POLINSAR 2019

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COSMO-SkyMed Second Generation Mission update

Luigi DINI (ASI CSG-Mission Manager)

28/01/2019
COSMO-SkyMed Second Generation (CSG) is the follow on mission to COSMO-SkyMed (CSK), currently operating in orbit, aimed at assuring operational continuity and performance improvement in supplying the SAR imaging services through data and image products, such to preserve and enhance the ability of customers and operational users to fulfil their mandates

- Operational continuity/preserve
- Performance improvements/enhance
DUAL MISSION

CIVIL DOMAIN

Institutional Users

Research Insti./Universities

Commercial Users

National Commercial Users
Intern. Commercial users

DEFENCE DOMAIN

Military Users

National Defence Users
International Defence Partners
MISSION KEY CHARACTERISTICS

Cosmo-SkyMED is mainly devoted to:

- Security: defence,
- Safety: prevention, monitoring and management of natural and man-made hazards
- Research: Earth Science

Cosmo-SkyMED is a user driven/on demand system characterized by:

- High Flexibility
  - Multi-mode acquisition (variety of sizes and resolutions)
  - Agility (reconfiguration and multiple acquisitions on a theater)
- High Reactivity
  - Response / Revisit Time
**PROGRAMME SCHEDULE - UPDATES**

**Phase C**
- Design
- **✓ CDR**

**Phase D**
- Manufacturing
- AIT

**Phase E1**
- Launch/Commis./Operations
- **FRR#1**
- **CRR#1**

**Phase E2**
- **FRR#2**
- **CRR#2**

**Nov. 2017**
- **Phase C**
- **Phase D**

**NOW**
- **Phase E1**
- **Phase E2**

**Oct. 19**
- SOYUZ (Korou SC)
- **Operations #1**

**Oct. 20**
- VEGA-C (Korou SC)
- **Operations #2**

**Apr. 20**
- **FRR#1**
- **CRR#1**

**Apr. 21**
- **FRR#2**
- **CRR#2**
<table>
<thead>
<tr>
<th><strong>Orbit type:</strong></th>
<th>SSO dawn-dusk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Repeat Cycle /#Revolutions</strong></td>
<td>16 days/237</td>
</tr>
<tr>
<td><strong>Orbital Period</strong></td>
<td>97.1 min</td>
</tr>
<tr>
<td><strong>Inclination</strong></td>
<td>97.86°</td>
</tr>
<tr>
<td><strong>Eccentricity:</strong></td>
<td>0.001185</td>
</tr>
<tr>
<td><strong>Argument of perigee:</strong></td>
<td>+ 90°</td>
</tr>
<tr>
<td><strong>height:</strong></td>
<td>619.6 km</td>
</tr>
<tr>
<td><strong>LTAN:</strong></td>
<td>6:00 a.m.</td>
</tr>
</tbody>
</table>

Image credit TAS-I
**SPACE SEGMENT**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wet Mass @ Launch</strong></td>
<td>~2226 Kg (CSK 1860 Kg)</td>
</tr>
<tr>
<td><strong>Operational Lifetime</strong></td>
<td>7 years (CSK 5 years)</td>
</tr>
<tr>
<td><strong>Platform</strong></td>
<td>PRIMA (as CSK)</td>
</tr>
<tr>
<td><strong>Antenna Size</strong></td>
<td>5.6 m. x 1.4 m.</td>
</tr>
<tr>
<td><strong>Imaging acq. capacity</strong></td>
<td>~1000 st.frames/day/satellite (CSK 475)</td>
</tr>
</tbody>
</table>

Image credit TAS-I
Wide Band SAR
- X-BAND (9.6 GHz) SAR with a wider transmission bandwidth (up to 1100MHz in Tx for Spotlight modes)
- multi-mode, multi-polarization
- electronic steering of the antenna beam in both azimuth and elevation (20°-60° incidence access area)

PRIMA Platform
- 3 axis stabilization system (with sun and stars sensors, reaction wheels, control moment gyro assembly, torque-rods), with steering capabilities on each axis, high pointing accuracy and knowledge and real time orbit determination
- 2 solar array wings
- A monopropellant propulsion system with 154 kg of hydrazine

Payload Data Handling and Transmission
- On Board storage memory 1530 Gbit (CSK 320 Gbit)
- Data Downlink Rate @ X-Band 520 Mbps (CSK 310 Mbps)
ACQUISITION MODES

Ref. Calabrese et. Al.; Proc EUSAR 2018

ESA UNCLASSIFIED - For Official Use
CSK/CSG Spotlight standard mode:
Separation between spotlight images is \( \sim 100 \) km.

CSG Theatre mode:
- The platform agility allows to perform pitch maneuvers.
- The ground separation of spotlight images can be 0 km.
- More images in a theatre region can be acquired.

CSG DI2S:
- The SAR instrument capabilities allows to acquire two targets almost simultaneously.
- The ground separation of spotlight images can be 0 km.
- The range swath is reduced.

Separation between spotlight images is \( \sim 100 \) km.
DI2S

- SAR works @ double PRF
- odd impulses are processed to acquire one image
- even impulses are processed to acquire the other image

Ref. Calabrese et. Al.; Proc EUSAR 2018
SQUINTED THEATER

✓ SAR acquires while maneuvering around pitch axis => No zero Doppler azimuth

Acquisitions can be either adjacent or scattered

Ref. Calabrese et. Al.; Proc EUSAR 2018
DATA POLICY

Cosmo-SkyMed Data Policy is under review of a dedicated working group. Due to the intrinsic nature of the mission (i.e. dual use), the philosophy behind Data Policy & System Access strategy will not undergo major changes, i.e.:

• Data & Products can not be freely used, reused & redistributed by anyone
• Not all modes/products can be accessed/requested by anyone
• Data are not, generally, free of charge

Nevertheless, in order to maximize returns in terms of societal benefits and research, ASI:

• keeps active an open call for national and international scientific research projects. 100 images/project can be obtained free of charge (ref. https://www.asi.it/en/agency/calls-and-opportunities/calls/cosmo-skymed-constellation-data-utilization)
• promotes & negotiates agreements with national & international organizations/bodies/institutions, space agencies etc. for cooperation on large projects in the EO field ( see SIASGE,ESA-Third Party, ASI-NASA, ASI-JAXA, CEOS-WGDISASTER/GFOI,WMO-Polar SpaceTask Group, etc.)
Thank You!
BIBLIOGRAPHY

- Diego Calabrese, Chiara Germani, Andrea Torre, Davide Rizzato, Stefano Federici, Roberto Formaro, Giancarlo Varacalli, Claudia Facchinetti, "CSG Status and New Solutions to Increase the Product Portfolio", Proc. EUSAR 2018
- Diego Calabrese, Valerio Grimani, Pasquale Salemme, “DI2S Improved resolution vs spoiling for X-Band comparison”, Proc. APSAR 2015
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Spot-2A (1)</th>
<th>Spot-2B (1)</th>
<th>Spot-2C (1)</th>
<th>D125 - DS</th>
<th>Stripmap (1)</th>
<th>PingPong (1)</th>
<th>Scan-1 (1)</th>
<th>Scan-2 (1)</th>
<th>Quadpol (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Area</td>
<td>degrees</td>
<td>20 - 60</td>
<td>20 - 60</td>
<td>20 - 60</td>
<td>20 - 45</td>
<td>20 - 60</td>
<td>20 - 60</td>
<td>20 - 60</td>
<td>20 - 60</td>
<td>20 - 45</td>
</tr>
<tr>
<td>Nominal Access Area</td>
<td>degrees</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Extended Access Area</td>
<td>degrees</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Swath (rng x az)</td>
<td>Km x Km</td>
<td>≥ 7.3 x 3.1 @ (20-25)</td>
<td>≥ 7.3 x 3.2 @ (25-50)</td>
<td>≥ 7.3 x 4.4 @ (50-60)</td>
<td>≥ 10 x 10 @ 20-60</td>
<td>≥ 10 x 5 @ 20-60</td>
<td>≥ 4 x 10 @ 20-45</td>
<td>≥ 40 x 40 @ 20-50</td>
<td>≥ 30 x 30 @ 20-50</td>
<td>≥ 100 x 100 @ 20-50</td>
</tr>
<tr>
<td>Single Look Resolution (rng x az)</td>
<td>m x m</td>
<td>0.55 x 0.35 @ (20-25)</td>
<td>0.51 x 0.35 @ (25-50)</td>
<td>0.48 x 0.35 @ (50-60)</td>
<td>0.63 x 0.63 @ 20-60</td>
<td>0.8 x 0.8 @ 20-60</td>
<td>0.63 x 0.63 @ 20-45</td>
<td>3 x 3 @ 20-50</td>
<td>5 x 12 @ 20-50</td>
<td>4 x 20 @ 20-50</td>
</tr>
<tr>
<td>Noise Equivalent a</td>
<td>dBm²/m²</td>
<td>-22 @ (20-25)</td>
<td>-22 @ (25-50)</td>
<td>-19.5 @ (50-60)</td>
<td>-20 @ 20-60</td>
<td>-22 @ (20-25)</td>
<td>-20 @ (25-50)</td>
<td>≤ -20 @ 20-45</td>
<td>-22 @ 20-50</td>
<td>-22 @ 20-50</td>
</tr>
<tr>
<td>Total Noise Equivalent a</td>
<td>dBm²/m²</td>
<td>-19 @ (20-25)</td>
<td>-19 @ (25-50)</td>
<td>-16.5 @ (50-60)</td>
<td>-17 @ 20-60</td>
<td>-19 @ (20-25)</td>
<td>-17 @ (25-50)</td>
<td>≤ -17 @ 20-45</td>
<td>-19 @ 20-50</td>
<td>-19 @ 20-50</td>
</tr>
<tr>
<td>Azimuth &amp; Range ASR</td>
<td>dB</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
</tr>
<tr>
<td>Ambiguity over a point target</td>
<td>dB</td>
<td>-40</td>
<td>-40</td>
<td>-40</td>
<td>-40</td>
<td>-40 (mrg)</td>
<td>-40 (mrg)</td>
<td>-40 (mrg)</td>
<td>-40 (mrg)</td>
<td>-40 (mrg)</td>
</tr>
<tr>
<td>RFP Shapes: -10 dB / -3 dB</td>
<td>-</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
</tr>
<tr>
<td>PSLR</td>
<td>dB</td>
<td>-12</td>
<td>-12</td>
<td>-12</td>
<td>-12</td>
<td>-12</td>
<td>-12</td>
<td>-12</td>
<td>-12</td>
<td>-12</td>
</tr>
<tr>
<td>Radiometric Accuracy</td>
<td>dB</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Radiometric Linearity</td>
<td>dB</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5 (*)</td>
</tr>
<tr>
<td>Radiometric Stability (over the image)</td>
<td>dB</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0 (*)</td>
</tr>
<tr>
<td>Local Radiometric Stability</td>
<td>dB</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.5 (az)</td>
<td>0.5 (az)</td>
<td>0.5 (az)</td>
<td>0.5 (az)</td>
<td>0.5 (az)</td>
</tr>
<tr>
<td>Instantaneous dynamic</td>
<td>dB/resol. cell</td>
<td>≥ 3</td>
<td>≥ 3</td>
<td>≥ 3</td>
<td>≥ 3</td>
<td>≥ 3</td>
<td>≥ 3</td>
<td>≥ 3</td>
<td>≥ 3</td>
<td>≥ 3 (*)</td>
</tr>
<tr>
<td>Global dynamic</td>
<td>dB</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
<td>≥ 60 (35dB Local dynamic + 25 dB Gain control)</td>
</tr>
<tr>
<td>Polarization</td>
<td></td>
<td>HH or VV</td>
<td>HH or VV</td>
<td>HH or VV</td>
<td>HH or VV</td>
<td>HH or VV</td>
<td>HH or VV</td>
<td>HH and VV</td>
<td>HH and VV</td>
<td>HH or VV</td>
</tr>
<tr>
<td>Geometric conformity</td>
<td></td>
<td>10³</td>
<td>10³</td>
<td>10³</td>
<td>10³</td>
<td>10³</td>
<td>10³</td>
<td>10³</td>
<td>10³</td>
<td>10³ (*)</td>
</tr>
</tbody>
</table>

(1) Performance are referred to the nominal access region
(2) (1) or (2) depending on the scan type
(3) (1) or (2) depending on the scan type
(4) Both azimuth and range are ≤ 45
(5) Both azimuth and range are ≤ 45

(*) These values are for the highest resolution setting.

Note: All values are approximate and may vary depending on the specific system configuration and environmental conditions.