Sustainable Support for the CSA

CSA Mandate

- The mandate of the Canadian Space Agency (CSA) is ``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”.
- Footnote: Established in March 1989, with a status equivalent to that of a Department of the Government of Canada, the CSA is responsible for the coordination and implementation of space policies and programs, the application and diffusion of space technology, and the promotion of commercial exploitation of space.
  - Innovation, Science and Economic Development Portfolio

Evaluation of the Space Astronomy Missions and Planetary Missions Programs

- The SAM & PM programs are well aligned with the government's innovation agenda and the CSA's mandate and strategic outcome. The SAM & PM programs are essential to maintaining a world-class cadre of astronomers and planetary scientists in Canada dedicated to advancing the knowledge of space through scientific discovery.
- **the CSA is the only federal organization that provides the scientific community with access to space astronomy opportunities and data**.
- http://www.asc-csa.gc.ca/eng/publications/er-1617-0202.asp

Budgets

- NASA

Science	5,762.2	5,725.8	5,895.0	5,859.9	5,841.1	5,822.4	5,803.6
Earth Science	1,907.7	--	1,784.2	1,784.2	1,784.2	1,784.2	1,784.2
Planetary Science	1,827.5	--	2,234.7	2,199.6	2,180.8	2,162.1	2,143.3
Astrophysics	1,352.3	--	1,185.4	1,185.4	1,185.4	1,185.4	1,185.4
Heliophysics	674.7	--	690.7	690.7	690.7	690.7	690.7

- The CSA's annual A-Base budget of $300 million was initially established in Budget 1999 ($215.4 million in 2015 dollars), and is now in the order of $260 million.

Budgetary financial resources (dollars)

2018–19 Main Estimates	2018–19 Planned spending	2019–20 Planned spending	2020–21 Planned spending
301,093,697	301,093,697	262,303,150	223,863,572

Human resources (full-time equivalents)

2018–19 Planned full-time equivalents	2019–20 Planned full-time equivalents	2020–21 Planned full-time equivalents
390.3	386.9	386.9

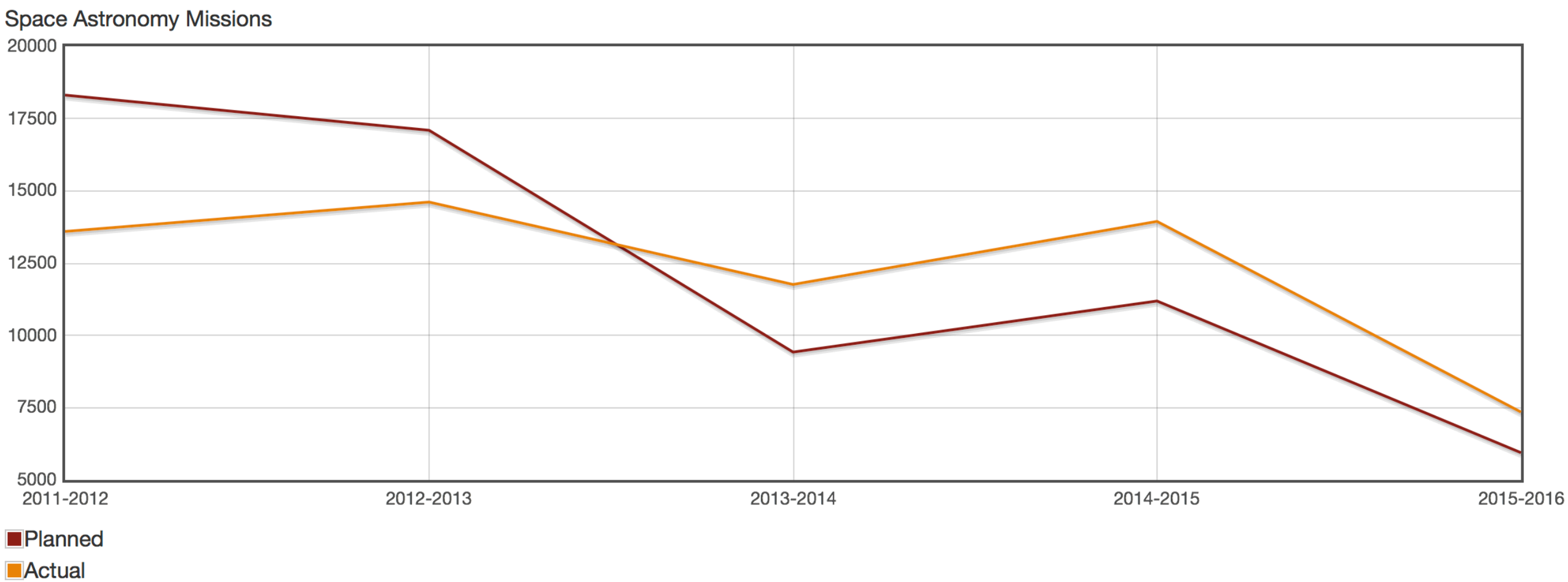
Space Astronomy Missions and Planetary Missions Programs

Table 1: Resources allocated to the SAM & PM programs for the evaluation period

Type of Resource	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016
FTEs [a]					
SAM	17.7	16.7	12	6	6
PM	11.2	9.9	10.6	9.5	9.6
Total	**28.9**	**26.6**	**22.6**	**15.5**	**15.6**
Forecasted Budget (,000$) [b], [c]					
SAM	18,311	17,094	9,422	11,189	5,942
PM	10,794	23,551	16,959	12,492	5,864
Total	**29,105**	**40,645**	**26,381**	**23,681**	**11,806**
5-year total = 131,618 (SAM = 61,958; PM = 69,660)					
Actual Spending (,000$)					
SAM					
Salary [c]	2,271	2,153	1,611	987	914
O&M - other [d]	892	671	743	802	904
O&M - contracts	4,406	5,424	4,699	3,316	1,775
Capital	5,741	6,055	4,391	8,519	3,415
G&C	285	308	318	317	341
Sub-total	**13,595**	**14,611**	**11,761**	**13,942**	**7,348**
PM					
Salary	1,222	1,091	1,173	1,120	1,117
O&M - other [d]	154	224	65	59	53
O&M - contracts	2,923	2,946	1,503	1,493	1,278
Capital	236	4,050	15,825	7,356	4,631
G&C	236	175	211	262	263
Sub-total	**4,771**	**8,486**	**18,777**	**10,290**	**7,342**
Total	**18,366**	**23,460**	**30,555**	**24,363**	**14,728**
5-year total = 110,923 (SAM = 61,258; PM = 49,665)					

Space Astronomy Missions

Figure 2: SAM Planned vs Actual disbursements in $1,000s, 2011–2016



Missions

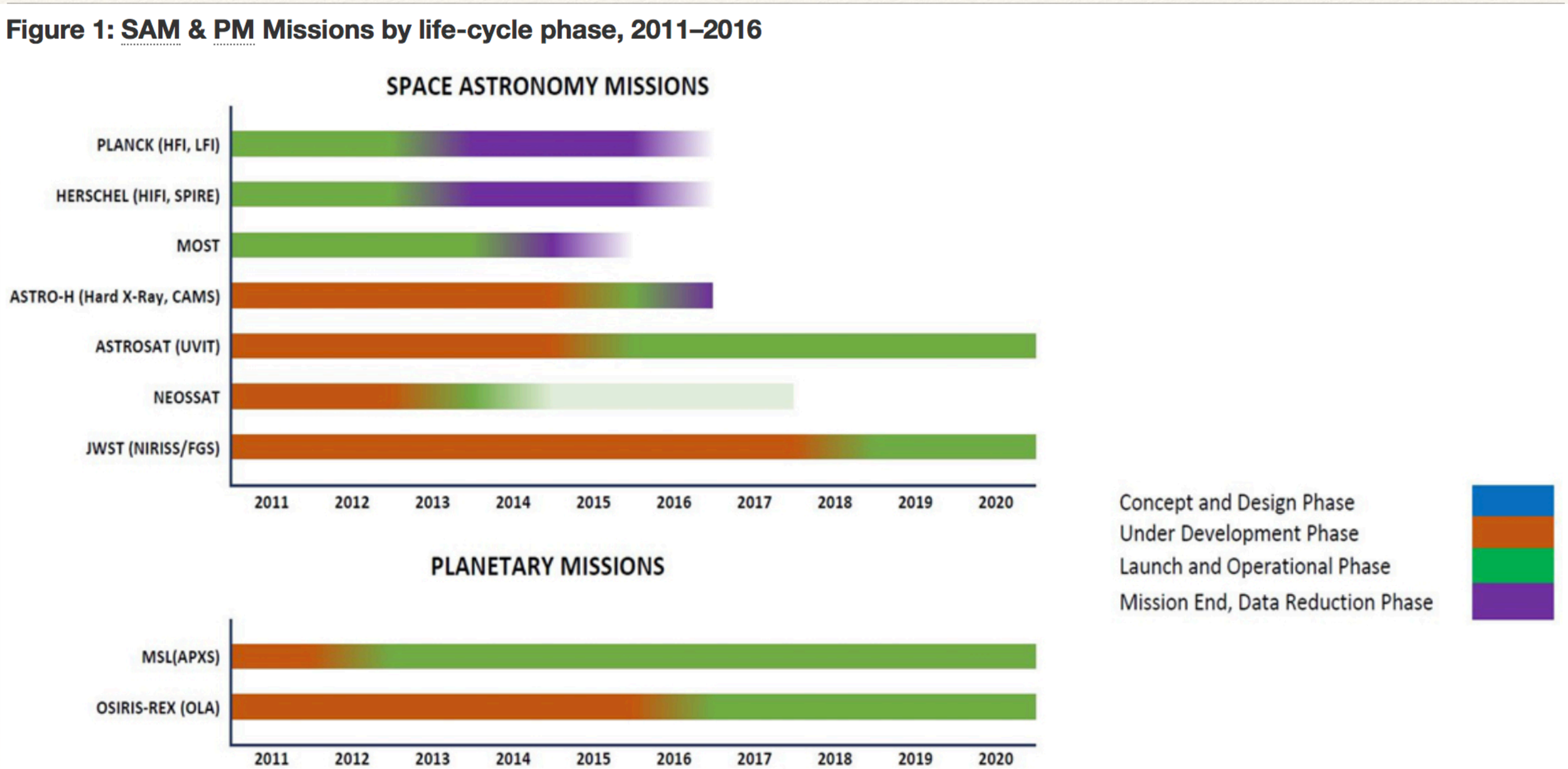


Figure 1: SAM & PM Missions by life-cycle phase, 2011–2016
SPACE ASTRONOMY MISSIONS
PLANCK (HFI, LFI)
HERSCHEL (HIFI, SPIRE)
MOST
ASTRO-H (Hard X-Ray, CAMS)
ASTROSAT (UVIT)
NEOSSAT
JWST (NIRISS/FGS)
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
PLANETARY MISSIONS
MSL(APXS)
OSIRIS-REX (OLA)
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Concept and Design Phase
Under Development Phase
Launch and Operational Phase
Mission End, Data Reduction Phase

A Vision for Canadian Space Exploration

We propose a sustained and balanced program in space exploration to fuel innovation in the space sector, support Canada's world-leading space researchers, inspire the next generation of scientists and innovators, and create thousands of highly skilled, well-paying jobs for Canadians. During the next decade we recommend a total investment of approximately $1B, increasing to $1.3B in each decade that follows, including a regular flagship mission that Canada would lead and a constellation of smaller missions, either led by Canada or in collaboration with international partners.

Contributors

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Per year, Canada spends only $16M on space exploration missions and technology, much less than comparable nations as a fraction of GDP. For example, France spends about 0.01% of GDP on space science, and the US about twice more. In the Canadian context, these would translate to $250-500M/yr, more than ten times the current funding level .

CSEW Report

2017 Canadian Space Exploration

Science and Space Health Priorities for Next Decade and Beyond

Summary of Space Astronomy Priorities

Space Astronomy: *Modern astronomy offers answers to fundamental questions about our universe and our place in it. Astronomy is the study of the physics of the universe and encompasses a wide range of subjects from the birth of the universe, its composition and evolution to the formation of planets, stars and galaxies.*

Astronomical research covers vast areas of specializations and some can only be conducted from space, but for the purpose of grouping the research priorities here, they will be categorized into three areas:

Cosmology: *Where did all the matter come from, can we explain the very early stages of the universe and how it expanded?*

Cosmic Origins: *How did stars and galaxies form and evolve to what we see today? How did our solar system and exoplanets form? Are there signs of life elsewhere? Are we alone?*

High Energy Astrophysics: *Most of light-emitting matter in the universe shines in x-rays. How do we understand the nature of matter in extreme temperatures, gravity and magnetic fields?*

Astronomy objectives are not in priority order.

Cosmology TT: 23 members from 11 organisations	COS-01 - Cosmic Microwave Background: Probing the Physics of Inflation – the Big Bang theory
	COS-02 - Dark Energy – seeking to understand why the universe is expanding and accelerating
	COS-03 - The Nature of Dark Matter – which has gravitational effects on galaxies but it is not visible
	COS-04 - The End of the Cosmic Dark Ages – when the first stars and galaxies formed
Cosmic Origins TT: 32 members from 14 organisations	COR-01 - Origins in The Ultraviolet: A Treasure Trove of Astrophysics: young, hot stars; hot intergalactic medium. Photometric red-shift for weak lensing (clues to dark energy)
	COR-02 - Exoplanet detection via gravitational microlensing, and spectroscopy of exoplanet atmospheres
	COR-03 - Survey of earliest galaxies (high redshift Universe)
	COR-04 - Explore the hidden universe obscured by dust – far infra-red space telescopes can see through the dust and reveal star and solar system formation
	COR-05 - Direct imaging of nearby Earth-like exoplanets for biosignatures
High Energy Astrophysics TT: 30 members from 17 organisations	HEA-01 - Accretion physics in the inner regions of compact objects – matter falling onto neutron stars and black holes emit X-rays
	HEA-02 - Feedback Mechanisms on all Scales – black holes can create jets of matter in a galaxy; supernova can create heavy elements that become material for next generation stars and planets
	HEA-03 - Demographics of Black Holes – almost every galaxy has a super massive black hole at its center. How did they come about and influence the evolution of its host?
	HEA-04 - Physics of dense matter and extreme magnetic fields – extreme conditions that cannot be replicated on Earth – contributes to knowledge in fundamental physics

Current and Future Opportunities

- XRISM, ATHENA, ULTRASAT, CASTOR, LITEBIRD, Astrosat, BRITE, JWST, NEOSSat, Spica, PLATO, Euclid
- Concept and Science Maturation Studies
  - Exoplanets, Colibri, EPPE
- LUVOIR, LYNX, HabEx, Starshades