Minnesat: GPS Attitude Determination Experiments Onboard a Nanosatellite

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Objective: to design and evaluate the performance of an ultra-short baseline GPS attitude determination system
GPS Attitude Determination

GPS Satellite

LOS Vector

GPS Signal Carrier

GPS Antenna

Baseline Vector

Relative Range

GPS Signal Carrier

GPS Antenna

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GPS Antenna Gain Patterns

Los Vector

Antenna Gain Pattern

Los Vector

Antenna Gain Pattern

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Carrier Phase Calibration

Attitude Errors, without phase delay estimation: 2° - 5°

Attitude Errors, with phase delay estimation: < 1°
General Design

- 8 GPS sensors
- Axi-symmetric hexagonal frame
- Physical Dimensions
  - circumscribed radius: 22.5 cm
  - height: 45 cm
  - mass: < 30 kg
- Dynamically Stable
GPS Antenna Configuration

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GPS Satellite

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GPS Antenna Baselines

24 Antenna Baselines

- Blue: 19.5 cm
- Green: 31.8 cm
- Red: 33.8 cm
System Overview

- **Navigation System**
- **Primary AD System**
- **GPS AD System**

**Orbit Insertion** → **Collect Sensor Data**
- 8 GPS Sensors
- Inertial Sensors
- Magnetometer

**Flight Computer**
- Archival Memory

**Communication System**
- Transmit to Ground Station

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