JOHN F. KENNEDY SPACE CENTER

LAUNCH SERVICES PROGRAM

Pathways Showcase Presentation
Summer 2023

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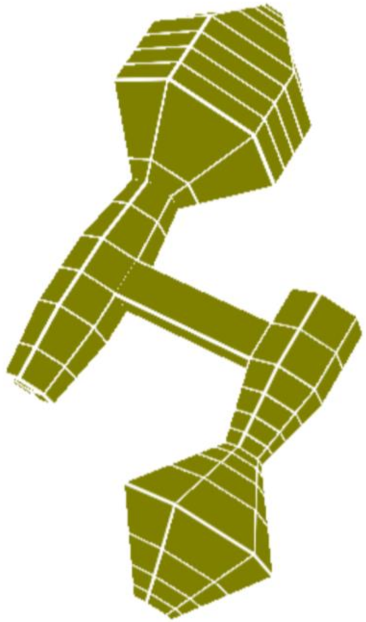
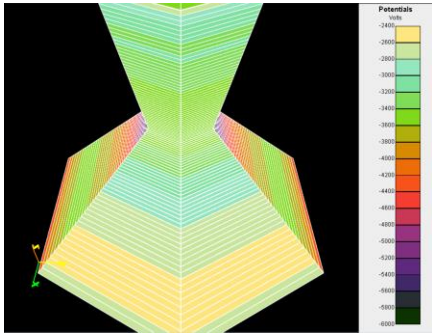
Agenda

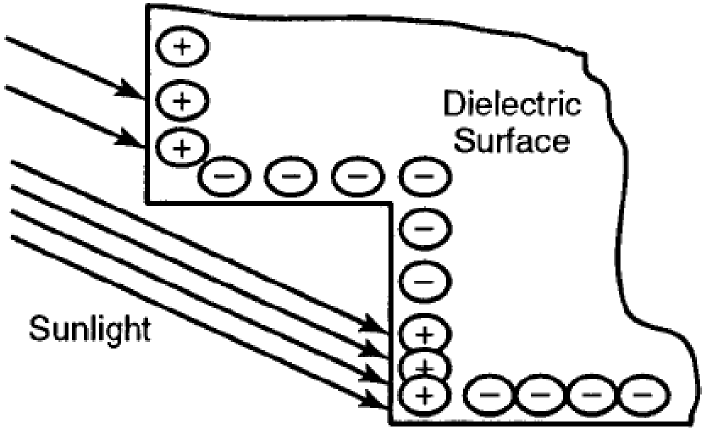
- Spacecraft Charging Intro
- NASCAP → EMA Charge
- Summer 2023 Project

Spacecraft Charging

- Spacecraft charging:
  - Buildup of charge on surfaces, or within materials, causes electrostatic discharges, arcing.
  - Varies with material, geometry, etc.
  - Can cause discharges on or between surfaces at different potentials (differential charging)
- Dielectric materials:
  - bad at distributing charge
  - susceptible to differential charging, internal charging
- largest differential potentials on a spacecraft surface:
  - between the sunlit and shaded regions

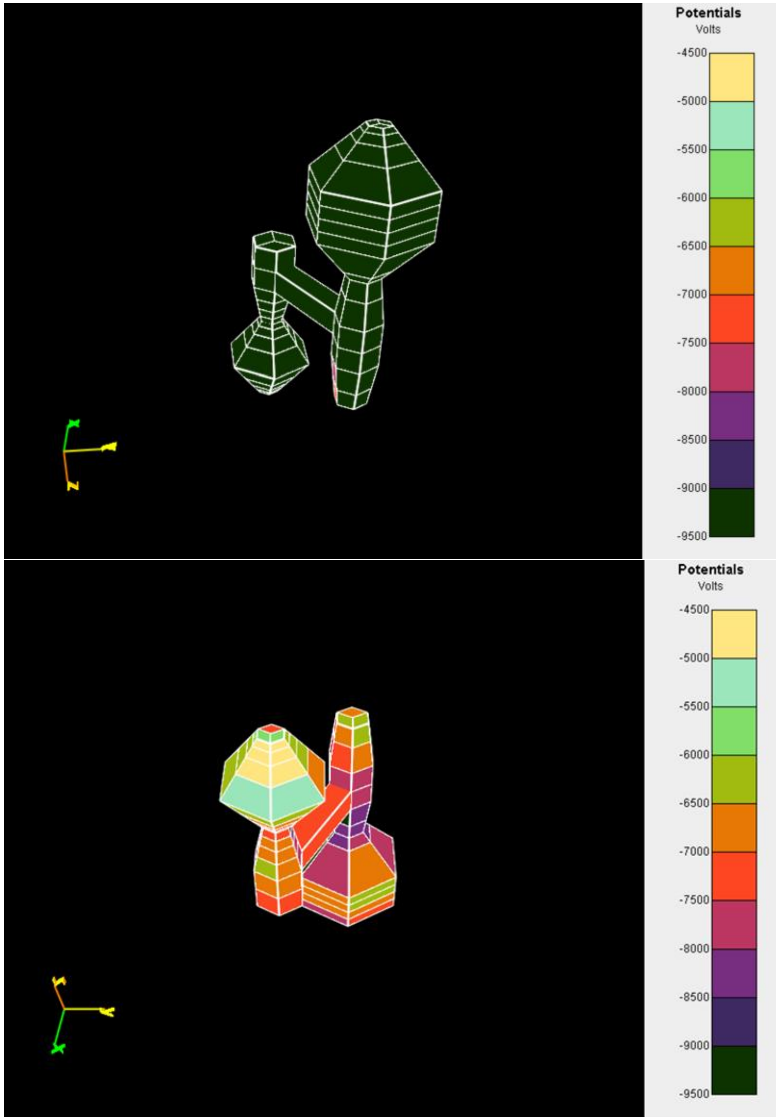






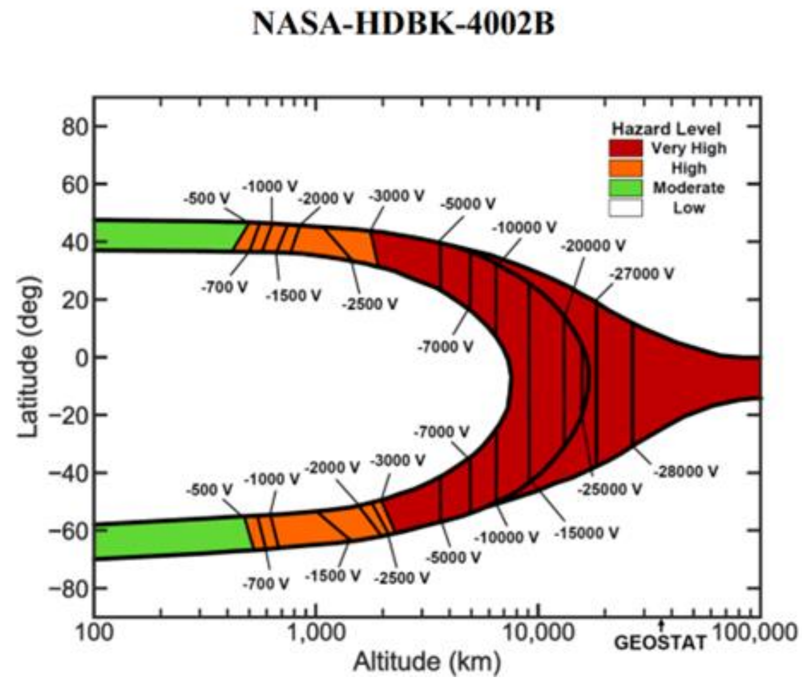
Dielectric Charging in Sunlight

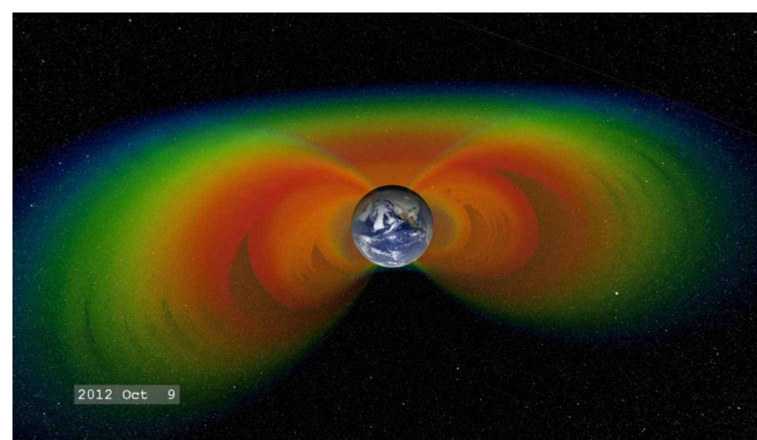
- The shadowed side is uniformly charged to ~9500 V
- Sunlit = charging to a positive potential (as photoelectron flux exceeds electron flux)
- The sunlit grids 'shadow' certain regions behind them (most dangerous surface region)
- Still a differential potential between sunlit areas, and sunlit to dark areas (sometimes very large)



Why is it important?

- There are a variety of materials on launch vehicles, and spacecraft
  - Susceptible to differential charging
  - particle flux varies across different regions
- Both can face a variety of environments based on trajectory
  - Van-Allen Belt
- Discharges could harm on-flight electronics, or even break down materials





How to assess?

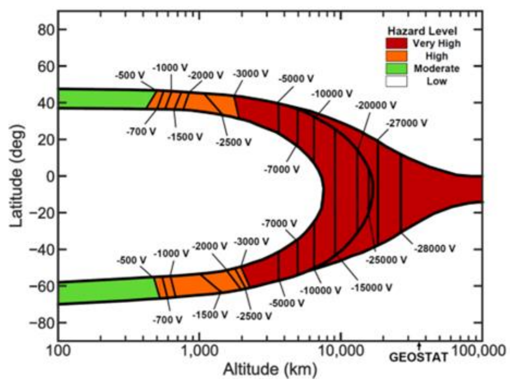
As a check:

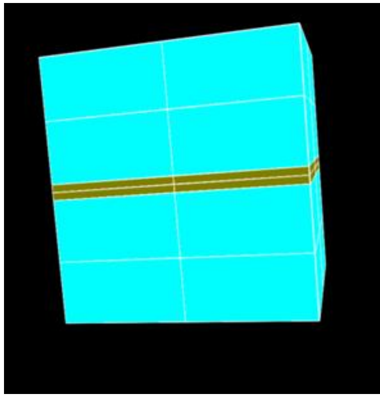
- can identify surface charging 'danger-zones' by plotting trajectory
- Use modeling software to estimate potentials (NASCAP, EMA Charge)
  - Coupon style runs, more complex runs

What is required?

- Material properties
  - Found in databases like MAPTIS, SCMD
  - Bulk conductivity, radiation-induced conductivity, surface resistivity, primary/secondary electron yield fits, breakdown voltages, etc.
- Trajectory, orientation
- Geometry for more accuracy

NASA-HDBK-4002B





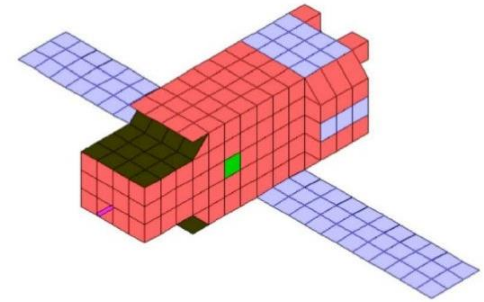
MAPTIS
MATERIALS AND PROCESSES TECHNICAL INFORMATION SYSTEM

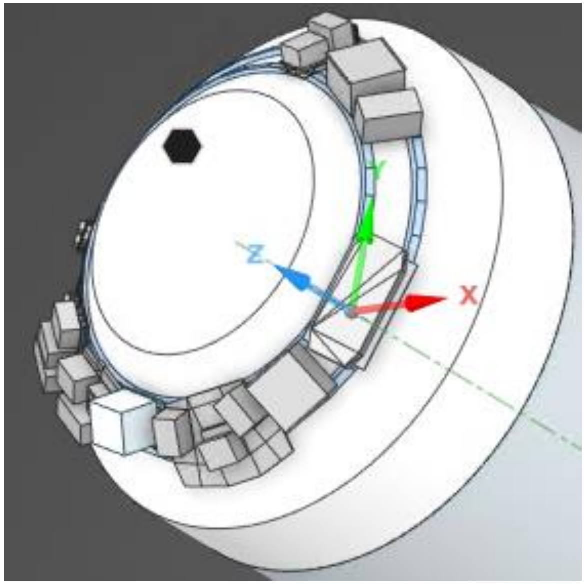
Welcome to Spacecraft Charging Material Database (SCMD)

- Spacecraft charging analyses are inherently difficult based on lack of material charging properties
- Data still being gathered and put into databases (no fancy lookup tables as with mechanical material properties)
- Same material data is even being re-measured for further accuracy
- So, it is best to take a conservative approach most of the time

EMA Charge

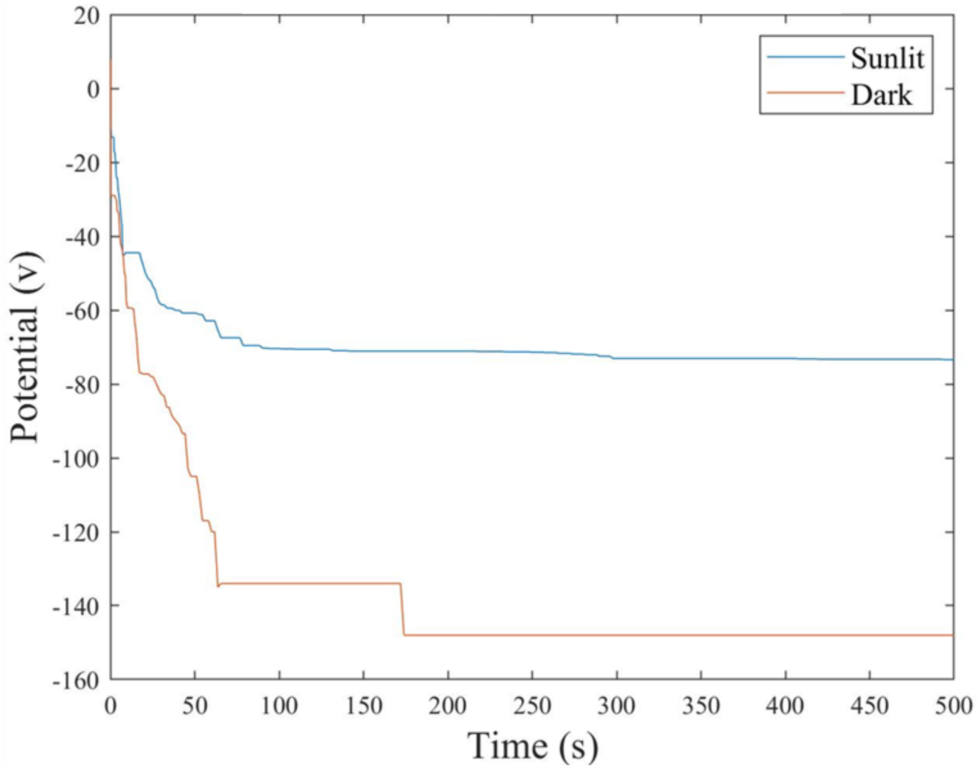
- EMA3D Charge:
  - Successor to NASCAP (surface charging) and NUMIT (internal charging)
- Offers:
  - CAD import
  - More complex meshes
  - Combines internal charging and surface charging analysis
  - Nice animations and data post-processing

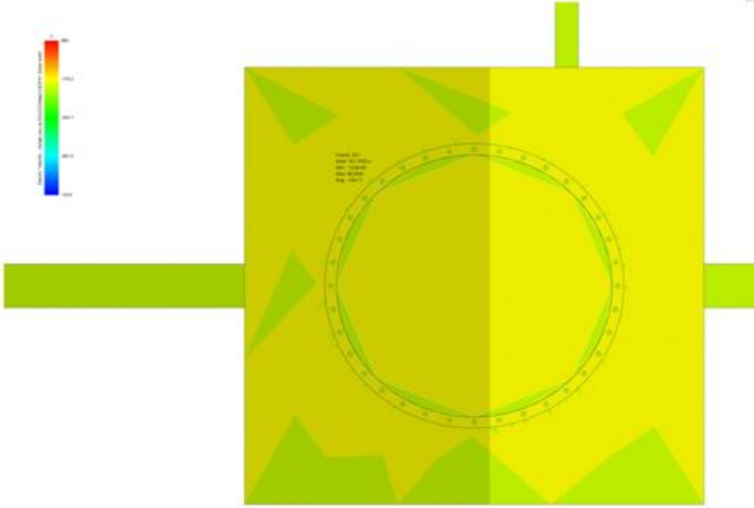


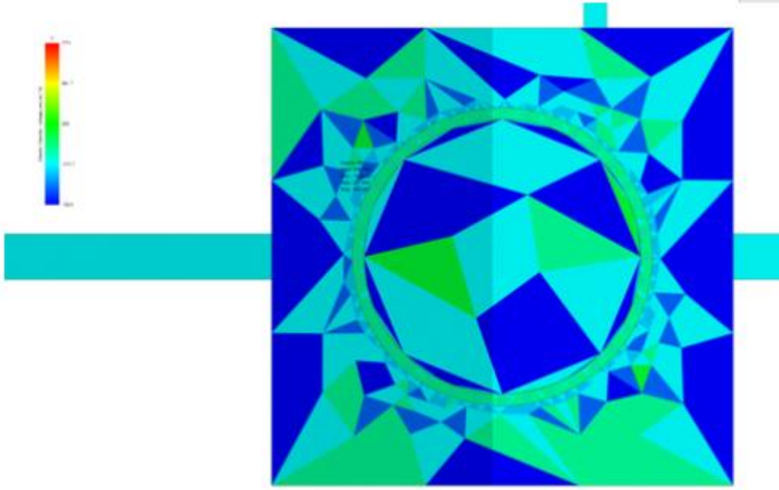


EMA Charge Simple Example

- Sunlit





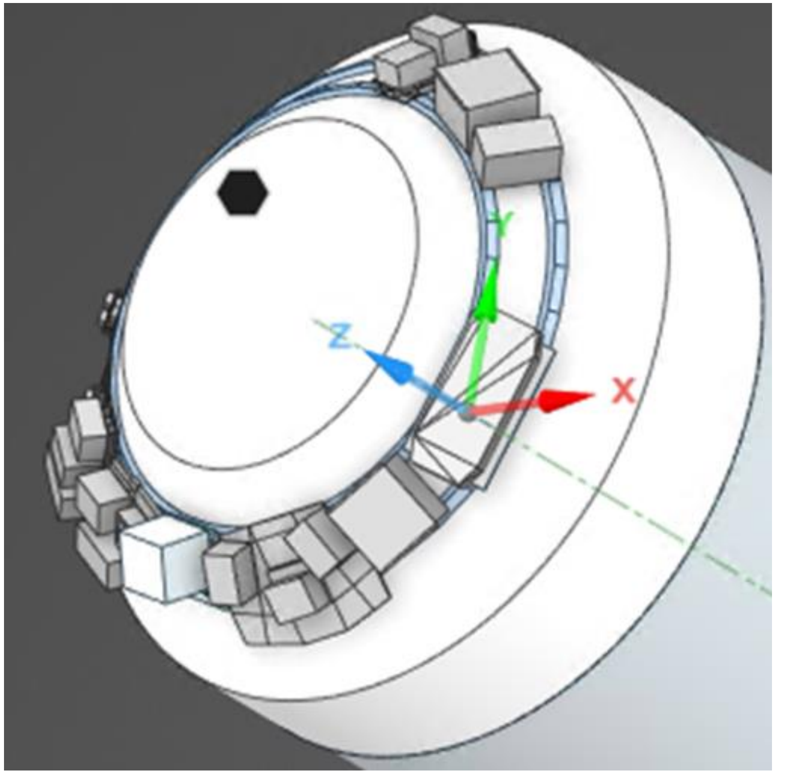


- Dark

Summer Project

Use EMA Charge to:

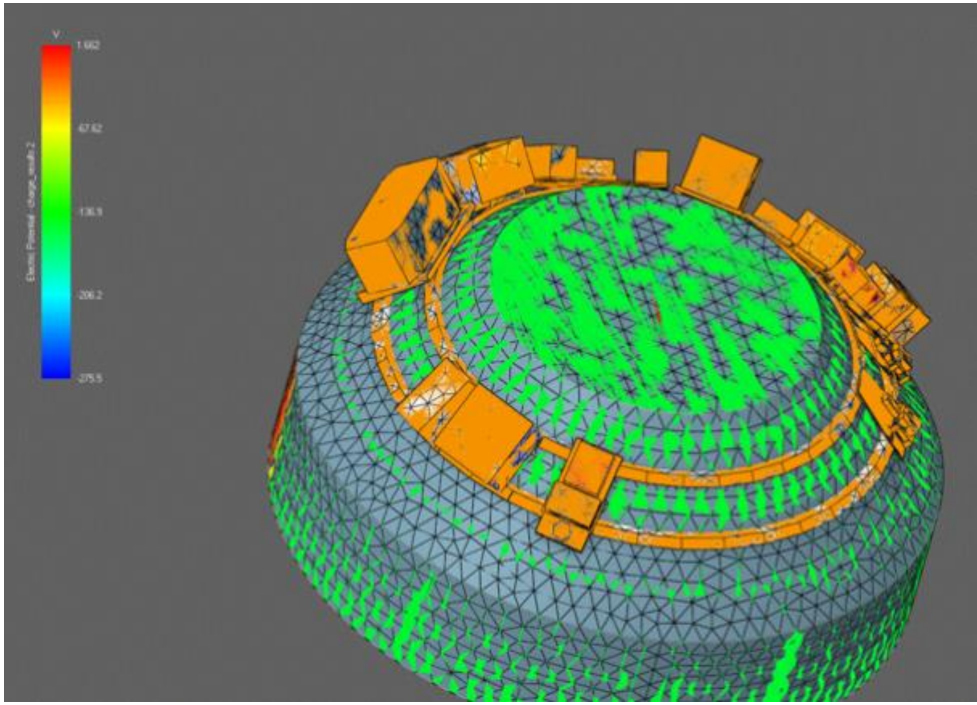
- Design a generic LV second stage model
  - Be able to implement any avionics box setup for future analyses
  - Compare results with radiated emission test reports
  - Verify ESD concerns for certain materials



Summer Project

Along the way:

- Gained expertise using EMA Charge
- Mastered the CAD cleanup process
- Gained a better understanding of:
  - Launch Vehicles
  - Surface/internal charging
  - Space environments
  - Spacecraft charging parameters
  - EMC verification efforts



Questions?