NORSTAR Project

Norfolk Public Schools Student Team for Acoustical Research

by

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Topic

The NORSTAR Project (GAS-325): The First High School Student-Run Space Flight Project

Abstract

Development of the NORSTAR (Norfolk Public Schools Student Team for Acoustical Research) Project includes the definition, design, fabrication, testing, analysis, and publishing the results of an acoustical experment. The student-run program is based on a space flight organization similar to the Viking Project. The experiment will measure the scattering transfer of momentum from a sound field to spheres in a liquid medium. It is hoped that the experimental results will shed light on a difficult physics problem - the difference in scattering cross section (the overall effect of the sound wave scattering) for solid spheres and hollow spheres of differing wall thicknesses.

The NORSTAR Project represents the first high school student-run space flight project ever attempted. The project includes the definition, design, fabrication, testing, analysis, and publishing the results of an acoustical experiment which will fly on the space shuttle in 1987. The project also represents the first time that an entire team of NASA scientists, engineers, and managers have volunteered to support a high school project.

The NORSTAR Project is a flagship example of a partnership in education between a public school system and private and public agencies from the community. The Norfolk Public Schools and the NASA Langley Research Center have embarked upon perhaps one of the most unique and fruitful community involvement programs to date, and one which has already received international attention as a prototype for other school systems to duplicate. In the first year, the project has generated equipment and consultant support from the educational community including Old Dominion University, the College of William and Mary, and Norfolk State University; and from the industrial sector including Nikon Corporation, Tandy/Radio Shack, Tektronix Incorporated, Valpey-Fisher Corporation, Town Point Center, and the list goes on. The project curriculum has been developed to incorporate an interdisciplinary, integrated approach in order to facilitate the most effective learning processes for areas of study including physics, mathematics, computer programming and applications, chemistry, communication and speech making skills, and utilizing a team approach to solve problems.

EVOLUTION OF THE *NORSTAR* PROJECT

In the fall of 1983, the NASA Langley Research Center initiated a request for experimental proposals from some 25 school systems in Virginia. The winning school system would be sponsored by NASA and given a "ticket" to develop a small self-contained payload operated under the Get Away Special program of the NASA Goddard Space Flight Center in Greenbelt, Maryland. This "ticket" is a container which houses the experiment at a cost of $10,000 and is placed in the cargo bay of the space shuttle.

At that time, a science extended day class of the Gifted and Talented program under the direction of teacher Ronald C. Fortunato was converted into a research proposal team. The team researched and developed three proposals, which were submitted to the Director of the Langley Research Center, Dr. Donald Hearth. All proposals were reviewed, and by the spring of 1984, the proposed experiments by the Norfolk students were judged to be the most significant and promising by NASA officials, and the Norfolk project was chosen for inclusion aboard a 1987 flight of the space shuttle.

At this point, Dr. Joseph Heyman, a world renowned researcher in the field of ultrasonics from the NASA Langley Research Center became extremely interested in the Norfolk Public Schools' experiment proposal. The students had developed an experiment which was closely related to some of his own research, and as it has turned out, if the experiment runs successfully in space, a problem plaguing researchers for many years may be resolved by the student's space experiment. Dr. Heyman volunteered to be the NASA scientific consultant to the Norfolk students for this remarkable project and significant undertaking. At this time, the students developed an acronym for their project: NORSTAR - Norfolk Public Schools Student Team for Acoustical Research. The NORSTAR team consisted of students from each of the five high schools in the city.

Word spread around the Langley Center about this fascinating student experiment, and an entirely unexpected event occurred: an entire team of NASA scientists, engineers, and managers volunteered to serve as mentors for the Norfolk experiment. The significance of this event cannot be appreciated enough, for it enabled the NORSTAR Project to develop an organization which was similar to a genuine NASA space flight project. This offer by the NASA personnel demonstrated in profound terms their commitment and dedication to the education of young students. It is also astounding to note that several of the mentors were on the Viking Project which sent the Viking spacecraft to Mars. The students (and teacher) had no idea what amazing experiences and hard work they were about to get physically and emotionally involved with in the near future.

DEVELOPMENT OF THE *NORSTAR* PROJECT ORGANIZATION

It is the project organization that duplicates a NASA space flight project which makes NORSTAR a space flight project, and not just an experiment (please refer to Figure 1). The organization places a student responsible for managing a system related to a particular experimental function. A NASA mentor "shadows" each student at each position. The NASA mentors are often affectionately referred to as the Shadow Team. The student project scientist has a NASA scientist as his mentor (Dr. Heyman); the chief engineer has a NASA engineer as his mentor; the student electrical systems manager has a NASA electrical engineer as his mentor, etc. It is only because of this tremendous support at each key position of the organization, that we were able to make one more historical change in the program goals. The project could be designed to be student-run. Only because there was such a high level of expertise available for the students to rely on for resource support, the students could be allowed to determine the fate of their own experiment. All

NORSTAR

NORFOLK PUBLIC SCHOOLS STUDENT TEAM FOR ACOUSTICAL RESEARCH

GETAWAY SPECIAL PROJECT ORGANIZATION 1985 - 1986

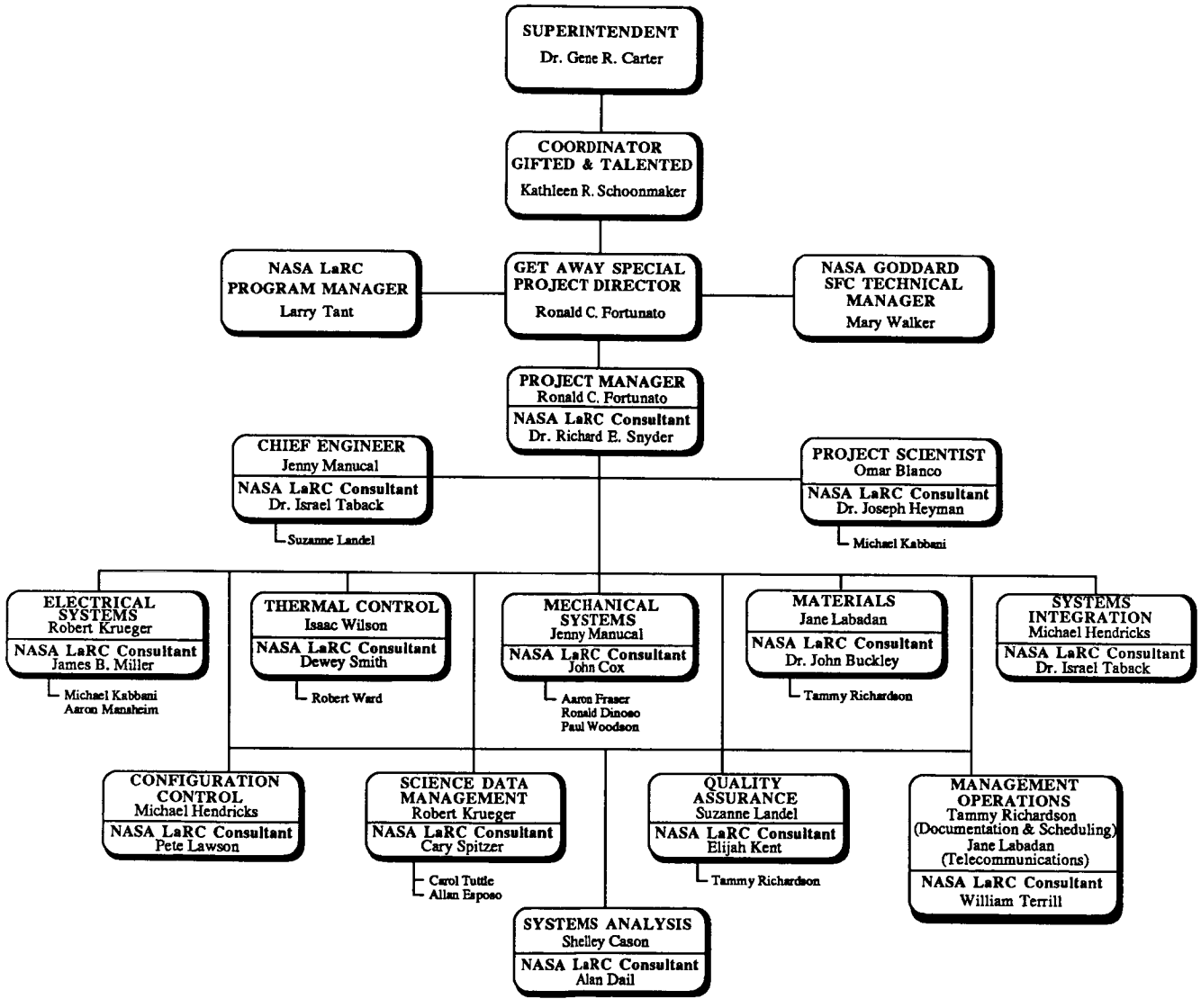

Figure 1.

mentors and teachers involved with the NORSTAR Project do not tell the students what to do. They develop all necessary and requested information required by the students to complete their tasks and to solve their problems, but the guidance is subtle. The students make their own decisions, and are allowed to make mistakes and to learn from them. The teachers and mentors make sure that the students do not head down dead ends, but allow them the freedom of following their own thoughts and ideas to fruition, and to express and develop their wonderful creativity in solving the multitude of problems which present themselves in a project of this nature. The students feel complete ownership of the experiment, yet know, respect, and appreciate the level of guidance they are receiving.

The Norfolk Public Schools demonstrated complete commitment to the project by generating several items of support. A clean room (relatively dust-free laboratory) was established at the Norfolk Technical Vocational Center with phone installations and computer networks set up so that the students could work on and communicate with NASA computers and mentors. The teacher (Mr. Ronald Fortunato) was assigned to the project on a full-time basis, and the students receive double weighted science elective credit. Each student is transported from his home school to the NORSTAR lab for a minimum of two periods per day to work on the project, and all students meet from 2:30 to 5:00 pm in the lab on Tuesdays and Thursdays. The afternoon sessions are used for group meetings which include a weekly status review delivered by each student manager to the rest of the team; for group communication integration sessions; and for running lengthy experiments. The students communicate with their mentors by phone whenever necessary, and meet personally with their NASA counterparts approximately every other week.

There is a very special reason for the NORSTAR laboratory being located at the Norfolk Technical Vocational Center (NTVC). The project draws on the support of several of the programs currently run by the center (see Figure 2). Students and teachers from these programs are directly involved with the development and fabrication of experimental components. Although not enrolled in the NORSTAR class, between thirty to fifty NTVC students are currently supporting the project, and feel ownership in the space flight experiment. The electronics program at NTVC supports the development of the experimental design and circuit board fabrication; the drafting program students draw the high quality mechanical designs required by the NASA personnel. The machine shop fabricates components to the specifications of the NORSTAR students. The word processing and reprographics program types all project documentation ranging from weekly status reviews and correspondence to research reports for publication. The welding program assists in fabrication of certain components in conjunction with the machine shop. The graphic arts students take the NORSTAR student designs and convert them into high quality posters, logos, and presentation material. The printing shop takes printed documents and develops publication quality materials. The data processing program works with the NORSTAR students in writing computer programs for data analysis of the ground based experiments.

The mechanism of the NORSTAR Project is far reaching and presently involves teachers from all five high schools. When the program director determines that one of the students is having difficulty understanding a particular concept, he differentiates the curriculum of that student. The problem area is identified, and the director writes a set of objectives, content area, and suggested activities which directly addresses the concept which the student is having difficulty with. The director then consults with the student and a teacher of that particular subject area at the student's home school. The curriculum packet is sent to the home school teacher, and the student makes contact with the teacher and sets up a one-on-one tutoring help session. The help session(s) are conducted, and the home teacher sends the results, progress, and recommendations to the director.

There is a transition which occurs when students graduate. All students in charge of subsystems are responsible for teaching younger students their jobs and responsibilities. This way, a new student may take over a subsystem upon the manager's graduation. Students are selected and brought into the program as sophomores. This allows a smooth transition and minimizes loss of time and information. The NORSTAR graduates are not lost to the program either. They are kept in contact with the project through communications and status updates which

NORSTAR **Project Support from Programs at the Norfolk Technical Vocational Center**

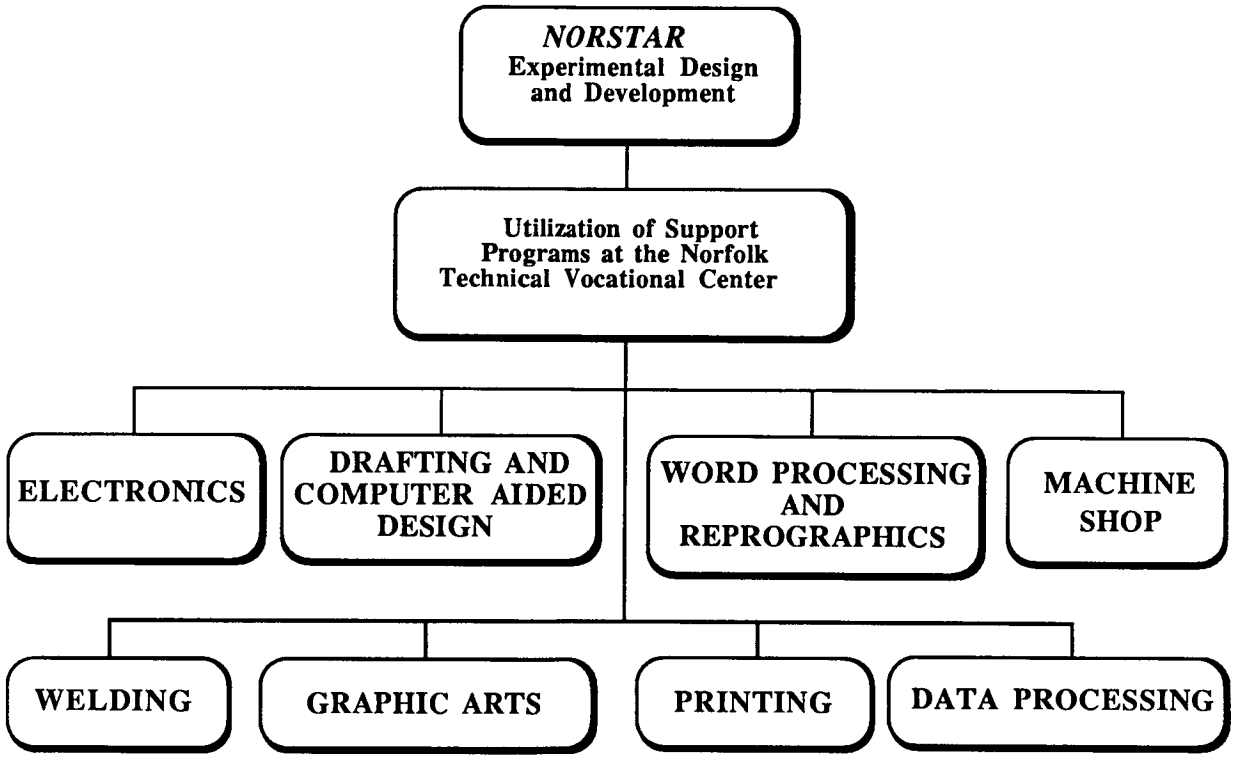

Figure 2

are sent to them by the regular students and the director. The graduates continue to have as much input into the project as their time allows.

THE *NORSTAR* EXPERIMENT

The title of the experiment is "Acoustic Radiation Momentum Transfer Measurement Utilizing Acoustic Phase System Techniques in a Microgravity Environment".

Acoustic scattering is a very important phenomena and has received attention recently in the field of Non-Destructive Evaluation. This is a process in which ultrasonic sound waves are used to detect flaws or weaknesses in solid structures such as the wing of a jet aircraft. Many scientists are trying to solve the inverse problem - to measure the scattering field and infer the scattering source - such as a crack in a pressure vessel. With that knowledge, we can insure the safety and reliability of critical structures.

The NORSTAR experiment will measure the acoustic radiation transfer of momentum from a propagating sound field to spheres in a liquid medium. Research in acoustic radiation force has been hampered by errors due to a suspension system which differs from an ideal system. Possible sources of error include surface tension of the suspension wire passing from air to the liquid medium; and attachment of the suspension to the sphere. The NORSTAR experiment will eliminate these errors by performing this experiment in a microgravity environment provided by a Get Away Special cannister mounted in the cargo bay of a space shuttle. Once in orbit, the microgravity environment eliminates the need for a suspension system and the errors associated with it. Flight data will be compared with ground-based control data. It is hoped that the experimental results will allow researchers to examine current and past data.

The NORSTAR experiment will utilize an acoustic phase system to measure sphere movement in addition to a photographic analysis technique. The system consists of a receiving transducer that will measure backscattering from a sphere driven by a driving transducer. Sphere velocity will be calculated by recording the phase-shifted wave reflected by the moving sphere. The momentum transfer can then be inferred through the use of the recorded data. Electronic circuits (mixers, filters, etc.) will detect and amplify the signal from the transducer before electronically storing this information. The NORSTAR project goals are therefore twofold: to determine the error present in a suspension system; and to determine the feasibility of the measurement system to determine sphere velocity.

This experiment can be performed only in the absence of gravity, and will provide important information concerning Non-Destructive Materials Evaluation, tissue characterization (determination of the depth of cell damage in burned skin), and the interaction between sound energy and solid materials in the absence of gravity (see Figures 3 and 4).

This high school project sponsored by the Norfolk Public Schools Gifted & Talented Program seeks comments from those in the acoustics community who would be interested in this experiment and wish to collaborate.

Any correspondence with the NORSTAR Project is welcomed, and may be addressed to:

NORSTAR
Norfolk Technical Vocational Center
1330 North Military Highway
Norfolk, Va. 23502
Lab phone: (804) 466-0701

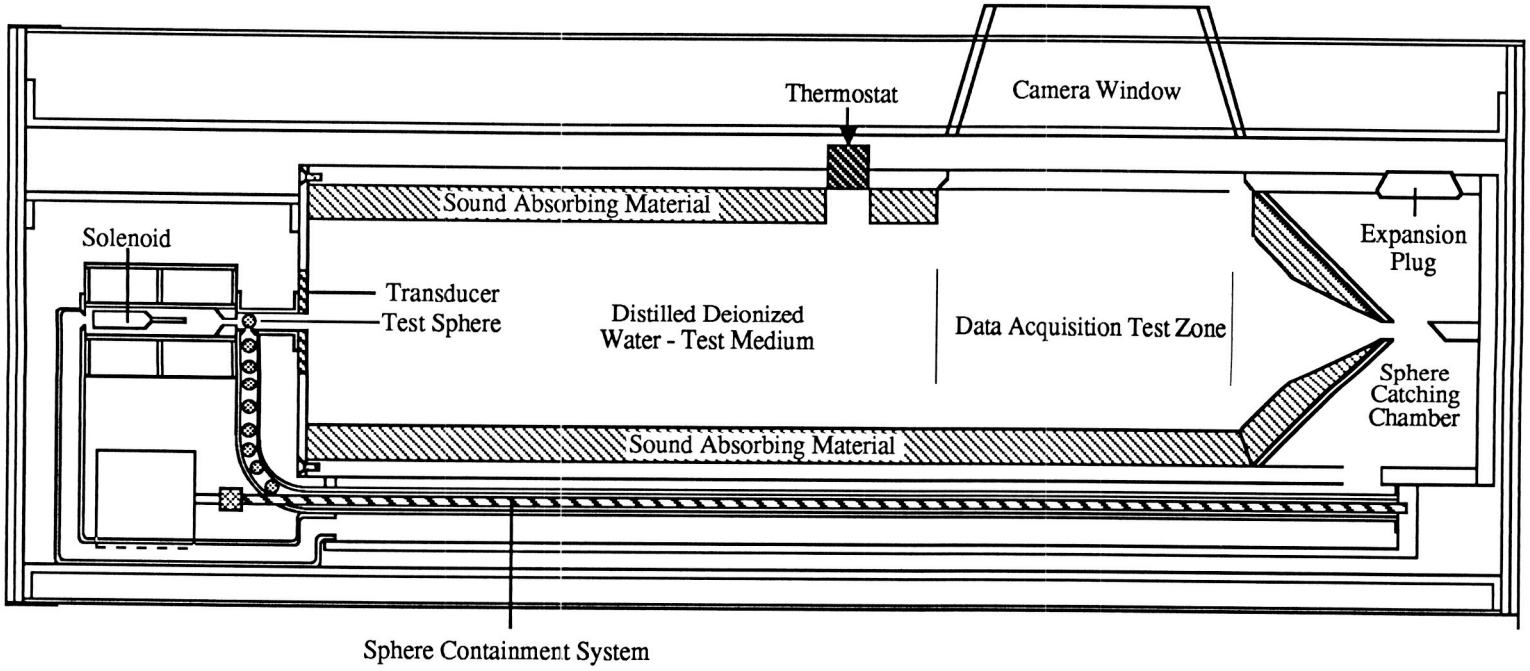

Figure 3

EXPERIMENTAL SETUP

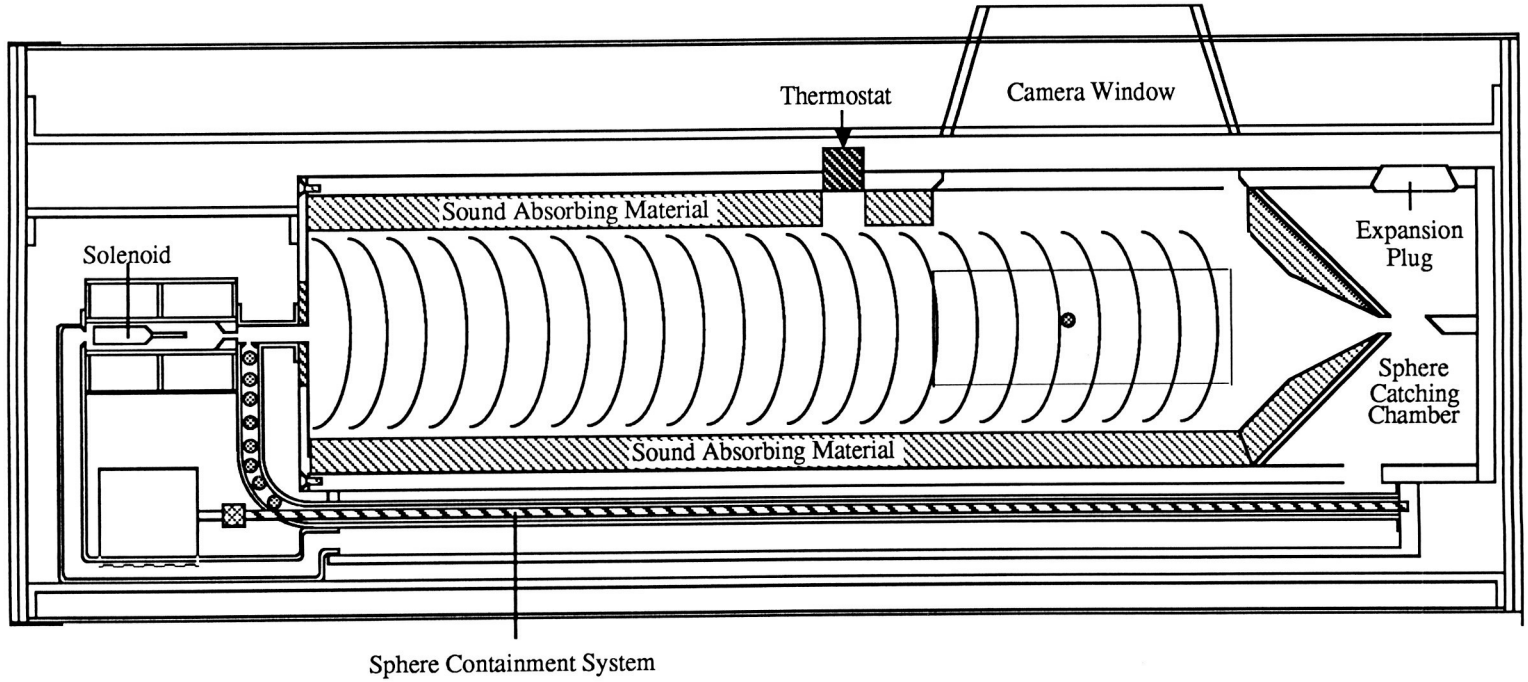

Figure 4

EXPERIMENT IN PROGRESS