



DIY Hybrid Rocket Motor

Sai Wai Phyo
Singapore Polytechnic

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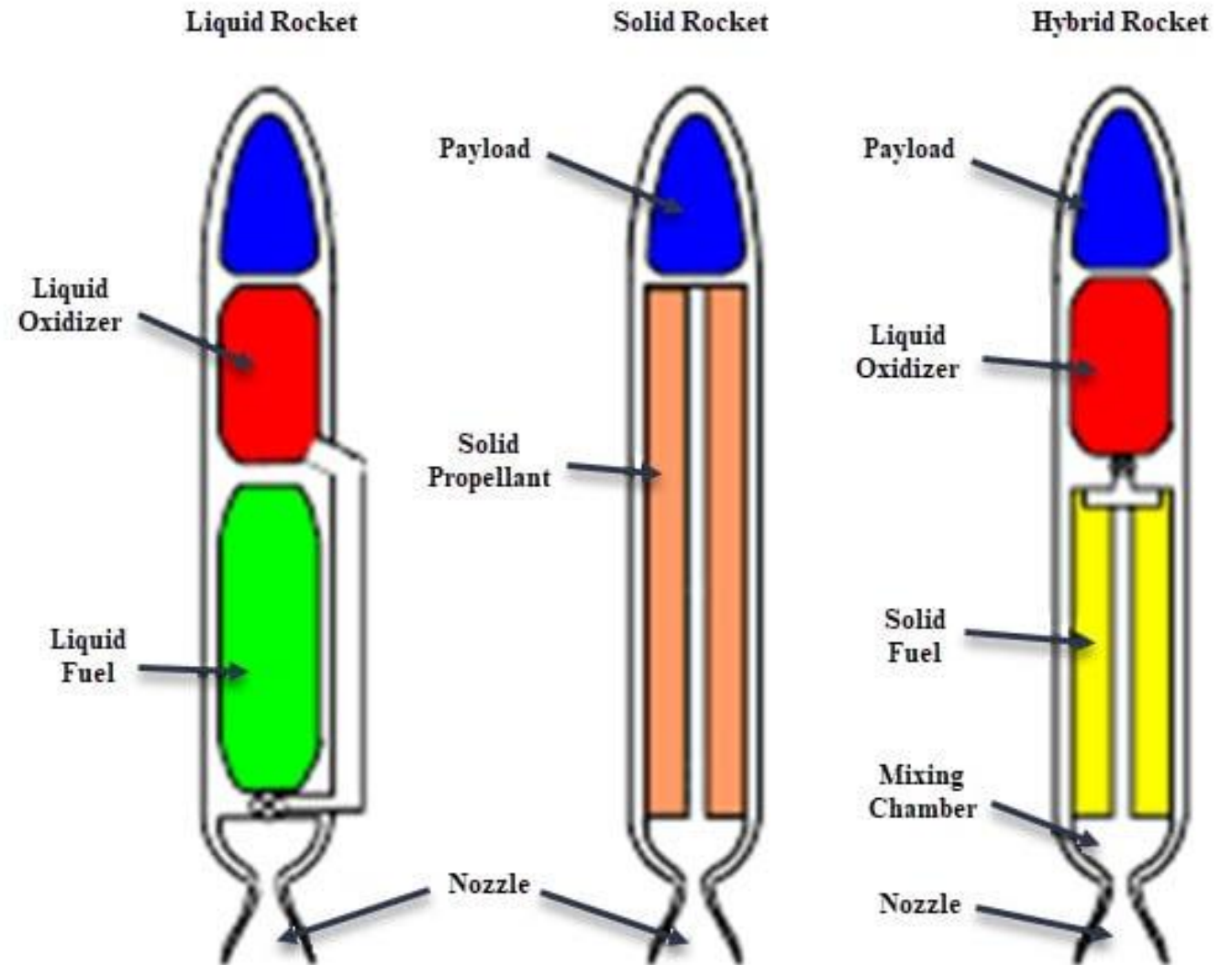
Nozzle Design

Ground Support
Equipment(GSE)

Local Manufacturing

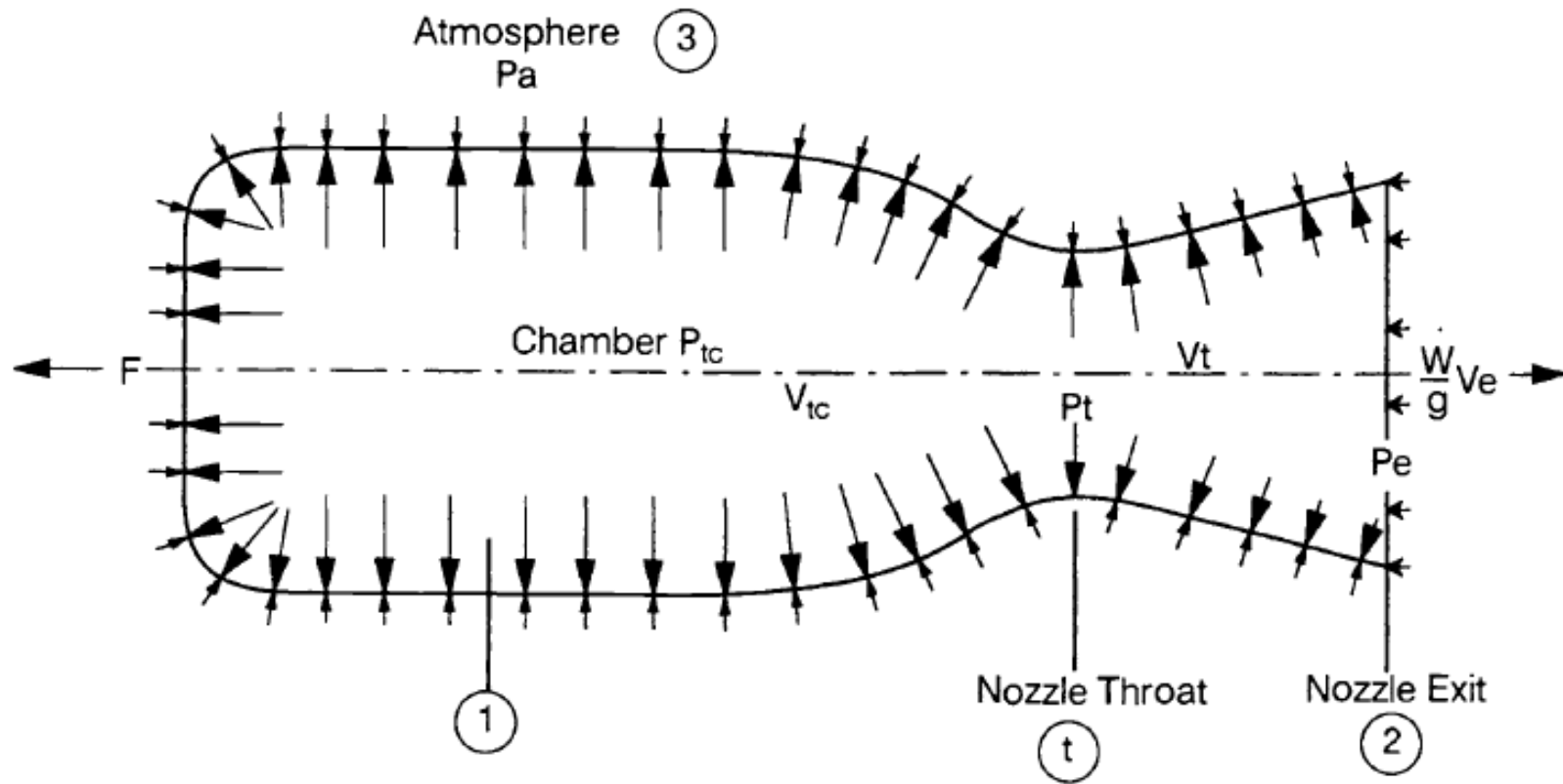
Cost Breakdown

Types of Rocket Motors



<https://www.google.com/url?sa=i&url=https%3A%2F%2Faerospacenotes.com%2Fpropulsion-2%2F&psig=AOvVaw2PjSOqBu9Aasi0uCZVTczM&ust=1634196912260000&source=images&cd=vfe&ved=0CAYQjRxqFwoTCODymobwxvMCFQAAAAAdAAAAABAD>

Nozzle



Huzel, Dieter K._ Huang, David H. - Modern Engineering for Design of Liquid-Propellant Rocket Engines-American Institute of Aeronautics and Astronautics (1992)

Typical Design Process

Performance Parameters



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graph TD; A[Performance Parameters] --> B[NASA CEA]; B --> C[Rocket Propulsion Analysis(RPA)]; C --> D[CAD];
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The diagram illustrates a four-step design process. It begins with 'Performance Parameters' in an orange box, followed by 'NASA CEA' in a reddish-brown box, then 'Rocket Propulsion Analysis(RPA)' in a darker brown box, and finally 'CAD' in a grey box. Each step is connected to the next by a downward-pointing arrow, indicating a sequential flow. The boxes are staggered to the right, creating a descending staircase effect.

NASA CEA

Rocket Propulsion Analysis(RPA)

CAD

Practical Performance Parameters

Propellant

Chamber Pressure

Thrust

Size

Propellant

- Solids:
 - Ammonium Perchlorate, Potassium Nitrate (stump remover) is unobtainable in SG.
- Hybrids
 - 3D printed Plastic Fuel (PLA or ABS)
 - “Simple”
- Liquids
 - Complex
 - Expensive

Chamber Pressure(Pc)

- Restricted by Plumbing
- Higher Pc=Higher Specific Impulse** but Higher cost
- Oxygen: 115psi (\$30 WKS Gas)
- Nitrous Oxide: 650psi-700psi
- I used a \$25 Oxygen Regulator made for Welding





Thrust

- Limited by the Facilities you have
- Rocket requirements, e.g Amount of Impulse needed

$$\text{Impulse(Ns)} = \text{Thrust(N)} * \text{time}$$





Size

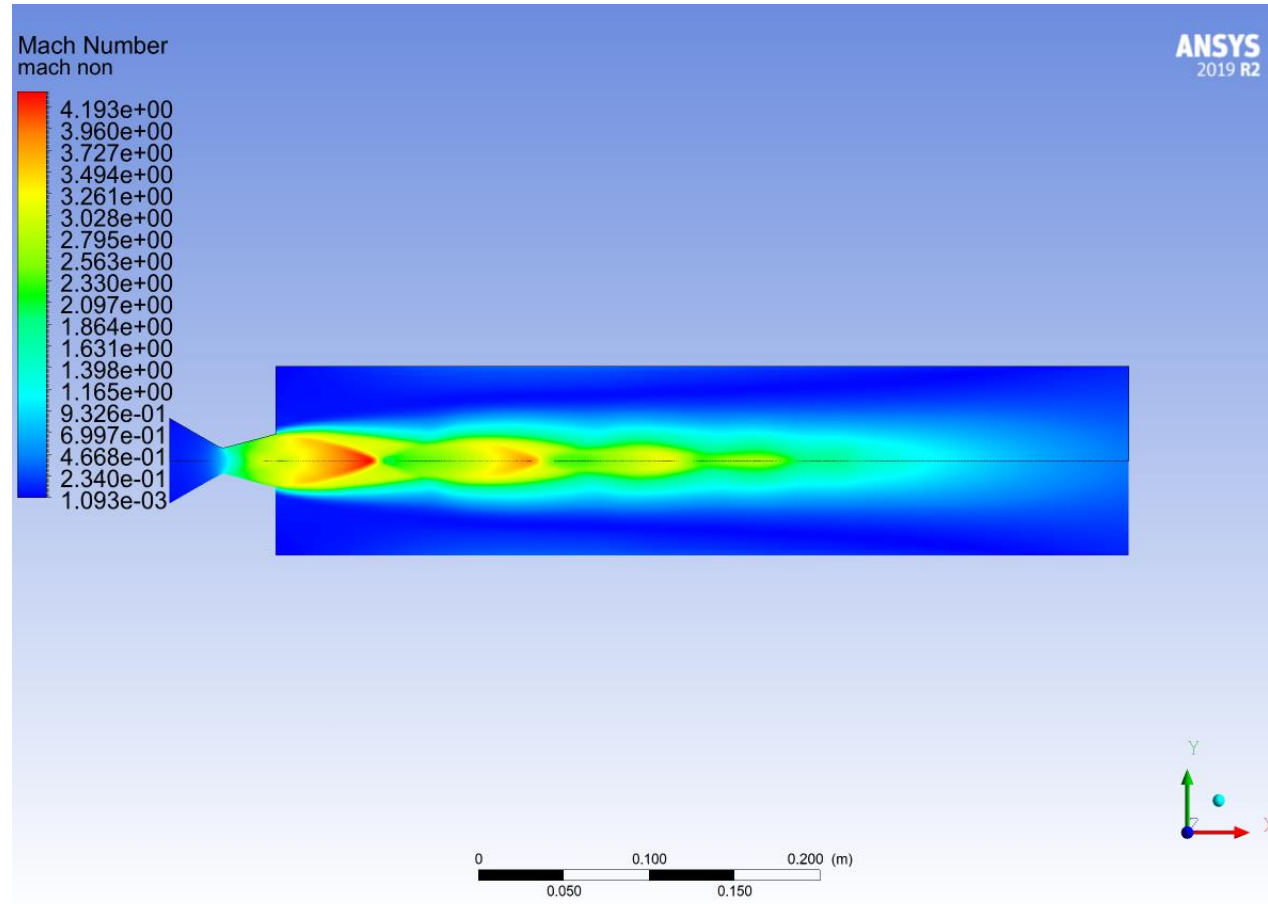
- “Amateur Standard Sizes” are fine
- 38mm, 54mm, 75mm , 98mm

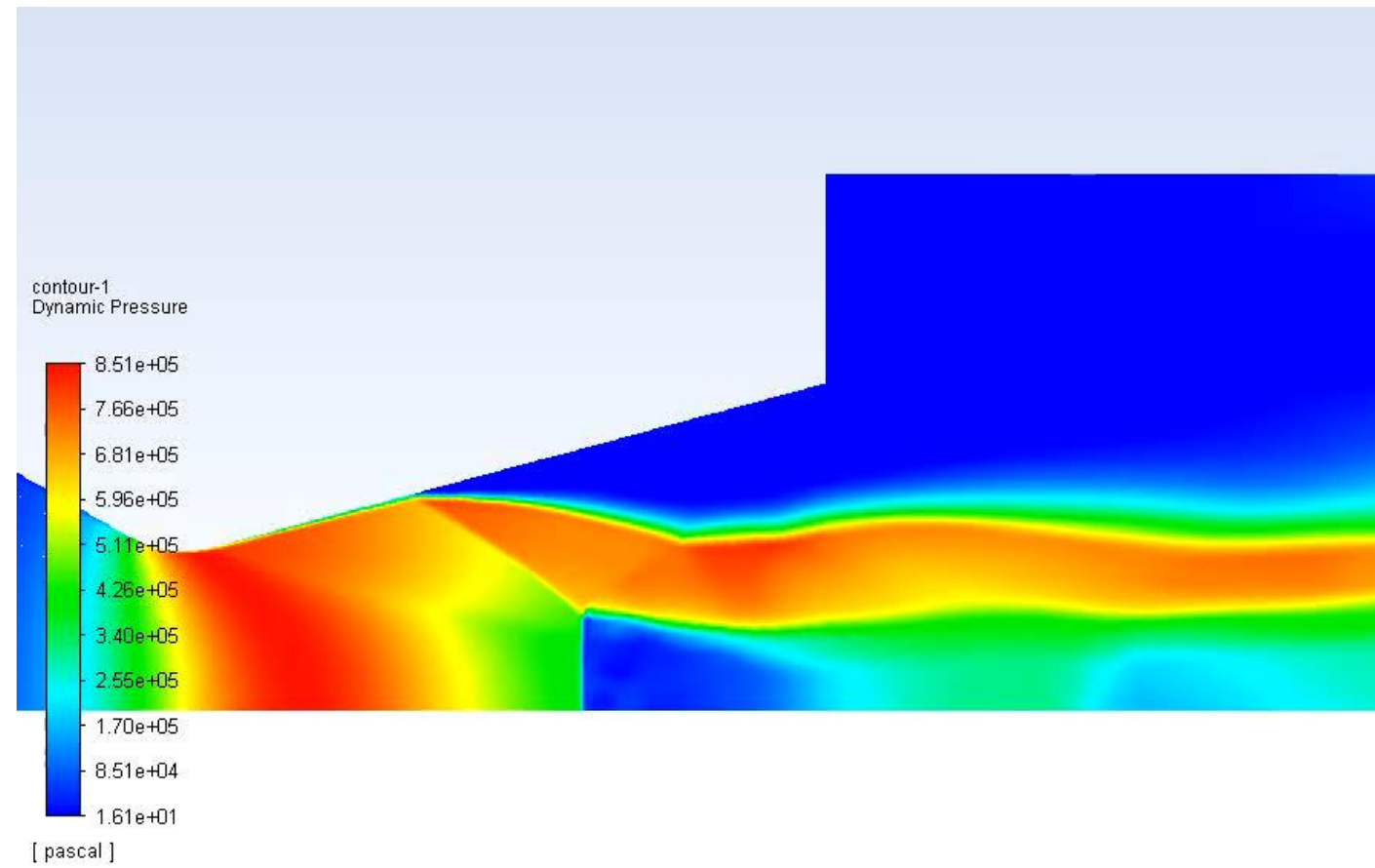


RPA demonstration

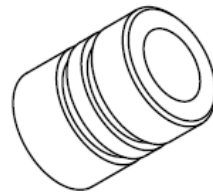
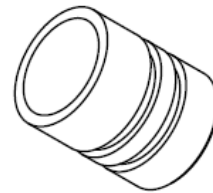
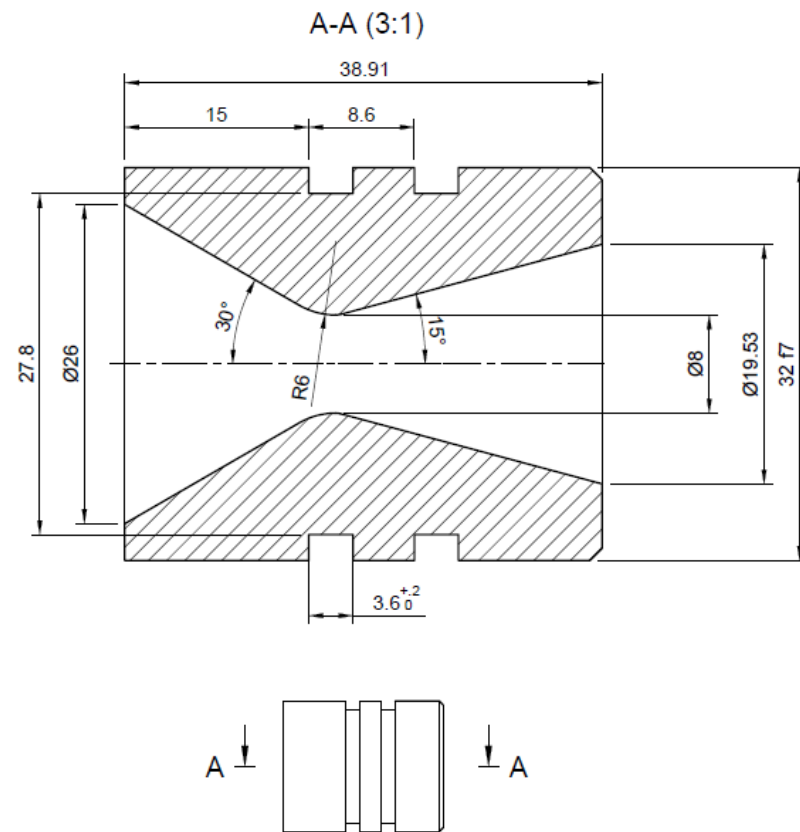


Optional: CFD verification





CAD



Cost Breakdown

- Nozzle: \$98 SGD

Material: Mild steel

Manufacturer: Factorem

- Alternatives:

Graphite Nozzle

Cost: \$7.50 each

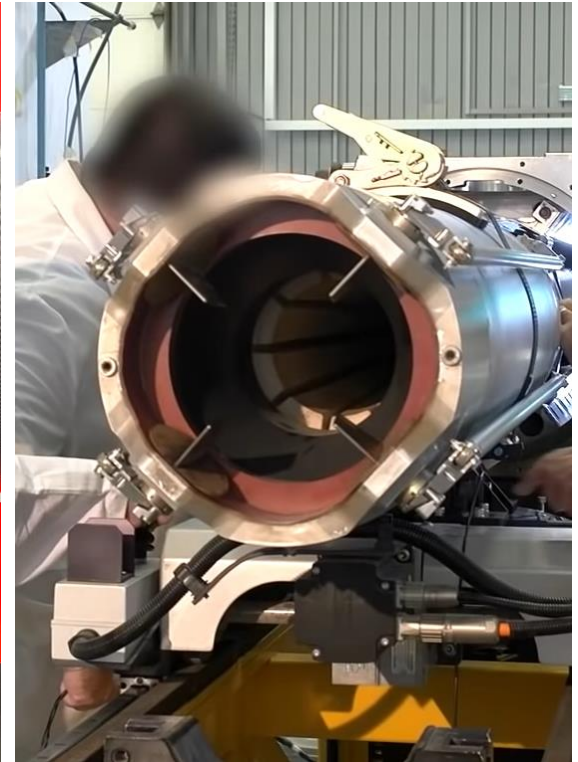
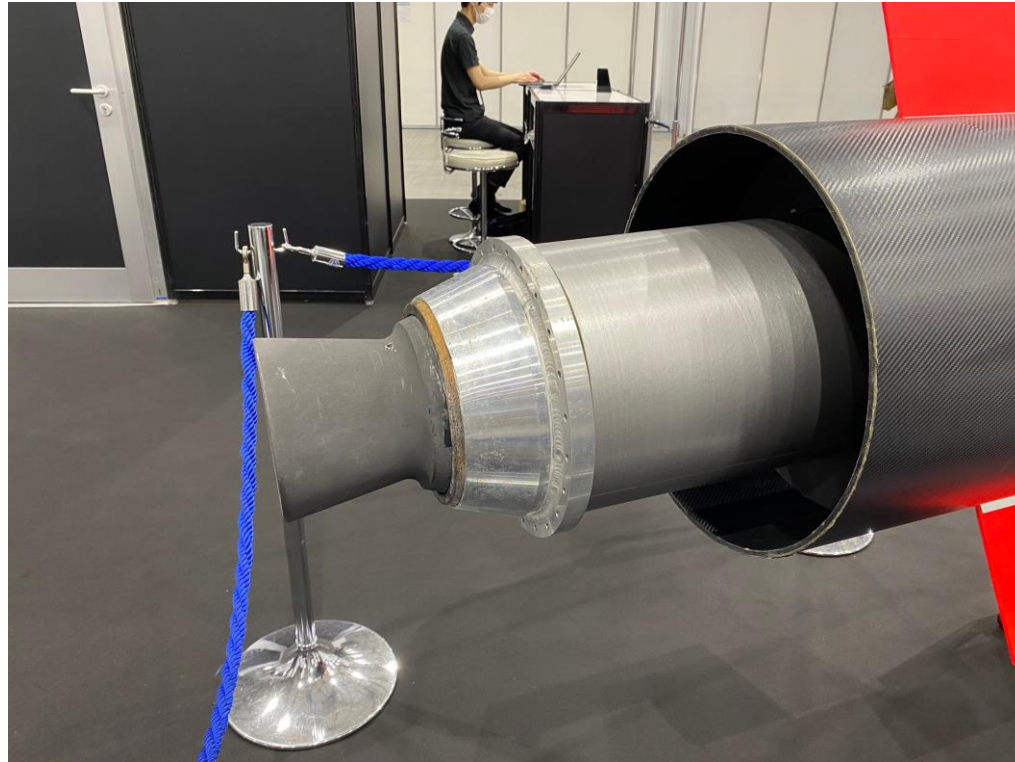
MOQ:10

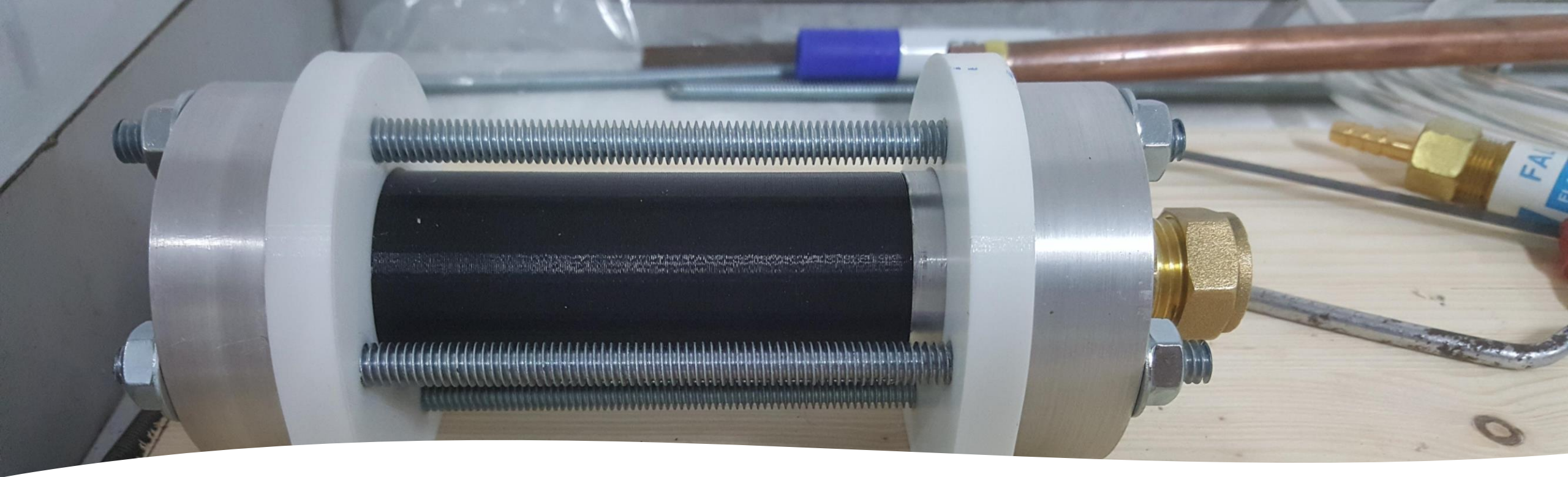
Total cost:\$130 USD

Manufacturer: Yunpeng Graphite Alibaba



Graphite Nozzles





- Aluminum Bulkheads: \$70 [factorem]
- ½ in NPT fitting+Ball valve: \$20 [Eng Guan]
- Studs and nuts: ~\$10 [Hong Feng hardware Toh guan]
- 3D printed fixtures: \$15 [3D print Singapore]
- PLA fuel: \$30 (100% infil) [3D print Singapore]
- Wooden base: ~\$35 [selfix singapore]
- FFKM o rings: \$12.92 [RS components]
- Copper tubing: \$30 [Eng Guan Hardware](I would recommend Teck Siong Huat)

Additional recommendations

- 200 bar 12VDC Solenoid Valve: COVNA HKKB (Alibaba) ~60USD
- Phenolic Tubing for combustion chamber insulation(Bakelite): ZTELEC (Alibaba)



- TOTAL COST: \$350

Set up



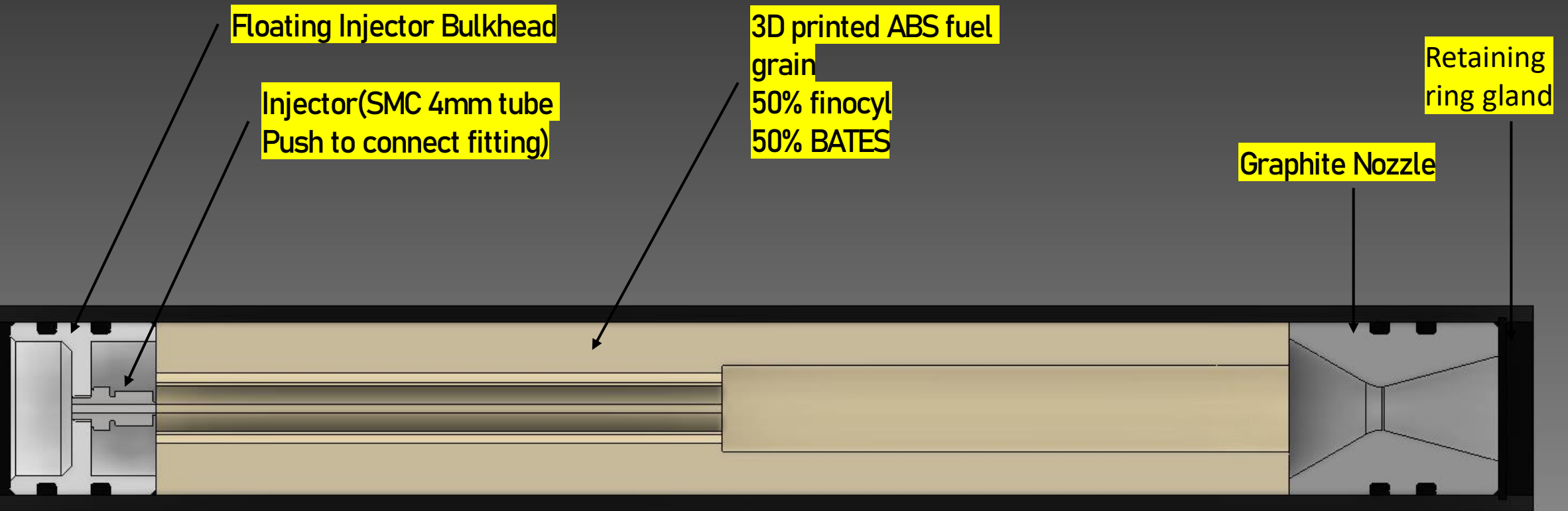
Fire!





Post fire pics

Want it to fly?



Total Impulse: ~800Ns

Propellant: Nitrous Oxide/ABS

Throat Diameter: 8mm

Ignition system: Non-Pyro U/C valve(GOx)

Nozzle Design Resource

- Chapter 1, Huzel, Dieter K._ Huang, David H. - Modern Engineering for Design of Liquid-Propellant Rocket Engines-American Institute of Aeronautics and Astronautics (1992)

Hybrid Rocket Propellant Sources

Heat of formation of ABS: -62.63 kJ/g/mol

Source: <https://doi.org/10.2514/1.B37957>

Heat of formation of PLA: -302.2kJ/g/mol

Source: <https://doi.org/10.2514/1.B37957>