DETECTION OF EXPLOSIVES USING LASER SPECTROSCOPY:

DATA ANALYSIS OF WEAK RAMAN SIGNALS

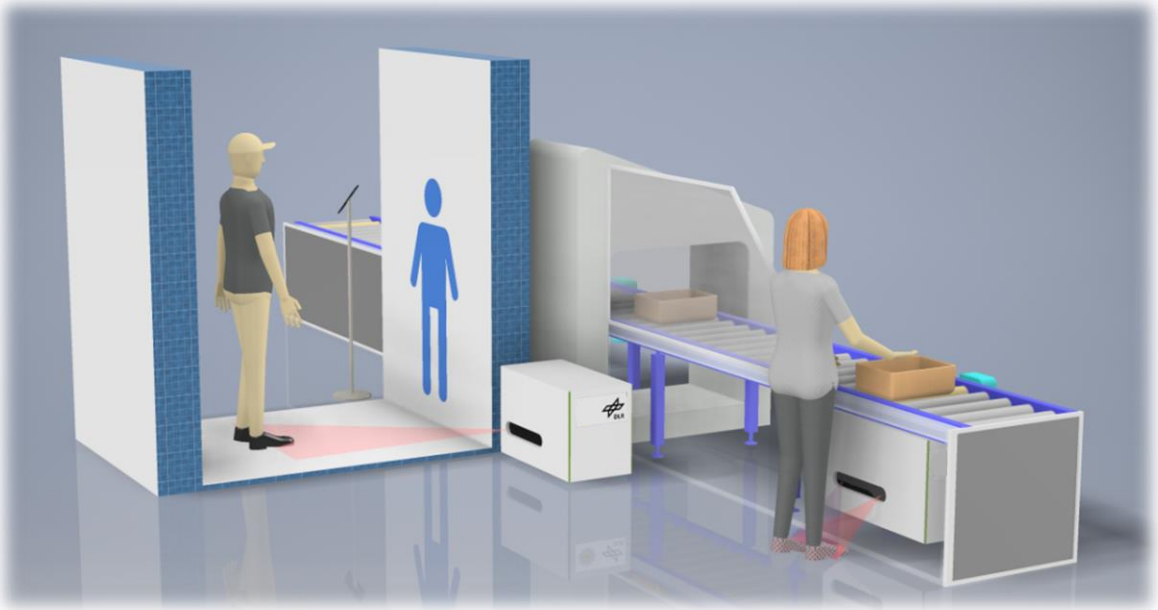
Anja Köhntopp, Lisa B. Dreier, Arne Walter, Christoph Kölbl, Frank Duschek

German Aerospace Center, Institute of Technical Physics

Motivation

Scenario

- Checking single persons for explosives at security check points
- Contactless examination of shoes
- No extra time required for testing



System

- Stand-off detection of explosives using Raman spectroscopy
- Fast data analysis
- Reliable results

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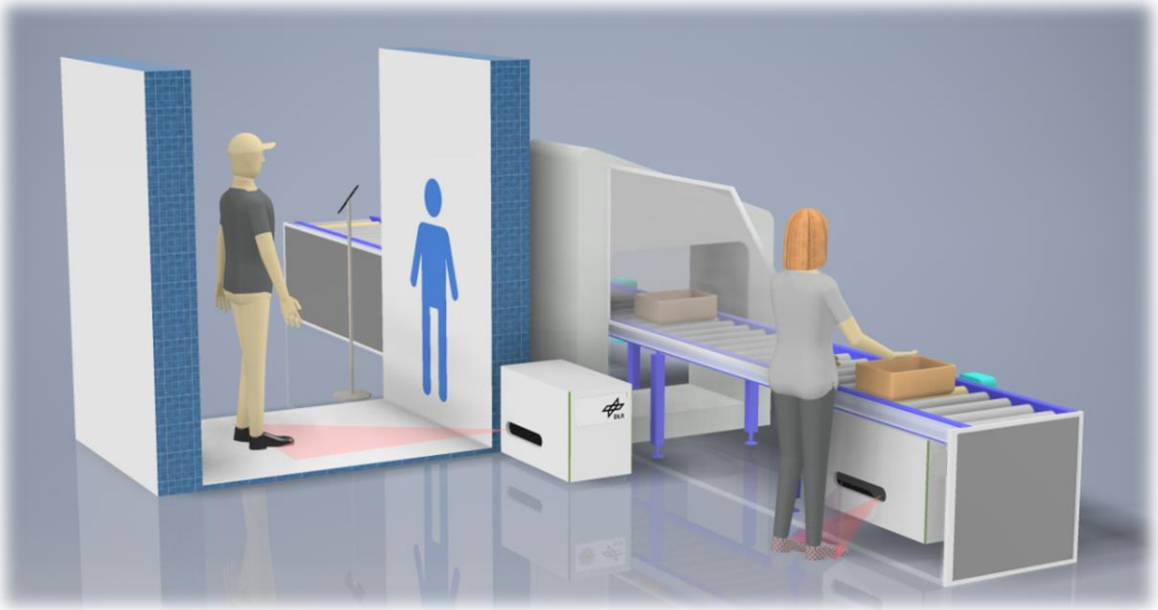

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- Stand-off detection of explosives using Raman spectroscopy
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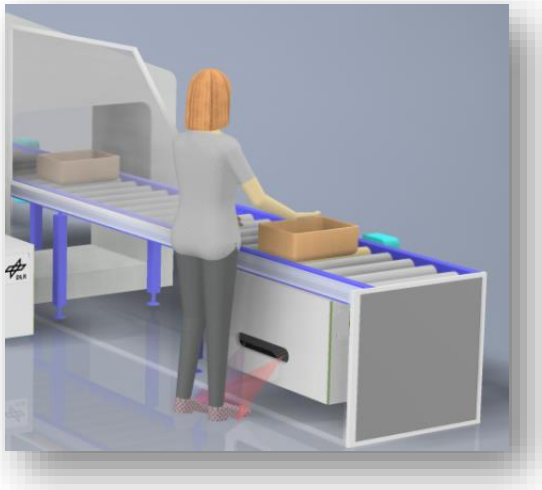

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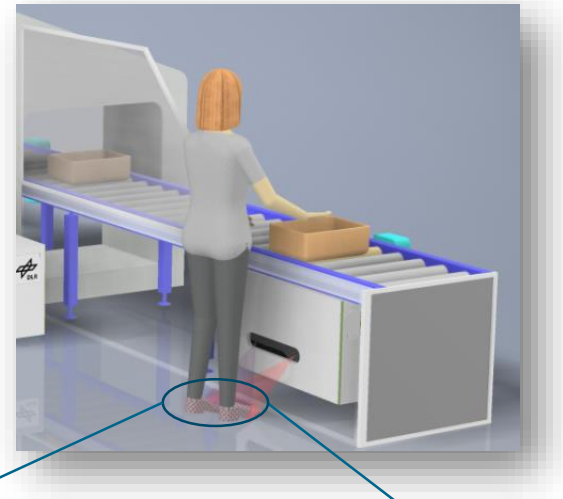
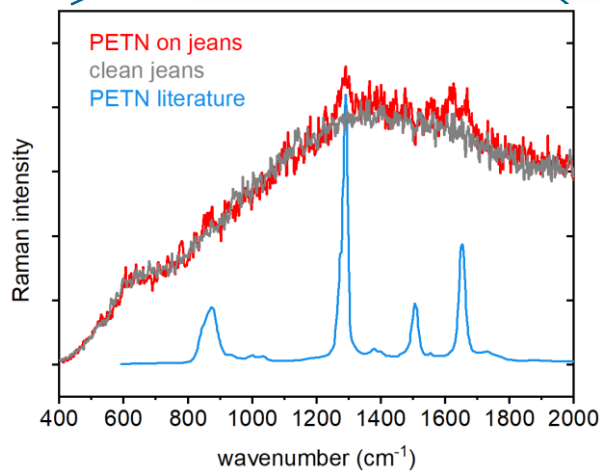
Challenges

- Small Raman cross sections
- Short acquisition times
- Wide variety of backgrounds
- Inhomogeneous surface coverage

Low signal-to-noise ratios
Interfering signals
Limited areal coverage





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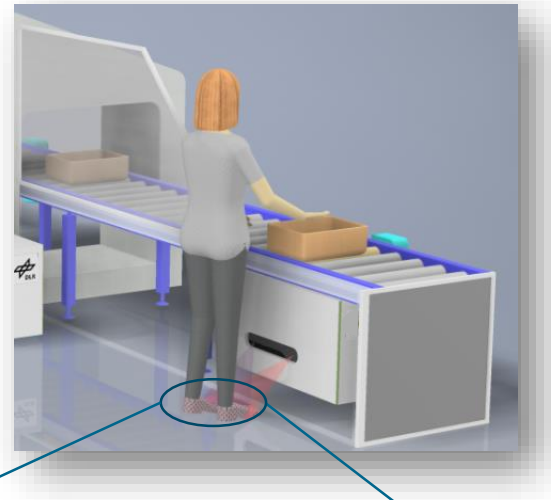
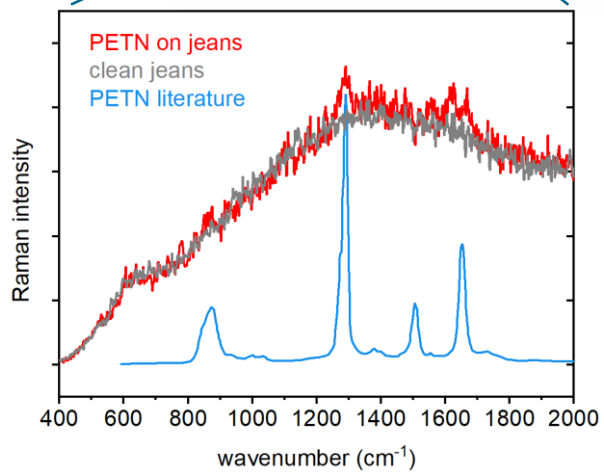




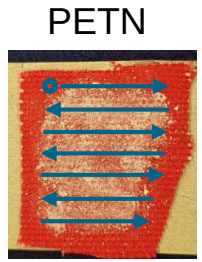
Goals

- Process and analyze spectra quickly
- Reliably identify explosive traces using algorithms
- Is there an easy way to improve data?

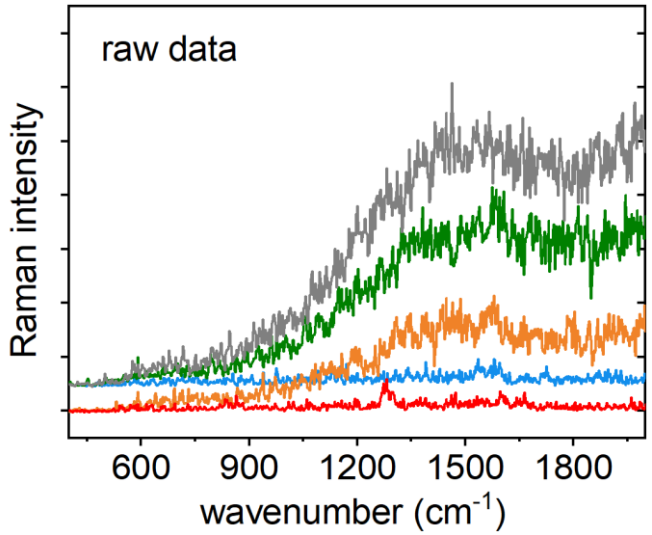
Experimental & Data processing

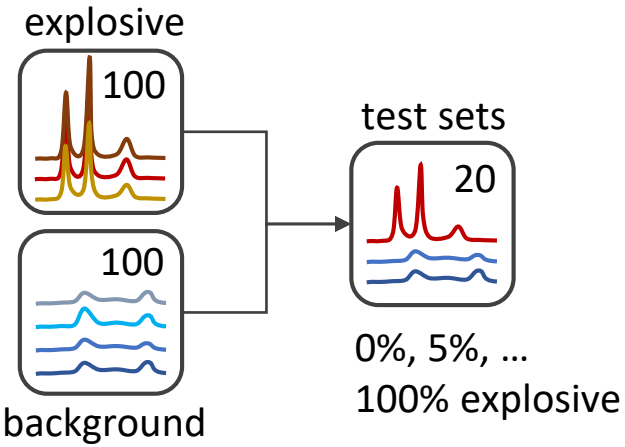
Test data sets

- 100 spots per sample
- Data sets of 20 spectra each
- Random selection from both groups
- Compositions from 0% to 100% PETN spectra



clean fabric





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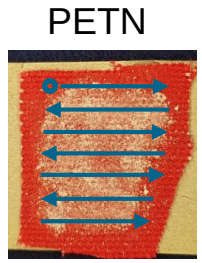

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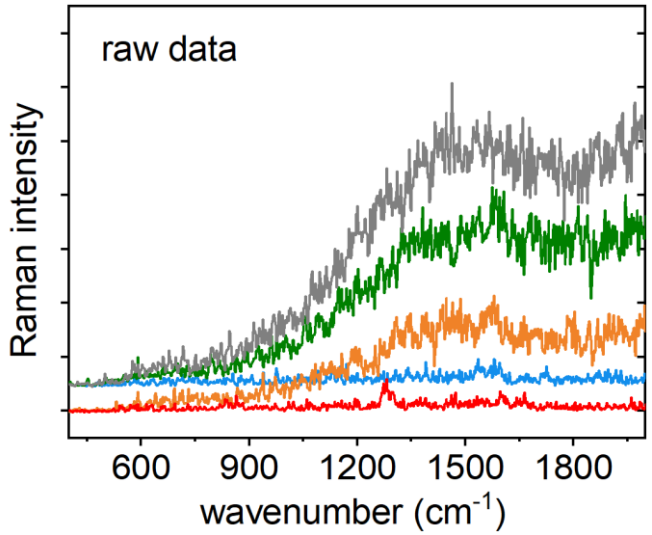
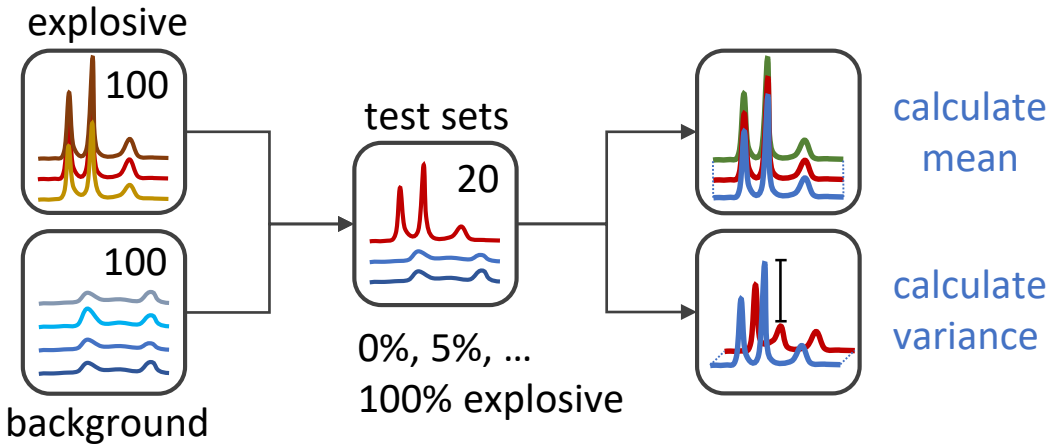


Data processing

- Mean of all spectra
- Variance between all spectra

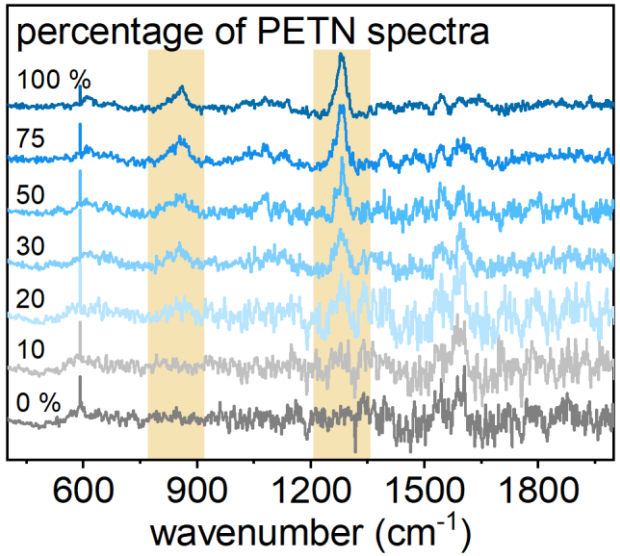


Data analysis

Mean spectra

- Useful for high surface coverages
- Identification threshold ~25% surface coverage

mean spectra



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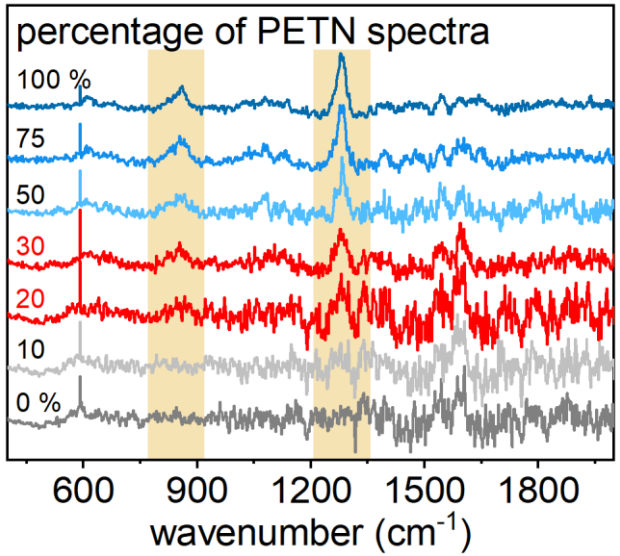

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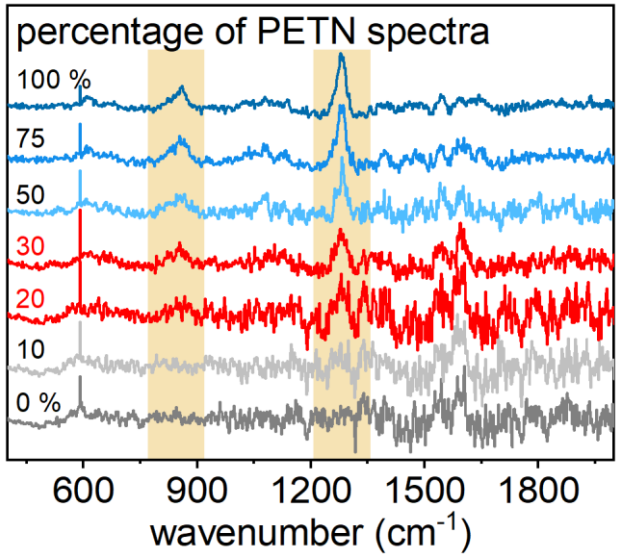
- Identification threshold ~25% surface coverage

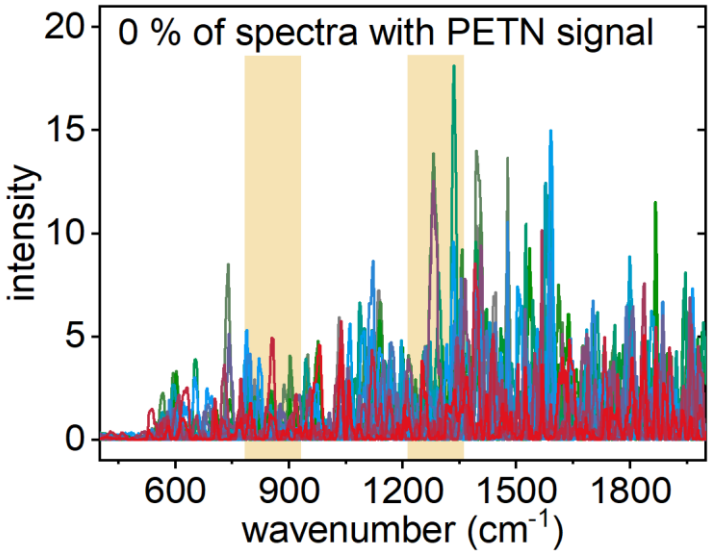
Variance spectra

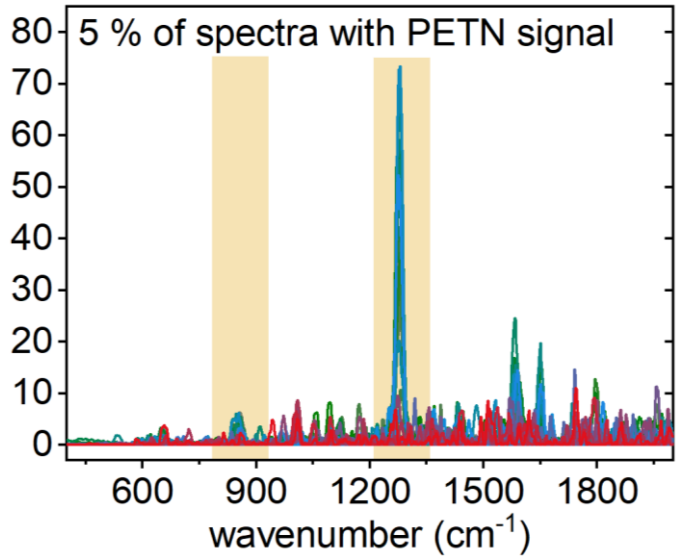
- Good SNR at 5 – 75 % PETN
- Identification threshold ~ 5% surface coverage

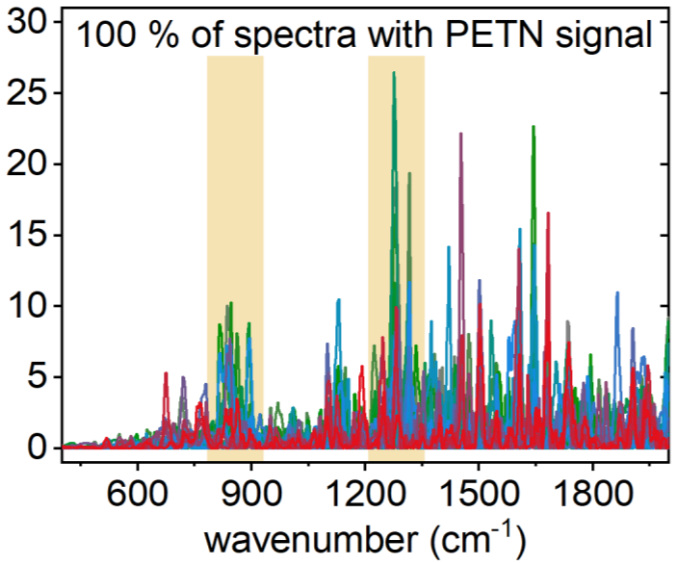
mean spectra



variance spectra







Conclusions and Outlook

- Including mean and variance increases data quality significantly
- Using variance spectra lowers detection threshold by ~20 %
- At high surface coverages mean spectra are better suited for identification
- Potential to increase classification quality and thus detection sensitivity

- Tests for samples with less favorable data quality
- Investigation of other statistical markers
- Classification of preprocessed data using different methods
- Evaluation of detection limits