Saturation Sensor to Protect Explosives Detection Equipment

SAND2015-10255PE

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Background

Most trace explosive detection is done with an ion mobility spectrometer (IMS) or a mass spectrometer (MS)

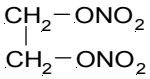
- Both types are effective in particular applications
- Both have detection limits in the pico-gram range

For this reason it is very easy to saturate the system

EGDN

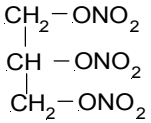
ethylene glycol dinitrate

(taggant)



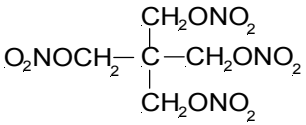
NG

nitroglycerin



PETN

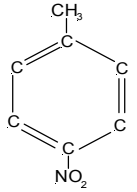
pentaerythritol tetranitrate



p-MNT

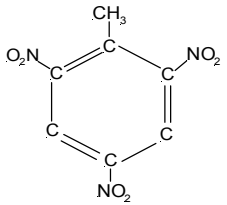
p-mononitrotoluene

(taggant)



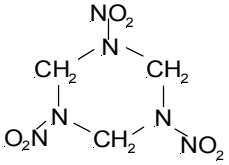
TNT

2,4,6-trinitrotoluene



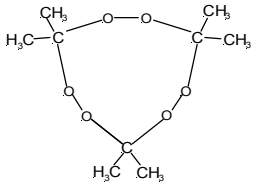
RDX

cyclo-1,3,5-trimethylene-2,4,6-trinitramime



TATP

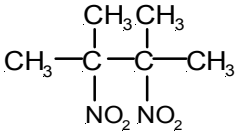
triacetonetriperoxide



DMNB

2,3-dimethyl, 2-3-dinitrobutane

(taggant)



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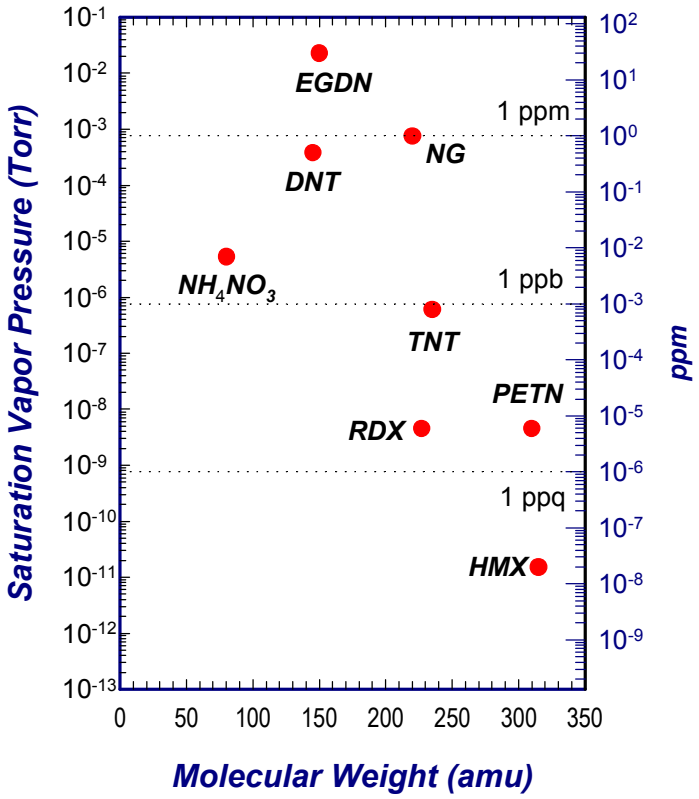
Vapor Pressures for Common Explosives



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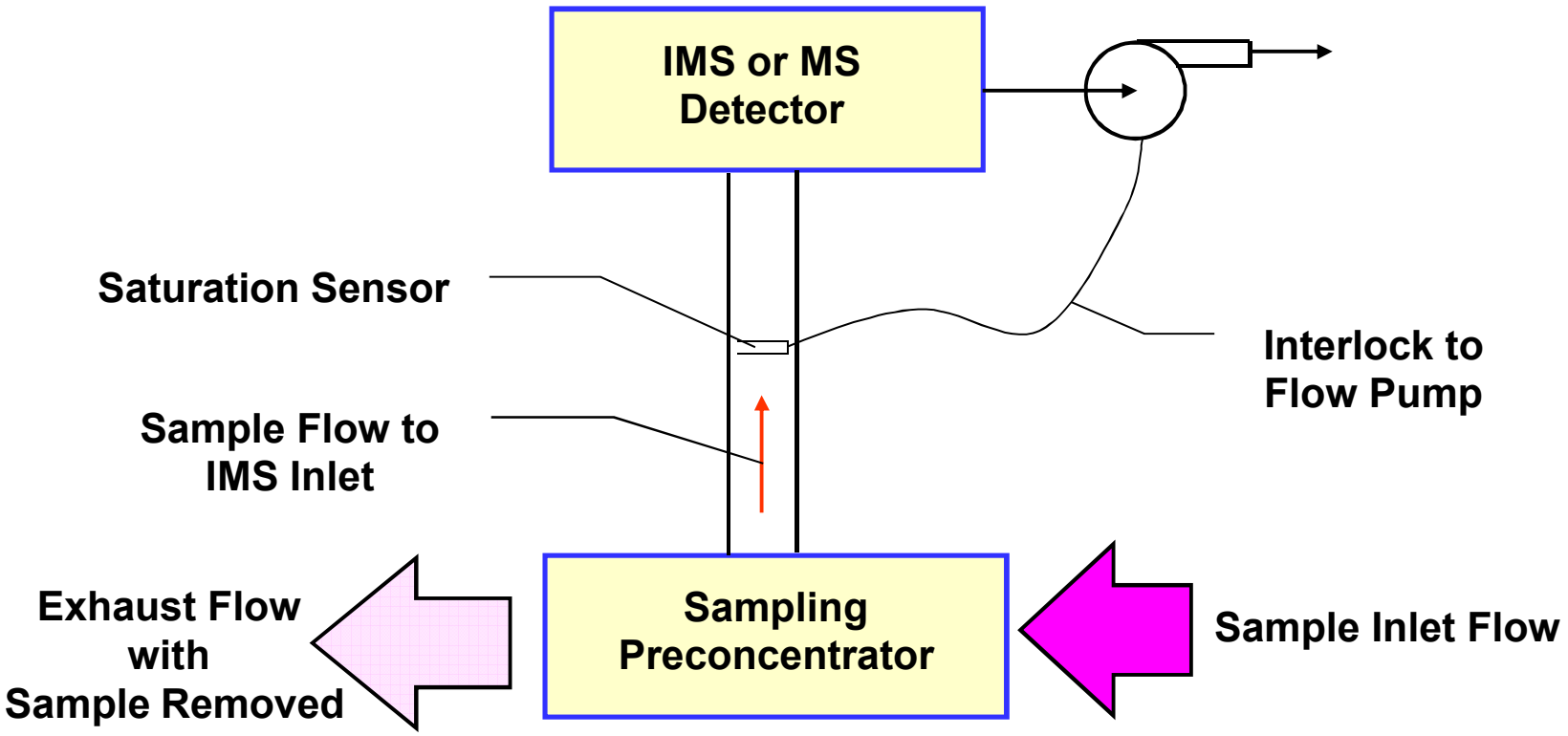
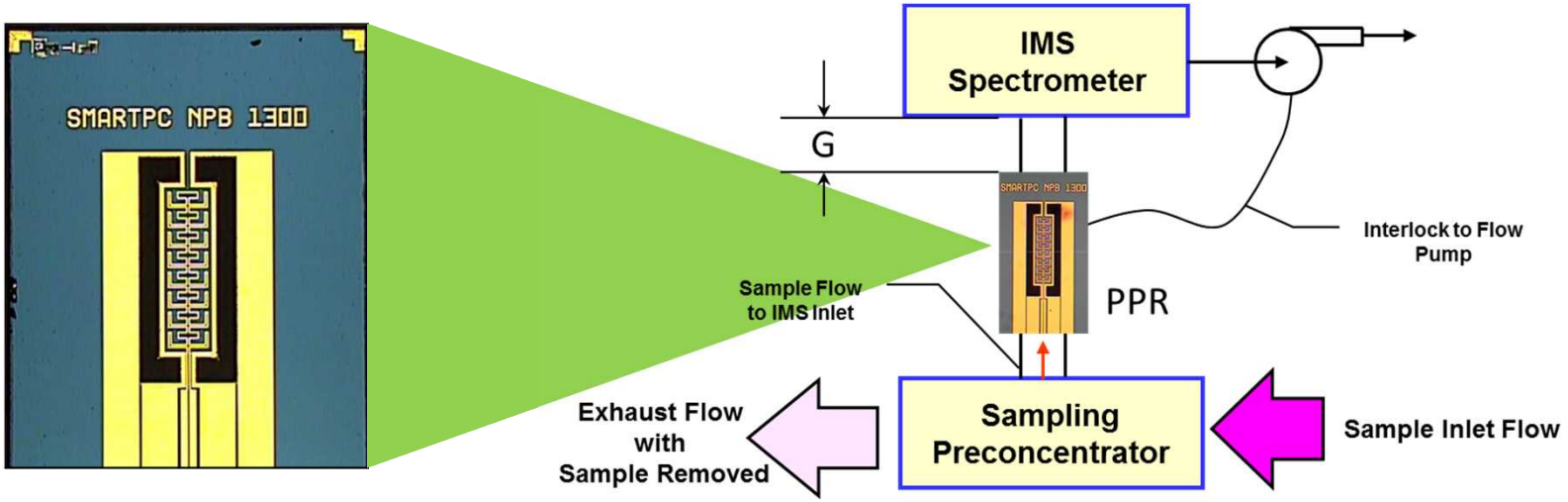
Preconcentrator System to Prevent Saturation



Preconcentrator System to Prevent Saturation



PPR device with paddle width of
500 μm and length of 1500 μm

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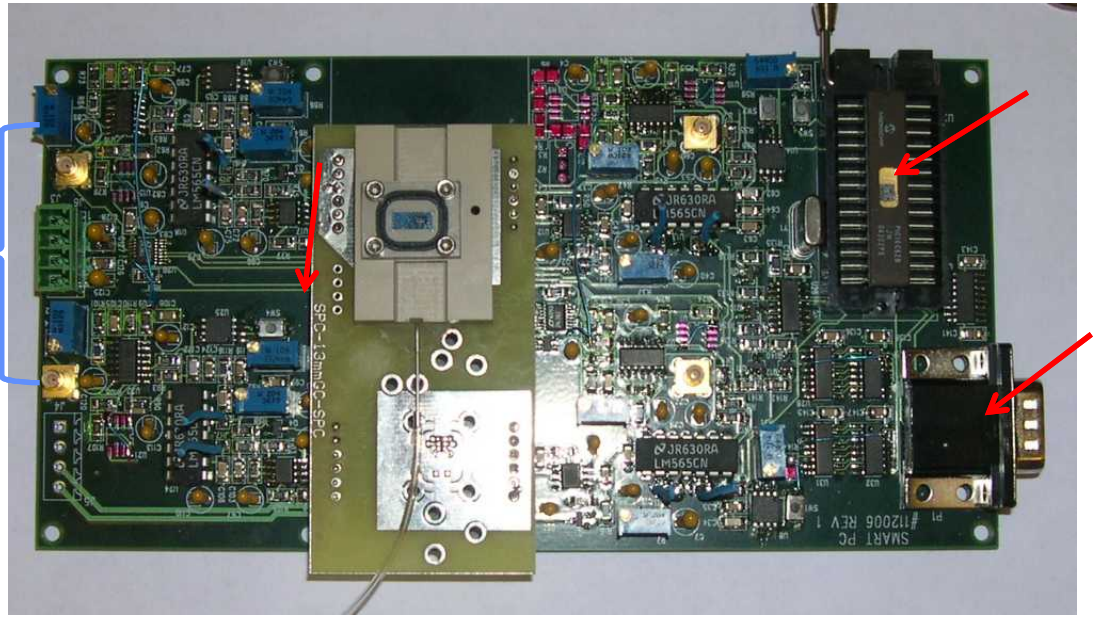
Operational Requirements

- Sensor must distinguish between explosives and thermal pulses
- Sensor must have a response time short enough to engage interlock sample arrives at IMS or MS

Device Setup

Control circuitry for one channel (four channels on board)



PIC processor

Communication Port

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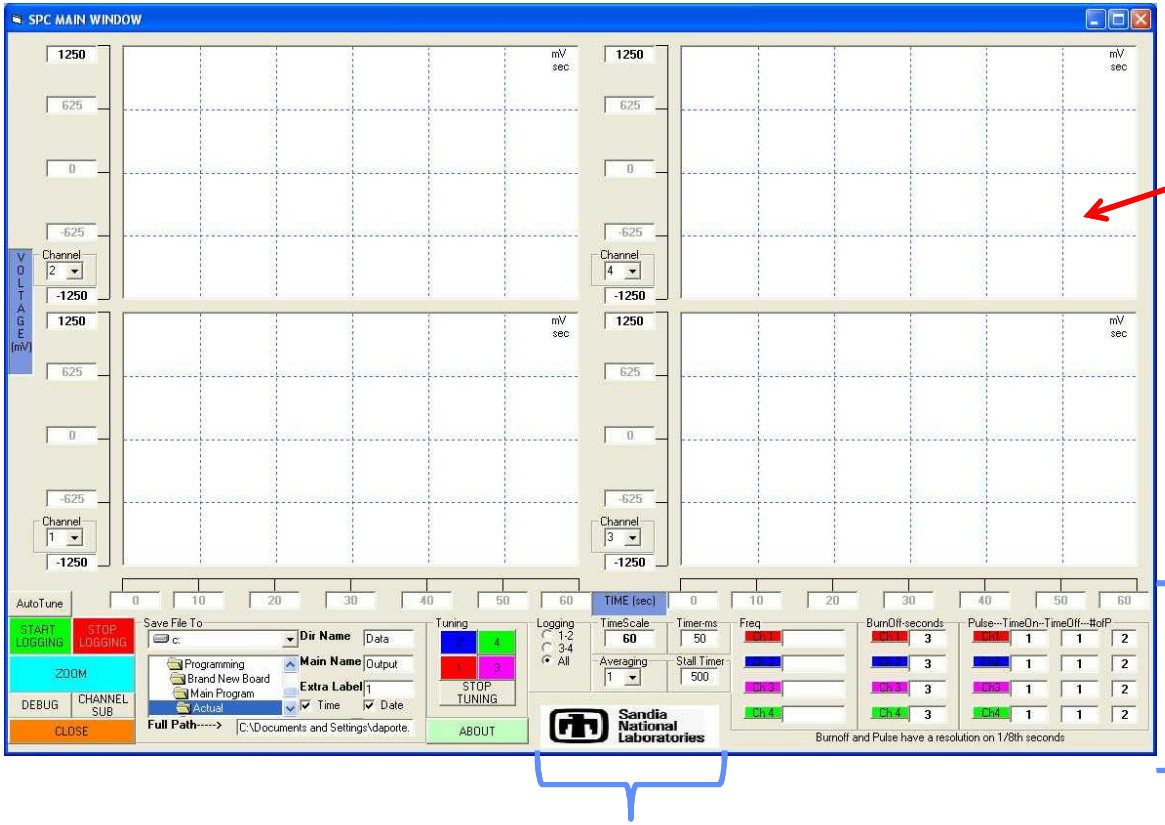
Software Interface



Displays data from all four channels

PPR heater settings

Data collection settings

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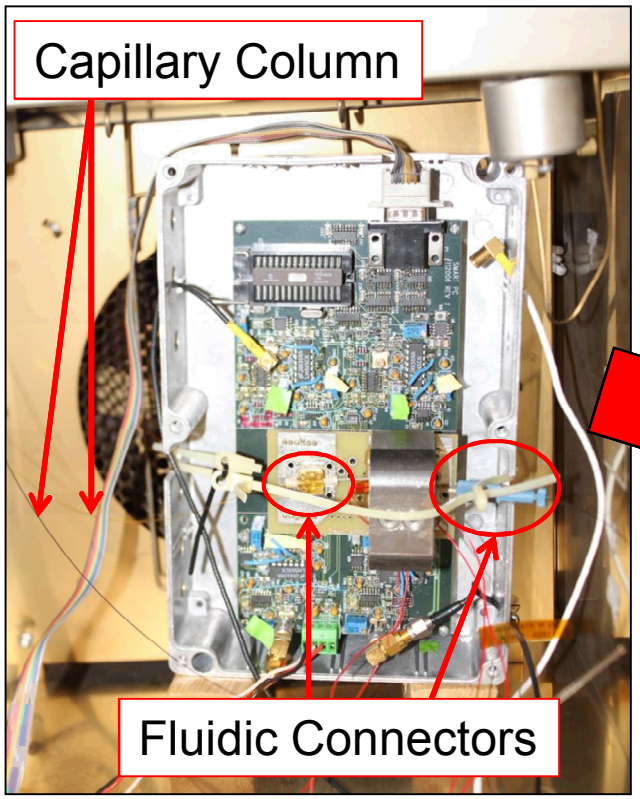
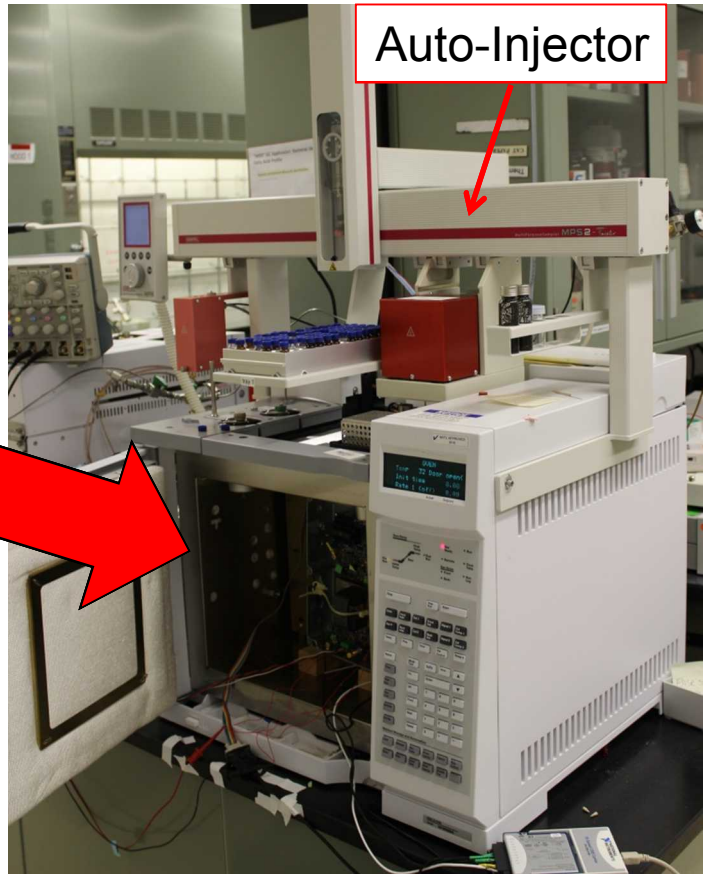
Experimental Setup





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Test Plan

- Test PPR detection of DNT and TNT
- Test capability over a range of temperatures between 60°C-100°C

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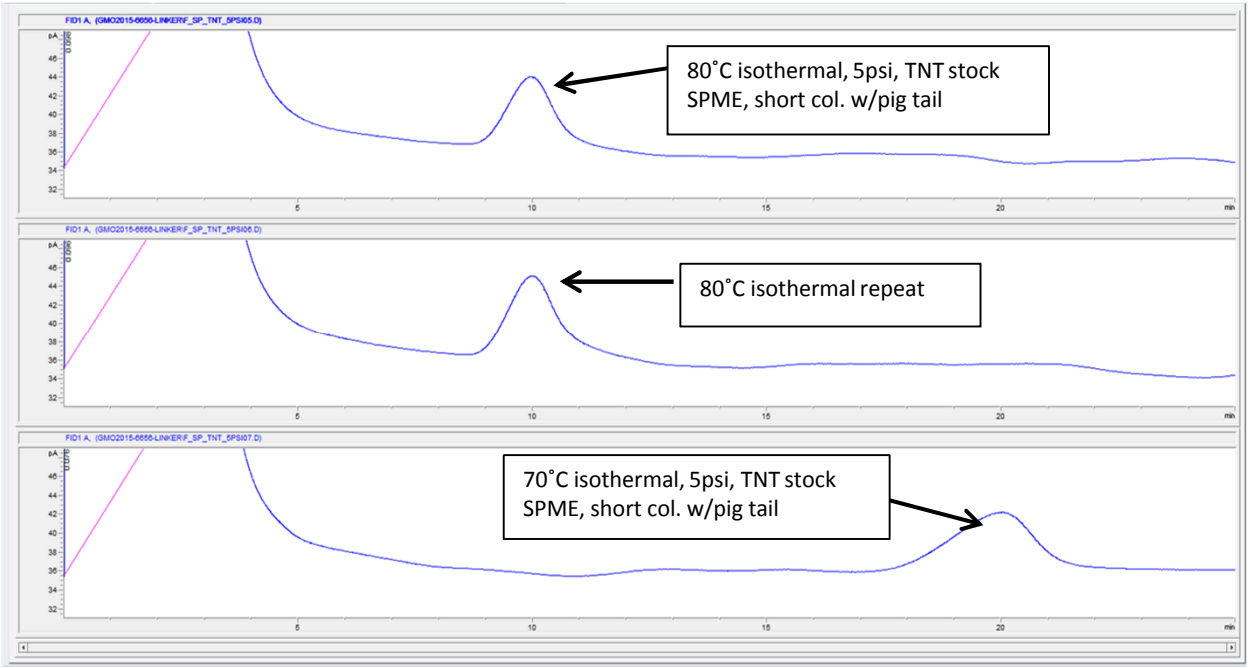
Gas Chromatography

- Sample is vaporized and injected into a polymer coated column
- Component gasses travel through column at different speeds
- Component materials are separated and can be analyzed individually

Initial Chromatography Results



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Challenges to be Overcome

- Explosive adherence within the system
- High noise to signal ratio

At room temperature the recorded baseline over one second had a standard deviation of 0.004mv

At 80°C the recorded baseline over one sec had a standard deviation of 0.28mv

Noise at temperature is ~70x greater

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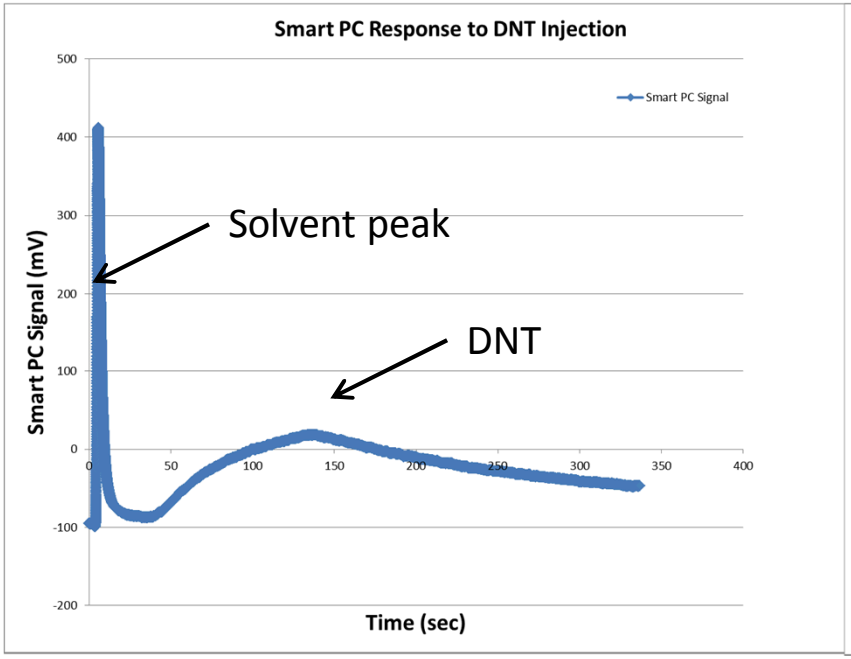
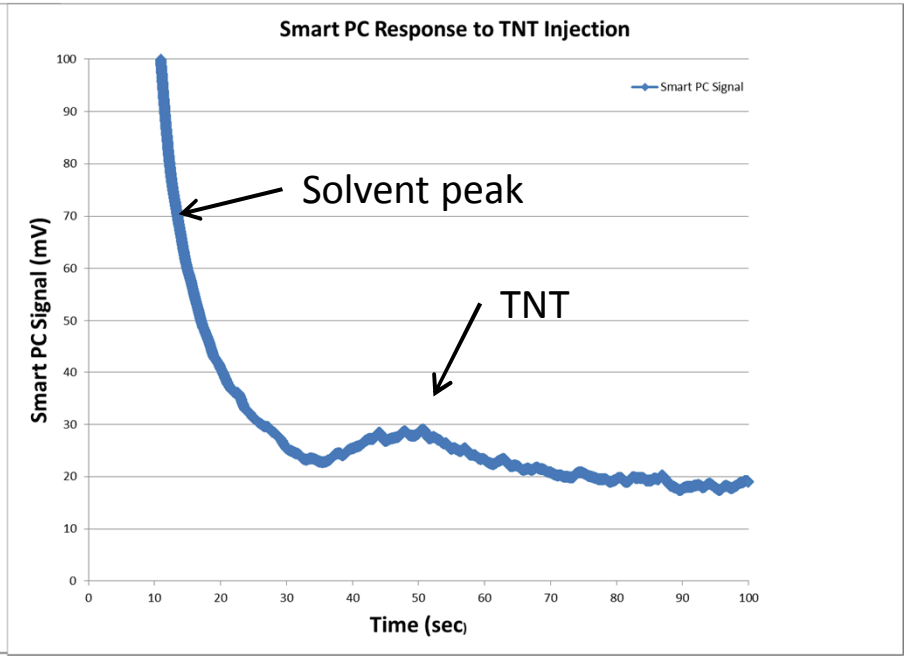
Results





System can successfully detect explosives

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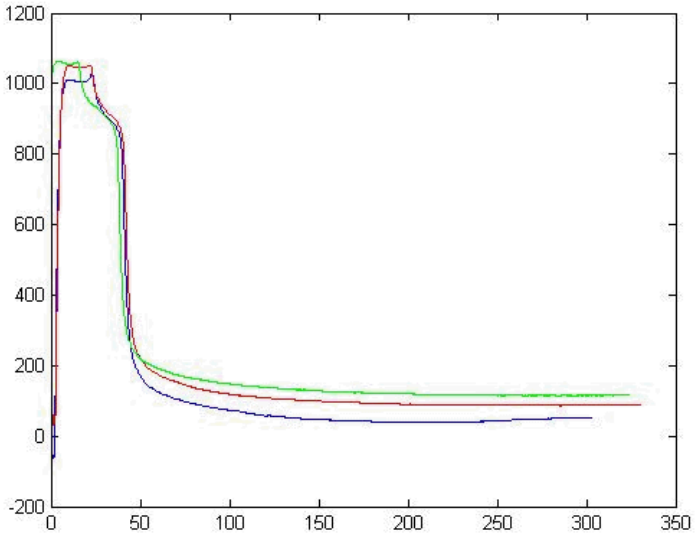
Results



- System was successful tested at 80°C, 90°C, and 100°C
- Explosive adherence within the system prevented detection below 70°C

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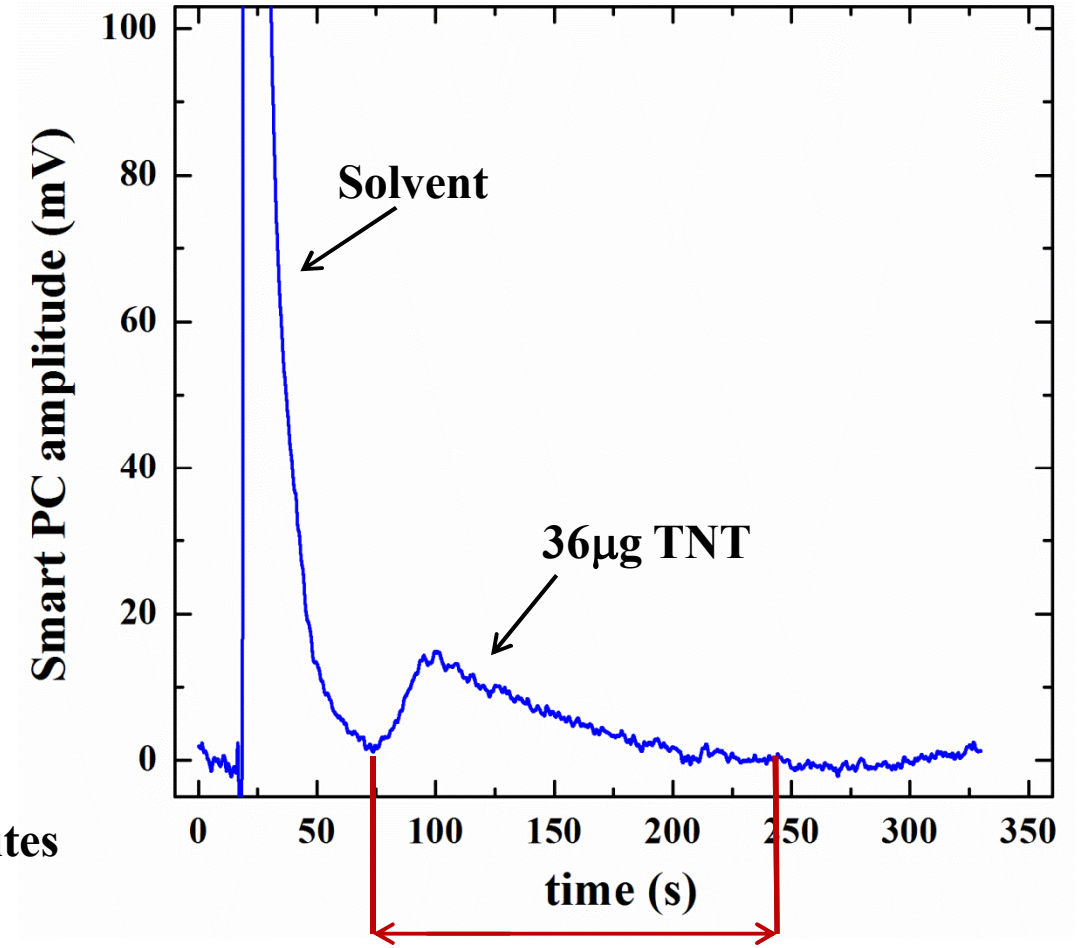
Problems with Experiment



Peak width ~3 minutes

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Conclusion

- Explosives can be detected with this system
- Detection is possible at least as low as 80°C

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