# Digital-analog Variational Quantum Eigensolver

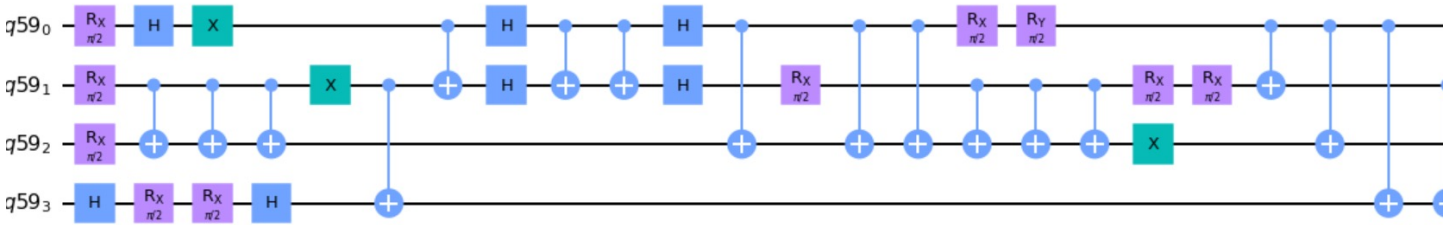
# Problem

**More Digital Gates → More Noise**

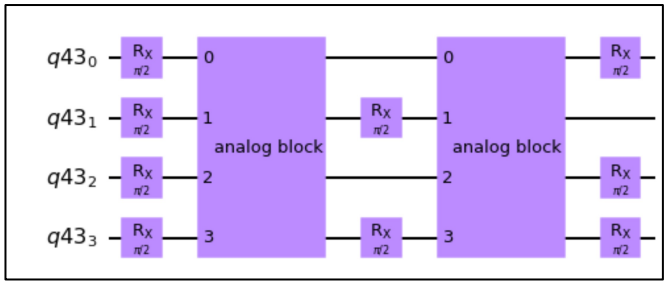
# Digital Analog Block Approach = Digital Block + Analog Block

## Less Gates → Less Noise

## [ Better value for Ground state Energy ]




By using analog block performing by zz Hamiltonian interaction as an entanglement resource

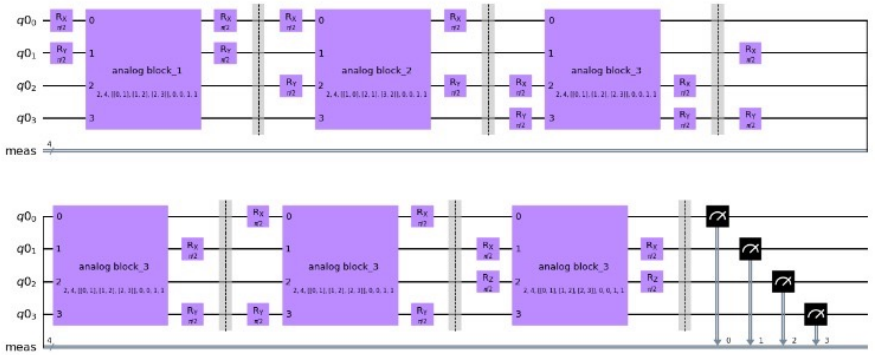



Reduce number of gates

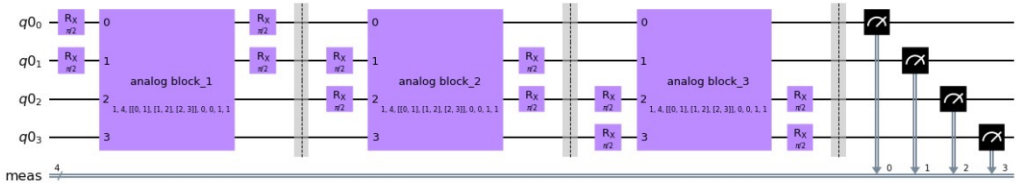
# Our Solution - Implementation On H2 molecule – Using Qiskit

Different Configurations

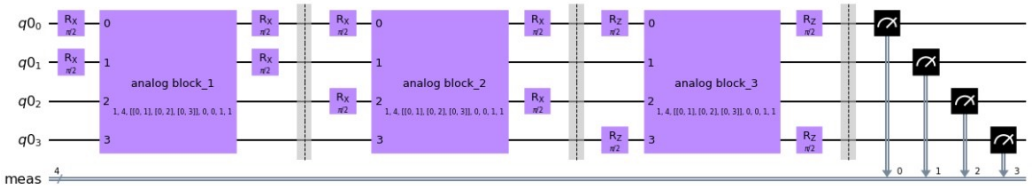
## All- Connectivity




## 1- chain Dimensional



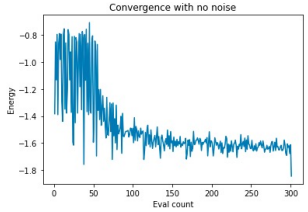

## Star Configuration



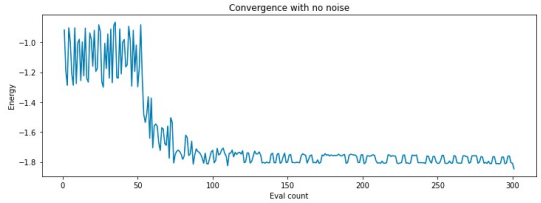
# Our Solution - Implementation On H2 molecule – Using Qiskit

Results

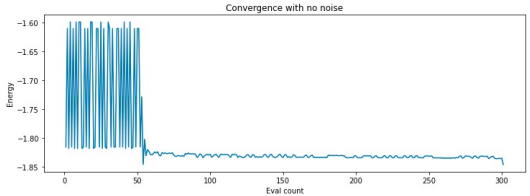
## All- Connectivity

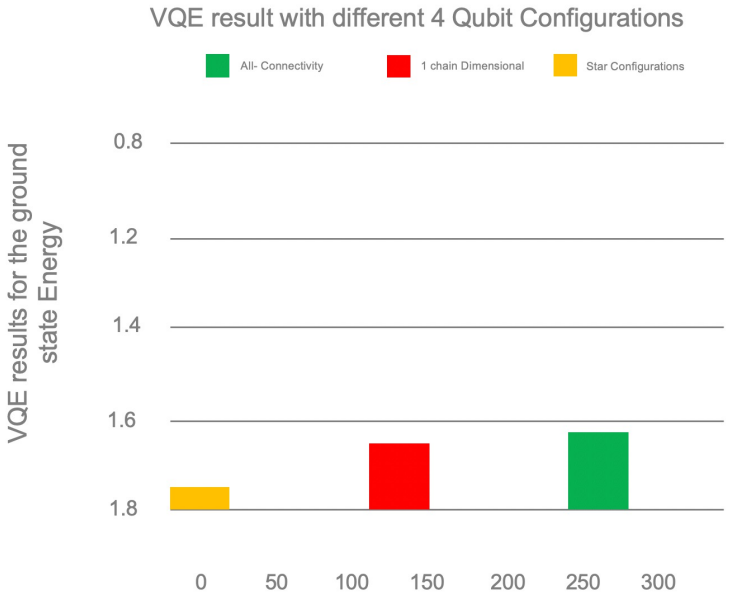



## 1- Chain Dimensional




## Star Configuration



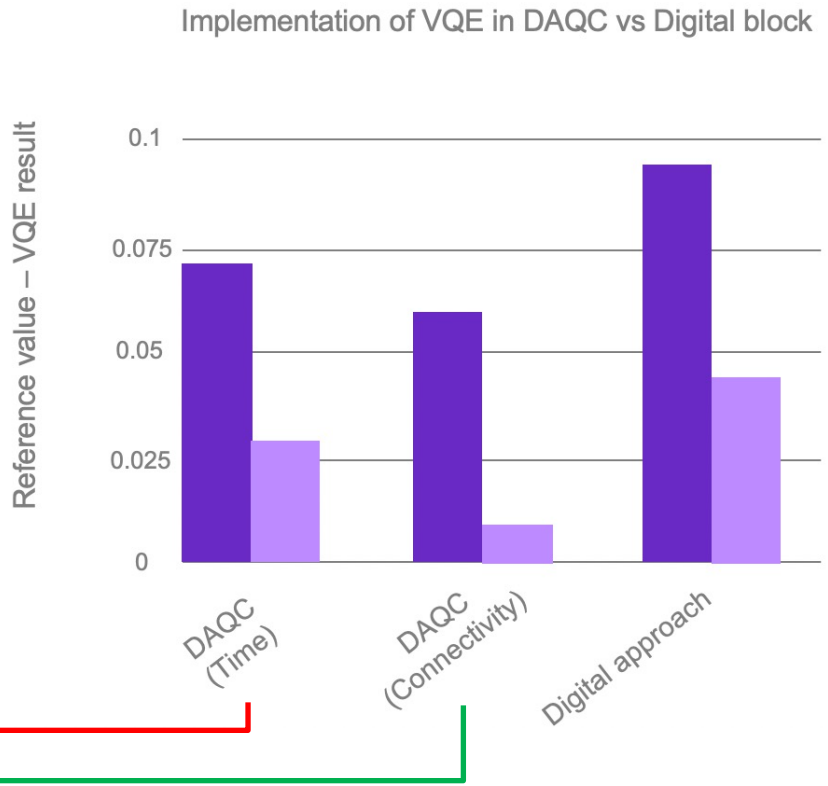

**Less Connectivity = More convergence**

# VQE in **DAQC Vs Digital block**

Played with Different parameter

**Time**

**Qubits connectivity**

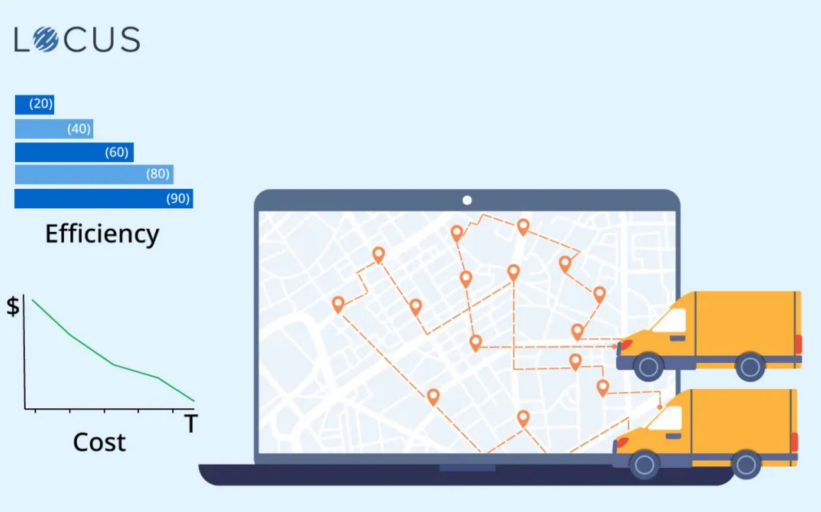


# Our team discover new problem Inspired from the DAQC

**Classical optimizers are not efficient** for Digital Analog Approach as it the Digital approach

How to optimize to our ansatz for the new approach DAQC with **a better optimizers** than (ADAM, SPSA, etc)

**Logistics is a major industry**, with some estimates valuing it at **USD 8183 billion globally** in 2015, the vehicle routing problem (VRP) is a combinatorial problem which asks " **What is the optimal set of routes for a fleet of vehicles to traverse in order to deliver to a given set of customers?"**




# What is Done?

## Cost using VQE digital block

| | n (No. of locations) | K (No. of vehicles) | Quantum Cost | Quantum Cost Execution Time (in s) |
|---|---|---|---|---|
| 0 | 2.0 | 1.0 | 12.656202 | 0.000043 |
| 1 | 3.0 | 2.0 | 88.970629 | 0.000040 |
| 2 | 4.0 | 3.0 | 253.487492 | 0.000048 |
| 3 | 5.0 | 4.0 | 281.543155 | 0.000041 |
| 4 | 3.0 | 1.0 | 91.608937 | 0.000058 |
| 5 | 4.0 | 1.0 | 18041.312168 | 0.000089 |
| 6 | 4.0 | 2.0 | 18064.157529 | 0.000063 |
| 0 | 2.0 | 1.0 | 12.656202 | 0.000048 |

# We are working

## Cost using VQE digital Analog block