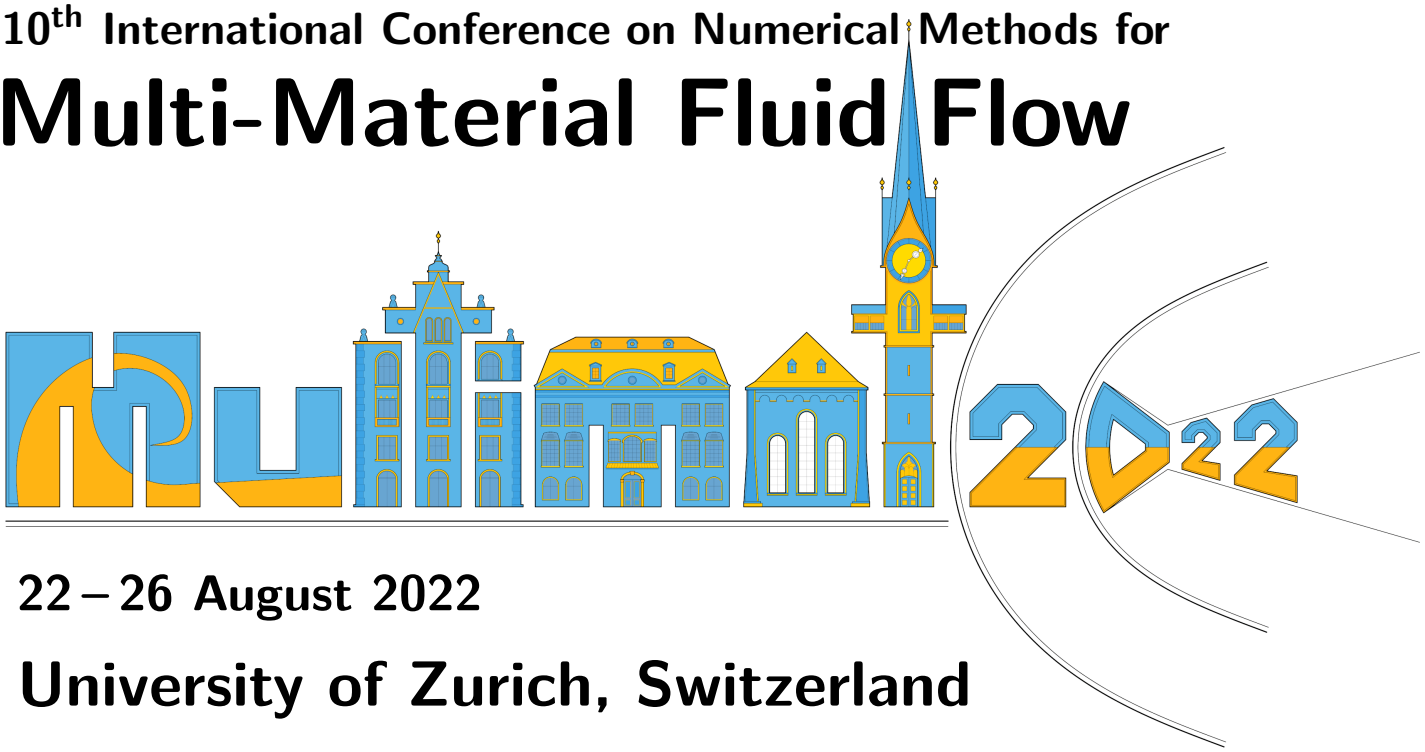
10th International Conference on Numerical Methods for

Multi-Material Fluid Flow



22 – 26 August 2022

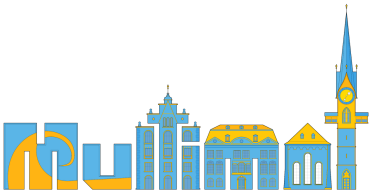
University of Zurich, Switzerland

Conference Program

Organizers:

Rémi Abgrall, Elena Gaburro, Franziska Robmann

"*Behind every result is a new challenge*"



This conference has been supported by:

University of Zurich (Switzerland)

Inria centre at the University of Bordeaux (France)

Marie Skłodowska-Curie Individual Fellowship *SuPerMan* (No. 101025563) (Europe)

Atomic Weapons Establishment (United Kingdom)

Commissariat à l'Énergie Atomique et aux Énergies Alternatives (France)

Sandia National Laboratories (USA, New Mexico)

Los Alamos National Laboratory (USA, New Mexico)

Welcome to MultiMat 2022!

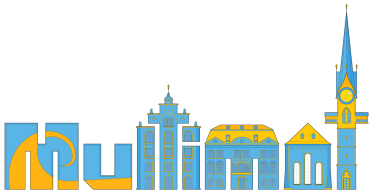
We are very pleased to welcome you to MultiMat 2022, *the 10th International Conference on Numerical Methods for Multi-Material Fluid Flows*, held at the University of Zurich in Switzerland. Switzerland lies at the heart of Europe, and the cosmopolitan city of Zurich, nestled between a crystal clear lake and an idyllic mountain landscape, offers many opportunities from cultural events, arts and history to natural beauties and good cuisine.

MultiMat 2022 builds on the success of previous MultiMat conferences: *Trento* in 2019, *Santa Fe* in 2017, *Würzburg* in 2015, *San Francisco* in 2013, *Arcachon* in 2011, *Pavia* in 2009, *Prague* in 2007, *Oxford* in 2005, and *Paris* in 2002. This year we have received 118 abstracts, which have been carefully reviewed by the members of the scientific committee. There will be 53 talks, 15 additional talks in thematic minisymposia, and more than 20 poster presentations, given by international researchers coming from *Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Israel, Italy, Japan, Mexico, Morocco, Russia, Switzerland, the United Kingdom, and the United States of America*. Unfortunately our friends from *China*, whose abstracts were accepted, could not come.

During the conference, we will push forward the state of the art in the field of *multiphase* and *multimaterial* flow problems. Researchers from academic and/or laboratory institutions will focus their discussions on relevant numerical methods, including the analysis of such methods as well as the modeling of complex multi-material flows, which is essential for the investigation and development of new sources of energy. Maintaining the tradition of its previous editions, the conference will focus on the mathematical and physical aspects of: Lagrangian hydrodynamics, Arbitrary-Lagrangian-Eulerian (ALE) methods, Radiation hydrodynamics, multi-material diffusion, mesh generation methods and mesh adaptation, interface reconstruction methods, multiphase flows, data transfer between meshes and remapping, advanced discretization methods and high order methods and numerical methods for complex constitutive models.

We would really like to thank the scientific committee, our sponsors and in particular *all the participants* for coming to MultiMat 2022 and to be physically *here*! We wish you a very pleasant stay in Zurich and many enriching scientific and personal interactions during the conference!

Elena & Rémi



Scientific committee:

Rémi Abgrall (University of Zurich, Switzerland)
Andy Barlow (AWE, United Kingdom)
Pavel Bochev (Sandia National Lab, New Mexico, USA)
Alan Dawes (AWE, United Kingdom)
Stéphane Del Pino (CEA, DAM, France)
Michael Dumbser (University of Trento, Italy)
Marianne François (Los Alamos National Lab, New Mexico, USA)
Elena Gaburro (Inria - University of Bordeaux, France)
Sergey Gavrilyuk (Aix-Marseille University, France)
Song Jiang (IAPCM, China)
Dmitri Kuzmin (TU Dortmund University, Germany)
Emmanuel Labourasse (CEA, France)
Richard Liska (Czech Technical University, Czechia)
Raphaël Loubère (CNRS - University of Bordeaux, France)
Pierre-Henri Maire (CEA, France)
Igor Menshov (Russian Academy of Sciences, Russia)
Doug Miller (Lawrence Livermore National Lab, California, USA)
Jim E. Morel (Texas AM, Texas, USA)
Nathaniel Morgan (Los Alamos National Lab, New Mexico, USA)
Renaud Motte (CEA, France)
Mike Owen (Lawrence Livermore National Lab, California, USA)
William Rider (Sandia National Lab, New Mexico, USA)
Guglielmo Scovazzi (Duke University, USA)
Mikhail Shashkov (Los Alamos National Lab, New Mexico, USA)
Feng Xiao (Tokyo Institute of Technology, Japan)

Organizing committee:

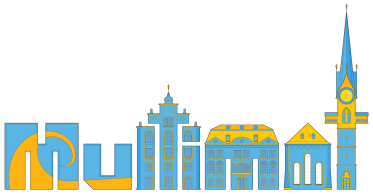
Rémi Abgrall *(University of Zurich, Switzerland)*
Elena Gaburro *(Inria center at the University of Bordeaux, France)*

Conference secretary:

Franziska Robmann *(University of Zurich, Switzerland)*

MultiMat logo credit:

Simone Chiocchetti *(University of Trento, Italy)*



MultiMat 2022 Venue

MultiMat 2022 takes place at the **Irchel Campus** of the **University of Zurich** (the GPS coordinates of the venue are: 47.397N 8.55E)

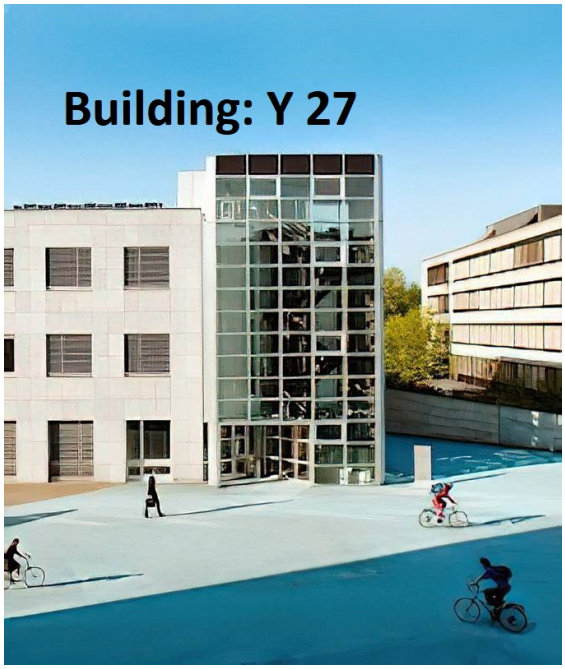
Registration is on Sunday from 17:00 to 19:30 in the building Y27

MultiMat 2022 talks: building Y15, room G-40, 9:00 – 18:00

MultiMat 2022 thematic minisymposia: building Y27, room H-25, 14:30 – 18:00

Welcome reception: Lichthof building Y24, G-100, on Monday from 18:30

Poster party: Lichthof building Y24, G-100, on Tuesday from 18:30



Social dinner: SORELL HOTEL Zürichberg, on Wednesday from 19:00
Orellistrasse 21, 8044, Zürich (30 minutes from the University)

Monday, 22 August 2022

08:00 – 09:00 **REGISTRATION** (∗)

09:00 – 09:30 **OPENING: Organizers and Stephan Neuhauss (vice-dean of the Mathematisch-Naturwissenschaftliche Fakultät of the University of Zurich)**

Chair: R. Loubère

09:30 – 10:00 **Walter Boscheri**
A 3D ADER MOOD FV method for updated Lagrangian hyperelasticity on unstructured grids

10:00 – 10:30 **Nathaniel Morgan**
On a 3D Lagrangian nodal discontinuous Galerkin method

10:30 – 11:00 **David Sidilkover**
Spurious vorticity in Lagrangian and Eulerian methods

11:00 – 11:30 **COFFEE BREAK**

Chair: W. Boscheri

11:30 – 12:00 **Bastien Manach-Pérennou**
Cell-centered Lagrangian scheme for multi-material flows with pressure equilibration

12:00 – 12:30 **Barbara Re**
An interpolation-free strategy to describe connectivity changes within the ALE framework

12:30 – 13:00 **Elena Gaburro**
Direct ALE DG schemes on Voronoi grids with topology changes and deferred mesh optimization

13:00 – 14:30 **LUNCH**

Chair: M. Owen

14:30 – 15:00 **Fernando Grinstein**
Transition and Multiphysics in 3D ICF Capsule Implosions

15:00 – 15:30 **Pierre Anguill**
A low mesh-constraints monotone scheme for the diffusion operator on general polyhedral meshes

15:30 – 16:00 **Emmanuel Labourasse**
An asymptotic preserving method for the linear transport equation on general meshes

Thematic Minisymposium: Structure preserving schemes

Chair: D. Kuzmin

Christian Klingenberg
Structure preserving numerical methods in a multi-scale context

Andreas Rupp
Bound-preserving flux limiting schemes for DG with applications to the Cahn–Hilliard equation

Thomas Paula
Robust modification of the discrete eqs method for multi-phase flow with interface capturing

16:00 – 16:30 **COFFEE BREAK**

Chair: M. François

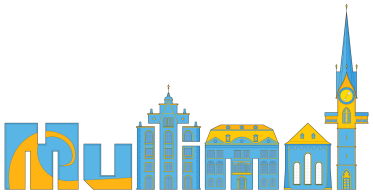
16:30 – 17:00 **Michael Dumbser**
On Thermodynamically Compatible Schemes for Continuum Mechanics

17:00 – 17:30 **Simone Chiocchetti**
Semi-implicit schemes with efficient finite rate stiff relaxation for compressible two-phase flow and plasticity

17:30 – 18:00 **Sergey Gavrilyuk**
A theoretical model of Leidenfrost's temperature

from 18:30 **WELCOME RECEPTION**

(∗) The **MAIN REGISTRATION** takes place on **Sunday 21** (17:00 – 19:30)



Tuesday, 23 August 2022

08:15 – 09:00 REGISTRATION

Chair: L. Krivodonova

09:00 – 09:30 **Bruno Després**
Interface reconstruction and development of VOFML

09:30 – 10:00 **Doug Miller**
Feature Preserving Interface Reconstruction and Tracking Using Piecewise Circular Facets with Cusps

10:00 – 10:30 **David Henneaux**
Enforcing Interface Coupling Conditions within a DG Sharp Interface Method (Viscous Gas-Liquid Flows)

10:30 – 11:00 **Daniel White**
Design Optimization of Richtmyer-Meshkov Instabilities

11:00 – 11:30 COFFEE BREAK

Chair: R. Rieben

11:30 – 12:00 **Matthew J. Zahr**
High-Order Implicit Shock Tracking for Flows with Interfaces

12:00 – 12:30 **Evan Bursch**
Radiation Hydrodynamics Modeling With High-Order Implicit Shock Tracking

12:30 – 13:00 **Jean-Luc Guermond**
Invariant-domain preserving high-order IMEX schemes

13:00 – 14:30 LUNCH

Chair: V. Perrier

14:30 – 15:00 **Riccardo Dematté**
A diffuse interface approach for multi-material simulations of condensed phase explosives

15:00 – 15:30 **Stephen Millmore**
A Multi-Physics Methodology for Four States of Matter

15:30 – 16:00 **Pavel Bochev**
Formulation and computation of partitioned schemes with nonconventional models

Thematic Minisymposium: Numerical methods for complex models

Chair: M. Zahr

Michele Giuliano Carlino
ADER scheme for incompressible Navier-Stokes on Overset grids with compact transmission condition

Jan-Phillip Bäcker
Level Set Extrapolation of Immersed Boundary Data in Unfitted FEM for Deformable Interfaces

Gerardo Hernández-Duenas
A new two-dimensional blood flow model with arbitrary cross sections

16:00 – 16:30 COFFEE BREAK

Chair: S. Chiocchetti

16:30 – 17:00 **Lilia Krivodonova**
An Arbitrarily High-Order Moment Limiter for the Discontinuous Galerkin Method

17:00 – 17:30 **Jose Castillo**
High-Order Mimetic Finite Differences on Non-trivial Geometries

17:30 – 18:00 **Andrés M. Rueda-Ramírez**
Subcell limiting strategies for the DGSEM

Thematic Minisymposium: Numerical methods for complex models

Chair: S. Gavrilyuk

Jens Keim
A Relaxation Formulation of the Navier-Stokes-Korteweg Equations

Firas Dhaouadi
A hyperbolic reformulation of the Navier-Stokes-Korteweg system

Duan Zhang
Fluid Mediated Particle Interactions Studied Using the Nearest Particle Statistics

from 18:30 POSTER PARTY

Wednesday, 24 August 2022

08:30 – 09:00 **REGISTRATION**

Chair: S. Del Pino

09:00 – 09:30 **Pierre-Henri Maire**
Entropy stable and positivity preserving schemes for multidimensional hyperbolic systems. Part I: theory

09:30 – 10:00 **Raphaël Loubère**
Entropy stable and positivity preserving schemes on unstructured grid. Part II: multidimensional validation

10:00 – 10:30 **Junming Duan**
High-Order Accurate Entropy Stable Adaptive Moving Mesh Methods

10:30 – 11:00 **Hennes Hajduk**
On the need for enforcing discrete entropy inequalities for scalar conservation laws and hyperbolic systems

11:00 – 11:30 **COFFEE BREAK**

Chair: P. Bochev

11:30 – 12:00 **Stéphane Del Pino**
Entropy stability analysis for semi-Lagrangian cell-centered schemes

12:00 – 12:30 **Eric J. Tovar**
Robust second-order approximation of the compressible Euler Equations with an arbitrary equation of state

12:30 – 13:00 **Dmitri Kuzmin**
New Limiters and Entropy Fixes for Discontinuous Galerkin Methods

13:00 – 13:30 **Alexiane Plessier**
Implicit semi-Lagrangian schemes for compressible gas dynamics

13:30 – 15:00 **LUNCH**

FREE AFTERNOON

Some suggestions:

Kunsthaus Zürich: Sammlung Emil Bührle
Major and beautiful collection of French paintings
Wednesday free admission to the collection for all visitors

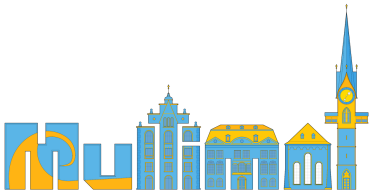
Clock and Watch Museum Beyer
Clock and watch collection, ancient and antique treasures. Entry CHF 10

Uetliberg – Top of Zürich
Uetliberg is Zürich's own mountain
Stunning view of the city and the lake

Lake cruises
Mini, short or long lake cruises on the lake of Zürich

from 19:00 **SOCIAL DINNER**

SORELL HOTEL Zürichberg
Orellistrasse 21, 8044, Zürich
(Note that it can take 30 minutes to reach the place both from the conference venue and the city center)



Thursday, 25 August 2022

08:30 – 09:00 REGISTRATION

Chair: B. Re

09:00 – 09:30 **Robert Rieben**
Multimaterial ALE remap with interface sharpening using high-order matrix-free finite element methods

09:30 – 10:00 **Rao Garimella**
Accurate remapping from 3D to 2D meshes for Multiphysics Simulations

10:00 – 10:30 **Matěj Klíma**
A three-dimensional cell-centered Lagrangian Lax-Wendroff HLL hybrid scheme

10:30 – 11:00 **Igor Menshov**
Interface capturing methods for heterogeneous multiphase flows

11:00 – 11:30 COFFEE BREAK

Chair: N. Morgan

11:30 – 12:00 **Mike Owen**
An SPH damage model appropriate for variable resolution

12:00 – 12:30 **Jason M. Pearl**
SPH for high-density ratio multi-material flows

12:30 – 13:00 **Ilya Peshkov**
An SPH method for the unified model of continuum mechanics

13:00 – 14:30 LUNCH

Chair: I. Peshkov

14:30 – 15:00 **Brody R. Bassett**
Dynamic Coupling of SPH and the FEM

15:00 – 15:30 **Paul Tsuji**
Embedded Meshes with Smoothed Particle Hydrodynamics

15:30 – 16:00 **Marianne François**
On exascale computing, Tusas and phase field method for solidification problem

Thematic Minisymposium: Interfaces

Chair: B. Després

Britton Olson
An immersed boundary method for gas-solid interface and multi-material flow in the presence of shocks

Pierson Guthrey
Complex Multi-Material Shock Interactions Using Moving DG with Interface Condition Enforcement

Shambhavi Nandan
Sharp Interface Capturing in Multi-Material Flows with an Accurate Diffuse Interface Method

16:00 – 16:30 COFFEE BREAK

Chair: P.-H. Maire

16:30 – 17:00 **Ian MacDonald**
Extension of the Interface Aware SubScale Dynamics (IA-SSD) closure model to 3D

17:00 – 17:30 **Andy Barlow**
A new fracture model based on Interface Aware SubScale Dynamics (IA-SSD) closure model

17:30 – 18:00 **Philippe Hoch**
High-order composite multi-dimensional FV schemes on unstructured meshes

Thematic Minisymposium: Radiation hydrodynamics

Chair: E. Labourasse

Sébastien Guisset
A colocalized scheme for three-temperature grey diffusion radiation hydrodynamics

Brian Haines
An iterative algorithm for solving the nonlinear heat transport equations

Alexander Farmakalides
A Computational Multi-physics Approach for Whole System Fusion Reactor Simulations

Friday, 26 August 2022

08:30 – 09:00 **REGISTRATION**

Chair: M. Dumbser

09:00 – 09:30 **Dinshaw S. Balsara**
High Order Adaptive Mesh Refinement (AMR) for Divergence Constraint-Preserving Schemes

09:30 – 10:00 **Tuan Anh Dao**
A nodal-based high-order nonlinear stabilization for finite element approximation of magnetohydrodynamics

10:00 – 10:30 **Jan Nikl**
High-order Curvilinear Finite Element Magnetohydrodynamics

10:30 – 11:00 **Maria Chrysanthou**
Mathematical and Computational Assimilation for Plasma Boundary Physics and Fusion Reactor

11:00 – 11:30 **COFFEE BREAK**

Chair: N. Nikiforakis

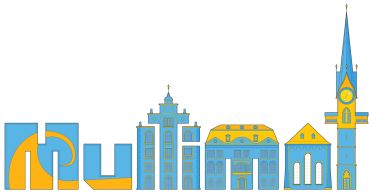
11:30 – 12:00 **Marco Petrella**
On the modeling of non-mixing compressible twophase flow

12:00 – 12:30 **Vincent Perrier**
A multiscale numerical scheme for the simulation of dispersed multiphase flows

12:30 – 13:00 **Kevin Schmidmayer**
Modelling interactions of waves with diffused interfaces

13:00 – 14:30 **CLOSING LUNCH WITH DESSERT**

FREE DISCUSSION



List of participants:

Rémi Abgrall (University of Zurich, Switzerland)

Pierre Anguill (CEA, DIF, France)

Omri Argov (Israel Institute of Technology, Israel)

Dinshaw S. Balsara (University of Notre Dame, Indiana, USA)

Andy Barlow (AWE, United Kingdom)

Brody R. Bassett (Lawrence Livermore National Lab, California, USA)

Saad Benjelloun (UM6P, Morocco)

Pavel Bochev (Sandia National Lab, New Mexico, USA)

Walter Boscheri (University of Ferrara, Italy)

Radouan Boukharfane (UM6P, Morocco)

Jean-Philippe Braeunig (CEA, CESTA, France)

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Benoît Cossart (CEA - University of Bordeaux, France)

Damian J. Coveney (University of Cambridge, United Kingdom)

Tuan Anh Dao (Uppsala University, Sweden)

Stéphane Del Pino (CEA, DAM, France)

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Bruno Després (Sorbonne Université, France)

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David Henneaux (von Karman Institute, Belgium)

Gerardo Hernández-Duenas (National University of Mexico, Mexico)

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Ryan Hill (AWE, United Kingdom)

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Jens Keim (University of Stuttgart, Germany)

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Christian Klingenberg (Würzburg University, Germany)

Matěj Klíma (Czech Technical University, Czechia)

Lilia Krivodonova (University of Waterloo, Canada)

John Kuczek (Los Alamos National Lab, New Mexico, USA)

Dmitri Kuzmin (TU Dortmund University, Germany)

Roger Käppeli (ETH Zürich, Switzerland)

Emmanuel Labourasse (CEA, France)

Yongle Li (University of Zurich, Switzerland)

Evan J. Lieberman (Los Alamos National Lab, New Mexico, USA)

Raphaël Loubère (CNRS - University of Bordeaux, France)

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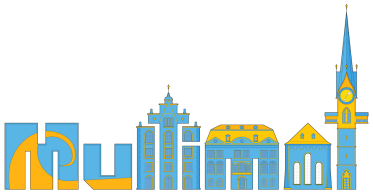

Lorenzo Micalizzi (University of Zurich, Switzerland)

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Thomas Paula (Technical University of Munich, Germany)

Christina Paulin (Onera, France)

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Ilya Peshkov (University of Trento, Italy)

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Andreas Rupp (LUT University, Finland)

Kevin Schmidmayer (Inria, France)

Sarswati Shah (National University of Mexico, Mexico)

David Sidilkover (Soreq NRC, Israel)

Giuseppe Sirianni (Politecnico di Milano, Italy)

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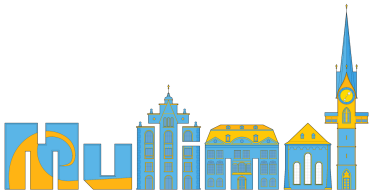

Nicolas Therme (CEA, CESTA, France)

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Amit Weintroub (Israel Institute of Technology, Israel)

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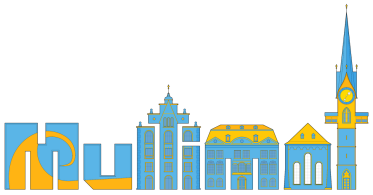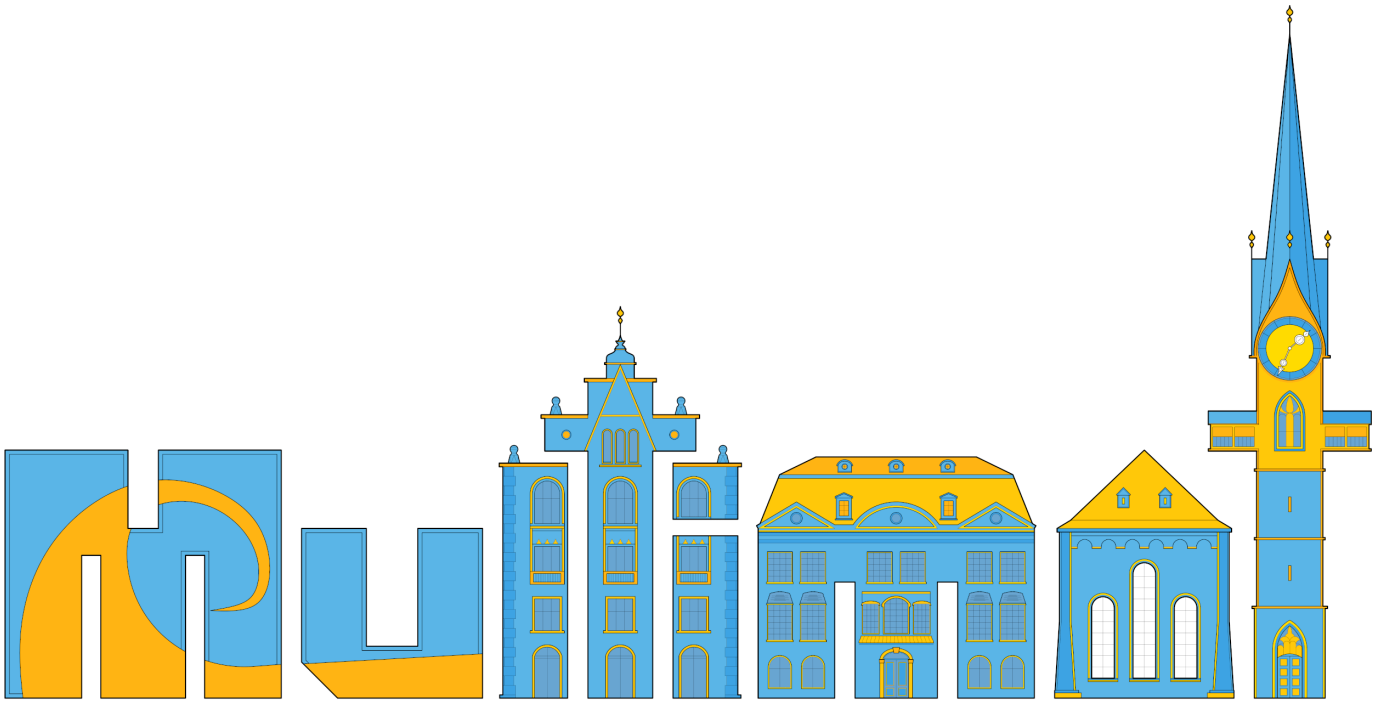
Duan Zhang (Los Alamos National Lab, New Mexico, USA)