



# Probing a Dynamical Purification Phase Transition in a Trapped-Ion Quantum Computer



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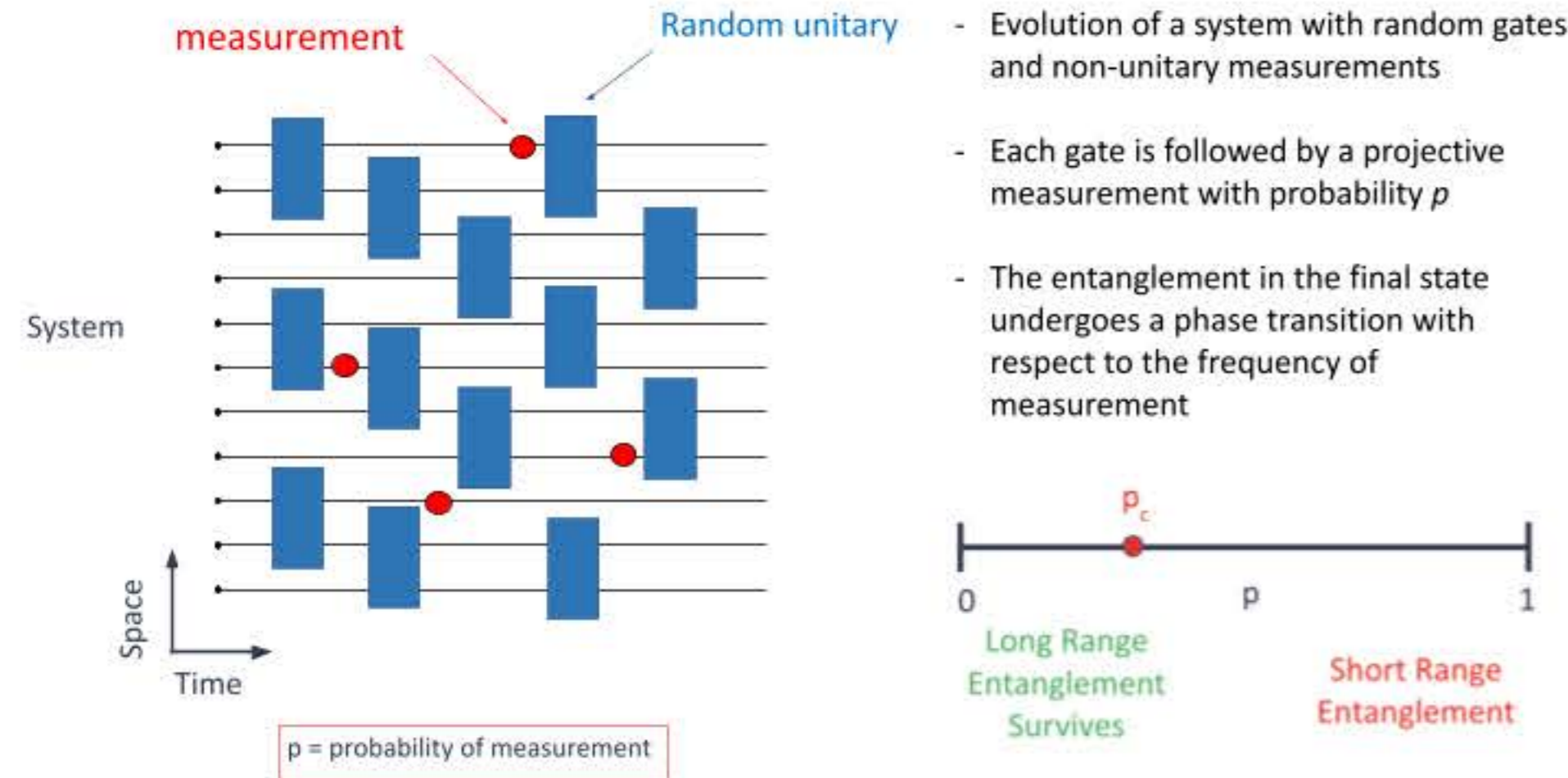
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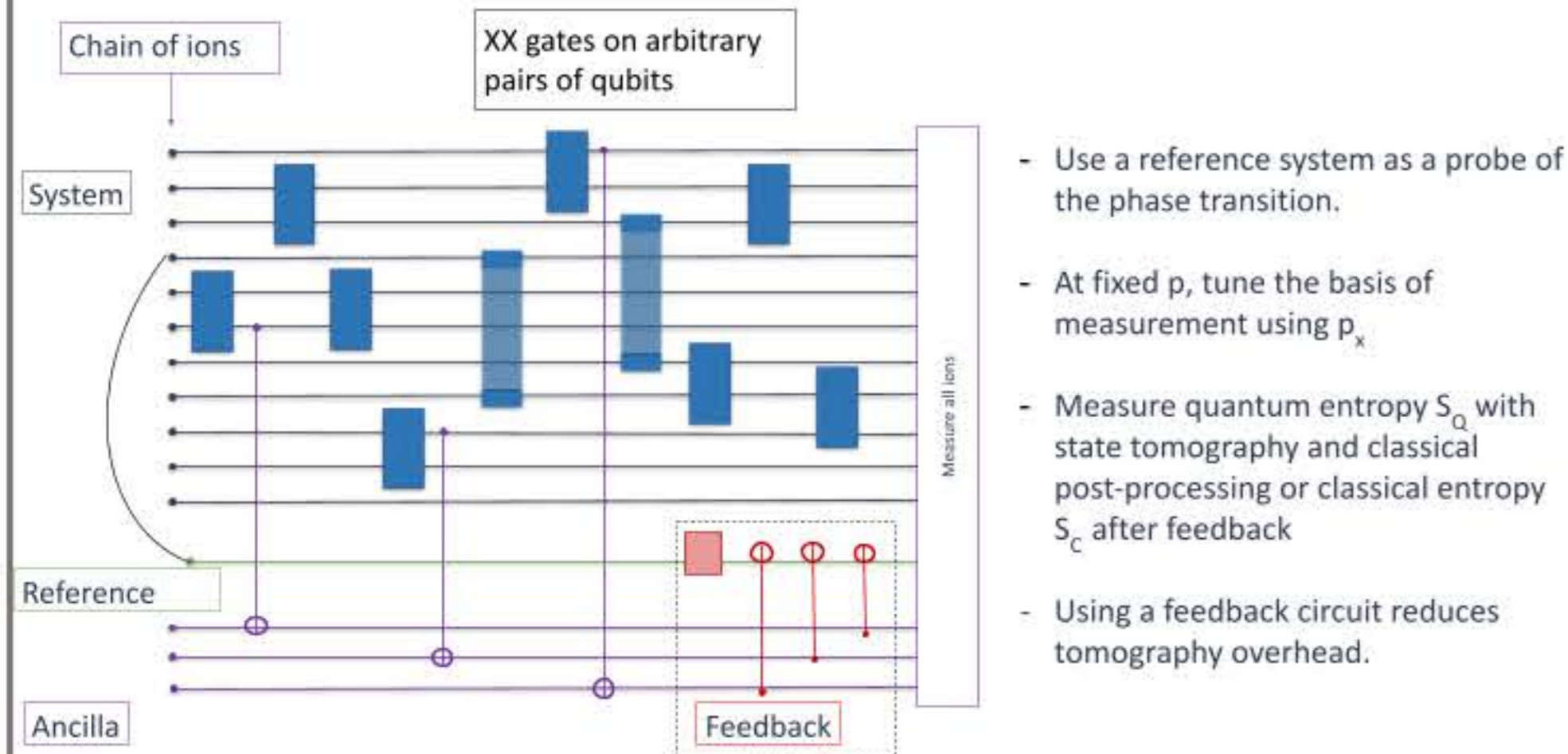
<sup>4</sup>Duke Quantum Center, Duke University, Durham, North Carolina 27701



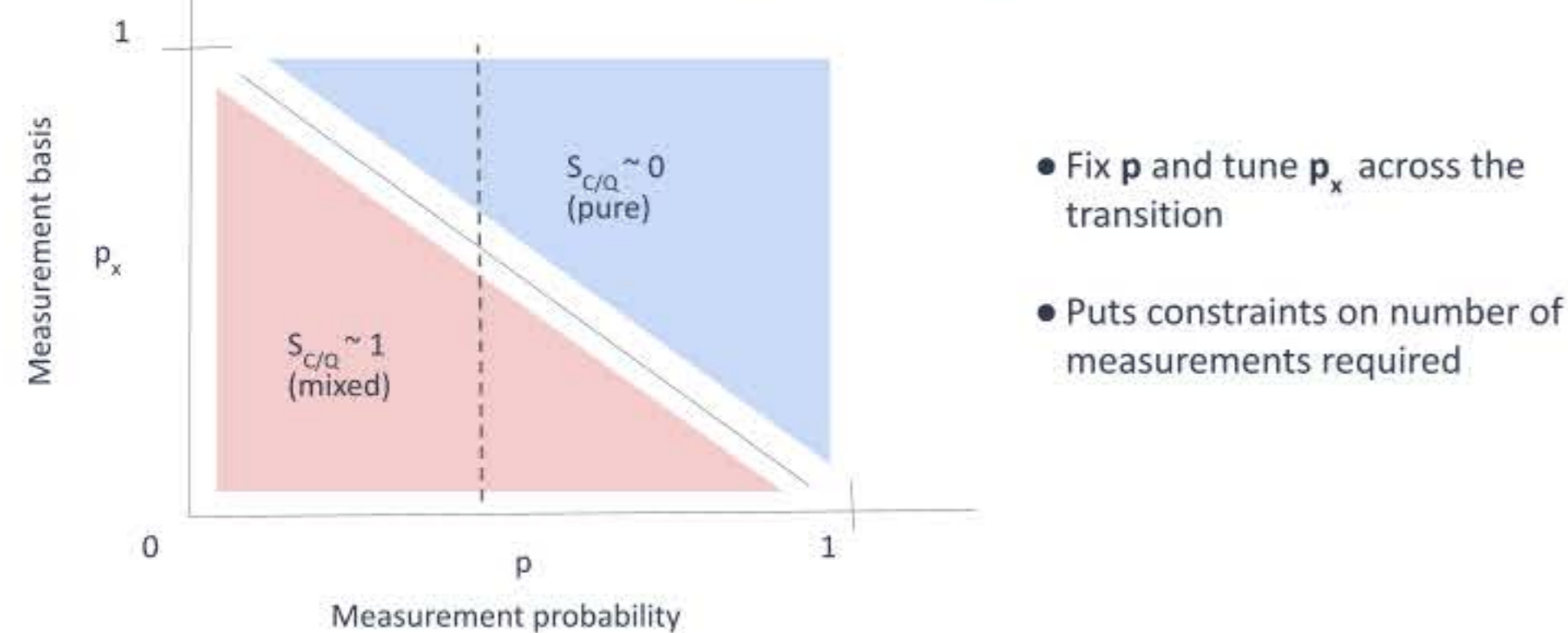
## General model



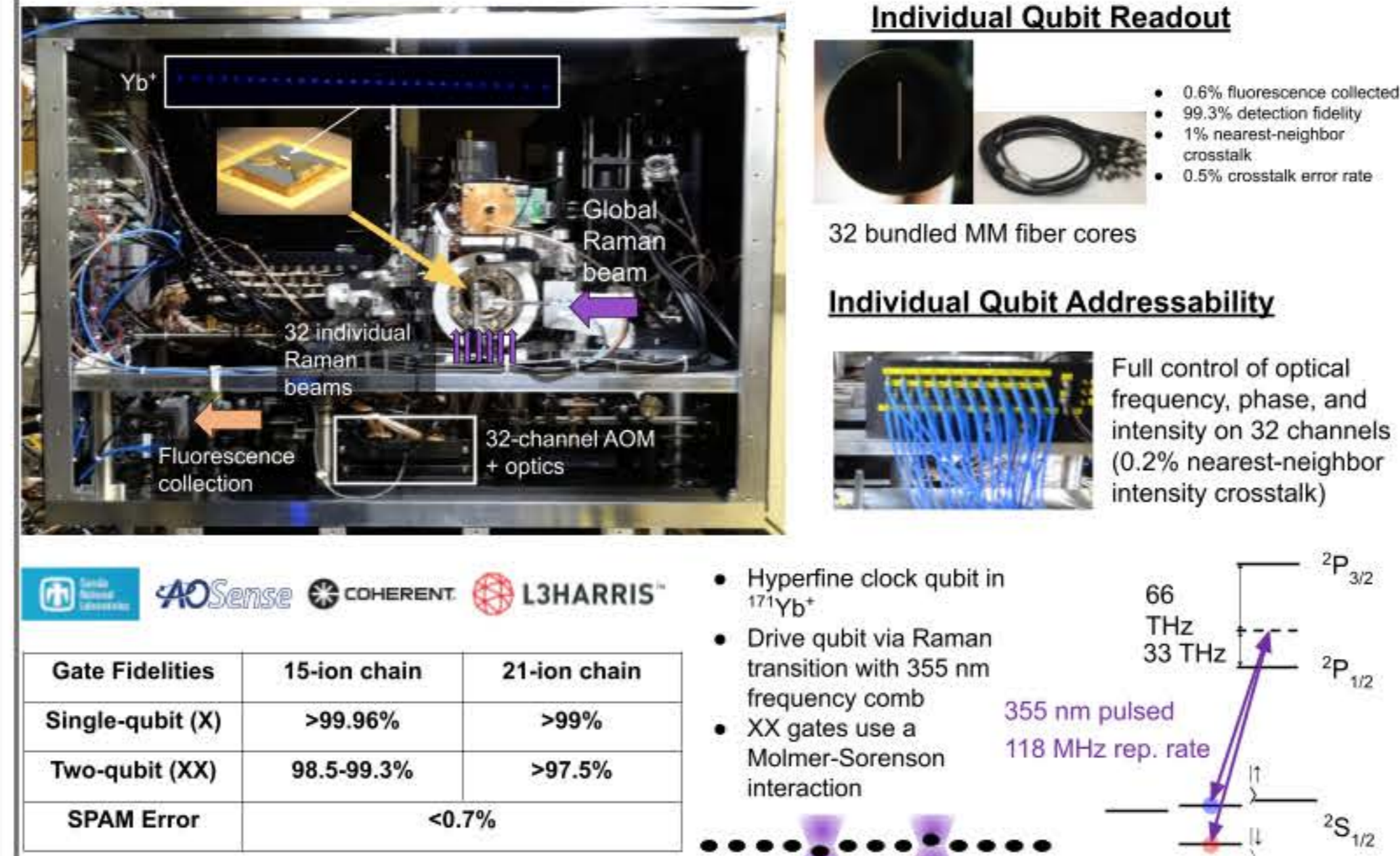
## Designing an experiment for a trapped-ion system



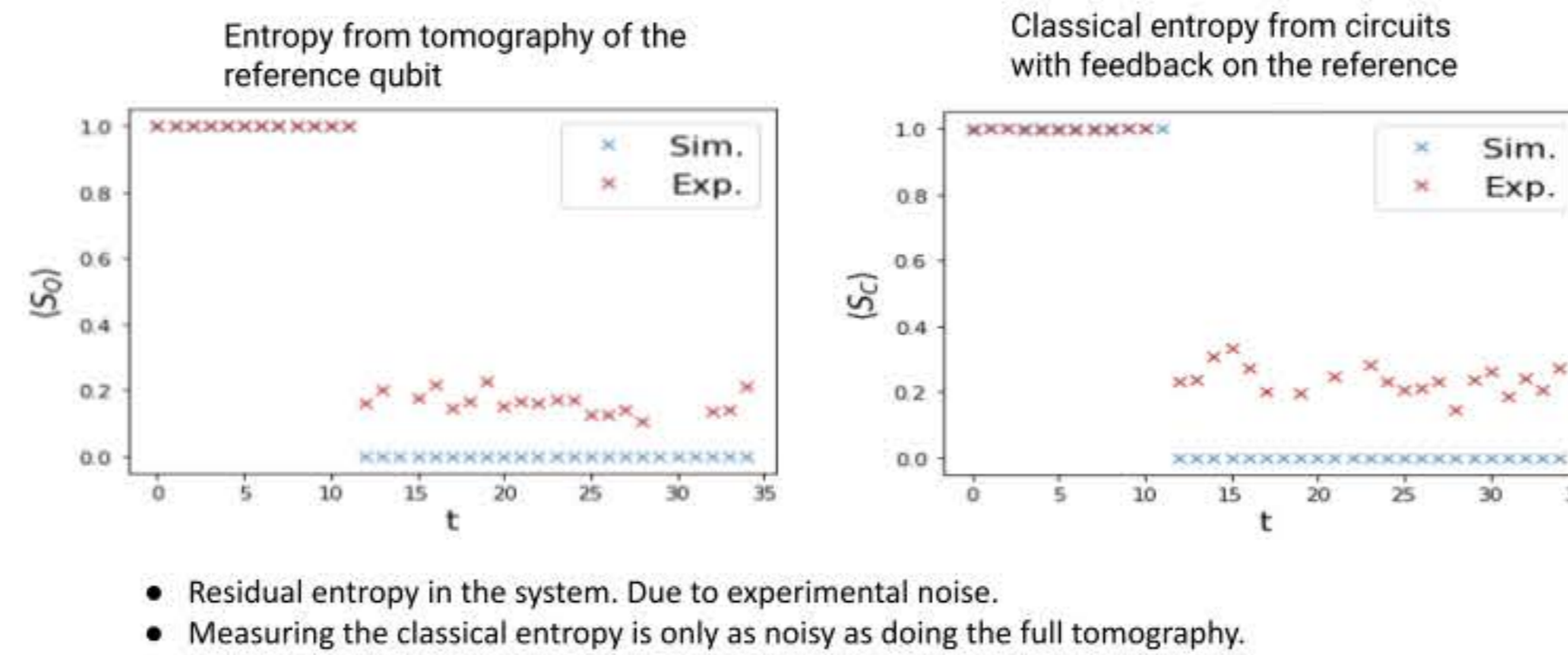
## Schematic of phase diagram



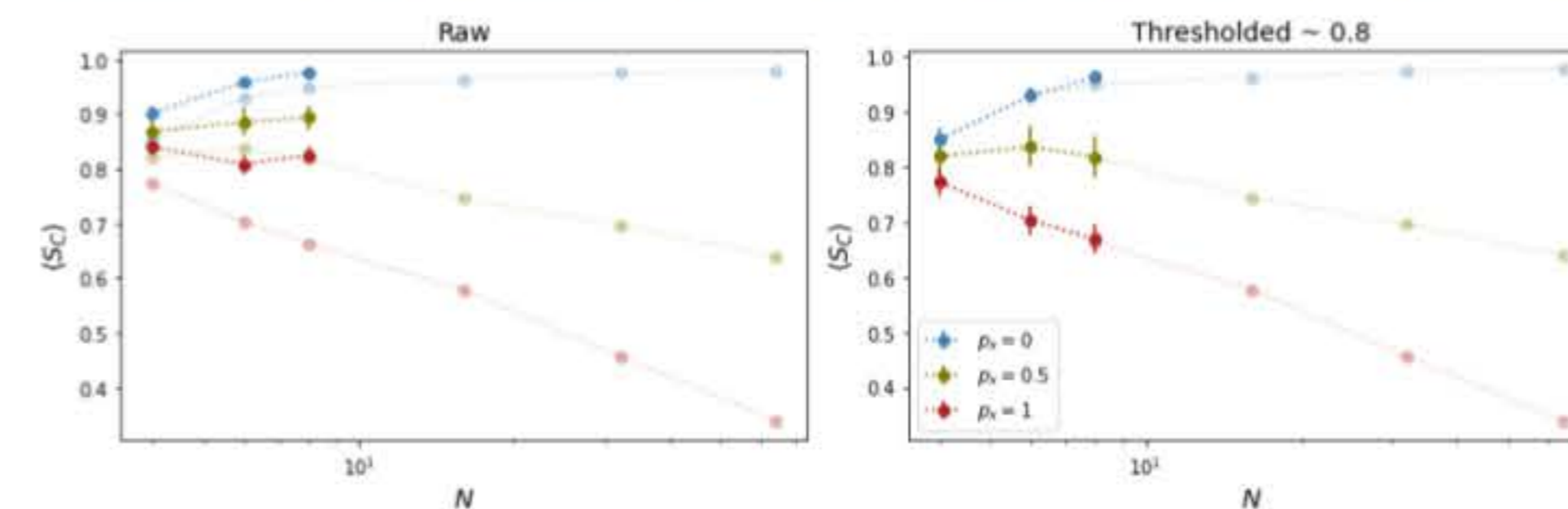
## Trapped-ion quantum computer



## Detecting the purification event for a single circuit

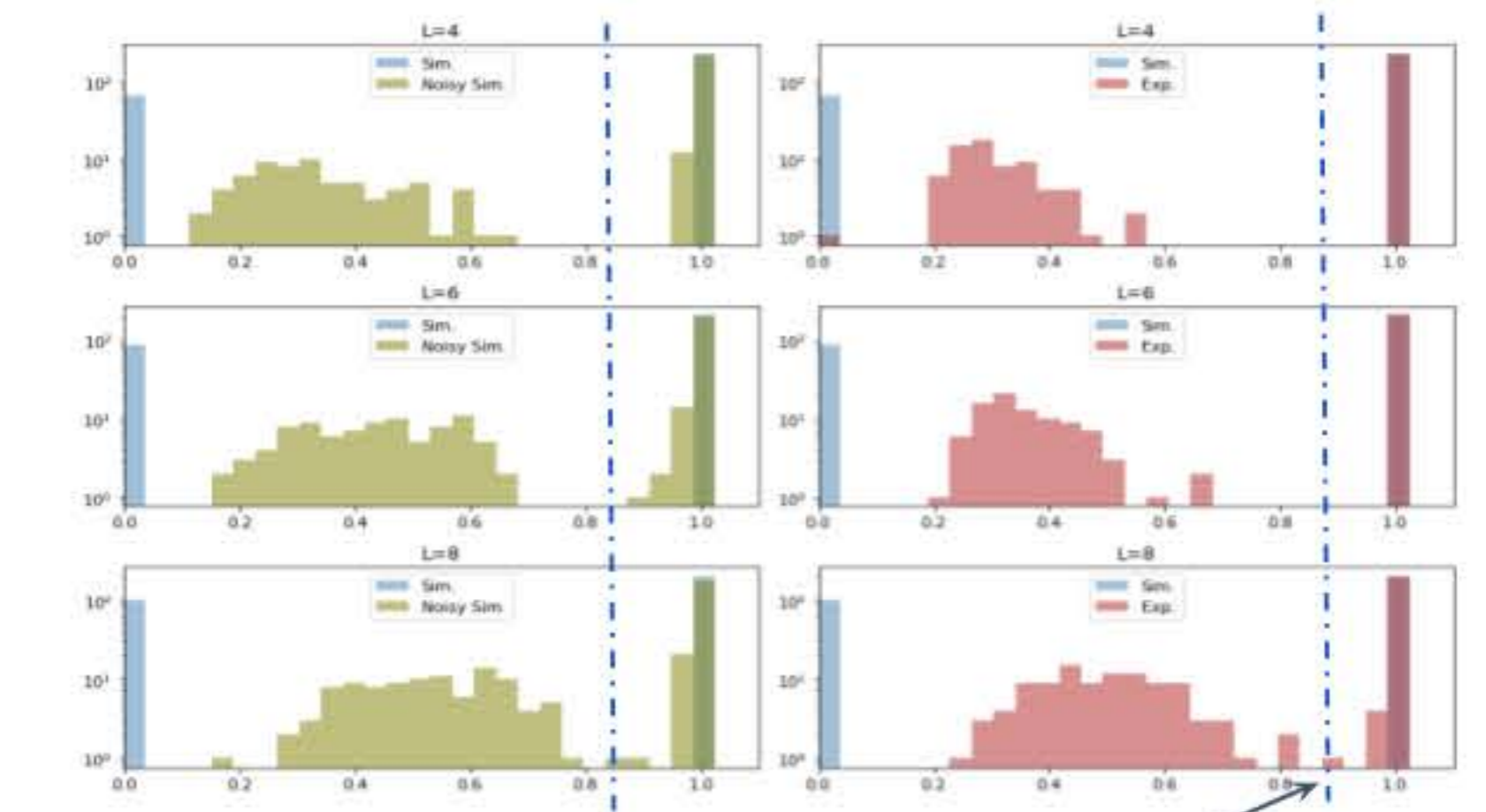


## Observing the "mixed" and "pure" phase in small systems

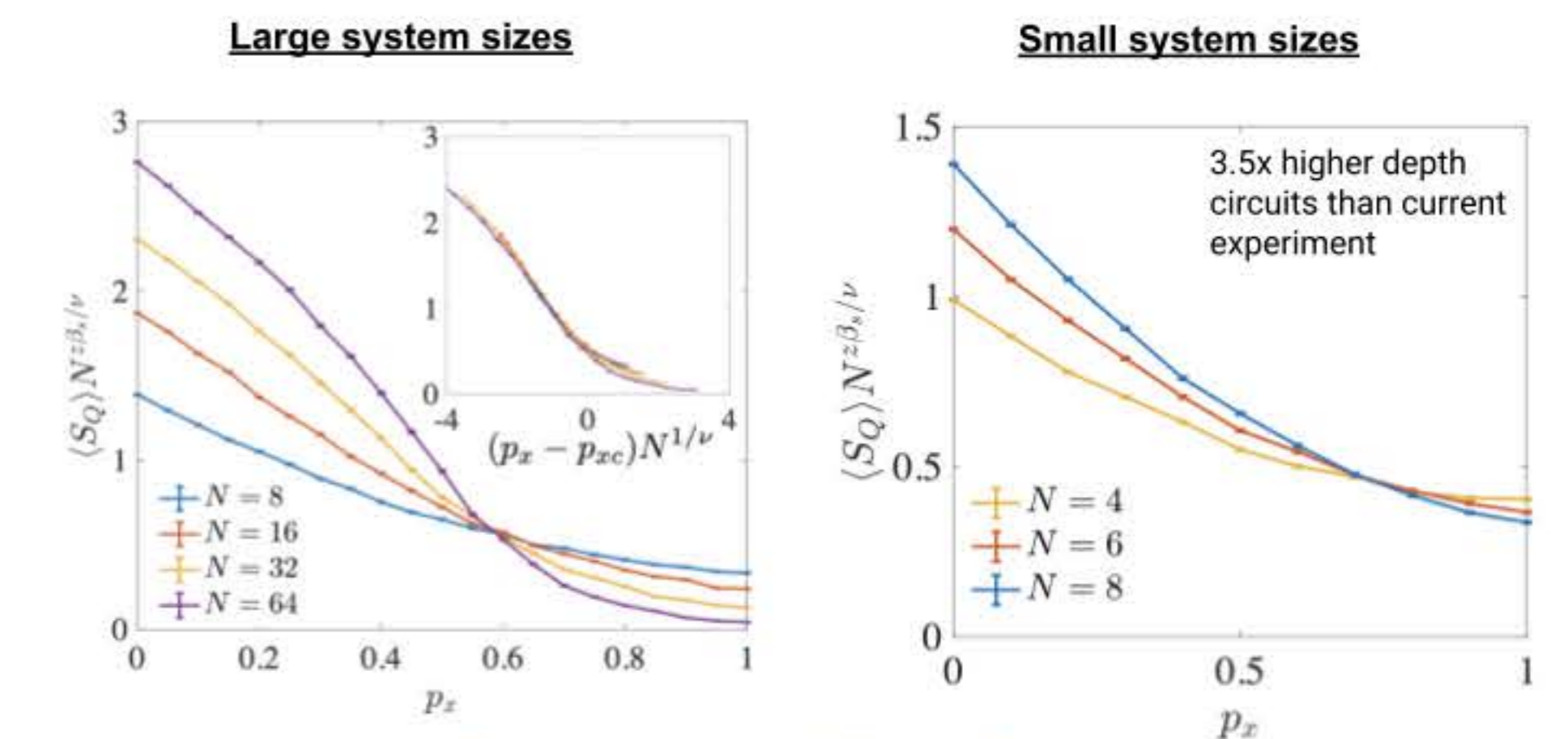


## A simplified noise model

- Single-qubit dephasing -  $T_2^*$  of 610 ms (negligible effect on  $S_{C/Q}$ )
- Fixed over-rotation of MS gates. All  $XX(\pi/4(1+\epsilon))$  with  $\epsilon = 0.15 \pm 0.01$
- Crosstalk on reference fixed for all  $XX(\pi/4 * 0.017)$



## Measurement-induced criticality



## Summary and Next Steps

- A model of random circuit with a 'purification transition' and amenable to implementation on a trapped-ion quantum computer.
- Experimental observations are consistent with theoretical expectations.
- Next steps: mid-circuit measurements, longer time scales, larger systems, and non-Clifford gates.

### References

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- [2] B. Skinner, J. Ruhman, and A. Nahum, Phys. Rev. X 9.3, 031009 (2019).
- [3] M. Gullans and D. Huse, Phys. Rev. Lett. 125, 070606 (2020).
- [4] C. Monroe, Nature 583, 10 (2020).
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- [6] M. Cetina et al. arXiv:2007.06768.



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