PITCH CUE SETTINGS

1. On-Runway Pitch Fore/Aft Acceleration Tilt Cue

The largest fore/aft accelerations experienced by the aircraft are likely to be during power-up on takeoff and during heavy braking on landing. The process below can be used to set the pitch axis fore/aft acceleration cue.

a. Place the aircraft on a long runway ready for takeoff.

b. Start the motion driver with a copy configuration file, and open the motion driver **Capture** and **P** settings windows. **IMPORTANT – first set parameters A and B = 1.00 (then click USE).** This ensures the values shown in the capture window are not scaled.

c. Power-up the aircraft and proceed with a normal takeoff – then just before takeoff remove power and apply full braking and bring the aircraft to a halt. Pause the sim.

d. In the Capture window note the maximum and minimum FWD accelerations. These are the accelerations on which you can base the force cue.

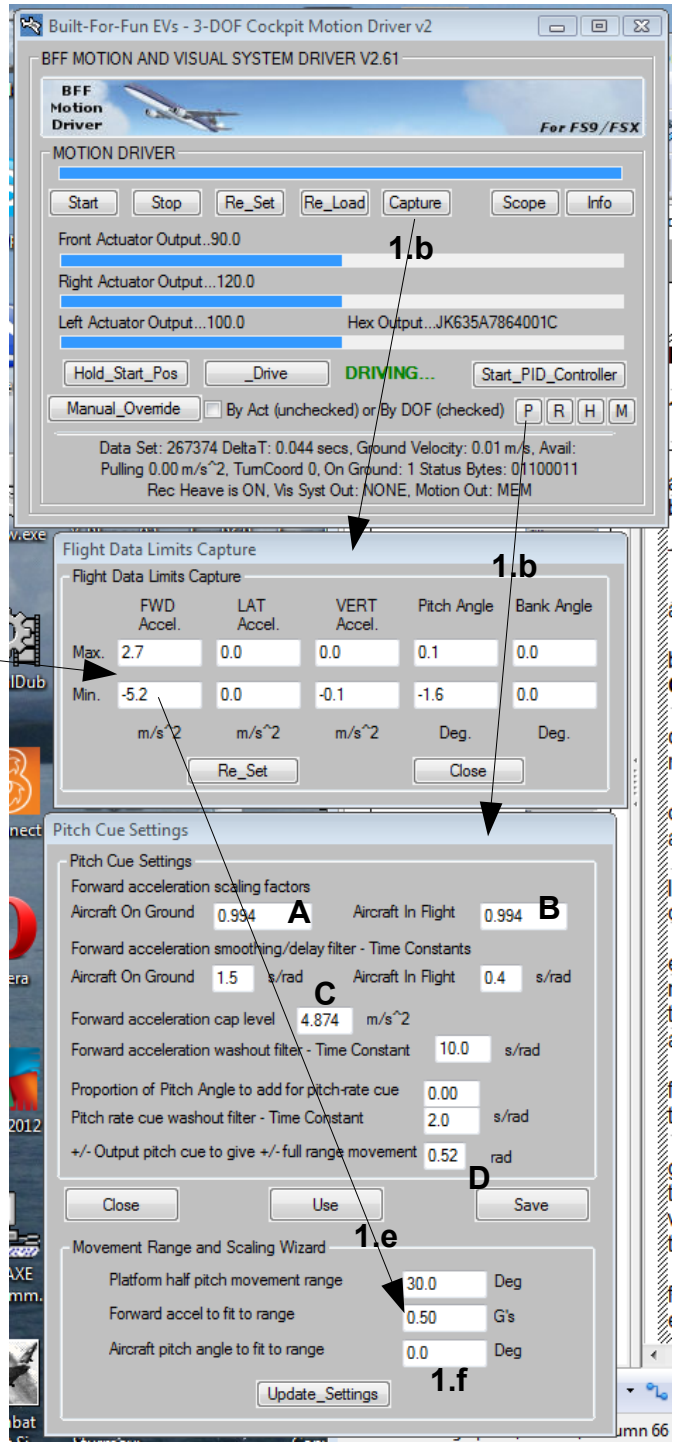
In the example shown the maximum acceleration was 2.7 m/s^2, and the maximum deceleration was -5.2 m/s^2. The braking forces are bigger than the thrust forces....

e. Chose a suitable forward acceleration range setting for the wizard. Note 1 G = 9.81 m/s^2. In the example shown a value of 0.5G's (4.9 m/s^2) is chosen for the full pitch tilt of the platform. This will capture most of the braking deceleration, but will also allow a reasonable pitch tilt movement during the approx 0.27G takeoff acceleration.

f. Click **Update_Settings** and the wizard will calculate values for items A, B, C and D to implement the acceleration settings.

g. To use the new settings click **Use.** Check the resulting cue movement by re-flying the takeoff with the motion driver set to **Drive**. The cue movement range can be checked visually in the cue progress bars in the driver window. The cue can be further adjusted by altering the G setting in the wizard....

f. It may be convenient to set the pitch angle fit to zero temporarily so that only the force tilt element of the pitch cue is active whilst the settings are being made.... see item **1.f**)



PITCH CUE SETTINGS

2. On-Runway Pitch Fore/Aft Acceleration Tilt Cue – smoothing and washout filters

a. Smoothing Filter – item **A** in image...

The forward acceleration of the aircraft on the runway can be noisy. A smoothing filter can be applied to take the edges off the accelerations before they are used to calculate the tilt cue.

The setting is a Time Constant for the filter – increasing the value of the time constant increases the smoothing effect. Note however that the noise smoothing process will also delay the acceleration output slightly which can affect the cue feel.

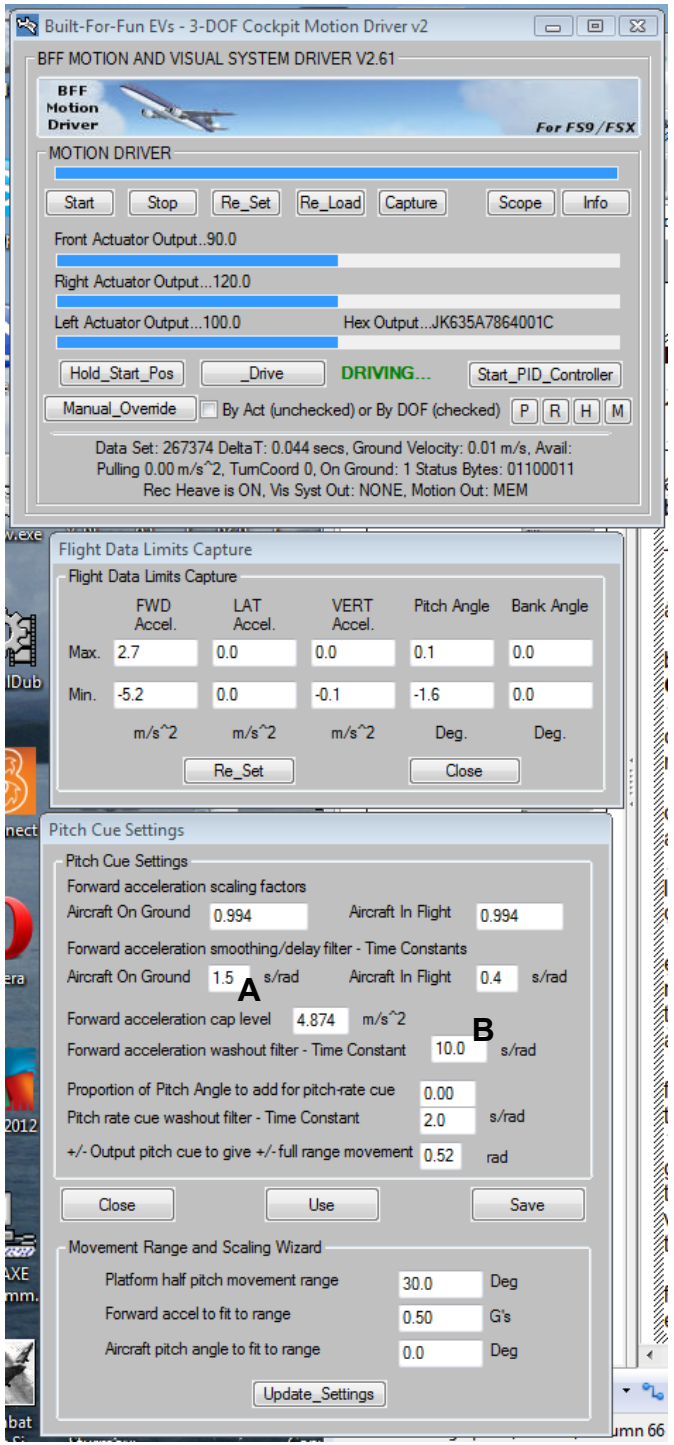
(The in-air aircraft forward accelerations tend to be fairly smooth already – hence in the example shown the time constsant for the in-flight smoothing filter is lower than the on-ground setting.)

b. Washout Filter – item **B** in image.

Often in motion cues the displacement of the platform is set to slowly return to the mid position even although the acceleration causing the cue may be sustained. This is usually done to allow the motion platform to react to further changes in the cue – which might otherwise have pushed the platform to its movement limit.

This cue washout is controlled using the washout filter time constant, item **B**. Larger values for the time constant cause a slower return to mid-position – ie larger time constant for a longer washout period.

If the time constant is set to zero the washout is disabled completely and the motion cue will be sustained for the full duration of the acceleration causing it.



PITCH CUE SETTINGS

3. In-Air Pitch Fore/Aft Acceleration Tilt Cue

If the in-air accelerations of the aircraft are significantly different from the on-ground accelerations then the pitch acceleration cue can be adjusted. This is done using the in-air acceleration scaling factor – item **B** in the image.

To check the in-air accelerations **first set item B = 1.00 (click USE)**. Place the aircraft in straight and level flight. **Re-set** the Capture window data and then adjust the power and flap settings of the aircraft etc in order to cause the maximum and minimum in-air acceleration and deceleration that you can for the aircraft. Note – maintain level flight whilst you do this, do not pitch up or down the aircraft.

a. In the example shown the max and min in-flight forward accelerations were +3.8m/s^2 and -2.0 m/s^2 (approx 0.38G and -0.22G).

b. The actual acceleration cue settings were made previously (in step 1) by the wizard for 0.5G's, so the in-air 0.38G max acceleration would not therefore cause full scale displacement of the platform pitch. However if the in-air acceleration was scaled up by a factor of 0.5 / 0.38 = 1.3 then the scaled acceleration used for the cue calculation would be close to 0.5G's and the platform would pitch by its full amount at the maximum in-air acceleration.

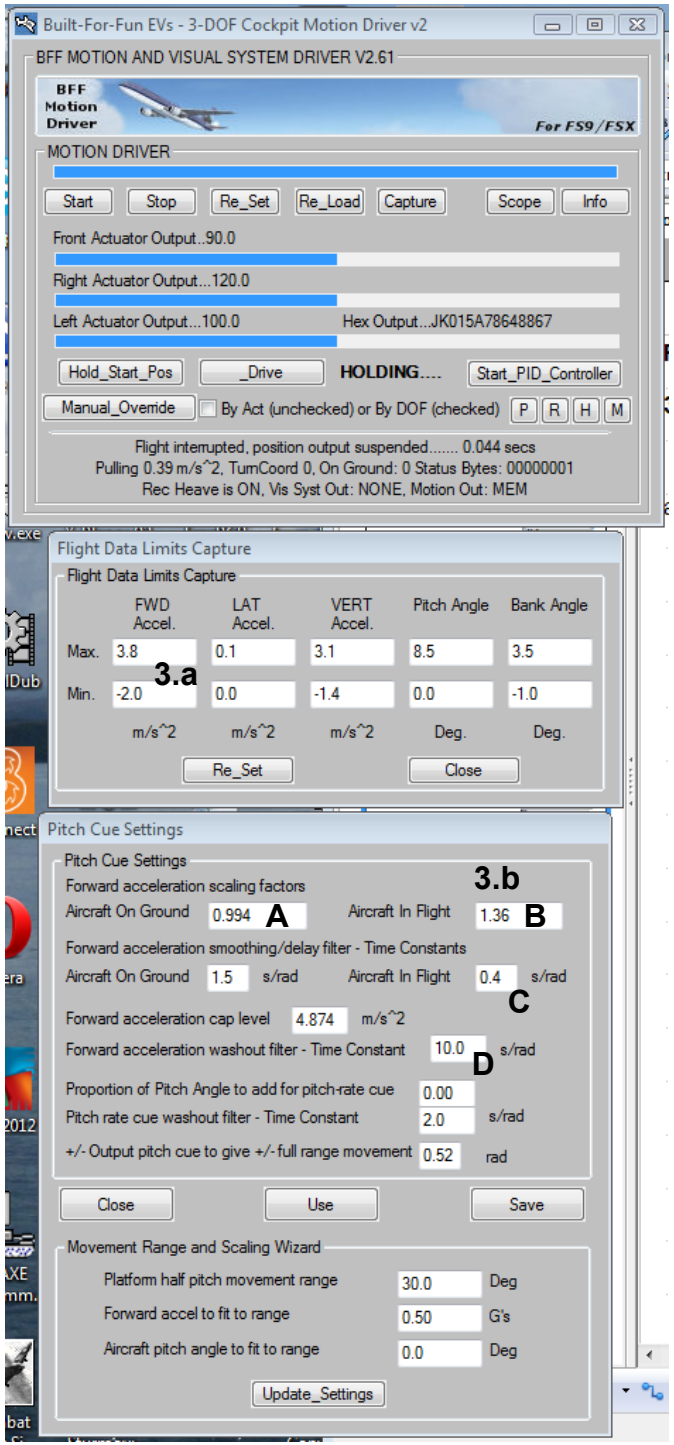
In the example shown the in-air acceleration scaling factor (**B**) has been set to 1.36 – thus increasing the sensitivity of the in-air acceleration tilt cue.

c. Some trial and error may be required to achieve optimum settings. It may be necessary to set the acceleration tilt cue to go to its maximum at lower than maximum aircraft accelerations. This may be required if tilt movement is to be felt for other flight events that cause smaller changes in acceleration – such as modest decelerations when flaps or landing gear are extended.

NOTE if you use the wizard to make these changes then the settings will be altered for both the on-ground and in-air operations. It may be better to use the wizard for one set only, and then make changes using the acceleration scaling factor for the other flight condition if needed.

4. In-Air Pitch Fore/Aft Acceleration Cue – Smoothing filter

Item **C** can be used to adjust the smoothing filter setting for the in-air acceleration used for the tilt cue. Note however that there is only one washout filter setting (**D**) – this applies to both in-air and on-ground operations.



PITCH CUE SETTINGS

5. Pitch Angle Following (Pitch Rate Cue)

The previous settings are for the element of the pitch cue which reacts to aircraft fore/aft acceleration changes. The other element of the pitch cue allows pitching in response to changes to the pitch angle of the aircraft.

Normally this is used to provide some sense of pitch rotation in visually enclosed platform cockpits and a setting is used which passes a set proportion of the actual aircraft pitch angle to the platform.

The setting can be made though the wizard, however if you have already set different in-air and on-ground acceleration cues then using the wizard again may overwrite them. In this case the pitch following setting can easily be made directly using item **A** in the image.

In the example shown a pitch angle proportion of 0.5 has been set – this will cause the platform to pitch at half the pitch rate of the aircraft.

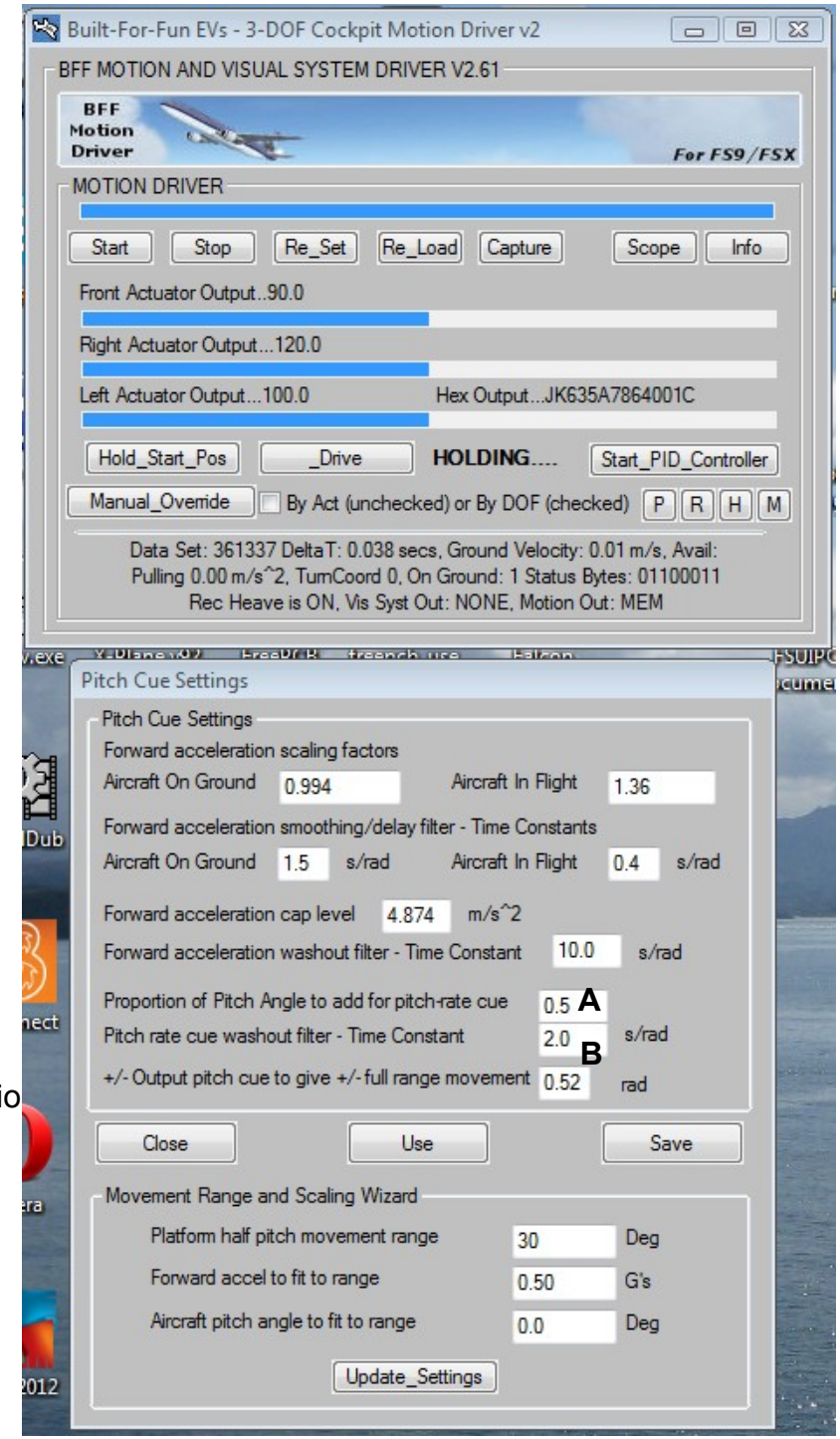
A value of 1.0 would pass the full pitch angle through to the pitch cue. When setting the proportion take into account the working pitch range of the platform and the normal nose up/down range of the aircraft so that normal aircraft pitch angles do not cause the platform to regularly pitch to its actuator limits.

6. Pitch rate cue washout

The pitch angle following component of the cue can be washed out to mid – it has its own washout filter setting – item **B** in image.

The washout allows the pitch angle to return slowly to zero if the nose up/down orientatio of the aircraft is sustained for a prolonged period.

As discussed previously setting a larger wahsout filter time constant increases the time taken for the washout to mid. Smaller values cause a faster return to mid.



ROLL CUE SETTINGS

7. Roll Axis Lateral Acceleration Tilt Cue

The roll axis acceleration cues can be tricky to set. Ideally the cue should give a reasonable feel of side-ways forcing when the aircraft is making taxiing turns on the ground. And also provide some sense of lateral forcing when uncoordinated turns are made in the air. However in-air lateral accelerations can be of short duration and excessive rolling of the platform to take up a particular lateral acceleration tilt cue can easily be mis-interpreted by the pilot as a bank angle rather than a sideways force. It is suggested that lateral acceleration cues are kept at modest levels and that the in-air roll cue is mainly the bank angle following cue to give a good sense of aircraft roll rate in turns.

The setting procedure is similar to that previously described for the pitch cue....

a. Place the aircraft on a runway ready to make a number of left and right taxiing turns to capture the actual aircraft lateral accelerations.

b. Open the motion driver **Capture** and **R** settings windows. **IMPORTANT – set parameters A and B = 1.00 (click USE).**

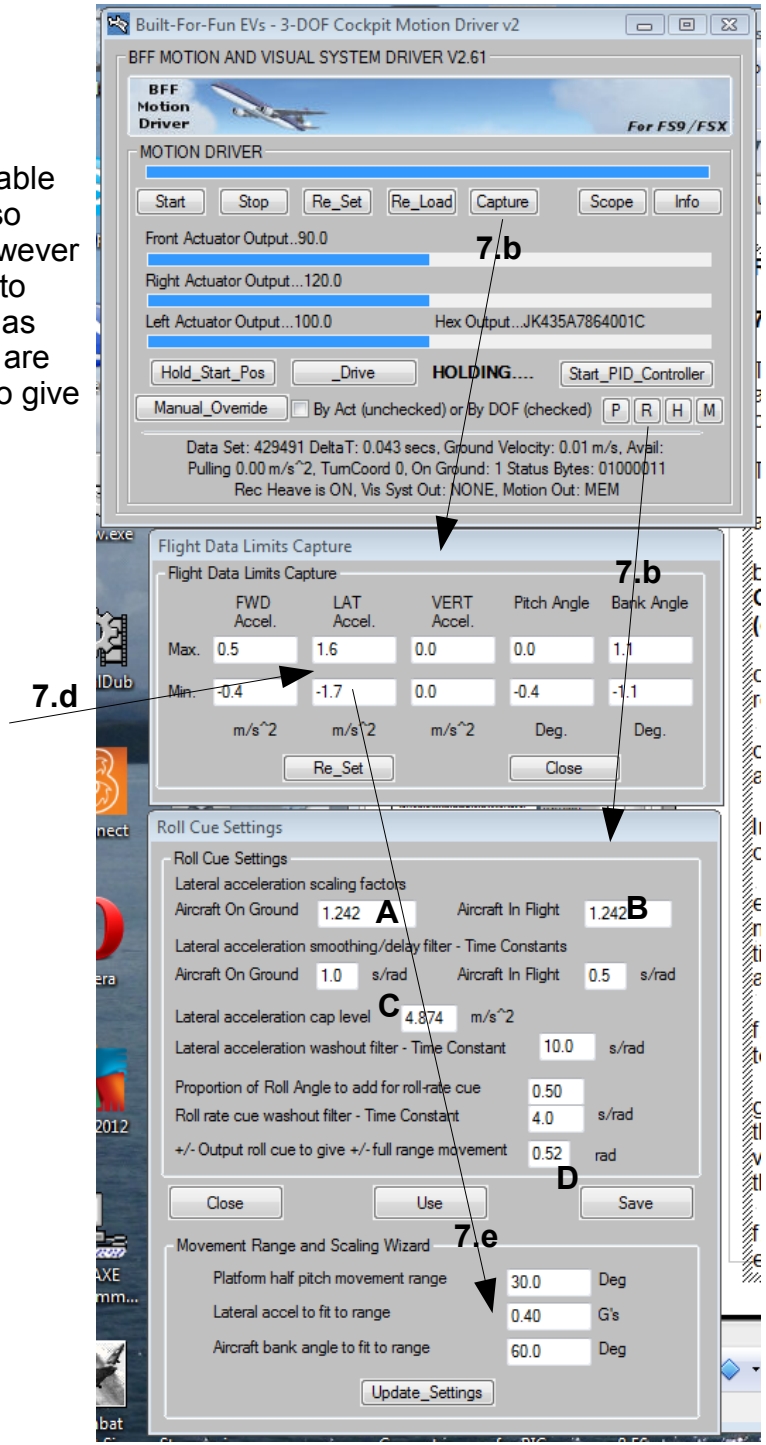
c. Power-up the aircraft and proceed to make a number of left and right taxiing turns at a reasonable speed (probably a bit faster than normal taxiing speed). Pause the sim.

d. In the Capture window note the maximum and minimum Lateral accelerations. These are the accelerations on which you can base the force cue.

In the example shown the maximum lateral accelerations during the turns were about +/- 1.7 m/s^2.

e. Chose a suitable lateral acceleration range setting for the wizard. Note 1 G = 9.81 m/s^2. In the example shown a value of 0.4G's (3.9 m/s^2) is chosen for the full roll tilt of the platform. This will cause the actual lateral accelerations present in the taxiing turns to cause only a moderate roll of the platform – consistent with the modest lateral forcing felt by the pilot.

f. Click **Update_Settings** and the wizard will calculate values for items A, B, C and D to implement the acceleration settings. To use the new settings click **Use.**



ROLL CUE SETTINGS

8. Roll Axis Lateral Acceleration Tilt Cue – smoothing and washout filters

a. Smoothing Filter – item **A** in image...

The smoothing filter is helpful in the lateral acceleration cue for smoothing the onset and offset of the sideways acceleration effects when making taxiing turns. The forces need to feel smooth and the filter time constant can be adjusted to obtain the right smoothness so that the tilt angles do not feel harsh...

The setting is a Time Constant for the filter – increasing the value of the time constant increases the smoothing effect. Note however that the noise smoothing process will also delay the acceleration output slightly which can affect the cue feel.

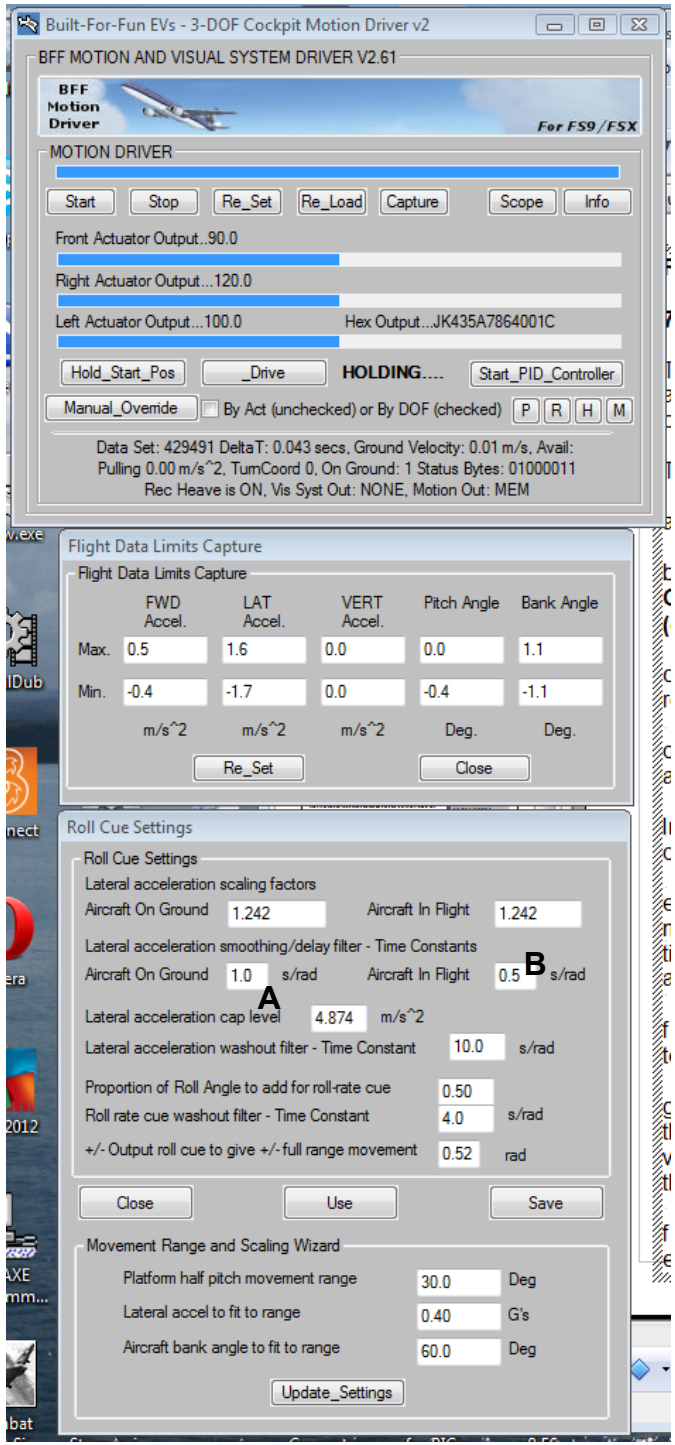
(The in-air aircraft lateral accelerations tend to be of short duration and shouldn't be delayed excessively by the filter – hence in the example shown the time constant for the in-flight smoothing filter is lower than the on-ground setting.)

b. Washout Filter – item **B** in image.

Often in motion cues the displacement of the platform is set to slowly return to the mid position even although the acceleration causing the cue may be sustained. This is usually done to allow the motion platform to react to further changes in the cue – which might otherwise have pushed to platform to its movement limit.

This cue washout is controlled using the washout filter time constant, item **B**. Larger values for the time constant cause a slower return to mid-position – ie larger time constant for a longer washout period.

If the time constant is set to zero the washout is disabled completely and the motion cue will be sustained for the full duration of the acceleration causing it.



ROLL CUE SETTINGS

9. Roll Axis Lateral Acceleration Tilt Cue – In Air

If the in-air accelerations of the aircraft are significantly different from the on-ground accelerations then the roll axis lateral acceleration cue can be adjusted. This is done using the in-air acceleration scaling factor – item **B** in the image.

To check the in-air accelerations **first set item B = 1.00 (click USE)**. Place the aircraft in straight and level flight. **Re-set** the Capture window data and then use the rudder to make fast and short left and right turns to induce sideways accelerations. You will need to disable auto-rudder in the realism settings..

a. In the example shown the max and min in-flight lateral accelerations were +/-2.4 m/s^2 (approx 0.25G).

b. The actual acceleration cue settings were made previously (in step 1) by the wizard for 0.4G's, so the in-air 0.25G max acceleration would not therefore cause full scale displacement of the platform pitch. However fast large scale roll movements are not good at simulating sideways accelerations and reducing the lateral acceleration sensitivity of the cue is sensible.

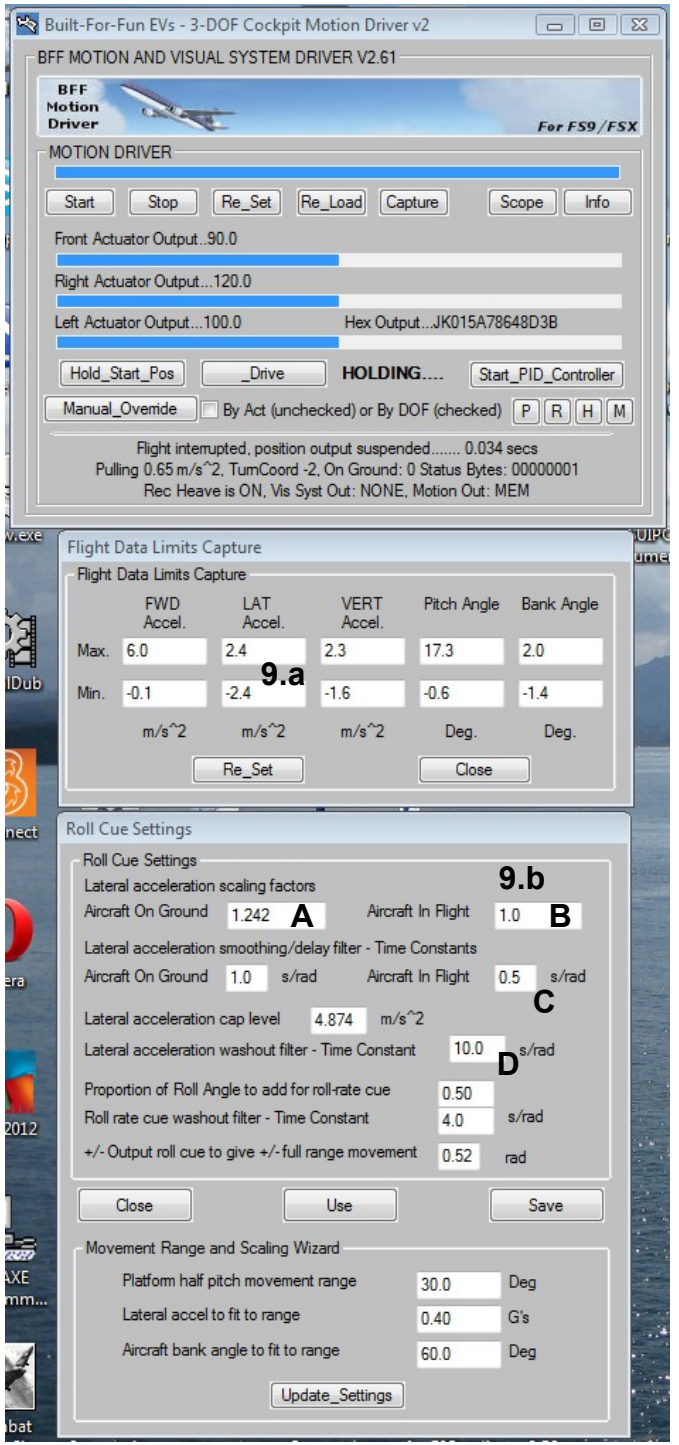
In the example shown the in-air acceleration scaling factor (**B**) has been reduced to 1.00 – thus reducing the sensitivity of the in-air acceleration tilt cue to keep the roll angles at a modest level.

c. Some trial and error may be required to achieve optimum lateral acceleration tilt settings.

NOTE if you use the wizard to make these changes then the settings will be altered for both the on-ground and in-air operations. It may be better to use the wizard for one set only, and then make changes using the acceleration scaling factor for the other flight condition if needed.

10. Roll Axis Lateral Acceleration Cue – In Air – Smoothing filter

Item **C** can be used to adjust the smoothing filter setting for the in-air acceleration used for the tilt cue. Note however that there is only one washout filter setting (**D**) – this applies to both in-air and on-ground operations.



ROLL CUE SETTINGS

11. Bank Angle Following (Roll Rate Cue)

The previous roll settings are for the element of the roll cue which reacts to aircraft lateral acceleration changes. The other element of the roll cue allows banking in response to changes to the bank angle of the aircraft.

Normally this is used to provide some sense of roll rotation in visually enclosed platform cockpits and a setting is used which passes only a set proportion of the actual aircraft bank angle to the platform.

The setting can be made though the wizard, however if you have already set different in-air and on-ground acceleration cues then using the wizard again may overwrite them. In this case the roll following setting can easily be made directly using item **A** in the image.

In the example shown a roll angle proportion of 0.5 has been set – this will cause the platform to bank at half the roll rate of the aircraft.

A value of 1.0 would pass the full bank angle through to the roll cue. When setting the proportion take into account the working bank range of the platform and the normal bank angle range of the aircraft so that normal aircraft bank angles do not cause the platform to regularly roll to its actuator limits.

12. Roll rate cue washout

The roll angle following component of the cue can be washed out to mid – it has its own washout filter setting – item **B** in image.

The washout allows the bank angle to return slowly to zero if the bank orientation of the aircraft is sustained for a prolonged period.

As discussed previously setting a larger washout filter time constant increases the time taken for the washout to mid. Smaller values cause a faster return to mid.