# Missions, Rides and Payload Classes: Available Options and Key Issues

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**Orbit options and issues**

1. LEO: lowest cost; most ride opportunities; must deorbit within 25 years of end of mission.
2. MEO, GTO, and GEO: more costly; high radiation; are there any compensating benefits?
3. Heliocentric: rides & com-links are both expensive, but pointing, views, and cooling all good.

Common features: vacuum; long view times; stable pointing; SEE on electronics; ITAR regs.

**Non-orbiting options and issues**

1. Sounding rocket: fairly cheap ride; can fly on demand; but viewing time only 5-10 minutes.
2. Balloon: cheap ride; hours to weeks viewing; some atmosphere; stability can be an issue.
3. Aircraft (including HAWGs): cheap; hours viewing; 0.1-0.2 atmosphere; stability an issue.

Usual common features: payloads recoverable; you must solve pointing stability problems.

**Options and issues for different orbital payload classes**

1. Primary: go when & where you want: $10M Falcon 1e (800 kg) to $100M EELV (>10 tons).
2. Booster secondary payload: line up suitable ride to suitable orbit (and preferably a backup).
3. Satellite secondary payload: add your package to a suitable satellite going to a suitable orbit.

{#1 Requires the most money; #3 the most luck; for #2, use standard I/F to allow backup ride.}

**Issues to consider when designing a flight test program**

- ITAR can cause delays and cost increases, if "non-US persons" are involved in the project.
- US government payloads can't ***pay*** for launch on foreign boosters (details may change).
- FAA and FCC require licenses and insurance for non-government payloads.
- Top-level recommendations:
    1. Orbital tests take lots of time & money: what can you test with aircraft, balloons, etc.?
    2. But don't get derailed by development efforts that are extraneous to your ultimate goals.
    3. What do you really need to learn, and is there a better way to learn it? (ask early & often!)
    4. If you decide to do a secondary payload, make sure you are "portable" between rides.
    5. In the past, programs got "serious" money only for flight tests; maybe that can be changed.

**Key secondary payload options and issues**

- Two integration options seem low risk (EELV ESPA and Cubesat): lose one ride, get the next.
- ESPA limits: up to 400 lb, ~24x28x35", Cubesats (up to ~10 lb, 113x113x340mm, ~$200K?).
- Opportunities and interfaces for rides between these 2 sizes are currently far less standardized.
- Most non-Cubesat secondary payloads cantilever sideways from booster support structure.
- Ride opportunities beyond LEO are far less common and less "portable" than rides to LEO.

**Some generic issues for experiment design**

- Large temperature differences can occur in vacuum; take thermal vac analysis & test seriously.
- Consider single-event effects (latchup, upset, SEFI), esp. sensors; total dose ***may*** be an issue.
- If you want to fly modules in formation, consider tethers, if light scattering & torques are ok.
- Weak effects can perturb spacecraft pointing: eg in LEO, current loops or battery magnetism.