Dissipation Nation

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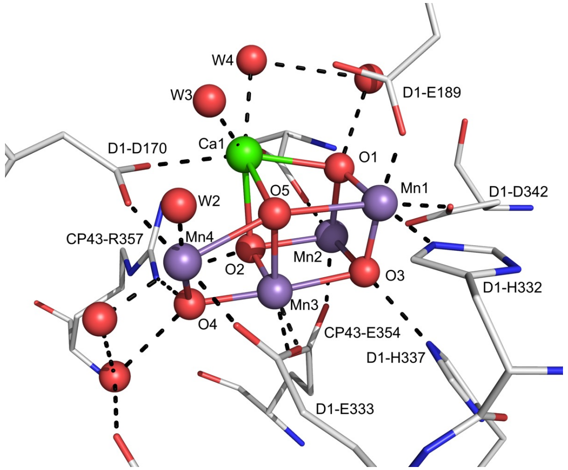
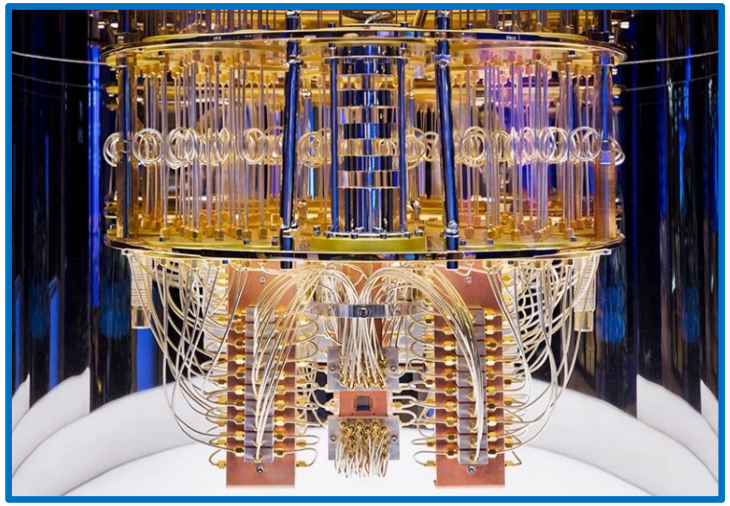
What is the Dissipative Quantum Eigensolver?

Algorithm to prepare a ground state due to T. Cubitt (arxiv:2303.11962)



Nature. 473 (7345): 55–60

H



Nature 599, 542 (2021)

ρ

What is the Dissipative Quantum Eigensolver?

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ρ = initial state
until (stop condition):
    ρ, b = E(ρ)
    if b:
        Do some qubit resets
return ρ
```

ρ will be close to the true ground state!

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Approximate GS projection

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Why DQE?

Scientifically important

- Ground state preparation central in quantum chemistry and materials!
- Enables computing important properties
- Example: energy → reaction rates

Advantages of DQE

- Provable guarantees
- Noise resilient
- Conceptually simple

Why DQE? A good fit for Triple Alpha!

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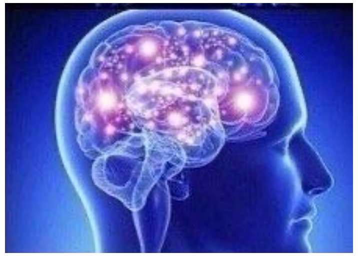

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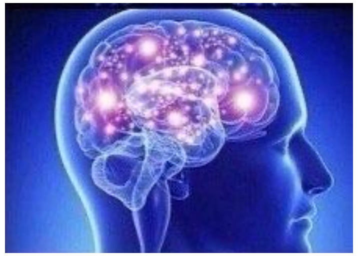

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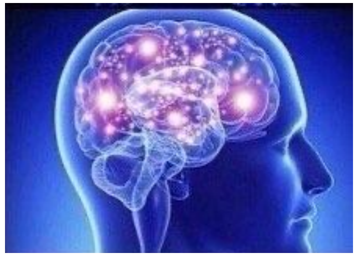

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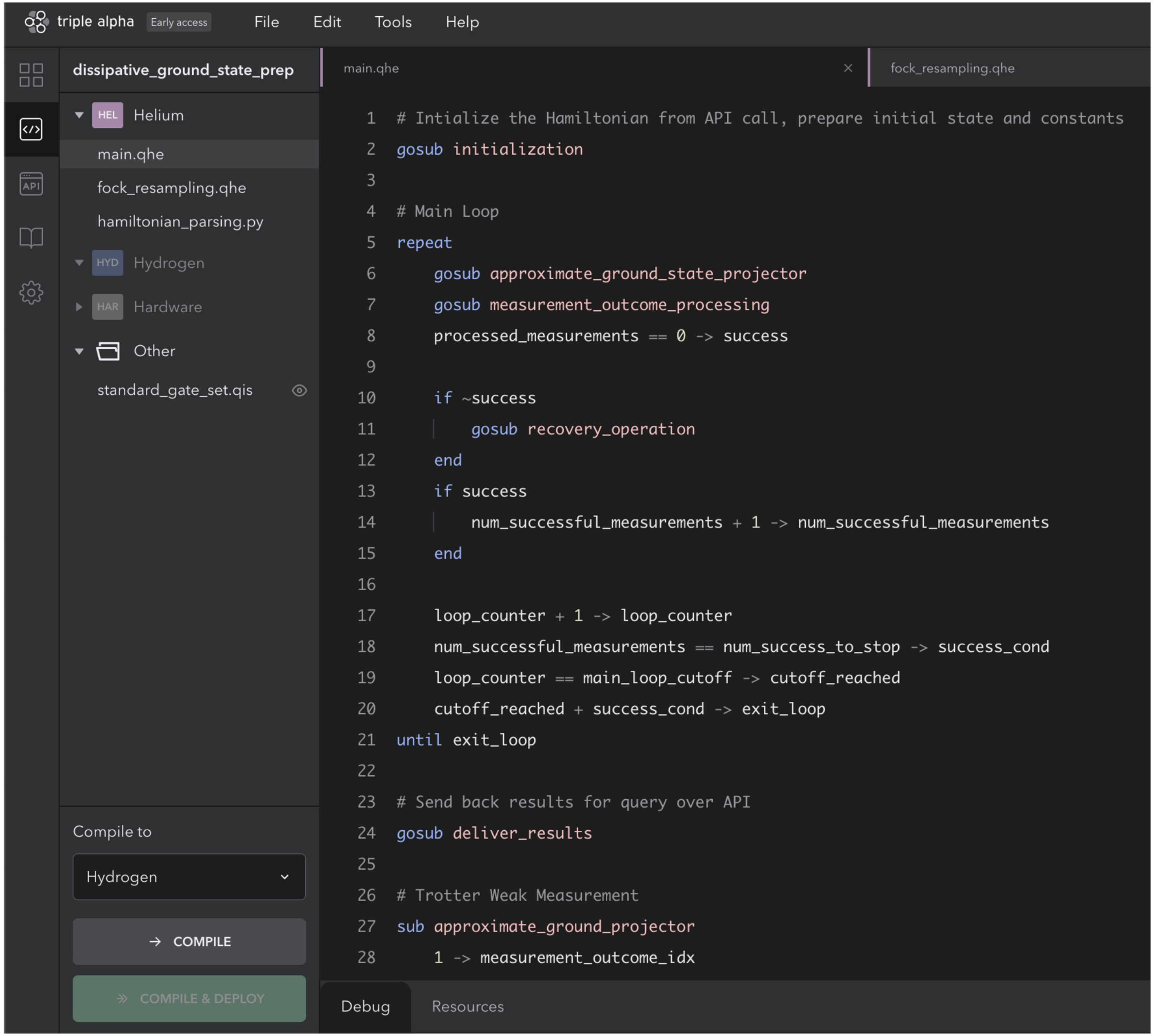
Interesting parameters to play with! Implementation has practical importance!

What did we do?

~ 200 lines of Helium code!
And Python client code!

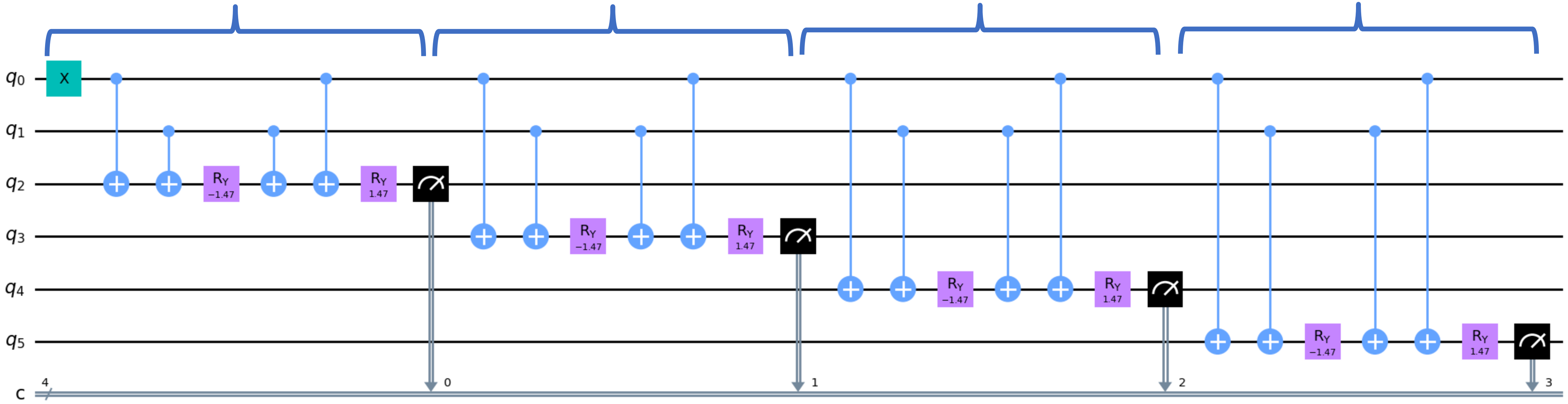
Deployed as an API!



What did we do?

Built down to IBM circuit :)

H → U = approximate GS projector



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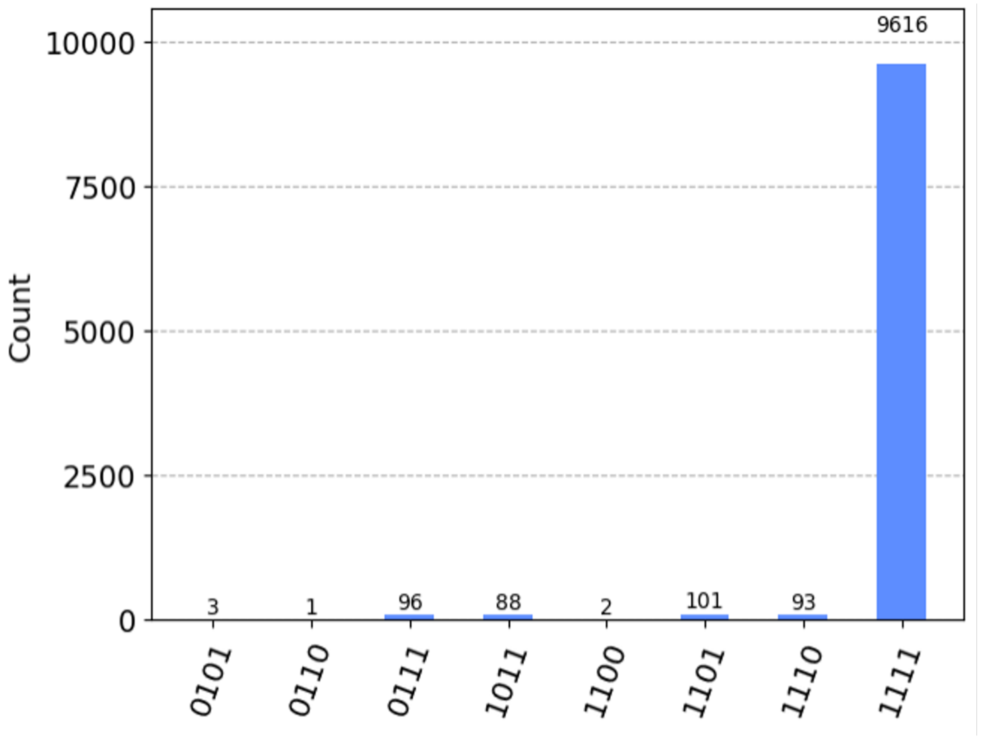
$\varepsilon = 0.9$



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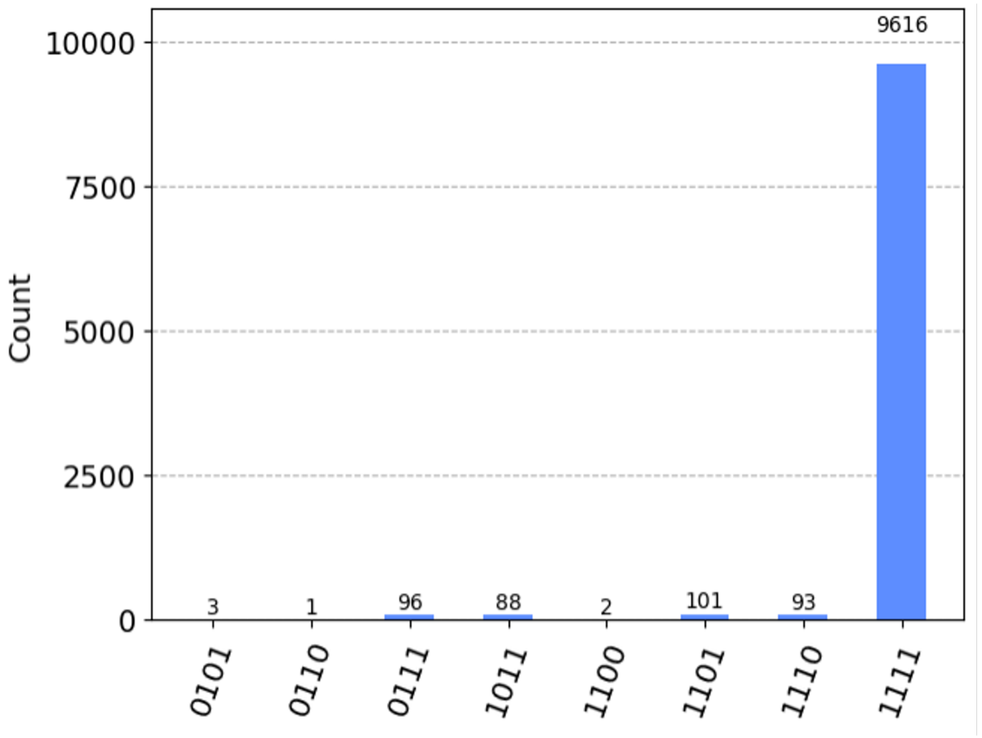

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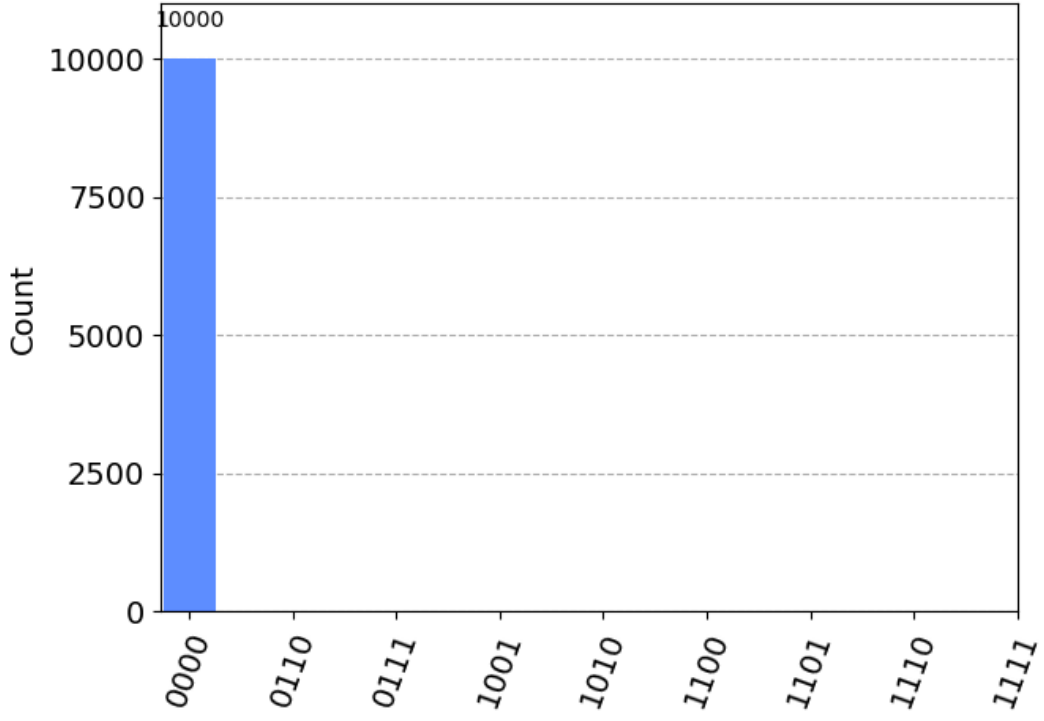
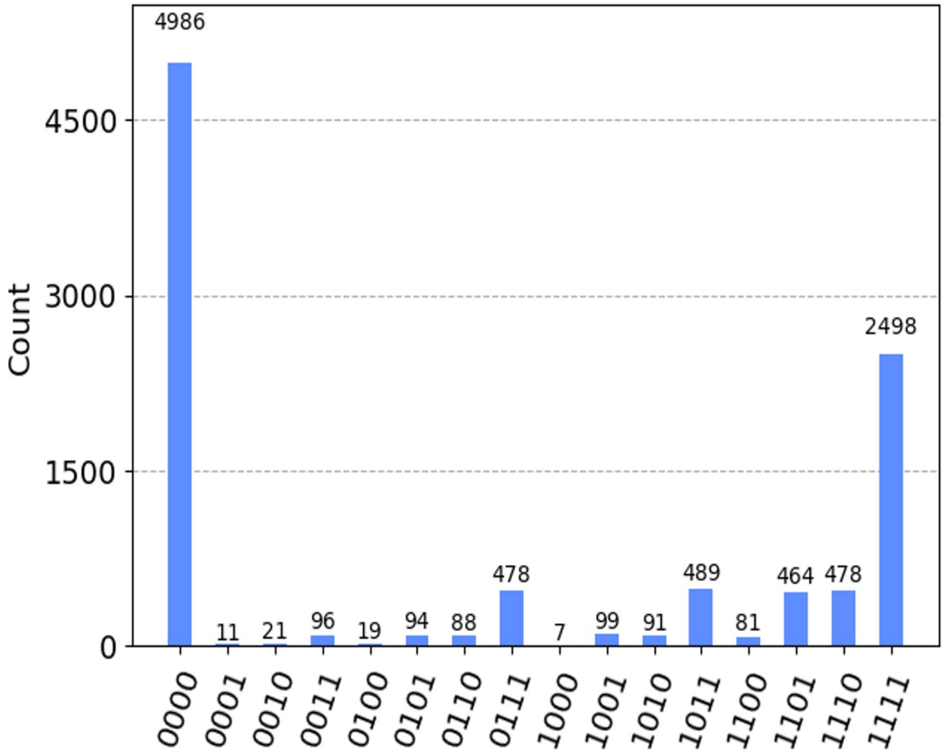


$|GS^{\perp}>$

What did we do?

$$\frac{1}{\sqrt{2}}(|GS > +|GS^{\perp} >)$$

$\boldsymbol{\varepsilon = 0.6}$



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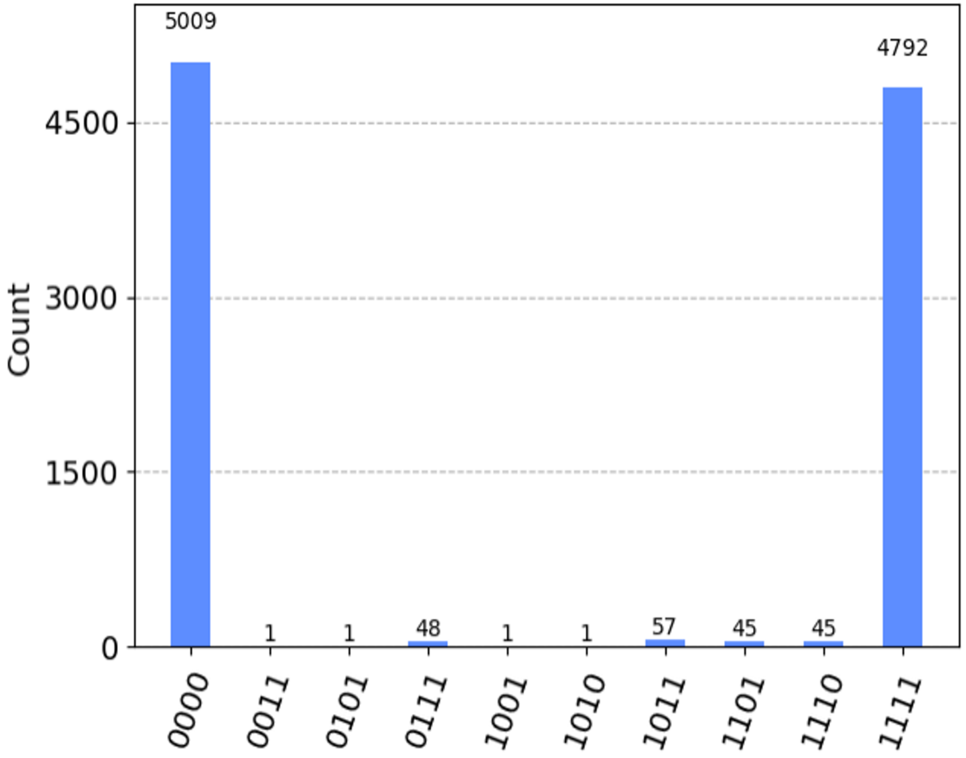

Decreasing ε makes the projector more gentle

Improvements to Triple Alpha

- Nondemolition measurements
- Client libraries that abstract away curl request.
- More expressive language features:

  `if expression` rather than `if int`
  `increment i` **`from A`** `to B`

- Local IDE and local compiler

Future Work (at Bali next year?!)

- Simulate DQE on H_n chain
- Different instantiations of DQE:
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  - Resampling
  - Parameter scheduling

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Thank you, Horizon,
for the amazing experience!