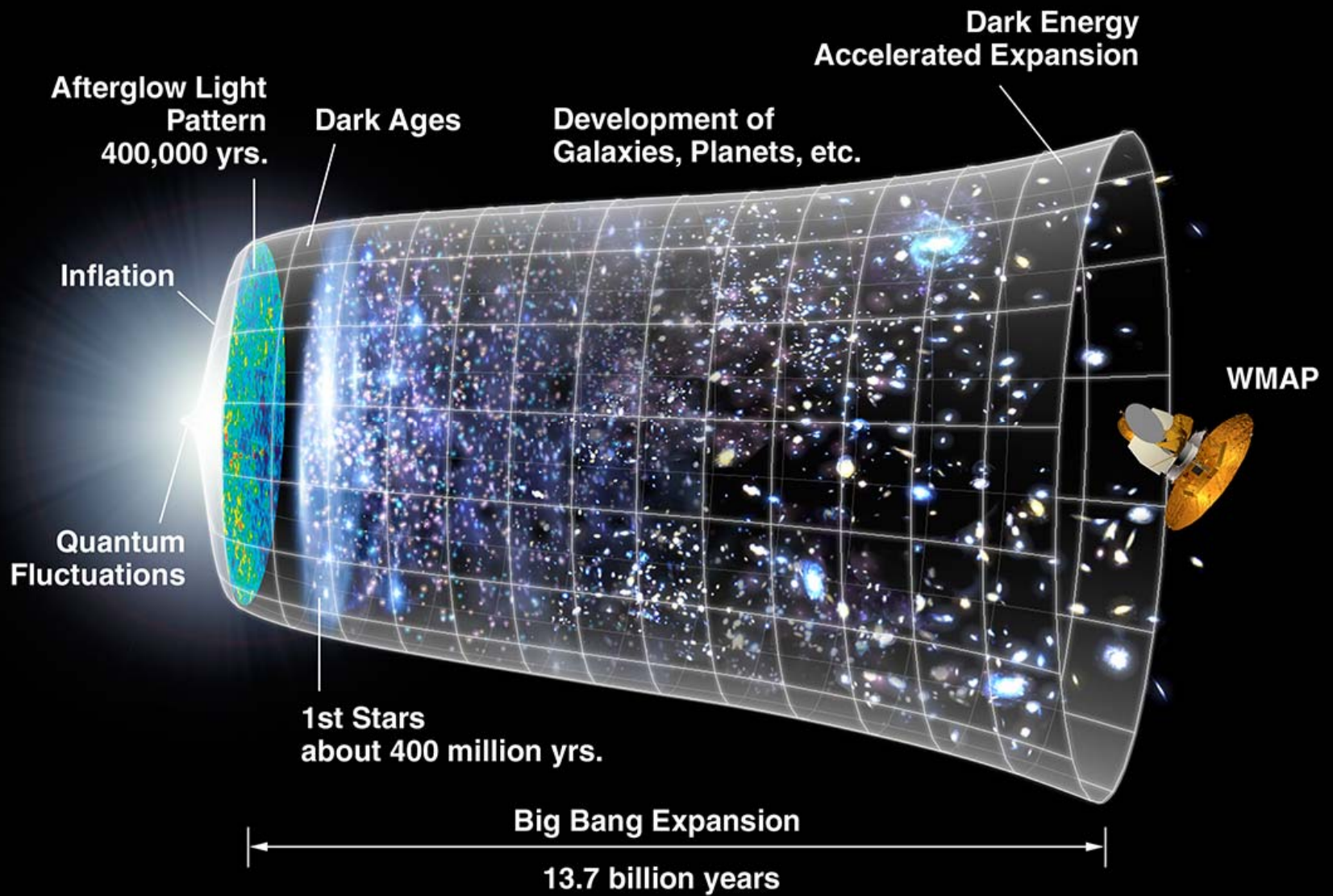


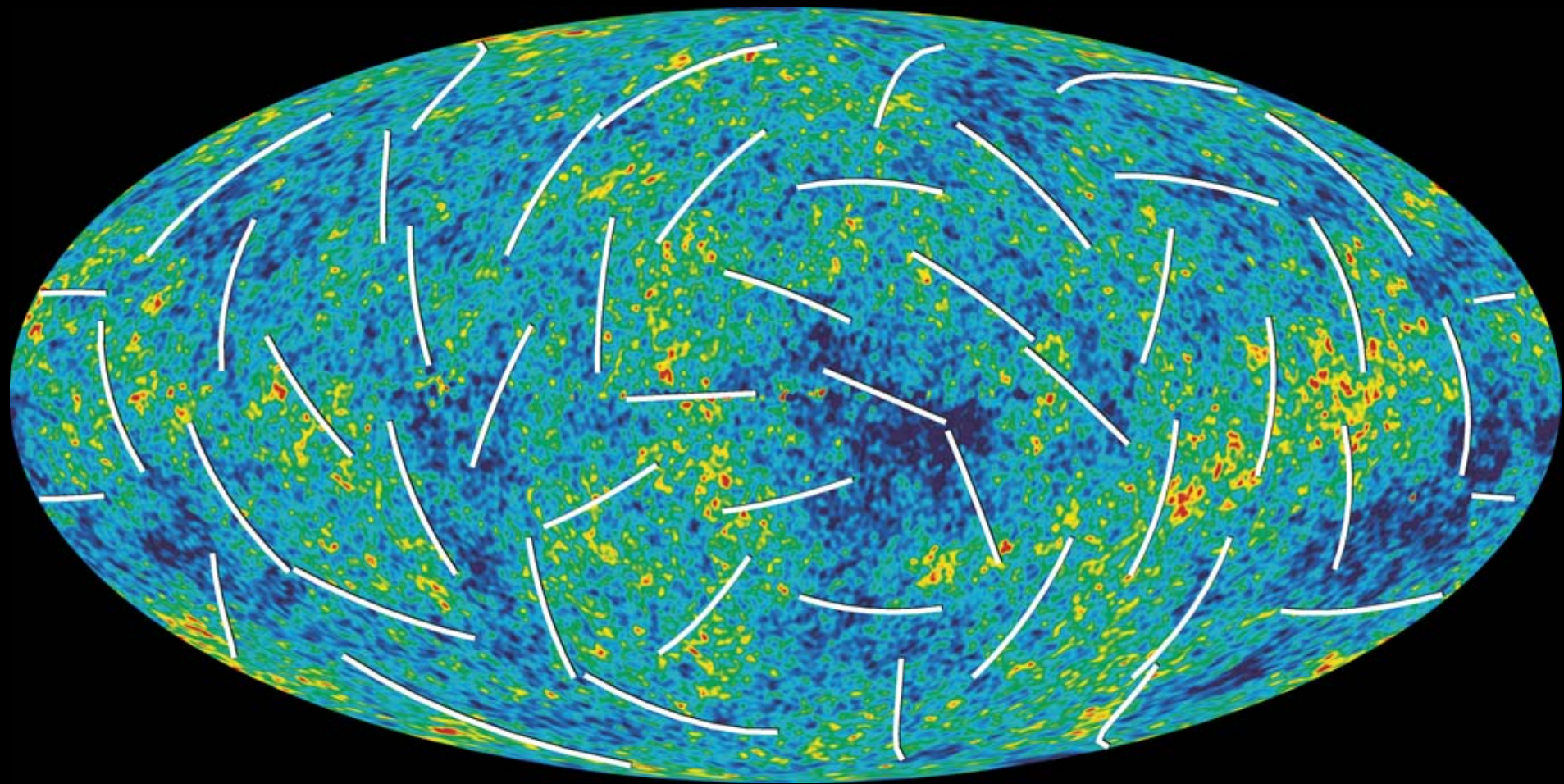


# **Presentation to the Board on Physics and Astronomy**

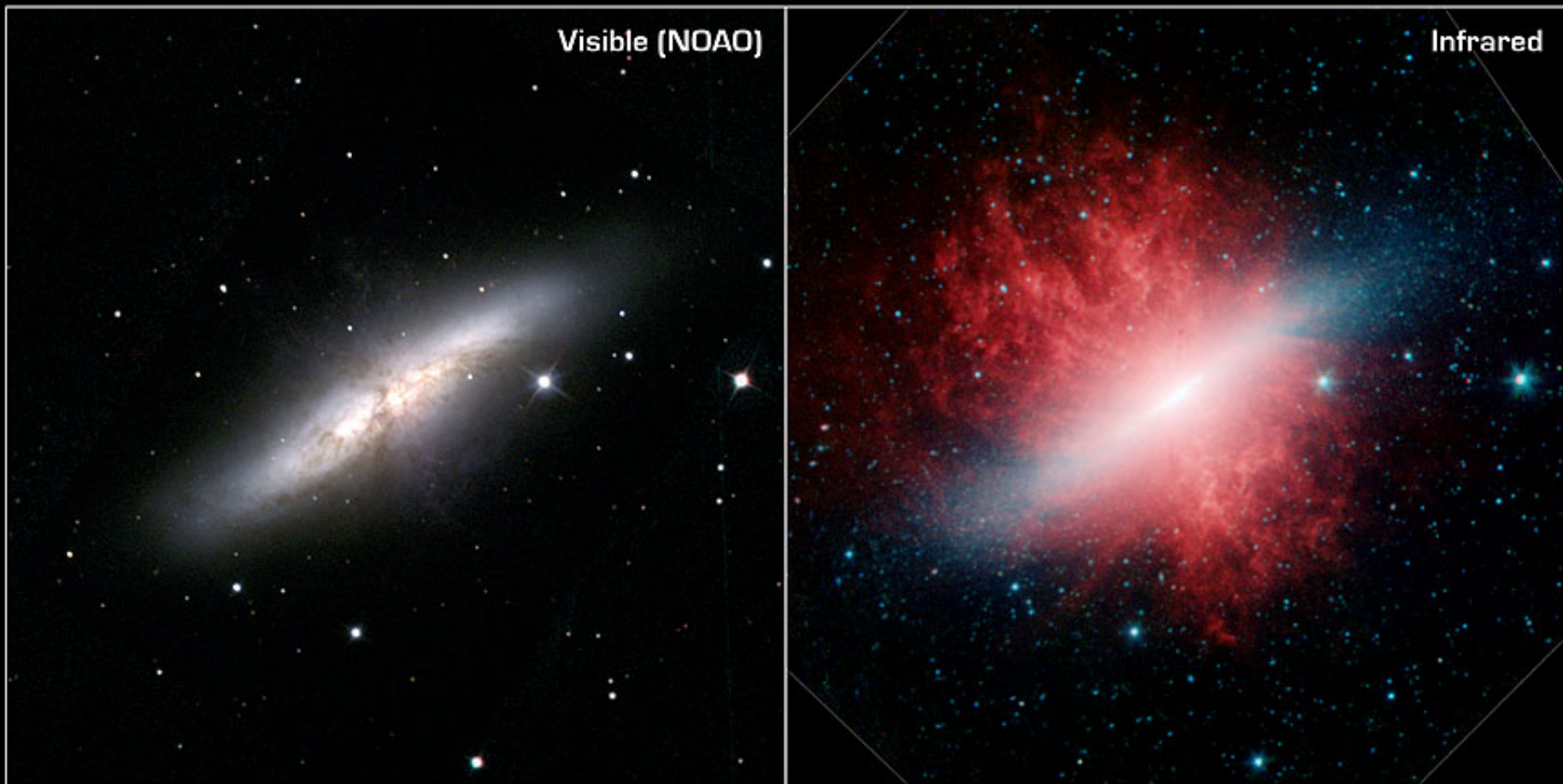
**Dr. Paul Hertz  
Chief Scientist, Science Mission Directorate  
NASA**

**April 22, 2006**





Credit: NASA/WMAP Science Team



**“Cigar” Galaxy M82**

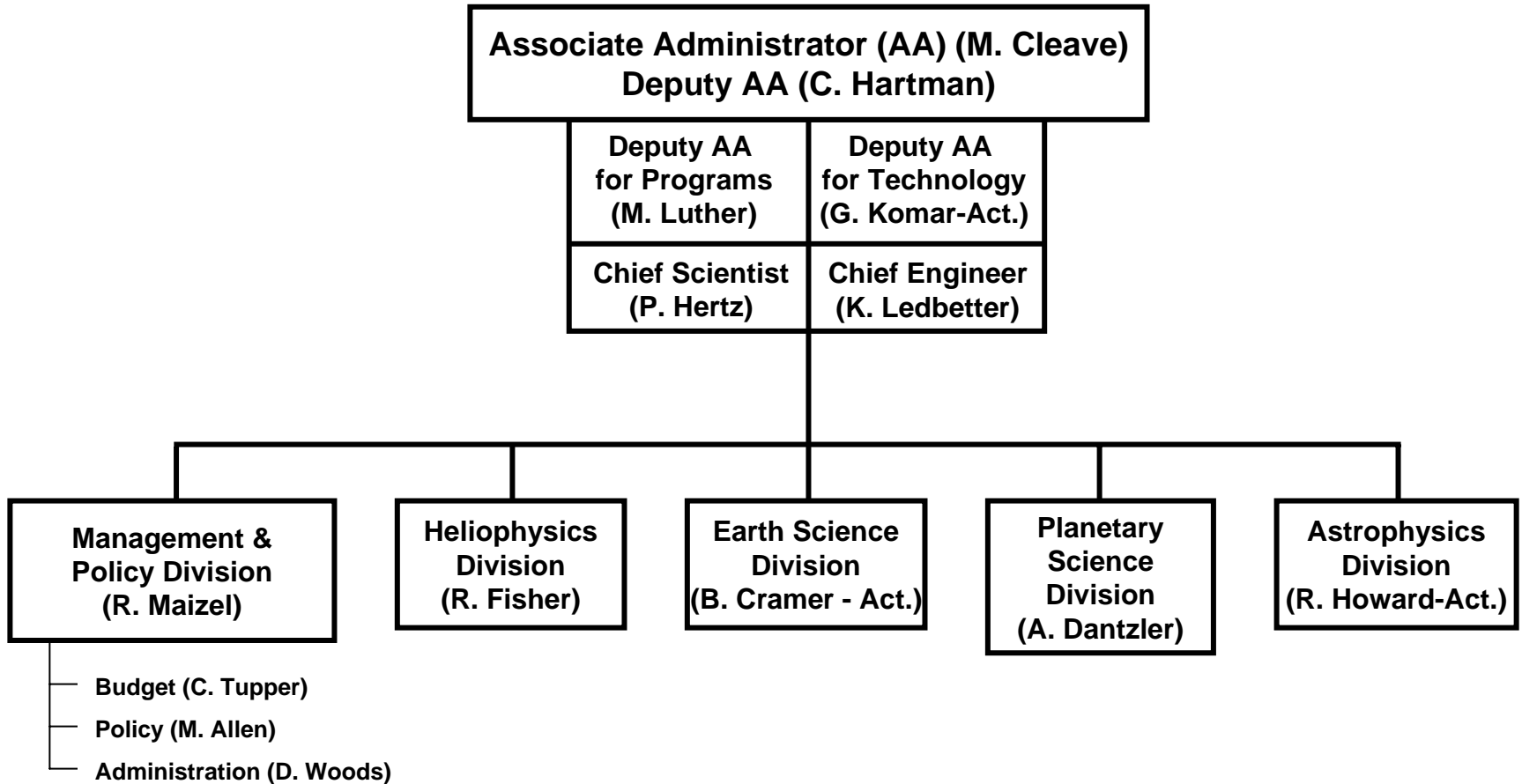
**Spitzer Space Telescope • IRAC**

NASA / JPL-Caltech / C. Engelbracht (Steward Observatory) and the SINGS team

ssc2006-09a



# Science Mission Directorate Organization Chart



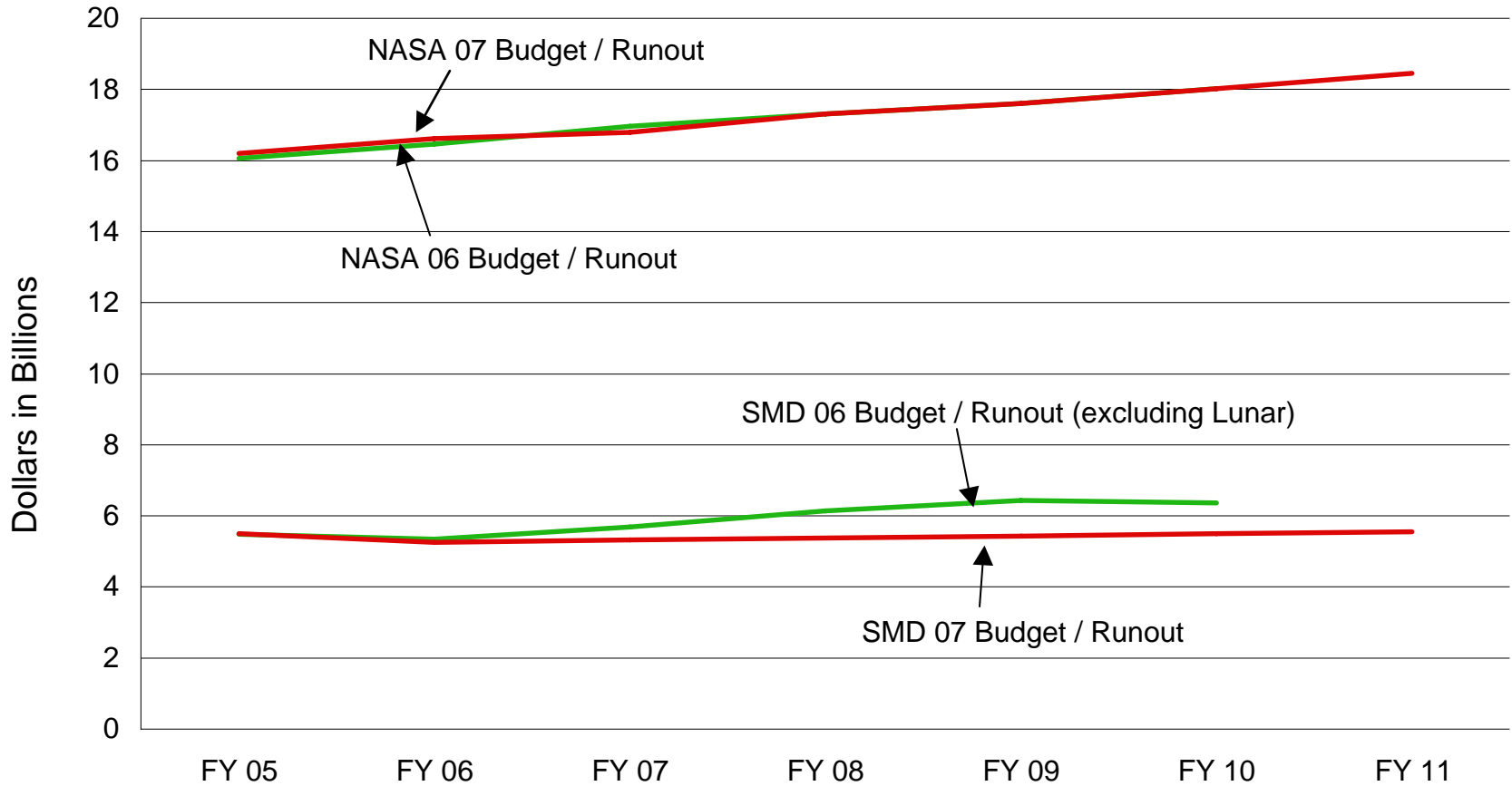


# FY07 NASA Budget (\$M)

	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11
<b>Total NASA</b>	<b><u>\$16,196.4</u></b>	<b><u>\$16,623.0</u></b>	<b><u>\$16,792.3</u></b>	<b><u>\$17,309.4</u></b>	<b><u>\$17,614.2</u></b>	<b><u>\$18,026.3</u></b>	<b><u>\$18,460.4</u></b>
<u>Science</u>	<u>\$5,501.6</u>	<u>\$5,253.7</u>	<u>\$5,330.0</u>	<u>\$5,383.1</u>	<u>\$5,437.1</u>	<u>\$5,491.5</u>	<u>\$5,546.4</u>
Solar System Exploration	\$1,720.5	\$1,582.3	\$1,610.2	\$1,598.6	\$1,840.4	\$1,899.6	\$1,846.7
The Universe	\$1,474.9	\$1,507.9	\$1,509.2	\$1,500.9	\$1,307.9	\$1,276.1	\$1,309.7
Earth-Sun System	\$2,306.2	\$2,163.5	\$2,210.6	\$2,283.7	\$2,288.9	\$2,315.8	\$2,390.0
<u>Exploration Systems</u>	<u>\$2,209.3</u>	<u>\$3,050.1</u>	<u>\$3,978.3</u>	<u>\$3,981.6</u>	<u>\$4,499.8</u>	<u>\$5,055.9</u>	<u>\$8,775.1</u>
Constellation Systems	\$422.3	\$1,733.5	\$3,057.6	\$3,067.6	\$3,612.9	\$4,083.8	\$7,698.4
Exploration Systems R & T	\$898.9	\$692.5	\$646.1	\$632.2	\$605.1	\$679.2	\$764.6
Human Systems R & T	\$888.1	\$624.1	\$274.6	\$281.8	\$281.8	\$292.8	\$312.1
Aeronautics Research	\$962.0	\$884.1	\$724.4	\$731.8	\$732.4	\$722.8	\$722.7
<u>Space Operations</u>	<u>\$7,114.4</u>	<u>\$6,869.7</u>	<u>\$6,234.4</u>	<u>\$6,680.4</u>	<u>\$6,442.3</u>	<u>\$6,242.9</u>	<u>\$2,896.7</u>
Space Shuttle	\$5,049.2	\$4,777.5	\$4,056.7	\$4,087.3	\$3,794.8	\$3,651.1	\$146.7
International Space Station	\$1,591.3	\$1,753.4	\$1,811.3	\$2,200.3	\$2,255.6	\$2,197.1	\$2,360.8
Space and Flight Support (SFS)	\$473.9	\$338.8	\$366.5	\$392.8	\$392.0	\$394.7	\$389.2
Inspector General	\$31.3	\$32.0	\$33.5	\$34.6	\$35.5	\$36.4	\$37.3
<u>Cross-Agency Support Programs</u>	<u>\$377.8</u>	<u>\$533.5</u>	<u>\$491.7</u>	<u>\$497.9</u>	<u>\$467.1</u>	<u>\$476.8</u>	<u>\$482.2</u>
Education Theme	\$178.9	\$162.4	\$153.3	\$152.4	\$153.1	\$154.0	\$153.3
Advanced Business Systems (IEMP)	\$0.0	\$156.3	\$108.2	\$106.9	\$73.8	\$78.5	\$80.6
Innovative Partnership Programs	\$198.9	\$214.8	\$197.9	\$205.5	\$206.2	\$209.7	\$212.9
Shared Capability Assets Program	\$0.0	\$0.0	\$32.2	\$33.1	\$33.9	\$34.7	\$35.5



# FY06 vs. FY07 Budget Comparison





# Science Budget Strategy

- **To support Space Operations Mission Directorate requirements within a fixed Agency budget, reductions to previous Science planning are necessary**
- **Science gets 1.5% growth from FY06 to 07, 1% per year thereafter**
  - \$3.1B decrease from FY06 Budget runout
- **Strategy for Adjustments**
  - Develop an executable program based on strategic National Academy science priorities





# Budget Comparison by Theme

	FY06	FY07	FY08	FY09	FY10	FY11	Total Changes
<b>Total Science</b>							
FY 06 President's Budget, excluding Lunar	5,341.7	5,684.2	6,132.0	6,436.8	6,370.7		
FY 07 President's Budget	5,253.7	5,330.0	5,383.1	5,437.1	5,491.5	5,546.4	
Changes	-88.0	-354.2	-748.9	-999.7	-879.2		-3,070.0
<b>Earth-Sun Systems</b>							
FY 06 President's Budget	2,063.6	2,081.2	2,132.2	2,359.0	2,324.8		
FY 07 President's Budget	2,163.5	2,210.6	2,283.7	2,288.9	2,315.8	2,390.0	
Changes	99.9	129.5	151.5	-70.2	-9.0		301.8
<b>Solar System Exploration</b>							
FY 06 President's Budget, excluding Lunar	1,765.9	2,071.5	2,460.5	2,582.7	2,639.2		
FY 07 President's Budget	1,582.3	1,610.2	1,598.6	1,840.4	1,899.6	1,846.7	
Changes	-183.6	-461.4	-861.9	-742.4	-739.6		-2,988.8
<b>The Universe</b>							
FY 06 President's Budget	1,512.2	1,531.5	1,539.4	1,495.0	1,406.7		
FY 07 President's Budget	1,507.9	1,509.2	1,500.9	1,307.9	1,276.1	1,309.7	
Changes	-4.3	-22.3	-38.5	-187.2	-130.6		-382.9



# FYX Budget Timeline

- **March/X-2 Program Operating Plan (POP) guidelines to projects**
- **May/X-2 Project response to POP**
- **July/X-2 Science Mission Directorate recommendation to NASA Comptroller**
- **August/X-2 NASA Budget decisions**
- **September/X-2 NASA budget to Office of Management and Budget (OMB)**
- **November/X-2 OMB Markup**
- **February/X-1 President's budget announced**
- **March/X-1 Congressional authorization committees**
- **August/X-1 Congressional appropriations committees**
- **September/X-1 Congressional conference committee**
- **October/X-1 President signs budget (beginning of FYX)**



# FY07 Budget Implications

## What's Changed:

- HST SM-4 scheduled for December 2007.
- JWST cost growth estimates incorporated for 2013 LRD.
- GLAST completed a schedule and cost re-baseline mainly due to development problems with the LAT; LRD no-earlier-than September 2007.
- Kepler confirmation baseline established
- WISE confirmation review conducted, budget assumes the project will enter development in 2006; Letter sent from AA/SMD to PI requesting the mission stay in formulation.
- SIM LRD no-earlier-than 2015/2016; TPF deferred; Keck Outriggers cancelled.
- A review of SOFIA is being in held order to determine the best course of action.
- A re-plan within the Beyond Einstein Program will be conducted to determine which mission (LISA, Con-X and JDEM) will be selected to proceed first.
- Research & Analysis funding reduced approximately 15%.
- Herschel and Planck budgets adjusted to reflect changes in schedule.

## What's Stayed the Same:

- Chandra operations and data analysis will continue through 2011.
- Spitzer operations will continue through lifetime of cryogenic mission.
- Maintain support for NASA work associated with Herschel and Planck.



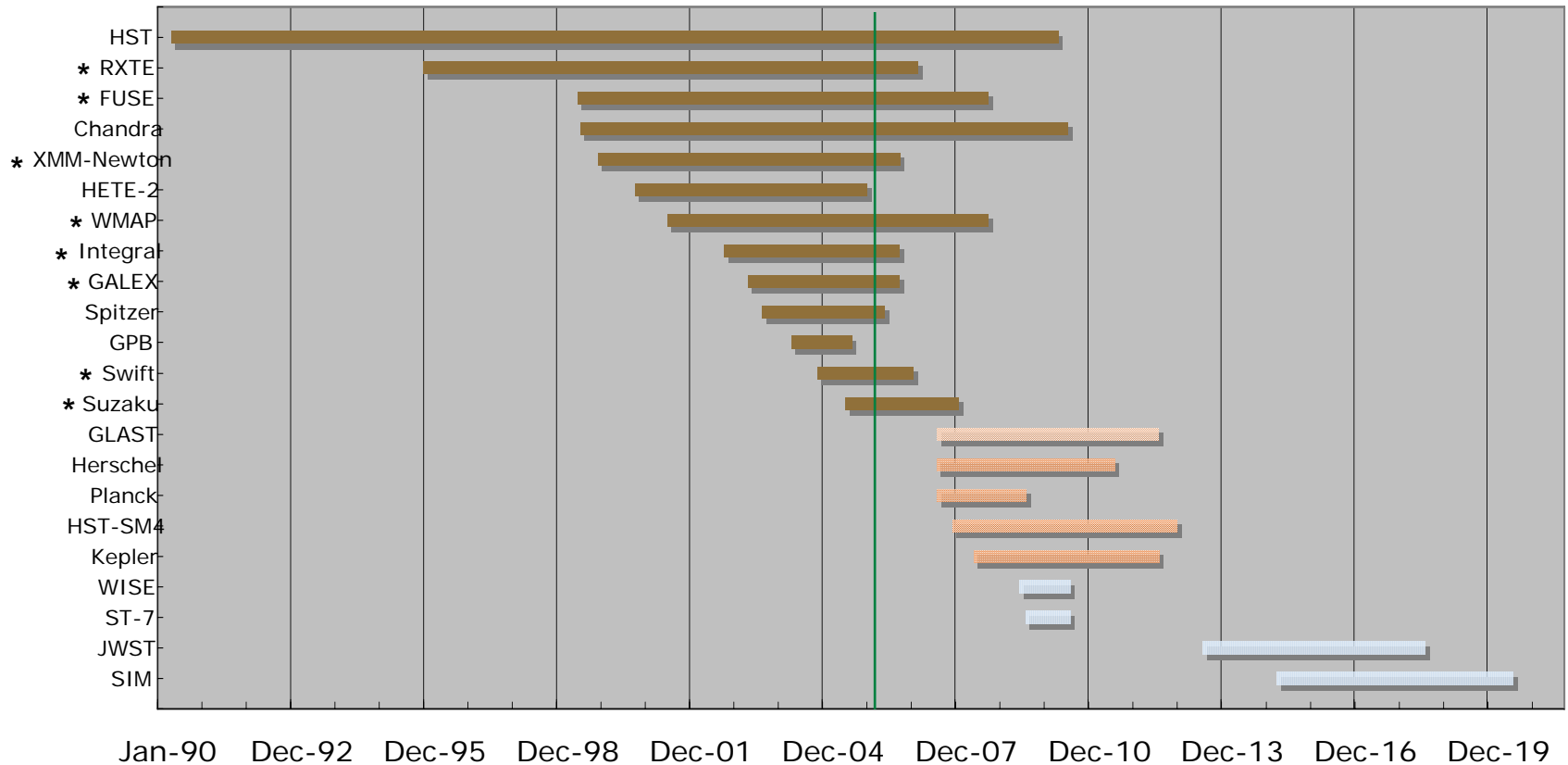
# Content of FY07 President's Budget

	FY06	FY07	FY08	FY09	FY10	FY11
<b>FY 07 President's Budget</b>	<b>1,507.9</b>	<b>1,509.2</b>	<b>1,500.9</b>	<b>1,307.9</b>	<b>1,276.1</b>	<b>1,309.7</b>
Navigator	145.5	128.1	170.6	276.9	261.6	347.0
SIM	117.0	98.5	139.0	236.2	222.5	302.2
Keck Interferometer / Single Aperture	9.6	10.2	9.6	8.4	7.0	7.0
TPF	3.4					
Corporate / Other	15.5	19.4	22.0	32.3	32.1	37.8
<b>James Webb Space Telescope</b>	<b>364.0</b>	<b>443.1</b>	<b>492.6</b>	<b>380.9</b>	<b>353.0</b>	<b>305.0</b>
Hubble Space Telescope	268.6	336.7	302.2	161.4	120.3	138.5
Development	166.5	216.2	178.9	55.0	45.4	45.7
Operations and Data Analysis	87.0	102.0	106.0	97.0	68.0	85.0
Corporate	15.1	18.5	17.3	9.4	6.9	7.8
Stratospheric Observatory for Infrared Astronomy (SOFIA)	48.0					
Gamma-ray Large Space Telescope (GLAST)	125.9	85.4	25.2	28.8	29.3	30.4
Discovery (Kepler / Corporate)	137.5	100.8	69.9	13.8	13.4	13.0
Explorer (Universe)	85.4	67.6	86.1	56.7	19.0	4.6
WISE	69.7	53.9	71.7	44.8	8.8	4.3
Swift, Suzaku	10.9	10.0	9.5	8.6	9.1	
Corporate	4.8	3.7	4.9	3.3	1.1	0.3
<b>Universe Research</b>	<b>305.8</b>	<b>306.6</b>	<b>309.2</b>	<b>297.4</b>	<b>288.9</b>	<b>259.6</b>
Research and Analysis	65.1	54.4	54.0	56.0	53.9	55.9
Chandra	58.4	63.0	65.1	64.7	65.1	65.0
Spitzer	74.3	76.6	75.7	71.7	66.4	35.9
Other Missions / Data	68.1	71.2	70.8	59.2	58.4	59.2
Balloons	22.8	24.5	25.8	28.5	28.8	29.0
Corporate / Other	17.1	16.9	17.8	17.3	16.3	14.6
ISSC (Herschel / Planck)	13.0	19.6	23.6	38.9	38.5	36.3
Beyond Einstein	14.1	21.2	21.4	53.0	152.2	175.4



# Astrophysics Division

## Operating Satellite



\* April 2006 Senior Review missions

Tan: mission in development, blue: mission in formulation



# Developmental Mission Status

<i>Project</i>	<i>Launch</i>	<i>Dec</i>	<i>Jan</i>	<i>Feb</i>	<i>STATUS</i>
<b>Keck Intrfrmrtr</b>	N/A	G	G	G	Technical effort focuses on nulling and support for highest priority science.
<b>Keck Outrigger</b>	N/A	R	R	R	Outriggers not funded in FY07.
<b>SOFIA</b>	TBD	R	R	R	Schedule delays for 1st test flight and ORR, reduce budget for FY06, no budget in FY07 and beyond. Initiating review of options.
<b>LBTI</b>	Jun 2007 init. capability	Y	Y	Y	Replan due to delays in telescope readiness complete.
<b>GLAST</b>	Sep 2007	Y	Y	Y	LAT and GBM in instrument-level I&T. S/C mechanism release device change and C&DH electronics problems threaten launch date.
<b>HST SM-4</b>	Dec 2007	G	G	G	Awaiting RTF flight 2 to firm the mission definition and manifest.
<b>Herschel</b>	2007	G	G	G	All hardware development has been completed.
<b>Planck</b>	2007	G	G	G	All hardware development has been completed.
<b>Kepler</b>	2008	G	Y	Y	Continued programmatic review indicates a need to reduce mission content to remain within cost & schedule. Changes should be done to support Apr CDR.
<b>WISE</b>	2009	G	G	G	Developing new plan based on FY06 plan and POP guidance.
<b>JWST</b>	NET 2013	Y	Y	Y	Replanning continuing on-track for completion in April. IPAO special review briefing to APMC in April/May.
<b>SIM</b>	NET 2015	G	G	G	Erosion of mass from 26% to 18%. Tiger Team formed to return mass margin to at least 25%. In process of finalizing engineering milestones for Phase B & C.
<b>LISA</b>	NET 2015	G	R	R	Cutbacks (staffing, tasks) being implemented in light of FY06 budget change. FY07 and beyond to be addressed through POP process.
<b>Con-X</b>	NET 2018	G	R	R	Cutbacks (staffing, tasks) being implemented. FY07 and beyond addressed by POP.
<b>TPF</b>	TBD	G	G	G	Received 2 formation flying robot for TPF-C testbed. TPF-I instrument concept + study final reports due 4-14-06.
<b>Balloons</b>	on-going	G	G	G	NASA and NSF office of Polar Programs conducted site visits to down select payloads for FY 2007 Antarctic LDB flights.
<b>MSC</b>	N/A	G	G	G	Scope of project reduced but still supports KI, LBTI & SIM on timely basis.



# Astrophysics Division Operating Missions Status

Launch/EOM		Dec	Jan	Feb	STATUS
<b>HST</b> (Extended)	4-25-90 2010	G	G	G	ACS suspended 3/18, halting the science timeline Cycle 15 TAC meets 3/20-24. 733 proposals received
<b>Rossi XTE</b> (Extended)	12-30-95 2-28-07	G	G	G	HEXTE instrument stopped rocking twice the week of 3/1. Team is investigating
<b>FUSE</b> (Extended)	6-24-99 9-30-08	G	G	G	FUSE in ACS hold 3/3-3/6 due to improper sun orientation. Recovered and operating nominally. Users group meeting 3/31.
<b>Chandra</b> (Extended)	7-19-99 7-19-10	G	G	G	723 GO proposals received for Chandra Cycle 8
<b>XMM-Newton</b> (Extended)	12-9-99 9-30-06	G	G	G	
<b>HETE-2</b> (Ext-Extended)	10-8-00 12-31-05	G	G	G	
<b>WMAP</b> (Extended)	6-30-01 9-30-08	G	G	G	
<b>Integral</b> (Extended)	10-17-02 9-30-06	G	G	G	
<b>GALEX</b> (Extended-Prime)	4-28-03 9-30-06	G	G	G	
<b>Spitzer</b> (Prime)	8-25-03 5-25-06	G	G	G	787 proposals received in response to Spitzer Cycle 3 GO announcement
<b>GP-B</b> (DA mode)	4-20-04 8-30-05	G	G	G	
<b>Swift</b> (Prime)	11-20-04 1-21-07	G	G	G	Swift Burst Alert Telescope (BAT) offline 2/25-28 due to FSW anomaly; rebooted successfully
<b>Suzaku</b> (Prime)	7-9-05 2-1-08	G	G	G	



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# Backup





# Astrophysics Missions

Mission	Launch	06 IBPD	Phase	End of Prime
HST	Apr-90	same	Implementation - Extended Operations	Apr-05
RXTE	Dec-95	same	Implementation - Extended Operations	Jan-98
FUSE	Jun-99	same	Implementation - Extended Operations	Mar-03
Chandra	Jul-99	same	Implementation - Extended Operations	Jul-04
XMM	Dec-99	same	Implementation - Extended Operations	Dec-04
HETE-2	Oct-00	same	Implementation - Extended Operations	Oct-01
WMAP	Jun-01	same	Implementation - Extended Operations	Sep-03
Integral	Oct-02	same	Implementation - Extended Operations	Sep-04
GALEX	Apr-03	same	Implementation - Extended Operations	Aug-05
Spitzer	Aug-03	same	Implementation - Prime Operations	May-06
Gravity Probe - B	Apr-04	same	Implementation - Post-Op Data Analysis	Sep-05
Swift	Nov-04	same	Implementation - Prime Operations	Jan-07
Astro-E2/Suzaku	Jul-05	same	Implementation - Prime Operations	Feb-08
Herschel	Jul-07	same	Implementation - Development	
Planck	Jul-07	same	Implementation - Development	
GLAST	Sep-07	May-07	Implementation - Development	
HST SM-4	NET Dec-07	robotic	Implementation - Development	
Kepler	Jun-08	TBD	Implementation - Development	
WISE	Jun-09	Aug-08	Implementation - Development	
JWST	Jun-13	Aug-11	Formulation	
SIM	2015-2016	Oct-12	Formulation	
LISA	TBD	Sep-13	Formulation	
Con-X	TBD	n/a	Pre-Formulation	
JDEM	TBD	n/a	Pre-Formulation	
TPF	n/a	n/a	delayed indefinitely	
SOFIA	n/a	Aug-06	under review	



# FY 2007 President's Budget (Budget Changes)

	FY06	FY07	FY08	FY09	FY10	FY11
<b>FY 2006 President's Budget</b>	<b>1,512.2</b>	<b>1,531.5</b>	<b>1,539.4</b>	<b>1,495.0</b>	<b>1,406.7</b>	
Hubble Space Telescope (Servicing Mission)	30.1					
Navigator (TPF)	-20.0					
<b>FY2006 President's Budget as Amended</b>	<b>1,522.3</b>	<b>1,531.5</b>	<b>1,539.4</b>	<b>1,495.0</b>	<b>1,406.7</b>	
James Webb Space Telescope	-7.5	70.6	164.0	153.9	163.6	
Hubble Space Telescope	47.8	118.5	159.0	-8.8	25.3	
Discovery (Kepler)	19.7	24.2	53.1	0.2	-1.1	
Universe Explorers (incl. WISE)	-15.4	-8.5	26.7	45.0	9.4	
Stratospheric Observatory for Infrared Astronomy (SOFIA)	-0.3	-57.1	-59.4	-60.2	-60.4	
Navigator (SIM, TPF, Keck)	-34.0	-118.5	-223.9	-155.2	-172.5	
Gamma-ray Large Space Telescope (GLAST) Program	26.5	18.7	1.3	9.5	3.5	
Universe Research	-9.9	-5.0	-0.1	-5.4	-7.5	
International Space Science Collaboration	0.0	-2.6	-16.2	0.5	4.4	
Beyond Einstein (LISA/Con-X)	-41.3	-62.7	-143.1	-166.6	-95.3	
<b>FY 2007 President's Budget</b>	<b>1,507.9</b>	<b>1,509.2</b>	<b>1,500.9</b>	<b>1,307.9</b>	<b>1,276.1</b>	<b>1,309.7</b>

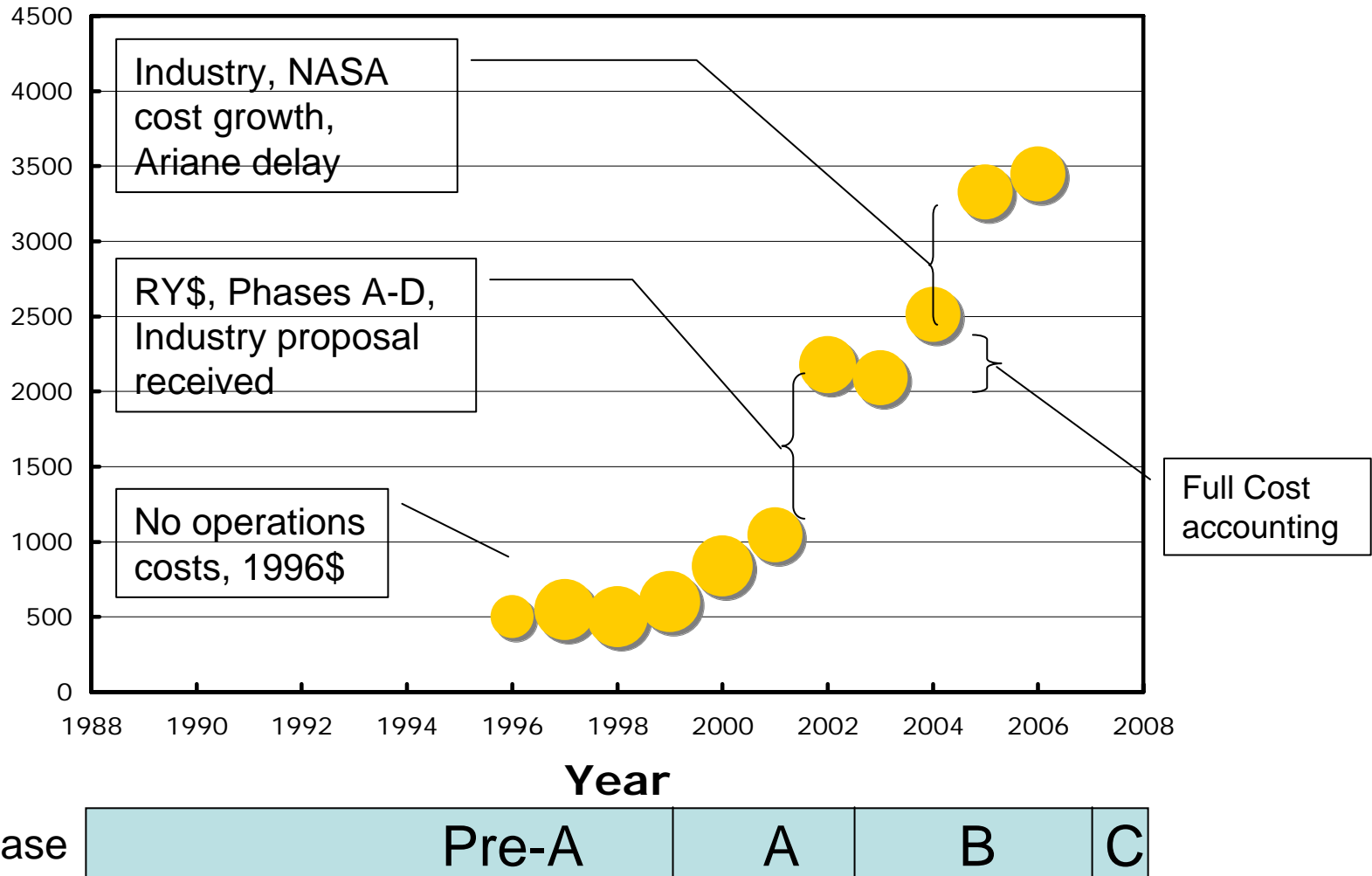


# FY 2007 President's Budget (Budget Changes)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>TOTAL</u>
FY 2006 PRESIDENT'S BUDGET	1,512.2	1,531.5	1,539.4	1,495.0	1,406.7	7,484.9
FY 2007 PRESIDENT'S BUDGET	1,507.9	1,509.2	1,500.9	1,307.9	1,276.1	7,101.9
Changes	(4.3)	(22.3)	(38.5)	(187.2)	(130.6)	(382.9)
James Webb Space Telescope (JWST)	(7.5)	70.6	164.0	153.9	163.6	544.6
Hubble Space Telescope (HST)	77.9	118.5	159.0	(8.8)	25.3	371.9
Gamma-ray Large Space Telescope (GLAST)	26.5	18.7	1.3	9.5	3.5	59.5
Discovery (Kepler)	19.7	24.2	53.1	0.3	(1.1)	96.2
Universe Explorers (incl WISE)	(15.4)	(8.5)	26.7	45.1	9.4	57.3
International Space Science Collab. (Herschel, Planck)	0.0	(2.5)	(15.3)	0.3	4.0	(13.5)
Navigator (SIM, TPF, Keck)	(54.0)	(118.5)	(223.9)	(155.2)	(172.5)	(724.1)
Beyond Einstein (LISA, Con-X, Einstein Probes)	(41.3)	(62.7)	(143.1)	(166.6)	(95.3)	(509.0)
Stratospheric Observatory for Infrared Astronomy (SOFIA)	(0.3)	(57.1)	(59.4)	(60.2)	(60.4)	(237.4)
Universe Research	(9.9)	(5.0)	(0.1)	(5.4)	(7.5)	(27.9)



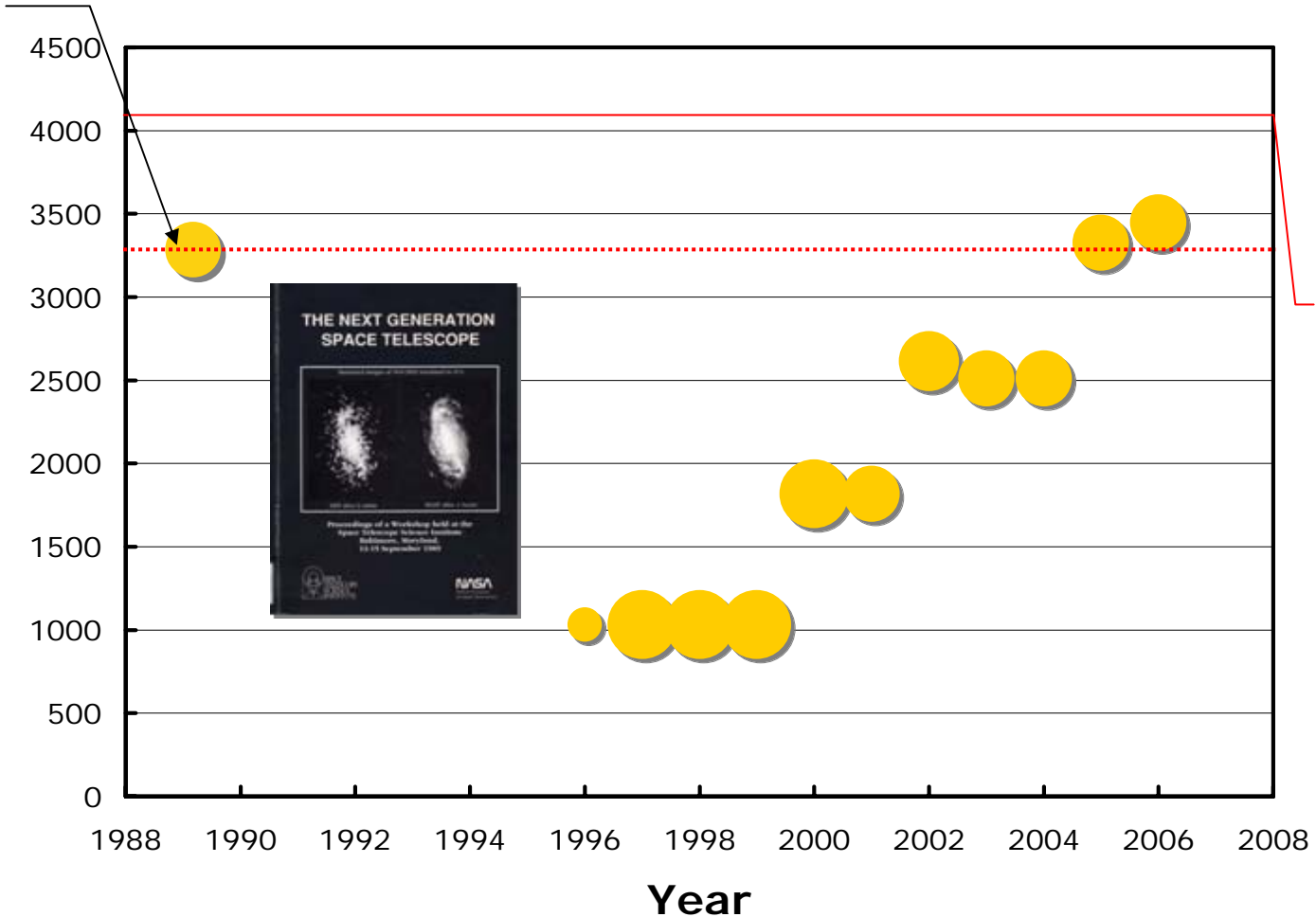
# JWST Advertised Cost vs. time





# JWST Constant \$ Cost vs. time

Field (1989)



HST in FY2006\$

Mission Phase

