

# Calculating Total Radiation Dosages at Mars

1. By finding the approximate area under the plotted data, calculate the total radiation dosage in Rems for the GCRs during the observation period between 4/03/2002 and 8/20/2003.

From the graph, the average dosage rate is about 20 mRads/day. The time span is about  $365 + 4 \times 30 + 17 = 502$  days. The area of a rectangle with a height of 20 milliRads/day and a width of 502 days is  $(20 \text{ milliRads/day}) \times (502 \text{ days}) = 10040$  milliRads. This can be converted to Rems by multiplying by  $(1 \text{ Rad}/1000 \text{ milliRads})$  and by  $(2 \text{ Rem}/1 \text{ Rad})$  to get **20 Rems**.

2. Assuming that each SPE event lasted 3 days, and that its plotted profile is a simple rectangle, calculate the total radiation dosage in Rems for the SPEs during the observation period.

Peak 1 =  $53 \text{ milliRads/day} \times 3 \text{ days} = 159 \text{ millirads}$   
Peak 2 =  $2866 \text{ millirads/day} \times 3 \text{ days} = 8598 \text{ milliRads}$   
Peak 3 =  $90 \text{ milliRads/day} \times 3 \text{ days} = 270 \text{ milliRads}$   
Peak 4 =  $1700 \text{ milliRads/day} \times 3 \text{ days} = 5100 \text{ milliRads}$   
Peak 5 =  $70 \text{ milliRads/day} \times 3 \text{ days} = 210 \text{ milliRads}$   
Peak 6 =  $140 \text{ milliRads/day} \times 3 \text{ days} = 420 \text{ milliRads}$

The total dosage is 14,757 milliRads.

Convert this to Rems by multiplying by  $(1 \text{ Rad}/1000 \text{ milliRads}) \times (2 \text{ Rem}/1 \text{ Rad})$   
To get **30 Rems after rounding**.

3. What would be the total radiation dosage for an unshielded astronaut orbiting Mars under these conditions?

Answer:  $20 \text{ Rems} + 30 \text{ Rems} = \mathbf{50 \text{ Rems}}$  for a 502-day visit.

4. Are SPEs more important than GCRs as a source of radiation? Explain why or why not.

**Answer:** Solar Proton Events may be slightly more important than Galactic Cosmic Radiation for astronauts orbiting Mars.

The biggest uncertainty is in the SPE dose estimate. We had to approximate the duration of each SPE by a rectangular box with a duration of exactly three days, although the plot clearly showed that the durations varied from SPE to SPE. If the average dose rate for each SPE were used, rather than the peak, and a shorter duration of 1-day were also employed, the estimate for the SPE total dosage would be significantly lower, perhaps by as much as a factor of 5, from the above estimates, which would make the GCR contribution, by far, the largest.