How to prevent an asteroid from impacting Earth

Line Drube

www.neoshield.net

Work funded by European Commission
FP7 and H2020 Programme

DLR

European Commission PROTEC-2 Horizon 2020 Access technologies and characterisation for Near Earth Objects (NEOs)

The NEOShield-2 Consortium:

Partner organisations
Airbus, Germany
German Aerospace Center (DLR)
Fraunhofer - Ernst-Mach-Institut, Germany
Airbus, France
Airbus, United Kingdom
The Queen's University of Belfast, United Kingdom
Observatoire de Paris
CNRS, Observatoire de la Cote d'Azur, FRancee
Deimos Space, Spain
GMV Aerospace and Defence, Spain
Istituto Nazionale di Astrofisica (INAF), Italy

Main themes/tasks of the project:

1. Science

- Mitigation-relevant physical and compositional characterization of small NEOs (D = 50–300 m): Population of 200,000 objects remains largely unexplored. NEOShield-2 is carrying out new observations and analyses of published data.

2. Technology

- Development of guidance, navigation, control systems: for accurate targeting of a kinetic impactor into a small NEO.
- Orbiting, hovering, manoeuvring close to a small asteroid: NEOs have very weak gravity fields - appropriate autonomous control systems is being developed.
- Development of techniques for robotic exploration: surface material sampling and collection, sample return to Earth, etc

Total NEOShield-2 funding = 6 million euro (4.2 from EC). Duration 2014-2017

Chelyabinsk 15 Feb. 2013

Diameter: 17-20 m, 12 000 tonnes, 70 000 km/h
500 kt TNT atmospheric explosion
(30 x energy of Hiroshima nuclear bomb)


Chelyabinsk
Weight : 654 kg


Челябинская область
РОССИЯ 24
По словам очевидцев, небосклон озарила яркая вспышка, затем огненный шар устремился к Земле

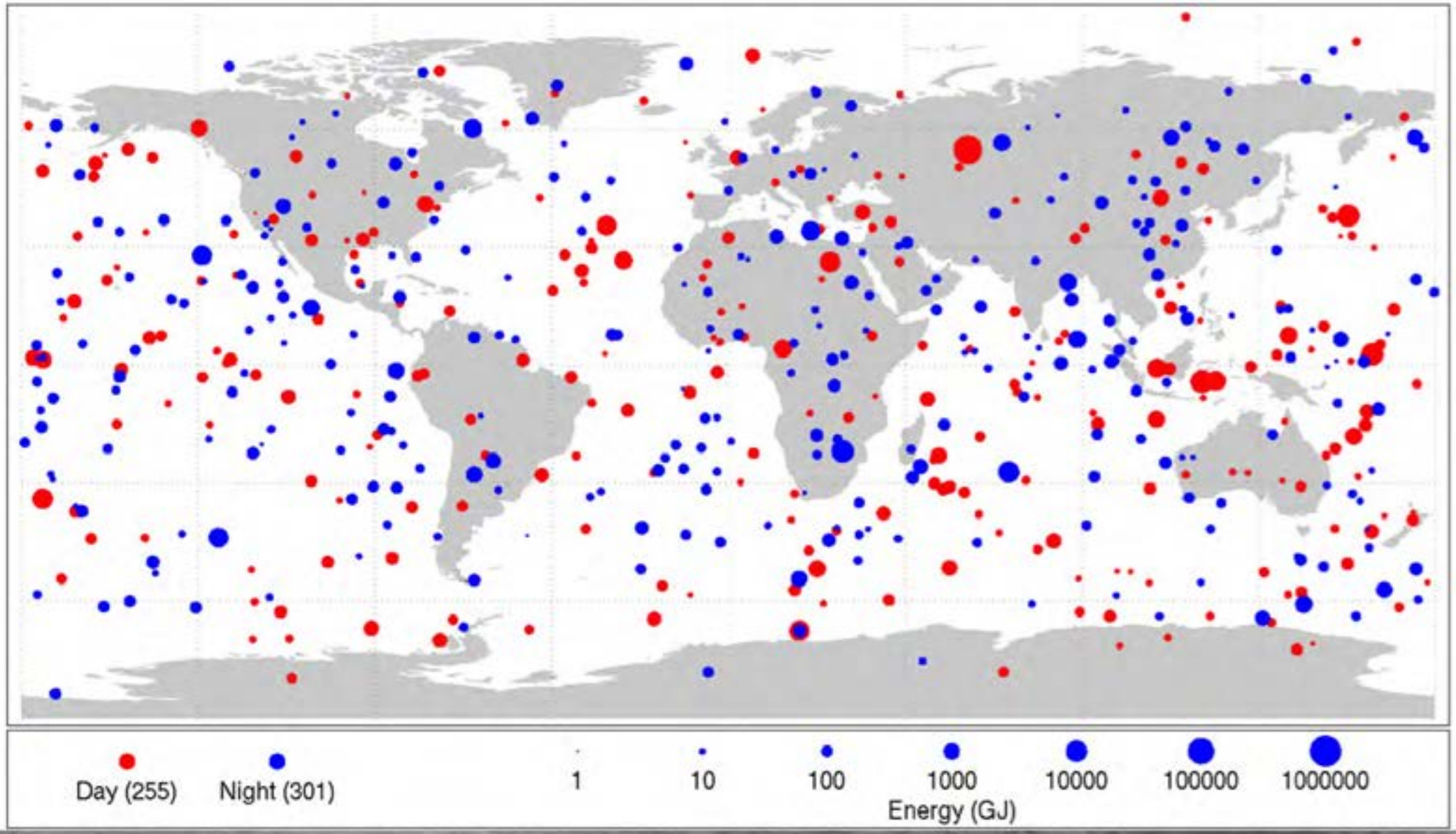

Der Pfad des Meteoriten
100 km
Beim Eindringen in die Atmosphäre beginnt der 12 000 Tonnen schwere Gesteinsbrocken zu glühen
Das Objekt rast mit 70 000 km/h von Ost nach West. Ein Großteil seiner Masse verdampft
50 km
25 km
Die dichter werdende Atmosphäre bremst den Gesteinsbrocken und er explodiert
Mehrere Bruchstücke (rund 4 bis 6 Tonnen) schlagen ein
Tscheljabinsk
Quelle: DLR
Tsp/Bartel

Dinosaurs go extinct
65 mio. years ago

Tunguska 1908

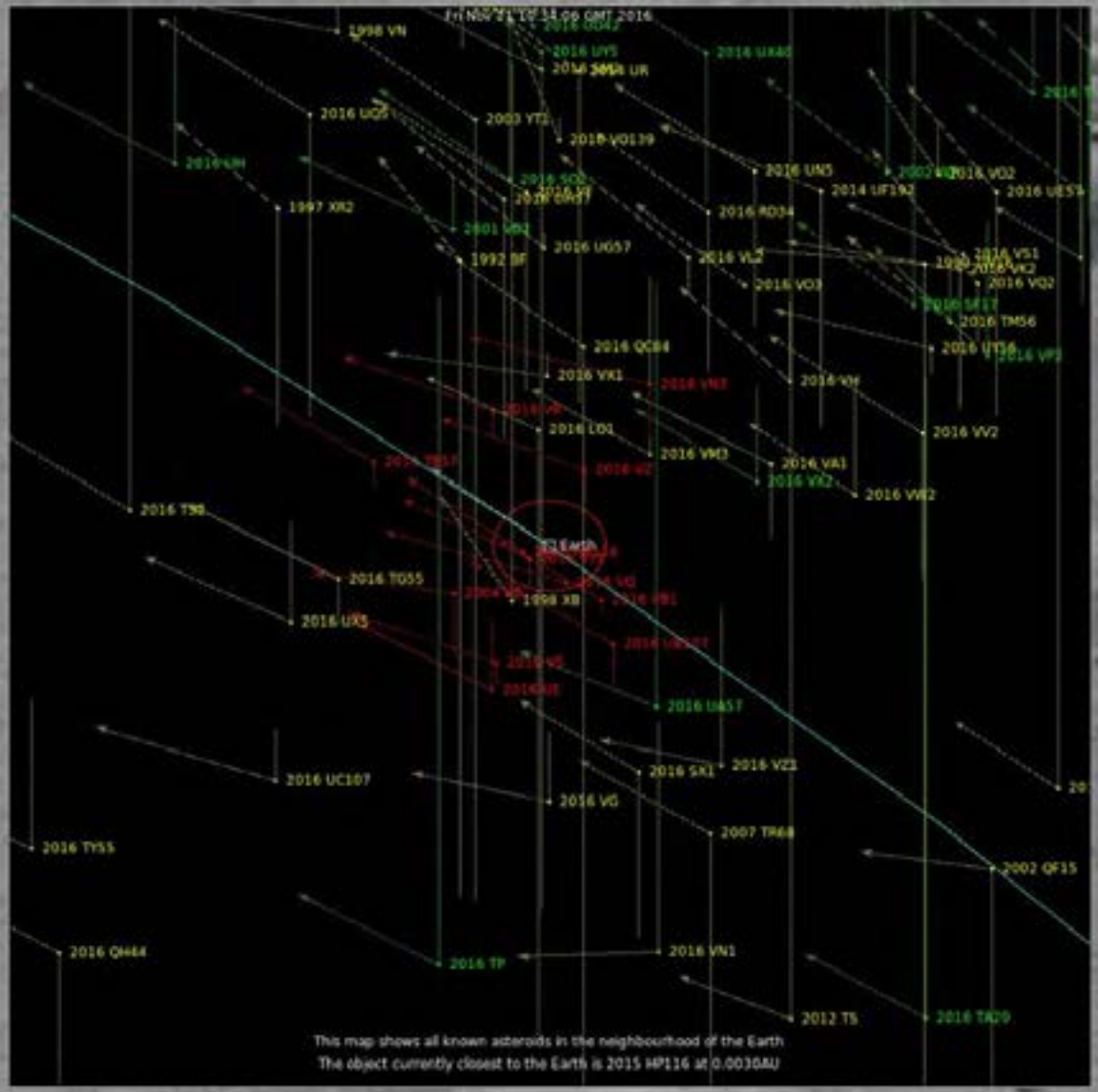
Arizona
50 000 years ago

Bolide events 1994 - 2013



This diagram maps the data gathered from 1994-2013. Sizes of red dots (daytime impacts) and blue dots (nighttime impacts) are proportional to the optical radiated energy of impacts measured in billions of Joules (GJ) of energy, and show the location of impacts from objects about 1 meter (3 feet) to almost 20 meters (60 feet) in size.
Image credit: NASA Planetary Science

Daily NEO map



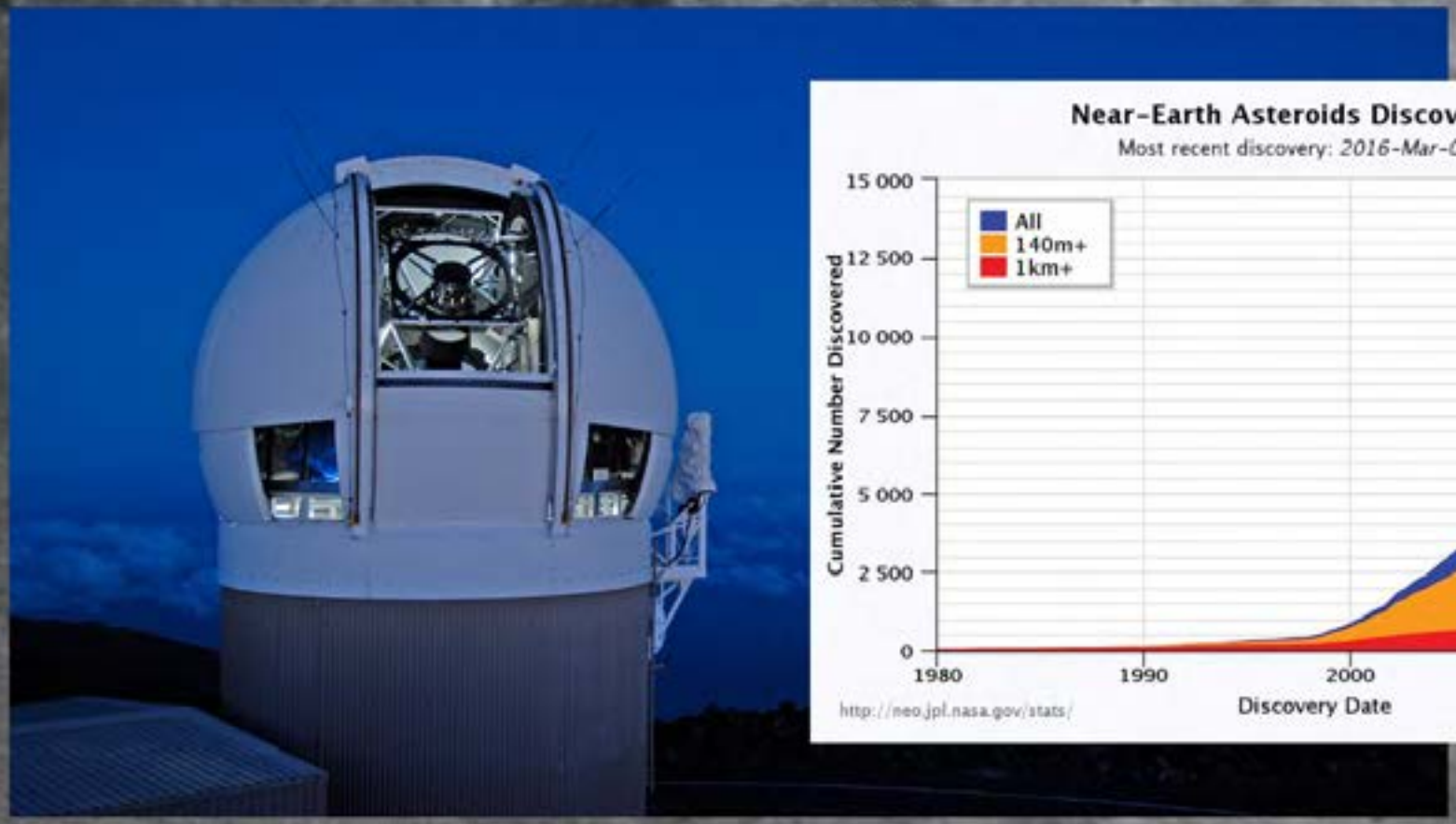
Red: PHAs within 10 Lunar distances

Yellow: Perihelia inside Earth

Green: Perihelia outside Earth

http://szyzyg.arm.ac.uk/~spm/local_map.html

Observing asteroids



The Panoramic Survey Telescope
& Rapid Response System (Pan-STARRS)

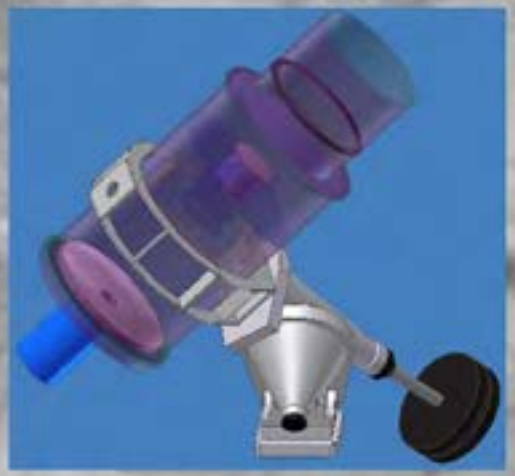
NASA's plan: Find 90% of asteroids larger than 140 meters before 2020

First predicted impact 2008
Discovered 19 hours before
Impact in Sudan
Asteroid: 2008 TC3

Impact warning

Asteroid Terrestrial-impact Last Alert System (ATLAS) by NASA
&
Flyeye by ESA

ATLAS plan to be complete in 2017
2 telescopes 100 miles apart,
scan the whole sky every night



1 day waring for "town killer"
1 week warning for "city killer"
3 weeks warning for "county killer"

Asteroid mitigation mission design

Kinetic impactor

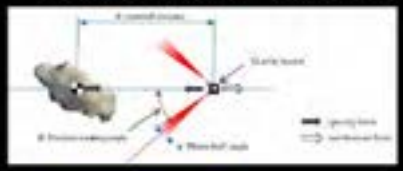
Advantage:
- Technology straightforward and almost ready

Challenges:
- Autonomous GNC at high 1+ km/s speeds
- Lack of knowledge of the impactor momentum transfer and of the NEO's physical properties

Gravity tractor

Advantage:
No contact with NEO
Fine control of the orbit

Challenge:
Autonomous station keeping over a long time period



ion beam shepherd

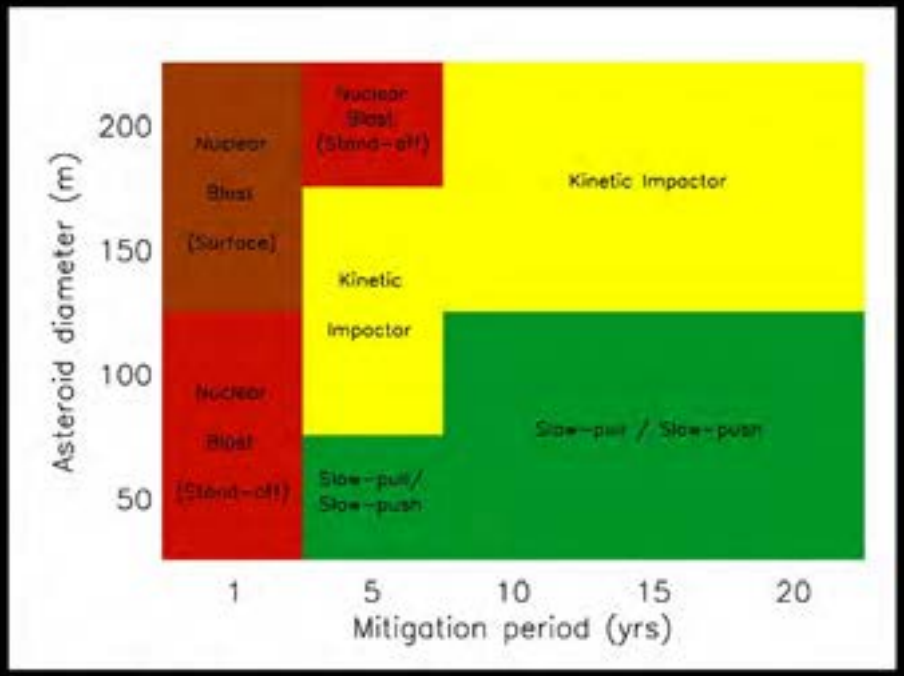


Figure credit: S. Eckersley (NEOShield, Airbus DS, UK) and D. Perna (NEOShield, Observatoire de Paris, LESIA).

Blast deflection

Advantage:
- "Biggest bang per buck"

Challenges:
- May break up the NEO
- Political issues
- Demo mission out of the question

Kinetic impactor

© ESA-AOES Medialab

Advantage:

- Technology straightforward and almost ready

Challenges:

- Autonomous GNC at high 5+ km/s speeds
- Lack of knowledge of the impactor momentum transfer and of the NEO's physical properties

Gravity tractor

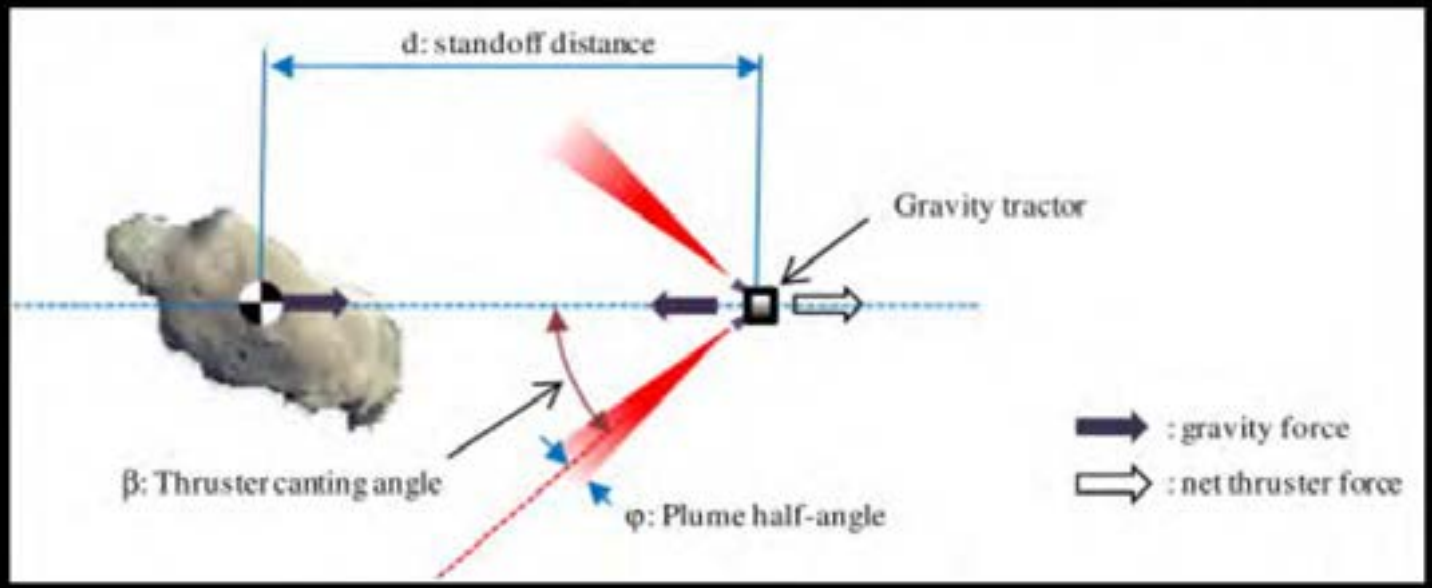
Advantage:

No contact with NEO

Fine control of the orbit

Challenge:

Autonomous station keeping over a long time period



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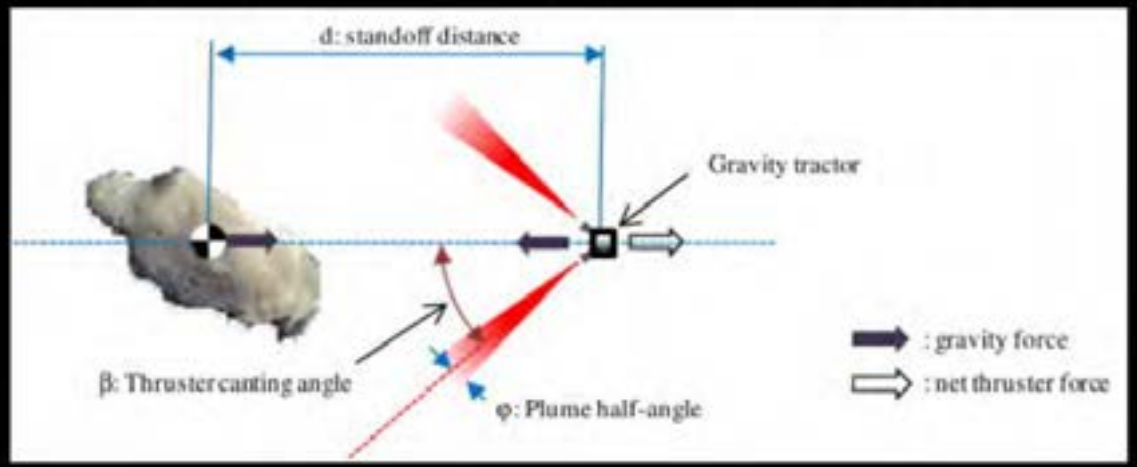

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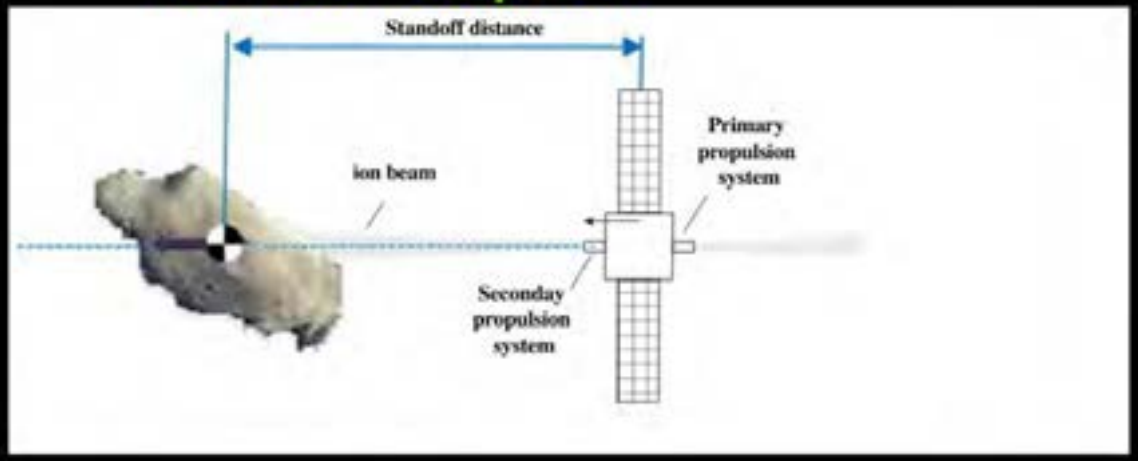

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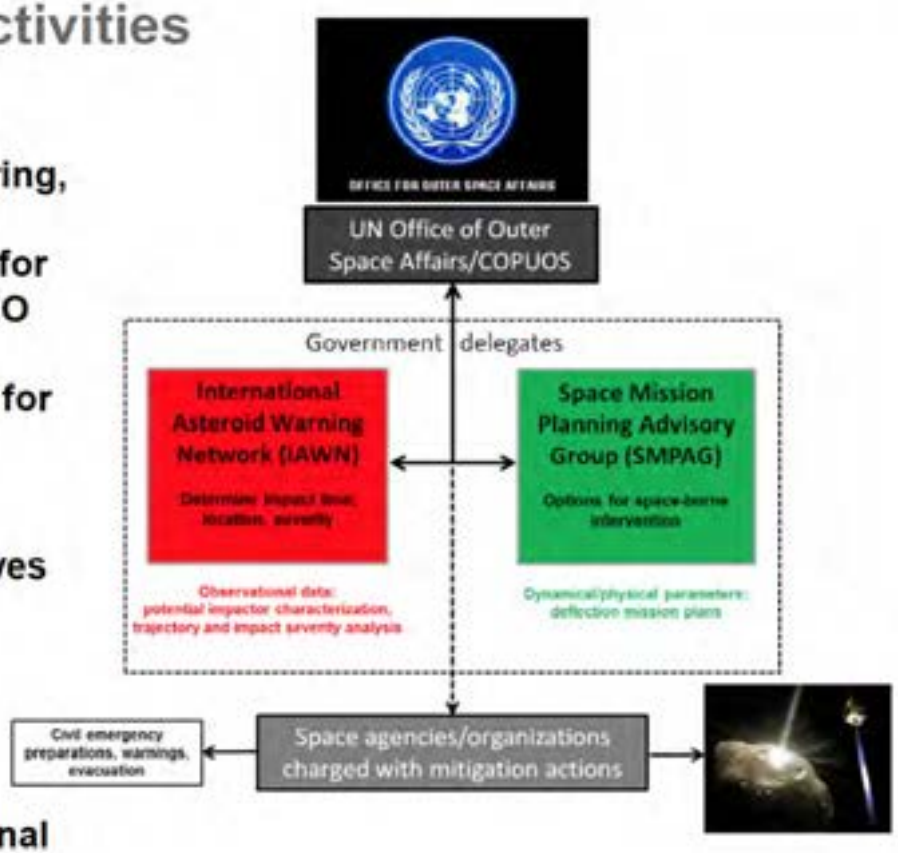
Figure credit: S. Ecl
D. Perna (NEOShiel

United Nations

Office for Outer Space Affairs

UN Impact-Hazard Activities

- IAWN should link together existing institutions (NEO discovery, monitoring, physical characterization).
- Maintain recognized clearing house for the receipt, and processing of all NEO observations (cf. MPC).
- Recommend criteria and thresholds for notification of an emerging impact threat.
- SMPAG should include representatives of spacefaring nations and other relevant entities.
- Lay out framework, timeline, and options for initiating and executing space mission response activities.
- Promote opportunities for international collaboration on research and techniques for NEO deflection.



All recommendations should be implemented with no cost to the regular UN budget.

History within UN

1994 Large comet impact on Jupiter. -If it had been Earth, it would have been similar to the dinosaur extinction

1999 UNISPACE III: Recommendations to improve international coordination of NEO activities

2001 COPUOS Action Team on NEOs established to follow-up on the recommendations.

2013 Action Team on NEOs finalized their work, and their recommendations was welcomed at the UN General Assembly, and lead to:

2014 establishment of the International Asteroid Warning Network (IAWN) and Space Mission Planning Advisory Group (SMPAG).

2016 establisment of the SMPAG Working Group for Legal Issues

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