MANNED SPACECRAFT RADIATION ISSUES

- ***Trends***: permanent presence, increasing numbers, longer stays (MIR, ISSA), possible interplanetary travel. Use of COTS lab experiments susceptible to single event effects.
- ***Parameters:*** equivalent dose, linear energy transfer spectra, particle fluxes.
- ***Long term variations:***
  - cosmic-ray modulation (factor 3 at high latitudes);
  - South Atlantic Anomaly intensity variation (factor 2 to 5 in one cycle, factor 2 differences between cycles) plus variable anisotropy;
  - South Atlantic Anomaly location (NW movement approx 0.3^{o} per annum).
- ***Short term variations:***
  - additional radiation belt at L=2.6 contributes to dose off of South Africa.
  - Outer-belt electrons and precipitating electrons in horn region.

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- ***Short term variations:***
  - solar particle events can give very significant doses over a few days;
  - complicated by suppression of cut-off rigidity if there is associated geomagnetic storm;
  - approx 2 rads for October 1989 event;
  - levels in interplanetary space are sufficiently high to produce deterministic, debilitating effects which threaten both life and the mission;
  - August 1972 event gave several hundred rads at 20mm of Al. Apollo 16 and 17 missions were April and December 1972 respectively.
- ***Retrospective assessment:***
  - determination of modulation levels and SPE contributions can be made;
  - however comprehensive monitoring is performed (unlike aircraft!).
- ***Economics:*** Loss of mission from radiation sickness would be devastating to manned spaceflight.