



# **Sviluppo tecnologico e progresso scientifico: alla ricerca di un equilibrio sostenibile**

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*PIERO BENVENUTI*

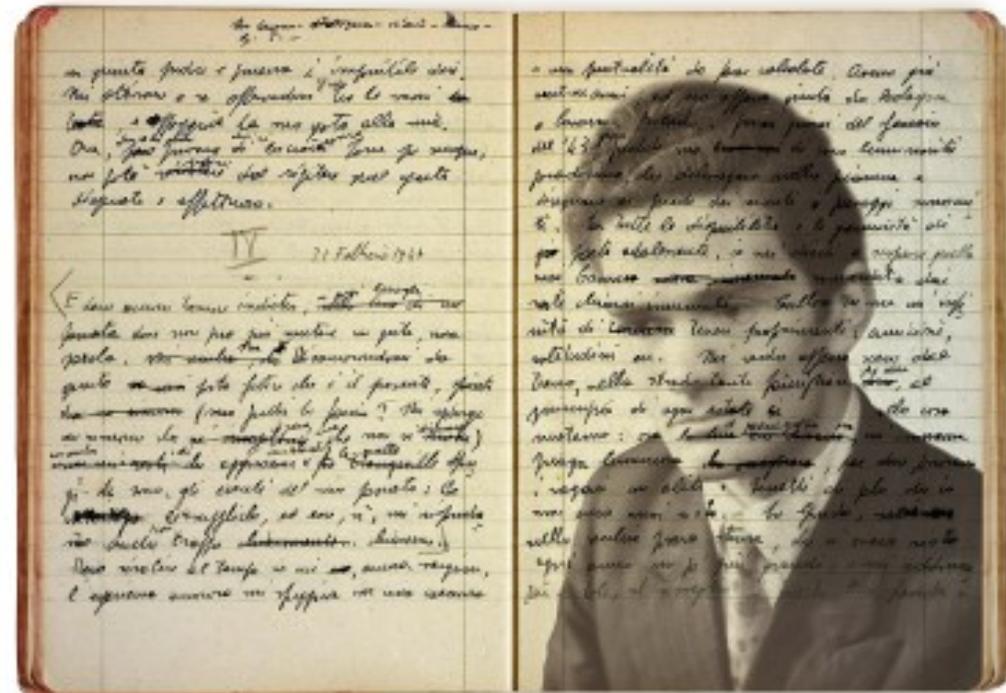
*INTERNATIONAL ASTRONOMICAL UNION*



Ci sono due parole che ritornano frequentemente nei nostri discorsi : anzi sono le parole chiave dei nostri discorsi. Queste due parole sono “sviluppo” e “progresso”.

Pier Paolo Pasolini, Scritti corsari

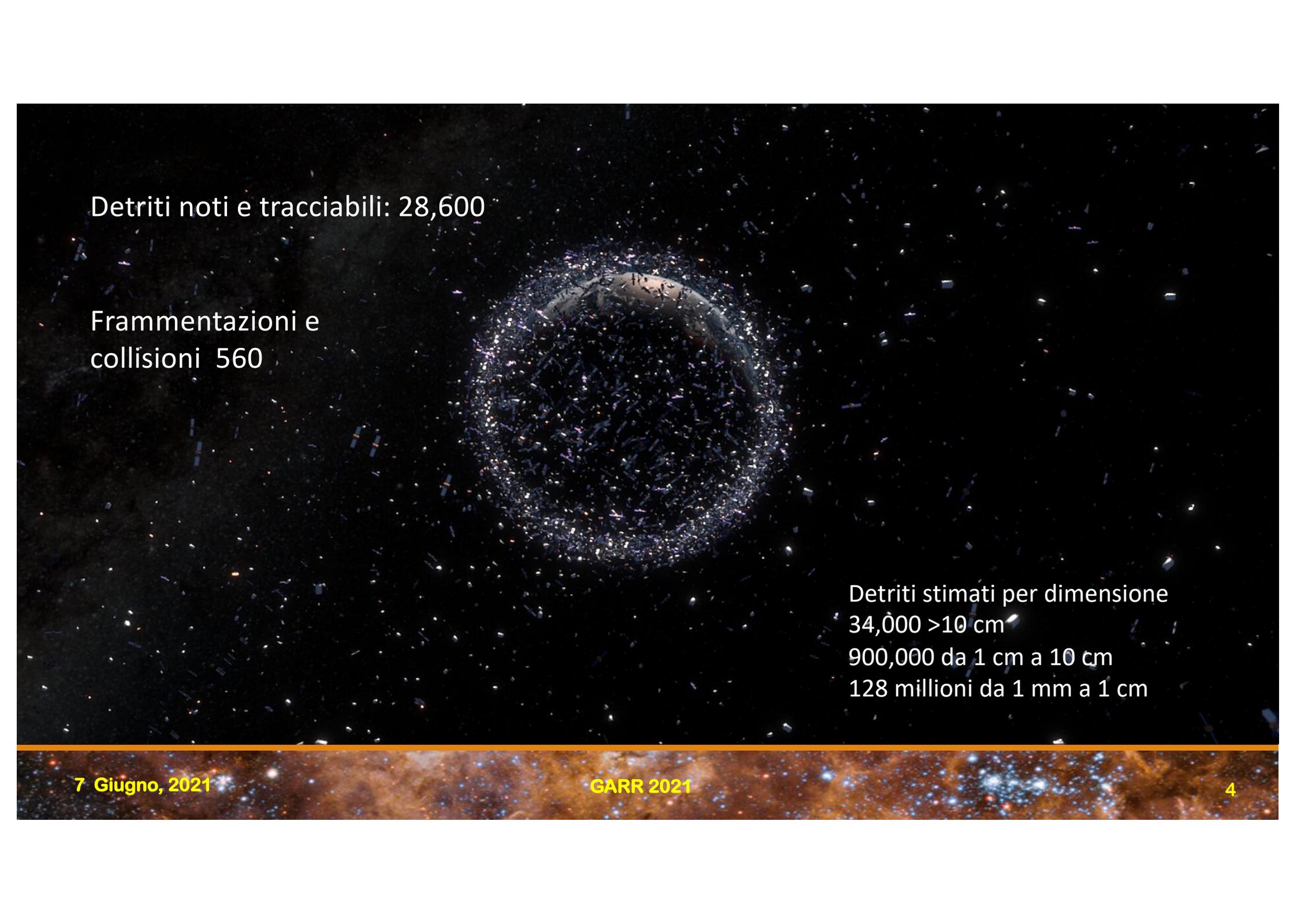
7 Giugno, 2021



GARR 2021

## La plastica e il disastro ambientale





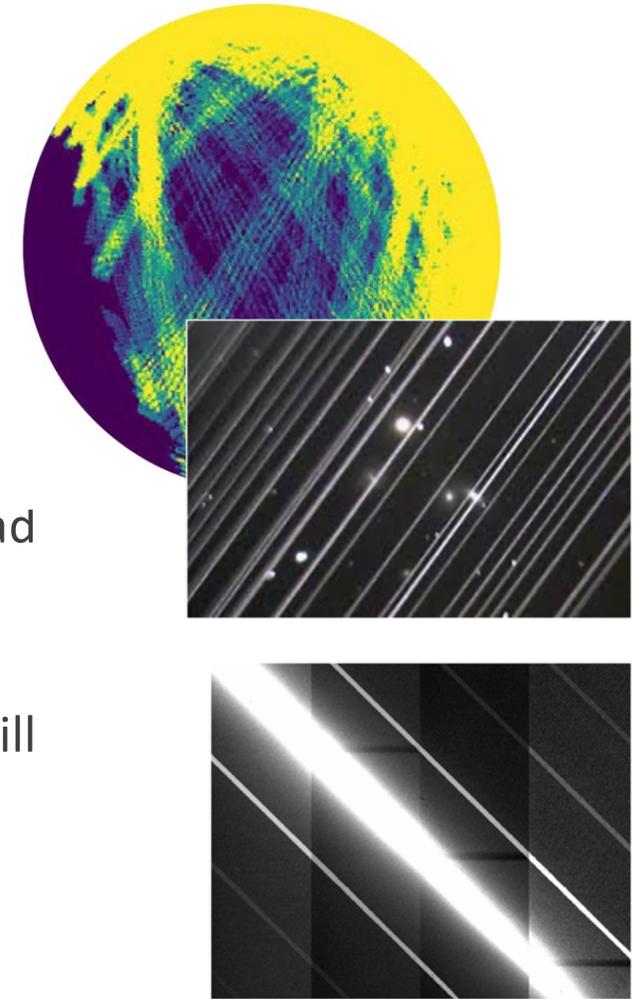
Detriti noti e tracciabili: 28,600

Frammentazioni e  
collisioni 560

Detriti stimati per dimensione  
34,000 >10 cm  
900,000 da 1 cm a 10 cm  
128 milioni da 1 mm a 1 cm

# The basic facts

- ❖ International Telecommunication Union (ITU) and national regulatory filings indicate that in the order of 100,000 satellites could be launched into LEO in the coming decade.
- ❖ That means that up to 5,000 satellites will be present overhead at any time at a typical observatory location.
- ❖ The satellites' density will be greatest at low elevation and during twilight, but increasing the orbit altitude over 600 km will increase their visibility all night long.
- ❖ The apparent brightness of the satellites can saturate the telescopes' detectors.



## **Astronomy must be protected and promoted...**

...as a unique way to progress in scientific knowledge, well beyond what can be achieved in our laboratories.

Astronomy needs unobstructive and undisturbed access to the observation of cosmic phenomena

For this reason, in 2017 COPUOS approved the organization of a conference aimed at studying all possible protections of dark and quiet skies.

The document analyzes all source of artificial interferences that affects the pristine visibility of the sky and makes a number on recommendations that can mitigate their negative impact.

The Conference Room Paper that is presented today to the attention of the STSC is an executive summary of the full report.



# Three categories of interference

1. The artificial light at night (aka ALAN) used to illuminate urban areas.
2. Transmitting and radar sounding in radio-wavelength
3. The ten to twenty-fold increase in the population of LEO satellites in the next decade

# The rationale for the three categories

- ❖ They affect astronomy in different way
- ❖ Their control and regulatory framework differ from local to international
- ❖ Controlling ALAN requires local (i.e. regional or governmental regulations)
- ❖ The mitigation of the impact of the trails of LEO satellites has to be agreed at international level.
- ❖ STSC and COPUOS are the logical fora to discuss the matter

# Principal factors of impacts on astronomical observations from satellite constellations

## The number of visible satellites

Increasing from a few hundred up until 2019 to tens of thousands in the next few years

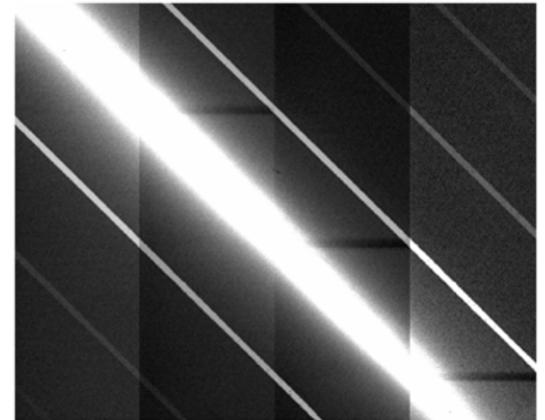
## The orbital altitude of the satellites

At any altitude, the projected surface density of bright satellites is greatest near the horizon and during twilight  
Increasingly visible all night long with increasing altitude over 600 km

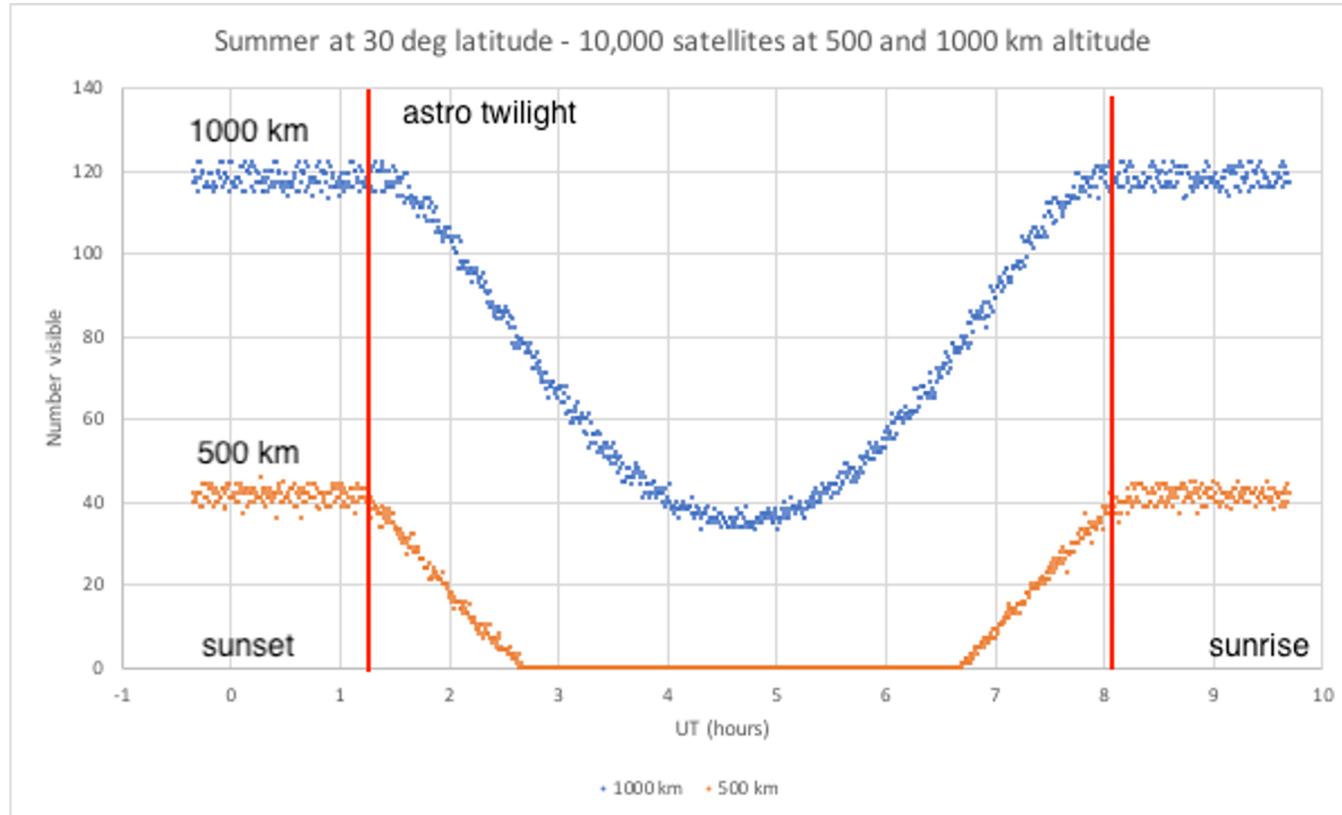
## The apparent brightness and attitude of the satellites

They are bright enough to saturate the detectors

## Lack of regulation (no requirement to mitigate, crowded space)



# Numbers



10,000 satellites @ 500 km

10,000 satellites @ 1000 km

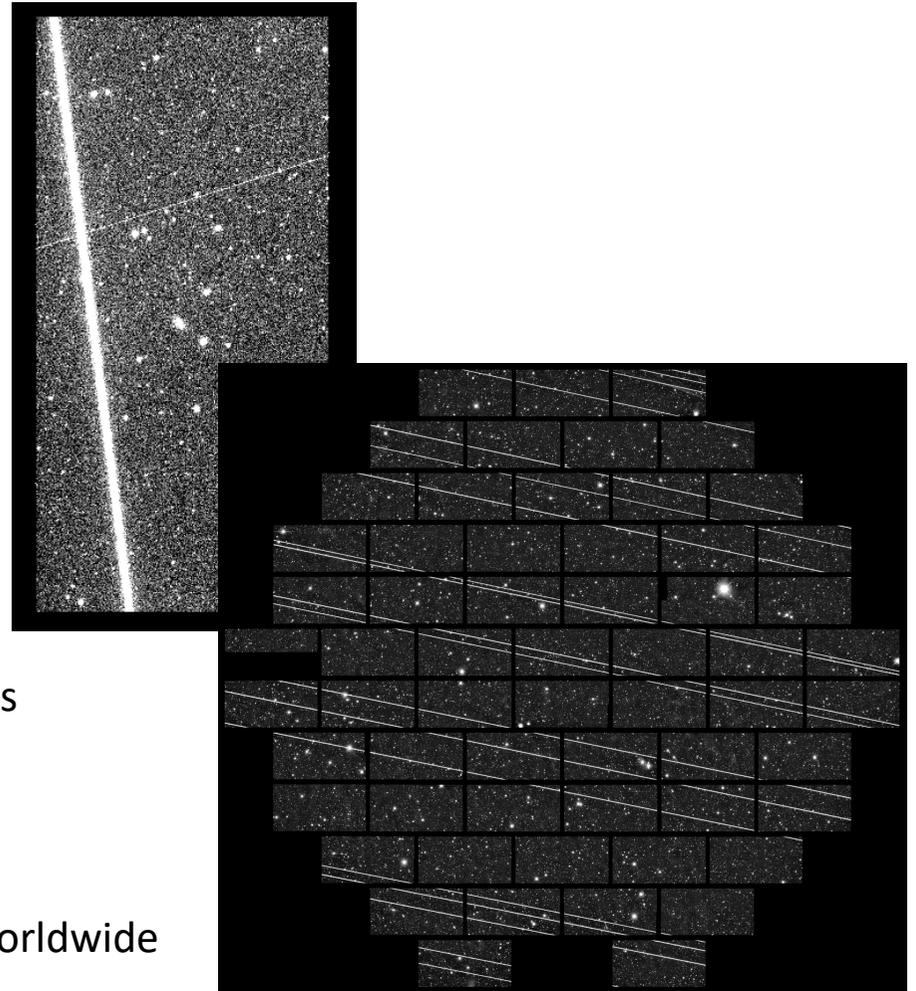
100 planes  
100 satellites/plane

orbital inclination = 53 deg

elevation > 30 deg

## Which programs will be affected?

- ❖ Rare transients
- ❖ Deep, wide, extragalactic imaging
- ❖ Near-Earth objects (NEOs)
- ❖ Deep multi-object spectroscopic surveys
- ❖ Deep wide-field near-infrared (NIR) imaging
- ❖ Imaging of large extended low surface brightness targets
- ❖ Exoplanet transits in wide-field surveys
- ❖ Discovery of new phenomena
- ❖ Citizen science, amateur astronomers, and stargazers worldwide



# The most relevant recommendations

## On the satellites design and operation:

- Design satellites to be fainter than 6<sup>th</sup> mag to naked eye and 7<sup>th</sup> mag at 550km for observatories
- Incorporate dynamic orientation adjustments
- Minimize the number of satellites and promptly de-orbit the non-operational ones
- Maintain a public data base of up-to-date orbital parameters and satellites' attitude to be used by astronomers to accurately predict the trails in a given field of view
- Minimize sidelobe radio emissions
- Prevent direct illumination of radio observatories

## On policy matters and observatory operation:

- Formulate satellite licensing requirements, guidelines and operational standards that take into account the impact on stakeholders.
- Support and expand the development of space domain decision intelligence
- Develop observing scheduling and procedures that avoids or remove the satellites trails
- Provide funding for understanding and mitigating the impact on the science of astronomy (e.g. additional observing facilities, development of smart detectors,...)

# The challenges to radio astronomy

- ❖ The protection by ITU of astronomical radio bands is becoming insufficient
- ❖ The large density of emitting satellites and their overlapping side lobes creates unescapable high level background noise
- ❖ High power space radar can easily burn out the very sensitive radio receivers