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GAIA

Outlook

- Launch expected to take place on December 20, 2013, as of this writing
- Effort to switch out faulty transponders delays launch by one month
- GAIA shipped to launch site in August 2013
- Sunshield and antenna tested as spacecraft tested for extreme temperatures in 2012

Orientation

Description. The GAIA spacecraft will operate in Lissajous-type, eclipse-free orbit around the L2 point of the Sun-Earth system.

Sponsor. The European Space Agency (ESA) is the sponsor of the GAIA mission.

Status. As of this writing, GAIA is at the Kourou launch center being prepared to launch.

Total Produced. GAIA has completed production and is awaiting launch.

Application. The GAIA mission will determine the composition, formation, and evolution of our galaxy through three-dimensional mapping of over 1 billion stars, which amounts to about 1 percent of the Galactic stellar population.

Price Range. A production contract awarded to Astrium in 2006 for the GAIA spacecraft is valued at $406 million. The entire program, including manufacturing, launch, and operations, is expected to cost about $1.3 billion.

Contractors

Prime

Astrium Satellites (EADS)	http://www.astrium.eads.net/en, 31, Ave des Cosmonautes, ZI du Palays, Toulouse, 31402 France, Tel: + 33 5 62 19 62 19, Fax: + 33 5 61 54 57 10, Prime
German Space Agency, DLR	http://www.dlr.de/, Linder Hohe, Koln, 51147 Germany, Tel: + 49 2203 601 0, Fax: + 49 2203 67310, RDT+E (CCD Support)
Thales Alenia Space - Milano	http://www.thalesgroup.com, SS Padana Superiore 290, Vimodrome, Milan, 20090 Italy, Tel: + 39 022 507 51, Fax: + 39 022 505 515, RDT+E (Payload Data Handling)
Thales Alenia Space France	http://www.thalesgroup.com, 26 ave JF Champollion, BP 1187, Toulouse, 31037 France, Tel: + 33 05 34 35 36 37, Fax: + 33 05 61 44 49 90, RDT+E (System-Level Technical Assistance)

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Subcontractor

Sener Ingenieria & Sistemas SA	http://www.sener.es, Severo Ochoa, 4, Parque Tecnológico de Madrid, TRES CANTOS (Madrid), 28760 Spain, Tel: + 34 91 807 7000, Fax: + 34 91 807 7201, Email: dep.ambiente@sener.es (Deployable Sunshield)
e2v technologies plc	http://www.e2v.com/, 106 Waterhouse Ln, Chelmsford, CM1 2QU United Kingdom, Tel: + 44 0 1245 493 493, Fax: + 44 0 1245 492 492, Email: enquiries@e2vtechnologies.com (CCDs)

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Design Features. Astrium, the GAIA prime contractor, performed a concept and design study for the GAIA spacecraft in 2000. The study found the following instruments necessary: a high-performance, small-pixel CCD for payload focal planes; a high-speed, high-integration, low-noise detector chain; further validation of silicon carbide (SiC) technology for large mirrors; a high-data-rate phased-array antenna for L2 operation; and a ground database, archiving, and processing center.

In 2002, as a result of ESA's Cosmic Vision 2020 program, GAIA was redesigned. Its new optical system involves two identical main telescopes, each 1.7 meters wide, which will simultaneously observe stars in two directions in the sky, separated by an angle of 106°. Called "squinting," this method is vital in order to accurately measure the relative positions of all stars.

Auxiliary mirrors will extend the focal length within the narrow confines of the spacecraft. The detectors of each main telescope will note the location of every star and its brightness in four broad bands of wavelength. A third telescope, 75 centimeters wide and situated between the two main telescopes, will observe the same stars and measure their brightness in 14 narrow wavelength bands. It will also measure the speed at which an object is approaching or receding.

The satellite was also reconfigured for launch on a less costly Soyuz-Fregat rocket rather than the originally planned Ariane 5. The key behind the Cosmic Vision 2020 effort is to maximize reuse of components and technologies and to limit expenditures.

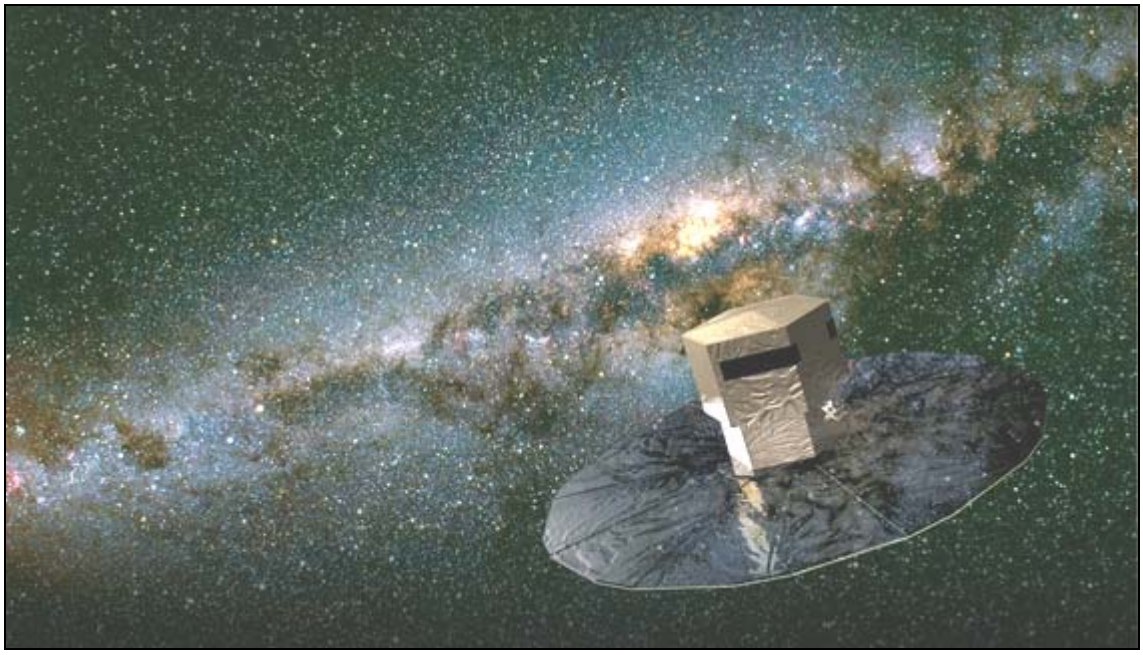
All GAIA operations will be carried out at the European Space Operation Center in Germany. These duties will include mission planning, spacecraft orbit and attitude determinations, and scientific instrument operations. Only one ground station will be used – either a Cebreros, Spain, ground station or a Perth, Australia station.

	Metric	**U.S.**
Weights		
Total Launch Mass (approx)	3,000 kg	6,615 lb
Payload	800 kg	1,764 lb
Service Module	900 kg	1,984.5 lb
System Margin	300 kg	661.5 lb
Fuel	1,000 kg	2,205 lb
Launch Adapter	100 kg	220.5 lb
Performance		
Design Life	6 yr	

Variants/Upgrades

GAIA will draw on technologies used in the Hipparcos and the Herschel and Planck missions.

GAIA



Artist's Impression of the GAIA Spacecraft

Source: ESA

Program Review

Background. Approval of a Concept and Technology Study for GAIA was granted in 1996. A one-year industrial and scientific study between mid-1997 and mid-1998 (by Matra Marconi Space, subsequently renamed Astrium SAS, and now EADS Astrium) led to the selection of GAIA by the ESA Science Program Committee in September 2000. The design included two separate astrometric telescopes (viewing directions), each with its own focal plane, and a dedicated telescope for medium-band photometry and to study radial velocity.

At the end of 2001, the revised ESA science program funding suggested that the high costs of cornerstone missions could not be supported, and a major review of the overall science program was undertaken by the agency's advisory bodies. The GAIA project initiated a rapid technical reassessment study in December 2001, with a duration of six months. The constraints on the launch vehicle were relaxed, and the detailed industrial reassessment study identified a payload design compatible with the smaller and cheaper Soyuz launch vehicle, but otherwise maintaining all of the primary scientific goals.

Cosmic Vision 2020. Upon realizing that its financial situation had become much more constricted than it ever imagined back at the start of its Horizon 2000 effort, the European Space Agency spent most of 2002 reassessing and prioritizing programs to accommodate its shrunken budget.

The revised approach, dubbed the Cosmic Vision 2020 program, requires that all missions be compacted tightly together in groups and that they reuse as much overlapping technology and components as possible to contain expenses. Ironically, the ESA did not cancel any missions under the new plan, but instead added the Venus Express and Eddington missions to its Space Science program. The price of this move was strict enforcement of cost-savings measures. For GAIA, this meant a design overhaul to accommodate launch on the less expensive Soyuz-Fregat rocket rather than the Ariane 5.

GAIA is the planned successor to ESA's Hipparcos satellite, which operated from 1989 to 1993 and charted the positions, motions, and variability of many stars with unprecedented accuracy. The GAIA mission is devised to expand upon the Hipparcos mission and to observe, chart, and track with precise, detailed 3-D imaging the billion brightest objects in and around the Milky Way galaxy. The spacecraft will operate for five years, identifying up to 100 asteroids in the solar system, 30 stars possessing planets, 50 stars exploding in other galaxies, and 300 distant quasars on a daily basis. Astronomers hope that GAIA's exceptional

view of the objects in the skies will expose some of them as relics of our galaxy's formation.

The 3-tonne spacecraft will be placed 1.5 million kilometers out at Lagrange Point No. 2 (L2). There, with its back to the Earth and shielded from light by a wide solar-cell collar, GAIA will scan the skies as it slowly revolves.

Contractors were chosen based on their expertise and response to specific statements of work. The prime contractor award – given to Astrium Satellites – was announced in May 2006 after a competitive study for Phase B. ESA will launch the spacecraft on a Soyuz-Fregat from Kourou, French Guiana.

In January 2010, three of the 10 payload mirrors were completed. The mirrors were delivered to EADS Astrium for integration into the payload module of GAIA. In November 2010, components of the spacecraft successfully completed tests to demonstrate the focal plane assembly and the video processing unit.

In June 2011, technicians at Astrium France finished assembling and aligning 106 separate charge-coupled devices (CCDs) that serve as the "eye" of the galaxy-mapping GAIA mission. Developed by e2v Technologies of Chelmsford, U.K., these CCDs can detect stars up to a million times fainter than the eye can see, according to ESA. Each CCD effectively operates as a miniature camera.

In December 2011, the sunshield was deployed. This test was followed by a test in July 2012 of the antenna system and a test in September 2012 to determine the spacecraft's ability to handle extreme temperatures. All of these tests will make sure the spacecraft is able to handle the rigors of space.

GAIA production was completed in August 2013 when it left Astrium's facility for the Kourou launch center. Launch was originally planned for November 20, 2013. However, an issue with the transponders installed on the spacecraft was discovered before launch. This discovery will delay launch by about a month, giving engineers time to install new transponders.

Funding

ESA will provide full funding for the GAIA program.

Timetable

Month	Year	Major Development
Oct	2000	GAIA chosen for sixth cornerstone mission
May	2006	ESA chooses Astrium Satellites as prime contractor
Jul	2007	Preliminary Design Review completed
	2013	Planned launch of GAIA on a Soyuz-Fregat

Forecast Rationale

The GAIA program has been restructured to keep costs under control. Under this restructuring, ESA is reusing overlapping technology and components from other programs. For example, the GAIA team and EADS Astrium will adopt the service module already developed for the Herschel and Planck missions. By using the existing system for housekeeping, communications, and attitude control, nearly all of the related design and production costs previously anticipated have been eliminated.

Along similar lines, EADS Astrium engineers incorporated optical technology they had developed for the Hipparcos mission. As a result, instead of two separate detectors, GAIA's two larger telescopes will image the sky from separate directions and the data will be superimposed into one image. This has allowed Astrium to cut costs with no reduction in capability.

In addition, the new optical payload is small enough to fit into the 3.8-meter fairing space of the Soyuz-Fregat launch vehicle while still retaining its desired accuracy. ESA also reduced the size of the GAIA spacecraft to allow launch on the smaller Soyuz-Fregat rocket rather than the more expensive Ariane 5.

The program achieved a number of milestones in 2010, and continued progress through 2013. In 2010, three of 10 payload mirrors were completed and tests on the focal plane assembly and the video processing unit were completed. In 2011, 106 charge-coupled devices of its billion-pixel camera were assembled and aligned. These CCDs will allow the detection of distant stars up to a

million times fainter than the eye can see. That same year, the sunshield was deployed. In 2012, the antenna was tested and the spacecraft underwent temperature tests. The spacecraft was shipped from Astrium's facility to the Guiana Space Center in Kourou for launch in August 2013. The discovery of a fault with GAIA's transponder, used to downlink data to Earth, will delay launch by one month. As of this writing, launch is expected to take place on December 20, 2013.

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