Project Timeline

This is an extended timeline of the project that covers the earliest development of the theory behind the project all the way up to launch.

1893

Mach's Principal - In his book The Science of Mechanics (1893), Ernst Mach put forth the idea that it did not make sense to speak of the acceleration of a mass relative to absolute space. Rather, one would do better to speak of acceleration relative to the distant stars. What this implies is that the inertia of a body here is influenced by matter far distant. This had a great influence on Einstein and in the development of his theory of general relativity.

1887

Michelson and Morley Experiment showing the speed of light remains constant - Einstein's theories sprang from a ground of ideas prepared by decades of experiments. One of the most striking, in retrospect, was done in Cleveland, Ohio, by Albert Michelson and Edward Morley in 1887. Their apparatus, shown above, was a massive stone block with mirrors and crisscrossing light beams, giving an accurate measurement of any change in the velocity of light. Michelson and Morley expected to see their light beams shifted by the swift motion of the earth in space. To their surprise, they could not detect any change. It is debatable whether Einstein paid heed to this particular experiment, but his work provided an explanation of the unexpected result through a new analysis of space and time.

1905

Special Relativity - Special relativity is a theory proposed by Albert Einstein that describes the propagation of matter and light at high speeds. It was invented to explain the observed behavior of electric and magnetic fields, which it beautifully reconciles into a single so-called electromagnetic field, and also to resolve a number of paradoxes that arise when considering travel at large speeds. Special relativity also explains the behavior of fast-traveling particle, including the fact that fast-traveling unstable particles appear decay more slowly than identical particles traveling more slowly. Special relativity is an indispensable tool of modern physics, and its predictions have been experimentally tested time and time again without any discrepancies turning up. Special relativity reduces to Newtonian mechanics in the limit of small speeds. According to special relativity, no

wave or particle may travel at a speed greater than the speed of light c. Therefore, the usual rules from Newtonian mechanics do not apply when adding velocities that are large enough. It is often incorrectly stated that special relativity does not correctly deal with accelerations and general relativity must be used when accelerations are involved. While general relativity does indeed describe the relationship between mass and gravitational acceleration, special relativity is perfectly adequate for dealing with relativistic kinematics.

1915
General Theory of Relativity - A theory invented by Albert Einstein which describes gravitational forces in terms of the curvature in space caused by the presence of mass. The fundamental principle of general relativity asserts that accelerated reference frames and reference frames in gravitation fields are equivalent. General relativity states that clocks run slower in strong gravitational fields (or highly accelerated frames), predicting a gravitational redshift. It also predicts the existence of gravitational lensing, gravitational waves, gravitomagnetism, the Lense-Thirring effect, and relativistic precession of orbiting bodies.

1915
Leonard Schiff born in Fall River, Mass

1917
Bill Fairbanks born in Minneapolis, Minn

1918
J Lense and H Thirring Effect-calculated that a rotating object will slowly drag space and time around with it! (a moon orbiting a rotating planet undergoes a relativistic advance of its ascending node). (Frame Dragging)

1924
A.S. Eddington-proposed an earth based gyroscope or pendulum experiment of general relativity. (if the earth's rotation could be accurately measured by Foucault's pendulum or by gyrostatic experiments, the result would differ from the rotation relative to the fixed stars by this amount (credit to Schouten 1918))

1929
Schiff enters college (Ohio State) at age 14

1930

P.M.S. Blakett inspired by Eddington, examined the prospect for building a laboratory gyroscope to measure the 19 mas/yr precession, but then concluded that it was hopeless due to existing technology. Blakett received the Nobel Prize in Physics in 1948. Francis Everitt later worked under Blackett while obtaining his Ph.D from the University of London (Imperial College).

1933
Schiff graduates college (Ohio State) at age 18

1937
Schiff gets PhD from MIT at age 22

1939
Bill Fairbanks graduates college Whitman College (Walla Walla Washington), BA Chemisty

1938-1940
Schiff is at UC Berkeley, working with Robert Oppenheimer leads the creation of the atomic bomb for the US. Oppenheimer first starts Schiff thinking about relativity with a question about rotation and Mach's Priniciple.

1940
Bill Fairbanks enters Grad School in Physics & Teaching Fellow at University of Washington

1940
Schiff moves to position at the University of Pennsylvania as a Physics Instructor

1941
Bill Fairbanks marries Jane

Dec 7, 1941
Pearl Harbor

1942
Bill Fairbanks receives a draft notice, then a mysterious offer transmitted by one of his professors for Bill and Jan to work in the Radiation Lab at MIT. Bill was defining his thesis on a molecular physics technique. She was the second women appointed to the rad lab.

1942
Schiff becomes acting head of the University of Penn, Physics Dept. (He is 27)

1941-1945
During WWII-Schiff continues his work at Penn while working with a number of groups working on the military activities at Columbia, UCBerkeley, Navy Anti-submarine Research Group.

1942-45
Bill Fairbanks is staff member of Seaborne Radar Division, Rad Lab at MIT (World War II going on) Rad Lab was run by Larry Marshall,later Ernest Pollard. Bill developed a new technique for calibrating Radar Systems.

1945
Schiff moves to Los Alamo, NM under Robert Oppenheimer to work on the atomic bomb

July 16, 1945
Schiff was one of the people present for Trinity, the first atomic bomb.

1945
WWII ends after the bombing of Hiroshima and Nagasaki.

1945
The war was ending, and on Pollard's recommendation Bill was accepted into grad school at Yale. Bill didn't know what field of physics to go into, and considered doing nuclear physics. Pollard advised Bill that nuclear physics would soon be ancient news. Something less developed like low temperature physics would be more rewarding and better suited for Bill's talents.

1945
Bill Fairbank goes to grad school at Yale - Sheffield Fellow at Yale (Superconductivity and Low Temp Physics). Yale was to become the first Physics department in the US with a significant low temp group.

1946-47
Schiff returns to the U of Penn

1947

Schiff accepts a position at Stanford

1947
Bill Fairbanks at Yale is one of the first investigators (with brother Henry) to publish observations of second sound observed in Liquid Helium in the U.S.

1948
Bill Fairbanks receives Ph.D from Yale (Superconductivity and Low Temp Physics)

1948
Schiff becomes the Head of the Physics Department at Stanford (He is 33)

1948-52
Fairbank is assistant professor at Amherst College, Mass

1949
Schiff publishes a book entitled "Quantum Mechanics"

1952-58
Fairbank is Professor at Duke

1957-59
Robert Cannon is Assistant Professor at MIT (mechanical engineering)

1958-
Von braun's Rocket Team (eventually NASA/MSFC) launches Explorer 1 the first US orbiting satellite

1959
Fairbank is Professor at Stanford

1959
Robert Cannon starts as professor at Stanford in Aeronautics and Astronautics Department (specializing in precision gyroscopes) Robert later starts Guidance and Control Laboratory at Stanford University.

1959
C. W. Francis Everitt obtains Ph.D. at the University of London (Imperial College) for research under P.M.S. Blackett, a nobel prize winning physicist (in 1930, Blackett examined the prospect for building a laboratory

gyroscope to measure the General Relativity [Lense-Thirring Effect (19 mas precession/yr)??] but determined it was hopeless.

1959
Schiff & George E. Pugh (Defense Department) independently propose to test General Relativity by observing the precession of a gyroscope in an earth orbiting satellite with respect to a distant star.

1959
Bill Fairbank introduces his boss, Schiff to Robert Cannon at the Stanford swimming pool.

1960-1962
Francis Everitt spends two years at the University of Pennsylvania working on liquid helium and was responsible for the experimental discovery of the Òthird soundÓ, a surface wave on superfluid helium films.

1961
First formal contact w/NASA - Fairbanks writes Dr Abe Siberstein describing an instrument that would measure the geodetic precession to a few percent.

1962
Francis Everitt joins William Fairbanks and Leonard Shiff at Stanford on the Gravity Probe B experiment.

1964
NASA funding commences (retroactive to 1963) with supplement from US Air Force (Cannon & Fairbanks-co-principal investigators)

1964
With help from Honeywell, start developing gyroscopes

1965
1st fused quartz telescope built

1970-74
Bob Cannon becomes U.S. Assistant Secretary of Transportation for Systems Development and Technology

1971

NASA begins examining feasibility of a flight experiment. Ball Aerospace completed a Mission Definition Study which was the first look at the spacecraft layout, including a dewar spaceflight test, a gyro spaceflight test, and then the science mission. The dewar spaceflight test was accomplished in the 1982 flight of the IRAS (Infra-red Astronomy Satellite dewar).

1973
Dan Debra's successful flight of a drag-free satellite (the Transit navigation satellite)

1974-79
Bob Cannon moved from US Government to Professor & Chairman, Div. of Engineering & Applied Science, Cal Tech

1976
Gravity Probe A - Gravity Probe A - GP-A was launched from NASA-Wallops Flight Center in Virginia. The 1 hour 55 minute flight of a MASER atomic clock demonstrated that time changed as it rose to weaker levels of gravity, then fell back to the Earth. The primary objective of the mission was to test a portion of Einstein's gravitation and relativity theories called the "Principle of Equivalence," or "redshift" to an accuracy of 200 parts per million. It attained an altitude of 6,200 miles above the Earth before crashing into the Atlantic Ocean.

1977
End of grant, which represented the end of the longest running single continuous research grant ever awarded by NASA (11/63-7/77). This ended the exploratory phase of the program.

1977-85
Fairbanks was engrossed in finding a free quark. He was the first to provide experimental evidence of the existence of quarks (1977).

1979-93
Fairbanks rofessor & Chairman, Dept. of Aeronautics and Astronautics, Stanford University

1980
NASA conducts major review of technological readiness. They review team remarked Òthe remarkable technical accomplishments of the dedicated Stanford experiment team give us confidence that, when they

are combined with a strong engineering team in a flight development program, this difficult experiment can be done. Phase A study at MSFC for planning flight program.

1981
NASA launches first Shuttle

1982
NASA/MSFC had already completed a Phase A study in-house and a more in depth Phase B study, that determined that GP-B would need to be a somewhat large spacecraft (5300 lbs needing 576 Watts of power) that would be too expensive.

1982
IRAS flight of proves out feasibility of spaceflight dewar

1983
Stanford restructured the program, which cut the weight to 2800 lbs and 143 W and lowered the cost to $130M. It was decided to build the dewar and science instrument first and launched it on a 7 day test flight on the shuttle in 1989. Once back on earth, the dewar could go through minor refurbishment while the rest of the spacecraft was being finished. The dewar with the science instrument within would then be integrated with the rest of the spacecraft and launched in 1991 (both on the shuttle).

1984
The first phase called STORE (Shuttle Test of the Relativity Experiment), was fully endorsed by NASA and Lockheed Martin was selected as the prime subcontractor to assist Stanford in building the equipment.

1985
Gyro production throws out Beryllium , Hollowed Beryllium, Hollow Quartz spheres and focuses on Quartz rotors. Stanford pulls gyro rotor manufacturing lapping, polishing, and coating process in house from NASA/MSFC. Ongaley-one of the scientists that came with Wehner Von braun from germany after WWII, is one of the developers of the system.

1986
Challenger explodes. It takes NASA 2.5 years to get Shuttle back in space. NASA eliminates plans for a Shuttle Western launch facility at VAFB, which is needed for polar orbits of the shuttle. Science Mission switched to Delta 2 launch vehicle.

1989
Stanford's 1st prolonged levitation of a quartz sphere.

1992
First Flight Hardware within the Science Mission starts to be built

1992
Dewar Starts Fabrication

1995
NASA cancels Shuttle Test and directs Stanford to go directly to flight.

1996
Science Dewar delivered to Stanford

1996
Dewar goes cold & Stanford establishes magnetic shield in Dewar.

1998
Probe Delivered to Stanford

1999
Gyroscopes, Quartz Block, & Telescope complete

1999
Integration of Gyroscopes, Quartz Block, & Telescope

1999
Integration of Science Instrument with Probe

1999
Integration of Probe with Dewar & Ground Testing

2000
Probe Repair & Gyro #4 replaced

2000
Probe & Dewar Re-Integrated

2001
Payload Acoustic Test

2001
Integrated Payload Testing

2001
Integrate Payload with Spacecraft

2002
Payload Electronic Boxes Delivered

2002
Modal Test

2002
Space Vehicle Acoustic Test

November 2002
Thermal Vacuum Test

2003
Spin Balance

May 2003
Thermal Vacuum Re-Test

June 2003
Final Space Vehicle Testing

July 2003 -
Shipment to Launch Site

September 2003
Integration with Delta II Rocket

2003
Launch