CSA – Completely Safe Airdrop

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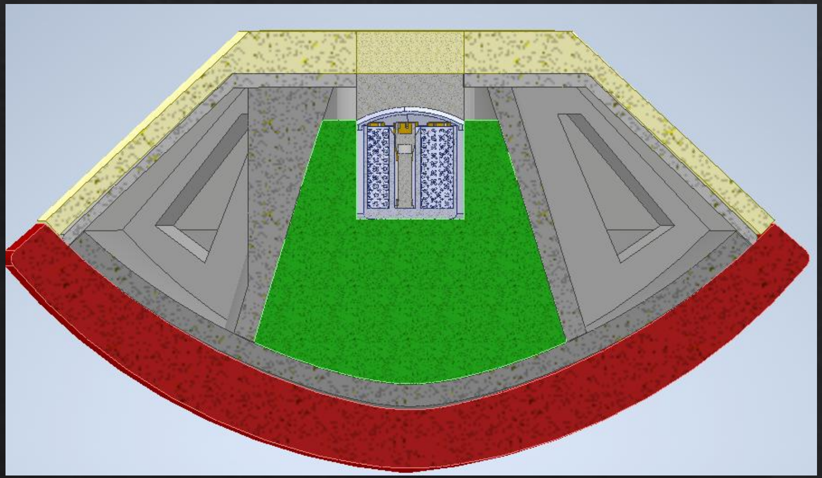
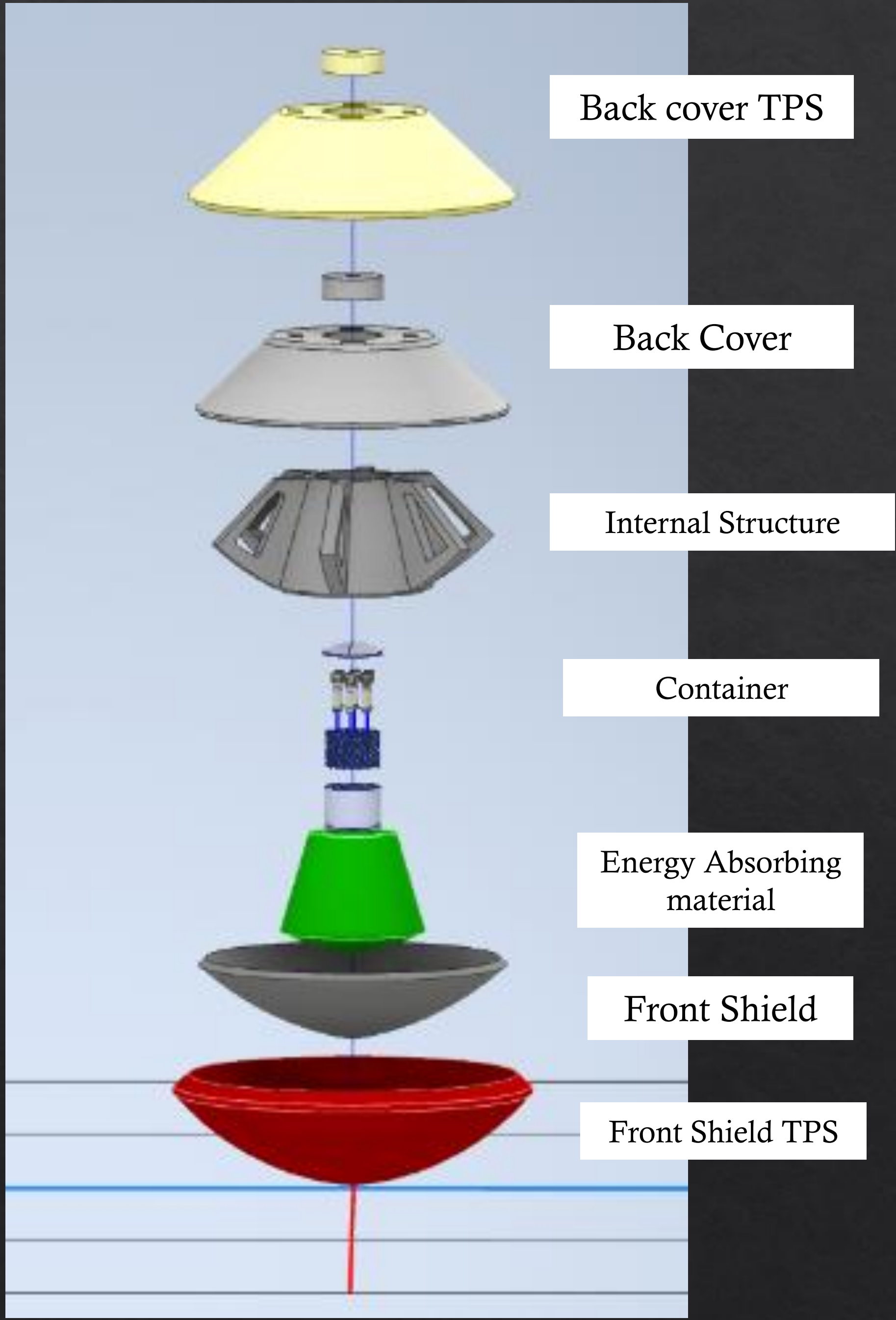
Problem Interpretation

- Sample Tube is mission critical
- No contamination or damage allowed
- Impact energy absorbed passively

Concept Design

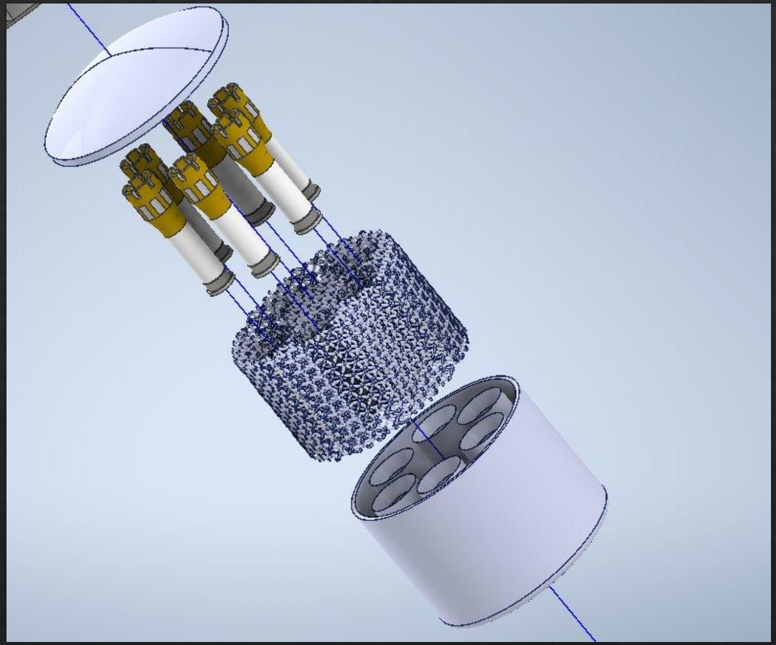
- **Energy absorbing material:**Ti-64, body centered cubic lattice architecture
  (why industry standard Al-5052 honeycomb core?)
- **Container:** Al-6061 Alloy, Ceramic and Aerogel Layered
- **Front shield TPS:** Phenolic-impregnated carbon ablator
- **Back cover TPS:** SLA-561V (Silicone low-density ablator)
  Front shield & Back Cover: Ti64
- Internal structure: Al-2219

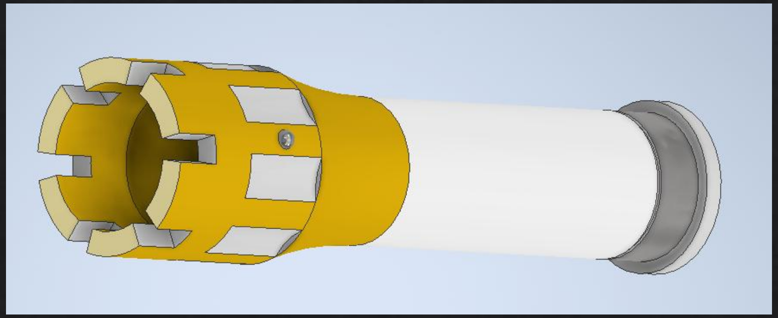




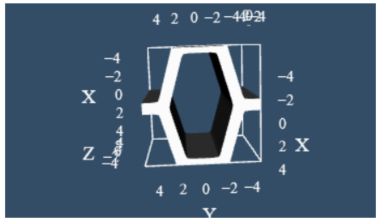
Concept Design

- Tubes are made out Titanium Nitride Coating to resist contamination
- Hermetic Seal at the bottom to protect the inside and avoiding the outside
- Ball lock (springer/plunger) on the top for helping the robots/recovery team grab the samples
- We also used body centered cubic lattice mesh for extra support inside the container

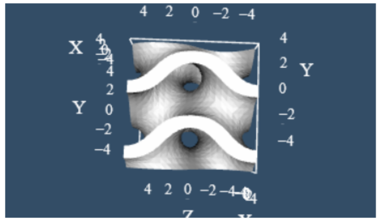




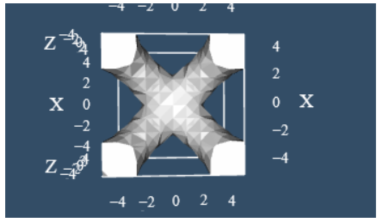
Lattice Research & Comparison



QOI	Value
Unitcell	Hexagonal honeycomb
Relative density	0.262
Rel. elastic modulus in direction X	0.0849
Rel. elastic modulus in direction Y	0.0116
Rel. elastic modulus in direction Z	0.262



QOI	Value
Unitcell	Gyroid
Relative density	0.292
Rel. elastic modulus in direction X	0.115
Rel. elastic modulus in direction Y	0.115
Rel. elastic modulus in direction Z	0.115
Min rel. elastic modulus	0.103 ±



QOI	Value
Unitcell	Body centered cubic
Relative density	0.36
Rel. elastic modulus in direction X	0.146
Rel. elastic modulus in direction Y	0.146
Rel. elastic modulus in direction Z	0.146

Max stress amplification: x	24.6 ± 8.34
Max stress amplification: y	113
Max stress amplification: z	4.02
Max stress amplification: xy	51 ± 45.7
Max stress amplification: yz	21.5
Max stress amplification: xz	10.5
Anisotropy index	13
Rel. thermal conductance in direction X	0.198
Rel. thermal conductance in direction Y	0.0926
Rel. thermal conductance in direction Z	0.262
Max rel. thermal conductance	0.262
Min rel. thermal conductance	0.092

Max stress amplification: x	19
Max stress amplification: y	18.7
Max stress amplification: z	18.3
Max stress amplification: xy	15.1
Max stress amplification: yz	16.2
Max stress amplification: xz	15.4
Anisotropy index	0.0487 ± 0.0462
Rel. thermal conductance in direction X	0.203
Rel. thermal conductance in direction Y	0.203
Rel. thermal conductance in direction Z	0.203
Max rel. thermal conductance	0.21

Max rel. Poisson's ratio	0.434 ± 0.546
Max stress amplification: x	17.1 ± 10.8
Max stress amplification: y	16.7 ± 10.7
Max stress amplification: z	16.7 ± 10.6
Max stress amplification: xy	14.3 ± 4.32
Max stress amplification: yz	15.7 ± 4.76
Max stress amplification: xz	14.3 ± 4.36
Anisotropy index	0.204 ± 0.199
Rel. thermal conductance in direction X	0.251
Rel. thermal conductance in direction Y	0.251
Rel. thermal conductance in direction Z	0.251
Max rel. thermal conductance	0.253

Manufacturing: Powder Bed Fusion

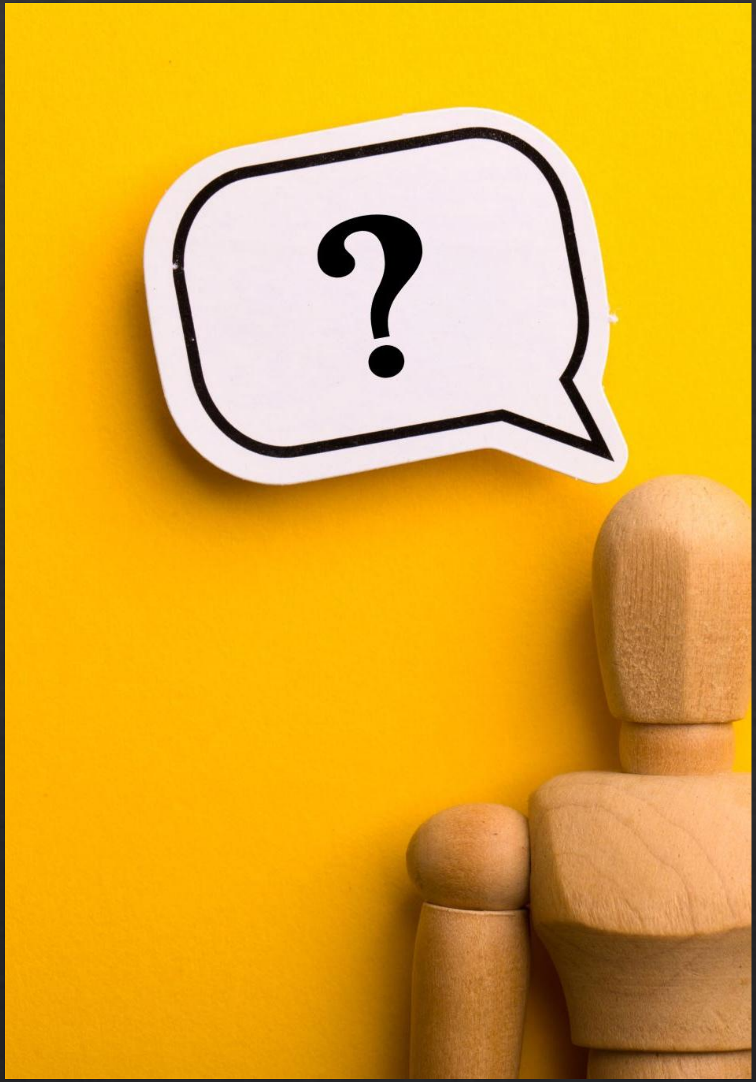
- Additive manufacturing process that builds parts layer by layer using metal or polymer powder.
- A laser or electron beam selectively melts the powder to solidify each layer.
- Produces highly detailed, near-net-shape components.
- Materials Commonly Used **: Titanium alloys , Aluminum alloys**

Net Based Capture Concept

- Inspired by Luke Aikins parachute free net landing
- Longer stopping distance --> lower G loads
- TPS ablates during re-entry
- Drag plates deploy after TPS ablation
- Capsule is captured by a Kevlar net
- Net deforms to absorb energy and allow cooling

Why This Design is a Completely Safe Approach

- Scientifically proved materials that are applicable for high impact resistance
- Tube remains sealed even if capsule fail
- Multilayered enclosures to reinforce tube protection
- Cost efficient lattice design that help absorb vibrations



Thank you for listening!!
Questions??