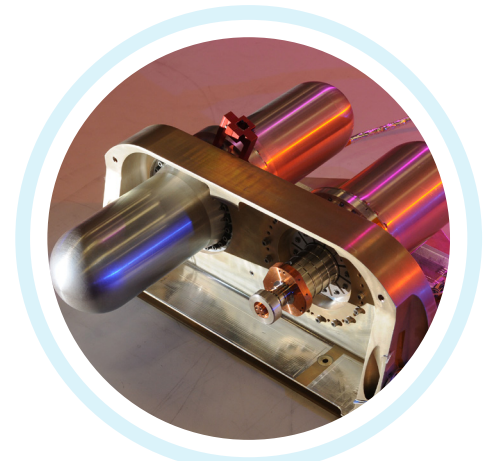


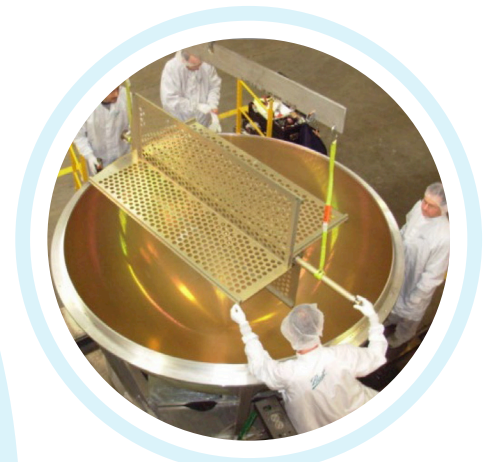
CRYOGENIC CAPABILITIES



For 50 years, Ball Aerospace has been an industry leader in cryogenic solutions for critical science and security missions for the nation. Our experience spans over 150 space flights and 25 years of designing and building cryocoolers (cryogenic coolers or refrigerators).



TIRS 40K Multi-Stage Cooler



Phantom Eye 20K Liquid Hydrogen Insulated Tank

Kepler Cryoradiator

GO BEYOND WITH BALL.®

Overview

Ball Aerospace has one of the largest cryogenic teams in the space industry, with a dedicated staff of multi-disciplinary experts in thermal analysis, structural analysis, mechanical design, electrical design, test, and project management. We deliver a wide range of cryogenics systems, from coolers and radiators to dewars, for a variety of mission needs.

Recent cryogenic programs include:

- 30K cryoradiators for the James Webb Space Telescope
- 40K cryocoolers for the Landsat Thermal Infrared Sensors
- 20+ flight 2-stage cryoradiators for the Space Based Infrared System High
- Airborne 8-foot diameter 20K hydrogen fuel tanks for the Phantom Eye UAV

Enabling Capabilities

Ball Aerospace specializes in delivering low cost, high capacity, low exported vibration/jitter cryocooler technologies. Compared to standard space cryocoolers, our flight-qualified cryocooler product line offers 3-7x lower cost, 50% greater efficiency/capacity, 33-50% shorter schedule, and 5-40x lower exported force and torque (EFT). Our products include:

- Klondike: 30 W cooling at 80K, 30 mN EFT
- Kodiak: Klondike with scalable Mission Class A to C-
- Verne: 2 kg cryocooler assembly, 2.5 W at 80K

Other capabilities include:

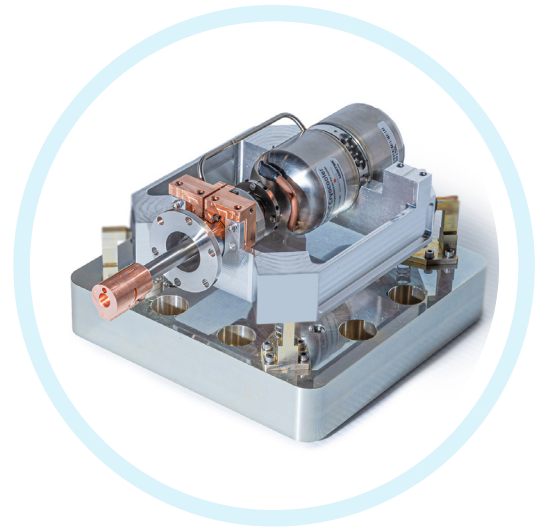
- EFT test facilities with 1 uN resolution, 6-foot diameter in vacuum testing
- Multi-stage 4-35K cryocoolers
- High performance (e^* of 0.004 and lower) multi-layer insulation (MLI)
- Flexible, high conductance thermal links
- High conductance conduction bars
- Metallic and composite low conductivity flexures and struts
- Low conductivity isolators and standoffs
- Electrical isolators with high thermal conductivity
- Low EFT transmission electrical cables and MLI

Quick Facts

- Over 50 years of experience in cryogenics
- 150 space flights of cryogenic systems
- One of the largest cryogenics organizations in the space industry
- Low-cost, high-capacity, low EFT cryocooler product line
- Toolbox of technology discriminators (MLI, struts, cables, links, etc.)



Webb 30K AOS Cryoradiator



Verne 2 kg Cryocooler Assembly



Ball Aerospace

303-939-4000 • Fax: 303-939-6104

info@ballaerospace.com • www.ball.com/aerospace