

**CANADIAN SPACE AGENCY  
2014-15 REPORT ON PLANS AND PRIORITIES**

**ANNEXES**

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- Annexe 2: Upcoming Internal Audits and Evaluations over the next three fiscal years
- Annexe 3: Status Report on Transformational and Major Crown Projects
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## **Annexe 1 – Details on Transfer Payment Programs (TPPs)**

### **Departmental Plan for Transfer Payment Programs for the Canadian Space Agency**

**Name of Transfer Payment Program:** Contributions under the Canada/European Space Agency (ESA) Cooperation Agreement.

**Start Date:** March 28, 2012 (ratification of the new Agreement)  
September 20, 2012 (approval of the revised T&C)

**End Date:** December 31, 2019 (end date of the new Agreement)

**Fiscal Year for Terms and Conditions:** 2012-13 - The revised terms and conditions for the contributions, under the 2012-19 Cooperation Agreement, were approved on September 20, 2012.

**Strategic Outcome:** Canada's exploration of space, provision of space services and development of its space capacity meet the nation's needs for scientific knowledge, innovation and information.

#### **Program 1.3 - Future Canadian Space Capacity**

Sub-program 1.3.2 Space innovation and Market Access

Sub-Sub-Program 1.3.2.1 – International market Access

**Transfer Payment Program Description:** Enhance Canadian industry's technological base and provide access to European markets for value added products and services in the fields of Earth observation (EO), telecommunications and generic technological activities; foster the participation of Canadian academia and make possible the demonstration of Canadian space technologies in European microgravity and space exploration missions and programs. This is achieved through a financial contribution by the CSA to European Space Agency (ESA) optional programs..

#### **Expected Results Specific to the Transfer Payment Program:**

Result: Canadian investments under the Canada-ESA Agreement allow Canadian industry to access the European institutional market.

Performance Indicator: Canada's performance in term of industrial return, and level of quality (e.g., advanced technology and innovative content) of contracts obtained by Canadian organizations)

Result: The Canadian industrial firms have access to flight opportunities where they may gain flight heritage for their technologies/components.

Performance Indicator: Number of Canadian technologies/hardware that have flown and/or have been space qualified as a result of Canada's participation in ESA's programs

	Forecast Spending 2013-14	<b>Planned Spending 2014-15</b>	Planned Spending 2015-16	Planned Spending 2016-17
Total Contributions ( in dollars)	23,990,148	27,373,853	26,215,147	27,031,000
Total Transfer Payments ( in dollars)	23,990,148	27,373,853	26,215,147	27,031,000

Notes: 1. This table details contribution programs with funding in excess of \$5 million per annum.

**Fiscal Year of Last Completed Evaluation: 2010–11**

To learn more, go to: [http://www.asc-csa.gc.ca/pdf/evaluation\\_2010-canada-esa\\_eng.pdf](http://www.asc-csa.gc.ca/pdf/evaluation_2010-canada-esa_eng.pdf)

**Decision following the Results of Last Evaluation:**

The CSA intensified its efforts to renew the Cooperation Agreement to ensure that Canada maintains a presence in European markets.

To meet program requirements, the CSA implemented a well-structured and transparent process for holding consultations with industry to support the selection of optional programs.

**Fiscal Year of Planned Completion of Next Evaluation: 2015–16**

**General Targeted Recipient Group:**

Canadian space sector firms, universities and not-for-profit research organizations.

**Initiatives to Engage Applicants and Recipients:**

During 2011–12, the CSA actively consulted the Canadian space sector (industry and academia) and Government of Canada organizations as part of the program selection process in preparation for the 2012 ESA Ministerial Council meeting during which ESA member states and Canada announced their position on contributions to the proposed ESA Programs. Similar consultations are planned for future ESA Ministerial Council meetings.

**Name of Transfer Payment Program:** Class Grant and Contribution Program to support Research, Awareness and Learning in Space Science and Technology.

**Start Date:** October 1<sup>st</sup>, 2009

**End Date:** N/A – Ongoing program

**Fiscal Year for Terms and Conditions:** 2009-10

**Strategic Outcome:** Canada's exploration of space, provision of space services and development of its space capacity meet the nation's needs for scientific knowledge, innovation and information.

**Program 1.1 Space Data, Information and Services**

Sub-program 1.1.1. Earth Orbit Satellite Missions and Technology

Sub-Sub-Program 1.1.1.3 Scientific Missions

Sub-program 1.1.2 Ground Infrastructure

Sub-Sub-Program 1.1.2.2 Data Handling

Sub-Program 1.1.3 Space Data, Imagery and Services Utilization Development

Sub-Sub-Program 1.1.3.1 Earth Observation Data and Imagery Utilization

Sub-Sub-Program 1.1.3.3 Scientific Data Utilization

**Program 1.2 Space Exploration**

Sub-program 1.2.1 International Space Station

Sub-Sub-Program 1.2.1.1 International Space Station Utilization

Sub-Program 1.2.2 Exploration Missions and Technology

Sub-Sub-Program 1.2.2.1 Space Astronomy Missions

Sub-Program 1.2.3 Human Space Missions and Support

Sub-Sub-Program 1.2.3.2 Operational Space Medicine

Sub-Sub-Program 1.2.3.3 Health and Life Sciences

**Program 1.3 Future Canadian Space Capacity Program**

Sub-Program 1.3.1 Sub-Program – Space Expertise and Proficiency

Sub-Program 1.3.2 Space innovation and Market Access

Sub-Sub-Program 1.3.2.2 Enabling Technology Development

**Transfer Payment Program Description:** The Class Grant and Contribution Program to support Research, Awareness and Learning in Space Science and Technology (S&T) supports knowledge development and innovation in the Canadian Space Agency's (CSA) priority areas while increasing the awareness and participation of Canadians in space-related disciplines and activities. The Program has two components: a) Research; and, b) Awareness and Learning.

The Research component aims at supporting the development of S&T; foster the continual development of a critical mass of researchers and Highly Qualified People (HQP) in Canada; and support information-gathering and space-related studies and research associated with the CSA's priorities.

The Awareness and Learning component aims at providing learning opportunities for Canadian students in various space-related disciplines. Please note that the CSA has not planned to support financially initiatives under the Awareness and Learning component which aimed at supporting elementary and secondary students.

### **Expected Results Specific to the Transfer Payment Program:**

#### **1. Research Component**

Result # 1: Increased knowledge from research projects in priority space S&T areas.

- . Performance Indicator: Number of new and ongoing space science and technology initiatives (Announcement of Opportunity) and projects.
- . Performance Indicator: Number of completed space science and technology initiatives (Announcement of Opportunity) and projects.
- . Performance Indicator: Number of Highly Qualified Personnel (research team) involved in space science and technology initiatives and projects.

Result # 2: Maintained and/or increased space focus in universities, post-secondary institutions, and not-for-profit organizations.

- . Performance Indicator: Number of universities, post-secondary institutions and not-for-profit and for-profit organizations involved in financed projects.

Result # 3: Partnerships established and/or sustained.

- . Performance Indicator: Number and type of new partnerships created and sustained.
- . Performance Indicator: Number of research partnerships (national and international).

Result # 4: Partner contributions leveraged.

- . Performance Indicator: Number of agreements leveraged funding.
- . Performance Indicator: Proportion of leveraged funds vs. grant/contribution funds.

Result # 5: Access to international collaboration for Canadian organizations.

- . Performance Indicator: Number of agreements leveraged by international funding.

To be updated by Finance	Forecast Spending 2012-2013	<b>Planned Spending 2013-2014</b>	Planned Spending 2014-2015	Planned Spending 2015-2016
Total Grants ( in dollars)	6,304,000	<b>6,535,000</b>	6,591,000	6,442,000
Total Contributions ( in dollars)	1,909,000	<b>5,398,000</b>	9,360,1180	2,700,000
Total Transfer Payments ( in dollars)	8,213,000	<b>11,933,000</b>	15,951,118	9,142,000

Notes: 1. This table details contribution programs with funding in excess of \$5 million per annum.

**Fiscal Year of Last Completed Evaluation:** N/A

**Decision following the Results of Last Evaluation:** N/A

**Fiscal Year of Planned Completion of Next Evaluation:** 2014-2015

**General Targeted Recipient Group:**

Eligible recipients for Grants:

The Research Component includes Canadian universities and post-secondary institutions, not-for-profit organizations established and operating in Canada and not-for-profit international research organizations or a cluster formed by a combination of the above.

Recipient categories: Industry-related, Non-profit organizations, International organizations

Eligible recipients for Contributions:

The Research Component include Canadian universities and post-secondary institutions, for-profit and not-for-profit organizations established and operating in Canada, and not-for-profit international research organizations or a cluster formed by a combination of the above.

Recipient categories: Industry-related, Non-profit organizations, International organizations

**Initiatives to Engage Applicants and Recipients:**

Since January 2012, CSA has engage applicants and recipients dialogue through automated annual follow-up of projects and extended the initiative in order to establish also a dialogue with potential applicants and recipients.

Consultations, presentations to and discussions with the academic and industrial communities as well as with other potential recipient groups are ongoing and will continue.

**Annexe 2 – Upcoming Internal Audits and Evaluations over the next three fiscal years**

<b>Name of Internal Audit</b>	<b>Type</b>	<b>Status</b>	<b>Expected Completion Date</b>
Advanced Exploration Technology Development Program – Economic Action Plan	Management Framework	Completed	December 2013
Project management Framework	Management Framework	Planned	March 2014
Office of the Comptroller General (OCG) Horizontal Audit of Financial Forecasting	Management Framework	Planned	March 2014
Planning and Implementation of the Deficit Reduction Action Plan (DRAP)	Compliance / Management Framework	Planned	June 2014
Security and Mission Assurance	Management Framework	Planned	December 2014
Governance Processes (monitoring and review of priorities)	Management Framework	Planned	December 2014
OCG Horizontal Audit of Information Technology (IT) Security	Compliance / Management Framework	Planned by OCG	March 2015
Space Astronomy Missions and Planetary Missions Programs	Management Framework	Planned	March 2015
Earth Observation Missions Program – RCM	Management Framework	Planned	December 2015
Satellite Operations of the Ground Infrastructure Program	Compliance / Management Framework	Planned	March 2016
Investment Plan Development Process	Compliance / Management Framework	Planned	March 2016
OCG Horizontal Audit of the Efficiency of Procurement and Contracting Practices	Management Framework	Planned by OCG	March 2016
Contracting and Acquisition Management	Management Framework	Planned	March 2016

The Risk Based Audit Plan is presently under revision; therefore, the audits that will be undertaken in fiscal year 2015-16 have not yet been identified.

## Evaluations

<b>Name of Evaluation</b>	<b>Program</b>	<b>Planned Start Date</b>	<b>Expected Completion Date</b>
Advanced exploration technology development	1.2.2.3	September 2012	March 2014
Scientific Missions (Cassiope Contribution Program only)	1.1.1.3	July 2013	March 2014
Space Astronomy Missions (NeosSat Project only)	1.2.2.1	July 2013	March 2014
Communications Missions (including M3MSat Project)	1.1.1.2/ 1.1.2/ 1.1.3.2	April 2014	March 2015
Qualifying Testing Services	1.3.3	April 2014	March 2015
Class Grant and Contribution Program to support Research, Awareness and Learning in Space Science and Technology	Includes several PAA elements	April 2014	March 2015
International Market Access Program	1.3.2.1	April 2014	September 2015
Scientific Missions	1.1.1.3/ 1.1.2/ 1.1.3.3	April 2015	March 2016
Enabling Technology Development	1.3.2.2	April 2015	March 2016
Earth Observation Missions	1.1.1.1/ 1.1.2/ 1.1.3.1	April 2015	March 2017
Space Expertise and Proficiency	1.3.1	April 2016	March 2017
International Space Station Utilization, Astronaut Training and Missions, Operational Space Medicine and Health and Life Sciences	1.2.1.2/ 1.2.3.1/ 1.2.3.2/ 1.2.3.3	April 2016	March 2018
International Space Station Assembly and Maintenance Operations	1.2.1.1	April 2017	March 2018
Space Astronomy Missions	1.2.2.1/ 1.2.2.2	April 2017	March 2018

The Five-Year Evaluation Plan is presently under revision; therefore, the evaluations that will be undertaken in fiscal year 2017-18 have not yet been identified.



## **Annexe 3 – Status Report on Transformational and Major Crown Projects**

### **RADARSAT Constellation Mission**

#### **1- Description**

The RADARSAT Constellation Mission (RCM) is the next generation of Canadian Earth observation radar satellites. RADARSAT-1 was launched in 1995 and continued in operation until March 2013. RADARSAT-2, developed in partnership with the private sector, was launched in 2007 for a seven-year mission, but given its current performance, it is expected to remain operational for many more years. Canada has established itself as a leading global supplier of C-band satellite radar data for Earth observation. The RADARSAT Constellation Mission will enhance this leadership and position Canadian industry in technology and value-added product markets.

The RADARSAT Constellation Mission is comprised of three small identical satellites orbiting the Earth. The launch of the constellation is planned in 2018. With a constellation, the time between successive imaging of a specific point on Earth is significantly reduced. The creation of a three-satellite constellation will increase the frequency of available information, as well as the reliability of the system, making it better suited to the operational requirements of departments. In the event of a satellite failure, the remaining tandem would continue to provide a reduced level of service. The lower cost of satellites facilitates the replacement of individual satellites and makes the system scalable.

The scope of the RCM Major Crown Project includes the requirement definition, design, development manufacturing, integration, testing and launching of the satellites as well as the design, development, manufacturing and installation of the associated ground segment. One year of operation of the three-satellite constellation is also included as well as an applications development program.

The RADARSAT Constellation Mission will provide reliable all-weather day and night data in support of federal departments' operations and mandates in areas such as: maritime surveillance, disaster management, environmental monitoring and natural resources management. The three-satellite constellation provides average daily coverage of most of Canada and its surrounding waters. The satellite coverage increases significantly in the North, where the constellation will provide coverage two to three times daily of the Arctic and the Northwest Passage.

In support of the maritime surveillance requirements of federal departments, the RCM is the principal data source envisaged for wide area surveillance of Canada's remote areas and marine approaches. Only satellite data can offer regular cost effective coverage to task ships and aircraft in order to intercept suspicious vessels. The daily coverage of marine areas will also support fisheries monitoring, ice and iceberg monitoring, pollution monitoring and integrated ocean and coastal zone management. The RCM's maritime surveillance capabilities also support Canadian sovereignty and security. Recently, the technology was developed to capture ship-originated Automatic Identification System (AIS) signals from space. The combination of space-based radar images and AIS signals will provide a powerful surveillance capacity over Canada's maritime approaches.

In support of disaster management, both in Canada and around the world, the RCM will provide critical and timely data to support disaster mitigation, warning, response and recovery activities carried out by the Department of National Defence and by Public Safety Canada, as well as to help Canada meet its obligations with respect to international disaster relief. The types of disasters for which RCM data will be used for monitoring and relief purposes include floods, oil spills, volcanic eruptions, earthquakes and hurricanes.

In support of environmental monitoring RCM will provide data for wide area change detection in order to provide support for activities such as water monitoring, wetlands mapping, coastal change monitoring and changes in the permafrost in northern Canada. RCM data will contribute to the production of more accurate weather forecasts and warnings pertaining to marine conditions, winds, severe storms and floods.

In support of natural resources management, RCM data will be a critical source of information used by government departments to monitor the changing state of Canada’s agricultural areas, forests and wildlife habitats. RCM data will also be used in the mining and energy sectors for resource explorations operations to ensure that critical infrastructure is monitored properly for safety and integrity.

In addition, the RADARSAT Constellation Mission sustains the development of Canadian high technology design and manufacturing capabilities and the integration of satellite data into information products and services. Canada’s space and geomatics industries will benefit from better positioning in international markets and privileged access to data deemed essential by many international users.

**Project phase: D - Implementation**

**Leading and participating Departments and Agencies**

<b>Sponsoring Agency:</b>	Canadian Space Agency
<b>Contracting Authority:</b>	Public Works and Government Services Canada
<b>Participating Departments:</b>	Aboriginal Affairs and Northern Development Canada Agriculture and Agri-Foods Canada Canadian Coast Guard Canadian Ice Service Department of Foreign Affairs and International Trade Department of National Defence Environment Canada Fisheries and Oceans Canada Industry Canada Natural Resources Canada Parks Canada Public Safety Canada Royal Canadian Mounted Police Statistics Canada Transport Canada

### Prime and Major Sub-Contractors

<p>Prime Contractor:</p> <p>MDA Systems Ltd (a division of MacDonald, Dettwiler and Associates (MDA))</p>	- Richmond, British Columbia
<p>Major Sub-Contractors:</p> <ul style="list-style-type: none"> <li>- MDA Montreal</li> <li>- Magellan Aerospace</li> <li>- MDA Halifax</li> <li>- Space X</li> <li>- EADS, Astrium</li> <li>- COMDEV Europe</li> </ul> <p>Canadian Tier 2 and Tier 3 Subcontractors:</p> <ul style="list-style-type: none"> <li>- EADS, Composites Atlantic</li> <li>- IMP Group</li> <li>- DRS</li> <li>- Mecachrome</li> <li>- Maya</li> </ul>	<ul style="list-style-type: none"> <li>- Ste.-Anne-de-Bellevue, Québec</li> <li>- Winnipeg, Manitoba</li> <li>- Halifax, Nova Scotia</li> <li>- Hawthorne, California, USA</li> <li>- United Kingdom</li> <li>- United Kingdom</li> </ul> <ul style="list-style-type: none"> <li>- Lunenburg, Nova-Scotia</li> <li>- Halifax, Nova-Scotia</li> <li>- Ottawa, Ontario</li> <li>- Mirabel, Quebec</li> <li>- Montreal, Quebec</li> </ul>

### Major Milestones

The following are the major milestones of the RADARSAT Constellation Major Crown Project, by phase:

Phase	Major Milestones	Date (at completion)
A	Requirement Definition	March 2008
B	Preliminary Design	March 2010
C	Detailed Design Review	November 2012
D	Launch satellite #1, #2, and #3	2018
E1	Operations (part of MCP)	2019-2020
E2	Operations (not part of MCP)	2025-2026

### Project Outcomes

This MCP contributes to the Program 1.1 Space Data, Information and Services which includes the provision of space-based solutions and the progression of their utilization. It also serves to install and run ground infrastructure that processes the data and operates satellites. This Program utilizes space-based solutions to assist Government of Canada (GoC) organizations in delivering growing, diversified or cost-effective programs and services within their mandate, which is related to key national priorities, such as sovereignty, defence, safety and security, resource management, environmental monitoring and the North. It also provides academia with data required to perform its own research. The contribution of the MCP to the program objectives is measured through the Performance Measurement Framework.

## **Program 1.1 Space Data, Information and Services**

Result: Government of Canada (GoC) organizations offer more diversified or cost-effective programs and services due to their utilization of space-based solutions

Performance Indicator # 1: Number of new GoC's programs offering more diversified or efficient services

### **Sub-Program 1.1.1 Earth Orbit Satellite Missions and Technology**

Result: GoC organizations are using space-based data to deliver their mandate.

Performance Indicator # 1: Number of GoC's programs using space data or related information to deliver their mandate.

Performance Indicator # 2: Percentage of RADARSAT data used in program's delivery.

## **Progress Report and Explanation of Variances**

On December 13, 2004, the Domestic Affairs Committee of Cabinet granted approval-in-principle to a ten-year program to implement a RADARSAT Constellation Mission aimed at addressing user needs in relation to Canadian sovereignty and marine surveillance, environmental monitoring and change detection, and disaster management. The RCM is to be government-owned and operated.

On June 6, 2005, Treasury Board granted Preliminary Project Approval (PPA) for the RADARSAT Constellation Mission and expenditure authority for the Project Initial Planning and Identification (Phase A). During Phase A, feasibility studies were completed, user requirements were defined, and risk mitigation activities and options analysis for the bus and payload were carried out. The initial scope of work of Phase A was completed in December 2006. Phase A was then extended to allow additional technical risk reduction activities to continue during the period prior to the Phase B contract award. This was completed in March 2008.

A revised Preliminary Project Approval Treasury Board Submission to proceed to Phases B and C was approved in March 2007. Following a competitive Request for Proposal (RFP) process, Public Works and Government Services Canada (PWGSC) obtained authority to enter into a contract with the Prime Contractor, MDA and the contract for Phase B was awarded to MDA in November 2008. The Preliminary Design (Phase B) was completed in March 2010. The contract for Phase B was subsequently amended to include the detailed design (Phase C).

A second revised Preliminary Project Approval was approved by Treasury Board in December 2010. The purpose of this revised PPA was to provide additional expenditure authority to include the procurement of long-lead items during Phase C and also to include a technology demonstration program for the Department of National Defence funded Automatic Identification System (AIS) payload.

The final review of the overall mission-level system detailed design, the Mission Critical Design Review (CDR), was conducted in November 2012. A selected set of activities are pursued until March 2014 on Phase C, such as closing actions resulting from the design reviews and the procurement of long-lead items.

Treasury Board granted Effective Project Approval for the RCM in December 2012, which provides expenditure and contracting authorities to complete the project and carry out the first year of RCM operations. The contract for Phase D and E1 was awarded on January 9, 2013. Since contract award, planning activities were completed and major milestones were achieved to initiate the implementation phase of the satellites and associated ground system. Except for a 6-month delay in the contract award for the bus, work is progressing as planned on the major sub-systems. Although the late signature of the bus subcontract has put some pressure on the implementation schedule, mitigation activities were applied to preserve the launch date, which is still planned for 2018.

### **Industrial Benefits**

Significant industrial benefits in the space and Earth Observation sectors are expected from the RADARSAT Constellation program. It is expected to generate employment growth in the Canadian knowledge-based economy and spur the growth of small and medium-sized businesses as the Canadian infrastructure and services industry continues to grow. As of March 31, 2013, the CSA had provided the Canadian industry with funding of more than \$214.05 million to carry out work resulting directly from the design of the RADARSAT Constellation Major Crown Project.

Regarding Canadian content and the distribution of contracts within Canada, the prime contract includes a requirement for 70% Canadian content, excluding launch services and sub-systems for which there are no suppliers available in Canada. The Prime Contractor is also required to meet the CSA's overall regional distribution targets on a "best efforts" basis. In addition, given some past challenges in achieving regional targets, a minimum requirement of 3.5% of the 70% Canadian content has been set for the Atlantic. This objective was met in March 2012 and held steady in 2013 (~3.2%).

The prime contract includes reporting obligations and performance measurements as well as financial penalties for not meeting the minimum Atlantic Canada content requirement. The CSA works closely with the Atlantic Canada Opportunities Agency (ACOA) to monitor regional distribution and to help support the Prime Contractor achieve the said targets.

**Regional Distribution of RADARSAT Constellation Mission  
Contracts to Canadian Industry (\$ in millions)  
(As of March 31st, 2013)**

	<b>British Columbia</b>	<b>Prairies</b>	<b>Ontario</b>	<b>Quebec</b>	<b>Atlantic Provinces</b>	<b>Total Canada</b>
Targets (%)	10%	10%	35%	35%	10% (3.5 % min.)*	100%
Actual (%)	38.6%	8.19%	16.33%	34.68%	2.24%	100%
Actual (\$)	82.55	17.52	34.95	74.23	4.49	214.05

\* The absolute Canadian Content requirement for the Atlantic Canada Region is of 2.45% of the total contract value (3.5% of the 70% Canadian Content Requirement). As of March 2012 this contractual requirement has been met and held steady in 2013 since 2.24% of the total contract value has been achieved in the Atlantic Canada region. This 2.24% corresponds to 3.2% of the 70% Canadian Content Requirement.

**Summary of Non-Recurring Expenditures (\$ in millions)  
(Forecasts to March 31, 2014)**

	<b>Current Estimated Total Expenditure</b>	<b>Forecast to March 31, 2014</b>	<b>Planned Spending 2014-15</b>	<b>Future Years</b>
RADARSAT Constellation Mission	1,085.3	489.9	200.2	395.3

## **James Webb Space Telescope**

### **1- Description**

The James Webb Space Telescope (JWST) is a joint mission of NASA, the ESA, and the Canadian Space Agency. The mission concept is for a large field-aperture telescope to be located 1.5 million km from Earth. Like Hubble, the JWST will be used by the astronomy community to observe targets ranging from objects within our solar system to the most remote galaxies which can be seen during their formation in the early universe. The science mission is centered on the quest to understand our origins and is focused on the following:

- Observing the very first generation of stars to illuminate the dark universe when it was less than one billion years old;
- Understanding the physical processes that have controlled the evolution of galaxies over cosmic time and, in particular, identifying the processes that led to the assembly of galaxies within the first 4 billion years after the Big Bang;
- Understanding the physical processes that control the formation and early evolution of stars in our own and other nearby galaxies; and,
- Studying the formation and early evolution of proto-planetary disks, and characterizing the atmospheres of isolated planetary mass objects.

The JWST is scheduled for launch in 2018. JWST instruments will be designed to work primarily in the infrared range of the electromagnetic spectrum, with some capability in the visible range. JWST will have a large mirror, 6.5 meters in diameter and a sun shield that will be the size of a tennis court once deployed in outer space.

Canada is providing the Fine Guidance Sensor (FGS) and Near Infra-Red Imager and Slitless Spectrometer (NIRISS). The NIRISS instrument replaces the Tuneable Filter Imager (TFI) originally planned. The FGS is integral to the attitude control system of JWST, and consists of two fully redundant cameras that will report precise pointing information of JWST. Canadian expertise in this area has been established with the successful fine error sensors for the FUSE mission. Packaged with the FGS but functionally independent, the Near Infra-Red Imager and Slitless Spectrometer covers the 0.7 to 5 micrometer spectral range. NIRISS provides a specialized capability for surveys of objects such as primeval galaxies, for the study of transiting planetary systems and for high-contrast imaging applications such as the detection of extra-solar planets.

Developed in partnership with COM DEV Canada, the JWST-FGS Major Crown Project consists of the design, development, testing and integration into the spacecraft, launching and commissioning of the FGS and NIRISS. By participating in this leading-edge international space exploration mission, the Canadian Space Agency is actively promoting Canadian scientific expertise and innovative, advanced space technologies.

The National Research Council's National Science Infrastructure (NSI), formerly known as Herzberg Institute of Astrophysics, is a key Government of Canada partner for activities related to the development of science instruments and distribution of telescope data. In return for its overall investment in the JWST, Canada will obtain a minimum of 5% of the time on this unique space telescope.

Already, the news of Canada's involvement in this international space exploration mission is inspiring youth, educators and amateur astronomers, and rallying members of Canada's world-renowned astrophysics community.

**Project phase: D - Implementation**

**Leading and Participating Departments and Agencies**

<b>Sponsoring Agency:</b>	Canadian Space Agency
<b>Contracting Authority:</b>	Public Works and Government Services Canada for the Canadian Space Agency
<b>Participating Departments:</b>	NRC's National Science Infrastructure Industry Canada

**Prime and Major Sub-Contractors**

Prime Contractor:  - COM DEV Canada	  - Ottawa, Ontario
Major Sub-Contractors: - Teledyne - Corning Netoptix - IMP Aerospace Avionics - ABB Bomem - MDA - INO - BMV - CDA - ESTL - Bach Research Corporation - Materion - Camcor	- USA. - USA. - Canada - Canada - Canada - Canada - Canada - USA. - Europe - USA. - USA. - Canada



## Major Milestones

The major milestones, by phase, are the following:

Phase	Major Milestones	Date
A	Requirement Definition	2003-2004
B	Preliminary Design	August 2004 to May 2005
C	Detailed Design	July 2005 to September 2008
D	Manufacturing/Assembly; Integration/Testing; Pre-launch preparations, Launch/System Commissioning	May 2007 to March 2019
E	Operations	2019 to 2024

**Note:** The Major Crown Project terminates with the completion of Phase D.

## Project Outcomes

This MCP contributes to the Program 1.2 Space Exploration which provides valuable Canadian science, signature technologies and qualified astronauts to international space exploration endeavours. It fosters the generation of knowledge as well as technological spin-offs that contribute to a higher quality of life for Canadians. This Program appeals to the science and technology communities. It is targeted mostly towards Canadian academia and international space exploration partnerships. Canadian industry also benefits from the work generated within this Program. The contribution of the MCP to the program objectives is measured through the Performance Measurement Framework.

### Program 1.2 Space Exploration

Result # 1 Expansion of scientific knowledge acquired through space exploration endeavours.

Performance Indicator # 1 Number of peer-reviewed scientific publications, reports and conference proceedings based on space exploration data produced by researchers (sciences and technologies) in Canada.

Result # 2 Multiple use and applications of knowledge and know-how acquired through space exploration endeavours.

Performance Indicator # 1 Number of terrestrial applications of knowledge and know-how acquired through space exploration endeavours.

Performance Indicator # 2 Number of space re-utilization of knowledge and know-how acquired through space exploration endeavours.

### **Sub-Program 1.2.2 Exploration Missions and Technology**

Result # 1: Technological know-how acquired through Space Exploration endeavours (Astronomy and Planetary).

Performance Indicator # 1: Proportion of CSA's missions/solutions/instruments that met their mission performance requirements at acceptance review and/or at commissioning.

Result # 2: CSA's participation in space exploration missions provides access to scientific data about the Solar system and the Universe.

Performance Indicator # 1: Number of CSA's sponsored astronomy and planetary missions' providing data to Canadian scientific community.

Result # 3 : Canada maintains a strategic positioning which supports its capacity to influence space exploration missions and decision making process in key international space exploration

Performance Indicator # 1: Number of CSA's sponsored highly qualified personnel (HQP) nominated on the International Space Exploration Decision bodies.

### **Progress Report and Explanation of Variances**

In March 2004, the Treasury Board granted Preliminary Project Approval for Phases B, C and D at an indicative cost of \$67.2 million. In December 2006, before the completion of the detailed design of the FGS, the CSA requested increased expenditure authority to complete the project. In February 2007, the Treasury Board granted Effective Project Approval for a substantive total cost estimate of \$98.4 million with the condition "that the Canadian Space Agency provide reports to Treasury Board at the completion of Phases C and D of the JWST project which include up-to-date information on the project scope, costs, schedule and risks". At the same time, the project became a Major Crown Project.

In March 2007, the first Critical Design Review (CDR) for the guider function of the FGS, revealed some technical issues which required additional effort to resolve. This review took place after the Effective Project Approval (EPA) received in February 2007. During the preparation of the system level CDR, new issues requiring additional analysis became apparent. Testing of the Tunable Filter Imager prototype also revealed technical issues that needed to be addressed.

On December 2007, the Treasury Board granted a revised Effective Project Approval (EPA) of \$156.7 million after the CSA's costs had risen significantly at the end of the detailed design phase.

In 2010, NASA discovered that the infrared detectors, extremely sensitive cameras capable of 'seeing' light produced by heat, were showing signs of performance degradation due to a design issue. Following an extensive investigation, NASA concluded that all detectors, including the four procured by Canada, need to be replaced. Two years after their acceptance by the project, the detectors started to show the same degradation as seen by NASA during extensive testing of the FGS/NIRISS. NASA initiated with Teledyne Scientific & Imaging LLC an improvement project in order to address the design issue causing the degradation.

In 2011–12, the participants in the project were very busy with hardware and software development. COMDEV Canada, the prime contractor for the JWST Fine Guider Sensor (FGS) project, worked on the Proto Flight Model (PFM). The Proto Flight Model FGS successfully completed a very stringent environmental test campaign during which the instrument was subjected to cryogenic temperatures over a period of 80 continuous days. The detector design improvement with Teledyne Scientific & Imaging LLC was completed and testing demonstrated that the new design addressed the degradation issues. NASA then initiated the procurement process for acquiring new detectors for the JWST Mission. The detectors for the FGS/NIRISS were under the responsibility of CSA for their acquisition.

The FGS Engineering Test Unit (ETU) was integrated into the NASA Goddard Space Flight Center (GSFC) test set-up and underwent system level testing with the other science instrument engineering units. An integration test onto the integrated science instrument module (ISIM) of the JWST was successfully conducted. On the Tunable Filter Instrument (TFI), development of the etalon proved to be technically challenging. In July 2011, the CSA decided to halt all etalon activities because the challenges facing this subsystem could not be resolved within the delivery timeframe defined by NASA. As a result, the Principal Investigator for the TFI proposed a plan to salvage the Canadian science instrument. From this was born the Near Infrared Imager and Slitless Spectrograph (NIRISS). This new instrument relied on all existing components of the old TFI with the exception of the etalon. The function of the etalon was replaced by selecting new optical elements capable of covering the light spectrum required for the science mission. Significant progress was achieved during this period.

On 30 July 2012, the PFM FGS/NIRISS was delivered to NASA GSFC. On 15 Nov 2012, the PFM FGS/NIRISS was officially accepted by NASA following the successful completion of post delivery functional checks. The FGS/NIRISS was the first instrument officially accepted by NASA as part of the JWST project.

On the detector front, CSA and NASA concluded an agreement regarding the cost sharing for the procurement of 4 detectors for the FGS/NIRISS. Under this agreement, NASA would manage the procurement with Teledyne Scientific & Imaging LLC until the detectors are completed at which point they would be procured off-the-shelf by PWGSC.

In August 2013, NASA started its first cryogenic test campaign with the Integrated Science Instrument Module (ISIM) which was completed in November 2013. The FGS/NIRISS performed as expected during this first of 3 cryogenic test campaigns.

The second cryogenic test campaign is planned to be conducted in FY14-15 as the integration and test activities at NASA with ISIM continue. As well, in 2014, the FGS/NIRISS detectors will be replaced as soon as the second cryogenic test campaign is completed.

On the programmatic front in 2013, CSA prepared a Treasury Board submission seeking an amended Effective Project Approval in order for the JWST project to proceed to completion. In 2007, when the project obtained TB approval for the revised EPA, the mission launch date was anticipated to be May 2013. Following a re-planning exercise conducted by NASA to implement a JWST mission plan with a high certainty of achieving the launch date, the launch date was slipped to October 2018, extending the project life by 5.5 years. In addition to this overall delay by NASA, there was an associated increase in the mission's integration and test phase, due to NASA having originally underestimated the work needed for this phase. The scope of work remaining to be completed for this project is as follows:

- Although the flight instrument has now been delivered, the project is still in the implementation phase where support must be provided for the integration of the FGS/NIRISS to the spacecraft, for the launch activities and for the spacecraft commissioning activities.
- With all the integration and test activities at NASA having been delayed and the duration of these activities revised under the NASA re-plan, CSA and COM DEV are required to provide direct engineering post delivery support to NASA for FGS/NIRISS and to the JWST mission commissioning activities from 2014 up until April 2019.
- Official mission operations will commence after the completion of the telescope's commissioning, 6 months after its launch. The JWST operations center will be located in the Space Telescope Institute in Baltimore, Maryland in the United States. Canadian scientists will be on location to directly support the operations of the FGS and NIRISS throughout the missions operations. The operations will also be supported by engineering staff in order to be able to address technical issues if and when they will occur to ensure the functionality of Canada's instruments.

Ultimately this remaining scope of work and the extension of the mission schedule resulted in cost increases that could not be absorbed by the CSA project's 2007 Treasury Board authorities. As well, PWGSC needed to seek contractual authorities for acquiring the new detectors under a sole source contract with Teledyne Scientific & Imaging LLC. The Treasury Board submission addressing these issues is being submitted in early 2014.

### **Industrial Benefits**

As of March 31, 2013, the CSA had funded close to \$112.2 million of work for Canadian industry that was directly attributable to the JWST-FGS Major Crown Project. Direct industrial benefits from the construction of the JWST-FGS, TFI and NIRISS system will benefit Canada's central regions. Although there is no regional distribution requirement for this project, the following table provides an approximate distribution:

**Regional Distribution of JWST Contracts to Canadian Industry (\$ in millions)  
(As of March 31, 2013)**

	<b>Ontario</b>	<b>Quebec</b>	<b>Atlantic Provinces</b>	<b>Total Canada</b>
Actual (%)	90.4%	8.0%	1.6%	100%
Actual (\$)	101.4	9.0	1.8	112.2

**Summary of Non-Recurring Expenditures (\$ in millions)  
(Forecasts to March 31, 2014)**

<b>Program</b>	<b>Current * Estimated Total Expenditure</b>	<b>Forecast to March 31, 2014</b>	<b>Planned Spending 2014-15</b>	<b>Future Years</b>
JWST- FGS/NIRISS	156.7	153.0	3.7	0

\* Current TB Authority

#### **Annexe - 4 User Fees**

**User Fee:** Fees charged for the processing of access to information requests filed under the Access to Information Act (ATIA)

**Fee Type:** Other products and services (O)

**Fee-Setting Authority:** Access to Information Act

**Date Last Modified:** 1992

**Reason for Planned Introduction of or Amendment to a Fee:** Not applicable

**Effective Date of Planned Change or Introduction;** Not applicable

**Consultation and Review Process Planned:** Not applicable