
# Le iniziative di ambito Spazio dell'Istituto Italiano di Tecnologia

Arianna Traviglia (IIT)

# IIT in breve

L'Istituto Italiano di Tecnologia articola la sua missione statutaria in tre componenti principali:

- Ricerca scientifica: promuovere l'eccellenza scientifica e sviluppare tecnologie all'avanguardia;
- Trasferimento tecnologico: applicare la tecnologia per giocare un ruolo strategico nella competitività del sistema produttivo italiano;
- Alta formazione: offrire programmi dedicati a formazione ed istruzione altamente specializzate

# IIT in breve


www.iit.it/web/spaceiit

# IIT in breve

**18**
Centers
16 in Italy
2 US outstations
50.000 $m^2$ of labs

**1895**
Staff
71 countries
35 years average age
44% female, 82% scientific staff

**803**
Scientific Projects
443.1 MEUR
260 ongoing

**18900+**
Publications
560k citations

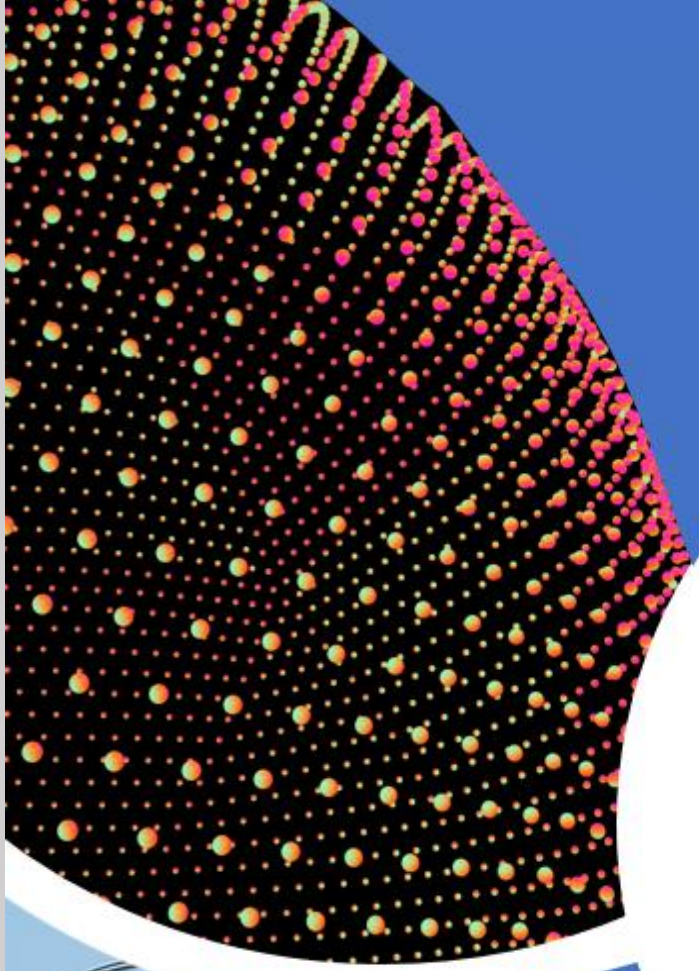
**903**
Commercial Projects
103.1 MEUR
173 ongoing

**1281**
Patents
404 inventions

**20**
Joint Labs

**33**
Start Ups

www.iit.it/web/spaceiit





**SPACE**

**SPA**ce **CE**n

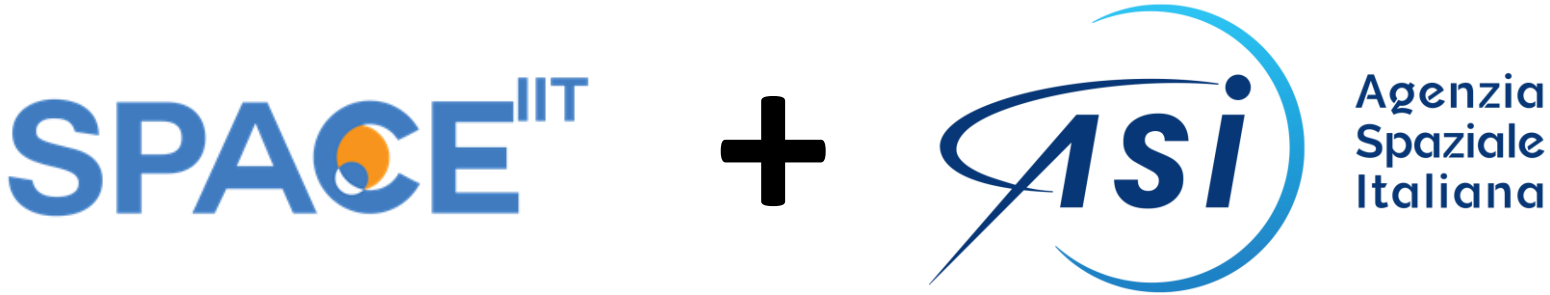
**I**nterdisciplinary

**T**echnol

iit ISTITUTO ITALIANO DI TECNOLOGIA | SPACE IIT

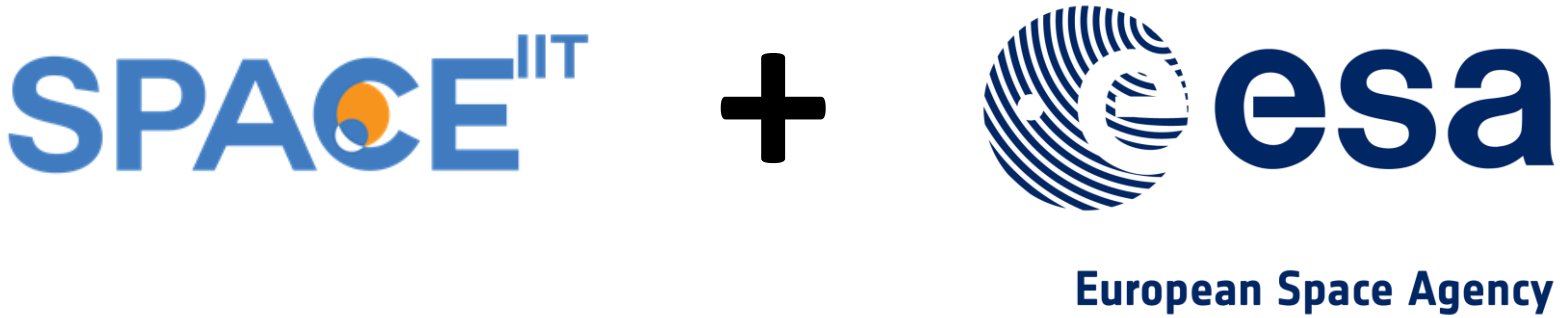
# Accordi istituzionali

Joint-Lab



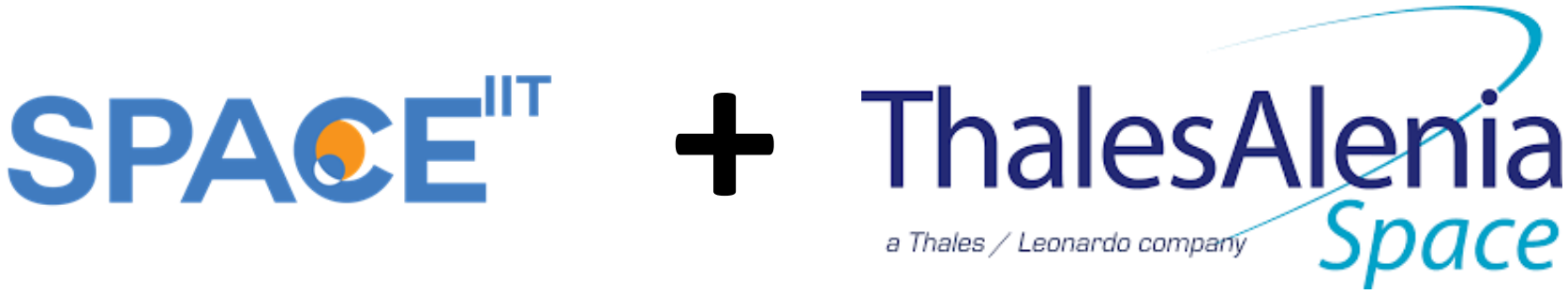
# Accordi istituzionali

Accordo co-finanziamento

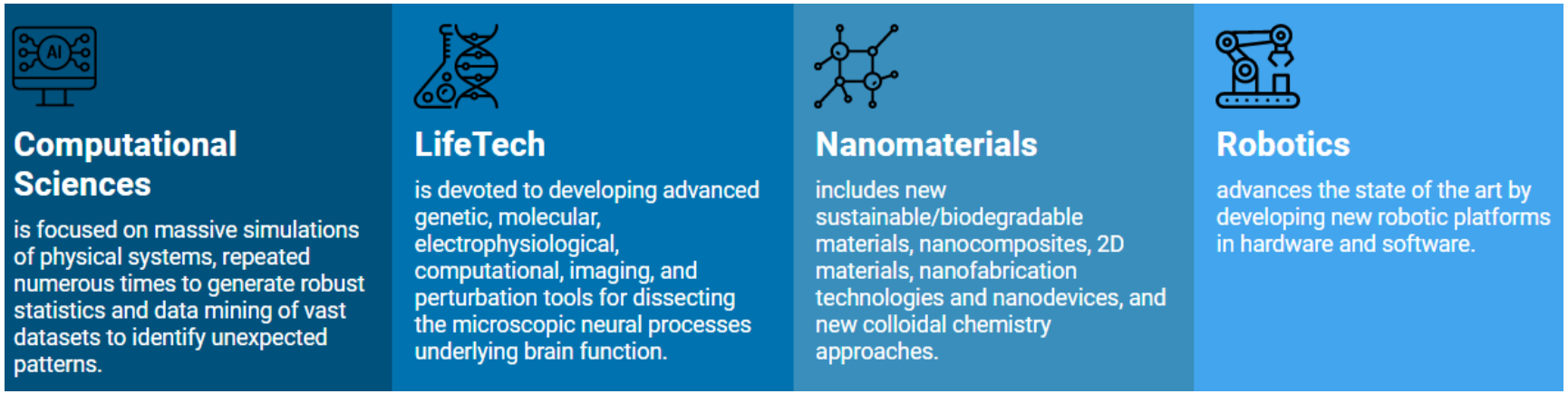


# Accordi istituzionali

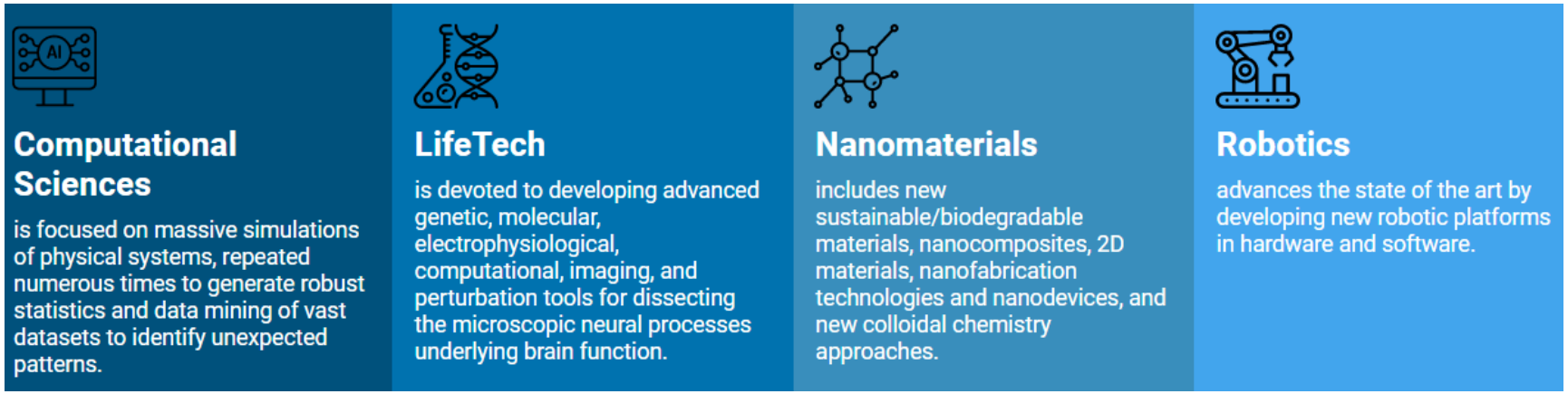
Sviluppo prototipi



# I 4 ‘Pilastri di Ricerca’ IIT

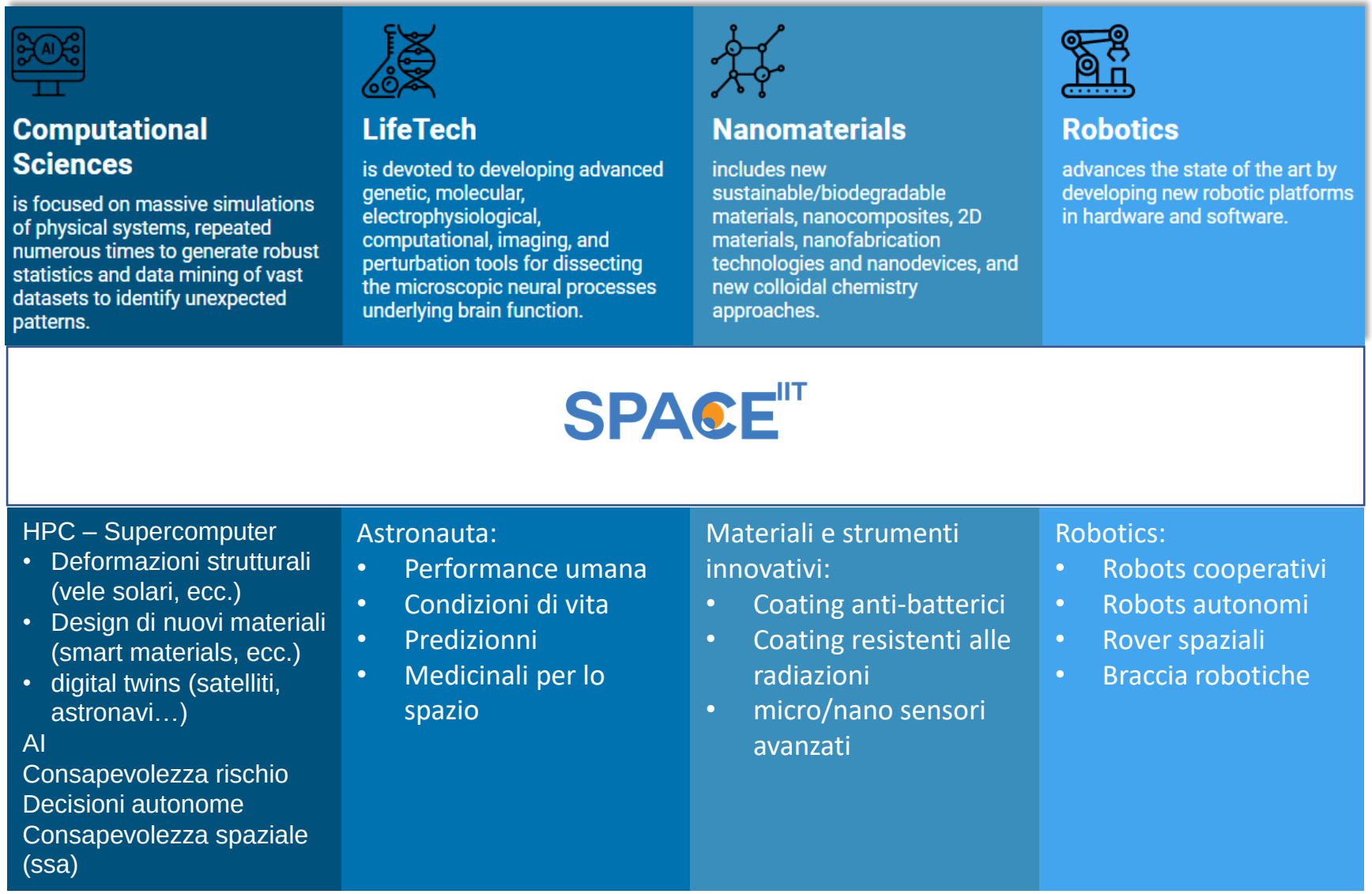


# I 4 ‘Pilastri di Ricerca’ IIT



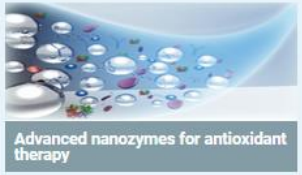

***Tecnologie Spaziali***

# I 4 ‘Pilastri di Ricerca’ IIT




www.iit.it/web/spaceiit

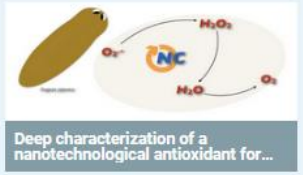
# SPACE$^{IIT}$ : > 20 progetti attivi

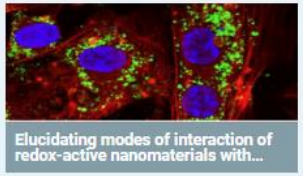

Advanced nanozymes for antioxidant therapy

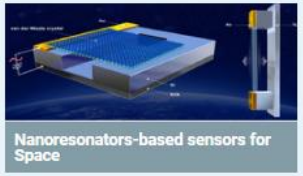

Autonomous Non-wheeled all-Terrain rover (ANT)


Biomarkers and biosensors to monitor body response in...


Cultural Landscapes Scanner (CLS): Earth Observation and automated...


Deep characterization of a nanotechnological antioxidant for...


Elucidating modes of interaction of redox-active nanomaterials with...


Nanoresonators-based sensors for Space


Nano-spectroscopy in the visible and near-IR

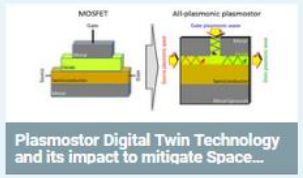

Nanotechnological countermeasures against oxidative stress in muscle...

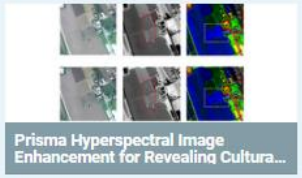

Nanotechnology solutions against oxidative stress in muscle tissue...


Nichoid in space: Advanced in vitro models for "on orbit" investigations...


OPtimal Transport for Identifying Marauder Activities on LiDAR...


Piezoelectric Flexible Smart Sensors for monitoring vital parameters and...


Plasmostor Digital Twin Technology and its impact to mitigate Space...


Prisma Hyperspectral Image Enhancement for Revealing Cultura...


Species production in altered gravity conditions: Preliminary investigatio...

www.iit.it/web/spaceiit

# SPACE$^{IIT}$ : alcuni esempi

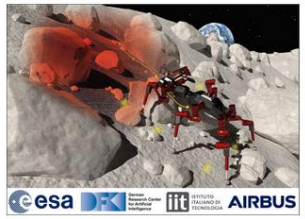
## Autonomous Non-wheeled all-Terrain rover (ANT)

*Research domain: Robotics - Subtopic: Autonomous robots*

The Autonomous Non-wheeled all-Terrain (ANT) rover will be a rover system tasked to explore difficult-to-access areas of the Moon and Mars such as high inclination slopes, cliffs, craters, caves and lava tubes. The objective of the activity is to develop the ANT navigation system for legged robots. It will be able to perceive the terrain, to plan a path to a desired goal and to control the path execution while traversing unconsolidated, inclined, and rugged terrain. A modular generic approach is being developed to exploit the potential of robots with four (quadrupeds) as well as with six legs (hexapods). Prime: German Research Center for Artificial Intelligence (DFKI), Germany. Partners: IIT, Italy and Airbus, UK., Germany. Partners: IIT, Italy and Airbus, UK.

Project funding: European Space Agency (ESA)

Rendering of the hexapod robot CREX inside a crater on Moon (image credit: DFKI, Finn Lichtenberg)




### Persons in charge of this project


Claudio Semini


Victor Barasuol


Michele Focchi

SPACE IIT

ISTITUTO ITALIANO DI TECNOLOGIA

iit

# SPACE$^{IIT}$ : alcuni esempi

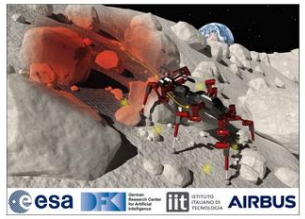
## Autonomous Non-wheeled all-Terrain rover (ANT)

*Research domain: Robotics - Subtopic: Autonomous robots*

The Autonomous Non-wheeled all-Terrain (ANT) rover will be a rover system tasked to explore difficult-to-access areas of the Moon and Mars such as high inclination slopes, cliffs, craters, caves and lava tubes. The objective of the activity is to develop the ANT navigation system for legged robots. It will be able to perceive the terrain, to plan a path to a desired goal and to control the path execution while traversing unconsolidated, inclined, and rugged terrain. A modular generic approach is being developed to exploit the potential of robots with four (quadrupeds) as well as with six legs (hexapods). Prime: German Research Center for Artificial Intelligence (DFKI), Germany. Partners: IIT, Italy and Airbus, UK., Germany. Partners: IIT, Italy and Airbus, UK.

Project funding: European Space Agency (ESA)

Rendering of the hexapod robot CREX inside a crater on Moon (image credit: DFKI, Finn Lichtenberg)




### Persons in charge of this project


Claudio Semini


Victor Barasuol


Michele Focchi

## Biomarkers and biosensors to monitor body response in microgravity conditions (MARS-PRE)

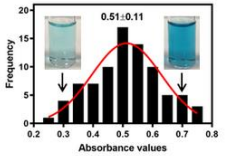
*Research domain: LifeTech - Subtopic: Bio-Materials*

With the rapid advances in spaceflight capability, investigating the effects of microgravity on the brain and nervous system is of paramount importance. Space travels present extreme conditions and consequent physiological effects, for example, induction of oxidative stress response in humans and related health risks.

In this project, we are investigating physiological changes and reactive oxygen species (ROS) production for the whole neurovascular system subjected to conditions of simulated microgravity in vitro. In addition, we are also implementing nanoparticle-based rapid and instrument-free colorimetric tests for semi-quantitative detection of biomarkers (namely, antioxidants and cortisol), using "non-invasive" biological fluids, such as saliva, avoiding inconvenient blood sampling.

In summary, our research team aims to elucidate the overall effect of reduced gravity and oxidative stress on the neurovascular system and set the basis for point-of-care devices to monitor health and stress conditions during space missions.

Project funding: Italian Space Agency (ASI)


### Persons in charge of this project


Pierpaolo Pompa


Fabio Benfenati

www.iit.it/web/spaceiit

# SPACE$^{IIT}$ : alcuni esempi

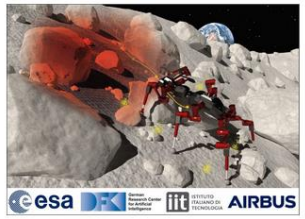
## Autonomous Non-wheeled all-Terrain rover (ANT)

*Research domain: Robotics - Subtopic: Autonomous robots*

The Autonomous Non-wheeled all-Terrain (ANT) rover will be a rover system tasked to explore difficult-to-access areas of the Moon and Mars such as high inclination slopes, cliffs, craters, caves and lava tubes. The objective of the activity is to develop the ANT navigation system for legged robots. It will be able to perceive the terrain, to plan a path to a desired goal and to control the path execution while traversing unconsolidated, inclined, and rugged terrain. A modular generic approach is being developed to exploit the potential of robots with four (quadrupeds) as well as with six legs (hexapods). Prime: German Research Center for Artificial Intelligence (DFKI), Germany. Partners: IIT, Italy and Airbus, UK., Germany. Partners: IIT, Italy and Airbus, UK.

Project funding: European Space Agency (ESA)

Rendering of the hexapod robot CREX inside a crater on Moon (image credit: DFKI, Finn Lichtenberg)




### Persons in charge of this project


Claudio Semini


Victor Barasuol

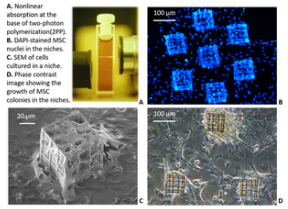

Michele Focchi

## Nichoid in space: Advanced in vitro models for “on orbit” investigations (Nichoid-ET)

*Research domain: LifeTech - Subtopic: Bio-Materials*

In most in vitro cell models, cultures are made adhering to flat culture slides and the expected activation of specific cell markers is measured on cells. However, in this simplified condition, cell behavior is not representative of the in vivo response, which is based on cell interactions that occur in three-dimensional (3D) non-flat environments and between several cell populations. In oncology, 3D cell culture models are exploited in particular during the process of the development of new anticancer agents, as they mimic the main features of human solid tumors more reliably than flat cultures. Recent evidences show that microgravity could provide appropriate cues to 3D cancer cell cultures, so that they can exhibit features resembling the physio/pathological conditions. However, up to now there is no evidence in the literature about the effect on cancer cells of the combination of microgravity and a 3D topographical environment. In this project, we want to use a miniaturized 3D scaffold to achieve a proof of concept of our idea that cell culture experiments can be performed in more realistic 3D environments also on orbit. We will develop a new microfabricated scaffold addressing the context of ESA technology (ET) that we will call Nichoid-ET. The scaffold, microfabricated by two-photon laser polymerization, will be only 30 µm thick, and fully inspectable in fluorescence. The Nichoid-ET will be manufactured on polymeric culture slides, already used in bioreactors onboard the International Space Station. This will require a custom design for the microarchitecture and the engineering of a relevant fabrication technology. Using the newly-designed Nichoid-ET scaffolds, we will set-up a cell model of glioblastoma multiforme. If successful, the relevant technology developments will bring the Nichoid-ET up to prototype level with potential customer interests in using this advanced substrate in multiple applications of biological research in space.

Project funding: European Space Agency (ESA)




### Person in charge of this project


Gianni Ciofani

## Biomarkers and biosensors to monitor body response in microgravity conditions (MARS-PRE)

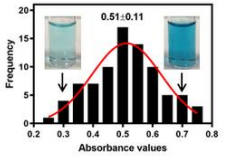
*Research domain: LifeTech - Subtopic: Bio-Materials*

With the rapid advances in spaceflight capability, investigating the effects of microgravity on the brain and nervous system is of paramount importance. Space travels present extreme conditions and consequent physiological effects, for example, induction of oxidative stress response in humans and related health risks.

In this project, we are investigating physiological changes and reactive oxygen species (ROS) production for the whole neurovascular system subjected to conditions of simulated microgravity in vitro. In addition, we are also implementing nanoparticle-based rapid and instrument-free colorimetric tests for semi-quantitative detection of biomarkers (namely, antioxidants and cortisol), using "non-invasive" biological fluids, such as saliva, avoiding inconvenient blood sampling.

In summary, our research team aims to elucidate the overall effect of reduced gravity and oxidative stress on the neurovascular system and set the basis for point-of-care devices to monitor health and stress conditions during space missions.

Project funding: Italian Space Agency (ASI)


### Persons in charge of this project


Pierpaolo Pompa


Fabio Benfenati

www.iit.it/web/spaceiit

# SPACE$^{IIT}$ : alcuni esempi

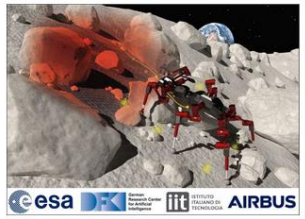
## Autonomous Non-wheeled all-Terrain rover (ANT)

*Research domain: Robotics - Subtopic: Autonomous robots*

The Autonomous Non-wheeled all-Terrain (ANT) rover will be a rover system tasked to explore difficult-to-access areas of the Moon and Mars such as high inclination slopes, cliffs, craters, caves and lava tubes. The objective of the activity is to develop the ANT navigation system for legged robots. It will be able to perceive the terrain, to plan a path to a desired goal and to control the path execution while traversing unconsolidated, inclined, and rugged terrain. A modular generic approach is being developed to exploit the potential of robots with four (quadrupeds) as well as with six legs (hexapods). Prime: German Research Center for Artificial Intelligence (DFKI), Germany. Partners: IIT, Italy and Airbus, UK., Germany. Partners: IIT, Italy and Airbus, UK.

Project funding: European Space Agency (ESA)

Rendering of the hexapod robot CREX inside a crater on Moon (image credit: DFKI, Finn Lichtenberg)




### Persons in charge of this project


Claudio Semini


Victor Barasuol

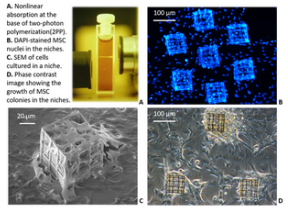

Michele Focchi

## Nichoid in space: Advanced in vitro models for “on orbit” investigations (Nichoid-ET)

*Research domain: LifeTech - Subtopic: Bio-Materials*

In most in vitro cell models, cultures are made adhering to flat culture slides and the expected activation of specific cell markers is measured on cells. However, in this simplified condition, cell behavior is not representative of the in vivo response, which is based on cell interactions that occur in three-dimensional (3D) non-flat environments and between several cell populations. In oncology, 3D cell culture models are exploited in particular during the process of the development of new anticancer agents, as they mimic the main features of human solid tumors more reliably than flat cultures. Recent evidences show that microgravity could provide appropriate cues to 3D cancer cell cultures, so that they can exhibit features resembling the physio/pathological conditions. However, up to now there is no evidence in the literature about the effect on cancer cells of the combination of microgravity and a 3D topographical environment. In this project, we want to use a miniaturized 3D scaffold to achieve a proof of concept of our idea that cell culture experiments can be performed in more realistic 3D environments also on orbit. We will develop a new microfabricated scaffold addressing the context of ESA technology (ET) that we will call Nichoid-ET. The scaffold, microfabricated by two-photon laser polymerization, will be only 30 µm thick, and fully inspectable in fluorescence. The Nichoid-ET will be manufactured on polymeric culture slides, already used in bioreactors onboard the International Space Station. This will require a custom design for the microarchitecture and the engineering of a relevant fabrication technology. Using the newly-designed Nichoid-ET scaffolds, we will set-up a cell model of glioblastoma multiforme. If successful, the relevant technology developments will bring the Nichoid-ET up to prototype level with potential customer interests in using this advanced substrate in multiple applications of biological research in space.

Project funding: European Space Agency (ESA)




### Person in charge of this project


Gianni Ciofani

## Biomarkers and biosensors to monitor body response in microgravity conditions (MARS-PRE)

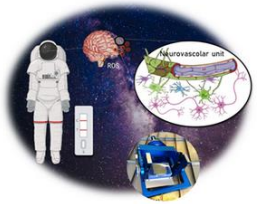
*Research domain: LifeTech - Subtopic: Bio-Materials*

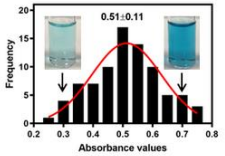
With the rapid advances in spaceflight capability, investigating the effects of microgravity on the brain and nervous system is of paramount importance. Space travels present extreme conditions and consequent physiological effects, for example, induction of oxidative stress response in humans and related health risks.

In this project, we are investigating physiological changes and reactive oxygen species (ROS) production for the whole neurovascular system subjected to conditions of simulated microgravity in vitro. In addition, we are also implementing nanoparticle-based rapid and instrument-free colorimetric tests for semi-quantitative detection of biomarkers (namely, antioxidants and cortisol), using "non-invasive" biological fluids, such as saliva, avoiding inconvenient blood sampling.

In summary, our research team aims to elucidate the overall effect of reduced gravity and oxidative stress on the neurovascular system and set the basis for point-of-care devices to monitor health and stress conditions during space missions.

Project funding: Italian Space Agency (ASI)




### Persons in charge of this project


Pierpaolo Pompa


Fabio Benfenati

## New Suspension Kinematics System

*Research domain: Robotics - Subtopic: Robots Manipulators*

The goal of the project is to develop a new kinematics with associated control for a new suspension system able to adapt the wheels to surface roughness. It will ensure progress over any terrain, a balancing of the rover itself, and consequently also smoother navigation. This new kinematics investigation is based, first of all, on modeling and prototyping to allow optimization of the best solution to provide to the control a simplified dynamics and, therefore, a fast and robust responses. Through kinematics and control, those new suspensions will have to effectively avoid singularity, low maneuverability positions vs reliability and safety.

Project funding: Italian Space Agency (ESA)

## In-Orbit Servicing Robotic Manipulator System

*Research domain: Robotics - Subtopic: Robots Manipulators*

The goal of the project is to develop a robotic system capable of detecting an approaching object, following its trajectory until the two flanges in charge of docking are matched, and finally making contact by damping the forces in place and thus avoiding potentially dangerous collisions that would lead to the bodies themselves moving away even to their damage. Key point of this project is the vibration control, which has always been one of the challenges in robotics because it especially affects the accuracy and speed of execution and indirectly of safety. Adding that in space it is not always possible to easily transfer elsewhere the energy to be dissipated, as in terrestrial systems, which are non-conservative due to the presence of friction, the need for damping control of the system also manifests itself for these kinds of applications.

Project funding: Italian Space Agency (ASI)


Ferdinando Cannella

## Space It Up

*Research domain: Robotics - Subtopic: Autonomous Robots and Manipulators*

The foundation of this project is to create a collaboration and innovation in the space sector that spans from Earth observation and protection to extraterrestrial exploration, from artificial satellites to remote sensing. An articulated and ambitious project to enable Italy to make the big leap into the international aerospace research scene, bringing together the resources of academia, research centers and companies and helping to enhance Italian excellence in the sector. This partnership represents a starting point for the development of research-business relations in this frontier field as well, opening new horizons for the sustainability of life on Earth and for space exploration..

Project funding: Italian Space Agency (ASI)

# Il segmento Downstream

IIT_CCHT lavora su due aree di applicazione di dati EO al mondo dei beni culturali:

- identificazione di nuovi siti archeologici
- identificazione di siti sottoposti a spoliazione e danneggiamento (antropico e naturale)

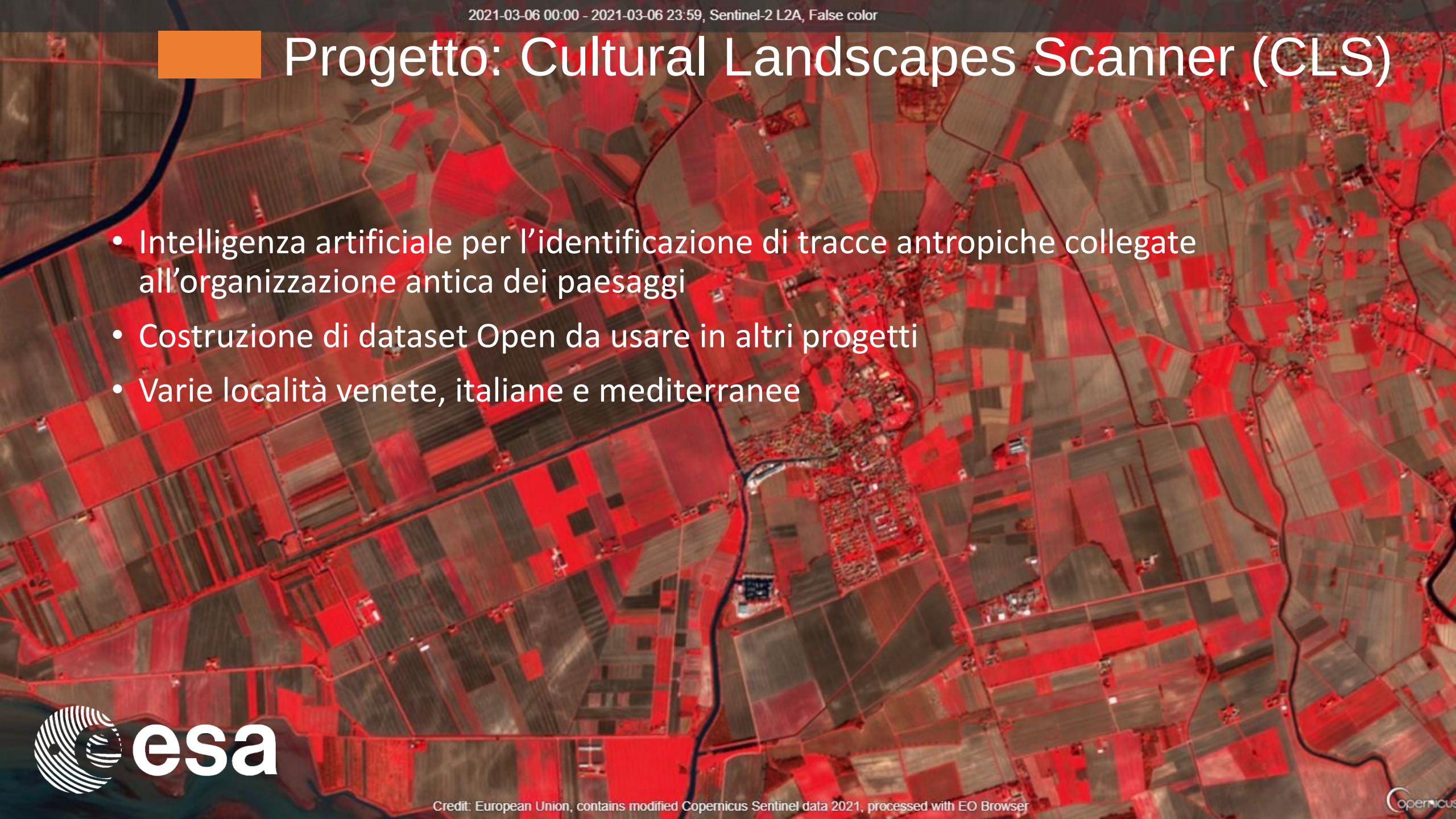
Scopo: mettere SPACE ECONOMY e SPACE BIG DATA a servizio di

- cultura
- territorio
- economia

ISTITUTO ITALIANO DI TECNOLOGIA

# Il segmento Downstream

- Aumentare le conoscenze dal punto di vista storico
- Capacità di osservare e mappare vaste aree in maniera sistematica e costante
- Realizzazione di carte di rischio archeologico che identificano ‘aree di rispetto’ e ‘attenzione’ (vincoli)
- Informazione mappata contribuisce alla corretta gestione territoriale
  - fornisce informazioni per la pianificazione degli interventi sul paesaggio rurale e urbano


# Progetto: Cultural Landscapes Scanner (CLS)

- Intelligenza artificiale per l'identificazione di tracce antropiche collegate all'organizzazione antica dei paesaggi
- Costruzione di dataset Open da usare in altri progetti
- Varie località venete, italiane e mediterranee

esa

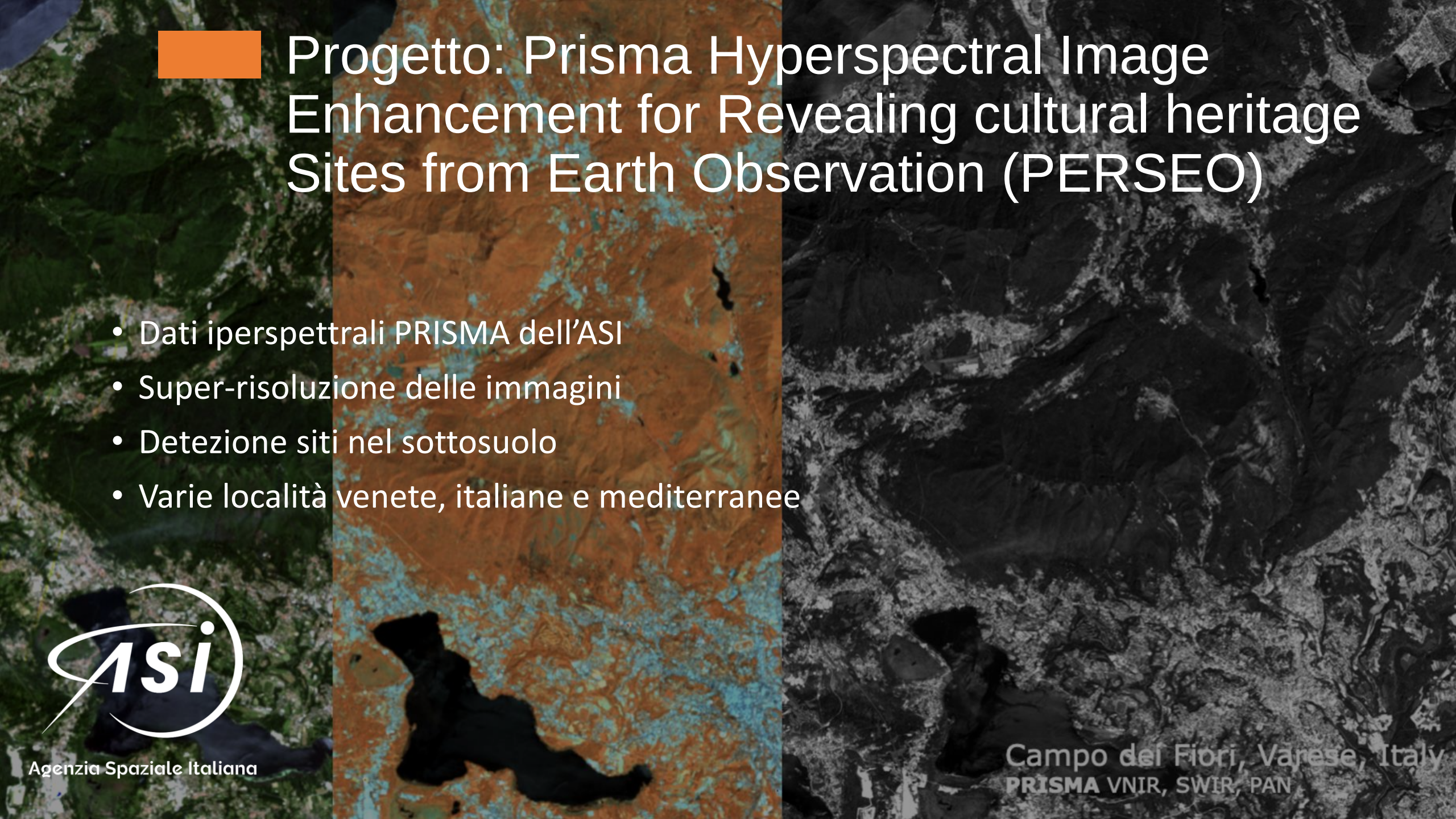


Copernicus

# Progetto: Prisma Hyperspectral Image Enhancement for Revealing cultural heritage Sites from Earth Observation (PERSEO)

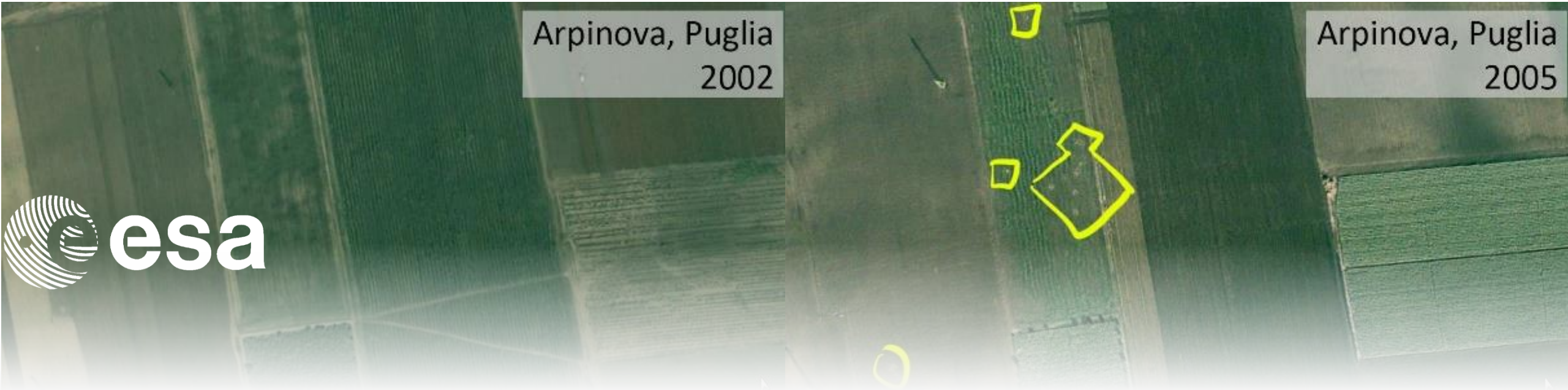
- Dati iperspettrali PRISMA dell'ASI
- Super-risoluzione delle immagini
- Detezione siti nel sottosuolo
- Varie località venete, italiane e mediterranee

Agenzia Spaziale Italiana

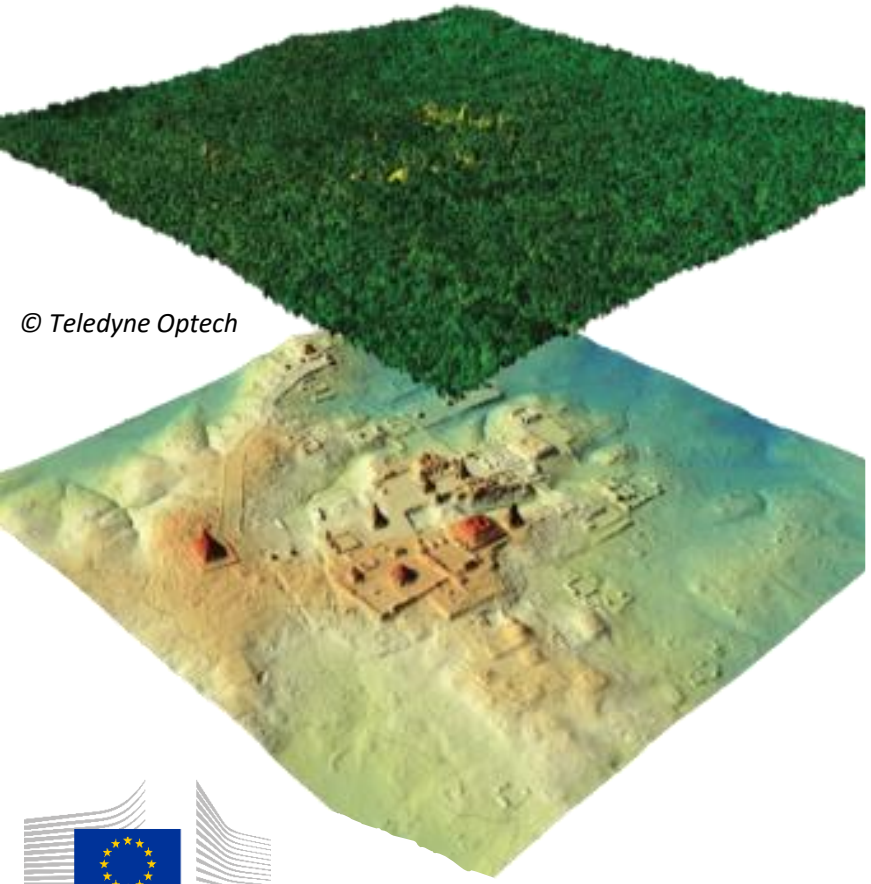


# Progetto: ALCEO (Automatic Looting Classification from Earth Observation)

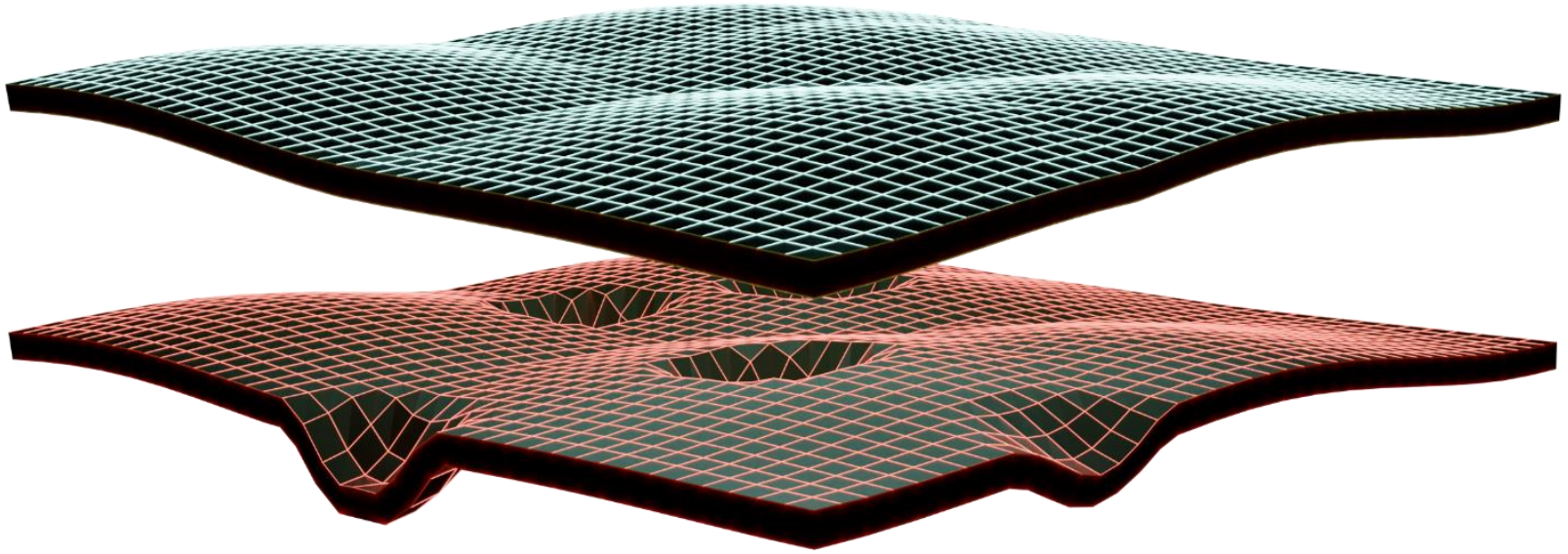
- Identificazione automatica di aree soggette a scavo clandestino
- Varie località venete, italiane e mediterranee



# Progetto: OPtimal Transport for Identifying Marauder Activities on LiDAR (OPTIMAL)

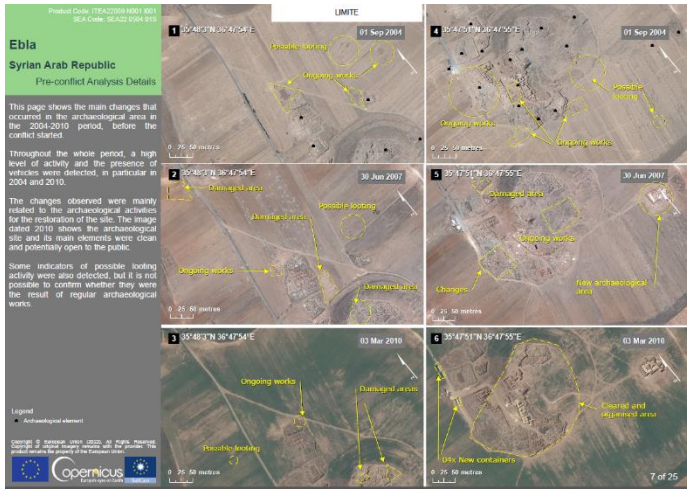


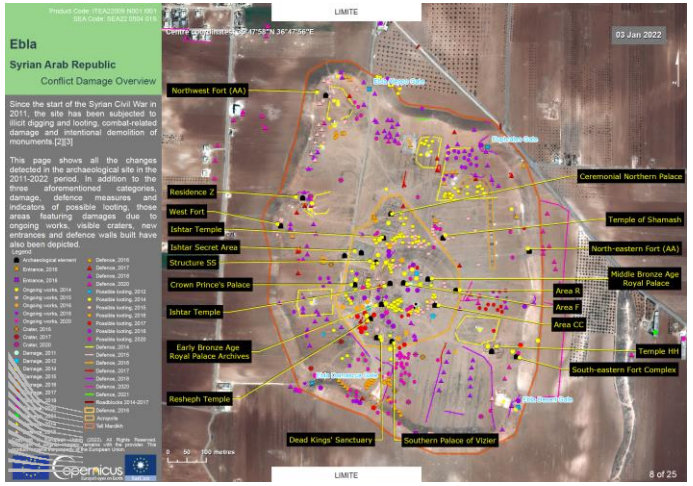


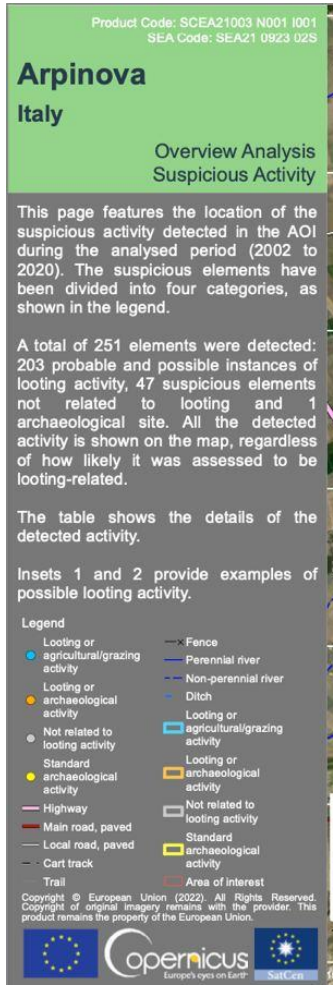


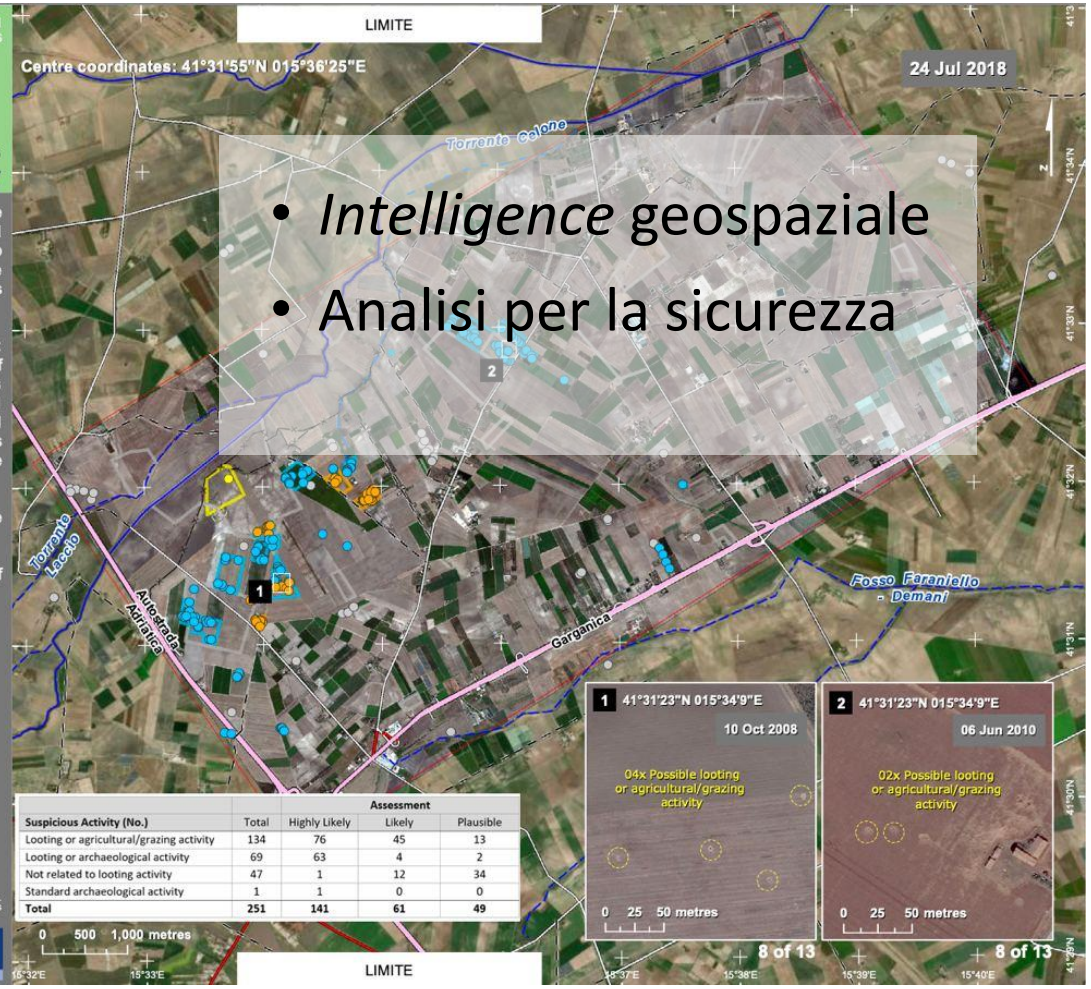
Commissione Europea

# Progetto RITHMS: Research, Intelligence and Technology for Heritage and Market Security




- *Intelligence* geospaziale
- Analisi per la sicurezza

Commissione Europea

ISTITUTO ITALIANO DI TECNOLOGIA | SPACE IIT

www.iit.it/web/spaceiit

In collaborazione con

Agenzia Spaziale Italiana

European Space Agency

SatCen
European Union Satellite Centre