Hybrid Motor Design Review

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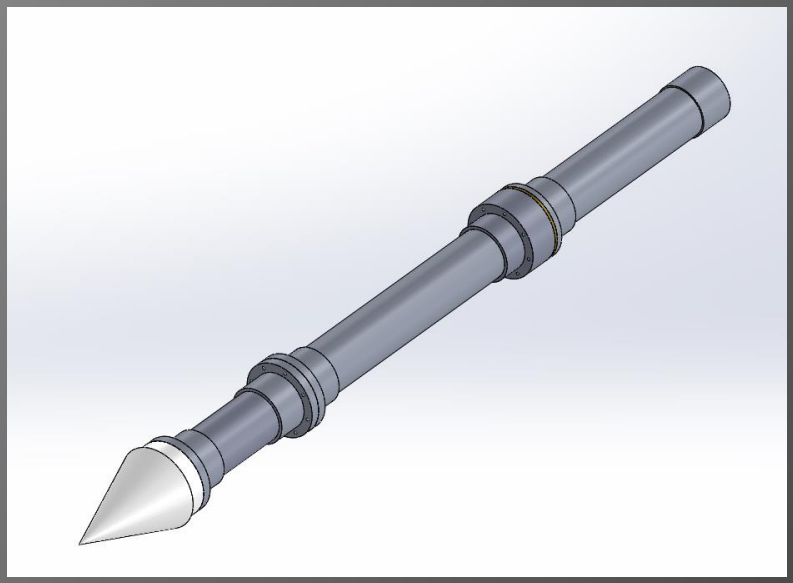
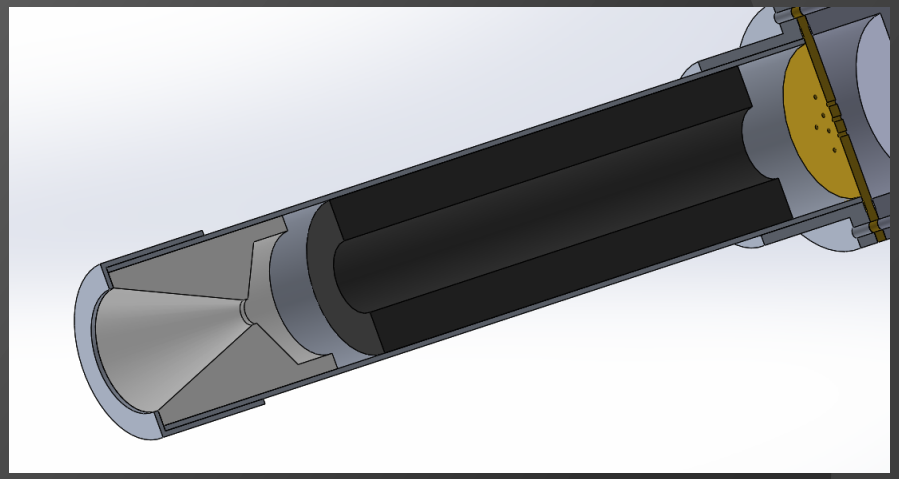
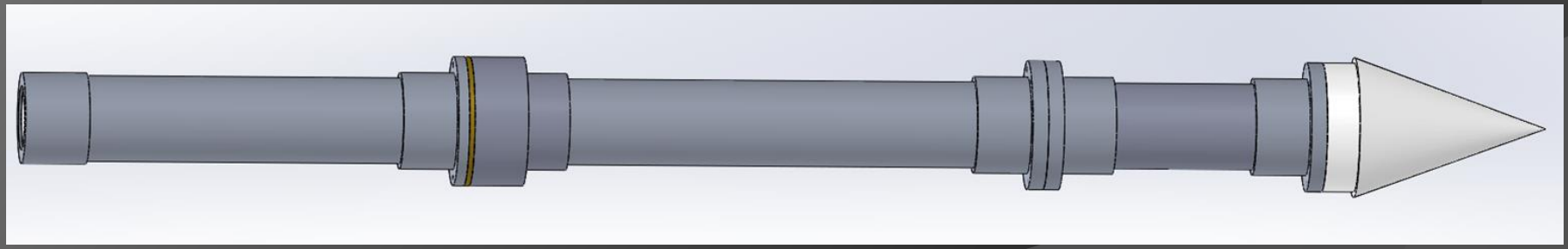
Preview



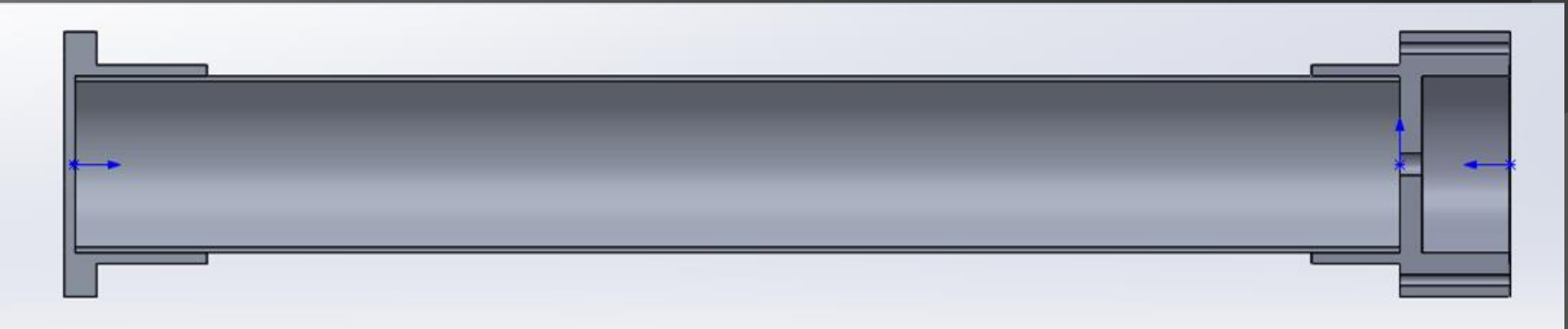




Oxidizer Tank

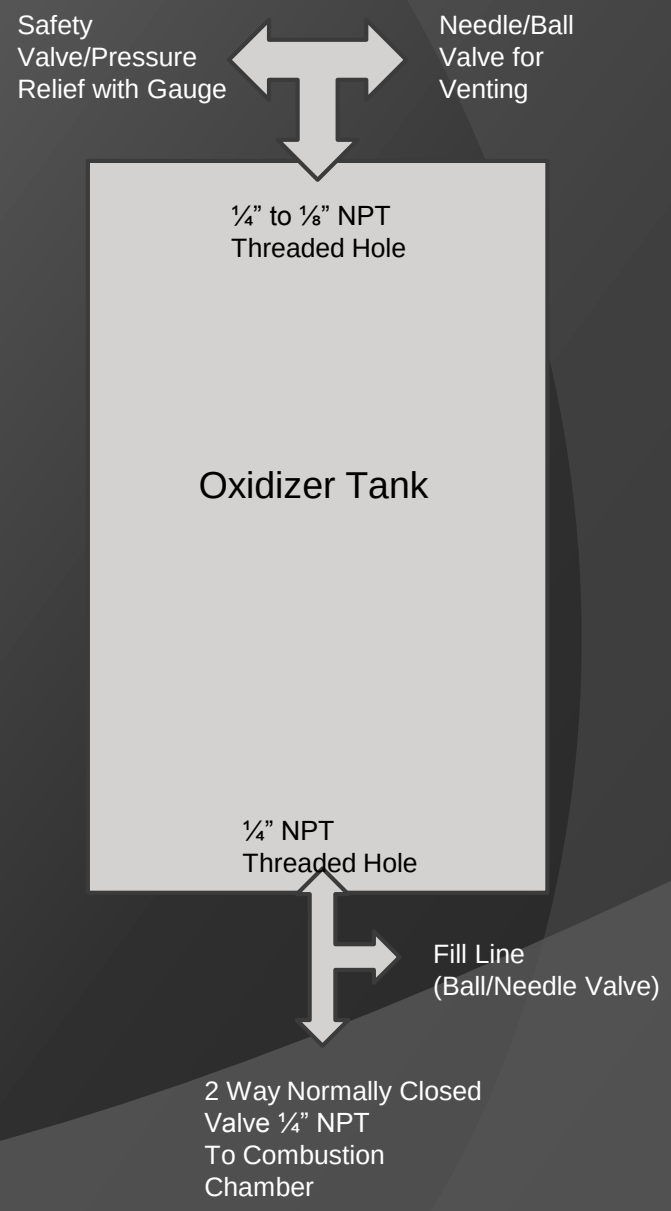
- Material: 6061 T6 Aluminum Alloy
- Manufacturing: Saw / Mill / Weld
- Cost: $56 / 4’

- OD: 4”
- ID: 3.75”
- Length: 24”
- Welded or Silver Solder at Both Ends to Coupler parts
- ¼” Threaded Holes in each end
- 2 Way Normally-Closed Valve in Conjunction with Ball or Needle Valves for filling/venting (Not Pictured)



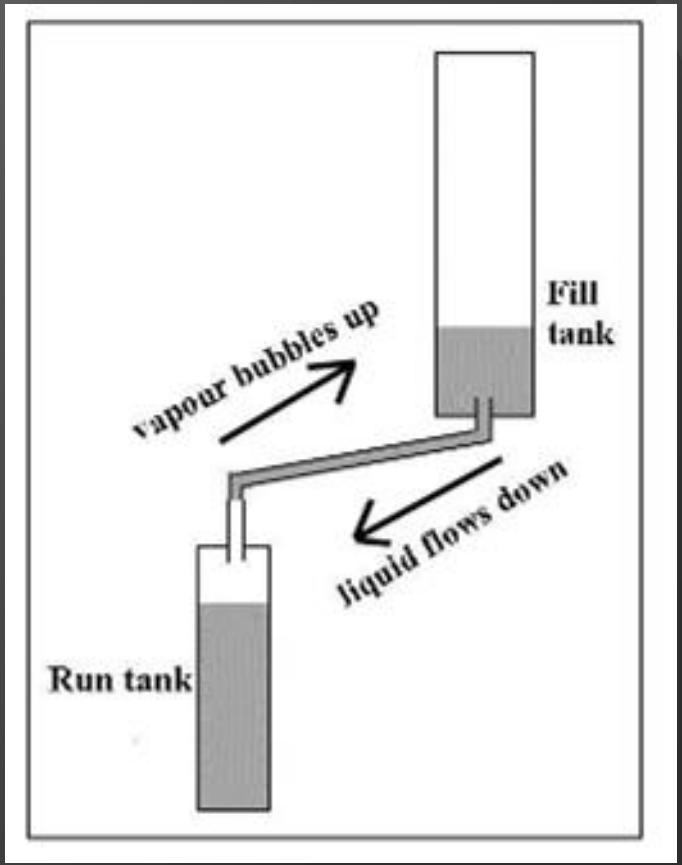
Valve Configuration

- T-Junctions at both ends to accommodate filling and the actual burn
- Threaded Holes with male to male fittings
- Limited Tubing

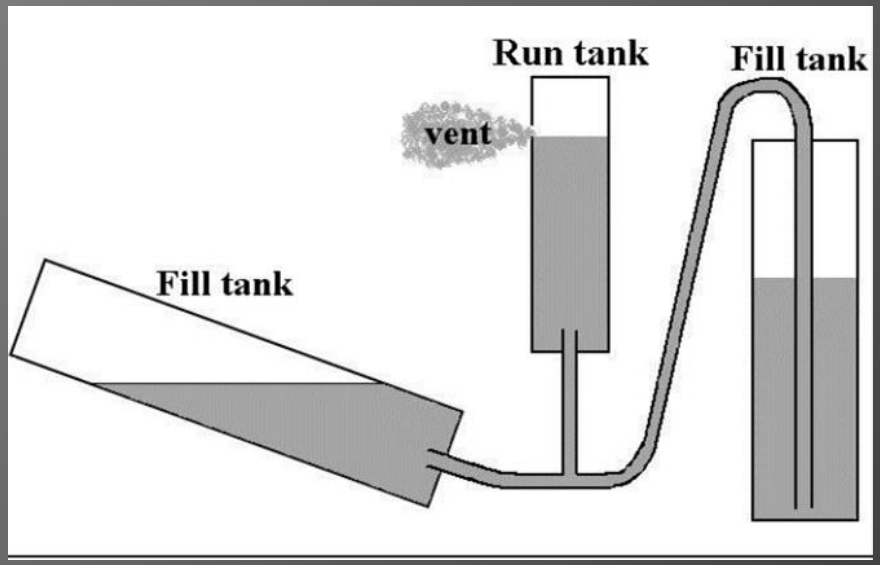


Filling The Oxidizer Tank

- Bulk Nitrous Oxide comes from WSU
  - 60 lb tank - $110 for Testing
- Nitrous Available for Purchase at IREC
- Fill Process
  - Two Processes - Gravity Feed or Vent Feed
  - Gravity Feed involves lifting fill tank above run tank
    - Gravity forces Nitrous Into Run Tank
    - Vapor travels up fill line into fill tank which pushes more oxidizer into Run Tank
    - Major Problem: Fill Tank is heavy and might not be able to be lifted above rocket
    - Problem: No way to consistently measure amount in run tank



Filling The Oxidizer Tank



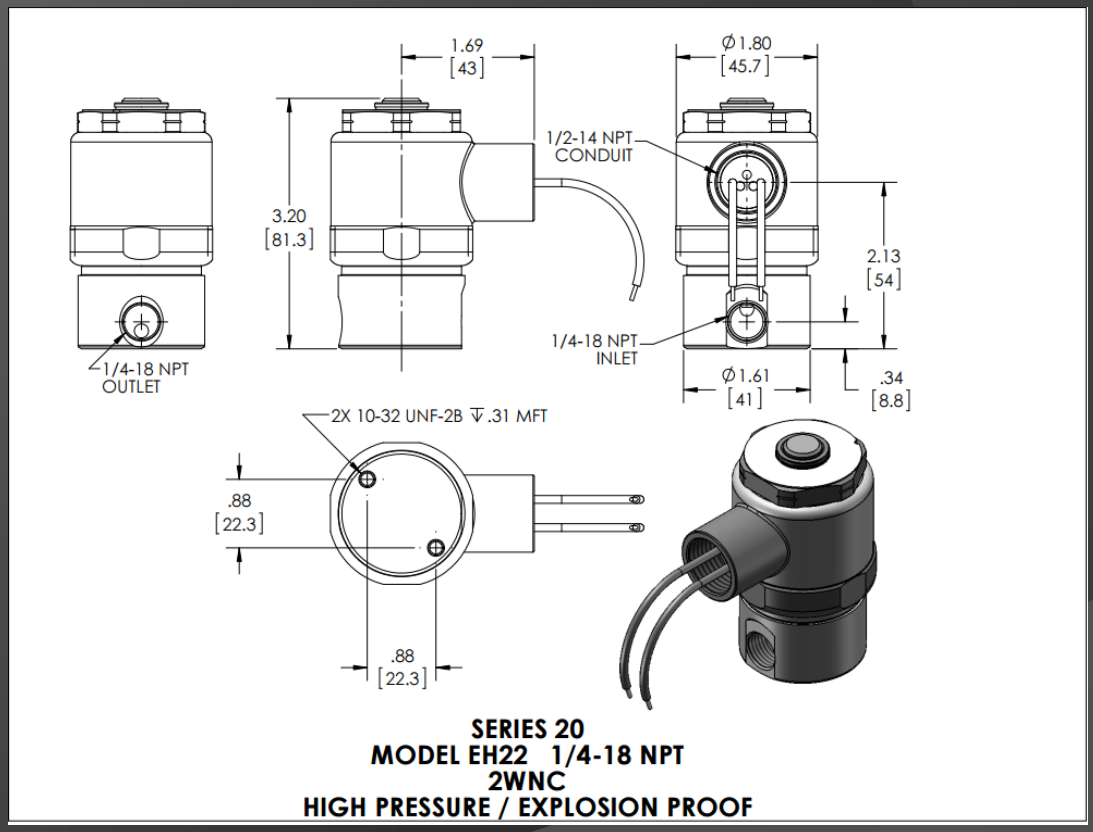
- Vent Feed
  - With an open vent in run tank, there is a pressure difference between run tank and fill tank
  - Oxidizer flows from high pressure fill tank and atmospheric pressurized run tank
  - Vapor is vented through hole
  - When liquid reaches vent, escaping vapor thickens and whitens visibly.
  - Vent is closed, fill is stopped, and run tank is allowed to pressurize
  - Rocket is launched once pressure is reached.

2 Way Valve

PeterPaul Serial Number:
EH22G9DCCM-E DC

- Material: Stainless Steel
- Cost: About $120

- Voltage: 1.8 to 265V DC
- Nominal Power: DC — 9.5 Watts
- Response TIme: 4 – 16 ms
- Weight: 1.13 lb
- Primary Orifice Size: ⅛ (Customizable)
- Body Port Size: ¼ NPT
- Operating Pressure: 3000 psi max
- Burst Pressure: 5000 psi



Battery Pack 4000mAh 7S 25C Lipo

- Cost: $57.16

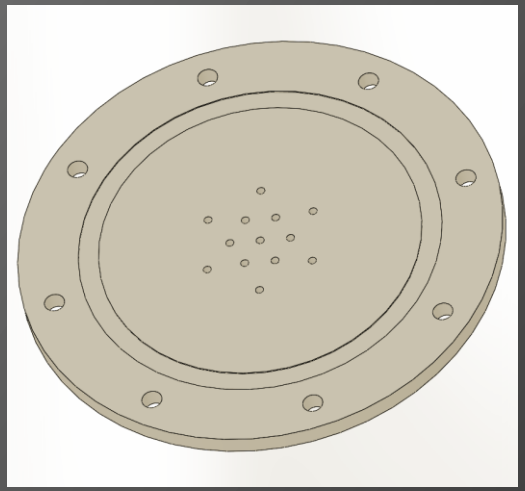
- Powers the valve
- Capacity: 4000mAh
- Voltage: 7S1P / 7 Cell / 25.9V
- Dimensions: 148x44x46mm
- Weight: 645g
- Might use lower cell Battery
- Expensive but we only need one

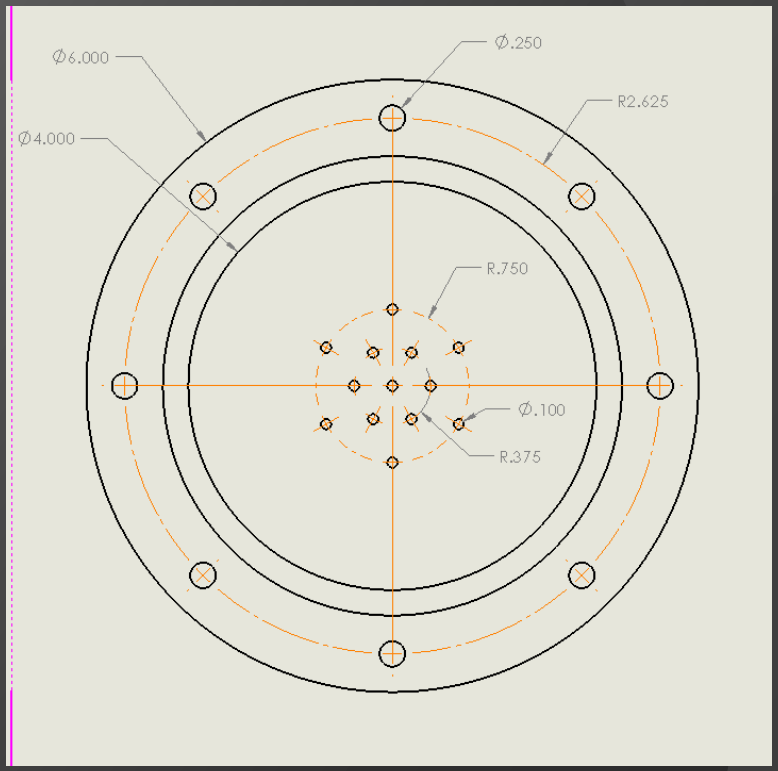
http://www.hobbyking.com/hobbyking/store/__33200__ZIPPY_Compact_4000mAh_7S_25C_Lipo_Pack_US_Warehouse_.html

Injector Plate

- Material: Aluminum 6061-T6
- Manufacturing: CNC Mill
- Cost: $8

- Showerhead-style 1/4” thick copper injector plate
  - Minimal weight
  - Easily optimized flow
- 13 Hole Pattern
  - At .75” and 1.5” circles
- 0.0625” hole diameter
  - compromise between atomization and avoidance of cavitation

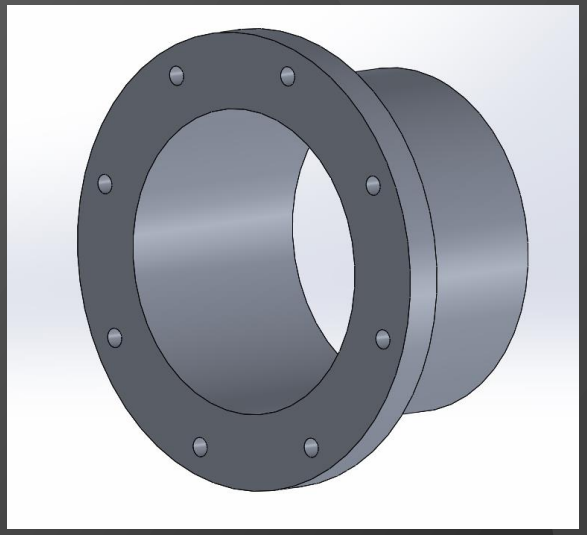


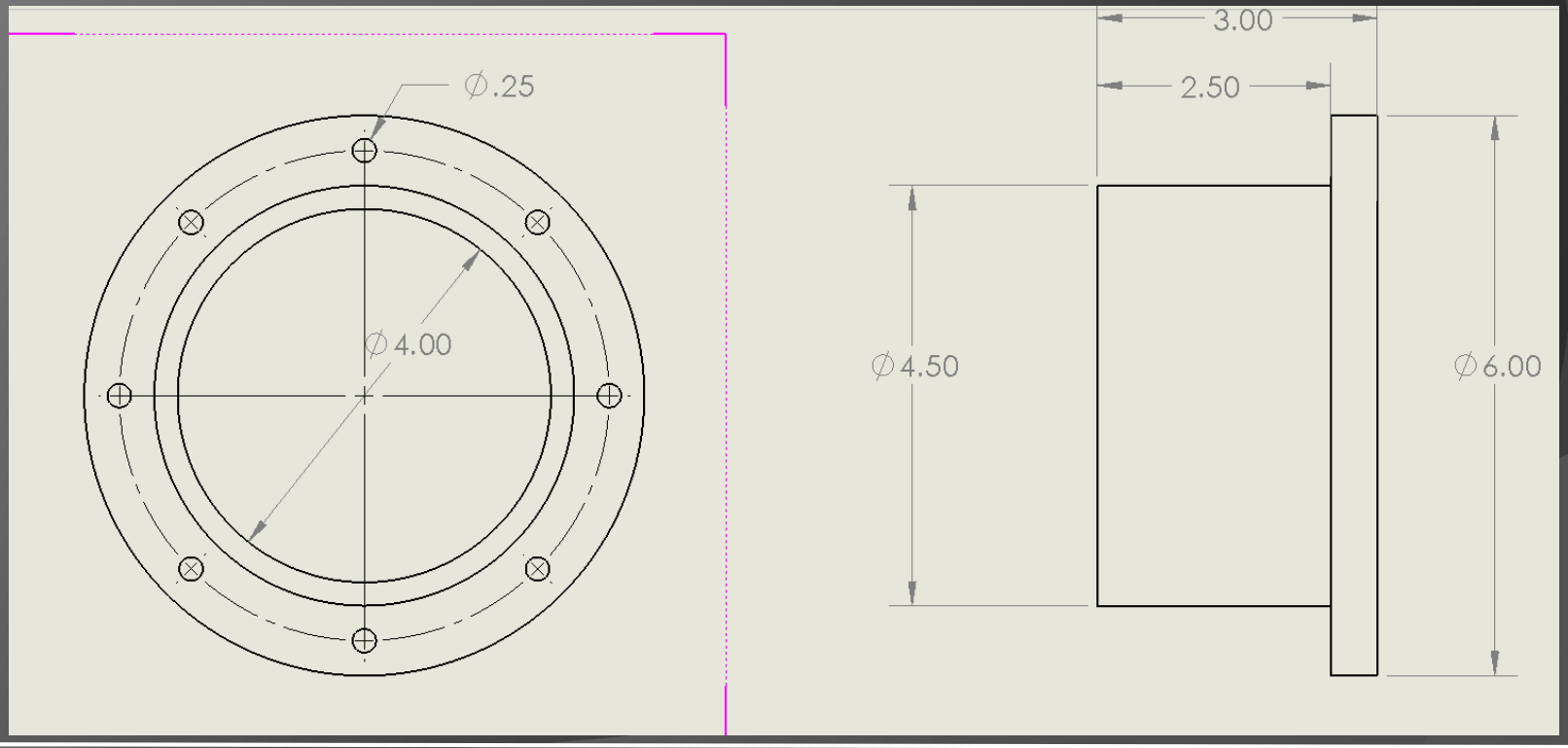


Coupler

- Material: Aluminum 6061 T6 (Bar Stock milled and lathed)
- Manufacturing: CNC Mill / Lathe
- Cost: $273 / 2’

- 8X (12X if weak) .25” Thru Holes for Bolts
- Slip fit over the tube in addition to silver solder/weld to secure





O-rings

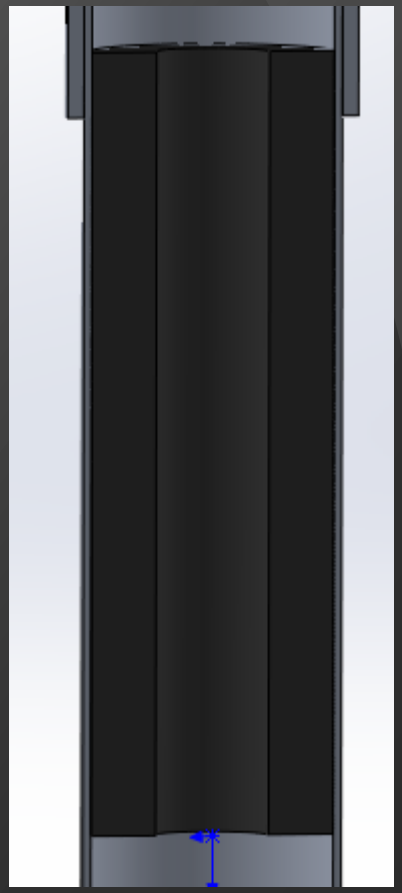
- Face Seals
- Square Cross Section
- 4 inch ID, ⅛ inch thickness
- Each vendor is fairly inexpensive (comparatively)

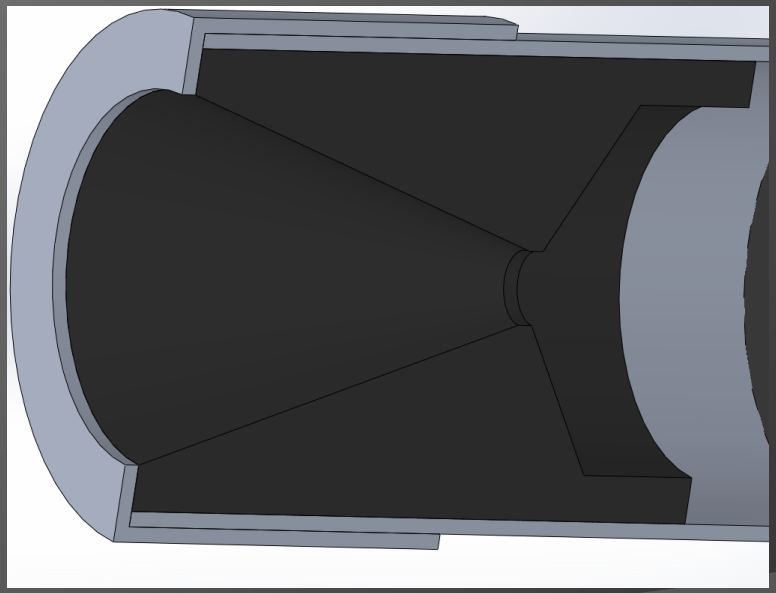
- Material: Viton
  - 242 V90 (4 ID X 4-1/4 OD X 1/8 W)
    - Cost: $1.44
  - 242 V75 (4 ID X 4-1/4 OD X 1/8 W)
    - Cost: $1.16
  - Fluorocarbon 75 Durometer O-Ring, Low & High Temperature (VM835-75)
- Material: Silicone
  - 242 S70 (4 ID X 4-1/4 OD X 1/8 W)
    - Cost: $0.46
- Vendors
  - hitchseals.com
  - oringsusa.com
  - anchorrubber.com
  - parker.com

Combustion Chamber

- Material: 6061-T6 Aluminum Alloy Tube
- Manufacturing Method: Saw / Mill / Welding
- Cost: $56 / 4’

- OD: 4”
- ID: 3.75”
- Length: Approx. 20 inches
- Coupler with a face seal O-Ring (Parker)
- Top End (Near Injector Plate) Silver Solder/Welded
- Bottom End (Near Nozzle) is threaded to screw on “End Cap”

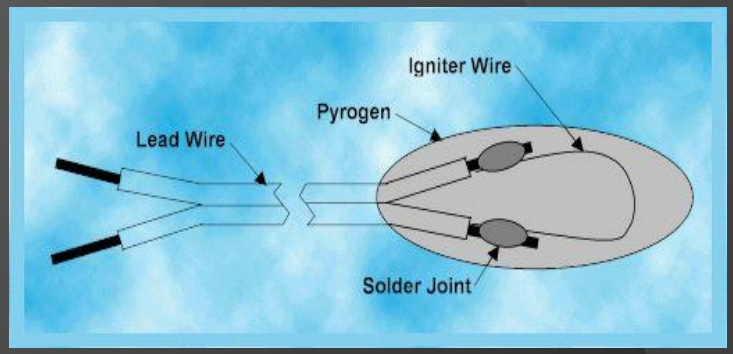




Igniter

E-Match

- Material: Wire and Pyrogen
- Manufacturing Method: Buying
- Cost: ~$12 / 3 pack

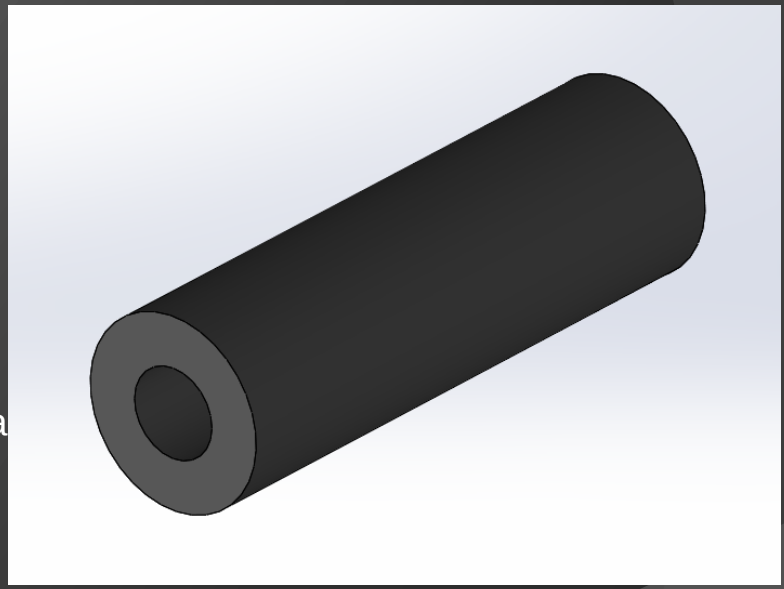


- Use some from Solids Group?
- 1 or 2 in the Post Combustion Chamber

Fuel Grain

- Material: HTPB, HPTB/Paraffin Mixture, Nylon
- Manufacturing Method: Casting in Phenolic Tubes
- Cost: Varies ($40 - $70)

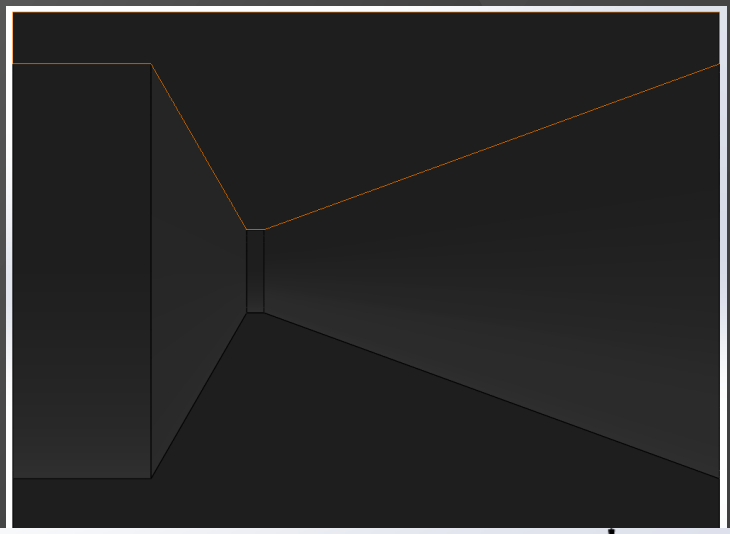
- OD: Slightly less than 3.75”
- ID: 1.75”
- Length: 12”
- Planned Around HTPB
- Will test HTPB, HTPB/Paraffin Mix, Nylon
- Can scale down the size once we have a better idea of how the fuel will burn
- Will cast within a sleeve that will slide into combustion chamber

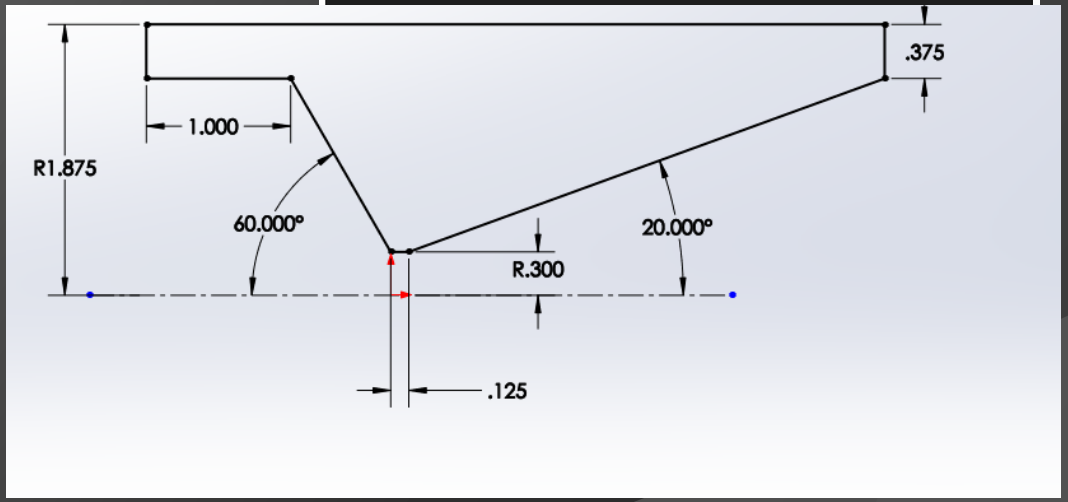


Nozzle

- Material: Graphite
- Manufacturing Method: CNC Mill/Lathe from Rod Stock
- Cost: Approx. $25/Nozzle

- Conical shape for design/machining simplicity
- Losses from Conical shape not significant for our purposes
- Tenting the CNC machine
- Respirators will be required
- Throat Diameter (currently .6”) will be dialed in after testing





Body/Insulation

- Fiberglass (Or other lightweight) body
- Wrap around a 6 inch Cardboard tube to cast (or buy)
- Screws into the coupler pieces
- Should not need a lot of force to stay on
- Should be lightweight (Thin shell)

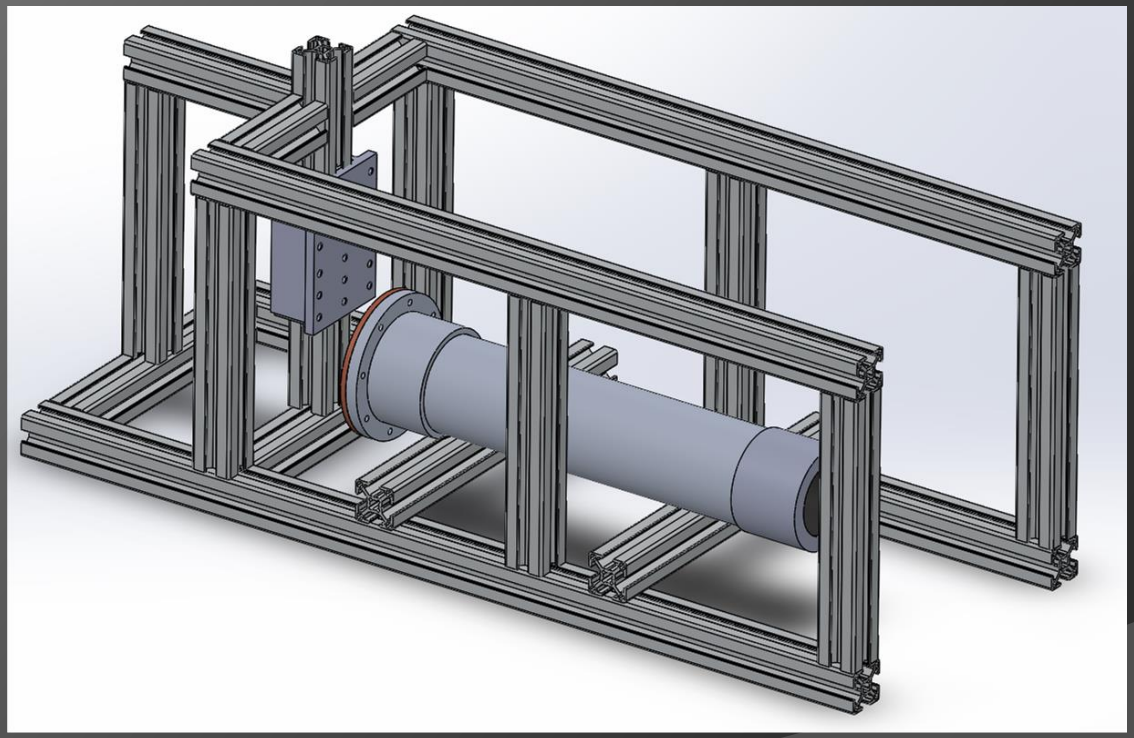
Bill Of Materials

- Total weight right now: about 60-70 lbs
- Total Cost (so far): $1318.60
- Well Under Budget so far

Component	Sub	Description	Qty	$/pc	Total
Nose Cone	Nose Cone	3D printed	1	40	40
Propellant	Nitrous Dioxide	60 lb tank from WSU	1	110	110
Propellant	HTPB	1 gallon Jug	3	69.99	209.97
Propellant	Nylon	3.75" OD 24" Length	1	130.76	130.76
Oxidizer Tank	Bullk Head Top	OD 6" Length 3" 6061	1	Bulk	0
Oxidizer Tank	Casing	4 OD x .125 wall x 3.75 ID 6061	1	56.16	56.16
Oxidizer Tank	Bulk Head Bottom	OD 6" Length 4.5"	1	Bulk	0
Nozzle	Nozzle	4" OD 20" Long	1	75.37	75.37
Injector	Plate	Aluminum Plate 6"X6"X1/4"	1	8.39	8.39
Combustion	Bulkhead	OD 6" Length 3" 6061	2	Bulk	0
Combustion	Casing	4 OD x .125 wall x 3.75 ID 6061	2	56.16	112.32
Outer Shell	Outershell	6" OD 5.75" ID 6ft Length	1	183.28	183.28
Valve	Valve	2 way norm closed, steel	1	119.51	119.51
End Cap	End Cap	OD 4.25" ID 3" Length 3"	1	Bulk	0
Bulk		6" OD 24" length 6061	1	272.79	272.79
					TOTAL
					1318.6

Testing

- Test Stand is Almost Finalized
  - Length of Bosch =
  - Waiting for Budget Approval from 406
- Propellant Material Purchase Order by 03/13
- Casting of Propellants after Spring Break
- Safety Test Procedure Submitted by 03/13



Additional Work

- Design Fins (Likely will attach to the outer body)
- Recovery system housing/weight
- Recovery System Attachment
- Method of Securing the Fuel Grain
- Figure out valve/vent/pressure relief placement
- Purchase ball valves and pressure relief valve
- Establishment of Burn Time
  - Get the Burn Time/Average Mass flow
  - Tweak Nozzle throat diameter to reach desired height