Recommendation: Start, as soon as possible, the initial design phases (phases A/B) of a fast flyby reconnaissance mission.

Decision Needed

To immediately start phase A development of a flyby asteroid reconnaissance mission

- Phase A represents a modest fraction of overall mission cost (<5%)
- If mission start postponed, mission's schedule will no longer be achievable
- If this opportunity is missed, large uncertainties in key asteroid properties would remain until at least 09/2030

Benefits of Action

- Fastest way to reduce uncertainties via flyby spacecraft reconnaissance
- High-heritage mission, with no new technology development needed

Risks of Inaction

- Lowers likelihood to successfully prevent Earth impact, should it become certain
- Delayed future actions have higher costs
- Large uncertainties in impact risks persist

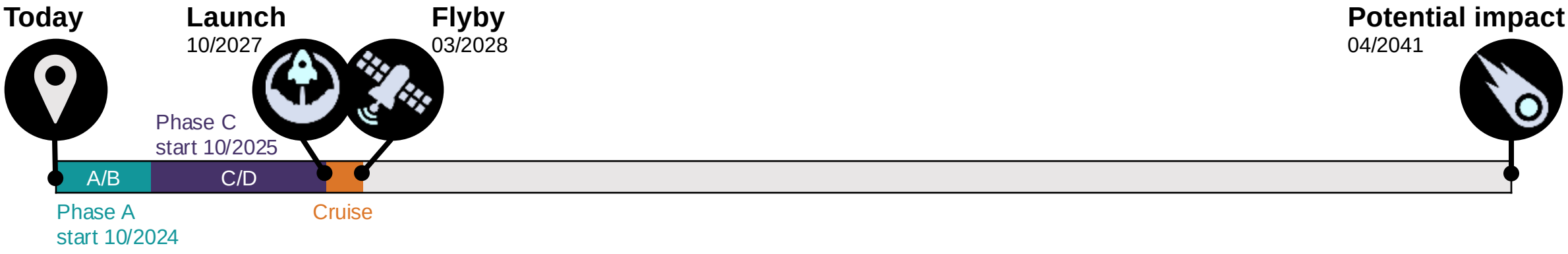
Factors to Consider

- Phase A must start immediately to realistically achieve launch date
- Development can be stopped at any time if telescopic observations rule out impact

Analogues to Past Missions

- Double Asteroid Redirection Test (DART), NASA
- Lucy, NASA
- Chang'e 2 flyby of Toutatis (China)

Mission Option Timeline



Recommendation: Consider retasking an already flying spacecraft to perform an early reconnaissance of the target asteroid.

Decision Needed

To pursue retasking of an existing spacecraft (e.g., OSIRIS-APEX) for flyby reconnaissance

- Space agencies could evaluate their flight projects to identify whether other missions could be redirected
- OSIRIS-APEX is a NASA spacecraft that could be redirected to flyby the asteroid
- Decision to retask APEX is needed ~1 month before redirect burn

Benefits of Action

- Early flyby reconnaissance without requiring a new development and launch
- Flyby would reduce key uncertainties in deflection requirements and impact risks

Risks of Inaction

- Spacecraft cannot reach the asteroid if the maneuver is delayed beyond the (TBD) NLT date

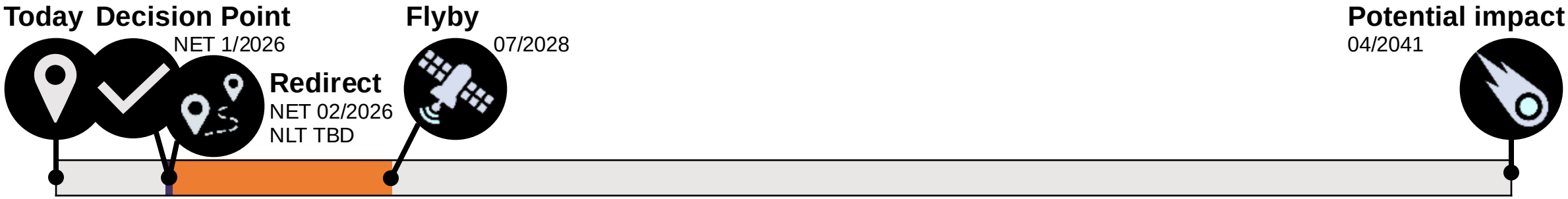
Factors to Consider

- The spacecraft may be beyond their design life, which increases risk
- Spacecraft and payloads may not be designed for a flyby

Analogues to Past Missions

- EPOXI (NASA)
- Stardust-NExT (NASA)
- New Horizons (NASA)

Mission Option Timeline



Recommendation: Start, as soon as possible, the initial design phases (phases A/B) of a solar electric propulsion (SEP) rendezvous reconnaissance mission, independently of the implementation of a flyby reconnaissance mission.

Decision Needed

To immediately start phase A development of a SEP rendezvous asteroid reconnaissance mission

- Phase A represents a modest fraction of overall mission cost (<5%)
- Phase A must start by 12/2024 or the mission's schedule will not be achievable
- If this opportunity is missed, uncertainties in key asteroid properties would remain until at least 10/2032

Benefits of Action

- Rendezvous recon is the best way to reduce uncertainties and is high-heritage
- Provides critical on-site monitoring during and after deflection/disruption

Risks of Inaction

- Lowers likelihood to successfully prevent Earth impact, should it become certain
- Delayed future actions have higher costs
- Limits options to prevent impact

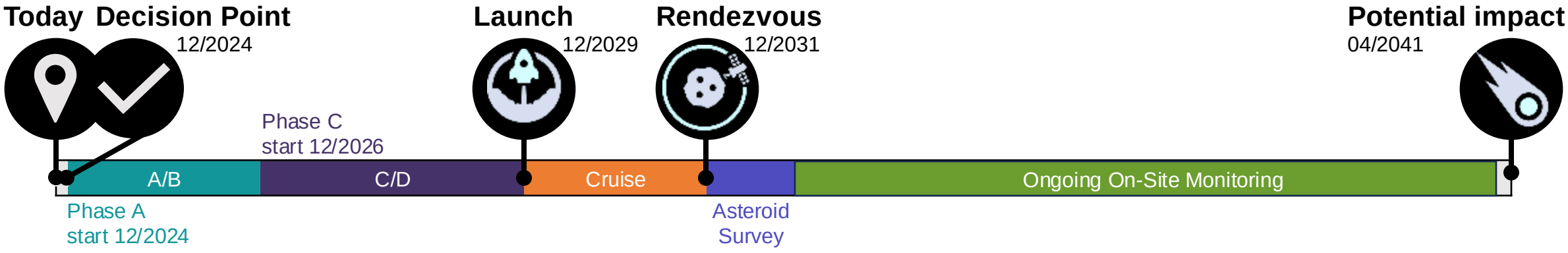
Factors to Consider

- SEP can reach the asteroid about a year earlier than chemical propulsion
- Development can be stopped at any time if telescopic observations rule out impact

Analogues to Past Missions

- OSIRIS-REx, NASA
- Psyche, NASA
- Hayabusa2, JAXA
- NEAR, NASA

Mission Option Timeline



Recommendation: Start, as soon as possible, the initial design phases (phases A/B) of in-space mitigation missions, based on the following concepts, including the risk assessment on each option: kinetic impactor (KI) and ion beam deflection (IBD).

Decision Needed

To begin Phase A studies of kinetic impactor and ion beam deflection Earth impact prevention missions

- Phase A represents a modest fraction of overall cost (<5% of each mission's cost)
- Resources put to deflection missions may reduce resources for recon missions
- Decisions about continuing deflection/ disruption mission developments should be dependent on results of flyby recon.

Benefits of Action

- Prepare to implement Earth impact prevention mission(s) if Earth impact becomes certain

Risks of Inaction

- May forgo earliest launch opportunities for Earth impact prevention missions
- Delayed future actions have higher costs
- May limit non-nuclear options

Factors to Consider

- Delaying the launch of an ion beam deflection mission until after 2029 may significantly reduce non-nuclear explosive device deflection options later.

Analogues to Past Missions

- Kinetic impactor: DART (NASA)
- Ion beam deflection has not been demonstrated in flight

Mission Option Timeline

Recommendation: Perform detailed simulations assessing the possibility to disrupt an asteroid by an impulse transfer. The work should be done by several SMPAG delegations independently.

Decision Needed

To support detailed simulations of possible asteroid disruption

- Resources required for numerical simulations are modest compared to resources required for a flight project
- The sooner resources are allocated for this effort, the sooner this effort can inform mission planning

Benefits of Action

- Tailor design of impulsive Earth impact prevention missions to either avoid unintentional partial disruption or ensure robust disruption

Risks of Inaction

- A deflection mission could, inadvertently, partially disrupt the asteroid.
- If the asteroid is on an impact course, some parts of it could still hit Earth.

Factors to Consider

- High-performance computing resources are required but available
- High-fidelity numerical codes already exist that are suited for these models

Analogues to Past Missions

- A numerical modeling campaign for DART and Hera has greatly aided interpretation of the outcome of the DART impact

Mission Option Timeline

Today

Potential impact
04/2041