# SPECS: A new open-source photonic circuit simulator built for speed and reliability





try it out!

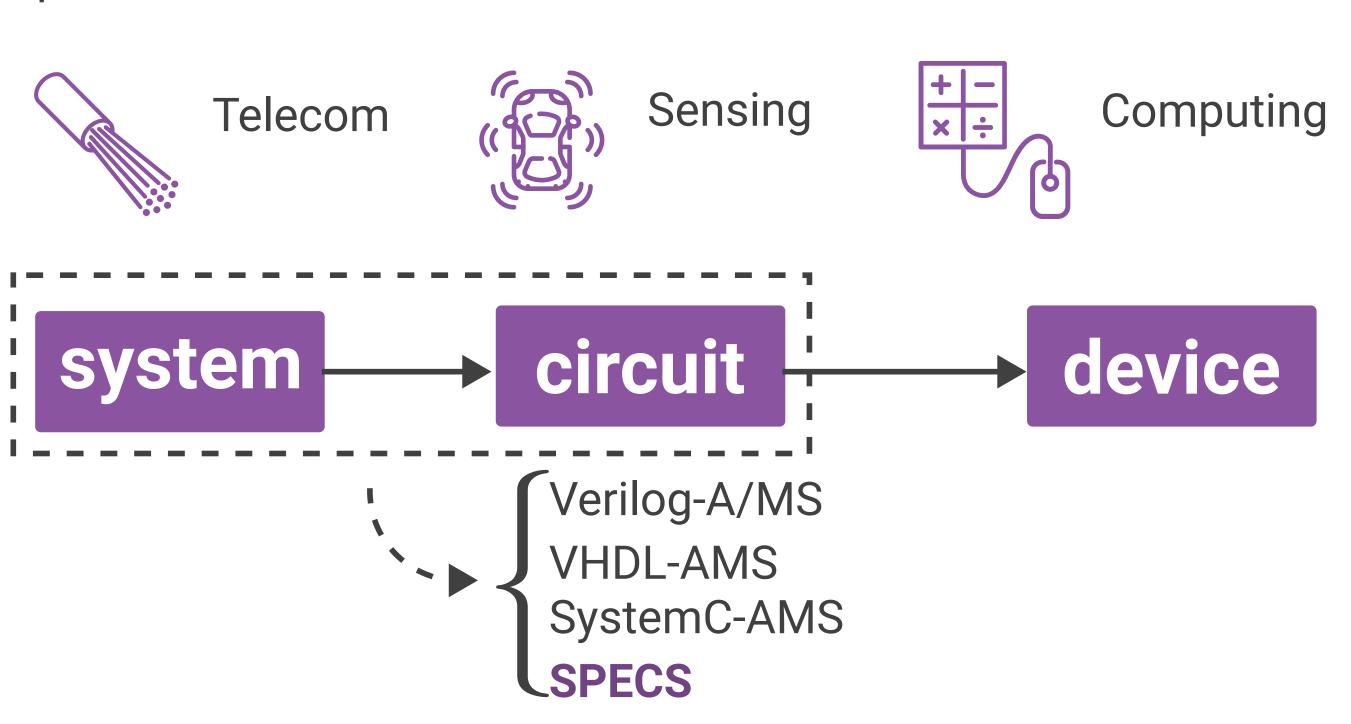
Clément Zrounba, Raphael Cardoso 🔔 M. G. de Queiroz, P. Jimenez, M. Abdalla F. Pavanello, A. Bosio, S. Le Beux, I. O'Connor





### Context

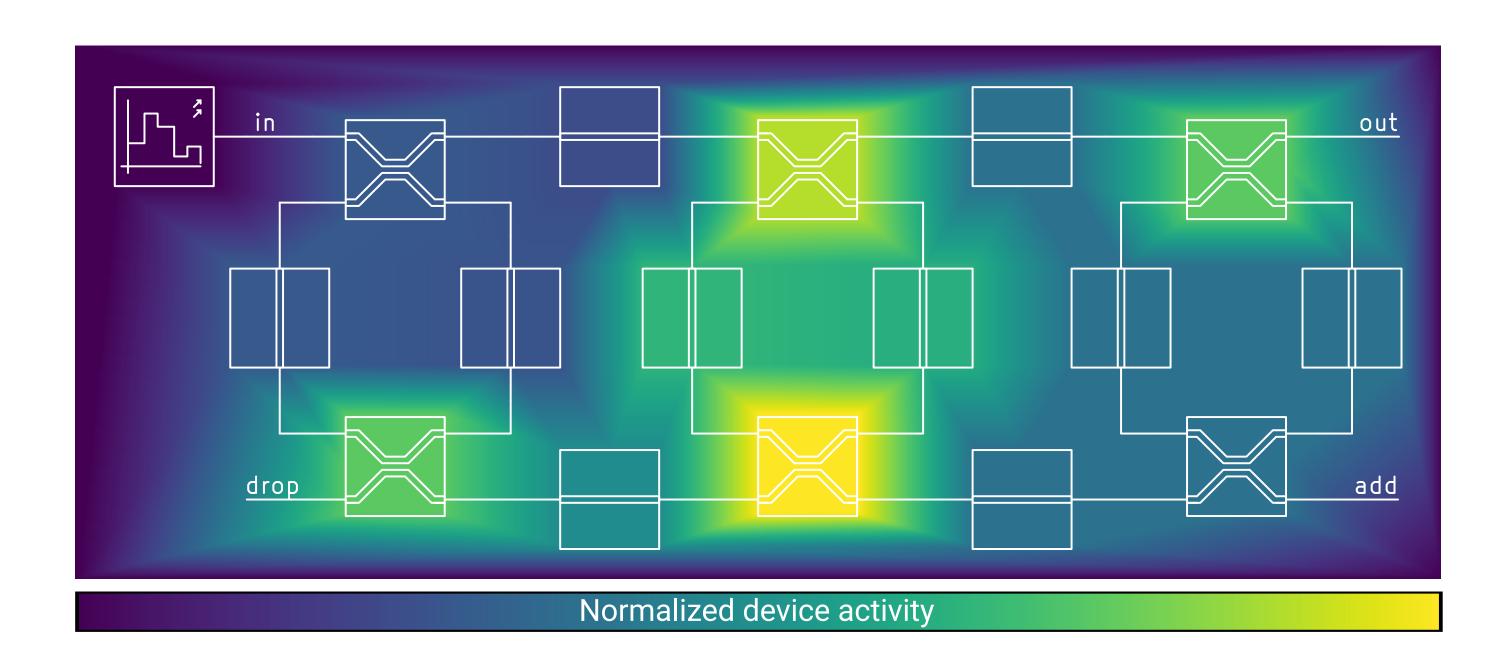
From communications to computing, building large-scale systems calls for efficient modeling tools beyond the devicelevel. We developped SPECS (Scalable Photonics Event-driven Circuit Simulator) as an effort to accelerate simulation of photonic circuits.



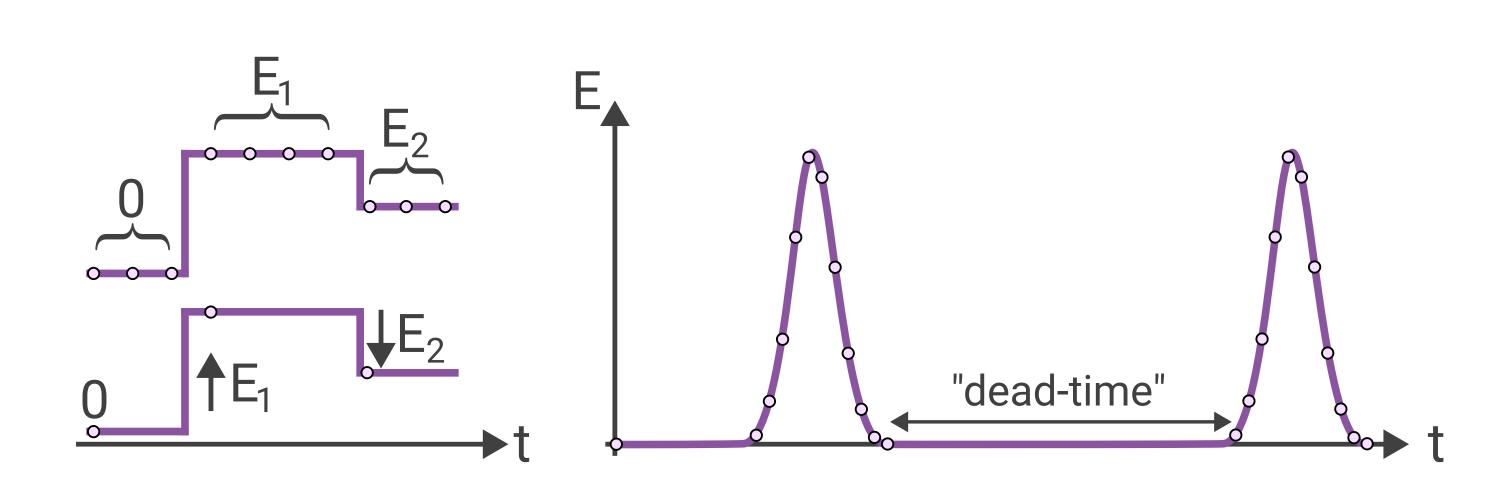
#### Define Define your circuit in a ; Circuit defin schematic editor, or CWSRC1 /in wl=155 WG1 /n2 /n3 length= directly as a netlist WG2 /n4 /n1 length={] COUPLER1 /in /n1 /o/ COUPLER2 /add /n3 PROBE1 /out PROBE2 /drop Simulate Run SPECS to simulate Edit Search Time Marker the photonic circuit and 🗓 🟮 🔍 Q Q 🤚 📂 obtain output trace files SystemC.ROOT/PROBEL.power ROOT/PROBE1 ROOT/PROBE2 SystemC.ROOT/PROBE1.phase Analyze Results can be viewed in GTKWave or exported to Pandas DataFrames

### **Event-driven photonics**

Usable as a SPICE-like standalone program or as a SystemC library, SPECS simulates devices only when needed, saving computer resources and designer time.



In event-driven simulation, signals are not sampled regularly: only variations of the electric field propagate. This scheme is particularly well suited to photonic circuits due to the timescale difference between signals (~ns) and propagation delays (~ps).



# t (ps) 800 (mw) x1000 **SPECS**

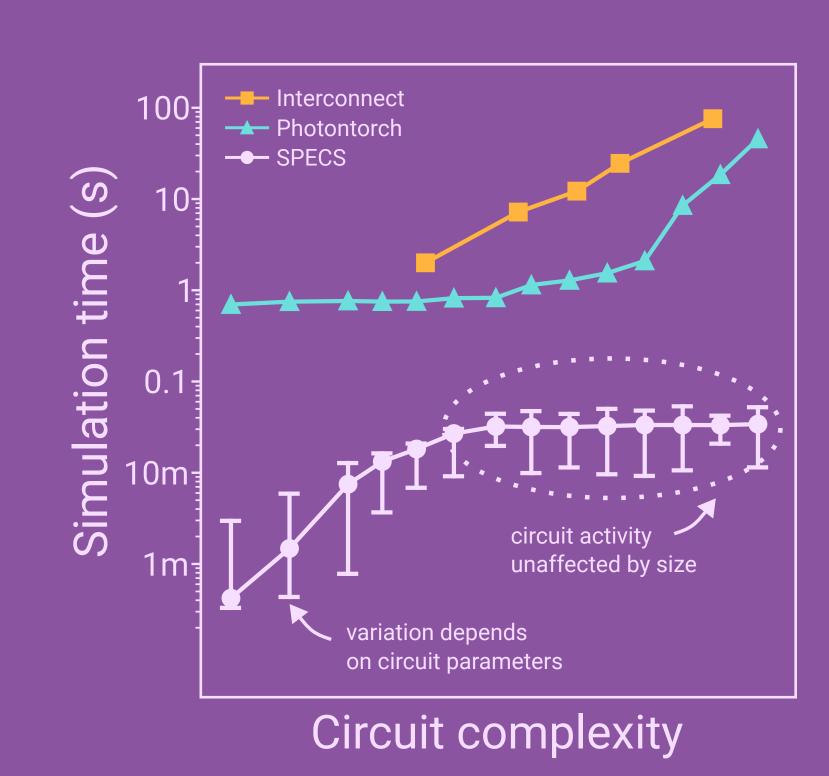
### Accurate...

(100 fs)

SPECS can match the results of tried and tested circuit simulators, such as Lumerical™ Interconnect or Photontorch, while being better at handling sub-timestep delays, avoiding numerical errors that can corrupt Interconnect's results at low temporal resolutions.

## ... and yet, fast!

SPECS is generally orders of magnitude faster in time-domain simulations of digitally controlled circuits, unless the circuit has a high activity rate, a rare case in large photonic circuits. SPECS is up to 1000x faster running a 512-ring CROW circuit.



ECOC 2023 - paper no: 578