

Cosmic Explorer Beamtube EXperiment (CEBEX)

*STATUS REPORT FOR THE BTW3 WORKSHOP AT LHO
1 OCT 2025*

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LIGO Laboratory and Cosmic Explorer Consortium

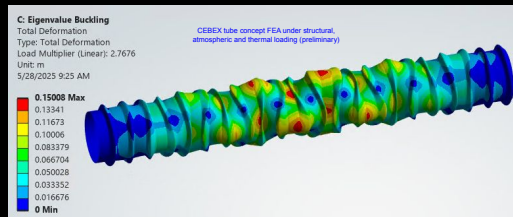
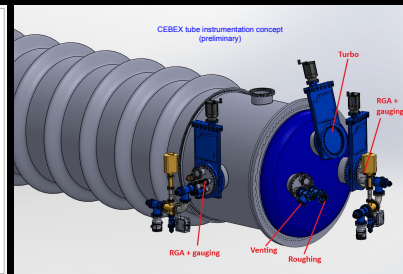
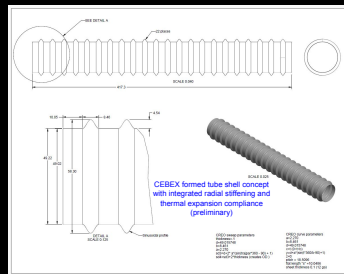
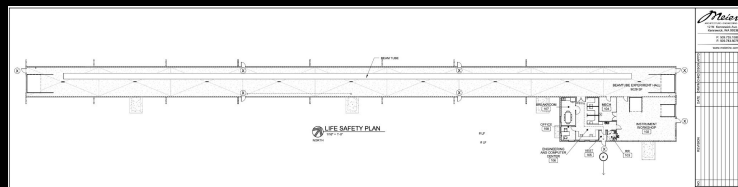
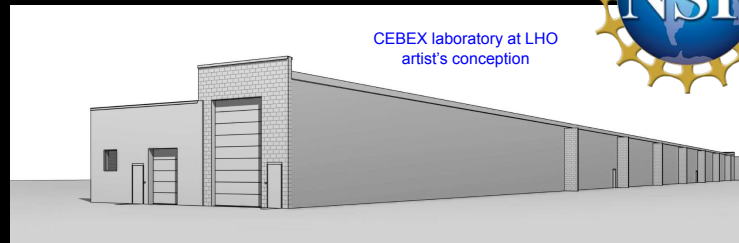
[LIGO-G2502103](#)

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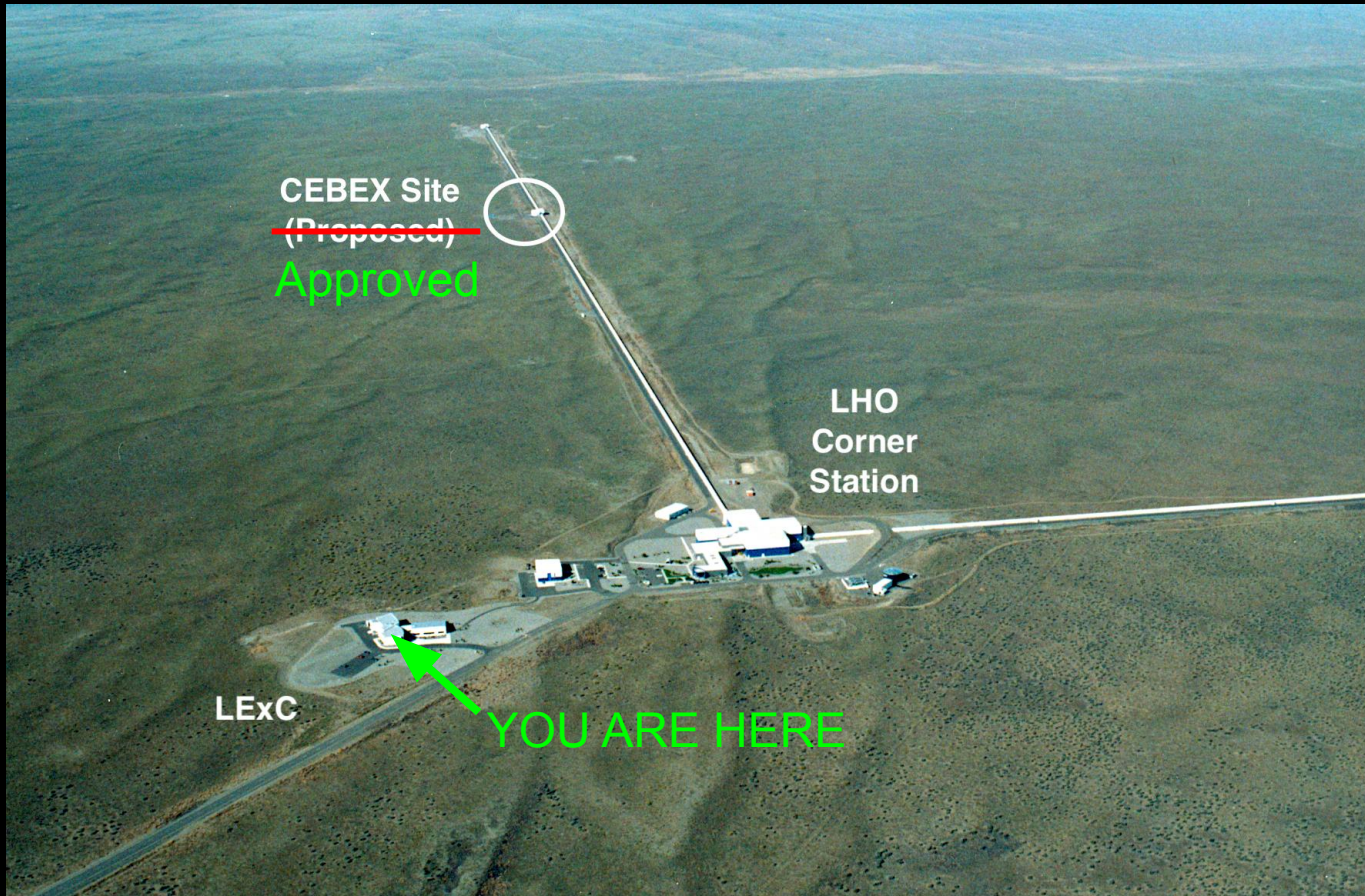


- NSF mission: qualify **scalable, fast, low-cost** UHV beamtubes for CE
 - Material, surface science, fabrication, welding, assembly, leaktest, bakeout, instrumentation
 - Generate **CE reference design and cost book**
 - **120m l. x 1.24m Ø prototype beamtube platform** (+ possible variants)
 - **New 11,400 ft² (1,063 m²) lab facility** near LIGO Hanford Y midstation
 - Complementary collaboration with **ET Pilot Sector** program, now in progress at **CERN**
- CEBEX laboratory facility
 - Architectural and engineering design is **complete**
 - Selecting builder in October, **target occupancy by summer '26**
- Prototype tube design
 - **Baseline RFI for circulation to industrial fabricators:**
 - Corrugation-stiffened 304L, ~2mm wall; **inspired by GEO600 and CERN designs**
 - Flared radial flange or formed socket field joints
 - I²R sector bakeout (similar to LIGO and Virgo)
 - **Targeting fabricator selection by late winter**
 - Options/variants under parallel study
 - Discrete stiffeners & expansion joints (like LIGO and Virgo)
 - Sleeved or butt-welded field joints
 - Alternative UHV construction materials
 - Ferritic SS (CERN)
 - Carbon steel (LIGO Lab)
 - Thinwall (corrugated or rib-stiffened)
 - Thickwall (petroleum pipeline)
 - **Traveling induction bake with ultra-dry viscous flow** } **coupled**
- CEBEX team is growing!
 - Tube engineering: Coyne, Franco, Iudintseva, Lazzarini, Sanchez
 - Civil & facility engineering: Gately, Guidry, McCarthy
 - PM: Richards, Hill, Hansen
 - Co-PI's: Csizmazia, Feicht, **Zucker***

*contact zucker@caltech.edu for info



CEBEX Site





Y MIDSTATION
(existing)

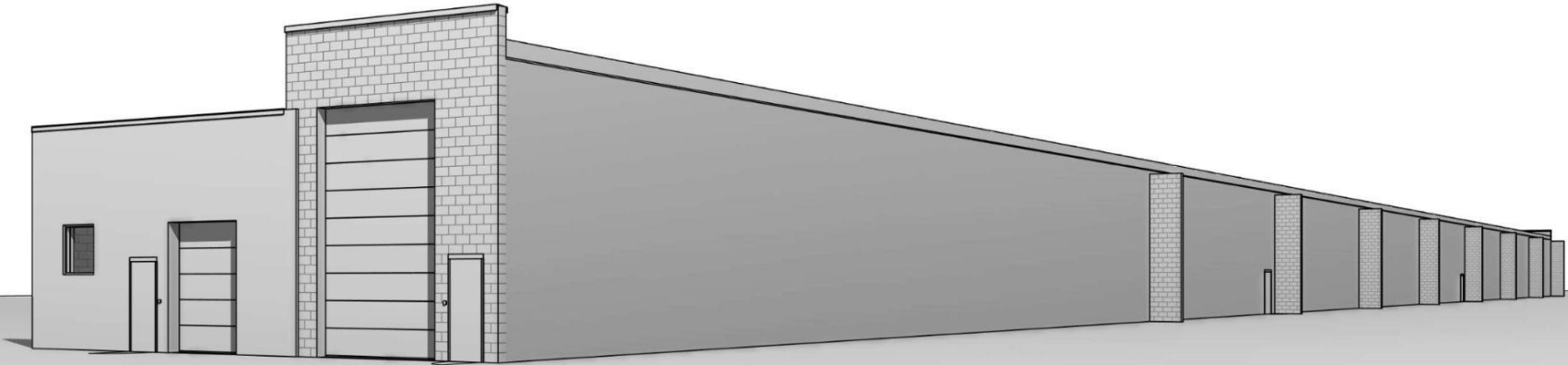
LIGO HANFORD Y
BEAMTUBE
(existing)

CHILLER PLANT
(existing)

CEBEX LAB
(proposed)

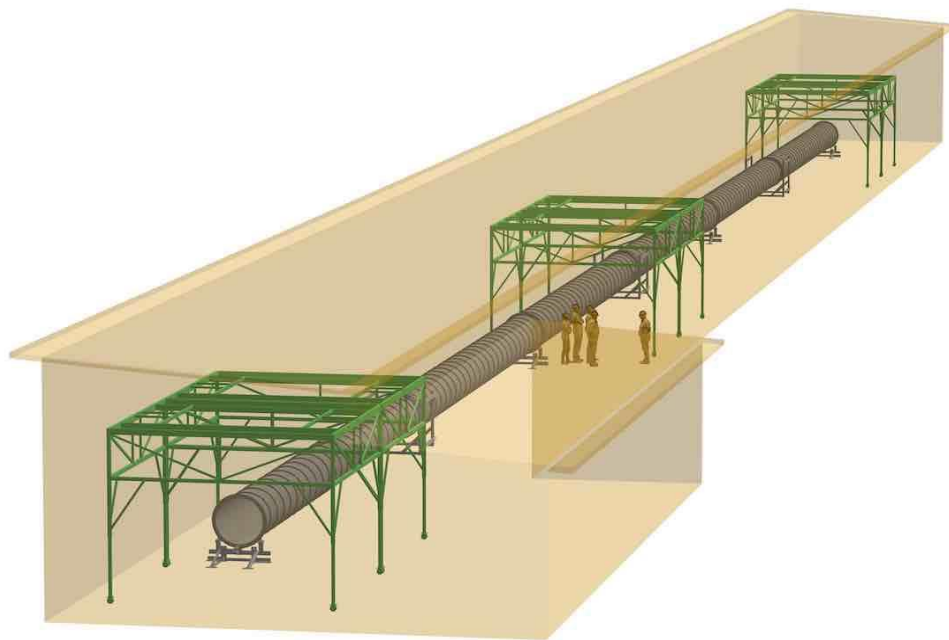
Earth

Artist's conception
(Meier A&E)



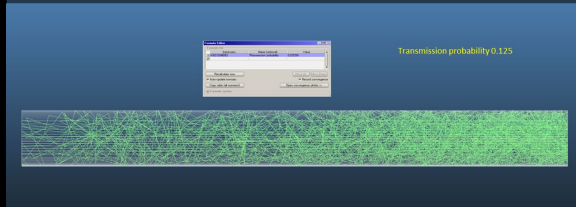
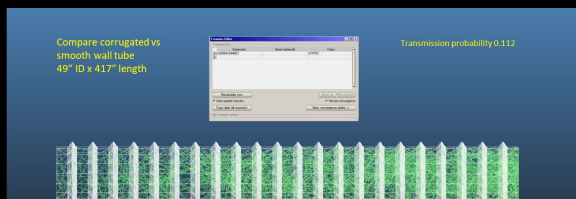
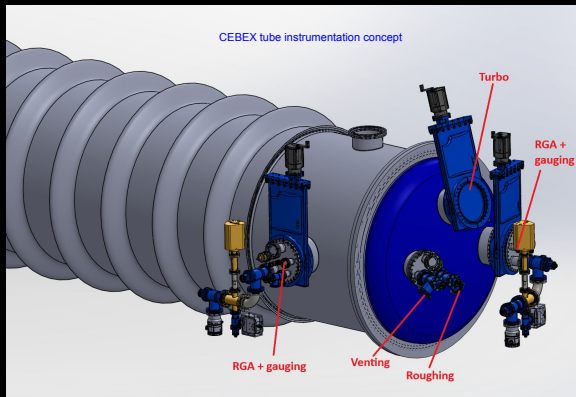
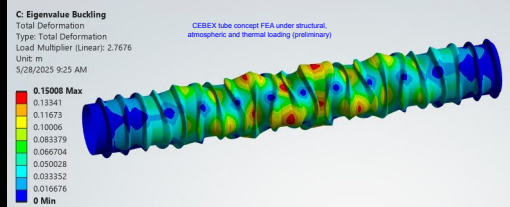
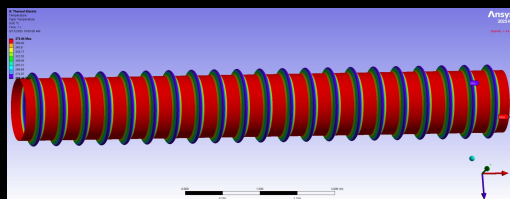
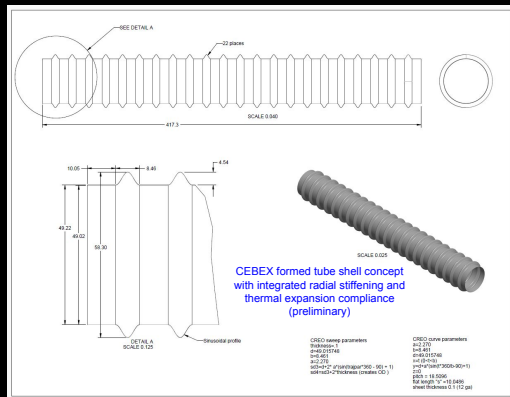


CEBEX high bay



- New 140m x 6m x 6m lab at LHO
- Low-cost CMU (“cement block”) construction with steel roof
- Sealed overhead doors at both ends
- Pressurized interior
- Local 5x5x5m ISO 5 cleanrooms over access points (like LIGO)
- 200 kVA electrical service for bakeout
- Attached instrument workshop/lab, offices and engineering center
- Exterior roadways & turnaround to accommodate 15m truck delivery

CEBEX Prototype Tube Concept



- Roll- or hydro-formed corrugated tube
 - 304/304L SS, air fired @450C
 - 2.1 mm thick x 1.24 m diameter
 - 115 mm tall sine convolution every 50 cm
 - 10m unit length (x12)
- I²R bakeout
 - Insulation type TBD
- Instrumented spools and end caps
 - Turbo, ion & NEG pumping
 - RGA & calibrator instrumentation
 - *Is low H₂ background practical/necessary?*
- Seeking industrial feedback on fabrication through *Request For Information (RFI)*

LIGO- L2500049-rev002 *Cosmic Explorer (CE)* 28 July 2025

Request for Information

Fabrication of Large Diameter Corrugated Stainless Steel Tubes for Vacuum Service*

*12 gauge wall x 1.24 meter diameter x 10 meter length

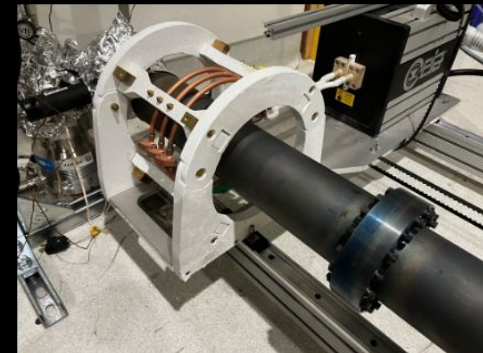
LIGO Laboratory, CE Team

CEBEX options/opportunities

- Alternate bake/desorption
 - Reusable insulation
 - Traveling induction heat
 - Ultra-dry gas flow entrainment
 - Plasma
- Alternate tube material
 - Carbon steel
 - Ferritic stainless
- Alternate construction
 - Discrete stiffeners/expansion joints
 - Heavy-wall pipeline
- Optical, structural and vibration tests
- Lab can support more than one test system
 - Anchoring, power, access allow subdividing into 60m sectors
 - Provision for mounting LIGO HAM type chamber in 3 locations



Thick-walled mild steel petroleum pipeline



Progressive induction heating bakeout

CEBEX baseline schedule



Building design	4/25-10/25
Building construction	1/26-6/26
Tube design	10/24-2/26
Tube fabrication	2/26-8/26
Tube Installation	8/26-11/26
Bakeout & testing	12/26-6/28
CE design report	9/27-9/28

Summary



- CEBEX was approved 1 year ago; support continuity came under threat in January
 - **We took delays** in lab construction, equipment procurements, and hiring
- In mid-August, we secured **full commitment for fiscal 2026** and part of 2027
- This lets us reopen positions, place contracts, and accelerate construction
- While a year or more behind the ET Pilot Sector program, we're on track to contribute data and experience that **benefits both ET and CE** and **complements the Pilot Sector** research
- Our program is flexible; **we're interested in your ideas** for CEBEX to help bring ET and CE closer to realization.

THANK YOU