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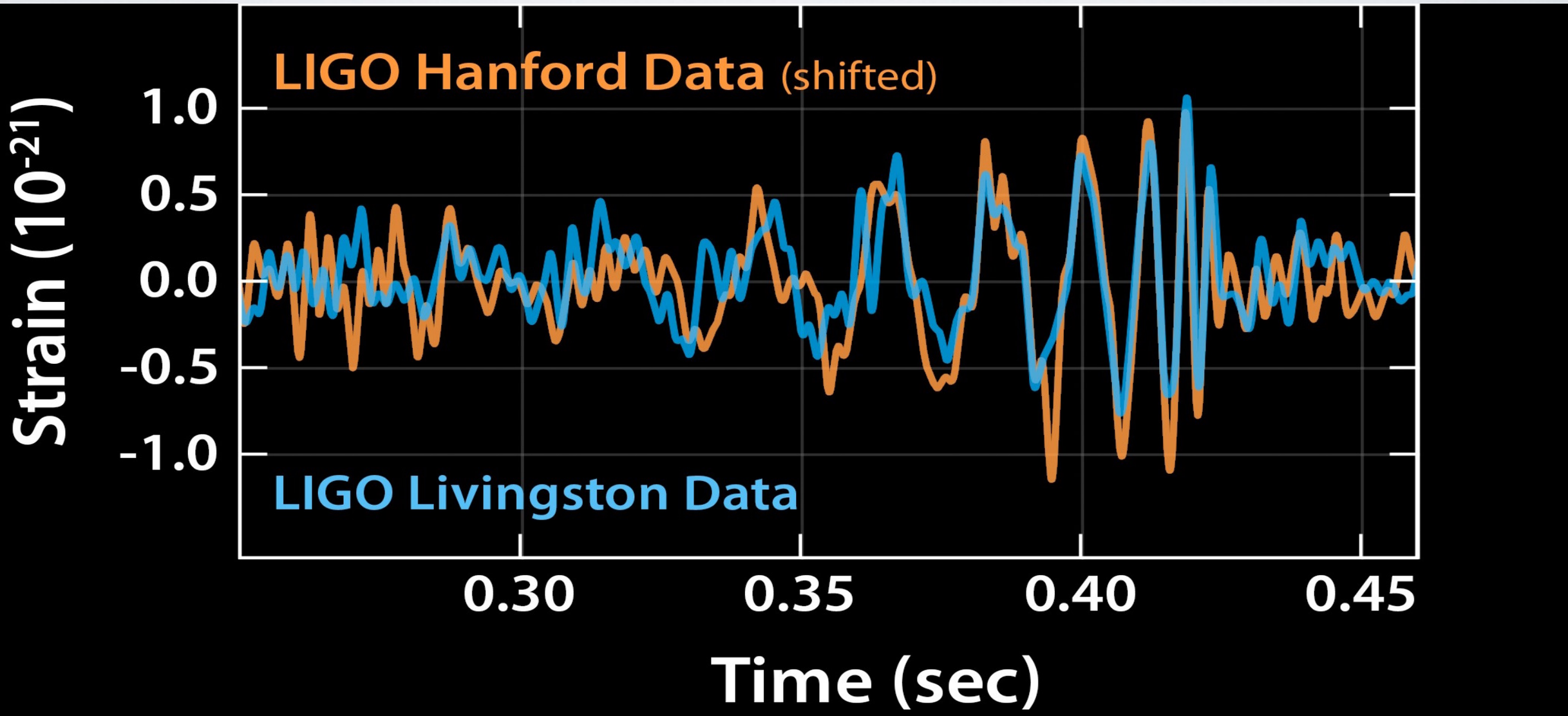

SCIENCE EVENT OF THE DECADE!

On NYC's Highline this week:

B F Schutz
Albert Einstein Institute/Cardiff University

26.05.2016

(Credit: Rachel Schutz 2016)

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> **The uncertainty in the waves' strength arises solely from the uncertain distance to the nearest such sources. The observed statistics of binary neutron stars in our own galaxy, extrapolated to include distant galaxies, give a best estimate (32, 33) of 200 Mpc (650 million light years) for the distance to which LIGO must look to see three neutron star inspirals per year.**

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"First Sound" 2015
the First Gravitational Wave Detections and Beyond

(Austin 2011)

Bernard Schutz
Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Potsdam, Germany and School of Physics and Astronomy, Cardiff University, Wales

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- The experimental effort was matched by intense data analysis development within the LSC. Talks by Brown, Capano, Mandel, Bulik showed many of the results of this work.
- What we proved: that LIGO and its data analysis work, GR describes strong-field gravity well, that BHs exist, that BH-BH binaries exist and in large numbers.

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- Contributors outside the LSC were not authors but happily some were recognised by being included in the award of the Breakthrough Prize: Blanchet, Damour, Kidder, Pretorius, Scheel, Teukolsky, and Vogt (former LIGO director).

AND THIS IS JUST THE START!

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- Start to do cosmography, independently measure local H_0 to <1% once we have >100 BBH coalescences — end of decade?
- Opportunity for better testing of GR, studies of ringdown, beyond-doubt demonstration that these really are BHs, alternative theories (van den Broeck, Damour). But recall the caveat of Barausse - merger/ringdown deviations will show up very late.

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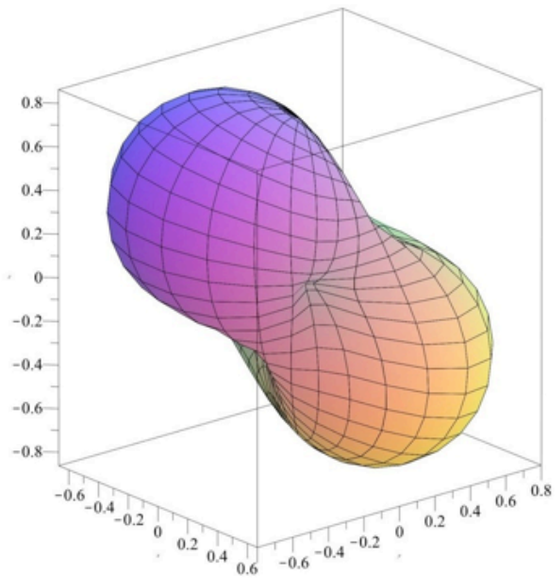
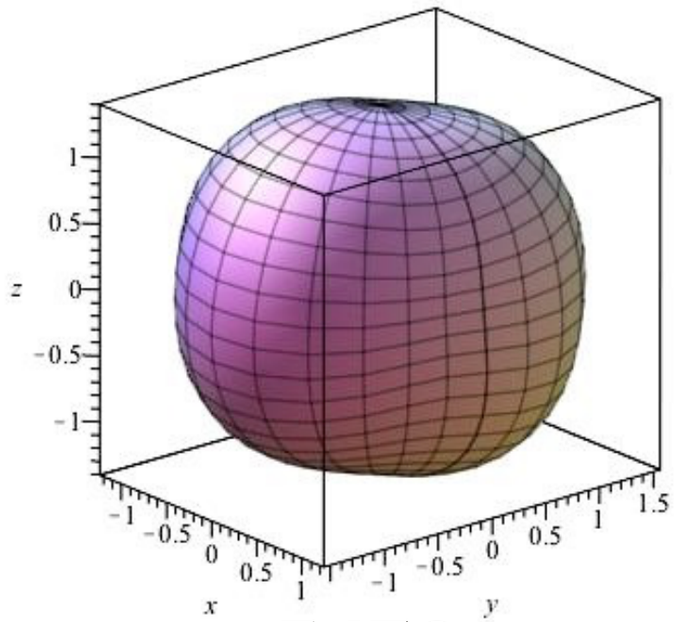


LIGO-Virgo



5 IFOs

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- We will be pushing on the boundaries of calibration (not discussed at this meeting). H_0 to better than 1% needs calibration at that level — this is hard!

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- Comparison of waveforms with NS-NS simulations is where the real physics will be examined: EoS, magnetic fields, neutrino transport, other physics? (Shibata, Kiuchi) I wonder if simulations see w-modes (analogues of BH QNMs) — for stiff EoS and 3 solar masses, they can have $f \sim 5$ kHz. They will be weak and compete against hydro modes.

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- Payoff is NS physics: crust properties, B-field configuration, …

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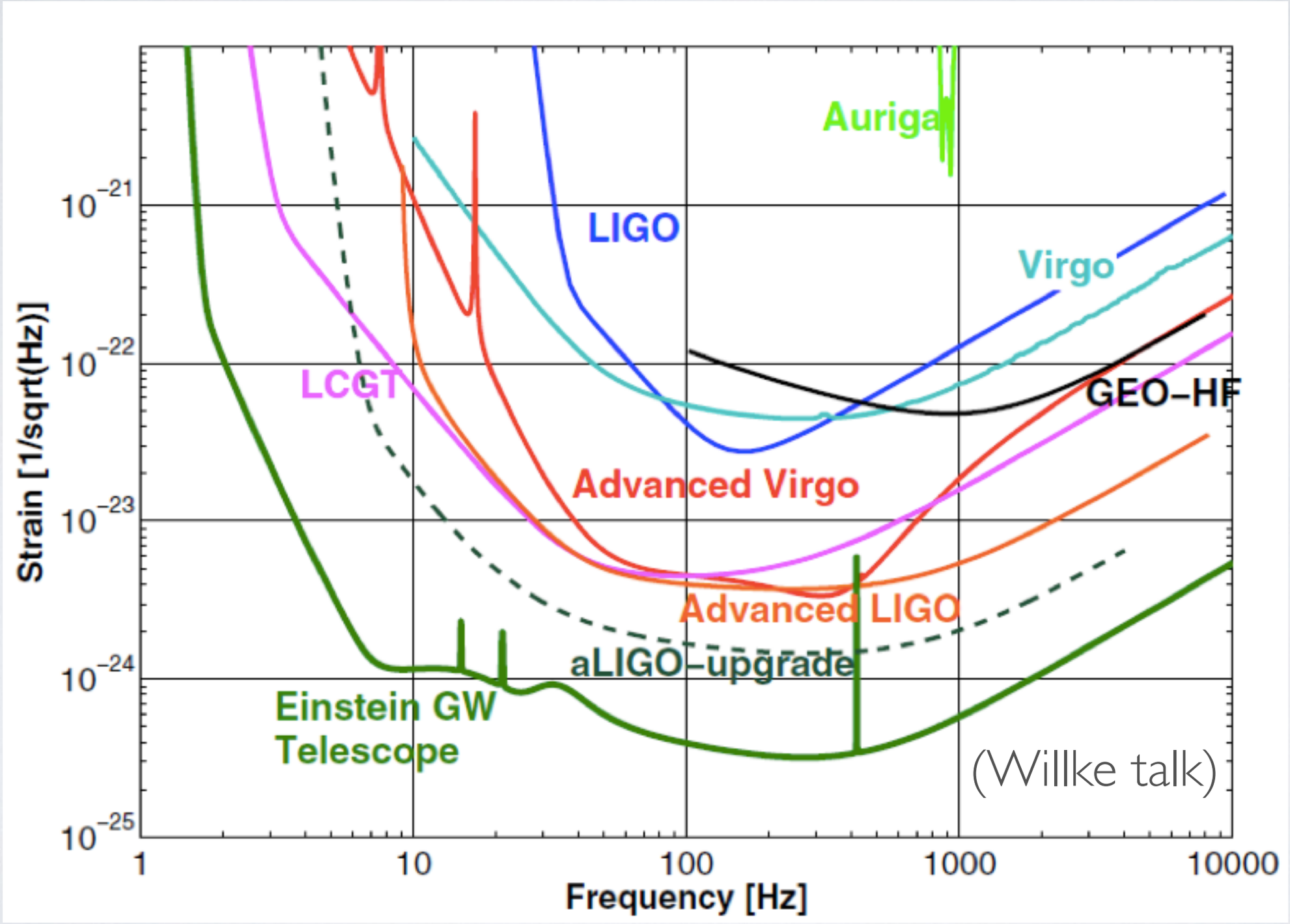
- But it is likely also to cover up the primordial background! The only "window" above nHz frequencies might be above 100 Hz — difficult to explore, very low *h*. New experimental thinking needed!

2.5 AND 3G DETECTORS



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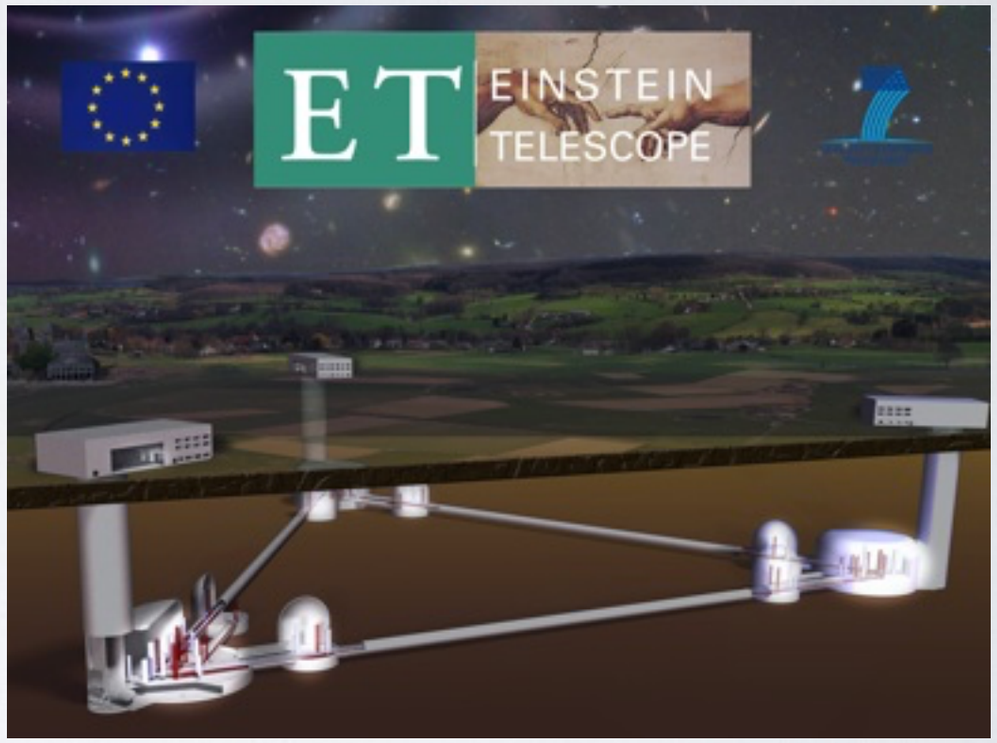

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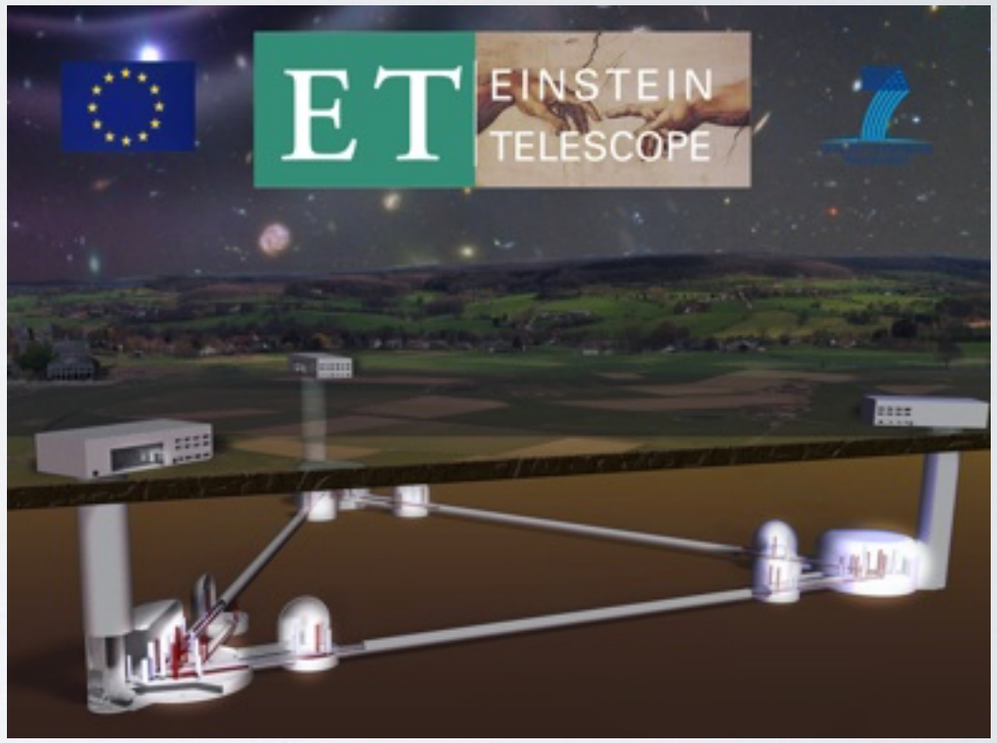
- Now is not too soon to get ET going! It took 25 years from the 1991 paper to the first LIGO announcement!



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- ESA's GOAT committee strongly supported going forward to LISA using LPF technology ASAP.
- LPF performance and GW150914 have created a serious effort inside ESA to bring the launch of LISA forward, and to return to 3-arm LISA, perhaps with 2

Gm armle

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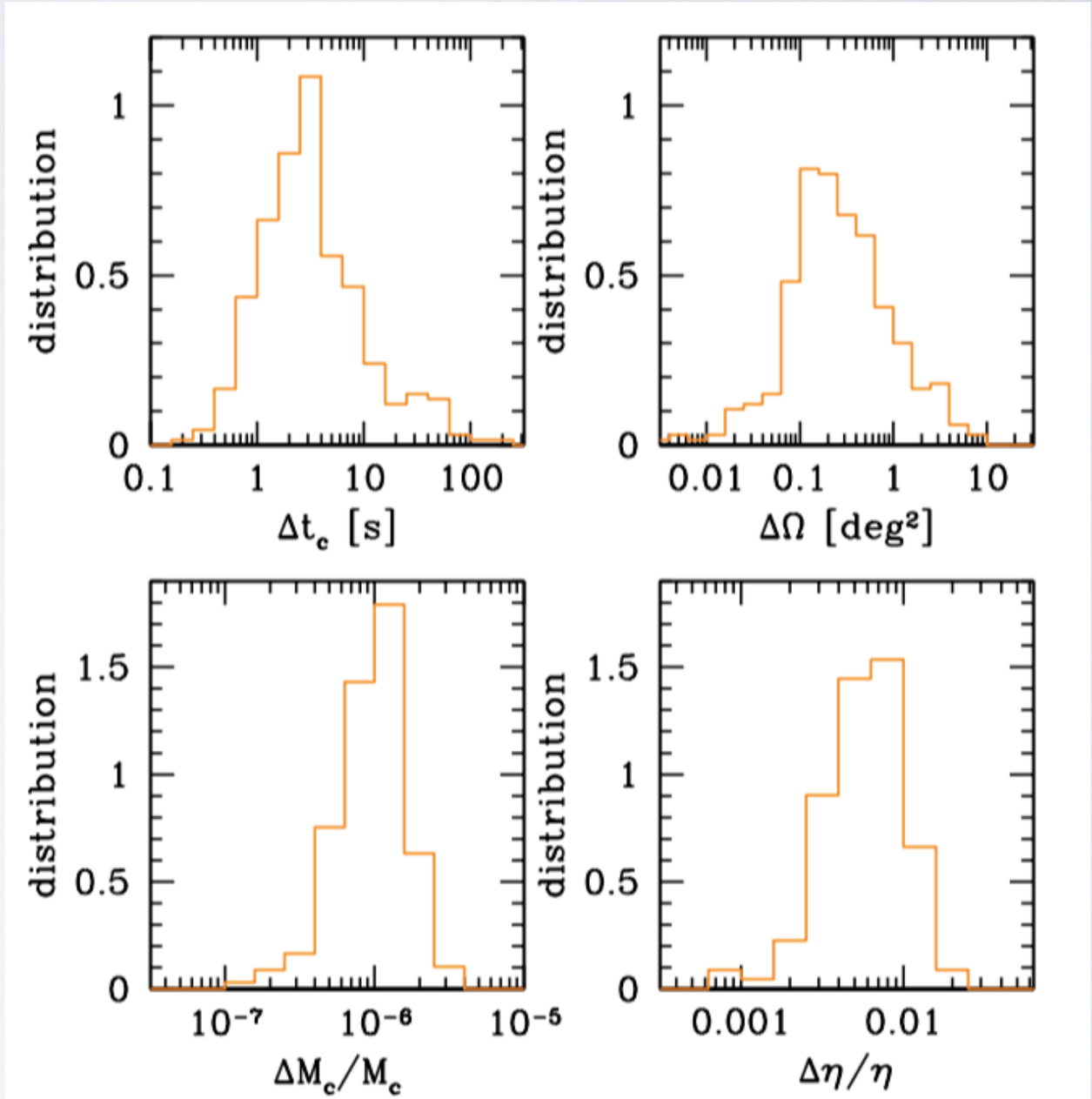

(based on eLISA sensitivity)

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- We have only about 10 years — not much time!!

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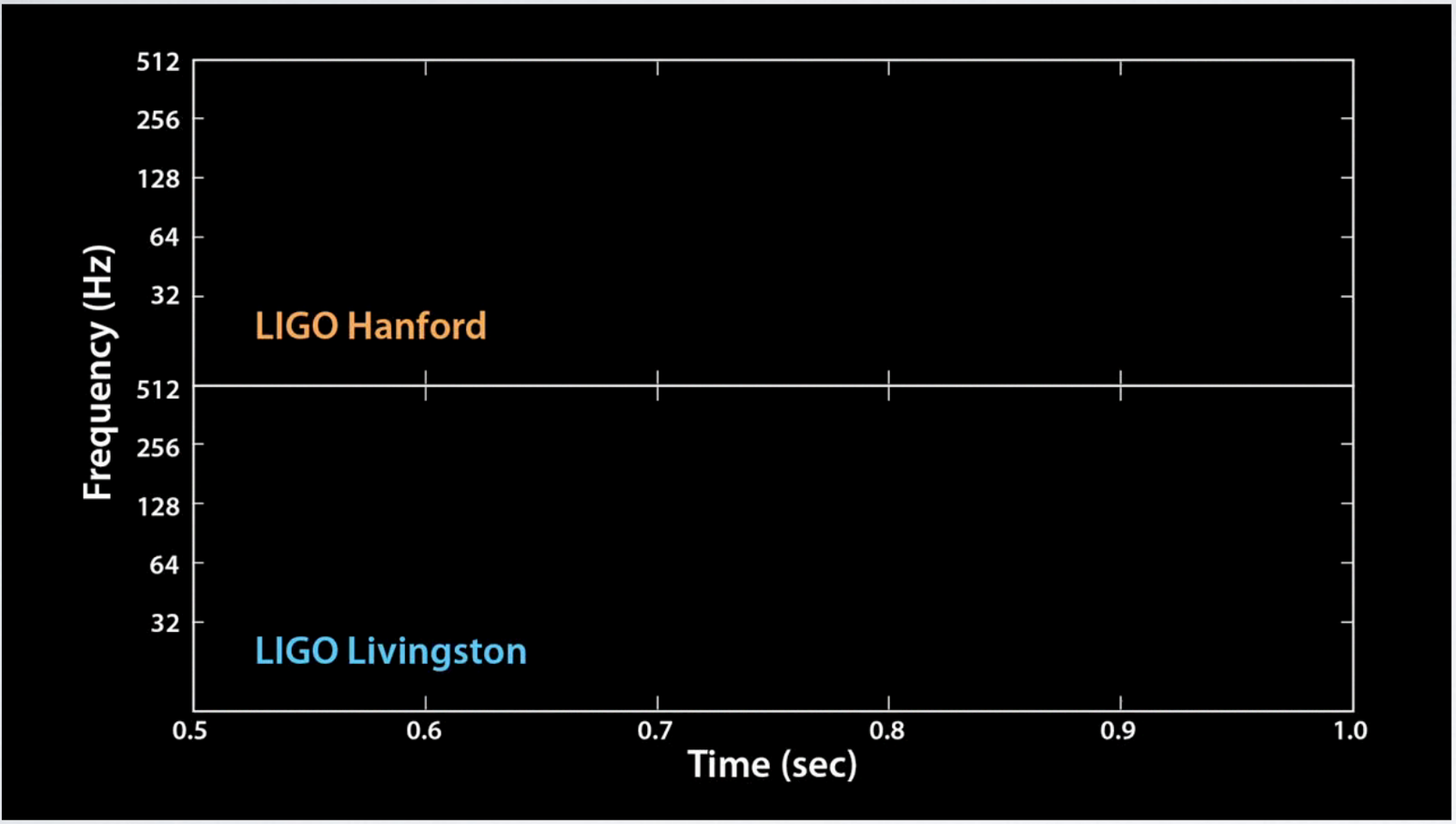

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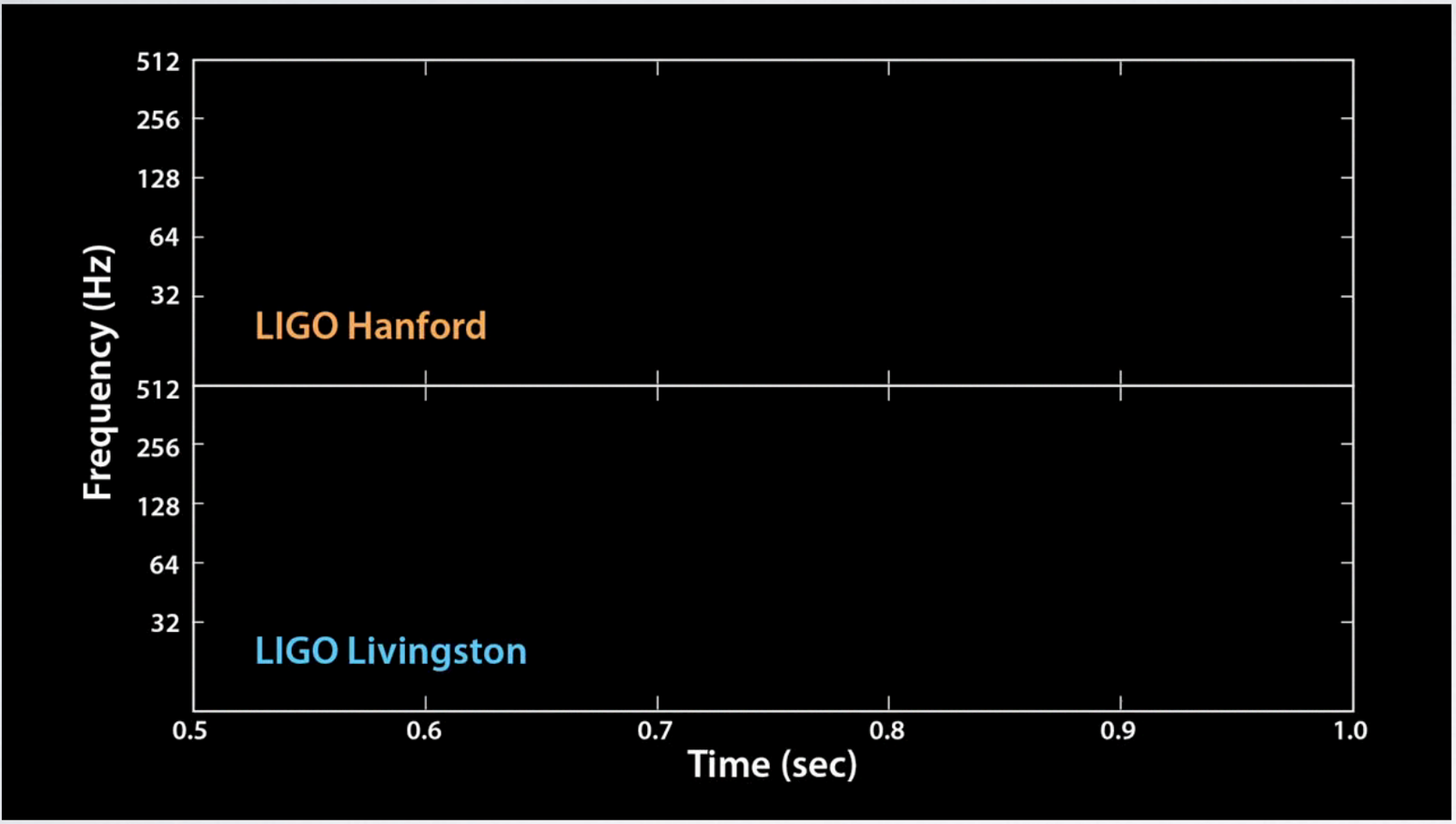

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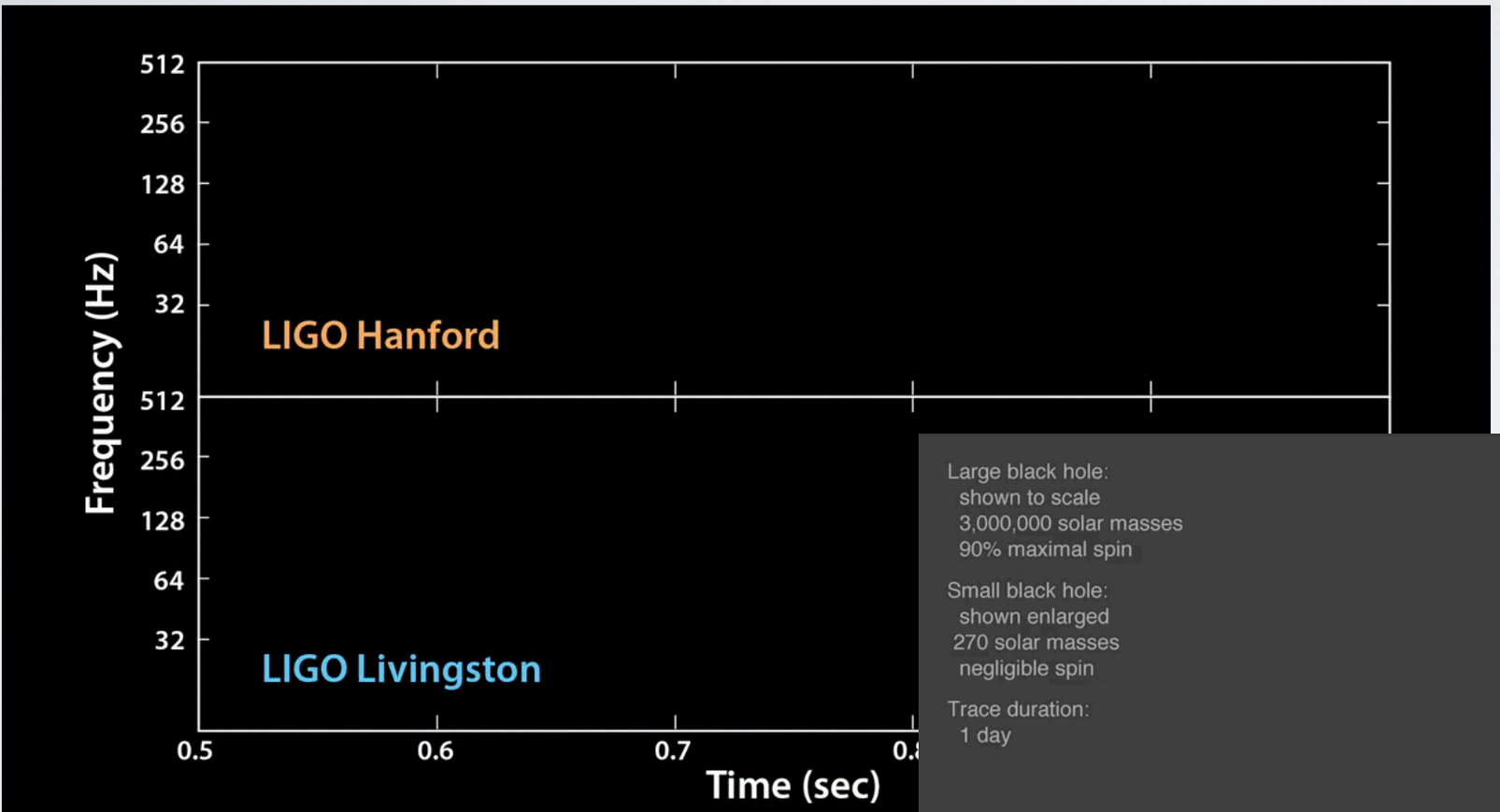

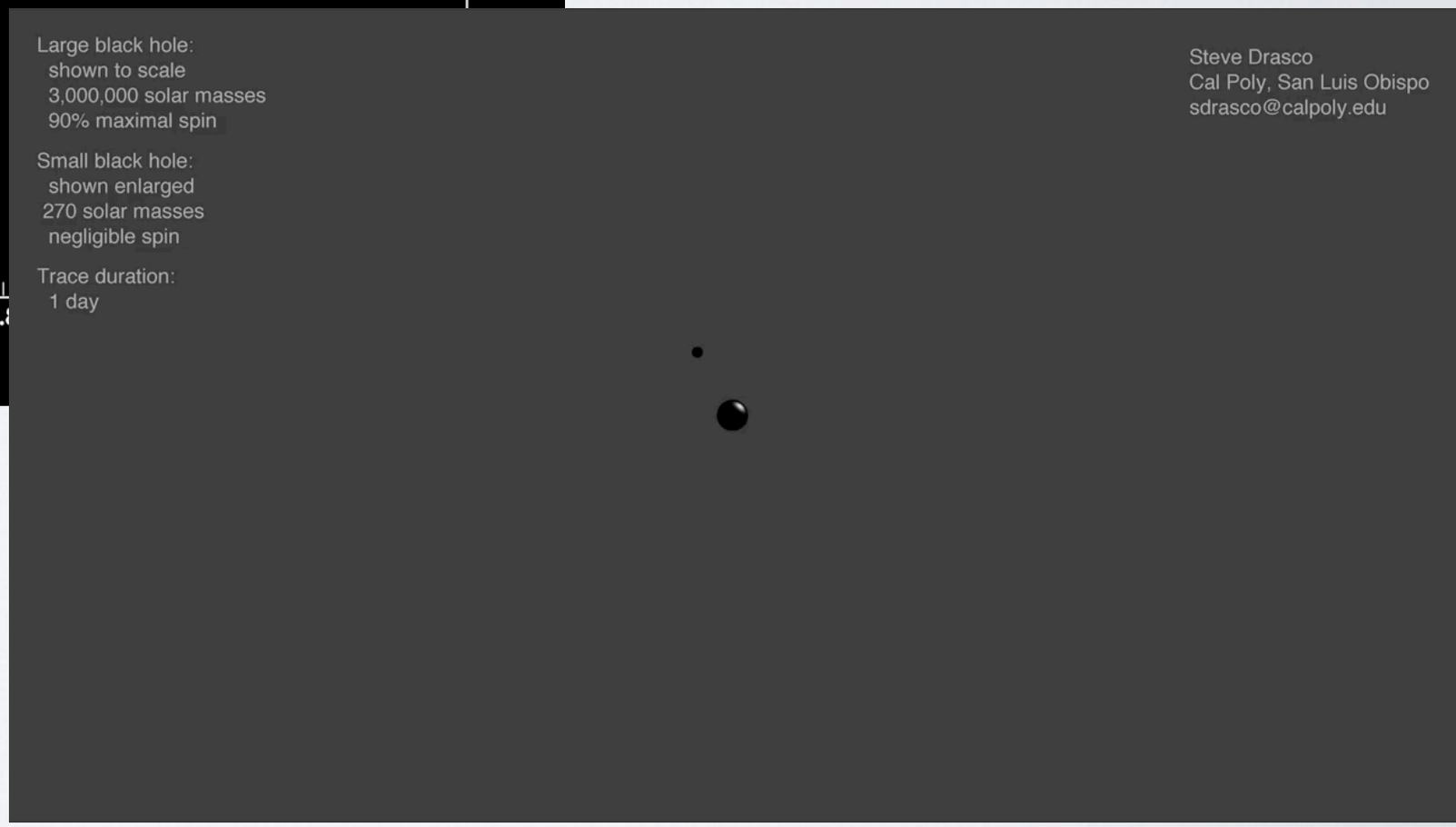

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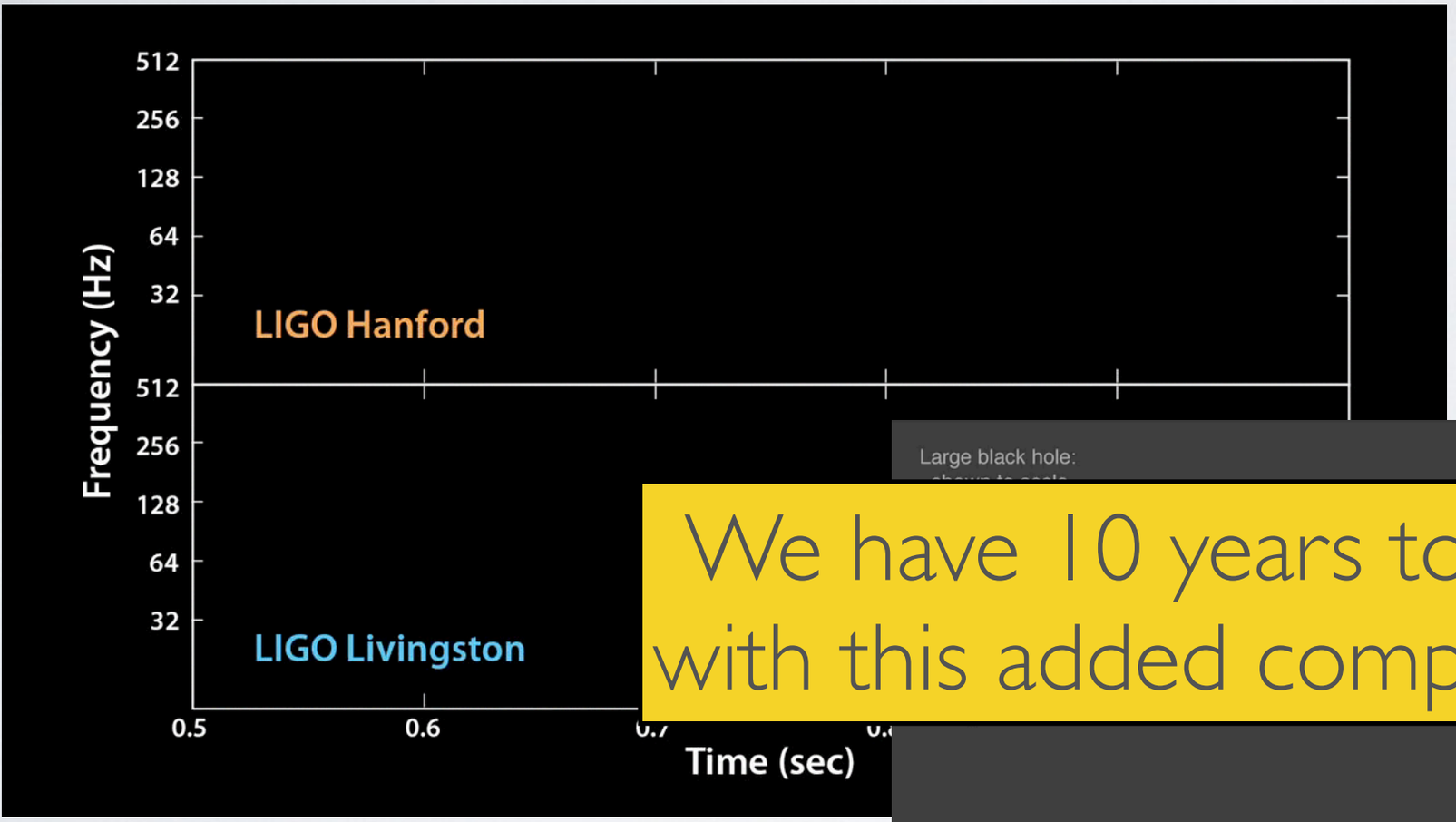

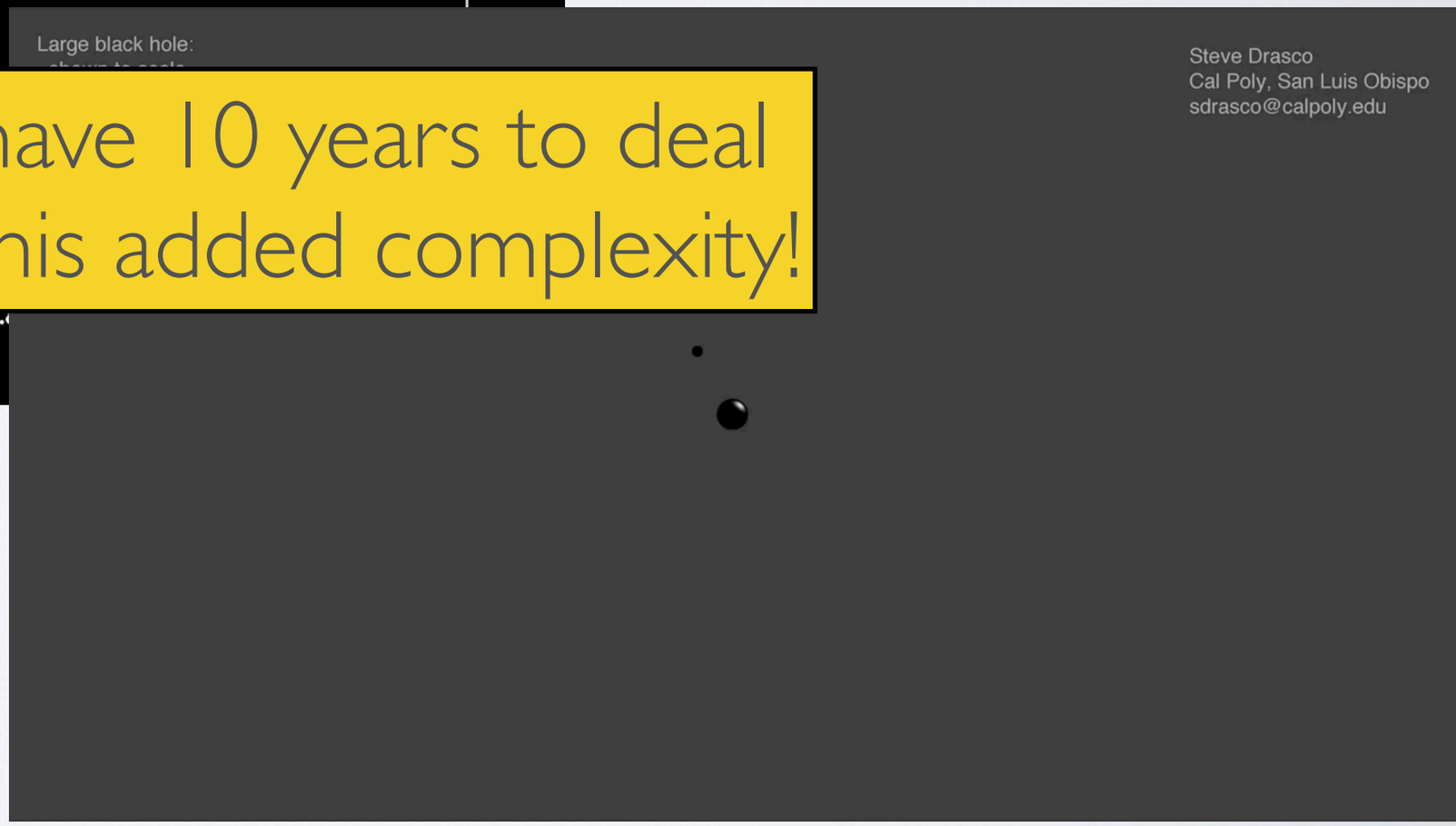

We have 10 years to deal with this added complexity!

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Window	Opened	1st Surprise	Year
Optical	1609 (Galileo)	Jupiter's moons	1610
Cosmic Rays	1912	Muon	1930s
Radio	1930s	Giant Radio Galaxies CMB Pulsars	1950s 1964 1967
X-ray	1948	Sco X-1 X-ray binaries	1962 Uhuru (1969)
γ-ray	1961 (Explorer 11)	GRBs	Late 1960s++ (Vela)

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