

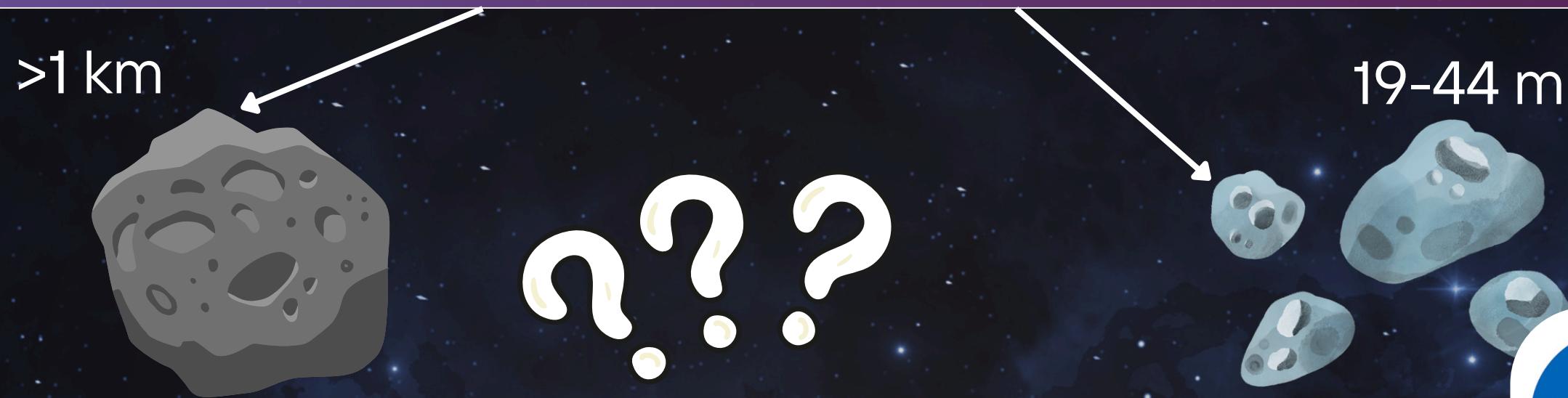
# Welcome to Syntharion!



## Team Members:

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# THE UNSEEN THREAT: Why We Miss 99% of Small NEOs



## 2013, Chelyabinsk meteorite

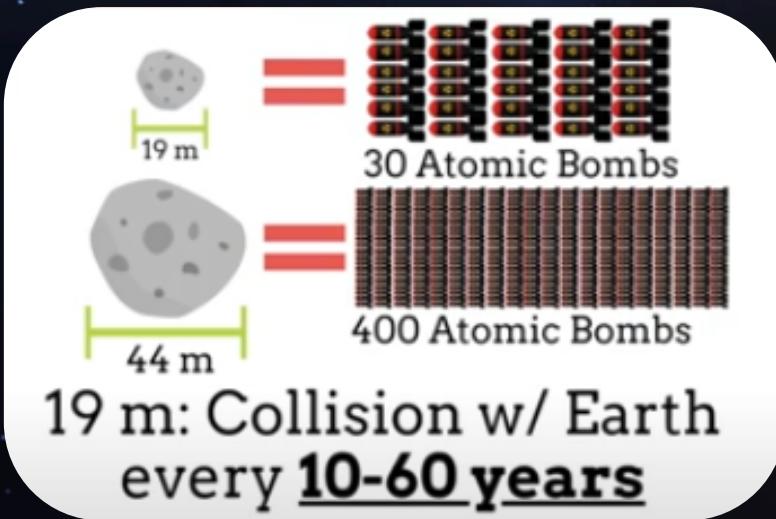
(19 m) the collision of a celestial body with the Earth caused a devastating wave, causing 1,500 people to be injured.

In 2005

NASA setted the goal:  
to detect 90% of  
asteroids with a  
diameter of more than  
140 meters by 2020.

In 2020

The result: billions were spent  
on telescopes, but only 30%  
of asteroids in this category  
were found. And the  
detection of 19-44 meters is  
even only 0.1%!



## The Hazard by the Numbers

How Big?	10 meters	50 meters	140 meters
How Often?	~1 per decade	~1 per 1000 years	~1 per 20,000 years

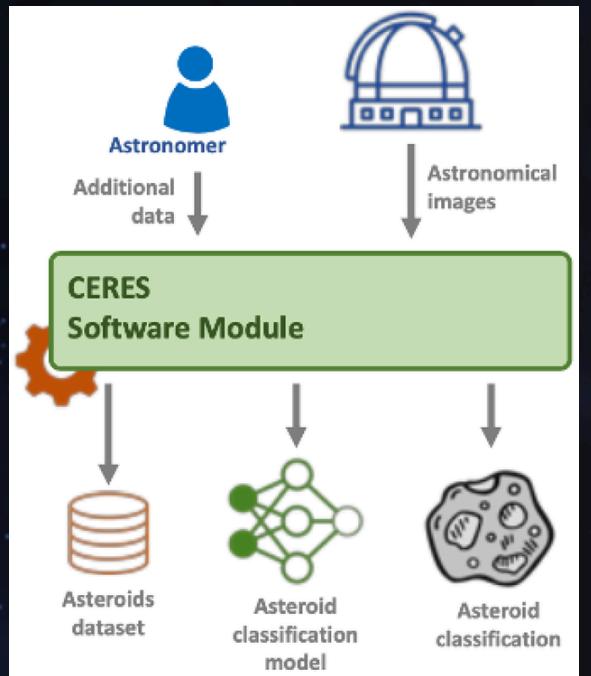
How Many? ~45 million ~230,000 ~25,000

% Discovered 0.03% 7% 40%

Located  
Not located

# INTRODUCING THE SOLUTION

*Imagine a world where we can detect every asteroid heading toward Earth before it becomes a threat...*

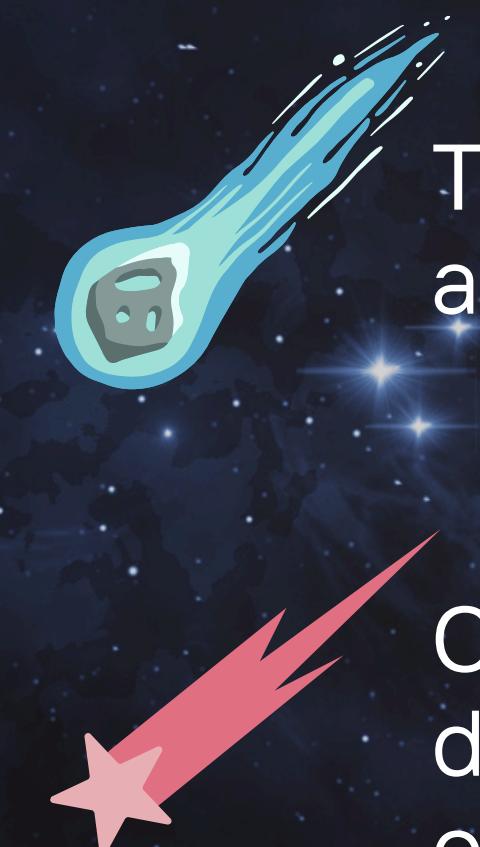


Concept Example:  
Assessment of Asteroid Classification Using Deep Convolutional Neural Networks

Difficulties in finding small asteroids:



Cons of the traditional manual dataset:



- **OBJECTIVE:**

To develop a deep learning model to detect asteroids quickly and accurately.

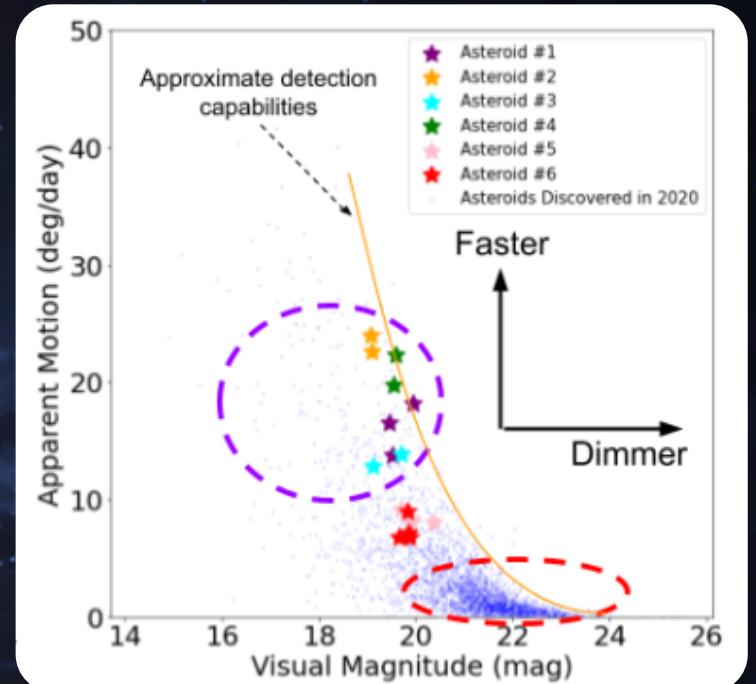
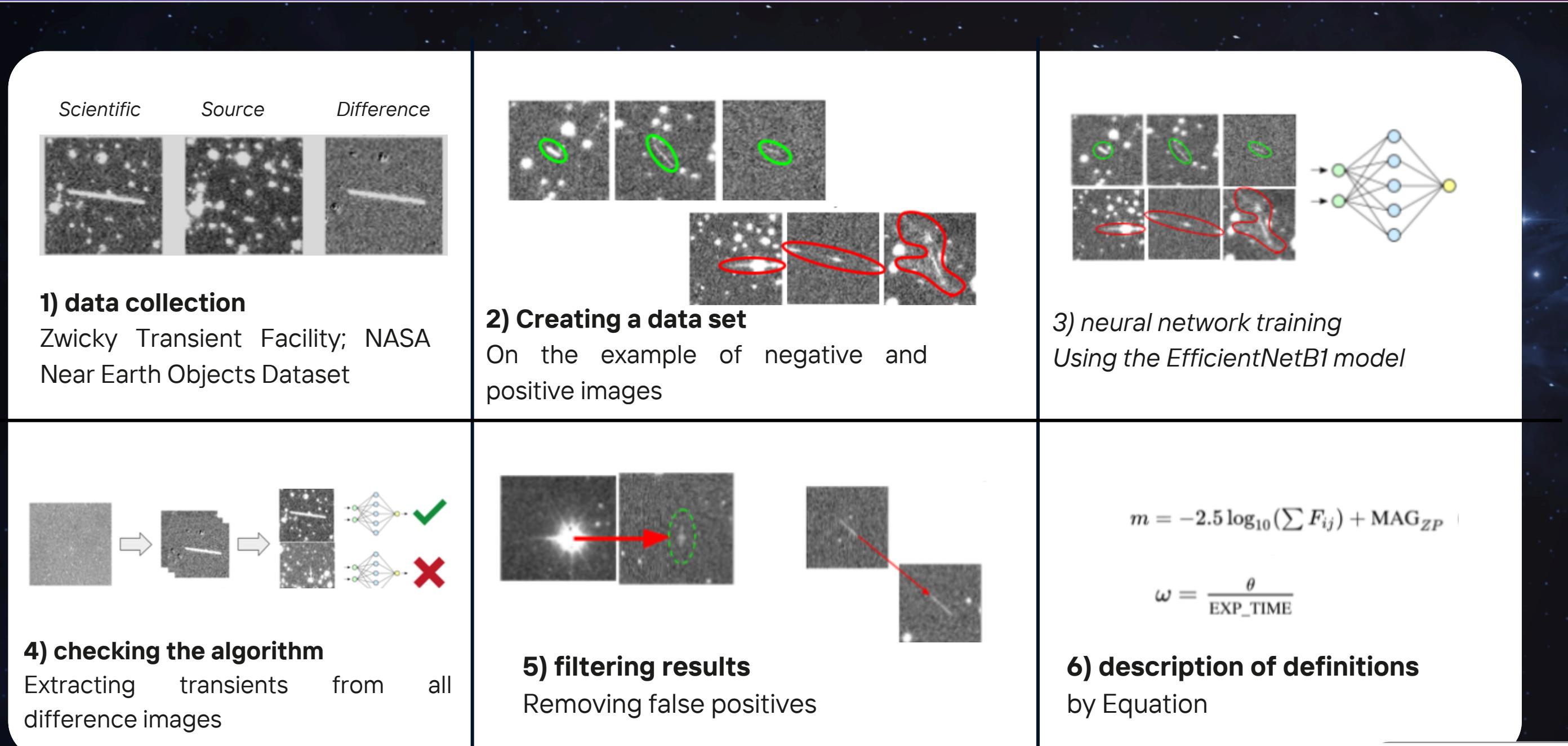
- **HYPOTHESIS:**

Convolutional Neural Networks (CNNs) can detect features invisible to the human eye, outperforming traditional software.

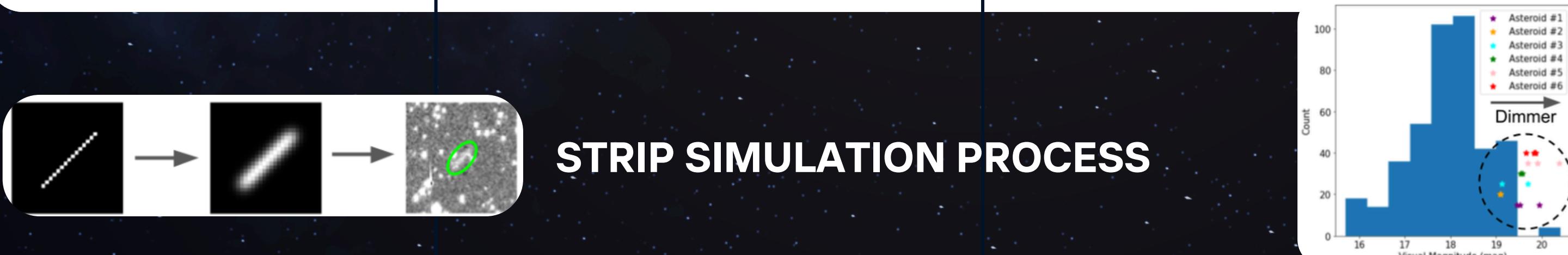
**SYNTHARION** is a planetary defense algorithmic project that utilizes deep learning and a novel synthetic data approach to drastically improve the detection of small, fast-moving Near-Earth Objects (NEOs). Its primary goal is to achieve near-perfect accuracy (99.8%), thereby eliminating the vast majority of false alarms that currently burden human analysts in major astronomical surveys.



# METHODOLOGY: RESEARCH STEPS



- Red zone: large, distant, slow-moving asteroids → easy to find.
- Purple zone of purple: weak light, fast moving asteroids → difficult to find.
- Newly discovered asteroids (#1, #2, #4) located in this area.
- Diameters: 1-50 m, distance from Earth: ≈20 lunar distance units.
- Result: the algorithm identified objects that traditional methods cannot find.



# COMPARATIVE PERFORMANCE

- Accuracy (Validation Accuracy): 99.8%
- True Positive Rate (recall): 97%
- False Positive Rate: 0.02%
- Practical discovery: 6 new asteroids (ZTF, 3 Night analysis)
- Brightness( m): 19.0 – 20.3 for asteroids found
- Angular velocity: 6.8-24 °/day

КерсөткішДәстүрj in My Drive

	A	B	C	D	E
1	Metric	Traditional Meth	SYNTHERION (Your Model)	Improvement	
2	Accuracy	84.80%	99.83%	+15.0 p.p. ( $\approx$ 17.7% increase)	
3	True Positive Ra	80.00%	97.00%	+17.0 p.p. ( $\approx$ 21.3% increase)	
4	False Positive R	15.00%	0.02%	99.9% Reduction	
5	Precision	21.90%	99.60%	4.5x Higher	
6	Processing Time	10 hours	3 hours	70% Reduction	

EFFICIENCY Saving...

F11 | fx

	A	B	C
1	Section	Metric	Formula / Validation Calculation
2	I. Scientific Validation (Target Population)		
3		Apparent Magnitude (m - Faintness)	$m=-2.5 \cdot \log_{10}(\sum F) + MAG_ZP$ (Example: $\sum F=158$ )
4		Angular Velocity ( $\omega$ - Speed)	$\omega_{deg/day} = EXPTIME_{pix} \cdot Factor$ (Example: 30 pix/30 sec)
5	II. Machine Learning Performance (Validation Set: 100,000)		
6		Accuracy (Overall Correctness)	TotalTP+TN=100,000 4,850+94,981
7		Precision (Trustworthiness)	TP+FPTP=4,850+194,850
8		False Positive Rate (FPR)	NFP=95,000 19
9		True Positive Rate (TPR/Recall) (No Misses)	0.97 5,000
10	III. Operational Efficiency		
11		Processing Time Reduction	$T_{new} = (1 - Reduction) \cdot T_{old}$ (Example: $T_{old}=10$ hrs)
12			
13			
14	SYNTHERION Result	Key Impact on Planetary Defense	
15	$m \approx 19.50$	ASTRA NOVA proves capability to detect the most challenging, unseen threats (faint and fast).	
16	24°/day	Confirms objects detected are very faint; traditionally missed by automated and human review.	
17		Confirms objects are fast-moving; typically fail existing tracking and linking algorithms.	
18	99.83%	Model delivers near-perfect trust and minimal false alarms.	
19	$\approx 99.61\%$	+15.0 p.p. increase over Traditional Methods, nearly eliminating missed detection.	
20		0.02% 4.5x higher than Traditional Precision, confirming detections are highly reliable.	
21	97.0% (4,850 TP)	99.9% reduction in false alarms, freeing up human analysts for critical orbital work.	
22		Confirms minimal False Negatives (150 FN), maximizing detection coverage.	
23	3 hours	Enables mission-critical speed for early warning alerts.	
24		70% reduction in data processing time, directly enabling faster alerts and follow-up.	
25			

SYNTHARION algorithm  
is 3 hours faster!

# BUSINESS CANVAS MODEL: USE OF PRIZ GURU

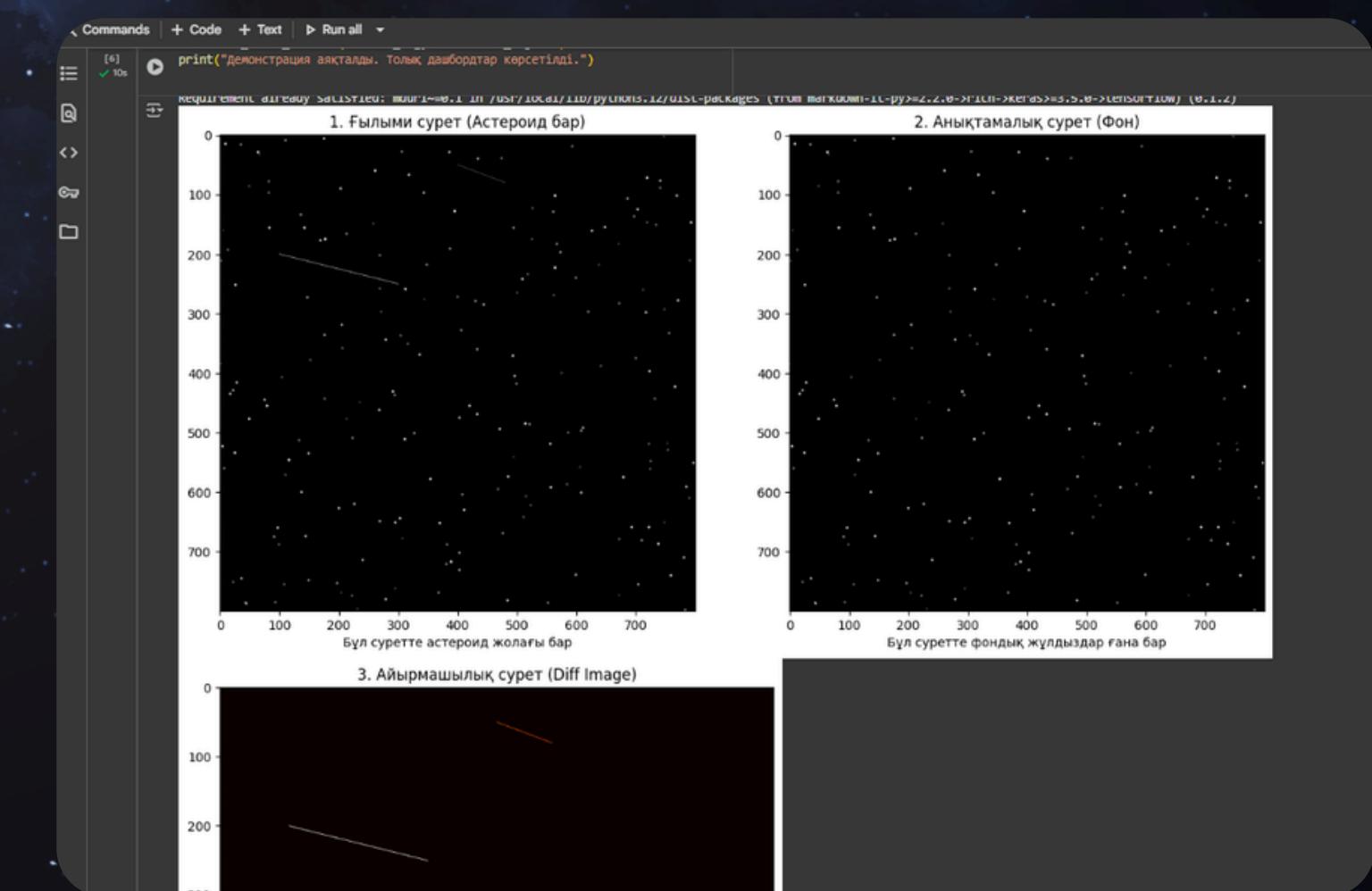
The diagram illustrates the Business Canvas Model using the Effective Brainstorming (EBS) template from PRIZ.GURU. The model is organized into nine key sections:

- KEY PARTNERS:**
  - 1. Major Observatories (ZTF, LSST): Access to raw, real-time data streams for testing and deployment.
  - 2. Space Agencies (NASA/ESA): Grant funding, regulatory support, and pilot program endorsement.
  - 3. Academic & Research Institutions: Peer review, independent validation, and next-generation R&D for orbital linking.
- KEY ACTIVITIES:**
  - 1. Algorithm Maintenance & Optimization: Continuous refinement of the EfficientNet CNN and the SYNTHARION PSF model fidelity.
  - 2. Synthetic Data Generation: Scaling the synthetic dataset to adapt to new telescope hardware/noise profiles.
  - 3. Orbital Linking Integration: Developing the feature to track objects across multiple nights and calculate definitive trajectories (Red Zone alerts).
- VALUE PROPOSITIONS:**
  - 1. Near-Perfect Accuracy (99.8%): Eliminates the risk of missing small, fast-moving threats (15% absolute improvement).
  - 2. Noise Elimination: Reduces the False Positive Rate (FPR) from ~78% to 0.02%, saving hundreds of hours of analyst time.
  - 3. Scalable, Unbiased Training: The SYNTHARION method eliminates data scarcity and training bias, making the model future-proof.
- CUSTOMER RELATIONSHIPS:**
  - 1. High-Touch Strategic Partnership: Co-development and direct scientific collaboration for integration and calibration.
  - 2. Scientific Validation: Publishing results in peer-reviewed journals to build credibility and trust.
  - 3. Dedicated Technical Support: Providing specialized astronomical and AI expertise for system integration.
- CUSTOMER SEGMENTS:**
  - 1. Planetary Defense Organizations (PDOs): NASA PDO, ESA PDC, UNOOSA.
  - 2. Astronomical Survey Observatories: Zwicky Transient Facility (ZTF), Vera Rubin Observatory (LSST), Pan-STARRS, ATLAS.
  - 3. Government/Defense Ministries: Agencies focused on Space Situational Awareness (SSA) and early warning systems.
- CHANNELS:**
  - 1. Direct API Integration: The primary channel for real-time delivery to observatory data pipelines (e.g., streaming alert service).
  - 2. Enterprise Licensing (SaaS): Annual subscription fees for the fully trained, high-performance ASTRA NOVA model and its updates.
  - 3. Scientific Publications & Conferences: The channel for communicating results and engaging key stakeholders (e.g., IAU, Planetary Defense Conference).
- COST STRUCTURE:**
  - 1. R&D Salaries: Compensation for specialized AI/Deep Learning engineers and scientific researchers.
  - 2. High-Performance Computing (HPC): Costs associated with cloud infrastructure (GPUs) for model training and high-volume data inference.
  - 3. Validation & Testing: Costs for securing and processing archival telescope data for continuous model validation and discovery (6 new asteroids found).
- REVENUE STREAMS:**
  - 1. Government R&D Grants: Primary funding source from space agencies (NASA/ESA) and scientific foundations.
  - 2. Data/System Integration Fees: Fees charged for customizing the SYNTHARION model and calibrating it for a specific telescope's unique noise characteristics.
  - 3. Academic & Non-Profit Use (Freemium Model): Basic model/API access may be provided at low cost or free to academic groups to encourage research and broader adoption.

## Why SYNTHARION is Essential?

*Traditional asteroid detection systems fail on two fronts:*

- Data Scarcity:** Real astronomical data is limited and contains insufficient examples of the most challenging objects—the faint, fast-moving, smaller NEOs (Near-Earth Objects) that pose an immediate, regional threat (like the Chelyabinsk meteor).
- Observational Bias:** The few labeled real-world streaks are biased toward brighter, slower objects. This results in AI models that are poor at generalizing to the critical, fast-moving, unseen population.



Project solves this problem by applying the **PRIZ Principle 17 (Moving to a New Dimension)**, shifting the entire training process from the expensive, limited "Real Data Dimension" to the unlimited, zero-cost "Synthetic Data Dimension."

# FUTURE WORK: GLOBAL DEPLOYMENT FOR PLANETARY SECURITY



## SCALABILITY

GPU-Native: The model utilizes GPU parallelism, enabling rapid processing of the daily terabytes of data from observatories (ZTF, ATLAS, LSST).



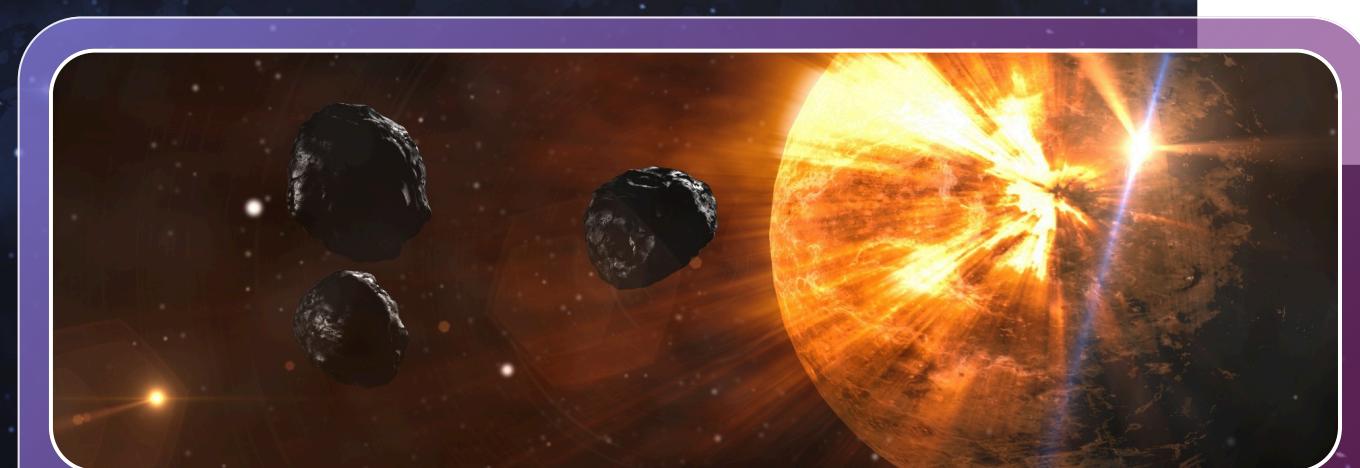
## INTEGRATION

Universal Pipeline: The SYNTHARION output (a trained model) can be immediately integrated into the data pipelines of any major survey telescope globally.



## NEXT STEP

Orbital Linking: Develop the final module to link the detected streak coordinates across multiple nights, automatically calculate the preliminary orbit, and generate a definitive Red Zone alert.



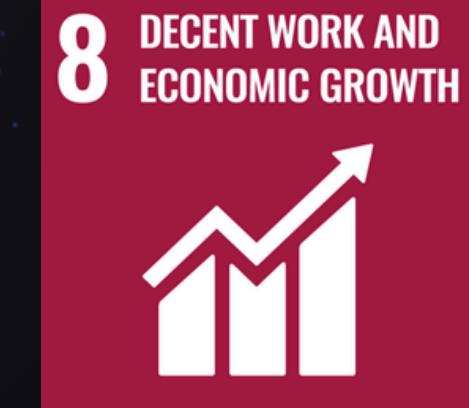
**From Simulation to Security: Training the Technology to See the Unseen!**



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