2025 Engineering Budget

$621,473

BREAKDOWN FOR THE MAJOR PROJECTS AND PROGRAMS

ALL FIGURES ARE BEST ESTIMATES FOR THE PLANNED PROGRESS IN 2025 AND CONTINUITY FOR THE PROJECTS CARRYING OVER INTO 2026

Update:
Projects Suspended

- SSTV
  - Original PI discontinued work, a few others tried to pick it up but now needed on GOLF-TEE
- PACSAT
  - Project needs further discussion of expectations

Vote "YES" for this 2025 Budget Proposal!

- We the engineering team leaders and teammates have the momentum to put on orbit three or four new satellites by EOY 2027
- GOLF-TEE NET 1Q 2026, depending on launch availability should be sometime in 2026
  - NASA push for PPRR, Pre-Procurement (of a launch manifest) Readiness Review shows and states their confidence in where we will be with GOLF-TEE for a 2026 launch
    - May provide insight and suggestions based on current ELaNa missions, it has been a relatively long time since we last did integration of a satellite (2020)
- GOLF-1 NET 1Q 2027, I will push right in order to have on orbit performance information on GOLF-TEE (if possible)

Vote "YES" for this 2025 Budget Proposal!

- Fox-Plus is gaining traction (members, learning) toward a 2025 launch
- Fox-Plus-B funding is highly recommended
  - XBT is FM repeater (and many other modes)
  - PACSAT payload expected to fly
- ASCENT is pursuing exciting new ways that will enhance our missions, orbit possibilities, and radio variety including microwave and some VHF/UHF (perhaps)
  - Microwave Ground Station for GOLF-TEE/-1 is needed, design expectations for buy, build, or kit by the end of the year (may not have all this year, but will do GOLF-TEE microwave)

Vote "YES" for this 2025 Budget Proposal!

ASCENT (contd.)

- SDR-B will fix the big hurdle of spaceframe/solar panel development (ARDC) by letting us use our typical vertical stack
  - Also adding more modes and microwave "fun" to both GOLF and Fox-Plus
- PROPULSION
  - Several types being evaluated/tested
  - Could fly perhaps GOLF-2, exercise LEO orbit changes for future ventures higher
  - Cost of some in consideration is around $50,000 - $150, 000
    - We can – should – plan to afford that if we expect a higher orbit for that elusive larger footprint

Vote “YES” for this 2025 Budget Proposal!

XBT Information

- Intended to break down the barrier between linear and FM transponders using modern signal processing and SDR
  - Capable of providing simultaneous multiple channel operation using multiple modes
  - "All" modes will be simultaneously supported from CW through SSB through narrow band FM through PSK31 (BPSK, QPSK and such) and even SSTV
  - The signal processing portion of the transponder will be reconfigurable in orbit
  - initial design is as a traditional U/v (non-inverting) configuration

Vote “YES” for this 2025 Budget Proposal!

XBT Information (contd.)

- XBT is our Fox-Plus FM radio
  - We are discussing the possibility of layering the development in order to provide first, the FM transponder and then build more whistles and bells on top of that
  - At this time we do not yet know if that can be possible with the design being worked now
    - “FM Rescue” for a LEO EasySat could in some form of XBT to fly on Fox-Plus-B, if we continue development

Program/Project Budget Proposals

ASCENT Engineering Projects

TOTAL ESTIMATED ASCENT COSTS (FOR 2025) = $49,723

COST CATEGORIES	SSTV	Propulsion	SDR	XBT	Ground Station	NOTES/COMMENTS
PRINCIPAL INVESTIGATORS	None	Jeff Vollin	Ray Roberge	Andrew Robinson	Jonathan Brandenburg	
Hardware: Components, PCBs, Connectors, etc.	~~$450~~	$700	$4,812 3 Breadboards $4,812 3 EM Boards $6,415 4 FM Boards	$2,500	$2,684	GND Station: Jonathan has provided "excruciating" detailed breakout of every single component that comprises this cost estimate! He provided NO inputs for any of the other cost categories at this time. SDR: : 10 assembled 12 layer boards (3 Bread Boards, 3 Engineering Models, 4 of these for Flight Models);
Outside Services: CM PCB assembly, Cable Builds, Other	~~$600~~	$2,600	$6,000 Rework Assembly	$1,200		PROPULSION: R3 e-propellant
Travel: Testing		$400	$600	$1,000		PROPULSION: Cross-country shipping

Red strikethrough = project suspended

COST CATEGORIES	SSTV	Propulsion	SDR	XBT	Ground Station	NOTES/COMMENTS
PRINCIPAL INVESTIGATORS	None	Jeff Vollin	Ray Roberge	Andrew Robinson	Jonathan Brandenburg	
Test Expenses: Unit/Module Form & FIT (CAC) EMST/ FMST Env Qual	~~$250~~	$700	$6,000	$2,500		PROPULSION: Power Supply; Test Probes; Test Bench set-up; NTS EMI/EMC testing
Development Support: Articles Software EDA (CAD, SIM, etc.) Design and Test	~~$500~~	$7,000	$2,000	$1,500		PROPULSION: MATLAB; CubeSat Sim; Test SW. SDR: RF EDA Design software
Miscellaneous Expenses			$2,600			SDR: Miscellaneous design support items

Red strikethrough = project suspended

Fox-Plus

TOTAL ESTIMATED FOX+ A AND B COSTS (FOR 2025) = $203,400

COST CATEGORIES	CY2025 Planned Expenses		NOTES/COMMENTS
Hardware (components, PCBs, connectors, etc.)	ISISPACE Components: frame, EPS incuding battery pack, antenna system for 2 sats	$35,800	AMSAT components include connectors, pcb, and all distributor purchased components.
	ISISPACE Solar Panels: for 2 sats	$36,000	
	AMSAT Components for 6 FM, 3 EM	$45,600	ISISPACE components are for 2 satellites at 2023 prices, most likely higher in 2025.
	FM Radio Development for Fox+	$3,000	
Outside Services			
CM PCB assembly	CM PCB assembly	$6,000	
Cable Builds	Cable builds	$3,000	
Other	FM Radio Development for Fox+	$3,000	
~~*Travel*~~			
~~*Mtgs & Seminars*~~	~~*Meetings and Seminars.....$9,000*~~		
~~Testing~~	~~Testing.....$4,500~~		~~For 2 engineers to go to final testing~~

Red strikethrough = moved to travel budget

COST CATEGORIES	CY2025 Planned Expenses		NOTES/COMMENTS
Postage and Shipping	Postage and Shipping Shipping (from Netherlands and intra-US)	7,000	
Testing Expenses Unit/Module Form & FIT (CAC) EMST/ FMST Env Qual	Other Testing expenses (other than travel	$5,000	This is a real “guess-timate!”
Development Spt Articles Software EDA: CAD, SIM, etc. Design and Test	Software Other Dev Support	$500 $2,500	
Miscellaneous Expenses	Miscellaneous Expenses, such as special tools, etc LAUNCH Services$55,000	$10,000 $55,000	Launch services for Fox+ A

GOLF-TEE & GOLF-1

TOTAL ESTIMATED GOLF-X COSTS (FOR 2025) = $283,100

SYSTEM	LEAD(S)	EM components, PCB, Assembly	FM components, PCB, Assembly	FS components, PCB, Assembly	"Reusables" left over for Future GOLF-X or partner LTM	NOTES/COMMENTS
Central Interface Unit (CIU) v1.2	~~Don Corrington~~	$4,000	$4,000	$4,000	YES	Bare PCBs ≈ $100/board (4 layer) Components ≈ $300/board CM Assembly ≈ $600/board (FM & FS units)
Internal Housekeeping Unit (IHU) v2.4[5] <<Bdale's V8 >>	Mike Moore, Burns Fisher, Bdale	$2,000	$2,000	$2,000	YES	IHU is NOT planned to be used in GOLF-1.
Improved Command Receiver (ICR)[5] v2.2	David Hartrum	$2,000	$2,000	$2,000	YES	SDR: Miscellaneous design support items
Receiver/Transmitter (RX/TX)[5] v2.2	Dan Habecker, Eric Skoog	$2,000	$2,000	$2,000	YES	

SYSTEM	LEAD(S)	EM components, PCB, Assembly	FM components, PCB, Assembly	FS components, PCB, Assembly	"Reusables" left over for Future GOLF-X or partner LTM	NOTES/COMMENTS
Radiation Tolerant Internal Housekeeping Unit and Digital Comm. Transceiver (RT/IHU-DCT) v1.3	Cameron Castillo, Zach Metzinger	$3,800	$3,800	$3,800	YES	EM v1.2 boards in test; v1.3 final upgrades underway for FM boards. Bare PCBs ≈ $44/each Components ≈ $250/board Assembly ≈ $600/board (CM)
MICROWAVE ANTENNAS Multi-Band (U/L/S/C Bands) Quad Patch Array (X Band)	Kent Britain	Pro bono TNX WA5VJB	Pro bono TNX WA5VJB	Pro bono TNX WA5VJB	YES	Protoboard units in-hand Need exact structual design antenna dimensions before laying out final FM units.
GNSS Receiver (NovAtel OEM719A[7]	Dr. Joseph DiVerdi	Pd. 2024	$5,000	$5,000	YES	Model OEM719AH-GSN-LNN-TBN-H. (High Speed, Space Qualified) Do we need more NovAtel OEM7 Series Development Kits and an OEM7-DESV-KIT-INTERPOSERs?
RF Matrix v1.7.1	Don Corrington	Pd.	$2,000	$2,000	YES	4 early ProtoBoards all cannibalized; One EM (v1.6.1)on-hand; two FM (v1.7.1) boards on-hand; MOQ procurement of expensive Mini-Circuit parts complete via earlier advanced purchase.

SYSTEM	LEAD(S)	EM components, PCB, Assembly	FM components, PCB, Assembly	FS components, PCB, Assembly	"Reusables" left over for Future GOLF-X or partner LTM	NOTES/COMMENTS
X-Band Solid State Power Amplfier (SSPA) v1.2	Cameron Costillo, Eric Skoog	$3,000	$3,000	$3,000	YES	RF PCBs (Rogers 4350) PCB MOQ: 20 = $1,400; Component costs (expensive uW RF IC's) » $600.00 1 EM (v1.0) cannibalized; 1 EM (v1.1) in test; 2 EM, 2 FM, 2 FS (v1.2) planned.
Software Defined Radio (SDR) Ettus E310 Mother and Daughter Boards	Ray Roberge, Rich Gopstein	Pd.	$6,800	$6,800	YES	We have 2 E310 SDR units expensed in 2019 -->2022: 1 for software development and electrical/mechanical checkout; 1 for FLAT-SAT integration testing; Ray has his own personal unit for uW Xponder development. Beyond those, we need 2 units for Flight Model integration and checkout and 2 for Flight Spare. UNLESS, SDR Plan B is ready in time for GOLF-1.
Vanderbilt University (VU) Radiation Experiment VU Controller (VUC) Low Energy Proton FinFET (LEPF)	Prof. Brian Sierawski	already expensed (from FOX-1)	already expensed by VU	already expensed by VU	NO	We have one set of Flight Model and Spares in hand from previous Fox builds. VU EXP builds for future GOLF-X satellites are TBD.

SYSTEM	LEAD(S)	EM components, PCB, Assembly	FM components, PCB, Assembly	FS components, PCB, Assembly	"Reusables" left over for Future GOLF-X or partner LTM	NOTES/COMMENTS
Electrical Power Subsystem (EPS) Battery Mgmt Subsystem (BMS) [charge / discharge / balancing regulation] and Batteries	Kip Moravec, Khaled Ahmed, Doug Drach, Dr. Carl Wick	$2,750	$2,750	$2,750	YES	
AMSAT BOARD SUBTOTALS		$34,450	$39,750	$39,750		$113,950 TOTAL BOARDS COSTS
Attitude Determination and Control Subsystem CubeADC Core Stack: CubeTorquer (x3) MEMS Gyro (x2) CubeWheel (x3) CubeMag Deployable Coarse Sun Sensor (x10) Fine Sun Sensor Earth Horizon Sensor	Don Mills, Dr. Joseph DiVerdi, Eric Skoog, Geoffrey Gentile	$60,000 (CY23 quote)	$60,000 (CY23 quote)	2024 budget not expensed	2024 funds purchased unit becomes GOLF-TEE's FS and then GOLF-1's FS unit. 2025 budgeted ADCS units are FM's for GOLF-TEE and GOLF-1.	The purchased ADCS units are from OEM CubeSpace. It is their GEN2 CubeADCS 3-Axis 3U System
ADCS PURCHASE TOTAL						$120,000 (1 EM & 1 FS)

SYSTEM	LEAD(S)	EM components, PCB, Assembly	FM components, PCB, Assembly	FS components, PCB, Assembly	"Reusables" left over for Future GOLF-X or partner LTM	NOTES/COMMENTS
SHIPPING Flat-Sat, EM/FM integration and volunteer design, development and testing	Team			$3,000	N/A	Total is for all stages Shown under FS
SOFTWARE and TEST ARTICLE DEVELOPMENT SUPPORT Sonnet EM Solver EDA AutoDesk Invento License CubeADCS xxxxx Miscellaneous Software	Burns Fisher et al			$3,100 $2,800 $9,750 $150	YES	
GOLF BATTERY TENDER (GBT)	Doug Drauch	$400	$1000	N/A	YES	The GBT is a GOLF-unique piece of Ground Support Equipment (GSE). It is designed to intelligently and separately charge the EPS battery packs to various SoC levels, and provide charge level information.
BREAK OUT BOARDS (v1.6.2)	Don Corrington		$4,500	N/A	YES	BREAK-OUT-BOARDS povide ready access to all QxH bus connections and are used by developers for on-bench stacked or single AMSAT board development, test (including FLAT-SAT testing), and integration. Cost estimate assumes fabrication house assembly.
MISCELLANEOUS ITEMS SUBTOTAL						$49,150

Travel (public events, shows)
Travel (all programs/projects)

TOTAL ESTIMATED PUBLIC EVENTS (FOR 2025) = $42,950
TOTAL ESTIMATED ASSEMBLY TESTING (FOR 2025) = $42,300

EVENT	No. of travelers	No. of Nights	Event Admission	Presence Cost (Table, Booth, etc.)	Airfare	Hotel	Meals	Car	EVENT TOTAL	
CubeSat Developer's Workshop	5	4	$2,250	$0	$4,500	$4,500	$500	$150	$11,875	
Hamvention	4	3	$0	$0	$3,600	$2,700	$300	$0	$6,600	
SmallSat	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$3,000	PROPULSION: travel to SmallSat conference (attendance fee and per diem food allowance only)
Astra-Con	4	4	$1,100	$0	$3,600	$3,600	$400	$175	$8,875	
Symposium	6	3	$2,700	$0	$5,400	$4,050	$450	$0	$12,600	
PUBLIC EVENTS SUBTOTAL									$42,950	

TBD Purchase Show Space, or Not

EVENT	Airfare	Hotel	Meals	Car	EVENT TOTAL
GOLF-X Development Testing FLAT-SAT EM System Test FM System Test ADCS in Simulator Day In The Life Test Environmental Test	$11,200	$13,200	$1,650	$375	$26,425
GOLF-TEE Mission Readiness Review	$1,500	$700	$75	$150	$2,425
GOLF-TEE Integration (Delivery)	$1,700	$1,200	$150	$150	$2,750
GOLF-TEE TRAVEL SUBTOTAL					$31,650

EVENT	Airfare	Hotel	Meals	Car	EVENT TOTAL
Fox-Plus-A Development Testing FLAT-SAT EM System Test FM System Test ADCS in Simulator Day In The Life Test Environmental Test	$2,100	$3,000	$375	$0	$5,475
Fox-Plus-A Mission Readiness Review	$1,500	$700	$75	$150	$2,425
Fox-Plus-A Integration (Delivery)	$1,700	$1,200	$150	$150	$2,750
Fox-Plus-A Travel Subtotal					$10,650

PACSAT –
(Alternate funding proposal)

THIS IS A HYPOTHETICAL FOR PRODUCING 6 PACSAT BOARDS
TOTAL ESTIMATED PACSAT COSTS (FOR 2025) = $19,000

COST CATEGORIES	CY2025 Planned Expenses		NOTES/COMMENTS
Hardware: Components, PCBs, connectors, etc.	Three PACSAT boards for Fox-Plus-B payload (EM, FM, FS) Three PACSAT boards “on the shelf” for future flight partners	$3,000	
Outside Services: PCB assembly Cable Builds Other	Three PACSAT boards for Fox-Plus-B payload (EM, FM, FS) Three PACSAT boards “on the shelf” for future flight partners	$12,000	PCB production and component population and other cable/board flight configuration assembly
Postage and Shipping	Board and component shipping to team members and mission partners	$2,000	Distributed Engineering CODB
Test Expenses: Unit/Module Form & FIT (CAC) EMST/ FMST Env Qual	Hardware to test PACSAT's Power chain and CAN Bus Interface	$1,000	For flight host compatibility and payload control
Development Support Articles: Software EDA: CAD, SIM, etc. Design and Test	New design requires thorough development and testing for payload to host and “off the shelf” partner readiness	$1,000	Includes Ground Station Software expenses (Exact purpose/meaning unknown, taken from PACSAT budget submission)