RASC - L2 Earth Observatory - Aperture Spacecraft

	Current Best Estimate						Future Best Estimate								
System	**Source**	**Quantity**	**Total Mass CBE (kg)**	**Average Power CBE (W)**	**Peak Power CBE (W)**	**Comments**	**Source**	**Quan-tity**	**Total Mass FBE (kg)**	**Average Power FBE (W)**	**Peak Power FBE (W)**	**Technology SOA Date for FBE**	**Comments**	**Revisions**	
Payload	**Subtotal**		**0**	**0**	**0**	No science instruments on Aperture s/c	**Subtotal**		**0**	**0**	**0**		No science instruments on Aperture s/c		
Power	**Subtotal**		**616**	**0**	**0**		**Subtotal**		**200**	**0**	**0**				
SRG	Bob Cataldo/Tim Sarver Verhey 7/14		474			Stirling Radioisotope Generators (SRG)	Ed Mettler 8/1	2	200				Stirling Radioisotope Generators (SRG) with output of 2000We		
Support Structure	"		142			"									
Cabling															
Shielding															
Thermal	**Subtotal**		**18**	**142**	**142**	**Revised was 0**	**Subtotal**		**10**	**142**	**142**			**Revised Pk PRW**	
Heaters	David Steinfeld 9/15		1	122	122	**Revised was 0**	SMAD - 2 to 5% of dry mass		10	122	122		Assumed 2% of s/c bus dry mass (500kg)		
Loop Heat Pipes	"		11	20	20	loop heat pipe operational controller heaters				20	20				
MLI	"		5.5	0		115 ft^2 @ 0.1 lb/ft^2: 12 lbs				0					
Propulsion	**Subtotal**		**490**	**1,005**	**1,985**	Low thrust, continuous operation case	**Subtotal**		**200**	**345**	**1,417**		Low thrust, continuous operation case	**Revised:E. Mettler**	**Used calc = 1.3 KW T**
Large Thrusters	Tim Sarver Verhey 10/5	8	60	713	**1,600**	Big Engines: 1.30 kW each for maximum operation of 2 engines; maximum thrust of 105 mN; 1675 seconds, 70% eff.	Tim Sarver-Verhey 10/5	8	28	238	1,300	2025-2030	Big Engines: 1.30 kW each for maximum operation of 2 engines; maximum thrust of **70 mN;** 9200 seconds, 90% eff.	**Revised PK Pwr**	
LT gimbals	"	8	26	n/a			"	8	14	n/a		2025-2030			
LT PPUs + cabling	"	8	104	125	**150**		"	8	66	50	55	2025-2030		**Revised PK Pwr**	
plumbing	"	8	36	n/a			"	8	16	n/a		2025-2030			
Small Thrusters	"	12	56	143	**200**	Small Engines: 250 W each for maximum thrust of 11.7 mN; 3000 second Isp; 70% eff.; assumed two engines operating	"	12	28	48	50	2025-2030	Small Engines: 250 W each for maximum thrust of 2.7 mN; 8700 second Isp; 90% eff.	**Revised Pk Pwr**	
ST standoffs	"	4	8	n/a			"	4	2	n/a		2025-2030			
ST PPUs + cabling	"	4	88	25	**35**		"	4	33	10	12	2025-2030		**Revised PK PWR**	
plumbing	"	4	48	n/a			"	4	8	n/a		2025-2030			
Prop Tank	"	1	64	n/a		5% tankage fraction	"	1	5	n/a		2025-2030	2.5% tankage fraction		
Propellant	**Subtotal**		**1,284**	**0**	**0**		**Subtotal**		**194**	**0**	**0**				
Propellant	Tim Sarver Verhey 9/24		1,284			Low thrust, continuous operation case - 3 year propellant load - case would not close with 5 year or longer load	Tim Sarver-Verhey 9/24		194						
GNC	**Subtotal**		**49**	**156**	**256**		**Subtotal**		**21**	**111**	**139**				
	Ed Mettler 10/3						Ed Mettler 10/3								
Formation Ka-Band Metrology	Ka-Band Transceiver & 4-Patch Antennae; one cm range, one arcminute bearing relative accuracy	2	4	2	2	Ongoing funded development for TPF. Relative Range & Bearing bt S/C	Advanced Ka-Band Transceiver & 4-Patch Antennae; 0.5-cm range, 0.5-arcminute bearing relative accuracy	2	1	1	1	2015	Reduced mass & power from further miniaturization/ integration of electronics chips and packaging technology		
Sun-Earth Limb Sensor	Similarity Ref is Questar-7 Maksutov Cassegrain Catadioptric: New design is 0.4-m Folded, 2.5-m Focal length, 10-cm Dia, 1.0 Deg FOV Telescope w/4096 Square CCD Detector & Digital Electr.	1	4	7	7	New Development needed for NAV function: Lightweight long focal length Telescope, Large format CCD for ~4.2 microradian resolutiopn, w/ internal detector and electronics Redundancy	Similarity Ref is Questar-7 Maksutov Cassegrain Catadioptric: Advance lightweight design is 0.4-m Folded, 2.5-m Focal length, 10-cm Dia, 1.0 Deg FOV Telescope w/4096 Square CMOS APS Detector, on-chip processing, Redundant internal detectors & electronics	1	2	2	3	2015	Athermalized Lightrweight Structure & Optical Train of Titanium or Silicon Carbide or Beryllium barrel and Lens Cells, BK-7, Zerodour, Pyrex, coated lens and mirrors, Heat rejection filters.		
Star Cameras & electronics	(4) Star Camera Heads plus (2) Electronics, CCD Detectors	1 Set	3	4	4	DTU Adv Stellar compass; Orsted, SAC-C, ADEOS 11, CHAMP	(4) Star Camera Heads plus (2) Electronics, Adv. CMOS APS Detectors w/on-chip processing	1 Set	2	2	3	2015	Reduced mass & power from further miniaturization/integration of electronics & packaging and APS tech.		
IMUs	Litton SIRU HRG, Internal Redundant Gyros/Accels, Electr.	1	5	27	27	Cassini; EOS AURA, CHEMISTRY: Bias Stability 0.003 deg/hr, R-W 0.0001 deg/rt-hr	Advanced MEMS version Litton SIRU, Internal Redundant Gyros/Accels, Electr.	1	1	4	4	2015	Reduced mass & power from further miniaturization/ integration of electronics chips and packaging technology		
Coarse Sun Sensors	EDO-Barnes 0.7 Deg Accuracy	4	1	1	1	FOV: 128 X 128 Deg Acquisition Sensor	Advanced Tech Version: APS detector tech, 0.2 Deg Accuracy	4	1	1	1	2015	FOV: 180 X 180 Deg, Digital CMOS 1000 X 1000 format APS w/on-chip processing		
Reaction wheels & drive elecronics	SMEX (Clagget) 4 Nms; 0.14 Nm	4	16	8	60	TRACE, WIRE, SWAS	Adv lightweight low power version SMEX (Clagget) 4 Nms; 0.14 Nm	4	5	3	15	2015	High speed low mass composite rotors on magnetic bearings & miniaturized lower power electronics		
Piezo Control Devices for Membrane Shape	Piezo MEMS, Inchworms & PVDF Thin Film Electrode Patterns	45K MEMS for Average of 100 per sq. meter	See areal density under structures	90	100	Tech devel. In early stage with working small scale Lab models	Piezo MEMS, Inchworms & PVDF Thin Film Electrode Patterns	45K MEMS for Av of 100 per sq. meter	See areal density under structures	90	100	2020	Assumed Tech advanced to large scale fabrication stage with precursor 10-m or larger dia flight experiments	**Revised all values for both CBE & FBE**	
Interface Electronics for GNC Sensors & Actuators, and RIU to Main Data Bus	I/O cards for Data I/F w C&DH Main Bus via RIU; Analog & digital I/O; A/D, D/A conversions; house keeping sensors; I/F w/ EP Thrusters Control and Metrology	4	2	2	2	All data channels are redundant. Mil-Std 1553B assumed for main data handling bus architecture, and distributed subsystem microprocessors I/F via RIU's (remote interface units); GNC LAN architecture assumed.	I/O 3-D modules for Data I/F w C&DH Main Bus via RIU; Analog & digital I/O; A/D, D/A conversions; house keeping sensors; I/F w/ EP Thrusters Control and Metrology	1	1	1	1	2015 - 2020	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture		
GNC Computers	Adv BAE SFC	2	1	5	26	Next Gen RAD 750 Microprocessor	3-D Ultra-Thin Chip Scale Integration SFC- Internal multi-Redundant w/ autonomous reconfiguration mng't.	1	1	2	5	2015 - 2020	Nanoscale Flight Computer w/ IC feature size <10 nm & ~ 9 Giga Gates/chip; 3-D Sugar Cube packaging architecture		

Non Volatile Memory	RAM NVM	4	4	2	6	12 GBIT Data per Card	Next Generation NVM RAM: FRAM, MRAM, CRAM Options	1	1	1	2	2015	Feature size 22 nm, 64GBit Data per Module, Non-volatile and Dynamic Random-Access	
DTCI I/F	Data, TLM, CMD, EP, Star Cameras Interfaces	2	1	3	7		3-D Ultra-Thin Chip Scale Integration- Internal Redundant w/ autonomous reconfiguration mng't.	1	1	1	1	2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture	
CMIC I/F	Heartbeat, Sys Reset Tr, A/B Side Selects	2	1	1	2		3-D Ultra-Thin Chip Scale Integration- Internal Redundant w/ autonomous reconfiguration mng't.	1	1	1	1	2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture	
ULDL I/F	RS-422 Data I/F to like units	2	1	2	8		3-D Ultra-Thin Chip Scale Integration- Internal Redundant w/ autonomous reconfiguration mng't.	1	1	1	1	2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture	
GIF I/F	Discrete I/O, Mil-Std 1553B I/F	2	1	3	5		Ultra-high speed Duplex-Redundant Data bus	1	1	1	1	2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture	
Backplane	6U cPCI	2	3				New Generation 3-D redundant architecture	1	1			2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture	
Chassis	Aluminum Enclosure	1	4				Compact 3-D Al enclosure	1	1			2015		
Subsystem Shielding	GNC: TBD for Solar Energetic Particles over 10 years		TBD			Need Environmental-Equipment Analysis	GNC: TBD for low susceptability		TBD				Robust parts & packaging technologies	
Comm	**Subtotal**		**31**	**12**	**30**		**Subtotal**		**22**	**6**	**15**			
S-Band transceiver	Fred Stillwagen 12/5	2	6	6	15	for commands and health/status telemetry	Fred Stillwagen 12/5	2	3	3	7.5	2012	for commands and health/status telemetry	
S-band patch dipole antenna	"	2	1	0	0	for full coverage on uplink	"	2	1	0	0	2012	for full coverage on uplink	
UHF transponder	"	2	6	6	15	for crosslink communications with science spacecraft	"	2	3	3	7.5	2012	for crosslink communications with science spacecraft	
Quadrafilar UHF Helix antenna	"	1	8	0	0	to allow redundant crossover communications capability -- (S-band, UHF and X-Band)	"	1	5	0	0.0	2012	to allow redundant crossover communications capability -- (S-band, UHF and X-Band)	
Misc Cables, switches, components	"	1	10	0	0		"	1	10	0	0			
C&DH	**Subtotal**		**12.32**	**17.5**	**20**	redundant C&DH is a cold spare	**Subtotal**		**6**	**10.35**	**12**		redundant C&DH is a cold spare	
CPU Board	Quang Nguyen/Ken McCaughey 10/17	2	1.4	8	20	BAE RAD 750 SBC - 133 MHz	Quang Nguyen / Ken McCaughey 10/17	2	0.8	5	12	2020	BAE tech. roadmap - 500 MHz	
House Keeping Board	"	2	2	3			"	2	0.6	2				
Network I/F Board	"	2	2	3		Spacewire, mult Buses - 100 Mbps	"	2	0.6	2			Spacerwire - 100 Mbps	
Low Voltage Power	"	2	2	3.5		75% efficiency	"	2	1.0	1.35			85% efficiency	
Backplane	"	2	1.4	0			"	2	1.0	0				
Chassis	"	2	3.52	0		40% of total mass	"	2	2.0	0			50% of total mass	
Structure	**Subtotal**		**3,363**	**0**	**0**		**Subtotal**		**545**	**0**	**0**			
Spacecraft bus	SMAD - 8 to 12% of wet mass	1	696			Assumed 12% of s/c bus wet mass (5600kg)	SMAD - 8 to 12% of wet mass	1	72				Assumed 6% of s/c bus wet mass (1200kg)	
Membrane	CBE for Membranes	1	2,260			5 kg/m² (452m² area per IDEAS model)	Ed Mettler 8/1	1	452				1 kg/m² - Primary Membrane Mirror	
Membrane Support Vibration Damping	Chris Strickland	1	200			Inflatable and rigidizable support rings and struts using 1kg/m² areal density	Chris Strickland	1	0				support structure included with membrane assumption	
Secondary Structure	Chris Strickland	1	207			secondary structure listed	Chris Strickland	1	21				secondary structure listed	
	Total Dry Mass (kg)		**4,578**	**1,333**	**2,433**	**Total Power (W)**	**Total Dry Mass (kg)**		**1,003**	**614**	**1,725**		**Total Power (W)**	
	Total Wet Mass (kg)		**5,862**				**Total Wet Mass (kg)**		**1,197**					

Mass Summary (CBE)	
System	Mass (kg)
Payload	0
Power	616
Thermal	18
Propulsion	490
Propellant	1,284
GNC	49
Comm	31
C&DH	12
Structure	3,363
Total Dry Mass (kg)	**4,578**
Total Wet Mass (kg)	**5,862**

Mass Summary (FBE)	
System	Mass (kg)
Payload	0
Power	200
Thermal	10
Propulsion	200
Propellant	194
GNC	21
Comm	22
C&DH	6
Structure	545
Total Dry Mass (kg)	**1,003**
Total Wet Mass (kg)	**1,197**

Power Summary (CBE)		
System	Avg Power (W)	Peak Power (W)
Payload	0	0

Power Summary (FBE)		
System	Avg Power (W)	Peak Power (W)
Payload	0	0

Power	0	0	
Thermal	142	142	Revised
Propulsion	1,005	1,985	Revised
Propellant	0	0	
GNC	156	256	
Comm	12	30	
C&DH	18	20	
Structure	0	0	
Total Power (W)	**1,333**	**2,433**	PK Pwr Revised

Power	0	0	
Thermal	142	142	Revised
Propulsion	345	1,417	Revised
Propellant	0	0	
GNC	111	139	Revised
Comm	6	15	
C&DH	10	12	
Structure	0	0	
Total Power (W)	**614**	**1,725**	Revised

'otal for 70mN PK total thrust Req'd & 90% Efficiency. See simulations

RASC - L2 Earth Observatory - Science Spacecraft

	Current Best Estimate							Future Best Estimate							
System	**Source**	**Quan-tity**	**Total Mass CBE (kg)**	**Average Power CBE (W)**	**Peak Power CBE (W)**	**Comments**	**Source**	**Quan-tity**	**Total Mass FBE (kg)**	**Average Power FBE (W)**	**Peak Power FBE (W)**	**Technology SOA Date for FBE**	**Comments**	**Revisions**
Payload	**Subtotal**		**300**	**300**	**0**		**Subtotal**		**100**	**90**	**120**	**2015-2020**	Advanced electronics miniaturization	
Vis	J. Zawodny	1	100	100			Ed Mettler 8/1	1	33	30	40	2015-2020	and low power devices	
SWIR	"	1	100	100			"	1	33	30	40	2015-2020		
Mid-IR	"	1	100	100			"	1	33	30	40	2015-2020		
Power	**Subtotal**		**616**	**0**	**0**		**Subtotal**		**300**	**0**	**0**			
SRG	Bob Cataldo/Tim Sarver Verhey 7/14		474			Stirling Radioisotope Generators (SRG)	Ed Mettler 8/1	2	300				Stirling Radioisotope Generators (SRG) with output of 3000We	
Support Structure	"		142			"								
Cabling														
Shielding														
Thermal	**Subtotal**		**23**	**210**	**0**		**Subtotal**		**20**	**210**	**210**			
Heaters	David Steinfeld 9/15		1	190		s/c bus + electronics heaters	SMAD - 2 to 5% of dry mass		20	190	190		Assumed 2% of s/c bus dry mass (1000kg)	Added pk power
Heat Pipes	"		11	20		loop heat pipe operational controller heaters				20	20			
MLI	"		10.5	0		231 ft2 @ 0.1 lb/ft2: 23 lbs				0	0			
Propulsion	**Subtotal**		**404**	**1,005**	**0**	Low thrust, continuous operation case	**Subtotal**		**200**	**1,408**	**1,408**		Low thrust, continuous operation case	
Large Thrusters	Tim Sarver Verhey 10/5	8	60	713		Big Engines: 1.25 kW each for maximum operation of 2 engines; maximum thrust of 70 mN; 2500 seconds, 70% eff.	Tim Sarver-Verhey 10/5	8	28	1,300	1,300	2025-2030	Big Engines: **1.3 kW each for maximum operation of 2 engines; maximum thrust of 70 mN; 9200 seconds, 90% eff.**	E. Mettler, 01-22-04
LT gimbals	"	8	26	n/a			"	8	14	n/a		2025-2030		added Pk power
LT PPUs + cabling	"	8	104	125			"	8	66	50	50	2025-2030		
plumbing	"	8	36	n/a			"	8	16	n/a		2025-2030		
Small Thrusters	"	12	36	143		Small Engines: 250 W each for maximum thrust of 7.8 mN; 4500 second Isp; 70% eff.	"	12	28	48	48	2025-2030	Small Engines: 250 W each for maximum thrust of 2.7 mN; 8700 second Isp; 90% eff.	
ST standoffs	"	4	4	n/a			"	4	2	n/a		2025-2030		
ST PPUs + cabling	"	4	50	25			"	4	33	10	10	2025-2030		
plumbing	"	4	30	n/a			"	4	8	n/a		2025-2030		
Prop Tank	"	1	58	n/a		5% tankage fraction	"	1	5	n/a		2025-2030	2.5% tankage fraction	
Propellant	**Subtotal**		**1,152**	**0**	**0**		**Subtotal**		**194**	**0**	**0**			
Propellant	Tim Sarver Verhey 9/24		1,152			Low thrust, continuous operation case - w/6 year propellant supply	Tim Sarver-Verhey - 9/24		194					
						Case would not close for 10 year propellant case for vehicle masses less than 10 tons.								
GNC	**Subtotal**		**79**	**99**	**213**		**Subtotal**		**36**	**38**	**65**			
	Ed Mettler 10/3						Ed Mettler 10/3							
Coarse Sun Sensors	EDO-Barnes 0.7 Deg Accuracy	4	1	1	1	FOV: 128 X 128 Deg Acquisition Sensor	Advanced Tech Version: APS detector tech, 0.2 Deg Accuracy	4	1	1	1	2015	FOV: 180 X 180 Deg, Digital CMOS 1000 X 1000 format APS w/on-chip processing	
Formation Ka-Band Metrology	Ka-Band Transceiver & 4-Patch Antennae; one cm range, one arcminute bearing relative accuracy	2	4	2	2	Ongoing funded development for TPF. Relative Range & Bearing bt S/C	Advanced Ka-Band Transceiver & 4-Patch Antennae; 0.5-cm range, 0.5-arcminute bearing relative accuracy	2	1	1	1	2015	Reduced mass & power from further miniaturization/ integration of electronics chips and packaging technology	
Formation Optical Metrology	Laser Transceiver & Platform	2	10	10	20	Ongoing funded development for TPF. Relative Range & Bearing bt S/C	Internal Redundant Laser Transceiver	1	6	7	7	2015	Reduced mass & power from miniaturization/ integration of electronics packaging & Internal Redundancy	
Two small telescope sensors: Sun-Earth Limb (SEL) Sensor, and Primary Mirror Center-of-Curvature (COC) Sensor	Similarity Ref is Questar-7 Maksutov Cassegrain Catadioptric: New design is 0.4-m Folded, 2.5-m Focal length, 10-cm Dia, 1.0 Deg FOV Telescope w/4096 Square CCD Detector & Digital Electr.	2	8	14	14	New Development needed for NAV function: Lightweight long focal length Telescope, Large format CCD for ~4.2 microradian resolutiopn, w/ internal detector and electronics Redundancy	Similarity Ref is Questar-7 Maksutov Cassegrain Catadioptric: Advance lightweight design is 0.4-m Folded, 2.5-m Focal length, 10-cm Dia, 1.0 Deg FOV Telescope w/4096 Square CMOS APS Detector, on-chip processing, Redundant internal detectors & electronics	2	4	4	6	2015	Athermalized Lightrweight Structure & Optical Train of Titanium or Silicon Carbide or Beryllium barrel and Lens Cells, BK-7, Zerodour, Pyrex, coated lens and mirrors, Heat rejection filters.	**Revised CBE and FBE values for added COC Sensor**
Star Cameras & electronics	(4) Star Camera Heads plus (2) Electronics, CCD Detectors	1 set	3	4	4	DTU Adv Stellar compass; Orsted, SAC-C, ADEOS 11, CHAMP	(4) Star Camera Heads plus (2) Electronics, Adv. CMOS APS Detectors w/on-chip processing	1 Set	2	2	3	2015	Reduced mass & power from further miniaturization/integration of electronics & packaging and APS tech.	
IMU	Litton SIRU HRG, Internal Redundant Gyros/Accels, Electr.	1	5	27	27	Cassini; EOS AURA, CHEMISTRY: Bias Stability 0.003 deg/hr, R-W 0.0001 deg/rt-hr	SIRU, Internal Redundant Gyros/Accels, Electr.	1	1	4	4	2015	miniaturization/ integration of electronics chips and packaging technology	
Reaction wheels & drive electronics	SMEX (Clagget) 4 Nms; 0.14 Nm	4	16	8	60	TRACE, WIRE, SWAS	Adv lightweight version SMEX (Clagget) 4 Nms; 0.14 Nm	4	5	3	15	2015	High speed low mass composite rotors on magnetic bearings & miniaturized lower power electronics	
Telescope Rotation Drive Motor & Electronics	2-Phase DC Torque Motor w/ 12-Bit Absolute Optical Encoder	1	3	4	8	Redundant Motor Windings, Encoders, Commutation & Drive Electronics	2-Phase DC Torque Motor w/ 12-Bit Absolute Optical Encoder	1	2	3	6	2015	Reduced mass/power from Higher efficiency magnetic materials & electronics miniaturization	
Momentum Wheel/Drive Electr.	For Telescope Momentum Cancellation	1	10	10	20	Integral Electronics; Aligned to Telescope Spin Bearing Axis; Higher speed counter-rotating rotor	For Telescope Momentum Cancellation	1	5	5	10	2015	High speed low mass composite rotors on magnetic bearings & miniaturized lower power electronics	
Interface Electronics for GNC Sensors & Actuators, and RIU to Main Data Bus	I/O cards for Data I/F w C&DH Main Bus via RIU; Analog & digital I/O; A/D, D/A conversions; house keeping sensors; I/F w/ EP Thrusters Control and Metrology	8	3	3	3	All data channels are redundant. Mil-Std 1553B assumed for main data handling bus architecture, and distributed subsystem microprocessors I/F via RIU's (remote interface units); GNC LAN architecture assumed.	I/O 3-D modules for Data I/F w C&DH Main Bus via RIU; Analog & digital I/O; A/D, D/A conversions; house keeping sensors; I/F w/ EP Thrusters Control and Metrology	1	1	1	1	2015 - 2020	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture	

GNC Computers	Adv BAE SFC	2	1	5	26	Next Gen RAD 750 Microprocessor	3-D Ultra-Thin Chip Scale Integration SFC- Internal multi-Redundant w/ autonomous reconfiguration mng't.	1	1	2	5	2015 - 2020	Nanoscale Flight Computer w/ IC feature size <10 nm & ~ 9 Giga Gates/chip; 3-D Sugar Cube packaging architecture
Non Volatile Memory	RAM NVM	4	4	2	6	12 GBIT Data per Card	Next Generation NVM RAM: FRAM, MRAM, CRAM Options	1	1	1	2	2015	Feature size 22 nm, 64GBit Data per Module, Non-volatile and Dynamic Random-Access
DTCI I/F	All Digital Data, TLM, CMD, EP, Star Cameras Interfaces	2	1	3	7		3-D Ultra-Thin Chip Scale Integration- Internal Redundant w/ autonomous reconfiguration mng't.	1	1	1	1	2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture
CMIC I/F	Heartbeat, Sys Reset Tr, A/B Side Selects	2	1	1	2		3-D Ultra-Thin Chip Scale Integration- Internal Redundant w/ autonomous reconfiguration mng't.	1	1	1	1	2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture
ULDL I/F	RS-422 Data I/F to like units	2	1	2	8		3-D Ultra-Thin Chip Scale Integration- Internal Redundant w/ autonomous reconfiguration mng't.	1	1	1	1	2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture
GIF I/F	Discrete I/O, Mil-Std 1553B I/F	2	1	3	5		Ultra-high speed Duplex-Redundant Data bus	1	1	1	1	2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture
Backplane	6U cPCI	2	3				New Generation 3-D redundant architecture	1	1			2015	Advanced 3-D stacked lowpower microchip technology or SUGAR CUBE architecture
Chassis	Aluminum Enclosure	1	4				Compact 3-D Al enclosure	1	1			2015	
Subsystem Shielding	GNC: TBD for Solar Energetic Particles over 10 years		TBD			Need Environmental-Equipment Analysis	GNC: TBD for low susceptability						
Comm	**Subtotal**		**45**	**89**	**248**		**Subtotal**		**26**	**52**	**149**		
Power Amp	Fred Stillwagen 12/5	2	6	65	200	100 Watt Tx Power	Fred Stillwagen 12/5	2	3	40	125	2,025	
X-Band telemetry transceiver	"	2	6	12	18		"	2	3	6	9	2,025	(QPSK modulation, operating at ~100 MBPS)
1 meter inflatable antenna and gimbal	"	1	2	0	0	(.53kg/m^2), including feed)	"	1	2	0	0	2,020	(.53kg/m^2), including feed)
S-Band transceiver	"	2	6	6	15	for commands and health/status telemetry	"	2	3	3	7.5		for commands and health/status telemetry
S-band patch dipole antenna	"	2	1	0	0	for full coverage on uplink	"	2	1	0	0	2,012	
UHF transponder	"	2	6	6	15	for crosslink communications with aperture spacecraft	"	2	3	3	7.5		for crosslink communications with aperture spacecraft
Misc. cables, switches, components	"	1	10	0	0		"	1	5	0	0	2,012	
Quadrafilar UHF Helix antenna	"	1	8	0	0	to allow redundant crossover communications capability -- (S-band, UHF and X-Band)	"	1	6	0	0	2,020	
C&DH	**Subtotal**		**20.16**	**28.75**	**31**	redundant C&DH is a cold spare	**Subtotal**		**9.80**	**18.40**	**20**		redundant C&DH is a cold spare
CPU Board	Quang Nguyen/Ken McCaughey 10/17	2	1.4	8	31	BAE RAD 750 SBC - 133 MHz	Quang Nguyen / Ken McCaughey 10/17	2	0.8	6	20	2020	BAE tech. roadmap - 0.5 to 1 GHz
House Keeping Board	"	2	2	3			"	2	0.6	2			
Mass Memory Boards	"	2	5	8		AiR S290 x4, 1 active - 2000 Gb	"	2	3.0	5			Non-volatile mem banks - 2000 Gb
Network I/F Board	"	2	2	4		Spacewire, mult Buses - 100 Mbps	"	2	0.6	3			Spacerwire - 1 Gbps
Low Voltage Power	"	2	2	5.8		75% efficiency	"	2	1.0	2.40			85% efficiency
Backplane	"	2	2.0	0			"	2	1.0	0			
Chassis	"	2	5.76	0		40% of total mass	"	2	2.8	0			40% of total mass
Structure	**Subtotal**		**1,124**	**30**	**90**		**Subtotal**		**314**	**20**	**60**		
** Spacecraft bus	SMAD - 8 to 12% of wet mass	1	444			Assumed 12% of s/c bus wet mass (3700kg)	SMAD - 8 to 12% of wet mass	1	96				Assumed 8% of s/c bus wet mass (1200kg)
Telescope	Ed Mettler 8/1	1	300			Rotating telescope section	Ed Mettler 8/1	1	100				Rotating telescope section
Secondary Structure	Chris Strickland	1	240			secondary structure listed	Chris Strickland	1	38				secondary structure listed
like tiles	Chris Strickland	1	40			22# / ft³ for Shuttle tiles assume 0.25m³	Chris Strickland	1	30				anticipated loads and speed
Spin/Despin Rotary Drive	Chris Strickland/ DJ Caldwell	1	100	30	90	scaled present day spin/despin motors on spacecraft comparing supported mass	Chris Strickland/ DJ Caldwell	1	50	20	60		50% reduction due to specific design for anticipated loads and speed
	Total Dry Mass (kg)		**2,610**	**1,762**	**582**	**Total Power (W)**	**Total Dry Mass (kg)**		**1,005**	**1,836**	**2,032**		**Total Power (W)**
	Total Wet Mass (kg)		**3,762**				**Total Wet Mass (kg)**		**1,199**				

Mass Summary (CBE)	
System	Mass (kg)
Payload	300
Power	616
Thermal	23
Propulsion	404
Propellant	1,152
GNC	79
Comm	45
C&DH	20
Structure	1,124
Total Dry Mass (kg)	**2,610**
Total Wet Mass (kg)	**3,762**

Mass Summary (FBE)	
System	Mass (kg)
Payload	100
Power	300
Thermal	20
Propulsion	200
Propellant	194
GNC	36
Comm	26
C&DH	10
Structure	314
Total Dry Mass (kg)	**1,005**
Total Wet Mass (kg)	**1,199**

Power Summary (CBE)		
System	Avg Power (W)	Peak Power (W)
Payload	300	0
Power	0	0
Thermal	210	0
Propulsion	1,005	0
Propellant	0	0
GNC	99	213
Comm	89	248
C&DH	29	31
Structure	30	90
Total Power (W)	**1,762**	**582**

Power Summary (FBE)		
System	Avg Power (W)	Peak Power (W)
Payload	90	120
Power	0	0
Thermal	210	210
Propulsion	1,408	1,408
Propellant	0	0
GNC	38	65
Comm	52	149
C&DH	18	20
Structure	20	60
Total Power (W)	**1,836**	**2,032**