TASK 5.2 MITIGATION MISSION TYPES AND TECHNOLOGIES TO BE CONSIDERED

Massimiliano Vasile

ACTIVITIES

Completed a new comparison among deflection strategies:

- Thiry and Vasile (2017), ‘ Statistical Multi-criteria Evaluation of Non-nuclear Asteroid Deflection Methods’, Acta Astronautica. http://www.sciencedirect.com/science/article/pii/S0094576517302916
- Completed the theoretical comparison of in-line and halo GT configurations
- Theoretical study of low-thrust kinetic impactor

Dynamical analysis of the fragmentation of contact binaries during close encounter post deflection.

On-going work with JPL on uncertainty on impact probability.

Started the preparation for the re-submission of Stardust2.

RECENT RESULTS

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Revised model of laser ablation

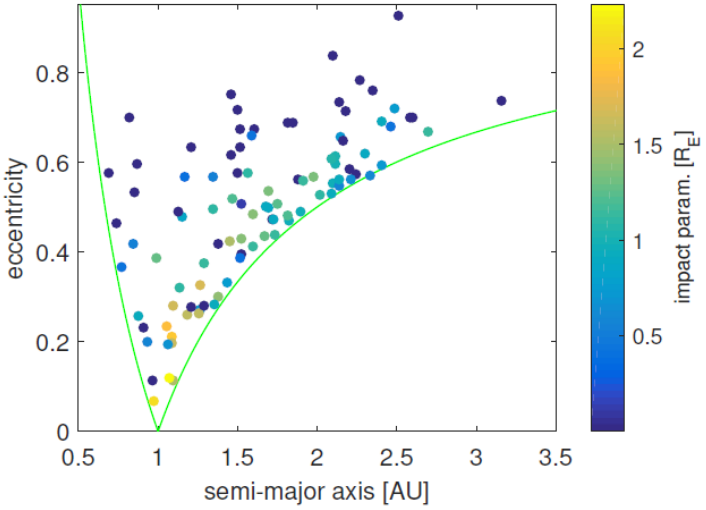
Revisited gravity tractor

Updated comparison of deflection methods

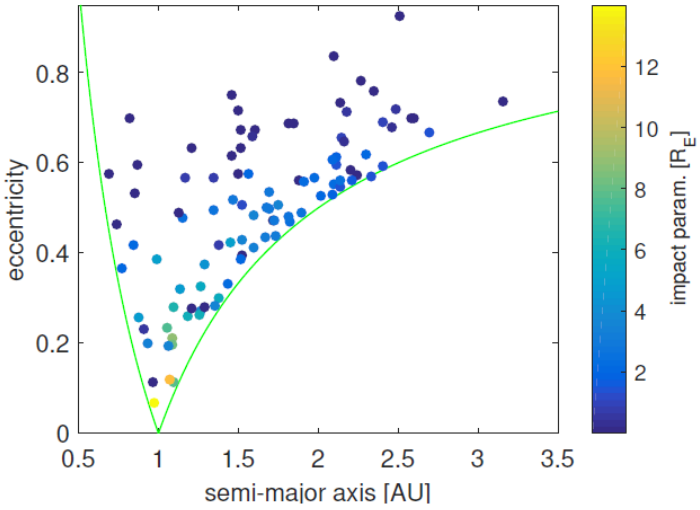
- Use of current NEO distribution model
- Reference asteroid mass equal to NEOShield
- Inclusion of launch and mission scenario
- Inclusion of system design consideration to size the spacecraft deflecting the asteroid
- Globally optimised solutions

Thiry, N., Vasile, M. Statistical multi-criteria evaluation of non-nuclear asteroid deflection methods. Acta Astronautica, Volume 140, November 2017, Pages 293-307.

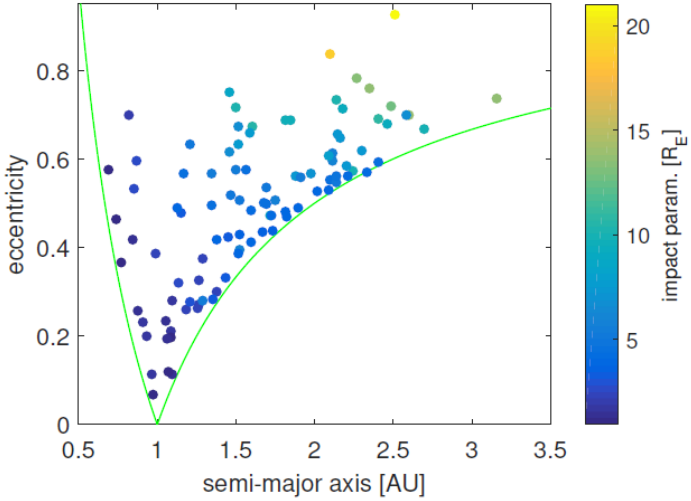
MISS DISTANCE IN A GIVEN TIME



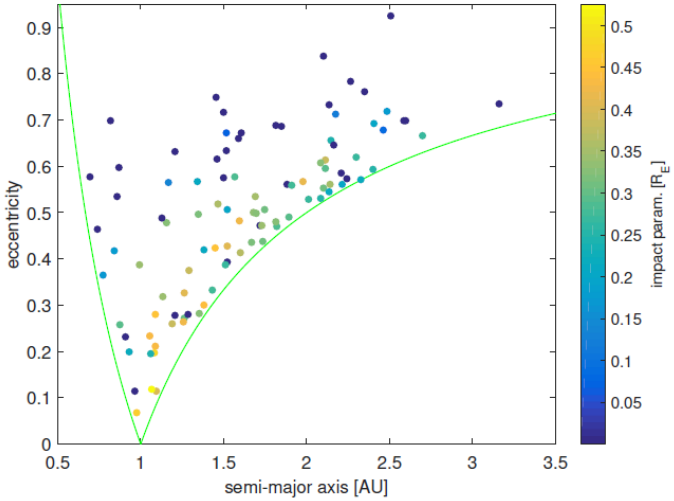
(b) Ion Beam Shepherd



(c) Laser Ablation System



(a) Kinetic Impactor



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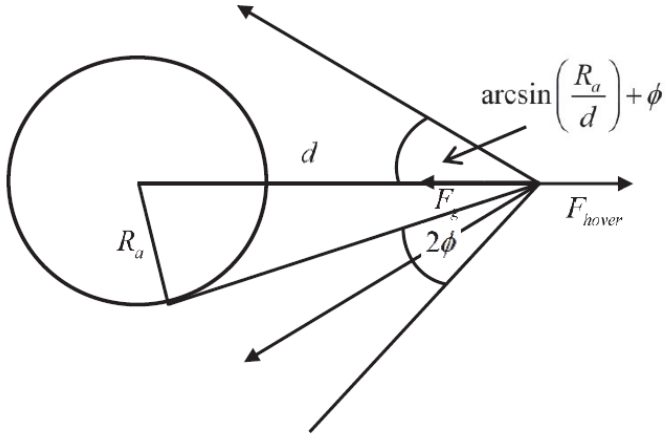
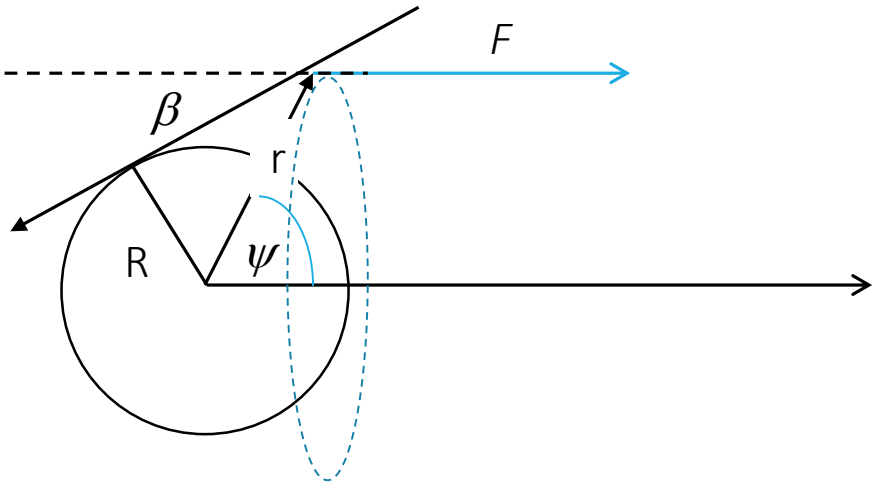
GRAVITY TRACTOR: IN-LINE VS HALO

In-line configuration:

$$a_{gtug}(t) = \frac{Gm_S(t)}{d^2}$$



Halo configuration:



For the same tugging acceleration and Δv:

$$m_H = m_S \cos\alpha$$

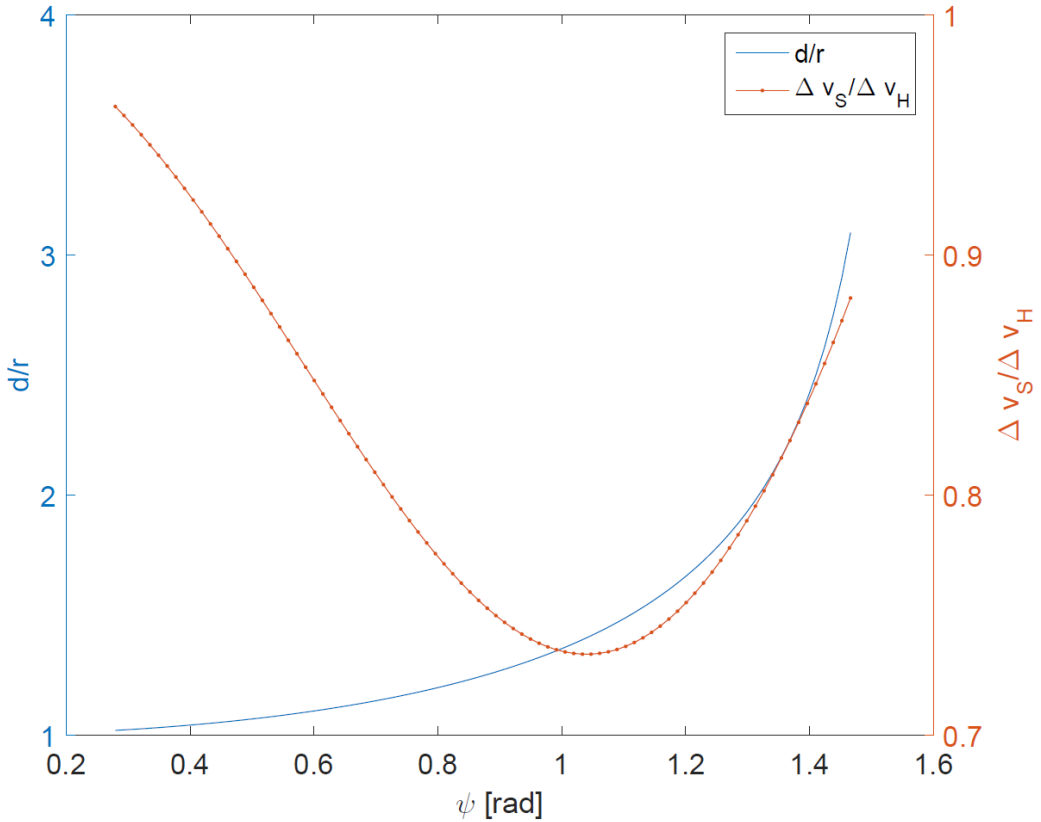
$$\alpha = \arcsin\left(\frac{R_a}{d}\right)+\phi$$

Thiry, N., Vasile, M. Statistical multi-criteria evaluation of non-nuclear asteroid deflection methods. Acta Astronautica, Volume 140, November 2017, Pages 293-307.

GRAVITY TRACTOR: IN-LINE VS HALO

Halo configuration:

$$a_H = \frac{Gm_H(t)}{R_a^2} \cos\psi \sin(\psi - \phi)^2$$



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LOW-THRUST KINETIC IMPACTOR

Can we enhance the transfer of linear momentum by using low-thrust engines to achieve a better impact trajectory?

$$\delta v = \beta \frac{m_{s/c}}{m_a} \delta v_{s/c}$$

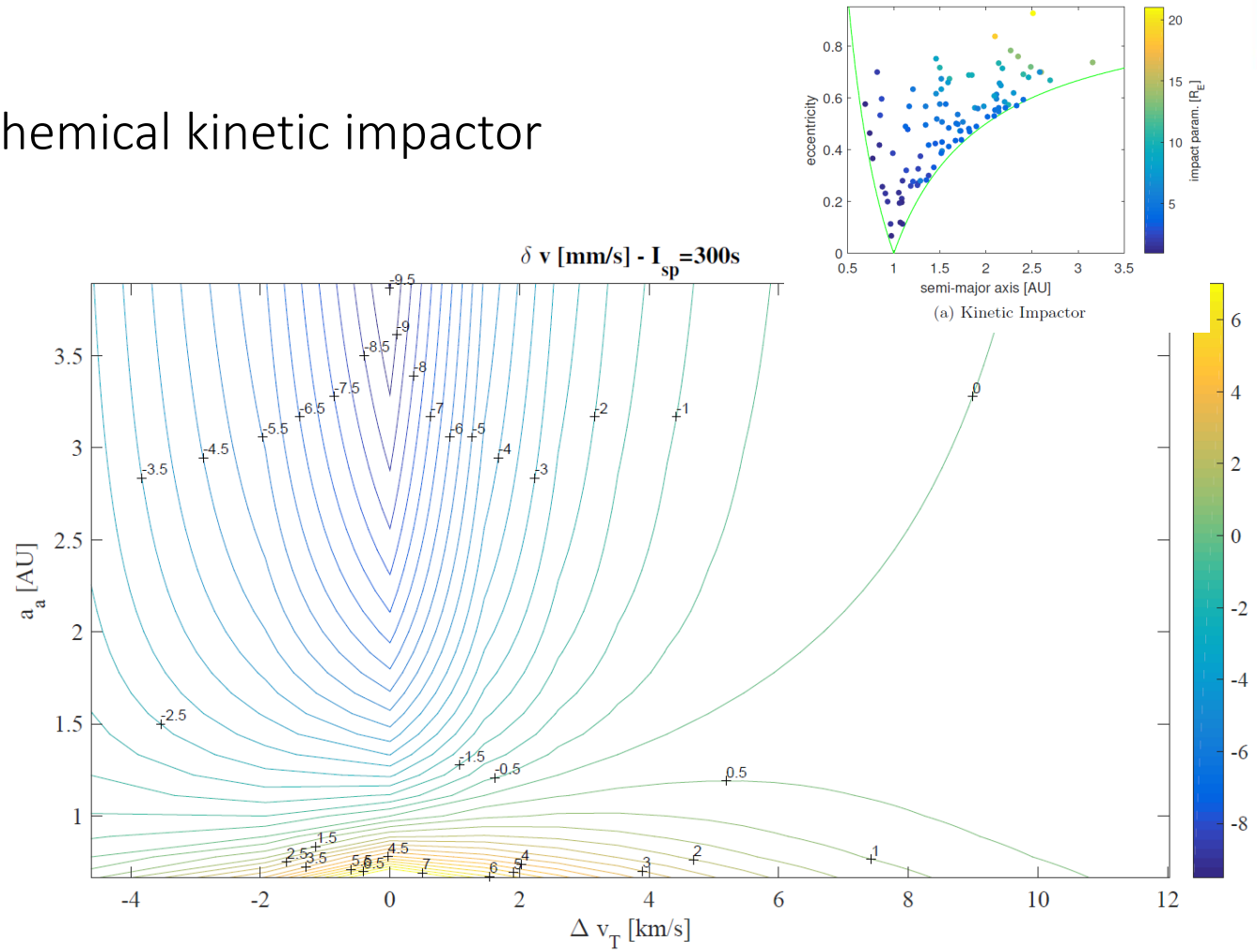
The impacting δv is partially due to the relative geometry of asteroid and Earth and partially due to the trajectory that leads to an impact.

$$\delta v = \frac{m_{s/c}}{m_a} (\|q\| - \Delta v_T)$$

Thiry, N., Vasile, M. Statistical multi-criteria evaluation of non-nuclear asteroid deflection methods. Acta Astronautica, Volume 140, November 2017, Pages 293-307.

LOW-THRUST KINETIC IMPACTOR

Only chemical kinetic impactor



(a) $I_{sp} = 300s$

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LOW-THRUST KINETIC IMPACTOR

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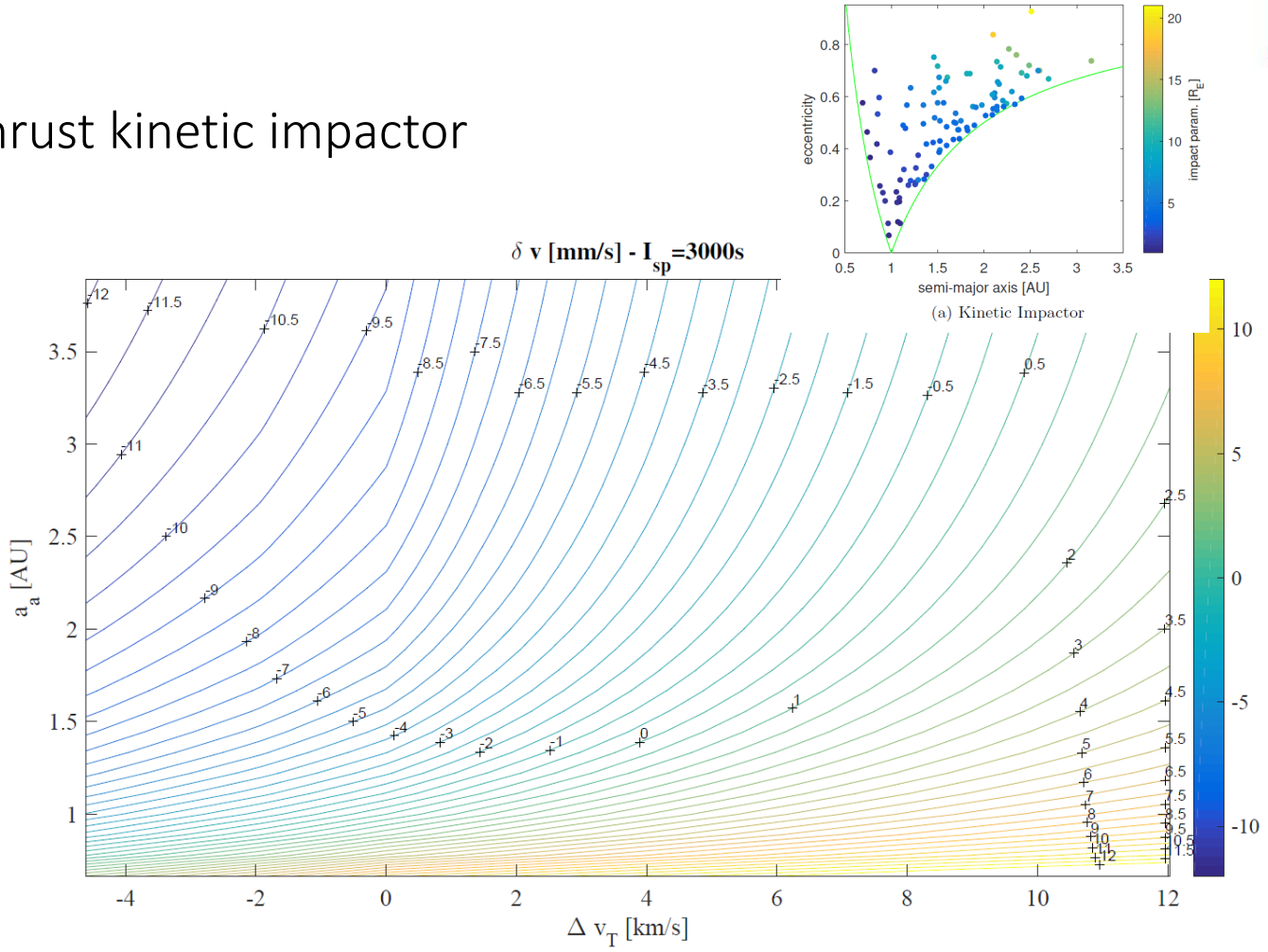
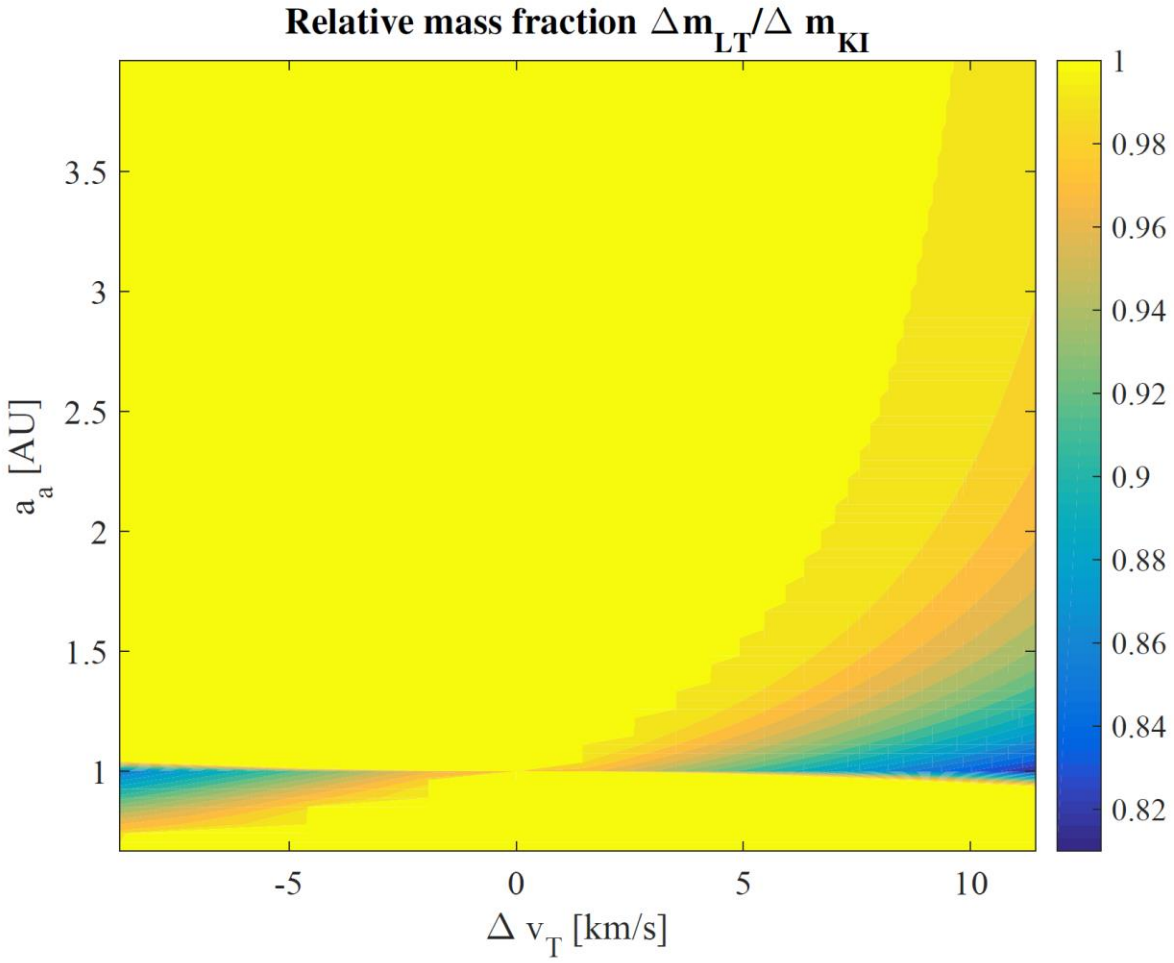
Low-thrust kinetic impactor

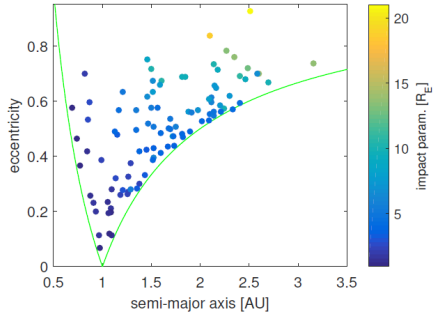


(b) $I_{sp} = 3000s$

Thiry, N., Vasile, M. Statistical multi-criteria evaluation of non-nuclear asteroid deflection methods. Acta Astronautica, Volume 140, November 2017, Pages 293-307.

LOW-THRUST DEFLECTION VS KINETIC IMPACTOR?





(a) Kinetic Impactor

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FUTURE ACTIVITIES

Stardust2 proposal will be submitted to the EC in January 2018

Expected evaluation in May 2018

Expected start of Stardust2, if successful Jan 2019

New work started on the inclusion of uncertainty in the deflection action

Combination of uncertainty on impact prediction, pre and post deflection.

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