Exploiting large astronomical data archives for space debris research

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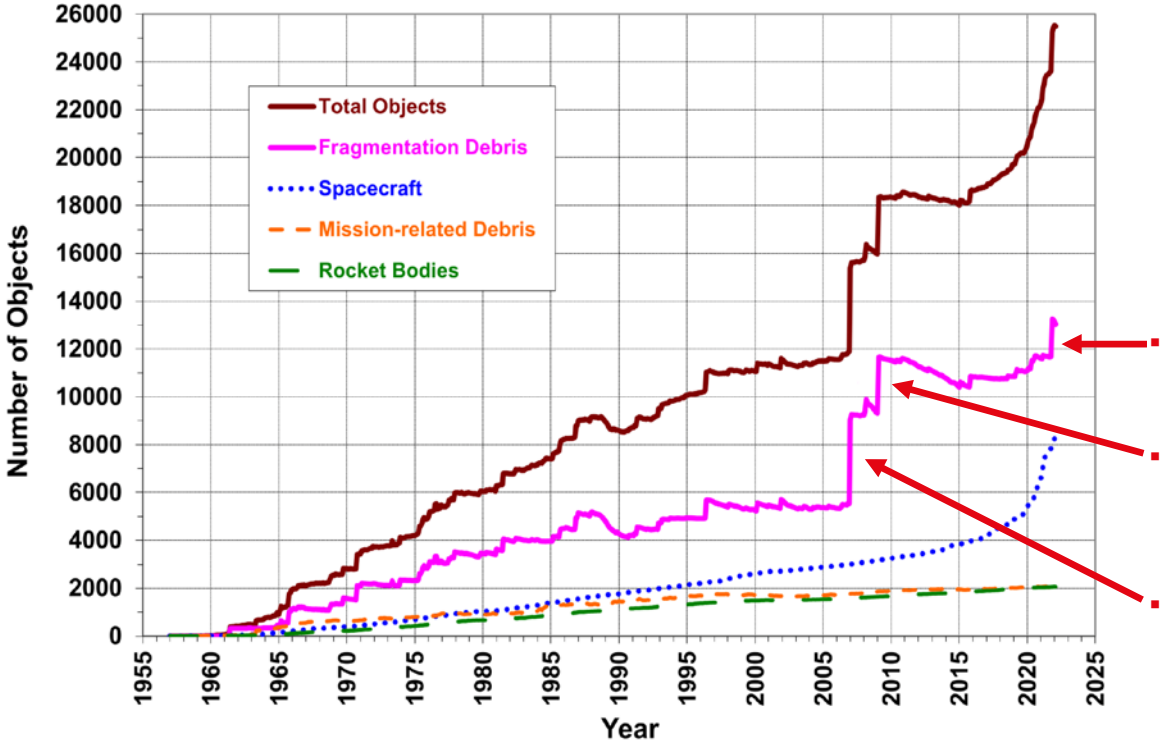
September 12 2022

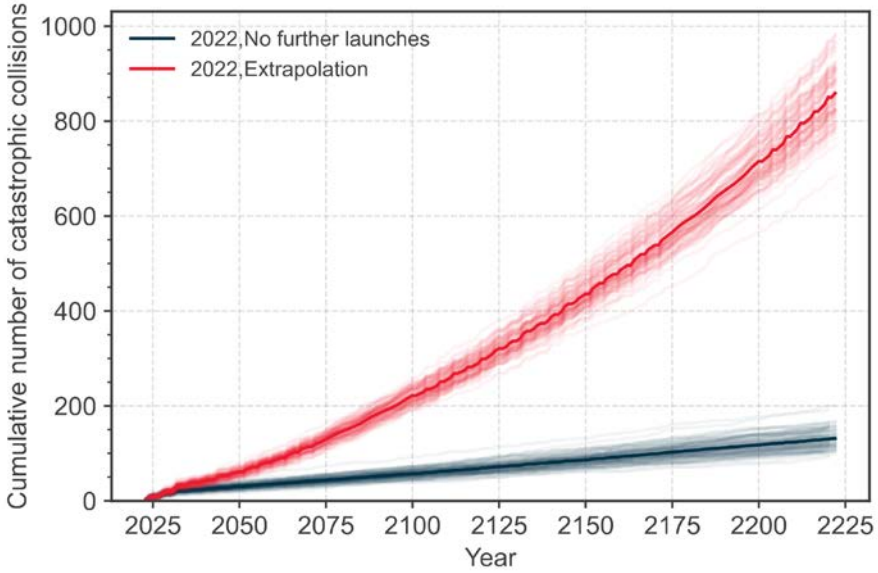
Space debris - A growing concern



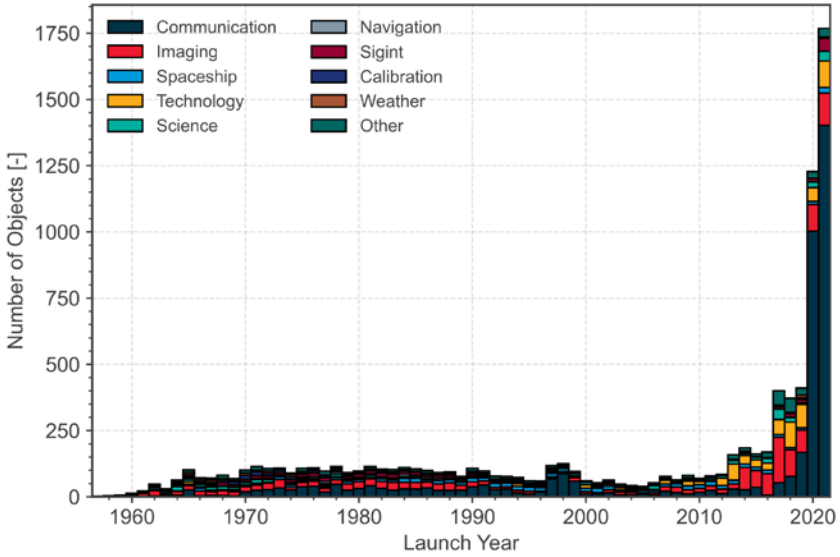
- **Russian anti-satellite missile test November 15, 2021**
- **Collision of Iridium 33 and Cosmos 2251 February 10, 2009**
- **Chinese anti-satellite missile test January 11, 2007**

Monthly number of objects in Earth orbit officially cataloged by the U.S. Space Surveillance Network.
NASA: ODPO

Space debris - A growing concern



Number of cumulative collisions in LEO (simulated)
ESA: Annual Space Environment Report 2022



Evolution of the launch traffic near LEO per mission type.
ESA: Annual Space Environment Report 2022

STARLINK

- 3000 satellites in orbit
- >9000 to be launched until 2027

OneWeb

- 428 satellites in orbit
- 220 to be launched

amazon | project kuiper

- 3276 satellites

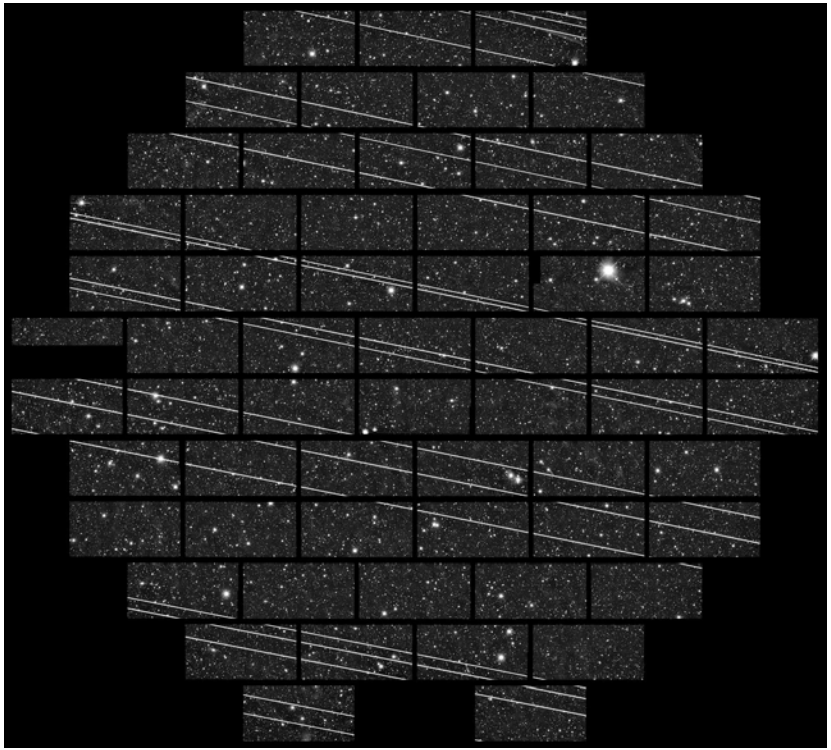
Impact on astronomical observations

Impact of satellite constellations on astronomical observations with ESO telescopes in the visible and infrared domains

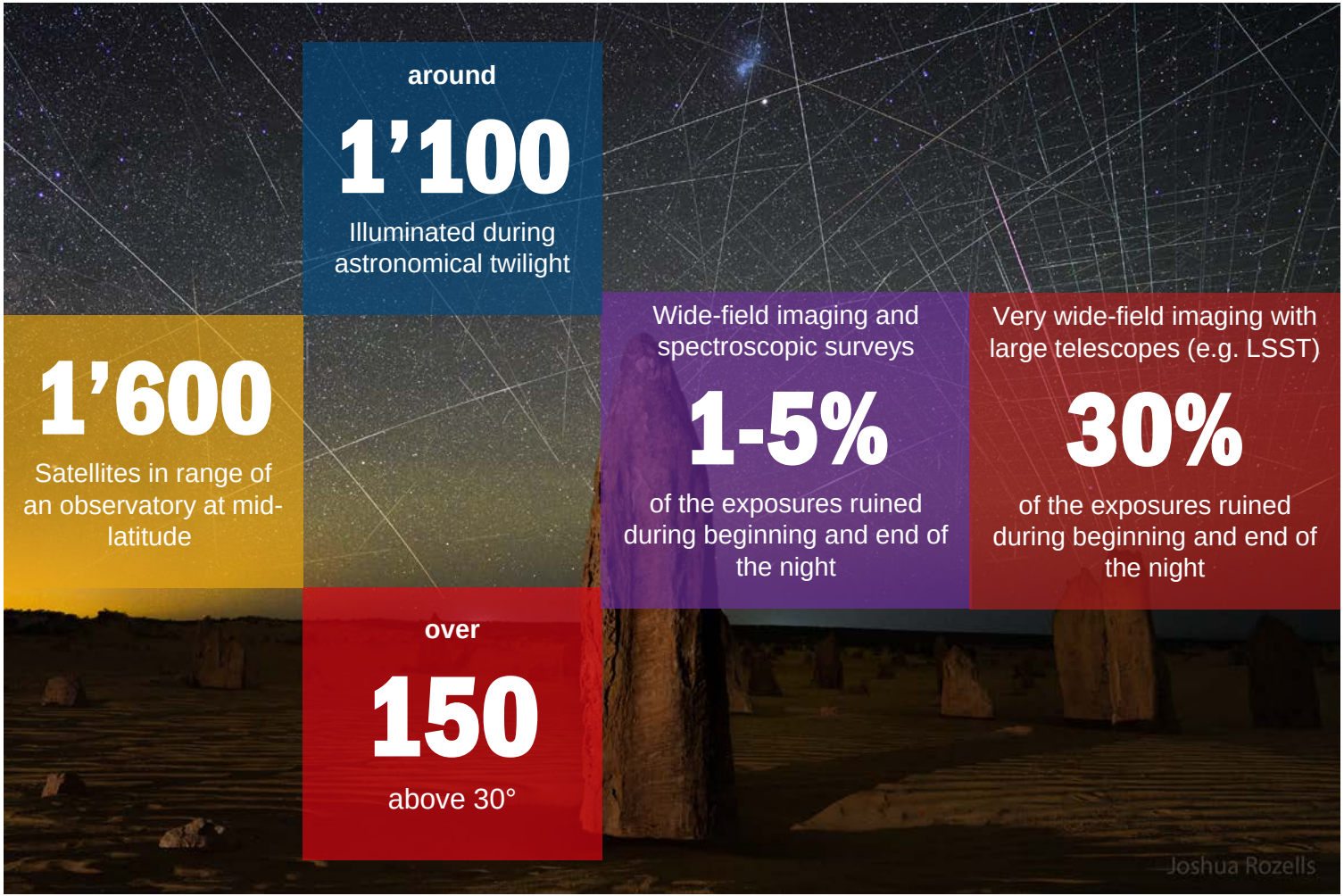
Olivier R. Hainaut, Andrew P. Williams, 2020, ESO

26000 satellites

from 18 representative constellations

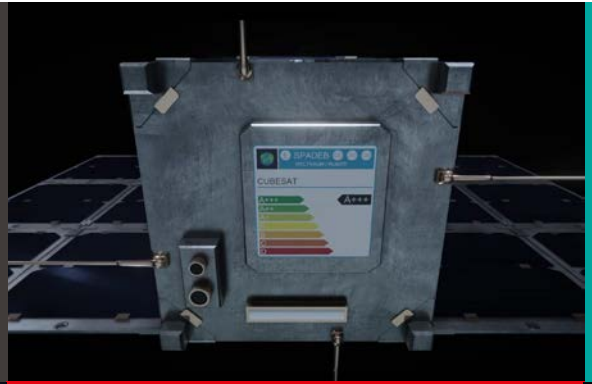


Starlink Satellites Imaged from CTIO
CTIO/NOIRLab/NSF/AURA/DECam DELVE Survey


around
1’100
Illuminated during astronomical twilight
1’600
Satellites in range of an observatory at mid-latitude
Wide-field imaging and spectroscopic surveys
1-5%
of the exposures ruined during beginning and end of the night
Very wide-field imaging with large telescopes (e.g. LSST)
30%
of the exposures ruined during beginning and end of the night
over
150
above 30°
Joshua Rozells

What can we do ?

Stop Launching



Active Space Debris Removal

Increase Sustainability in Space

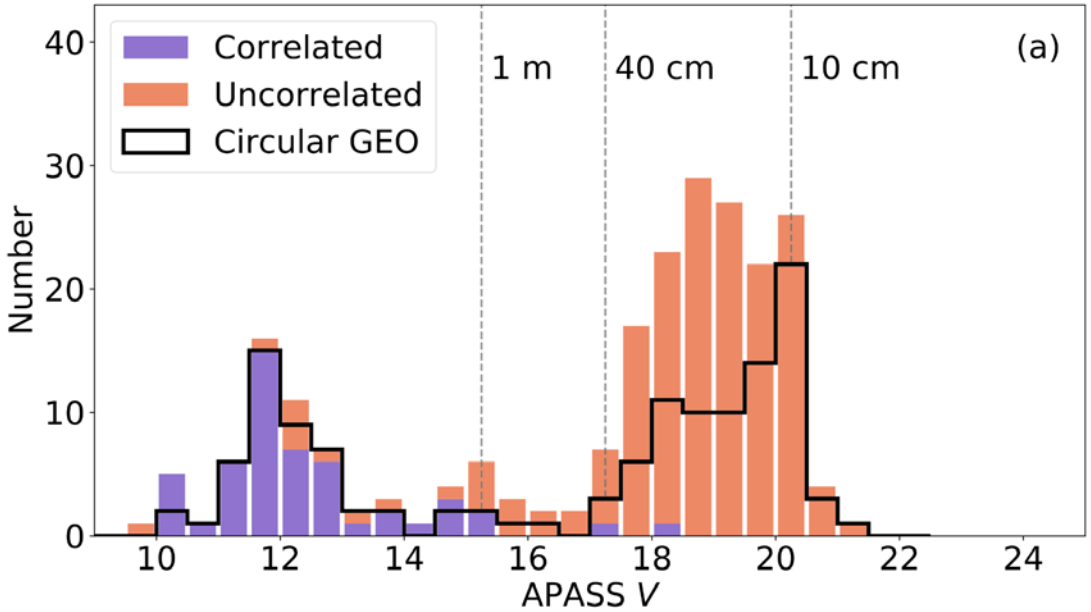
What is missing ?

DebrisWatch I: A survey of faint geosynchronous debris

James A. Blake et al., 2020, University of Warwick

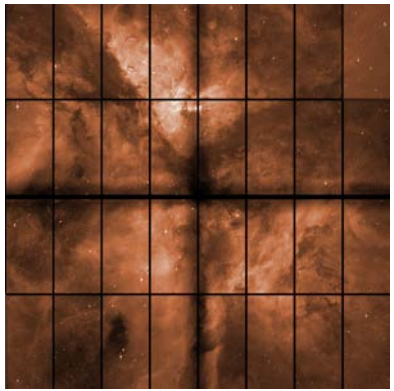
226 detections in 8 Nights

“over 80% of tracks with V < 15 correlated with objects in the publicly available USSTRATCOM catalogue, while the vast majority of fainter tracks failed to correlate”



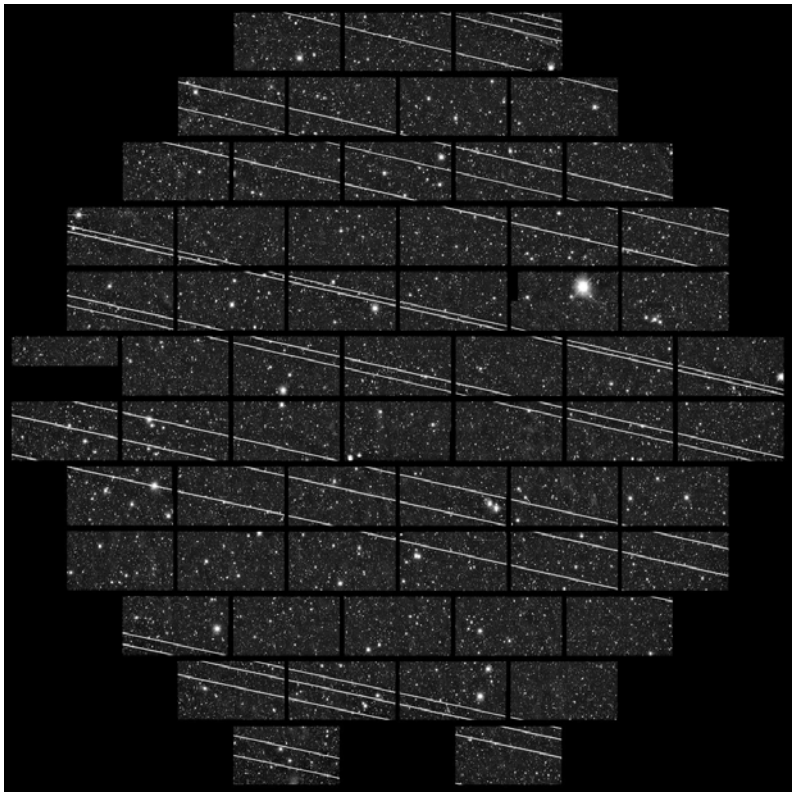
Brightness histogram for the detected population
James A. Blake et al., 2020

Where can we find it ?



1°

- **OmegaCAM @ VLT Survey Telescope**
  - 2.6 m Telescope on Cerro Paranal
  - 32 4k x 2k CCDs
  - $1^{\circ 2}$ field of view
- **DECam @ Blanco Telescope**
  - 4 m Telescope on Cerro Tololo
  - 62 4k x 2k CCDs
  - $3^{\circ 2}$ field of view



2.2°

How do we find it ?

Streak detection

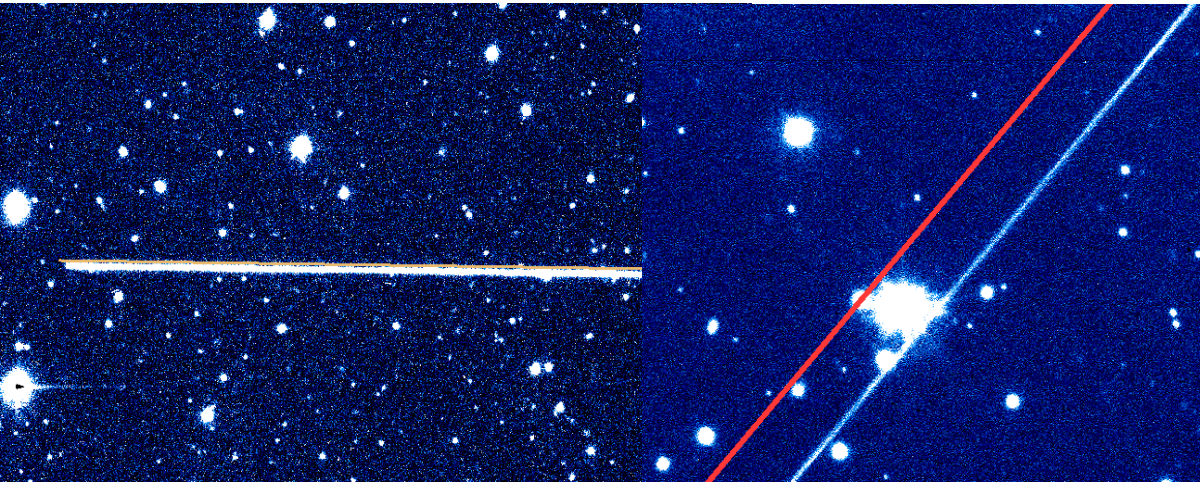
- Developing methods to efficiently extract satellite observations
- Evaluating traditional image processing algorithms and machine learning based methods

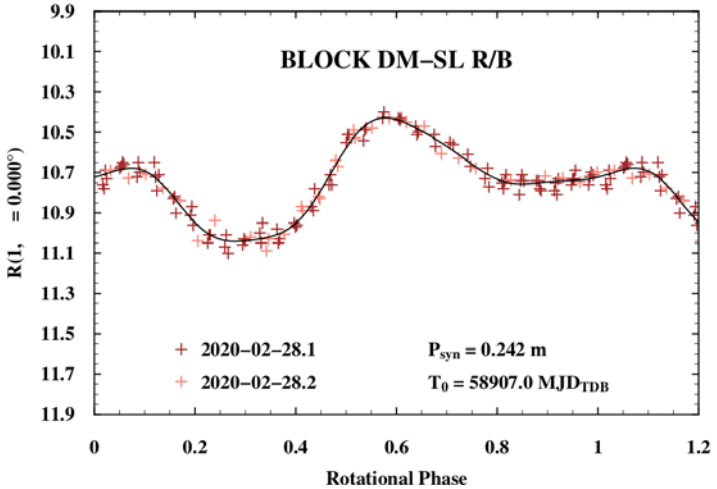
Identification, orbit determination

- Interface to publicly available catalogs (AstriaGraph)
- Orbit determination for uncorrelated objects

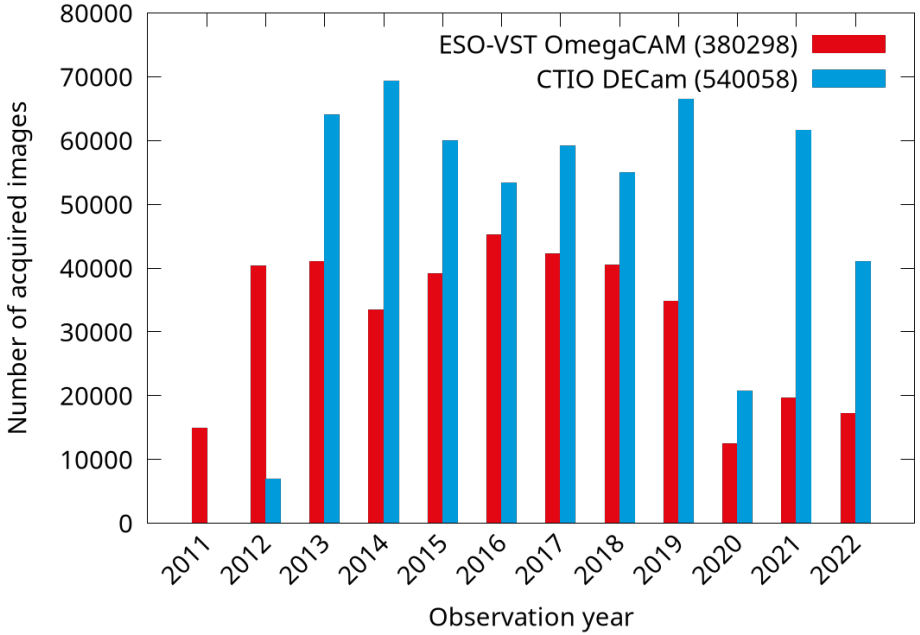
Photometry

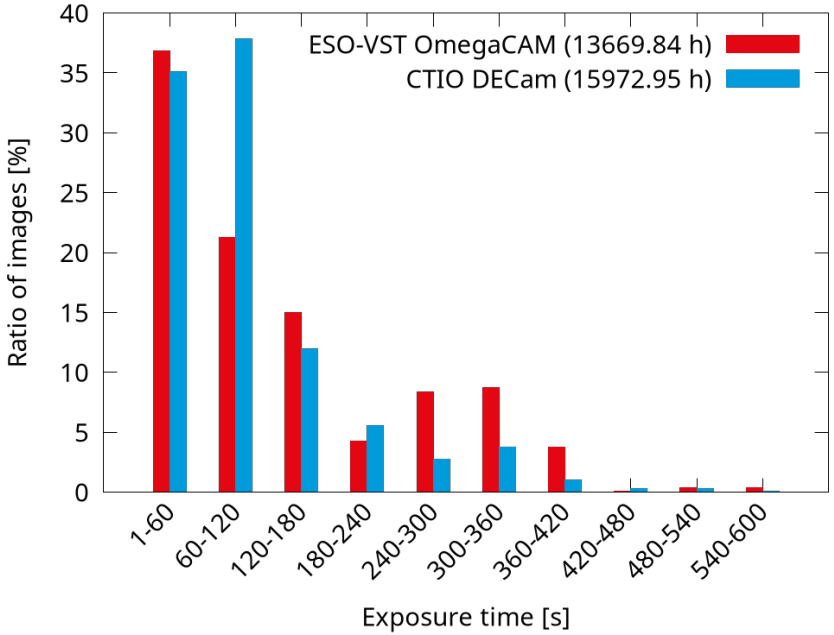
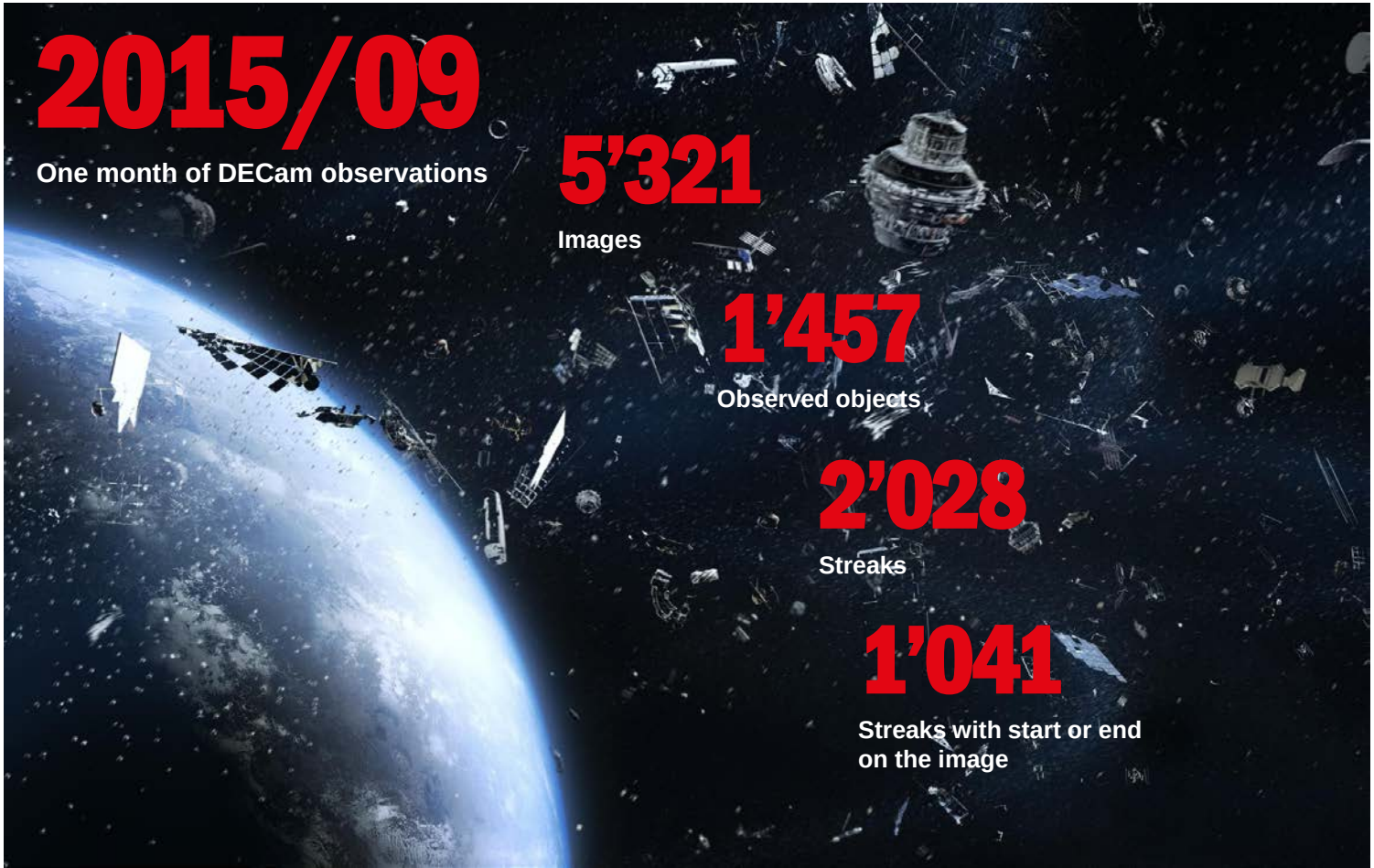
- Lightcurve extraction from streaks
- Determination of rotation periods
- Phase curves to estimate object sizes





OmegaCAM vs DECam





What can we expect to find in the DECam archive?