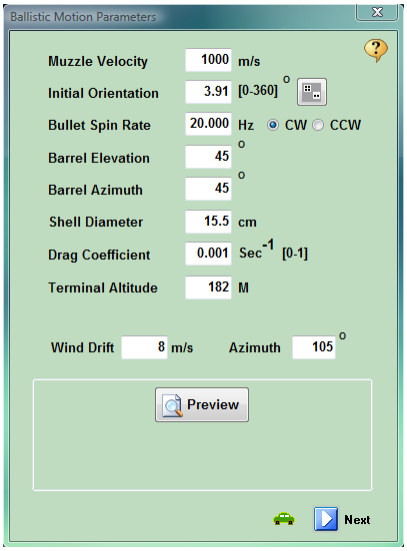
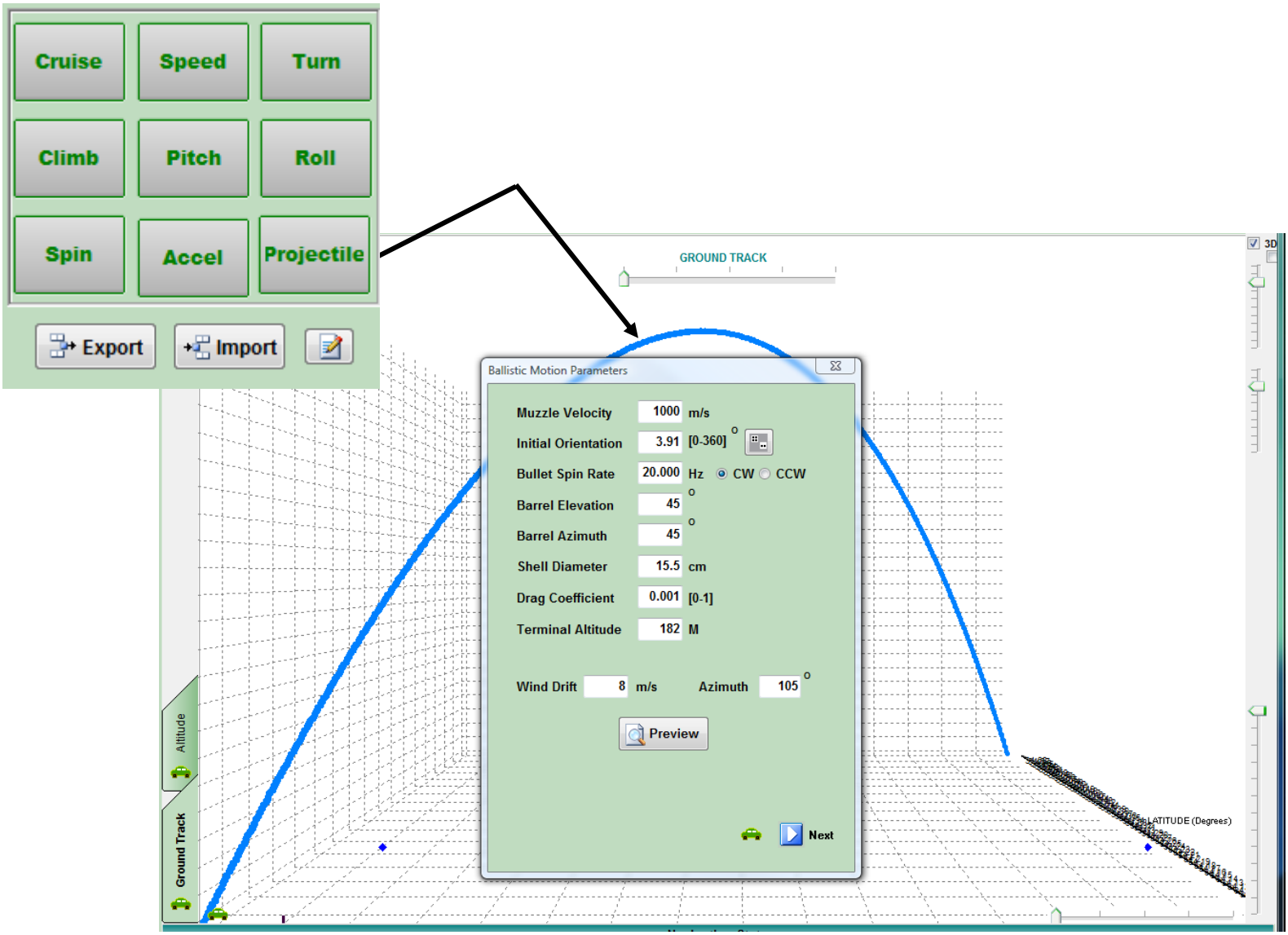
The Ballistic Projectile Model

The **Ballistic-Projectile** maneuver facilitates the testing of spinning GPS guided munitions. The figure below illustrates the parameters associated with the model.



Model Details & Parameters

To Access the Ballistic-Projectile maneuver, locate the Maneuver Keypad and select **Projectile**:

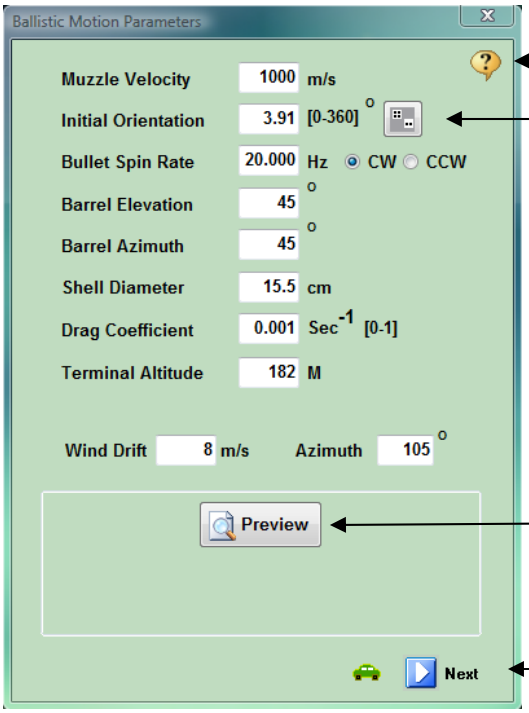


You can use the Ballistic Maneuver as you would any other maneuver with the following caveats:

- The Ballistic maneuver is mechanized assuming the launch vehicle is stationary. You may preference the Ballistic Maneuver with other maneuvers (eg. Stationary Cruise) as long as the terminal state is non-dynamic.

- The Ballistic maneuver terminates when the projectile reaches the **Terminal Altitude** entered in the parameters form. Unless you add additional maneuvers, the simulation will terminate.

- You can follow the Ballistic Maneuver with other maneuvers including additional Ballistic Maneuvers.



Displays this document

Randomly draw the **Orientation** of Bullet (antenna). Use for Monte Carlo Trials

The Maneuver is previewed for review. See the description below.

Save the maneuver and insert it into the Maneuver-Profile-Script.

[D] **Shell Diameter**: Enter the diameter of the shell. This is used in the Antenna Lever Arm model. Follow this link for a description of the Antenna Modeling including the Lever Arm and Gain patterns.
..\..\..\..\Tapestry\Documentation\Manuals\AntennaMaskFormat.pdf

[H] **Terminal Altitude**: Enter the Terminal Altitude for the shell. This provides a capability of simulating the *gun-and-target* at different altitudes or terminating the bullet somewhere in flight – such as the altitude apex. Clicking the **Apex** control terminates at the top of the flight profile.

[V_M] **Muzzle Velocity**: Enter the muzzle velocity of the ballistic projectile (bullet). This is the speed the projectile has when it exits the gun.

[θ] **Elevation**: Elevation angle of the gun barrel in Degrees relative to the locally level.

[ϕ_M] **Azimuth**: The Azimuth relative to north of the vehicle gun axis in Degrees.

[ω] **Spin Rate:** Spin rate of the projectile in Hertz (0-300 Hz). Use the Clockwise (CW) or Counter-Clockwise (CCW) control to reverse the sense of rotation. A positive rotation is shown in the figure above.

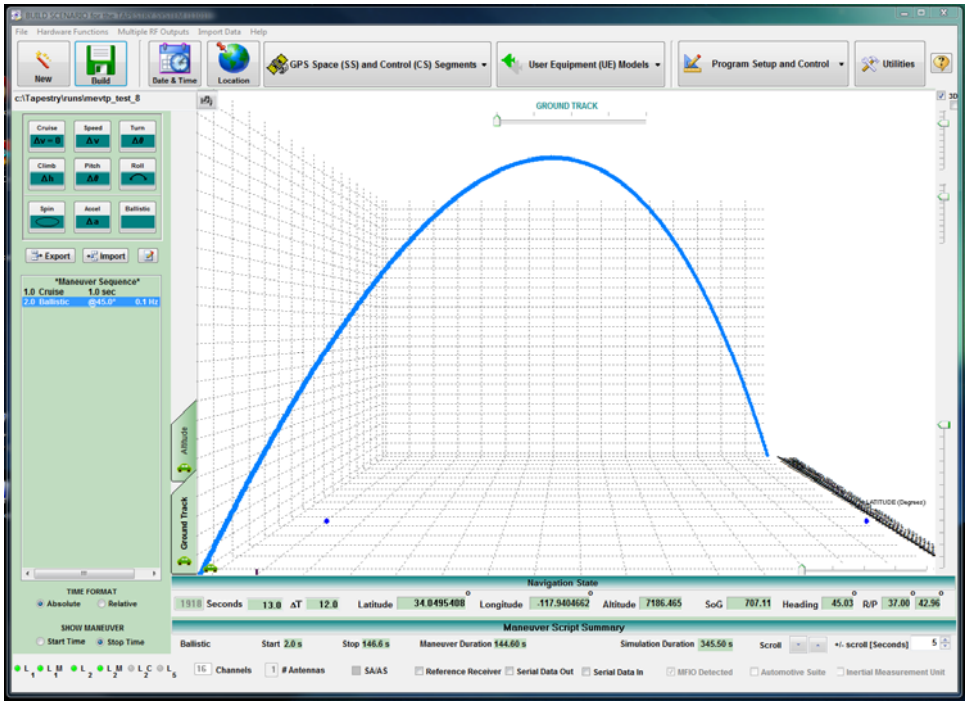
[α_D] **Drag Coefficient**: A linear drag model is implemented. Enter the reciprocal time constant (seconds^{-1}) for the model. τ is the time for the velocity to bleed to e^{-1} of the initial velocity (0.001 s^{-1} or smaller is typical). Enter "0" for this value if you do not want to include drag effects on the projectile.

[V_W] **Wind Drift:** Enter the velocity of the wind. This is the driver of the cross-axis deviation displayed in the Preview-Box. ϕ_W is the angle of the wind relative to North. Enter "0" if you do not want to include wind effects.

[ϕ_W] **(wind) Azimuth**: Enter the angle relative to North for the direction of the wind.

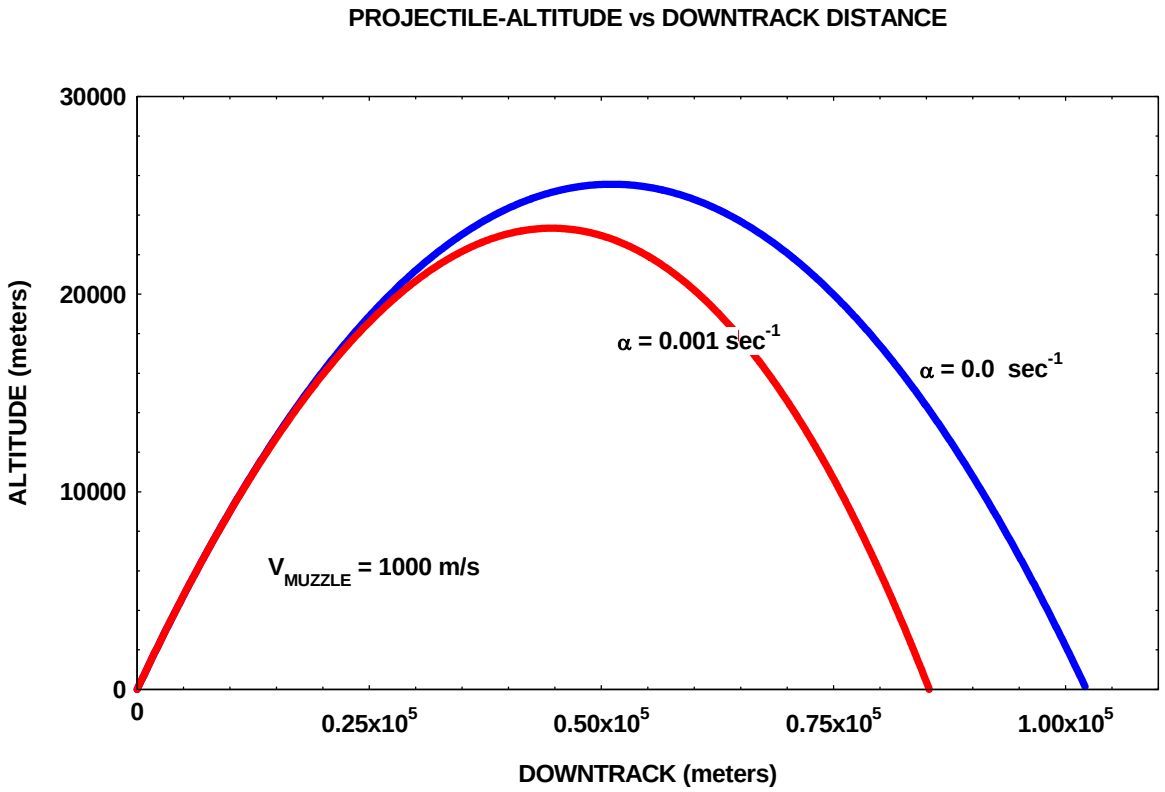
[φ_O] **Initial Orientation**: When the Bullet exits the gun the orientation of the antenna is arbitrary. This value specifies the initial condition. Enter a non-zero value to rotate the initial antenna orientation clockwise. Use this in conjunction with the Monte Carlo control. When pressed, this control draws the initial angle from a uniform distribution between 0 and 360^O. This variable is accessible by the ***Remote Control Application***[1] in Monte Carlo mode.

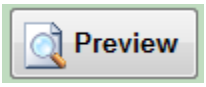
The following example is a 3D representation a Ballistic Maneuver from Build Scenario (TapVpg).



[1] See "The Remote Control Interface Manual" in the Tapestry Documents folder.

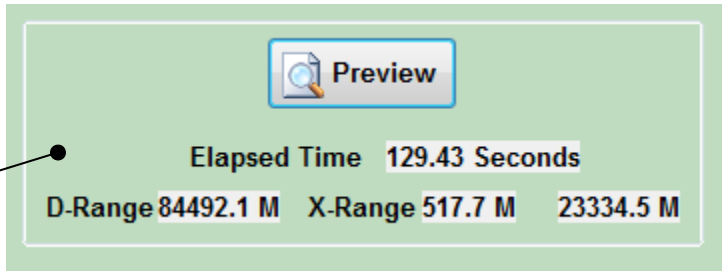
The following plot contrasts the effect of the drag model and projectile altitude.



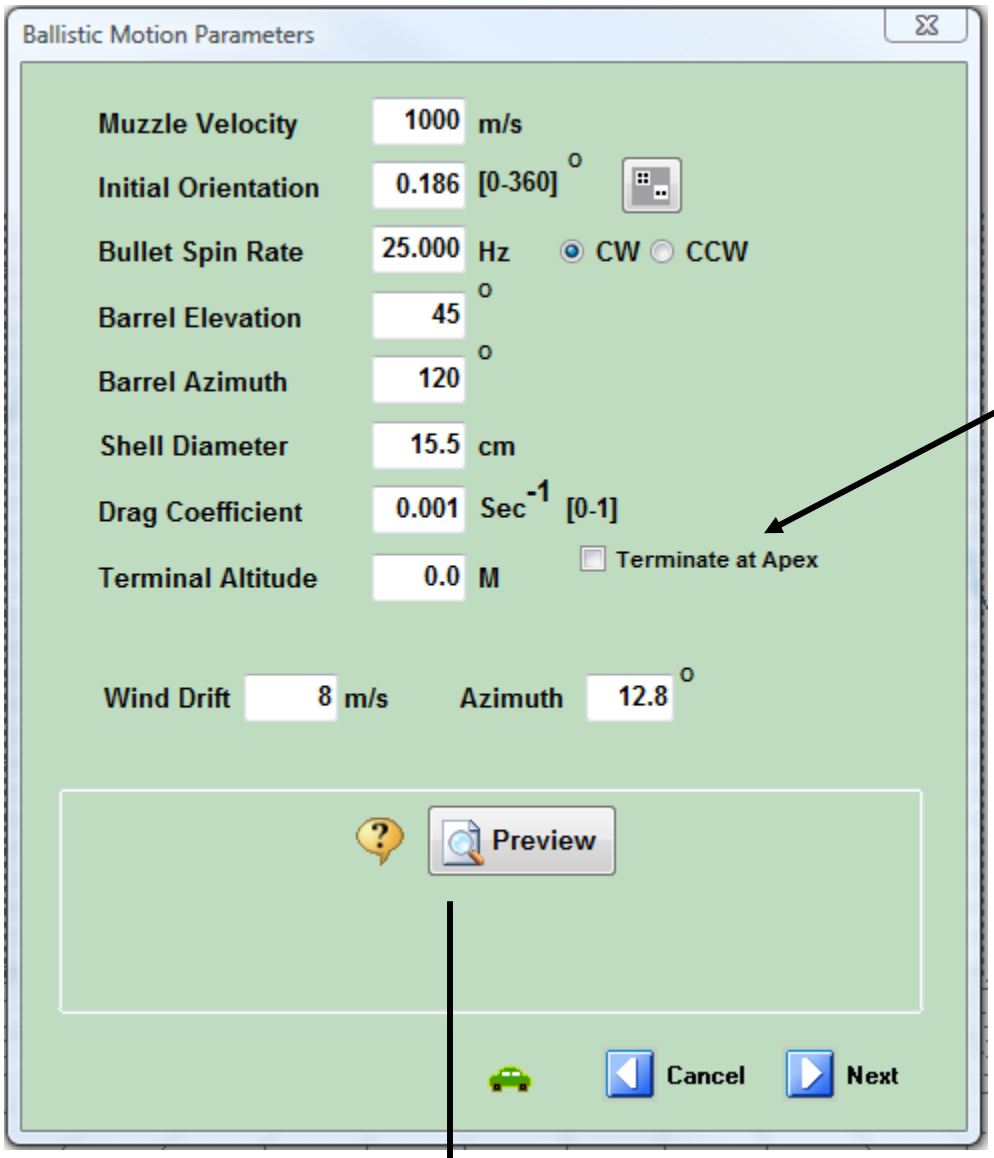


If you press the Preview button, the model will run through the algorithm resulting in the terminal conditions saving them in a text file:

- DownTrack: The range down track from the launch vehicle.
- CrossTrack: The deviation of the gun perpendicular to the Downtrack direction. This is caused by wind.
- Elapsed Time: Duration of the maneuver. The terminal condition is when the projectile reaches the Terminal Altitude entered in the form.

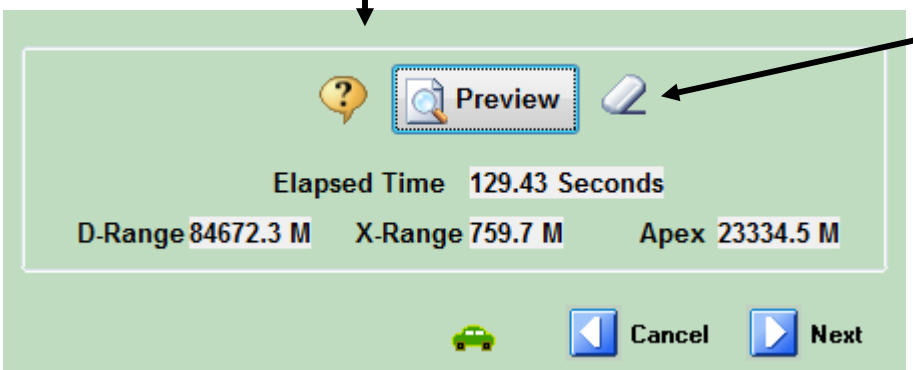


Data is presented ***after*** pressing the Preview Button. You can change the parameters and press Preview repeatably.



This terminates the Maneuver at the Top of its flight (full state vector). You would then add additional maneuvers to Target the terminal Location:

Clears the Preview Screen and “hides” all the controls.



Clears the Preview Screen and “hides” all the controls.