S&B NONTOX Ammunition in Criminal Casework

By Robert Berk
Illinois State Police
Forensic Science Center - Chicago

Typical Gunshot Residue Analysis

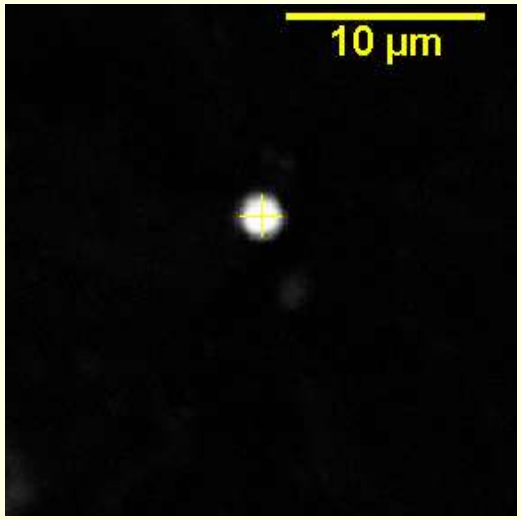
- Small Arms Percussion Primers
  - Explosive, initiator
  - Oxidizers
  - Fuel
  - Frictionators
  - Sensitizers
  - Binders

Typical Gunshot Residue Analysis

- Sinoxid "*without rust*" primer formulation
  - Lead styphnate
  - Tetrazene
  - Barium nitrate
  - Lead dioxide
  - Antimony trisulfide
  - Calcium silicide

Typical Gunshot Residue Analysis

- Bulk analysis
  - Elevated levels of the elements
  - In proper proportions
- Particle analysis
  - Elemental composition
  - Morphology



Experience with Atypical Primers

- 1996 MRP (Magtech Recreational Products)
  - Primers purchased from CBC (Companhia Brasileira de Cartuchos)
- 1987 – 1995 Various Calibers
  - Priming Mixture 5067
    - Barium nitrate 60%
    - Lead styphnate 38%
    - Tetrazene 2%

Experience with Atypical Primers

- Test results from typical case guns
  - Six different 9mm firearms test fired
    - 1 or 2 shots under ideal test fire conditions
  - All test results inconclusive
    - Lack of elements/unacceptable ratios
  - Discharged cartridge cases antimony free
    - AAS and SEM/EDX

Sellier and Bellot NONTOX

- Promoted as “green” ammunition
  - Discharge a large amount of toxic heavy metals… do not meet environmental standards.
- Sports, hunting, and practice shooting
- Pb/Ba/Sb/Hg free

U.S. Patent 6964287

- “Non-toxic and non-corrosive ignition mixture”
  - Initiator
    - Nitroesters or nitramines
  - Sensitizer
    - Tetrazene or derivatives of tetrazoles
  - Oxidizers
    - Oxides and peroxides of metals
  - Fuel
    - Amorphous boron

U.S. Patent 6964287

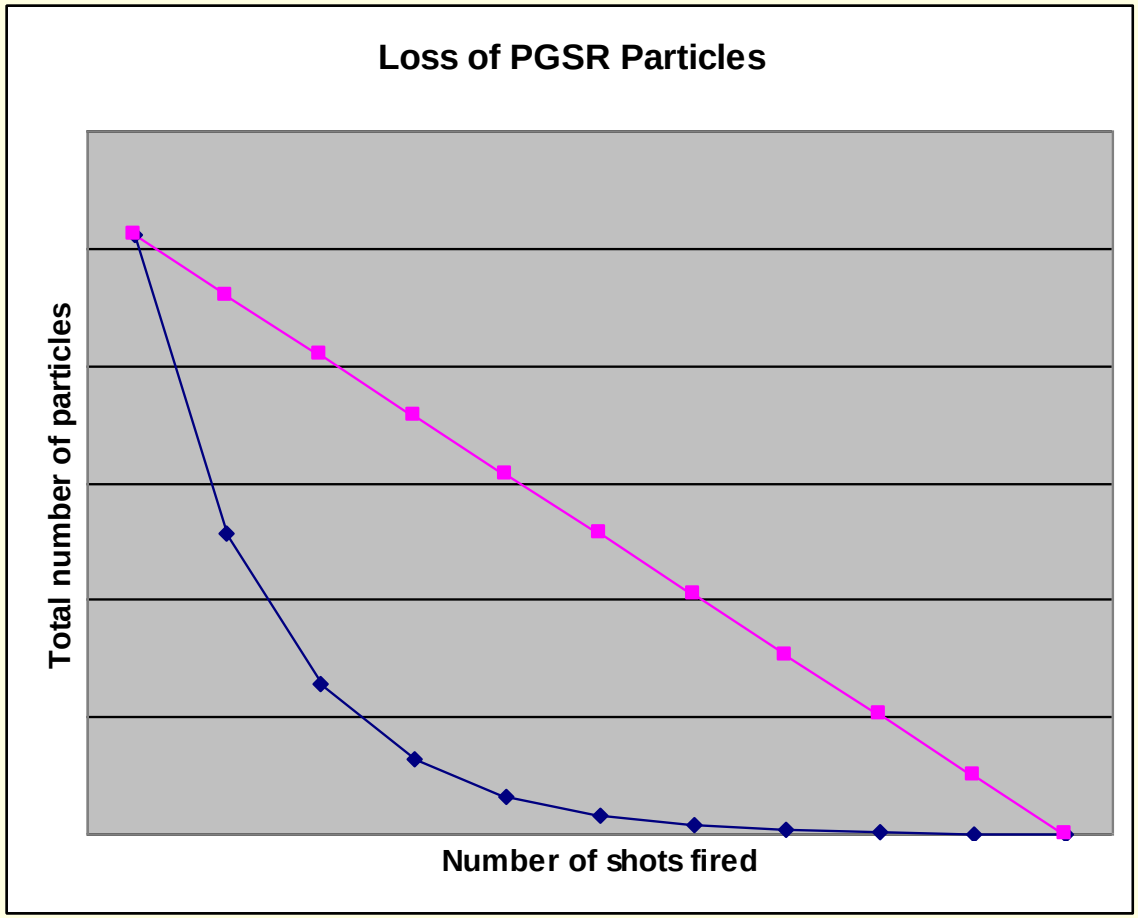
- “Non-toxic and non-corrosive ignition mixture”
  - 20 different examples of formulations
    - Tetrazene 25%
    - PETN 25%
    - Potassium nitrate 33.5%
    - Boron 6%
    - Nitrocellulose 0.5%
    - Glass 10%

Availability

- Sellier and Bellot recently purchased by CBC
  - 7.65/.32 auto
  - 9x19 and 9x21
  - .357 magnum
  - .38 special
  - .40 S&W
  - .45 ACP

- Magtech Ammunition sole importers into US
- 9mm and 40 S&W available on-line

Sellier and Bellot Nontox



Fundamental Questions

- How many discharges before false negative test results?
- How will a lead free primer affect the sodium rhodizonate test for distance determinations?

Typical Test Results

- Automated test results
  - Antimony 44
  - Barium 362
  - Ba-Sb 22
  - Lead rich 19
  - Lead-Antimony 5
  - Lead-Barium 23
  - Pb-Ba-Sb The “X” Factor

Eventual False Negative Results

- X factor
  - X greater than 1
    - None of the particles are confirmed
      - Don’t meet identification criteria
    - Don’t meet threshold values
    - Red flag
  - X = 0
    - No particle meets the sorting criteria
      - Confident negative lab report

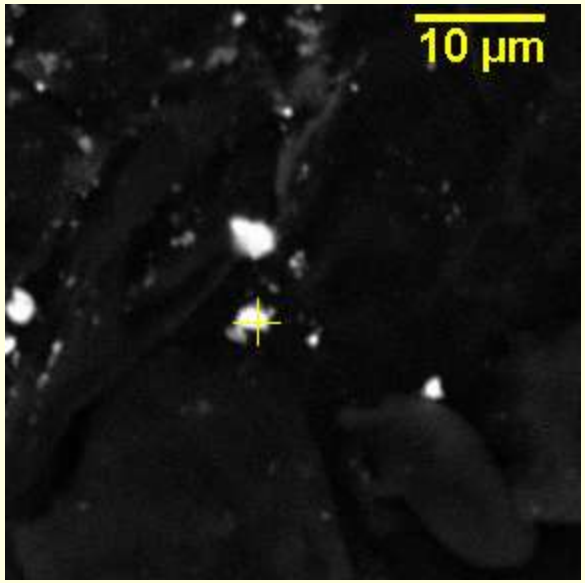
ASTM E1588 - 10

- “Gunshot Residue Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry”

ASTM E1588 - 10

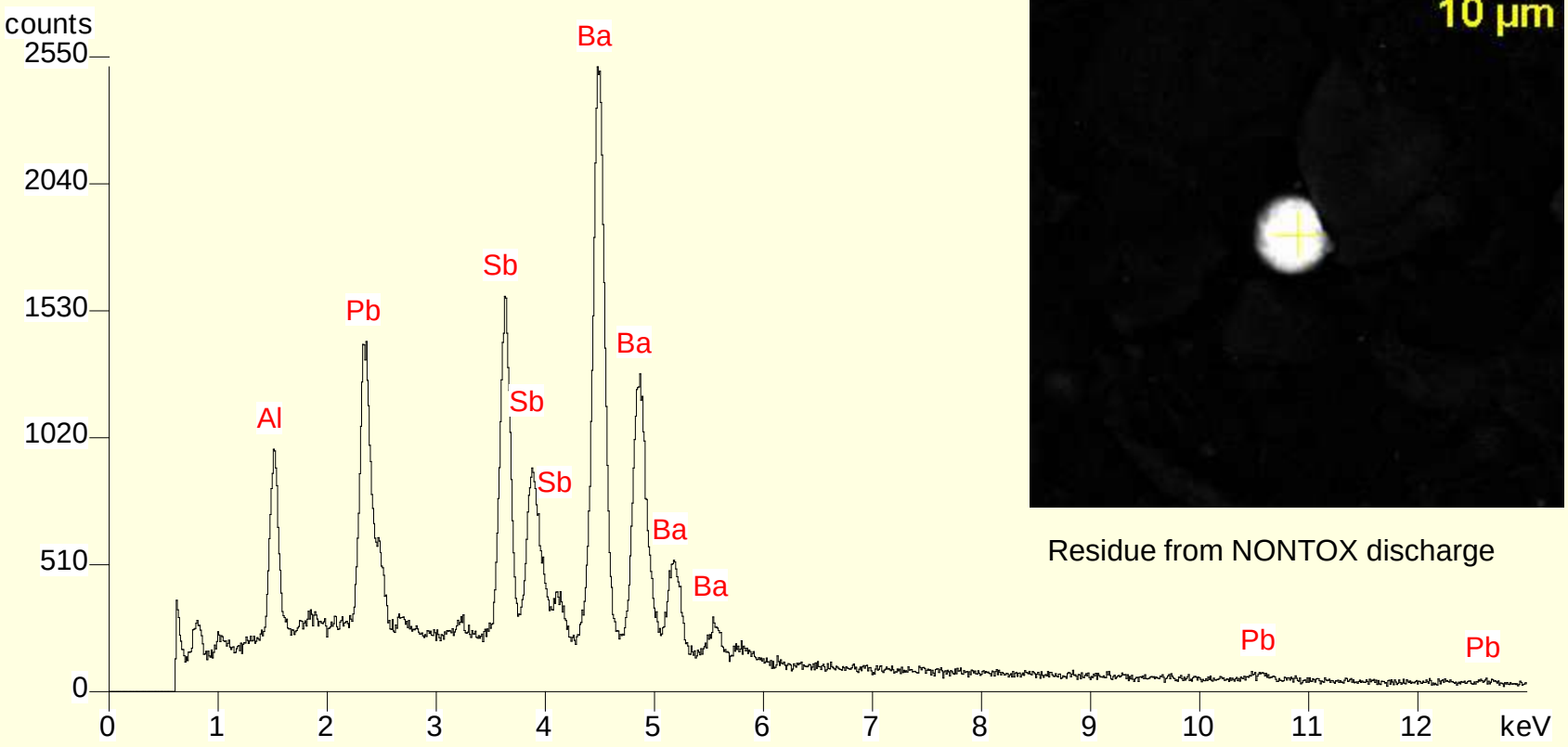
- 7. Data Analysis
- 7.1.3 Particles *characteristic* of GSR (that is, most likely associated with the discharge of a gun) will have the following elemental composition:
- 7.1.3.1 Lead, antimony, barium

Characteristic PGSR Particle



Residue from a NONTOX discharge

Doesn’t Meet Criterion

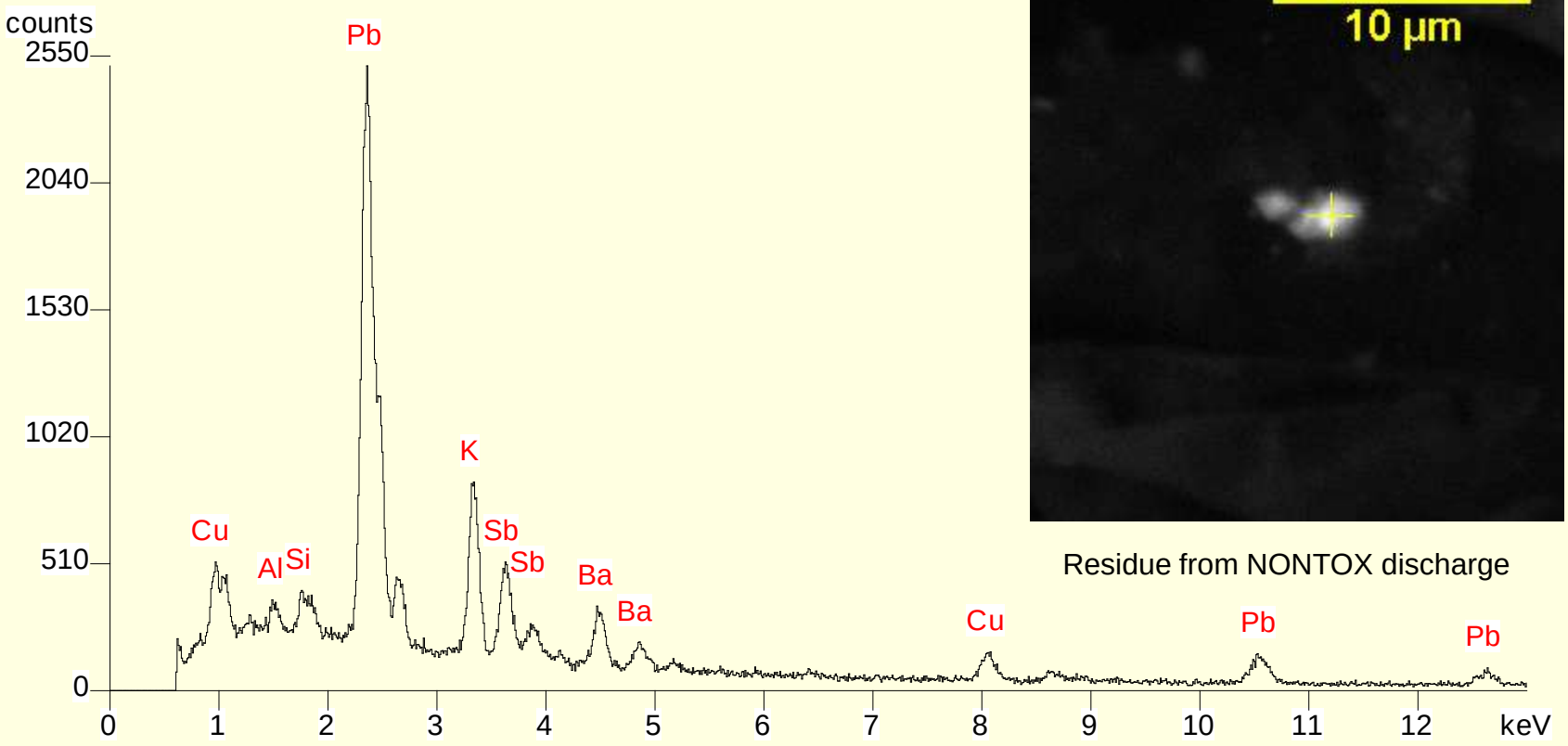


Residue from NONTOX discharge

ASTM E1588 - 10

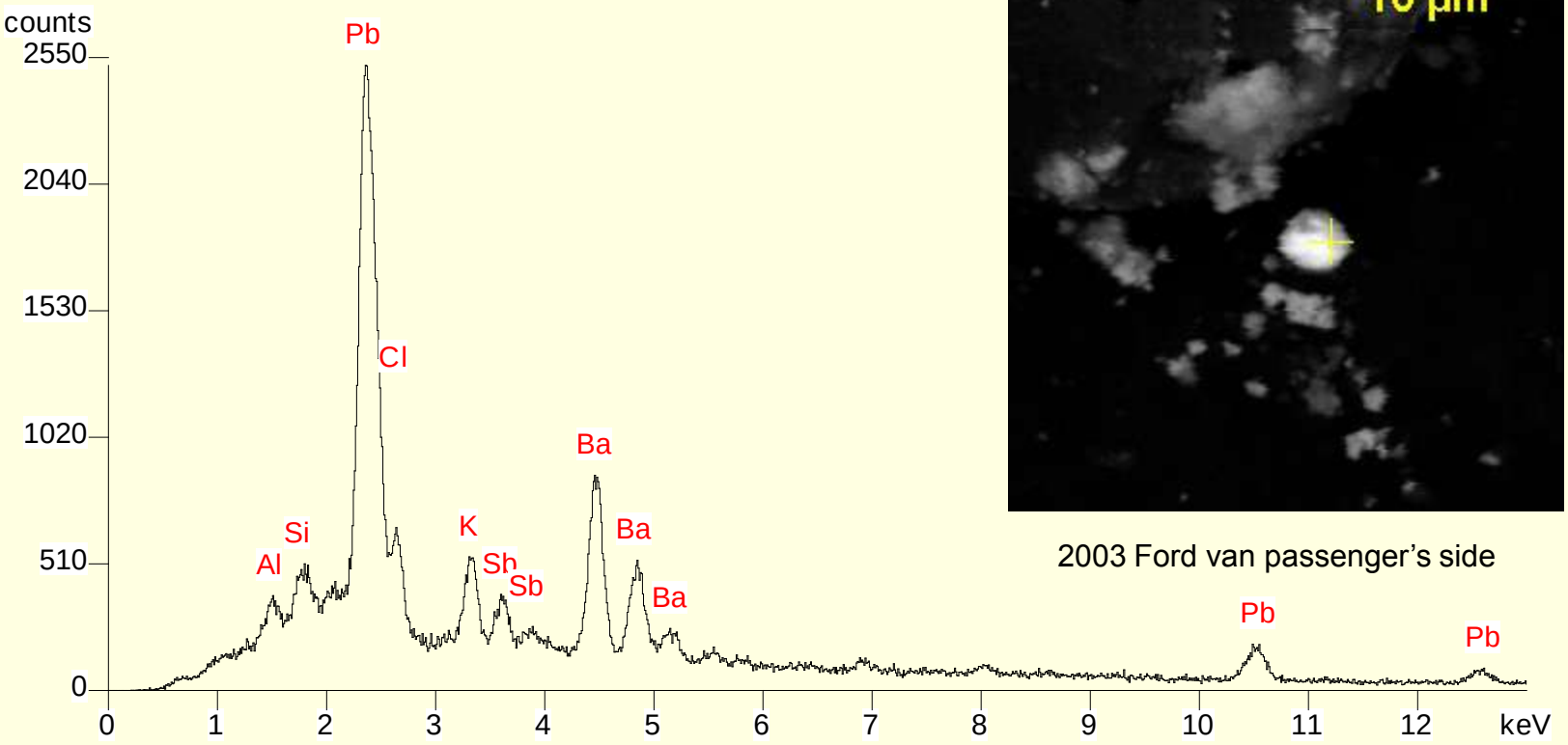
- 7. Data Analysis
- 7.1.3.2 It is common for additional elements to become incorporated into particles containing these elements. (Pb/Sb/Ba)
  - Potassium

Non-verified PGSR Particle



Residue from NONTOX discharge

Airbag Residue Particle



2003 Ford van passenger's side

Test Fire Technique

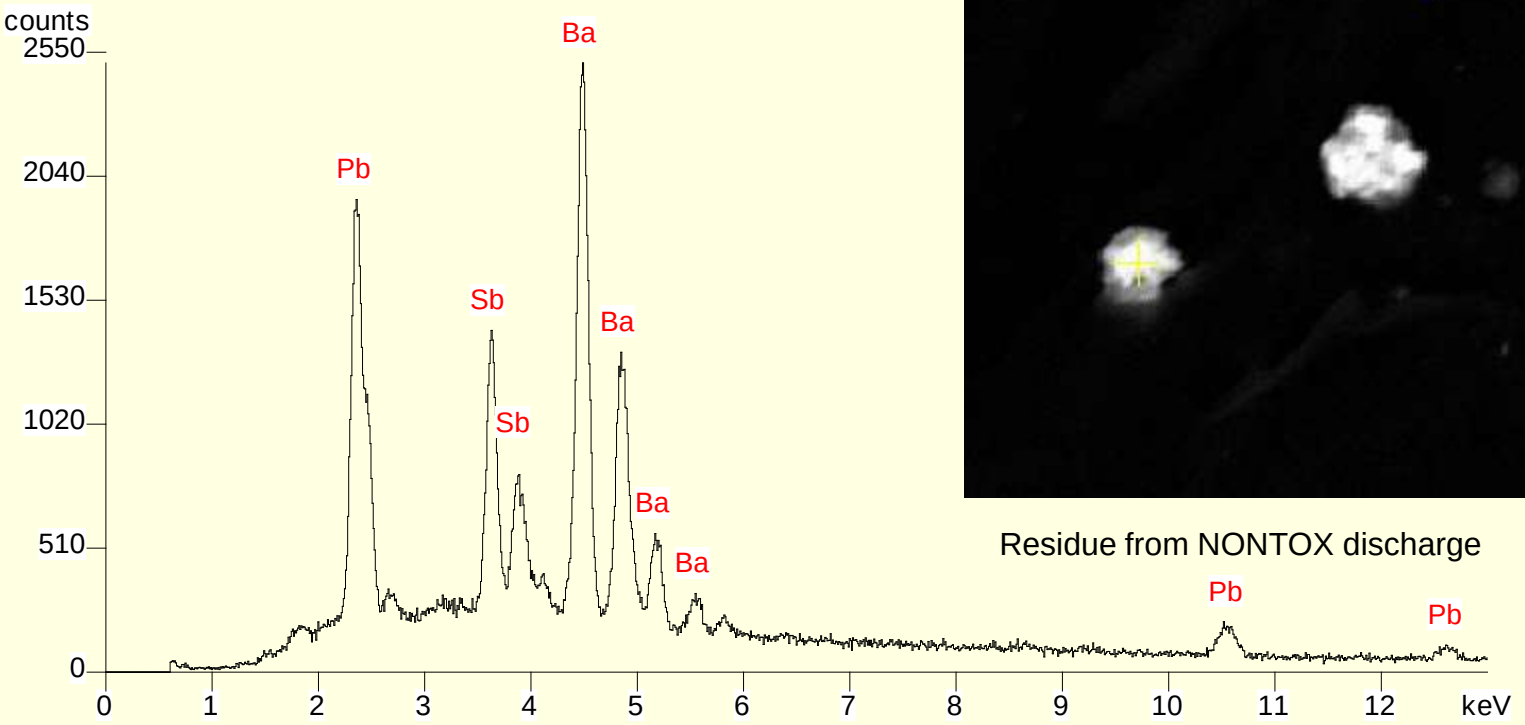
- Hands in “normal” condition
  - Relatively clean
- Ideal Sampling Conditions
  - Very thorough
  - “Willing” suspect
- Factors not taken into consideration
  - Particle loss/time
  - Environmental loss

Series 1: 9mm single shot

- Ruger model P89
- 1 round Sinoxid discharged as baseline.
- 1 NONTOX fired daily
  - Left hand sampled before as background
  - Right hand sampled immediately after discharge

Test Fire Results

- Typical PGSR particles

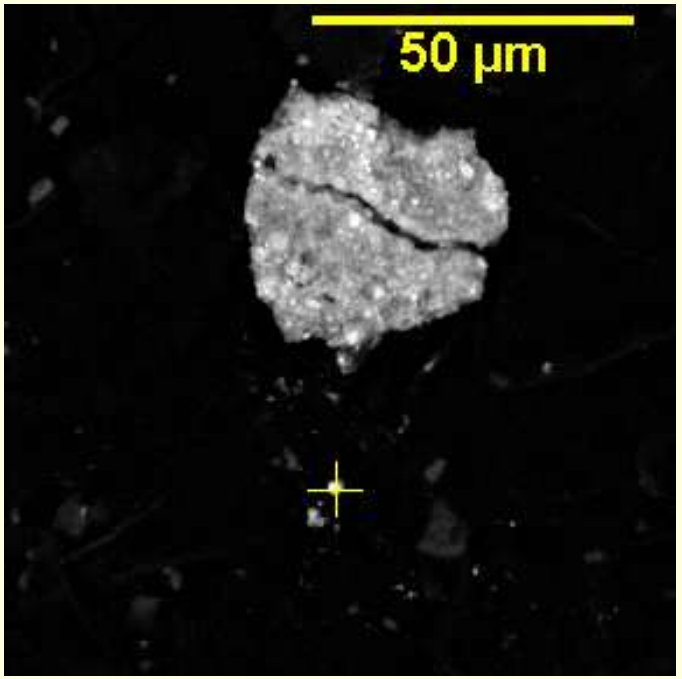


Residue from NONTOX discharge

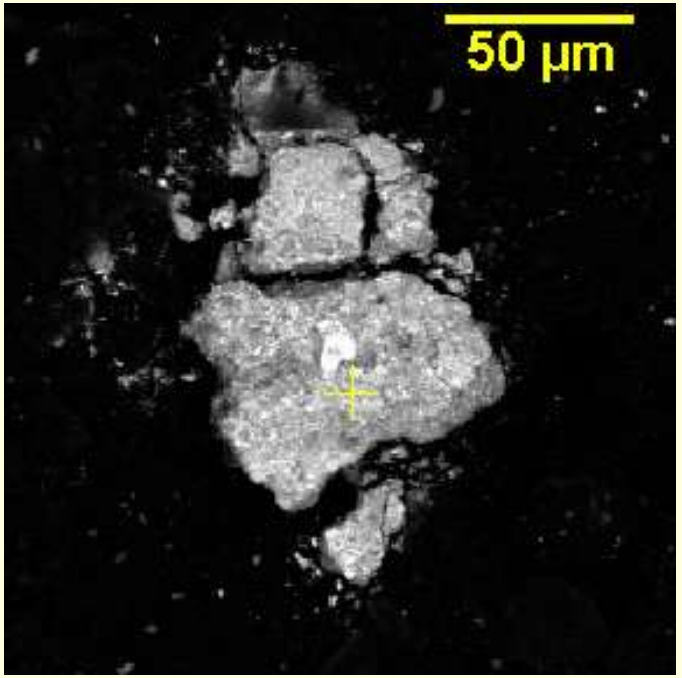
Test Fire Results

- Clusters
  - Large, brittle conglomerates of particles
  - Source of sequential PGSR particles

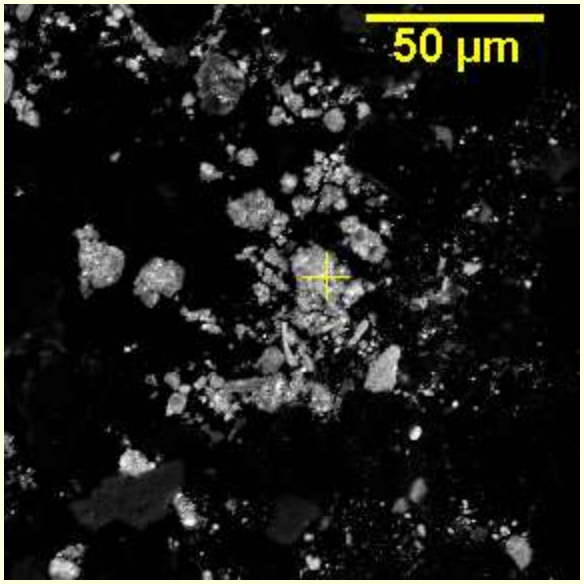
Particle Clusters



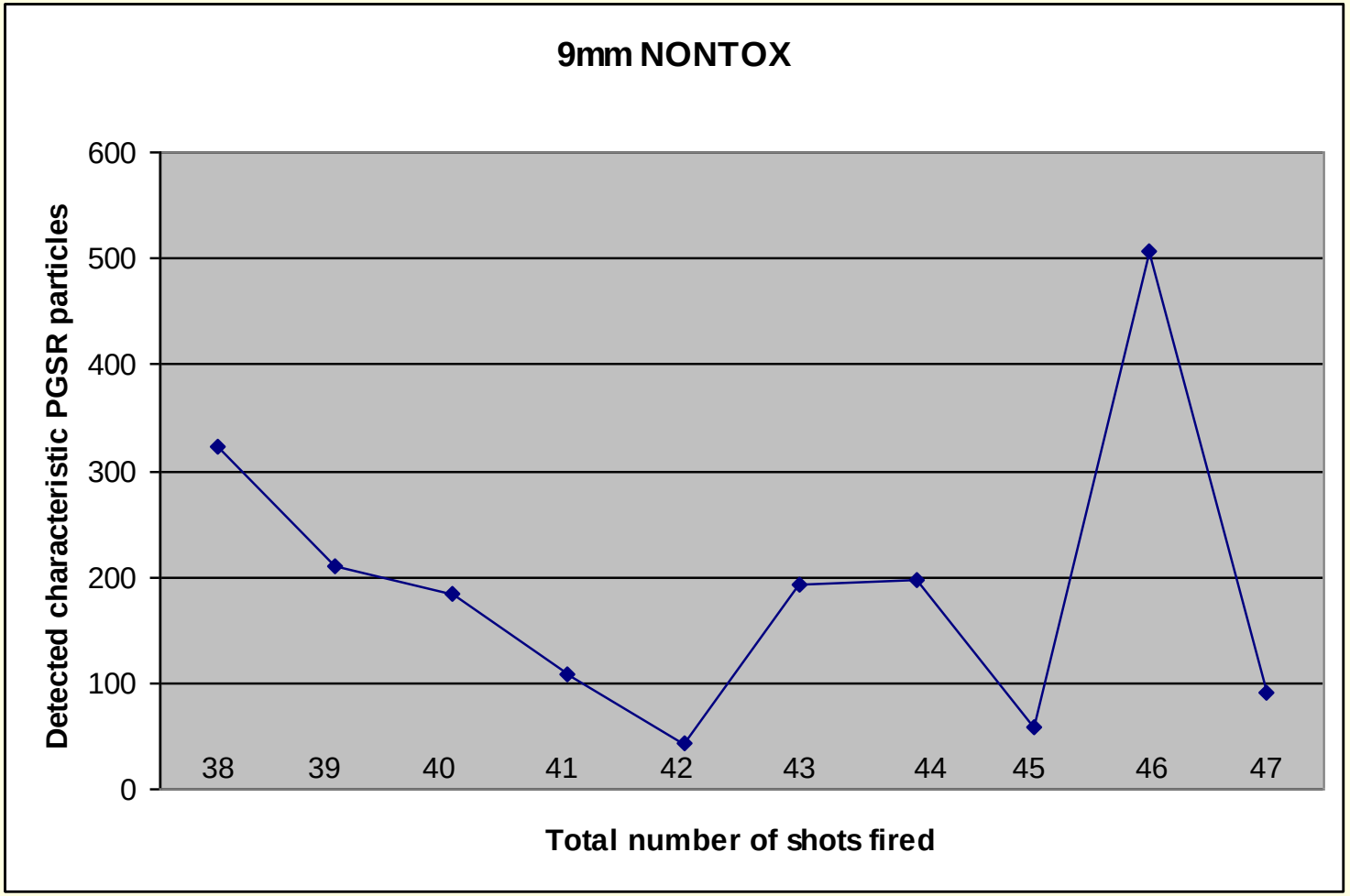
Particle Clusters



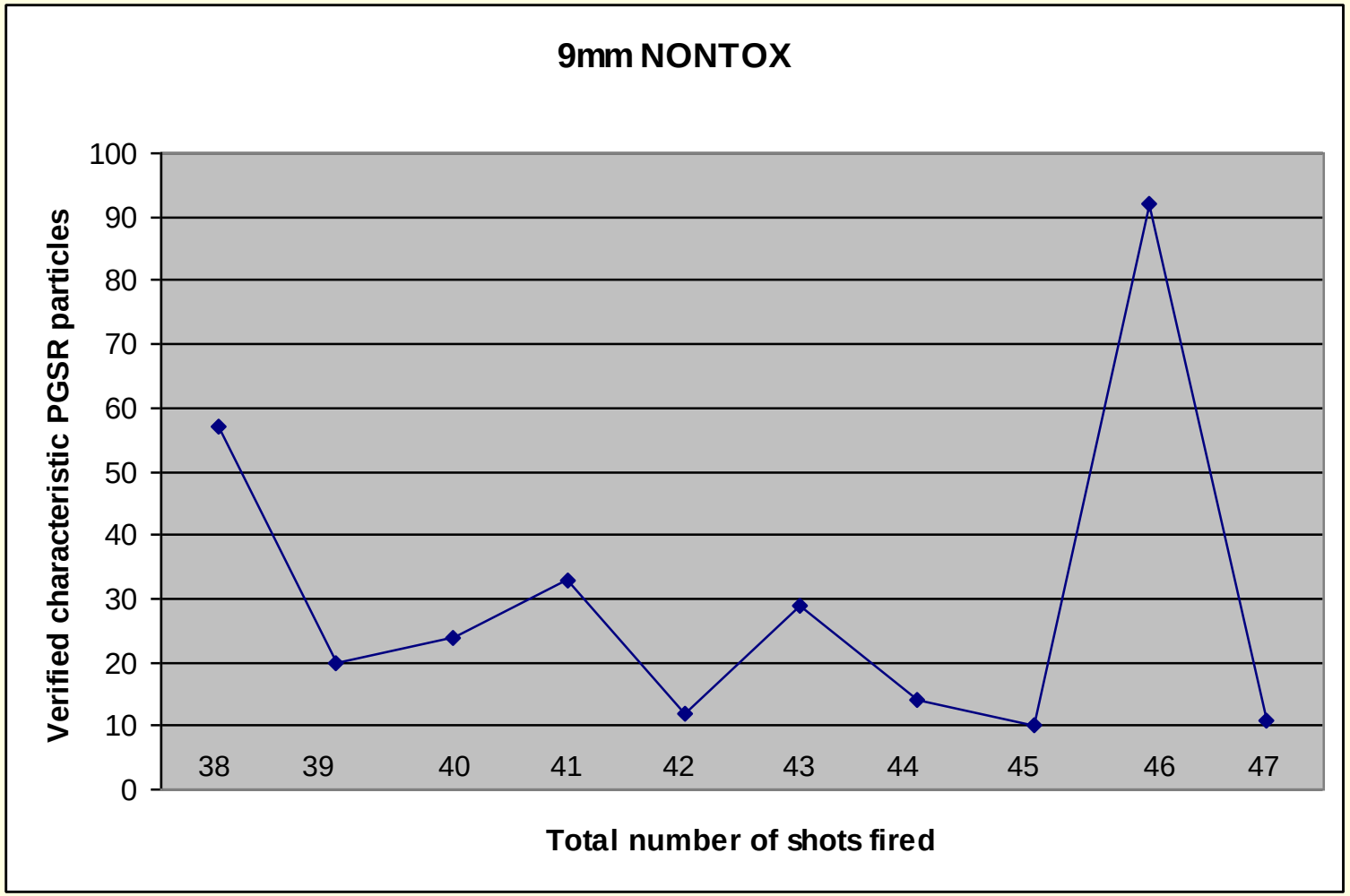
Particle Clusters



Last 10 Test Fires

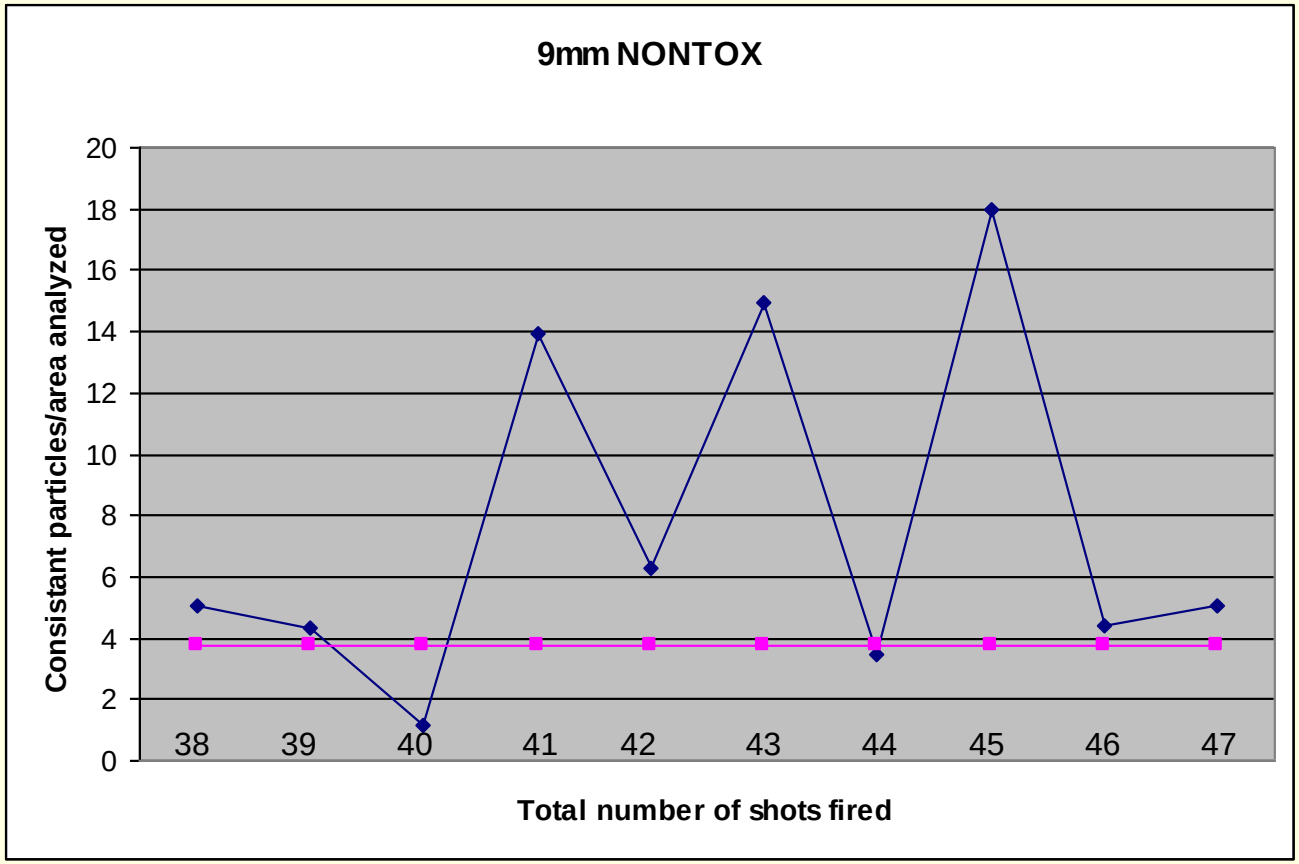


Last 10 Test Fires

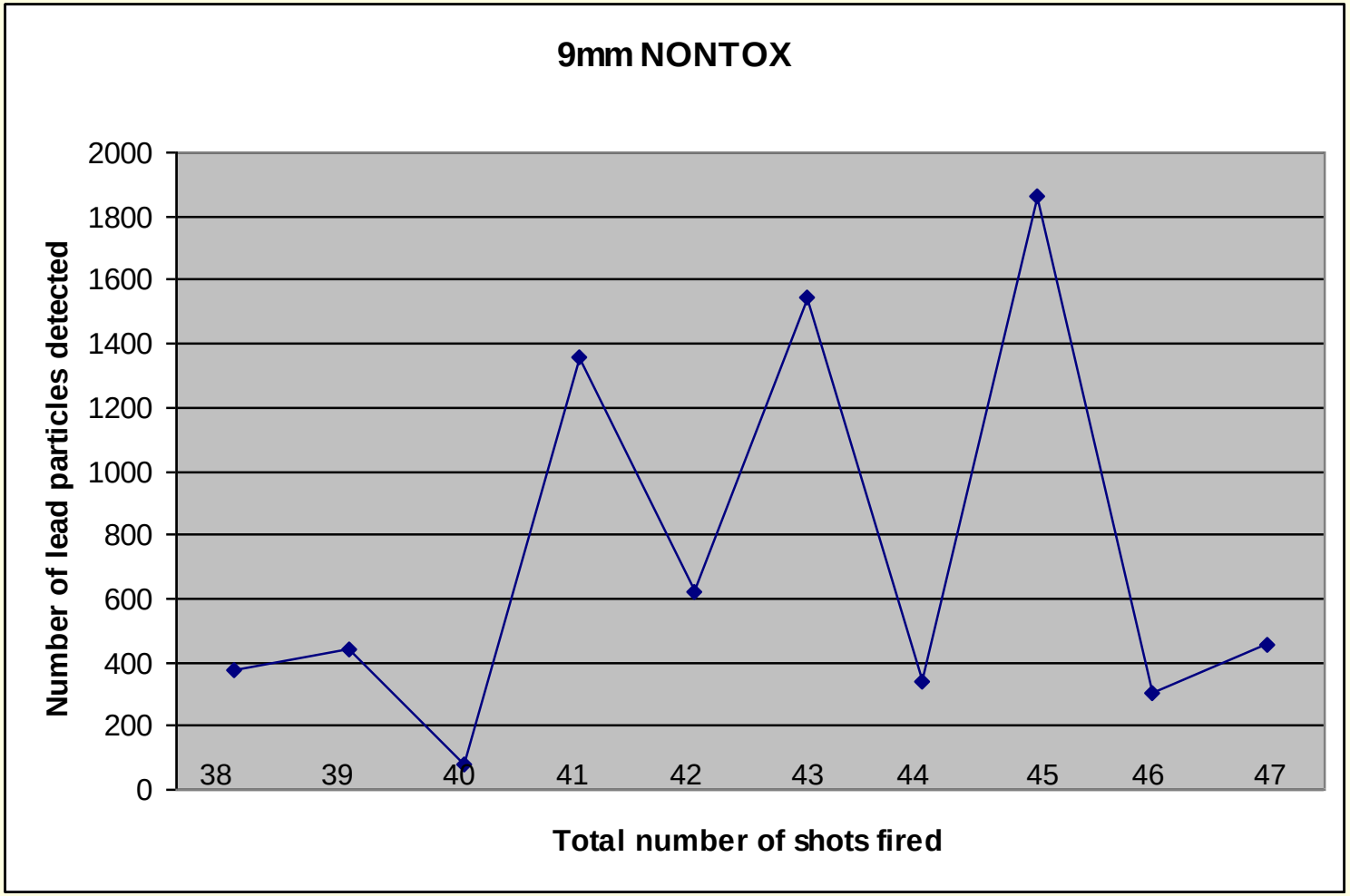


Last 10 Test Fires

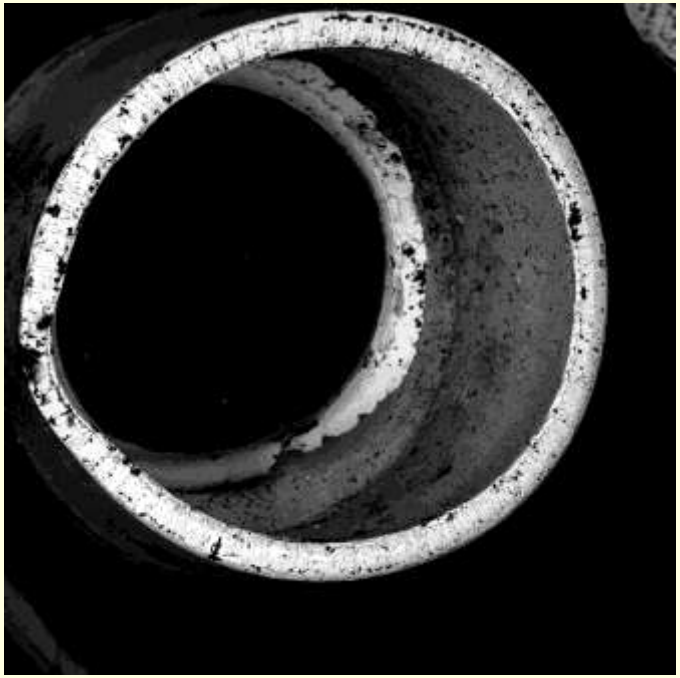
- Load = consistent PGSR particles/area
  - Red flag



Last 10 Test Fires



Cartridge Components

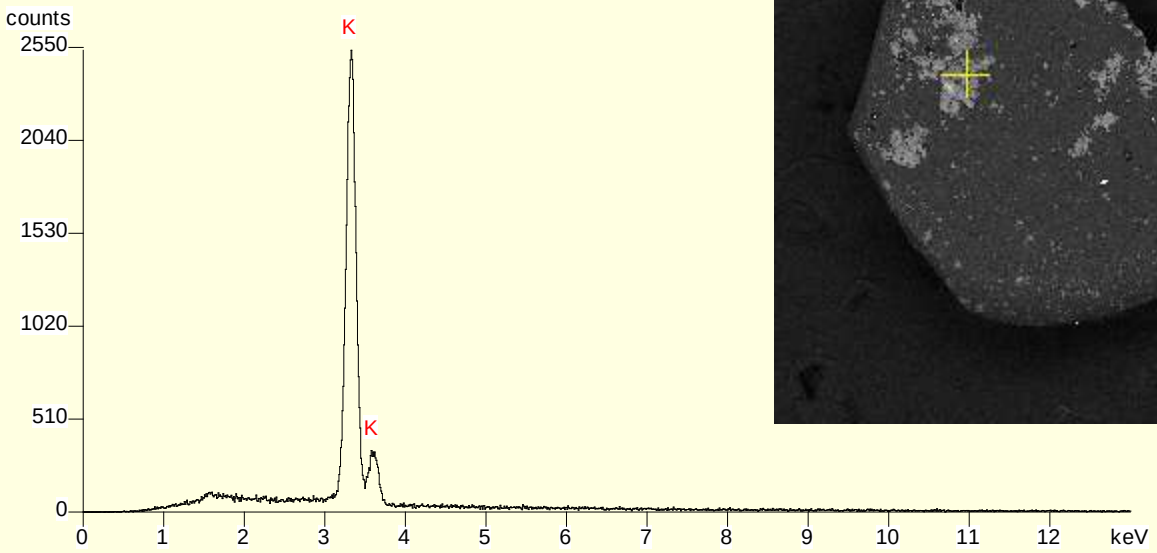


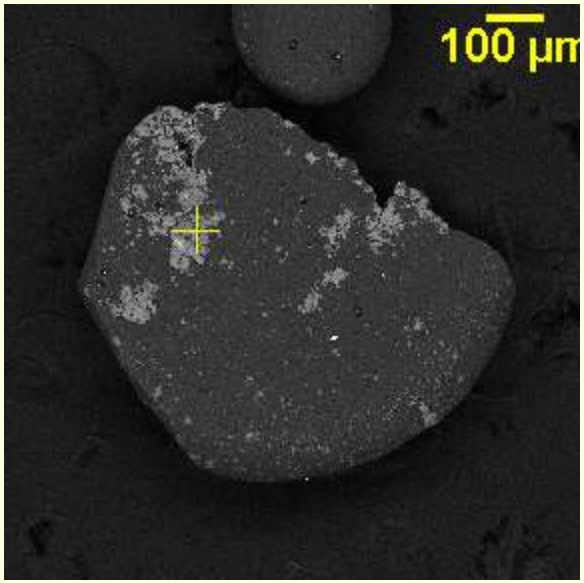
Brass primer cup

Nickel anvil

Cartridge Component

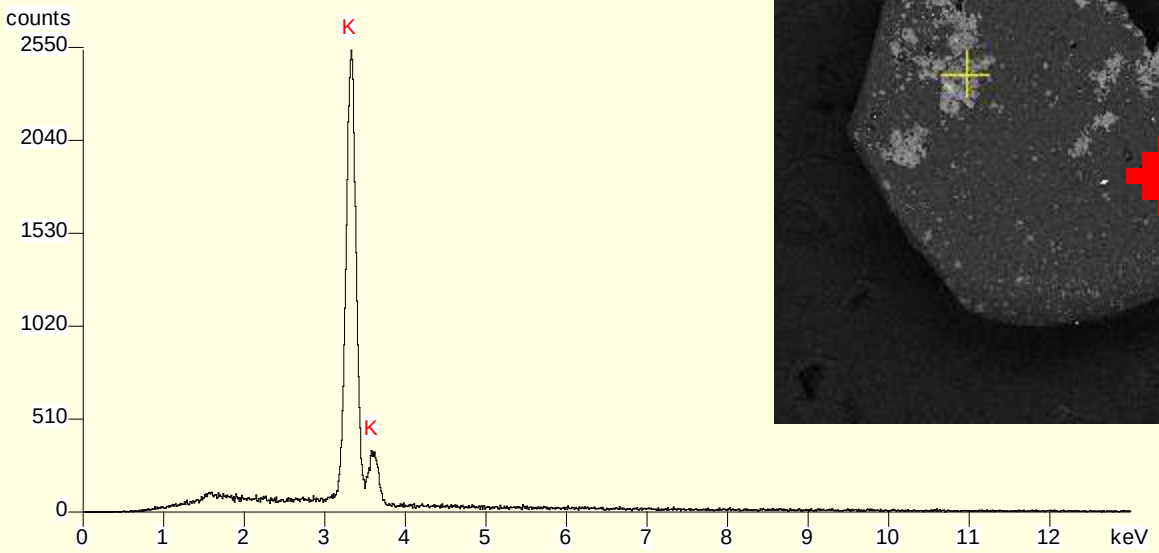
- Potassium coating on smokeless powder

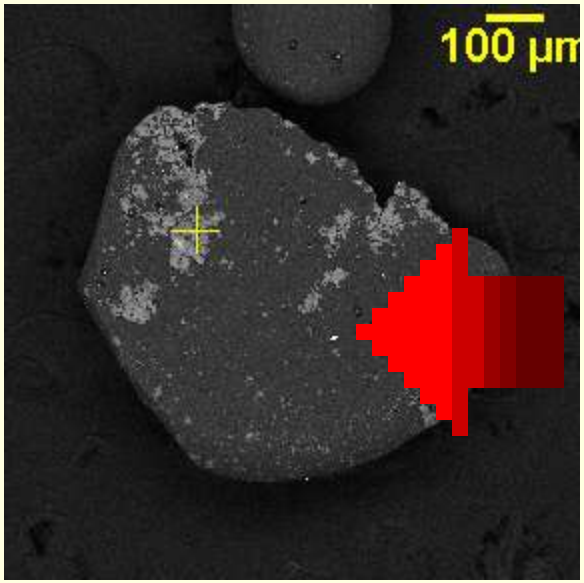




Cartridge Component

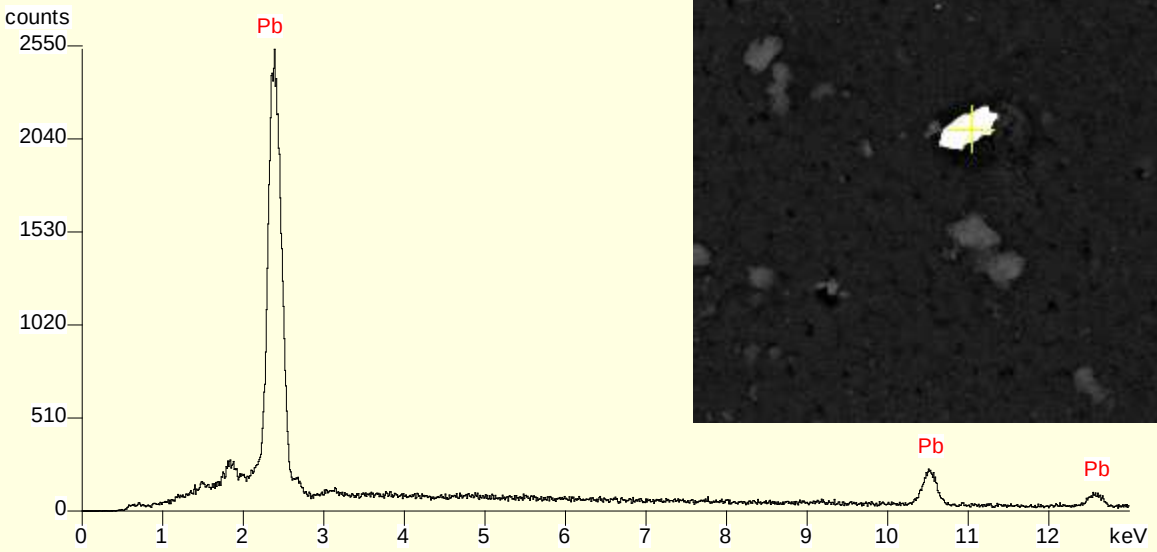
- Potassium coating on smokeless powder





Cartridge Component

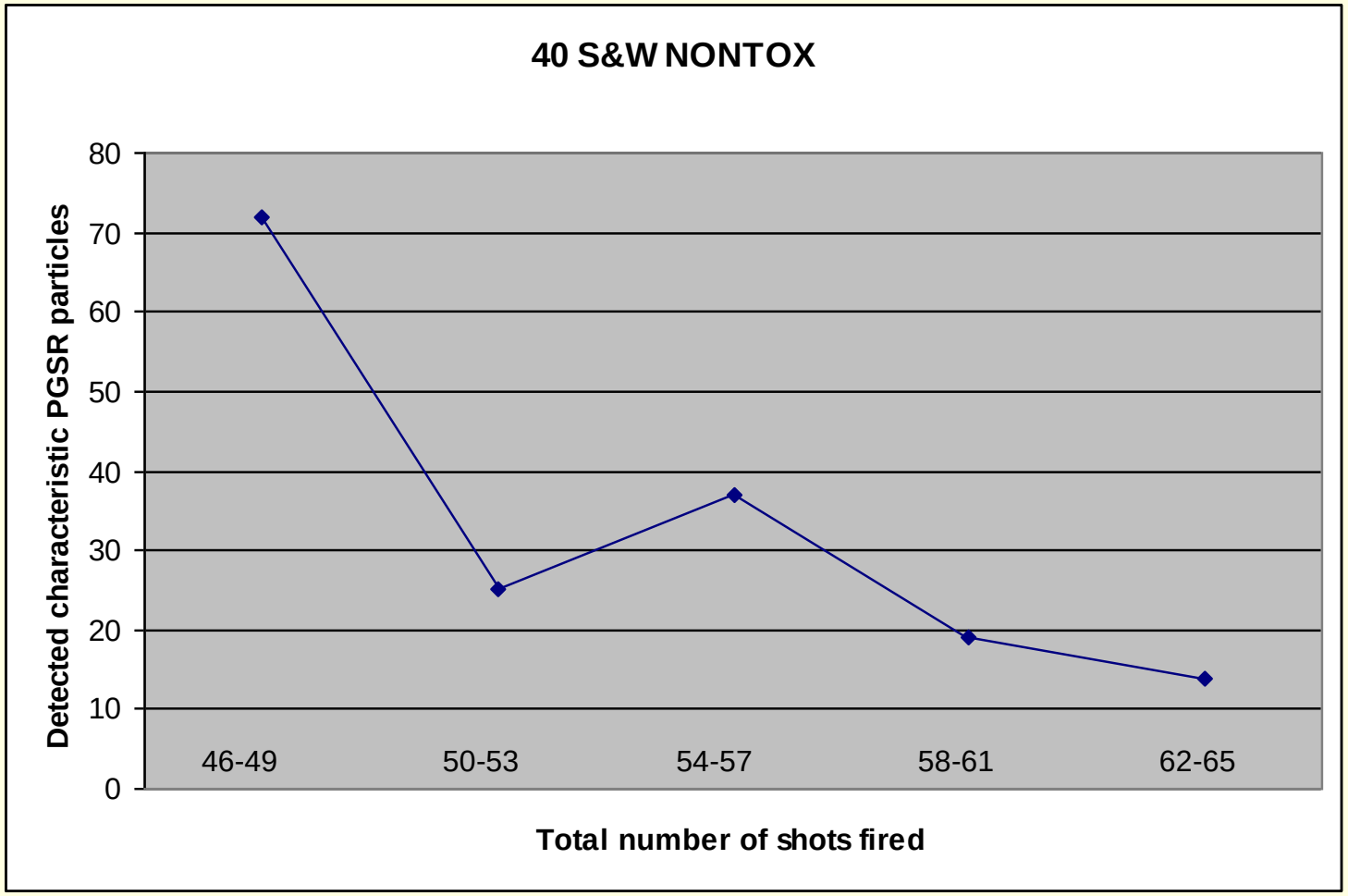
- Particulate lead in smokeless powder
- Present in 9mm, .40 S&W, 38 spl.



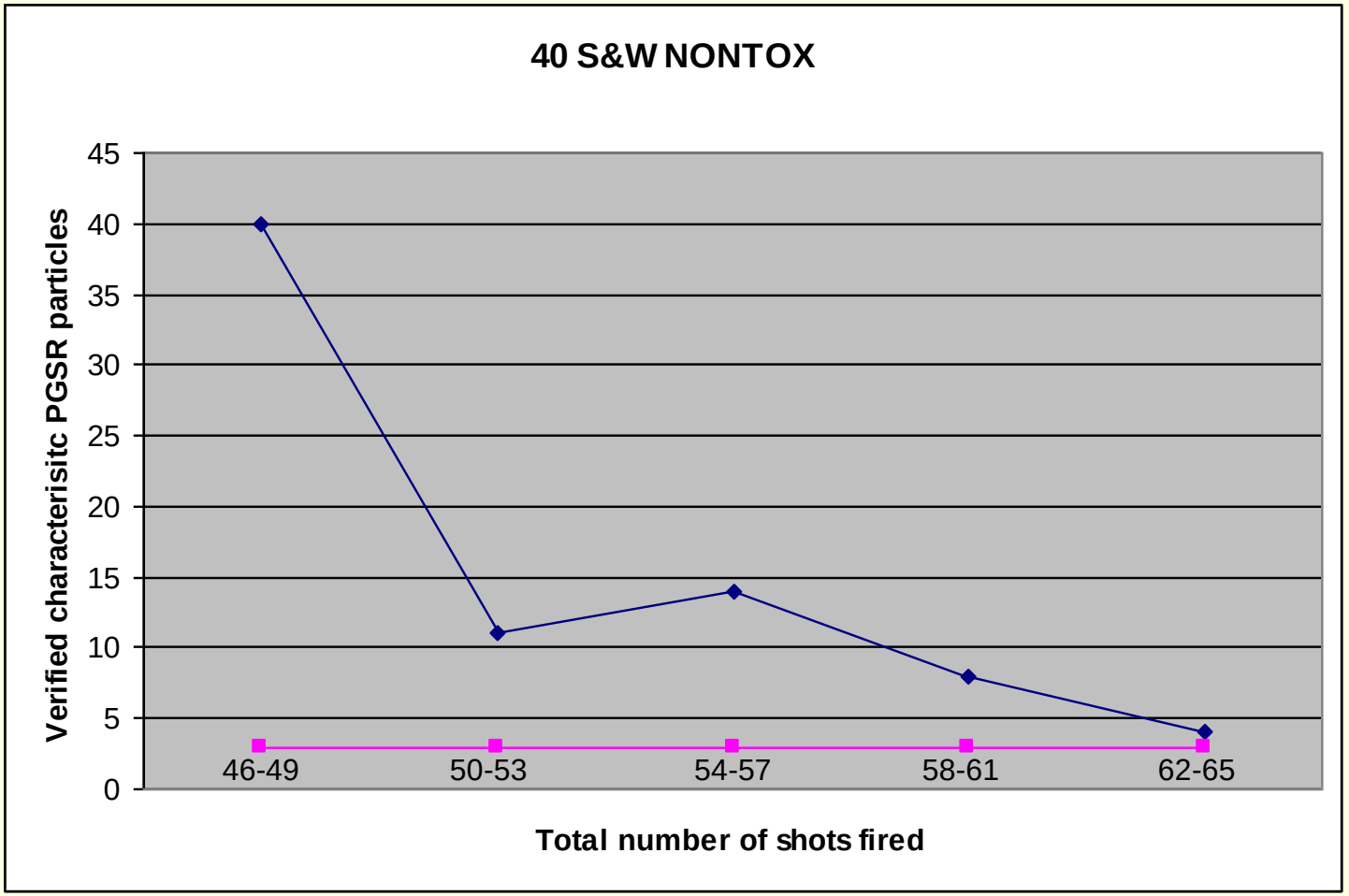
Series 2: 40 S&W 4 shot bursts

- 40 Smith and Wesson model SW40V
- 1 Sinoxid discharged
- 1 NONTOX discharged as baseline
- 4 NONTOX discharged daily
  - Left hand sampled as background
  - Right hand sampled immediately after discharge

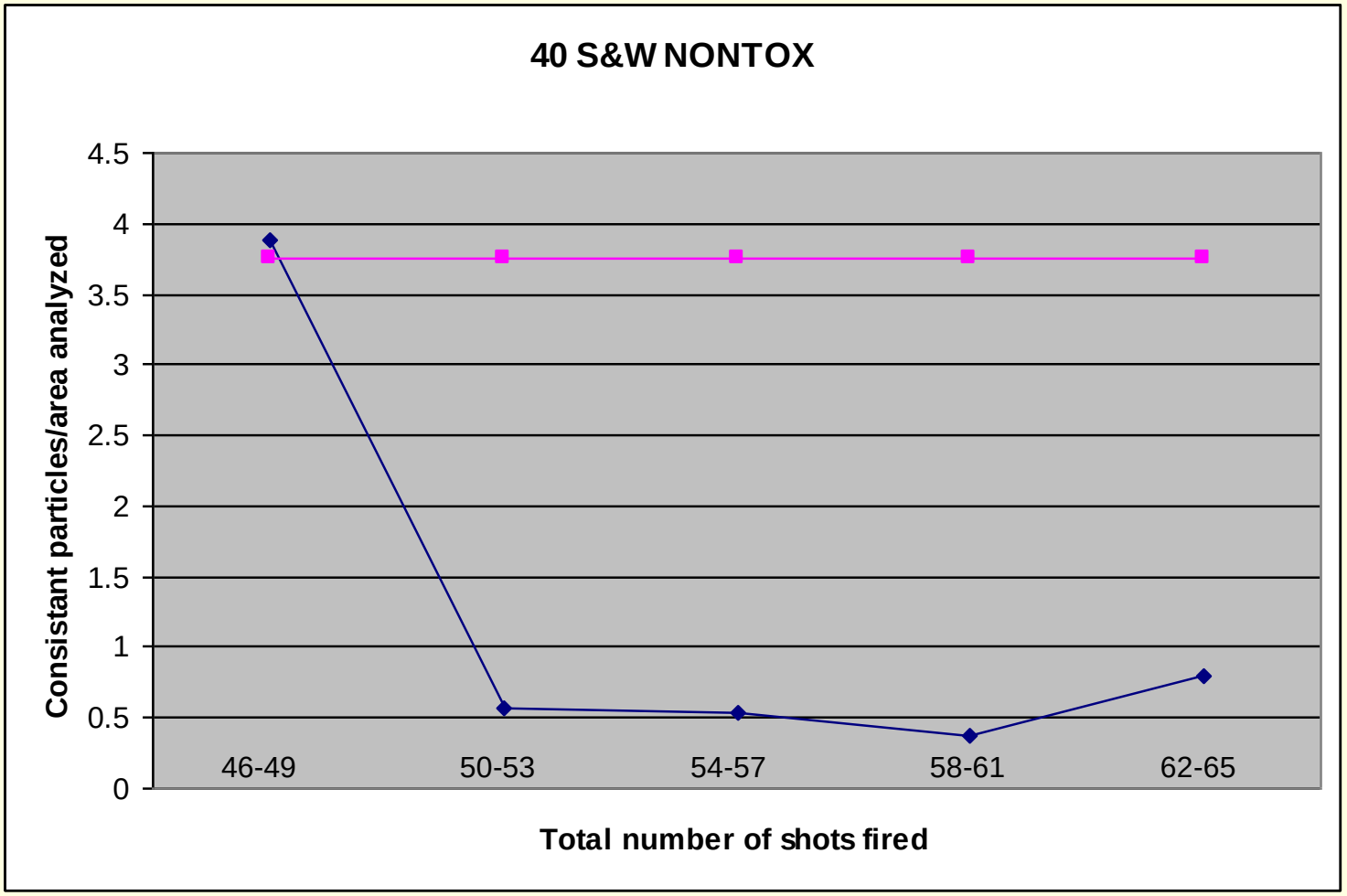
Last 20 Test Fires



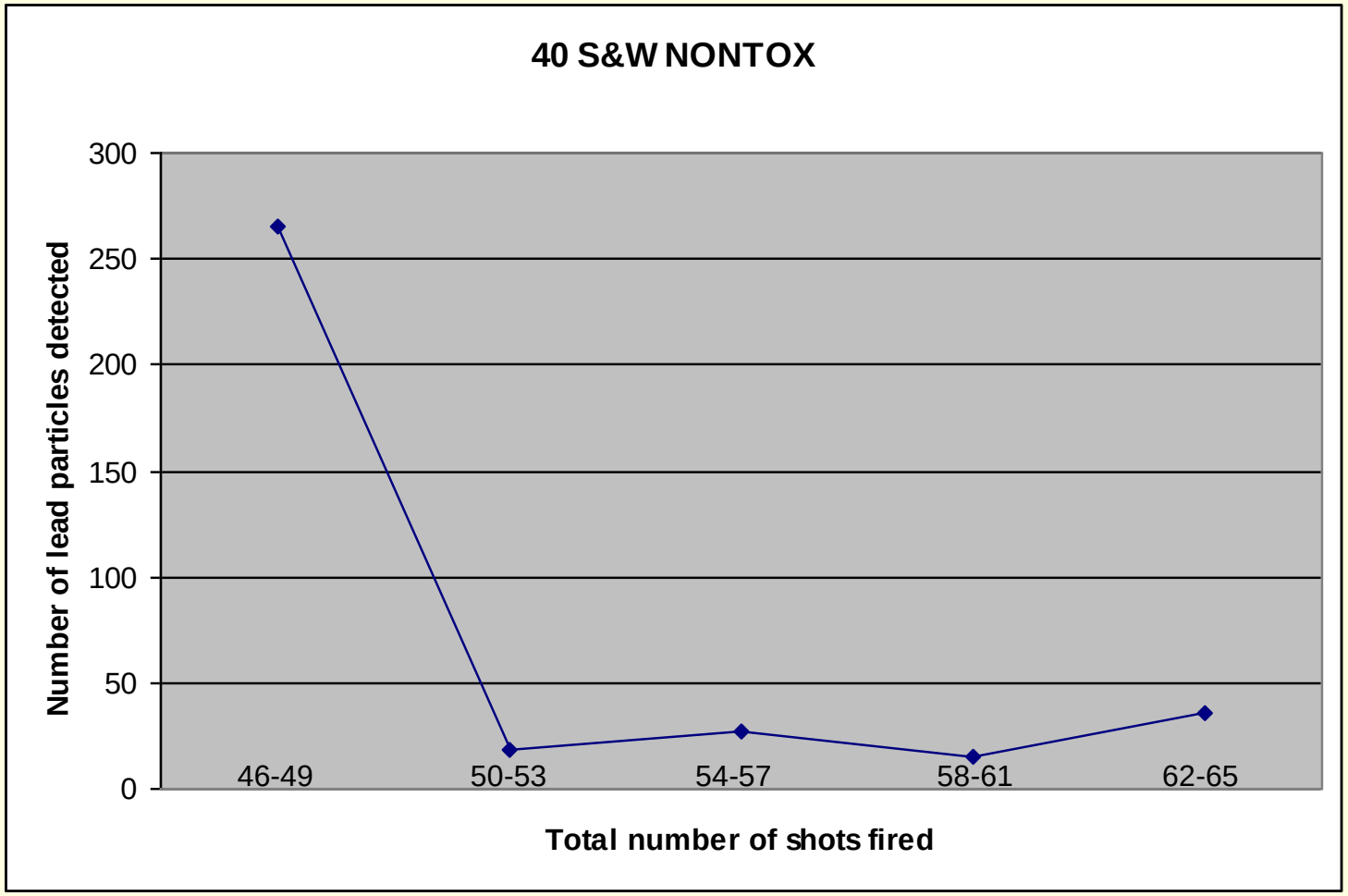
Last 20 Test Fires



Last 20 Test Fires



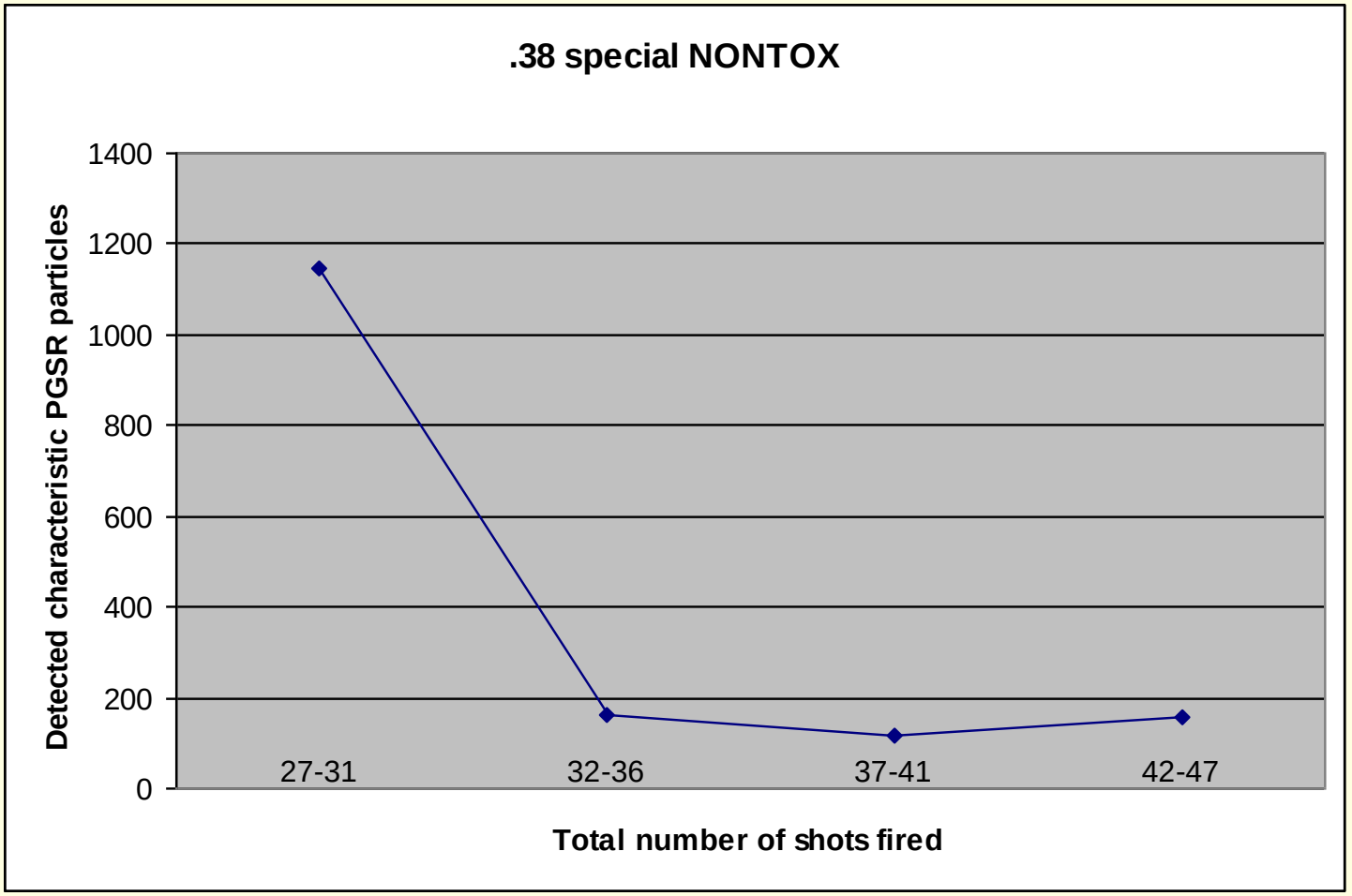
Last 20 Test Fires



Series 3: 38 special 5 shot capacity

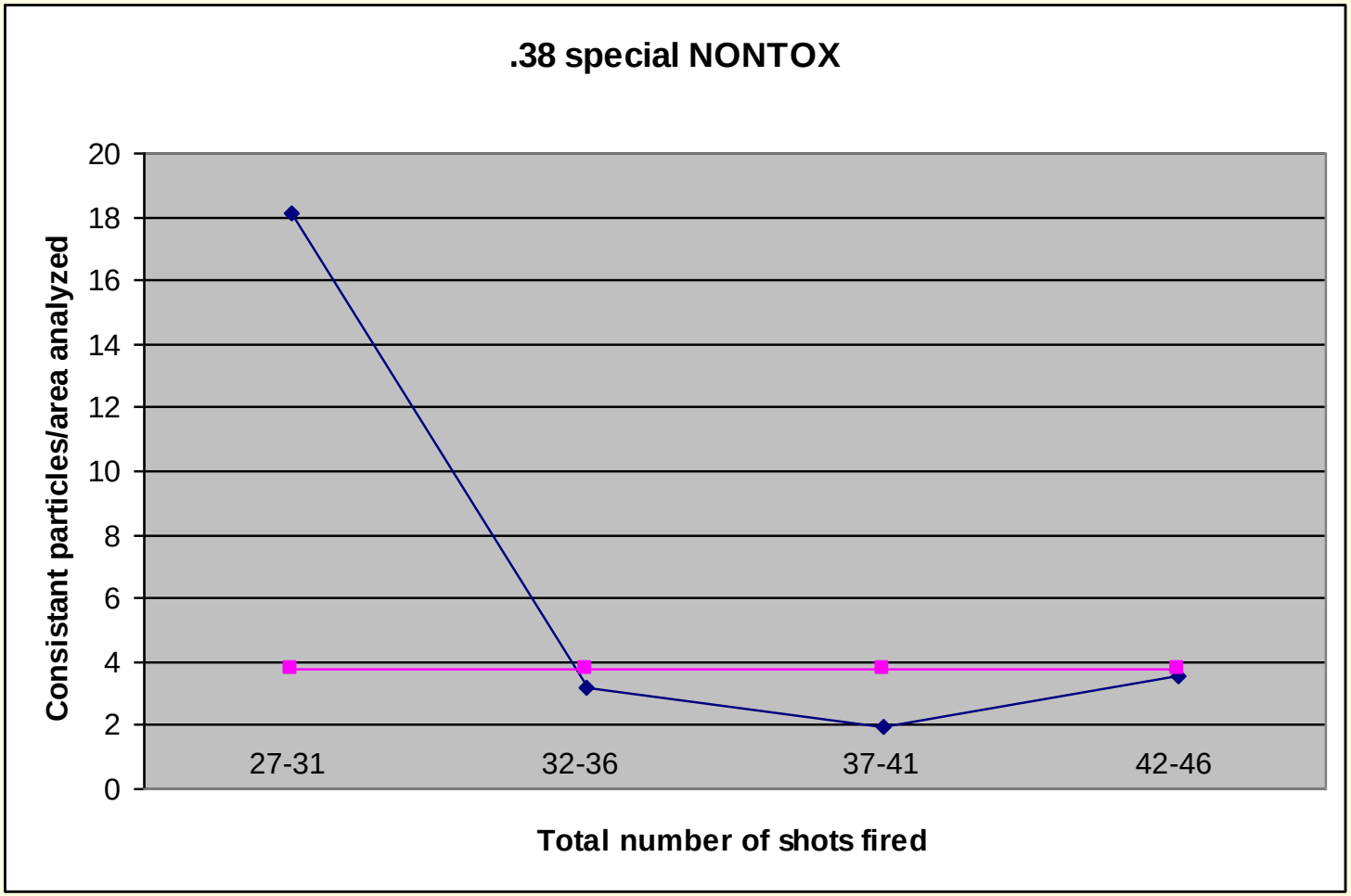
- Ruger model SP101
- 1 Sinoxid discharged
- Gun “cleaned” by Intern
  - Dust-off, paper towels, Q-tips
- 1 NONTOX discharge as baseline
- 5 NONTOX fired daily
  - Left hand sampled as background
  - Right hand sampled immediately after discharge

Last 20 Test Fires

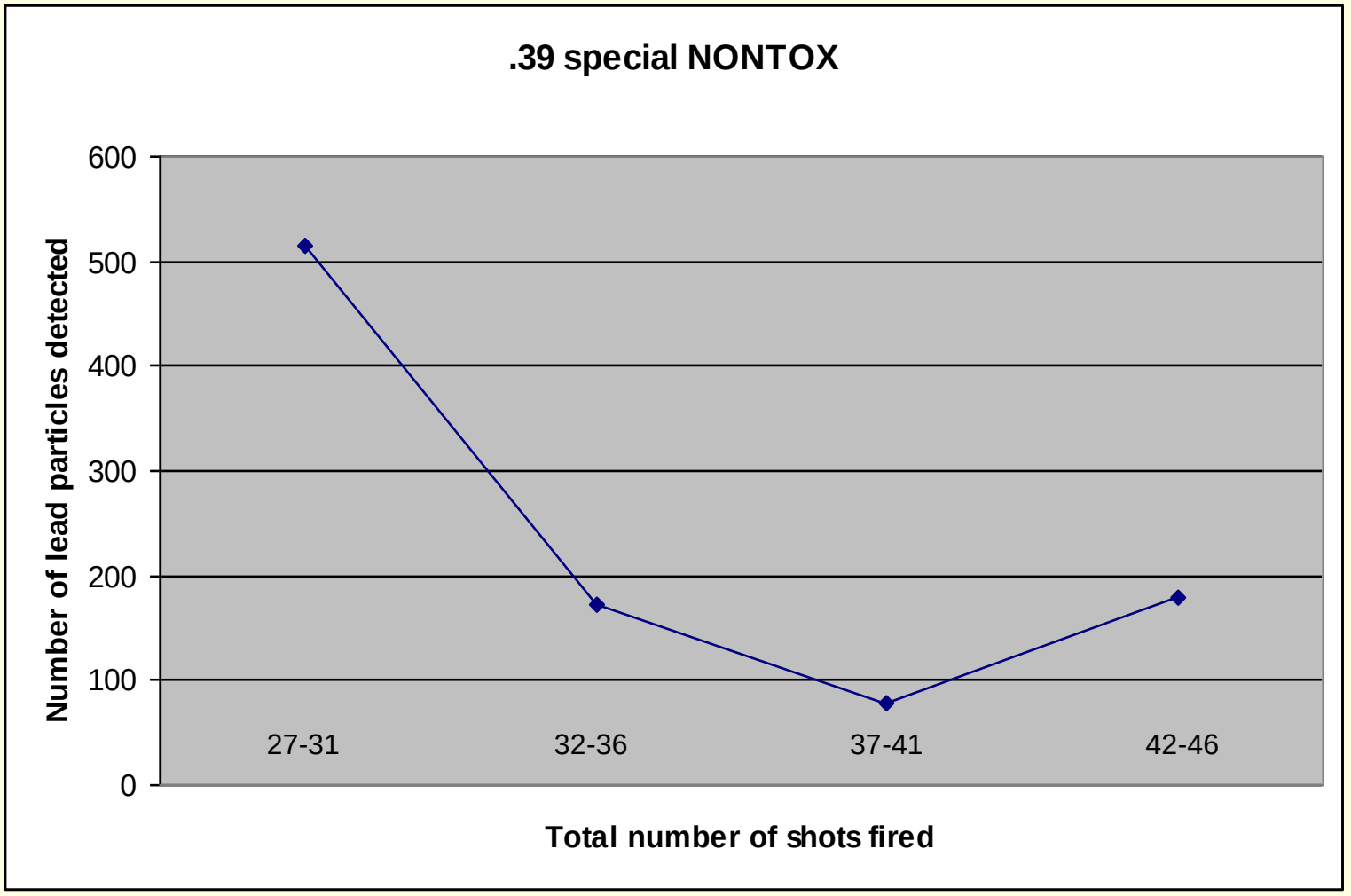


Last 20 Test Fires

Last 20 Test Fires



Last 20 Test Fires



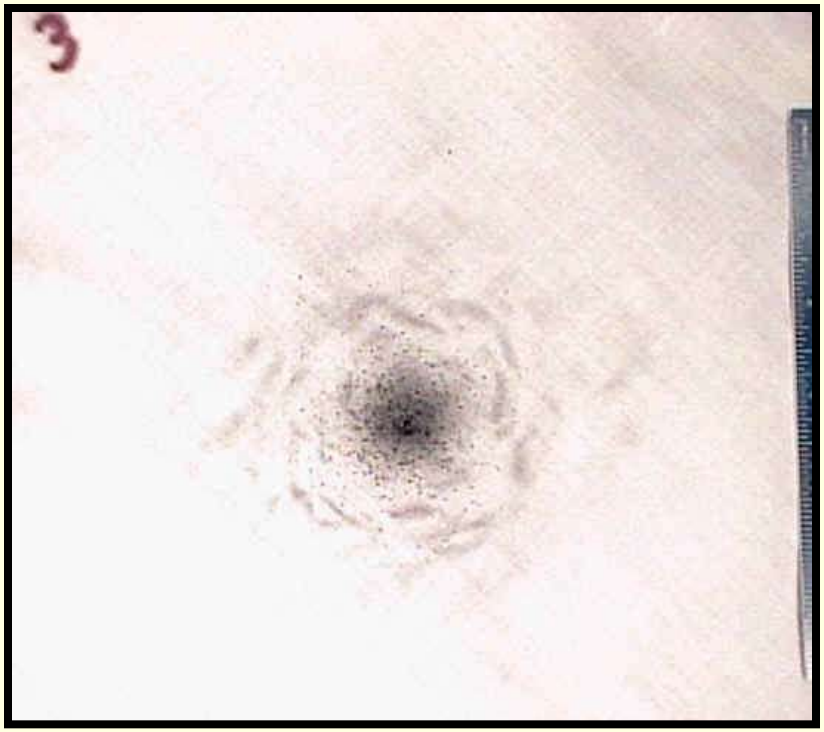
Distance Determination

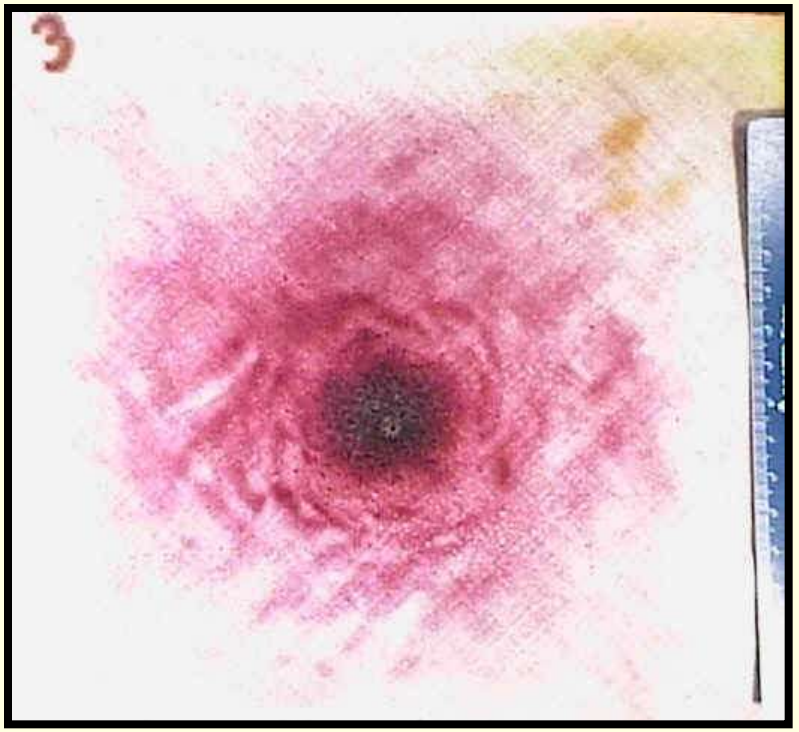
- “A Versatile Technique for the Investigation of GSR Patterns on Fabrics and Other Surfaces: m-XRF” Berendes et al (BKA) JFS Sept 2006
  - “Nontox ammunition containing only potassium as a detectable metallic composition of the primer.”
  - Fired at 5 cm into target

Distance Determination

- “The Sodium Rhodizonate Test: A Chemically Specific Chromophoric Test for Lead in Gunshot Residues” Dillon (FBI) AFTE Journal July 1990
  - “primarily due to the lead compounds typically found in cartridge primer mixtures”
  - “bullet/barrel interactions”

Distance Determination





Distance Determination

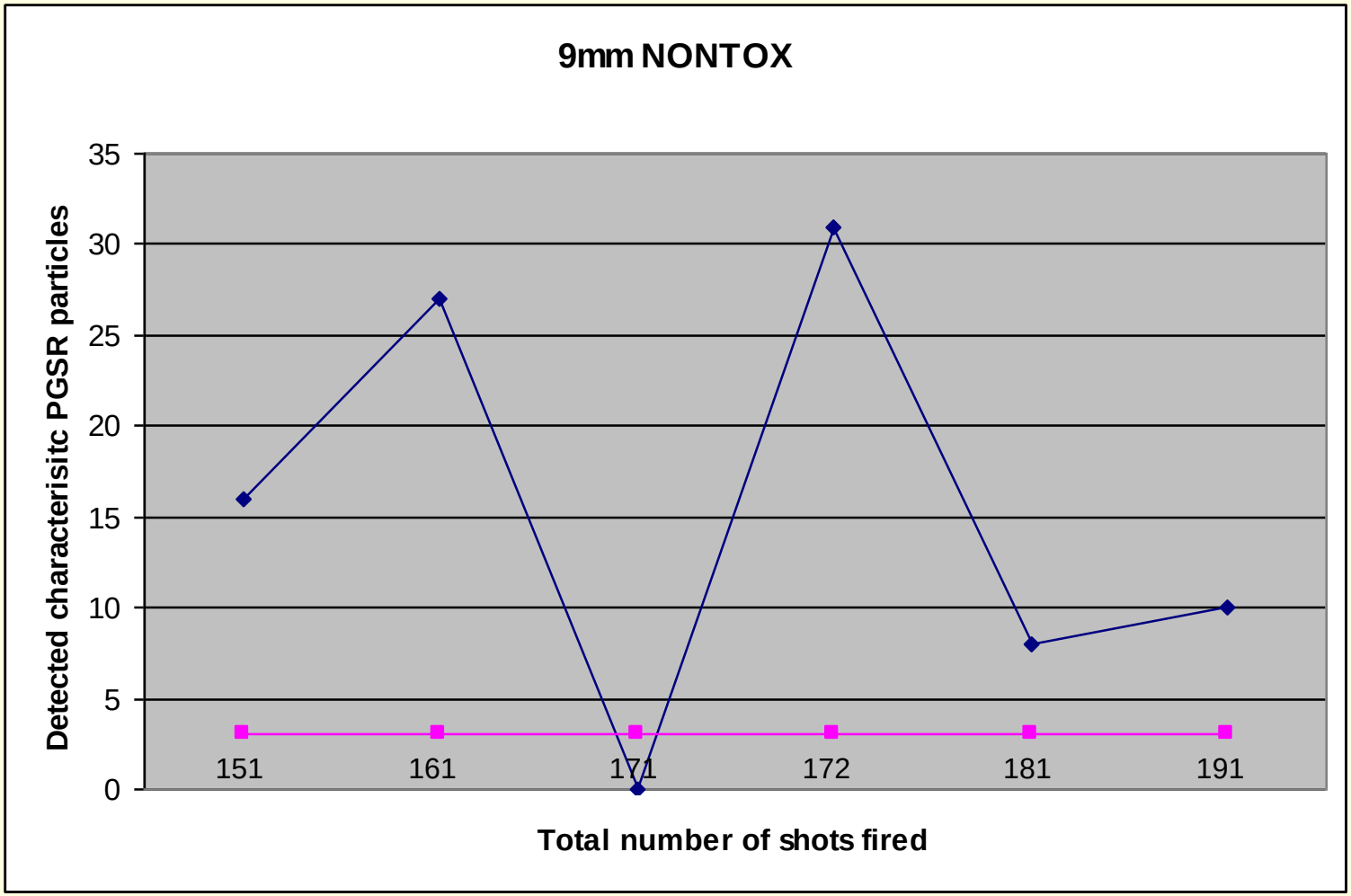
Distance Determination

- No visible soot
- No partially burnt smokeless powder
- Atypical vaporous lead results
- Problematic for Medical Examiners
  - Stippling and visual examinations

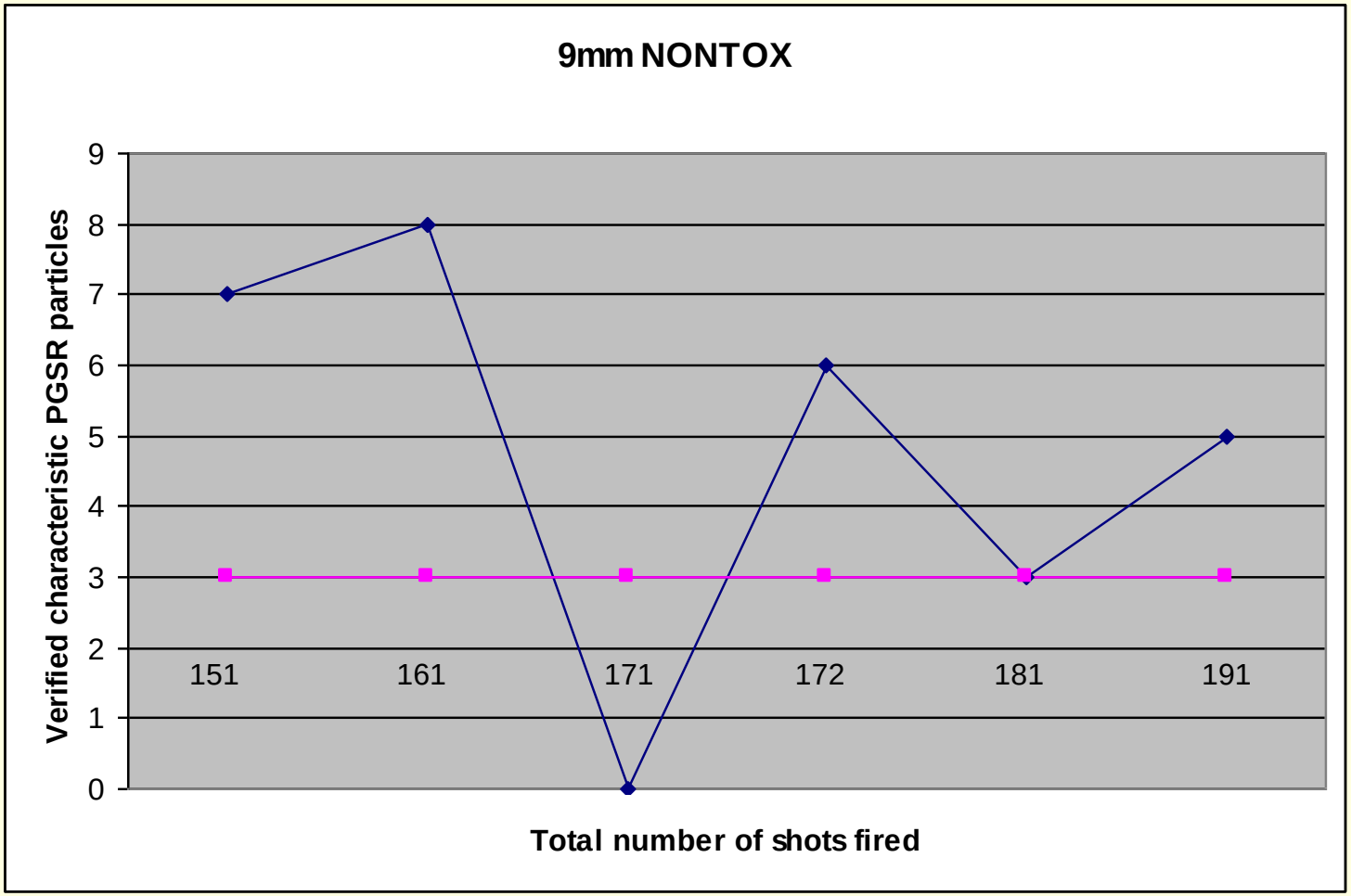
Series 4: 9mm with multiple shots

- Beretta Model 92D
  - Retired P.O.’s firearm
  - Not shot in 4+ years
- 150 shots fired rapidly
- 151st shot as test fire
- Additional shots fired
- Additional test fires

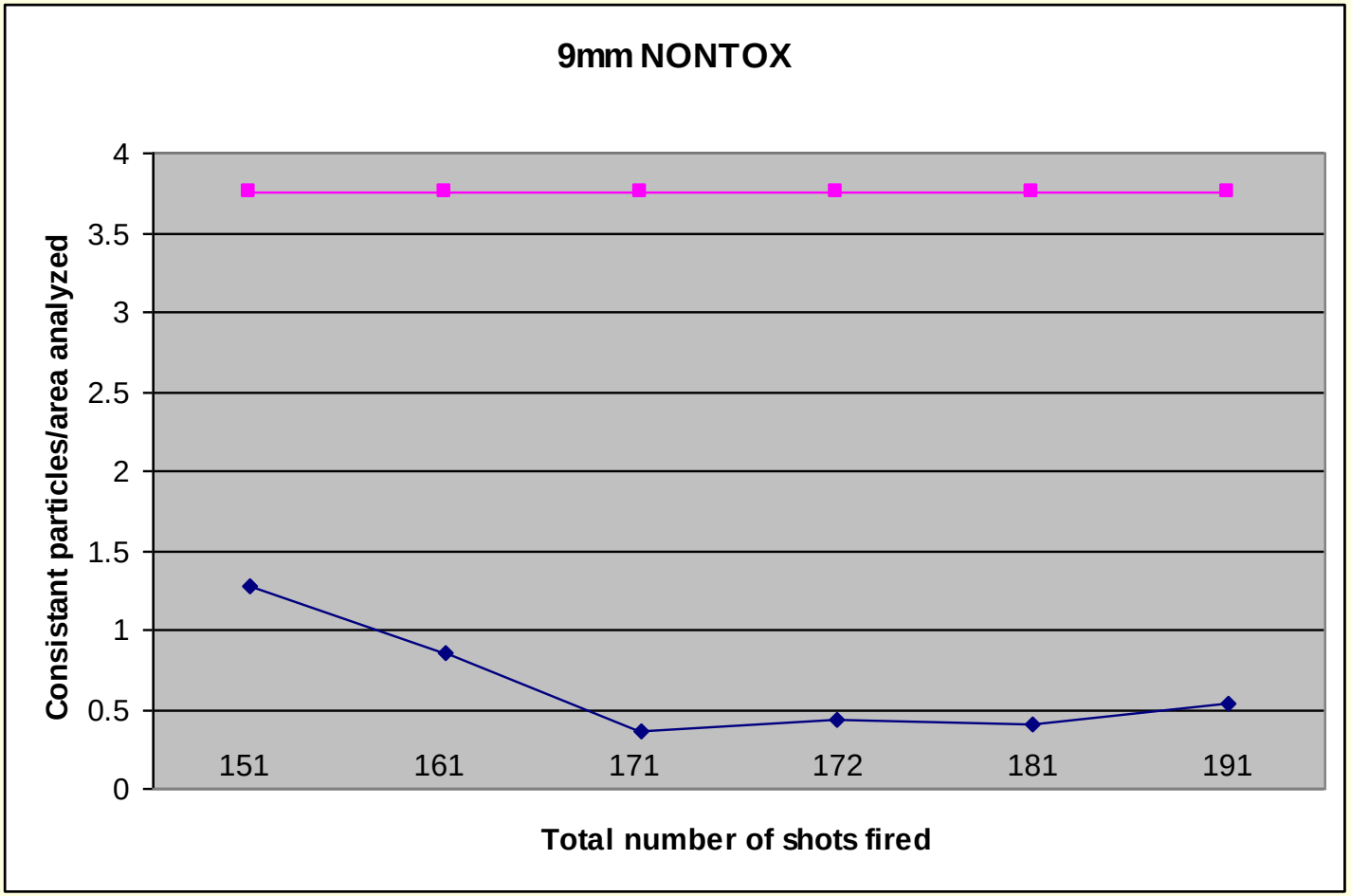
Last 40 Test Fires



Last 40 Test Fires



Last 40 Test Fires



Conclusions

- Positive PGSR test results possible with NONTOX ammunition
- False negative PGSR test results are possible with NONTOX in actual casework
- Difficult to remove all “memory effect” from weapon
- Distance determinations may be problematic

Acknowledgements

- ISP Forensic Science Command
- ISP Research and Development Laboratory
- Marc Pomerance – Firearms
- Radson Muradpejohi – Summer Intern
- Scott Rochowicz – Trace
- Kellen Hunter - Firearms
- Magtech Ammunition