POLITECNICO DI TORINO

CubeSat
polito team

CUBESAT TEAM OF POLITECNICO DI TORINO: PAST, PRESENT AND FUTURE PROJECTS

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OUTLINE

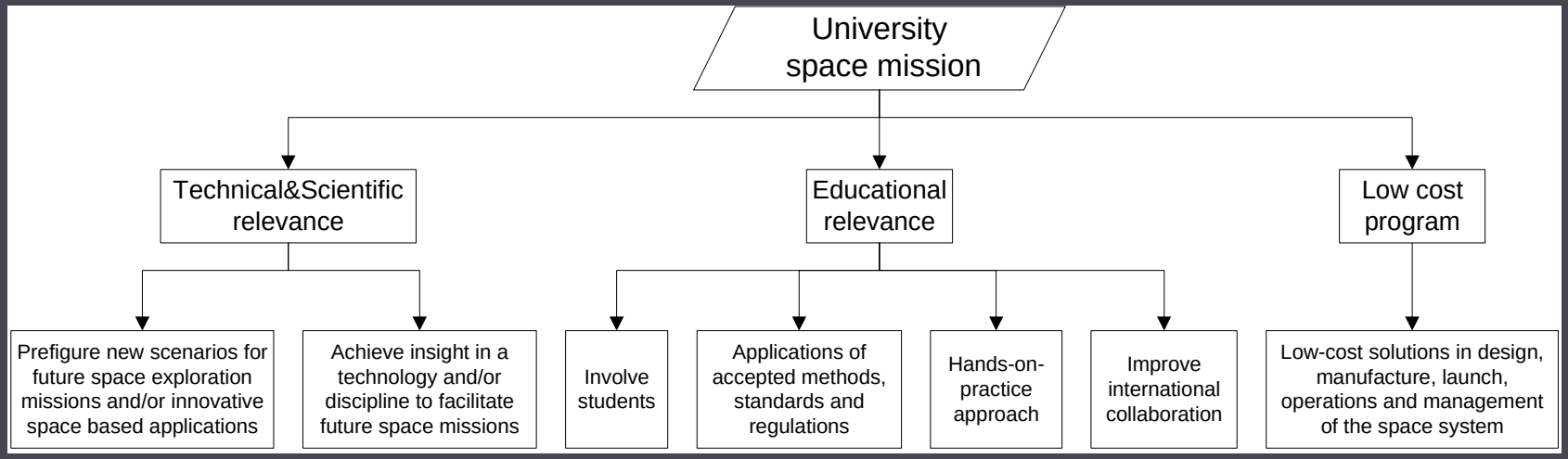
- CubeSat Team at Politecnico di Torino
- Satellites
  - e-st@r program
  - 3-STAR program
- Students: role and opportunities
- Missions design
- Future activities and collaborations
- Conclusions

- The CubeSat Team is a student team of Politecnico di Torino involved in the design and development of small platforms for scientific space missions and for testing new technologies in orbit. It was created on 2008.
- The group consists of undergraduate and PhD students led by Prof. Sabrina Corpino and works in the Systems and Technologies for Aerospace Research Laboratory (STARLab), located inside the Department of Mechanical and Aerospace Engineering of Politecnico di Torino (DIMEAS).

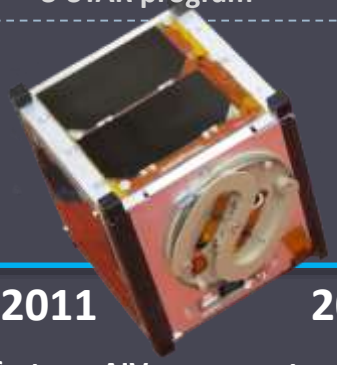
- The Team is officially recognized as a student team of Politecnico di Torino and receives financial support by the university through the committee “Fondi Progettualità Studentesca” (Funds for Students Projects), which basically reinvests part of the annual fees paid by students, by financing projects of the students themselves.

- Programs developed by the Team have a common mission statement:

"To educate aerospace-engineering students on systems development, management, and team work. To achieve insight in the development of scenarios and enabling technologies for future space missions."



- Since our research program has educational relevance, students must learn how to build a space mission from the very beginning throughout the project development, dealing with all the aspects related to a space program.
- The educational purpose of the program is pursued at several levels: undergraduate, graduate and PhD students



e-st@r-I

2008

e-st@r-I Accepted for ESA Ed. Office "CubeSat on VEGA MF" initiative

2009 - 2011

Design, manufacture, AIV of e-st@r-I

2012

Launch and operations of e-st@r-I

e-st@r-II

2013

Accepted on ESA Ed. Office "FYS!" Programme e-st@r-II as a follow-on of e-st@r-I

2014

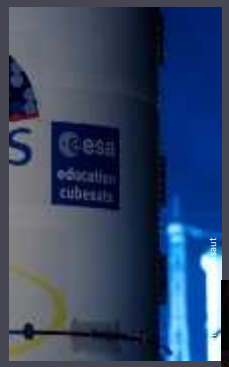
Functional tests of e-st@r-II within FYS! programme

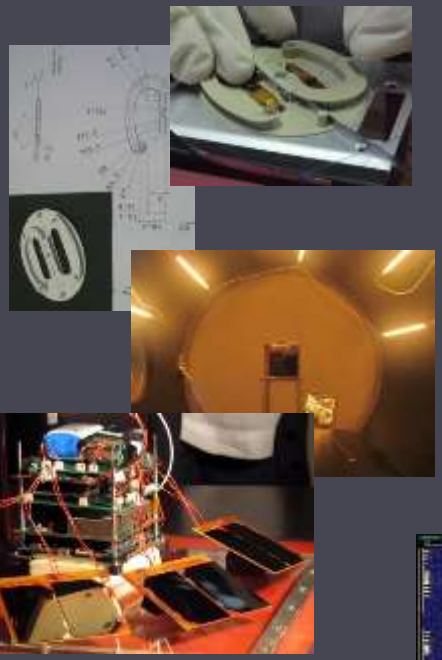
2015

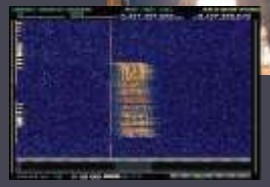
Environmental tests campaign at ESA/ESTEC

2016

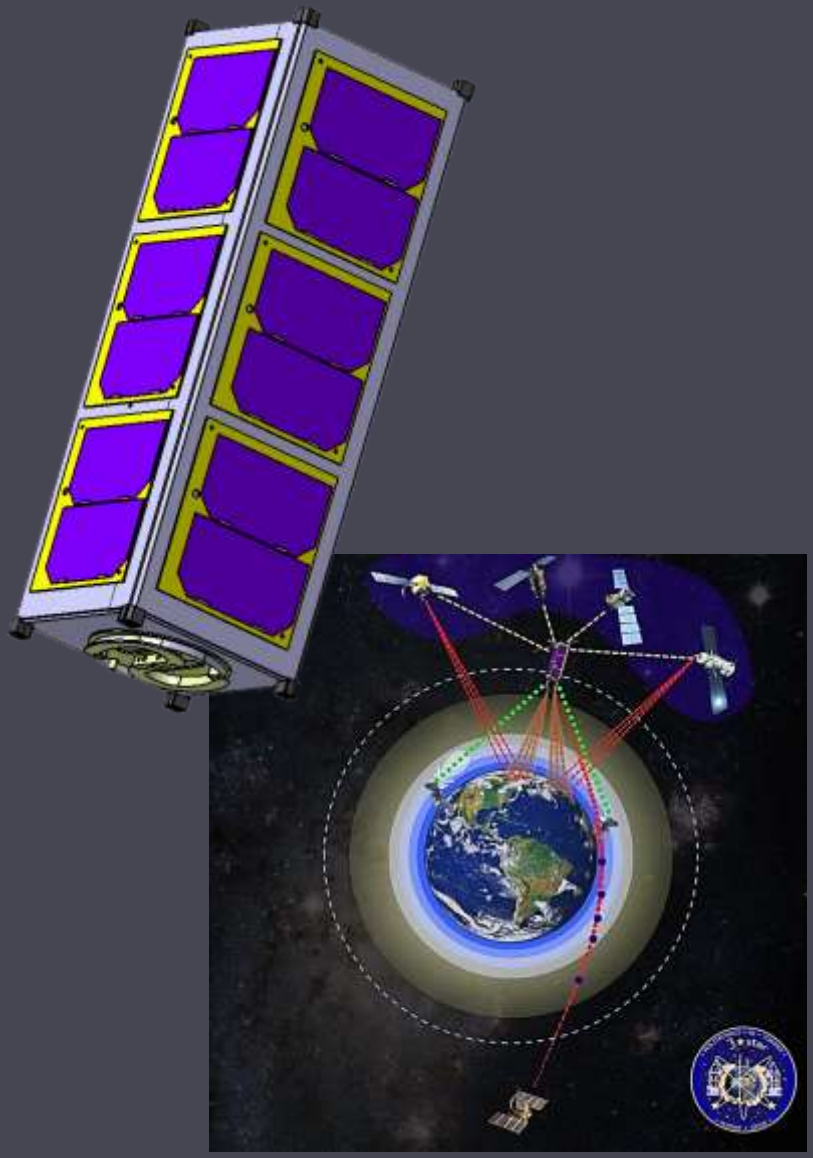
Launch and operations







- It is the first 3U designed by the Team and it represents the evolution of the e-st@r family
- Born under the ESA GEOID initiative, for the validation of the GENSO network
- GNSS Remote Sensing payload reflectometry and radio occultation experiments
  - It is developed by the Remote Sensing Group and NavSAS Group of the Dept. of Electronics and Telecommunications of Politecnico
  - Multidisciplinarity is a key-feature of this program
- HumSat additional communication payload
  - Project HumSAT (Humanitarian SATellite) is supported by ESA and by the United Nations
- 3-STAR mission is the reference mission for thesis development and it will also used as technology test-bed



- Many students have been involved in the programs, participating in every stage of the design….







Working in an international context

Experiencing first hand a real project

Through a multidisciplinary approach

With theoretical lessons and practical experience in the laboratory

Through theses, publications on journals, internal reports

Participating in workshops and conferences

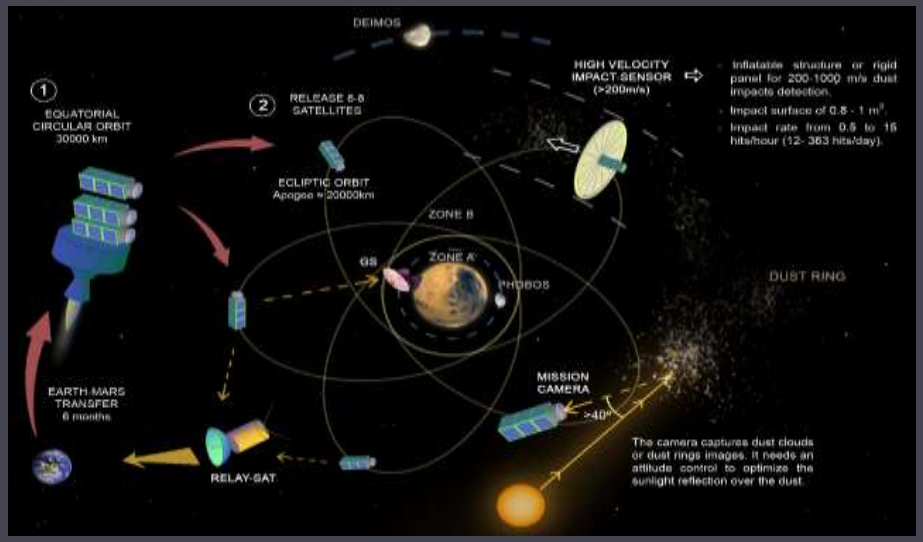
… enriching their Curricula with activities that are not commonly offered within the typical study plans

A new Challenge: interplanetary CubeSat

- The scientific community shows a growing interest in the nanosatellites with CubeSat platforms involved in Operational and scientific missions even in low-cost/fast-delivery interplanetary missions

- After the participation in the first international workshop on CubeSat interplanetary mission (in May 2012) the Team decided to begin to study interplanetary CubeSat mission feasibility (e.g. by using tradespace and MAUT analysis)

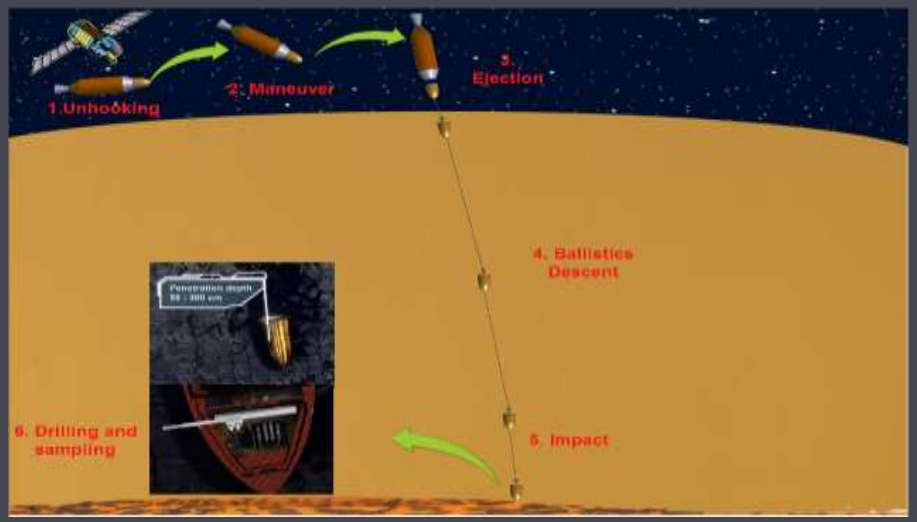
Interplanetary CubeSat: Where and How?- From Mars



- To study orbital particulate environment and dust climatology, focusing on micrometeoroids and dust rings by using CubeSat platforms.

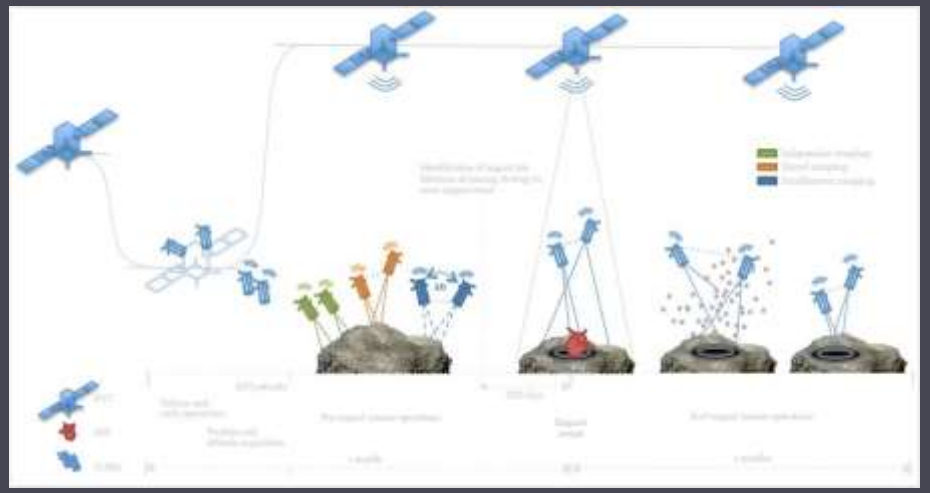
- To investigate upper and lower atmosphere in order to characterize and study atmospheric features and processes of Martian atmosphere and its interaction with future human in situ missions. It consists of orbiters and swarm of CubeSats, and landers with deployable tethered balloons

Interplanetary CubeSat: Where and How?-To Asteroids



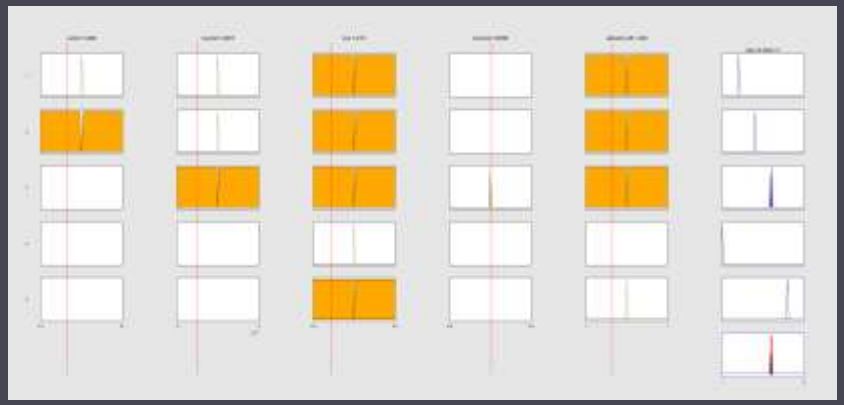
- To search for evidences on Martian (sub) surface that could represent hazard for human exploration. Space Penetrator System (based on CubeSat-sized technology) are the key elements of this mission

- Mission with the objective to deploy & operate a CubeSat-based space asset at a NEA:
  - Providing measurements
  - Knowledge-gap-filling activities, to the study of the consequences of an impact on an asteroid, and to the demonstration of key-technologies.

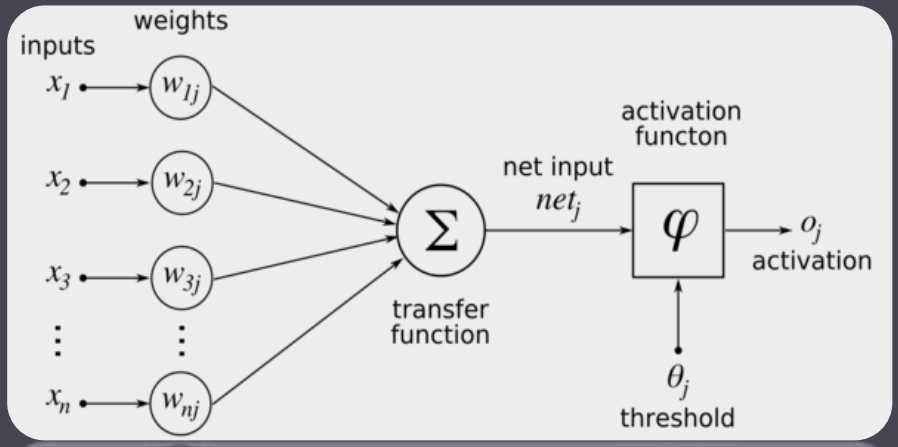


Autonomous systems

- The Team is investigating the feasibility of a total autonomous system
- Algorithms involving artificial intelligence (i.e. neural networks and fuzzy logics)
- Example: identify a failure and recover it not via active/passive hardware redundancy (as usually done) but only via software
- Possible Test Bench: 3-STAR



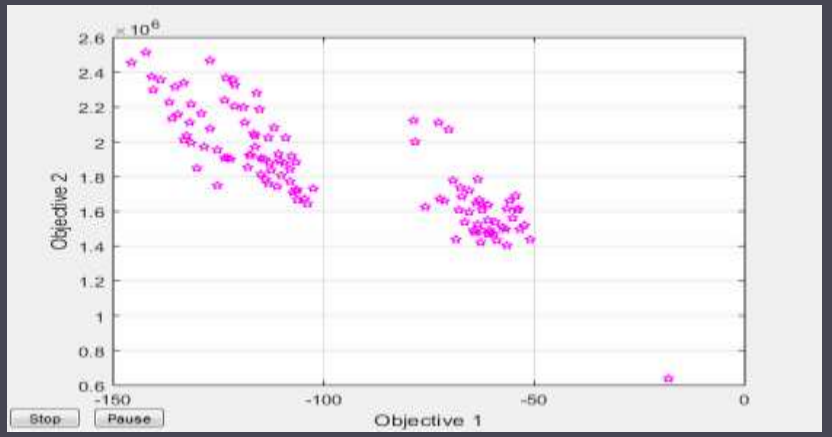
Fuzzy Logic Rule viewer



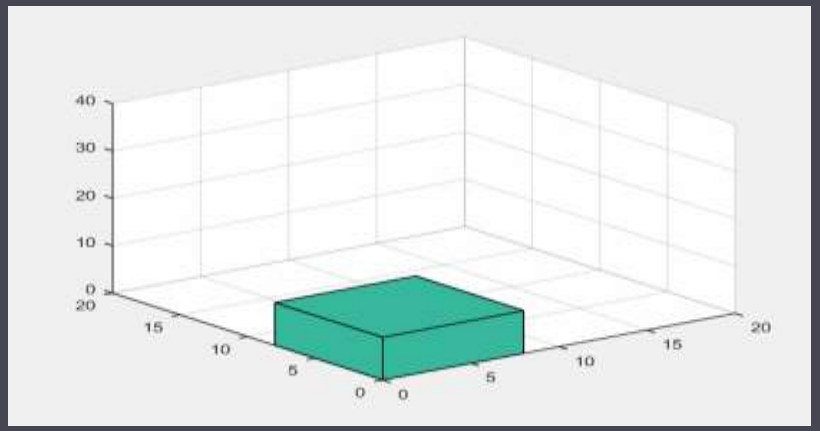
Neural network structure

Optimal design

- Robust and multidisciplinary design (Pareto analysis, MAUT and so on)
- Concurrent Design (CD) methodology
  - Concurrent engineering is a systematic approach to integrated product development that emphasizes the response to customer expectations. It embodies team values of cooperation, trust and sharing in such a manner that decision making is by consensus, involving all perspectives in parallel, from the beginning of the product life-cycle
- It provide many benefits in terms of the learning quality of the members



Optimization process: evolution in time of the population



Optimization output: 3U CubeSat for Earth Observation

Next collaboration

ESA- Education Office (ESTEC)

Missioni CubeSat

- Call of Interest for new mission proposal

MIT

CubeSat 4 Planetary Science

- Developing of Telecommunication Technologies
- Collaboration and student exchange

Industria

TAS-I, OHB, Tyvak International

- Interest in Operational and Commercial use of CubeSat

NASA/JPL

CubeSat 4 Asteroid Mission

- Developing of Telecommunication Technologies
- Opportunity for students to have access to their laboratories

Universidade de Vigo

3-STAR

- HumSAT

Radioamatori – sez. ARI-Bra

Collaboration

- Ground station improvement
- Operations of e-st@r-II

Skolkovo Institute for Science and Technology

Small Satellites

- Collaboration and student exchange

- The CubeSat Team is a student team of Politecnico di Torino, which deals with the design and development of space missions carried out by small platforms
- The main activities of the Team are the two CubeSat programs, e-st@r and 3-STAR
- Several scientific mission are being and will be investigated, with two main destinations, that are Mars and Near Earth Asteroids
- Research activities are strongly influenced by the roadmaps and methodology established by space agencies
- The Team collaborates with other universities and research centres, international agencies and industry, and some other partnerships are being planned to grown team know-how

THANK YOU FOR YOUR ATTENTION

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