AAReST Attitude Determination and Control System (ADCS):
Operational Modes, Mission Chronology, and Sensor Locations

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ADCS Operational Modes

- Ground Testing
- Idle
- Detumble
- Configuration Change
- Reaction Wheel Desaturation
- Survival** (Default)
- Slew
- Rendezvous and Docking (RDV)
- Science (Fine Pointing)
- Ground Track
- ADCS Calibration
- Telescope Calibration

**Includes 3-axis stabilized Sun Pointing Mode; Survival Mode is Safe Mode

Shaded modes are 3-axis stabilized

Using RWs or Torque Rods

Boom Deployment, Frangibolt Separation
## Operational Modes Mapping

- Table defines mapping between ADCS operational modes and CubeSpace ADCS control and estimation modes

<table>
<thead>
<tr>
<th>Operational Mode</th>
<th>ADCS Control Mode(s)</th>
<th>ADCS Estimation Mode(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Testing</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Idle</td>
<td>No Control</td>
<td>No Estimation</td>
</tr>
<tr>
<td>Detumble (w/Torque Rods**)</td>
<td>Detumbling</td>
<td>MEMS Rate Sensing or Magnetometer Rate Filter</td>
</tr>
<tr>
<td>Survival (Default)</td>
<td>R-Wheel Sun Tracking Control</td>
<td>Full State EKF w/Minimum Sensor Complement</td>
</tr>
<tr>
<td>Configuration Change</td>
<td>No Control</td>
<td>Full State EKF</td>
</tr>
<tr>
<td>Reaction Wheel Desaturation</td>
<td>XYZ Wheel Control</td>
<td>Full State EKF</td>
</tr>
<tr>
<td>Telescope Calibration</td>
<td>R-Wheel Target Tracking Control</td>
<td>Full State EKF</td>
</tr>
<tr>
<td>Slew</td>
<td>XYZ-Wheel Control</td>
<td>Full State EKF</td>
</tr>
<tr>
<td>Rendezvous and Docking (RDV)</td>
<td>TBD</td>
<td>Full State EKF</td>
</tr>
<tr>
<td>Science (Fine Pointing)</td>
<td>R-Wheel Target Tracking Control</td>
<td>Full State EKF</td>
</tr>
<tr>
<td>Ground Track</td>
<td>R-Wheel Target Tracking Control</td>
<td>Full State EKF</td>
</tr>
</tbody>
</table>

**A 2nd Detumble Mode uses reaction wheels**
AAReST Nominal Mission Chronology

Launch → Deployment from Launch Vehicle → Turn ON Subsystems → Antenna Deployments

Detumble → Recharge Batteries → ADCS Commissioning → Boom Deployment and Re-stabilization

Telescope Calibration (Narrow) → Science Operations in Narrow Configuration → RDV Maneuver for 1st MirrorSat → RDV Maneuver for 2nd MirrorSat

Telescope Calibration (Wide) → Science Operations in Wide Configuration → Extended Mission

ADCS Mode (if applicable):
- Idle
- Detumble
- Survival
- Configuration Change
- ADCS Calibration
- Fine Pointing
- RDV

Note: AAReST returns to Survival Mode and recharges batteries after every step in chronology before proceeding to next step.
ADCS Commissioning

AAReST bypasses pitch-axis control and goes directly to a 3-axis stabilized, sun pointing attitude using reaction wheels

1. Determine initial angular rates (1 pass)
2. Initial detumbling – reaction wheels or torque rods (4 orbits)
3. Detumble to 3-axis stabilized, sun pointing attitude using reaction wheels (end state of 2.)
4. Magnetometer deployment (1 pass)
5. Magnetometer calibration (min. 1 orbit)
6. Magnetometer EKF activation (min. 1 orbit)
7. Sun/nadir sensor commissioning (1 orbit)
8. EKF activation w/sun and nadir measurements (min. 1 orbit)
9. Star tracker commissioning (1 orbit)
10. EKF activation w/star tracker measurements (min. 1 orbit)
11. EKF w/rate gyro and star tracker measurements (min. 1 pass)
12. Sun tracking 3-axis control (1 pass)

Note: Steps 1-3 occur during Detumble in the Nominal Mission Chronology.
ADCS Sensor Locations
Flight-like Launch/Stowed Configuration

Star Tracker

Note: star tracker baffle not shown
See Slide 7 for exact location of nadir sensor

Flight-like Launch/Stowed Configuration
Redundant Magnetometer and Nadir Sensor

Flight-like Launch/Stowed Configuration

See Slide 7 for exact location of nadir sensor
Fine Sun Sensor

Flight-like Launch/Stowed Configuration

See Slide 7 for exact location of sun sensor