Biodosimetry and Space Radiation Risks

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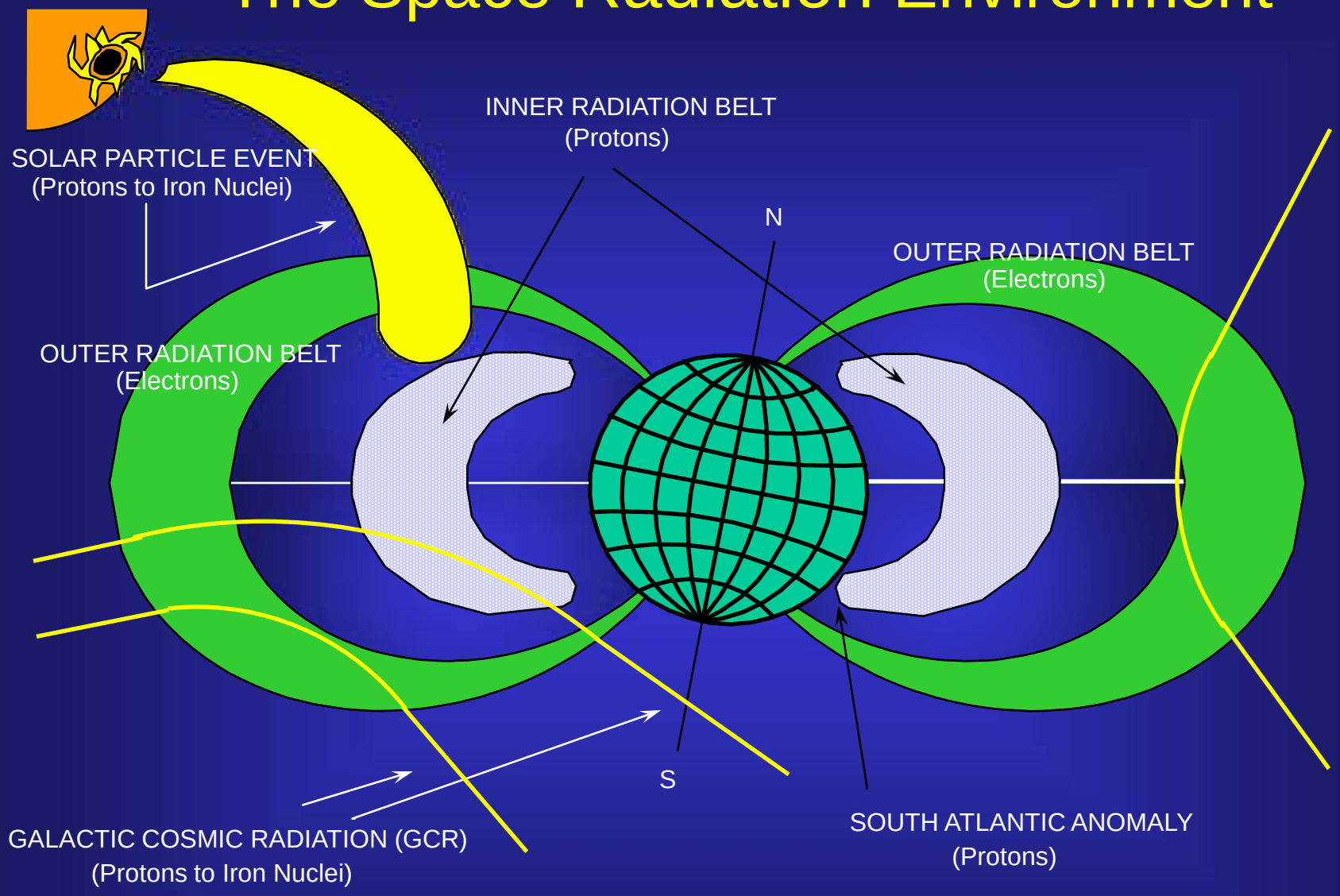
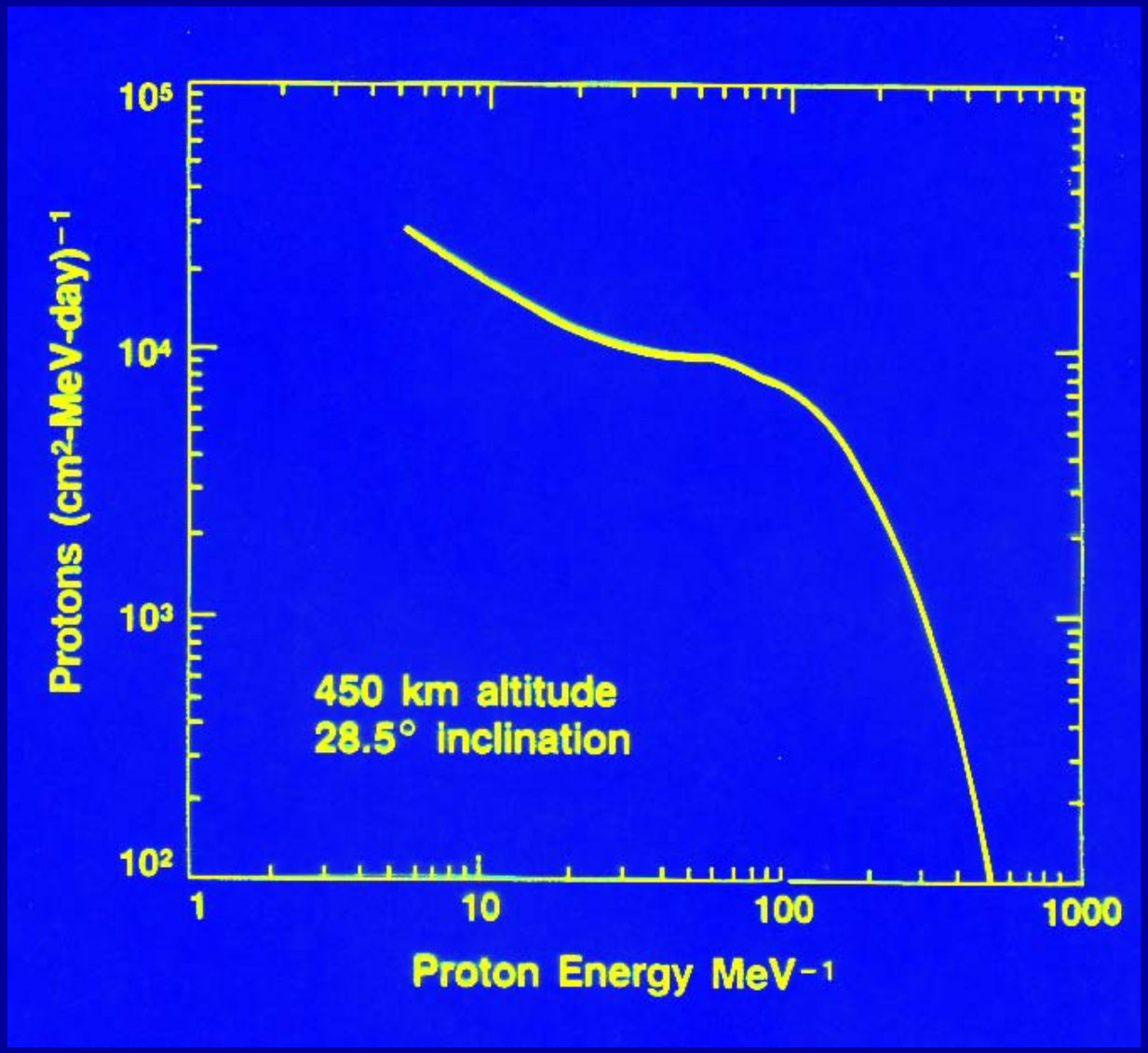
The Space Radiation Environment

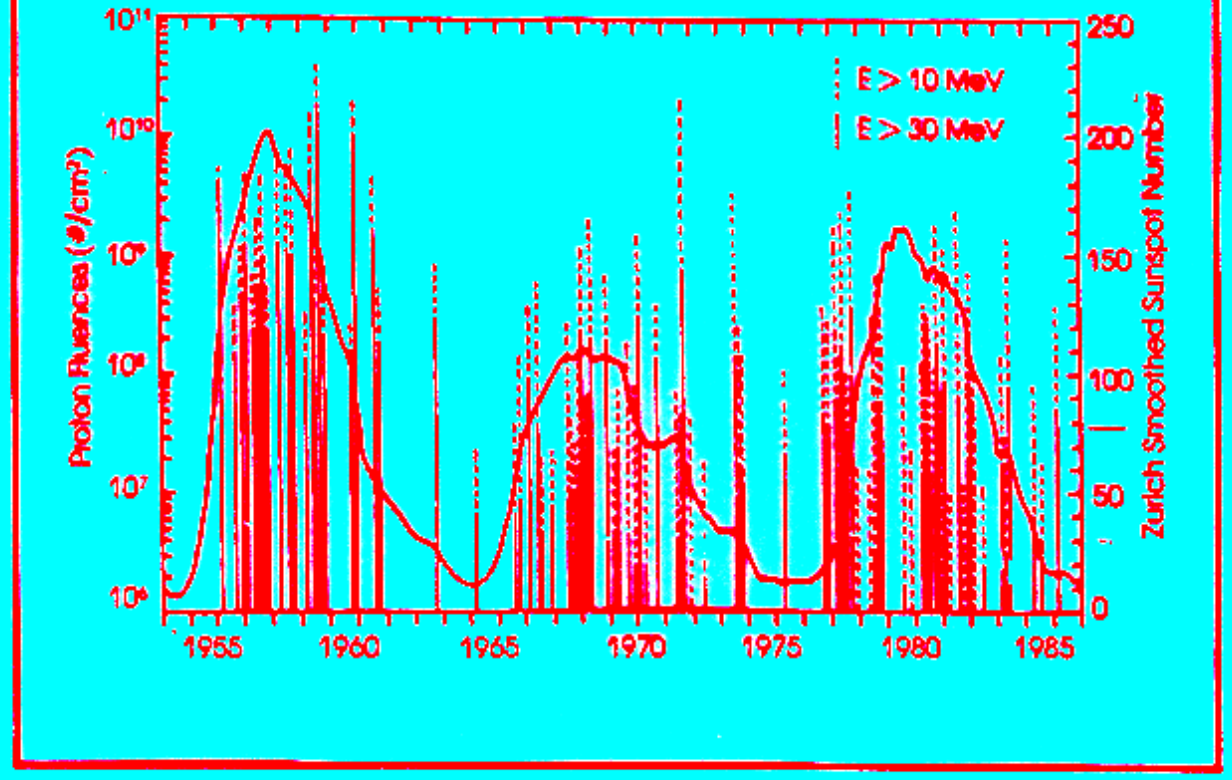


Representation of the major sources of ionizing radiation of importance to manned missions in low-Earth orbit. Note the spatial distribution of the trapped radiation belts.

Energy spectrum of trapped protons



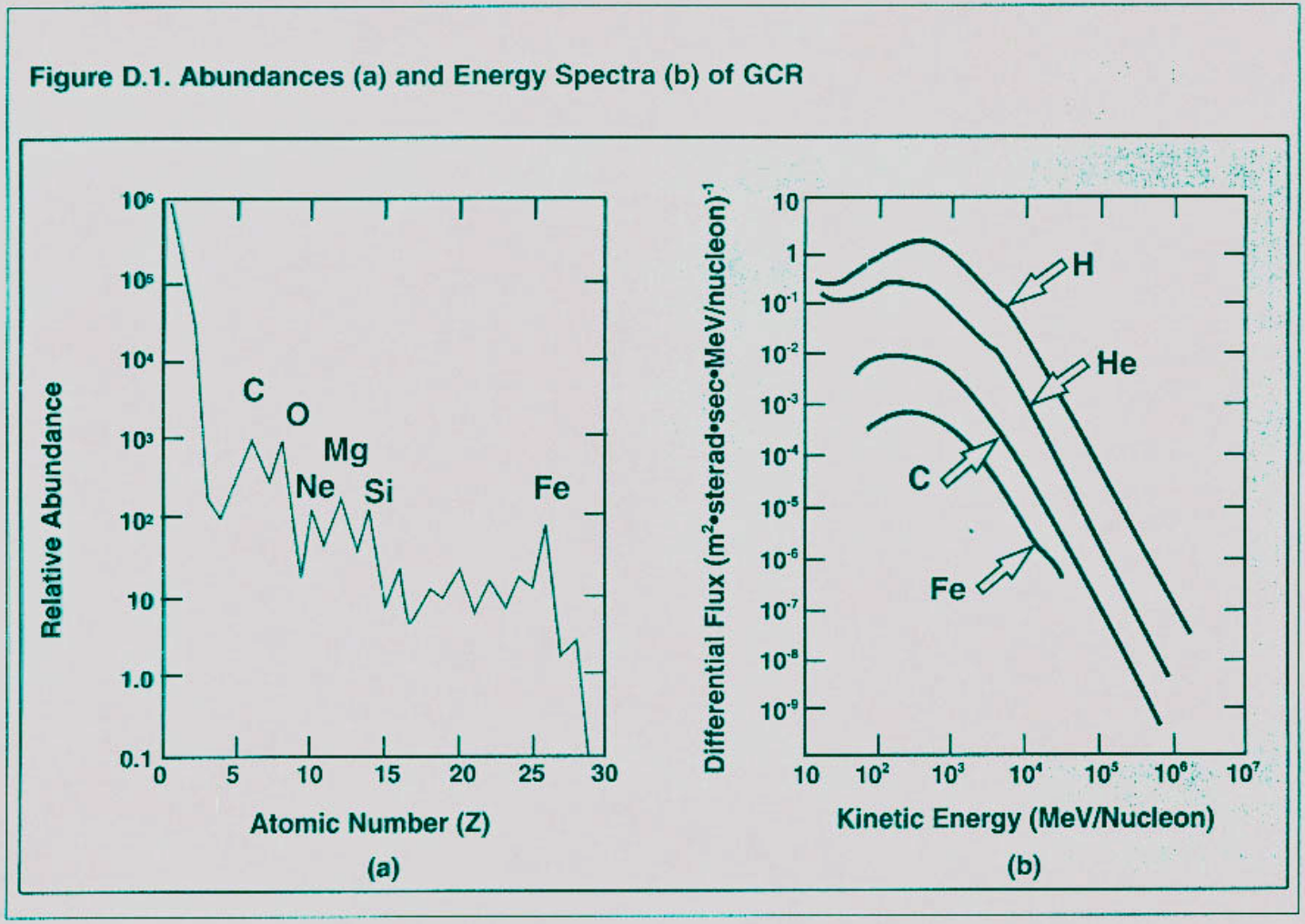
Solar particle events

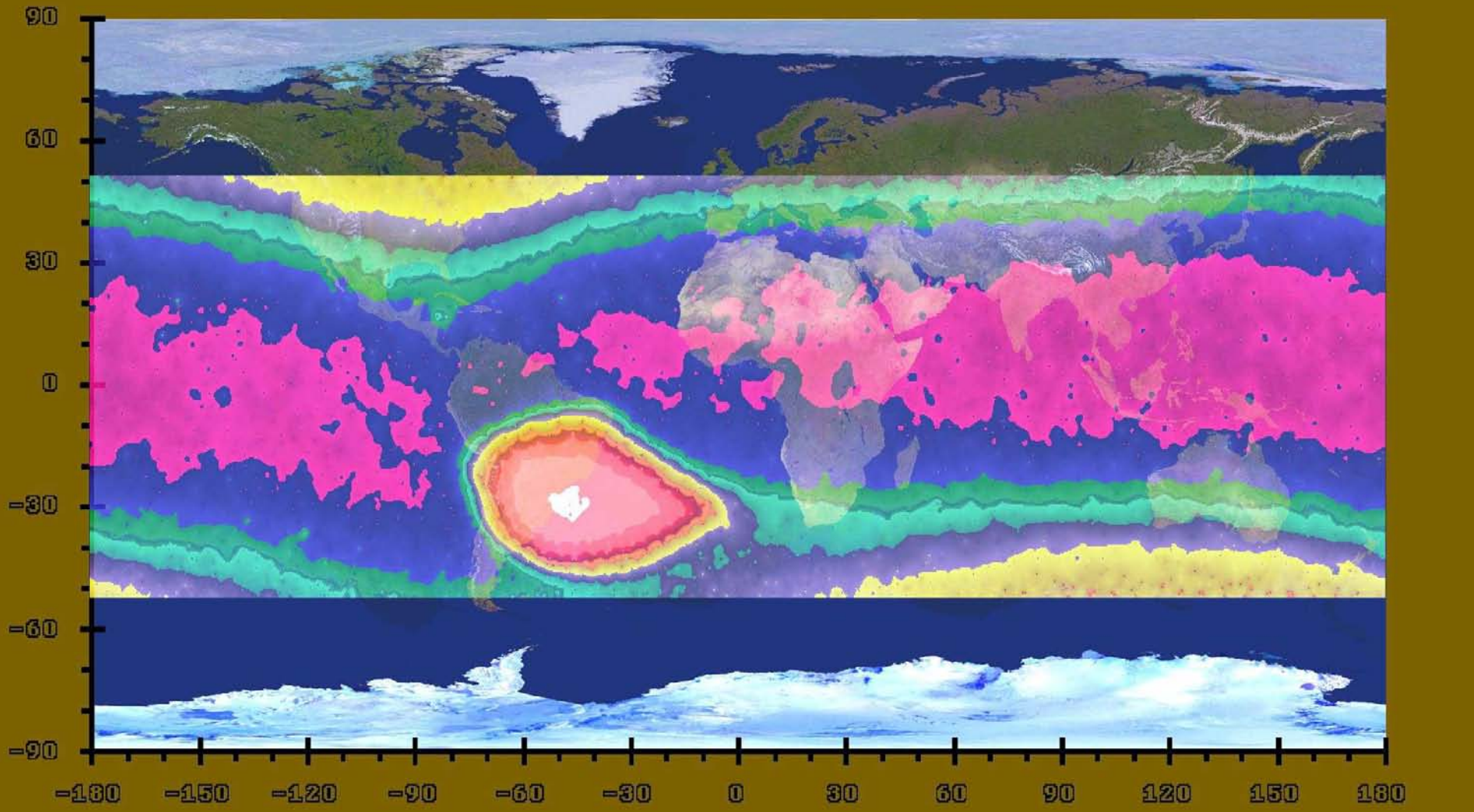


Sunspot Activity vs. Solar Flare Proton Flux

D.S. Nachtwey, NASA Johnson Space Center

Galactic cosmic radiation





Inclination = 51.6 deg.
Altitude ~ 385 km.
November 2, 1997 -
November 4, 1997

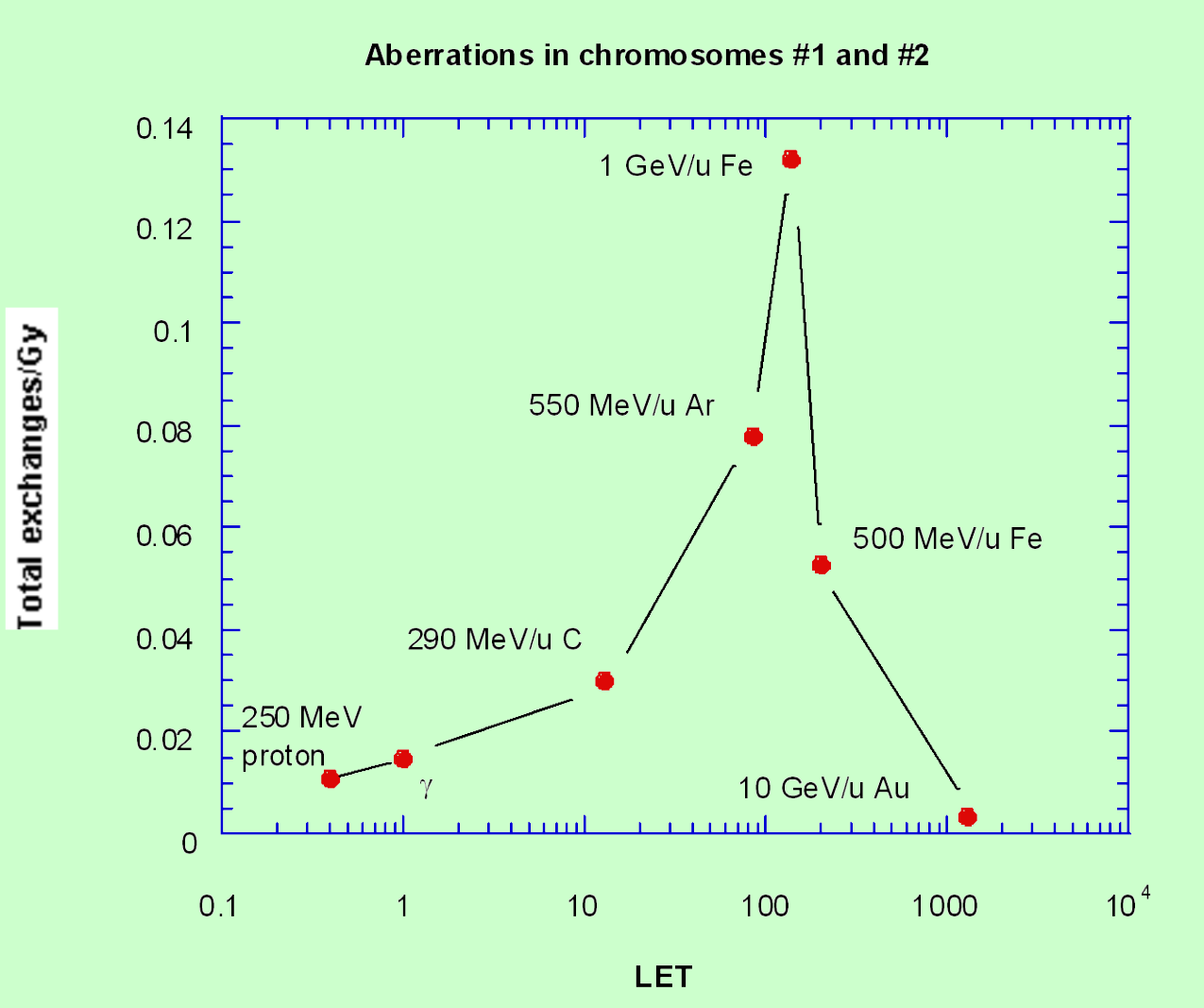
NASA-MIR 6 - Radiation Dosage
TEPC- PRIRODA

0 nGy/min 6500

Summary of space radiation environment

- Major sources: Trapped protons, GCR, solar particle events
- Radiation type: Protons and heavy ions
- Energy of interest: 100 MeV/u ~10000 MeV/u
- Secondary neutrons

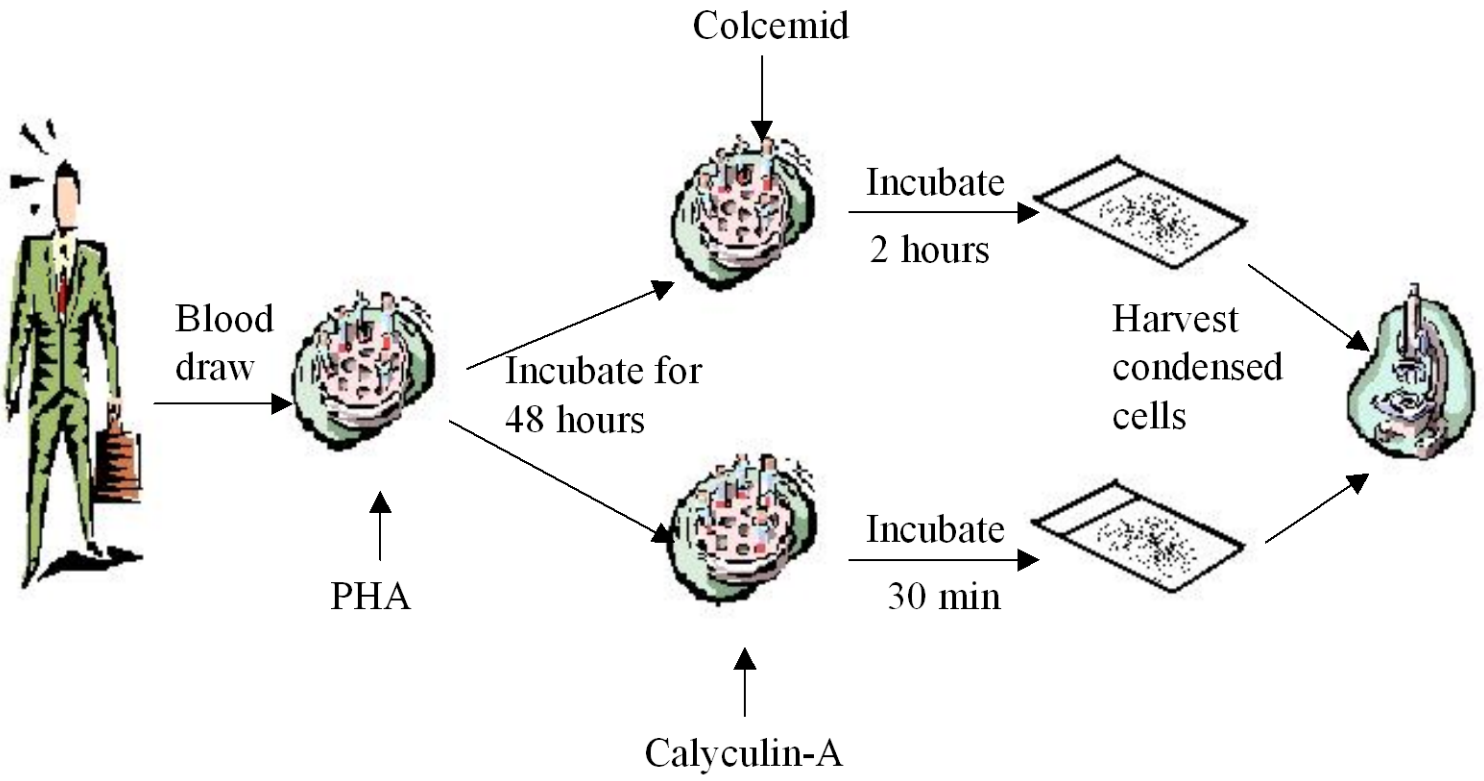
Chromosome aberrations induced by charged particles in human lymphocytes



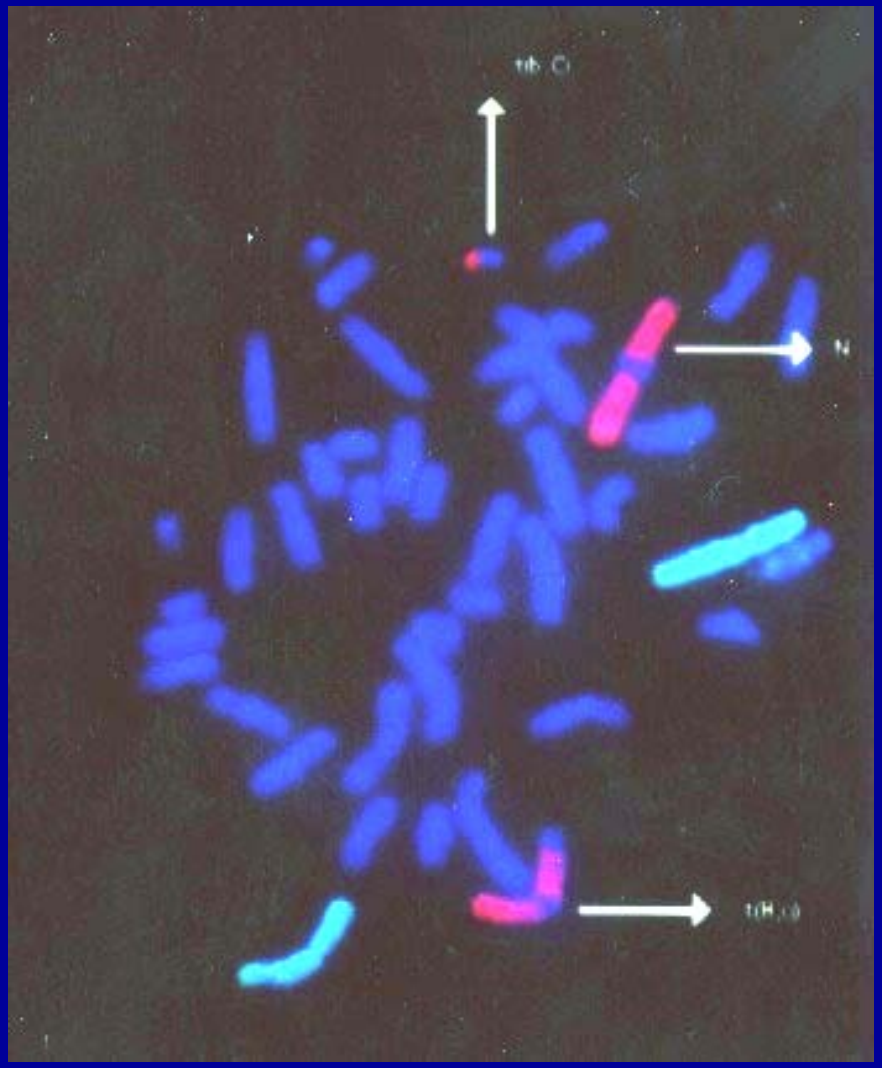
Biodosimetry for space radiation exposure

- Limitation of physical dosimeters
- Lack of understanding of the genetic effects of heavy ions
- Lack of understanding of the synergistic effect of radiation and microgravity

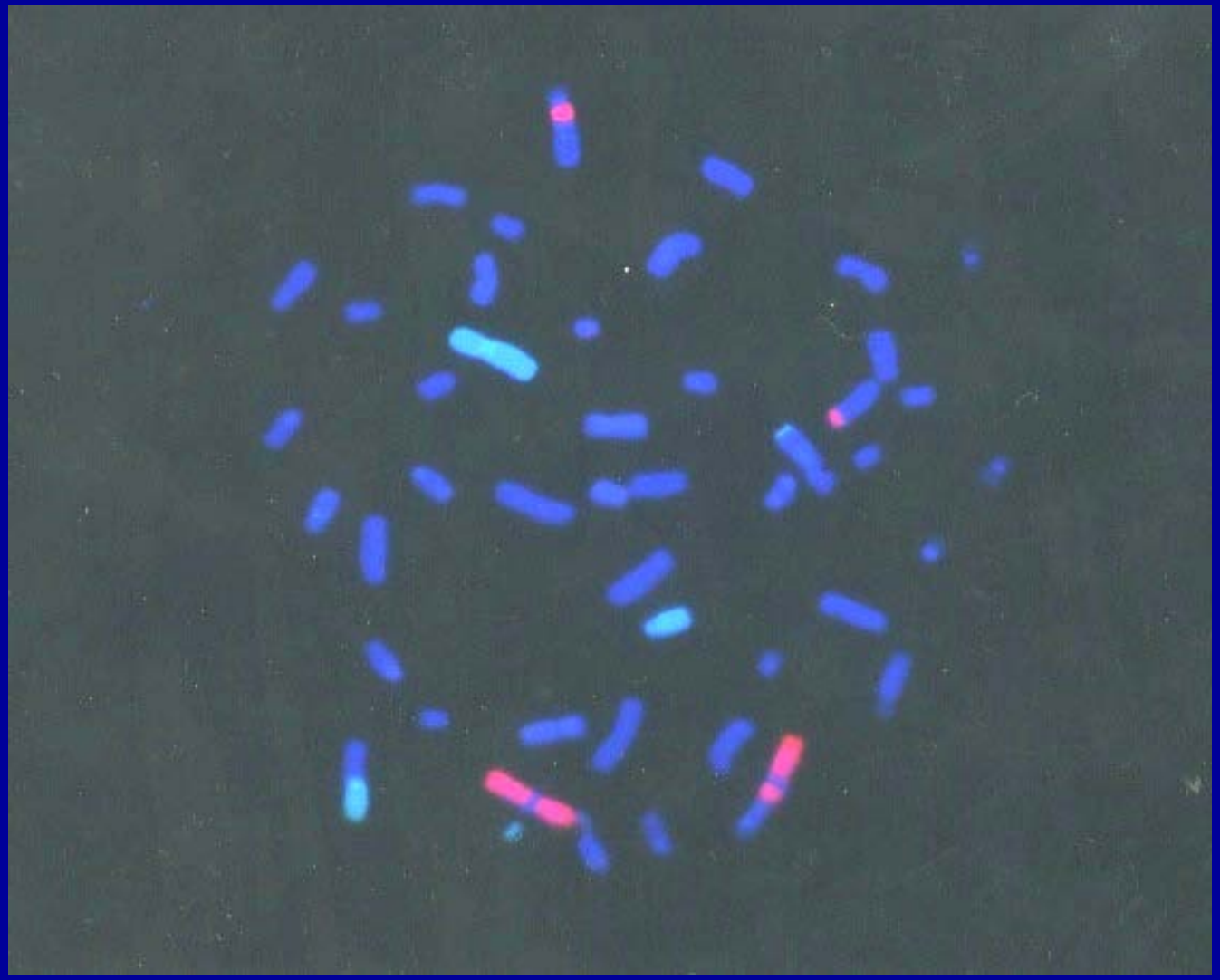
Biodosimetry procedure

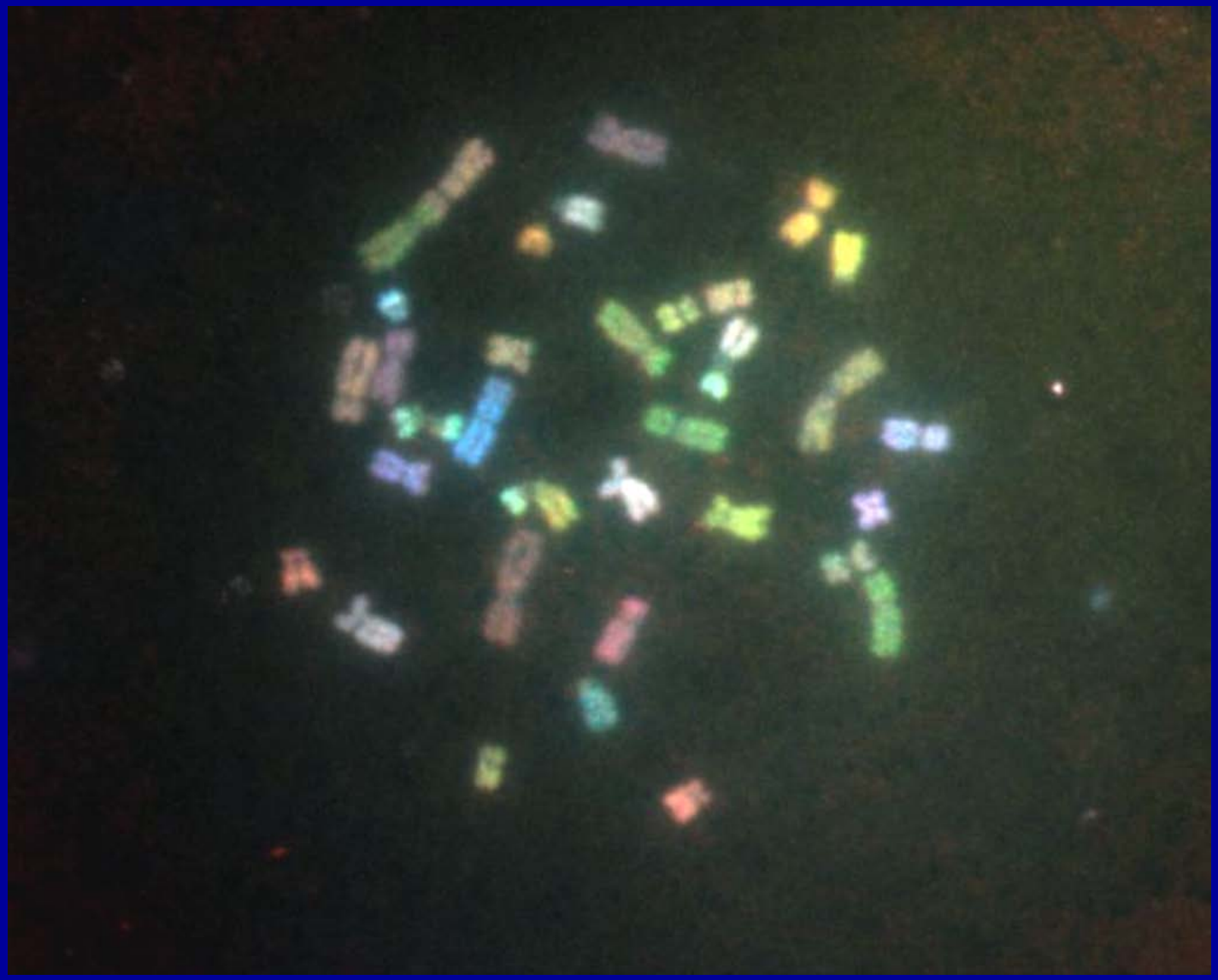


Simple exchange

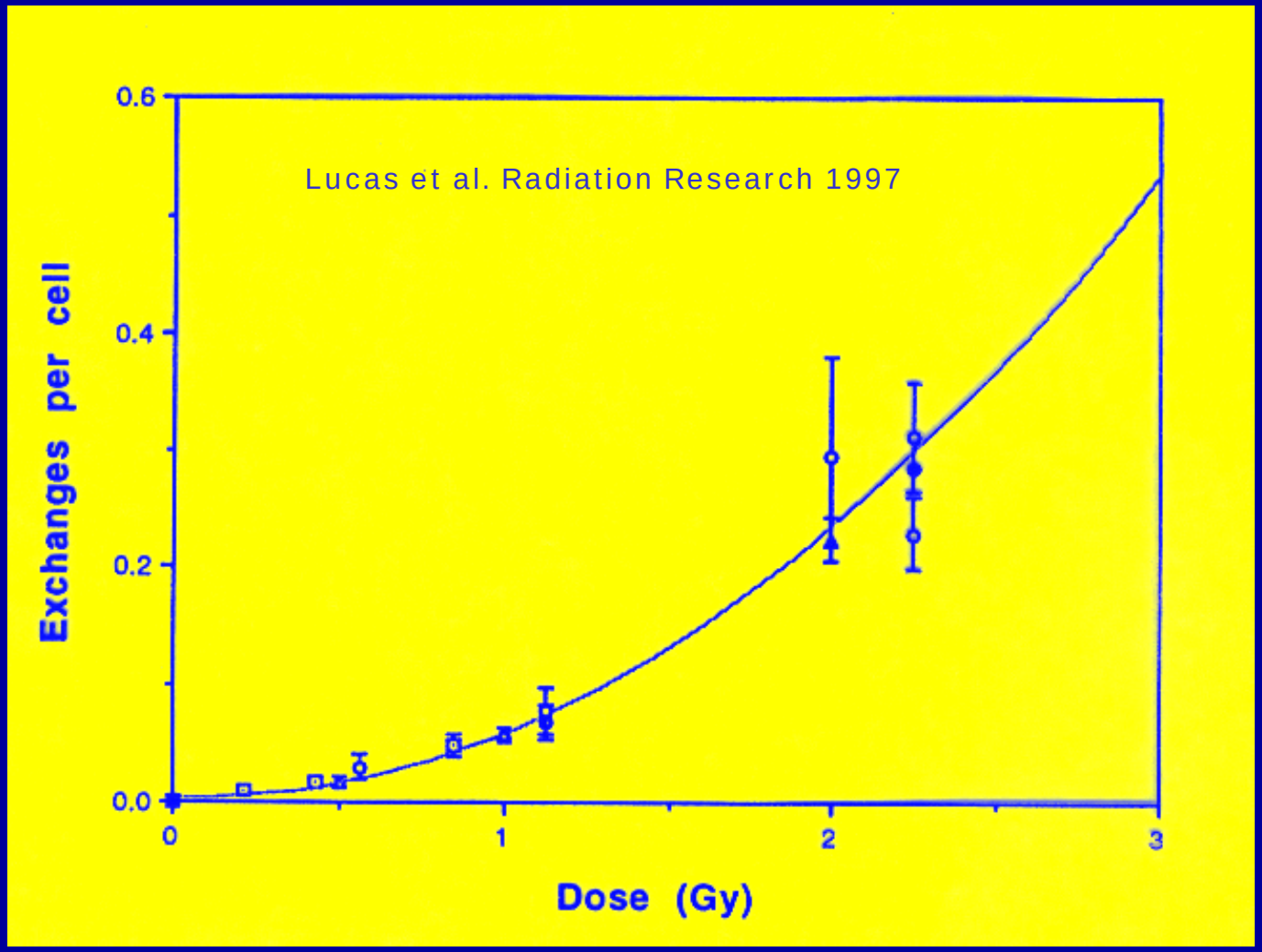


Complex exchange

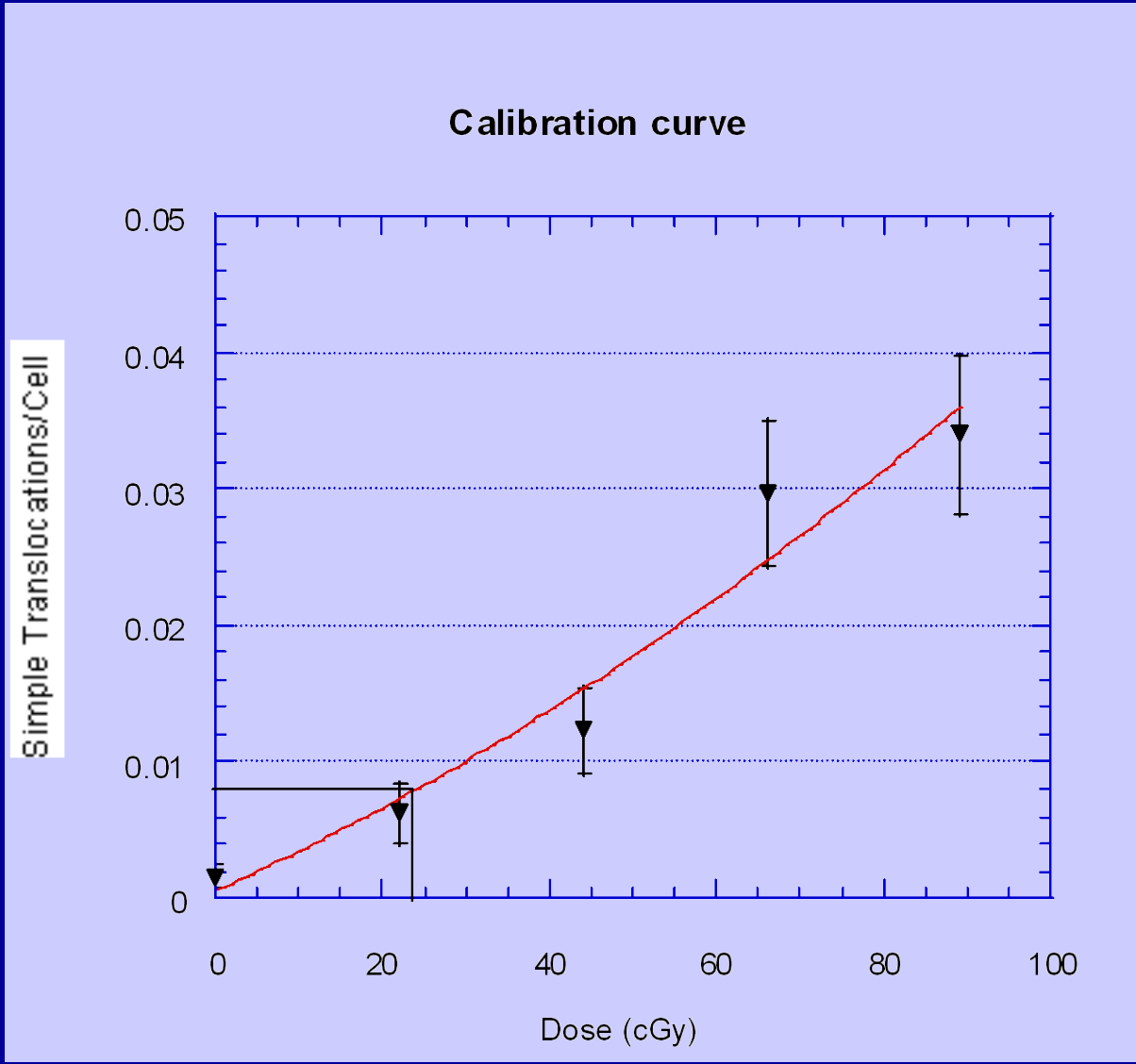




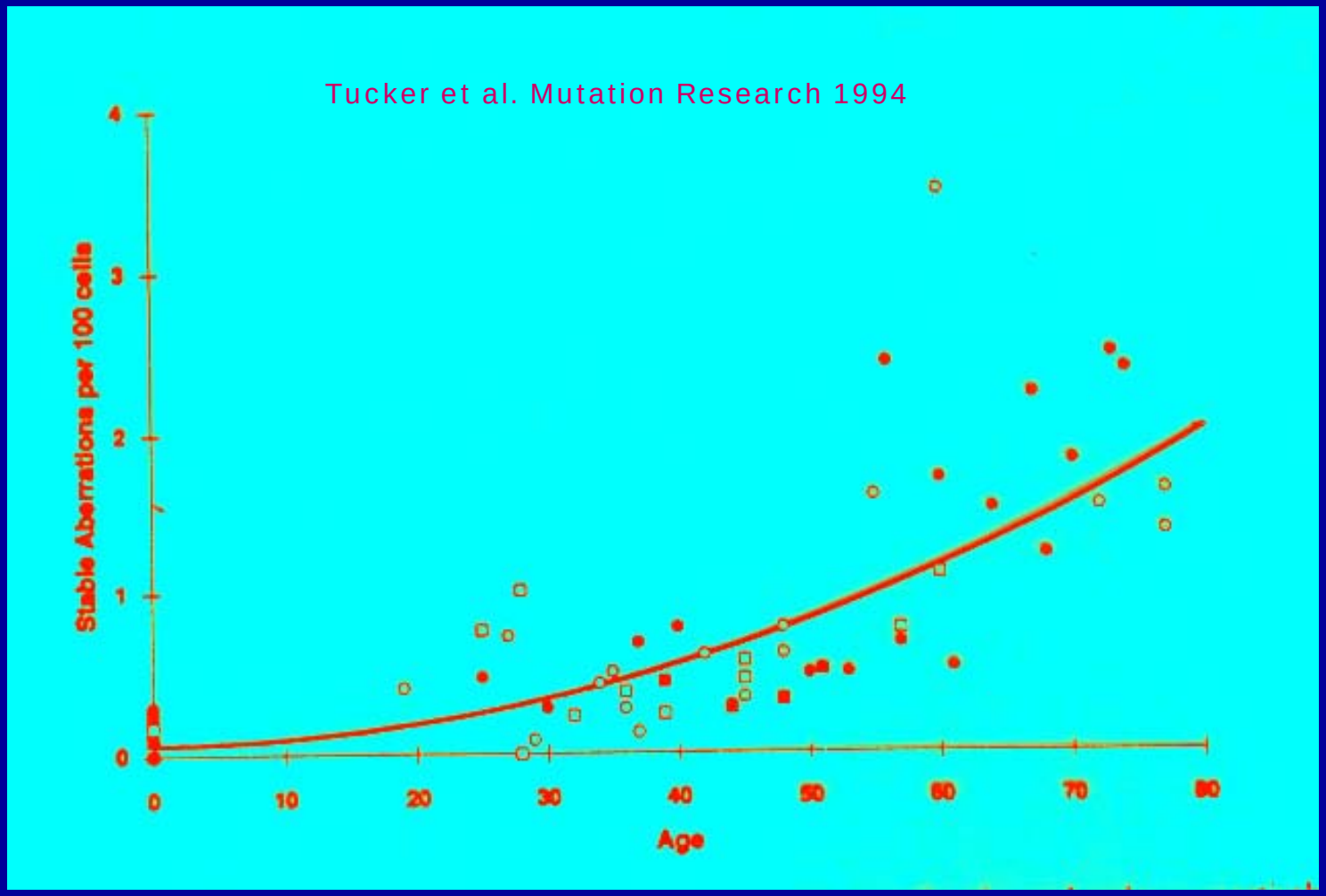
Comparison of in vitro and in vivo results



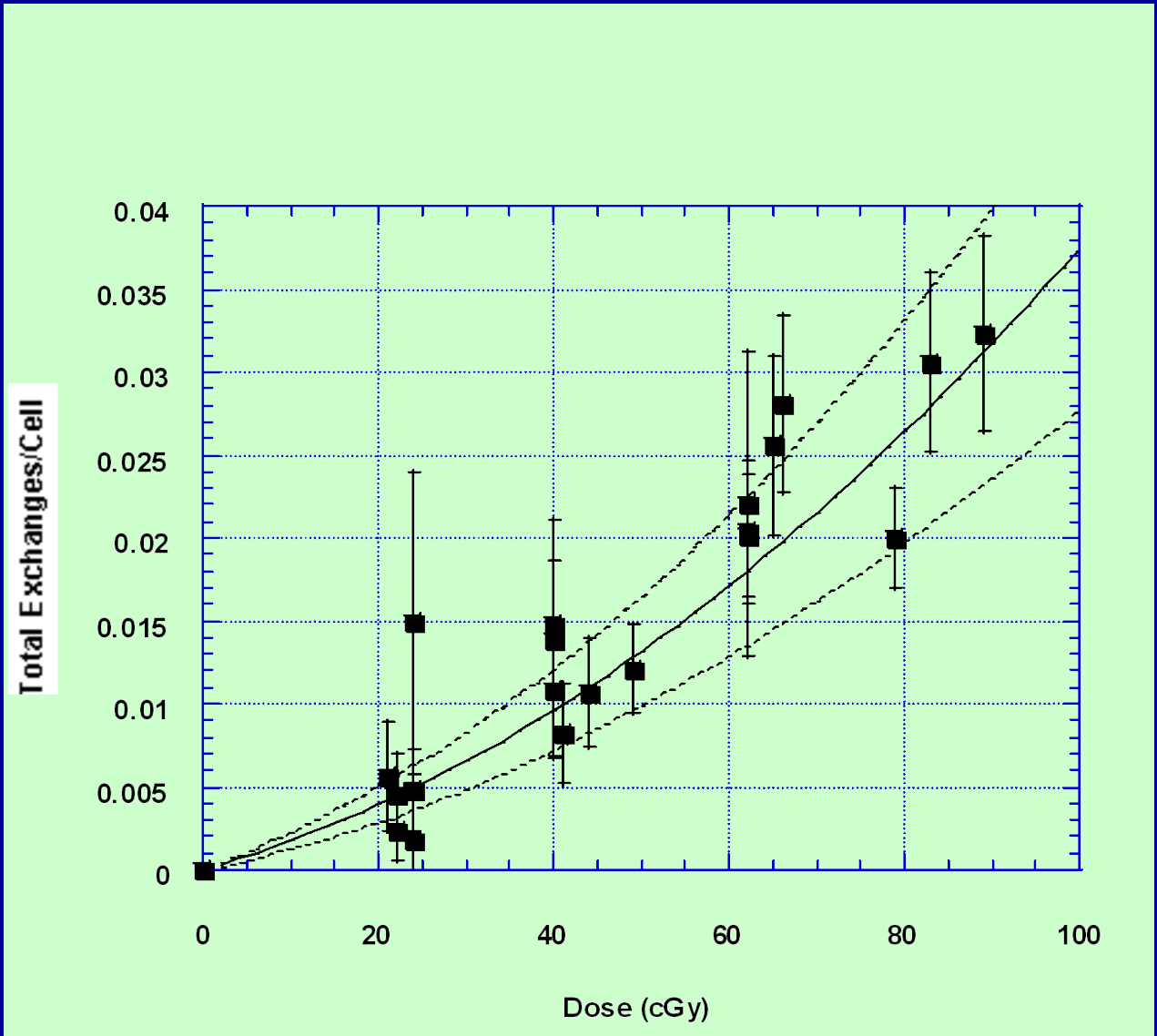
Calibration curve for chromosome aberrations



Background frequency of chromosome aberrations



Dose response of chromosome aberrations



Biodosimetry results

Subject	TLD reading (cGy)	Biological dose measured using values for translocation (cSv)	Average RBE*
1	3.06	16	4.2
2	3.78	18	3.8
3	5.68	20	2.8
4	4.16	23	4.4
5	4.16	14	2.7
6	4.16	12	2.3

*25% correction for high-LET radiation in TLD measurement is included.

Mission duration: 3-5 months
Altitude: 190 NM
Inclination: 51.6 degree

Conclusions

- Space radiation risk assessment
  - Ground based investigations
  - Flight experiments
- Countermeasures
  - Physical
  - Biomedical