Association of Space Explorers

SWF-ASE-ESA
NEO Workshop - MPOG
27-29 October 2010

Scenario 2
(direct impact)

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ASE-NEO Committee

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Scenario 2

1) Scenario description
2) Additional background information
3) Issues and Questions
   a) Technical
   b) Institutional

Note: Current date = 24 December 2016

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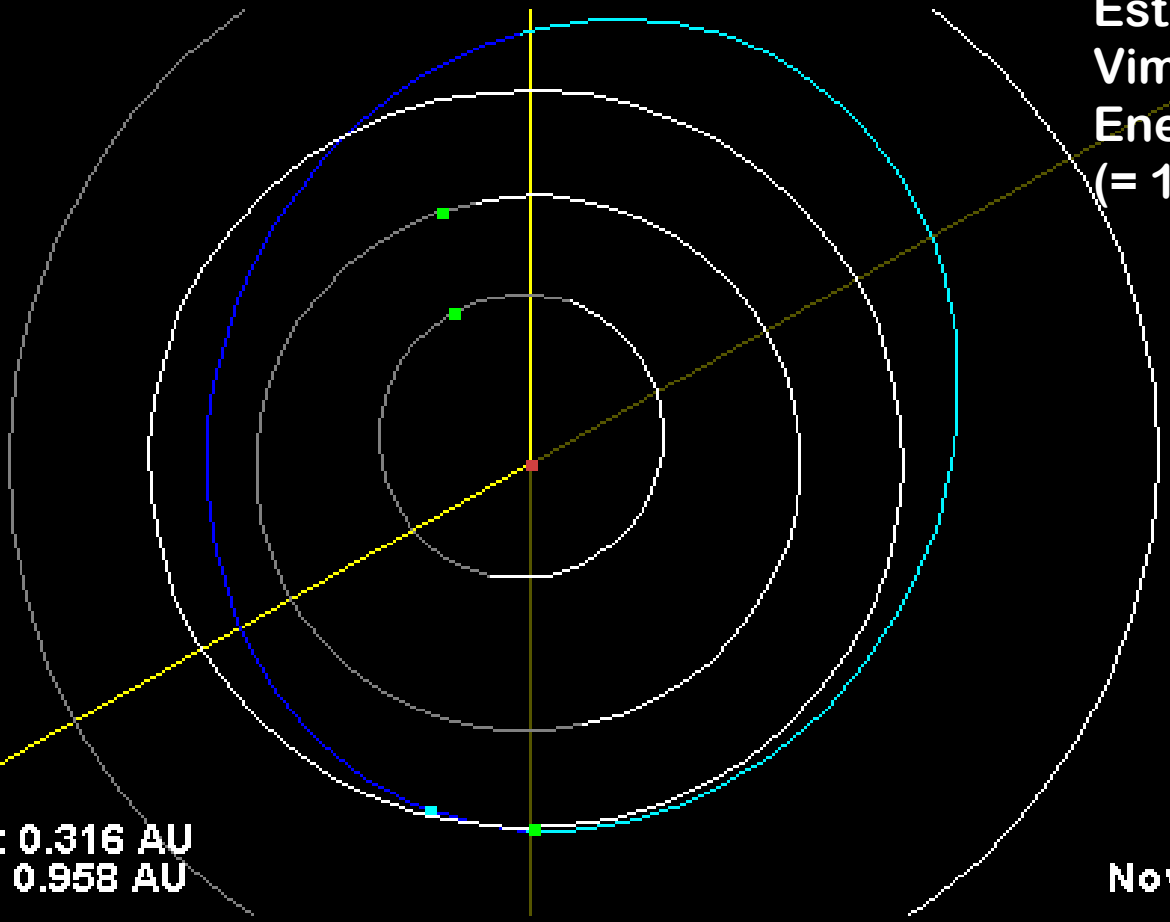
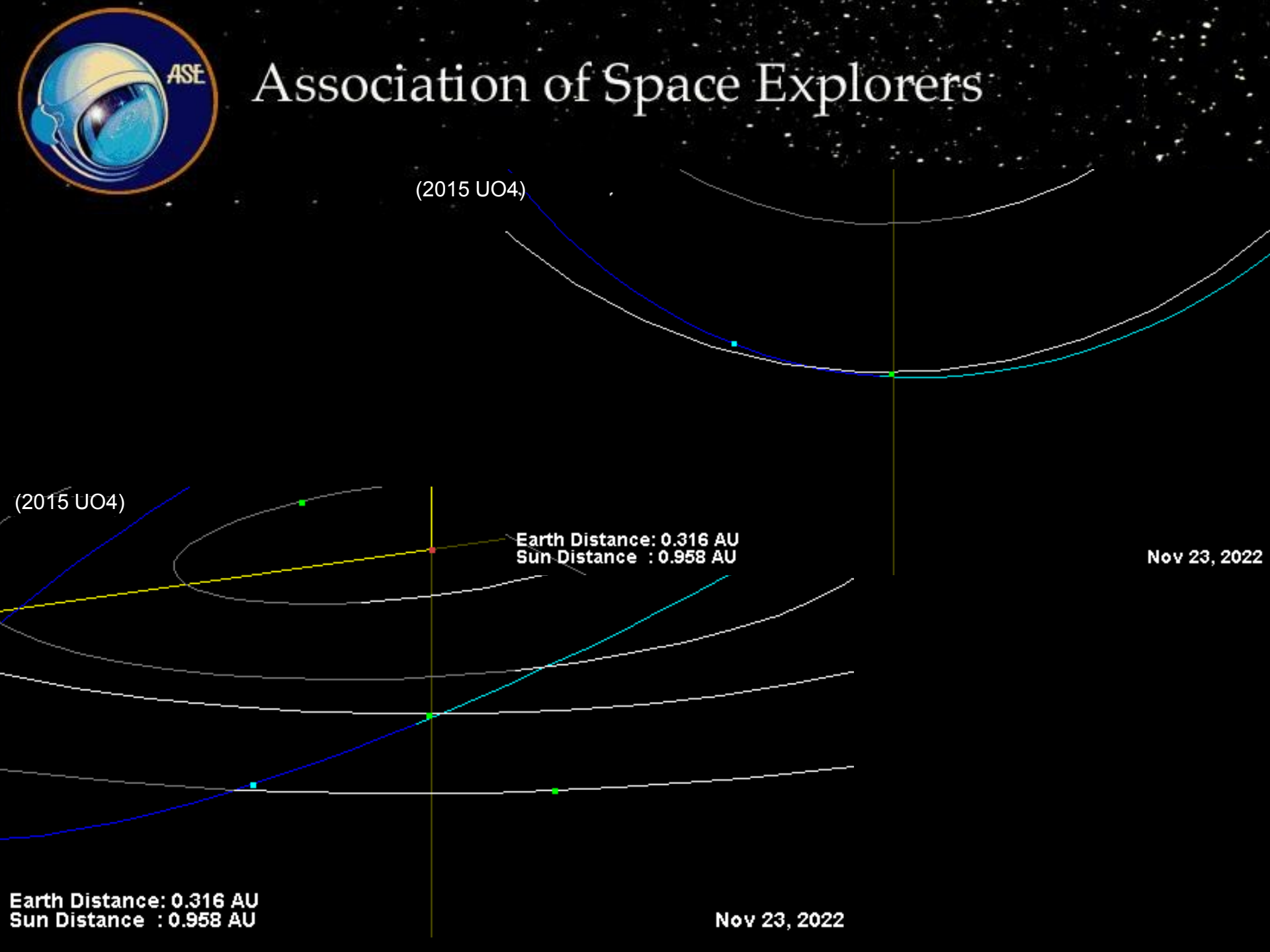
2015 UO4

Period: 1.16 yr
Inclination: 25.15 deg
Mass: 5.7e8 kg
Est. diameter: 75 m
Vimp: 17.64 km/sec
Energy: 21 MT
(= 1,400 Hiroshimas)



Earth Distance: 0.316 AU
Sun Distance : 0.958 AU

Nov 23, 2022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(2015 UO4)
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2015 UO4

Earth Impact Risk Summary

Torino Scale (maximum)	0
Palermo Scale (maximum)	-4.46
Palermo Scale (cumulative)	-4.21
Impact Probability (cumulative)	4.0e-06
Number of Potential Impacts	292

V_{impact}	17.64 km/s
$V_{infinity}$	13.68 km/s
H	23.3
Diameter	0.075 km
Mass	5.7e+08 kg
Energy	2.1e+01 MT

all above are mean values weighted by impact probability

Analysis based on
14 observations spanning 3.0066 days

Orbital Elements at Epoch 2454243.5 (2007-May-23.0) TDB
Reference: JPL 1 (heliocentric ecliptic J2000)

Element	Value	Uncertainty (1-sigma)	Units
e	0.161725957055478	0.0025052	
a	1.10317967744095	0.0097649	AU
q	0.924766888302661	0.0054419	AU
i	25.1485361159166	1.2014	deg
node	61.16714902307633	0.21342	deg
peri	299.3201336016319	1.8138	deg
M	253.0755982755737	2.3564	deg
t_p	2454369.201984517504 (2007-Sep-25.70198452)	1.615	JED
period	423.2215817576438 1.16	5.6193 0.01538	d yr
n	.8506182470773727	0.011294	deg/d
Q	1.281592466579244	0.011344	AU

Orbit Determination Parameters

# obs. used (total)	14
data-arc span	3 days
first obs. used	2007-05-22
last obs. used	2007-05-25
planetary ephem.	DE405
SB-pert. ephem.	SB405-CPV-2
condition code	9
fit RMS	.43795
data source	ORB
producer	Otto Matic
solution date	2007-May-25 10:50:03

Additional Information

Earth MOID = 0.00722721 AU
T_jup = 5.539

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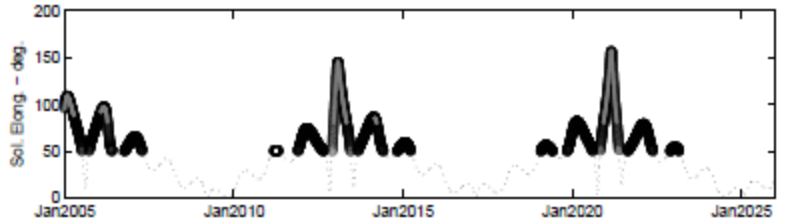
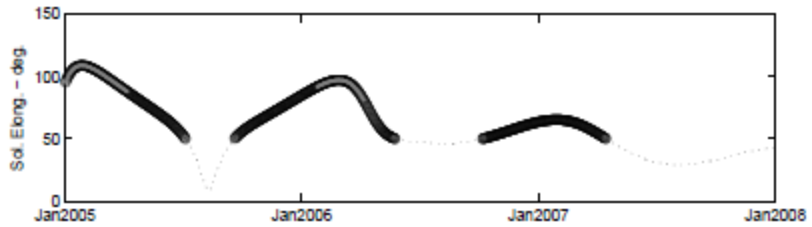
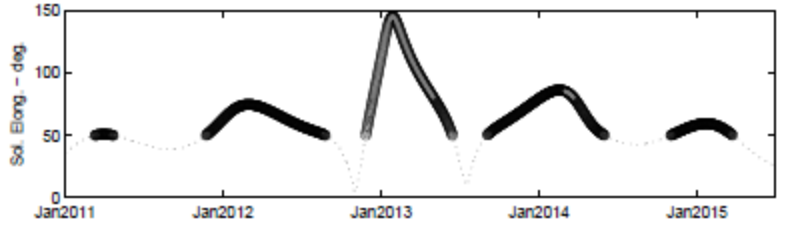
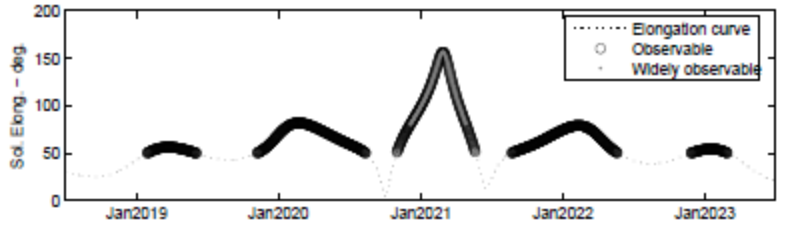
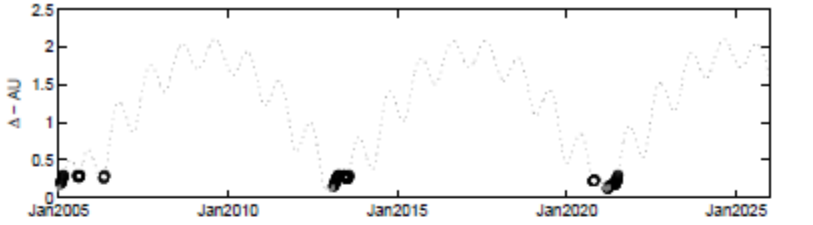
Potential Impact Detection

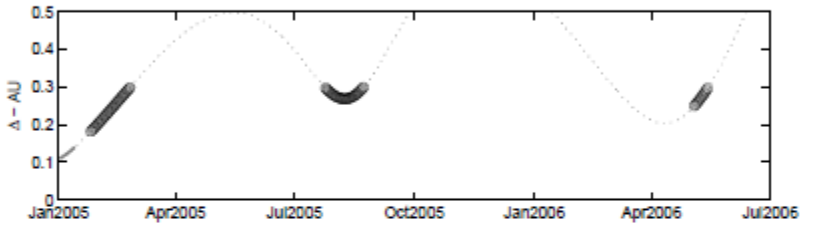


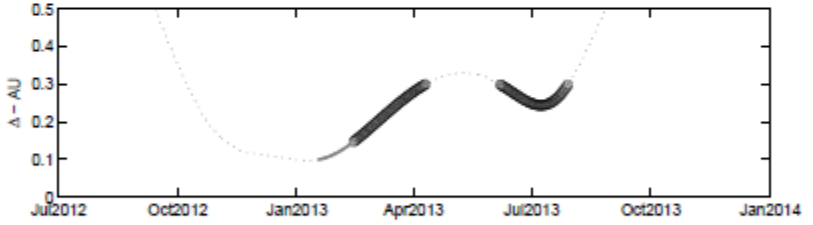


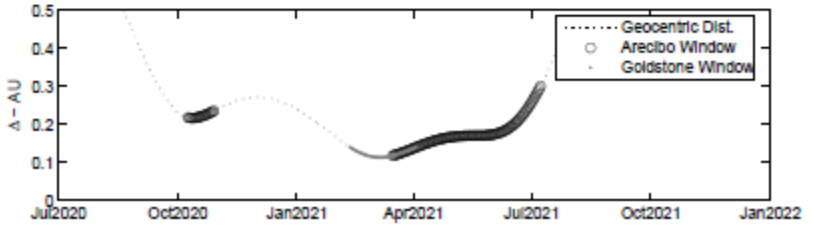












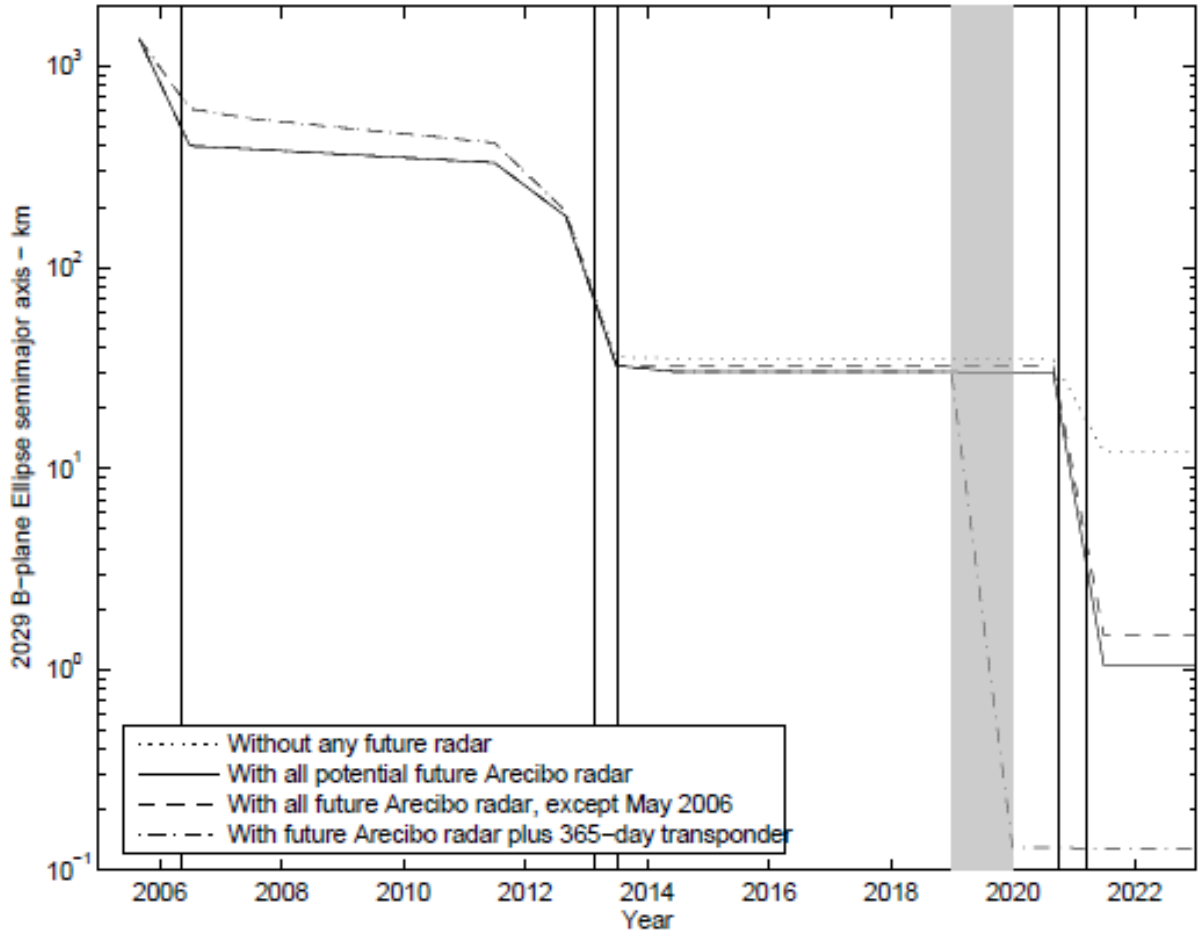


Figure 7. Predicted evolution of the uncertainty extent on the 2029 b-plane for 99942 Apophis. The four curves represent various observation scenarios. The contribution of the uncertainty in Yarkovsky modeling is included as described in the text. The vertical lines indicate the epoch of future Arecibo ranging opportunities. The gray region demarcates the time of a possible radio tracking mission, as described in the text.

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2030 LOV & Risk Corridor
Impact Probability 1:250

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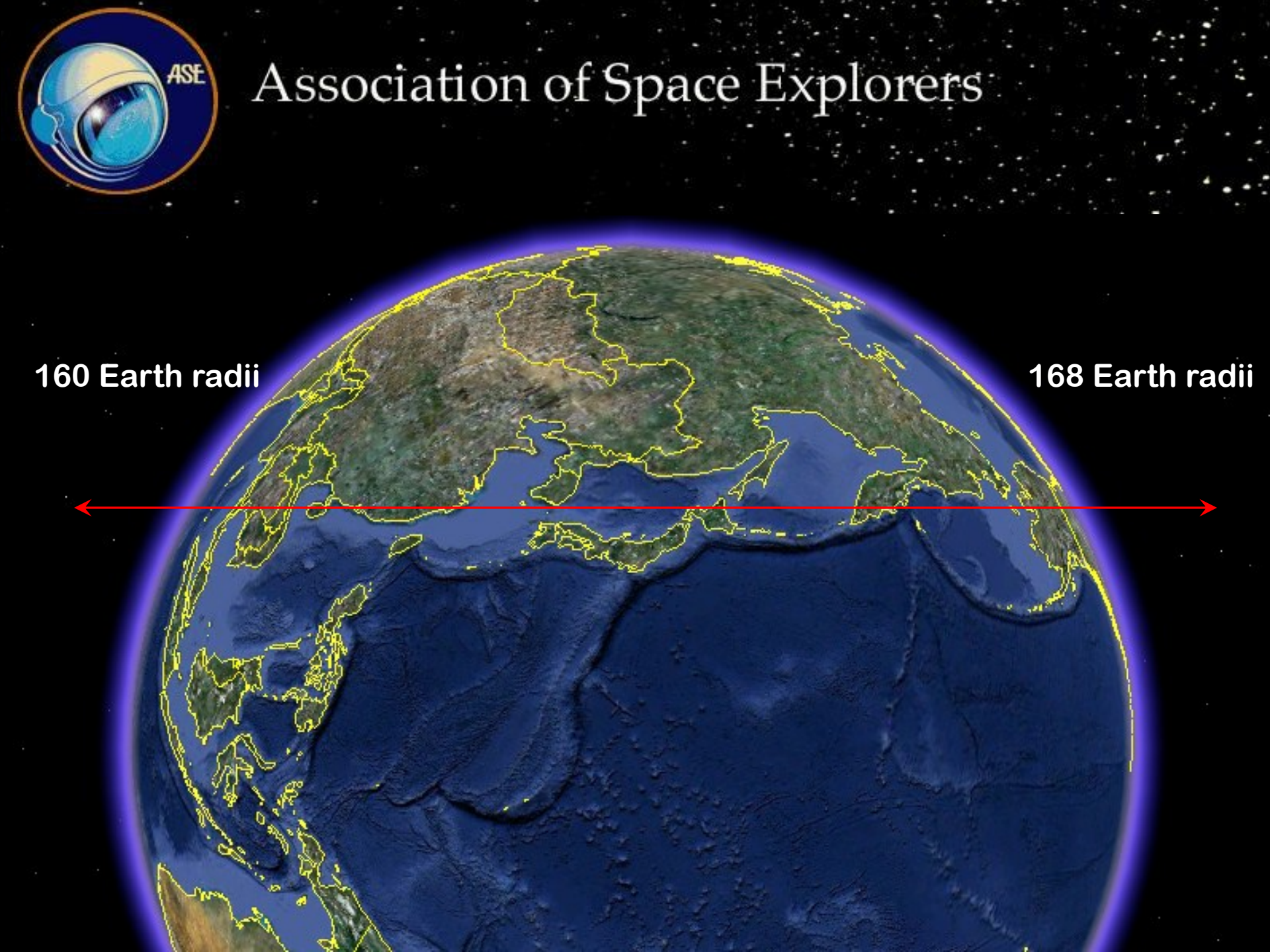

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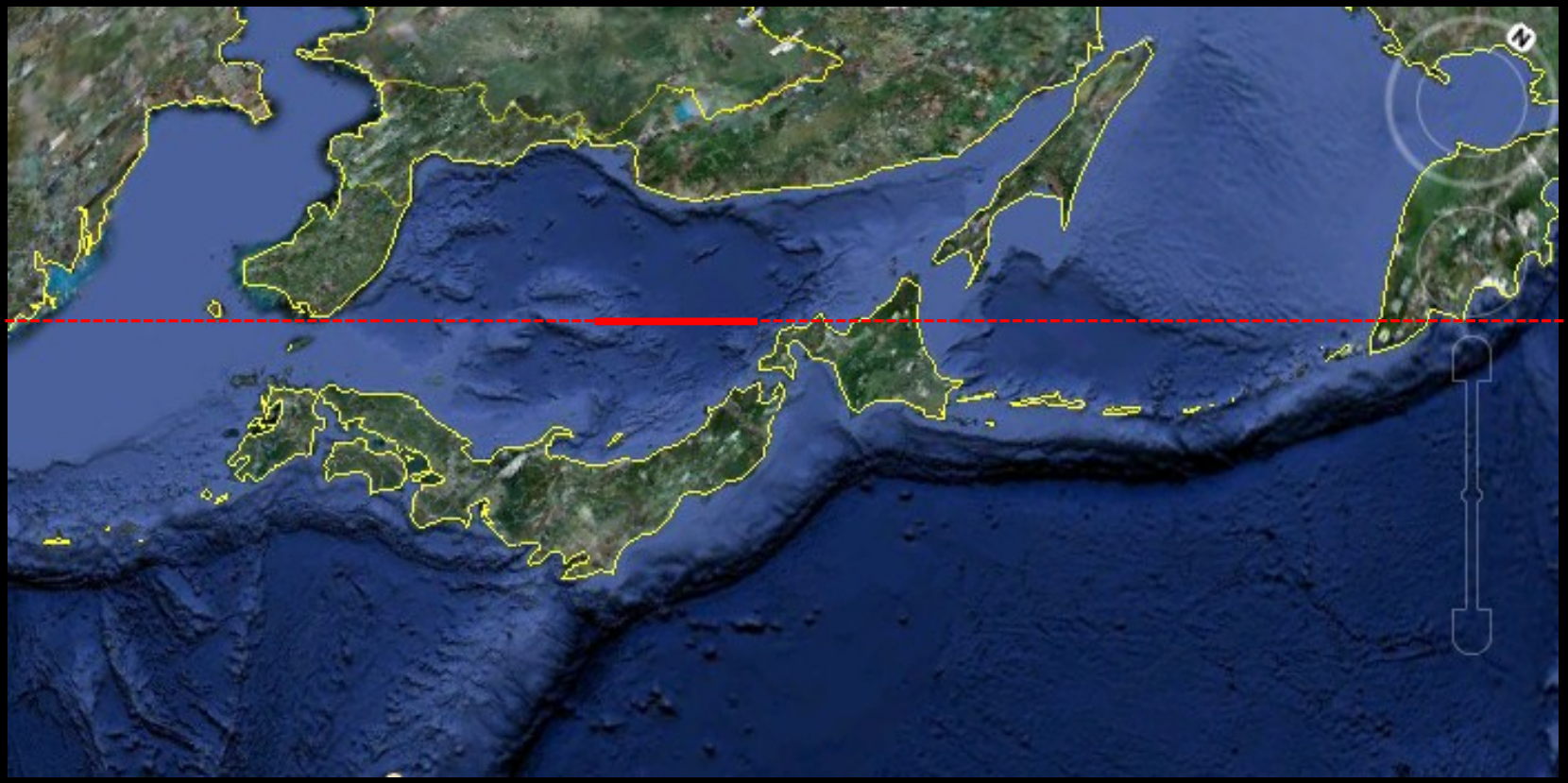

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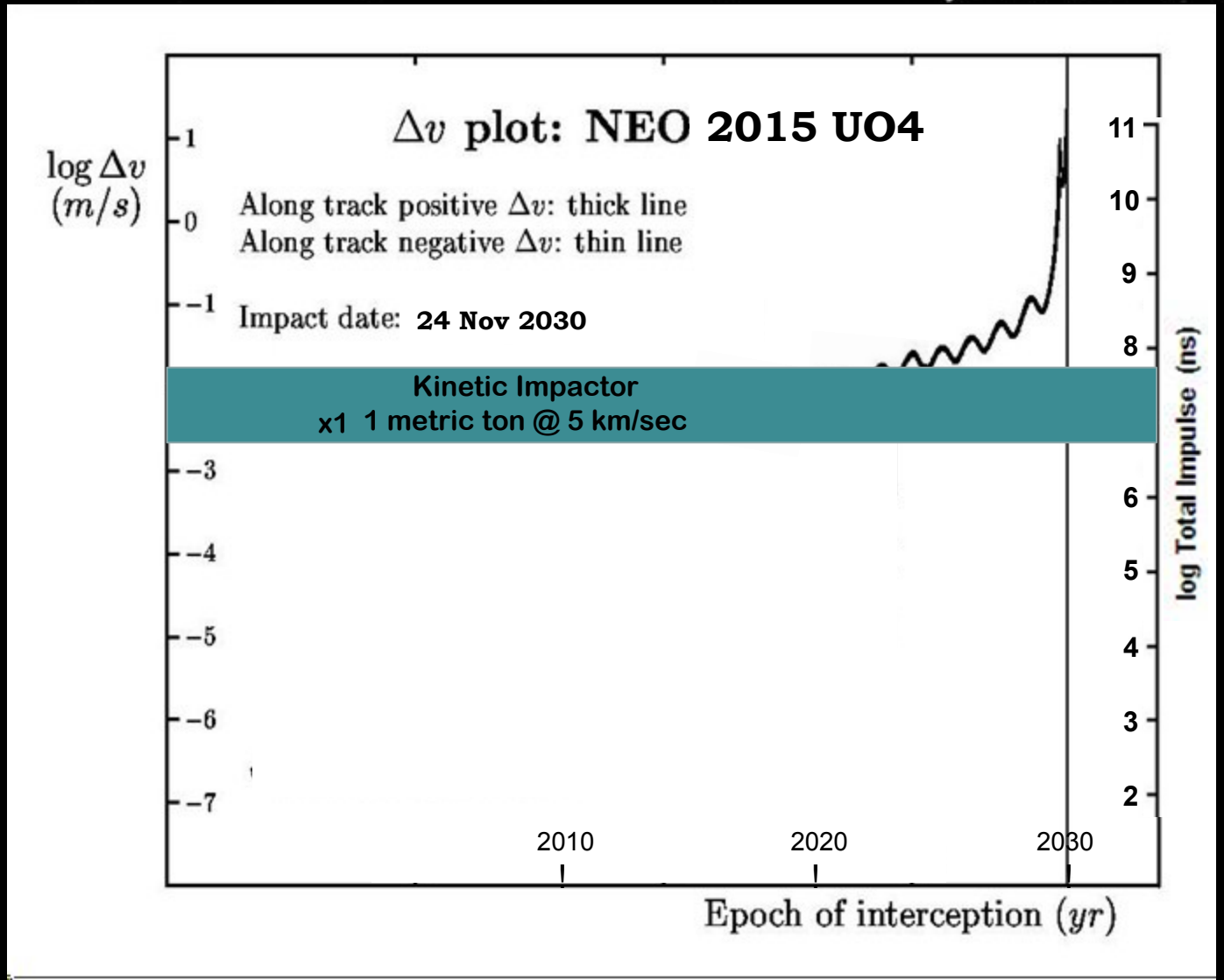
Δ V requirement



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Questions & Issues

Scenario 2

1) Are there additional questions or issues raised by the direct impact case which differ from those below for the keyhole impact case?

2) What information and/or analysis differences might there be for a situation requiring the immediate commitment to a deflection campaign?

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Questions & Issues

Scenario 2

3) Is the 14 year time horizon used in this example an adequate time for meeting the deflection challenge? If not, what are the minimum time requirements and can they be reduced by having pre-established certain criteria or policies?

4) Can we “recover” the asteroid via improvements in search capability (e.g. space-based search telescope launched to track the object) early in the 14-yr window? Is that cheaper than a transponder mission or deflection campaign?

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Questions & Issues

Scenario 1

1) What criteria should guide the binary choice of deflecting the NEO ahead of or behind the Earth? (Minimum people along risk corridor?; minimum infrastructure value?; shortest distance?; lowest cost?; minimum time to completion?; etc.)

2) What considerations should guide the final targeted miss distance beyond the Earth's surface? (Roche limit? i.e. potential breakup?; future close approach planning?; cost minimization?; etc.)

Questions & Issues

Scenario 1

3) What tracking and/or analytical information is required from the IAWN for MPOG to perform its mission? What timing requirements (re planning) should be levied on IAWN to insure MPOG can address the mission planning issues?
4) Should there be levels of alerting or warning provided by IAWN, and if so, how should they be defined? E.g. preliminary mission planning advised as in Scenario#1?
5) What deflection techniques are available? What criterion should apply, if any, to the use of various techniques?

Questions & Issues

Scenario 1

6) Who deflects? What are the options for selection and the basis to be applied for such selection? Who makes the determination, and how? **(MPOG, MAOG, Security Council, first on scene, maximum self-interest)**
7) **Who pays? How is cost determined and by what process is it approved and allocated?**
8) Are there liability and/or other legal issues that must be addressed as MPOG moves ahead? What are they?

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Questions & Issues

Scenario 1

9) **What oversight and/or control of the deflection planning and execution is required or appropriate?**

10) Will national security (e.g. export control issues; ITAR & equivalent) preclude international cooperation in a deflection campaign? Can this be avoided?

11) How should MPOG be structured? Should this be integrated into ISECG in any way? Other existing structure?

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Questions & Issues

Scenario 1

12) Should membership in MPOG be limited to the launch capable nations? Should nations specify which of their national space organizations will represent them in MPOG? Should MPOG representatives be able to commit their governments? If not, then in what higher forum should this occur?

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Discussion