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## On the origin of the late-side tail in the time-of-flight distribution: A long-standing puzzle solved

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Dedicated Time-of-Flight detectors are used for particle identification in ALICE, HADES, PHENIX, and STAR. New TOF detectors for Belle II, BESIII, LHCb, MPD, Panda, and SoLID are in various stages of development and implementation. Heavy ion detector experiments using TOF observe an anomalous early-late asymmetry in the time of flight distribution for particles of a given narrow momentum interval and mass hypothesis. A number of competing explanations have been sought, most of which focus on the pronounced late-side tail in the TOF signal. Some examples include: influence of feeddown descendants, energy losses from multiple scattering, biases from inner-to-outer detector track matching, and biases innate to TOF detector technology. Herein we examine each of these and derive from first principles the ideal TOF distribution and momentum dependent early-late asymmetry. We further conclusively explain its mysterious absence in test beam trial data. This new understanding will refine the standard fit-to-data calibration technique critical for high precision TOF detectors. Furthermore, it will improve the momentum range over which particle separation is possible, the estimates of systematic uncertainties, and detector simulations.

### Content type

Experiment

### Collaboration

### Centralised submission by Collaboration

Presenter name already specified

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