

Using Pyrope to Create

Transformable RISC-V Architectures

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<http://masc.soe.ucsc.edu>



Challenge to Address

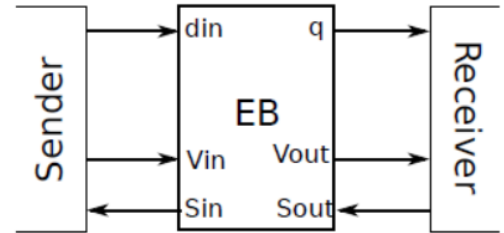
- Difficult to design hardware
 - Need multiple Codebases
 - Cycle-accurate version for synthesis
 - High-level simulation
 - Verification reference model
 - Need to adjust pipeline stages
 - Need to verify the hardware
- New HDL (Pyrope) can help

My Hammer to Handle Design Complexity

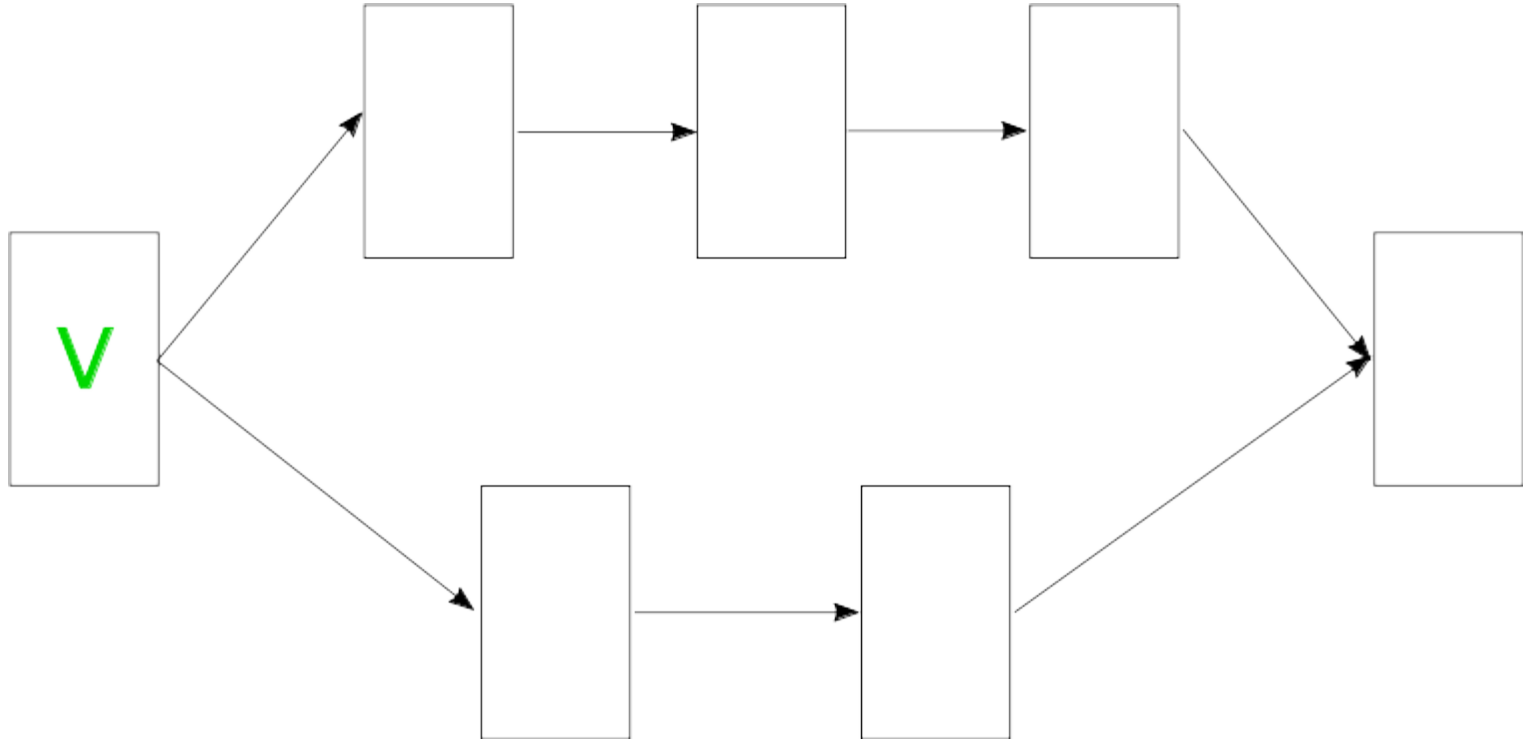
- Fluid Pipelines design
- Correct by construction Fluid Pipelines transformations
 - Change the number of stages as part of compile flow
- Use Pyrope Language to build Fluid Pipelines designs

Quick Fluid Pipeline Review

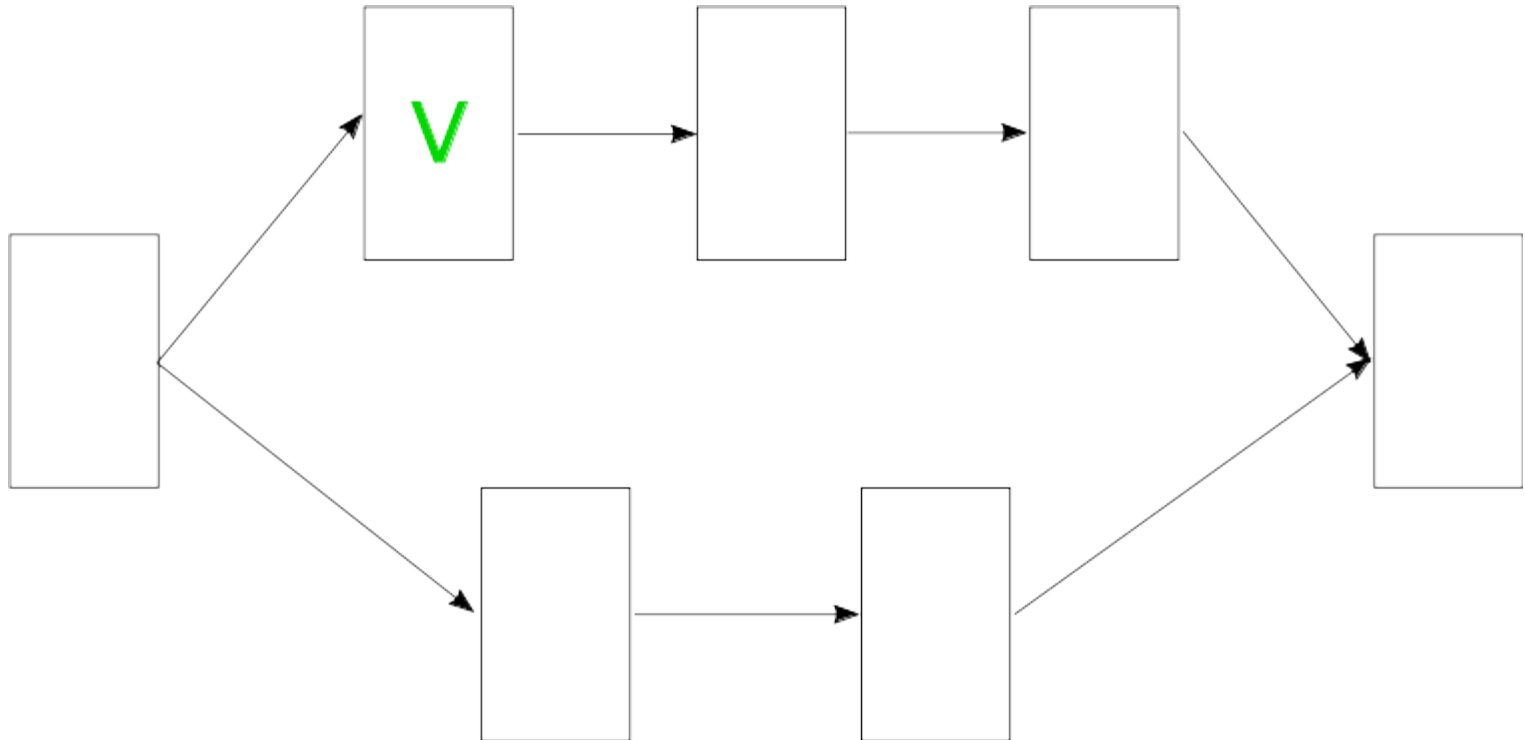
- Each pipeline stage has valid/stop signals
- Pipeline stages should tolerate random delays



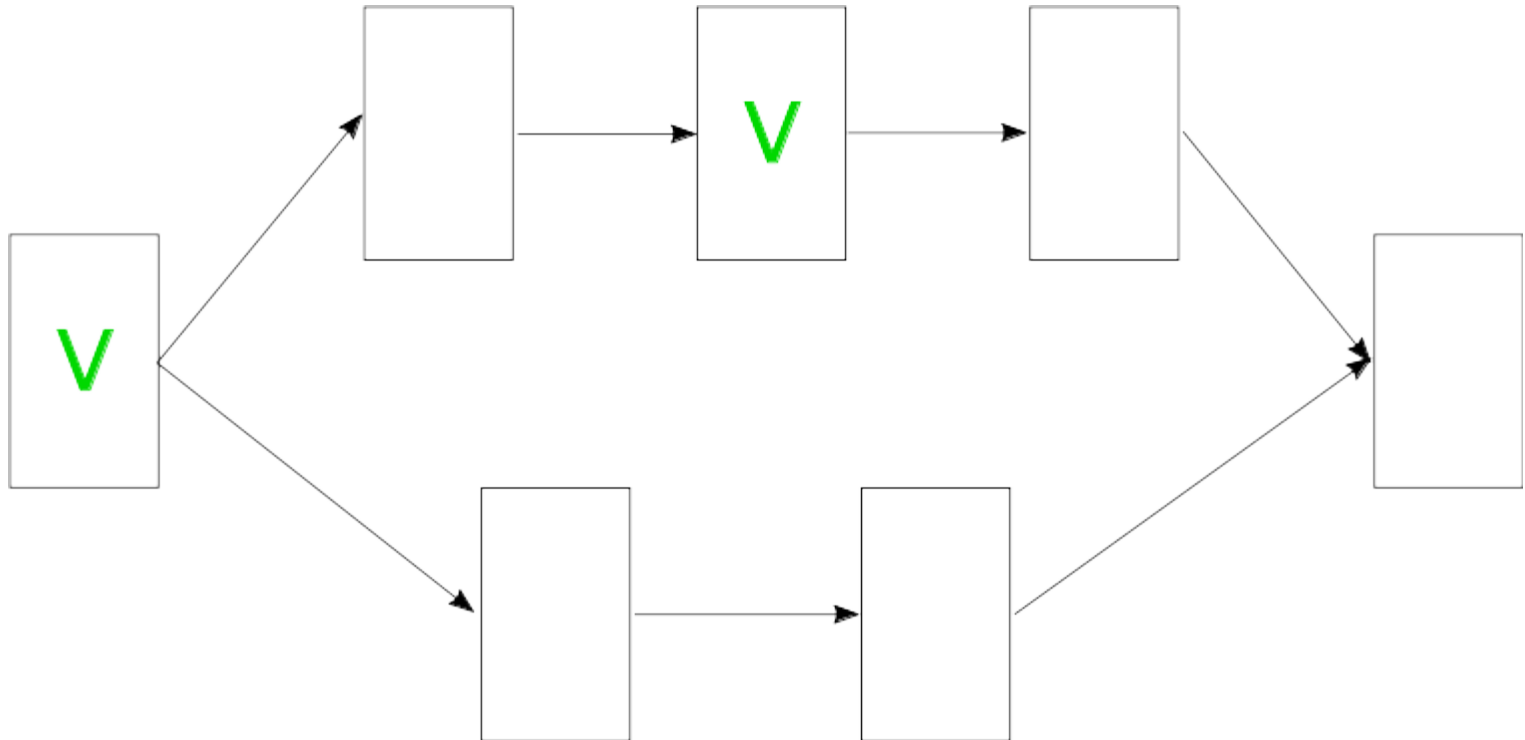
Quick Fluid Pipeline Review



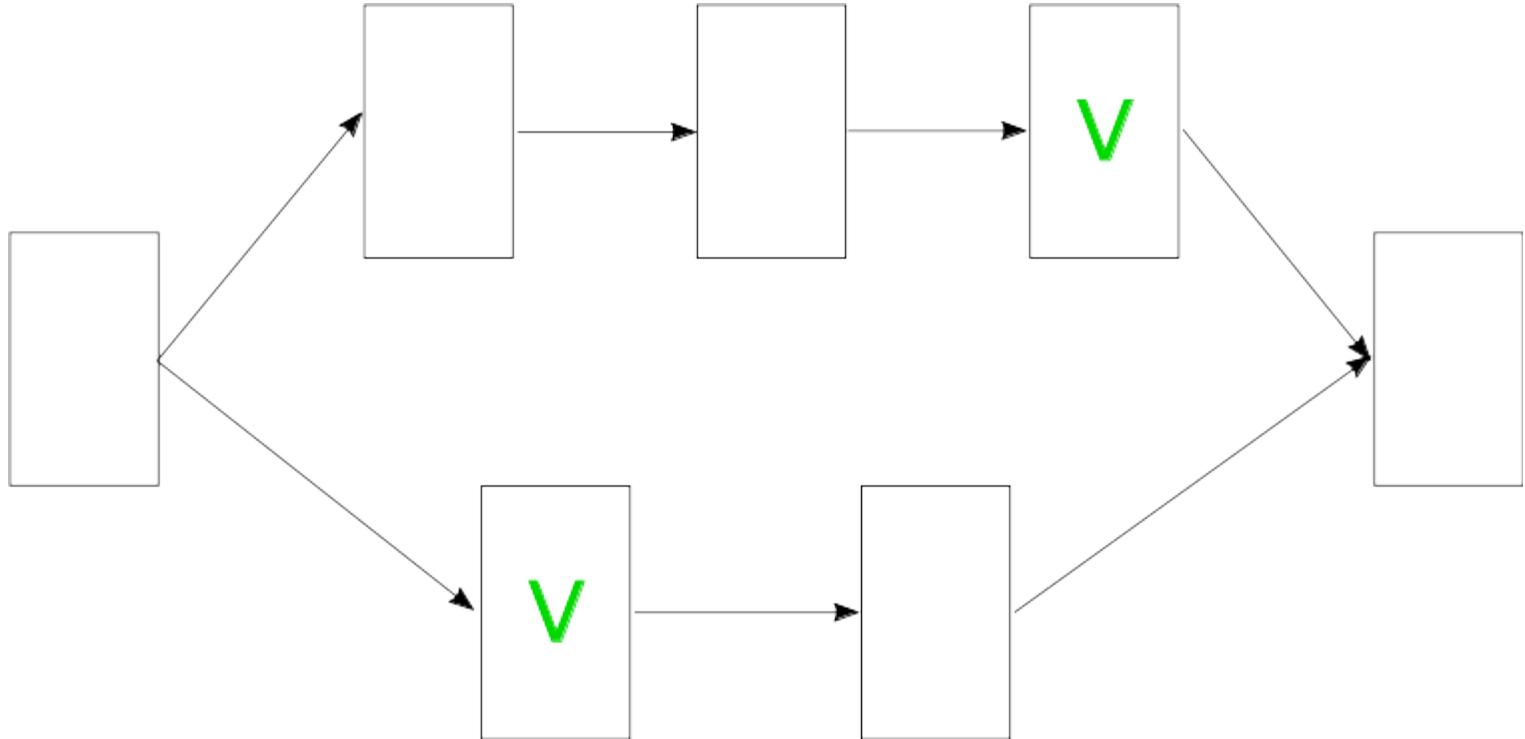
Quick Fluid Pipeline Review



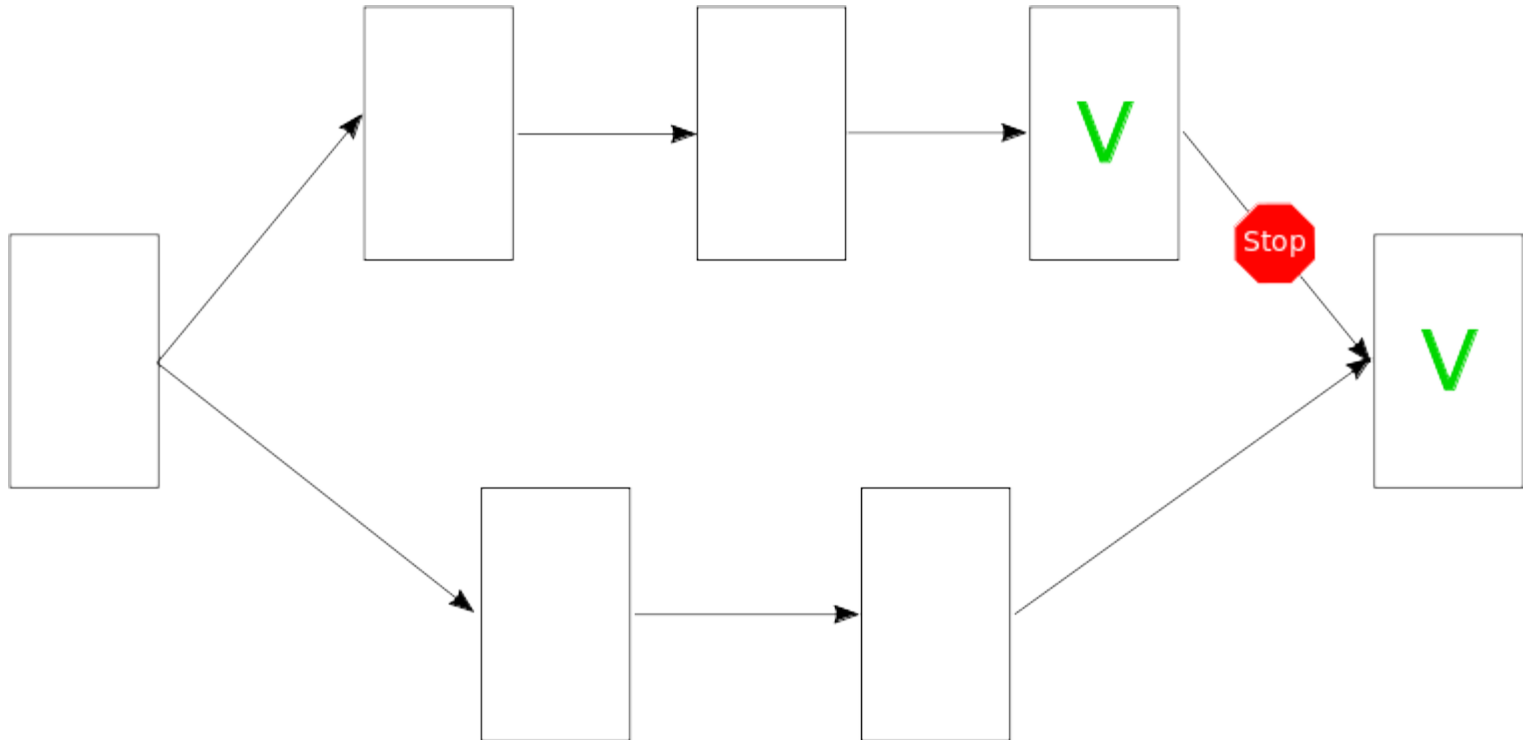
Quick Fluid Pipeline Review



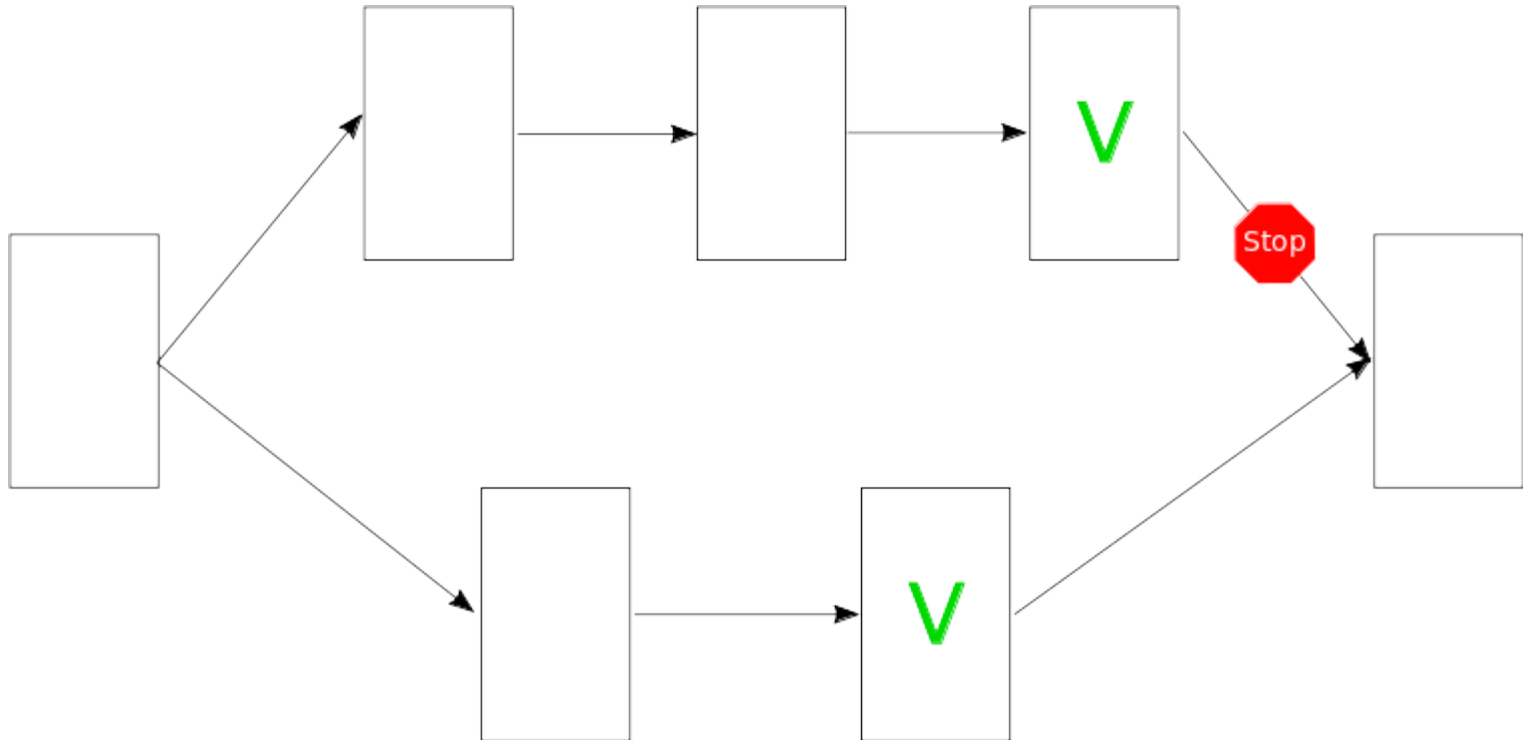
Quick Fluid Pipeline Review



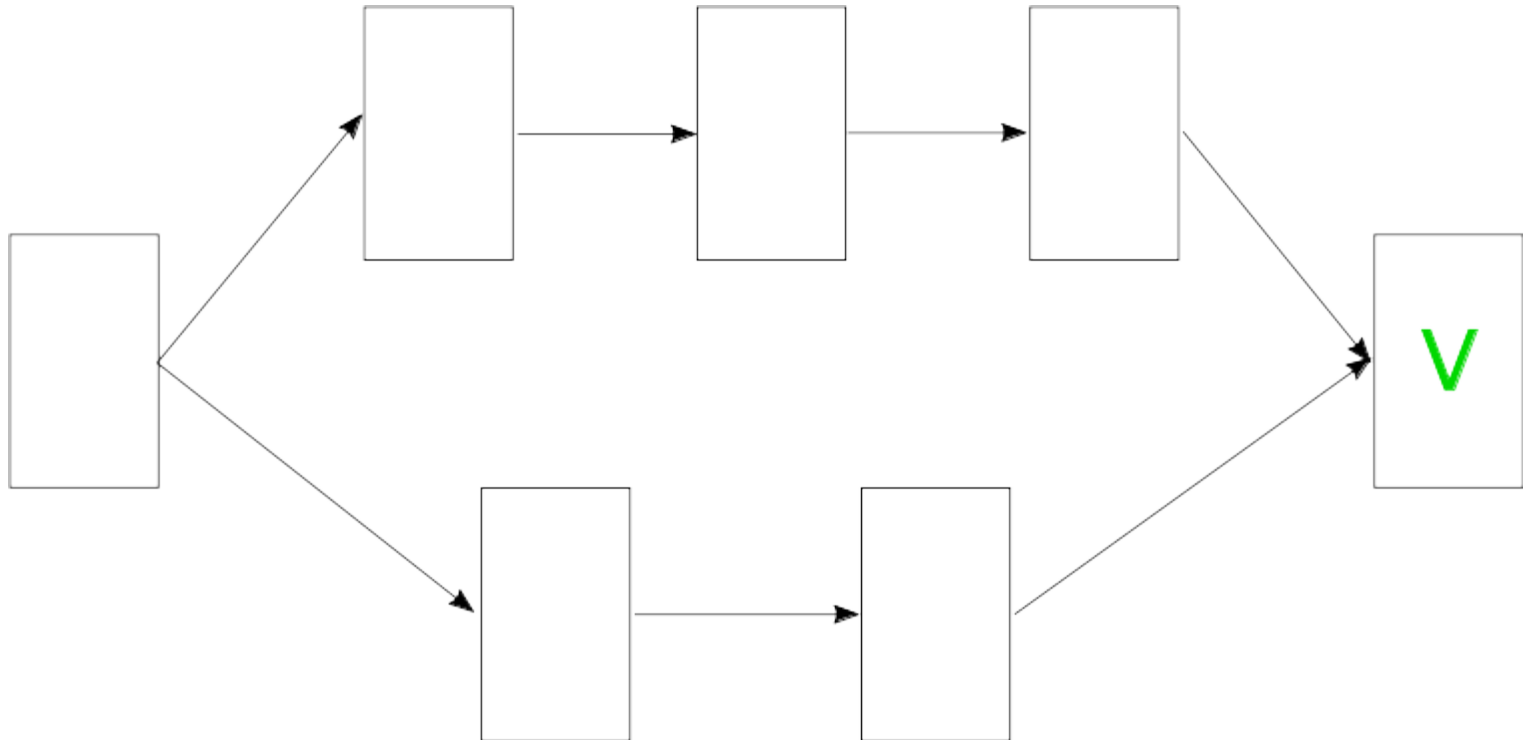
Quick Fluid Pipeline Review



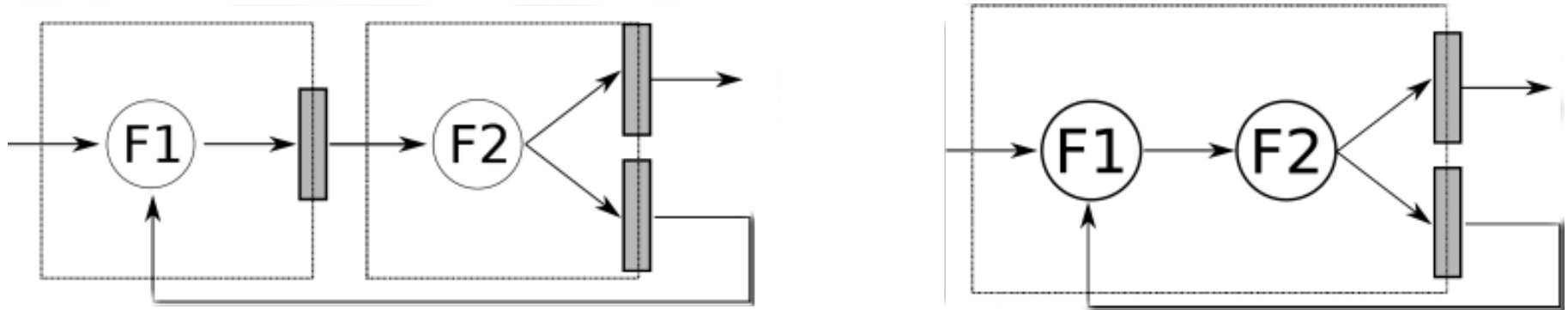
Quick Fluid Pipeline Review



Quick Fluid Pipeline Review



New Fluid Pipeline Collapse

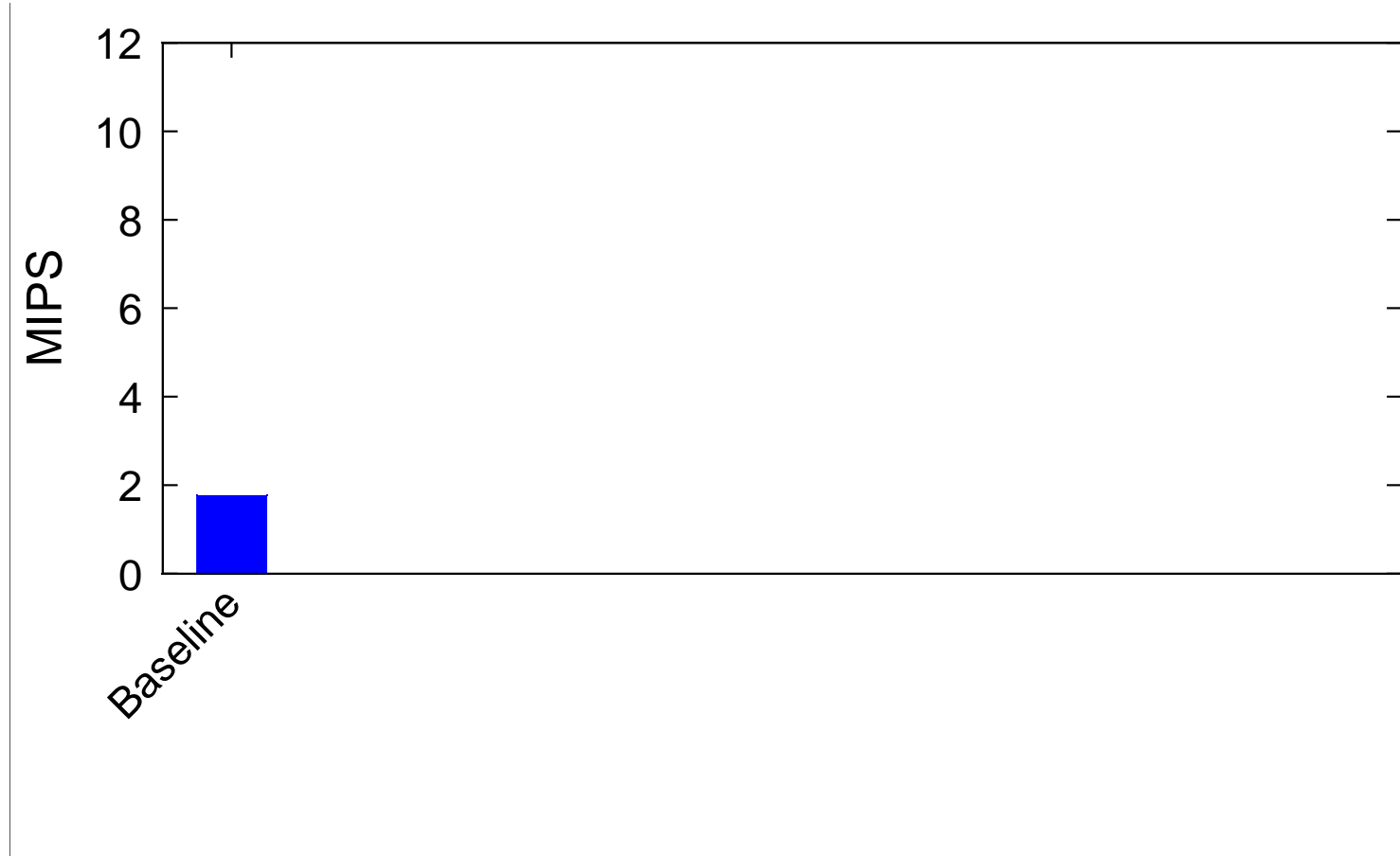


We can reduce designs to a single pipeline stage

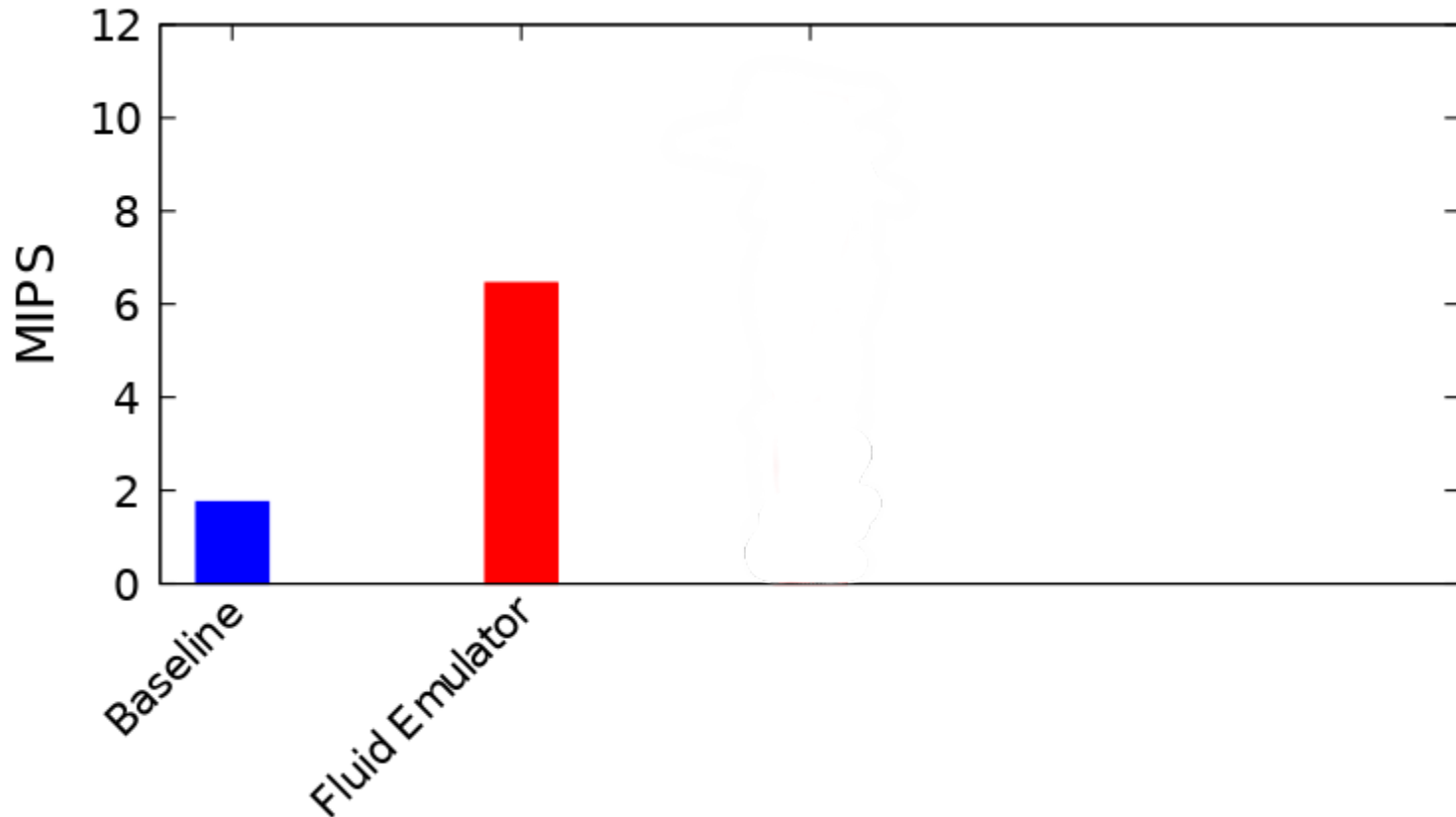
Fluid Collapse Usages

- Build an emulator out of a RISC-V Fluid Core
- Change number of pipeline stages automatically
- Perform formal verification

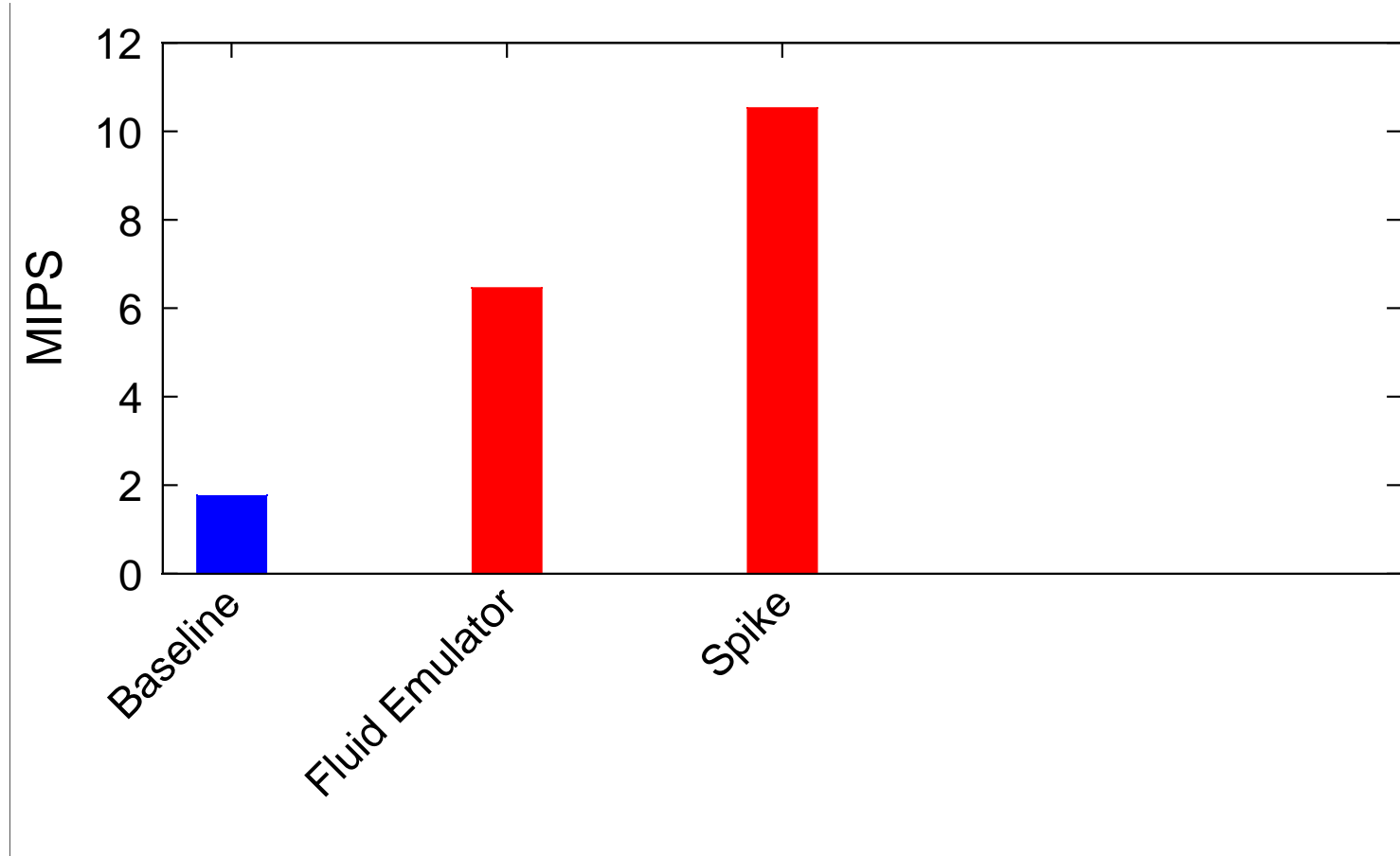
Build a Fast Simulator



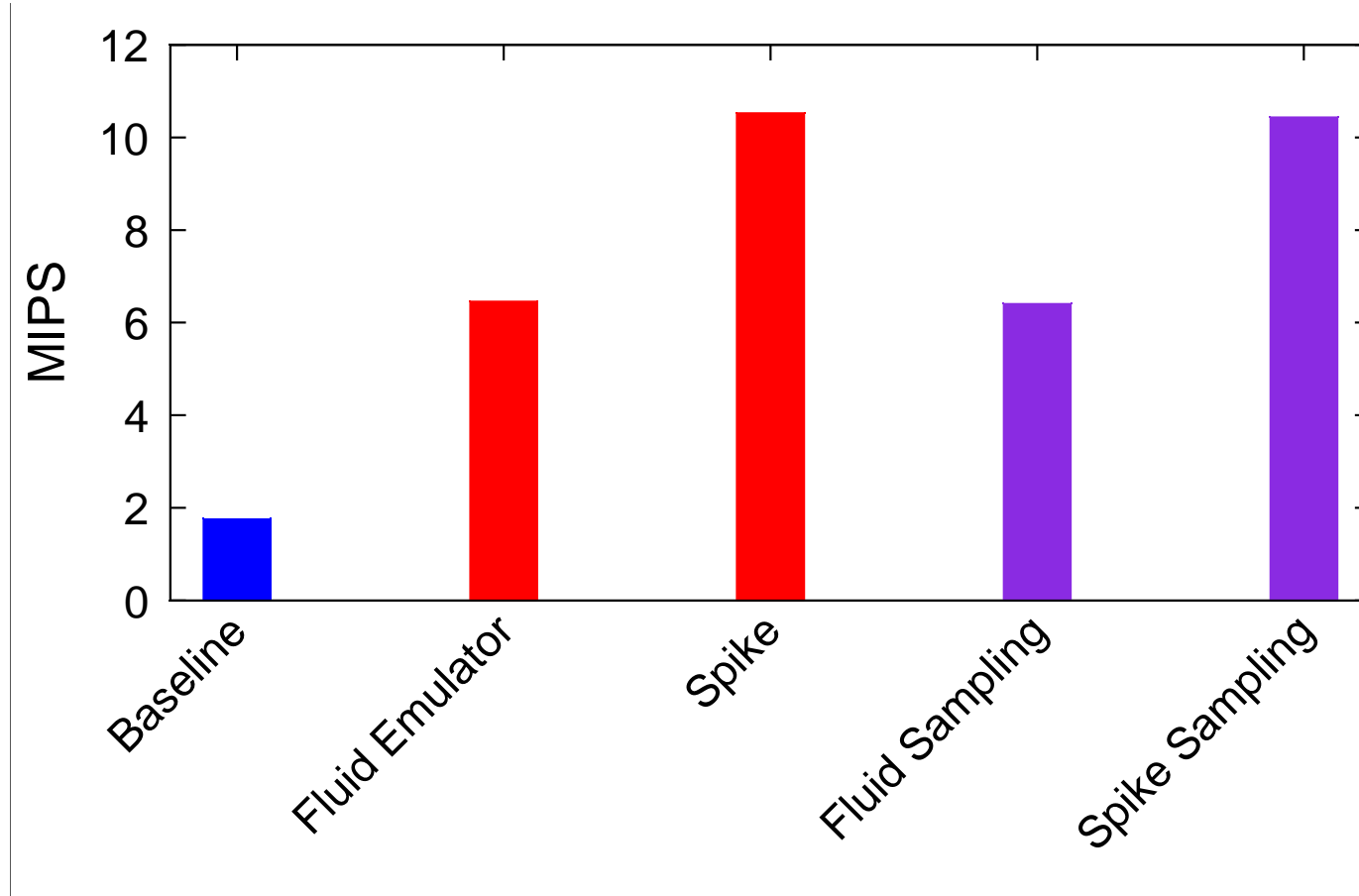
Build a Fast Simulator



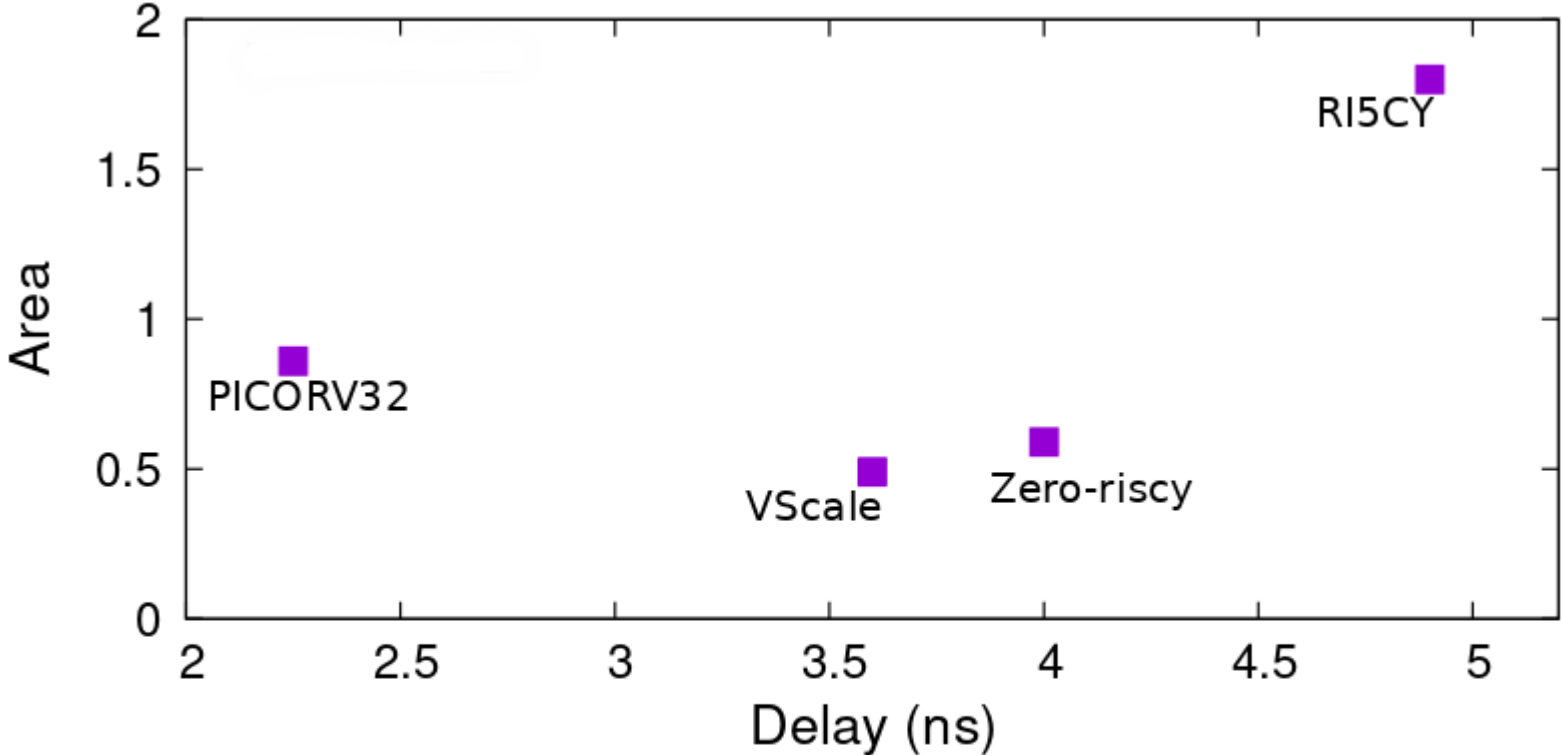
Build a Fast Simulator



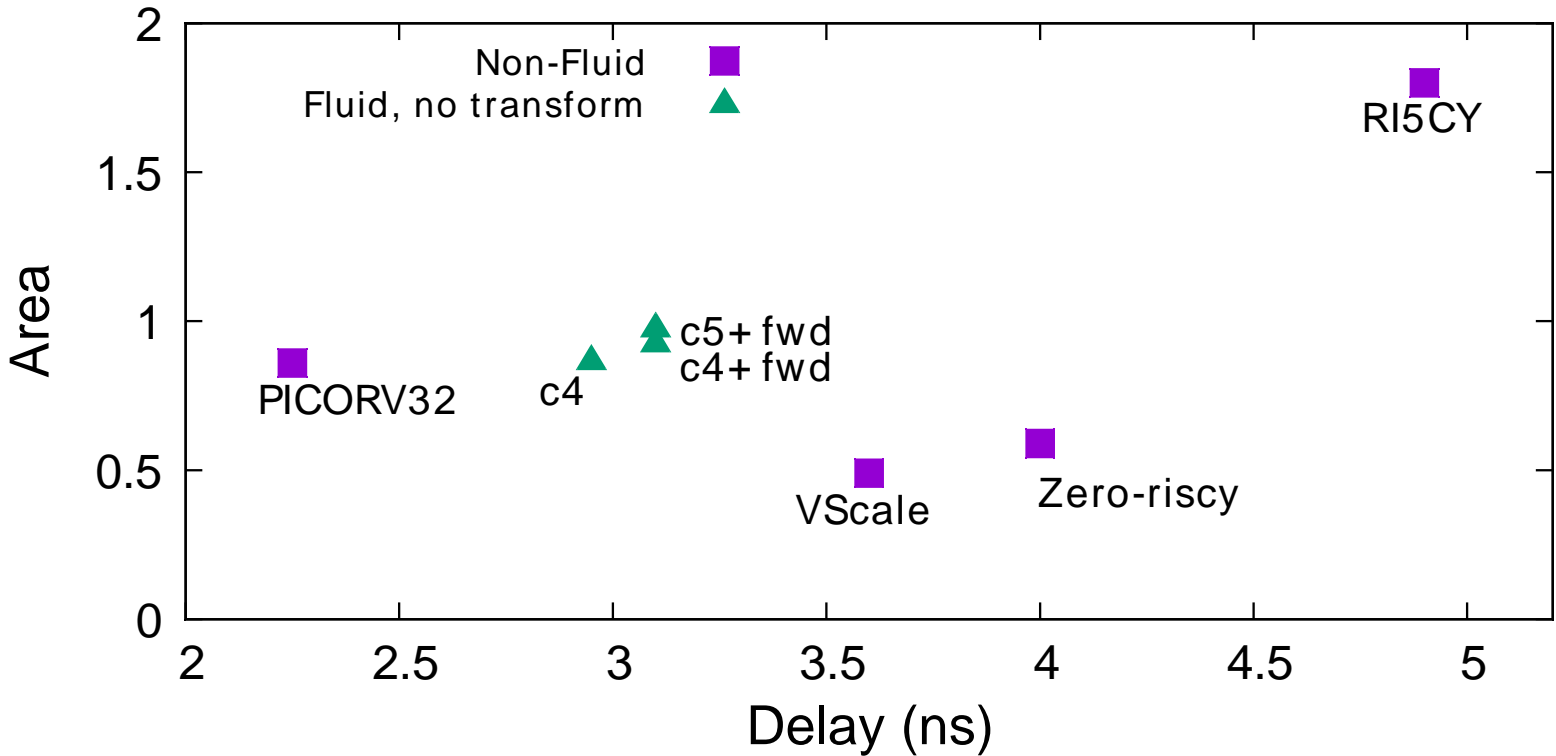
Build a Fast Simulator



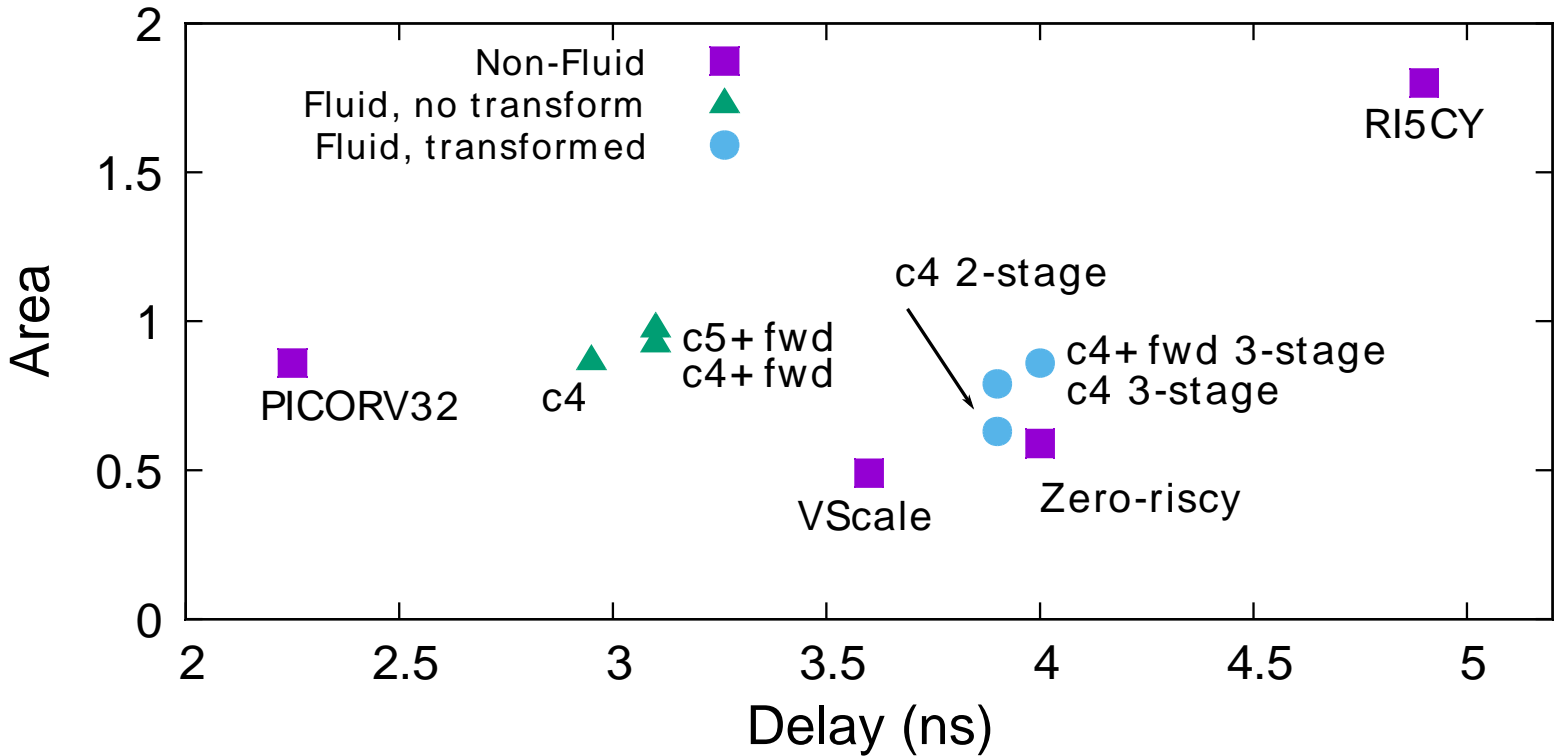
Fluid Synthesis



Fluid Synthesis



Fluid Synthesis



Fluid Verification

- Just collapse the RISC-V core
- Verify it against a trivial single stage RISC-V core
- We used this method on our RISC-V cores

What about Pyrope?

- No time to cover a language in 12 minutes but...
 - I created Pyrope 1.0, this work uses it
 - Akash Sridhar (UCSC) is building Pyrope 2.0 parser
 - Tutorial <https://masc.soe.ucsc.edu/pyrope.html>
 - Working on new backend for fast code generation and hot reload
 - Still not available
 - But we are committed, just look at my advisor's license plate



Questions?



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