1 PPE Detector

Introduction

Personal Protective Equipment (PPE) Detector is a part of Luxriot video analytics (VA) suite and is a real-time video analytics engine that utilizes **neural networks** to detect the cases when the **personal protective equipment** is not used. Personal protective equipment (PPE) is protective **helmets** (hard hats) and **vests** designed to protect the wearer's body. The PPE Detector engine is seamlessly built into the Luxriot EVO software and a part of the unified Luxriot EVO licensing system.

Luxriot EVO VA with PPE Detector can:

- detect and classify objects of related types in the live video stream
- trigger events based on these objects' [dis]appearance and convert them into automated action rules
- count objects over time or momentarily using lines and zones
- generate alarms and reports using E&A and other Luxriot EVO functionality

Supported object classes for detection:

- person with PPE
- person without PPE (no vest and no helmet)
- person with partial PPE (vest or helmet missing)
- PPE itself (yellow-green/orange vest, any color head cover)

This user guide will explain how to enable and set up PPE Detector for pre-configured video channels on Luxriot EVO servers.

PPE Detector is a part of Luxriot VA, which is an integral part of Luxriot EVO core, therefore:

- no additional installation is needed but an additional per-channel license is required (regular VA channel license does not work so ask Luxriot sales explicitly for PPE Detector channels)
- VA cannot operate on its own without Luxriot EVO channels
- triggered rules can be used in the Event & Action scenarios to create complex and flexible automated behaviour patterns
- VA metadata overlay is displayed in Luxriot EVO Monitor for the user to see the tracked objects both in live view and in playback
- VA metadata can be used for forensic search and reports in Luxriot EVO Monitor

As PPE Detector is one of the Luxriot EVO VA engines, it is impossible to combine PPE detection VA with other VA engines (e.g., generic object detection). As any server-side VA, PPE Detector can be freely combined with any kind of camera-side (edge) analytics.

PPE Detector Usage

A typical application for the PPE Detector is **personnel monitoring** to ensure compliance with safety rules in areas like **construction, manufacturing, or mining**, where the safety rules prescribe the personnel to use the personal protection equipment at all times.

The analytics can effectively detect, alarm, and report the cases when persons without PPE are entering workshops, construction/manufacturing sites, or other hazardous areas under surveillance. For example, Luxriot EVO can trigger alarms in places of high risk (cranes or other operating machinery) and poor visibility (smoke, steam, etc.) or make audio announcements whenever a person without PPE is detected.

As a result, the work discipline and safety is significantly increased. PPE Detector helps comply with the work legislation and provides an evidence base in case of any incidents (e.g., to prove that an injury was caused by the disciplinary violation and not by unsafe working conditions). Also, you can use it for access control by automatically granting access to restricted area only in case PPE is present.

Getting Started

PPE Detector can be enabled and configured on any Luxriot EVO server that either has a Luxriot EVO S license or is a part of Luxriot EVO Global system. The server license must include the required number of purchased PPE Detector channels; kindly contact https://www.luxriot.com/purchase/inquiry-form/ to for license upgrade.

- ensure that you have installed your Luxriot EVO server, version 1.21.0 or newer, 64-bit version
- activate your Luxriot EVO server with a license key that allows PPE Detector usage (by default, no channels are included, additional channels can be purchased by contacting us at https://www.luxriot.com/purchase/inquiry-form/),
- add video sources to be analyzed (please check with the main Luxriot EVO manual for details),
- enable and configure PPE Detector via VA configuration in Luxriot EVO Console for the desired channels,
- configure E&A rules, if necessary,
- enjoy.

PPE Detector is enabled and configured via Luxriot EVO Console using the main VA interface. After you set it up, it is possible to add Event & Action scenarios based on the the VA detections in Luxriot EVO Console, and see the VA metadata overlaying the video in Luxriot EVO Monitor.

Factors That Affect Detection

The engine is optimized to work with color images in a well-lit environment. Night/IR/darker images lead to lower quality of detection.

Things to improve:

- increase camera/image quality
- avoid glares and backlight, low-contrast images or scenes
- camera position and angle
- get rid of obstructions between cameras and people

The engine works well with close-up and full height views, both front and back (remember to adjust object size) - such positioning can be used for access control at entrance/exit/checkpoint. Up to 45-degree downright views can be used as well for detecting people standing, walking, or sitting in the area.

The camera should be fixed; it is possible to use PTZ cameras that stay in the same position (preset) for some time. Constantly moving PTZ cameras/bodycams have lower accuracy.

When configuring detection, always start from default values, and then slowly change the settings one by one if you are not happy with results. If changing a certain setting in certain direction produces worse results, change it back to default and try the opposite direction (decrease vs increase). Do not change the advanced engine values (e.g. workers) if the detection is working OK.

All frames are downsampled to 640x480 or similar resolution, preserving aspect ratio, so using ultra high resolution streams is not recommended as there will be more distortion. Smaller frames are not upscaled.

System Requirements

Hardware: Intel processor Coffee Lake or newer, 4 physical cores per channel

Operating system: Microsoft Windows 10 or newer

Processing on GPU is not supported.

Configuration

PPE Detector is enabled and configured via Luxriot EVO Console for each individual channel, in the *Video analytics* tab.

1. Make sure your license supports PPE Detector by running the license manager (regular VA channel license is not suitable for PPE Detector)
2. Turn ON the *Enable server-side VA* option
3. Choose *Personal Protective Equipment Detector* from the list of detectors and adjust its settings
4. Choose desired classes from the corresponding section
5. Configure specific zones and rules, if desired
6. Adjust other settings, if required

Main Settings

Most of the settings are the same as for generic VA engines. You can pre-configure everything without turning ON the video analytics, and then enable VA later.

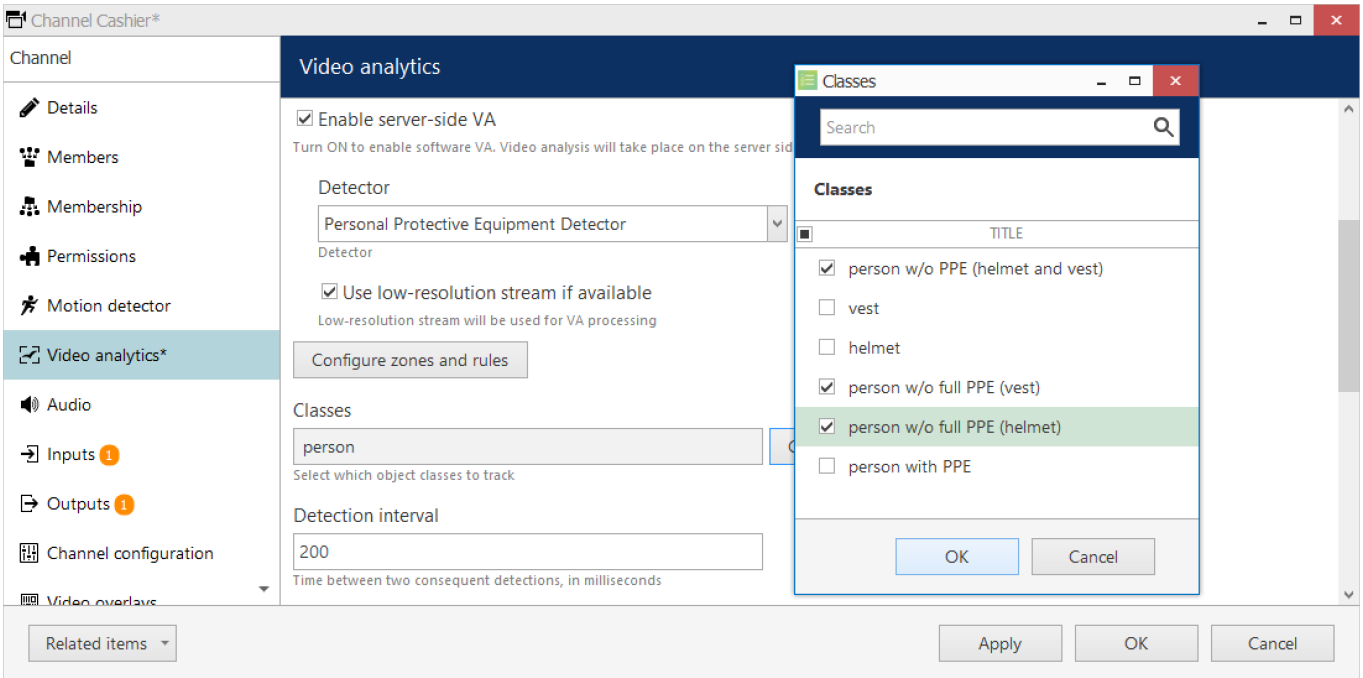
These settings describe the scene to the VA engine, "teach" it about the scene specifics, so take a moment and think about these. Does the scene have perspective? What is the maximum expected size of the object? Settings and recommendations:

- *Object loss timeout*: after how much time the object is forgotten by VA once it disappears from the scene. Increase this value if the object is likely to dwell (re-enter the scene).
- *Scene dynamics*: defines how fast the changes occur in the scene. For large scenes (far away or zoomed out) the dynamics are lower; highly dynamic scenes are close-ups where objects swiftly cross the frame from one side to another.
- *Confidence threshold*: how certain the engine is about the object class. Tweak this setting if you don't get any or enough detections,, always start with default value. Too high confidence levels leads to no detections, too low - to false positives.
- *Object similarity*: higher levels correspond to lower variability of the same object's appearance across frames, lower levels mean the same object changes a lot while crossing the scene. Set lower similarity for scenes with perspective and other scenes where objects tend to change their shape/appearance as they move (e.g., they cross the frame border, turn, persons change not just the position but also the pose etc.)

A general recommendation is to leave the defaults and then start changing the settings one by one to improve detection. If you see that detection is not improving, stop changing the setting or even reset it to default.

Defaults: 500ms/6s/normal/70/85/50-50.

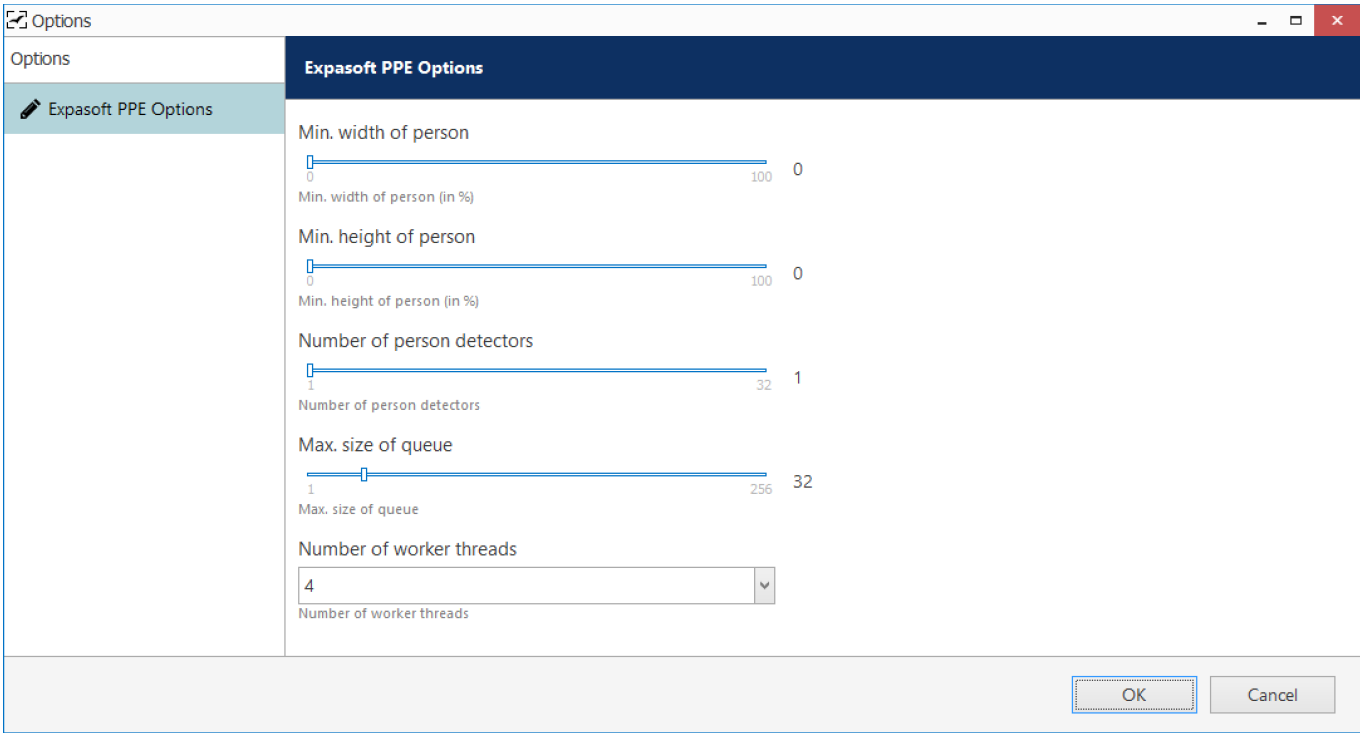
Pay attention to the *Detection interval*: this setting defines how frequently the frames are analyzed, and it dramatically affects CPU usage. 200ms means the recognition FPS is equal to 5FPS. Higher frequency = higher accuracy. If you want to run recognition on more channels (sacrificing accuracy), set it to 500ms (2FPS), which is also the default setting.



Enable PPE Detector in the VA settings

Engine-Specific Settings (Advanced)

Some advanced engine-specific options are available. You can use those to fine-tune the engine (mostly when the adjustments are advised by Luxriot support). Changing these settings may lead to lower detection quality, so if you feel the accuracy is worse after changing them, change the settings back to **defaults**. These settings are per-channel, meaning that they can be changed **independently for every video channel**. Again, changing advanced settings is NOT obligatory, do not change them unless you know what you are doing.



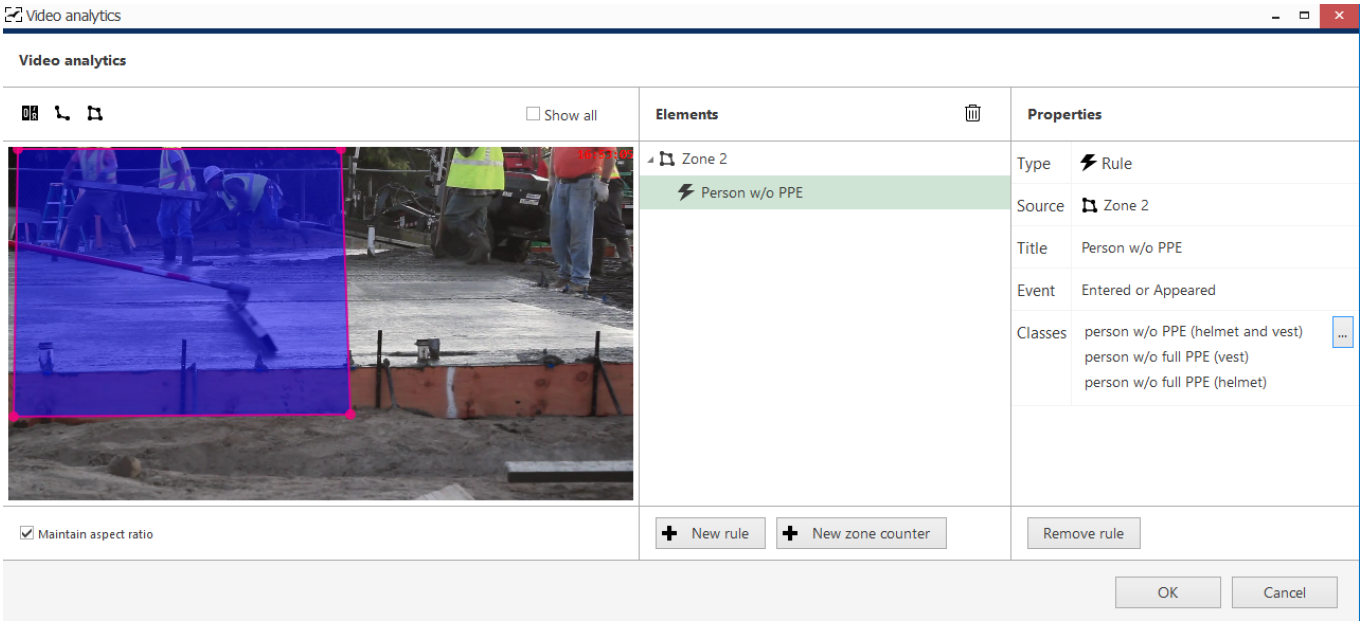
Default PPE Detector engine settings

Available settings:

- **Min width/height of person**: minimum and maximum expected size of persons, % of image width/heigth - increase these settings to filter out tiny objects in a distance
- **Person detectors + worker threads**:
    - For **faster** results, set worker threads to 1 and increase the number of person detectors (but do not exceed the number of your CPU threads)
    - To handle more **frames**, set person detectors to 1 and increase the number of workers
- **Queue size** optimal value is equal to the number of workers, otherwise the frames will be analyzed slightly longer, but you might want to increase the queue size to ensure that more frames are analyzed

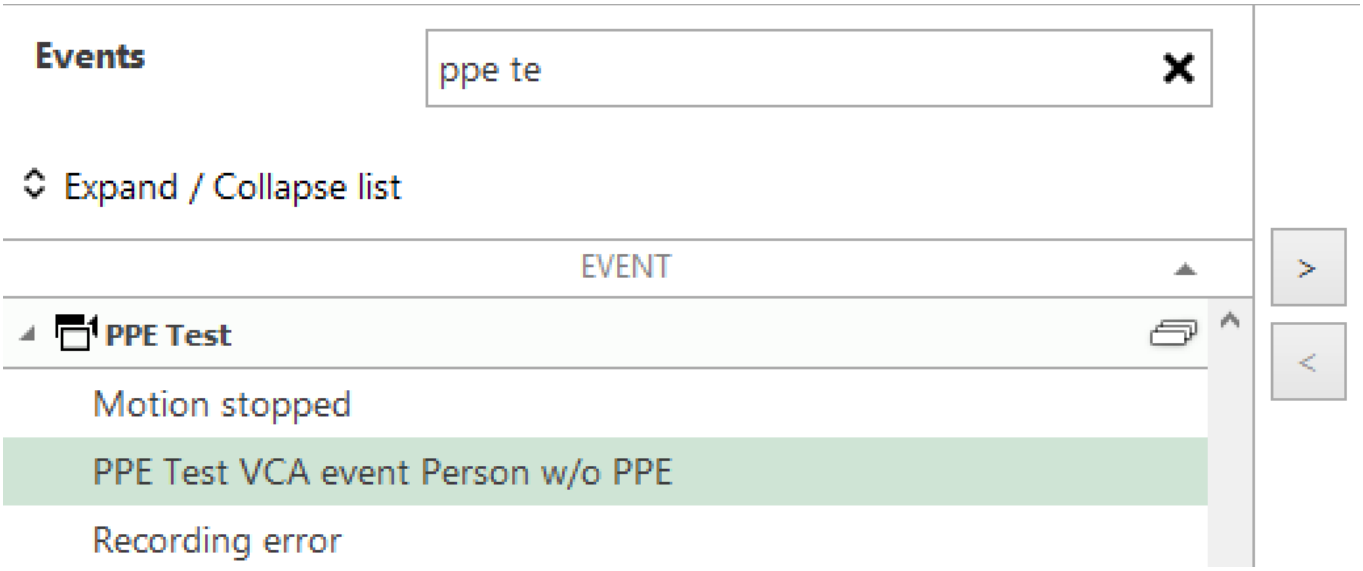
Zones, Rules, and Events

Without zone rules, the metadata will appear on top of the video but no events will be triggered. To trigger events, create a at least one **zone** and then create the desired **rules** for that zone. For each rule, you can choose some or all of the object classes, which are enabled for detection (but you cannot choose the classes that are not enabled in the detector settings on the level above).



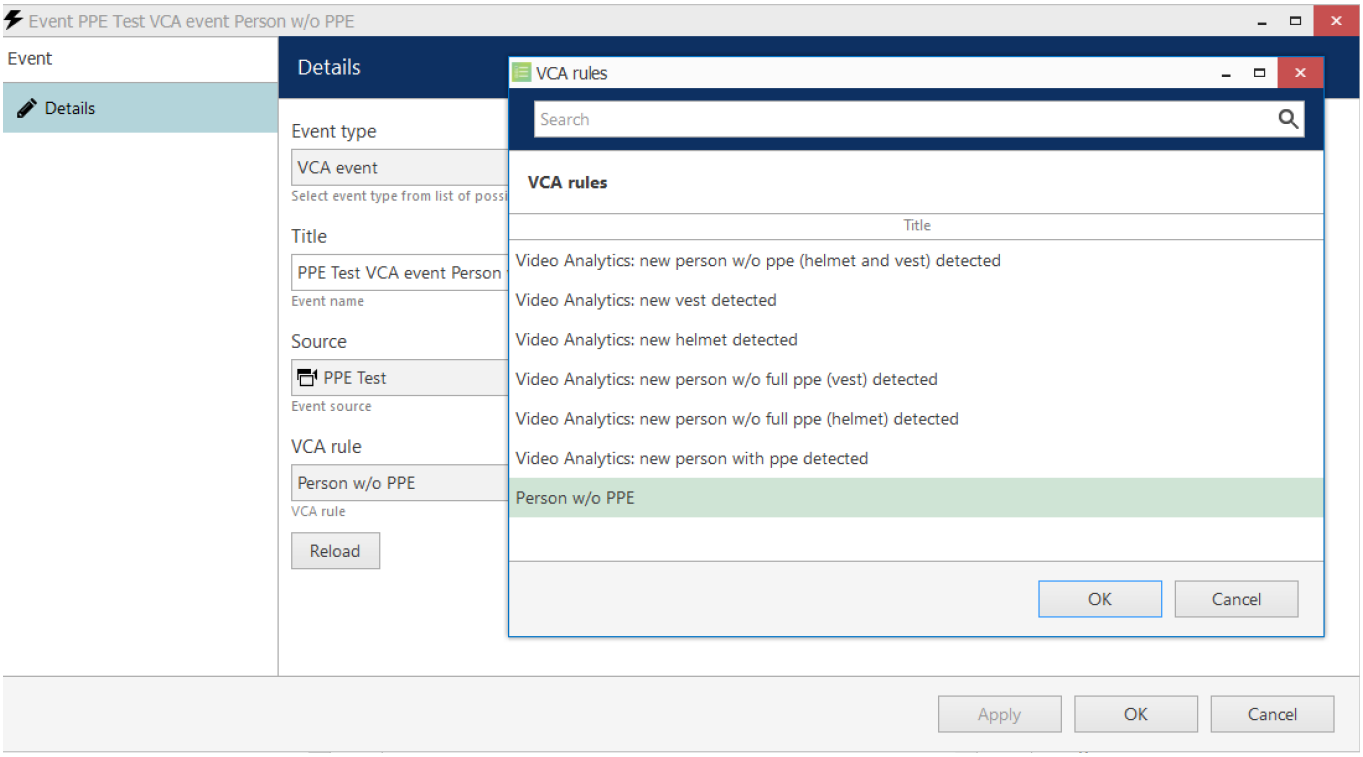
Zone configuration and zone rules in VA configuration

The created **rules will appear as events** in the Event & Action Configurator so you can use them straight away for building automated scenarios, for example, to trigger alarms, create bookmarks, or send out emails with attached snapshots.



Zone event rule automatically appears in E&A under the related channel

You can modify these events later via E&A Configurator because these are not built-in events but rather automatically created events of the *VCA event* type.



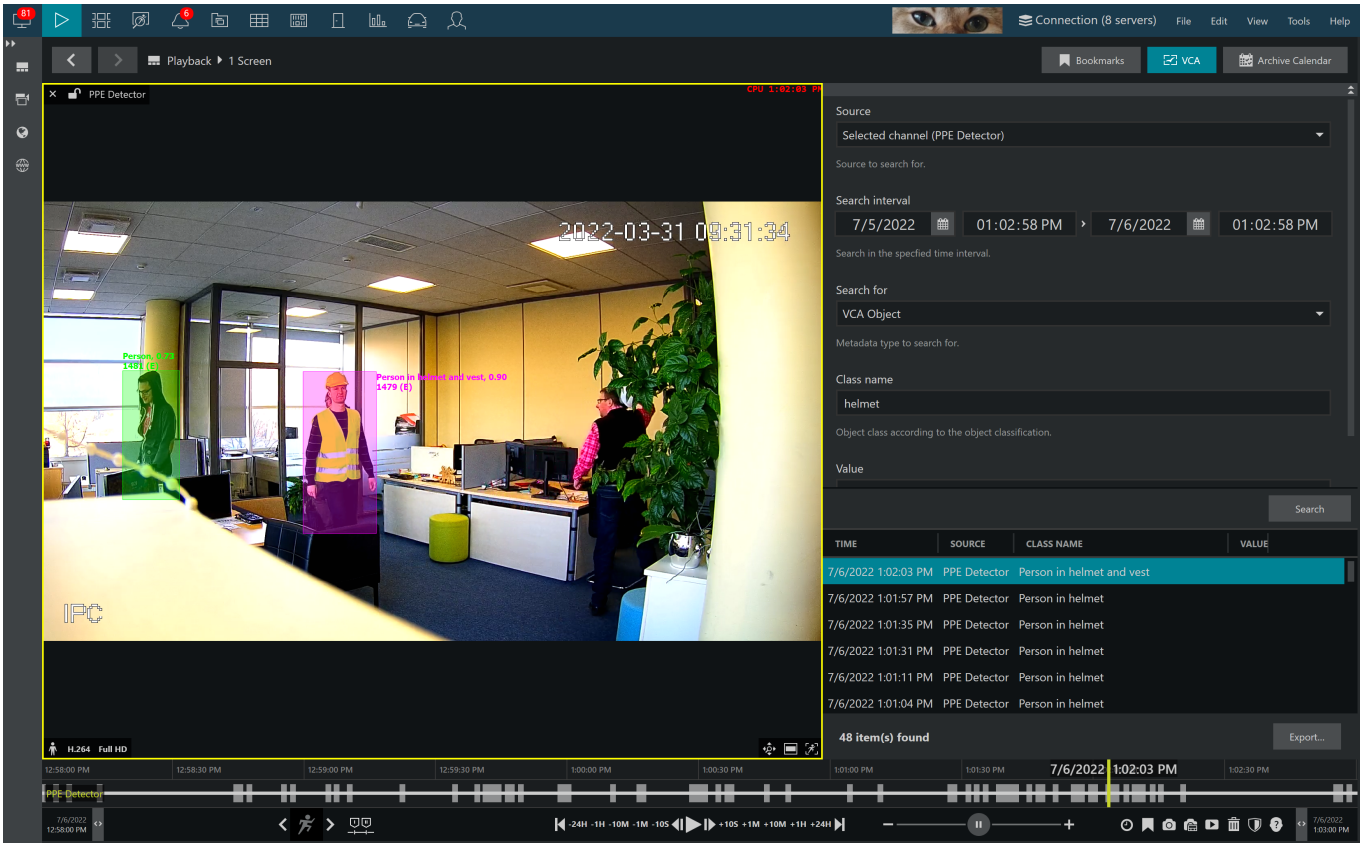
VA event settings

Feel free to create any E&A rules based on PPE Detector events.

Once PPE Detector (actually, any VA) is enabled, even without any zones/rules, the colorful **bounding boxes** will appear on top of the video in the Luxriot EVO Monitor application, designating detected objects. These appear in both **live** view and video **archive playback**, and you can turn them OFF/ON in the application settings.

An example of PPE detection vs person without PPE

In the *Playback* mode, you can also enable the VCA panel and search for specific events/objects/classes during specific time periods.



A VA search example displaying a detected person with helmet

Example

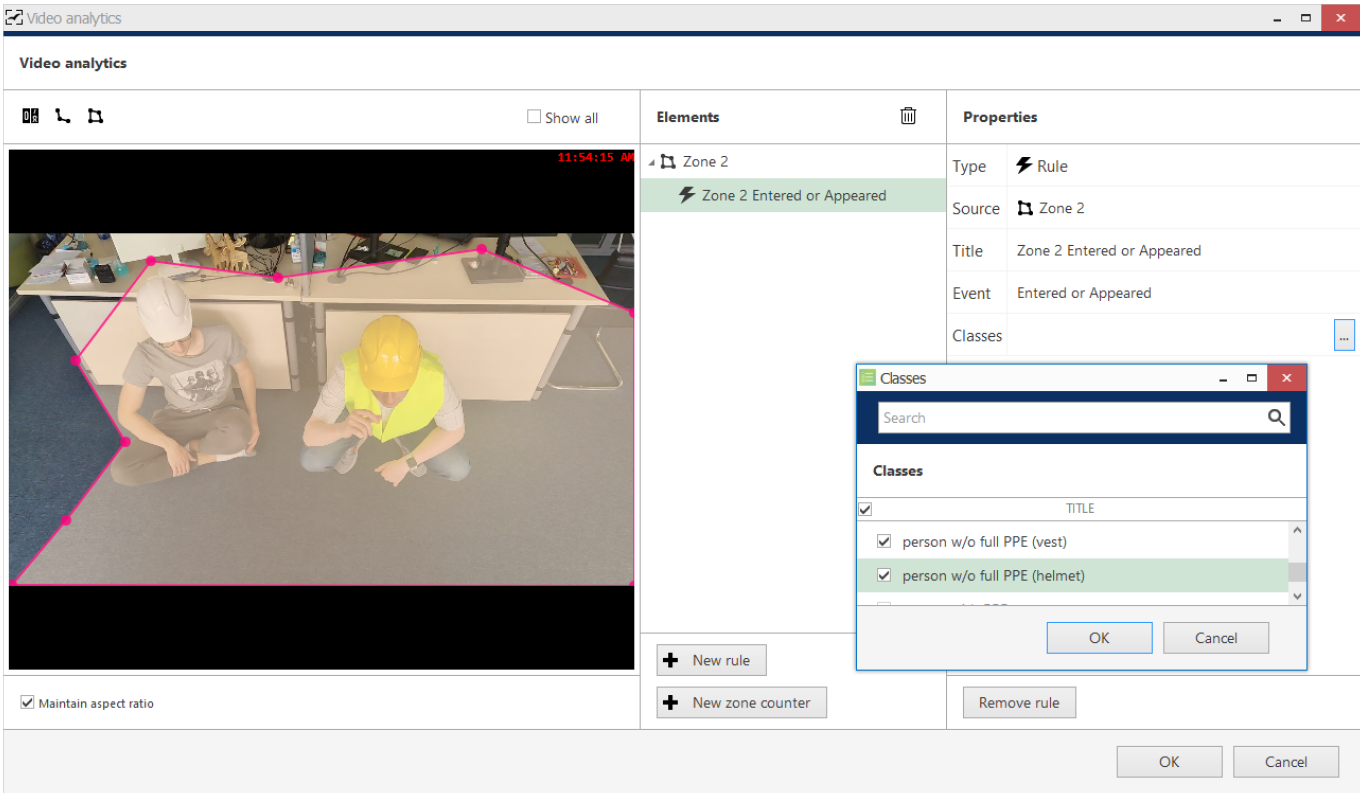
Let us consider the following example scenario: the system should **trigger an alarm when a person without full PPE is detected**.

The plan is:

1. Enable PPE Detector and enable required object classes
2. Create a zone
3. Create a zone rule
4. In E&A, use the zone event to trigger the alarm

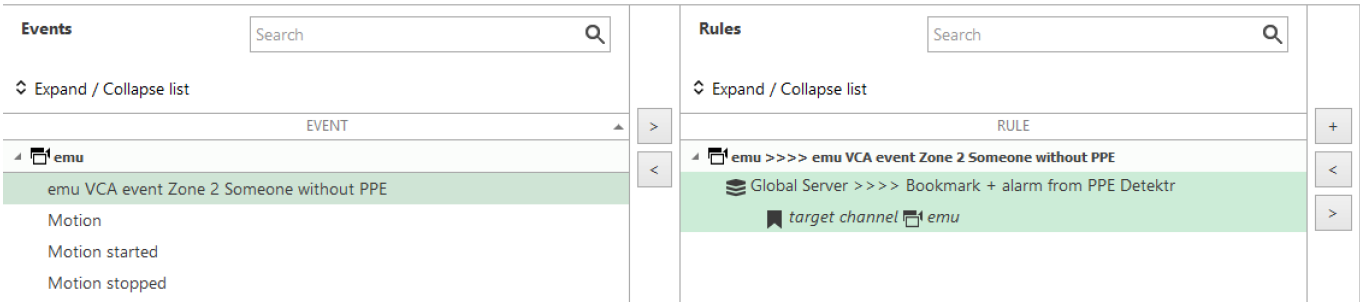
First, in the detector settings, enable the relevant object classes. There are two: person w/o full PPE (vest) and person w/o full PPE (helmet).

Next, draw a zone and create a new rule for it by clicking the + *New rule* button. On the right side of the window, choose both object classes and set the event type to *Entered/Appeared*. Make sure to name your event something meaningful so that it is easier to locate it in E&A afterwards. Click *OK/Apply* to save.



Create a zone and attach an object appearance rule to it

This rule will be automatically copied to Event & Action Configurator, so when you now go to the E&A, you will have the event listed under the corresponding channel events. The event will use the rule name (the one you used in VA configuration) and you can change the event name anytime; note that changing the rule name later will NOT affect the event name anymore as the rule name is used the moment when the rule is copied to E&A (and is not updated anymore). The event type is *VCA event* and it is editable.

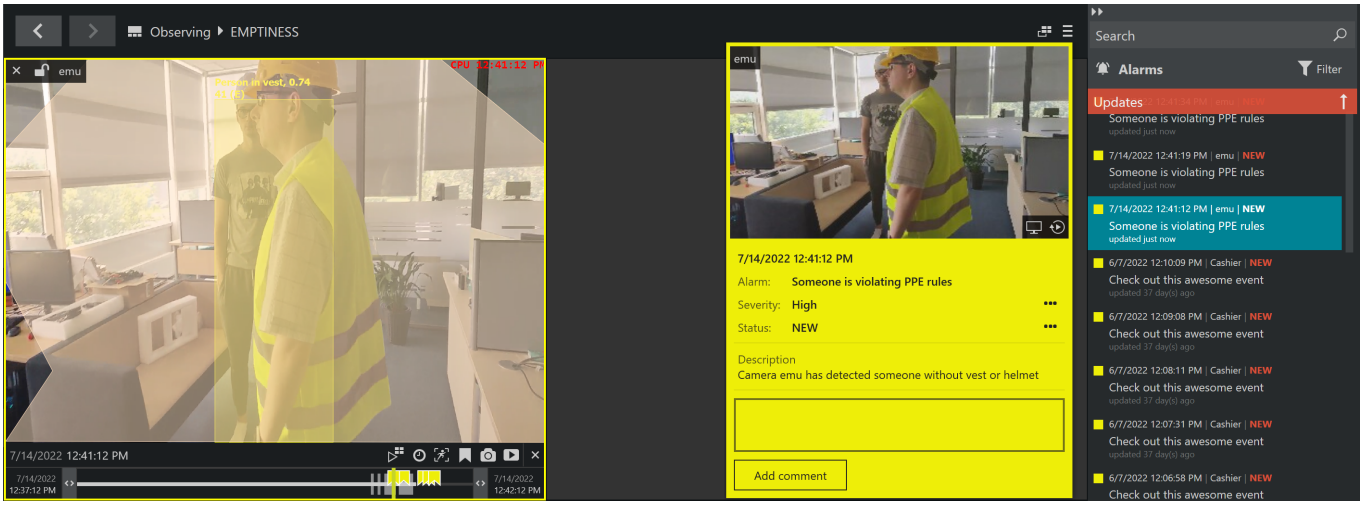


An automatically created VA rule event used in an E&A rule

In the E&A Configurator, choose the event from the list on the left and move it to the central column either by double-clicking or by clicking the > button. Use any of the alarm actions you like. In this example, a *Bookmark* action is used with the following parameters:

- *Bookmark title*: Someone is violating PPE rules
- *Bookmark body (description)*: Camera {EVENT_SOURCE_TITLE} has detected someone without vest or helmet
- Severity: high
- *Create alarm* option enabled (this will ensure that the bookmark will pop up in the alarms panel in Luxriot EVO Monitor)

And here is the result: each time VA detects a person who is missing a vest or a helmet, a bookmark will be added to the archive and an alarm will pop up in the alarm panel. (Please see the Luxriot EVO Monitor user guide on how to enable the alarm panel).



Bookmarks in alarm panel based on PPE Detector events

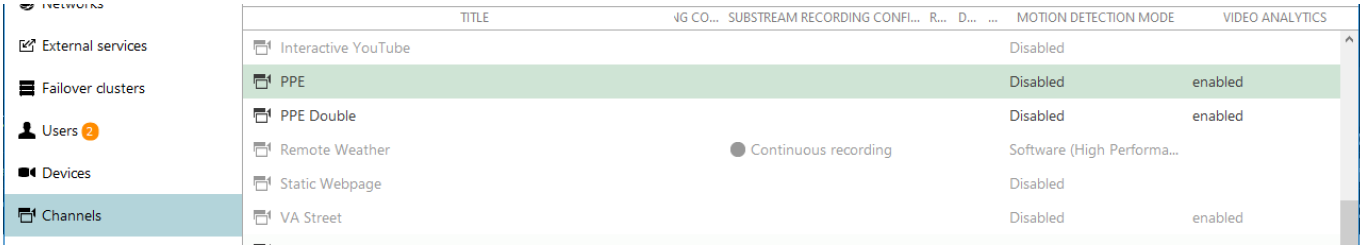
Troubleshooting

Q. I get the *Video analytic channel count exceeded* error when I enable PPE Detector and save the settings.

A. Make sure your Luxriot EVO license has sufficient PPE Detector channels. You can run the license manager locally on the server. If other channels are using the license, disable VA on those channels or disable the channels via Luxriot EVO Console.

Q. How to check on which/how many channels VA/PPE Detector is running?

A. In Luxriot EVO Console under *Configuration* > *Channels* enable the *Video Analytics* column, then scroll horizontally to that column.



Video analytics setting status in the Channels section

Q. I have enabled VA/PPE Detector but there are no bounding boxes appearing in the image in Luxriot EVO Monitor.

A. Check application settings to see if you have accidentally/previously disabled visualization (main menu *Edit* > *Settings* > *Viewport overlays*). If zones and counters appear but there are no bounding boxes, it means no objects are detected: verify your analytics settings. Maybe the detection interval or detection confidence is too low, or the selected classes are not present in the scene.