Status of GW Detectors & When will we send SNEWS alerts?

Christian D. Ott

TAPIR, California Institute of Technology

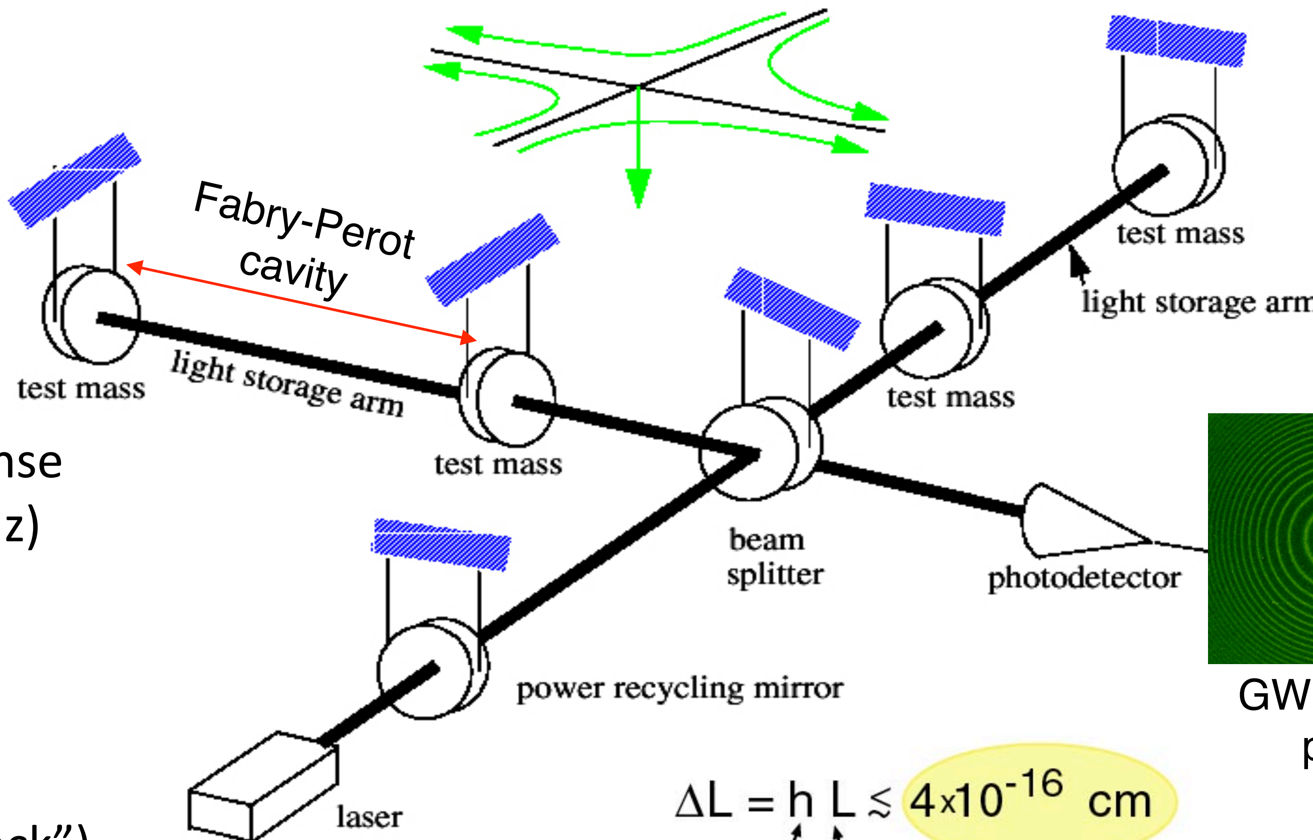
cott@tapir.caltech.edu

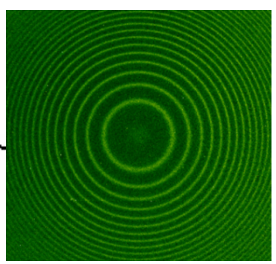
Disclaimer: Member of the LIGO Scientific Collaboration, but **not officially speaking** on behalf of the LIGO Scientific Collaboration in this talk.

Detecting Gravitational Waves: Laser Interferometers

Advantages:
- Broadband response (~50 Hz to few KHz)
- High sensitivity

Disadvantage:
- Very difficult to keep stable (“in lock”) -> poor duty cycle (~50%)





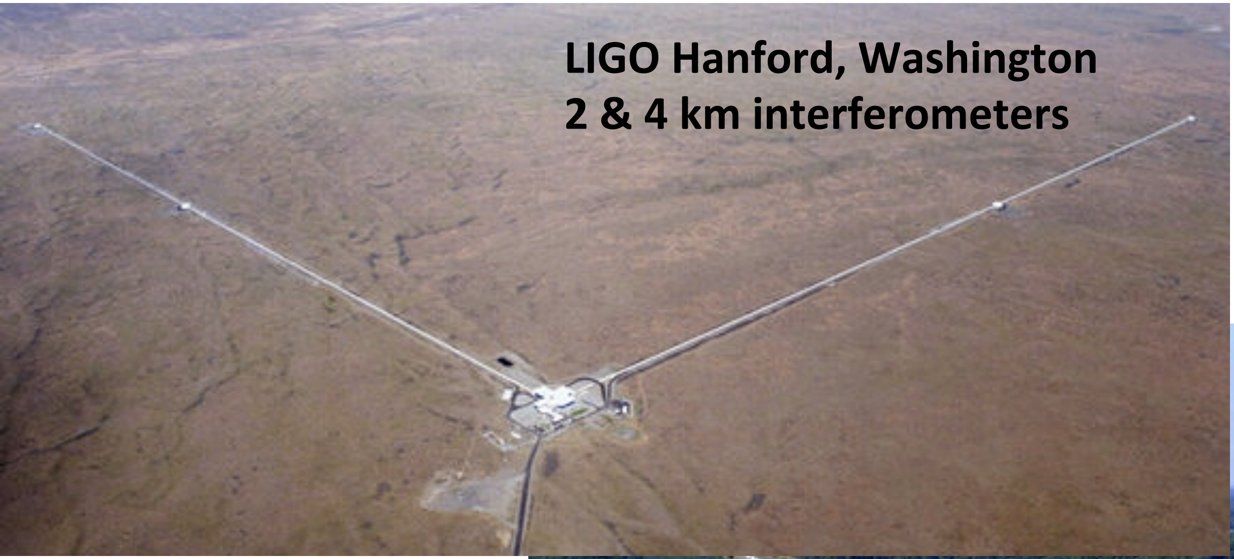
GW output port

$$\Delta L = h\,L \lesssim 4\times10^{-16}\ \text{cm}$$

$h \lesssim 10^{-21}$, L = 4 km

Basic Michelson Interferometer design + upgrades (power recycling, Fabry Perot cavities)

Laser Interferometer Gravitational-Wave Observatory





Kip Thorne, Rai Weiss, Ron Drever

Envisioned in the 1980s by
Kip Thorne, Rai Weiss, Ron Drever

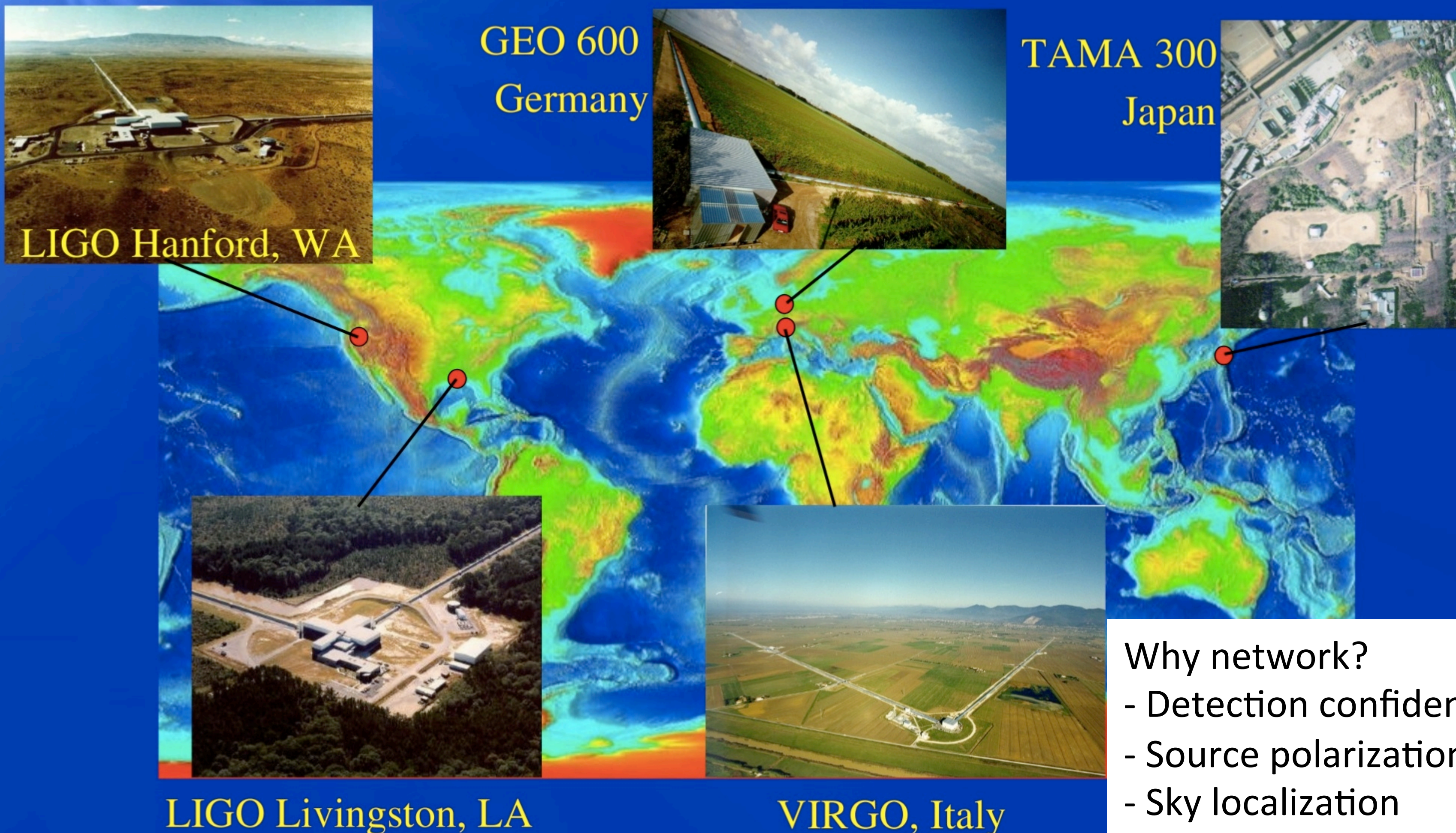
Built in the 1990s.

6 “science runs” 2002-2010.

Gravitational Wave Astronomy

International Network of LIGOs

First Generation – 2000 -- 2010



Why network?
- Detection confidence
- Source polarization
- Sky localization
- Sky coverage
- Duty cycle

Advanced Detectors

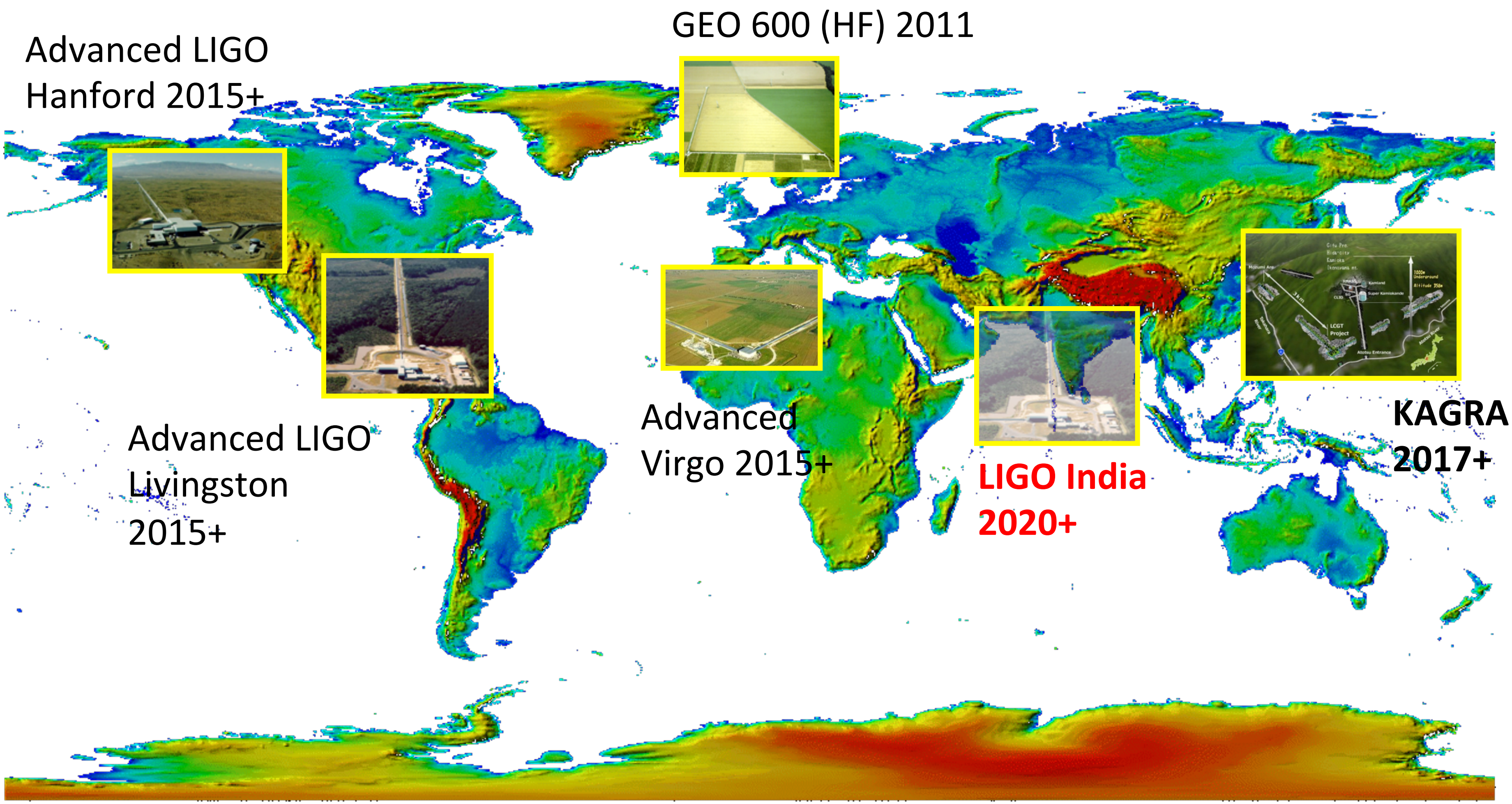
Advanced LIGO and VIRGO

- ~10 x sensitivity of initial detectors
- Expected to observe multiple events from binary mergers per year.
- **Will detect galactic core-collapse supernova even for most pessimistic gravitational-wave emission models.**
- **Limited extragalactic reach: ~Andromeda. Comparable to SuperK!**
- Network (data sharing in place):
  - 2 x 4 km LIGOs in the US
  - 1 x 3 km Virgo in Italy
  - 1 x 600 m GEO-HF in Germany (focusing on high frequencies)
  - 1 x 4 km in India (2020+)

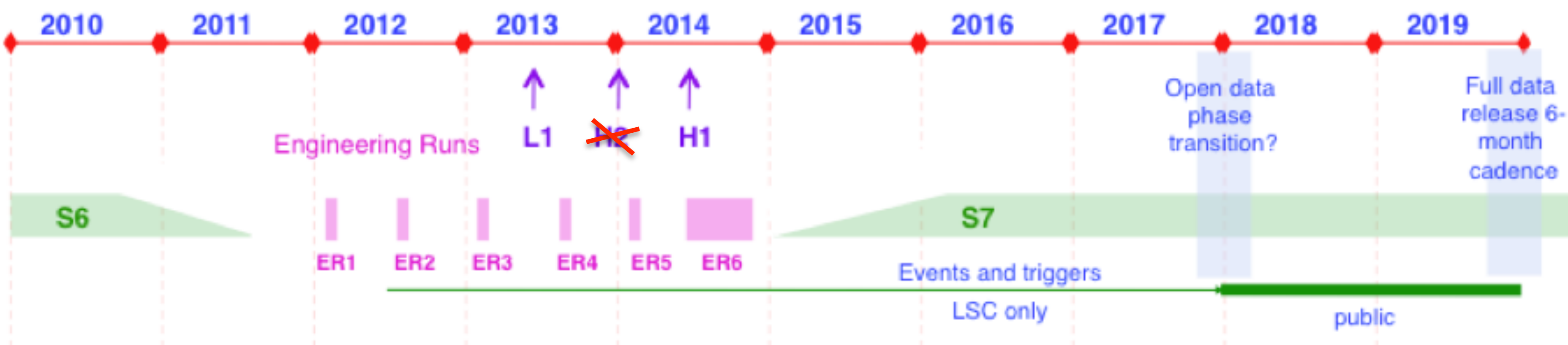
KAGRA

- 2016+
- 1 x 3 km in Kamioke mine
- cryogenic, superior sensitivity at intermediate frequencies
- **Data sharing between LIGO-Virgo & KAGRA being negotiated!**

The Advanced GW Detector Network: 2020+



Advanced LIGO Timeline and Trigger Release



Discovery Phase

- 2015/16+, until multiple (N>=4) detections have been made.
- Trigger release to partner collaborations (via MoU) and electromagnetic telescopes for follow-up.
- No low-latency public data release.

Observational Phase

- 2017+ (?), after at least 4 detections/publications.
- High-confidence triggers released to public (-> SNEWS).
- Full data release with 2 year latency, 6 month cadence.

The Case for Joint GW-Neutrino Analyses

Archival data (2005-2010)

- Conservative approach: Search for temporal coincidence of >= 2 neutrino events with gravitational-wave trigger. Require FAR 1/1000 yrs.
- **Main benefit: Background reduction by requiring O(10) s coincidence.**
- Can improve sensitivity of GW search by ~20-50%.
- May allow lowering of energy threshold for deep neutrino search. If lowered to ~8 MeV -> factor of two improvement of detection probability while maintaining 1/1000 yrs FAR.

Advanced Detector GW data (2015+)

- Comparable distance reach of SuperK and KAGRA/aLIGO/AdvVirgo.
- Will get high-SNR data from galactic event -> study supernova physics, but must develop joint analysis/parameter estimation techniques (exciting opportunities, see my talk tomorrow morning)
- Joint low-latency triggering (via SNEWS).

-> Now is the time to start talking, collaborating, and preparing!