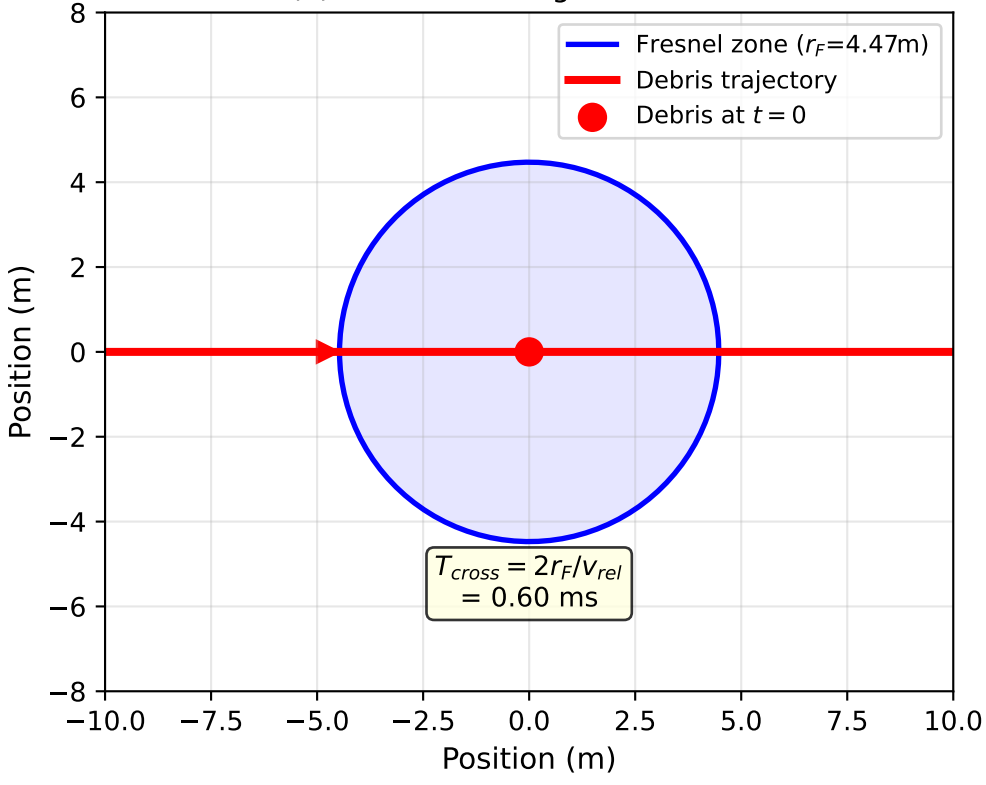

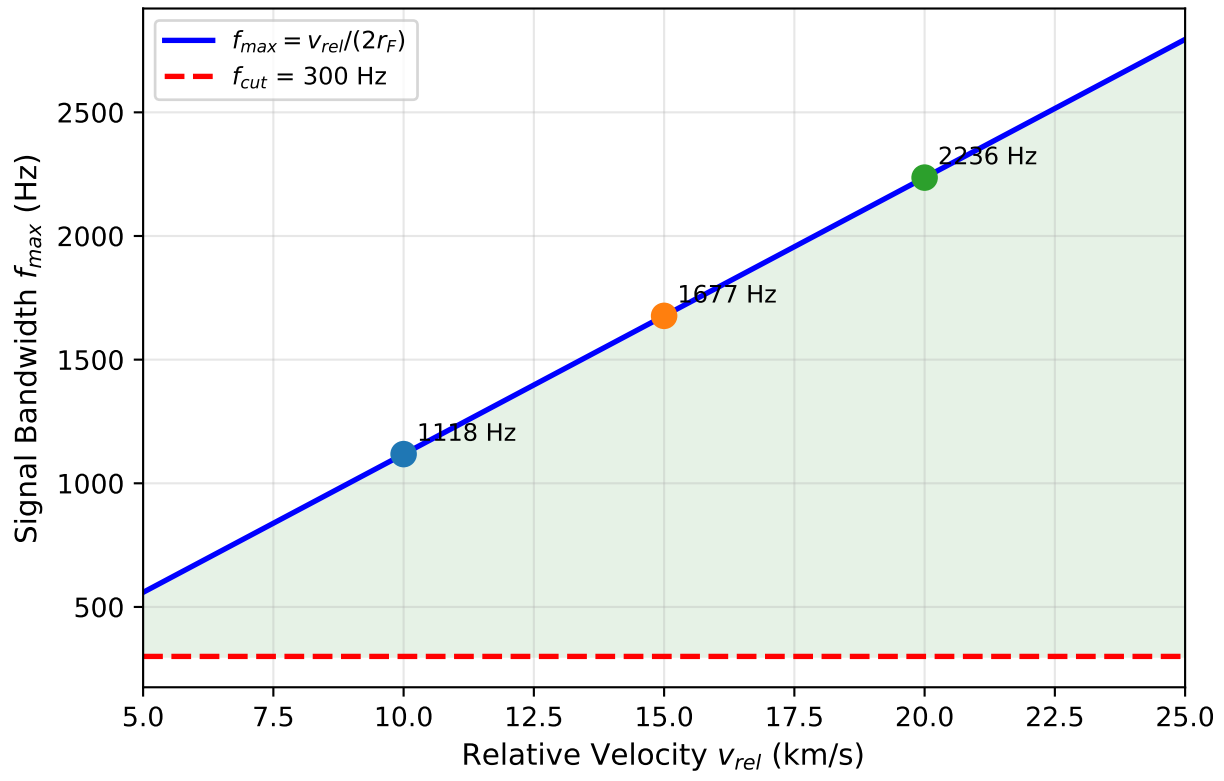

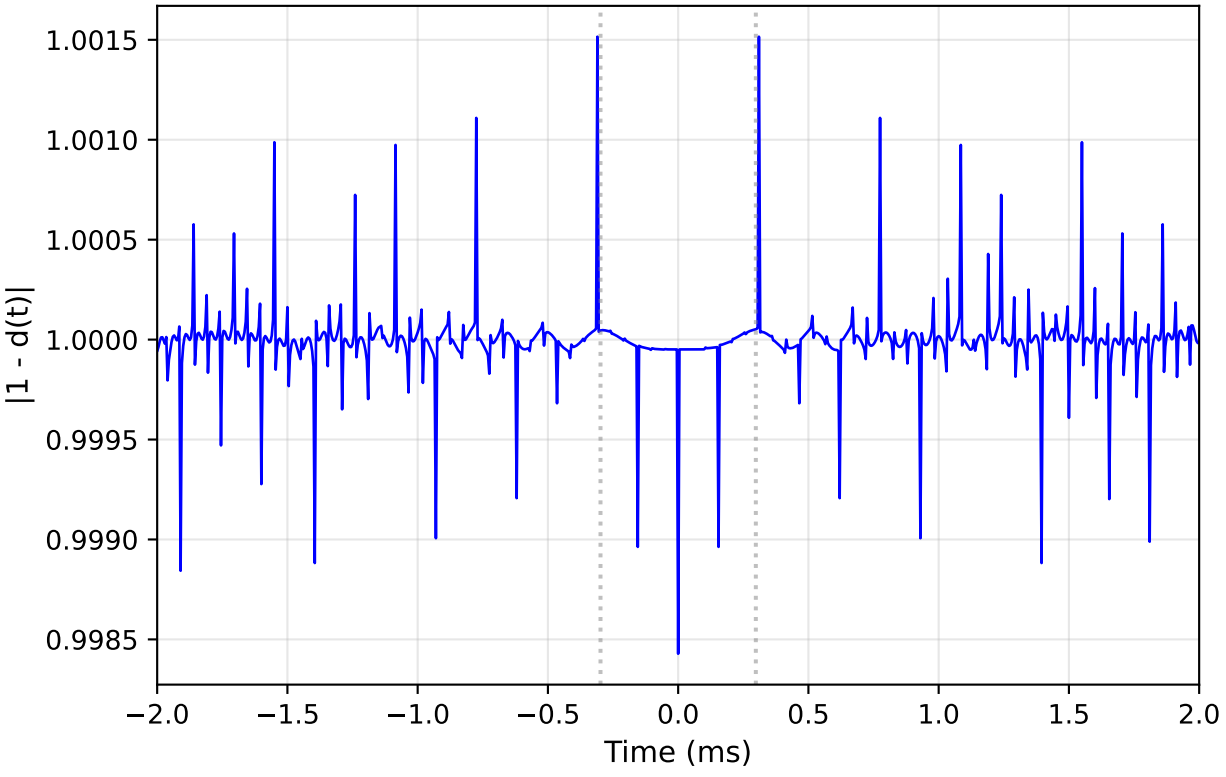

(d) Theoretical Summary

```
SIGNAL BANDWIDTH DERIVATION

1. Fresnel Zone Radius
   r_F = sqrt(lambda * L_eff)

   For lambda = 1 mm, L_eff = 20 km:
   r_F = sqrt(1e-3 * 2e4) = 4.47 m

2. Fresnel Crossing Time
   T_cross = 2*r_F / v_rel

   For v_rel = 15 km/s:
   T_cross = 8.94 / 15000 = 0.60 ms

3. Signal Bandwidth Upper Bound
   f_max = 1/T_cross = v_rel / (2*r_F)

   For v_rel = 15 km/s:
   f_max = 1677 Hz

4. Survival Space Design
   Constraint: f_knee < f_cut << f_max

   With f_cut = 300 Hz:
   - f_cut/f_knee = 1.5 (noise rejection)
   - f_cut/f_max = 0.18 (signal preserved)

5. Working Range (CORRECTED)
   Require: f_cut <= f_max/2
   With f_cut = 1.5*f_knee:
   => f_knee <= f_max/3 = 559 Hz
```