Open Source Development of Advanced Vacuum Testing Infrastructure for Space Hardware: Micro-TVAC and EXEDA

Applied Ion Systems

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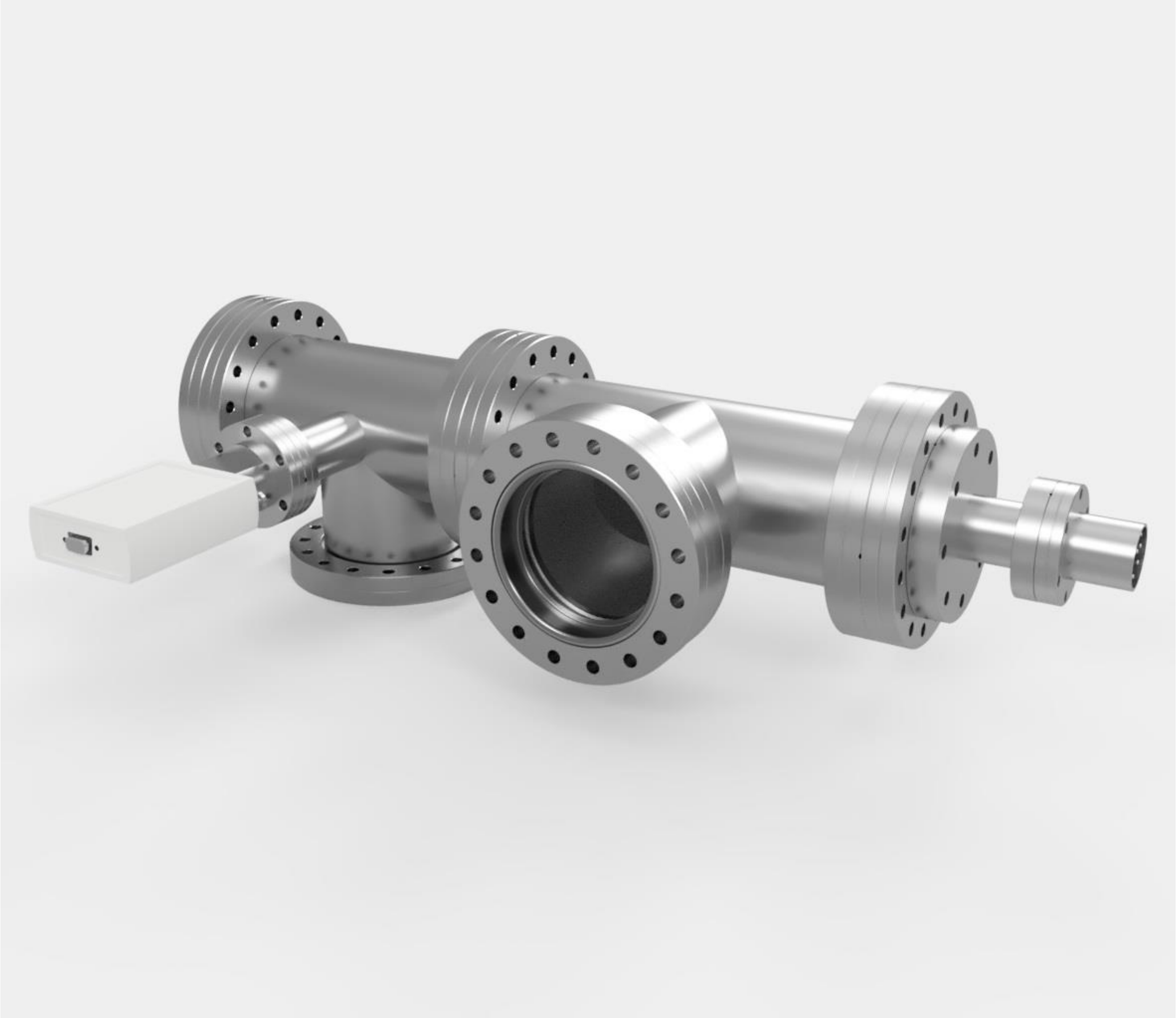
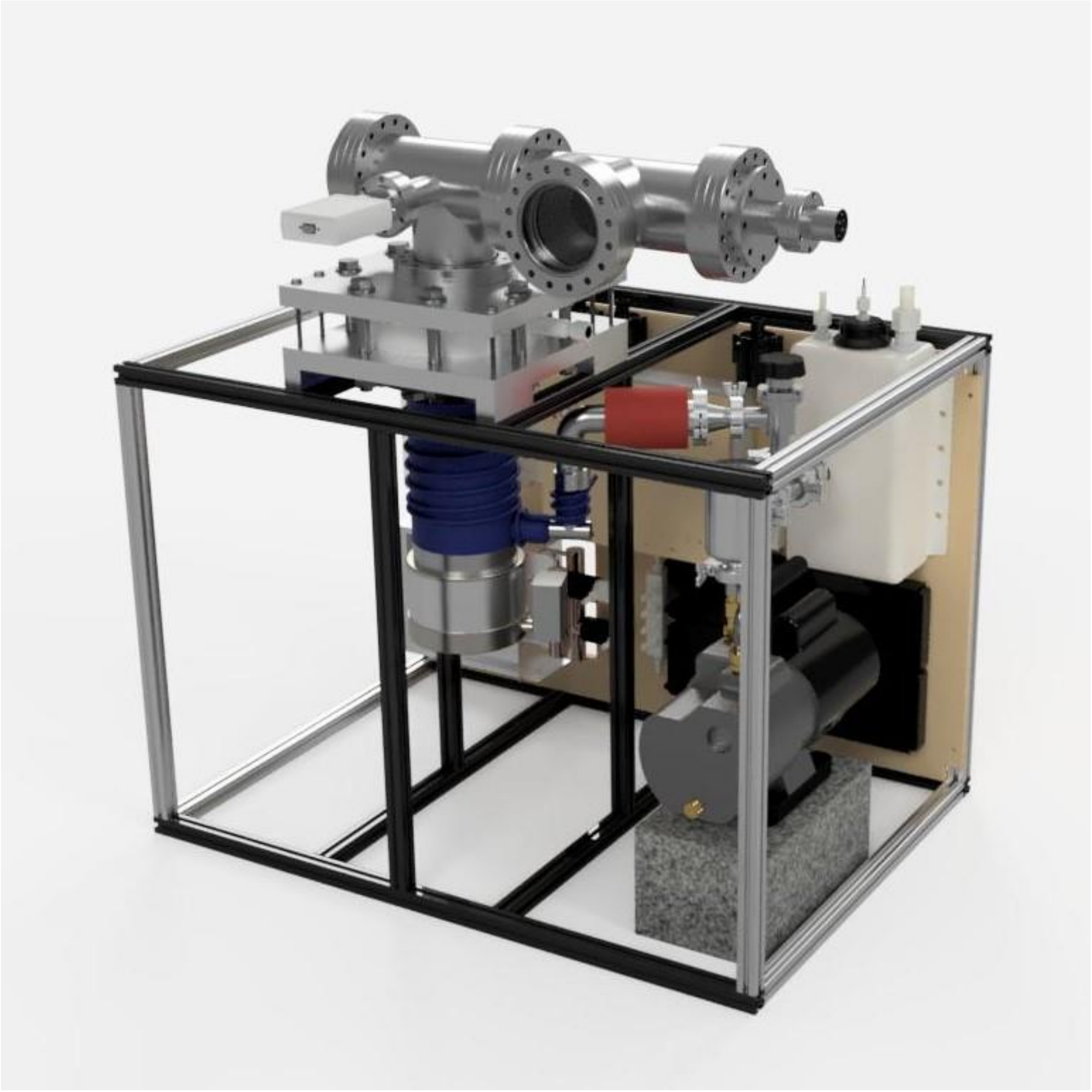
OVERVIEW

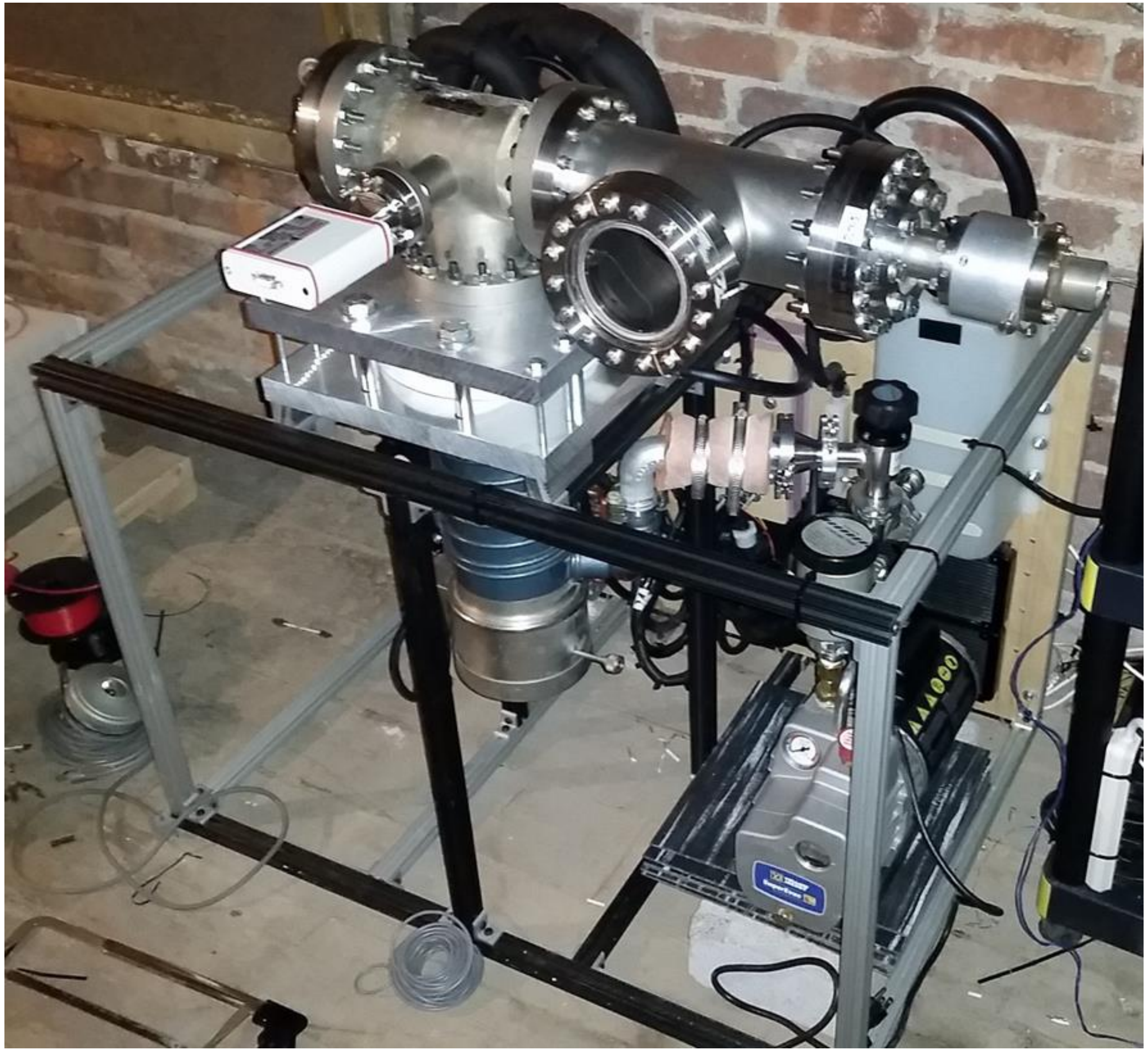
- Advanced high vacuum testing infrastructure for space applications is often extremely costly and highly specialized
    - Very large/complex facilities
- Goal: miniaturize/simplify these technologies for use with small, off-the-shelf, modular testing chambers for small satellite applications
    - Employ standard vacuum hardware and simplified in-house built systems
    - How to demonstrate feasibility? Design/build at home with hobby budget with limited materials and open source the designs!

MICRO PROPULSION TEST CHAMBER

- 6" conflat hardware
  - Double-sided inputs
  - Large viewport
- Optimized design for rapid pumping speeds
  - 600 L/s diffusion pump w/ water cooled baffle
  - 1x10^-5 Torr in < 1 hour pumping from atmosphere



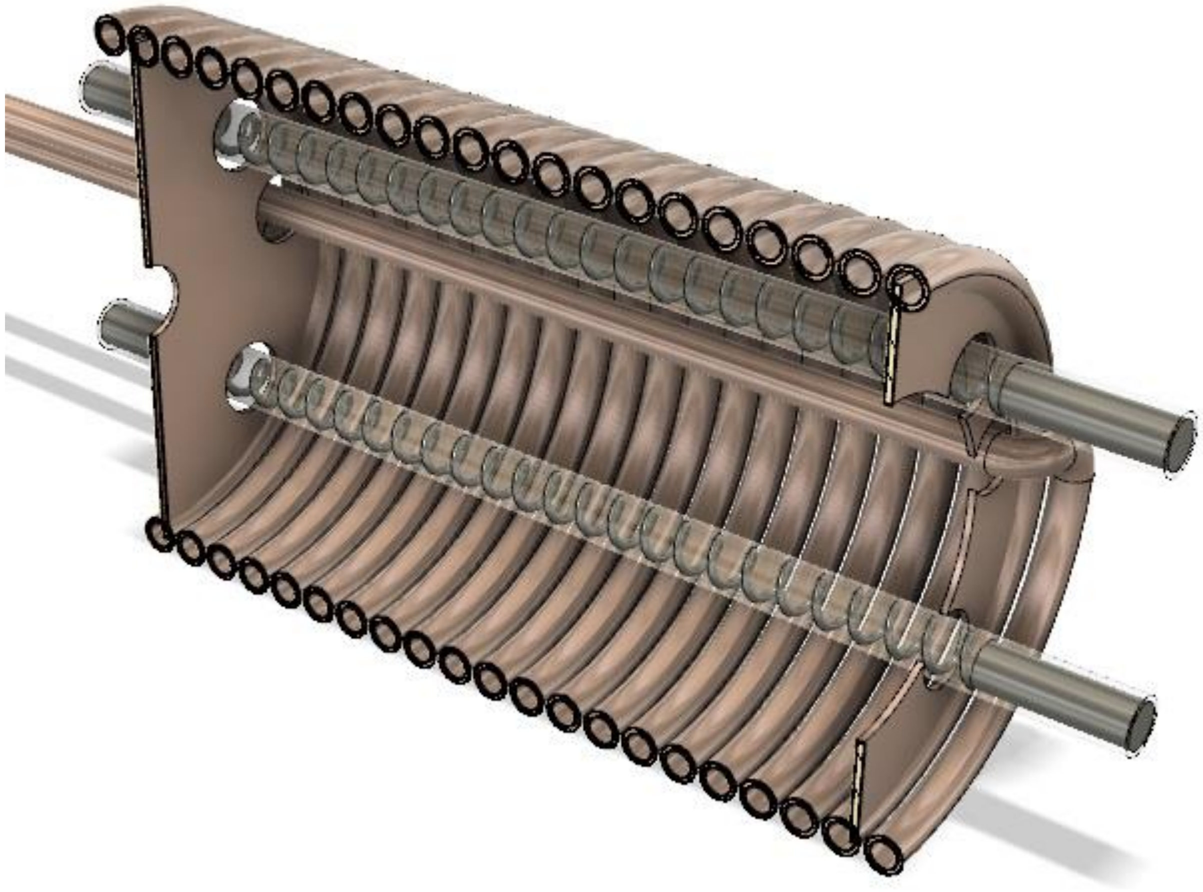




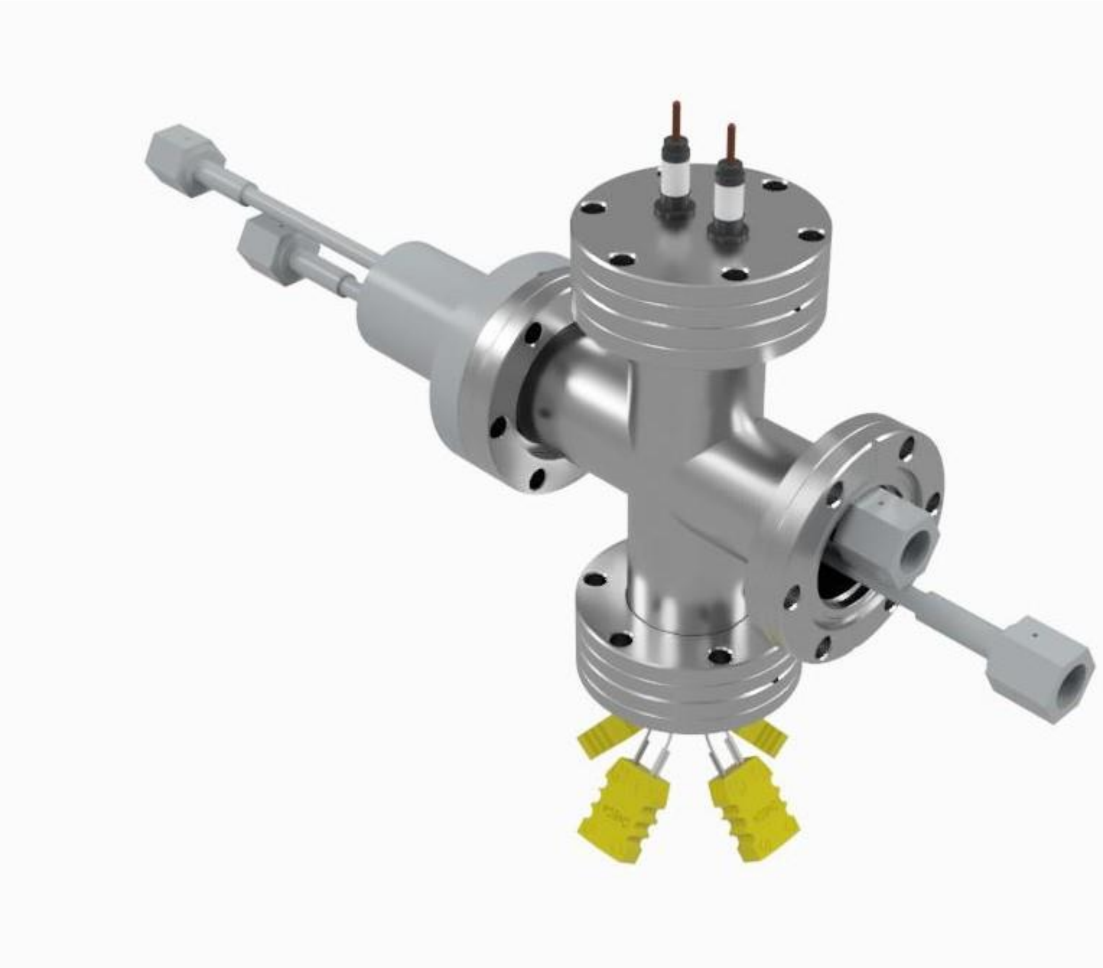
MICRO-TVAC

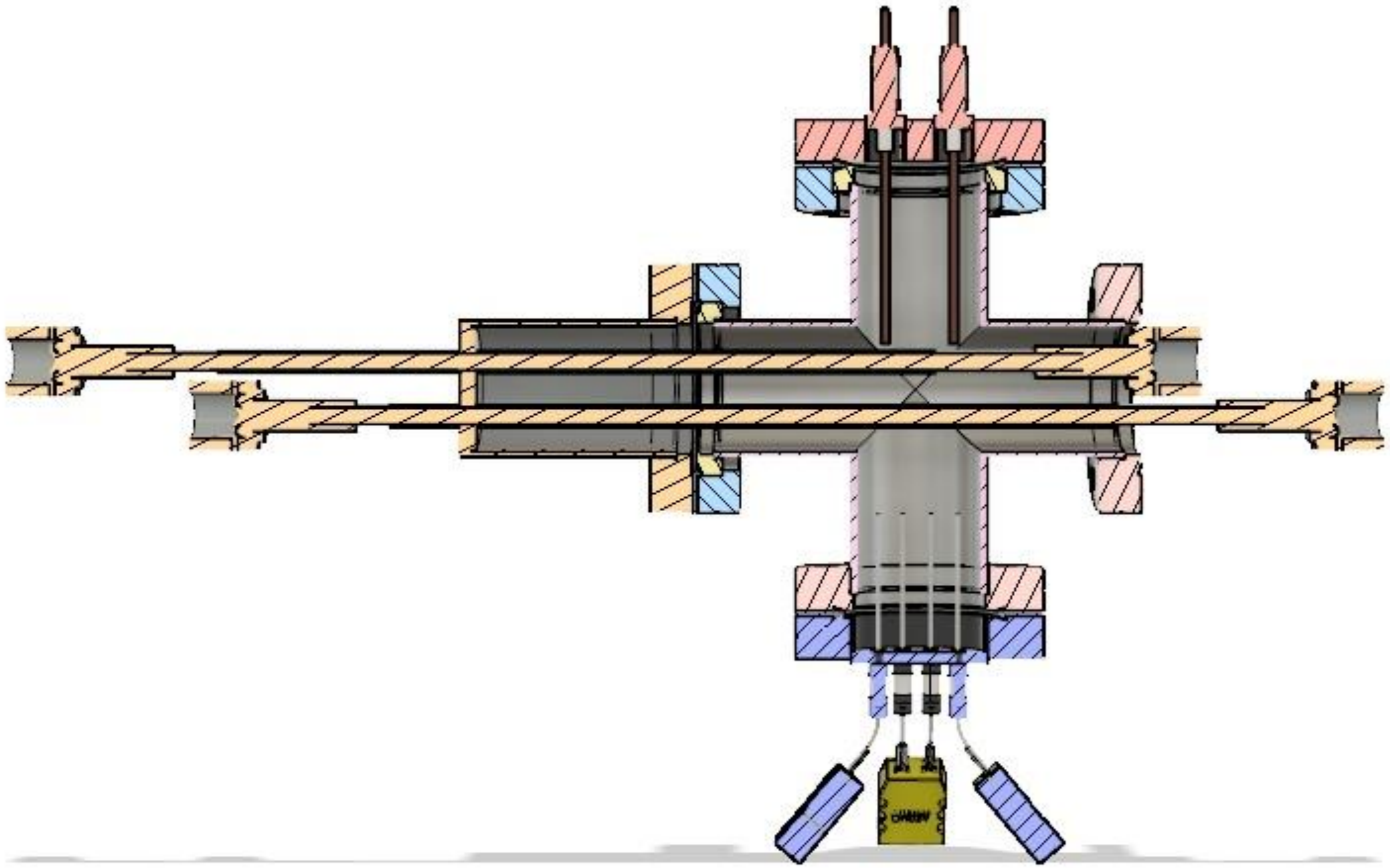
Open Source Micro Thermal Vacuum System for Small Sat Subsystem and Micro Propulsion Development

MICRO-TVAC THERMAL SHROUD CONCEPT DESIGN

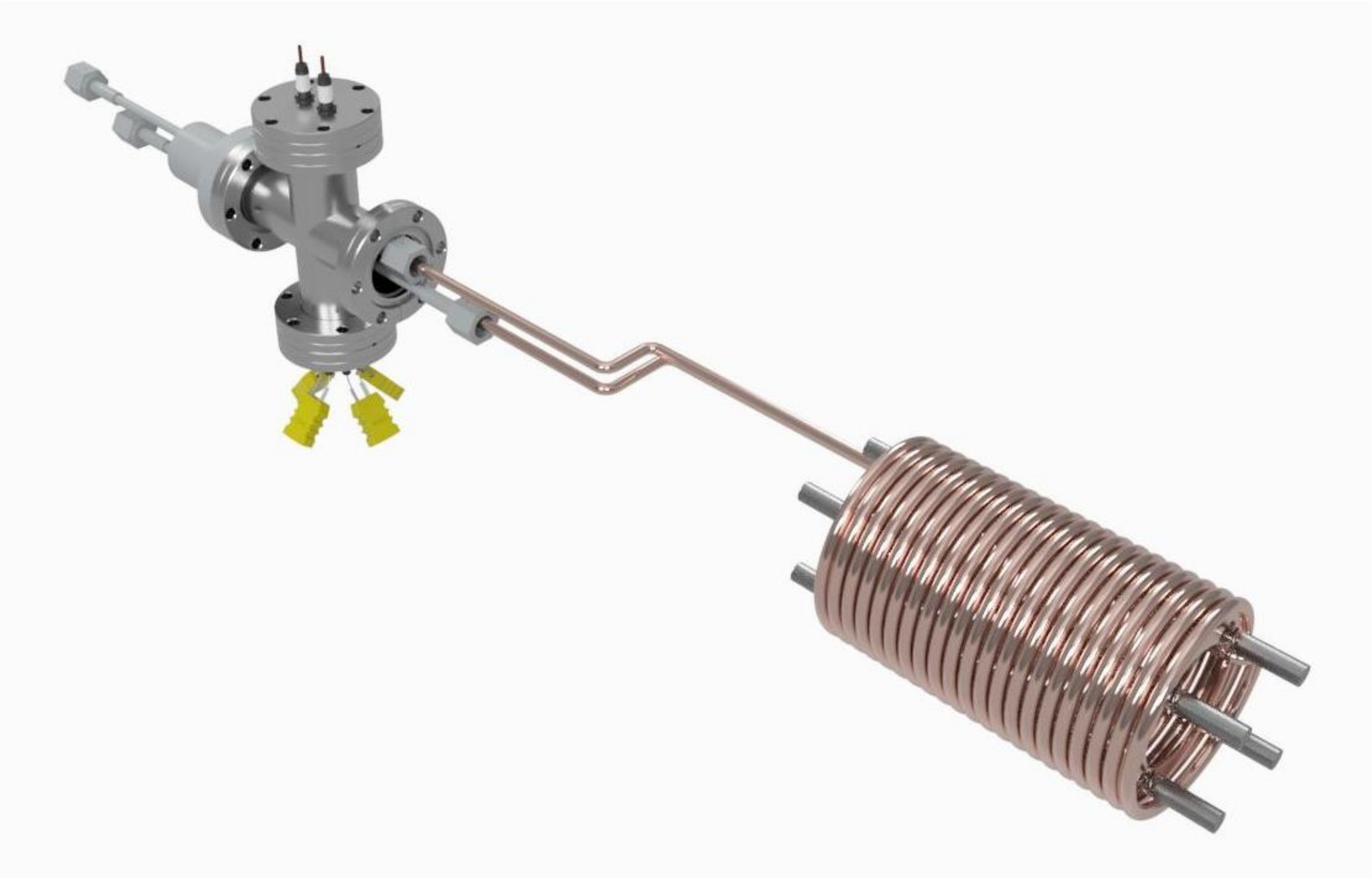


LN2, THERMOCOUPLE, AND HEATER POWER FEEDTHROUGH ADAPTER

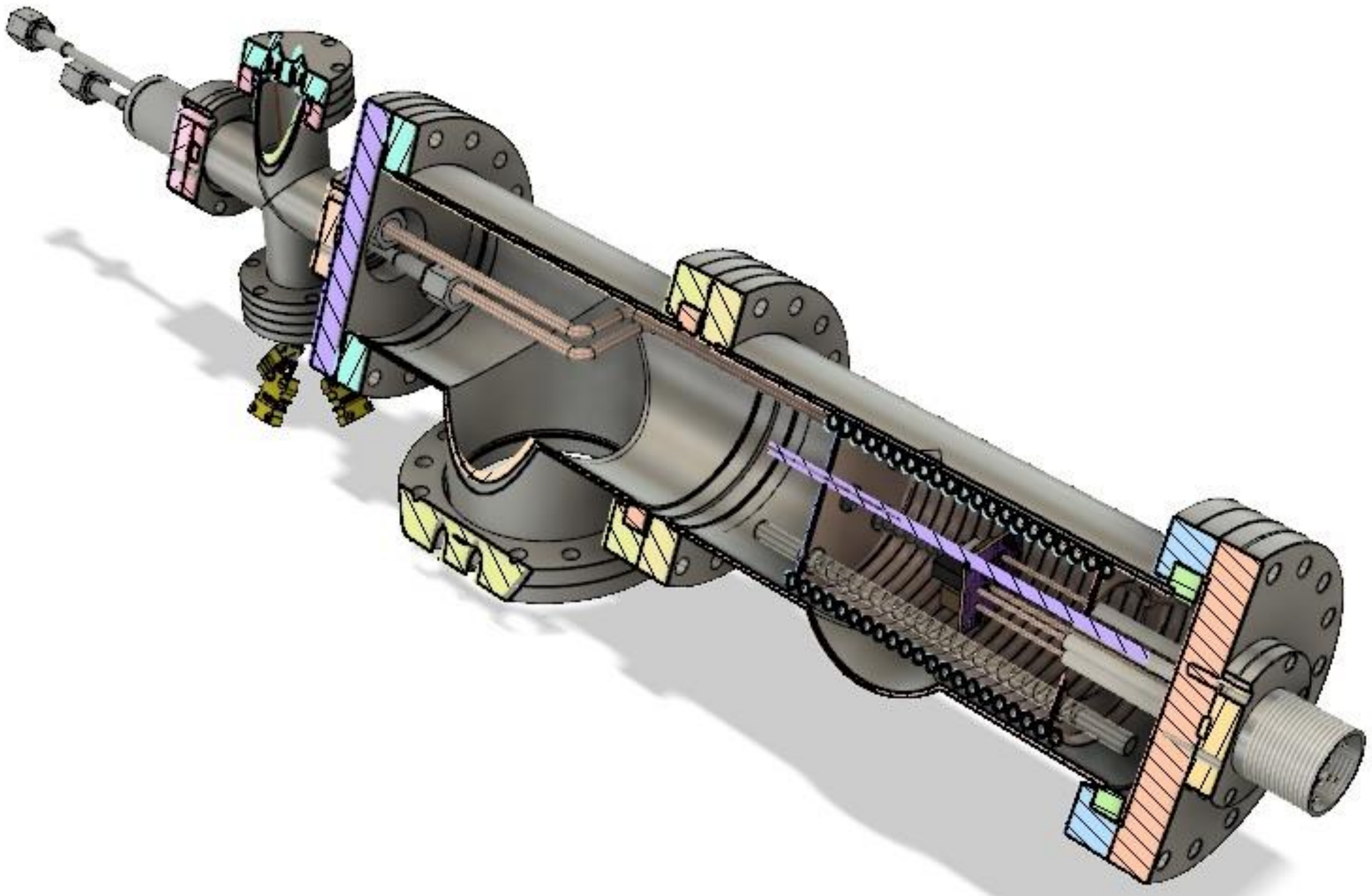


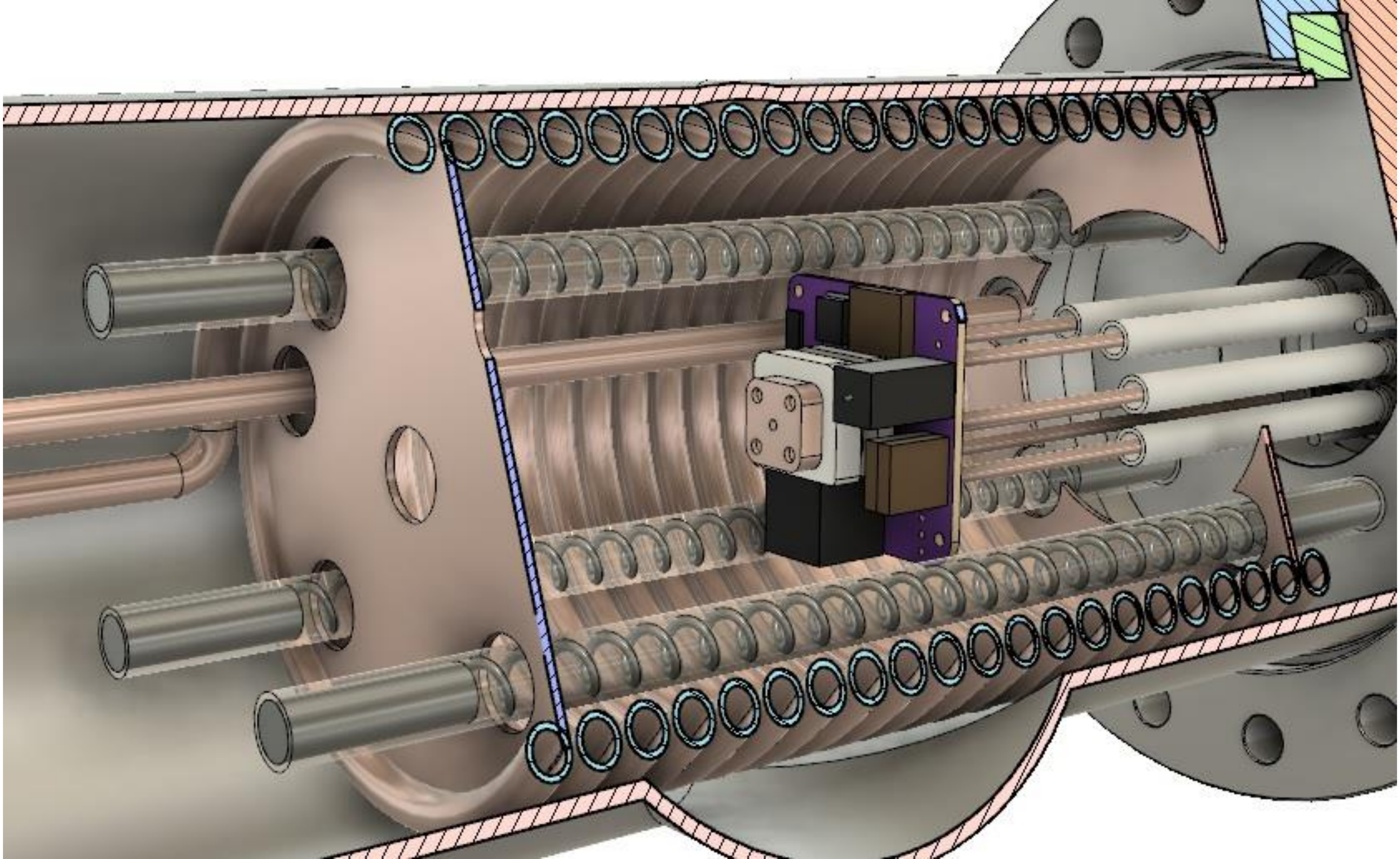


MICRO-TVAC ASSEMBLY



MICRO-TVAC ASSEMBLY IN CHAMBER





EXEDA

Open Source High Power Pulsed Accelerator

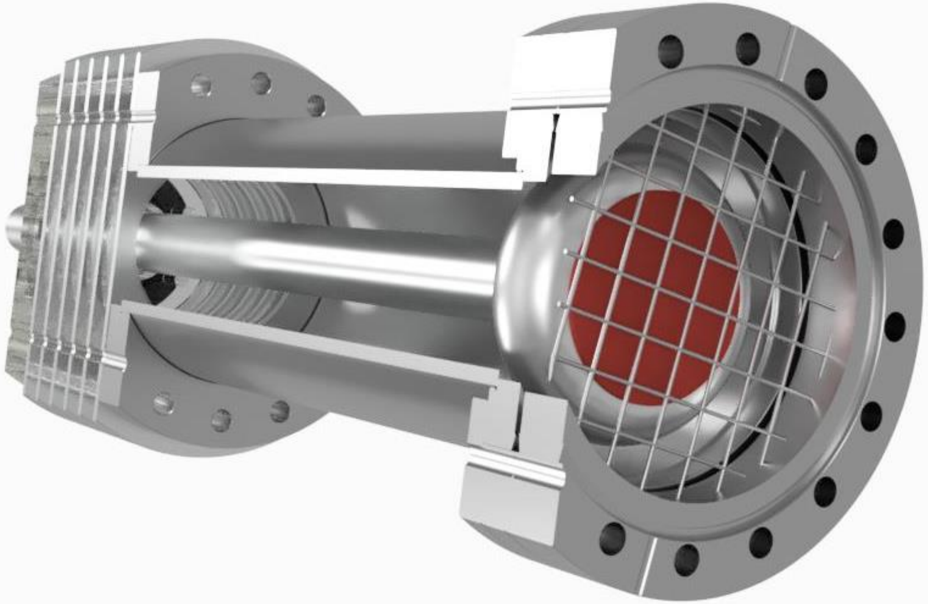
OVERVIEW

- ***EX***plosive ***E***mission ***D***iode ***A***ccelerator
- Based on Explosive Electron Emission (EEE) Intense Relativistic Beam (IREB) Direct-Drive Pulsed Diode Accelerator Technology
- Dielectric Fiber Cold Field Emission Plasma Cathode using Velvet Cloth
- Extremely low-cost accelerator
- Highly modular/scalable design (any size conflat standard)

ADVANTAGES

- Very cheap
- Very simple
  - GW-class systems demonstrated by J.C. Martin using hardware store supplies
- Highly versatile
  - e-beam, ion beam, flash x-rays, high power microwaves, intense gas laser pumping, FEL driving, etc.
- Extreme scalability
  - low energy (25keV) low power (several MW) tabletop accelerators to medium energy (several MeV) extreme power (TW class systems)
- Extremely low power requirements
  - Standard outlet power converted to MWs/GWs peak due to pulse compression techniques in pulsed power

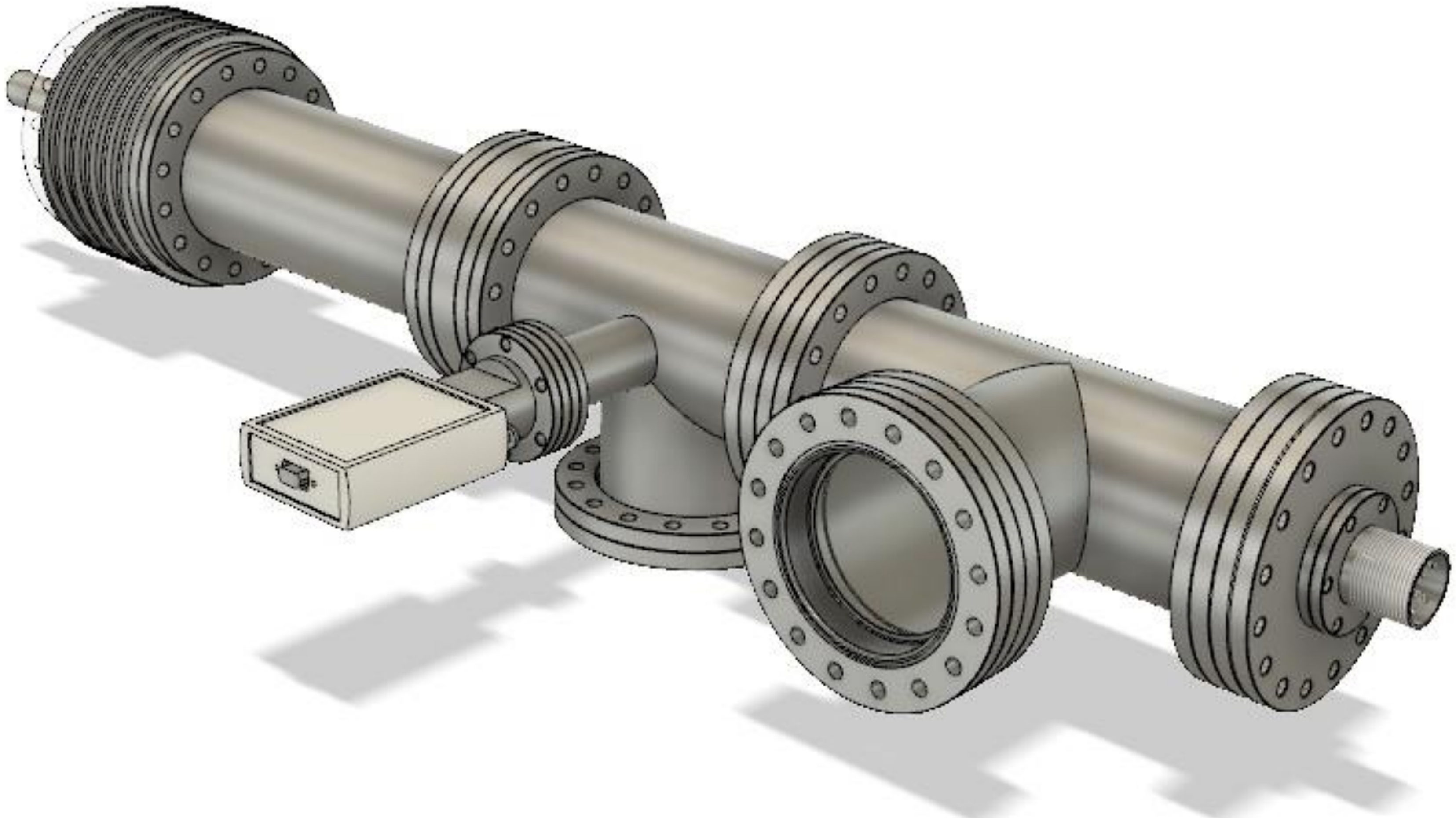
EXEDA – PRIMARY BEAMLINE INJECTOR



BEAM PARAMETERS

- Electron Beam Energy: 25 - >300keV
- Electron Beam Current: 100s of Amps to >1kA
- Spot Size: up to 55mm
- X-Ray Energy Range: 25 - >300keV
- Light/Heavy Ion Energy Range: 25kev - 6MeV
- Pulse Width: 20-30ns
- Peak Beam Power: up to 300MW
- Repetition Rate: Single-Shot to <10 Hz
- Anode Mesh Transparency: 82%
- Impedance: Variable

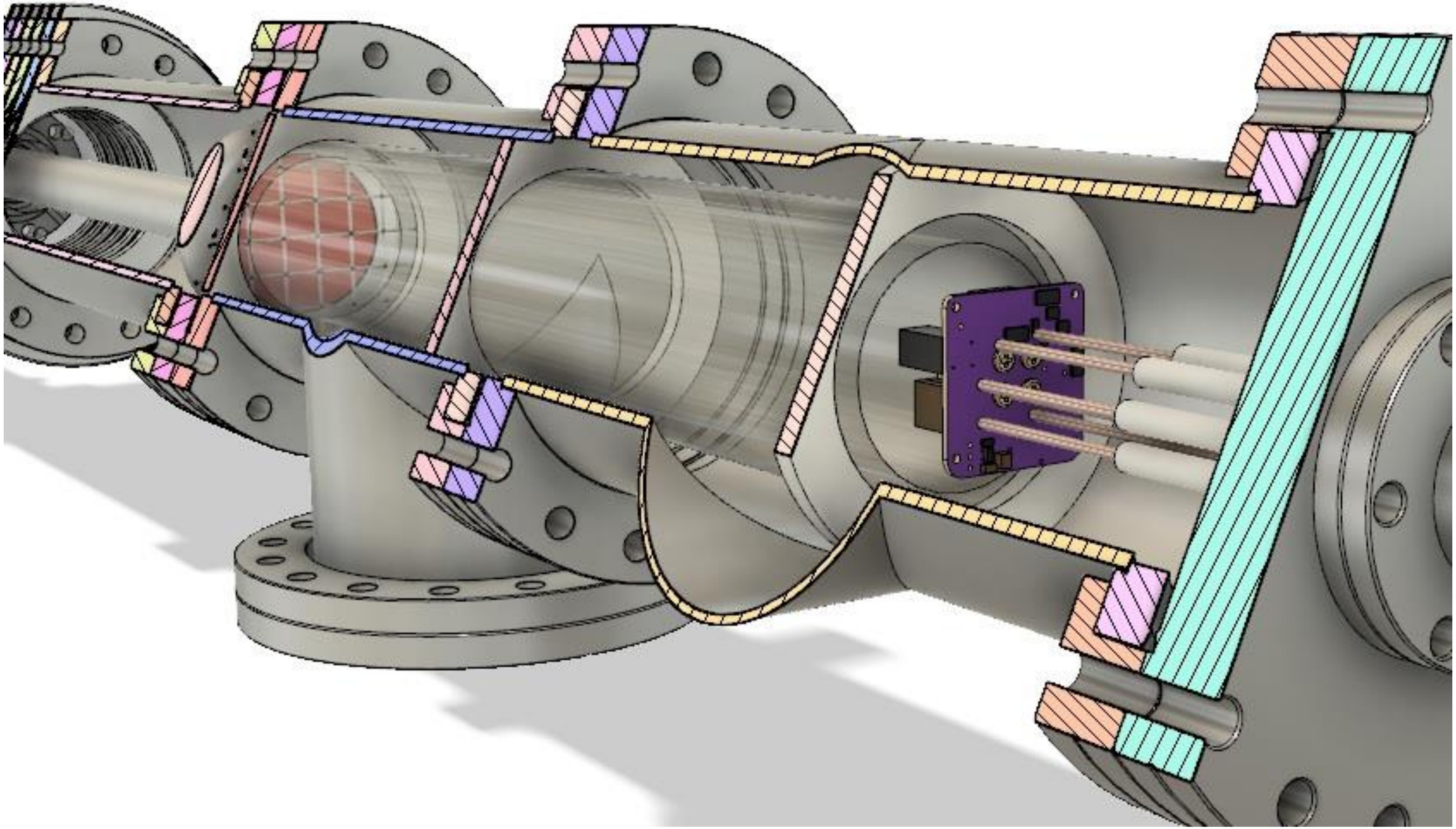
EXEDA WITH MICRO PROPULSION CHAMBER



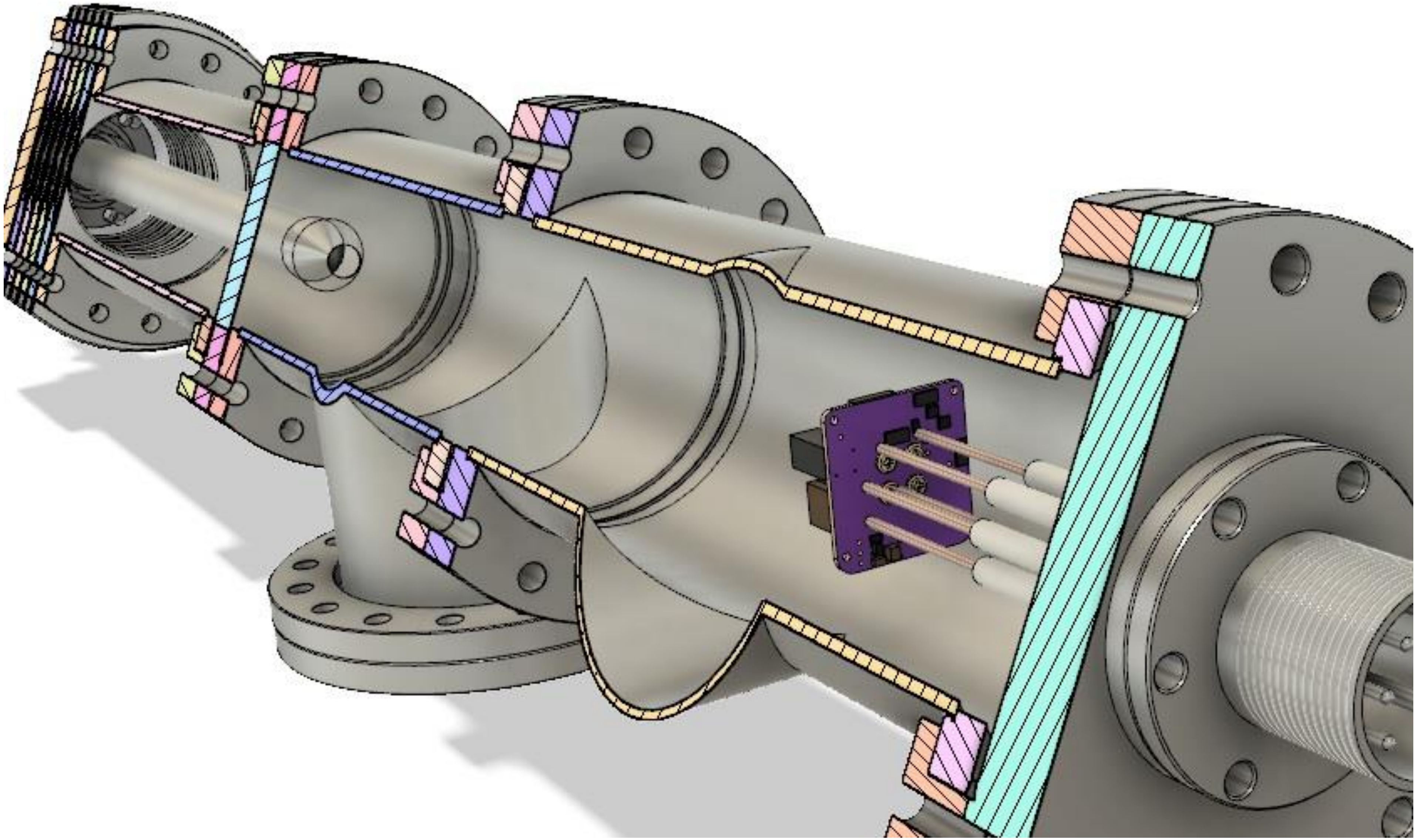
APPLICATIONS FOR SPACE SYSTEMS

- **Low Energy Electron Beams (<100keV)**
    - surface charging effects (solar panels, plastic structure surface charge build-up, surface discharges on circuitry, etc.)
- **Medium Energy Electron Beams (100keV - >300keV)**
    - relativistic electron particle bombardment, high kRad TID
- **Intense Soft and Hard X-Ray Dosing**
- **Low-Medium Energy Proton Dosing (25kev - 300keV)**
    - SEE and low TID
- **Medium-High Energy Proton Dosing (300keV - 6MeV)**
    - SEE and low TID

EXEDA-RADOSE – HIGH TID DIRECT BEAM DOSE



EXEDA-MEVI – HIGH ENERGY ION BEAM DOSE



Thank You for Listening!