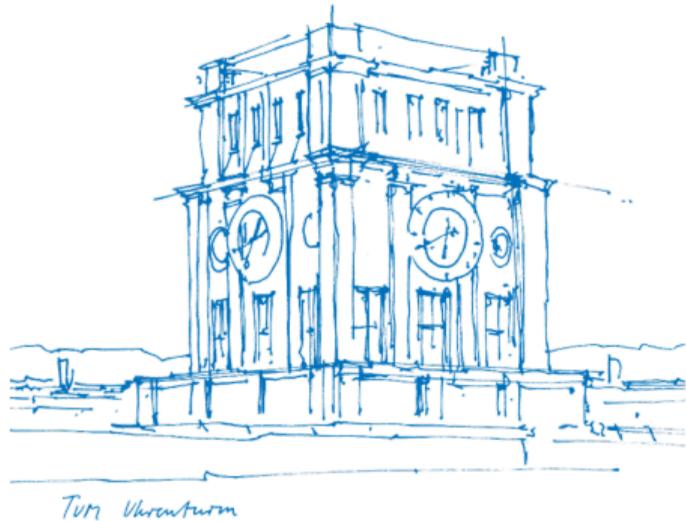


# Growing preCICE from an as-is coupling library to a sustainable, batteries-included ecosystem

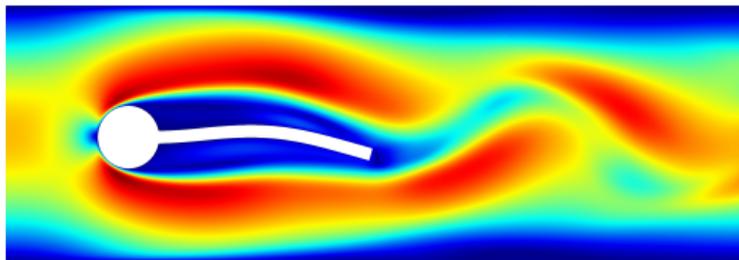
ECP Webinar series:  
Best Practices for HPC Software Developers

Gerasimos Chourdakis  
Technical University of Munich

July 6, 2022

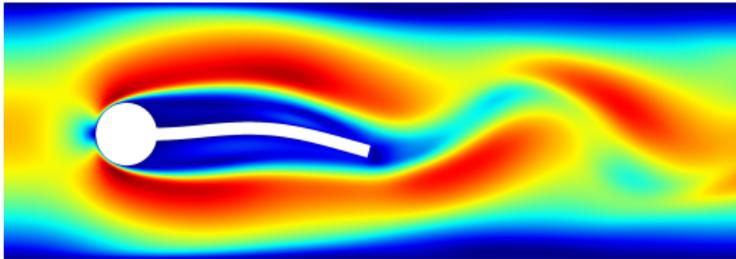


## Motivation: Partitioned multi-physics simulations

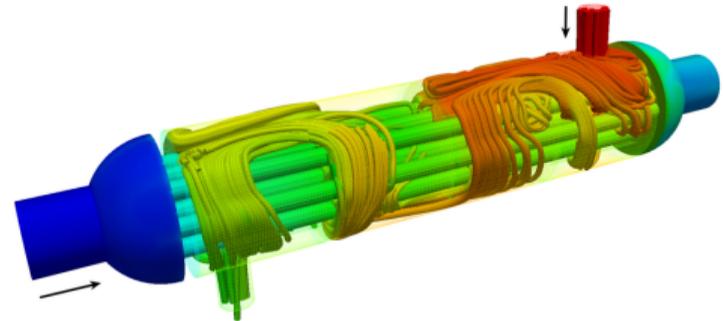


Fluid-Structure Interaction:  
Turek-Hron FSI3 benchmark

## Motivation: Partitioned multi-physics simulations

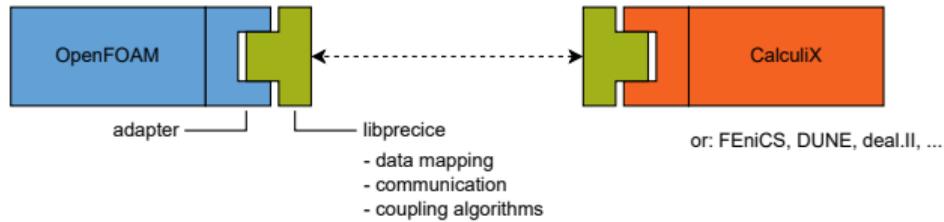


Fluid-Structure Interaction:  
Turek-Hron FSI3 benchmark

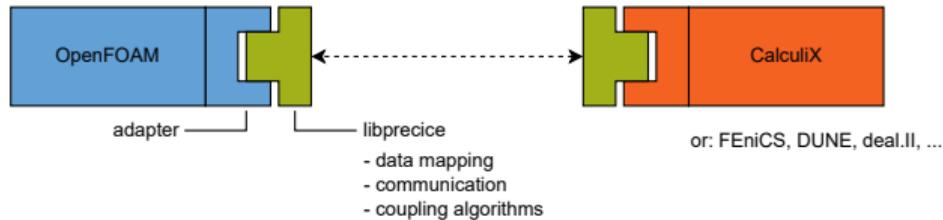


Conjugate Heat Transfer:  
heat exchanger

## preCICE in a nutshell

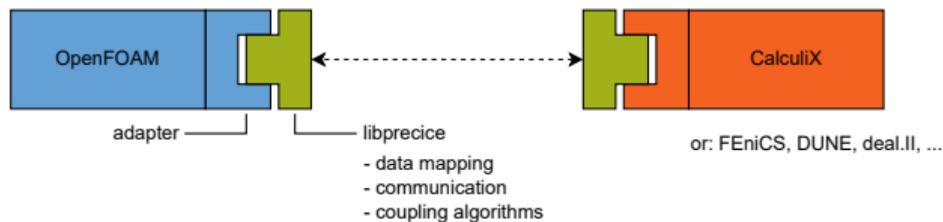


## preCICE in a nutshell



```
while (t < t_end){
  solve(dt);
  precice.write_data(force);
  max_dt = precice.advance(dt);
  precice.read_data(displacement);
}
```

## preCICE in a nutshell



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while (t < t_end){
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    max_dt = precice.advance(dt);
    precice.read_data(displacement);
}
```

Adapters and examples for: OpenFOAM, SU2, CalculiX, deal.II, FEniCS, DUNE, Nutils, ...

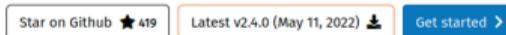
API in C++, C, Fortran, Python, Matlab, Julia

# Walking around the website (1)



## Welcome to preCICE

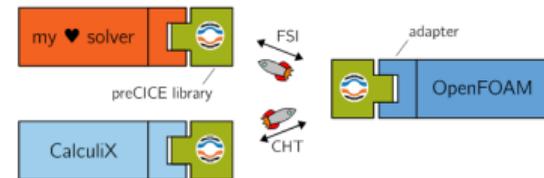
The coupling library for partitioned multi-physics simulations.



preCICE is an **open-source coupling library** for partitioned multi-physics simulations, including, but not restricted to fluid-structure interaction and conjugate heat transfer simulations.

Partitioned means that **preCICE couples existing programs/solvers** capable of simulating a subpart of the complete physics involved in a simulation. This allows for the high flexibility that is needed to keep a decent time-to-solution for complex multi-physics scenarios.

The software offers convenient methods for transient equation coupling, communication, and data mapping.



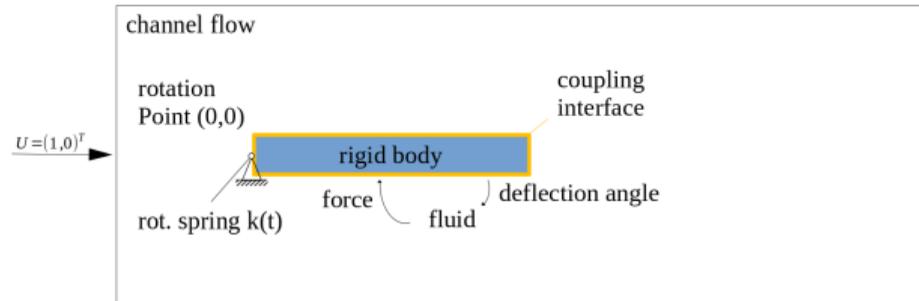
- Available adapters
- Tutorials
- Quickstart

## Live demo

Quickstart tutorial:  
[precice.org/quickstart.html](https://precice.org/quickstart.html)

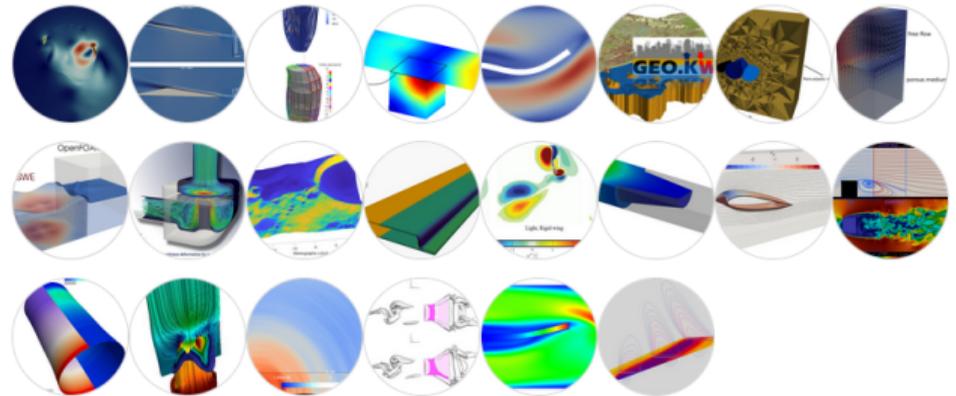
Running on the preCICE demo VM:  
[precice.org/installation-vm.html](https://precice.org/installation-vm.html)

**Homework:** Run it yourself! :-)



## Walking around the website (2)

- Couple your code
- User stories
- Who uses preCICE



## Achievements unlocked: Usability & Reachability

*You don't need to talk to us to successfully use preCICE,*

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*You don't need to talk to us to successfully use preCICE,  
but if you want, you can reach us very easily.*

## Achievements unlocked: Usability & Reachability

*You don't need to talk to us to successfully use preCICE,  
but if you want, you can reach us very easily.*

*"After the amount of support I received from this community, I am switching to  
opensource for every one of my needs."*

*(@nithinadidela on the preCICE forum)*

## But why all this effort?

We are not the target users of preCICE:  
we research and develop **methods and software**, not **applications**.

# Lessons learned

## Lessons learned: Technical

1. Library vs framework
2. Separation of concerns
3. Few, common dependencies
4. Packages for common platforms
5. Standard practices (e.g., xSDK<sup>1</sup>, OpenSSF Best Practices<sup>2</sup>, code quality checkers)



### Project Status

release **v2.4.0** doi **10.18419/darus-2613** Build and Test **passing** system tests **check**

### Project Quality

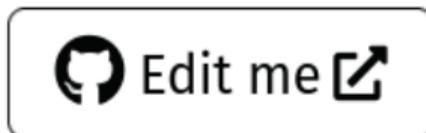
openssf best practices **passing** codefactor **A** lgtm:C++ **A+** codecov **89%**

<sup>1</sup><https://xsdk.info/>

<sup>2</sup><https://bestpractices.coreinfrastructure.org/>

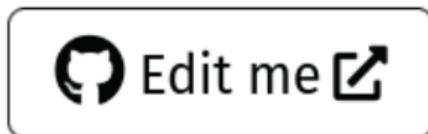
## Lessons learned: Documentation

1. Content from multiple sources, rendered at one place
  - website + a wiki for each repository + dev docs → website
  - content next to code
  - content available offline
2. Very easy to contribute (“edit me” button + review)



## Lessons learned: Documentation

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Implementation: GitHub Pages (Jekyll) + Bootstrap

Extra features: search (Algolia), PDF export (Prince), privacy-respecting analytics (Plausible)

## Lessons learned: Documentation (2)

Q&A strategy: add to the documentation, send link as answer

## Lessons learned: Documentation (2)

Q&A strategy: add to the documentation, send link as answer



Lufthansa

Home > [Timetable & flight status](#)

**Please note:** all the flight information displayed is up-to-date. Our Service Centres also obtain their information from this flight status feature.

# Lessons learned: Communication

1. Mailing list + chatroom → Discourse forum
  - Threaded, great search, tags, categories, answers, ...
  - Also used as blog, FAQ, conferences
2. preCICE Workshops (+ feedback, training)
3. Some outreach is essential.

preCICE<sup>TM</sup> Home GitHub Twitter YouTube Q ☰

all categories ▾ all tags ▾ Categories Latest Top Bookmarks ☰ + New Topic

Category	Topics	Latest
<b>News</b> News, announcements, "blog"-like posts	1 / month	<input type="checkbox"/> Connection never accepted 2 15h <input checked="" type="checkbox"/> Using preCICE <input checked="" type="checkbox"/> calcule <input checked="" type="checkbox"/> fo <input checked="" type="checkbox"/> openham
<b>Is preCICE for me?</b> General questions regarding preCICE as a coupling solution.	17	<input type="checkbox"/> Problems with installing pyprecice on MacOS 3 21h <input checked="" type="checkbox"/> Installing preCICE <input checked="" type="checkbox"/> python
<b>Installing preCICE</b> Any issues with getting the preCICE library installed	1 / month	
<b>Using preCICE</b> Using the preCICE API, configuring a new simulation	5 / month	<input checked="" type="checkbox"/> preCICE Workshop 2021: Introduce yourself! 38 22h <input checked="" type="checkbox"/> conferences <input checked="" type="checkbox"/> workshop2021

## Lessons learned: Release strategy

1. Major (breaking) releases not too often (min. 2-3 years)
2. Feature releases often, but not too often (6 months)
3. Downstream component releases at anytime
4. Ecosystem distribution (1-2/year)

## Still learning: Publication strategy

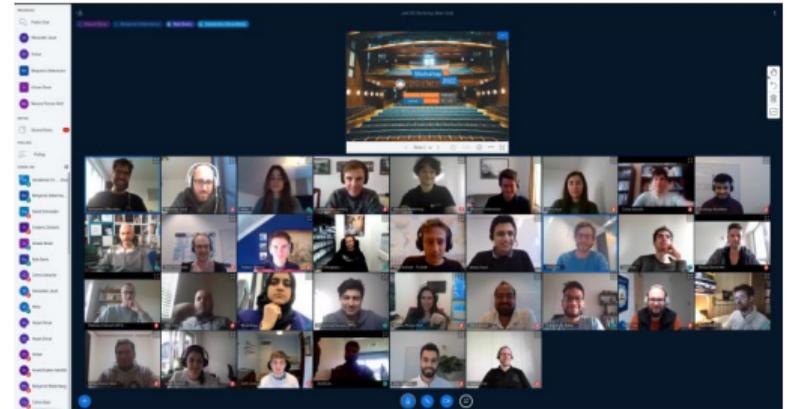
1. Reference article
  - 1.1 Needs updates (features, results, authors)
  - 1.2 Also reference articles for adapters
2. Feature-specific articles
3. Citable ecosystem distribution

# Workshops


**preCICE**

**Workshop #4**  
**2023**

Technical University of Munich February  
 Germany 13 - 16



## Challenge: Sustainable funding

1. Research-driven, niche topic: academic funding important
2. Research proposals together with users
3. Workshops
4. More support and collaboration requests than we can handle

Solution: Support program



## Not discussed (feel free to ask)

- Features, numerics, performance
- Testing and CI
  - BSSW Blog post: “Overcoming Complexity in Testing Multiphysics Coupling Software”
  - System tests
- Collaboration & project management
- Outreach
- ...

(enough topics for future talks)

# Key reference (fresh!)



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SOFTWARE TOOL ARTICLE

## preCICE v2: A sustainable and user-friendly coupling library [version 1; peer review: 2 approved]

Gerasimos Chourdakis , Kyle Davis , Benjamin Rodenberg , Miriam Schulte , Frédéric Simonis , Benjamin Uekermann , Georg Abrams, Hans-Joachim Bungartz, Lucia Cheung Yau, Ishaan Desai , Konrad Eder, Richard Hertrich, Florian Lindner , Alexander Rusch , Dmytro Sashko, David Schneider , Amin Totounferoush , Dominik Volland, Peter Vollmer , Oguz Ziya Koseomur

This article is included in Excellent Science gateway

### Open Peer Review

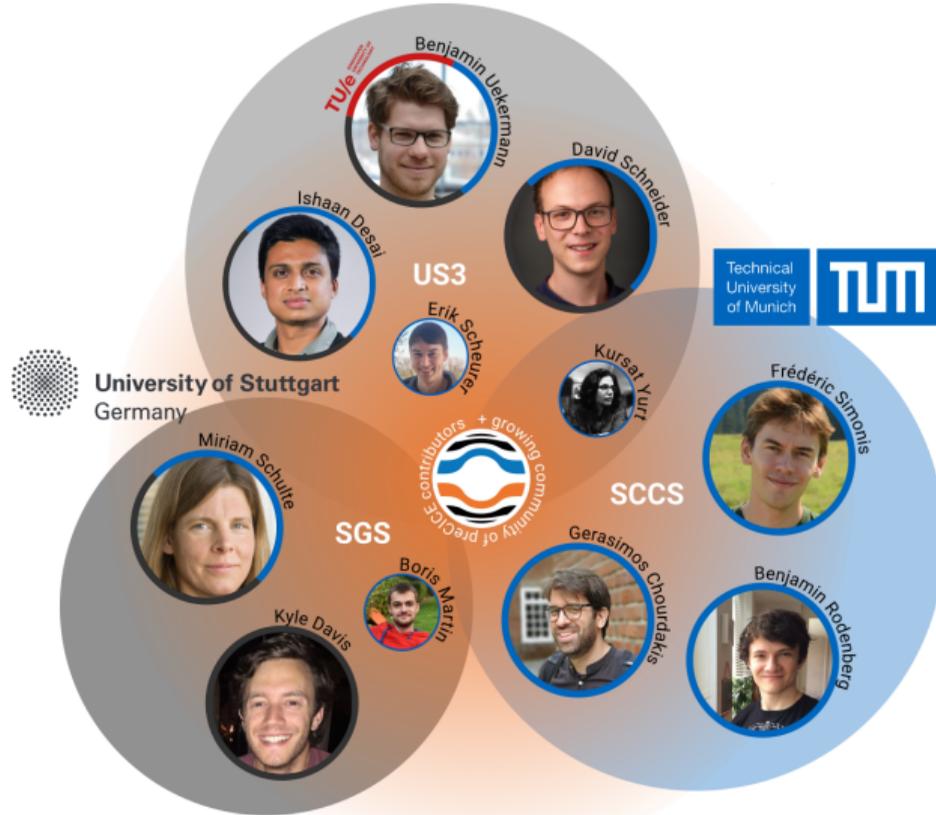
Approval Status ✔✔ ①

	1	2
Version 1		
29 Apr 22	✔ view	✔ view

1. **Axelle Viré**, Delft University of Technology, Delft, The Netherlands
2. **Garth Wells** , University of Cambridge, Cambridge, UK

Comments on this article

# People



# Funding

Supported by:



Federal Ministry  
for the Environment, Nature Conservation,  
Nuclear Safety and Consumer Protection

based on a decision of  
the German Bundestag



# DFG

- Research Software Sustainability  
- EXC 2075 SimTech



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 754462



## See also

Talks at the same webinar series with similar interests:

- OpenFOAM** Tomislav Maric, July 2021 and March 2022:
  - “A Workflow for Increasing the Quality of Scientific Software”*
  - “Software Design Patterns in Research Software with Examples from OpenFOAM”*
- deal.II** Wolfgang Bangerth, September 2021:
  - “What I Learned from 20 Years of Leading Open Source Projects”*
- xSDK** Ulrike Meier Yang & Piotr Luszczek, December 2019:
  - “Building Community through xSDK Software Policies”*
- E4S** Lois Curfman McInnes, December 2021:
  - “Scientific software ecosystems and communities: Why we need them and how each of us can help them thrive”*

## Summary

**Main message:** always think of the user, it may be highly beneficial (in the long run).

Discussed:

- Coupling with preCICE
- Technical decisions
- Documentation
- Communication
- Release & publication strategy
- Sustainable funding

Slides & feedback: [go.tum.de/266671](https://go.tum.de/266671)



[gerasimos.chourdakis@tum.de](mailto:gerasimos.chourdakis@tum.de)

(Note: looking for a research stay abroad in 2023)