



Test Mass Discharging System (TMDS) *Design Review*

20 Nov 2014

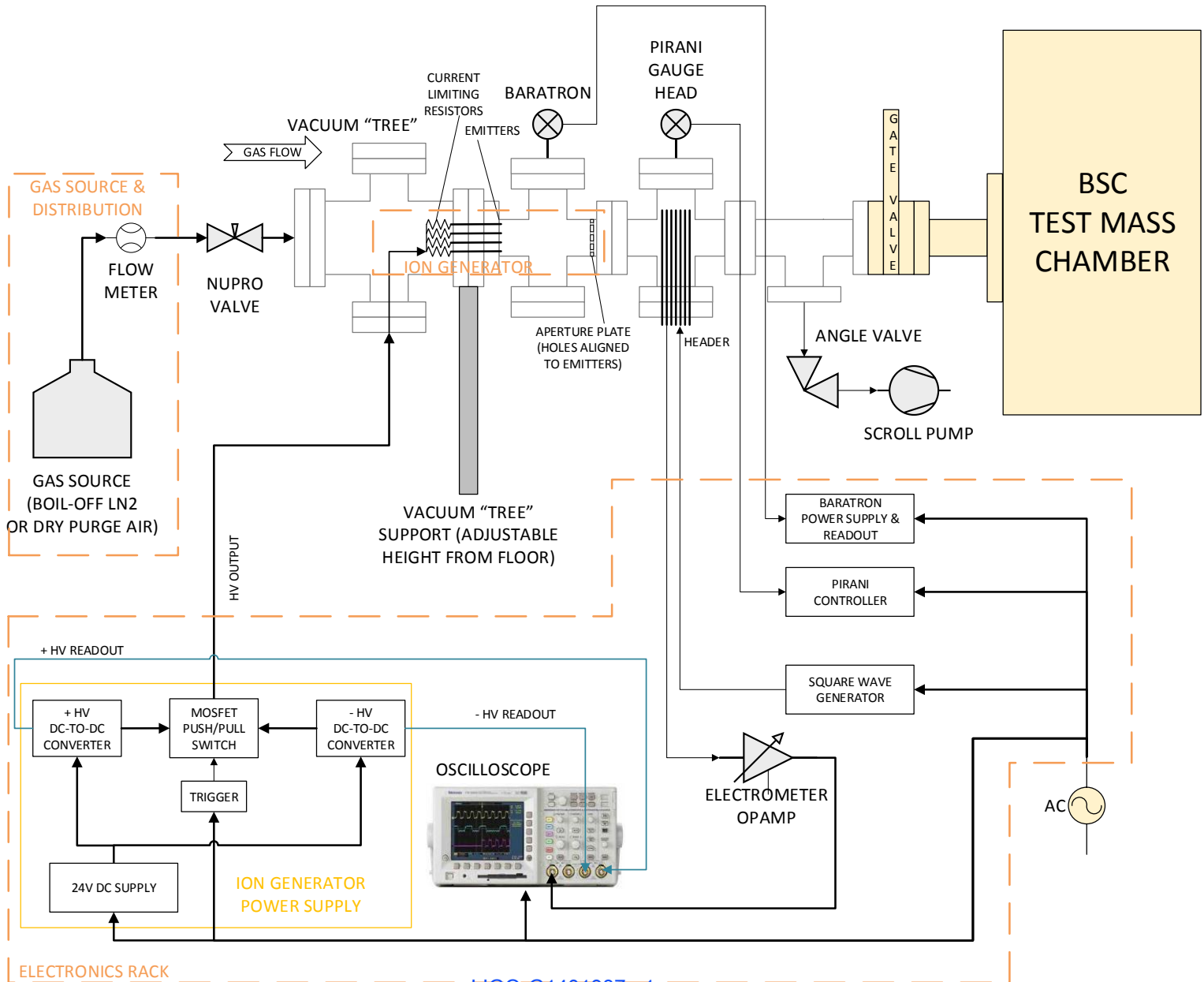
Rich Abbott, Dennis Coyne, Eddie Sanchez, Calum Torrie

References

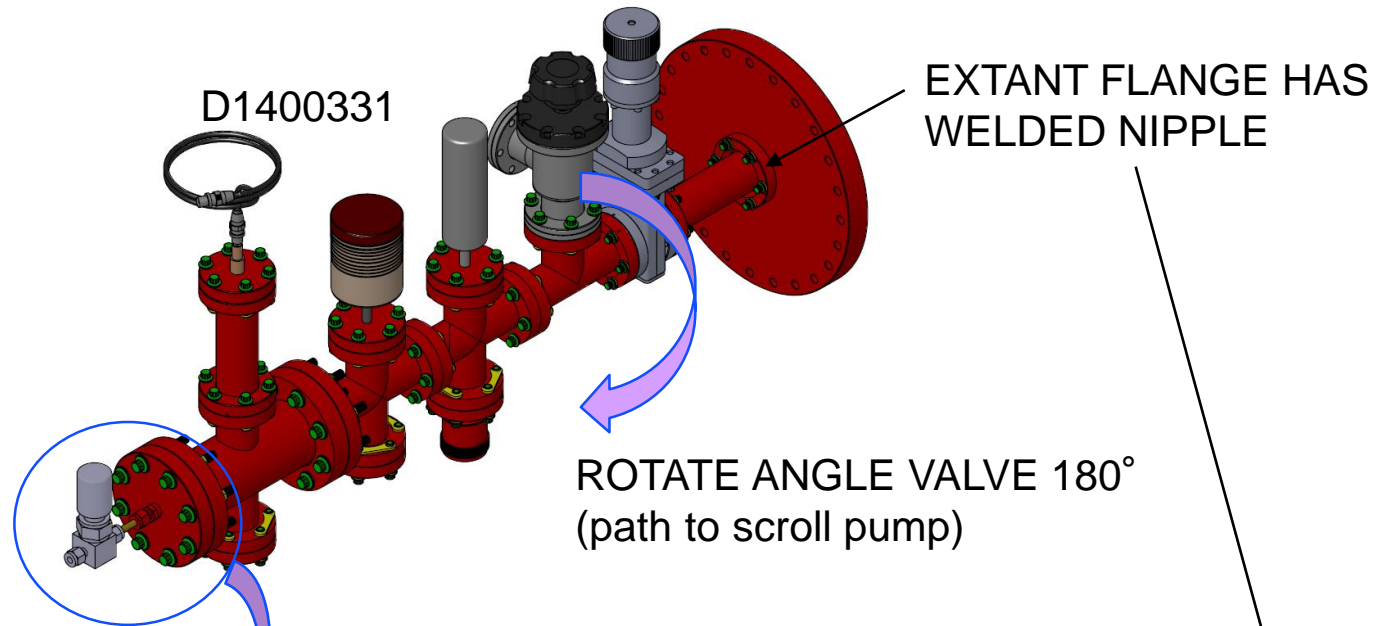
- [T1400713](#): Test Mass Discharging System: Design Document
- [E1400447](#): BOM & Cost Estimate: Test Mass Discharging System
- [D1400331](#): Surface Charge Control Ionizer
 - » Plus linked part drawings
- plus all of Rai's memos on the prototype which are collected as "related document" links under T1400713
 - » G1401265: ESD and Charging: LHO F2F, Oct 28, 2014
 - » G1401153: charging presentation to systems group
 - » T1400620: Additional notes on charging
 - » T1400647: Significant puzzle in explaining the charging mechanism of the test masses
 - » G1100364: ion neutralization
 - » T1100332: Surface charge control of the Advanced LIGO mirrors using externally introduced ions
 - » T1400477: Preparations for discharging the test mass at LHO ETMY and hypotheses about the charging
 - » T1400535: Experience with discharging the ETMY test mass at LHO in August 2014
 - » T1400497: Steps in operation of the ionizer
 - » T1400705: Ionizer research at LHO 1028-110314

- We need a test mass discharging system - no debate.
- The basic approach that Rai Weiss has prototyped will remain the concept
 - » i.e. a gas field ionization system GFIS and not for example a UV illumination system

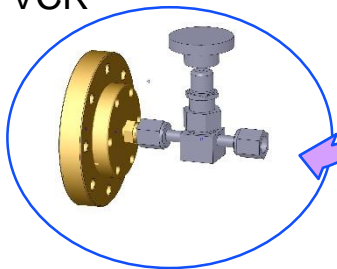
Proposed Test Mass Discharging System (TMDS)



Pending Corrections

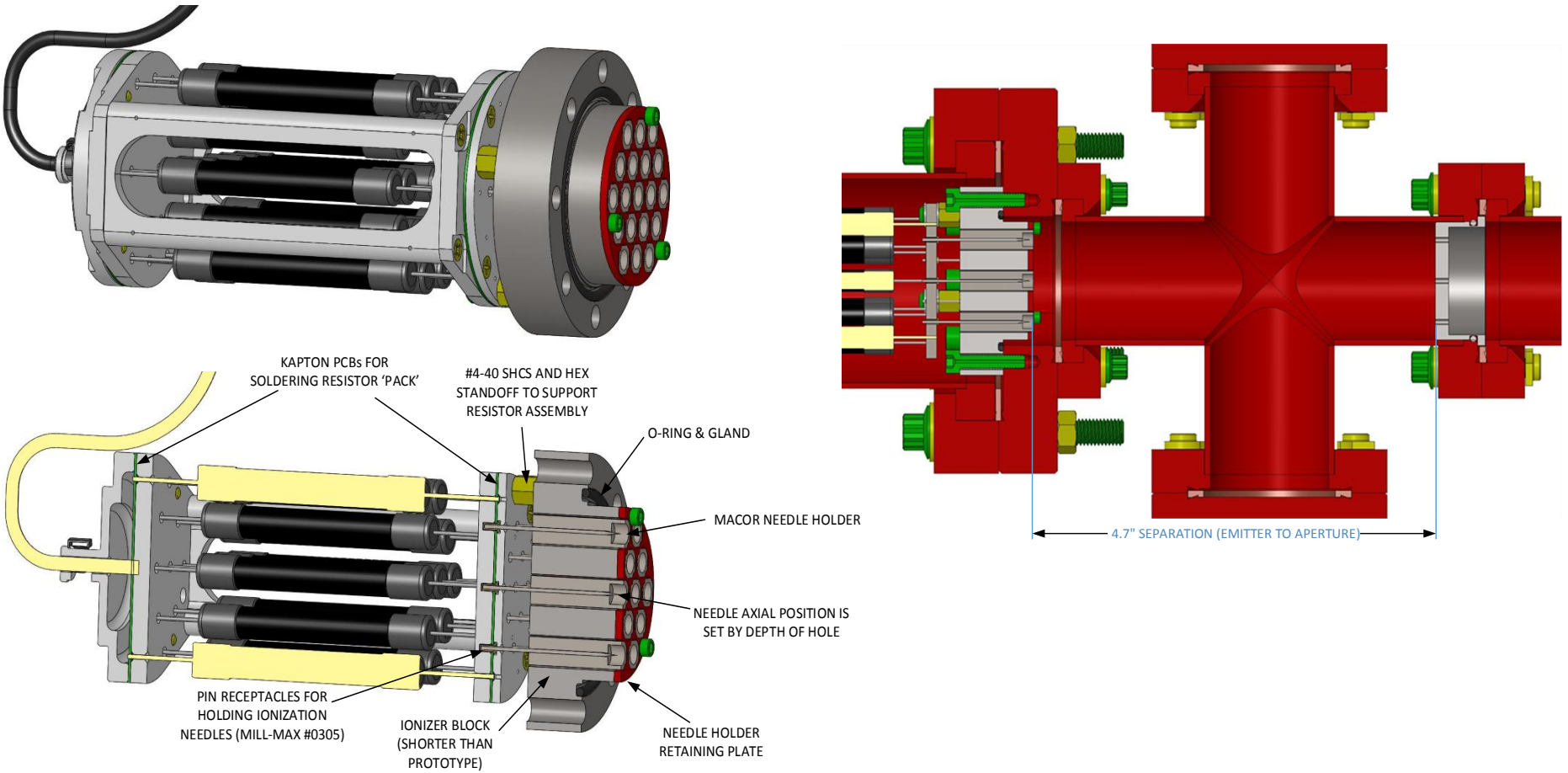


FOR EASIER LEAK CHECKING: CHANGE FROM PIPE THREAD TO SWAGELOK FITTING TO ZERO-LENGTH CF FITTING TO VCR



Pending Corrections

- Incorporate alignment marks/references to facilitate alignment of the emitter array to the aperture plate holes



- Quantities
 - » Planning to install an Ion Generator on every Test Mass chamber for all 3 Interferometers
 - » N = number of simultaneously operated TMDS
 - » Assuming each observatory can provide 1 LN2 Dewar, 1 Scroll Pump, N Oscilloscopes
 - » Vacuum 'Tree', Ionizers, Electronics & Gauges:
 - $17 = [4 \text{ TM chambers/IFO} + 1 \text{ spare/IFO}] \times 3 \text{ IFOs} + \text{LASTI} + 1 \text{ in-process spare}$
 - » Vacuum pumping, Gas Sources (GN2 boil-off & purge air)
 - $[3 \text{ vacuum volumes/Obs} - \{1 \text{ Dewar/Obs}, 1 \text{ Scroll pump}\} \text{ avail}] \times 2 \text{ Obs} = 4$
 - (Not providing for 3rd IFO or LASTI; Std equipment.)

- Gas Sources
 - » Planning to support both LN2 and purge air as options
 - Optical absorption scans for coatings exposed to ions show no change (after cleaning off particulates) with either gas source
 - » Do we need to procure more LN2 dewars, or do the Observatories have enough?
 - » What is the appropriate piping and fittings for the GN2 line from the dewar to the flow meter?
 - » What is the appropriate piping and fittings for the purge air port to the flow meter?
 - » Do the observatories have sufficient piping & fittings to connect to the TMDS at the flow meter, or should this be part of the TMDS procurements?
 - » Planning to use neither a particulate filter nor a cold trap on the purge air line, unless measurements on the purge air indicate problems – OK?

Questions to Resolve

- Electronics
 - » Ion Generator HV Power Supply: Use which approach?
 - prototype sinusoid: Variac + Neo sign transformer, or
 - proposed sq wave: HV Push/Pull Switch with DC-to-DC
 - » Incorporate custom Sq Wave generator into custom electrometer circuit bd, or continue to use a Lab Function Generator instrument (e.g. SRS DS335)? If the later, do the observatories have N units available?
 - » Still OK with oscilloscope display? (e.g. no custom digital readout)
 - » No need/desire to provide electrometer feedback to HV Supply to automatically keep below corona discharge, correct?

Questions to Resolve

- Gas Field Ionization Source (GFIS)
 - » The prototype emitter/needle material was stainless steel
 - » Ti and Ta may have less particulate generation
 - » Planning to purchase a complete set of Ti needles plus a few sets of stainless steel, tungsten carbide (WC) and steel (M2 HSS) to experiment on particulate generation rates
 - » OK?

- Authorization to proceed with procurement of:
 - » Vacuum equipment (trees, plumbing, gauges/controllers) – all commercial-off-the-shelf
 - » Gas Field Ionization System (GFIS) – custom design based on prototype
 - » Gas source components for both options (purge air and LN2 boil off)
- Agreement to pursue detailed design and prototyping of the custom electronics
 - » Ion Generator Power Supply
 - » Electrometer