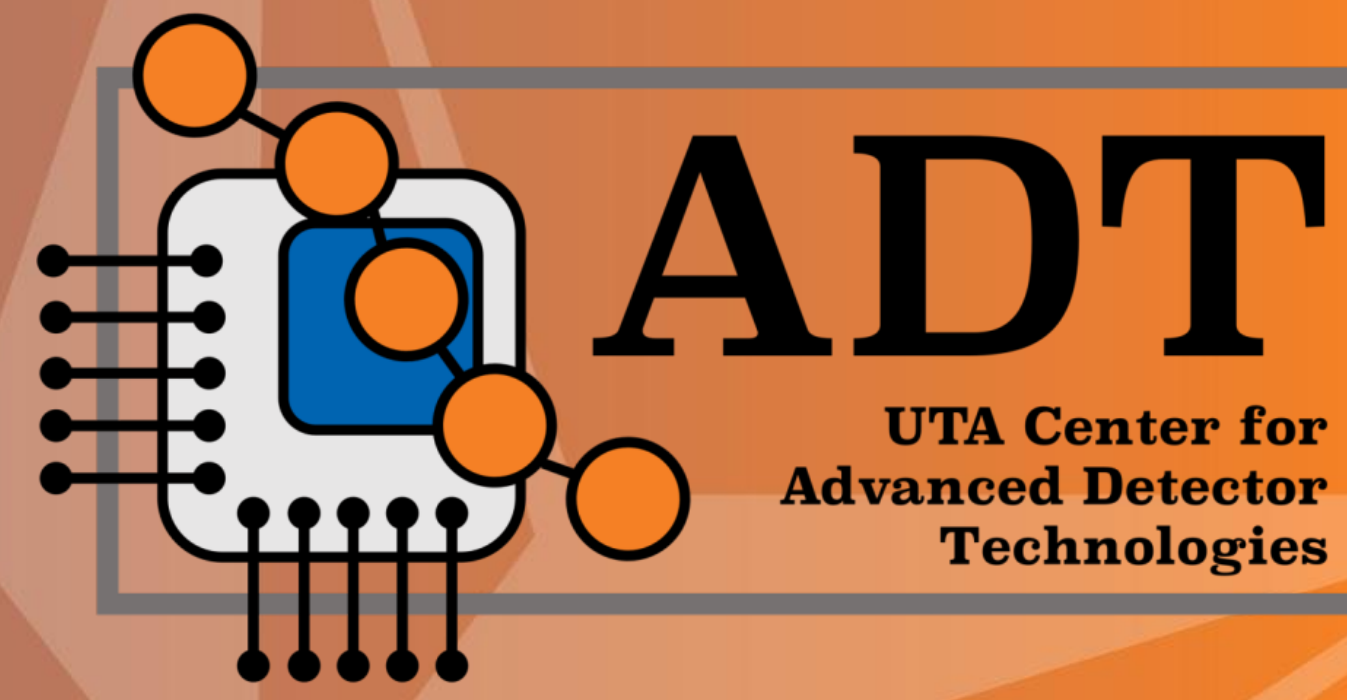




THE UNIVERSITY OF TEXAS
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OSAM: Open Source AI-Assisted Analog Design for Room Temperature and Cryogenic Detector Electronics

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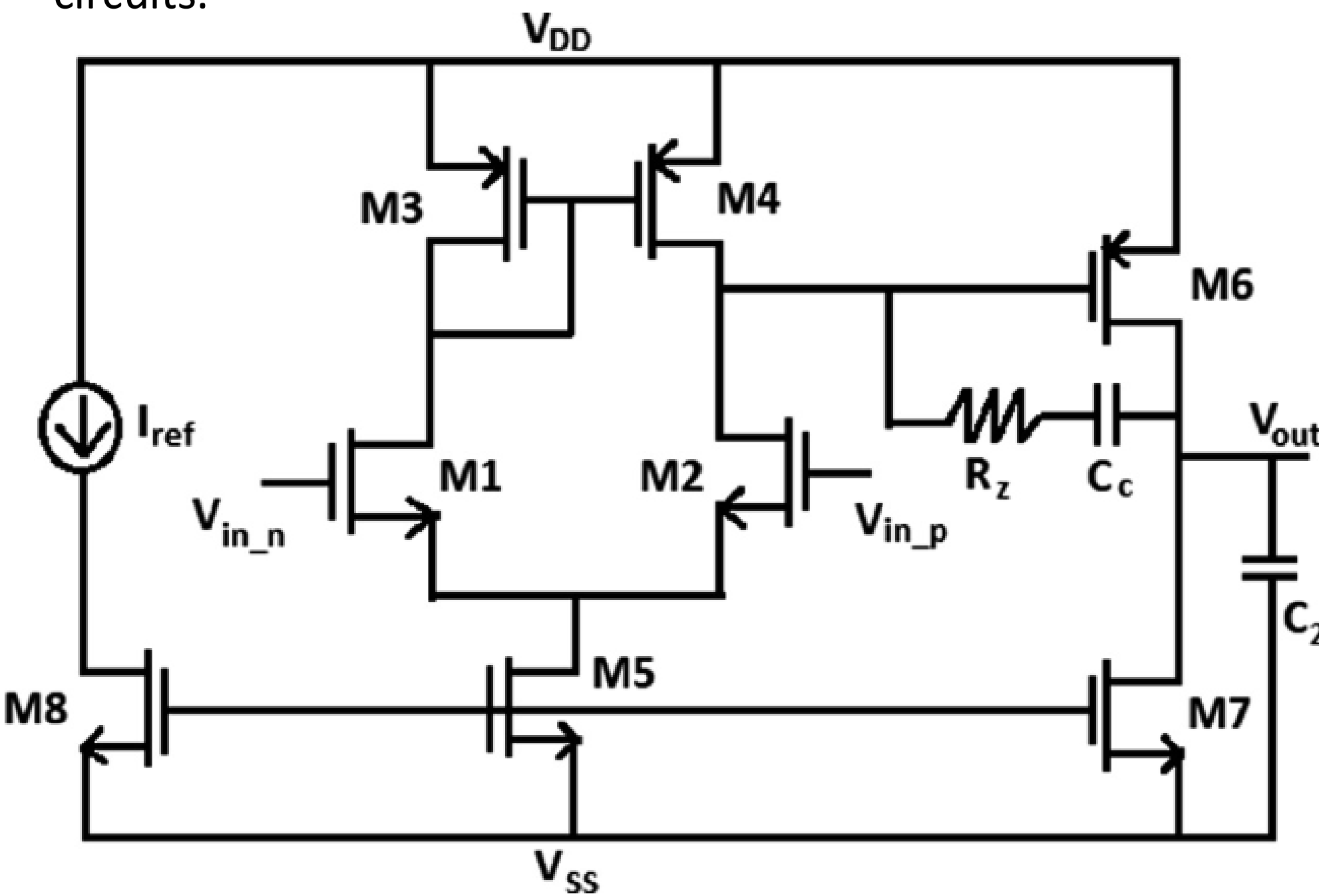
Introduction/Motivation

Analog integrated circuit design is time-consuming and traditionally requires years of specialized expertise. Liquid-argon particle detectors rely on custom application-specific integrated circuits (ASICs) operating at cryogenic temperatures, motivating the development of electronics compatible with operation near 77 K.

We introduce **OSAM (Open-Source Analog designer Machine)**, a multi-agent, AI-driven framework for automated analog circuit design and optimization. OSAM integrates open-source EDA tools with standard SKY130 PDK models for room-temperature design (300 K) and cryogenic transistor models developed at the University of Texas at Arlington (UTA) for 77 K operation.

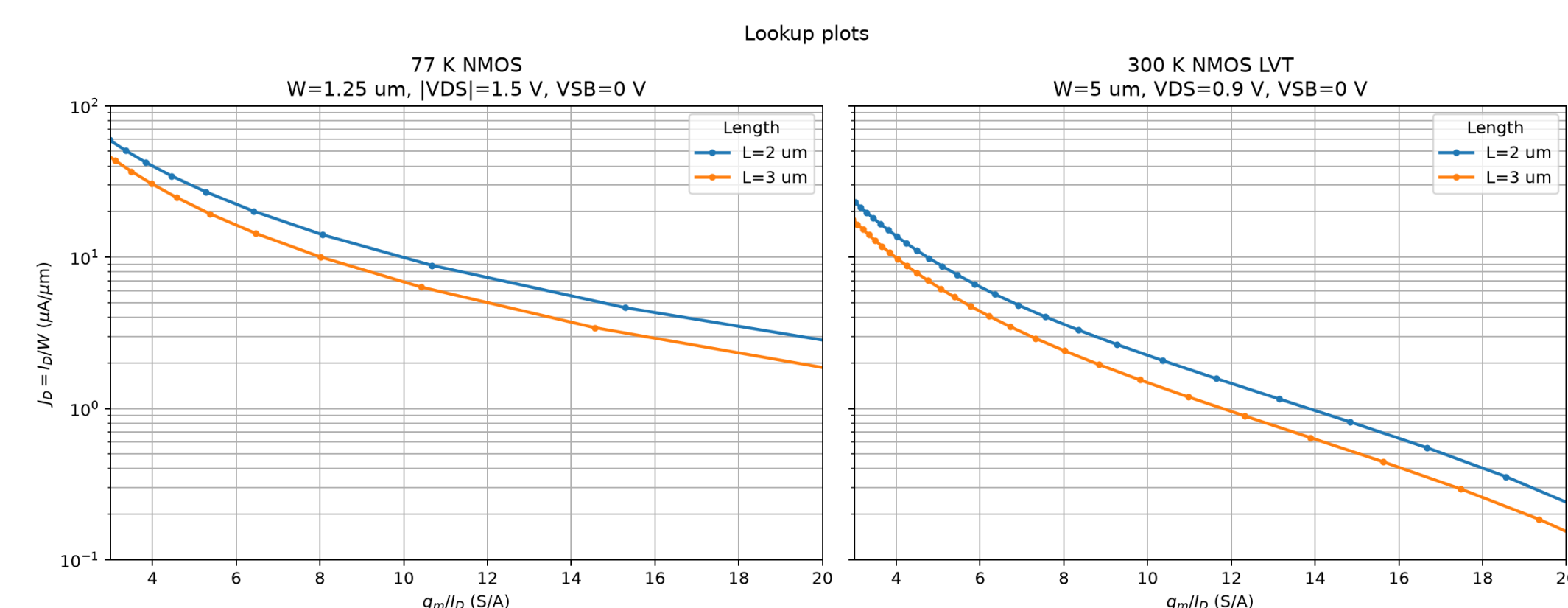
Circuit Under Design

We demonstrated OSAM using a two-stage Miller-compensated CMOS operational amplifier as an initial benchmark, establishing a foundation for extending the framework to a broader range of analog circuits.

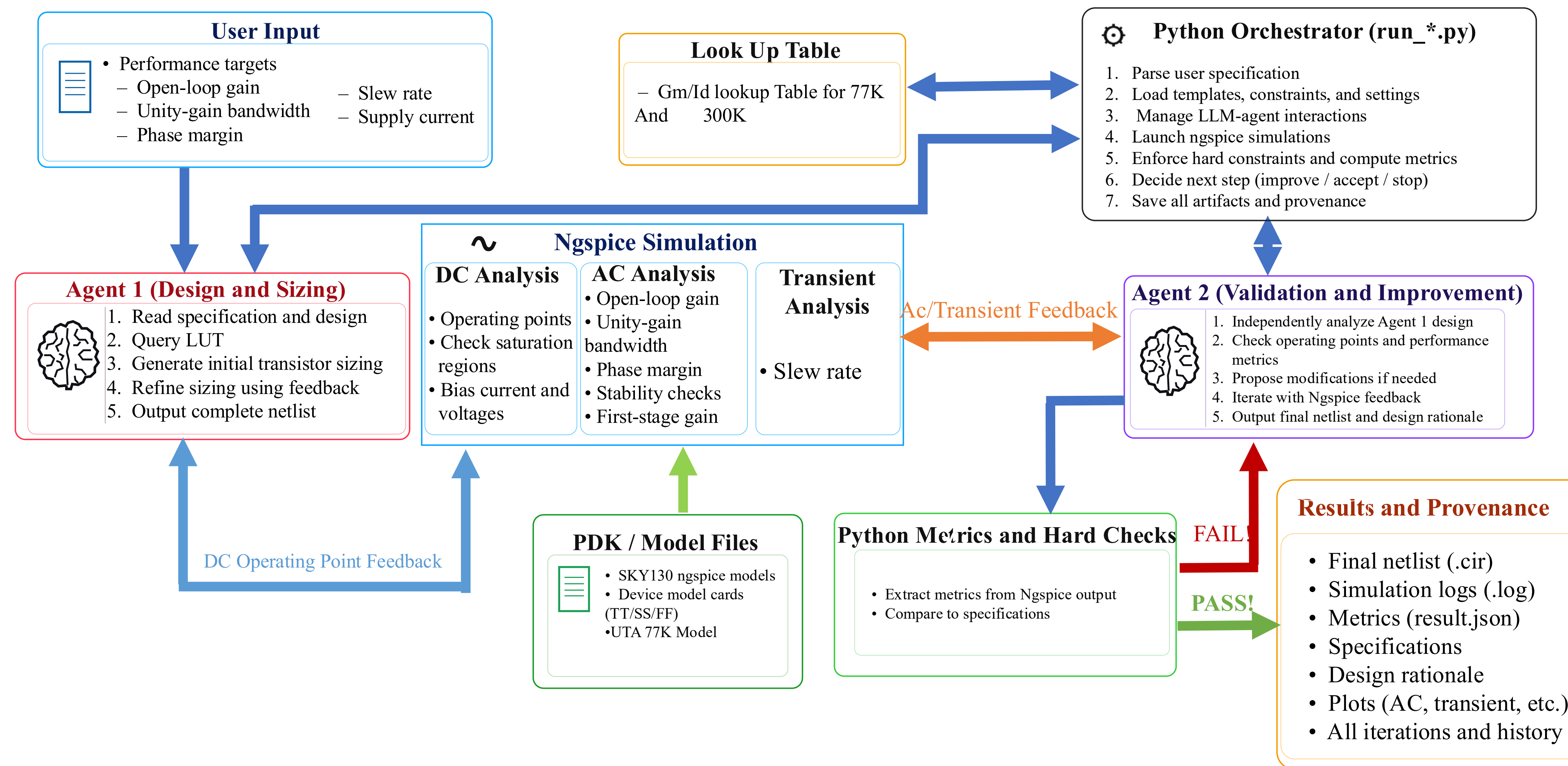


Circuit Under Design

OSAM uses transistor-characterization lookup tables based on the (gm/ID) design methodology of Jespers and Murmann [1, 2]. The framework uses the open-source SKY130 PDK at 300 K and cryogenic transistor models developed at UTA for 77 K [3]. Three LLMs—GPT-6.1 Sol, Gemini 3.8 Flash, and Claude Sonnet 5.5—were evaluated using the same two-agent design framework. The agents iteratively design and optimize circuits using Ngspice feedback, while independent Python-based checks verify that the final designs meet the specified performance requirements.

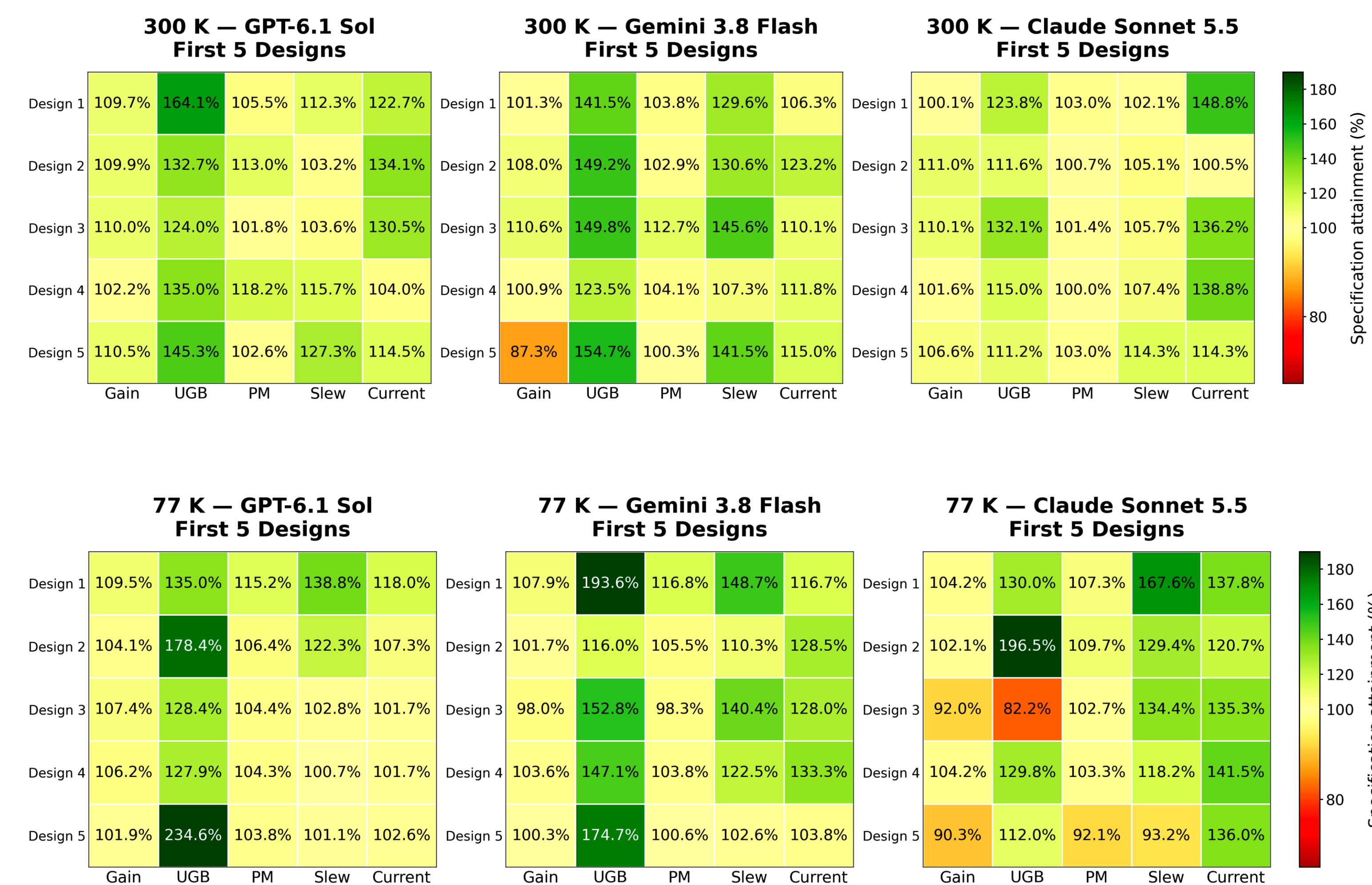


OSAM Multi Agent Design Workflow



OSAM: Design Performance at 300 K and 77 K

- GPT-6.1 Sol, Gemini 3.8 Flash, and Claude Sonnet 5.5 were evaluated using the same OSAM framework.
- The first five completed op-amp designs generated by each model at each temperature.
- Performance relative to design specifications. Green indicates greater margin, yellow indicates near-threshold performance, and red indicates a specification violation.

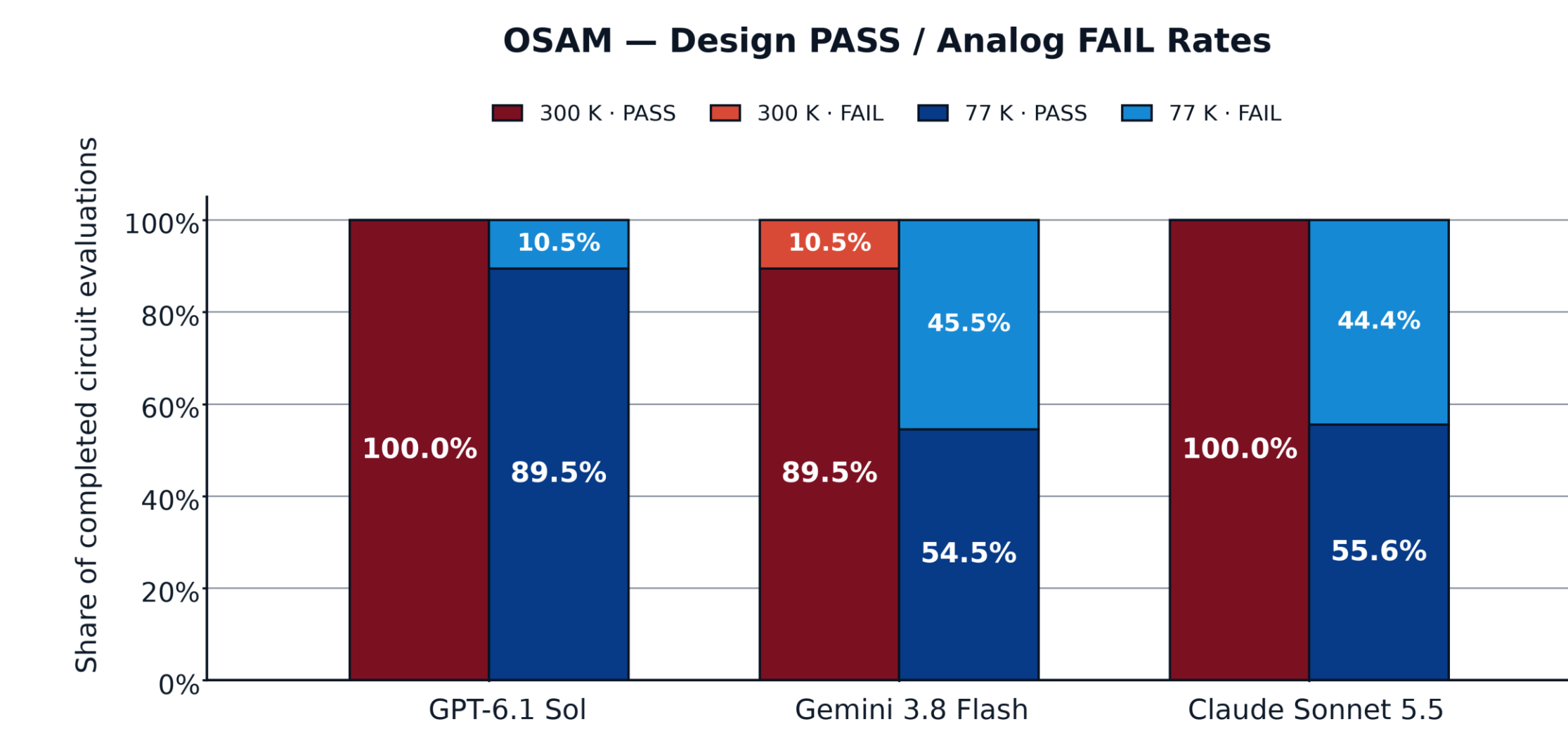
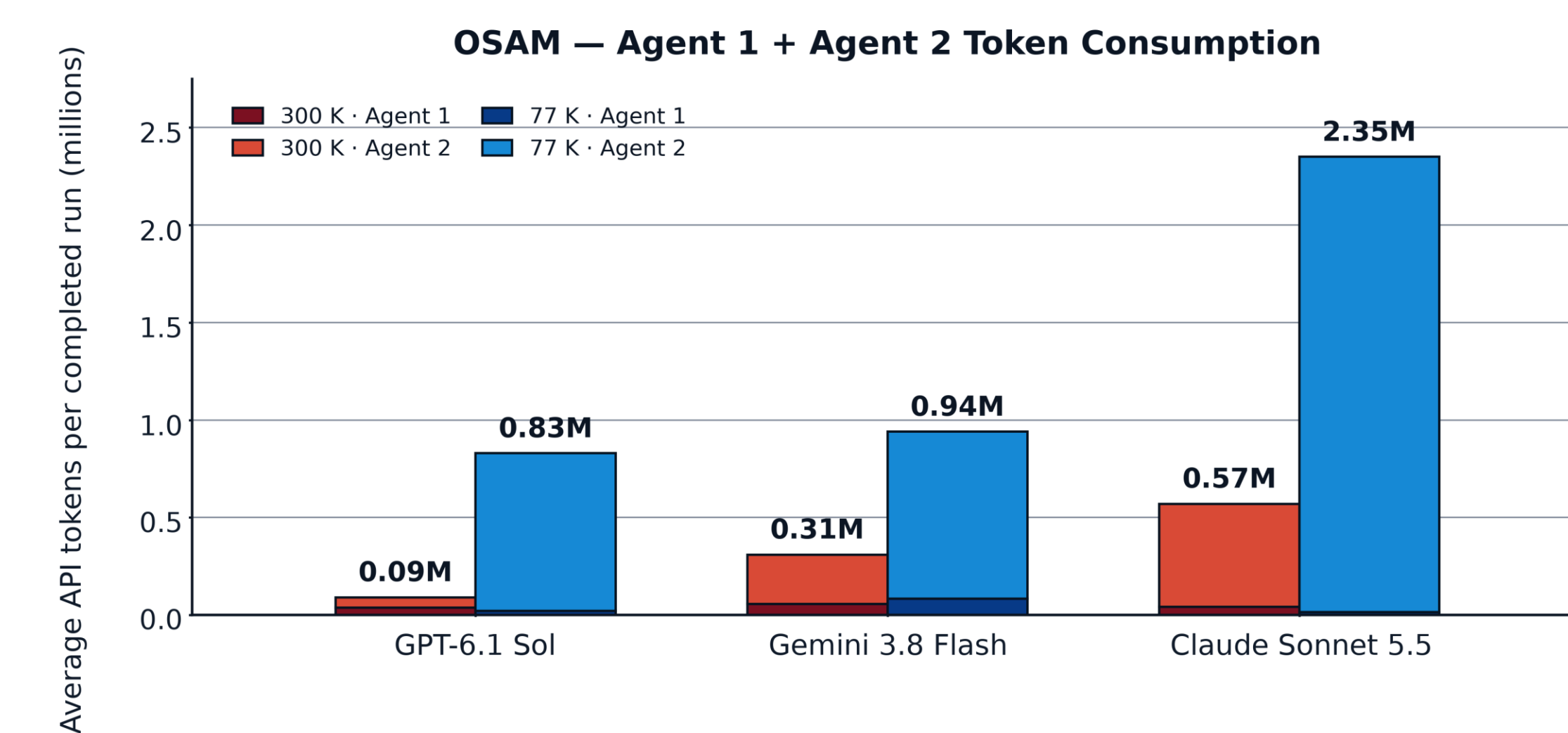


References

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- B. Murmann, Book-on-gm-ID-design: Ancillary Material for Systematic Design of Analog CMOS Circuits, GitHub repository. Available: github.com/bmurmann/Book-on-gm-ID-design
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LLM Performance and Computational Cost

OSAM achieves high analog-design success rates across multiple LLMs at both 300 K and 77 K, with model-dependent performance differences. The PASS/FAIL analysis and token consumption reveals substantial differences in computational cost between models. Together, these results highlight the trade-off between design reliability and token efficiency.



Future Work

Extend OSAM beyond operational amplifiers by developing a library of reusable, validated analog circuit building blocks, such as current mirrors, differential pairs, biasing networks, and amplifier stages. These blocks will enable AI agents to compose, size, and optimize more complex analog circuits through a hierarchical design approach.

Conclusion

We demonstrated **OSAM**, a multi-agent, AI-driven framework for autonomous analog circuit design using SKY130 technology at both 300 K and 77 K. Across three LLMs, OSAM successfully generated two-stage operational amplifier designs meeting specified performance constraints, verified through independent ngspice simulations and Python-based checks. The results demonstrate the feasibility of AI-assisted cryogenic analog design while revealing model-dependent differences in reliability and computational cost.