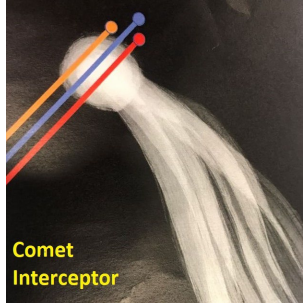


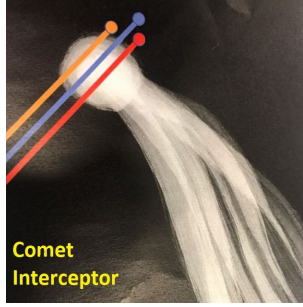
Comet Interceptor’s Back-Up Targets

Mark Kidger & Michael Kueppers

SOC

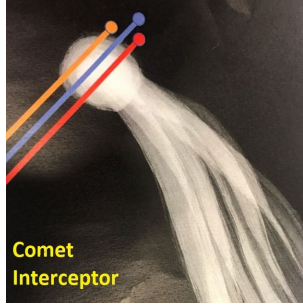
ESAC

Why go to a Back-up Target?



- It is estimated that there is an ~20% risk of finding no suitable target comet up to three years after launch → **forced switch to back-up target**.
- The target discovery window may, in extreme circumstances, according to the final launch date, extend to 2.5 to 4 years after launch.
  - **The best case scenario**: >4 years from launch until the commit to a back-up target, is given for a launch in **Q3 2030**, or in **Q1 2031**.
  - **The worst case scenario**: <3 years from launch to commit, is found in Q2 2030, or from Q2 2032 onwards.

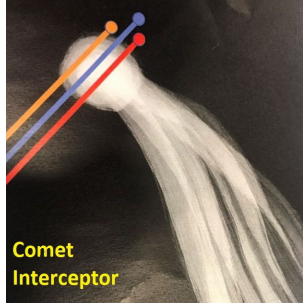
Our Back-up Targets in the Red Book



1. Launch from 2029-03-24 to 2030-05-18: **15P/Finlay**
2. Launch from 2030-05-18 to 2030-12-14: **289P/Blanpain**
3. Launch from 2030-12-14 onwards: **300P/Catalina**

As the ARIEL launch is now baselined to be Q4 2029, an encounter with 26P/Grigg-Skjellerup, which would only cover 2029-01-01 to 2029-03-24, is no longer expected to be feasible.

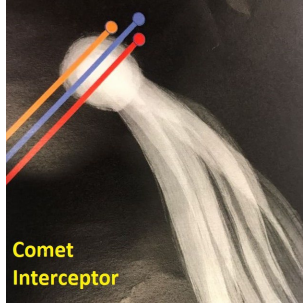
What a Back-up Target Implies



- Much lower encounter velocity than for a DNC.
  - **9.5 km/s, 289P/Blanpain**
  - **11 km/s, 15P/Finlay**
  - **13.5 km/s, 300P/Catalina**

- A much closer pass distance is compatible with the CoCa Rotating mirror assembly and MIRMIS scan mirror, but…
  - *May not be feasible due to targeting constraints*.
- Longer time available to do science at the comet.
- But…
  - **Much lower activity → closer pass may not compensate, even if feasible.**
  - **Smaller nuclei than 1P/Halley.**

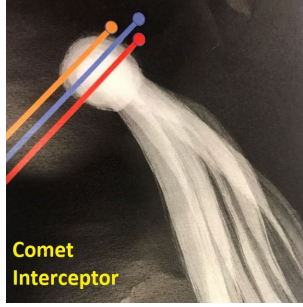
Nucleus Diameter Estimates



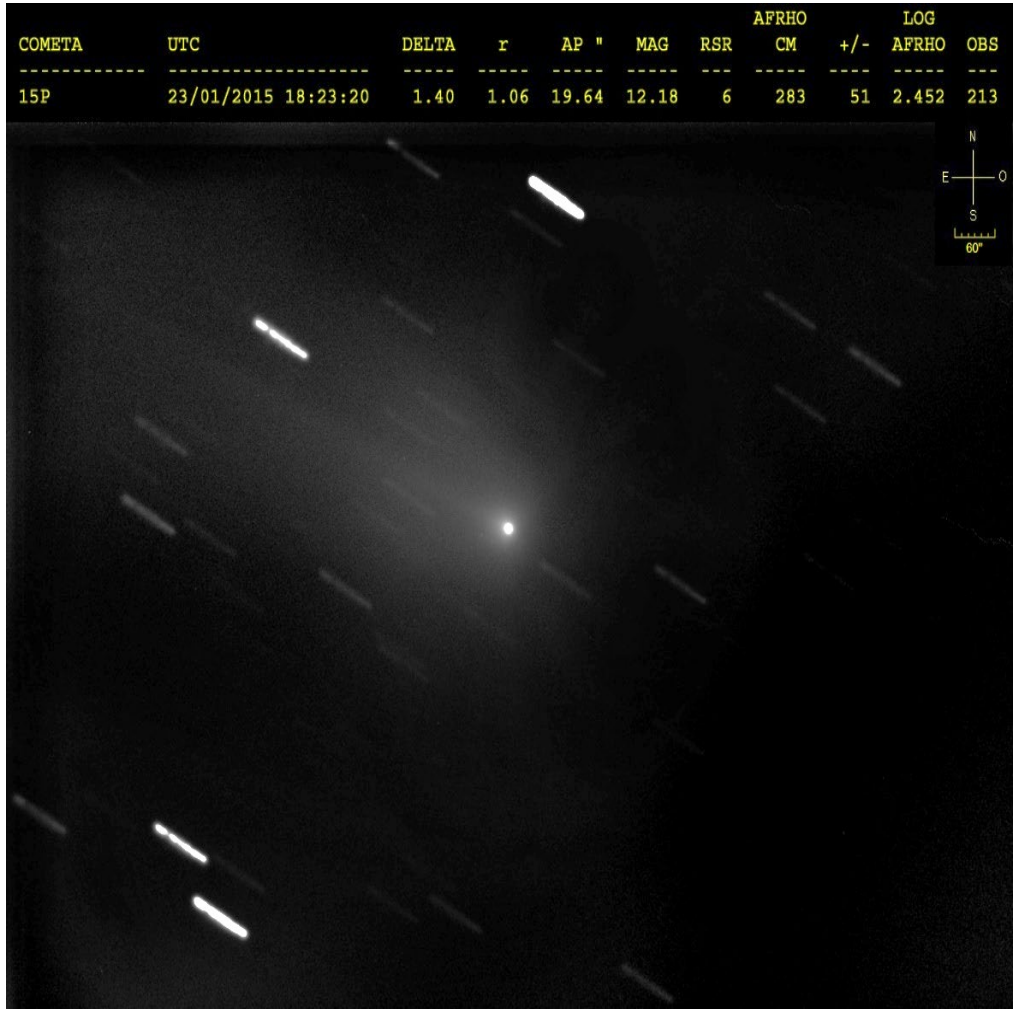
	Estimated diameter	Reference
15P/Finlay	0.4-2.8 km[1] 1.86 km	Mendis et al., 1985, Fundam. Cosmic Phys., 10, 1 Fernández et al., 2013, Icarus, 226, 1138
289P/Blanpain	0.32 km	Jewitt, D., 2006, AJ, 131, 2327
300P/Catalina	1.4km (radar) 2.5km (coma subtraction)	Harmon, J.K. et al., 2006, Icarus, 184, 285 Fernández et al., 2013, Icarus, 226, 1138

[1] Dependent on the nucleus albedo and the assumption that the nucleus is inactive at aphelion.

15P/Finlay

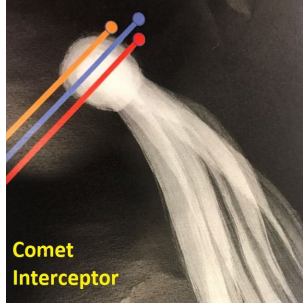


- Discovered in 1886.
  - **Observed at 15 of 20 returns.**
  - **Close to naked-eye visibility in 1906.**
- Absolute magnitude faded by ~0.5 magnitudes per return.
  - **H=8.5 (1886 return) to H=16 in 1981 (Kresak L., Kresakova M., 1989, Bull. Astron. Inst. Czech., 40, 269).**
- Outburst several times at 2015 return (Ishiguro et al., 2015, AJ, **152**, 169).

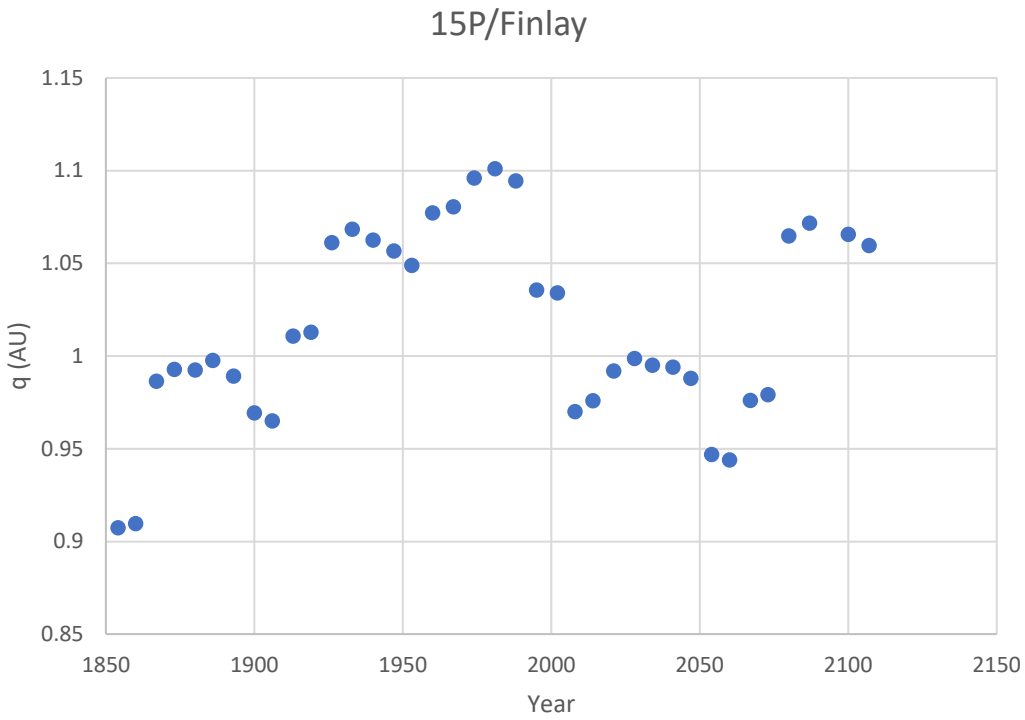


15P/Finlay at r=1.06AU (T+27 days)

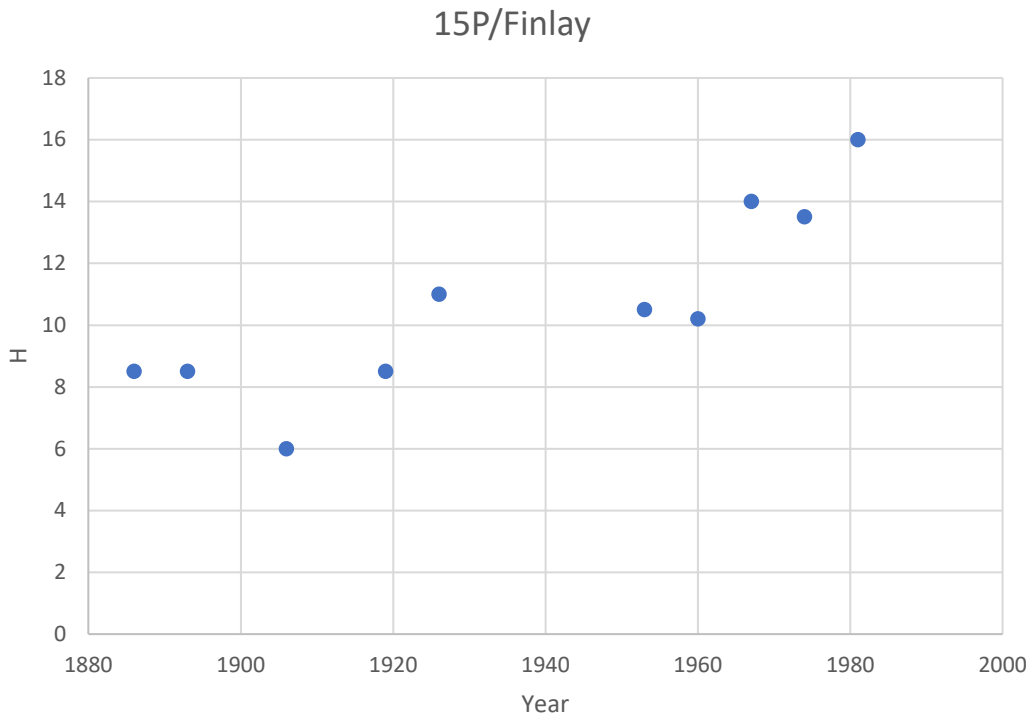
15P/Finlay



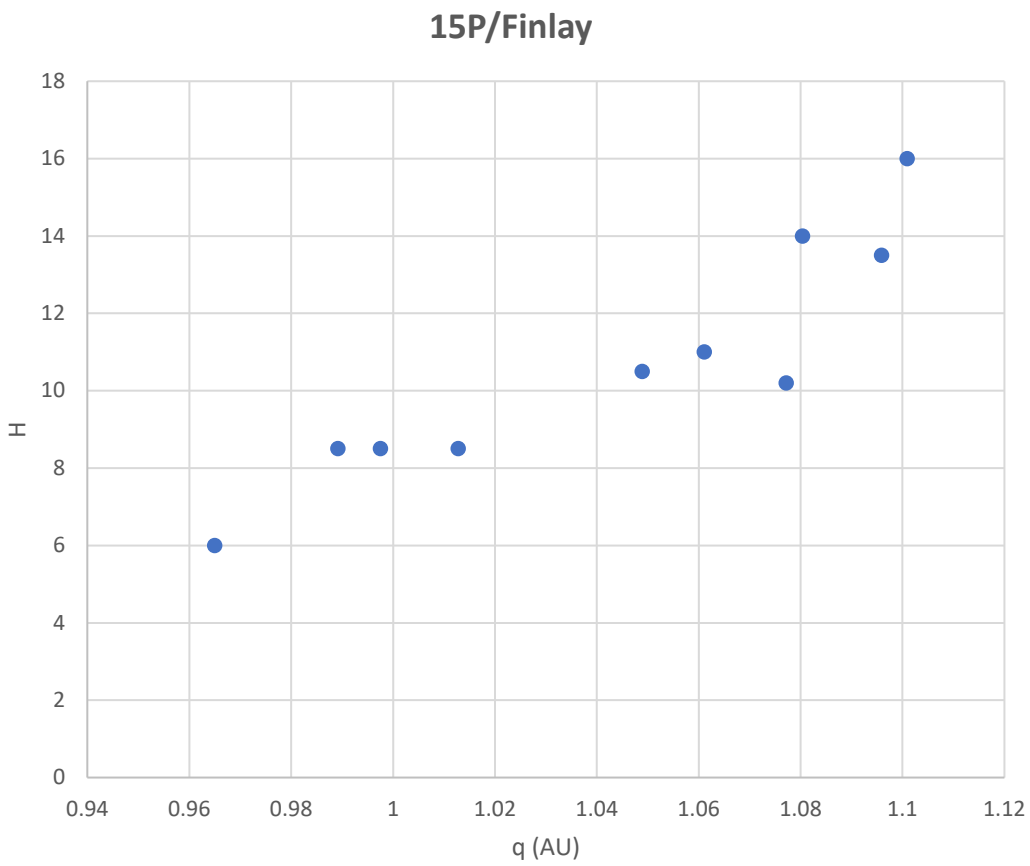
Perihelion distance evolution



Absolute magnitude evolution

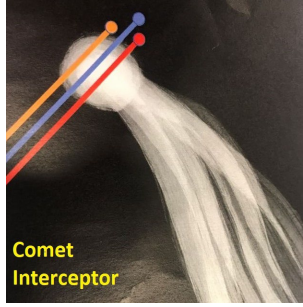


15P/Finlay



- Strong correlation of absolute magnitude (i.e., activity) with perihelion distance.
  - Significantly weaker correlation with time.
- **An increase in 0.14 AU in perihelion distance → 10^4 reduction in activity**.
  - Why such a large decrease???

15P/Finlay

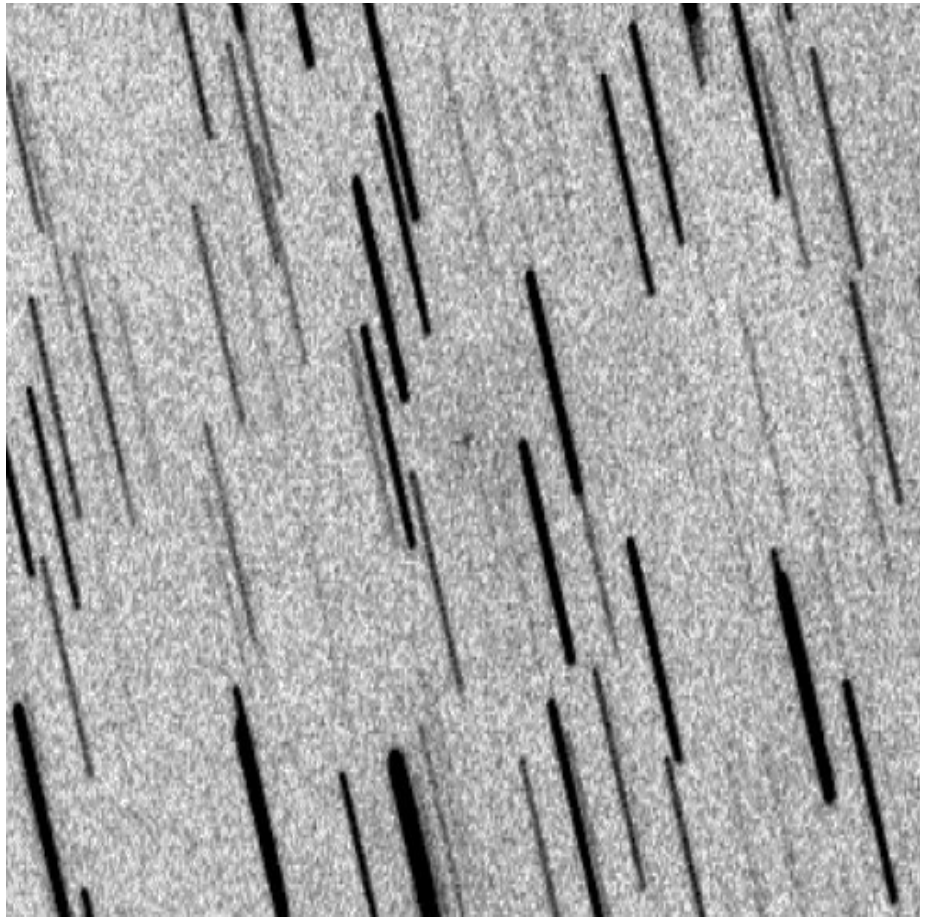


- Date of departure: **18/08/2033**
- Date of encounter: **19/09/2034**
- Encounter relative velocity: **11km/s**
- Dust production rate (estimated): **7×10^{-5} Halley**
- Scaled encounter distance for dust production equivalent to 1P/Halley: **7km**

- **Second best Earth-encounter in two and a half centuries in 2034.**
- **Perihelion passage: 2034 September 8 (Encounter – 11 d)**
- **Geocentric distance: 0.345AU at encounter.**
  - **Encounter circumstances are close to the best possible for this comet.**
- **Morning object in Gemini (5º Galactic Latitude) at encounter, 80º solar elongation.**

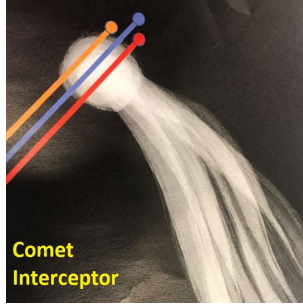
289P/Blanpain

- Discovered in 1819 in major outburst.
  - **Lost until 2003, when recovered as NEA 2003 WY_{25}.**
  - **Brief outburst of ~8 magnitudes, ~420 days before perihelion in 2013, around r ≈ 3.9AU.**
- Parent of Phoenicid meteor stream.
  - **Total stream mass of 10^{11}kg.**
  - **Far larger than can be explained by the current level of dust emission of 10^{-2} kg/s (Jewitt, 2006).**

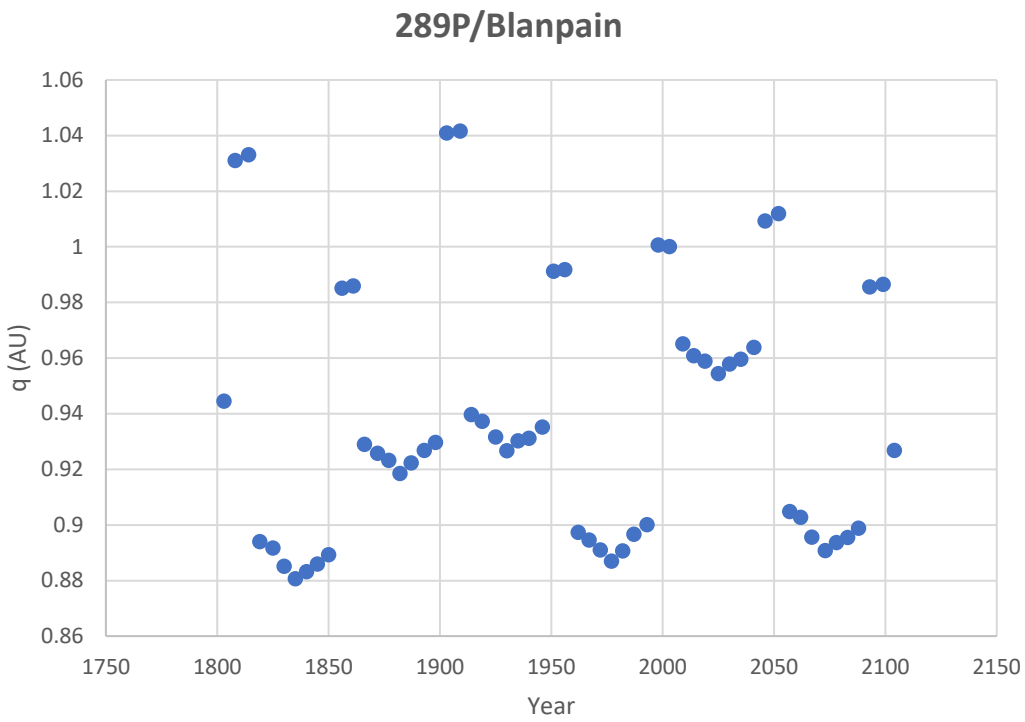


289P/Blanpain at r=0.966AU (T+8 days) – 2019 return.

289P/Blanpain



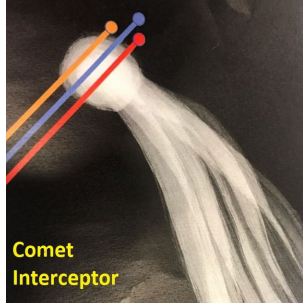
Perihelion distance evolution



Orbit Evolution

- Orbit fairly stable since 1800, with no major orbit changes.
- Significant perihelion jumps between successive apparitions.
  - Range from 0.881AU (in 1835) to 1.042AU (in 1909).
- Typically
  - Seven returns at a stable, lower perihelion distance, followed by two at an increased distance, before jumping back.

289P/Blanpain

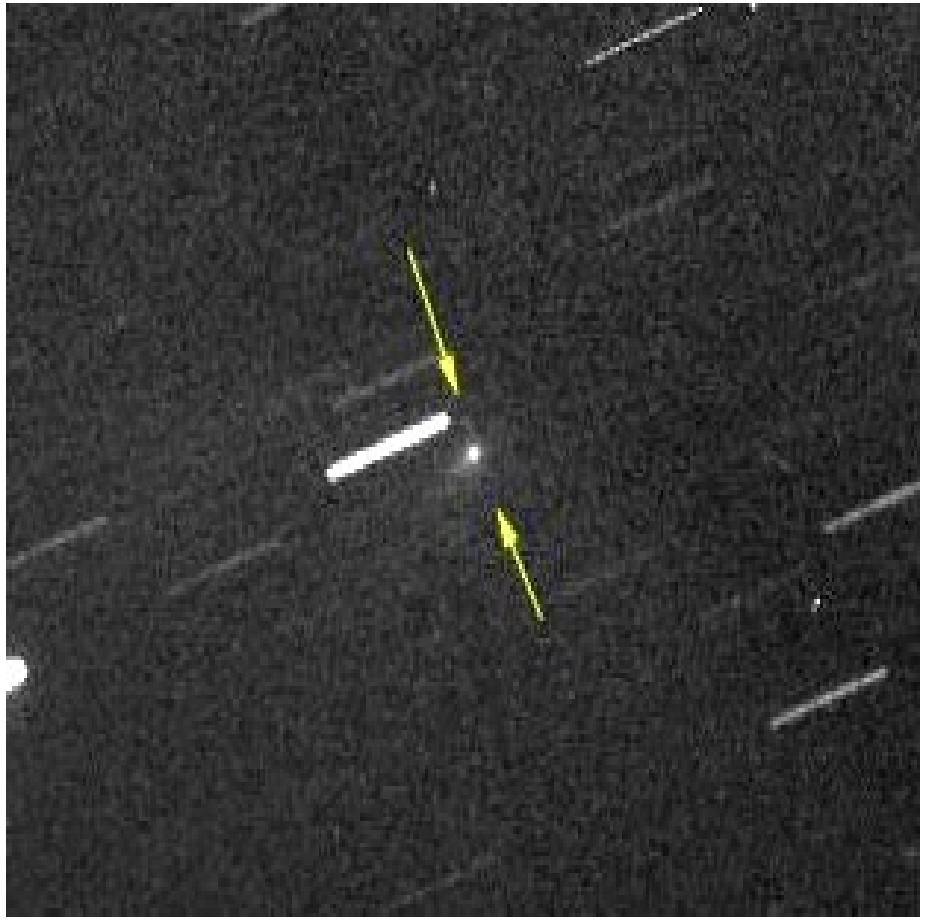


- Date of departure: **04/02/2035**
- Date of encounter: **23/11/2035**
- Encounter relative velocity: **9.5 km/s**
- Dust production rate (estimated): **10^{-7} Halley**
- Scaled encounter distance for dust production equivalent to 1P/Halley: **0.4 km**

- **Second best Earth-encounter in three centuries in 2035.**
- **Perihelion passage: 2035 November 20 (Encounter – 8 d)**
- **Geocentric distance: 0.141AU at encounter.**
  - **Encounter circumstances almost the best possible, with the encounter very close to Earth.**
- **Comet fairly well positioned in the evening sky at encounter (77º solar elongation in Leo/Sextans).**

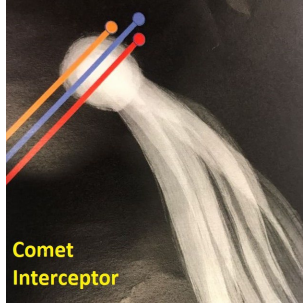
300P/Catalina

- Discovered in 2005 during a very close Earth encounter.
  - **9th shortest orbital period known (4.42 y).**
- Nucleus has very low albedo (0.033) and fast rotation (<7 hours) [**Harmon et al., 2006**].

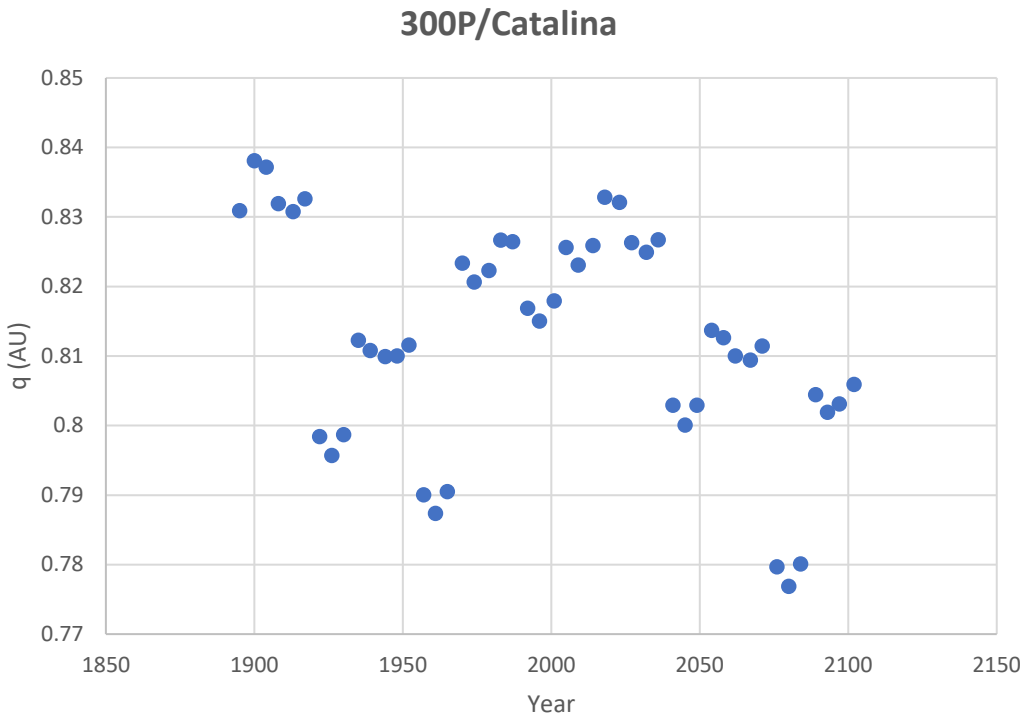


300P/Catalina at r=1.090 AU (T+8 days) – 2019 return.

300P/Catalina



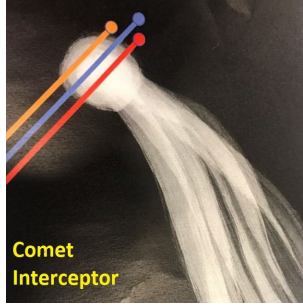
Perihelion distance evolution



Orbit Evolution

- Very stable orbit.
- Slight trend to decreasing perihelion distance 1900-2100.

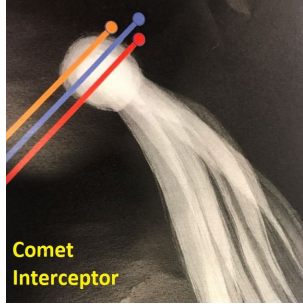
300P/Catalina



- Date of departure: **17/11/2035**
- Date of encounter: **20/06/2036**
- Encounter relative velocity: **13.5 km/s**
- Dust production rate (estimated): **8×10^{-6} Halley**
- Scaled encounter distance for dust production equivalent to 1P/Halley: **2 km**

- **Closest approach to Earth: 0.0537AU, on 2036 June 8th.**
- **Perihelion passage: 2036 July 18 (Encounter + 28 d)**
  - **Comet activates suddenly at T-80d and brightens as r^{-11}.**
  - **Probably very low activity at encounter.**
- **Geocentric distance: 0.152AU at encounter.**
- **Comet a morning object in Aries, at only 47º solar elongation.**
  - **Very limited ground-based support at encounter.**

Conclusions



- Of the three back-up targets listed in the Red Book, probably 15P/Finlay is the most interesting, although all offer significant challenges for the Comet Interceptor instruments in terms of activity ($<10^{-5}$ Halley).
- 289P/Blanpain appears to have an extremely small nucleus, as well as low activity → *small pass distance essential, even to image the nucleus*.
- 300P/Catalina would be encountered rather far from perihelion (pre-perihelion) and would have limited visibility from Earth at encounter.