

Desired Results of the Cosmic Explorer Engineering Study

This is an appendix to the Astro2020 ground-based technology development white paper *Cosmic Explorer: The U.S. Contribution to Gravitational-Wave Astronomy beyond LIGO* (Reitze et al.). It describes the desired results from a Cosmic Explorer engineering study in the 2020s.

Beam Tube Vacuum System

- Authoritative cost for the beam tube vacuum system
- Design drawings for the vacuum system with choice of materials.
- Calculations for vacuum pressure, outgassing rate, and pumping rates.
- A thermal analysis of stresses and beam tube support design to mitigate stick slip events, both in the routine operating environment and the bakeout environment.
- Detailed description of tubing manufacture, including recommended methods. Issues include whether the tube should be assembled in-field or transported to the site; whether the tube should be extruded or welded (spiral or longitudinally); if coatings and pretreatment are required for outgassing and to protect optics; whether stiffening rings should be included; and leak hunting per component.
- Valving strategy, including number and type of hard close and soft close valves, and internal mechanisms for small motions.
- Pumping strategy, including the number and size of ports along the arms (optical and pump ports); the number of independent sections along the 40 km; the configuration of getter, evaporation and ion pumps; and the roughing system.
- Cleaning methods and cleaning tests.
- In-field assembly methods: welding methods and leak test techniques of the welds, maintenance of clean conditions in the field, and technique for alignment of the tube.
- Bakeout strategy (if needed): water bakeout technique and removal of remaining hydrocarbons.
- Pressure and flow measurements: optical column density measurements, local gauges, and residual gas analysis.
- Maintenance, failure recovery and leak localization: backfill technique and recovery from an accident, leak localization and repair techniques, and normal maintenance schedules for pumps.
- Anticipatory failure analysis and risk reduction: control of corrosion; material thickness (or the inclusion of beam tube covers) for bullets and other impact risks; flood, storm and earthquake risk; and risk reduction.

Reference Site and Structures

- Land availability and acquisition costs
- Orientation and alignment of the US site relative to the other sites in the network
- Authoritative cost of the beam tube structures and civil work
- Layout and drawings for the construction: mix of cut and fill, excavation, tunneling and structures; structures required to minimize cost.
- An analysis of environmental and human hazards, including the probability of flooding, storms, local major earthquakes, and significant population increase near the site.
- An assessment of environmental concerns and possible mitigation strategies.
- An analysis of accessibility: ease of access and living conditions for people who will work at the site, access for construction, availability of utilities.
- Operations costs, including anticipated utility costs and infrastructure maintenance costs.
- Data on seismic, infrasound, and wind noise spectra over time.