EXERCISE EXERCISE EXERCISE

Hypothetical Asteroid Impact Exercise

Panel 1b: Acting on results from an information-gathering space mission

Point of Contact: Terik Daly
terik.daly@jhuapl.edu

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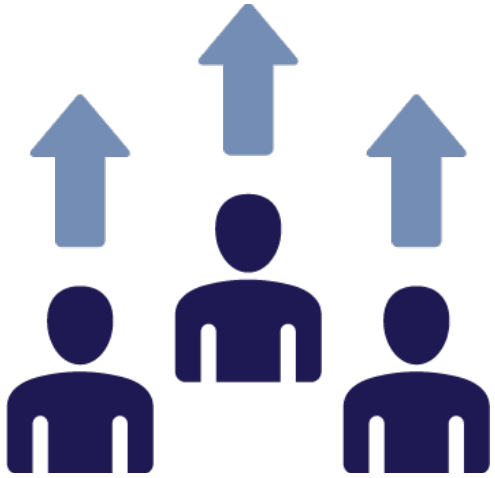
Panel Objectives



Awareness Raising

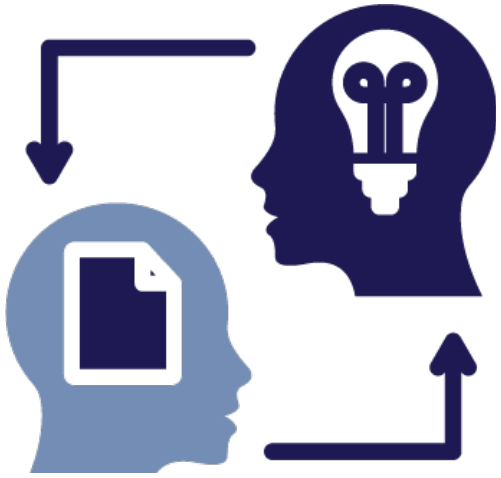
Raise awareness about the nature of asteroid threats and challenges related to preparing for an effective international response

International Views

Hear international viewpoints about asteroid impact threats and potential ways of responding to them

Decision Making

Discuss ways of communicating with decision makers about a potential asteroid impact and options for responding to it



Perception

Expand perspectives of planetary defense specialists about how non-specialists perceive asteroid impact threats

Meet the Presenters

Kelly Fast

NASA Headquarters & International Asteroid Warning Network

Nancy Chabot

Johns Hopkins University Applied Physics Laboratory

Lorien Wheeler

NASA Ames Asteroid Threat Assessment Project

Detlef Koschny

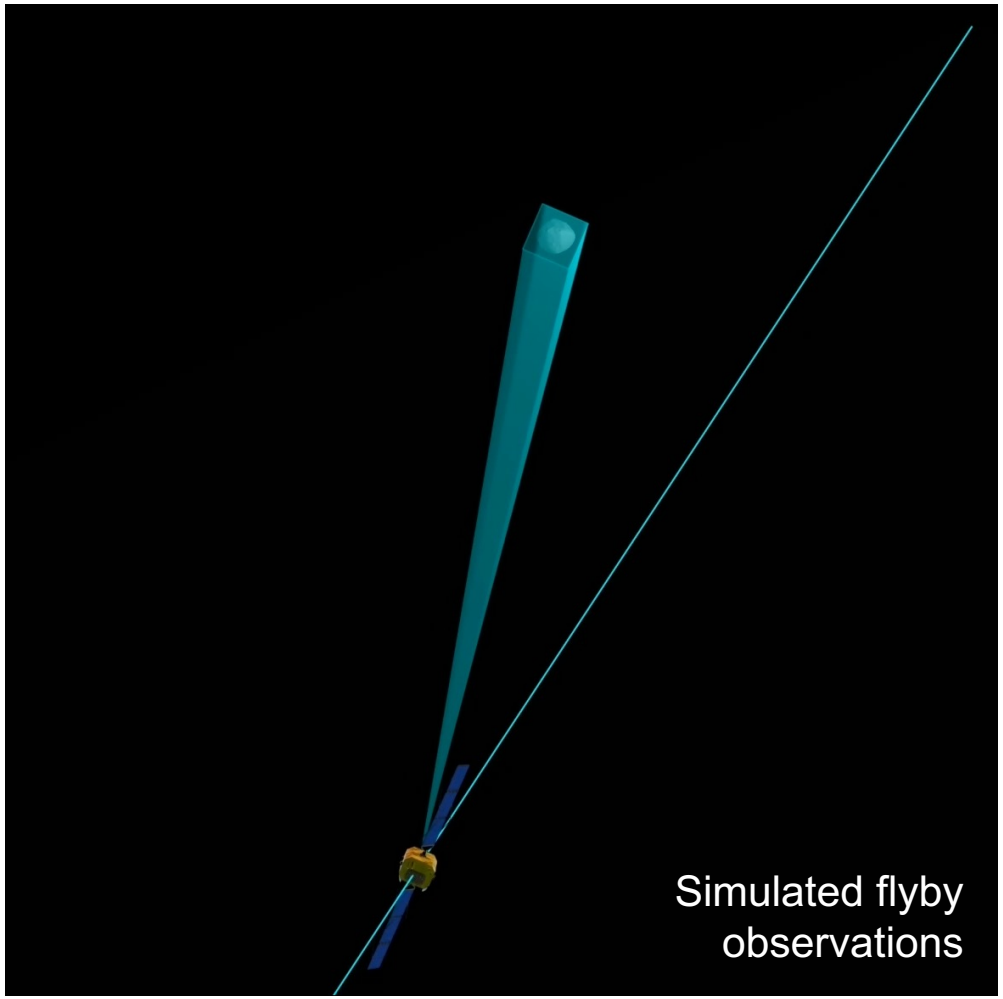
Technical University of Munich & Space Mission Planning Advisory Group

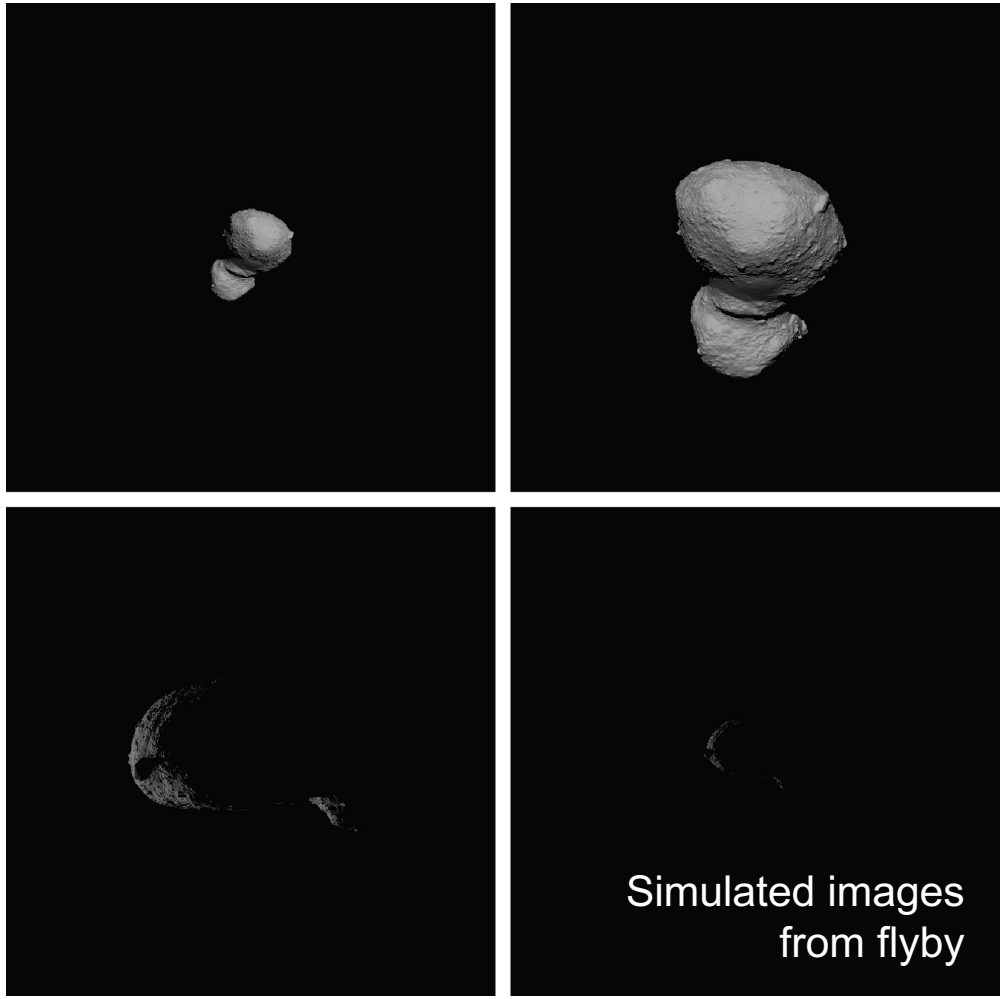
It is now April 2028.

13 years until a definite Earth impact

The international community implemented a fast flyby mission

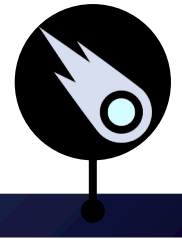
Key uncertainties reduced to improve plans for Earth impact prevention missions & disaster management





It is April 2028.
13 years until a definite Earth impact

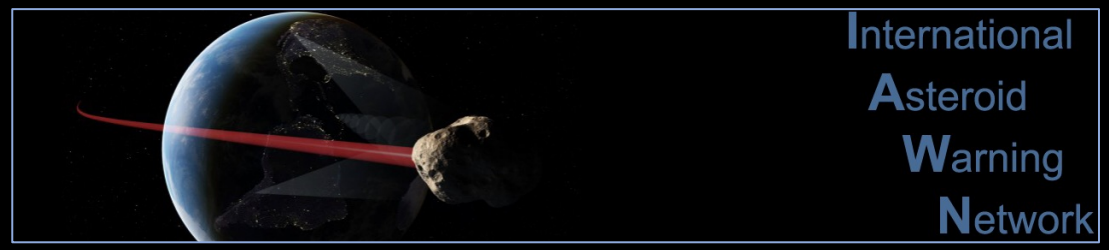
Potential impact
24 April 2041



INTERNATIONAL ASTEROID WARNING NETWORK (IAWN)

POTENTIAL ASTEROID IMPACT NOTIFICATION – HYPOTHETICAL SIMULATION

Date: 28 April 2028
From: International Asteroid Warning Network (IAWN)
Point of Contact: IAWN Coordinating Officer for the IAWN Steering Committee [email]
To: Chair, Space Mission Planning Advisory Group (SMPAG);
United Nations Office of Outer Space Affairs
Title: Updated potential for impact of Near-Earth Asteroid 2024 PDC25 using data from reconnaissance spacecraft flyby



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Simulated Impact Threat Scenario: Update After Flyby Reconnaissance

Notification by IAWN

Kelly Fast, NASA
IAWN Coordinating Officer

9th IAA Planetary Defense Conference

Scenario date: April 2028

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https://iawn.net/

International Asteroid Warning Network

Updated IAWN Notification

EXERCISE EXERCISE EXERCISE

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Impact Probability	100% as calculated by NASA JPL CNEOS and ESA NEOCC
Impact Date	24 April 2041
Impact Risk Region	Extends 470 km across Angola and the Democratic Republic of the Congo
Asteroid Size	140–160 m (460–520 ft) in size
Expected Damage	Regional blast damage, likely extending 100–120 km (60–75 mi) from the impact location, but possibly as far as 130 km (80 mi). Energy released most likely to be in the range 60–105 Mt, but possibly in the range 45–160 Mt.
When will there be new information?	Telescopic data available starting in July 2029 will not add significantly to what is known of 2024 PDC25 from the reconnaissance spacecraft flyby. Additional spacecraft data would improve the impact risk predictions. The asteroid will not come within range for radar observations until 2041.
Technical Information	https://cneos.jpl.nasa.gov/pd/cs/pdc25/

ADDITIONAL DETAILS:
A reconnaissance spacecraft flew by asteroid 2024 PDC25 on 12 April 2028 and the data collected on the asteroid's position and physical properties were used to improve the predicted impact location and the expected damage.

- **Impact Probability:** There is a 100% probability that near-Earth asteroid 2024 PDC25 will impact Earth on 24 April 2041 as independently calculated by the NASA JPL Center for Near-Earth Object Studies (CNEOS) and the ESA Near-Earth Objects Coordination Centre (NEOCC).
- **Impact Risk Region:** The data collected by the reconnaissance spacecraft on the precise position of 2024 PDC25 was used by CNEOS and NEOCC to improve the asteroid's predicted trajectory and narrow the potential impact locations on the African continent. The region of possible impact locations for 2024 PDC25 extends 470 km across Angola and the Democratic Republic of the Congo (see Graphic 2 below).

EXERCISE EXERCISE EXERCISE

- **Asteroid size:** 140–160 meters (460–520 feet) in size from images taken as the reconnaissance spacecraft flew by 2024 PDC25. The asteroid has an elongated shape, with an estimated axis ratio of around 2:1 (*i.e.*, the asteroid is around twice as long as it is wide).
- **Asteroid mass and expected damage:** The potential mass range calculated from data taken by the reconnaissance spacecraft is 2.0–7.0 x 10^9 kg, most likely between 2.8–4.1 x 10^9 kg. The mass range was used to update the expected damage that is detailed above.
- **Future observability and updated information:** Further telescopic observations will be possible starting in July 2029, but they will not add significantly to what is currently known about 2025 PDC from the data gathered by the flyby reconnaissance spacecraft. Additional spacecraft data would improve impact risk predictions. The asteroid will not come within range for radar observations until 2041.
- **Technical information:** The latest technical information concerning this and any future IAWN notifications about asteroid 2024 PDC25 is made available by IAWN to the worldwide community at https://cneos.jpl.nasa.gov/pd/cs/pdc25/

This notification is issued by the International Asteroid Warning Network (IAWN) in accordance with criteria and thresholds for impact response actions in report A/AC.105/C.1/2017/CRP.25 to the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space. The threshold for issuing warnings of possible impact effects is a probability of impact greater than 1% and a rough size estimated to be greater than 10 meters (33 feet). IAWN is a worldwide collaboration of asteroid observers and modelers that was recommended by the United Nations. https://iawn.net*

**The United Nations General Assembly in its resolution 70/82 of 9 December 2015 noted with satisfaction the establishment of the International Asteroid Warning Network (IAWN) and the Space Mission Planning Advisory Group (SMPAG) to implement recommendations for an international response to the near-Earth object impact threat that were endorsed by the Committee on the Peaceful Uses of Outer Space in 2013 (A/68/20, para. 144).*

The Committee in its annual reports (e.g. A/78/20, para. 119) notes that should a credible threat of impact be discovered by the IAWN, available information would be provided by IAWN and disseminated to all Member States through the Office for Outer Space Affairs. The Office for Outer Space Affairs disseminates information pursuant to General Assembly resolution 78/72, paragraph 14, concerning the work carried out by the International Asteroid Warning Network (IAWN) and the Space Mission Planning Advisory Group (SMPAG) and in its capacity as the permanent secretariat of SMPAG.

Graphics

1. Hello-centric orbit diagram relative to Earth orbit
2. Impact risk region maps
3. Impact risk summary chart

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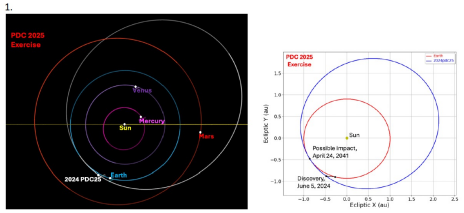
1.



2a.

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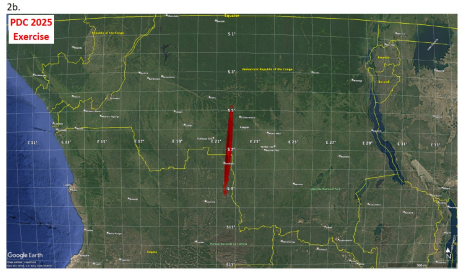
2b.



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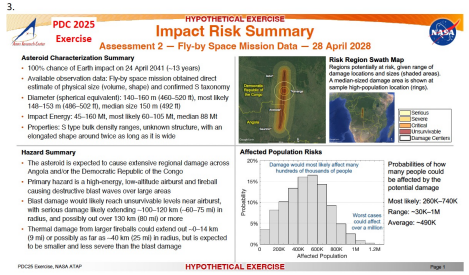

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Notification shared with UNOOSA and SMPAG

IAWN Notification: Key Points

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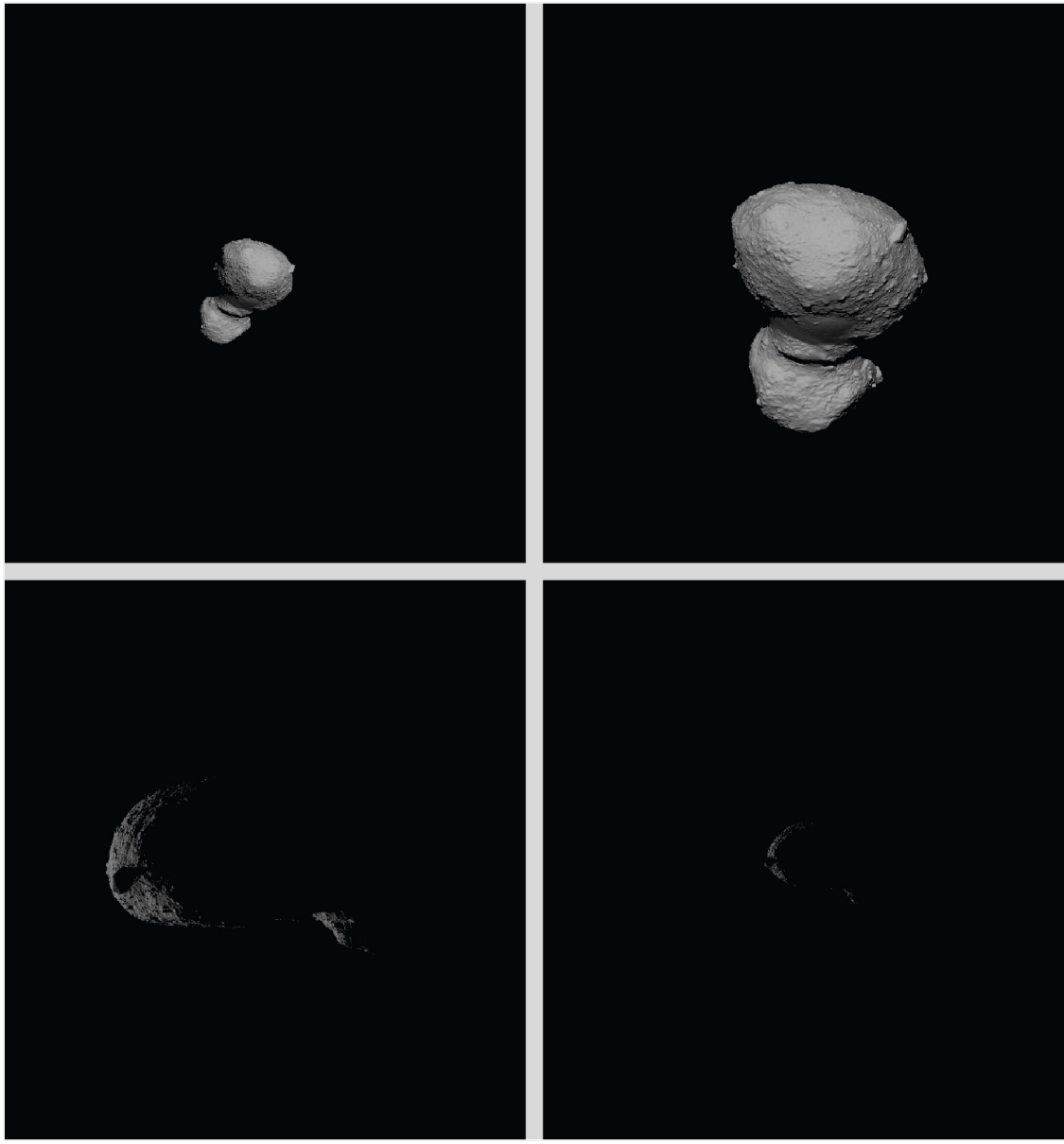
Information Gathered by Flyby Mission



Nancy Chabot
Johns Hopkins University Applied Physics Laboratory

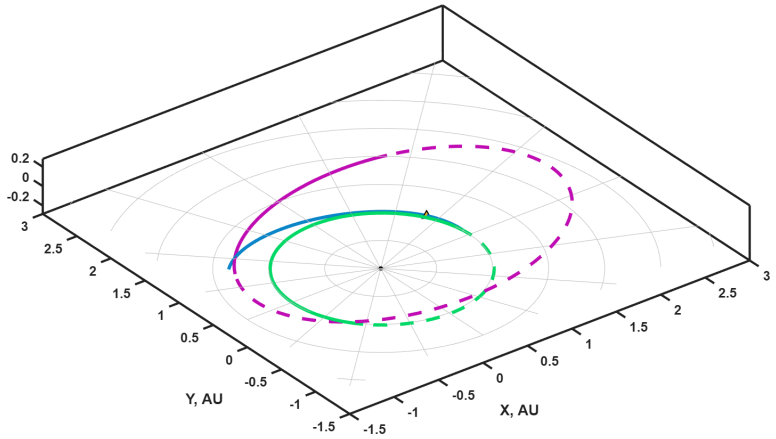
Flyby Details

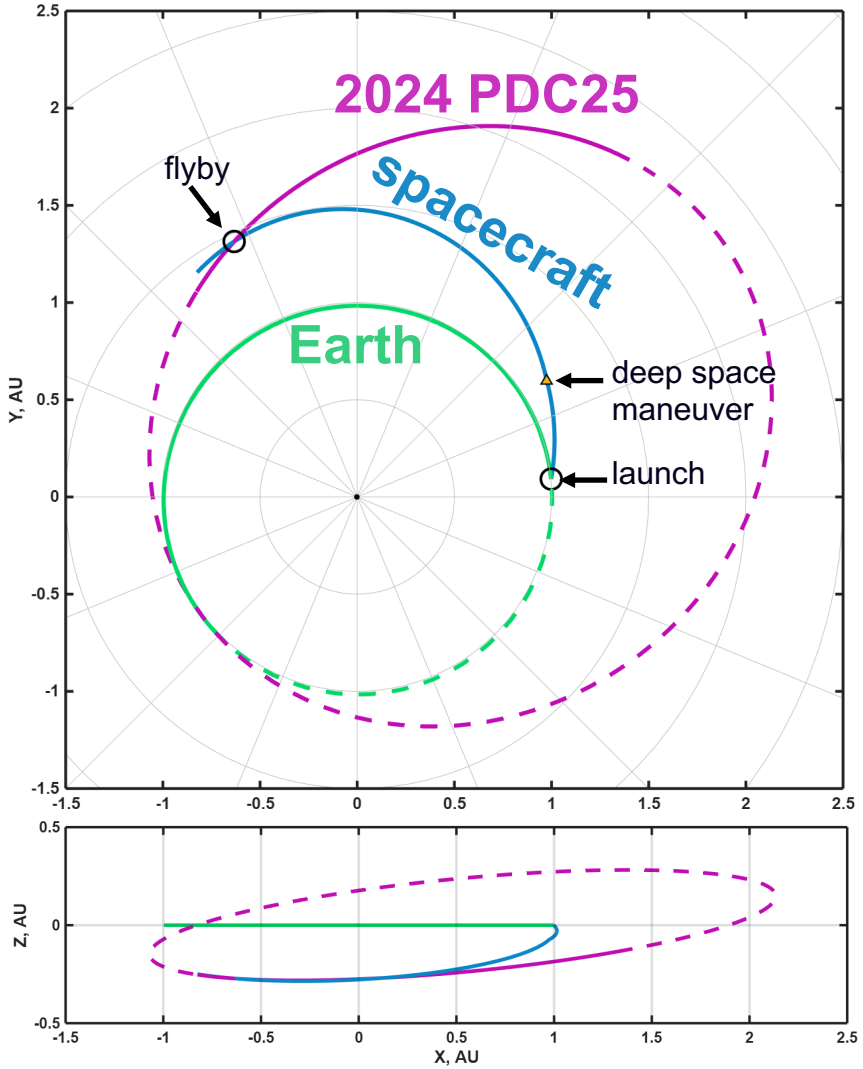
Launch: 29 September 2027

- Falcon Heavy
- 2 km/s of on-board propellant

Flyby: 12 April 2028

- Flyby speed: 8 km/s
- Approach solar phase angle: 30°
- Close approach distance: 100 km
- Solar distance: 1.48 AU
- Earth distance: 1.75 AU

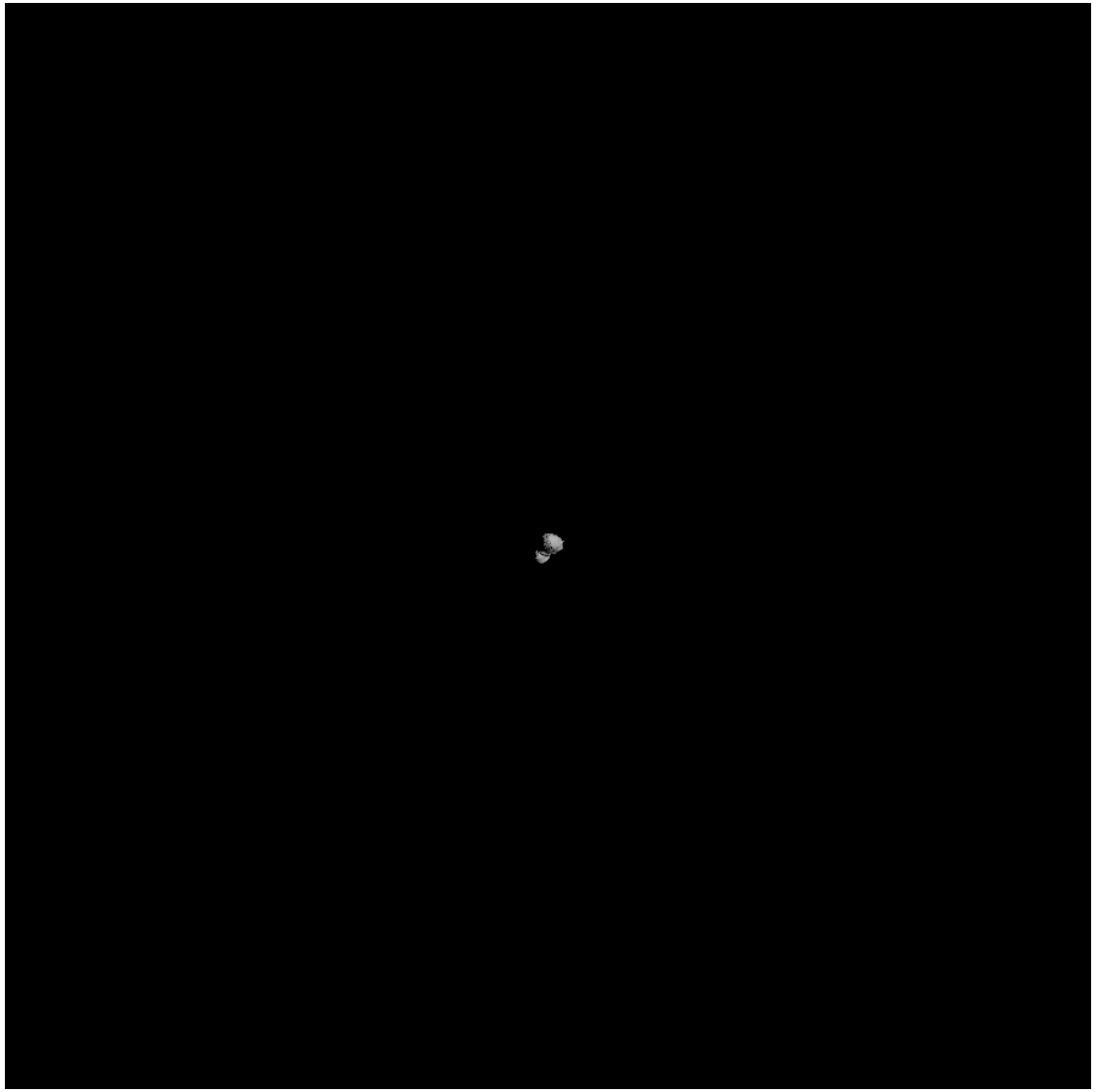




Flyby Mission Data

Flyby Imaging Acquired

- Approach to 23 s: NAC images
- 2 s prior: WAC image
- 2 s after: WAC image
- Departure after 23 s: NAC images

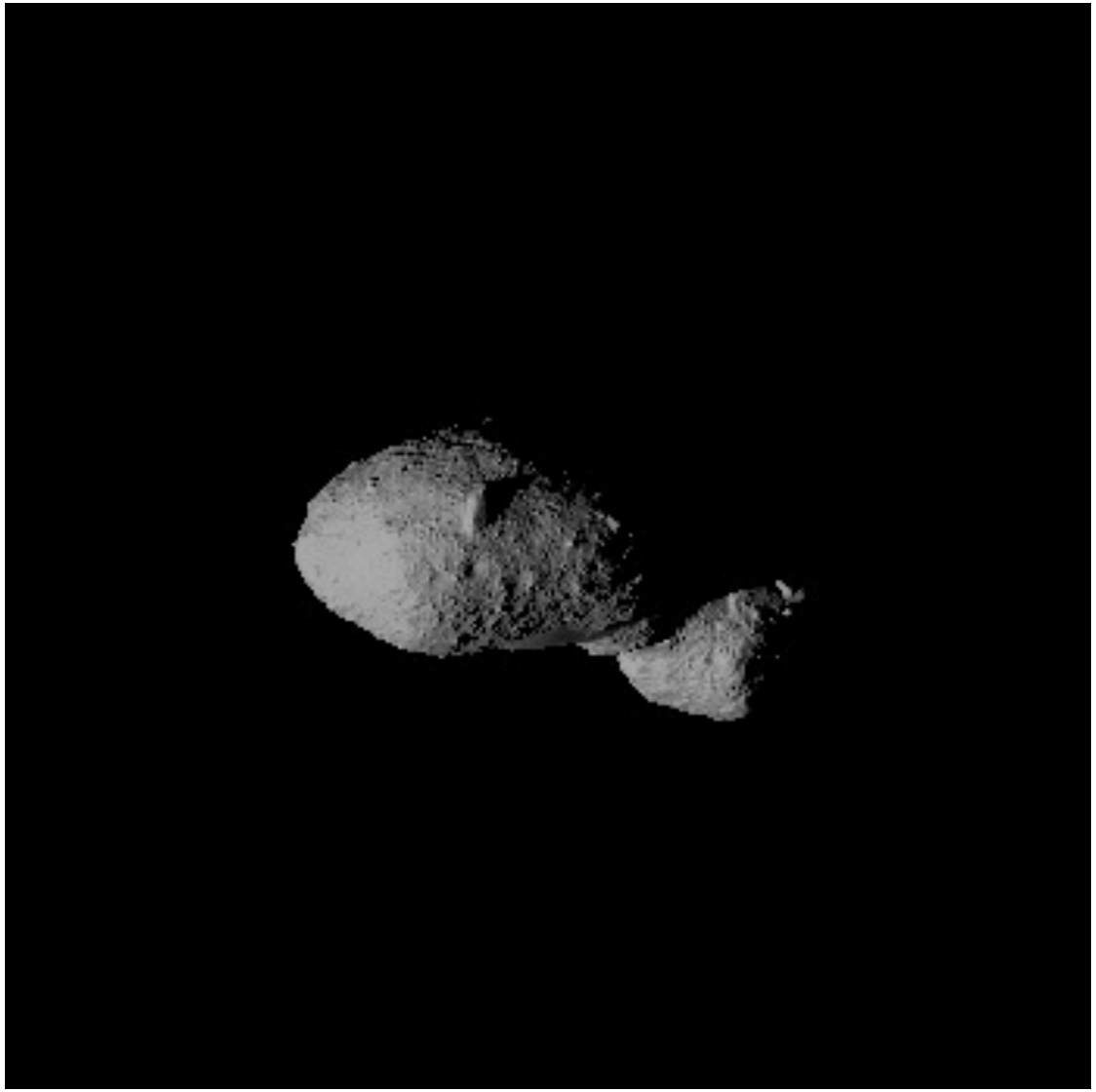


Narrow Angle Camera (NAC) imager like DART DRACO (FOV 0.29°), from 6 minutes to 23 seconds prior to closest approach (2905 km to 209 km; 50 cm pixel scale at 209 km)

Flyby Mission Data

Flyby Imaging Acquired

- Approach to 23 s: NAC images
- **2 s prior: WAC image**
- 2 s after: WAC image
- Departure after 23 s: NAC images

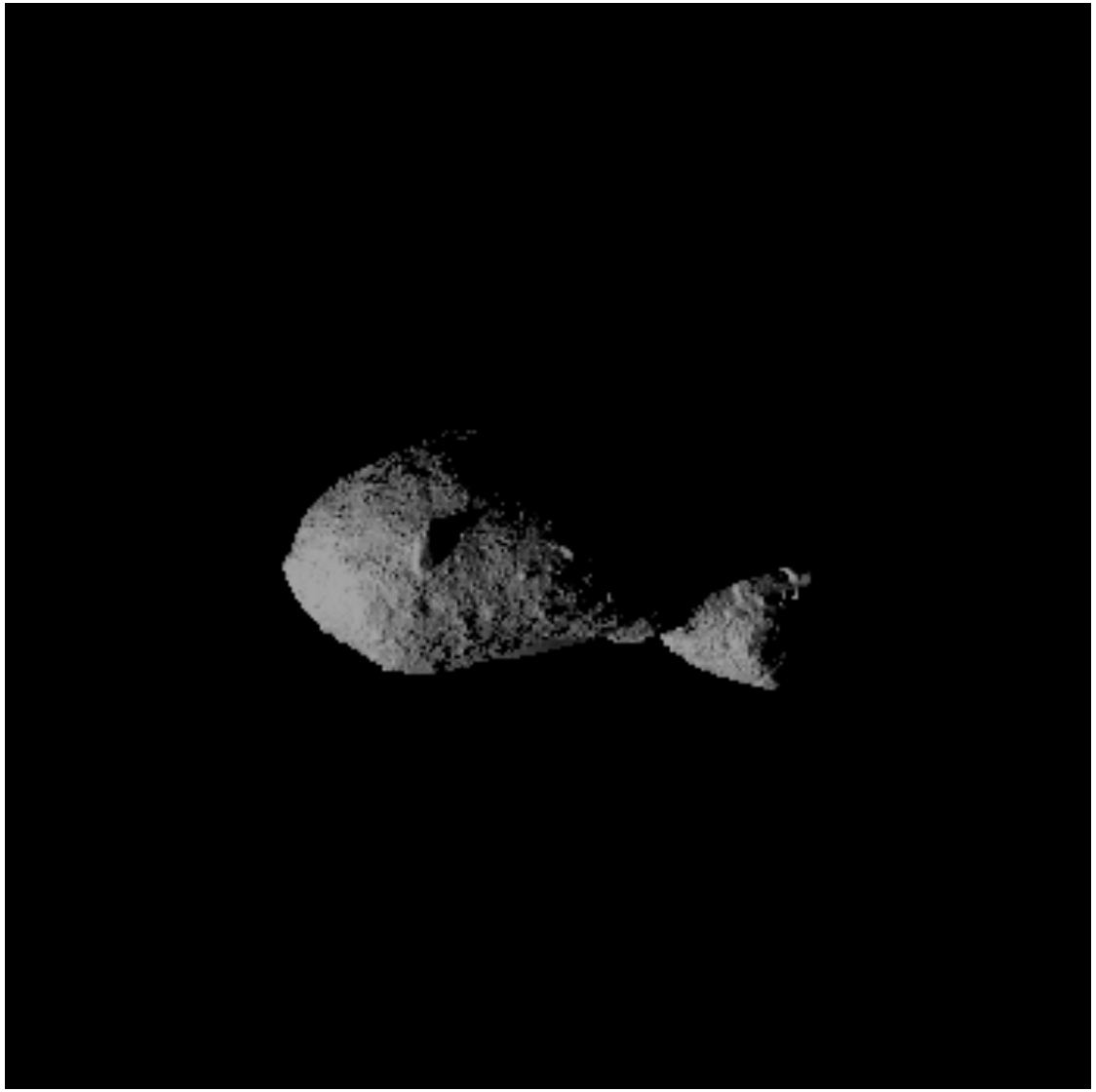


Wide Angle Camera (WAC) imager like OSIRIS-REx PolyCam (FOV 0.79°), at 2 seconds prior to closest approach (100 km, pixel scale 135 cm)

Flyby Mission Data

Flyby Imaging Acquired

- Approach to 23 s: NAC images
- 2 s prior: WAC image
- **2 s after: WAC image**
- Departure after 23 s: NAC images



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Flyby Mission Data

Flyby Imaging Acquired

- Approach to 23 s: NAC images
- 2 s prior: WAC image
- 2 s after: WAC image
- **Departure after 23 s: NAC images**

Asteroid Properties

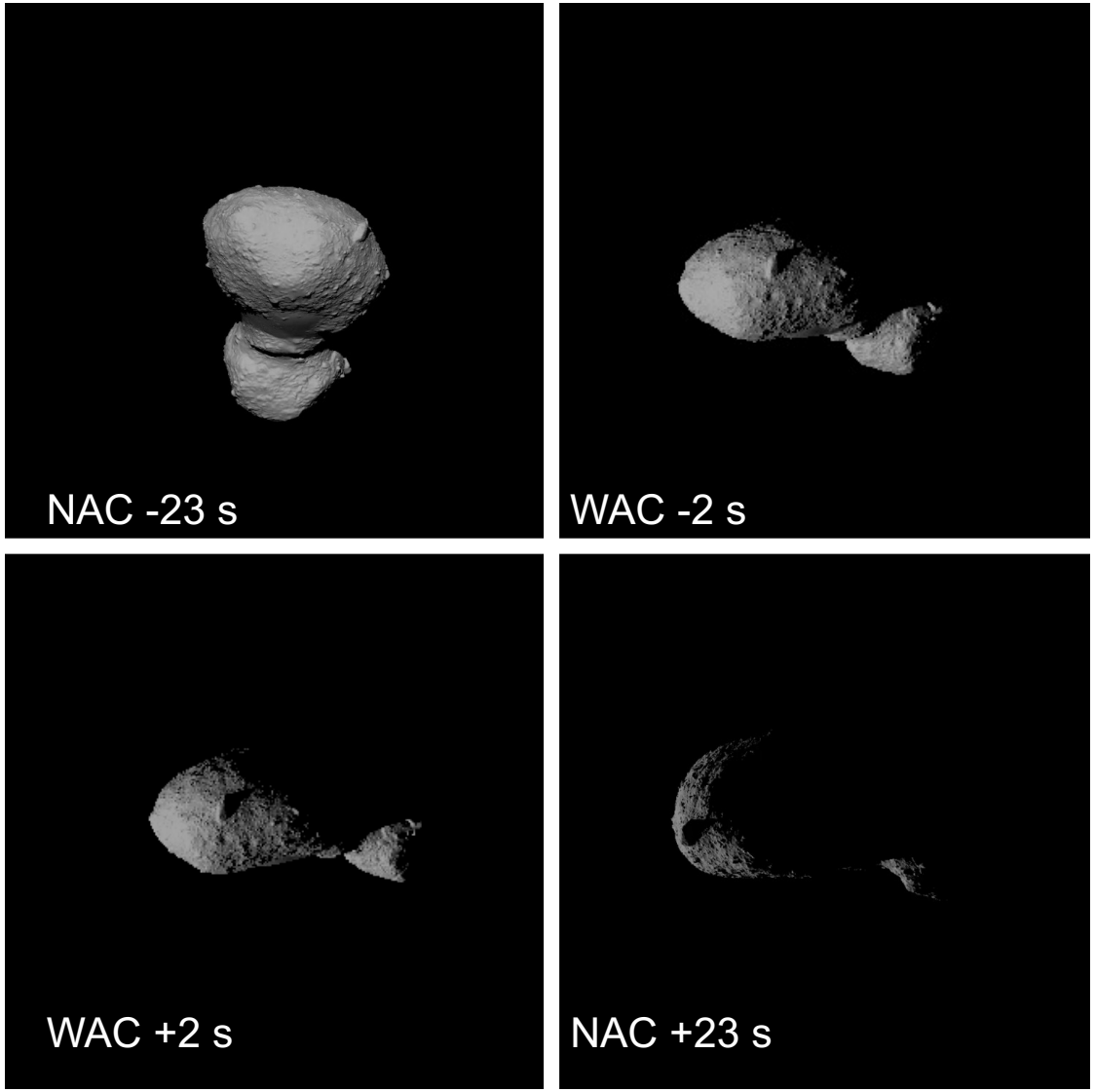
- Rotation period: 3 hrs.
- Thermal inertia: 200 ± 20 (SI units)
- Spin axis: RA, Dec (253°, 74°) ± 3°
- Taxonomy: S-type
- Yarkovsky semimajor axis drift: 586 ± 195 m/yr

Narrow Angle Camera (NAC) imager like DART DRACO (FOV 0.29°), from 23 seconds to 6 minutes after closest approach (209 km to 2905 km; 50 cm pixel scale at 209 km)

Flyby Mission Results

Multiple imaging geometries constrain the asteroid's size, shape, and surface characteristics.

- **Size:** 150 m ± 2.5 m (1σ) effective spherical diameter
- **Shape:** two-lobed, ~240 m long by ~120 m wide by ~120 m high



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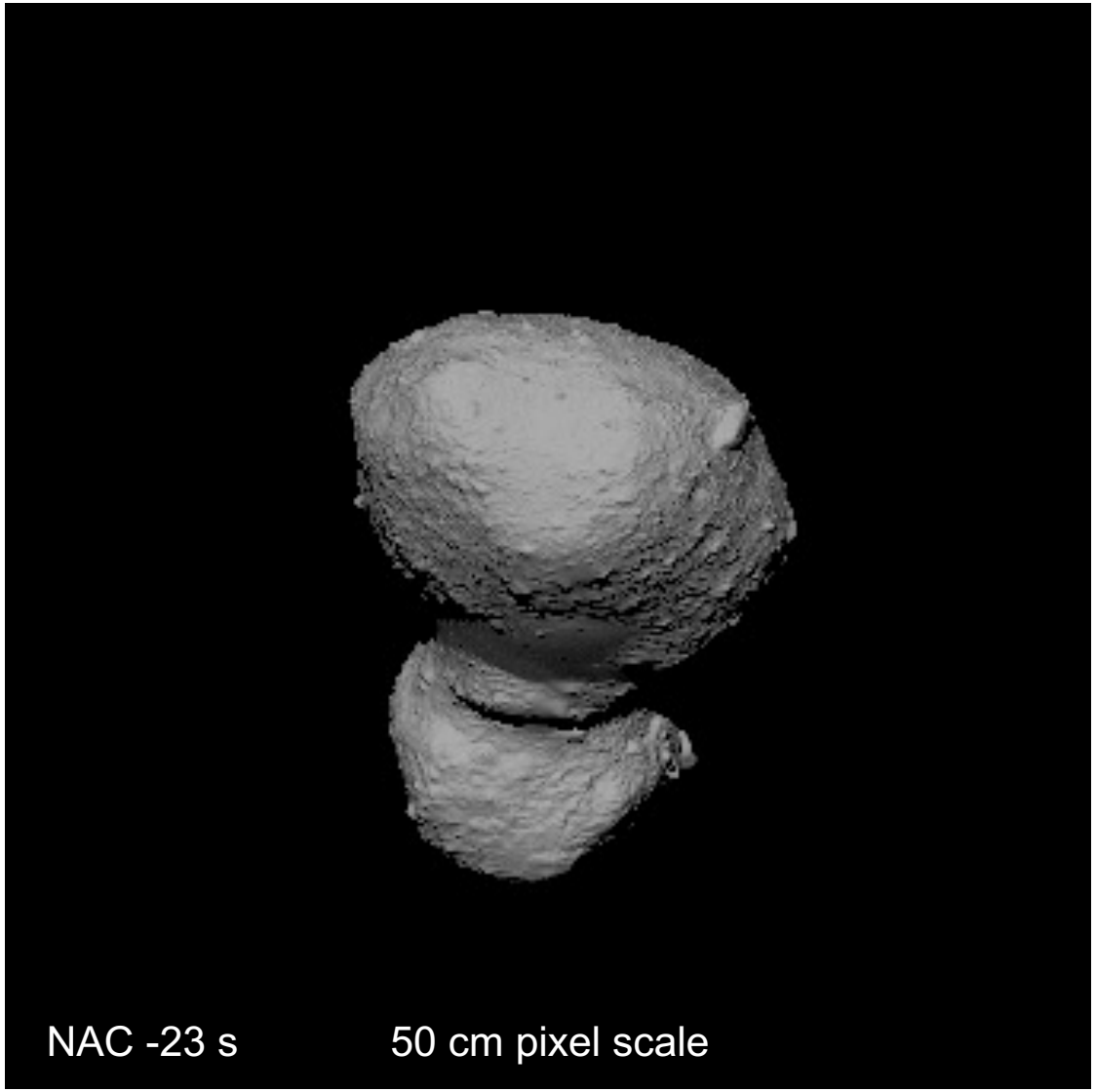
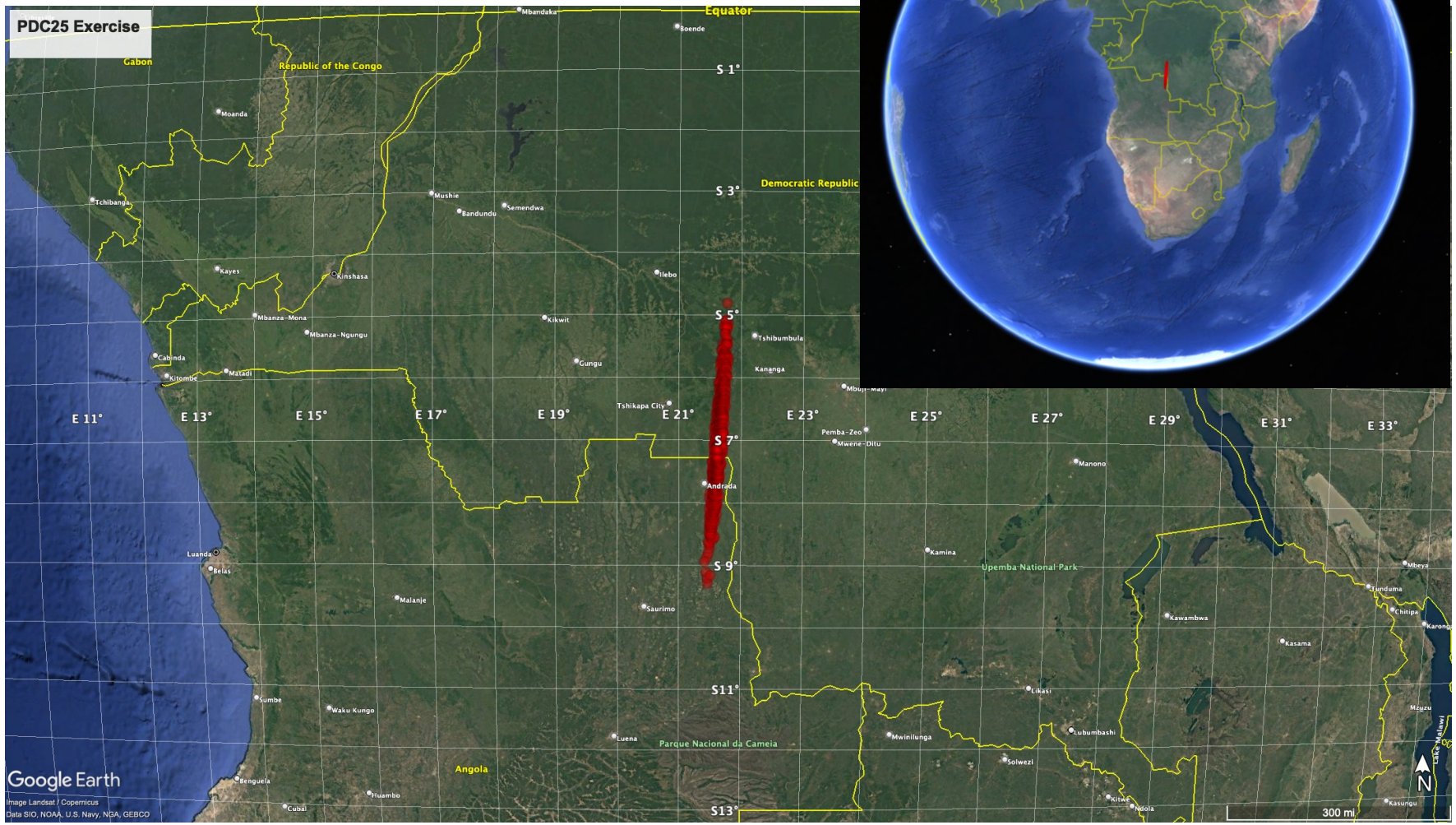
- **Shape:** two-lobed, ~240 m long by ~120 m wide by ~120 m high
- **Surface:** boulder-covered, rocky S-type surface

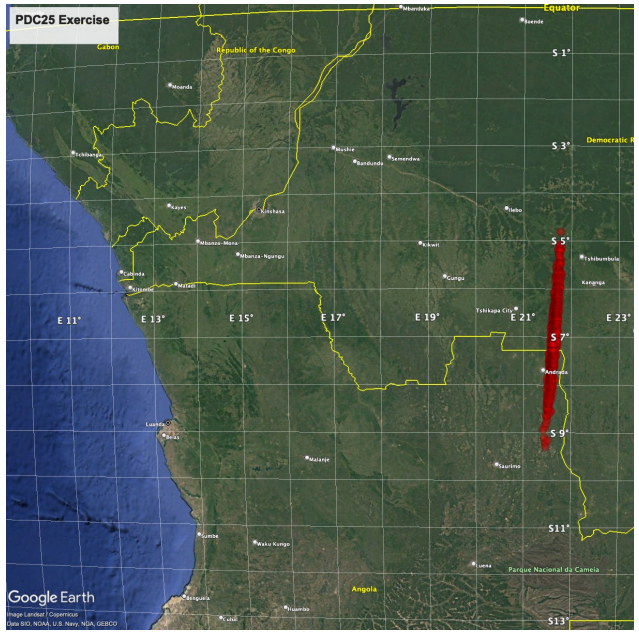


Flyby Mission Results

Orbital tracking from the flyby, together with ground-based astrometry, constrain the region of possible impact to a 470-km corridor that crosses the border between Angola & the Democratic Republic of the Congo.

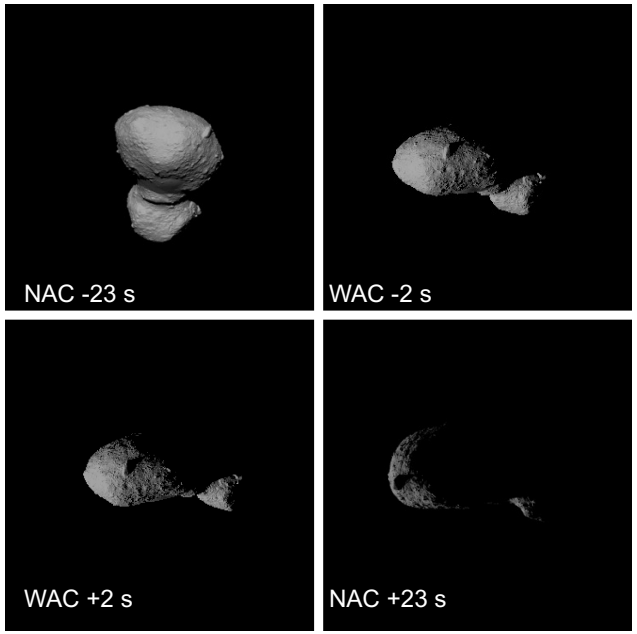


Flyby Mission Results



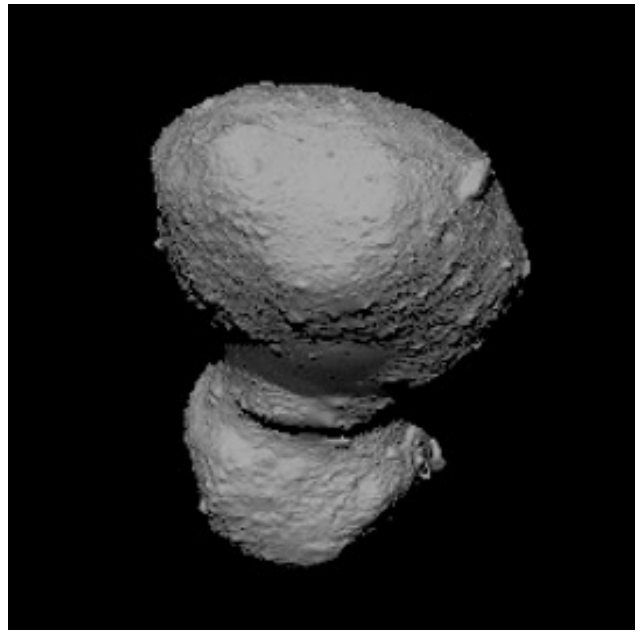
Impact Location

Impact corridor spans 470 km, crossing Angola and the Democratic Republic of the Congo



Asteroid Size

150 m ± 2.5 m (1σ) effective spherical diameter

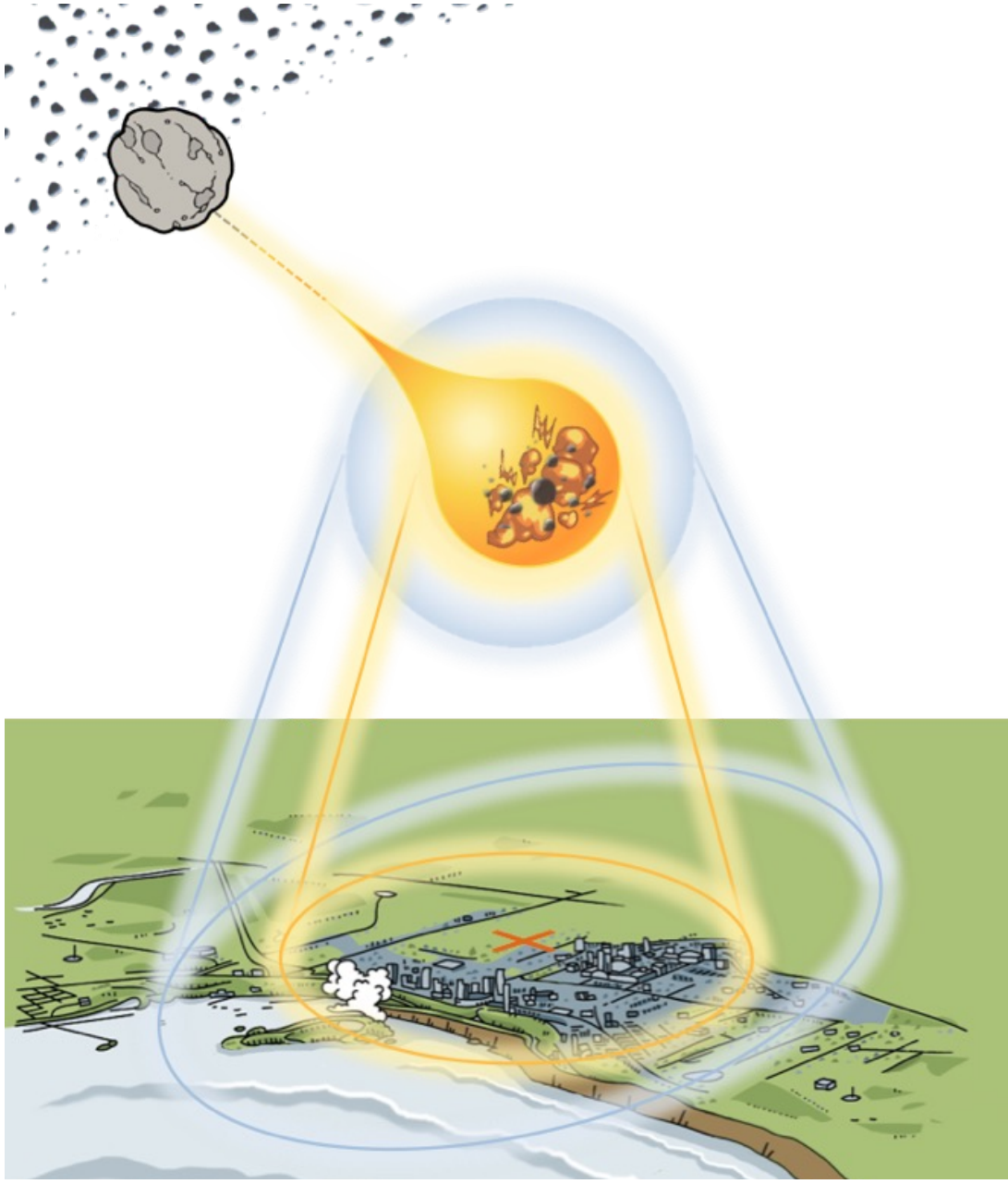


Asteroid Characteristics

Two-lobed shape (~240 m long, ~120 m wide, ~120 m high). Rocky, boulder-covered S-type surface.

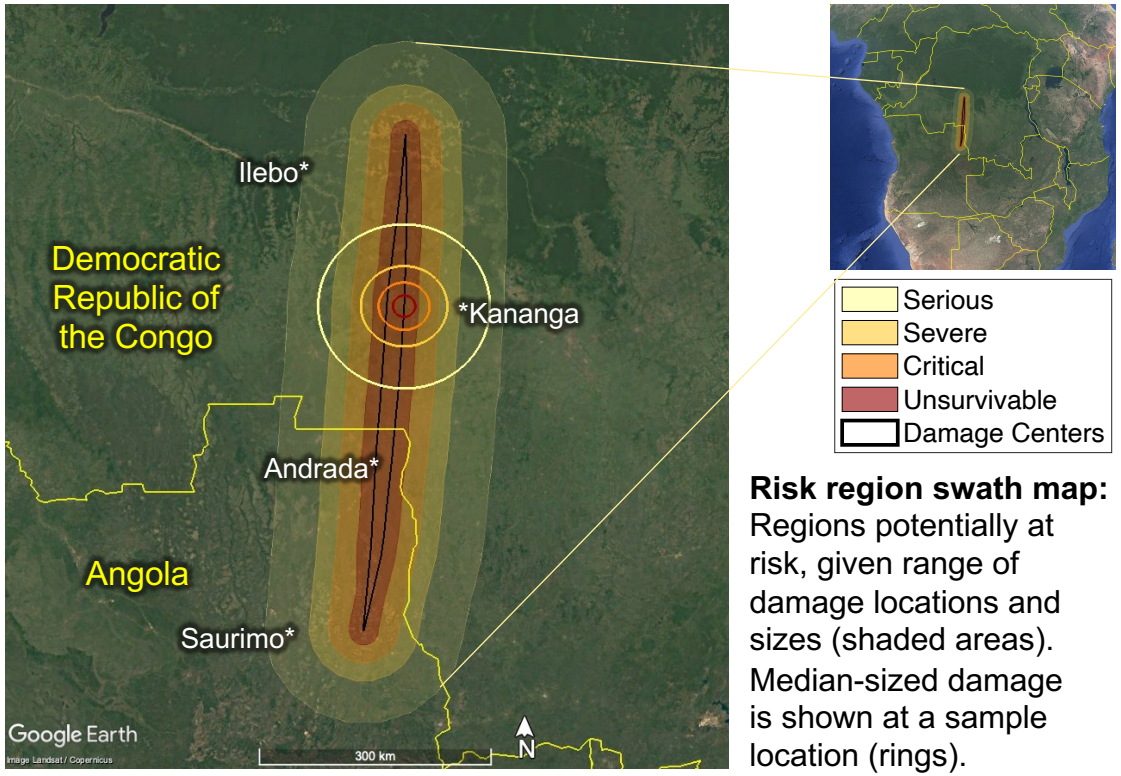
Updated Impact Risk Assessment

Lorien Wheeler
Asteroid Threat Assessment Project
NASA Ames Research Center



Impact Hazard Summary

April 2028: **100%** chance of Earth impact by an asteroid **~150 m** in diameter with **~45–160 Mt** of energy



Risk region swath map: Regions potentially at risk, given range of damage locations and sizes (shaded areas). Median-sized damage is shown at a sample location (rings).

- 100% chance of damage to populated regions among possible impact locations
- Primary hazard is a destructive blast wave from a high-energy, low-altitude airburst
- Damage severities could reach unsurvivable levels near airburst
- Serious damage (causing structural damage, shattered windows) is likely to span multiple cities and provinces

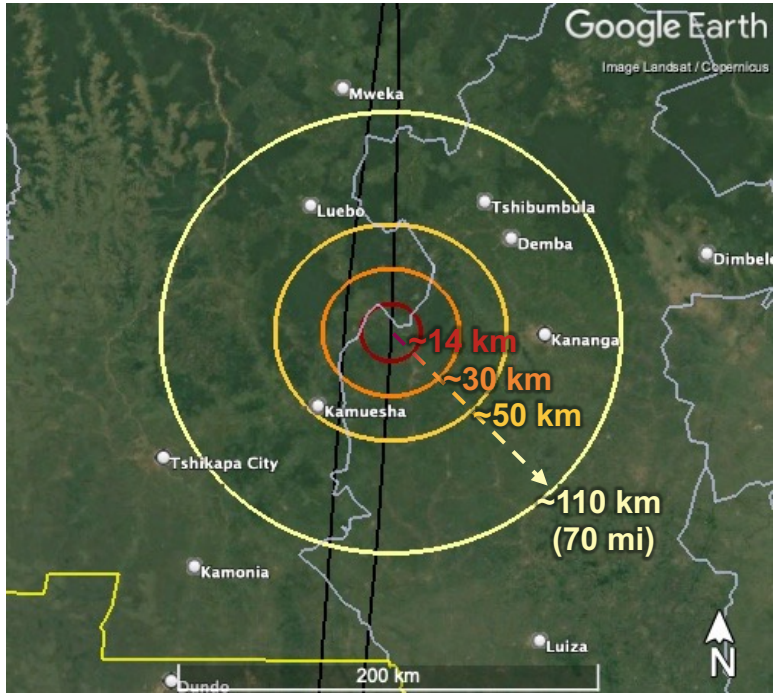
Impact would cause extensive blast damage across a large region in Angola and/or DRC, potentially affecting ~30K–1M people

Potential Ground Damage Sizes & Severities

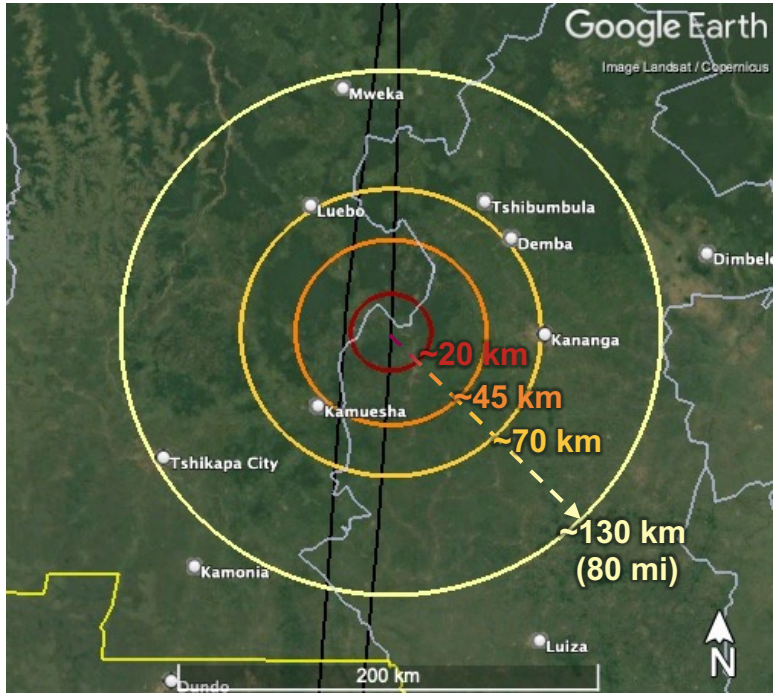
Example near Kananga, DRC

Damage areas would most likely extend over ~100 km (>60 miles) in radius

Large damage areas could extend out over ~130 km (~80 miles) or more in radius



Median (50th%) Damage

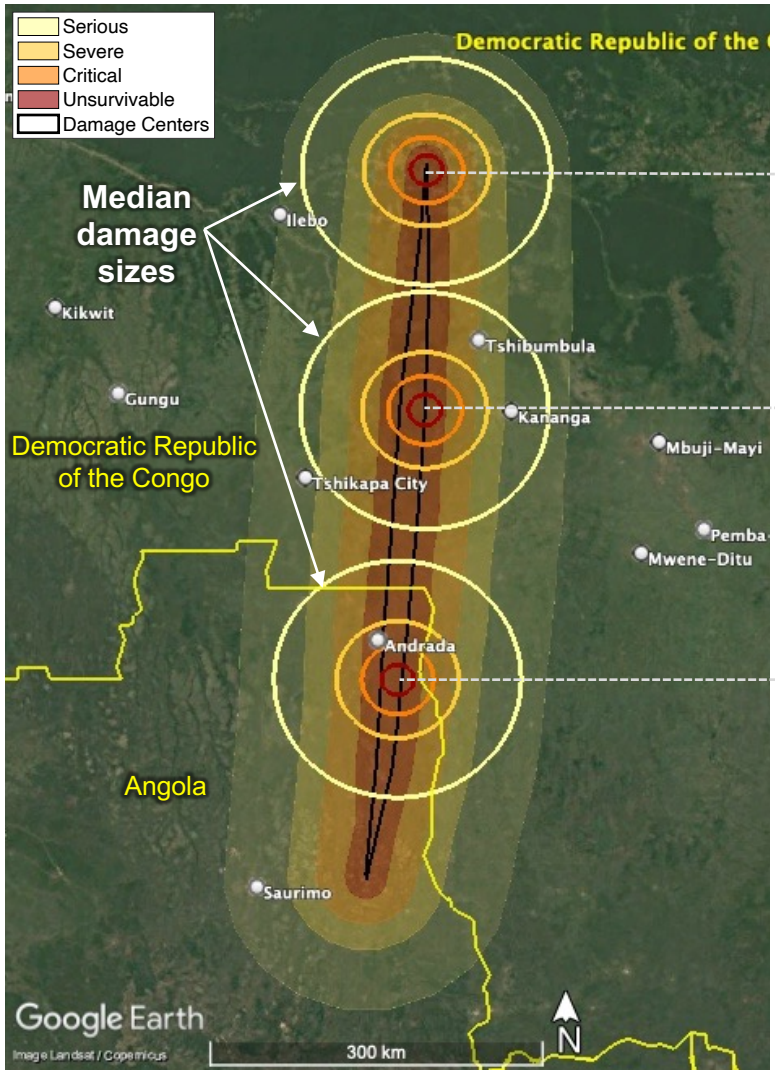


Large (95th%) Damage

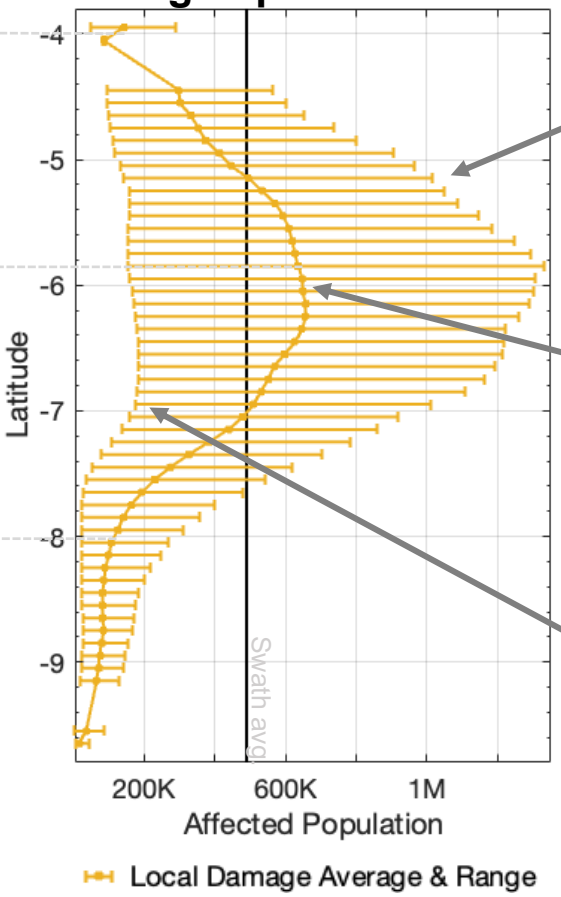
Damage severities could reach **unsurvivable** levels near the blast, extending to larger areas of **structural damage, fires, and shattered windows**

Damage Level	Description
Serious	Windows shatter, some structure damage
Severe	Widespread structure damage
Critical	Residential structures collapse
Unsurvivable	Devastation, structures flattened or burned

Affected Population Ranges by Location



Affected population ranges for potential damage sizes along impact locations



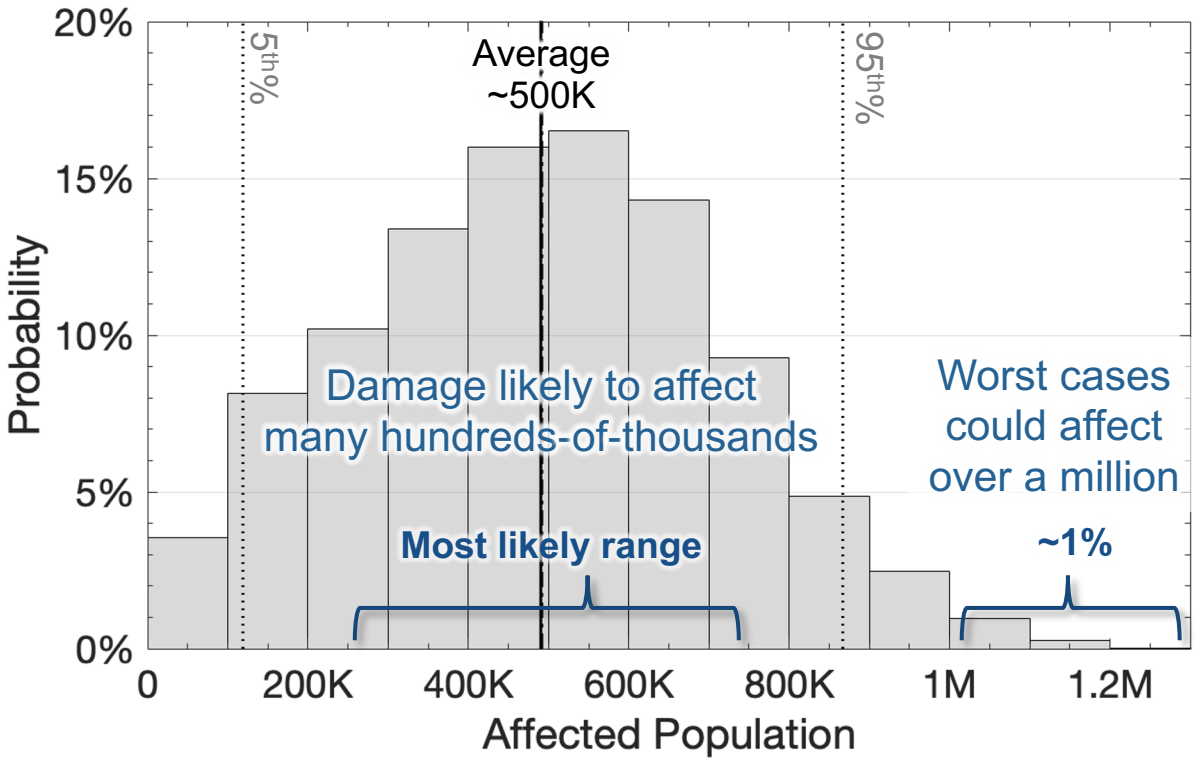
Large damage could affect hundreds-of-thousands to over 1 million people

Average damage could affect tens-of-thousands to ~700 thousand people

Smaller damage could affect several thousands to ~200 thousand people

Affected Population Risks

Damage probabilities among modeled impact sizes and locations; Earth impact probability is 100%



Likelihood of the impact affecting at least this many people

>30K	>100K	>500K	>800K	>1M
~100%	**96%**	**48%**	**9%**	**~1%**

Damage likely to affect ~250K–750K people and potentially over 1M people

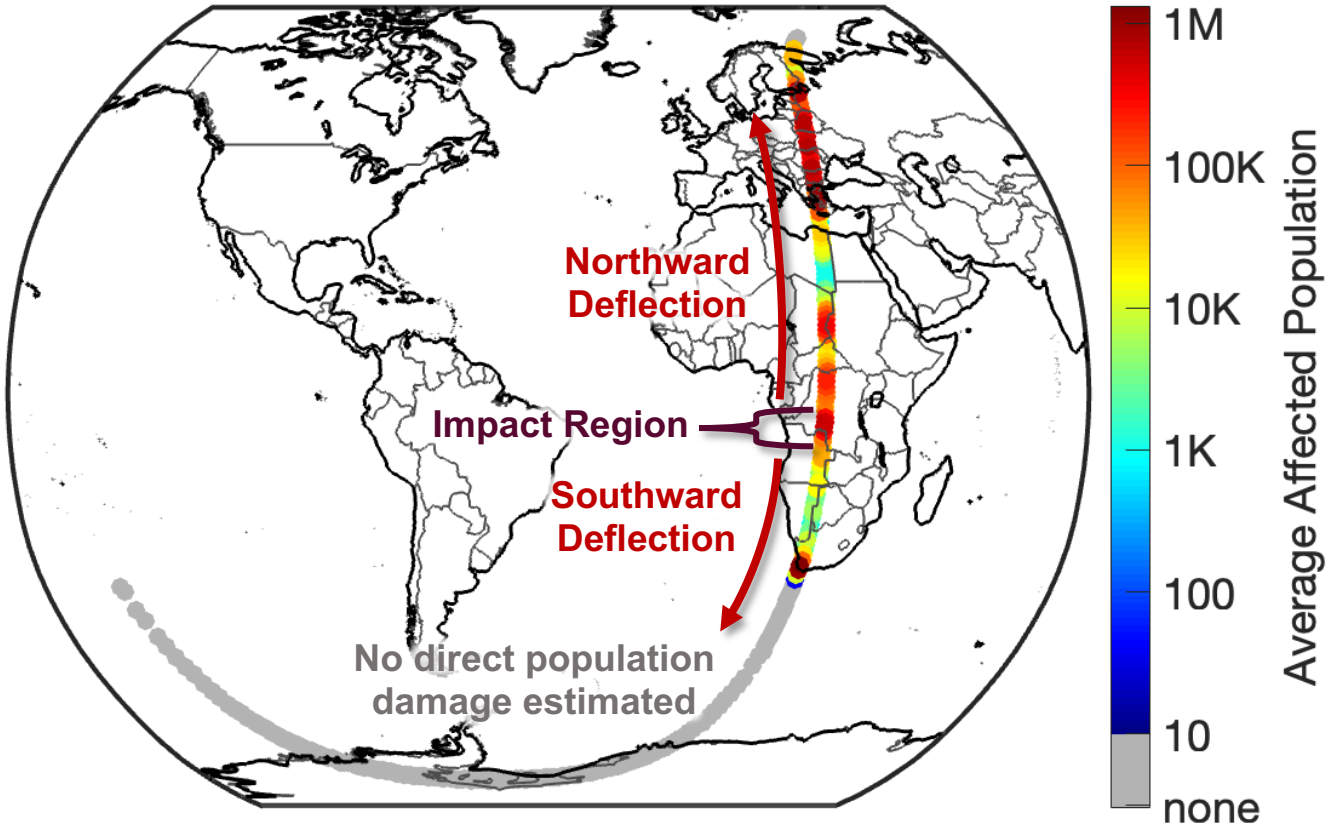
~500K people affected on average

100% chance of large damage to populated regions

Population Risks for Asteroid Deflection

Gradual deflection of the asteroid changes the number and location of people at risk of damage if Earth impact should occur

Average affected population along deflection corridor



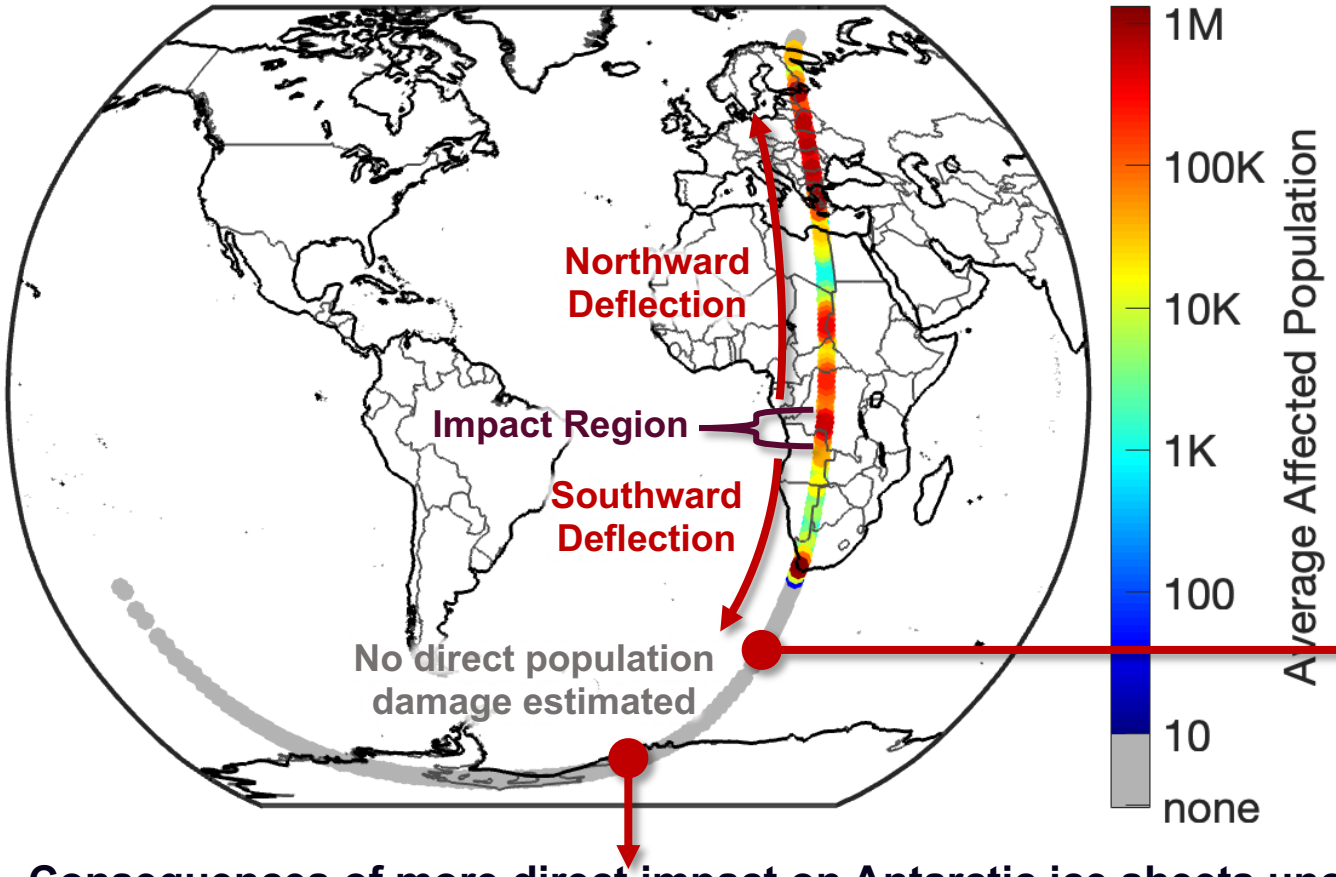
Deflecting the asteroid **northward** would cross **~85%** of population within the corridor (~80M–120M people)

Deflecting the asteroid **southward** would cross **~15%** of population within the corridor (~15M–25M people)

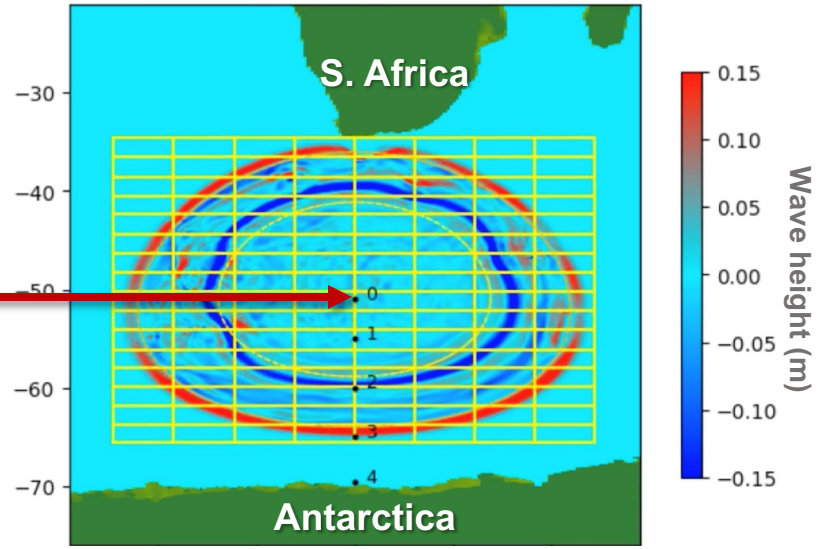
Tsunami Risk from Deflection into the Southern Ocean

No direct population damage or significant tsunami expected for impacts into the Southern Ocean along most of the ocean-crossing deflection corridor

Average affected population along deflection corridor



High-fidelity simulation of tsunami from largest asteroid size deflected into mid-ocean shows waves too small to cause substantial damage



M. Aftosmis, NASA/ARC ATAP team

Consequences of more direct impact on Antarctic ice sheets uncertain


9TH IAA
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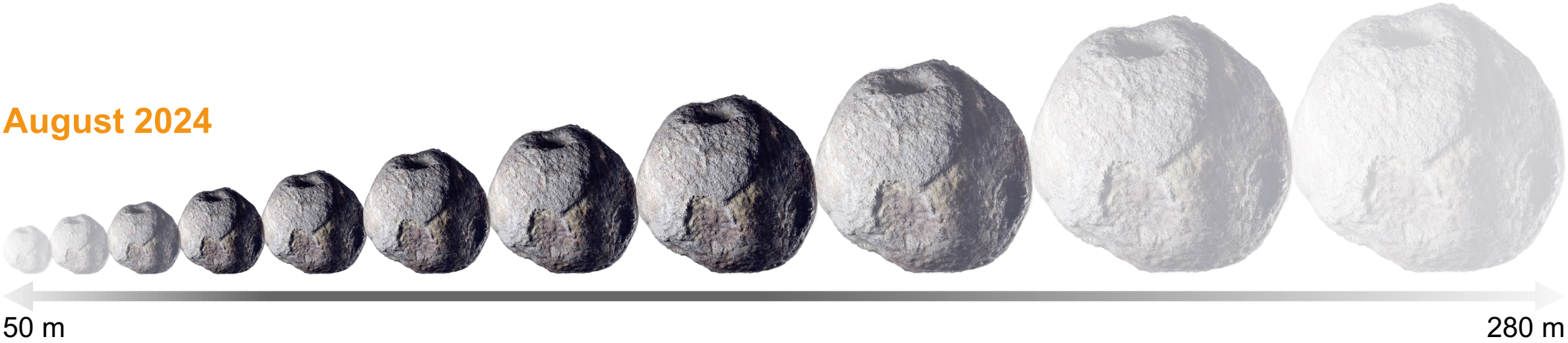
PLANETARY DEFENSE
CONFERENCE
STELLENBOSCH
SOUTH AFRICA
IAA
INTERNATIONAL ACADEMY OF ASTRONAUTICS
2025

Asteroid Size Knowledge

Potential impact
24 April 2041



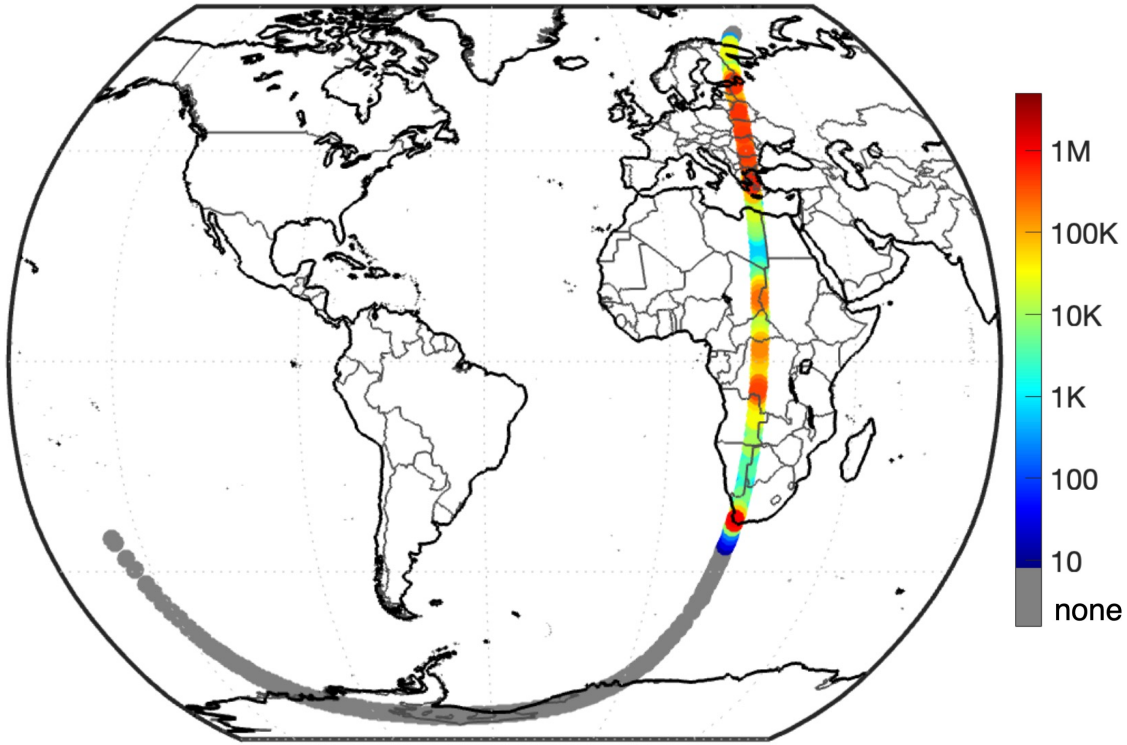
April 2028 (post flyby)

Average Affected Population

Potential impact
24 April 2041

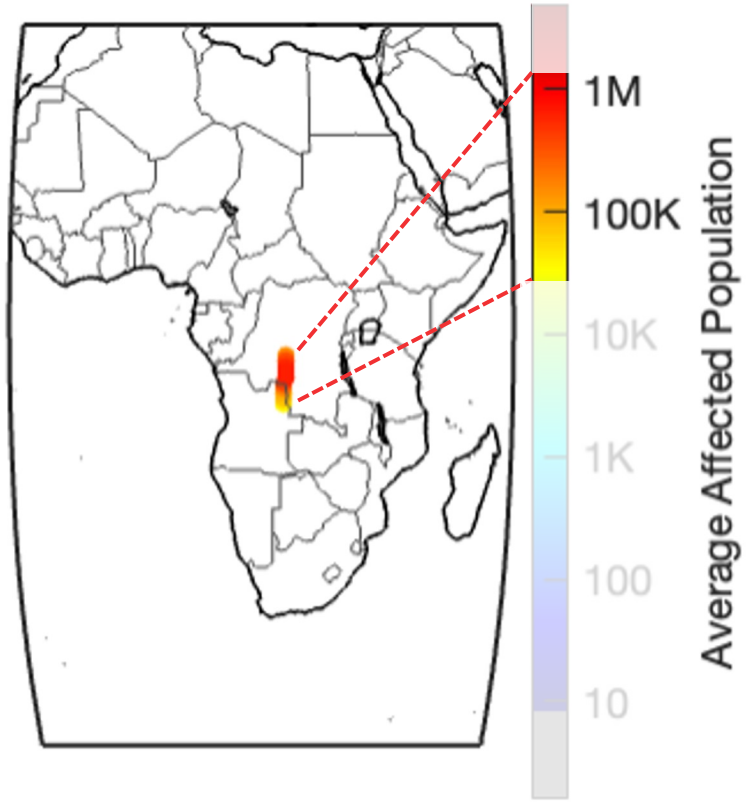
August 2024 (1.6% chance of impact)

Small chance of damage; large uncertainties



April 2028 (post flyby, impact assured)

Certain damage to populated regions



It is now April 2028.

13 years to definite Earth impact

October 2024
SMPAG makes recommendations

September 2027
Flyby reconnaissance mission launches

Potential impact
24 April 2041

IAWN issues notification
1 August 2024

Earth impact becomes certain
September 2025

Reconnaissance spacecraft flies past asteroid

IAWN issues an update

April 2028
SMPAG meets to review space mission options in light of new information

Recommendations for Further Space Mission Options

Detlef Koschny
Chair, Space Mission Planning Advisory Group
(SMPAG)

9th IAA Planetary Defense Conference

Scenario date: April 2028

Recommendations to Prevent Earth Impact

1 

Deflection direction
Decide whether the deflection will be northward or southward.

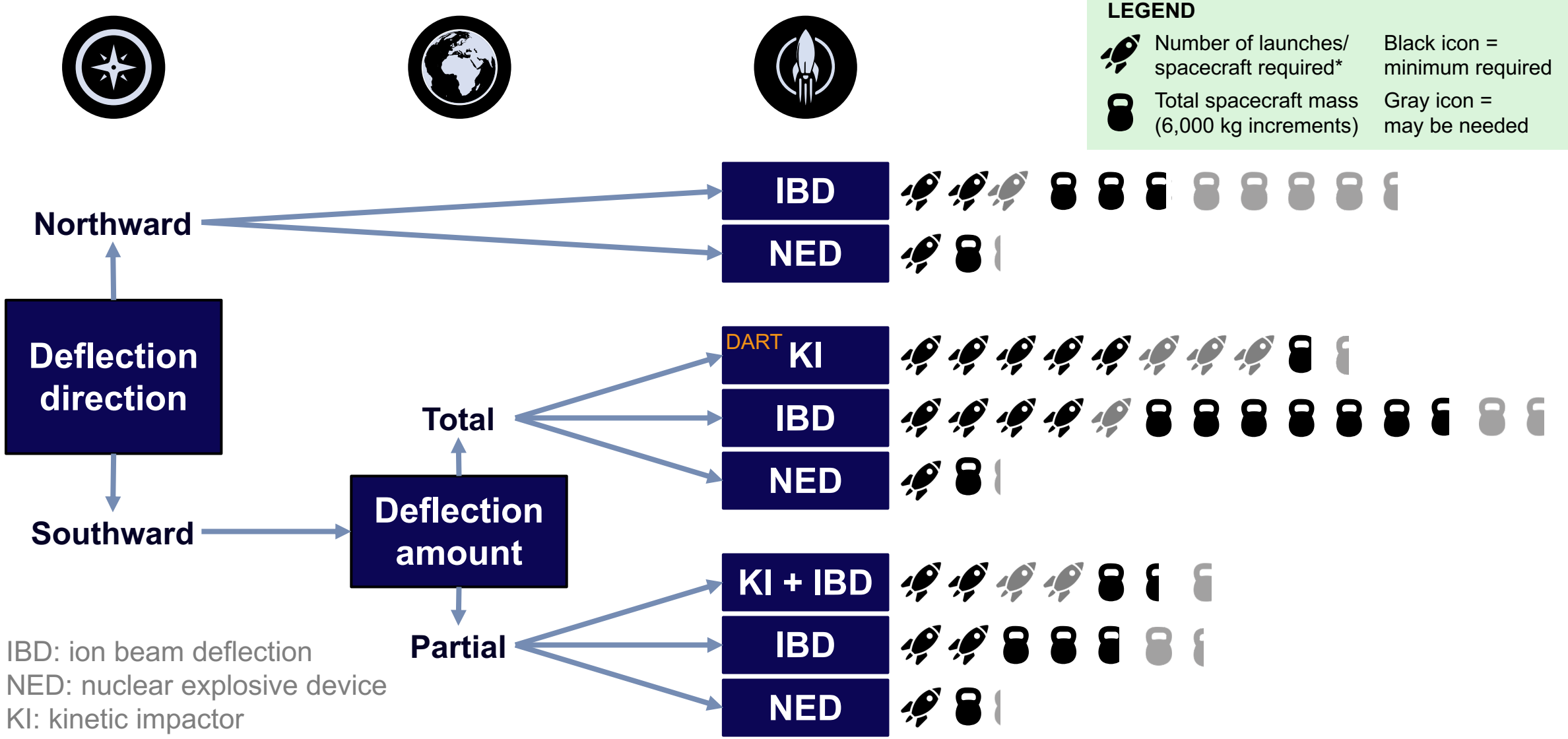
2 

Deflection amount (southward only) If southward deflection is selected, decide whether a partial deflection option is considered safe/acceptable, then decide whether partial deflection or total deflection will be the mission goal.

3 

Deflection method Select a deflection mission type—kinetic impact (KI), ion beam deflection (IBD), or nuclear explosive device (NED)—complete its development, and deploy it.

Asteroid Deflection Options Flowchart



*NED requires multiple deployed devices from a single spacecraft


9TH IAA
INTERNATIONAL
PLANETARY DEFENSE
CONFERENCE
STELLENBOSCH
SOUTH AFRICA
IAA
INTERNATIONAL ACADEMY OF ASTRONAUTICS
2025

It is April 2028.
13 years until a definite Earth impact

Potential impact
24 April 2041

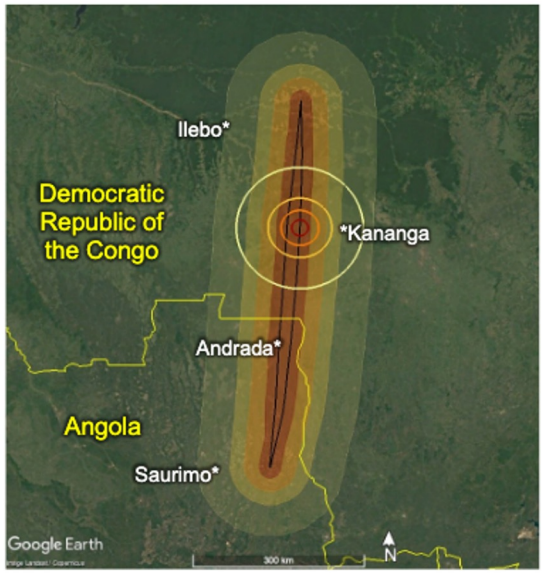
Affected people

>30K	>100K	>500K	>800K	>1M
~100%	96%	48%	9%	1.3%

Asteroid properties

Size: 140–160 m, most likely 148–153 m
Composition: Rocky

Impact risk corridor



Serious
Severe
Critical
Unsurvivable
Damage Centers

Risk region swath map:
Regions potentially at risk, given range of damage locations and sizes (shaded areas).
A median-sized damage area is shown at sample high-population location (rings).

SMPAG Recommendations

Deflection direction

Partial or total deflection

Earth impact prevention method

Participant Discussion

What did you learn during the panel?

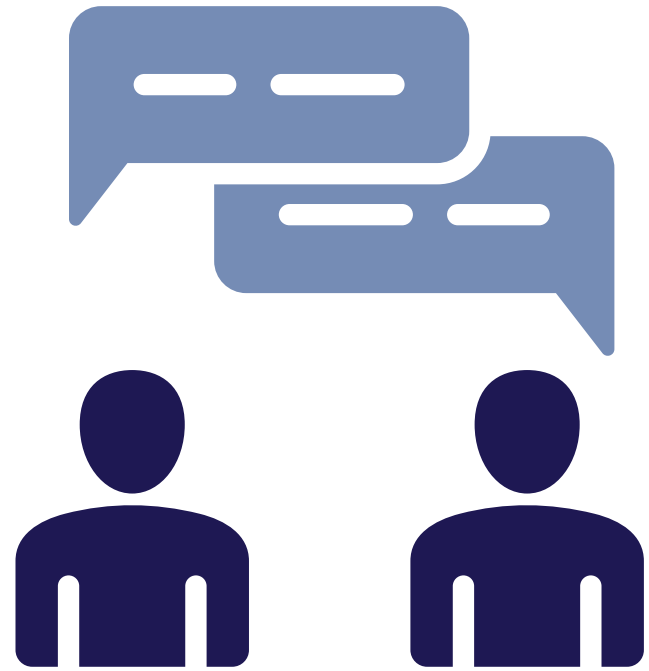
What in the panelists' comments aligned with your expectations? What surprised you?

Did your perspective on planetary defense change in any way after listening to the panelists? If so, how?

What are the implications of the panelists' comments for your own work?

What concrete actions could be taken to make progress on the issues raised by the panelists?

If you could ask the panelists to elaborate on one specific point, what would it be?



Share Your Perspectives

Which factor do you think decision makers should prioritize when weighing deflection options?

a) Minimizing the number of people potentially placed in harm's way along the deflection corridor

b) Maximizing the chance of preventing an Earth impact by moving the asteroid a shorter distance

c) Choosing a method that has been demonstrated to deflect an asteroid in a flight test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