GW150914: Beginning A New Era For LIGO & Gravitational Wave Astronomy

Arecibo Observatory
3/8/16
Corey Gray

LIG

Courtesy of Raab (G1600258

LIGO

My Resume (18 in “LIGO Years”)

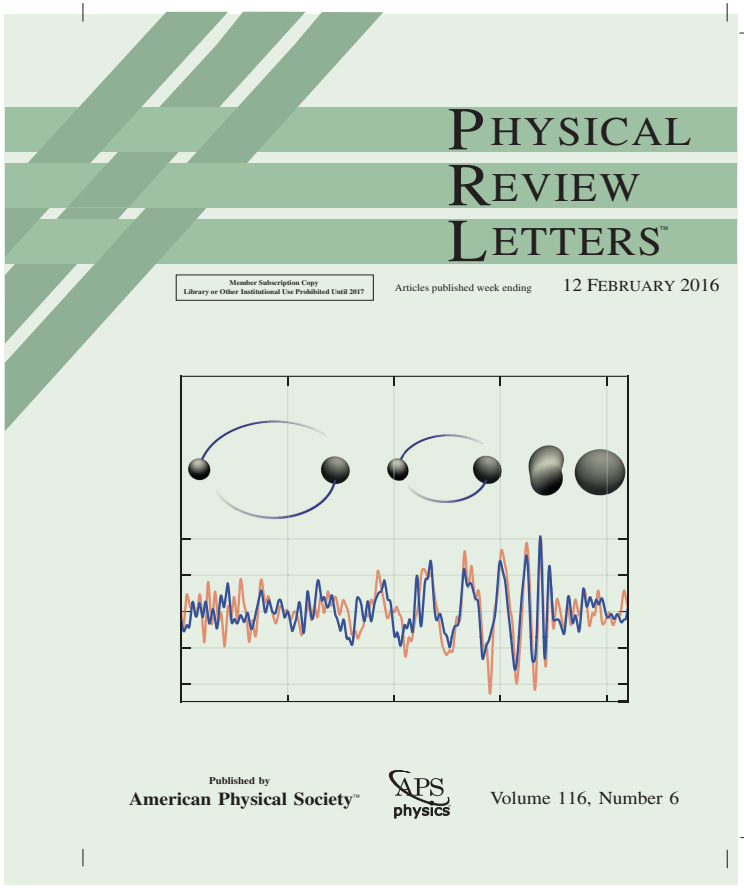
- B.S. Physics & Applied Mathematics
- Physicist
- Hands-on work
- Operator
- Supervisor

The Control Room

National Press Conference 2/11/16!

Observation of Gravitational Waves from a Binary Black Hole Merger

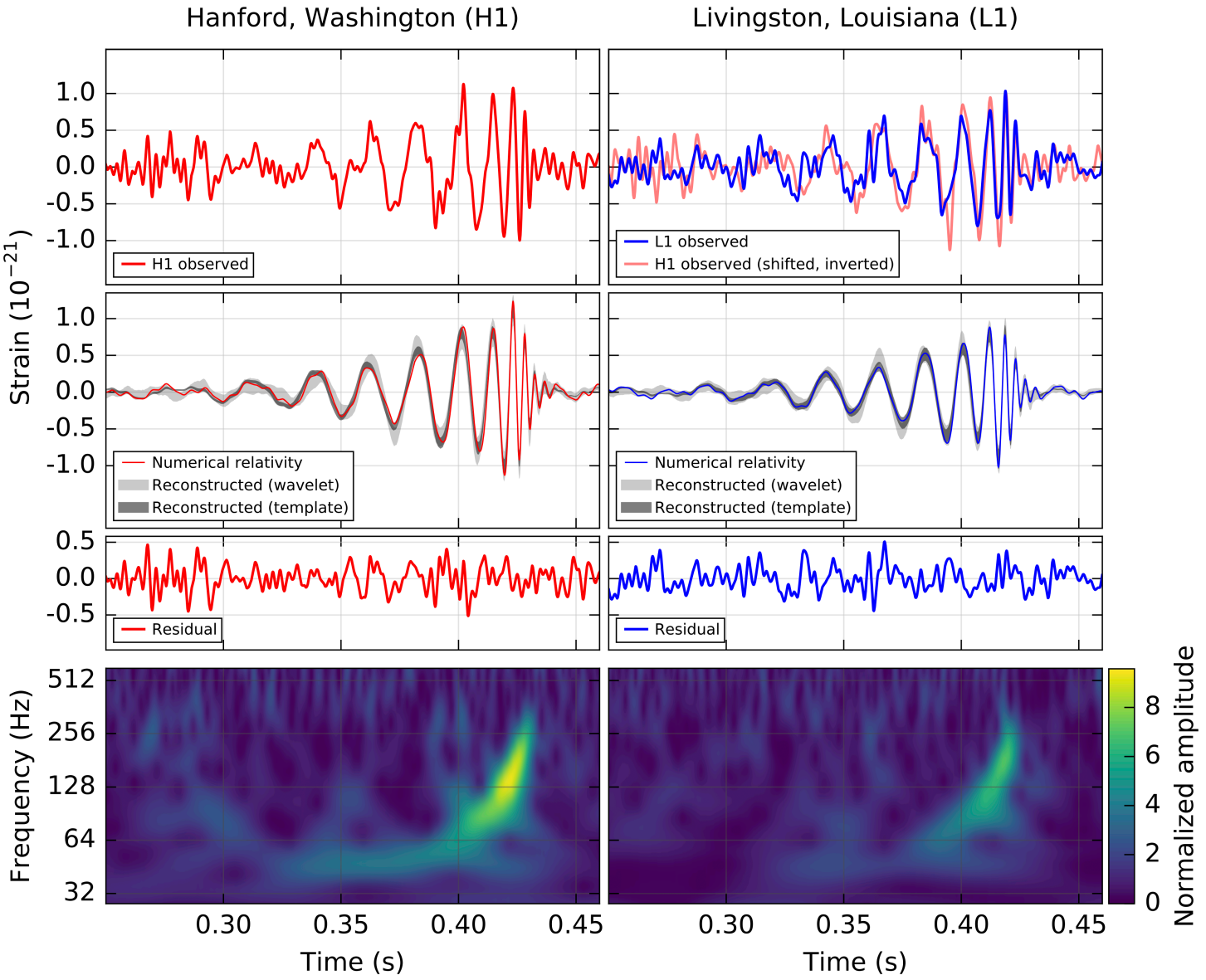
B. P. Abbott *et al.*[*]
(LIGO Scientific Collaboration and Virgo Collaboration)
(Received 21 January 2016; published 11 February 2016)



https://www.ligo.caltech.edu/page/detection-companion-papers

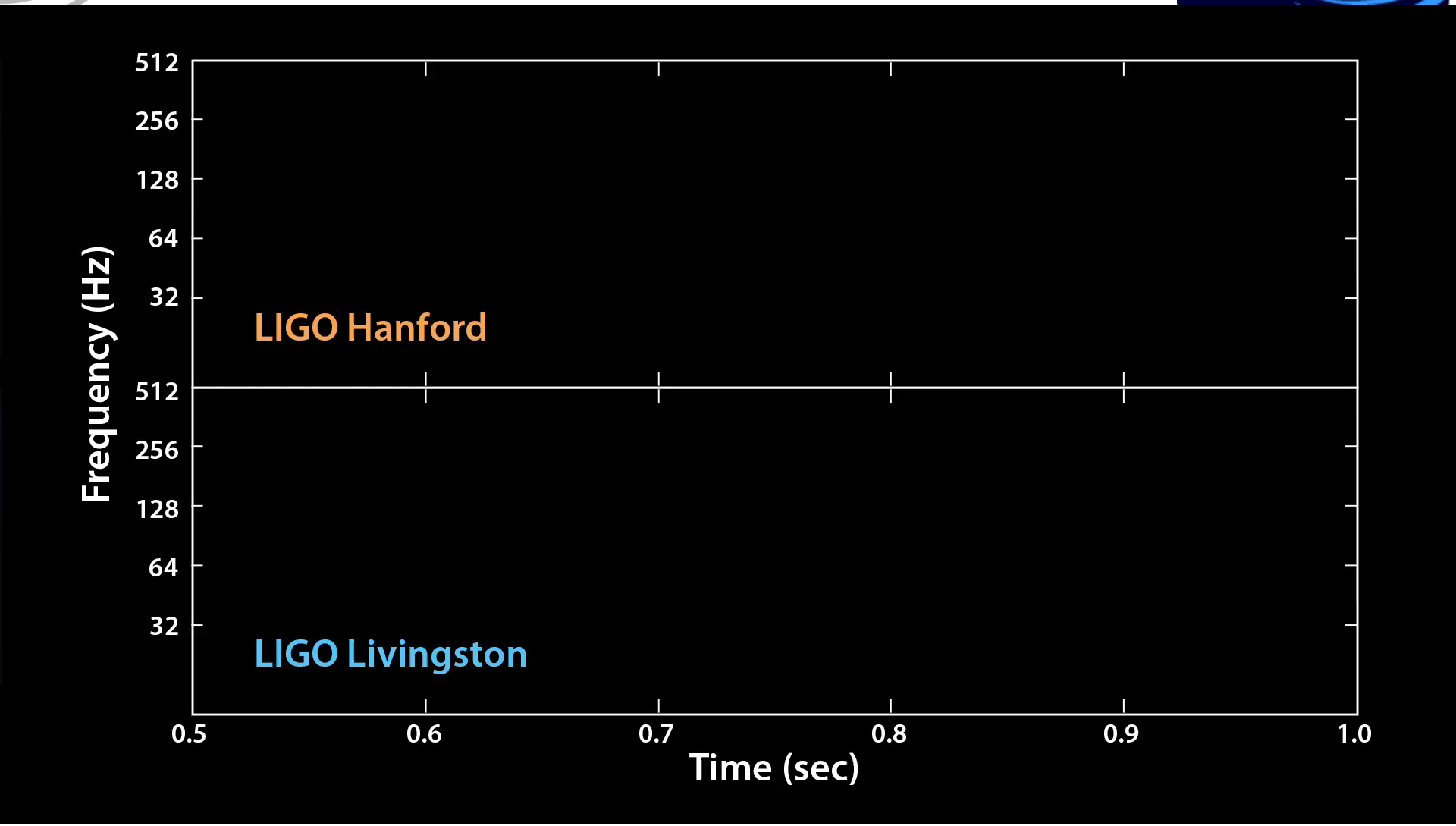
Courtesy of Dooley & Cavaglia (G1600354)

What was observed?

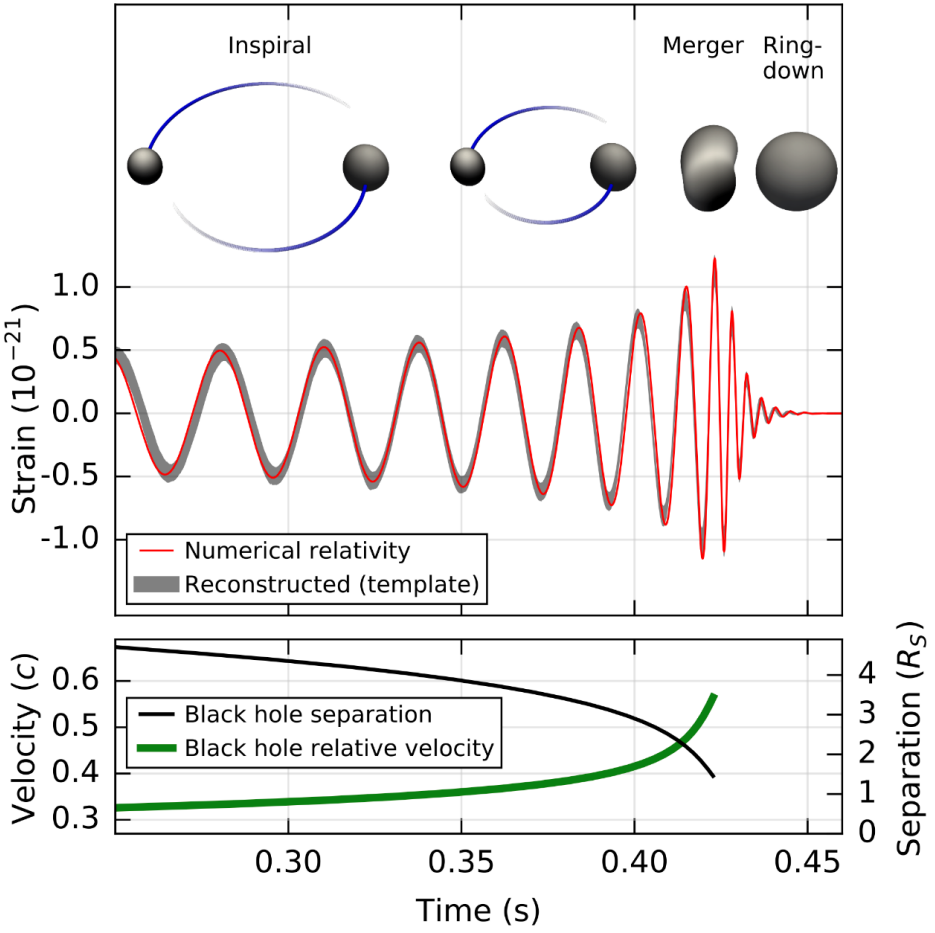


LIGO

LSC


512
256
128
64
32
LIGO Hanford
512
256
128
64
32
LIGO Livingston
Frequency (Hz)
0.5
0.6
0.7
0.8
0.9
1.0
Time (sec)

LIGO A signal from a binary black hole merger



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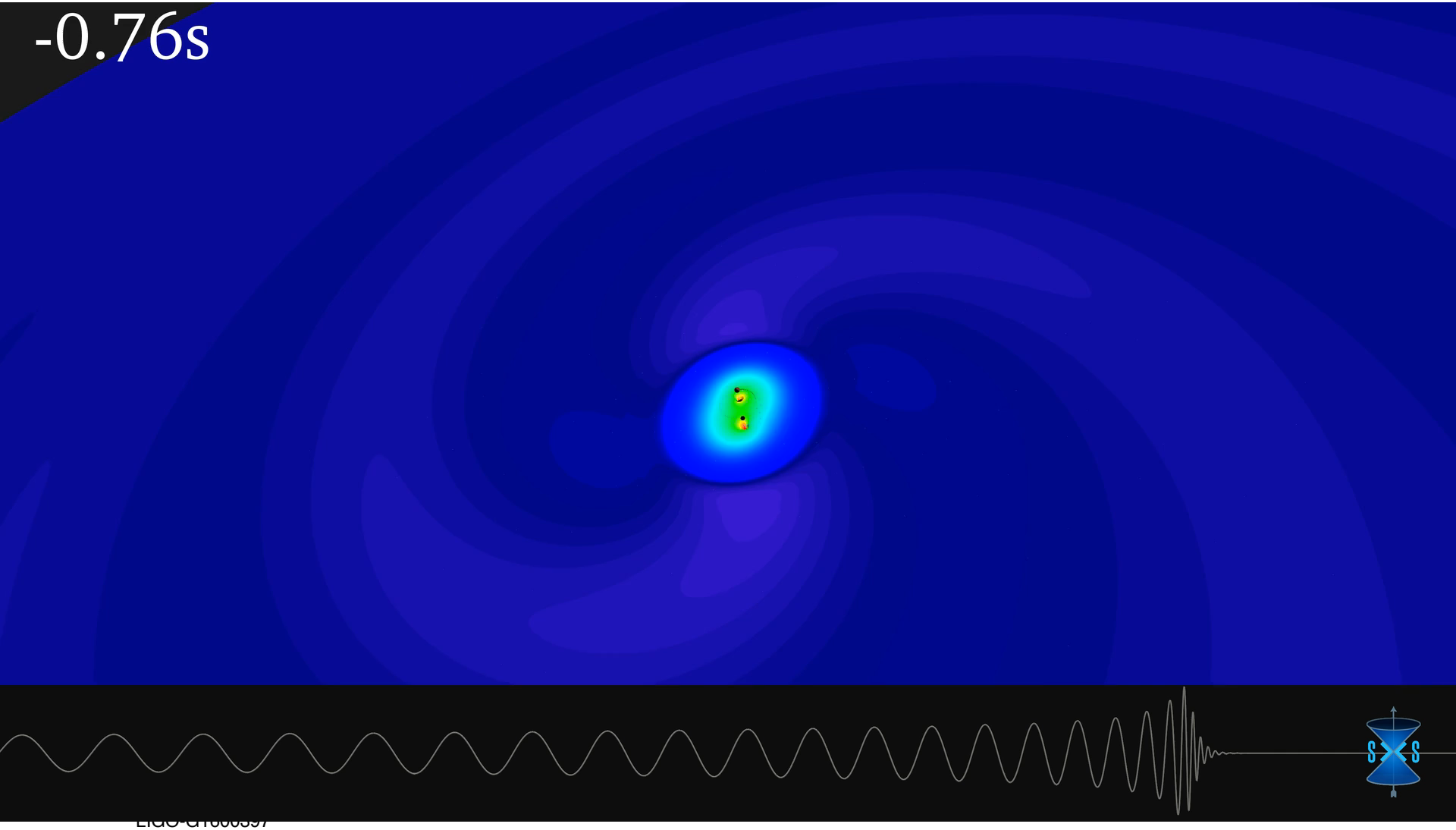
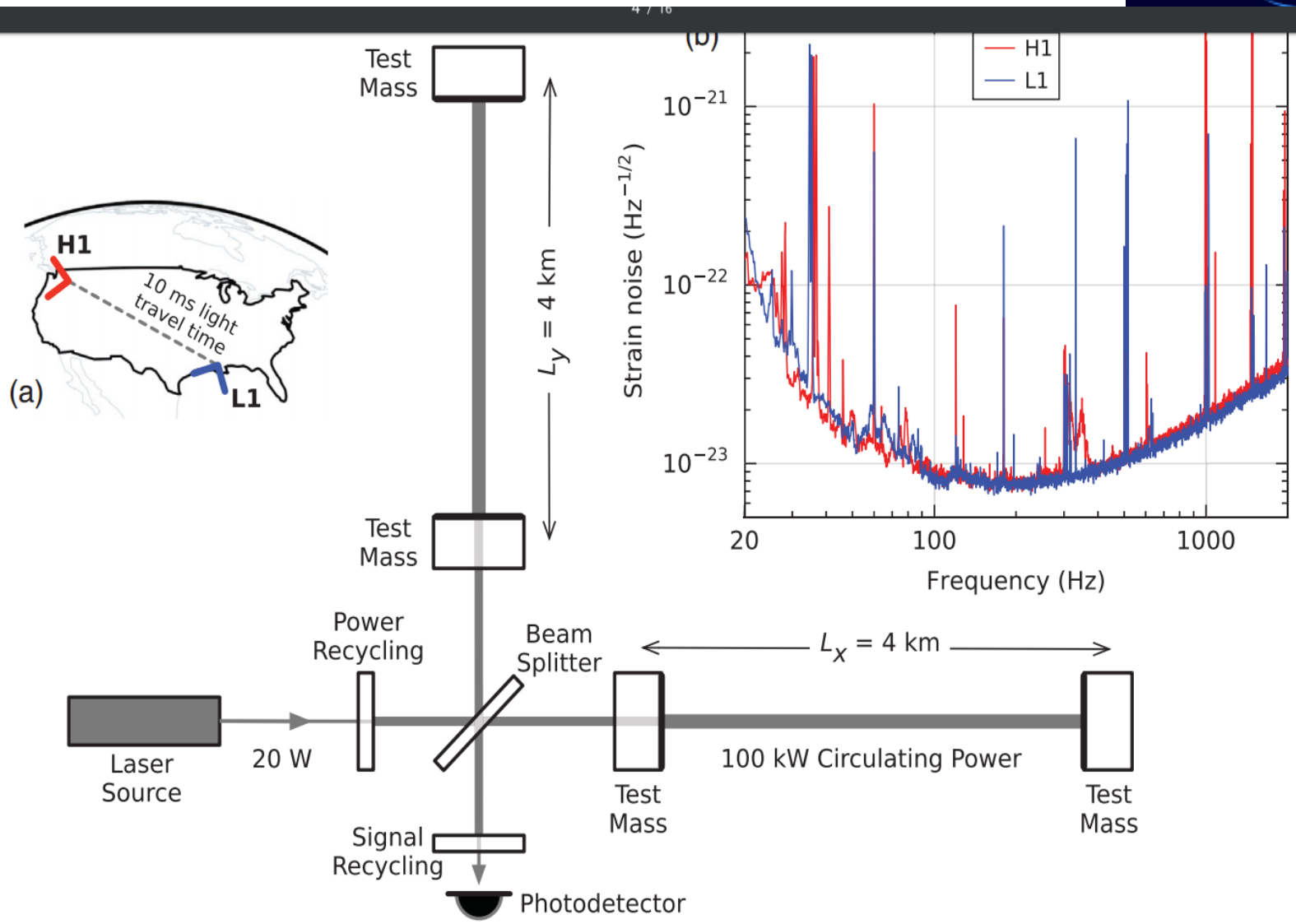


LIGO

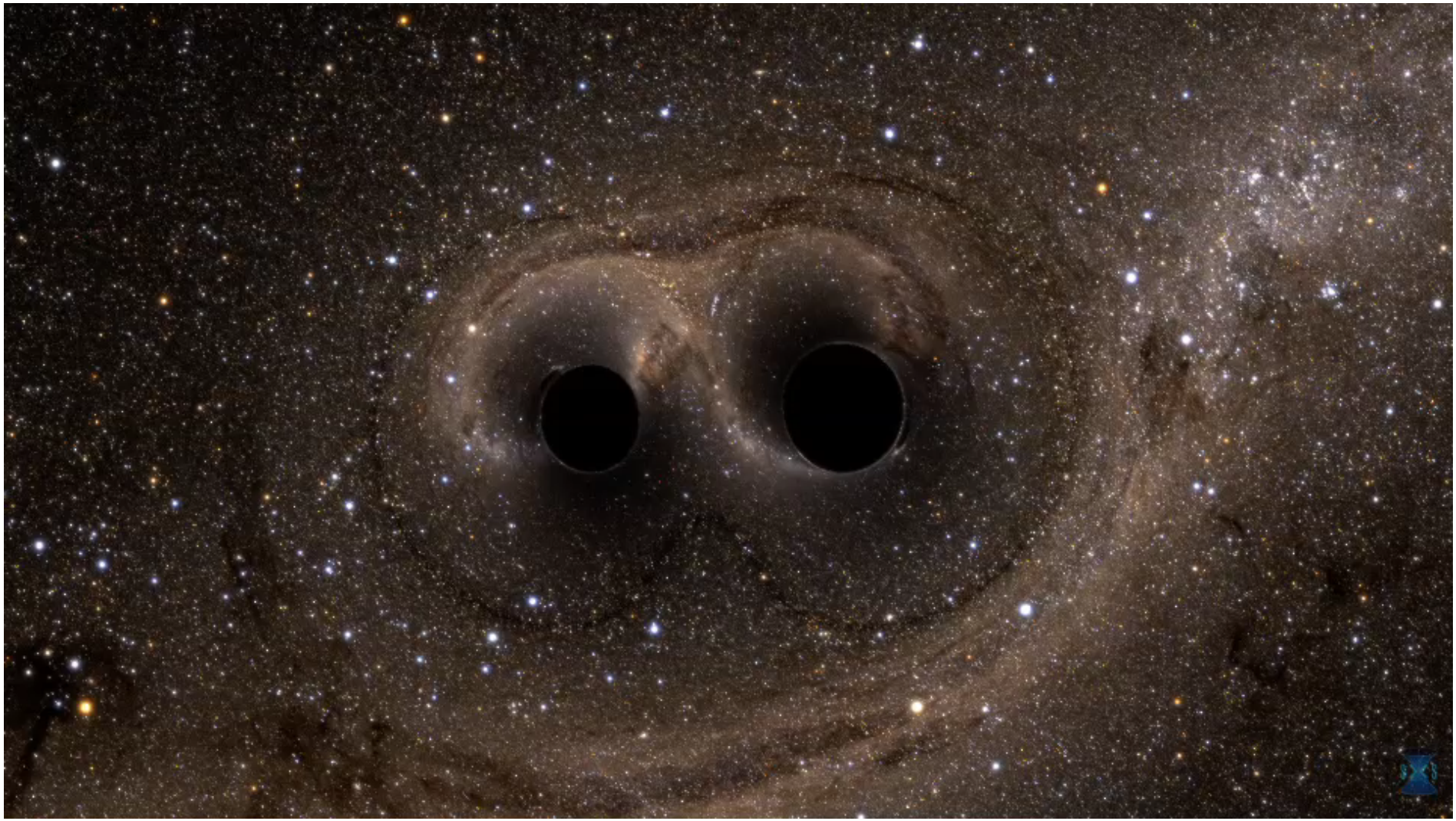
LSC



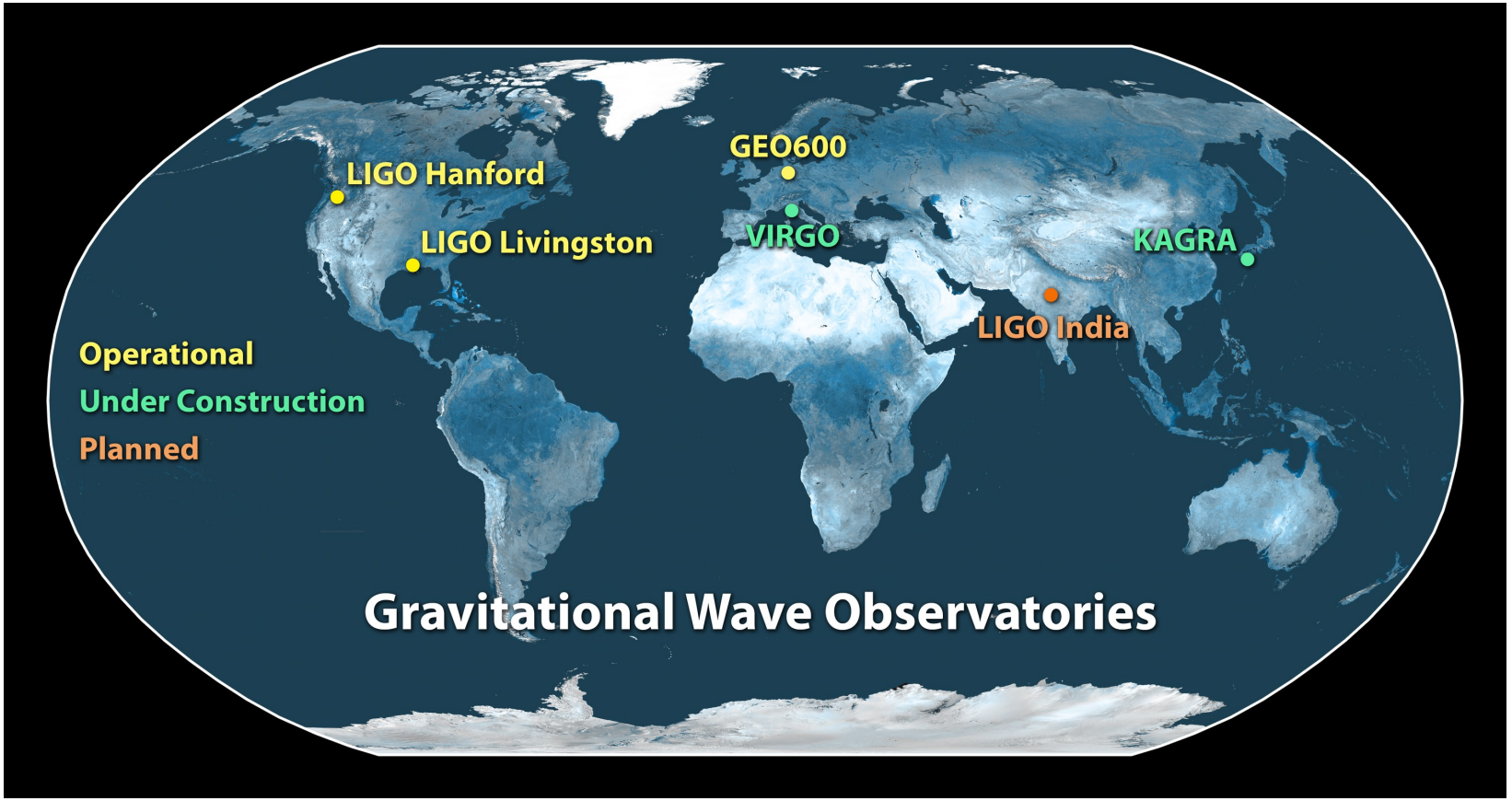
LIGO-G1600397

Courtesy of Dooley & Cavaglia (G1600354)

First-ever tests of Einstein's theories under dynamical, extreme-gravity conditions



Gravitational wave observatories around the world



Original detection strategy succeeds!

Proposal to the National Science Foundation

THE CONSTRUCTION, OPERATION, AND SUPPORTING RESEARCH AND DEVELOPMENT OF A

LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY

Submitted by the
CALIFORNIA INSTITUTE OF TECHNOLOGY

Rochus E. Vogt
Principal Investigator and Project Director
California Institute of Technology

Ronald W. P. Drever
Co-Investigator
California Institute of Technology

Kip S. Thorne
Co-Investigator
California Institute of Technology

Frederick J. Raab
Co-Investigator
California Institute of Technology

Rainer Weiss
Co-Investigator
Massachusetts Institute of Technology

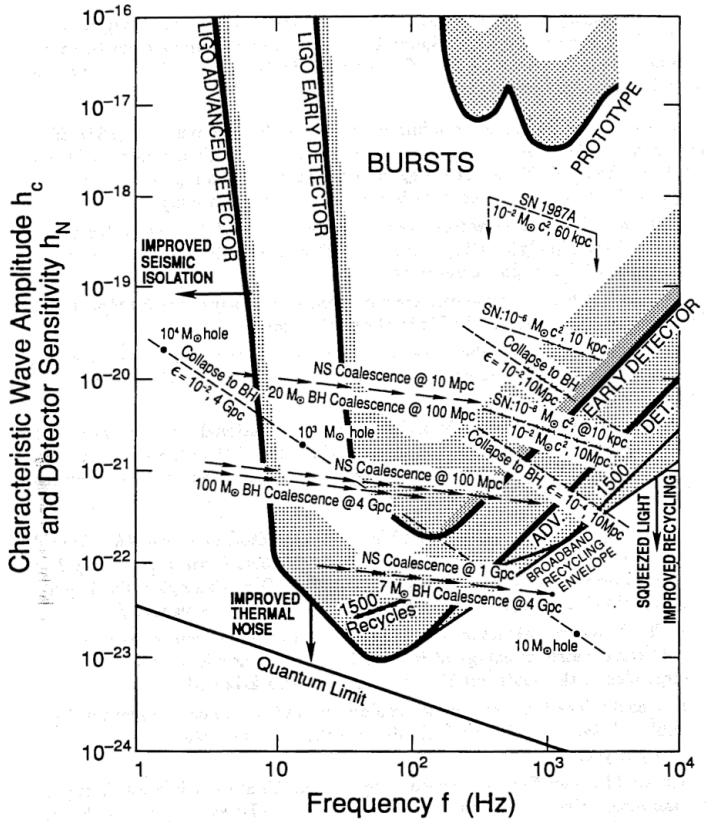


Figure II–2 A comparison of the strengths of gravitational waves (characteristic amplitude h_c and frequency f) for burst signals from various sources (dashed lines and arrows), and benchmark sensitivities h_N (solid curves and stippled strips atop them) for interferometric detectors today (*prototype*) and in the proposed LIGO (*early detector, advanced detector*). See the caption of Figure A-4a (a duplicate of this figure) and the associated discussion in Appendix A for more details.

Extra Slides

Amazing Facts about GW150914

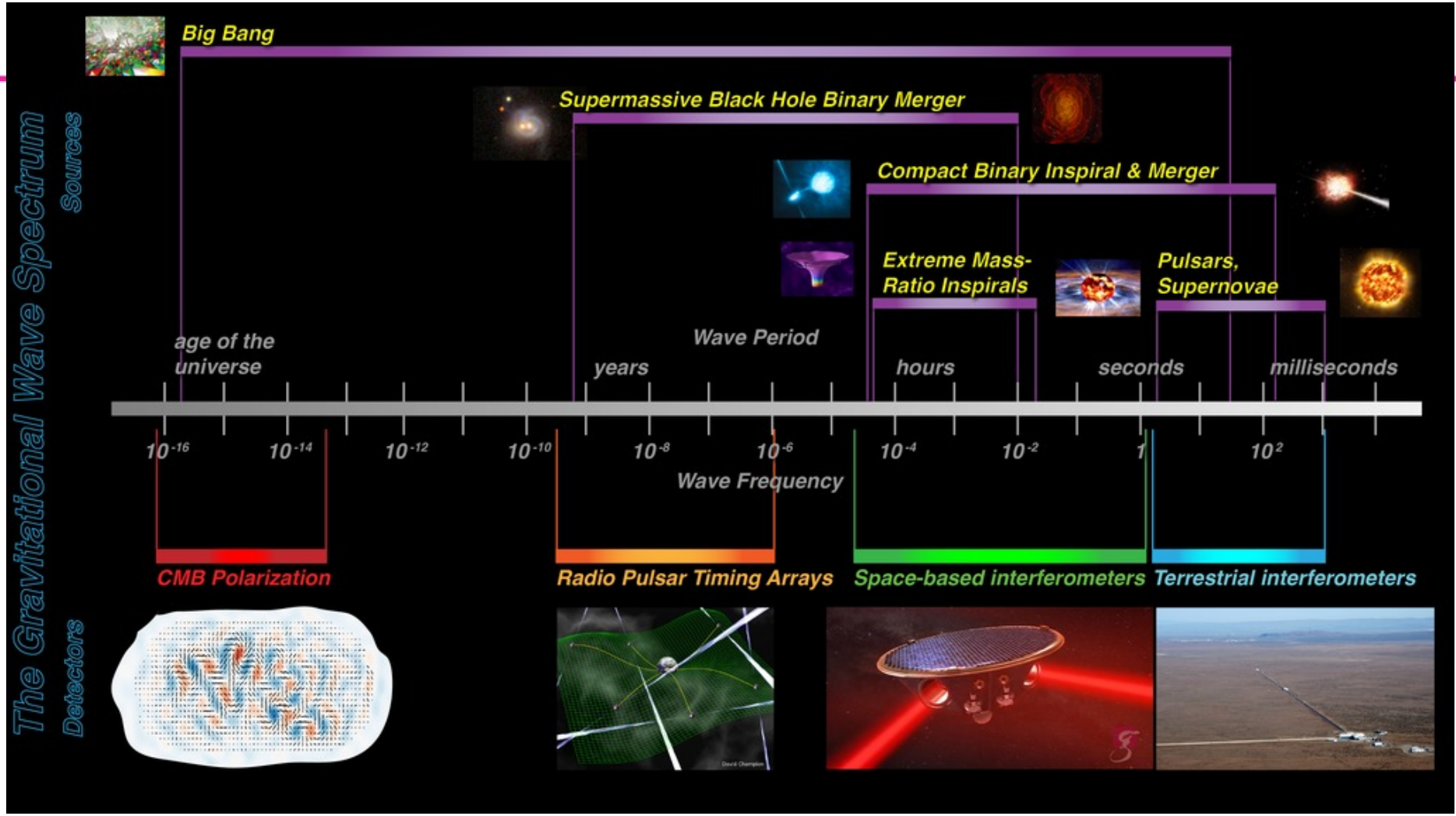
3 times the mass of the sun (1 million times the mass of Earth) turned into energy vibrating the fabric of spacetime

Peak power more than **10,000,000,000,000,000,000,000,000,000,000,000,000,000 times** the output of the Columbia Generating Station

Relative distance change same as **changing distance to nearest star by width of human hair**

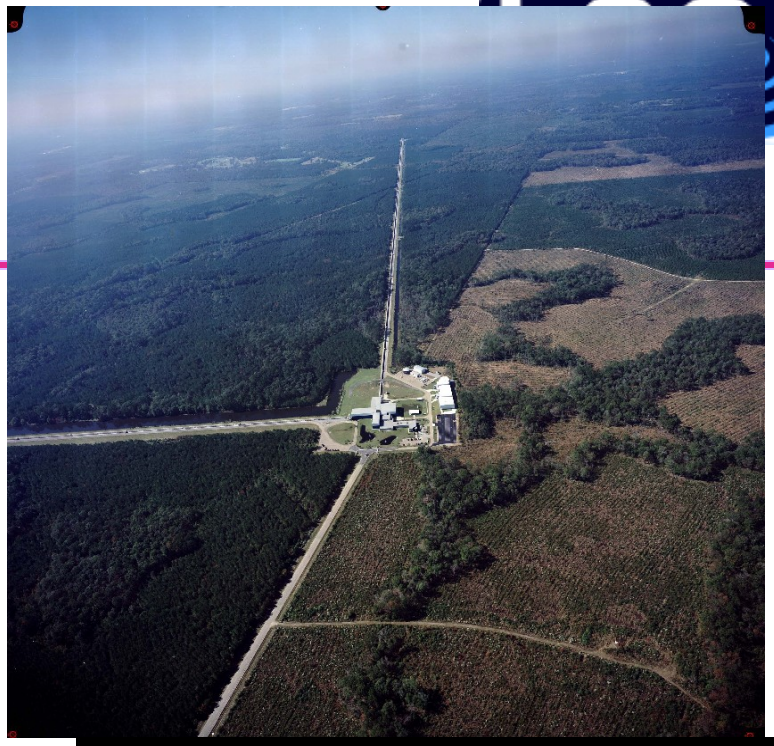
Merger actually happened more than **1 billion years ago**

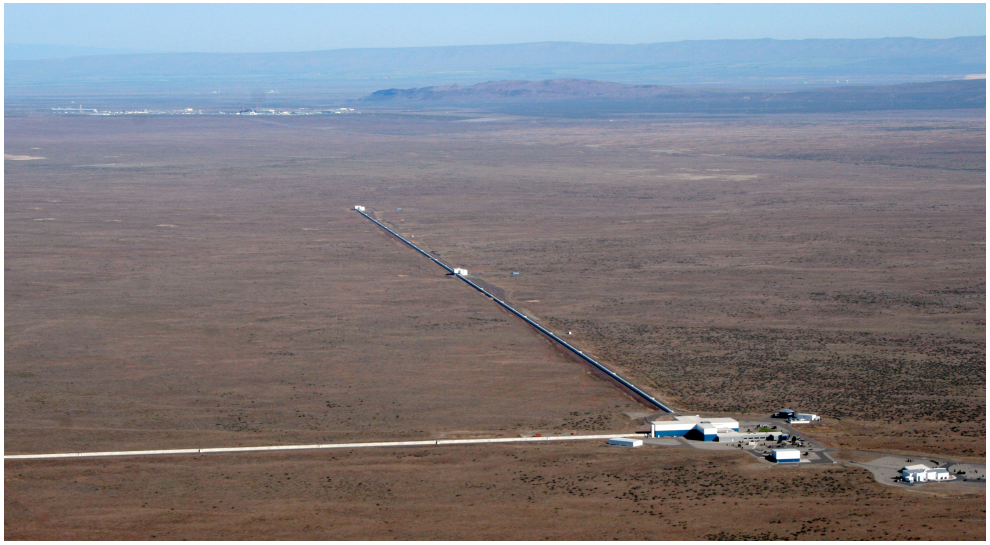
In the volume that we can see systems like GW150914, there are more than **5 million galaxies**



Courtesy of Dooley & Cavaglia (G1600354)

LIGO

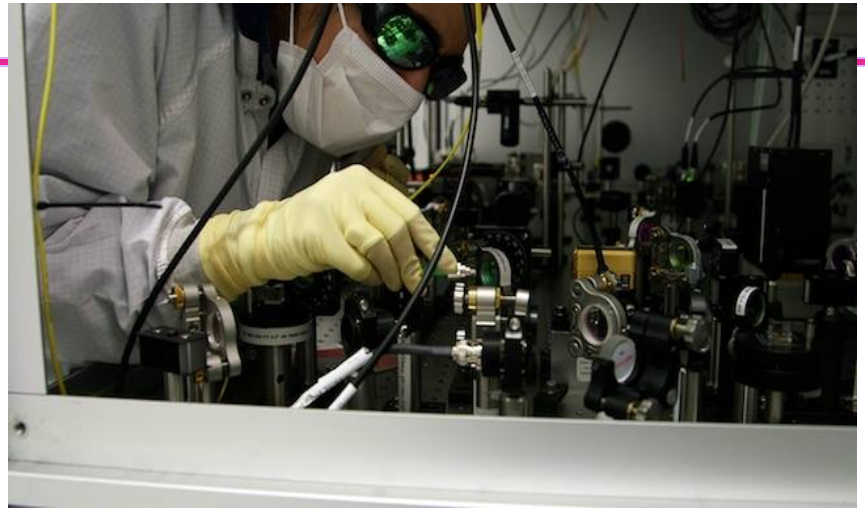


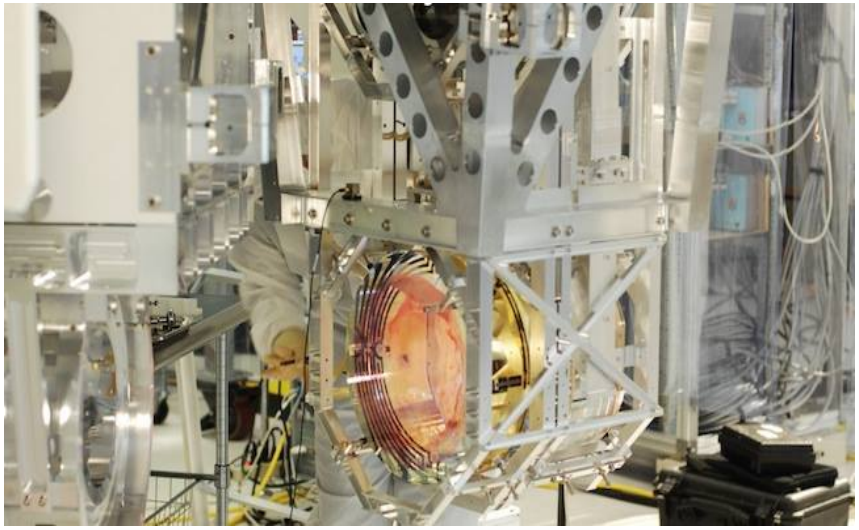


Courtesy of Dooley & Cavaglia (G1600354)

LIGO

LSC





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Courtesy of Dooley & Cavaglia (G1600354)

LIGO

LSC

Abilene Christian University
Albert-Einstein Institut
Andrews University
American University
California Institute of Technology
California State Univ., Fullerton
Canadian Inst. Th. Astrophysics
Carleton College
College of William and Mary
Columbia U. in the City of New York
Embry-Riddle Aeronautical Univ.
Eötvös Loránd University
Georgia Institute of Technology
Goddard Space Flight Center
Hobart & William Smith Colleges
ICTP-SAIFR
IndIGO
IAP-Russian Acad. of Sciences
Inst. Nacional Pesquisas Espaciais
Kenyon College
Korean Gravitational-Wave Group
Louisiana State University
Montana State University
Montclair State University
Moscow State University
National Tsinghua University
Northwestern University

Penn State University
Rochester Institute of Technology
Sonoma State University
Southern Univ. and A&M College
Stanford University
Syracuse University
Szeged University
Texas Tech University
Trinity University
Tsinghua University
Universitat de les Illes Balears
University of Alabama in Huntsville
University of Brussels
University of Chicago
University of Florida
University of Maryland
University of Michigan
University of Minnesota
University of Mississippi
University of Oregon
University of Sannio
Univ. of Texas-Rio Grande Valley
University of Washington
University of Wisconsin-Milwaukee
Washington State University
West Virginia University
Whitman College

LIGO Laboratory: California Institute of Technology, Massachusetts Institute of Technology, LIGO Hanford Observatory, LIGO Livingston Observatory

Australian Consortium for Interferometric Gravitational Astronomy (ACIGA):
Australian National University, Charles Sturt University, Monash University, University of Adelaide, University of Melbourne, University of Western Australia

Collaboration for the Detection of Gravitational Waves (GEO600):
Cardiff University, Leibniz Universität Hannover, Albert-Einstein Institut, Hannover, King's College London, Rutherford Appleton Laboratory, University of Birmingham, University of Cambridge, University of Glasgow, University of Hamburg, University of Sheffield, University of Southampton, University of Strathclyde, University of the West of Scotland

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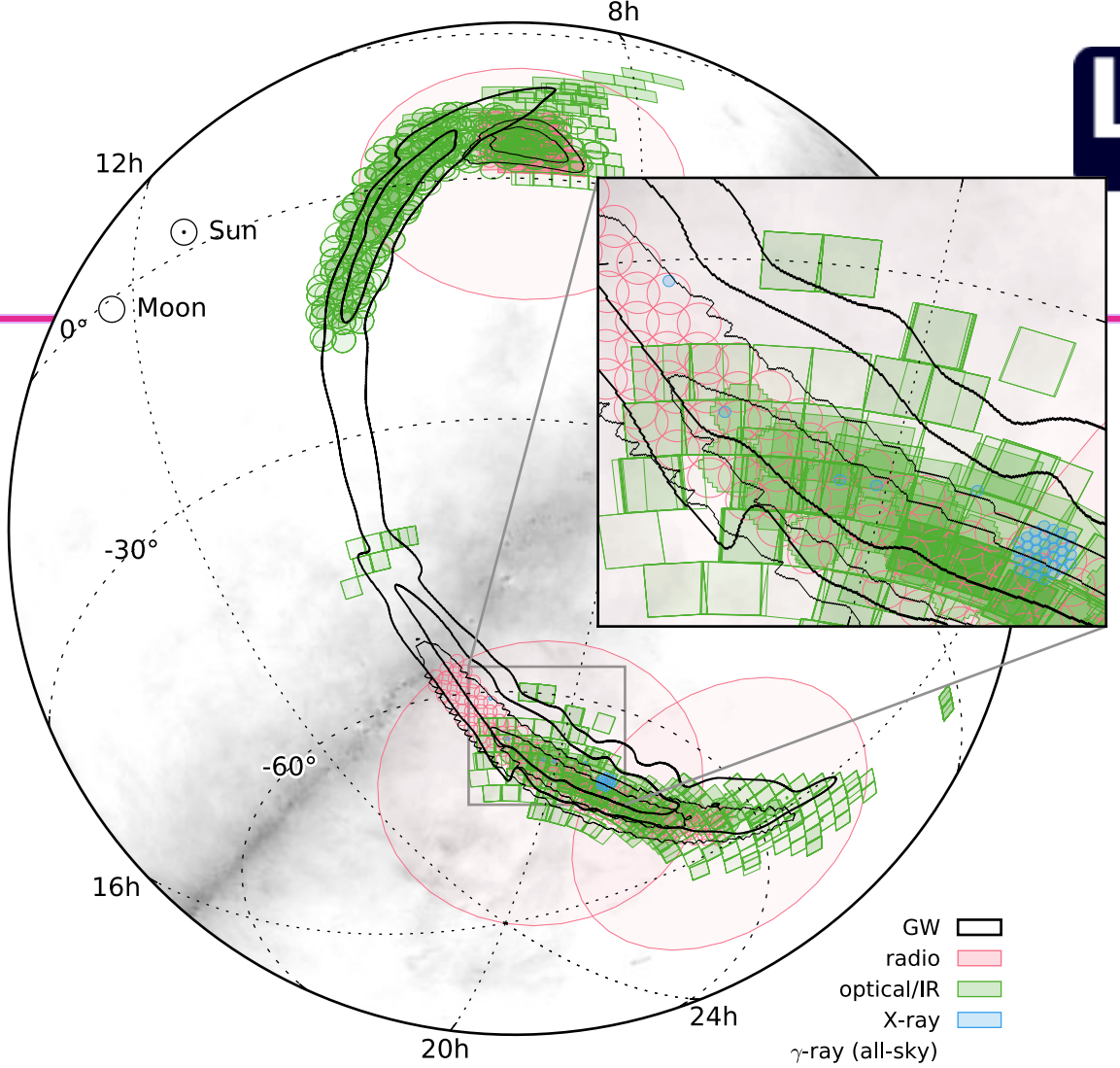
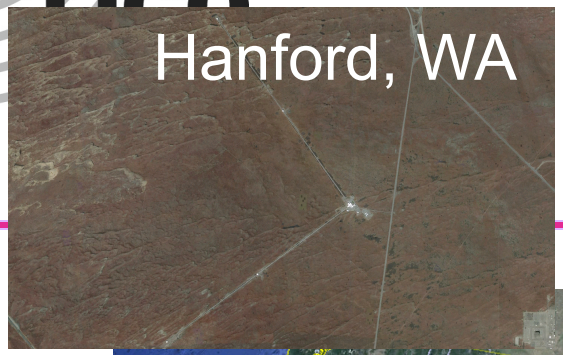
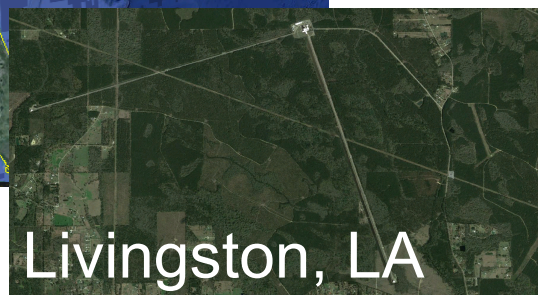


"Localization and broadband follow-up of the gravitational-wave transient GW150914"
(https://dcc.ligo.org/public/0122/P1500227/009/GW150914_localization_and_followup.pdf)





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