```
Setting up initial conditions for slider
Info in <TCanvas::Print>: pdf file Slider.pdf has been created
********************************
Coordinates when x=60 feet
(x,y,x) = (60.600000,1.183647,-3.055844)
(vx,vy,vz) = (110.388451,4.403547,-13.700529)
********************************
```
Slider

```
Setting up initial conditions for curveball
Info in <TCanvas::Print>: pdf file Curveball.pdf has been created
********************************
Coordinates when x=60 feet
(x,y,x) = (60.600000,0.837490,-3.896188)
(vx,vy,vz) = (110.225731,3.113712,-16.820377)
********************************
```
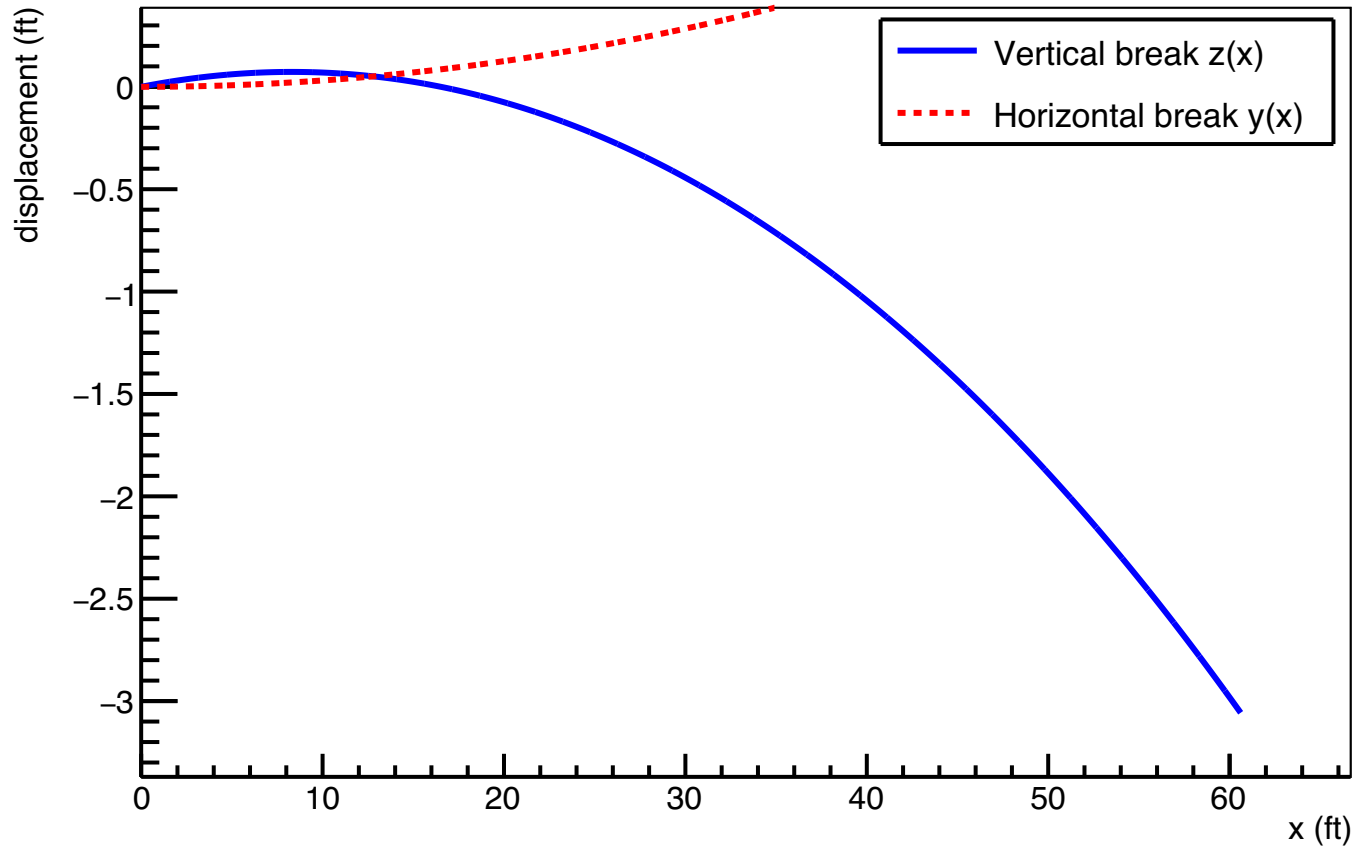Curveball

```
Setting up initial conditions for screwball
Info in <TCanvas::Print>: pdf file Screwball.pdf has been created
********************************
Coordinates when x=60 feet
(x,y,x) = (60.600000,-0.837490,-3.896188)
(vx,vy,vz) = (110.225731,-3.113712,-16.820377)
********************************
```
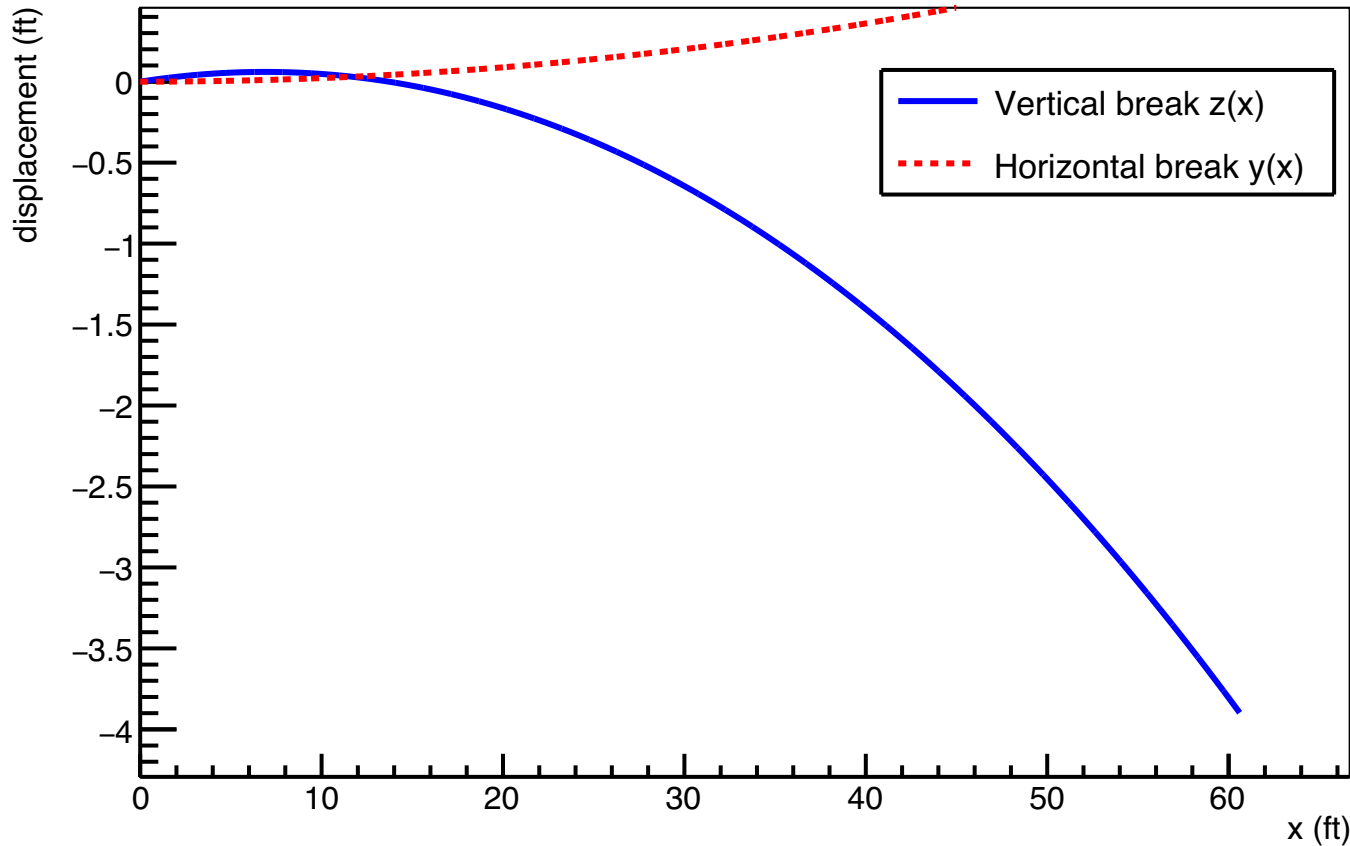Screwball

```
Setting up initial conditions for fastball
Info in <TCanvas::Print>: pdf file Fastball.pdf has been created
********************************
Coordinates when x=60 feet
(x,y,x) = (60.600000,-0.743607,-1.446239)
(vx,vy,vz) = (126.211120,-3.149027,-8.635635)
********************************
```
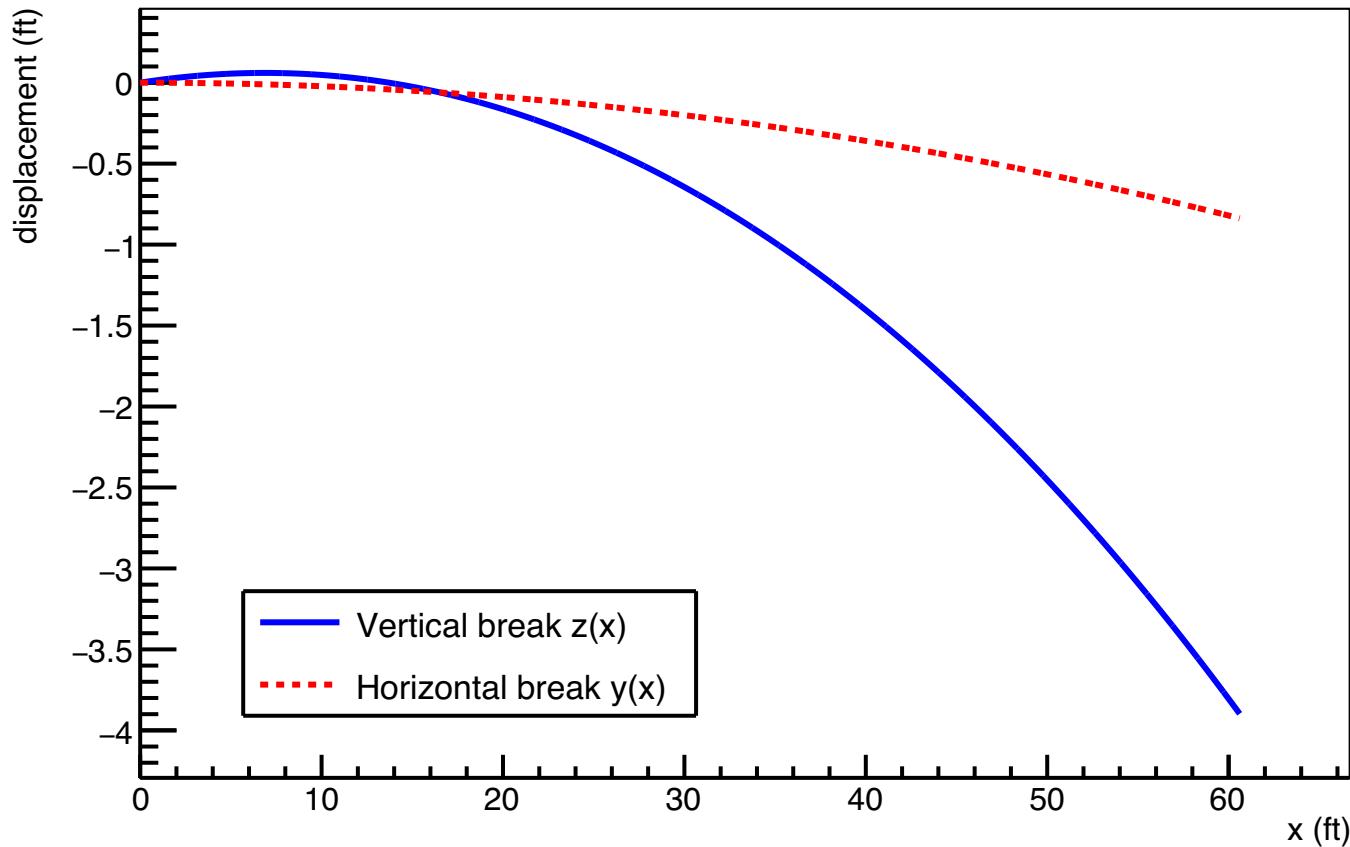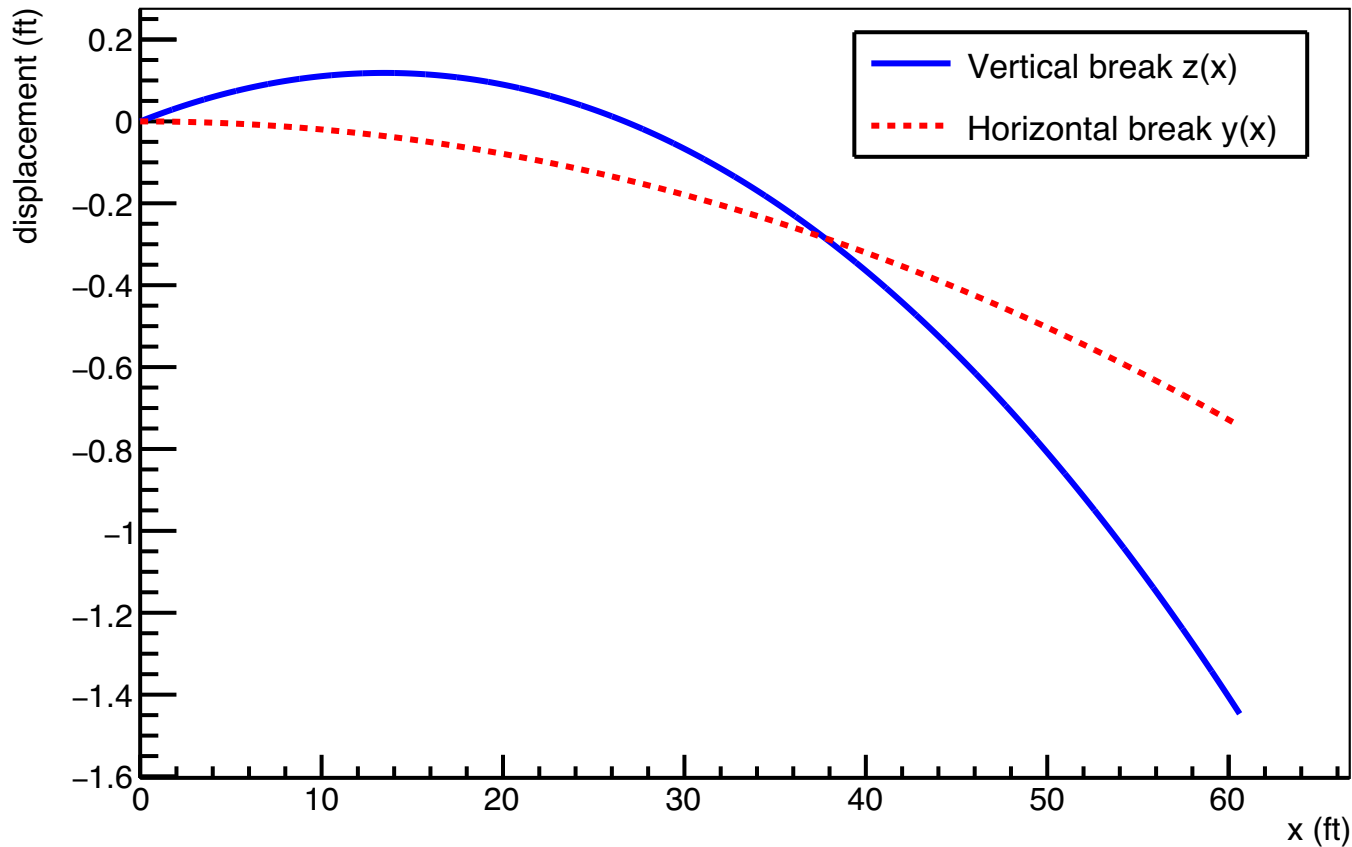Fastball

Curveball

- Vertical break z(x)
- Horizontal break y(x)

Screwball

Vertical break z(x)
Horizontal break y(x)

Fastball

- Vertical break z(x)
- Horizontal break y(x)

displacement (ft) vs x (ft)

Constants we used in our implementation:

Drag model: $F(v) = 0.0039 + 0.0058 / (1 + \exp((v - 35)/5))$
Drag acceleration: $a\_D = -F(v) * v * v\_vector$
Magnus force: $a\_M = B * (\text{omega cross } v)$, where $B = 4.1 \times 10^{-4}$
Spin rate: omega = 1800 rpm
Spin angle phi for each pitch:
Slider: 0 degrees
Curveball: 45 degrees
Screwball: 135 degrees
Fastball: 225 degrees
Initial speeds:
Slider / Curveball / Screwball: 38.01 m/s (approximately 85 mph)
Fastball: 42.47 m/s (approximately 95 mph)
Release angle: 1 degree above horizontal