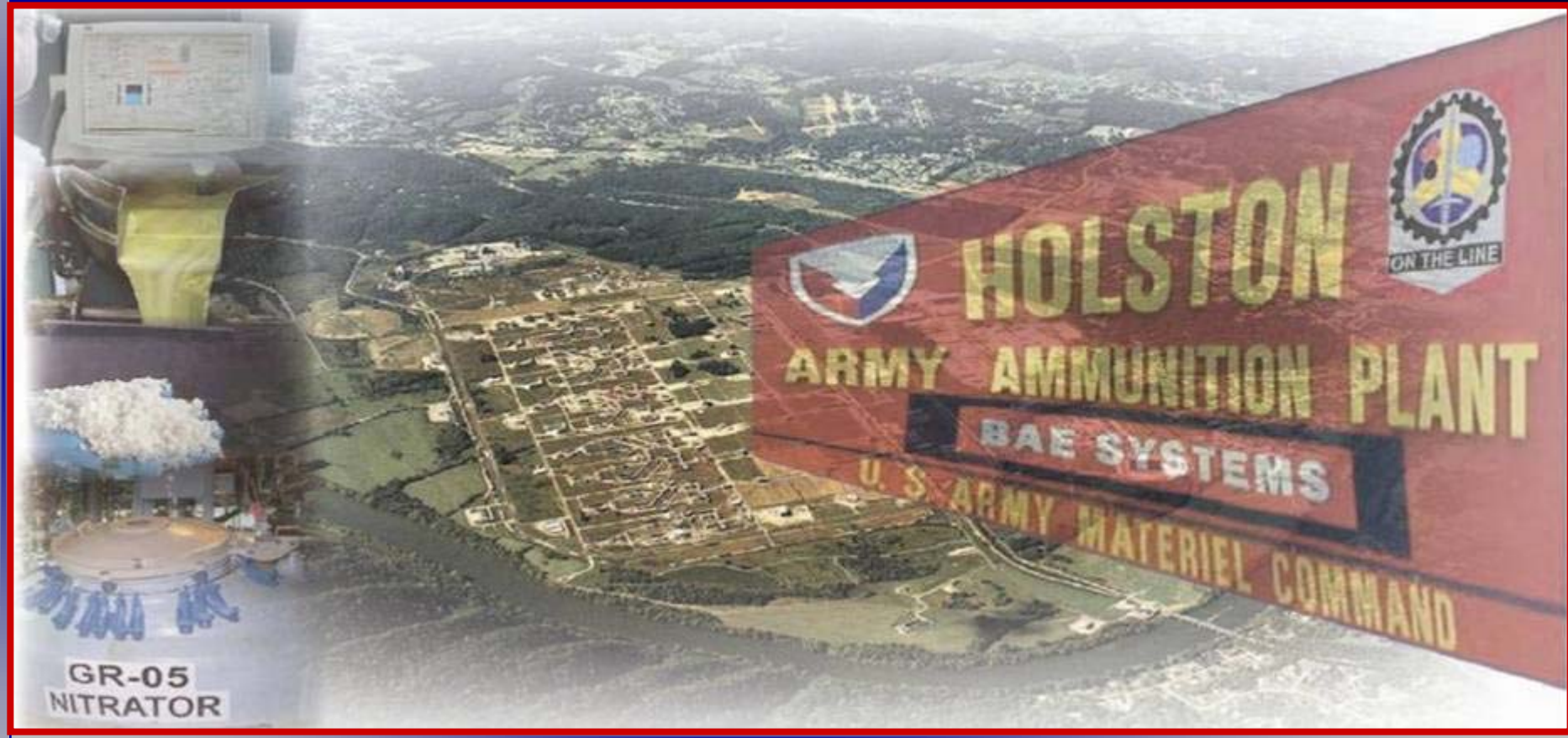
Crystal Growth of Micronized Cyclotrimethylenetrinitramine (RDX)
Preliminary Study



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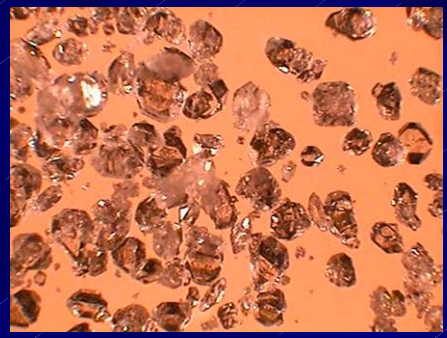
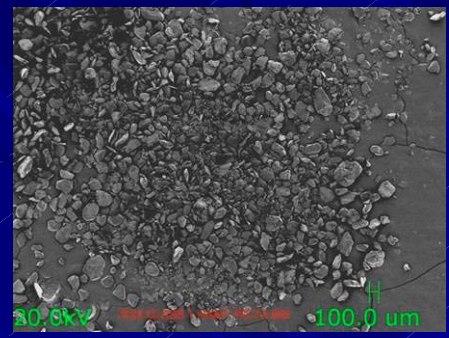
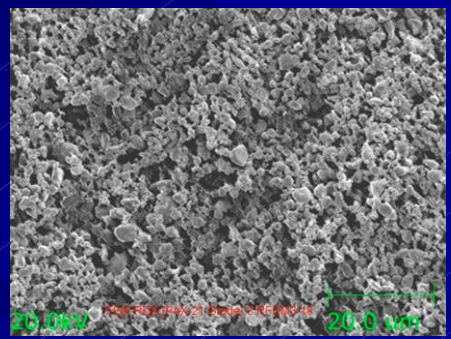
Briefing Aims

- Background
- Study Goals
- Approach
- Results
- Summary







Background

- Micronized RDX (FEM RDX) Shows an Effect in Reducing Sensitivity of Explosive Formulations to Unplanned Stimuli compared to that of conventional product classes of RDX
- Micronized RDX Allows for a Narrow Size Distribution and General Uniform Shape
- HSAAP Expanded Manufacturing Infrastructure to Include Micronized RDX
- Facility Currently Supporting the 60 mm Mortar and 155 mm Artillery Programs

Study Goals

- Determine Impact of Storage or Shipping Conditions on the Material Particle Size
- Answer Key Questions:
  - Does Any Change in Particle Size Occur?
  - Is the Material Agglomerated or Are Particle Forces Influencing the Test Results?
  - Storage Life of FEM RDX?
- Determine Acceptability of FEM RDX After Study

Approach

- Evaluation of FEM RDX Under Differing Conditions
- 4 Samples Divided from 25 lb. Bulk Sample
- Samples Placed in Velostat Bags
- Conditions:
  - Temperature Controlled Environment
  - Humidity Controlled Environment
  - 15% Water Wet (by Mass)
  - Dynamic Environment
- Analysis Conducted Using a Laser Diffraction Technique

HSAAP Fluid Energy Milling Facility

- Production Scale Sturtevant Micronizer Mill
- Feed and Flow Rates Dictate Particle Size
- RDX Capabilities to <2.8µ mean particle size
- Material Collected in Material Beds
- Material Ready for Use or Packaging

Instrumentation

- Laser Diffraction Technique
- Malvern Mastersizer 2000
  - Hydro 2000G Dispersion Unit
- Wet Analysis
  - Main Purpose is to Begin Breaking Down the Inter Particle Forces
  - Detergents/non-ionic Surfactants and Solvents can be Used as Wetting Agents and Dispersion Aids

Particle Adhesion Forces

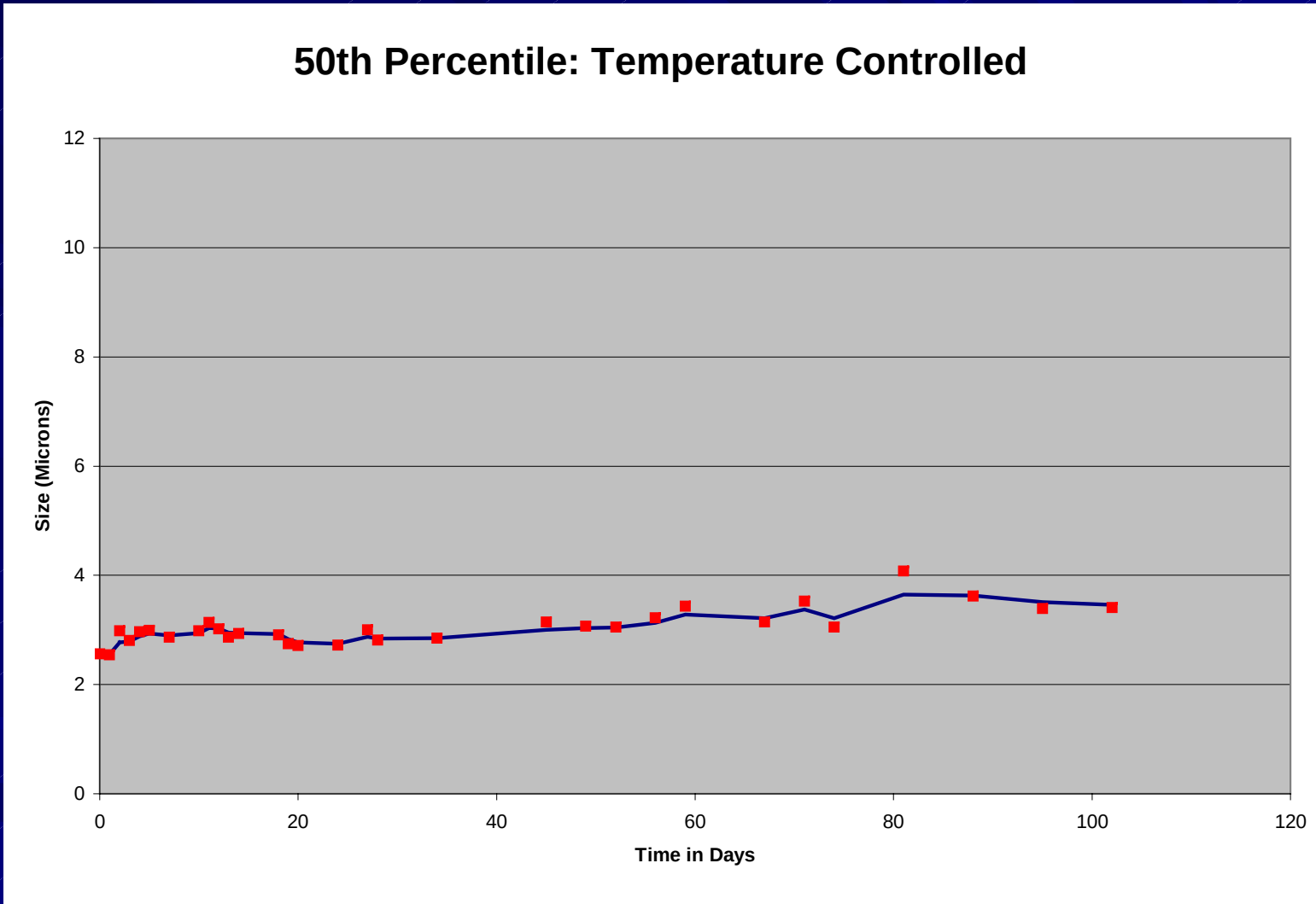
Particle Size (mm)	Force of Gravity (g)
10 mm	100 g
1 mm	1000 g
0.1 mm	$10^4 – 10^5$ g

Davies, CN, Aerosol Science, Academic Press, London and New York, 1966.

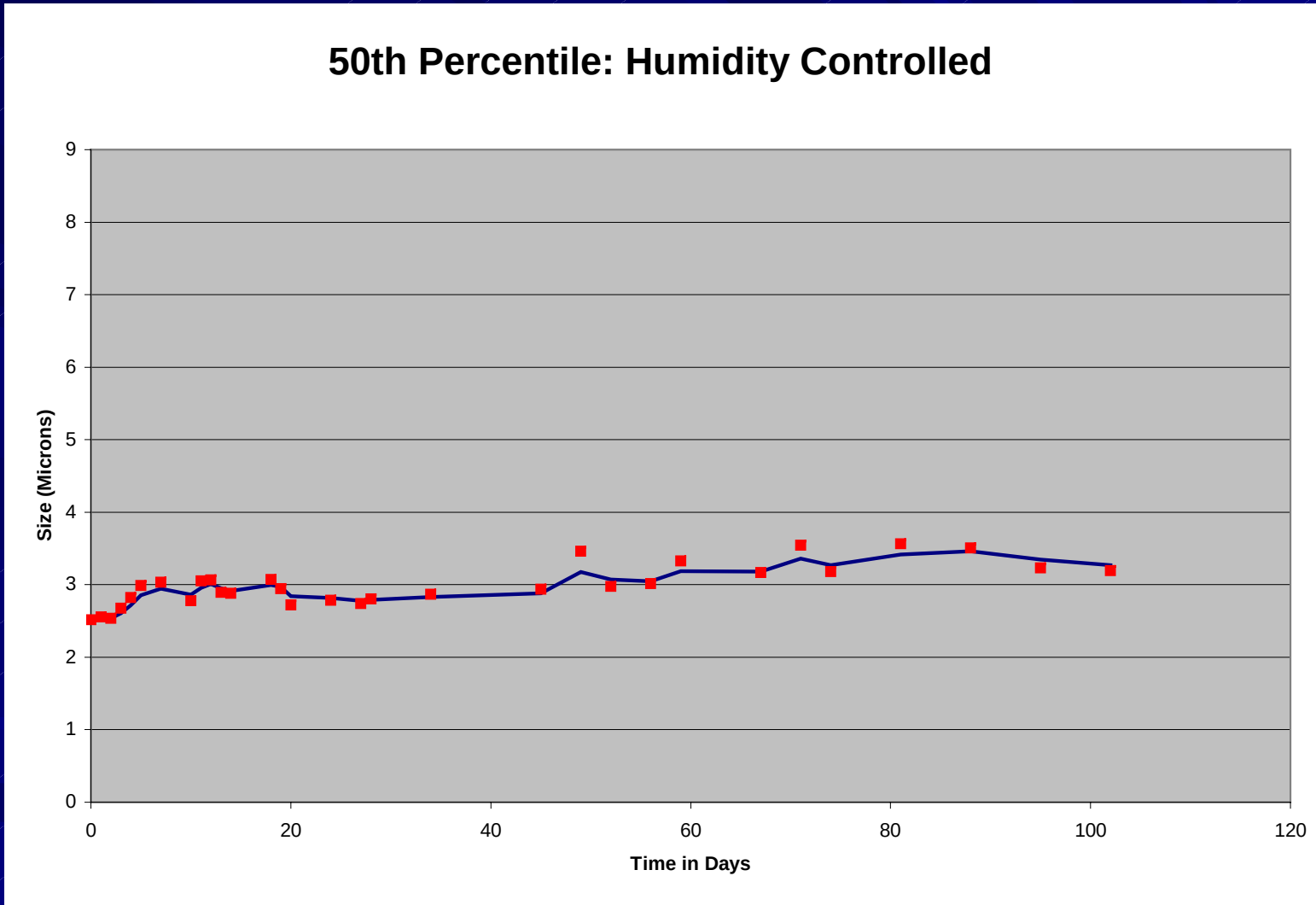
Analysis

- Samples Riffled Before Analysis
- FEMRDX Place into Sample Container with Wetting/Dispersion Agents
- Ultrasonic Energy Applied
- Sample Addition to Instruments Dispersion Unit
- Material Analysis - 20,000 individual snapshots
- Software Statistical Package Generated Particle Size Distribution

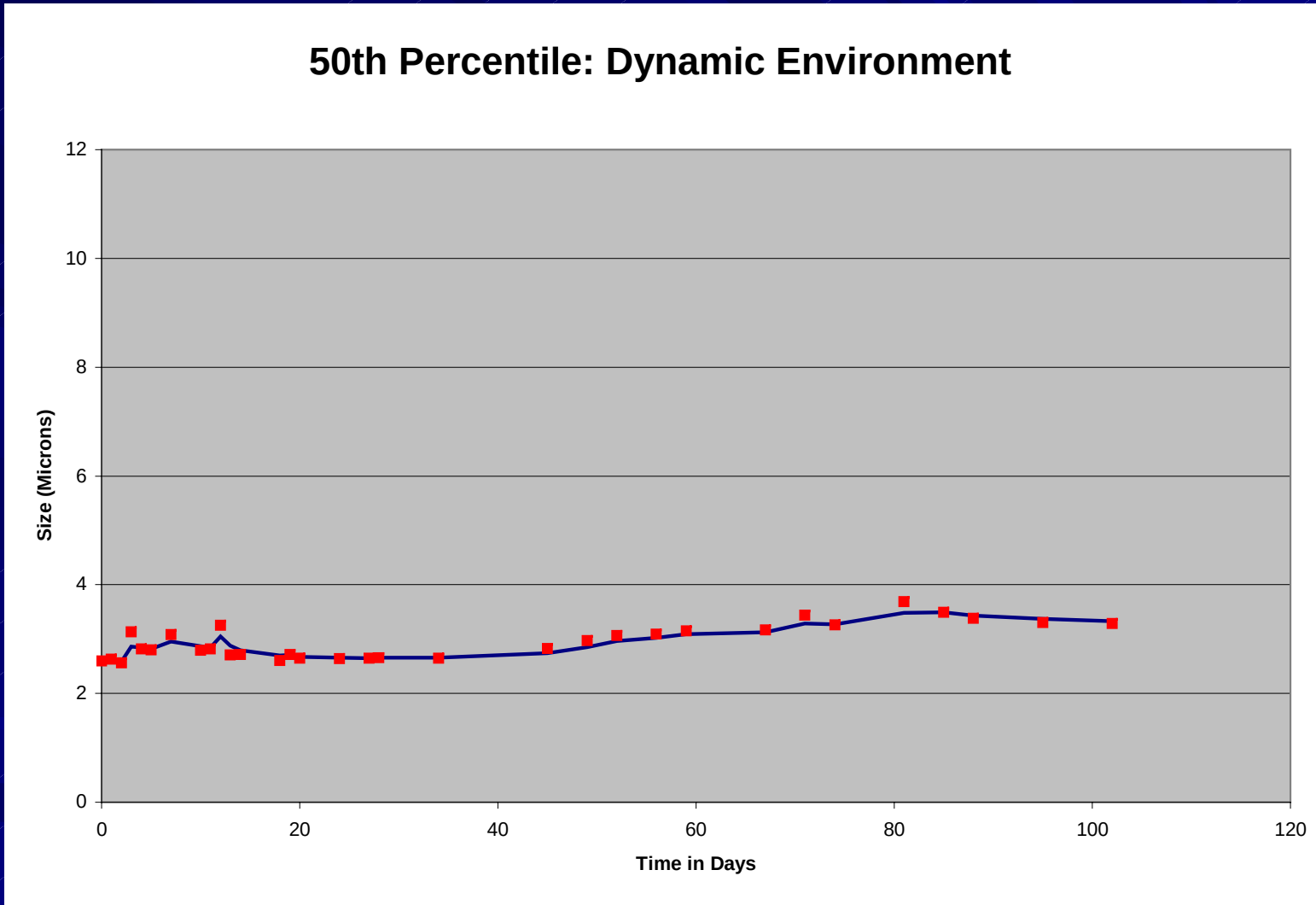
Temperature Controlled Data



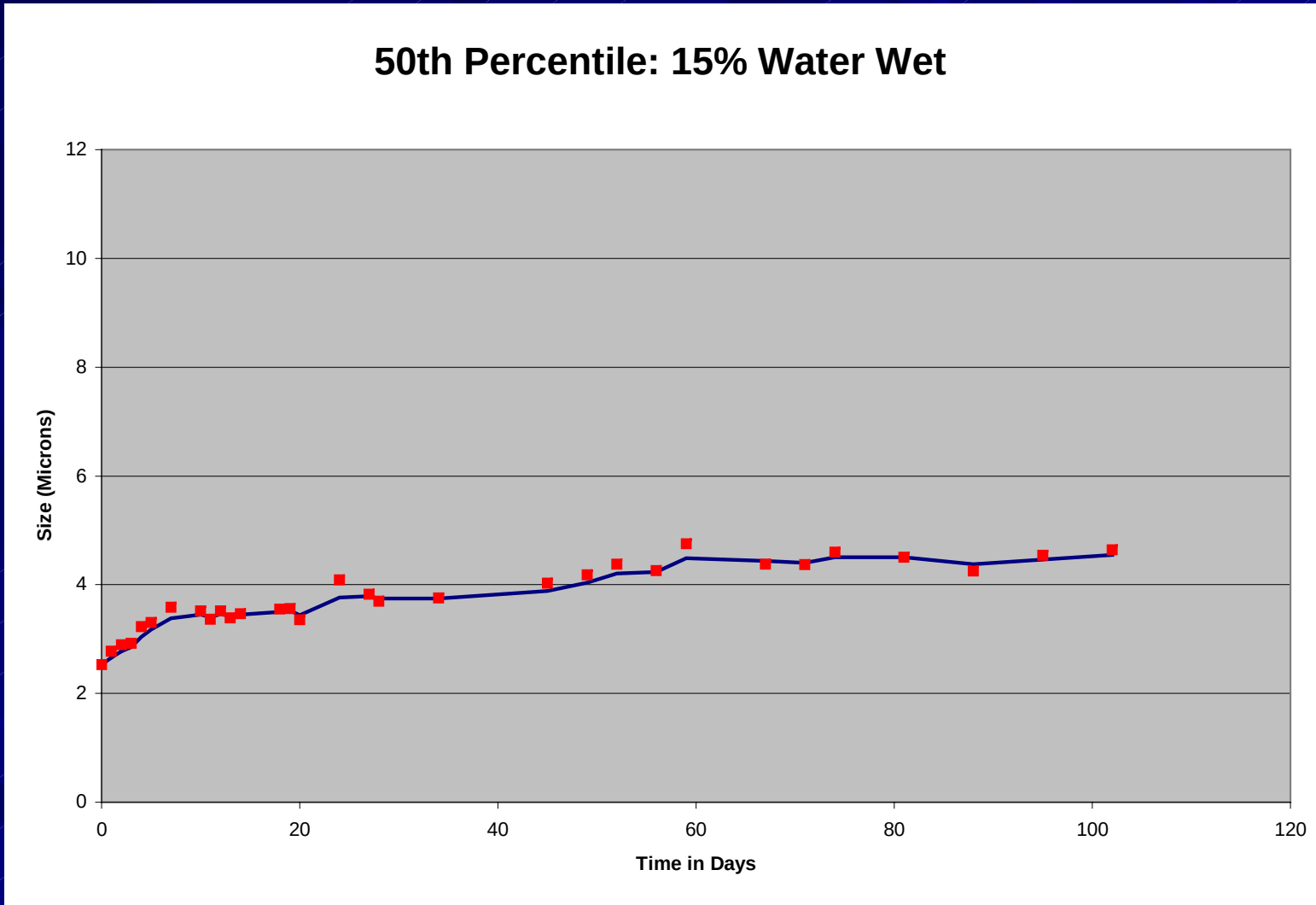
Humidity Controlled Data



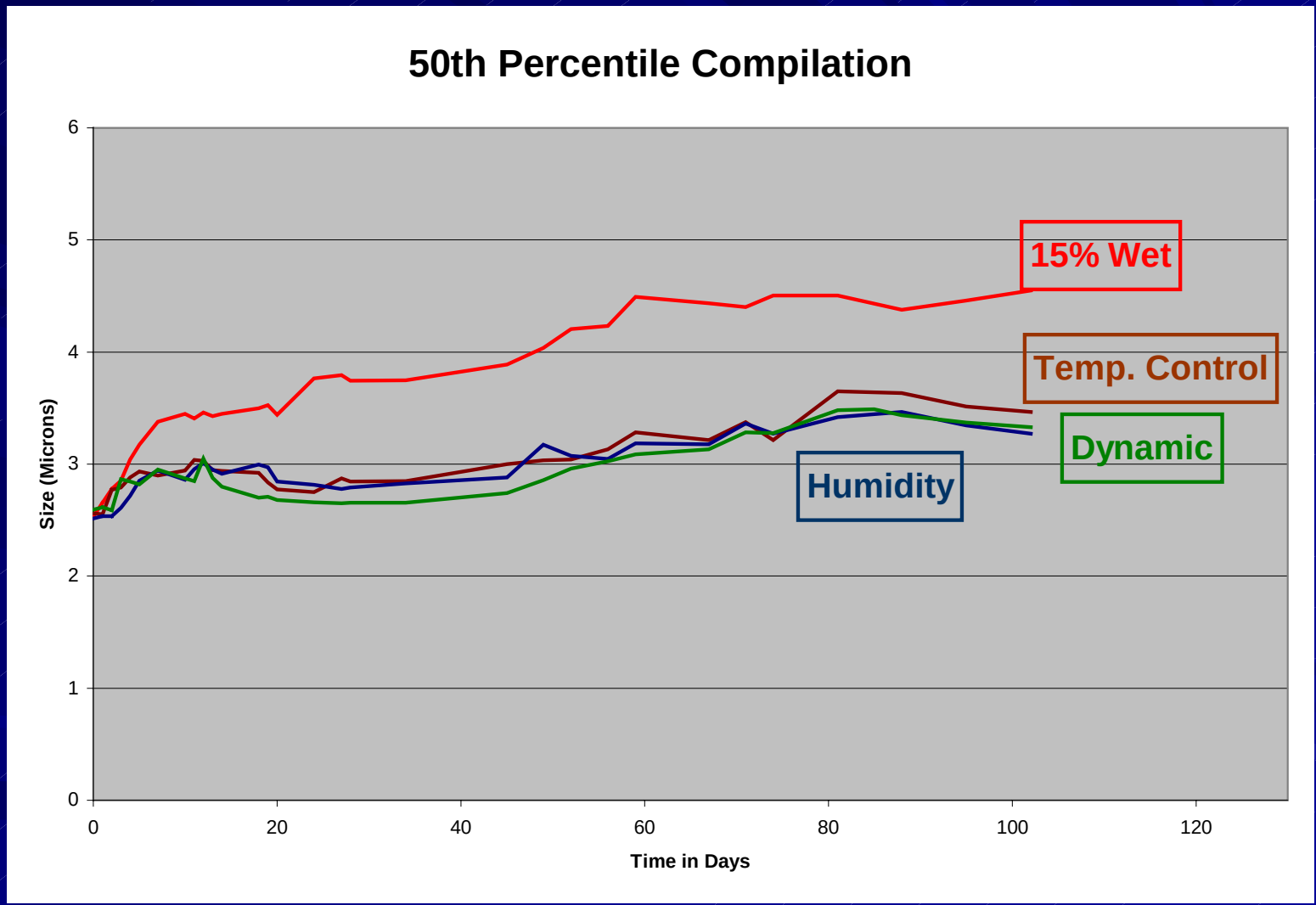
Dynamic Environment Data



15% Water Wet Data



50th Percentile Comparison



Conclusions

- All Material Showed Evidence Of Size Increase
  - Not Restricted to Certain Storage Configurations
  - Relatively Slow Rate in Dry Samples
  - Wet Sample Showed Significant Change in the Shortest Duration
- Particle Forces Played Heavy Role in Analysis
  - Large Variance of the 90th Percentile
- Storage Life
  - Dry Samples Met Specifications at End of Study
  - Water Wet Sample was Non-Spec Compliant within first 25 Days

Recommendations

- **Process the FEM RDX into Premix Formulations (Desensitized and Dry)**
  - Coated with suitable plasticizer, polymer, etc
  - Tailored to customer applications
- **Repeat the Study Due to Lessons Learned**
  - Adhesion Forces
  - Sample Introduction to Analysis System
- **Growth studies in Varying Solvents**
  - Due to Certain Customer Application Requirements of Wetting Agents Other than Water

Acknowledgements

- Ms. Lisa Jones and Bert Jasper (OSI) for support of the experimental work and for conducting testing on the material.