ESASky: A new window for Solar System Data Exploration

Elena Racero, Fabrizio Giordano & Juan Gonzalez
On behalf of ESAC Science Data Centre (ESDC), European Space Agency

14th October 2018

Solar System Search Engine

❑ Allow users to search through the entire astronomical archives for observations containing Solar System Objects (SSOs), targeted and **serendipitous**!

❑ **Scientific exploitation** of ESDC data holdings.

❑ HST, Herschel and XMM-Newton missions.
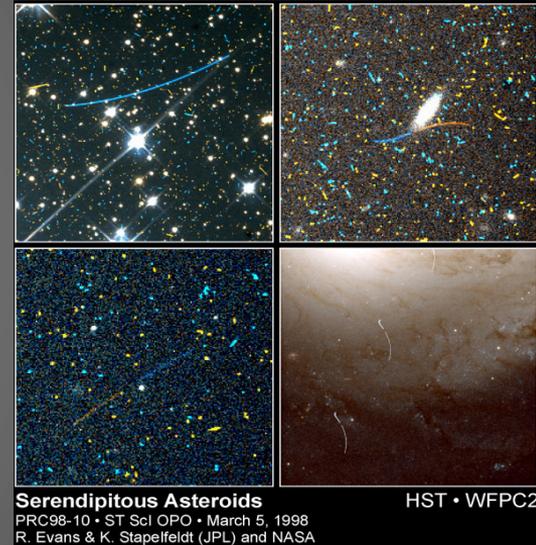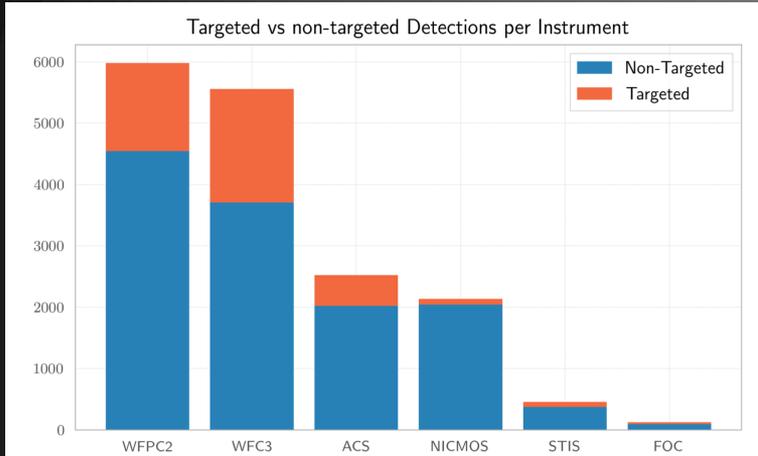
Serendipitous Asteroids
PRC98-10 • ST ScI OPO • March 5, 1998
R. Evans & K. Stapelfeldt (JPL) and NASA

HST • WFPC2

Solar System Search Engine

HST Near Earth Object (NEO) population: Total #Detections

Targeted vs non-targeted Detections per Instrument

Work presented at ESA SSW11 @ESTEC.
Credits: A.Mahlke

European Space Agency

Solar System Search Engine

HST Near Earth Object (NEO) population: Total #Detections

Targeted vs non-targeted Detections per Instrument
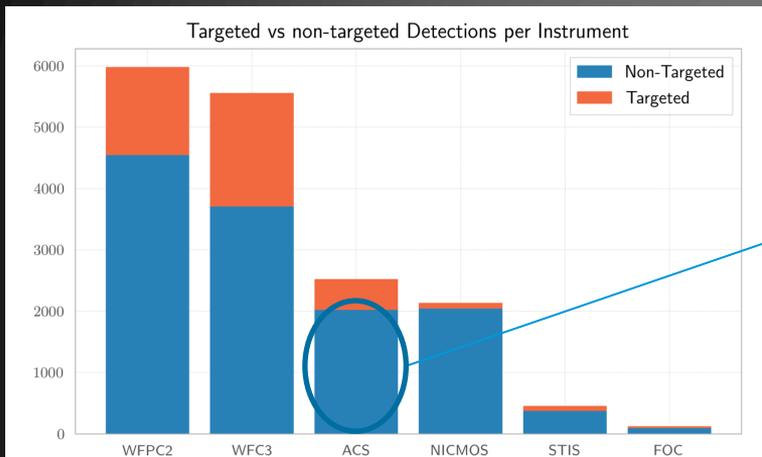
Work presented at ESA SSW11 @ESTEC.
Credits: A.Mahlke
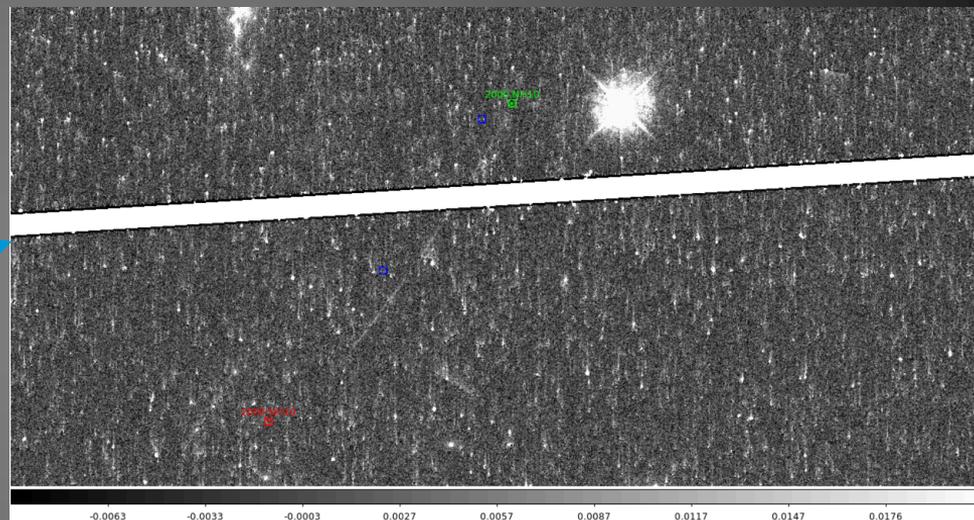
Example 1: a non-targeted observation from ACS for NEO 2000 NH10. Green and red regions mark calculated start and end of asteroid streak by the ESASky algorithm.

European Space Agency

Solar System Search Engine

HST Near Earth Object (NEO) population: Total #Detections

Targeted vs non-targeted Detections per Instrument
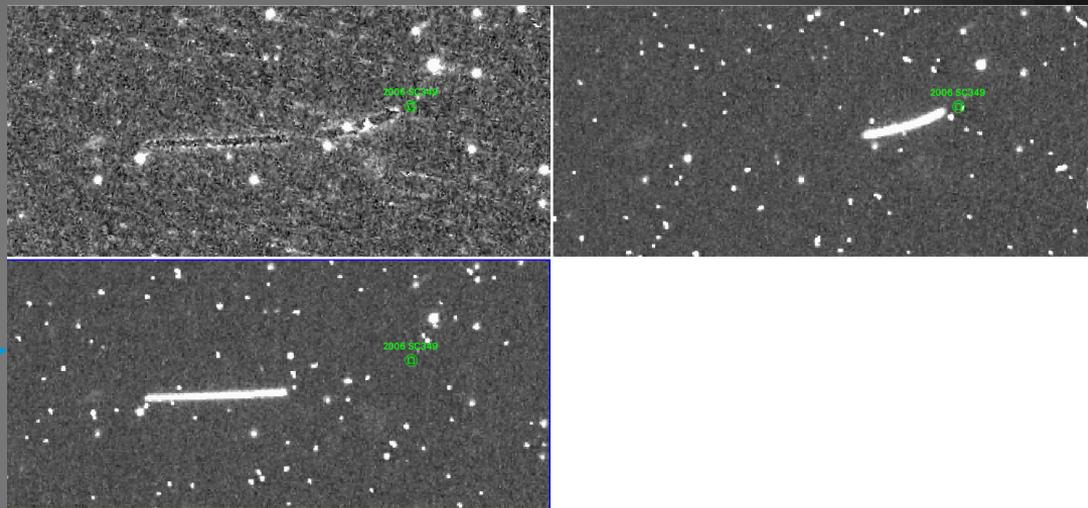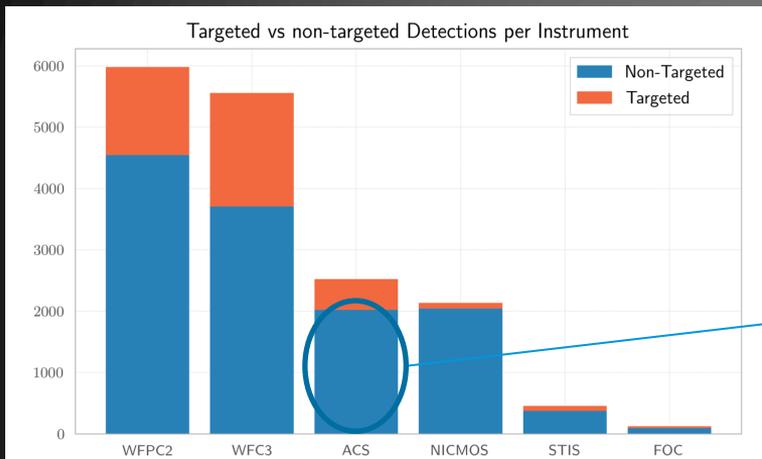
Work presented at ESA SSW11 @ESTEC.
Credits: A.Mahlke

Example 2: Serendipitous observation of NEO 2006 SC349 by the ACS. The predicted position at the beginning of the observation is shown in green.

Solar System Search Engine

Herschel total #detections of SSOs = 336879

European Space Agency

Solar System Search Engine

Herschel total #detections of asteroids ($m_v < 18.0$): 3437

Targeted
24%

Serendipitous
76%

European Space Agency

Solar System Search Engine

Herschel total #detections of SSOs ($m_v < 18.0$)

SSO Pipeline

Orbital Parameters → Ephemerides Computation → Cardinality Reduction → Real Cross-Match

SSO Pipeline

Orbital Parameters → Ephemerides Computation → Cardinality Reduction → Real Cross-Match
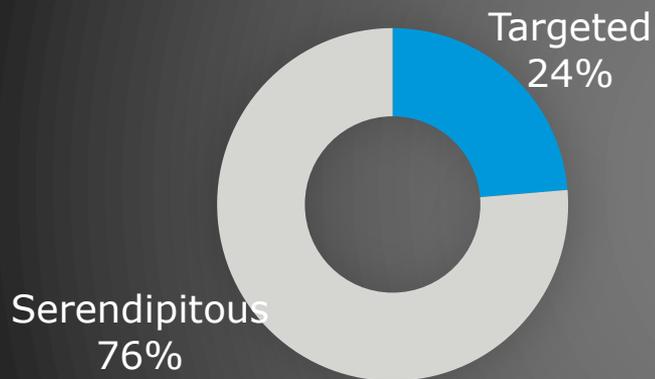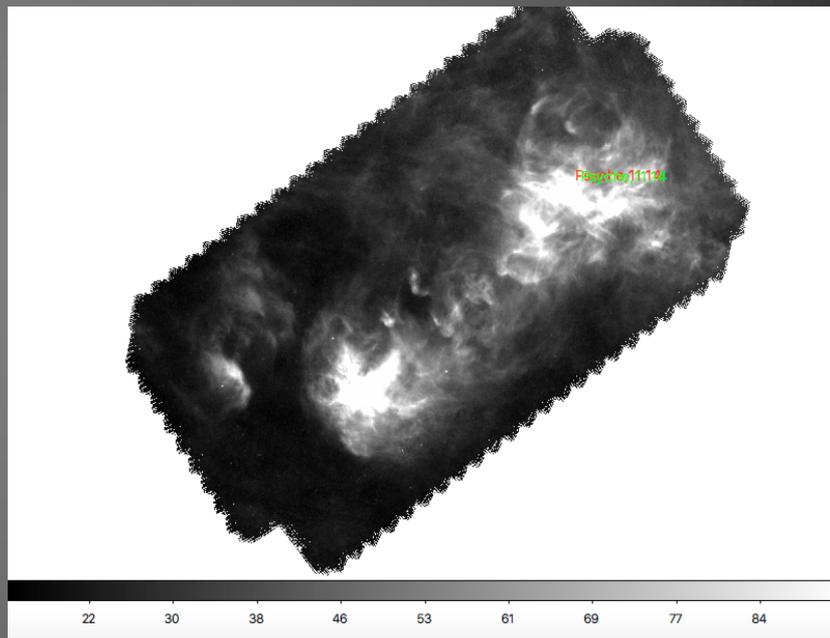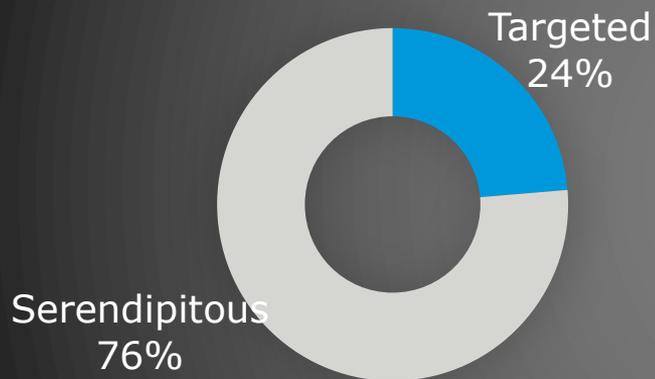
ASTORB
Asteroid dataset @ Lowell Observatory

COMETPRO
Comet dataset @ iMcce

European Space Agency

SSO Pipeline

```
Orbital          →  Ephemerides  →  Cardinality  →  Real
Parameters          Computation     Reduction       Cross-Match
```

- ❑ Eproc v3.2

- ❑ Orbit sampled evenly every 10 days

European Space Agency

SSO Pipeline

European Space Agency

SSO Pipeline

```
Orbital        →   Ephemerides   →   Cardinality   →   Real
Parameters         Computation       Reduction         Cross-Match
```
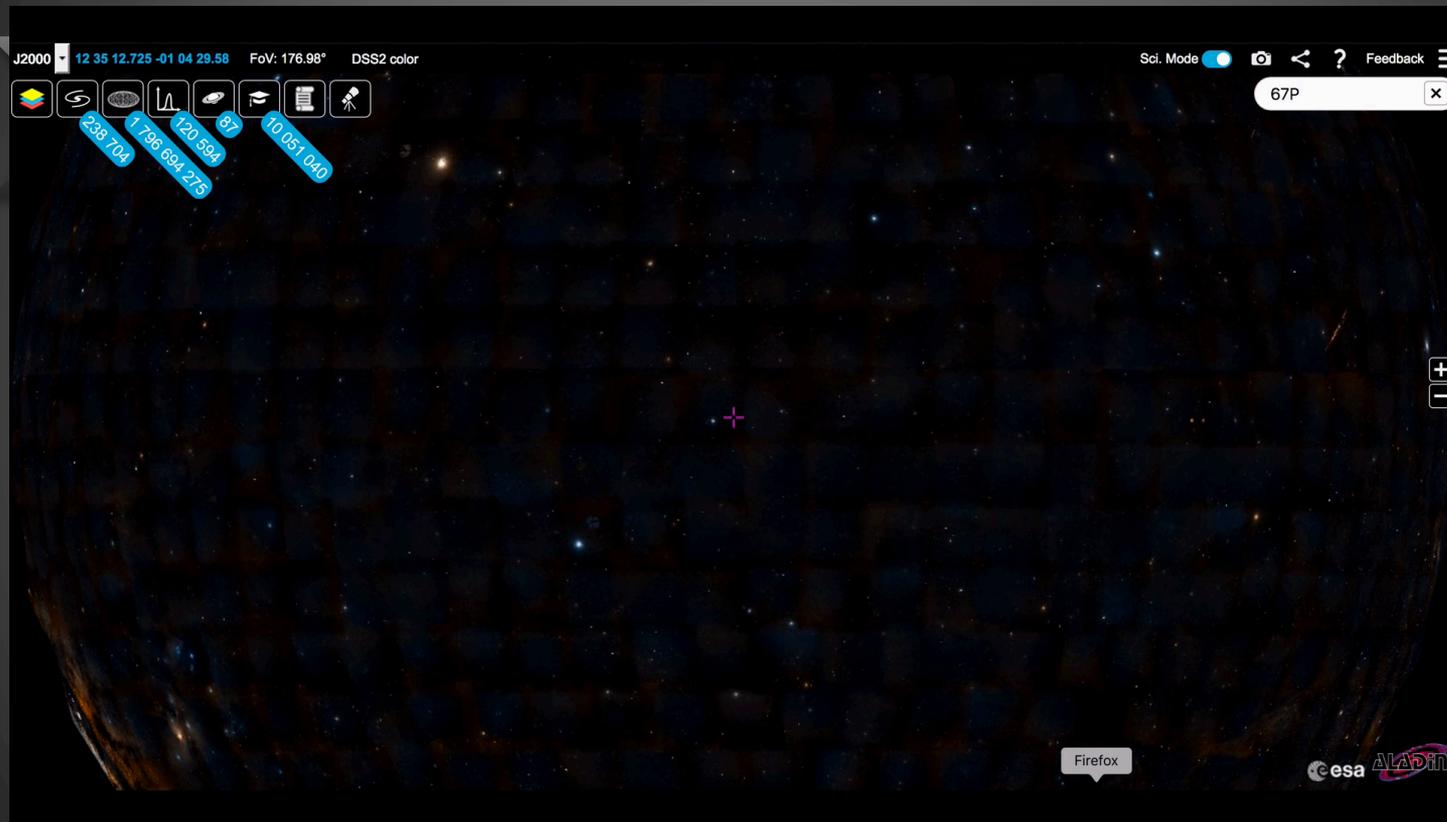
- ❑   Eproc v3.2

- ❑ Orbit sampled evenly every 10 days

- ❑ Spacecraft SPICE kernels:

    HST: public @ http://naif.jpl.nasa.gov/pub/naif/HST/

    Herschel: OEM provided by SOC and kernel produced in-house.

   XMM-Newton: provided by SOC (P.Rodriguez)

SSO Pipeline

Orbital Parameters → Ephemerides Computation → **Cardinality Reduction** → Real Cross-Match

❑ Possible candidates selection based on HEALPix sky tesselation.

❑ HEALPix order selected based on distance to the object and proper motion.

Order 0   Order 1   Order 2   Order 3

SSO Pipeline

Orbital Parameters	Ephemerides Computation	Cardinality Reduction	Real Cross-Match
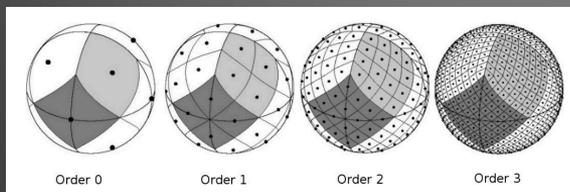
❑ Precise cross-match: position of SSO re-computed using start time and duration of observation and cross-match performed against image footprint.

ESASky Concept

Goal: to facilitate data discovery and archival science for ALL users

- Multi-wavelength
- Project agnostic
- Exploration

Interface "on top of" all ESA astronomy archives

ESASky - sky.esa.int

Legacy: IUE, Hipparcos | Herschel | XMM-Newton | Chandra (NASA) | HST | Gaia | Planck | ISO | Integral | EXOSAT | SUZAKU (JAXA) | Future: JWST, Euclid, ..

European Space Agency

Final Remarks

❑ In collaboration with IMCCE, we've added functionality through ESASky that **allows fast discovery of observations from ESA missions that potentially contain SSOs within their field of view.**

❑ The value of this service is that it allows you **to visualize the exact predicted position of the solar system object superimposed to a satellite image.**

❑ Current version contains all asteroids, comets and planets observed by HST, Herschel and XMM-Newton (EPIC) missions.

❑ Future work:

- Orbital parameters input interface

- Add SSO functionality on ESASky Astroquery module

- Include observations from other missions

esa

Feedback:
http://esasky.userecho.com

J2000 11 24 00.029 +06 19 54.85 FoV: 09.95' DSS2 color Sci. Mode Feedback

Saturn

ub963203m

		Observatio...				Dec end		Pos.Err Start		Pos.Err End		Mag. V		Distance	
		ub963208m				341173						0.67		8.4173	
		ub963206m				341115						0.67		8.4173	
		ub963207m				341144						0.67		8.4173	
✔		ub963203m	SATURN-TITAN	170.965636	6.341017	170.965636	6.341017					0.67		8.4174	
		ub963205m	SATURN-TITAN	170.965331	6.341086	170.965327	6.341087					0.67		8.4173	
		ub963204m	SATURN-TITAN	170.965456	6.341058	170.965453	6.341059					0.67		8.4174	
		ub963201m	SATURN-TITAN	170.965966	6.340929	170.965963	6.340					0.67		8.4174	

HST

Total mission coverage

LINKS

http://sky.esa.int

➤ **How to use ESASky and links to help pages:**

https://www.cosmos.esa.int/web/esdc/esasky-how-to

➤ **API: Astroquery python module information:**

https://www.cosmos.esa.int/web/esdc/esasky-astroquery-module

➤ **API: ESASky TAP:**

http://sky.esa.int/esasky-tap/tap

➤ **Observations Planning tool:**

https://www.cosmos.esa.int/web/esdc/esasky-interface#planning

➤ **How to contribute data to ESASky:**

https://www.cosmos.esa.int/web/esdc/esasky-contributing

European Space Agency