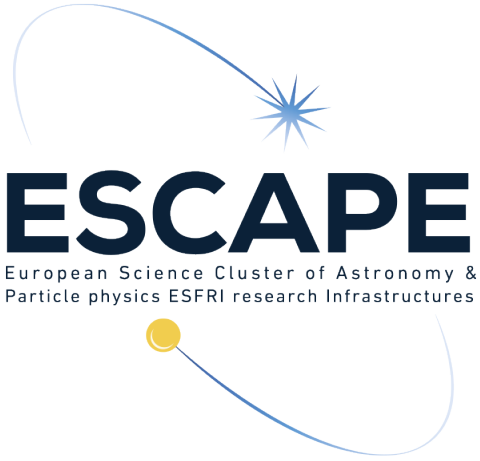

Project Title	European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructure
Project Acronym	ESCAPE
Grant Agreement No	824064
Instrument	Research and Innovation Action (RIA)
Topic	Connecting ESFRI infrastructures through Cluster projects (INFRA-EOSC-4-2018)
Start Date of Project	01.02.2019
Duration of Project	42 Months
Project Website	www.projectescape.eu

D3.2: SOFTWARE AND SERVICE LIST AND INTEGRATION PLAN

Work Package	WP3, OSSR - Open Science Software and Service Repository
Lead Author (Org)	Kay Graf (FAU)
Contributing Author(s) (Org)	Cristiano Bozza (INFN), Elena Cuoco (EGO-Virgo), Thomas Vuillaume (CNRS-LAPP)
Due Date	31.01.2020, M12
Date	17.02.2020
Version	1.0

Dissemination Level

X	PU: Public
	PP: Restricted to other programme participants (including the Commission)
	RE: Restricted to a group specified by the consortium (including the Commission)
	CO: Confidential, only for members of the consortium (including the Commission)

Versioning and contribution history

Version	Date	Authors	Notes
0.1	12.01.2020	Kay Graf (FAU)	Start of drafting the work plan
0.2	29.01.2020	Kay Graf (FAU), Jutta Schnabel (FAU), Thomas Vuillaume (CNRS-LAPP)	Editing section on Integration Plan
0.3	07.02.2020	Kay Graf (FAU)	Add responses from the survey and from an editing session
1.0	17.02.2020	Kay Graf (FAU)	Including partner and WP1 feedback

Disclaimer

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Executive Summary

This document lists the software and services that the ESCAPE partners will contribute to the *ESCAPE Work Package 3* and especially to the *OSSR (Open source Software and Service Repository)*. The software and services will be provided by the partners on behalf of the ESF/RIs they represent in the ESCAPE project. The list is a first collection and will be extended and adapted during the project, e.g. when new developments in the ESCAPE framework arise, they will be added. In addition, a plan for the integration of the items on the list is presented, both from the repository and from the partner perspective.

Project Summary

ESCAPE (European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures) addresses the Open Science challenges shared by ESFRI facilities (SKA, CTA, KM3NeT, EST, ELT, HL-LHC, FAIR) as well as other pan-European research infrastructures (CERN, ESO, JIVE) in astronomy and particle physics. ESCAPE actions are focused on developing solutions for the large data sets handled by the ESFRI facilities. These solutions shall: i) connect ESFRI projects to EOSC ensuring integration of data and tools; ii) foster common approaches to implement open-data stewardship; iii) establish interoperability within EOSC as an integrated multi-messenger facility for fundamental science. To accomplish these objectives, ESCAPE aims to unite astrophysics and particle physics communities with proven expertise in computing and data management by setting up a data infrastructure beyond the current state-of-the-art in support of the FAIR principles. These joint efforts are expected to result into a data-lake infrastructure as cloud open-science analysis facility linked with the EOSC. ESCAPE supports already existing infrastructures such as astronomy Virtual Observatory to connect with the EOSC. With the commitment from various ESFRI projects in the cluster, ESCAPE will develop and integrate the EOSC catalogue with a dedicated catalogue of open-source analysis software. This catalogue will provide researchers across the disciplines with new software tools and services developed by astronomy and particle physics community. Through this catalogue, ESCAPE will strive to provide researchers with consistent access to an integrated open-science platform for data-analysis workflows. As a result, a large community "foundation" approach for cross-fertilisation and continuous development will be strengthened. ESCAPE has the ambition to be a flagship for scientific and societal impact that the EOSC can deliver.

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Acronym list

Partners

AIP	Leibnitz-Institut für Astrophysik Potsdam
CERN	European Organization for Nuclear Research
CNRS-LAPP:	Laboratoire d'Annecy de Physique des Particules (CNRS)
CNRS-CPPM:	Centre de Physique des Particules de Marseille (CNRS)
NWO-I-CWI:	Centrum Wiskunde & Informatica (NWO-I)
CTA:	Cherenkov Telescope Array
CTAO:	Cherenkov Telescope Array Observatory
EGO-Virgo:	European Gravitational Observatory
CERN:	European Organization for Nuclear Research
EST:	European Solar Telescope
ESO:	European Southern Observatory
ELT:	Extremely Large Telescope (was E-ELT)
FAIR:	Facility for Antiproton and Ion Research
FAU:	Friedrich-Alexander University Erlangen-Nuremberg
GSI:	GSI Helmholtzzentrum für Schwerionenforschung
HITS:	Heidelberg Institute for Theoretical Studies
HL-LHC:	High-Luminosity Large Hardon Collider
IFAE:	Institut de Fisica d'Altes Energies
INFN:	Istituto Nazionale di Fisica Nucleare
JIVE:	Joint Institute for VLBI ERIC
AIP:	Leibnitz-Institut für Astrophysik Potsdam
MPG-MPIK:	Max-Planck-Institut für Kernphysik (MPG)
KM3NeT:	multi-km3 sized Neutrino Telescope
NWO-I-Nikhef:	Nationaal instituut voor subatomaire fysica (NWO-I)
OROBIX:	OROBIX SRL
SKA:	Square Kilometre Array
SKAO:	Square Kilometre Array Organisation
UCM:	Universidad Complutense de Madrid
UNITOV:	Universita degli Studi di Roma Torvergata

General

ASTERICS:	Astronomy ESFRI & Research Infrastructure Cluster
E-EB	ESCAPE Executive Board
EOSC:	European Open Science Cloud
EOSC-Hub:	Integrating and managing services for the European Open Science Cloud
ESCAPE:	European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures
ESFRI:	European Strategy Forum on Research Infrastructures
ESF/RI:	ESFRIs and major RIs as projects within ESCAPE

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FAIR:	Findable, Accessible, Interoperable, Reusable
IVOA:	International Virtual Observatory Alliance
OSSR:	Open Science Software and Service Repository (ESCAPE WP3 itself and the final product within the EOSC catalogue of services)
RDA:	Research Data Alliance
RI:	Research Infrastructure
VO:	Virtual Observatory
WP:	Work Package

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1. Introduction and Background

As introduced in ESCAPE D3.1, the project plan of WP3 - OSSR:
“All the ESFRI and RI projects concerned by ESCAPE have the mission in common to provide open access to their quality-certified scientific data, including dedicated analysis software stacks, and high-level science tools to utilise this data. … ”
“The aim of WP3 OSSR is to expose software tools of the ESCAPE ESF/RI projects in a repository under the EOSC catalogue of services, ensuring compatibility with *FAIR* principles. The tools encompass the software itself, as well as the environment to enable the scientific community to use the software, e.g. documentation, continuous integration and deployment services and evaluation data sets.”

Here, we report on the initial set of software and services that the partners will expose - on behalf of their respective ESFRIs or RIs - to the EOSC catalogue of services through the OSSR. We refer to the collection of software, tools and services generally as “services” in the following. The ESCAPE partners that are participating in the OSSR work package, and their connection to the ESFRI or major RIs are:

ESFRI/RI	Institute/SME
CTA	CNRS-LAPP
CTA	CTAO
CTA	IFAE
CTA	MPG-MPIK
CTA	UCM
EGO-Virgo	EGO
ELT	HITS
EST	AIP
EST	NWO-I-CWI
EST	UNITOV
FAIR	GSI
HL-LHC, CERN	CERN
JIVE	JIVE
KM3NeT	CNRS-CPPM
KM3NeT	FAU
KM3NeT	INFN
KM3NeT	NWO-I-Nikhef
SKA	SKAO
SME	OROBIX

Table 1 OSSR Partners

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2. Software and Service List

A survey to gather the necessary information on the software and services to be exposed to the EOSC catalogue of services via OSSR was set up, coordinated with the partners and finally filled by all partners.

Annex A - Software and Service Survey

lists the relevant information on this initial survey, it will be extended and adapted to new inputs from the partners during the project. The full responses are collected in Annex A.

Software/Service Name	Providing ESF/RI or Project	Responsible Partner(s)	Status of Project
ESCAPE template project	*ESCAPE*	*LAPP*	*template for further development*
Corsika module with options for specific Air Showers situations	-	UCM	Under discussion, might be added to OSSR
IndexedConv	-	OROBIX, LAPP	Existing project, to be added/linked to OSSR
CORSIKA Module with optimization for muography experiments	-	INFN	Under discussion, might be added to OSSR
Hangar	-	OROBIX	Existing project, to be added/linked to OSSR
PLIBS_9_DATA_GENERATOR	CTA	LAPP	Existing project, to be added/linked to OSSR
ctapipe-io-mchdf5	CTA	LAPP	Existing project, to be added/linked to OSSR
HiPeRTA	CTA	LAPP	Existing project, to be added/linked to OSSR
HiPeCTA	CTA	LAPP	Existing project, to be added/linked to OSSR
ctaplot	CTA	LAPP	Existing project, to be added/linked to OSSR
GammaLearn	CTA	LAPP	Existing project, to be added/linked to OSSR
gLike	CTA	IFAE	Existing project, to be added/linked to OSSR

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Gammapy - A Python package for γ-ray astronomy	CTA	MPG-MPIK	Existing project, to be added/linked to OSSR
CORSIKA modules for sea/ice experiments, atmospheric cosmic ray detectors, air shower experiments and containers for physics use cases	ESCAPE	INFN	Under development, will be added to OSSR
Improving solar wind predictions with machine learning	EST	NWO-I-CWI	Under discussion, might be added to OSSR
DDS	FAIR	GSI	Existing project, to be added/linked to OSSR
FairMQ	FAIR	GSI	Existing project, to be added/linked to OSSR
FairRoot	FAIR	GSI	Existing project, to be added/linked to OSSR
CASA 6	JIVE	JIVE	Existing project, to be added/linked to OSSR
KM3Pipe	KM3NeT	FAU	Existing project, to be added/linked to OSSR
Jpp	KM3NeT	FAU, NWO-I-Nikhef	Under development, will be added to OSSR
OrcaNet	KM3NeT	FAU	Under development, will be added to OSSR
CORSIKA Module for optimization of muon and neutrino production at sea level and muon and neutrino propagation in water	KM3NeT	INFN	Under discussion, might be added to OSSR
pLISA	KM3NeT	INFN	Under development, will be added to OSSR

Table 2 List of Software and Services for OSSR

All remaining partners and ESF/RIs are currently finalising their contributions to the OSSR. In addition, the software and services listed in the ASTERICS/OBELICS repository will be included and thus sustained in OSSR. All providers with entries there will be contacted and

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the relevant information, requirements and inputs gathered, once the conceptual design of the OSSR is finalised, see Section 3.

3. Integration Plan

The plan to integrate the initial software and services list from Section 2 into the repository is detailed below both from the perspective of the repository and the responsible partner. The timeline is given by the deliverables and milestones listed below:

De-liverable Number	Description and Comment	Lead participa nt	Estimated Date
D 3.1	Detailed project plan for WP3	FAU	M09
D 3.2	Software and service list and integration plan - this deliverable.	FAU	M12
D 3.3	Conceptual design report on the software and service repository, demonstrator	CNRS-LAPP	M18
D 3.6	Mid-term technology WP3 project progress report	FAU	M24
D 3.7	License and provenance model for the software and service repository	CNRS-LAPP	M24

Table 3 List of relevant deliverables of WP3

Milestone Number	Milestone name	Estimated date	Means of verification
M 14	List of software and services	M15	Review of D3.2
M 16	Software and service repository demonstrator	M24	Repository online and available to partners (online service), Review of D3.3
M 17	Progress of common software and service proposition	M27	Review of D3.6
M 18	Final workshop to evaluate the outcome of WP3 with respects to the main objectives of the call and define the necessary future steps.	M40	Workshop summary report
M 19	Software and Service Repository online	M42	Repository available to community (online service), workshop

Table 4 List of relevant milestones of WP3

Repository Perspective

After analysing the software and service list of Section 2, specific needs will be extracted and an online common service template will be proposed to partners - this is part of the project

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milestone M14. Filling this template will ensure the integration of the software in the repository. A first implementation of the repository and a template project have been proposed. Both are currently under review by the partners and based on the software list. Up to five software and services from the list above that are already fully developed by the partners and open source, will be selected to fill this first implementation. They will serve as example use-cases to uncover the possible limitations and unexpected requirements for the repository demonstrator conceptual design, deliverable D3.3 and milestone M16. After the demonstrator is put in place, more and more services will be added, the interface improved and finally the OSSR will be put online, milestone M19.
From the repository perspective, here are the points that need to be addressed:

- understanding the partners and projects' needs (milestone M14);
- defining the repository requirements (deliverable D3.3);
- defining the services requirements (deliverable D3.3);
- providing a template and interface for integration of the services into the repository (deliverable D3.3);
- providing a license and provenance model for the services (deliverable D3.7).

Partner Perspective

The partners will report on their needs and requirements for the repository (input to milestone M14 and deliverable D3.3). From the partner perspective, it is understood that the initial decision to publish software and services to the OSSR is preceded by an internal reviewing mechanism which results in the compliance of the software with general software quality standards, including software documentation and manuals. After registering the software to the OSSR software survey (this deliverable, or a later registration form), the software interfaces and implementation procedure is adapted or expanded to meet the requirements of the OSSR integration template, including installation procedures, containerization, documentation and licensing. Integration into the OSSR here not necessarily refers to copying of the original software repository content, but might consist of mirroring or linking to the original resource depending on the software provider. After integration, functionality within the EOSC framework will be tested by providing tutorials of usage examples for the software or services. The integration timeline for submissions to the OSSR survey depends on the technical requirements of the individual software, but will be finalized until milestone M19. However, integration procedures are started as soon as the integration template becomes available with deliverable D3.3.

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Annex A - Software and Service Survey

Below, the main results from the software and service survey collected between December 2019 and January 2020 from all partners of WP3 are listed:

Survey Question	Answer
Service Name	*ESCAPE OSSR Software template*
Authors	Garcia E, Vuillame T.
Location	GitLab, https://gitlab.in2p3.fr/escape2020/escape/template_project_escape
Digital Object Identifier	-
Description	Template repository for the ESCAPE project (LAPP test of the template)
General Use Case	Repository to be used as a template
Current Version	1
Subjects and Keywords	template, ESCAPE
Type of Main License	PD License (Public)
Funding by	-
Programming languages, compilation environment and CI/CD Environment	Python, - , -
External Dependencies	None
Operating System and typical computing requirements	Any None

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Survey Question	Answer
Software Name	Corsika module with options for specific Air Showers situations
Authors	D. Morcuende, J. Rosado, F. Arqueros, J.L. Contreras
Location	GitLab, -
Digital Object Identifier	-
Description	Version of Corsika optimized for special situations of Air Showers detectors. It may include the production of fluorescence radiation.
General Use Case	Simulate the performance of a detector, or compute its response function.
Current Version	-
Subjects and Keywords	Monte Carlo, Cherenkov, Fluorescence
Type of Main License	PD License (Public)
Funding by	ASTERICS, own funds
Programming languages, compilation environment and CI/CD Environment	Fortran, -, -
External Dependencies	Corsika Code
Operating System and typical computing requirements	Linux, 1 core, - RAM, - HDD space, GPUs: -

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Survey Question	Answer
Software/Service Name	IndexedConv
Authors	Luca Antiga, Mikael Jacquemont, Thomas Vuillaume
Location	GitHub, https://github.com/IndexedConv/IndexedConv
Digital Object Identifier	10.5281/zenodo.2542664
Description	The indexed operations allow the user to perform convolution and pooling on non-Euclidian grids of data given that the neighbors pixels of each pixel is known and provided.
General Use Case	Use Indexed Convolution as a part of artificial neural network
Current Version	1.1
Subjects and Keywords	
Type of Main License	MIT (Permissive)
Funding by	ASTERICS, Fondation de l'Université Savoie Mont Blanc
Programming languages, compilation environment and CI/CD Environment	Python, -, -
External Dependencies	torch, torchvision, numpy, tensorboardx, matplotlib, h5py,sphinxcontrib-katex"
Operating System and typical computing requirements	Any None

Survey Question	Answer
Software/Service Name	CORSIKA Module with optimization for muography experiments
Authors	C. Bozza, S. M. Stellacci, B. Spisso
Location	GitLab, -
Digital Object Identifier	-
Description	Set of optimisations to speed up CORSIKA computations for simulations of muography experiments. The focus is on high energy secondary muons.
General Use Case	Muography experiments are interested in high (> 10 GeV) and very high energy muons (for thick objects, 500 m or more) at low elevation.
Current Version	-
Subjects and Keywords	Muography; CORSIKA; muons.
Type of Main License	PD License (Public)
Funding by	-
Programming languages, compilation environment and CI/CD Environment	Fortran, -, -
External Dependencies	CORSIKA v7 and v8 when it becomes available.
Operating System and typical computing requirements	Linux (CentOS-Debian) 100 cores or more, - RAM, - HDD space, GPUs: -

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Survey Question	Answer
Software/Service Name	Hangar
Authors	Rick Izzo, Luca Antiga
Location	GitHub, github.com/tensorwerk/hangar-py
Digital Object Identifier	-
Description	Data version control for numerical data
General Use Case	Perform versioning of numerical data (think git for multidimensional arrays), time-travel through history, branching, merging, cloning from remotes, pushing to remotes.
Current Version	0.4.0
Subjects and Keywords	Data versioning, Multidimensional arrays, Python, Reproducibility, Collaboration
Type of Main License	Apache (Permissive)
Funding by	Tensorwerk Inc
Programming languages, compilation environment and CI/CD Environment	Python, Python >= 3.6.x Distribution: https://pypi.org/project/hangar/, https://anaconda.org/conda-forge/hangar , https://travis-ci.com/tensorwerk/hangar-py
External Dependencies	HDF5, LMDB, NumPy, GRPC
Operating System and typical computing requirements	Linux, macOS, MS Windows 1 core, 2Gb RAM, 500MB HDD space, GPUs: No

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Survey Question	Answer
Software/Service Name	PLIBS_9_DATA_GENERATOR
Authors	CTA-LAPP
Location	GitLab, https://gitlab.in2p3.fr/CTA-LAPP/PLIBS_9_DATA_GENERATOR
Digital Object Identifier	-
Description	High performance data format generator with automatic SIMD friendly data.
General Use Case	Code generation of high performance data format from a simple config file.
Current Version	3
Subjects and Keywords	High performance data format, HPC, vectorisation
Type of Main License	CeCILL-C (Public)
Funding by	ESCAPE
Programming languages, compilation environment and CI/CD Environment	Python, C++, gcc7-9, clang9-10, GitLab CI/CD
External Dependencies	PLIBS_9_CORE, PLIBS_9_MATH, PLIBS_9_COMPRESS
Operating System and typical computing requirements	GNU Linux, Mac OS >2 Gb RAM, GPUs: No

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Survey Question	Answer
Software/Service Name	ctapipe-io-mchdf5
Authors	CTA-LAPP
Location	GitHub, https://github.com/cta-observatory/ctapipe_io_mchdf5
Digital Object Identifier	-
Description	ctapipe plugin for reading and converting Monte-Carlo files (contains the same information as Simtel files)
General Use Case	Data conversion of cta simulations (Monte Carlo Simtel)
Current Version	0.1
Subjects and Keywords	data format, optimization, hdf5, ctapipe
Type of Main License	CeCILL-C (Public)
Funding by	ESCAPE
Programming languages, compilation environment and CI/CD Environment	Python, -, Travis (CI/CD GitHub - https://travis-ci.org/cta-observatory/ctapipe_io_mchdf5)
External Dependencies	ctapipe, PyTables, pyeventio
Operating System and typical computing requirements	GNU Linux, Mac OS, None

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Survey Question	Answer
Software/Service Name	HiPeRTA
Authors	CTA-LAPP
Location	GitLab, https://gitlab.in2p3.fr/CTA-LAPP/HiPeRTA
Digital Object Identifier	-
Description	HiPeRTA (or HiPeRTA) is a Python 3 library providing High Performance computing algorithms which provide full C++ programs from HiPeCTA C++ sources for the Cherenkov Telescope Array (CTA) low-level data analysis real time reconstruction.
General Use Case	Real time analysis of the CTA-LST1 Prototype telescope
Current Version	1.1.2000
Subjects and Keywords	gamma-astronomy, HPC, proto LST1 real time analysis
Type of Main License	CeCILL-C (Public)
Funding by	ESCAPE
Programming languages, compilation environment and CI/CD Environment	C++, gcc7-9, clung9-10 GitLab CI/CD
External Dependencies	Optional: HDF5, zeromq
Operating System and typical computing requirements	GNU Linux, Mac OS SSE4, AVX, AVX2, >2 Gb RAM, 2 Gb (data) HDD space, GPUs: No

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Survey Question	Answer
Software/Service Name	HiPeCTA
Authors	CTA-LAPP
Location	GitLab, https://gitlab.in2p3.fr/CTA-LAPP/HiPeCTA
Digital Object Identifier	-
Description	HiPeCTA is a Python 3 library providing High Performance computing algorithms for the Cherenkov Telescope Array (CTA) low-level data analysis.
General Use Case	Low level reduction and data analysis of CTA data
Current Version	1.0.0
Subjects and Keywords	gamma-astronomy, cta, iact, HPC, LST
Type of Main License	CeCILL-C (Public)
Funding by	ESCAPE
Programming languages, compilation environment and CI/CD Environment	Python, C++, gcc7-9, clang9-10 , GitLab CI/CD
External Dependencies	Cython, Numpy, PyTables, Optional: sphinx (for documentation), ctapipe-io-mchdf5 (https://github.com/cta-observatory/ctapipe_io_mchdf5)
Operating System and typical computing requirements	GNU Linux, Mac OS SSE4, AVX, AVX2, >2 Gb RAM, 4 Gb (Image), 2 Gb (data) HDD space, GPUs: No

ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n° 824064.

Survey Question	Answer
Software/Service Name	ctaplot
Authors	T. Vuillaume, M. Jacquemont
Location	GitHub, https://github.com/vuillaut/ctaplot
Digital Object Identifier	-
Description	ctaplot is a collection of functions to make instrument response functions (IRF) and reconstruction quality-checks plots for Imaging Atmospheric Cherenkov Telescopes such as CTA.
General Use Case	-
Current Version	v0.4.1
Subjects and Keywords	visualization, CTA, Cherenkov telescopes, instrument response function
Type of Main License	MIT (Permissive)
Funding by	ASTERICS (grant 653477), ESCAPE (grant 824064)
Programming languages, compilation environment and CI/CD Environment	Python, -, travis
External Dependencies	Software: Matplotlib, numpy , scipy , astropy , tables , pandas , jupyter, ipywidgets , scikit-learn Documentation: sphinx>=1.4 nbsphinx
Operating System and typical computing requirements	Any 1 core, 1 GB RAM, - HDD space, GPUs: -

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Survey Question	Answer
Software/Service Name	GammaLearn
Authors	M. Jacquemont, T. Vuillaume
Location	GitLab, https://gitlab.lapp.in2p3.fr/GammaLearn/GammaLearn
Digital Object Identifier	-
Description	GammaLearn is a collaborative project to apply deep learning to the analysis of low-level Imaging Atmospheric Cherenkov Telescopes such as CTA. It provides a framework to easily train and apply models from a configuration file.
General Use Case	GPU recommended for most use-cases. The RAM and GPU requirements will depend mainly on the data.
Current Version	-
Subjects and Keywords	machine learning, gamma-ray astronomy, cherenkov telescopes, deep learning, convolutional neural network
Type of Main License	MIT (Permissive)
Funding by	ASTERICS (Grant 653477), ESCAPE (Grant 824064)
Programming languages, compilation environment and CI/CD Environment	Python, -, -
External Dependencies	PyTorch (>= 1.2), Numpy, PyTables, Matplotlib, scikit-image, Ignite , tensorboardX , TensorBoard , IndexedConv, ctapipe
Operating System and typical computing requirements	Any 4 cores, 18 GB RAM, - HDD space, GPUs: yes

ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n° 824064.

Survey Question	Answer
Software/Service Name	gLike
Authors	Javier Rico, Jelena Aleksic
Location	GitHub, https://github.com/javierrico/gLike
Digital Object Identifier	-
Description	gLike is a general-purpose ROOT-based code framework for the numerical maximization of joint likelihood functions. The joint likelihood function has one free parameter (named g) and as many nuisance parameters as wanted, which will be profiled.
General Use Case	Framework for likelihood maximisation for multiple instrument data.
Current Version	v00.08.00
Subjects and Keywords	likelihood maximisation, high-level multi-instrument statistical analysis
Type of Main License	GPL (Protective)
Funding by	Spanish Ministry for Science, European Commission
Programming languages, compilation environment and CI/CD Environment	C++, Makefile (C++11) None
External Dependencies	ROOT (https://root.cern.ch)
Operating System and typical computing requirements	Linux, MacOS any Intel core, 1 core, no requirements on RAM, HDD space, GPUs: not supported

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Survey Question	Answer
Software/Service Name	Gammapy - A Python package for γ-ray astronomy
Authors	Axel Donath, Christoph Deil, Manuel Paz Arribas, Johannes King, Ellis Owen, Régis Terrier, Ignasi Reichardt, Jon Harris, Rolf Bühler, Stefan Klepser
Location	GitHub, https://github.com/gammapy/gammapy
Digital Object Identifier	-
Description	Gammapy is a community-developed, open-source Python package for gamma-ray astronomy. It is a prototype for the CTA science tools. It is built on the scientific Python stack (Numpy, Scipy, matplotlib and scikit-image) and makes use of other open-source software.
General Use Case	Gammapy runs on any current (newer than ~5 years) consumer type desktop computer or laptop. At some point Gammapy will support distributed computing for small clusters (~100 CPUs), but this is only needed for rare special use-cases and currently not supported.
Current Version	v0.15
Subjects and Keywords	Python, Astropy, Numpy, Scipy, Gamma-Rays, Astronomy, Gamma-Ray Astronomy
Type of Main License	Other
Funding by	Christoph Deil, Axel Donath
Programming languages, compilation environment and CI/CD Environment	Python, Distribution via pip and conda packages, No Special requirements, Any virtual python environment or conda environment works.
External Dependencies	Required: Numpy, Scipy, Astropy, pydantic, pyyaml, regions, click, python Optional: Sherpa, Naima, matplotlib, healply, Minuit,
Operating System and typical computing requirements	Linux, Mac OS and Windows (via conda or pip). Standard consumer CPU, 4 cores, 4GB RAM, 1000 HDD space, GPUs: -

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Survey Question	Answer
Software/Service Name	CORSIKA Module for sea/ice experiments
Authors	ESCAPE WP3 Participants
Location	GitLab, -
Digital Object Identifier	-
Description	This module optimises CORSIKA performances for experiments in the sea or under ice.
General Use Case	-
Current Version	-
Subjects and Keywords	CORSIKA; sea experiment; ice experiment; cosmic rays
Type of Main License	PD License (Public)
Funding by	ESCAPE
Programming languages, compilation environment and CI/CD Environment	C++, Fortran, -,
External Dependencies	CORSIKA
Operating System and typical computing requirements	Linux none

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Survey Question	Answer
Software/Service Name	CORSIKA Module for atmospheric cosmic ray detectors
Authors	ESCAPE WP3 Participants
Location	GitLab, -
Digital Object Identifier	-
Description	This module provides optimised CORSIKA simulation for cosmic ray detectors in the atmosphere at various heights.
General Use Case	-
Current Version	-
Subjects and Keywords	CORSIKA; atmospheric experiments; cosmic rays
Type of Main License	PD License (Public)
Funding by	ESCAPE
Programming languages, compilation environment and CI/CD Environment	C++, Fortran, -,
External Dependencies	CORSIKA
Operating System and typical computing requirements	Linux None

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Survey Question	Answer
Software/Service Name	CORSIKA Module for air shower experiments
Authors	ESCAPE WP3 Participants
Location	GitLab, -
Digital Object Identifier	-
Description	This is a module for CORSIKA to optimise the performances for phenomena detectable by air shower experiments.
General Use Case	-
Current Version	-
Subjects and Keywords	CORSIKA; new development; air shower experiment
Type of Main License	PD License (Public)
Funding by	-
Programming languages, compilation environment and CI/CD Environment	C++, Fortran, -,
External Dependencies	CORSIKA
Operating System and typical computing requirements	Linux None

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Survey Question	Answer
Software/Service Name	CORSIKA containers for physics use cases
Authors	ESCAPE WP3 Participants
Location	GitLab, -
Digital Object Identifier	-
Description	A set of containers for CORSIKA applications focused on specific use cases.
General Use Case	-
Current Version	-
Subjects and Keywords	CORSIKA; cosmic rays; containers
Type of Main License	PD License (Public)
Funding by	ESCAPE
Programming languages, compilation environment and CI/CD Environment	Fortran, -,
External Dependencies	CORSIKA
Operating System and typical computing requirements	Linux None

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Survey Question	Answer
Software/Service Name	Improving solar wind predictions with machine learning
Authors	Members of Multiscale Dynamics group, CWI (part of NWO-I)
Location	GitLab, -
Digital Object Identifier	-
Description	In the context of ESCAPE, we plan to develop an open-source software package in which machine learning techniques are used to improve predictions for the solar wind at L1 (or earth). We will make use of data sources that are linked to the upcoming EST telescpope.
General Use Case	Too early to predict what we will need at this moment
Current Version	-
Subjects and Keywords	machine learning, space weather, solar wind
Type of Main License	GPL (Protective)
Funding by	ESCAPE
Programming languages, compilation environment and CI/CD Environment	Python, -, No special requirements
External Dependencies	Can probably imported relatively easily, since we will be using Python.
Operating System and typical computing requirements	Any None

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Survey Question	Answer
Software/Service Name	DDS
Authors	A. Manafov, A. Lebedev
Location	GitHub, https://github.com/FairRootGroup/DDS
Digital Object Identifier	-
Description	DDS is a tool-set, which automates and significantly simplifies a deployment of user defined processes and their dependencies on any resource management system using a given topology.
General Use Case	
Current Version	3
Subjects and Keywords	
Type of Main License	LGPL (Public)
Funding by	GSI Helmholtzzentrum für Schwerionenforschung GmbH
Programming languages, compilation environment and CI/CD Environment	C++, c++ 11 compiler, Buildbot: demac012.gsi.de:22001/#1
External Dependencies	boost
Operating System and typical computing requirements	Linux, macOS None

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Survey Question	Answer
Software/Service Name	FairMQ
Authors	M. Al-Turany, D. Klein, T. Kollegger, A. Rybalchenko, N. Winckler
Location	GitHub, https://github.com/FairRootGroup/FairMQ
Digital Object Identifier	10.5281/zenodo.3362435
Description	FairMQ is designed to help implementing large-scale data processing workflows needed in next-generation Particle Physics experiments. FairMQ is written in C++ and aims to provide an asynchronous message passing abstraction of different data transport technologies.
General Use Case	Multicore PC, batch farm, computing cluster
Current Version	1.3
Subjects and Keywords	fairroot, zeromq, libfabric, nanomsg, shmem, c-plus-plus
Type of Main License	LGPL (Public)
Funding by	GSI Helmholtzzentrum für Schwerionenforschung GmbH
Programming languages, compilation environment and CI/CD Environment	C++, Compilers: gcc >= 4.9.2, clang Build system: CMake CI based on Jenkins and CDash
External Dependencies	DDS, boost, FairLogger, flatbuffers, msgpack, nanomsg, asiofi, ofi, protobuf, ZeroMQ
Operating System and typical computing requirements	Linux (Debian 8, Ubuntu 18.04, CentOS 7, Fedora 31) macOS (10.14, 10.15) Multicore CPU per node, 2 GB per core RAM, 10GB HDD space, GPUs: no

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Survey Question	Answer
Software/Service Name	FairRoot
Authors	M. Al-Turany, R. Karabowicz, D. Klein, D. Kresan, A. Rybalchenko, F. Uhlig
Location	GitHub, https://github.com/FairRootGroup/FairRoot
Digital Object Identifier	10.5281/zenodo.3614662
Description	A simulation, reconstruction and analysis framework that is based on the ROOT system. The user can create simulated data and/or perform analysis with the same framework. Geant3 and Geant4 transport engines are supported.
General Use Case	Single computer use. With threads option of Geant4 - multicore PC.
Current Version	18.2
Subjects and Keywords	geant4, c-plus-plus, cmake, reconstruction, vmc, modular, analysis, simulation
Type of Main License	LGPL (Public)
Funding by	GSI Helmholtzzentrum für Schwerionenforschung GmbH
Programming languages, compilation environment and CI/CD Environment	C++, Compilers: gcc >= 4.9.2, clang Build system: CMake CI based on Jenkins and CDash
External Dependencies	boost, FairLogger, FairMQ, Geant3, Geant4, geant4_vmc, GSL, googletest, HepMC, Millipede, Pythia6, Pythia8, ROOT, VGM, yamlcpp
Operating System and typical computing requirements	Linux (Debian 8, Ubuntu 18.04, CentOS 7, Fedora 31) macOS (10.14, 10.15) Single- / Multicore, 2GB RAM, 20GB HDD space, GPUs: no

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Survey Question	Answer
Software/Service Name	CASA 6
Authors	An international consortium of scientists based at the National Radio Astronomical Observatory (NRAO), the European Southern Observatory (ESO), the National Astronomical Observatory of Japan (NAOJ), the Academia Sinica Institute of Astronomy and Astrophysics (ASIAA), the CSIRO division for Astronomy and Space Science (CASS), and the Netherlands Institute for Radio Astronomy (ASTRON) under the guidance of NRAO.
Location	Other, https://open-bitbucket.nrao.edu/projects/CASA
Digital Object Identifier	[ascl:1107.013]
Description	CASA, the Common Astronomy Software Applications package, is being developed with the primary goal of supporting the data post-processing needs of the next generation of radio astronomical telescopes such as ALMA and VLA.
General Use Case	Recommended medium workstation
Current Version	6.0.0
Subjects and Keywords	radio astronomy, interferometry, calibration, imaging, data processing
Type of Main License	LGPL (Public)
Funding by	-
Programming languages, compilation environment and CI/CD Environment	Python, C++, Red Hat 6 or 7 with devtoolset-4 (GCC 4.4.7). JIRA/Bitbucket/Bamboo hosted by NRAO
External Dependencies	GNU Scientific Library (>=2.2) SWIG (>=3.0) OpenMPI (>=1.10, optional)
Operating System and typical computing requirements	Linux (Red Hat 6 & Red Hat 7 are officially supported) x86-64, 12 cores, 32GB RAM, 9TB HDD space, GPUs: none

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Survey Question	Answer
Software/Service Name	KM3Pipe
Authors	Tamas Gal, Moritz Lotze
Location	GitLab, https://git.km3net.de/km3py/km3pipe
Digital Object Identifier	10.5281/zenodo.808829
Description	KM3Pipe is a framework for KM3NeT related stuff including MC, data files, live access to detectors and databases, parsers for different file formats and an easy to use framework for batch processing.
General Use Case	-
Current Version	8.27.2
Subjects and Keywords	pipeline, python, data processing
Type of Main License	MIT (Permissive)
Funding by	-
Programming languages, compilation environment and CI/CD Environment	Python, -, Gitlab with docker runners
External Dependencies	HDF5lib
Operating System and typical computing requirements	Linux, macOS, Windows None

Survey Question	Answer
Software/Service Name	Jpp
Authors	Maarten de Jong
Location	GitLab, https://git.km3net.de/common/jpp
Digital Object Identifier	-
Description	The Jpp-package is a Java inspired set of C++ interfaces, classes and methods. It is the low-level data processing software for the KM3NeT collaboration.
General Use Case	low-level data processing in 3-dim optical arrays
Current Version	12.1.2000
Subjects and Keywords	data filter algorithms, reconstruction, calibration, log-likelihood reconstruction
Type of Main License	MIT (Permissive)
Funding by	KM3NeT, Nikhef
Programming languages, compilation environment and CI/CD Environment	C++, gcc 4.8.5, make build system, docker and singularity containers, Gitlab with docker runners
External Dependencies	Root; catch, chsm, json for Modern C++ (the latter three included as externals in the Jpp software itself)
Operating System and typical computing requirements	Linux, base system for testing: CentOS7 2 CPUs, 16 cores, 2GB RAM, 8GB HDD space, GPUs: none

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Survey Question	Answer
Software/Service Name	OrcaNet
Authors	Stefan Reck, Michael Moser
Location	GitLab, https://git.km3net.de/ml/OrcaNet/
Digital Object Identifier	-
Description	An open-source python package for conviniently managing the training of deep neural networks on large datasets. It makes heavy use of keras, tensorflow and h5py.
General Use Case	Intended to be run on GPUs with Cuda/CudNN. RAM/vRAM requirements depend on use case.
Current Version	-
Subjects and Keywords	Deep Learning, Python, HDF5, keras, tensorflow
Type of Main License	AGPL (Protective)
Funding by	-
Programming languages, compilation environment and CI/CD Environment	Python, -, None
External Dependencies	keras, tensorflow, numpy, h5py, matplotlib
Operating System and typical computing requirements	Linux None

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Survey Question	Answer
Software/Service Name	CORSIKA Module for optimization of muon and neutrino production at sea level and muon and neutrino propagation in water
Authors	R. Coniglione and KM3NeT Collaboration
Location	GitLab, -
Digital Object Identifier	-
Description	Evaluation of the possibility to further speed up Corsika production of high energy muons and neutrinos at sea level. Propagation/interaction of neutrinos and muons in water.
General Use Case	under water/ice neutrino detectors interested in high energy muons and neutrinos
Current Version	-
Subjects and Keywords	Muon, neutrino, Corsika
Type of Main License	PD License (Public)
Funding by	-
Programming languages, compilation environment and CI/CD Environment	C++, Fortran, -, None
External Dependencies	Corsika v7 and v8 when available
Operating System and typical computing requirements	Linux None

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Survey Question	Answer
Software/Service Name	pLISA
Authors	C. Bozza, C. De Sio, R. Coniglione
Location	Other, https://baltig.infn/bozza/plisa/
Digital Object Identifier	-
Description	Parallel Library for Identification and Study of Astroparticles
General Use Case	Stand-alone GPU-equipped PC/server or GPU cluster.
Current Version	1
Subjects and Keywords	Machine Learning, astroparticles, convolutional neural networks
Type of Main License	MIT (Permissive)
Funding by	EU (H2020) - ASTERICS
Programming languages, compilation environment and CI/CD Environment	Python, C++, none
External Dependencies	CUDA 8.0 or higher, Jupyter notebooks
Operating System and typical computing requirements	Linux 8GB RAM, GPUs: CUDA-capable NVidia boards (3.0 or higher recommended)

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