General Principles for the Successful Design and Manufacture of an EmDrive Thruster

1. Design the cavity for the required operating frequency and mode, at a specified temperature. Do not just make a cavity and then find out what the resonant frequency is. This has been the case for a number of experimenters who have either obtained no thrust or have achieved only a very low level of thrust.

2. The design should aim for a clear separation of operating frequency and mode from the various possible modes. A series of designs should be undertaken as part of a full model analysis. The operating mode must remain above cut-off at the small end of the cavity.

3. For a narrow band microwave source, the cavity geometry should include shaped end plates to ensure that wave-front phase distortion, which results in a bandwidth spread, does not limit the Q of the cavity. Also correct geometric alignment is impossible with flat end plates. Spherical end plates with correct radii are the simplest option.

4. The cavity design should be initially tested with a swept frequency to identify the resonant frequencies of the required mode and adjacent modes. A successful design and build will give an initial resonant frequency within a maximum of 0.5% of design value, at the specified temperature.

5. Cavity manufacture to high tolerance is essential to obtain high Q at the specified resonant frequency. Manufacturing tolerance should be around ± 0.01mm.

6. Assembly of the cavity must include an end plate alignment process to obtain a Q of at least 50,000. Low Q values are unlikely to give predicted thrust values, as they are a sign of poor design or manufacture.

7. Whatever input circuit is used, loop, slot, dipole etc., it must be designed and tested to deliver a match between the wave impedance of the cavity at the input point and the microwave source impedance. Input tuning is inevitably a sensitive and lengthy adjustment process.

8. A correctly matched input circuit will give a loaded Q value of half that of the natural unloaded Q. Optimum match can be checked by measuring internal cavity power using a small detector probe positioned at E field maximum. The probe should be designed to give an output at least 20dB down on input power to avoid loading the cavity.

9. Thrust measurement requires a clear understanding of Newtonian principles, as applied to a propellantless thruster. Expecting to measure thrust as if EmDrive is a conventional propulsion system will lead to ambiguous results. Ideally, thrust should be measured by measuring the acceleration of a freely suspended thruster, and then applying Newton's laws.