

EXERCISE

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NOT A REAL WORLD EVENT *This is part of an asteroid threat exercise conducted during the 2015 IAA Planetary Defense Conference.*

Asteroid 2015 PDC Impact Now Certain

Paul W. Chodas (International Asteroid Warning Network/JPL)

Press Conference, December 27, 2016

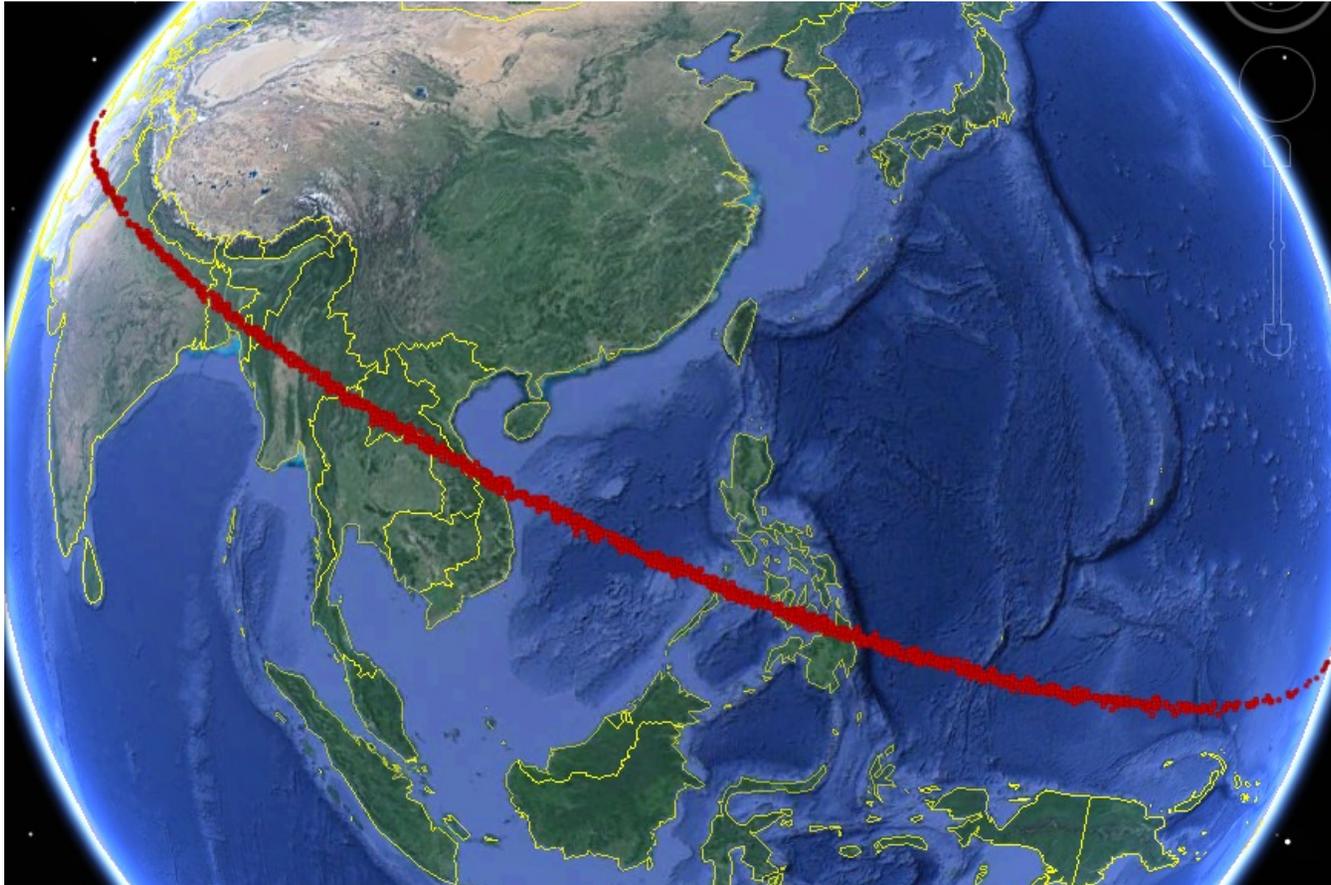
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Chance of Impact in 2022 is Now 100%

- ▶ Based on new tracking observations obtained over the last month, IAWN has determined that asteroid 2015 PDC is on a course that will impact the Earth on September 3, 2022, less than 6 years from now
- ▶ The exact location of the impact cannot yet be determined, but it will occur somewhere within a shortened risk corridor, unless the asteroid is deflected or disrupted
- ▶ Seven Kinetic Impactor missions are being developed, 4 by the U.S., and 1 each by Europe, Russia and China. Officials are confident that in combination, these missions will succeed in deflecting the asteroid away from the Earth, despite uncertainties in the size and mass of the asteroid
- ▶ For more info: <http://neo.jpl.nasa.gov/pdc15/day3.html>

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Updated Risk Corridor for 2015 PDC



Risk corridor is shorter now, starting in the western Pacific Ocean and continuing through the Philippines, South China Sea, Southeast Asia, Myanmar, Bangladesh, India, Pakistan, Afghanistan, Iran, and Turkey

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To Sun

Updated Uncertainty Region in 2022



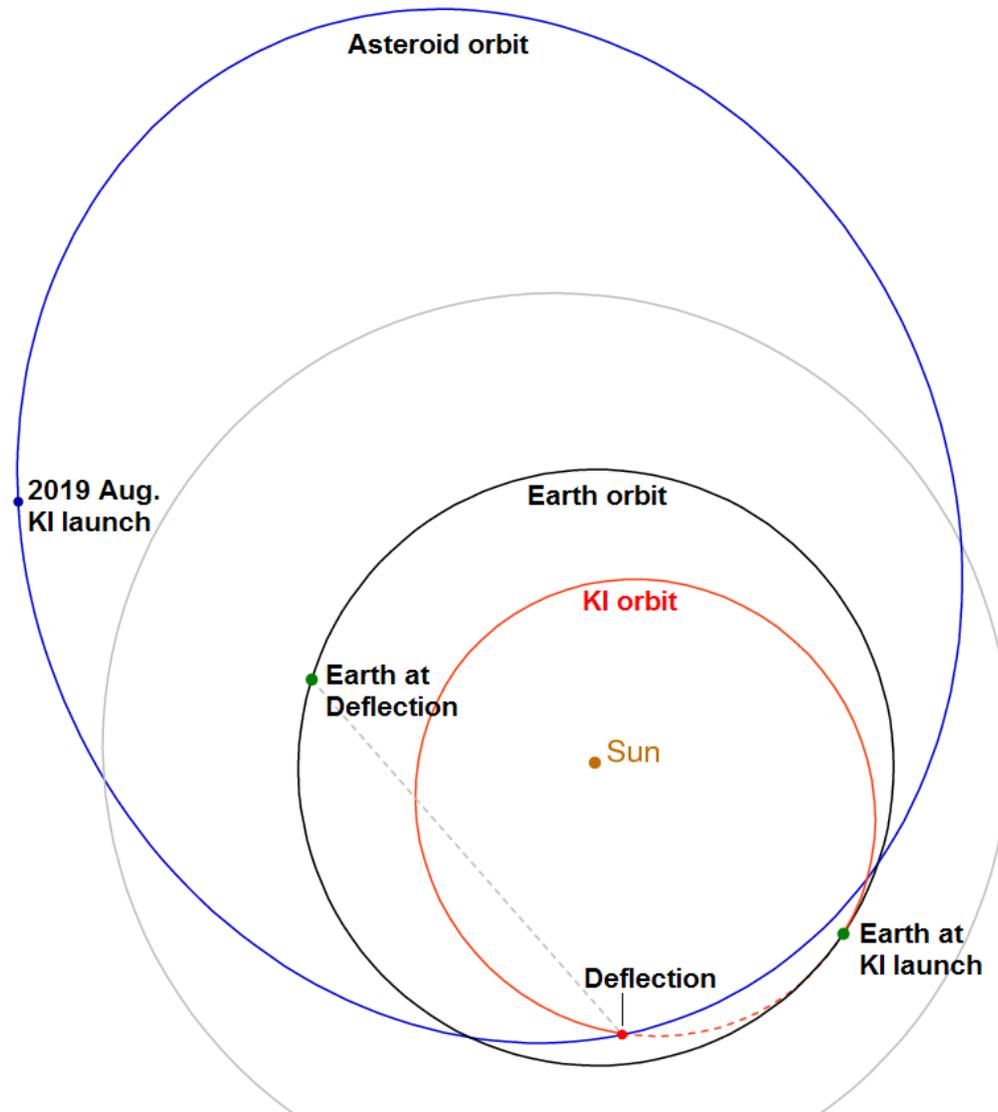
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Kinetic Impactor Mission Design

- ▶ Key parameters are asteroid size and mass, which are still both very uncertain for 2015 PDC
 - ▶ Based on a few photometric color measurements of the asteroid, it is believed to belong to the S-class
 - ▶ Based on average albedo for this class, the **best estimate** of the asteroid size is **150 to 250 meters**, but the **worst case** estimate is still **400 meters**, based on a possible low albedo
- ▶ The amount of deflection required also depends on the precise orbit solution, which is still uncertain
- ▶ Multiple kinetic impactors will be likely be required
- ▶ Kinetic Impactor deflection can only push the trajectory in one direction, towards the leading edge of the Earth

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Kinetic Impactor Trajectory to 2015 PDC



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Design Your Own Deflection Mission



<http://neo.jpl.nasa.gov/nda>

Delta-V Mode | **Intercept Mode**

Time of Deflection (D): 1096 days

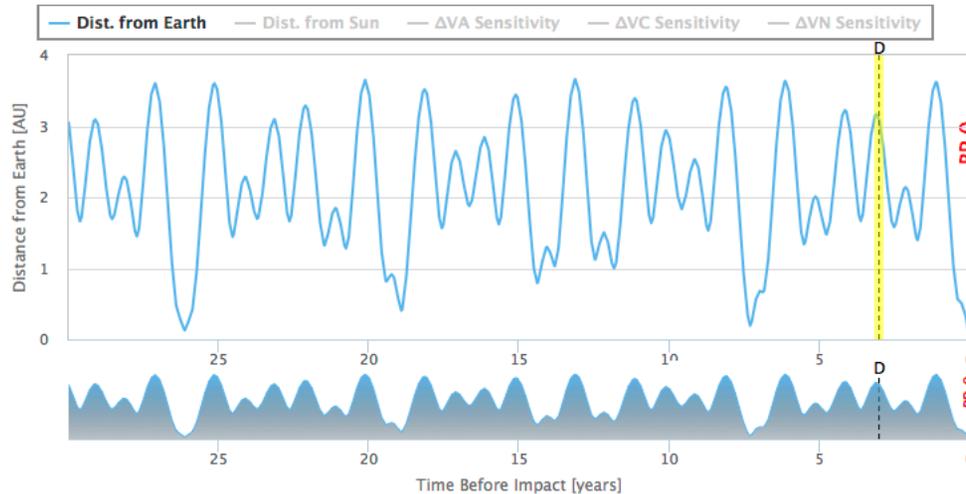
ΔVA : 0.000 mm/s
 ΔVC : 0.000 mm/s
 ΔVN : 0.000 mm/s

Simulated Near Earth Object (NEO)
 PDC15 a=1.78 i=5 e=0.49

Object parameters are only applicable in Intercept Mode

Diameter: 0.14 km
 Density: 1.5 (porous rock) g/cm³
 Beta:
 Mass: kg

Reset | Slider Δ 's | Advanced Mode | Tips

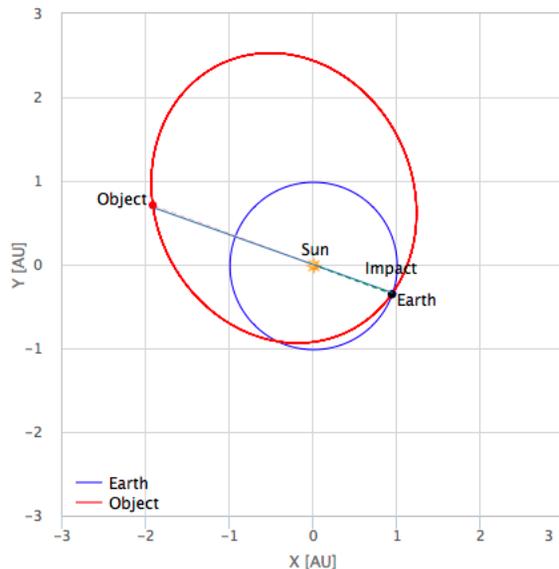


Read overview

Start the app

Take a tour of the app using the 2015 PDC scenario

Orbit and Positions at Deflection



Orbit Changes

ΔVA : 0.000 mm/s
 ΔVC : 0.000 mm/s
 ΔVN : 0.000 mm/s
 Total ΔV : 0.000 mm/s
 Period at D: 864.071 d
 Δ Period: 0.0000 s

B-Plane Values

ζ (zeta): 0.621 R_e
 ξ (xi): -0.436 R_e
 B magnitude: 0.759 R_e
 Capture Rad.: 1.420 R_e
 Perigee Dist.: 0.405 R_e

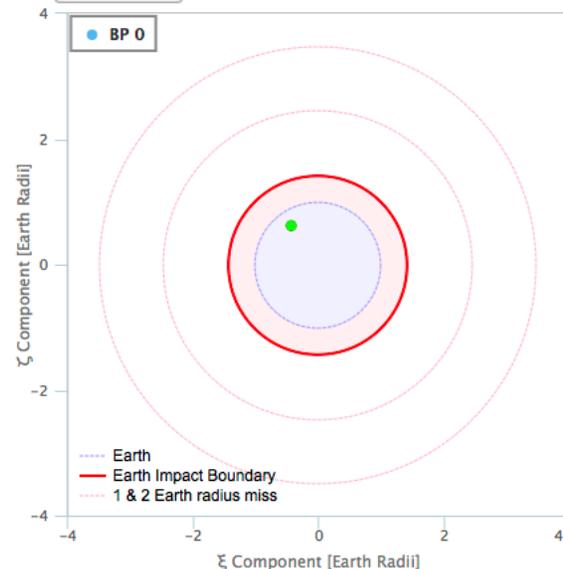
IMPACT

V_{∞} : 11.087 km/s

* R_e = Earth Radii

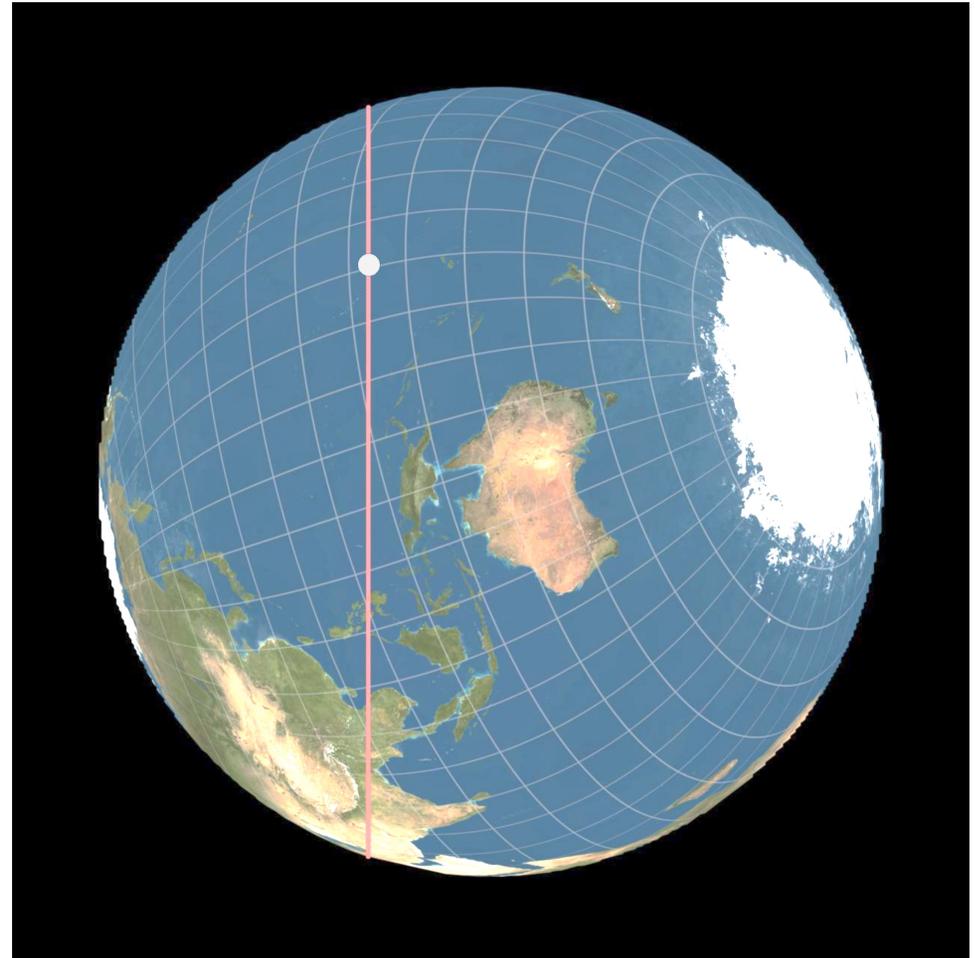
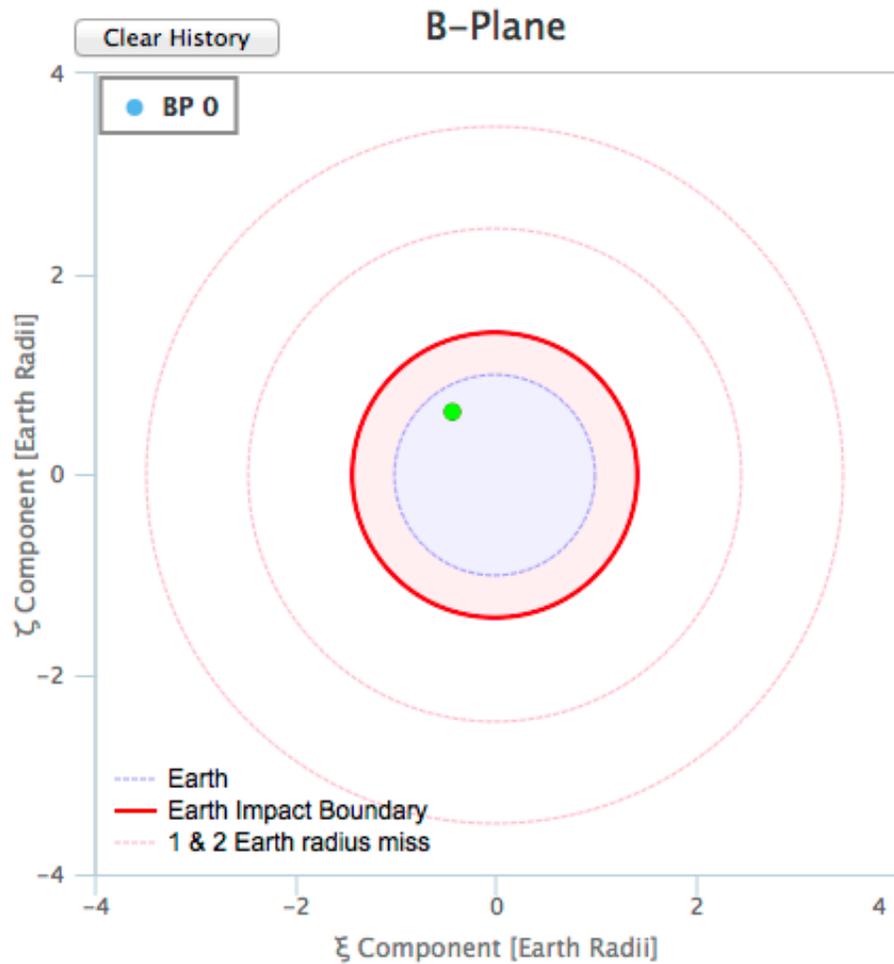
- Save Current Session
- Restore Session
- Deflection Map

B-Plane



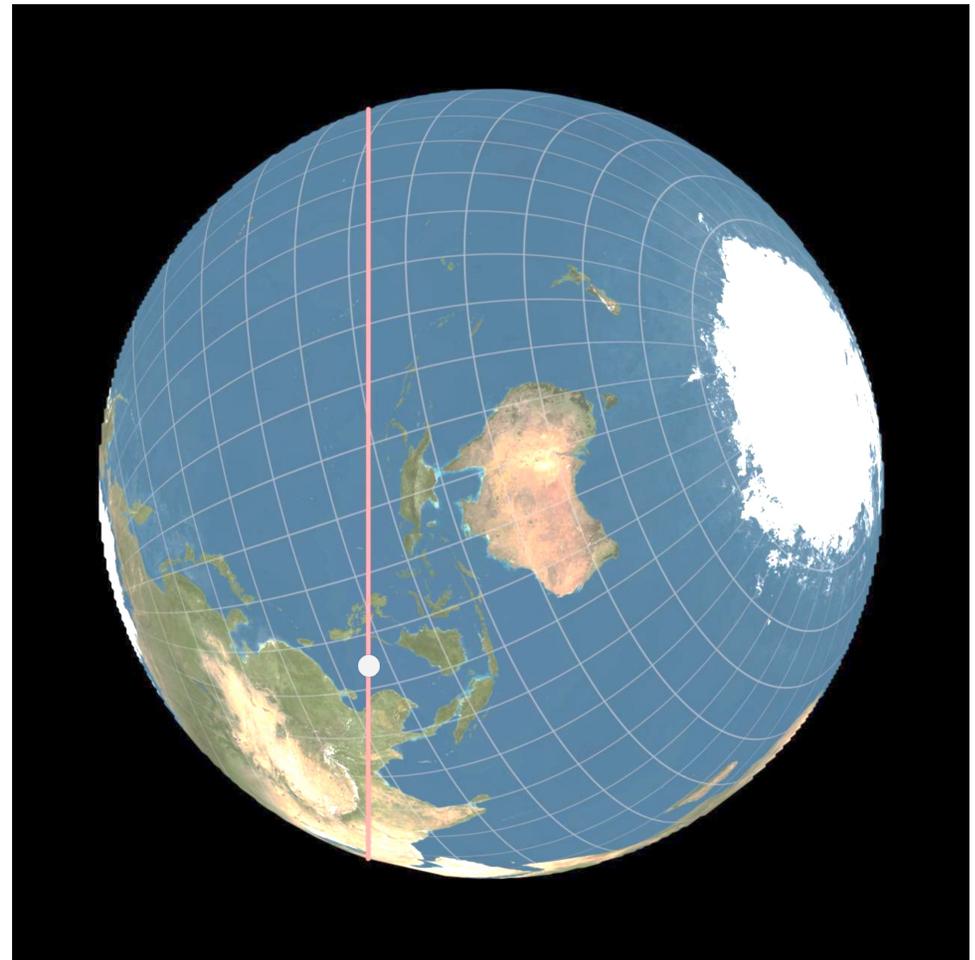
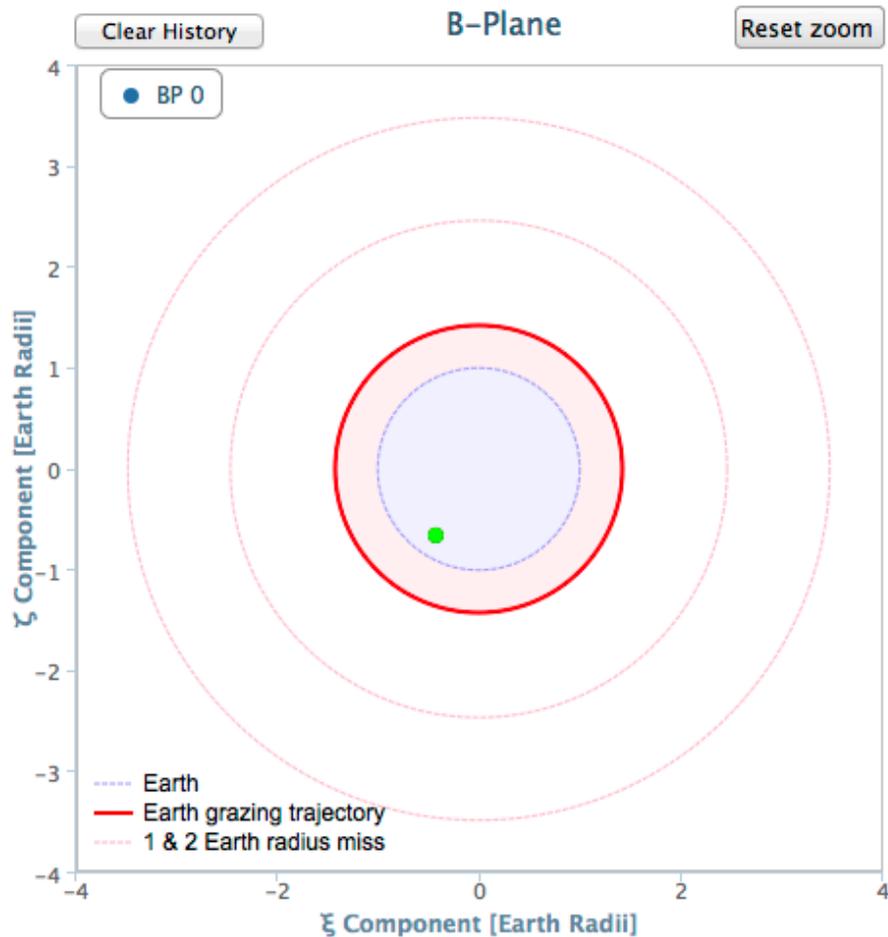
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Nominal Impact Trajectory in Apr. 2016



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Updated Nominal Impact Trajectory



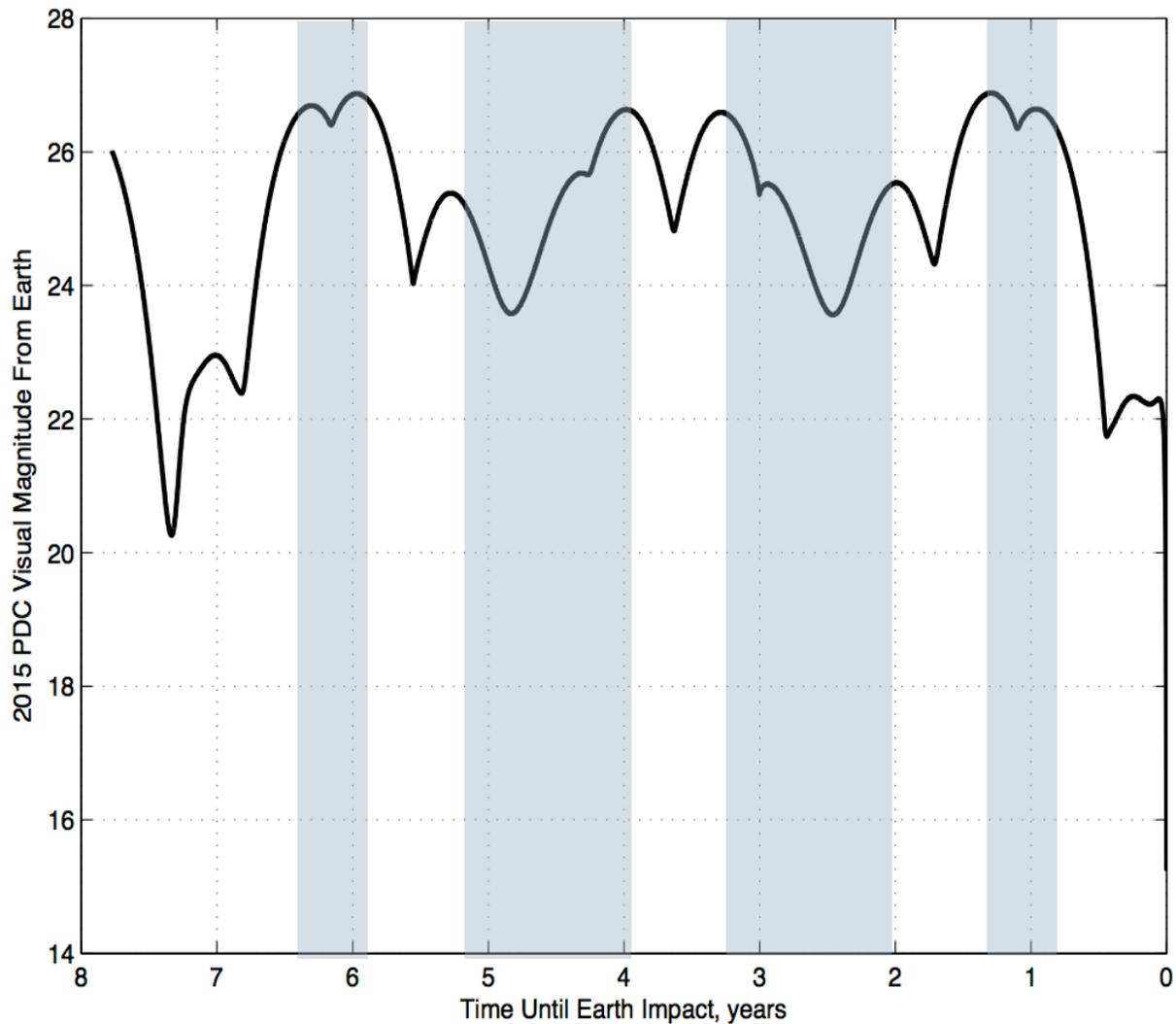
This more precise trajectory can be selected as PDC15a in the NEO Deflection App

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Opportunities for Observer Spacecraft

- ▶ Observer spacecraft could be used to:
 - ▶ Characterize the physical properties of the asteroid
 - ▶ Provide a position fix on the asteroid to reduce orbit uncertainties
 - ▶ Measure the size of deflection achieved
- ▶ 2015 PDC is in a difficult orbit to reach and time is short
- ▶ Flyby observers: There are a few opportunities for launch in 2018 and 2019, but they arrive around the time of deflection and would only assist in targeting
- ▶ Rendezvous observer: There is one opportunity for a launch in March 2020, a flyby of Venus, and arrival at the asteroid in Sep. 2021, 18 months after the deflection

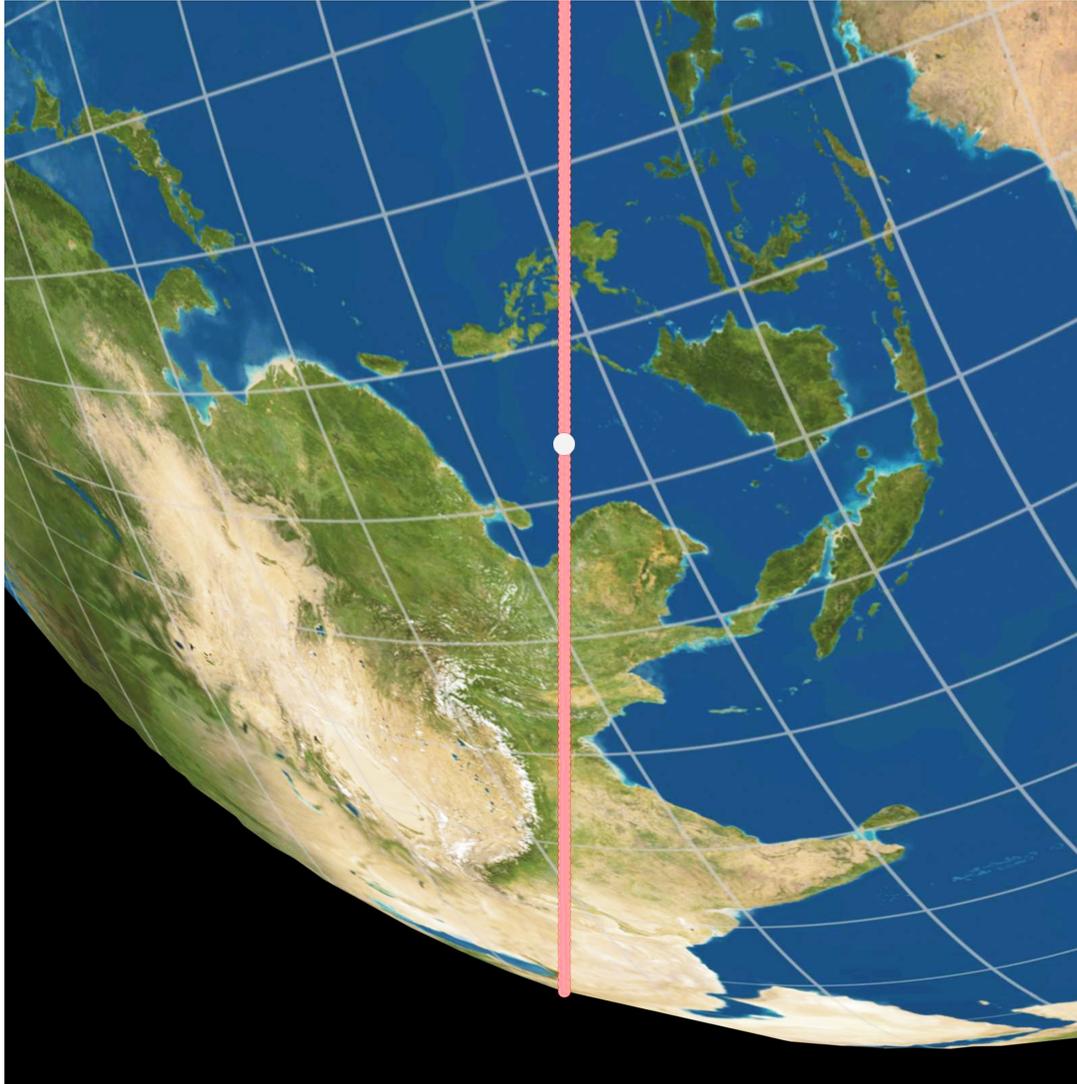
Visual Magnitude vs. Time to Impact



2015 PDC is unobservable within shaded regions due to low solar elongation

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Close-up of Risk Corridor in B-Plane



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