

# SAIC's Munitions Residue Inspection System

## Global Demilitarization Symposium

Reno, NV • May 2007

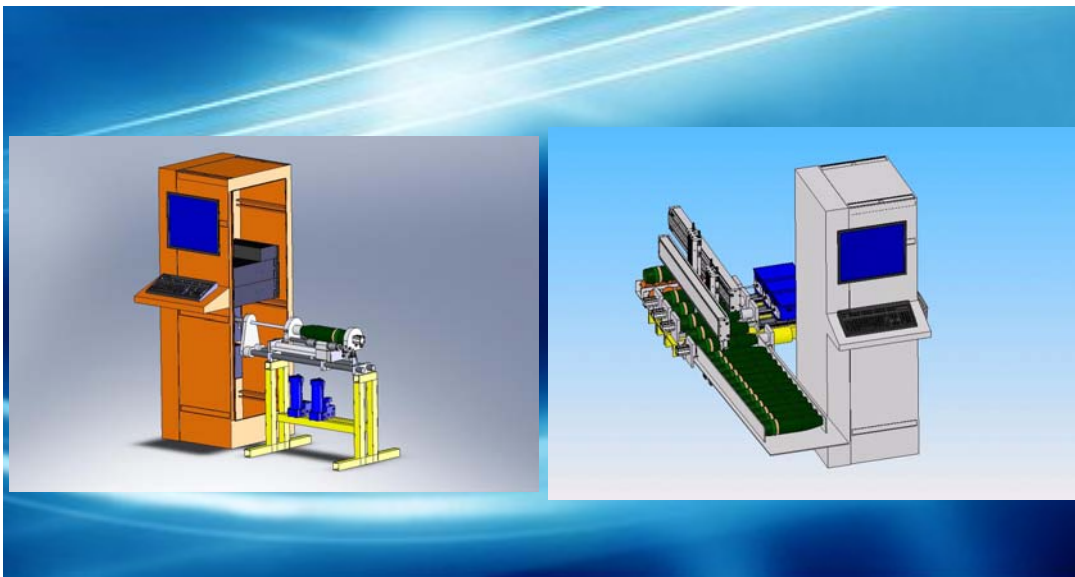
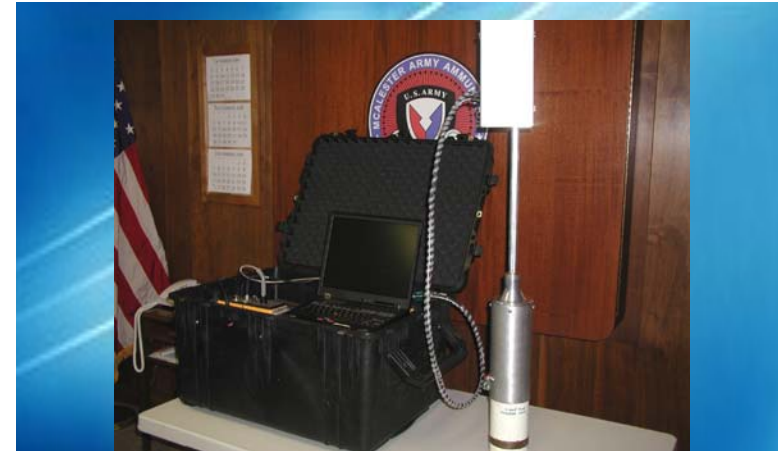


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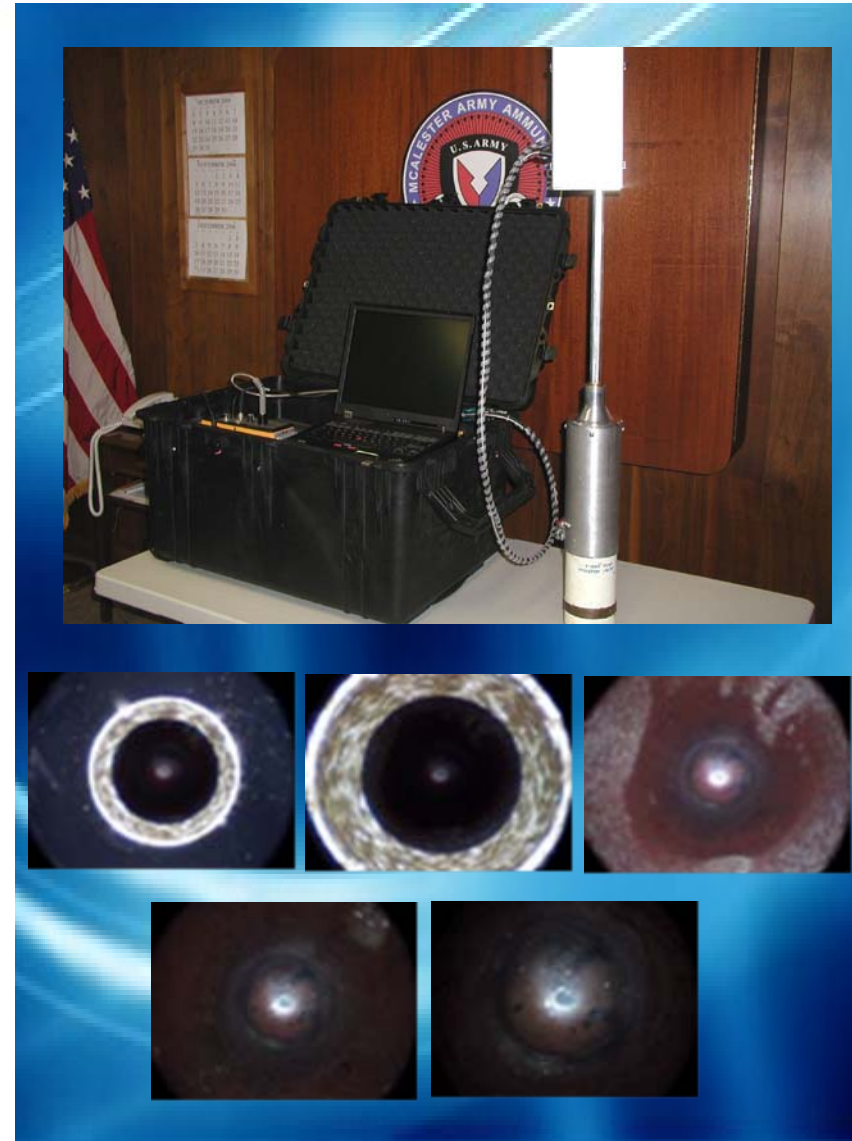
# MUNITIONS RESIDUE INSPECTION SYSTEM

(MRIS)

**Machine Vision Based Inspections of  
Munitions for Residual Explosives  
in Support of Production  
Demilitarization Processes**



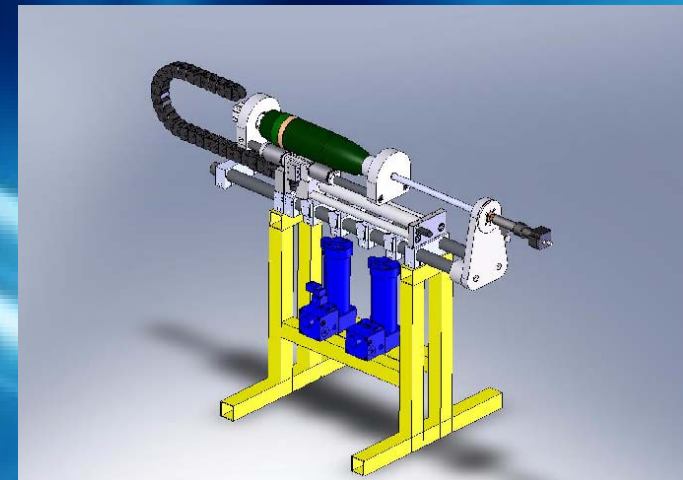
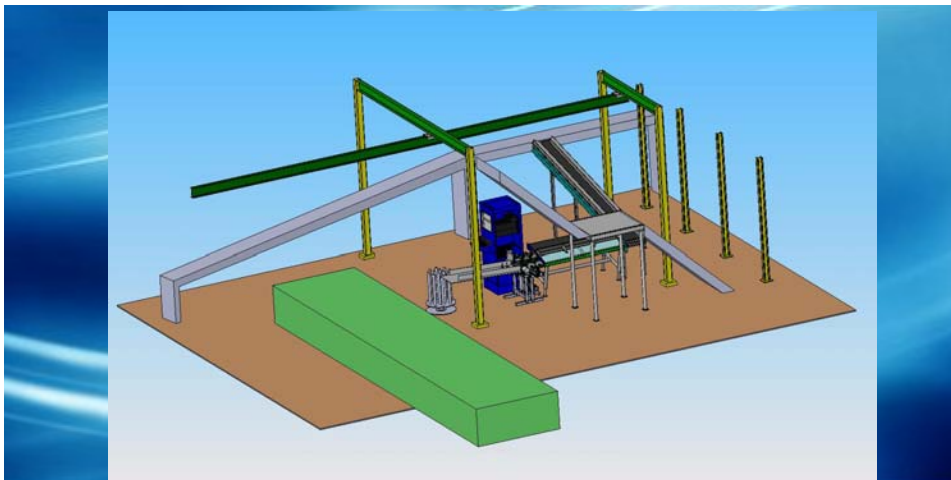
- **A Wide Angle Optical Borescope Is Used In Conjunction With A PC Controlled Camera and Image Capture Card To Display Live Video Of Munitions Interiors And Capture Standardized Image Sets**
- **Image Sets Are Collected At Five Fixed Locations Using Manual Or Automated Positioning Rigs – Objective Is 100 % Coverage Of A 105 mm Round's Interior Surfaces And Threads**
- **Advanced Image Processing And Classification Algorithms Are Applied To The Inspection Image Sets For The Automated Detection And Quantification Of Residual Explosives**



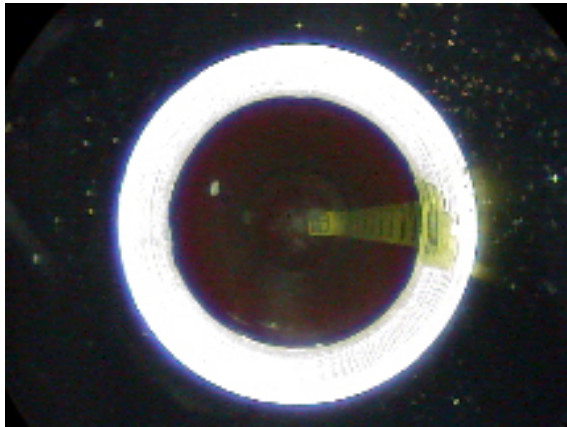


## MRIS – Development Status

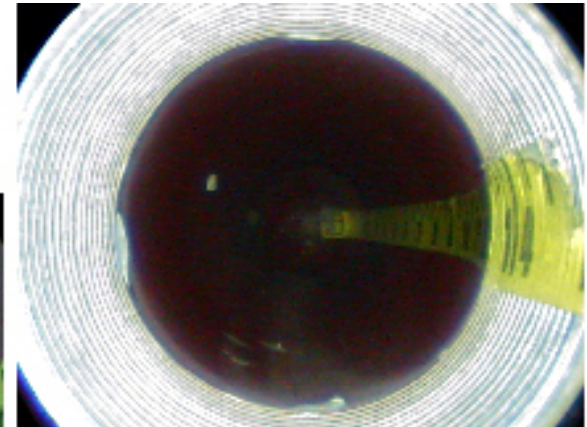
- **Manually Operated MRIS Fielded At MCAAP In October 2006 And February 2007**
- **Manually Loading/Unloading Automated MRIS Installation/Fielding At MCAAP In June 2007**
- **Fully Automated “Line Integrated” MRIS Installation At MCAAP In September 2007**



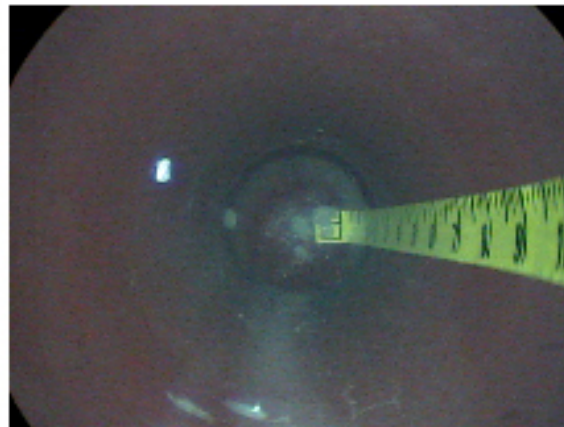
## Manually Operated MRIS – 105 mm Round Coverage



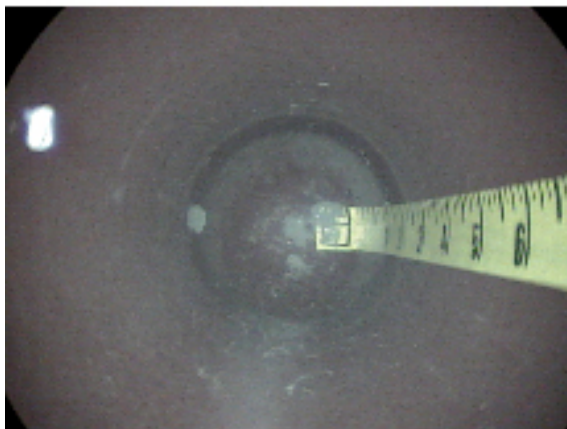
Position 1 – Threads and Interior



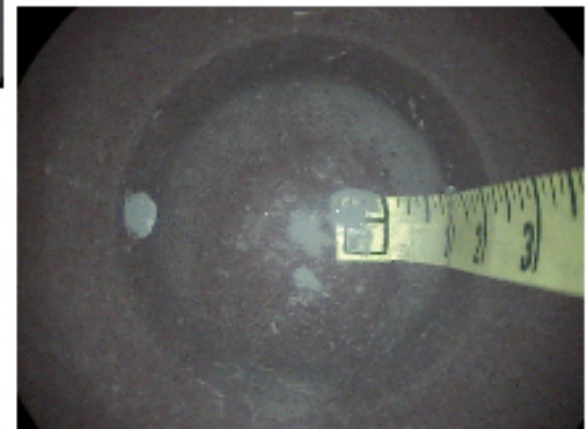
Position 2 – “Neck” Region



Position 3 – Upper Interior



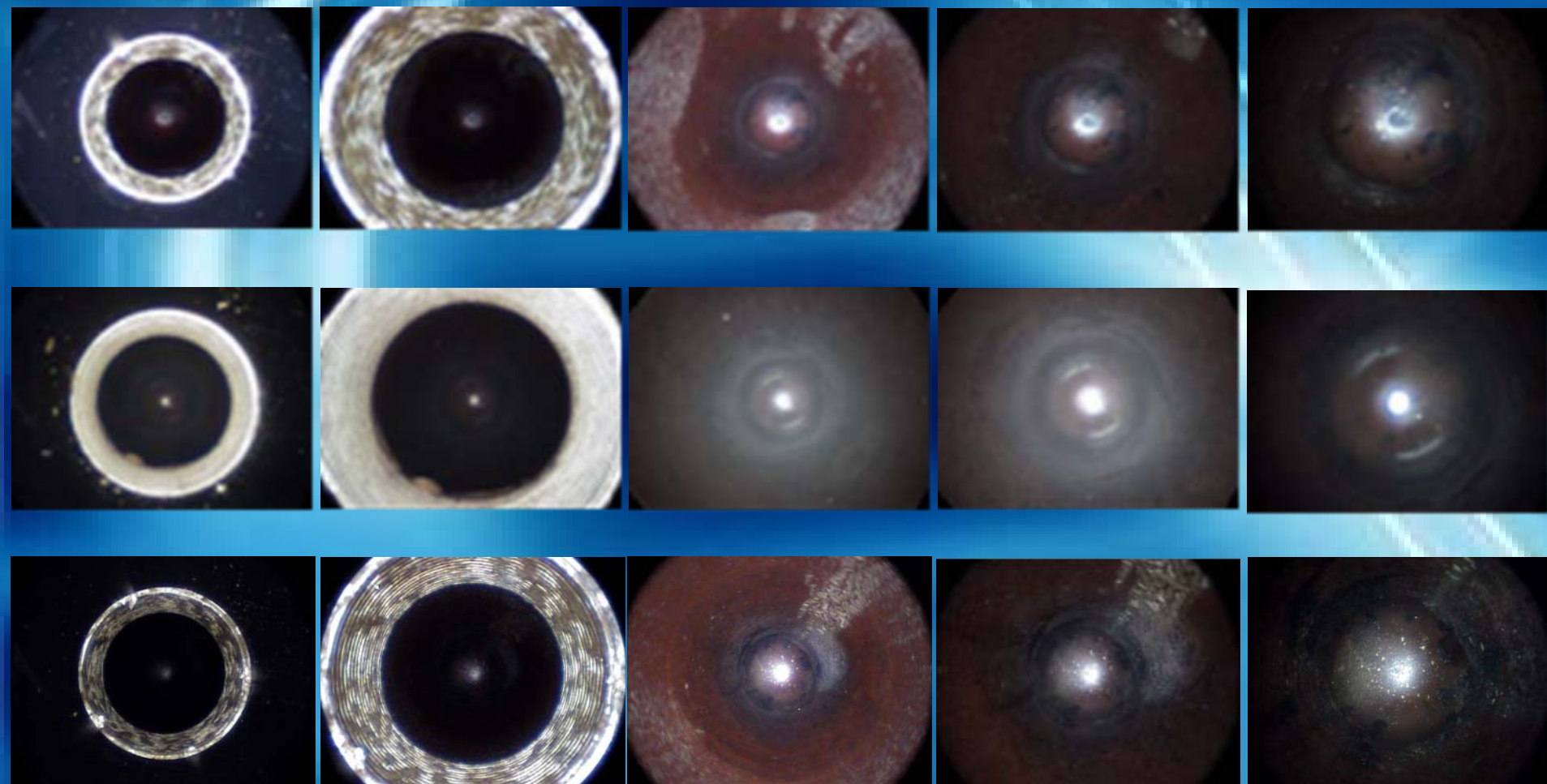
Position 4 – Lower Interior



Position 5 – Interior Base



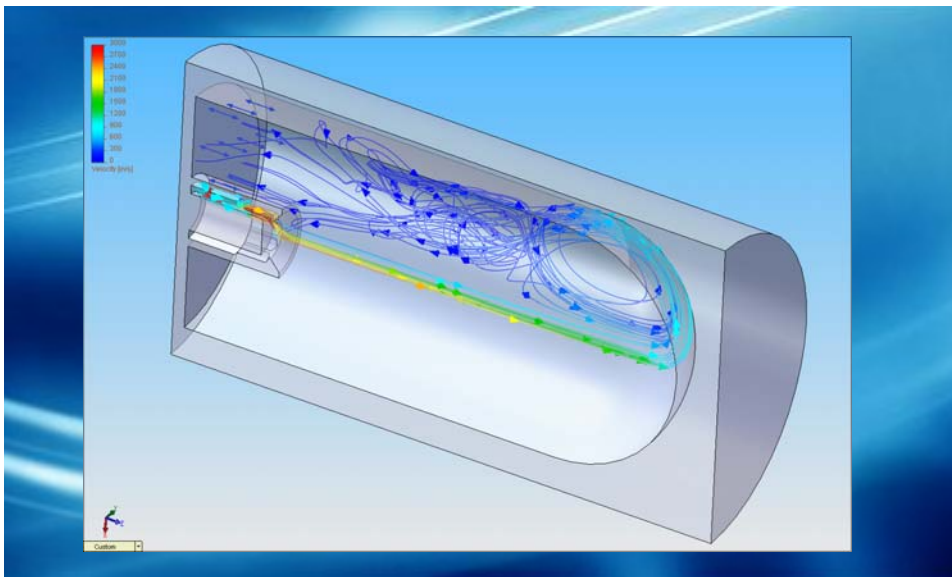
## Manually Operated MRIS – Image Sets



### 105 mm Munitions Image Sets — MCAAP — February 2007

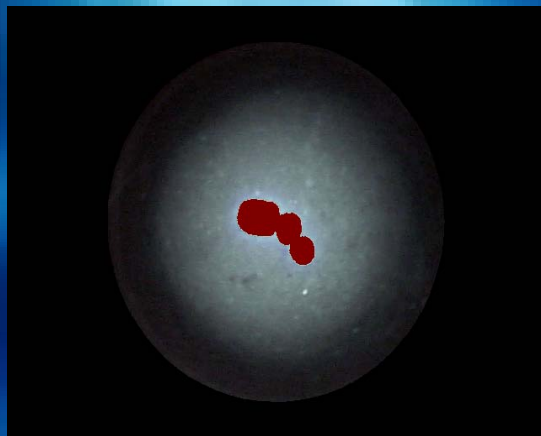
## Manually Operated MRIS – Lessoned Learned

- **Vapors In Hot Munitions Create Vapor Opacity And Condensation Issues For Optical Borescope**
- **Unique Purge Tip Design Will Protect The Borescope's Distal End From Condensing Vapors And Help “Purge” Munitions**

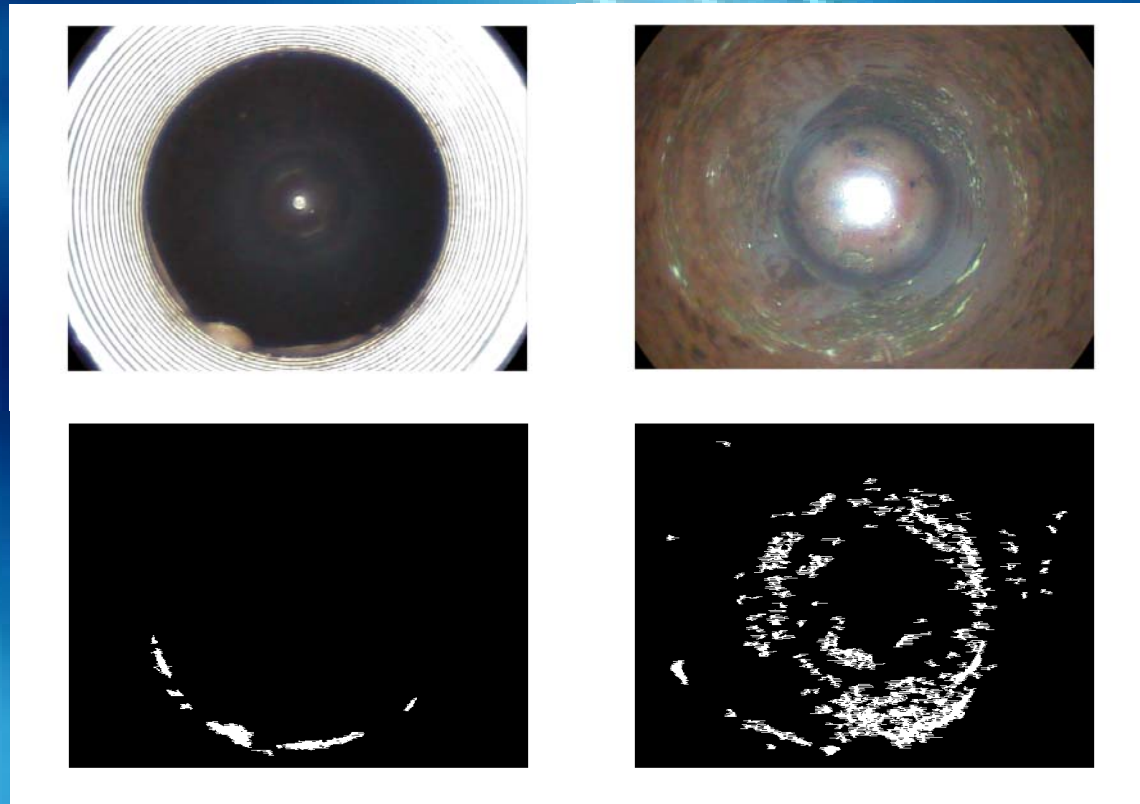




## MRIS – Automated Explosives Residue Detection



**Automated TNT Simulant  
Detection – October 2006**

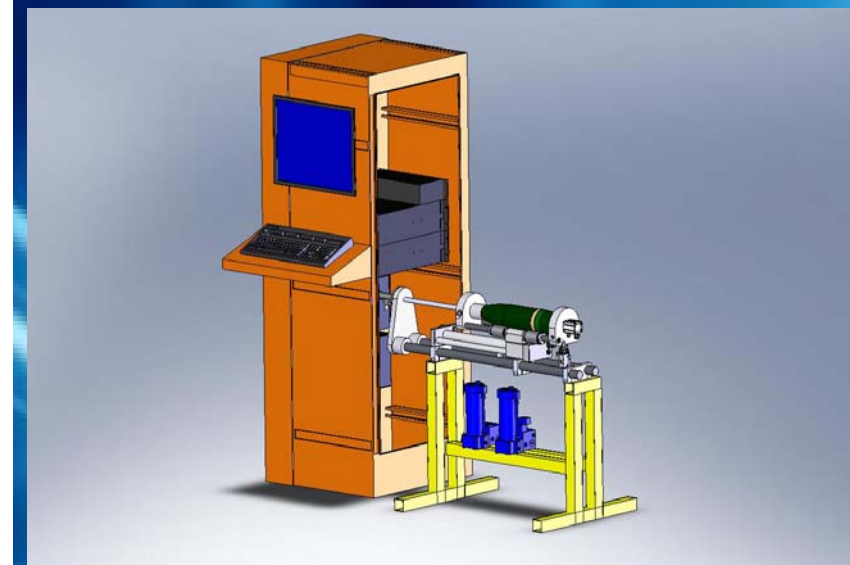
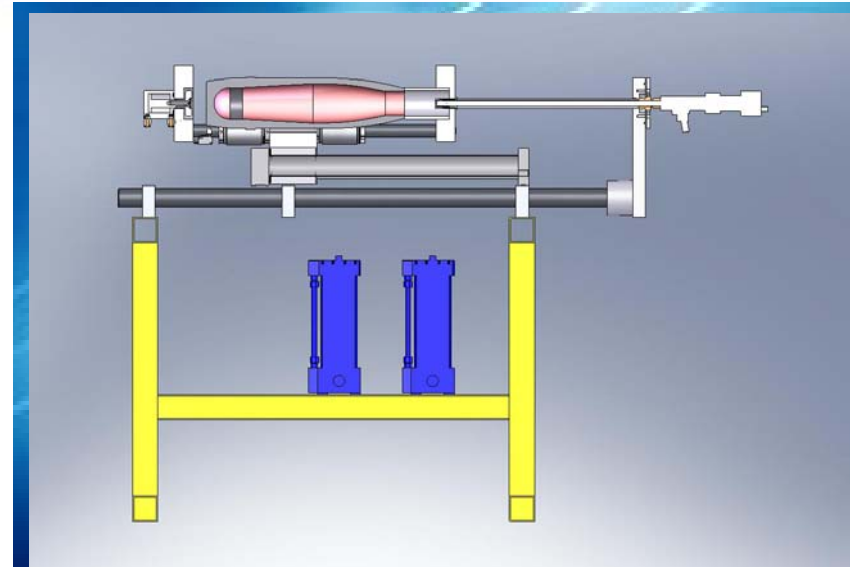


**Automated Detection of Explosives Residues  
– February 2007**



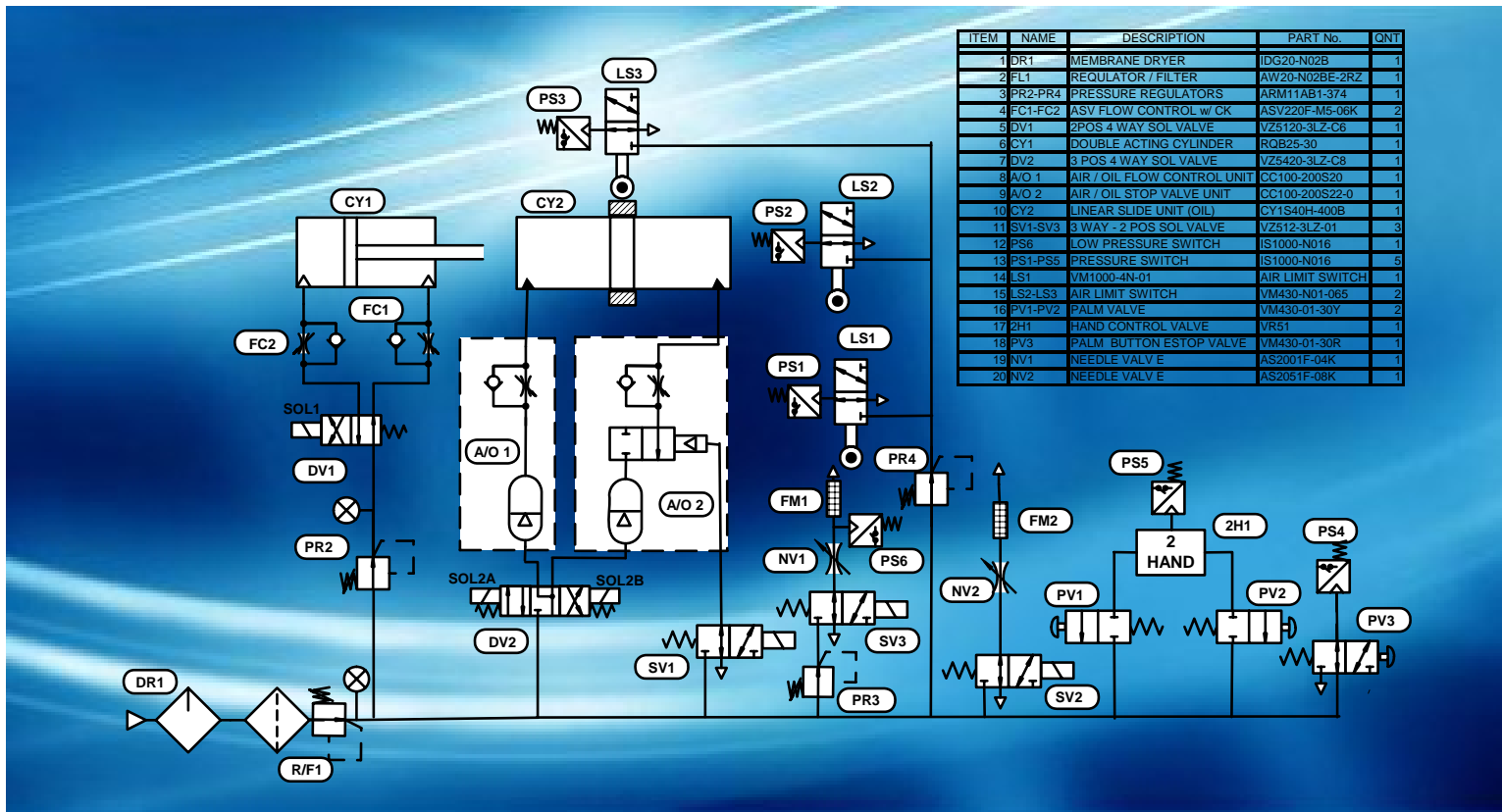
## Manually Loading/Unloading Automated MRIS

- **Munitions Are Manually Loaded Into The Inspection Fixture**
- **PC Controls All Inspection Functions Without Operator Intervention (Round Movement, Image Collection, Image Analyses, And Inspection Report Generation)**
- **Munitions Are Manually Unloaded From The Inspection Fixture**
- **All Components Outside Of The “Explosion Proof Cabinet” Are Electrically Passive**
- **First Unit Is In Production**



## Manually Loading/Unloading Automated MRIS

Manually Loading/Unloading Automated MRIS And Fully Automated MRIS Use A Unique Pneumatic Based Power And Position Sensing Approach For Increased Safety



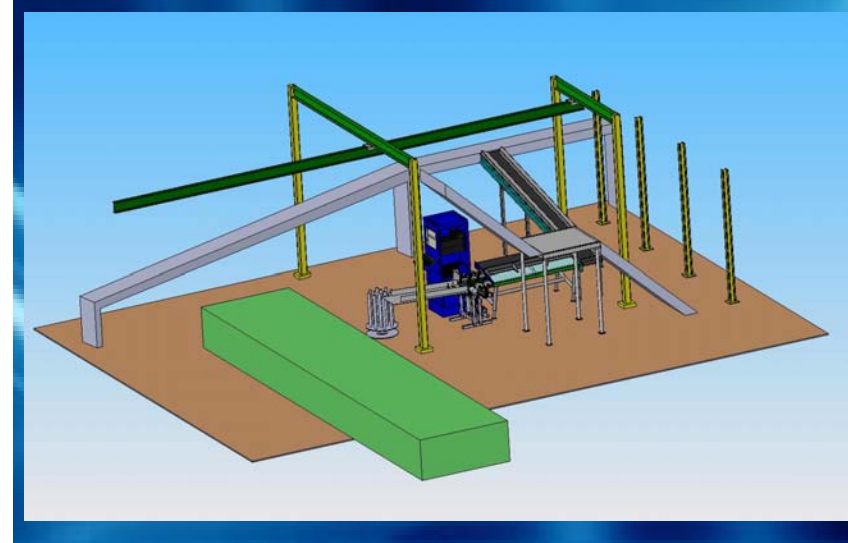
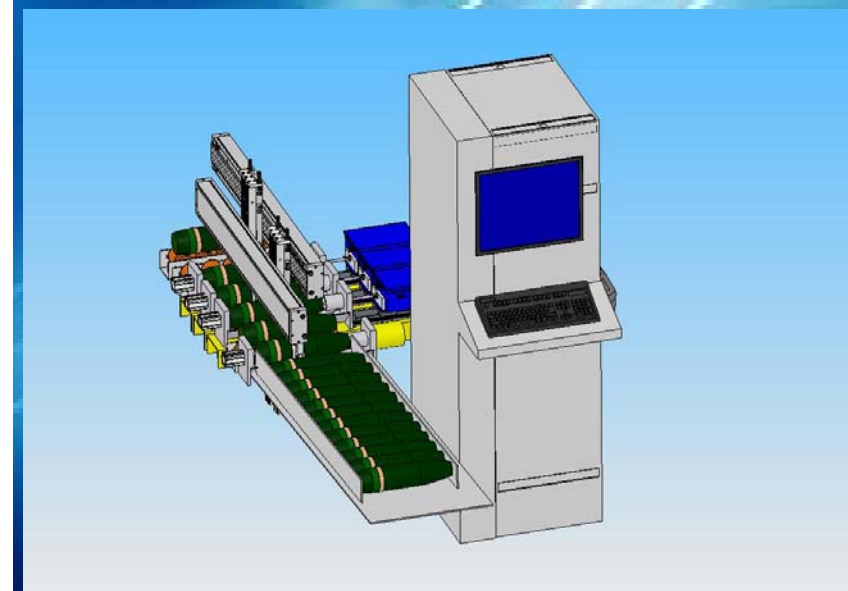
## MRIS Benefits for Production Demilitarization

- **Manually Loading/Unloading MRIS Is An Intrinsically Safe – Explosion Proof System - Will Be Installed at MCAAP In June 2007**
  - **System Will Be Evaluated During Production Demilitarization To Afford Direct Comparison to Manual Methods**
  - **Major System Components Will Be Used In The Fully Automated MRIS**
- **Improved Traceability And Characterization Of Munitions Interior Surfaces For Residual Explosives**
  - **Each Round Assigned A Unique ID During Inspection**
  - **Automated Detection And Rough Quantification Of Residual Explosives**
  - **Digital Image Archive Of Inspection Results**
  - **Affords Easier Adaptation To Various Cleanliness Standards**
- **Automated Report Generation**
  - **Inspection Reports In Standardized Formats At the Individual Round And Batch Levels**



## Line Automated MRIS

- **Automated Loading And Transfer Of Munitions From Autoclave Carousel Deposit Point**
- **Automated Inspection And Physical “Sorting” Of Munitions Based On Inspection Results**
- **Automated Labeling Of Munitions With A Unique ID, Inspection Date, And Cleanliness Ranking (e.g. XXX)**
- **Inspection Throughput – 5 rounds/min**
- **Automated Report Generation and Data Archive**
- **Scheduled for MCAAP Installation in September 2007**



## MRIS – Additional Considerations

- **What Level And Types Of Residuals Are Acceptable?**
- **Automated Cleaning Of Munitions Threads And Neck Area Prior To Inspection**
  - **MCAAP Autoclave Process Leaves Residual Explosives In The Thread And Neck Areas Of The Munitions**
  - **These Residues Are Currently Manually Removed Prior To Inspection**
  - **Automating This Removal Process Is Labor Savings**
- **Automated Capping Of Munitions Following Inspection And “XXX” Cleanliness Ranking**
  - **Process Is Currently Performed Manually**
  - **Automating Cap Insertion Is Labor Savings**
- **Marking Munitions – Still Defining The Requirements For Marking Munitions With A Unique ID And With The Results Of The Inspection (e.g. XXX)**

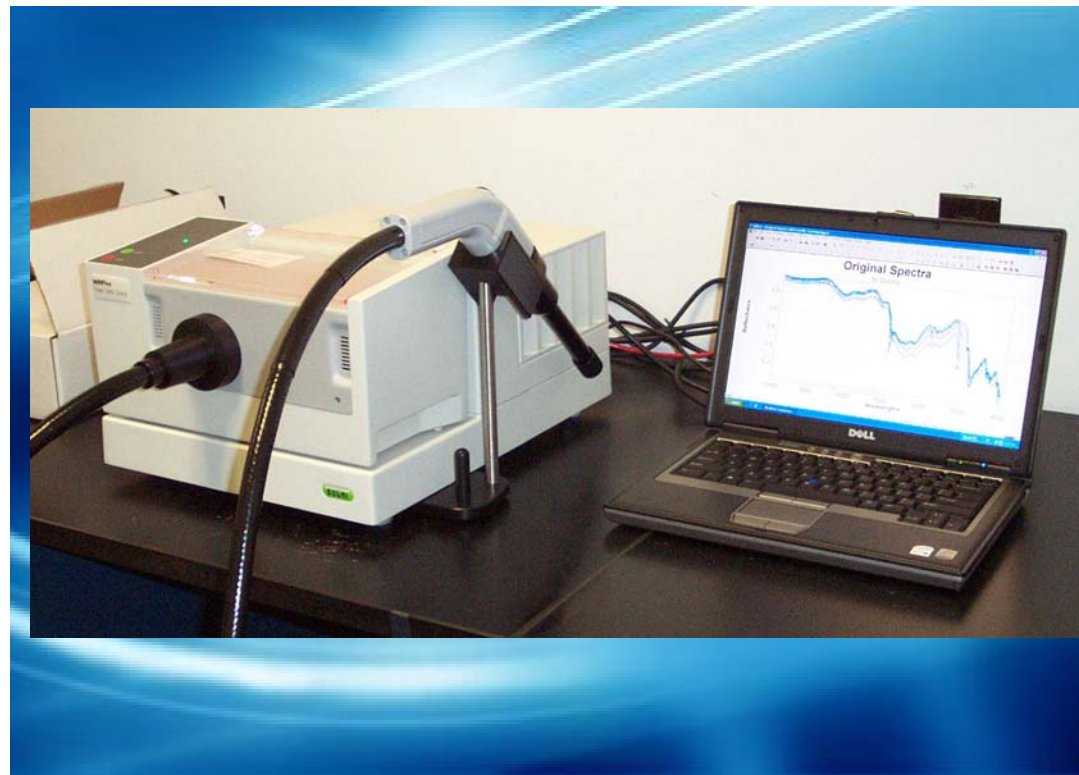
## MRIS - Future Plans

- **Field Manually Loaded/Unloaded Automated MRIS**
  - **Evaluate Rounds In Parallel With the Manual Inspection Station**
  - **Generate Ground Truth Image Sets Required to Finalize And Test Image Processing And Classification Algorithms For Automated Explosives Testing**
  - **Demonstrate The Efficacy Of Automated Inspection Methods In Production Munitions Demilitarization**
- **Finalize Requirements For The Line Automated MRIS**
  - **Automated Marking, Cleaning And Capping?**
- **Produce And Install Line Automated MRIS To The MCAAP Production Demilitarization Facility And Demonstrate System Advantages In A Production Environment**
- **Develop Automated MRIS Optimized For Other Production Demilitarization Facilities, Demilitarization Processes And Munitions Types**
  - **Mobile System For Inspecting “Piled” Munitions**



## Development of Munitions Residue Quantification System (MRQS) Module

- ✦ Use As An Addition To The Visual Inspection System
- ✦ Or In Place Of The Visual Inspection System

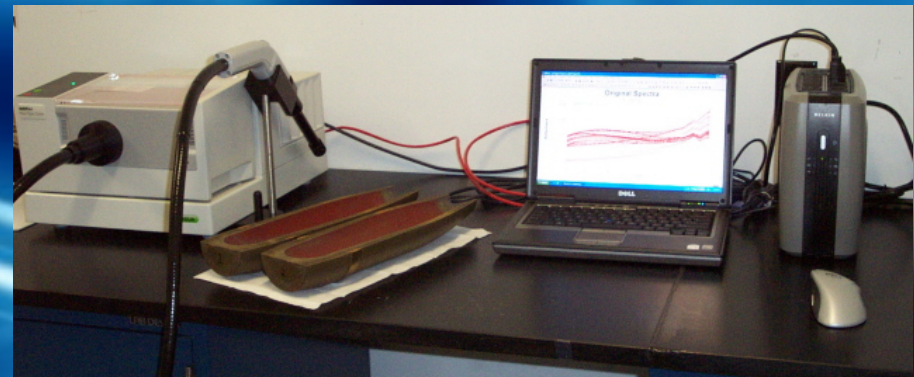


## MRQS: Introduction (cont'd)

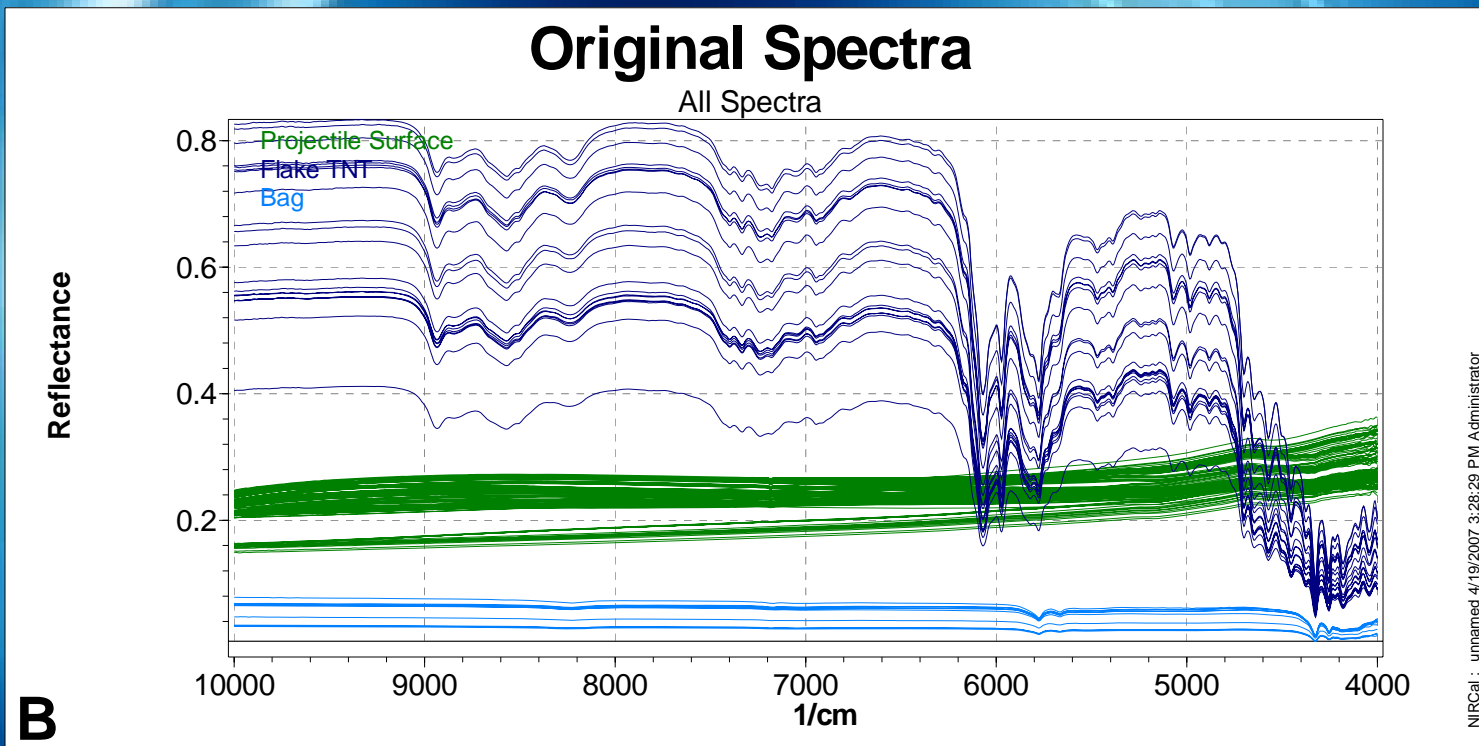
- ✦ **Near Infrared (NIR) Technology**
- ✦ **Will Be Used To Quantitate The Remaining Thin Film Of TNT In Demilitarized Projectiles**
- ✦ **Appropriate To Use For Multiple Demilitarization Technologies :**
  - ✦ **Autoclave Melt-Out**
  - ✦ **Hot Water Wash-Out**
  - ✦ **High Pressure Wash-Out**
  - ✦ **Inductive Coil Melt-Out**

- ✦ **Same Technology Used For APE 1995 Propellant Scanner And ASD Explosives Identification System**

### **Buchi NIRFlex N-500 with Fiber Optic Solids Probe**



## MRQS: Initial Spectra



Primed Projectile Surface

Flake TNT

Bag containing TNT

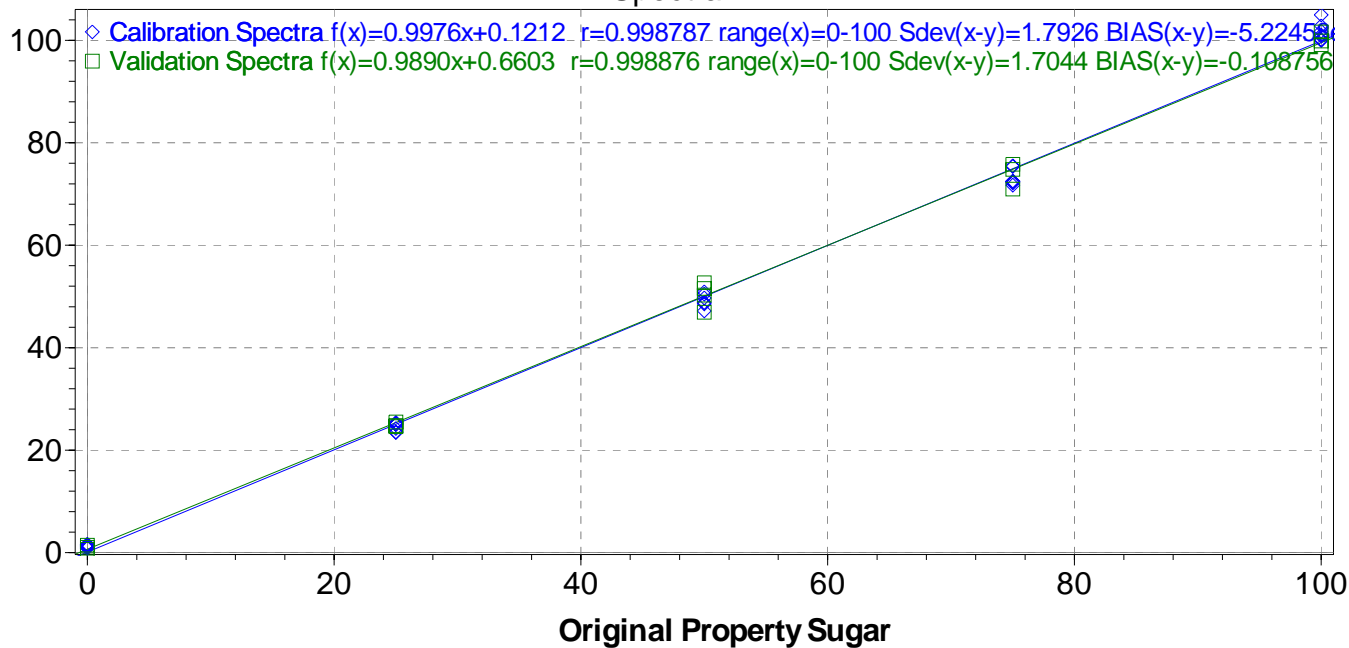


# MRQS Calibration with Sugar/Creamer Mixtures

## Predicted Property vs. Original Property

All Spectra

Predicted Property Sugar

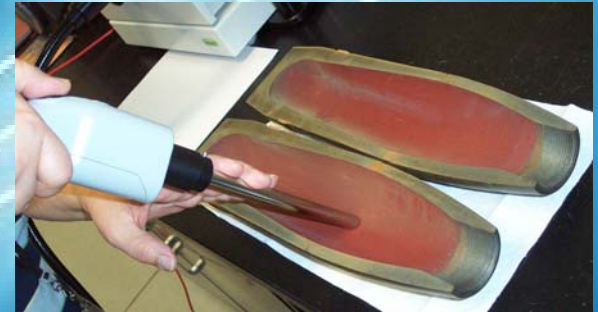


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## MRQS: Future Plans

- **Demonstrate Detection Of TNT Film On Primed Projectile Surface**
- **Develop Calibration Model Using Melted TNT On Primed Projectile Surface**
- **Develop Preliminary Process To Calculate The Total TNT Remaining In Projectile Body**
- **Demonstrate Technique On Contaminated Demilitarized Projectiles**



## MRIS: Prospective Future



- **Expand The Inspection Capability to Other Munition Families And Energetic Fills**
- **Mobile MRIS To Document Inspection of Piled Munitions Awaiting Disposition Due To The Need For Reinspection/Cleanliness Certification**
- **As A Tool To Determine And Monitor “How Clean Is Safe”**
- **As An Addition To Developing Demilitarization Technologies**





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