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SYSTEMS REPORT FOR PAYLOAD G-652: PROJECT ORIGINS

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This paper reports on experiments conducted during the past year which investigated possible hardware configurations and methodologies for our payload project.

Test Data collected from the operation of a free electron laser wiggler using simulated ram glow phenomenon are described.

Results of an experiment to synthesize organic compounds within a primordial atmosphere using a laser induced plasma are discussed.

An experiment is described which utilized neutron bombardment to assess the risk of genetic alterations in embryos in space.

Because of limited space for the amino acid experiments, we have configured the device with a major effort toward miniaturization. The original single chamber concept has been eliminated to prevent a large array of chemical and gas storage along with robotic measuring devices which could encumber the experiment. Collection of the amino acids from a single chamber also is difficult. Therefore, various gas and chemical mixes will be housed in small 2cc vials which will be irradiated by laser to produce a small plasma within them. This configuration allows us to have the samples already collected and isolated after the plasma (spark) has caused the combination to occur.

The failure of mixing because of valve or relay latch up from a dispenser array is eliminated and discrete amounts of the elements can be stored in minor amounts thus eliminating the hazards associated with large volumes of gases.

The laser initiated plasma (spark) is easily positioned within the 2cc vial as is shown in Fig. I.

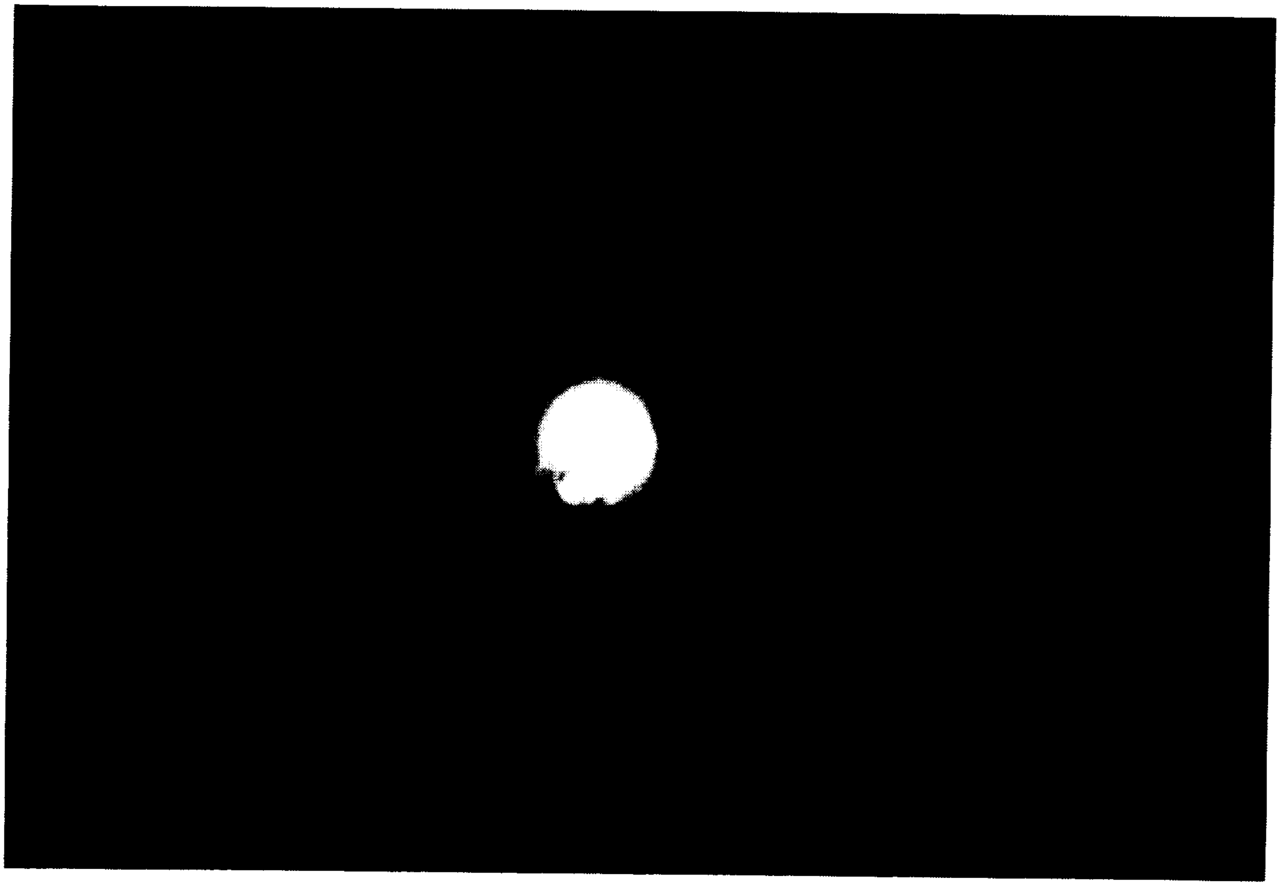

Fig. I
2cc vial with laser initiated plasma within the vial and gases with an electrode free environment.

The original experiment in the 1950's produced amino acids by introducing an electrical spark into a chemical environment which replicated the primordial atmosphere. The problem as we see it with such a device is that the electrodes themselves boil off, or sputter metallic material into the environment. The use of a laser spark (plasma) within a vial containing a chemical atmosphere eliminates the electrode variable in the experiment and allows us to look closely at the combined materials minus the electrode contaminants. Care must be taken to prevent the laser induced plasma from contacting the vial wall as is seen in Fig. II. Contamination of chemical atmosphere could result from contact of the plasma with the vial wall.

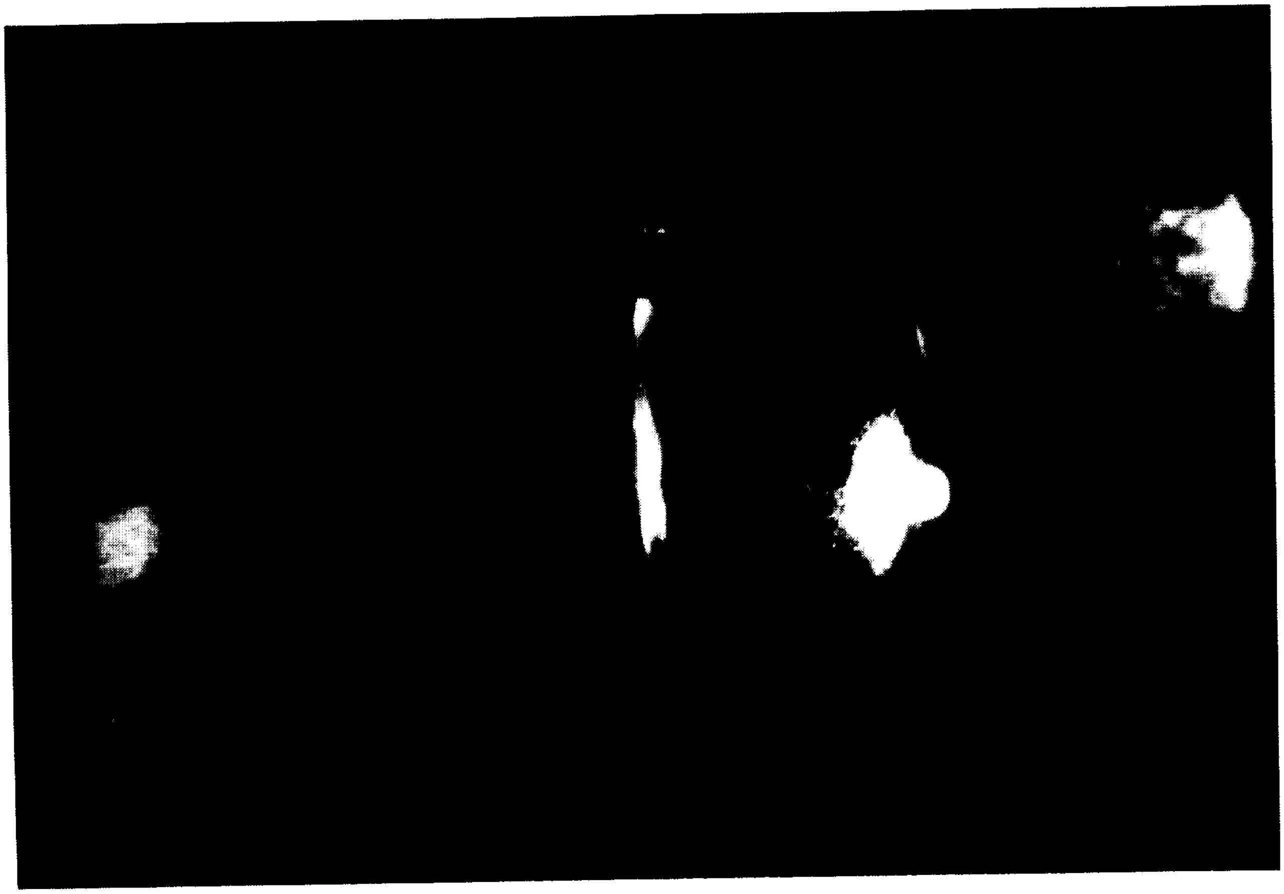

Fig. II
Improper focusing of laser light results in plasma production too close to vial wall.

The free electron laser wiggler configuration was introduced into a vacuum chamber and the remaining gases excited with high voltage. The magnetic lines of force were evident as they related to the magnetic array.

In near earth orbit, our GAS payload will be subjected to a cosmic ray flux of nearly 2000 impacts per square meter per second. These cosmic rays are known to consist primarily of protons and alpha particles, travelling at very nearly the speed of light. It is virtually impossible to simulate this environment on the surface of the earth. In an attempt to assess the effects of cosmic ray bombardment on a biological sample, we have placed biological samples in a neutron howitzer.

The neutron howitzer used contains a 5 curie plutonium source, mixed interstitially with beryllium. This results in the release of about ten million fast neutrons per second, which are moderated by a water jacket, and also gamma rays. The biological sample was placed in proximity to the neutron source, so that it was irradiated by thermal neutrons and by gamma rays, as a simulation of the actual cosmic ray bombardment that will be encountered in orbit.

Neutron and gamma ray bombardment of biological samples in order to assess the risk of genetic alterations in space due to cosmic rays has limitations. In our case, the result of placing the biological sample in the howitzer was the death of the sample in a manner of minutes. As a form of ionizing radiation of very high particle energies, cosmic rays should pose a risk of genetic alterations in biological samples. This thesis will be tested in earth orbit.

For the actual experiment, we have chosen to place the embryos in several cylindrical vials, surrounded by a detector stack consisting of CR-39 and Lexan. In this way we hope not only to gain information regarding the number of hits suffered by our sample, but also the trajectory of the cosmic ray particles. Subsequent microscopy and/or electron microscopy could further aid in determining the effects of cosmic rays on the genetic structure of the samples.