

Figure 46: Detection zone for a human intrusion (left) and for a car (right)

Note: the maximum instrumented range of a PSR-500 system radar is 900m. Beyond the range, the system won't be able to detect. This explains why the detection zone for the car seems to be truncated beyond this range.

Note: the PSR-500 Installer assumes that there is no obstacle in the radar coverage between the target and the radar, and assumes that the radial velocity of the target is high enough to be detected by the radar.

The last concept to remind is the « Doppler effect » on which rely the PSR-500 radars.

While non-Doppler radars compare radar image after radar image to detect motion in the area, Doppler radars use the Doppler Effect to do so.

The Doppler Effect is an effect visible on the radar signal due to the change of range of the target within the observation time of the radar. The Doppler effect provides access to the **radial velocity of the targets**

The radial velocity of a target is the projection of its absolute velocity of this intrusion over the straight line from the radar to the intrusion. This projection depends on the direction and on the speed of the intruder movement:

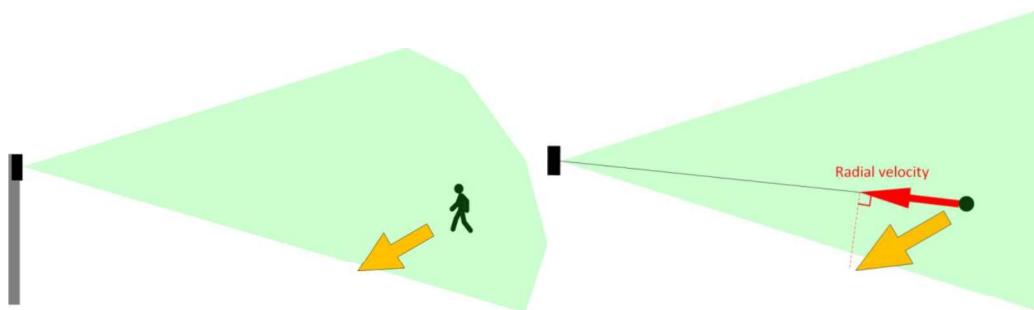


Figure 47: Illustration radial velocity (3D/2D)

Note: the radial velocity is independent from the sensor orientation.

Doppler radar technology has been selected for PSR-500 system radars because this technology is much more efficient to discriminate targets from their surrounding environment (building, moving trees...) which allows mitigating false alarm rate of the system. Below a certain radial velocity, the system automatically filters out the detections.

Doppler radar technology implies installation constraints in order to detect human intrusion with enough radial velocity so that the system does not filter them. One can consider situations where a moving target shows a low radial velocity to the radar, such as transverse trajectory. Therefore, to avoid this case, the radar shall be positioned carefully. This is what we are going to explain in the following section, helped by an intuitive tool of the **PSR-500 Installer**.

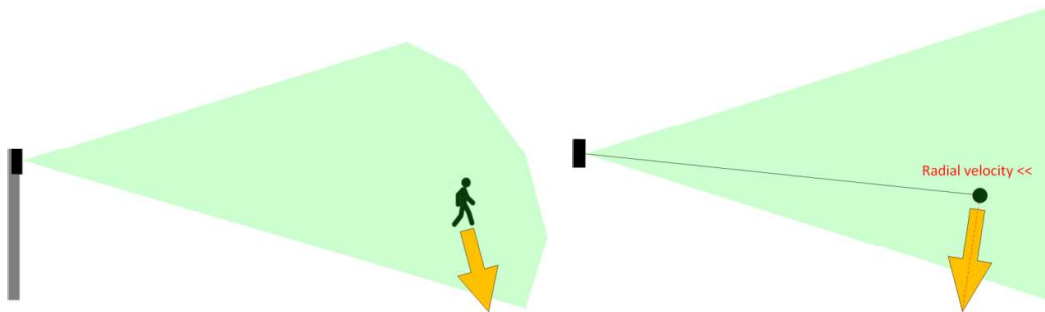


Figure 48: transverse trajectory case (3D/2D)

6.1.3.2. Position the radar effectively

- Position the radar where you plan to deploy it considering:
 - o Multi-radar deployment: it is recommended to the installation operator to read the associated section of this document.
 - o the zones you previously defined (« **Warning** », « **Caution** » and « Exclusion »)
 - o The radar coverage area for the detection of human intrusion (blue zone)
 - o Potential masking that may limit the detection of intrusion (in case of presence of obstacles between the radar and the intrusions ...)
 - o expected intrusion motion (keep in mind that we need to maximize radial velocity)

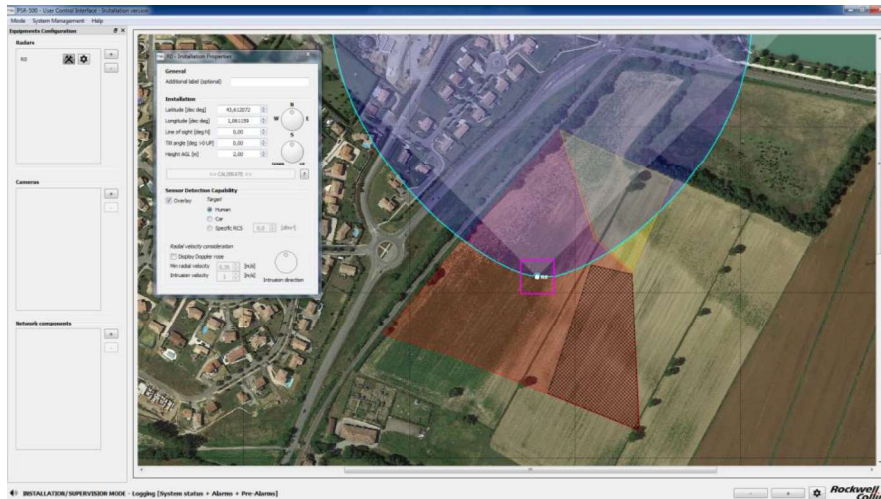


Figure 49: PSR-500 Installer – Positioning of a radar on the map

Note: You can move the radar holding the magenta square and moving the mouse, or entering its GPS coordinates through the popup “Installation Properties” windows. Similarly, the orientation of the radar can be set up either by modify the value in the window or by moving the rotating cursor.

To evaluate the best installation for the PSR, let’s consider radial velocity now (Doppler Effect). As explained previously, PSR-500 system radars rely on the Doppler Effect to discriminate an intrusion from its environment. Therefore, our objective is to maximize this effect otherwise the radar may miss some intrusions.

In our example, the expected intrusions are coming from the North West of the site, through the fence indicated by the red dotted line and by the yellow arrows on the following figure:

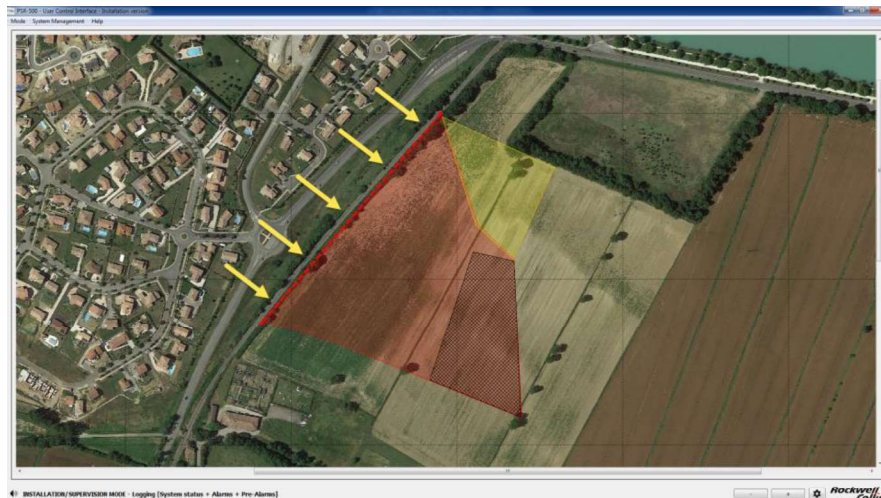


Figure 50: Example on an intrusion scenario on a site

The first idea that may arise to a non-informed operator would be to position the radar over the fence so that the radar coverage (blue pattern) covers entirely the fence.

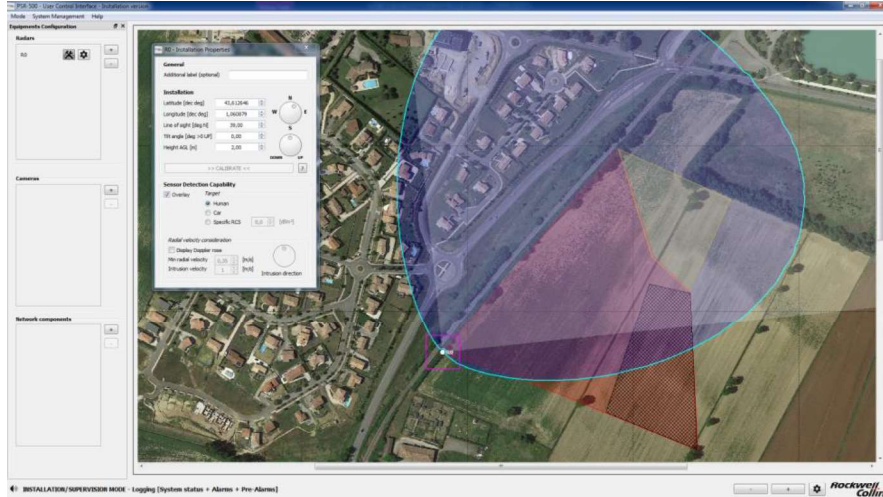


Figure 51: Not recommended radar installation

In order to see why this type of installation is not recommended taken into account the trajectory of the intrusion and the Doppler Effect, let's display the « Doppler Rose ». Click on the « Display Rose Doppler » button of the Installation properties window of the radar in deployment.

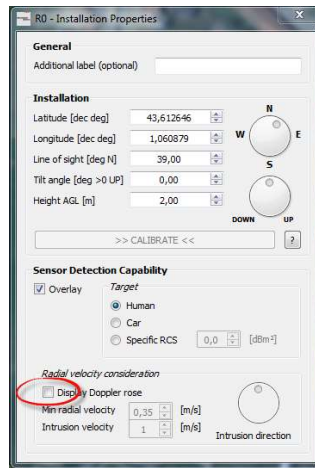


Figure 52: PSR-500 Installer – Display the Doppler Rose

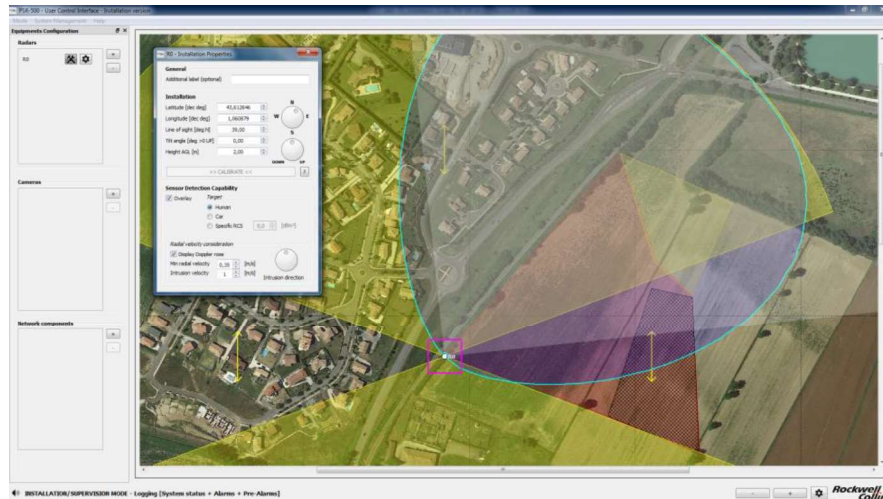


Figure 53: PSR-500 Installer - Doppler Rose displayed

The Doppler rose is the yellow area that tells you where the radar will measure more than [min radial velocity] according to the [intrusion velocity] and the [intrusion motion] (yellow arrows).

These three values may be configured in the “radial velocity consideration” part of the “Installation Properties” window.



Figure 54: PSR-500 Installer – Setting of the Doppler Rose

The « Doppler Rose » takes into account the following properties:

- Absolute velocity of the intrusion
- Intrusion direction
- Minimal radio velocity of the radar

By default, the values of these properties are the following one:

- Absolute velocity of the intrusion = 1m/s (normal walking velocity)
- Intrusion direction = North/South & South/North trajectories. The direction is shown by the yellow arrows.
- Min radial velocity = 0.35 m/s (PSR normal sensibility)

Note on the « Rose Doppler » configuration:

- Increase absolute velocity of the intrusion will increase yellow area coverage since the radar will perceive a minimum radial velocity of 0.35m/s in more areas

- The orientation of the « Doppler Rose » depends directly on the intrusion direction.
- Decrease minimum radial velocity will increase yellow area coverage since the radar will perceive the minimum radial velocity in more areas.

Let's now set the intrusion motion angle according to the expected threat on the North West fence: Turn the Intrusion motion button to align the yellow arrows of the « Doppler Rose » with the intrusion direction.

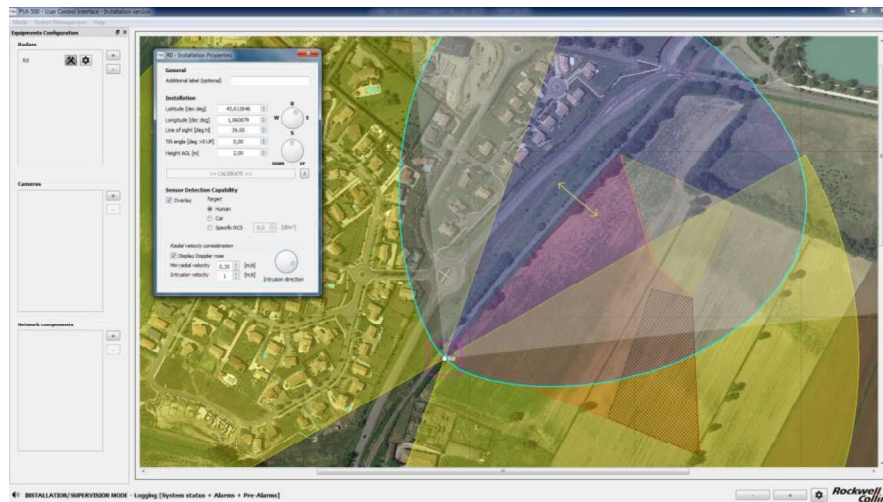


Figure 55: PSR-500 Installer – Doppler Rose aligned with expected intrusions

To ensure protection, the area of interest must be both in the blue area (radar coverage) and in the Yellow area (zone with enough radial velocity).

The « hole » in the Doppler zone (Yellow) over the fence underlines the fact that due to the radar position, the intrusion velocity (1m/s) and the sensibility of the zone (normal = 0.35m/s), the intrusions in this area will not have enough radial velocity and will therefore be filtered by the radar; even if the fence is in the coverage area of the radar (blue zone). Consequently, we must change the radar position.

One solution may be to install the radar inside the site so that the fence is inside the yellow zone (Doppler zone) and to turn the radar toward the fence, so that its coverage area overlaps the fence. See below an example of radar position that will ensure site protection.

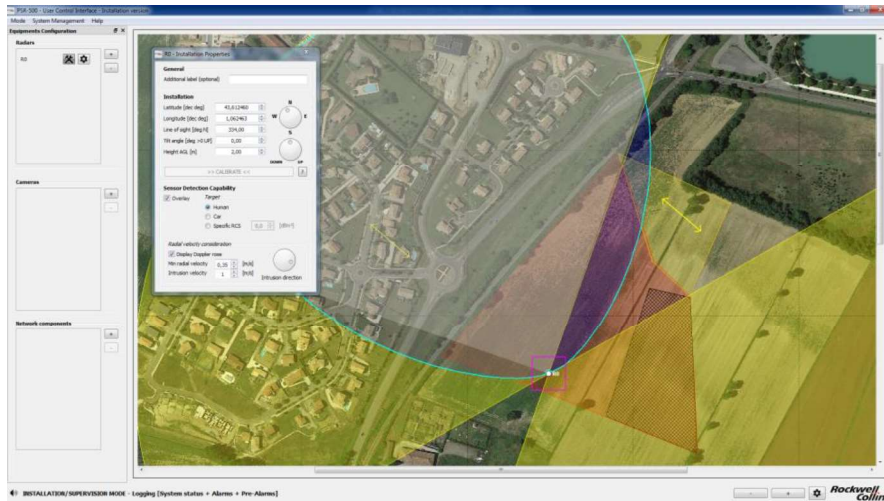


Figure 56: PSR-500 Installer – Possible Installation #1

Another example is presented below:

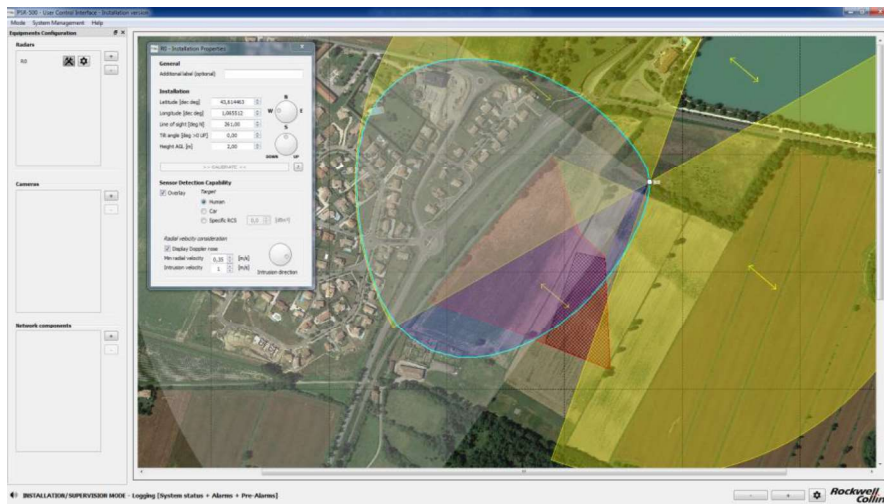


Figure 57: PSR-500 Installer - Possible Installation #2

A third solution is presented below:

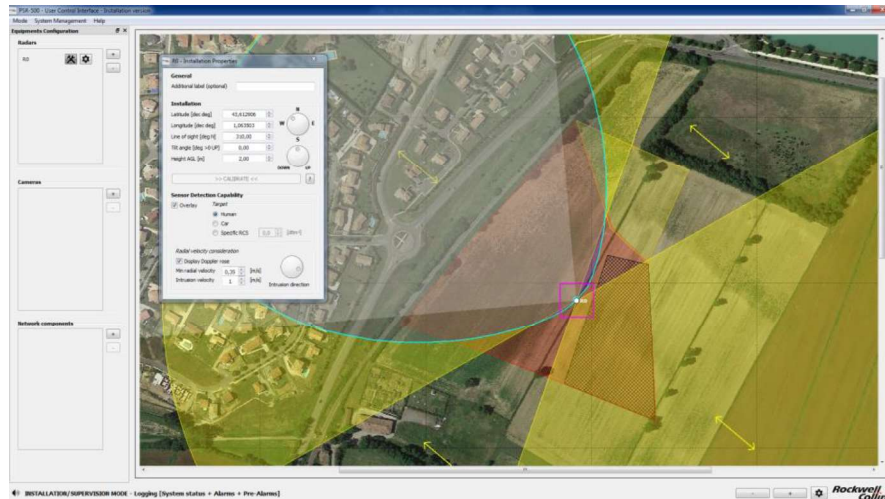


Figure 58: PSR-500 Installer - Possible Installation #3

One can consider many deployments as long as the area to survey is covered both by the blue and the yellow areas.

If deployment constraints impose to install the radar closer to the fence, one solution would be to create a local high sensibility area (0.2m/s for the minimum radial velocity) so the Doppler rose extends a bit.

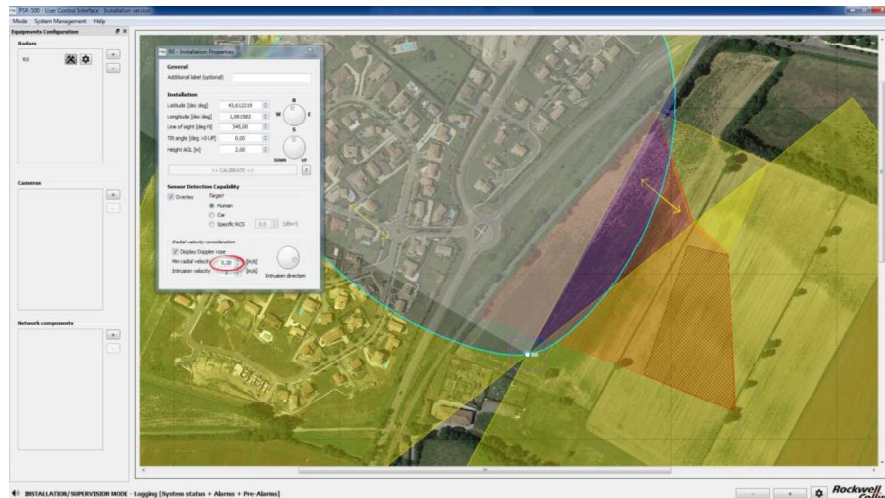


Figure 59: PSR-500 Installer – sensibility increase and possible Installation #4

Nevertheless, this solution shall only be used when no other solution can be found since it will increase the false alarm probability in this high sensibility zone.

Once some positions are defined, let's ensure that no obstacle may generate shadow in the area limiting the detection capability of the radar.

We need to determine the height above the ground at which the radar shall be installed to taken into account potential obstacles.

Let's take the example of possible installation #2:

- The radar would be at 30m away from the beginning of the area to protect (A value)
- The area to protect would start at 15m away from the end of the forest (B value)
- The trees are 5m high

The formula provided below tells that the radar needs to be installed at a minimum of 10m above the ground so that the shadow induced does not impact the detection zone.

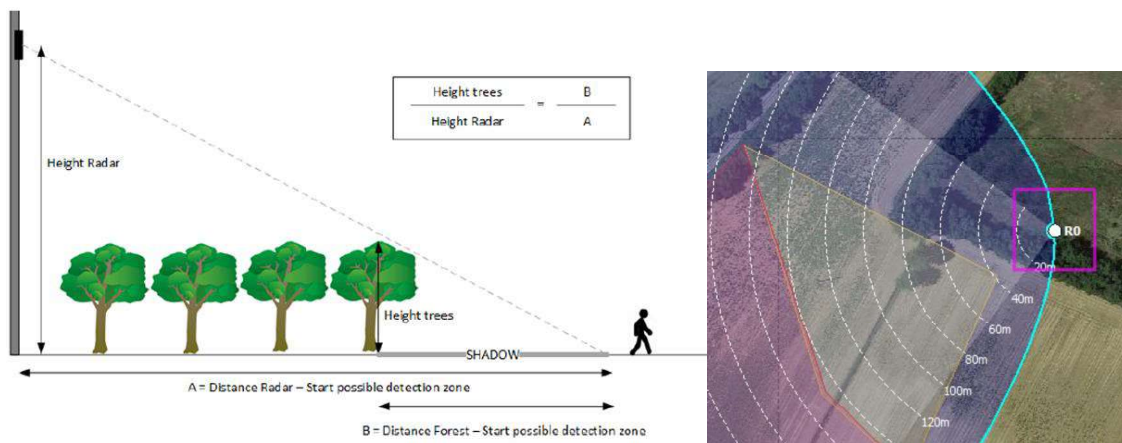


Figure 60: Position/height of the radar w.r.t the shadow zone

The 10m shall be set in the radar properties as shown below:

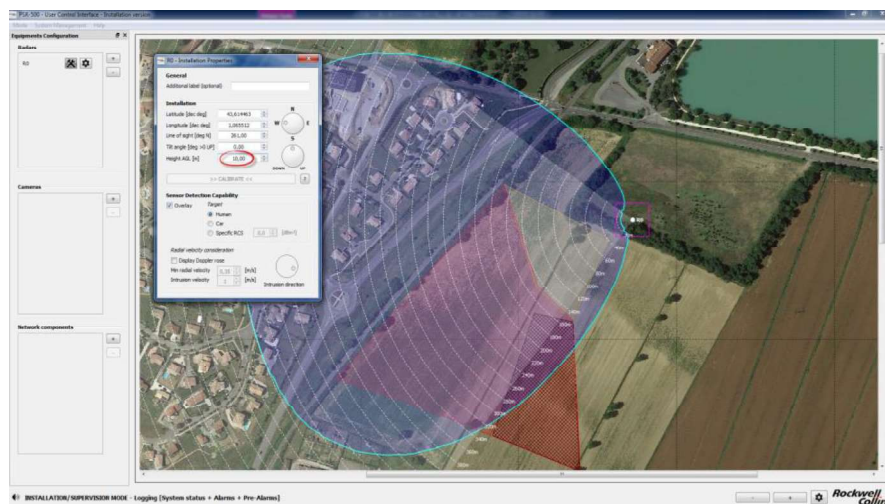


Figure 61: Radar height modification

The modification of the radar height changes its coverage zone (blue pattern). Nevertheless, the area to protect is still in the coverage zone in this example.

If trees would have been higher, the radar would have to be installed higher on the mast and the impact on detection capability may have become significant. The following picture presents a scenario where the radar is installed at 50m high.

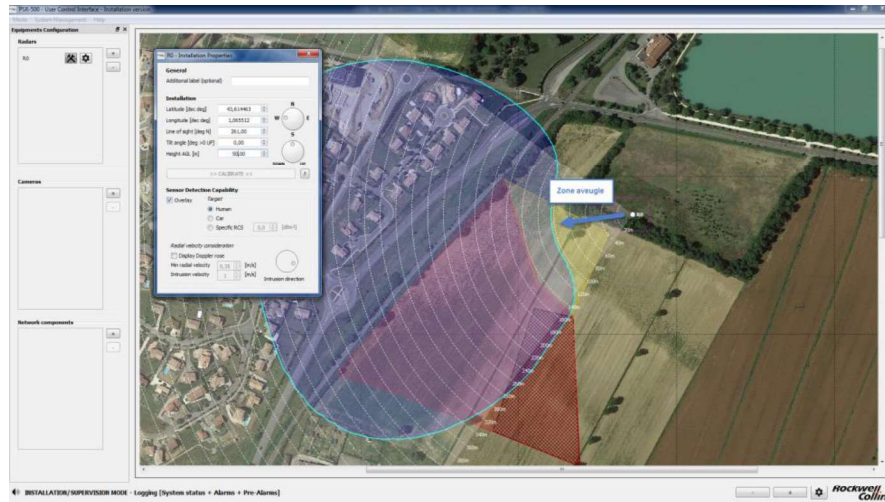


Figure 62: Impact of radar position/height on detection capability

In such a configuration, the impact on the detection capability of a human intrusion would be significant at short range. In this case, a lower tilt angle would be necessary to recover the detection capability at short range (always keeping an eye on the long range as the entire detection capability is impacted by a change of tilt angle).

In the case of an installation at 50m high, a tilt angle of -15° would be a good compromise between coverage at short and long range, as shown below.

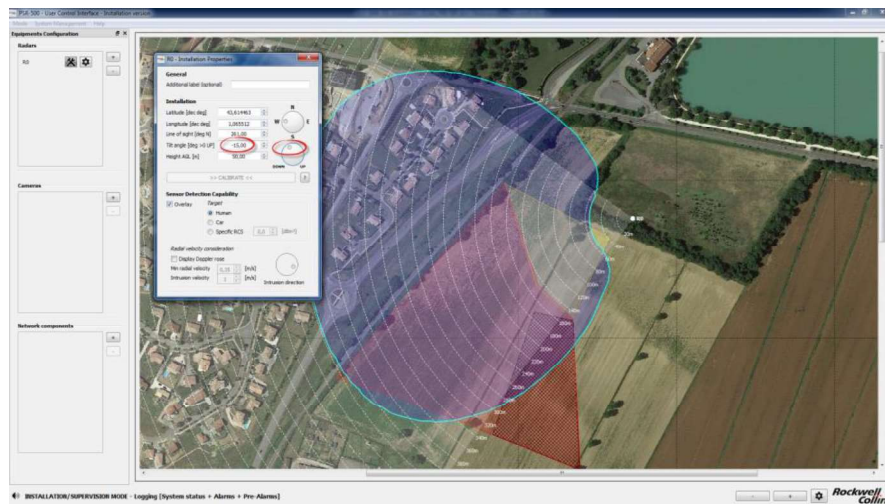


Figure 63: Modification of the tilt angle to improve detection capability

Once the radar position is set up, let's now close the installation properties popup.

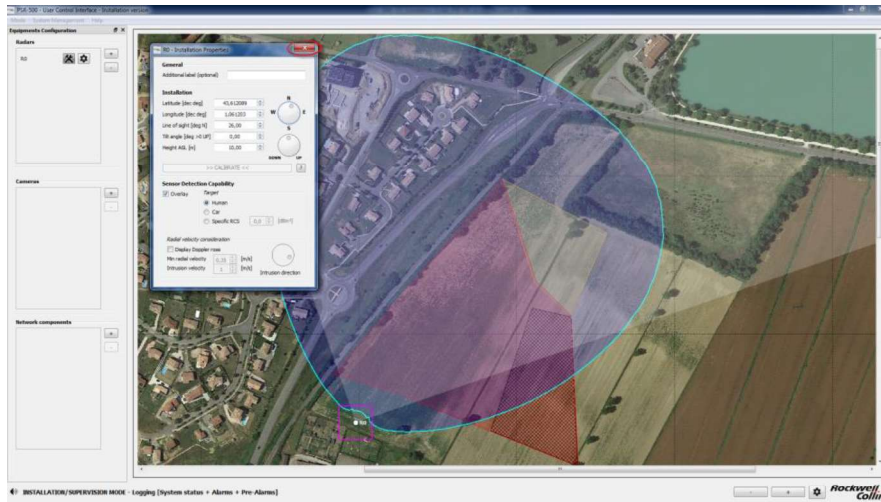


Figure 64: Closing the « Installation Properties » window

Let's now configure the network properties of this radar. Click on the “Configuration” button of the radar to be configured.



Figure 65: Opening radar configuration window

This configuration popup is actually a dockable window that will be used later on as a way to keep an eye on the status of this radar. Indeed, if you double click on its menu bar, it will dock into the edge of the UCI so you can keep an eye on it while doing over things.

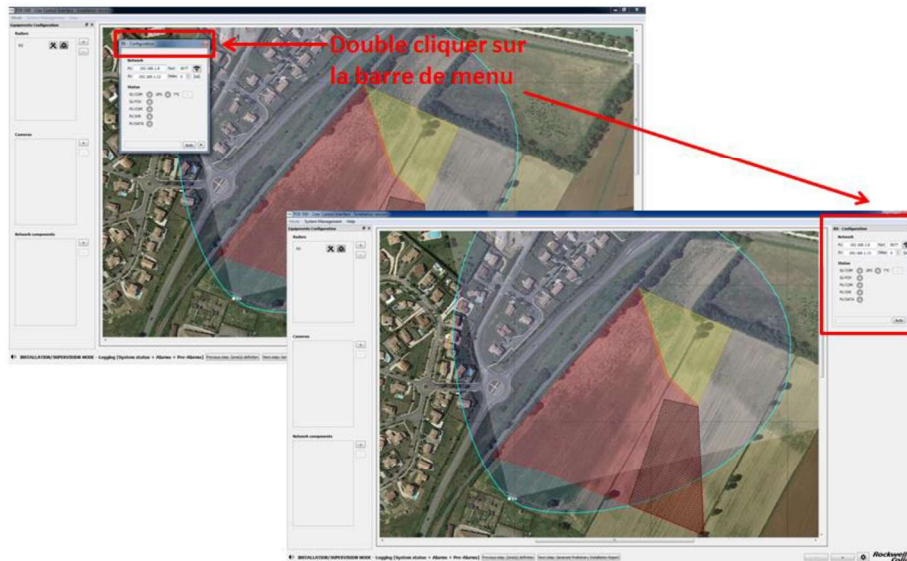


Figure 66 : Dockable configuration window

The network properties of the radar shall be configured (i.e: SU & PU IP addresses and PU port). In our case: the following values are set up:

- PU IP address: 192.168.1.8
- PU Port: 5677
- SU IP address (by default) : 192.168.1.13

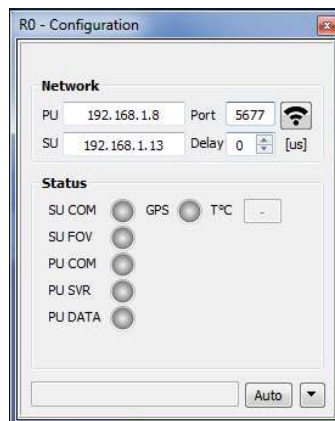


Figure 67: Configuration réseau SU & PU

The default IP address of the SU (192.168.1.13) may be changed, as explained in 6.2.7.

Warning: if you change this default value, the update of the PU by the PSR-500 Installer application will have to be followed by a re-start of the SU and then a re-start of the PU.

6.1.4. Step#4: Add, position and configure one or several cameras (CCS)

This paragraph is only applicable if the CSS option is included in the PSR-500 system deployed.

Once properly configured for each controlled camera, the CSS module will allow to:

- Align each camera
- Support automatic visual confirmation of intrusion alerts as precisely as possible

In order to perform this step, the following actions shall be performed:

- Click on the « + » button in the camera dedicated zone (see below) to add a camera

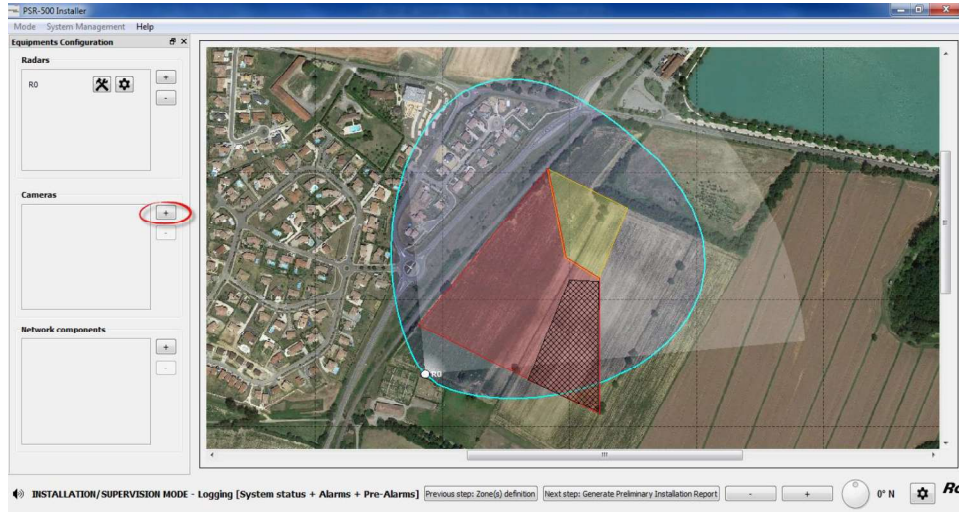


Figure 68: Add a camera

- Position the camera at the same location than the radar. It could be actually positioned anywhere on the site but in our case, the camera is collocated with the radar.

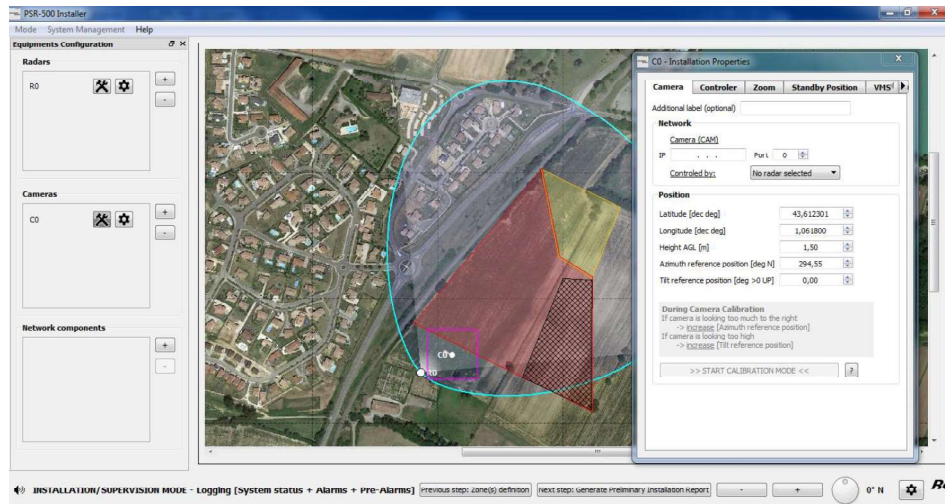




Figure 69: Set the position and the orientation of the camera

- In the **Camera** tab of the camera configuration window that opens automatically, Set the following properties:
 - **Additional label** (optional) = give a name to the camera in case of an installation with multiple cameras
 - **IP** = IP address of the camera
 - **Port** = Communication port with the CCS module = 80
 - **Controlled by** = select the radar that shall be associated to this camera in the drop-down menu
 - **Latitude, Longitude** = if the camera position is set manually on the background map, these values will be update automatically, otherwise enter them in these areas.
 - **Height AGL** = Set the height above ground of the camera
 - **Azimuth reference position & Tilt reference position** = these values will be set up during the camera calibration phase, ignore them for the moment.

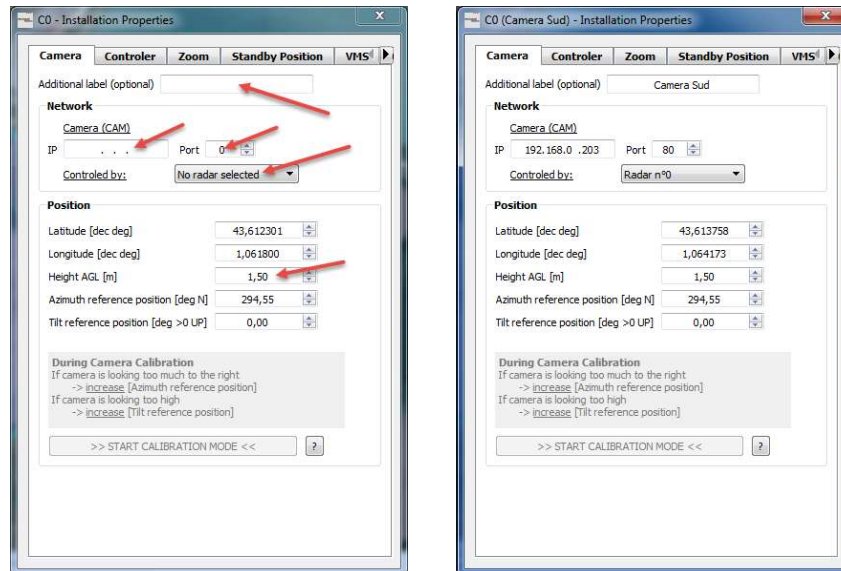


Figure 70 – Camera properties configuration window – “Camera » tab

- In the **Controller** tab of the camera configuration window, set the following properties related to the way the camera is controlled:
 - **Min zone level** = minimum alerting level taken into account by the camera

- **Time on track** = time spent by the camera on each alert (in case a the radar associated with this camera raises several alert simultaneously)
- **Focus only on Alarm** = if selected, the camera will only be steered on the alerts. If unselected, the camera will also be steered on the pre-alerts (radar track not yet identified as intrusion alerts) – see section **Erreur ! Source du renvoi introuvable.** to enable pre-alert display.
- **Camera Controller** = select OnvifPlugin
- **Predefined configuration** = select the controlled camera brand – it will automatically fill the remaining information required in this tab.

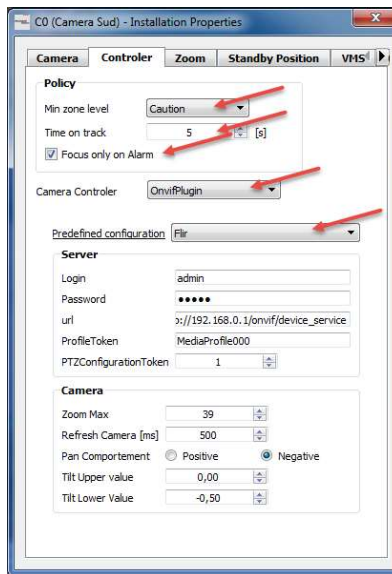


Figure 71 – Camera properties configuration window – « Controller » tab

- In the **Zoom** tab of the camera properties configuration window, set the following properties related to the zoom rules:
 - **Zoom factor** = define the factor of the linear function that linked the zoom to the distance between the alert and the camera (indications are given in the window)
 - **Minimum zoom** = When the alert is very closed to the camera
 - **Range flat** = distance threshold beyond which the camera won't zoom any more

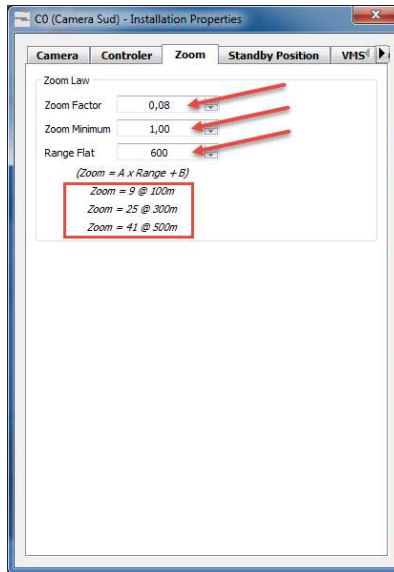


Figure 72 - Camera properties configuration window –« Zoom » tab

- In the **Standby position** tab of the camera properties configuration window, set the following properties related to the standby position of the camera :
 - **Time before back to standby** = time before the camera will get back to its standby position in case there is no intrusion alarm anymore in the coverage area of the radar associated with the camera
 - **Position**
 - **Pan** = standby position pan value of the camera w.r.t. the geographical North
 - **Tilt** = standby position tilt value of the camera w.r.t. horizontal
 - **Zoom** = standby position zoom factor of the camera

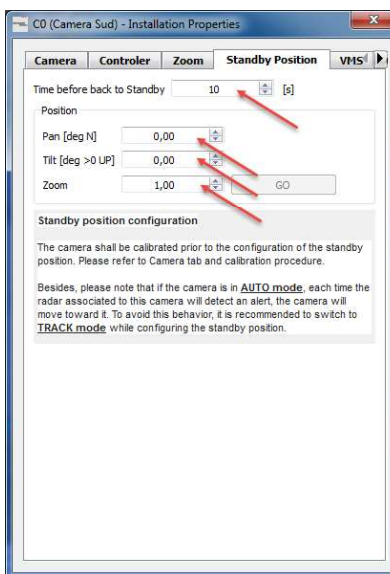


Figure 73 - Camera properties configuration window – « Standby position » tab

Note: this standby position can be set at the step or once the application will be connected to the camera which will allow the operator to see in real-time what the camera can see in this position.

All other tabs shall be ignored.

- Close the camera « Installation Properties » window

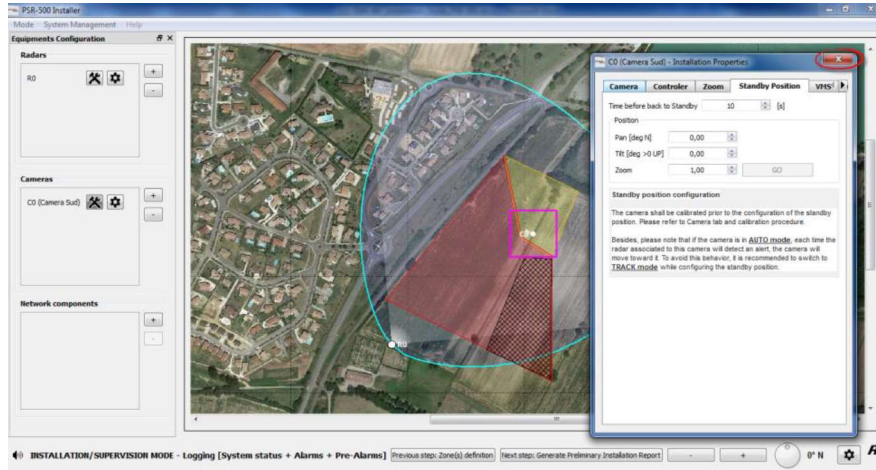


Figure 74: Close the camera « Installation Properties » window

6.1.5. Step#5: add and configure network components

The network components are elements that will either add a feature to the PSR-500 system or ensure automatic maintenance of deployed radars.

The following components are the one compatible with the **PSR-500 Installer**:

- **Switch POE** = Ethernet switch allowing to remotely control the power supply of the POE port connected to the SU. The communication protocol used is SNMPv3. The following references are tested and compatibles:
 - o Switch POE CISCO IE-2000-16PTC-G-E
 - o Switch POE AT-IE200-6GP Allied Telesis



Figure 75 - Examples of compatible POE switch

- **Dry Contact Module audio E/S AXIS P8221** = Dry Contact allowing to remotely rebooting the PU. The communication protocol used is HTTP. The Dry Contact module is also used to inform an external system when a zone is in alert.



Figure 76 - Module audio E/S AXIS P8221

The deployment ways and means of these components (cabling, internal configuration ...) are detailed in annex.

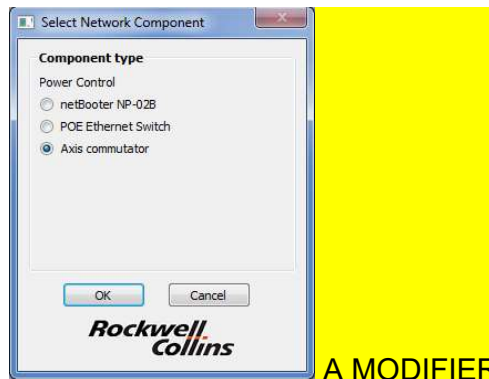
In order to add a network component, the following actions shall be performed:

- Click the button « + » in the area dedicated to the “Network components” in the “Equipments Configuration” window.



Figure 77: Add a network component

- The « Select Network Component » window opens :



A MODIFIER

Figure 78: Select Network Component window

6.1.5.1. Configuration of Maintenance through POE switch and Dry Contact

Two network components are used to ensure radar maintenance:

- POE Switch to manage SU power supply
- Dry Contact to manage PU power supply

Let's start with the POE Switch:

- Select the Ethernet POE switch in the network component list proposed and click « OK »
- Click on the associated « configuration » button, as illustrated below :



Figure 79: « configuration » button associated to the network component

The following configuration window opens:

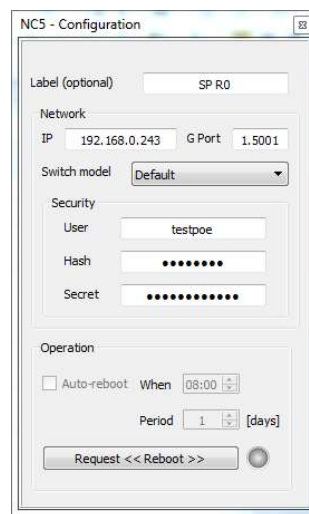


Figure 80: POE Switch configuration window

In our example, the following parameters values are set:

- Label (optional) : SP R0 for the POE Switch controlling R0
- IP : 192.168.0.243
- G Port (Group port) : 1.5001 (i.e. the port 1of the POE Switch used to power the SU)
- Switch mode
 - o Default for *Switch POE AT-IE200-6GP Allied Telesis*
 - o Cisco for *Switch POE CISCO IE-2000-16PTC-G-E*
- User, Hash and Secret shall be configured based on POE Switch configuration credentials.

Association between the POE Switch and the radar (more precisely its SU) is done in the radar configuration pop-up when extended. In our example, the automatique maintenance of the SU (radar R0) will be done by the POE Switch we have created (only POE Switches are displayed in the combo box for the monitoring of the SU).

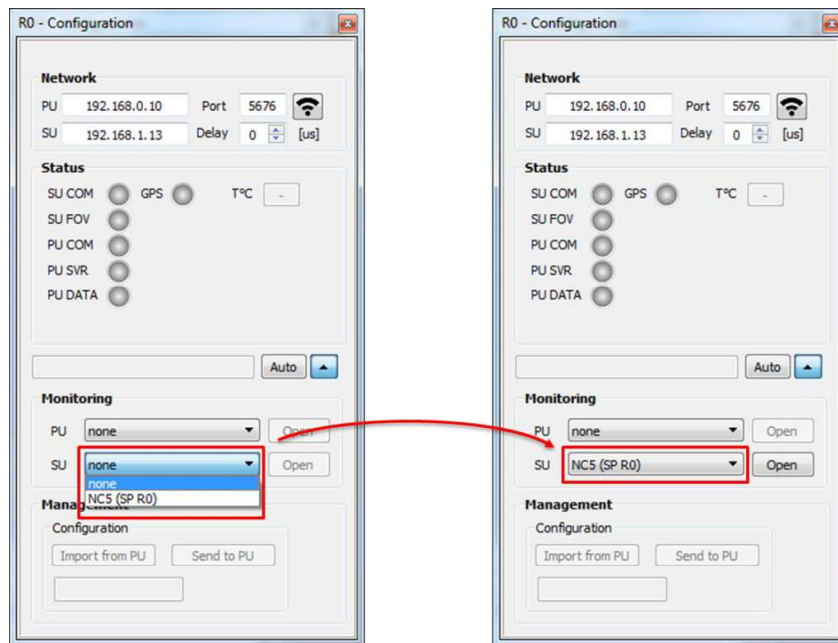


Figure 81: Selection of the POE switch for the automatic maintenance of the SU

When the POE Switch has been associated to the radar, the « OPEN » button is enabled, in order we can directly open the associated network component. A manual test can be performed by clicking « Request Reboot » button. The associated SU shall restart.

- Close the POE Switch configuration window
- Let's now add and configure the Dry Contact
- Add a new network component
- Select the Axis commutator component in the proposed network component list and click « OK »
- Open the Dry Contact configuration window

The configuration window opens:

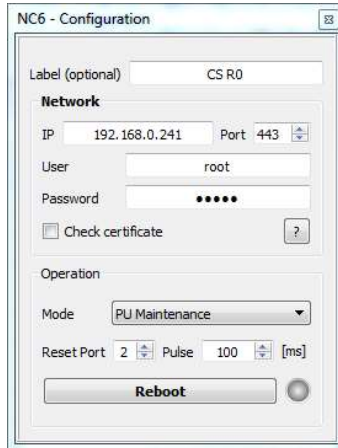


Figure 82: Dry Contact Configuration window

In our example, the following parameter values are set:

- Label (optional): CS R0 for the Dry Contact that controls R0
- IP : 192.168.0.241
- Port : 443
- User, password and Reset port shall be configured in conformity with Dry Contact credential configuration
- For an automatic maintenance of the PU, the mode is selected to « PU Maintenance » and the pulse duration is 100ms by default.

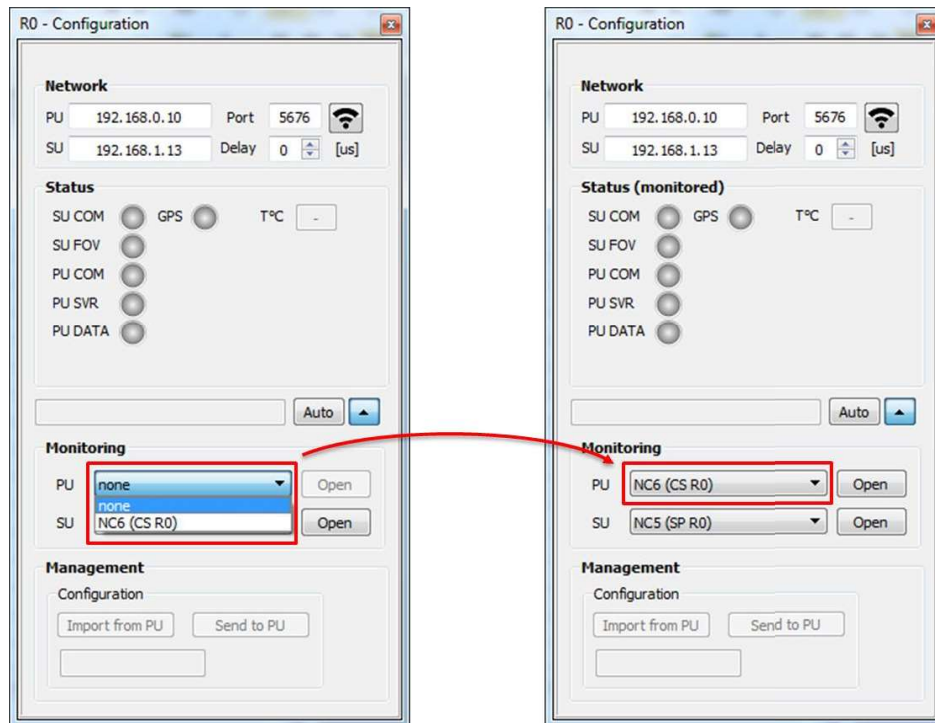


Figure 83: Select the Dry Contact for the automatic maintenance of the PU

When a Dry Contact has been associated to the radar, the « Open » button is enabled, in order we can directly open the associated network component. A manual test can be performed by clicking « Reboot ». The associated PU shall restart.

If these components are configured as previously explained and associated to the radar, then when a failure will be detected on the SU or the PU, than an automatic reboot will be performed. This monitoring activation is indicated by the « monitored » label that appears next to « Status » in the radar Configuration window when a network component is associated to the radar.

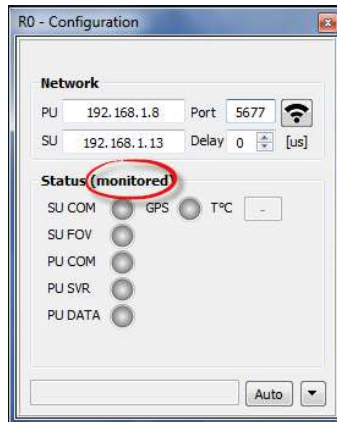


Figure 84: Radar monitored and under automatic maintenance

6.1.5.2. Dry Contact trigerring on zone in alarm

The Dry Contact module can also be associated to a surveillance zone to inform an external system when a zone is in alarm. The component will then be configured in « Single Pulse » mode, taking care to use a free Reset Port and adapting the pulse duration to the external system interface.

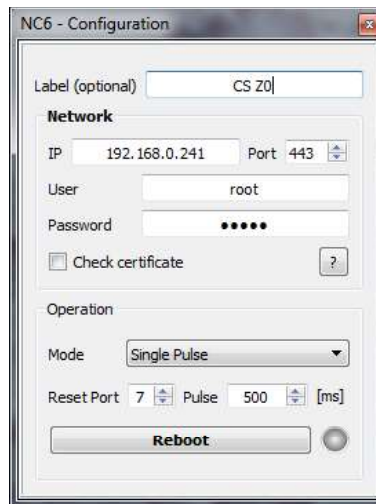


Figure 85: Dry Contact in « Single Pulse » mode configuration window

Association with the surveillance zone is done in the surveillance zone configuration window. In our example, the CS Z0 Dry Contact will be triggered when the

surveillance zone Z0 will be in alarm (only Dry Contacts configured in « Single Pulse » mode will appear in the combo box).

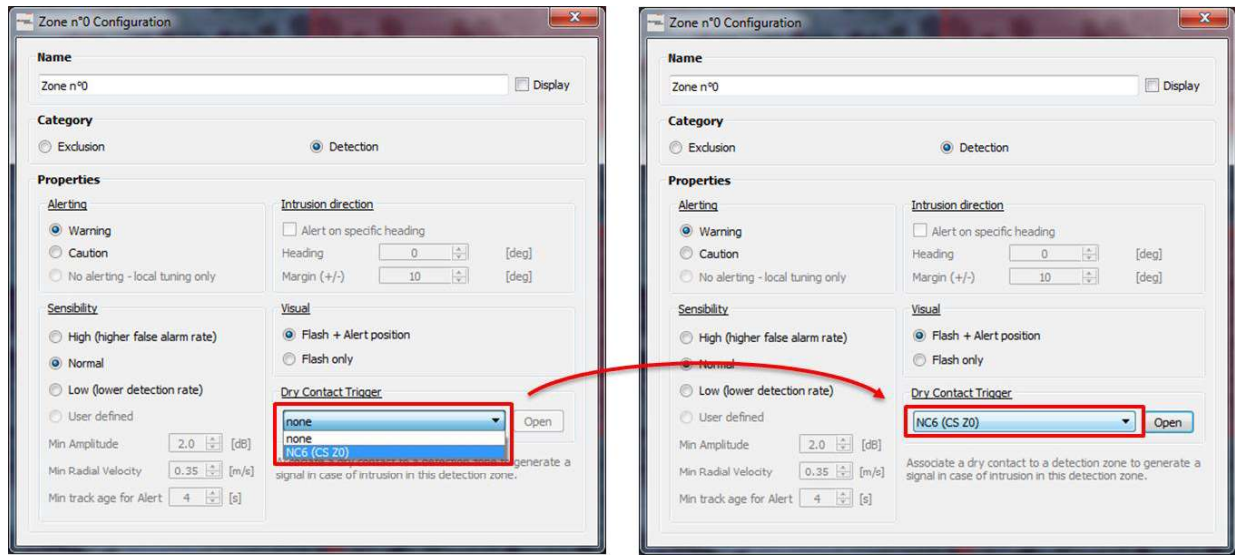


Figure 86: Dry Contact Selection for zone alerting

When a Dry Contact has been associated to the zone, the « Open » button is enabled, in order to be able to directly open the associated network component. A manual test can be done, clicking on the « Trigger » button. The Rest Port of the dry contact associated to the zone will be triggered for the specified duration.

When an alert will be detected in the zone associated to a dry contact, this one will be triggered only for the specified duration. While an alert is present in the zone (the zone is in alarm), no new trigger will occur on new alert. We must wait the zone is no more in alarm before a new alert trigger the dry contact again. If an alert is detected in a position covered by 2 surveillance zones associated to different dry contacts, the 2 dry contacts will be triggered.

6.1.6. Step#6: Generate the preliminary installation report

The following actions shall be performed :

- Click on « Next step : Generate Preliminary Installation Report » button

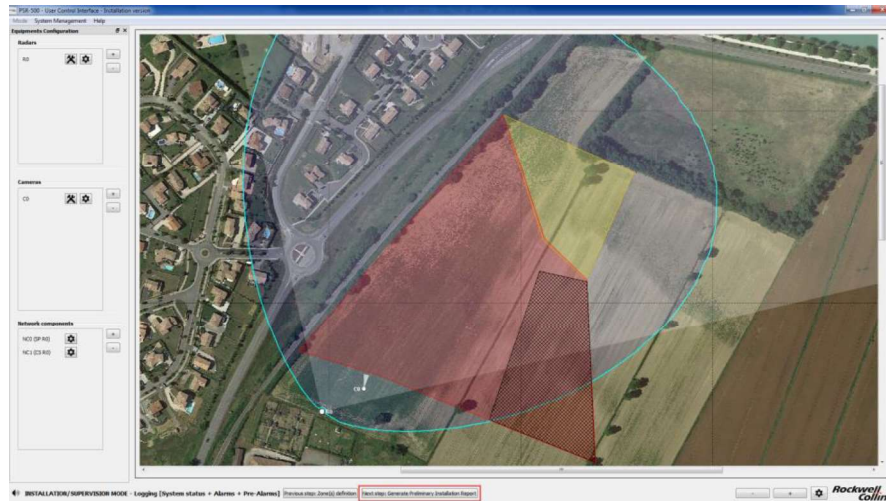


Figure 87: Button to generate the preliminary installation report

- The following window opens when the report is correctly generated



Figure 88: Preliminary Installation report is correctly generated

- The report may be opened from the following address « < PSR-500_Installer_Directory>\PSR_InstallationReports\ » with a text editor and can be print to help the installation support team during the installation and the deployment of the system on site.

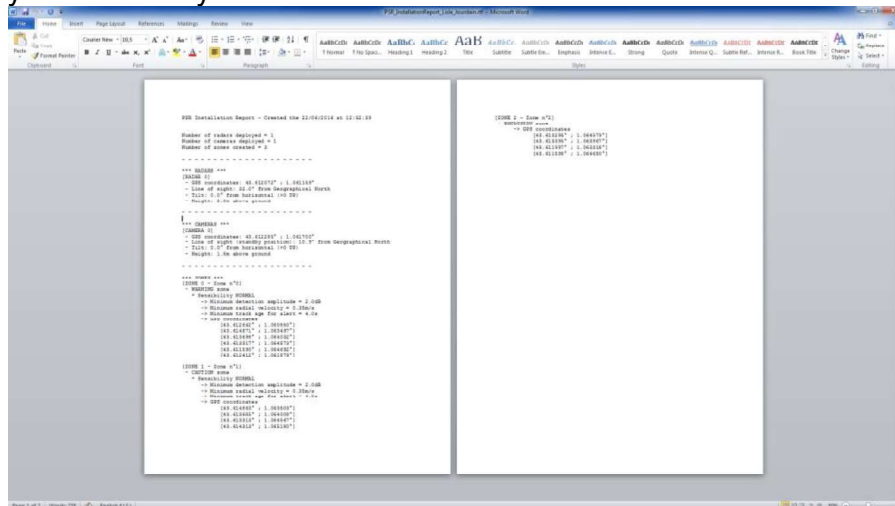


Figure 89: Preliminary installation report

- Click on “OK”, the following window opens automatically :

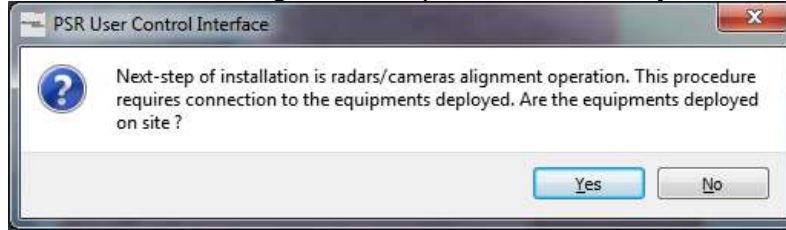


Figure 90: End of installation window

- At the step, 2 options are possible:
 - o If you are deploying the radar system at the same place as you prepare the previous preparation of the system configuration, the **PSR-500 Installer** can stay opened. Once the physical deployment of the system is done, click on « Yes » to pass to next step.
 - o If you are not deploying the radar at the same place where you perform the system configuration preparation, the **PSR-500 Installer** shall be to go on the deployment site. Click on « No » to interrupt the installation wizard and close the **PSR-500 Installer** (click the cross in the tope right-hand corner). Click « Yes » to save :

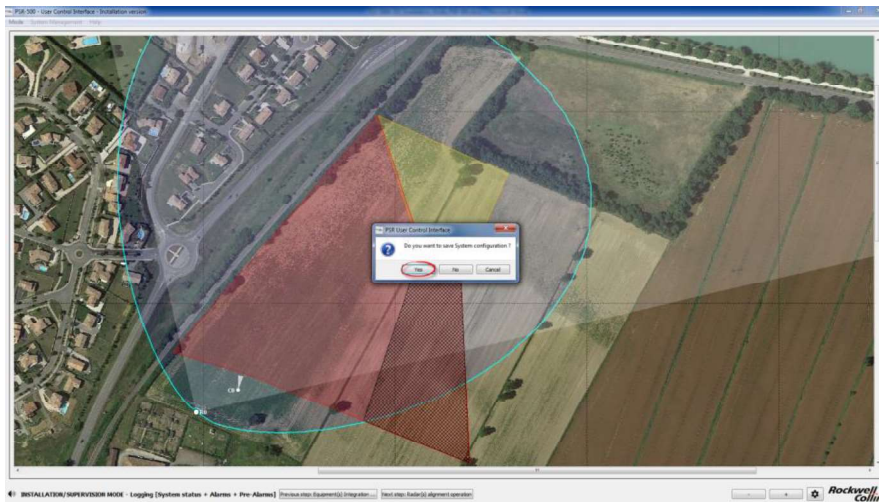


Figure 91: Close the PSR-500 Installer and save the system configuration

6.1.7. Step#7: Visit the site and Validate/Update the foreseen installation

Once on the site, and based on the preliminary installation report, the attention shall be focused on the following « **O-IC-S** » points:

- **O** = Obstacles between the radar location and potential intrusions you did not expected based on the background map analysis (buildings, vegetation, vehicles...)
- **IC** = Installation constraints on the mast (height above ground of the PSR Sensor Unit, orientation...) and resulting impact (shadows of trees, zone illumination...)

- **S** = Spurious activity on the area covered by the Sensor Unit (vehicles traffic, air conditioner, windmills, WiFi transmitter at the same frequency band...)
 - o **Traffic of vehicles** = traffic of vehicles in the coverage area of the radar may cause false alarms if the operator have not create exclusion zone. Moreover, if the traffic is dense, this area will desensitize the radar for any intrusion occurring on similar range and radial velocities than cars (see complete explanation below). It is recommended to turn the radar away from any busy road.
 - o **Air conditioning blocks, windmills ...** = any object that includes a rotating piece in the radar coverage area may cause false alarms if this object is not in an exclusion zone. . It is recommended to direction the radar so that any rotating object in the direct proximity is at the back of the radar as much as possible.
 - o **Transmitter at the same frequency band as the PSR-500** (example: WiFi transmitter in the same frequency band as the PSR-500); it is recommended to direction the radar so that the disturber is at his back as much as possible.
 - o **Building proximity** = the proximity of building is not an issue as long as the radar is not oriented toward it. In case such a situation may happen, the radar may be disturbed by its own emission that is reflected by the wall of the building. This will cause a desensitization of the radar and thus a degradation of the detection performances. It is therefore recommended to avoid the combination of proximity with a building and the illumination of the building.

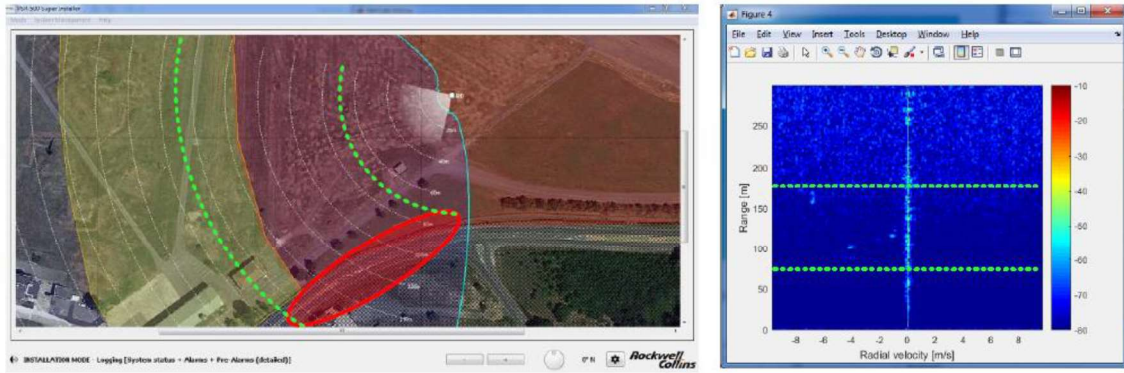
Busy road effect

PSR-500 radars map the backscattered energy in range and radial velocity over their complete coverage (~90° in azimuth) before trying to detect intrusions.

Every target over their coverage and moving at range and radial velocity similar to the one expected for human intrusions may potentially mask human intrusions.

- It is important to create exclusion zones on these areas to avoid false alarm on such areas considered as public and authorized areas
- Nevertheless, exclusion zones will not avoid the fact that some cars may mask human intrusions if they move at similar range and radial velocity than the human intrusion. The radar is therefore desensitized for human detection. The busier the road the higher the risk.

In order to illustrate this effect, the left picture below shows a deployment performed close to a busy road. Although the traffic (red area) is not geographically in the area of interest for the surveillance (field), the cars move at a range and a radial velocity close to the one expected for human intrusions over the area of interest (as we can see of the right picture which is the range x radial velocity map the radar is working on). The road is in a exclusion zone, avoiding false alarm on cars. But cars radar signature will regularly mask human intrusion radar signatures that may occur on the entire coverage bounded with green lines.



In this case, it is recommended to turn the radar to less illuminate the busy road.



To update the installation properties, follow the actions listed below:

- If the **PSR-500 Installer** application is not closed, click on the « Previous steps » : Equipment(s) integration... » buttons on the bottom left-hand corner to get back to the configuration phase, and then set up the properties of the equipment and generate the preliminary installation report to finally reach the calibration phase (cf §0).
- If the **PSR-500 Installer** application is closed and the configuration saved, follow the steps below :
 - o Start the **PSR-500 Installer** application
 - o The authentication window opens



Figure 92 – PSR-500 Installer – Authentication window

- Enter the default password
- Click on « Update ... » :



Figure 93: PSR-500 Installer –« Update ... » button

- Select the system configuration previously saved
- Click on « Add / Configure Equipments » button:

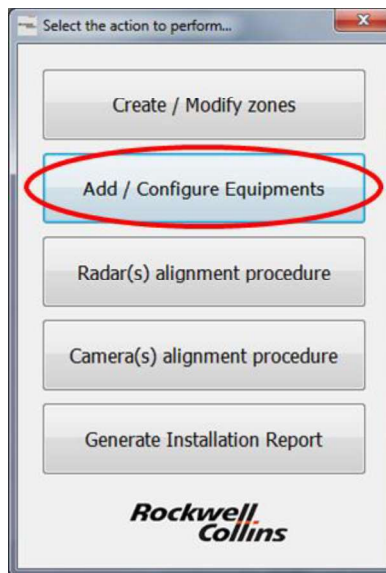


Figure 94: PSR-500 Installer –« Add / Configure Equipments » button

The following window automatically opens :



Figure 95: PSR-500 Installer – open the saved system configuration

- Update the installation properties of the equipments
- Click on menu bar « System Management -> System Configuration ... -> Generate Installation Report » to generate the installation report :

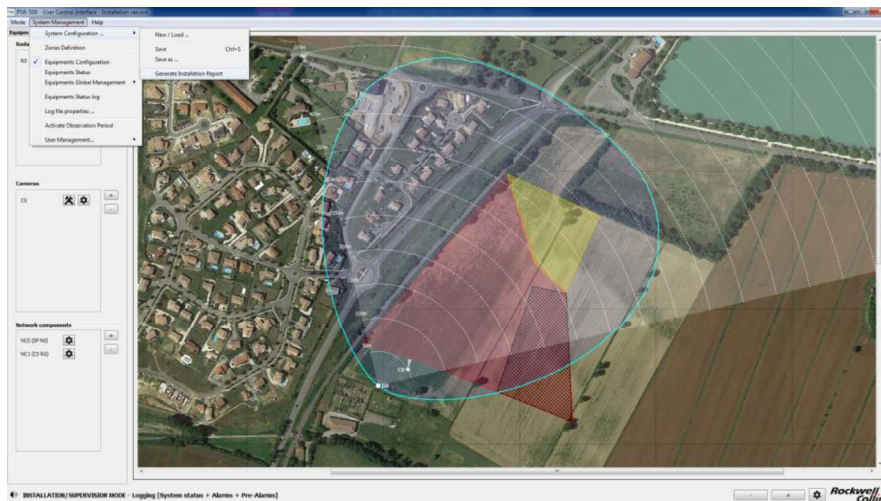


Figure 96: PSR-500 Installer – Generate installation report from the menu bar

6.1.8. Step#8: Add installation operators

To add installation operators, once the **PSR-500 Installer** application opened, click on “System Management -> User Management... -> Add User”.

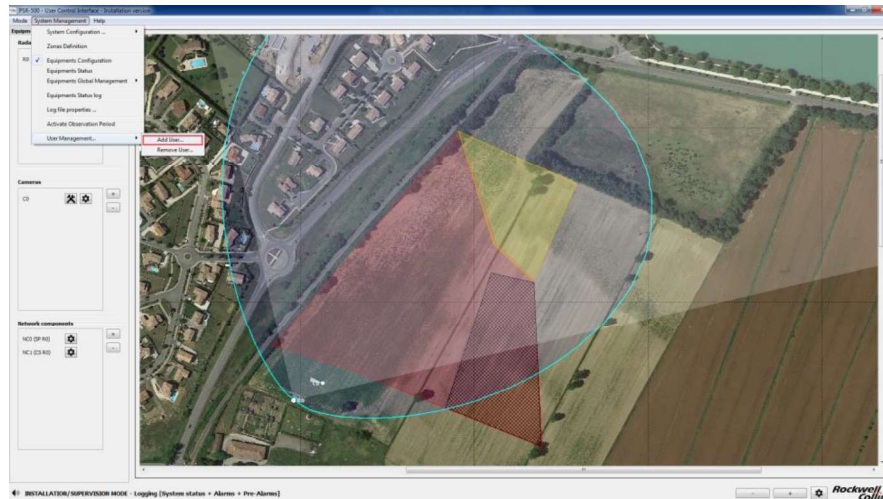


Figure 97: PSR-500 Installer – Add installation operators

- The following window opens. Create a new user by entering a user name and a password.

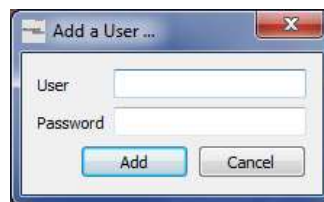


Figure 98: PSR-500 Installer – installation operator creation window

These installation operators will now appear in the list of authorized operators when the application starts.

To delete installation operators, once the **PSR-500 Installer** application opened, click on « System Management -> User Management... -> Remove User » and select in the list the name of the user to be deleted.

The names and the passwords are locally stored within the **PSR-500 Installer** directory in an SQL database. Only hashed passwords are stored.

6.2. Installation & start of a radar

As a reminder, a radar of the PSR-500 system is composed of a SU and a PU. This part will describe how to physically install this set and start it up.

In case of a deployment with several radars, the operator shall also configure the interoperability of each radar in order to exploit them (as explained in the next section).

6.2.1. Cabling

The SU is powered and communicate through the Ethernet. The Ethernet plug of the radar is defined as follow:

- Connector RJF RB 71 (Amphenol)
- Ethernet Plug RJF RB 6 (Amphenol)
- Cat IP67



Figure 99: PSR-500 SU plug

The Ethernet cable connected to the SU shall be Cat.6 S/FTP.

Its end connected to the SU shall be equipped with a RJF RB6 adapter as illustrated by the following picture:



Figure 100: Ethernet Connector RJF RB 6

6.2.2. Dimensions

- Length : 370 mm
- Width : 144 mm

- Depth : 50 mm
- Fixings : 348.5 * 106 mm ; holes diameter = 8 mm
- Weight : 1.5kg

6.2.3. Power Supply

The SU shall be power supplied with a 48V POE (Power Over Ethernet). It does not require any additional specific cabling. The 48V POE shall be compliant with 802.3af/at standard and shall be configured in **half-duplex**.

6.2.4. Energy Consumption

The energy consumption of the SU is 8W.

6.2.5. Direction of installation

The radar of the PSR-500 system shall be installed as recommended below.

Recommendation 1 = the SU includes a GPS antenna used to receive the GPS signal. This signal is used to synchronize the different SU together and ensure their interoperability.



Figure 101: Position of the GPS antenna on the PSR-500 radar

The direction of installation is thus identifiable through two points of reference:

- On the edge of the radar, an arrow/text is present. This arrow/text shall be direction toward the up when the radar is installed.
- when the operator is in front of the radar, the RJ45 connector shall be on the right of the radar.

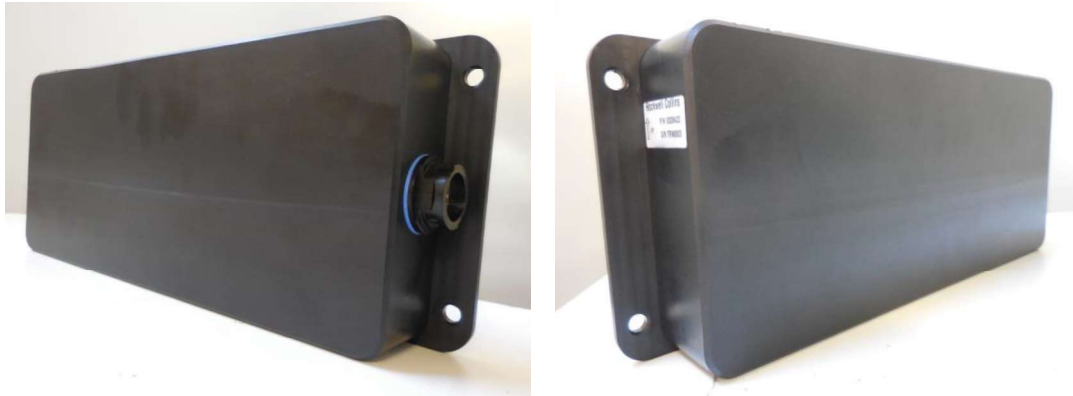


Figure 102: Radar of the PSR-500 correctly oriented



Figure 103: Arrow/text on the edge of the radar

Recommendation 2 = the top of the radar shall be cleared of any obstacles in order that the GPS antenna correctly received the GPS signal.

Recommendation 3 = the close proximity of the radar (<1m) and the radar beam area shall be cleared of obstacles as much as possible.

Recommendation 4 = each radar of the PSR-500 system shall be oriented and tilted following the conclusion of the preparation phase of the deployment. The following figures illustrate the radar points of reference.

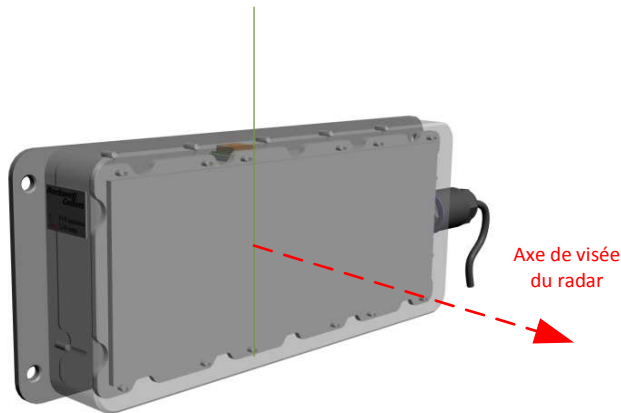


Figure 104: line of sight of the PSR-500 radar

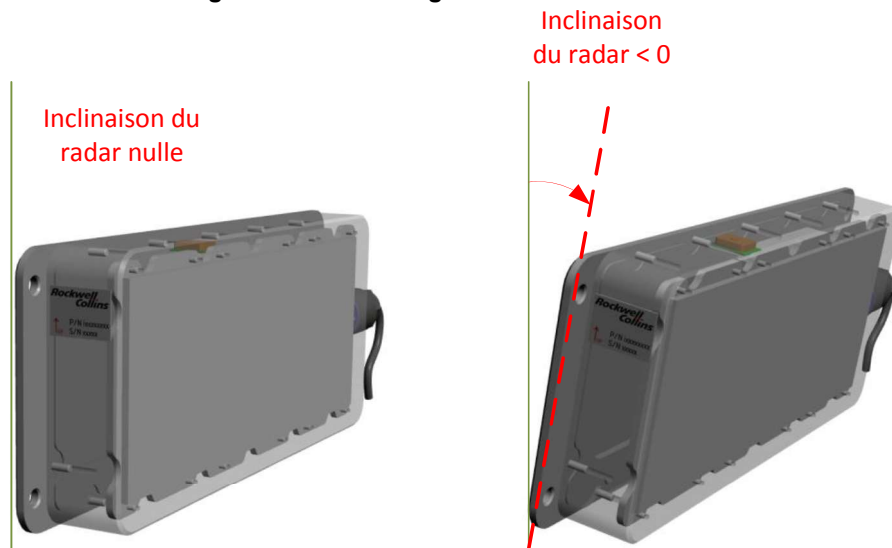


Figure 105: Tilt indications for the PSR-500 radar

Note: when the radar is installed below 6m height, it is recommended to keep a zero Tilt to keep good detection performance at 500m.

6.2.6. Network configuration

The SU integrated a DHCP client in order to retrieve its IP address from the network.

- When the SU is powered up, the DHCP client is started and the SU waits for an IP address. Any IP address can be allocated to the SU.
- After 30 seconds, if no IP address is allocated to the SU, it uses its default IP address i.e.192.168.1.13

In order to be integrated in a DHCP server, the MAC address of the SU can be retrieved on the stickers on the edge of the SU.

6.2.7. SU to PU connection

The POE connection of the SU to the PU is at the choice of the installation operator. The installation operator shall define the network configuration so that the PU and the SU can communicate, given the IP address allocated to the SU.

The current delivered disk image of the PU is configured to be connected with an SU configured with its default address, i.e. 192.168.1.13. If the user allocates a different IP address to the SU through a DHCP server, then the PU will be updated when it will connect to the PSR-500 installer for the first time.

Warning: if the default IP address is modified, the PU update by the PSR-500 installer shall be followed by a reboot of the SU and then a reboot of the PU.

6.2.8. Radar Power Up

If the PU has been installed in compliance with the installation procedure 226-0098-036_Installation_Logiciels_Activation, then at the power up of the PU the **Tracking software** automatically starts, configuring the emission of the SU. The SU starts its emissions and the radar is started. The following steps can be performed.

6.2.9. Update of each PU

We shall now connect the **PSR-500 installer** to each PU in order to apply the system configuration previously prepared. The following procedure shall be performed for each radar.

- Open the configuration window of the radar to be updated.
- Click on the button to connect to the associated PU :

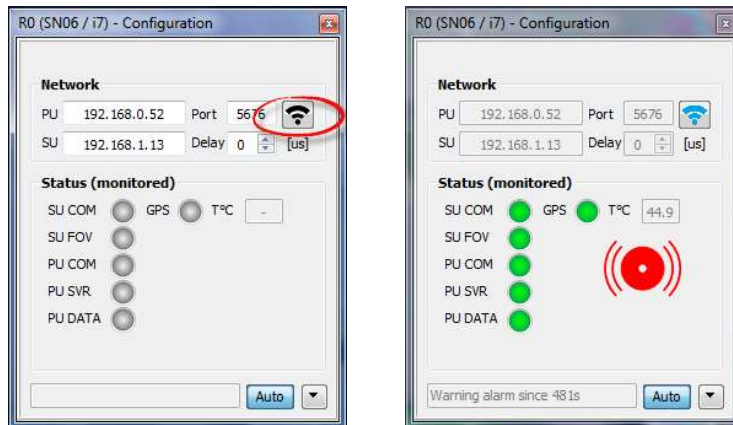


Figure 106: Connection to the PU of a radar

- All the lights shall turn green. If this is not the case, confer to the debug section in annex of this document.
- Since it is the first time that the installation operator connect to the PU (that only have a blank system configuration), the **PSR-500 Installer** application automatically detect that the PU shall be updated.
- The following window automatically opens.



Figure 107: System configuration alignment window

- Click on "Send to Radar PU" to update the system configuration of this radar's PU. If you don't click on "Send to Radar PU", then after 10s, the button "Import from Radar PU" will be automatically clicked
- After few seconds, the radar's PU is updated.

Re-do the same procedure for all the deployed radars.

Now that the system configurations of all the radars are up to date, we can now pass to the configuration of the interoperability of the radars.

6.3. Interoperability of the radars

Before being able to do the alignment and the deployment validation of each radar, we shall first configure the interoperability of the radars.

Indeed, if several radars shall be installed on the same site, it is essential to position and configure them so that they do not disturb each other's.

- **Positionning** = ensure a minimum physical isolation (see below)
- **Configuration** = in case the radar are in "radio visibility", configure the synchronization of their emission (see below definition)

Note on the capability of « inter-SU synchronization »

The SU of the PSR-500 system includes a GPS antenna in order to synchronize the FMCW emissions of each SU on a GPS clock. This synchronization is essential to avoid interferences between the SUs in case they are in "radio visibility".

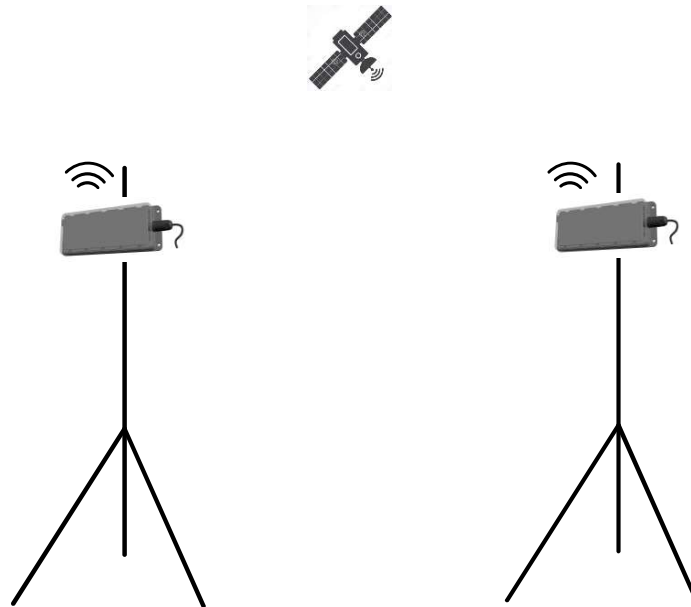


Figure 108: Synchronization of the emissions of the SU thanks to the GPS signal



Note: the GPS antenna of the SU is located at the top of it, it is therefore essential that the top of each SU remains clear if any obstacles with a direct view to the sky.



Figure 109: GPS antenna position on the PSR-500 radar

Note on the concept of « radio visibility »

If two SU emits in a free space, there are in « radio visibility » of each other since each radar receives the other's signals. If two SU are isolated because of obstacles in the visible domain, the emission of an SU may still be received with enough power by the other due to reflections on several obstacles. In such conditions, the two SU are still considered in "radio visibility".

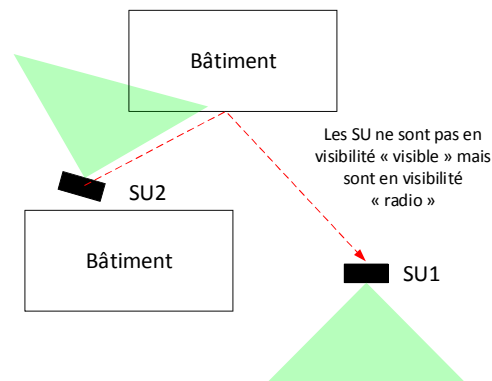


Figure 110: Example of jamming of the SU1 by the SU2 due to the buildings

In such a configuration, the emissions of the two radars shall be synchronized. A time offset w.r.t. to the GPS clock of reference will be added to each radar emission. The offset will be different for each radar.

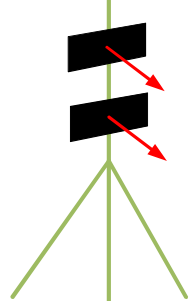
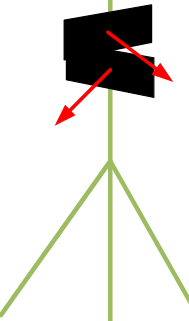
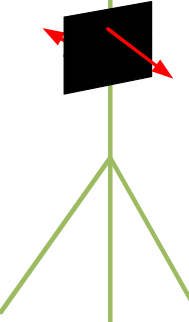
6.3.1. Relative positioning

First of all, we must ensure that the physical isolation between two SU is enough:

- Vertical distance
- Horizontal distance
- Respective lines of sight

If the minimum physical isolation is not respected, the radar will disturb each other whatever their synchronization properties.

The following abacuses indicate the minimum physical isolation to be applied for some typical installations:

Installation	scheme	Distance
<p>Same mast Same line of sight</p>		<p>Minimum of 2m</p>
<p>Same mast 90° between the two lines of sight</p>		<p>Minimum of 70cm</p>
<p>Same mast 180° between the two lines of sight</p>		<p>Minimum of 70cm</p>

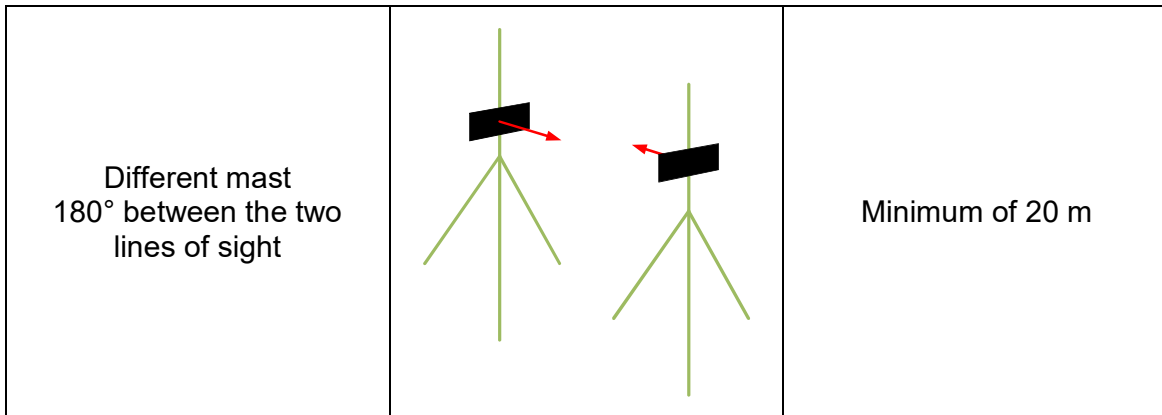


Figure 111: Abacuses of minimum physical isolation

Once that physical isolation is respected, we can now proceed with the configuration of radar interoperability. As indicated above, this synchronization is required if several SU are in « radio visibility ».

6.3.2. Radio environment analysis

We must first check that there is no jammer in the PSR-500 system radar frequency band of operation [5.77GHz – 5.87GHz].

To do so, we are going to use one of the deployed radar as « spectrum analyser ». First, we are going to set the synchronization of this radar to be sure that it does not « see » any other radar of the deployed PSR-500 system and that the cleanliness of its signal is representative of the radio environment.

To set the synchronization of the PSR-500 system radar, we shall tune the offset of the start time of the FMCW waveform w.r.t. the GPS clock. This time offset is called « delay » and is set in microseconds.

This « delay » can modified through the radar network property configuration window.

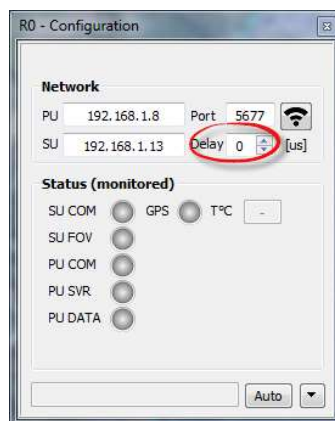


Figure 112: setting of a radar delay

By default, all radars are synchronized on 0us.