

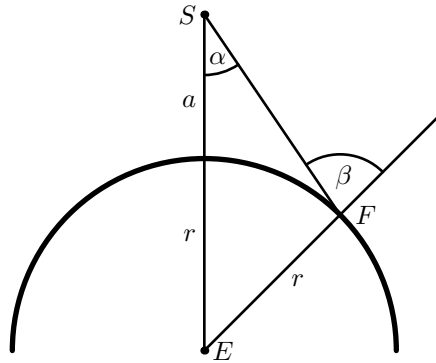
### SPOT Mirror and Incidence Angles

Consider the Earth centered at  $E$  with radius  $r$ , a SPOT satellite  $S$  at altitude  $a$ , and a focus point on the Earth's surface  $F$ . The *mirror angle*,  $\alpha$  in the figure below, describes how far off-nadir the focus point is. For the SPOT HRV sensors it can range from  $-27^\circ$  (west) to  $+27^\circ$  (east) of the ground track. In SCIE metadata records the mirror angle is described by an integer “mirror step” value  $s \in [3, 93]$ . The correspondence between mirror angle and mirror step is  $\alpha = 0.6(s - 48)$ .

The *incidence angle*,  $\beta$  in the figure below, describes how far off-zenith the satellite is. Were the Earth flat, we would have  $\alpha = \beta$ , but the Earth's curvature causes  $\beta$  to be slightly larger than  $\alpha$ . From the law of sines,

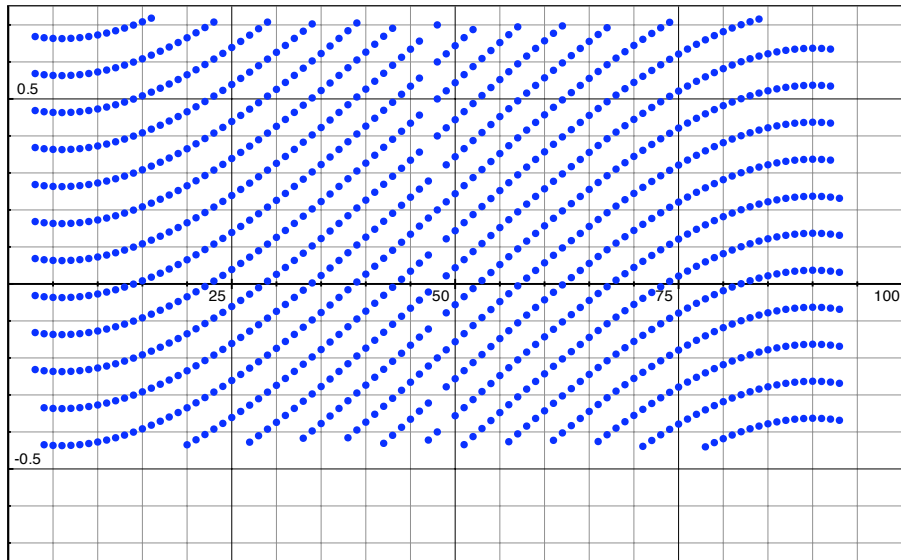
$$\frac{\sin \alpha}{r} = \frac{\sin(\pi - \beta)}{r + a} = \frac{\sin \beta}{r + a}$$

Using  $r = 6378$  km and  $a = 830$  km, the maximum incidence angle corresponding to  $\alpha = 27^\circ$  is  $30.9^\circ$ .



In practice, the relationship between mirror step and incidence angle deviates slightly from the theoretical model presented above. If  $s$  and  $\beta$  are the mirror step and incidence angle values recorded in the SCIE metadata, respectively, and if  $\beta_s$  is the incidence angle computed from the mirror step using the above formulas, then  $-0.44^\circ < \beta - \beta_s < 0.72^\circ$ . Observed deviations as a function of mirror step are plotted on the next page.

Greg Janée <gjanee@alexandria.ucsb.edu>  
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Deviations in degrees between observed incidence angles and the theoretical incidence angle as a function of mirror step.