REMOTE DETECTION OF EXPLOSIVE TRACES USING RAMAN AND MIR LASER SPECTROSCOPY

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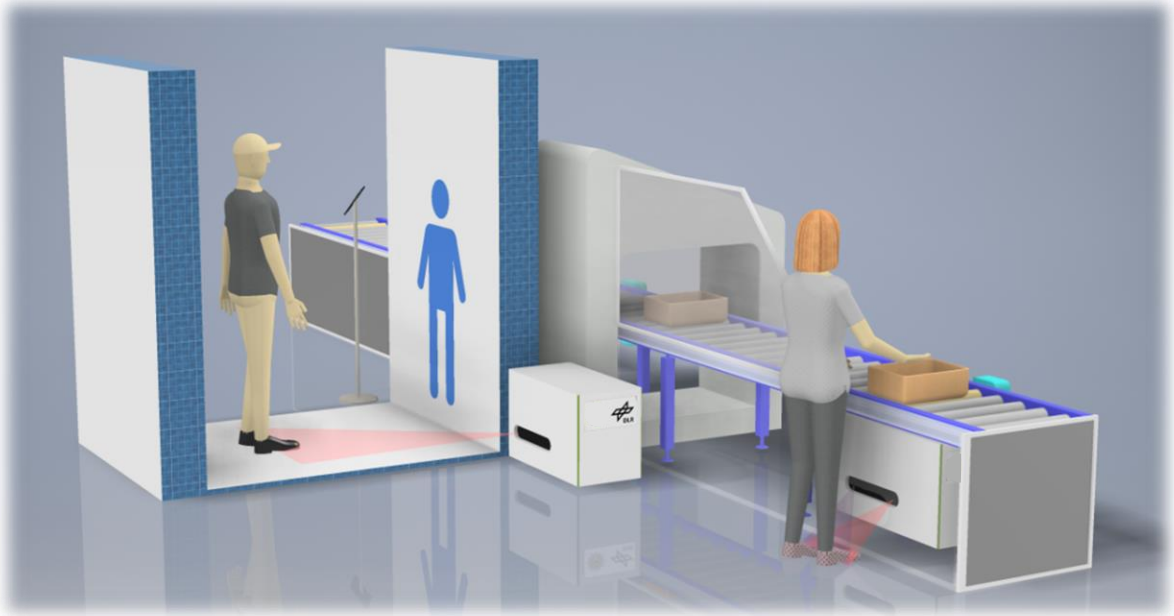
DLR

Motivation

Enhancing security at public buildings and critical infrastructures

Goals

- Fast and reliable technologies for security check points
- Comprehensive detection of hazardous substances, e.g. explosives, on surfaces

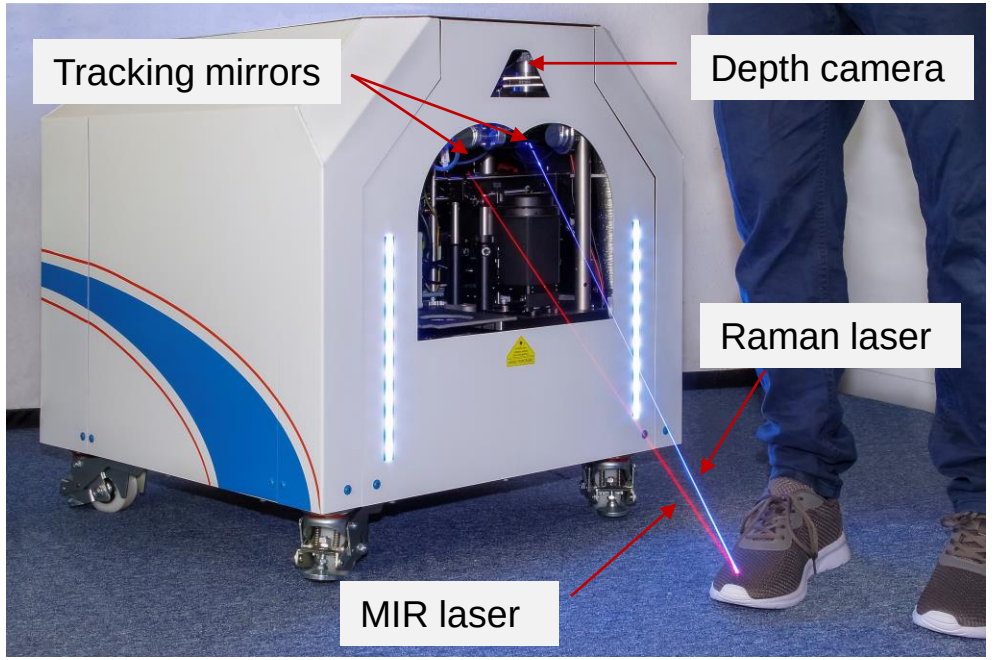


Ideas

- Standoff laser spectroscopy to scan peoples shoes for explosive residues
- Fully automated system to minimize time and personnel resources

Current System

- Depth camera for tracking of shoes
- Tracking mirrors to align detection system
- Simultaneous Raman & MIR spectroscopy
- “Real-time” data analysis



Raman
- excitation at **266 nm**
- detection via gated iCCD camera

MIR
- tunable quantum cascade laser **7 – 11 µm**
- MCT detectors

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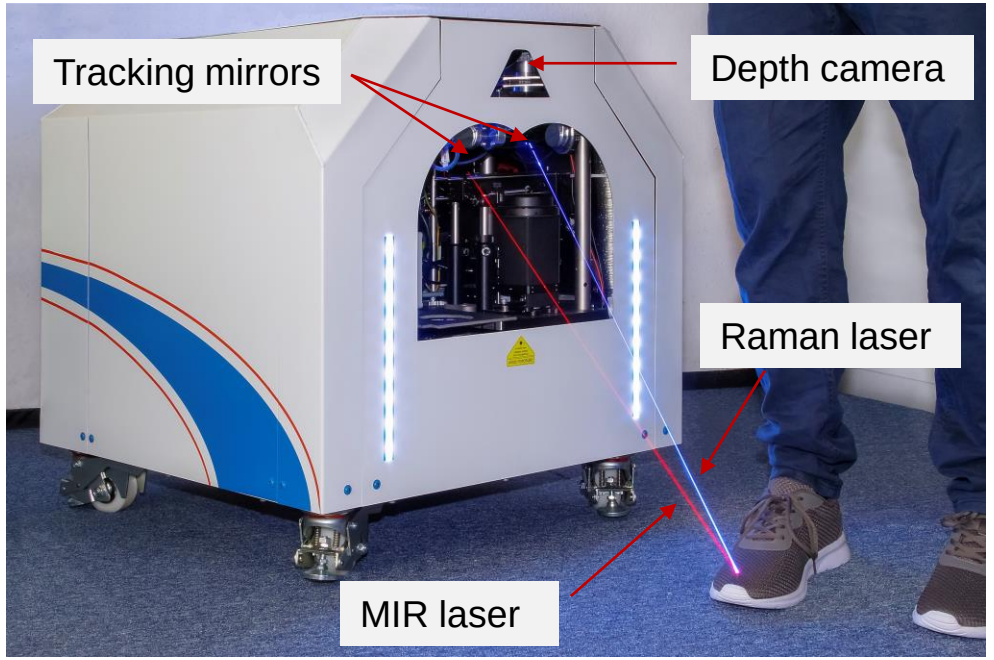
- Detection time of < 5 s
- Compensation of movement via tracking
- Detection from ~ 1 m distance



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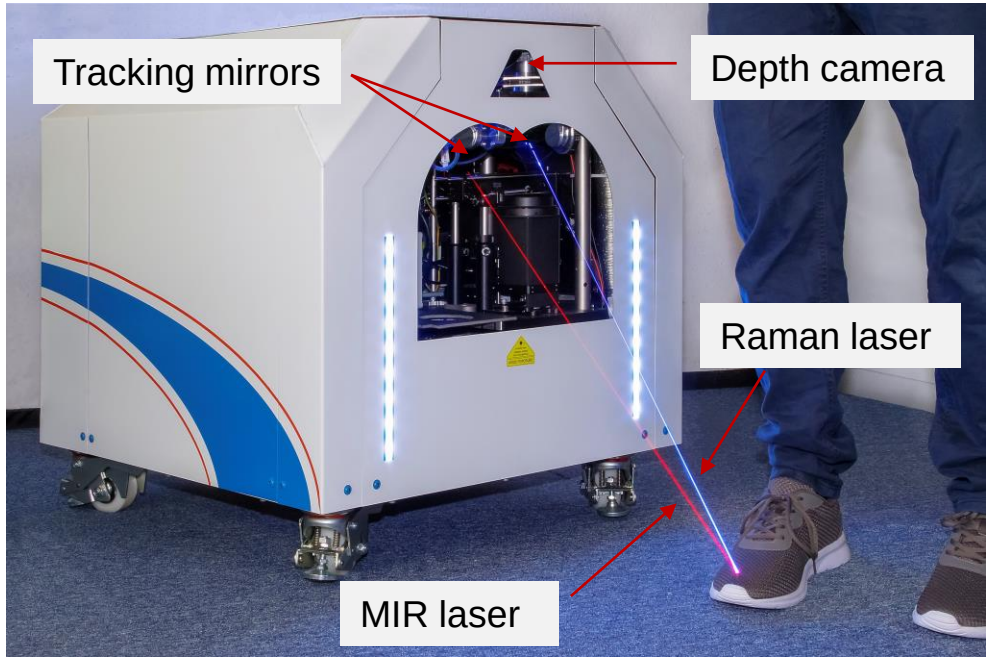
- Development ongoing

➡ **Evaluation of system**



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System sensitivity

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  - Pentaerythritol tetranitrate (PETN)
  - Trinitrotoluene (TNT)
  - Hexogen (RDX)
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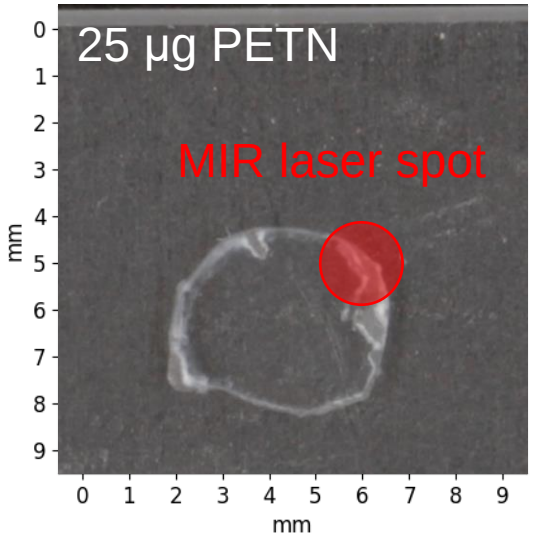
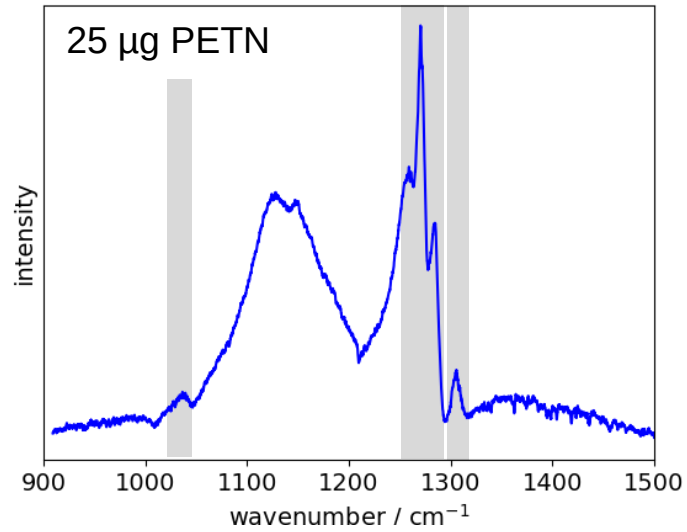
  - Potassium chlorate (PC)
- 100 µg – 100 ng on quartz substrates



MIR data



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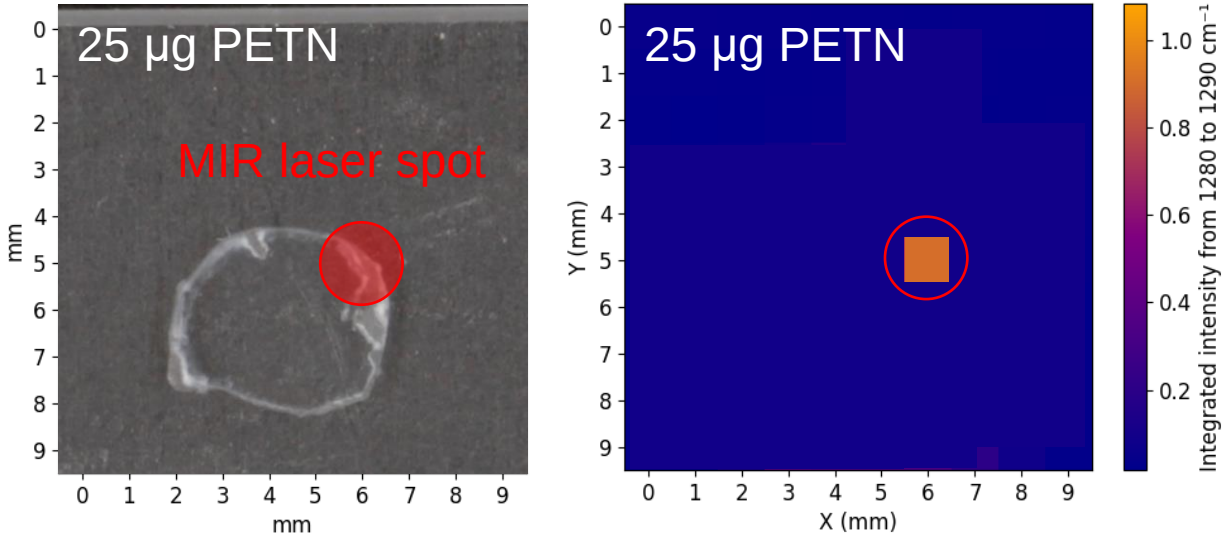

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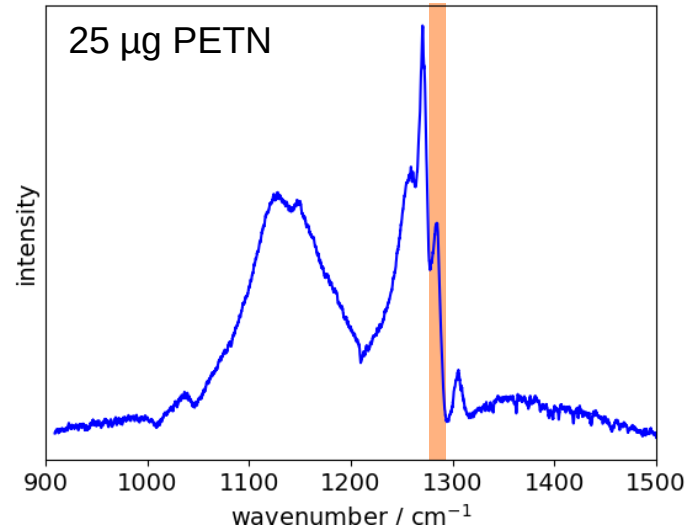

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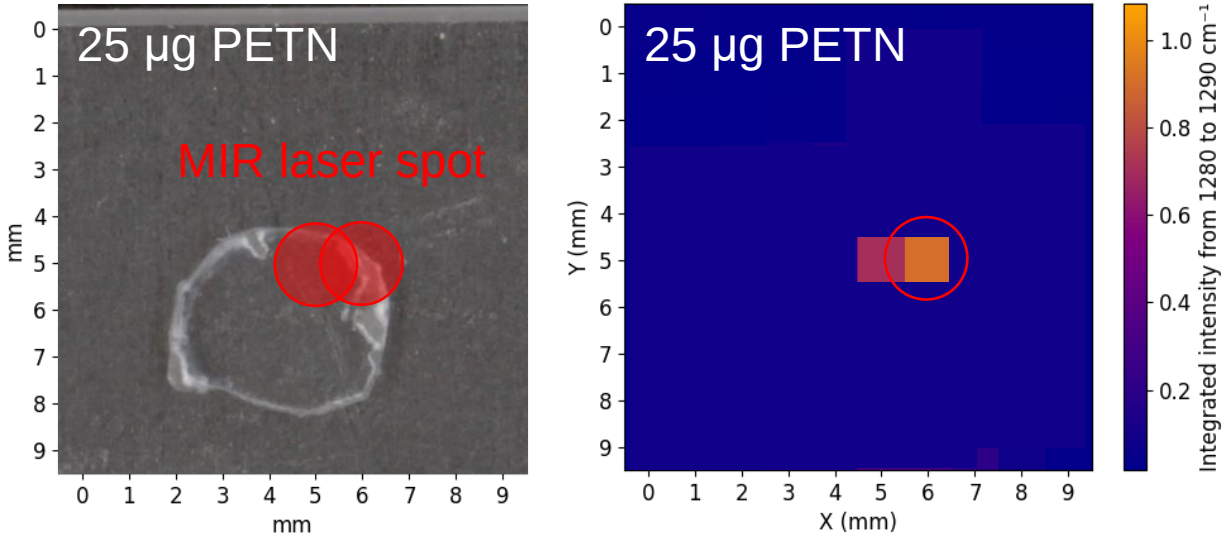

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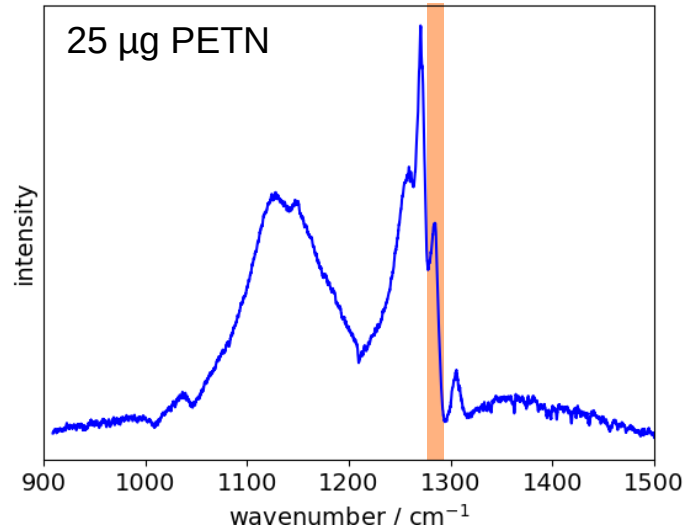

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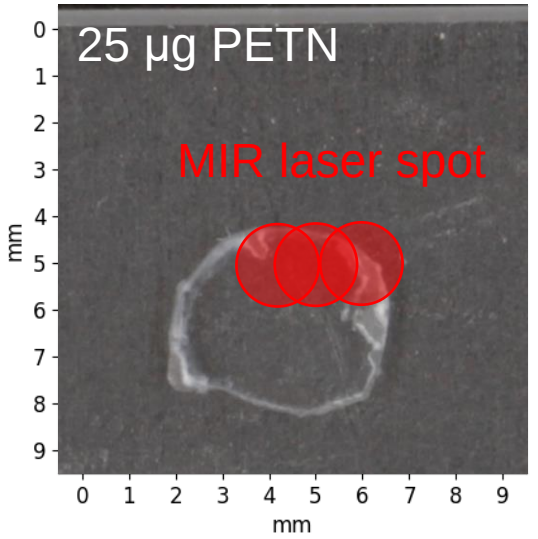

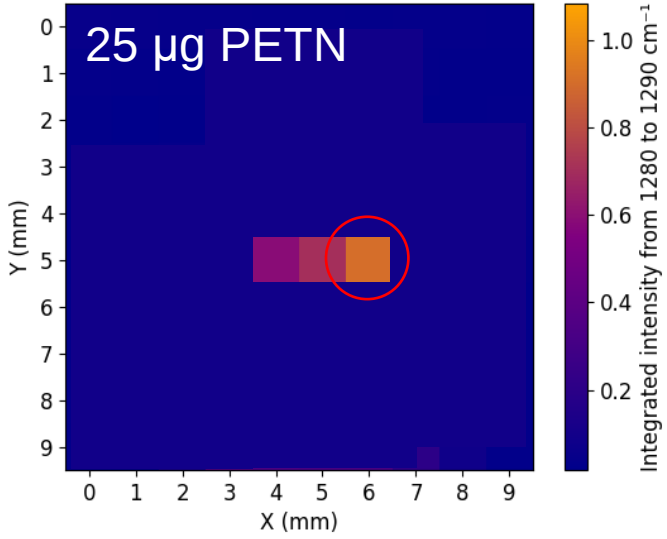

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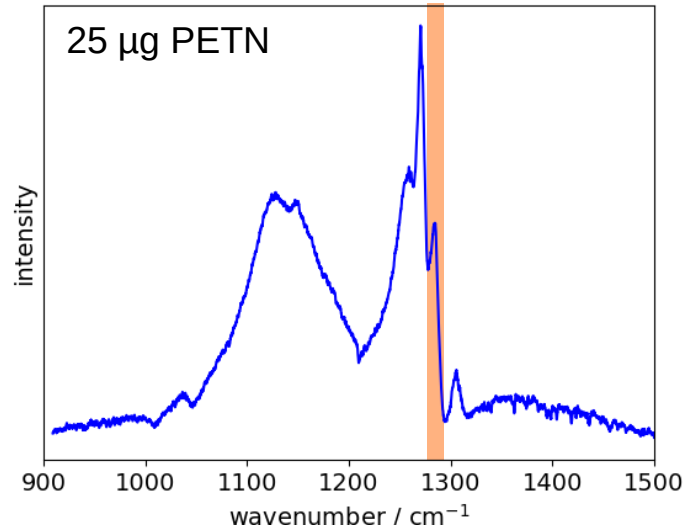

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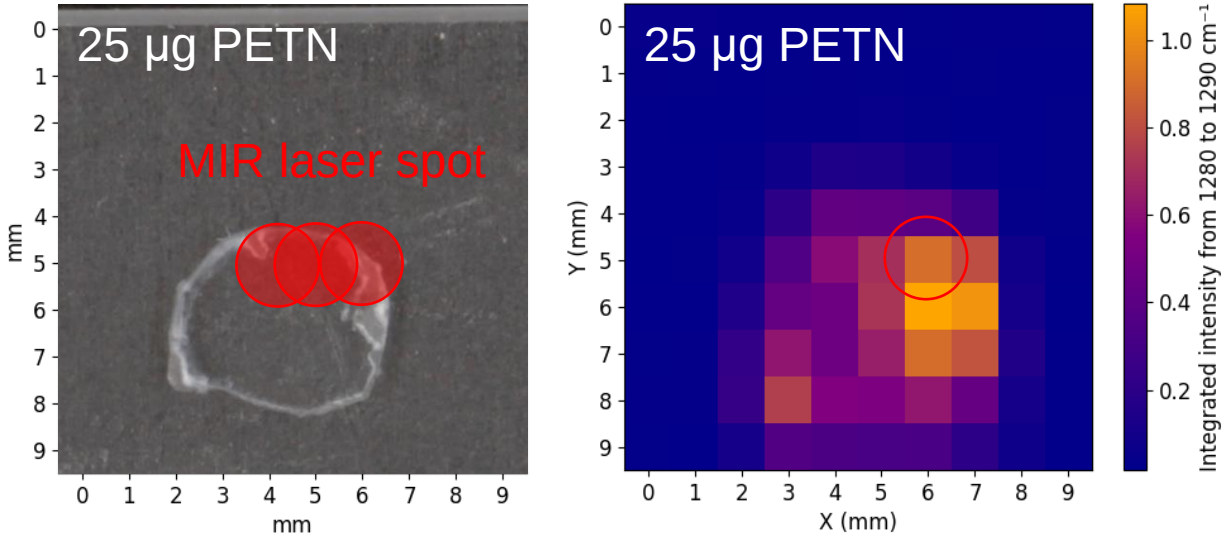

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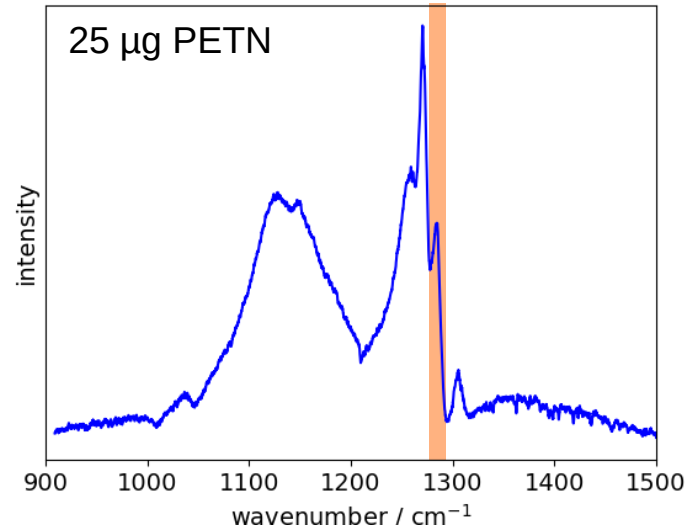

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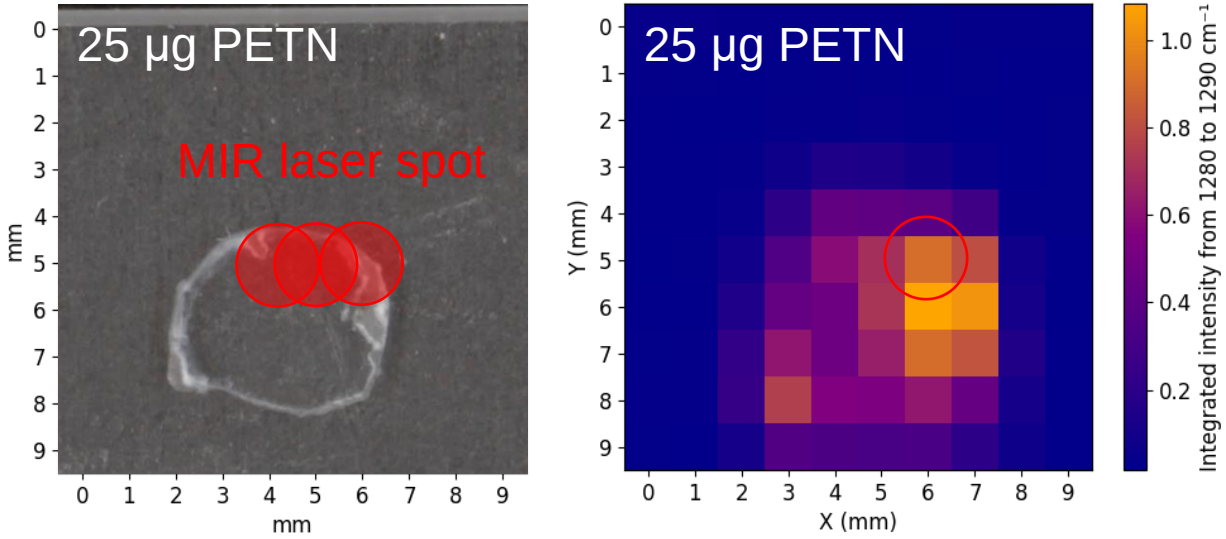
- Estimation of **minimum detected amount** for all explosives
  - MIR: **10 ng**
  - Raman: **600 ng**

MIR data



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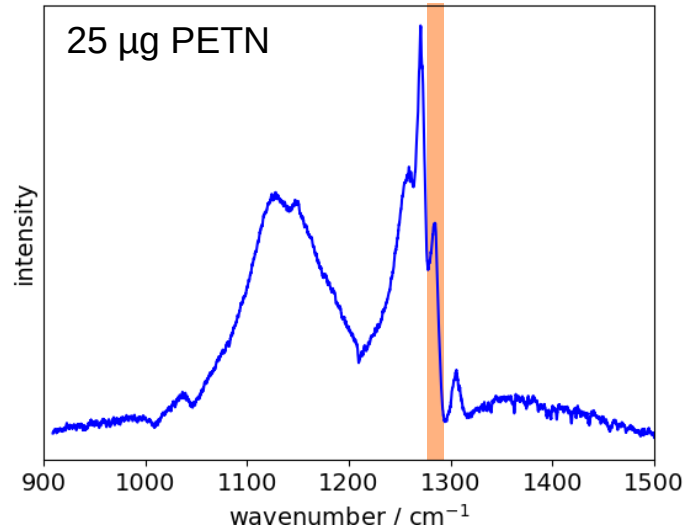

Detection on textile surfaces

- Different fabrics:
  - cotton
  - synthetic fibers
  - leather
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- Explosives transferred onto fabric using PTFE wipe with defined amount of explosive
- Samples are not standardized

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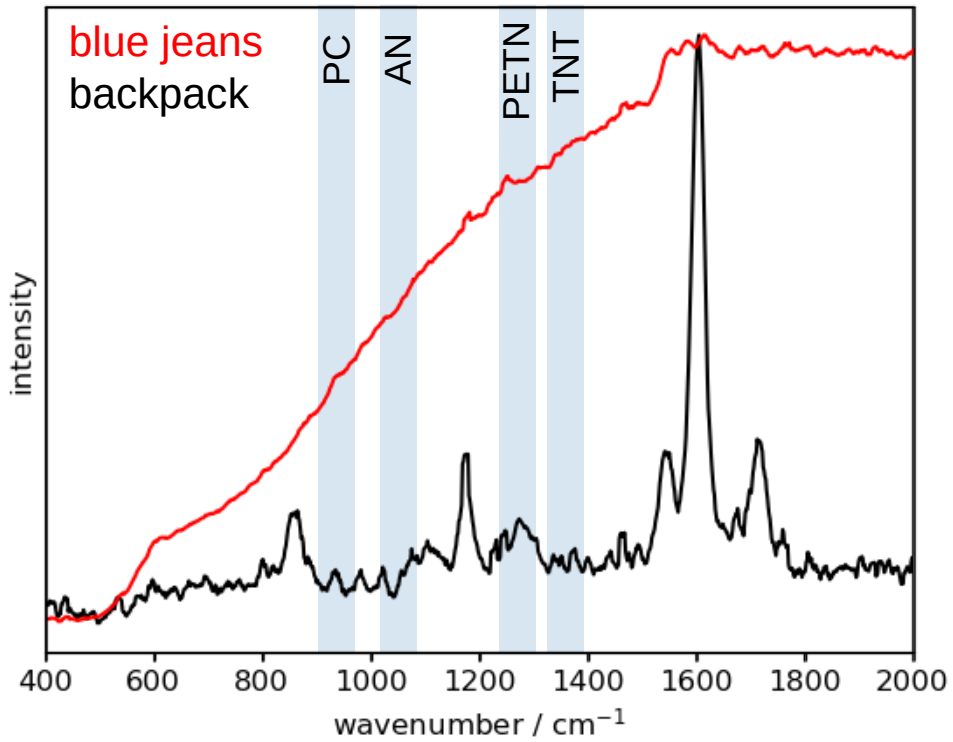
Raman data



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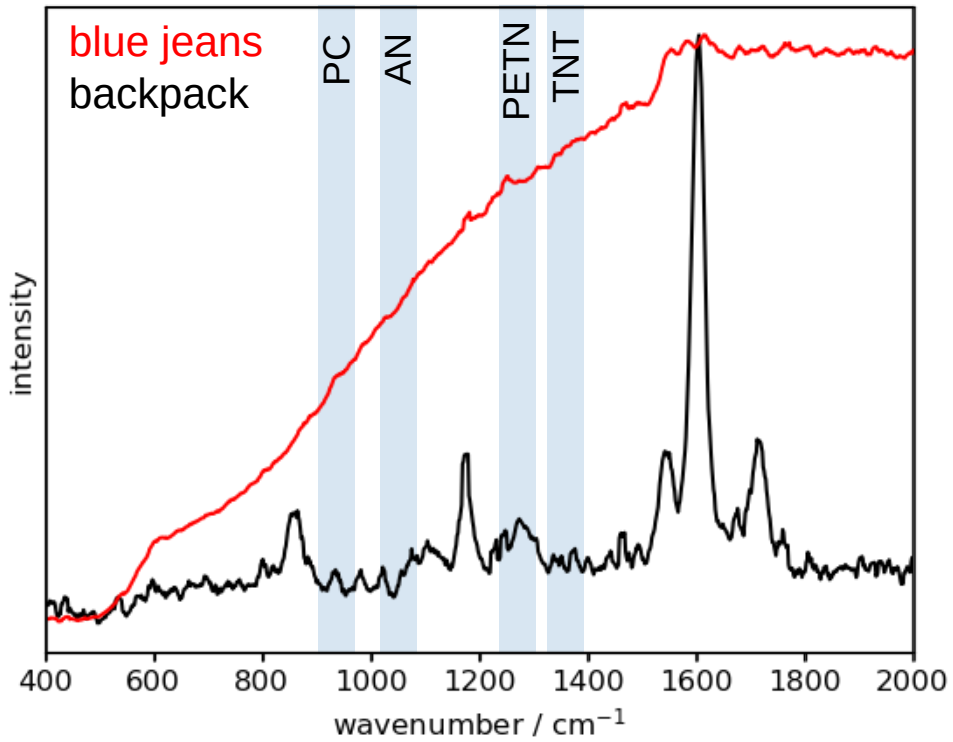
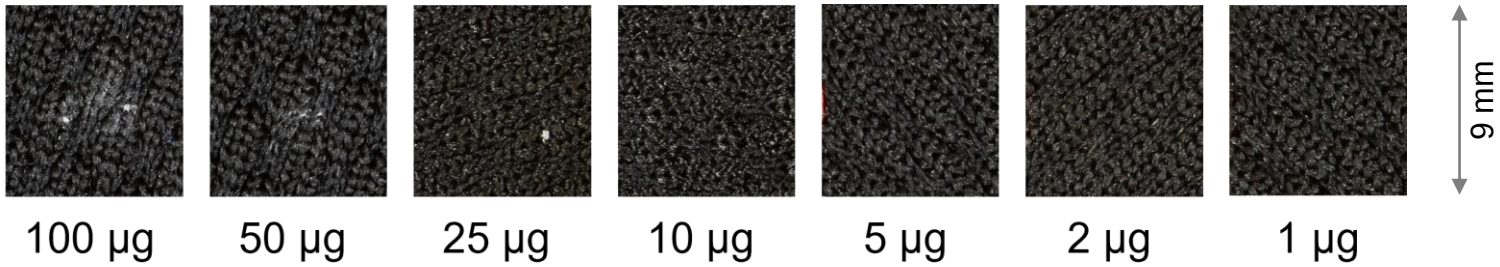
- Fabrics provide MIR and Raman signals and fluorescence
- Sensitivities lower than on quartz

Raman data



Detection on textile surfaces

AN on sports shoe



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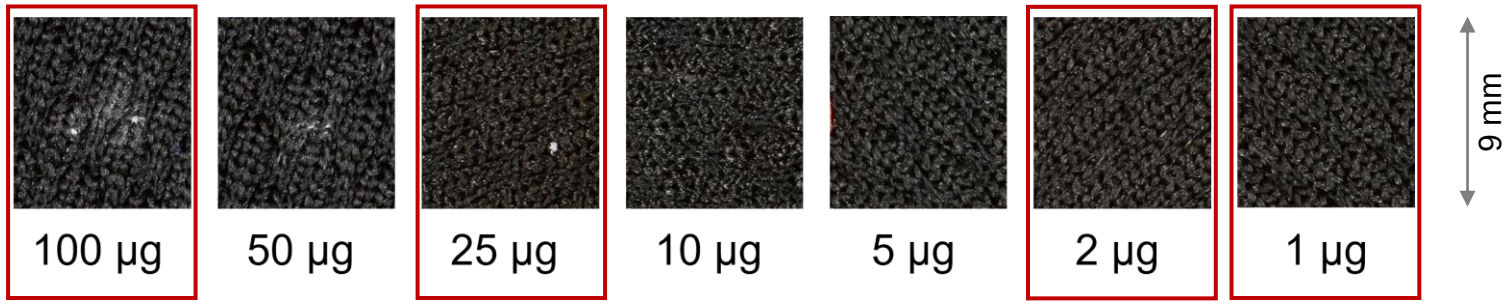

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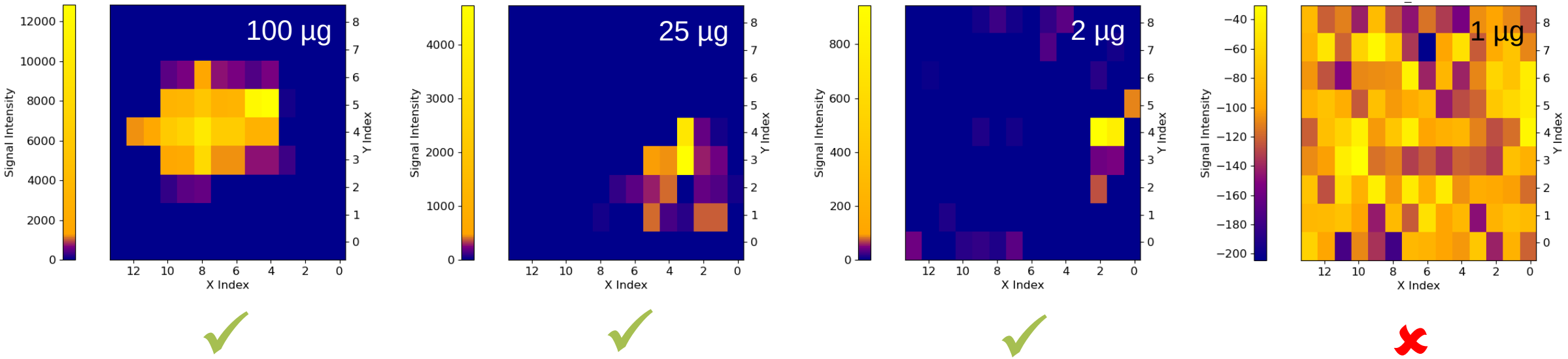


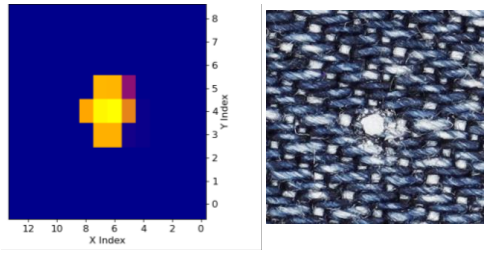
Detection on textile surfaces

General results

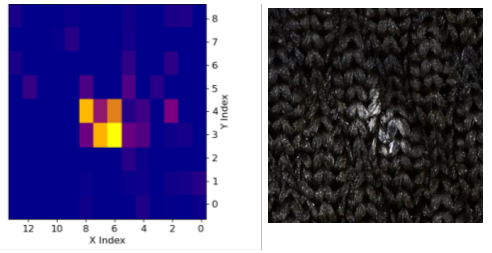
- Sensitivity depends on fabric and explosive
- Results on similar scale for all fabrics and explosives
- Lowest detected amounts on fabrics

MIR	Raman
25 – 50 µg	2 – 50 µg

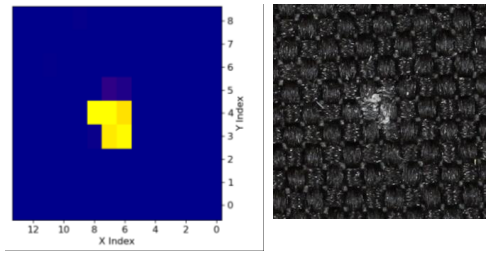
AN on blue jeans



TNT on sports shoe



PC on backpack



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- Similar sensitivities for MIR and Raman, but:
  - MIR better for RDX detection
  - Raman better for AN and PC detection
- Combination of both methods needed

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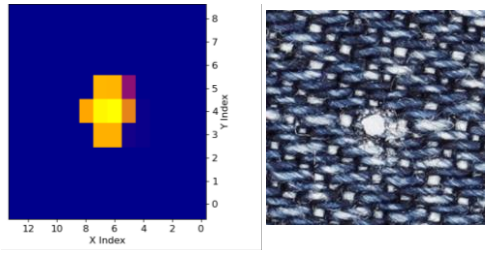

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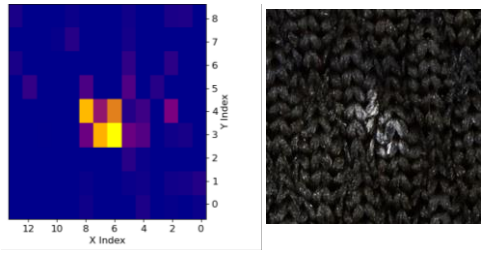

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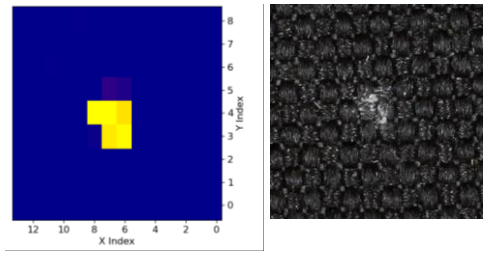

Conclusion and Outlook

Standoff detection of 5 different explosives at ~ 1 m distance using MIR and Raman spectroscopy

- “Sensitivity” determined on quartz and textiles
- Strong influence of background signals
- Both methods complement each other

Sample type	MIR	Raman
Quartz	~10 ng	~600 ng
Textiles	25 – 50 µg	2 – 25 µg

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- Development of detection algorithm for „real-time“ analysis is ongoing
- Potential applications of technology in civil and military security:
  - Security checks
  - Baggage checks
  - Surface contamination detection

Thank you for your attention!