General Comments:

First of all I would like to convey my and our team's appreciation for the opportunity to compete. The issues that we had with the formatting of the submittal package proved to be more substantive than we had thought and being afforded the opportunity to correct them was sincerely appreciated.

Secondly our goal in this debrief is to better understand the identified strengths and weaknesses so they can inform how we should proceed with the mission.

Strengths:

• Mission concept uses a novel low energy trajectory to meet both Deep Space and Lunar Derby objectives.

1. This affirmation that our proposed alternate minimum energy trajectory and corresponding concept of operations as presented is an accepted strength provides us a basis for going forward with the Alpha CubeSat mission under the auspices of the CubeQuest Challenge.

• Design concept utilizes multifunctional deployable solar panel also as antenna reflector.

1. This affirmation that our proposed use of reflectarray multifunctional deployable deployable solar panels is an accepted strength provides us a basis for going forward with the design optimization best suited to the Alpha CubeSat mission.

• Some system level requirements provided.

1. The affirmation that the chosen design process for Alpha CubeSat (Phase A: Conceptual Design ==> Phase B: Preliminary Design ==> Phase C/D: Detailed Design/Construction) is making demonstrable progress in drawing out and codifying system level requirements is a welcome vote of confidence in the Team's efforts.

Weaknesses:

• Technical maturity lacking for this point in overall project development. Much of the technical description is still high level at conceptual or notional design level, and details of most baselined subsystems and components are absent.

1. Team Alpha CubeSat treated GT-1 as a ***Conceptual Design Review*** with the goal of being able to define a mission that was boundable in terms of requirements, as well as cost, schedule, and technical risk.
2. We feel that we achieved the GT-1 goals and that team enumerated and judging affirmed technical risks associated with our propulsion choices/trajectory delta V requirements as well as the need for more detail Communications link analysis were the tall poles in the tent of required technical work.

3. Team Alpha CubeSat treated GT-2 as a ***Preliminary Design Review*** with the goal of being able to show that the mission has been successfully bounded in terms of requirements, as well as cost, schedule, and technical risk.
4. We feel that we achieved the GT-2 goals (see team Technology Flight Readiness Assessment attached for the overall design) and that team enumerated and judging affirmed technical risks associated with our propulsion choices/trajectory delta V requirements as well as the need for more detail Communications link analysis had been meaningfully addressed/mitigated to a level appropriate for this stage of the design.

• Provided insufficient substantiation of program realism with discussion of program costs and overall program budget.

1. At the inception of Team Alpha CubeSat we obtained a top downcost estimate from an existing smallsat manufacturer for what we were proposing was nominally a Five Million Dollar spacecraft for which the unmitigatable costs assuming successfully selling the technology demonstrator model to vendors would not be less than One Million Dollars.
2. Our subsequent analysis both top down and bottom up (based on COTS list prices) has demonstrated that the initial estimate constitutes a reasonable bound.
3. Given the constraint that Team Alpha CubeSat took as a ground rule that we would not and could not afford to buy the prize the overall program budget (Unmitigatable costs + In-kind Contributions) by definition must not exceed value of the prizes which is nominally Five Million Dollars.
4. Team Alpha CubeSat enumerated the cost, schedule, and technical risks associated with our mission being that of a technology demonstrator, subject to system/subsystem manufacturer schedule constraints, with an inherently limited budget, and accomplishment authority vested in honorarium compensated staff.
5. Any statements Team Alpha CubeSat would or could make concerning vendor cost arrangements prior to the successful negotiation of agreements would presuppose an outcome and likely disrupt the process.

• Provided insufficient description of the flight software needed and how its development would be completed.

1. Team Alpha CubeSat clearly indicated that we intended to use the NASA ARC Mission Control Technologies (MCT/WARP) mission operations control suite augmented by the near realtime state model extensions being developed for it by XISP-Inc.
2. The conceptual design provided a state transition diagram that outlined a deterministic control logic and a design-to-recover based programming strategy to achieve the necessary resiliency.
3. The COTS system/subsystem products that require it come with their own control software as described in the vendor literature and presentations provided.

• No discussion of X and Ka--band antenna feeds, and supporting rationale for expected performance of reflectorarray.

1. The reflectarrays are now COTS products from various vendors as noted.

2. The modifications to allow the feed horn to be a body mounted patch for the chosen frequencies rather than a fold out flap (see attached diagram) were deemed as a less critical design element since it is a known geometry problem with two or more solutions already defined.
3. The decision to move from Ka-band downlink and uplink to Ka-band downlink and X-band uplink resulting from the communications analysis and design discussions with JPL occurred late in the design cycle.
4. The Teams technical assessment was the changes required to accommodate both Ka-band downlink and X-band uplink were tractable and were well within the scope of forward work.
5. The GT-2 package provided both COTS product specification sheets as well as a foundational paper on design and performance of reflectarrays.
6. Team Alpha CubeSat views the reflectarray as mission enabling and would appreciate any additional data available on the NASA JPL testing and analysis of the same.

• <u>The absence of many technical details contributed to an inability to assess the performance of design baselines to determine if they met needed requirements</u>.

1. Team Alpha CubeSat as a technology demonstration mission is proposing to use many components provided by vendors in return for an early high visibility flight opportunity and inclusion in a readily integratable toolkit for subsequent missions.
2. Where COTS or COTS similar products are being used for Systems/Subsystems the corresponding manufacturers specification sheets were referenced and attached along with presentations where applicable.
3. Given that other teams were using the same or similar components was the referencing rather than transcribing material from the manufacturers specification sheets and design guidelines/analysis into the report narratives treated in a similar manner?