

X-ray Star Scanner for Spin-stabilized Microspacecraft

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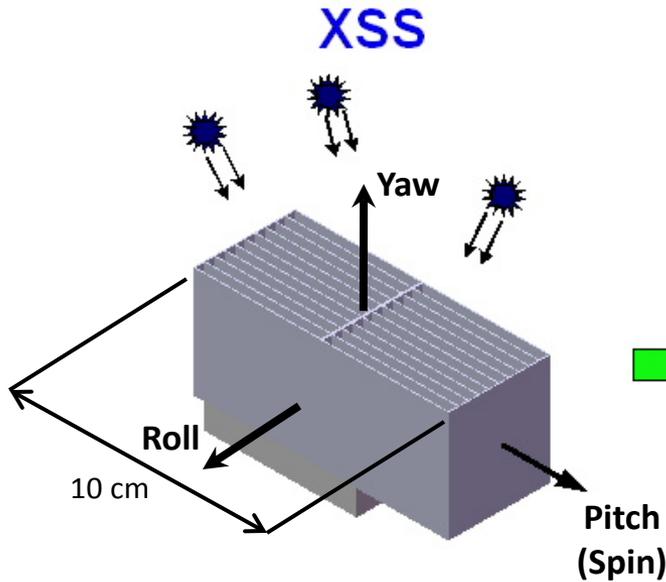
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Overview

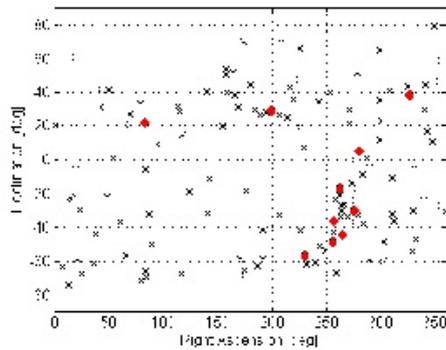
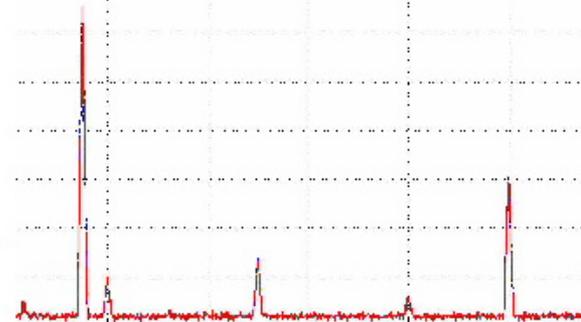
- Motivation for the X-ray Star Scanner and Spin Stabilized Microspacecraft
- XSS Concept and Operation
- Expected XSS Performance
- Applications for Spin Stabilized Microspacecraft
- Summary and Future Work

Motivation

- Previous CubeSat missions typically passively stabilized
 - Fixed magnet with hysteresis rods
 - Aerodynamic
 - Uncontrolled tumblers
- New ADCS hardware for CubeSats tend to be miniaturized versions of larger ADCS hardware
 - Star cameras, IMU's, reaction wheels
 - Large mass and power relative to CubeSat capabilities
- Spin-stabilized microspacecraft can perform a number of valuable missions
 - XSS enables arcminute level spin stabilized missions
 - Low power & mass allows larger payloads to be flown



Star Pattern

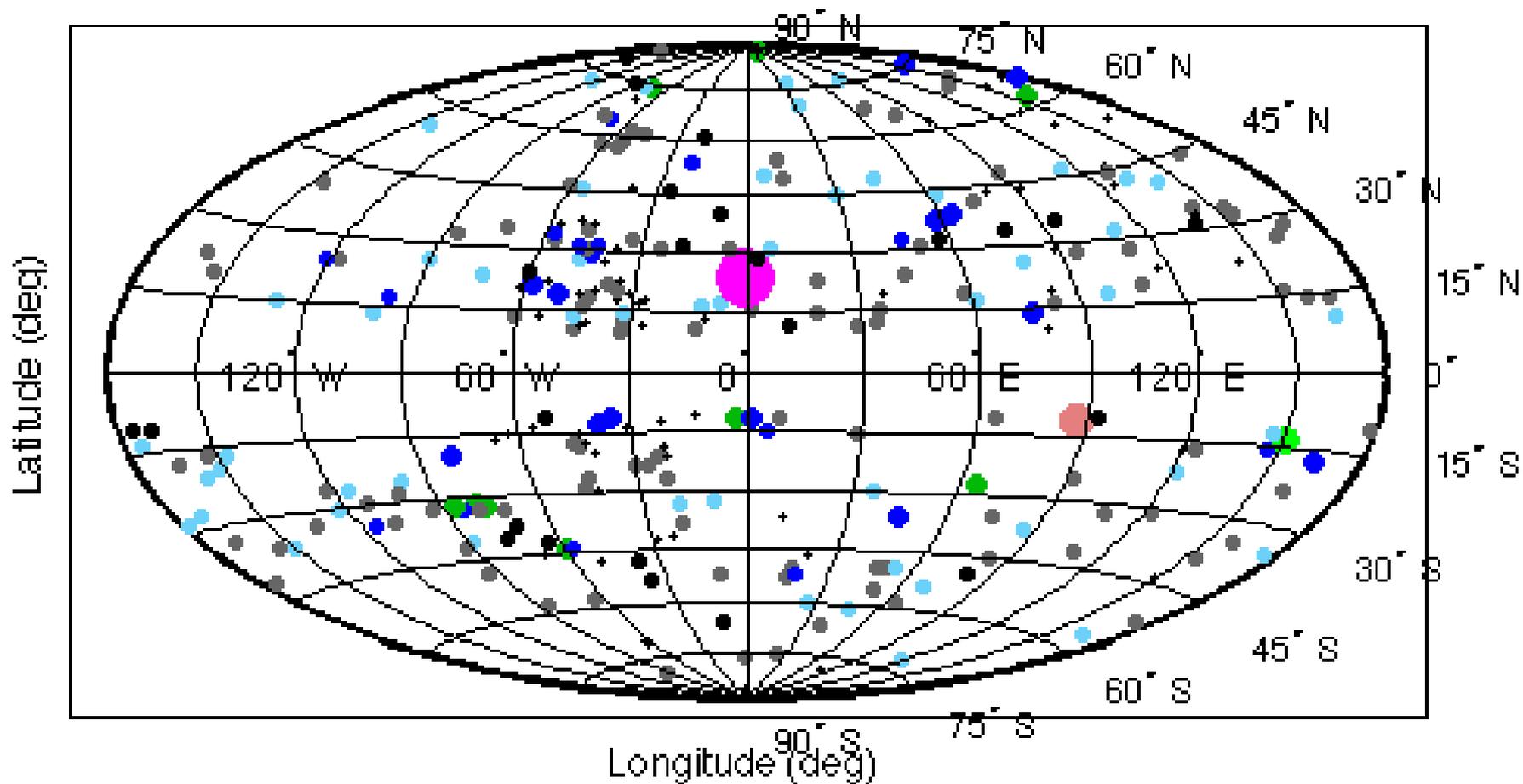


Star Catalog

- Simple X-ray detector with collimator limits field of view
- As spacecraft spins, a series of pulses are created
- Each corresponds to the position of a star
- Attitude solution generated from unique pattern

X-ray Star Catalog

Galactic Coordinates of RXTE ASM Sources

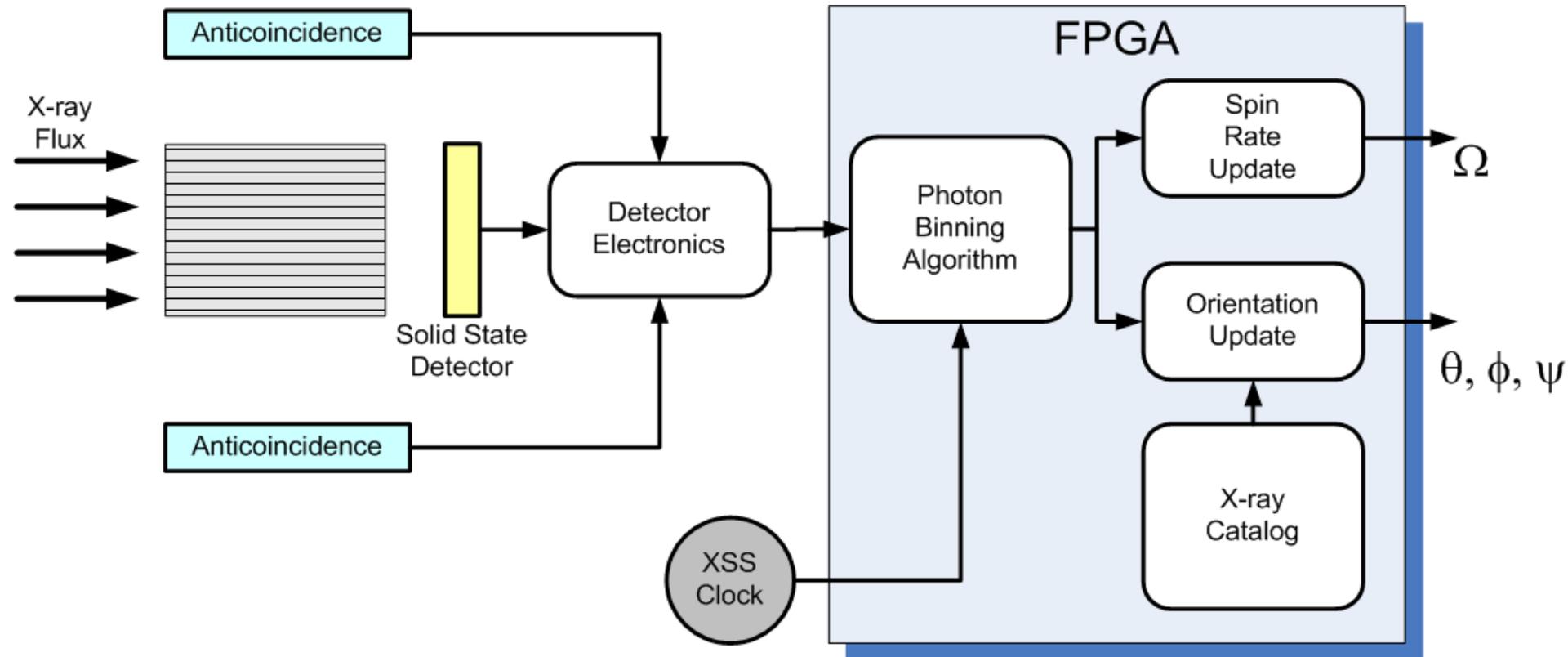


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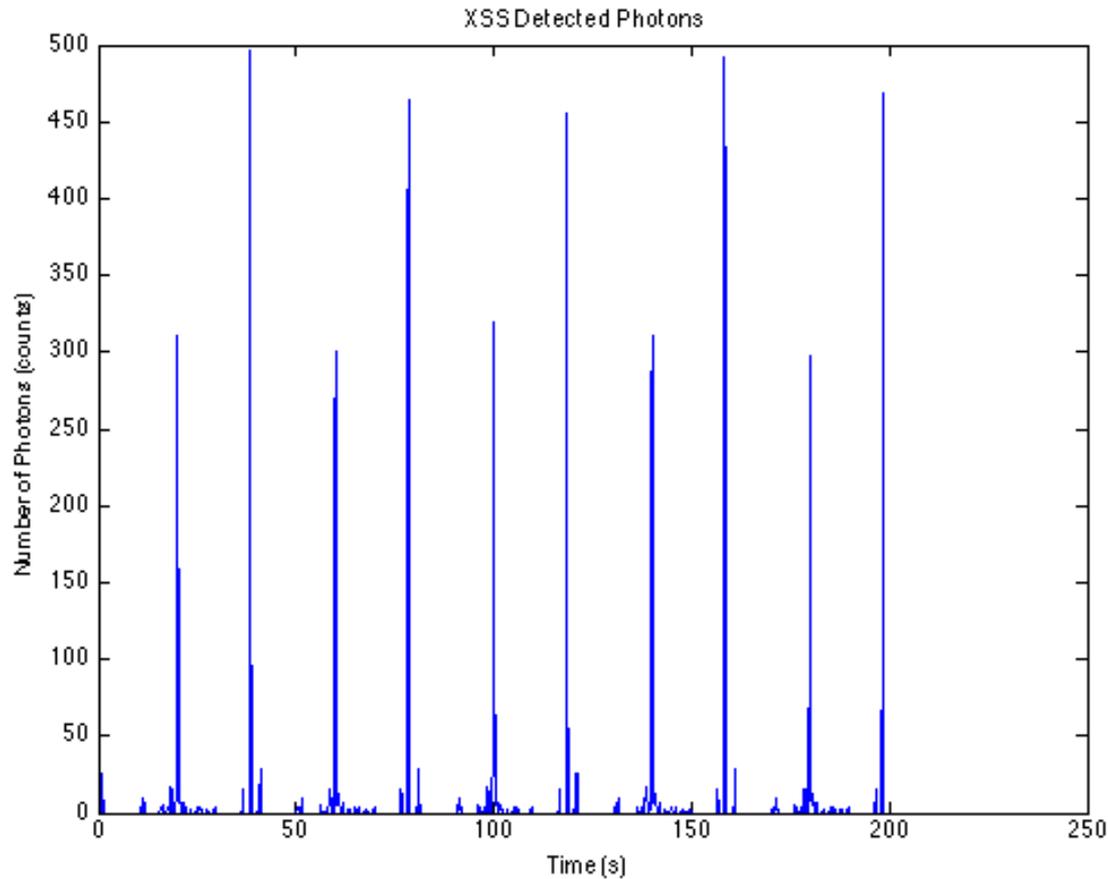
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XSS Block Diagram



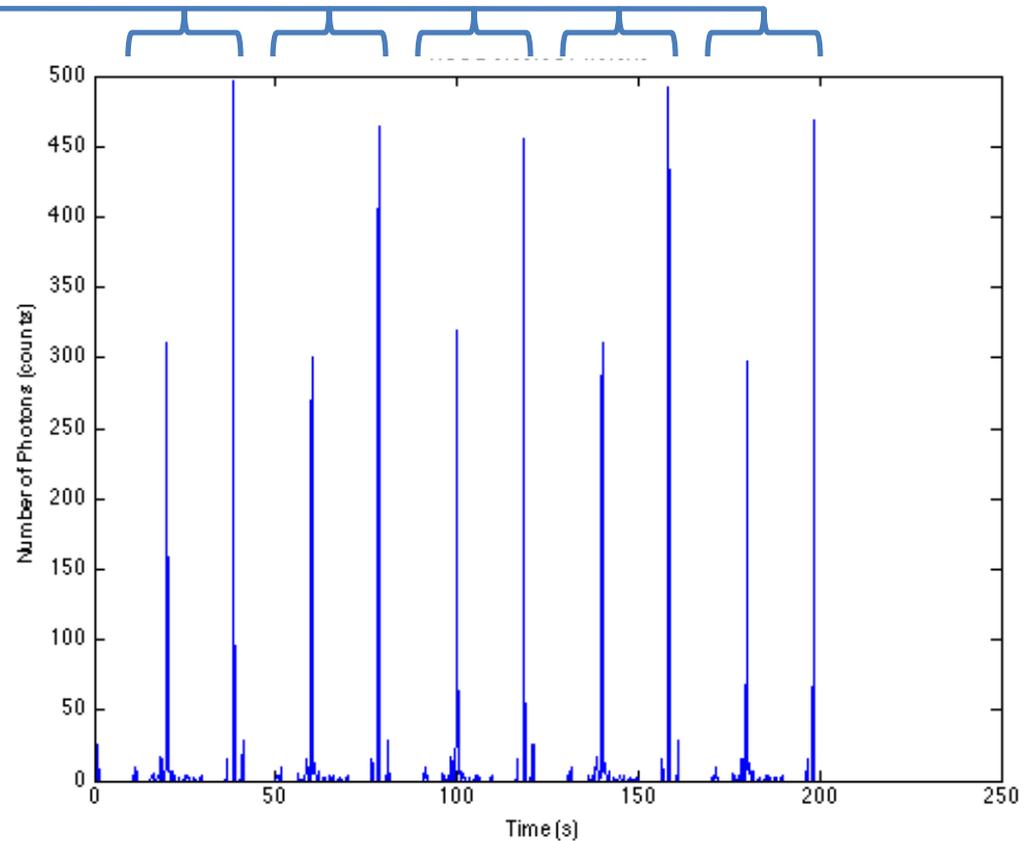
Typical XSS Time History



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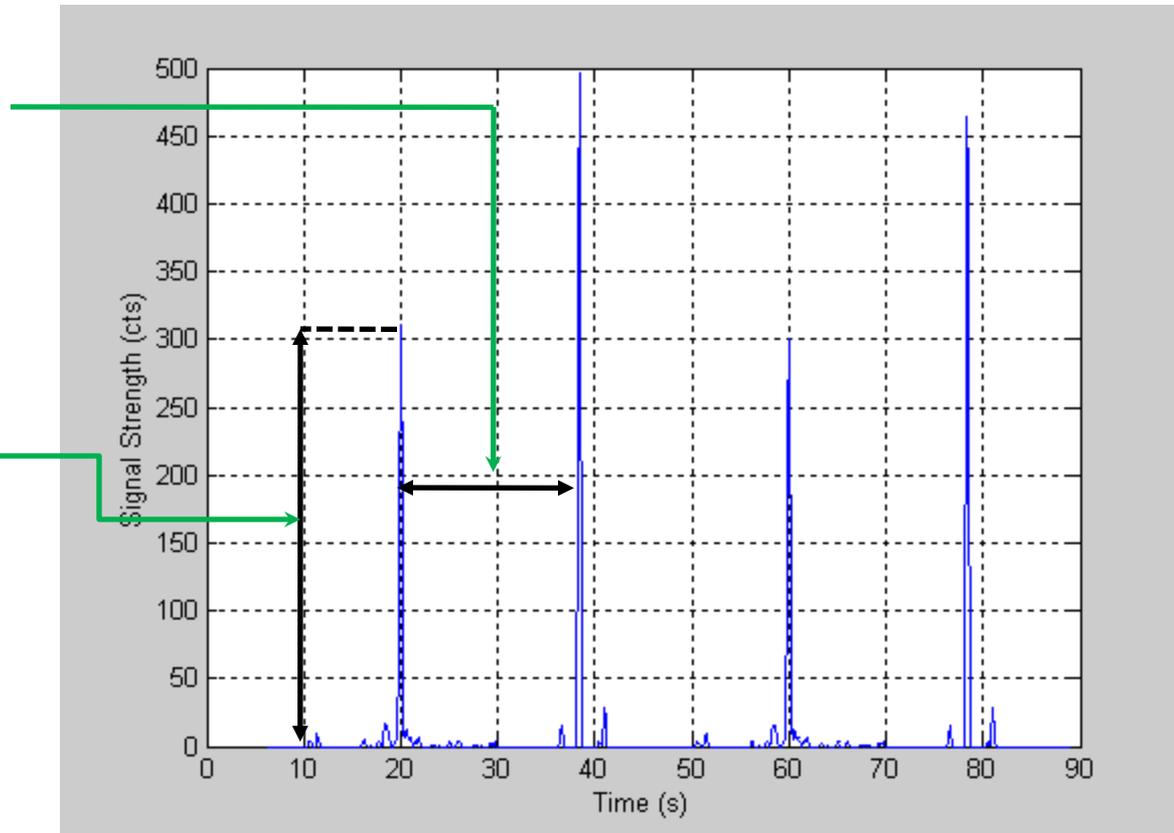
XSS Measurement Algorithms - Spin

- Repeated pattern of pulses is a measure of spin rate
- Position of one X-ray source is a measure of spin phase

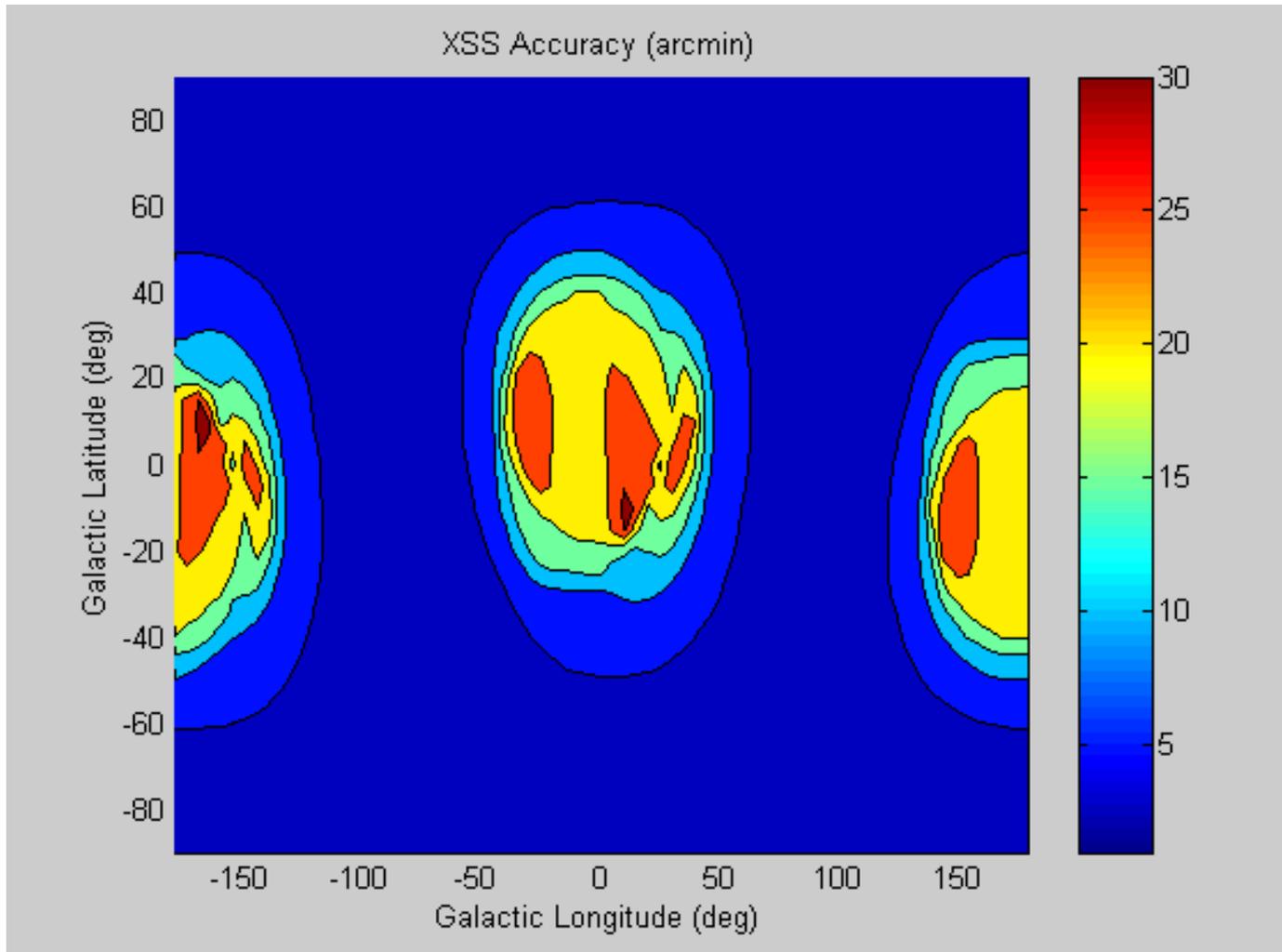


XSS Measurement Algorithms - Orientation

- Spacing between X-ray pulses is a measure of yaw angle
- Height of X-ray pulse is a measure of roll angle



XSS Performance



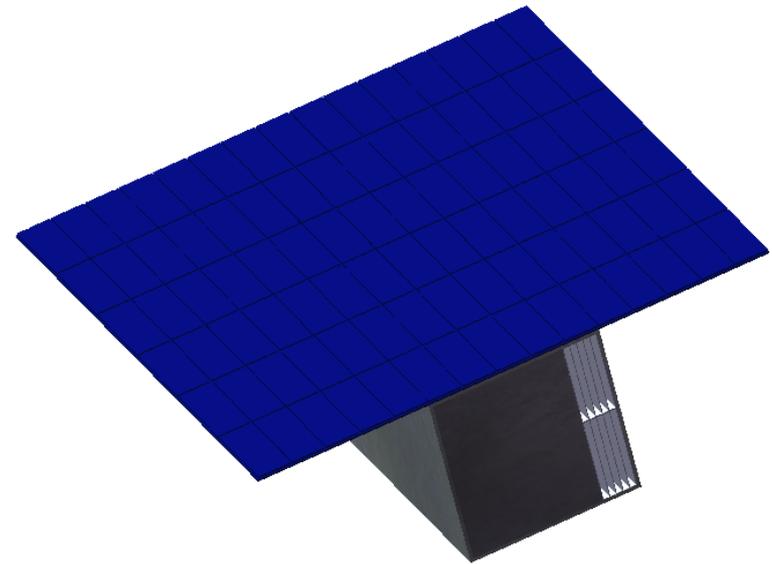
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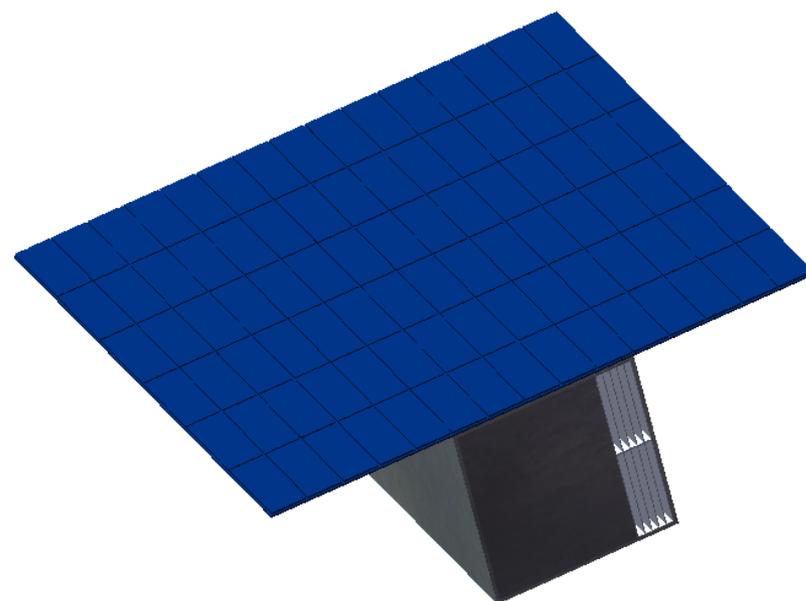
Unique Features of XSS

- Provides **arcminute** level attitude determination from a small package
 - Target < 1 W, < 1 kg, < 50% of 1U CubeSat
- FPGA provides Plug-n-Play capability
- Must be used on spin stabilized spacecraft with arbitrarily large spin rate
 - Simple, stable platform for many applications
- Inherently radiation hard
 - Detectors are radiation hard
 - Detector electronics provided by FPGA core
- Cannot be blinded by sun or spoofed or jammed by adversaries



Spin Stabilized Smallsat Applications

- Sun-pointed missions
 - Solar physics
 - Space science
- Inertial Pointers
 - Astronomy missions (e.g. spectroscopy)
 - Measurements of fundamental physical constants
 - Space science
 - Imaging of specific earth targets
- Thompson Spinners
 - Earth observing missions
 - Multispectral imaging
 - Atmospheric measurements
 - Communication relays



Spin Stabilized Spacecraft Opportunities

- Interviewed members of user community
 - Small and large prime contractors
 - CubeSat developers
- Key findings
 - Limited but ongoing market for spinning platforms
 - Science and space weather
 - Lower cost ADCS for CubeSat clusters/swarms
 - Backup and safe mode applications
 - Target SWaP and performance would be interesting/useful
 - <1 kg
 - <1 W
 - ~500 cm³ (10 cm x 10 cm x 5 cm)
 - ~1 Arcminute

Summary

- The X-ray Star Scanner will provide spin stabilized microspacecraft with arcminute level attitude knowledge capabilities in a small, low power package
- Precision spin stabilization will open up new, important missions for CubeSats and related microspacecraft
- XSS development currently in Phase I under JPL direction
 - Basic design being refined