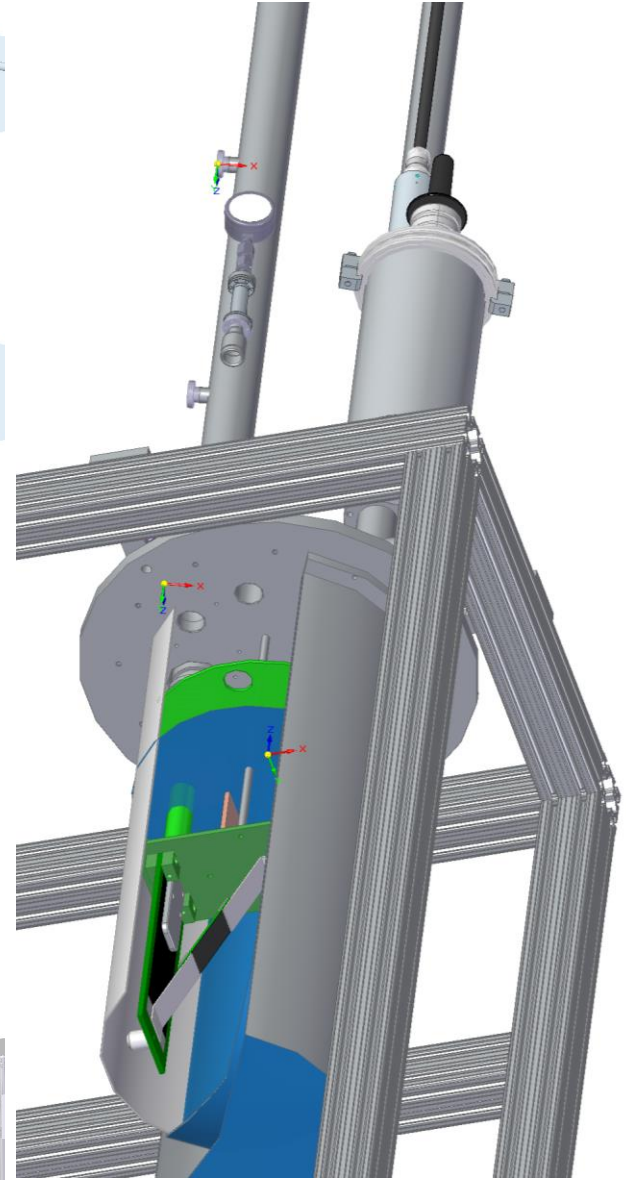
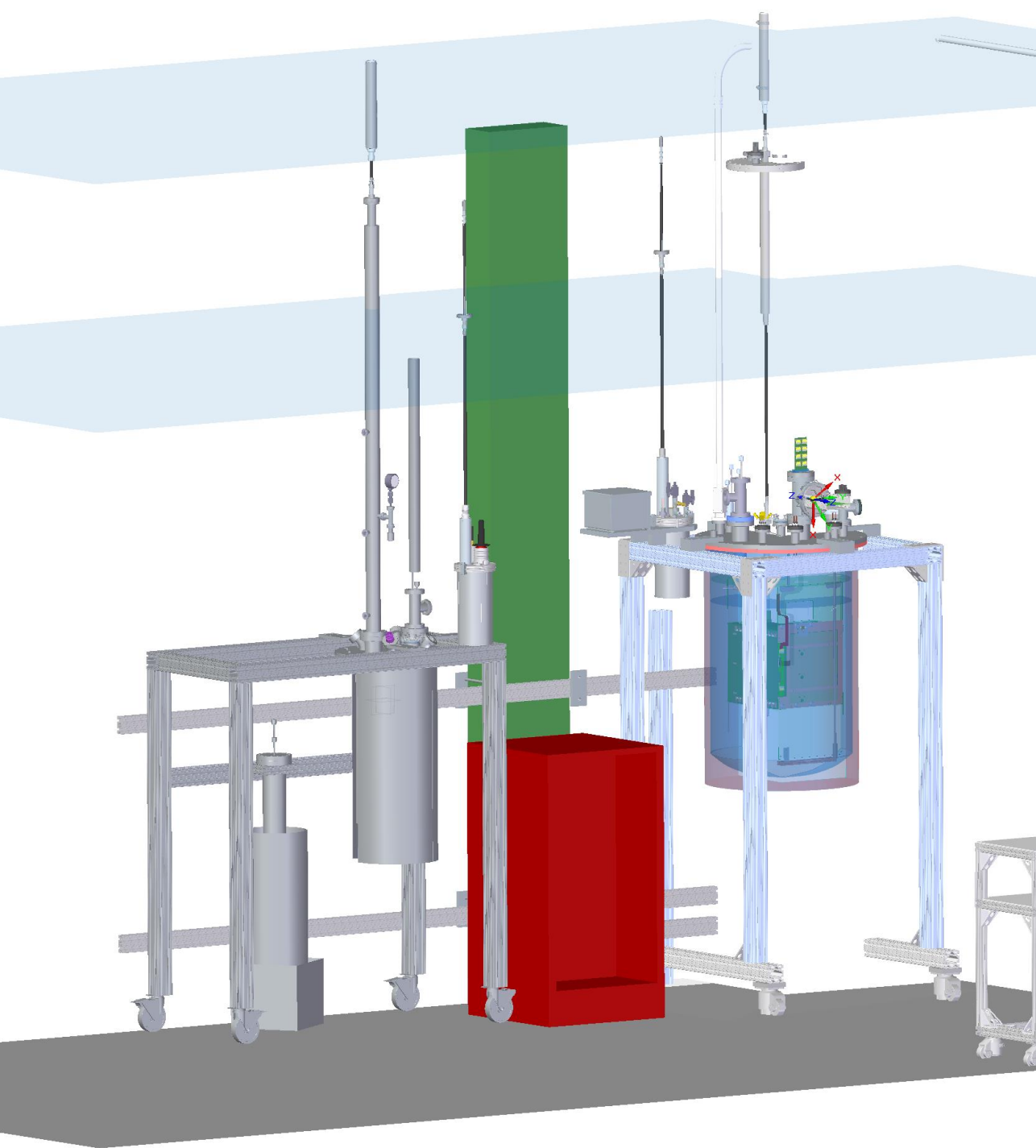
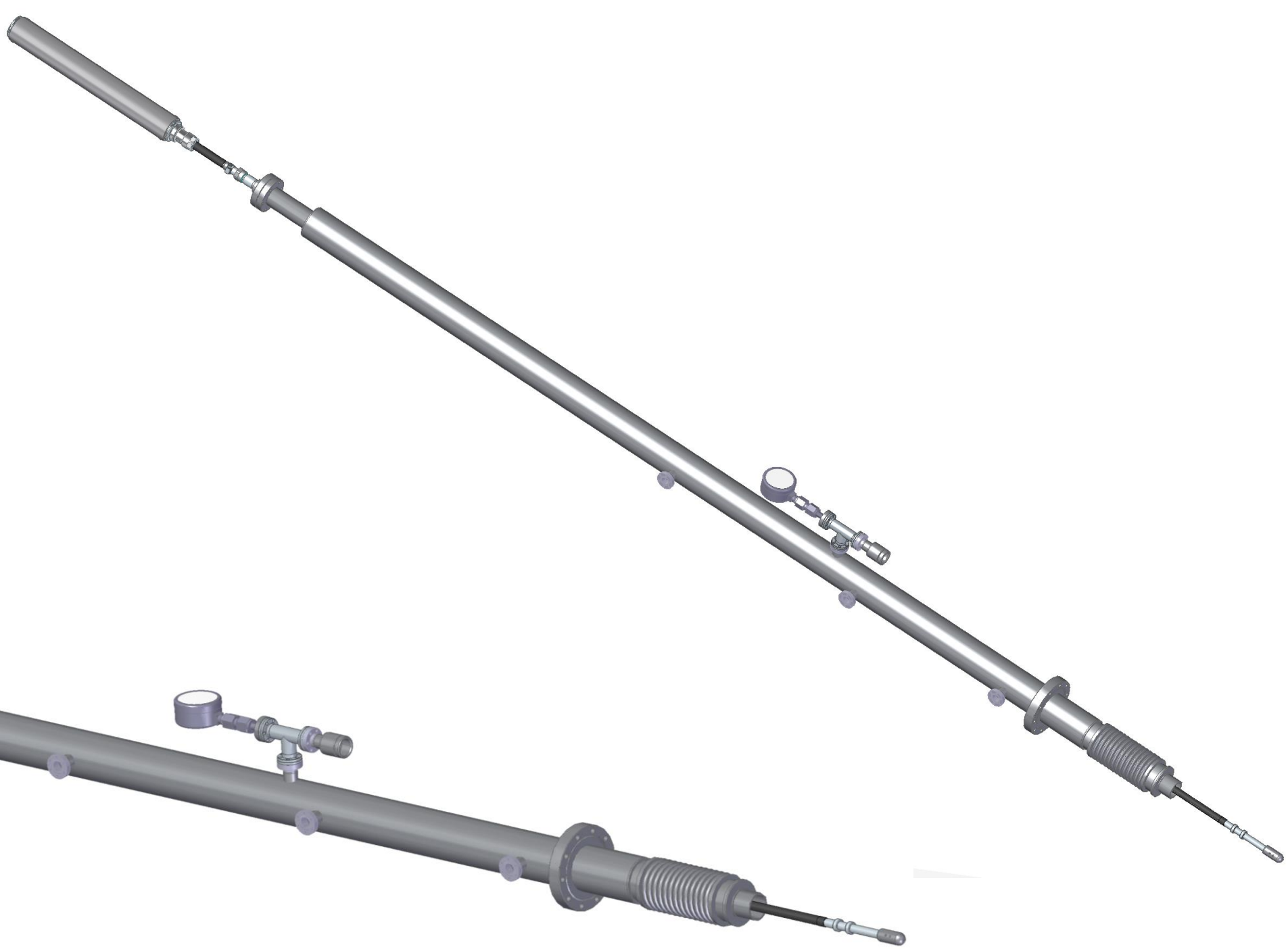


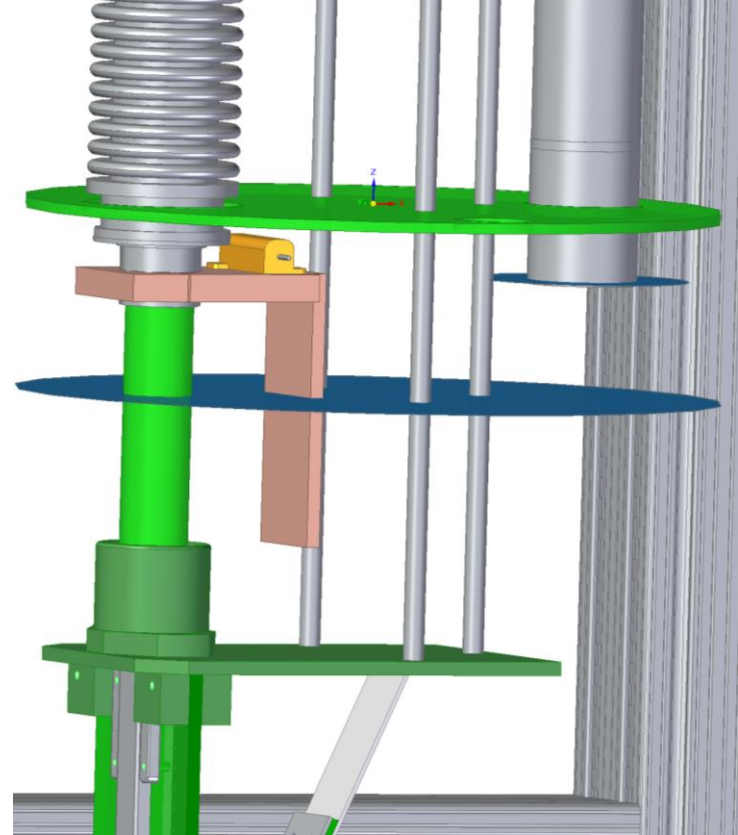
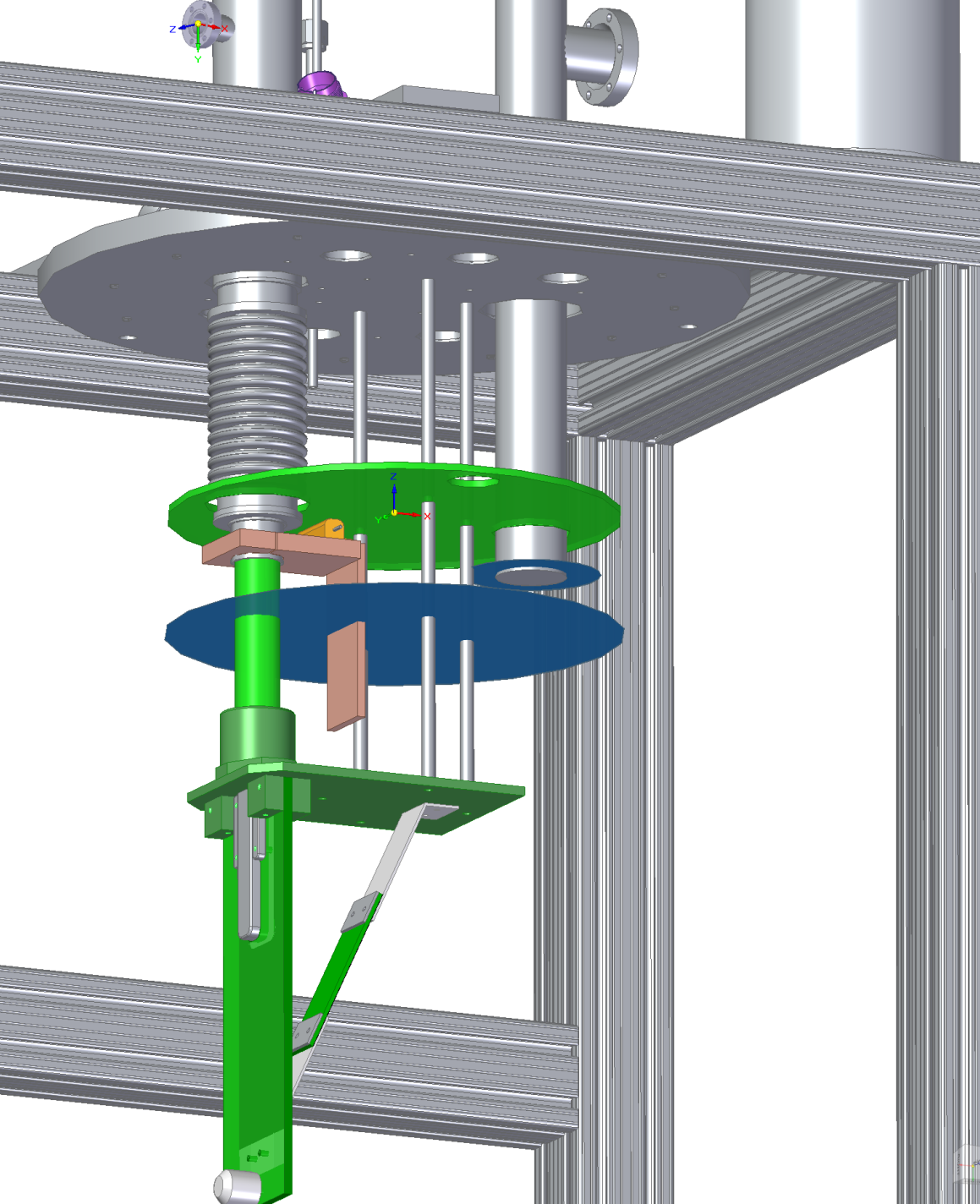
HV Test System and Conventional Field Cage Updates and Details

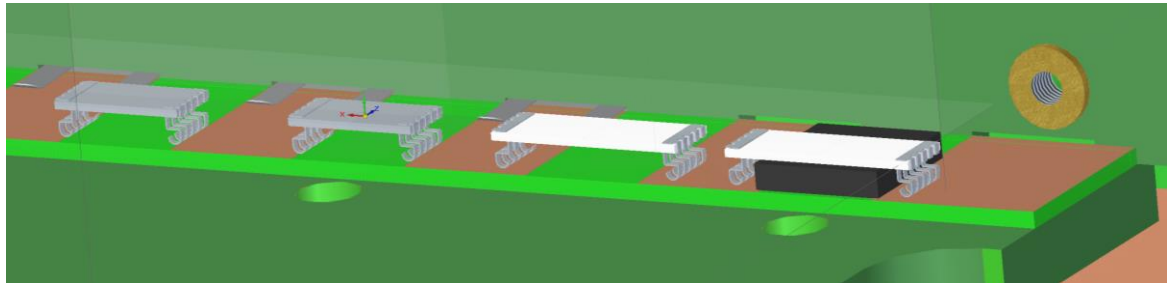
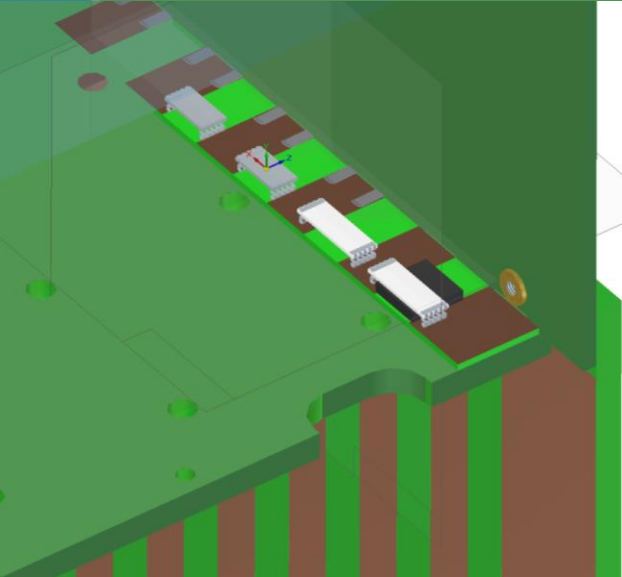
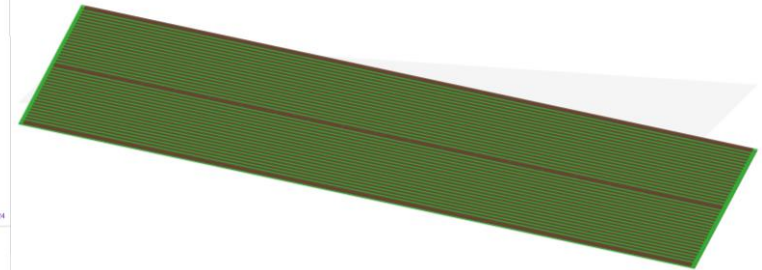
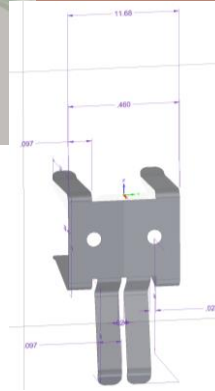
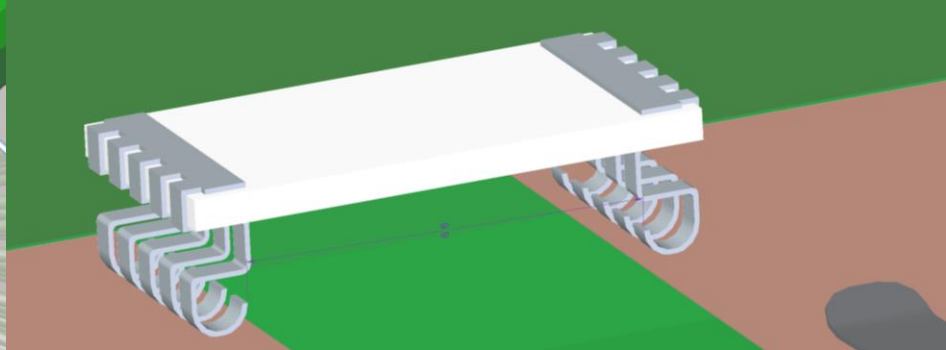
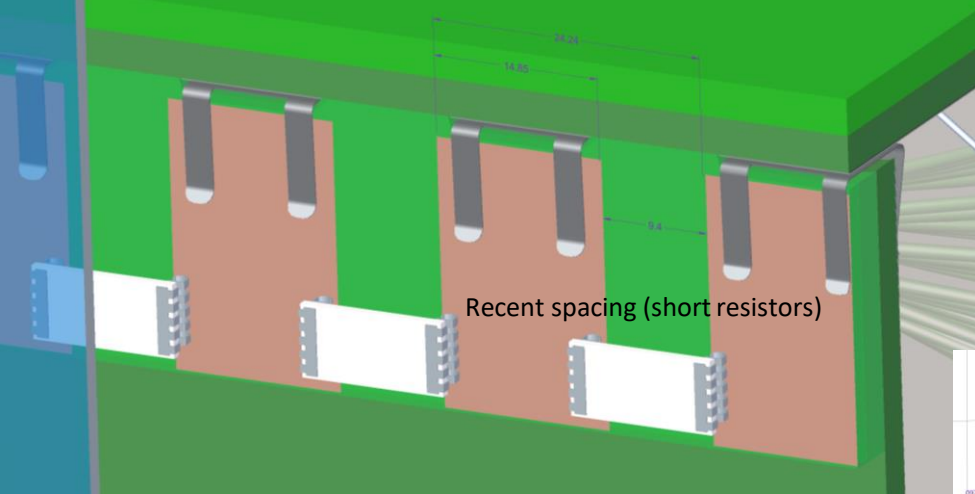
Knut Skarpaas

11/15/2023





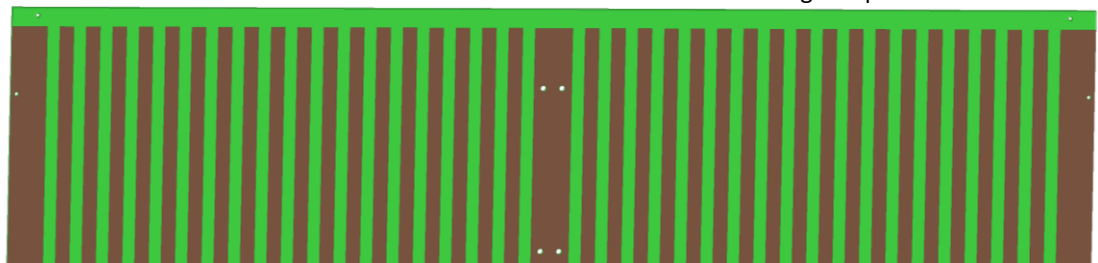
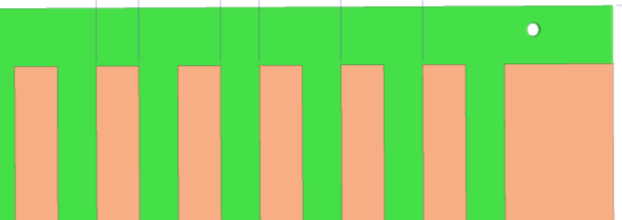
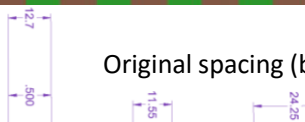




Original spacing (big resistors)
(pitch can be close to this with shorter resistors)

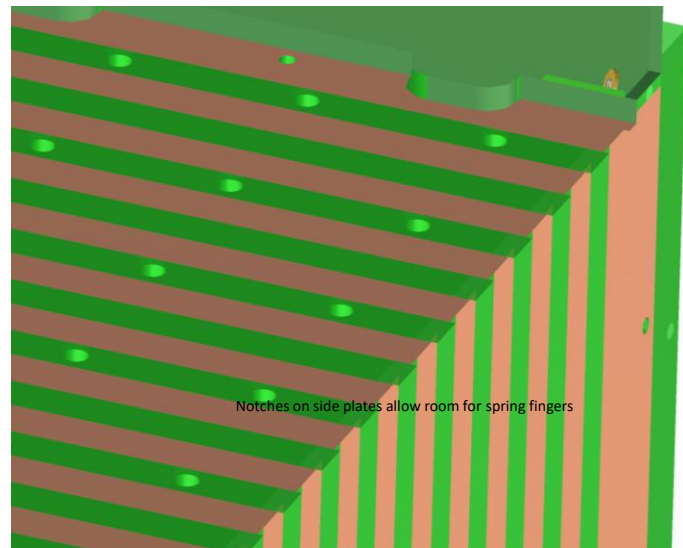
Original pitch-
19 gaps (resistors) per drift corner
152 resistors per module
5320 resistors total
Would be more with tighter pitch-

Original spacing (big resistors)

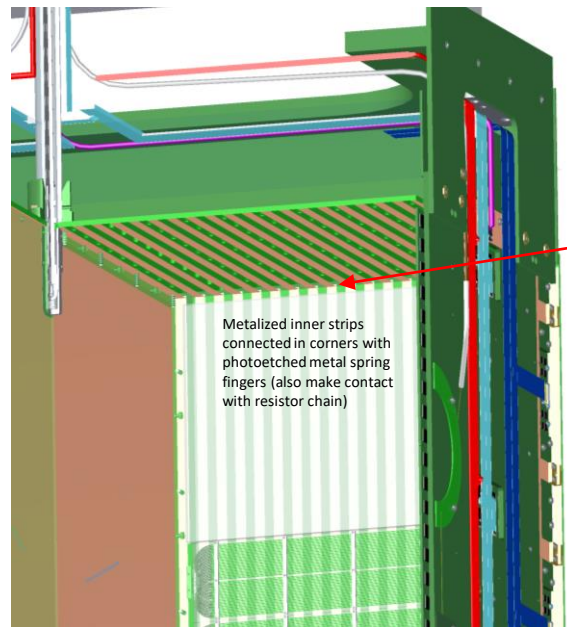


Prior relevant slides follow-

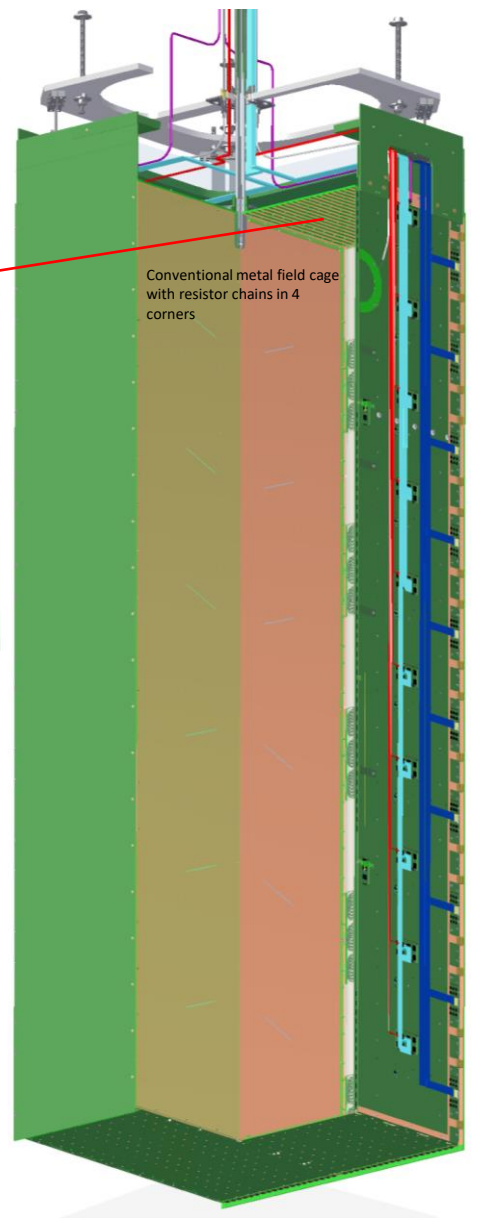
H
G
F
E
D
C
B
A



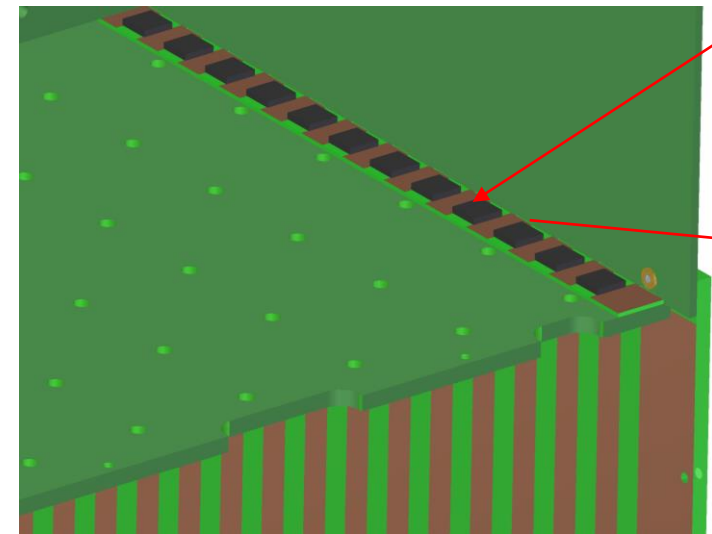
Notches on side plates allow room for spring fingers



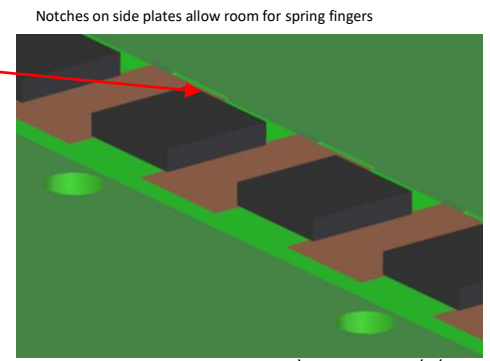
Metalized inner strips connected in corners with photoetched metal spring fingers (also make contact with resistor chain)



Conventional metal field cage with resistor chains in 4 corners



Resistors on PCB board grounded to the top and side with custom edge clips (through notches)



Notches on side plates allow room for spring fingers

**NOT FOR MANUFACTURING
FOR REFERENCE ONLY**

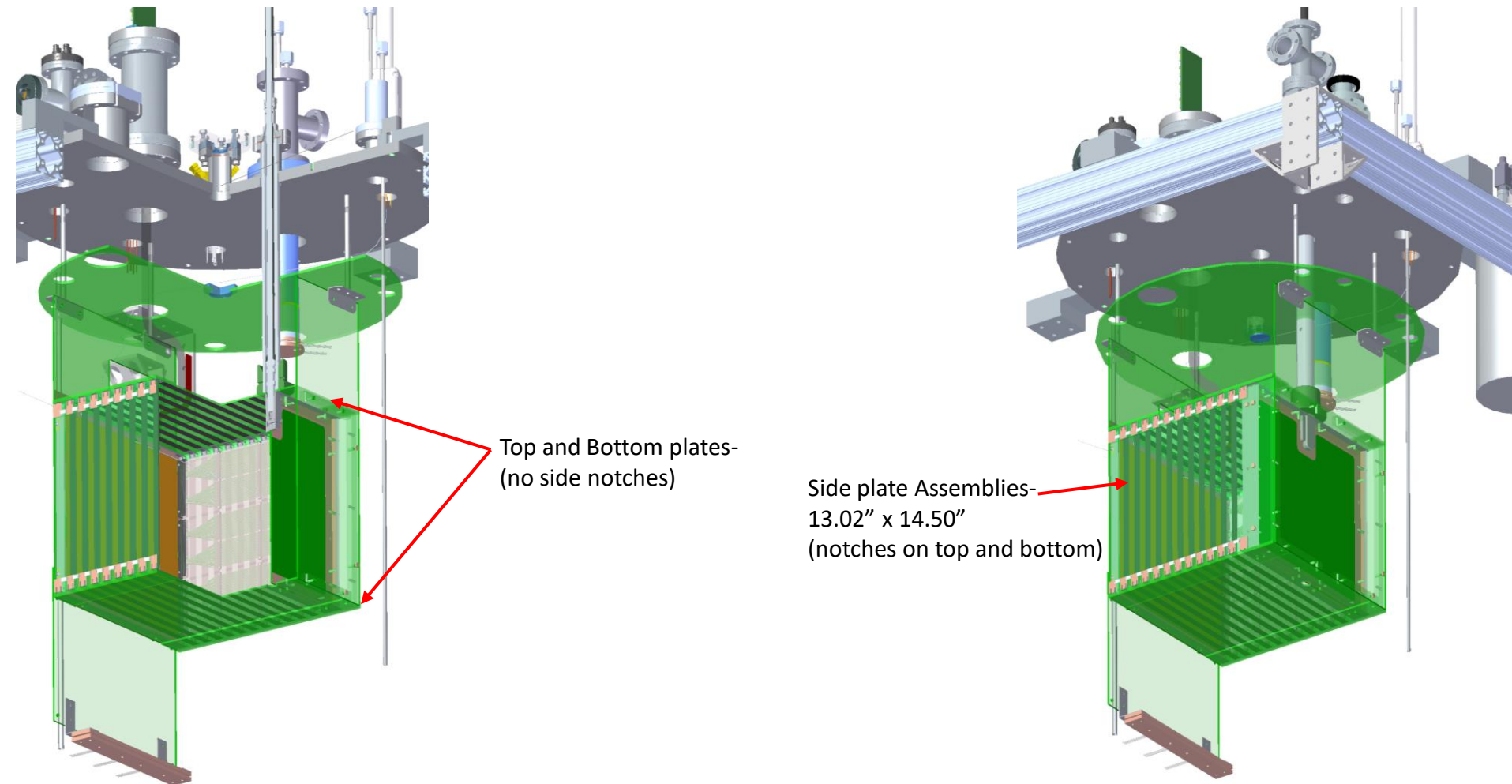
<p>UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES</p> <p>BREAK EDGES AND CHAMFERED CORNERS SHOWN UNLESS OTHERWISE SPECIFIED</p> <p>FRACTIONS <math>\frac{1}{2}</math> <math>\frac{3}{4}</math> <math>\frac{1}{4}</math></p> <p>DEC .001 .002 .005</p> <p>FINISH .001 .002 .005</p> <p>ANGLE <math>45^{\circ}</math> ALL SHARP</p> <p>NEXT ASSEMBLIES</p>	<p>SCALE: </p> <p>ESTIMATED MASS: .000 LB</p> <p>CAD FILE NAME:</p> <p>SLAC U.S. DEPARTMENT OF ENERGY Stanford Linear Accelerator Center</p> <p>PROJECT: DUNE NEAR DETECTOR CONVENTIONAL FIELD CAGE</p> <p>DESIGNED BY: K. SKARPAAS CHECKED BY: K. SKARPAAS DATE: 11/11/2011 DRAWN BY: K. SKARPAAS</p> <p>REVISION NUMBER: 00</p>
--	--

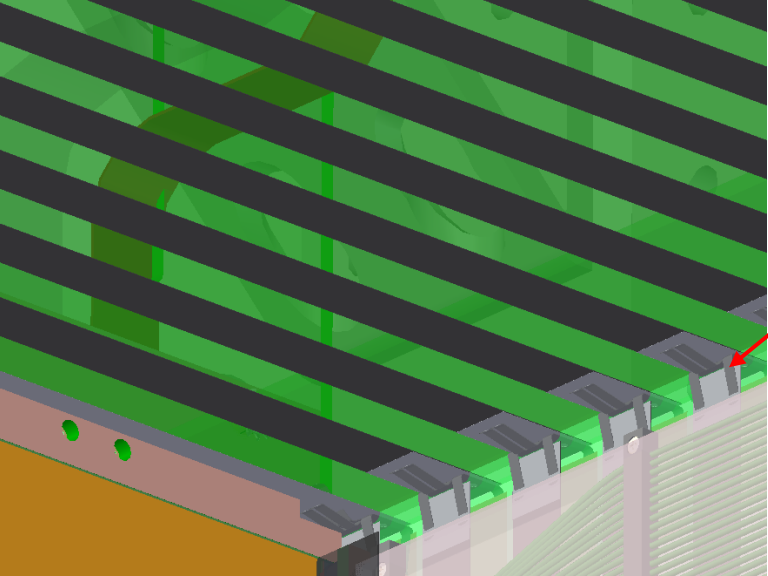
11
10
9
8
7
6
5
4
3
2
1

Resistive Stripe Field Cage Prototype Parts for DUNE

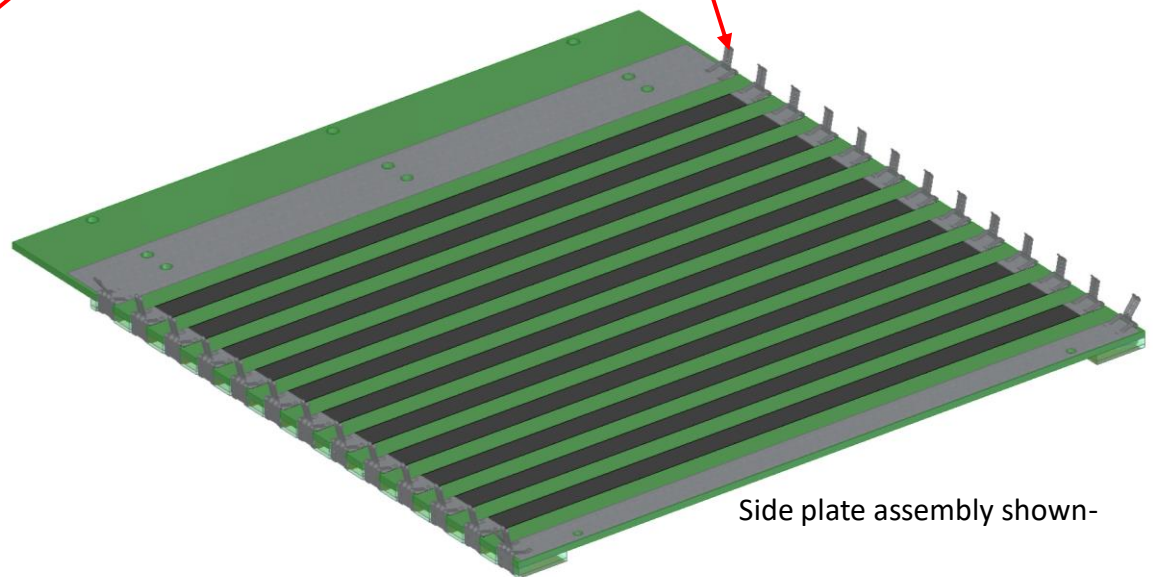
Knut Skarpaas (650)743-2510

11/7/2023

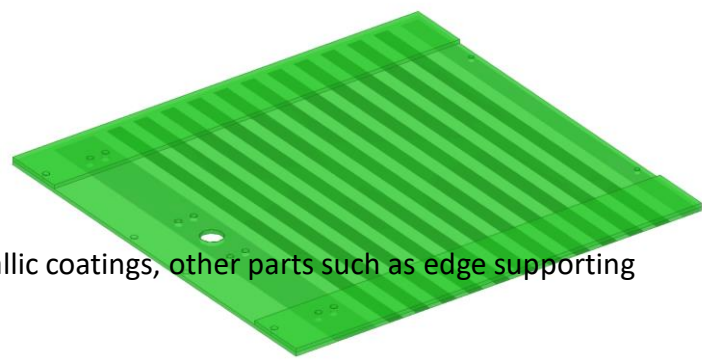
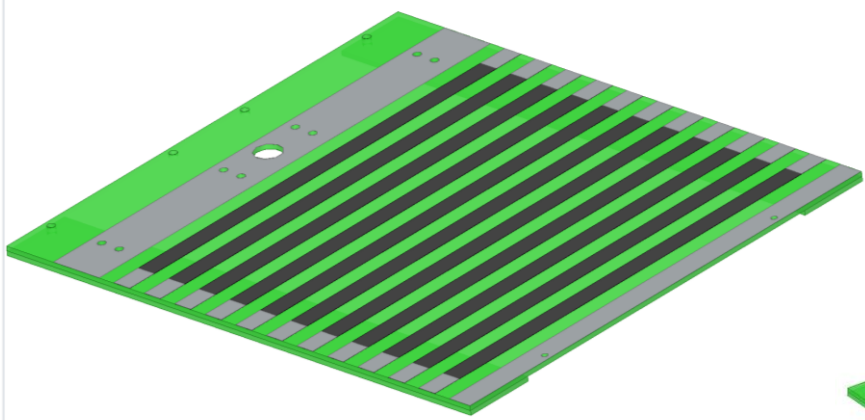




Metal pads on ends of stripes are electrical contacts for spring clips



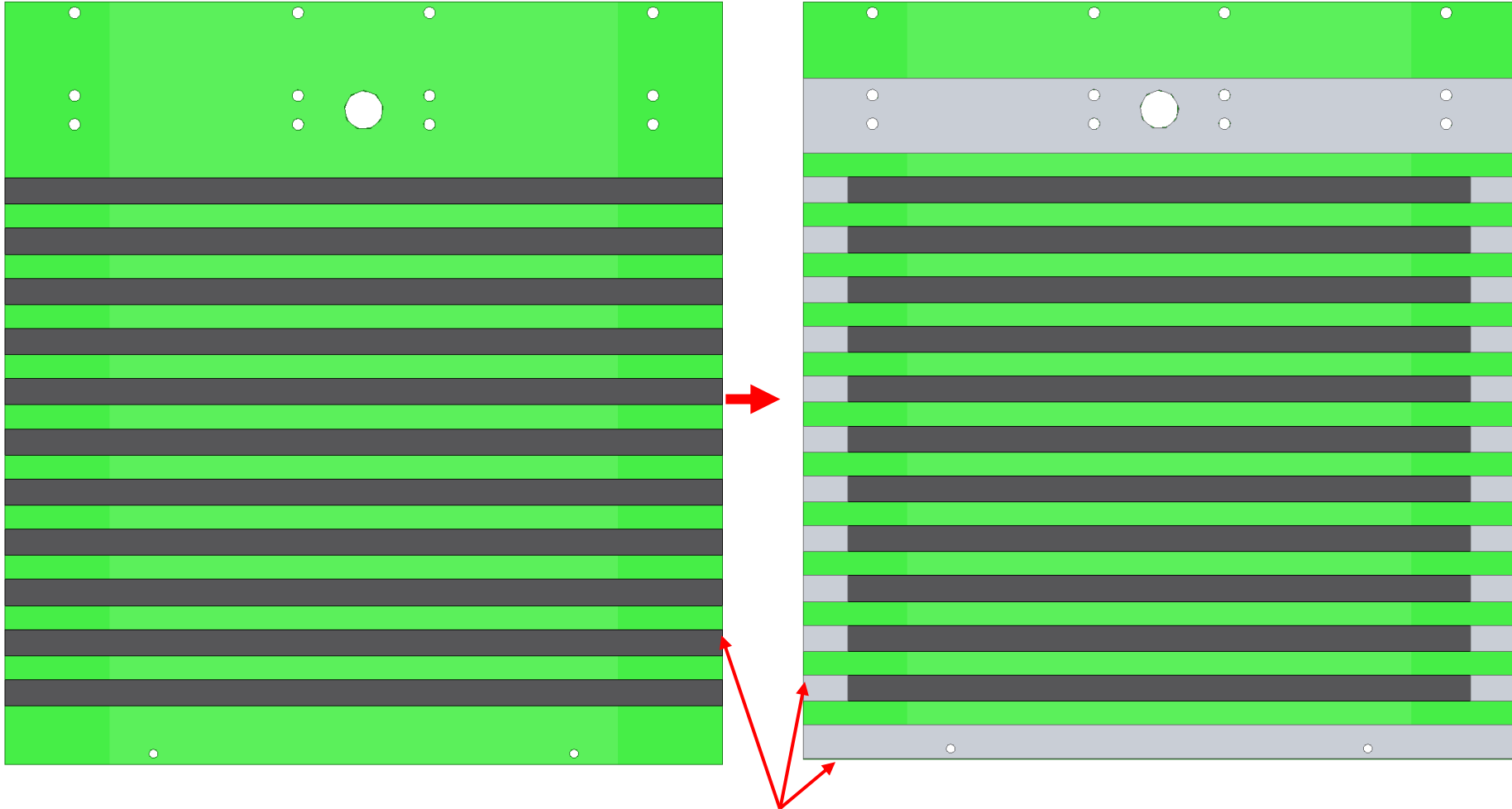
Side plate assembly shown-



Top and Bottom Plate Assemblies-
(Plates are supplied by SLAC, Vivid will do the resistive and metallic coatings, other parts such as edge supporting strips and clips will be added by SLAC later)

Top and Bottom plates- (need 2 per test)

Coat with resistive coating first (see .stp file – can turn off metal layers)



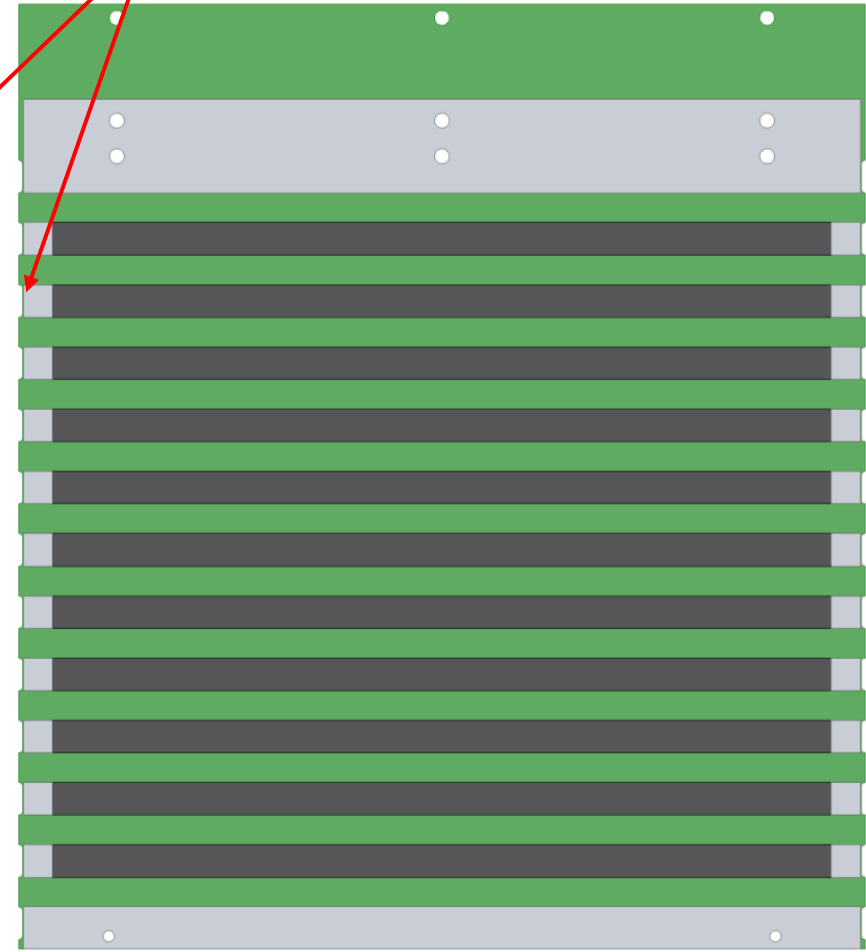
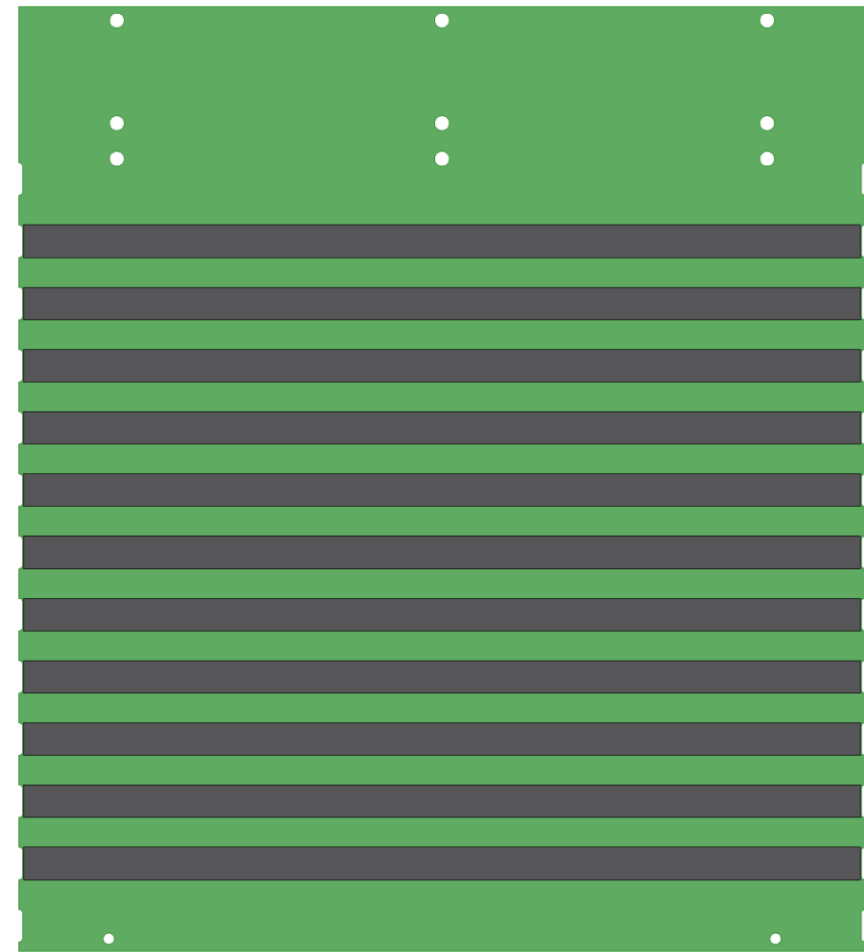
Coat with zinc metal at stripe ends and in two end areas shown
(note- metal and resistive coatings are permitted to the edge of the part but may not wrap around the edges, clean up with abrasive material is permitted)



Side plate shown- (need 2 per test)

Coat with zinc metal at stripe ends and in two end areas shown
(note- metal and resistive coatings are permitted to the edge of the part but may not wrap around the edges, clean up with abrasive material is permitted)

Coat with resistive coating first (see .stp file – can turn off metal layers as needed)



DUNE HV Cable Assembly Instructions (with notes and parts)

Knut Skarpaas

12/14/2022


Updated 1/24/2023

Updated 1/25/2023

Updated 2/6/2023

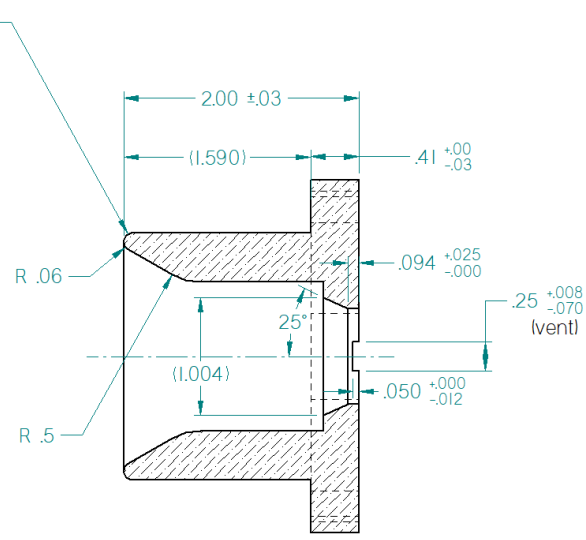
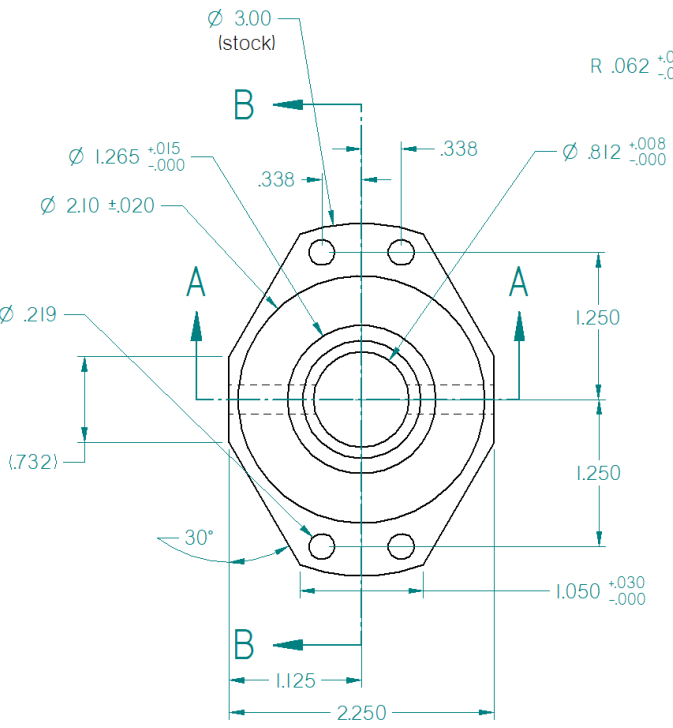
Updated 8/28/2023

Flame-Retardant G-10/FR4 Rod
 3/16" Diameter

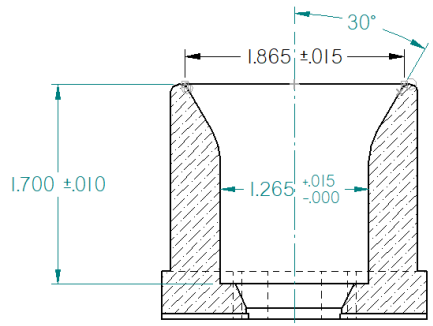


Length, Ft.	Each
1	
4	
ADD TO BASKET	
0669K15	

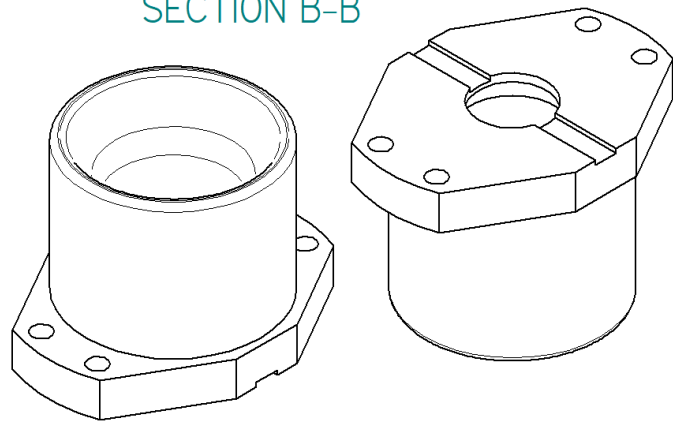
Material	Garolite
Grade	G-10/FR4
Reinforcement Material	Fiberglass Fabric
Resin Material	Epoxy
Shape	Rod and Disc
Texture	Smooth
Color	Yellow
Clarity	Opaque
Diameter	3/16"
Diameter Tolerance	-0.001" to 0.001"
Tolerance Rating	Standard
Length Tolerance	-1" to 1"
Backing Type	Plain
Hardness	Rockwell M115
Hardness Rating	Extra Hard
For Use Outdoors	No
Minimum Temperature	Not Rated
Maximum Temperature	265° F
Impact Strength	5.5-12 ft.-lb./in.
Impact Strength Rating	Excellent
Tensile Strength	35,000-50,000 psi
Tensile Strength Rating	Excellent
Specifications Met	ME + 2476/027 - UL 94V0
Straightness Tolerance	Not Rated
Compressive Strength	35,000-46,000 psi
Flexural Strength	45,000-60,000 psi
Flexibility	Rigid
Density	0.069 lbs./cu. in.
Dielectric Strength	300-800 V/mil
Electrical Insulation Rating	Good
Water Absorption	0.1-0.15%
Water Absorption Rating	Good
Performance Properties	Electrical Insulator, High Strength, High Temperature, Impact Resistant, Low Water Absorption
Warning Message:	Physical and mechanical properties are not guaranteed. They are intended only as a basis for comparison and not for design purposes.
RoHS:	RoHS 3 (2015/863/EU) compliant



SECTION B-B



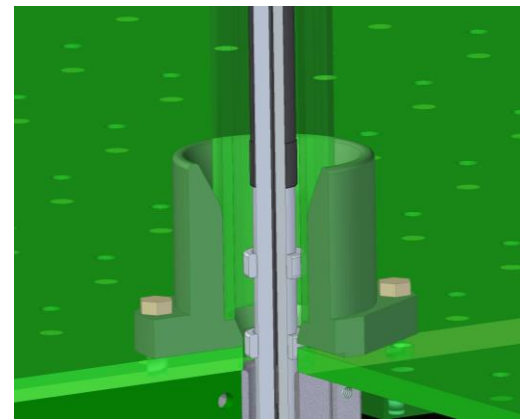
SECTION A-A

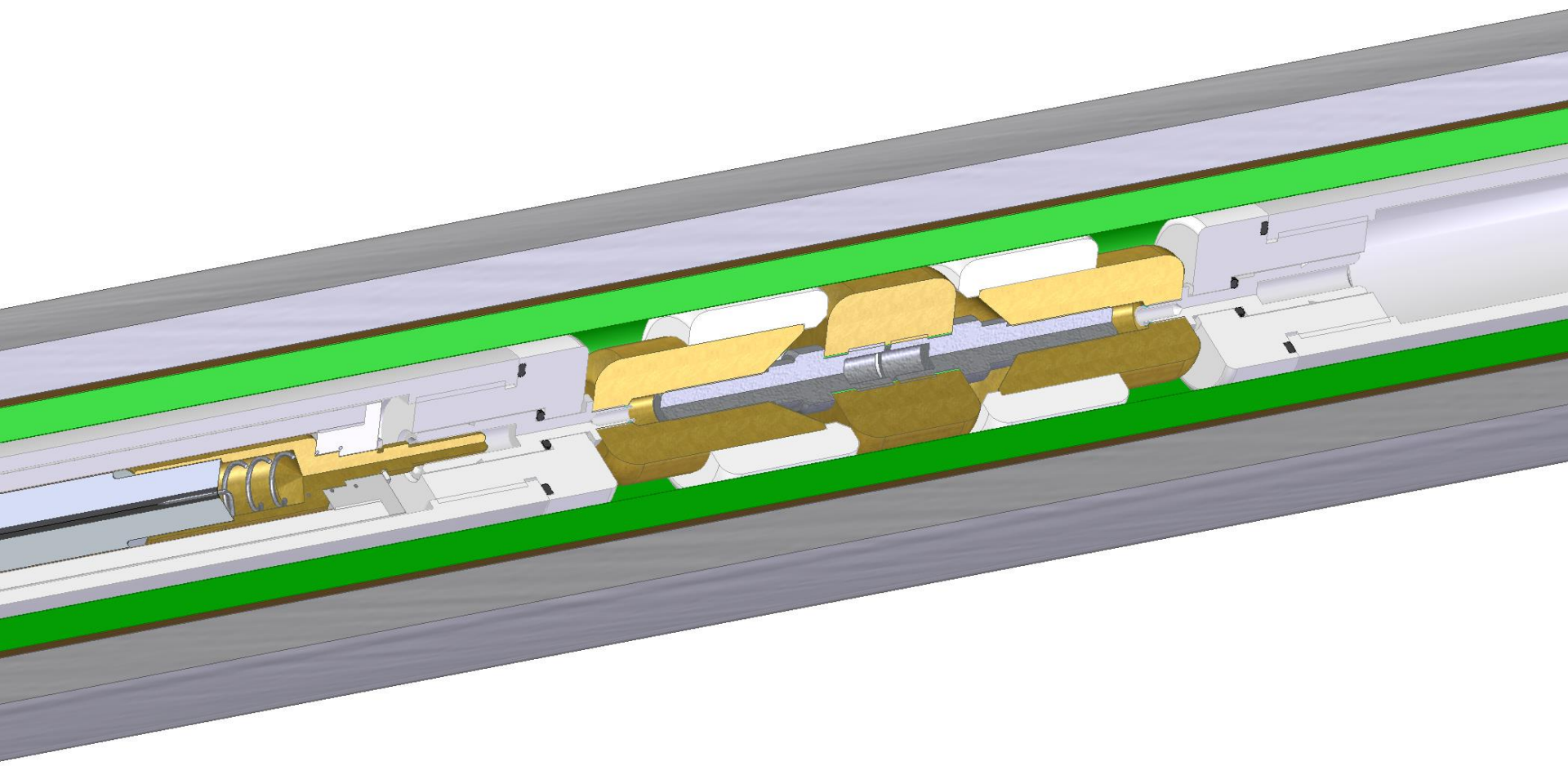
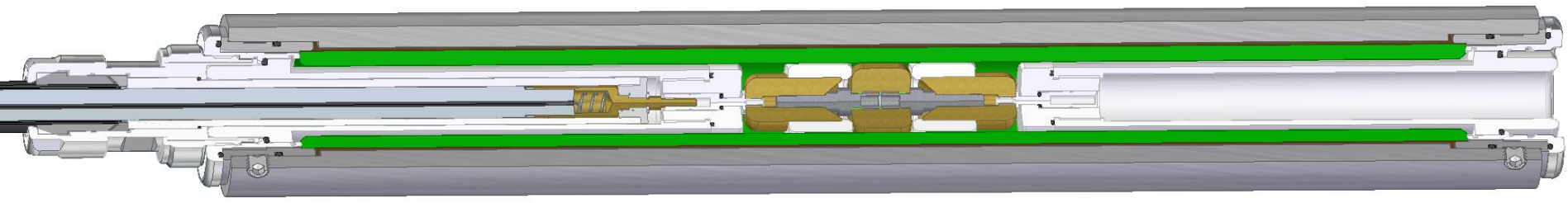


- ND HV Guide
- Make from G-10 rod (McMaster Carr- 3" dia)
- Qty- 1 per module
- Sand surface to be smooth (400 grit)
- Use care when clamping hollow part (don't crush)
- Use no oil based coolant
- (inner counterbore loosely fits fiberglass tube)

ND version notes-

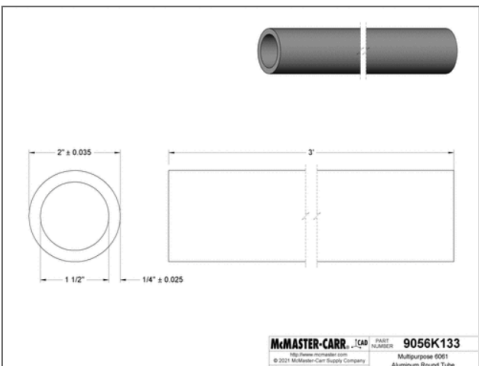
This part is mounted with four PEEK M5 x 25 mm long, hex head bolts from SolidSpot (very light torque – about 1 in-lb).
 (They will tighten more as they cool)





Multipurpose 6061 Aluminum Round Tube

1/4" Wall Thickness, 2" OD



Length, ft. Each

✓ 3

ADD TO ORDER

\$94.19 Each

In stock

9056K13

CAD 3-D Solidworks

New Add-In Version

Streamline your design process with our [Solidworks Add-In](#).

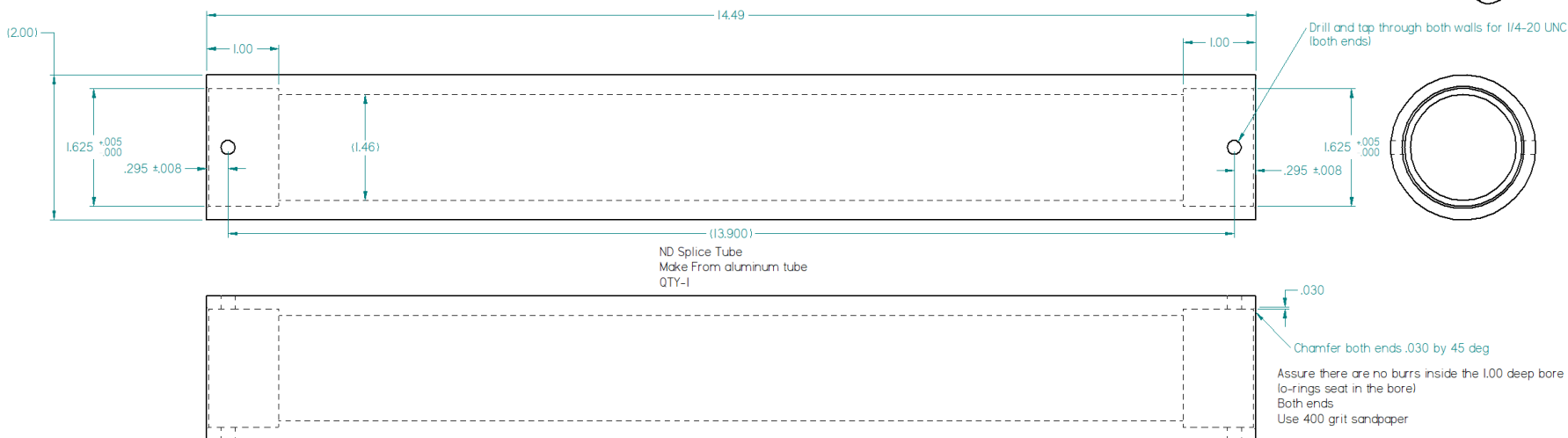
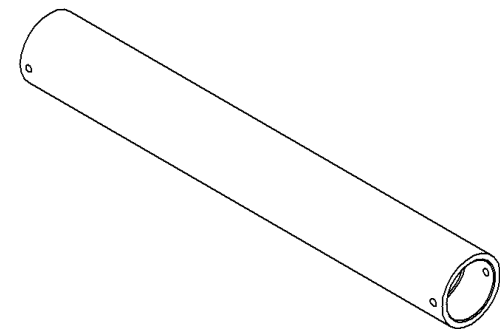
Available for Solidworks 2017 or newer.

Material	6061 Aluminum
Shape	Round Tube
Shape Type	Round Tubes
Wall Thickness	1/4"
Wall Thickness Tolerance	-0.025" to 0.025"
Tolerance Rating	Standard
OD	2"
OD Tolerance	-0.035" to 0.035"
ID	1 1/2"
ID Tolerance	Not Rated
Yield Strength	35,000 psi
Fabrication	Extruded
Temper	T6511
Heat Treatment	Hardened
Hardness	Brinell 95
Hardness Rating	Soft
Heat Treatable	Yes

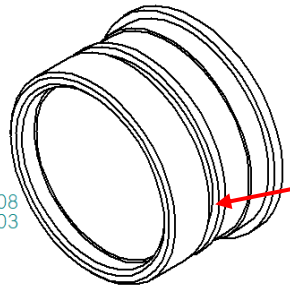
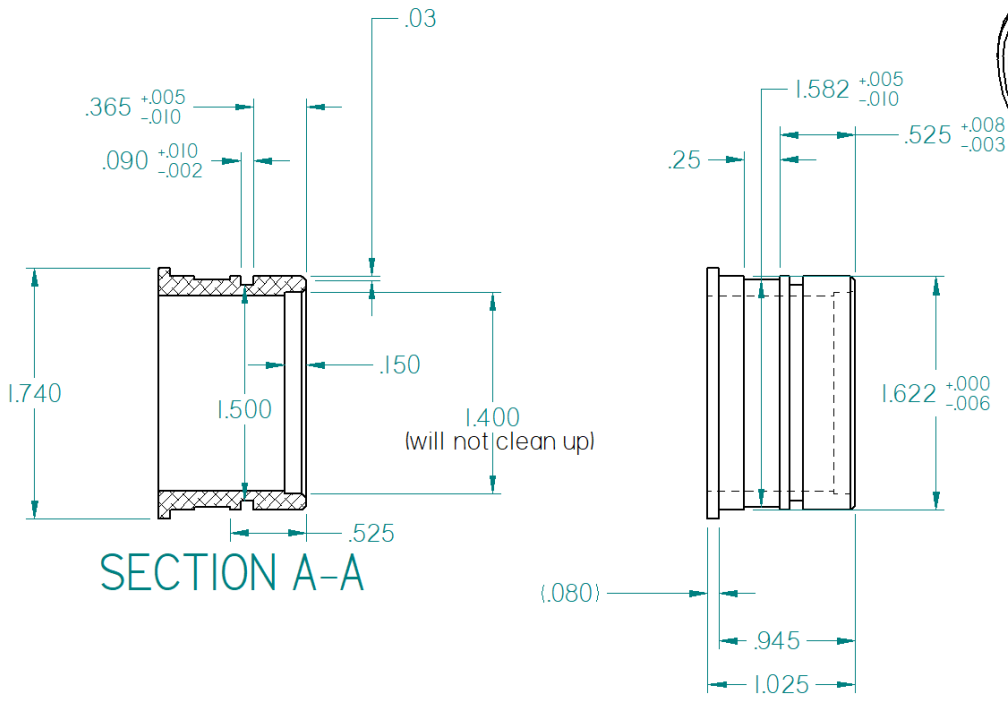
To be used on ND (sealed version)

Note-

This can be made from the old design by removing .080" from each end and increasing the bore depth back to 1.00" deep (use care to center part so bore dia does not increase since it is a sealing surface) The tapped holes should end up in the correct locations.



Chamfer inner and outer rims .03 by 45 deg



To be used on ND (revision with small flange for seal 8/28/2023)

Size 029 Viton O-ring to seal to tube

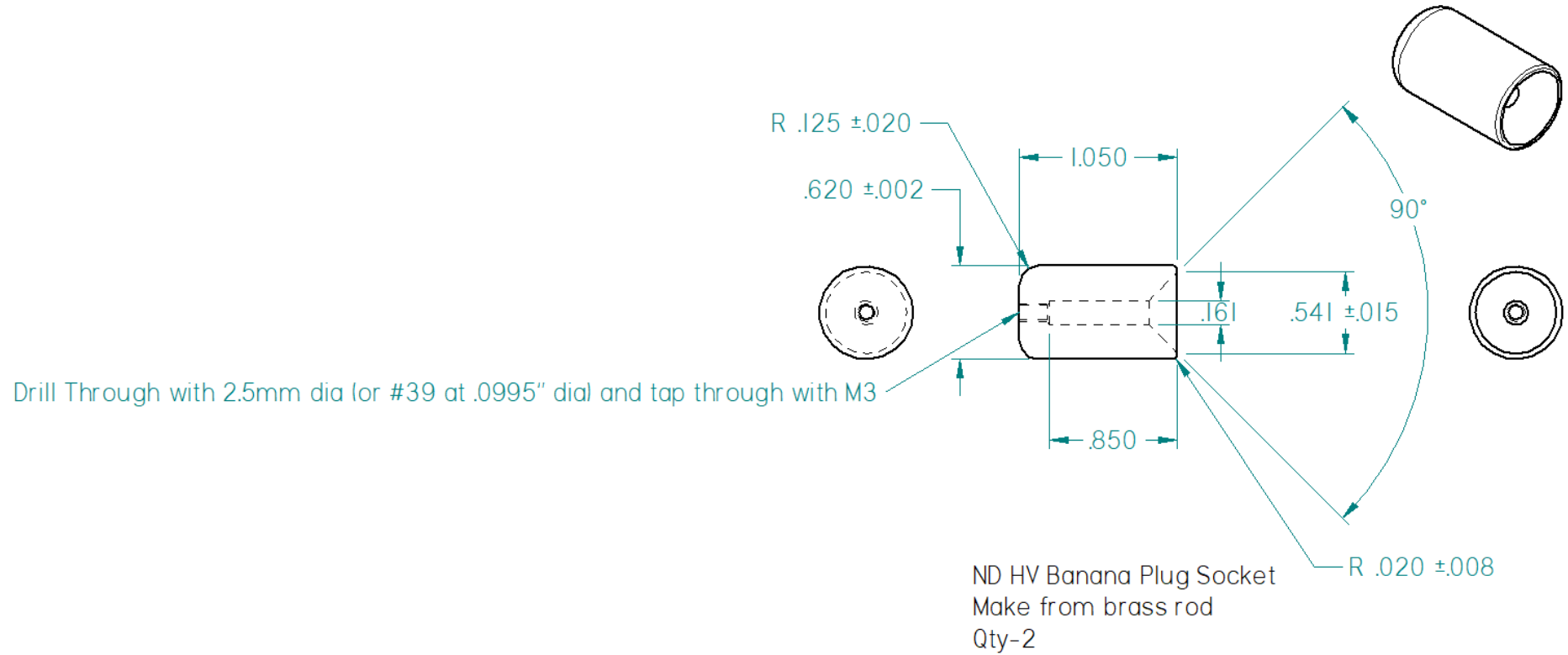
Material	Viton® Fluoroelastomer-Rubber
Series	Chemical-Resistant Viton® Fluoroelastomer O-Ring
Stock Number	029
Part Number	029
Material	Viton® Fluoroelastomer-Rubber
Series	Chemical-Resistant Viton® Fluoroelastomer O-Ring
Stock Number	029
Part Number	029
Material	Viton® Fluoroelastomer-Rubber
Series	Chemical-Resistant Viton® Fluoroelastomer O-Ring
Stock Number	029
Part Number	029

Bore through with 1.358" dia (34.50mm) and tap through with M36 by 1.5mm pitch

Material	6061 Aluminum
Shape	Round Tube
Wall Thickness	1/4"
Wall Thickness Tolerance	-0.031" to 0.037"
Tolerance Rating	Standard
OD	1.34"
OD Tolerance	-0.025" to 0.025"
ID	1.14"
ID Tolerance	Not Flated
Yield Strength	35,000 psi
Fabrication	Extruded
Temper	T6
Heat Treatment	Hardened
Hardness	Brinell 95
Hardness Rating	Soft
Heat Treatable	Yes
Certificate	Material Certificate with Traceable Lot Number
Mechanical Finish	Polished

Quantity Type	Tap
Application	Through Hole Threading, Closed End Hole Processing
Series	M36
Pitch	1.5 mm
Length	1.625"
Overall Length	4"
Number of Tapping Flutes	1, 1.4"
Maximum Tapping Depth	1.4"
OD Dia	3/4, 5/8, 3/4, 5/8
Flute Dia	1.362"
Flute Dia Tolerance	±0.002" to ±0.002"
Stock Type	Standard
Material	Uncoated High-Speed Steel
Flute Type	Straight
Number of Flutes	Metric
Flute Diameter Level	DB
Flute Diameter Tolerance	0.0025" to 0.0025"
Stock Type	Standard
Material	Uncoated High-Speed Steel
Flute Type	Straight
Number of Flutes	Metric

To be used on ND HV Splice (sealed version with G-10 tube and Teflon sliders)



To be used on ND (updated for sealed splice 8/28/2023)

Ultra-Machinable 360 Brass Rod
7/8" Diameter

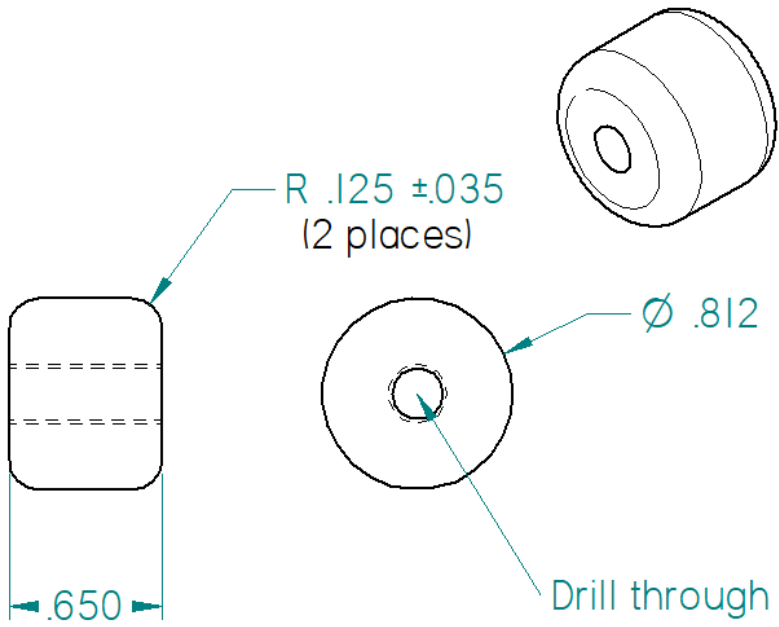


Length, ft. Each
 ✓ 2 Each
ADD TO ORDER
 \$75.52 Each
 In stock
 8953K97

CAD 3-D Solidworks

New Add-In Version
 Streamline your design process with our [Solidworks Add-In](#).
 Available for Solidworks 2017 or newer.

Material	360 Brass
Shape	Rod and Disc
Appearance	Plain
Diameter	7/8"
Diameter Tolerance Range	-0.003" to 0.003"
Tolerance Rating	Standard
Yield Strength	15,000 psi
Fabrication	Cold Worked
Temper	H02
Temper Rating	1/2 Hard
Hardness	Rockwell B25 (Soft)
Heat Treatable	No
Certificate	Material Certificate with Traceable Lot Number
Specifications Met	ASTM B16
Density	0.307 lbs./cu. in.
Surface Resistivity	39.9 Ohms
Melting Point Temperature	1630° F
Modulus of Elasticity	14.0 ksi × 10 ³



Drill through with 7/32" dia (.2188") and tap through with 1/4-32 UNEF

HV Banana Plug Adapter (for fiberglass tube splice)
 Make from - Brass rod
 Qty-1

350x187.5=65.625kV minimum for fr-4
 10,000 more for polyimide layer (minimum)
 4,300 for inner air gap minimum
 2,400 outer air gap
 20,000 more for central double wrap

McMASTER-CARR

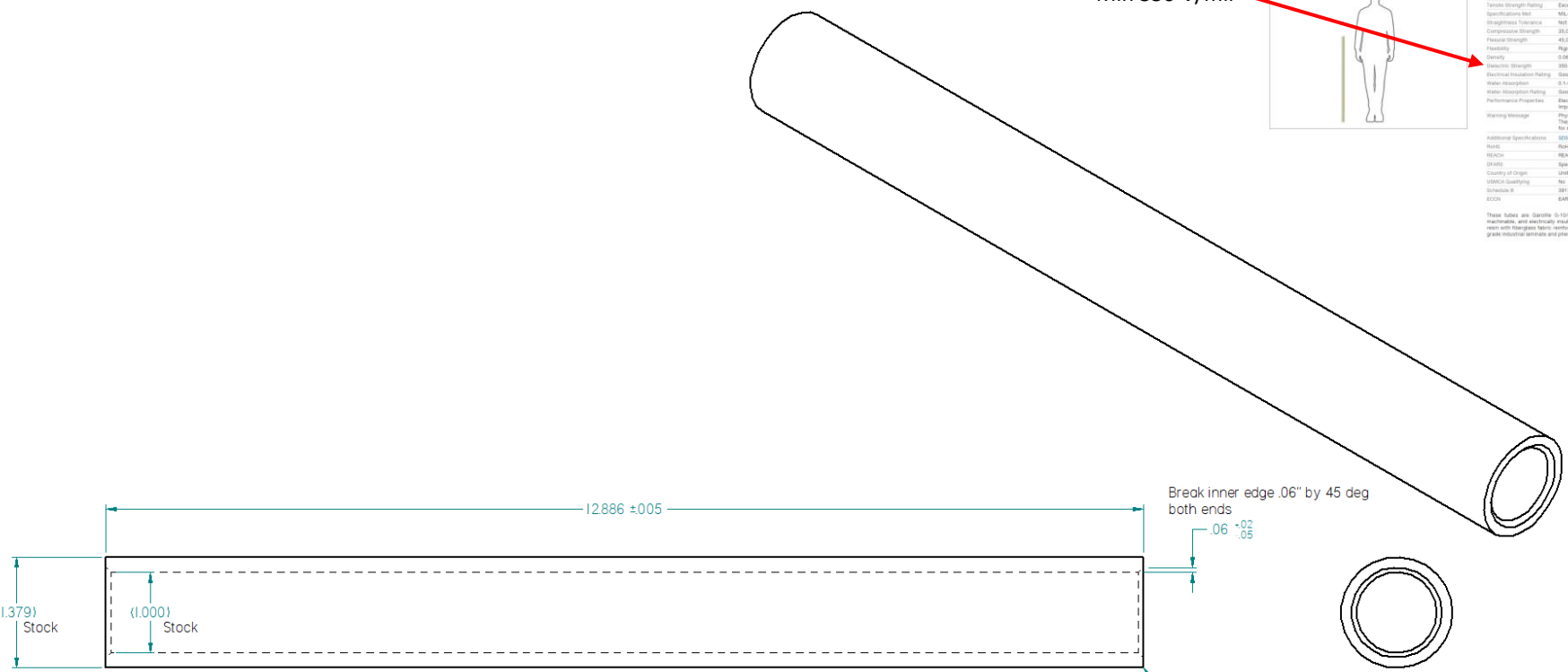
Flame-Retardant Garolite G-10/FR4 Tube
 2.10" Wall Thickness, 1.31" OD, 1" ID, 42" Long



Material	Garolite
Material Grade	Garolite G-10/FR4
Reinforcement Material	Fiberglass Fabric
Resin Material	Epoxy
Shape	Round Tube
Texture	Smooth
Color	Green
Quantity	Change
OD	1.31"
OD Tolerance	-0.005" to 0.000"
ID	1"
ID Tolerance	-0.004" to 0.000"
Wall Thickness	0.15"
Length	42"
Length Tolerance	0" to 0.1"
Tolerance Rating	Standard
Hardness	Rockwell M110
Hardness Rating	220A Hard
For Use Outdoors	No
Minimum Temperature	Not Rated
Maximum Temperature	280°F
Impact Strength	3.0 to 10 ft-lb/in
Impact Strength Rating	Excellent
Tensile Strength	35,000-60,000 psi
Tensile Strength Rating	Excellent
Specifications Met	IEEE 480/2707, UL 94 V-0
Straightness Tolerance	Not Rated
Compressive Strength	35,000-60,000 psi
Flexure Strength	45,000-60,000 psi
Flexibility	Rigid
Density	2.000-2.010 in
Dielectric Strength	350-500 v/mil
Electrical Insulation Rating	Good
Water Absorption	0.1 to 0.2%
Water Absorption Rating	Good
Performance Properties	Electrical Insulation: High Strength, High Temperature, Impact Resistant, Low Water Absorption
Warning Message	Physical and mechanical properties are not guaranteed. They are intended only as a basis for comparison and not for design purposes.
Additional Specifications	505
RoHS	RoHS 2 (2015) REACH Compliant
REACH	RoHS 2 (2015) REACH (2015/08/03, 204 SVHC) Compliant
RoHS	Specialty Metals C013-0 exempt
Country of origin	United States
USDA/CAS Quality	No
RoHS 2	2017082000
RoHS	RoHS

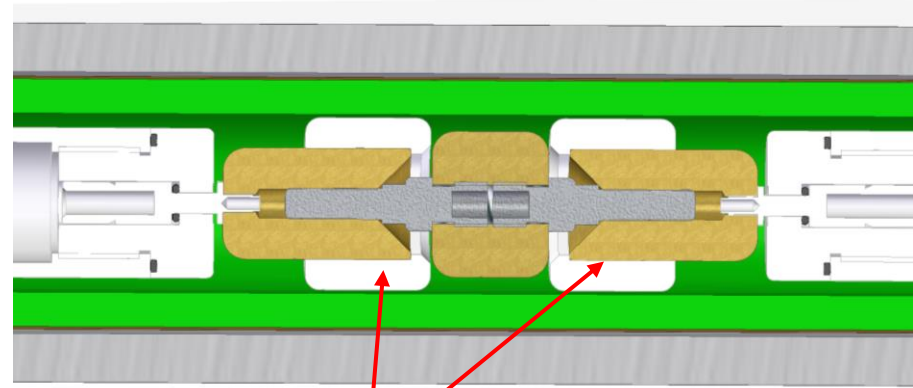
(face both ends of fiberglass tube and sand with 400 grit)

Min 350 V/mil

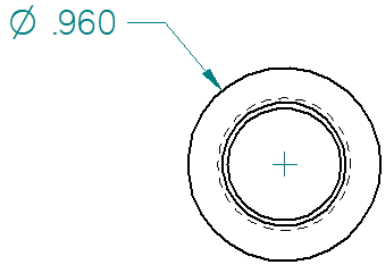



Make from supplied fiberglass tube
 Use care to not crush while clamping
 Qty- 1 per splice
 Turn ends to be square

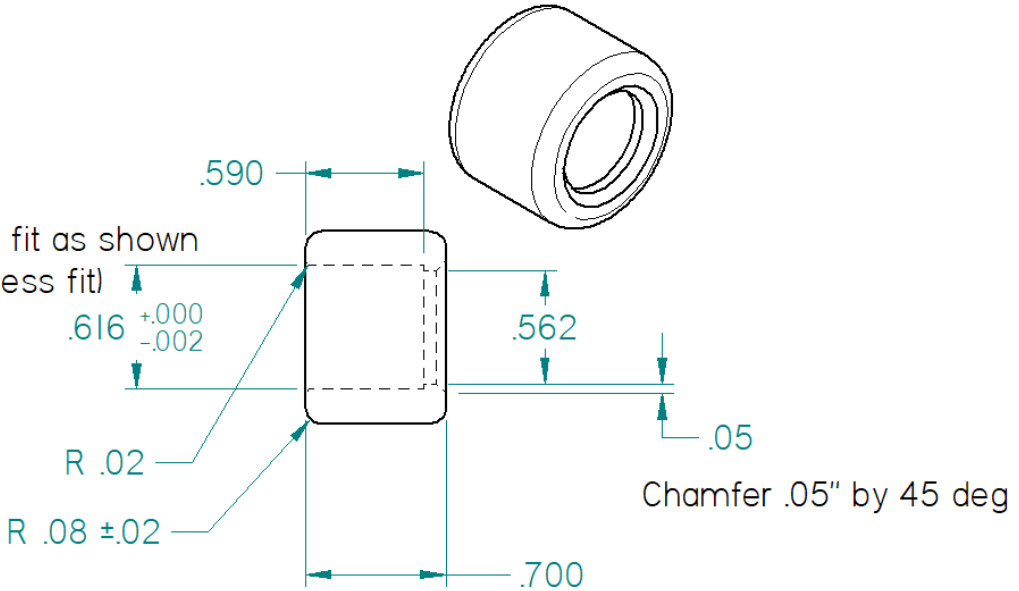
Clean surface with 400 grit sandpaper to assure no dark marks which could initiate arcing
 Inspect insides to assure no visible marks



Once insulator is pressed onto the clean brass part, do not remove it (assure that it is Teflon since this should stretch without cracking)



This should be a press fit as shown (clean brass prior to press fit)



Banana socket insulator
 Make from Teflon rod
 Qty- 2

ND HV Test Setup at SLAC

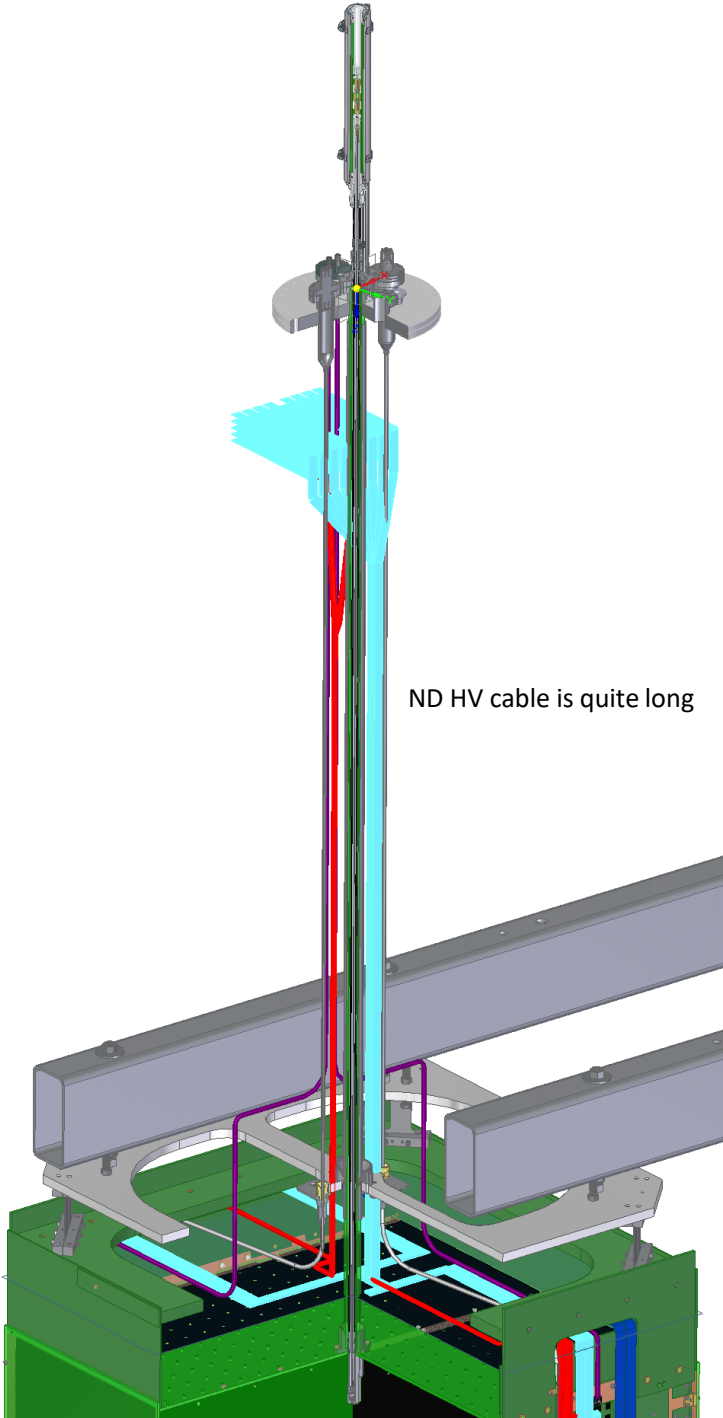
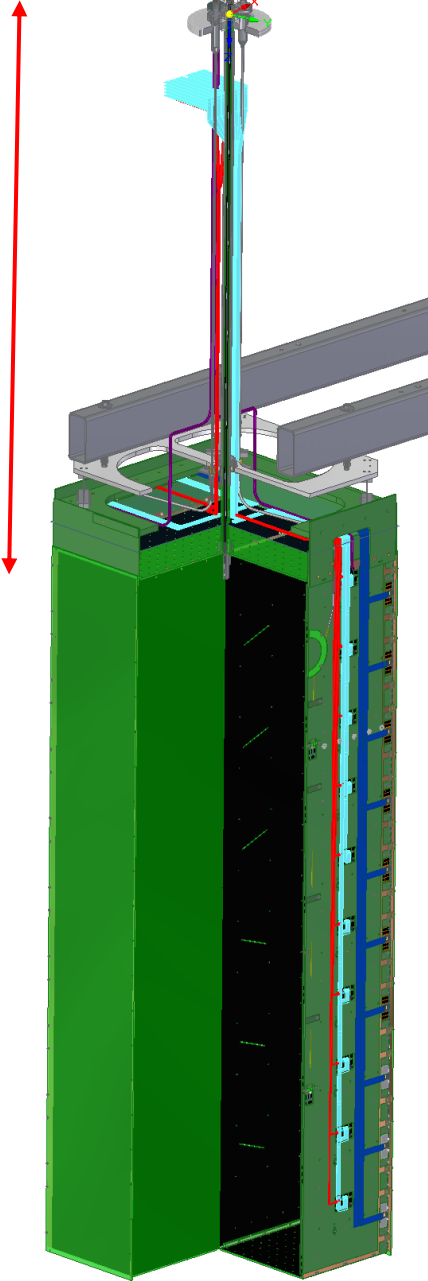
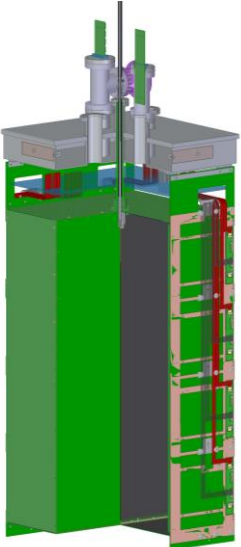
Knut Skarpaas

8/25/2023

The HV input for ND is quite long-

For the ND TPC, the HV cable is quite long (so it has significant contraction)

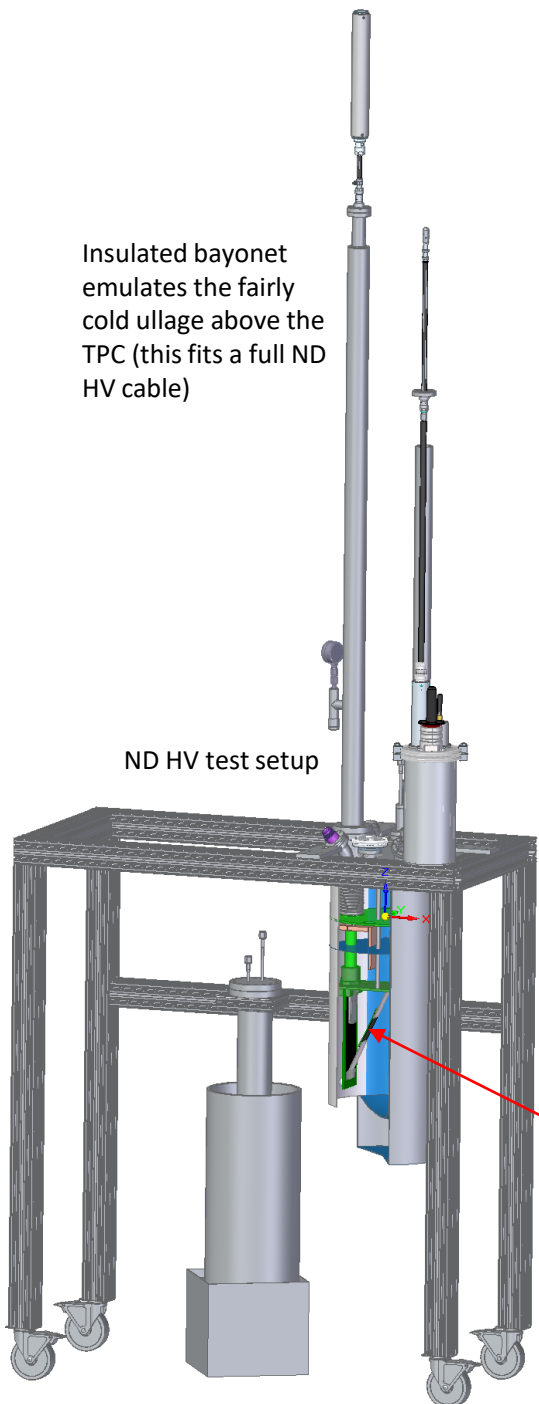
For the 2x2 TPC, the HV cable is fairly short



ND HV cable is quite long

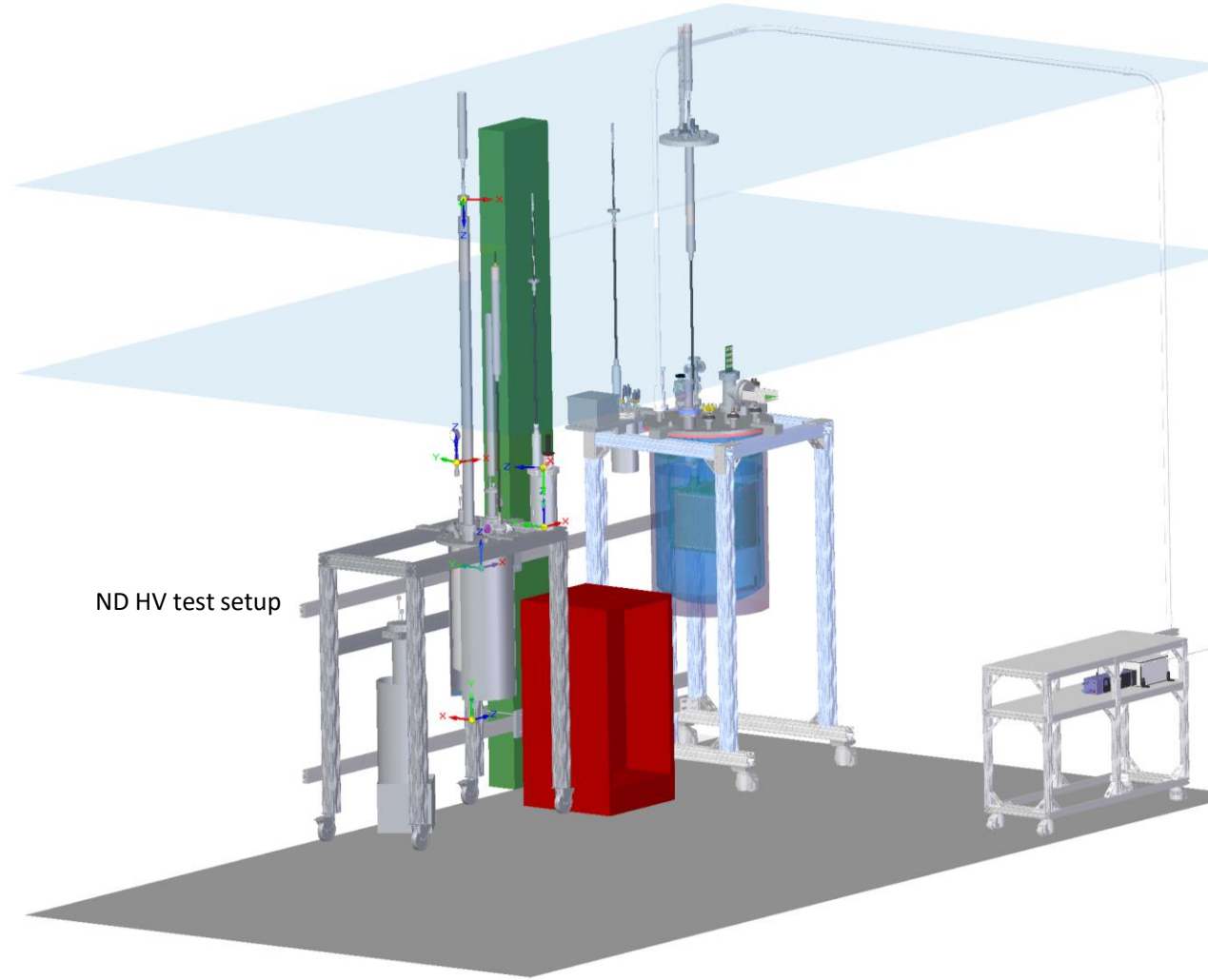
Insulated bayonet
emulates the fairly
cold ullage above the
TPC (this fits a full ND
HV cable)

ND HV test setup

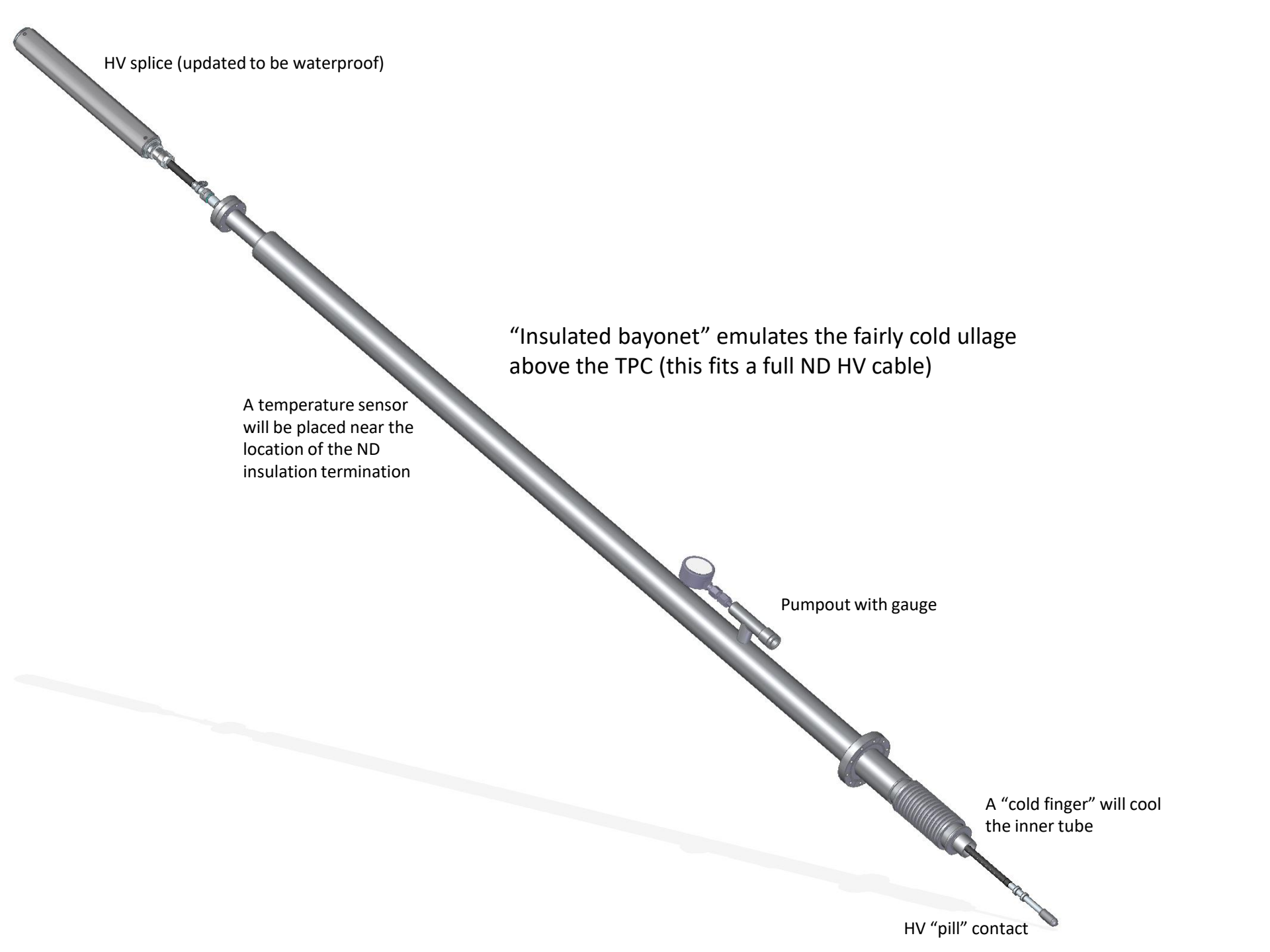


Small resistive
return emulates
the TPC in liquid
argon

ND HV test setup



A test setup at SLAC will permit cold testing full scale
ND HV cables and their associated thermal
contraction while using a relatively small amount of
liquid argon (which can reduce cycle times as well)



HV splice (updated to be waterproof)

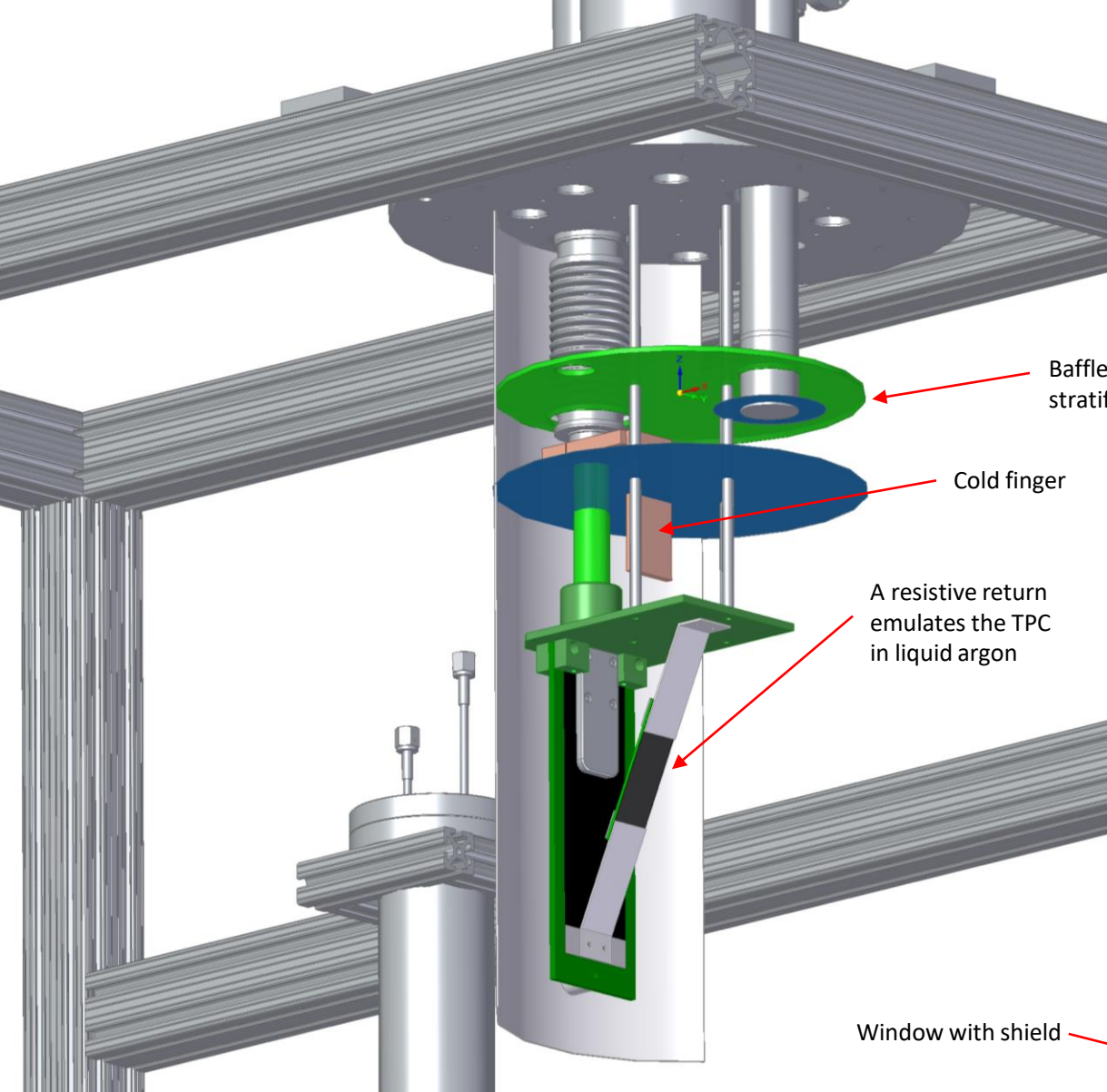
“Insulated bayonet” emulates the fairly cold ullage above the TPC (this fits a full ND HV cable)

A temperature sensor will be placed near the location of the ND insulation termination

Pumpout with gauge

A “cold finger” will cool the inner tube

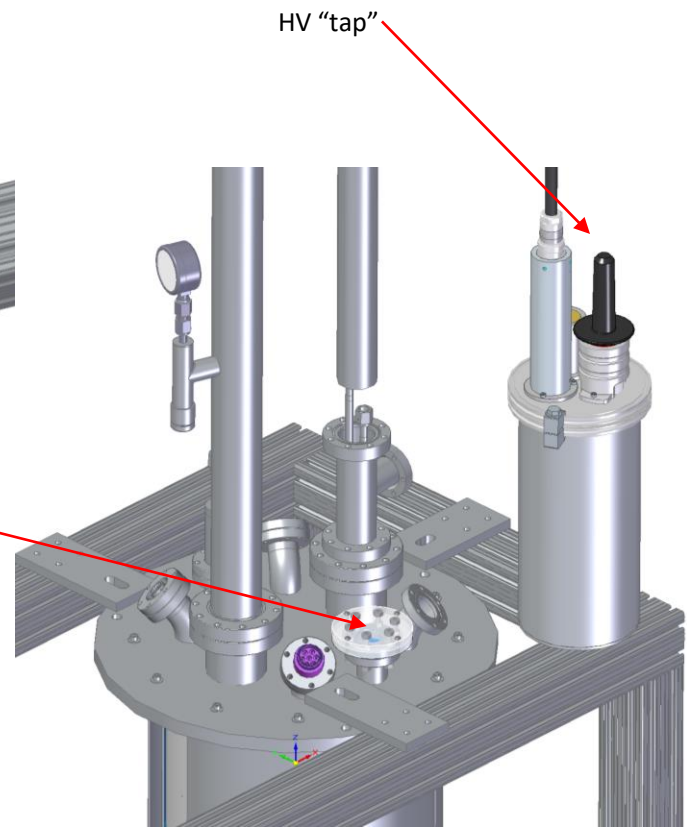
HV “pill” contact



Baffle helps with stratification

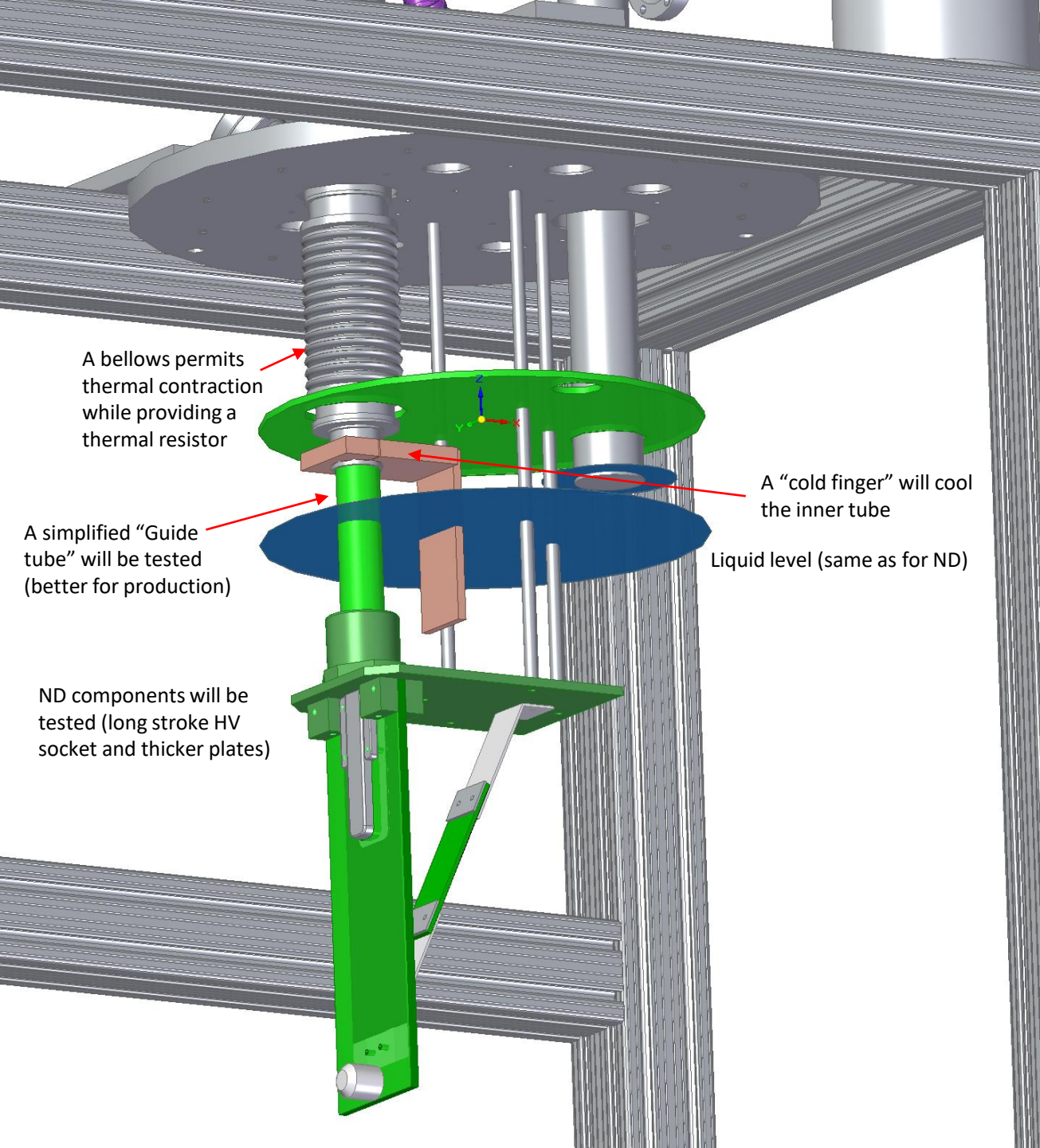
Cold finger

A resistive return emulates the TPC in liquid argon



HV "tap"

Window with shield



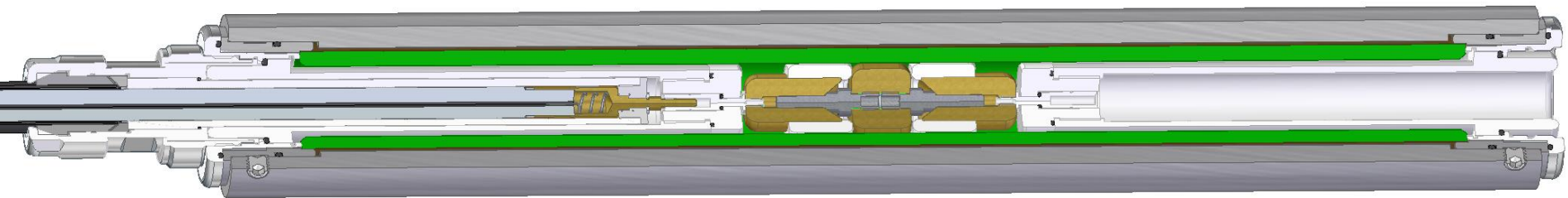
A bellows permits thermal contraction while providing a thermal resistor

A simplified "Guide tube" will be tested (better for production)

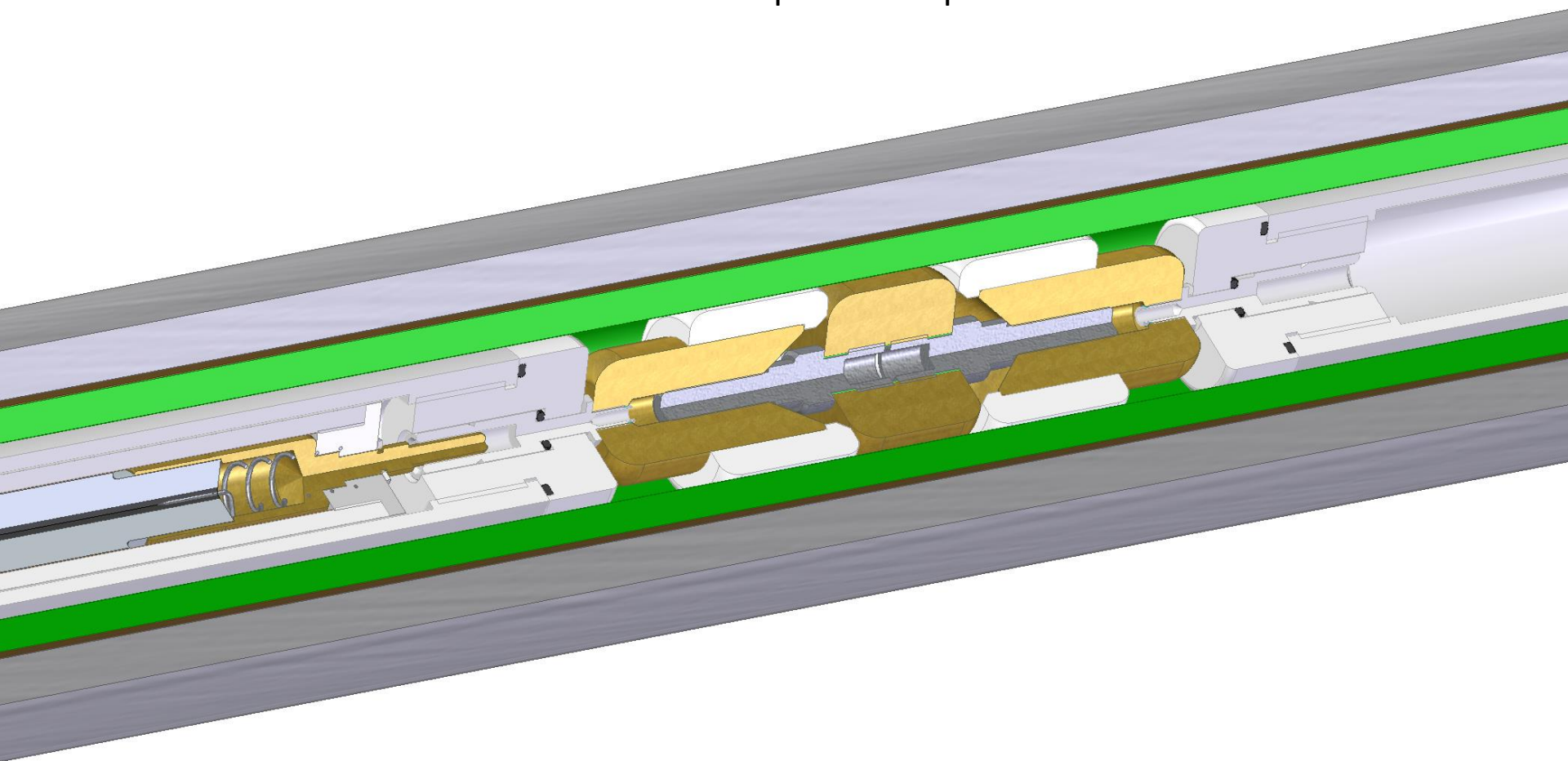
ND components will be tested (long stroke HV socket and thicker plates)

A "cold finger" will cool the inner tube

Liquid level (same as for ND)



Waterproof HV Splice



Misc. cable views and info-

**Cable Assembly Data-
(for DUNE 2x2 detectors)**

Cable Assembly # 1

(Tag at both ends)

Nominal flexible length 3.5m

Warm end termination

Cold end Termination

(small dia pill)



Notes: The 21 psi actually lasted about an hour. The seal was valved out and no reduction in pressure was seen. He leak check after saw "no indicated leak". Various cable resistance measurements may be due partially to ambient temperature changes.



Both O-rings to be cleaned with ethanol and rubbed with Dow Corning high vacuum grease (silicone)- wipe grease away with a clean wipe to only leave a slight film on the surface to ease installation

Modified Ultra-Torr fitting
Bore ID .612" x Bore depth 1.093"

Modified 2.75" Conflat

Dielectric Sciences cable #2353

Polymer core (small inner dia version)

Pressure Check 12 psi for 10 minutes Date 12/8/2022

Pressure Proof Test 21 psi for over 10 minutes Date 12/13/2022

Helium Leak Check (rate and result) 1.3×10^{-9} mbar-liter/sec Date 12/8/22

Cable braid

Stainless steel worm drive hose clamp

McMaster # 54225K211 (welded on inside)

Extended Ultra-Torr seal compressor

Modified Ultra-Torr nut

Viton size 906 o-ring (brown) for strain relief
(McMaster #5267T488)

Trelleborg Sealing Solutions Lot#202209261583 date 3Q22
Shelf life - 20 years

Ultra-Torr O-ring spacer Tube
ID .489" x OD .604" x length .600"

Butyl size 906 O-ring (black) seal
(the O-Ring Store #IIR70906 AS568-906)

Ultra-Torr adapter

Cable Core Resistance 196.5k Ω Date 12/8/22

Cable Core Resistance 193.4k Ω Date 12/9/22

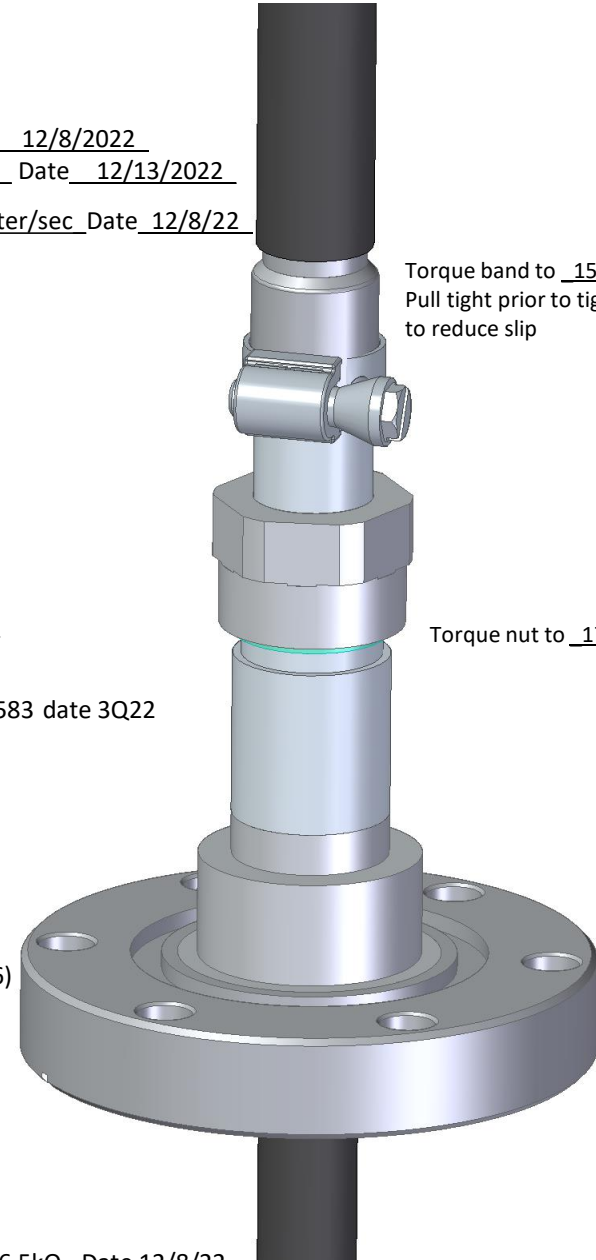
Cable Core Resistance 191.2k Ω Date 12/14/22

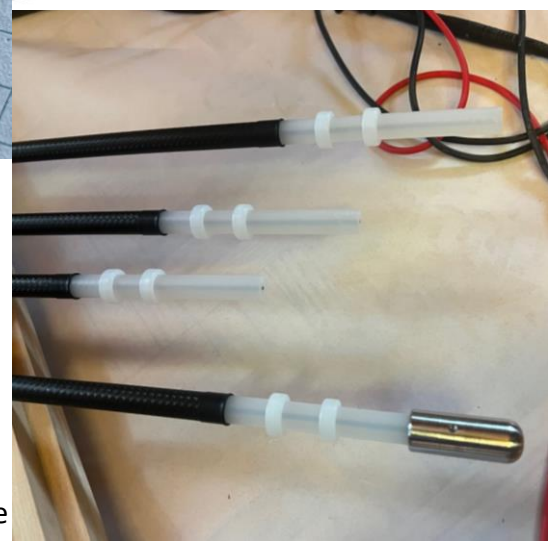
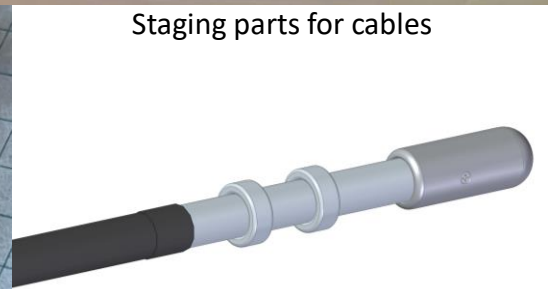
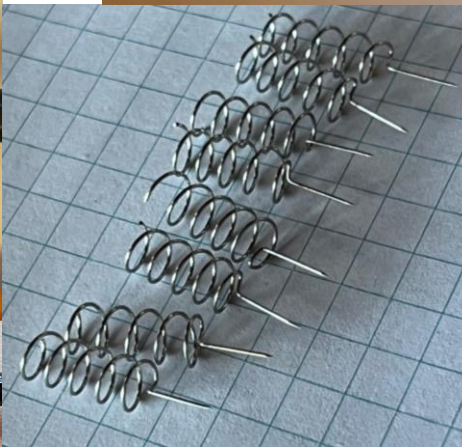
Cable Core Resistance 192.9k Ω Date 1/20/23

Shield Continuity Check 1 ohm, Inner to Outer conductivity check (open/good) Date 12/8/2022

Torque band to 15 in.-lbs.
Pull tight prior to tightening
to reduce slip

Torque nut to 17 in.-lbs.





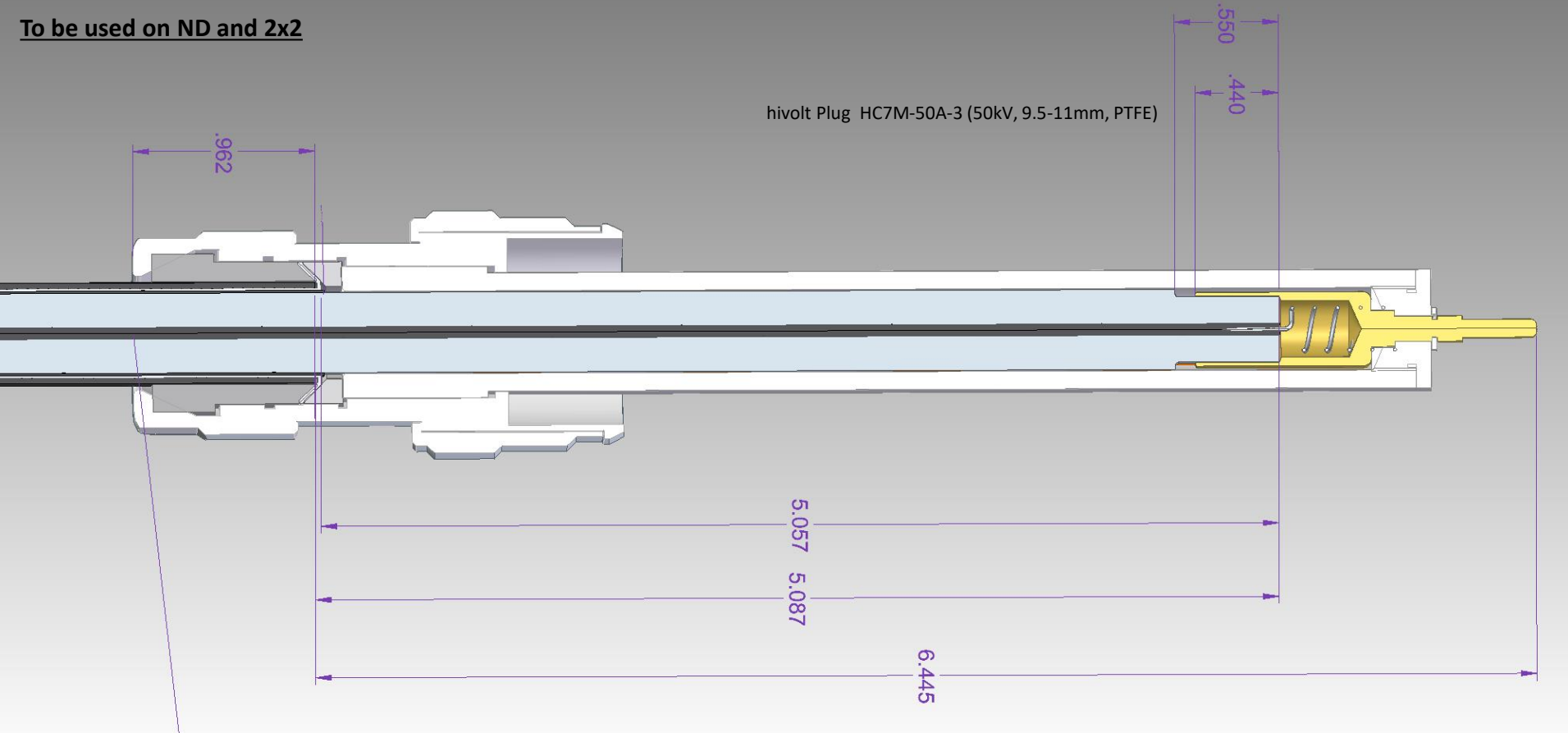
Staging parts for cables

Custom spring contacts with piercing needles

Labels on each end for identification (now two places per end to permit better viewing)

Surface disrupters in place

To be used on ND and 2x2



Prepare the cable end with the trimming tool rotating about 300 RPM. If the plastic guide is used the sous vide procedure on this end may not be required (but does not hurt). Push in spring/needle with long nose pliers. Only push .07" per "bite". Verify concentricity and spring length (about .2" longer than final bore in brass) Crimp the brass in the relieved zone with the Thomas & Betts .375 hex crimper.



The insulator above is being replaced with a composite one