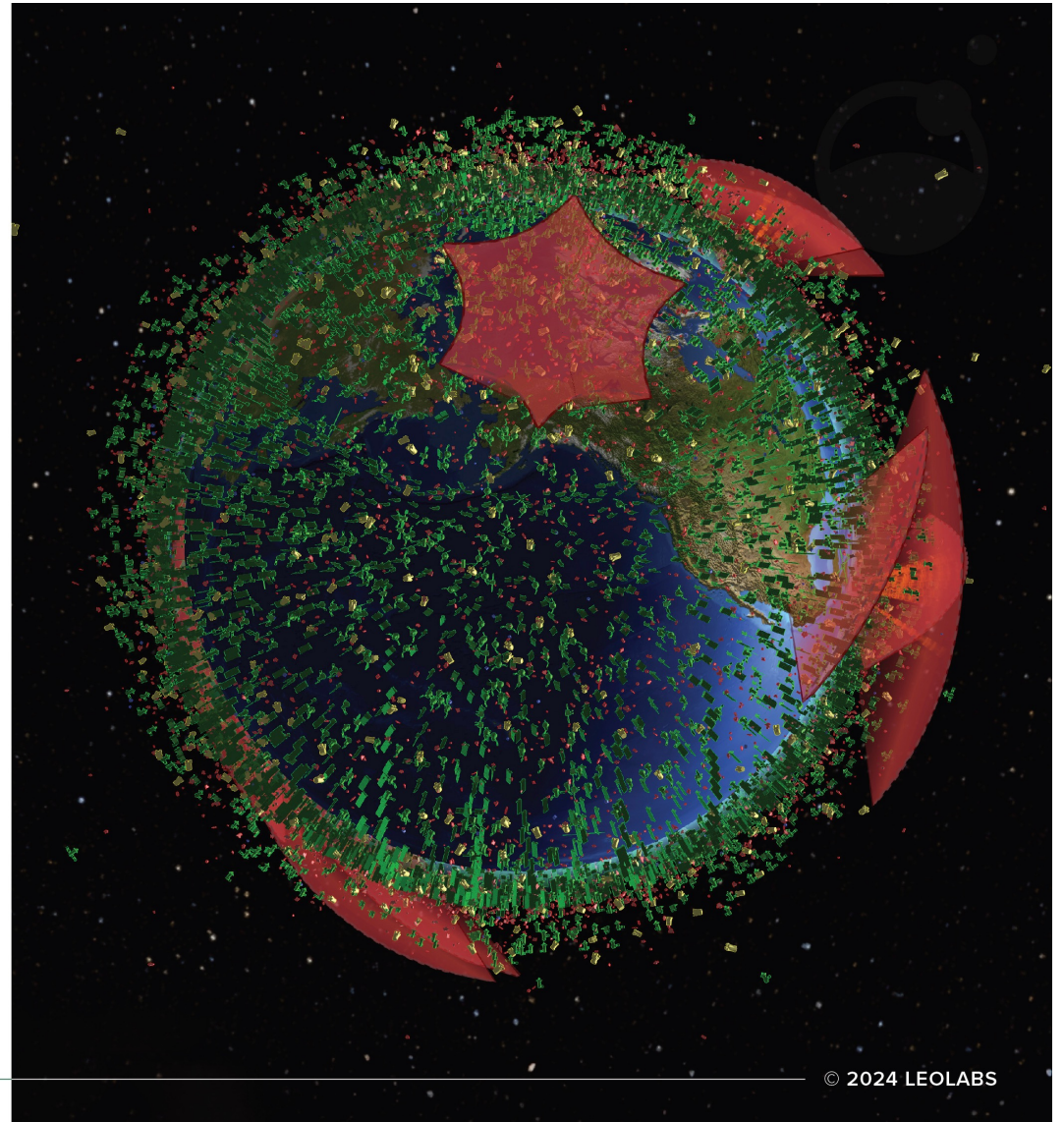


# Operational Implementation of STM services

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Clean Space Days – Oct 9<sup>th</sup> 2024

S. Delattre – Sr Space Domain Awareness Architect



# Summary

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### 3.5. MINIMISE RISKS OF INTERNAL BREAK-UPS

To keep the probability of debris generation through collisions and break-ups below 1 in 1000 per object, it is essential to minimise the risk of internal break-ups during both the operational lifetime and post mission. Reliable passivation reduces the risk of in-orbit break-ups by depleting on-board sources of energy. While autonomous systems improve the likelihood of successful passivation, they also introduce new risks, such as premature activation, which must be managed. Solutions to address this issue include:

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### 4.1. IMPROVE SPACE TRAFFIC COORDINATION AND INFORMATION SHARING

Improved STC<sup>13</sup> will help prevent collisions and reduce the occurrence of unnecessary collision avoidance manoeuvres.

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### 4.2. IMPROVE SPACE SURVEILLANCE PERFORMANCE

Collision risk assessment is based on knowing the position and velocities of the objects involved. A reduction in uncertainty on these parameters will reduce the amount of false perceived risky close encounters, and hence reduce the burden on the operator. The capability to track smaller objects down to 5 cm in LEO and 20 cm in GEO will reduce the risk for catastrophic collisions in these orbital regions.

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### 4.4. ROBUST TASKING OF TRACKING FOR LARGER CATALOGUES

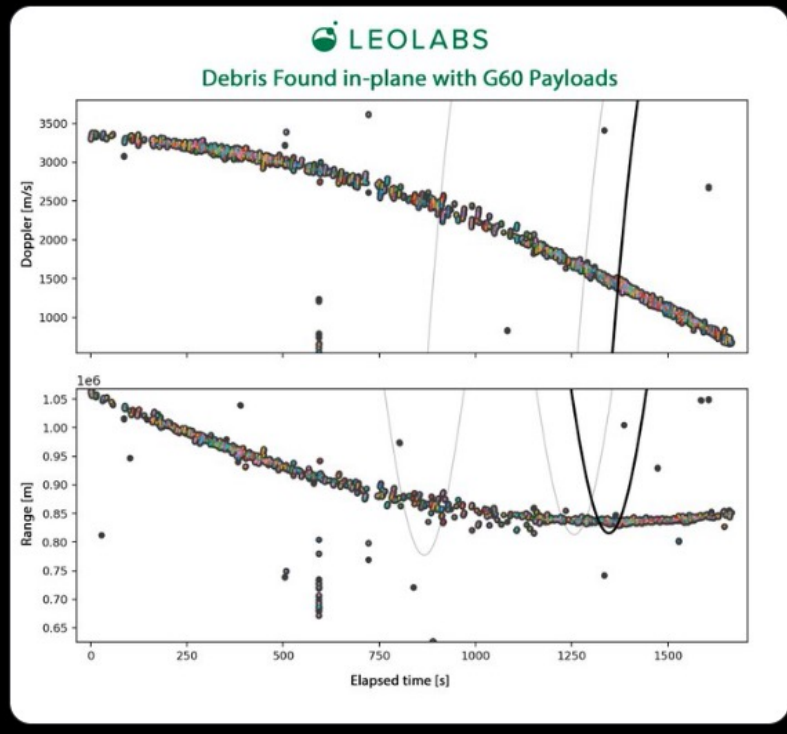
With increasing amounts of debris and active spacecraft alike, current sensor networks can become overloaded leading to larger times between tracks and hence larger uncertainties on derived space surveillance products.

Making space debris catalogues and services available to other space actors or the public is a simple route to share knowledge of the space debris population and cross-validate models and measurements of space debris. Solutions to address this issue include:

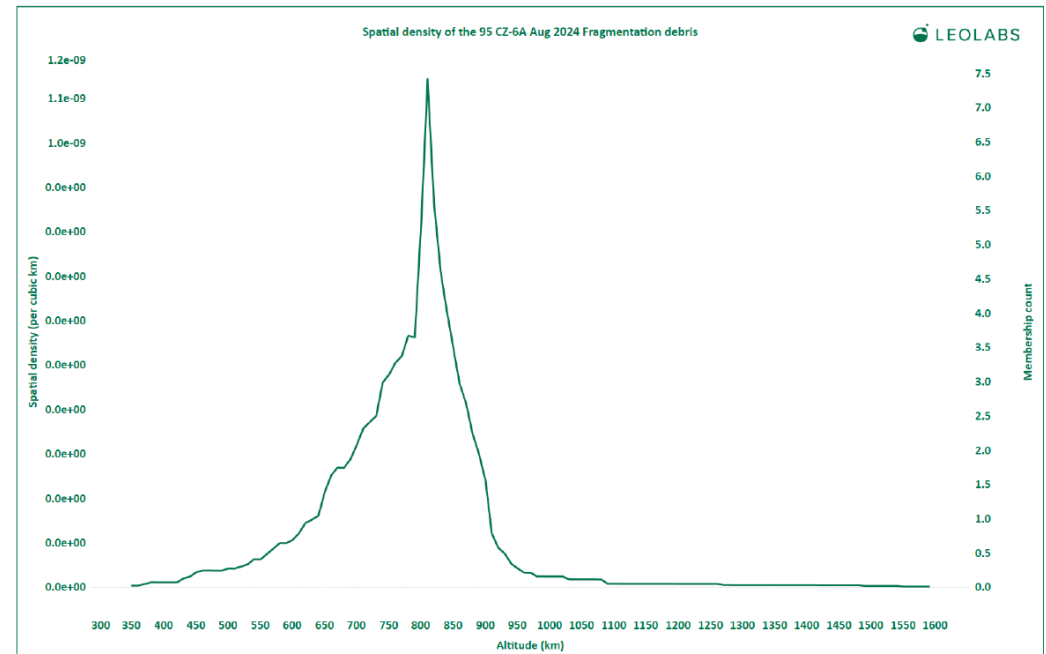


🚨 We're actively monitoring and analyzing the breakup event in #LEO involving a Chinese rocket body, CZ-6A. Our radar data indicates this event occurred on 6 August at ~20:10 UTC at ~810 km.

It resulted in at least 700 debris fragments and potentially more than 900.



## CZ-6A Rocket Body Explosion August 6<sup>th</sup> 2024



Search **cz-6a**

Speed

Debris

Beams

Instruments

Follow Earth

Auto Refresh

**Views**

Object Type

Perigee

Period

Inclination

Country of Origin

**Filters**

Perigee

Add Filter

**Ground view**

Hide Menu

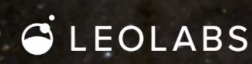
**Object Type**

- Payload
- Rocket Body
- Debris
- Unknown



⚠ Special events are not shown

🔗 Copy link to share



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Milky Way images from NASA/Goddard Space Flight Center Scientific Visualization Studio

2024-09-30 04:45 UTC

1248 objects displayed

	Object 1	Object 2	TCA	Miss Distance	PoC	Relative Speed	CDMs
<a href="#">View</a>	CZ-6A DEB Catalog Number: L132994 NORAD ID: 54397	STARLINK-6336 Catalog Number: L136968 NORAD ID: 56788	2024-10-01 01:52:58 UTC (in 18 hours)	2.278 km	5.4e-5	12.234 km/s	85
<a href="#">View</a>	CZ-6A DEB Catalog Number: L133118 NORAD ID: 54520	STARLINK-31100 Catalog Number: L140916 NORAD ID: 58714	2024-10-02 15:02:03 UTC (in 2 days)	0.307 km	2.4e-5	12.843 km/s	19
<a href="#">View</a>	CZ-6A DEB Catalog Number: L133078 NORAD ID: 54483	STARLINK-30150 Catalog Number: L139287 NORAD ID: 57621	2024-10-02 11:17:46 UTC (in 2 days)	5.692 km	2.1e-5	11.063 km/s	12
<a href="#">View</a>	SL-16 R/B Catalog Number: L1585 NORAD ID: 24298	CZ-6A DEB Catalog Number: L133117 NORAD ID: 54519	2024-10-02 13:36:18 UTC (in 2 days)	9.087 km	1.7e-5	10.473 km/s	19
<a href="#">View</a>	CZ-6A DEB Catalog Number: L133078 NORAD ID: 54483	STARLINK-30893 Catalog Number: L140926 NORAD ID: 58724	2024-10-04 01:25:26 UTC (in 4 days)	11.000 km	1.7e-5	10.473 km/s	19
<a href="#">View</a>	CZ-6A DEB Catalog Number: L133092 NORAD ID: 54495	STARLINK-1349 Catalog Number: L2009604 NORAD ID: 45587	2024-09-30 06:14:58 UTC (2 hours ago)	1.000 km	1.7e-5	10.473 km/s	19
<a href="#">View</a>	CZ-6A DEB Catalog Number: L132980 NORAD ID: 54387	STARLINK-31595 Catalog Number: L141534 NORAD ID: 59273	2024-09-30 10:29:07 UTC (in 2 hours)	0.600 km	1.7e-5	10.473 km/s	19
<a href="#">View</a>	CZ-6A DEB Catalog Number: L133092 NORAD ID: 54495	STARLINK-1349 Catalog Number: L2009604 NORAD ID: 45587	2024-09-30 06:14:58 UTC (2 hours ago)	0.800 km	1.7e-5	10.473 km/s	19

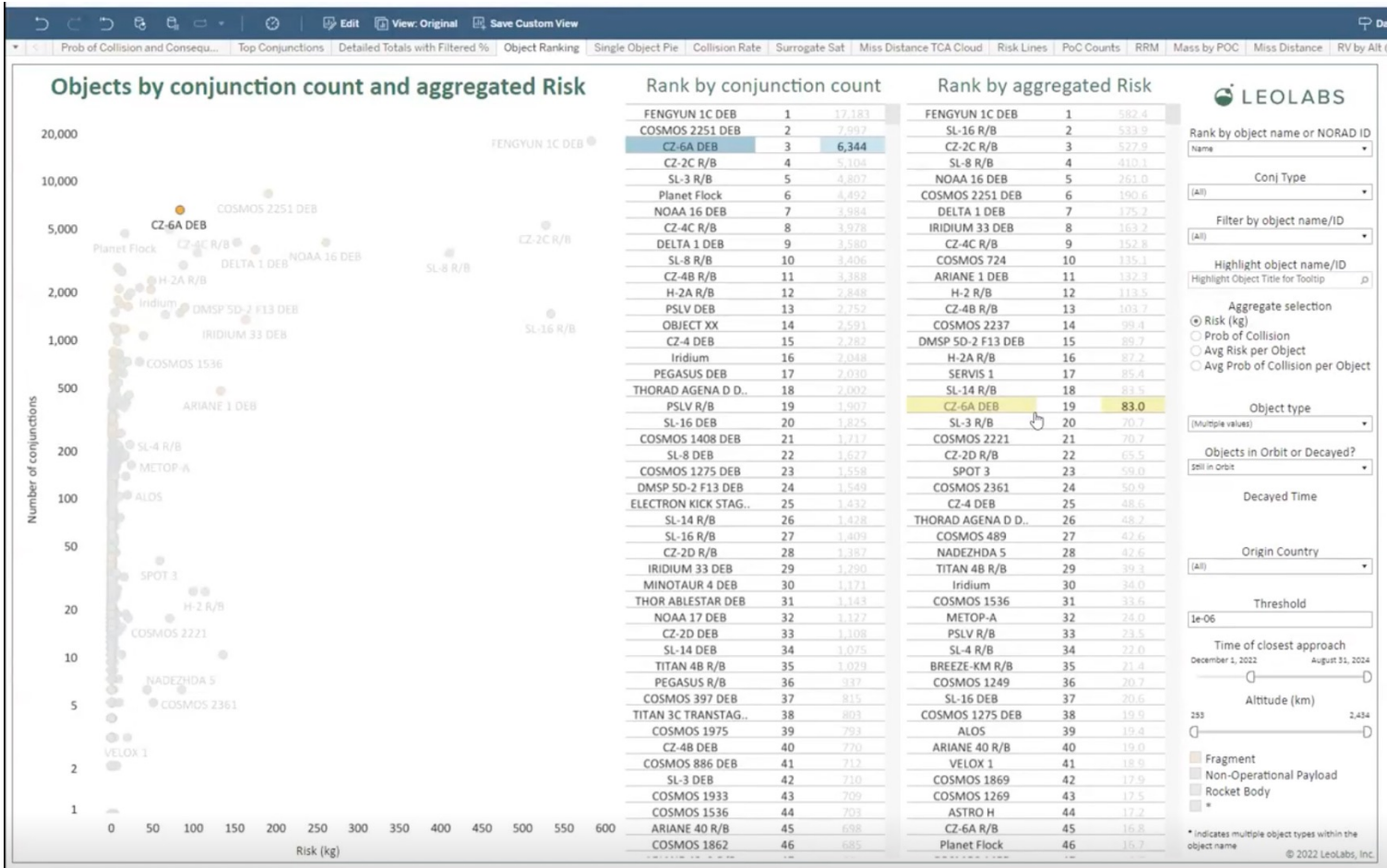
# CZ-6A CDMs extract on Sept 30th

**Conjunction Details** [View report](#)

Epoch: 2024-09-30 04:50:23.00 UTC  
 TCA: 2024-10-01 01:52:58.61 UTC  
 Object 1: L136968 (STARLINK-6336)  
 Object 2: L132994 (CZ-6A DEB)  
 Miss Distance: 2.278 km  
 Miss Distance (RIC): -0.073 km, 1.350 km, 1.833 km  
 Collision Probability: 5.4e-5

	1-σ	2-σ	3-σ
L136968 (STARLINK-6336)	Green	Yellow	Red
L132994 (CZ-6A DEB)	Green	Yellow	Red

2024-10-01 01:52:48.61 UTC  
 Relative Speed: 12.234 km/s  
 Distance Between Objects: 122.363 km  
 Distance Between Objects (RIC): -0.831 km, 99.896 km, -70.660 km  
 STARLINK-6336 Uncertainty (RIC): 19 m, 851 m, 4 m  
 CZ-6A DEB Uncertainty (RIC): 49 m, 3672 m, 13 m



Since Dec 2022, 15% of conjunctions with  $P_c > 1e-06$  involved CZ-6A

# Leolabs Catalog: foundational for SSA

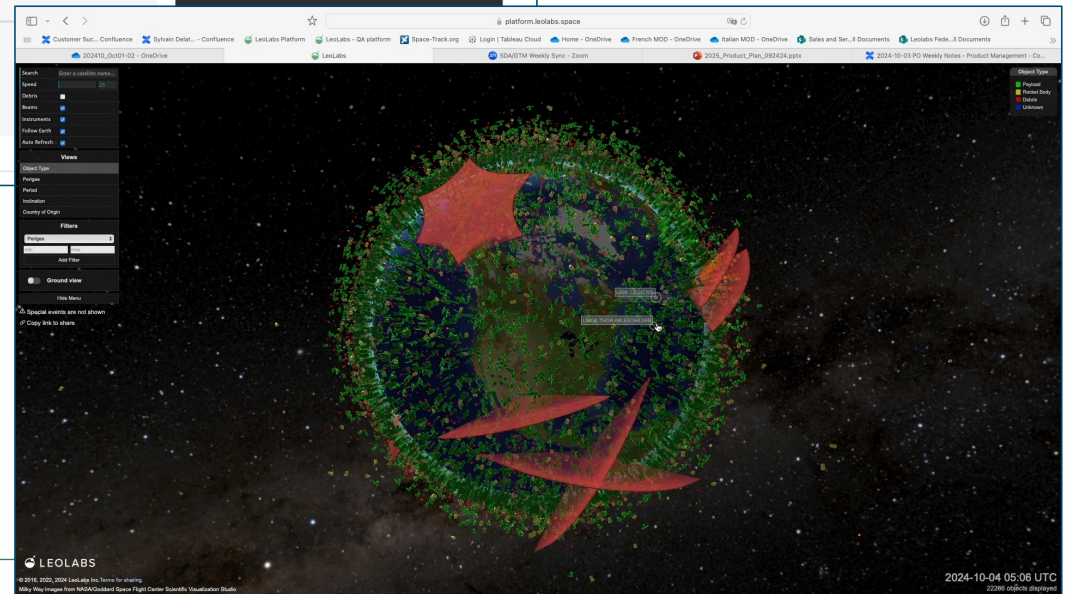
## LeoLabs System Metrics

Full transparency on LeoLabs system speed, accuracy, and quantity of data

### Key Performance Indicators

9/4/2024 - 10/4/2024

LATENCY TIME - RADAR PASS TO STATE VECTOR	ACCURACY VS TRUTH DATA DIFFERENCE BETWEEN LEOLABS & TRUTH DATA	PRECISION OF STATE VECTORS RMS UNCERTAINTY	Livestream Counter All time
4 MIN	56 METERS	18 METERS	
RADAR PASSES 2,653,117	MEASUREMENTS 45,364,995	OBJECTS 22,465	STATE VECTORS 81,445,961
STATE VECTORS 2,586,241	OPERATIONAL EPHEMERIS SCREENINGS 954,723		



# STM and information sharing

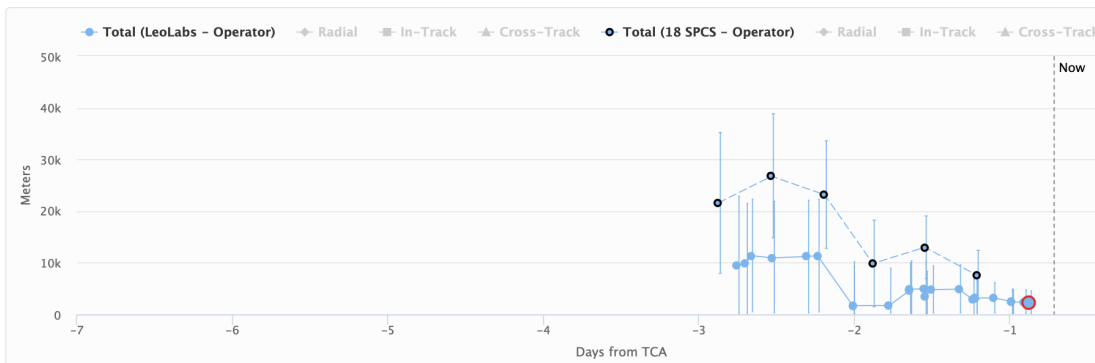
CDM Source	Ephemeris Source				
LeoLabs (79)	<input type="checkbox"/> LeoLabs - LeoLabs (56    20 - 37)	<input type="checkbox"/> Operator - LeoLabs (0    0 - 0)	<input type="checkbox"/> Operator - Operator (0    0 - 0)	<input checked="" type="checkbox"/> LeoLabs - Operator (23    14 - 0)	
18 SPCS (6)	<input type="checkbox"/> 18 SPCS - 18 SPCS (0)	<input type="checkbox"/> Operator - 18 SPCS (0)	<input type="checkbox"/> Operator - Operator (0)	<input checked="" type="checkbox"/> 18 SPCS - Operator (6)	

## Conjunction Analysis

The point marked with a \* is the representative CDM for this conjunction event.

## Miss Distance

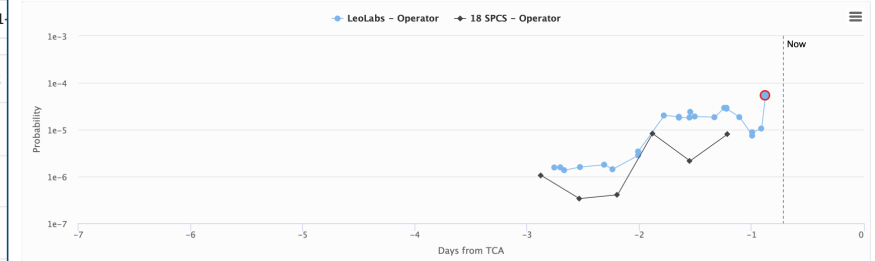
The predicted distance between the objects at the Time of Closest Approach (TCA)



1

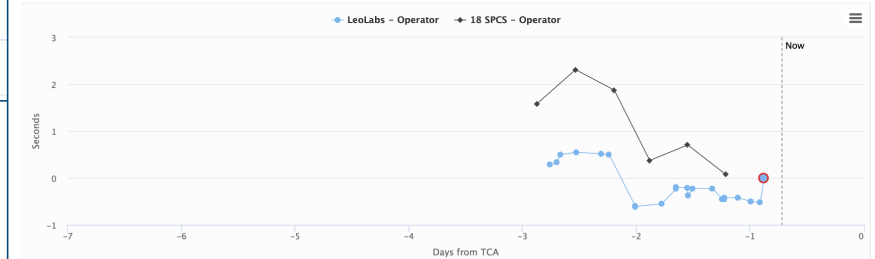
## Probability of Collision

The probability of collision determined in the Conjunction Data Message (CDM)



## TCA Change from Latest

The Time of Closest Approach (TCA) relative to the TCA in the latest CDM





# STM and improved Space Traffic Coordination : latency

- Streaming CDM service that provides a 24/7 screening of uploaded O/O ephemeris
- On-demand screening against LeoLabs catalog and results back in less than ~5 mn
- Average S/V generation : 4 mn

### Upload Ephemeris File

**Object to Screen**

Primary Object  
Search for objects...

**Screening Parameters**

Max Miss Distance (km) \* 20.00 Min Probability of Collision Max Mahalanobis Distance

Override Hard Body Radius for Primary Object (m) Enter HBR or leave blank for existing value... Override Hard Body Radius for All Secondary Objects (m) Enter HBR or leave blank for existing values...

**Screen Against All Objects or One Object**

All Objects  Single Object

**Which Uncertainty Should Be Used**

Use File Uncertainty  Use Default Uncertainty

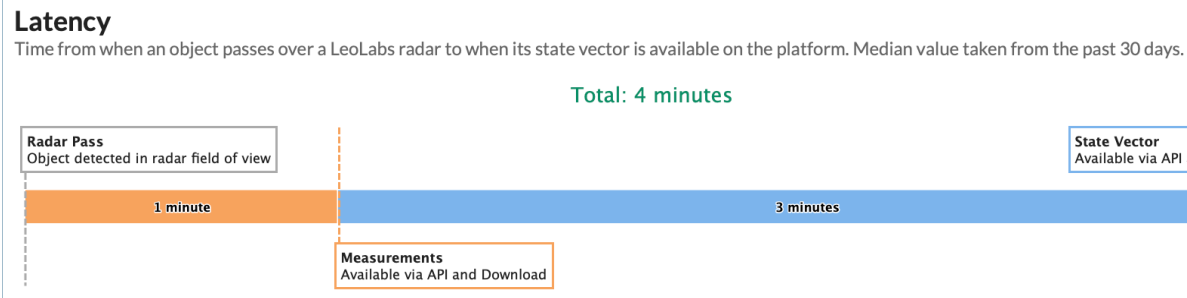
Files without uncertainty data, such as STK and TLE files, will use an uncertainty of 0 unless you specify a default uncertainty.

**File Upload**

Ephemerides File \*  
Accepted formats: LeoLabs ephemerides file (.json), STK Ephemeris File Format (.e), CCSDS OEM format (.oem), NASA Ephemeris format, Generic On-Orbit Ephemeris Format, Modified ITC Ephemeris format and TLE. [View details.](#)

Choose File no file selected

Cancel Upload



# STM and performance : accuracy & transparency

## State Vector Performance

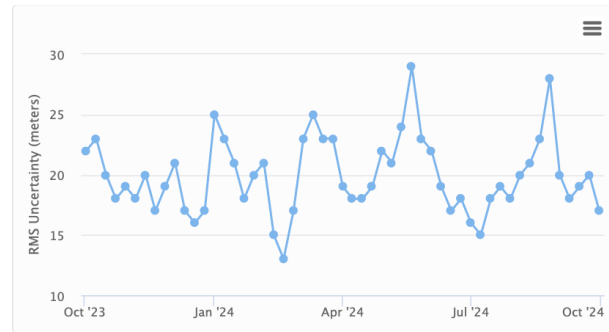
### LeoLabs State Vectors vs Truth Data

Distance between LeoLabs calibration object state vectors and International Laser Ranging Service (ILRS) truth data



### LeoLabs State Vector RMS Uncertainty

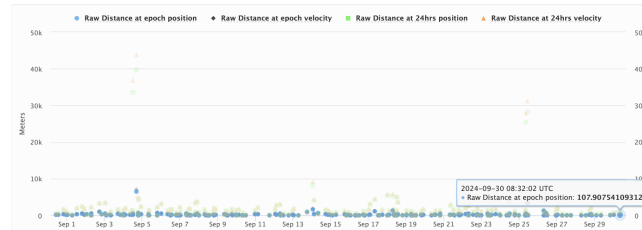
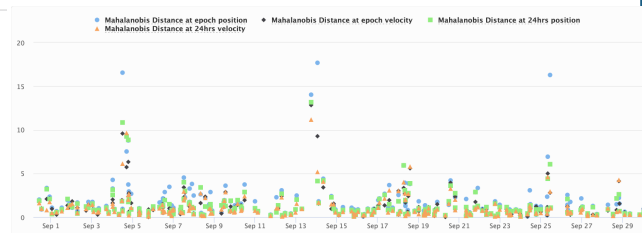
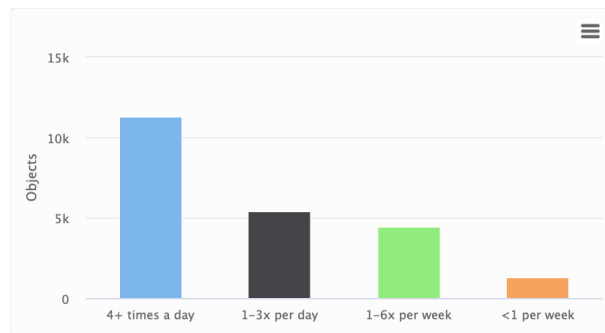
State vector position RMS uncertainty. Weekly median at epoch. Calculated as the square root of the trace of the position covariance matrix



## Data Quantity

### Revisit Rates

Rolling 30-day average calculated from each radar even at multi-radar sites



- Accuracy monitored and shared with operators
- Accuracy against truth data (ILRS) and self consistency
- High revisit rate for OD quality and operations timeliness
- Propagation accuracy shared with operators

# Towards 2030 Zero Debris Charter's objectives

5. Access to timely and accurate data on space objects down to a size of 5 cm or smaller in low Earth orbit and 20 cm or smaller in geostationary Earth orbit should be improved to enhance decision making capabilities for collision avoidance.

- Leolabs is expanding its radar network with next-generation UHF and S-band radars.

- Increased capability in VLEO
- Increased visibility of small objects
- Increase detection capability (Launches, break-up events)



# Towards 2030 Zero Debris Charter's objectives

- 4. Routine and transparent information sharing should be facilitated and active participation in strengthening global space traffic coordination mechanisms should be encouraged.
- **75% of the operational satellites in LEO are supported by LeoLabs services**
- **Active participation in Space Traffic Management processes definition**
- **Supports the U.S. Office of Space Commerce's Consolidated Pathfinder Project for its Traffic Coordination System for Space (TraCSS).**
- **Technical discussions with EUSST**



**EU SST**  
Space Surveillance and Tracking





**THANK YOU.**

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**VISIT US AT [LEOLABS.SPACE](https://leolabs.space)**

**For more information, contact:  
[sdelattre@leolabs.space](mailto:sdelattre@leolabs.space)**