

The XB1 Precision CubeSat Bus:

A New Paradigm for Space Exploration Platforms

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About BCT



Blue Canyon Technologies is a small business founded in 2008 by industry veterans who have developed, tested and flown components and systems on more than 27 diverse space missions

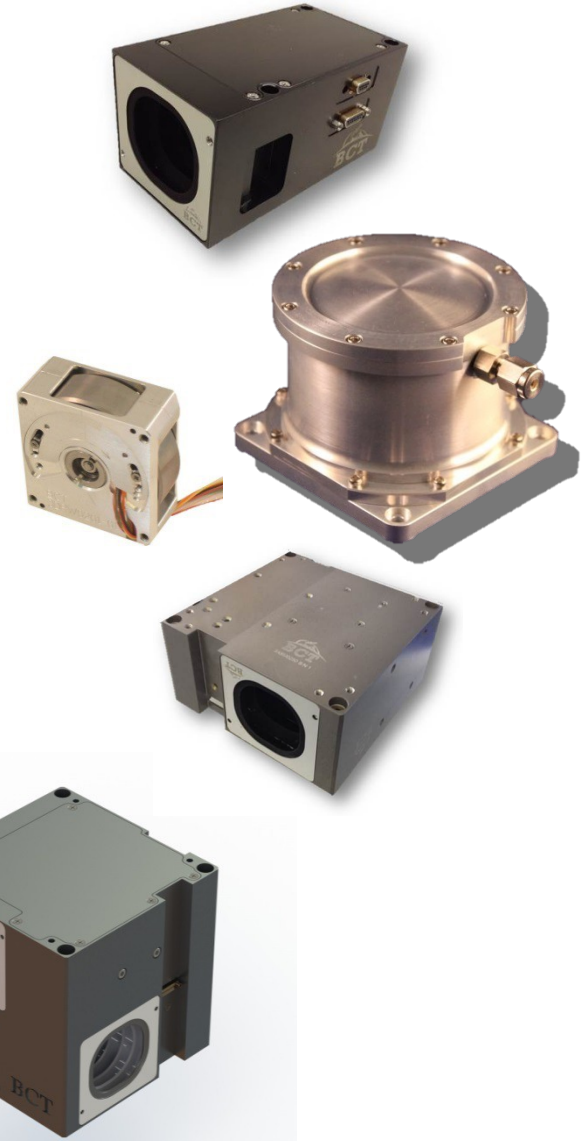
Advancing the state of the art in affordable space access

Current customers include: US Air Force, NASA (JPL, Marshall, Johnson), Southwest Research, University of Boulder, other commercial.

High Performance Products



- **Nano ST** – High performance, ultra-small Star Tracker
- **Reaction Wheels** – Nano, CubeSat, and Micro-Sat sized Wheels
- **XACT** - Complete CubeSat GN&C System (1/2U with Precision 3-Axis Pointing)
- **XB1** - Complete CubeSat Bus in 1U, based on XACT



Recent Vibration Test of Various Hardware



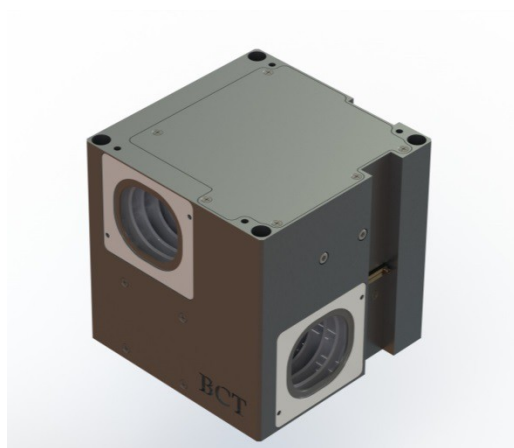
Integrated Spacecraft Design



- XB1 represents a paradigm shift
 - Complete spacecraft bus (GN&C, Power, Thermal, C&DH, RF-Comm, propulsion control, and flight software)
 - Ready straight out of the box, much like laptop computers and smart phones today
 - No programming or assembly required (except for your payload)
- And in the paradigm of smart phones, the XACT-Bus Development and Operations Environment (using model-based design) will provide users the ability to develop their own flight “apps” to operate their payload, process payload data, and control XB1
 - For example, new RPOD algorithms
 - Mission specific onboard processing of payload data
 - The user needs only to provide the mission-dependent payload
- Increases mission capabilities by maximizing payload volume, power availability, and autonomy

XB1

XACT-Based High Performance CubeSat Bus



- Highest-available pointing performance from *Dual* Micro-Star Trackers
- Bus functionality for GN&C, EPS, Thermal, C&DH, SSR, RF Comm*
- Interfaces and control provided for Payload, Propulsion, and Solar Arrays
- Supports configurations up to 27U

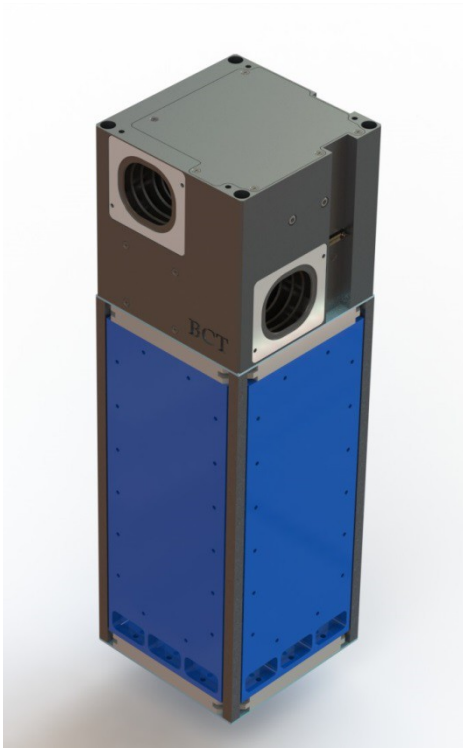
* optional 1-cm slice

	XB1 Parameter	Value/Notes
G N & C	Pointing Accuracy	$\pm 0.003^\circ$ (1-sigma), 3 axes, 2 Trackers
	Pointing Stability	1 arc-sec/sec
	Maneuver rate	10 deg/sec (typical 3U CubeSat)
	Orbit knowledge	10m, 0.15m/s (GPS)
C D H	Data Interfaces	Serial: RS-422, I2C, SPI, LVDS
	Onboard Data Processing	Configurable via user loadable "apps"
	Telemetry Acquisition	16 12bit Analog, 32 discrete inputs
	Commands	Real-time, 10,000 stored, macros
E P S	Onboard Data Storage	4 Gbytes (option)
	System Bus Voltage	12 ± 2 V
	Energy Storage	>20Whrs
	Payload Power Feeds	QTY 3, 12V or Regulated 1.2V to 5.0V
Co m m *	Frequency	UHF or SBand
	Uplink	CCSDS, USB, SGLS
	Downlink	250 kbps / 5 Mbps
	Encryption	AES 256
P r o p	Solid State Recorder Capacity	4 Gbytes
	Heater Controllers	4 independently controlled zones
	Propulsion System Drive	8 Thruster drivers, 2 Latch Valve Drivers
	Telem. Interfaces	1 Temperature, 1 Pressure, 2 Status
	Mass / Volume	1.5 kg / 10 cm x 10 cm x 10 cm
	XACT-Bus Nominal Power	<2.5W

Supports Multiple Configurations of BCT Structures

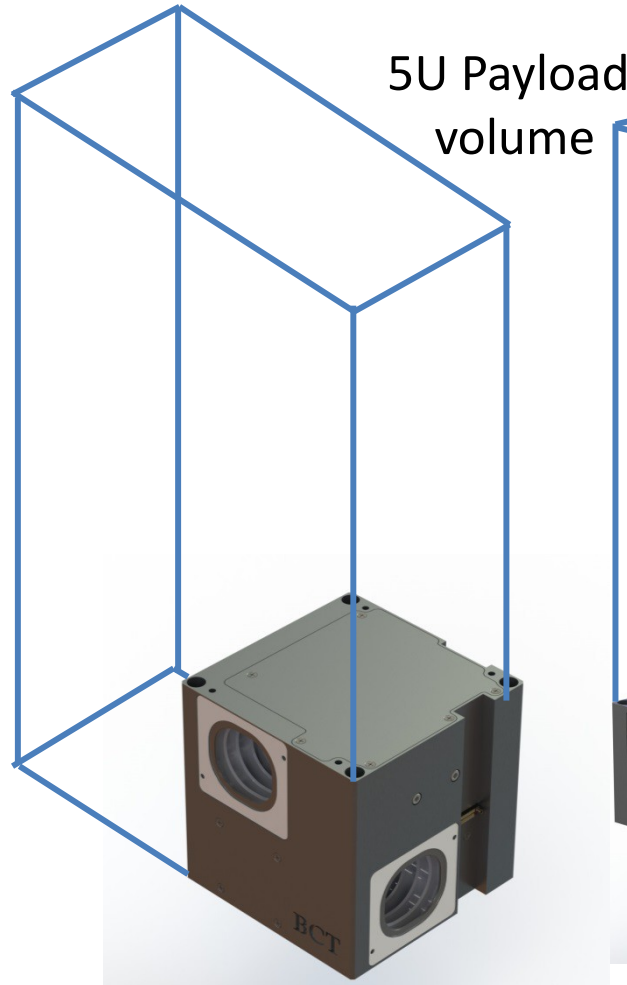


3U



2U Payload
volume

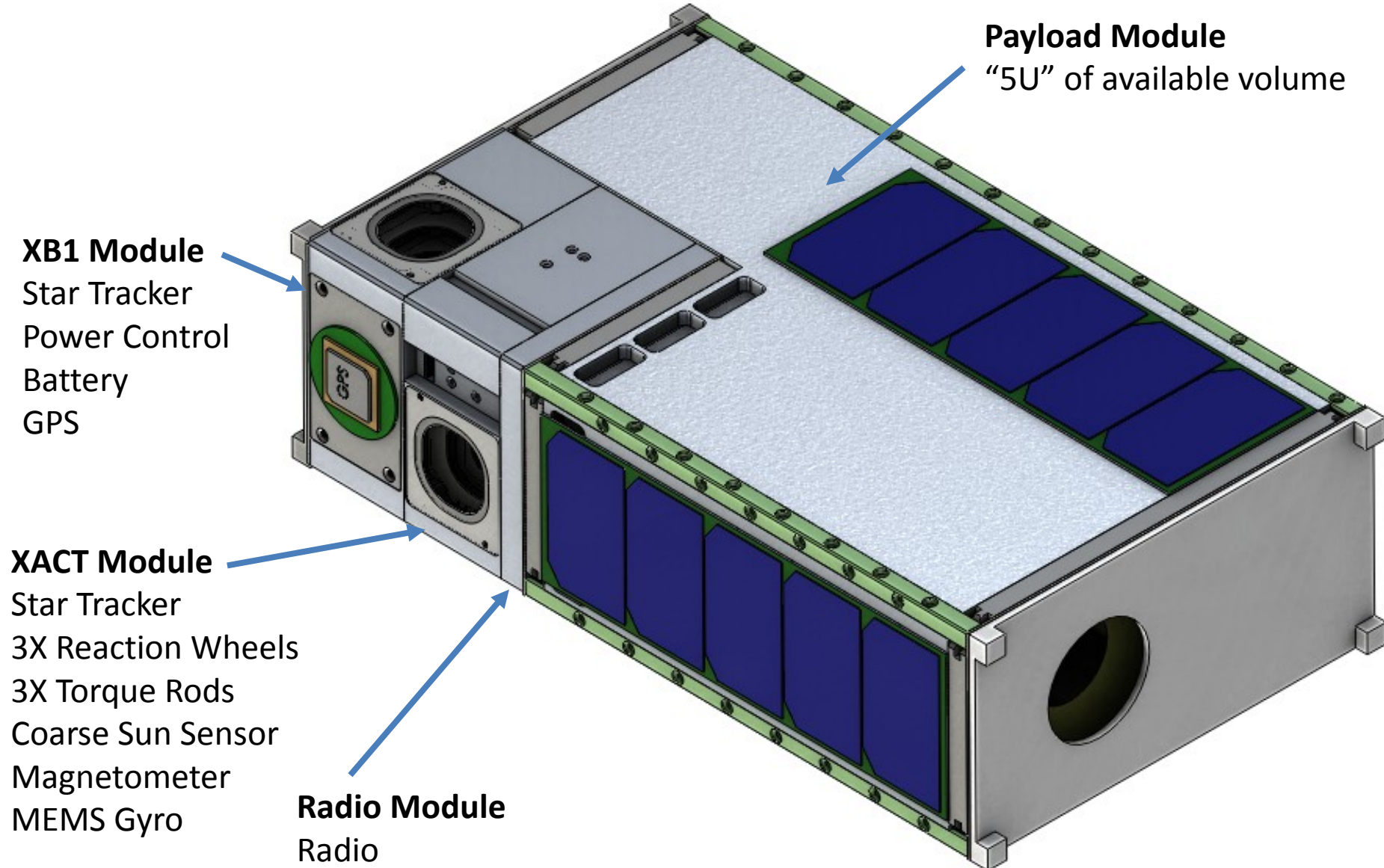
6U 'Stack'



6U 'Side-by-side'



6U Stack Configuration



XB1 Flight Software Highlights



- Highly autonomous operation
- Precision stellar-based attitude determination & control
 - Operates with stars down to 7.5 magnitude (over 21,000 stars in catalog)
 - Lost-in-space star identification in less than 2 seconds
- Supports precision orbit propagation of multiple target objects
- Flexible pointing commands support a wide range of missions
 - *e.g. Inertial, LVLH, Earth-Fixed, Solar, object tracking*
- Supports user-developed payload apps
 - *Built-in 'hooks' for high rate, low rate, and asynchronous task processing, with easy access to all XB1 data, including raw star camera images*
 - *XB1 interface functions allow user apps to receive commands and send telemetry*
 - *XB1 interface functions allow user apps to command the XB1*
(e.g. a wide-field payload detects lunar feature of interest, then commands XB1 to point narrow-field payload for more accurate data.)
- Supports 10,000 stored commands, as well as real-time, macro sequences, and commands from user apps
- Multiple telemetry formats

XB1 Development & Operations Environment (XDOE)



- XDOE supports user through all stages of satellite life cycle.
- Model-based design (using Matlab/Simulink) supports flight software and simulation software in one unified environment.
- All-software simulation of spacecraft (provided out-of-the-box) supports mission analyses and training.
- Customizable with user payload models and flight apps.
- Auto-code generation of custom models and apps.
- Test console supports real-time closed-loop testing of XB1.
- Command, telemetry, and 3d animation displays.
- Generation of uploadable flight parameter tables.

All the tools you need to quickly get to the science

XDOE Simulation Highlights



- Supports constellation of 99 satellites (each independently configured and controlled)
- Variable run speed (<<real-time to >>real-time)
- Command script or GUI control
- Selectable gravity field model with user-friendly initialization command features to support formation flying (can use earth or lunar harmonic model)
- Sun, moon, star field vector models
- High-fidelity GN&C component models
- Built-in 3d animation driver for user-provided VRML model
- Real-time STK “connect” interface, or play-back files supported

XB1 Integrated Command, Telemetry & Animation



Control and visualize the XB1 out of the box

CMD & TLM for XB1 and simulation

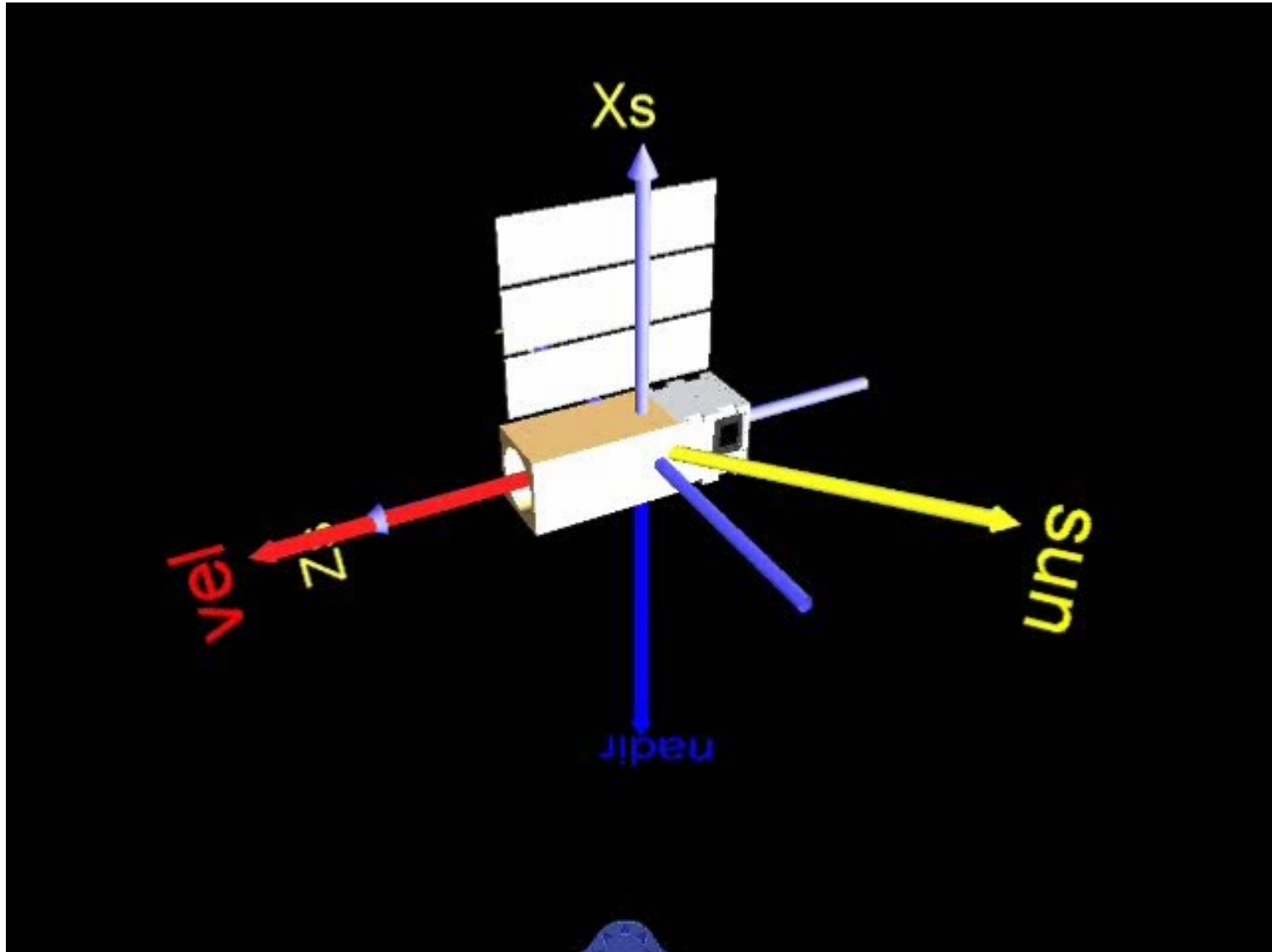
User-friendly command GUI

TLM pages support limit checking, yellow & red limits

3D animation for immediate visualization

The screenshot displays the MATLAB R2012a environment with several windows open. The 'Command & Telemetry Main Menu' window is the central focus, showing 'Flight Command' and 'Simulation Command' sections with 'Orbit propagator' selected. Below these are 'Flight Telemetry' and 'Simulation Telemetry' sections. The 'Set Orbit Propagator' dialog is open, allowing users to input Position (X, Y, Z), Velocity, and Time. The 'Last Cmd' window shows the last command sent (23). The 'Ctrl Torque [mN-m]' window shows torque values for X, Y, and Z. The 'Wheel Speed [rpm]' window shows wheel speeds for X, Y, and Z. The 'Torque Rod Cmd' window shows torque rod commands for X, Y, and Z. The 'Tank Pressure [psi]' window shows a pressure gauge with a red limit. The 'Tank Temp [C]' window shows a temperature gauge. The 'Position [km]', 'Velocity [km/s]', and 'Momentum [mN-m-s]' windows show various telemetry data. The 'Sun Vector' window shows the sun vector components. The '3D animation for immediate visualization' window shows a 3D model of the XB1 satellite with axes labeled 'sat', 'x', 'y', 'z', 'sun', 'nadir', and 'rel'.

XB1 Flexible Pointing Demo



XB1

Enabling A New Realm of CubeSat Science



- Remote Sensing
- Formation Flying
- Rendezvous, Proximity Operations & Docking
- Autonomous Operations
- Inter-satellite Communications Networks
- Thruster control for lunar orbit insertion
- Lunar impactor steering



Contact BCT for more information

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