The TWINS Geometric factor was measured during Flight calibration performed at SwRI [McComas et al., 2009]. Each of the TWINS sensor heads were illuminated with a spatially broad (~10 cm diameter), mono-energetic (\(\Delta E/E < 1e-3\)) parallel ion beam (angular divergence < 0.1°). The incidence angle was scanned from -2 to +2 degrees in the non-imaging direction in 2 degree steps, and from -60 to +60 degrees in the imaging direction in 2 degree steps. The measurement was repeated for a range of energies ranging from 2.8 to 50 keV.

The geometric factor was determined as

\[
G_{i,j,k,E} = \frac{1}{R} \sum_{\phi=-2}^{0} \sum_{\theta=-60}^{60} \frac{C_{\theta,\phi,k,E}}{\tau_{\theta,\phi,k,E}} D_{\theta,\phi,i,j,k,E} \Delta\theta \Delta\phi \cos(\theta)
\]

where:

- \(i\) = Start Position Byte, \(j\) = Stop Position Byte, \(k\) = Sensor Head,
- \(E\) = Incident beam energy step
- \(R\) = Measured particle flux = \(\frac{\text{Amptektron Rate}}{\text{Detector Efficiency}}\) / (Active Area)
- \(T_{\theta,\phi,E}\) = Total time measuring at \(\theta, \phi, E\)
- \(C_{\theta,\phi,k,E}\) = Total valid events for head \(k\) at \(\theta, \phi, E\)
- \(\tau_{\theta,\phi,k,E}\) = Total TOF events for head \(k\) at \(\theta, \phi, E\) = total number of direct events
- \(D_{\theta,\phi,i,j,k,E}\) = number of direct events for head \(k\), for start/stop position \(i, j\), at \(\theta, \phi, E\)
- \(\Delta\theta = \Delta\phi = 2\degree\)

The intensity of the ion beam was measured using an Amptektron MD-501 CEM based detector system. The active area of the Amptektron is 0.1 cm\(^2\), and the Amptektron detector efficiency values are from Egidi [1969]. This determination of the geometric factor includes the efficiencies of the TWINS detectors.
The geometric factor was measured for a number of discrete incident energies which ranged from ~ 2.7 to 50 keV. Both sensor heads for TWINS1 were calibrated with 4 different energies. The TWINS2 sensor heads were calibrated with > 10 energies. A fit to the Geometric factor as a function of energy was then performed. The fit was used to determine the geometric factor for the full energy range of TWINS. Finally, the energy was converted to TOF (assuming a mass of 1 AMU) to produce a mapping of the Geometric factor as a function of Stop Position, Start Position, and TOF Direct Event values.

Geometric factors are stored in IDL savesets `gfact_fmNH.sav`, where \( N \) is the TWINS spacecraft number, and \( H \) is the Head identifier. Allowable values for \( N \) is 1 or 2, and allowable values for \( H \) is A or T. For more information on the Geometric Factor Look Up Table (LUT), see *Look-Up Table Guide*.

Reference: