A “nano” rotary compressor with a 1:12 compression ratio for CubeSats
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SpaceWorks Projection (2014 - 2016)

- Earth Observation/Remote Sensing: 52%
- Scientific: 17%
- Communications: 9%
- Technology: 20%
- Reconnaissance: 2%

Total: 650

(c) SpaceWorks
Increasing power budgets on Cubesats heat removal is an issue for Earth observation and remote sensing.

Passive heat sinks: over 258K
Target $T$ for photo detectors: below 180K

$n_0 = k_3 T^{-1.5} e^{-\left(k_4 / T\right)}$

$n$ is the concentration of electrons in the conduction band, $T$ is the temperature, and $k_3$ and $k_4$ are constants that depend on technology.
CRYOCOOLER BY LOCKHEED MARTIN
10W INPUT POWER
650mW @ 150K
HELIUM

RECIPROCATING COMPRESSOR
(VIBRATION)

CLASSIC STIRLING TYPE
COMPRESSOR DESIGN SPECS

1. COOL OPTICAL SENSORS FROM 313K TO 180K OR LESS
2. REMOVE 20W
3. MINIMAL VIBRATION
4. FIT 100x100x40mm
5. <200g
APPROACH
ROTARY COMPRESSOR TO MINIMISE VIBRATION

\[ P = A \varepsilon \sigma T_{\text{Rad}}^4 \]

HEATING IS BENEFICIAL => HIGH COMPRESSION RATIO
THE MODEL
20W HEAT REMOVAL
COOLING TO 120K
COMPRESSOR RATIO 1:12
COMPRESSOR POWER 20W
RADIATION PANEL SURFACE AREA 0.24 M^2
AVAILABILITY OF COMPRESSORS

Power

100kW

Pressure

10 bar (g)

Small Piston, 10 bar(g)

1 bar (g)

Rotary Vane, mini-Scroll, max 1.5 bar(g)

Scroll, 10 bar(g)

Rotary Twin-Screw, 10 bar(g)
VERT ROTORS’ CONICAL TYPE

- VERT Rotors has developed a new type of Conical Rotary Compressor (CRC) with improved efficiency. The CRC consists of an Inner Rotor revolving inside an Outer Rotor.

- Tests have verified that the CRC meets these needs:
  - Volumetric efficiency 20% better than a comparable twin-screw (no blowhole, less leakage flow)
  - Very low noise (small axial discharge => low pulsations)
  - 40% smaller than comparable twin-screw
  - 100% oil-free air ISO 8573-1 CLASS 0 with water injection instead of oil

CRC is the most compact rotary compressor on the market that produces 10 bar(g) at standard motor speeds with virtually no vibration and low noise.
TESTS OF THE MAXIMUM COMPRESSION RATIO OF CRC:
1:22 IN A SINGLE STAGE
TESTS OF THE 2kW CRC HAVE VERIFIED:
42% smaller than comparable twin-screw
Volumetric efficiency 20% better than a comparable twin-screw
MK03 // “NANO” ROTARY COMPRESSOR

SCREW ROTOR LENGTH: 40 MM
COMPRESSION RATIO: 1:12
FLOW RATE: 5 SLPM
QUESTIONS?

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