NEXT-100 Energy plane

D. Shuman

Lawrence Berkeley National Laboratory

May 8, 2012

Table of Contents

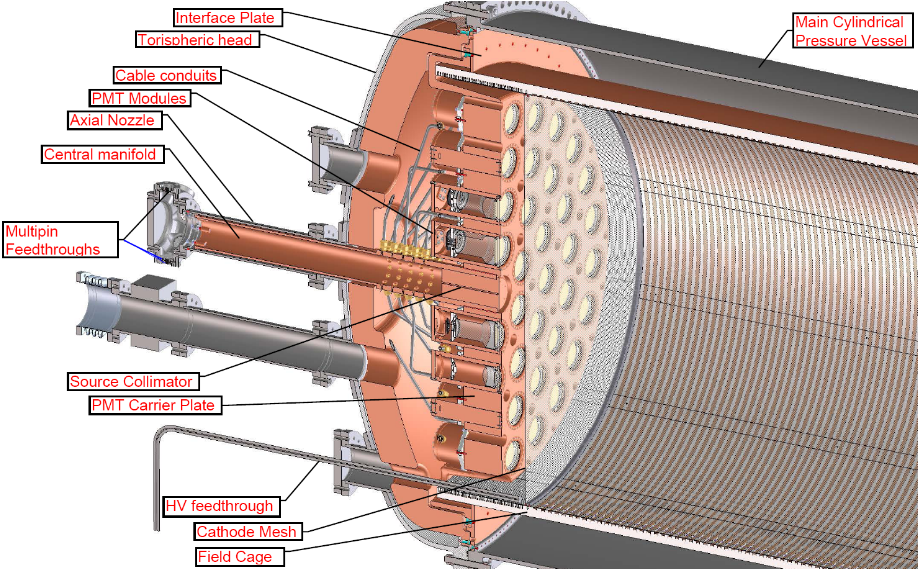
with much valuable input from (among others):

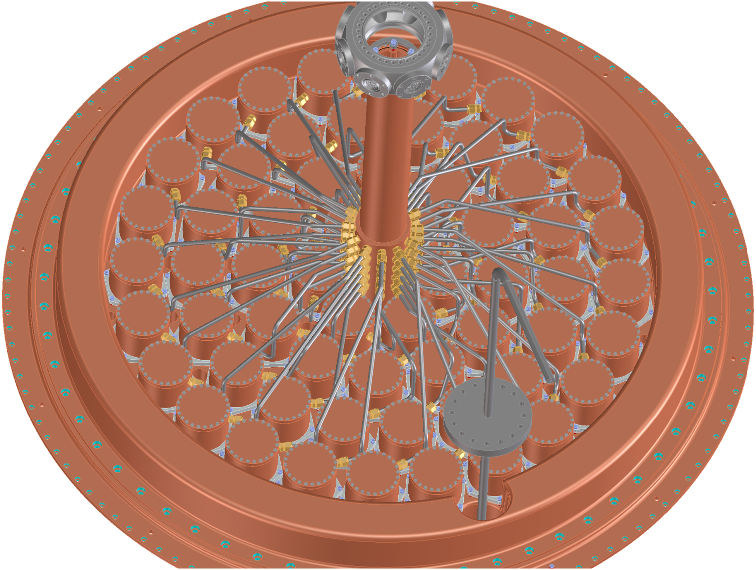
- D. Nygren
- A. Goldschmidt
- T. Miller
- G. Pryzbilski
- I. Liubarsky
- S. Carcel
- V. Alvarez
- A. Martinez

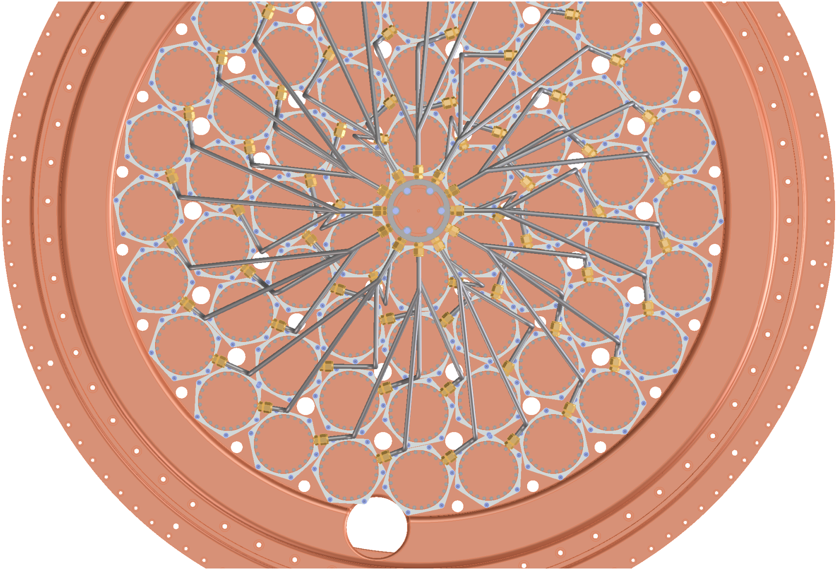
Basic Description of Baseline System

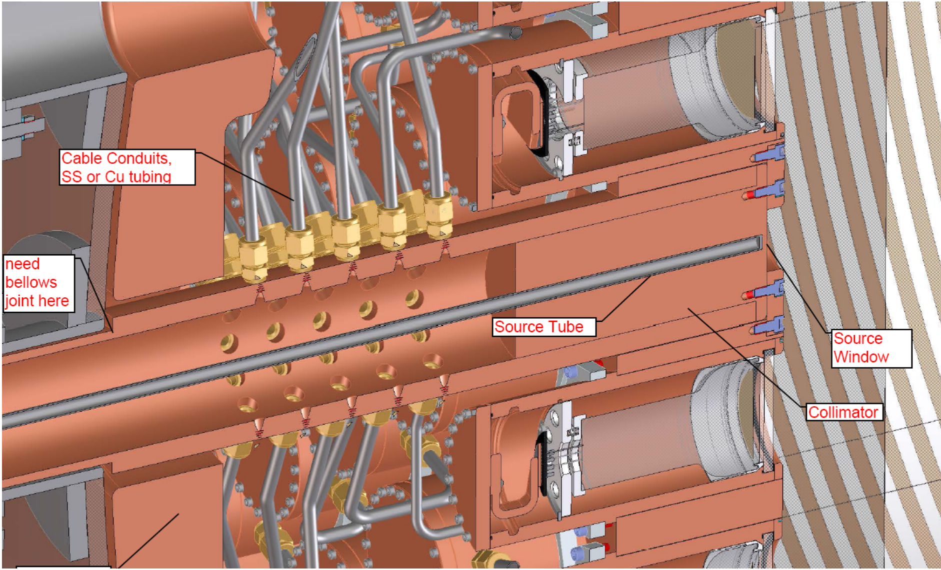
- PMTs (R11410-10) sealed into individual pressure resistant, vacuum tight Cu enclosures (PMT Module).
- PMT's operated at +HV (grounded body/photocathode). Body insulated from enclosure.
- Base design is a zener stabilized differential output, scheme from D. Nygren
- Initial base design by V. Alvarez
- Sapphire windows are secured with clamps having soft interfaces, and are O-ring or Helicoflex sealed
- Sapphire windows are coated on outside with ITO (to shield e-field) then overcoated with TPB
- PMT bases are potted with heat conducting epoxy to flexible copper braids thermally connected to enclosures
- Modules (60 total) mounted to a common carrier plate that attaches to an internal flange of the pressure vessel head.
- PMT cables are enclosed in individual pressure resistant, vacuum tight metal tubing conduits.
- Conduits all lead to a central vacuum manifold and sealing to internal flange of axial nozzle.

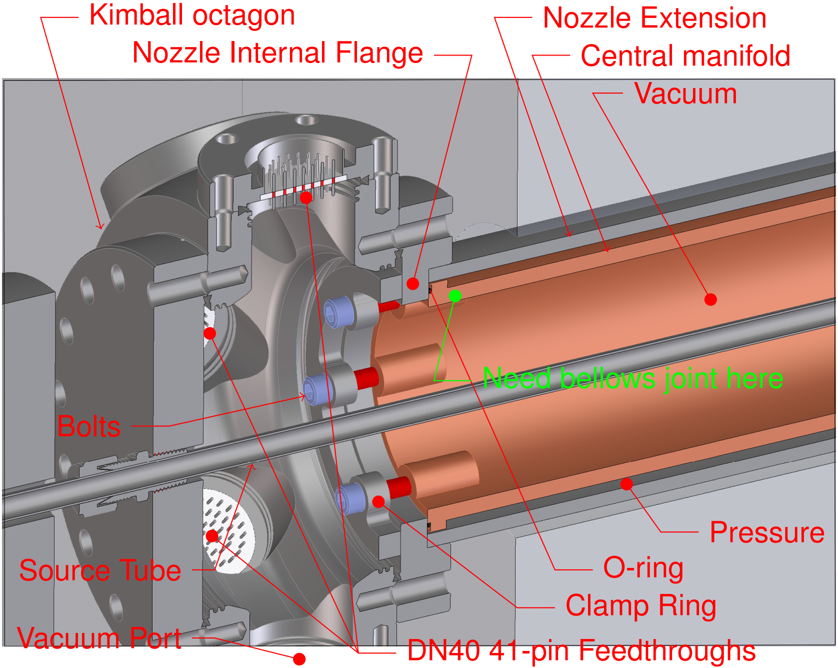
- PMT cables route through central manifold to (5) 41 pin CF feedthroughs on a CF octagon, outside the lead shielding.
- Vacuum($< 10^{-4}$ torr) is applied at octagon port; gives($low 10^{-3}$ torr) inside enclosures for insulation.
- Large vacuum tank limits pressure build in central manifold in case of sapphire window failure
- Xenon permeation through seals is recovered with a cold trap.
- Base cooling is by conduction into enclosure and out to vessel flange. (1/3 convected into Xe)
- Central manifold incorporates a calibration source tube and collimator.


Interface Plate
Torispheric head
Cable conduits
PMT Modules
Axial Nozzle
Central manifold
Multipin Feedthroughs
Source Collimator
PMT Carrier Plate
HV feedthrough
Cathode Mesh
Field Cage
Main Cylindrical Pressure Vessel



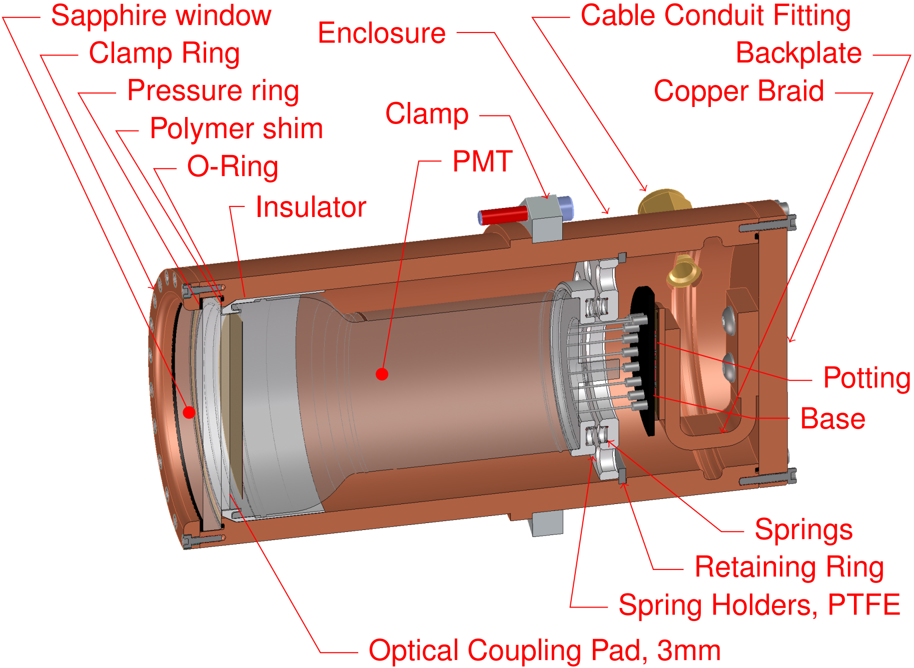


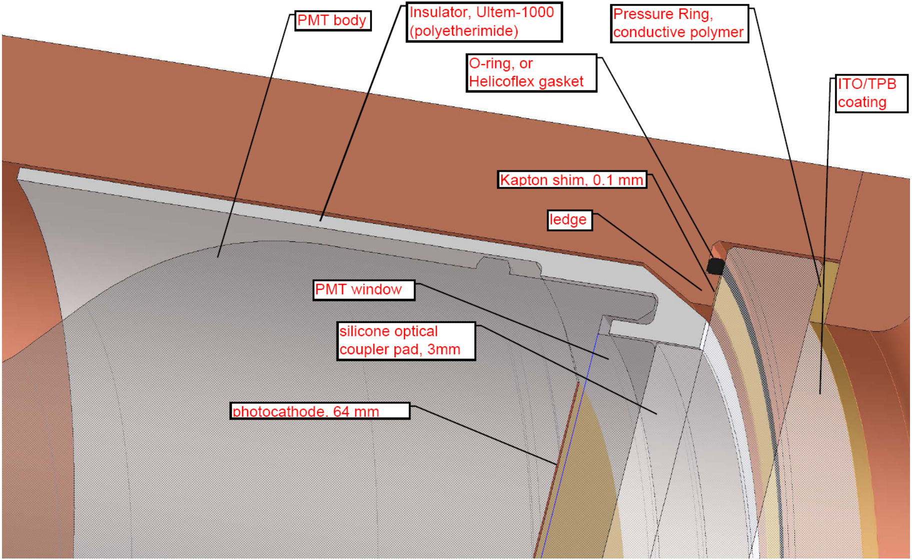

Cable Conduits, SS or Cu tubing
need bellows joint here
Source Tube
Source Window
Collimator


Kimball octagon
Nozzle Internal Flange
Nozzle Extension
Central manifold
Vacuum
Need bellows joint here
Bolts
Pressure
O-ring
Clamp Ring
Source Tube
Vacuum Port
DN40 41-pin Feedthroughs

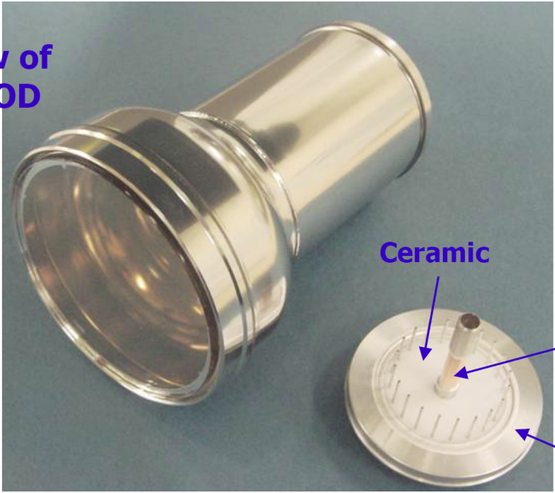
Design Changes

- PMT enclosures of copper (fab from OFE pipe)
- Cu carrier plate thickened - flush with enclosures at window
- Cu carrier plate now fastened to main cylindrical vessel (ICS shield remains in head)
- PMT Module assembly rotated 7.5 deg. - give more clearance for HV feedthrough
- Carrier plate will be redesigned for adjustable buffer distance

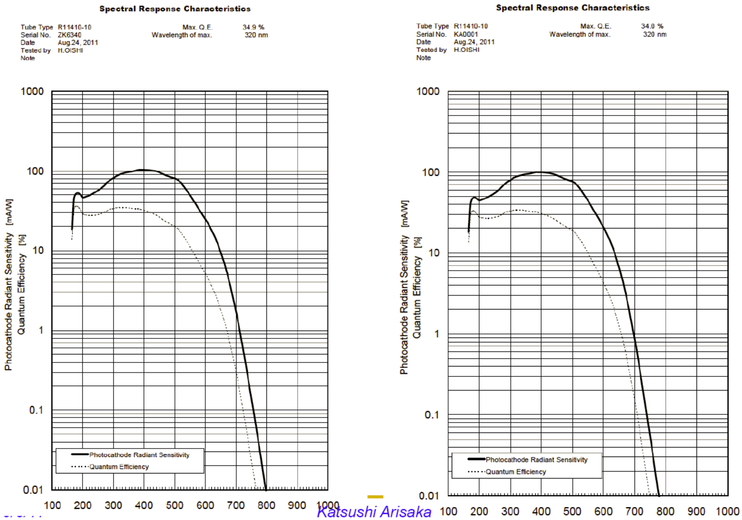

Sapphire window
Clamp Ring
Pressure ring
Polymer shim
O-Ring
Insulator
Enclosure
Clamp
PMT
Cable Conduit Fitting
Backplate
Copper Braid
Potting
Base
Springs
Retaining Ring
Spring Holders, PTFE
Optical Coupling Pad, 3mm

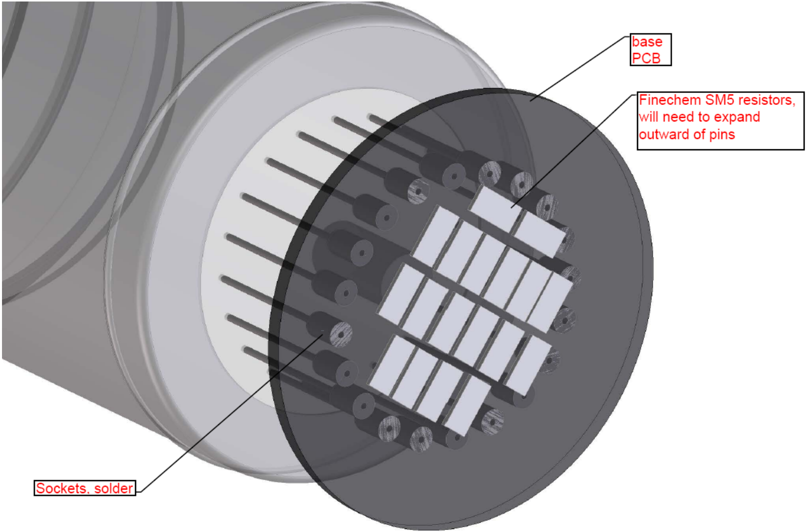

PMT body
Insulator, Ultem-1000
(polyetherimide)
Pressure Ring,
conductive polymer
O-ring, or
Helicoflex gasket
ITO/TPB
coating
Kapton shim, 0.1 mm
ledge
PMT window
silicone optical
coupler pad, 3mm
photocathode, 64 mm

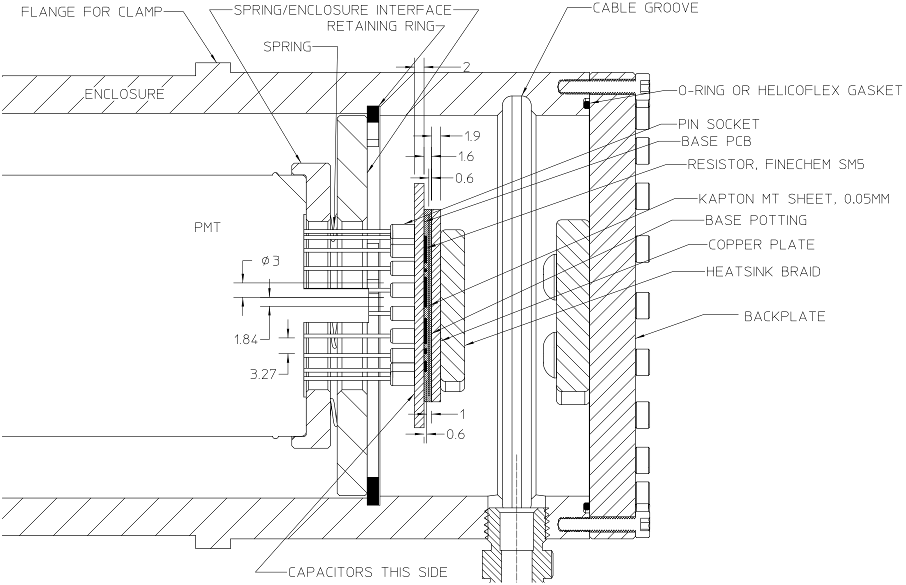
Hamamatsu R11410-10

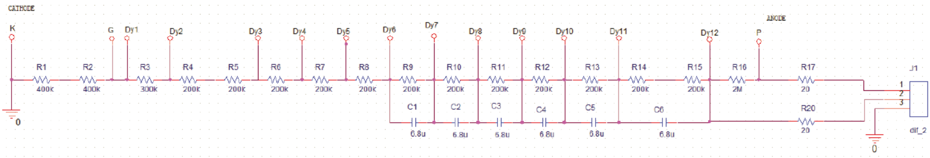


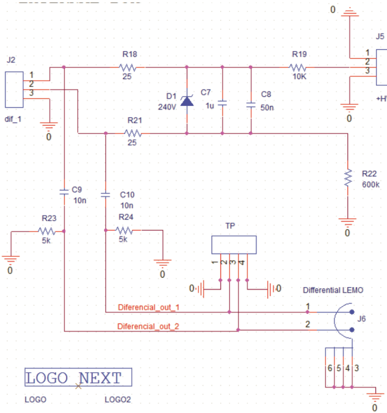
Typical quantum efficiencies, as measured, from [arisaka]




base
PCB
Finechem SM5 resistors,
will need to expand
outward of pins
Sockets, solder


FLANGE FOR CLAMP
SPRING/ENCLOSURE INTERFACE
RETAINING RING
SPRING
CABLE GROOVE
2
ENCLOSURE
O-RING OR HELICOFLEX GASKET
PIN SOCKET
1.9
BASE PCB
1.6
RESISTOR, FINECHEM SM5
0.6
KAPTON MT SHEET, 0.05MM
PMT
BASE POTTING
COPPER PLATE
ϕ3
HEATSINK BRAID
BACKPLATE
1.84
3.27
1
0.6
CAPACITORS THIS SIDE


CATHODE
K
0
G
Dy1
Dy2
Dy3
Dy4
Dy5
Dy6
Dy7
Dy8
Dy9
Dy10
Dy11
Dy12
ANODE
P
R1 400k
R2 400k
R3 300k
R4 200k
R5 200k
R6 200k
R7 200k
R8 200k
R9 200k
R10 200k
R11 200k
R12 200k
R13 200k
R14 200k
R15 200k
R16 2M
R17 20
R20 20
C1 6.8u
C2 6.8u
C3 6.8u
C4 6.8u
C5 6.8u
C6 6.8u
J1
1
2
3
dif_2
0


J2
1
2
3
dif_1
0
R18 25
R19 10K
J5
+HV
D1 240V
C7 1u
C8 50n
R21 25
R22 600k
C9 10n
C10 10n
R23 5k
R24 5k
TP
1 2 3 4
Differential LEMO
Diferencial_out_1
Diferencial_out_2
J6
6 5 4 3
LOGO NEXT
LOGO
LOGO2

Temp. Drops from Base Resistors (SM5) to Vessel (@1750V, 3.5MOhm)

Section	**deg. C**
Potting Compound, 1mm (1W/(m*K))	2.38
Kapton MT insulation, .05mm	0.33
Cu braid, 259 kcmil x 7.5cm	1.34
Contact, into backplate	0.04
Contact, into enclosure	0.02
Enclosure to Clamp	0.17
Contact into Carrier Plate	0.02
Carrier plate to convolution	0.22
Convolution to Vessel flange	0.48
Vessel flange	1.32
Total Temp Drop	6.3

Prototyping progress

- 3 sapphire windows purchased and received, screened for gross radiopurity: Activity: <10 mBq/kg (U,late), <25mBq/kg (Th)
- prototype enclosure parts are designed, fabricated, assembled and undergoing first vacuum tests.
- pressure vessel for testing enclosure is designed, fabricated and pressure tested, ready for use
- sample 32 pin feedthrough has been tested (preliminarily) for flashover as a function of vacuum.

For U_z = E, in V/cm:

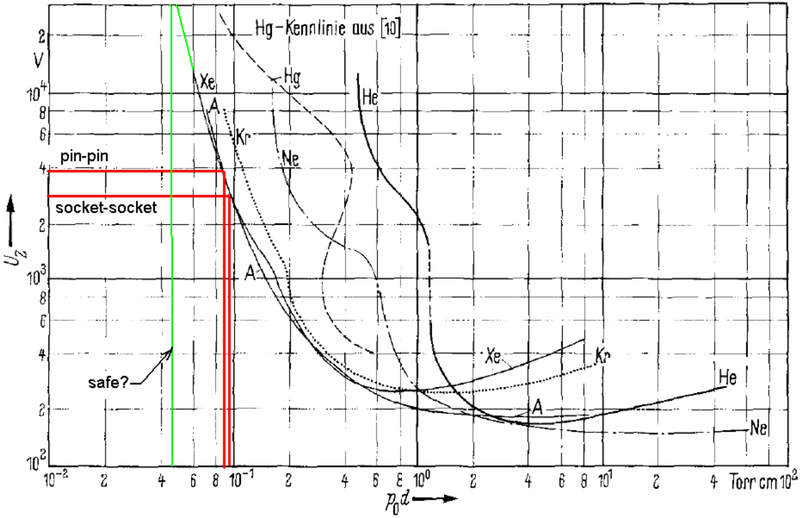
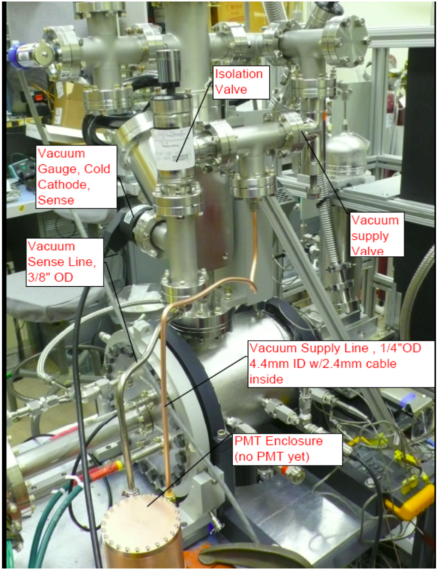
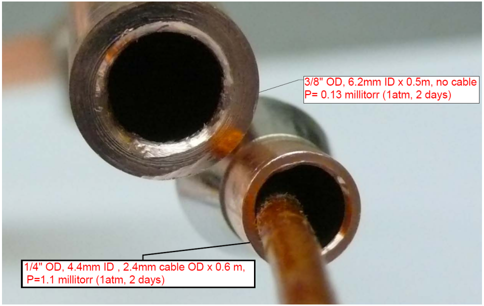


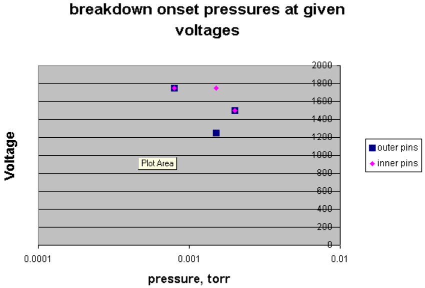
Bild 7. Zündkennlinien der Edelgase, Hg-Kennlinie aus [10].

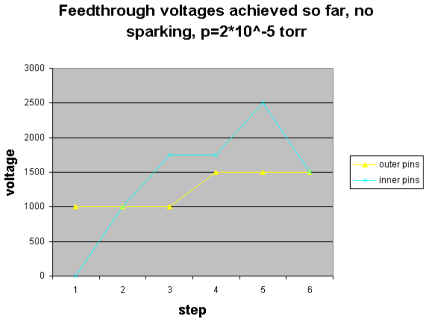




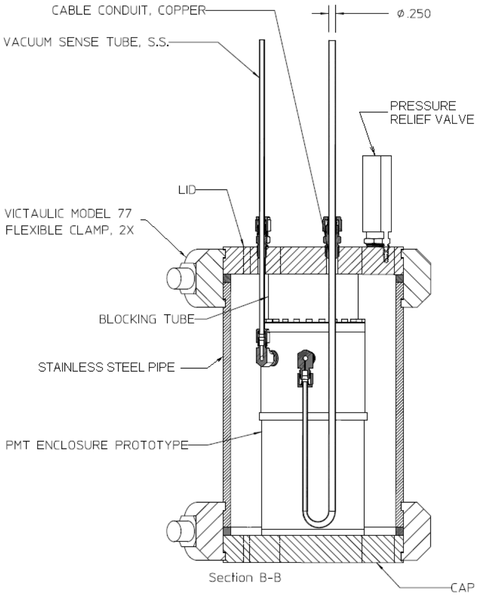
- not yet clear ratio outgassing to permeation - RGA He leak test negative
- Nitrile O-ring seals, window, backplate
- Expect 1 decade higher at high pressure

32 pin Ceramtec (similar to VACOM)





Pressure Testing Vessel for Permeation, HV? Studies



The following prototyping activities remain:

- Design, fabricate and test prototype base/front end for +HV operation (Nygren zener design).
- Assemble prototype enclosure, check parts for fit, function. Improve ledge design
- Install enclosure module into pressure test chamber. Repeat vacuum test with 15 bar various gases (Ar, Ne, He)
- Repeat with Helicoflex gaskets - check groove dimensions
- Investigate feasibility of H2 (5%) leak testing.
- Final test 32 pin feedthroughs for 1750 V voltage capability, as a function of vacuum, including pin connections inside vacuum.
- Test PMT base/pin mockup for flashover resistance and glow discharge as a function of vacuum.
- Test various fittings (flare, VCR, Swagelok) for vacuum tightness repeatability.
- Complete base/heatsink design, design sockets, potting fixture
- Pressure test prototype windows to test pressure - test at least one window to failure
- Simulate buffer region e-field at window/carrier plate - test in pressure test chamber

- Central manifold - design bellows joints, integrate source and collimator, design cable termination harness at feedthroughs
- Carrier plate - Detail design - add buffer length adjustment - Issues: finalize HV cable location, is there to be a common ground mesh?
- Design and build window pressure test cell.
- Final base/front end/data acquisition
- Design tooling and fixtures for assembly and shipping
- Design hexapod fixture for head removal and carrier plate removal/rotation