



LIGO Laboratory

Subject	<i>Design Review Report for the Test Mass Discharging System (TMDS)</i>
To	TMDS design team: Rich Abbott, Dennis Coyne, Eddie Sanchez, Calum Torrie
From	TMDC review committee: Scott McCormick, Richard Mittleman, David Nolting, Rainer Weiss, John Worden, Mike Zucker (chair)
Refer to	L1400202-v1
Date	18 Dec 2014

The Test Mass Discharging System (TMDS) Design Review Committee reviewed the design document ([T1400713](#)) and met on 20 Nov 2014 to go over the presentation, [G1401337](#). The design review committee recommends proceeding with the proposed TMDS design and implementation, with the caveats and recommendations included below.

The review committee concluded the following:

- 1) Seventeen (17) sets should be procured, as proposed.
- 2) Four (4) sets of scroll pumps (2 for LHO and 2 for LLO) should be procured, as proposed.
- 3) Since concern about potential mirror damage due to ozone has been retired, the dry purge air should be the baseline gas source; There is no need to carry LN2 boil-off as an option.
- 4) Purge air plumbing should be provided to each of the test mass chambers.
- 5) Commandeering existing LP outlet & piping from dryer skids is not considered safe. Implement a specific tap on HP side of dry air skid with dedicated regulator and separate SS piping system and particulate filters to deliver gas to ionizers.
- 6) A dry ics mixture bath, subsequent heater and particulate filter system must be added to the dry purge air to insure hydrocarbon and particulate-free operation.
- 7) The review committee considered an electrically insulated aperture plate mount which would allow independent adjustment of the aperture plate potential with regard to ground, either as a means to improve ion generation efficiency or as a diagnostic. In the end this was deemed not likely to be useful¹.

Action Items/tasks which resulted from the review are listed below (with nominal assigned individual indicated in parenthesis). The team will collect responses to these action items in a separate document.

¹ The positive and negative ions are in bunches separated by the flow velocity times 1/120 second. The flow velocity is entirely determined by the pressure difference between the ionizing needle chamber and that in the chamber following the apertures. The pressure is exerted on the entire gas which is neutral except for a fraction 10^{-4} that is ionized. The mobility of the ions, the ratio of the velocity given to the ion divided by the electric field at a neutral density of 10^{22} molecules/cc is small. It would require a field of 30KV/cm to change the ion flow pattern from being entrained in the neutral gas. The flow at these high gas densities is almost entirely determined by the neutral gas streamlines.

- 1) (Dennis) Provide suitable mechanical support to transmit moments to the 10" chamber nozzle or to other suitable chamber features. Mechanical support from lab floor or other independent structure may subject assembly to moments/loads due to thermal and barometric flexing of the vessel and vessel supports.
- 2) (Dennis) Consider alternate methods of providing for alignment of aperture plate to source array. Determine if "hot" alignment (using electrometer readout with ionizer operating) is required after assembly, or if precision assembly with some fiducial is adequate.
- 3) (Scott) Provide preferred scroll pump spec/order info to the TMDS team.
- 4) (Calum) Integrate dry ice cold trap in gas feed
- 5) (Calum) Integrate active or passive warming loop to recover room temperature before gas injection
- 6) (all) Commandeering existing LP outlet & piping from dryer skids is not considered safe. Implement specific tap on HP side of dry air skid with dedicated regulator and separate SS piping system and particulate filters to deliver gas to ionizers.
- 7) (Calum) Swagelok connections are vulnerable to thermal cycling, consider changing supply side gas fittings to VCR or other hi-rel standard. (see pg. 5 of [G1401337](#))
- 8) (Rich) Solid state HV design provides enhanced flexibility, but may not be necessary. Also may be fussy to develop. While working this problem we recommend procuring variac/NST components and chassis/packaging/safety systems in parallel, since cost impact of duplication is low.
- 9) (Dennis) Model the flow and ion entrainment around the needles (consider consultants or services if needed). Consider alternate needle and/or needle insulator designs which could modify flow conditions around the tip (e.g., increased bores; grinding flats on needle sides).
- 10) (Rai, Rich) Consider if automated "corona monitor" safety cutoff is worth implementing (probably not)
- 11) (Calum) Define a suitable particulate filter for the dry purge air system. This filter will be used in testing at LLO with the prototype TMDS in December and January.
- 12) (Eddie) rotate the angle valve so that it's operation does not require proximity to the gate valve handle. (see pg. 5 of [G1401337](#))
- 13) (Eddie) show the existing interface/flange at BSC door with a welded nipple (see pg. 5 of [G1401337](#))