COMMERCIAL SPACE TRACKING SERVICE FOR SMALL SATELLITES

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ABOUT LEOLABS

Based in Menlo Park, CA

Founded in 2016 (spun out of SRI International)

Top-to-bottom approach to mapping LEO:

- Hardware R&D (radars)
- Data science / Algorithm development
- Web-based platform / API

INTRODUCTION

Brand new era for LEO, with recent proliferation of low cost small satellites sized 1U and smaller

LeoLabs data can assist these operators in navigation, SSA tasks

Image credit: NASA

INTRODUCTION

LeoLabs ephemeris has benefits over a traditional TLE

- Improved accuracy
- Covariance
- Input measurements

Can also provide conjunction alerts / assessments, and conjunction screening against input ephemeris

Image credit: NASA

LEOLABS RADAR NETWORK

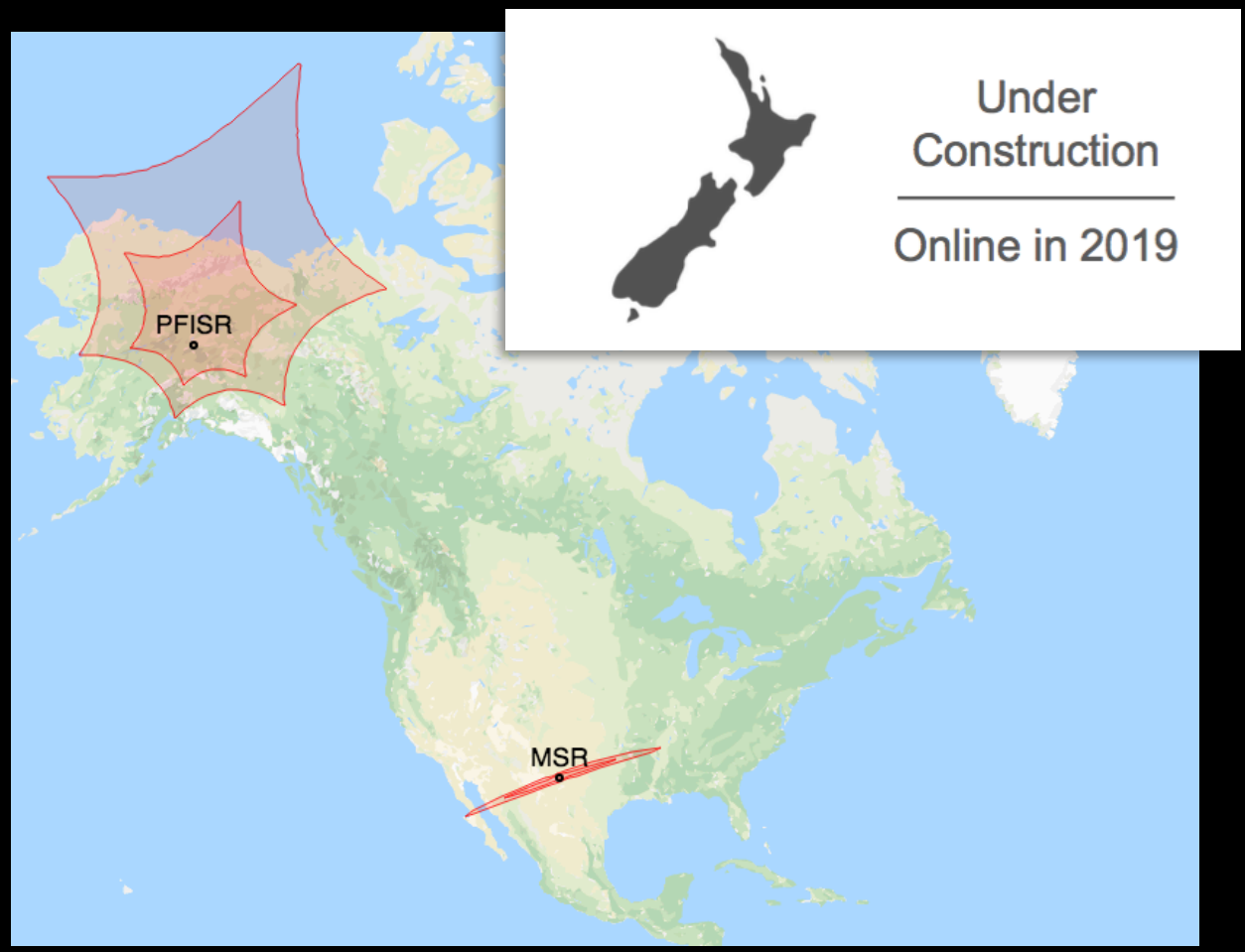
Phased array design (can track many objects simultaneously)

Network currently consists of 2 radars capable of tracking objects 10 cm in size and greater

- PFISR (near Fairbanks, AK)
- MSR (near Midland, TX)

10,000+ object catalog

Polar objects pass through a sensor about 1 - 4 times a day



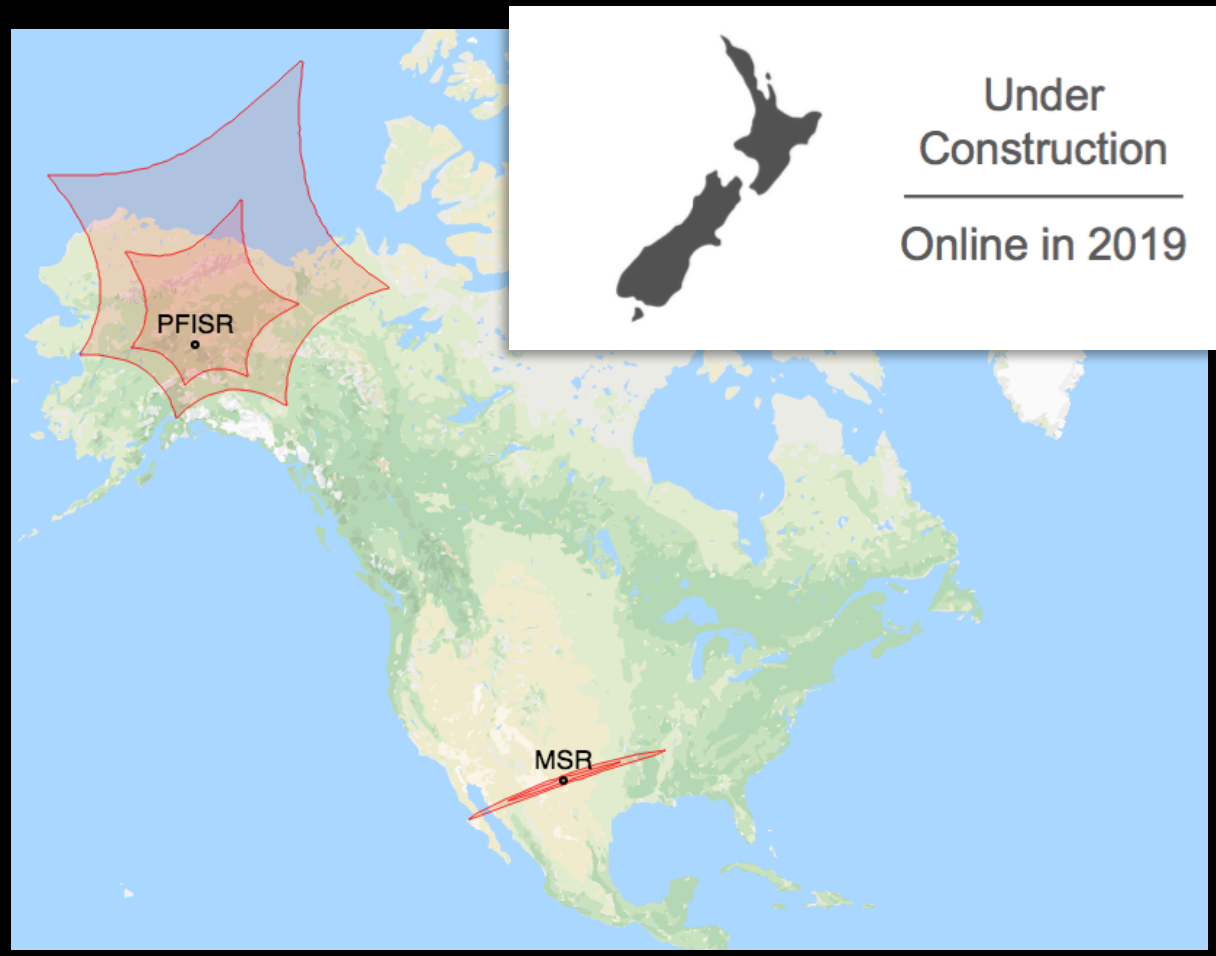
Credit: Google Maps

LEOLABS RADAR NETWORK

Third radar under construction in New Zealand

Will be capable of detecting objects as small as 2 cm

This means 10X more objects trackable by LeoLabs



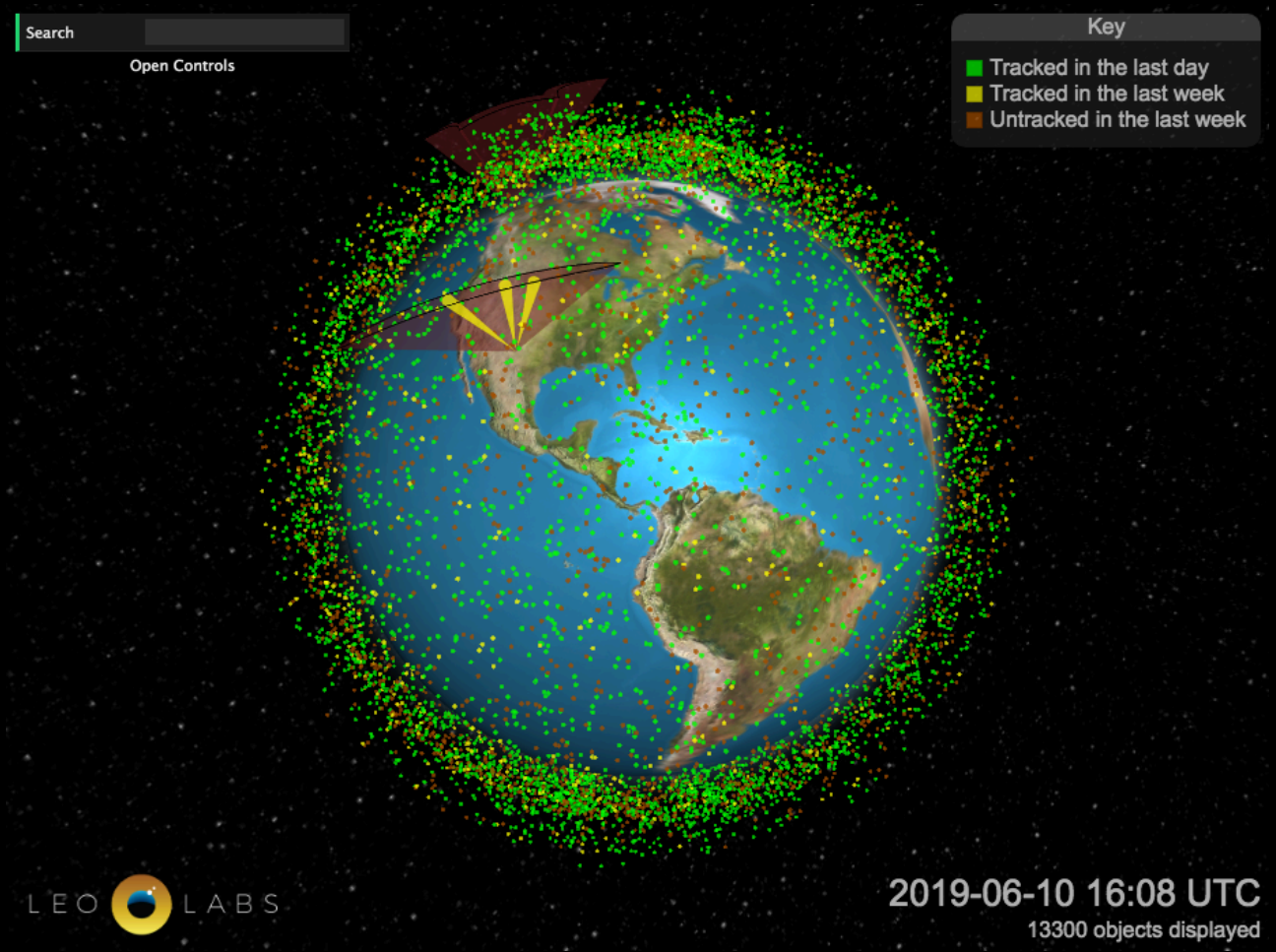
Credit: Google Maps

LEOLABS DATA PLATFORM

- Radar measurements
- Object state estimations
- Object propagations
- Conjunction screening and alerts

Available via two interfaces:

- Graphical interface (web app)
- Web-based API

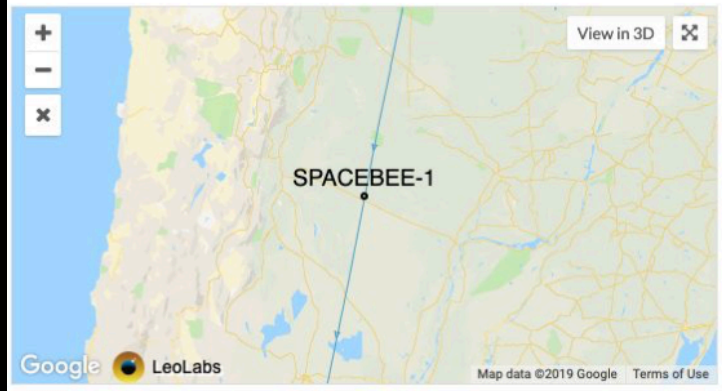


LEOLABS DATA PLATFORM

LEO LABS

SPACEBEE-1

Catalog Number L19943



Name	SPACEBEE-1
Catalog Number	L19943
NORAD ID	43142
Perigee	483 km
Apogee	497 km
Inclination	97°
Period	94 min

Available Data

Type	All Time	Last Month	Last Week	Last Day
Measurements	11318	1032	220	4
Observed Passes	566	53	12	1
State Vectors	197	21	5	1

DATA PLATFORM USE CASES

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- Regulatory

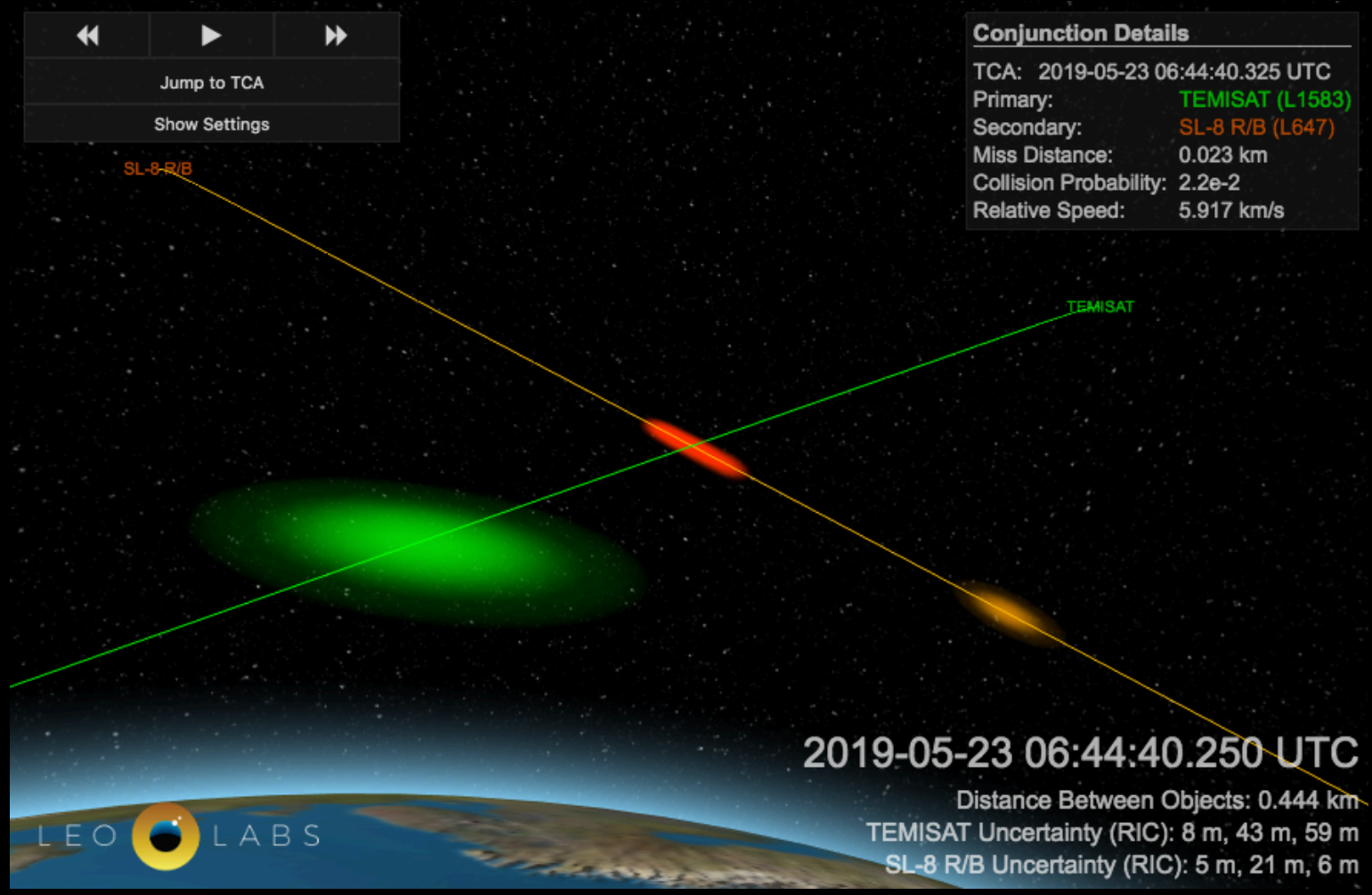
  (render LEO within context of national / agency guidelines)

- Backup navigation

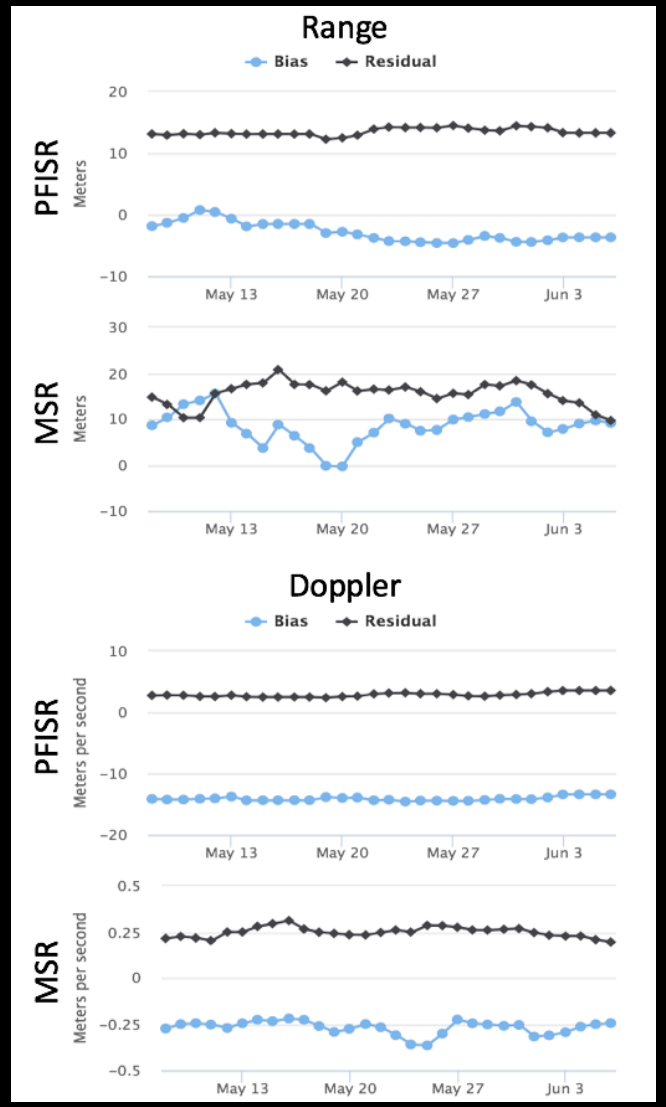
  (augment / supplement existing on-board or ground based systems)

- SSA

  (as source of upcoming conjunctions, maneuvers, orbit change alerts)



MEASUREMENT CALIBRATION



Ongoing (multiple times per day) assessment of sensor bias and uncertainty

Use ephemerides data from ILRS as truth

Some typical values:

PFSIR

- Range uncertainty: ~15 m
- Doppler uncertainty: ~3 m/s

MSR

- Range uncertainty: ~15 m
- Doppler uncertainty: 25 cm/s

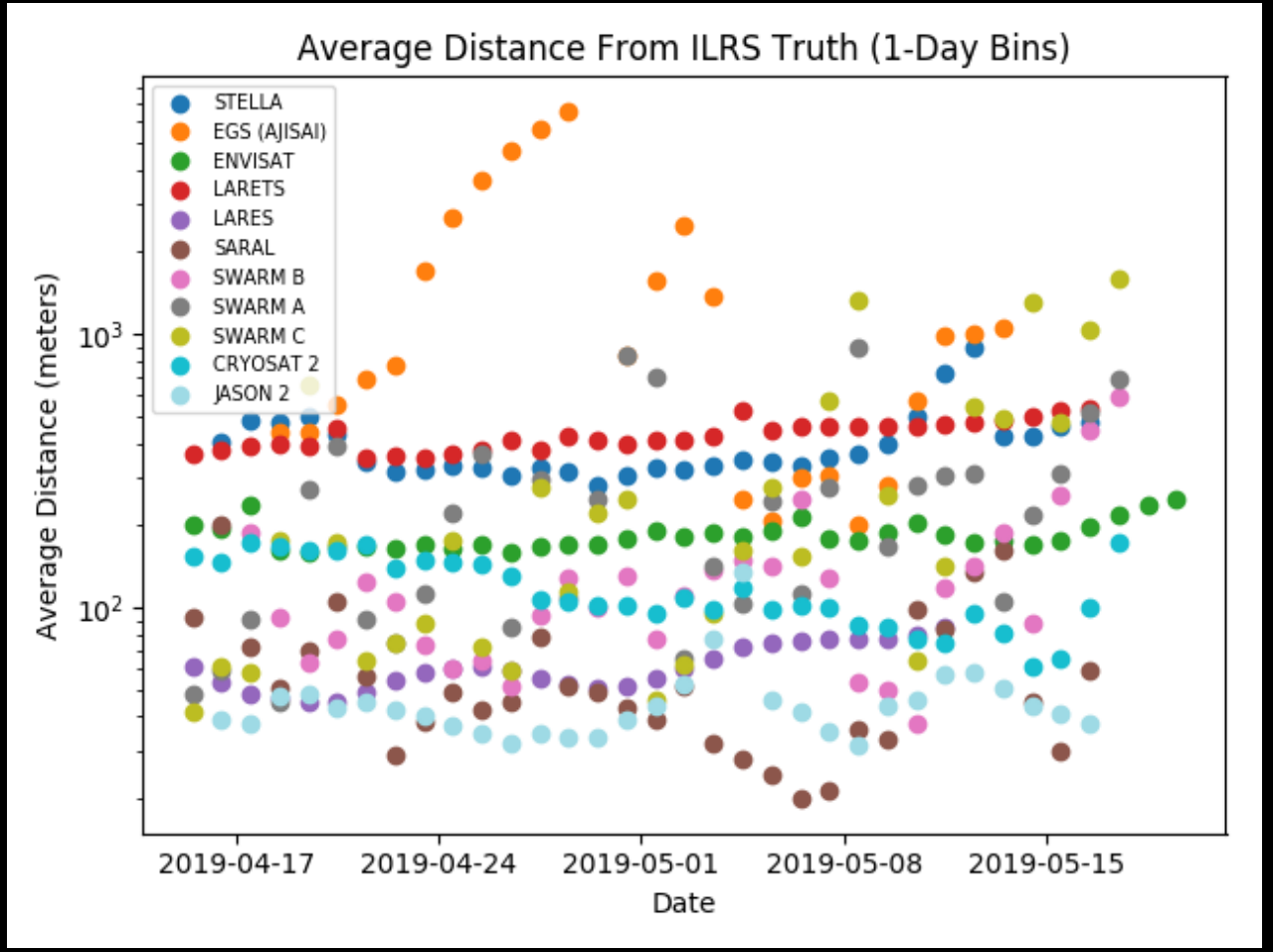
ORBIT DETERMINATION

Use unscented Kalman filter (UKF) algorithm

Orekit[1] open source orbital dynamics

Forces considered:

- Gravity (42x42)
- Atmospheric drag (NRLMSISE-00)
- Solar radiation pressure
- Third body (Sun and Moon)



[1]*https://www.orekit.org/*

ORBIT DETERMINATION

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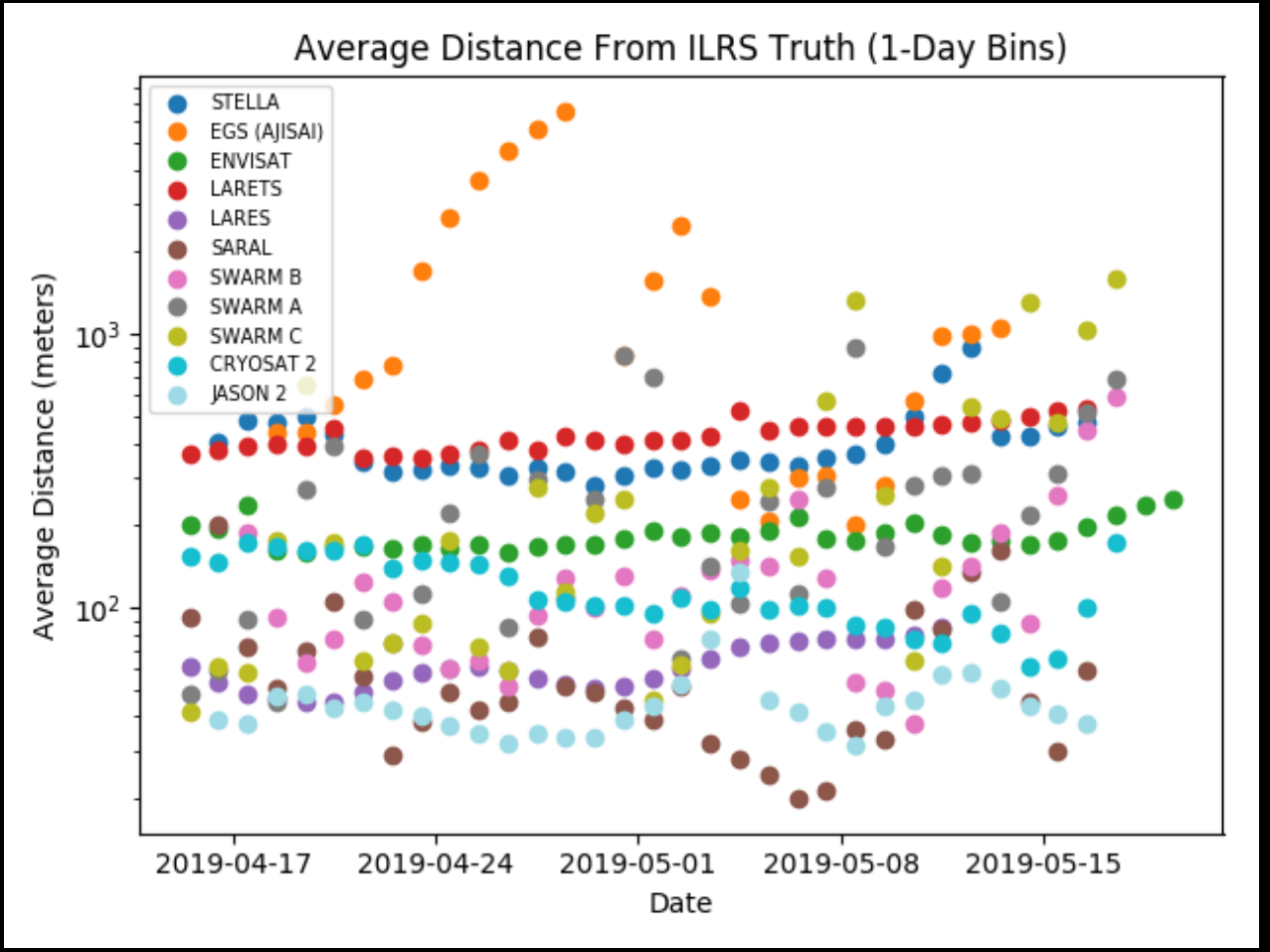
Estimations of subset of ILRS targets automatically compared against truth data (similar analysis shown on the right)

Also compared with other recent estimations of that target using Euclidean and Mahalanobis distances (these are viewable on the LeoLabs Platform site)



SMALLSAT PERFORMANCE (≤ 1U)

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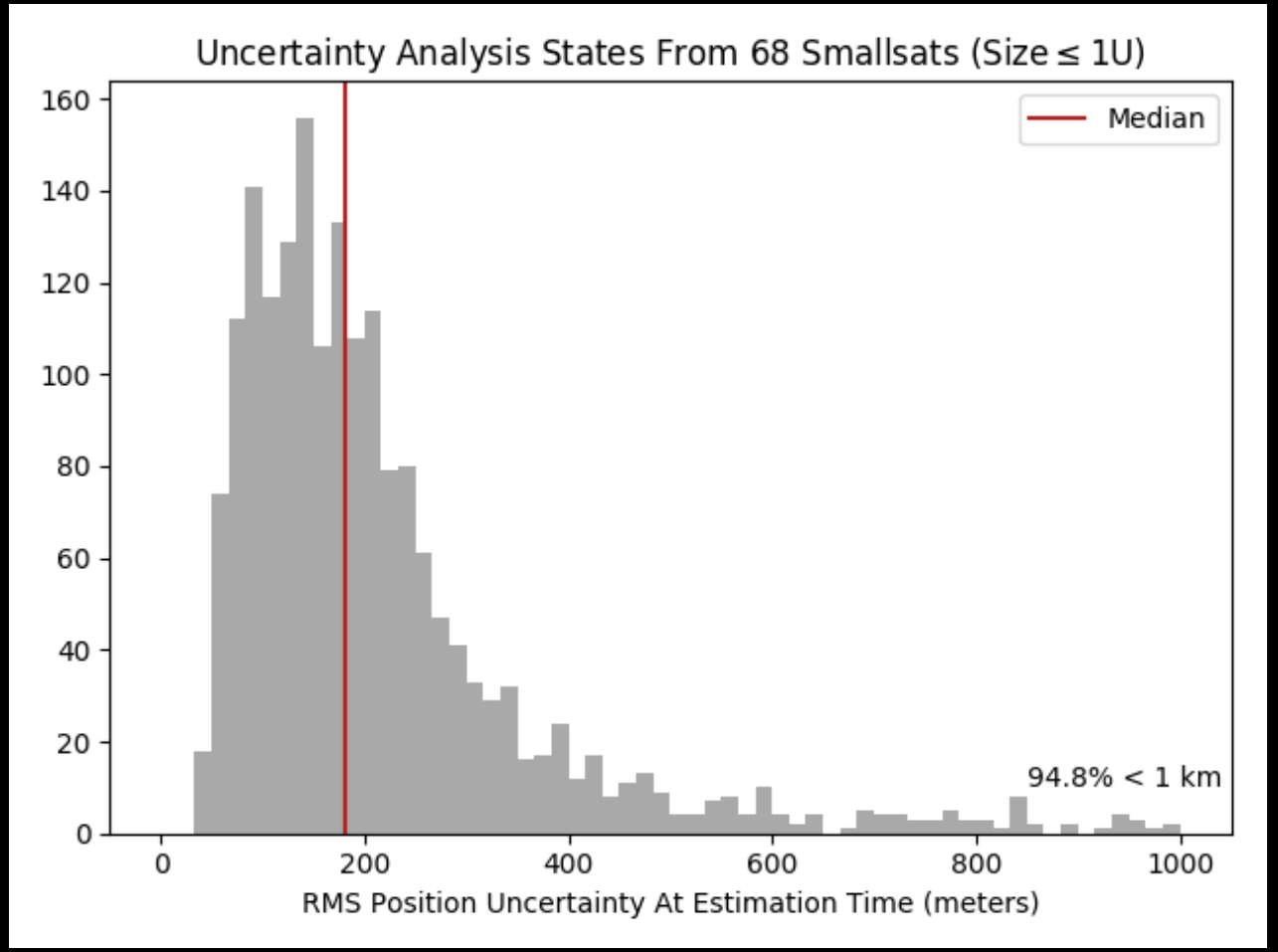
Analysis of epoch uncertainties for 68 targets 1U or smaller

Median uncertainty < 200 m

About 95% of uncertainties fall below 1 kilometer



SMALLSAT PERFORMANCE (SUB-1U)

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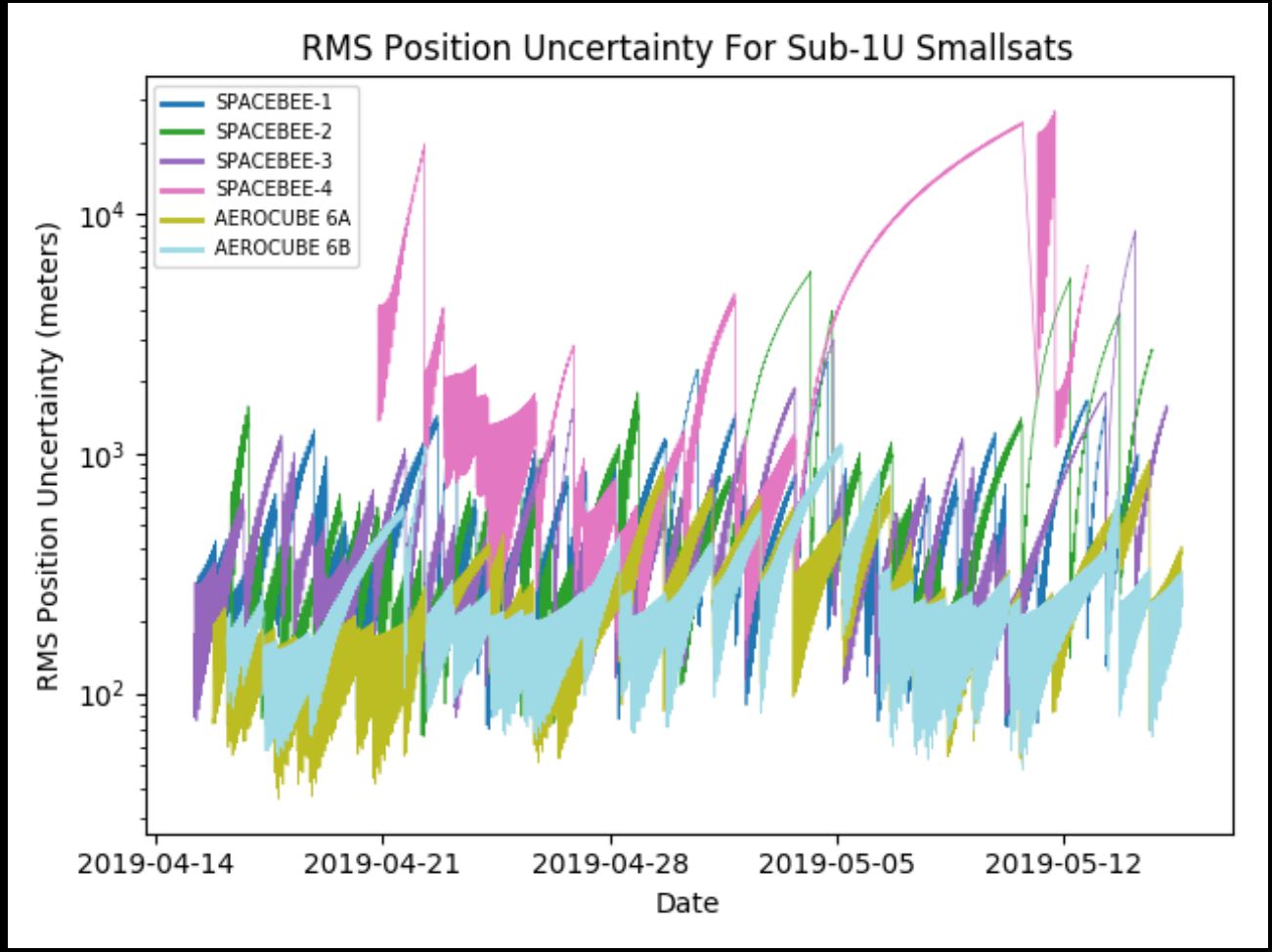
Time-series view of uncertainties for 6 sub-1U SmallSats

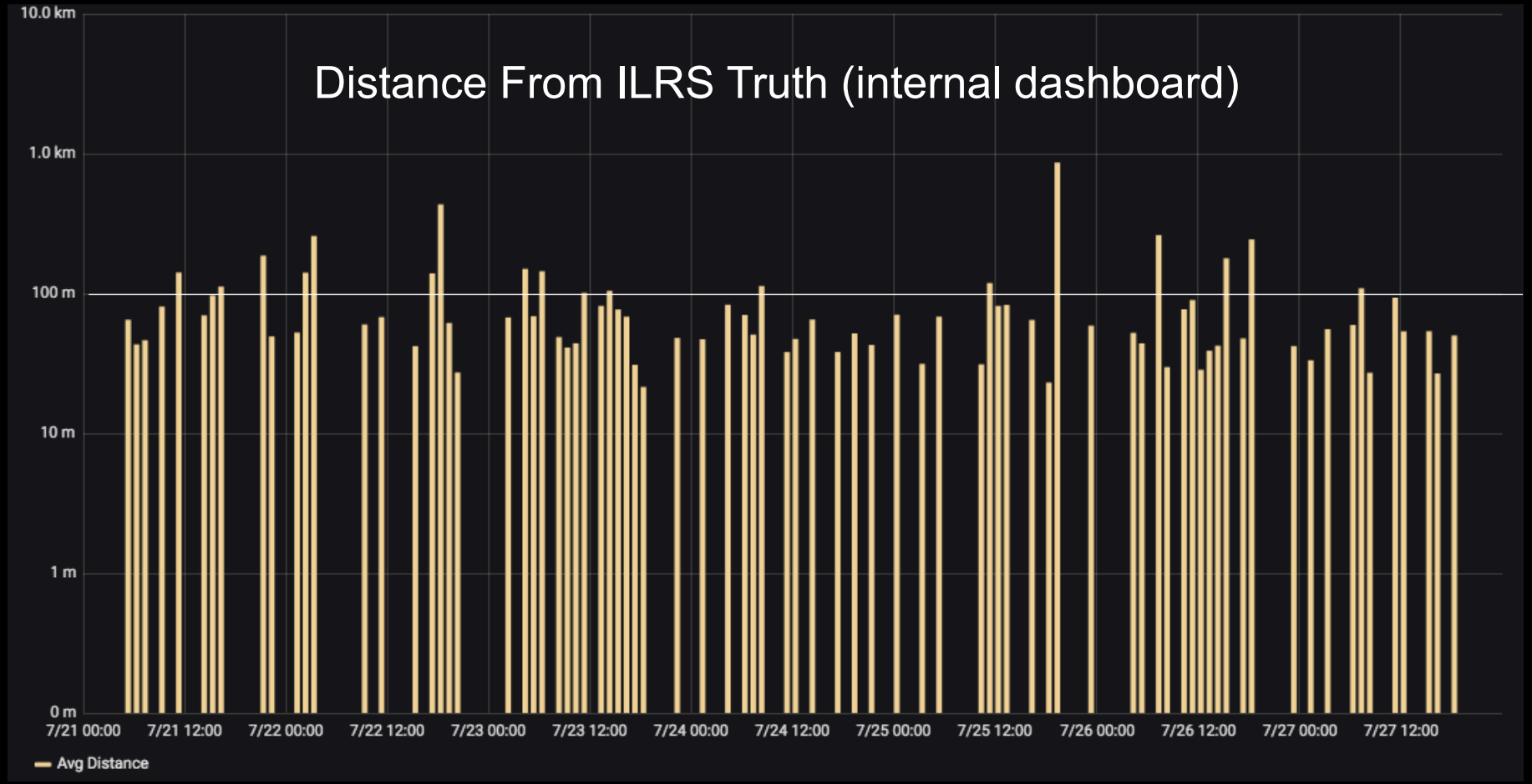
RMS position uncertainty typically below 1 km even under propagation



ONGOING DEVELOPMENT

Orbit determination algorithm development is a major focus at LeoLabs

Recent estimations when compared to ILRS truth frequently do better than 100 m



NEW SERVICE FOR SMALLSATS

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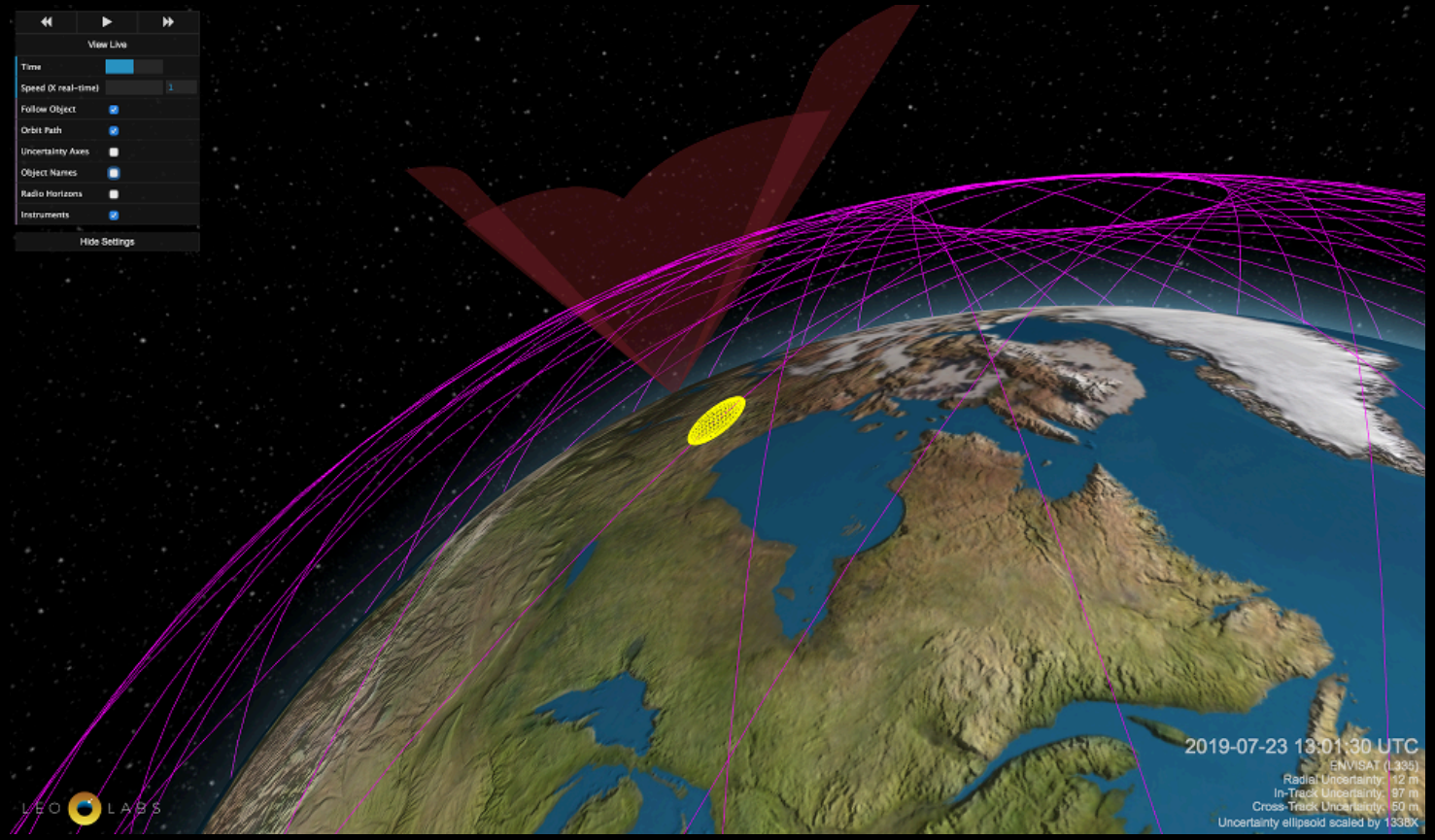
LeoTrack



New off-the-shelf service for SmallSat and CubeSat operators

- State vector updates
- Ephemerides (with covariance)
- Historical data / trending tools
- 2D / 3D visualizations

Demos: Booth 146 in the fieldhouse

CONCLUSION

LeoLabs offers a highly detailed map of the low earth orbit environment via its web-based platform

This data is useful within operational contexts such as navigational assistance and SSA

Performance against 1U and sub-1U SmallSats is seen to be favorable

- 50% of epoch position RMS uncertainties below 200 m
- Propagated uncertainties for sub-1U SmallSats largely on order of 100 m

New service, LeoTrack, offers a turn-key package of LeoLabs data products to SmallSat operators

Come say hi! (Booth 146 in the fieldhouse)