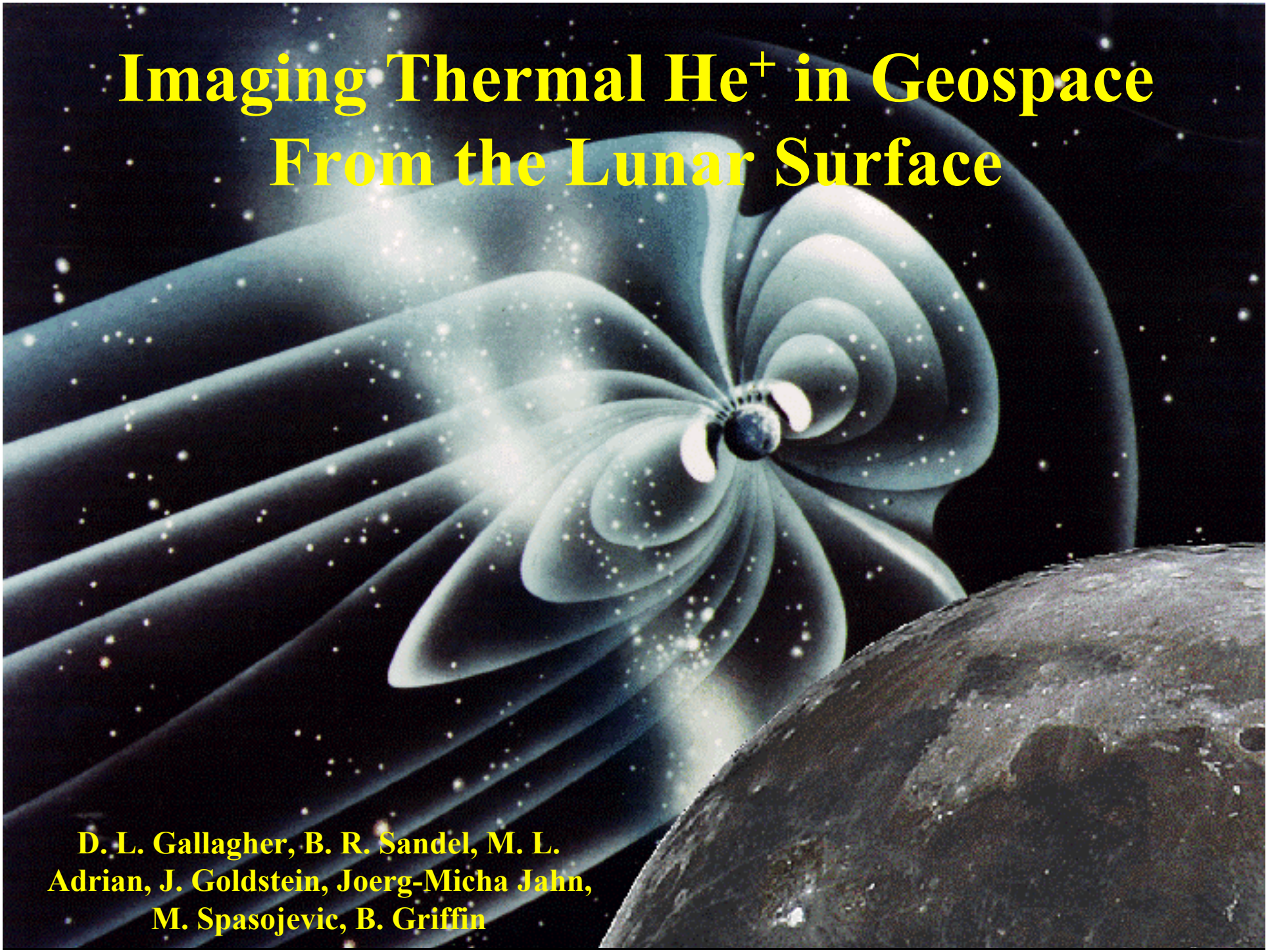
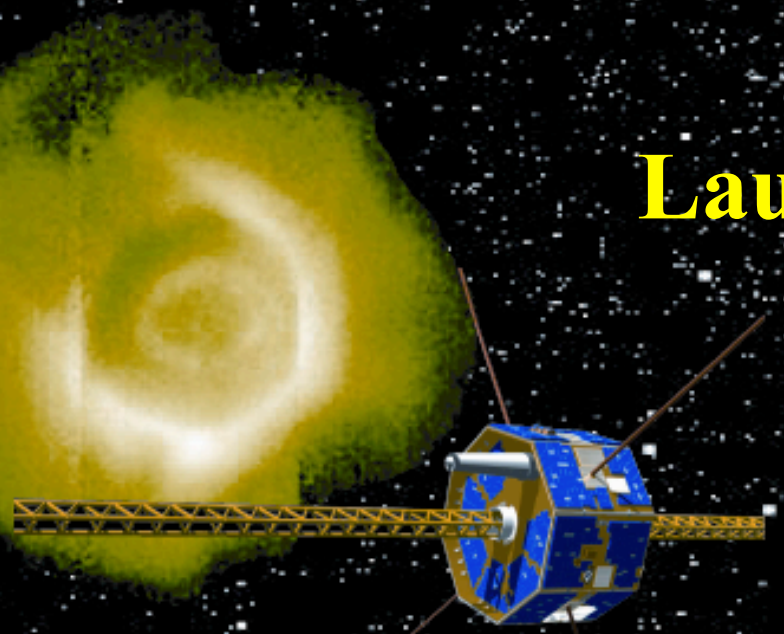
Imaging Thermal He^+ in Geospace From the Lunar Surface



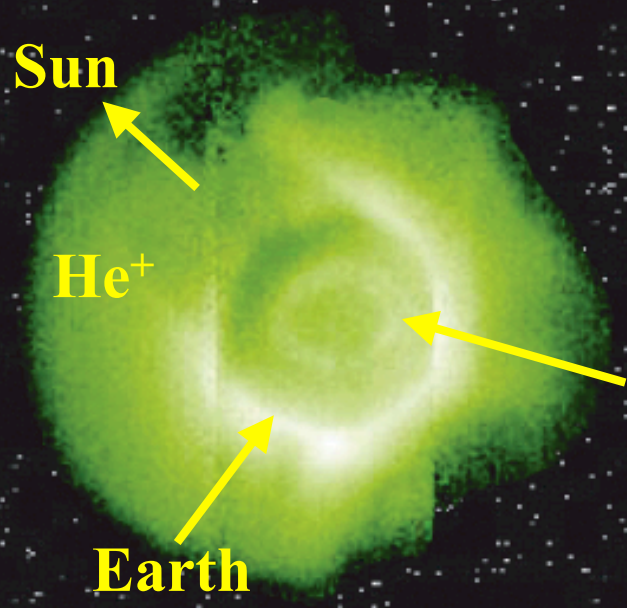
D. L. Gallagher, B. R. Sandel, M. L. Adrian, J. Goldstein, Joerg-Micha Jahn, M. Spasojevic, B. Griffin

IMAGE Mission
Launch March 25, 2000

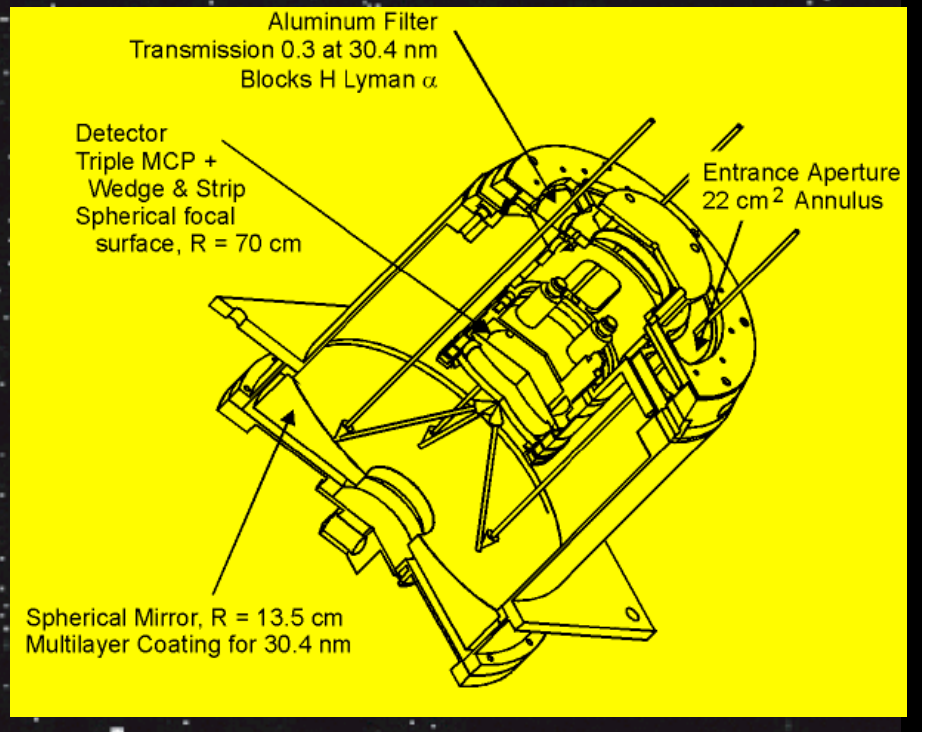


- First all-remote sensing Geospace mission.
- Auroral imaging in far ultraviolet light of proton and electron precipitation
- Plasmasphere imaging in extreme ultraviolet light at 30.4 nm
- Particle imaging in Energetic Neutral Atoms 10 ev – 500 keV
- Radio imaging of remote plasma density in reflected radio waves at 3 kHz to 3 MHz

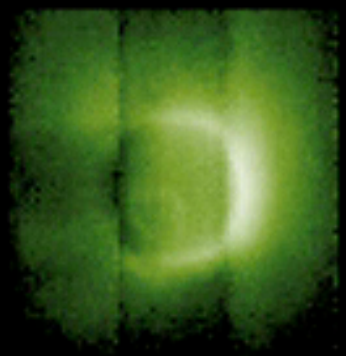
The IMAGE Extreme Ultraviolet Imager



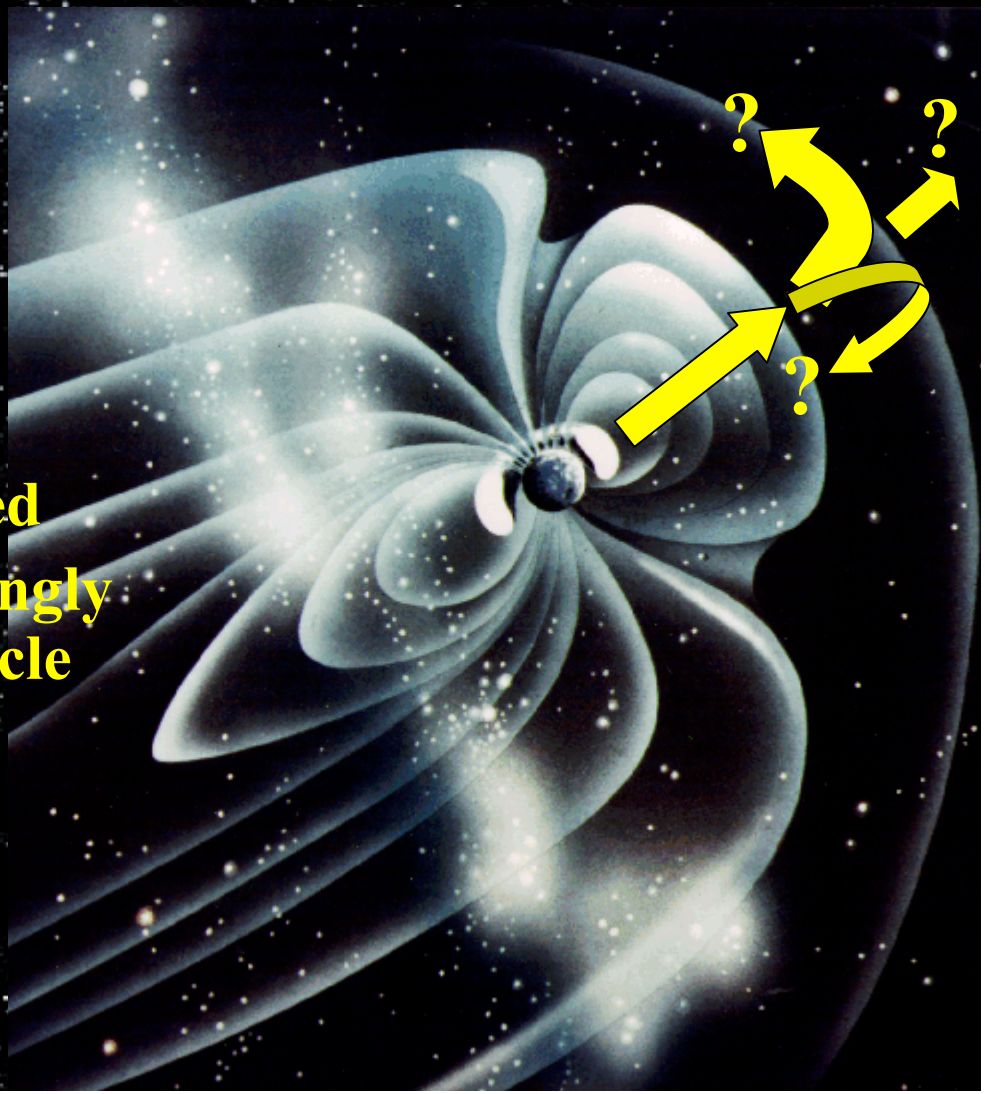
- 0.1 R_E resolution at 8 R_E
- Sensitive to $n_e \sim 40$ cm^{-3}
- 84° x 360° field of view
- 10 minute integrations
- Mass: 15.6 kg
- Power: 9.0 Watts



An Unanswered Question

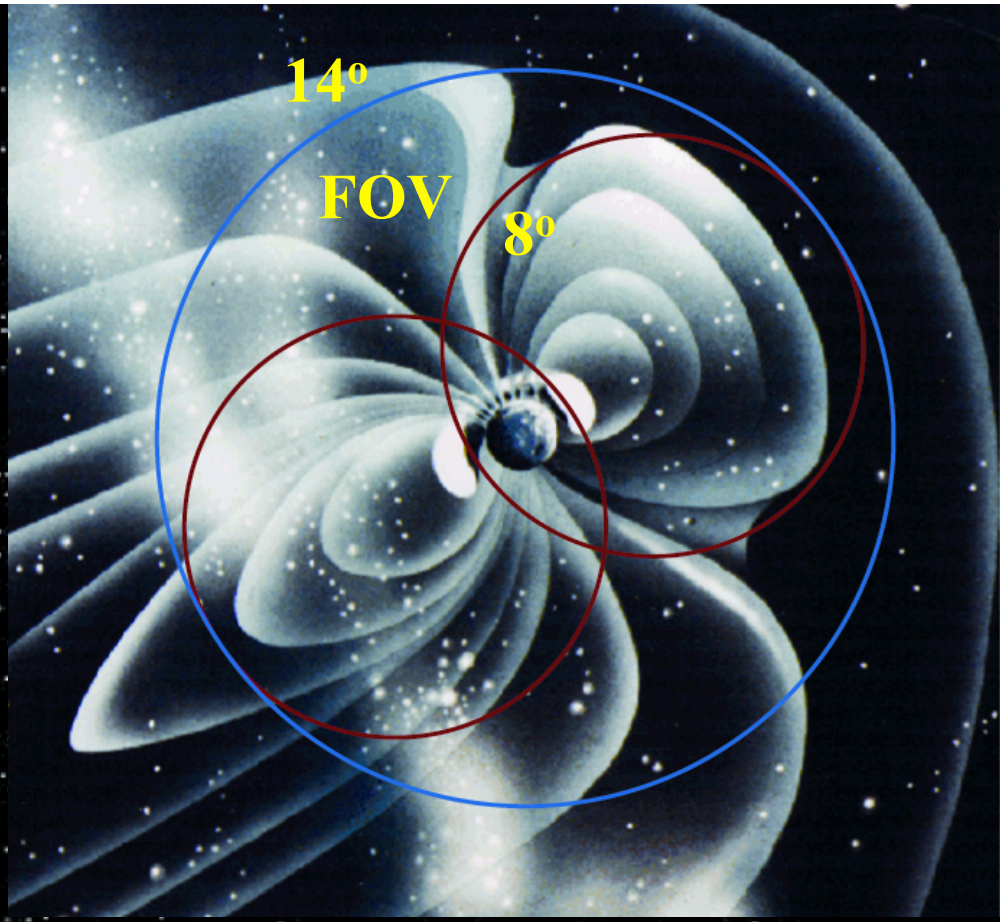


- 50-75 metric tons can be eroded
- Thermal plasma densities strongly influence energetic wave-particle processes
- Is this plasma lost?
- Does it change solar wind coupling, substorm triggering, radiation belt loss rates, etc?

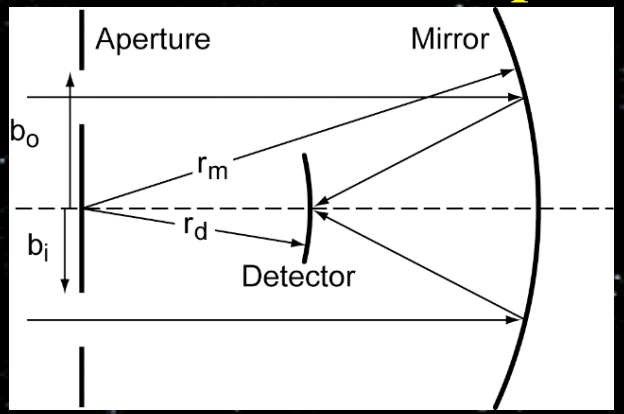


Geospace EUV Imager for the Lunar Surface

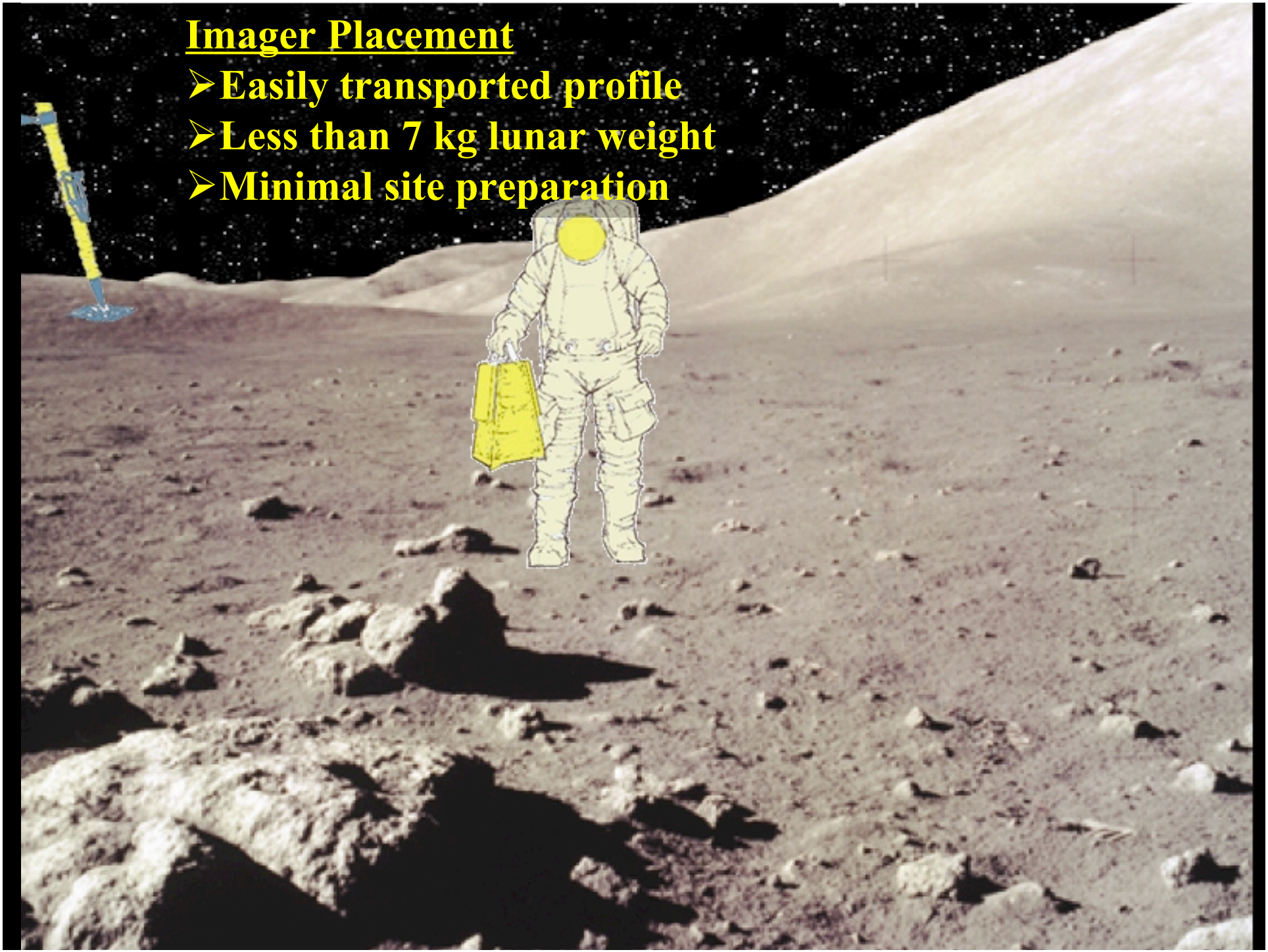
- Sensitivity >200 times that of IMAGE EUV possible
- Mass: ~25 kg
- One or two imagers to cover the required region
- Even with energization, much He^+ still observable
- Better filtering of interplanetary background 58.4 nm light
- Flight proven technology

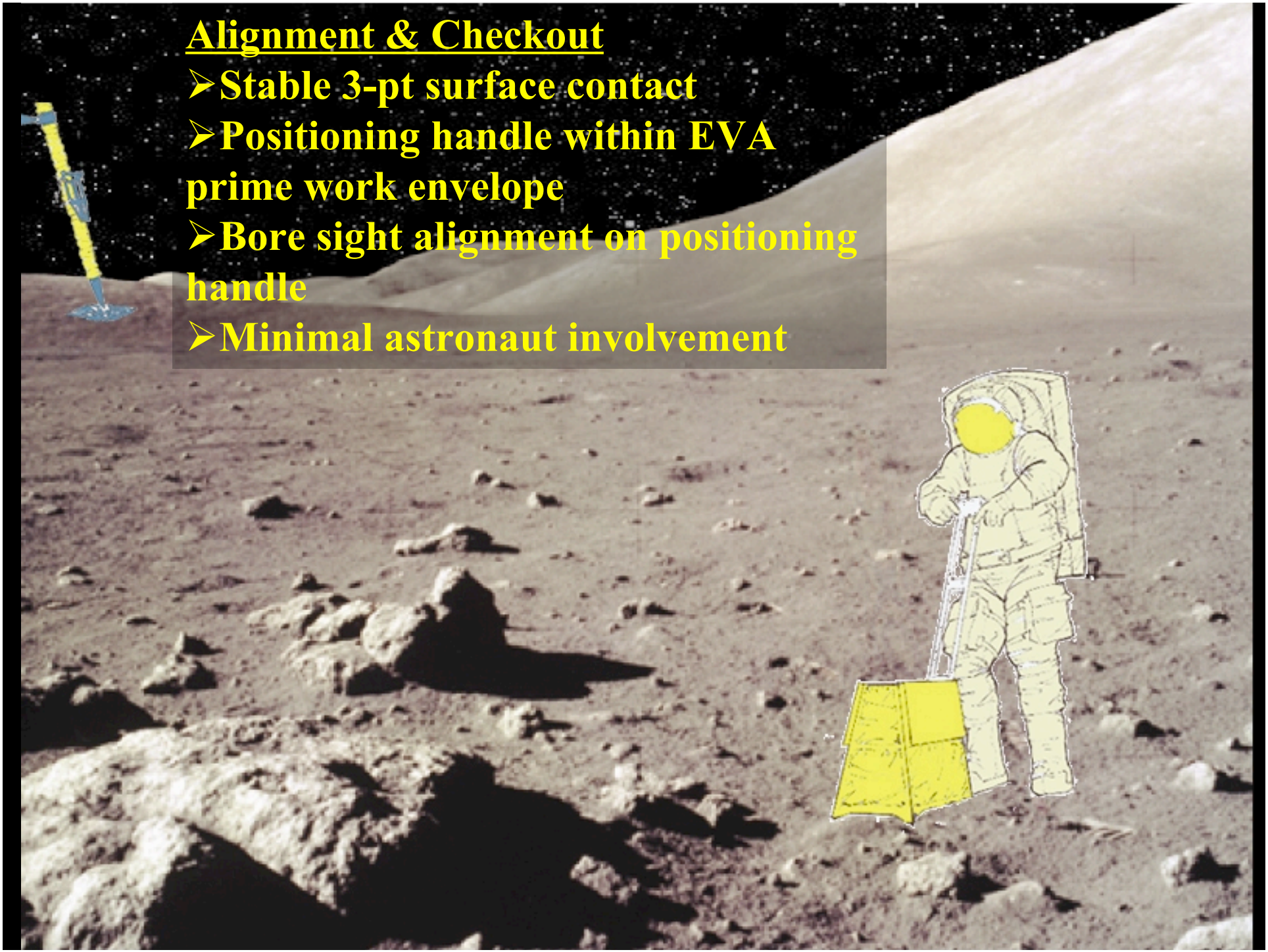


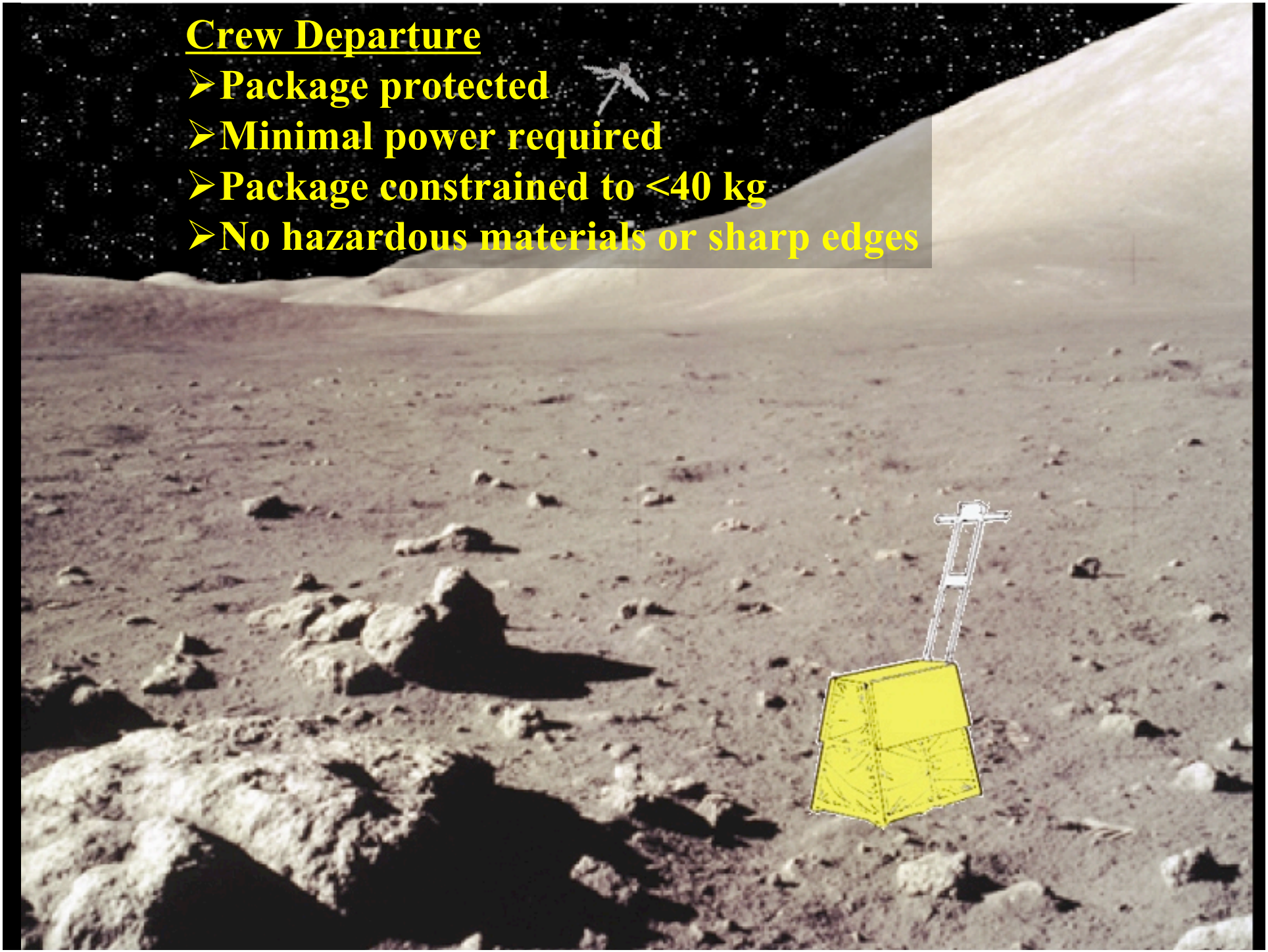
Basic Instrument Optics

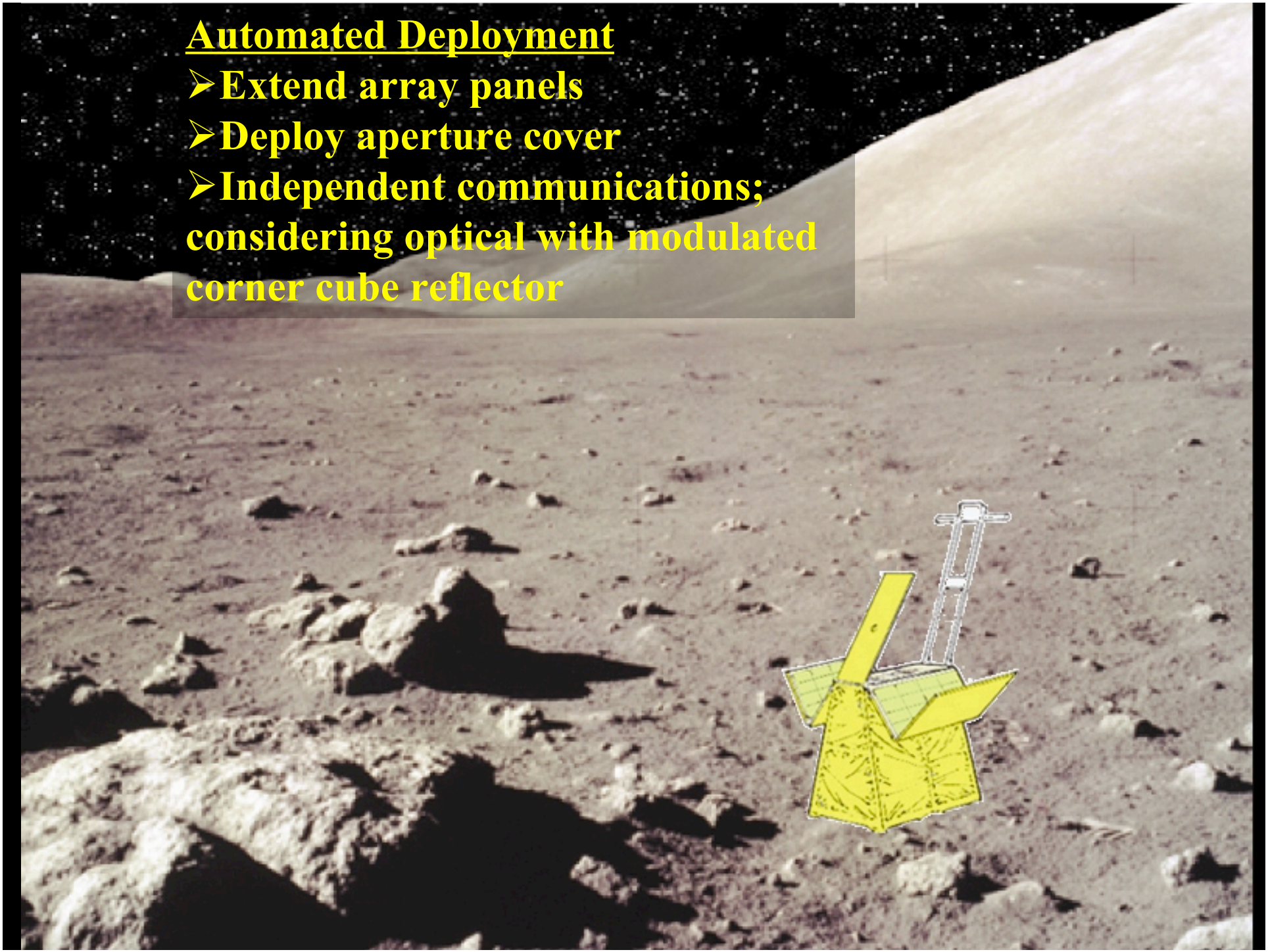


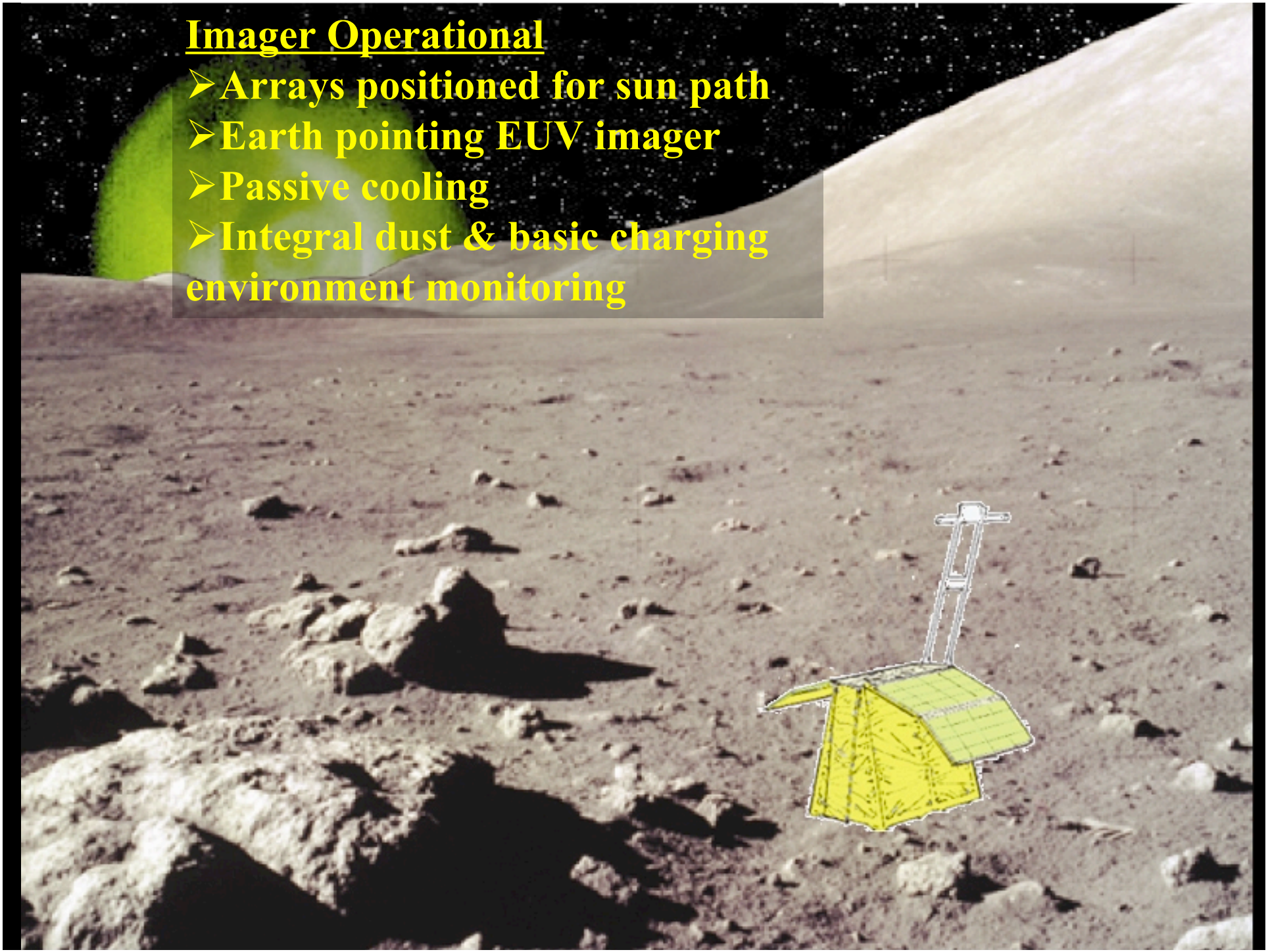
Imager Deployment
➢No tools are required
➢Within EVA Prime Work Envelope
➢For polar or equatorial sites


Imager Placement
➢Easily transported profile
➢Less than 7 kg lunar weight
➢Minimal site preparation

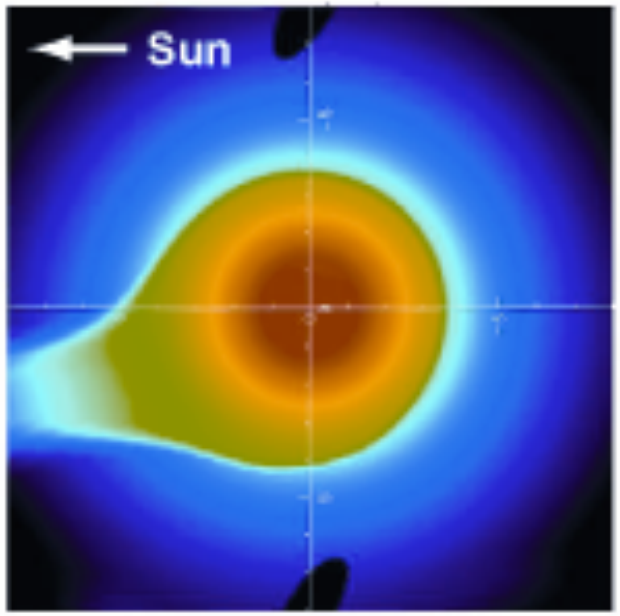

Alignment & Checkout
➢Stable 3-pt surface contact
➢Positioning handle within EVA prime work envelope
➢Bore sight alignment on positioning handle
➢Minimal astronaut involvement

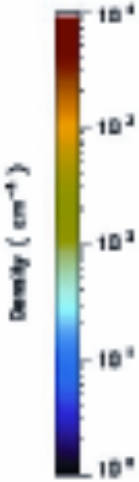

Crew Departure
➢Package protected
➢Minimal power required
➢Package constrained to <40 kg
➢No hazardous materials or sharp edges

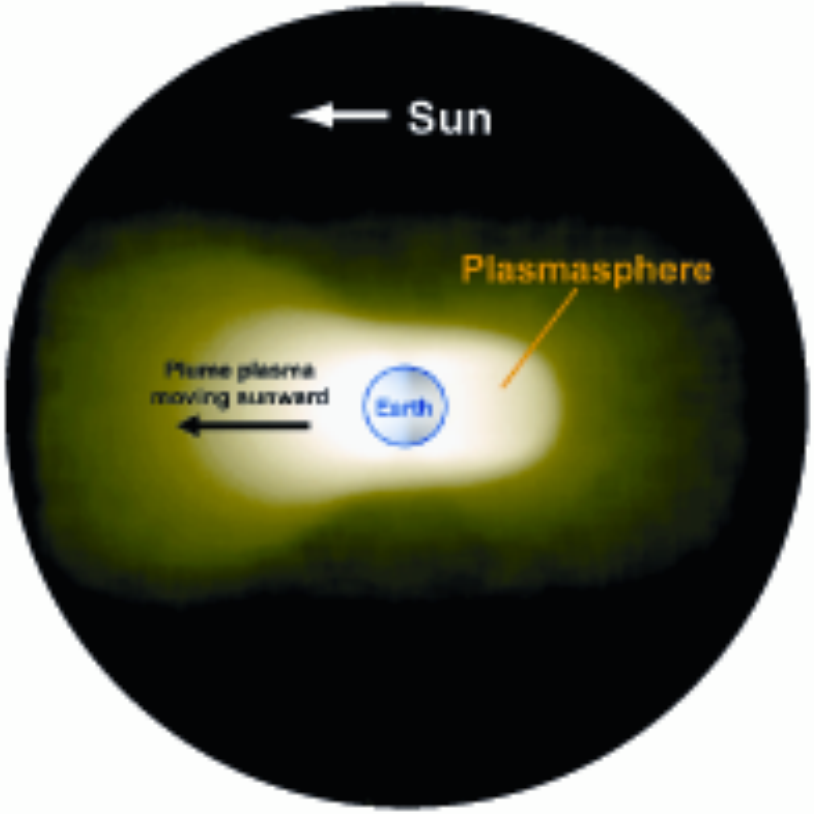

Automated Deployment
➢Extend array panels
➢Deploy aperture cover
➢Independent communications; considering optical with modulated corner cube reflector


Imager Operational
➢Arrays positioned for sun path
➢Earth pointing EUV imager
➢Passive cooling
➢Integral dust & basic charging environment monitoring

At ~100x the IMAGE EUV Sensitivity



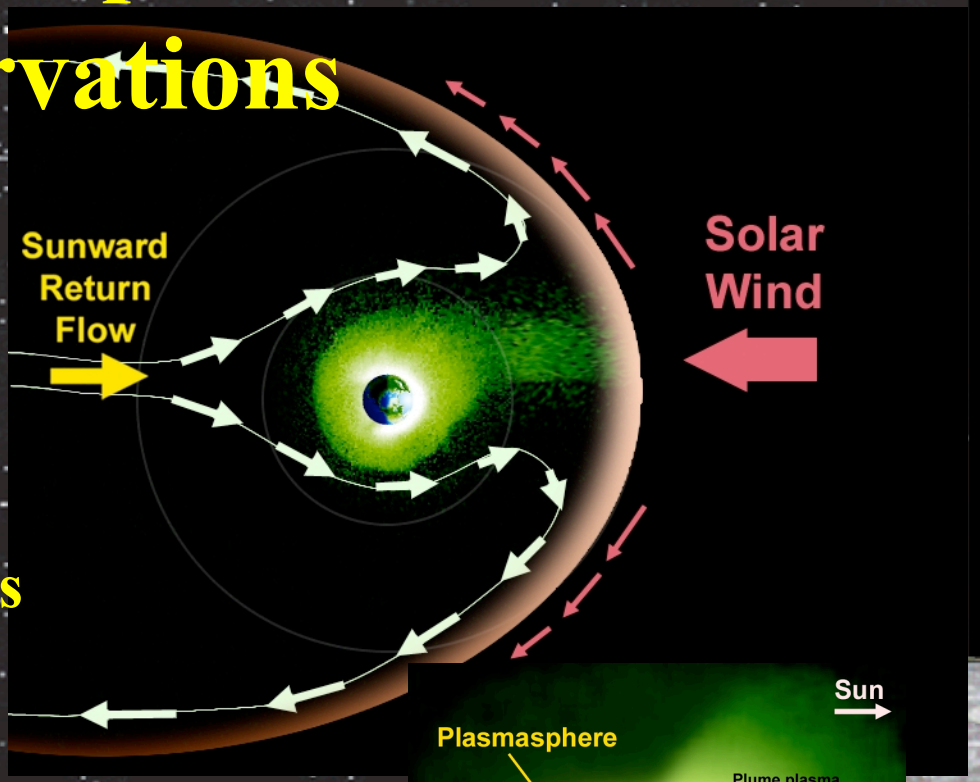
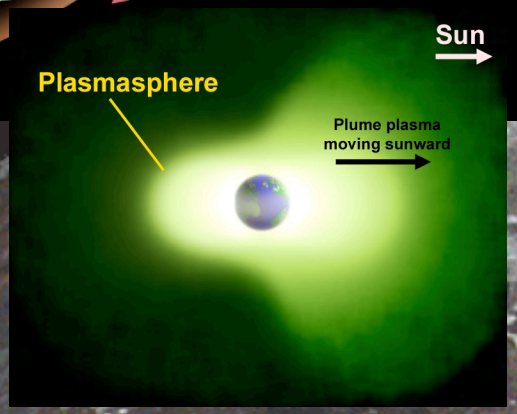




Dynamic Plasmasphere Model

Simulated Image

The subsolar magnetosheath might light up in He^{+} from charge exchanged solar He^{++}. Merging & convected field lines might be directly seen; all due to "tracer" thermal He^{+} ions.

A Box Seat for Space Weather Observations

- Thermal plasma strongly influences instabilities & the transport of particles/energy that dominate space weather hazards in Geospace
- Lunar surface has advantages for communication & pointing
- Strong heritage from IMAGE
- Well suited for Lunar Sortie Science
- Pioneer for future optical science packages by understanding dust effects