Potential impactor 2024 YR4

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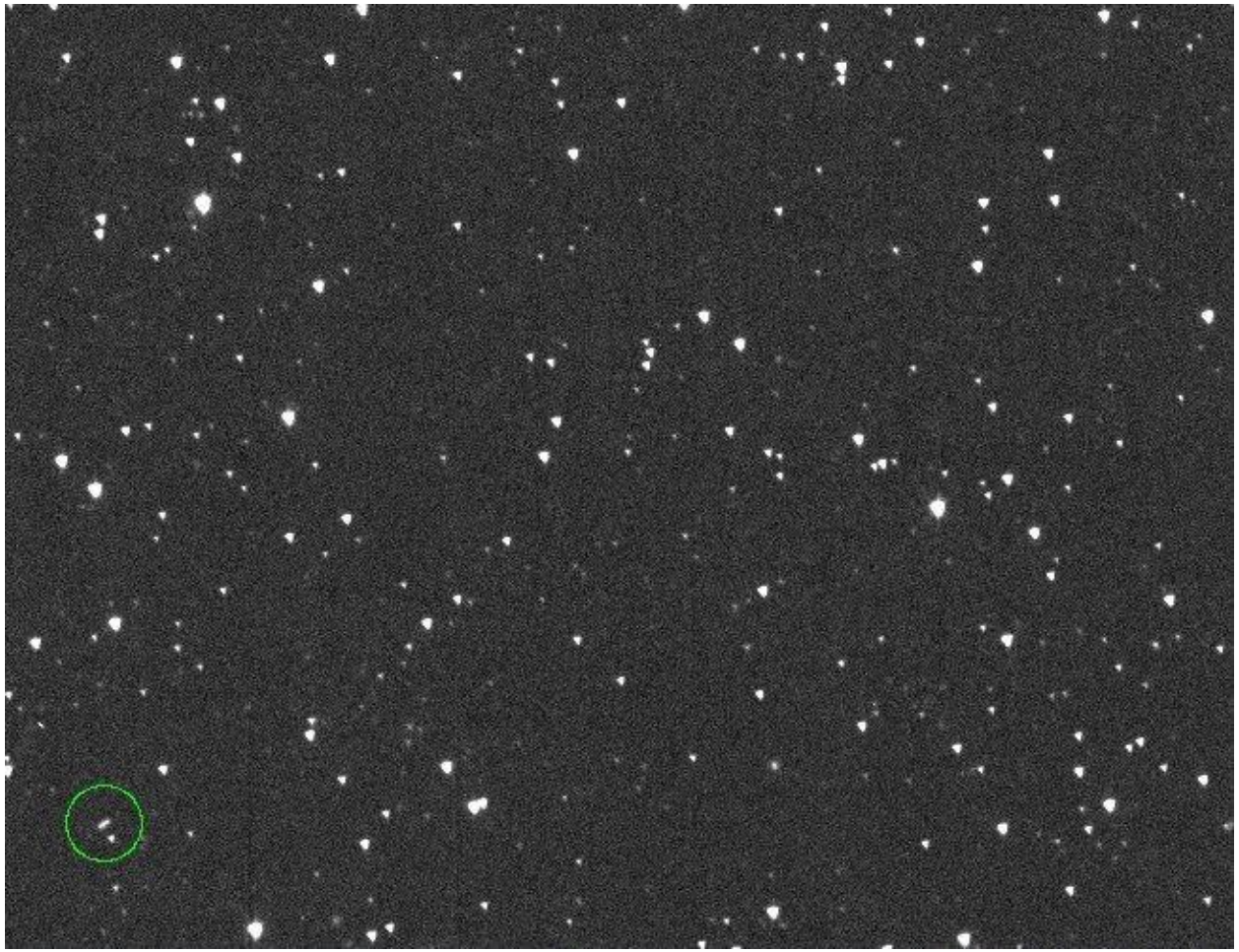
Discovery



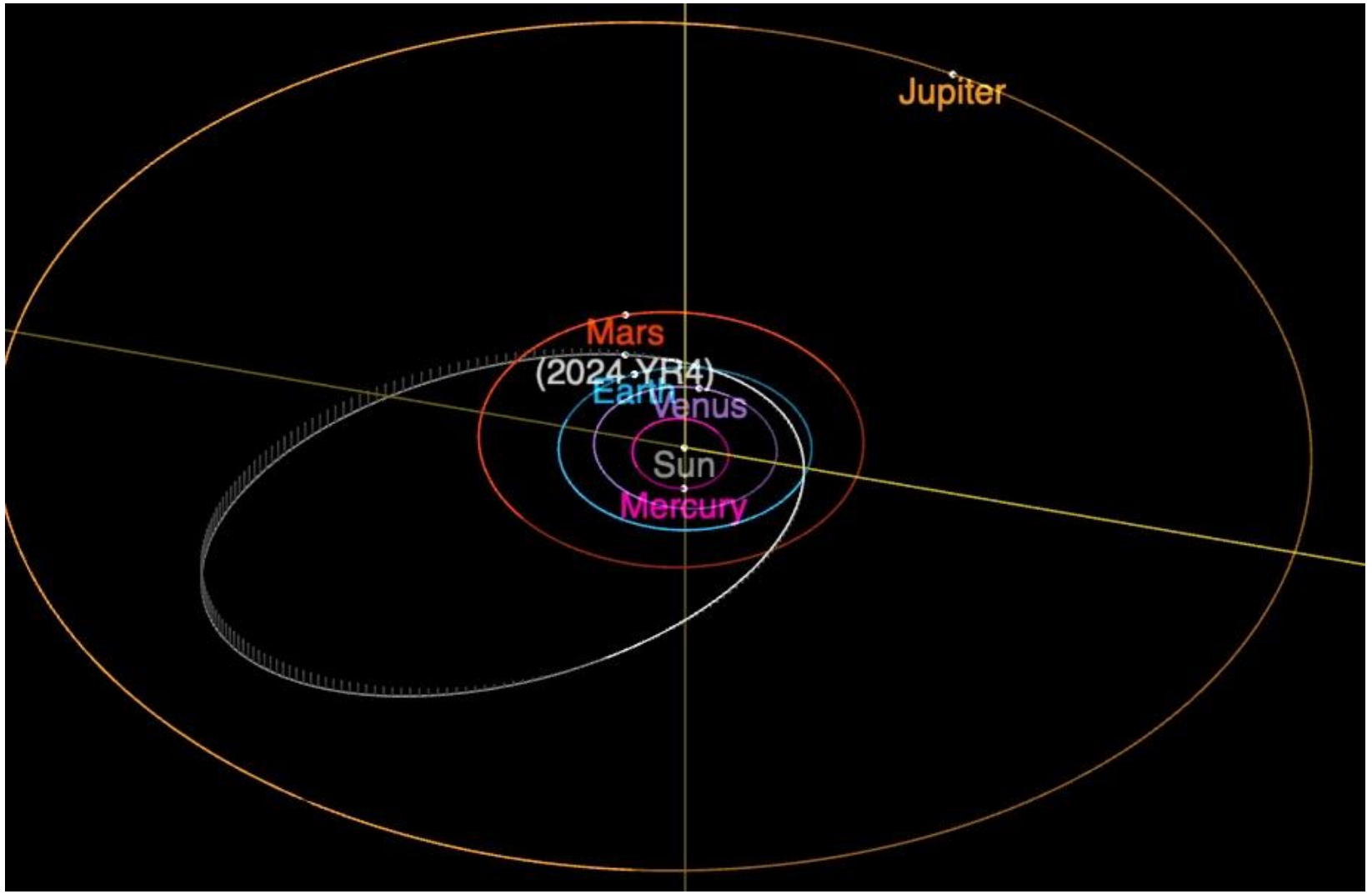
ATLAS Rio Hurtado, Chile

2024-12-27 at V = 16.5

Right after close approach on Dec. 25 at 2.2 LD.

Precoveries from Catalina on Dec. 26 and ATLAS on Dec. 25.

Orbit



Eccentricity = 0.66

Semimajor axis 2.5 au

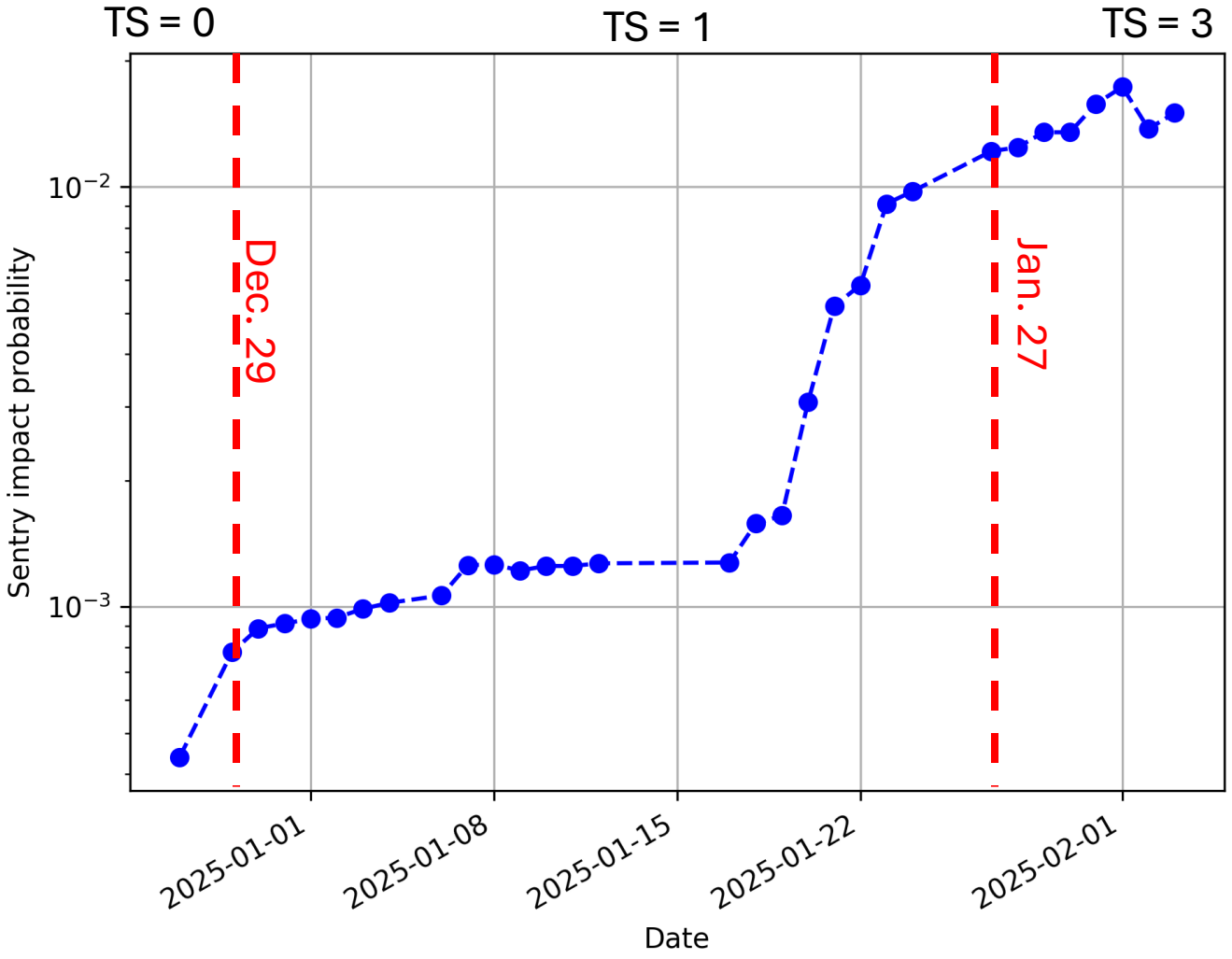
Period 4 years

Inclination 3.5 deg

MOID 0.003 au

Upcoming close approaches in 2028 and 2032.

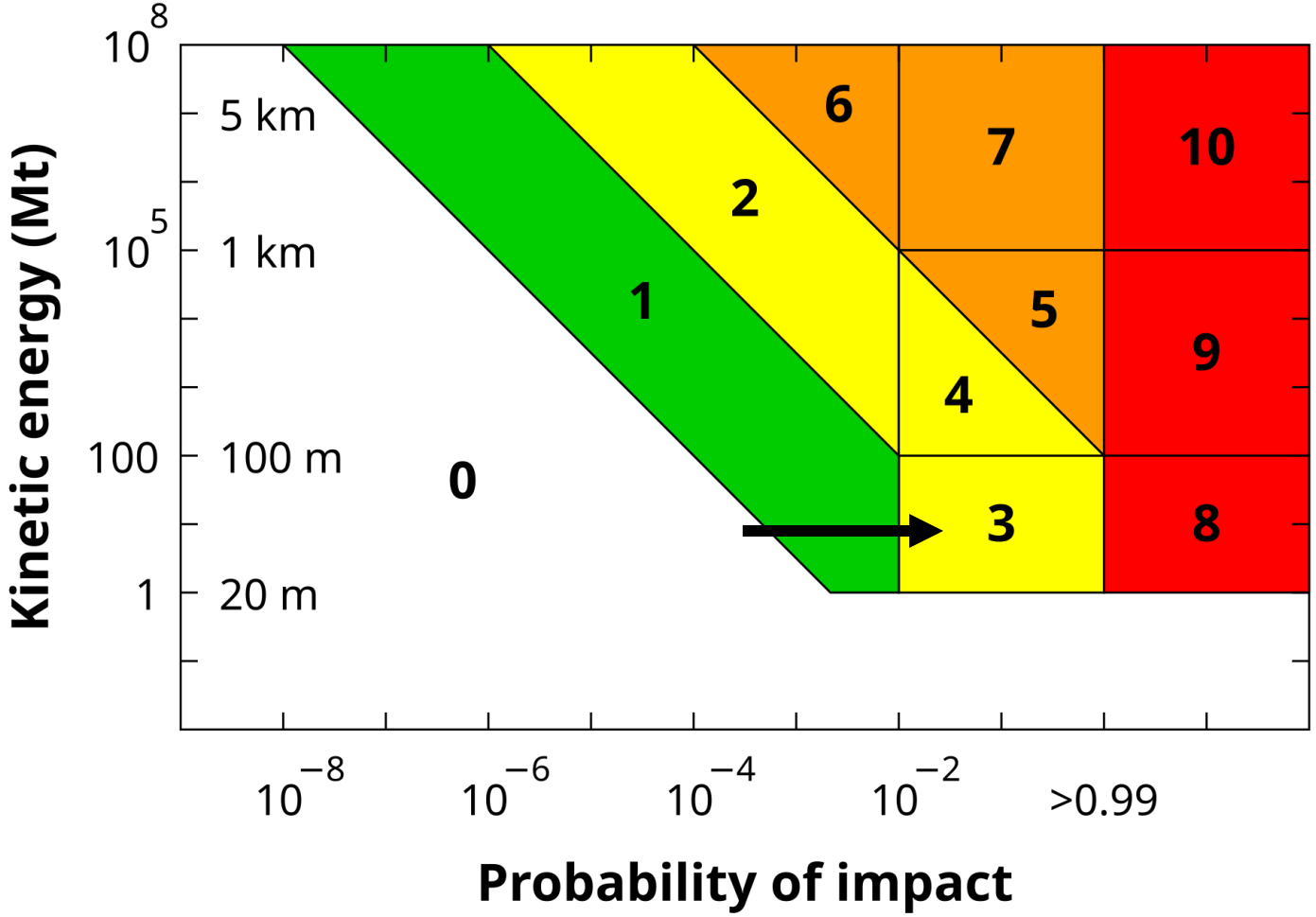
Sentry results for an impact in 2032



Recognized early as a potential impactor.

The probability has been steadily increasing over time until it crossed 1% on Jan. 27.

Torino Scale



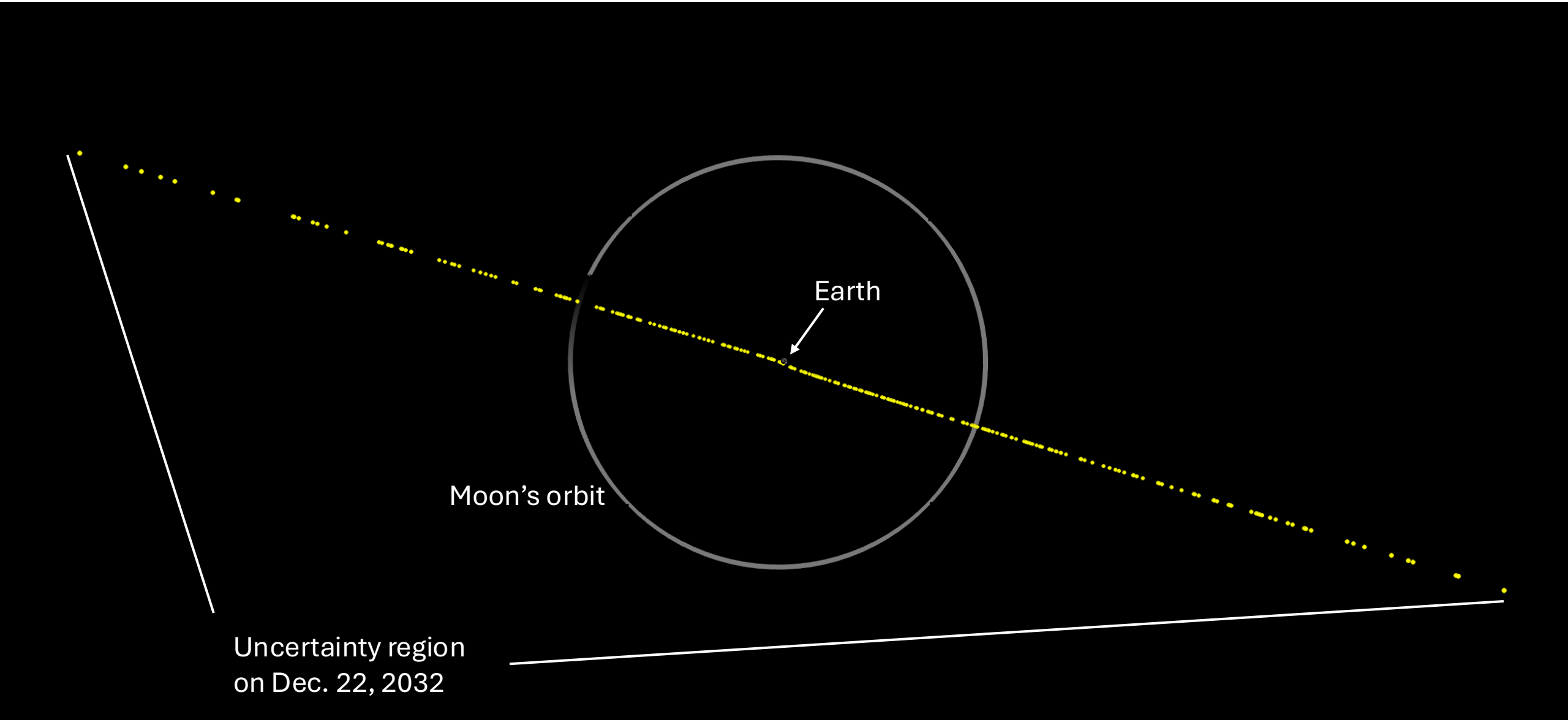
Torino Scale moved from 0 to 1 on Dec. 29, and eventually to 3 on Jan. 27.

Average time interval between impacts for this size ~5,000 years.

So, a 1% impact probability is a 1-in-50 year event.

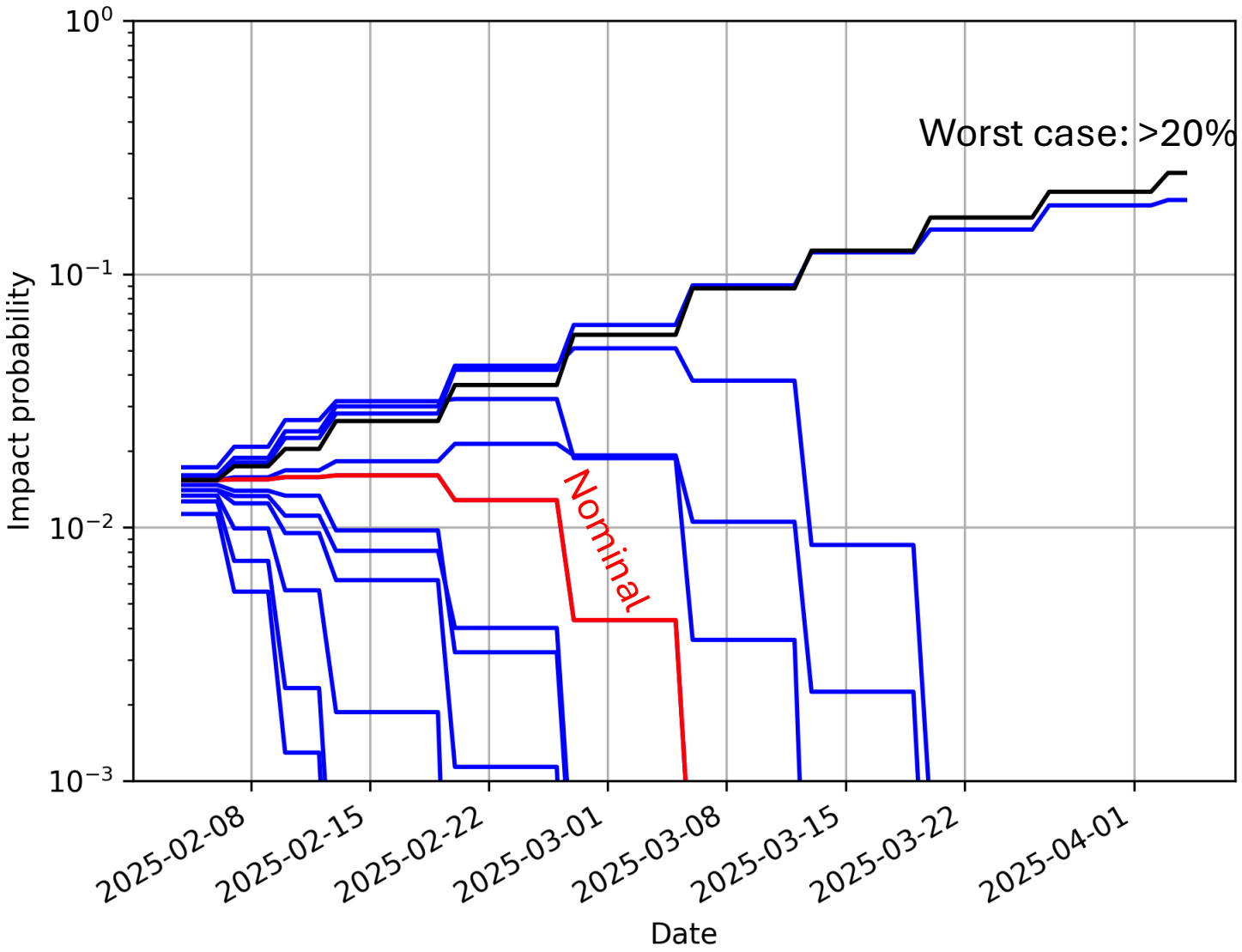
Coordination between NASA, ESA, & NEODYS

- Jan. 21: PDCO & NEOCC meeting to assess the situation given the impact probability ~0.5% and rising
- Jan. 22: Technical meeting between CNEOS, NEOCC, and NEODyS
  - Compare results and understand source of differences
  - Data weights, outlier rejections, timing errors
  - Reliability and stability of orbital solutions.
  - Expectations going forward (i.e., IP likely to rise above 1%)
- Jan. 23: Technical meeting between CNEOS, NEOCC, and NEODyS
  - Made substantial progress toward more consistent results
  - Agreed that minor differences are okay, but 1% should be crossed at the same time
- Jan. 27: Everyone crossed 1%, results made official
  - Excellent agreement ever since



Solution 40 computed on 2025-Jan-31

What to expect?

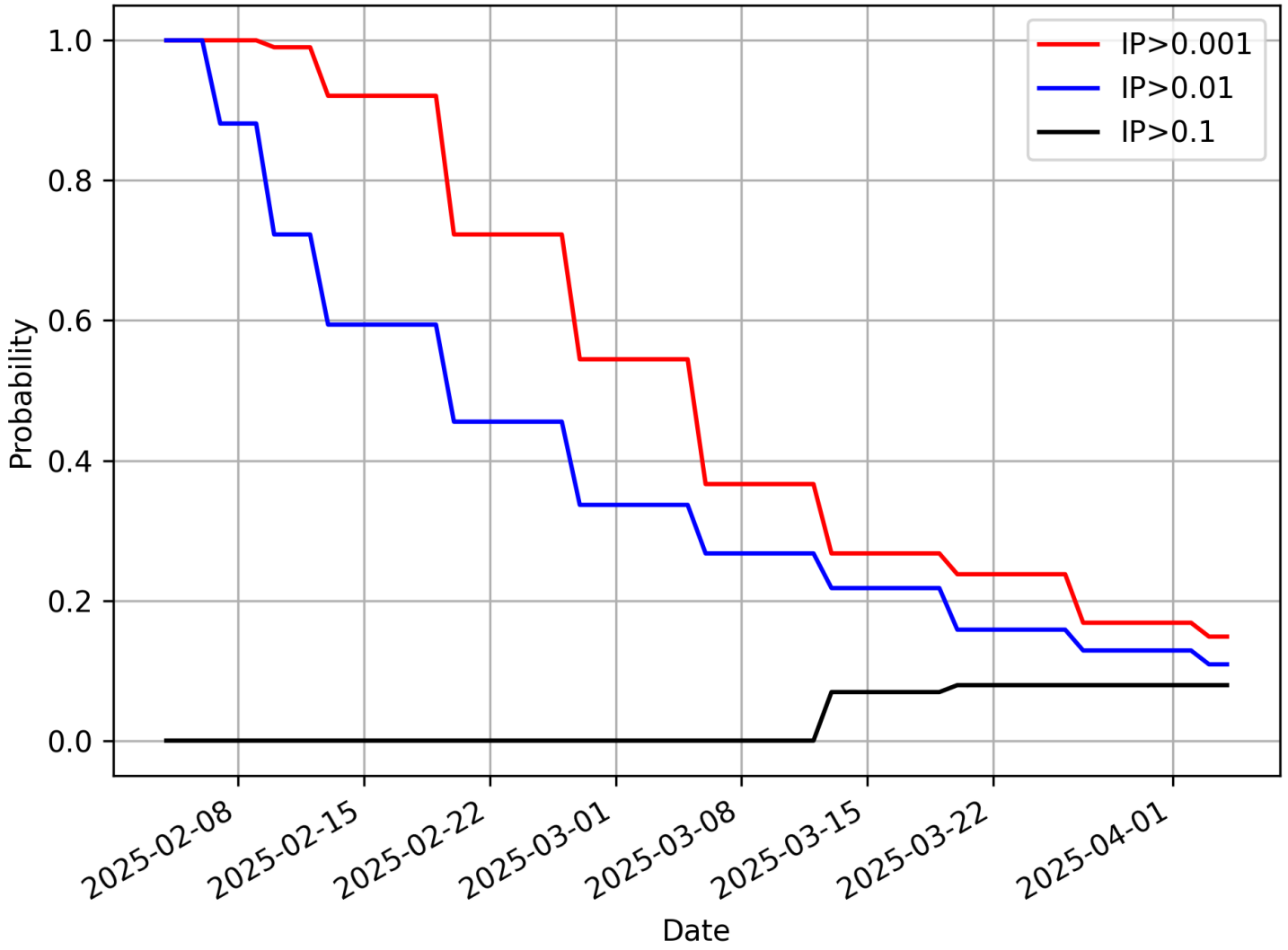


2024 YR4 remains observable through early April.

Statistical analysis of possible impact probability evolution, 10 samples + nominal shown.

Assumed 50 mas astrometry in the future.

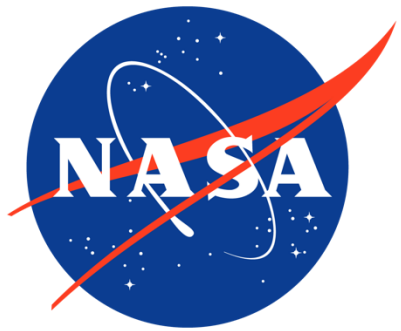
What to expect?



The probability is likely to drop below 0.1%, but there is a non-negligible possibility that of having a significant residual impact probability at the end of the apparition.

Lessons learned

- ADES reported uncertainties are extremely valuable
  - It is also extremely important to have direct communication to key observers
- Multiple centers performing calculations are beneficial
  - Comparison of results and sensitivity to different software and assumptions
  - Mitigate risk of one center being offline
- Multiple observers tracking YR4 prevented chasing single-station biases
- Tracking the orbital evolution important to assess reliability of predictions
- Need to mitigate the risk of bad data analyses:
  - Precovery searches and submissions should involve trusted observers
  - Negative observations are hard to interpret correctly. Use as last resort and with appropriate peer-review process
- Simulating future impact probability helps us be prepared for what comes next



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