Space Shields to Terraform Mars

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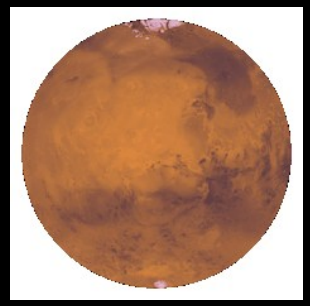
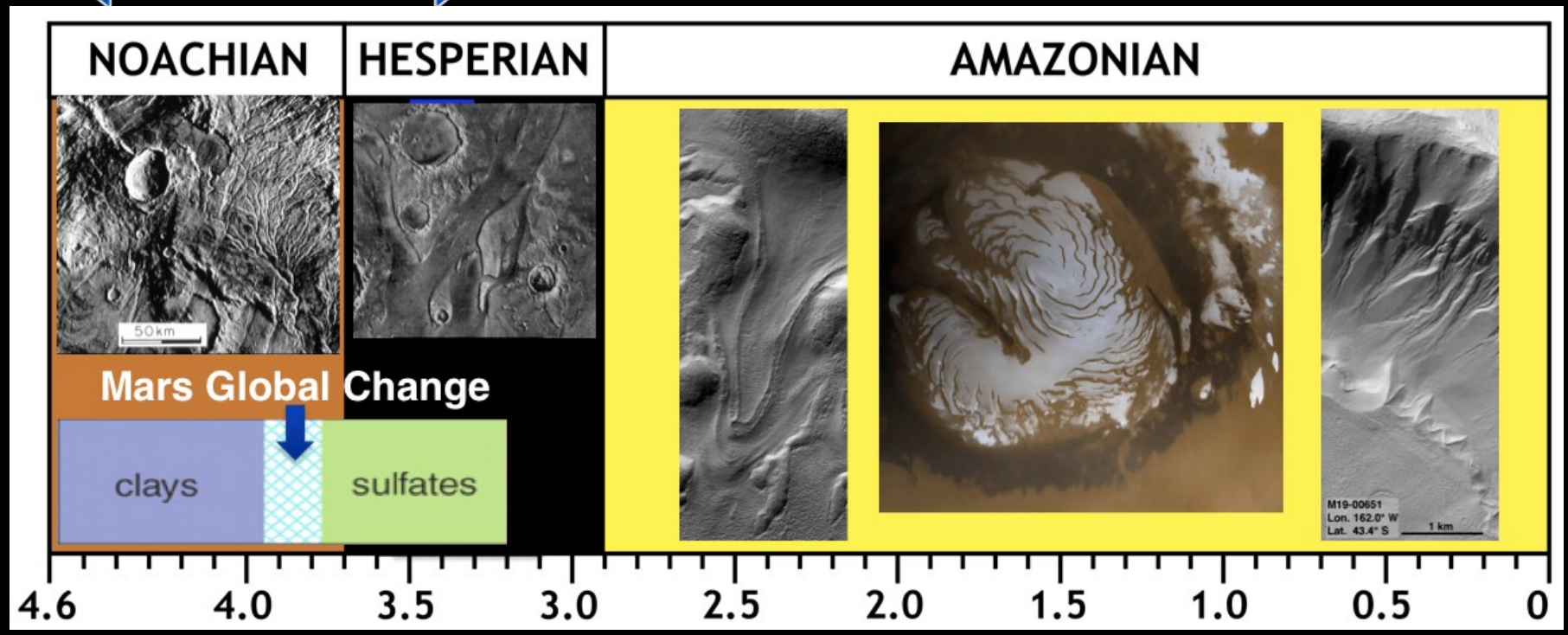
Ancient Water & Habitable Environments

Neutral pH Acidic

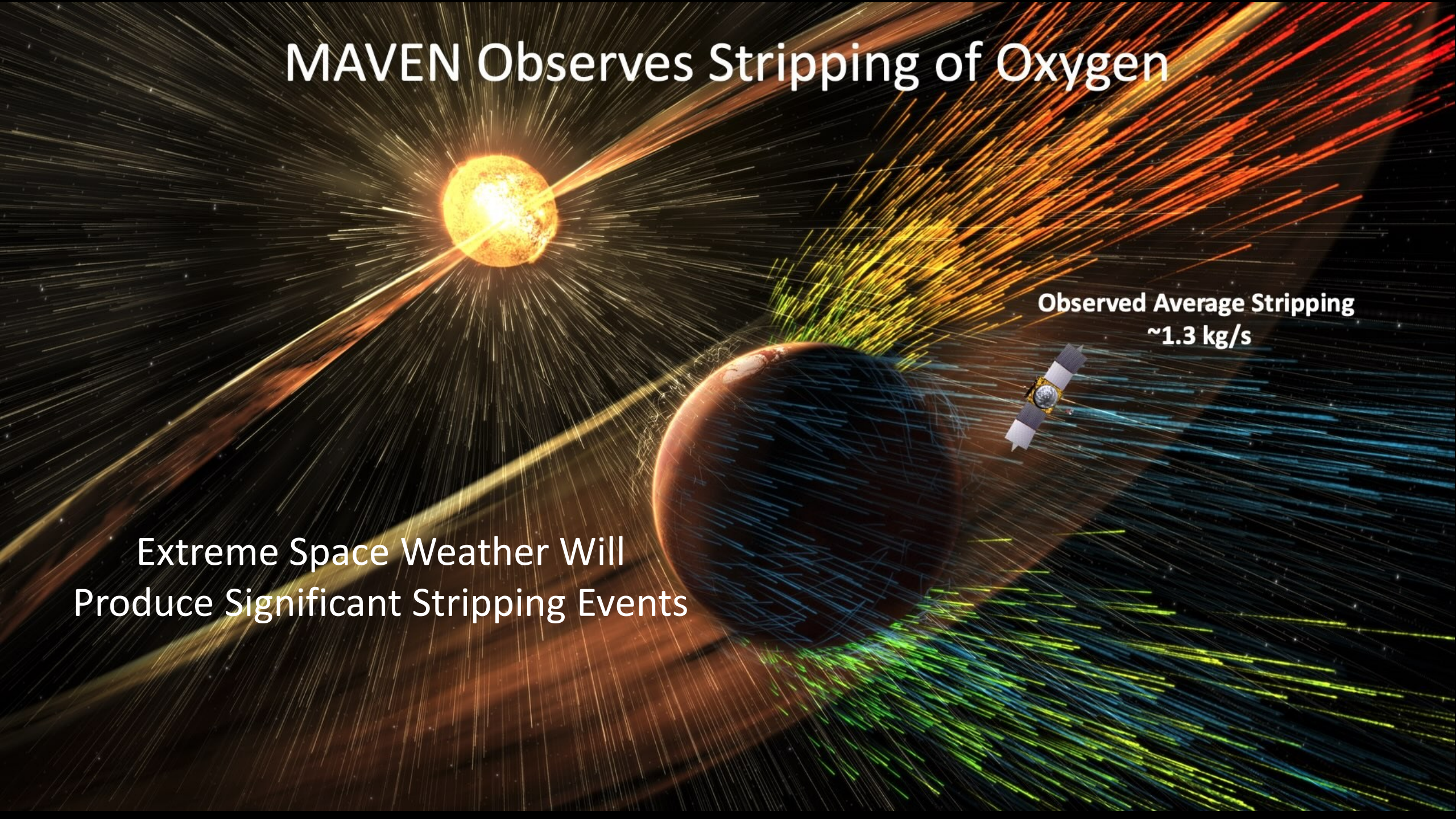


Anhydrous Ferric Oxides



Billions of Years

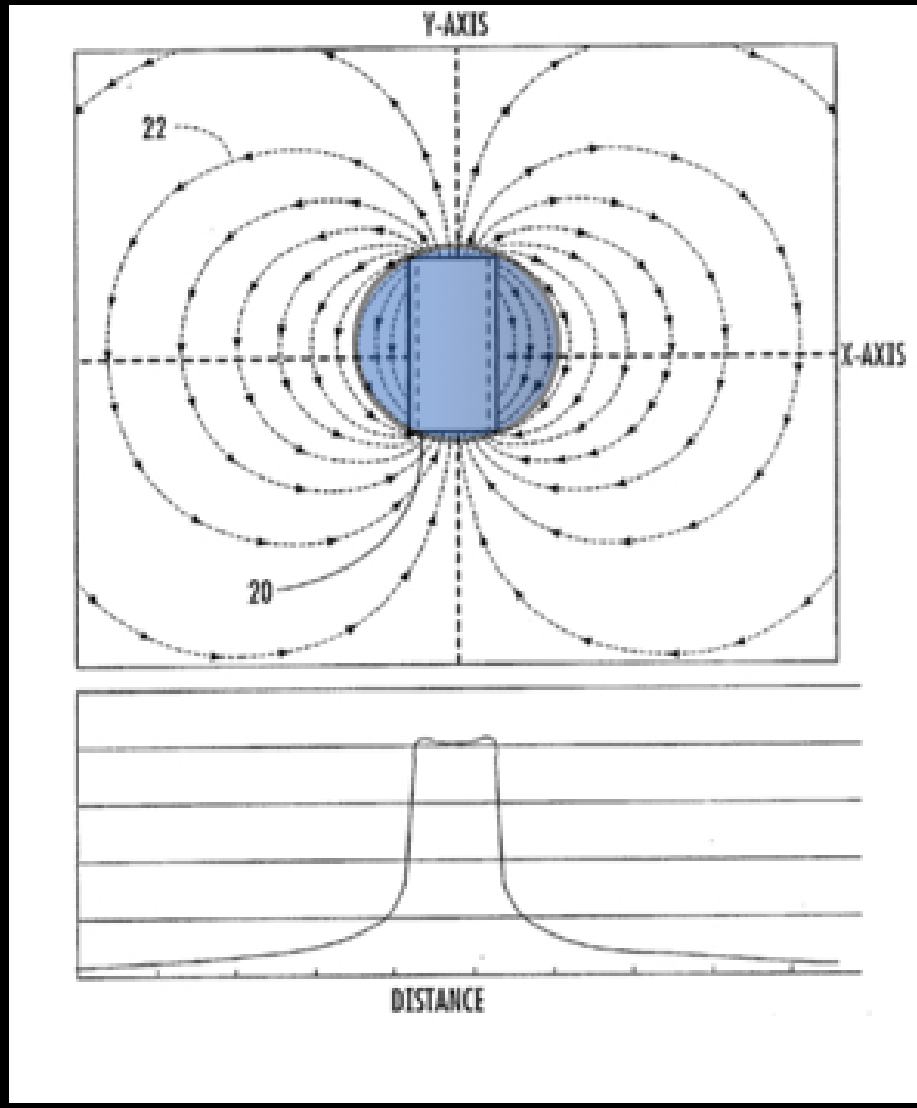
MAVEN Observes Stripping of Oxygen



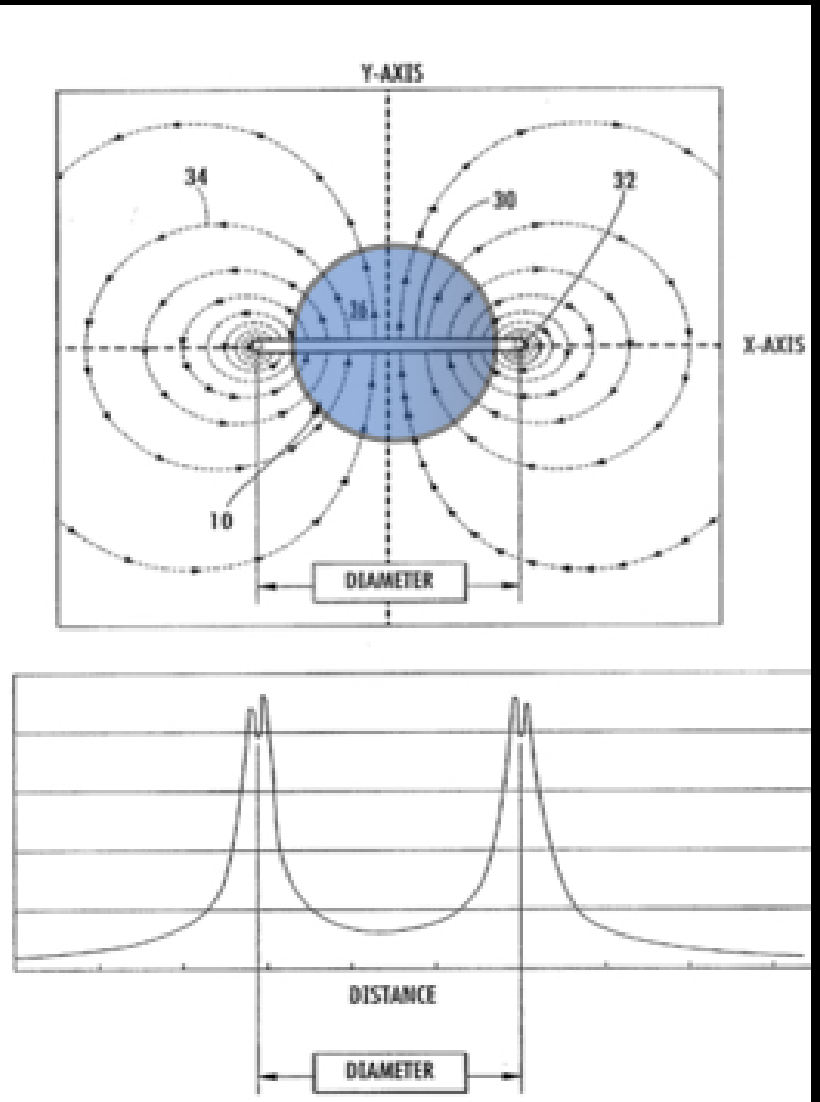
Extreme Space Weather Will
Produce Significant Stripping Events

How to Create an Artificial Global Magnetosphere?

Bar Magnet



Current Loop



Field Generation:

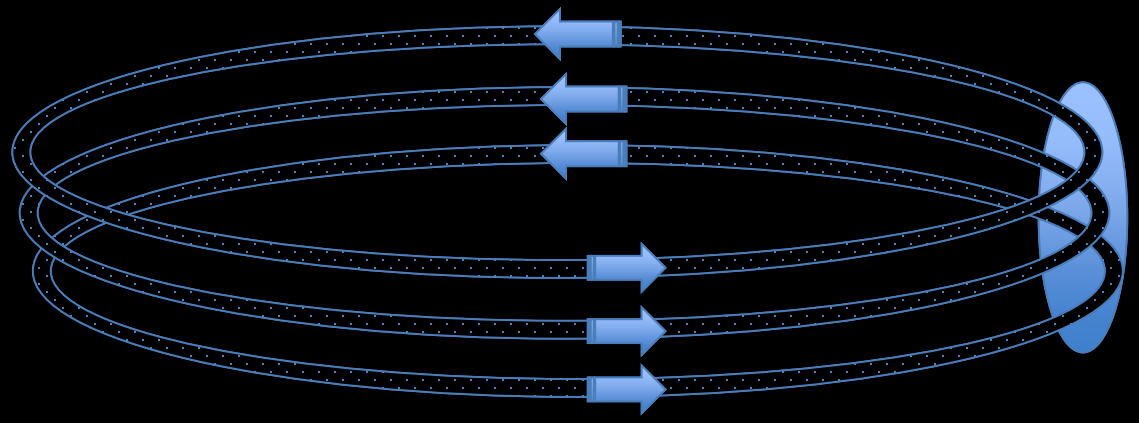
1. Superconductor
2. Current Loops

Plasma loop

- Beam the electrons across space between a configuration of space stations.

Current : I = nevA/N

I =current
n = electron density
v = flow speed
A = area of minor cross section
N= no. of loops

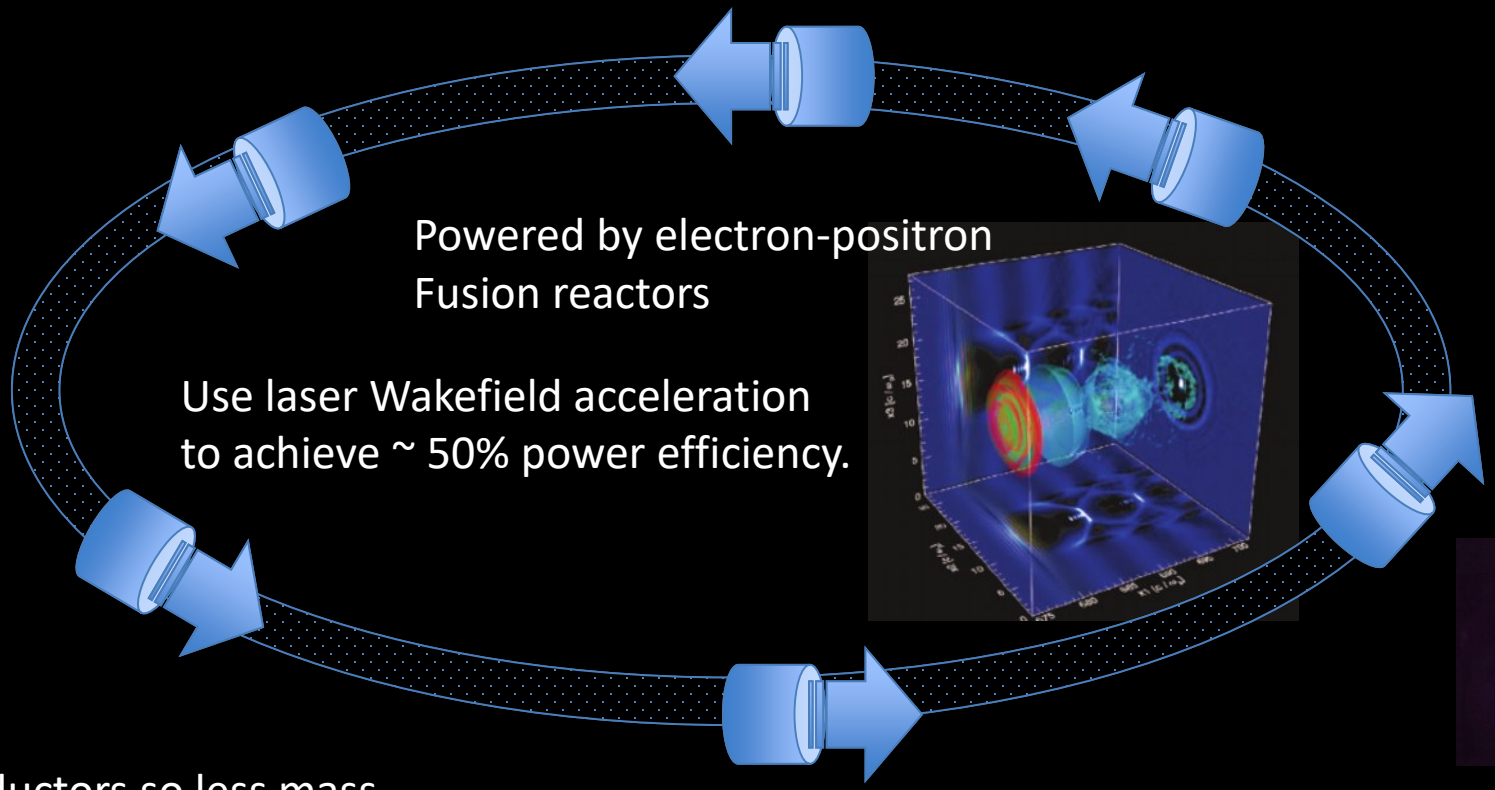


Generate Earth's field
Total Power needed ~65 GW*

* Lowes, 1984 Surveys in Geophysics, Vol 7(1), page 91-105

Use emerging technology in plasma physics
Beam electrons from station-to-station

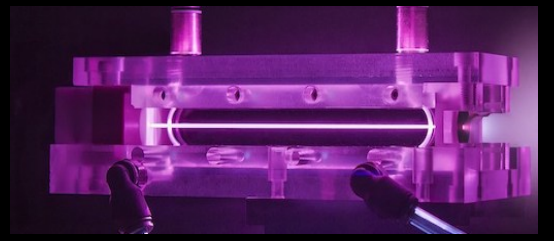
Ejecting electrons at high speed (above Dreiser limit of local plasma) to create ‘runaway’ electrons to avoid instabilities and beam filamentation.



Powered by electron-positron
Fusion reactors

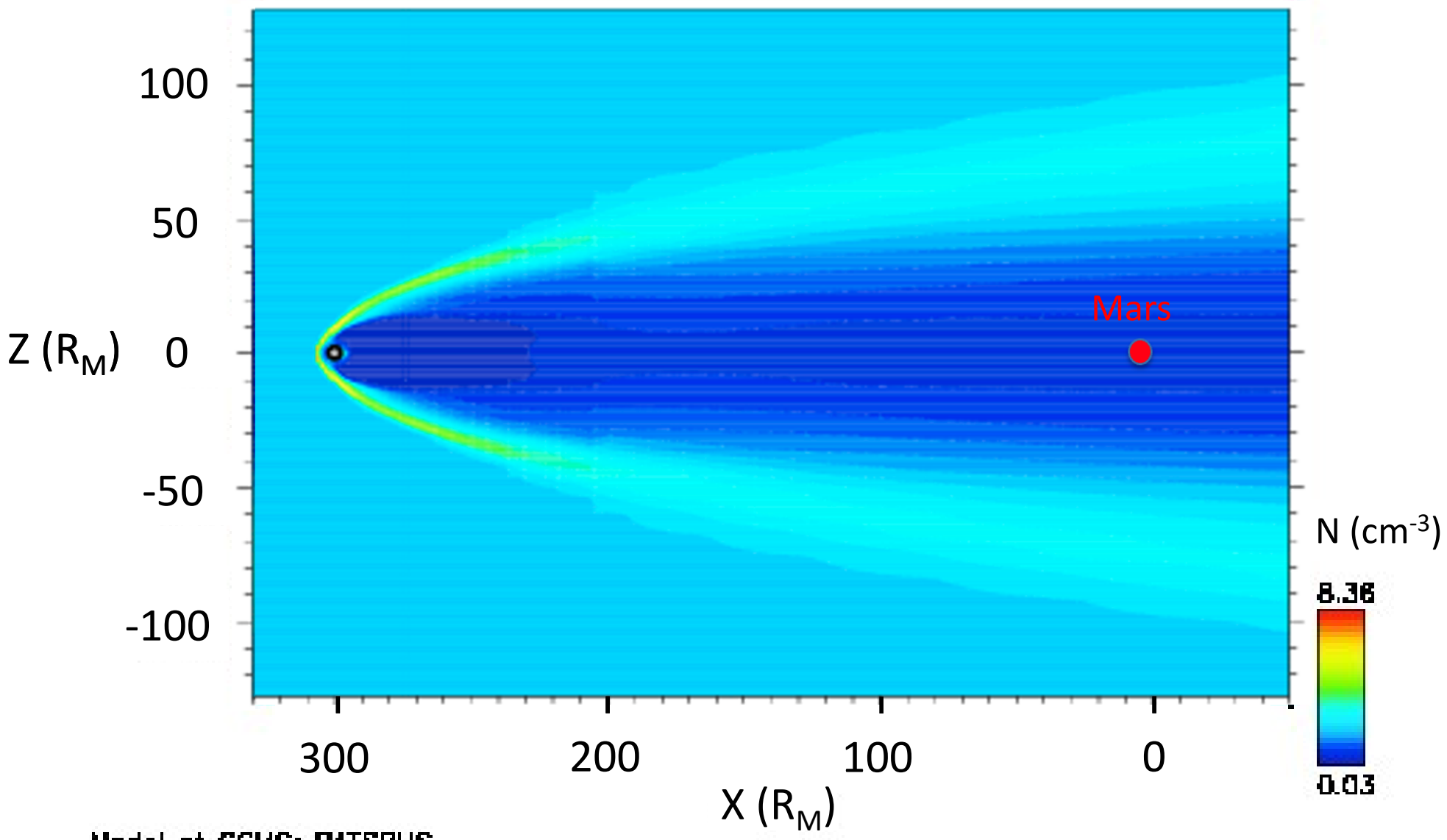
Use laser Wakefield acceleration
to achieve ~ 50% power efficiency.

Plasma ‘kickers’
To bend beam

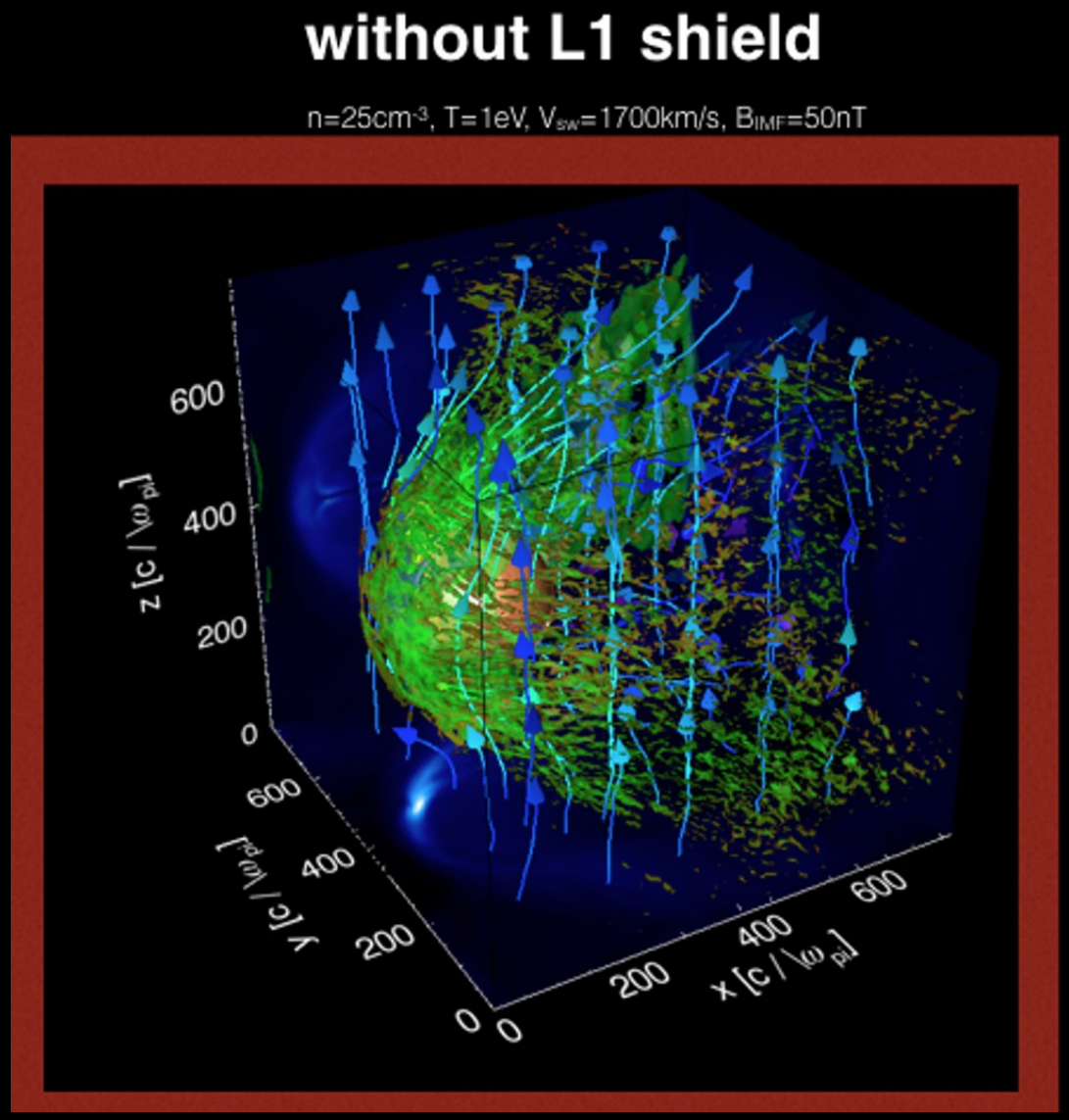


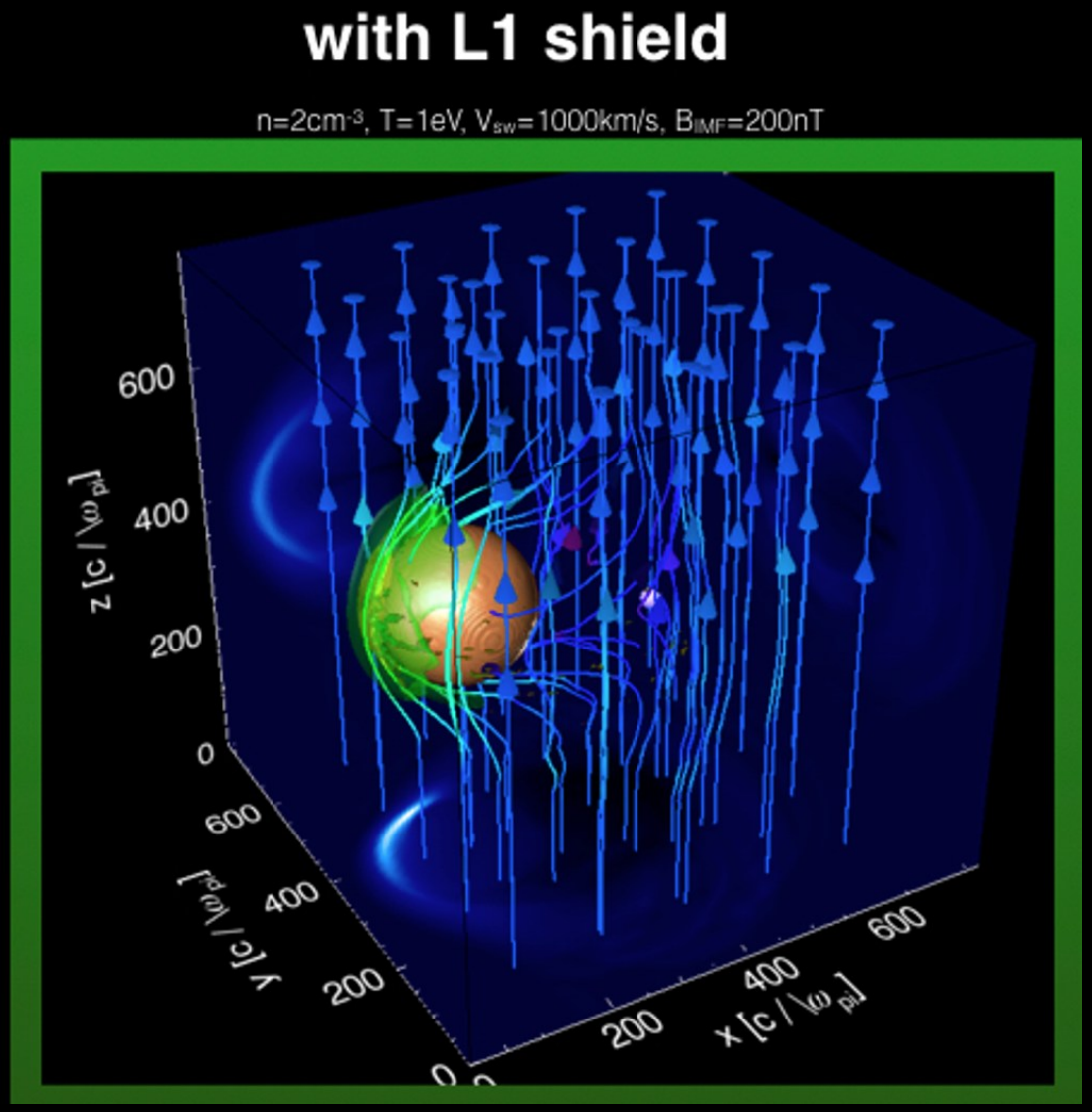
No connecting conductors so less mass

Simulation of the Solar Wind Density

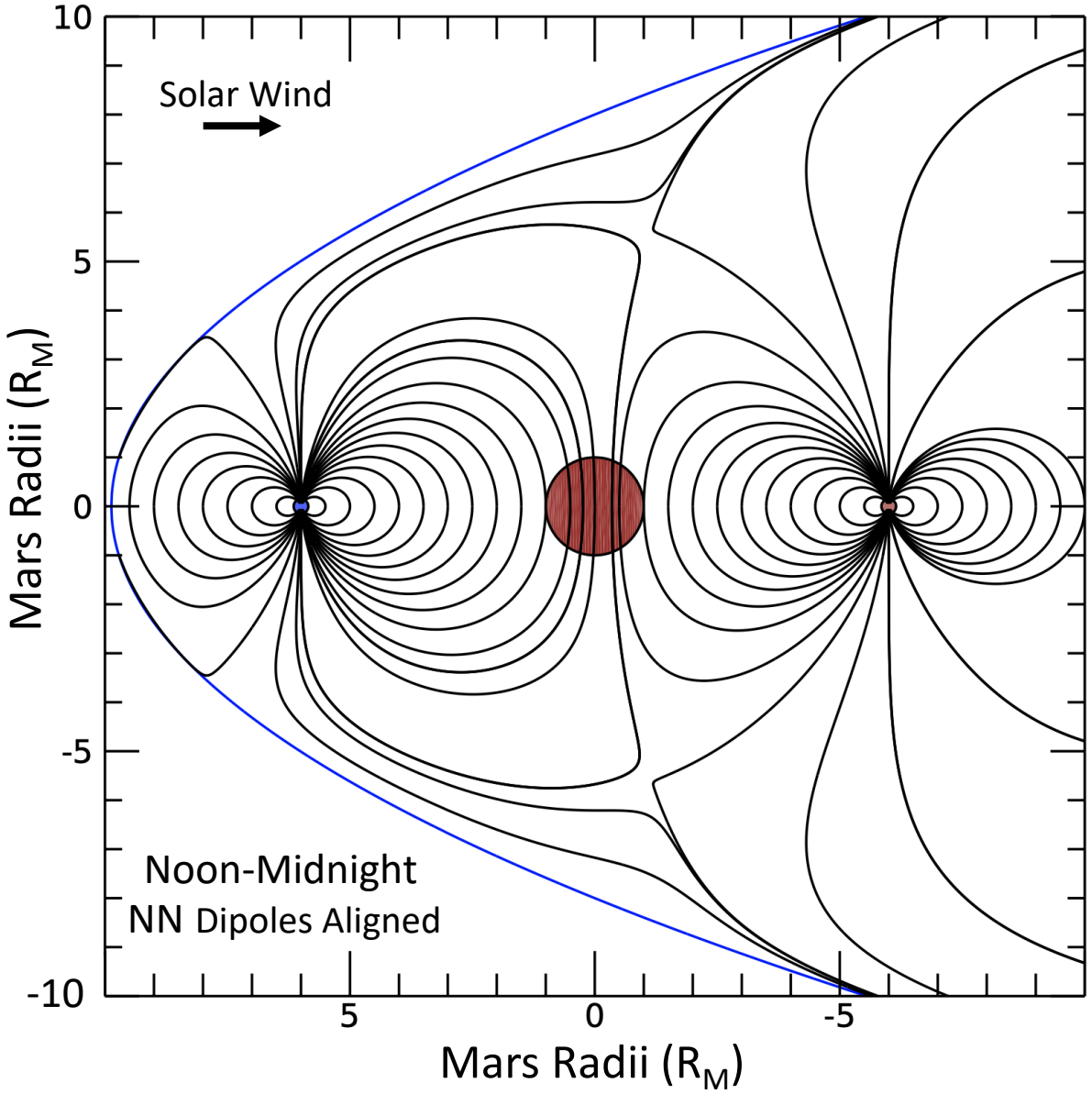


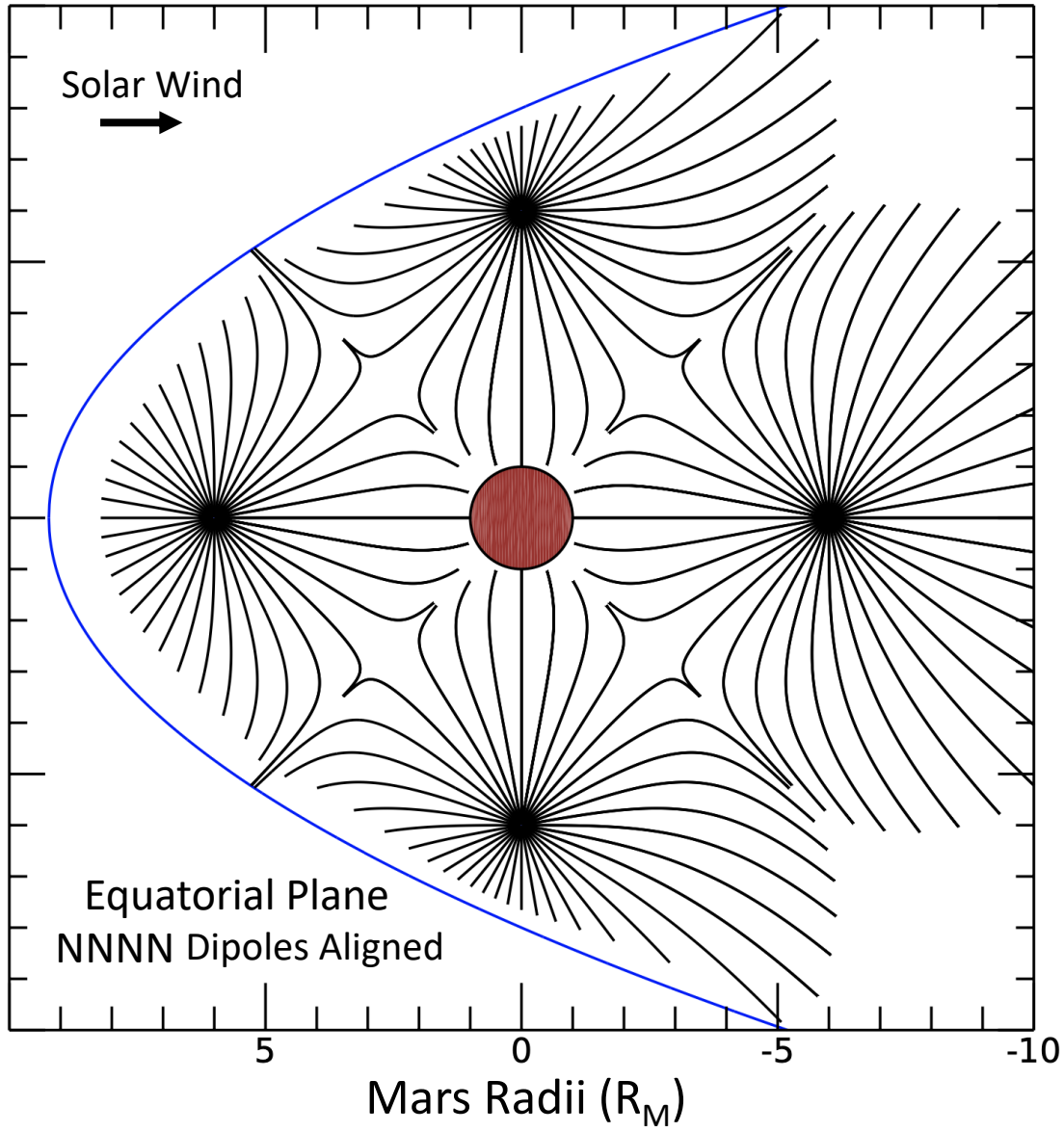
Hybrid MHD Simulation of Mars



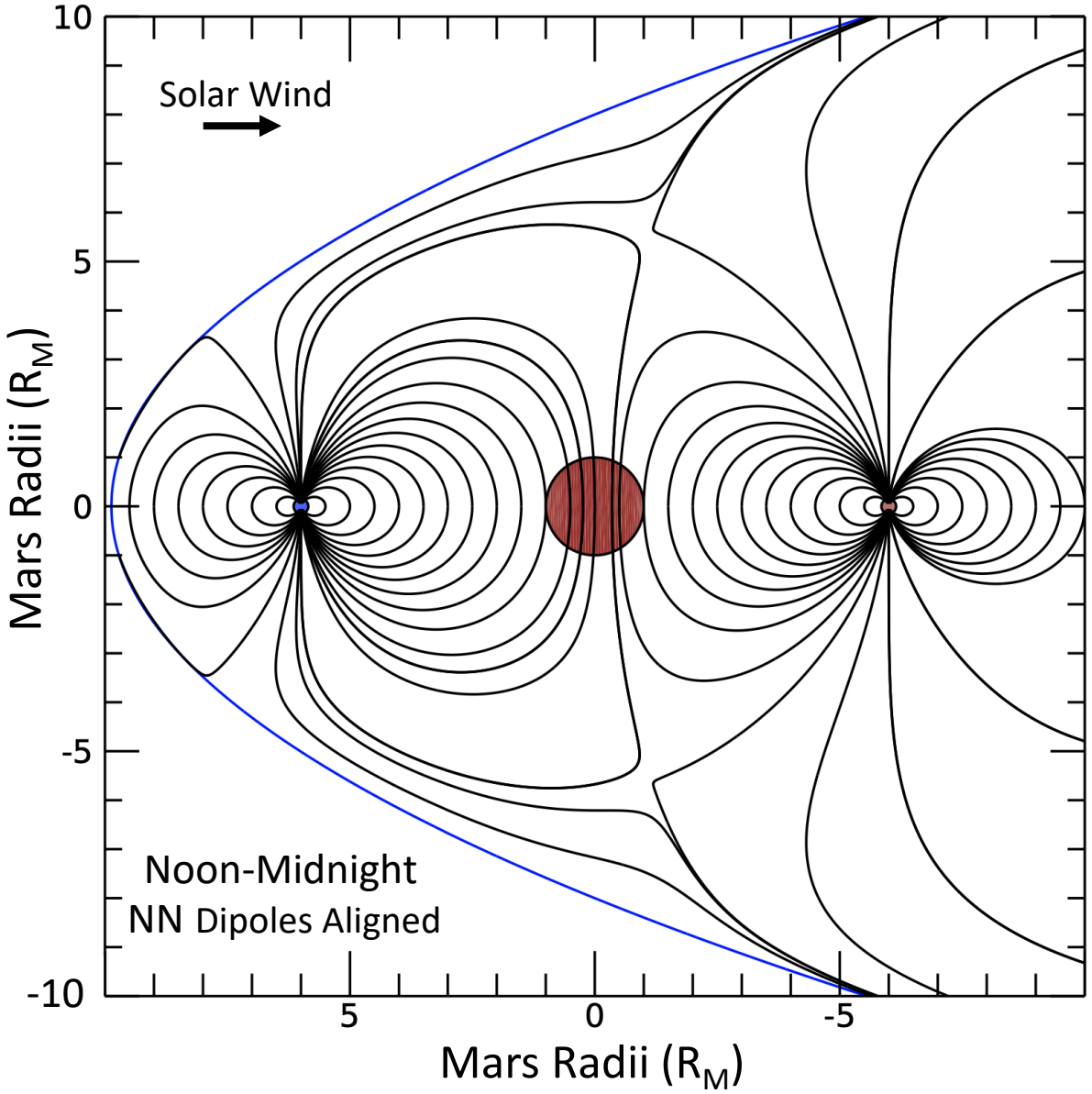


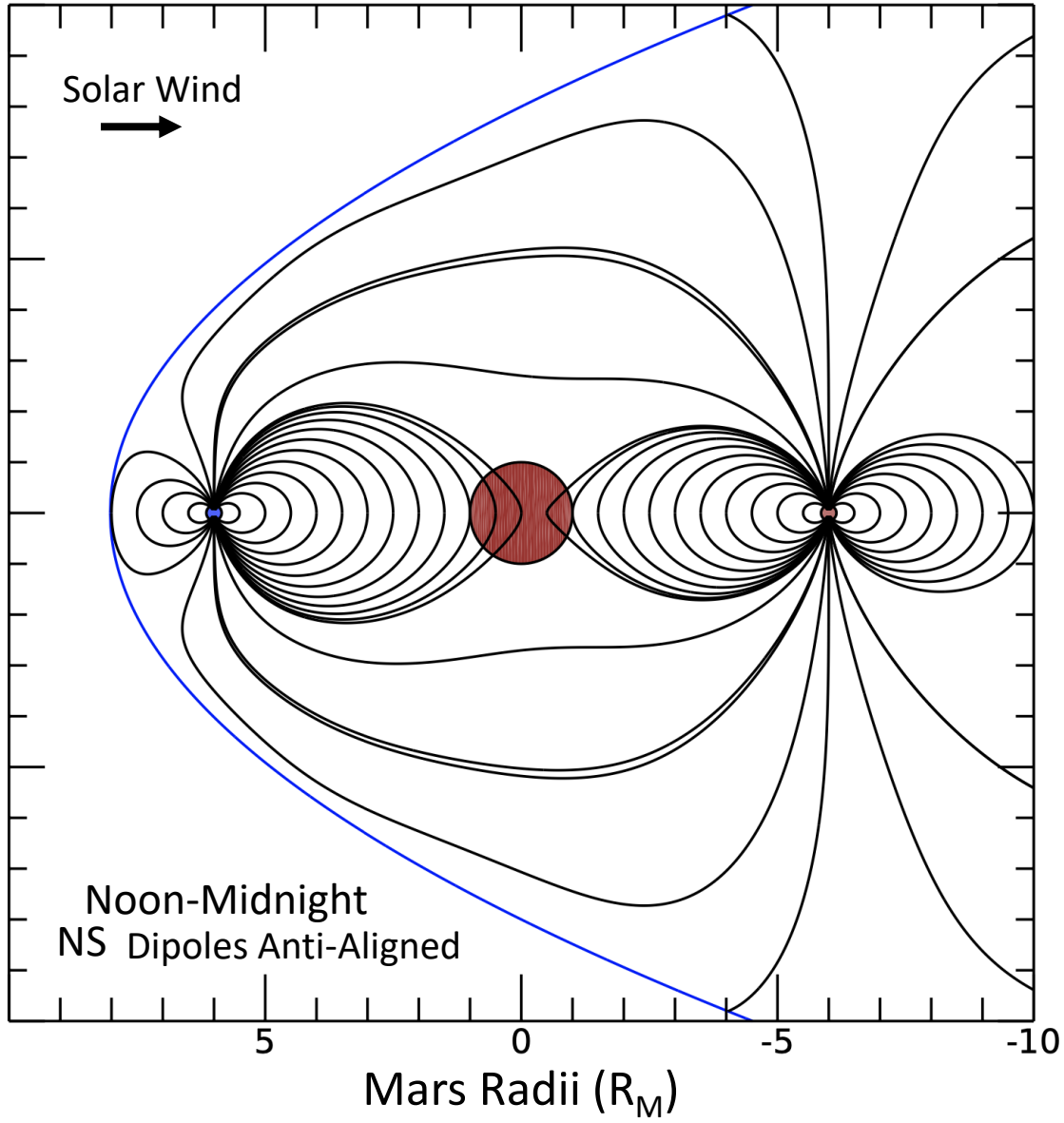
Generate the Current at Four Aerostationary Locations

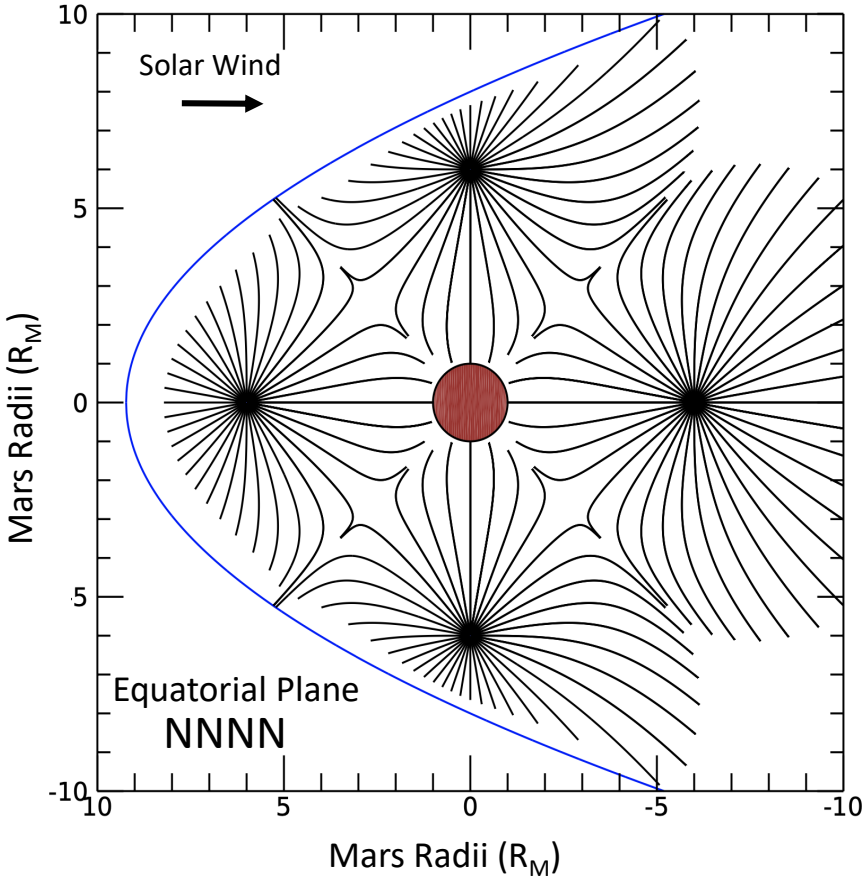


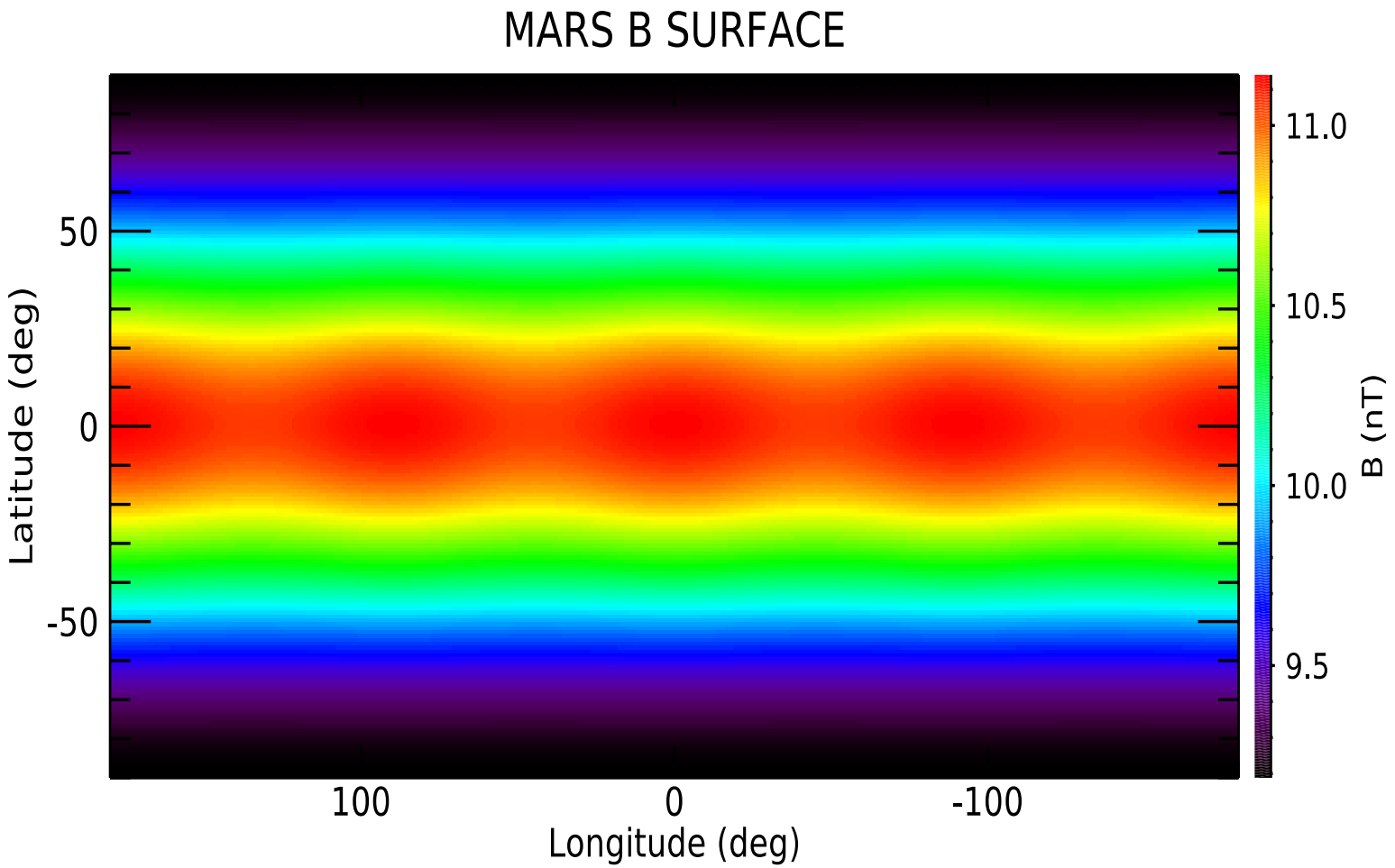


Produces Flexibility of B Field Direction and Magnitude






Solar Wind
Equatorial Plane
NNNN
Mars Radii (R_M)
Mars Radii (R_M)
10
5
0
-5
-10


MARS B SURFACE
Latitude (deg)
Longitude (deg)
50
0
-50
100
0
-100
B (nT)
11.0
10.5
10.0
9.5

Conclusions

- The magnetic field from a large current loop is similar to a dipole bar magnet field at large distances
- Two scenarios were modeled:
  - One Current loop at Mars Lagrange point L1
  - Four current loops at aerostationary orbit (inclination 0^o)
- Benefits of a magnetic shield include:
  - Significantly reducing atmospheric loss by the solar wind
  - Planetary outgassing contributes to a higher pressure (and temperature)
- Additional advantages with current loops at aerostationary orbit
  - Magnetic protection against SPEs and Cosmic Rays over the Exploration Zone
  - All currents in the same direction provides maximum protection
  - May be used to determine latitude/longitude location enabling exploration

Questions?