

# Cosmic Explorer status and update

Evan Hall  
LIGO MIT

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# Summary and status

Cosmic Explorer will proceed in two stages:

2030s: room-temperature glass at  $1.0\ \mu\text{m}$  (like aLIGO)

2040s: cryogenic silicon at  $1.5$  or  $2.0\ \mu\text{m}$  (like Voyager)

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vacuum system concepts

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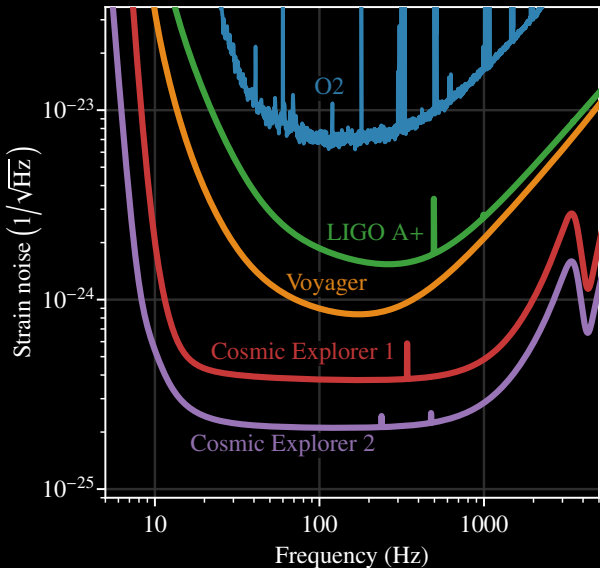
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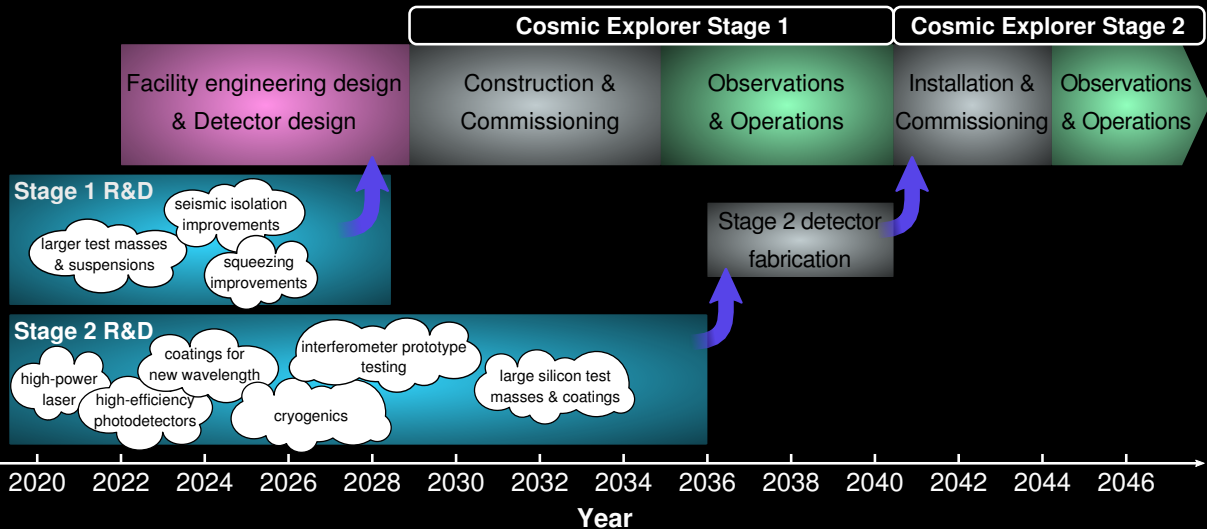
Collaborating institutions in the US:

**Caltech:** R. Adhikari, Y. Chen; **Cal State Fullerton:** G. Lovelace, J. Read, J. Smith; **Penn State:** B. Sathyaprakash; **Syracuse:** S. Ballmer, D. Brown; **MIT:** M. Evans, S. Vitale.

# A two-stage approach

	<b>CE1</b>	<b>CE2</b>
	2030s, à la aLIGO	2040s, à la Voyager
Wavelength	1.0 $\mu\text{m}$	1.5 to 2.0 $\mu\text{m}$
Temp.	293 K	123 K
Material	glass	silicon
Mass		320 kg
Coating	silica/tantala	silica/aSi
Spot size	12 cm	14 to 16 cm
Suspension	1.2 m fibers	1.2 m ribbons
Arm power	1.4 MW	2.0 to 2.3 MW
Squeezing	6 dB	10 dB





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Hinges on several unknowns:

When will Voyager technology be ready?

Which detectors will be online after 2025, and with what sensitivity?

How many facilities would be upgraded to Voyager?

Under what conditions would the astro community tolerate a multiyear shutdown of 4 km facilities?

# Next-generation vacuum systems

Since the '90s...

Lessons learned: microbial-induced corrosion, leak detection strategy

New developments: plain carbon steel may have acceptable outgassing

New ideas: double-walled vacuum system, anti-adsorption coatings

NSF-sponsored workshop on large ultrahigh-vacuum systems (Jan 2019)

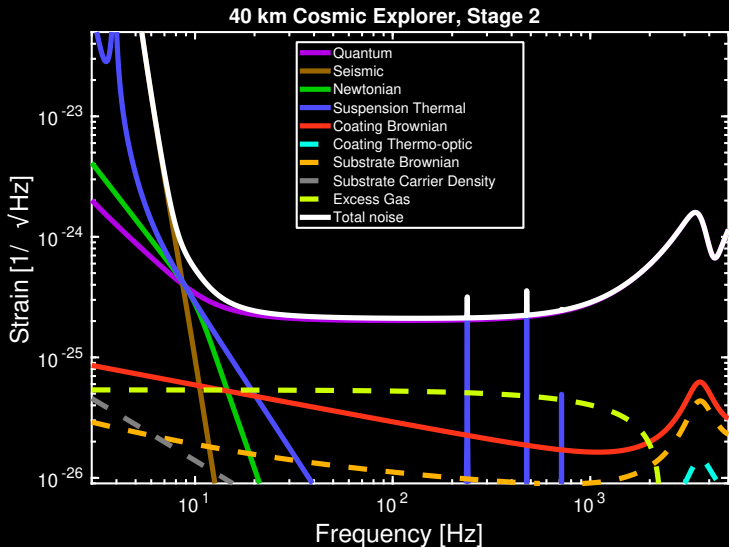
<https://dcc.ligo.org/LIGO-P1900072> (F. Dylla, R. Weiss, M. Zucker, eds.; good attendance from outside the GW community)

# The canonical CE noise budget

Some important noises are not included (atmospheric Newtonian noise, scattered light)

Others are not estimated in full detail (seismic Newtonian noise)

Some detector parameters are not optimized for maximum science payoff (work in progress: V. Srivastava, S. Ballmer, D. Brown)

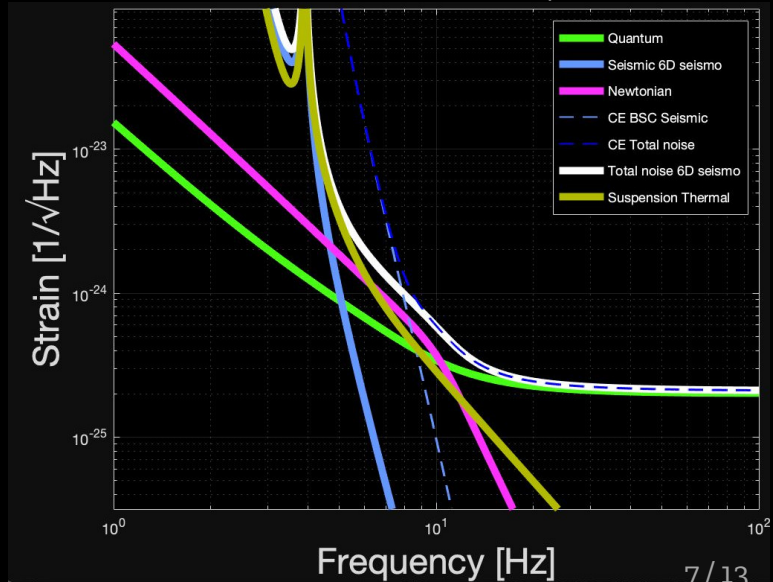


# Beyond 2G seismic isolation

J. Smith, after H. Yu

3G seismic isolation platforms will employ (we hope) superior inertial sensors; e.g., Birmingham's HoQI.

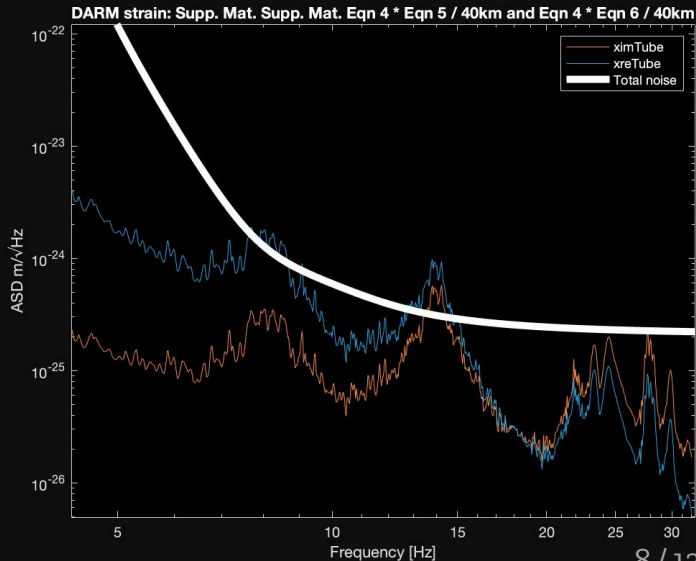
Prospects for „LIGO-LF“: H Yu et al., *Phys. Rev. Lett.* **120**, 141102 (2018)



# Scattered light

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As a first pass: estimate based on power scattered from tube and baffles.

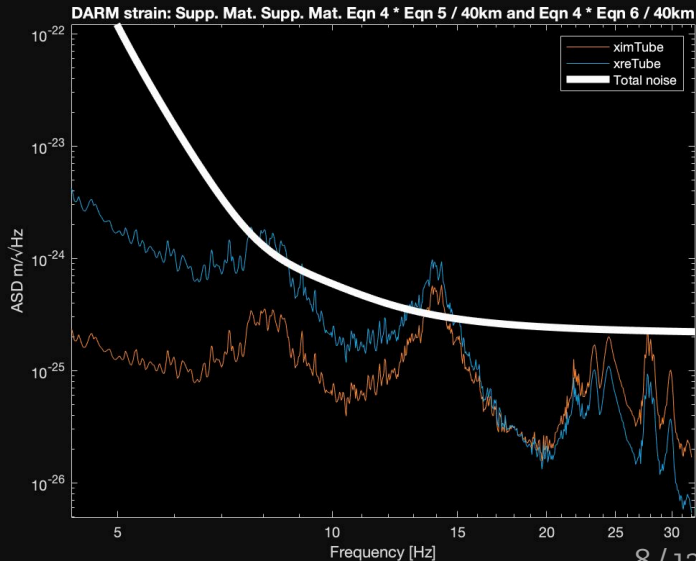


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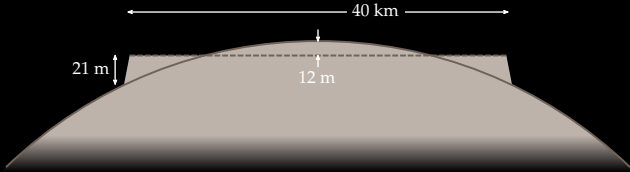
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Still to do: coherent estimate, taking into account both mirror roughness and point scatterers.

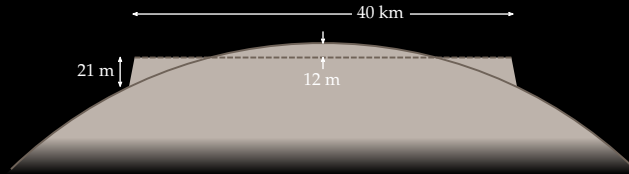


# Civil engineering and geophysics





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What earthwork minimizes seismic Newtonian noise: berms, trenches, henges, strata...?

Seismic metamaterials: resonators, boreholes, trees... (B. Kama)

Does this earthwork also minimize atmospheric Newtonian noise?

What is the variability in geophysical noise between potential sites?

What are the limits to geophysical noise subtraction?

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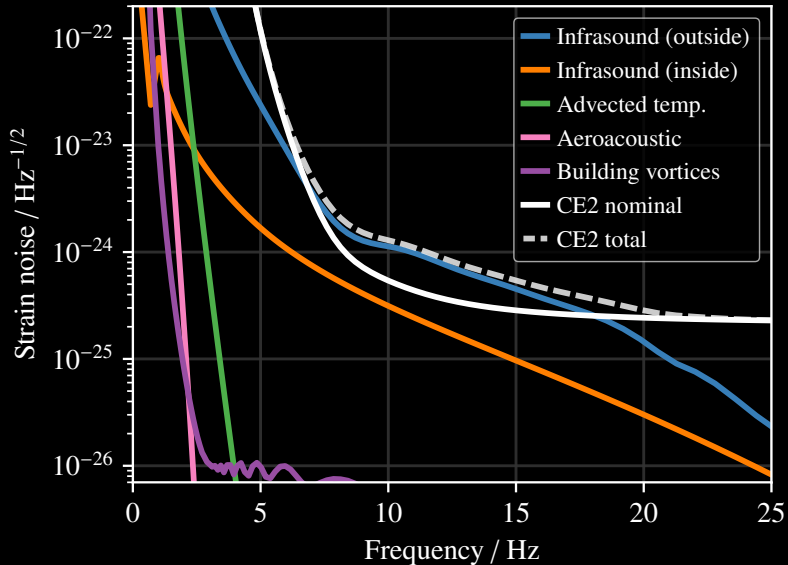
Numerical simulation in progress (B. Lane)

# Atmospheric Newtonian noise

So far: analytical estimates

Unclear if subtraction is feasible

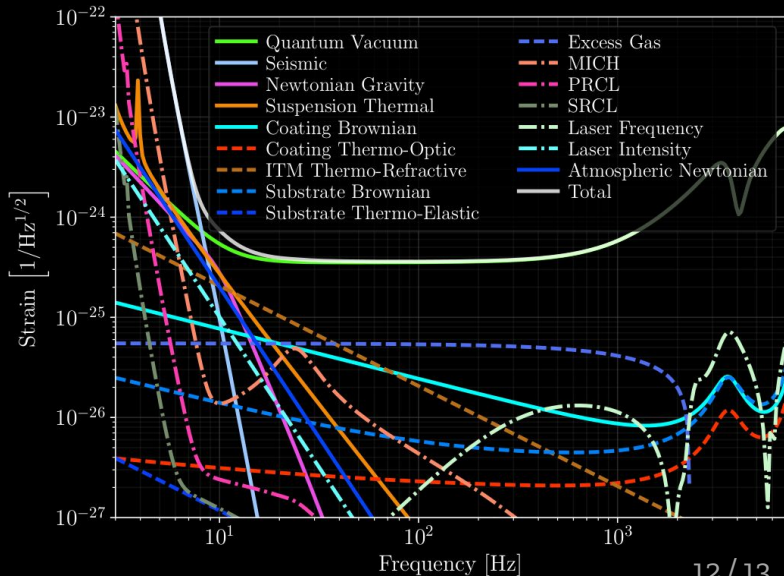
Work in progress: fluid dynamics simulation



# Controls design

Also working on actuator design, including radiation-pressure drive for differential arm length.

Work in progress: incorporating angular control noise



# Next steps

Coherent scatter estimates, including point defects → beam tube and baffling requirements

Realistic Newtonian noise estimates → civil engineering requirements; subtraction requirements

Angular control noise estimates → seismic, suspension, and sensor requirements