COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Let's Create an Open-Source MOSbius

Peter Kinget

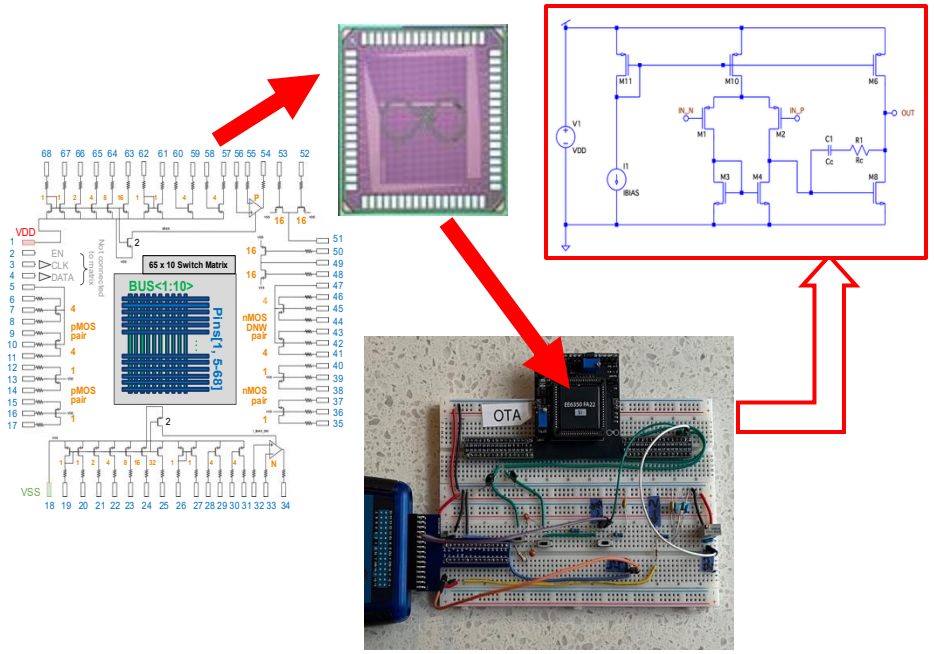
Analog & RF IC Design Research

Columbia Integrated Systems Laboratory

http://www.cisl.columbia.edu

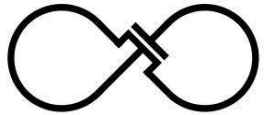
IEEE SSCS Chip-A-Thon 2025

MOSbius Track



https://sscs.ieee.org/technical-committees/tc-ose/sscs-pico-design-contest/

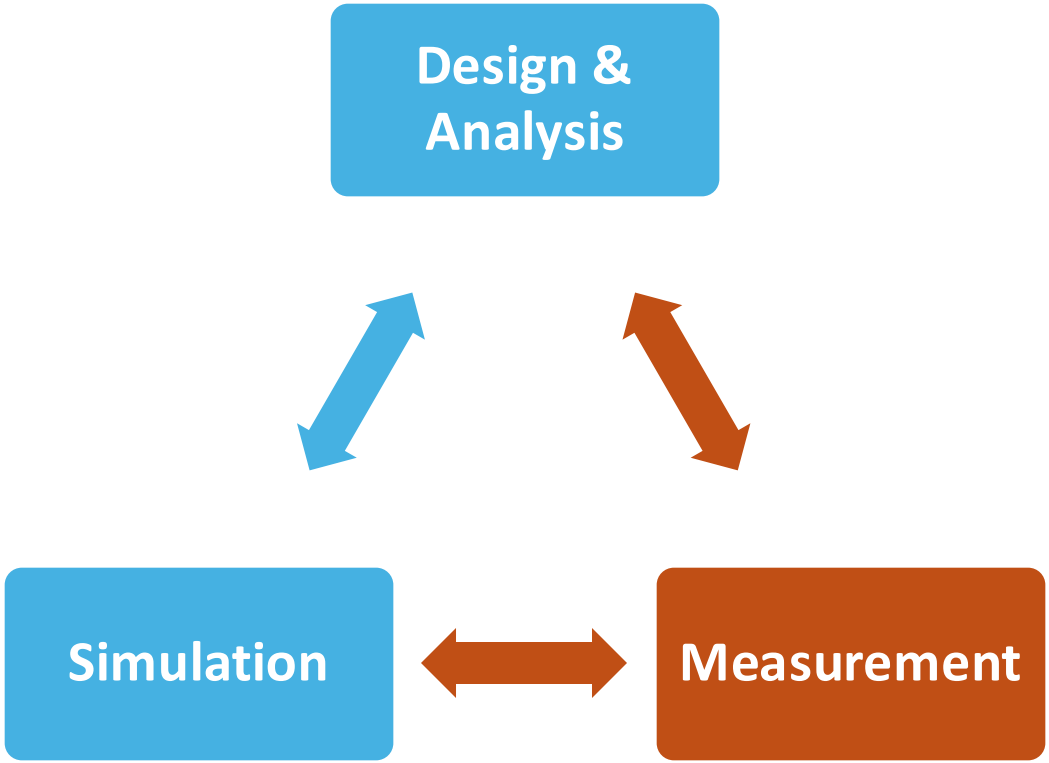
MOSbius Mission



Make it easy for learners to experiment with CMOS transistors in circuits relevant to IC design

https://mosbius.org

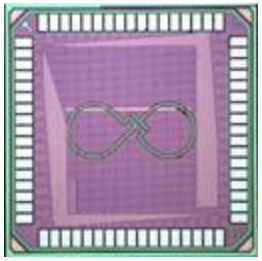
Motivation: Learning IC Design

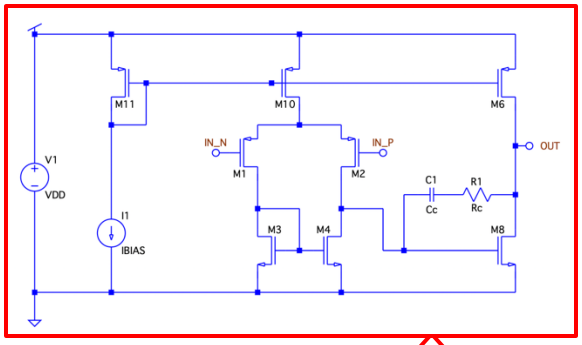


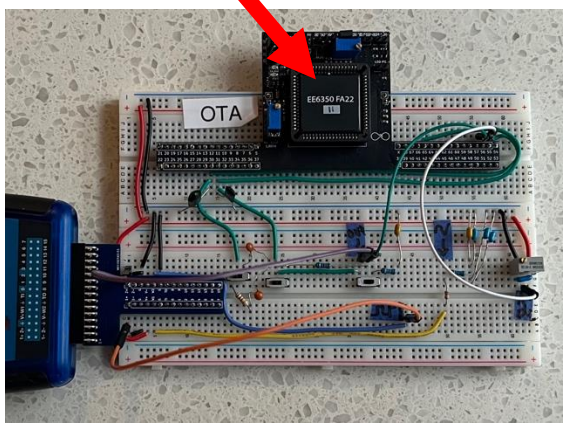
Simulators only answer the questions you ask them … What questions should you be asking?

Silicon does what ***it*** wants to do, not always what ***you*** want it to do …

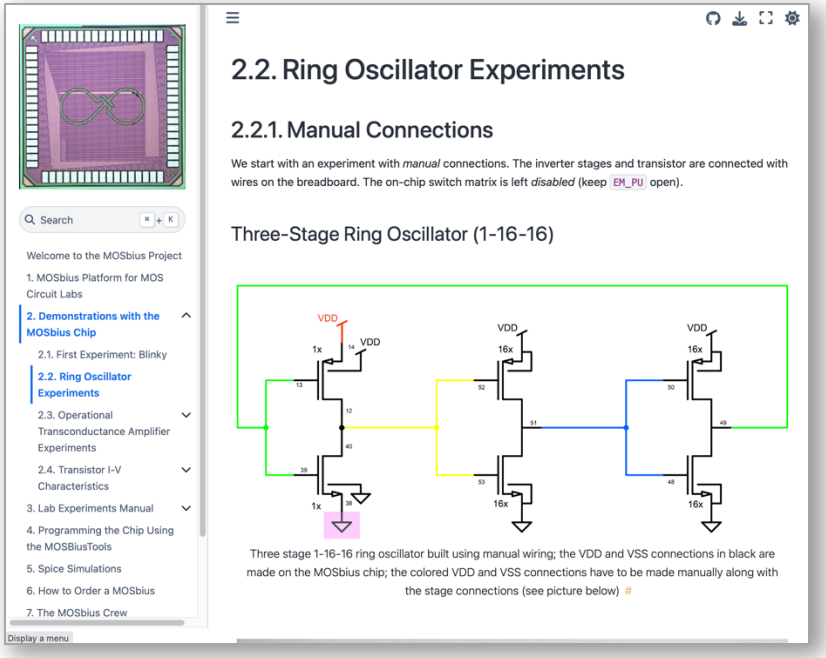
What is MOSbius, so far?







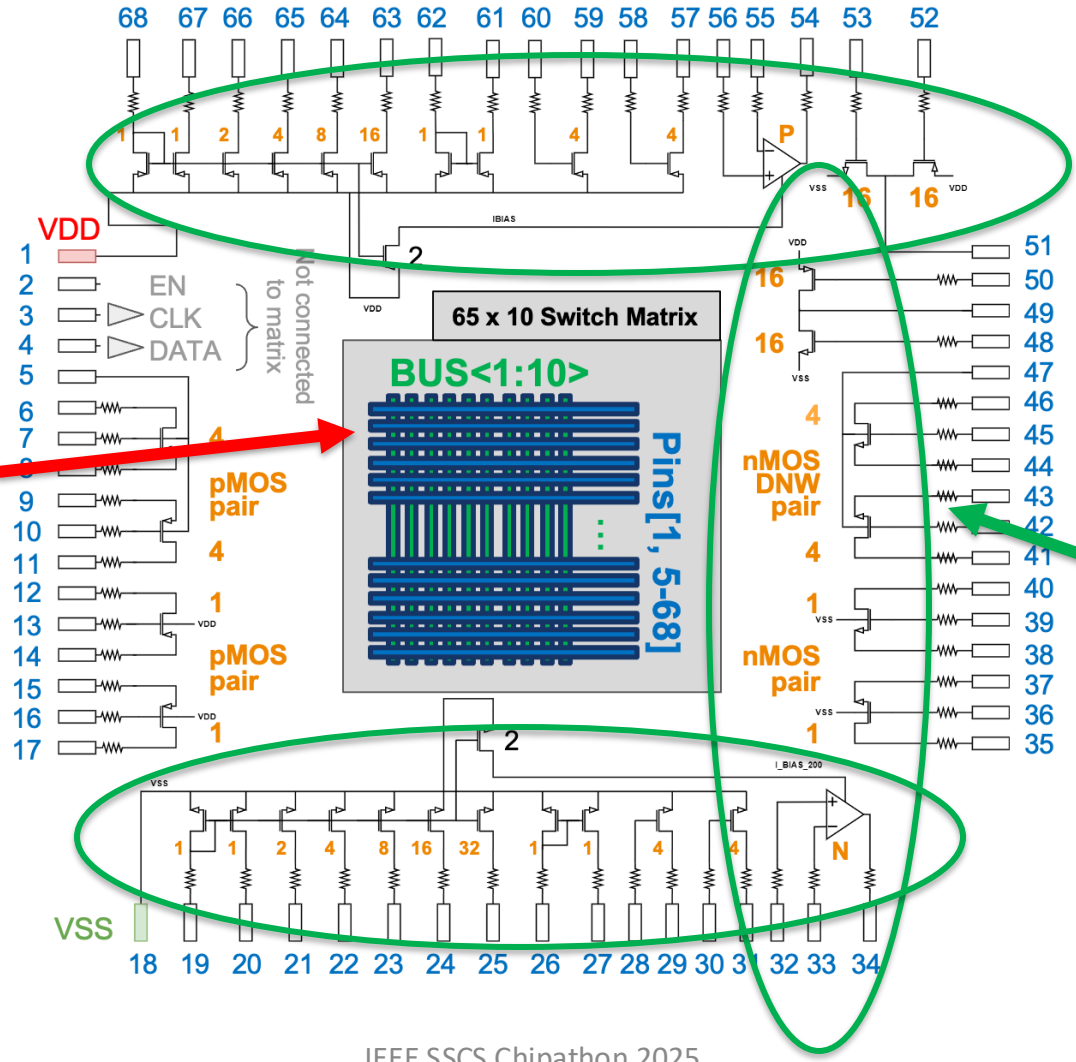
Current version: focus on transistor-level analog design



- Website
- Programming support
- Simulation support

https://mosbius.org

What is MOSbius, so far?



Programmable On-Chip Switch Matrix

Custom Digital

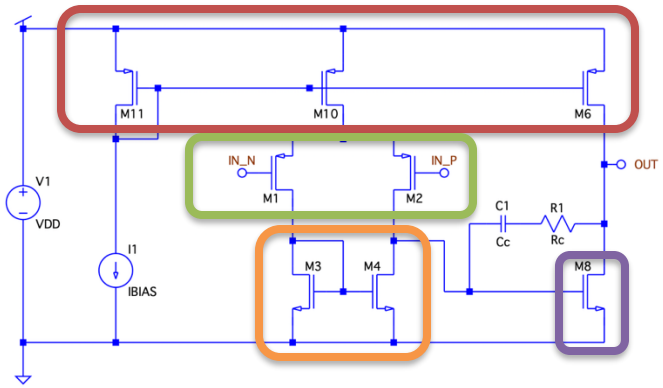
Building Blocks

connected to pins

Custom Analog

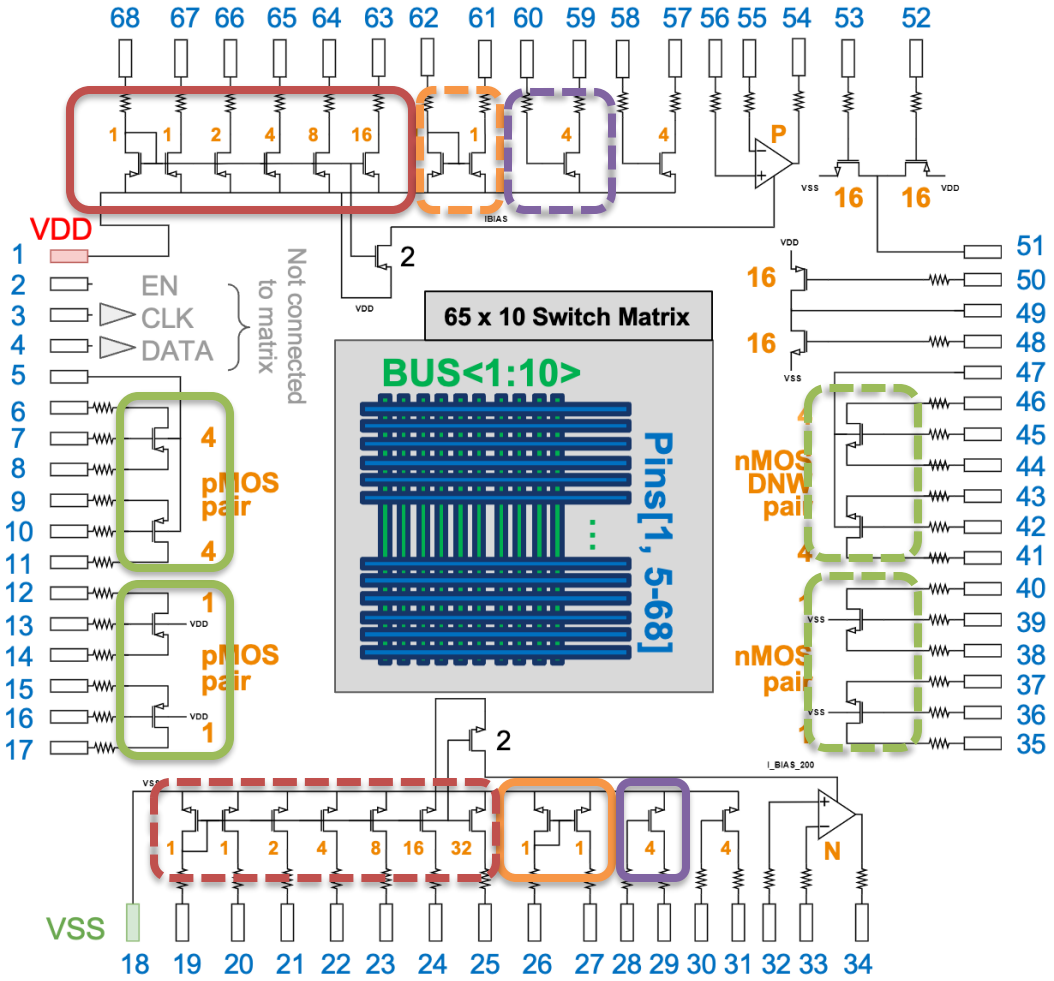
How was MOSbius architected?

- Started from two-stage OTA
  - pMOS input diff. pair

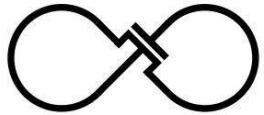


  - nMOS input diff. pair → dashed boxes
- Provided all components for a fully differential two-stage OTA
- Added other blocks like:
  - One-stage OTAs
  - Inverter output stages
- Added Switch Matrix
  - 10 BUSes
  - CLK, DATA, EN pins

Note: Even though we started from a two-stage OTA, many other circuits have been built with these basic transistor assemblies



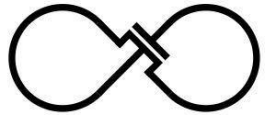
How to architect your MOSbius chip:



- Think about use cases for your chip
  - What experiments can your chip support?
  - How easy will your chip be to use, program, …
  - How will your chip & experiments draw people into IC design?

The design goals are not only about the design and tape-out, but also about your chip's application, i.e., what experiments your chip can support.

MOSbius Chipathon Ideas



- Port current '*analog*' MOSbius (in part) to GF180
  - Significant benefits that everything will be in open-source, in particular, transistor models and layouts → better simulations, 3D animations, …
- Develop '*digital-transistor-level*' MOSbius
  - DFFs, logic gates, ... at circuit level
- (very advanced) *RF* MOSbius
  - RF building blocks to configure various RF receiver topologies
- **Your Ideas ….**