

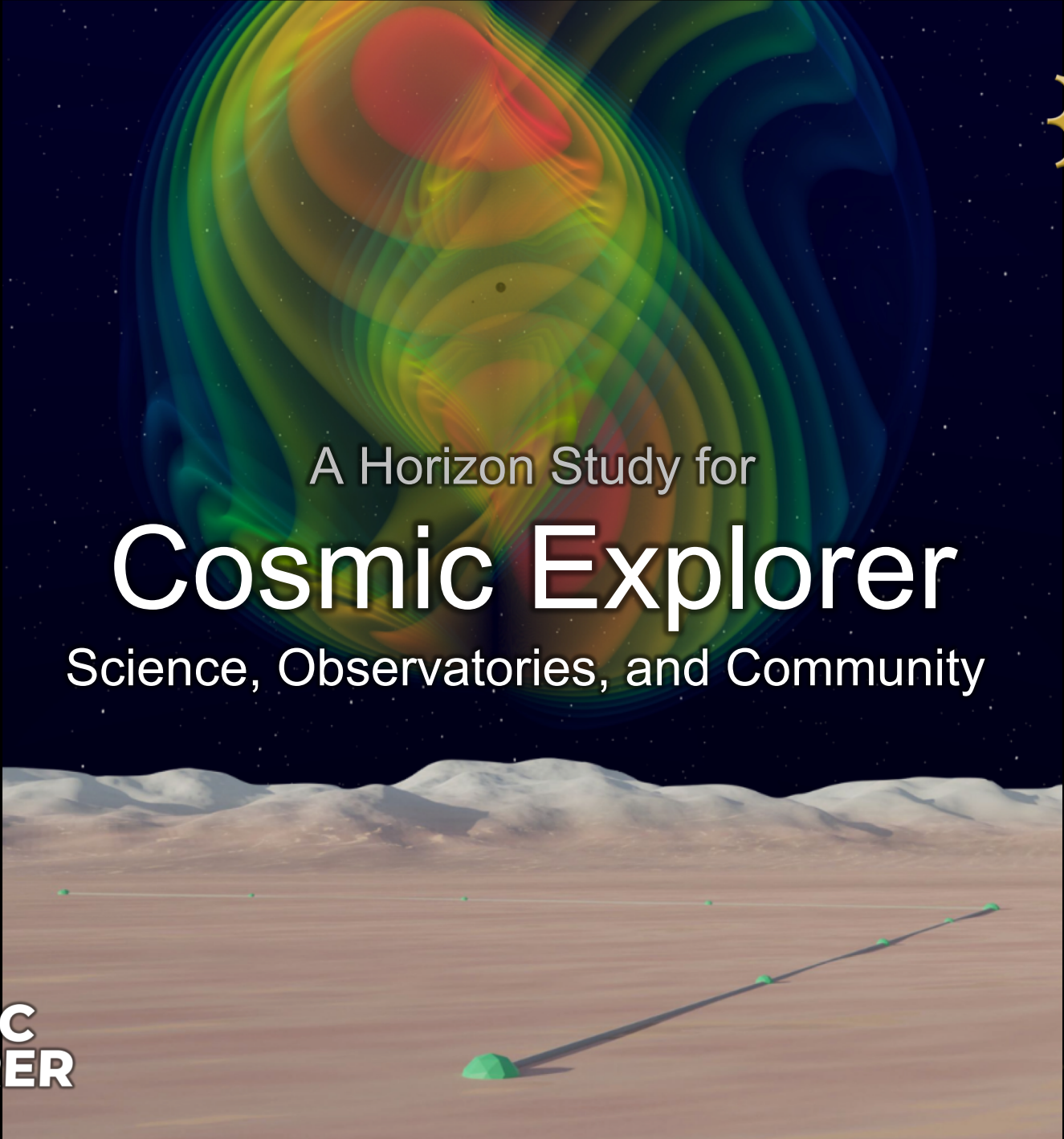
# Cosmic Explorer Horizon Study



Matthew Evans, on behalf of the Cosmic Explorer Team



A Horizon Study for  
**Cosmic Explorer**  
Science, Observatories, and Community





# CEHS: the current draft



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## Timeline for finishing the CE Horizon Study

- June 9: Draft ready for wide circulation (to CE Consortium, LVK, Astro/DGrav/DOE communities, others)
- July 15-30: Incorporate input in final round of editing
- Aug 1: Deliver polished draft to NSF
- October 5-7: Present at DAWN meeting for community for input and endorsement





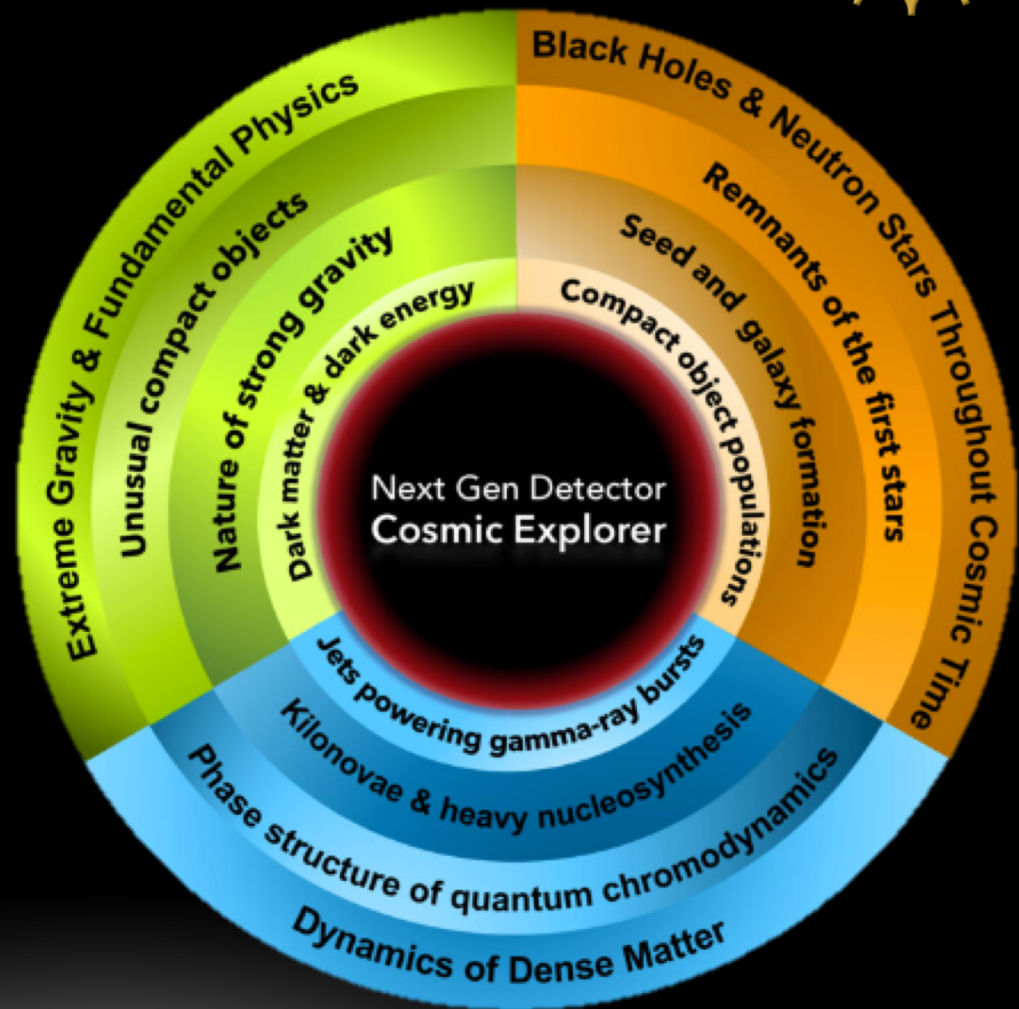
## 2) Purpose and Scope

- The CE Horizon Study includes
  - A vision of the science enabled by CE
  - A reference design for the CE instrument and its evolution
  - An analysis of design options and their impact on the scientific output of CE
  - A parametric cost estimate for CE construction
- It is intended to inform the **scientific community**, and the agencies which fund that community, with the goal of providing a **foundation for further development of CE** in those communities while spurring action toward CE's construction.



# 5) Key Science Questions

- 3 main categories of science goals
- Discussed in terms of what CE can do as a function number of observatories and global GW network

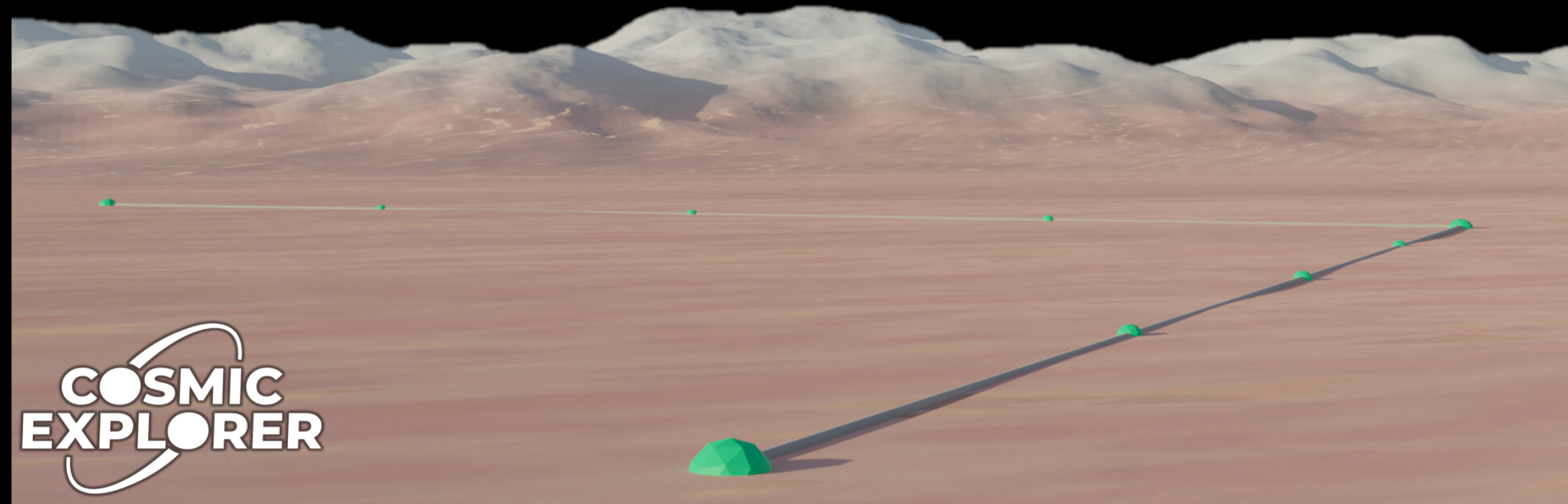






## 6) A Science-Driven Design for CE

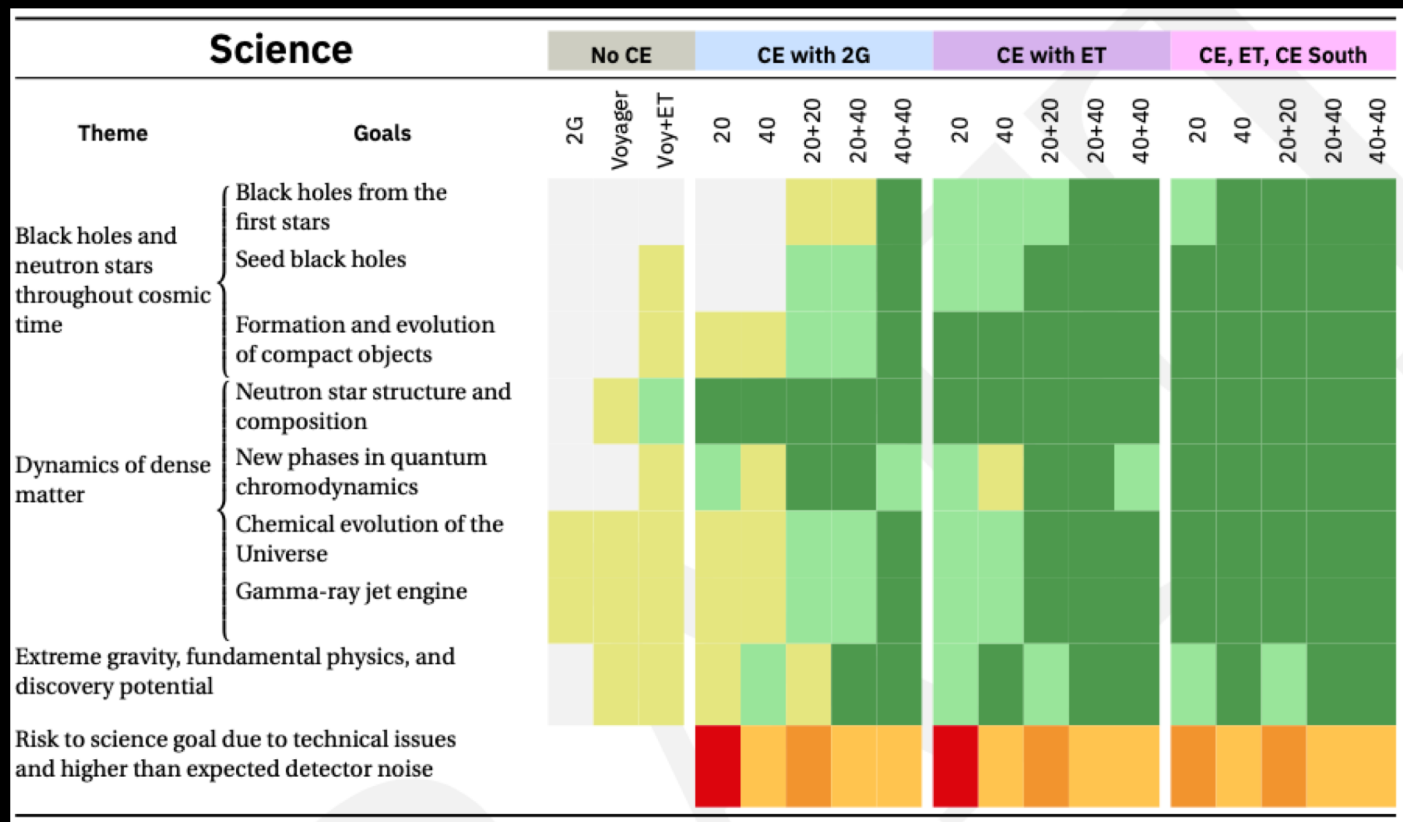
- This section provides a high-level discussion of the design concept for CE
  - Why is ground-based laser interferometry the best way to achieve our science goals?
  - Why are we considering large L-shaped above-ground facilities?
    - What are the fundamental drivers behind arm length?
    - What are the advantages of 1 vs. 2 or more facilities?





# 7) Optimizing Design Performance

A study of how design choices impact the key science goals, in the context of a global network with ET and CE South

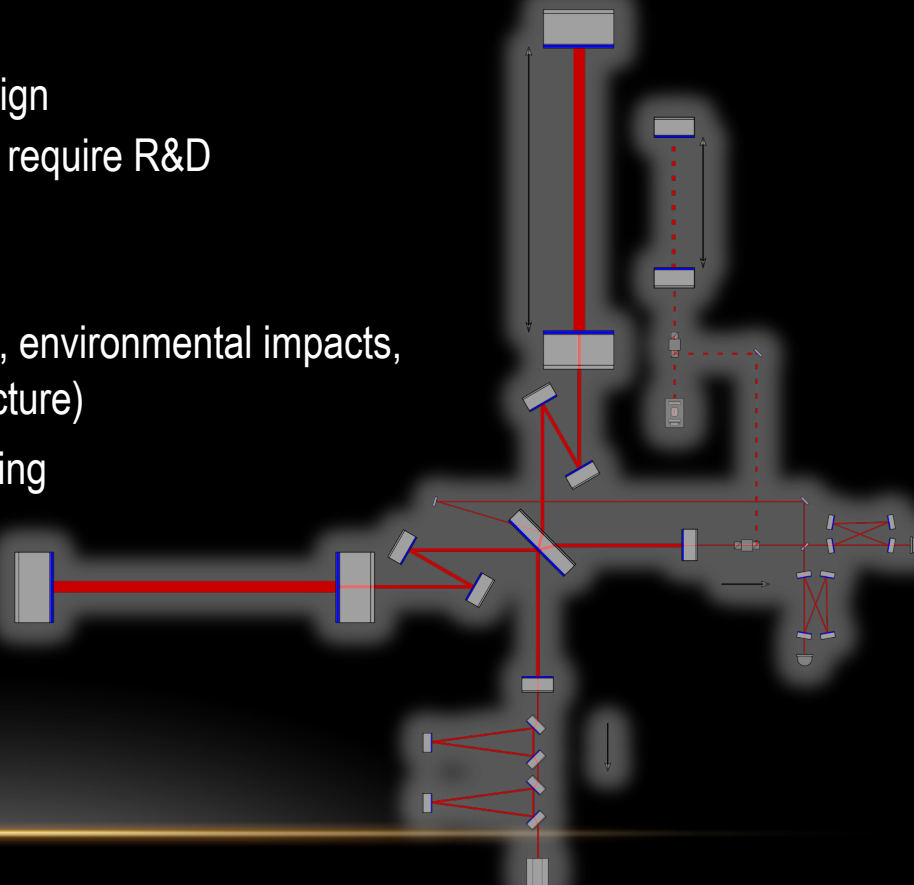






## 8) Technical Overview and Design Choices

- This section provides a technical overview of the Cosmic Explorer Observatory including
  - technical siting considerations (seismicity, infrasound, etc.)
  - required infrastructure
  - vacuum system requirements and design
- It also outlines the key technologies that will require R&D to enable the CE science goals.
- Finally, other key considerations including
  - Choice of site (esp. local stakeholders, environmental impacts, natural hazards, surrounding infrastructure)
  - Cost vs. Arm length – not a linear scaling
  - Beamtube material and diameter





## 9) Data Management, Analysis, and Computing

- Here we present a vision for providing CE data to the scientific community
- Describe plans for Open Data and dissemination of
  - Production of clean, calibrated data set for science community
  - Dissemination of alerts for multi-messenger science
- Estimate the computing and human resources needed to deliver these goals
- Discuss needs for operations analysis and computing
- Discuss areas where support is needed for community's analysis and computing

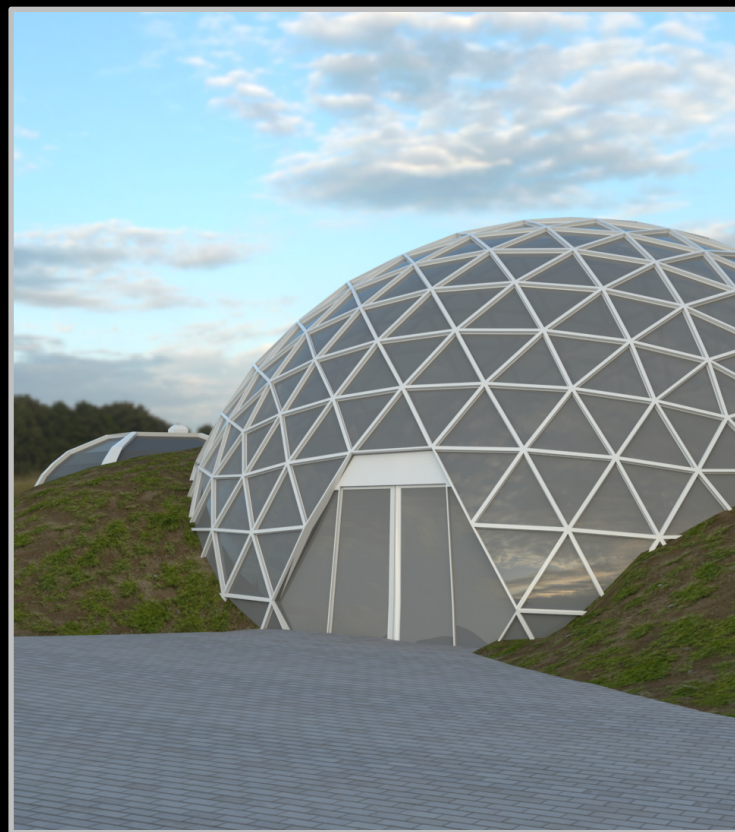




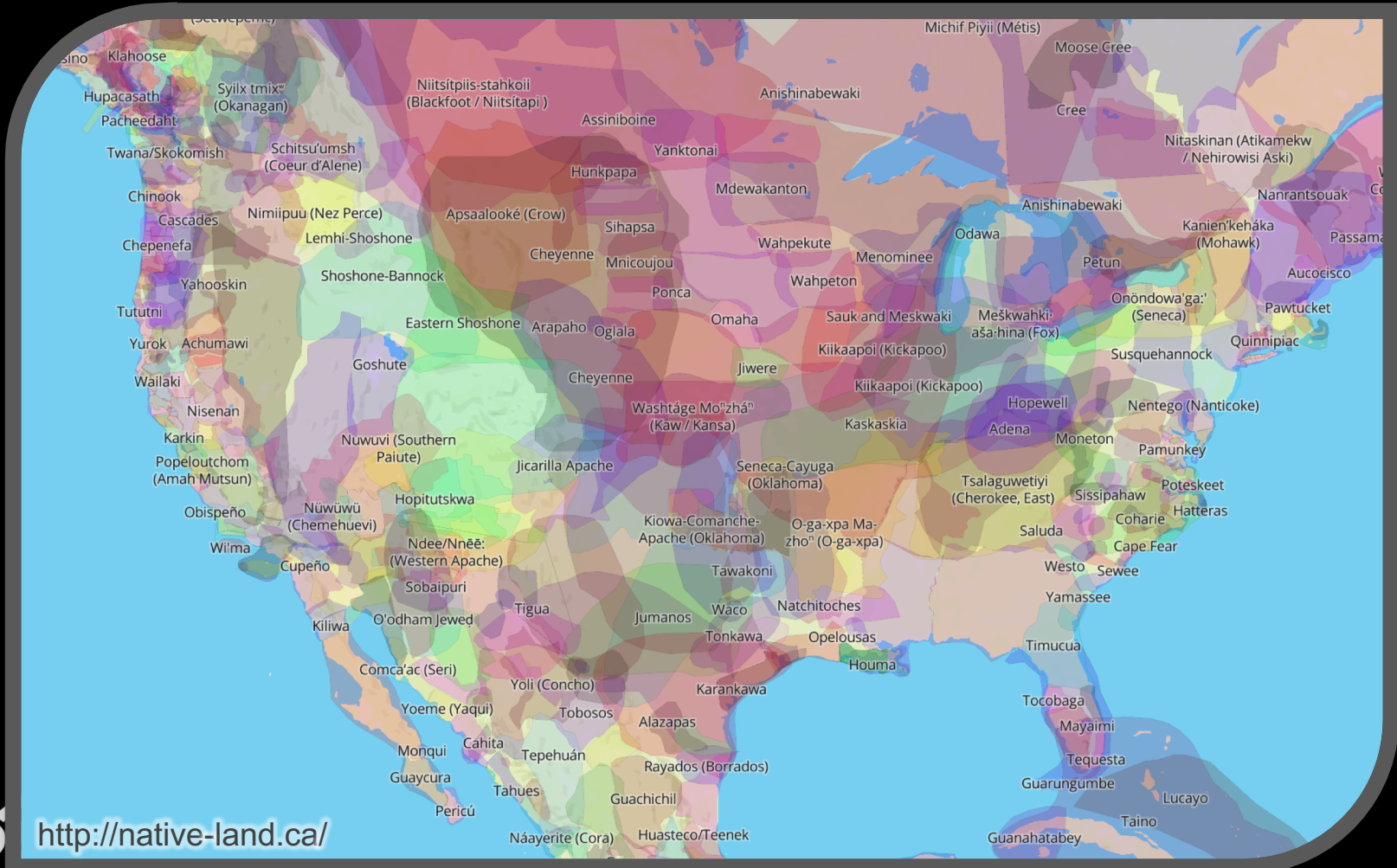


## 10) Cosmic Explorer at the Local and Global Scales

The Cosmic Explorer project will develop observatory designs with a **multi-dimensional approach that creates synergy with its respective local, scientific, and global communities**. This includes designing the physical and virtual infrastructure to serve Cosmic Explorer's broad community integration and engagement goals, and developing interpersonal relationships among members of these communities. **Early and ongoing engagement with communities connected with Cosmic Explorer, from local to global, will be crucial to the project's success.**



No matter where we build Cosmic Explorer, the history of the land will play a **pivotal** role in this project. We will have the **opportunity**, and obligation, to work with Indigenous Peoples to build synergistic relationships and to ensure that we respect their land, their culture and their sovereignty.



<http://native-land.ca/>



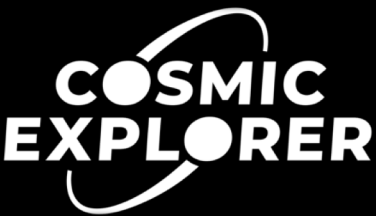
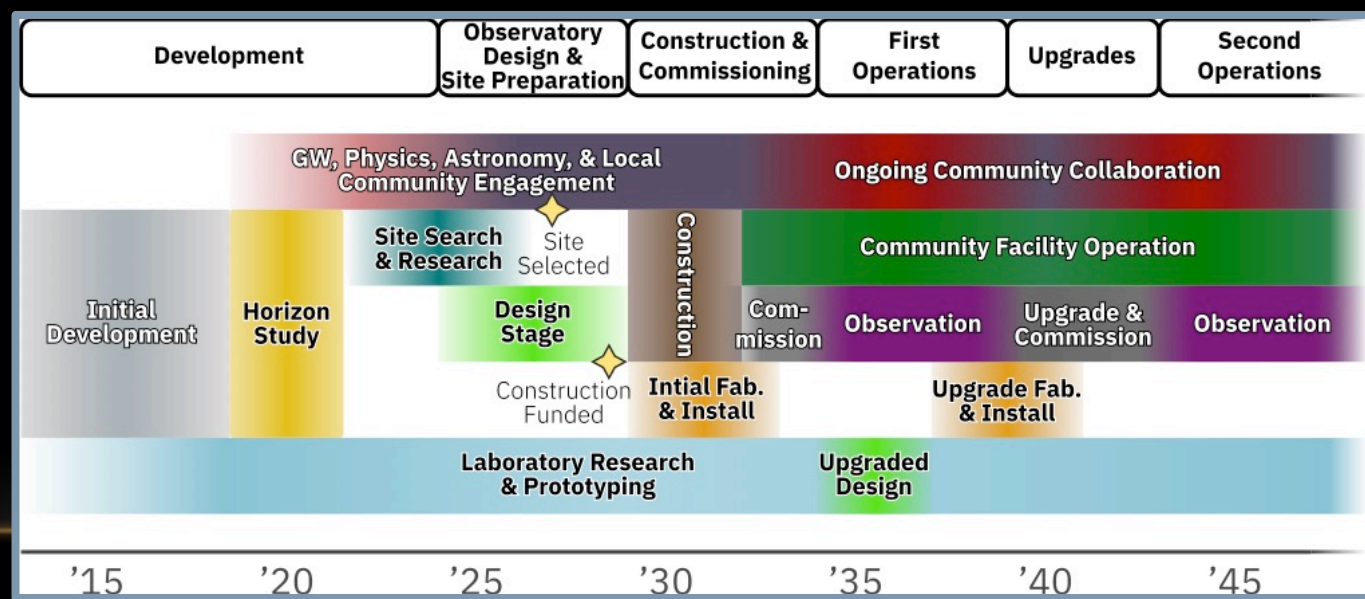
If you are not aware of issues surrounding TMT, please read [arXiv:2001.00970](https://arxiv.org/abs/2001.00970).



# 11) Cosmic Explorer Project

|                                                       |            |
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| Top-Level Costs                      | \$(M) USD 2021 | Percent    |
|--------------------------------------|----------------|------------|
| Civil Engineering                    | 358.2          | 28         |
| Vacuum System                        | 482.1          | 37         |
| Detector                             | 306.2          | 24         |
| Management, Design, Project          | 146.2          | 11         |
| <b>Grand Total (2 Observatories)</b> | <b>1292.7</b>  | <b>100</b> |







# The Message

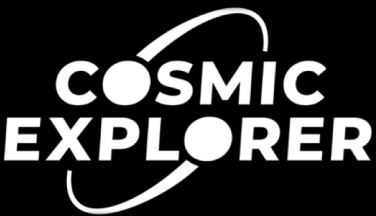
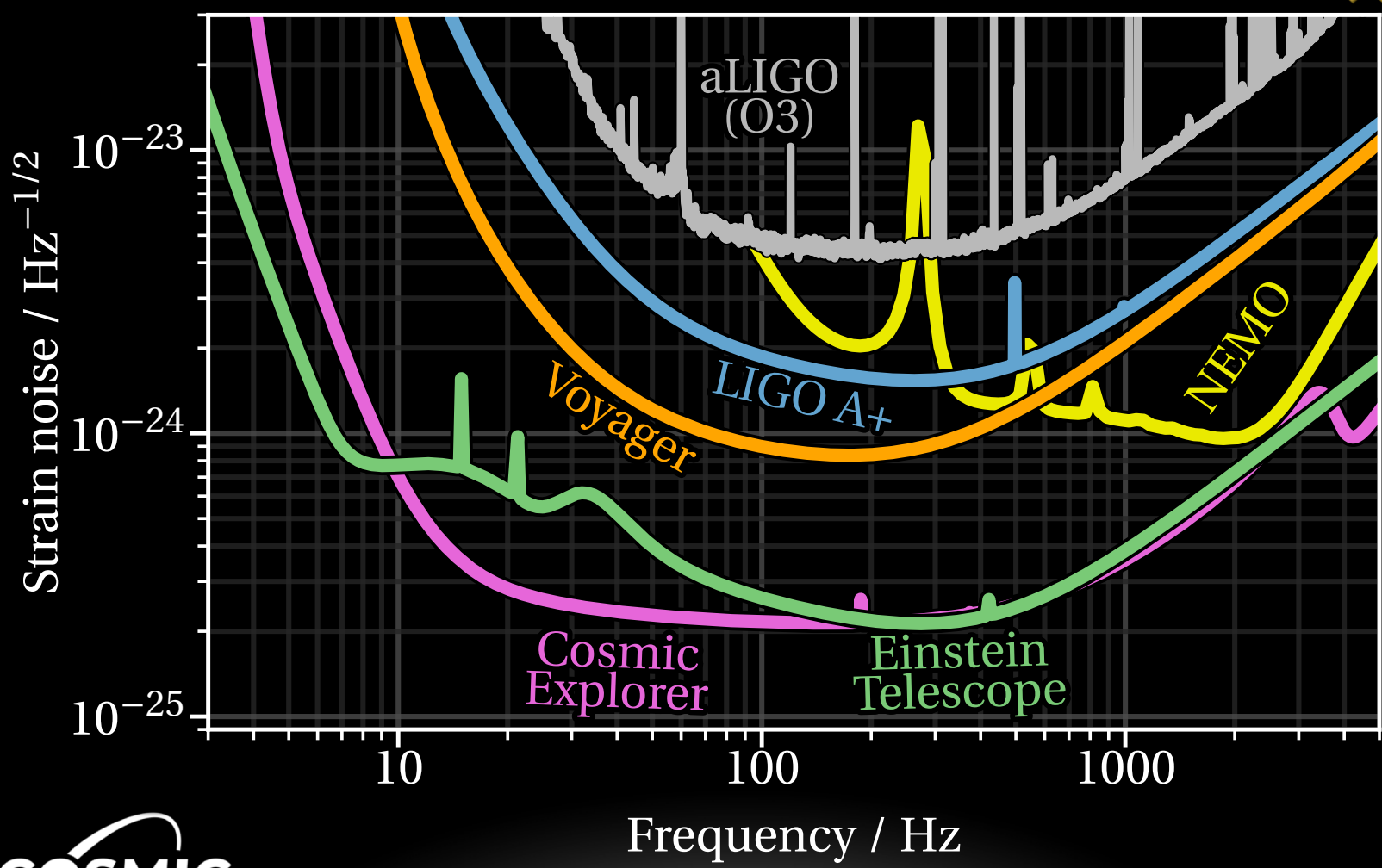
- Over the next few months, we (**i.e. including you!**) will be
  - setting the stage for future GW observatories in the US
  - delivering the CE Horizon Study to the NSF
  - following through by expanding the CE support base
- We need you to be involved!
  - google form for feed-back: [tinyurl.com/CEHSform](https://tinyurl.com/CEHSform)
  - **CE will be built by this community.**

[cosmicexplorer.org/consortium.html](https://cosmicexplorer.org/consortium.html)

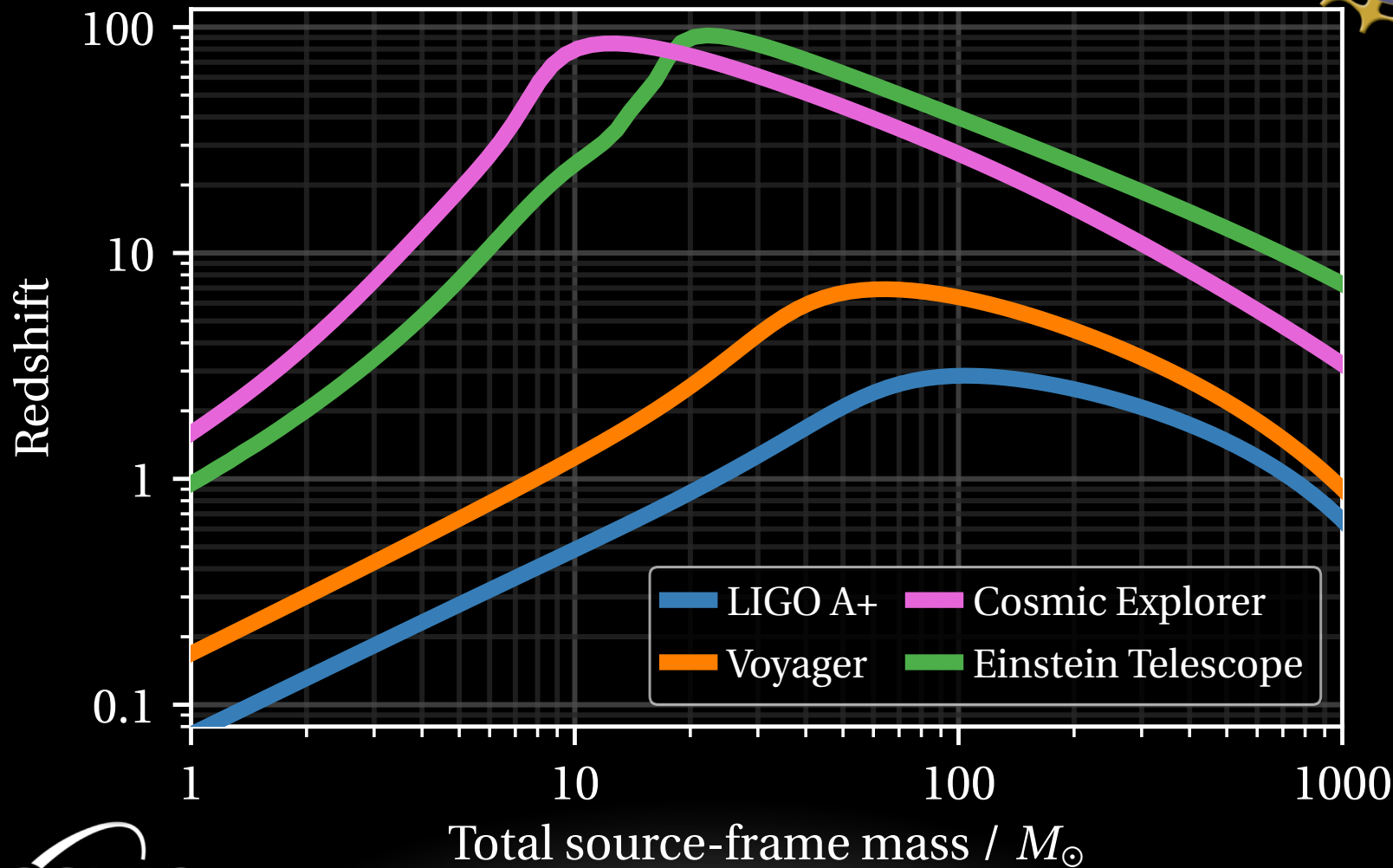


Extra material



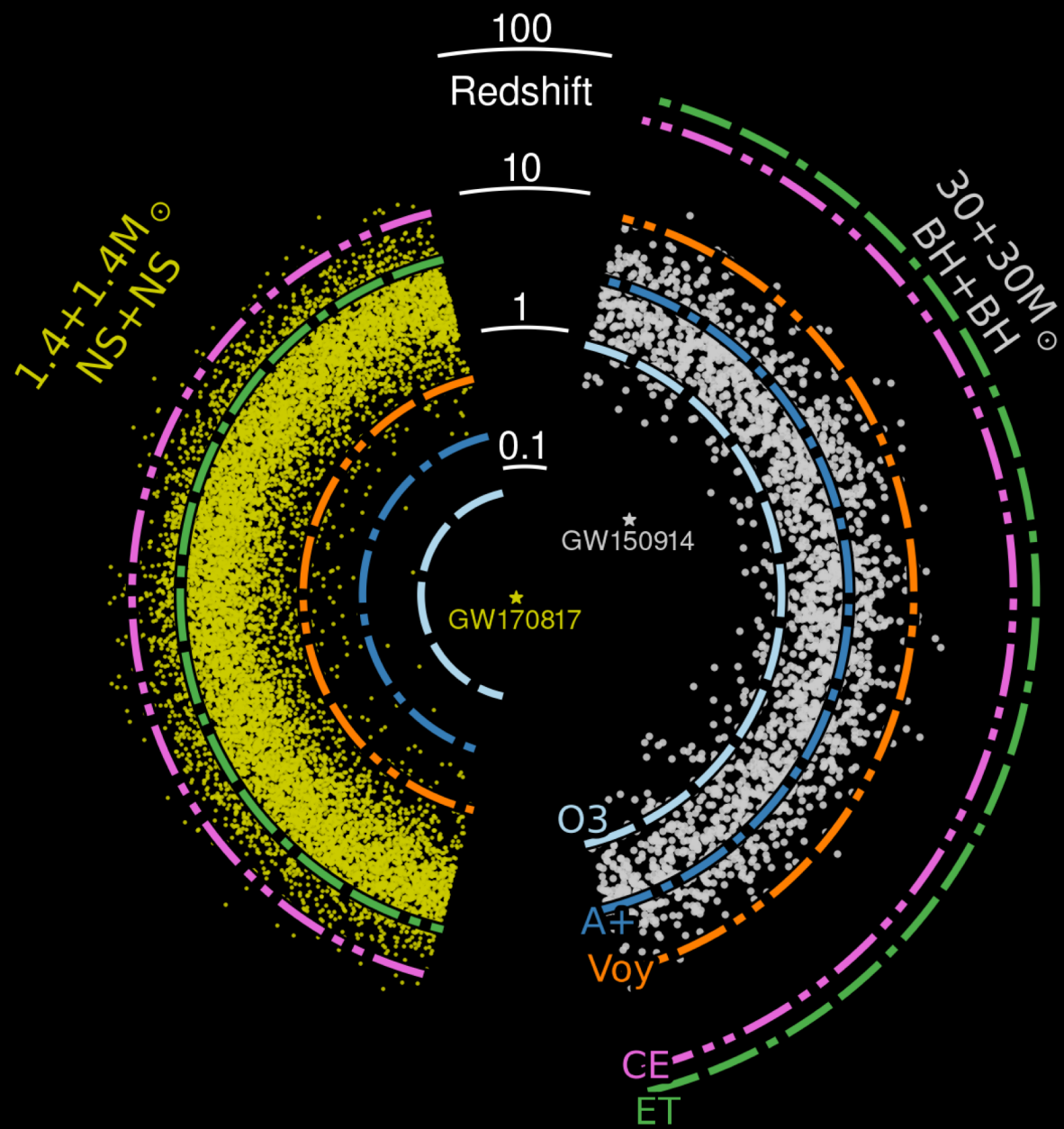








Black Holes & Neutron Stars  
Throughout Cosmic Time

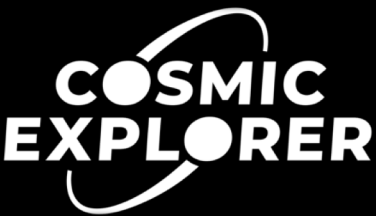
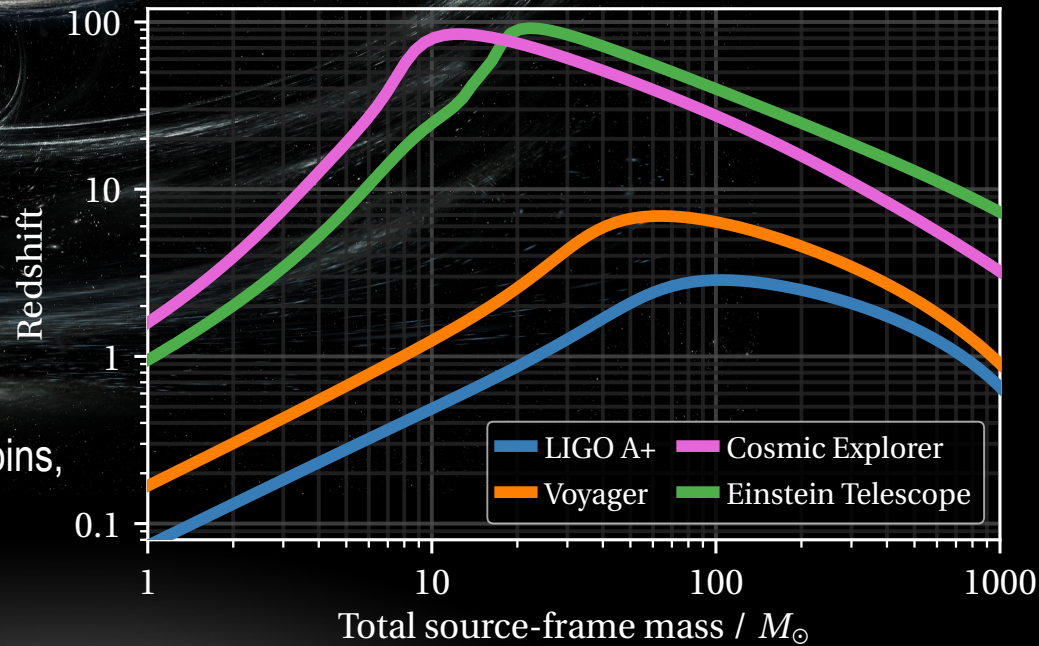


Precision tests will be enabled by black hole mergers like those seen now ( $\sim 30$  solar mass, at  $z \sim 0.3$ ), which will have an SNR  $\sim 1000$  in CE.



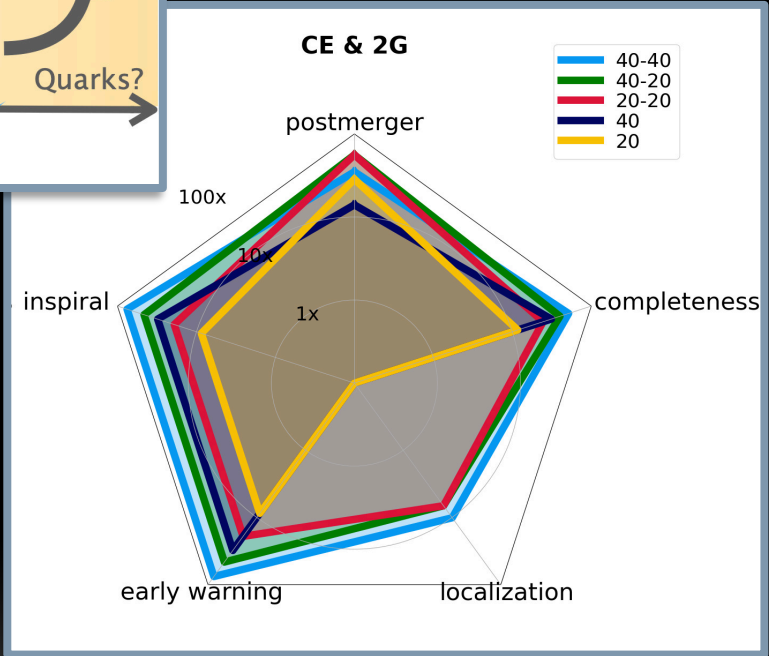
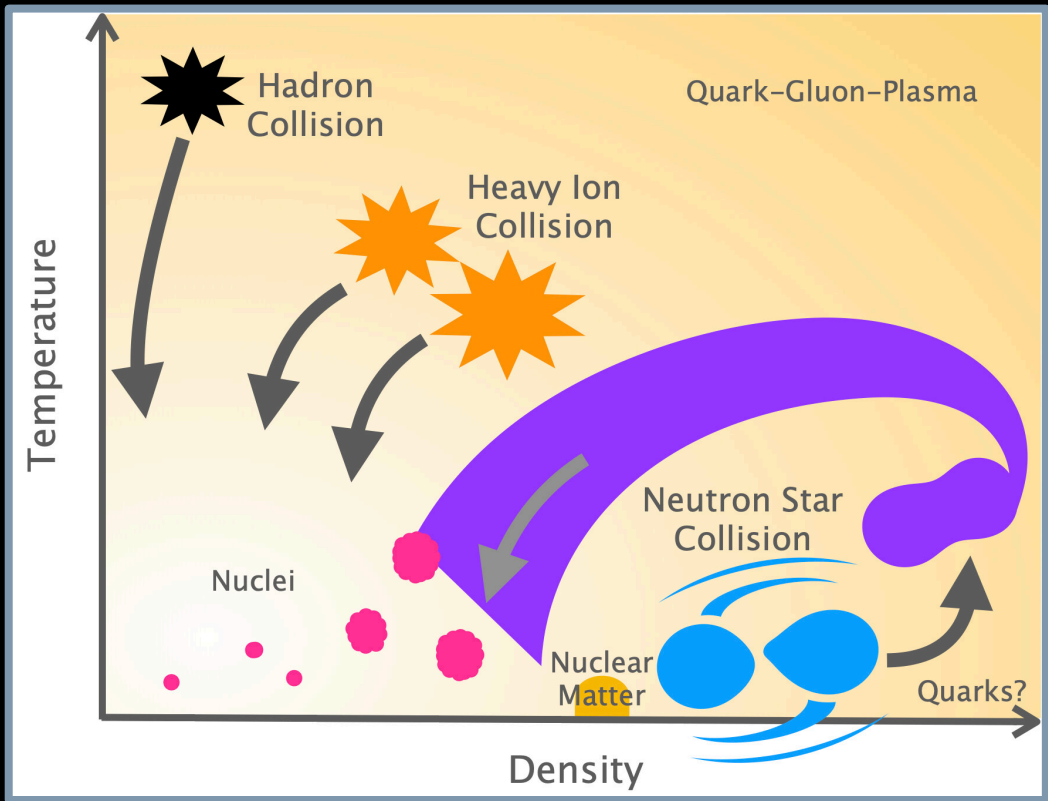
Extreme Gravity  
& Fundamental Physics

With thousands of BBH events per day, we will be able to cherry pick the most telling events (high spins, large kicks, edge-on, high ellipticity, etc.).





Dynamics of Dense Matter & Extreme Environments





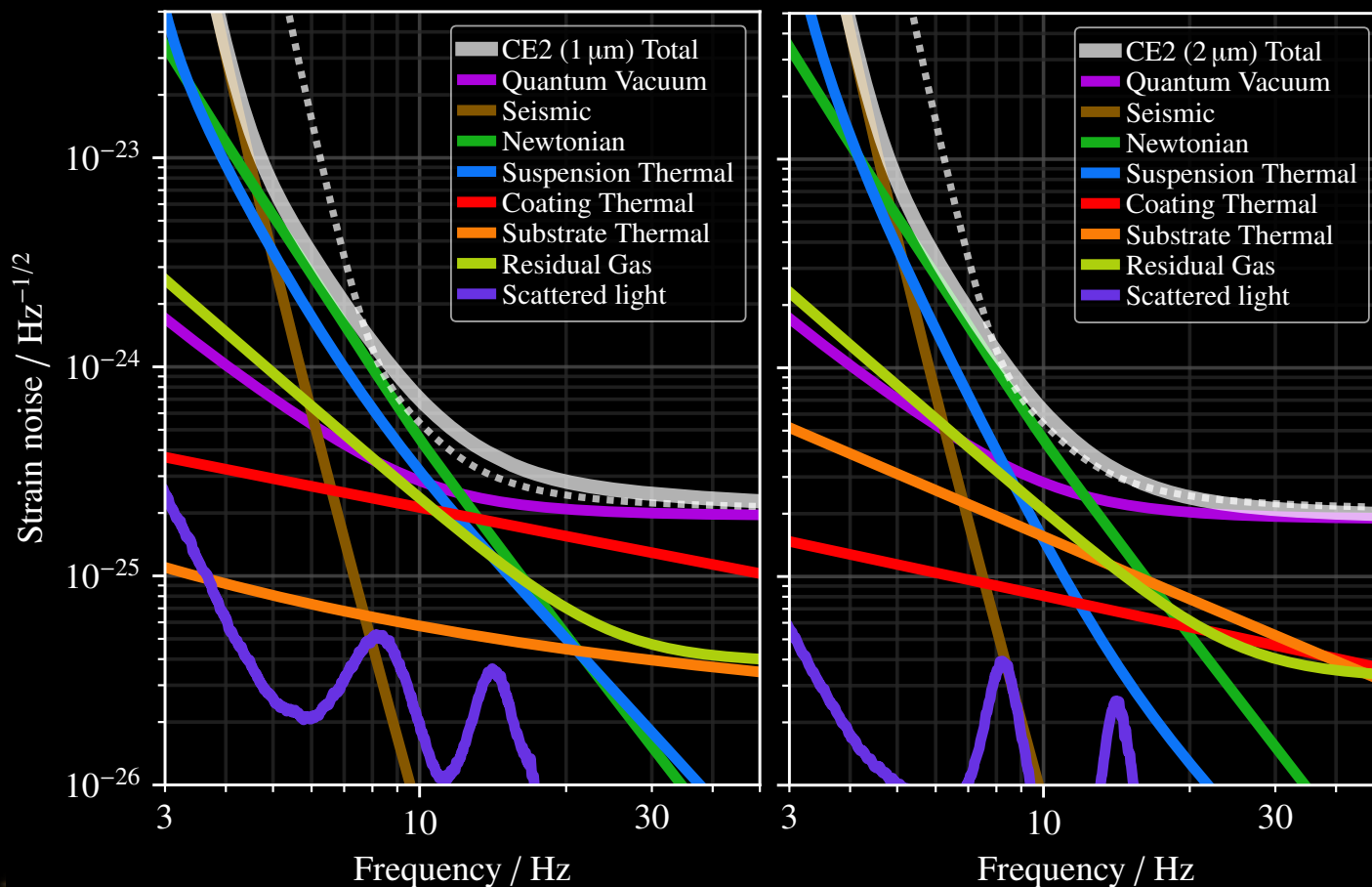


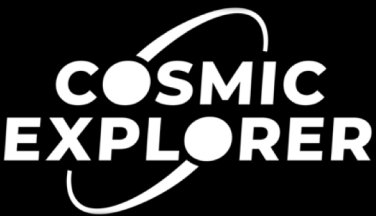
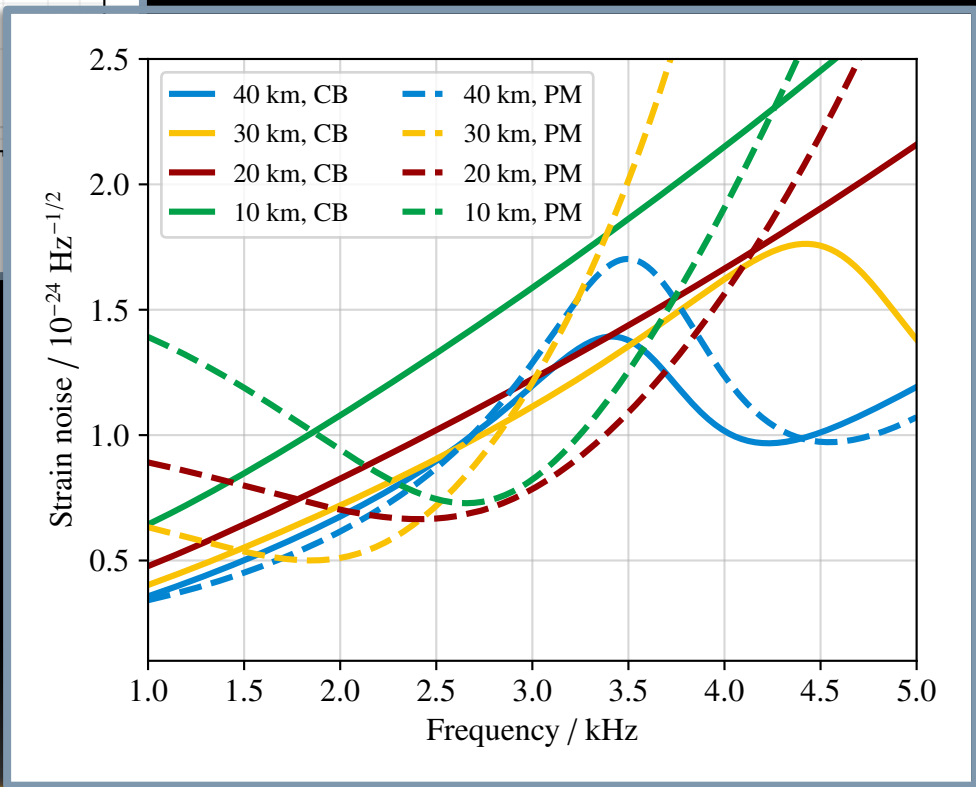
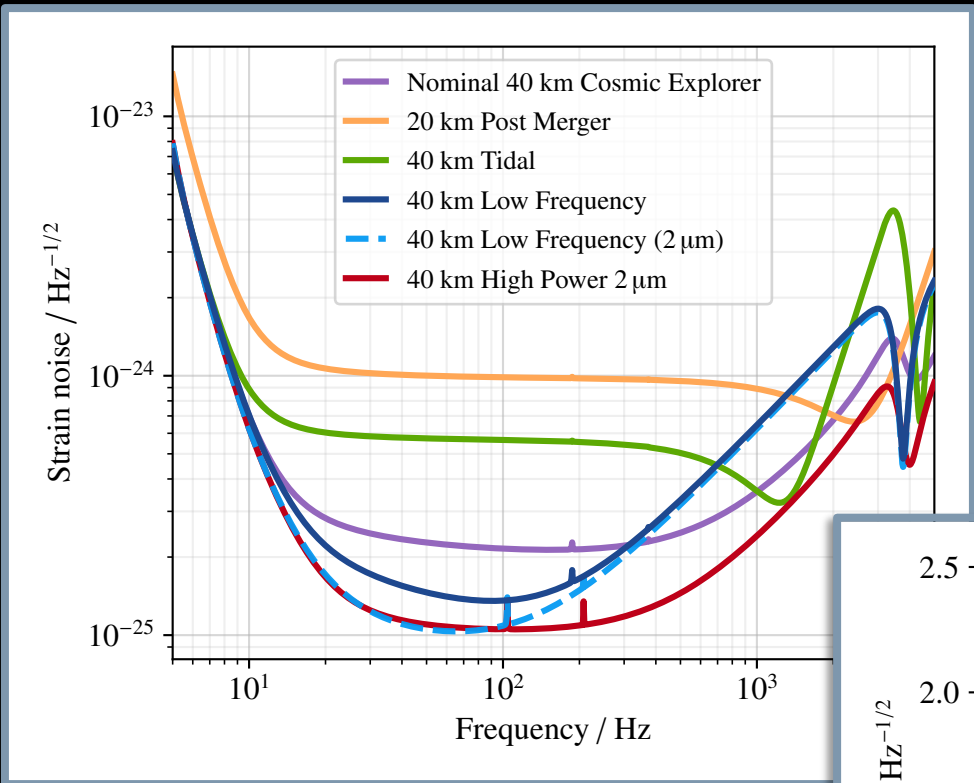
# Cosmic Explorer Update

- Incremental improvements on current technology maybe another path to the target CE sensitivity (formerly CE2)

Extreme Gravity  
& Fundamental Physics

Black Holes & Neutron Stars  
Throughout Cosmic Time





The background of the slide is a 3D rendering of the Moon's surface. In the foreground, a series of green, diamond-shaped observatories are connected by a grey line, forming a path across the lunar terrain. In the distance, two large, dark, swirling structures resembling gravitational wells or black holes are visible against the blackness of space. The title 'COSMIC EXPLORER' is written in large, white, bold, sans-serif capital letters with a black outline, positioned on the right side of the image. Two white curved lines arch over and under the text.

# COSMIC EXPLORER



CE: 40 and 20km L, surface, 1 interferometer per observatory

