Painting analysis of chromosome aberrations induced by energetic heavy ions in human cells

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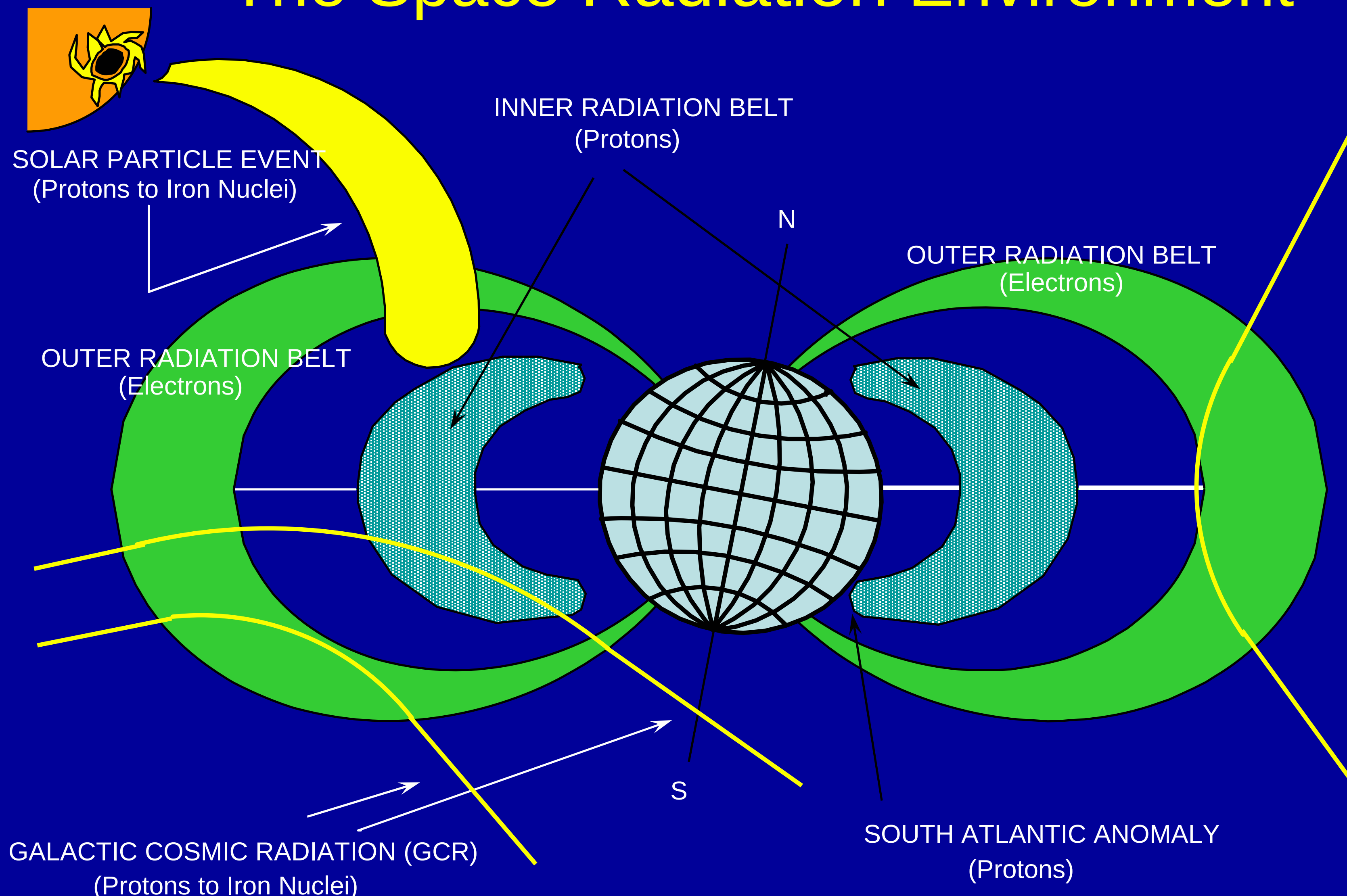
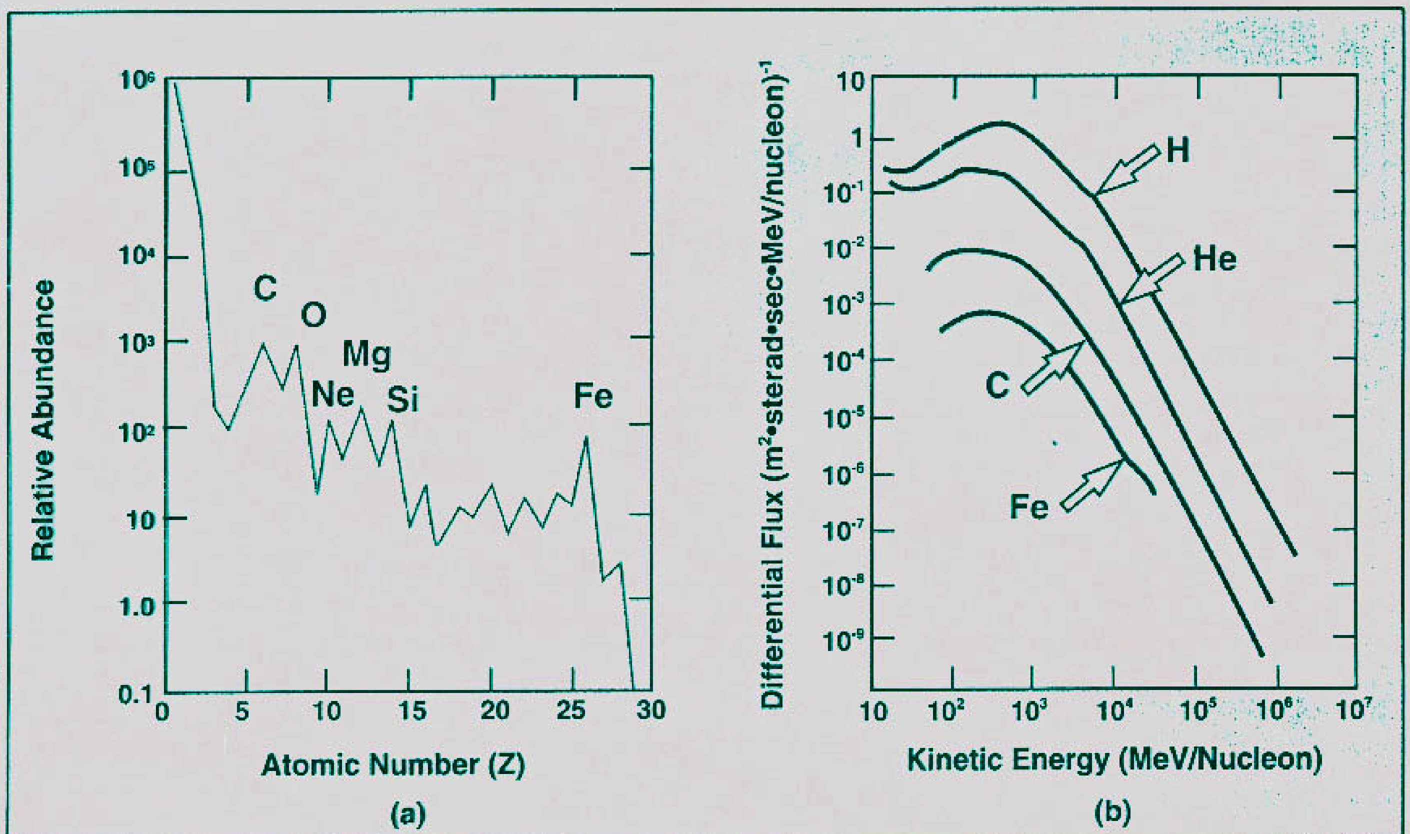
The Space Radiation Environment



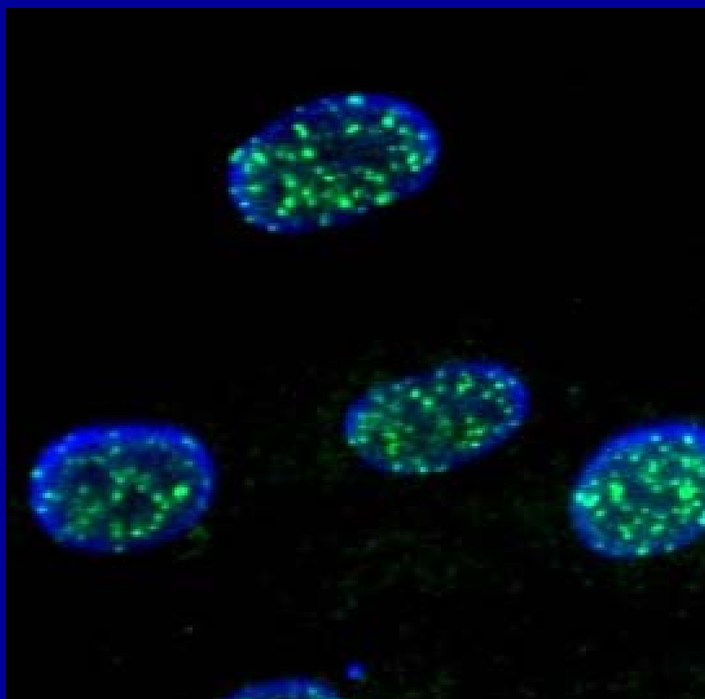
Representation of the major sources of ionizing radiation of importance to manned missions in low-Earth orbit. Note the spatial distribution of the trapped radiation belts.

Galactic cosmic radiation

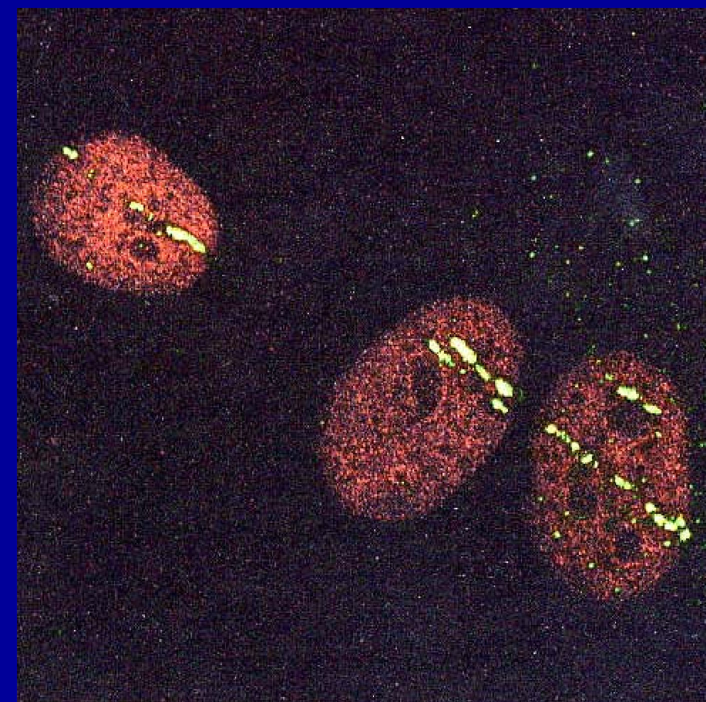
Figure D.1. Abundances (a) and Energy Spectra (b) of GCR



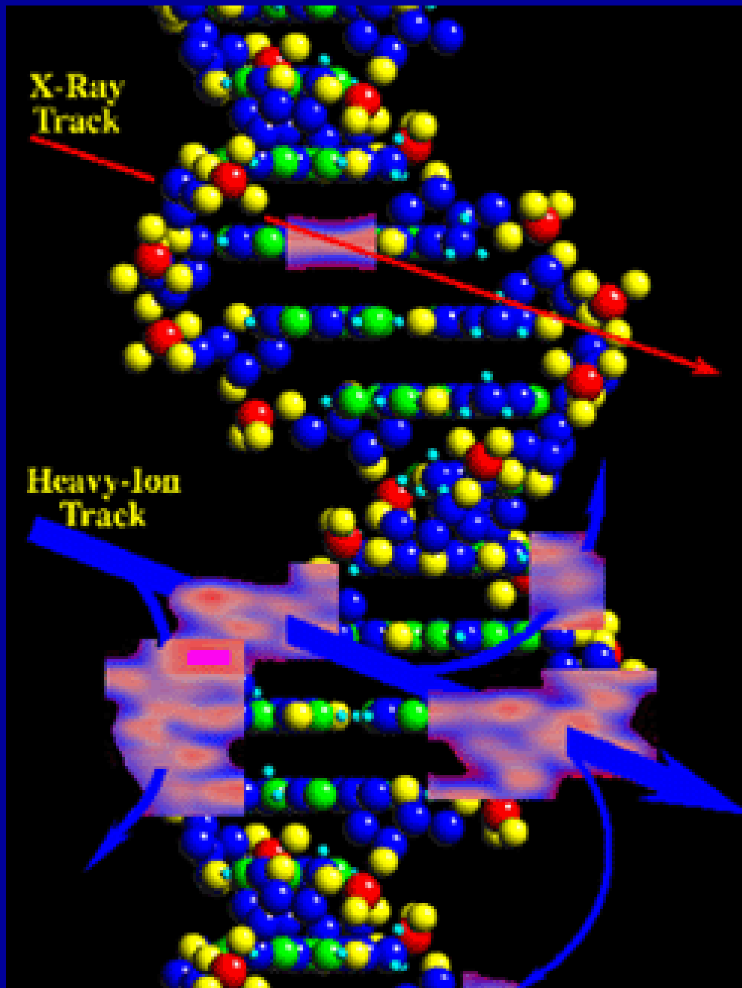
DSB induction

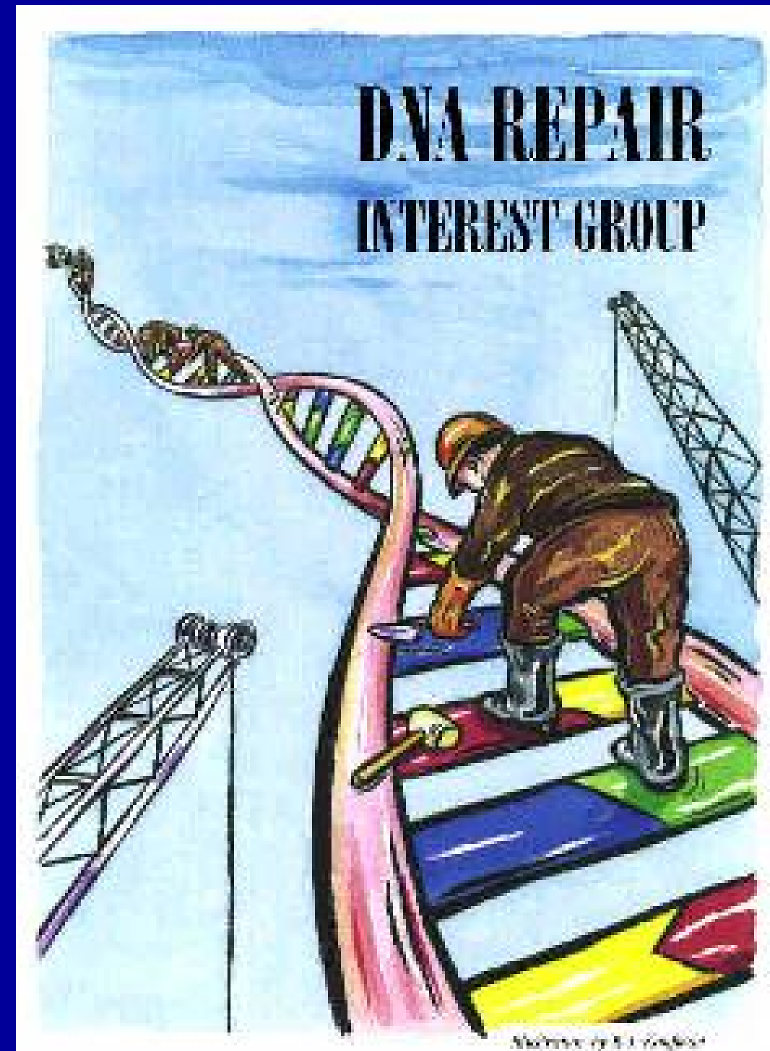


Low-LET

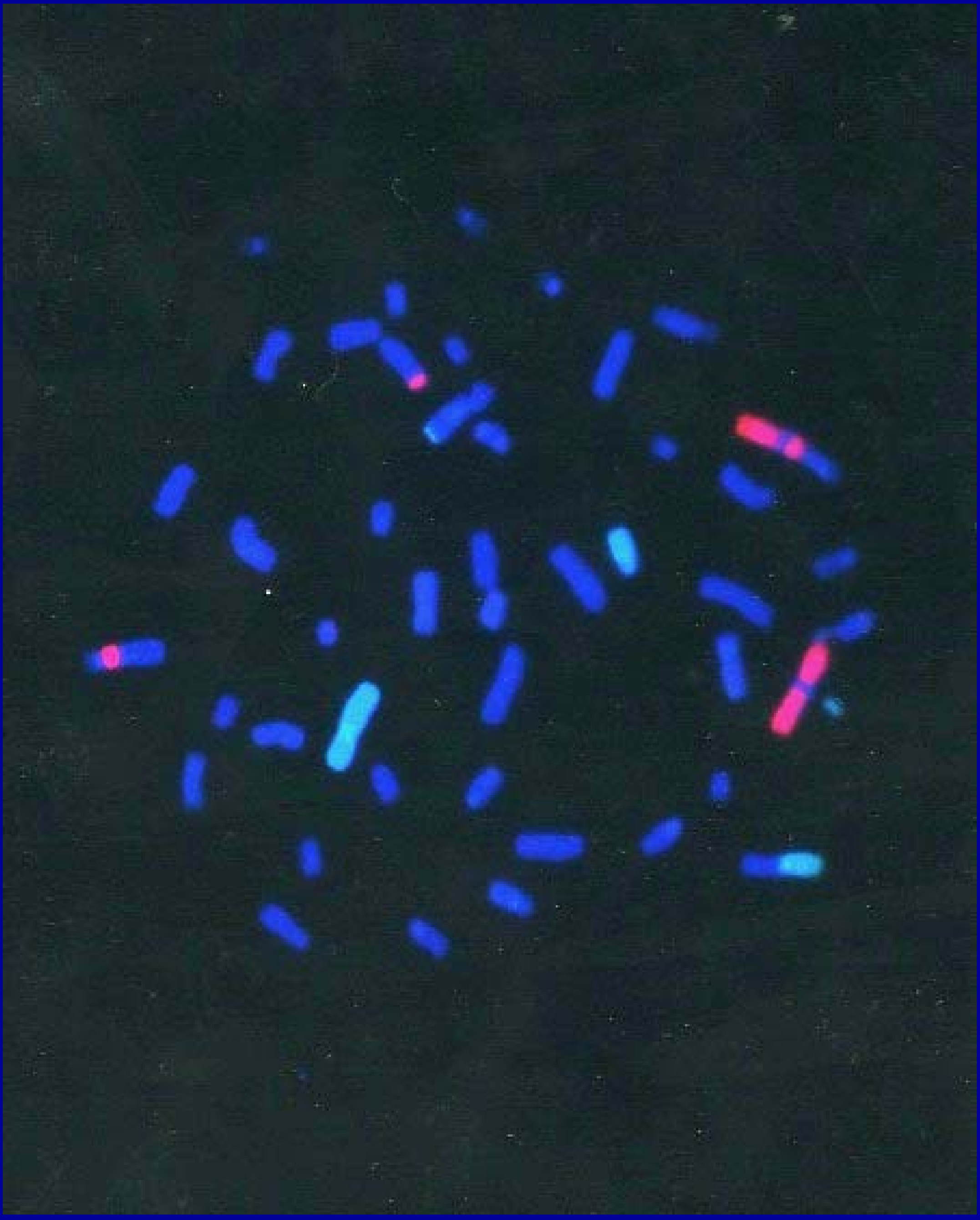


High-LET

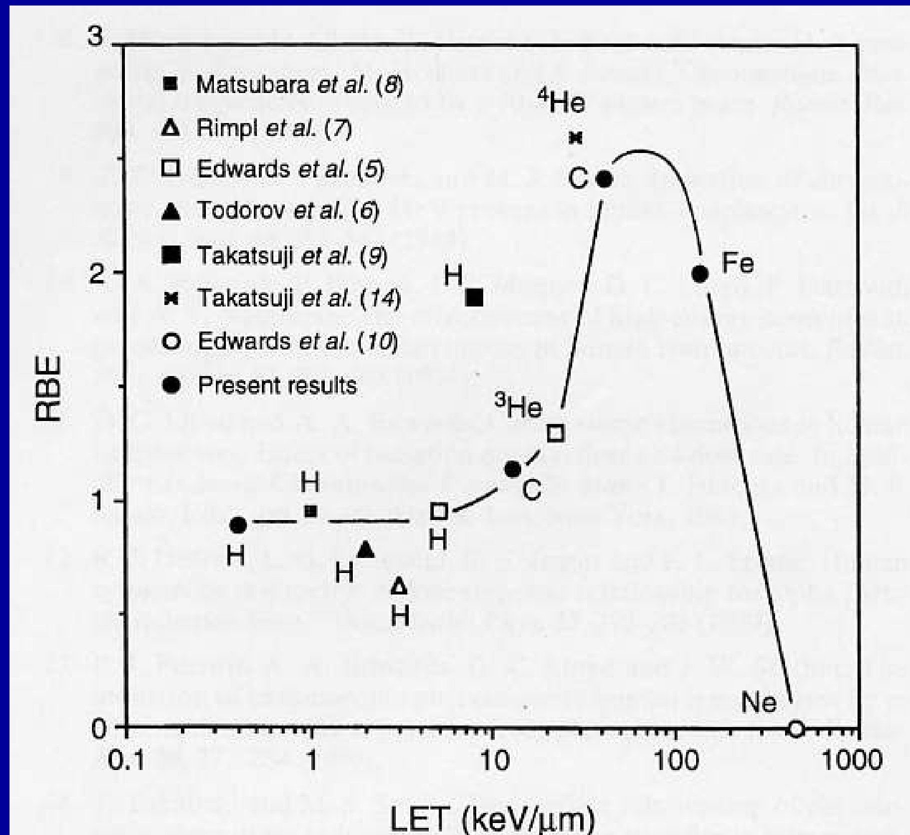

X-Ray
Track
Heavy-Ion
Track


DNA REPAIR
INTEREST GROUP

Complex aberrations

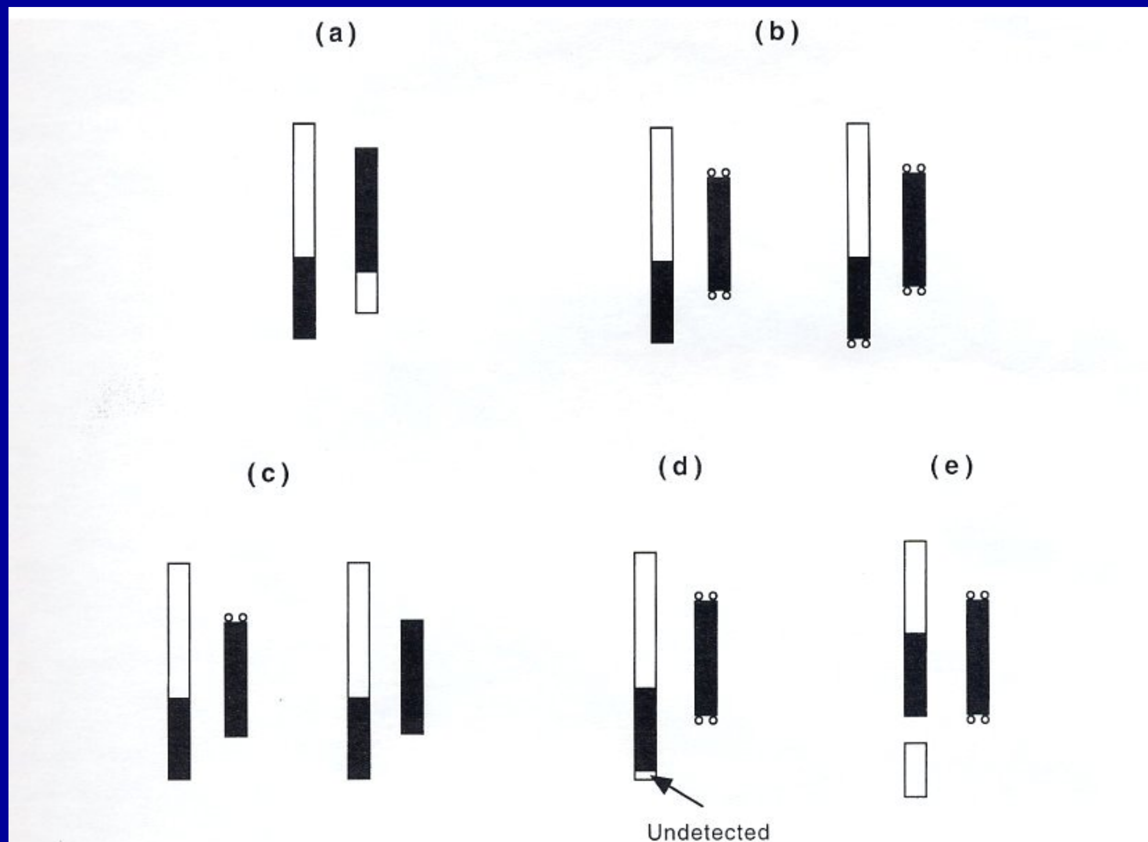


Radiation-induced chromosome aberrations in lymphocytes in vitro

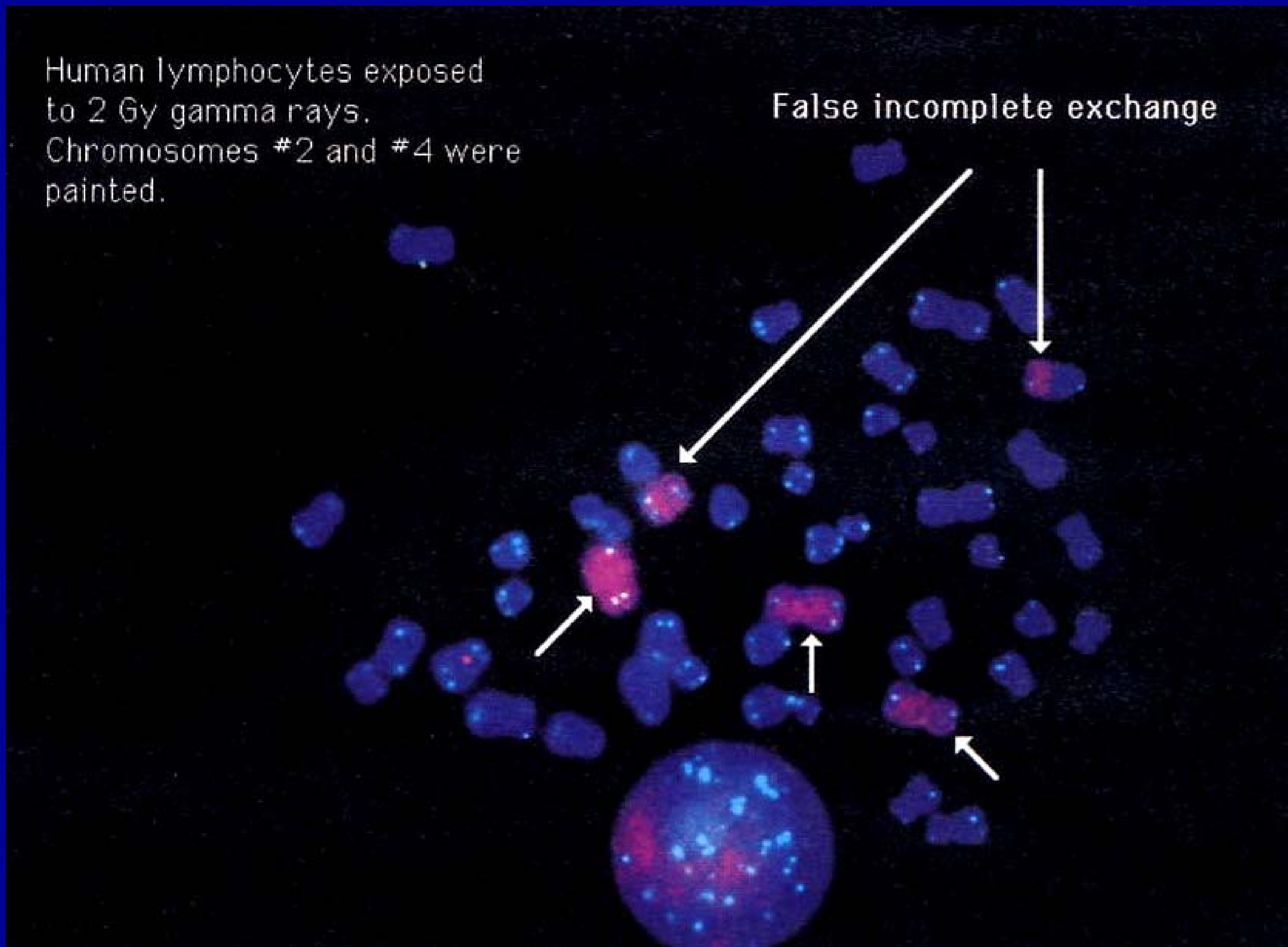


Wu, Durante, George and Yang, *Radiat. Res.* (1997)

Analysis of truly incomplete exchanges using telolmere probes



Telomere Analysis



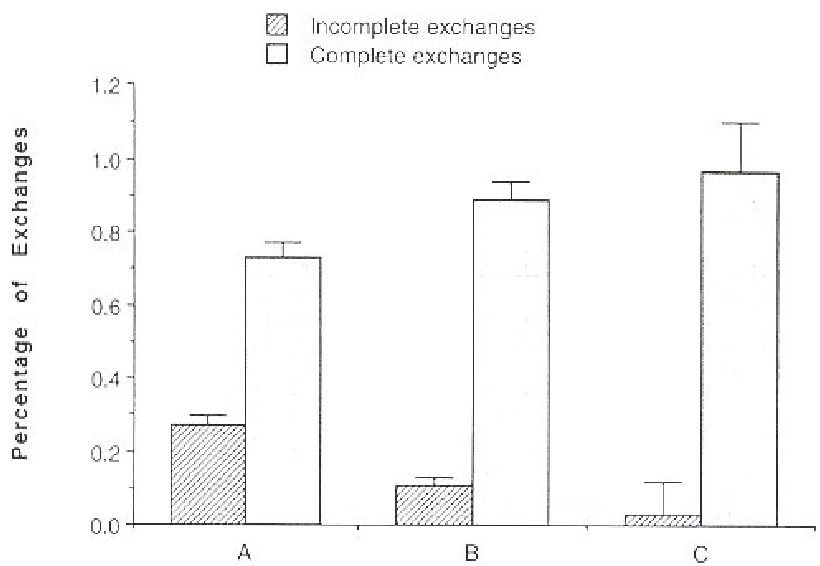
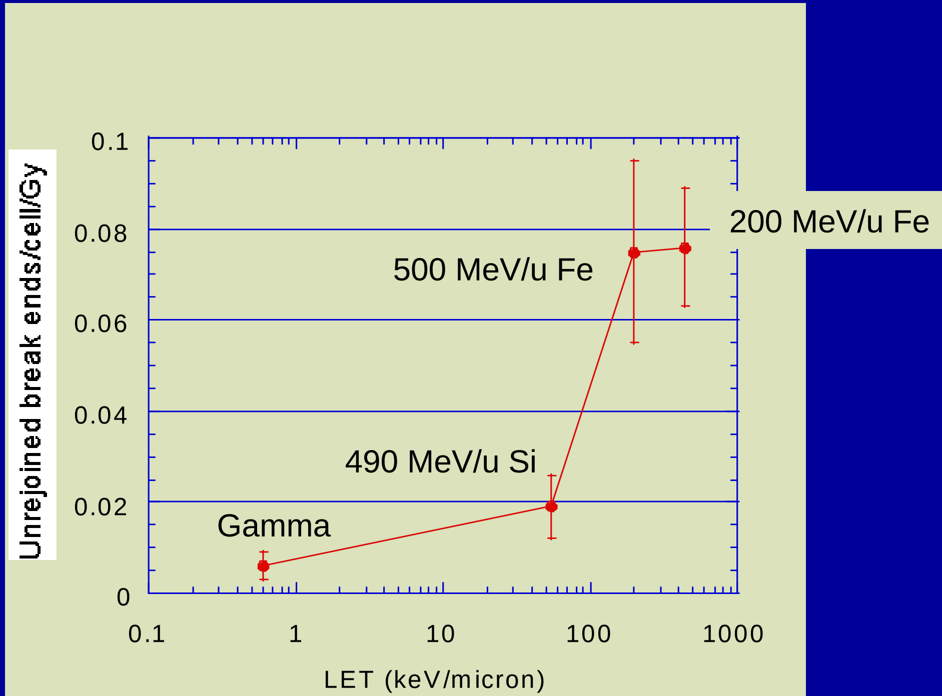
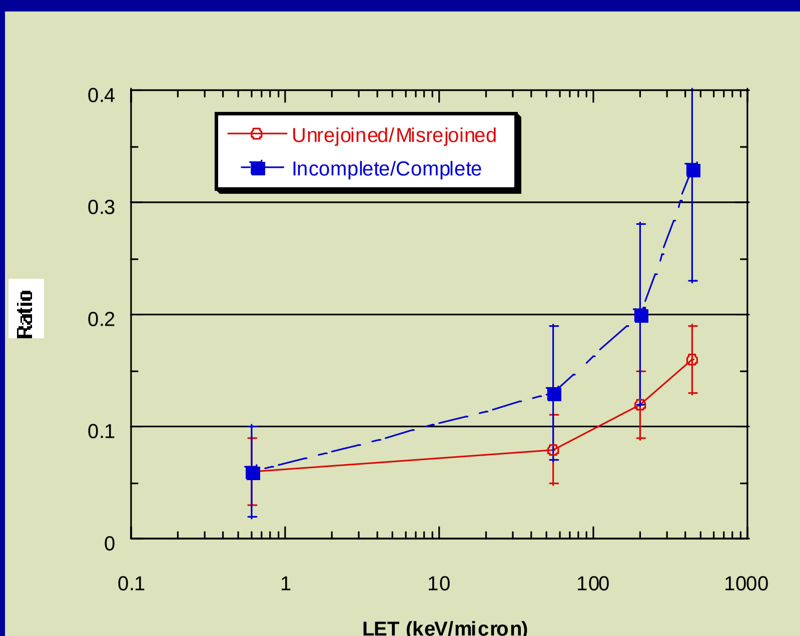


Figure 4. Percentage of complete and incomplete exchanges from the sum of the data. (A) The percentage of incomplete exchanges was 27% without the consideration of telomere probes. (B) With false incomplete exchanges included as complete, the percentage of incomplete exchanges decreased to 11%. (C) The estimated percentage of true incomplete exchange was 3%. (bar = 1 SD)

Most of the incomplete exchanges analyzed with FISH are actually complete

Wu, George and Yang, IJRB (1998, 1999)

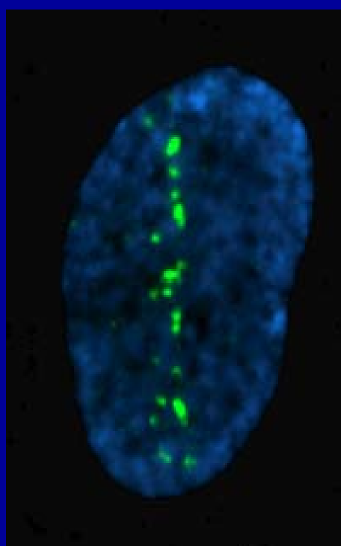


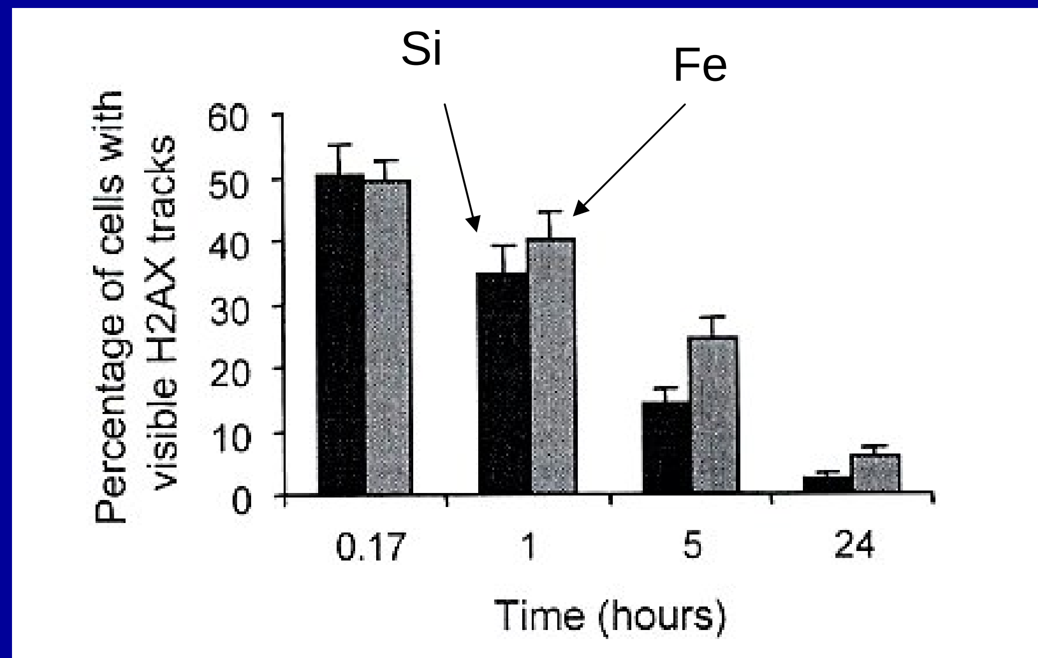


- The fraction of unrejoined chromosome breaks are higher for high LET
- Unrejoined breaks and incomplete chromosomal exchanges are possible biosignatures of high-LET radiation

Wu, Durante, Furusawa, George, Kawata and Cucinotta, Rad. Res. (2003)

High-LET radiation induces more unrejoined DNA double strand breaks

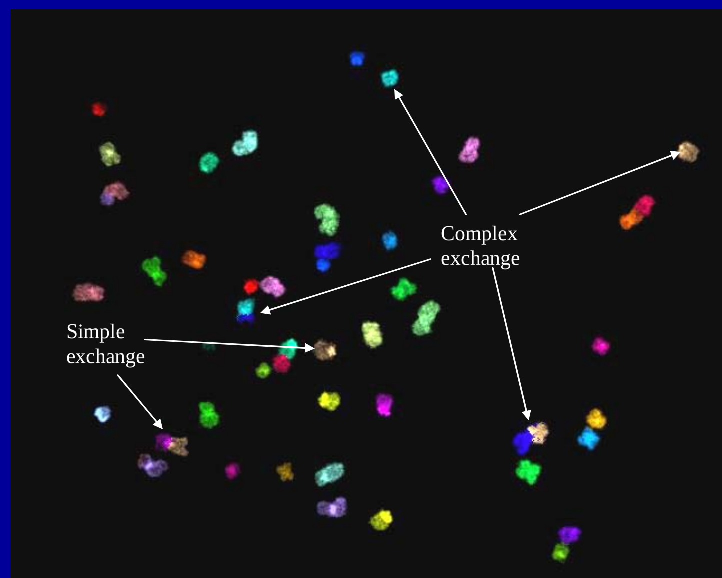




Desai, Davis, O'Neill, Durante, Cucinotta and Wu, Rad. Res. 2005

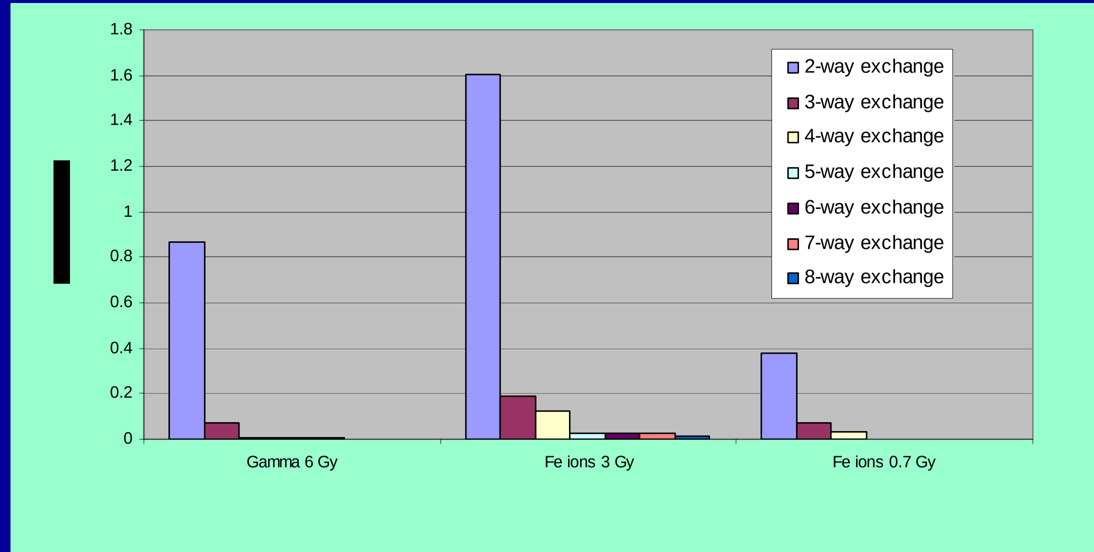
Complex aberrations -- mFISH analysis

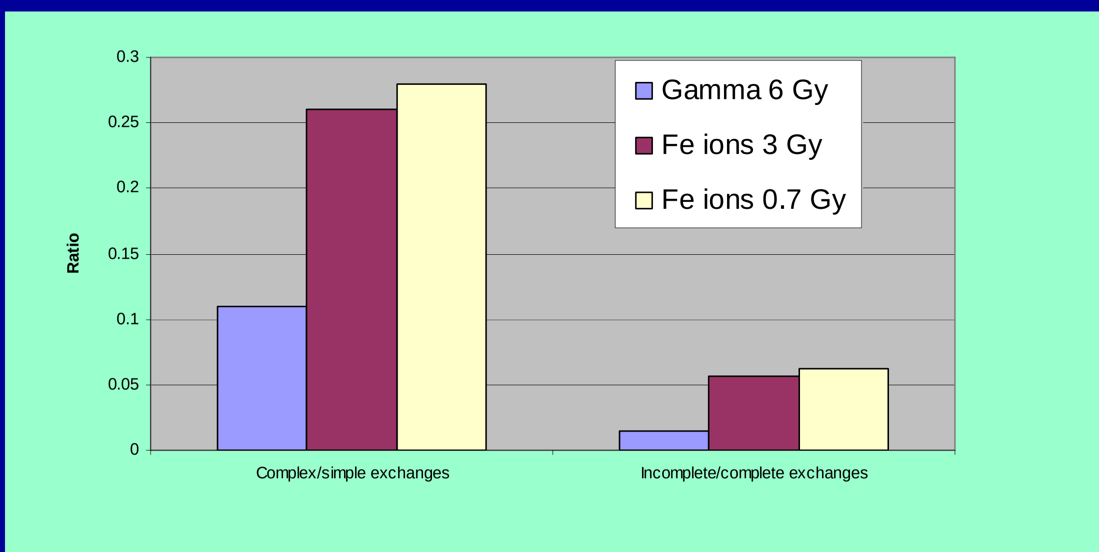
BIOSIGNATURE OF HIGH-LET RADIATION



Wu, Durante, Furusawa, George, Kawata and Cucinotta, Adv. Space Res. (2002)

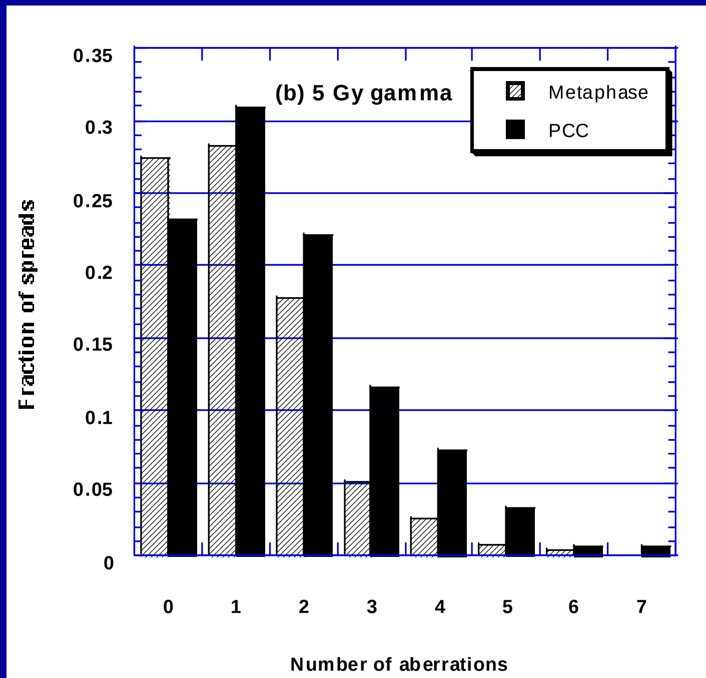
Complex type aberrations





mFISH showed a higher fraction of complex and incomplete exchanges for high-LET

Interphase vs. metaphase: Issues of biosignature

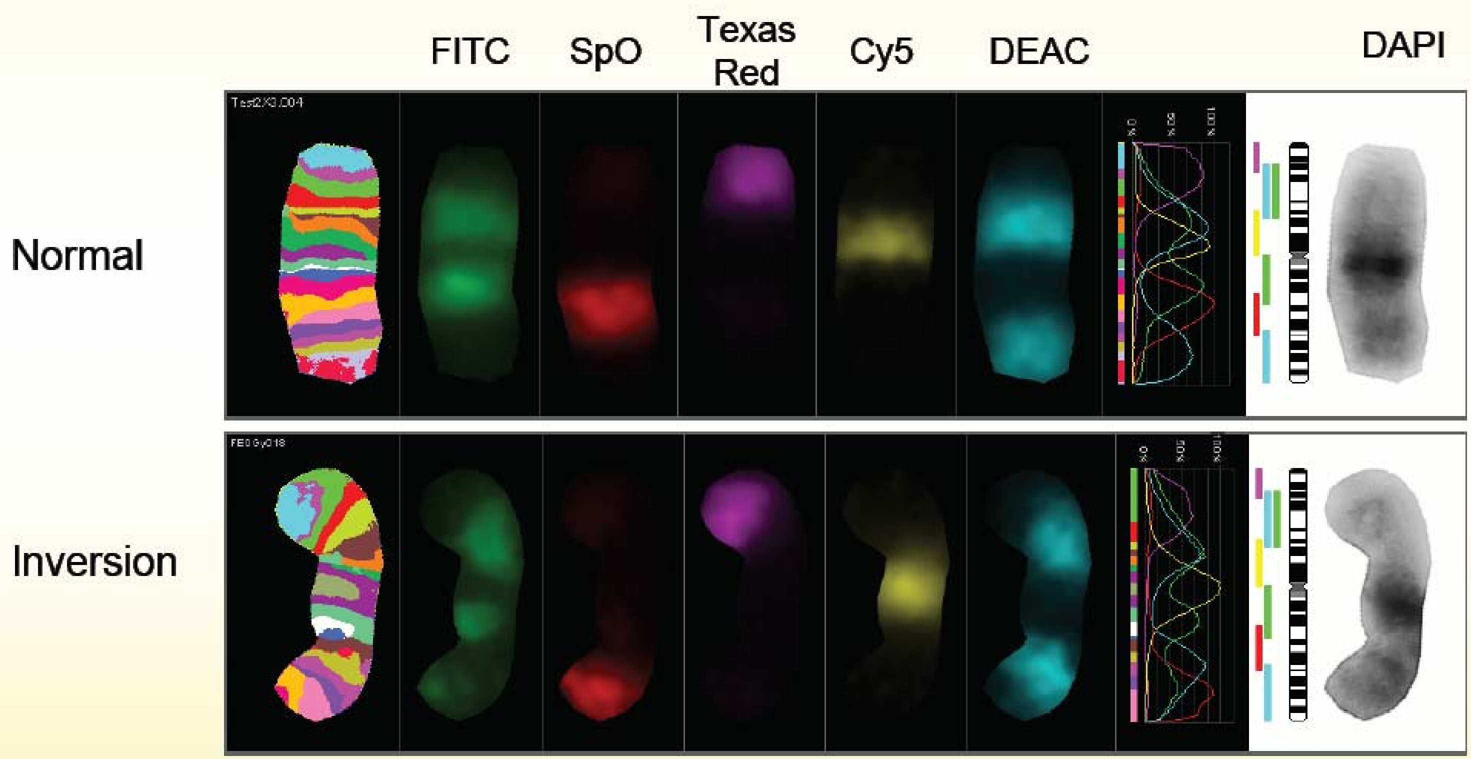


Centromere probes were used.

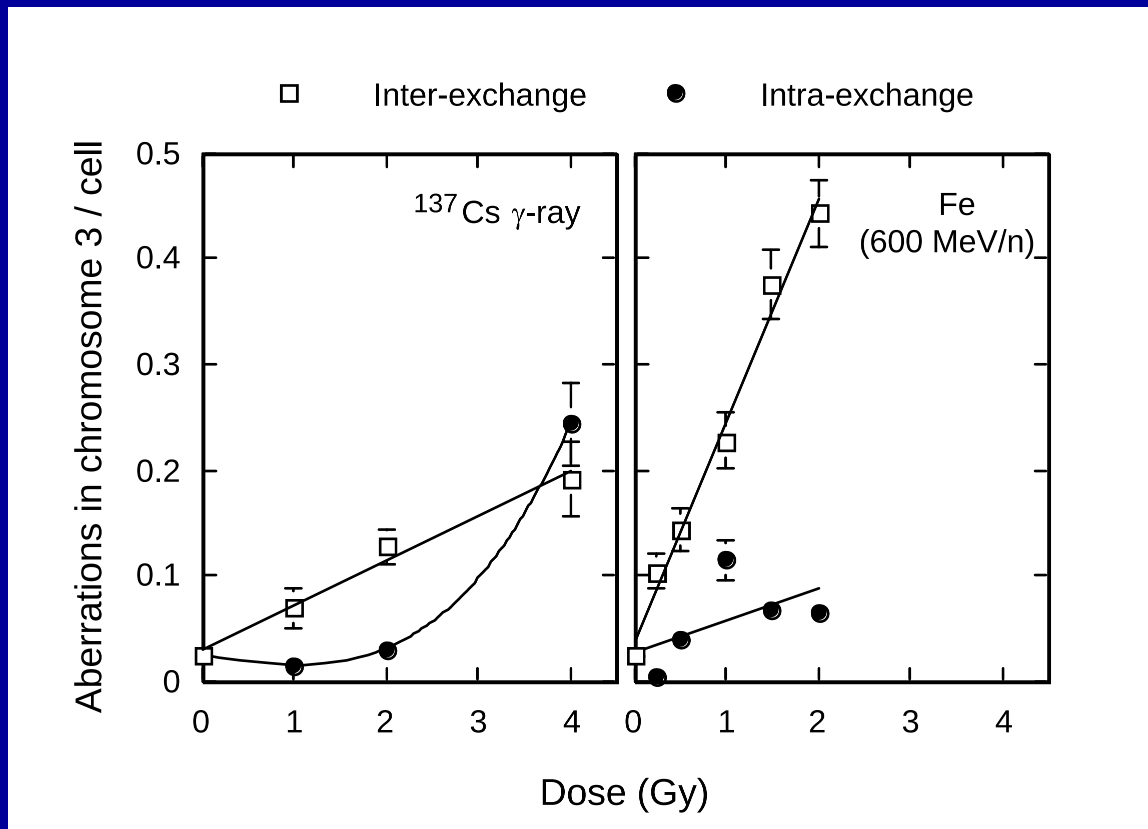
Radiation	Dose (Gy)	Harvest method	F ratio
γ ray	2	PCC	15.3±6.3
γ ray	2	Meta	12.5±5.9
γ ray	5	PCC	8.2±2.0
γ ray	5	Meta	9.1±2.5
1 GeV/u Fe	3	PCC	5.2±0.9
1 GeV/u Fe	3	Meta	9.1±2.2

Wu, George, Kawata, Willingham and Cucinotta, Rad. Res. 2001

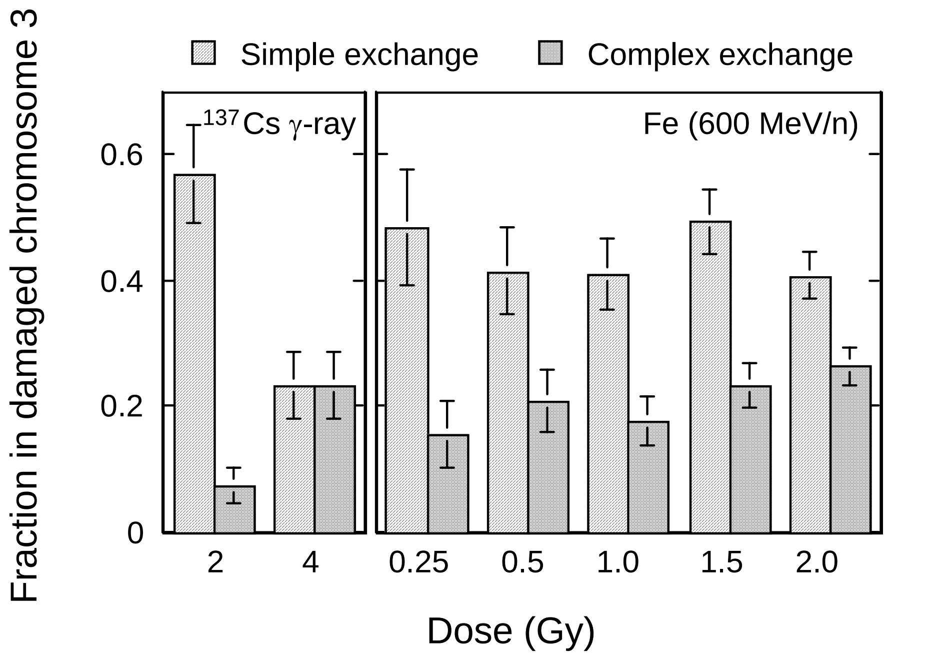
mBAND analysis

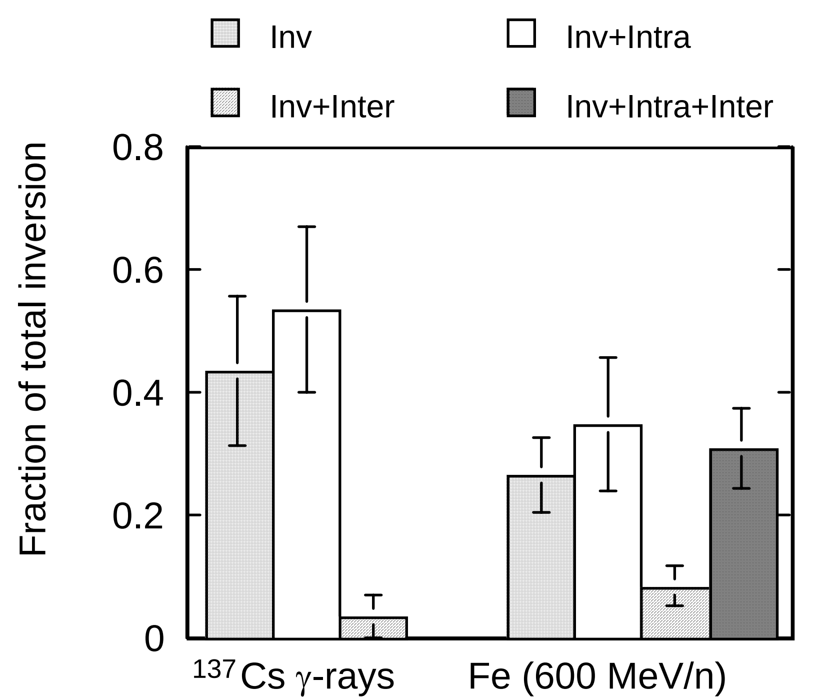


Inter- vs. intra chromosome exchanges (mBAND)



mBAND analysis

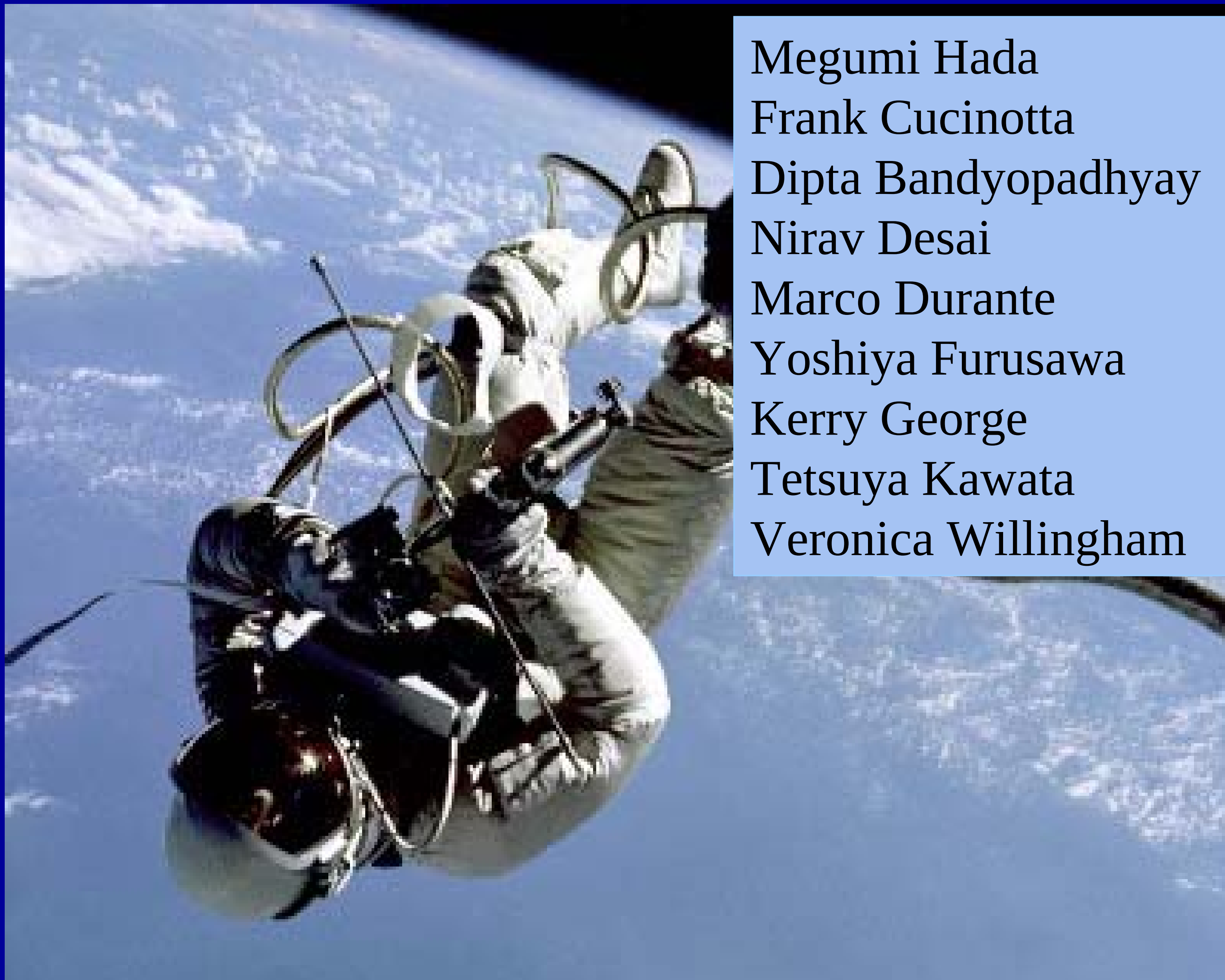




Most inversions were involved with other inter- and/or intra-chromosome rearrangements

Summary

- FISH, mFISH, mBAND, telomere and centromere probes have been used to study chromosome aberrations induced in human cells exposed to low- and high-LET radiation in vitro
- High-LET induced damages are mostly a single track effect
- Unrejoined chromosome breaks (incomplete exchanges) and complex type aberrations were higher for high-LET
- Biosignatures may depend on the method the samples are collected
- Recent mBAND analysis has revealed more information about the nature of intra-chromosome exchanges



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