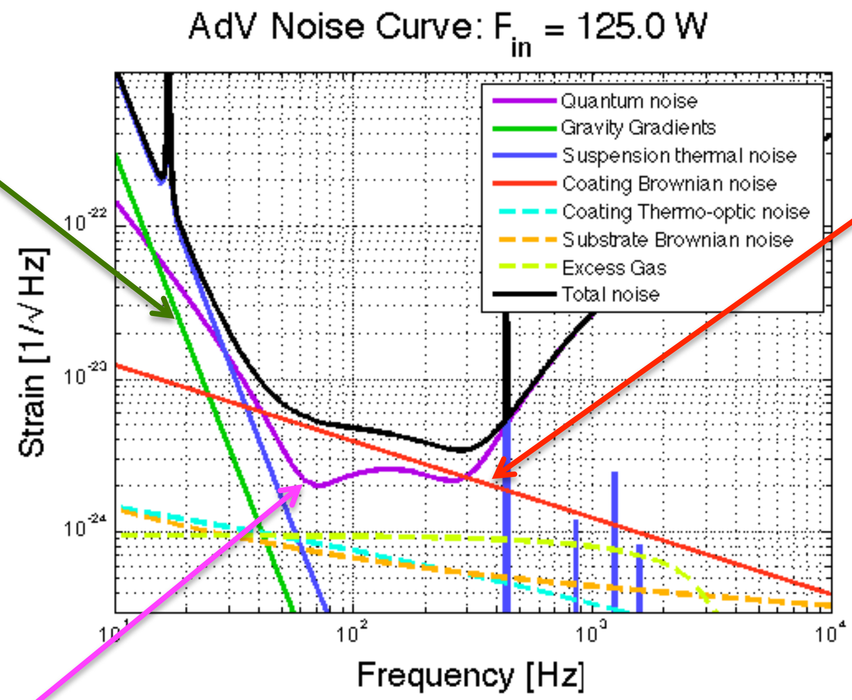
Prospects for Observing and Localizing Gravitational-Wave Transients with Advanced LIGO, Advanced Virgo and KAGRA

Abbott, B. P. et al. (KAGRA Collaboration, LIGO Scientific Collaboration and Virgo Collaboration)

Received: September 11, 2017/ Accepted:

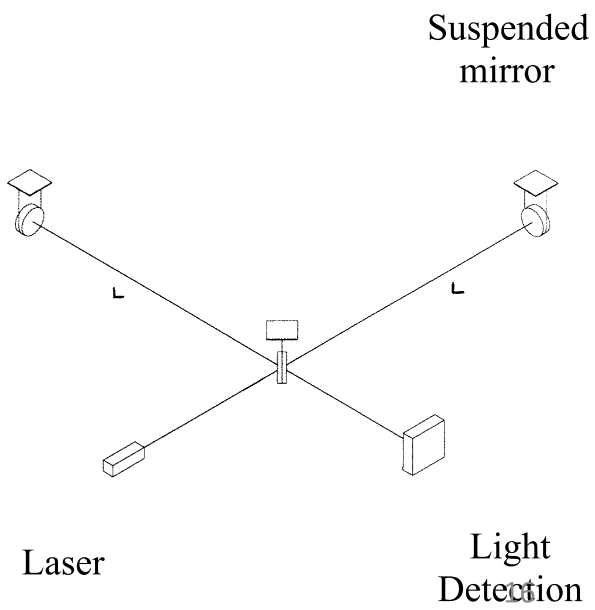
Virgo sensitivity curve

Seismic and gravity gradient noise
Geophysics



Thermal noise
Thermodynamics

Quantum noise
Quantum mechanics



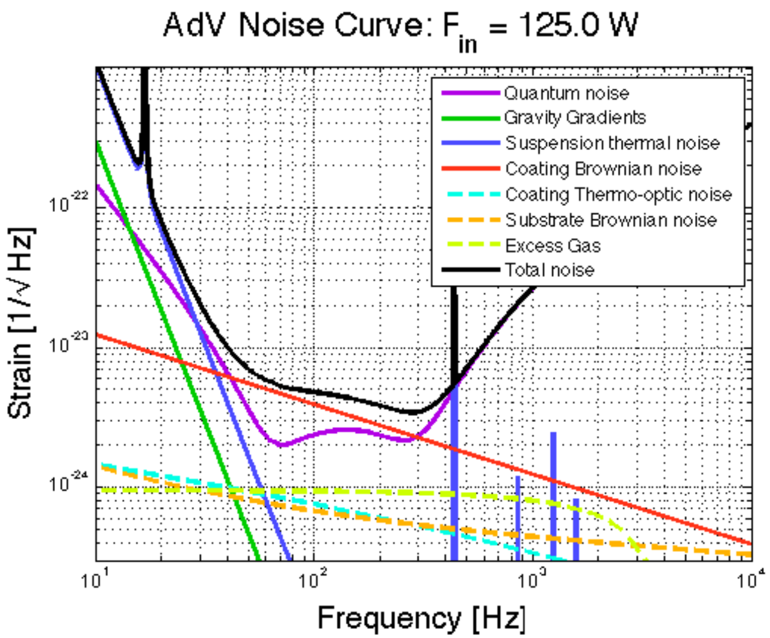
Upgrade between O2 and O3 in detail

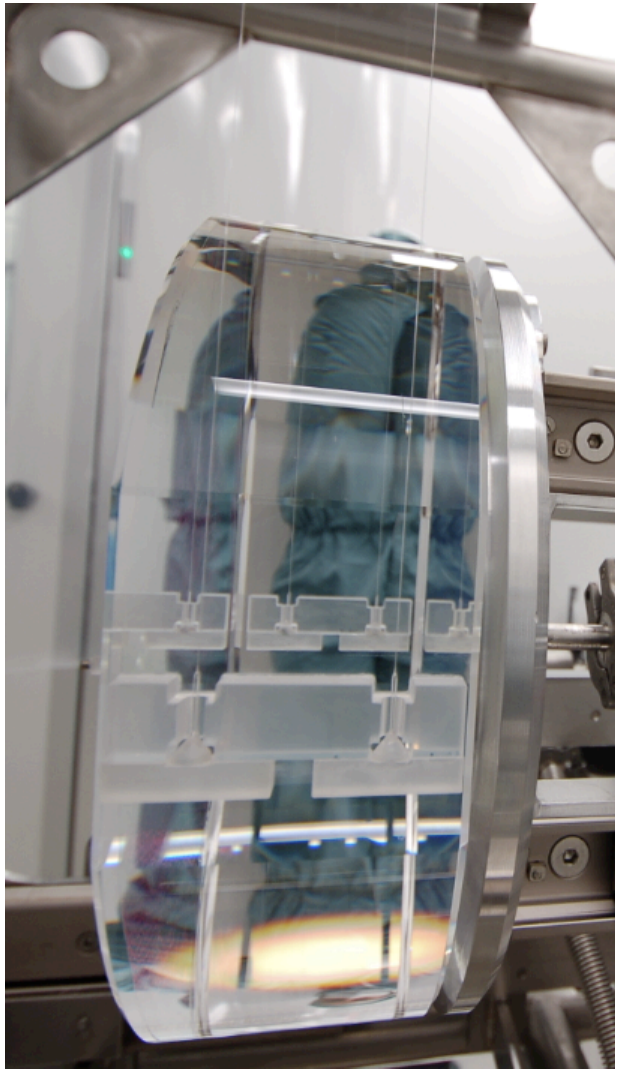
- Replace steel wires with fused silica wires
  - Reduce suspension thermal noise
- Increase laser power
  - Reduce quantum noise (at high frequency)
- Use frequency dependent squeezing
  - Reduce quantum noise (at high frequency)

Goal: ~ 60 Mpc (max is 100 Mpc) factor ~ 2 wrt 02

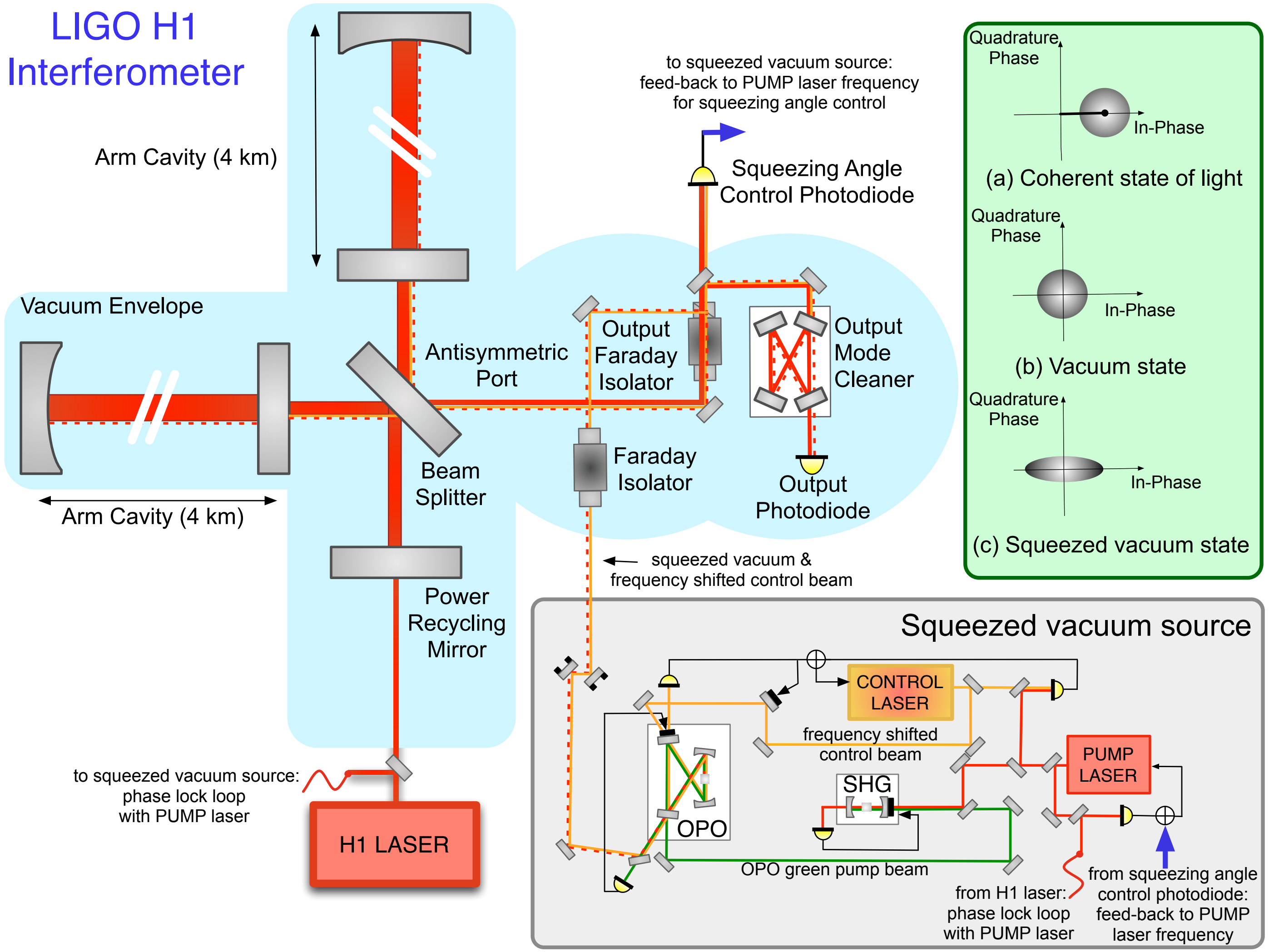
(goal for LIGO ~ 120 Mpc)

Virgo / Fused silica fibers



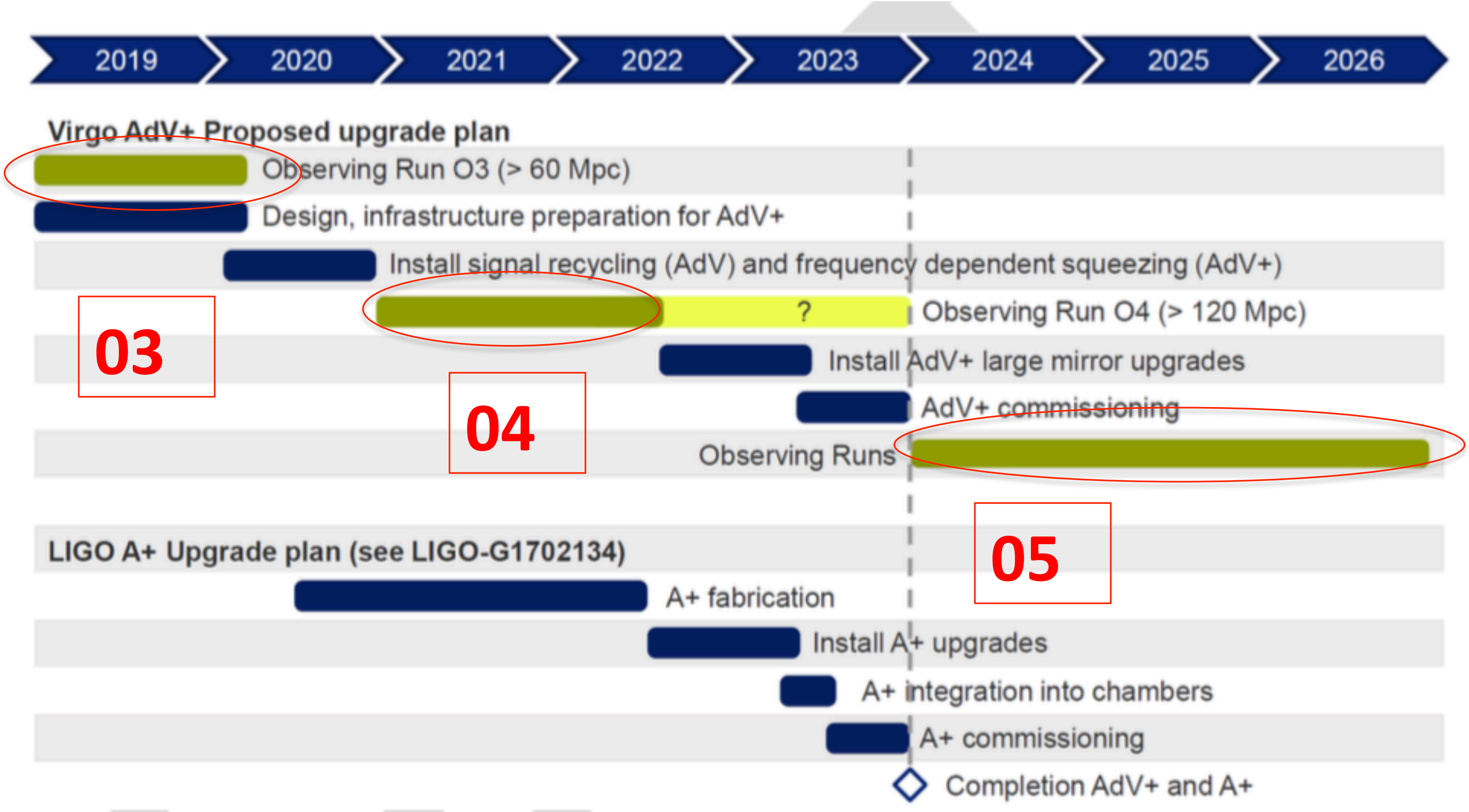


Squeezed light injection

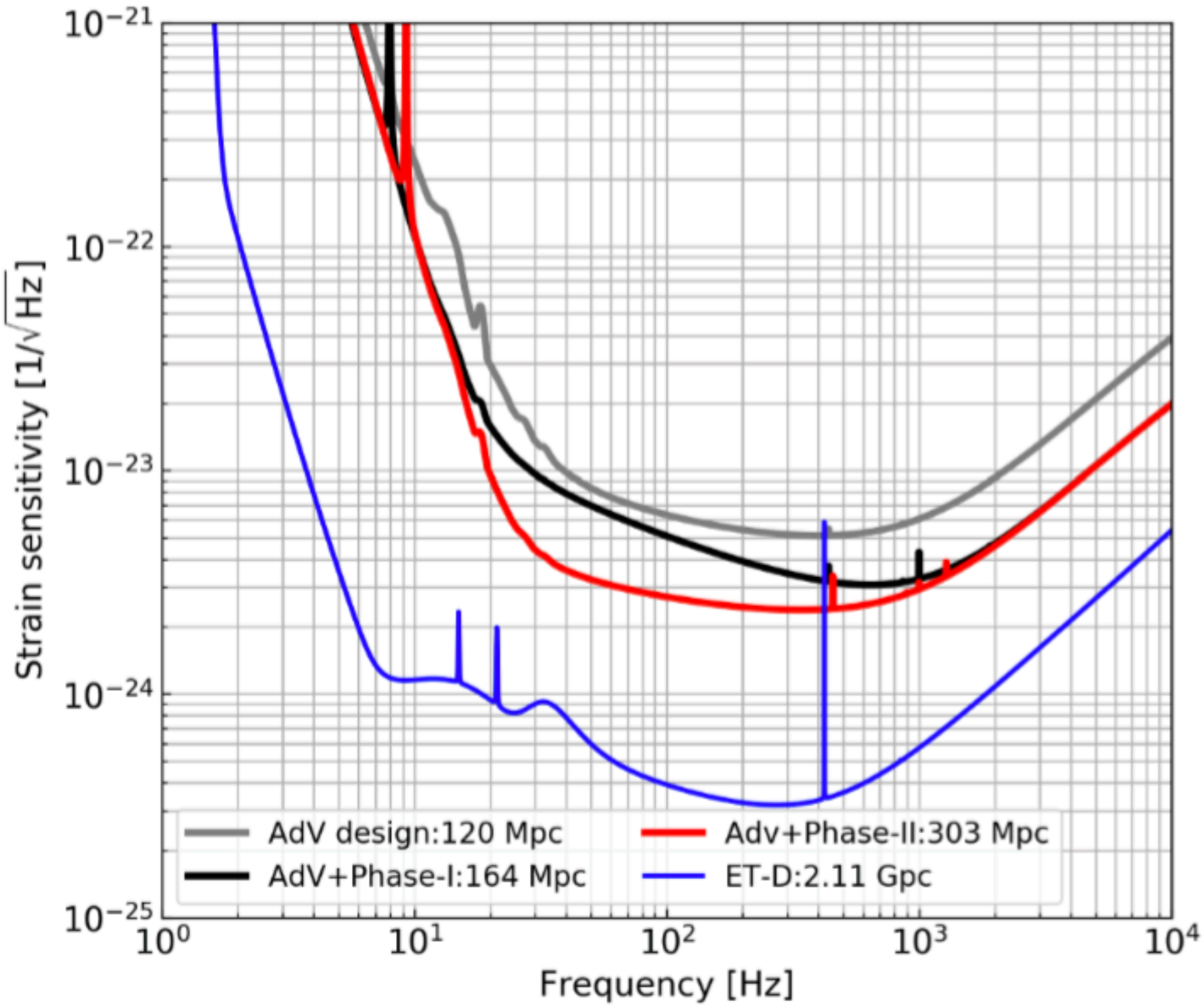


After 03

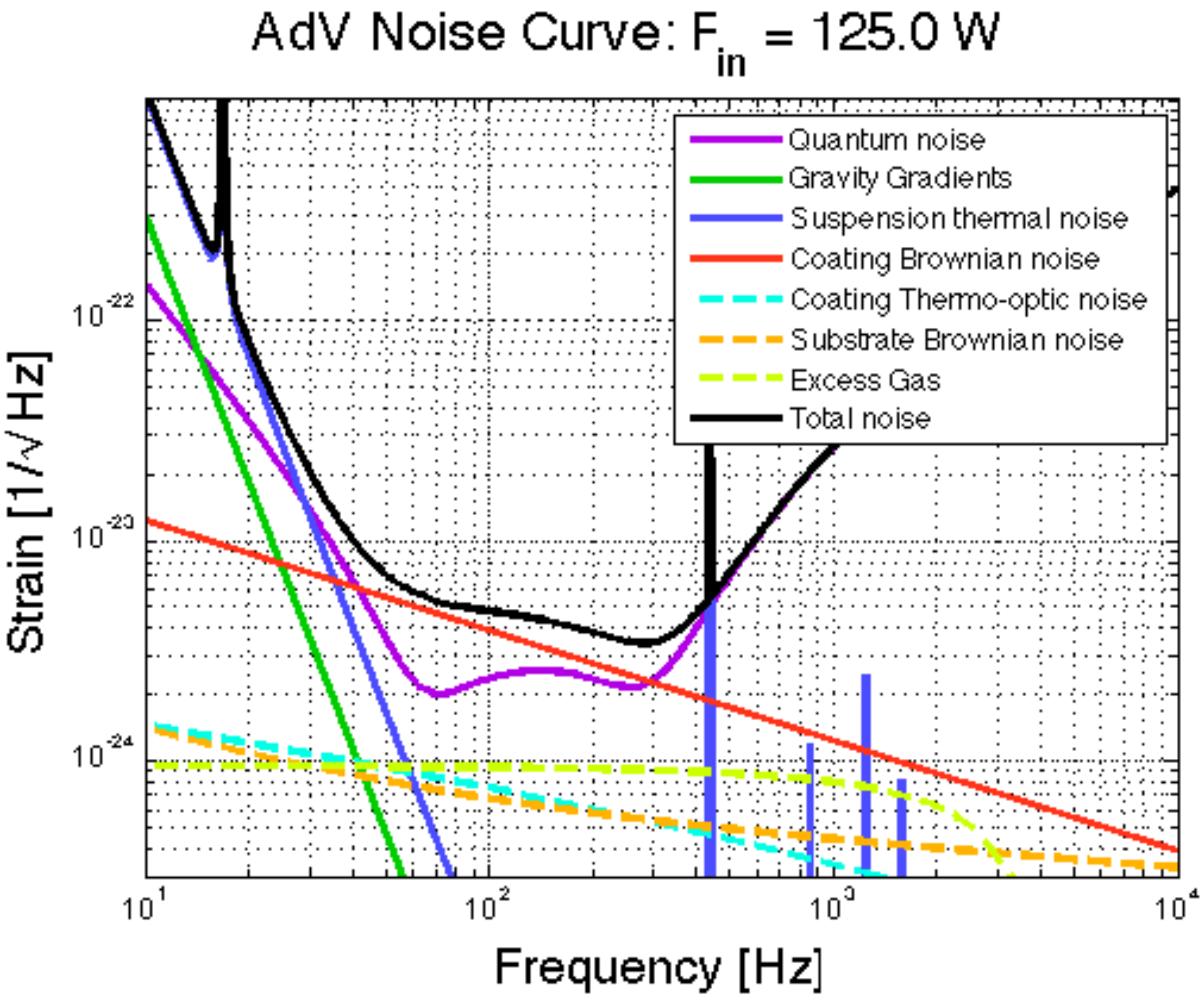
Virgo/LIGO plans > 2019



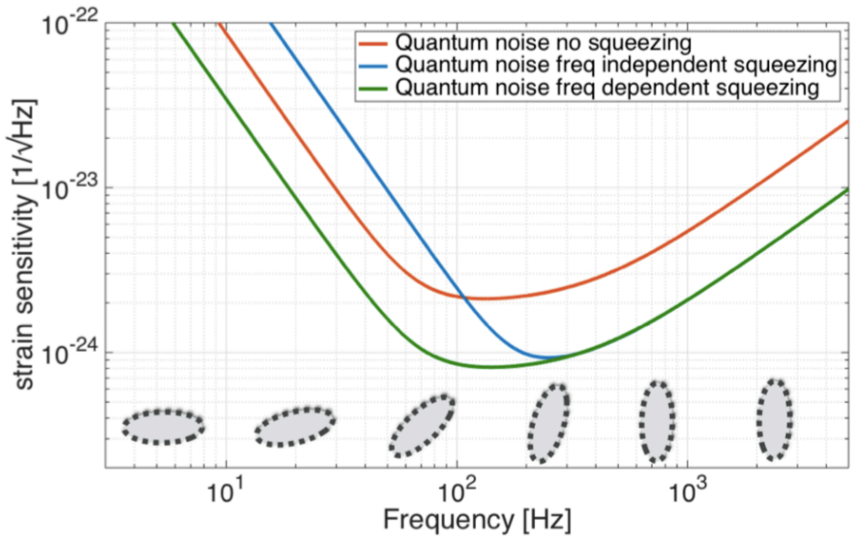
Sensitivities after 03



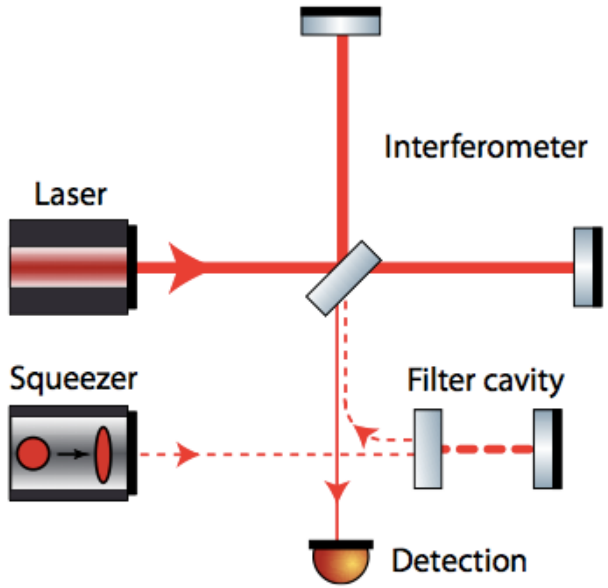
Advanced Virgo sensitivity



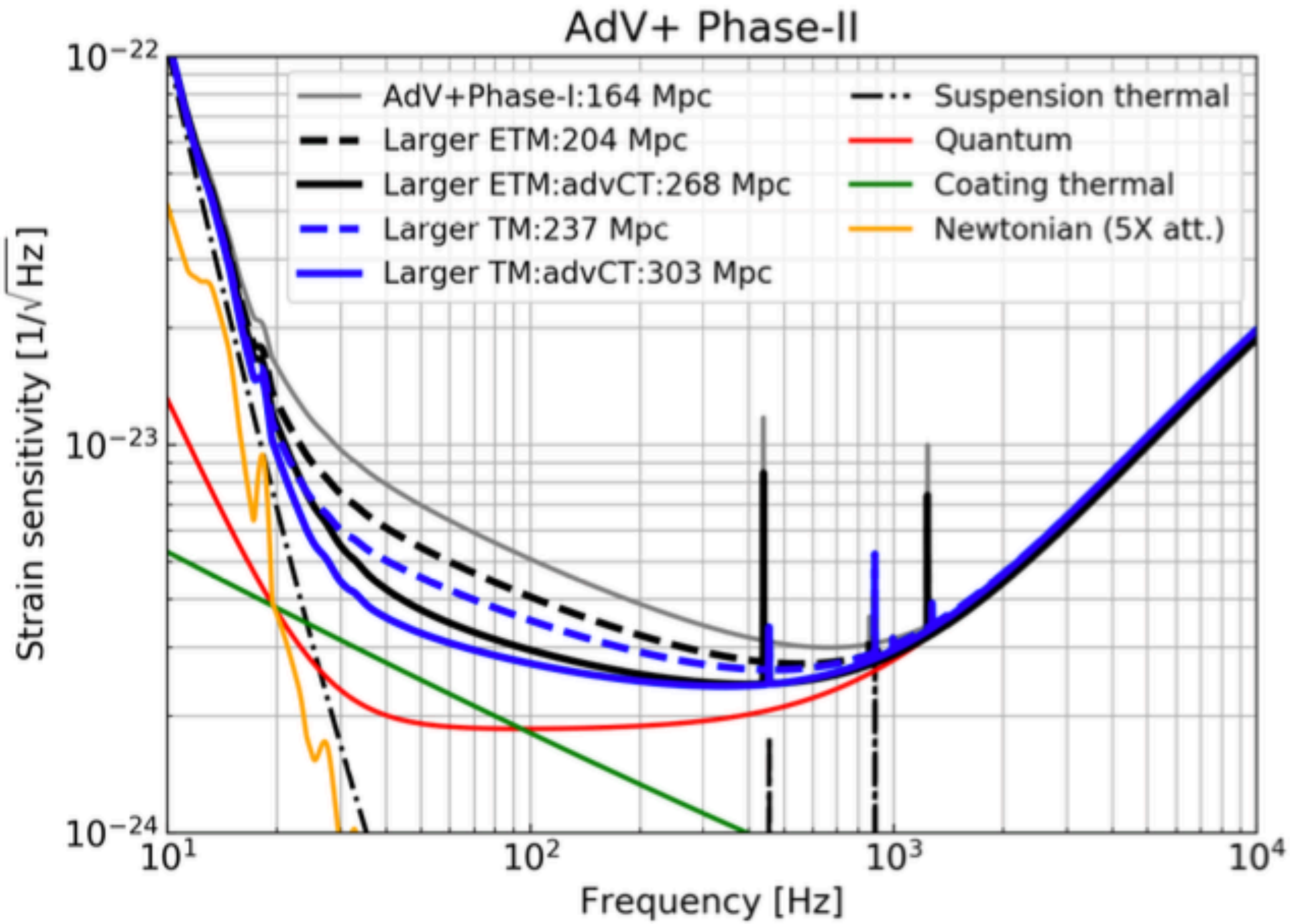
Upgrades between 03 and 04

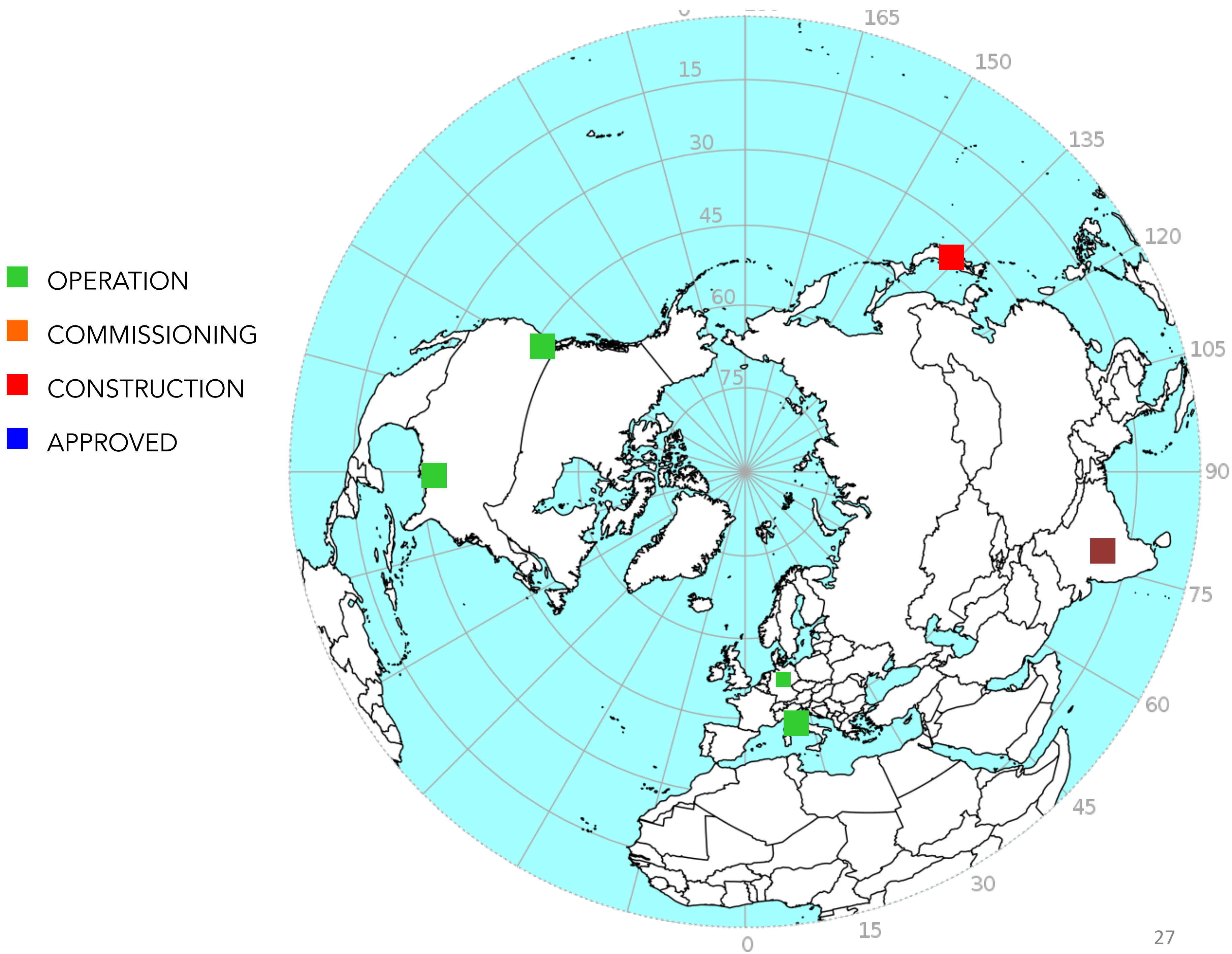


- Signal recycling
- Newtonian noise reduction
- Frequency dependent squeezing



The role of the thermal noise coating and mirror size

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CONSTRUCTION
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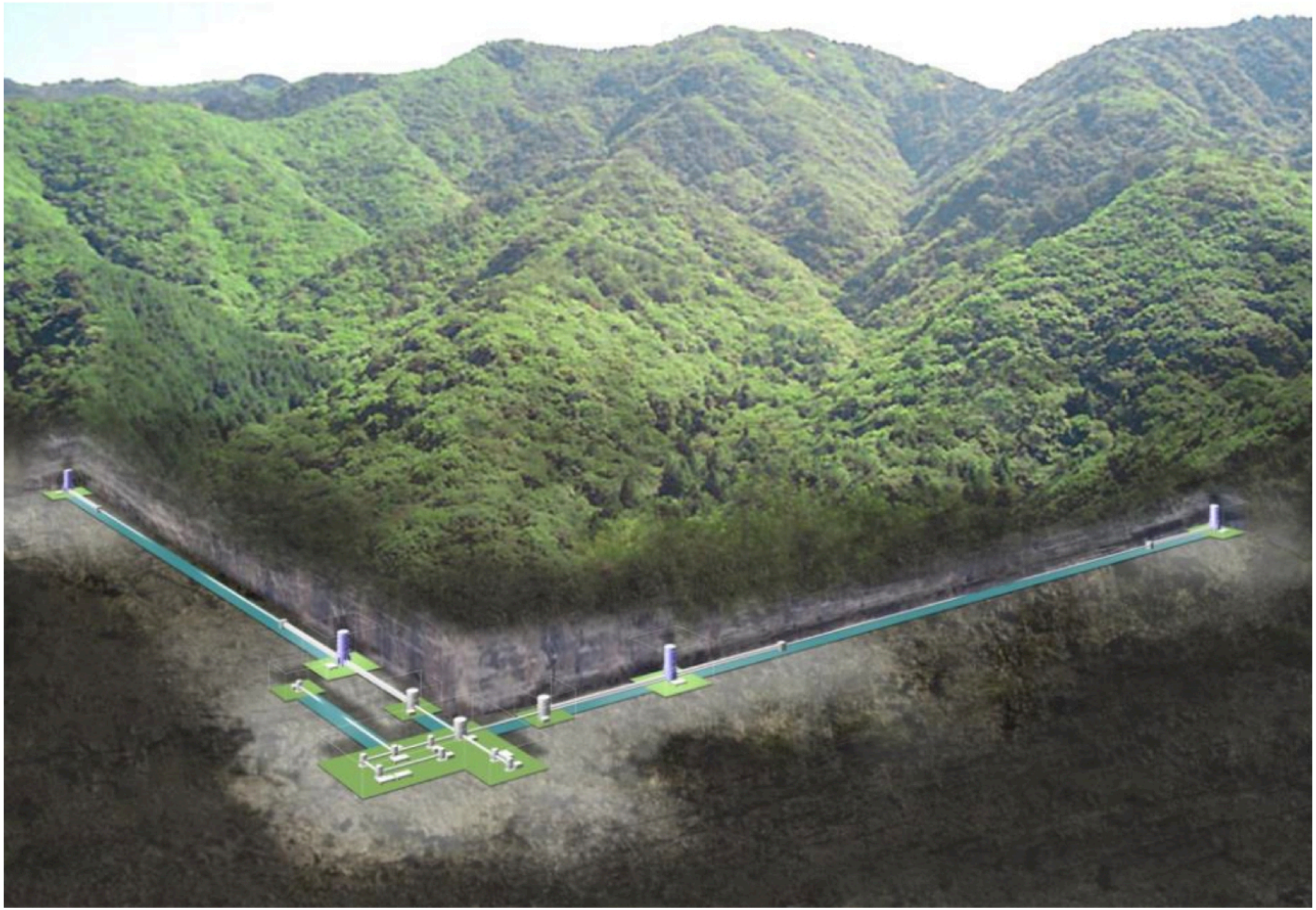
KAGRA



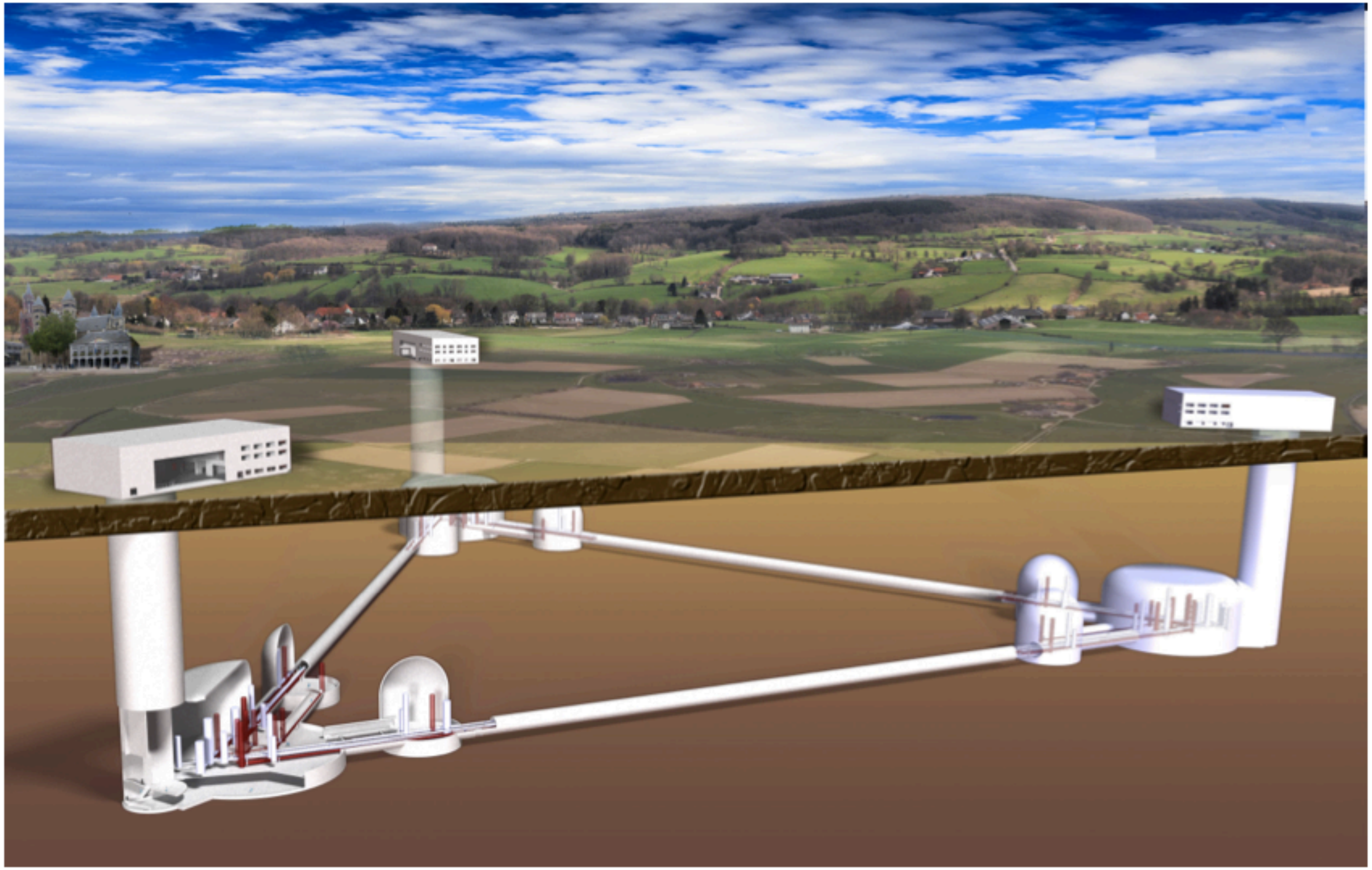
Credit Kagra

Ranges

	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

The new infrastructures

Einstein Telescope
(and US Cosmic Explorer)



Credit: Einstein Telescope

The big picture (again, as a summary)