Planetary Science Division Perspectives on Flight Mission Cost Management

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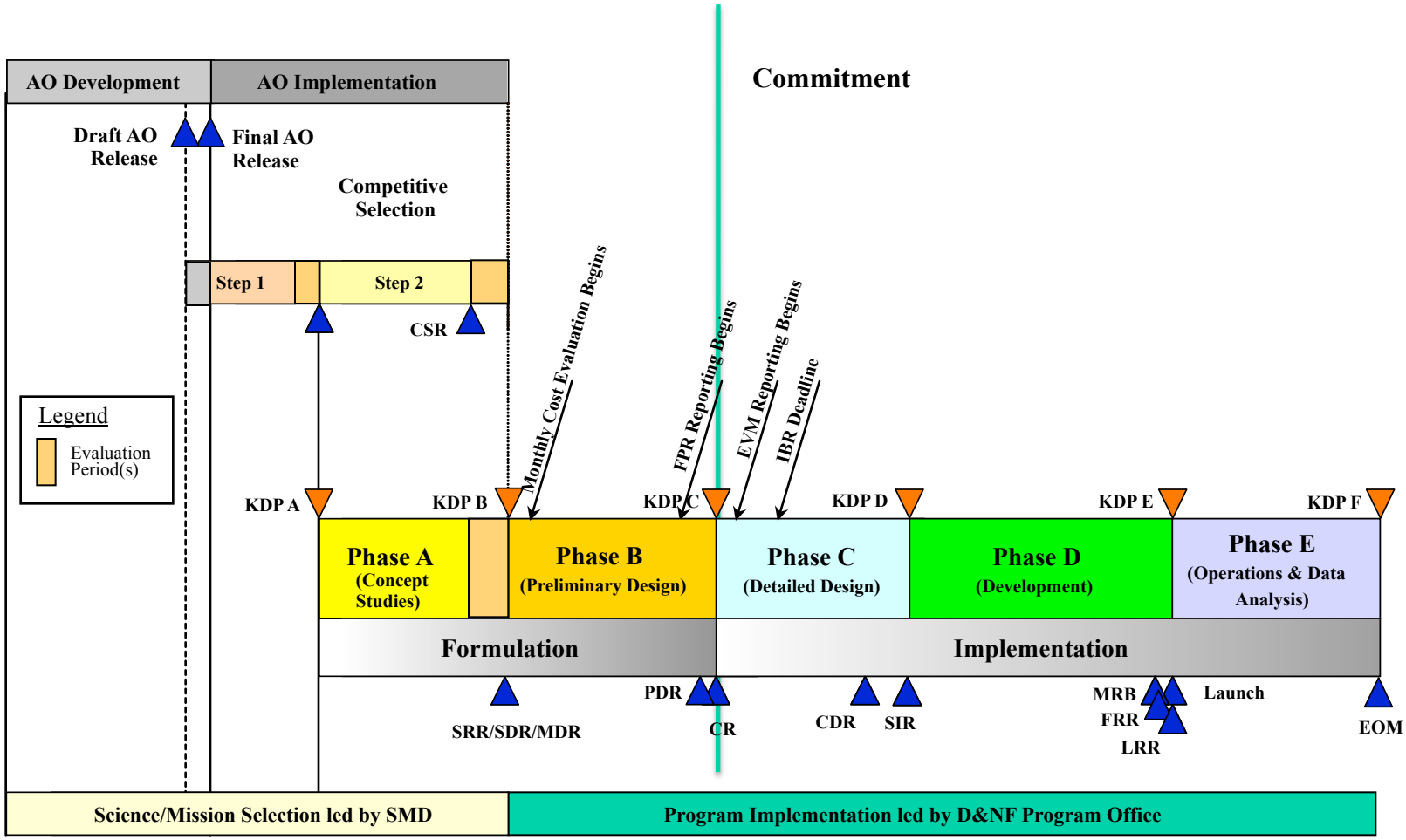
Why did Juno and GRAIL Stay on Cost?
(and schedule)

- AO/Competition
- Understood Complexity
- Solid Planning and Baselines
- Requirements Stability
- Funding Stability
- 70% Confidence Level Budgeting
- Forward Looking Risk Management
- Highly Involved PI's

Juno and GRAIL Cost Control Techniques

- Estimation
  - Techniques and Sources
  - Competitive Factors
- Commitment
  - Confidence Levels
  - “Two Sets of Books”
  - UFE “understanding”
- Management
  - Delegating
  - Communicating
  - Stability

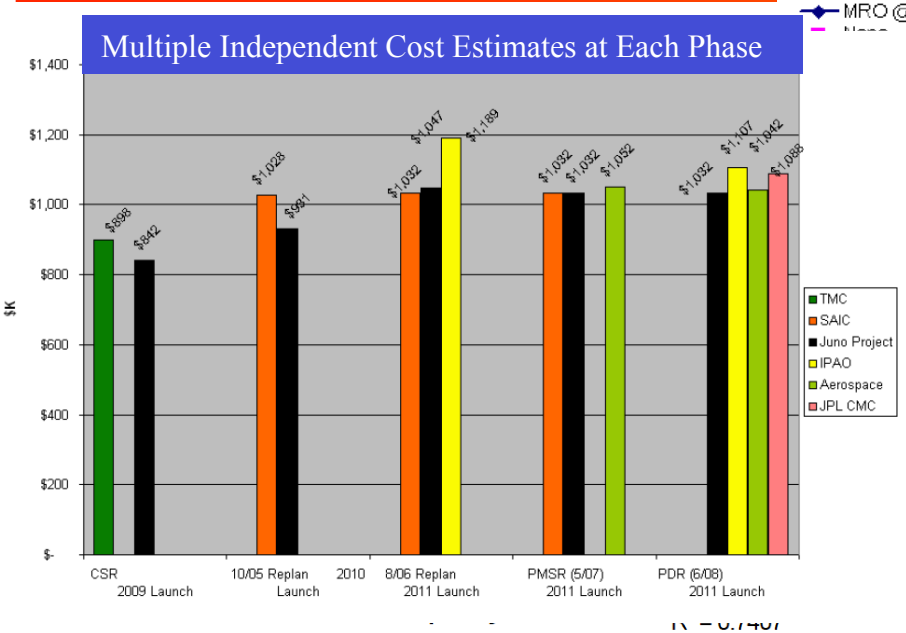
Mission Lifecycle and Phases



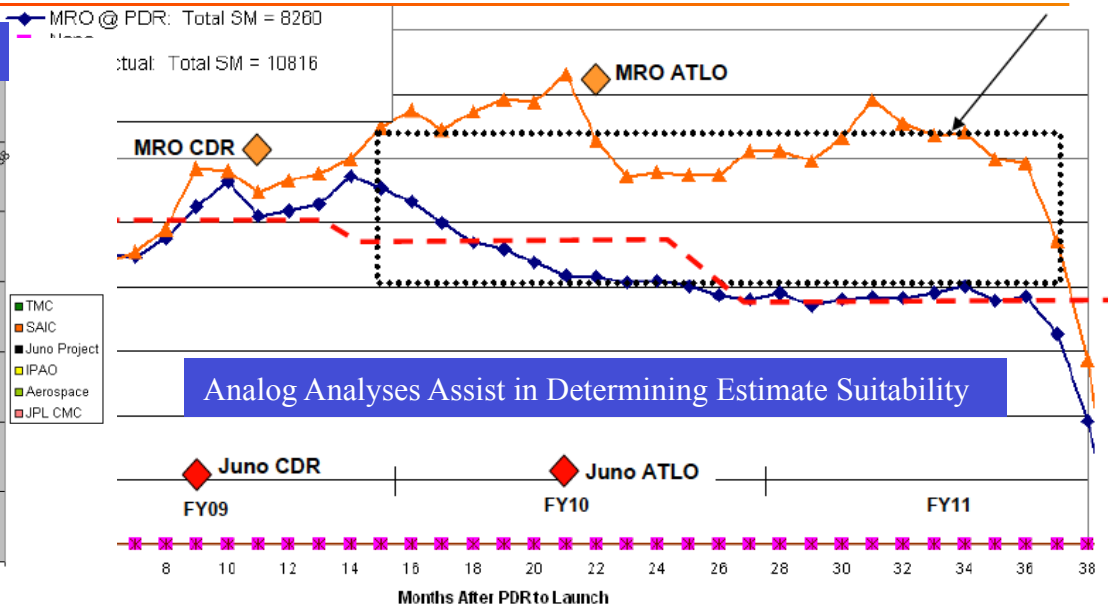
Key Decision Point C (KDP-C) sets the baseline cost of a mission

Tools to Confirm Estimated Cost

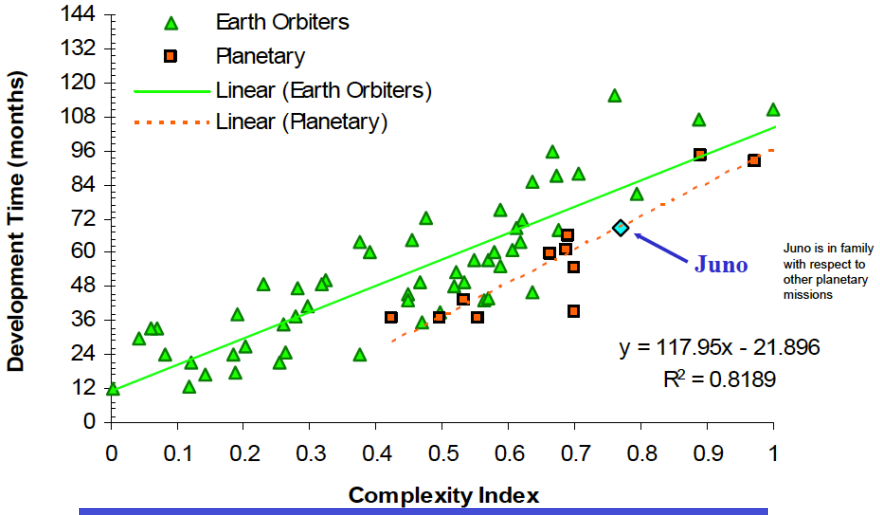
Multiple Independent Cost Estimates at Each Phase



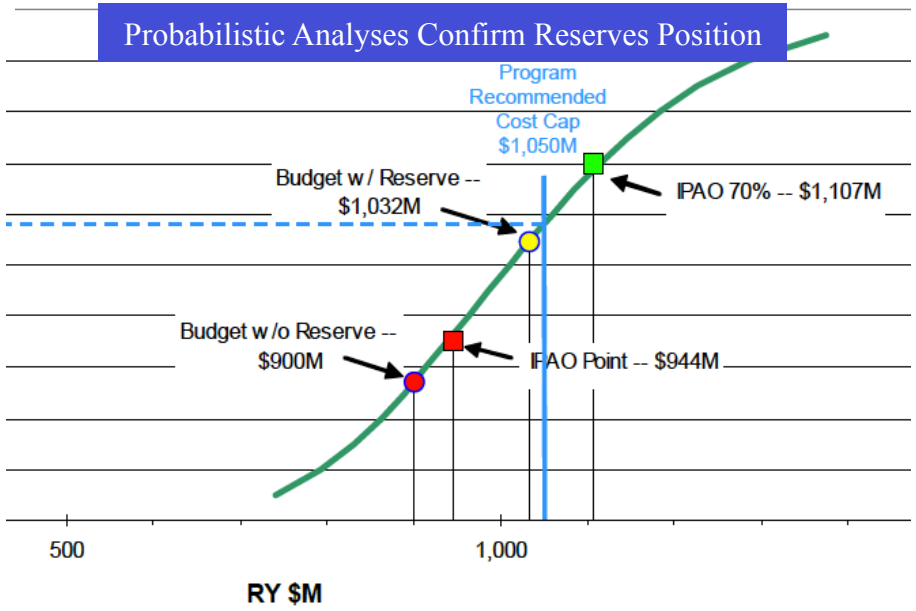
Analog Analyses Assist in Determining Estimate Suitability



Complexity Checks Determine Family and Risk



Probabilistic Analyses Confirm Reserves Position



Confirmation Commitment Starts Reporting and EVM

- No estimates, quotes, bids, models or guesses are valid until Mission Confirmation (KDP-C)
- Projects are Measured against the Baseline set at Confirmation
  - EVM reporting to begin 60 days after Confirmation
  - EVM IBR to be held within 180 days of Confirmation
  - Usually attended by Independent EVM Analyst
- MPAR Reports are based on Agency Baseline Commitment
- Monthly Status is measured against Internal Management Agreement

Table 1: Baseline Commitments with civil service labor

Commitments[1]	Management Agreement (Internal)	Agency Baseline Commitment (External)
Cost – LCC (all phases) w/ cs labor	$235 M[2]	$262 M
Cost - Development (C/D) w/ cs labor	$135 M	$162 M
LRD	May, 2013	November, 2013
Duration of Mission	100 days	100 days
Joint Confidence Level	50%	70%

Baseline Commitments Tables in A/D PMC Minutes Provide Traceability to Decisions

Baseline Established at Confirmation

- Technical Requirements and Definition of Mission Success
- Quality Assurance Level
- Project Cost Estimates
  - LCC (EAC)
  - Development (Phase C/D)
- Budget: Internal and External
- Definition of UFE and Phasing
- Earned Value Requirements
  - IBR Date
  - Independent EVM Reviews Required?
- Schedule
  - Key Decision Points
  - Launch Readiness Date
  - Mission Completion

GRAIL FY 2010

DISCOVERY PROGRAM

ADJUSTED PROJECT BUDGET REPORT

GRAIL FY 2010

SAMPLE

CTR:	JPL	PROJECT #:	408256	PLRA:	
ANALYST:	Marjorie Raymond	UPN:		REV:	
PHONE:	(818) 354-5403			DATE:	4/29/2010

BEGINNING APPROVED PROJECT LIFE CYCLE COST PROFILE FY2010

$K	Phase B FY2009	Phase C/D FY2009	Total Prior	Phase C/D FY2010	Phase C/D FY2011	Phase E FY2012	Phase E FY2013	Phase E FY2014	Phase E FY2015	Phase E BTC	TOTAL LCC	BASELINE COST CAP
TOTAL PROJECT	**17,008.000**	**135,926.000**	**221,201.000**	**124,104.000**	**104,766.000**	**13,316.000**	**4,736.000**				**468,123.000**	**468,200.000**
JPL	16,675.000	83,204.700	127,290.700	93,894.000	68,008.000	10,186.000	812.000				300,190.700	
GSFC	40.000		351.000	1,020.000	788.000	868.000	763.000				3,790.000	
MSFC/MIT	293.000	701.000	1,539.000	1,845.000	2,556.000	2,262.000	3,161.000				11,363.000	
KSC		52,000.000	92,000.000	27,345.000	33,414.000						152,759.000	
JSC		20.300	20.300								20.300	

FUNDING PROFILE DESCRIPTION / EXPLANATION:

2nd QTR FUNDING PROFILE ADJUSTMENT #1

Center	Phase B FY2009	Phase C/D FY2009	Total Prior	Phase C/D FY2010	Phase C/D FY2011	Phase E FY2012	Phase E FY2013	Phase E FY2014	Phase E FY2015	Phase E BTC	TOTAL ADJUSTMENT	PR#
TOTAL ADJ												
JPL				8,845.000	(8,845.000)							
KSC				(8,845.000)	8,845.000							

Adjustment #1 Explanation:

Funding borrow/payback, directed by email from M. Raymond dated 03/02/10.

2nd QTR FUNDING PROFILE ADJUSTMENT #2

Center	Phase B FY2009	Phase C/D FY2009	Total Prior	Phase C/D FY2010	Phase C/D FY2011	Phase E FY2012	Phase E FY2013	Phase E FY2014	Phase E FY2015	Phase E BTC	TOTAL ADJUSTMENT	PR#
TOTAL ADJ												
JPL					500.000						500.000	
KSC					(500.000)						(500.000)	

Adjustment #2 Explanation:

Reallocation of FY11 funding from KSC to JPL to help assist JPL with the cost of funding the GRAIL Softride.

ADJUSTED PROJECT LIFE CYCLE COST (NOA) PROFILE FY2010

$K	Phase B FY2009	Phase C/D FY2009	Total Prior	Phase C/D FY2010	Phase C/D FY2011	Phase E FY2012	Phase E FY2013	Phase E FY2014	Phase E FY2015	Phase E BTC	TOTAL LCC	BASELINE COST CAP
TOTAL PROJECT	**17,008.000**	**135,926.000**	**221,201.000**	**124,104.000**	**104,766.000**	**13,316.000**	**4,736.000**				**468,123.000**	**468,200.000**
JPL	16,675.000	83,204.700	127,290.700	102,739.000	59,663.000	10,186.000	812.000				300,690.700	
GSFC	40.000		351.000	1,020.000	788.000	868.000	763.000				3,790.000	
MSFC/MIT	293.000	701.000	1,539.000	1,845.000	2,556.000	2,262.000	3,161.000				11,363.000	
KSC		52,000.000	92,000.000	18,500.000	41,759.000						152,259.000	
JSC		20.300	20.300								20.300	

FUNDING PROFILE DESCRIPTION / EXPLANATION:

As per KDP-C decision and memorandum, the Grail project management (internal to NASA) approved LCC is $468.2M, while the Agency/MD externally reported LCC is $496.2M. The Agency/MD externally reported $496.2M includes $28M for the IPAO 70% Cost Confidence Level, which is reported under the Unallocated Future Expenses (UFE) budget line, and to be managed by HQ/SMD. The $28M for UFE is neither managed by nor made available to the project without prior approval from either the DPMC or the APMC.

Project Budget Records Retain the History of Funding Decisions

GRAIL FY 2010	DISCOVERY PROGRAM ADJUSTED PROJECT BUDGET REPORT			GRAIL FY 2010
CTR: JPL		PROJECT #: 408256		PLRA:
ANALYST: Marjorie Raymond		UPN:		REV:
PHONE: (818) 354-5403				DATE: 4/29/2010

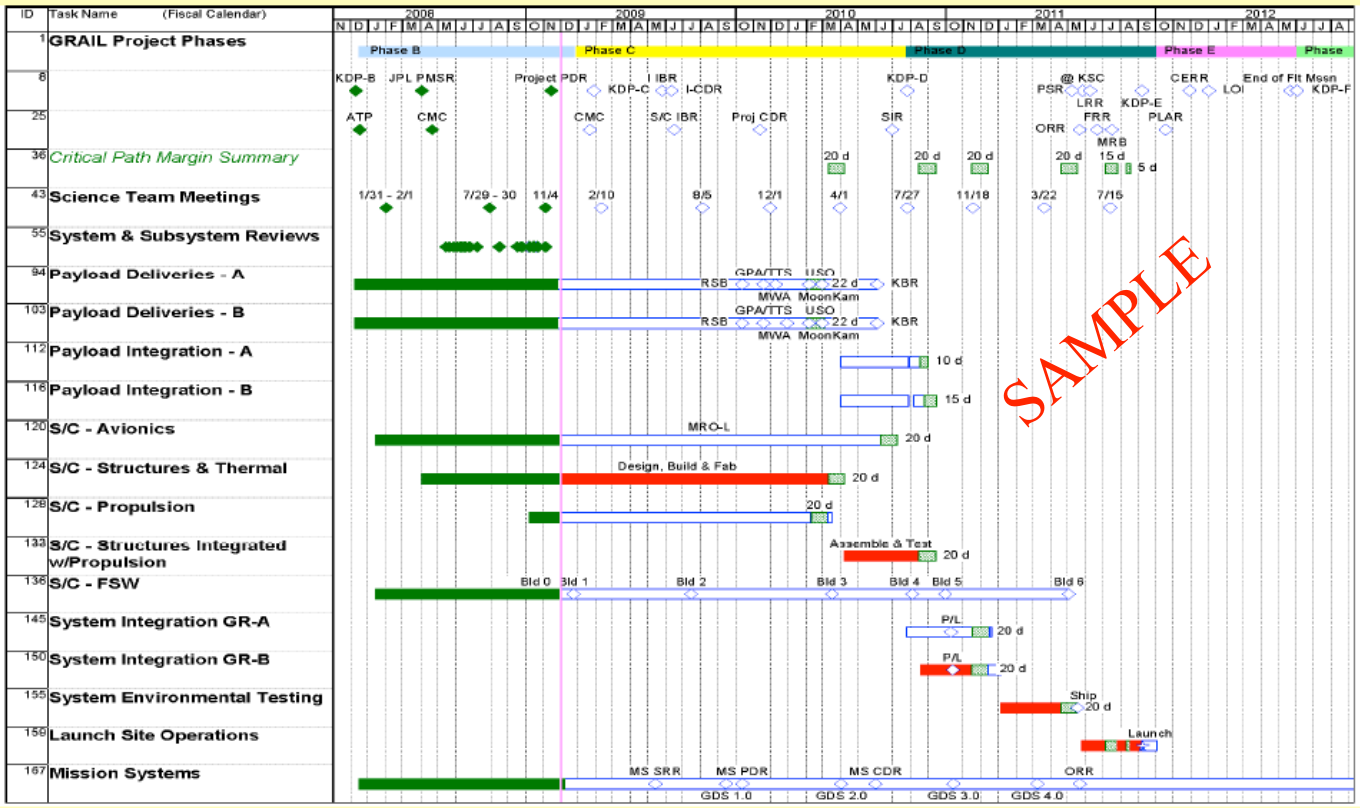
ADJUSTED PROJECT LIFE CYCLE COST (NOA) PROFILE BY PHASE

$K	Prior	FY2010	FY2011	FY2012	FY2013	TOTAL LCC
TOTAL	**221,201.000**	**124,104.000**	**104,766.000**	**13,316.000**	**4,736.000**	**468,123.000**
JPL	127,290.700	102,739.000	59,663.000	10,186.000	812.000	300,690.700
GSFC	351.000	1,020.000	788.000	868.000	763.000	3,790.000
MSFC/MIT	1,539.000	1,845.000	2,556.000	2,262.000	3,161.000	11,363.000
KSC	92,000.000	18,500.000	41,759.000			152,259.000
JSC	20.300					20.300

ADJUSTED PROJECT LIFE CYCLE COST (NOA) PROFILE BY FY

$K	Phase A	Phase B	Phase C/D	Phase E	TOTAL LCC
TOTAL	**1,239.000**	**44,036.000**	**404,796.000**	**18,052.000**	**468,123.000**
JPL	1,189.000	42,897.000	245,606.700	10,998.000	300,690.700
GSFC	50.000	301.000	1,808.000	1,631.000	3,790.000
MSFC/MIT		838.000	5,102.000	5,423.000	11,363.000
KSC			152,259.000		152,259.000
HQ					
JSC			20.300		20.300

FY2010 MILESTONE SCHEDULE

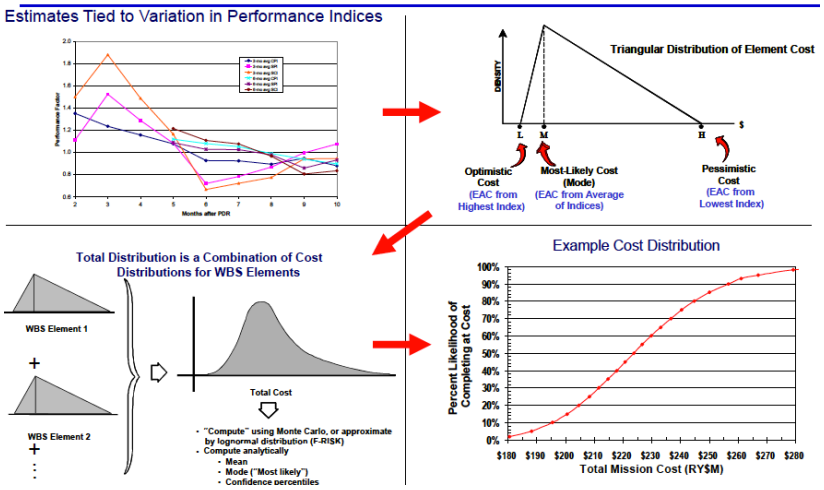


Independent EVM Analysis

- Required Monthly Independent Aerospace Corporation Analysis
  - Double Check of Project EVM Analysis
  - Probabilistic Assessment of EAC
  - Schedule Assessment
  - Screen for Emerging Problem Areas
    - MSL
    - Juno
    - GRAIL
    - LADEE
    - MAVEN

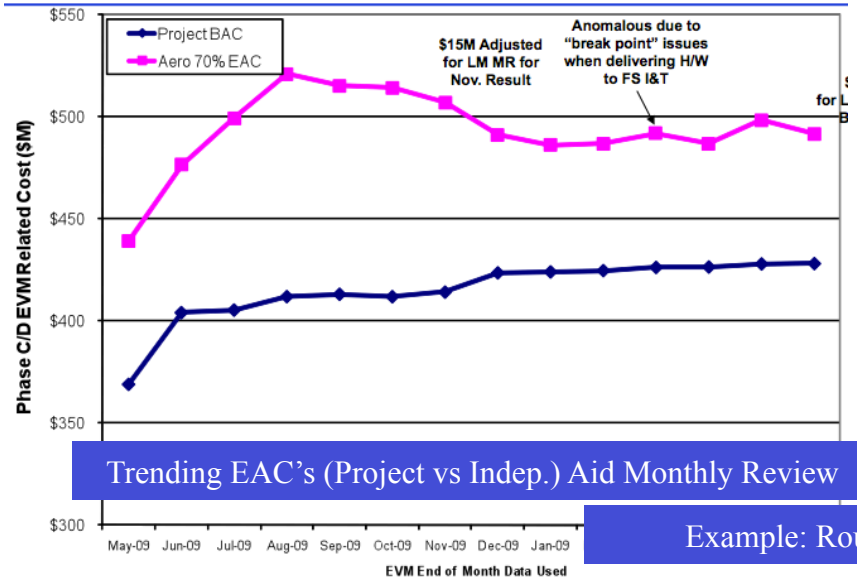
Independent Cost Trend Analysis

Aerospace Approach Combines EVM Analysis & Cost-Risk Process to Predict EAC for Projects in Implementation

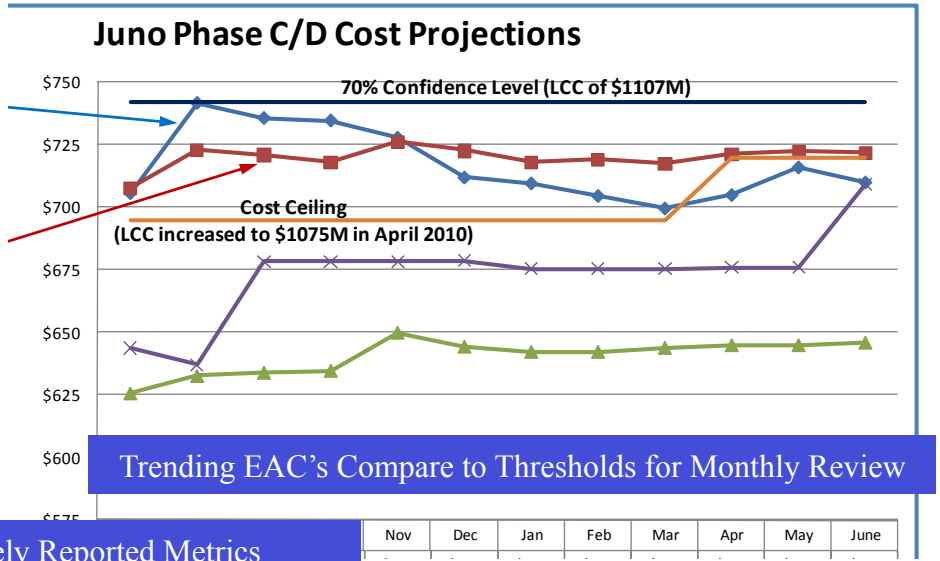


Cost in RY$M Category	Budget at Complete	Estimate at Complete*	Dollar Difference	Percent Difference	Status
WBS 1, 2 & 3 PM/SE/MA	$ 42,250	$ 45,557	$ 3,306	8%	G
WBS 4 Science	$ 5,427	$ 4,780	$ (647)	-12%	G
WBS 5.1 & 5.2 Payload PM/SE	$ 7,469	$ 7,362	$ (107)	-1%	G
WBS 5.4 JEDI	$ 9,847	$ 13,793	$ 3,946	40%	R
WBS 5.6 Plasma Wave	$ 6,772	$ 9,777	$ 3,005	44%	R
WBS 5.7 JADE	$ 10,025	$ 15,577	$ 5,552	55%	R
WBS 5.8 MWR	$ 24,293	$ 32,190	$ 7,897	33%	R
WBS 5.9 Ultraviolet Camera	$ 7,329	$ 8,993	$ 1,663	23%	Y
WBS 5.10 JunoCam	$ 3,915	$ 3,801	$ (113)	-3%	G
WBS 6.1, 6.2, 6.3 Flight System PM/SE/MA	$ 34,871	$ 36,572	$ 1,701	5%	G
WBS 6.4 Electrical Power	$ 57,745	$ 62,439	$ 4,695	8%	G
WBS 6.5 C&DH	$ 19,305	$ 25,176	$ 5,871	30%	R
WBS 6.6 Telecom	$ 19,361	$ 20,230	$ 870	4%	G
WBS 6.7 Structures & Mechanisms	$ 30,231	$ 37,254	$ 7,023	23%	Y
WBS 6.8 Thermal	$ 5,372	$ 6,956	$ 1,584	29%	R
WBS 6.9 Propulsion	$ 26,188	$ 30,066	$ 3,878	15%	Y
WBS 6.10 GN&C	$ 27,657	$ 32,859	$ 5,202	19%	Y
WBS 6.11 Harness	$ 4,157	$ 6,198	$ 2,041	49%	R
WBS 6.12 Flight Segment Software	$ 15,632	$ 23,085	$ 7,453	48%	R
WBS 6.13				8%	G
WBS 6.14				3%	G
WBS 7 MOS/GDS				5%	G
Total Phase C/D	$ 428,050	$ 491,768	$ 63,719	15%	Y

Subsystem Level Assessments Flag Problem Areas



Trending EAC's (Project vs Indep.) Aid Monthly Review

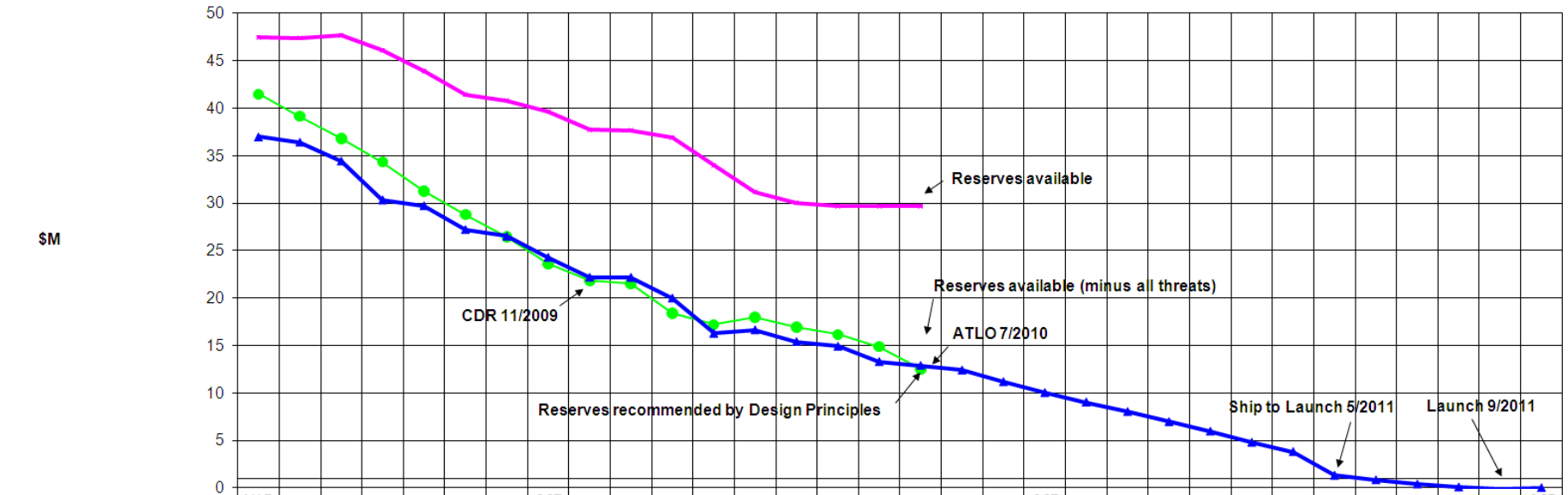


Trending EAC's Compare to Thresholds for Monthly Review

Example: Routinely Reported Metrics

GRAIL Cost Reserve Status (as of 7/25/10)

SAMPLE

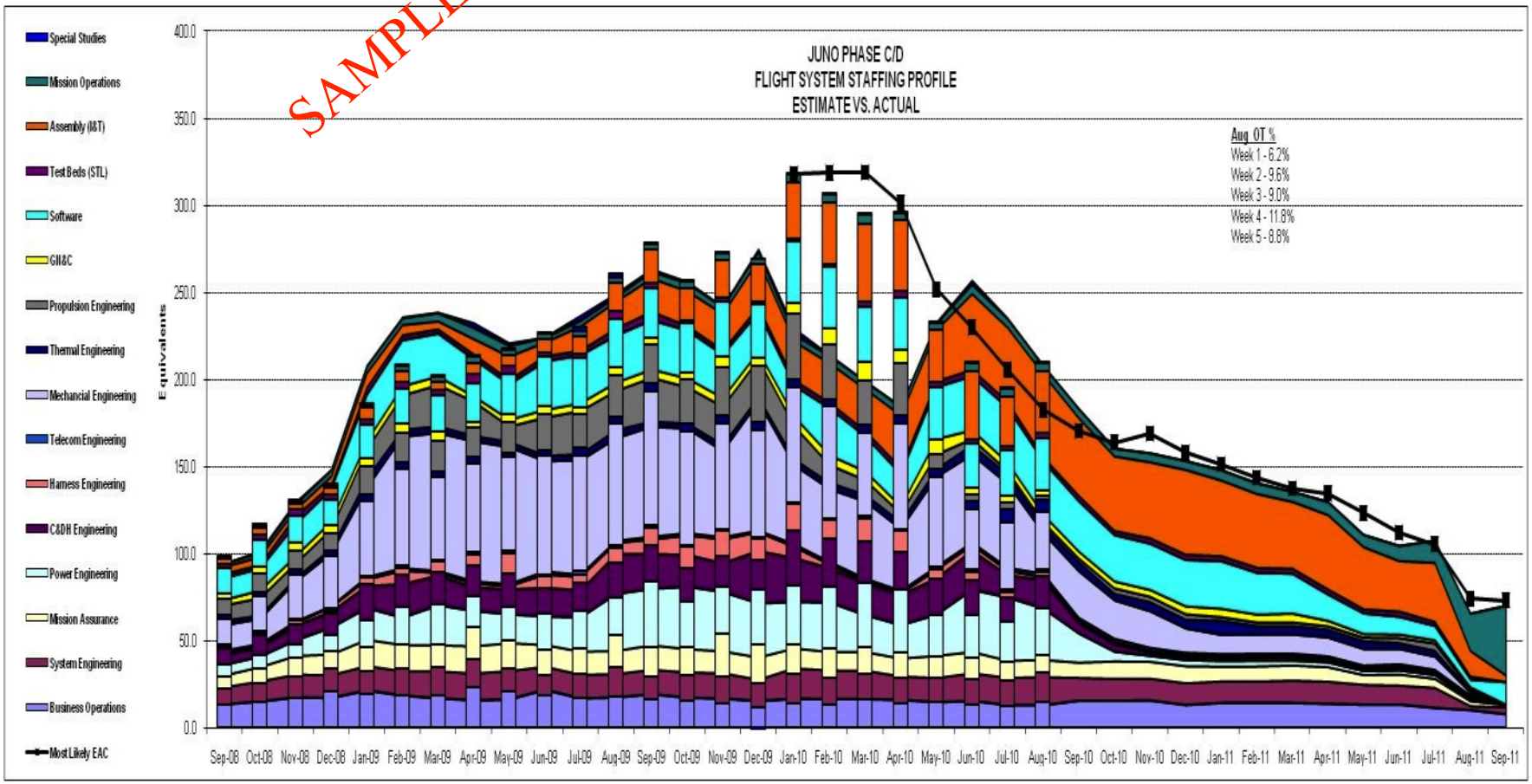


	MAR FY09	APR	MAY	JUN	JUL	AUG	SEP	OCT FY10	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT FY11	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT FY12
Reserve Usage $	47	47	48	46	44	41	41	40	38	38	37	34	31	30	30	30	30															
Reserve Usage w/Threats $	41	39	37	34	31	29	26	24	22	22	18	17	18	17	16	15	12															
DP recommended Reserve $	37	36	34	30	30	27	27	24	22	22	20	16	17	15	15	13	13	12	11	10	9	8	7	6	5	4	1	1	0	0	0	0
Reserve Delta to DP over/(under)	10	11	13	16	14	14	14	15	16	16	17	18	15	15	15	16	17															
Design Principles Reserve%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	10%	10%	10%	10%	10%	10%
Actual Reserve %	26%	26%	28%	30%	30%	30%	31%	33%	34%	34%	37%	42%	37%	39%	39.8%	44.7%	46.1%															

Example: Routinely Reported Metrics

Juno

Flight System Manpower Status



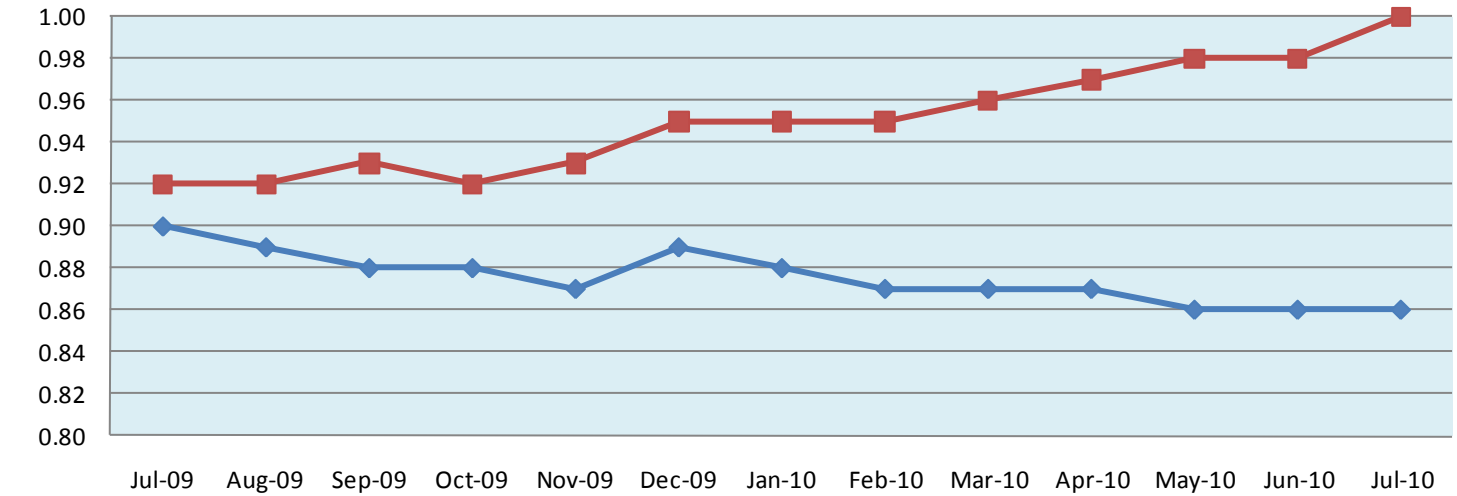
- LM continues to underrun the Jan'10 Most Likely EAC (black line)
- Latest CEAC (haystack profile starting in June'10) reflects deferred avionics work in the C&DH and PDDU areas (expectation is that a lower peak will occur in August-Sept).

Example: Routinely Reported Metrics

Juno

SPI/CPI Trend Analysis

SAMPLE



	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10
CPI	0.90	0.89	0.88	0.88	0.87	0.89	0.88	0.87	0.87	0.87	0.86	0.86	0.86
SPI	0.92	0.92	0.93	0.92	0.93	0.95	0.95	0.95	0.96	0.97	0.98	0.98	1.00

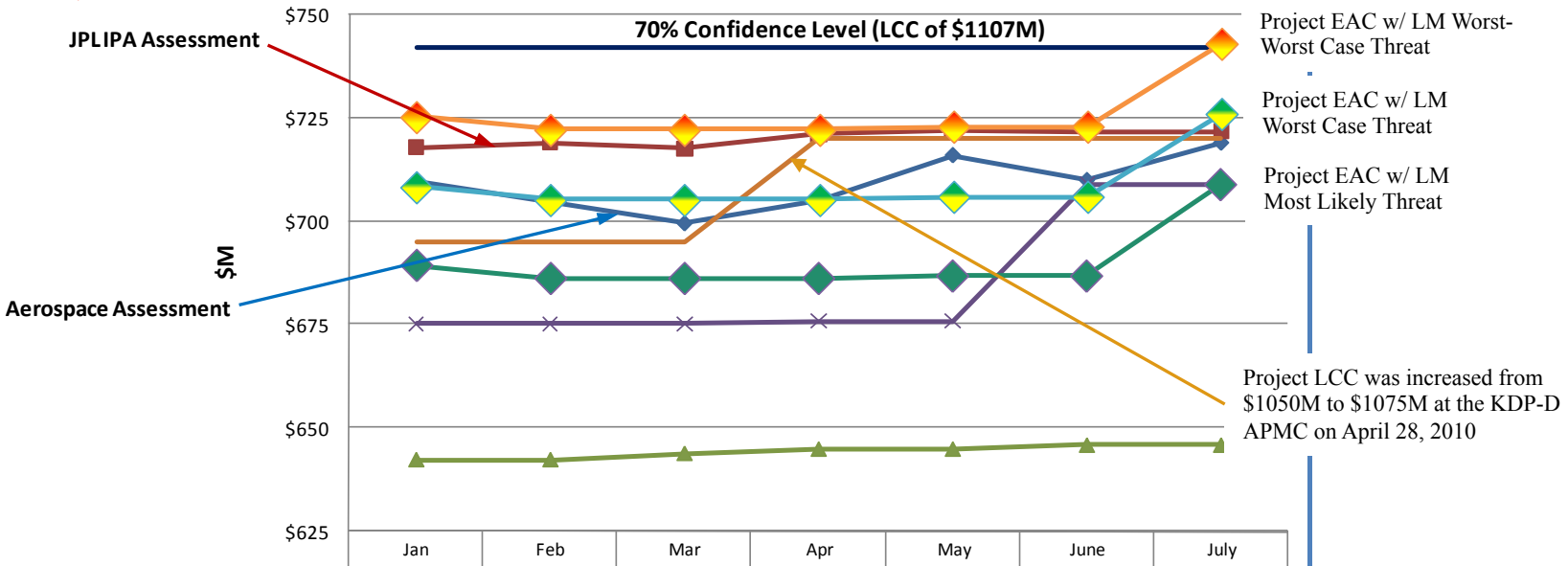
Example: Routinely Reported Metrics

Juno

EVM Cost Comparison

SAMPLE

Juno Phase C/D Cost Projections



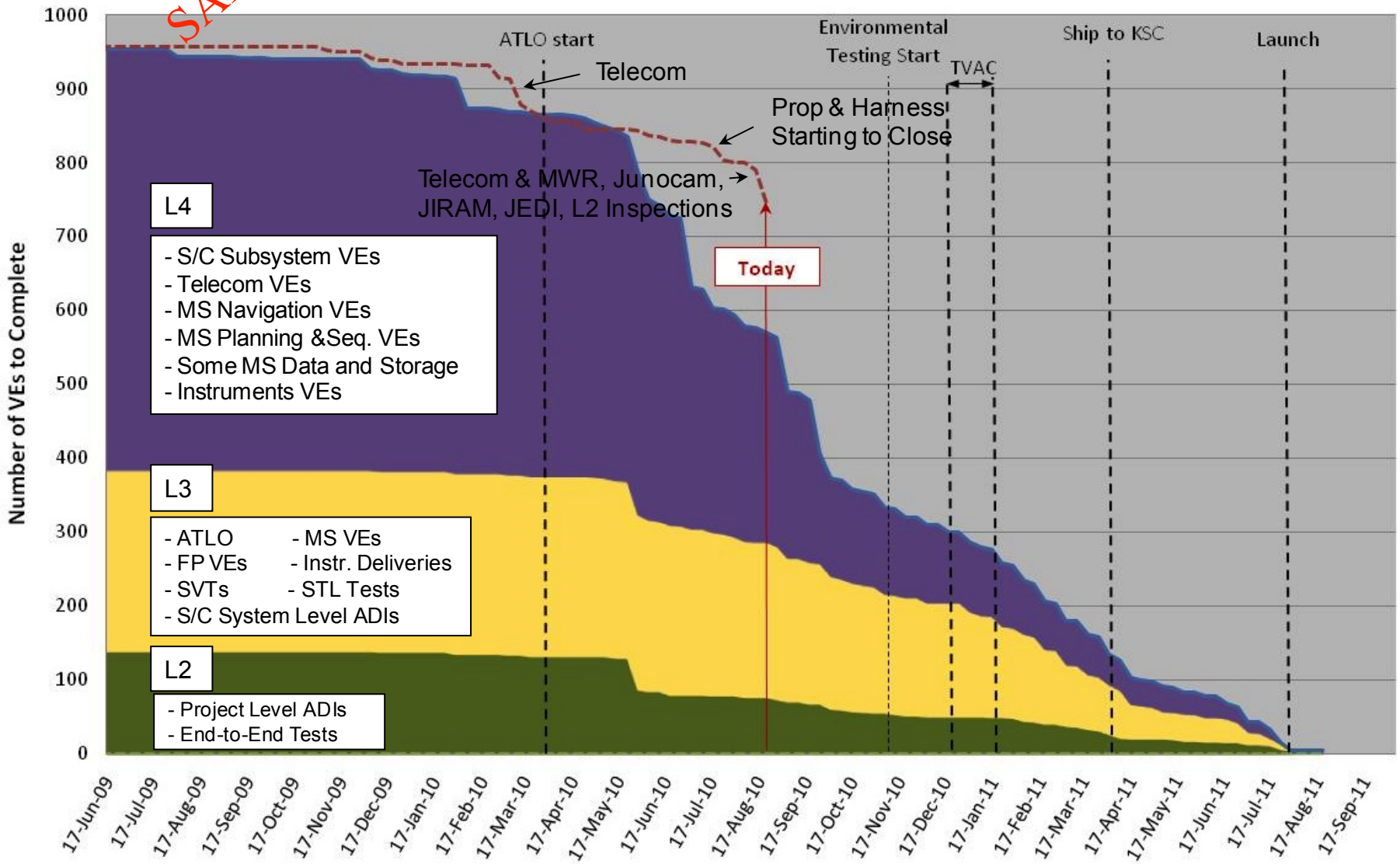
	Jan	Feb	Mar	Apr	May	June	July
Adjusted Aerospace Projection	$710	$705	$700	$705	$716	$710	$719
Adjusted JPL IPA Projection	$718	$719	$718	$721	$722	$722	$722
Adjusted Project Baseline	$642	$642	$644	$645	$645	$646	$646
Adjusted Project EAC	$675	$675	$675	$676	$676	$709	$709
Reserves (excludes Phase B Carry-in)	$53	$53	$51	$75	$75	$74	$74
Phase C/D Cost Ceiling	$695	$695	$695	$720	$720	$720	$720
Phase C/D 70% Confidence Level	$742	$742	$742	$742	$742	$742	$742
Phase C/D 15% Breach Limit	$853	$853	$853	$853	$853	$853	$853
Phase C/D 30% Breach Limit	$965	$965	$965	$965	$965	$965	$965
Juno Threats Realized (LM Most Likely)	$689	$686	$686	$686	$687	$687	$709
Juno Threats Realized (LM Worst Case)	$708	$705	$705	$705	$706	$706	$726
Juno Threats Realized (LM Worst-Worst Case)	$725	$722	$722	$722	$723	$723	$743

Example: Routinely Reported Metrics

Juno

Project Verification Event Burndown

SAMPLE



Example: Routinely Reported Metrics

SAMPLE

Juno

Weekly Quick-look Status – Subsystems

Subsystem	Hardware-Software Deliverable	Baseline Date	Current Estimate or Actual[3]	ATLO Required Date[3]	Interim Tracking Dates			Notes (as of 10/01/2010)
					Activity	Plan Date	Completion Date	
EPS	PDDU	3/19/2010	~~10/14/2010~~ ~~10/20/2010~~ ~~10/25/2010~~ 11/15/2010	~~10/14/2010~~ ~~10/20/2010~~ ~~10/25/2010~~ 11/15/2010	Backplane Fab & Test Complete	~~8/13/2010~~	complete	Board manufacturing is underway using round-the-clock shifts, 7 days/week. Board builds are taking more time to complete than originally planned. Flight USM cards are in final assembly (critical path). Card fabrication taking longer than planned.
					SASM Fab & Test Complete	~~8/27/2010~~	complete	
					USM Fab & Test Complete	~~9/16/2010~~ ~~9/26/2010~~ 10/8/2010		
					Open Box Assembly & Test ~~Complete~~ Start	~~9/19/2010~~ ~~10/4/2010~~ 10/11/2010		
					Box-level Environmental Testing Complete	~~10/20/2010~~ ~~10/25/2010~~ 11/12/2010		
C&DH	C&DH-A	12/2/2009	~~11/1/2010~~ ~~10/20/2010~~ ~~10/29/2010~~ ~~11/4/2010~~ 11/15/2010	~~11/1/2010~~ ~~10/20/2010~~ ~~10/29/2010~~ ~~11/4/2010~~ 11/15/2010	Backplane Fab & Test Complete	9/22/2010	complete	ATU#1 has been retrofitted with the new DTCI Sync FPGA boards to provide full capability on all payload interfaces. Board builds are taking more time to complete than planned. Current critical path is the C&DH Power Supply - Pressure Tranducer (CPS-PT) board. Delays in box-level test due to change out of resistors on the DTCI card (found during open box test). Schedule is being reworked and interim dates will be updated soon. DTCI card is the critical path.
					Card Fab & Test Complete	~~8/24/2010~~ ~~9/13/2010~~ 10/8/2010		
					Open Box Assembly & Test ~~Complete~~ Start	~~9/21/2010~~ ~~10/8/2010~~ 10/19/2010		
					Box-level Environmental Testing Complete	~~10/16/2010~~ ~~10/29/2010~~ 11/12/2010		
	C&DH-B	2/4/2010	~~9/29/2010~~ ~~9/23/2010~~ ~~10/8/2010~~ ~~10/14/2010~~ 10/20/2010	~~9/29/2010~~ ~~9/23/2010~~ ~~10/8/2010~~ ~~10/14/2010~~ 10/20/2010	Card Fab & Test Complete	9/3/2010	complete	
					Open Box Assembly & Test ~~Complete~~ Start	~~8/24/2010~~ ~~9/17/2010~~ 9/21/2010		
					Box-level Environmental Testing Complete	~~9/20/2010~~ ~~10/8/2010~~ 10/14/2010		

- Updates shown in blue.
- Activities have been listed for tracking purposes
- Current ATLO planning utilizes ATUs for PDDU, C&DH-A, and WAIF (3) to start of Environmental Test (EMI/EMC)

Example: Routinely Reported Metrics

SAMPLE

Juno

Weekly Quick-look Status – Instruments

Jovian Auroral Distribution Experiment (JADE)	FM	3/15/2010	8/30/2010	9/3/2010				Current FM delivery contains screened HV801 optocouplers. Replacement HVPS boards have completed fabrication; waiting for the new HV801 parts due in from Amptek on Sept 30. Decision to remove the FM, return to SwRI for board level R&R, perform required box level tests, ship back to LM, perform BAT, turn over to ATLO, and reinstall pending. Pre-Ship Review completed on 7/7/2010. Decision made to remove JADE-I sensor, rebuild TOF board and replace prior to system environmental test. Re-delivery of JADE I-sensor planned for Oct ~~18~~ 11.
	Ebox	3/15/2010	~~8/13/2010~~ 8/30/2010	~~8/13/2010~~ 9/3/2010	Thermal Vacuum Test Complete	~~8/13/2010~~ 8/15/2010	completed 8/15/2010	
	E-Sensor 1	3/15/2010	~~8/13/2010~~ 8/30/2011	~~8/13/2010~~ 9/3/2011	EMI/EMC Test Complete	8/24/2010	completed 8/24/2010	
	E-Sensor 2	3/15/2010	~~8/13/2010~~ ~~9/2/2012~~	~~8/13/2010~~ ~~9/8/2012~~	E-Box Vibration Test Complete	8/26/2010	completed 8/26/2010	
	E-Sensor 3	3/15/2010	~~8/13/2010~~	~~8/13/2010~~				
	I-Sensor	3/15/2010	~~8/13/2010~~	~~8/13/2010~~				
Ultraviolet Spectrometer (UVS)	FM	12/9/2009	~~8/17/2010~~ ~~8/20/2010~~ ~~8/27/2010~~ ~~8/30/2010~~ ~~9/7/2010~~ ~~9/13/2010~~ ~~9/18/2010~~ ~~9/22/2010~~ ~~9/30/2010~~ ~~10/7/2010~~ ~~10/9/2010~~ 10/15/2010	~~8/17/2010~~ ~~8/30/2010~~ ~~9/6/2010~~ ~~9/13/2010~~ ~~9/17/2010~~ ~~9/22/2010~~ ~~9/26/2010~~ ~~10/3/2010~~ ~~10/10/2010~~ ~~10/15/2010~~ 10/18/2010	Sensor Vibration Test Complete	8/2/2010	Failure - broken mirror mount	EMI/EMC anomalies have been resolved by making changes in the cable sheath material, re-test completed. Pre-Ship Review completed on 7/8/2010. Critical path is completion of environmental test flow. Vibration test has been successfully completed. ATLO delivery date delayed an additional 5 days; due to cracks found in a high voltage connector during thermal vac testing. Decision made to replace connector and cables; thermal vacuum testing will be performed and penalty vibration test. Sensor HV connectors and cable have been rebuilt. Thermal vac has resumed and is expected to complete 10/4.
					Sensor Vibration Re-test Complete	~~8/17/2010~~ ~~8/24/2010~~ 8/28/2010	completed 9/3/2010	
					E-Box Vibration Test Complete	8/3/2010	8/3/2010	
					Thermal Vacuum Test Complete	~~9/23/2010~~ ~~9/28/2010~~ 10/4/2010		
					Thermal Calibration Complete	~~10/4/2010~~ ~~10/6/2010~~ 10/14/2010		
Waves	FM	2/17/2010	~~9/3/2010~~ ~~9/2/2010~~ ~~9/11/2010~~ ~~9/18/2010~~ ~~10/2/2010~~ ~~10/9/2010~~ 10/16/2010	~~9/3/2010~~ ~~9/13/2010~~ ~~9/20/2010~~ ~~9/23/2010~~ ~~10/6/2010~~ ~~10/13/2010~~ 10/20/2010	Dynamic Test Complete at Rockwell	~~9/9/2010~~ ~~9/13/2010~~ 9/20/2010	completed 9/21/2010	Critical path is completion of environmental test. Oscillation issue understood and corrections have been made. Final board rework is complete. The Waves Pre-ship review was successfully completed on August 31. All re-fabricated flex-cables have been received. Environmental test program is progressing according to plan.
					EMI/EMC Test Complete at Orbital	~~9/14/2010~~ ~~9/23/2010~~ 9/30/2010	completed 10/1/2010	
					Thermal Vacuum Test Complete	~~9/28/2010~~ ~~10/7/2010~~ 10/14/2010		
	FSW	2/17/2010	~~8/16/2010~~ 8/11/2010	~~8/16/2010~~ 8/11/2011	SRCR	8/11/2010	8/11/2010	

- Updates shown in blue. Green indicates that delivery/integration has occurred.
- Activities have been listed for tracking purposes
- Overall JADE delivery shown as Green-Yellow based on pending decision to R&R post-environment test

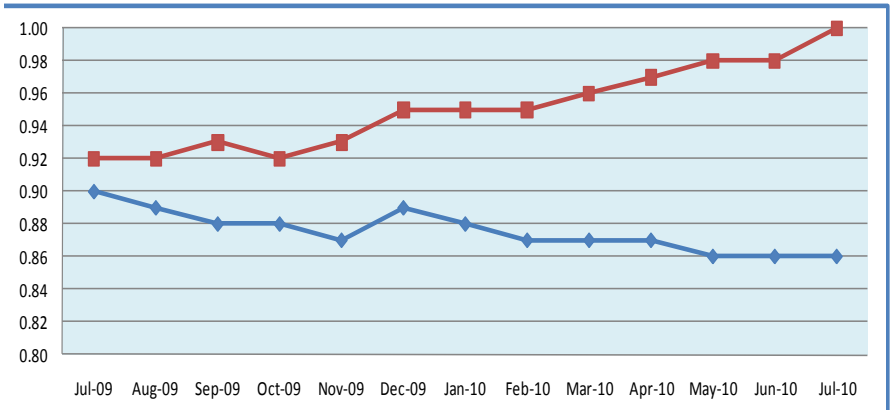
Example: Routinely Reported Metrics

Decision Making Examples

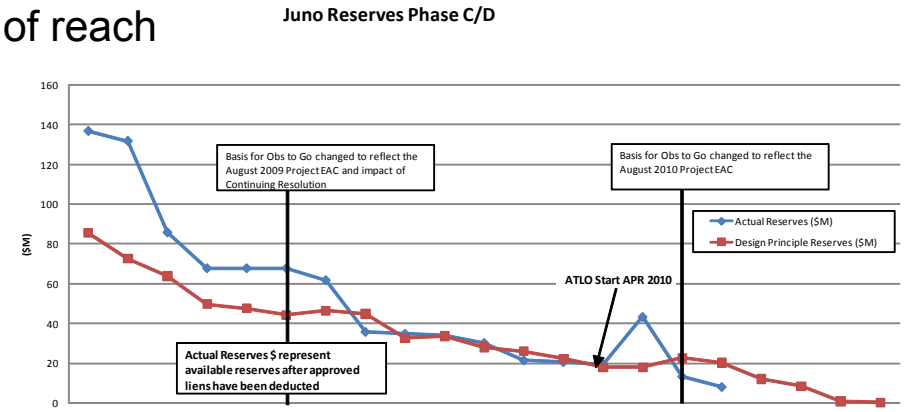
Decision Making, Example 1

- Juno Required the rephasing of UFE from FY12 to FY11

- Why?
  - Division direction to hold schedule by spending reserves
  - UFE was intentionally pushed out to deal with MSL 2-year slip
  - Op Plan change required to bring UFE back into earlier FY's
    - Not always a bad thing
    - Keeps "the blank check" just out of reach
    - Promotes Transparency



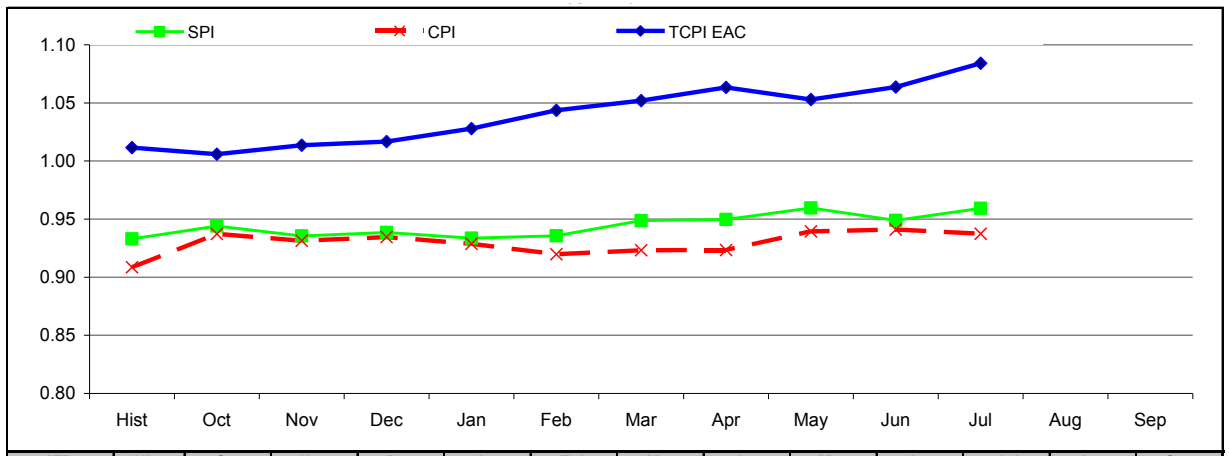
- How much?
  - Use EVM based efficiencies to calculate how much to rephase ($15M)



- Reviewed at the October 6 Agency Program Management Council

Decision Making, Example 2

- GRAIL Mission conducted CDR and SIR
  - Schedule Analysis Produced Confidence Level Range 5%-70%
  - EVM/SPI performance looked strong as did Milestone Completions
  - Countered Schedule Analysis which was in Error
  - Decision made by SMD Directorate Program Management Council to “stick to the plan”



ITD	Hist	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SPI	0.93	0.94	0.94	0.94	0.93	0.94	0.95	0.95	0.96	0.95	0.96		
CPI	0.91	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.94	0.94	0.94		
TCPI EAC	1.01	1.01	1.01	1.02	1.03	1.04	1.05	1.06	1.05	1.06	1.08		

Variance Thresholds: = > 110% or < 90%; = 110% to 120% or 80% to 90%; = > 120% or < 80%

Decision Making, Example 3

- Juno at confirmation (August 2008) needed double check of 70% CL reserve to hold
- Used historical EVM performance from MRO as part of an analog analysis
- Corroborated that $57M would be sufficient HQ held UFE given analogous performance from MRO

Except from Juno Confirmation Review (8/5/08):

Juno has $250 M in planned C/D work (BCWP) in FY10/11 (w/o payload and LV)
Assume Juno performs at MRO level of CPI=0.83

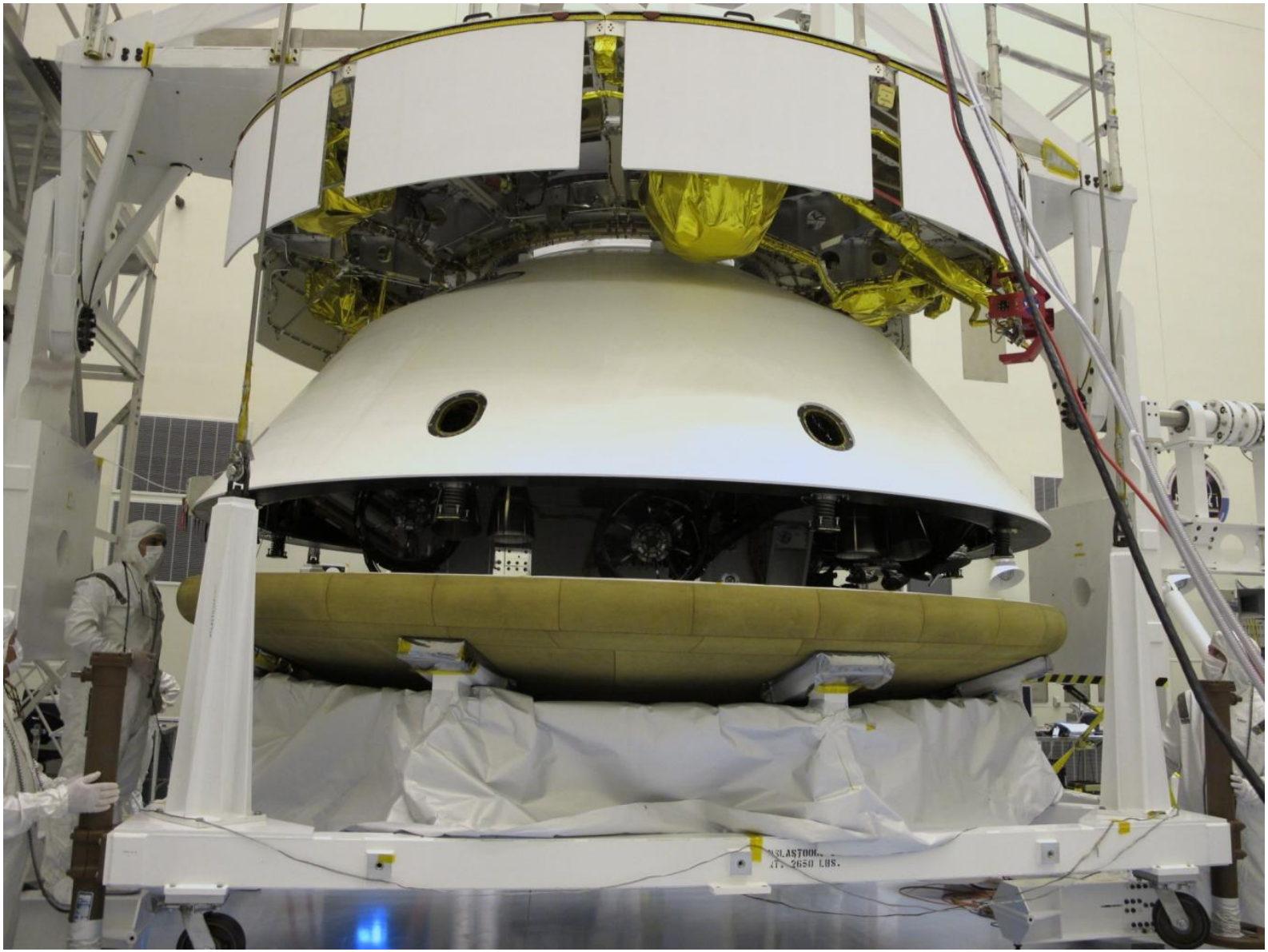
CPI = BCWP/ACWP

Projected actual cost (ACWP) based upon a 0.83 CPI is 301M
(Reserve required in FY10/11 for the Spacecraft is $ 301M- $250M = $51M)

Management Observations

- Effective cost management involves
  - Careful estimates at confirmation (more is better)
  - Attention to labor, cost and technical metrics
  - Willingness to interact and take action
  - A carefully laid out manpower loaded schedule
  - Experience to know when to stick to the plan
  - Long Range Funding Stability
  - Solid UFE strategy
- Detractors
  - GAO Quicklook Book and Special Audits
  - Independent Analysts
  - New Tool Developers
- Advice
  - Stick to your plan
  - Try to think 2 steps ahead of your team

MSL Heat Shield



MSL Encapsulation

MSL Entry, Descent and Landing