LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Bibliography for the Vacuum System Toolbox

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1 Bibliography

1. LIGO Document T880003, “Pressure changes in the beam tubes with temperature and some theory of outgassing,” R. Weiss.

   This note describes how density and components of residual gases change with temperature, as well as some theory of outgassing.

2. LIGO Document T940090-00, “Water Outgassing Data and Model for the LIGO Beam Tubes,” R. Weiss.

   This note gives a more thorough theory of outgassing with a model that uses Langmuir adsorption theory with the Dubinin-Radushkevich binding energy distribution function. It includes a brief outline of the algorithm used in *waterbakesm.f*, which calculates the outgassing rate for a small section of beamtube, given temperature and properties of molecules of material adsorbed.

3. LIGO Document E950019-00, “Beam Tube Enclosure: Functions and Requirements,” R. Weiss, 27 Feb 1995.

   Appendix A of this document lists physical, structural, and thermal properties of the LIGO beamtube and enclosure.

4. LIGO Document G950082-v1, “Beam Tube Modules,” R. Weiss, L. Jones, 9 October 1995.

   This presentation contains a slide listing the requirements and goals for partial pressure of different molecules (H_2, H_2O, etc.).

5. LIGO Document T080126-v1, “Opening Beamtube Isolation Valves After Incursions,” M. Zucker, 19 May 2008.

   This note describes how to calculate the quantity and partial pressure of gas entering the beamtube when opening gate valves.

6. LIGO Document T080330-00, “Reanalysis of average pressure in the beamtube as a function of water injected at the ends,” R. Weiss, 30 October 2008.

   This note describes the effects of water injected at the ends of the beamtube, including the effects of adsorption and re-emission dynamics. It includes the source code for *btwaterdistsurf2b.for*, which includes outgassing calculations based on adsorption and re-emission, and *btwaterdistribution2a.for*, which only uses a set value for outgassing.

7. LIGO Document G1100105-v1, “Residual Gas in the LIGO Beam Tubes,” R. Weiss, 5 November 2003.

   This presentation contains slides with additional beamtube properties, as well as schematic descriptions of outgassing and leak localization.

8. LIGO Document T1200375-v2, “Transient response of a beam tube during leak checking,” M. Zucker, R. Weiss, 30 July 2012.

   This note shows the effects (pressure versus length and pressure versus time) on injecting helium into the beamtube at a given location at a given rate for a given time.

9. LIGO Document T1200399-v1, “Consequences of the LLO beamtube leak and strategies to deal with them,” R. Weiss, 17 August 2012.

   This note describes the effects of a leak in the LLO Y-arm beamtube and a number of strategies to remove water from the beamtube, including additional pumps and/or a bakeout of the beamtube.

10. LIGO Document T1200518-v1, “Report on the Leak Localization on the Y arm at LLO,” M. Meyer et al., 30 November 2012.

    This note presents the analysis methods and results of numerical models used to localize the position of a leak or leaks in the LLO Y-arm beamtube. It includes a code listing for *btleakfind4.for*, which is an earlier version of *btleakfind5.for*.

11. LIGO Document T1300553-v1, “Effect of leak-test port separation; measurement of He transient at z = 250m,” M. Zucker, 17 June 2013.

    This note describes the effect of separating the test site and sampling port of a helium mass-spectrometer leak detector, and compared simulated and actual results.

12. LIGO Document T1300560-v1, “Helium leak detection response of the LIGO beamtube using a finite element diffusion model,” R. Weiss, 19 June 2013.

    This note describes the use of a finite element diffusion program (*btleakfind5.for*) to estimate the pressure of helium in the beamtube after the helium covers a leak in the beamtube.