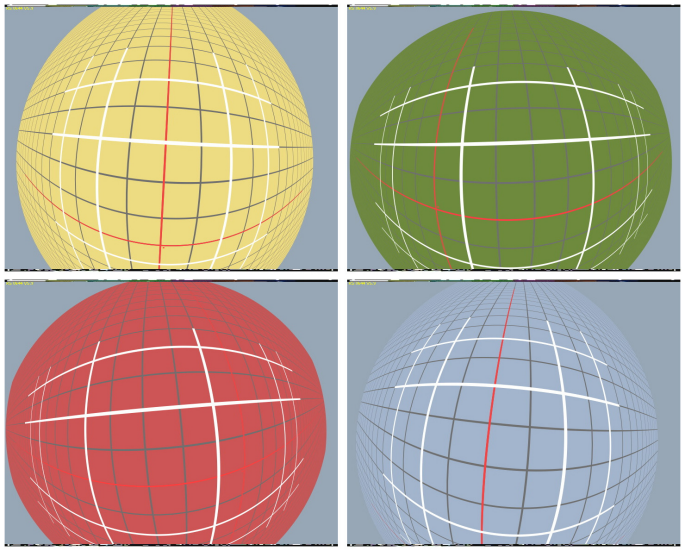
Using the ASL Configuration Tool for Surround View calibration and design

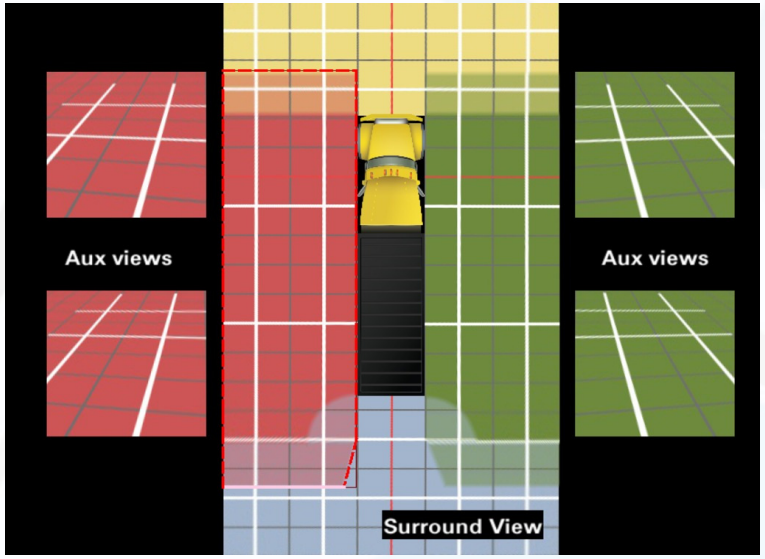
U-0644_2298 v2.3

Generating a Surround View with ASL360

- **How to create a coherent surround view for improving situational awareness using images from wide angle cameras?**



- **Overview:**
  - How ASL360 does it
  - How to install and calibrate cameras on a specific vehicle
  - How to design user screens

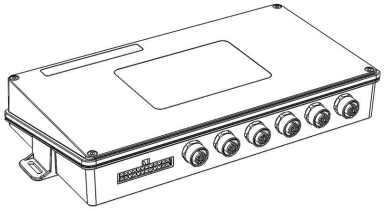


ASL360 active system components

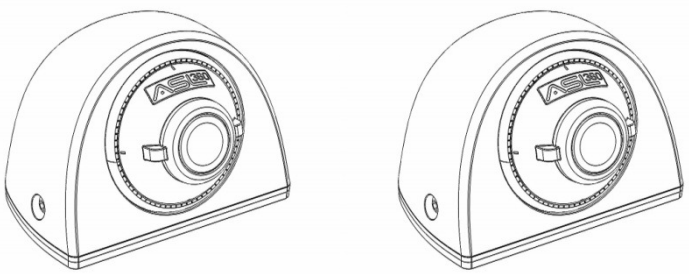
Configuration Tool (PC)

For system configuration

Connects to ECU via Ethernet



ECU

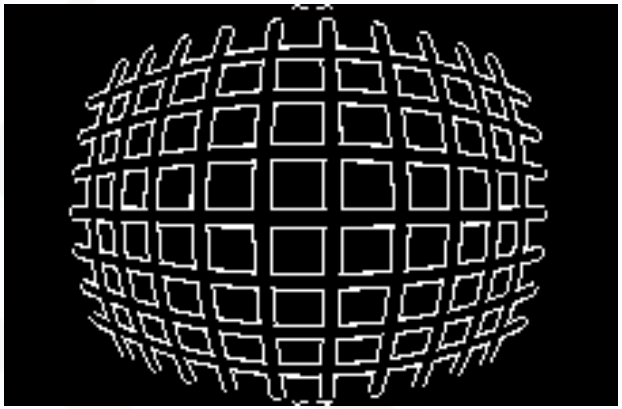


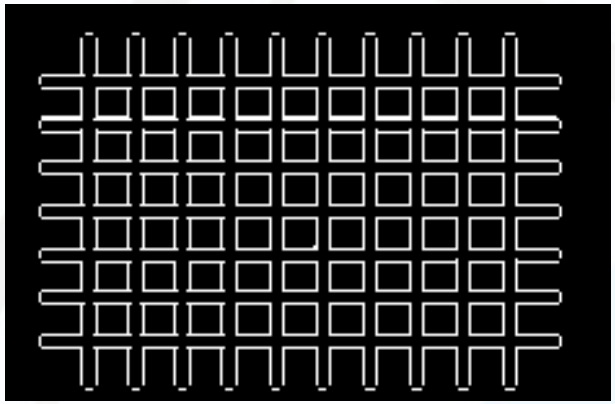
Wide angle fisheye cameras

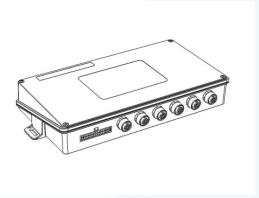
1 – 6, typically 4

How ASL360 does it – Camera fisheye correction

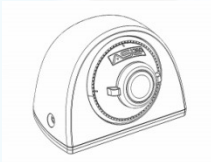
- **Fisheye correction needed due to compensate:**
  - Image curvature resulting from lens characteristics
  - Camera manufacturing tolerances
- **Fisheye correction makes straight lines in the real world appear straight**
- **Each camera is unique and requires a unique correction**
- **For ASL cameras, fisheye parameters are:**
  - Calibrated in the camera factory
  - Embedded in the camera's video output
  - Decoded by the ECU
- **Completely handled by ASL360; installer has nothing to do**





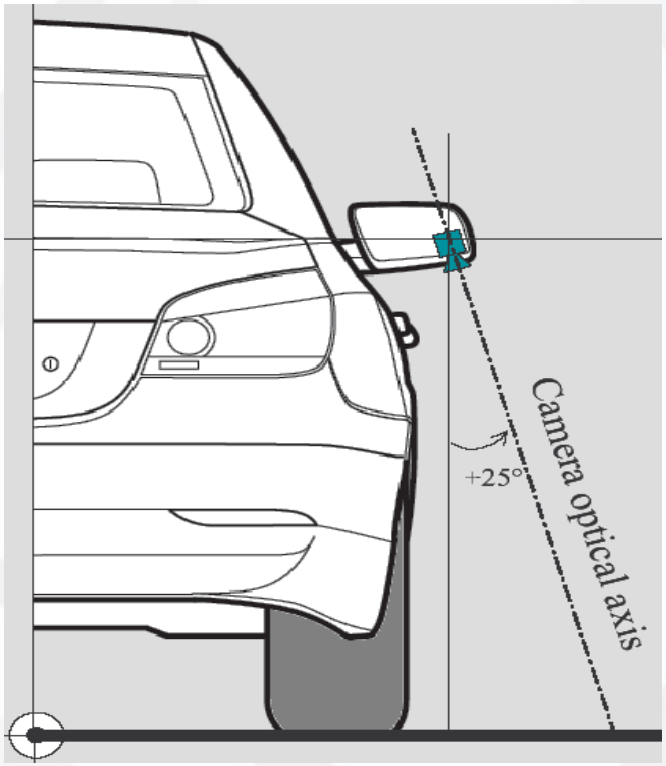


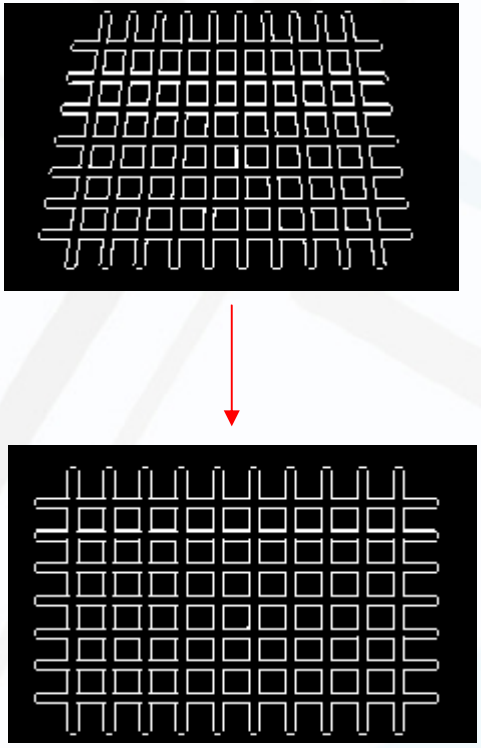
Video & Embedded data



How ASL360 does it - Perspective correction

- **Perspective correction needed due to:**
  - Camera mounting tolerances affecting the orientation of the camera
  - No two vehicle installations are exactly the same
- **After installation ASL Configuration Tool finds Position & Orientation (Pose) of each camera**

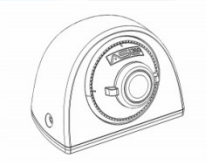




Video

Camera data

Video

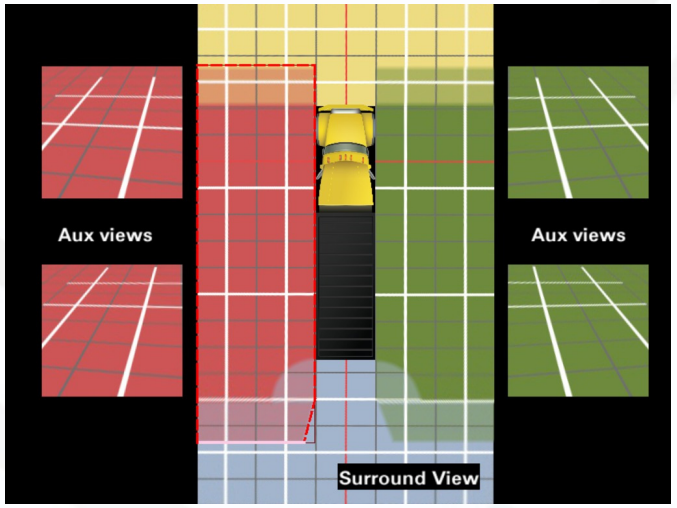


How ASL360 does it - Presentation

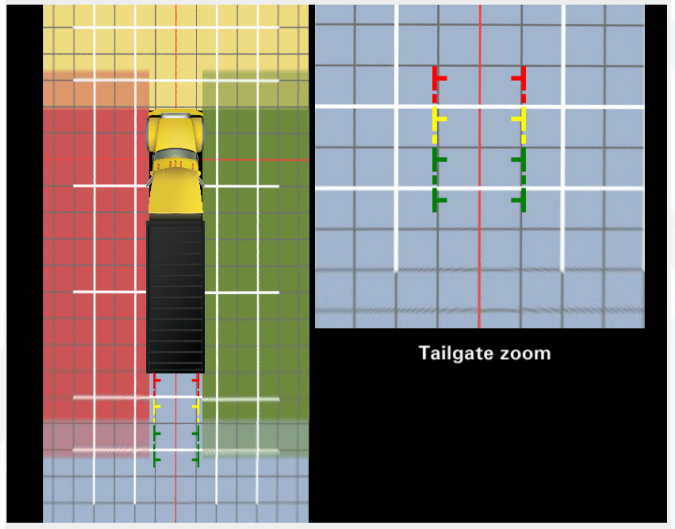
- **ASL360 can present:**
  - Coherent surround views
    - Merged camera images (Cameras must be calibrated)
  - Auxiliary views
  - Vehicle & overlay bitmaps, logos, text
  - Multiple screens

- **Design created with ASL Configuration Tool**

- **Design must be downloaded to ECU**



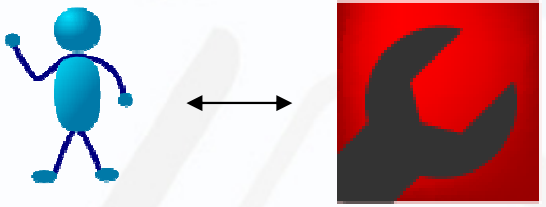
Design



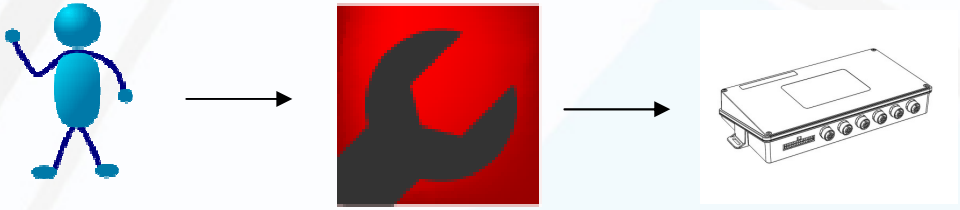
ASL Configuration Tool

- **PC based application**
- **Calibration**
  - Defines Camera data (Camera Pose)
  - Semi-automatic process
  - Offline working possible

- **User Interface Design**
  - Screen layouts
  - Interactive
  - Best done offline



- **Download to ASL360 ECU:**
  - User Interface Designs
  - Camera data



Calibration - overview

- **Perspective correction:**
  - Needed due to camera mounting tolerances affecting the orientation of the camera
  - Achieved by determining complete and precise camera *pose*
- **Camera pose is fully defined by:**
  - Position: 3 measurements in 3D space
  - Orientation: 3 angles defining the direction and rotation of the camera's centre ray
- **Fractions of degree matter**
  - Even small errors result in mismatch in the surround view where the contribution from adjacent cameras meet
- **Configuration Tool requires:**
  - Precise measurement of the position of each camera in vehicle plan view
  - Approximate measurement of the height of each camera
  - Very approximate orientations for each camera (default values are provided)
- **Configuration Tool determines precisely for each camera:**
  - Camera height
  - Camera orientation

User Interface Design - overview

- **Screen layout:**
  - Surround view
    - Each camera contributes to part of the surround view
    - Size and nature of merges
    - Shape and extent of total view on the ground
    - Planar/Pie-dish projection
  - “Virtual camera” views
  - Other images:
    - Logos
    - Text
    - Vehicle bitmaps
  - Sizing and positioning windows on the screen
  - Multiple screens
- **Dynamic screen selection using vehicle signals:**
    - Reverse, Indicators, Tacho
- **Screen design per vehicle type**

Download to ASL360 ECU - overview

Load Design

Design +

Nominal Camera Data*

** Camera Data in the design should be default or nominal data, not specific to a particular installation*

Load Camera Data

Installation specific

Camera Data**

*** Camera Data unique to a particular installation*

Download design to ECU

Design

Download Camera Data to ECU

Camera Data

Installation – total process for first vehicle

- **Survey vehicle, find candidate camera locations**
- **Install cameras**
  - Validate camera images
- **Define precise camera positions**
  - Measurement frame of reference
- **Establish calibration and evaluation area**
  - Design calibration grid
  - Typically requires area > 2 m around periphery of vehicle
- **Lay out calibration grid**
- **Locate vehicle on grid**
  - Precise location is not necessary
- **Perform calibration (Configuration Tool)**
  - At vehicle, or
  - Off-line from camera snapshots
- **Evaluate calibration**
- **Design User Interface**
- **Download design and camera data to ECU**

Installation – process for series vehicles

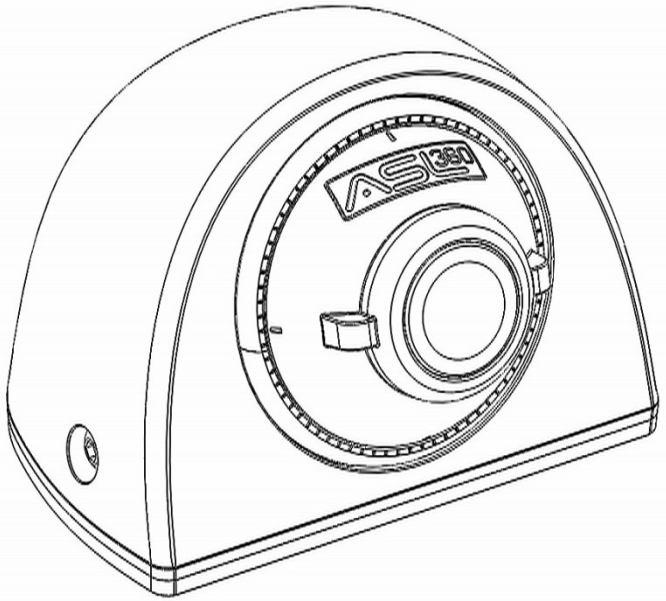
- Survey vehicle, find candidate camera locations
- **Install cameras**
  - Validate camera images
- Define precise camera positions
  - Measurement frame of reference
- Establish calibration and evaluation area
  - Design calibration grid
  - Typically requires area > 2 m around periphery of vehicle
- Lay out calibration grid
- **Locate vehicle on grid**
  - Precise location is not necessary
- **Perform calibration (Configuration Tool)**
  - At vehicle, or
  - Off-line from camera snapshots
- **Evaluate calibration**
- Design User Interface
- **Download design and camera data to ECU**

Installation – survey vehicle

- **Determine the extent of the ground to be visible in the final surround view**
  - The cameras between them must have sight of this ground
- **Determine if there are special risk areas**
  - Ensure these are covered by view from one camera
- **Enough overlap between neighbouring cameras**
  - Recommend in excess of 2 m
- **Higher the better**
  - Minimises “stretching” of vertical objects
- **Clear view of ground**
  - Avoid positions where a nearby object is in camera’s view
- **Identify rigid, static structure for camera mounting, which**
  - Allows for maintenance
  - Protects from impact damage
  - Minimises exposure to dirt

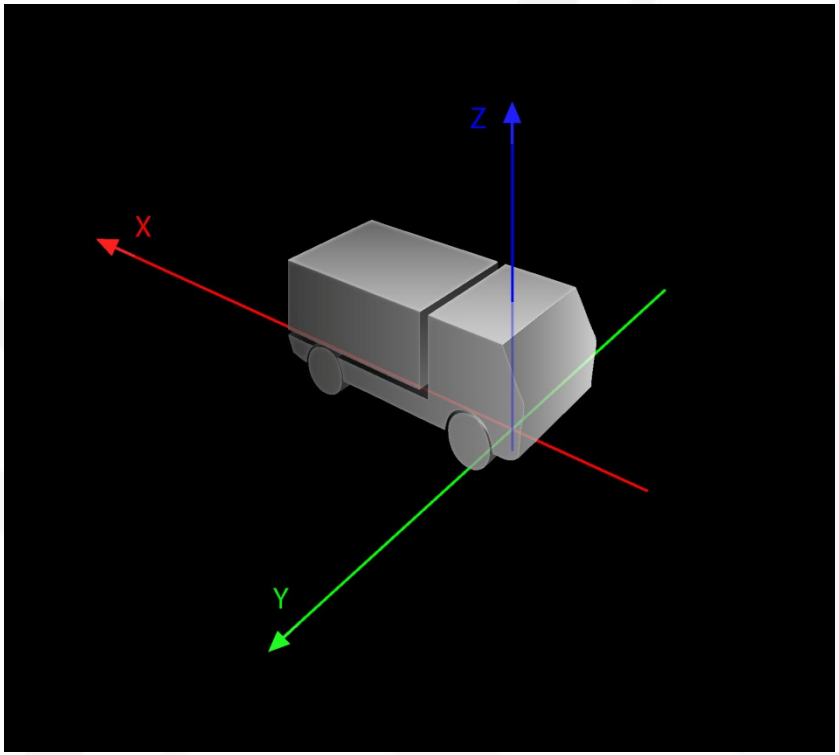
Installation – install cameras

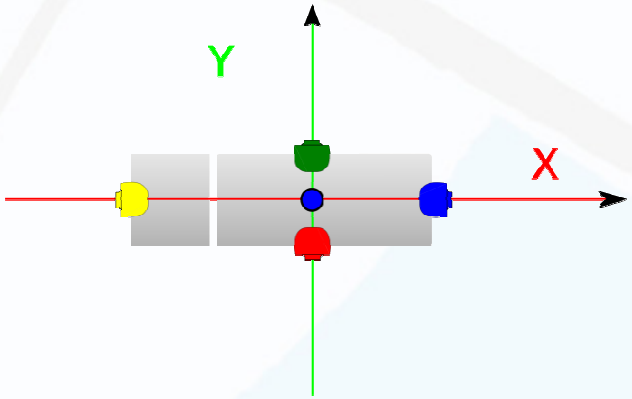
- **Locate on solid structure**
- **Use suitable fixings**
  - Compatible with the nature of the mounting surface
- **Use isolation bushes provided**
- **Cable installation**
  - Prevent damage from impact and chaffing
  - Observe the minimum bend radius
  - Allow enough slack so in-line connector can be accessed from outside
  - For long cable runs:
    - extension cables may be joined together
    - custom cable fabricated
- **Configuration Tool can show raw images**
  - Validate camera location
  - Validate installation



Installation – measurement frame of reference

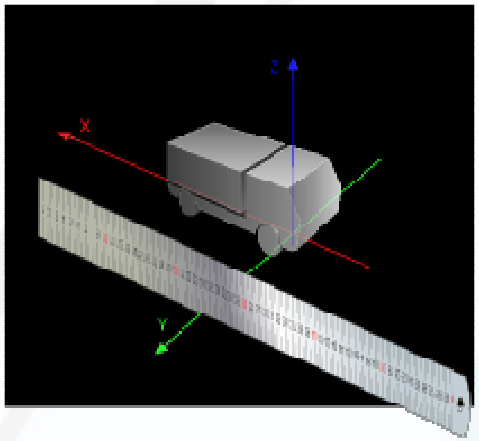
- **Axes:**
  - X axis lies on the vehicle centre line
  - Y axis parallel to axles
  - Z axis height above ground
- **Camera position is the distance from the datum on each axis:**
  - X mm, Y mm, Z mm
- **Datum is where X = 0, Y = 0, Z = 0**
- **Datum as shown right:**
  - Mid-point between point of contact of front wheels, on the ground
- **Choose alternate X, Y datum**
  - Easiest direct measurement of relative camera position
  - Easier to measure: less error

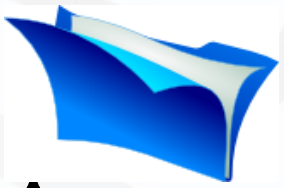


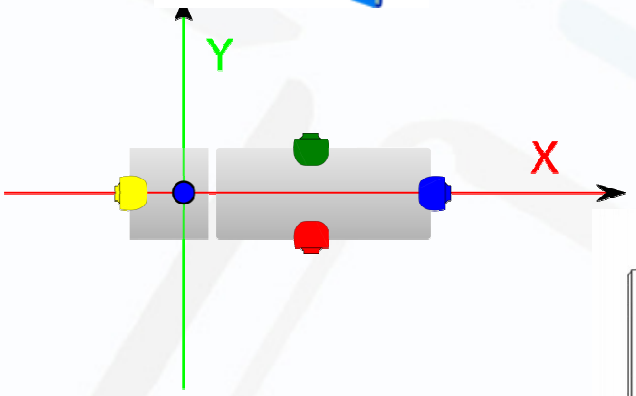


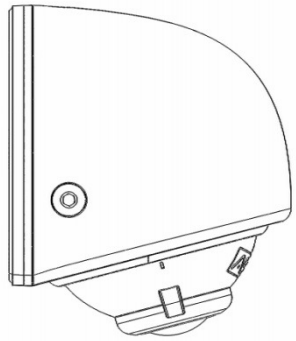
Installation – define camera positions

- **Measurement frame of reference**
  - ASL360 uses the X,Y,Z frame of described
- **Measure to the camera's lens**
- **CAD drawings**
  - Convert axes, translate datum
- **Position measurement**
  - Measurement precision
    - X, Y axis: +- 10 mm
    - Z (height): +- 100 mm
- **Orientation**
  - For cameras in, or approximately in, standard position and standard orientation (i.e. mounted vertically, as shown right), default rotations are provided



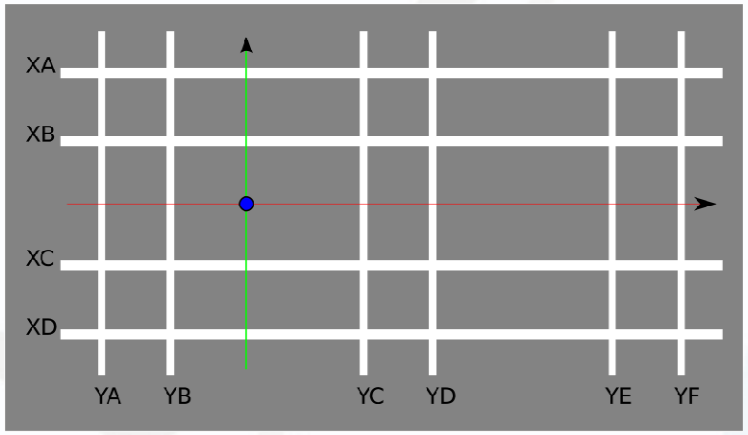


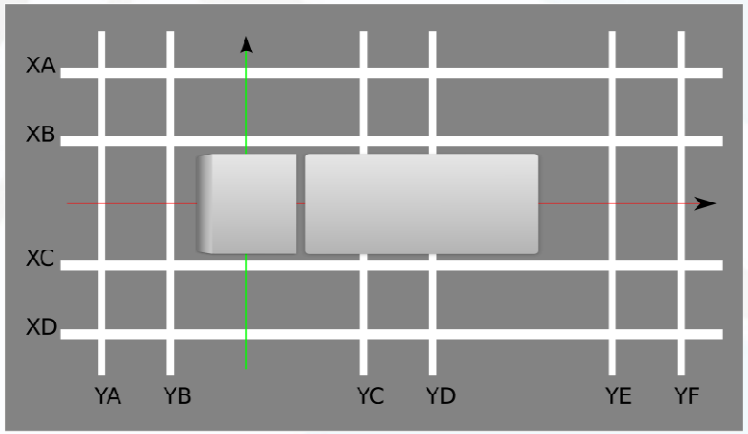




Installation - design calibration grid

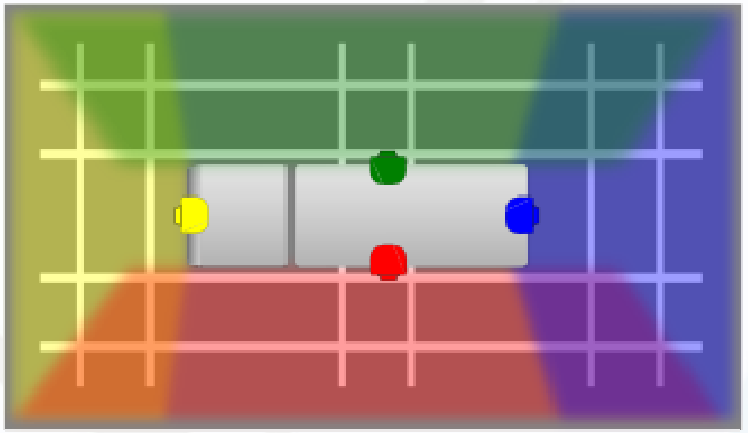
- **Ground – flatter the better**
  - < 50 mm deviation from flat
  - Need not be level
- **Lines must:**
  - Occupy large part of cameras view
  - Have no significant height (< 5 mm) – painted lines or tape work well
  - Be wide enough (50 mm for small vehicles, 100 mm for large vehicles)
  - Have sufficient separation: line pairs to be 1500 mm – 2000 mm apart
  - Be genuinely straight (deviate by < 10 mm over line length)
  - Clearly visible – white lines on a dark floor work well; avoid relying on colour contrast
  - Be parallel:
    - Lines XA XB XC XD must all be parallel (< 10 mm deviation over line length)
    - Lines YA YB YC YD YE YF must all be parallel (< 10mm deviation over line length)
- **Ideally:**
  - YB and YE need to be close to the vehicle, but still visible to front and rear cameras





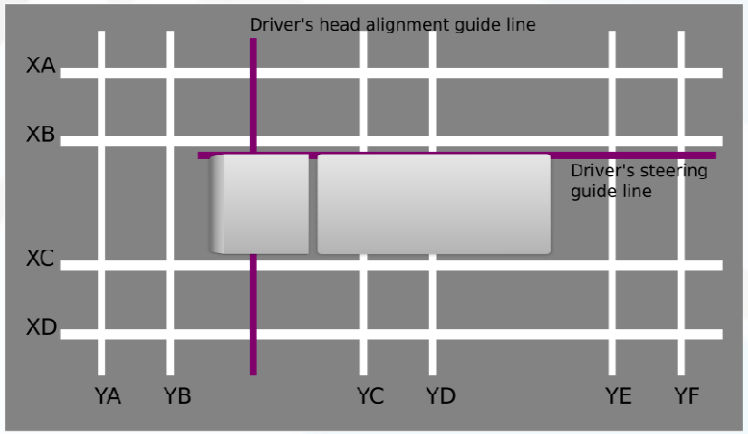
Installation – lay calibration grid, position vehicle

- **Lines pairs need not:**
  - Be at perfect right angles
  - Have identical separation distances
- **Vehicle alignment**
  - Not necessary to carefully position vehicle, but
  - Each camera must see its part of the grid (diagram right)
    - 8 line intersections



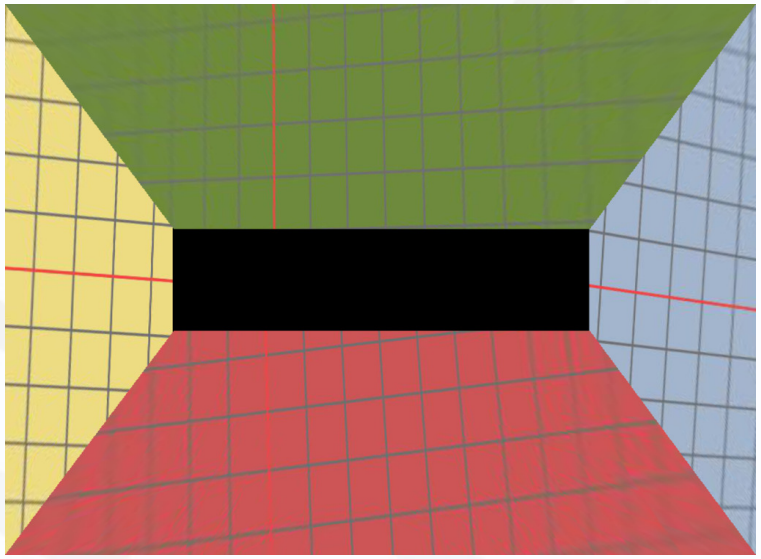
- **Grid also useful for post calibration evaluation**

- **Consistent vehicle position**
  - In series production useful when assessing the surround view after camera set-up
  - Driver's guidelines may be added to grid (diagram right)

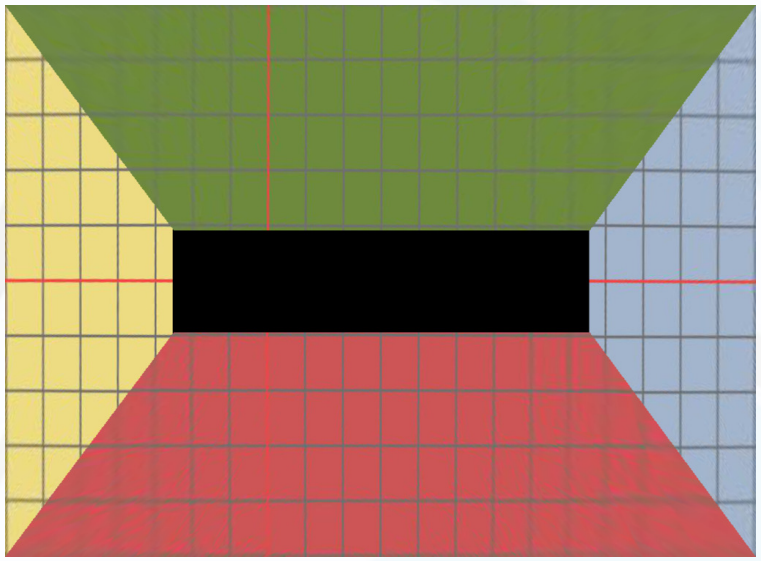


Calibration - overview

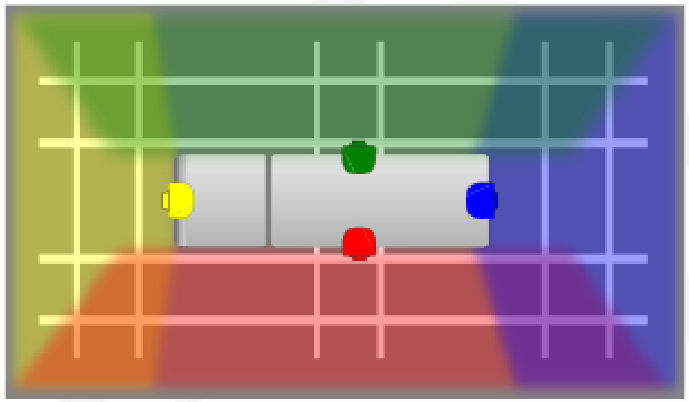
- **After installation ECU does not know exactly where the cameras are pointing**
  - Disjointed surround view

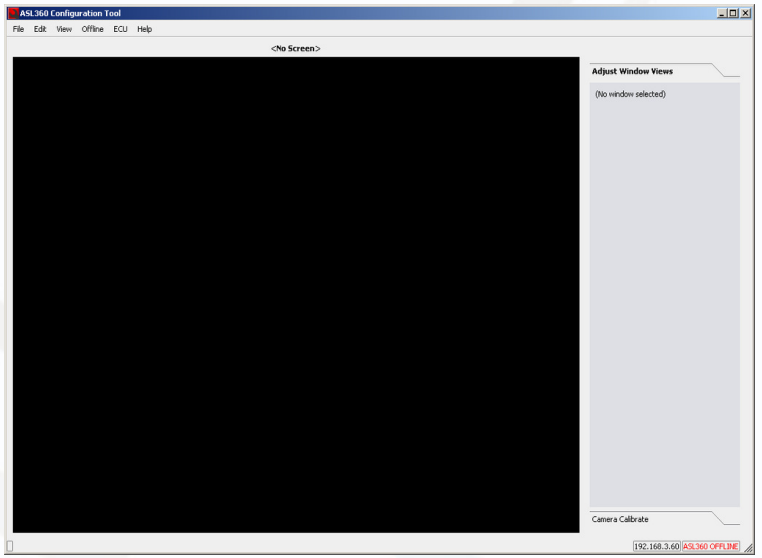


- **After calibration, ECU knows exactly where the cameras are pointing**
  - ECU can apply necessary corrections to make a coherent surround view



Calibration – getting started





- **Preconditions:**
  - ASL360SV system correctly installed and functional
  - PC configured with static IP address of 192.168.3.1
  - ASL360SV ECU connected via Ethernet to PC
  - Vehicle correctly positioned on the set-up grid
  - ASL360SV system powered
  - ASL Configuration Tool started

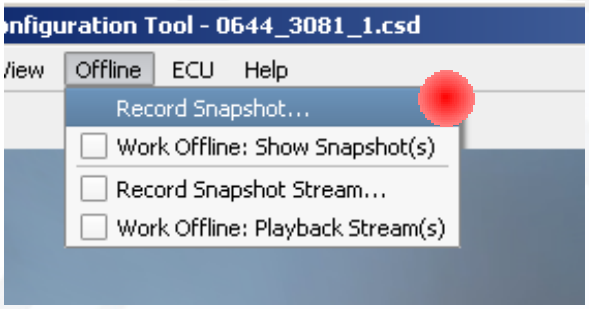
Calibration – online v. offline

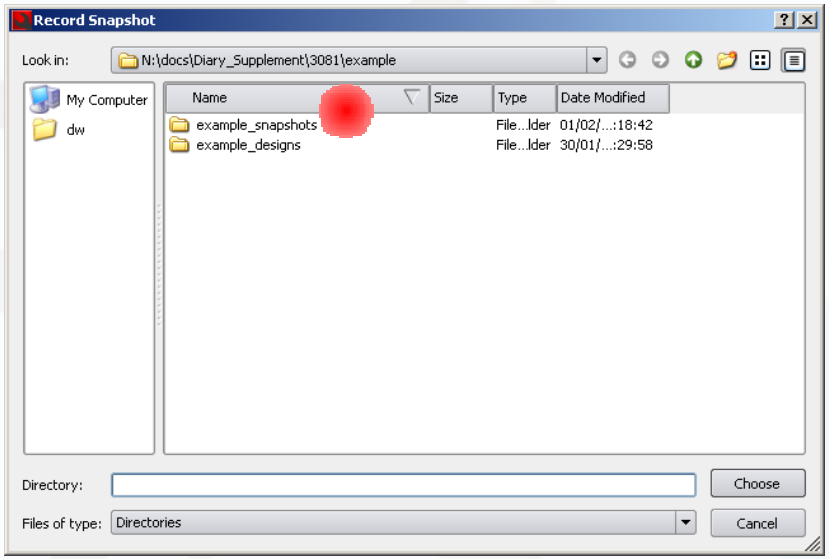
- **Online**
  - When Configuration Tool is connected to live ECU
  - Live video from ECU available to view in Configuration Tool
  - Snapshots of live video may be taken and stored

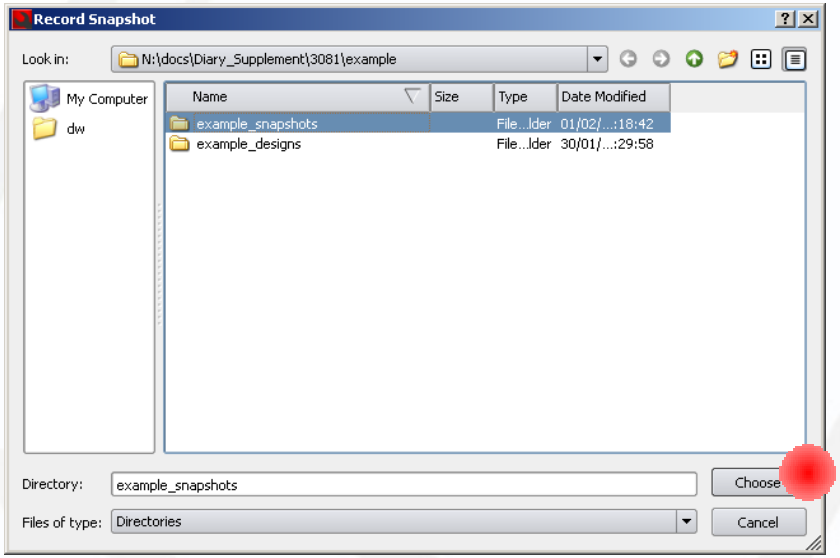
- **Offline**
  - When Configuration Tool is not connected to a live ECU
  - Configuration Tool can use previously stored snapshots
  - Configuration Tool examples in this presentation generated offline

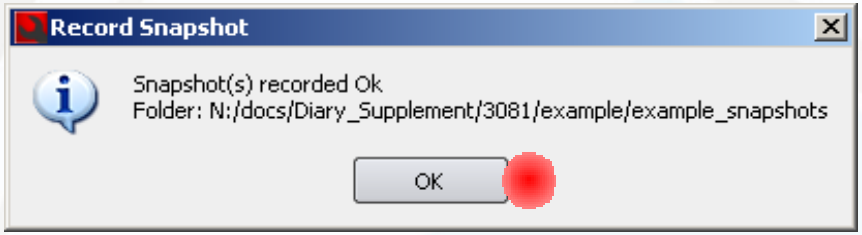
Calibration – saving snapshots

- **Select the folder where the snapshots are to be stored**
  - All 4 camera images are stored

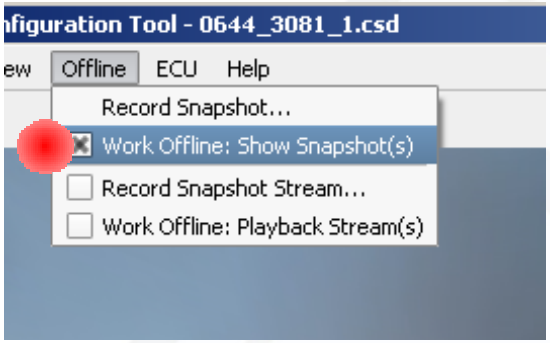


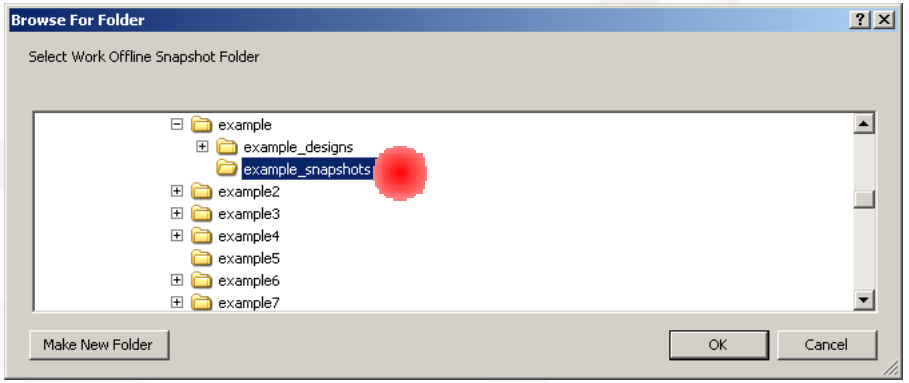






Calibration – loading snapshots

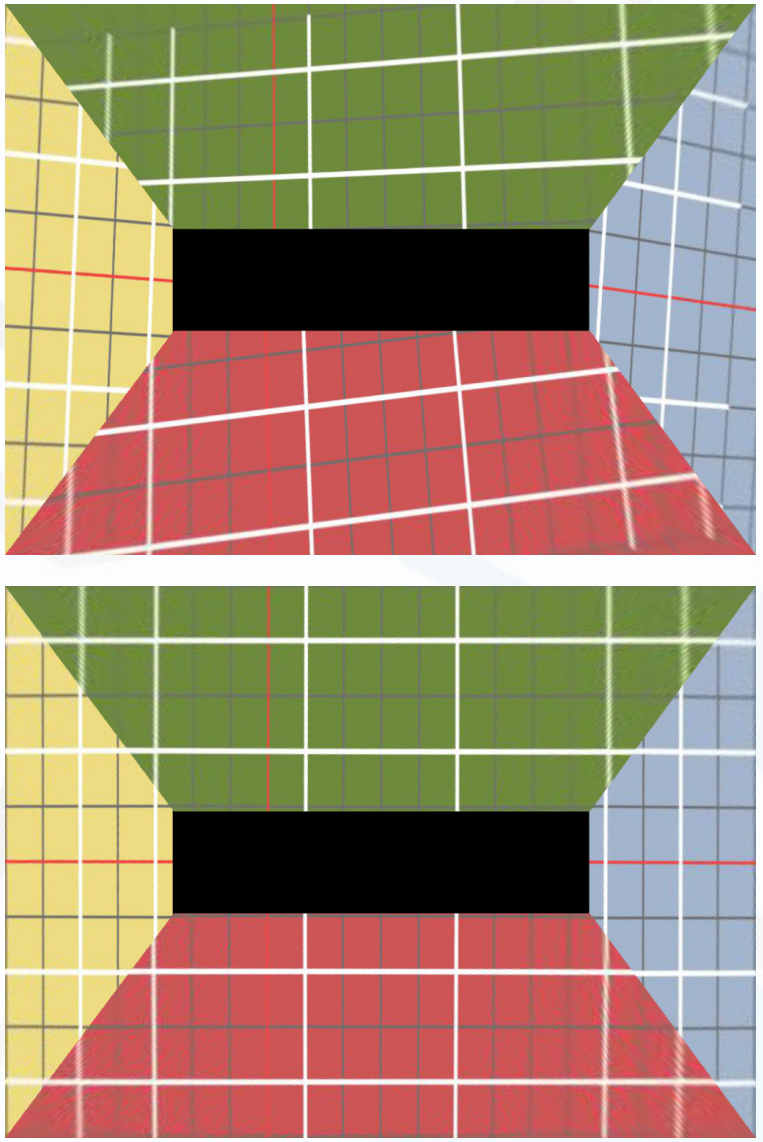




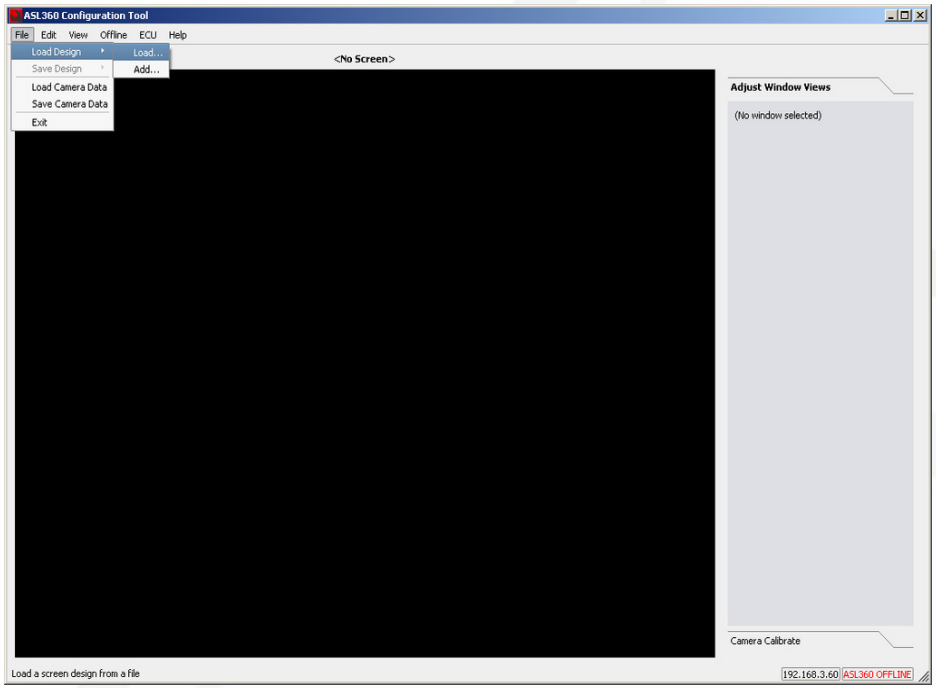
- Select the folder where the snapshots are stored
  - All camera images are loaded

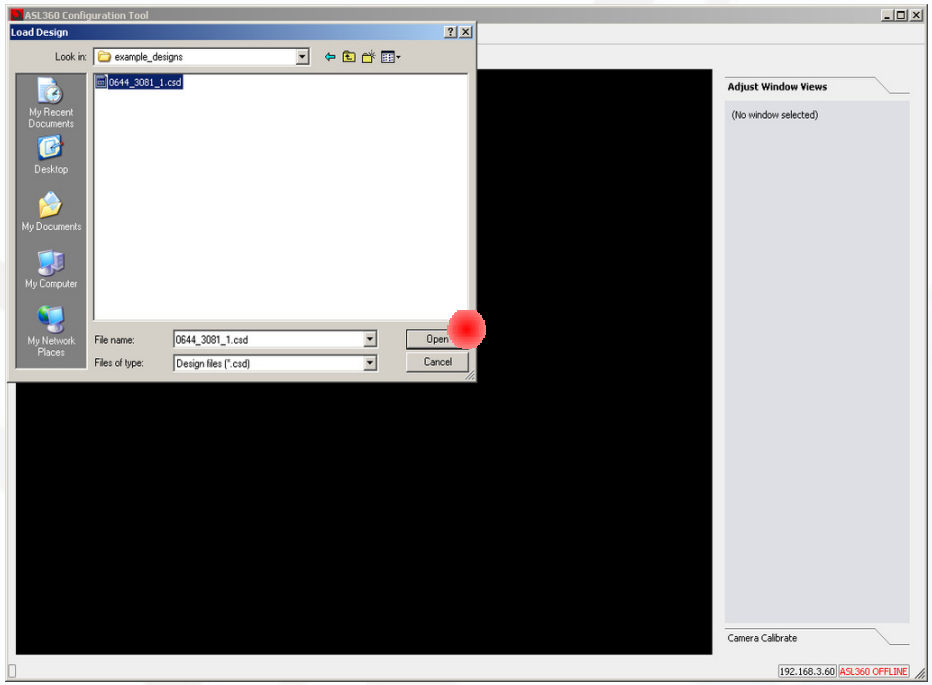
Calibration – visualisation

- **Useful to see ‘before’ and ‘after’**
  - Critically evaluate calibration quality
- **Load / create a design to see calibration area**
- **Design is:**
  - Intended for calibration visualisation
  - Not intended for download to ECU
    - (but it could be)



Calibration – load design

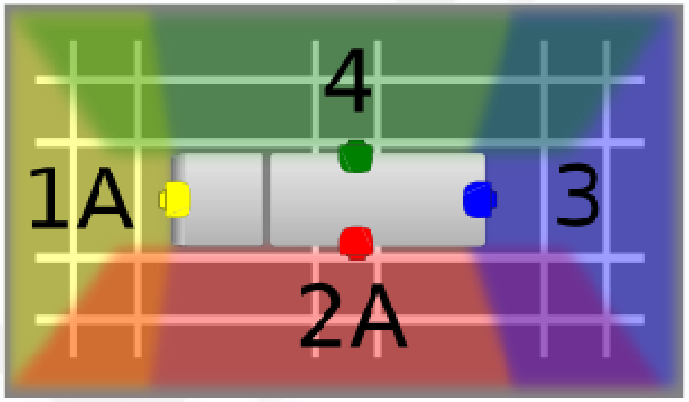


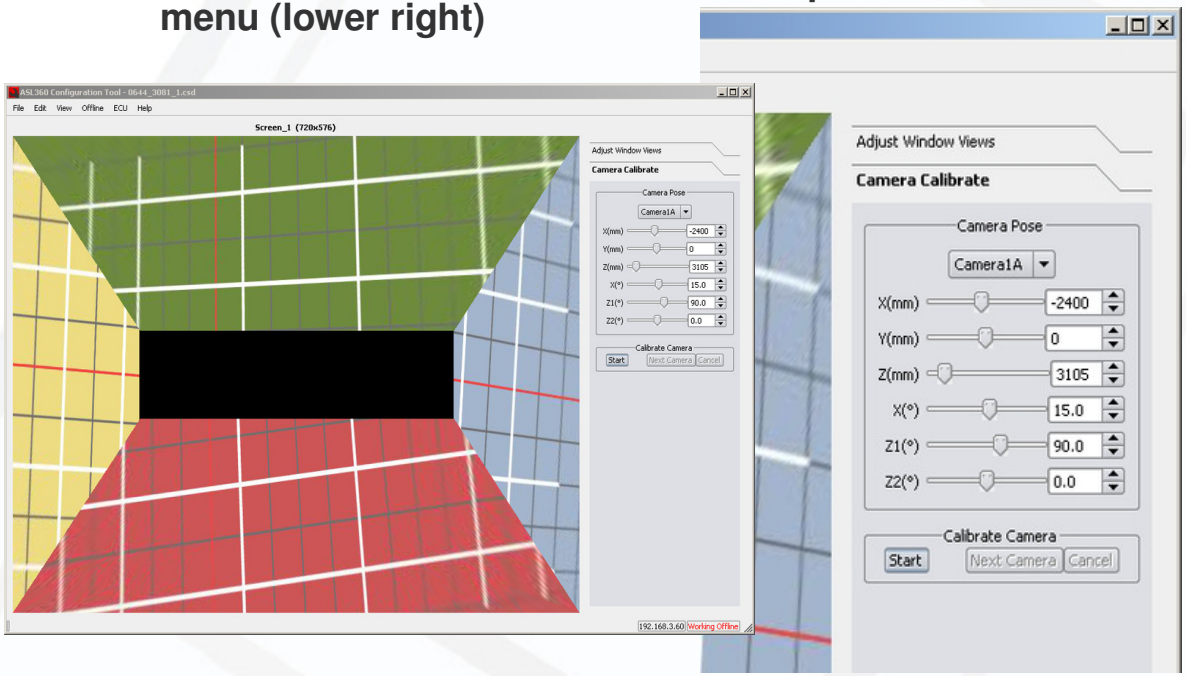


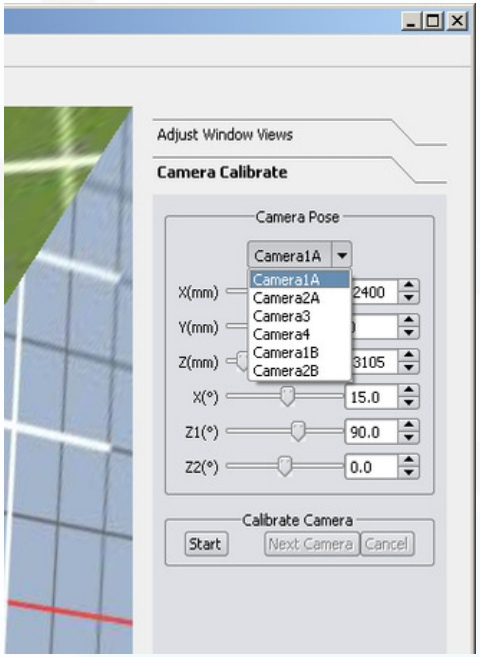
- **Configuration Design files have "csd" file extension**
  - E.g. 0644_3081_1.csd
- **Calibration visualisation csd file**
  - Assume a csd file has already been prepared for this vehicle
  - Generating design

Calibration – check camera position data

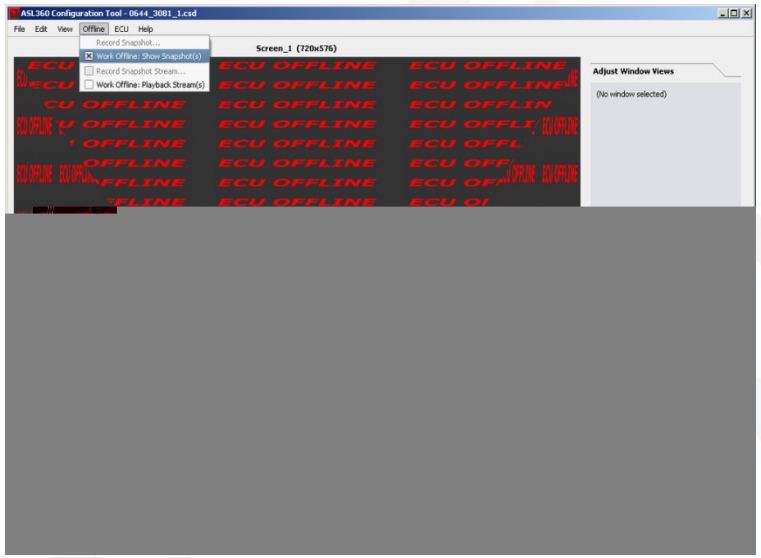
- **csd file should hold nominal camera pose values**
  - (default camera orientation can be obtained from camera_pose_defaults.csd - supplied)
- **Cameras are numbered (see right)**
- **Select ‘Camera Calibrate’ tab**
- **Ensure camera positions and default orientations are correct**
- **All cameras can be accessed via drop down menu (lower right)**

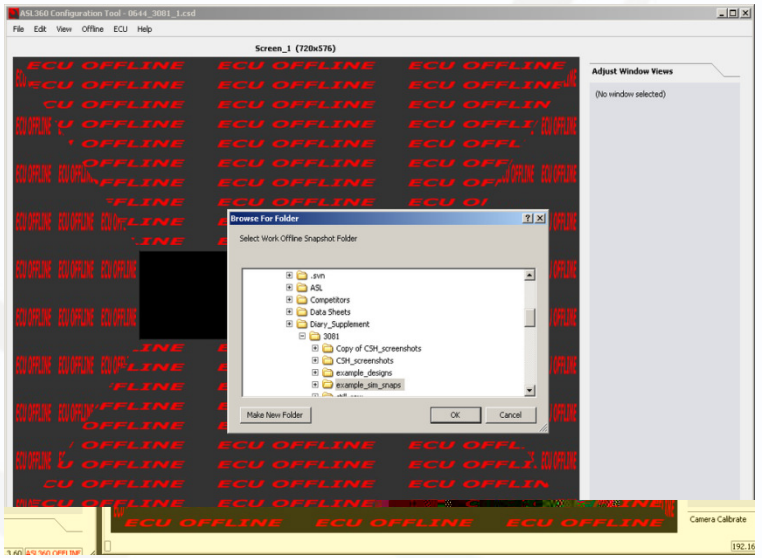


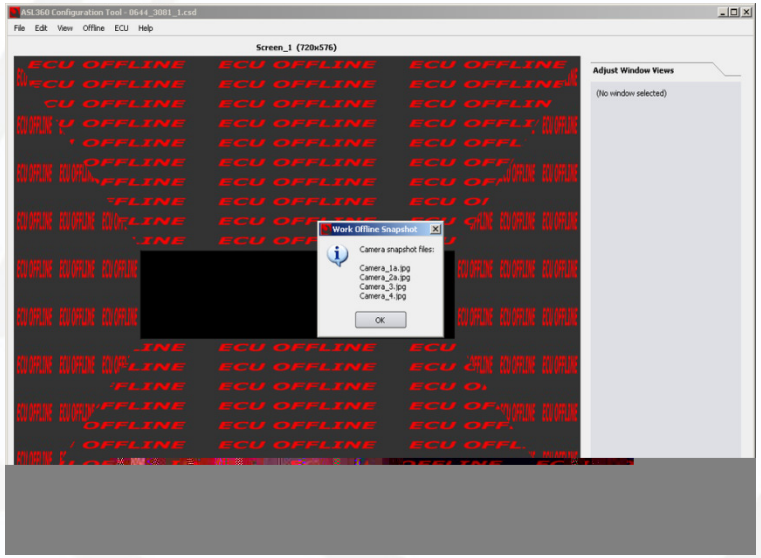


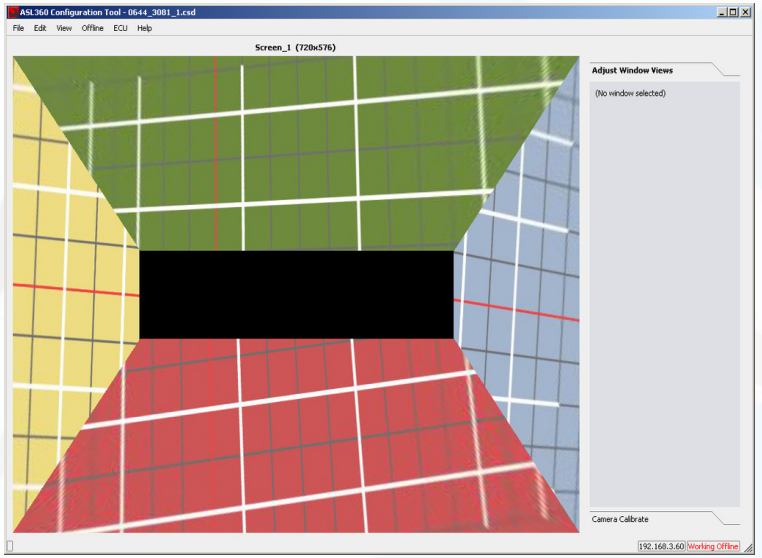


Calibration – load snapshots



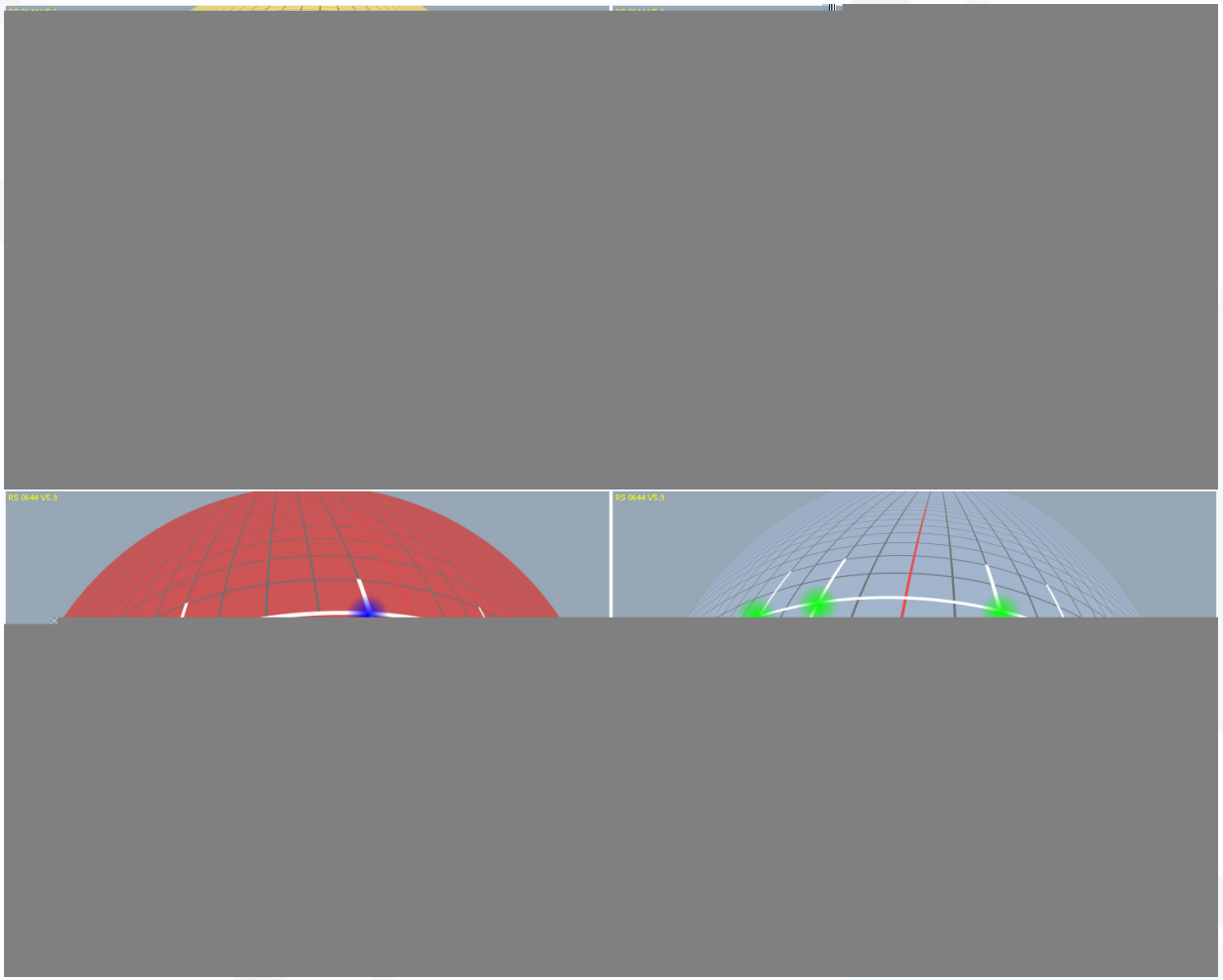




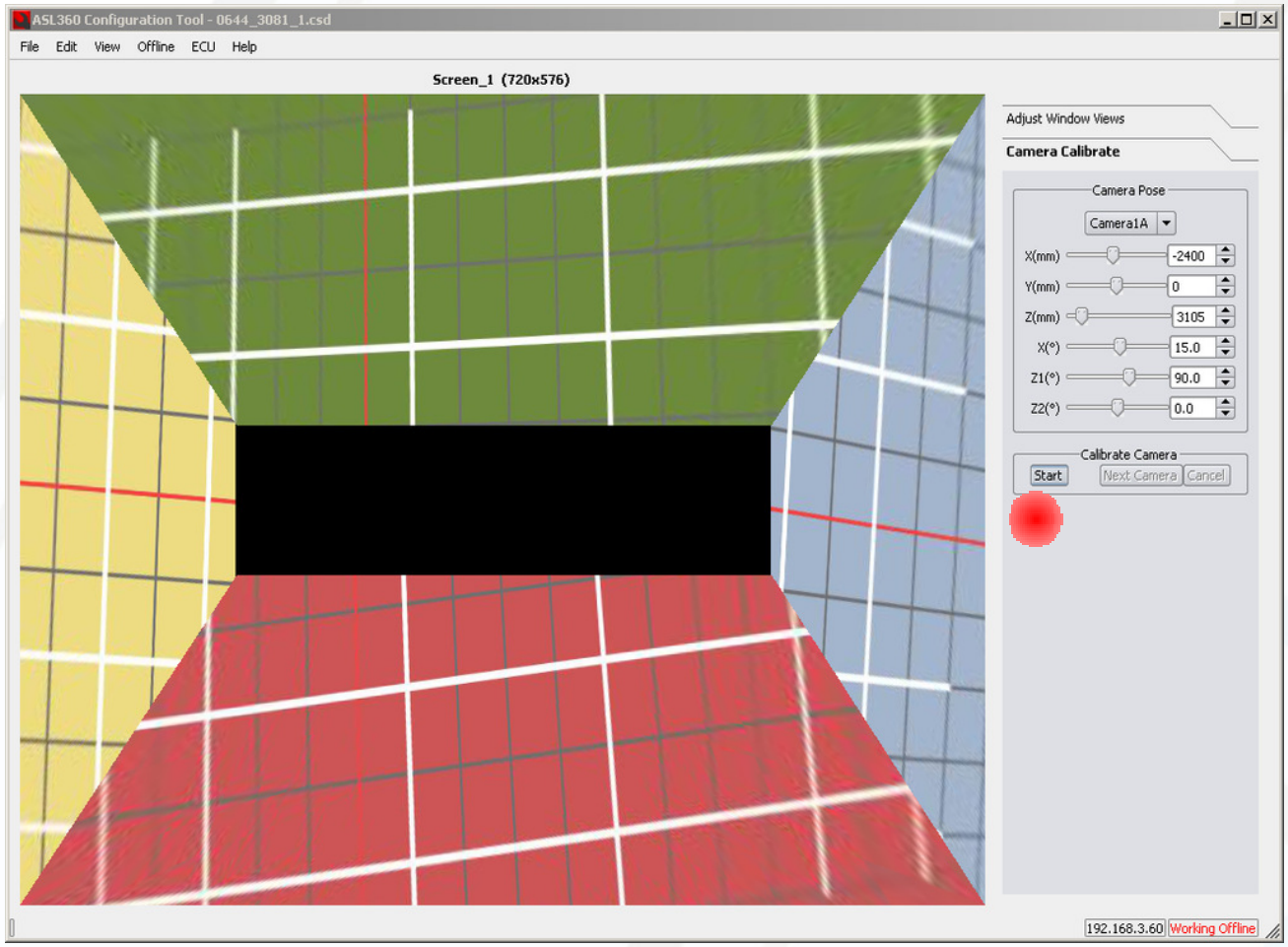


Calibration – the task

- **Semi-automatic process**
  - Exactly the same online or offline
- **User must nominate intersection points in each camera image**
  - User is presented with each camera image in turn
  - User selects 8 points (shown right)
- **Configuration Tool will compute camera pose to achieve coherent surround view**

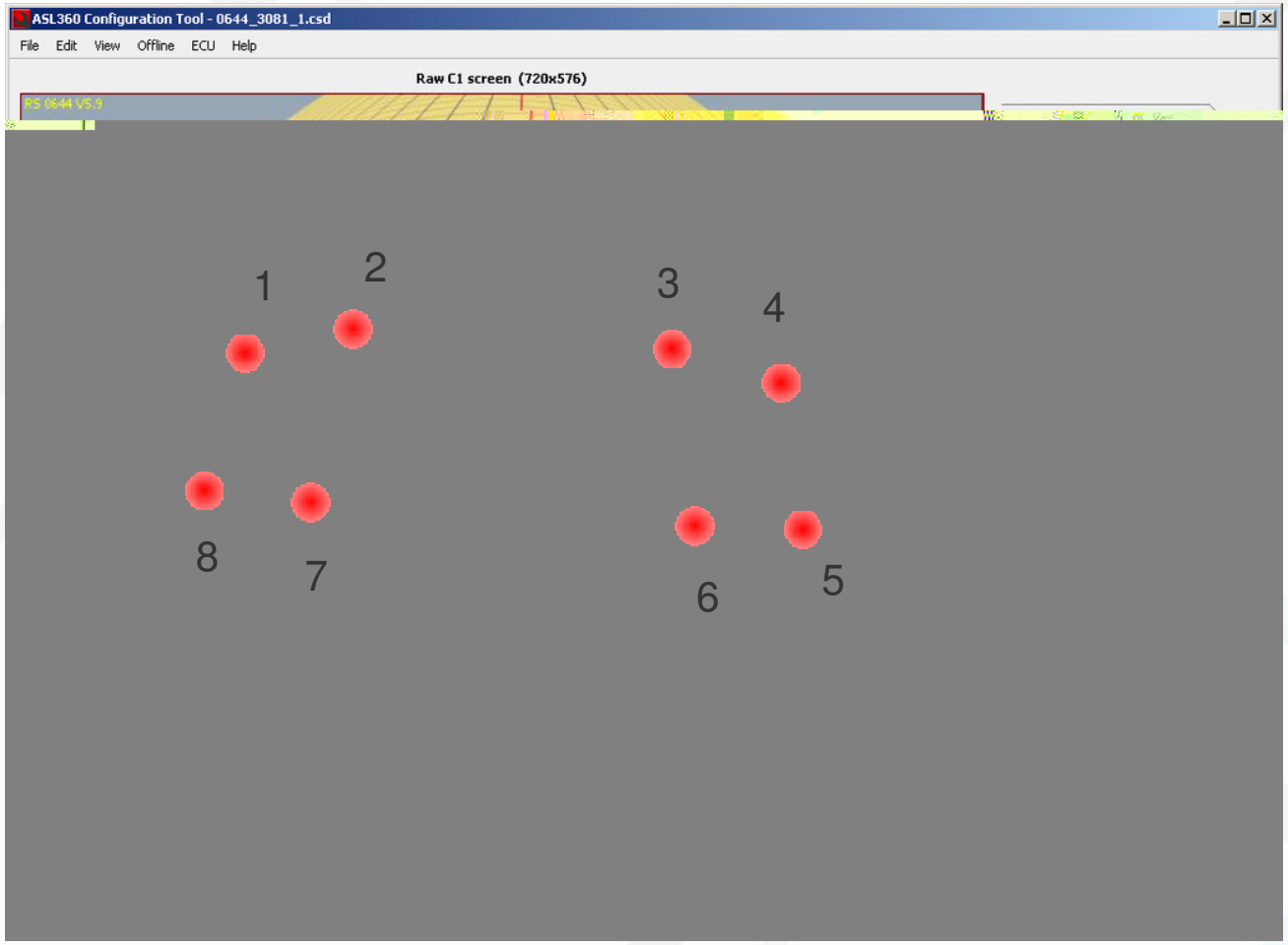


Calibration – start calibration



- **Click ‘Camera Calibrate’ tab**
- **Click ‘Start’ button**

Calibration – task recap – first camera

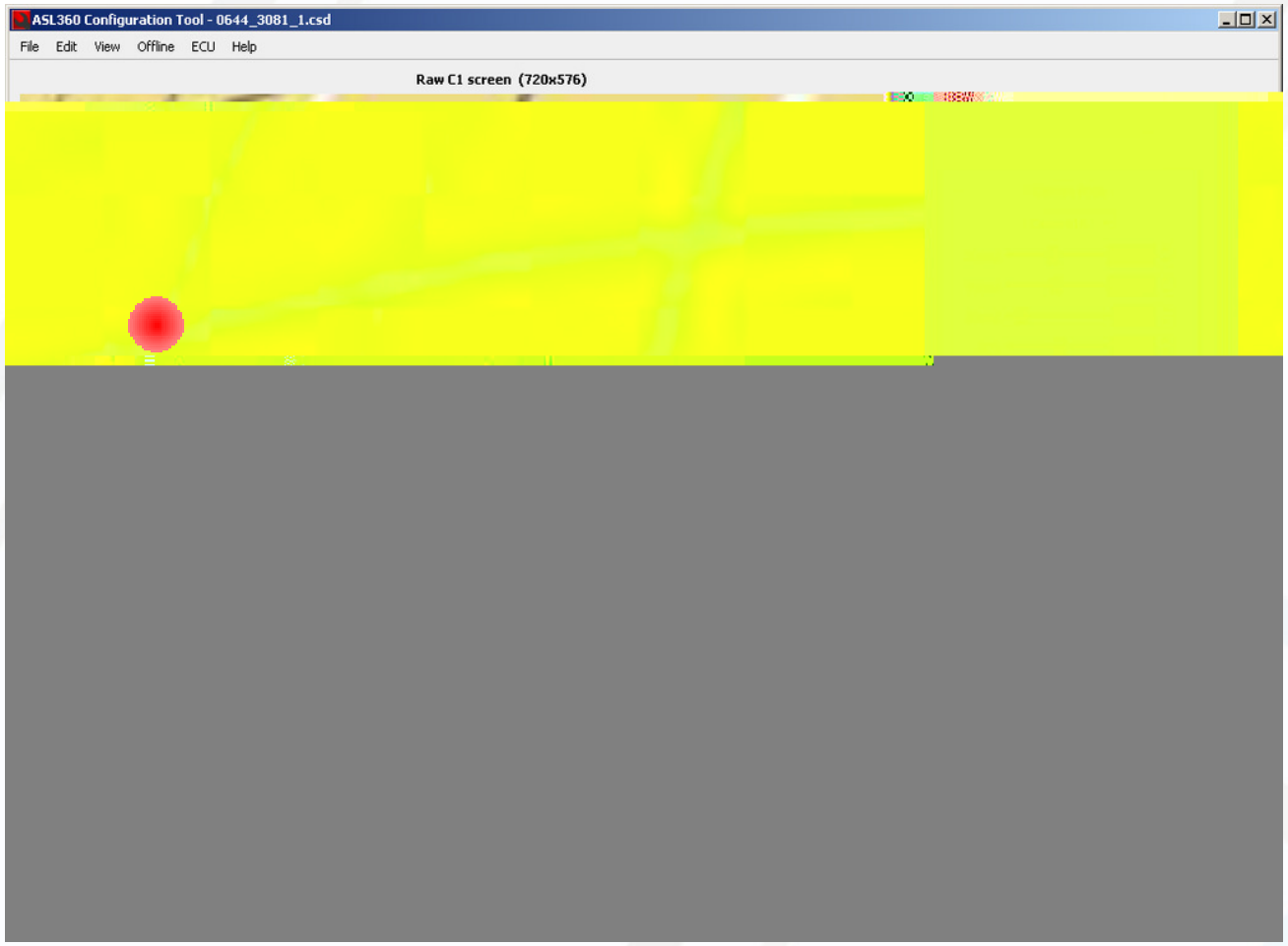


- First camera (1A) is presented
- Task is to mark the 8 intersection points – in the order shown above

Calibration – first camera

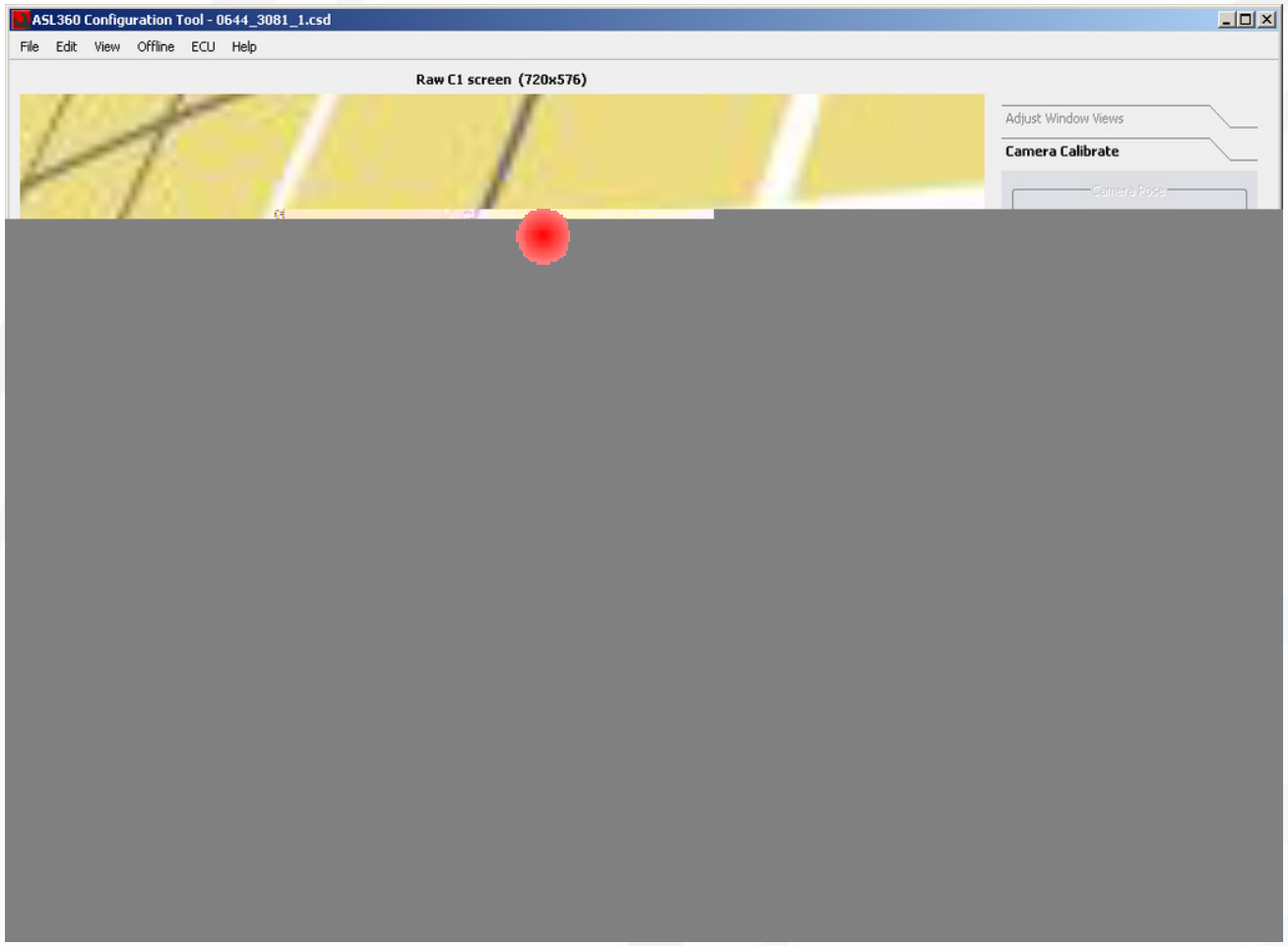
- **Holding ‘Alt’ key will zoom in on the current mouse position**

Calibration – first camera



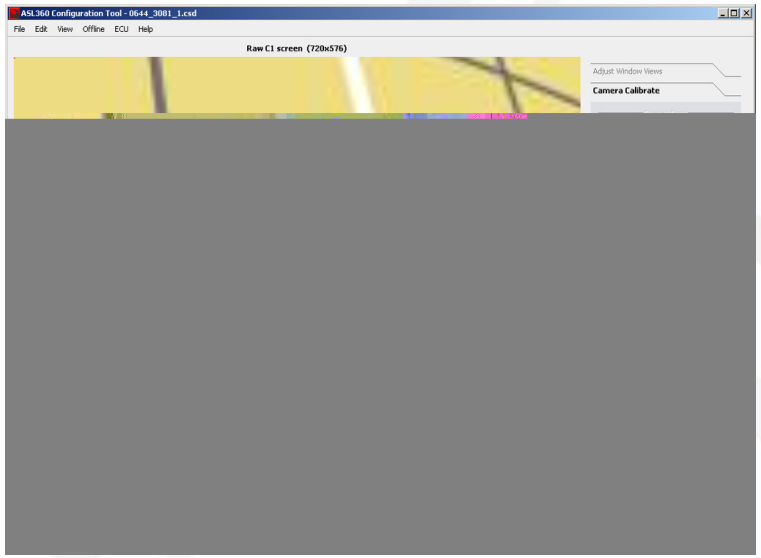
- Holding ‘Alt’ key, position mouse on first intersection
- Click mouse left button to mark point (+)

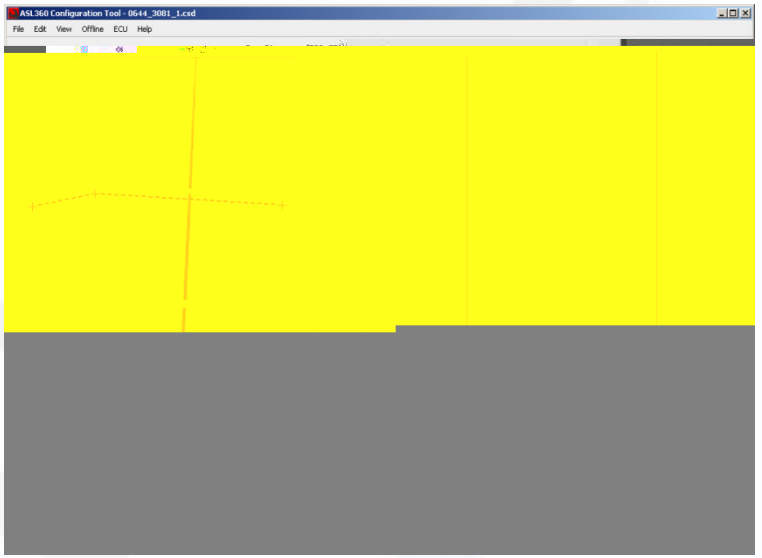
Calibration – first camera

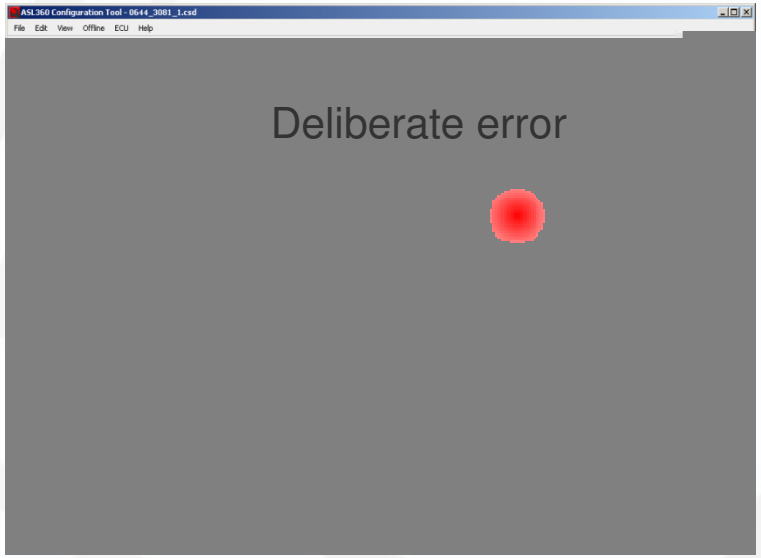


- Mark 2nd point
- Note red dotted line connects marked points

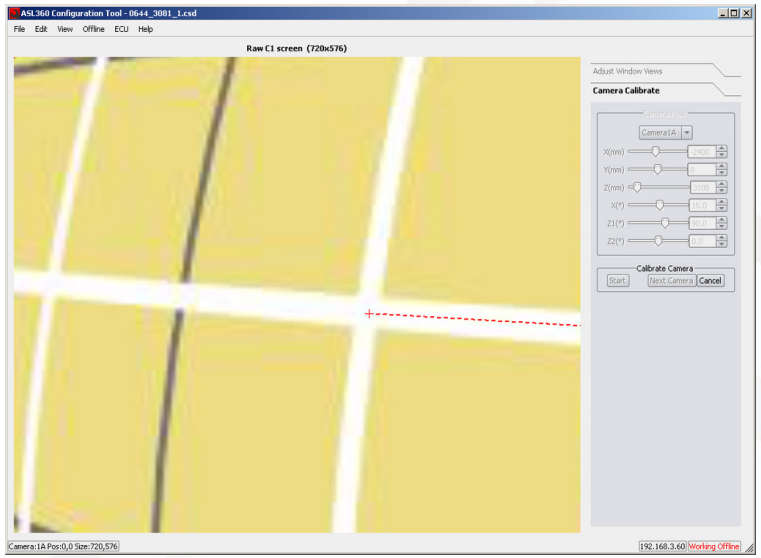
Calibration – first camera



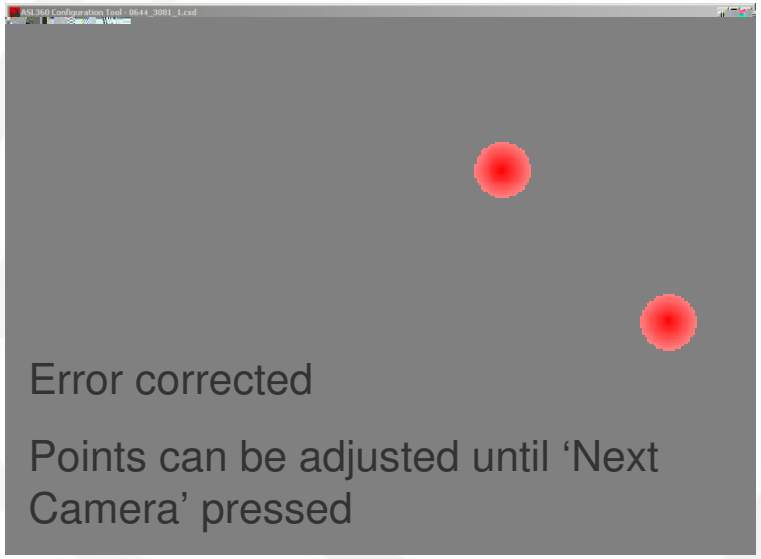




Calibration – first camera

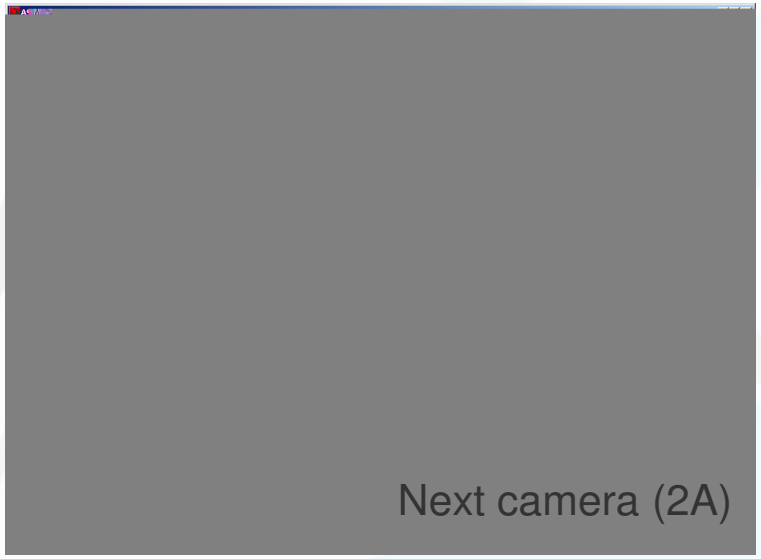


Deliberate error



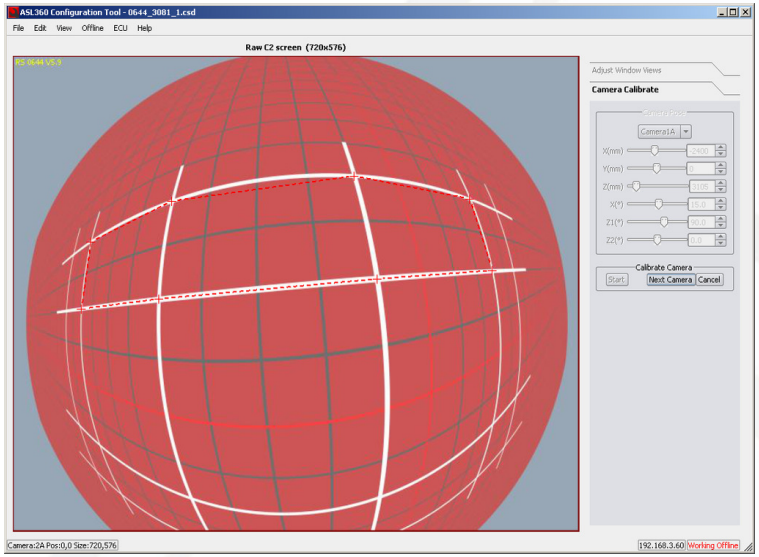
Error corrected

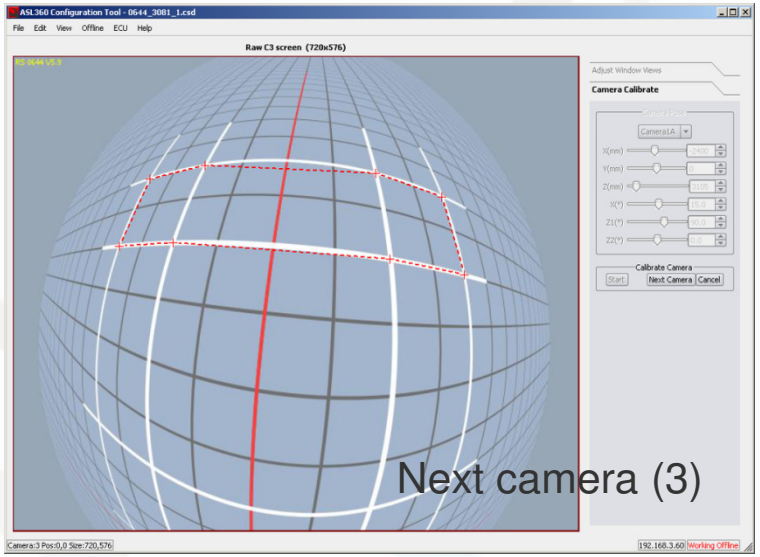
Points can be adjusted until ‘Next Camera’ pressed

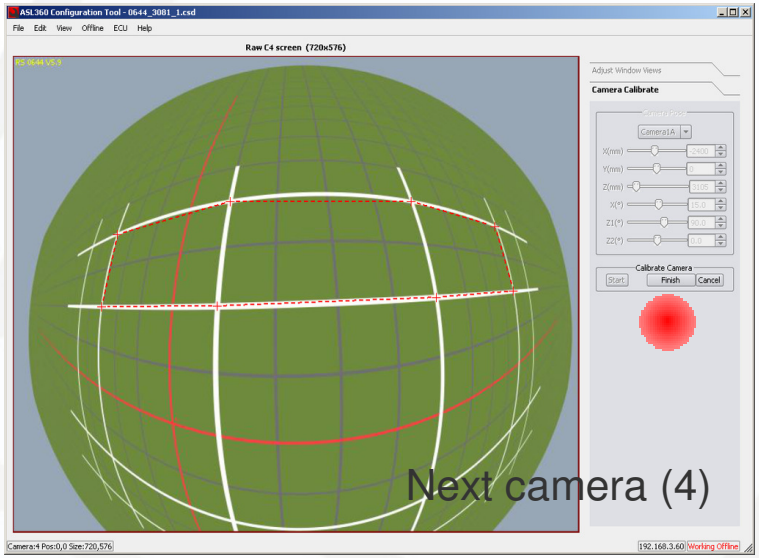


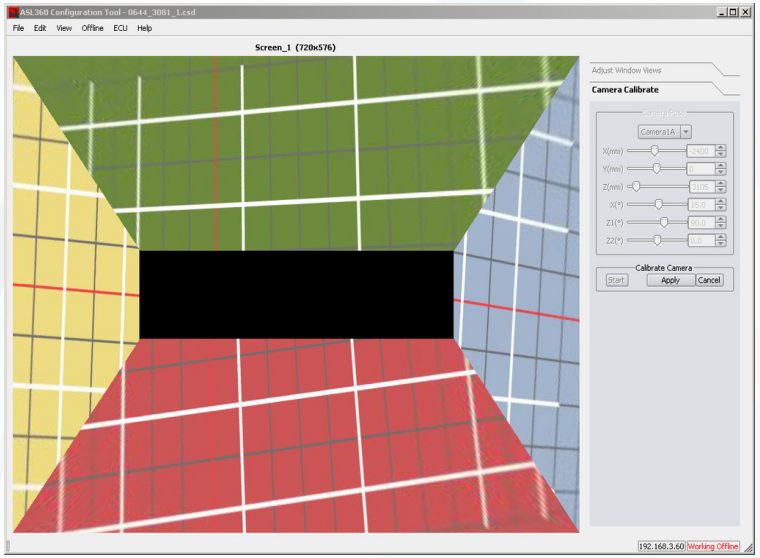
Next camera (2A)

Calibration – remaining cameras

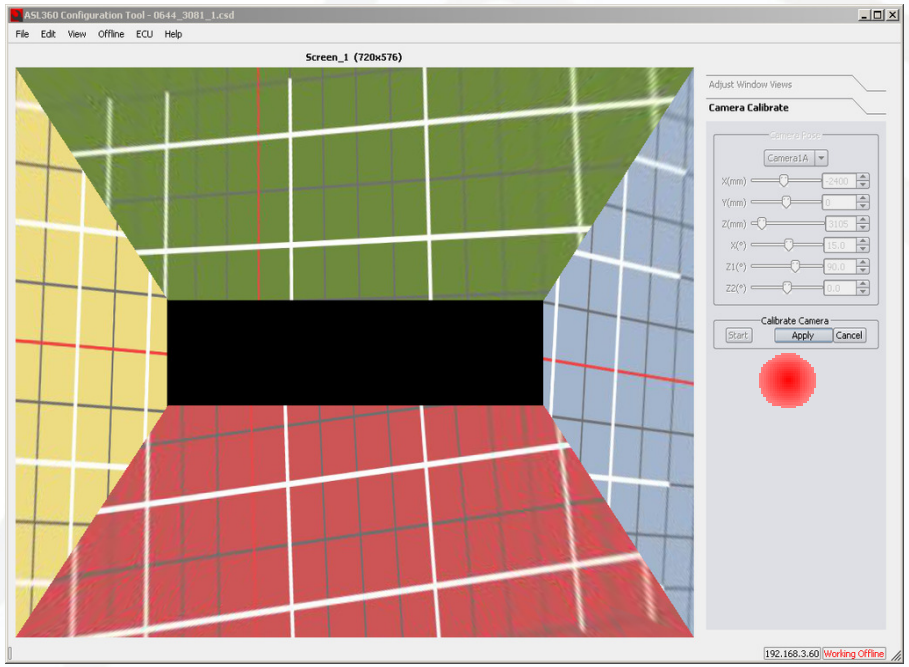


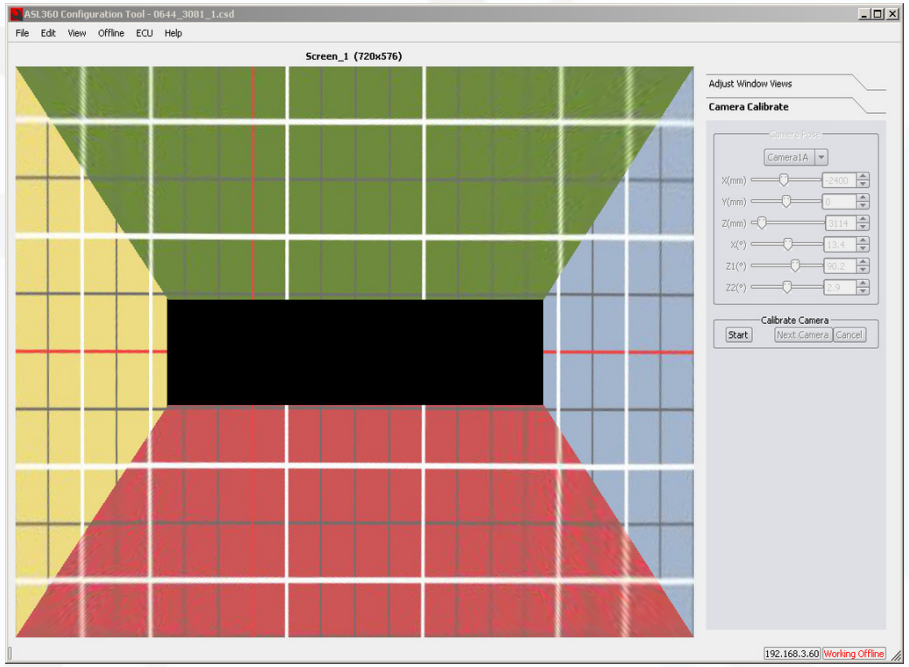






Calibration – completion





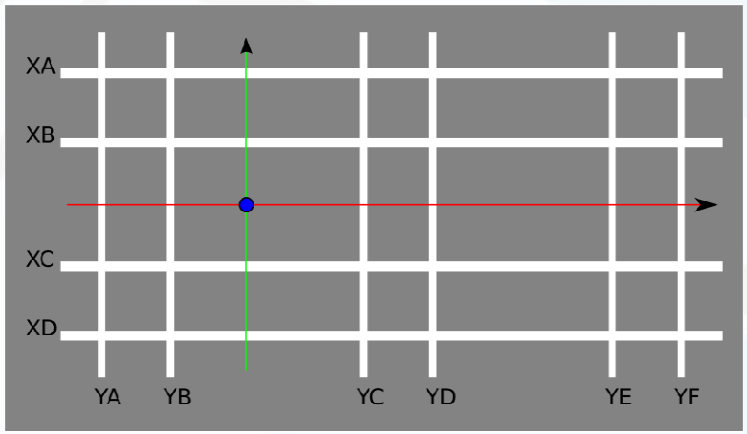
Calibration – evaluation

- **Configuration Tool tests the quality of the calibration**
- **3 possible outcomes:**

Calibration quality	Warning message	Subsequent actions
GOOD	*None*	User to check the surround view.
ACCEPTABLE	"The camera calibration is complete but the result is poor. Please critically evaluate the surround view and consider re-calibrating. Press Cancel to restart calibration, Press OK to continue.”	On pressing OK: The surround view display is updated for review by the operator.
UNUSABLE	"The camera calibration is complete but the result is unusable (Error #)"	On pressing OK: The display is not updated. The user should attempt to re-calibrate.

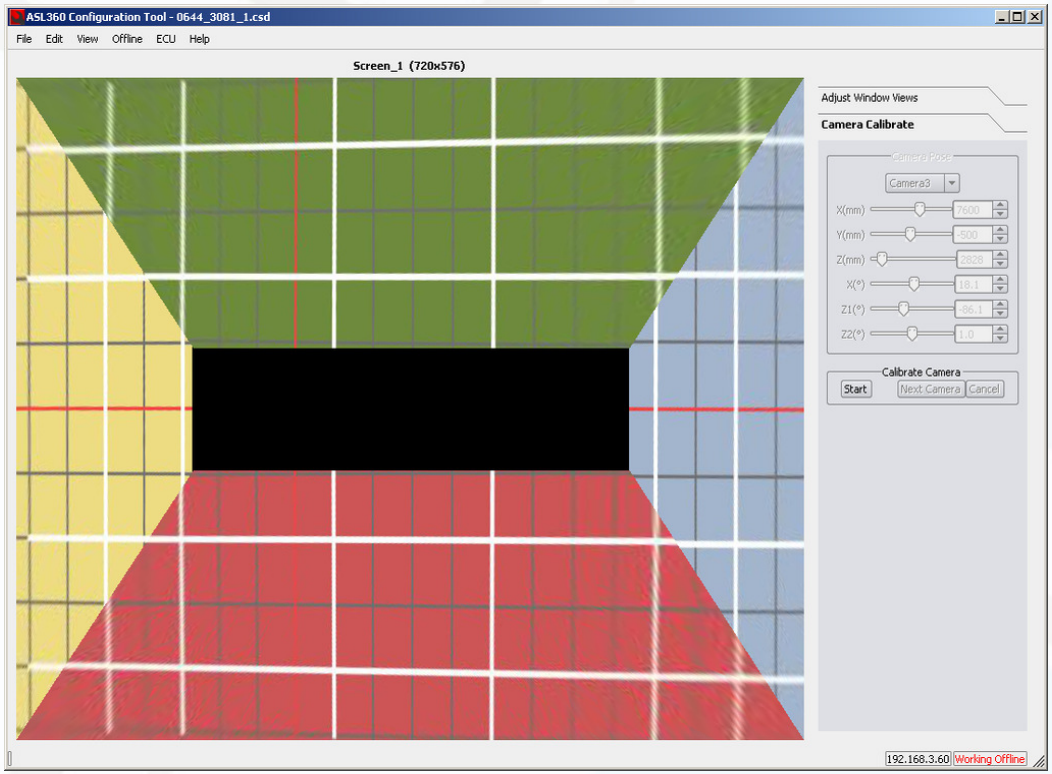
Calibration – evaluation

- **Factors causing poor calibration results:**
  - Imprecise ‘clicking’ on grid intersections
  - Some intersections too far from camera
    - Grid lines YB and YE need to be close to the vehicle
  - Errors in the stated camera X or Y positions
    - Incorrect sign (e.g. missing – sign)
    - Transposed x and y measurements
    - Certain systematic small X or Y errors have a signature effect (next slide)
    - Very small errors may not be detected by Configuration Tool
  - Errors in the grid
    - Lines not parallel
    - Lines not straight
    - Ground not flat



Calibration – evaluation

- **Signature effect of systematic camera error position**
  - Front camera +200 mm on X axis
  - Rear camera +200 mm on X axis
- **Effect:**
  - Detected by Configuration Tool (Poor)
  - Convergence of X lines
  - Slight mismatch of X lines
- **Random errors in camera positions have random effect on surround view**



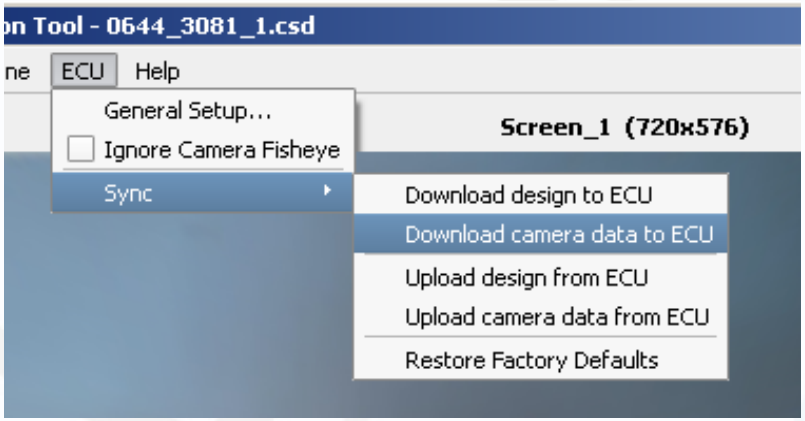
Calibration – storage of data

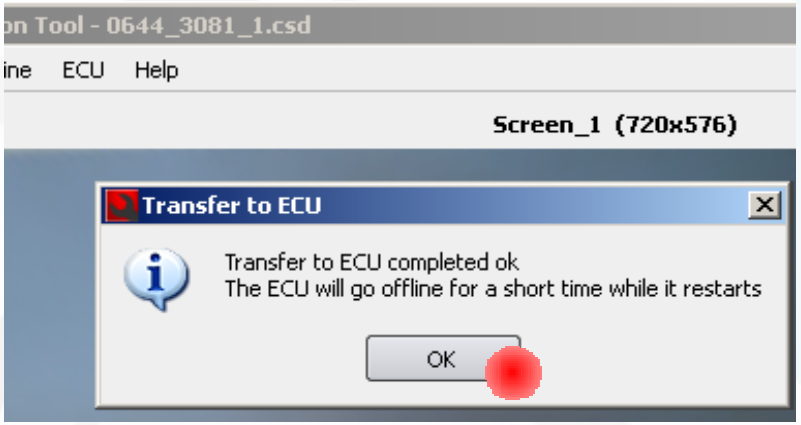
- **On successful completion**
  - Save Camera Data (csd file)
    - Suggest file name convention that includes:
      - Vehicle type
      - Vehicle ID (unique to vehicle)
      - Date of calibration
  - Save Snapshots of calibration area
    - Suggest directory name convention that includes:
      - Vehicle type
      - Vehicle ID (unique to vehicle)
      - Date taken

- **Review after the event**
  - With appropriate design file, the calibration conditions can be reviewed with the Configuration tool by loading the snapshots and csd file.

Calibration – download to ECU

- **On successful completion**
  - Download Camera Data to ECU
  - ECU will be rebooted
    - Configuration Tool prompts
      - Hit ‘OK’
  - ECU now using calibrated cameras
- **DO NOT PHYSICALLY MOVE THE CAMERAS**
  - Calibration would become invalid





Design – topics

- **Simple calibration view**
  - Purpose of the calibration view
  - Creating views
  - Moving & resizing views
  - Assigning views to a surround view
  - Shaping windows
  - Controlling the surround view area & datum position
- **Blending**
  - Showing objects with height
  - Blend edge direction
  - Blend parameters
    - Width
    - Plateau
- **Improved surround view with bitmap and simple blending**
  - Adding vehicle bitmap
  - Adding blends
- **Adding piedish effect**
- **Vertical view**
- **Virtual camera views**
- **Complex screens**
  - E.g. SV + RV + text + overlay
- **Multiple screens**
  - React to vehicle signals
- **Design issues**
  - Image resolution
  - Visualising how vertical objects will appear
    - Stretching
    - In blend regions
  - Maximising view of ground for ‘non-box-like’ vehicles
  - False ground registration when cameras are inboard
  - Display monitor cropping

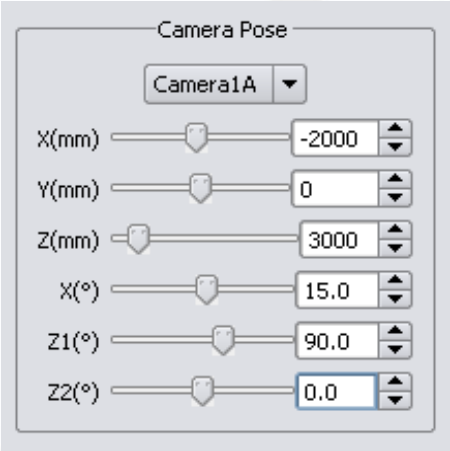
Design – calibration view

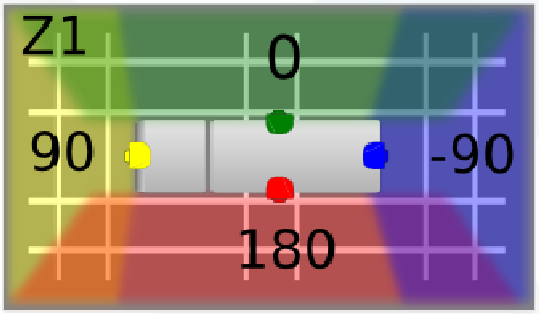
- **To help evaluate a calibration**
  - Must extend far enough to completely cover the calibration grid
    - Extent of view can be configured in X and Y axes
  - Grid line matching in both X and Y axes can be clearly observed
    - Placement of the transition between cameras can be configured
  - Only interested in seeing the grid on the ground
    - No need to be concerned about objects with height (*at this stage*)
- **Simple calibration view**
  - Can be kept for use when calibrating similar vehicles
  - Could be used as template for dissimilar vehicles
  - Design *could be* downloaded to the ECU
  - Is **not** suitable for use as a realistic surround view for improving driver awareness
  - Introduces an number of basic operations; useful as an initial design exercise

Design – entering valid camera positions

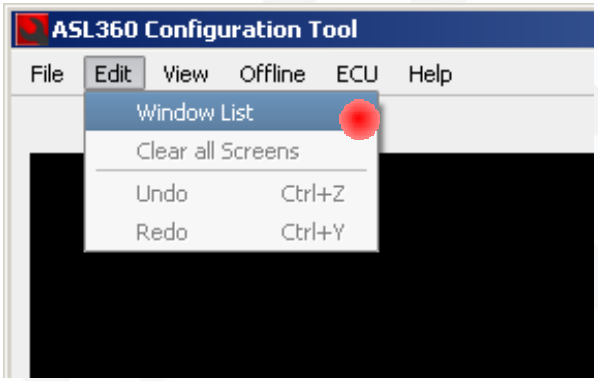
- **Camera positions (in table) are typical of a large road going vehicle**
  - Cameras mounted mid side
- **Modify these to suit target vehicle**
- **Camera orientations (in table) are good defaults for normally placed and vertically mounted ASL cameras**
  - ASL cameras have in-built X=15 degrees
- **Data (in table) can be obtained by loading file: camera_pose_defaults.csd**

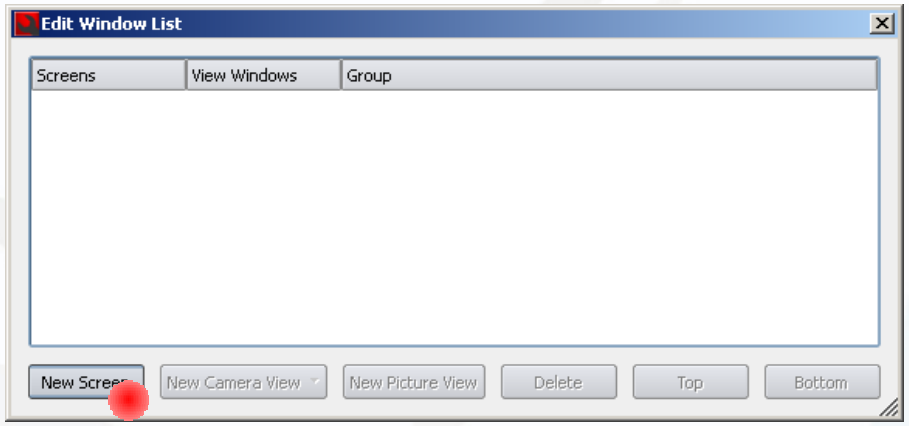
	Camera_1A	Camera_2A	Camera_3	Camera_4
X (mm)	-2000	3000	8000	3000
Y (mm)	0	-1250	0	1250
Z (mm)	3000	3000	3000	3000
X (°) default	15.0	15.0	15.0	15.0
Z1 (°) default	90.0	180.0	-90.0	0.0
Z2 (°) default	0.0	0.0	0.0	0.0

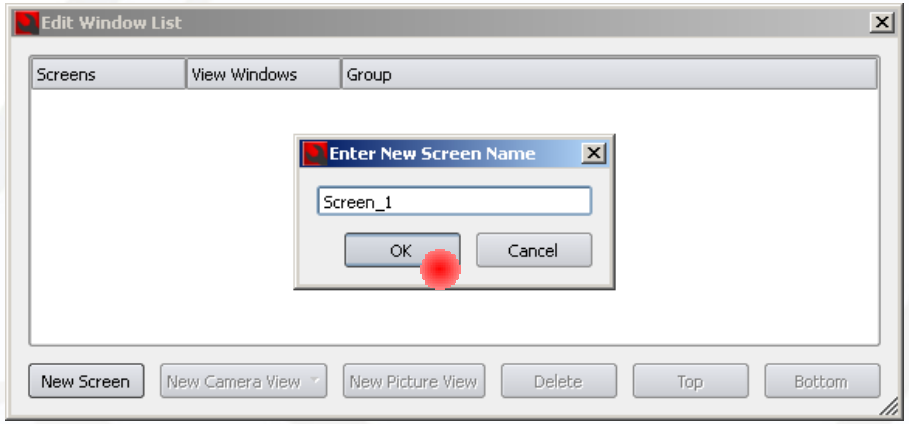


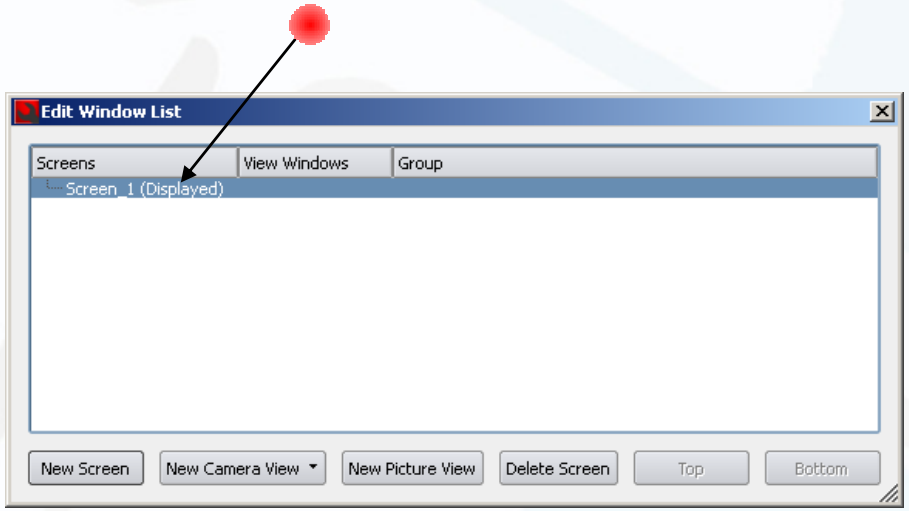


Design – creating views – adding a screen

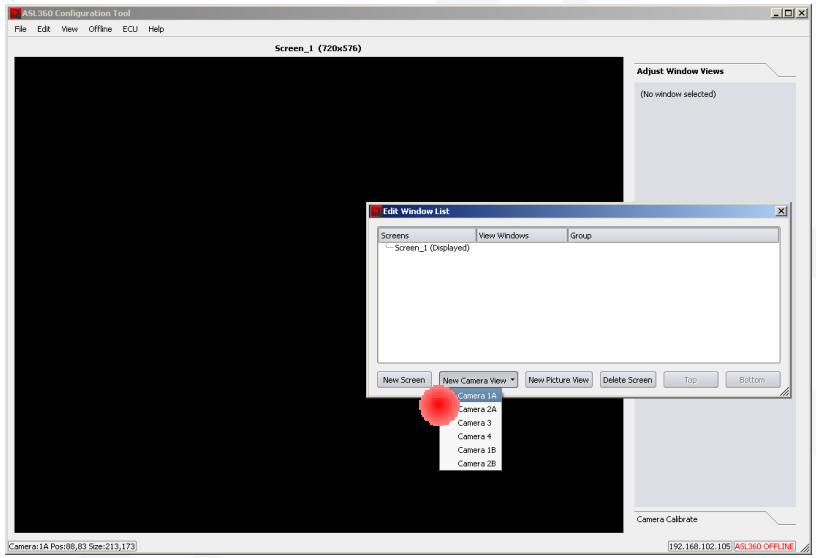


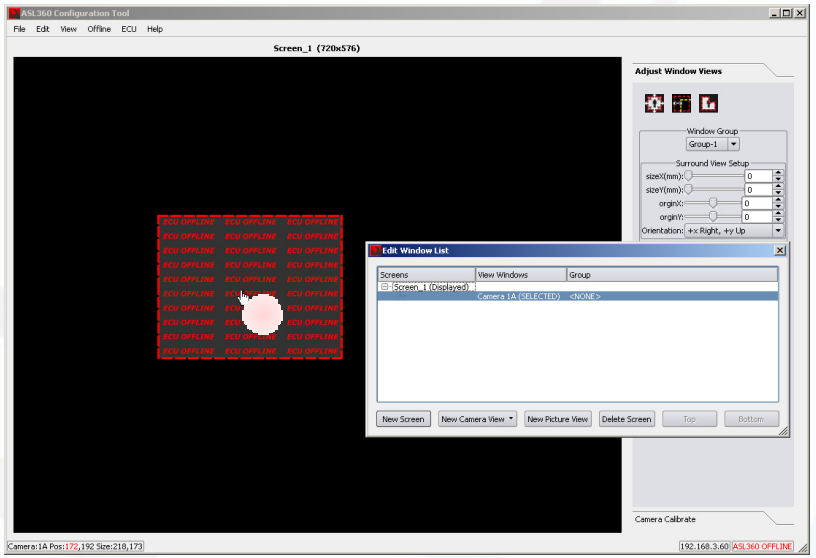


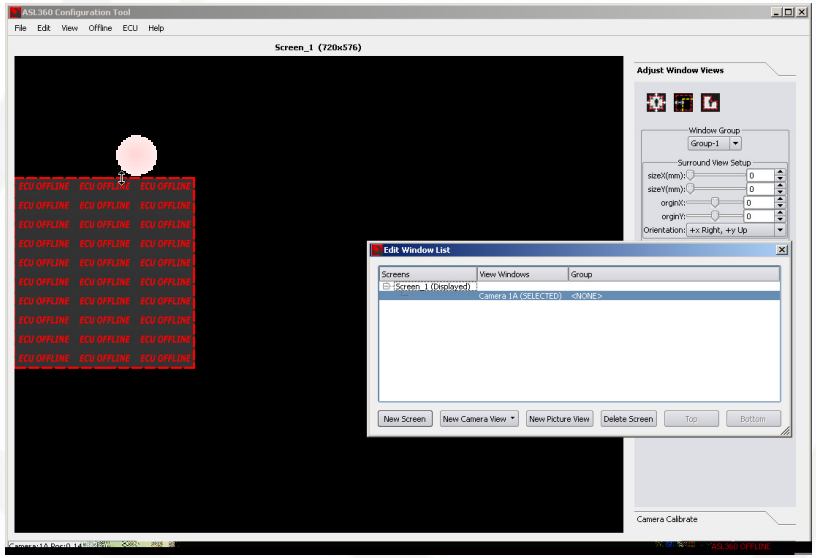


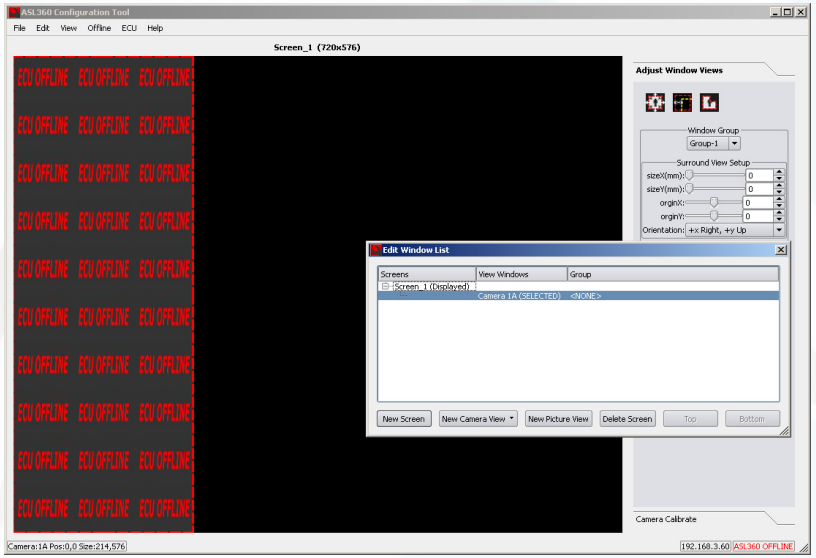


Design – adding camera windows

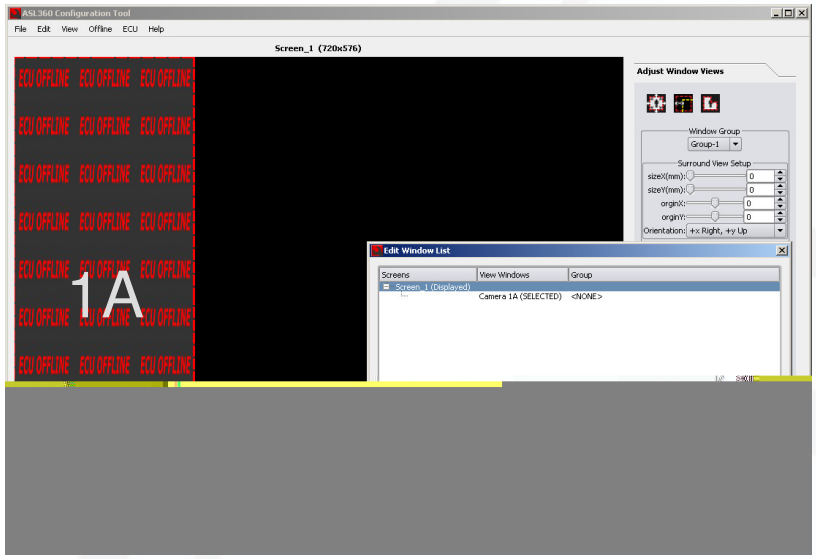


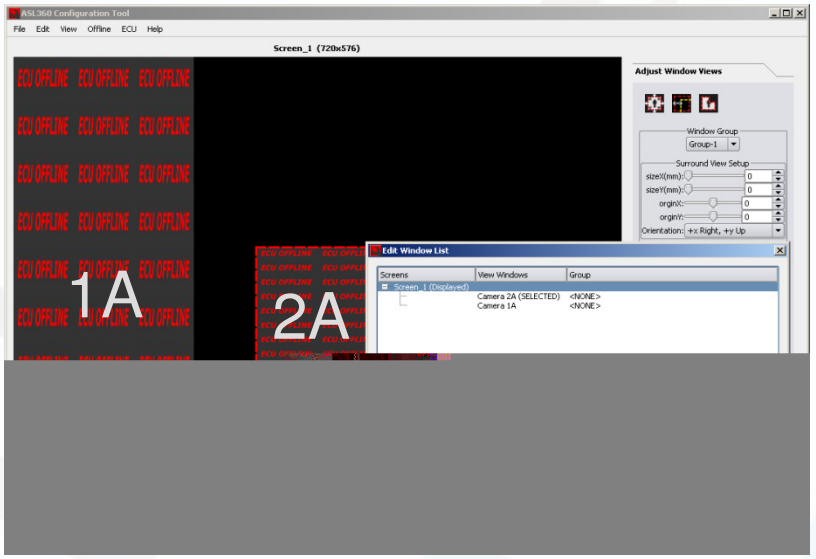


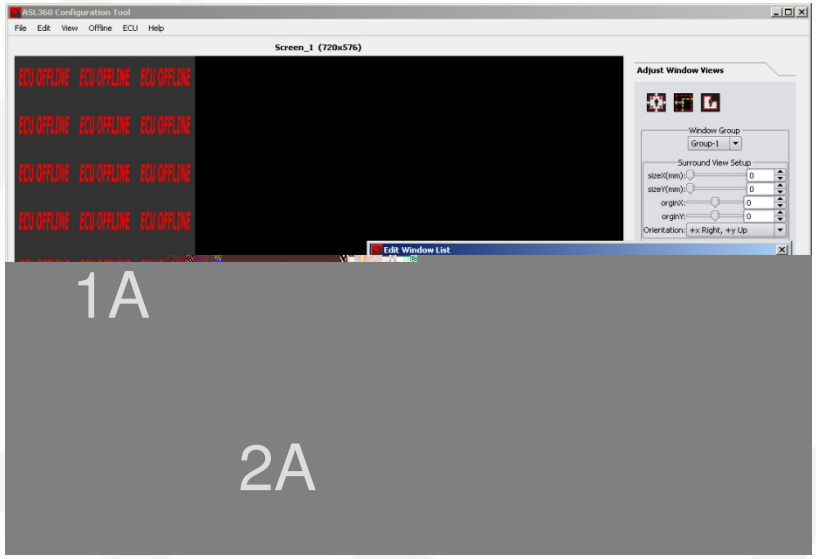


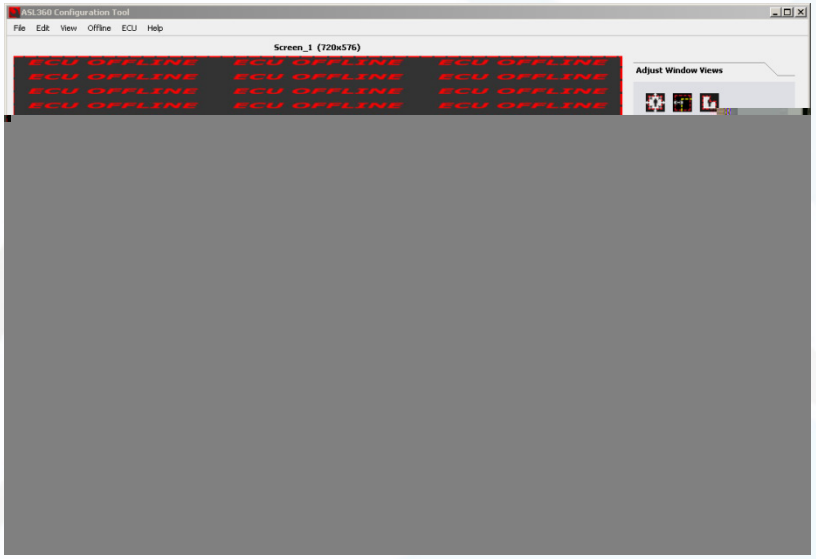


Design – adding camera windows



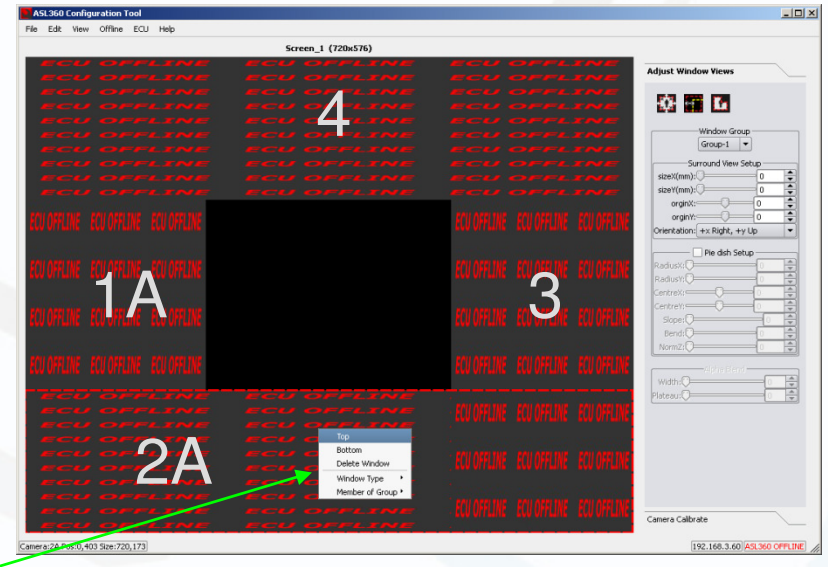


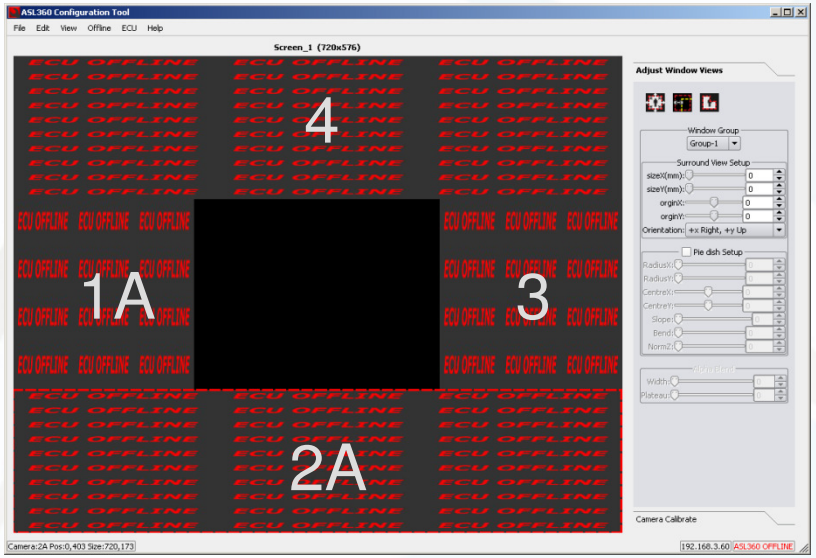




Design – Z order (controlling which window is on top)

- **Z order:**
  - 4 on top of:
  - 3 on top of:
  - 2A on top of:
  - 1A
- **Double (left) click to select camera 2A window**
  - Red dashed border appears
- **Right click gets this drop-down menu:**
  - Click ‘Top’

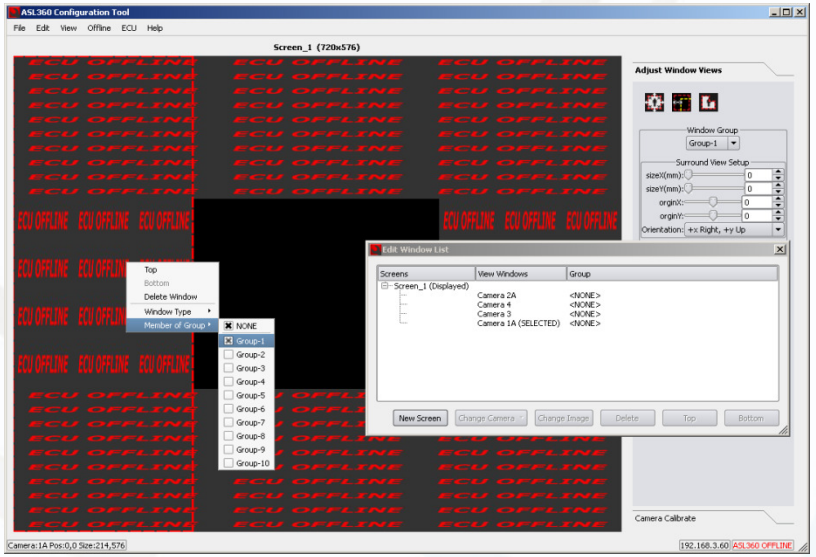


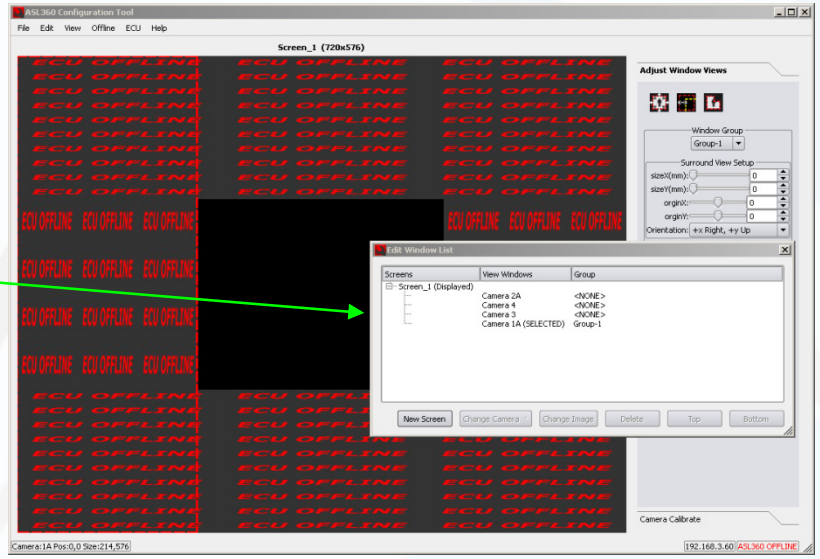


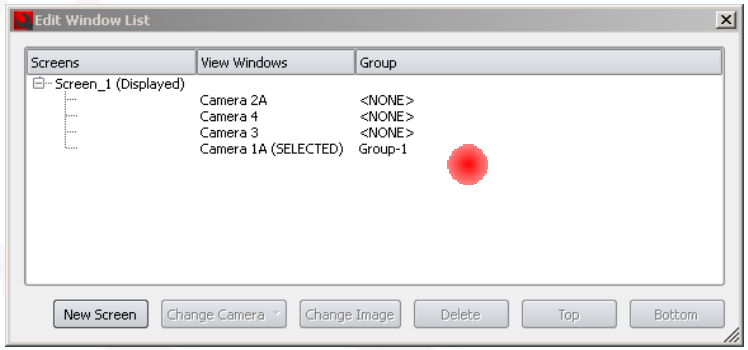
- **Camera 2A now on top of 3 and 1A, Z order:**
  - 4, 2A both on top of:
  - 3, 1A

Design – window groups

- **Windows are created by default as surround view windows**
  - A ‘surround view’ can comprise 4, 3 , 2 and even 1 window
- **ASL360 design can support several different surround views**
  - Different views, coverage etc.
- **On creation windows are not assigned to a particular group**
  - Necessary to indicate which windows are participating in which surround view – start with Group1

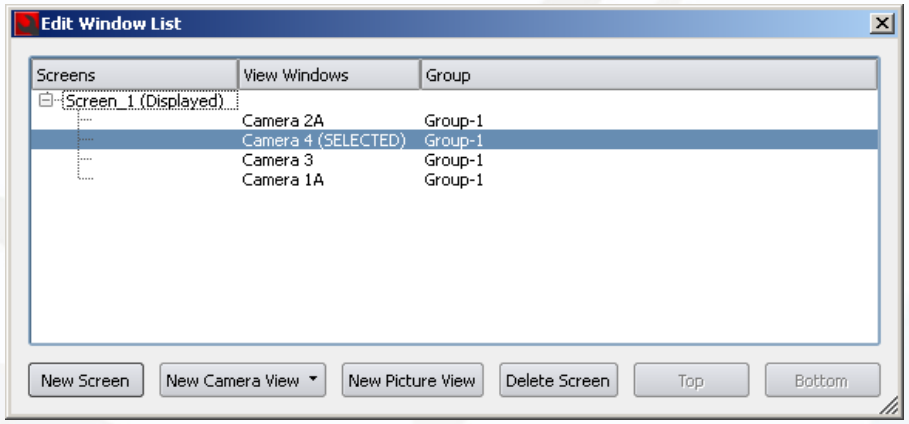




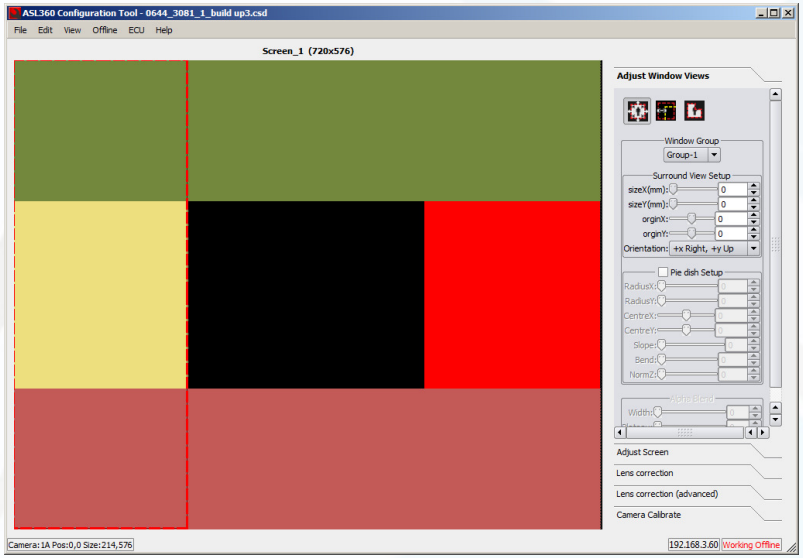


Design – window groups

- **Assign remaining cameras to Group1**

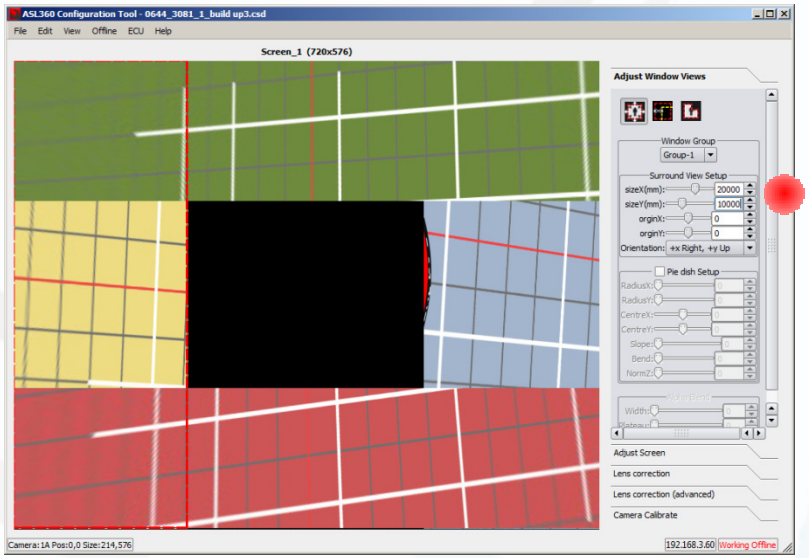


- **Load snapshots**
  - Note snapshots could be loaded at any stage
  - Notice that images in windows (right):
    - Not recognisable
    - Maybe red

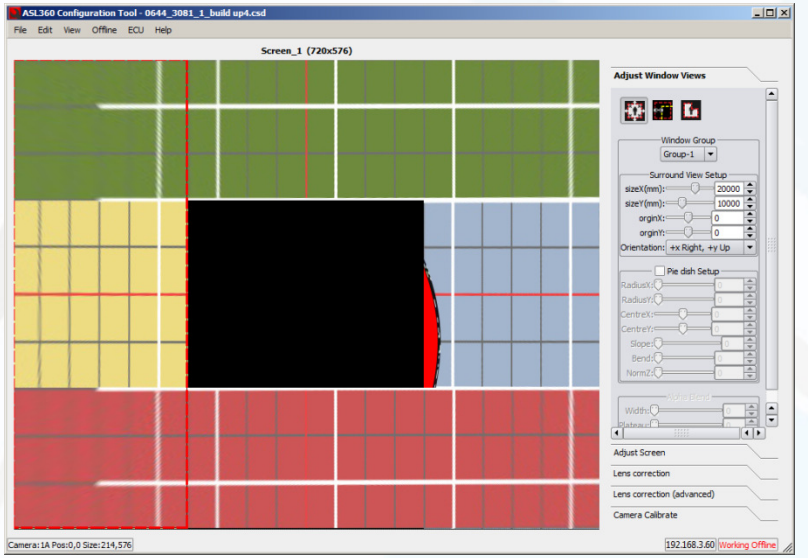


Design – define surround view area size, offset

- **Define the Surround View area**
  - SizeX(mm), SizeY(mm)
  - This example: 20 m x 10 m
  - The Configuration Tool maintains this area when the surround view windows are resize and re-arranged

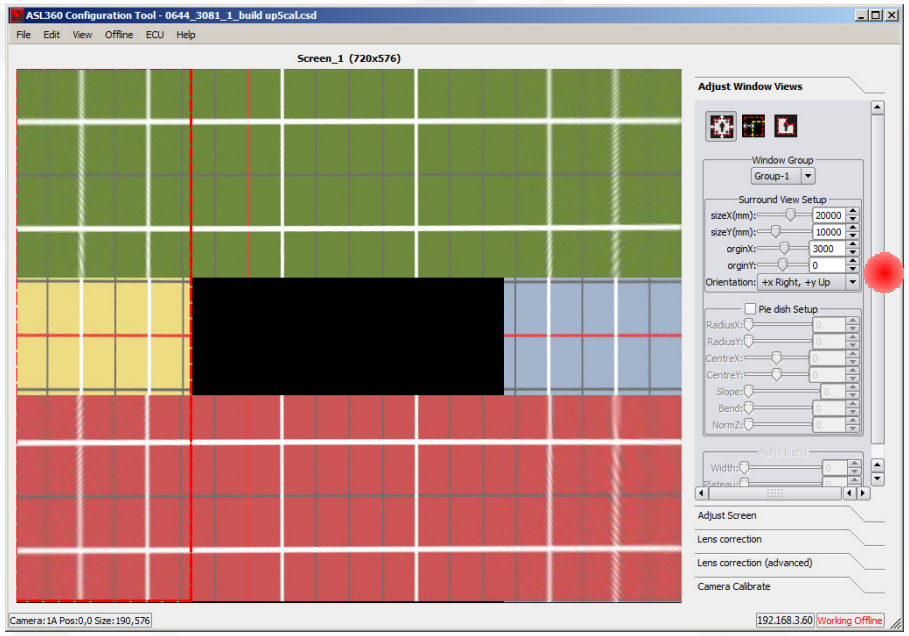


- **Calibrate**
  - Or load established calibration (csc)



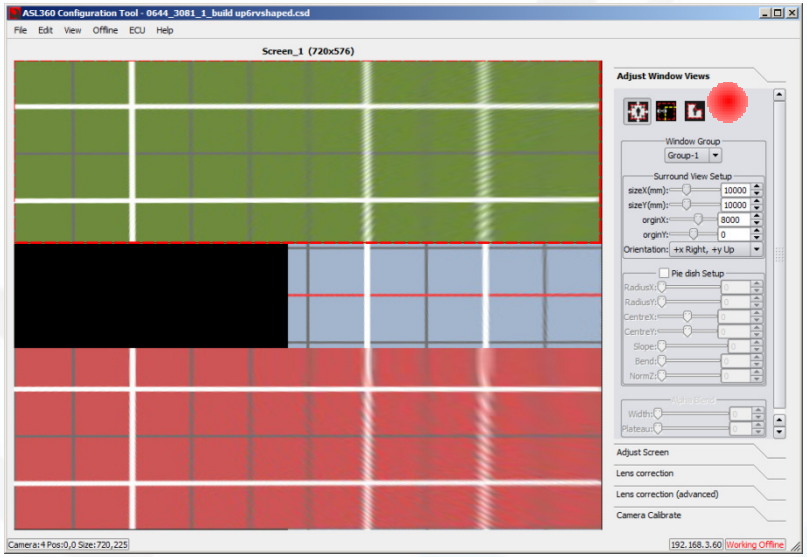
Design – define surround view area offset

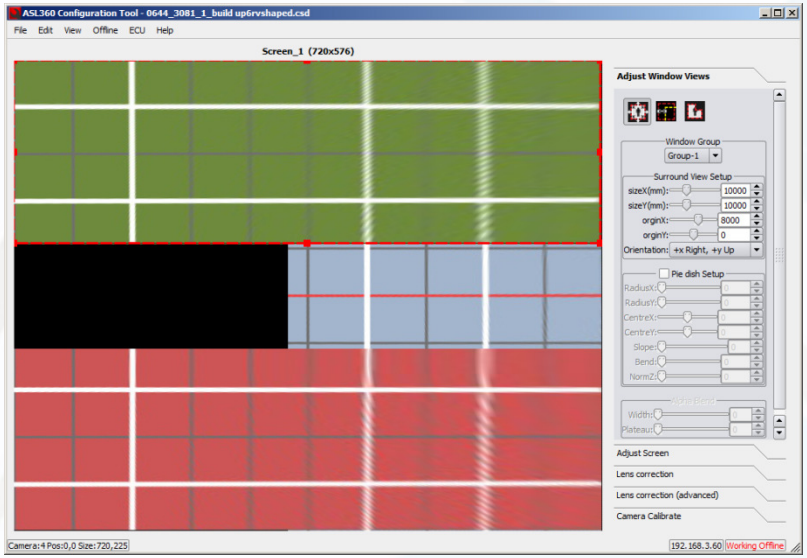
- **Adjust window sizes**
  - Ensure all grid visible
- **Define the Surround View offset**
  - SV datum offset: distance of vehicle datum from surround view centre
  - This example: 3m, 0m
  - Lateral offsets can be defined
    - Bias view to one side of the vehicle



Design – shaping windows

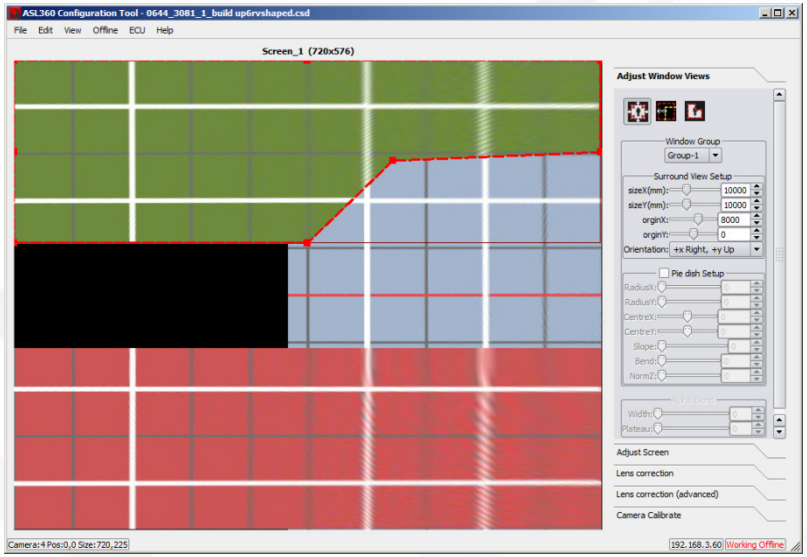
- **Window to be shaped must be on top**
- **Select the window**
  - Window is red dash outlined
  - If necessary bring to top: right click ‘Top’
- **Hold down ‘shift’**
  - (Or click icon)
  - Square control points appear



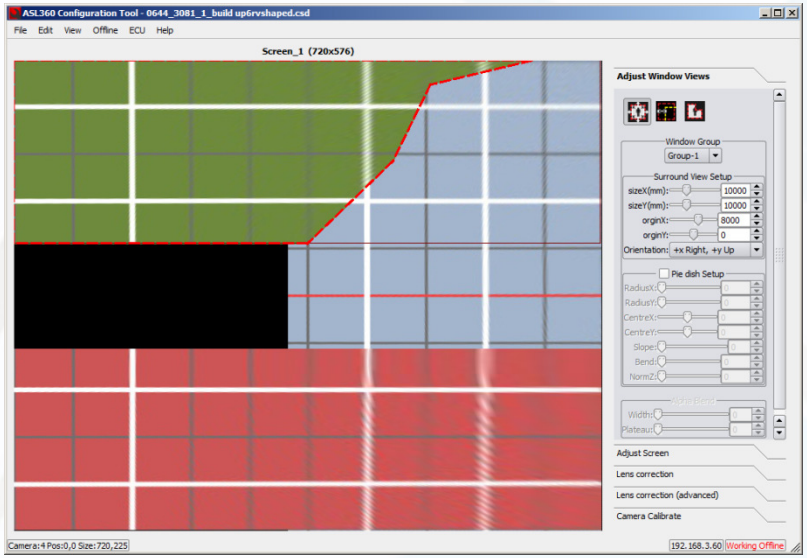


Design – shaping windows

- Click & drag control points
- 8 control points per window

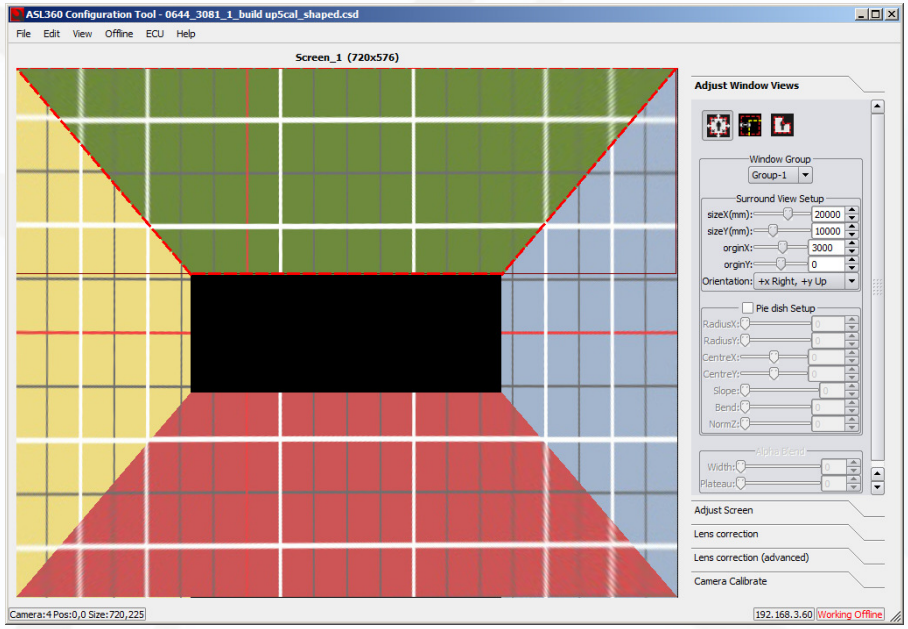


- Arbitrary shapes can be made



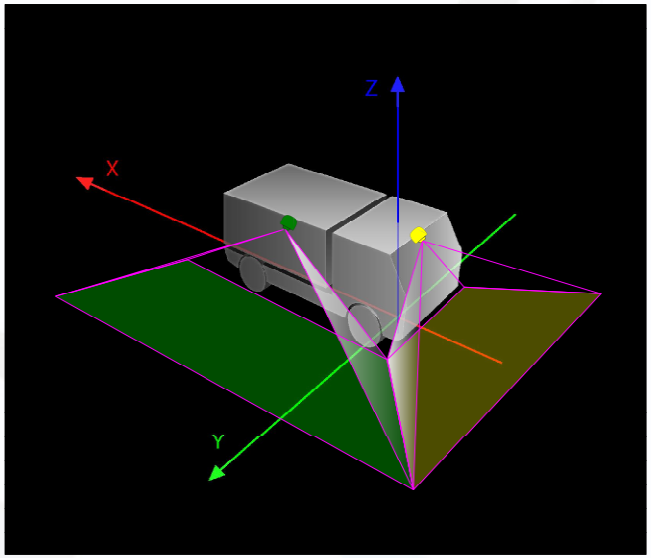
Design – calibration view completed

- **Calibration view**
  - Calibration assessment
    - Grid line matching in both X and Y axes can be clearly observed
  - View is confined to grid by design
  - Can used when calibrating similar vehicles on the same grid
  - Template for different vehicles requiring different grid dimensions
- **NOT a useable surround view**
  - Objects with height on the camera joints not adequately shown

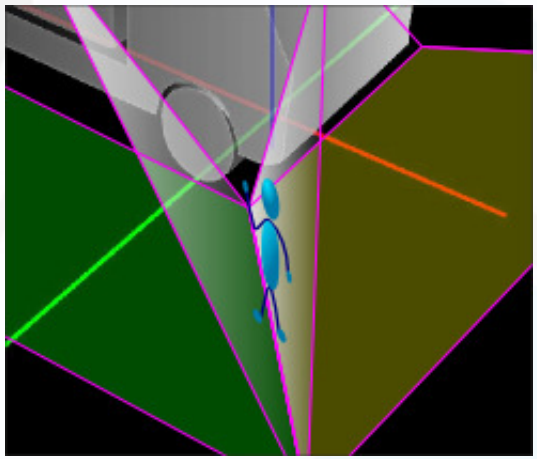


Design – objects with height

- **Simple ‘butted’ surround views**
  - Only show ground level objects
  - Above the join line at ground level there is a “blind wedge” standing on its sharp edge

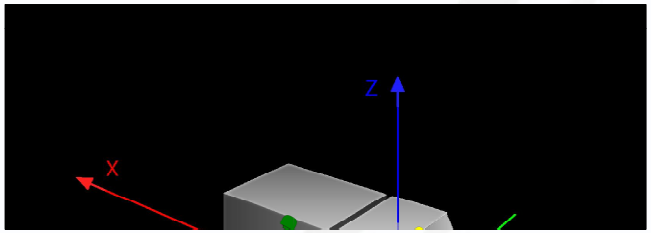


  - A vertical object standing on the join of between two cameras disappears into the “blind wedge”
    - Any object in this volume will not be seen in the surround view
      - ***Unacceptable***



Design – objects with height

- **Objects with height at the merge line can be made visible with blending**

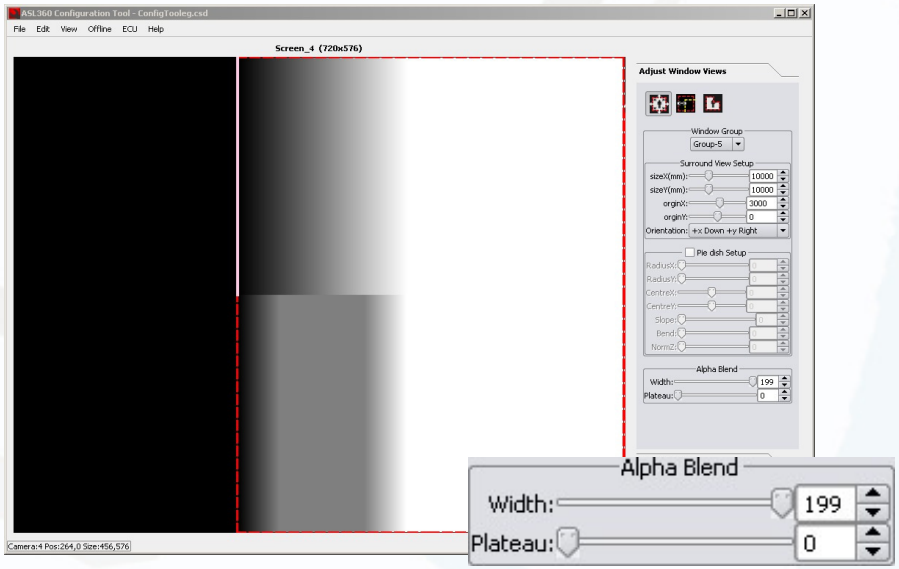


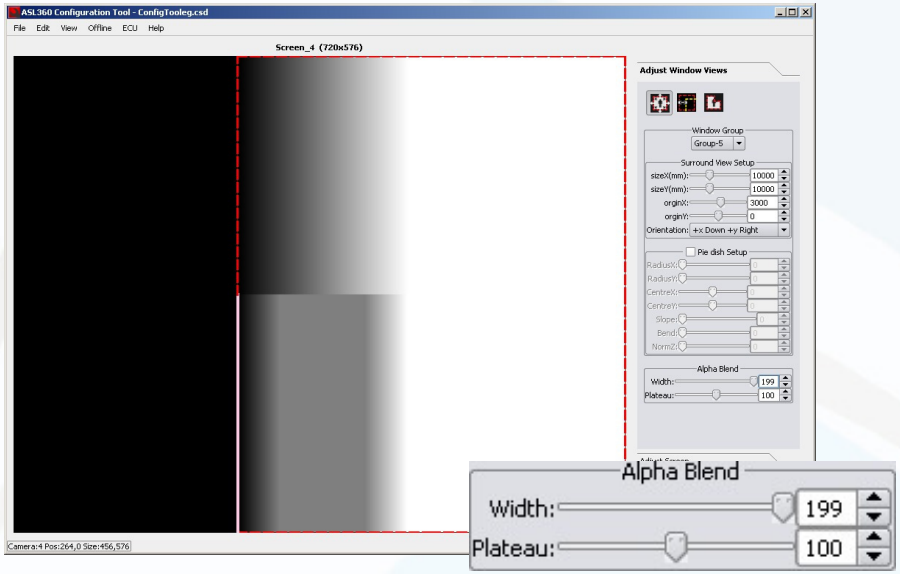
- **Butted join is replaced with a merge zone**
  - Contributions from adjacent cameras are overlapped
  - Within the “merge zone” imagery from both cameras is shown

- **Effectively raises the “blind wedge” off the ground**

Design – blending

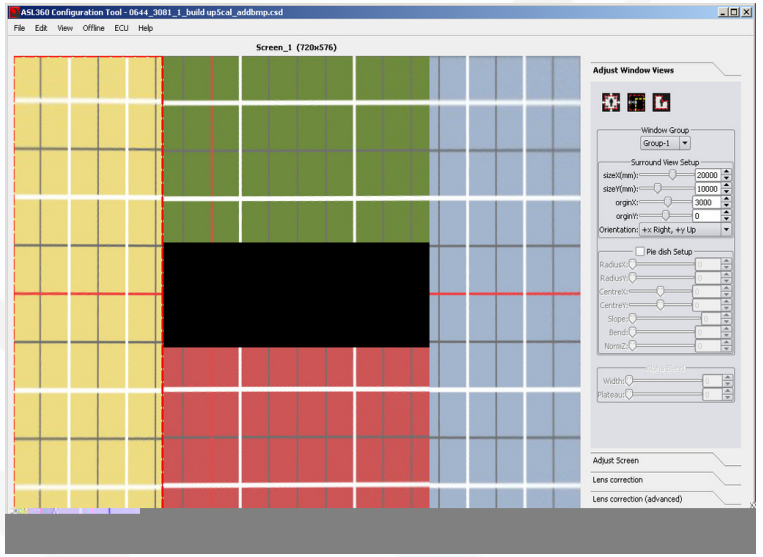
- **Apply blending by:**
  - Selecting window (double left click)
  - Selecting edge in window (shift & right click)
    - Selected edge is shown pink
  - Defining blend width
    - 0 – 199 pixels
- **Graded blend (upper blend)**
  - Defined width with Plateau = 0
  - Camera image is linearly faded with adjacent camera
- **Graded blend with central step (lower blend)**
  - Aka Plateau blend
  - Defined width with defined Plateau
    - 0 – 199 pixels
  - Plateau parameter defines width of central band of 50% / 50% blend
  - Remaining area outside this band is linearly faded

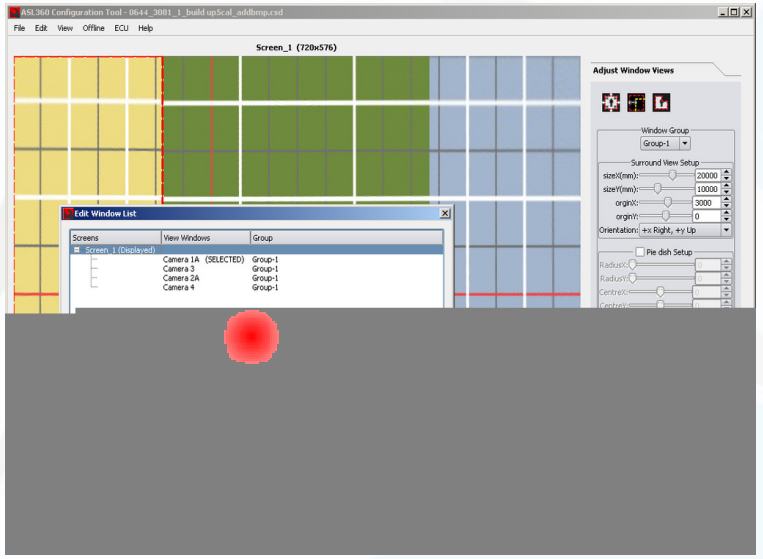




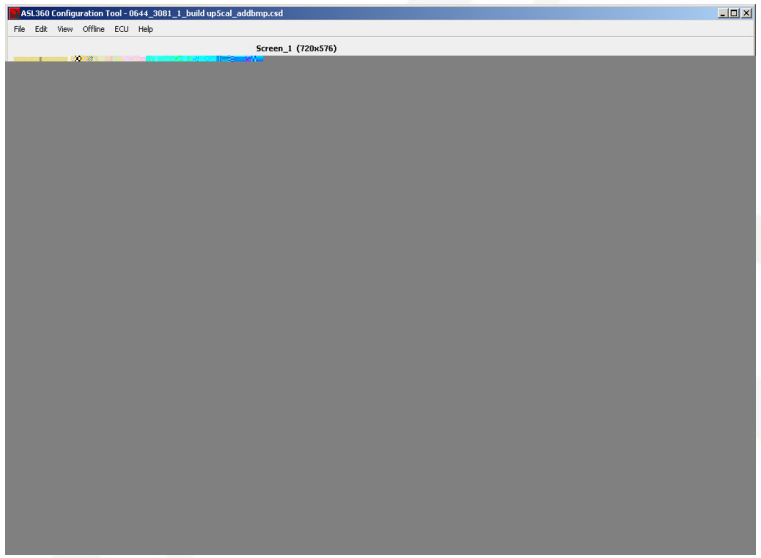
Design – improved surround view

- **Simple useable surround view**
  - Vehicle bitmap
  - Blended joins
- **Produce design (upper right)**
  - Required extent
  - Central (black) portion approximately sized according to known vehicle size
  - Best to place Front and Rear windows on top (right click ‘Top’)
- **Add bitmap (lower right)**
  - Show window list (Edit/Window List)
  - Select screen
  - Press “New Picture View”
  - Bitmaps: BMP, JPG, PNG
    - PNG supports transparency

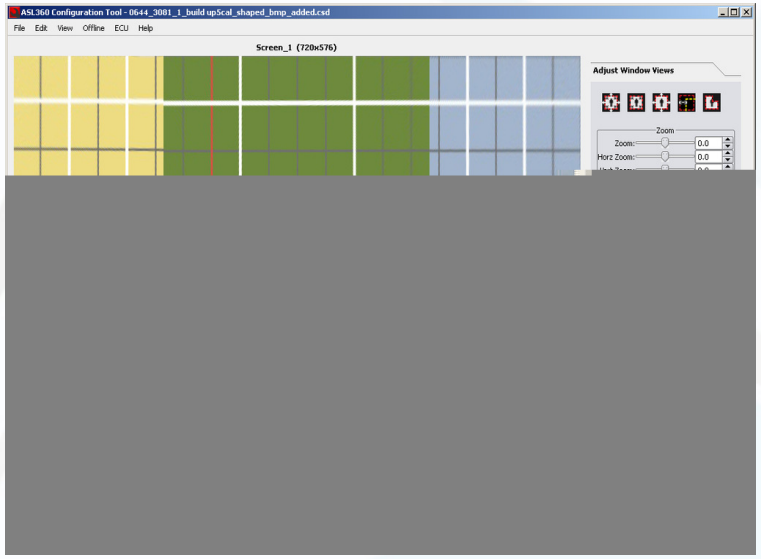




Design – improved surround view

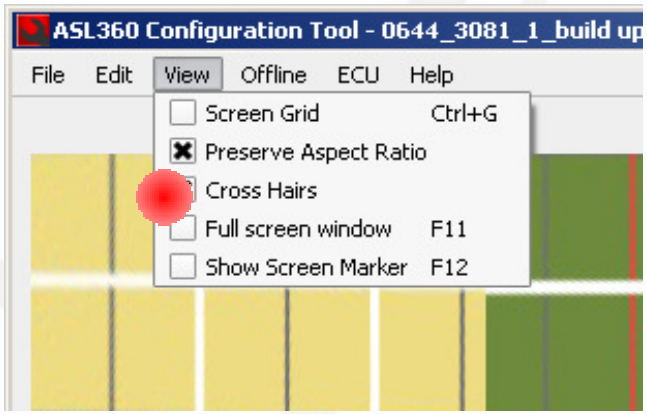


- **Move and resize bitmap**
  - (clockwise from above)

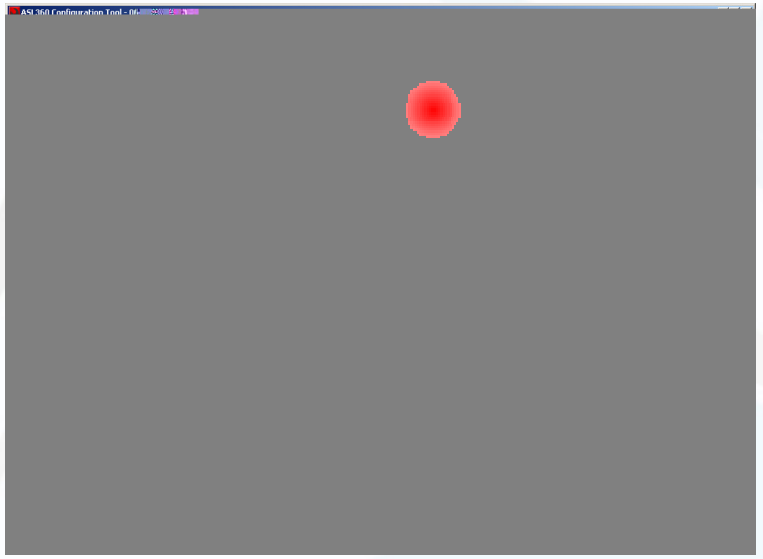


Design – improved surround view

- **Using crosshair to align window control points**
  - Check View/Cross Hairs



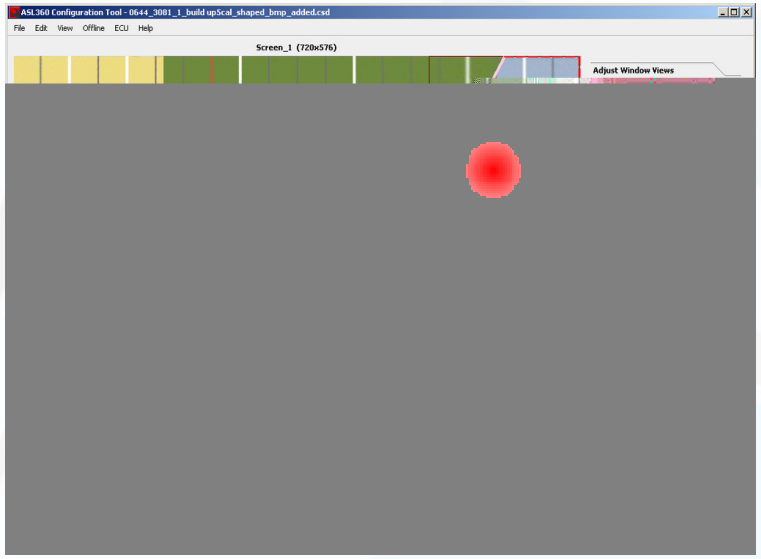
  - Crosshair is shown when clicking on window control point



Design – improved surround view

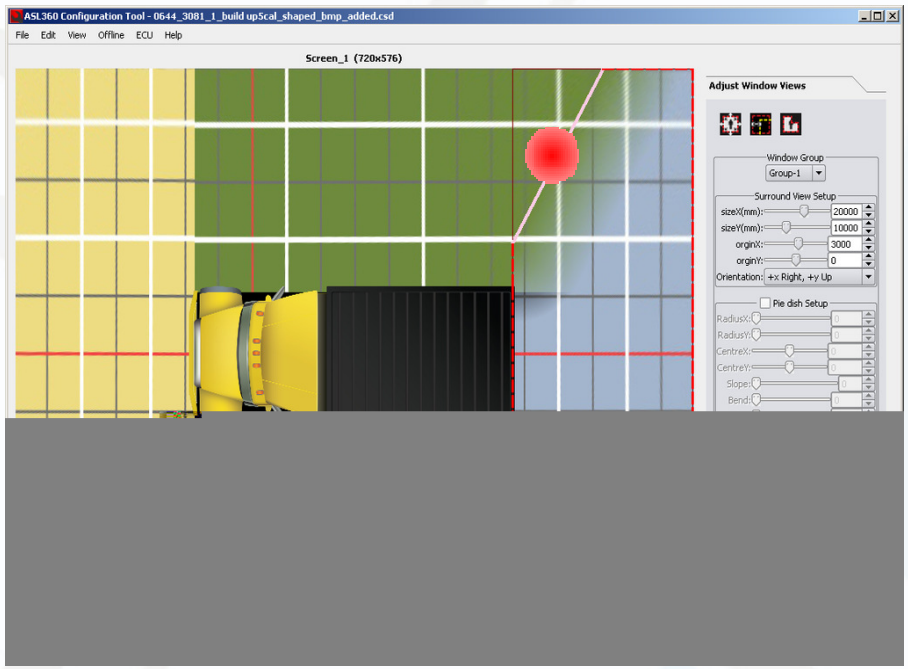
- **Blends**
  - Can be applied where two different windows (cameras) overlap
  - Must be defined on the uppermost window
  - Are a property of an edge (between 2 window control points)

- **Adding a blend**
  - First shape the window by moving control points (Shift 'click and drag') – upper right
  - Select edge to be blended (Shift, click on edge) – lower right
    - Edge is now shown pink



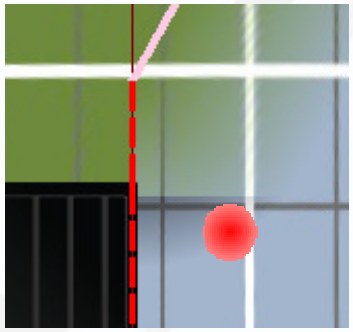
Design – improved surround view

- **Define blend width**
  - Use Alpha Blend control
  - Width defined in pixels
- **Blend direction**
  - At right angles to edge
  - At end of edge, the blend direction pivots on the end until it meets the adjacent edge – along which it extends by the defined blend width

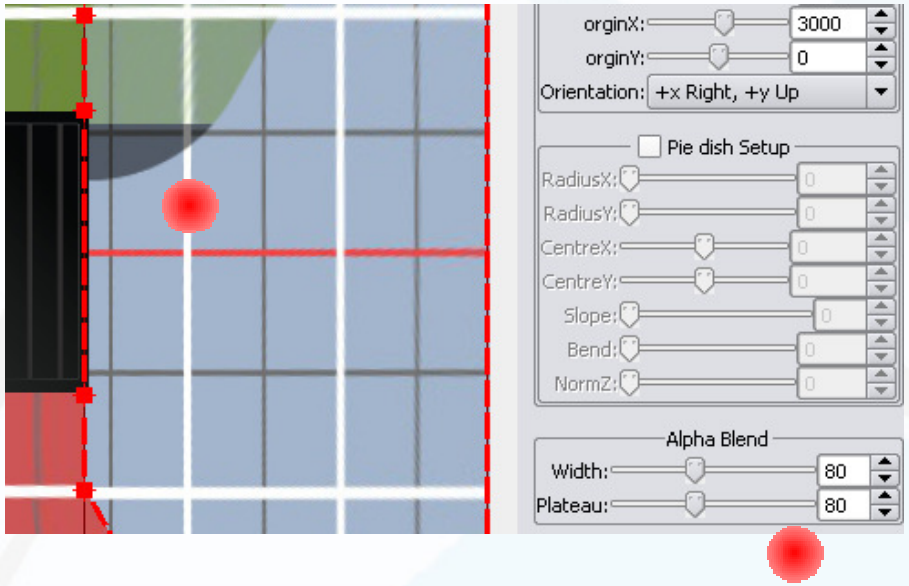


Design – improved surround view

- **Adjusting blending**
  - In example lower right, part of the blend is not on top of a window, and therefore blends onto black



  - This can be made more obvious by temporarily defining ‘Plateau’ to be as large as ‘Width’



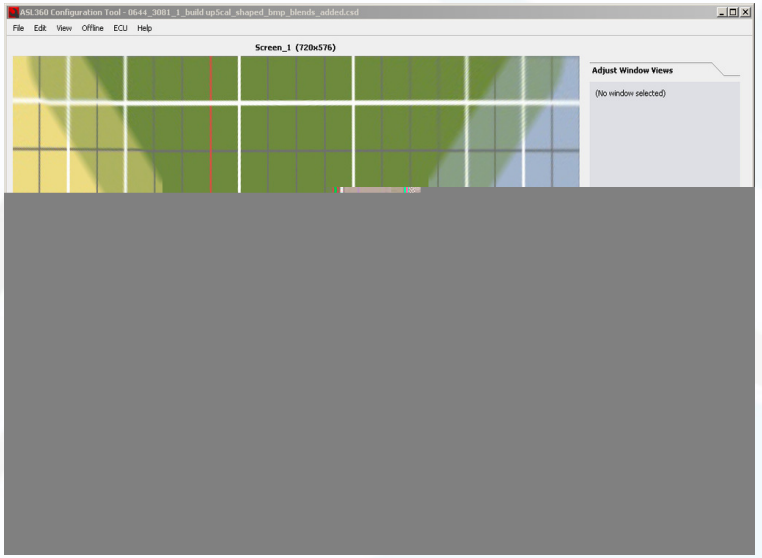
Design – improved surround view

- **Adjust position of control point on blend edge**
  - until blend is entirely within overlap (where it meets edge of vehicle)

  - Adjust ‘Plateau’ to soften edge
    - Recommend 75% / 80% of ‘Width’
      - Soft edge
      - Large area of 50% / 50% blend helps make vertical objects more conspicuous

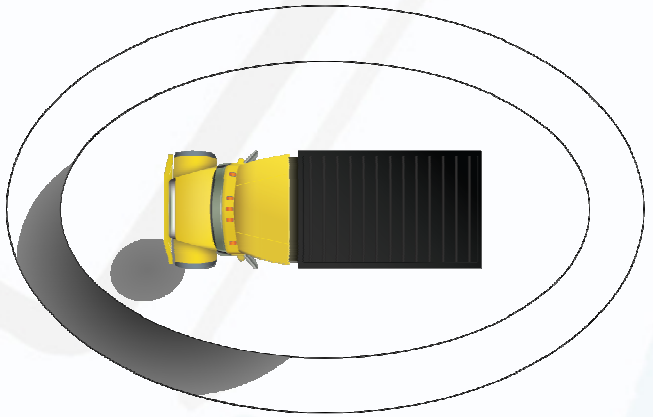
Design – improved surround view

- Repeat blending for remaining merges
- Save design!



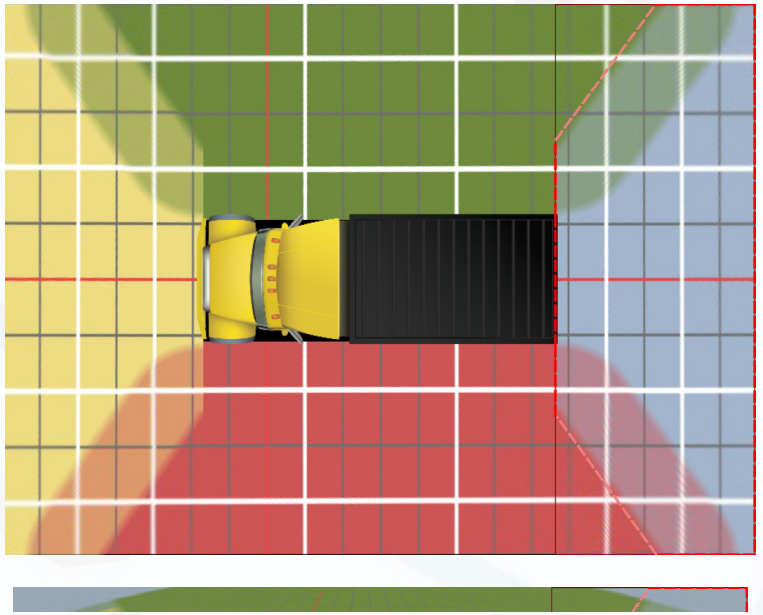
Design – pie dish effect

- **Pie dish is an alternative method of 'projecting' the surround view**
- **Pie dish effect is useful to:**
  - See further away from the vehicle without reducing the scale of the surround view in the immediate vicinity of the vehicle
    - Cameras must be orientated to able to see distant objects/ground
  - Reduce perspective stretching of vertical objects
    - In standard surround views, significant perspective stretching occurs for:
      - Nearby objects with height similar to camera height
      - Distant objects
- **Pie dish configuration**
  - Can simply be 'added' to existing surround view
  - Describes shape of a giant pie dish within which the vehicle sits



Design – pie dish effect

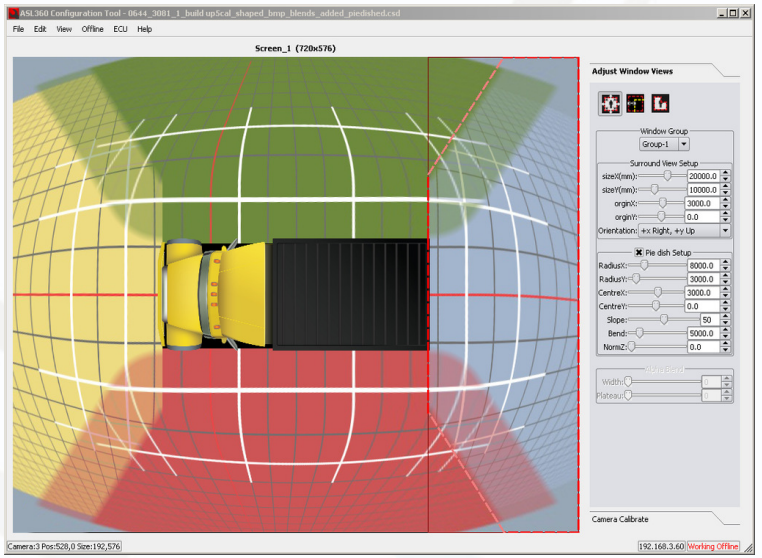
- **Standard (planar) surround view**
  - All real world straight lines are straight in the surround view

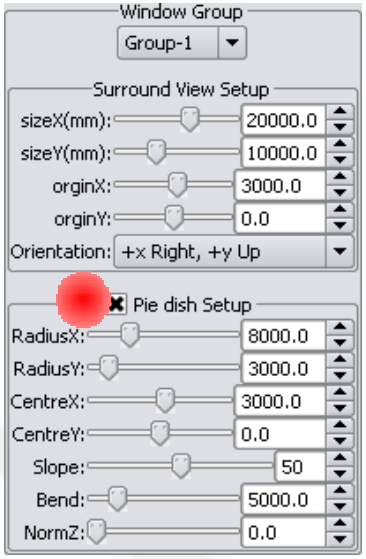


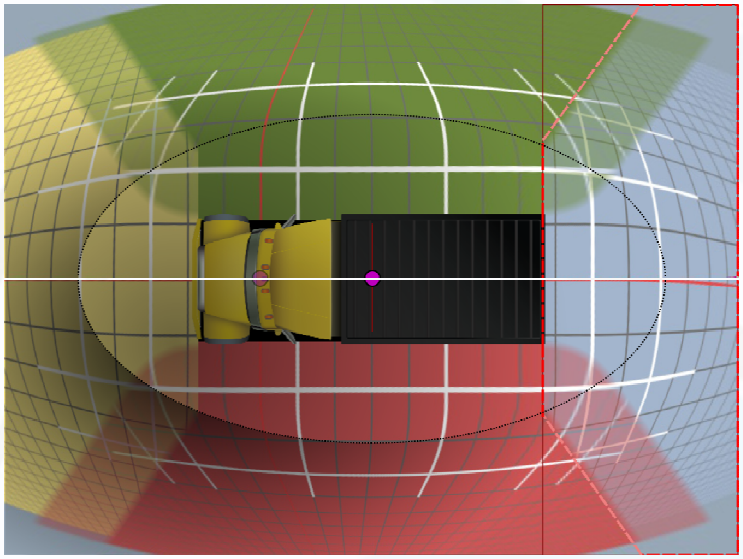
- **Extreme example of pie dish**
  - Vehicle need not be smaller
  - All real world straight lines are straight in the surround view – in the immediate vicinity of the vehicle
  - Away from the vehicle
    - Lines curve allowing more of the real world to be revealed
    - In merge regions, lines on the ground overlap

Design – pie dish effect

- **Controlling the pie dish shape**
  - Enable Pie Dish Setup
    - (check box)
  - Image lower right:
    - Configuration Tool screen shot with added overlay to indicate the position and shape of the configured pie dish

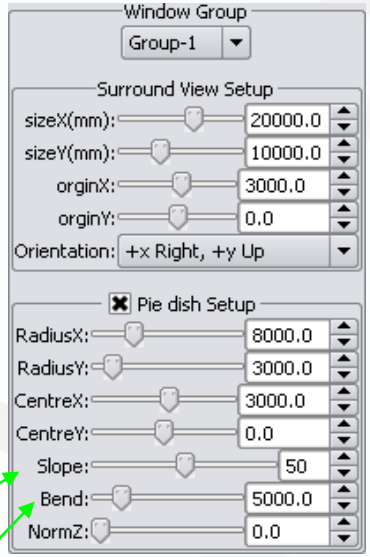


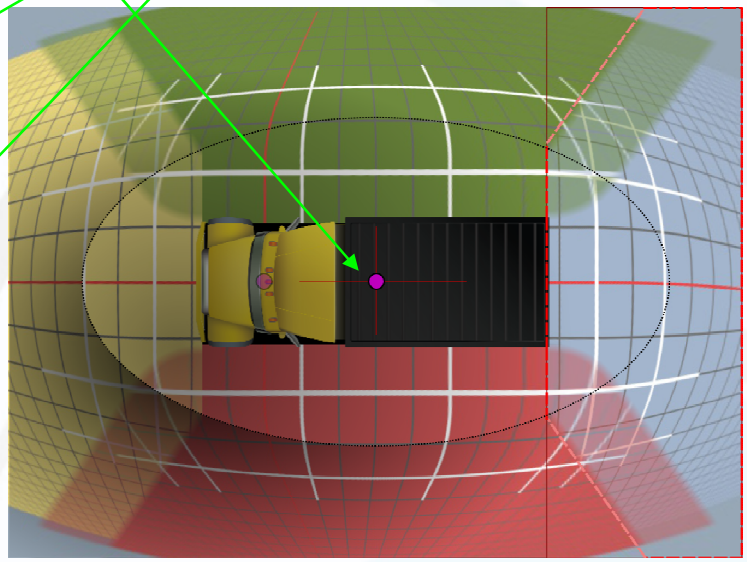




Design – pie dish effect – controlling the shape

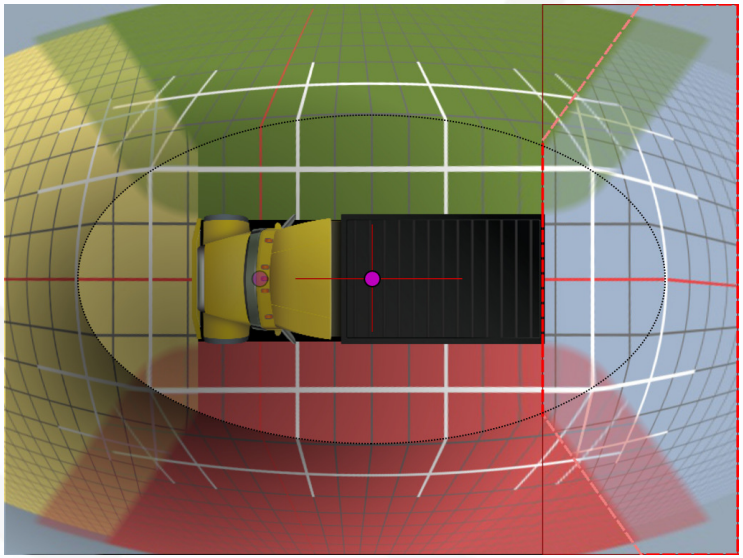
- **Define in mm X (long) and Y (short) radii of pie dish base**
  - Unequal radii make an elliptical dish
  - Equal radii make a circular dish
- **Define the centre of the ellipse**
  - Distance in mm from the centre of the displayed surround view
  - Often (but need not be) same as surround view origin
- **Define Slope of dish edge**
  - Defined as %age gradient
- **Define in mm radius of bend between flat base and straight side**

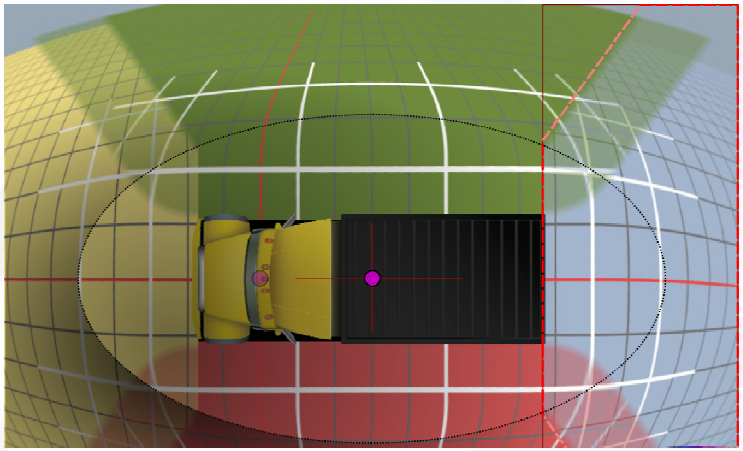




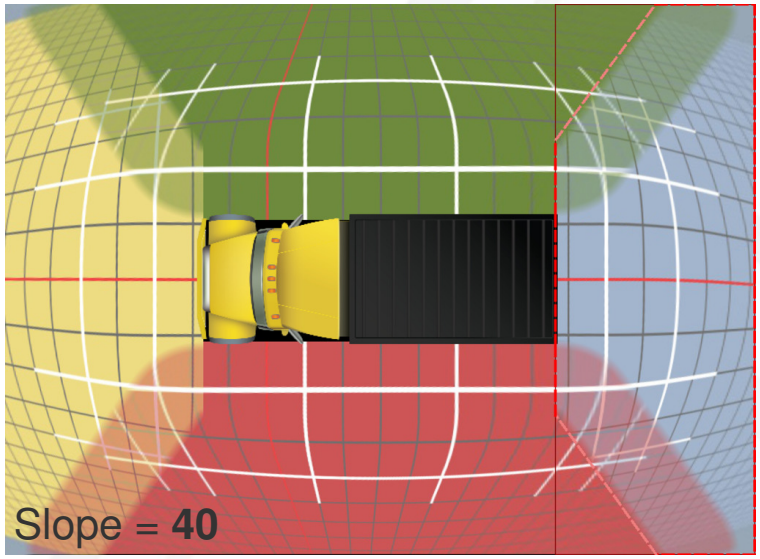
Design – pie dish effect - bend

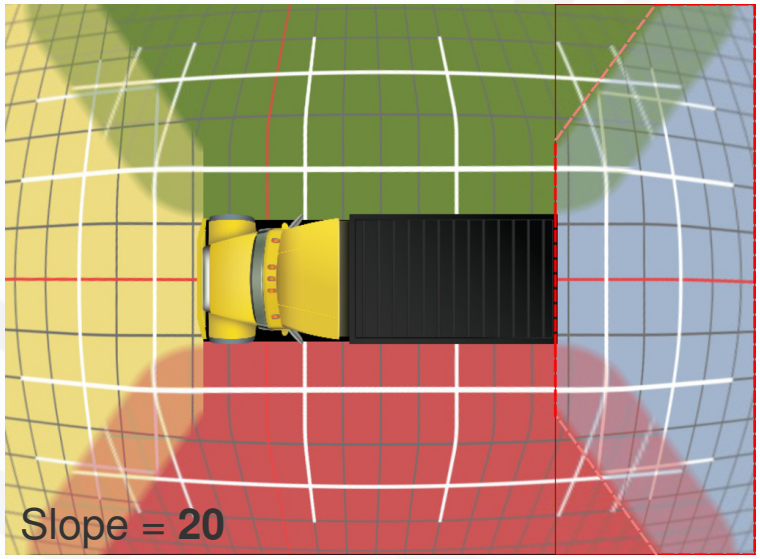
- **With 0 or small Bend**
  - Transition from straight to curved lines is abrupt
- **With large Bend**
  - 5000 mm in this case
  - Transition from straight to curved lines is smooth

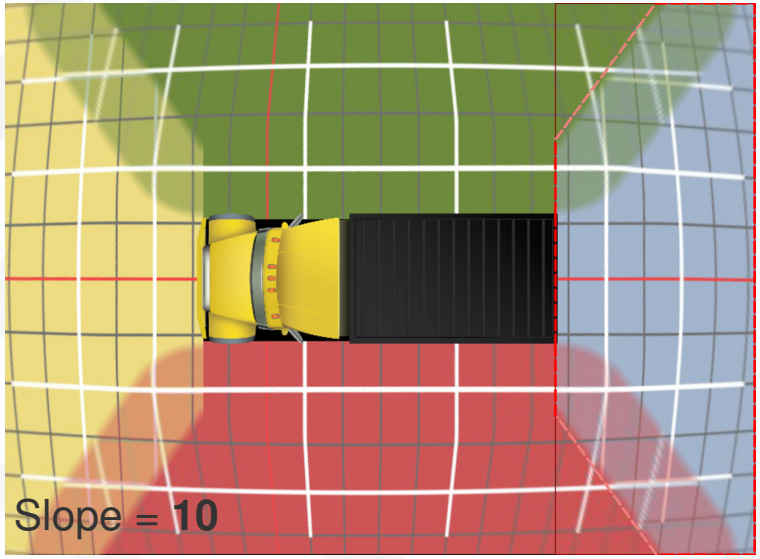


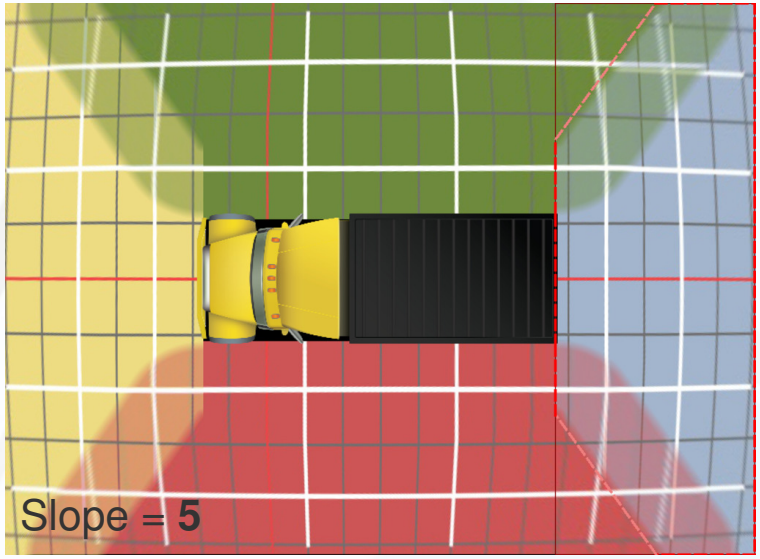


Design – pie dish effect – varying slope







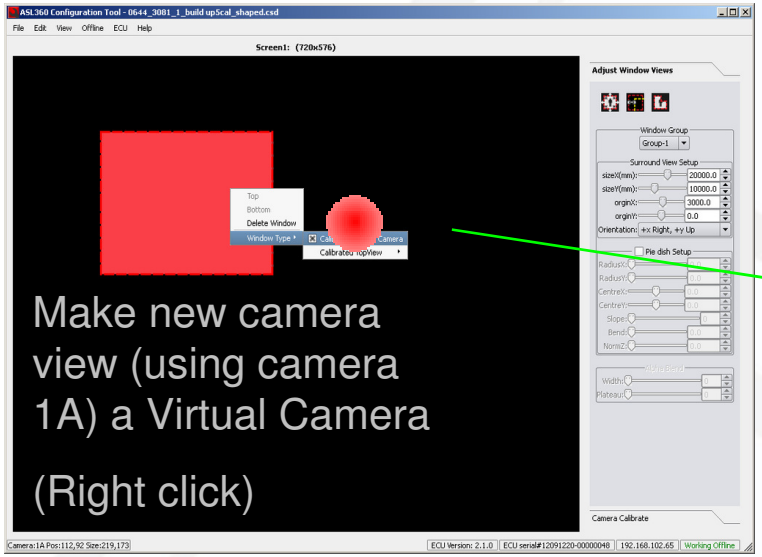


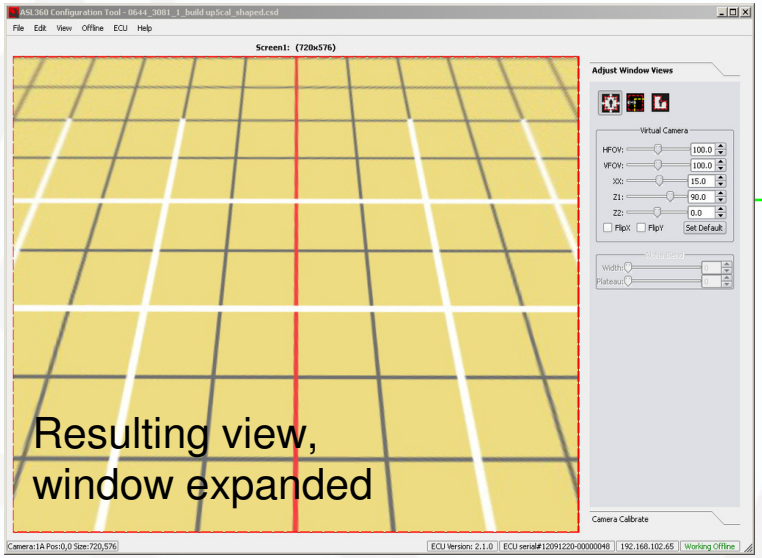
Design – virtual cameras

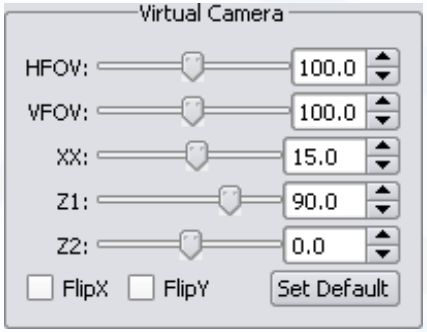
- **ASL360 usually used to generate surround view from several cameras**
  - Merged camera images
  - Fisheye corrected
  - Corrected for perspective to produce the illusion of viewing the vehicle surroundings from above (bird-eye view)

- **ASL360 can also provide virtual camera views**
  - Single camera image from any ASL360 camera
  - Fisheye corrected
  - Perspective corrected for the physical position of the camera
  - As if the view was provided by a normal digicam placed at the position of the ASL360 camera
  - Like a normal digicam, the view can be:
    - Pointed
      - 3 angular adjustments
    - Zoomed
  - Unlike a normal digicam:
    - Zoom has independent controls
      - Horizontal
      - Vertical
    - Image can be “flipped” to produce mirror images

Design – virtual cameras - creating





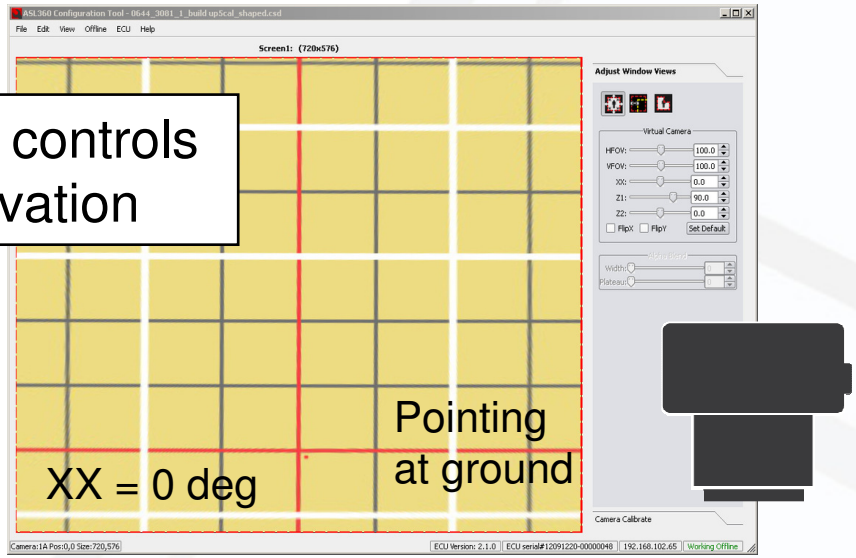


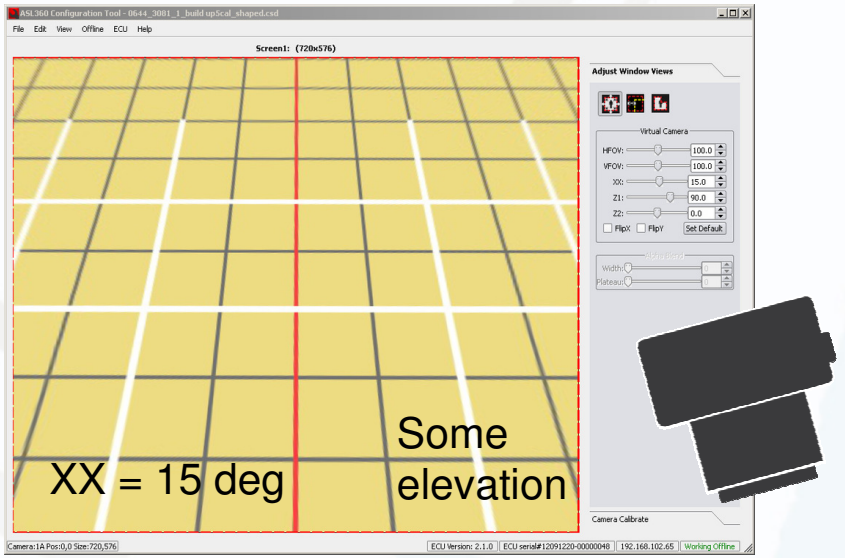
Virtual Camera (VC) parameter defaults for Camera 1A (v2.0 and above)

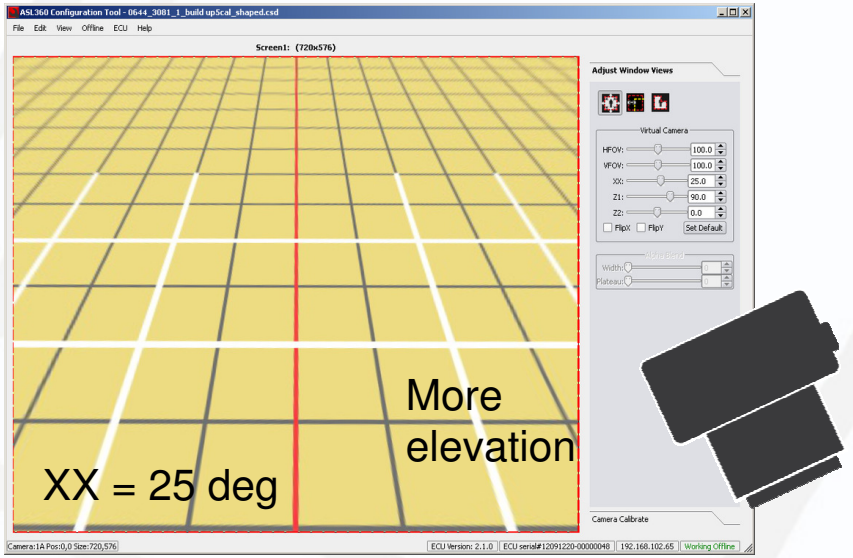
(Note the orientation is the same as camera 1A default orientation: the virtual camera is pointing in the same direction)

Design – virtual cameras – parameter XX

XX controls elevation



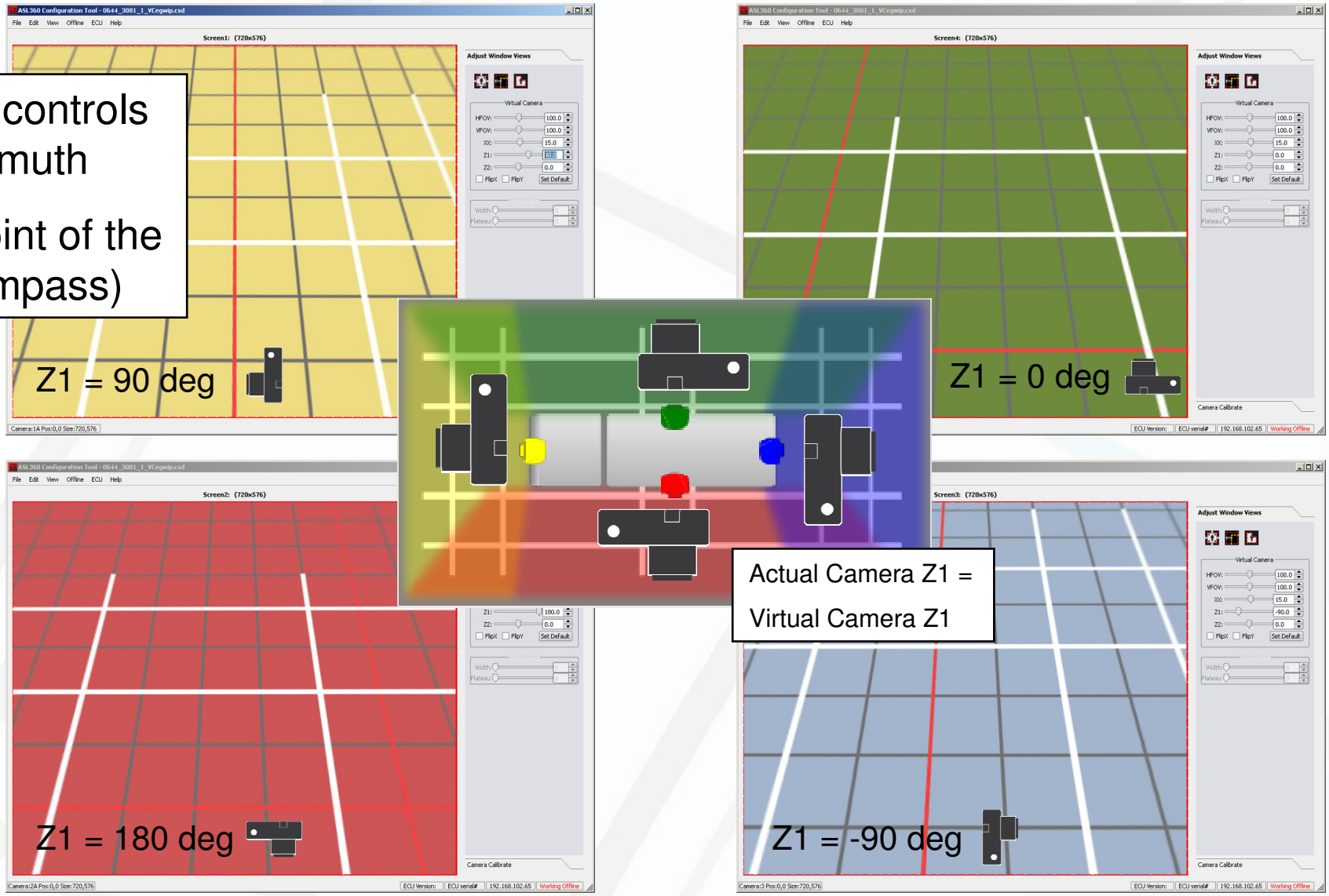




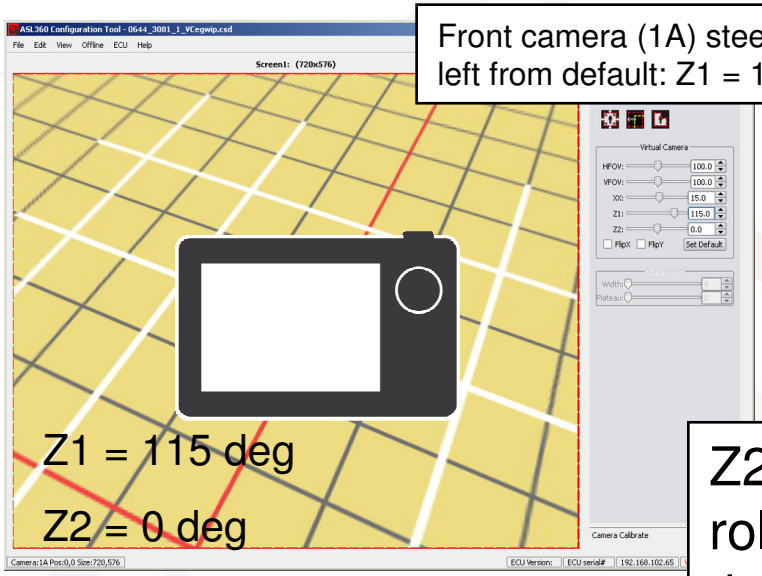
Design – virtual cameras – parameter Z1

Z1 controls azimuth

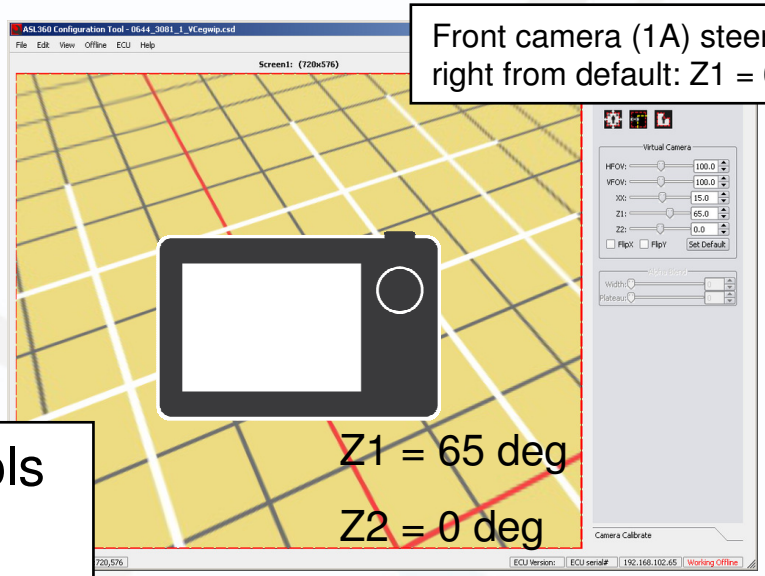
(point of the compass)



Design – virtual cameras – parameter Z2

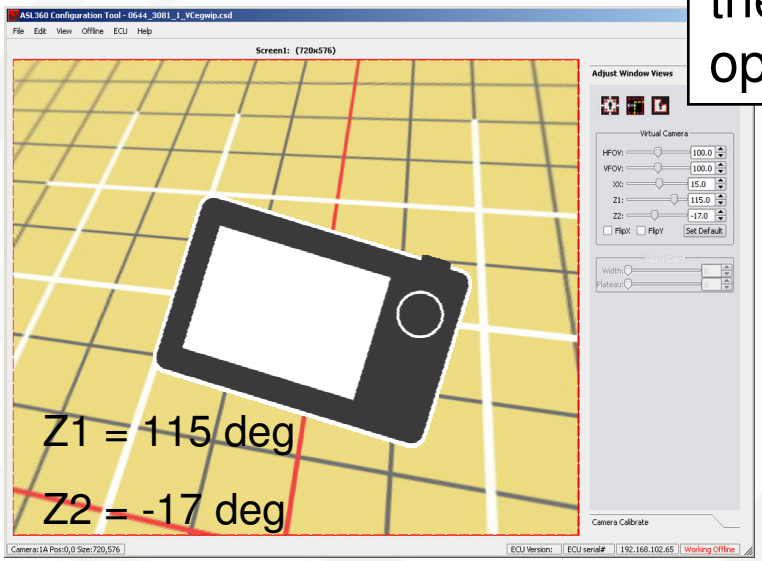


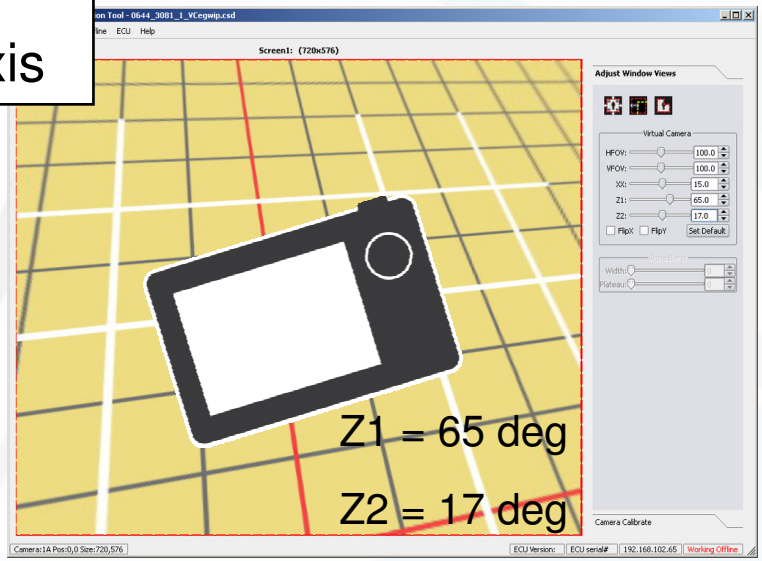
Front camera (1A) steered to left from default: Z1 = 115 deg



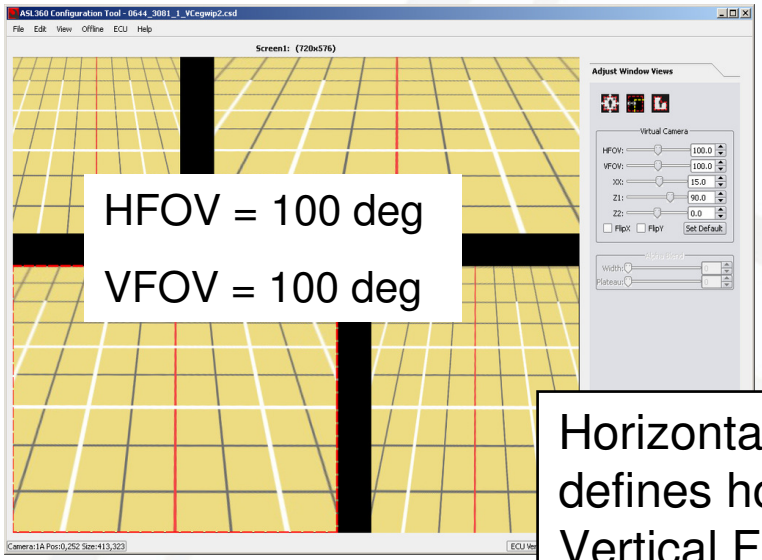
Front camera (1A) steered to right from default: Z1 = 65 deg

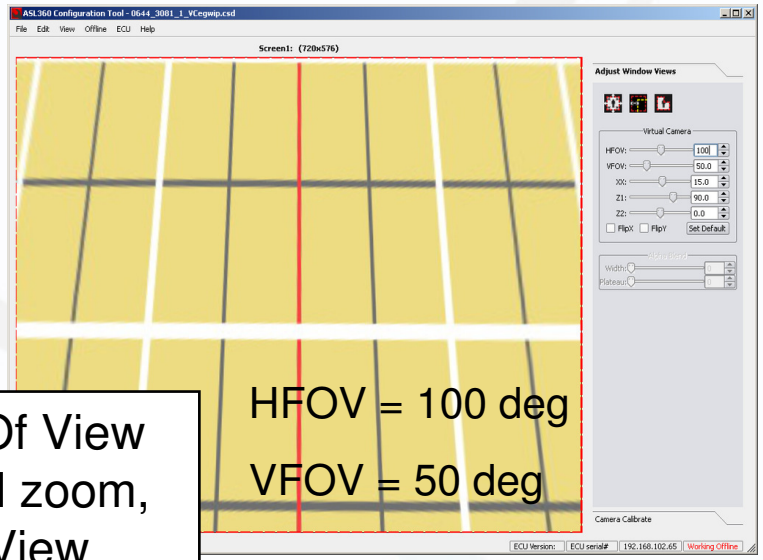
Z2 controls roll about the lens optical axis



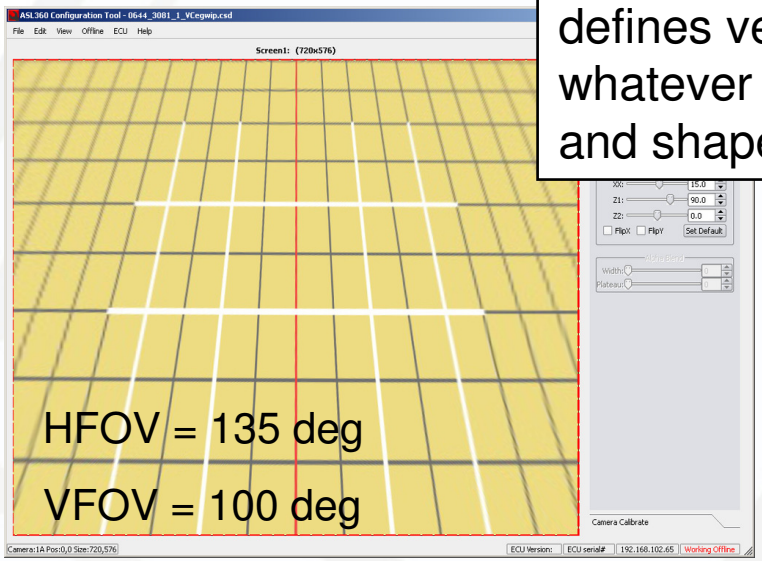


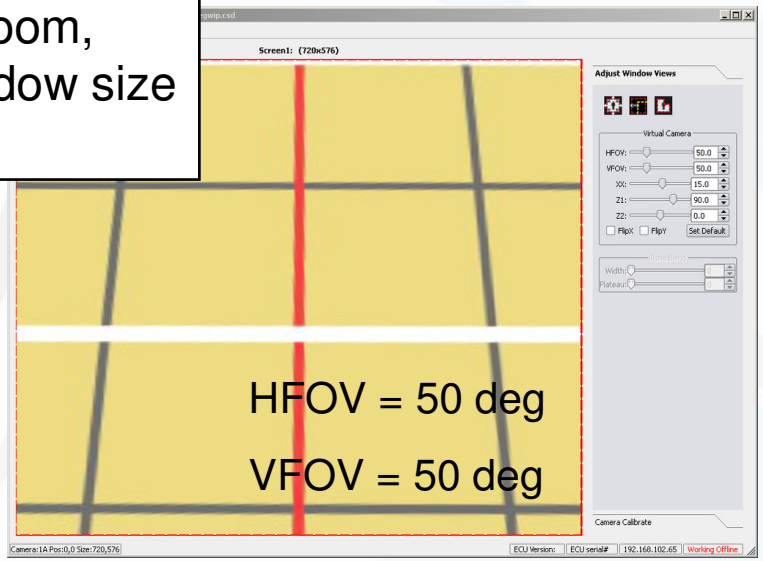
Design – virtual cameras – HFOV & VFOV





Horizontal Field Of View defines horizontal zoom, Vertical Field Of View defines vertical zoom, whatever the window size and shape





Design – virtual cameras – FlipX, FlipY

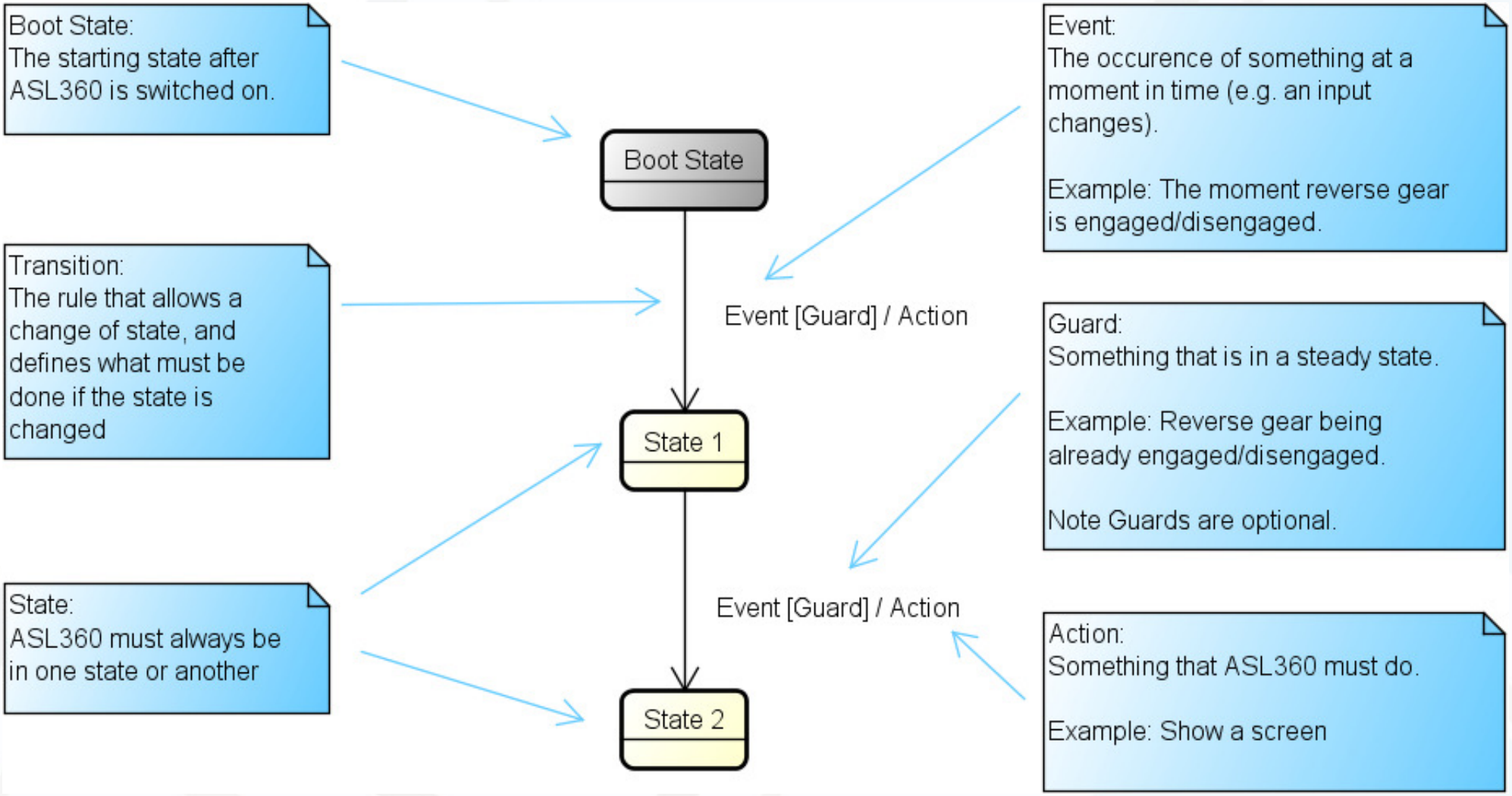
- **If the Virtual Camera is simulating a rear view mirror**
  - Check FlipX to laterally invert the image

Design – Screen Activation Setup

- **User can define how ASL360 responds to inputs**
  - Change Screens in response to vehicle signals
    - E.g. Reverse engaged, Door open, Indicators, Vehicle speed, etc.
  - ASL360 inputs:
    - 4 x Opto-isolated
      - OPTO1, OPTO2, OPTO3, OPTO4
      - ‘True’ (activated) when a current flows from opto inputs + to -
    - 4 x Non-isolated (but protected)
      - GPIO1, GPIO2, GPIO3, GPIO4
      - Ideal for volt free switches (though can be driven)
      - ‘True’ (activated) when pulled down to ground
      - GPIO4 can be used to count Tacho pulses
  - Available in Configuration Tool v2.4 onwards
- **Other features:**
  - 4 x Timers
  - Outputs: Camera power, digital output, relay output
  - “View loop” (list of screens to display)
- **Generalised model to describe desired functionality**
  - Very simple, e.g. show only one screen, or
  - Complex, e.g. multiple screens, multiple inputs, multiple timers, complex behaviour

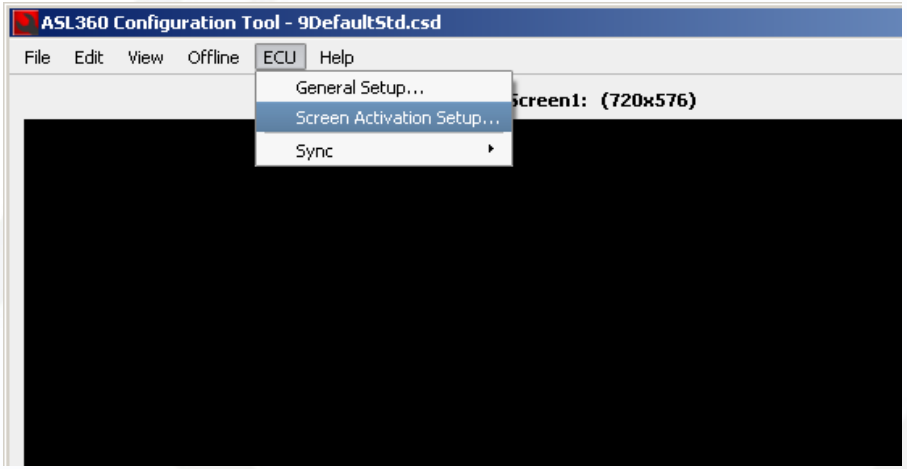
Design – Screen Activation Setup

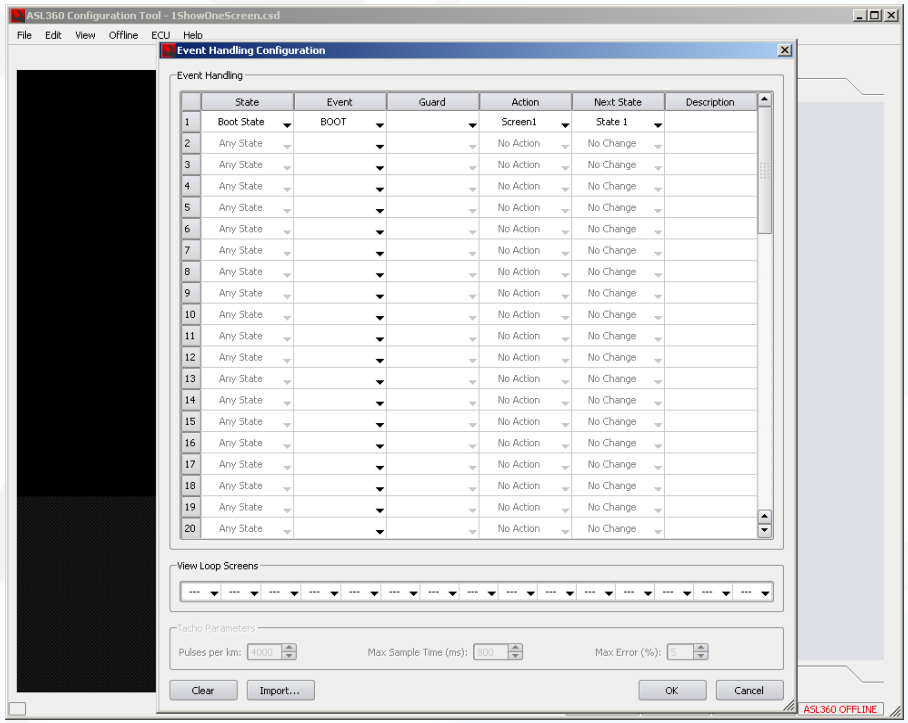
- **Generalised state model can describe any desired functionality**



Design – Screen Activation Setup

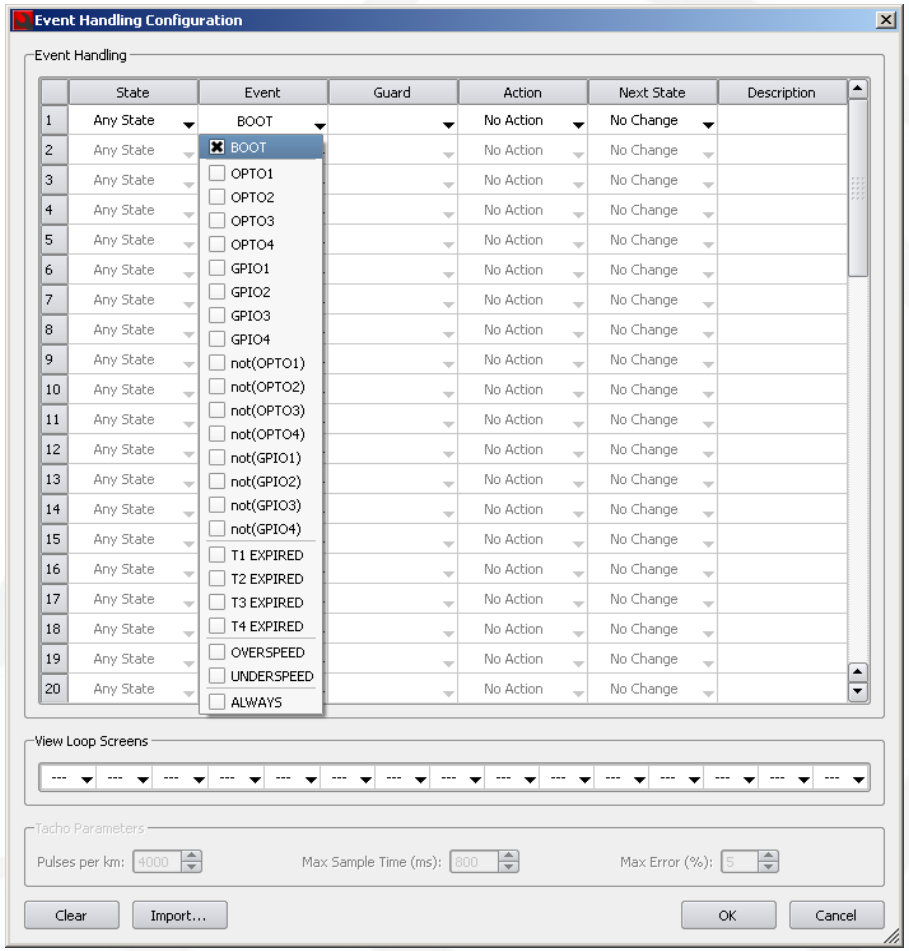
- **Setup editor under ECU/Screen Activation Setup**
  - Opens Event Handling table
- **Event Handling table**
  - Describes in tabular form exactly the same information as the state diagram
  - ASL360 looks at each row in order, trying to find a matching transition
    - In some cases, care must be taken to put transitions in the correct order

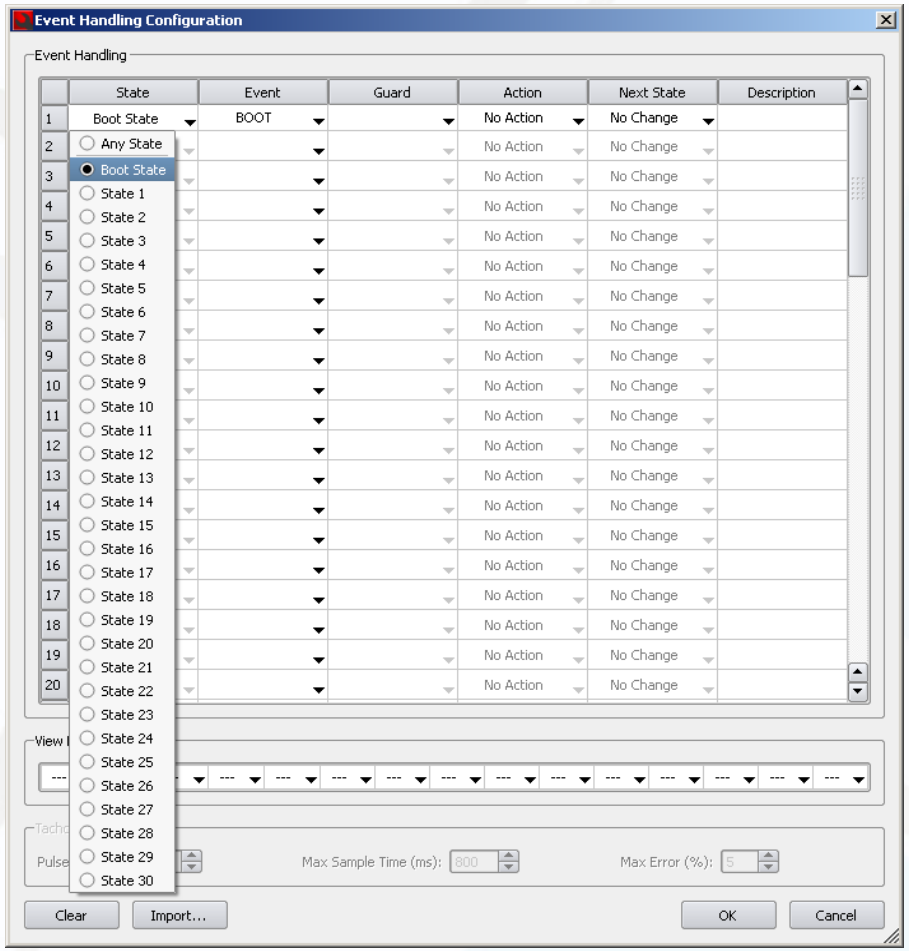




Design – Screen Activation Setup

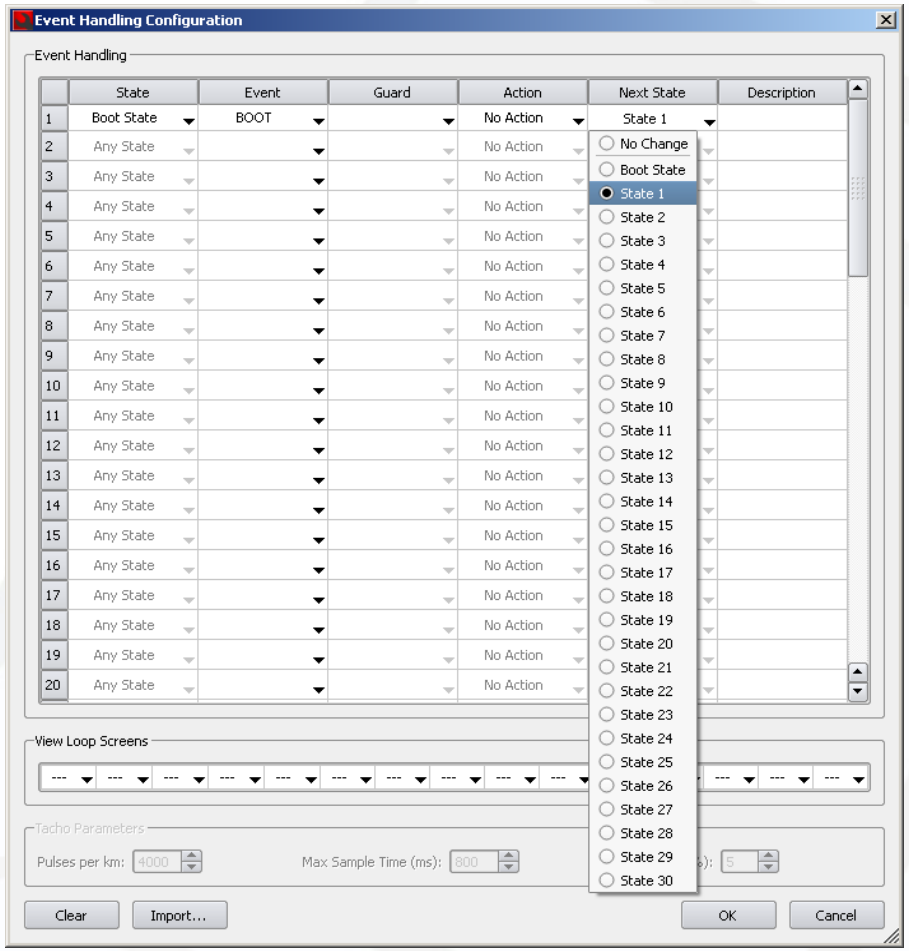
- **Cell content defined by drop down menus (left click to select)**
  - Input and state resources can be seen in drop down menus

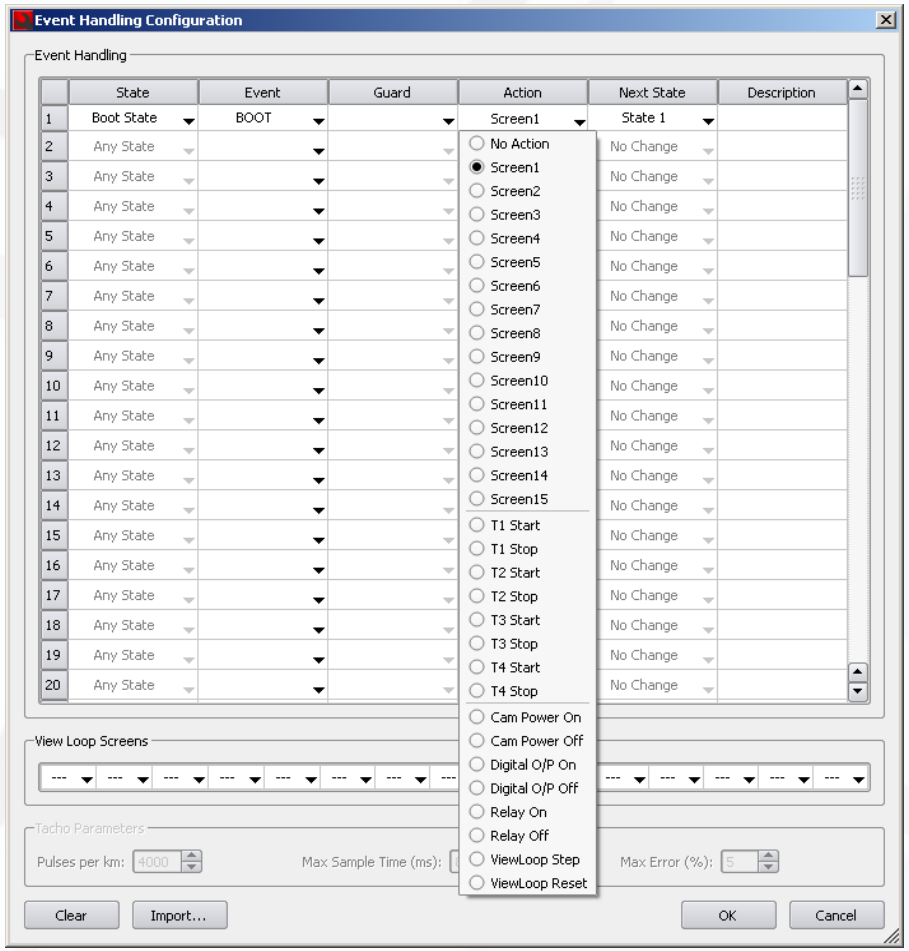




Design – Screen Activation Setup

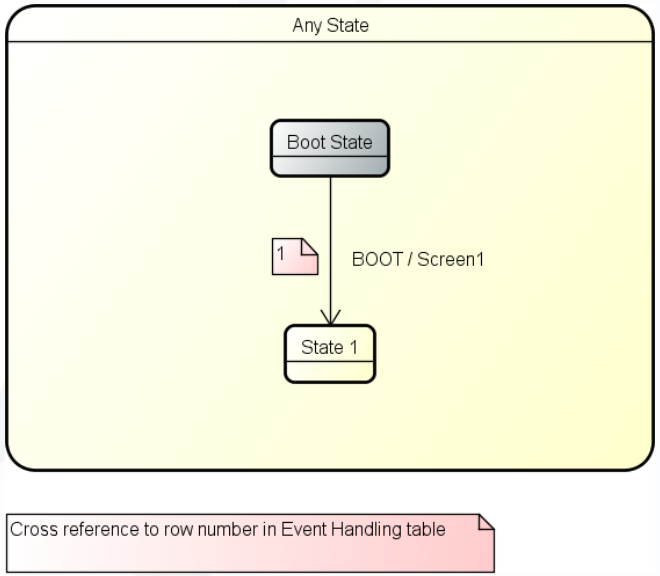
- **Cell content defined by drop down menus (left click to select)**
  - State and Action resources can be seen in drop down menus

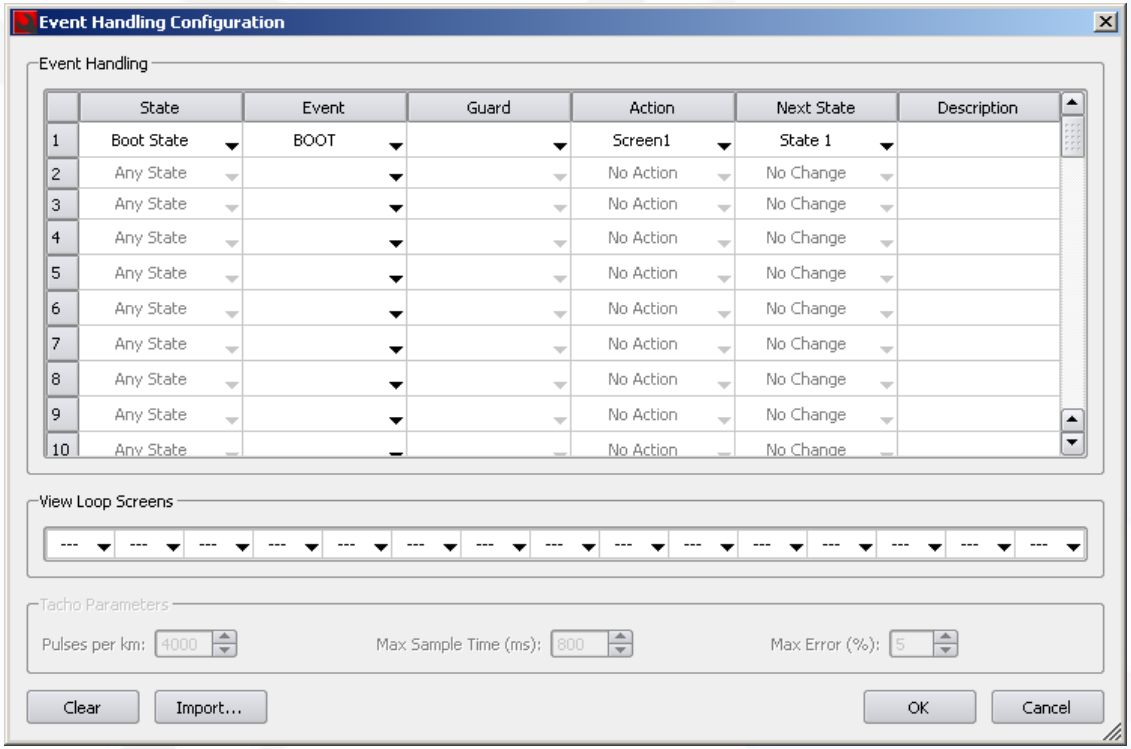




Design – Screen Activation Setup

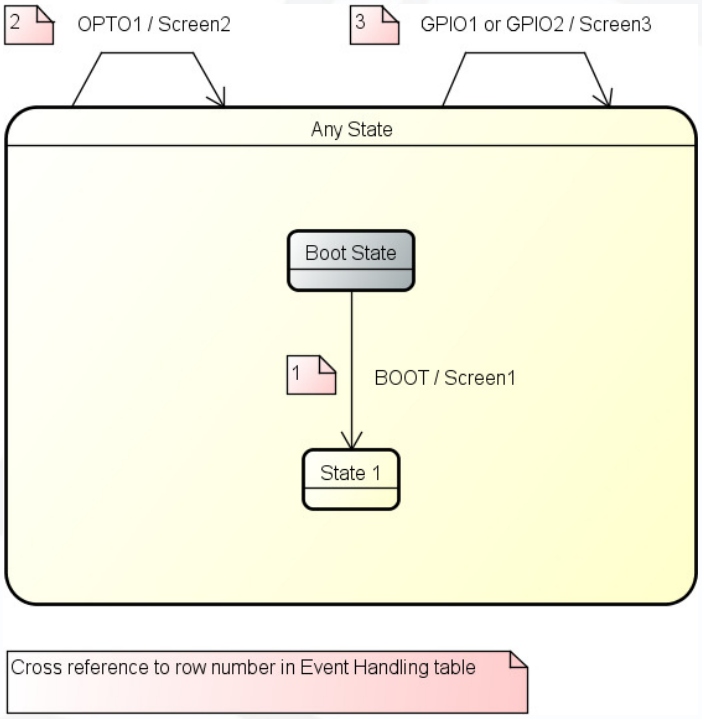
- **Simplest useful case: no interactivity**
  - Show a screen when ECU starts up

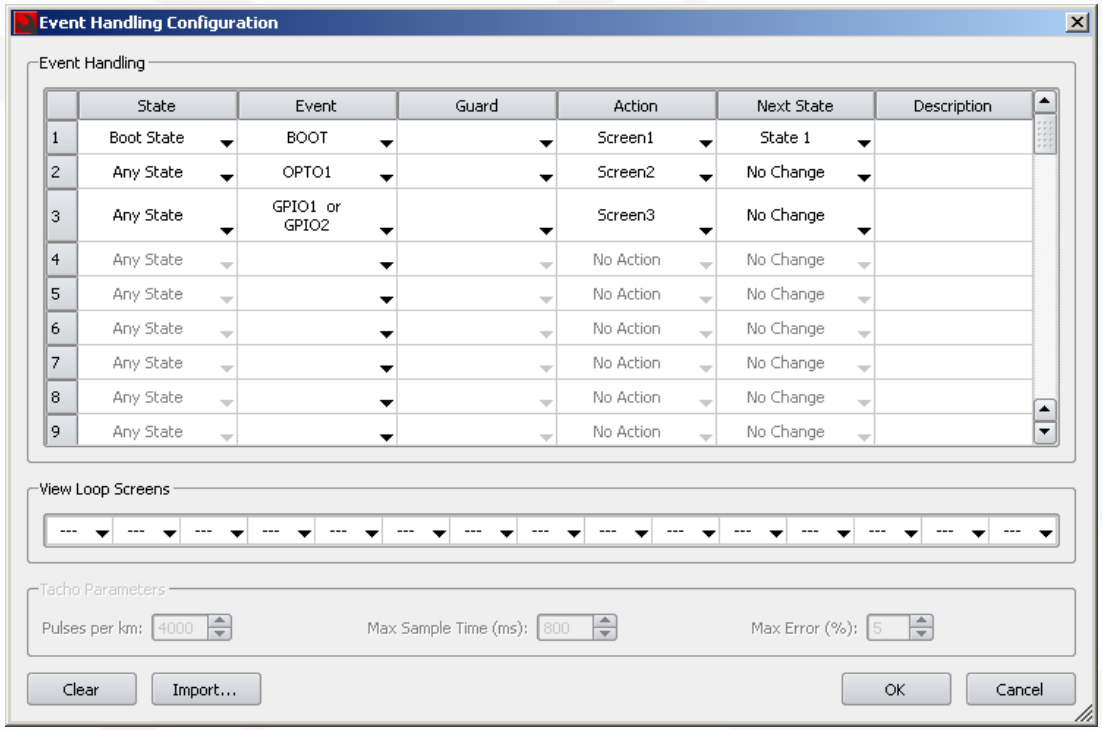




Design – Screen Activation Setup

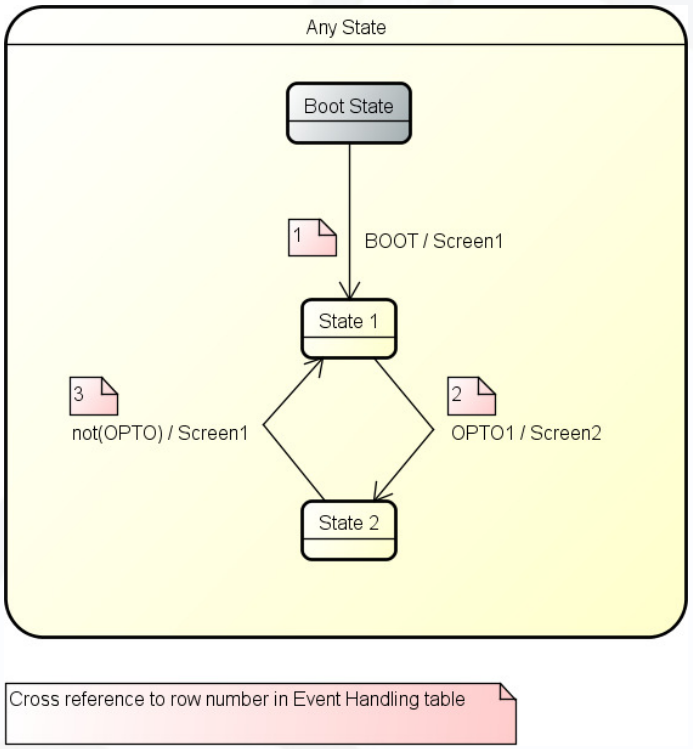
- **Activity can be independent of state**
  - Note multiple events can be defined

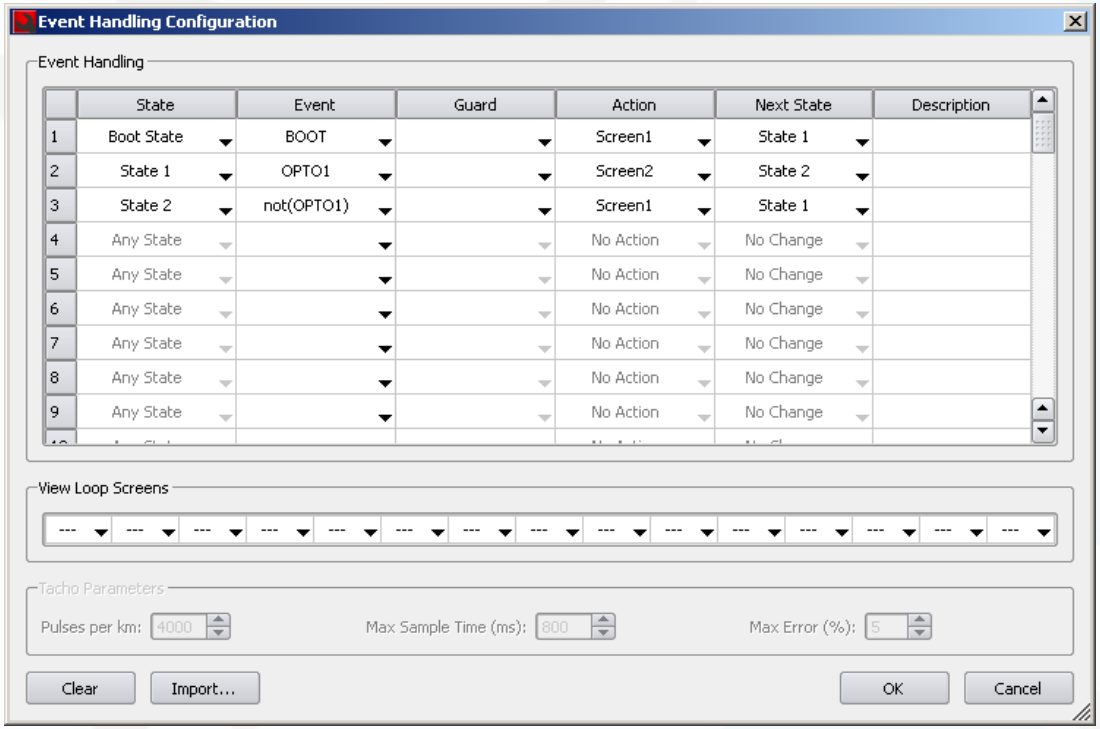




Design – Screen Activation Setup

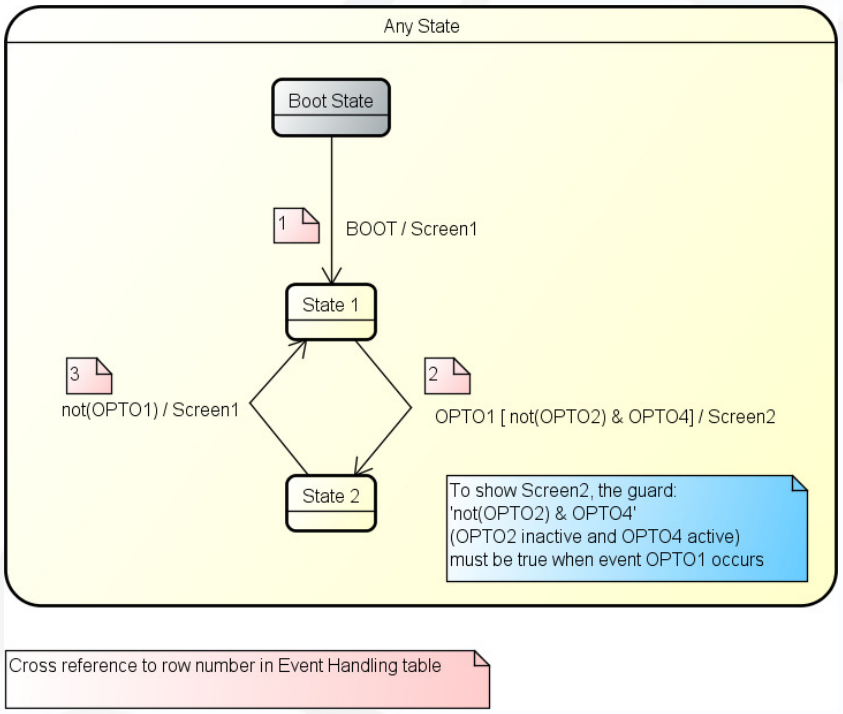
- **Respond to external events**
  - Show Screen2 when OPTO1 goes active, show Screen1 when OPTO1 goes inactive
    - OPTO1 inactive = not(OPTO1)

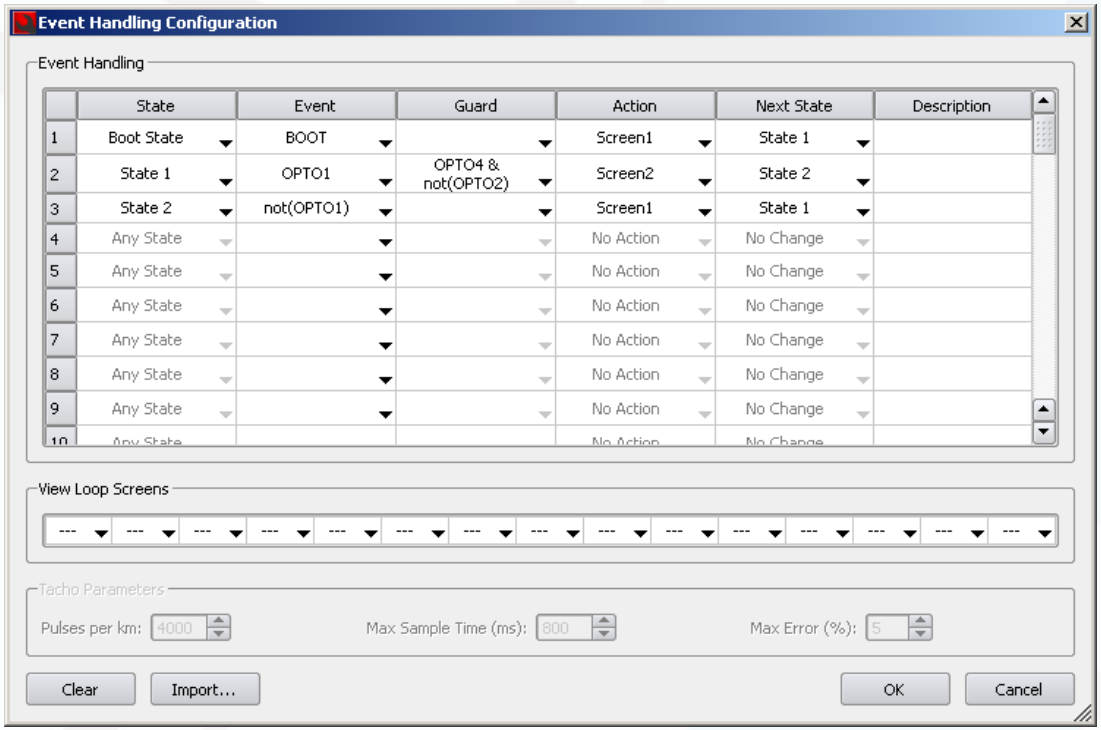




Design – Screen Activation Setup

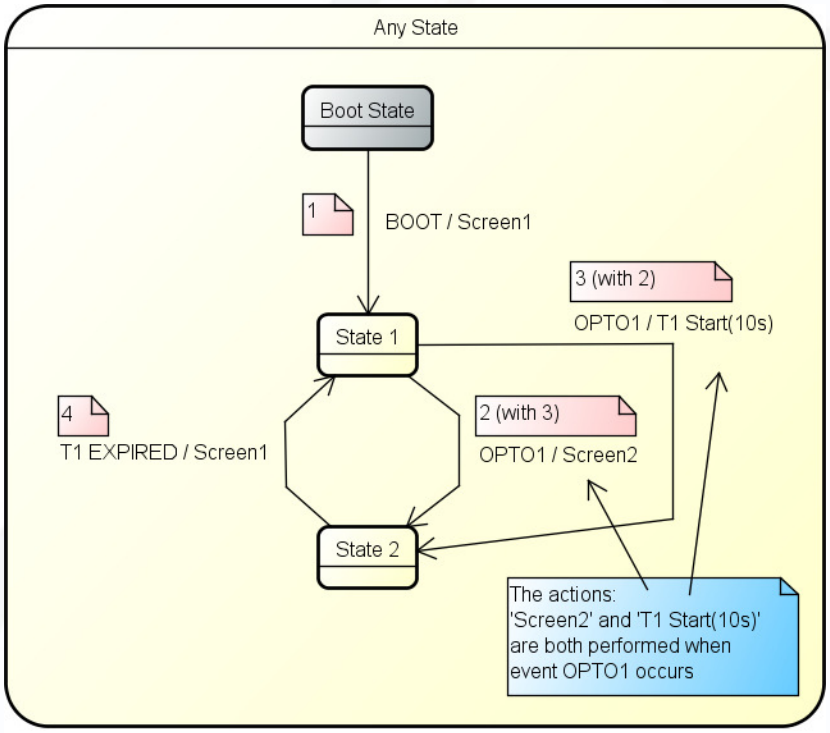
- **Respond to external events + use of Guard**
  - Use Guard to control if Event should be responded to
    - Single or multiple Guards can be defined



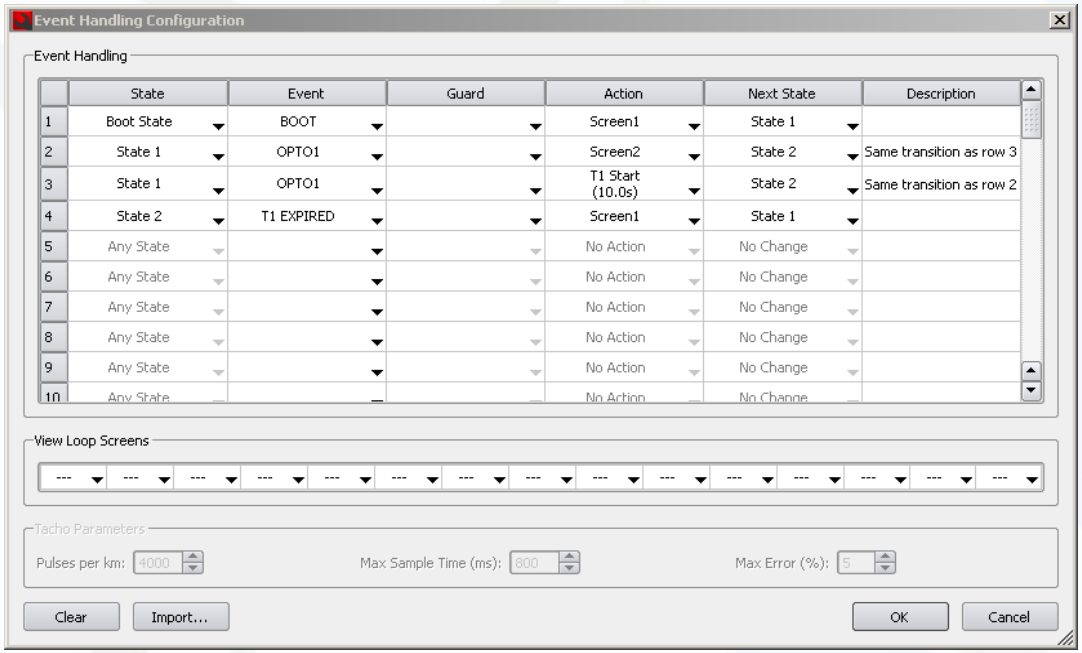


Design – Screen Activation Setup

- **Respond to external event + use of timer**
  - Show Screen2 when OPTO1 becomes active, show Screen1 10 seconds later
  - 4 timers are available; duration: 0.1 second to over 100 minutes
  - Note multiple actions (here Screen2 and T1 Start) require 2 transitions / rows

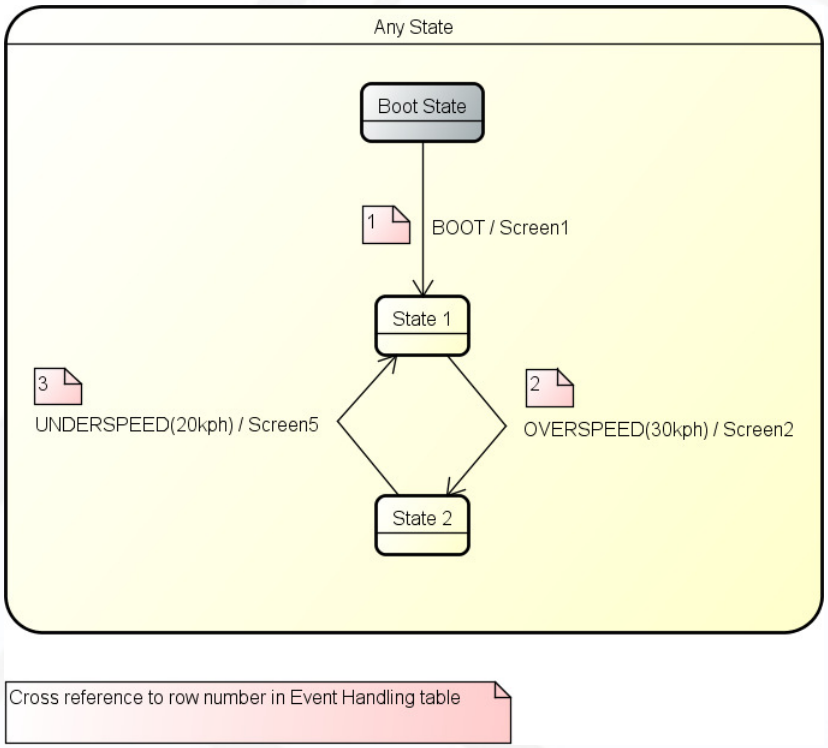


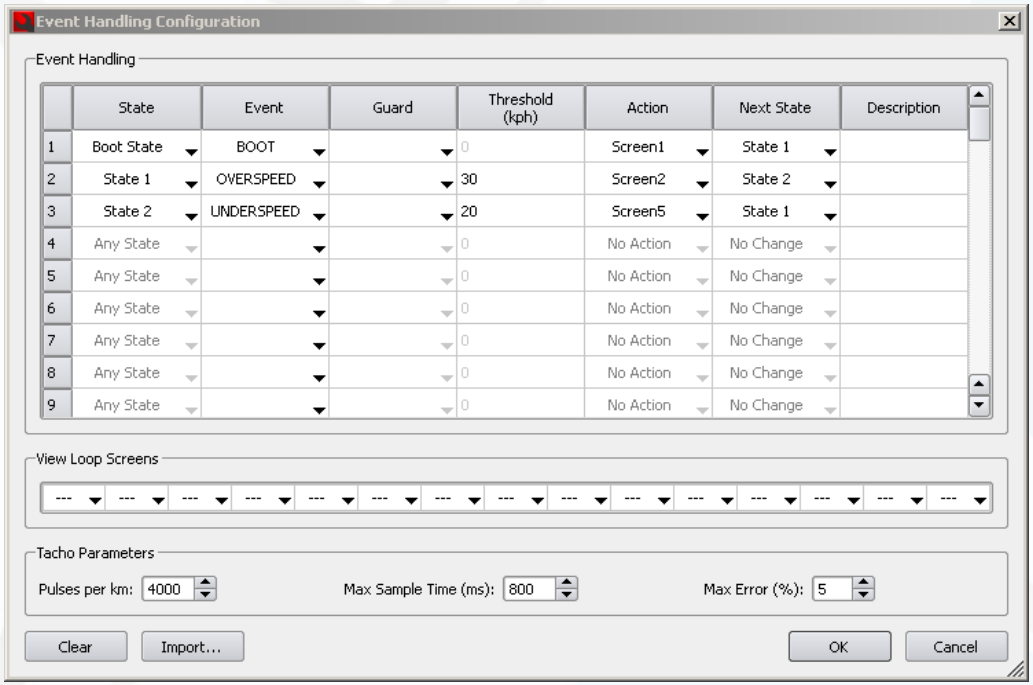
Cross reference to row number in Event Handling table



Design – Screen Activation Setup

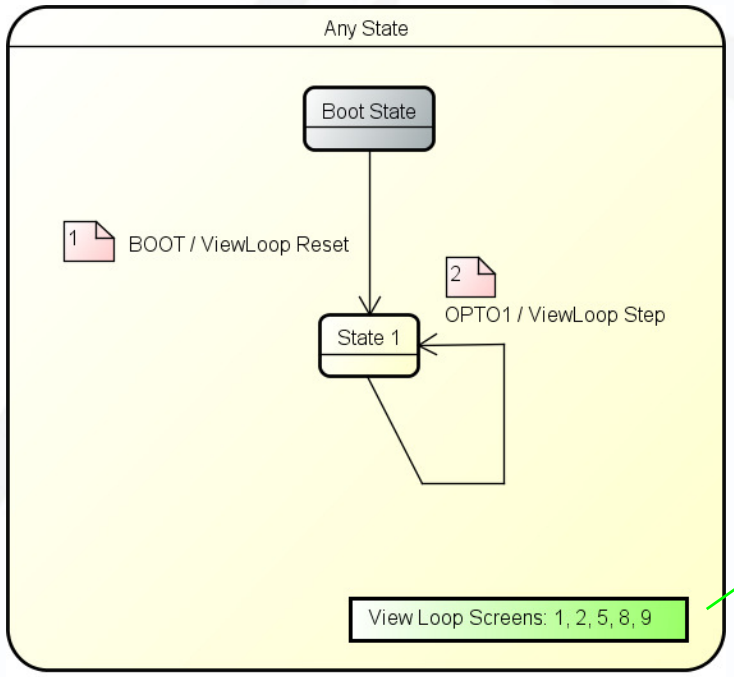
- **Respond to external event: vehicle speed**
  - Show Screen2 when speed rises over 30 kph, show Screen5 when speed drops below 20 kph
  - Configurable Tacho parameters: Number pulses per km, longest measurement duration allowed, % error allowed
    - Note: only 1 OVERSPEED and 1 UNDERSPEED value allowed

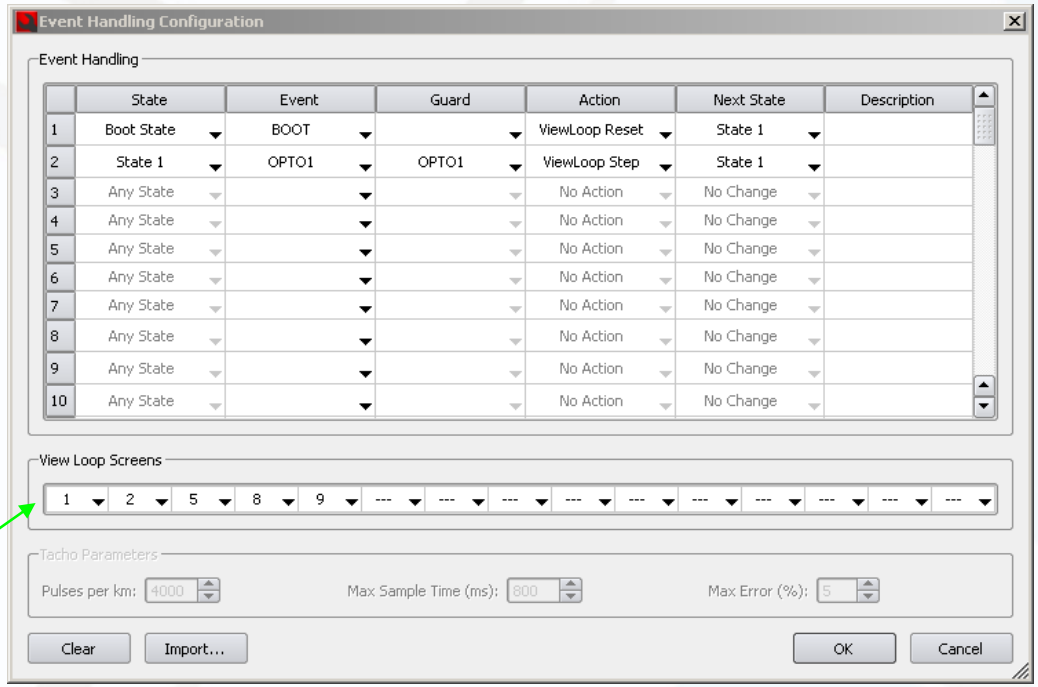




Design – Screen Activation Setup

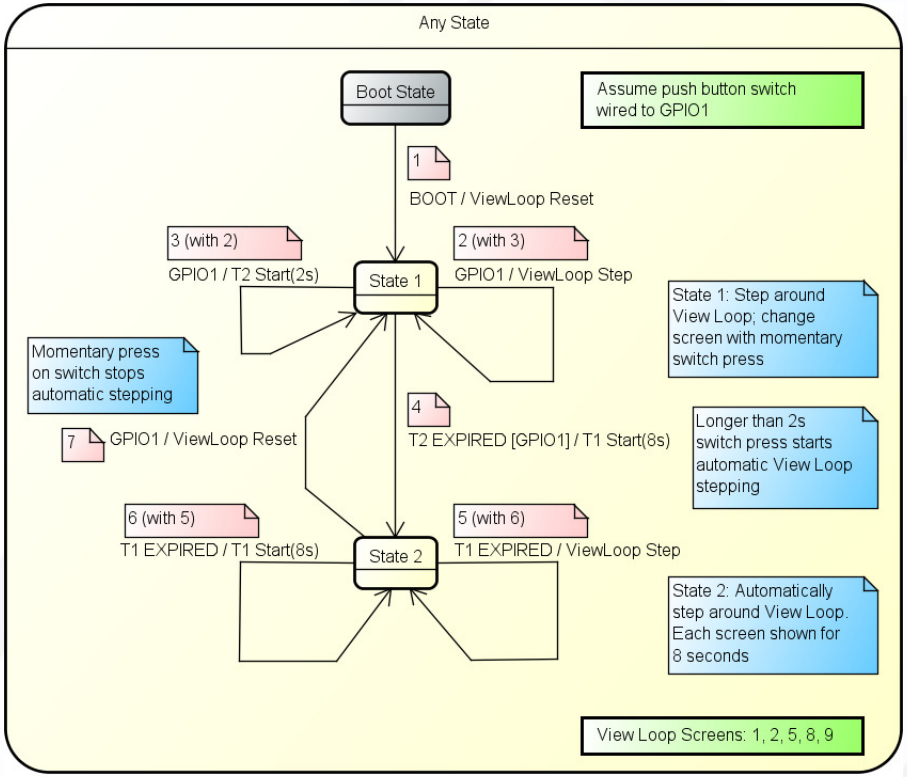
- **View Loop – a sequence of screens**
  - View Loop Screens: up to 15 in sequence, each selected by drop down menu
  - ViewLoop Reset – shows 1st screen in the sequence
  - ViewLoop Step – shows the next screen in the sequence; at end wraps to start

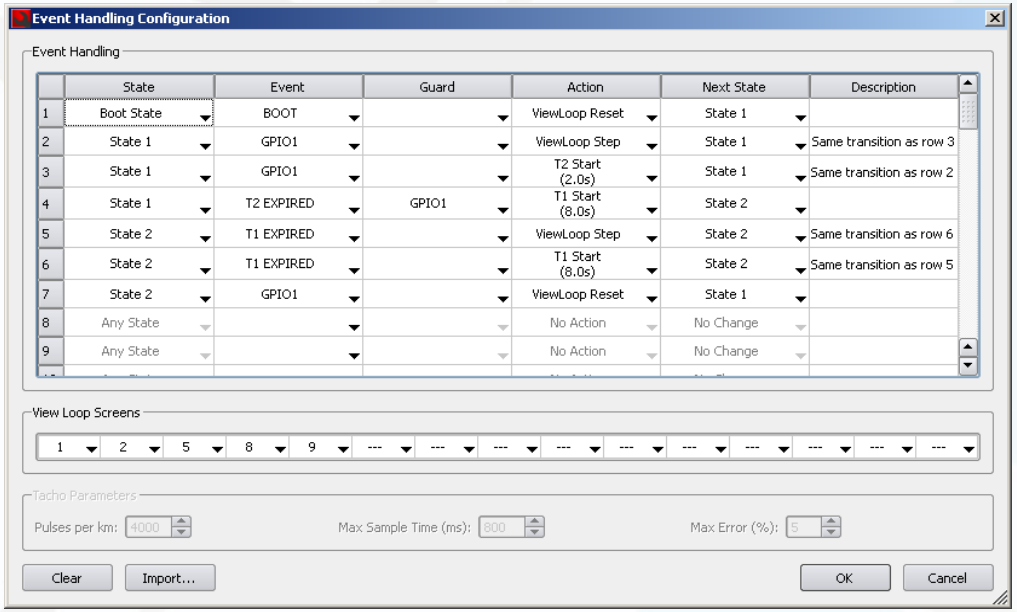




Design – Screen Activation Setup

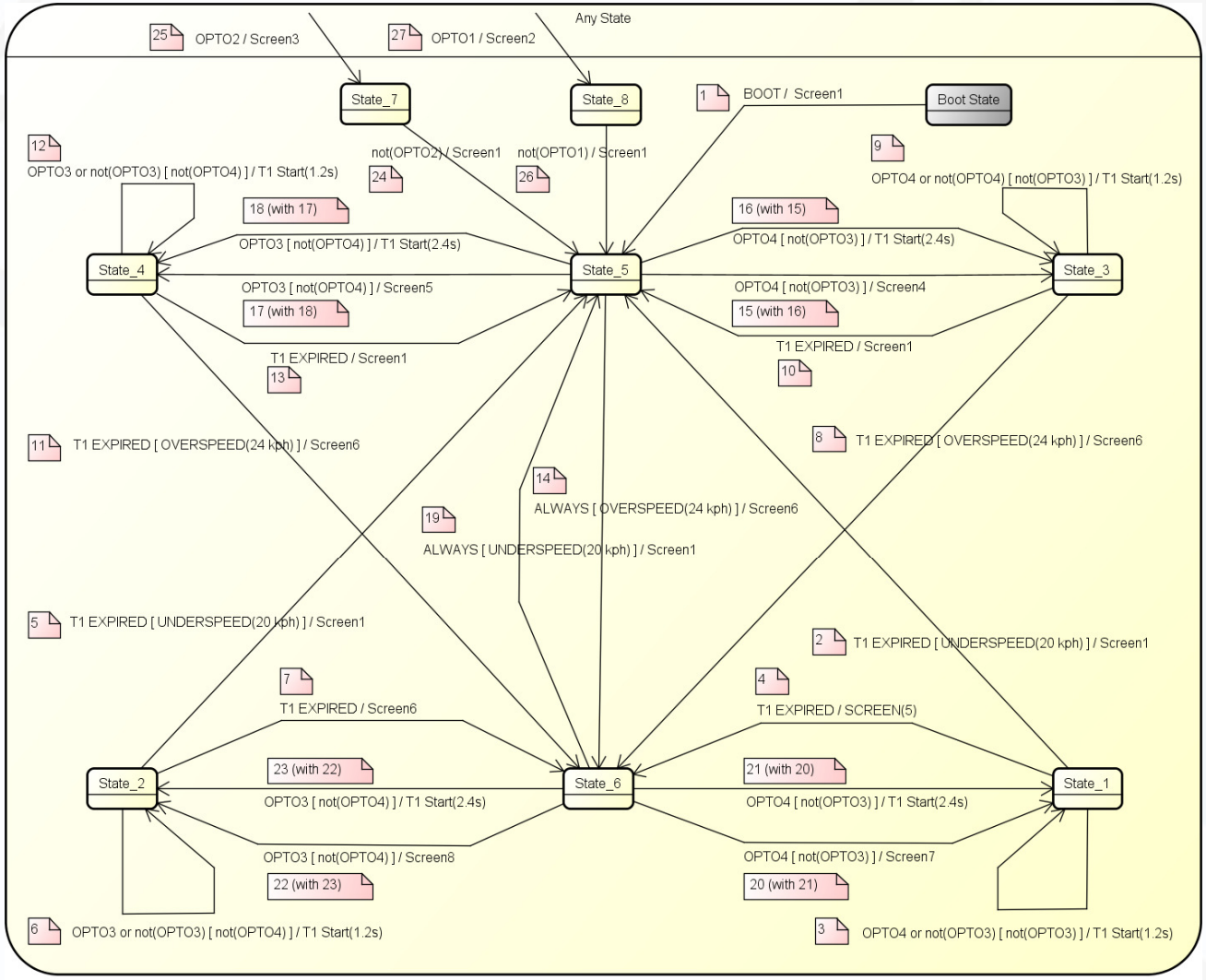
- **View Loop - example useful for demonstrations**
  - View Loop manually stepped by pushbutton or stepped automatically on timer
  - Defaults to manual mode, long press to move to automatic mode, momentary press returns to manual mode.





Design – Screen Activation Setup

- **Built-in default design**
- **8 screens**
- **Responding to:**
  - Reverse gear
  - Door open
  - Indicators (flashing)
  - Speed (via tacho)
- **Simple aspects:**
  - Starts by showing Screen1
  - OPTO1 shows Screen2
  - OPTO2 shows Screen3

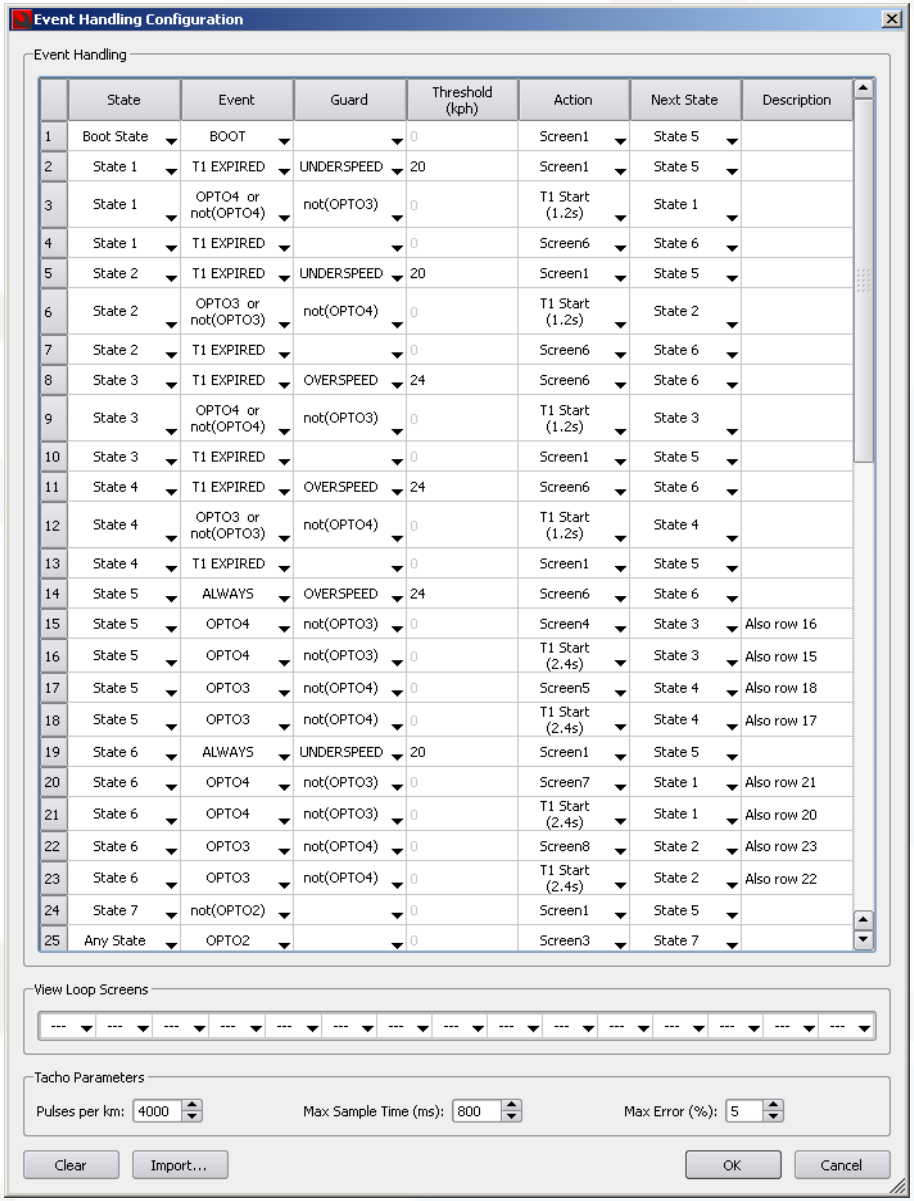


Cross reference to row number in Event Handling table

Input assignments:
GPIO OPTO1 - e.g. DOOR OPEN
GPIO OPTO2 - e.g. REVERSE
GPIO OPTO3 - e.g. INDICATOR LEFT
GPIO OPTO4 - e.g. INDICATOR RIGHT
GPIO_IP4T - SPEED (Pulses per km: 4000, Max Sample Time (ms): 800, Max Error (%): 5

Design – Screen Activation Setup

- **Built-in default design**
- **8 screens**
- **Responding to:**
  - Reverse gear
  - Door open
  - Indicators (flashing)
  - Speed (via tacho)
- **Simple aspects:**
  - Starts by showing Screen1
  - OPTO1 shows Screen2
  - OPTO2 shows Screen3



	State	Event	Guard	Threshold (kph)	Action	Next State	Description
1	Boot State	BOOT		0	Screen1	State 5	
2	State 1	T1 EXPIRED	UNDERSPEED	20	Screen1	State 5	
3	State 1	OPTO4 or not(OPTO4)	not(OPTO3)	0	T1 Start (1.2s)	State 1	
4	State 1	T1 EXPIRED		0	Screen6	State 6	
5	State 2	T1 EXPIRED	UNDERSPEED	20	Screen1	State 5	
6	State 2	OPTO3 or not(OPTO3)	not(OPTO4)	0	T1 Start (1.2s)	State 2	
7	State 2	T1 EXPIRED		0	Screen6	State 6	
8	State 3	T1 EXPIRED	OVERSPEED	24	Screen6	State 6	
9	State 3	OPTO4 or not(OPTO4)	not(OPTO3)	0	T1 Start (1.2s)	State 3	
10	State 3	T1 EXPIRED		0	Screen1	State 5	
11	State 4	T1 EXPIRED	OVERSPEED	24	Screen6	State 6	
12	State 4	OPTO3 or not(OPTO3)	not(OPTO4)	0	T1 Start (1.2s)	State 4	
13	State 4	T1 EXPIRED		0	Screen1	State 5	
14	State 5	ALWAYS	OVERSPEED	24	Screen6	State 6	
15	State 5	OPTO4	not(OPTO3)	0	Screen4	State 3	Also row 16
16	State 5	OPTO4	not(OPTO3)	0	T1 Start (2.4s)	State 3	Also row 15
17	State 5	OPTO3	not(OPTO4)	0	Screen5	State 4	Also row 18
18	State 5	OPTO3	not(OPTO4)	0	T1 Start (2.4s)	State 4	Also row 17
19	State 6	ALWAYS	UNDERSPEED	20	Screen1	State 5	
20	State 6	OPTO4	not(OPTO3)	0	Screen7	State 1	Also row 21
21	State 6	OPTO4	not(OPTO3)	0	T1 Start (2.4s)	State 1	Also row 20
22	State 6	OPTO3	not(OPTO4)	0	Screen8	State 2	Also row 23
23	State 6	OPTO3	not(OPTO4)	0	T1 Start (2.4s)	State 2	Also row 22
24	State 7	not(OPTO2)		0	Screen1	State 5	
25	Any State	OPTO2		0	Screen3	State 7	

Design – Screen Activation Setup

- **Caution: if no Event Handling is defined**
  - ASL360 will not show any user defined screen
    - Disclaimer screen remains visible

- **Either:**
  - Define required interactivity

  or
  - Use built-in default design (previous page)
    - With no csd file loaded start ‘Screen Activation Setup’
      (Or load csd file created pre v2.4)
    - Built-in default design is automatically loaded