
Generalized Space-Time Electromagnetic Metamaterials (GSTEMs)

A Data Management Plan created using DMPonline.be

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Project abstract:

This project explores Generalized Space-Time Electromagnetic Metamaterials – GSTEMs –, metamaterials formed by the modulation of a host medium with arbitrary space-time profile, as one of the next potential frontiers in contemporary research. As an extension of previously reported Uniform STEMs – USTEMs – they merge general relativity and classical electrodynamics towards uncharted territories of huge scientific and technological potential. Among their most remarkable features, GSTEMs bend light similarly to astronomical systems (e.g., black holes) but with their enormous, and hence unpractical, masses being replaced by micro-scale accelerated modulations holding in human-scale devices. Not only can this be done, as very recently demonstrated by our group, but this can be done in an engineerable fashion and with unprecedented features, such as curved space-time frequency transitions, extreme operation bandwidth, unusual velocity regimes (e.g., superluminal) and gravity analog effects (e.g., white hole like cloaking). The project performs two major advances in this emerging research field. On one hand, it mathematically solves several canonical GSTEM light scattering problems and investigates the related new physics. On the other hand, it develops a related generalized computer code and pioneers the first related structures and electro/photonic applications (e.g., communications, imaging, analog computing) upon the basis of a mixed microwave-acoustic experimental platform.

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Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

Dataset name / ID	Description	New or reuse	Digital or Physical data	Data Type	File format	Data volume	Physical volume
Internal Reports	This will essentially represent powerpoint presentations produced by the two PhD students involved in the project on a weekly or biweekly basis that will describe their detailed research progress (literature presentations, problems resolution, new idea proposals, paper plans, computer animations). All of these documents will be archived in a special folder according to the following filename code example: 2023_08_15_Einstein_Equivalence_Principles and will be conserved in a permanent manner.	<i>New</i>	Digital	Images Numerical Textual Model		<100GB	
Publications	The publications will separate in two categories. 1) journal and letter papers and 2) conference communications, both being peer-reviewed. Records of all these publications, with related construction material (Word/LaTeX files, figures, detailed mathematical derivations, editorial communications, revision documents, etc.), will be recorded in a special folder with the following folder name code example: 2023_08_15_Feynmann_Quantum_Electrodynamics and will be conserved in a permanent manner.	<i>New</i>	Digital	Images Numerical Textual Model		<10GB	
Code	The code are typically Matlab programs that 1) produce output data and graphs from analytical derivations and formulas, 2) contain actual numerical-method codes (e.g., FDTD) for simulating specific structures, 3) represent short programs to construct animations.	<i>New</i>	Digital	Software		<2GB	
Prototypes	A few GSTEM prototypes will be fabricated and tested at ESAT and WaveCore as well as ad hoc measurement setups. The measurements will be performed using standard microwave instrumentation, particularly vector network analyzers (VNAs), spectrum analyzers, real-time oscilloscopes, and infrastructure. The corresponding data files will be those delivered by the related measurement instruments, such as s2p files for VNAs, etc. The prototypes will be microwave GSTEMs consisting in modulated artificial transmission lines, consisting in thin plates of about 0.2x20x20 cm including control PN switches and varactor diodes. The pictures (and possible videos) will be taken by high-resolution smart phones and stored in jpg (mpeg4) formats. The GSTEM devices will be conserved in a permanent manner in the premises of the WaveCore group. Pictures of all the related hardware will be placed in the related publications. The prototypes will be shown to academic and industrial visitors, to foster collaborations and stimulated future funding, but none of them will be leaving KU Leuven.	<i>New</i>	Physical	Hardware		<2GB	<1cm x30cm x30cm
Patents	We are hoping to have intellectual property generation in this project. We will contact for that the technology transfer office of KU Leuven at the earliest possible stage of the idea development and make sure that all the disclosure steps are followed according to rules of KU Leuven.	<i>New</i>	Digital	Images Numerical Textual Model		<1GB	

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

Not applicable.

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? If so, refer to specific datasets or data types when appropriate and provide the relevant ethical approval number.

- No

Will you process personal data? If so, please refer to specific datasets or data types when appropriate and provide the KU Leuven or UZ Leuven privacy register number (G or S number).

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, ...)? If so, please comment per dataset or data type where appropriate.

- Yes

Potential new GSTEM devices, with IP to be processed via the KU Leuven technology transfer office.

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material or Data transfer agreements, Research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- No

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g. in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, codebook.tsv etc. where this information is recorded).

See description of the research data summary.

Will a metadata standard be used to make it easier to find and reuse the data?

If so, please specify which metadata standard will be used.

If not, please specify which metadata will be created to make the data easier to find and reuse.

- Yes

See description of the research data summary (e.g., instruments dedicated file types, photographs and videos standard file type).

Data Storage & Back-up during the Research Project

Where will the data be stored?

- Shared network drive (J-drive)
- Personal network drive (I-drive)

On the J-/I-drives of KU Leuven's ICTS.

How will the data be backed up?

- Personal back-ups I make (specify below)

The data, being saved on the J-/I-drives, are automatically backed up by KU Leuven's ICTS.

Is there currently sufficient storage & backup capacity during the project?

If no or insufficient storage or backup capacities are available, explain how this will be taken care of.

- Yes

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

From (default) initial multi-factor KU Leuven's standard authentication.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

Less than 200 EUR, supported bench fees in the proposal.

Data Preservation after the end of the Research Project

Which data will be retained for 10 years (or longer, in agreement with other retention policies that are applicable) after the end of the project?

In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

- All data will be preserved for 10 years according to KU Leuven RDM policy

Where will these data be archived (stored and curated for the long-term)?

- Large Volume Storage (longterm for large volumes)
- Shared network drive (J-drive)

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

200 EURO, via the part of the budget for bench fees.

Data Sharing and Reuse

**Will the data (or part of the data) be made available for reuse after/during the project?
Please explain per dataset or data type which data will be made available.**

- Yes, as restricted data (upon approval, or institutional access only)

This will be accomplished via the KU Leuven's Research Data Repository (RDR).

If access is restricted, please specify who will be able to access the data and under what conditions.

Scientific collaborators and potential funding partners for future related projects, using appropriate IP licensing wherever appropriate.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)?

Please explain per dataset or data type where appropriate.

- Yes, intellectual property rights

Provisional patent and other IP constraints.

Where will the data be made available?

If already known, please provide a repository per dataset or data type.

- KU Leuven RDR (Research Data Repository)

After proper authorization.

When will the data be made available?

- Upon publication of research results

At the publication time for papers and patents, of course, but upon request via RDR for all other data, including computer codes, animations and videos on experiments.

Which data usage licenses are you going to provide?

If none, please explain why.

- Other (specify below)

No licence will be used and the data will be made available upon request, eventually with a data sharing agreement or specific licensing.

Do you intend to add a persistent identifier (PID) to your dataset(s), e.g. a DOI or accession number? If already available, please provide it here.

- Yes, a PID will be added upon deposit in a data repository

This is automatically managed by RDR.

What are the expected costs for data sharing? How will these costs be covered?

No cost. Digital data can be shared via the internet and prototype shown to visitors.

Responsibilities

Who will manage data documentation and metadata during the research project?

Myself.

Who will manage data storage and backup during the research project?

Myself.

Who will manage data preservation and sharing?

Myself.

Who will update and implement this DMP?

Myself.

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