# Characterization of Meteor Head Echoes and Corresponding Non-Specular Trail as Measured by a High Power Large Aperture Radar

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Meteoroids entering the Earth's atmosphere are detected by high-power, large aperture (HPLA) radars as they ablate between 70 and 140 km altitude in the E-region of the ionosphere. The radar returns are classified as head echo, the plasma surrounding the meteoroid, and trail, the expanding plasma column left in the meteoroid's wake. A particular type of trail is categorized as non-specular, which is thought to be reflections from field-aligned irregularities (FAI) after the onset of plasma turbulence when the radar beam is pointed quasi-perpendicular to the background magnetic field. Using data collected at the Advanced Research Project Agency (ARPA) Long-range Tracking and Identification Radar (ALTAIR), which included dual frequency, dual polarized, and high range resolution in-phase (I) and quadrature (Q) returns with additional azimuth and elevation data derived from the monopulse system, a detection algorithm was conceived to efficiently locate head echo and non-specular trail pairs by combining understanding of range and time dependence of meteor events with image processing techniques.

The detection algorithm facilitated the correlation of head echo and non-specular trail features, such as duration, altitude of occurrence, and signal to noise ratio (SNR). Detected pairs of head echoes and trails were then analyzed in order to characterize the time and range delays between the detection of the head plasma and that of the trail. These statistics showed that faster meteoroids lead to shorter time delays and longer lags in range. Moreover, the formation of FAIs at higher altitudes indicated longer postponements in time and range differences between the reflections of the head echo and the non-specular trail.