



Target in the Environment Response Tool

MR23-7943

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Final Debrief

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Project Team

Dr. Steven G. Kargl



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Dr. Ahmad Abawi, HLS Research, PI on MR21-1275

Bottom Line Up Front

- *What technology or methodology is being evaluated during this demonstration?*

A software package to predict the scattered acoustic time signatures from underwater munitions and scientific objects.

- *What's been going well?*

Source code has been placed in a self-contained environment. Documentation and user interfaces has been improved.

- *What's not working?*

Distribution of the software to other munition response practitioners.

- *What support do you need?*

SERDP&ESTCP administered website to host the software and vet those seeking access to the TIER tool.

Technical Approach and Test Design

The main goal was to take high-quality research-grade software and package for others to use without a deep understanding of underwater acoustics or scattering from objects.

Tasks for MR23-7943

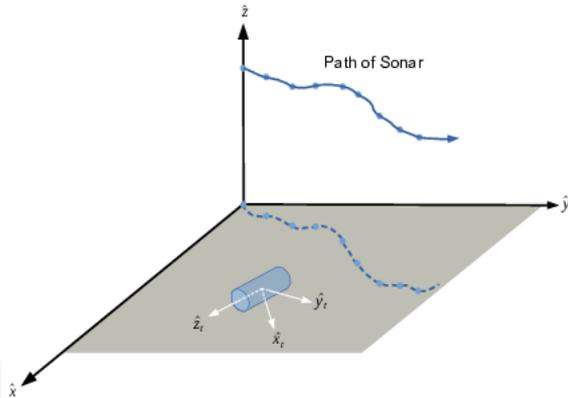
1. Isolate source code into a self-contained repository
2. Improve the user interface through validation of input
3. Develop a validation suite to ensure changes to source code do not introduce regressions
4. Documentation improvements including on-line manuals and comprehensive user manual
5. Support multiple operating systems
6. Alternate output file format
7. Establish a distribution method
8. Bistatic scattering amplitudes (BSA) for new munitions
9. Utility to pack third-party simulations in BSA tables

Technical Approach (Primary Utilities)

User describes a “scene”

- Water/sediment properties
- Path of sonar
- Description of sonar
- Objects within the scene

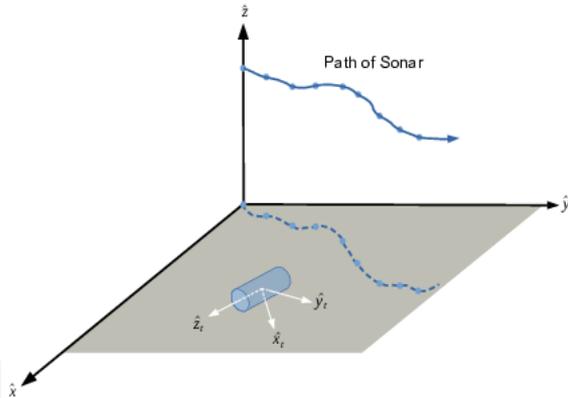
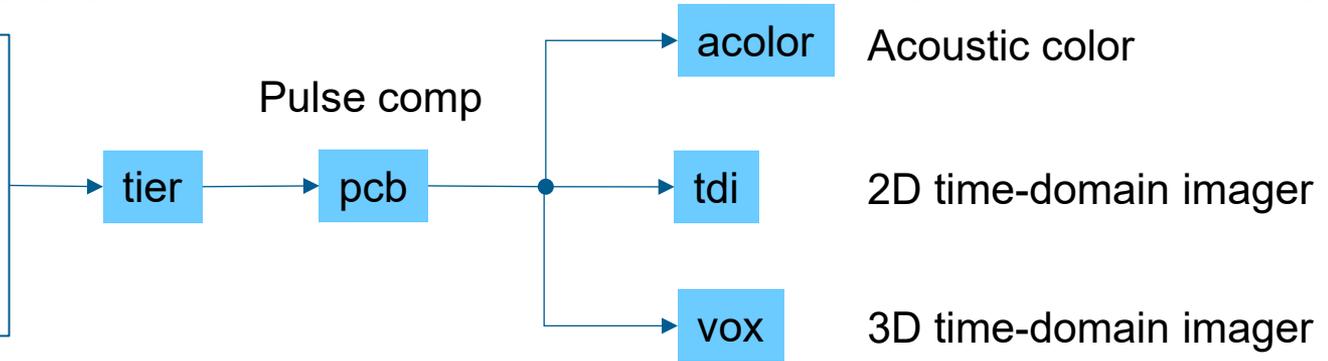
tier



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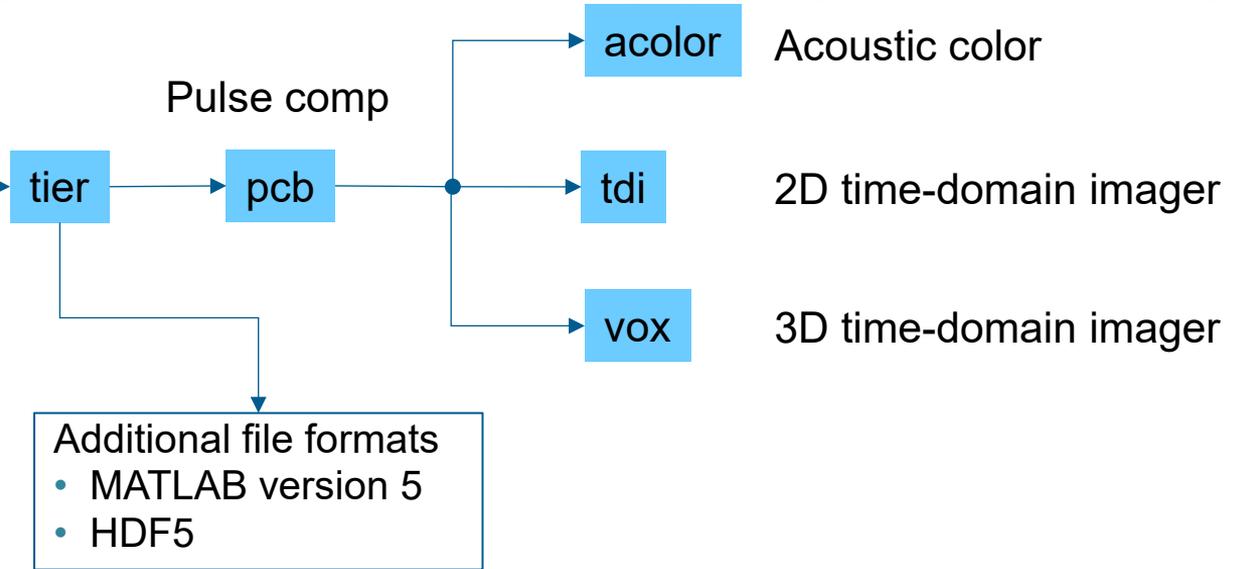
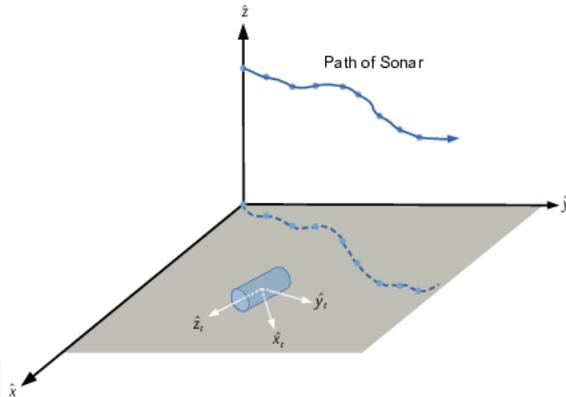
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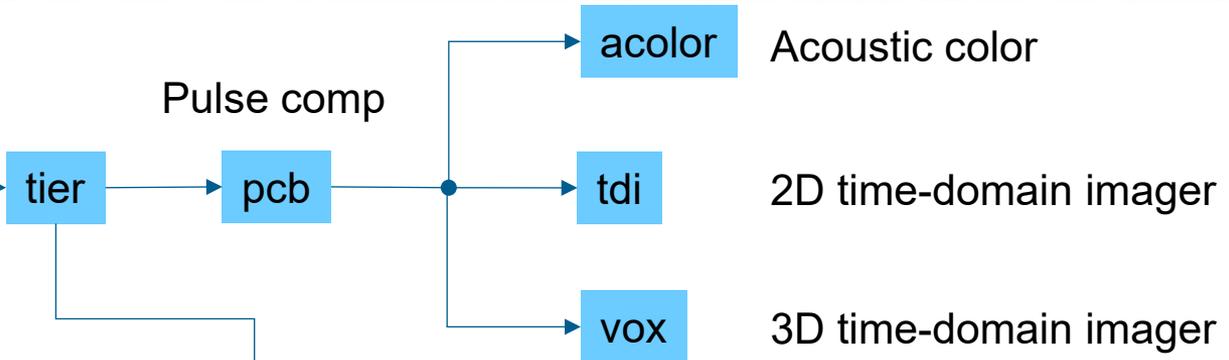
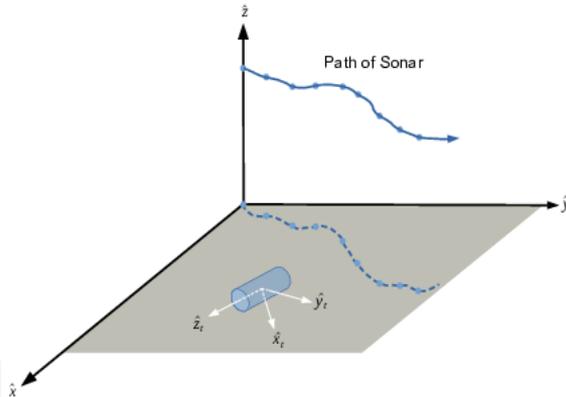
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Additional file formats

- MATLAB version 5
- HDF5

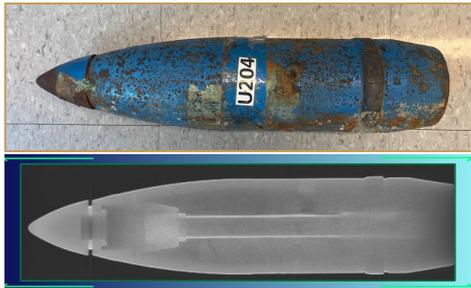
Package contains several additional utilities that can be used for diagnostic purposes.

Case Study: TIER used by SERDP MR23-3978

TIER tool used by MR23-3978 to model the scattering from 6 UXO deployed in Sequim Bay, WA Testbed 2021.

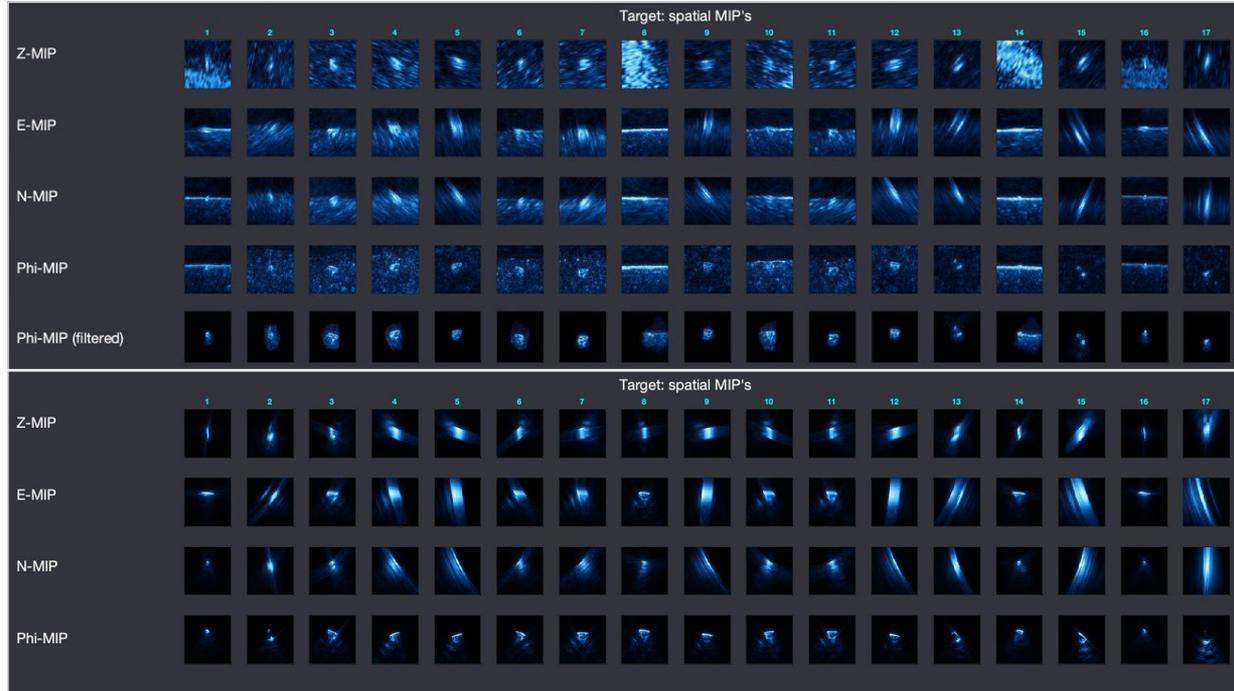
Simulated data pushed through the MuST processing chain

U204 – 105mm M60 with fuze plug



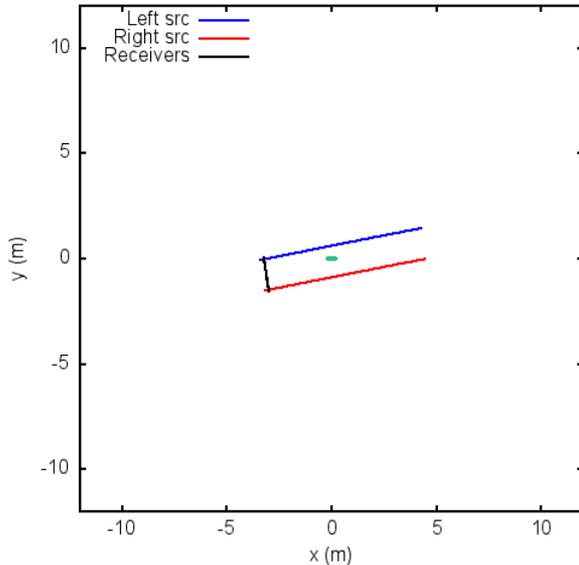
MuST Data

TIER Simulation



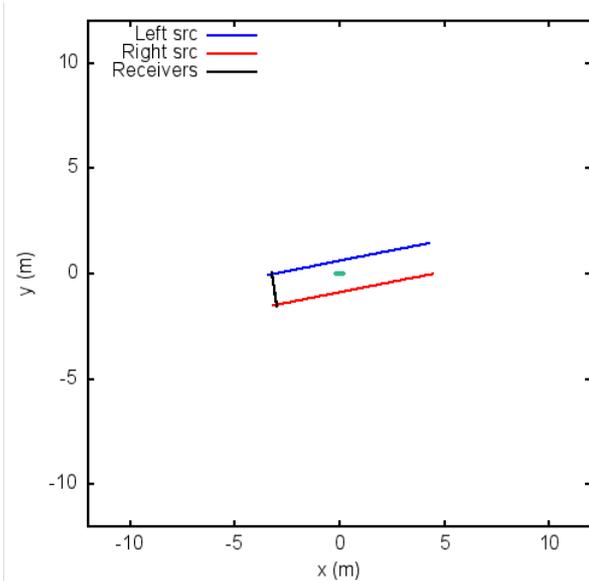
Case Study: TIER used by SERDP MR23-3978

MuST navigation information extracted from data for the portion of a transect that observes an object.



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MuST navigation information extracted from data for the portion of a transect that observes an object.



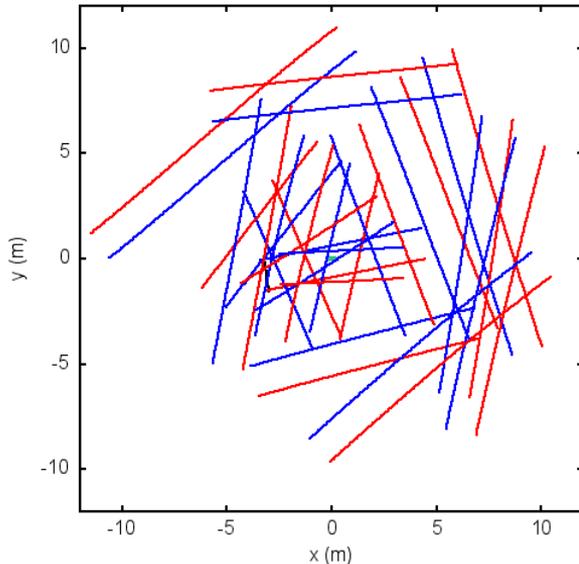
Track	Pings	Signals	Time (min)	File Size (MB)	Track	Pings	Signals	Time (min)	File Size (MB)
1	237	15168	4.039	348	10	290	18560	5.598	426
2	349	22336	6.244	512	11	293	18752	5.514	430
3	223	14272	4.694	327	12	431	27584	8.003	633
4	355	22720	7.494	521	13	416	26624	7.460	611
5	450	28800	8.920	661	14	247	15808	5.129	363
6	254	16256	5.475	373	15	453	28992	8.981	665
7	395	25280	8.618	580	16	167	10688	2.871	245
8	239	15296	5.020	351	17	369	23616	6.585	542
9	382	24448	7.552	561	Total	5550	355200	108.19	7.96 GB

Pings: number of transmissions from the sources

Signals: pings × 64 array elements

Case Study: TIER used by SERDP MR23-3978

MuST navigation information extracted from data for the portion of a transect that observes an object.



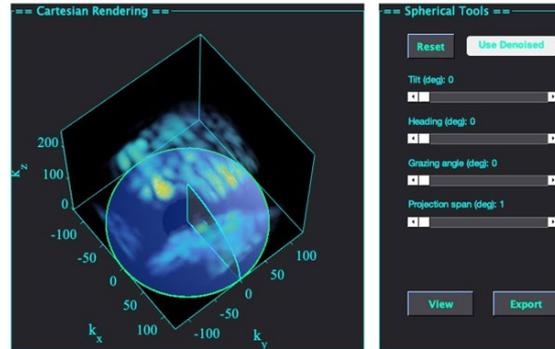
- Simulations for each track considered three target orientations (i.e., 1-1.6 GB of data)
- Tracks can be computed in parallel.
- In total, 800 GB of data generated.
- Simulations used BSA tables based on both APL-UW hybrid model and Abawi's CFEBE model
- Simulated data beamformed with an NVidia GPU (~20 minute per target). This generates IM_dats data structures used by MuST post-processing analysis tool.
- IM_dat files occupy ~11.56 GB.

Case Study: TIER used by SERDP MR23-3978

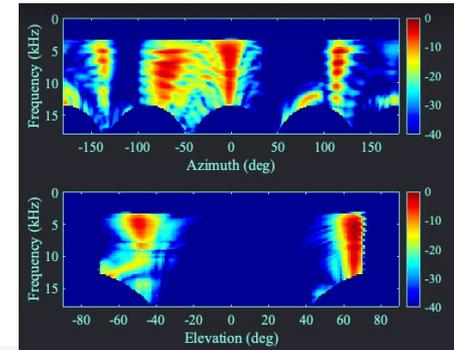
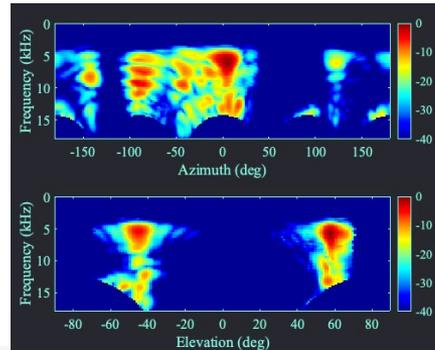
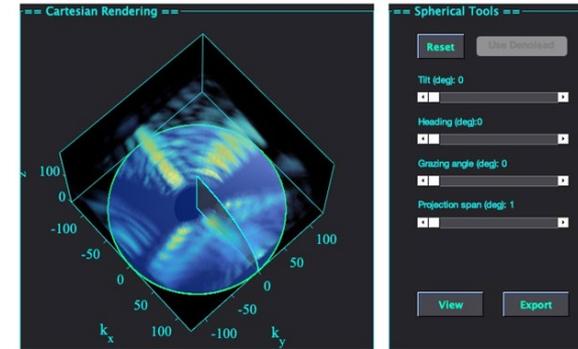
Examine only the tracks 7, 12, and 13. These span 0° (broadside) to 40° .

Under MR23-3978 the files containing IM_dat data structure were used as fodder for a CNN.

MuST Data



TIER Simulation



Cost Assessment

- MR23-7943 packaged software developed through 20+ years of funding from SERDP and ONR. Additional costs would be associated with any future maintenance and the development of bistatic scattering amplitude tables for new targets.
- The TIER Tool software package is available for free.

Issue / Lessons Learned

- Distribution of the software requires either physical media or a fast internet connection. While the executables occupy an 15 MB archive, the BSA tables for 28 objects occupy 158 GB of disk space.
- Portions of software were developed and maintained under DoD contracts that contain DFAR clauses. This impacts access to the software and the method of access.

Scale-up

- The TIER tool contains a limited selection of BSA tables for 60-mm, 81-mm, 105-mm, and 155-mm munitions. Additional objects can be added to catalogue at the cost of needed high-fidelity simulations.
- The models with the TIER tool considers target scattering and includes the environment through reflections coefficients at bounding surfaces. Reverberation from the environment (i.e., background) is needed to produce a fully realistic simulation of a sonar survey at an underwater site.

Technology Transfer

- There has been a discussion with program managers from ONR Code 32 to make available and integrate TIER Tool source with the Modular Acoustic Simulation Toolset of the Department of Navy (MASTODON) package from the NSWC-PCD.



Backup Slides

MR23-7943: Target in the Environment Response Tool

Performers: Dr. Steven Kargl (PI), Dr. Aubrey Espana (Co-PI)

Technology Focus

- A software package to predict the scattered acoustic time signatures from underwater munitions and scientific objects.

Demonstration Site

- Software distributed to ARL-PSU
- TIER Tool used by MR-3978 to simulate APL-UW MuST deployment in Sequim Bay, WA

Demonstration Objectives

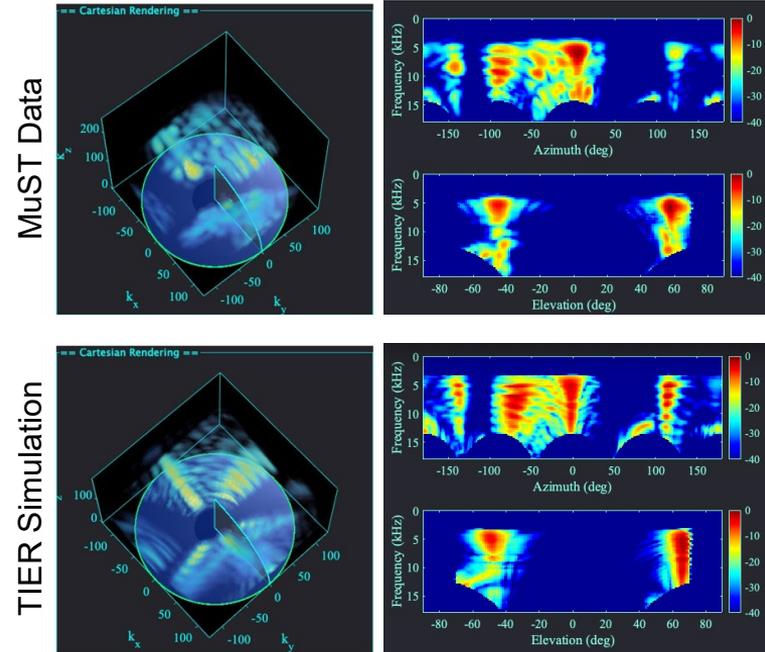
- The TIER tool simulated the scattered acoustic signals from 6 UXO deployed in Sequim Bay, WA and surveyed by the MuST system. The simulated signals were sent through the MuST processing chain to demonstrate synthetic data can be used to test and train a system.

Project Progress and Results

- The TIER Tool and documentation have been packaged to facilitate their use by third-party munition response practitioners.

Implementation

Access to the software package may be restricted by DFAR and likely requires approval from a DoD agencies.



Plain Language Summary

The TIER Tool software package provides a means to simulate the scattering of a transmitted sonar signal from objects in an underwater environment. The tool allows one to

- prototype a proposed sonar system or modifications to an existing system
- generate synthetic data to assist in the development of detection and classification algorithms
- aid in post-mission analysis after a sonar survey of a munition response site

Impact to the DoD Mission

- The TIER Tool packages more than 20+ years of research-quality software that can be used to predict the interaction of transmitted sonar signal with one or more objects in scene.
- Objects are not restricted to UXO remediation activities. The TIER tool can also be used in MCM efforts if appropriate BSA tables are available.
- The TIER Tool is design to provide a high-fidelity estimate of the scattered pressure via a fast acoustic ray model approximation.

Publications

- SERDP/ESTCP Webinar on July 25, 2024