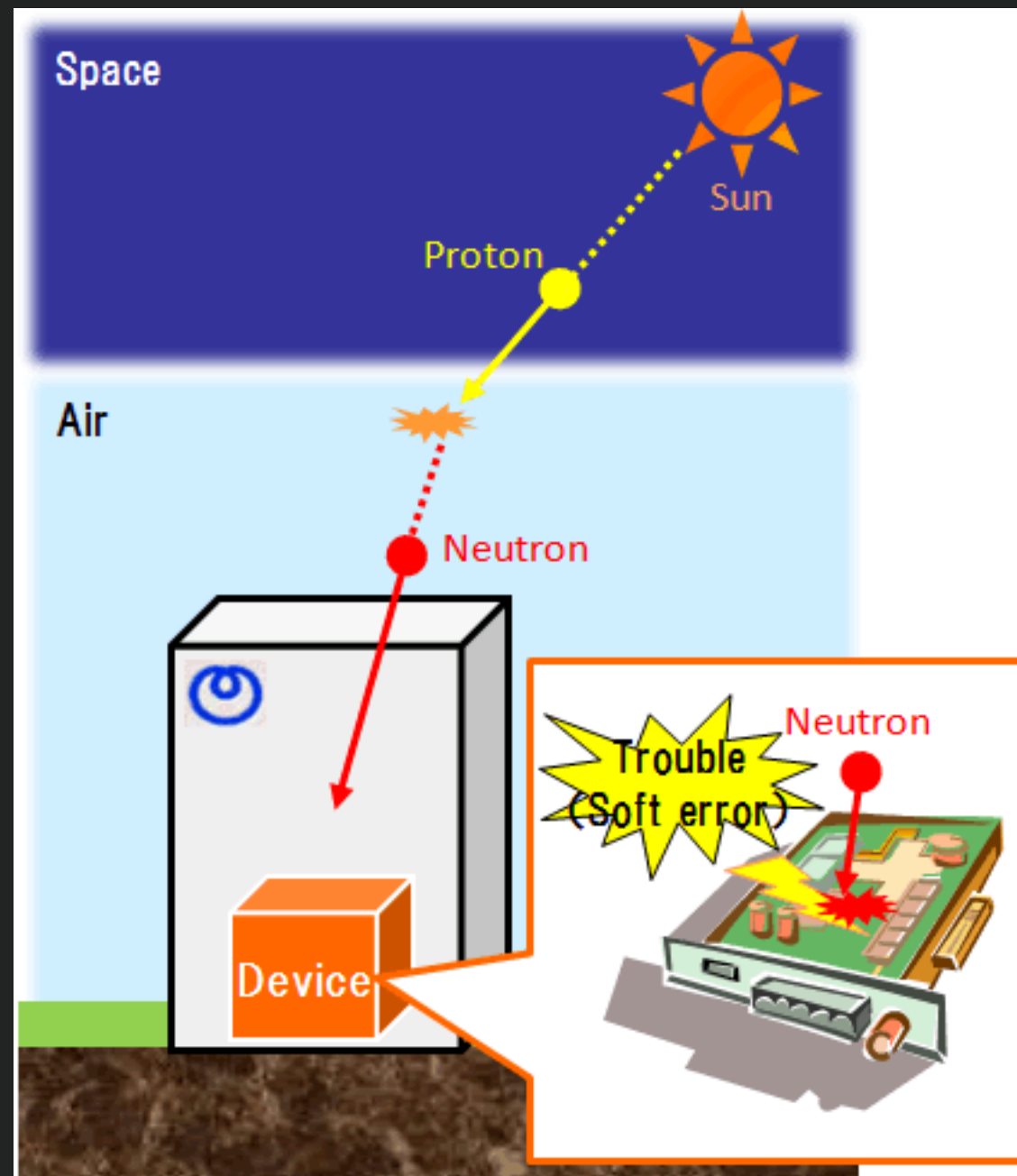


Soft Error Sensitivity and Vulnerability of Programming Languages

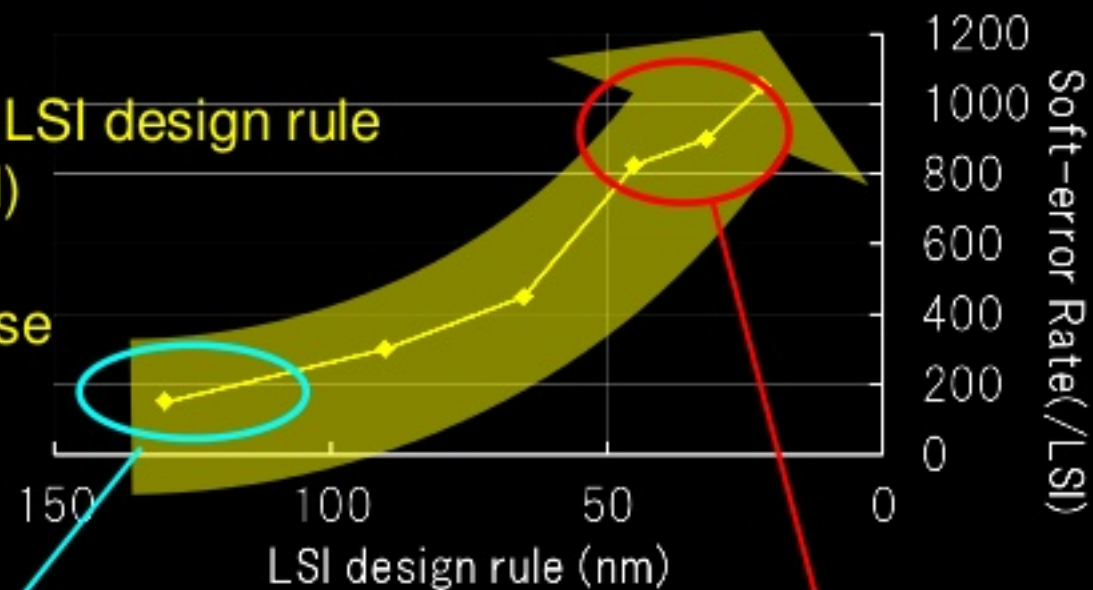
Frederico Cerveira, Alcides Fonseca,
Raul Barbosa e Henrique Madeira



3. The increase of soft errors

Miniaturization of LSI design rule
(Highly integrated)

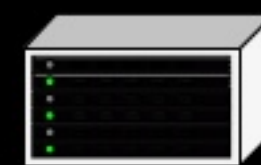
Soft errors increase



Past,
Only in space or the sky



Current,
At ground level



3. The increase of soft errors

How often do soft errors occur ?

SRAM

Since SRAMs have less critical charge (are more sensitive), soft errors occur more frequently.

E.g.

FPGA

SRAM

The FPGA contains large capacity SRAM.

Without soft error mitigation you got **more than 10000 FIT.**

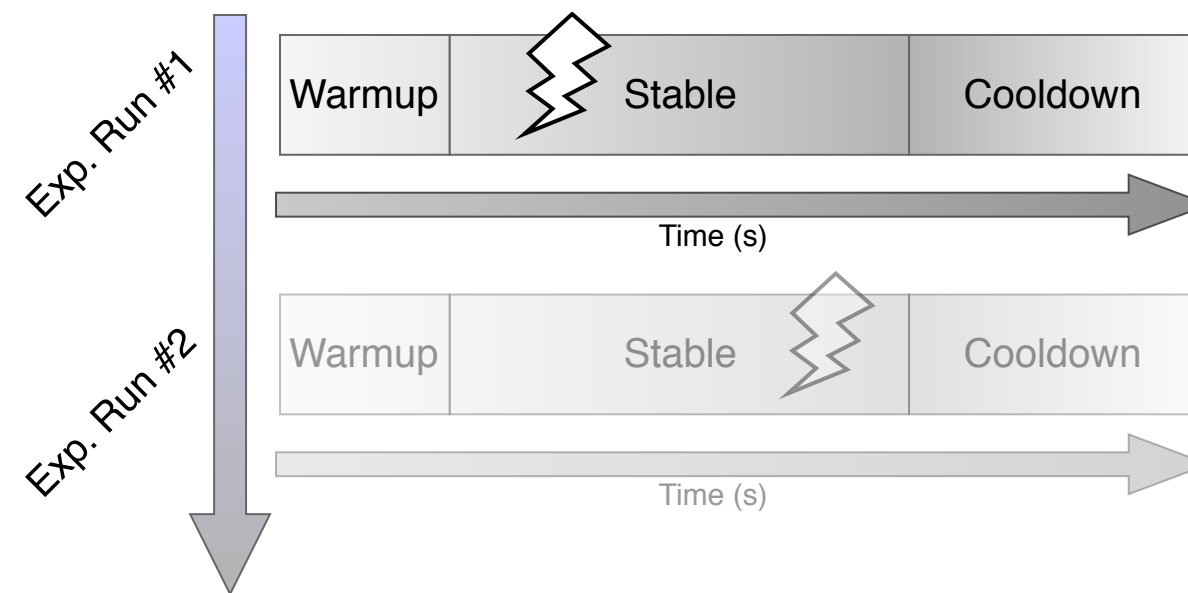


×1000 units in network



About **1.5 devices per day** fail

FAULT INJECTION



The Computer Language Benchmarks Game

“Which programming language is fastest?”

Should we care? How could we know?

“It's important to be realistic: most people don't care about program performance most of the time.”

“By instrumenting the ... runtime, we measure the JavaScript behavior of ... web applications... Our results show that real web applications behave very differently from the benchmarks...”

Too hard, let's measure benchmark programs!

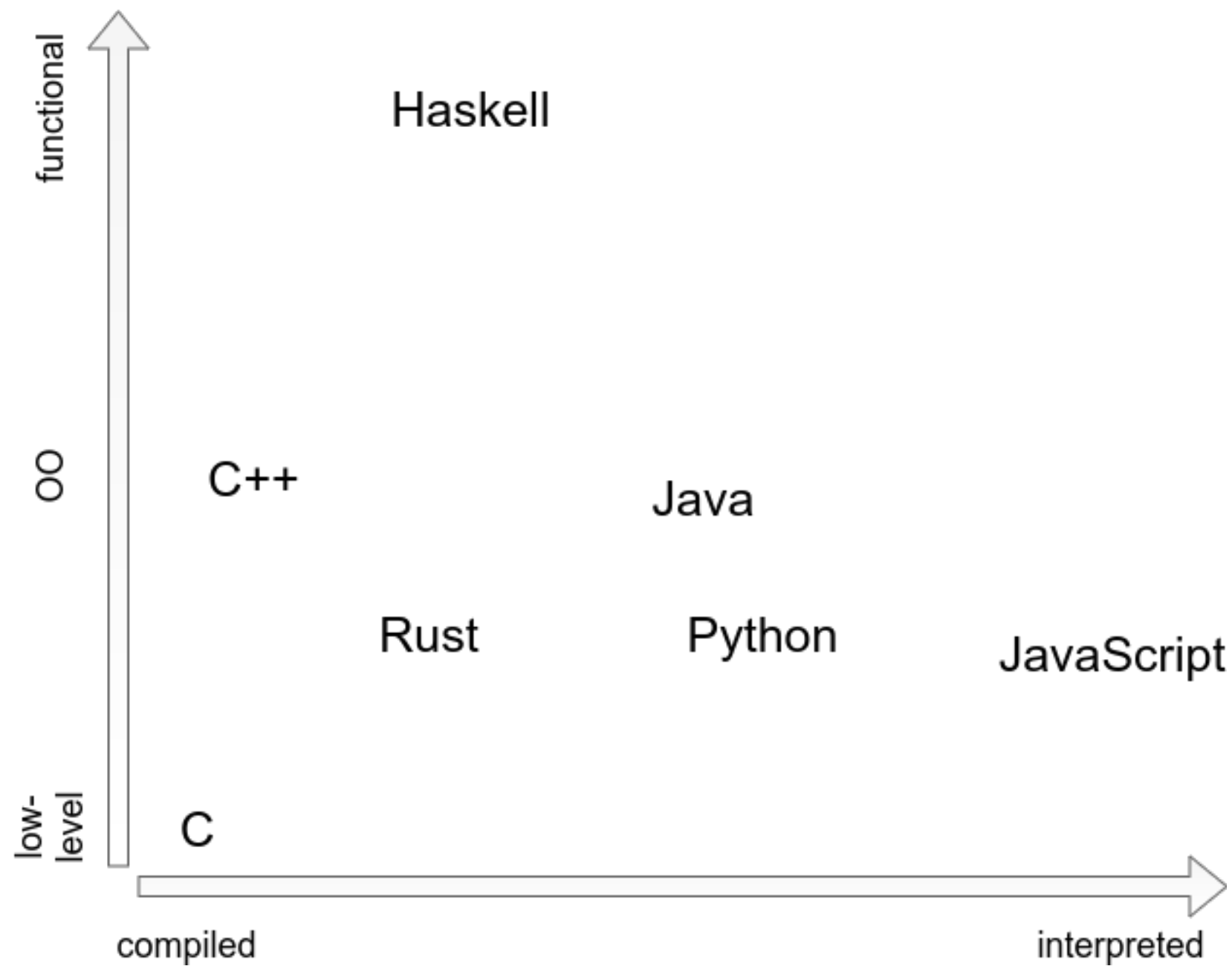
Ada C Chapel C# C++ Dart

Erlang F# Fortran Go Haskell

Java JavaScript Julia Lisp Lua

600 runs per
Benchmark/Language
19800 total runs
~1 month

FAULT INJECTION

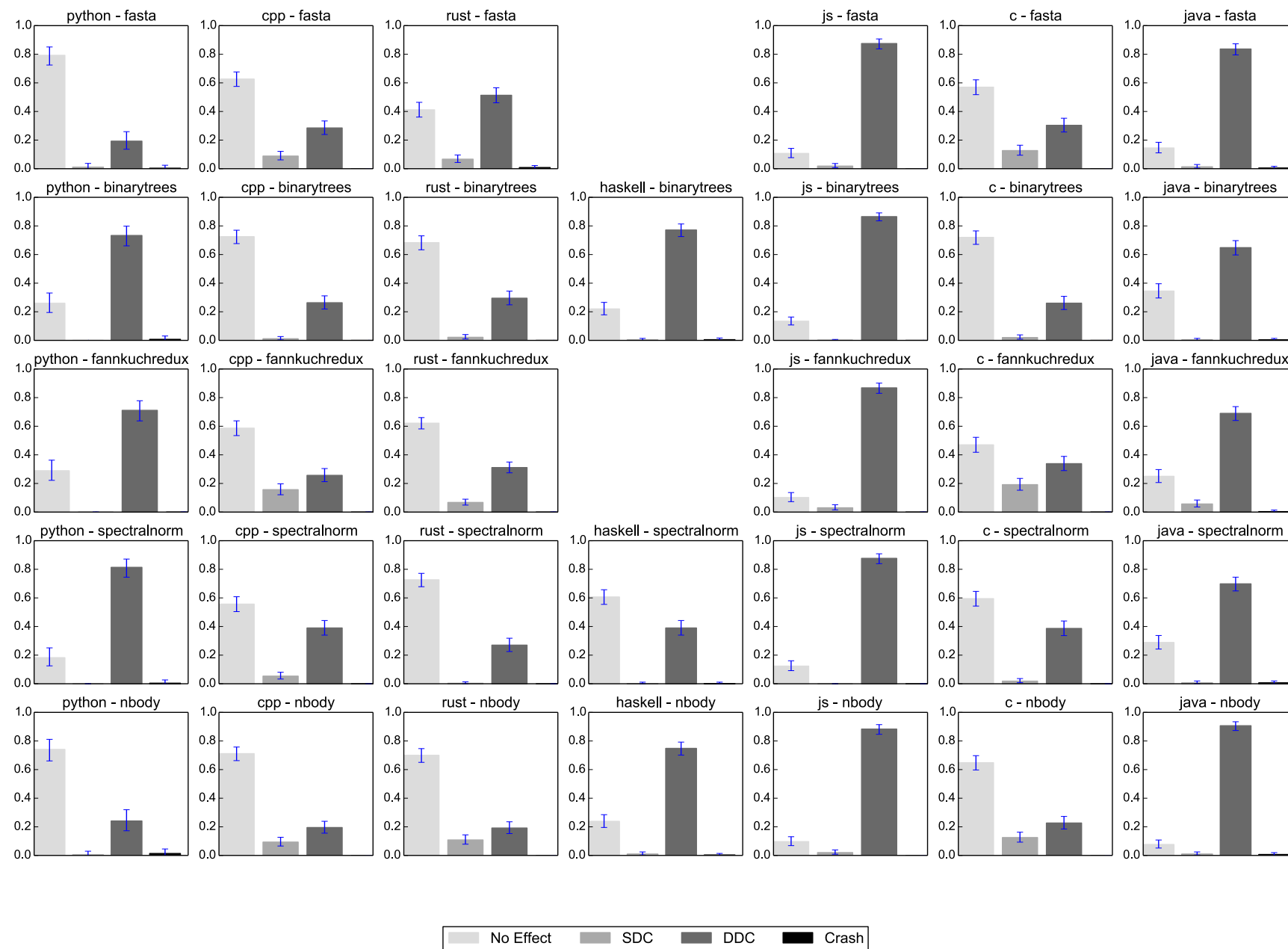


RQ1. *Does programming language have an effect on application sensitivity?*

Yes

RQ2. *Does programming language have an effect on failure modes and probability?*

Yes

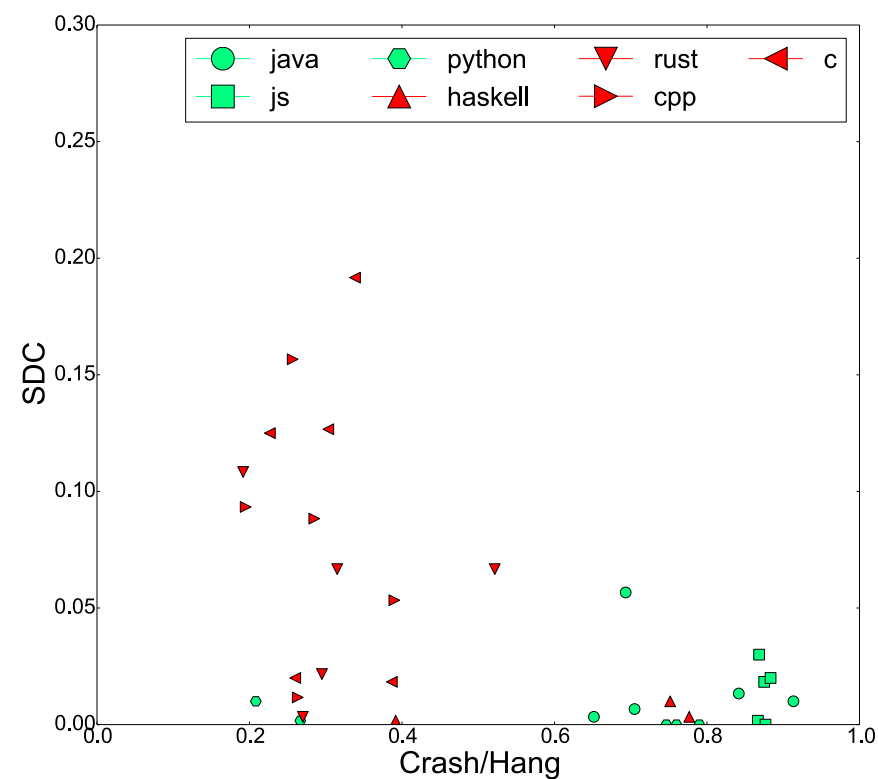


RQ3. *Can we group languages according to their type with regards to failure modes and probabilities?*

Yes

RQ4. *Does workload have an effect on application sensitivity?*

Yes



RQ5. *How large is the effect of programming language on application vulnerability?*

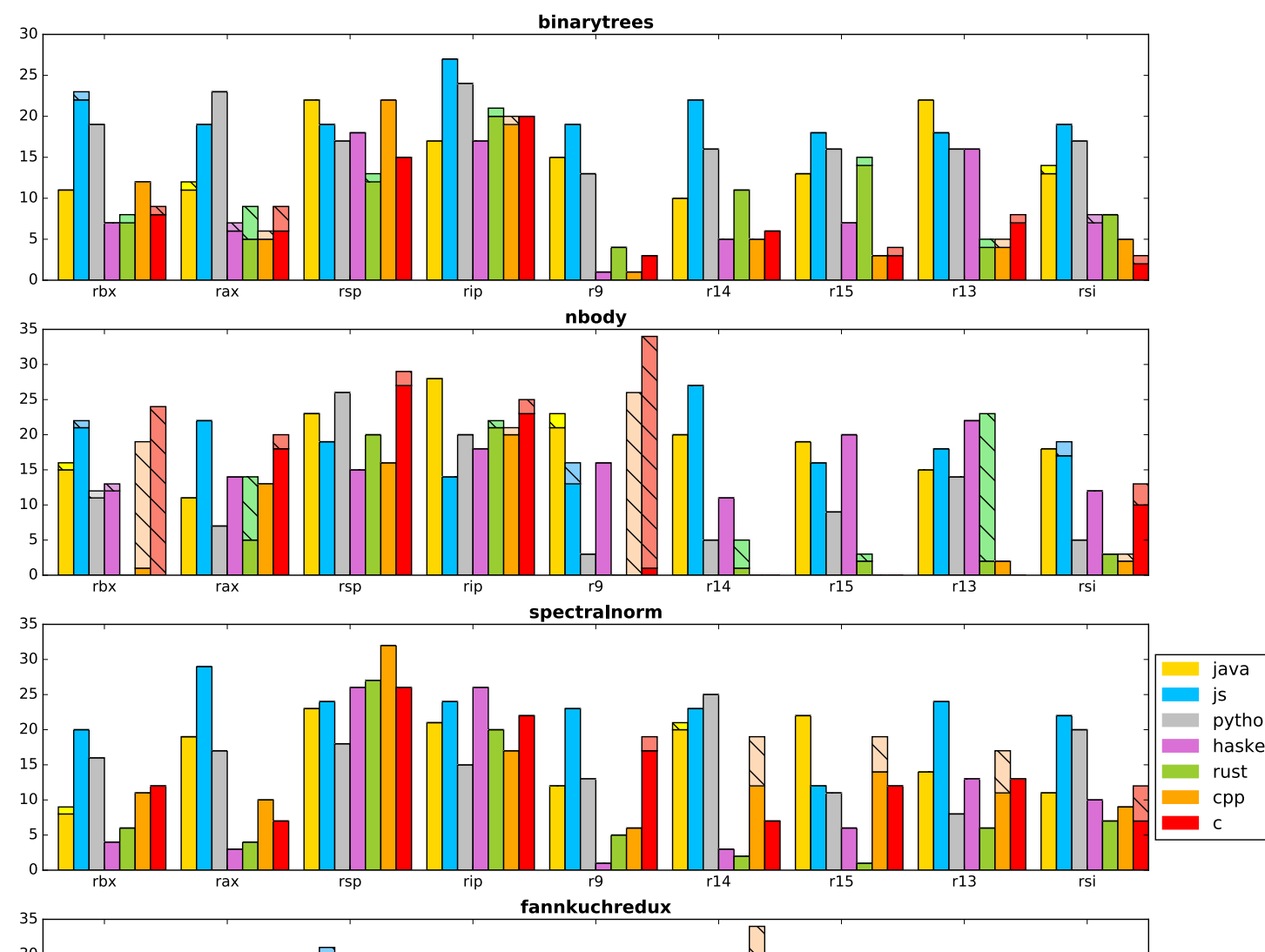
Yes

Mean Time to Failure (m = Months; M=millions of executions)

	spectral		nbody		fasta		binary		fannkuch	
	m	M	m	M	m	M	m	M	m	M
java	195	142	<u>150</u>	42	162	41	212	20	185	82
js	<u>158</u>	23	154	37	<u>155</u>	9	<u>160</u>	4	<u>155</u>	14
python	176	<u>1</u>	518	<u>2</u>	636	<u>3</u>	183	<u>2</u>	186	<u>2</u>
haskell	353	260	182	39	—	—	178	7	—	—
rust	508	762	463	133	236	76	439	184	364	201
c++	313	471	482	193	372	103	505	288	336	169
c	343	483	395	141	323	100	496	295	262	153

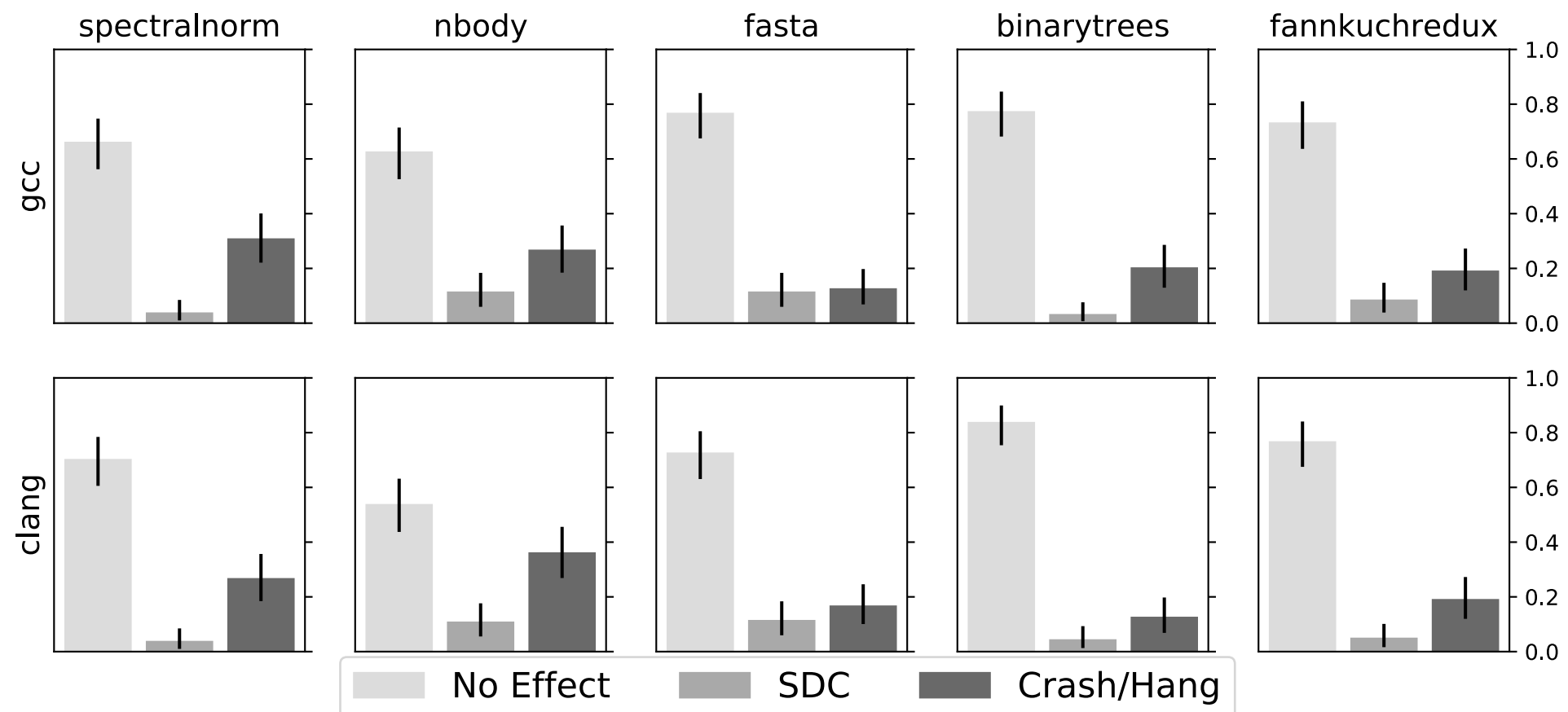
13 to 42 years

RQ6. *What is the interplay between PL, WL and affected register?*



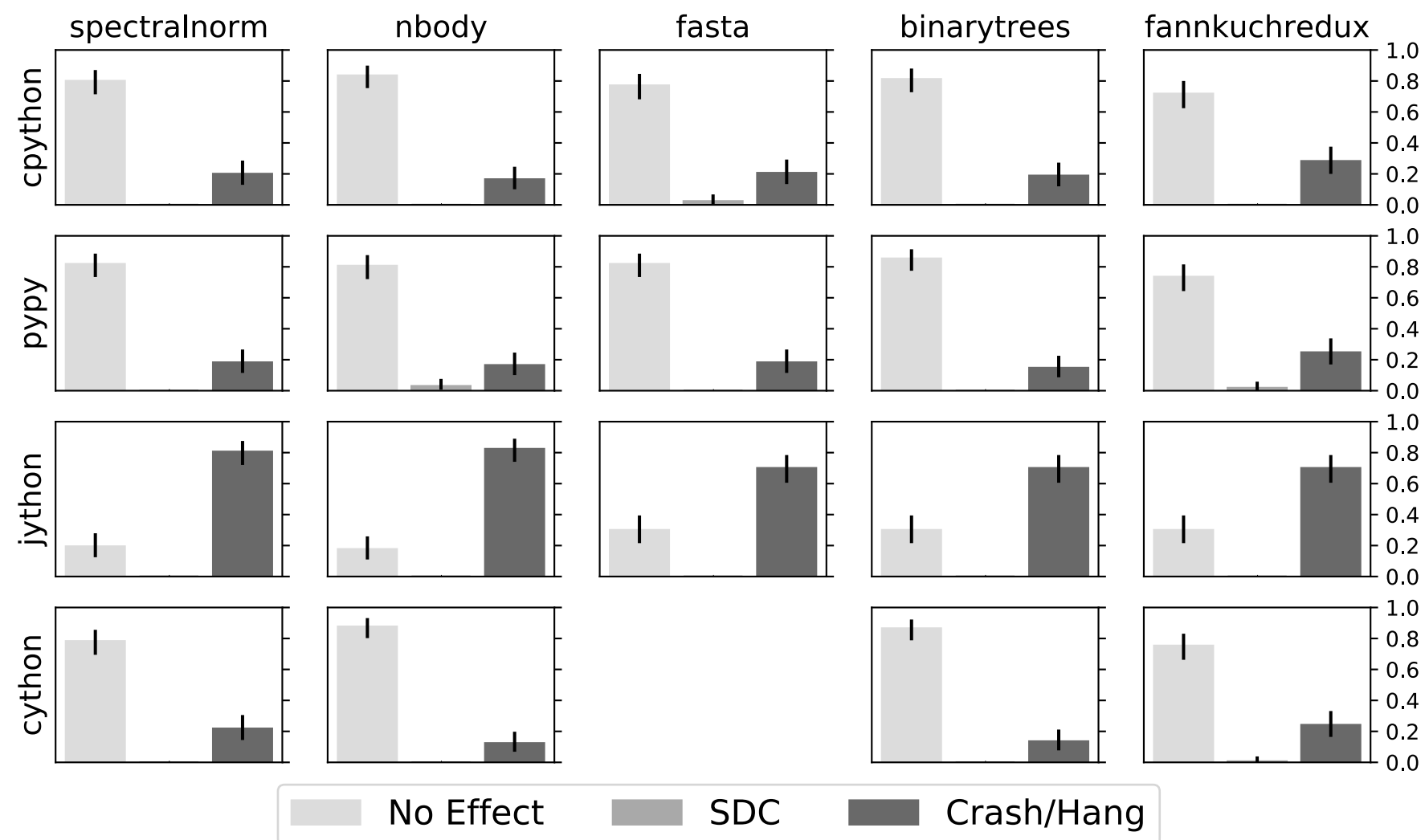
RQ7. *Do different implementations lead to different sensitivity in the C language?*

No



RQ7. *Do different implementations lead to different sensitivity in the Python language?*

Yes



RQ7. *Do different implementations lead to different sensitivity in the Python language?*

Yes

	spectralnorm	nbody	fasta	binarytrees	fannkuch-redux
pypy	905	324	206	297	75
cython	151	97	-	111	23
cpython	77	44	46	32	13
jython	<u>9</u>	<u>6</u>	<u>3</u>	<u>9</u>	<u>5</u>

3m to 17y

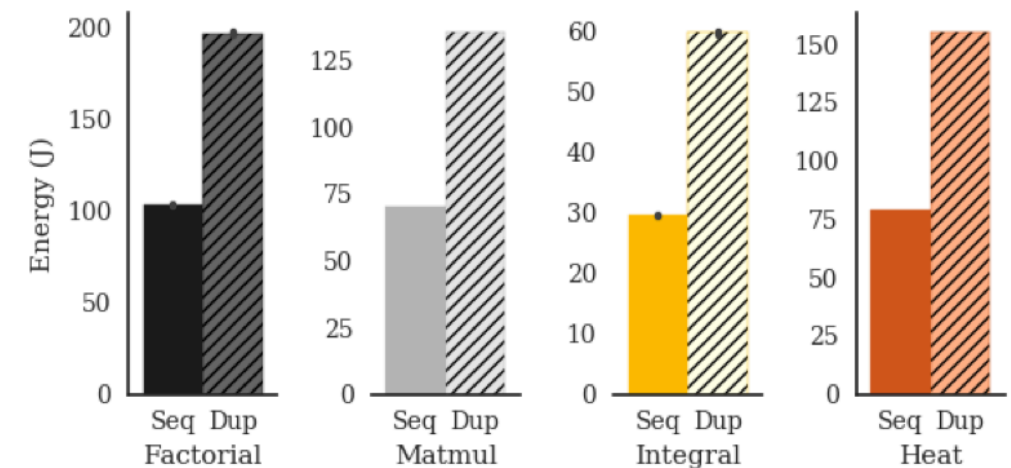
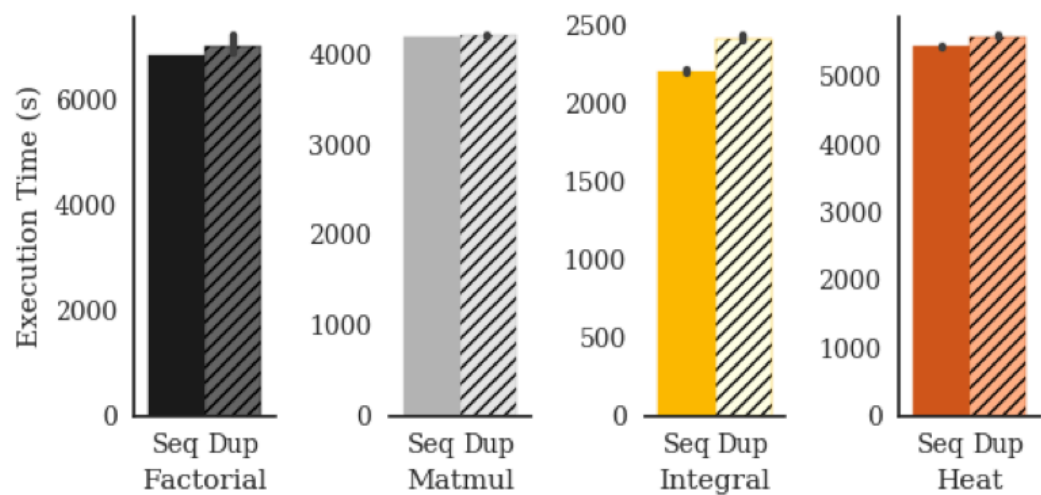


Rock Concert Movement #78

WHAT CAN WE DO ABOUT IT?

- MISO

Program	Factorial		Matmul		Integral		Heat	
Crash	46.51%	(-17.65%)	41.36%	(-24.52%)	43.74%	(-11.74%)	32.52%	(-34.55%)
Incorrect Output	0.0%	(-10.43%)	0.0%	(-1.8%)	0.0%	(-1.74%)	0.0%	(-0.39%)
No effect	53.49%	(+28.08%)	58.64%	(+26.32%)	56.26%	(+13.48%)	67.48%	(+34.94%)



- Refinement Types

Demo!

LASIGE driven by
excellence

Questions?