SMART

Airport

Foreign Object Debris (FOD) Detection

RHEINMETALL DEFENCE

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Rheinmetall SMART
Airport FOD Detection Radar System

Summary

- Introduction – The FOD Issue
- SMART Radar Technical Characteristics
- SMART System Features
- FOD Detection System Configuration
- FOD Trails
- Ground Surveillance Application
- Conclusions

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Introduction (1)

- **Old Requirements for Airport Ground Surveillance**
  - Target detection and reporting for only fixed or moving aircrafts on taxiways and runways (not on APRON).
  - Discrimination capability better than 10 m (movement areas are not crowed and congested zones)
  - Accuracy capability better than 10 m (targets involved, i.e. aircrafts, have usually large dimensions)
- As matter of fact, radar surveillance systems available on the market have been designed and developed in order to detect nothing else but fixed or moving aircraft on the ground.

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Introduction (2)

- **Today Requirements for Airport FOD Detection & Ground Surveillance**
  - **Increase the SAFETY in the operational areas (APRON, parking etc.) operating all weather high resolution sensors.**
  - **Increase the SAFETY operating all weather systems capable to detect foreign objects debris and wildlife on runways, which can heavily damage aircrafts with very high repairing/maintenance costs**
  - **Increase the SECURITY, in terms of perimeter intrusions detection**

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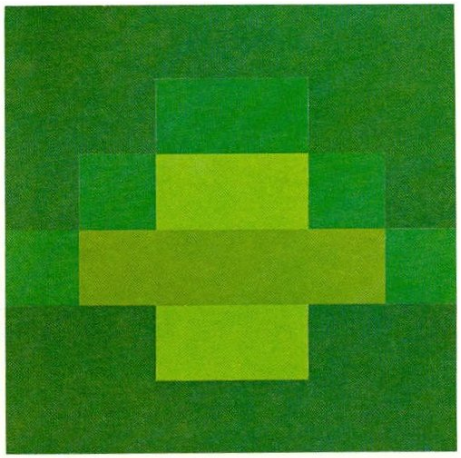
Resolution Capability
“X-band SMR” vs. “95 GHz SMART”

Typical SMR X band radar

CELL SIZE: 1/5 MAJOR DIMENSION

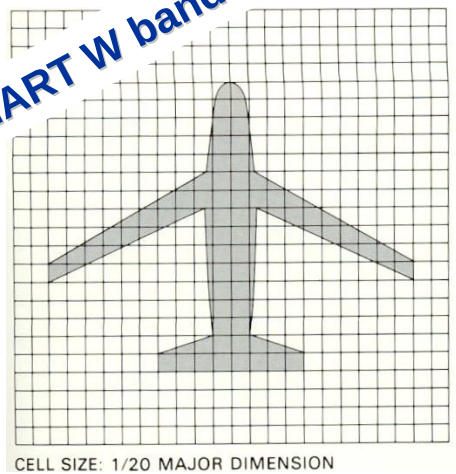


CORRESPONDING MAP

optical map

Radars predicted ideal maps

SMART W band radar



CELL SIZE: 1/20 MAJOR DIMENSION

CORRESPONDING MAP

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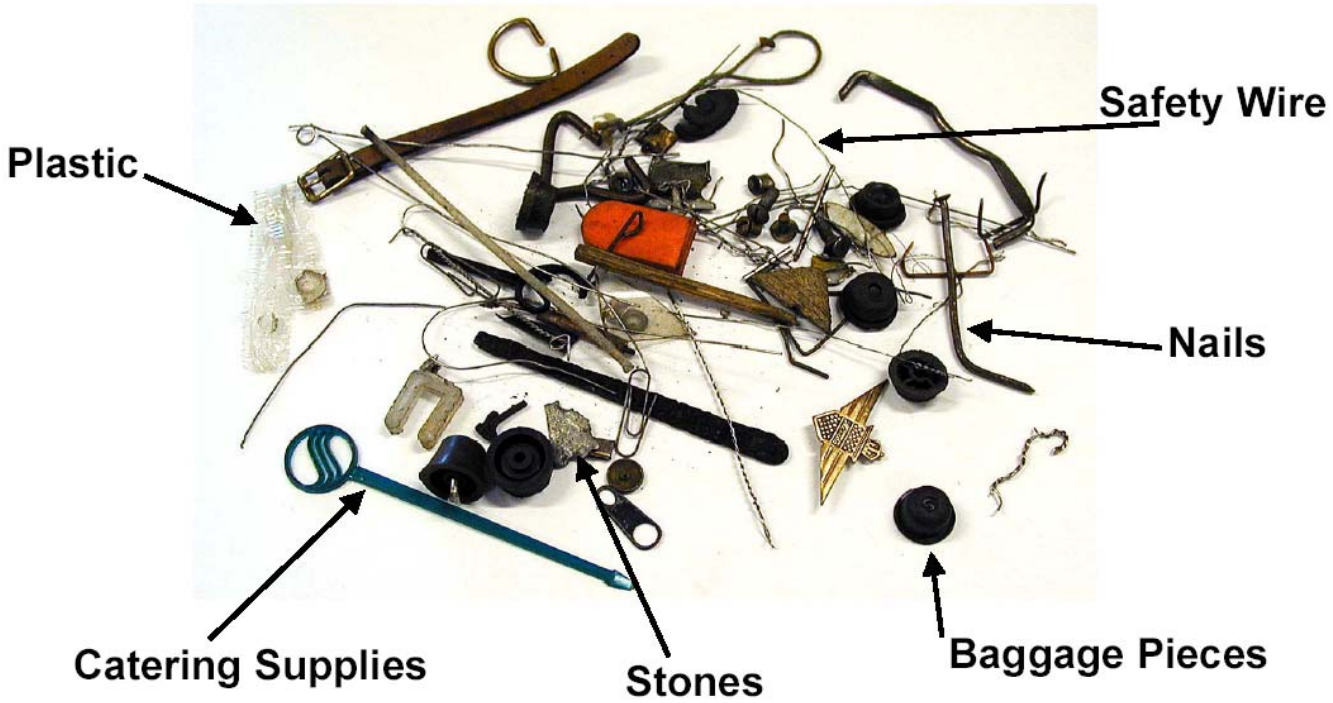
Foreign Object Debris (FOD)



An Airport FOD can be a Bolt, a Concrete Chip, a Piece of Paper, a Paint Can, a Hat, Tire Tread.... which can damages the aircraft structure and effect the passengers and cargo safety.

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FOD Effects (1)

- Velocity impact of Debris launched by Jet Blast into Other Aircraft, Personnel (Ramp/Passengers), and Buildings
- Aircraft damage (Body, tires, …)

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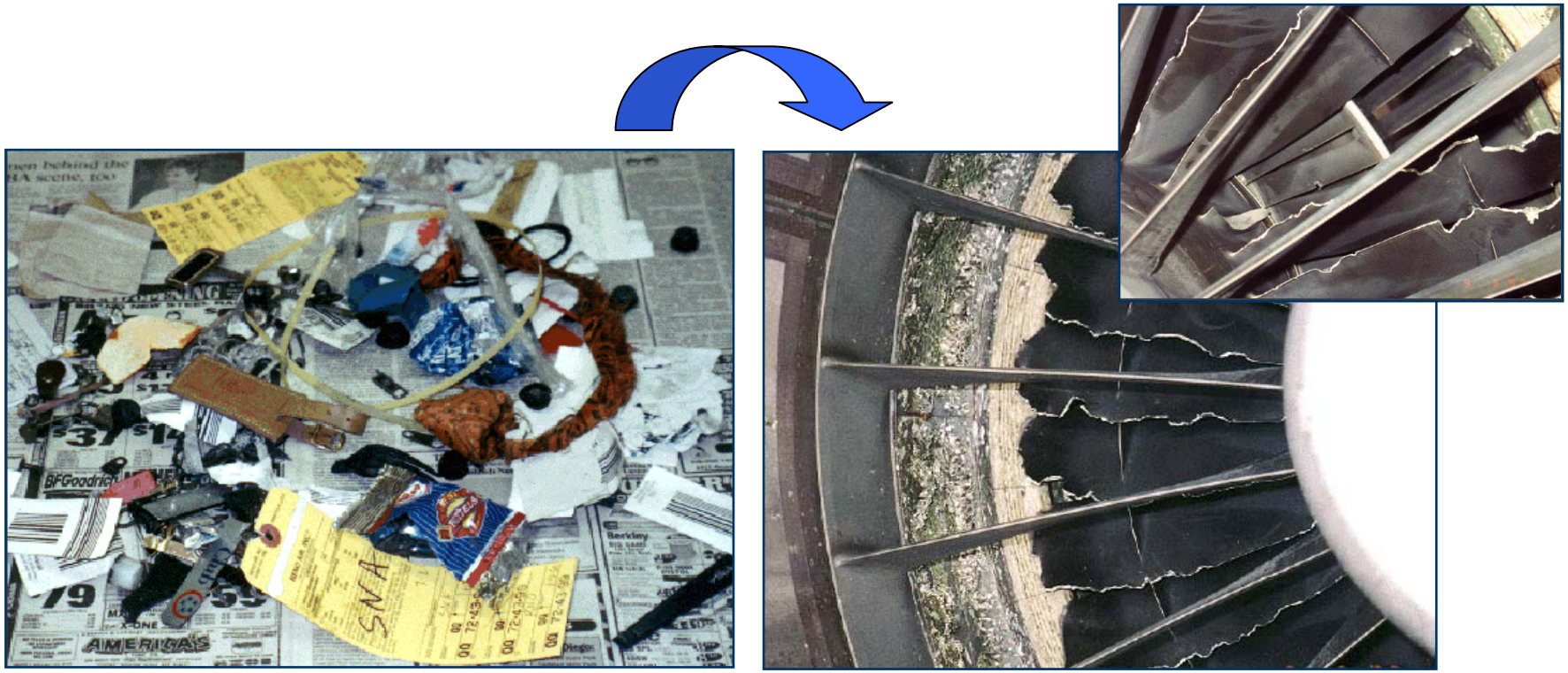
FOD Effects (2)

- FOD Ingestion into Engine Turbine



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FOD Disaster

Accident of Concorde, Paris July 25th, 2000

“During take-off from runway 26 right at Roissy Charles de Gaulle airport, shortly before rotation, the front right tyre (tyre No 2) of the left landing gear ran over a strip of metal, which had fallen from another aircraft and was damaged. Debris was thrown against the wing structure leading to a rupture of the fuel tank 5. A major fire, fuelled by the leak, broke out almost immediately under the left wing …… “

The plate that caused the tyre to explode

Concorde taking off from Roissy airport

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FOD Commercial Impacts

- **Repair cost for aircraft engines damaged by FOD (above 1 billion USD)**

- **Total annual cost estimated 12 billion USD, taking into account indirect costs by:**
  - **Flight delays and cancellations**
  - **Flights reschedule and re-deployment of airplanes and crews**
  - **Potential liability because of injury**

<u>Example</u>

The cost of repairing FOD damage to an engine can easily exceed 20% of its original purchase price:

- **Purchase cost of MD-11 engine: $8-10 million**
- **MD-11 engine overhaul to correct FOD damages: $500,000-1.6 million**
- **MD-11 fan blades (per set): $25,000**

(source Boeing Aero Magazine "Foreign Object Debris and Damage Prevention")

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SMART System

The Rheinmetall Italia solution for

Airport FOD Detection

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SMART Radar Technical Characteristics

Frequency	***95 GHz (W band)***
Average TX Power	***500 mW***
Polarization	***Circular***
Pulse Length	***20 ns***
Range Resolution Cell	***3 m***
Azimuth Beam-width	***0.2°***
Cross Range Resolution	***3 m @ 1 km distance***
Update Rate	***360° in 1 s***
Range	***Up to 3 km***
FOD Detection Type	***Fixed and moving objects***
Interface	***LAN / ASTERIX CAT10***
Operations	***24h/7d***

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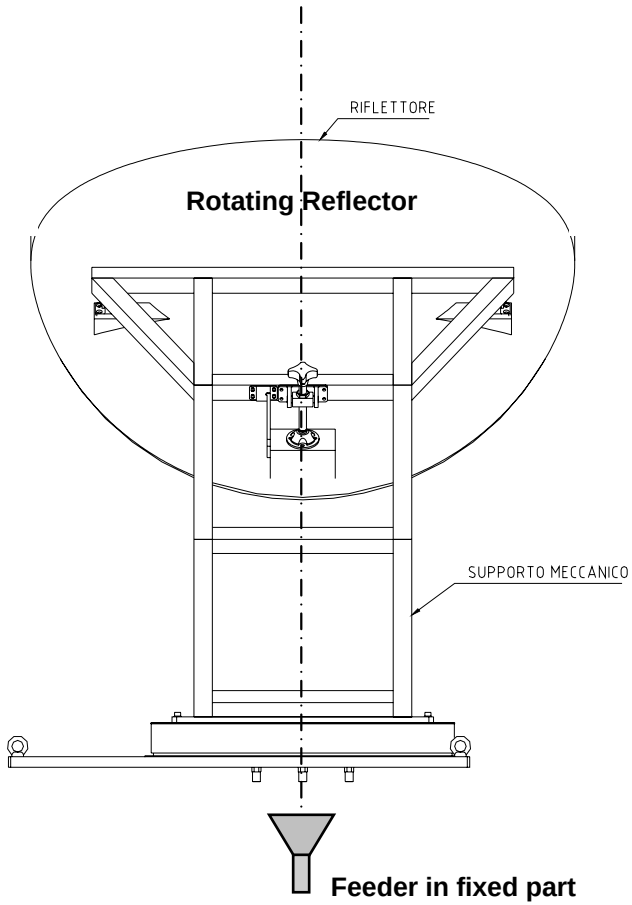
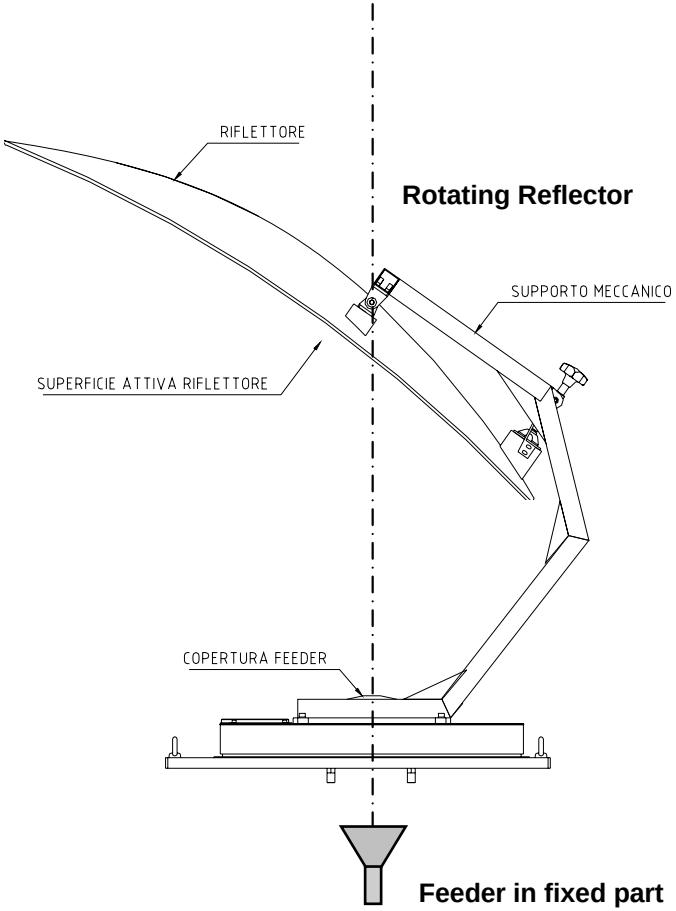
SMART Antenna Assembly





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SMART System Features

- Single/Double Channel Configuration
- Frequency Agility
- Remote Command & Control by LAN
- Integrated “ARES FOD 1/LLT” Colours/Infrared Camera
- Integrated Controller Work Position for FOD alarm presentation, analysis and recording
- Multi-sensor networking
- Easy integration based on standard protocols with ATM systems in operation
- No Rotating Parts (except antenna) – No Slip-rings
- High Availability/Maintainability

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Single Channel Configuration

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Double Channel Configuration

Internal View

Shelter

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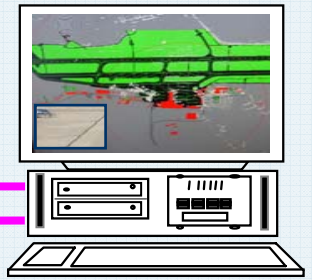
FOD Detection System Configuration

SMART 95 GHz Radar

ARES FOD 1/LLT Camera



Controller Working Position (CWP)

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ARES FOD 1/LLT Camera

- ARES-FOD1/LLT produced by FAENZI-OPTRONITALIA is an integrated tracking system composed by 3 electro-optical systems (Visible, NIR,MWIR/LWIR).
- It is a precise and reliable tool for both day and night time shooting, which can provide images and data, to an operator, through a very friendly and easy-use graphical interface.
- ARES-FOD1/LLT is designed for viewing and verification of unwanted debris on airports runways (F.O.D/ Foreign object debris)

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ARES FOD 1/LLT Technical Characteristics

Dimensions:	925x590x569 mm.
Weight:	Approx. 90 Kg.
Structure:	Aluminium/steel 316/Carbon
Rotation:	H.Continuous 360° / +45°- 45° V.
Speed:	Variable 0° to 20° sec.
Resolution:	0.0012°
Motors:	Step motors
Remote Control:	All functions - ethernet (interface box.)
Operating Voltage:	12vcc.- 9 A.max. interface box.
Environmental:	-40+60 c° / wind 180 Kmh
IP:	IP 67 (pointing system) IP 68 (cameras box)(nitrogen protection)

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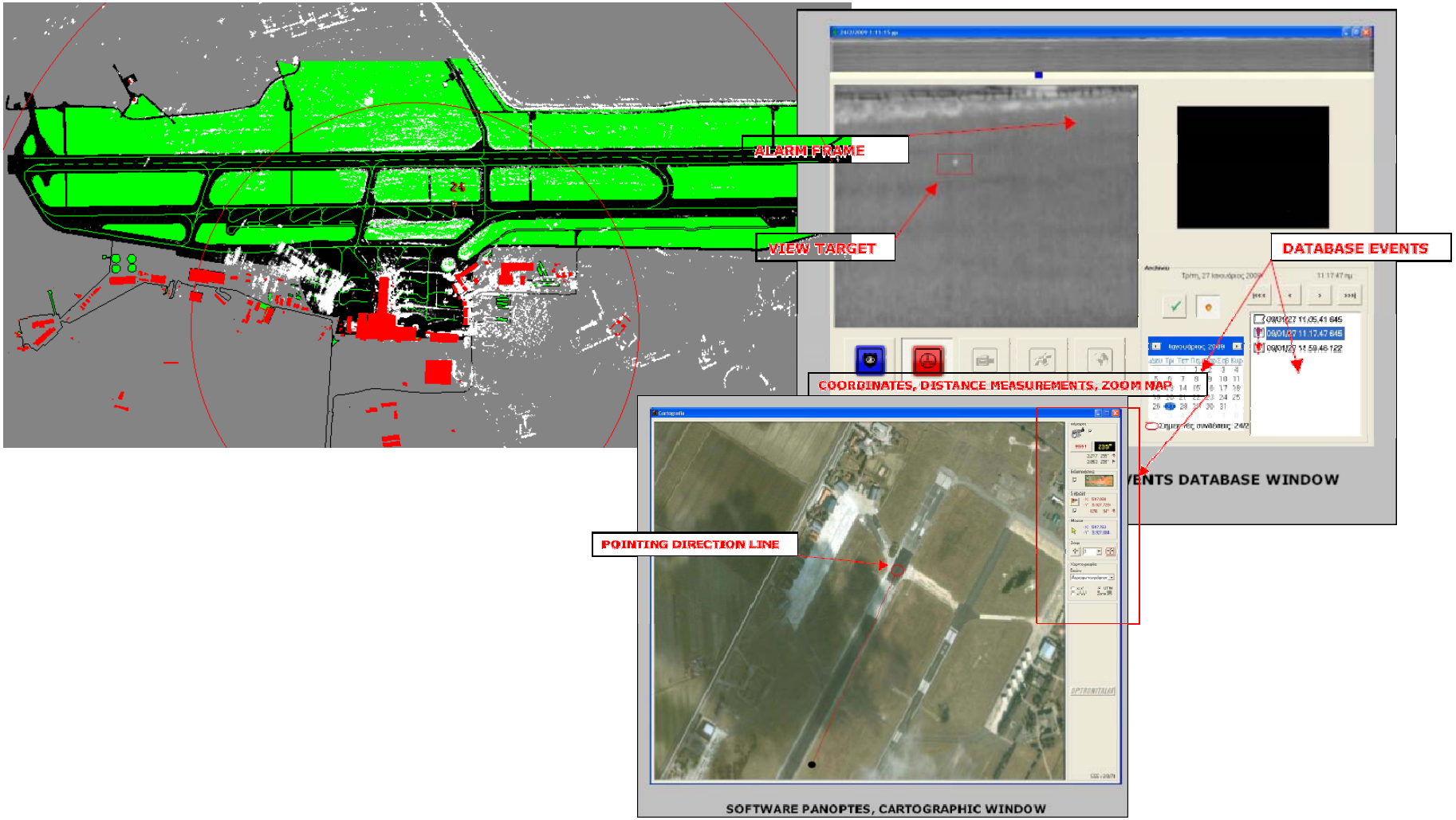
Controller Working Position (CWP)



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FOD Trails Executed by Rheinmetall Italia

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FOD Evaluation Trials in Pratica di Mare (Italy)








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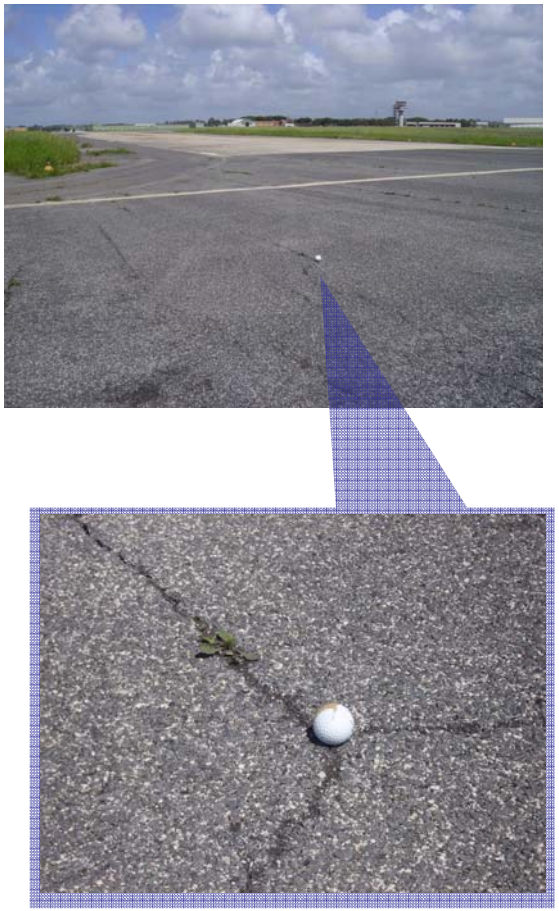
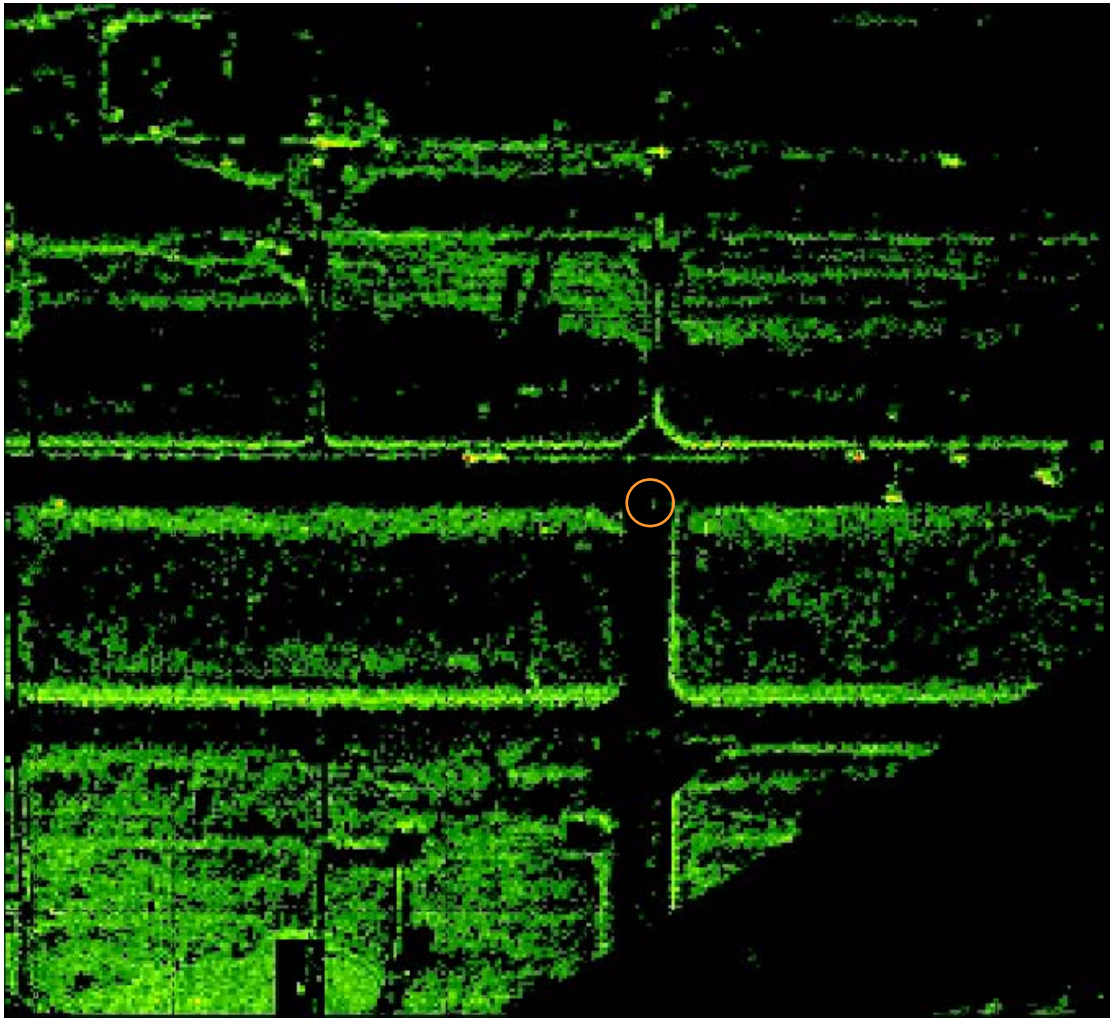
FOD Example – Golf Ball





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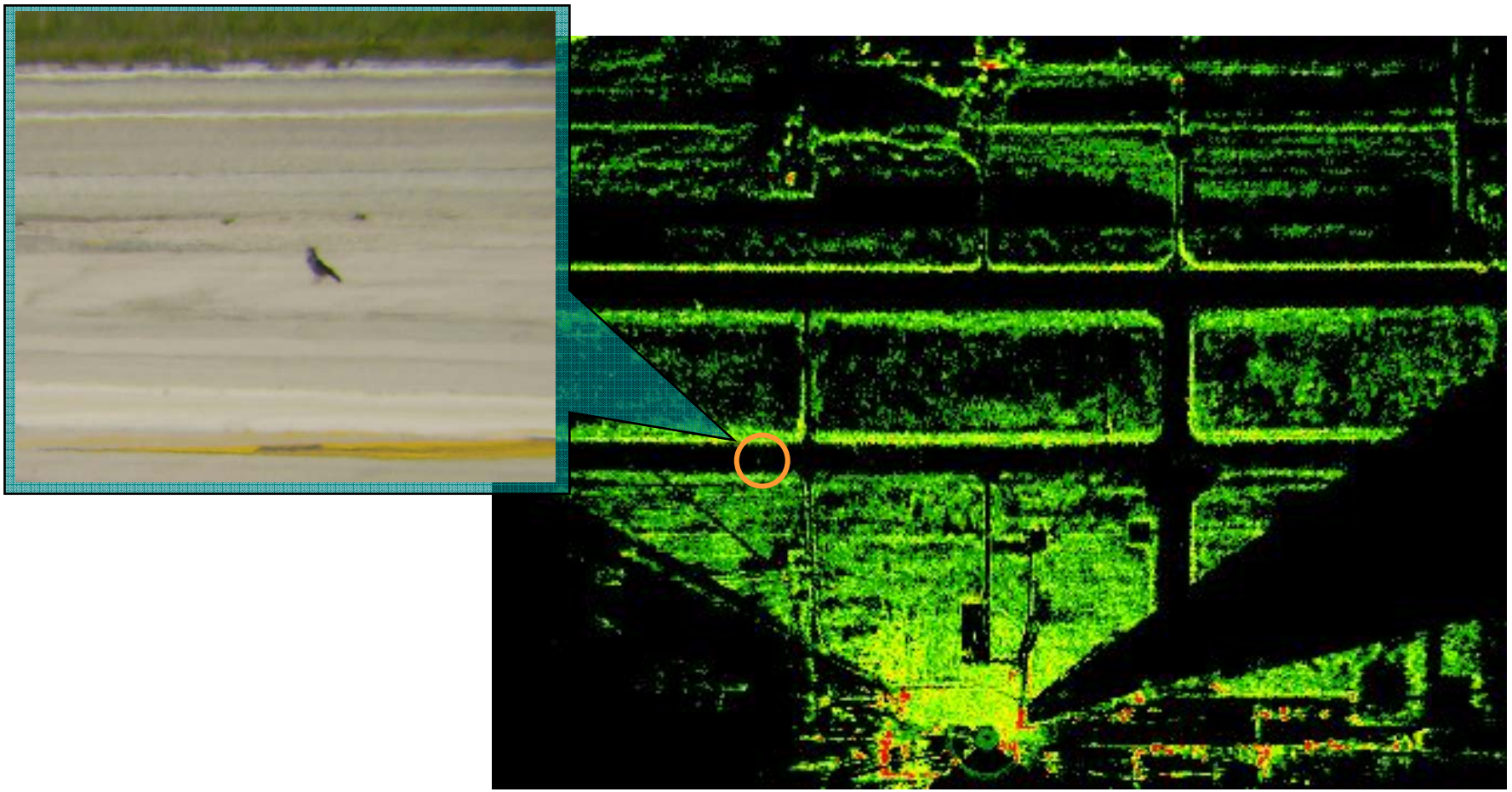
FOD Example – Wildlife



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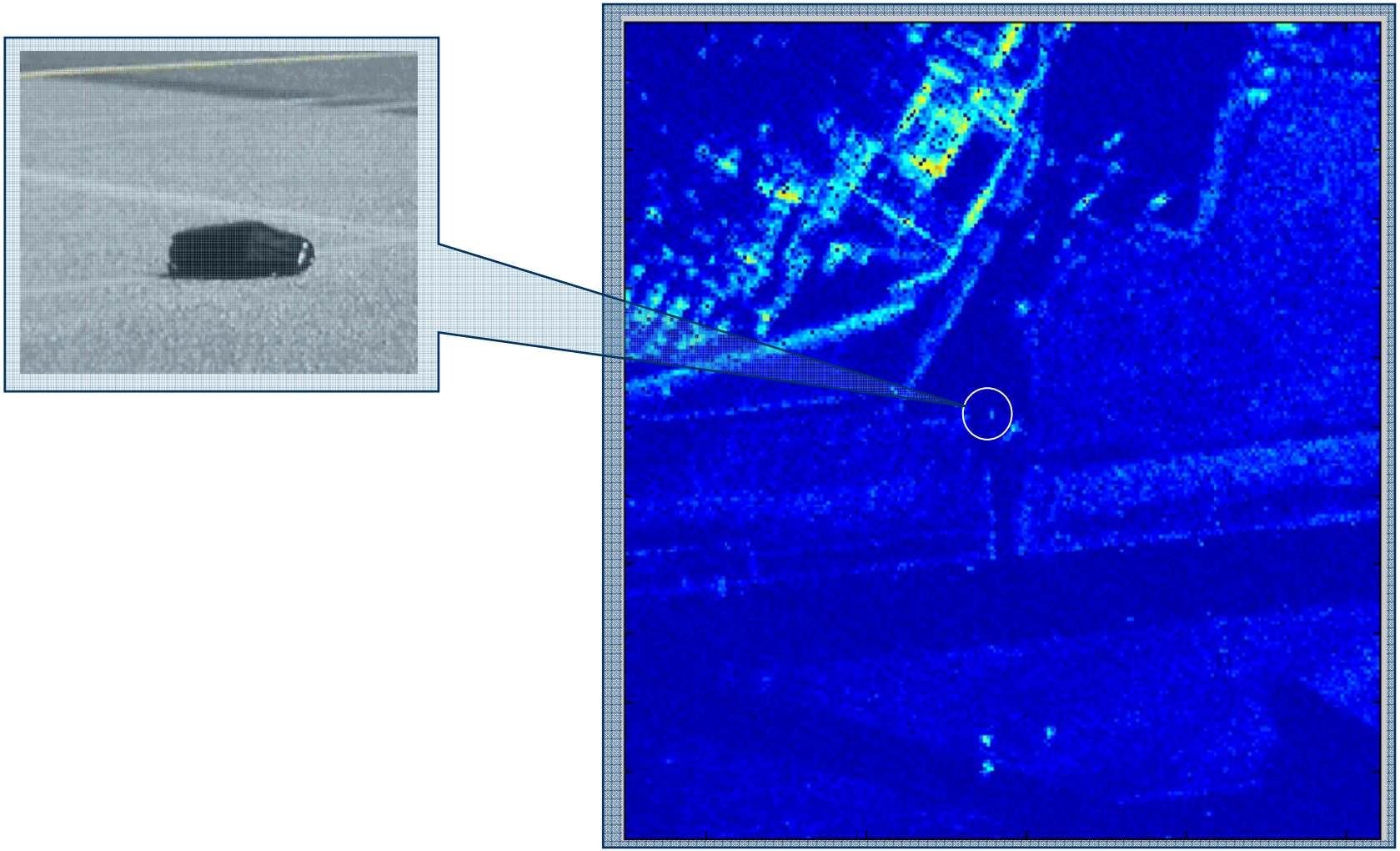
FOD Example – Small Baggage



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FOD Evaluation Trials in Cagliari (2007)

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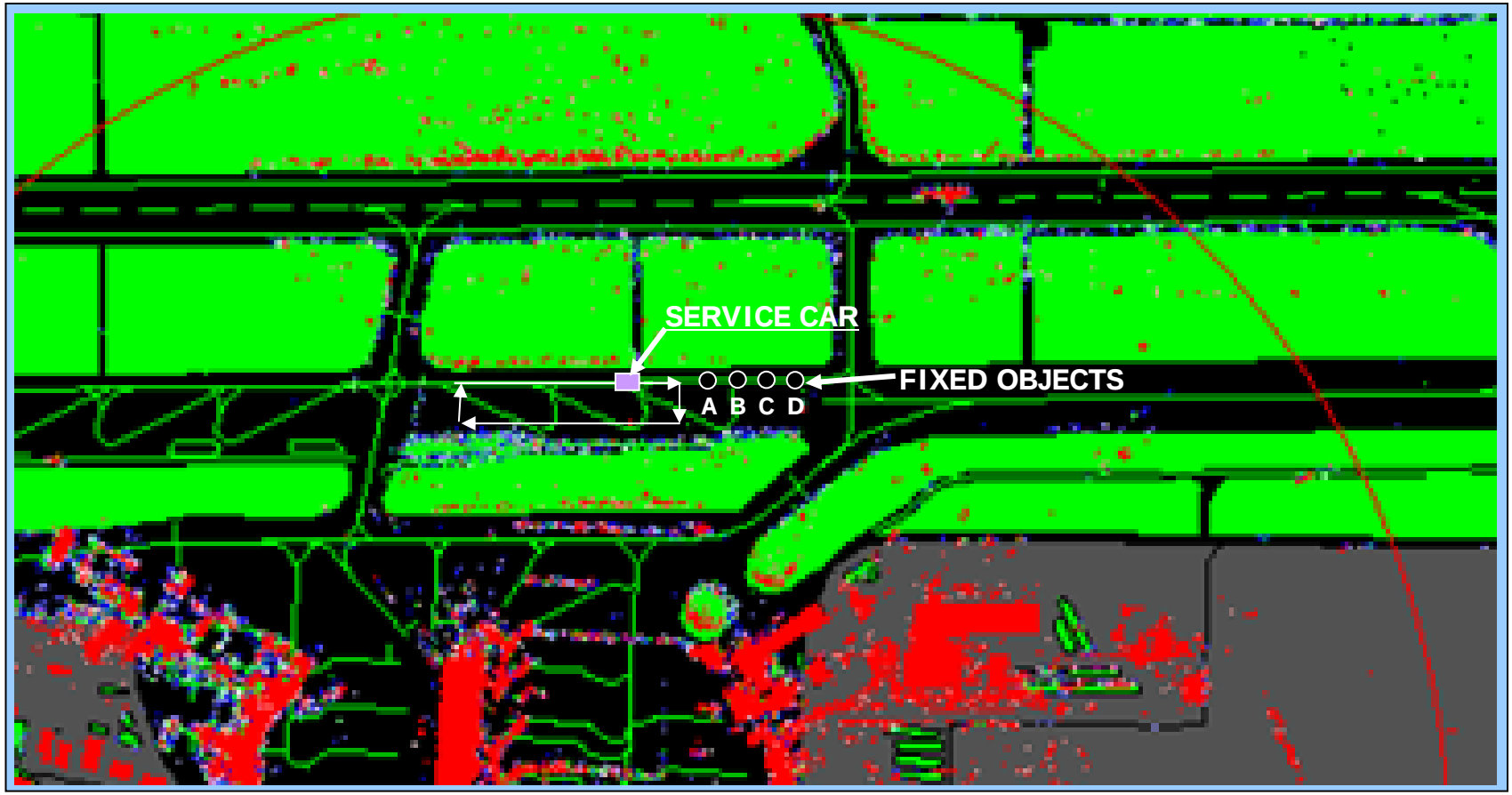
FOD Evaluation Trial in Cagliari

Actual Displayed FOD A, B, C and D on the Taxiway



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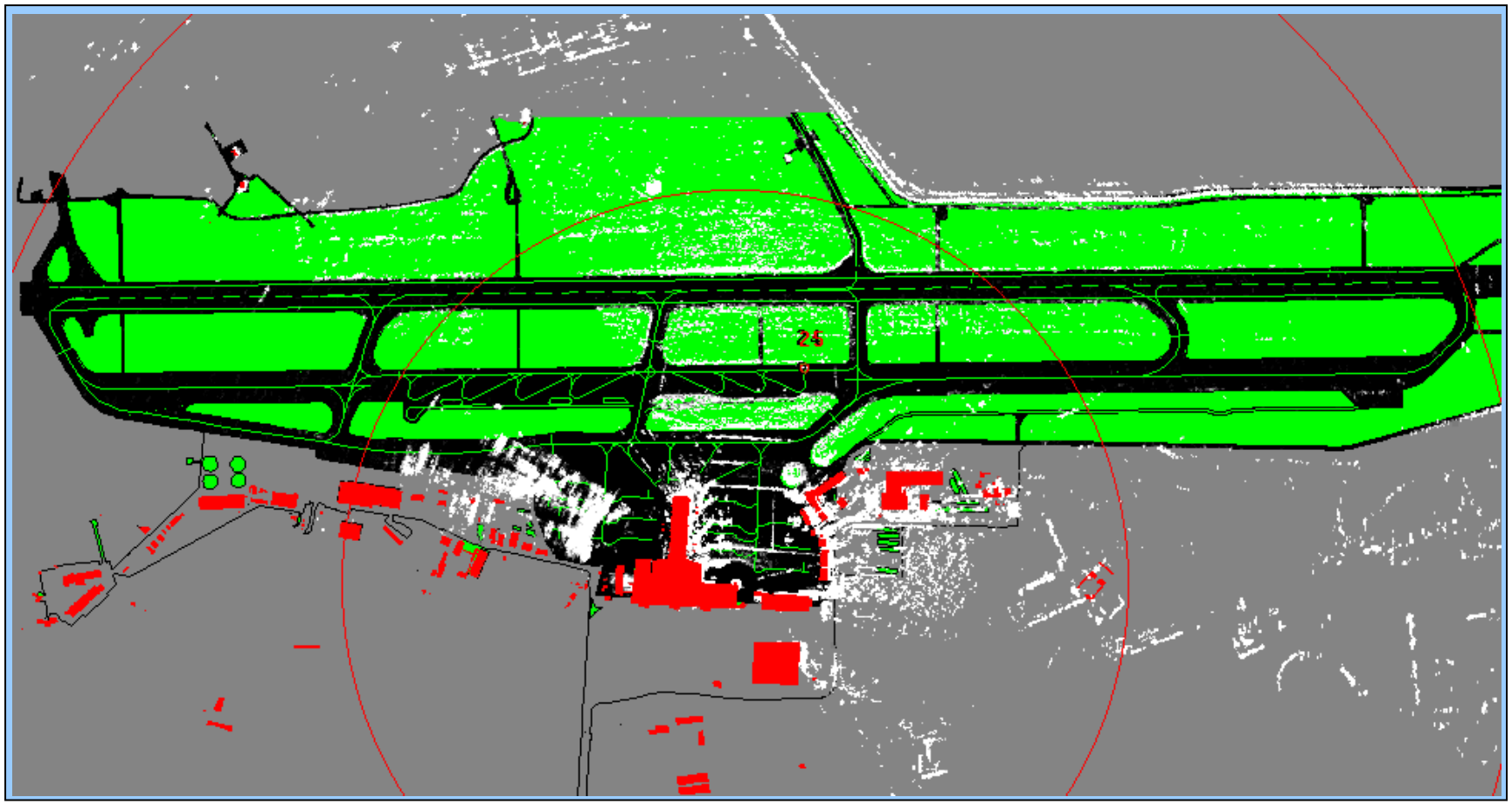
FOD Evaluation Trial in Cagliari

SERVICE CAR on the Taxiway Detected and Plotted



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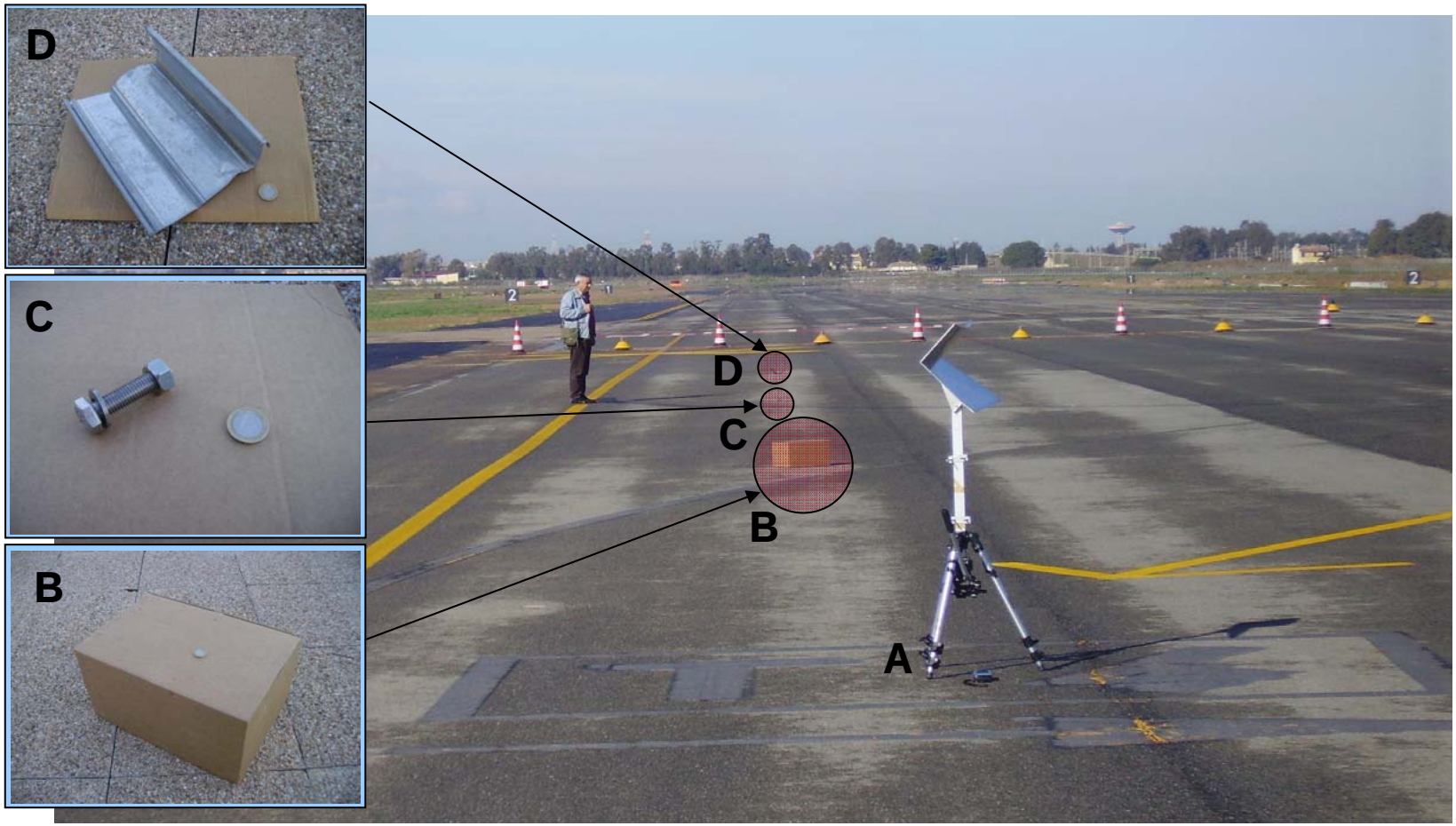
FOD Evaluation Trial in Cagliari
Deployment of FOD



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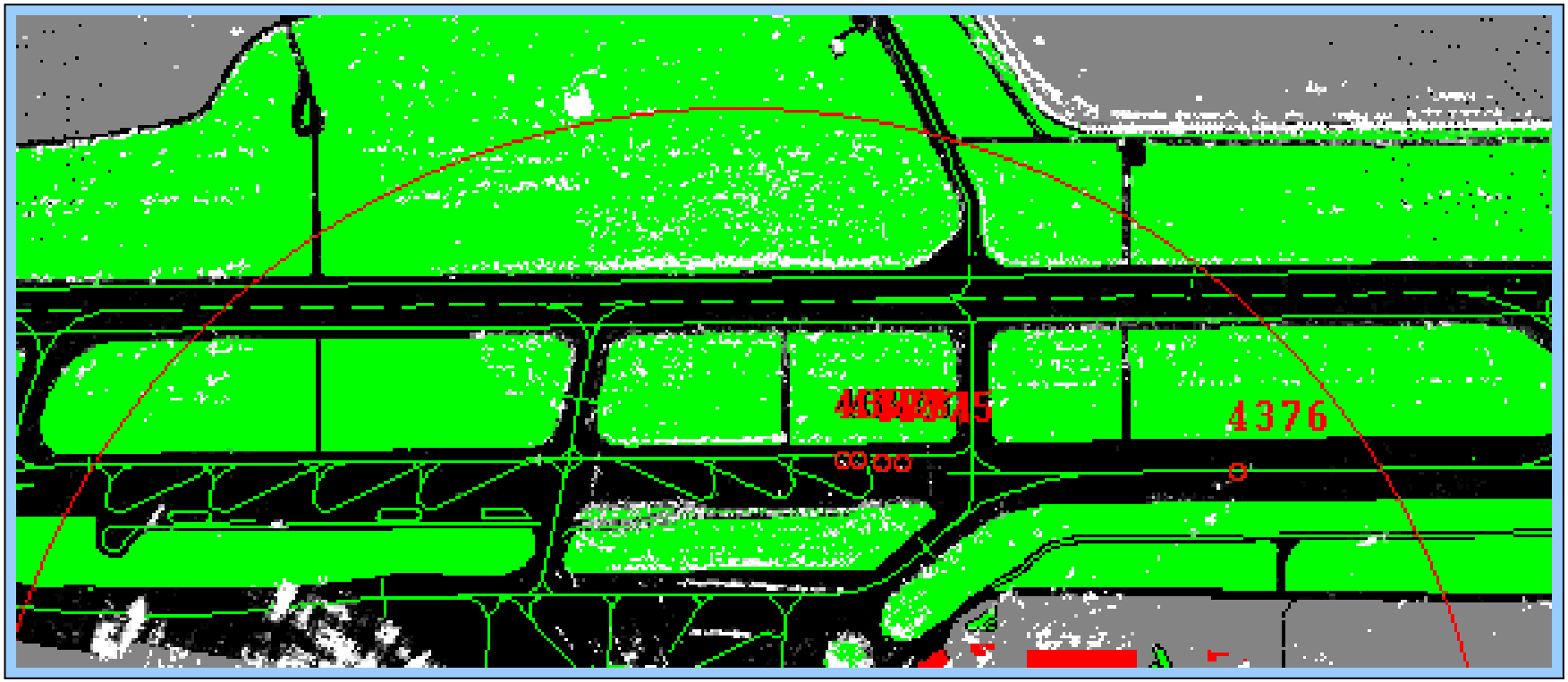
FOD Evaluation Trial in Cagliari

Actual FOD A, B, C and D Detected and Plotted



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Rheinmetall SMART System
Ground Surveillance Application

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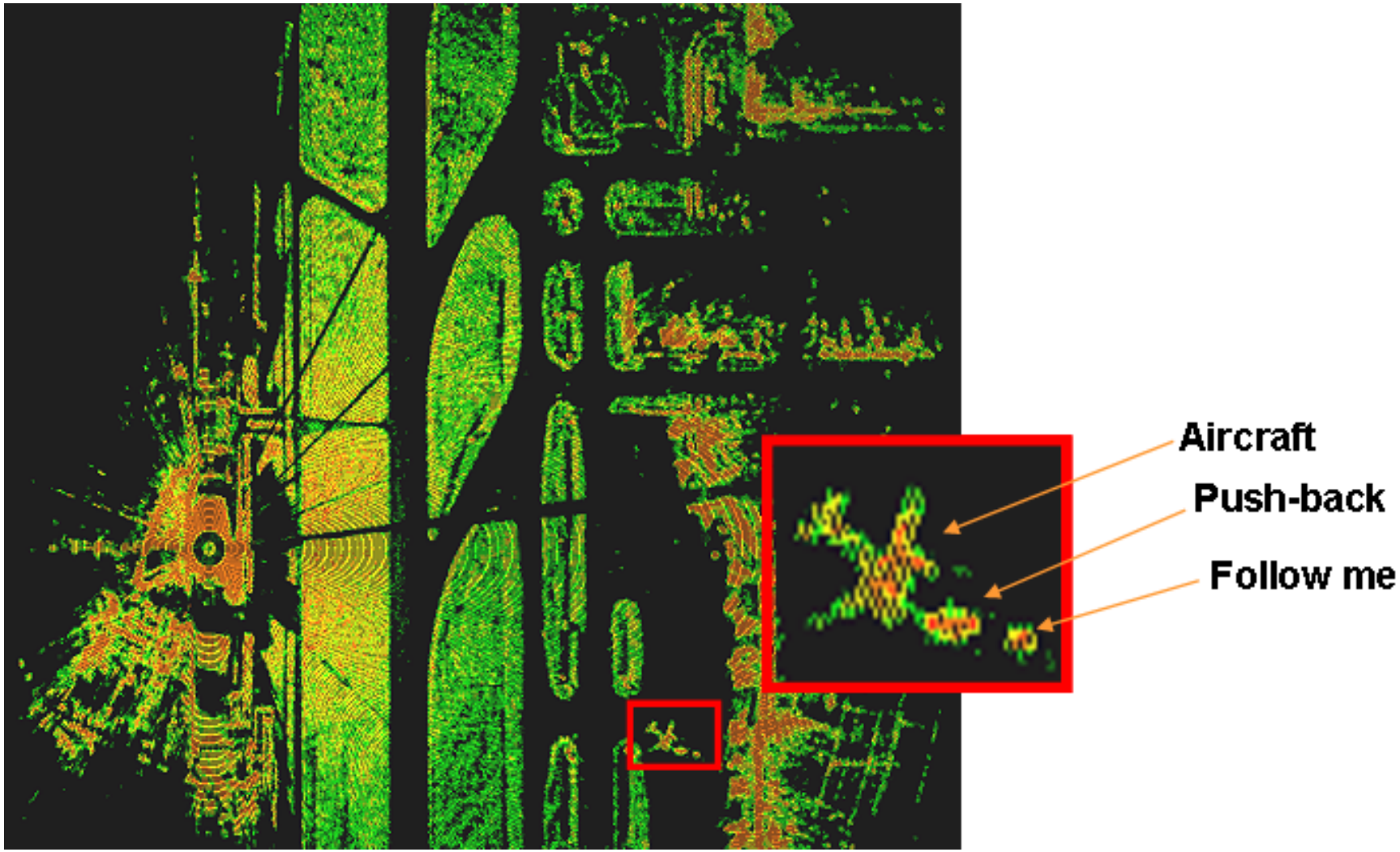
Singapore Airport – Example of Raw Video



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Milan Linate Airport (2008)

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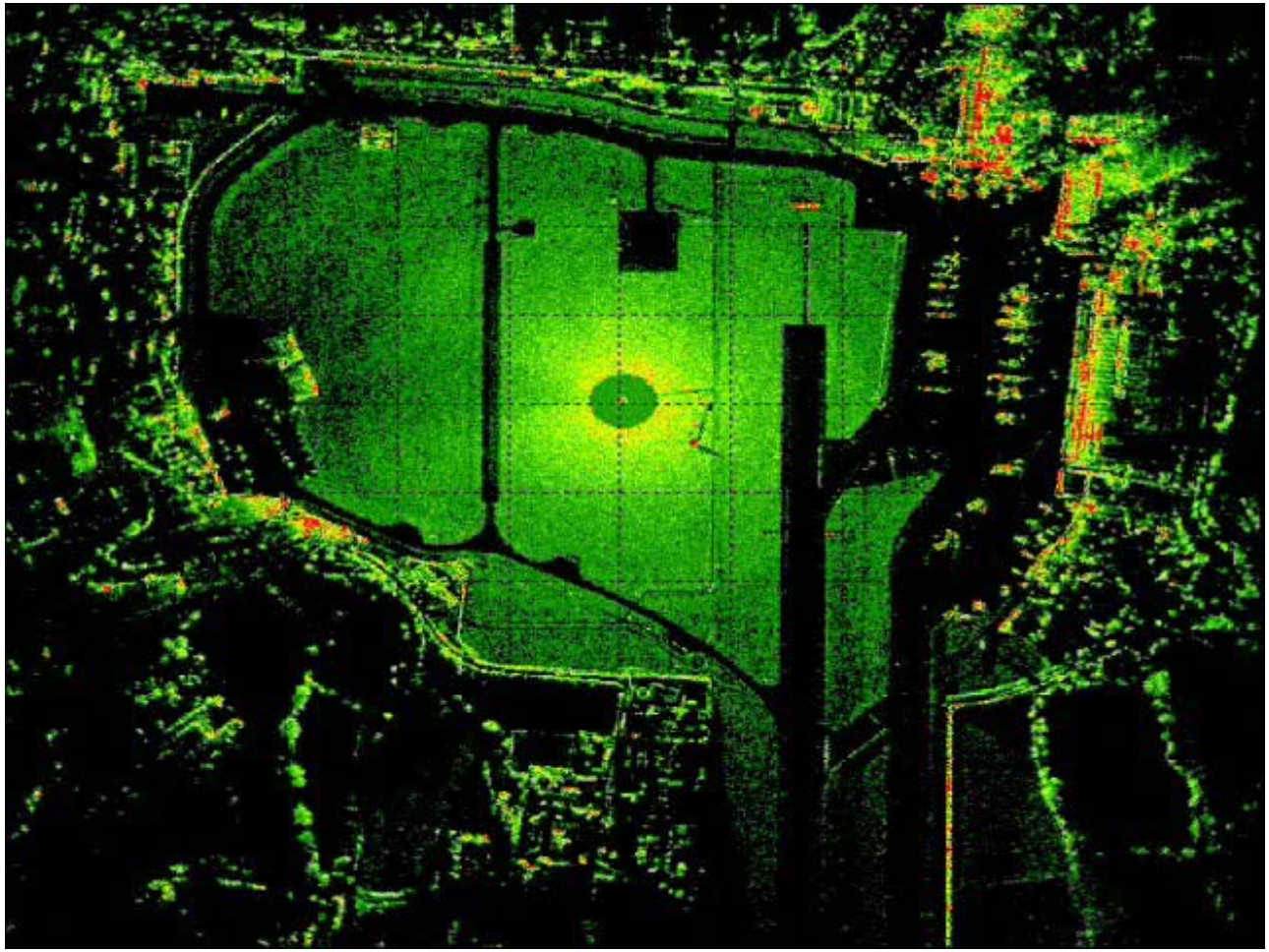
RAW Video at Milan Linate Airport



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Other Installations

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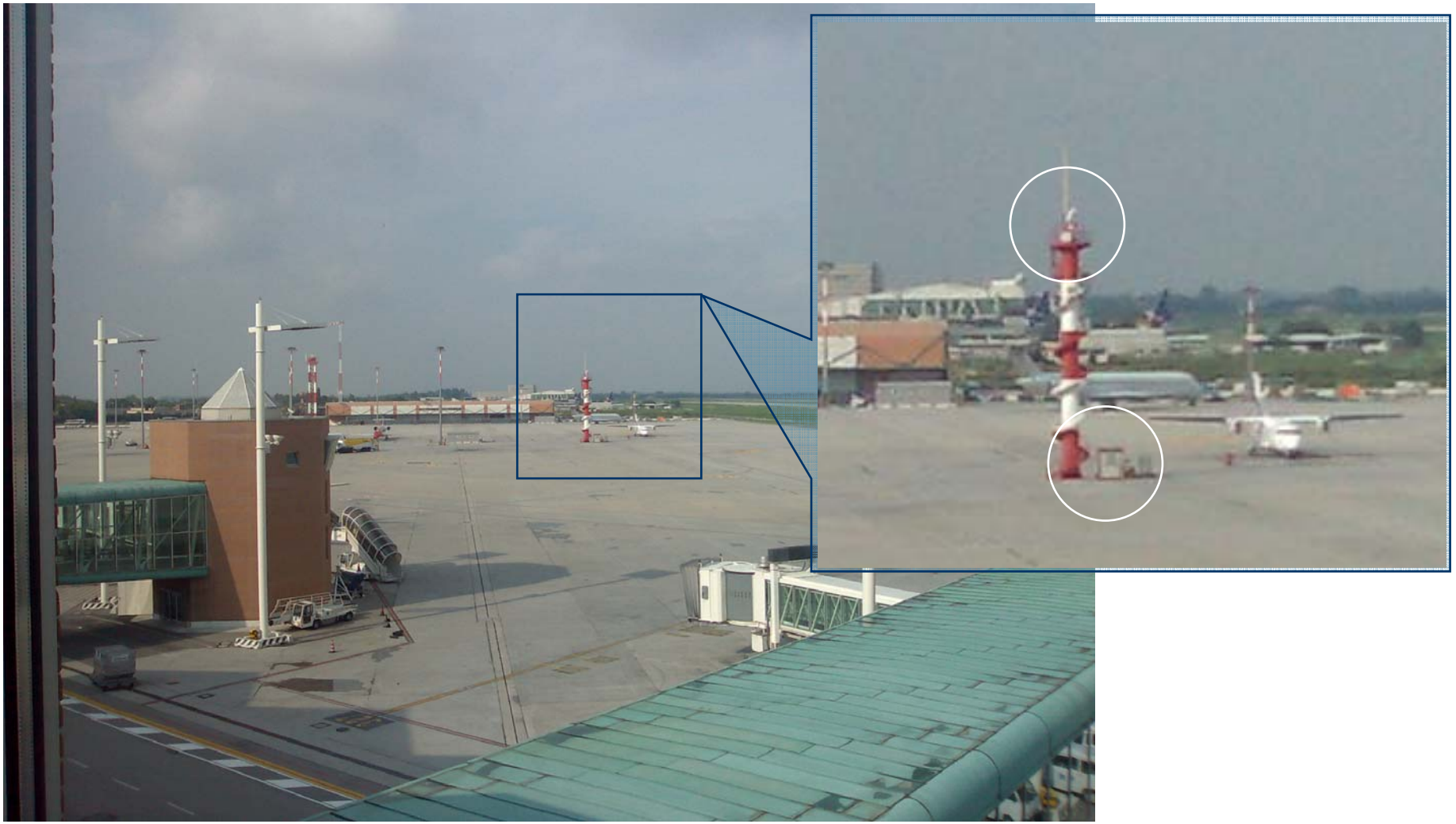
Venice Airport



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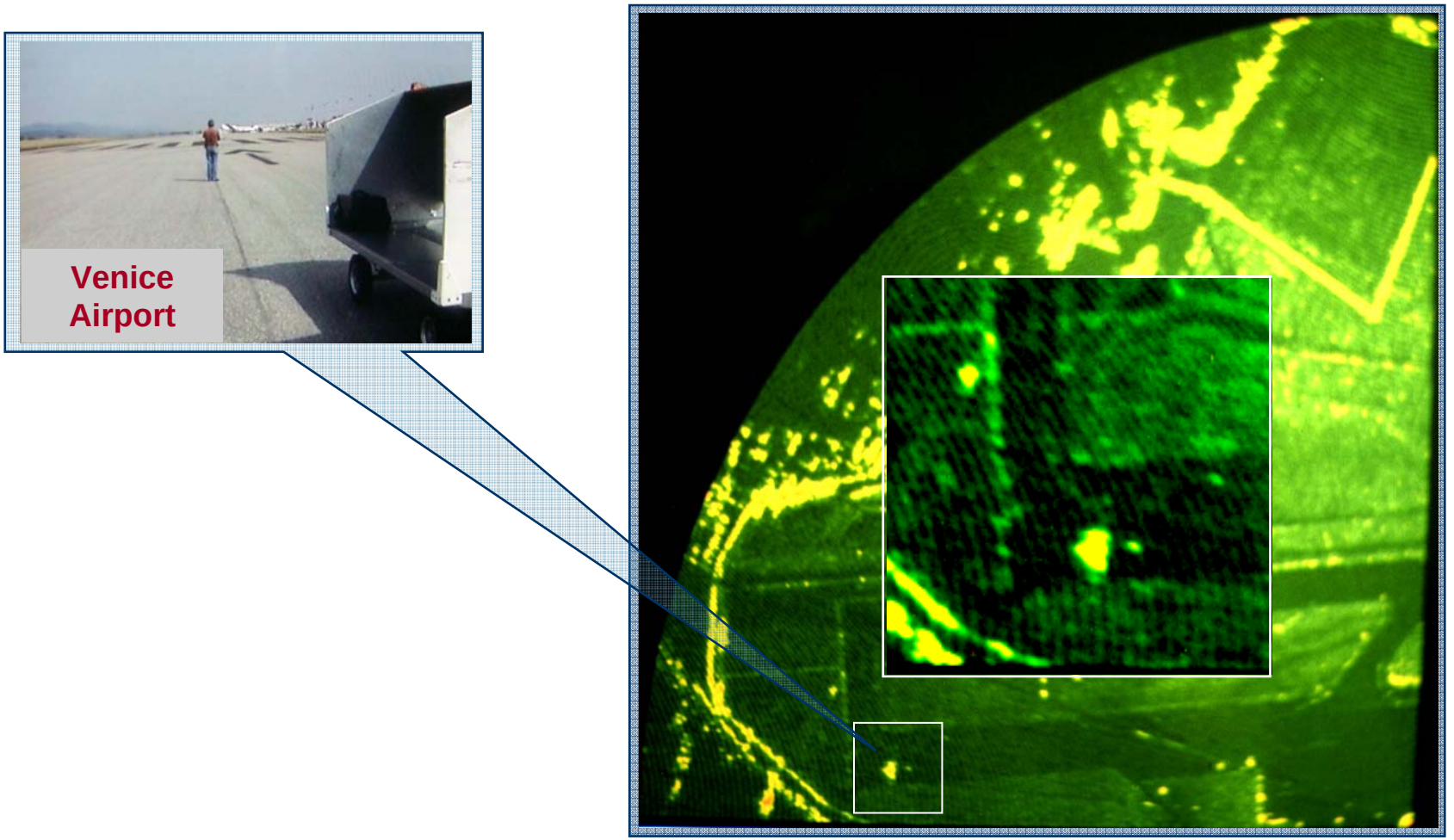
Man Detection



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Frankfurt Airport

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Conclusions

SMART System

- Off-the-shelf equipment
- Based on long lasting Rheinmetall Italia radar experience
  - 50 years in radar designing and manufacturing
  - 20 years in W band sensors
- Non cooperative target detection (FOD, aircraft, vehicles, etc.)
- Stand-alone operation capability
- Easy integration in legacy ATM systems
- Available in multi-sensor network configuration
- Modular design (high maintainability, tailoring to customer requirements)

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