

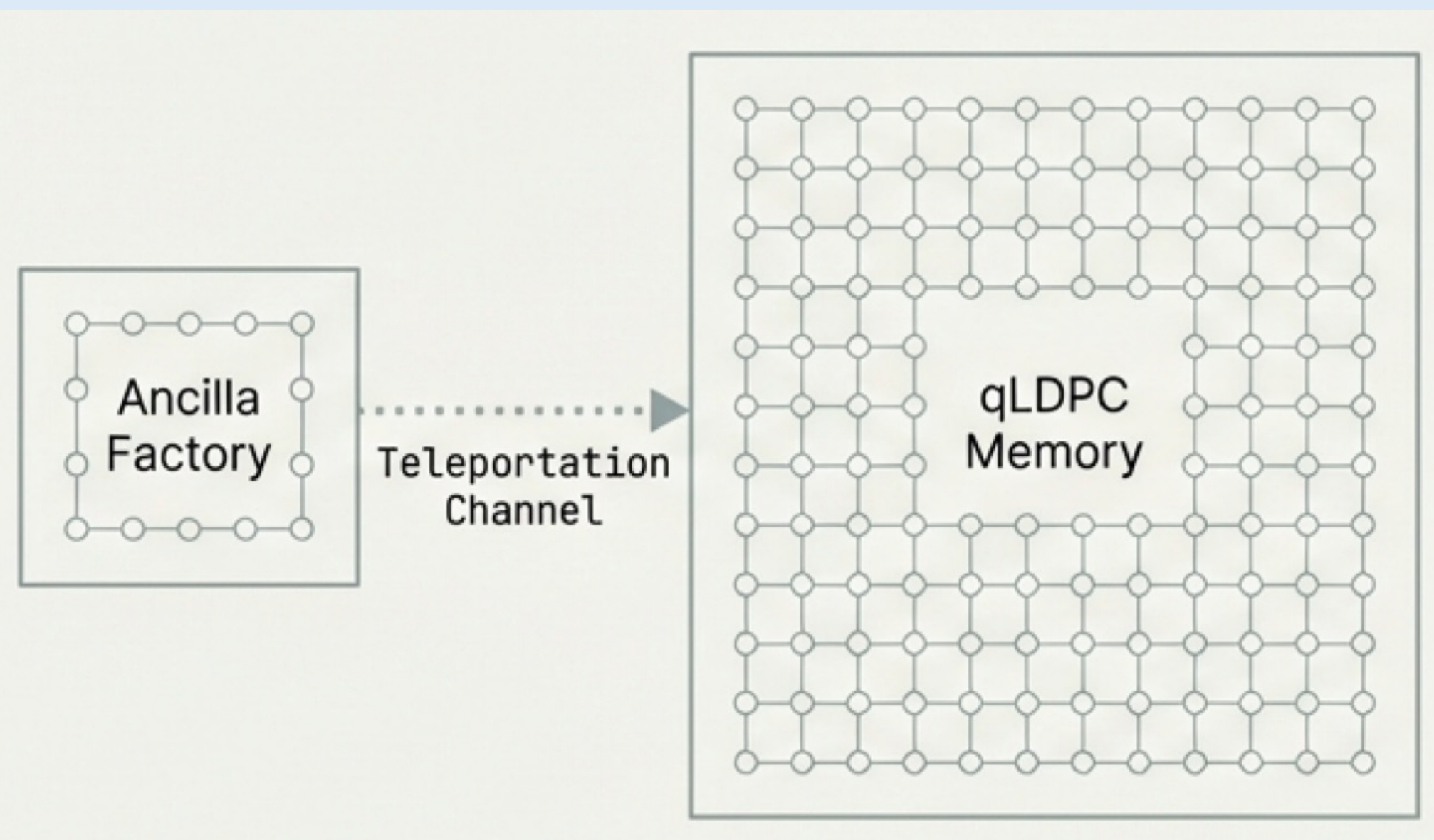
# In-Situ Simultaneous Magic State Injection on Arbitrary CSS qLDPC Codes

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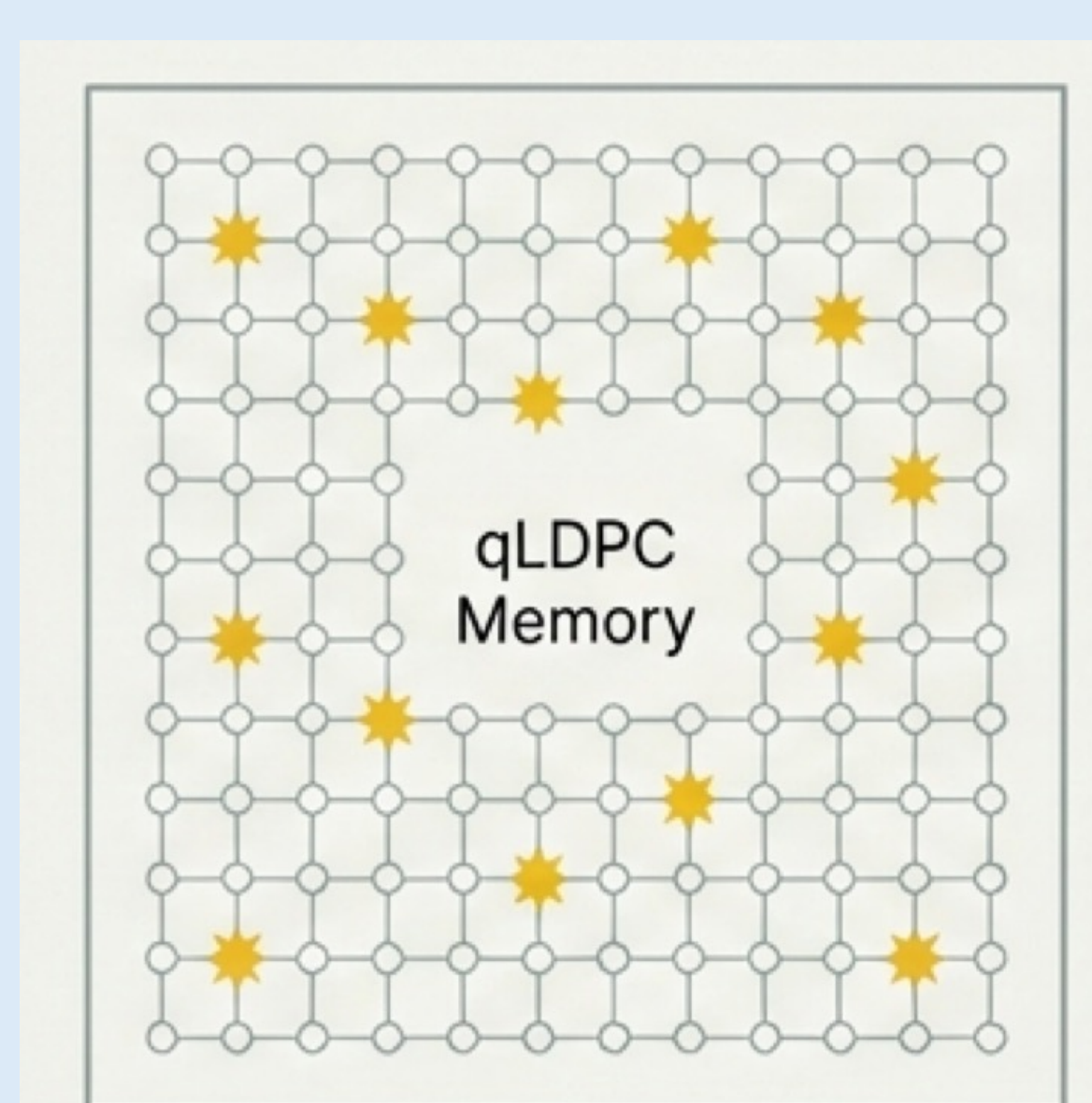
## Take-Home Message

Prepare outside, transfer in



## Proposed:

In-situ simultaneous injection

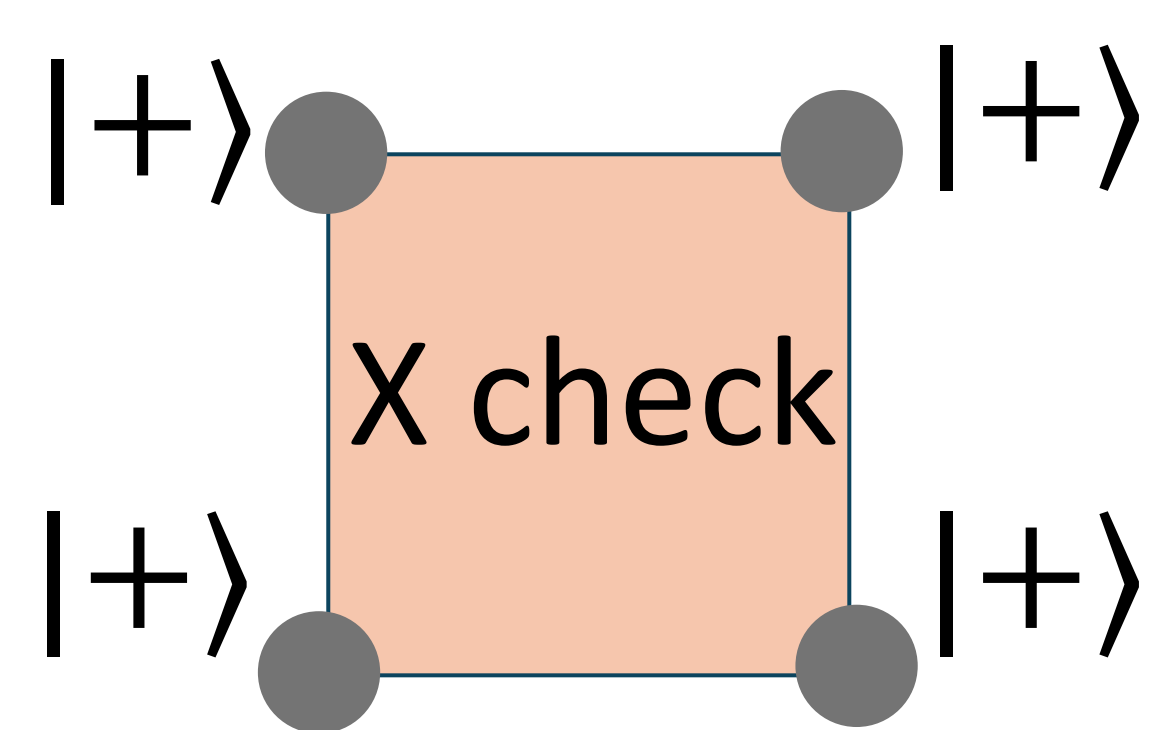


Magic states can be injected directly inside a qLDPC memory block, without auxiliary transfer blocks → Lower qubit overhead

## Main Steps

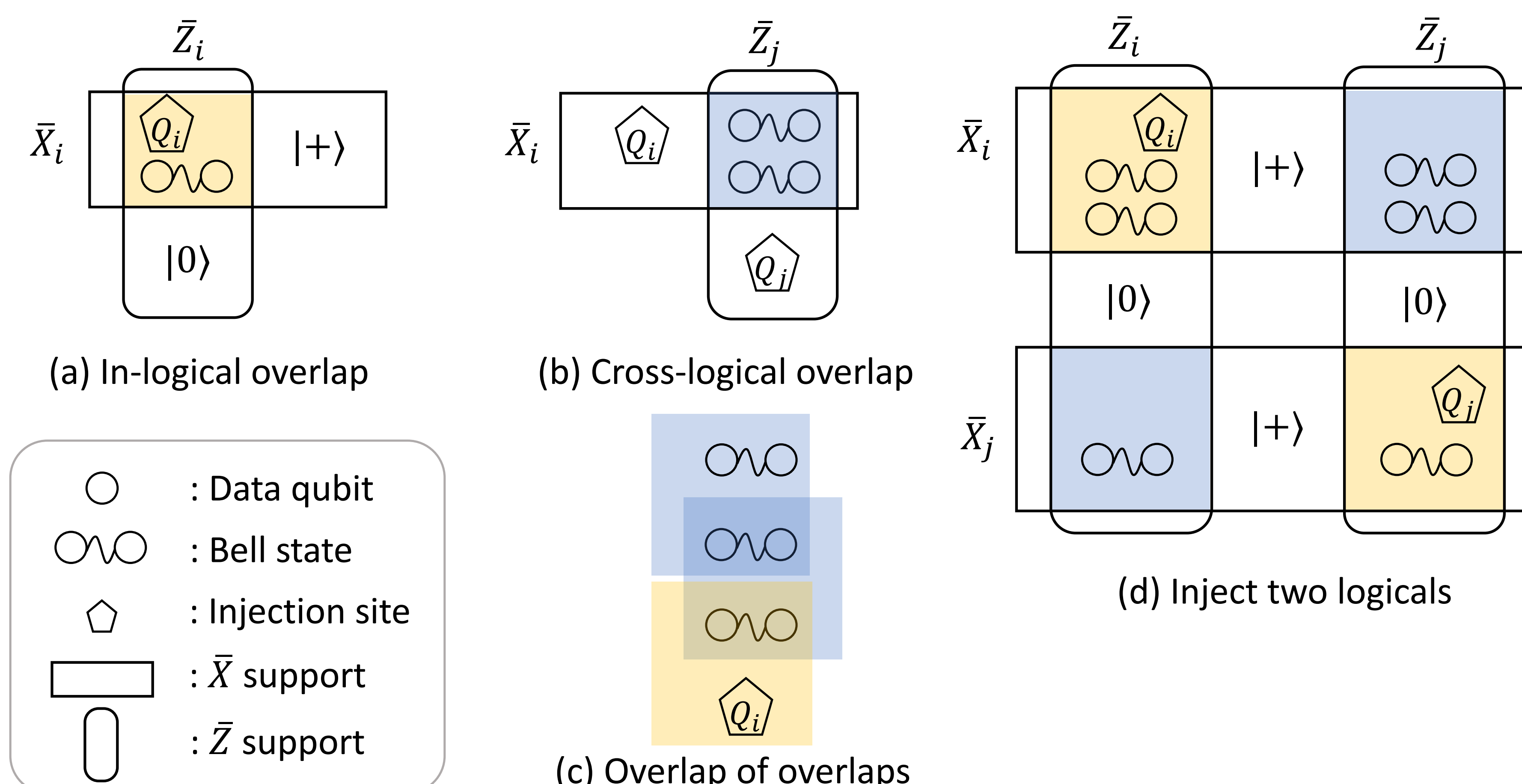
- 1. State prep.** Prep. simultaneous +1 eigenstate of  $\bar{H}_{XY}$  for logicals
- 2. Syndrome extraction** Preserves logical information
- 3. Post-selection** Reduce kept-shot injection error rate

## Main Technique: Post-Selection by Fixed Stabilizers



- Its measurement outcome must be +1
- If it is flipped → an error occurs
- Discard a shot if any fixed stabilizer is not +1

## Challenges: Overlaps of Logical Representatives



Overlaps can be handled by Bell pairs.

## Main [[144,12,12]] BB Code Result

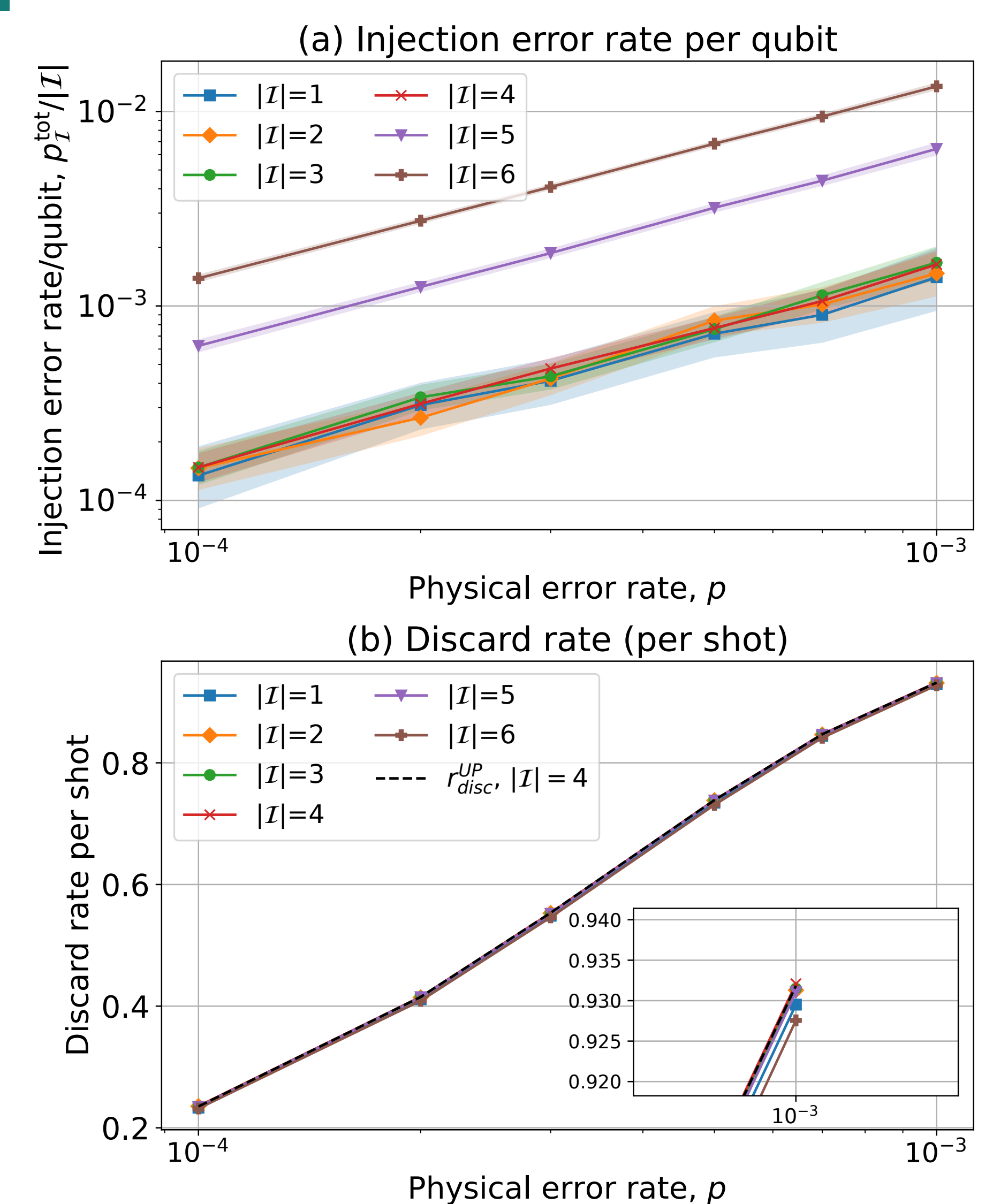
**4**  
logical  $|Y\rangle$  states injected simultaneously

**1.62e-3**  
per-logical error at  $p = 1e-3$ , under uniform noise model

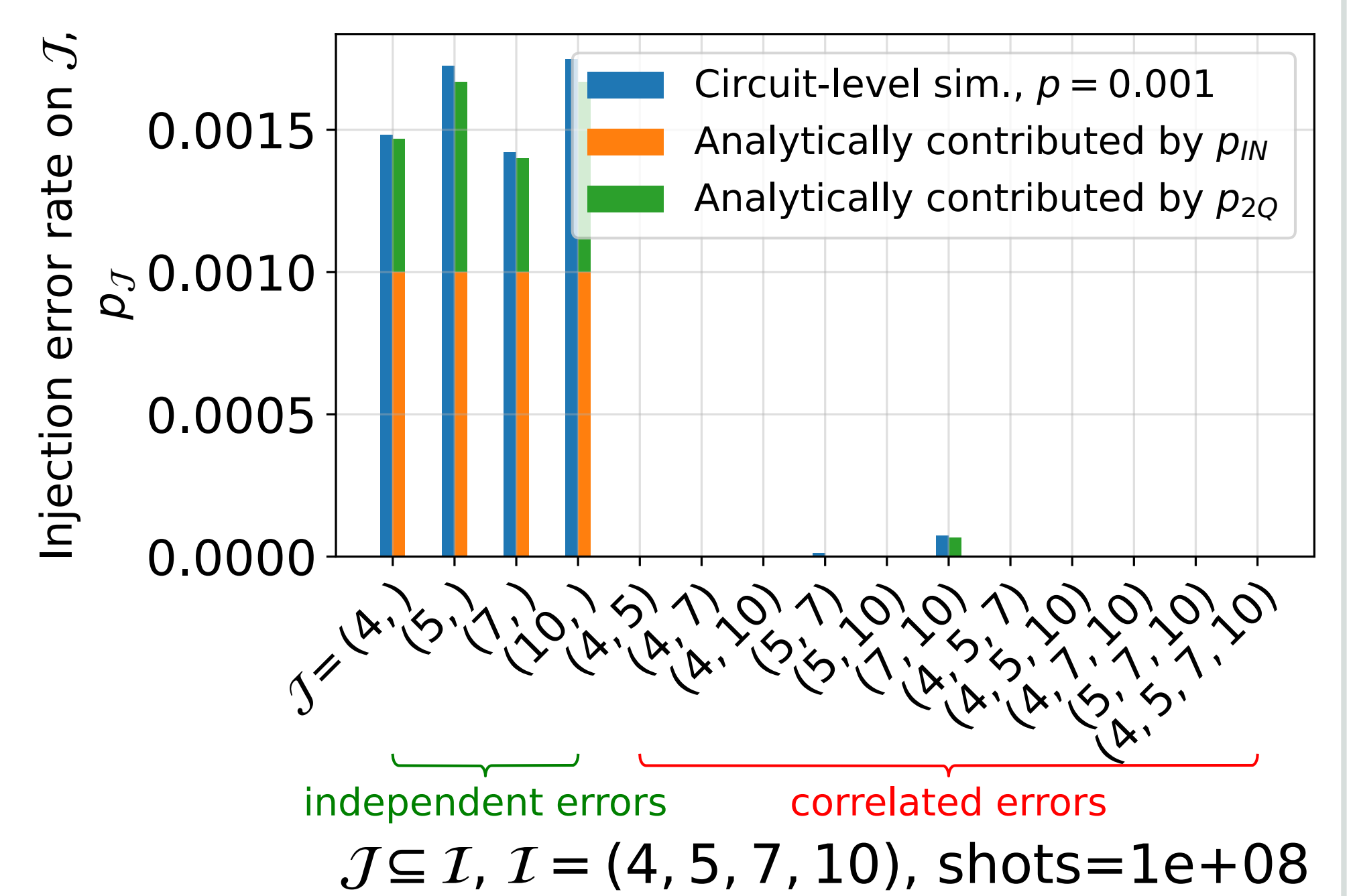
**2e-5**  
correlated error contribution

**6.7e-4**  
per-logical error under asymmetric noise model

## Circuit-Level Simulation



## Error Breakdown



Main contributor: 1Q init error

## Compare to Surface Code

At $p=1e-3$ , 4 logicals	Gidney	BB in situ
Per-logical error	8.4e-4	1.7e-3
Discard rate	0.33	0.93
<b>Physical qubits</b>	<b>968</b>	<b>288</b>

Portability and next steps: The method also applies to a [[225,9,4]] HGP code, where up to six logicals were injected in a portability test.

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Data & Code: