

# **Effects of Operating Parameters on MMOD Risk**

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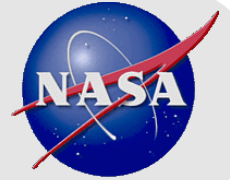
**Dana Lear/JSC-XI4**

**Jim Hyde/JSC-XI4 (JETS)**



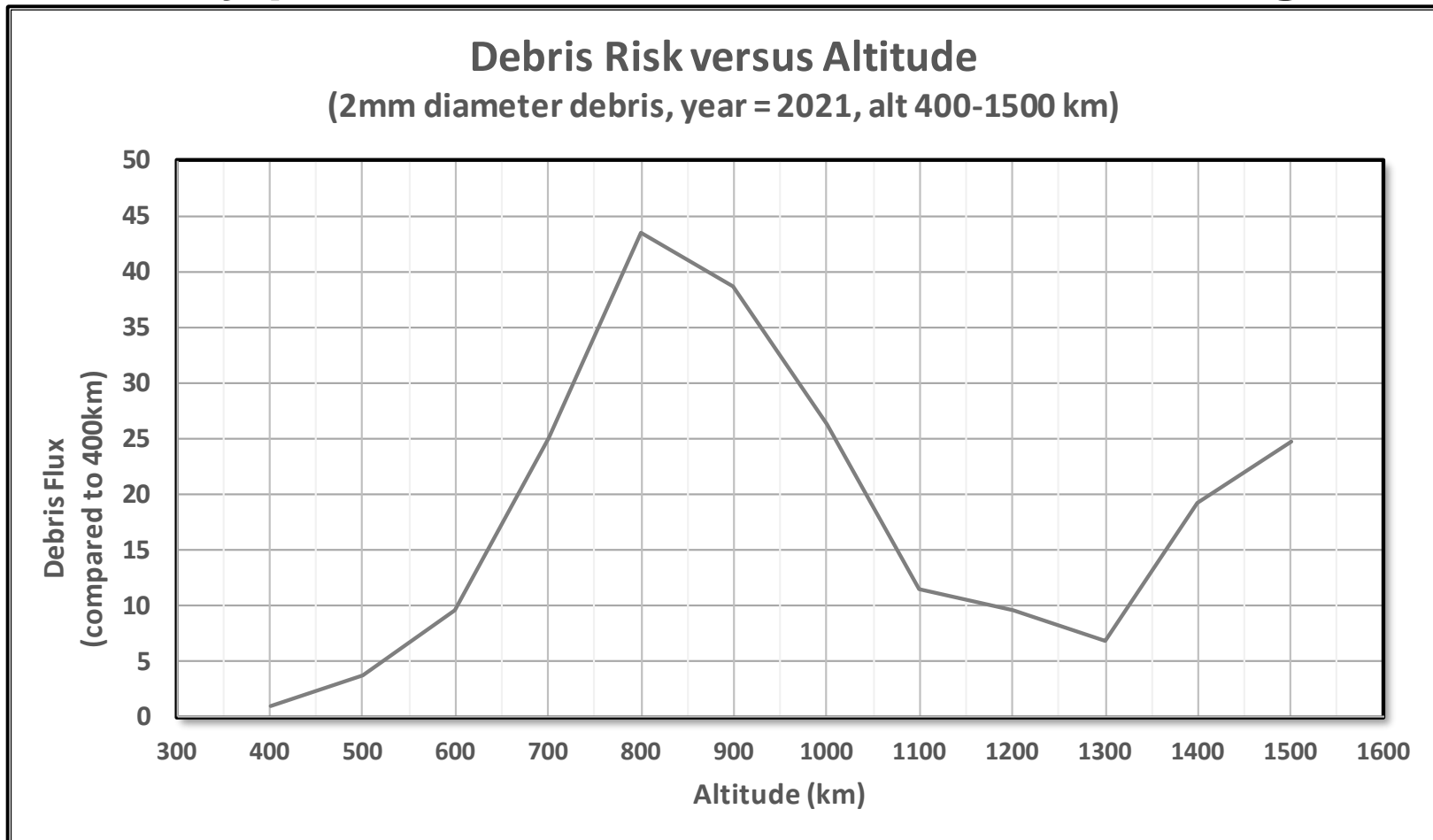
# Presentation Overview

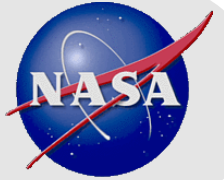
- **Effects on MMOD Risk:**
  - Altitude
    - Debris
    - Meteoroid
  - Inclination
  - Year of Flight
  - Spacecraft Orientation
  - Mission Duration



# Effect of Altitude on MMOD Risk: Debris

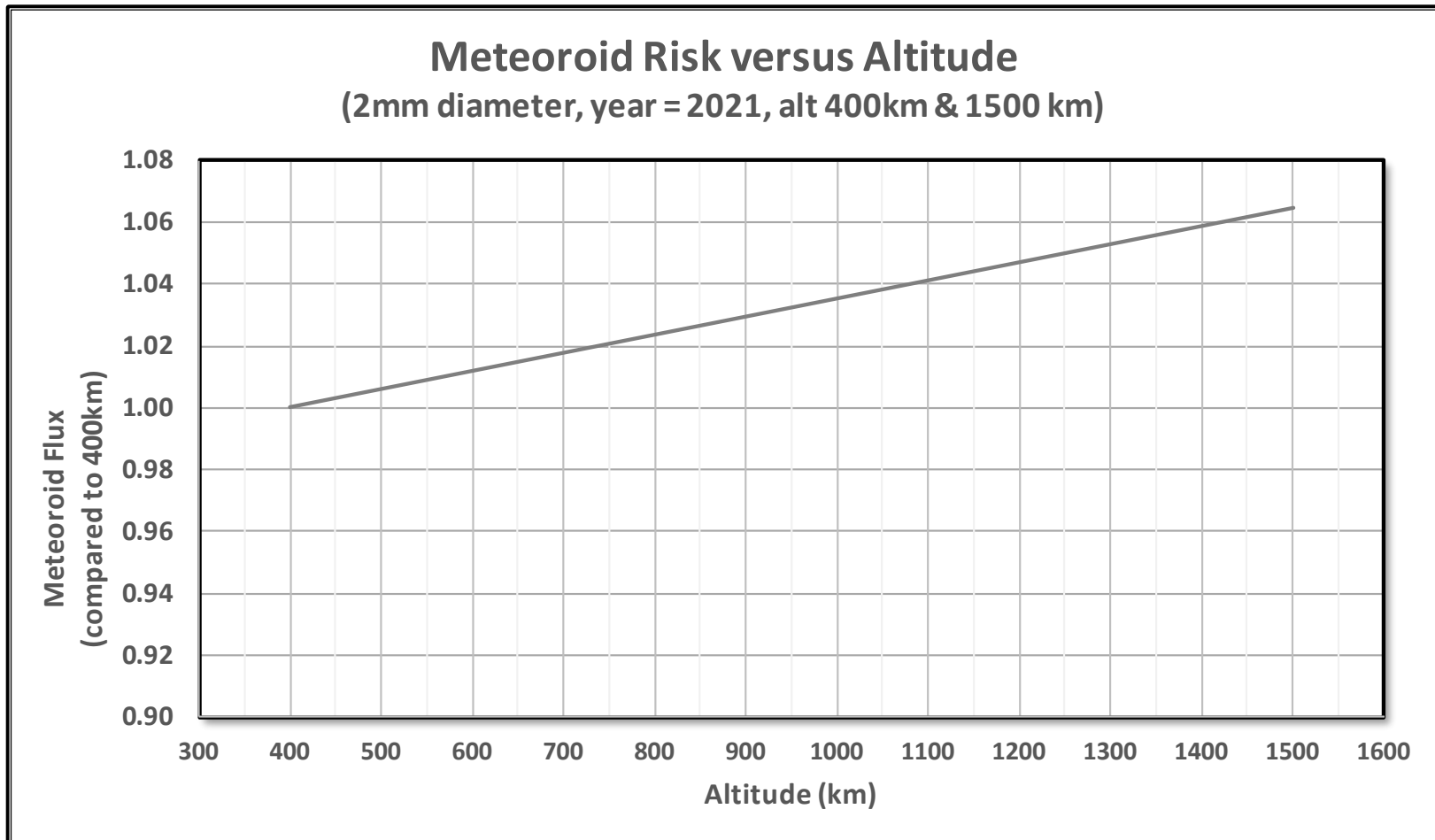
- Debris flux varies significantly with altitude
- Generally peaks in the 800-1000 km altitude range

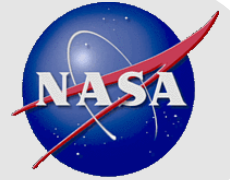




# Effect of Altitude on MMOD Risk: Meteoroid

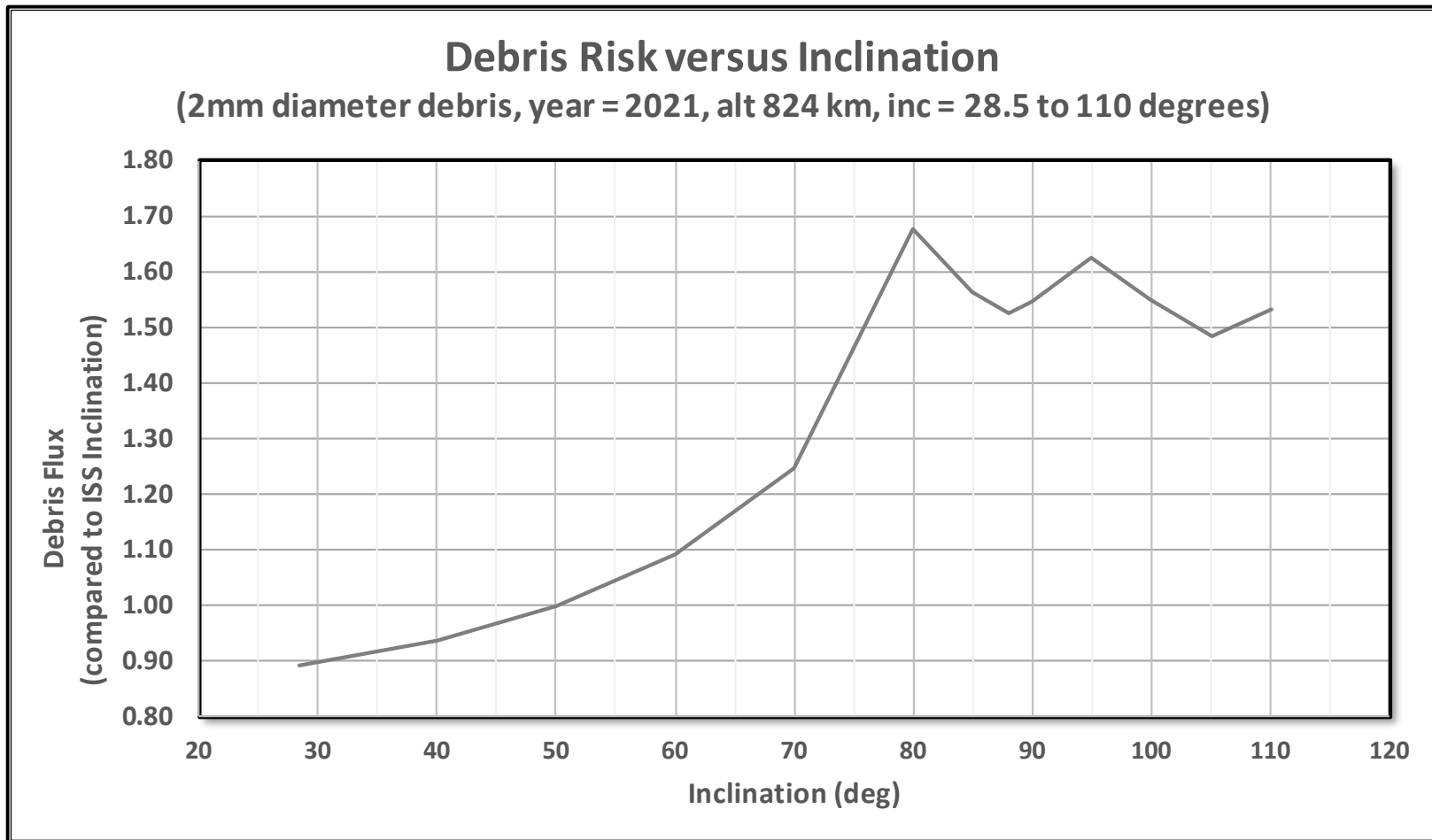
- **Meteoroid flux is relatively insensitive to altitude**
- **Increases about 6% between 400km and 1500km**





## Effect of Inclination on MMOD Risk

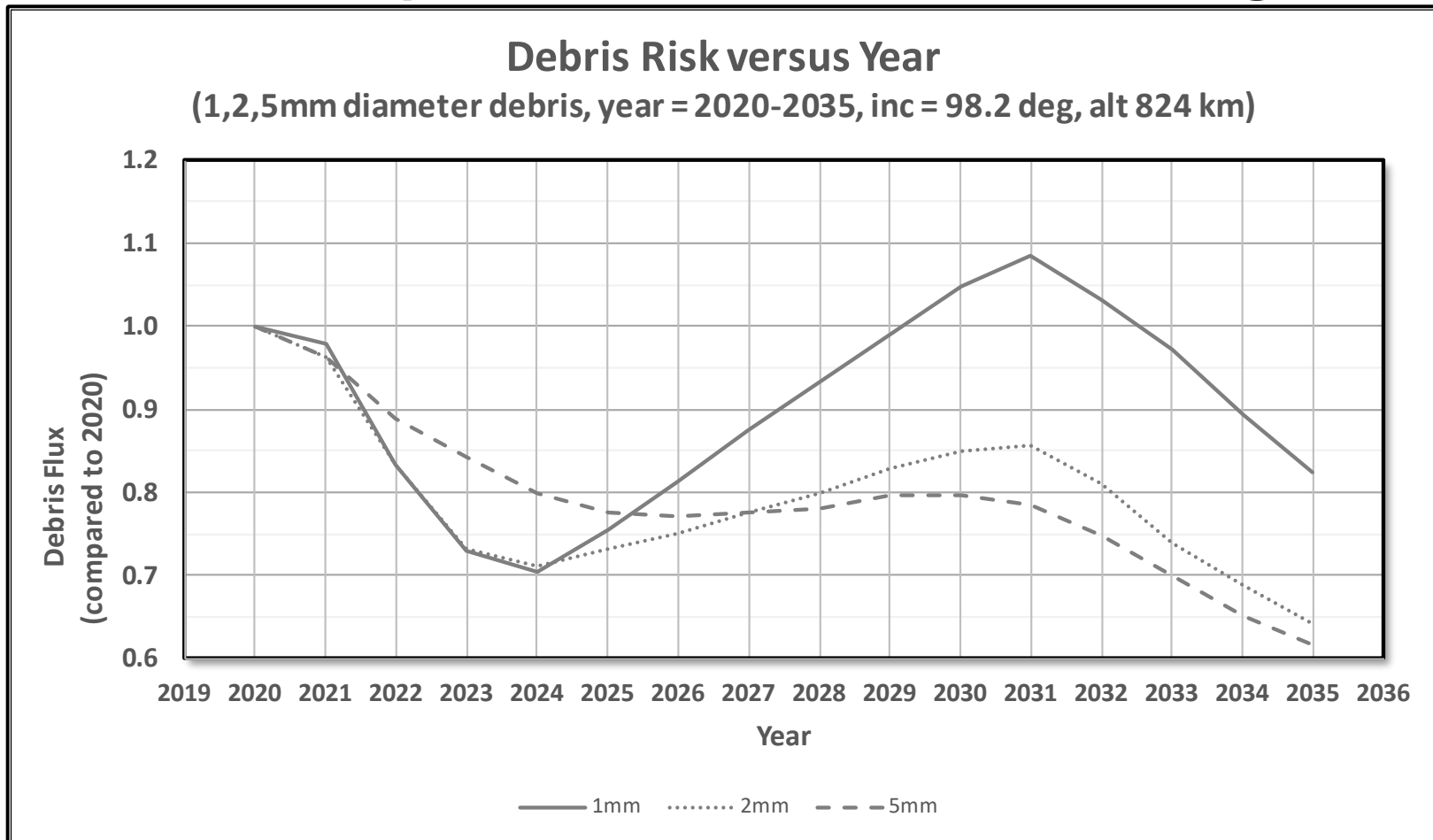
- Debris risk increases with inclination and levels out/decreases between 80-110 degrees





# Effect of Year of Flight on MMOD Risk

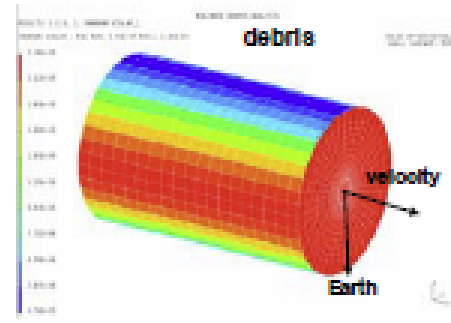
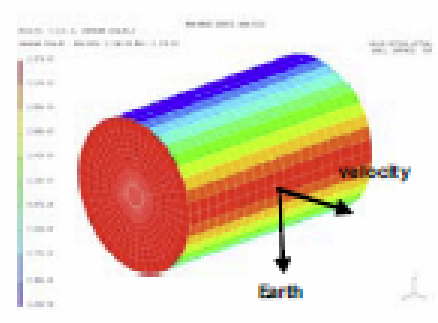
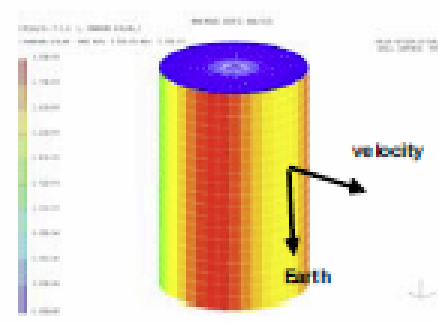
- Debris flux varies each year
- Smaller debris particles affected more than large



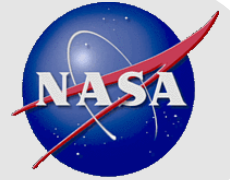


## Effect of Orientation on MMOD Risk

- Orientation can have large effect on risk
- Applies to debris and meteoroids

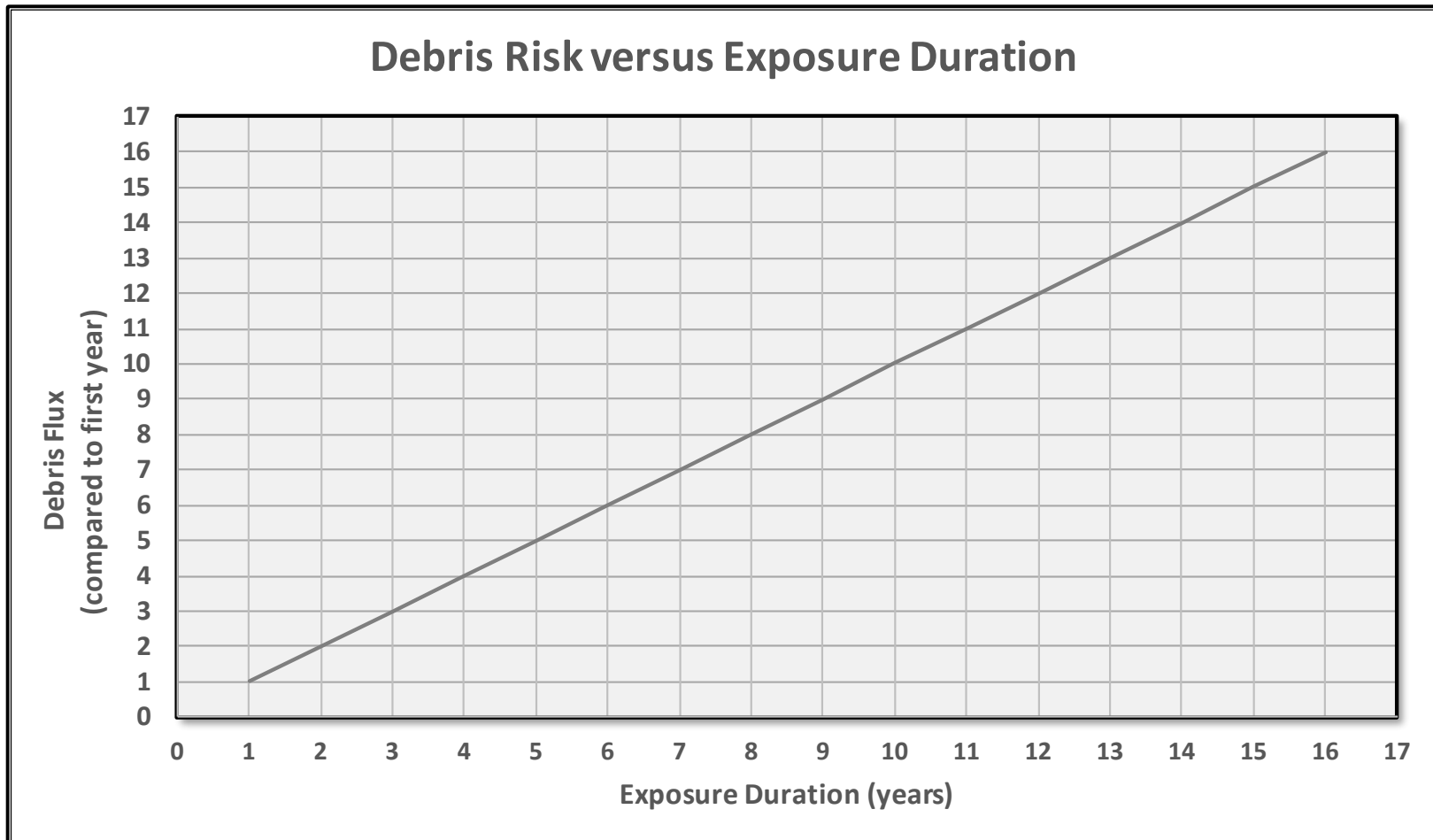
<p><b>FEM</b> (Color contour: Red = high penetration risk, Blue = low penetration risk)</p>			
<p>Number of MMOD Penetrations</p>	<p>9.31E-5</p>	<p>8.22E-5</p>	<p>1.06E-4</p>
<p>PNP</p>	<p>0.99991</p>	<p>0.99992</p>	<p>0.99989</p>
<p>N Ratio</p>	<p>1.13</p>	<p>1.0</p>	<p>1.29</p>

Source: Ref: TM-2009-214785, Section 2.11.5, p25. (1m diameter by 1.5m long cylinder, year 2010, duration 1 year, 400km altitude, 0.13 cm Al 6061-T6 bumper, 10 cm standoff, 0.32 cm Al 2219-T87 rear wall, ORDEM 2k, 91 Meteoroids)



# Effect of Mission Duration on MMOD Risk

- **Debris (and meteoroid) risks increase linearly with exposure duration.**







# Summary

- **Effects on MMOD Risk:**
  - Altitude
    - Debris flux varies considerably with altitude
    - Can be significantly higher than at lower altitudes
    - Meteoroid flux is relatively insensitive to increasing altitude
  - Inclination
    - Debris risk generally increases with inclination
    - Decreases and increases between 80-110 degrees
  - Year of Flight
    - Debris risk generally decreases from 2020-2024
    - Increases from 2024-2030/2031, then decreases
  - Spacecraft Orientation
    - Some orientation have lower risk than others
  - Mission Duration
    - Debris and meteoroid risks increase linearly with exposure duration