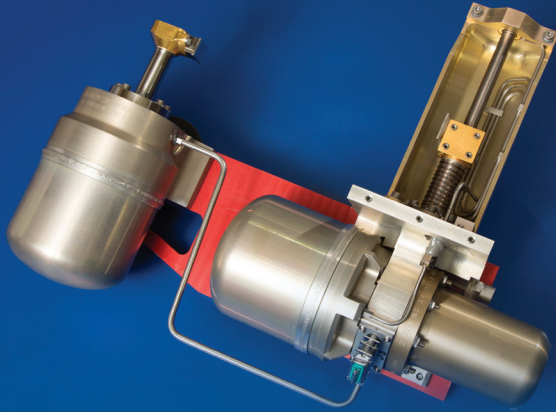


THE VALUE OF PERFORMANCE.

NORTHROP GRUMMAN

HEC Cryocooler Product Family

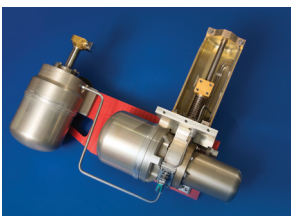


High Efficiency Coolers (HEC): delivered to multiple customers for over 230 years of on orbit operation with no failures or change of performance.

Cryocooler Performance

| | |
|--------------------------------------|---------------------------------------|
| Refrigeration Capacity (27°C Reject) | 2W @ 45 K 10W @ 77 K 23W @ 150K |
| Compressor Input Power | Up to 180 W |
| Reliability | > 98% at 87,600 Hours (10yrs) |
| Environment | - 40°C to +70°C |
| Exported Vibration | < 50 mN Drive Axis |
| Exported Vibration | < 200 mN Pulse Tube Axis |
| Mass (Single Stage) | < 4.5 kg |
| Mass (Electronics) | < 3.8 kg |

- Northrop Grumman's TRL 9 HEC cooler—unmatched legacy of success in space cryocoolers
- Space cryocooler system includes radiation-hardened flight electronics and cold heads—all TRL 9
- Available in one and two stage cooling configurations, enabling thermal control of multiple sites
- Pulse tube architecture provides very low exported vibration
- Electronics provides active vibration cancellation, as well as temperature control
- High efficiency over a wide range of operating temperatures
- Low mass reduces system level cost
- Cold head optimized for different operating temperatures



Linear configuration provides high thermal performance (shown in two stage configuration)



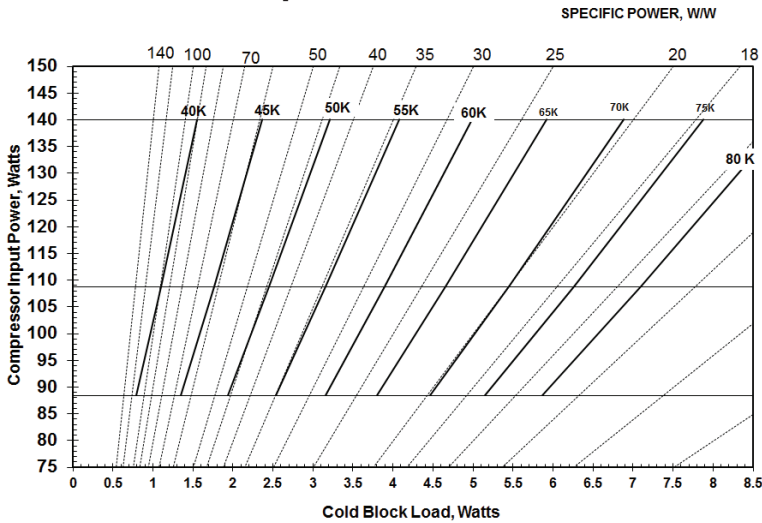
Proven electronics provides active vibration and temperature control, and telemetry



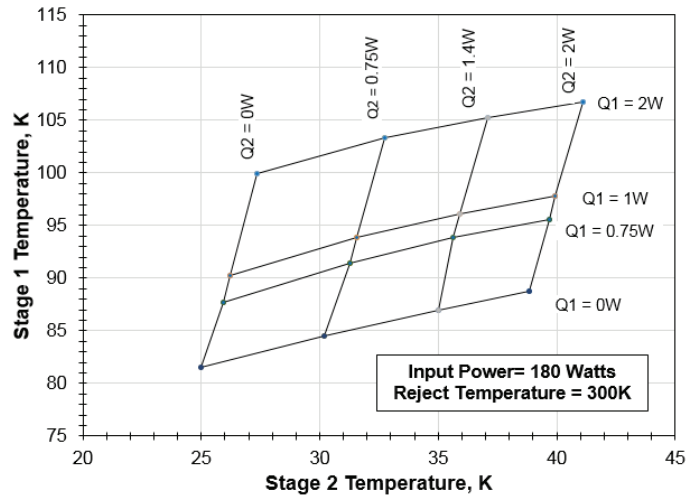
Coaxial configuration provides small form factor, ease of integration

HEC Cryocooler Performance

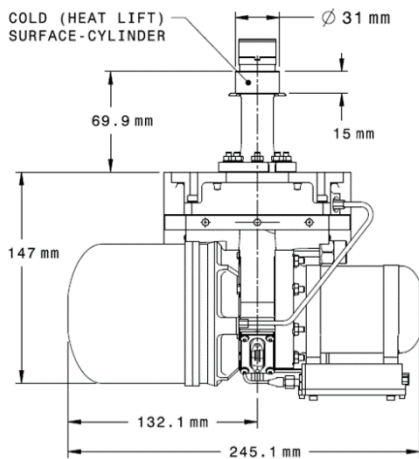
Performance Curves for Cold Head Optimized for 60K



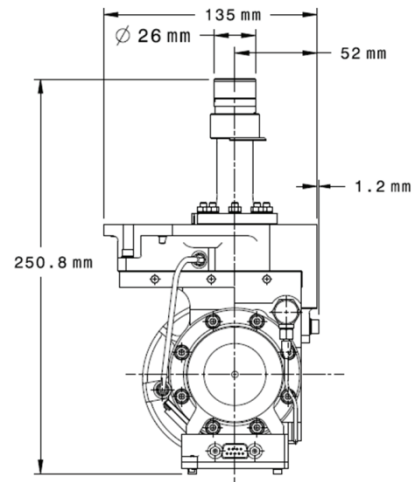
Performance Curves for Two Stage Cold Head



Custom Performance Tuning to Optimize Performance at Other Cold Head Temperatures is Available



Cryocooler Envelope, Coaxial Configuration



Visit us on the web for more information:

<http://www.northropgrumman.com/Cryocoolers>

Email: Cryocoolers@ngc.com

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