Challenges of Quantum Process Characterization

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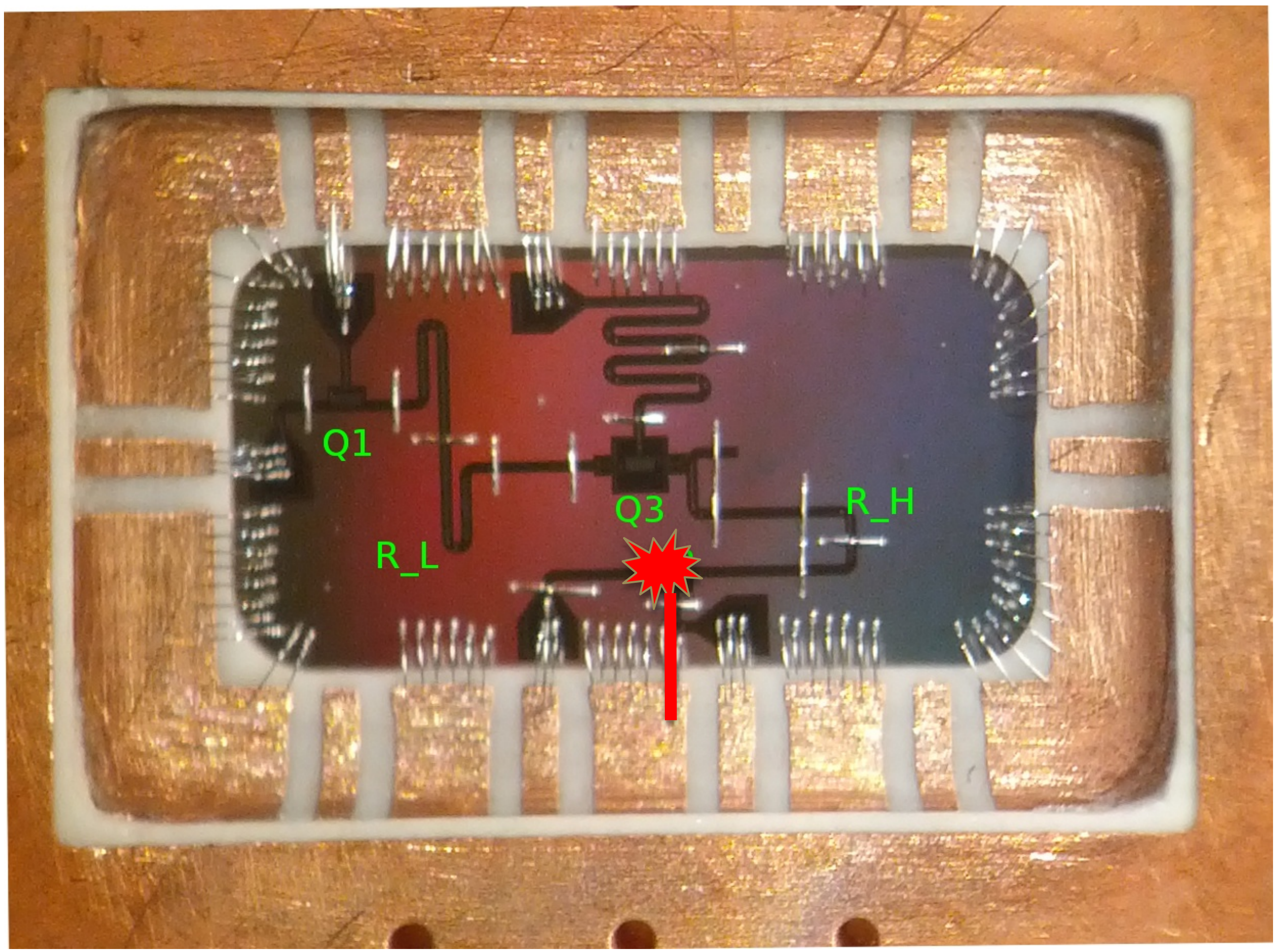
Quantum Device



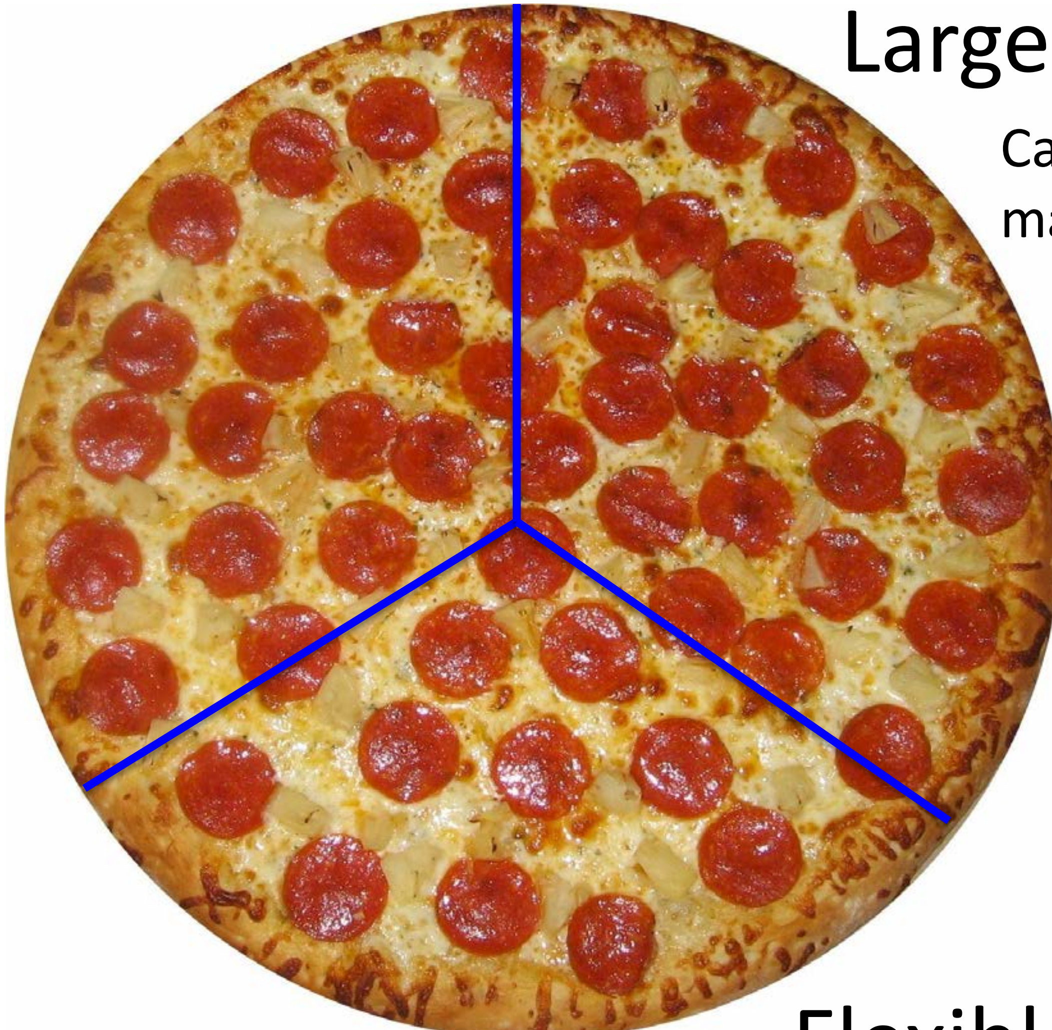
Quantum Process Characterization

$$\mathcal{E} = ?$$

$$\mathcal{E}(\rho) = \sum_i A_i \rho {A_i}^\dagger \qquad \sum_i {A_i}^\dagger A_i = \mathbb{I}$$

For operation on n qubits, $16^n - 4^n$ free parameters.

Ideal Process Characterization



Large Access

Can get info about many parameters

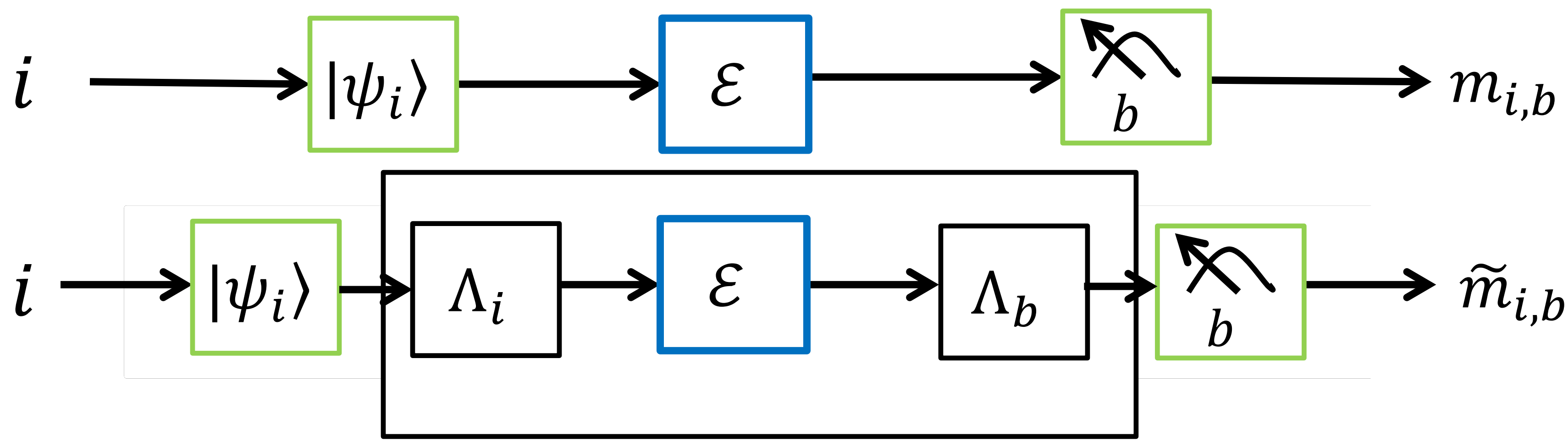
Robust

Flexible Input

$\mathcal{E}$ can be anything

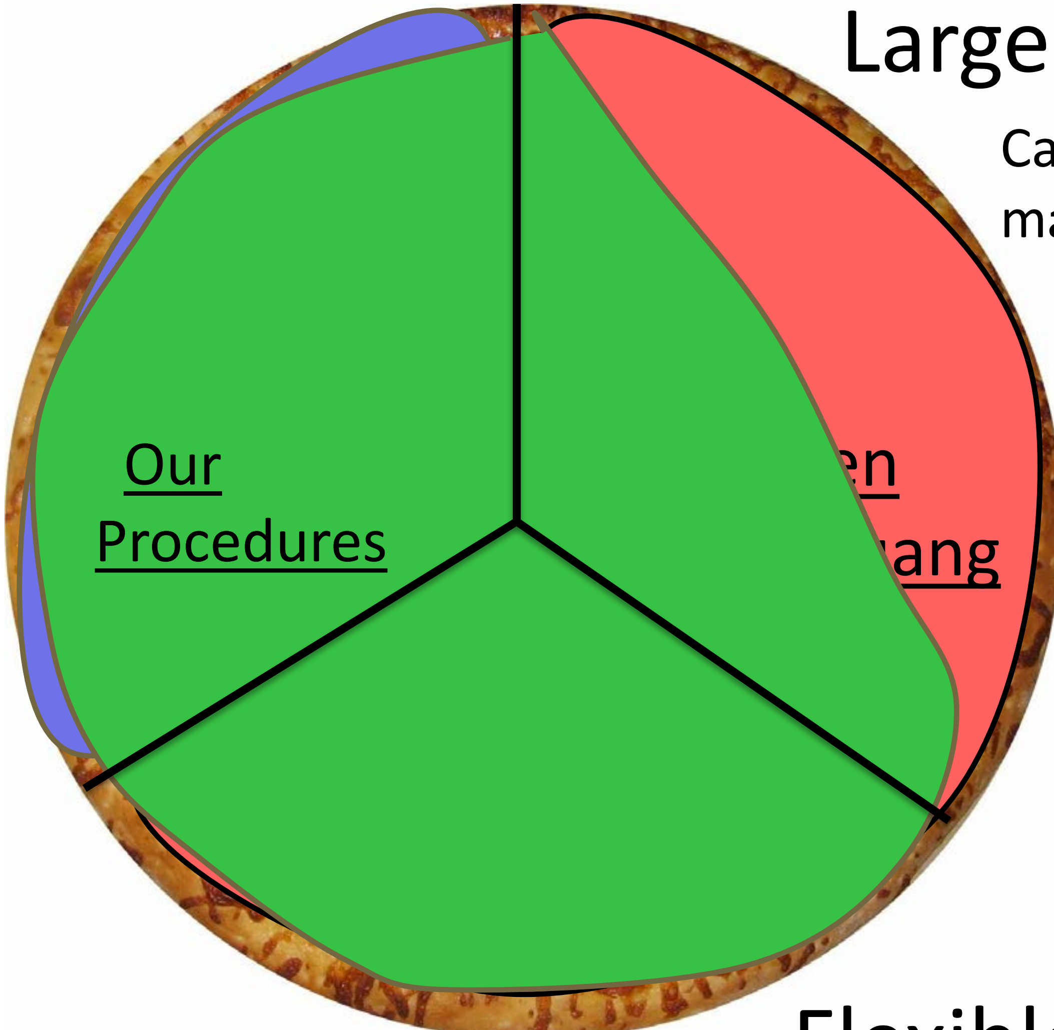
Robust Characterization

Accessing process involves preparing a state, and a measurement



Ideal Process Characterization

Robust



Large Access

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Flexible Input

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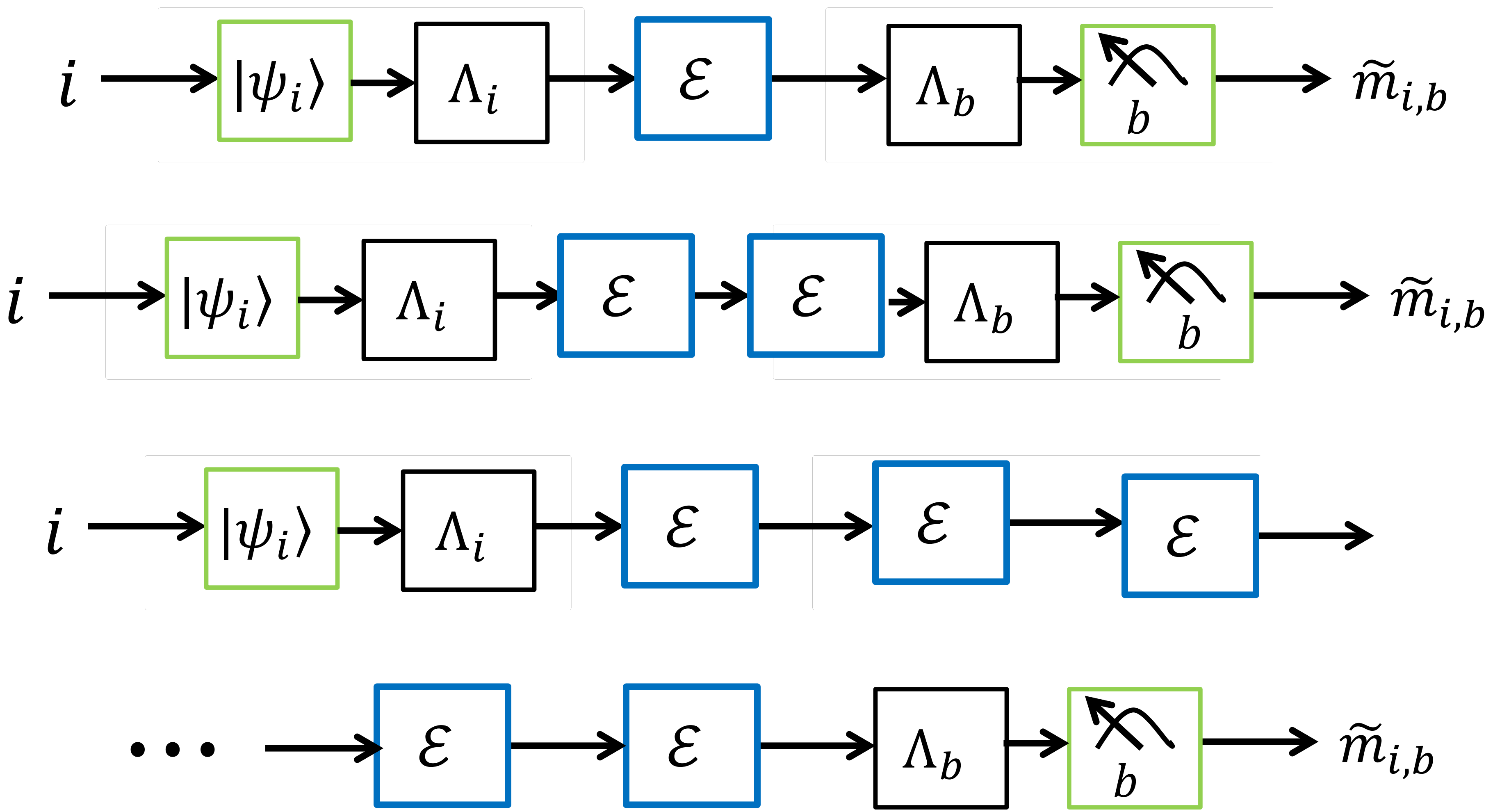
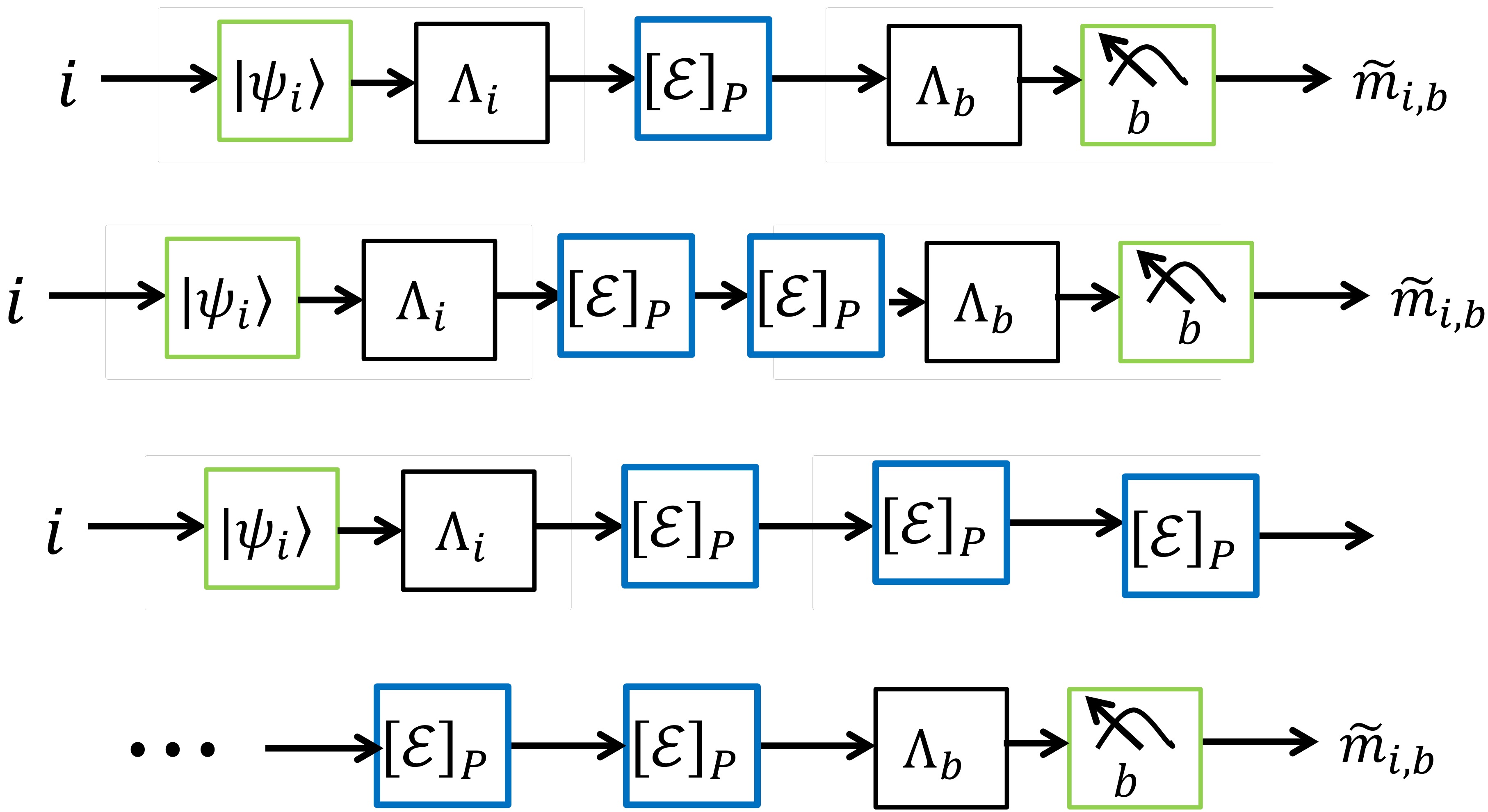
Robust



i
$|\psi_i\rangle$
Λ_i
$\mathcal{E}$
Λ_b
b
$\tilde{m}_{i,b}$
i
$|\psi_i\rangle$
Λ_i
$\mathcal{E}$
$\mathcal{E}$
Λ_b
b
$\tilde{m}_{i,b}$
i
$|\psi_i\rangle$
Λ_i
$\mathcal{E}$
$\mathcal{E}$
$\mathcal{E}$
$\cdots$
$\mathcal{E}$
$\mathcal{E}$
Λ_b
b
$\tilde{m}_{i,b}$

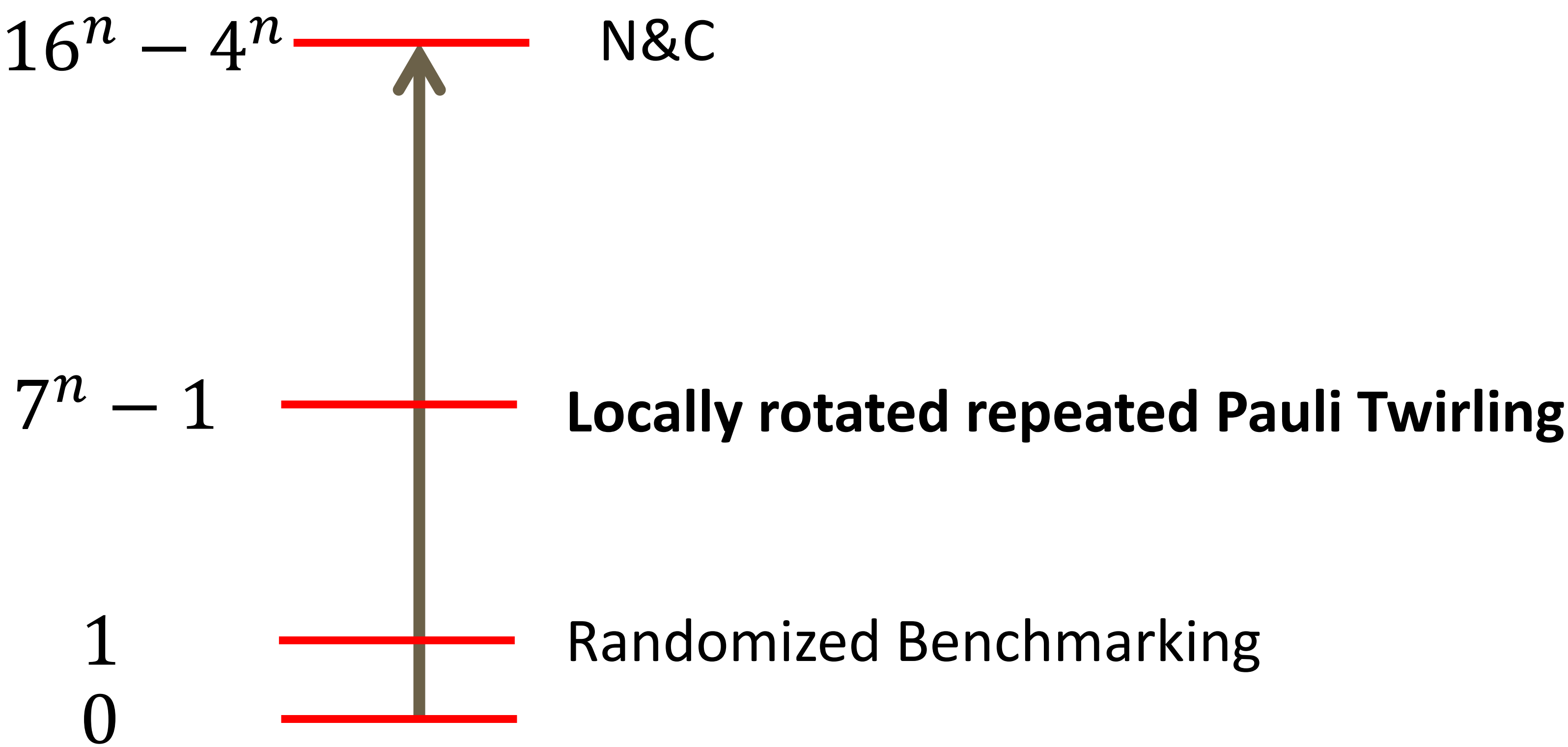
Robust Cont.

$[\mathcal{E}]_P$= Pauli Twirl = “Averaged” Version of $\mathcal{E}$



Large Access

n qubits:
accesible parameters



To Do/Open Questions

- Implement!
- Get better trade offs between robustness and number of accessible parameters?

Thank you!

- Questions?

χ Matrix Examples

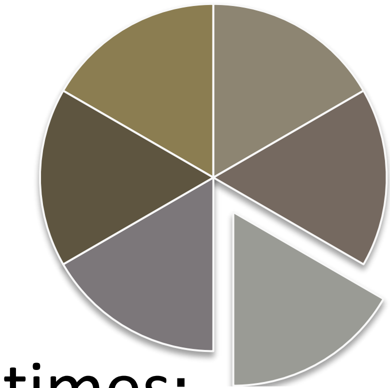
$$\mathcal{E}(\rho) = \sum_{i,j=1}^{4^n} \chi_{i,j} P_i \rho P_j$$

Identity: $\chi_{I,I} = 1$, all other $\chi_{i,j}$=0

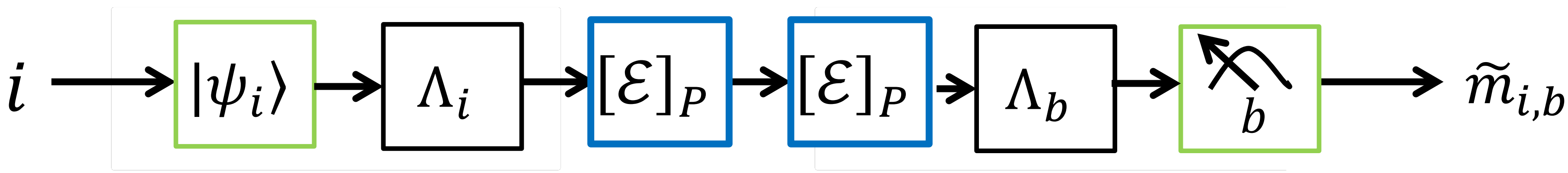
Hadamard: $\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$

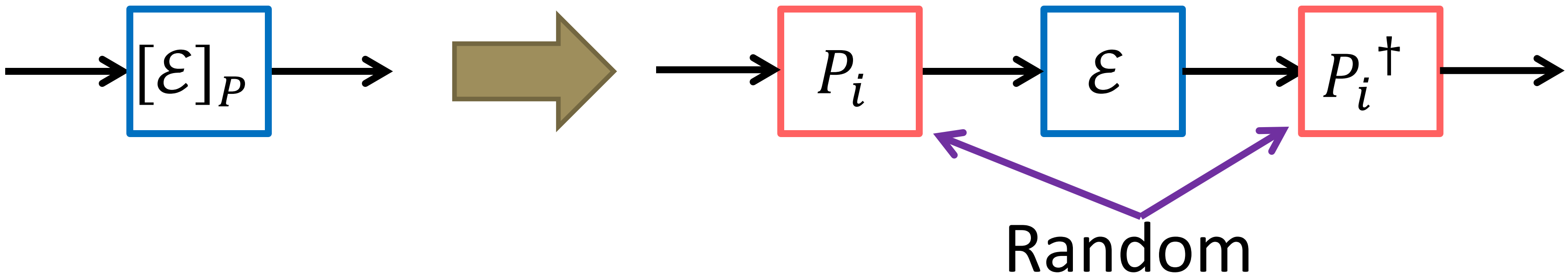
$\chi_{X,X} = \chi_{Z,X} = \chi_{X,Z} = \chi_{Z,Z} = \frac{1}{2}$, all other $\chi_{i,j}$=0

Easy Implementation



Repeat each sequence a constant number of times:





All Pauli Operations are Local!

Not perfect Paulis – but we can bound the effect of these errors