Geosphere Infrastructures for Questions into Integrated Research

D5.6 WP5 Status of research infrastructures at M30

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1 Introduction

Deliverable D5.6 provides the status of WP5 research infrastructures at M30 of Geo-INQUIRE project term. The present report is follow-up of D5.3 due at M18 and aims to demonstrate the progress of installations since the last 12 months.

Specifically, the deliverable focuses on:

- for Virtual Accesses (VA):
  - current status, readiness level, including aggregated Service Status KPIs;
  - progress/enhancements since last 12 months;
- for Transnational Accesses (TA):
  - TA calls, user applications and visits completed;

Systematic installation progress reporting (Ch. 2) is completed by a short note on novel service (Ch. 3) and descriptions of selected highlights (Ch. 4). Appendix 1 contains updates regarding installation description at Geo-INQURE website.

2 Status of research infrastructures at M30

2.1 Service Status KPIs

The following table summarizes Service Status KPIs (SSRI-01 to SSRI-04) for VA-installations of WP5. In total, WP5 presents 13 Virtual Access (VA) installations.

(Note, in the previous D5.3 "WP5 Status of research infrastructures at M18" twelve VA installations were reported. During the time period after M18 combined installation VA4-532-3/4 was effectively split into two separate installations: one at GFZ presenting the software repository and another at INGV providing access to the web-application).

The KPIs in the following table are collected from the Tables below (see section 2.2) and the Geo-INQUIRE Implementation Level Matrix.

KPI ID	KPI Group	KPI definition	KPI values	Comment
SSRI-01	Service Status and RI Integration	% / number of Installations with full RI integration	46% 6 / 13	See Remark #1 below the table
SSRI-02	Service Status and RI Integration	% / number of Installations fully operating	100% 13 / 13	
SSRI-03	Service Status and RI Integration	% / number of Installations under implementation operating	67% 8 / 12	Installations not yet reached their final state
SSRI-04	Service Status and RI Integration	% / number of services running and reachable publicly	100% 13 / 13	same as SSRI-02

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Remark #1:

For selected distributed research infrastructures like EPOS RI, the exact definition of "full RI integration" (SSRI-01) still needs additional clarification. Implementation Level Matrix is perfectly defined and tuned to VA-accesses to data services, e.g., via OGC-compliant web-services. For non-data services like SaaS ("Software-as-a-Service"), integration into RI is, however, not yet strictly defined. As a result, some WP5 VA-services cannot be quantified in the sense of the SSRI-01 metric.

Remark #2:

Service Status KPI's SSRI-01-04 are best defined for the Virtual Accesses (VA) and could be tracked by the Geo-INQUIRE Implementation Level Matrix. That is, however, not the case for installations providing Transnational Accesses (TA). For TA installations, KPIs SSRI-01 and -04 are less suitable and, hence, cannot be reported.

In WP5, there are in total 12 original TA-installations (plus 2 supporting CINECA installations TA2-55-1 and -2). To M30, **all** the original installations are fully operating, issuing calls, receiving applications, and implementing TA visiting projects.

2.2 Installations providing Virtual Access (VA)

The following tables – one table per Virtual Access (VA) installation – report in a short, standardized way, the status of installations at M30 as well as the main activities carried out since last status reporting at M18.

Installation ID	**VA4-52-1 SDL@CINECA** VA4-52-2 SDL@CINECA/GFZ VA4-52-3 SDL@CINECA/INGV VA4-52-4 SDL@CINECA/CSIC VA4-52-5 SDL@CINECA/NGI VA4-52-6 SDL@CINECA/LMU VA4-52-7 SDL@CINECA/BSC VA4-52-8 SDL@CINECA/UMA
Installation name	Simulation Data Lake (SDL)
Hosting Institution	SDL@CINECA is composed of several installations. The main one (VA4-52-1) being the physical storage server providing the actual VA resides at CINECA. The sub-installations (VA4-52-2, VA4-52-3, VA4-52-4, VA4-52-5, VA4-52-6, VA4-52-7, VA4-52-8) refer to the contribution of the T5.2 participants to ensure the preparation and up taking of existing simulation datasets, and the inclusion of new ones from the other VAs and TAs in WP5.

Are the developments proposed in Geo-I finalised?	The Data Lake is in a production-ready state and is ready to receive data from partners. The developments are not finished because we constantly make improvements based on user feedback.
Is the installation providing DOIs and metadata description of its assets?	The DOI field has been added and managed in the Simulation Data Lake metadata schema along with the resource descriptive fields. DOI minting operation via Simulation Data Lake will be available in the next release.
Description of work carried out since March 2024 (M18)	In these months all the product releases have been created, from the first to the last (0.4.0), which contain the required features of the project. From the initial release, the Simulation Data Lake includes the setup of the infrastructure and software stack, including S3 object storage and a web server for RESTful APIs, as well as a web app UI and a command-line tool. An infrastructure with a storage capacity of 500T has been set up as required by the project. The implemented features include: • Storing large amounts of simulation data • Implementing advanced search functionalities, including search by spatial and temporal coverage • Experiment publication with different policies: Restricted, Open Access, Embargoed • Experiment version management • Uploading and downloading resources (datasets, simulations, or entire experiments) • Adoption of the RO-Crate standard • Workflow management with CWL • Admin Dashboard for KPIs: automated FAIR assessment using the F-UJI tool

Installation ID	**VA4-531-1**
Installation name	Ch-SeisSol-ExaHype-VA
Hosting Institution	LMU
Are the developments proposed in Geo-I finalised?	No. The software is available via github (also as docker container), a github action has been installed to monitor KPIs. Workshops have been held in 2024 and 2025 and SeisSol has been ported and used on Leonardo for the corresponding TA. First datasets have been stored in the SDL. The two development teams (at LMU and TUM) are constantly

	improving the software, e.g., output formats, GPU porting, SaaS approaches.
Is the installation providing DOIs and metadata description of its assets?	Yes: https://doi.org/10.5281/zenodo.14051105
Description of work carried out since March 2024 (M18)	• SeisSol v1.3.0 released in Nov 2024 • Improvement of the docker container for MAC users and aptainer for HPC • Installation instructions provided for Leonardo • github repo action installed to monitor VA-KPIs • SeisSol was part of the HPS SeisScoped Training 2023 & 2024 (reported in D5.5, video recordings available at https://www.youtube.com/watch?v=lpYoPIeh4gI); see also M. Denolle et. al. (2024): Training the next Generation of Seismologists: Delivering Research-Grade Software Education for Cloud and HPC Computing through Diverse Training Modalities. - arXiv, physics, 95. https://arxiv.org/abs/2409.19147 • SeisSol was part of the Quakeworx Kickoff event (held in January 2025, recordings will be made available) • Two SeisSol talks were given at the "Workshop on Simulation Data Lakes and Earthquake Ground Motions" (Sept. 2024 in Potsdam) • extensive testing (webinterface, CLI, wizard) of the SDL with first datasets

Installation ID	**VA4-531-2**
Installation name	Ch-Fall3D
Hosting Institution	CSIC
Are the developments proposed in Geo-I finalised?	No. The software is available via gitlab (also as docker containers). The metadata and the CWL workflows will be stored in the SDL. A CI/CD runner is being developed in GitLab (CASTIEL project from EuroHPC) to automate code compilation, testing, and verification of new FALL3D versions on both CPU and GPU across three different HPC servers: MN5, Leonardo, and Lumi. In connection with this, once the verifications are completed, a push will be made to the production environment, and Docker containers with the new version will be generated.

Is the installation providing DOIs and metadata description of its assets?	DOI: https://doi.org/10.5281/zenodo.6343786 Metadata description: https://gitlab.com/cheese5311126/codes/fall3d/fall3d-cpu/-/blob/main/FALL3D_metadata.json?ref_type=heads
Description of work carried out since March 2024 (M18)	• FALL3D v9.0.1 released in Dec 2024 • Docker Containers for MAC and Linux Users • Metadata Implementation • Implementation of satellite image assimilation • Acceleration of the FALL3D code on GPU

Installation ID	**VA4-531-3**
Installation name	Ch-OpenFOAM-VA
Hosting Institution	INGV
Are the developments proposed in Geo-I finalised?	Some of the numerical codes provided (OpenPDAC) will undergo CI/CD (Continuous Integration / Continuous Deployment). An updated release/installation is expected in 2025.
Is the installation providing DOIs and metadata description of its assets?	DOI for the OpenFOAM-based solvers is provided through Zenodo https://zenodo.org/records/14160640 https://zenodo.org/records/6560777 https://zenodo.org/records/5031825 MetaData of OpenPDAC (a ChEESE-2p flagship code) are provided here: https://gitlab.com/cheese5311126/codes/openpdac/openpdac-12
Description of work carried out since March 2024 (M18)	OpenFOAM-based numerical solvers made available: OpenPDAC-12 • New release (August 2024) of the numerical code • Update of benchmarks and documentation • New installation on Tier-0 supercomputer LUMI-C • Updated workflow for volcanological applications (setting of simulation parameters and scientific use-case) MagmaFOAM • Work on new release, planned for Fall 2025 ASHEE • Adapting the workflow to TA requirements (setting of simulation parameters and scientific use-case)

Installation ID	**VA4-531-4**
Installation name	Ch-HySEA-VA
Hosting Institution	UMA
Are the developments proposed in Geo-I finalised?	Essentially finished. The computing platform is up and running, has been used in training courses and hands-on activities and it has had tens of external users. It also includes documentation. Only several improvements, for example in the post-processing part, may be performed.
Is the installation providing DOIs and metadata description of its assets?	No
Description of work carried out since March 2024 (M18)	• Installations of T-HySEA: Leonardo, IGN (Spanish NTWC), SINAMOT-UNA (Costa Rica), among others • Installations of L-HySEA: Leonardo, IGN (Spanish NTWC) • Installations of the computing platform: atlantico cluster (EDANYA-UMA), Picasso supercomputer (SCBI, UMA) https://www.scbi.uma.es/web/es/recursos/hysea-platform/) • Webpage entrance at EDANYA-UMA site: https://www.uma.es/edanya/info/151578/hysea-platform/ • T-HySEA v4.3.2 released on Feb 2025 • T-HySEA v4.1.2 MC released on Feb 2025 • T-HySEA v1.2 (mini-app) released on Dec 2024 • L-HySEA v4.0.1 released on Oct 2024 • NH-HySEA v1.0.4 released on Feb 2025 • L-Multilayer-HySEA v1.4.1 released on Feb 2025 • Meteo-HySEA v1.0.0 released on Feb 2025 • April 2024 - Tsunami-HySEA training course (Geo-INQUIRE, virtual, material, recorded) • May 2024 - Tsunami-HySEA/Meteo-HySEA training course (ChEESE-2P, virtual) • Dec 2024 - Tsunami-HySEA training course (ChEESE-2P, in-person, UNA, Costa Rica) • April 2025 - Landslide-HySEA training course (Geo-INQUIRE, virtual) Landslide-HySEA invited talk at ICG CARIBE-EWS Expert Meeting (Dec 2024) • Presentations in international meetings and congresses

Installation ID	**VA4-532-1**
Installation name	TS-BingClaw-VA
Hosting Institution	NGI
Are the developments proposed in Geo-I finalised?	No. Some additional documentation will be updated before the end of the project.
Is the installation providing DOIs and metadata description of its assets?	Yes. The installation DOI is https://dx.doi.org/10.5281/zenodo.8354763
Description of work carried out since March 2024 (M18)	Some small modifications have been made to auxiliary software under https://github.com/norwegian-geotechnical-institute/BingCLAW_5.6.1 for easier visualization of output from the BingClaw software and easier utilization of the output by other programs (e.g. tsunami simulation codes).

Installation ID	**VA4-532-2**
Installation name	TS-AmpFact
Hosting Institution	NGI
Are the developments proposed in Geo-I finalised?	No. Software for users to produce their own amp.factors including documentation will be uploaded before the end of the project.
Is the installation providing DOIs and metadata description of its assets?	Yes. The installation DOI is https://doi.org/10.5281/zenodo.10732728
Description of work carried out since March 2024 (M18)	The global ampfactor fileset has been updated, and preparatory software development work related to letting users calculate their own ampfactors have been carried out.

Installation ID	**VA4-532-3**
Installation name	TS-GAUSS
Hosting Institution	GFZ
Are the developments proposed in Geo-I finalised?	No. Static dataset will be stored in the Simulation Data Lake within 06/2025
Is the installations providing DOIs and metadata description of its assets?	Yes (https://doi.org/10.5880/GFZ.2.5.2024.002)
Description of work carried out since March 2024 (M18)	This new installation was first launched during the 2nd year of the Geo-INQUIRE project. The first release by 12/2023. The branch distributed by GFZ-Potsdam is a software package coupled to a dataset of precomputed tsunami propagation

	Green's functions in the Mediterranean region. In the 1st release, dataset is located at the Google Drive. Later on, to be moved to the SDL (VA4-52-1). The code plus dataset allow fast simulation of arbitrary seismic tsunami scenarios in the region of coverage (now-Mediterranean Sea). Estimated wave heights are provided at selected off-shore positions (ca. 50-m water depth). The release can be used by tsunami modelers for fast assessment of the tsunami propagation pattern and intensity. Please also note the web-application version of TS-GAUSS – installation VA4-532-4.

Installation ID	**VA4-532-4**
Installation name	TS-GAUSS
Hosting Institution	INGV
Are the developments proposed in Geo-I finalised?	No. Performance improvement and optimization of the web-interface within 06/2025
Is the installations providing DOIs and metadata description of its assets?	No
Description of work carried out since March 2024 (M18)	This new installation was first launched during the 2nd year of the Geo-INQUIRE project. The first release by 12/2023. The branch distributed by INGV is a web-application which allows fast simulation of arbitrary seismic tsunami scenarios in the region of coverage (now- Mediterranean Sea). Estimated wave heights are provided at selected off-shore positions (ca. 50-m water depth). This app can be used by tsunami modelers for fast assessment of the tsunami propagation pattern and intensity. Please also note the source code version of TS-GAUSS: installation VA4-532-3.

Installation ID	**VA4-532-5**
Installation name	TS-Slip
Hosting Institution	IFREMER
Are the developments proposed in Geo-I finalised?	Yes. Training material has been improved. Interoperability with other software, an online training event has been provided, and a docker container has been created.
Is the installations providing DOIs and metadata description of its assets?	Yes: https://doi.org/10.5281/zenodo.7525449

Description of work carried out since March 2024 (M18)	• Version 2 of the k223d has been released on Github which can calculate rupture times across the fault in October 2024. • Interoperability has been improved by changing input and output to a vtk format which can be read by Paraview. • The Readme file has been updated. • Jupyter notebooks have been released as tutorials on how to use k223d and now to link it with other installations (EFSM20, VA2-33-1) and software (e.g. QGIS and Paraview) • A joint online training event was run withTS-Slip (VA4-532-6) and EFSM20 (VA2-33-1, WP2) on 4th November 2024. The videos of which are available on the Geo-Inquire website. • A docker file and a docker container have been developed and released: https://hub.docker.com/r/shanemurphy190/k223d

Installation ID	**VA4-532-6**
Installation name	TS-Slip
Hosting Institution	UNINA
Are the developments proposed in Geo-I finalised?	Yes. A new Python version (containerized through CONDA) has been developed and the instructions for installations and running of the examples are now available for this new version.
Is the installations providing DOIs and metadata description of its assets?	Yes: https://doi.org/10.5281/zenodo.13614658
Description of work carried out since March 2024 (M18)	• Python version released on github at the following link: https://github.com/antonioscalaunina/pyANTI-FASc • Readme, license and examples for the new Python version have been uploaded within the new repository. Within this version a Jupyter Notebook is also available and can be used as a tutorial • Implementation of KPI monitoring through github-repo-stats. Daily report available at: https://github.com/antonioscalaunina/pyANTI-FASc/blob/github-repo-stats/antonioscalaunina/pyANTI-FASc/latest-report/report.pdf

	• Interoperability improved. Input meshes compatible with the fault database made available by EFSM20 (VA2-33-1, WP2). Output in geoJSON format to be plotted also through tools like QGIS • A joint online training event was run withTS-Slip (VA4-532-5) and EFSM20 (VA2-33-1, WP2) on 4th November 2024. The videos of which are available on the Geo-Inquire website.

Installation ID	**VA4-533-1**
Installation name	VO-CIV
Hosting Institution	INGV
Are the developments proposed in Geo-I finalised?	The first preparatory phase has been finalised. The service prototype is up and running and ready for testing. A second prototype based on a standard (OGC-API) released by OGC (Open Geospatial Consortium) was started. Additionally, interaction with the reference scientific community (EPOS VO-TCS, the EPOS Volcano Observation Thematic Core Service) and with the EPOS ICS (Integrated Core Services) has suggested further improvements of the service prototype, aimed at a wider and more useful service. These will be implemented in the next reporting period.
Is the installations providing DOIs and metadata description of its assets?	No
Description of work carried out since March 2024 (M18)	During the first preparatory phase the following activities were carried out: • develop of three custom web services • configuration of the system to offer the services • open the service to external access • testing The implementation of a second prototype, based on an open source framework (PyGeoAPI) adhering to a standard (OGC-API), and recently (Jul. 2024) certified as compliant, was started and the following activities were carried out: • study of the open source framework • development of a module enhancement to the framework (connection to PostgreSQL DB to record processing information) • development a specific module for one web service (not completed yet)

	• configuration of a system to offer the service (not completed yet)

Installation ID	**VA4-534-1**
Installation name	Pyrocko
Hosting Institution	GFZ
Are the developments proposed in Geo-I finalised?	The web service for one seismic Green's functions (GF) to calculate forward model seismograms and static displacements from simple point and extended finite rupture models is online and operational at https://greens-mill.pyrocko.org/. The code repositories are online at https://git.pyrocko.org/.
Is the installations providing DOIs and metadata description of its assets?	Yes
Description of work carried out since March 2024 (M18)	• Versioning semantics • Improvement of scalability of the GF service

2.3 Installations providing Transnational Access (TA)

This section summarizes in a tabular form the progress of Transnational Accesses (TA) in WP5.

Installation ID	**TA2-531-1**
Installation name	Ch-SeisSol/ExaHyPE-TA
Hosting Institution	LMU
Description of work carried out in the installation since March 2024 (M18)	*TA2-531-1-C1-2 (**haiti-drm, Zoe Yin**)* Development of dynamic rupture simulations for the 2021 Haiti earthquake. The mesh includes a detailed fault system geometry comprising 17 fault segments among which the two main faults that broke during the earthquake. A set of dynamic rupture scenarios helped to evaluate under which conditions the peculiar characteristics of the event could be reproduced. Results of this study under review for publication in JGR, preprint available at https://eartharxiv.org/repository/view/8231/. See more about this project in Ch. 4.3 "Selected highlights." TA2-531-1-C1-1 (**RADIATE**) In preparation for a Magnitude 1 earthquake planned to be triggered in The Bedretto Lab (tunnel in Switzerland Alps), prognostic rupture scenarios were simulated, constrained by the local site conditions. Special attention was paid to the effect of fault roughness. Specially to note is the new automatic workflow

	to generate multiple meshes (with Cubit) with faults of various roughness that allowed statistical treatment of simulation results.
Number of applications received (per call: 1st, 2nd and 3rd)	Two applications received in the 1st call. One application received in the 2nd call.
Number of projects accepted by the TARP (per call, with project IDs)	All applications were accepted.
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	C1_TA2-531-1_2 (haiti-drm, Zoe Yin): • visit in July 2024, • preprint available at https://eartharxiv.org/repository/view/8231/ C1_TA2-531-1_1 (RADIATE): • visit in October 2024 • large runs on-going C2_TA2-531-1_2 (CapCosC-HPC): • SDL testing has started • visit scheduled for summer 2025

Installation ID	**TA2-531-2**
Installation name	Ch-OpenFOAM-TA
Hosting Institution	INGV
Description of work carried out in the installation since March 2024 (M18)	Assistance in preparation of projects for the three calls and associated visits. Virtual meetings and extensive contacts with PIs of the projects, to prepare the in-person visits. Two-week visit of a PhD candidate from the University at Buffalo to advance his research on pyroclastic surge dynamics using the OpenPDAC code within the OpenFOAM framework. The primary focus of the visit was the numerical modeling of pyroclastic surge sedimentation and the comparison of simulation results with experimental data from flume experiments conducted at Arizona State University. During the visit, he worked under the guidance of INGV researchers on refining numerical setups for simulations over both idealized and real topographies derived from the experiments, implementing post-processing tools to extract ground-level sediment flux, and optimizing computational workflows on HPC resources available at INGV and at CINECA (through external calls).
Number of applications received (per call: 1st, 2nd and 3rd)	1st call: 2 applications 2nd call: 2 applications 3rd call: 1 application

Number of projects accepted by the TARP (per call, with project IDs)	1st call: 2 C1_TA2-531-2_1, C1_TA2-531-2_2 2nd call: 2 C2_TA2-531-2_1, C2_TA2-531-2_2
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	2: C1_TA2-531-2_2, C2_TA2-531-2_2

Installation ID	**TA2-531-3**
Installation name	Ch-HySEA-TA
Hosting Institution	UMA
Description of work carried out in the installation since March 2024 (M18)	Preparation of first call projects and associated visits. Virtual meetings and extensive contacts with IPs of the projects, to prepare the in-person visits. Two in-person stays performed in October 2024 and February 2025. This meant the request for access to computing resources to CINECA, installation of codes, training of the projects' IPs, assistance in the initial configuration of the problems/scenarios to be simulated, and further assistance in the effective development of the project. We continue working in both projects now virtually to conclude all tasks. Third call projects have been received and they have to be initiated.
Number of applications received (per call: 1st, 2nd and 3rd)	• 6 applications were received for the 1st call • The installation was not opened for the 2nd call • 5 applications were received for the 3rd call
Number of projects accepted by the TARP (per call, with project IDs)	• In the first call, 5 projects were accepted and 3 finally granted granted: ○ C1-TA2-531-3_1 (TRUSTIC) ○ C1-TA2-531-3_6 (IALGTLRCH1960) ○ C1-TA2-531-3_7 (FLOOD-IMG) • In the second call we did not open this installation • In the third call, 5 projects submitted: ○ C3-TA2-531-3_3 (SLAM) ○ C3-TA2-531-3_5 (MILESTWS) ○ C3-TA2-531-3_6 (ELITS-SEA) ○ C3-TA2-531-3_7 (TRAMAC-SL-RS) ○ C3-TA2-531-3_8 (BETON)
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	Two projects were already started (IALGTLRCH1960, in June 2024 and FLOOD-IMG in October 2024), both with their in-person component at the installation already done (October 2024 and February 2025, respectively). The third project is currently

	stopped, probably because of the situation in Israel, and with no feedback received by the solicitor. We can try a final contact. Since the beginning of March 2025, we are initiating the contacts with the 3rd call projects IPs to start the new set of projects.

Installation ID	**TA2-532-1**
Installation name	TS-BingClaw-TA
Hosting Institution	NGI
Description of work carried out in the installation since March 2024 (M18)	Preparations for all visits have taken place with meetings with the prospective participants and validation and testing of the proposed models (topo-bathymetry, file formats etc.). Visit C2_TA2-532-1_1 took place in January 2025 and this involved compilation and installation of software on the participant's computer, a suite of numerical landslide simulations, and visualization and analysis of simulation output. Visits C2_TA2-532-1_3 and Visits C2_TA2-532-1_6 took place jointly in March 2025 and involved training on landslide modelling and interpretation in general, and further involves integration of BingClaw modeling with tsunami generation and propagation.
Number of applications received (per call: 1st, 2nd and 3rd)	6 applications were received for TA2-532-1 in the 2nd call. No applications were received for the first call, and the installation was not open for the third call.
Number of projects accepted by the TARP (per call, with project IDs)	4 projects were accepted by the TARP for the second call: • C2_TA2-532-1_1 • C2_TA2-532-1_2 • C2_TA2-532-1_3 • C2_TA2-532-1_6
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	All four of the accepted projects have been started as of 31 March 2025 with either a completed visit (C2_TA2-532-1_1) or preparatory discussions and meetings (C2_TA2-532-1_2, C2_TA2-532-1_3, and C2_TA2-532-1_6).

Installation ID	**TA2-541-1 and TA2-541-2**
Installation name	Ch-PVHA
Hosting Institution	INGV and CSIC (distributed installation). INGV is the physical host of the TA awardees. Both INGV and CSIC provide support and training before, during and after the visit towards the full project execution.

Description of work carried out in the installation since March 2024 (M18)	In the preparatory phase before the period in presence, we have been remotely in contact with the applicants to define the input framework for simulations. Both applicants have received remote support on how to access HPC resources on Galileo100. For one of them, the in presence period is taking place at the time of writing (March 2025). At the moment she is learning to use HPC resources and has launched the first batch of simulations.
Number of applications received (per call: 1st, 2nd and 3rd)	2 in 1st call, we did not open positions in the other 2 calls
Number of projects accepted by the TARP (per call, with project IDs)	2 in 1st call
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	Both projects started before March 2025. The period in presence for C1_TA2-541-1_2 is taking place at the time of writing and will end by March 23rd, 2025. For C1_TA2-541-1_1, we have started remote support in January 2025 and the in presence period will take place between May 25th to July 5th, 2025.

Installation ID	**TA2-541-2**
Installation name	Ch-PVHA
Hosting Institution	INGV and CSIC (distributed installation)
Description of work carried out in the installation since March 2024 (M18)	Remote support to both C1_TA2-541-1_1 and C1_TA2-541-1_2
Number of applications received (per call: 1st, 2nd and 3rd)	2 in 1st call, we did not open positions in the other 2 calls
Number of projects accepted by the TARP (per call, with project IDs)	2 in 1st call
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	Both projects started before March 2025. The period in presence for C1_TA2-541-1_2 has started recently at **TA2-541-1**; periodic (weekly) meetings have been done. For C1_TA2-541-1_1, we have started remote support in January 2025 and the in presence period will take place between May 25th to July 5th, 2025.

Installation ID	**TA2-541-3, TA2-541-4, TA2-541-5**
Installation name	Ch-PTHA
Hosting Institution	INGV (remote support by UMA and NGI). INGV is the physical host of the TA awardees. All (NGV, UMA, NGI) provide support and training before, during and after the visit towards the full project execution. In particular, NGI collaborates with INGV regarding the PTHA project definition and execution, while UMA provides the training and the support for the usage of the simulation code.
Description of work carried out in the installation since March 2024 (M18)	Update and improvement of the workflow. Remote support to the approved projects regarding preparatory work and HPC access. One visit (2 weeks, one in Nov 2024 and one in Jan 2025) has taken place. Introductory meetings for another project, which should have taken place in February 2025 but could not yet due to visa issues.
Number of applications received (per call: 1st, 2nd and 3rd)	3 applications in the 1st call. Installation not open in the second and third call.
Number of projects accepted by the TARP (per call, with project IDs)	All 3 approved (C1_TA2-541-3-1, C1_TA2-541-3-2, C1_TA2-541-3-3) - C1_TA2-541-3-2 moved to NGI
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	C1_TA2-541-3-1 in presence period already done C1_TA2-541-3-2 in presence period already done at NGI C1_TA2-541-3-3 not started yet due to visa issues

Installation ID	**TA2-541-6, TA2-541-7, TA2-541-8**
Installation name	Ch-PTHA
Hosting Institution	NGI (remote support by UMA and INGV). NGI is the physical host of the TA awardees. All (NGV, UMA, NGI) provide support and training before, during and after the visit towards the full project execution. In particular, INGV collaborates with NGI regarding the PTHA project definition and execution, while UMA provides the training and the support for the usage of the simulation code.
Description of work carried out in the installation since March 2024 (M18)	Update and improvement of the workflow and support for HPC access. For project C1_TA2-541-3_2, a visit has taken place with calculation setup, validation, and tsunami simulations carried out. For project C2_TA2-541-6_2, meetings have taken place

	regarding the hazard models and sources and requirements and availability of high-resolution topobathymetry.
Number of applications received (per call: 1st, 2nd and 3rd)	1 application for first call, 2 applications for second call. Installation not open in the third call.
Number of projects accepted by the TARP (per call, with project IDs)	One application (C1_TA2-541-3_2) was accepted by the TARP for the first call, and one application (C2_TA2-541-6_2) was accepted by the TARP for the second call.
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	Both of the accepted projects have started. A one week visit for project C1_TA2-541-3_2 was completed in February 2025, and preparatory work (hazard disaggregation, preparation and advice on topobathymetry, preparatory meetings) have taken place for project C2_TA2-541-6_2.

Installation ID	**TA2-541-9**
Installation name	Ch-Cyber-PSHA
Hosting Institution	LMU
Description of work carried out in the installation since March 2024 (M18)	We prepared an application for computational time (1.3 million core hours) for the Spanish Supercomputing Network (RES). The proposal was submitted in collaboration with the BSC research team in January 2025 and has already been approved. We are currently providing our first TA service (CyberSISZ) at LMU, using the granted computational resources. C2_TA2-541-9_2 (***CyberSISZ)*** A calibration for Icelandic earthquakes of the Graves and Pitarka (GP) fault-rupture code was proposed, taking as a reference recorded strong earthquakes nucleated at the South Iceland Seismic Zone (the Mw 6.5 and 6.4 earthquakes in 2000 and the Mw 6.3 earthquake in 2008). GP is part of the CyberShake tool, which has already been used for ground-motion simulations in South Iceland (Rojas et al., 2024). In this work, the slip generator is being adjusted to represent the characteristics of slip distributions observed in Icelandic earthquakes, such that near-fault velocity pulses can be simulated with CyberShake and ground motions can be more accurately predicted, improving the results by Rojas et al. As part of the TA provision, the awardee visited our collaborators at BSC on Feb 17 and worked in person at LMU from Feb 18-28, 2025. Currently, he is working remotely with the LMU's advice on completing the scientific results.

Number of applications received (per call: 1st, 2nd and 3rd)	Three applications received in the 2nd call.
Number of projects accepted by the TARP (per call, with project IDs)	All three applications passed the threshold. One (CyberSISZ) was approved.
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	The PI of the successful TA proposal "CyberSISZ" visited LMU from Feb 17 to Feb 28, 2025.

Installation ID	**TA2-541-10**
Installation name	Ch-Cyber-PSHA
Hosting Institution	BSC
Description of work carried out in the installation since March 2024 (M18)	• Improvements to the UnifiedCSWFlow. • In January 2025, in collaboration with LMU we applied for 1.3 million core hours to the Spanish Supercomputing Network (RES), which has been granted.
Number of applications received (per call: 1st, 2nd and 3rd)	Two applications: one application per call (1st and 2nd)
Number of projects accepted by the TARP (per call, with project IDs)	One application accepted by TARP on the 1st call. Successful one from OGS, Italy ID: C1-TA2-541-10_4. One application for the 2nd call was not accepted (C2_TA2-541-10_1).
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	C1-TA2-541-10_4 will start on March 17th 2025, visiting BSC until March 21st, and continuing in virtual mode. Besides, support and site provision for TA2-541-9 application TA proposal "CyberSISZ" (C2_TA2-541-9_2).

Installation ID	**TA2-541-11**
Installation name	Ch-MP-PSHA
Hosting Institution	LMU
Description of work carried out in the installation since March 2024 (M18)	We improved the workflow and updated the TA description to open the TA in the 3rd call.
Number of applications received (per call: 1st, 2nd and 3rd)	MP-PSHA opened in the 3rd TA Call and received two applications: • C3_TA2-541-11_2 (PhyDRMT) • C3_TA2-541-11_3 (FFM-Tohoku)

Number of projects accepted by the TARP (per call, with project IDs)	Evaluation is on-going.
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	N.A.

Installation ID	**TA2-542-1**
Installation name	EF-PSHA
Hosting Institution	ETHZ
Description of work carried out in the installation since March 2024 (M18)	Within the reporting period, one Transnational Activity (TA) was conducted for the EF-PSHA - Probabilistic Seismic Hazard Analysis (TA2-542-1) installation. Within this TA, the focus was the refining ground motion models (GMMs) tailored to the Vrancea (VRI) region, Romania. The main activities can be summarised as: • Implementation of the codes (Kuehn et al., 2019; Lavrentiadis et al., 2023) for estimating the non-ergodic terms (source, site, and path) of the Manea et al. (2022) ground motion models (GMMs). • Development of a cell-based grid for evaluating path effects, following the approach of Kuehn et al. (2019). • Sensitivity analysis of the updated Vrancea (VRI) GMMs and comparison with the ESHM20 backbone model published by Weatherill et al., 2020. • Hazard computation using the updated VRI GMMs and comparison with ESHM20. As part of this research, we have already published a paper evaluating and testing the ESHM20 in Romania: Manea, E. F., Danciu, L., Cioflan, C. O., Toma-Danila, D., & Gerstenberger, M. C. (2025). Testing the 2020 European Seismic Hazard Model (ESHM20) against observations from Romania. Natural Hazards and Earth System Sciences, 25(1), 1-12. We also plan to submit another paper on the re-evaluation of seismic hazard of Romania in an international open-access peer-reviewed journal by the end of the year.
Number of applications received (per call: 1st, 2nd and 3rd)	three applications for 1st call and four for the 3rd call. 2nd call was not open for this installation
Number of projects accepted by the TARP (per call, with project IDs)	three projects were accepted: C1_TA2-542-1_1, C1_TA2-542-1_2, C1_TA2-542-1_3

Number of projects started before and/or finalised by 31 March 2025 (with IDs)	C1_TA2-542-1_1, first in-person visit done, second visit to be scheduled C1_TA2-542-1_2, postponed C1_TA2-542-1_3, in person and completed

Installation ID	**TA2-55-1**
Installation name	Leonardo booster
Hosting Institution	CINECA
Description of work carried out in the installation since March 2024 (M18)	User and high-level support to the HPC computational activity. Environment (profile/modules) creation, suitable to TA researchers.
Number of applications received (per call: 1st, 2nd and 3rd)	N.A.
Number of projects accepted by the TARP (per call, with project IDs)	N.A.
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	5 projects. 2,5 ML of GPU hours requested.

Installation ID	**TA2-55-2**
Installation name	Galileo100
Hosting Institution	CINECA
Description of work carried out in the installation since March 2024 (M18)	User and high-level support to the HPC computational activity. Environment (profile/modules) creation, suitable to TA researchers.
Number of applications received (per call: 1st, 2nd and 3rd)	N.A.
Number of projects accepted by the TARP (per call, with project IDs)	N.A.
Number of projects started before and/or finalised by 31 March 2025 (with IDs)	2 projects. 4,6 ML of core hours requested.

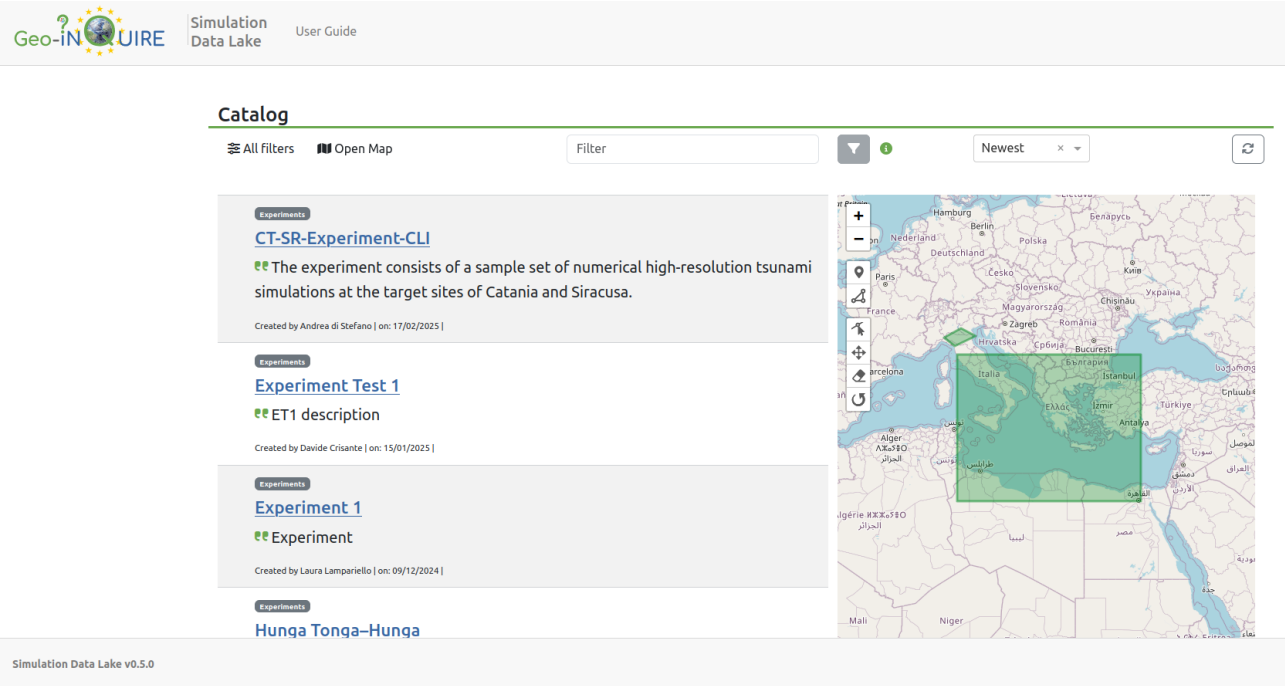
3 New services available since M18

The Simulation Data Lake (VA4-52-1) is now in the production-ready state and is ready to receive data from partners.

4 Selected highlights

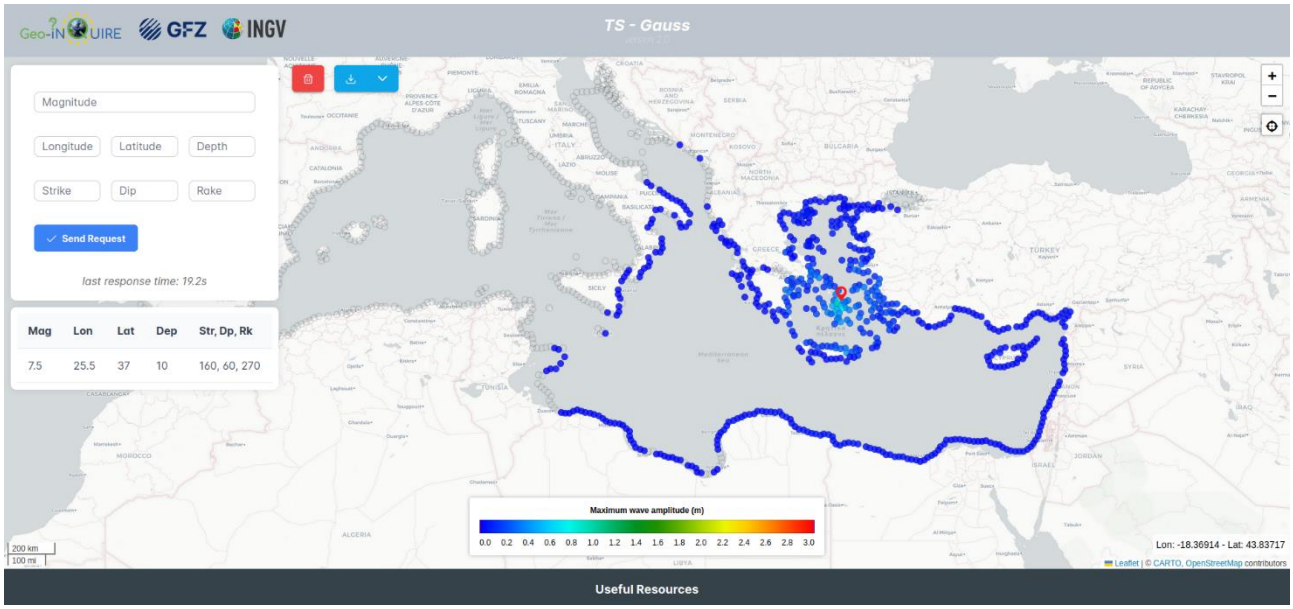
4.1 Simulation Data Lake in operational phase

Installation **VA4-52-1** has now entered in its operational phase and is ready to host large-volume simulation data from project partners (production environment at https://sdl.hpc.cineca.it). TA projects of WP5 are invited to store their results in SDL for later re-use. Contacts: sdl@cineca.it



4.2 Web-application of TS-Gauss launched

Installation **VA4-532-4** which is a web-interactive version of the TS-Gauss service (VA4-532-3 and -4) was launched. Users can configure arbitrary earthquake parameters and receive visualization of the tsunami propagation and impact pattern around the Mediterranean Sea: http://ts-gauss.rm.ingv.it/. Simulation results – as tsunami time series or maximum wave heights – can be also downloaded.



4.3 Dynamic rupture simulations with SeisSol

The Installation **TA2-531-1** "Ch-SeisSol/ExaHyPE-TA" hosted by LMU provided a summary of the scientific results of their first TA project.

TA project *haiti-drm*

The 2021 Mw 7.2 Haiti earthquake was a devastating event which occurred within the Enriquillo Plantain Garden Fault Zone (EPGFZ). It is not well-understood why neither the 2021 nor the prior 2010 Mw 7.0 earthquake were simple strike slip events and, instead, ruptured with distinct patches of dip slip and strike slip motion on largely separate fault planes. During her stay in LMU, Zoe has learnt to use SeisSol and started developing dynamic rupture simulations for the 2021 Haiti earthquake. We first built a detailed fault system geometry comprising 17 fault segments, which includes the two main faults that broke during the earthquake (Thrust Fault and Ravine du Sud Fault), along with surrounding regional and secondary faults. Zoe then developed a set of dynamic rupture scenarios to evaluate under which conditions the peculiar characteristics of the event could be reproduced. We find that along-strike changes in the frictional strength of the Thrust Fault as well as lateral changes in the regional stress shape and orientation are key to reproducing the rupture transfer from the Thrust Fault to the Ravine du Sud Fault, the slip rake partitioning, the main characteristics of the InSAR surface deformation, and the multi-peak source time function. The best model is shown in Figure 4.3.1. Zoe's results have been submitted to Journal of Geophysical Research: Solid earth (preprint: https://eartharxiv.org/repository/view/8231/).

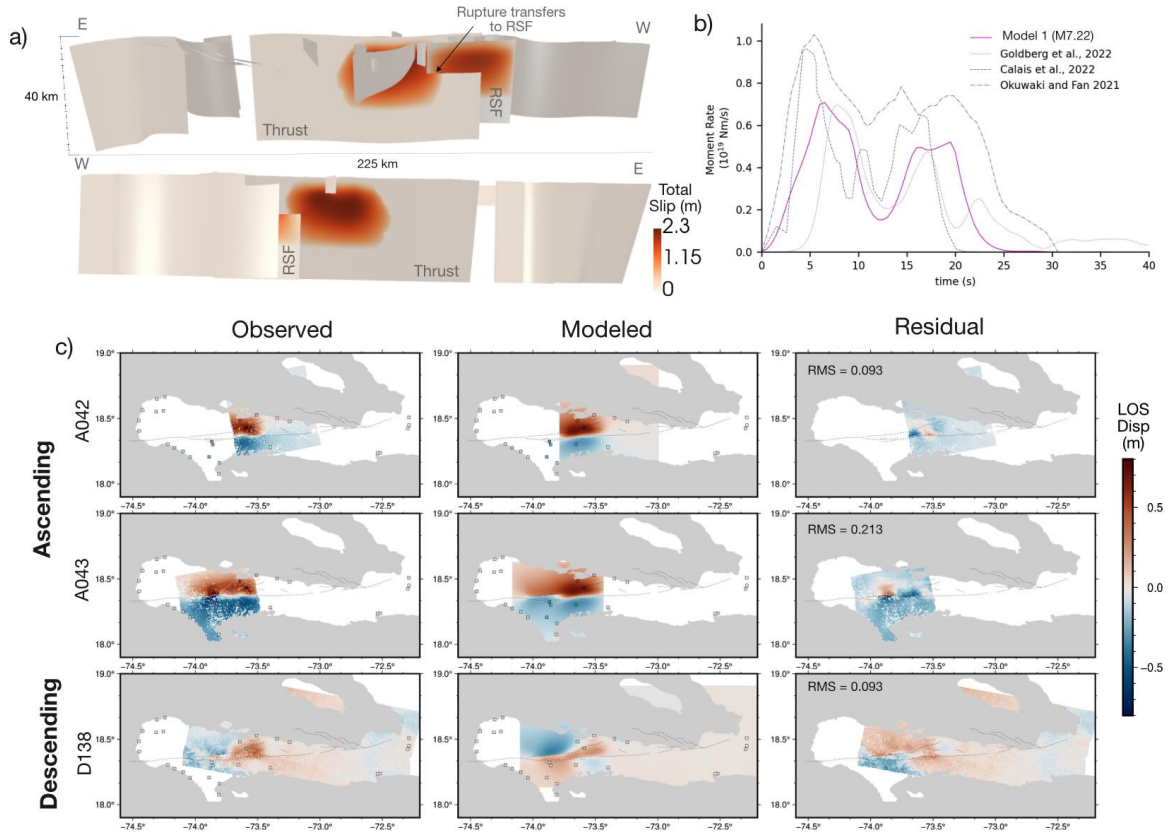


Figure 4.3.1 Preferred dynamic rupture model for the 2020 Mw 7.2 Haiti earthquake. The initial conditions include lateral variations in regional stresses combined with data-constrained stress heterogeneities and fault strength variations: a) Final slip distribution of the simulation. Slip patches concentrate compactly on the Thrust Fault (TF) and Ravine du Sud Fault (RSF). Slip on the RSF indicates successful rupture transfer b) source time function comparison between observations (grey) and model (purple), showing a good agreement in the moment magnitude and timing. The two distinct peaks in the source time function correspond to the rupture of the TF and RSF, respectively. c) Observed InSAR comparison with simulated LOS surface deformation data. Modeled surface deformation data closely matches the pattern and amplitude of the observations, with the synthetic descending LOS deformation (D138) showing the expected lobe of positive deformation in the LOS direction.

Appendix 1 – Update of installation descriptions

This Appendix contains information about installations that require an update of their description at the Geo-INQUIRE website.

Installation ID	**VA4-532-3 and -4**
Installation name	**TS-Gauss**
Hosting institution	**GFZ Helmholtz Centre for Geosciences, Potsdam, Germany (VA4-532-3)** **Istituto Nazionale di Geofisica e Vulcanologia (INGV), Rome, Italy (VA4-532-4)**
Description	The "GaussToolbox" provides fast tsunami propagation modelling based on the Greens' functions technique. Pre-computed Greens' functions correspond to tsunami time-series as modeled at selected off-shore positions from the Gaussian-shape elementary sources distributed evenly over the sea surface. The service, in its first implementation, covers the Mediterranean region and is distributed in two instances. (1) Source code repository coupled to a dataset of Green's functions (VA4-532-3) and (2) Web-application for online scenario simulations (VA4-532-4). On-demand training will be provided as a part of this VA.
Target community/users	tsunami modellers; hazard and risk analysts; early warning centres
Estimated users/year	under 100
Community standards	netCDF
URL	Repository Version: https://git.gfz-potsdam.de/babeyko/ts-gauss Web-App Version: http://ts-gauss.rm.ingv.it/ DOI: https://doi.org/10.5880/GFZ.2.5.2024.002

Installation ID	**VA4-531-1**
Installation name	**Ch-SeisSol-ExaHype-VA**
Hosting institution	**LMU**
Description	SeisSol is an earthquake and wave simulation open-source community code. SeisSol solves the seismic wave propagation problem (elastic, viscoelastic, poroelastic) linked to earthquake dynamic rupture in complex 3D models. SeisSol uses Discontinuous Galerkin discretization which is high-order accurate in space and time and local time-stepping on unstructured adaptive tetrahedral meshes. Scalable performance at Petascale has been demonstrated up to several thousands of nodes (on several supercompers, e.g., Cori, SuperMUC, Hazel Hen, Shaheen, Frontera). As part of the ChEESE/ChEESE-2P Centre of Excellence, SeisSol has been ported and is being optimized for GPU-based supercomputers. ExaHyPE is an open source simulation engine to solve hyperbolic PDE systems, as stemming from conservation laws. It is built on top of dynamically adaptive

	Cartesian meshes and offers support for Finite Volume and Discontinuous Galerkin discretizations. ExaHyPE is written in a way that most computer science aspects as well as most of the numerics are hidden away from the user: Users plug in user functions for their PDE formulation (such as flux functions and eigenvalues) into the engine and then delegate all further work to ExaHyPE. A concrete model for seismic wave propagation and dynamic rupture problems has been developed within ChEESE. The model is based on high-order Discontinuous Galerkin discretization and works on octree-structured Cartesian meshes. Through the VA we offer several different options: • Gain a first understanding via the projects websites • Download the latest version of the code with git • Use the documentation and tutorials for SeisSol and ExaHyPE • Test both by using docker containers https://github.com/SeisSol/Training https://hub.docker.com/r/seissol/training https://hub.docker.com/repositories/peanoframework • Video recordings of the latest training events: https://www.youtube.com/watch?v=lpYoPIeh4gI https://www.youtube.com/watch?v=18sdWebeL0Y
Target community/users	Researchers of any level either from Seismology or interdisciplinary fields (e.g. Tsunami, Geodynamics, Engineering); Students.
Estimated users/year	Less than 100
Community standards	HDF5, NetCDF, Standard Rupture Format (SRF) https://seissol.readthedocs.io/en/latest/standard-rupture-format.html?#standard-rupture-format)
URL	• www.seissol.org • www.exahype.org • https://github.com/SeisSol/SeisSol • https://gitlab.lrz.de/hpcsoftware/Peano • DOI: https://doi.org/10.5281/zenodo.4672483