Istituto Nazionale di Astrofisica
Radio Astronomia

Bologna, 18 e 19 Maggio 2018

SRITAC 2 - 2018 Officine orbitali, primo livello di espansione civile nello spazio

Sistemi avanzati di propulsione e mobilità spaziale

ELENA TOSON, T4I

SUMMARY

- A revolution is in action!
- Access to Space: what is happening in the international context?
- Propulsion systems for large and micro satellites: new challenges
- What are we doing in T4i?

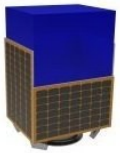
A REVOLUTION IS IN ACTION!

THERE'S A REVOLUTION!

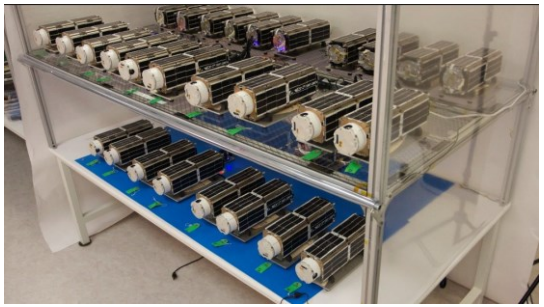
Recent trend towards small satellites (mini-micro-nano…)

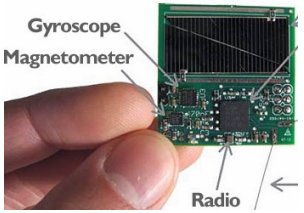
- Miniaturization -> high capabilities on smaller platforms
- Sensor fusion -> small satellites constellations/formations

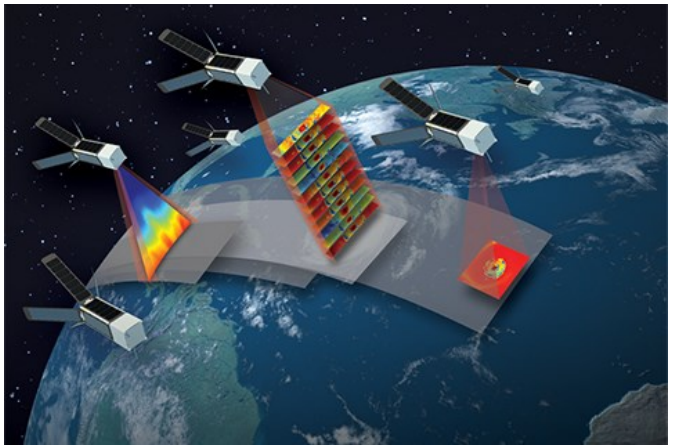
SSTL-X50
Precision

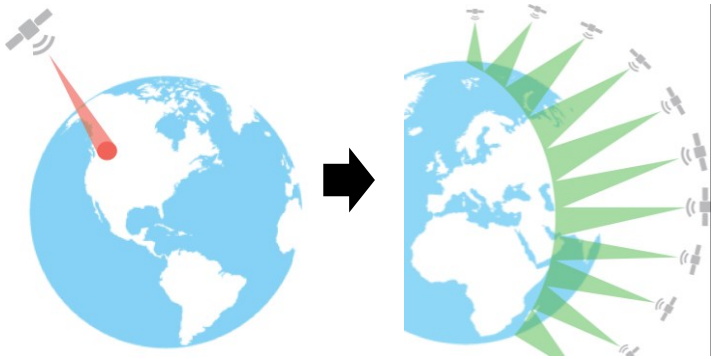


SSTL-X50
Platform





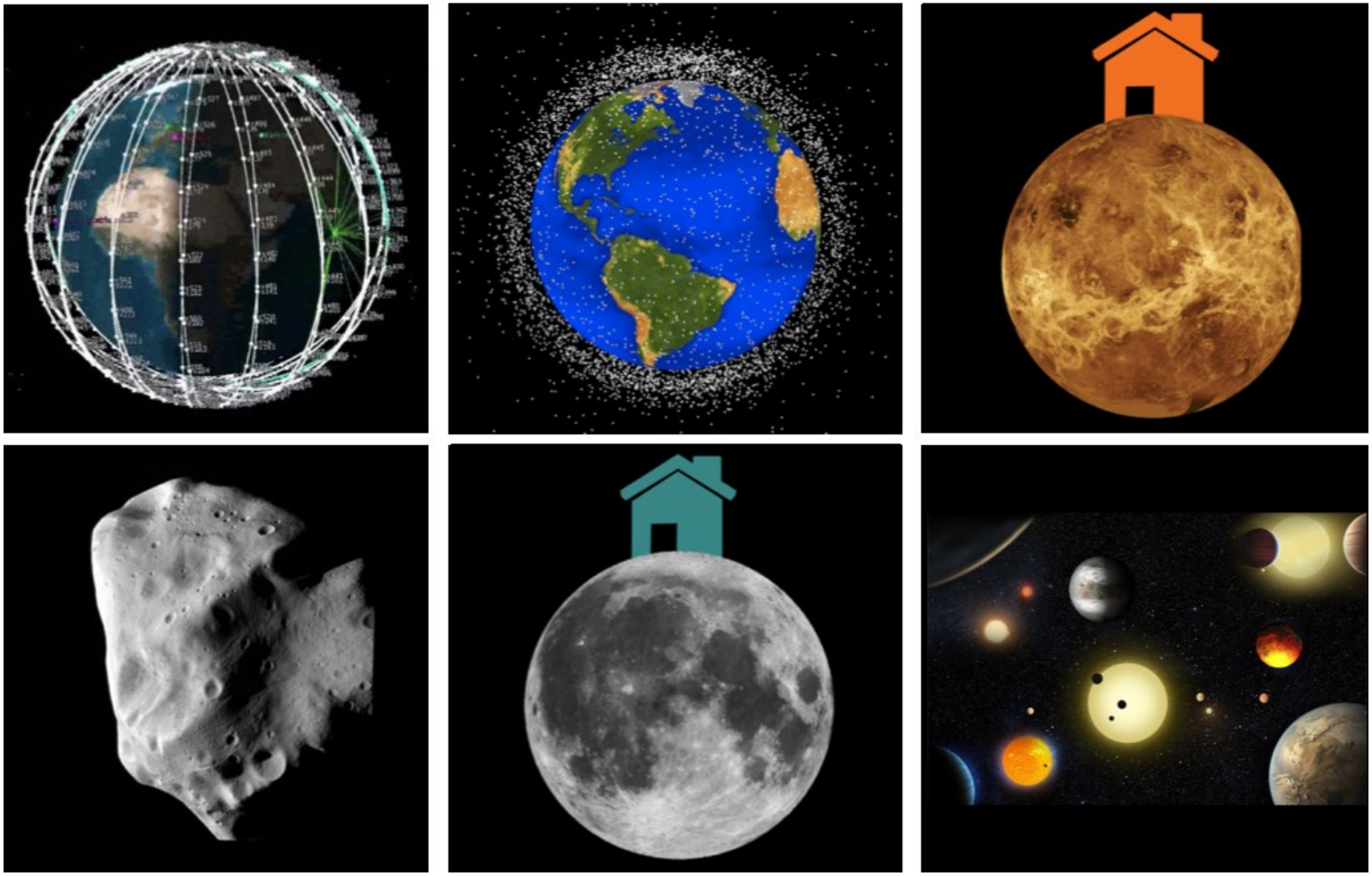




Higher coverage
Higher replacement rates
Series production
Flexibility and reliability
Lower investment risks

THERE'S A REVOLUTION!

New ways to approach the Space Markets



ACCESS TO SPACE

WHAT IS HAPPENING IN THE INTERNATIONAL CONTEXT?

NEED OF A NEW WAY TO LAUNCH MICROSATELLITES

New Small Satellite Launch Vehicles

NEED OF A NEW WAY TO LAUNCH MICROSATELLITES

New Small Satellite Launch Vehicles

Rank[1]		Name	Stated IOC	Payload to SSO (kg)[2]	Target Launch Price[3]	Major Recent Milestone
1		Electron	2018	150	$33K/kg	Successful orbital launch and satellite deployment
2		Kuaizhou 1A ↑	2017	250	$57K/kg	Successful orbital launch and satellite deployment
3		LauncherOne	2018	300	$40K/kg	Secured $1B investment from Saudi Arabia Public Investment Fund
4		Small Satellite Launch Vehicle (SSLV) ↑	2019	700	$12K/kg	Development announced by Indian Space Research Organization
5	VECTOR	Vector-R	2018	28	$54K/kg	Successful suborbital flight demonstration
6	PLDSPACE	Arion 2 ↑	2021	83	$38K/kg	Secured $2.5M grant from the European Commission

25+ companies are pursuing the development of new small satellite launch vehicles, 5 expected to fly customer payloads by 2020

NEED OF A NEW WAY TO LAUNCH MICROSATELLITES

European institutional answ

Small Spacecraft Mission Services (SSMS)

Vega C: Vega launcher evolution. From 1500 kg t
in LEO. Better performances at more com

- VESPA Adapter
- VAMPIRE Adapter
- Small Spacecraft Mission Service (SSMS)

Vega E: more flexibility and versatility. Low-cost
methane propulsion.

REUSABLE LAUNCH VEHICLES (RLVS) AND POINT-TO-POINT SUBORBITAL AND SPACE TRANSPORTATION

Worldwide developments and demonstrators

PROPULSION SYSTEMS FOR LARGE AND MICRO SATELLITES

NEW CHALLENGES

THE REQUIREMENTS

Smaller, cheaper, lighter, green…

System integrators view of Satellite Propulsion:

Zero volume

Zero exhausts

Zero mass

Infinite Delta V

Fully controllable thrust from zero to infinity

Cost close to nothing

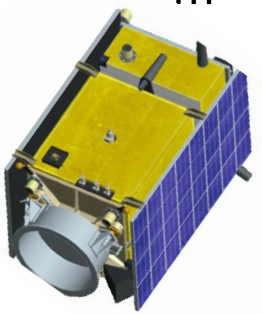
GREEN PROPULSION IS A NEED

Safer, faster, cheaper fuel storage and loading

Hydrazine is a highly toxic fuel with associated handling concerns.

After 30 years of hydrazine motors, performant alternatives are under development.

PRISMA High Performance Green Propulsion (HPGP) is based on ADN (Ammonium dinitramide) mixed with ammonia and methanol.



Europe

- FOI is working on ADN green alternatives, funded project H2020 project GRAIL.

USA

- Green Propellant Infusion Mission (GPIM) is using Hydroxyl Ammonium Nitrate AF-M315E

MICRO-PROPULSION IS A NEED

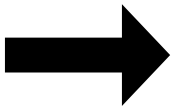
Propulsion systems able to answer to the New Space Market requests

- Series production
- Low costs
- Versatile in mission needs
- Scalable
- Flexible in integration

- High thrust for quick orbit raising and lowering
- High deltaV (in the order of 100s or 1000s m/s)
- Low thrust levels for high precision manoeuvring
- Robust systems that can de-orbit the satellite at EOL

Expanded role of propulsion in **constellations**

- Injection error correction
- In-plane phasing
- Orbit maintenance
- Collision avoidance
- Injection orbit to operational orbit
- Nodal phasing
- De-orbiting
- And in some cases, controlled re-entry



From 10s of m/s →

100s or even 1000s of m/s

MICRO-PROPULSION IS A NEED

Smaller, cheaper, lighter

European and other countries Universities and Start-Ups are developing new micro electrical propulsion and chemical propulsion systems, both with private investments and EU funding; established companies are descaling their propulsion offers.

NEW SPACE COMPANIES

WHAT ARE WE DOING IN T4i ?

CREATIVITY MAKES INNOVATION POSSIBLE

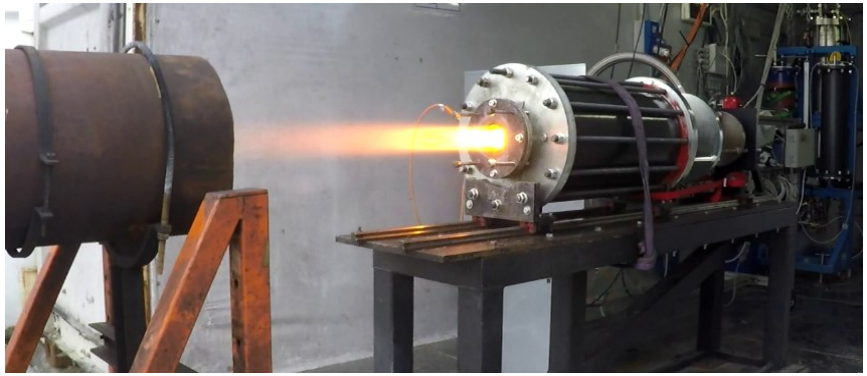
The **New Space Arena**,
an exciting arena where **innovation**, **entrepreneurship**, **creativity** and **braveness** are mixed together for the revolution of a 50 years conservative space area.

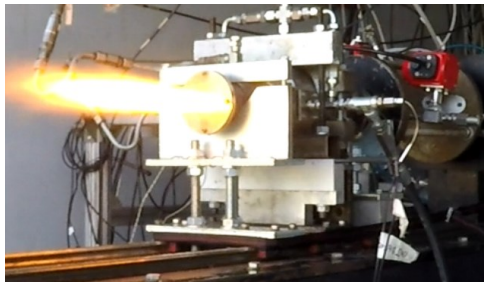
New, cheap, small and powerful satellites will provide humanity a **new, more comfortable and efficient way of leaving, truly connected with the whole planet**.

Our mission is to cover satellite mobility needs and orbit insertion developing **innovative small propulsion systems** and **innovative rocket engines**.

We find simple, brilliant solutions to achieve highly performant systems at accessible costs.

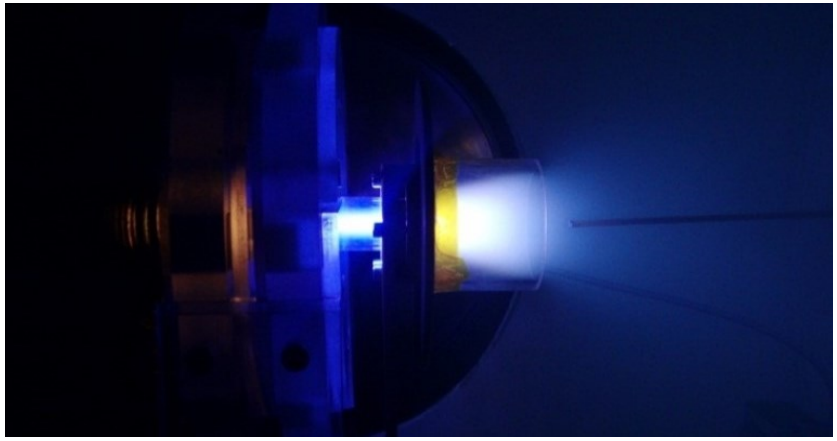
INNOVATIVE ROCKET ENGINES

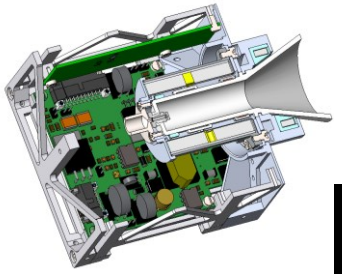


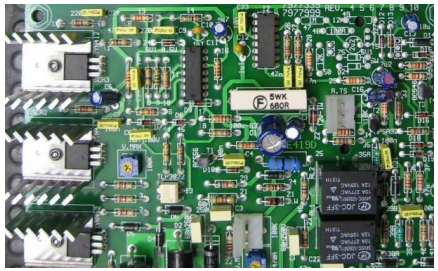


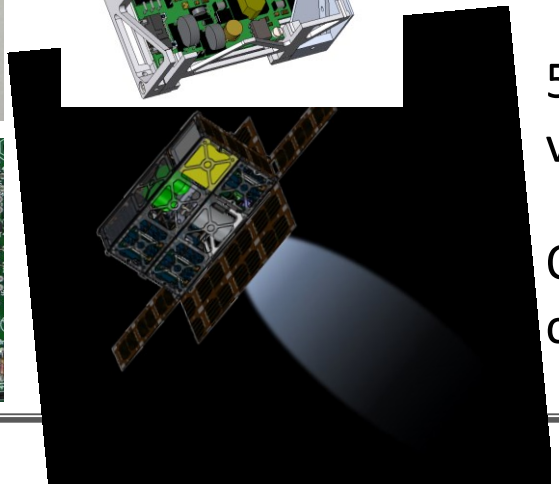
- We are developing **Simple, Green, Versatile and Cost Effective** chemical propulsion systems based on hydrogen peroxide
- Hybrid rockets, liquid thrusters, mono propellant thrusters
- Sub-orbital systems
- Access to Space
- Orbit configuration

MICRO PROPULSION SYSTEMS









- We are developing **Versatile and Cost Effective magnetically enhanced plasma thruster** based on radio frequency technology for micro satellite platforms (< 100 kg)
- No neutralizer, and grids, multiple propellant utilization
- Standard interfaces

50W power, 0.8mN thrust, 1.5U volume, > 6000Ns total impulse

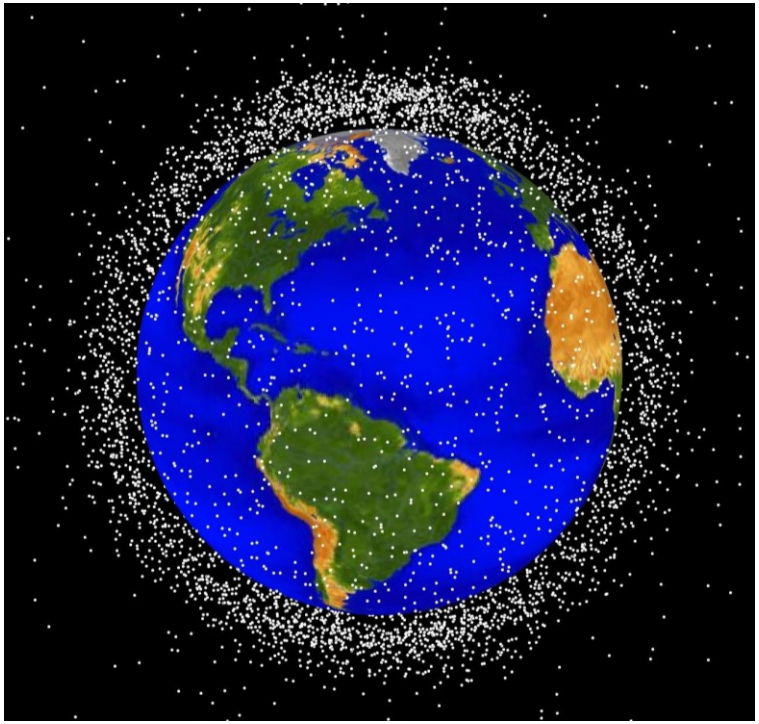
Orbit configuration, drag compensation, attitude control

EXAMPLE OF APPLICATION

Lifetime at very low altitude is very limited!

Necessary to compensate atmospheric drag with a **Thruster**

Altitude	mass / area	Natural life
250 km	0.01 kg/cm^2	5.7d
	0.02 kg/cm^2	11d
	0.03 kg/cm^2	17d
300 km	0.01 kg/cm^2	21.6d
	0.02 kg/cm^2	1m 13d
	0.03 kg/cm^2	2m 4d
350 km	0.01 kg/cm^2	2m 8d
	0.02 kg/cm^2	4m 16d
	0.03 kg/cm^2	6m 24d
400 km	0.01 kg/cm^2	6m 12d
	0.02 kg/cm^2	1y 1m
	0.03 kg/cm^2	1y 7m
450 km	0.01 kg/cm^2	1y 5m
	0.02 kg/cm^2	2y 10m
	0.03 kg/cm^2	4y 2m



Lack of **small, reliable, really low cost** propulsion systems

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Enjoy Space!

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APPLICATIONS

Micro satellites: a huge market with an invaluable social benefit!

Disaster

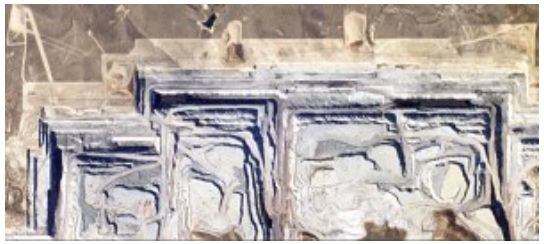
Mapping

Refugees

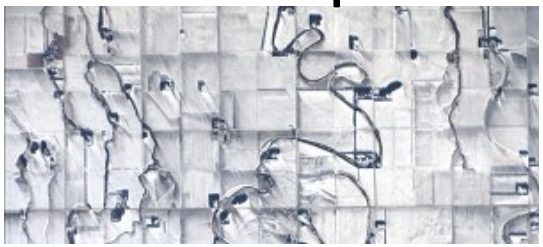
Agriculture

Maritime monitoring

Resource extraction



Weather response



Urbanization

Alternative energy

APPLICATIONS

Micro satellites: a huge market with an invaluable social benefit!


Distributed internet access


Maritime Trade Monitoring


Weather forecasting


Forecasting medical emergencies


Security


Education


Science


Agriculture Health Monitoring


Pollution


Geological motorization


Humanitarian support


New job opportunities