

Application Note: Serstech Arx mkII Raman Spectrometer

Combating Chemical Contraband in Correctional Facilities

Overview

Prison investigators and correctional staff face an unprecedented challenge in identifying increasingly sophisticated forms of chemical contraband. From synthetic drugs impregnated into paper and sent through mail to homemade alcohol fermented in hidden locations, the methods used to smuggle and produce intoxicating substances within correctional facilities have evolved dramatically. The Serstech Arx mkII handheld Raman spectrometer provides investigators with a powerful forensic tool for rapid, accurate identification of these diverse chemical threats without requiring laboratory analysis or exposing staff to potentially dangerous substances.



Arx mkII

The Prison Contraband Crisis: Understanding the Challenge

Scale and Impact of the Problem

Drug overdose deaths in U.S. state prisons have increased by more than 600% over the past two decades, highlighting the severity of the contraband crisis. Correctional facilities face a multifaceted challenge as inmates and their accomplices employ increasingly creative

methods to introduce intoxicating substances into secure environments. The consequences extend far beyond individual health risks, affecting facility security, staff safety, inmate behavior, rehabilitation efforts, and taxpayer costs.

Traditional Contraband Methods

Historically, contraband entered prisons through physical smuggling by visitors, corrupt staff members, or items thrown over perimeter fences. While these methods persist, modern contraband trafficking has become far more sophisticated and difficult to detect.



DIRECT SCAN OF POWDER

Emerging Contraband Threats

Correctional facilities now confront several categories of chemical contraband that pose unique detection challenges:

Drug-Impregnated Paper

The most concerning recent development involves synthetic drugs dissolved in liquid form and applied to ordinary paper materials. This method has become the predominant smuggling technique because:

- Paper appears completely normal to visual inspection
- Drug-soaked paper is odorless and colorless once dry
- Standard X-ray screening cannot detect chemical saturation
- Legal mail and documents often receive less scrutiny
- A single letter-sized sheet can contain hundreds of doses
- Small pieces (as small as a postage stamp) produce intense intoxication

Common substances impregnated into paper include:

- Synthetic cannabinoids (K2, Spice, synthetic marijuana) - the most prevalent
- Synthetic cathinones ("bath salts")
- Suboxone and buprenorphine (opioid treatment medications abused recreationally)
- Fentanyl and fentanyl analogs
- Novel psychoactive substances (designer drugs)

The synthetic cannabinoid problem has become so severe that it's reportedly the third most common contraband in many facilities, surpassed only by homemade alcohol and tobacco. Inmates can purchase small pieces of drug-saturated paper for \$200-\$400 each within prison economies.

"Wasp Dope" - Insecticide Abuse

An alarming trend involves the abuse of insecticide products containing pyrethroids and pyrethrins. These compounds, found in common wasp and hornet sprays, are being:

- Sprayed onto paper and mailed into facilities
- Obtained from prison commissaries and maintenance supplies
- Smoked or dissolved under the tongue
- Used to produce methamphetamine-like effects

Research indicates that approximately 19% of substance abusers in certain regions have used "wasp dope." The health effects are severe and include:

- Rapid heart rate and cardiovascular stress
- Severe headaches and dizziness
- Vomiting and breathing difficulties
- Loss of motor control (inability to walk or speak)
- Risk of toxic reactions and organ damage
- Violent and erratic behavior

The crystalline nature of pyrethroid insecticides makes them particularly dangerous when concentrated and ingested.

Organophosphates

Similar to pyrethroid abuse, organophosphate insecticides have been found impregnated in paper materials. These compounds, which interfere with nervous system function, pose

extreme health risks when deliberately ingested or inhaled. Common symptoms include difficulty breathing, skin irritation, nausea, and in severe cases, life-threatening conditions may arise.

Homemade Alcohol (Pruno/Hooch)

Prison-manufactured alcohol, known as "pruno," "hooch," "prison wine," or "toilet wine," remains one of the most common forms of contraband. Inmates ferment available ingredients including:

- Fruit and fruit juices from meals
- Sugar, hard candy, and sweetened beverages
- Bread (as a yeast source)
- Potatoes and other vegetables
- Ketchup (to accelerate fermentation)

The fermentation process occurs in:

- Plastic bags hidden in cells, walls, or ventilation
- Toilet tanks and plumbing spaces
- Trash containers and shower areas
- Any warm, concealed location



Arx mkII - through dark glass

Pruno poses multiple risks:

- Unpredictable alcohol content ranging from 2% to 14% ABV (beer to strong wine strength)

- Botulism contamination - multiple outbreaks have occurred when potatoes or contaminated ingredients were used, resulting in paralysis, hospitalization, and intensive care admissions
- Unsanitary production conditions leading to bacterial contamination
- Behavioral effects including intoxication, violence, and impaired judgment

Cleaning Fluids and Solvents

Household cleaning products containing alcohol or intoxicating solvents are sometimes consumed or inhaled for their psychoactive effects. These include:

- Alcohol-based hand sanitizers and disinfectants
- Cleaning solutions with isopropanol or ethanol
- Aerosol products that can be concentrated and abused

Detection Challenges

Prison investigators face several obstacles in identifying chemical contraband:

1. Visual Inspection Limitations - Drug-impregnated paper looks identical to normal paper; homemade alcohol resembles fruit juice or water
2. Volume of Material - Thousands of pieces of mail enter facilities daily, making comprehensive screening nearly impossible
3. Legal Mail Protections - Attorney-client correspondence receives special protection, creating smuggling opportunities
4. Laboratory Delays - Traditional analysis requires sending samples to labs, with results taking days or weeks
5. Safety Concerns - Opening suspicious packages exposes staff to fentanyl and other dangerous substances
6. Evolving Chemistry - New synthetic drugs are constantly developed to evade detection and regulation
7. Staff Exposure - Correctional officers report becoming intoxicated from secondhand exposure to synthetic cannabinoid smoke

Solution: Serstech Arx mkII Raman Spectrometer

Technology Overview

The Serstech Arx mkII utilizes Raman spectroscopy to identify chemical substances through their unique molecular signatures. When the device's 785 nm laser interacts with a sample, it produces a distinctive spectral "fingerprint" that can be matched against comprehensive

reference libraries. This non-destructive analysis provides definitive identification within seconds.

Key Features for Correctional Applications

Patented Autofocus Technology (SharpEye)

- Automatically identifies the optimal measurement point
 - Penetrates through packaging materials (plastic bags, containers)
 - Enables through-container analysis without opening suspicious items
 - Minimizes staff exposure to dangerous substances
 - Focuses on the substance rather than container materials
-

Handheld, Rugged Design

- Weighs approximately 590g (1.3 lbs) - pocket-portable
- 12-hour battery life supports extended shifts and investigations
- Single-button, one-handed operation
- IP67 and MIL-STD-810G certified for harsh correctional environments
- Operates in temperature extremes: -20°C to +50°C (-4°F to 122°F)
- Resistant to drops, moisture, and daily wear



Arx mkII - designed for tough conditions

Comprehensive Chemical Libraries

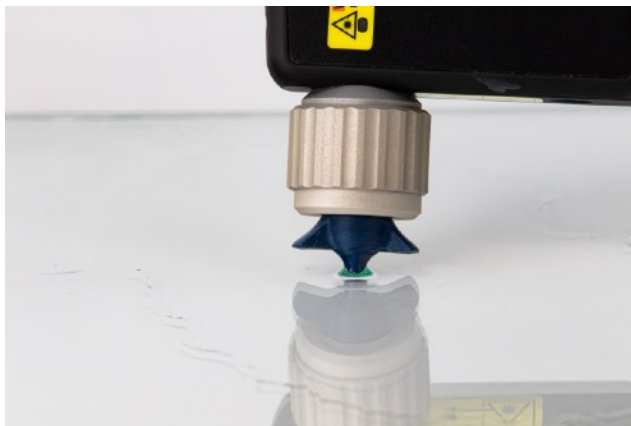
- Narcotics Library - Comprehensive coverage of controlled substances including:
 - Synthetic cannabinoids (K2, Spice variants)
 - Synthetic cathinones
 - Fentanyl and analogs
 - Traditional narcotics (cocaine, heroin, methamphetamine)
 - Prescription opioids and benzodiazepines
- Pharmaceuticals Library - Legitimate medications that may be smuggled or abused
- Hazardous Chemicals Library - Industrial chemicals, solvents, and toxic substances
- Quarterly Library Updates - New substances added at no additional cost

Paper and Surface Analysis Capability

- Direct scanning of paper materials to detect impregnated substances
- Identifies synthetic cannabinoids, Suboxone, and other drugs absorbed into paper
- Analyzes substances through clear or translucent plastic packaging
- Can detect contamination on various surfaces

Liquid Analysis

- Identifies homemade alcohol (pruno/hooch)
- Distinguishes between water, juice, and alcoholic beverages
- Analyzes cleaning fluids and solvents
- Works with Capillary Probe for trace liquid samples (as small as 10 μ L)



CAPILLARY PROBE

Enhanced Sensitivity with optional SERS

- Optional Surface Enhanced Raman Spectroscopy (SERS) kit



SERS ACCESSORY

- Reduces detection limits to 200 ppm
- Critical for identifying trace amounts of fentanyl and other potent substances
- Detects drugs even when heavily diluted or present in small quantities
- Simple snap-on attachment design

Application Scenarios in Correctional Facilities

Scenario 1: Drug-Impregnated Mail Detection

Investigator Thompson is screening incoming mail in the facility mail room. A letter from a frequent correspondent to an inmate with a history of synthetic cannabinoid violations appears normal but has a slightly waxy texture. Visual inspection and the facility's X-ray system reveal nothing suspicious.

Solution: Using the Arx mkII, Investigator Thompson scans the paper directly through the clear plastic evidence bag. Within 15 seconds, the device identifies synthetic cannabinoid JWH-018 impregnated into the paper fibers. The letter is immediately flagged as contraband. The non-destructive scan preserves the evidence for disciplinary proceedings and potential criminal charges. The investigator continues screening without having to open the letter or expose themselves to the substance.

Scenario 2: Wasp Spray Identification on Paper

During a cell search, Officer Martinez discovers several small squares of paper hidden inside a book. The inmate claims they are bookmark materials, but the officer is suspicious given recent intelligence about "wasp dope" trafficking in the facility.

Solution: Officer Martinez uses the Arx mkII to scan one of the paper squares. The device identifies the presence of permethrin and cypermethrin - pyrethroid insecticides commonly found in wasp and hornet sprays. The spectrum matches the hazardous chemicals library, confirming the paper has been treated with insecticide for abuse purposes. The discovery leads to a broader investigation revealing a smuggling operation through contaminated greeting cards. The identification is documented with GPS-tagged spectral data for the incident report.

Scenario 3: Homemade Alcohol Detection During Cell Inspection

Investigator Chen conducts a routine cell inspection and notices a plastic bag partially hidden beneath the bunk. The bag contains a cloudy, amber liquid with visible fruit pieces floating inside. The inmate claims it's simply fruit juice he's saving from meals.

Solution: Without opening the suspicious bag, Investigator Chen uses the Arx mkII to scan the liquid through the plastic. The device identifies ethanol at concentrations consistent with fermented beverages (approximately 8% alcohol by volume), confirming it as pruno. The spectral signature also reveals the presence of fermented sugars and fruit acids. The investigator seizes the contraband and documents the violation. Because the bag wasn't opened, the risk of botulism exposure to staff is eliminated, and the evidence is preserved in its original condition.

Scenario 4: Cleaning Fluid Analysis

A correctional officer notices an inmate has accumulated multiple bottles of hand sanitizer in their cell - far more than needed for personal hygiene. Suspicious of alcohol extraction or abuse, the bottles are sent to the investigations unit.

Solution: Investigator Rodriguez uses the Arx mkII with the small volume adapter to analyze the contents of each bottle. Most contain standard hand sanitizer with normal ethanol content (62%), but one bottle's analysis reveals nearly pure ethanol (95%) - indicating the inmate has been concentrating the alcohol through evaporation for consumption. The concentrated alcohol is confiscated, and the inmate faces disciplinary action. The rapid analysis allows the investigator to check multiple bottles within minutes rather than waiting days for laboratory results.

Scenario 5: Trace Fentanyl Detection with SERS

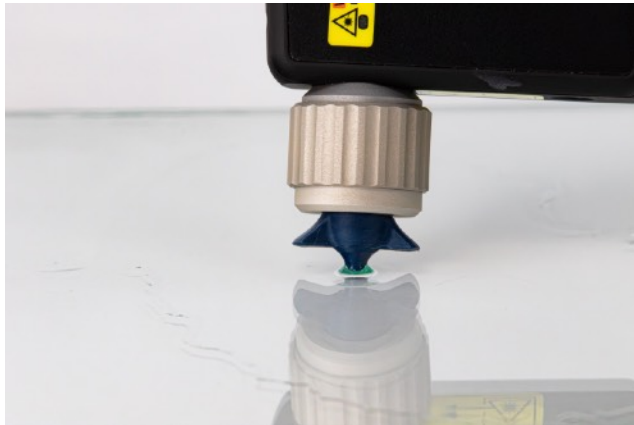
The investigations unit receives intelligence that a specific inmate has been receiving letters containing fentanyl, but visual inspection of recent mail shows no obvious signs of contamination. Standard Raman scans of the paper detect only normal paper fibers and ink.

Solution: Investigator Kim attaches the SERS kit to the Arx mkII for enhanced sensitivity. She takes a small sample from the edge of a suspicious letter and places it on the SERS substrate. The enhanced analysis detects fentanyl at trace levels (less than 0.1% of the paper weight) - concentrations too low for standard Raman but sufficient to provide multiple dangerous

doses. The SERS technology reveals what standard methods missed, preventing potentially lethal contraband from reaching the inmate population. The discovery prompts enhanced screening of all mail from this sender.

Scenario 6: Capillary Probe Analysis of Spilled Liquid

During a shakedown of a housing unit, investigators notice small droplets of clear liquid on a table surface near several inmates' belongings. The liquid has no obvious smell, but its presence is suspicious.



CAPILLARY PROBE

Solution: Using the capillary probe attachment, Investigator Williams touches the probe tip to one of the droplets. The capillary action draws up the tiny sample (approximately 10 μ L). The Arx mkII analyzes the liquid and identifies it as methanol – a toxic alcohol sometimes produced in poorly controlled pruno fermentation or extracted from other sources. The high toxicity of methanol makes this discovery critical for inmate safety. Investigators locate the source container and seize it before anyone can consume the dangerous liquid.

Scenario 7: Multi-Substance Cell Search

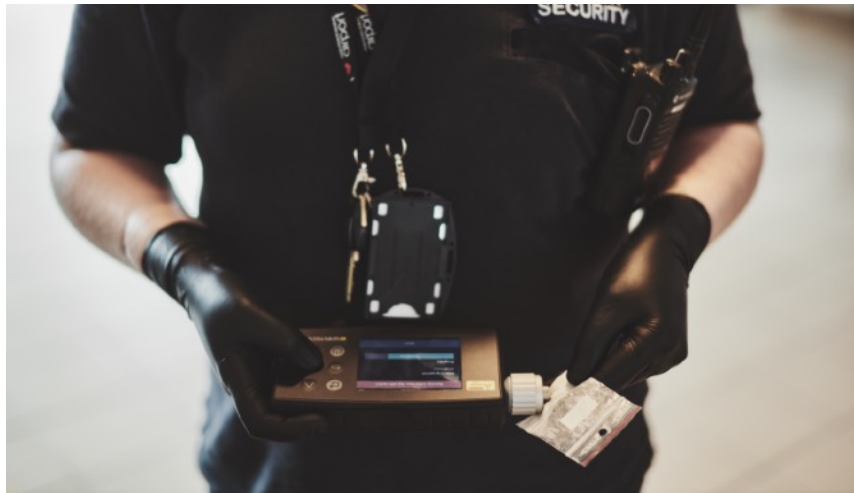
Intelligence indicates a specific cell may contain multiple types of contraband. During a comprehensive search, investigators find: a letter that seems ordinary, a sports drink bottle containing clear liquid, white powder in a folded magazine page, and a plastic bag with cloudy liquid.

Solution: Lead Investigator Davis uses the Arx mkII to rapidly identify all discovered substances:

1. Letter – Scanned directly, reveals synthetic cannabinoid AB-CHMINACA impregnated in paper
2. Sports drink bottle – Point-and-shoot scan through translucent container identifies ethanol (ethanol in water)

3. White powder - Initial scan shows mostly crushed aspirin, but SERS analysis detects trace amounts of methamphetamine (2% concentration)
4. Cloudy liquid in bag - Identified as fermenting pruno at early stages (approximately 4% ethanol)

Total analysis time: approximately 8 minutes for all four items. The comprehensive identification allows investigators to document multiple serious violations and understand the full scope of contraband activity in the cell. All evidence is preserved for disciplinary hearings and potential prosecution.



Operational Advantages for Correctional Facilities

Enhanced Staff Safety

- Non-contact analysis eliminates exposure to fentanyl, synthetic drugs, and toxic chemicals
- Through-container scanning prevents accidental skin contact or inhalation
- No presumptive tests required - avoids reagents that can be dangerous or create false positives
- Rapid threat assessment allows appropriate safety precautions before handling

Improved Investigation Efficiency

- Instant results enable real-time decision-making during searches and mail screening
- No laboratory delays - results in seconds rather than days or weeks
- High throughput allows screening of large volumes of mail or evidence

- Portable operation brings laboratory-grade analysis to cell blocks, mail rooms, and visiting areas

Legal and Evidentiary Benefits

- Scientific identification provides legally defensible evidence for disciplinary hearings
- Detailed spectral data can be archived and presented in court
- GPS tagging documents where and when substances were discovered
- Chain of custody maintained - non-destructive testing preserves evidence integrity
- Expert testimony support - scientifically accepted methodology

Cost-Effectiveness

- Reduced laboratory expenses for routine contraband identification
- Single device handles multiple substance types - drugs, alcohol, chemicals, insecticides
- Five-year warranty protects investment
- No consumables required - unlike chemical field tests that require replacement kits
- Quarterly library updates provided at no additional cost
- Regular firmware updates are provided at no additional cost for the life of the instrument

Intelligence and Pattern Detection

- Identify smuggling trends by tracking which substances are entering the facility
- Source attribution - link similar contraband to specific suppliers or methods
- Proactive interdiction - deploy screening at points where specific threats are identified
- Staff training - real examples of confiscated contraband for education

Integration into Correctional Operations

Mail Room Screening

Setup:

- Station dedicated screener with Arx mkII in mail processing area
- Implement risk-based screening protocols targeting:
 - Mail from known problematic correspondents

- Letters with suspicious appearance (waxy texture, discoloration, unusual weight)
- Legal mail opened in controlled circumstances
- All mail to inmates with substance abuse histories

Procedure:

1. Conduct initial visual and X-ray screening
2. For suspicious items, place in clear evidence bag
3. Scan paper directly through bag using point-and-shoot mode
4. Document findings with device-generated reports
5. Preserve contraband evidence with GPS-tagged spectral data
6. Flag patterns for intelligence analysis

Cell Searches and Inspections

Preparation:

- Ensure device is charged for full shift (12-hour battery)
- Brief search teams on current contraband intelligence
- Bring evidence bags and documentation materials

During Search:

1. Document location and appearance of suspicious items
2. Scan substances through containers when possible
3. For liquids, use appropriate adapters (capillary probe for traces, small volume adapter for containers)
4. For powders and papers, scan directly or place on clean surface
5. When SERS sensitivity needed, attach kit and use substrates
6. Record all findings with GPS location stamps

Post-Search Documentation:

1. Transfer scan results via WiFi or USB to ChemDash software
2. Generate comprehensive reports with spectral graphs
3. Attach data to disciplinary and investigative files
4. Brief intelligence unit on discoveries

Visiting Area Monitoring

- Screen items brought by visitors when suspicious
- Analyze residues on surfaces where exchanges may occur
- Identify contamination on clothing or personal items
- Document patterns of visitor-based smuggling

Random and Targeted Screening Programs

- Implement random screening of housing units
- Focus resources on areas with known substance abuse issues
- Screen commissary items if contamination suspected
- Analyze cleaning supplies and maintenance materials for abuse potential

Technical Specifications Summary

Specification	Details
Weight	Approximately 590g (1.3 lbs)
Battery Life	12 hours continuous operation
Laser	785 nm, Class 3B, 300 mW max output
Operating Temperature	-20°C to +50°C (-4°F to 122°F)
Durability	IP67 (dust/water resistant), MIL-STD-810G certified
Analysis Time	5-15 seconds per sample (typical)
Connectivity	WiFi, USB, optional ATAK integration
Operation	Single-button, one-handed use
Detection Limit	Standard: substance-dependent; SERS: 200 ppm
Display	High-resolution touchscreen with glove operation

Safety Considerations

Laser Safety

- Class 3B laser (300 mW at 785 nm) requires basic precautions
- Never direct beam toward people or reflective surfaces
- Maintain 1-meter (3-foot) safety distance during operation
- Follow EN 60825-1 safety guidelines
- Use in well-ventilated areas away from flammable materials

Substance Handling

- Always use through-container analysis when possible to minimize exposure
- Wear nitrile gloves when handling suspected contraband
- Avoid opening packages suspected of containing fentanyl or toxic substances
- Use capillary probe for liquid traces to avoid direct contact
- Follow facility protocols for evidence handling and decontamination

Fentanyl and Potent Substances

- The Arx mkII enables identification WITHOUT opening packages
- Never taste, smell, or directly contact unknown substances
- Have naloxone (Narcan) readily available when screening suspected opioids
- Brief emergency medical staff when working with potentially lethal substances

Training Recommendations

For effective deployment in correctional settings, staff should receive training in:

1. Basic Raman Spectroscopy Principles
 - Understanding how molecular analysis identifies substances
 - Interpreting spectral matches and confidence levels
 - Limitations of the technology
2. Device Operation
 - Proper handling and maintenance
 - Scanning techniques for various sample types
 - Using accessories (SERS kit, capillary probe, adapters)
 - Troubleshooting common issues
3. Library Management

- Activating appropriate libraries for facility needs
 - Understanding library updates and new substance additions
 - Interpreting results when substances aren't in library
4. Evidence Protocols
- Maintaining chain of custody
 - Documenting findings with photographs and spectral data
 - Preparing reports for disciplinary proceedings
 - Preserving evidence for potential criminal prosecution
5. Safety Procedures
- Laser safety compliance
 - Minimizing exposure to dangerous substances
 - Emergency response to accidental exposure
 - Decontamination procedures
6. Current Contraband Threats
- Emerging synthetic drugs and their effects
 - Smuggling methods and concealment techniques
 - Health risks associated with specific substances
 - Intelligence-led screening strategies

Recommended Package Configuration

For correctional facility applications, the Arx mkII Narcotics Pro Package is recommended:

Core Components:

- Arx mkII base unit
- Bundled Narcotics, Explosives and Hazardous Chemicals libraries
- SERS kit for enhanced fentanyl detection at trace levels as well as other narcotics
- ChemDash Pro software for multi-user management and reporting
- Capillary probe for trace liquid analysis
- Small volume adapter for analyzing small liquid quantities
- Ruggedized carrying case
- Spare battery pack

- Five-year comprehensive warranty

Optional Enhancements:

- Additional pharmaceutical library for prescription medication verification
- ChemDash Mobile for addition of GPS location, photos and colorimetric test kit data
- TAK, WinTAK, ATAK (etc.) integration for tactical operations with installed Universal Protocol Architecture
- Multiple user licenses for ChemDash enterprise deployment
- Extended warranty and priority support



TraSERSwab, Capillary Probe, Bag Clip, Puncture Tool

- Puncture probe
- Capillary probe
- Plastic bag clip for handsfree measurements of bag
- TraSERSwab for SERS measurements of residues on surfaces

Support and Maintenance

Warranty and Support

- Five-year comprehensive warranty included with all Serstech instruments
- Quarterly library updates covering new synthetic drugs and substances
- Technical support available through Serstech and authorized distributors

- Emergency response support for critical identification needs

Maintenance Requirements

- Regular lens cleaning using provided lens pen or isopropanol swabs
- Periodic inspection of device exterior and charging contacts
- Battery condition monitoring and replacement as needed
- Annual calibration verification (recommended)
- Software updates downloaded via WiFi or USB

Replacement Parts and Accessories

- SERS substrates (disposable, purchased in packs)
- Replacement batteries
- Spare adapters and probes
- Additional carrying cases
- License expansions for ChemDash software

Conclusion

The contraband crisis in correctional facilities has evolved beyond traditional smuggling methods to include sophisticated chemical threats that are nearly impossible to detect through visual inspection alone. Drug-impregnated paper, insecticide abuse, homemade alcohol, and concentrated solvents present complex identification challenges that overwhelm conventional screening methods and endanger staff and inmates alike.

The Serstech Arx mkII Raman spectrometer provides prison investigators with a transformative capability: instant, accurate, scientifically defensible identification of chemical contraband without laboratory delays or staff exposure to dangerous substances. From scanning drug-saturated paper in the mail room to identifying homemade alcohol hidden in cells, the device brings forensic-laboratory capabilities directly to the front lines of correctional security.

The combination of portability, rapid analysis, comprehensive chemical libraries, and through-container scanning makes the Arx mkII ideally suited for the demanding, unpredictable environment of correctional facilities. By enabling proactive interdiction of contraband before it reaches the inmate population, the technology supports facility security, staff safety, inmate health, and rehabilitation objectives.

As correctional agencies confront the 600% increase in drug-related inmate deaths over the past two decades, tools like the Arx mkII represent a critical investment in comprehensive security. The device's ability to identify emerging threats - from synthetic cannabinoids to wasp spray abuse - ensures facilities can adapt to evolving contraband tactics while maintaining the evidentiary standards required for disciplinary and criminal proceedings.

For More Information

Serstech AB

Website: www.serstech.com

Email: info@serstech.com

Address: Åldermansgatan 13, SE-227 64 Lund, Sweden

Product Documentation

- Technical specifications and data sheets
- ChemDash software guides and training materials
- Video tutorials and application demonstrations
- Case studies from correctional facilities

Authorized Distributors

Contact Serstech for information about authorized distributors and government procurement channels. Special pricing and support packages are available for correctional agencies.

References and Resources

- Bureau of Justice Statistics reports on drug-related deaths in custody
- Research on synthetic cannabinoid abuse in prisons
- Technical literature on botulism outbreaks from pruno consumption
- Studies on pyrethroid insecticide abuse ("wasp dope")

This application note is provided for informational purposes. Correctional facilities should consult with legal counsel regarding appropriate use of

substance identification technology within their jurisdiction and ensure compliance with applicable laws, regulations, and constitutional requirements. Testing procedures should align with facility policies and collective bargaining agreements.