Flash-X, An Open-Source Simulation Software Instrument

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GitHub Open-Source Fridays
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LAND ACKNOWLEDGMENT

The City of Chicago is located on land that is and has long been a center for Native peoples. The area is the traditional homelands of the Anishinaabe, or the Council of the Three Fires: the Ojibwe, Odawa, and Potawatomi Nations. Many other Nations consider this area their traditional homeland, including the Myaamia, Ho-Chunk, Menominee, Sac and Fox, Peoria, Kaskaskia, Wea, Kickapoo, and Mascouten

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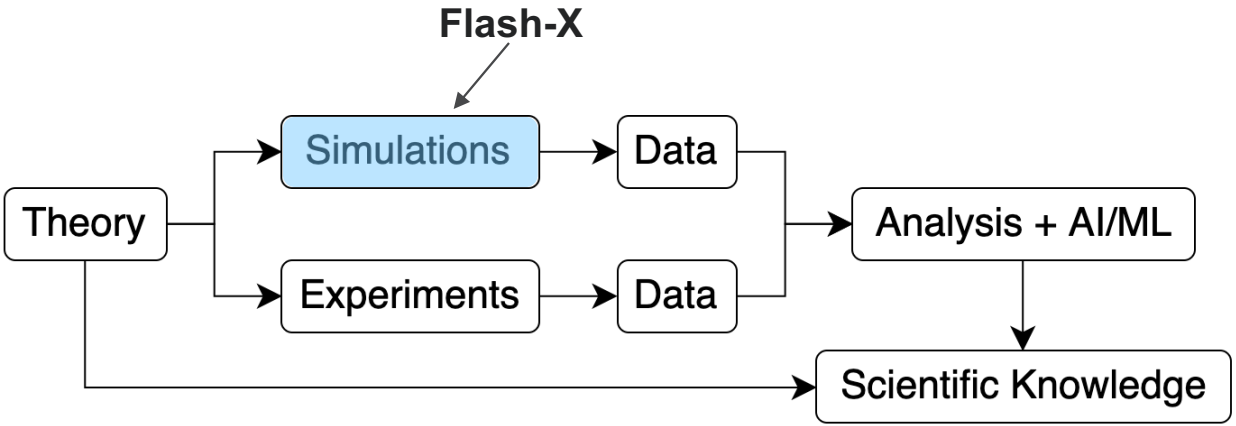
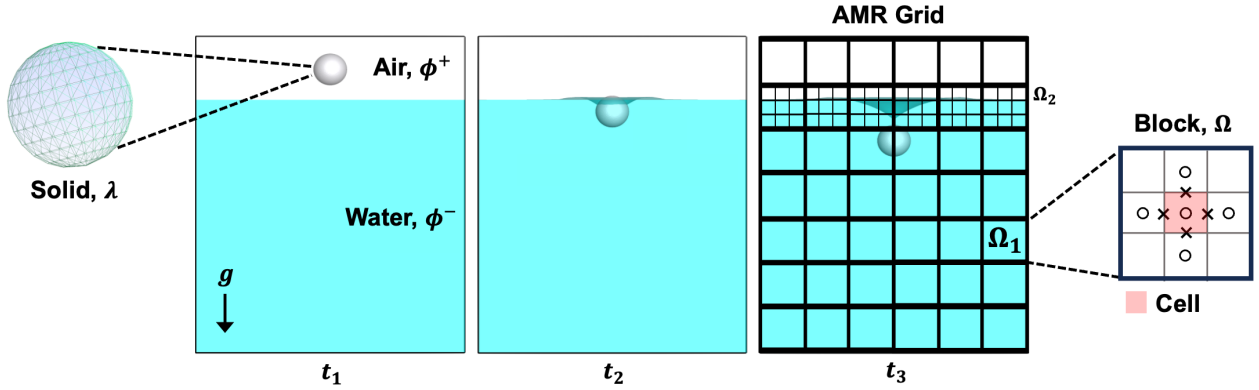
SCIENTIFIC WORKFLOW



Simulations solve physics-based partial differential equations in space and time



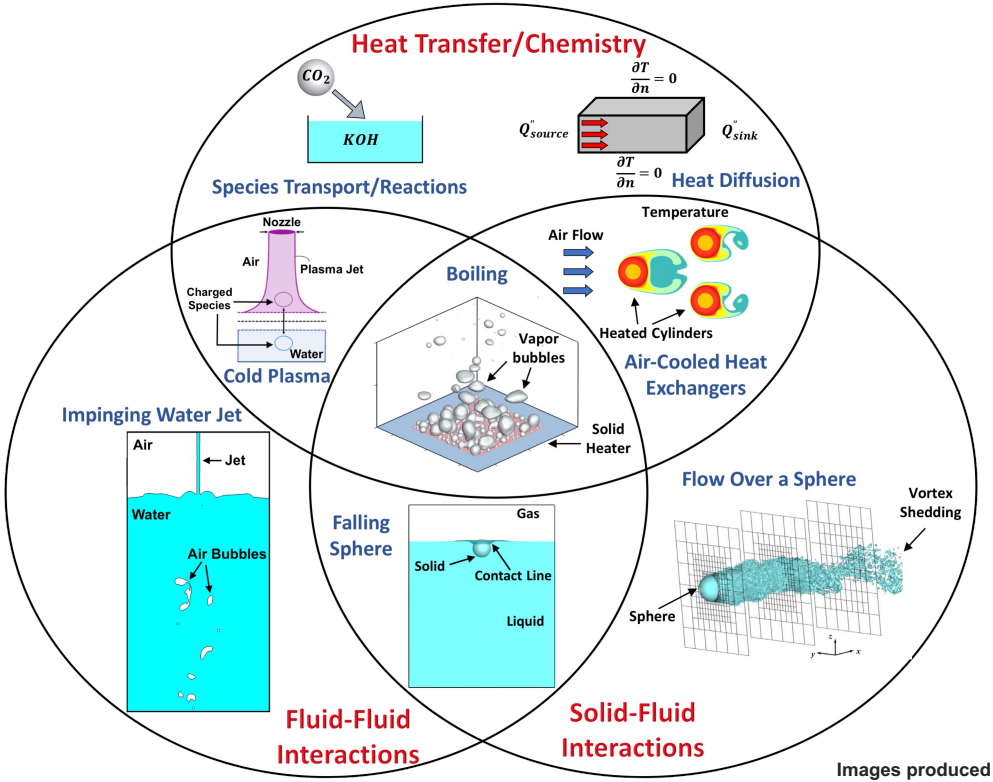
Temporal Evolution — Diffusion

$$\frac{\partial Q}{\partial t} - \vec{u} \cdot \nabla Q = K\nabla^2 Q + f$$

Advection — Source Terms

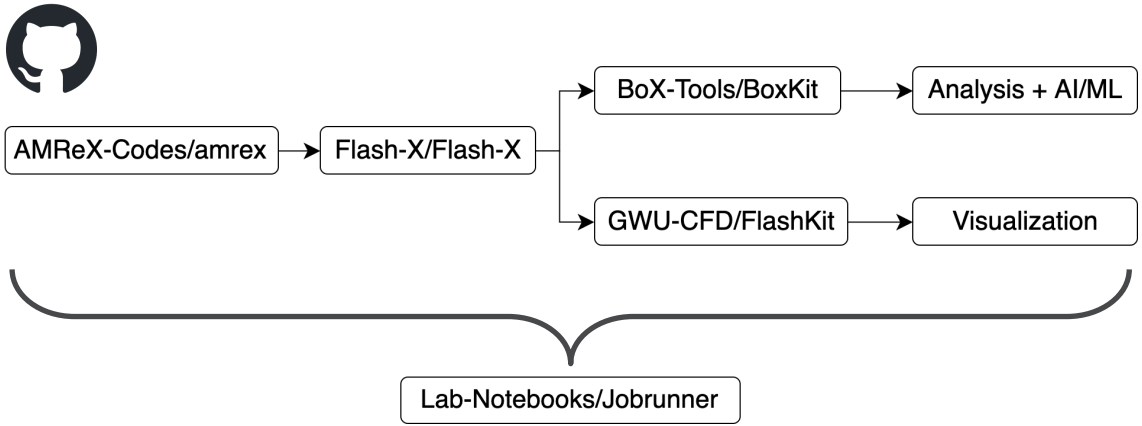
- ***Solid-Fluid and Liquid-Gas interfaces are presented with level-set functions, λ (+ in solid, - in fluids) and ϕ (+ in gas, - in liquid) respectively.***
- ***AMR – Adaptive Mesh Refinement***

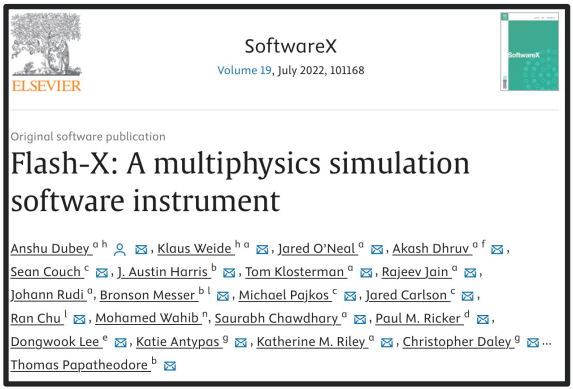
Venn diagram of Multiphysics interactions and applications that can be modeled using Flash-X



Images produced by:
- Akash Dhruv, GWU, 2015-2019
- Luis Martinez, GWU, 2016-2019
- Marcos Vanella, GWU, 2009-2010

FLASH-X WORKFLOW





SoftwareX

Volume 19, July 2022, 101168

Original software publication

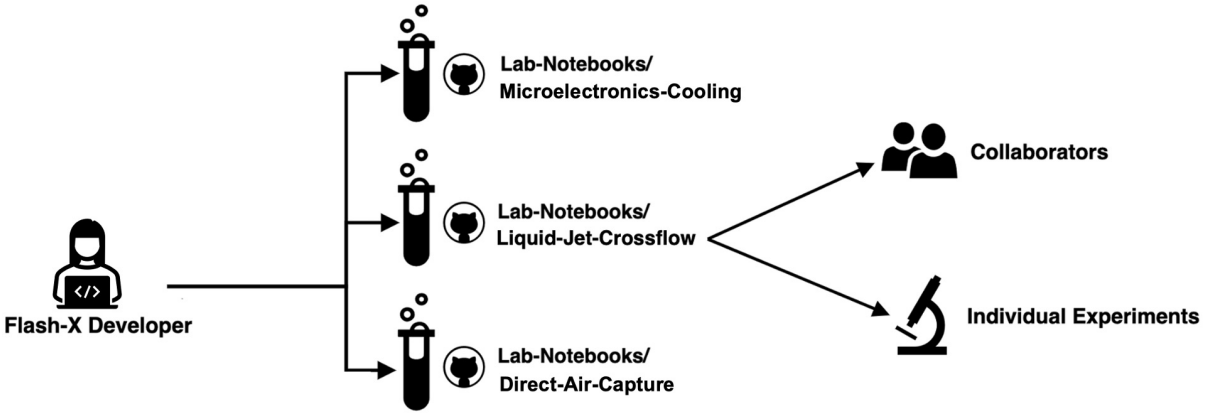
Flash-X: A multiphysics simulation software instrument

Anshu Dubey [a h], Klaus Weide [h a], Jared O'Neal [a], Akash Dhruv [a f], Sean Couch [c], J. Austin Harris [b], Tom Klosterman [a], Rajeev Jain [a], Johann Rudi [a], Bronson Messer [b l], Michael Pajkos [c], Jared Carlson [c], Ran Chu [l], Mohamed Wahib [n], Saurabh Chawdhary [a], Paul M. Ricker [d], Dongwook Lee [e], Katie Antypas [g], Katherine M. Riley [a], Christopher Daley [g] ... Thomas Papatheodore [b]

Open-source with Apache 2.0 license (**https://flash-x.org**), designed for exascale platforms. Recipient of 2022 R&D 100 award.

LABORATORY NOTEBOOKS

- Laboratory notebooks are a common practice in experimental science to record and reproduce scientific observations.
- Computational science lacks this rigor.
- In-depth analysis by Jared O'Neal (https://www.youtube.com/watch?v=OpzofH8U0Bs).



LABORATORY NOTEBOOKS

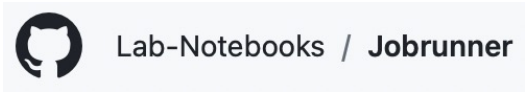
```
# Setting up software and dependencies
jobrunner setup software/amrex
jobrunner setup software/flashx

# Setting up and running experiments
jobrunner setup simulation/FlowBoiling
jobrunner submit simulation/FlowBoiling

# Archiving results to jobnode.archive
jobrunner archive \
            simulation/FlowBoiling

# Running Flash-X test suite
jobrunner submit tests
```

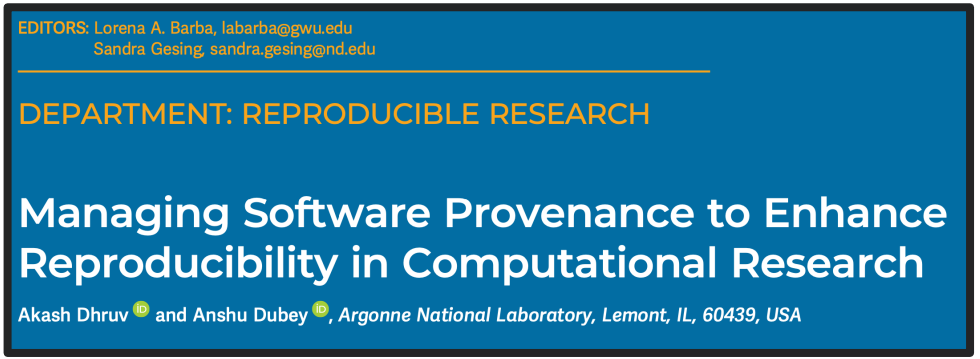
FIGURE Jobrunner commands for setting up dependencies, running tests and experiments, and archive data. These commands are executed from the root of the directory-tree

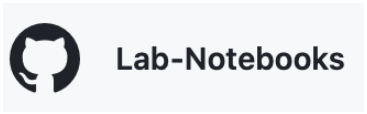



```
Experiment
├── software/
│   ├── amrex/
│   │   ├── setupAMReX.sh
│   │   └── Jobfile
│   └── flashx/
│       ├── setupFlashX.sh
│       └── Jobfile
├── simulation/
│   └── FlowBoiling/
│       ├── flashBuild.sh
│       ├── flashRun.sh
│       ├── Jobfile
│       └── jobnode.archive/
│           └── <mm-dd-yyyy>/
├── tests/
│   ├── Tests.suite
│   ├── runTests.sh
│   └── Jobfile
├── environment.sh
└── Jobfile
```

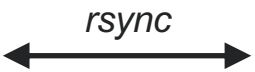
FIGURE Directory tree for a Flash-X experiment.

LABORATORY NOTEBOOKS





Execution Environment



Data Clone

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