Cosmic Explorer Progress and Plans

Matthew Evans, on behalf of the Cosmic Explorer Team


NSF
A Horizon Study for
Cosmic Explorer
Science, Observatories, and Community
COSMIC EXPLORER

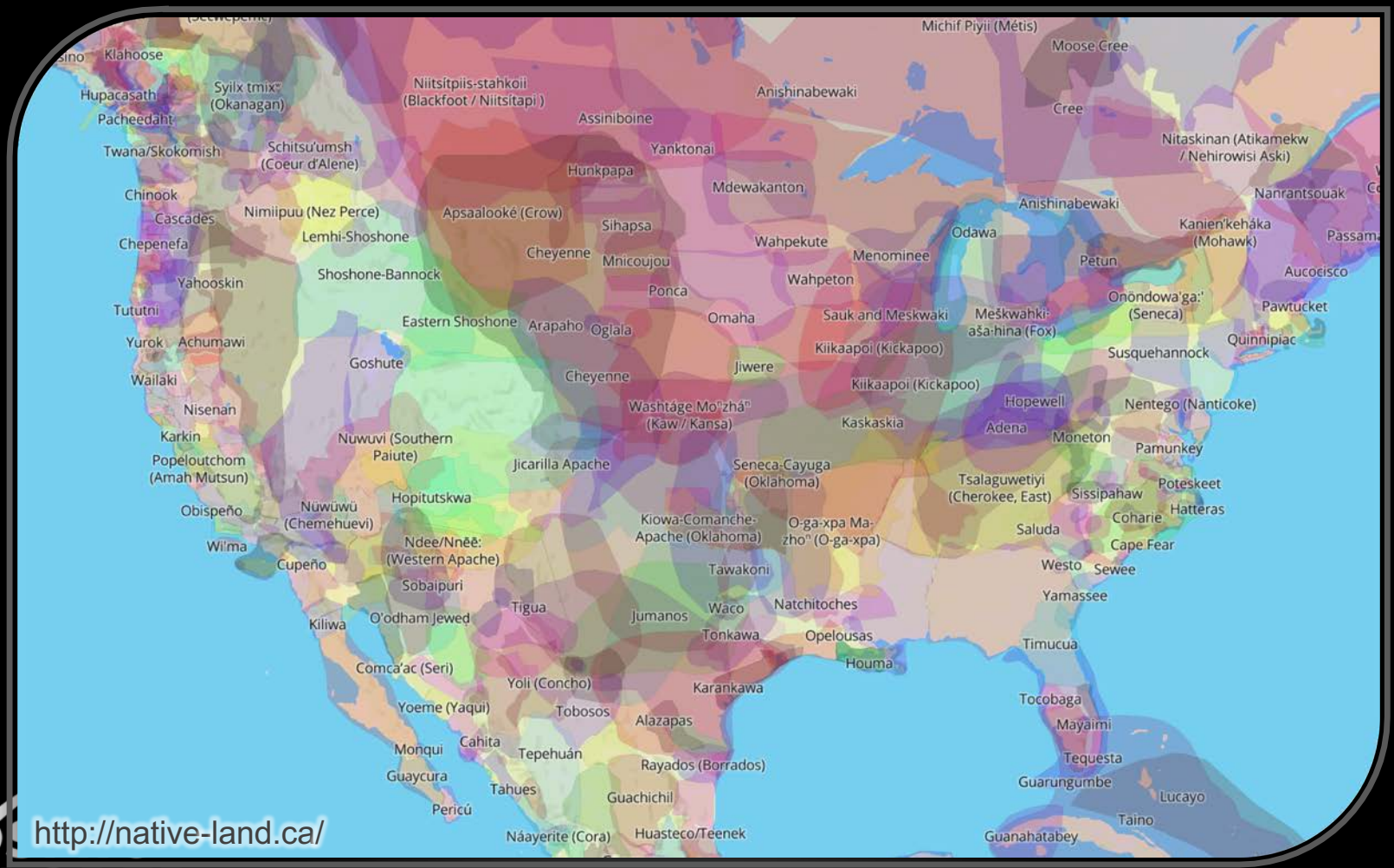
Getting Started

- Your input and involvement is important to CE:
  - **CE Horizon Study available at cosmicexplorer.org**
    - **dcc.cosmicexplorer.org/CE-P2100003/public**
  - **And your feedback is much appreciated!**
    - **cosmicexplorer.org/horizon-study-feedback**

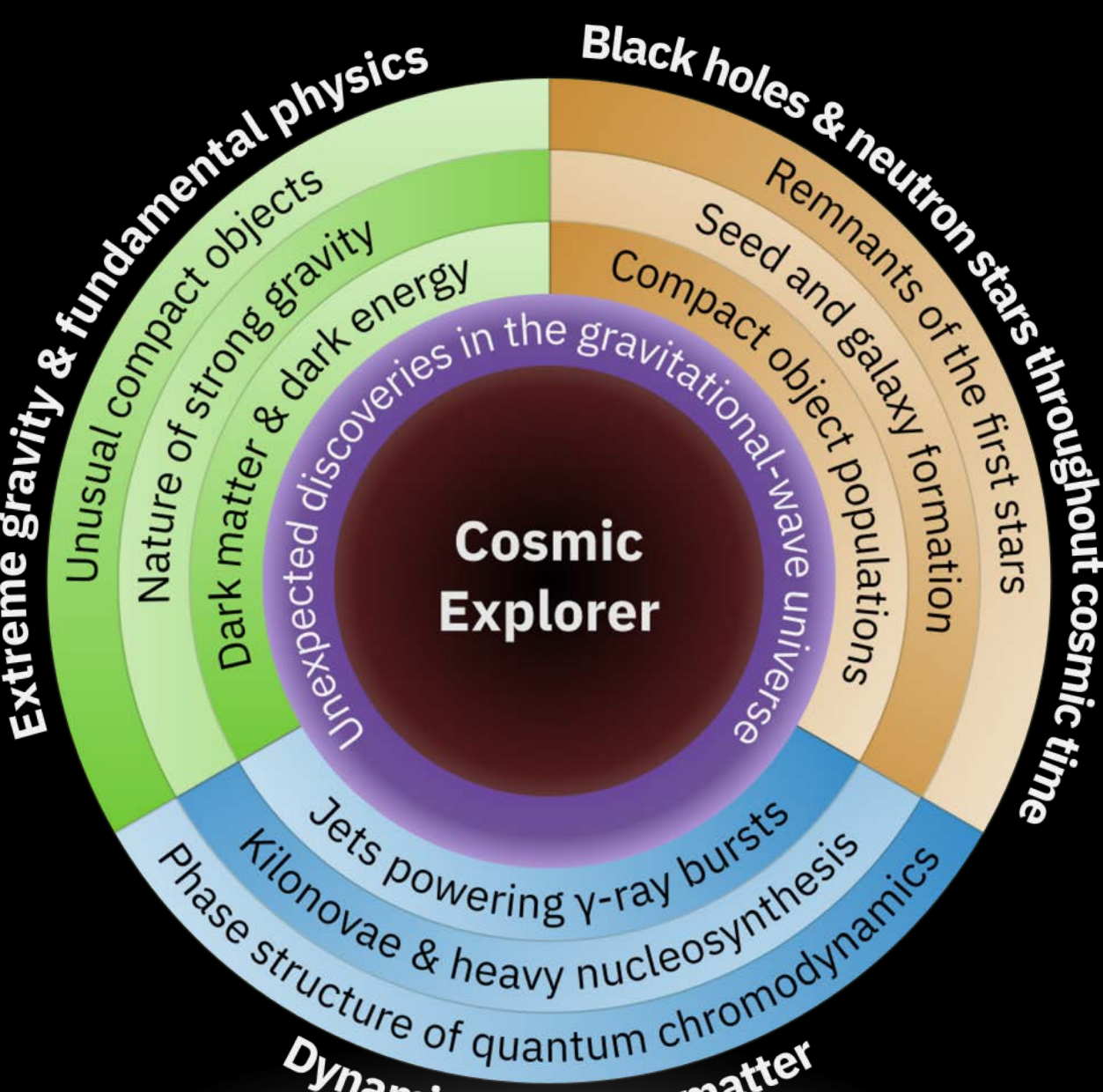
  - **CE will be built by this community. Please join the CE consortium**
    - **cosmicexplorer.org/consortium.htm**

- EDI play a central role in our thinking about CE. I'll start with a few words about one EDI aspect of the CE project…

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.



If you are not aware of issues surrounding TMT, please read arXiv:2001.00970 .



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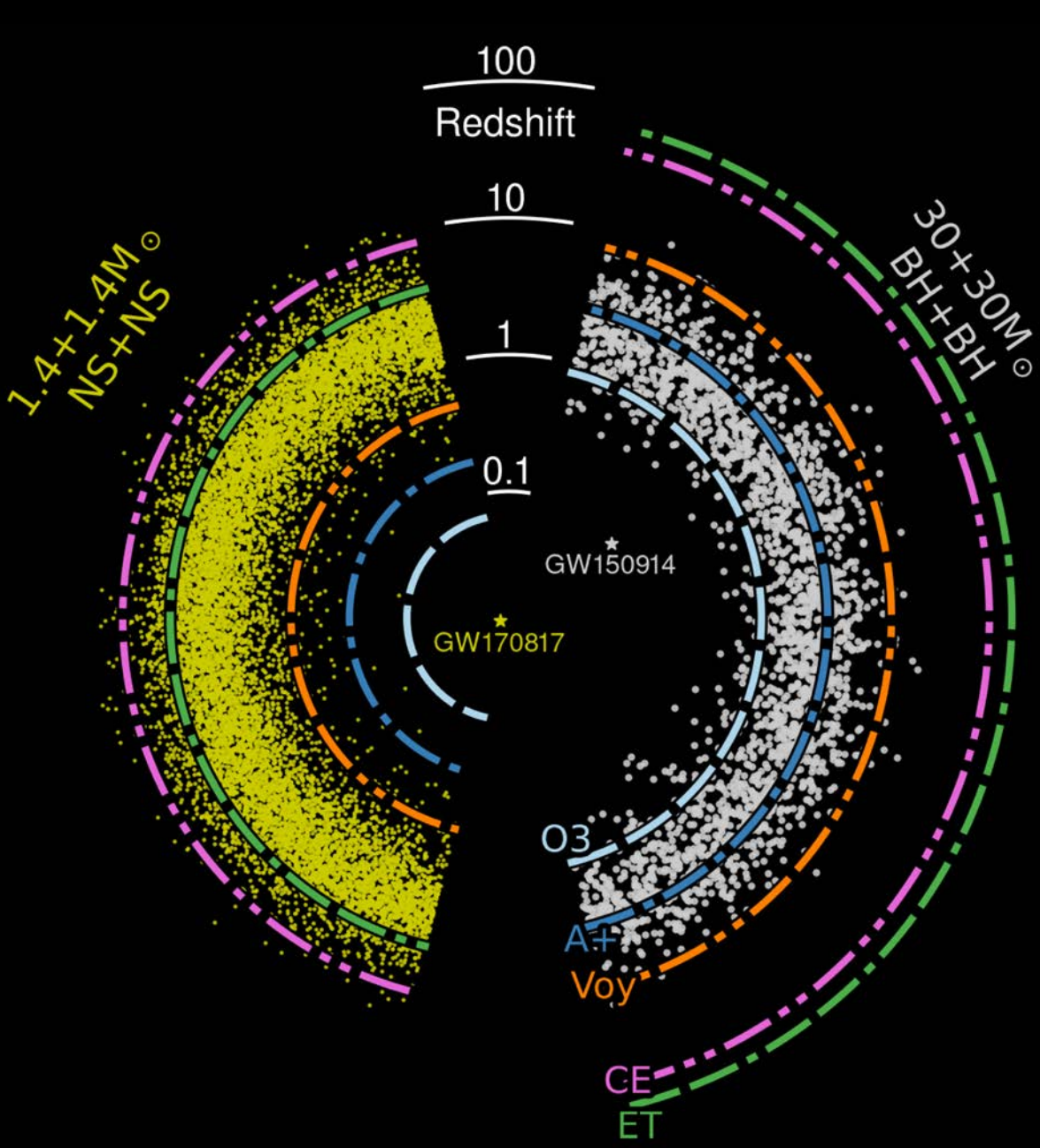
Black Holes & Neutron Stars Throughout Cosmic Time



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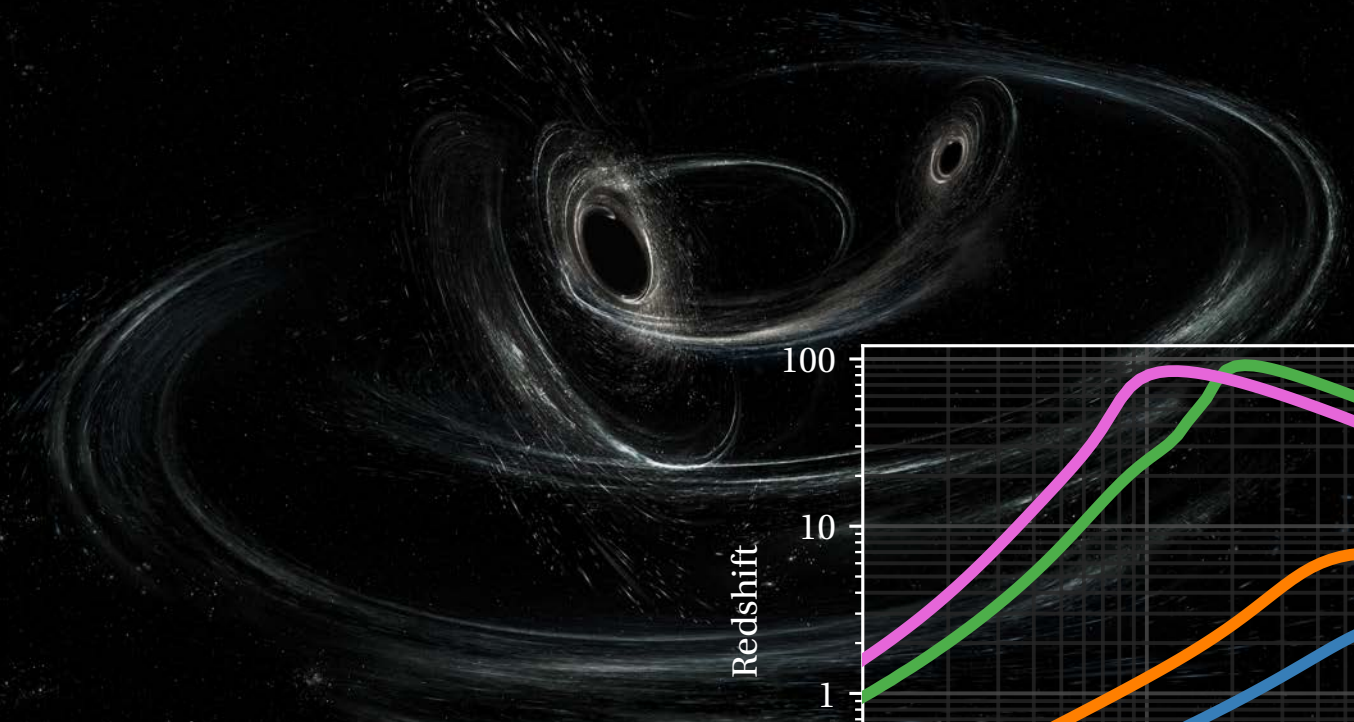
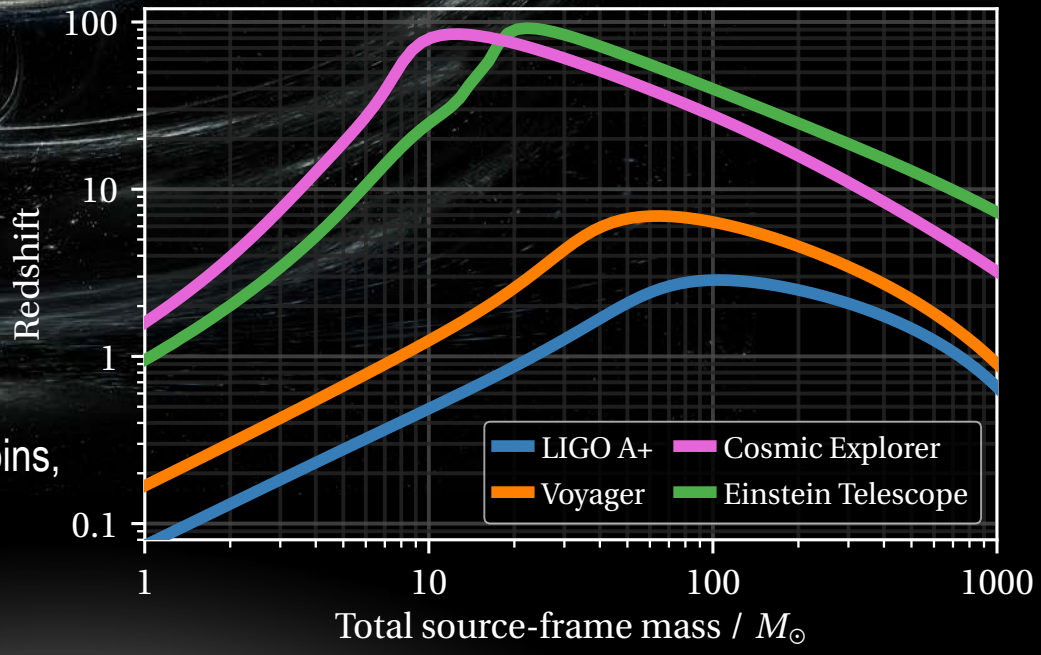
Precision tests will be enabled by black hole mergers like those seen now (~30 solar mass, at z ~ 0.3), which will have an SNR ~ 1000 in CE.

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.).

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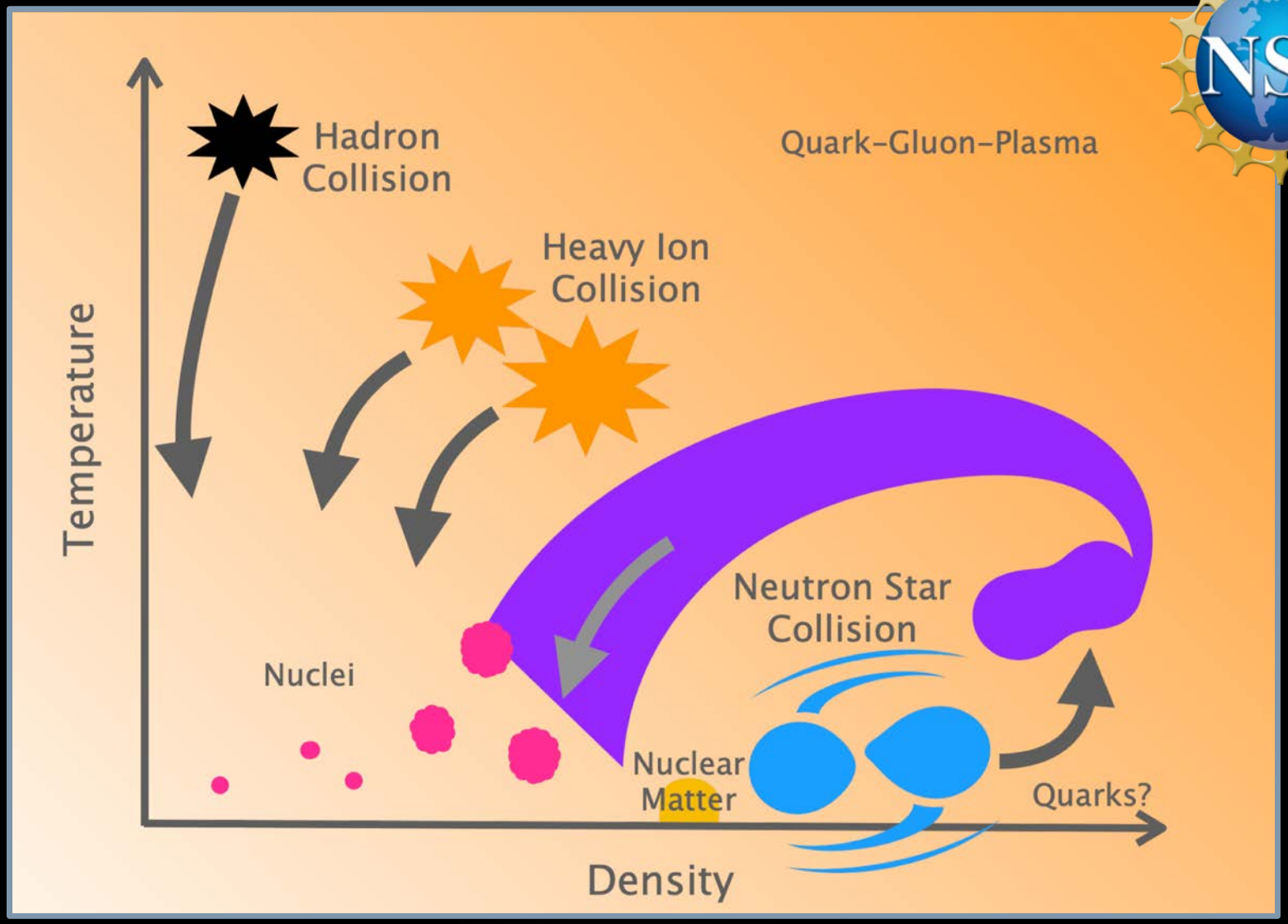
Dynamics of Dense Matter & Extreme Environments



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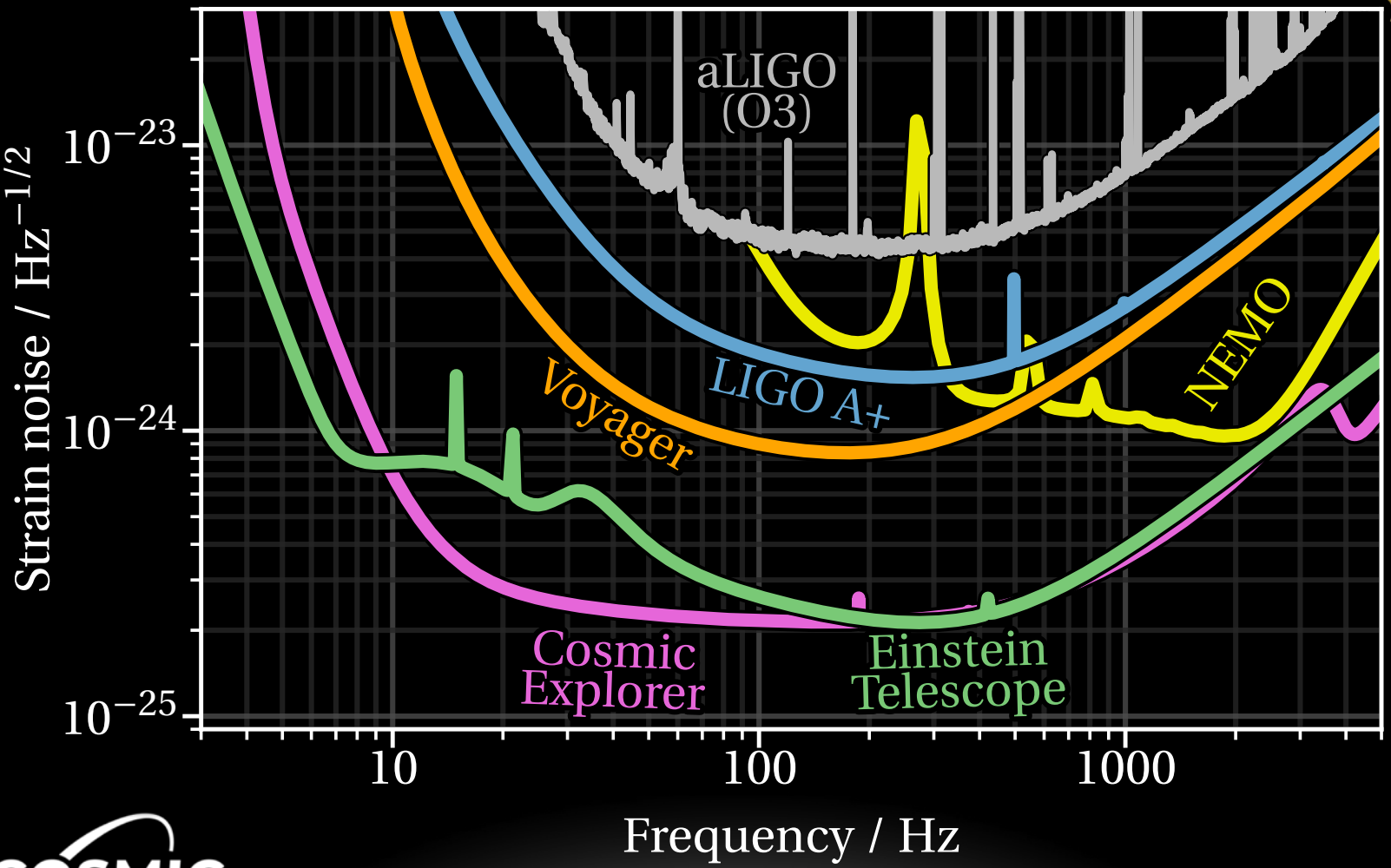
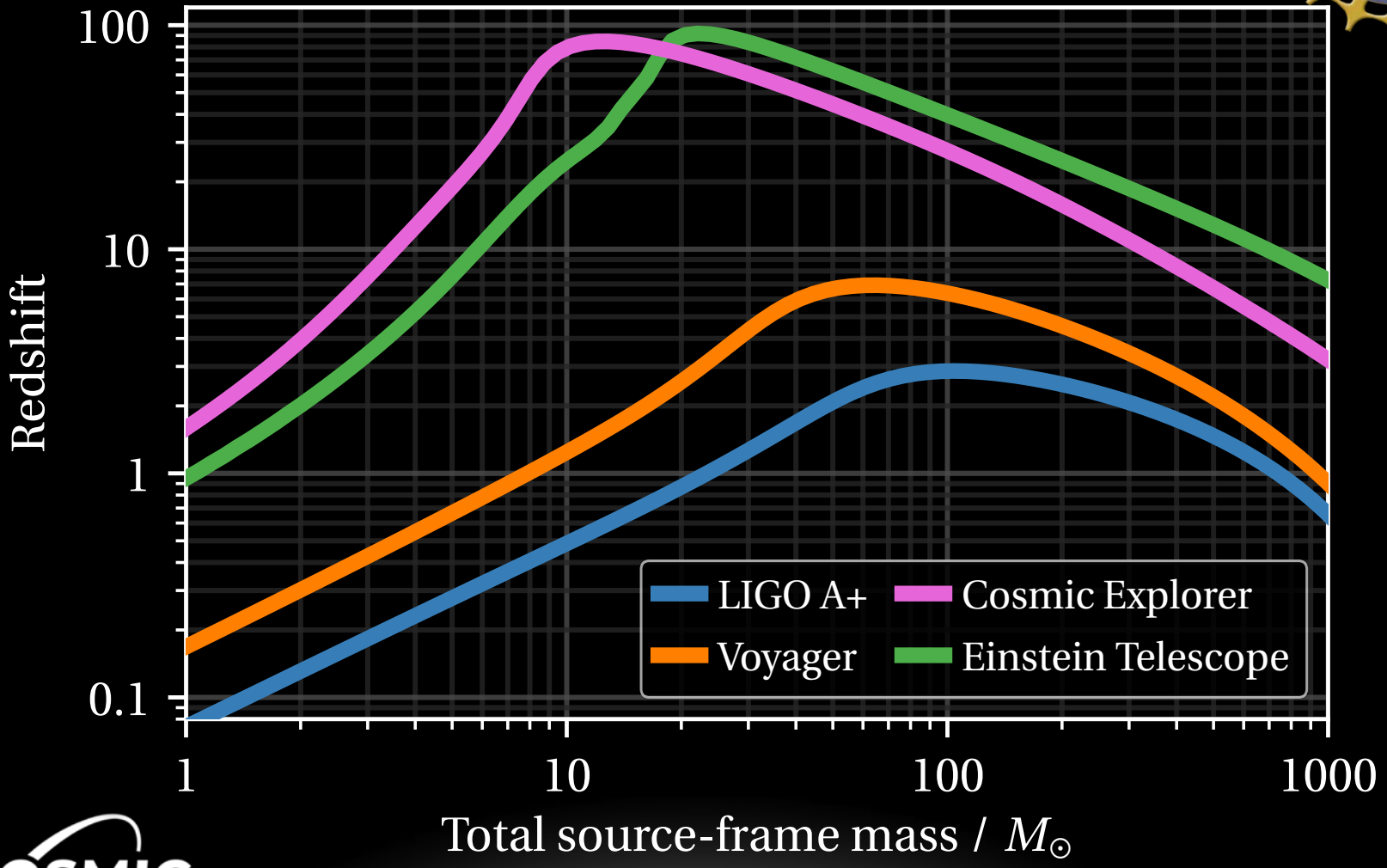
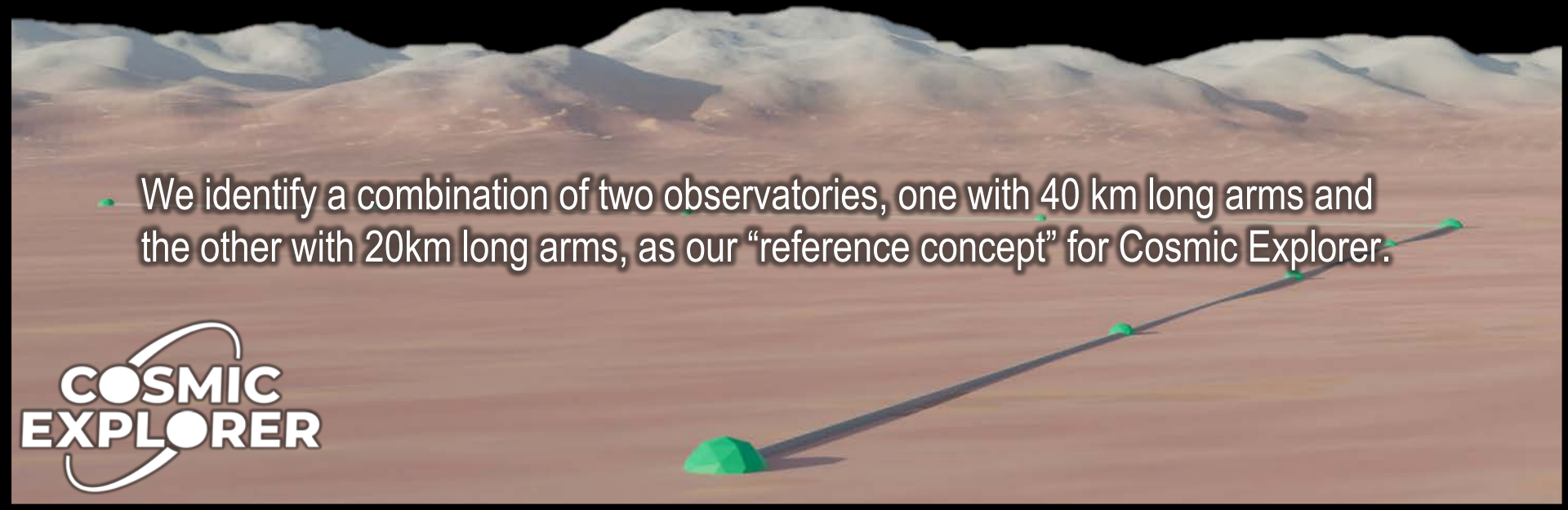
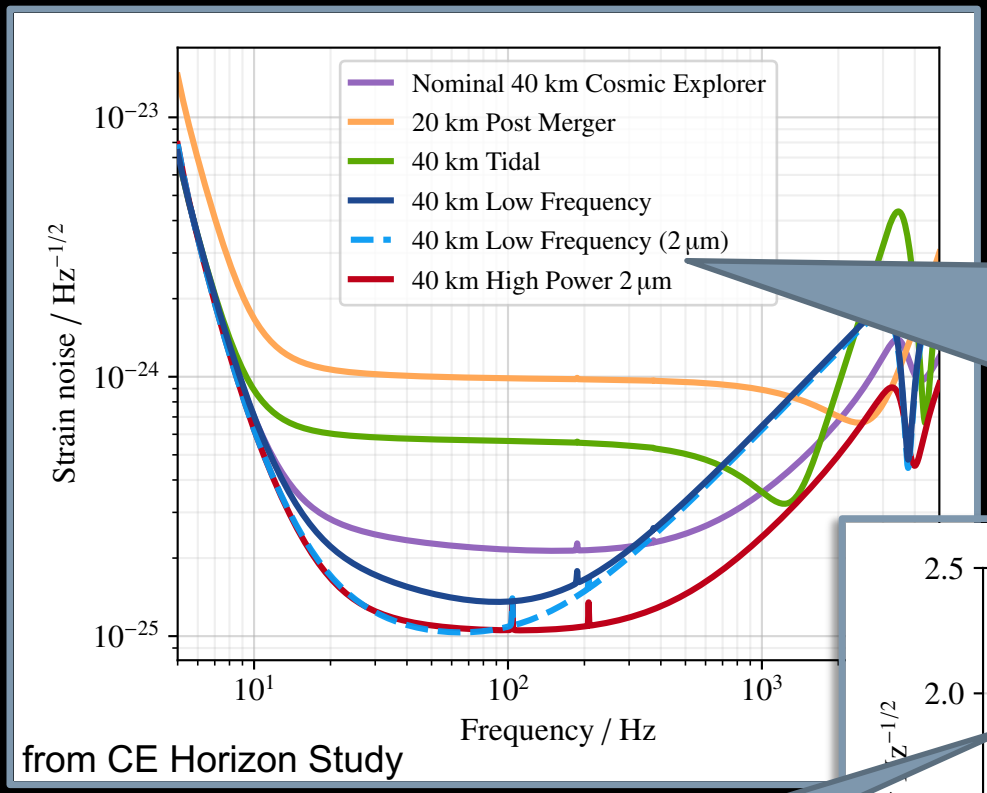

aLIGO
(O3)
LIGO A+
Voyager
NEMO
Cosmic
Explorer
Einstein
Telescope
10^{-23}
10^{-24}
10^{-25}
Strain noise / $Hz^{-1/2}$
10
100
1000
Frequency / Hz


100
10
1
0.1
Redshift
1
10
100
1000
Total source-frame mass / $M_\odot$
LIGO A+
Cosmic Explorer
Voyager
Einstein Telescope

A Science-Driven Design for CE

- In the Horizon Study we explore a variety of potential CE designs, and address questions such as:
  - 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 advantages of 1 vs. 2 or more facilities?
- The CE approach — seek to optimize detector length and design for maximum science while minimizing technical risk and complexity

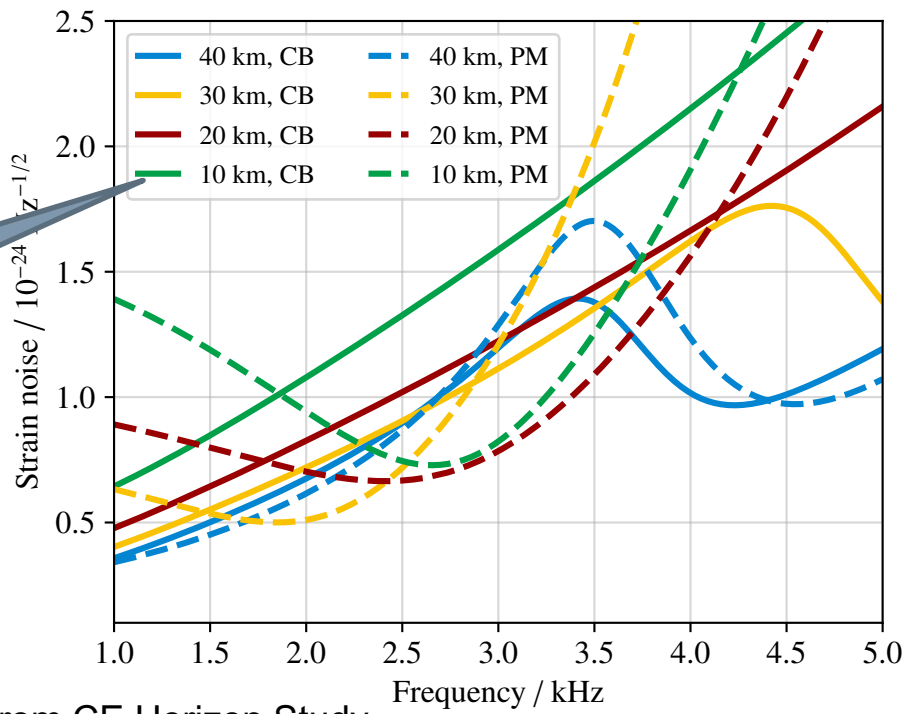




from CE Horizon Study

Note: These 2um curves assume **super-high power** (12MW instead of 1.5MW) and may not be realistic.

They are shown to illustrate the potential of the CE facility to go beyond the current design concept.

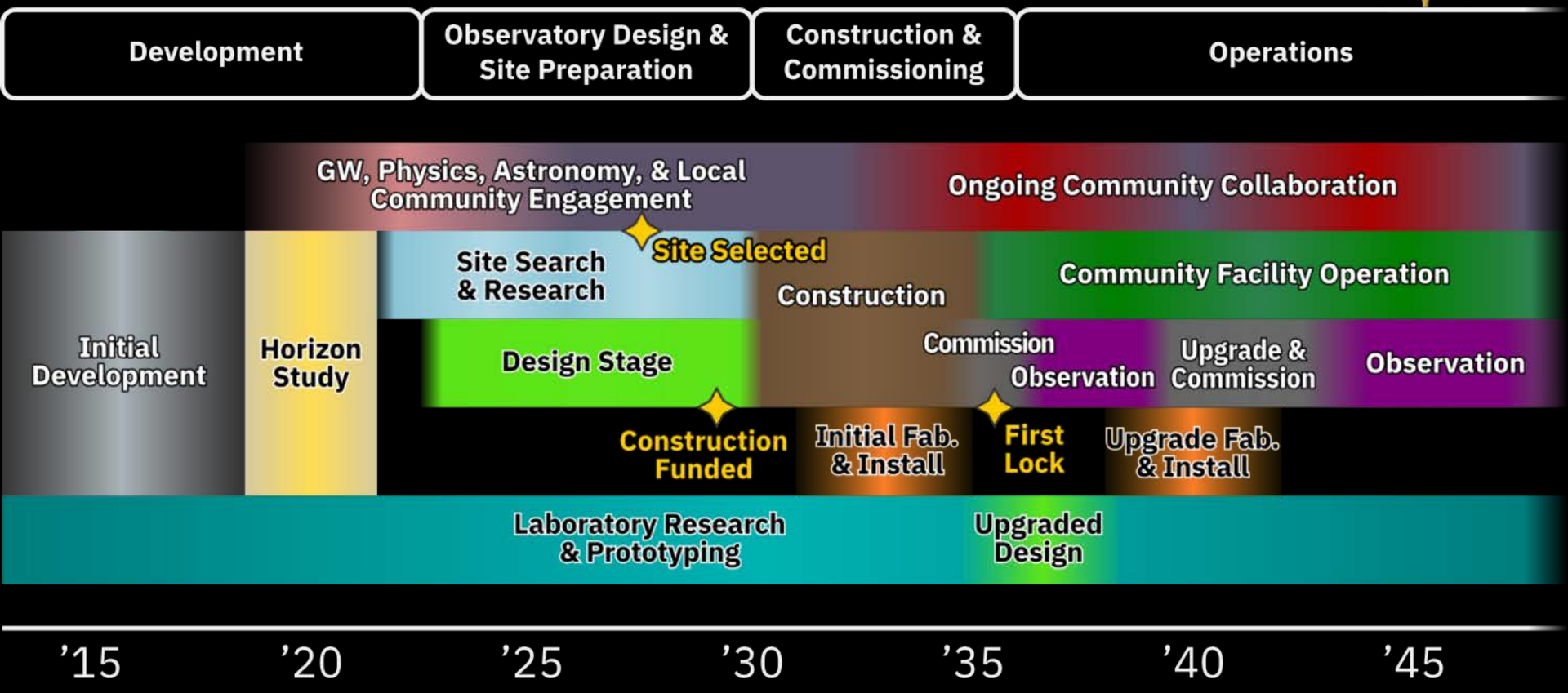


from CE Horizon Study

PM = post-merger optimized

CB = compact binary optimized

Cosmic Explorer Timeline



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The Message

- Next-Generation Observatories have great potential!
  - Cosmic Explorer and ET are moving forward
  - We are guided by researchers like you!

- Your input and involvement is important to CE:
  - **CE Horizon Study available at cosmicexplorer.org**
    - **cosmicexplorer.org/horizon-study-feedback**
  - **CE will be built by this community.**

cosmicexplorer.org/consortium.html

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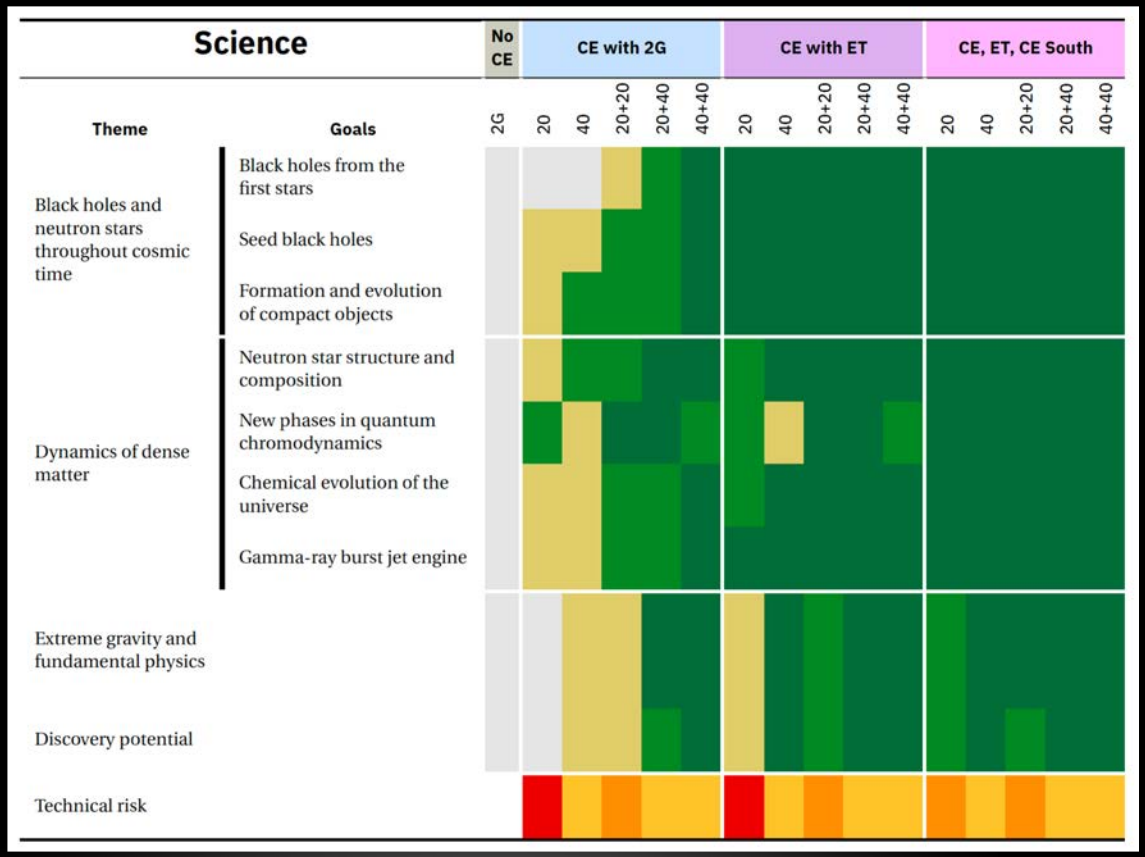
Extra material

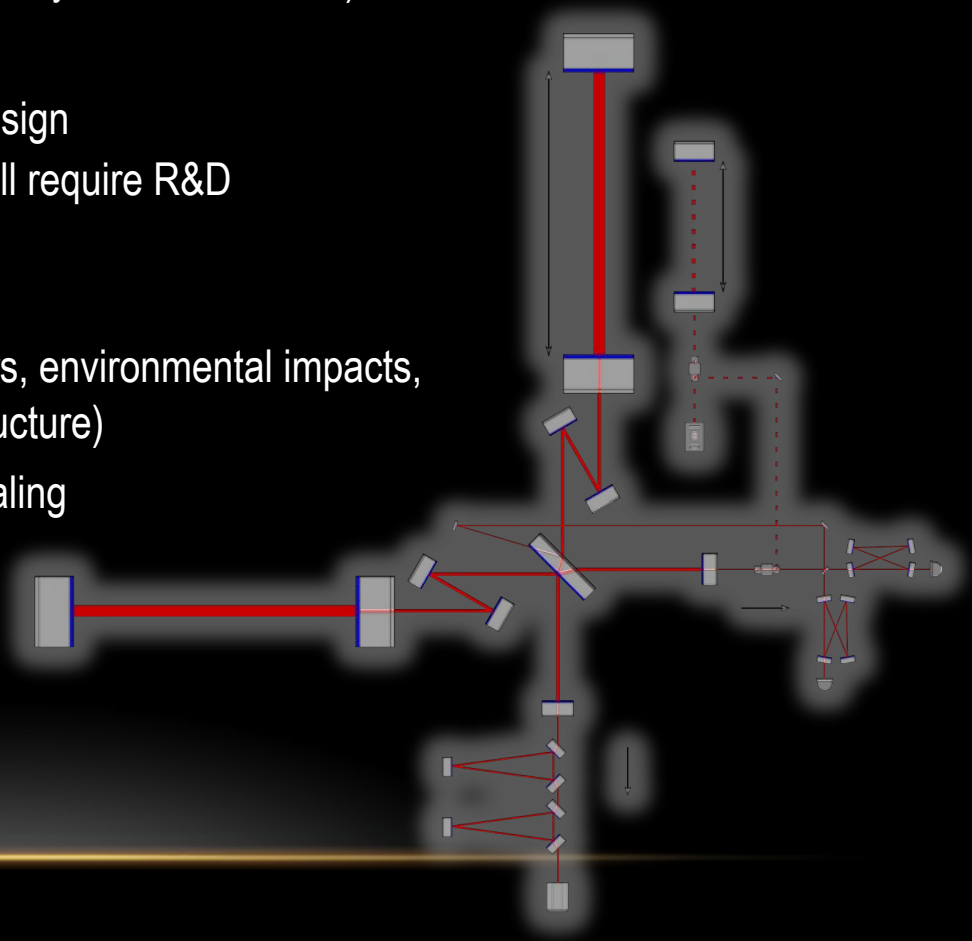
7) Optimizing Design Performance

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

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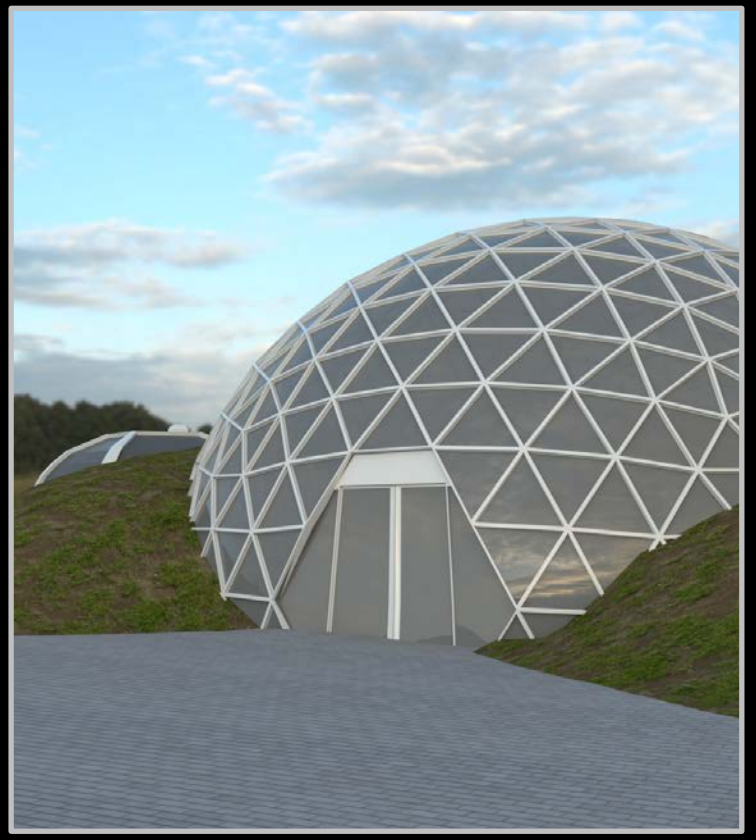
10) Cosmic Explorer at the Local and Global Scales

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**.



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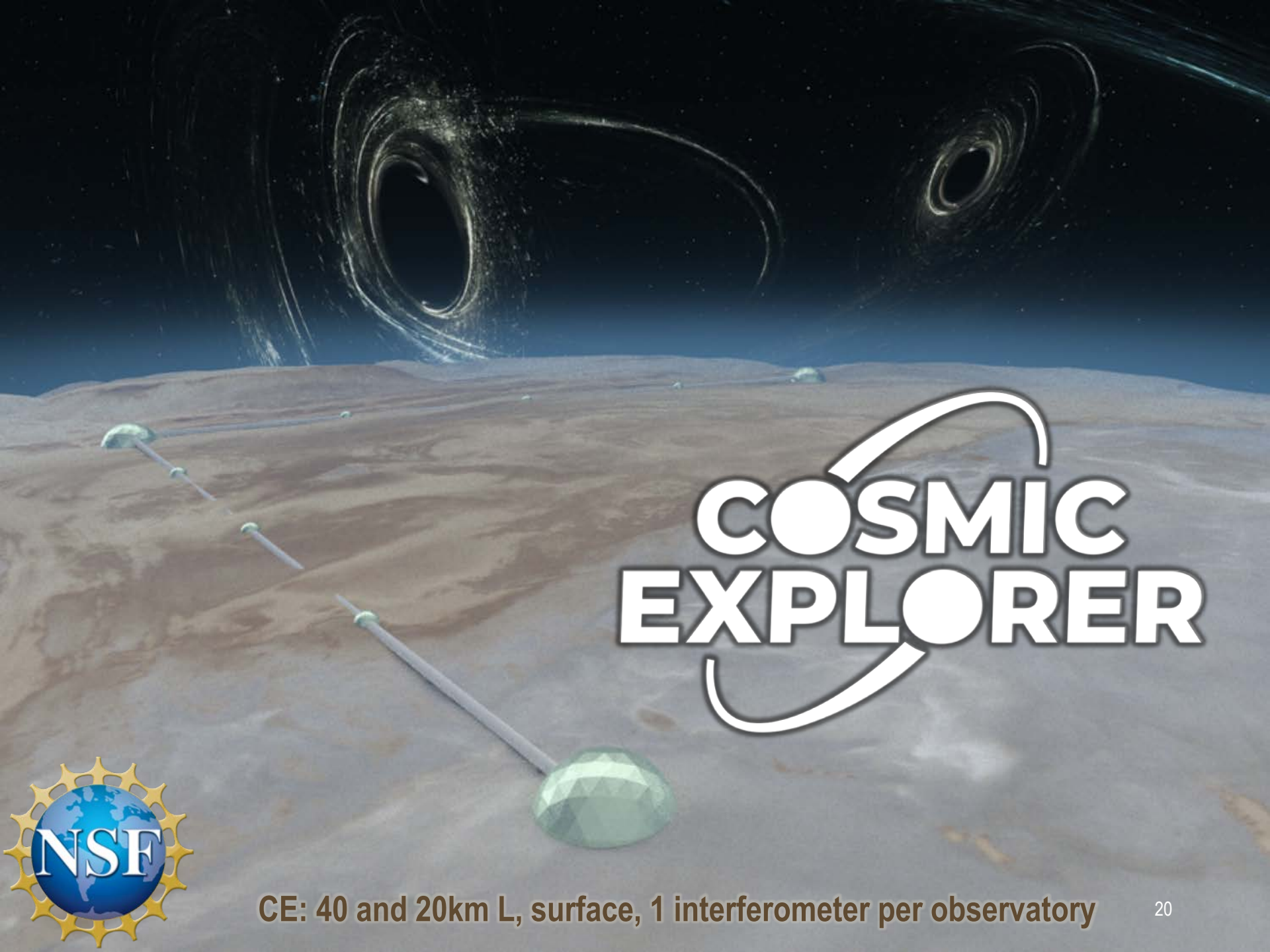

CE: 40 and 20km L, surface, 1 interferometer per observatory