Time of fight range and range rate detection are examined within the constraint of laser pulse energy fixed by peak power such as is the case for self-focusing in fiber lasers.

1) An optimized algorithm is assumed where the uncertainty in range and the uncertainty in range rate are parametrized in terms of system time discrimination. Nominally, the system clock is set to the laser pulse width to determine the maximum two degree of freedom vector field.
2) Each vector, comprised of a range uncertainty and a range rate uncertainty, is considered independently. Due to sampling uncertainty, for noise considerations, a time window of at least three laser pulse widths is assumed. For the case where the sampling window is substantially larger than the laser pulse width, a two window “linewidth” is assumed.
3) The “true” vector is considered using binomial integration, M choices out of N samples, a technique used for many decades in the ranging community.
4) The system is characterized by “dark counts” and “white counts.” The former is a false detection from whatever cause. This is the noise term. The latter is a detection of a real photon return at a Poisson average.
5) A link budget is generated which is characterized by E1 or the energy required, on average, to receive a single detection from the single photon counter used as the receiver. This is couched in simple terms. An example is used for a possible space fence application.
6) The laser output is constrained in terms of peak power where a linear dependence on pulse width is assumed. Hence, the energy from a 1 ns pulse width is assumed to be 1/10 of a 10 ns pulse width and etc. This models fiber laser output limited by self-focusing, for example. Other constraint equations can be utilized which determine laser pulse energy as a function of pulse width.
7) A system constraint equation is derived assuming the time window is the same width as the laser pulse and scaled with pulse repetition frequency. This
8) A system level equation is derived which gives a quasi-closed form solution for a given probability of false detection and a given probability of missing an event using binomial integration and the system constraint equation. The binomial integration process is modeled by assuming equal probability of false detection and missed detection for a choice of M from N, on average samples.
9) The system bandwidth is modeled and shown to be optimized for a given M/N binomial integration.