The Lithium Ion Battery DeOrbiter

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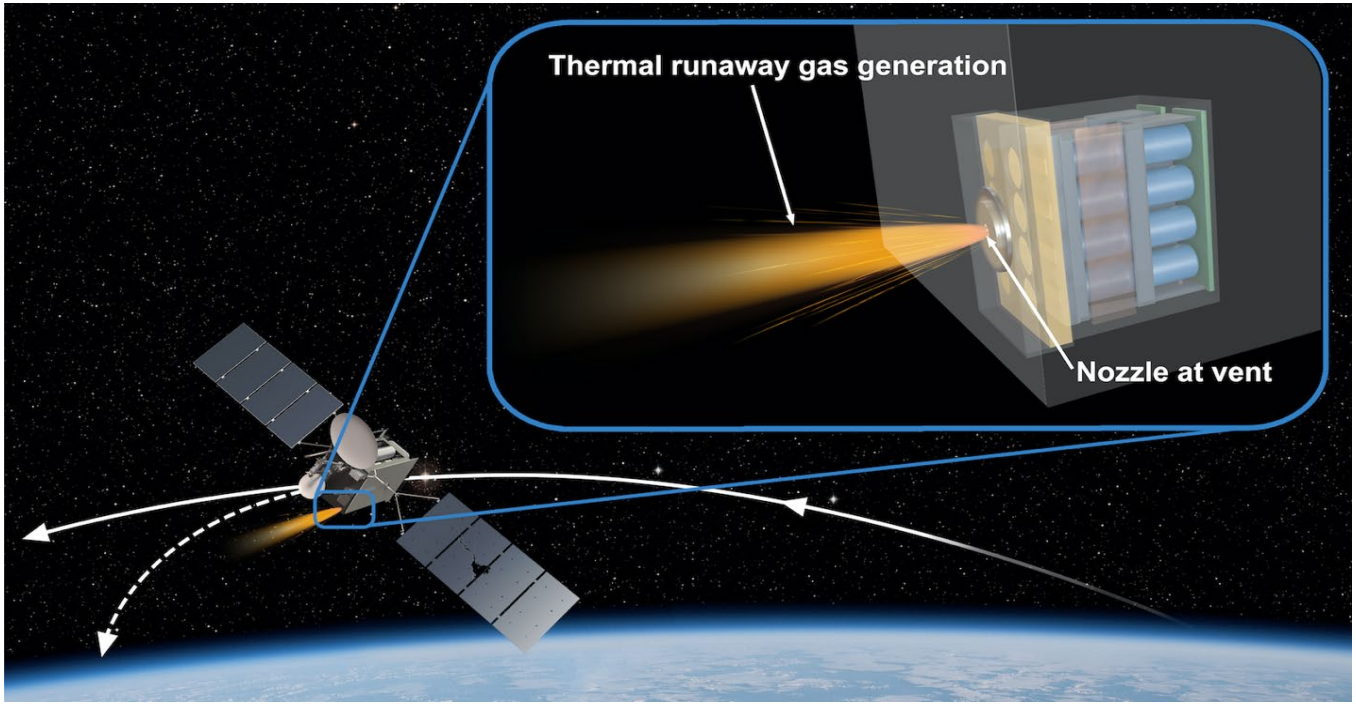

The greatest weakness of lithium ion batteries is their potential to burst into hot gasses and flames in thermal runaway. BDO turns that risk into a new strength.

Using the battery heater already installed to send the cells into controlled thermal runaway will generate hot gasses. Channeling those gasses can create thrust to deorbit at end of life and passivate the battery.

The Lithium Ion Battery DeOrbiter (BDO) is a zero additional mass technology that can be added to any spacecraft to shorten residual orbit time and reduce space debris.

BDO reduces space debris by passivating the battery and reducing residual orbit times

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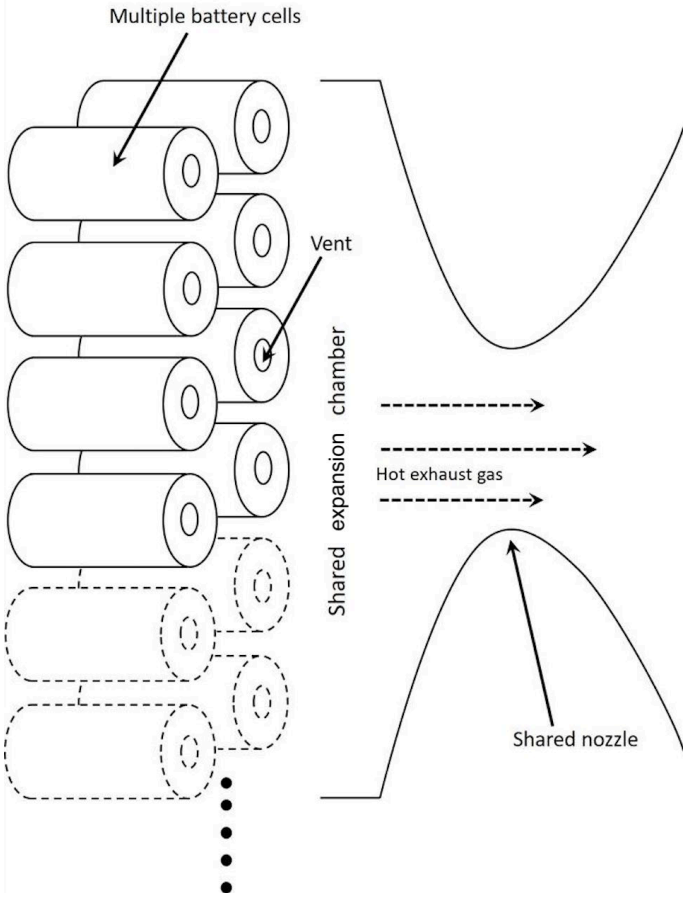
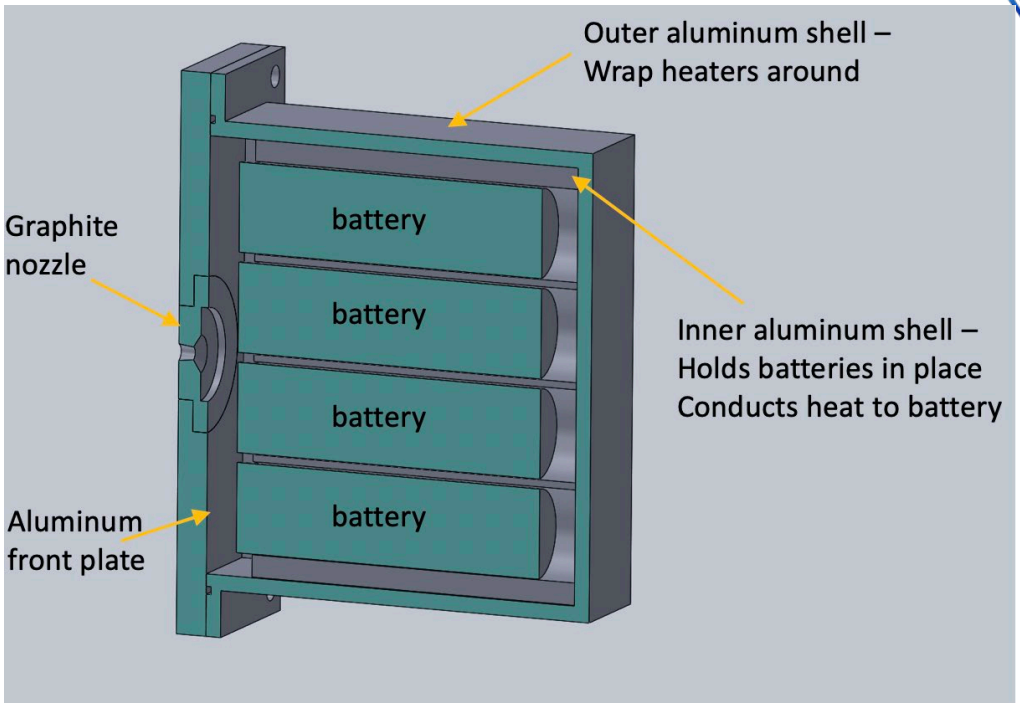
Designing BDO as a spacecraft system





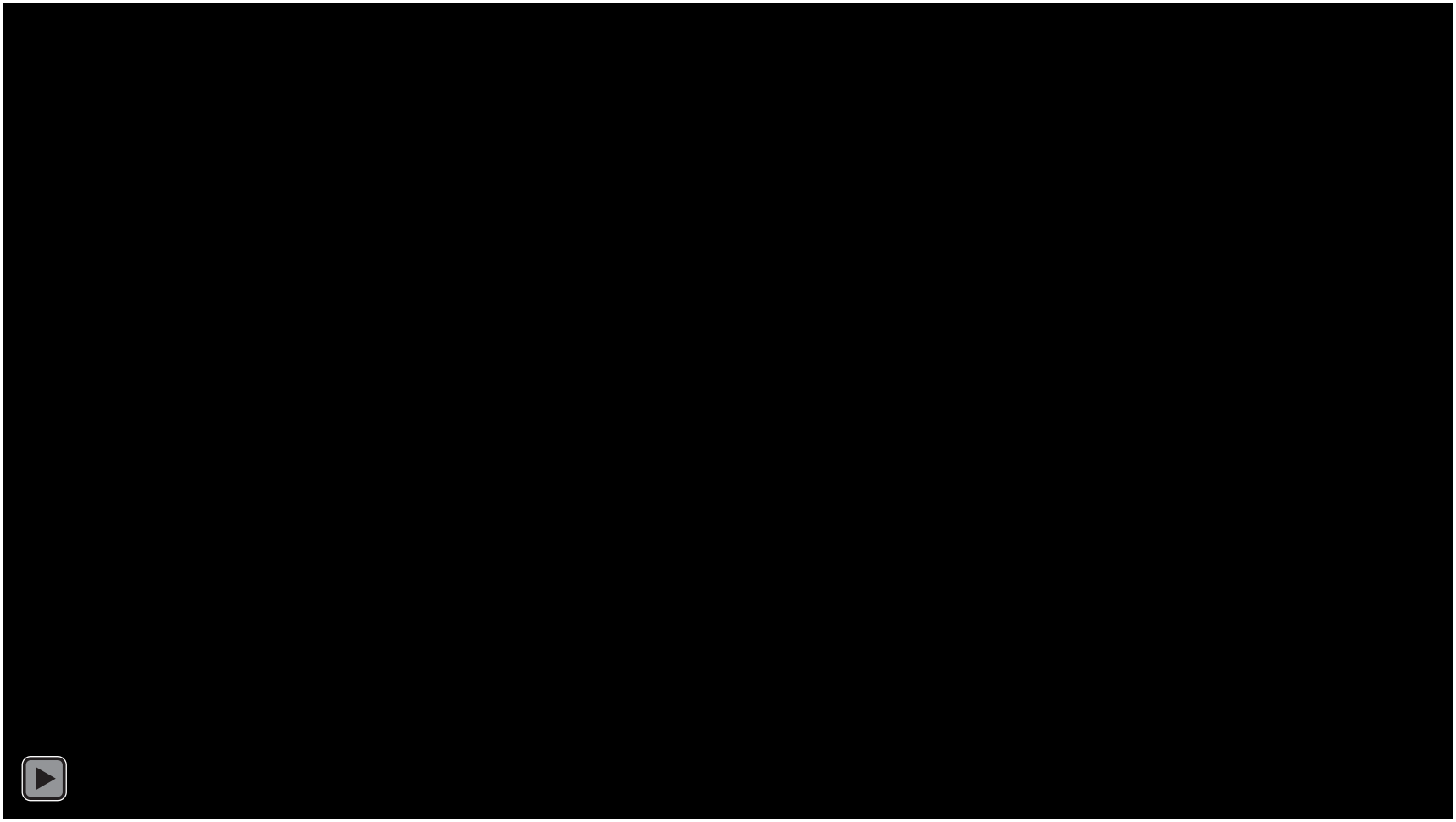
- The gasses escape the cell vents and are channeled into a gas expansion chamber, and into a nozzle.
- ACS keeps the vehicle pointed during the burn for reducing orbit.

Battery boxes are already designed to channel gasses in the case of internal thermal runaway.

Existing battery box vents can be changed into a nozzle to make venting a propulsive event. BDO harnesses the venting of those gasses for a new capability without an increase in safety risk.

BDO leverages the existing battery safety features for operation

Demonstration of thrust from a Li-ion cell



Cell on the left charged to 90% SoC and send into thermal runaway using a heater. Thrust was successfully harnessed.

Cell on the right charged to 150% SoC and send into thermal runaway using a heater. Gas pressure was too high for existing nozzle design.

BDO has a higher ceiling for thrust than we have demonstrated

Conclusions

- The Lithium Ion Battery DeOrbiter technology can help reduce space debris by deorbiting vehicles at end of life without the addition of new mass or systems.

- Existing testing has demonstrated 21 Ns of thrust per 18650. This is sufficient to reduce deorbit time of a 2U vehicle by 60% and a 15U vehicle by 51%.
  - This 21 Ns only includes testing where the gasses could be harnessed, not for more energetic events. Redesigning the nozzle and expansion chamber should allow for higher pressure activations to be harnessed, leading to substantially increased thrust.

- This technology works with existing space qualified 18650s. It is anticipated improvements could be made to these cells for improvements. Current cell and battery box vents would still be in place to mitigate risk