ÖAW AUSTRIAN ACADEMY OF SCIENCES



Machine Learning at the Austrian Academy of Sciences

- A thematic platform of the ÖAW -

Make it (Net)work! #12, Innsbruck, 10.11.26

Claudius Krause (MLA²S)
10.11.2026

ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

MLA²S – Machine Learning at the Austrian Academy of Sciences

Mission

- a catalyst of inter-institutional collaboration
- regarding scientific machine learning (Theory, Development, and Application)
- at the ÖAW and beyond

Activities

- educational events
- networking events
- support of (institute) initiatives (Conception, Organization, Budget)
- establishing a network of internal and external experts
- …

Initiated by

ISF & HEPHY INSTITUTE OF HIGH ENERGY PHYSICS

now coordinated with

ESI IMAFO

IGF

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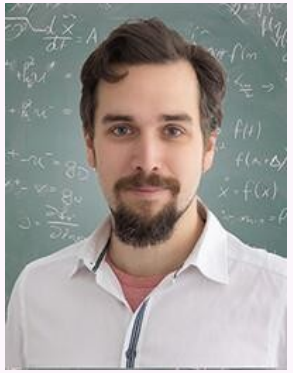
MLA²S – Machine Learning at the Austrian Academy of Sciences

- Our team of coordinators grew:


Kati Sparber (IGF)


Nicki Holighaus (ISF)


Claudius Krause (MBI)


Jan Odstrčilík (IMAFO)


Claus Trost (ESI)


Elisabeth Eder (ACDH)

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MLA²S

Stay in contact…

- via e-mail: https://lists.oeaw.ac.at/mailman/listinfo/mla2s
  — or — e-mail subject “subscribe” to mla2s-request@lists.oeaw.ac.at
- via website: https://www.oeaw.ac.at/mla2s/
- via bluesky: @mla2s-oeaw.bsky.social
- past and upcoming events: https://indico.global/category/958/
- general questions, ideas, concerns: mla2s-admin@oeaw.ac.at

We have access to MUSICA!

- You can run jobs now on MUlti-SIte Computer Austria – MUSICA
- The ÖAW got a 1,000,000 token budget to run in the next 12 months.
- If you haven't heard this info from your institutes AI contact, talk to me!
- Applications are simple:

Field	Information
Project title	[Enter project title]
Responsible scientist	[Name, title]
Principal Investigator (PI)	[Name, title]
Institute / research unit	[Institute / research unit]
Contact person for technical coordination	[Name, email, phone]
Planned period for the applied computation	[Start date – end date]
Requested start date for computing resources	[Date]
Estimated amount of tokens	[est. number of tokens]

Please provide an abstract of approximately 250–500 words, roughly half an A4 page. The abstract should describe the scientific question, the planned computational approach, expected outputs, and the relevance of HPC resources for the project.

[Enter text here]

ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

MUSICA: Status

~25%

of the ÖAW MUSICA budget used so far

First results:
MBI already has 2 papers based on MUSICA runs
(details discussed at the last meeting)

Outlook 2027:
We plan to continue using MUSICA in 2027, but budget talks are not finalized yet.



MBI-ML-26-04, MCNET-26-23, MSUHEP-26-012

Efficient Event Generation for High-Multiplicity LHC Processes: An End-to-End GPU Workflow with Normalizing Flows

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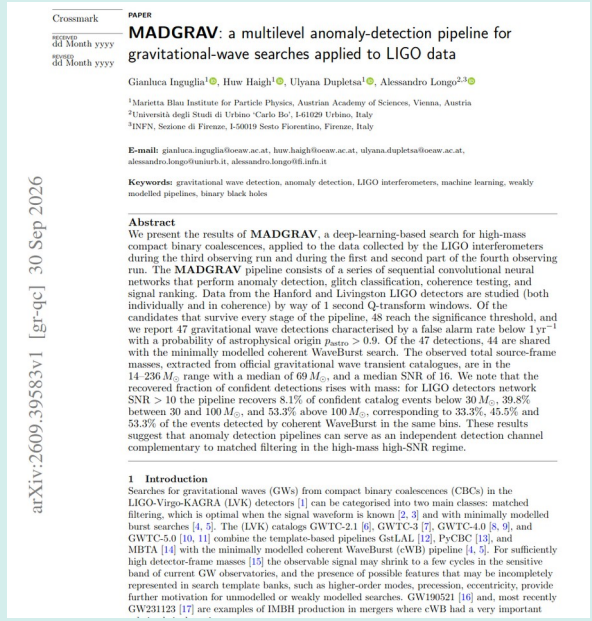
(Dated: August 24, 2026)

Producing very large unweighted event samples for high-multiplicity processes is limited by expensive matrix-element evaluations and low unweighting efficiencies. We present the first end-to-end GPU-resident event-generation workflow that integrates normalizing-flow proposals with the parton-level event generator PEPPER. Helicity-conditioned coupling flows are trained using online updates supplemented by sample replay and deployed across all subprocesses of complete proton–proton collision processes with many final-state jets. In this workflow, a Python-based control layer and PEPPER exchange flow-generated phase-space points and the corresponding target-density evaluations directly in device memory. The control layer performs flow sampling, proposal-density evaluation, and unweighting, while PEPPER evaluates the matrix elements, PDFs, and phase-space factors defining the target density and writes the accepted events in standard formats. We compare subprocess-specific flows, with one flow per partonic subprocess, to grouped conditional flows that share parameters among subprocesses with related parton content. The workflow is benchmarked for $pp \to e^+e^- + 4j$, $pp \to e^+e^- + 5j$, $pp \to t\bar{t} + 4j$, $pp \to 4j$, and $pp \to 5j$ production. On four H100 GPUs, we generate 10^9 unweighted events for each benchmark process. Including the cost of flow training, the workflow achieves end-to-end speedups of up to two orders of magnitude over standalone PEPPER event generation and turns a multi-week task into a sub-day computation. It thereby makes billion-event production more practical and offers a pathway to alleviating the Monte Carlo statistics bottleneck in high-multiplicity collider physics.

CONTENTS

arXiv:2608.21338v1 [hep-ph] 21 Aug 2026

GPU event generation with normalizing flows
arxiv.org/abs/2608.21338



Crossmark

received
dd Month yyyy
revised
dd Month yyyy

PAPER

MADGRAV: a multilevel anomaly-detection pipeline for gravitational-wave searches applied to LIGO data

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Keywords: gravitational wave detection, anomaly detection, LIGO interferometers, machine learning, weakly modelled pipelines, binary black holes

Abstract
We present the results of **MADGRAV**, a deep-learning-based search for high-mass compact binary coalescences, applied to the data collected by the LIGO interferometers during the third observing run and during the first and second part of the fourth observing run. The **MADGRAV** pipeline consists of a series of sequential convolutional neural networks that perform anomaly detection, glitch classification, coherence testing, and signal ranking. Data from the Hanford and Livingston LIGO detectors are studied (both individually and in coherence) by way of 1 second Q-transform windows. Of the candidates that survive every stage of the pipeline, 48 reach the significance threshold, and we report 47 gravitational wave detections characterised by a false alarm rate below $1\,\mathrm{yr}^{-1}$ with a probability of astrophysical origin $p_{\mathrm{astro}} > 0.9$. Of the 47 detections, 44 are shared with the minimally modelled coherent WaveBurst search. The observed total source-frame masses, extracted from official gravitational wave transient catalogues, are in the 14–236 $M_\odot$ range with a median of 69 $M_\odot$, and a median SNR of 16. We note that the recovered fraction of confident detections rises with mass: for LIGO detectors network SNR > 10 the pipeline recovers 8.1% of confident catalog events below 30 $M_\odot$, 39.8% between 30 and 100 $M_\odot$, and 53.3% above 100 $M_\odot$, corresponding to 33.3%, 45.5% and 53.3% of the events detected by coherent WaveBurst in the same bins. These results suggest that anomaly detection pipelines can serve as an independent detection channel complementary to matched filtering in the high-mass high-SNR regime.

1 Introduction
Searches for gravitational waves (GWs) from compact binary coalescences (CBCs) in the LIGO-Virgo-KAGRA (LVK) detectors [1] can be categorised into two main classes: matched filtering, which is optimal when the signal waveform is known [2, 3] and with minimally modelled burst searches [4, 5]. The (LVK) catalogs GWTC-2.1 [6], GWTC-3 [7], GWTC-4.0 [8, 9], and GWTC-5.0 [10, 11] combine the template-based pipelines GstLAL [12], PyCBC [13], and MBTA [14] with the minimally modelled coherent WaveBurst (cWB) pipeline [4, 5]. For sufficiently high detector-frame masses [15] the observable signal may shrink to a few cycles in the sensitive band of current GW observatories, and the presence of possible features that may be incompletely represented in search template banks, such as higher-order modes, precession, eccentricity, provide further motivation for unmodelled or weakly modelled searches. GW190521 [16] and, most recently GW231123 [17] are examples of IMBH production in mergers where cWB had a very important

arXiv:2609.39583v1 [gr-qc] 30 Sep 2026

MADGRAV: anomaly detection for gravitational waves
arxiv.org/abs/2609.39583

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MLA²S

CBE.next: ÖAW's HPC System Got a Major Upgrade

What's new

- CLIP/CBE replaced by latest-generation hardware: Zen5 CPUs, up to 8 TB memory, 400 Gbit/s network
- New GPU partition with **8 × 8 NVIDIA B200**
- **SSH login without VPN**
- Interactive apps (Jupyter, RStudio, Desktop) on OpenOnDemand: ood.cbenext.vbc.ac.at
- EESSI software modules; BeeGFS with 1200 TB at up to 800 GB/s
- AI agent skills, e.g. for Claude Code:

```
claude plugin marketplace add CLIP-HPC/skills
claude plugin install cbe@clip-hpc
```

What you need to do

Partitions g1, g2 and g3 go offline

Old system shuts off **Fri, 18 Dec 2026**

→ migrate your $HOME data!

Migration guide · Quick Start

Docs: docs.vbc.ac.at/research-computing

DHinfra: there is also an HPC cluster for the humanities with free access (more info in the slides of the last meeting)

Short Term Scientific Missions

Purpose

- Invited talks and short research visits
- No deadlines: rolling submission, decision within 4 weeks
- Up to €3,000 per mission for travel, accommodation & subsistence (€15,000 in total for 2026)

Requirements

- Relevant to two or more institutes*
- Includes a public talk / lecture

Details & submission: on our website

First mission done!

→ ARTEMIS talk was last meeting

→ 2 more applications received

MLA²S: Upcoming Events

on https://indico.global/category/958/



Coming up: AI Ambassador round table, 24.11., 15:00

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AI / ML Roundtable



What's new at your Institute regarding AI / ML?