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# GPU Programming Workshop

3 – 6 February 2025

Workshop material:

<https://tinyurl.com/hdli1w24>



# Overview



- The workshop is co-organised by Leibniz Supercomputing Centre (LRZ), Erlangen National High Performance Computing Center (NHR@FAU) and NVIDIA Deep Learning Institute (DLI).
- NVIDIA Deep Learning Institute (DLI) offers hands-on training for developers, data scientists, and researchers looking to solve challenging problems with deep learning.
- The workshop combines lectures about Fundamentals of Accelerated Computing with OpenACC, CUDA C/C++ and Python on a single GPU with a lecture about Accelerating CUDA C++ Applications with Multiple GPUs.
- The lectures are interleaved with many hands-on sessions using Jupyter Notebooks. The exercises will be done on a fully configured GPU-accelerated workstation in the cloud.



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## DEEP LEARNING INSTITUTE

**DLI Mission: Help the world to solve the most challenging problems using AI and deep learning**

We help developers, data scientists and engineers to get started in architecting, optimizing, and deploying neural networks to solve real-world problems in diverse industries such as autonomous vehicles, healthcare, robotics, media & entertainment and game development.

# Lecturers

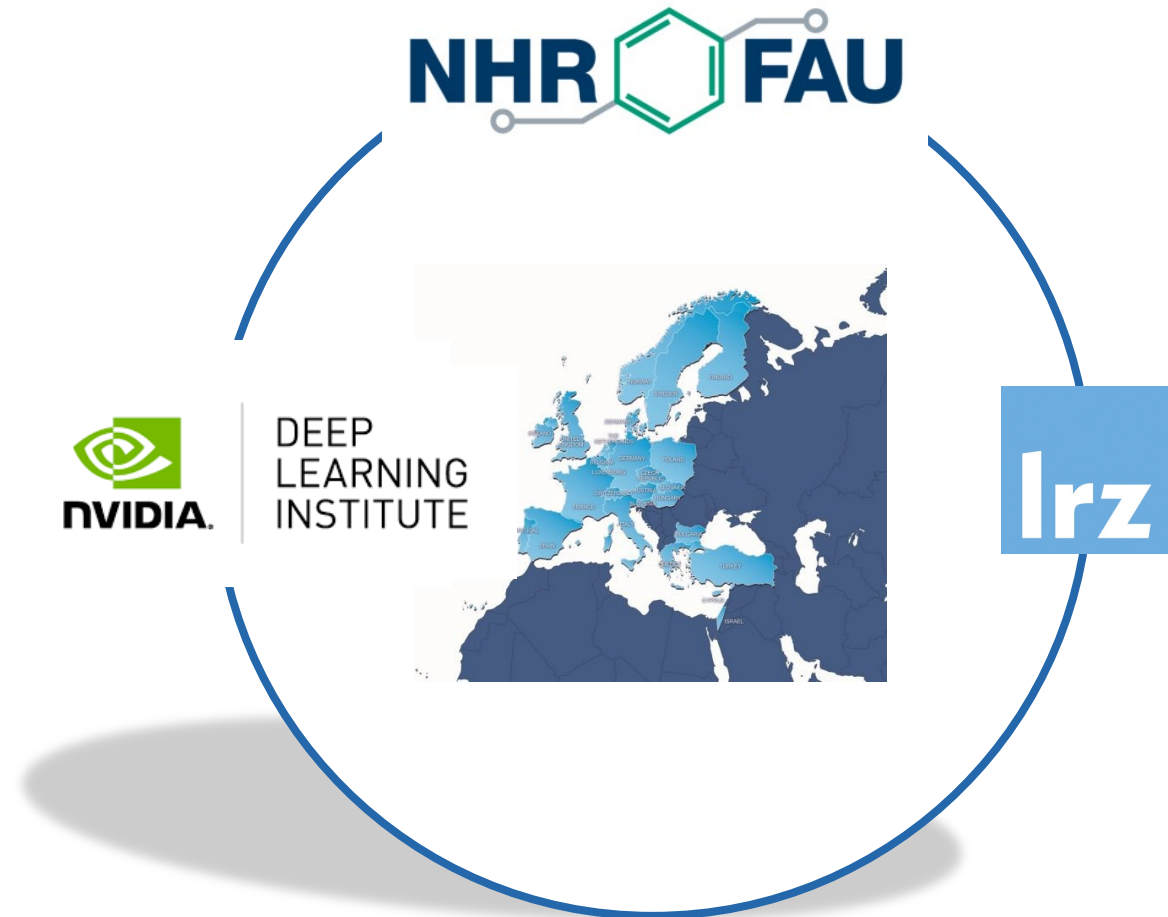


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- **Lecturers:**

- Dr. Momme Allalen (LRZ)
- Dr. Sebastian Kuckuk (NHR@FAU)
- Dr. Volker Weinberg (LRZ)



All instructors are NVIDIA certified University Ambassadors.

1<sup>st</sup> day:

# Fundamentals of Accelerated Computing with OpenACC



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- Learning Objectives:

- Profile and optimize your CPU-only applications to identify hot spots for acceleration.
- Use OpenACC directives to GPU-accelerate your codebase.
- Optimize data movement between the CPU and GPU accelerator.

2<sup>nd</sup> day:

## Fundamentals of Accelerated Computing with CUDA C/C++



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- This lecture teaches the fundamental tools and techniques for accelerating C/C++ applications to run on massively parallel GPUs with CUDA.
- You'll learn how to write code, configure code parallelisation with CUDA, optimise memory migration between the CPU and GPU accelerator, and implement the workflow that you've learned on a new task—accelerating a fully functional, but CPU-only, particle simulator for observable massive performance gains.
- At the end of the lecture, you will be able to create new GPU-accelerated applications on your own.

3<sup>rd</sup> day:

## Fundamentals of Accelerated Computing with CUDA Python



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- This lecture explores how to use Numba — the just-in-time, type-specialising Python function compiler — to accelerate Python programs to run on massively parallel NVIDIA GPUs. You'll learn how to:
- Use Numba to compile CUDA kernels from NumPy universal functions (ufuncs)
- Use Numba to create and launch custom CUDA kernels
- Apply key GPU memory management techniques
- Upon completion, you'll be able to use Numba to compile and launch CUDA kernels to accelerate your Python applications on NVIDIA GPUs.

4<sup>th</sup> day:

## Accelerating CUDA C++ Applications with Multiple GPUs



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- Learning Objectives
  - Use concurrent CUDA streams to overlap memory transfers with GPU computation
  - Utilize all available GPUs on a single node to scale workloads across all available GPUs
  - Combine the use of copy/compute overlap with multiple GPUs
  - Rely on the NVIDIA Nsight™ Systems Visual Profiler timeline to observe improvement opportunities and the impact of the techniques covered in the workshop



# Tentative Agenda Day 1: Fundamentals of Accelerated Computing with OpenACC



10:00-10:15 Welcome

10:15-12:00 Introduction and Profiling

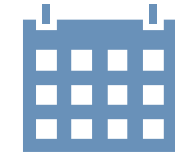
**12:00-13:00 Lunch Break**

13:00-15:15 OpenACC Directives and GPU Programming

**15:15-15:30 Coffee Break**

15:30-16:30 Data Management

16:30-16:45 Q&A, Final Remarks



**All times are in CET**

# Workshop Webpage



- All slides will be made available during the workshop under:

- <https://tinyurl.com/hdli1w24>

- Further information on:

- Agenda
- Training Setup
- Slides
- Documentation



# Training Setup



- To get started, follow these steps:
- Create an NVIDIA Developer account at <https://learn.nvidia.com/join> Select "Log in with my NVIDIA Account" and then "Create Account".
- If you use your own laptop, make sure that WebSockets works for you:  
Test your Laptop at <http://websocketstest.com>
  - Under ENVIRONMENT, confirm that "WebSockets" is checked yes.
  - Under WEBSOCKETS (PORT 80], confirm that "Data Receive", "Send", and "Echo Test" are checked yes.
  - If there are issues with WebSockets, try updating your browser.  
We recommend Chrome or Firefox for an optimal performance.
- Visit <https://learn.nvidia.com/dli-event> and enter the event code provided by the instructor.
- You're ready to get started.

# Course Datasheets by NVIDIA



- <https://developer.nvidia.com/dli/getready>
- **Prepare For Your NVIDIA DLI Training**
- **Course Datasheets**
  - Please review the workshop datasheet, which includes prerequisites, agenda, suggested material, and resources for continued learning.



# zoom

## Participants List



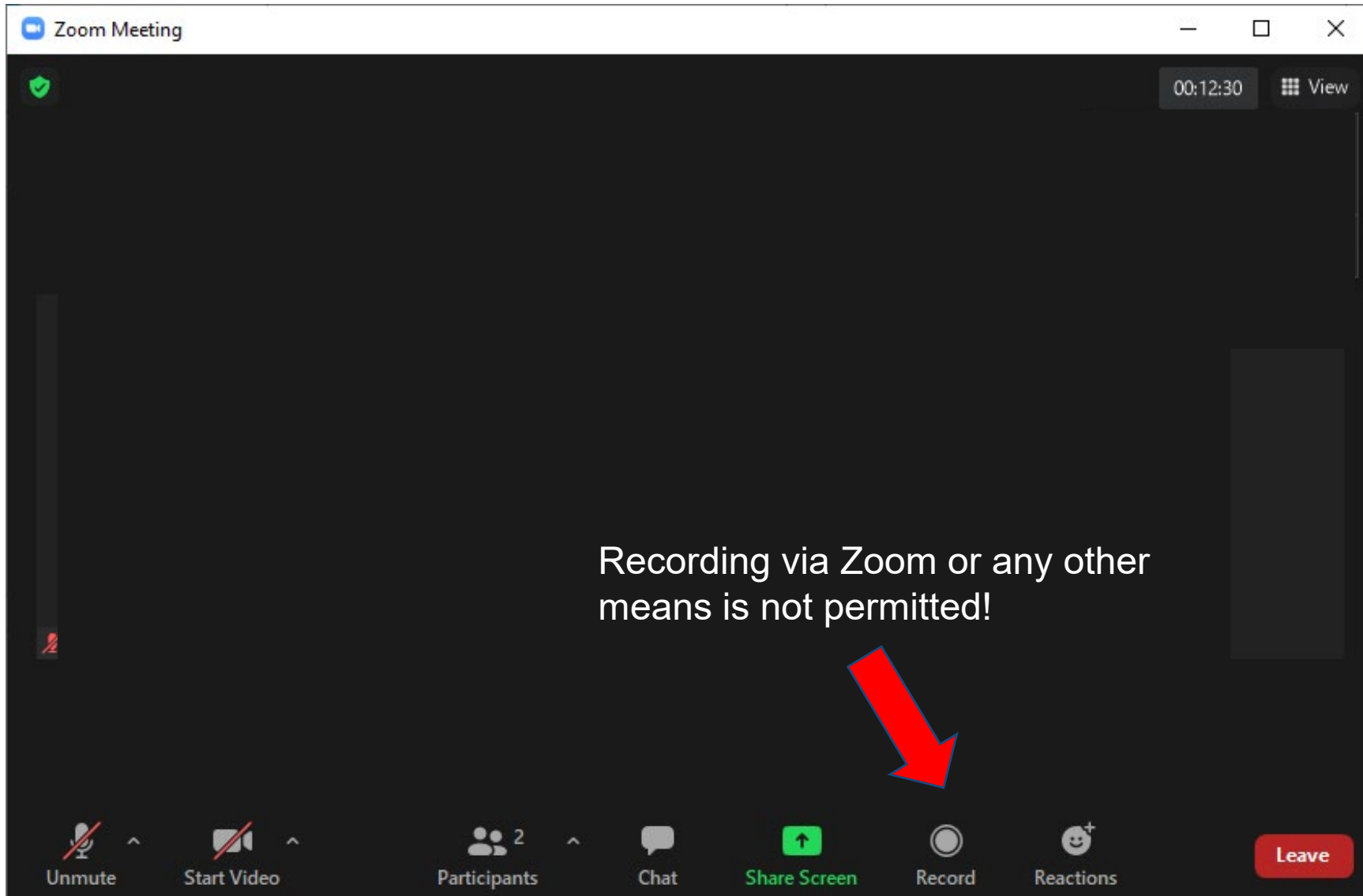
Kindly use “<first name> <last name> (<institute>)” as your screenname.

Otherwise you will not receive a certificate of attendance after the course.

The screenshot shows a Zoom Meeting window with a dark theme. The top bar displays 'Zoom Meeting', a green checkmark, a timer at '00:19:17', and a 'View' button. The main area is mostly black. At the bottom, there is a toolbar with icons for Unmute, Start Video, Participants (with a '2' next to it), Chat, Share Screen, Record, Reactions, and a red 'Leave' button. On the right side, a 'Participants (2)' panel is open, showing two participants: 'Volker Wei... (Me)' and 'Volker Weinberg Backup (Host)'. The 'Me' participant has an 'Unmute' button and a 'More >' button. A context menu is open over the 'More >' button, showing 'Edit Profile Picture' and 'Rename' options. A red arrow points from the 'Rename Yourself' text below to the 'Rename' option in the menu. A large orange circle with the number '1' is positioned over the 'Participants' icon in the toolbar, with the text 'Open Participants List' and a red arrow pointing down to the 'Participants' icon. A second large orange circle with the number '2' is positioned below the 'Rename Yourself' text.

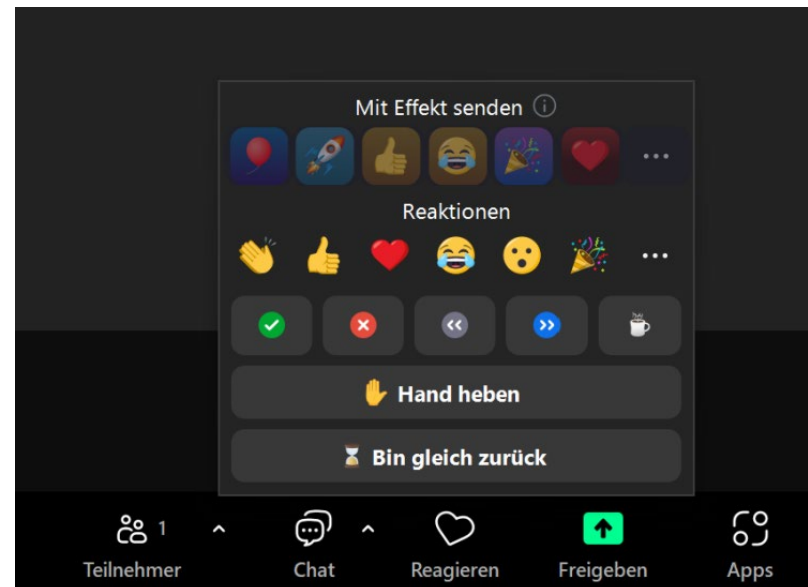
1  
Open Participants List

2  
Rename Yourself



- Please **raise your hand** if you have questions (of general interest).
- You can also use **chat window** to ask questions.
- If you do not mind, please **show your video when asking questions** to make this course as interactive as possible.
- **Push to Talk:** The Push to Talk feature allows you to remain muted throughout the Zoom meeting and only if you hold down the spacebar you will be unmuted.

- **Instant Feedback:**



And now ...



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**Enjoy the workshop!**