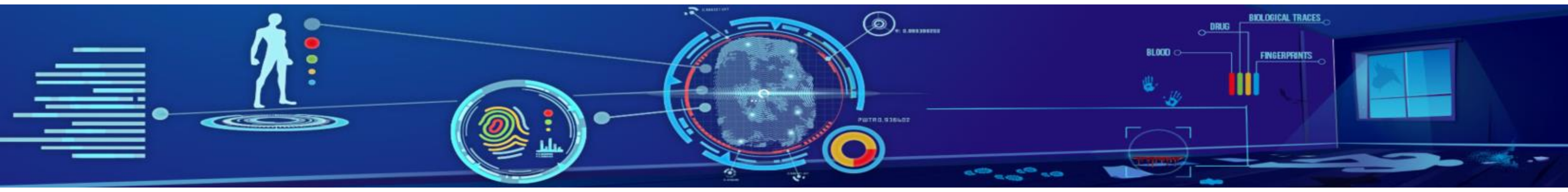
RISEN Newsletter

REAL TIME ON-SITE FORENSIC TRACE QUALIFICATION



Issue No. 4, July 2022

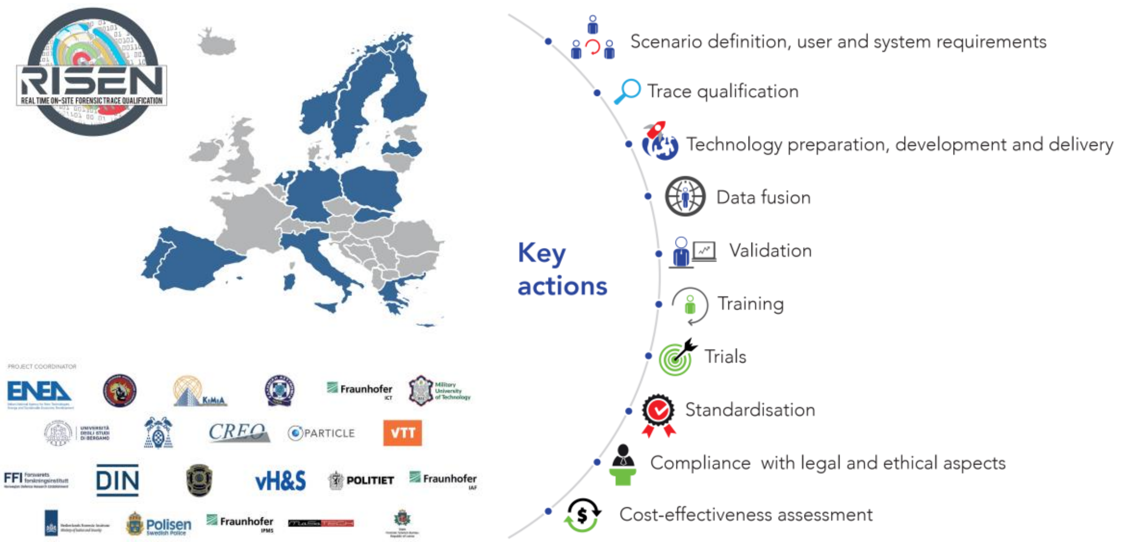
The RISEN Project

The aim of the RISEN project is to develop a set of rapid, contactless sensors and an Augmented Crime Scene Investigation system for the optimization of trace identification, classification and interpretation on site, capable of creating an interactive 3D model of the crime scene with the position and labelling of traces and the relative results of the on-site analysis.

The RISEN Consortium comprises 20 partners from 12 different European Countries that represent Research Institutes, Law Enforcement Agencies, Universities, Small and Medium Enterprises, and Standardisation Institutes. The management structure of the RISEN project is organized to meet the specific needs and scope of the challenge ahead, ensuring the involvement of all partners in the Consortium's decision-making process, whilst retaining the necessary level of autonomy allowing for fast decisions on operational and technical issues. RISEN's management structure consists of two main management boards, the Coordinator Team and the RISEN Steering Board, both supported by the Ethics Advisory Board, the Security Board and the Stakeholders and Practitioner Advisory Board.

The RISEN project is accomplished through the scientific and technological innovations stemming from 11 work packages, from scenario definition and the elicitation of user and system requirements to the preparation, development and delivery of the RISEN technologies.

Importantly, RISEN foresees an extensive training, testing and validation trials program that brings technical partners and LEAs together to improve and mature the RISEN system and enhance the EU's forensic investigation state-of-play. In the process, standardisation and full compliance with existing legal and ethical aspects support the conduct of a thorough cost-effectiveness assessment of the RISEN system, while contributing to reinforce the RISEN's trustworthiness and acceptance by LEAs across Europe.



RISEN Consortium and key actions

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 883116.

RISEN Accomplishments

RISEN is developing sensor solutions for facilitating crime scene investigation on-site. Furthermore, a 3D reconstruction and positioning tool will be used to reconstruct the crime scene and map all the sensor measurements onto this reconstruction. Sensor data fused together with the RISEN 3D Augmented Crime Scene Investigation system allows increased analysis of traces while reducing laboratory activities for further analysis, faster information exchange, and digitalization of documentation and the chain of custody. Illustration of the different modules is shown in Figure 1.

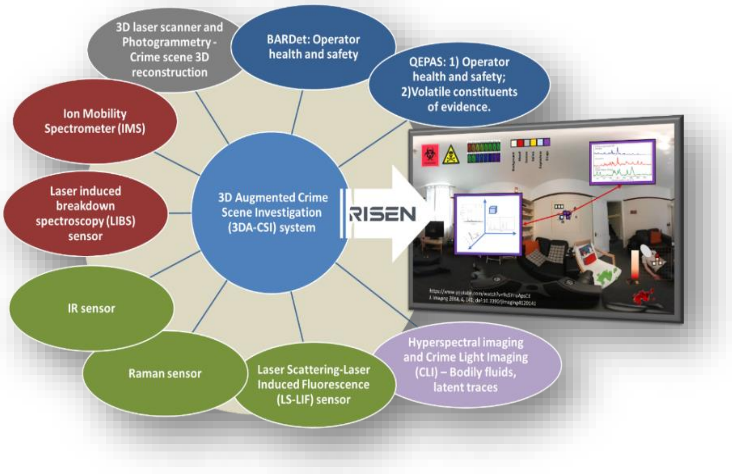


Figure 1. Illustration of the integrated RISEN modules.

The first year of the RISEN project's realization resulted in the finalization of the tasks within WP2 "State of the art of Forensic trace qualification, requirements and gaps". The WP2 tasks focused on review of the state of the art in areas related to crime scene investigation, forensic scenarios and trace evidence associated with them and covered CSI's operational procedures, technical aspects of CSI, training of CSI personnel, and CSI personnel safety. The important input into this work was provided by RISEN LEAs who, together with Stakeholders and Practitioners Board (SPB) members, gave RISEN project expertise and experience from a total of fourteen LEAs from thirteen EU countries. The results of the WP2 were described in five deliverables and will serve as a basis for a scientific publication planned to be published in 2022.

The first RISEN trials took place successfully at the ENEA research centre in Frascati (Rome) the 22nd and 23rd of March 2022. The aim of the event was the acquisition of 3D models from indoor and outdoor mock crime scenes with different technologies. The trials saw the participation of some of the RISEN partners directly involved in the digitalised documentation of a crime scene: SPA, VTT, RaCIS and SFSB (Figure 2).

Figure 2. The 3D team in Frascati for the first trials.

The main objectives of the trials were (Figure 3):

- Get familiar with each other;
- Knowledge sharing – how other LEA's are operating;
- Obtain development data;
- Plan properties of RISEN official trial crime scenes;
- Evaluate effect of "real" conditions (e.g. strong sunlight);
- Guide the development of RISEN 3D tools.

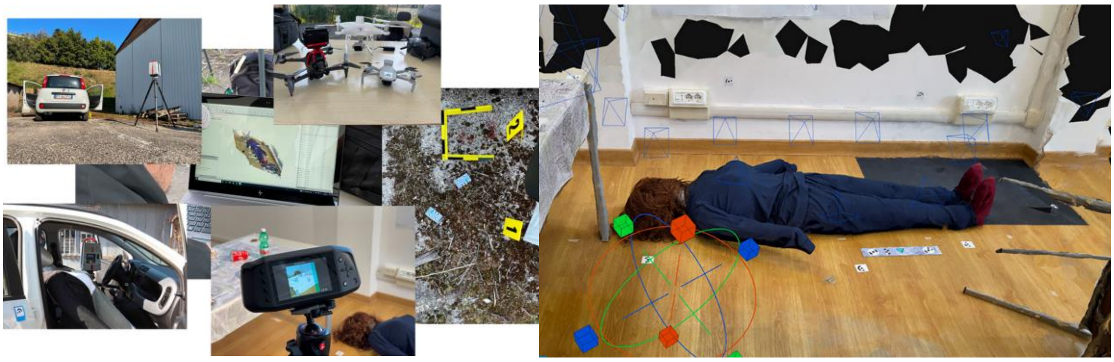


Figure 3. Tools and scenarios from the trials in Frascati.

The RISEN Project meeting No.4 (technical sessions) took place in Lisbon in April. After almost two years since the project start, the RISEN partners had finally the opportunity to meet in person for fruitful discussions. Even if the project meeting No. 4 was officially organised in January as virtual event, the RISEN consortium found it necessary to organise this event to discuss in person more technical aspects of the project. The meeting, including the excellent organisation by the Portuguese Judicial Police, was a complete success.

Figure 4. Participants to the RISEN Project Meeting No. 4 (Lisbon, Portugal).

During the meeting the following main results were presented:

- WP4 presented the procedure in use to update and finalise the User and System Requirements lists to include in the Requirements overview document;
- The sensor providers gave an update on the sensor development status from which it can be said that the work is on average progressing on schedule. Sensors have already started performing laboratory tests in their final configuration or in a manual configuration instead of a scanning one;
- Discussions covered aspects related to the methodology to follow for the final selection of the training materials and SRMs and, for the performance verification and validation of the sensors;

- After the presentation of a summary of the standardization potentials within RISEN, partners were asked to vote to reduce the list of standardization potentials. The standardization potentials with most votes were the folowings:
  - CBRNe SENSOR API: Network Protocols, Data Formats and Interface standardization;
  - Forensic Report Format (Terms, taxonomy, trace information, etc.);
  - Best Practices for validation of non-standard methods.

Introduction to the RISEN Tools (Part 3)

Hyperspectral imaging

Hyperspectral imaging (HSI) is a rather continuous hundreds of thousands narrow-banded version of the Multispectral imaging (MSI) technology. Although the HSI resolution may range from 2 nm to 40 m approximately, depending on the application and how modern the system is, the new benchtop and portable systems capture normally within a <2 nm to 50 nm resolution range.
HSI can be performed using wavelengths in the following ranges: Visible (VIS) and near infrared (VNIR: 400 nm to 1000 nm), extended-VNIR (600 nm to 1700 nm), NIR (900 nm to 1700 nm), short wave IR (SWIR: 900 nm to 2500 nm), medium wavelength IR (MWIR: 3000 nm to 5000 nm), long wavelength IR (LWIR: 8000 nm to 14000 nm), and Raman (5600 nm to 50000 nm).
In most modern cases, the HSI sensor, can be a broad (full) wavelength range application sensor (UV, VNIR, SWIR, MWIR, Raman, etc.) with or without ad-hoc/selected wavelength filters. These filters can be arranged in front of the sensor or they can already be built on top of the sensor. The filters maybe ordered in a kind of continuous sequence simulating the natural spectral wavelength pattern, or in any desired/required order/pattern/mosaic depending on the customer's final use.
The HSI imagers/sensors can record three-dimensional (3D) data consisting of tenths to hundreds (discrete or not) spectral channels/wavelenghts gathered from the samples. Such 3D data arrays are called hypercubes because they consist of two spatial dimensions (the vertical and horizontal position coordinates) and one spectral dimension (the total number of wavelengths/bands/channels the image was taken with). HSI takes a multidimensional spectral picture of a trace while characterizing its spectral profile, which provides selective chemical information about the trace. The additional information given by those bands allows distinguishing among visually similar materials. Alone or combined with other techniques, HSI is highly useful for the detection of a wide variety of forensic traces. This is a great advantage over traditional VIS and ultraviolet-VIS (UV–VIS) imaging, where the substances discrimination deals with limited selectivity and limitations for separating coloured backgrounds.
There is a large variety of HSI systems and manufacturers; however, they all share basically the same principles and sometimes the same sensors and components providers. Since its origins, this technology has been linked to the defense and law enforcement bodies. Therefore, there are plenty of large and small devices developed for various forensic purposes. The devices showing the largest advances are those whose manufacturers can produce (or pay for) their own sensors or sensor complements.
One large drawback regarding crime scenes investigation is the difficulty of transporting and setting in place heavy, bulky, and disturbing equipment. For this reasons, rather portable devices are appearing in the market, which somehow lack the horsepower of their benchtop counterparts, but compensate their downsides with speed, portability, simplicity, user-friendliness, etc.
The HSI application in forensic investigation is, but not limited to: discrimination of chemical evidences of drugs and explosives and in biological evidences as bodily fluids (blood, semen, vaginal fluid, urine), and blood dating. It could also be used in the identification of the stains distribution (mixtures of bodily fluids on different substrates).

Crime Light Imaging (CLI, Multispectral imaging)

In 1919 Dr Wood published a paper in France (Woods, R. W.; "Communications Secretes au Moyen de Rayons Lumineux"; Journal de Physique Theor et Appl (5th series) 9:77-90, 1919) and noted the potential use of Ultra Violet (UV) light for pathologists when examining human beings. He referred to a "black light". Over time this lamp and its medical application to humans has become termed as the "Wood's Lamp". Today Wood's Lamp, emitting UV Radiation, is usually employed in the detection of body fluid by forensic practitioners.
It is one of the most relevant historical example of the introduction and use of forensic light to detect traces and evidences on the crime scene. Forensic light sources based on different technologies (e.g. laser, led, lamps) may optimize visualization and localization of these impressions by exploiting also their interaction with light. For instance, fluorescence can be obtained by body fluid suitably illuminated; on the other hand, blood does not fluoresce, but views as black in NIR range and may offer contrast between the impression and the substrate of the item it is on. The Crime Light Imaging (CLI) system designed for the RISEN project will develop this idea of a multispectral approach to the crime scene: many light sources (light emitting diodes) at different wavelengths illuminating areas of possible interest associated with an appropriate detection to allow the visualization and localization of useful traces. The final results of this tool will be images characterized by high resolution and quality identifying possible areas of interest to be explored with further techniques (e.g. Raman, LS-LIF, LIBS, IR).
The commercial systems employed in the forensic laboratories are not stand-off devices remotely controlled; hence the CLI represents a significant improvement in many realistic scenarios. It will be located on the scene and remotely driven to realize many of the activities that nowadays are implemented by an operator.
It can be employed in many fields (e.g. fingerprint, body fluids, questioned documents, inks, fibers, counterfeit money) and it was thought with a modular approach in order to be adapted for further future developments and applications.

The RISEN Sensor API

The RISEN System gathers data from different networked sensors - including the sensors' on-site analytical analysis, trace classification and identification and scene location - optimising on-site trace detection, visualisation, identification and interpretation in forensic investigation. At the centre of this action is one of the many innovations of the RISEN Project: the RISEN Sensor Application Programming Interface (API).
Supported by the RISEN sensor manufacturing partners, the open RISEN Sensor API supports the modularity of the overall RISEN System, connecting the different sensors and analytical tools in support of a specific investigation scenario and providing the collected data, via a common network-enabled sensor interface bus, to the Digital Evidence component of the RISEN 3D Augmented Crime Scene Investigation (3DA-CSI) module for a comprehensive visualisation and analysis (Figure 5).

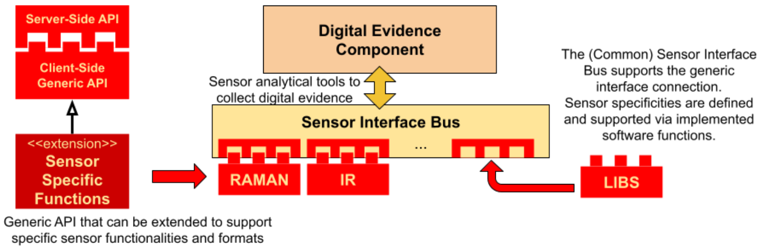


Figure 5. RISEN Sensor API Concept.

A generic API component defines the general functions to be supported by any RISEN sensor, such as registration, connection and measurement information, whereas sensor specific functions are implemented by extending the generic API, while also ensuring compatibility with the RISEN System. Because of the innovative RISEN Sensor API, different RISEN sensors (e.g., RAMAN, GC-QEPAS, IMS, IR, etc.) are able to

seamlessly connect (i.e., *plug'n'play*) with the RISEN System in a harmonised way, exchanging data and information, which is then aggregated to build the augmented information layer upon a realistic 3D visualisation of the crime scene, supporting and optimising the work performed by forensic investigators.
Moreover, forensic investigators benefit from the RISEN Sensor API to easily understand which sensors are deployed and employed in a given crime scene, including their position, power settings and calibration status. In addition, investigators have real-time access to results of the combined 360º sensing analysis of the crime scene, identifying each trace, their comprising substances and their concentration levels.
The RISEN Sensor API allows sending the following type of information:

- Sensor measurements, consisting of trace classification information (i.e., list of detected substances as well as their probability) as well as timeseries, spectroscopy and map-density data.
- Sensor operational data, consisting of operational status, calibration status and battery status.
- Ancillary data, like location and annotations, are also supported

Figure 6 shows examples of sensor data that has been transmitted using the RISEN Sensor API.

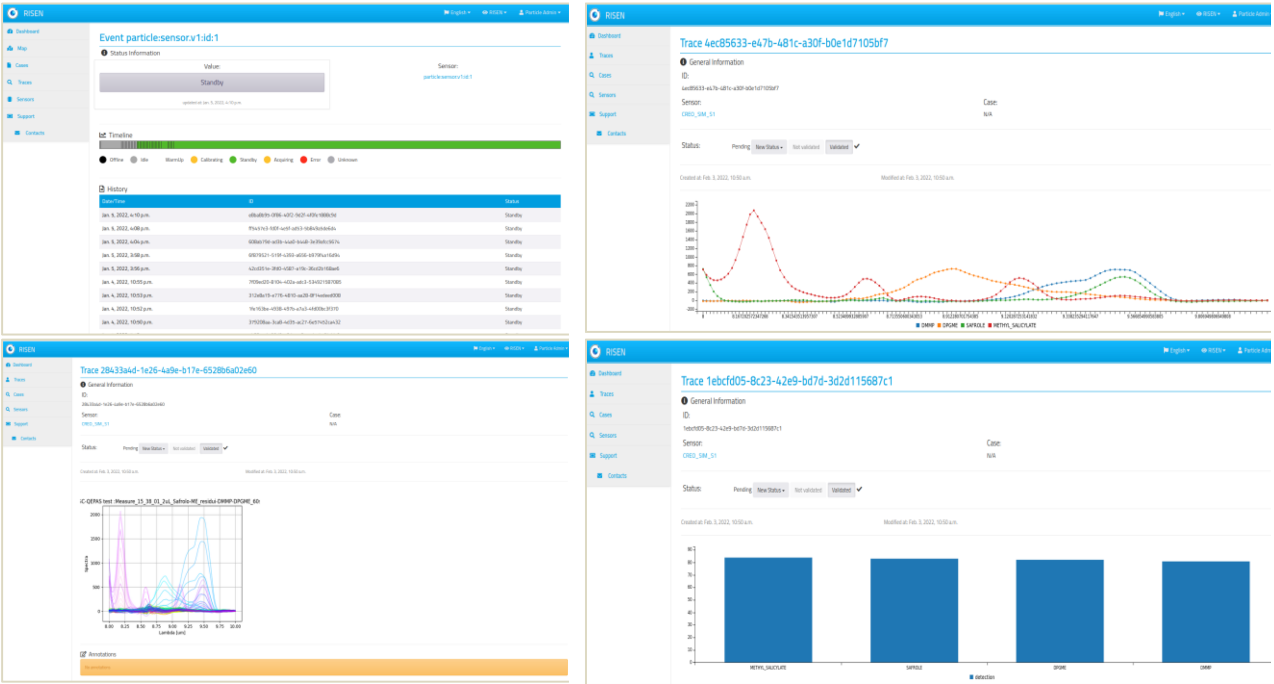


Figure 6. Collecting Sensing Results Using the RISEN Sensor API. Top-left: sensor operational status, including historical information. Top-right: a sensor measurements' results across different wavelengths. Bottom-left: picture generated as a result of a sensor measurement. Bottom-right: a sensor provides a list of trace classifications (probability of) after a measurement is concluded.

Following a server-client architecture, the RISEN Sensor API supports Internet-based technologies for maximum interoperability and compatibility, including the use of the popular TCP/IP (Transmission Control Protocol / Internet Protocol) for data exchange, connected via wired or wireless technologies. The API follows the REpresentational State Transfer (REST) architecture. The client-side component can send requests to the server-side component using the Hypertext Transfer Protocol (Secure) (HTTP(S)) protocol, including payload data typically formatted as JavaScript Object Notation (JSON), eXtensible Markup Language (XML) or plain text. The API is specified in accordance to the OpenAPI Specification (https://www.openapis.org), a standard and language-agnostic interface that presents the service's capabilities in a user-friendly way.
Furthermore, a publish-subscribe paradigm based on the standardised lightweight Message Queuing Telemetry Transport (MQTT) complements the REST architecture, bringing a fully proactive approach as the RISEN System's message broker. This ISO/IEC PRF 20922 protocol is a relevant novel add-on to the RISEN Sensor API, empowering on-event processing.

The incorporation of widely recognised Internet-based standards and technologies amplifies the flexibility, modularity and interoperability offer of the RISEN Sensor API, translated into a variety of deployment options for the RISEN System in operational environments.
The RISEN Sensor API is described in public deliverable D4.3 (RISEN Sensor API Definition Document) that has been submitted in August 2021.

RISEN activities

EAFS

EAFS 2022 is the largest Forensic Science Event in Europe in 2022. The conference was organised by the National Forensic Centre (NFC), a department within the Swedish Police Authority, and held in Stockholm, Sweden, on May 30th – June 3rd June 2022. The RISEN project was presented at the conference both in an oral presentation "*A novel rapid approach to crime scene investigation proposed in the framework of the H2020 RISEN project*" given by Giuliano Iacobellis (RaCIS), and at a booth on the European Day (Figure 7). The European Day focused on promoting the work supported by EU funding over the last decade and at present, disseminating results and discussing future challenges for the forensic community and law enforcement. In particular, the video presentation of the project – also intended for future public dissemination– increased the awareness of the RISEN aim, objective and ongoing R&D. The ability to identify bodily fluids recovered at crime scenes is a crucial aspect of any forensic Investigation. This is one important aspect of the RISEN R&D needed to develop the RISEN system. Anna Barbaro et al (Universidad de Alcalá) gave at the conference more insight presenting two posters; one on "*Human and Animal oral fluid stains differentiation by infrared spectroscopy (ATR FTIR)*", and the other on "*Age estimation of oral fluid stains by infrared spectroscopy (ATR FTIR*)".

Figure 7. RISEN activities presented by Giuliano Iacobellis from RaCIS, the RISEN booth on the European day and Anna Barbaro from UAH-IUICP with one of the posters presented.

FACTS AND FIGURES

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The RISEN Project is a collaboration between: