Standoff Vibrational Detection and Their Figures of Merit

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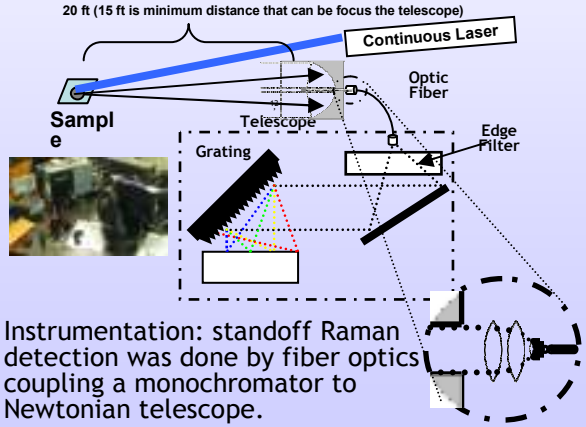
Introduction

Research on standoff detection was done using infrared and Raman spectroscopy and their figures of merit such as precision, accuracy, detection limits and selectivity were determined. Detection systems were designed by coupling commercially available instrumentation and optics system. In the investigation, real samples of C4 were used. The next step is to use complex samples, where the obtained data is difficult to differentiate which type of sample it is composed of and try to solve this by means of Chemometrics: math enhanced data analysis.

Experimental

Standoff Raman Detection

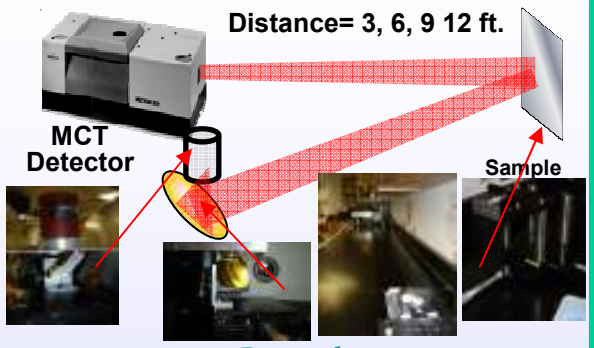


Instrumentation: standoff Raman detection was done by fiber optics coupling a monochromator to Newtonian telescope.

High explosives such as: RDX, C4, Semtex, 2,4-DNT, TNT, TATP, Toxic Industrial Compounds (TICs) and Chemical Warfare Agents Simulants (CWAS) were detected.

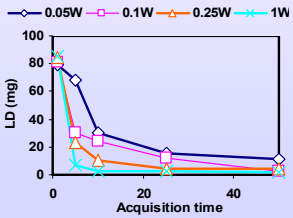
Standoff Infrared Detection

Standoff infrared detection was designed by coupling a FT-IR instrument, an external mirror and an external MCT detector.



Results

Standoff Raman Detection



LOD for C4 at different conditions

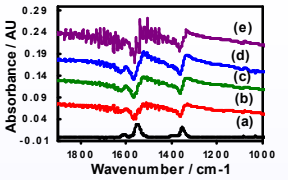
Power (W)	Acquisition time (s)	sb	m	LOD (mg)
0.05	1	61	2	79.6
0.1	1	65	2	81.3
0.25	1	60	2	84.1
1	1	128	5	85.3
0.05	5	138	6	67.9
0.1	5	70	7	30.4
0.25	5	100	13	23.3
1	5	121	52	7.0
0.05	10	91	9	30.3
0.1	10	65	8	24.4
0.25	10	114	34	10.1
1	10	98	99	3.0
0.05	25	137	27	15.2
0.1	25	83	21	11.9
0.25	25	116	76	4.6
1	25	198	240	2.5
0.05	50	126	33	11.6
0.1	50	72	72	3.0
0.25	50	231	158	4.4
1	50	931	497	2.0

Detection limit for C4 was calculated at different LASER powers (488 nm) and acquisition times. Different masses of C4 (5.0 ± 0.1 to 85 ± 0.1 mg) were used.

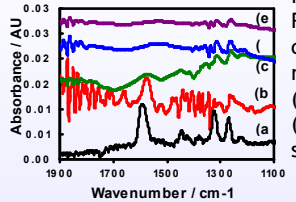
$$LD = \frac{sb}{m} x3$$

Where sb is the deviation of intercept and m is the slope

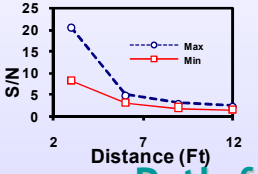
Standoff Infrared Detection



IR spectra of 15 μg/cm² TNT: (a) reference: neat TNT (RAIRS); (b) 3 feet; (c) 6 feet; (d) 9 feet; and (e) 12 feet source to target distance



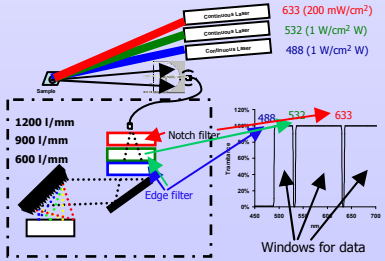
IR spectra of 15 μg/cm² RDX atmospheric compensation: (a) reference: neat RDX (RAIRS); (b) 3 ft; (c) 6 ft; (d) 9 ft; and (e) 12 ft source to target distance.



Plots of maximum and minimum values obtained of S/N for TNT vs. distance.

Path forward

Double or multiple Laser excitations and different gratings



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