FIU Applied Research Center

DOE-FIU Cooperative Agreement Annual Research Review – FIU Year 4

Monday, September 16, 2024		
9:00 - 9:05 AM ET	Kick-Off /Welcoming Remarks (DOE-EM)	Rod Rimando (Acting Director, Technology Development) – DOE EM-3.2
9:05 - 9:10 AM ET	Welcoming Remarks (DOE-LM)	Ms. Jalena Dayvault (Site Manager) – DOE LM
9:10 - 10:10 AM ET	Project 3: Waste and D&D Engineering & Technology Development	FIU, DOE HQ, SRNL, PNNL, LBNL, INL, ANL
10:10 - 10:25 AM ET	Project 3: Q & A	
10:25 am - 11:25 AM ET	Project 1: Chemical Process Alternatives for Radioactive Waste	FIU, DOE HQ, PNNL, WRPS, SRNL, SRS
11:25 - 11:40 AM ET	Project 1: Q & A	
35-MIN BREAK [11:40 AM – 12:15 PM]		
12:15 - 1:15 PM ET	Project 2: Environmental Remediation Science & Technology	FIU, DOE HQ, SRNL, PNNL, ORNL, LANL, LBNL, CBFO
1:15 - 1:30 PM ET	Project 2: Q & A	
Thursday, September 19, 2024		
2:30 - 3:30 PM ET	Projects 4 & 5: STEM Workforce Development and Training	FIU, DOE HQ (EM & LM), SRNL, PNNL, WIPP, SRS, ORP, LBNL, WRPS, INL, Grand Junction
3:30 - 3:45 PM ET	Project 4 & 5: Q & A	
BREAK [3:45 – 4:00 PM]		
4:00 - 5:00 PM ET	Wrap Up (FIU Projects 1, 2, 3, 4 & 5)	FIU, DOE HQ (EM & LM)

PROJECT 3

Waste and D&D Engineering & Technology Development

FIU Personnel and Collaborators

Project Manager: Leonel Lagos

Faculty/Researcher: Himanshu Upadhyay, Joseph Sinicrope, Walter Quintero, Clint Miller, Santosh Joshi, Jayesh Soni, Mellissa Komninakis

DOE Fellows/Students: Alejandro De-La-Noval, Aris Duani Rojas, Fabiola Rivera-Noriega, Victor Gonzalez

DOE-EM: Nancy Bushman, Dinesh Gupta, Genia McKinley, Jonathan Kang, Douglas Tonkay, Jennifer McCloskey, Nick Machara, Rod Rimando, Daniel Scott Boyd

SRNL: Hansell Gonzalez-Raymat, Thomas Danielson, Evan Koelker, Austin Coleman, Connor Nicholson, Carol Eddy-Dilek

PNNL: Rob Mackley, Xuehang Song

*Former staff/student contributors

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Project Tasks and Scope

TASK 1: WASTE INFORMATION MANAGEMENT SYSTEM (WIMS) (HQ)	
Subtask 1.1	WIMS System Administration & Cyber Security – Database Management, Application Maintenance & Performance Tuning
Subtask 1.2	Waste Stream Annual Data Integration and Application Enhancements
TASK 2: D&D SUPPORT TO DOE EM FOR TECHNOLOGY INNOVATION, DEVELOPMENT, EVALUATION AND DEPLOYMENT	
Subtask 2.1	Development of Uniform Testing Protocols and Standard Specifications for Fixative Technologies in Support of Complex-Wide D&D Activities
Subtask 2.2	Test and Evaluation of Down-Selected Intumescent Foams/Foam Plug Technologies to Mitigate Contaminant Release during Nuclear Pipe Dismantling in Support of a Hot Demo at F/H Labs in FY25
Subtask 2.3	Certifying Fixative Technology Performance when Exposed to Impact Stressors as Postulated in Contingency Scenarios Highlighted in Safety Basis Documents
Subtask 2.5	Digitalization in Decommissioning (NEW)
TASK 3: D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL (KM-IT) (HQ, SRNL, INL, ANL)	
Subtask 3.4	Content Management
Subtask 3.5	Marketing and Outreach
Subtask 3.6	D&D KM-IT System Administration & Cyber Security
Subtask 3.8	KM-IT Tech Talks

Project Tasks and Scope

TASK 7: AI FOR EM PROBLEM SET (SOIL & GROUNDWATER) - DATA ANALYTICS, VISUALIZATION & MACHINE LEARNING MODEL DEVELOPMENT FOR HEXAVALENT CHROMIUM [CR(VI)] CONCENTRATION IN THE 100 AREA (PNNL)

TASK 8: AI FOR EM PROBLEM SET (SOIL & GROUNDWATER) – SENSOR DATA ANALYSIS & VISUALIZATION FROM THE WELLS AT THE SRS F-AREA USING MACHINE LEARNING / DEEP LEARNING (LBNL, SRNL)

TASK 9: AI FOR EM PROBLEM SET (WASTE PROCESSING) - NUCLEAR WASTE IDENTIFICATION AND CLASSIFICATION USING DEEP LEARNING (SRNL)

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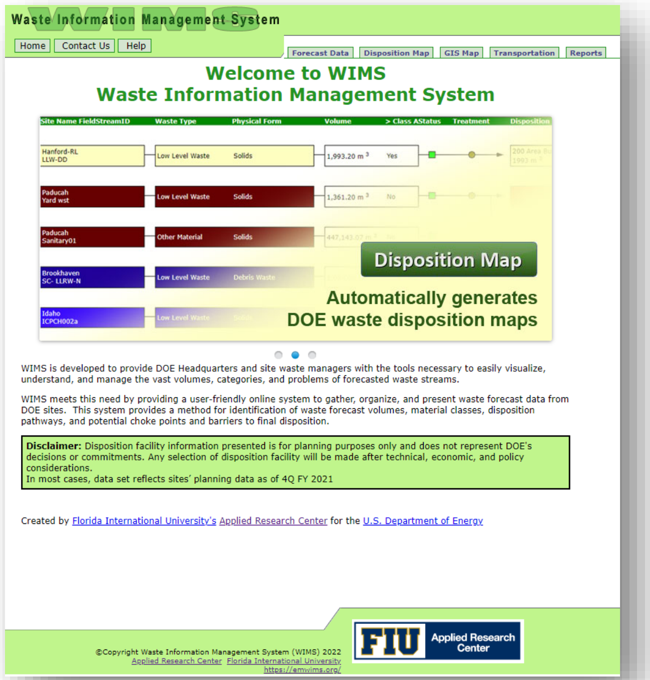
Task 1

Waste Information Management System (WIMS)

Waste Information Management System (WIMS)



Site Needs:

- Accurate estimates of the quantity and type of present and future radioactive waste streams is critical to the development of tools to integrate the complex-wide management of LLW/MLLW treatment and disposal. A complex-wide LLW and MLLW database and reporting system is needed to communicate this information to local and national stakeholders and governmental groups.

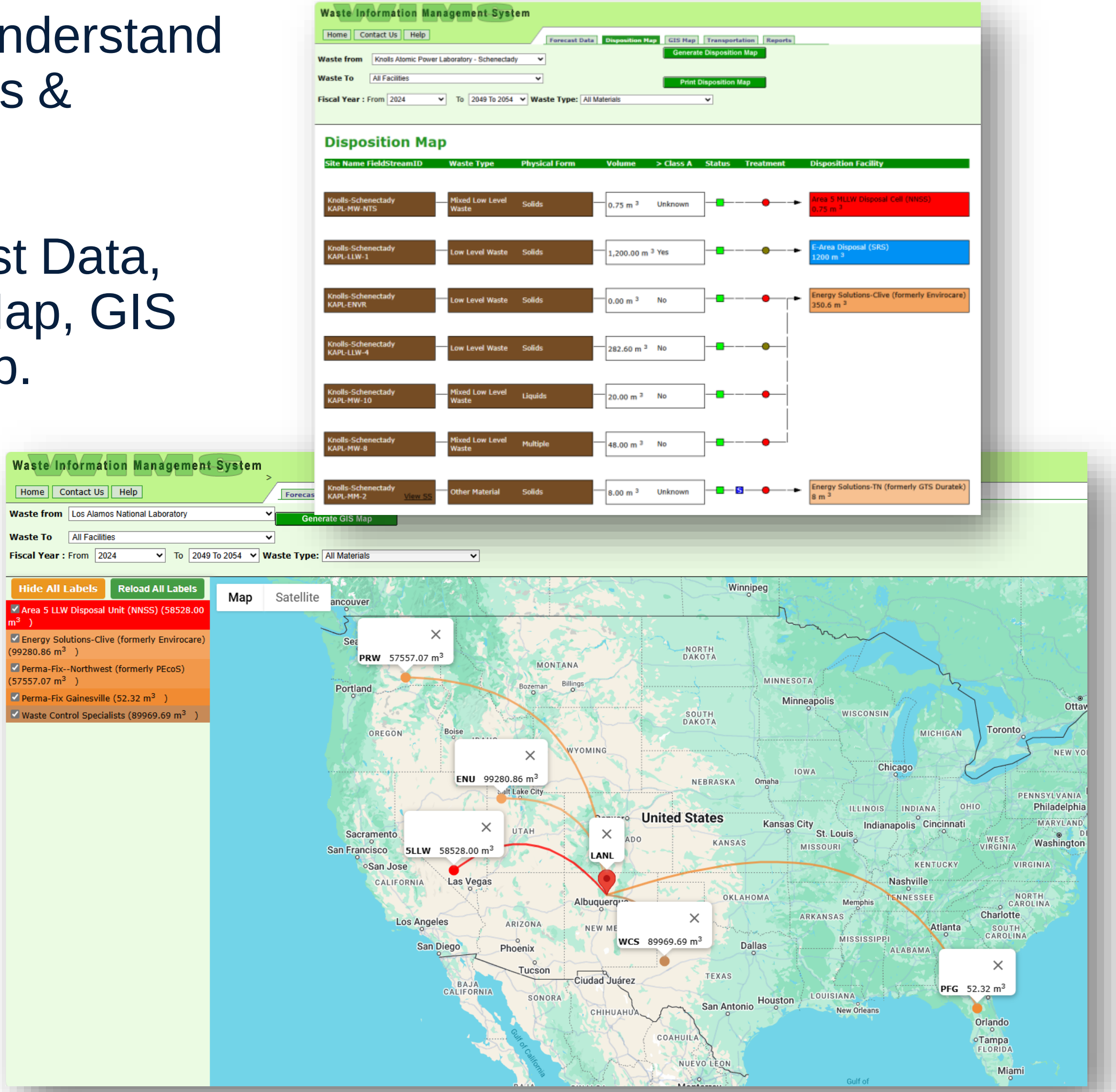
Objectives:

- Provide a central web-based system to access waste forecast streams for sites across the DOE complex.
- Provide easy-to-use systems to view & download waste stream forecast information in various formats.
- Update waste stream forecast information annually.

Subtask 1.1	WIMS System Administration & Cyber Security – Database Management, Application Maintenance & Performance Tuning
Subtask 1.2	Waste Stream Annual Data Integration and Application Enhancements

Waste Information Management System (WIMS)

- Easy-to-use system to visualize and understand the forecasted DOE-EM waste streams & transportation information.
- Various modules of WIMS are Forecast Data, Disposition Map, Successor Stream Map, GIS Map, Transportation, Reports and Help.
- WIMS is deployed and available at https://emwims.org
- Application supports 704 complex waste stream from 36 sites and 36 disposition facilities.
- 5 Waste Types
  (LLW, MLLW, 11e(2) Byproduct Material, Other & Unknown)
- Forecast date range 2023-2050



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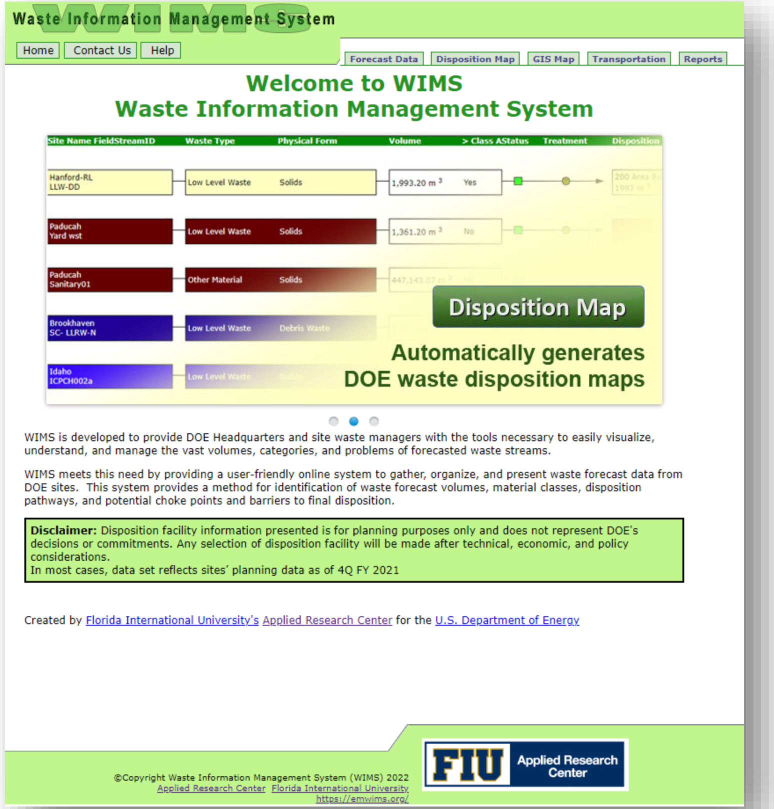
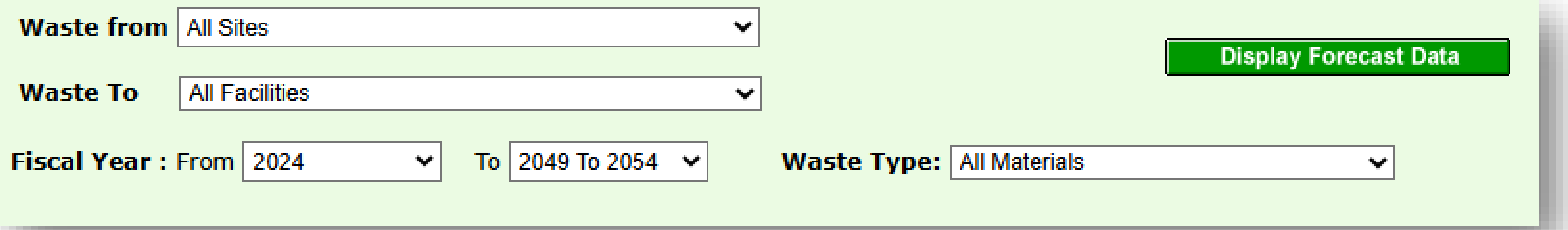
Subtask 1.2: Waste Stream Annual Data Integration and Application Enhancements

Accomplishments:

- FIU received the revised waste forecast data from DOE HQ and incorporated the data on the system.
- Completed integration of 2024 waste forecast and transportation data into WIMS system (Milestone 2023-P3-D5).
- Published 2024 Forecast Waste stream information and DOE was notified on May 5, 2023.
- Status: 5 waste types, 708 waste streams, 36 reporting sites and 36 disposition facilities.





Subtask 1.2: Waste Stream Annual Data Integration and Application Enhancements

Accomplishments:

- FIU presented WIMS research and accomplishments at 2024 Waste Management Symposia, March 2024

WM SYMPOSIA

Walter Quintero and Dr. Himanshu Upadhyay presenting WIMS poster at WM2024.

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Waste Information Management System Development, Maintenance and New Data Integration (WIMS) (HQ)

FIU Year 5 Projected Scope

- **Subtask 1.1: WIMS System Administration & Cyber Security – Database Management, Application Maintenance & Performance Tuning**
  - This subtask includes the day-to-day maintenance and administration of the application and the database servers.
  - Administrator will monitor the network and server traffic and performs updates necessary to optimize the application performance.
  - FIU will provide application and database security as well as help desk support to DOE site managers, HQ managers and other users who need assistance with WIMS.
  - Provide cyber security to WIMS infrastructure, application, database server and reporting server.
- **Subtask 1.2: Waste Stream Annual Data Integration and Application Enhancements**
  - Update WIMS modules – Forecast Data , Waste Stream and GIS map.
  - Update and publish reports.
  - Update and publish transportation module.

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Task 2

D&D Support to DOE EM for Technology Innovation, Development, Evaluation and Deployment

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Subtask 2.2

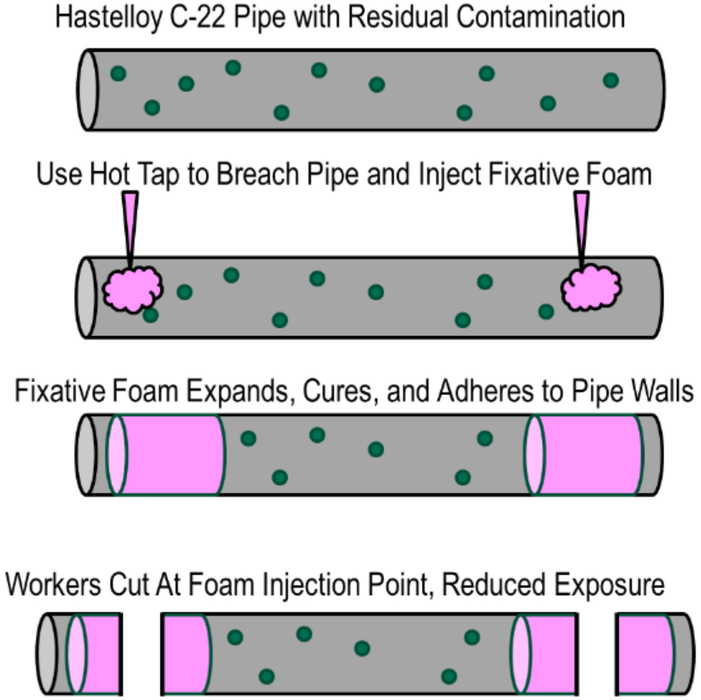
Test and Evaluation of Foam Fixative Technologies to Mitigate Contaminant Release in 3D Void Spaces for D&D

Subtask 2.2: Test and Evaluation of Foam Fixative Technologies to Mitigate Contaminant Release in 3D Void Spaces for D&D

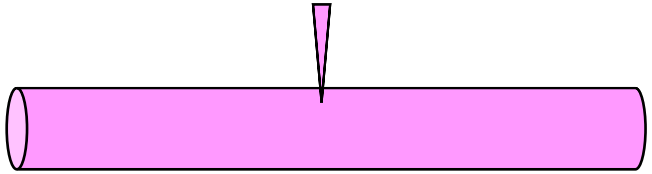
Site Needs:

- By FY ‘27, the F/H Laboratory Deactivation Project Team plans to remove all the buried LAD and HAD piping in the Courtyard between 772-F and 722-1F.
- The driver for removal is to prevent future release(s) to the environment from the buried, highly-contaminated piping.
  - Foam fixative has applications during removal process and pre-removal process.
- The intent is to remove the piping to within 1’ of the respective building and then to cap both the 2 & 3-inch “core” pipe and the 3 & 4-inch “jacket” pipe.
- The piping is generally buried to a depth of 3-5 feet.
- Total length of piping to be removed is approximately 250 feet. Piping will be cut to 5’ lengths so that it may be disposed to B-25.
- Has large-scale applications across DOE-EM complex.

Aerial view of Potential Hot Site at F-Area



Pre-removal Stabilization Concept of Employment



Subtask 2.2: Test and Evaluation of Foam Fixative Technologies to Mitigate Contaminant Release in 3D Void Spaces for D&D

Research Highlights & Accomplishments:
Identify & Down-select Most Compatible Technology

Hilti

- A two-component polyurethane (PU) intumescent foam that expands up to six times in volume upon application.
  - Meets ASTM E84 standard.
- Foam is applied through a dispenser and a mixer nozzle attachment.

Foambag™

- Expanding PU resin foam.
  - Used in the UK in gloveboxes at Sellafield & meets the UK gas industry technical standard T/SP/E/59.
- Injected into a semiporous bag via an injection tube which passes up through the standpipe assembly.

The FOAMBAG™ holds the resin foam in place as it expands. At full expansion some of the foam seeps through the semi-porous panels of the bag to form an adhesive seal with the pipe

- ASTM E3191-18, Standard Specification for Permanent Foaming Fixatives Used to Mitigate the Spread of Radioactive Contamination and requirements outlined by F/H Labs Decommissioning Project Team were used to guide initial screening, testing and evaluation.
- New foam technology (Endseal) is also being tested and showing extremely promising results.

Research Highlights & Accomplishments: Technology Comparison to Support Down-selection

	Curing Time	Max Curing Temp.	Average Plug Strength	Adhesion to Wetted Surface	Fire Retardant	Environmental Chamber	Headspace	Hot Tap Compatible
Hilti	1-3 mins	276°F	7733 lbf	**888 lbf**	YES	PASS	PASS	**FAIL**
Foambag™	15-45 mins	277°F	9684 lbf	**4741 lbf**	YES*	In progress (SRNL)	In progress (SRNL)	**PASS**
Endseal	15-45 mins	In progress	In progress	In progress	YES*	TBD	TBD	**PASS**

*Fire retardant with addition of Exolit AP 750 additive.

*Endseal creates airtight seal as early as 5 mins after application and a stronger airtight plug when fully cured.

Foambag™ & Endseal Thermal Resistance

- Exolit-AP-750 additive significantly improved the foam's resistance to thermal/fire stressors
- Optimized ratio mix to provide highest level of passive fire protection without degrading other performance requirements (e.g.: adhesion)
- Secondary benefits included increased viscosity which significantly enhanced application for end user

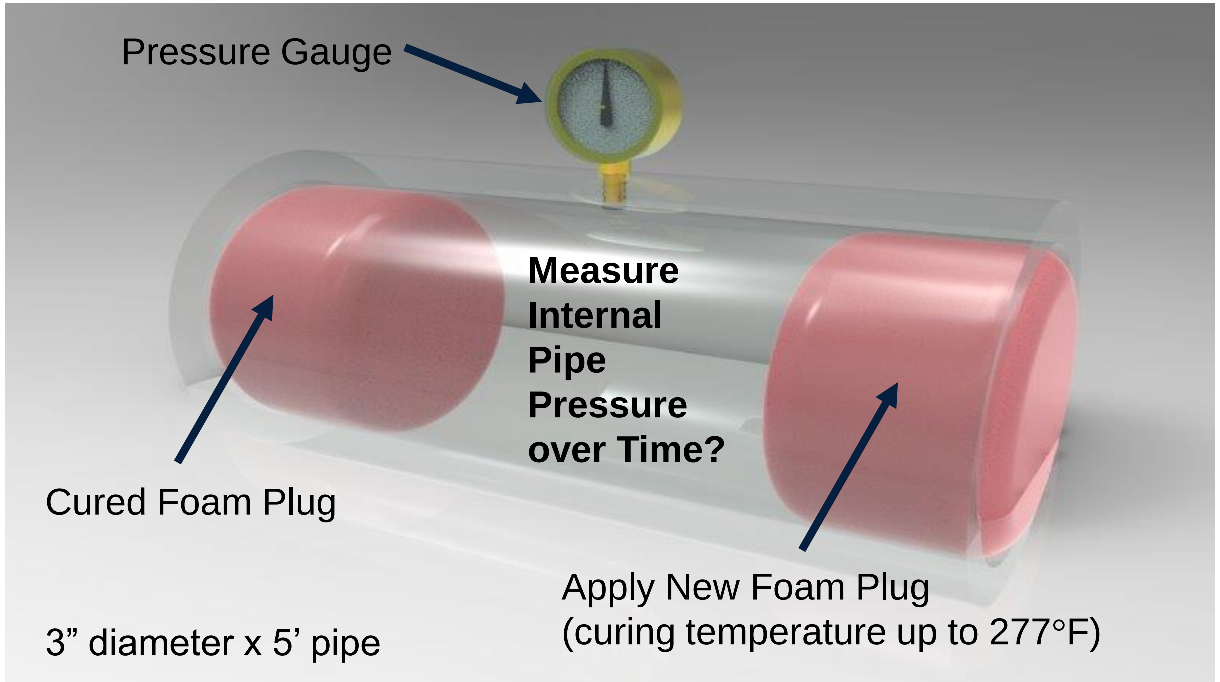
Containment / Leak Testing Under Pneumatic and Hydrostatic Pressure (Thermal / Fire Stressors)

Applied direct flame from BERNZOMATIC Butane Hand Torch to FOAMBAG plug w/ EXOLIT AP 750 fire retardant additive for 4 minutes (Max flame temperature 3400°F).

Foambag plug w/ EXOLIT AP 750 fire retardant additive intumesced consistent with previous tests, causing plug to self-extinguish when flame was removed and creating thermal insulating barrier.

Foambag plug was relatively intact underneath thermal insulating char.

Experimental Design:
Impacts of Curing Temperatures on Internal Pipe Pressure



- **Hypothesis:** Pressure buildup will be minimal
- Reasoning:
  - Foam expansion rate to seal off 3' inner diameter pipe is 5-8 minutes (need more test to confirm)
    - Allows heated air to escape down pipe
  - Once foam fully expands, it has already reached its highest temp of 276 F
    - Only 2 minutes to heat air volume in sealed 3" x 3' pipe section
  - Determine at what point the foam plug being applied produces an air-tight seal
    - Endseal achieved an airtight seal in less than 5 minutes

- **Initial Test Run:**
  - Heat generation profile during curing mirrored past thermal profile
  - Verified experimental design set-up
  - First test run with new foam plug yielded highest measurement of 1 psi at 15 minutes, which correlated with highest temp
  - Dropped to 0 psi at 30 minutes

Subtask 2.2: Test and Evaluation of Foam Fixative Technologies to Mitigate Contaminant Release in 3D Void Spaces for D&D

FIU Year 5 Projected Scope

- Improve consistency of plug performance at higher psi levels
  - Further investigate Endseal and Foambag with tungsten fillers
- Confirm impacts of curing on internal pipe pressure
- Initiate testing of hot tap and cutting equipment on Hastelloy C-22, Schedule 80 pipes and determine impacts on foam fixative plug (mechanical stressors)
- Codify additional performance requirements and testing protocols into update of ASTM E3191
- Complete development of Hot Test Plan with SRNL
  - Initial mtg w/SRNL held on Monday, 8 July
  - FIU will confirm hot tap compatibility for application of technology and cutting tools
    - Work Plan Procedures developed

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Subtask 2.3

Certifying Fixative Technology Performance when Exposed to Impact Stressors as Postulated in Contingency Scenarios Highlighted in Safety Basis Documents

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Subtask 2.3: Certifying Fixative Technology Performance when Exposed to Impact Stressors as Postulated in Contingency Scenarios Highlighted in Safety Basis Documents

Site Needs:

- Fixative materials encapsulate / stabilize residual radioactive contamination under normal operating conditions & contingency scenarios.
  - Mitigates the risk of a release in facilities from active use to final disposition.
- Regulations don't account for materials that could stabilize contamination in solid polymer layer, potentially reducing airborne release of radiological contamination.
  - Doesn't allow for a reduction safety calculations.
- Calculations partially determined by the coefficients in the form of ARFs of radioactive material at risk.
- No literature to-date that has empirically evaluated the potential impacts of fixative materials.
  - Lack of new data to corroborate results from experimental data from over 30 years ago.

Objectives:

- Reevaluate ARF coefficients for powder contaminants under impact.
- Determine ARF coefficients for fixative materials under impact.
  - Fixative/Polymer State
- Integrate results to update DOE-HDBK-3010.

$$Source\ Term = MAR \times DR \times ARF \times RF \times LPF$$

FIXATIVE STATE

- Reduces ARFs
- Reduces RFs

Contaminant Form	Impact ARF
Gas / Vapor	1.0
Powder	**4e-4**
Liquid	4e-5
Metal / Solid	No significant airborne release is postulated for this accident configuration.

High Risk

Low Risk

Subtask 2.3: Certifying Fixative Technology Performance when Exposed to Impact Stressors Postulated in Contingency Scenarios Highlighted in Safety Basis Documents

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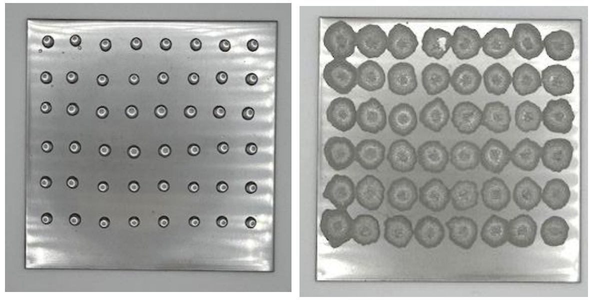
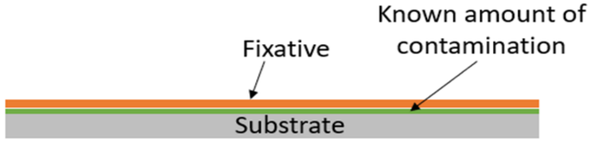
Research Highlights & Accomplishments:

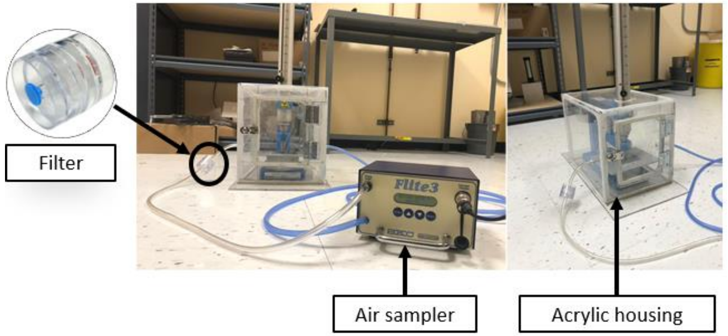
- Developed a new hybrid experimental design that incorporates tried and true practices with new analytical techniques.
  - ASTM E3283 – Standard Practice for Preparation of Loose Radiological/Surrogate Contamination on Nonporous Test Coupon Surfaces
  - ASTM D2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
- ICP-MS will detect specific element in the surrogate & quantifies the amount detected.
- Airborne Release Fraction:

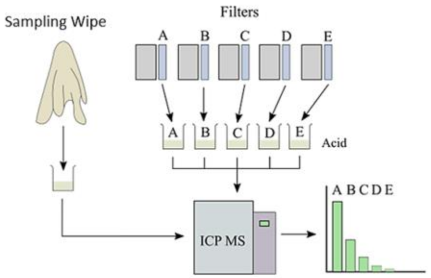
$$ARF = \frac{m_{ICP\ Filter}}{m_{released}}$$

  - $m_{ICP\text{-}Filter}$ is the mass of Cs from the air filter determined from the ICP-MS
  - $m_{released}$ is the total mass of contamination released





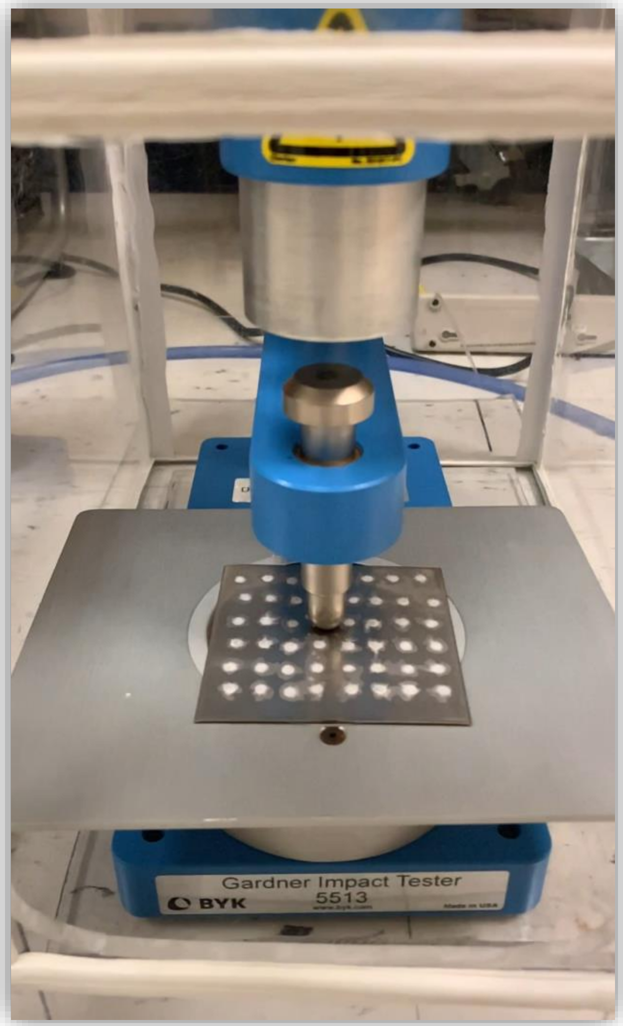




Research Highlights & Accomplishments: Reevaluate Powder ARFs

- Powder contaminant only coupons with no coating applied.
- Impact with no fixative shows a potential for a large release.
    - Higher ARFs
    - Coupon deformation
- Revalidated - Average ARF of 3.47E-04.

	Impact (in-lb.)	Average Airborne Release Fraction	Standard Deviation
Powder	320	2.27E-04	2.76E-04
	240	1.08E-04	1.69E-04
	200	1.05E-05	2.77E-06
	160	6.32E-07	2.43E-07
Total Average		**3.47E-04**	

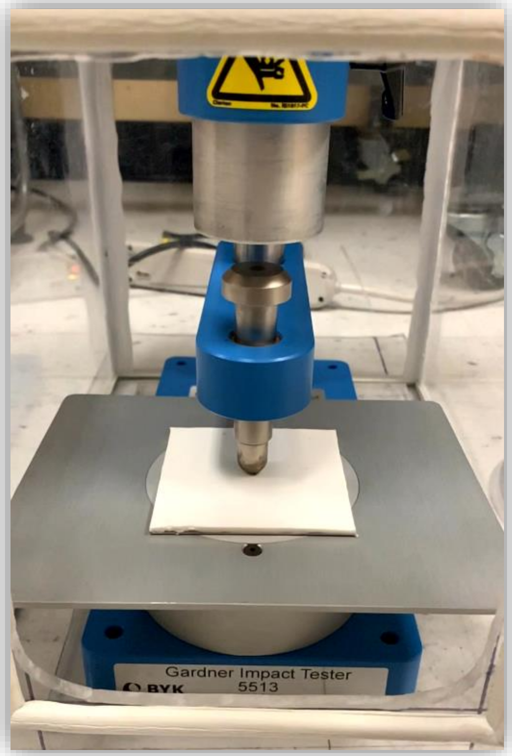


No Fixative

Subtask 2.3: Certifying Fixative Technology Performance when Exposed to Impact Stressors Postulated in Contingency Scenarios Highlighted in Safety Basis Documents

Research Highlights & Accomplishments: Determine Fixative ARFs

- Empirical data supports that fixatives significantly reduces ARFs.



Stabilization of Powder due to Polymer Fixative

	Impact (in-lb.)	Average ARF	Standard Deviation
PBS	320	4.06E-07	1.62E-07
	240	3.08E-07	1.13E-07
	200	2.28E-07	1.26E-07
	160	1.61E-07	3.66E-08
Total Average		**1.10E-06**	

	Impact (in-lb.)	Average ARF	Standard Deviation
FD	320	4.46E-08	4.36E-08
	240	2.61E-08	9.88E-09
	200	1.92E-08	1.15E-08
	160	1.52E-08	7.32E-09
Total Average		**1.05E-07**	

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Subtask 2.3: Certifying Fixative Technology Performance when Exposed to Impact Stressors Postulated in Contingency Scenarios Highlighted in Safety Basis Documents

FIU Year 5 Projected Scope

Expand Impact Levels

- Expand to include lower forces for a more comprehensive range of ARFs.

Material Characterization

- SEM/EDS for detailed characterization of fixative coatings before and after impact.

ASTM Testing Practice

- Submit experimental design/procedures to ASTM E10.03 Subcommittee for development into an ASTM testing practice or protocol.

Comparison with Additional Fixative Technologies for Impact Stress

Provide Empirical Data to Support Potential Update to DOE-HDBK-3010

FIXATIVE

PBS: 1.1E-6
FD: 1.1E-7

Contaminant Form	Impact ARF
Gas / Vapor	1.0
Powder	4E-4
Liquid	4E-5
Metal / Solid	No significant airborne release.

Higher Risk

Lower Risk

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Subtask 2.1

Development of Uniform Testing Protocols and Standard Specifications for Fixative Technologies in Support of Complex-Wide D&D Activities

Subtask 2.1: Development of Uniform Testing Protocols and Standard Specifications for Fixative Technologies in Support of Complex-Wide D&D Activities

Site Needs:

- A uniform, peer-reviewed, stakeholder endorsed test and evaluation methodology for D&D technologies, with a current emphasis on fixatives.
  - Define the operational requirement for the technology (What should it do and to what standard – characteristics and performance).
  - Develop uniform testing protocols so the D&D community can confirm it does, in fact, do it (also facilitates comparison).
- **Operationalize knowledge**, not just archive it.

Objectives:

- Engage ASTM International's E10.03 Subcommittee on Radiological Protection for Decontamination and Decommissioning of Nuclear Facilities and Components to develop, ballot and promulgate standard specifications and uniform testing practices for fixative technologies intended to support D&D activities.

DOE EM Citations Referencing ASTM E10.03 Fixative Technology Standards and Impact Performance

- ASTM E10.03 standards have established a recognized, community-wide, uniform methodology for testing, evaluating, certifying and crediting fixative technologies for use in support of D&D activities and have been extensively cited. A few recent examples include:
  - SRNL-STI-2021-00115, “A Novel Approach to Mitigating the Potential Release of Radioisotopes Under Fire Conditions - Enhancing Fire Resiliency of Radiological Contamination Fixatives During Deactivation & Decommissioning Activities”, 2021,

    *Supported Incombustible Fixative site deployment for SRS 235-F PUFF Facility
  - SRNL-STI-2023-00005, “Radiation Hardened Foam Cold Test Plan - Phase II: Foam Characterization Testing and Environmental Chamber Testing of FoamBag Fixative Foam”, 2023

    *Supporting Foam Fixative Plug site deployment for F/H Labs
  - Lee, E. H., et al., “Removable coatings: Thermal stability and decontamination of steel surfaces from 241Am,” Chemosphere, Vol 301, August 2022, 134680
  - FY 22 Minority Serving Institutions Partnership Program (MSIPP), RFP 000749
    - PA3: Incombustible fixatives and decontamination agents
    - RN3: R&D leading to the development of these fixatives and agents for a nuclear facility. Also, the development of testing protocols to demonstrate their acceptance.
    - C3: Meets ASTM standard from E10.03. Protocols should be applicable to various DOE facilities
- Certifying Fixative Technology Performance Under Impact Stressors
  - Technical Progress Report, “Certifying Fixative Technologies – Impact” – submitted for upload to OSTI
  - Peer-reviewed manuscript, “Determination of Airborne Release Fractions from Loose Powder Contamination under Impact Stress” – submitted to the Nuclear Technology Journal, Aug 2023

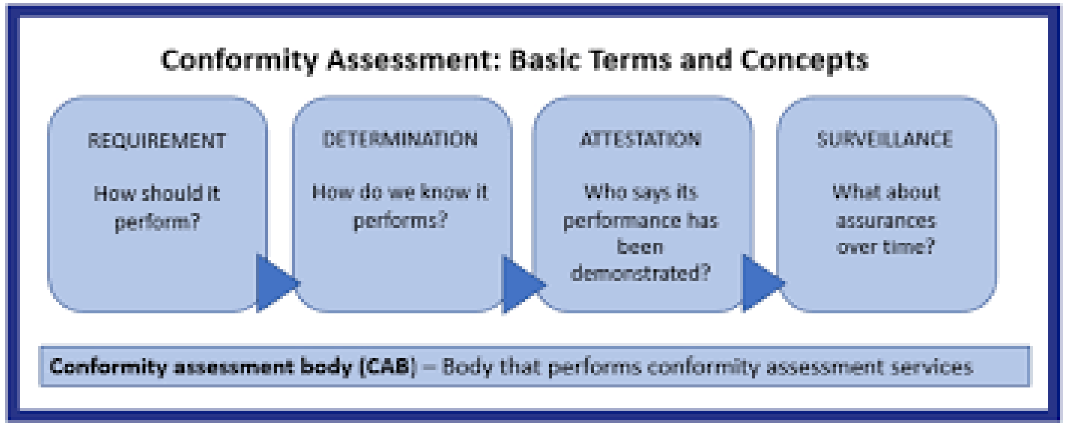
Subtask 2.1: Development of Uniform Testing Protocols and Standard Specifications for Fixative Technologies in Support of Complex-Wide D&D Activities

Development of Standard Specifications and Test Methods for Foam Fixatives to Minimize Risk and Promote Use Complex-wide

- Revise and ballot ASTM E3191 based on additional performance requirements and existing / newly developed testing practices
  - Fire
    - UL94
    - IEC 60695
    - D635
    - D3801
  - Containment / Leak Testing
  - Volatiles
  - Internal Pipe Pressure
- Outline pros and cons of a DOE EM Conformity Assessment Program for fixative technologies similar to NRC

PERFORMANCE CHARACTERISTICS

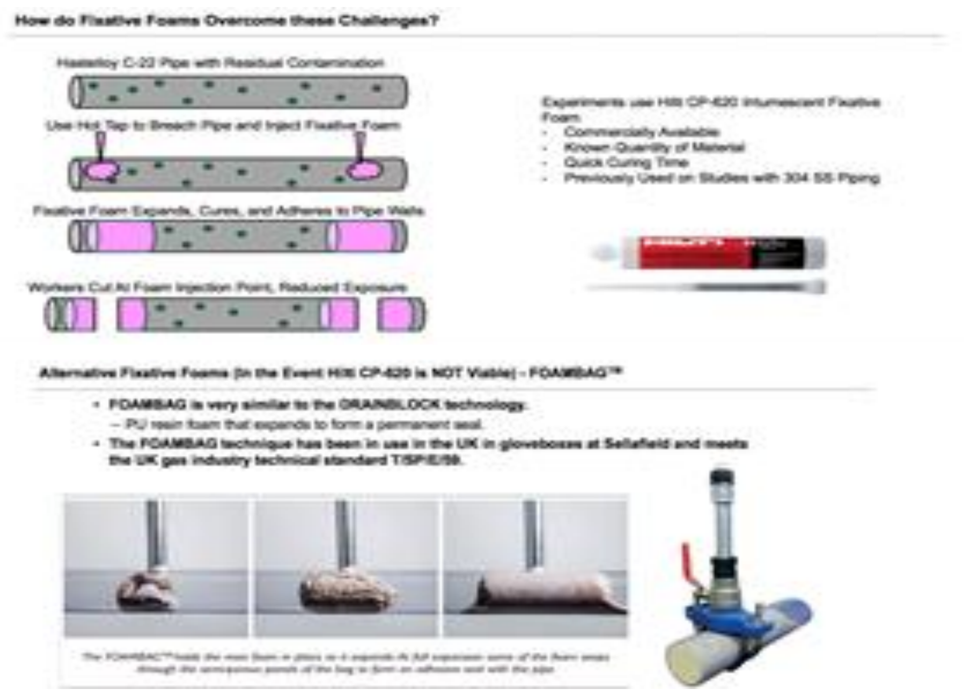
Test Name	System	Results
Abrasion Resistance ASTM D4060	646N	120 mg loss
Adhesion ASTM D4541 ASTM D7234	646N	3,180 psi (steel); 482 psi (concrete)
Chemical Resistance ASTM D3912	646N	No Effect
Decontamination ASTM D4256	646N	99%
Direct Impact Resistance ASTM D2794	646/646	120 in. lb.
Effects of Gamma Radiation* ASTM D4082	646N	Pass
Salt Fog* ASTM B117	646N	2,000 hours
Simulated DBA ASTM D3911	646N Steel and Concrete	Pass
Slip Coefficient, RCSC	646N	Class A
Surface Burning ASTM E84/NFPA 255	646N	Flame Spread Index 5; Smoke Development Index 20 (at 10.0 mils or 250 microns)
Thermal Conductivity* ASTM E1530	646N	@ 100°F = 0.21 BTU/h ft °F; @ 200°F = 0.21 BTU/h ft °F

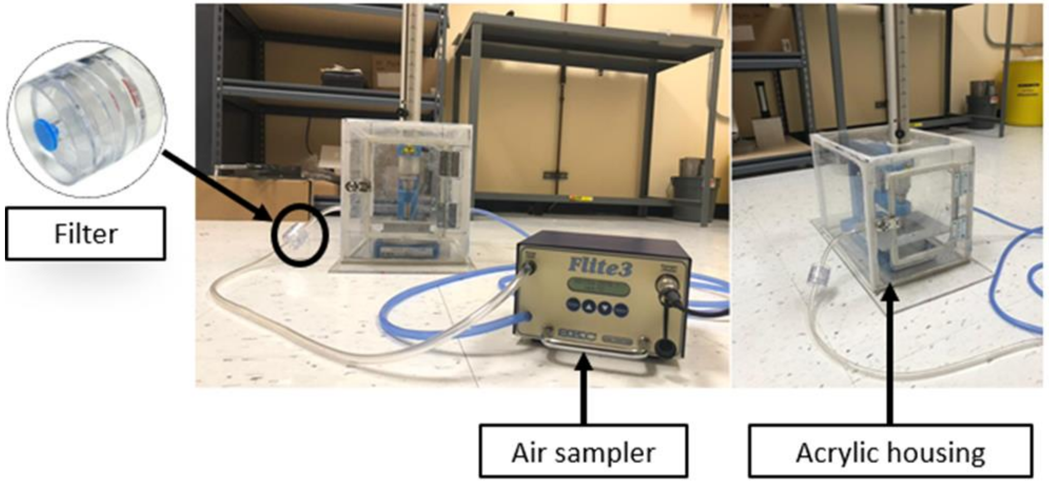


FIU Year 5 Projected Scope

- ASTM E 3191 (Foam Fixatives) updated and balloted
  - **Supporting Foam Fixative Plug site deployment for F/H Labs**

- ASTM Working Group established to codify experimental design developed in support of “certifying fixative technologies under impact stressors” into a formal testing practice





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Subtask 2.5

Digitalization in Decommissioning (Oak Ridge and Savannah River) (NEW)

Subtask 2.5: Digitalization in Decommissioning (Oak Ridge and Savannah River) (NEW)

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Site Needs:

- Evaluation and introduction to new and innovative technologies to accelerate D&D activities.
- Better protection of the workforce and the environment – 3Ds (dull, dangerous and dirty).
- Facilitate better method for site surveys and walk downs

Objectives:

- Investigate the use of robotic systems and LiDAR system for potential application in D&D.
- Select state of the art technologies (SPOT and Trimble LiDAR)
- Integrate radiation sensors to create radiation maps to support radiological characterization.
- Develop 3D Parametric Models and facility “Walk downs”
- Incorporate 3D Parametric Models into BIM models

Subtask 2.5: Digitalization in Decommissioning (Oak Ridge and Savannah River) (NEW)

Research Highlights & Accomplishments:

- Integration of Trimble X7 3D LiDAR (Light Detection and Ranging) is used to develop high quality 3D point cloud scans using laser beams.
- Use of Boston Dynamics SPOT robot to navigate indoor/outdoor environments.
- Integration of Kromek Sigma 25/50 Gamma detector.
- Data post-processed by using various software tools (i.e. AutoDesk ReCap, SCENE “video Pro).
- Development of 3D models and digital environments (Digital Twins).
- Collaboration with IAEA as part of NET4D international project.

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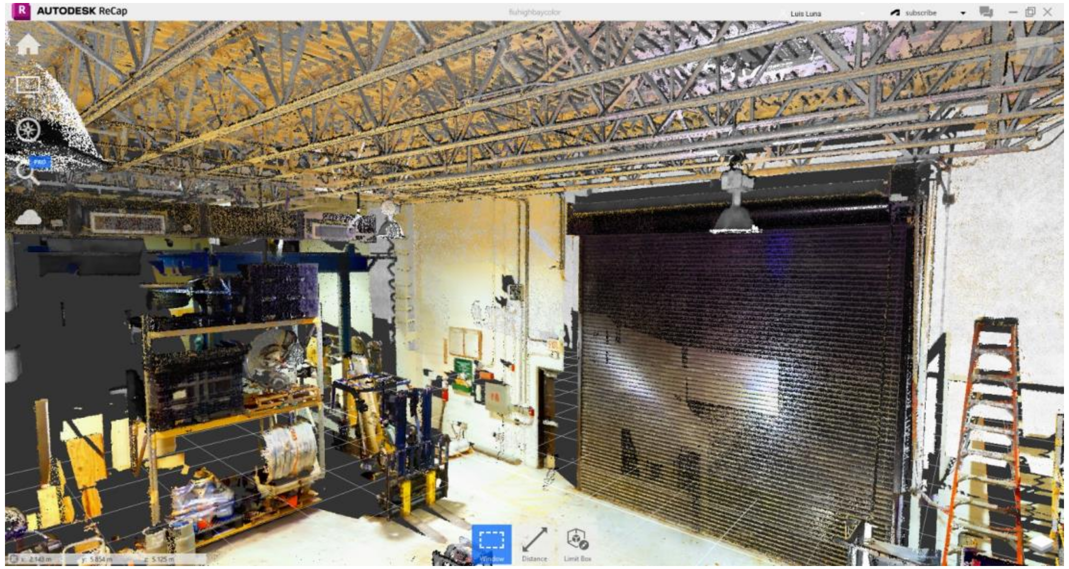
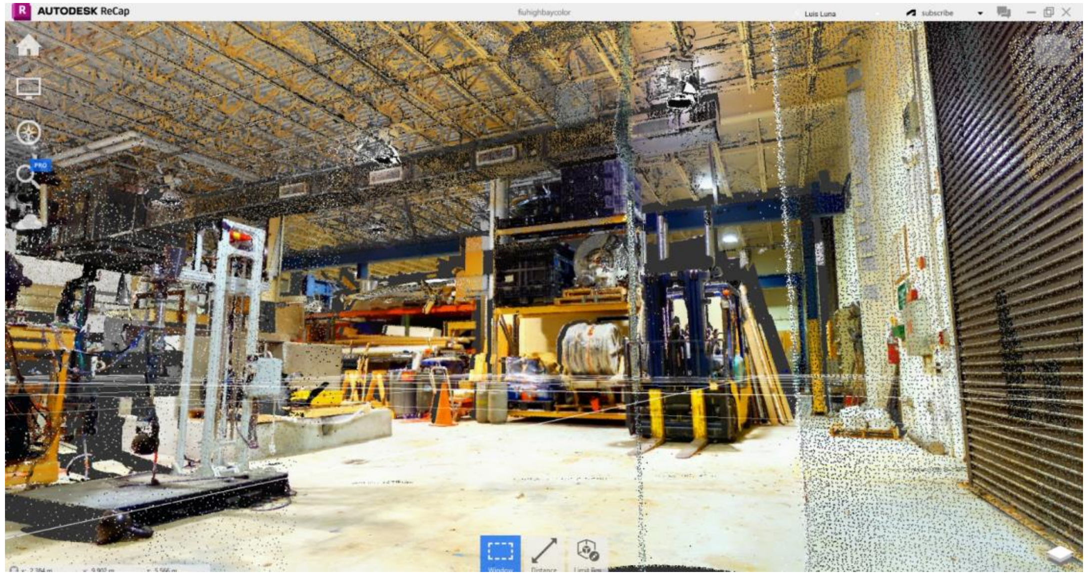
Subtask 2.5: Digitalization in Decommissioning (Oak Ridge and Savannah River) (NEW)

Research Highlights & Accomplishments:





3D Laser Scanning of ARC's High Bay Facility

Subtask 2.5: Digitalization in Decommissioning (Oak Ridge and Savannah River) (NEW)

Research Highlights & Accomplishments:

- High-quality detailed scans produced with Trimble X7 (LiDAR fixed in place during scanning)
- SPOT integration allows for autonomous navigation through the facilities
- Focus will be on implementing sequential stops during SPOT deployment for Trimble X7 to activate and scan
- Presentation of the research at various national and international forums

Subtask 2.5: Digitalization in Decommissioning (Oak Ridge and Savannah River) (NEW)

Courtesy of Nucleco (Italy) and IAEA: Laser Scanner “Faro S150 + and SCENE “video Pro”

Subtask 2.5: Digitalization in Decommissioning (Oak Ridge and Savannah River) (NEW)

FIU Year 5 Projected Scope

- Integration of 3D parametric models to BIM system undergoing research.
- Implementation of Virtual/Extended Reality to BIM or 3D parametric models.
- Completion of fully tested radiation mapping device and programming
- Deployment of system at DOE facility.
- Development of VR/AR models for site inspection and traning worker on various D&D activities.
- Begin new task proposed under CA Year 5 "Remote Spraying" of fixatives and coating (collaboration with UCOR and Argonne)

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Task 3

D&D Knowledge Management Information Tool (KM-IT)

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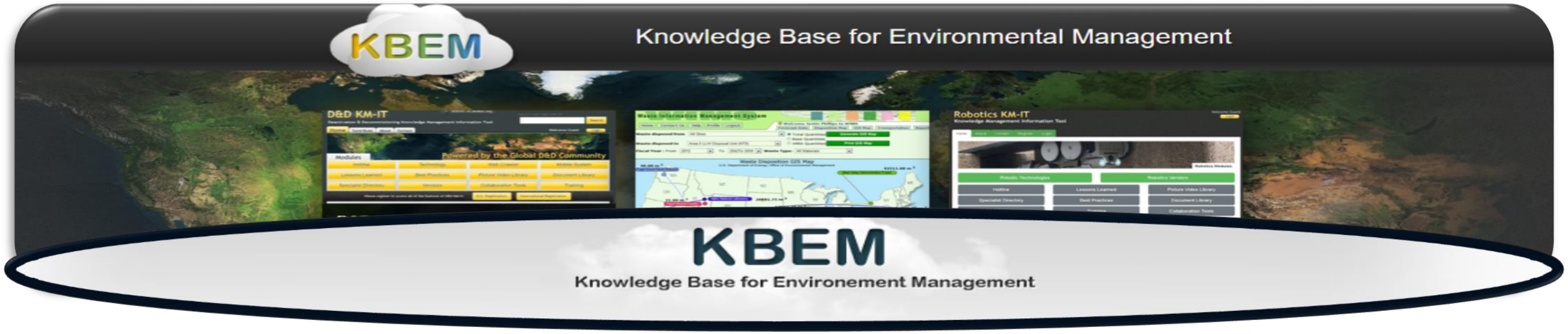
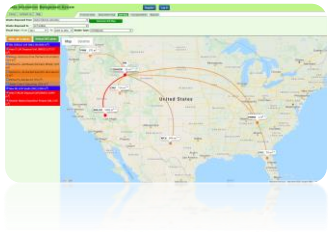
Knowledge Base for Environmental Management



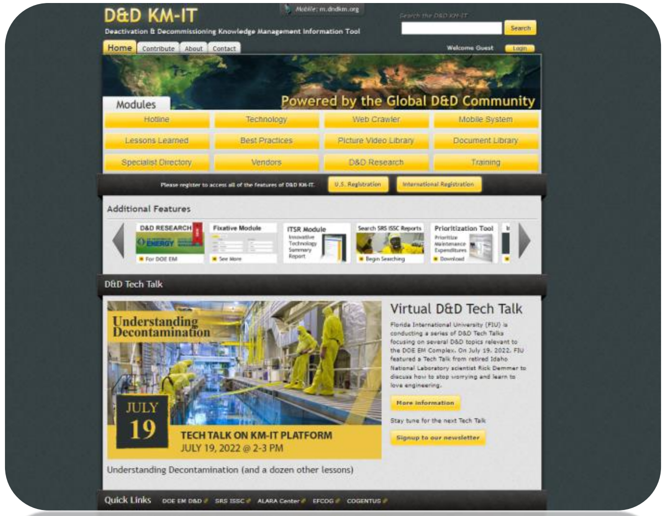
DND KM-IT dndkm.org	WIMS emwims.org	DOE FELLOWS fellows.fiu.edu	DOE RESEARCH doeresearch.fiu.edu	Robotics KM-IT rkmit.org



Task 3: D&D Knowledge Management Information Tool (KM-IT)

Site Needs:

- To prevent the loss of the collective knowledge from the aging workforce, the need to collect, retain and disseminate knowledge in an organized and structured way through the development and maintenance of a universally available and usable knowledge management system for DOE-EM.



Objectives:

- Knowledge management (KM) is a modern approach & discipline being used within EM to capture knowledge. Objectives for KM-IT are to attain the long-term active use, operation, and continued growth of the knowledge from across the DOE global community and capture within the KM-IT system, resulting in enhanced worker safety, improved operational efficiencies, improved communication & knowledge among stakeholders, and the cross-generational transfer of knowledge to the future workforce.

Subtask 3.4	Content Management
Subtask 3.5	Marketing and Outreach
Subtask 3.6	D&D KM-IT System Administration & Cyber Security
Subtask 3.7	KM-IT Tech Talks

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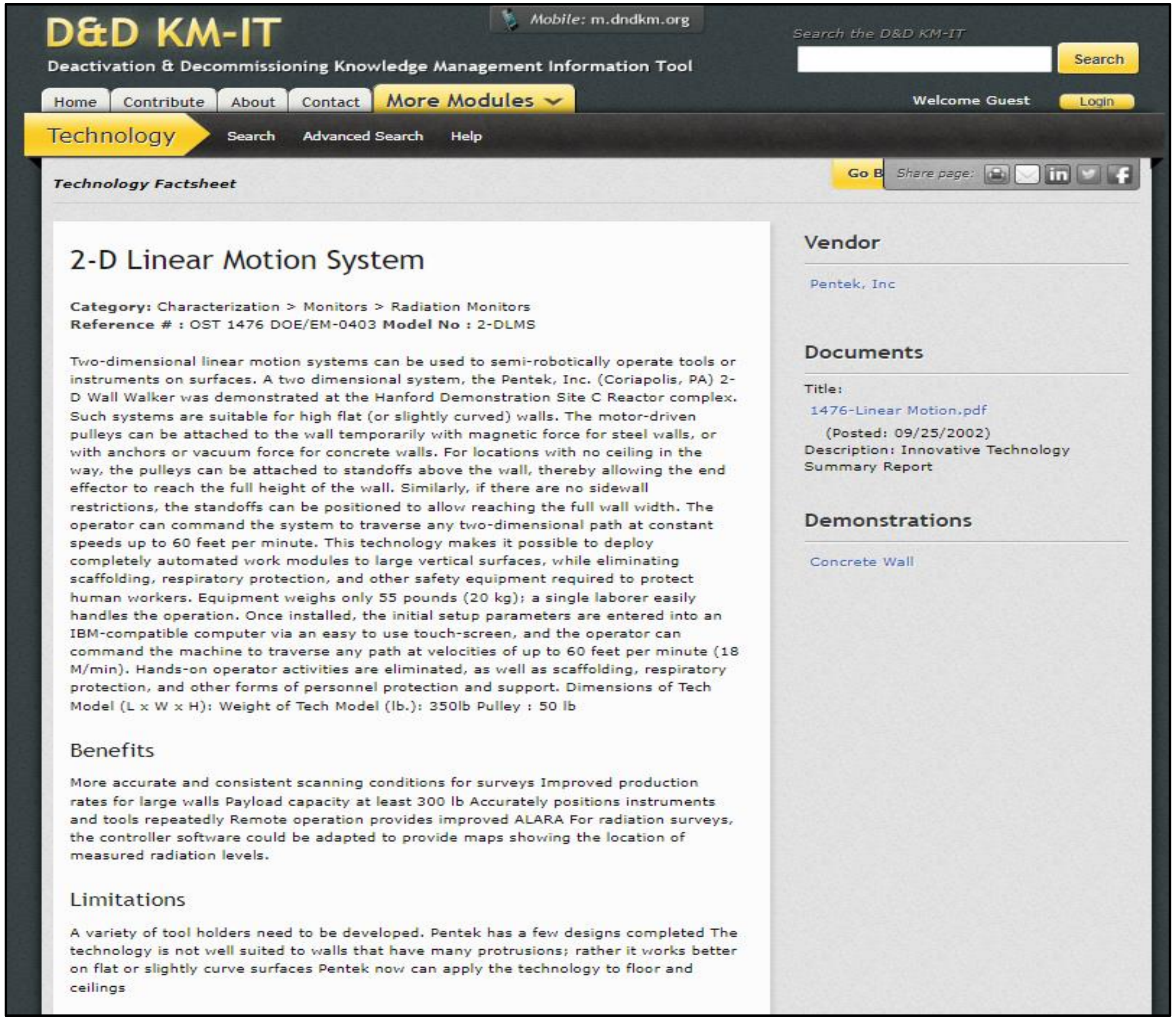
D&D KM-IT - Technology Module



D&D KM-IT
Mobile: m.dndkm.org
Deactivation & Decommissioning Knowledge Management Information Tool
Search the D&D KM-IT
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Technology Factsheet

Go B | Share page:

2-D Linear Motion System

Category: Characterization > Monitors > Radiation Monitors
Reference # : OST 1476 DOE/EM-0403 **Model No :** 2-DLMS

Two-dimensional linear motion systems can be used to semi-robotically operate tools or instruments on surfaces. A two dimensional system, the Pentek, Inc. (Coriapolis, PA) 2-D Wall Walker was demonstrated at the Hanford Demonstration Site C Reactor complex. Such systems are suitable for high flat (or slightly curved) walls. The motor-driven pulleys can be attached to the wall temporarily with magnetic force for steel walls, or with anchors or vacuum force for concrete walls. For locations with no ceiling in the way, the pulleys can be attached to standoffs above the wall, thereby allowing the end effector to reach the full height of the wall. Similarly, if there are no sidewall restrictions, the standoffs can be positioned to allow reaching the full wall width. The operator can command the system to traverse any two-dimensional path at constant speeds up to 60 feet per minute. This technology makes it possible to deploy completely automated work modules to large vertical surfaces, while eliminating scaffolding, respiratory protection, and other safety equipment required to protect human workers. Equipment weighs only 55 pounds (20 kg); a single laborer easily handles the operation. Once installed, the initial setup parameters are entered into an IBM-compatible computer via an easy to use touch-screen, and the operator can command the machine to traverse any path at velocities of up to 60 feet per minute (18 M/min). Hands-on operator activities are eliminated, as well as scaffolding, respiratory protection, and other forms of personnel protection and support. Dimensions of Tech Model (L x W x H): Weight of Tech Model (lb.): 350lb Pulley : 50 lb

Benefits

More accurate and consistent scanning conditions for surveys Improved production rates for large walls Payload capacity at least 300 lb Accurately positions instruments and tools repeatedly Remote operation provides improved ALARA For radiation surveys, the controller software could be adapted to provide maps showing the location of measured radiation levels.

Limitations

A variety of tool holders need to be developed. Pentek has a few designs completed The technology is not well suited to walls that have many protrusions; rather it works better on flat or slightly curve surfaces Pentek now can apply the technology to floor and ceilings

Vendor

Pentek, Inc

Documents

Title:
1476-Linear Motion.pdf
(Posted: 09/25/2002)
Description: Innovative Technology Summary Report

Demonstrations

Concrete Wall

D&D KM-IT - Technology Factsheet

INNOVATIVE TECHNOLOGY
Summary Report

DOE/EM-0403

2-D Linear Motion System

Deactivation and Decommissioning Focus Area

Prepared for
U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

November 1998

The Wall Walker 2-D LMS allows D&D and survey instrumentation to be operated remotely from the ground, eliminating the need for work on manlifts or scaffolds, and minimizing work in proximity to contamination. In addition, the Wall Walker 2-D LMS provides a measure of precision and productivity that is not available with the baseline method, i.e., manned operation of D&D and survey tools. The model demonstrated is designed for remotely operating tools weighing up to 158 kg (350 lb) and models are available for up to 909 kg (2,000 lb).

Potential Markets / Applicability

The Pentek, Inc. Wall Walker 2-D LMS is useful at DOE or other federal or commercial sites where tools or instruments must be used on high, vertical, flat or slightly curved surfaces. Because it is remotely controlled, it is especially effective in areas that are contaminated or where personnel would otherwise be required to work from manlifts or scaffolding. Also, because the instruments can be interfaced with computer software applications, the Wall Walker 2-D LMS is useful for performing surveys in which an automatic mapping feature is desired.

Features and Components

- Two motorized pulleys temporarily mounted near top corners of the wall
- Two wire cables threaded through the pulleys to a tool holder/shroud
- Programmable controller at remote ground-level location controls motorized pulleys to provide desired position and speed of movement to the tool holder/shroud

Advantages of the Improved Technology

The following table compares the improved technology to the baseline in key areas:

Category	Comments
Cost	In this application, the baseline cost is 64% of Wall Walker; however, ALARA exposure and worker safety is improved.
Performance	Production rate is about 0.6 m^2/min (6 ft^2/min) for a release survey; baseline production is about 0.3 m^2/min (3 ft^2/min). Accuracy in positioning equipment was within 1% to 2%, speed control was within 7%, much better than baseline. Repeatability in relocating equipment to specific positions was within 2.54 cm (1 in.), which is comparable to baseline.
Implementation	No special site services are required for implementing this tool.
Secondary Waste Generation	Does not generate secondary waste.
ALARA/Safety	Use of this tool improves ALARA conditions and safety, significantly reducing exposure and risks of workers falling.
Ease of use	Easy to deploy and control, short learning curve. Requires minimal skills.

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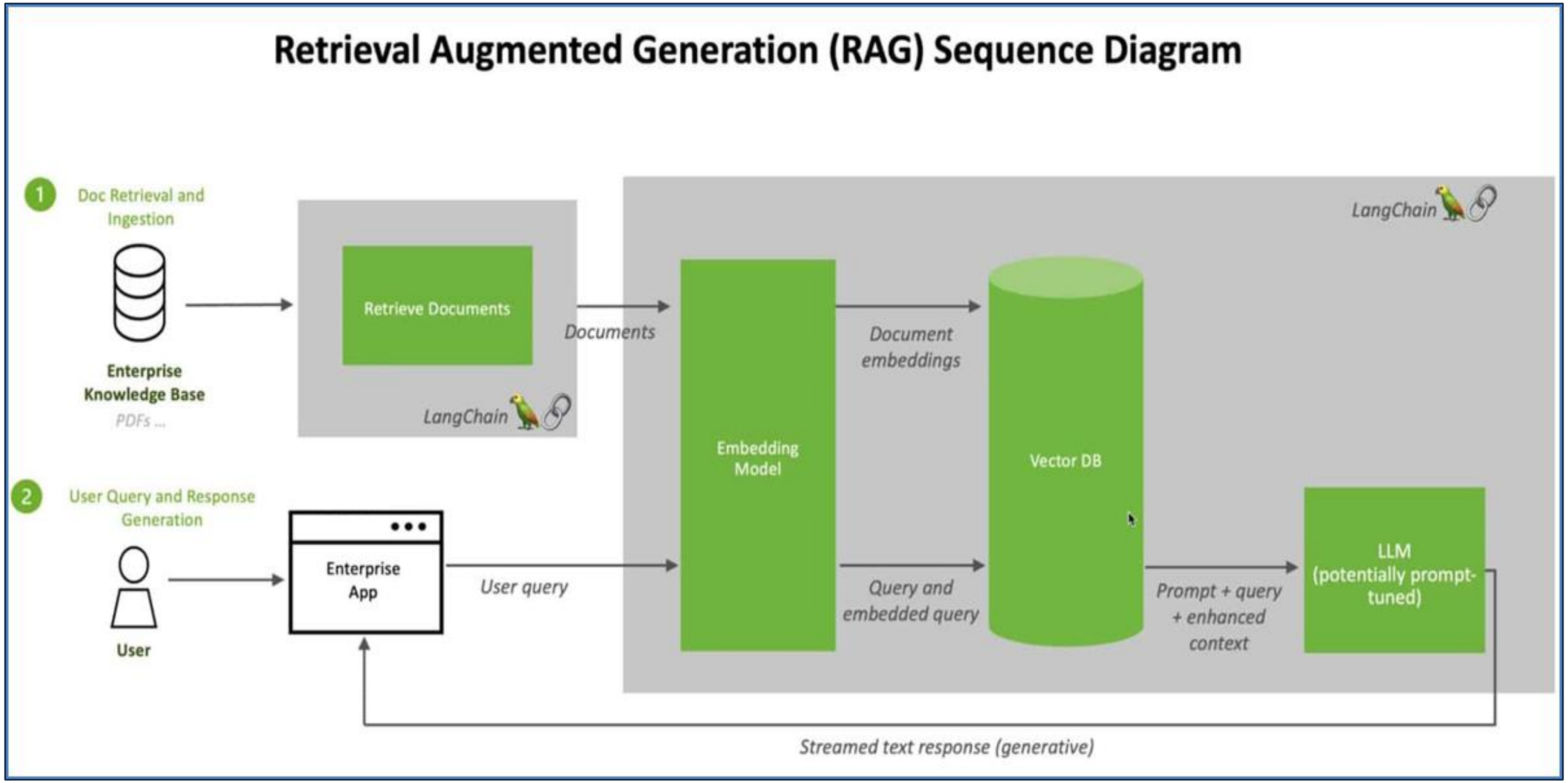
Generative AI – Document Summarization

- **AI Driven Analysis:** Quickly extracts key insights, minimizing manual effort.
- **Ensures Consistency:** Uses LLM for uniform identification of key points.
- **Boosts Efficiency:** Transforms extensive documents into brief summaries, aiding swift decision-making.



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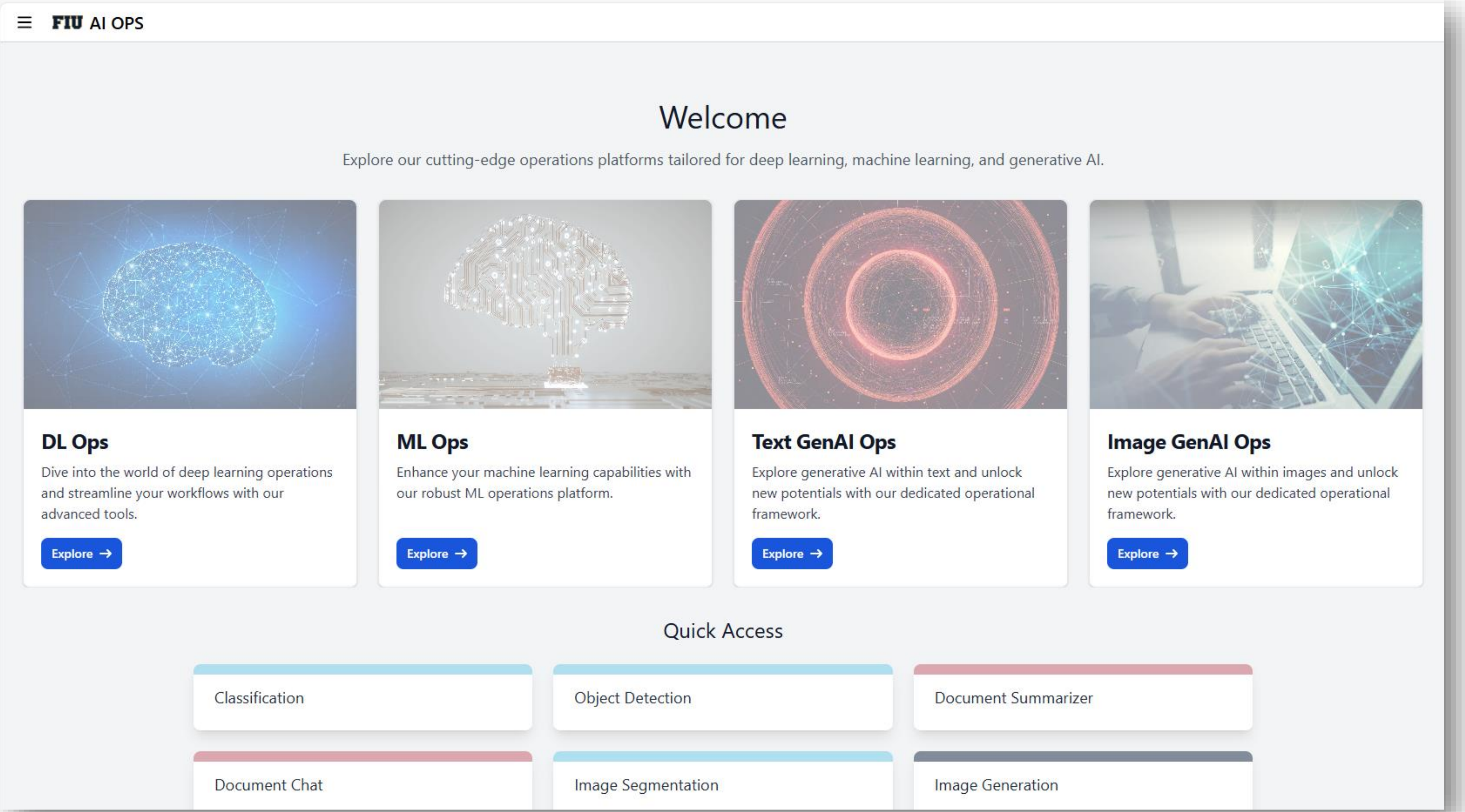
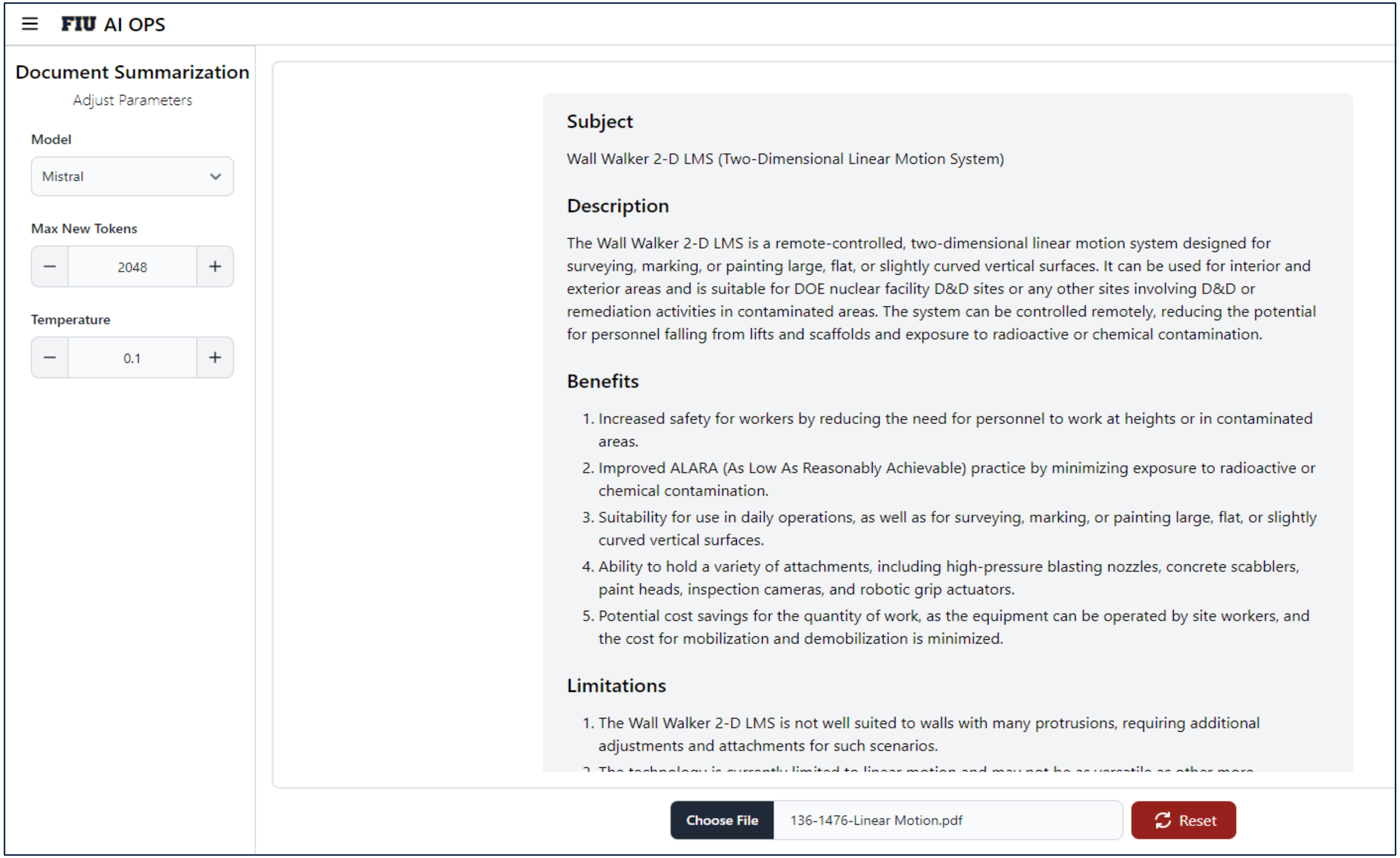
AI OPS (https://aiops.aamls.org/)



2-D Linear Motion Technology Document Summary



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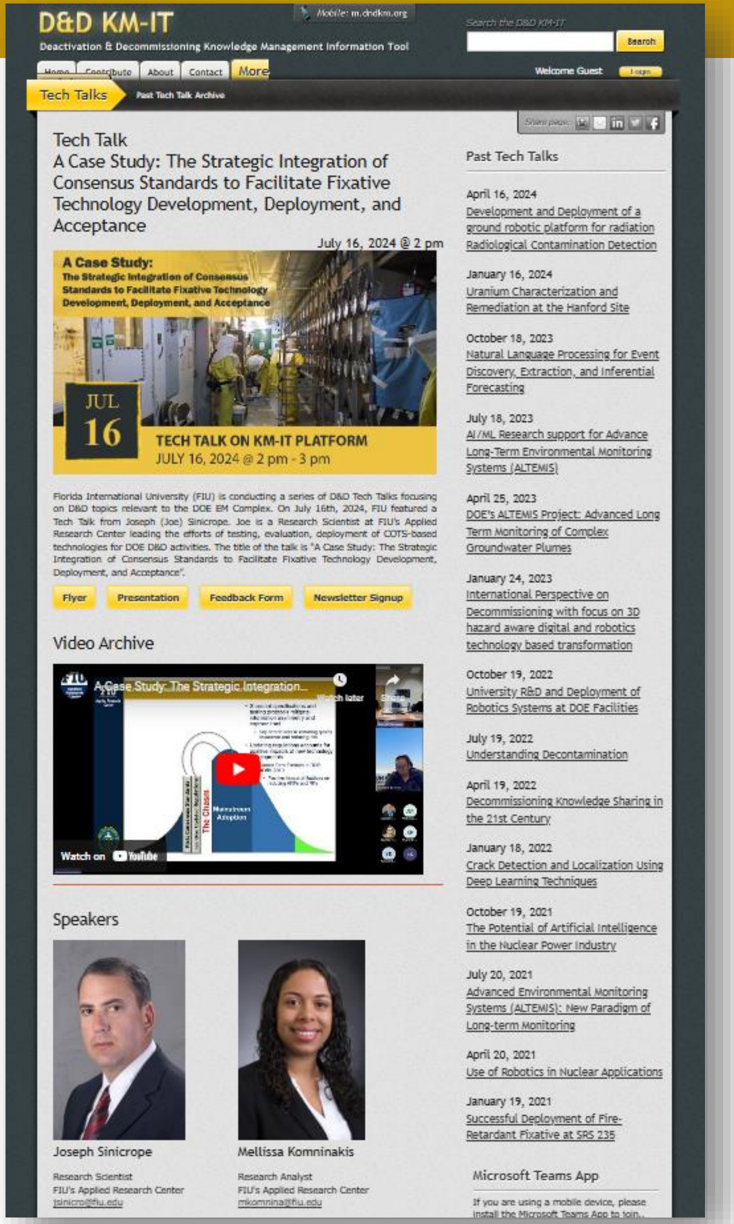
Subtask 3.8: KM-IT Tech Talks

Accomplishments:

- Collaborated with National Laboratories and/or DOE sites to identify and present technical topics of interest to the community.
- Conducted 4 virtual Tech Talks (https://www.dndkm.org/TechTalk)
  - October 18, 2023
    Natural Language Processing for Event Discovery, Extraction, and Inferential Forecasting
  - January 16, 2024
    Uranium Characterization and Remediation at the Hanford Site
  - April 16, 2024
    Development and Deployment of a ground robotic platform for radiation Radiological Contamination Detection
  - July 16, 2024
    A Case Study: The Strategic Integration of Consensus Standards to Facilitate Fixative Technology Development, Deployment, and Acceptance
- Tech Talks are recorded and posted on website for archive.



D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL (KM-IT) (HQ, SRNL, INL, ANL)

FIU Year 5 Projected Scope

- **Subtask 3.4: Content Management**
  - Publishing D&D technologies, vendors, D&D technologies, lessons learned, best practices, D&D news, conferences and other content to KM-IT
  - Perform QA/QC of existing content in the system with assistance of DOE Fellows
- **Subtask 3.5: Marketing and Outreach**
  - Reaching out to sites/national labs to increase KM-IT user involvement
  - Participation at workshops and conferences such as Waste Management and engagement with other agencies such as the IAEA.
  - Introduce the system to SME who may not be aware of its features and capabilities
  - Development of newsletters, post cards, factsheets and other print material to promote KM-IT
  - Integrate a ChatBot on the Technology module that will integrate with the Generative Text AI models developed using the KM-IT technology documents.

D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL (KM-IT) (HQ, SRNL, INL, ANL)

FIU Year 5 Projected Scope

- **Subtask 3.6: D&D KM-IT System Administration & Cyber Security**
  - D&D KM-IT System Administration is an ongoing task which involves day-to-day administration of servers that house the KM-IT databases and web applications.
  - This task includes updating patches and OS fixes, updating antivirus engines and definitions, updating drivers and assuring that the network (firewall, routers and switches) is working properly.
  - Securing the network by conducting routine cyber security tasks to test the network's vulnerability.
  - Coordination between the FIU security team and DOE Fellows who learn cybersecurity skills while assisting staff do penetration testing and other tasks to test the overall security of the system at the application, database and infrastructure levels.
- **Subtask 3.8: KM-IT Tech Talks**
  - Conduct D&D related Tech Talk every quarter on the D&D KM-IT platform.
  - Collaborate with National Laboratories and/or DOE sites to identify and present technical topics of interest to the community.
  - Tech Talks will be performed virtually using an online meeting platform (KM-IT)
  - Promote Tech Talks via newsletters, website, emails and flyers developed by FIU.

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Task 7

AI for EM Problem Set – Soil and Groundwater:

Data Analytics, Visualization and Machine Learning Model Development for Hexavalent Chromium [Cr(VI)] Concentration in the 100 Area (PNNL)

Task 7: AI for EM Problem Set – Soil and Groundwater–- Data Analytics, Visualization and Machine Learning Model Development for Hexavalent Chromium [Cr(VI)] Concentration in the 100 Area (PNNL)

Site Needs:

- Subsurface Chromium transport temporal and spatial relationships identification using Artificial Intelligence and Machine Learning.

Objectives:

- Develop Artificial Intelligence and Machine Learning algorithm for spatiotemporal relationship exploration.
- Perform exploratory data analysis using state-of-the-art statistical methods.
- Explain historical contaminant transport through model interpretation.

FIU Year 4 Research Highlights:

- During Year 4, FIU implemented generative AI techniques to generate additional synthetic data to fill in the missing values, which captures the underlying distribution, variability, and behavior of the actual data from the Hanford groundwater wells.
- The Generative AI algorithms include
  - Conditional Generative Adversarial Network (CGAN)
  - Variational AutoEncoder (VAE)
  - Time-series Generative Adversarial Networks (TimeGAN)
- Previously developed models are retrained with the synthetic data, which provides more points of inspection when performing analysis.

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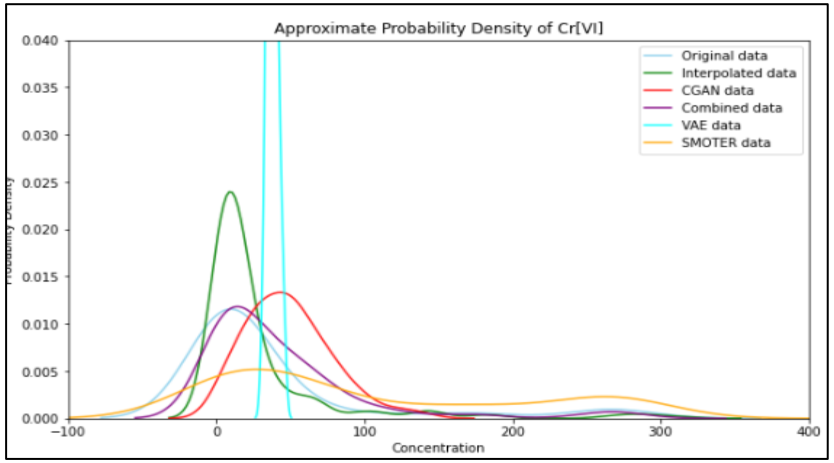
Task 7: AI for EM Problem Set – Soil and Groundwater–- Data Analytics, Visualization and Machine Learning Model Development for Hexavalent Chromium [Cr(VI)] Concentration in the 100 Area (PNNL)

FIU Year 4 Research Highlights:

Real and Synthetic Data Distributions:

Dataset	Minimum	Maximum
Original	1.5	288.0
Interpolated	0.8	321.5
GAN-Generated	1.2	141.0
VAE-Generated	31.3	45.9
Combined	1.2	288.0

Value Ranges for the Cr[VI] Concentration



The Approximate Probability Densities of Cr[VI] for each Synthetic Dataset

- Previously developed models are retrained with the combined (Original and Synthetic) dataset and prediction results shows the improvement over the Original dataset.
- Research papers:
  1. "**Machine Learning Approach for Spatiotemporal Multivariate Optimization of Environmental Monitoring Sensor Locations**" in Artificial Intelligence for the Earth Systems Journal - Published
  2. "**Generative AI Techniques for the Simulation of Groundwater Well Data at Hanford Site**". 19th International Conference on Data Science 2024 (ICDATA). IEEE - Accepted
  3. "**Spatial-Temporal Analysis of Groundwater Well Features from Neural Network Prediction of Hexavalent Chromium Concentration**" in ACS ES&T Water Journal – Under Review

FIU Year 5 Projected Scope

- Leveraging attention mechanisms within Artificial Neural Networks (ANN) to provide more robust explanations for inter-well relations.
- Dual-Stage Attention LSTM (DA-LSTM) architecture will be employed to deploy Attention at both the feature and temporal levels.
- Implement DA-LSTM to analyze Hanford well data, extracting attention scores to establish stable relationship analysis.

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Task 8

AI for EM Problem Set (Soil & Groundwater):

Sensor Data Analysis and Visualization from the Wells at the SRS F-Area using Machine Learning / Deep Learning (LBNL, SRNL)

Task 8: AI for EM Problem Set (Soil & Groundwater) – Sensor Data Analysis and Visualization from the Wells at the SRS F-Area using Machine Learning / Deep Learning (LBNL, SRNL)

Site Needs:

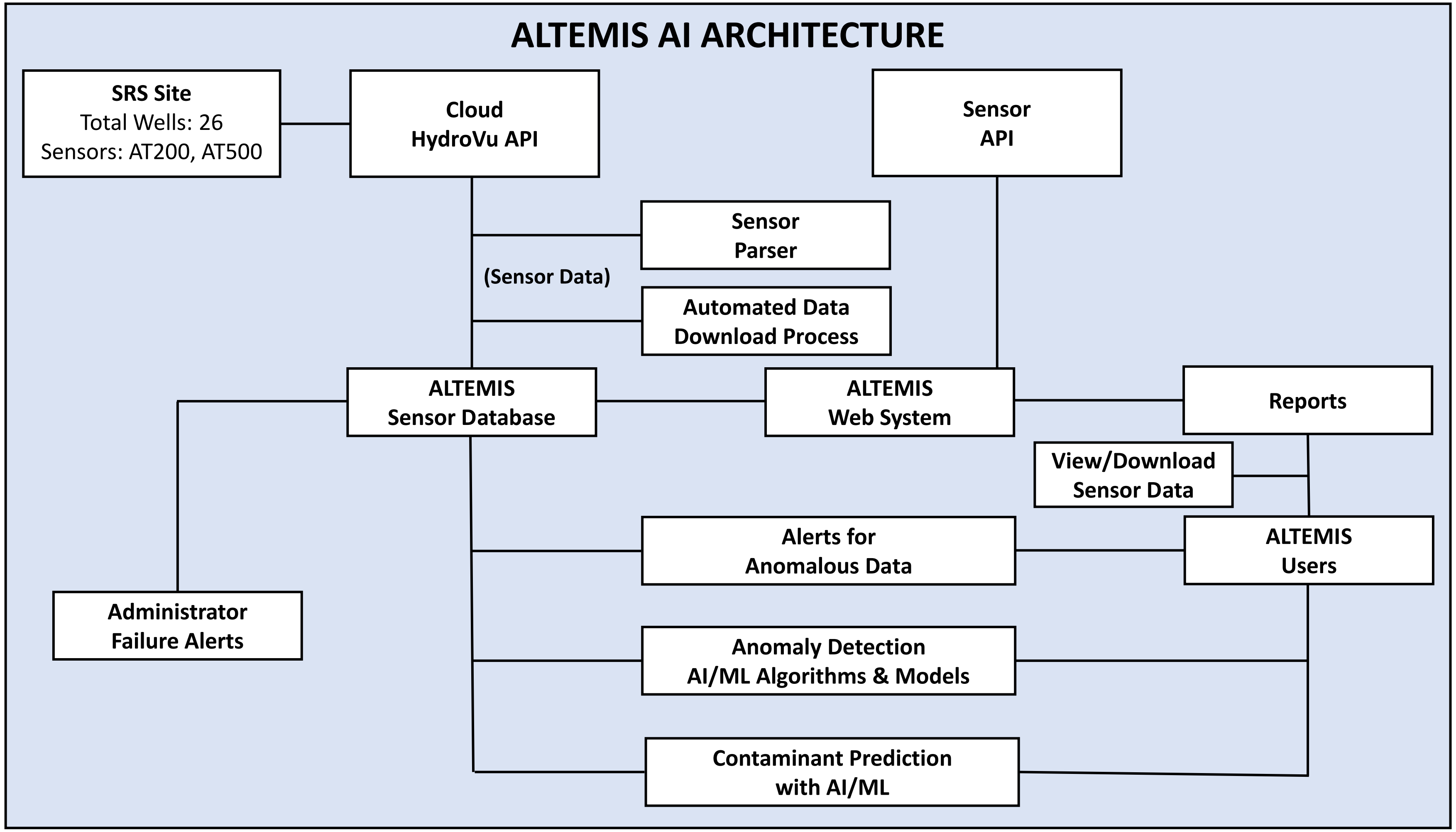
- Develop a pipeline to establish a database system to collect and store sensor data received from SRS into the secure database by connecting to In-Situ's proprietary site using cloud based HydroVu API.

Objectives:

- Develop a web based ALTEMIS AI system to create a pipeline to collect and store data from the SRS.
- Development of various reports requested by the ALTEMIS team.
- Publish AI/ML model prediction results on the ALTEMIS AI system.

Task 8: AI for EM Problem Set (Soil & Groundwater) – Sensor Data Analysis and Visualization from the Wells at the SRS F-Area using Machine Learning / Deep Learning (LBNL, SRNL)

- During Year 4, FIU has developed a web-based system (ALTEMIS AI) to serve as a comprehensive platform for hosting and managing SRS sensor data.



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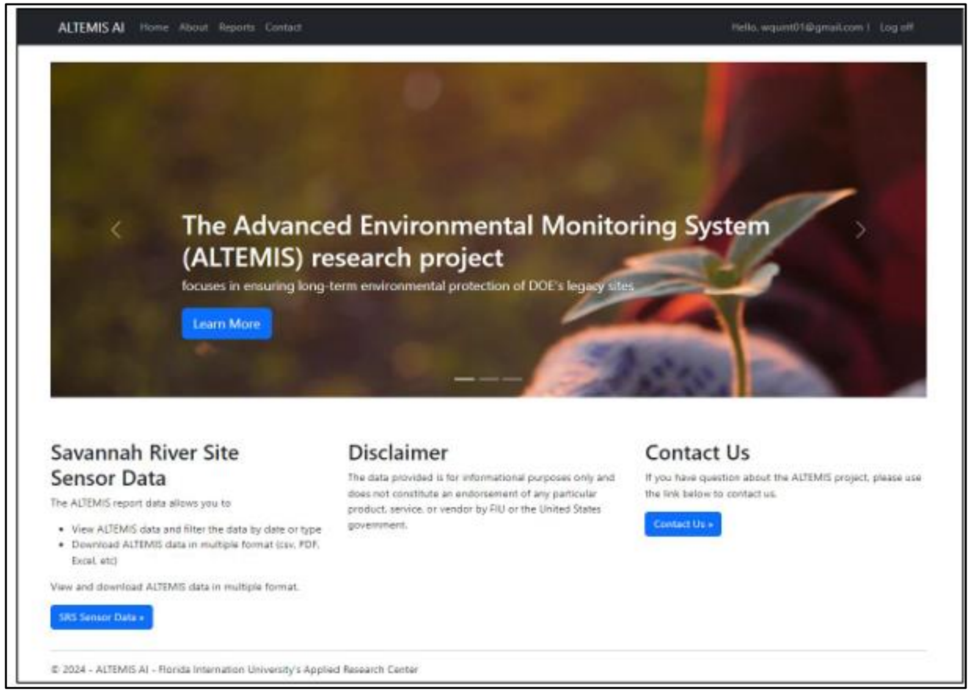
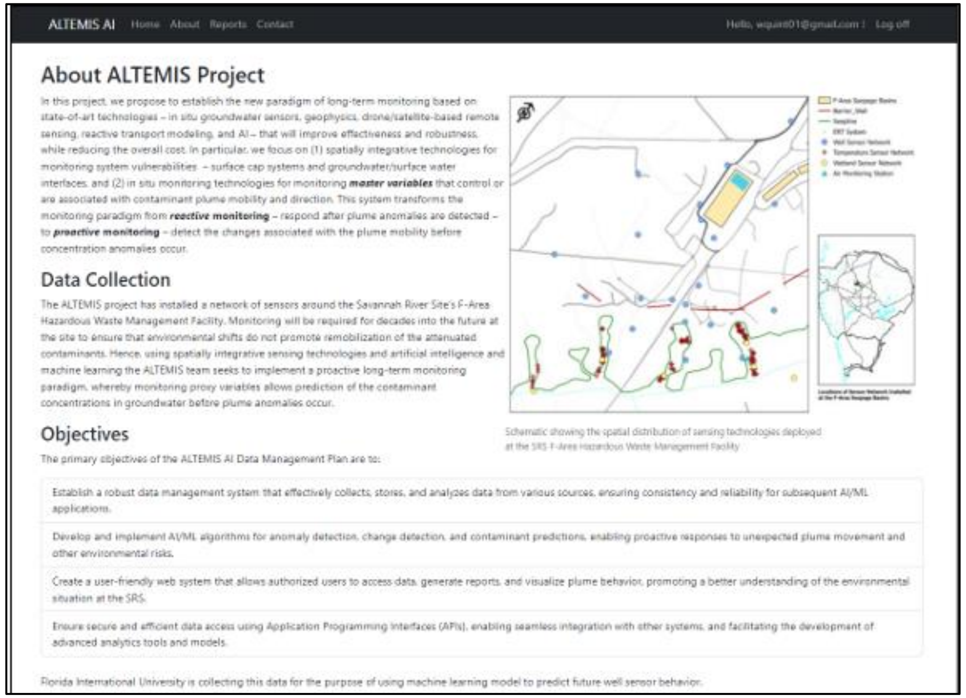
Task 8: AI for EM Problem Set (Soil & Groundwater) – Sensor Data Analysis and Visualization from the Wells at the SRS F-Area using Machine Learning / Deep Learning (LBNL, SRNL)

- The homepage provides an overview of the website's capabilities and quick access to key features (About, Reports and Contact).
- The about page offers detailed information about the website, its purpose.



ALTEMIS AI homepage

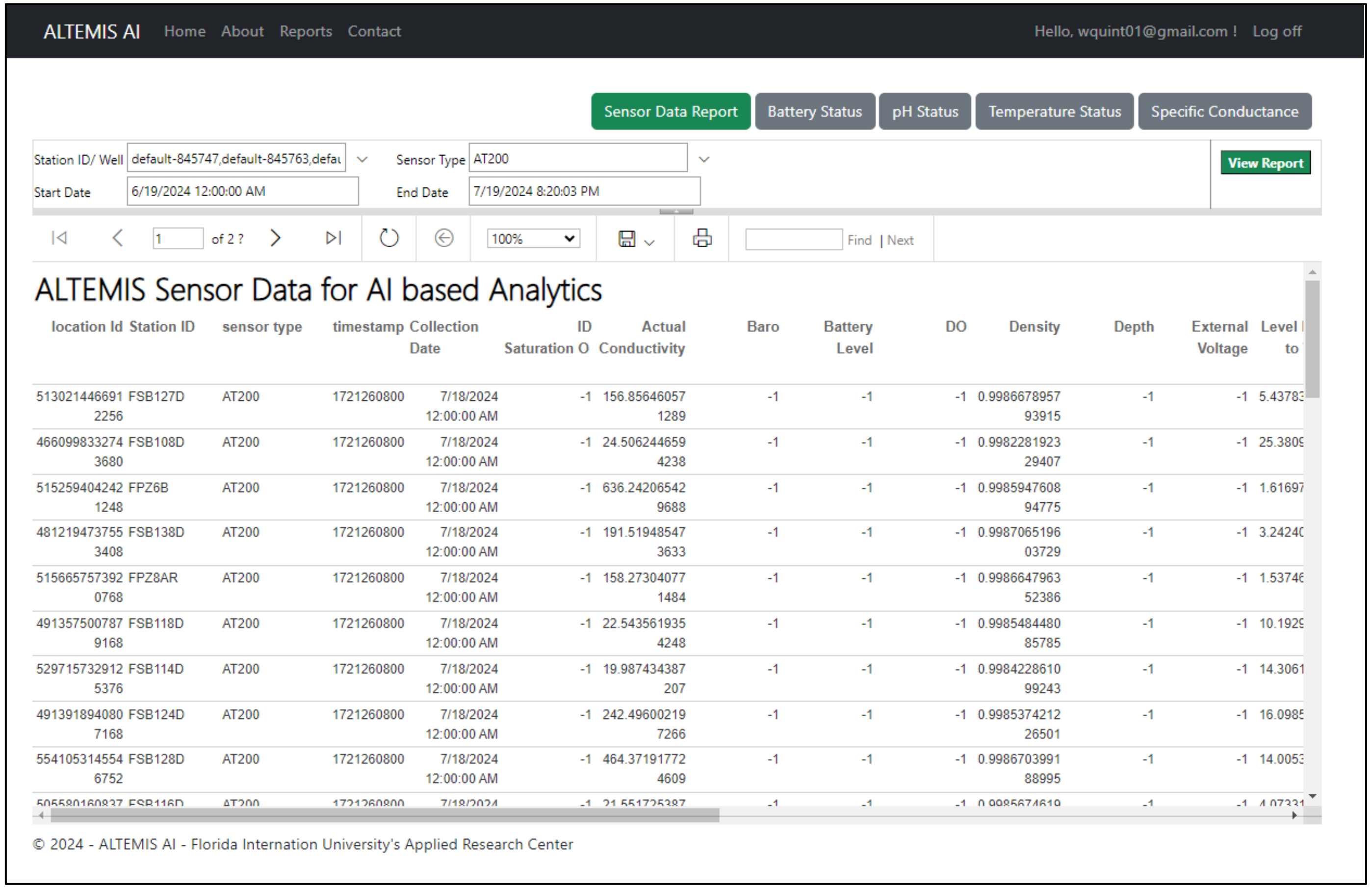


ALTEMIS AI about page

Task 8: AI for EM Problem Set (Soil & Groundwater) – Sensor Data Analysis and Visualization from the Wells at the SRS F-Area using Machine Learning / Deep Learning (LBNL, SRNL)

Research Highlights & Accomplishments:

- The reports page is the central hub for accessing sensor data reports.
- A python script was implemented to retrieve the SRS F-Area sensor data through the HydroVu API and store data in the ALTEMISAI database hosted at FIU.
- Users can view and download real-time and historical sensor data reports in multiple formats (PDF, CSV) through an intuitive web interface, improving data accessibility and analysis.
- Implemented customizable reporting features that allow users to filter sensor data by well, sensor type, and date range, providing tailored insights for specific monitoring needs and enhancing data-driven decision-making.



location Id	Station ID	sensor type	timestamp	Collection Date	ID Saturation O	Actual Conductivity	Baro	Battery Level	DO	Density	Depth	External Voltage	Level to
5130214466912256	FSB127D	AT200	1721260800	7/18/2024 12:00:00 AM	-1	156.856460571289	-1	-1	-1	0.998667895793915	-1	-1	5.43783
4660998332743680	FSB108D	AT200	1721260800	7/18/2024 12:00:00 AM	-1	24.5062446594238	-1	-1	-1	0.998228192329407	-1	-1	25.3809
5152594042421248	FPZ6B	AT200	1721260800	7/18/2024 12:00:00 AM	-1	636.242065429688	-1	-1	-1	0.998594760894775	-1	-1	1.61697
4812194737553408	FSB138D	AT200	1721260800	7/18/2024 12:00:00 AM	-1	191.519485473633	-1	-1	-1	0.998706519603729	-1	-1	3.24240
5156657573920768	FPZ8AR	AT200	1721260800	7/18/2024 12:00:00 AM	-1	158.273040771484	-1	-1	-1	0.998664796352386	-1	-1	1.53746
4913575007879168	FSB118D	AT200	1721260800	7/18/2024 12:00:00 AM	-1	22.5435619354248	-1	-1	-1	0.998548448085785	-1	-1	10.1929
5297157329125376	FSB114D	AT200	1721260800	7/18/2024 12:00:00 AM	-1	19.987434387207	-1	-1	-1	0.998422861099243	-1	-1	14.3061
4913918940807168	FSB124D	AT200	1721260800	7/18/2024 12:00:00 AM	-1	242.496002197266	-1	-1	-1	0.998537421226501	-1	-1	16.0985
5541053145546752	FSB128D	AT200	1721260800	7/18/2024 12:00:00 AM	-1	464.371917724609	-1	-1	-1	0.998670399188995	-1	-1	14.0053

ALTEMIS AI report module

Task 8: AI for EM Problem Set (Soil & Groundwater) – Sensor Data Analysis and Visualization from the Wells at the SRS F-Area using Machine Learning / Deep Learning (LBNL, SRNL)

Research Highlights & Accomplishments:

- Developed an automated alert system that identifies sensors with low battery levels or malfunctioning.

StationId	SensorType
FAI12D	AT500
FAI3B	AT500
FAI7	VuLink
FAI9D	AT500
FPZ8AR	VuLink
FSB128D	VuLink
FSB135D	AT200
FSB135D	VuLink
FSB91D	AT200
FSB91D	VuLink
FSB99D	VuLink

Output of the SRS_SensorData_GetLowBatteryOrMissingSensors

FIU Year 5 Projected Scope

- Implementation of Power BI reports using the live feed data received from the SRS and publish them on the ALTEMIS AI web platform.
- Development of AI/ML models to predict the contaminants Uranium 235 and Tritium using the real-time sensor data from the SRS.
- Publish prediction results on ALTEMIS AI web platform.

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Task 9

AI for EM Problem Set (Waste Processing):

Nuclear Waste Identification and Classification using Deep Learning (SRNL)

Task 9: AI for EM Problem Set (Waste Processing): Nuclear Waste Identification and Classification using Deep Learning

Site Needs:

- Develop computer vision models for waste identification and segregation.
- Integrate computer vision models with robotic arm for waste segregation.

Objectives:

- Research and implementation of various computer vision models for the waste identification and segregation.
- Transition computer vision models to Robotics team to integrate with ROS2 code developed for the robotic arm for the waste identification and segregation.

Task 9: AI for EM Problem Set (Waste Processing): Nuclear Waste Identification and Classification using Deep Learning

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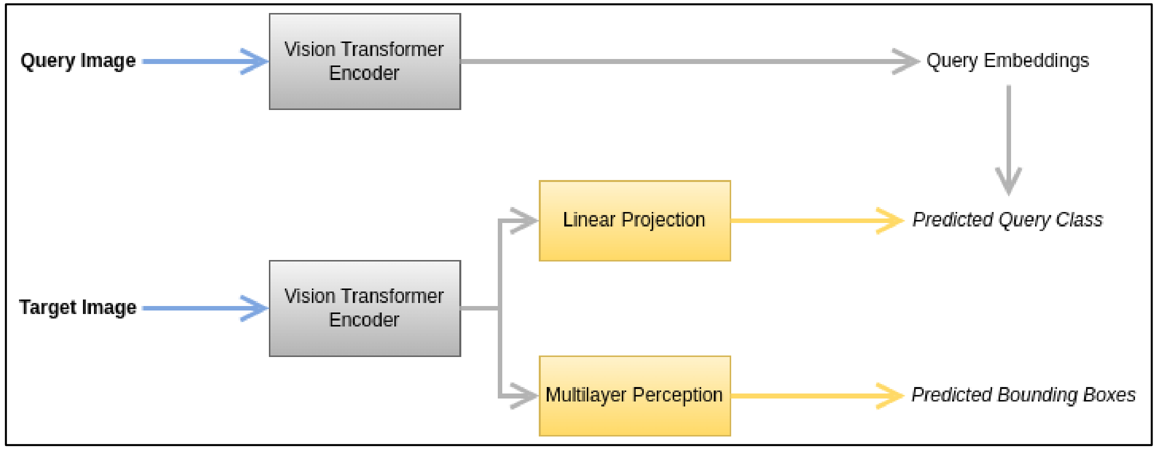
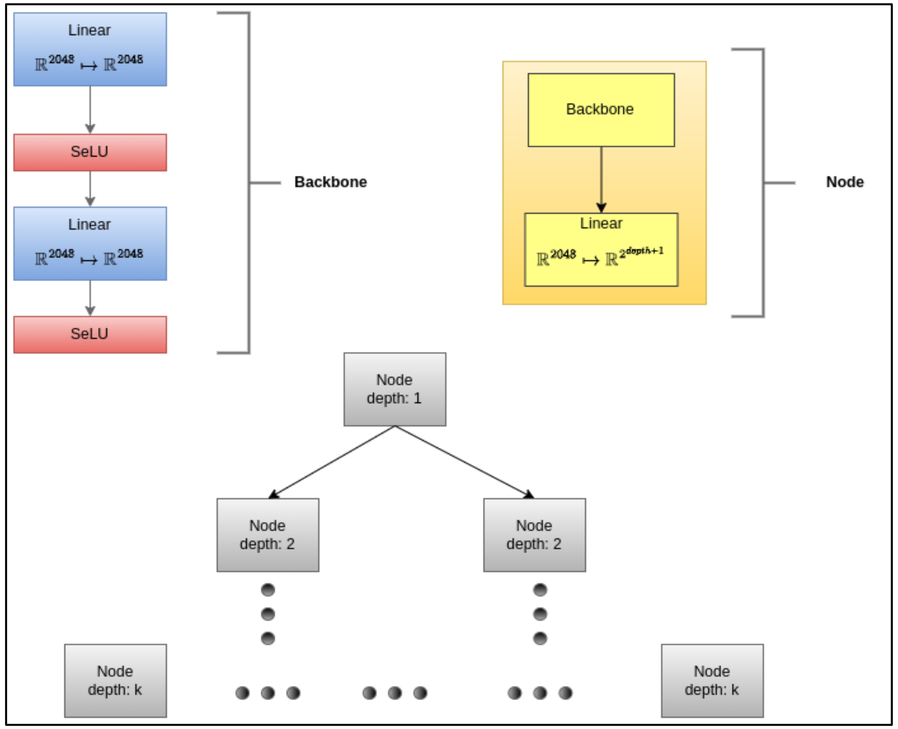
FIU Year 4 Research Highlights:

- During Year 4, FIU team conducted research on multiple object detection algorithms.
- Implemented below mentioned algorithms
  - ➢OWL-VIT model for One Shot Object Detection
  - ➢Custom RL algorithm for One Shot Object Detection
  - ➢De-ViT model for Few-Shot Object Detection



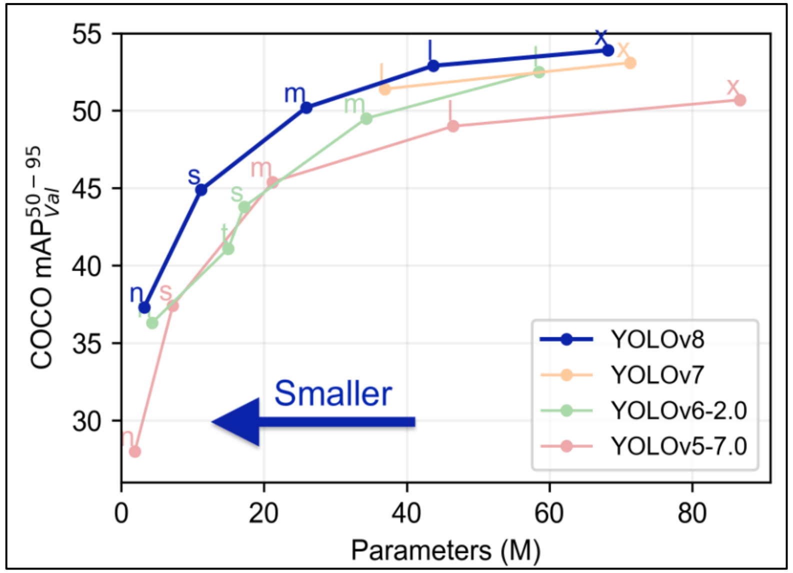


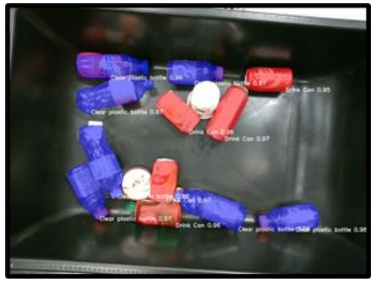
Task 9: AI for EM Problem Set (Waste Processing): Nuclear Waste Identification and Classification using Deep Learning

FIU Applied Research Center

FIU Year 4 Research Highlights:

- Implemented YOLOv8 model for supervised object detection.
- Evaluated the Model Performance with the previously implemented YOLO models.
- Developed API for the YOLOv8 model to Integrate with Robotic Arm.
- Published Research Paper: "**AI-based detection and identification of low-level nuclear waste: a comparative analysis**" in Neural Computing and Applications Journal.





FIU Year 5 Projected Scope

- Implementation of the API for the One Shot and Few Shot object detection models.
- Integrate the APIs with the Robotics Arm for the Waste Segregation
- Research on different methods to augment available datasets.
- Generative AI models such as stable diffusion will be explored to generate new images of the desired objects with labels.

FIU Applied Research Center

DOE EM IT/AI Deployment Roadmap

	Technology	2020	2021	2022	2023	2024	2025
HQ All Sites	 WIMS	Site Deployment ✔					
HQ, SRNL, ANL, PNNL	 KM-IT	Site Deployment ✔					
PNNL	AI Soil & Ground Water	Data Exploration/ Visualization	Algorithm Development	Algorithm Optimization & Analysis	AI System Development & Integration	In-house Deployment	Site Deployment
LBNL, SRNL	AI Soil & Ground Water	Data Exploration & Visualization	Algorithm Development	Algorithm Optimization & Analysis	AI System Development & Integration	In-house Deployment	Site Deployment
SRNL	AI Waste Process				Algorithm Development	Algorithm Optimization & Analysis	In-house Deployment

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DOE EM IT/AI Deployment Roadmap

HQ
All Sites

WIMS

HQ, SRNL, ANL, PNNL

KM-IT

PNNL

LBNL, SRNL

SRNL

- WIMS - Web application deployed at https://emwims.org - Used by DOE sites, disposition facilities and DOE HQ
- KM-IT - Web application deployed at https://www.dndkm.org - Used by DOE sites/facilities, National Laboratories, DOE HQ and D&D community
- AI PNNL (Soil & Ground Water) - AI Models will be deployed on AAMLS to be used by PNNL
- AI SRNL (Soil & Ground Water) - ALTEMIS AI will be hosted to be used by LBNL, SRNL
- AI Waste Process (SRNL) - Site deployment

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DOE-FIU Cooperative Agreement

Upcoming Events Announcement

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18TH ANNUAL

DOE FELLOWS POSTER EXHIBITION

NOVEMBER 12, 2024
1:00 - 4:00 PM
FIU ENGINEERING CENTER
PANTHER PIT

fellows.fiu.edu

A STEM Workforce Development Program
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SAVE-THE-DATE

18th Annual

DOE Fellows Induction Ceremony

WEDNESDAY NOV. 13 2024 AT 12:00 PM

FIU MODESTO MAIDIQUE CAMPUS
Graham Center (GC) Ballroom
GC Parking, 10955 SW 15th St, Miami, FL 33199

A collaboration between
the U.S. Department of Energy's Office of Environmental Management
and Florida International University's Applied Research Center

Thank You. Questions?