COST Action TU1208
Civil Engineering Applications of Ground Penetrating Radar

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Transport and Urban Development Domain
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Outline

- Objectives and working programme
- Working method – organisation and management
- Distribution of tasks
- Promotion of Early-Stage Researchers and of gender balance
- Time-table
Objectives and working programme
Main Objective

- Exchange and increase scientific-technical knowledge and experience of Ground Penetrating Radar (GPR) techniques in Civil Engineering, simultaneously promoting throughout Europe the effective use of this safe and non-destructive technique.

*The Action will establish active links between universities, research institutes, companies and end users working in this field, fostering and accelerating its long-term development in Europe.*
Areas to be addressed in order to promote the GPR use in Civil Engineering:

• **Advancement of GPR systems**: increase of sensitivity to enable usability in a wider range of conditions, increase of amount and quality of collected data through the use of arrays of novel multi-frequency multi-polarization sensors.

• **Development of data processing/EM algorithms**: improve quality of GPR images, allow shape reconstruction and quantitative estimation of EM parameters, characterize a priori complex scenarios, ease interpretation of results by un-experienced operators.
Areas to be addressed in order to promote the GPR use in Civil Engineering:

- **Training of end users**, to increase awareness of operators.

- Identify and describe **procedures and guidelines**, so that GPR users know how GPR surveys should be conducted and what the quality level for the results should be. This would ensure a higher efficiency and quality of GPR services and would create a scientific basis for the introduction of EU Standards on the application of GPR in CE.

- **Comparison with GPR technology & methodology used in different fields.**

- **Integration of GPR with other NDT techniques.**
Objectives and Working Programme

I. Highlight problems, merits and limits of current GPR systems in CE applications.

II. Design, realization and optimization of innovative GPR equipment.

III. Develop innovative protocols and guidelines for an effective GPR use in CE tasks → published in a handbook and constitute a basis for EU Standards.

IV. Develop EM scattering & data-processing methods → novel freeware tool for shape-reconstruction and estimation of geophysical parameters.

V. Comparison with GPR technology and methodology used in different applications, and integration with other NDT techniques for CE applications.

VI. Promotion of a more widespread, advanced and effective use of GPR in CE.

VII. High-level modular training program.
Objectives and Working Programme

- Interaction with other COST Actions (as TU1206 “SUB-URBAN - A European network to improve understanding and use of the ground beneath our cities”)

- Interaction with other European and international research projects

- Establishment of cooperation with

  - IEEE
  - EAGE
  - GPR Association
  - FEHRL

- Focus on dissemination, on impact and outputs of our Action
Objectives and Working Programme

- **Multidisciplinary approach**: participation of civil and electronic engineers, software developers and geophysicists, from the academic world and from commercial companies manufacturing non-destructive testing equipment.

- **Contribution of experts from end users**: will help in turning the high research context to practical problems and to strategic and actual applications.

- **Sharing of human and technical resources**: GPR and other NDT equipment, measuring instruments, computers and software, manufacturing machinery and vehicles to set GPR prototypes and carry out validation activities.

A flexible work plan, to ensure that further participants may join the Action at a later stage and that new disciplinary perspectives and activities may be included.
Working method – organisation and management
This scheme will be checked after its first year and will be modified according to the actual number of active participants in each WG - and the number of participants joining the Action.
Will focus on the design of innovative GPR equipment for CE applications, on the building of prototypes and on the testing and optimization of the new system.

Synergy with WG2 and WG4 will for a deep understanding of problems, merits and limits of currently available GPR equipment. This will help in selecting the working parameters for the new GPR, according to the application’s requirements.

The architecture of the novel system will assume the use of an array of antennas, operating simultaneously and lined up in the transverse direction with respect to the direction of movement → faster data collection, clear images, improved detection probability of sought targets, possibility to survey the site with a regular grid and use of advanced data-processing methods → interaction with WG3.

In cooperation with the WG3, the possibility of designing a beamforming network for the transmitting antennas will be studied, in order to develop an equipment able to focus the EM waves at specific depths and at focal areas of specified size, according to the needs of the various CE applications.

It will be necessary to interact with the WG2 also for the development of advanced calibration measurement procedures as well as to test and optimize the fabricated prototypes in laboratory experiments and in real case studies.
The organization of the Action conforms to the “Rules and Procedures for Implementing COST Actions” (document COST 4154/11).

**Project Management structure:**

- Management Committee (MC), coordinating the Action, supervising its progress, reporting on the progress of the Action to the COST Office
- Editorial Board (EB), dealing with dissemination of Action's activities, Action's reports; Editorial Coordinator
- STSM Manager
- TS Manager
- Steering Group (SG) comprising MC Chair and Vice Chair, WG Chairs and Vice Chairs, Editorial Coordinator, STMSs and TS Managers + ‘Women in TU1208’ Chair

- End-user database.
- Communication system and Website.
Will focus on the surveying, through the use of a GPR system, of pavement, bridges, tunnels and buildings, as well as on the sensing of underground utilities and voids.

Initially, information will be collected and shared about state-of-the-art, ongoing studies, problems and future research needs, in the application of GPR to the above-mentioned CE applications.

Test scenarios will be defined, representing both typical and unusual situations that may occur in the various CE tasks, for an advanced comparison of available inspection procedures (taking advantages of the interaction with the WG4), GPR equipment (interacting with the WG1), application of EM forward-scattering simulators and data-processing algorithms (thanks to the cooperation with the WG3).

The available equipment, inspection procedures and algorithms will be applied to the test scenarios as a joint effort of the WG1, WG2 and WG3. On the basis of these studies, innovative inspection procedures will be outlined in the WG2 for the inspection of pavement, bridges, tunnels and buildings and for the detection of underground utilities and voids. The new procedures will be tested through laboratory experiments and in real scenarios, in synergy with the WG1 and the WG3. A deep analysis and critical review of the obtained results will lead, at the end of the Action lifetime, to the development of a handbook with protocols and guidelines at EU level.
Distribution of tasks
# NOVEL GPR INSTRUMENTATION

<table>
<thead>
<tr>
<th>Project 1.1</th>
<th>Design, realization and optimization of innovative GPR equipment for the monitoring of critical transport infrastructures (pavements, bridges and tunnels)</th>
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<tbody>
<tr>
<td>Project 1.2</td>
<td>Design, realization and optimization of innovative GPR equipment for the monitoring of buildings</td>
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<tr>
<td>Project 1.3</td>
<td>Design, realization and optimization of innovative GPR systems for sensing and mapping of underground utilities and voids, with a focus to urban areas</td>
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<td>Project 1.4</td>
<td>Development and definition of advanced testing, calibration and stability procedures and protocols, for GPR equipment</td>
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<tr>
<td>Project 2.1</td>
<td>Innovative inspection procedures for effective GPR surveying of critical transport infrastructures (pavements, bridges and tunnels)</td>
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<tr>
<td>Project 2.2</td>
<td>Innovative inspection procedures for effective GPR surveying of buildings</td>
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<td>Project 2.4</td>
<td>Innovative procedures for effective GPR inspection of construction materials and structures</td>
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<td>Project 2.5</td>
<td>Determination, by using GPR, of the volumetric water content in structures, sub-structures, foundations and soil</td>
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<td>Project 3.1</td>
<td>Development of new methods for the solution of forward electromagnetic scattering problems by buried structures</td>
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<tr>
<td>Project 3.2</td>
<td>Development of new methods for the solution of inverse electromagnetic scattering problems by buried structures</td>
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<td>Project 3.3</td>
<td>Development of intrinsic models for describing near-field antenna effects, including antenna-medium coupling, for improved radar data processing using full-wave inversion</td>
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<td>Project 3.4</td>
<td>Shape-reconstruction and quantitative estimation of electromagnetic and physical properties from GPR data</td>
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<td>Project 3.5</td>
<td>Development of advanced data processing techniques</td>
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<td>Project 3.6</td>
<td>Development of physical-model based algorithms for joint inversion of GPR and other non-destructive techniques</td>
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<td>Project 4.1</td>
<td>Applications of GPR and other non-destructive testing methods in archaeological prospecting and cultural heritage diagnostics</td>
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<td>Project 4.2</td>
<td>Applications of GPR in association with other non-destructive/non-contact testing methods in surveying of transport infrastructures</td>
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<tr>
<td>Project 4.3</td>
<td>Applications of GPR in association with other non-destructive testing methods in building assessment</td>
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<tr>
<td>Project 4.4</td>
<td>Advanced application of GPR to the localization and vital signs detection of buried and trapped people</td>
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<tr>
<td>Project 4.5</td>
<td>Development of other advanced electric and electromagnetic methods for the inspection of construction materials and structures</td>
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<td>Project 4.6</td>
<td>Applications of GPR in association with other NDT methods in hydrogeology, in the engineering of water resources and in water-contamination monitoring</td>
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<td>Project 4.7</td>
<td>Applications of GPR in association with other non-destructive testing methods in mining, geological and geotechnical applications</td>
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<td>Project 4.8</td>
<td>Applications of GPR in association with other non-destructive testing methods in railway ballast assessment</td>
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Promotion of Early-Stage Researchers and of gender balance
The Action will especially encourage young researchers to contribute actively in its activities.

**COST Strategy towards increased support of early stage researchers - Support Measures (COST 295/09)**

- **SM 1**: STSMs - *mainly* dedicated to ESRs!  ➔ 75% of the total
- **SM 2**: Training Schools  ➔ exclusively to ESRs!
- **SM 3**: Action Think Tank  ➔ ESRs Day Workshops
- **SM 4**: Conference Grants – those are awarded by the Domain Committee, but *we will give strong support to the ESRs to apply.*
- **SM 5**: Leading Roles to ESRs.
- **SM 6**: Open Call – Already applied.
- **SM 7**: ESR as national MC delegates – those are nominated by COST National Coordinators.
Gender Balance

- Gender balance is a priority of this network.
- Effort will be made to pursue stronger participation of women to the Action’s activities.
- The Action will take care to ensure that the distribution of beneficiaries of the STSM scheme is gender-balanced and the same with participation in Training Schools.
- Action events will be planned and organized so that they will be accessible to researchers with family duties.
- Joint activities with IEEE Women in Engineering and EGU Women in Geoscience will be encouraged and promoted.

Election of ‘Women in TU1208’ Chair
Time-table
Year 1

Collection and sharing of information about state-of-the-art, ongoing studies and open problems, in the field of CE applications of GPR.

Definition and coordination of test scenarios, representing both typical and unusual situations that may occur in CE applications, for an advanced comparison of available GPR equipment, inspection techniques, EM methods and data-processing algorithms, to be performed during the next year of activity.

Creation of end-user database (to be always integrated as new expressions of interests will come).

Set-up of an advanced communication system, for partnership integration and dissemination of results. Set-up of the Action website (to be always kept up-to-date).

Short-Term Scientific Missions!
Year 2

Multidisciplinary and multinational application and comparison of GPR equipment, inspection practice, EM and data-processing algorithms.

Strong human exchange and sharing of resources: numerous Short-Term Scientific Missions.

Year 3

Outline and test of innovative inspection procedures, on the basis of the activity carried out during the previous years.
Codification and development of new EM algorithms and of new methods for an effective data-processing with accurate estimation of geometrical and geophysical parameters.
Assessment for the design of novel GPR equipment and prototype realization.

Short-Term Scientific Missions!
Year 4

Critical study and review of results obtained during preceding years.

Coordination and elaboration of a handbook with protocols and guidelines at EU level.

Optimization of the new EM and data-processing codes. Realization of graphical user interface and manuals. Releasing freeware software for the benefit of GPR community.

Test and optimization of the new GPR equipment.

Short-Term Scientific Missions.
### Other annual deliverables:

1. STSM Reports
2. WG Reports
3. TS Lessons
4. Proceedings of Annual Conference, ESR Day, STSM Workshop
6. Articles in peer-reviewed scientific and technical Journals, contributions to international and national conferences and symposia
7. Multimedia material, mailing list, flyers, brochures

**Interactive Website** (fully set up at month 3, constantly updated throughout the ACTION)
Thank you!