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GALILEO: FINISHING GEM AND MEETING CASSINI(?)

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Galileo has been in orbit about Jupiter since December of 1995. It is currently completing the second phase of the Galileo Extended Mission (GEM), devoted to lowering the orbit's periapsis to enable close flybys of Io in the Fall of 1999. During this phase, accomplished using four successive Callisto flybys, the spacecraft has been sampling the Io plasma torus at progressively lower and lower altitudes. If the spacecraft is still operational following the Io encounters the Project is proposing an extension of mission (subject to NASA approval) with the goal of conducting several more satellite flybys (with Europa, Io, and two Ganymede encounters) and making observations during the Cassini flyby in December 2000. Penetrating high energy radiation (primarily electrons and protons) is currently the major risk factor limiting the expected duration of the mission. Power and propellant reserves are believed to be sufficient to operate the spacecraft into 2001.

There are two major effects of radiation which are of concern:

1.) Interference with spacecraft and instrument electronics and sensors while in the high radiation environment - Galileo successfully operated its space physics instrumentation (but not the remote sensing package) and completed the Probe relay and Jupiter orbit insertion burn while inside the orbit of Io (5.9 Rj), receiving ~50 krads of radiation dose. During the primary mission and the first phase of GEM, periapses altitudes have been typically ~9 Rj or higher, and the dose on each periapsis pass only ~10 krad. Radiation effects on instrumentation have generally been in the range planned for, and there have only been a few suspected radiation induced problems with instruments or spacecraft systems. The remaining orbits in GEM will be more stressful than the bulk of the orbital mission to date, but the final encounters with Io will still be at significantly higher altitudes than during JOI - resulting in doses on I24 and I25 of ~33-35 krads.

2.) Long term degradation due to the build-up of radiation damage over the course of the mission - The effects of long term dosage build up are harder to estimate. The expected lifetime of various components have to be estimated by individual parts tests and analysis. The design requirement for the prime mission was to survive a total dose of 150 krad. This level was reached approximately at the start of GEM, on the 12th orbit, with no confirmed failures of systems due to radiation. The initial phase of GEM, E12-E19, added about 50% additional dosage. The only degradation observed during this time as being likely due to radiation has been biases in the output of the gyro units (which are now compensated on each orbit by software parameters). To complete GEM the spacecraft must survive approximately another 150 krad (or one prime mission "equivalent"). If the spacecraft is still operational after the 25th orbit, the post GEM mission has been designed to reduce further radiation accumulation during 2000 as much as possible - another 100 krads in four encounters (E26, I27, G28 and G29), bringing the mission total to ~475 krads. There are numerous uncertainties in estimates of radiation effects, not the least of which is that the Jovian environment is known to be variable. However, the status of the spacecraft health at the midpoint of GEM suggests a reasonable proability for successful completion of GEM and some post GEM operations.

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