= CryoSat @-@ 2 =

CryoSat @-@ 2 is a European Space Agency environmental research satellite which was launched in April 2010 . It provides scientists with data about the polar ice caps and tracks changes in the thickness of the ice with a resolution of about 1 @.@ 3 centimetres (1 ? 2 in) .

CryoSat @-@ 2 was built as a replacement for CryoSat @-@ 1 , whose Rokot carrier rocket was unable to achieve orbit . Compared to its predecessor , CryoSat @-@ 2 features software upgrades , greater battery capacity and an updated instrument package . Its main instrument is an interferometric radar range @-@ finder with twin antennas , which measures the height difference between floating ice and open water .

CryoSat @-@ 2 is operated as part of the CryoSat programme to study the Earth 's polar ice caps , which is itself part of the Living Planet programme . The CryoSat @-@ 2 spacecraft was constructed by EADS Astrium , and was launched by ISC Kosmotras , using a Dnepr @-@ 1 carrier rocket , on 8 April 2010 . On 22 October 2010 , CryoSat @-@ 2 was declared operational following six months of on @-@ orbit testing .

= = Background = =

The initial proposal for the CryoSat programme was submitted as part of a call for proposals in July 1998 for Earth Explorer missions as part of the European Space Agency 's Living Planet programme . It was selected for further studies in 1999 , and following completion of a feasibility study the mission was authorised . The construction phase began in 2001 , and in 2002 EADS Astrium was awarded a contract to build the spacecraft . A contract was also signed with Eurockot , to conduct the launch of the satellite using a Rokot / Briz @-@ KM carrier rocket .

Construction of the original spacecraft was completed in August 2004 . Following testing the spacecraft was shipped to the Plesetsk Cosmodrome in August 2005 , and arrived on 1 September . The launch occurred from Site 133 / 3 on 8 October , however due to a missing command in the rocket 's flight control system , the second stage engine did not shut down at the end of its planned burn , and instead the stage burned to depletion . This prevented the second stage and Briz @-@ KM from separating , and as a result the rocket failed to achieve orbit . The spacecraft was lost when it reentered over the Arctic Ocean , North of Greenland .

Due to the importance of the CryoSat mission for understanding global warming and reductions in polar ice caps , a replacement satellite was proposed . The development of CryoSat @-@ 2 was authorised in February 2006 , less than five months after the failure .

= = Development = =

Like its predecessor , CryoSat @-@ 2 was constructed by EADS Astrium , with its main instrument being built by Thales Alenia Space . Construction and testing of the spacecraft 's primary instrument was completed by February 2008 , when it was shipped for integration with the rest of the spacecraft . In August 2009 , the spacecraft 's ground infrastructure , which had been redesigned since the original mission , was declared ready for use . Construction and testing of the spacecraft had been completed by mid @-@ September . The Project Manager for the CryoSat @-@ 2 mission was Richard Francis , who had been the Systems Manager on the original CryoSat mission .

CryoSat @-@ 2 is an almost @-@ identical copy of the original spacecraft , however modifications were made including the addition of a backup radar altimeter . In total , 85 improvements were made to the spacecraft when it was rebuilt .

= = Supporting Measurements : CRYOVEX = =

It was clear from the beginning of the CryoSat programme that an extensive series of measurements would be needed , both to understand interaction of the radar waves with the surface of the ice caps and to relate the measured freeboard of floating sea ice with its thickness . This latter

, in particular , would have to take account of snow loading . For sea ice , which moves as it is blown by the wind , it was also necessary to develop techniques which could give consistent results when measured from platforms travelling at different speed (scientists on the surface , helicopter @-@ towed sounders , aircraft @-@ borne radars and CryoSat itself) . A number of campaigns were performed under a programme called CRYOVEX which aimed to address each of the identified areas of uncertainty . These campaigns continued through the development of the original CryoSat and were planned to continue after its launch .

Following the announcement that CryoSat @-@ 2 would be built the CRYOVEX programme was extended . Experiments were conducted in Antarctica to determine how snow could affect its readings , and to provide data for calibrating the satellite . In January 2007 the European Space Agency issued a request for proposals for further calibration and validation experiments . Further CryoVEx experiments were conducted on Svalbard in 2007 , followed by a final expedition to Greenland and the Devon Ice Cap in 2008 . Additional snow measurements were provided by the Arctic Arc Expedition , and the Alfred Wegener Institute 's Airborne Synthetic Aperture and Interferometric Radar Altimeter System (ASIRAS) instrument , mounted aboard a Dornier Do 228 aircraft .

= = Final preparations = =

When it was approved in February 2006 , the launch of CryoSat @-@ 2 was planned for March 2009 . It was originally planned that like its predecessor it would be launched by a Rokot , however due to a lack of available launches a Dnepr @-@ 1 rocket was selected instead . ISC Kosmotras were contracted to perform the launch . Due to delays to earlier missions and range availability problems , the launch was delayed until February 2010 .

The Dnepr rocket assigned to launch CryoSat @-@ 2 arrived at the Baikonur Cosmodrome by train on 29 December 2009 . On 12 January 2010 , the first two stages of the rocket were loaded into the launch canister , and the canister was prepared for transportation to the launch site . On 14 January , it was rolled out to Site 109 / 95 , where it was installed into its silo . The next day saw the third stage transported to the silo , and installed atop the rocket .

Following the completion of its construction , CryoSat @-@ 2 was placed into storage to await launch . In January 2010 , the spacecraft was removed from storage , and shipped to Baikonur for launch . It departed Munich Franz Josef Strauss Airport aboard an Antonov An @-@ 124 aircraft on 12 January , and arrived at Baikonur the next day . Following arrival at the launch site , final assembly and testing were conducted .

During final testing , engineers detected that the spacecraft 's X band (NATO H / I / J bands) communications antenna was transmitting only a tiny fraction of the power that it should . Thermal imaging showed that the waveguide to the antenna , deep inside the spacecraft , was very hot . Clearly that was where the missing power was being dissipated . The waveguide could not normally be inspected or repaired without major disassembly of the satellite , which would have required a return to the facilities in Europe and resulted in a major delay to the launch . To avoid doing this , a local surgeon was brought in to inspect the component with an endoscope . The surgeon , Tatiana Zykova , discovered that two pieces of ferrite were lodged in the tube , and was able to remove both of them . Engineers were able to assist the removal of the second one with a magnet . It was determined that the ferrite had come from an absorption load installed deep inside the antenna , which was intended to improve its performance . Some ferrite (the remaining stump of this load) was removed from inside the base of the antenna in order to prevent any further debris falling into the waveguide .

On 4 February , the CryoSat @-@ 2 spacecraft was fuelled for launch . Then on 10 February it was attached to the payload adaptor , and encapsulated in the payload fairing , to form a unit known as the Space Head Module . This was transported to the launch pad by means of a vehicle known as the crocodile , and installed atop the carrier rocket . Rollout occurred on 15 February , and the next day the satellite was activated in order to test its systems following integration onto the rocket .

= = Launch = =

When the spacecraft was installed atop the Dnepr , launch was scheduled to occur on 25 February , at 13 : 57 UTC . Prior to this , a practice countdown was scheduled for 19 February . Several hours before the practice was scheduled to begin ISC Kosmotras announced that the launch had been delayed , and as a result the practice did not take place . The delay was caused by a concern that the second stage manoeuvring engines did not have a sufficient quantity of reserve fuel .

Following the delay , the Space Head Module was removed from the rocket , and returned to its integration building on 22 February . Whilst it was in the integration building , daily inspections were made to ensure that the spacecraft was still functioning normally . Once the fuel issue had been resolved , the launch was rescheduled for 8 April , and launch operations resumed . On 1 April , the Space Head Module was returned to the silo , and reinstalled atop the Dnepr . Following integrated tests , the practice countdown was successfully conducted on 6 April .

CryoSat @-@ 2 was launched at 13 : 57 : 04 UTC on 8 April 2010 . Following a successful launch , CryoSat @-@ 2 separated from the upper stage of the Dnepr into a low Earth orbit . The first signals from the satellite were detected by a ground station at the Broglio Space Centre in Malindi , Kenya , seventeen minutes after launch .

= = Mission = =

CryoSat @-@ 2 's mission is to study the Earth 's polar ice caps , measuring , and looking for variation in , the thickness of the ice . Its mission is identical to that of the original CryoSat .

The primary instruments aboard CryoSat @-@ 2 are SIRAL @-@ 2 , the SAR / Interferometric Radar Altimeters ; which uses radar to determine and monitor the spacecraft 's altitude in order to measure the elevation of the ice . Unlike the original CryoSat , two SIRAL instruments are installed aboard CryoSat @-@ 2 , with one serving as a backup in case the other fails .

A second instrument , Doppler Orbit and Radio Positioning Integration by Satellite , or DORIS , is used to calculate precisely the spacecraft 's orbit . An array of retroreflectors are also carried aboard the spacecraft , and allow measurements to be made from the ground to verify the orbital data provided by DORIS .

Following launch , CryoSat @-@ 2 was placed into a low Earth orbit with a perigee of 720 kilometres (450 mi) , an apogee of 732 kilometres (455 mi) , 92 degrees of inclination and an orbital period of 99 @.@ 2 minutes . It had a mass at launch of 750 kilograms (1 @,@ 650 lb) , and is expected to operate for at least three years .

Launch and Early Orbit Phase operations were completed in the morning of 11 April 2010 , and SIRAL @-@ 2 was activated later the same day . At 14 : 40 UTC , the spacecraft returned its first scientific data . Initial data on ice thickness was presented by the mission 's Lead Investigator , Duncan Wingham , at the 2010 Living Planet Symposium on 1 July . Later the same month , data was made available to scientists for the first time . The spacecraft underwent six months of on @-@ orbit testing and commissioning , which concluded with a review on 22 October 2010 that found the spacecraft was operating as expected , and that it was ready to begin operations .

The exploitation phase of the mission started on the 26 October 2010 under the responsibility of Tommaso Parrinello who is currently the Mission Manager .

= = Results = =

Data from CryoSat @-@ 2 has shown 25 @,@ 000 seamounts , with more to come as data is interpreted .