



The Future of Human Exploration and the Role of NEOs –

Canadian Space Agency Perspective

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Outline

- **CSA Mandate and Structure**
 - Exploration Division
- **CSA Current Human Exploration & NEO Activities**
 - ISS & Astronaut Core
 - CSA/DND NEOSAT
 - NASA Osiris Rex New Frontiers
- **Future planning**
 - CSA Exploration Priorities
 - CSA Participation in International Space Exploration Co-ordination Group (ISECG)
 - Canadian Science Priorities for the Global Exploration Strategy (GES)
 - *Small bodies*
 - CSA Exploration Core Program

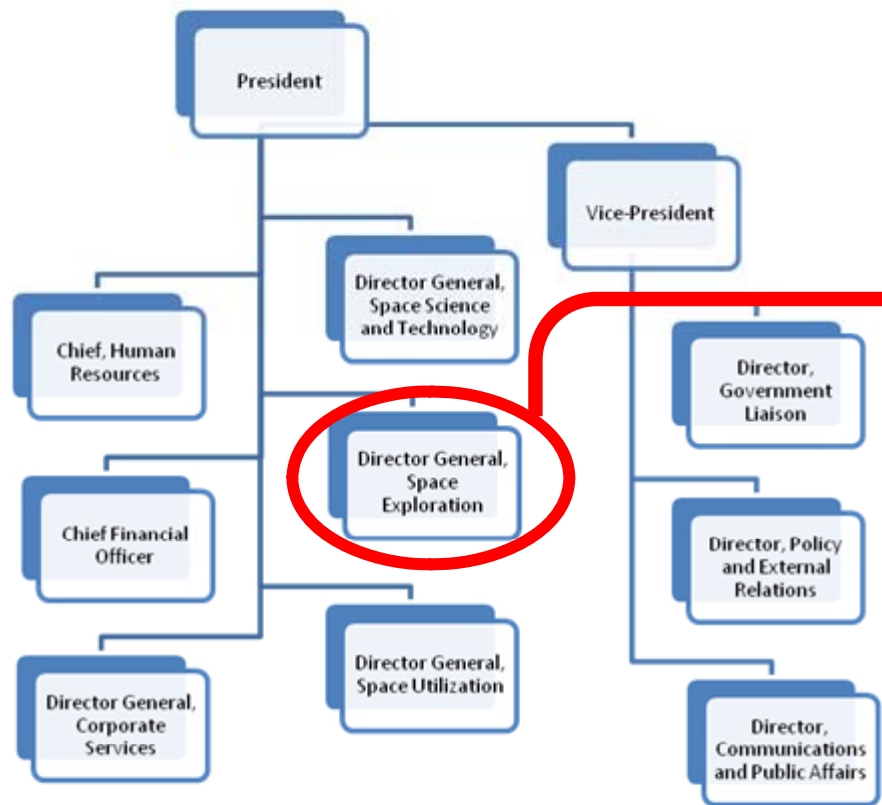




CSA Mandate and Structure

To promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians.

Canadian Space Agency Act 1990



SPACE EXPLORATION (Gilles Leclerc)

- Operations & Infrastructure
- Astronauts, Life Sciences & Space Medicine
- Exploration Development
 - Systems engineering
 - Robotics
 - Astronomy & Planetary Missions
- Exploration Planning





ISS and Astronaut Core



Chris Hadfield, Expedition 34/35
1st Canadian commander of ISS (from March 2013)
Also active: Jeremy Hansen, David St Jacques



CanadArm2 berths JAXA H-II Transfer Vehicle



Canadian Space Agency
Agence spatiale canadienne

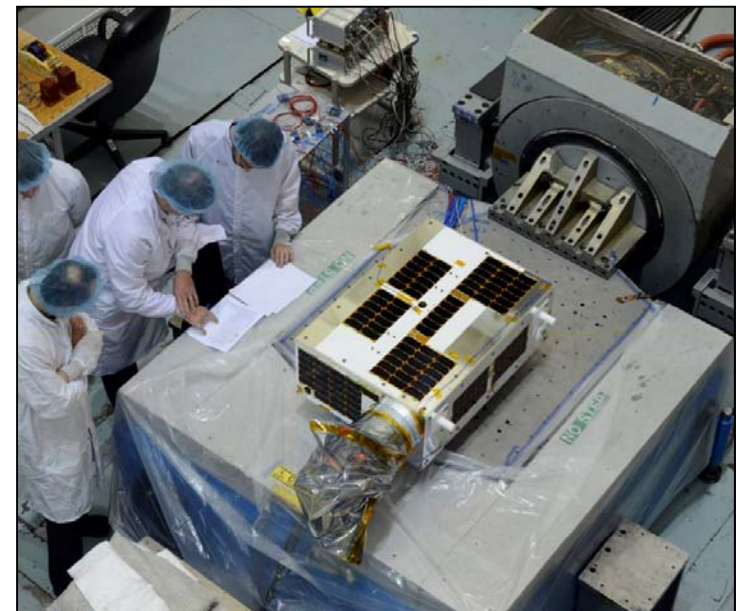
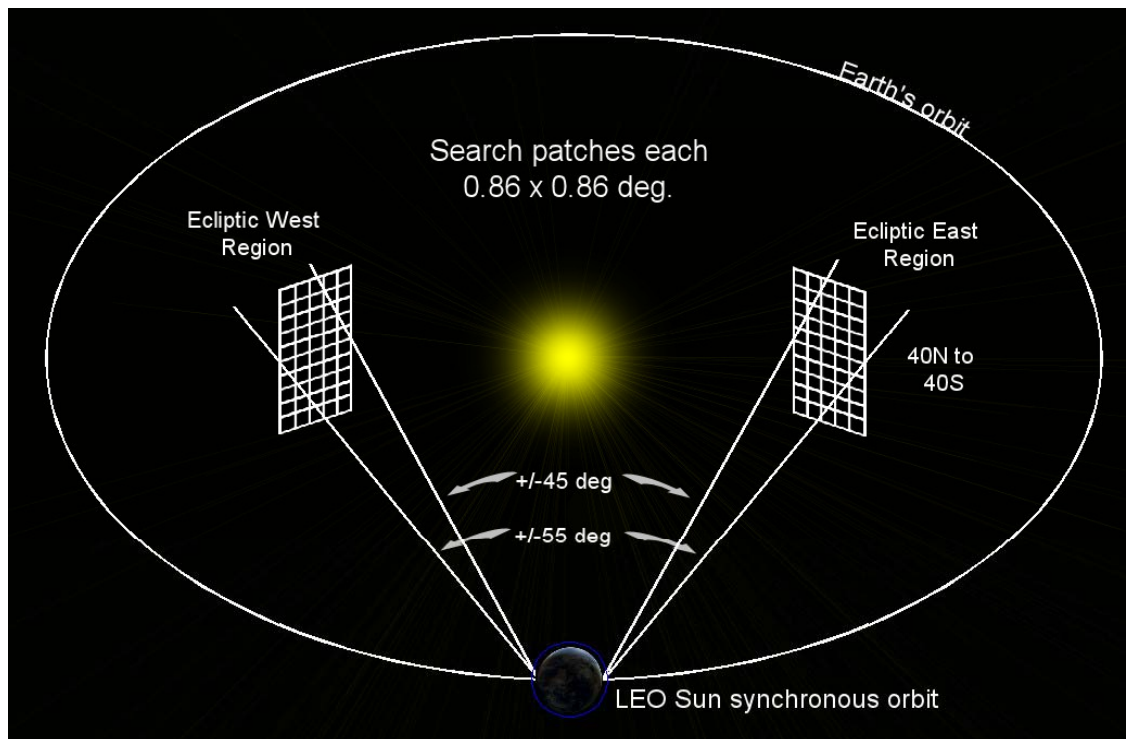
Canada



The Canadian **Near-Earth Object Survey Satellite**



- Goal: Find NEA > approx 500 m: Expect 4-12 discoveries per month
- First space telescope dedicated to NEA search: MOST heritage (MSCI)
- Contribute to int'l program on NEA awareness: Potential exploration targets
- Launch February 2014, secondary payload on India's PSLV-20
- Mission lifetime min 1 year, goal 2 years+
- NESS PI: Alan Hildebrand, University of Calgary



NASA New Frontiers Program

OSIRIS-REx

Origins Spectral Interpretation Resource Identification Security-Regolith Explorer



- Asteroid (1999 RQ36) sample return (samples curated at JSC)
- \$650M PI-led science mission (excluding launch)
- Launch 2016, Sample return: 2023
- US PI: Dante Lauretta, University of Arizona
- **Canadian contribution (MDA): OSIRIS-REx Laser Altimeter (OLA) - Advanced scanning LIDAR science instrument**
- **OLA lidar maps spacecraft-to-RQ36-surface distances from 7 km to 500 m (10km to 50m capability) using low and high power pulsed lasers**
- Canadian PI (for OLA instrument): Alan Hildebrand, University of Calgary
- Canadian science team : U of Calgary, York University, U of Winnipeg, U of Toronto, UBC
- In exchange for our participation, Canada will own 4% of the returned sample





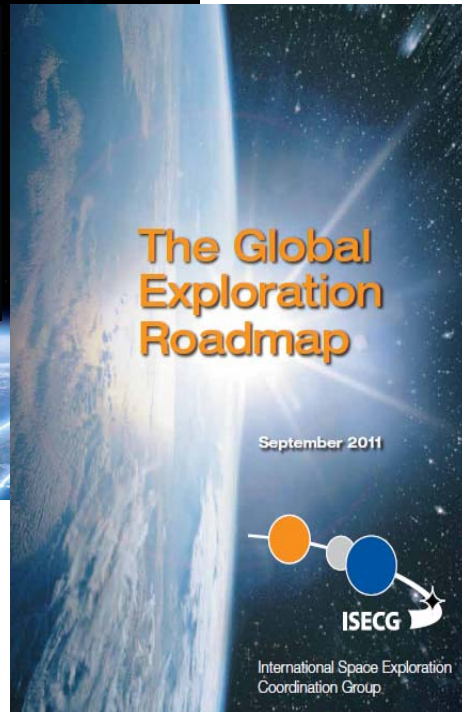
Future Planning

■ CSA Exploration Priorities

- *Canada will join in the human and robotic exploration of the solar system and space-based astronomical observation of the Universe beyond. The CSA will maintain a robust and balanced space exploration program to ensure that, as a nation, Canadians share in the discoveries, technological breakthroughs, societal impact and economic benefits stemming from the global exploration endeavour.*
- To realize this vision, the CSA has defined four exploration goals: (1) Gain knowledge about the solar system and the Universe, (2) Expand Canadian presence in space and on other planets, (3) Maintain and strengthen Canadian signature technologies, and (4) Augment the space exploration stakeholder base.
- The priorities of Canada's Space Exploration Program for the next ten years are the following:
- ***International Space Station (ISS):*** Operate and maintain the Mobile Servicing System (MSS), the Canadian robotic system on the ISS. Cost-effective and sustainable evolution of this robotic capability up to 2020. ISS utilisation rights focussed on important issues in space life sciences and medicine.
- ***Planetary exploration with robots and humans:*** Robotic exploration of Mars and robotic and human exploration of the Moon and cis-lunar space. The CSA envisions the potential for Canadian astronauts to explore the Moon, and seeks to prepare for the human exploration on Mars, generally accepted as a long-term goal of the international space community.
 - *also consider robotic asteroid missions and opportunistic missions to other destinations aligned with Canadian science priorities and signature technologies.*
- ***Space-based astronomy:*** The CSA will focus on space missions aligned with the scientific priorities proposed by the 2010 Canadian Long Range Plan for Astronomy.



Canadian participation in ISECG



- ISECG: 14 space agencies
- Global Exploration Strategy and Global Exploration Roadmap products
- Moon-Next, Asteroid Next scenarios
- CSA Chair in 2012
- Canadian signature technologies
 - Vision systems
 - Robotic servicing systems
 - Spectrometers
 - Radiation mitigation
- Canadian emerging signature technologies
 - Rovers
 - Advanced crew medical systems
 - Planetary drilling and sample extraction

To be updated 2013-2014

Canadian Scientific Priorities for the Global Exploration Strategy



Potential Canadian science and medical contributions to the exploration of the Moon, Mars and beyond, developed from the proceedings of the 6th Canadian Space Exploration Workshop (CSEW6) held at the Canadian Space Agency's headquarters, December 1-3, 2008

Small Bodies and Outer Planet Moons

- PG-S-1 Detailed investigations of the geology, mineralogy and chemistry, gravity and magnetism of asteroids and comets.
- PG-S-2 Describe and model the water ice dynamics of Ganymede, Europa and Enceladus.
 1. Application of ice-penetrating radar to map water distribution within and potentially beneath icy shells.
 2. Ice tectonics studies of the resurfacing processes on icy moons, built from models of continental ice-sheet formation and dynamics on Earth.
 3. Developing and testing remote-sensing technologies at terrestrial analogue sites such as the sulfur-rich springs which discharge on to the surface of glacial ice at Borup Fiord in Canada's high Arctic.

Astromaterials Research: Preparing Canada for Sample Returns



Exploration Core Program

■ ExCore Elements

- ' Instrument and mission concept studies
 - Eg. Phobos Reconnaissance & International Mars Exploration mission (PRIME) 2006, Lee et al.
- ' Prototyping: science instruments: 3D microscope, LIBS, Raman, Lidar/IR spectrometer
- ' Analogue deployments

■ Budget 2009: Canada's economic action plan

.....provides the Canadian Space Agency with \$110 million over three years so that it can contribute to the development of terrestrial prototypes for space robotic vehicles, such as the Mars Lander and Lunar Rover, and for the further development of other technologies and space robotics.





Summary

- The Canadian Space Agency would like to participate in the next steps of international human exploration beyond earth orbit
 - The CSA is an active member of the International Space Exploration Co-ordination Group, and is committed to ISS until at least 2020
 - The CSA is currently engaged in robotic missions related to NEOs. NEO missions will be considered in future, though Mars and the Moon are priority destinations for the next decade.

