SURVEYING AND MONITORING OF CULTURAL HERITAGE:
THE ROLE OF COSMO-SkyMed MISSION

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COSMO-SkyMed Mission Management Unit
Italian Space Agency (ASI)
COSMO-SkyMed features
COSMO-SkyMed features

Since May 2011 the Italian COSMO SkyMed four SAR satellites constellation is fully operational.
COSMO-SkyMed features

- SINCE MAY 2011 THE ITALIAN COSMO SKYMED FOUR SAR SATELLITES CONSTELLATION IS FULLY OPERATIONAL
- THE LARGEST ITALIAN INVESTMENT IN SPACE SYSTEM FOR EARTH OBSERVATION
- FIRST DUAL USE SYSTEM
- NO OTHER 4 SAR SATELLITES CONSTELLATION TODAY ON THE EO OPERATIONAL SCENE
COSMO-SkyMed features

- **SENSOR:** X-BAND SAR (9.6 GHz)
- **BANDWIDTH:** 400 MHz
- **HEIGHT:** 619.6 Km
- **ORBIT:** SSO
- **INCLINATION:** 97.8°
- **ORBITAL PERIOD:** ~ 97 m

**4 SAR SATELLITES CONSTELLATION**
- Worldwide global coverage
- All weather night/day acquisitions
- Fast response time
- Fast large/long area mapping
- Accurate information frequently updated
- Interferometric revisit (1 day)
- Motion tracking
COSMO-SkyMed features

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Diagram showing the 4 SAR satellites (COSMO-1, COSMO-2, COSMO-3, COSMO-4) in orbit with 90° angular separation.
### COSMO-SkyMed features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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#### 4 SAR Satellites Constellation
- Worldwide global coverage
- All weather night/day acquisitions
- Fast response time
- Fast large/long area mapping
- Accurate information frequently updated
- Interferometric revisit (1 day)

![Diagram of 4 SAR satellites](image-url)
SCANSAR WIDE
100 Km X 100 Km
30 m Resol.

SCANSAR HUGE
200 Km X 200 Km
100 m Resol.

STRIPMAP – PING PONG
30 Km X 30 Km
15 m Resol.

STRIPMAP – HIMAGE
40 Km X 40 Km
3 m Resol.

SPOTLIGHT
10 Km X 10 Km
1 m Resol.

MULTI-MODE ACQUISITION CAPABILITY
MULTI-MODE ACQUISITION CAPABILITY

**SPOTLIGHT**
- 10 Km X 10 Km
- 1 m Resol.

**SCANSAR WIDE**
- 100 Km X 100 Km
- 30 m Resol.

**SCANSAR HUGE**
- 200 Km X 200 Km
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- 10 Km X 10 Km
- 1 m Resol.

**75 Narrow Field**

+ **375 Wide Field**
  - Images per day per satellite

**1800 images per day**

**MULTI-MODE ACQUISITION CAPABILITY**

**WIDE FIELD**

**NARROW FIELD**
COSMO-SkyMed features

Constellation Unique Capabilities

ASI HEADQUARTERS

ESA-ESRIN
COSMO-SkyMed features

ESRIN, Frascati, 13 November 2015 (morning - Asc)

SAR4 H4-11
Right
04:54 UTC

SAR3 H4-04
Left
04:12 UTC
COSMO-SkyMed features

ESRIN, Frascati, 13 November 2015 (afternoon - Desc)
Wide application range

- Risk Monitoring and Management of Emergencies
- Ocean and Ice Monitoring
- Monitoring and Management of Coasts and Inland Waters
- Monitoring and Management of Forestry and Agricultural Resources
- Technical Cartography – Urban Planning
- Scientific Applications
- Security Applications
More than 750,000 CSK products have been processed
In a 16-days cycle there are 4 interferometric acquisitions
(Same orbit direction, same look side, same incidence angle)
Long term interferometric time series analysis provide useful information for land stability analysis in urban subsidence, landslide, infrastructure monitoring such as railways, pipeline, dams, bridges, etc. The high geometric accuracy of COSMO-SkyMed images as well as its high spatial and temporal resolution are incisive instruments in this framework, being Interferometry a widely used technique to detect and monitor slow terrain movements with millimetre accuracy.
MAP ITALY StripMap mosaic

- USE OF 4 SATELLITES
- 16 DAYS PASSAGES (INTERFEROMETRIC ACQUIS.)
- ASC./DESC. PASSAGES
ASI has moved a proposal to realize a monitoring plan of the building and infrastructural heritage over the Italian territory by exploiting the COSMO-SkyMed system (PS ITALIA project).

Monuments as well as archaeological and architectural sites of interests are a significant part of this heritage.
ASI programs

Although at the moment ASI doesn’t have an applicative program devoted to cultural heritage, this task is indicated as a priority in the 3-year plan of activities 2015-2017.

• ASI has supported and co-financed projects proposed by SME, such as the WHERE project, thanks to which a system for the monitoring of those sites classified as UNESCO World Heritage in urban areas has been performed.

• Two institutional projects using COSMO-SkyMed data over archaeological sites and finalized to prevention and monitoring:
  - A project with the Soprintendenza Beni Archeologici of Calabria region for the monitoring and safe maintenance of the archaeological area of Capo Colonna (March 2015)
  - ITACA project (activated in 2014 with the Soprintendenza del Mare of Sicily region, 2-year duration) for the monitoring of submerged archaeological sites (marine archaeology)

• ARCHAEOMODE project, activated in 2014 with Universita’ Orientale di Napoli in the framework of ASI/CSA AO, and devoted to the monitoring of archaeological sites in desert areas.
SOME EXAMPLES...

Archeological sites and historical buildings monitoring based on COSMO-SkyMed data
Rome - San Pietro Basilica
CSK PSP-I FSAR analysis (Jan. 2010 - May 2012)
Naples - Piazza Plebiscito and Palazzo Reale
CSK Feb. 2010 - Feb. 2011
Venice - Piazza San Marco
Rome - Central Archaeological area
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Temporal evolution

Displacement [mm]

Time

01/10/10 05/10/10 09/10/10 01/10/11 05/10/11 09/10/11 01/10/12 05/10/12
Rome - Central Archaeological area

Temporal evolution

- Displacement [mm]
- Time

Mean velocity
(mm/year)

- < -0.8
- -0.8 - -1.0
- -2.0 - -3.0
- -3.0 - -4.0
- -4.0 - -5.0
- -5.0 - -6.0
- -6.0 - -7.0
- -7.0 - -8.0
- -8.0 - -9.0
- -9.0 - -10
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 7.0
- > 7.0
Rome - Central Archaeological area

Temporal evolution

Displacement [mm]

Time

01/10/10 05/10/10 09/10/10 01/10/11 05/10/11 09/10/11 01/10/12 05/10/12

Mean velocity (mm/year)
- < 0.8
- 0.0 - 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- > 8.0

Google

Elevation 29 m

2009
GIZA Necropolis

Sensor mode: SPOTLIGHT 10 km x 10 km
Resolution: 1 m
Acquisition date: Sept 18, 2009
Pass Direction: Descending
GI ZA Necropolis

Sensor mode: SPOTLIGHT 10 km x 10 km
Resolution: 1 m
Acquisition date: Sept 18, 2009
Pass Direction: Descending

Pyramid of Cheops
Pyramid of Khafre
Pyramid of Menkaure
DAHSHUR Necropolis

COSMO-SkyMed Spotlight 2
- 2011, May 29
- 2011, June 01
- Coherence

Red Pyramid
Bent Pyramid or Pyramid of Snefru

PYRAMIDS
TANI S excavations

COSMO-SkyMed Spotlight 2

- 2011, May 28
- 2011, June 01
- Coherence
TANIS excavations

COSMO-SkyMed Spot

- 2011, May 28
- 2011, June 01
- Coherence
Excavations in **Tanis**, where archaeologists uncovered a 3,000-year-old house.
MATERA
European Capital of Culture 2019
THANK FOR ATTENTION

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