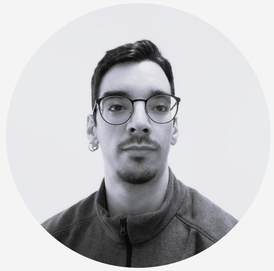
Quantum Radar for Battleship Game

Álvaro Nodar
Technical Lead
Global Data Quantum

Ángel Rodríguez
PhD Student
Material Physics Center



Benjamin Tirado
PhD Student
Centro de Física de Materiales
(CSIC – UPV/EHU)

Raúl Guerrero
Researcher in Quantum Tech.
Tecnalia: Research & Innovation

Joaquim Jornet-Somoza
Scientific Computing Specialist
University of the Basque Country

IBM

BasQ
Basque Quantum

QISKIT 2025 2025 FALL FEST

Battleship game

The game of **Battleship** is a two-player strategy game where each player secretly arranges a fleet of ships on a grid (typically 10×10 in size)

Ships vary in length and are placed either horizontally or vertically, without overlapping.

Players take turns calling out grid coordinates (for example, “B7”) to target their opponent’s hidden ships. The opponent responds with “hit” if the chosen square contains part of a ship or “miss” if it does not.

https://www.johnlewis.com/john-lewis-battleship-game/p4351540

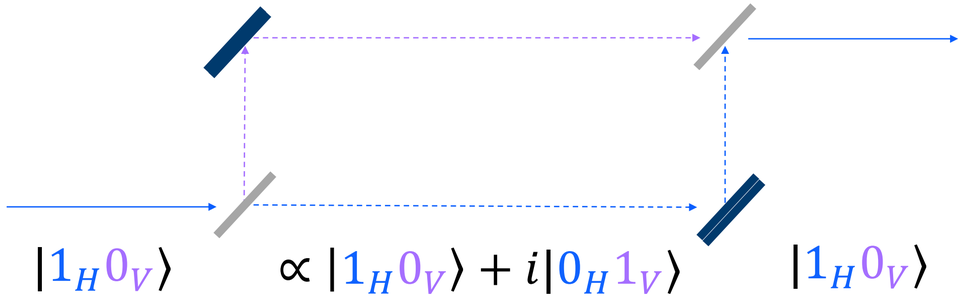
Our goal:
Find all ships with minimum chance of hitting them

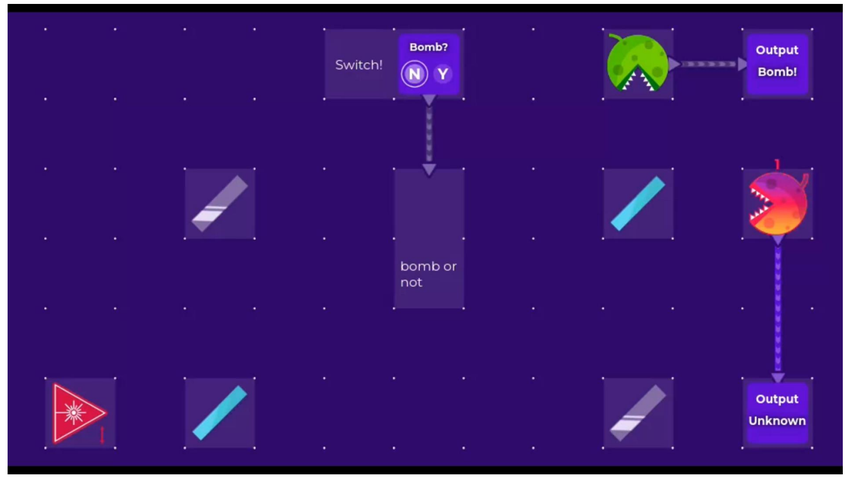
Elitzur-Vaidman interaction-free bomb-tester

Elitzur-Vaidman bomb tester

First proposed in 1993, the Elitzur–Vaidman bomb tester is a landmark thought experiment—later confirmed experimentally—that demonstrates how core principles of quantum physics, such as superposition and entanglement, can be harnessed to perform *interaction-free measurements*.

Mach-Zehnder interferometer





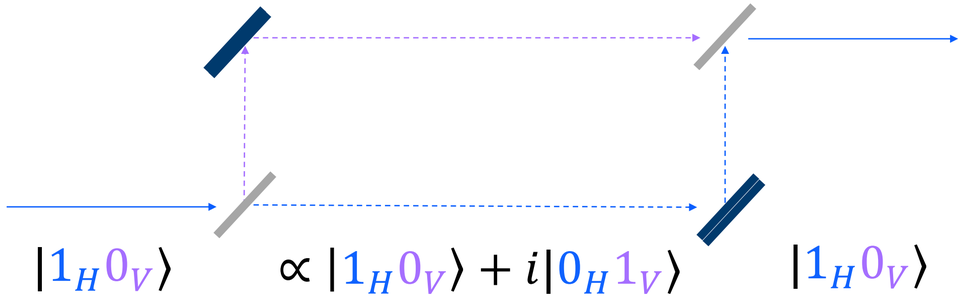
https://lab.quantumflytrap.com

Century of Quantum

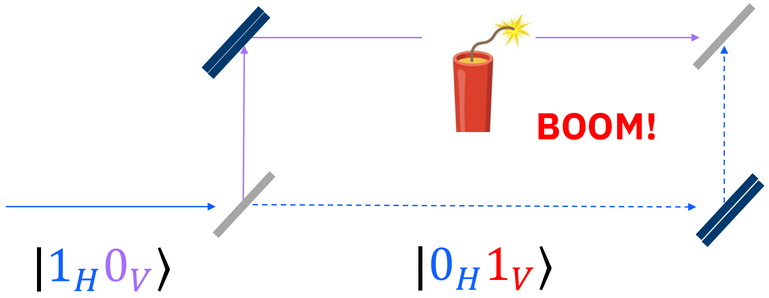
Elitzur-Vaidman bomb tester

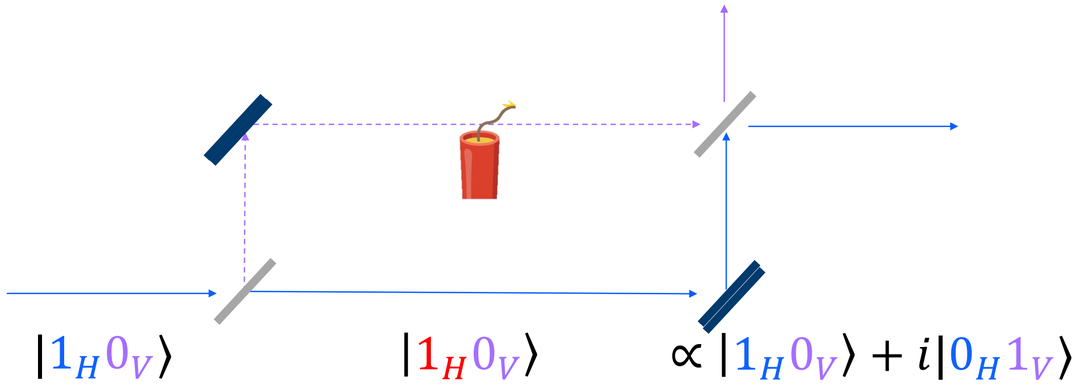
First proposed in 1993, the Elitzur–Vaidman bomb tester is a landmark thought experiment—later confirmed experimentally—that demonstrates how core principles of quantum physics, such as superposition and entanglement, can be harnessed to perform *interaction-free measurements*.

Mach-Zehnder interferometer



Place a bomb = collapse superposition



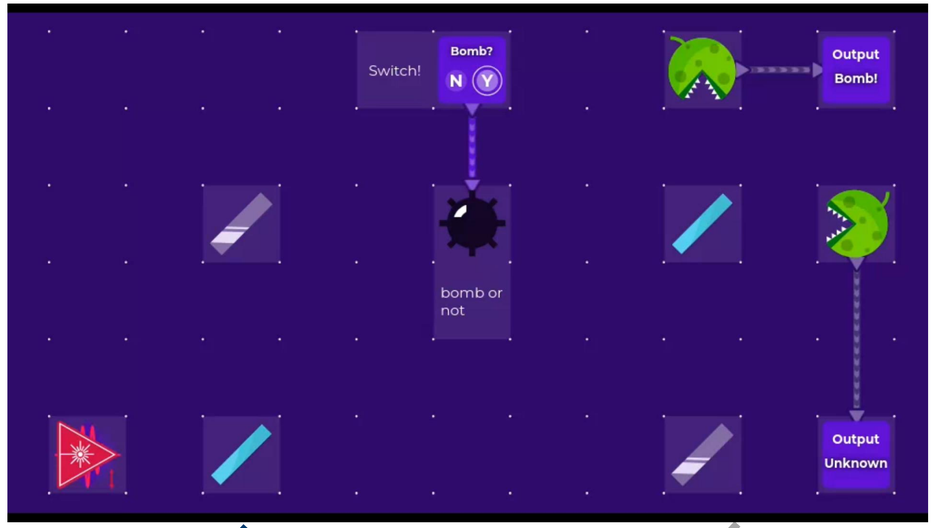


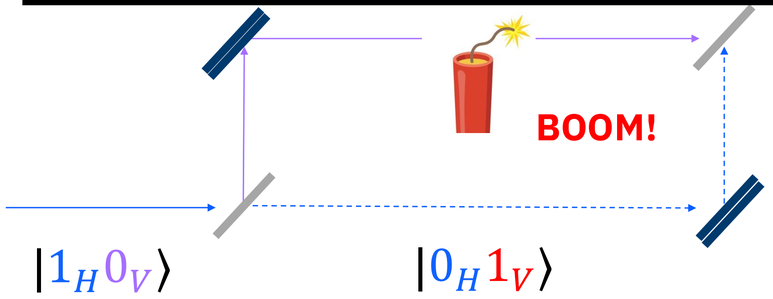
Century of Quantum

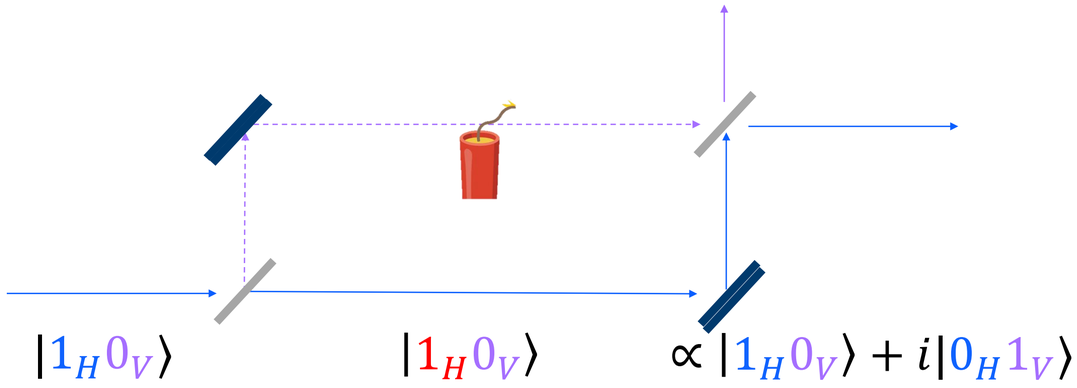
Elitzur-Vaidman bomb tester

https://lab.quantumflytrap.com

First proposed in 1993, the Elitzur–Vaidman bomb tester is a landmark thought experiment—later confirmed experimentally—that demonstrates how core principles of quantum physics, such as superposition and entanglement, can be harnessed to perform *interaction-free measurements*.





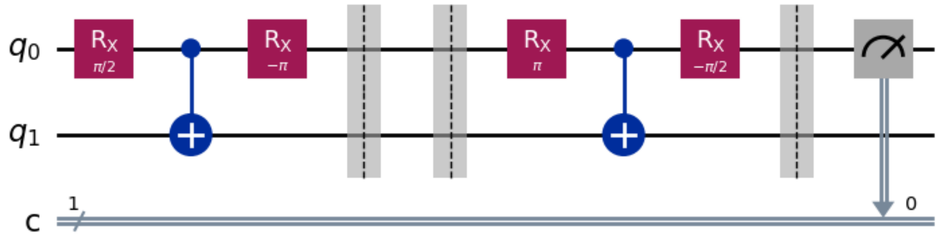


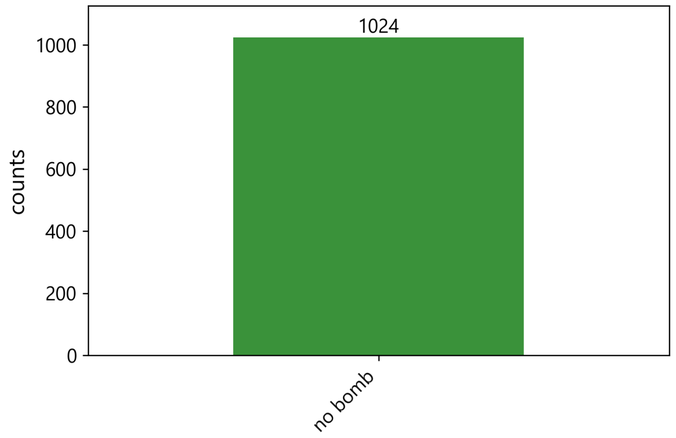
Century of Quantum

There’s a chance of detecting a bomb without hitting it

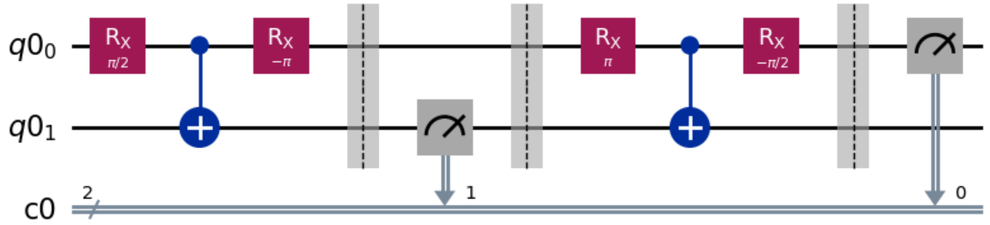
Elitzur Vaidman at Qiskit

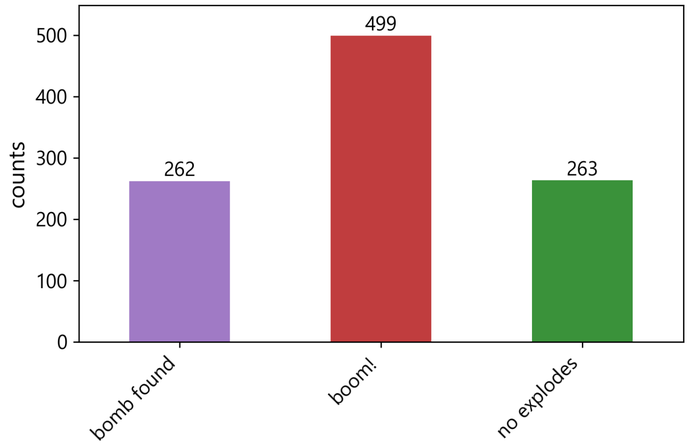
Mach-Zehnder interferometer





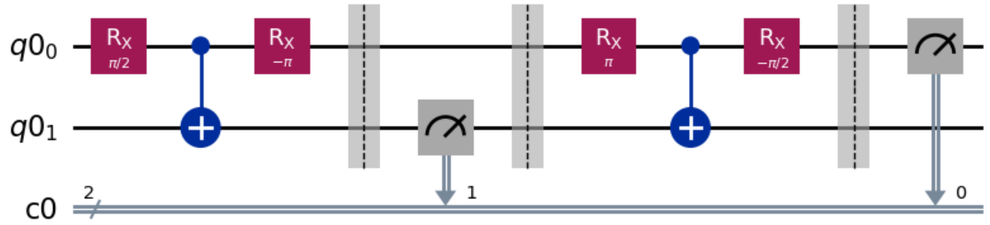
Bomb placement

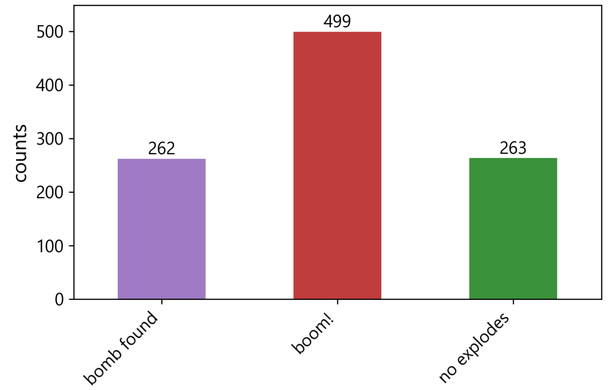




E.V. score = Detection (25%) / Explosion (50%) = 50%

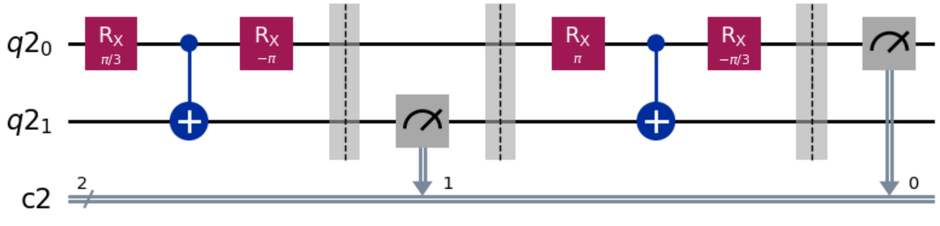
Original experiment

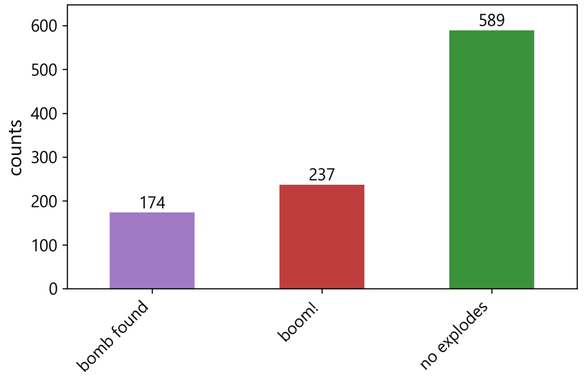




50%

Upgrade by changing angle





75%

Let’s play battleship

Battleship game

The game of **Battleship** is a two-player strategy game where each player secretly arranges a fleet of ships on a grid (typically 10×10 in size)

Ships vary in length and are placed either horizontally or vertically, without overlapping.

Players take turns calling out grid coordinates (for example, “B7”) to target their opponent’s hidden ships. The opponent responds with “hit” if the chosen square contains part of a ship or “miss” if it does not.

https://www.johnlewis.com/john-lewis-battleship-game/p4351540

Classical brute-force plan

	A	B	C	D
1				
2			X	X
3				
4				

Plan:

1. Measure A1
2. Measure A2
3. Measure A3
4. Measure A4
5. Measure B1
6. Measure B2
7. Measure B3
8. Measure B4
9. Measure C1
10. Measure C2
11. Measure C3
12. Measure C4
13. Measure D1
14. Measure D2
15. Measure D3
16. Measure D4

16 measurements
0% E.V. score

Quantum plan <> superposition

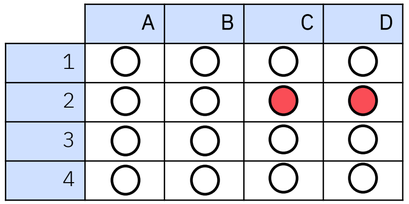
	A	B	C	D
1				
2			X	X
3				
4				

Plan:

1. Measure A column
2. Measure B column
3. Measure C column
4. Measure D column
5. Measure 1 row
6. Measure 2 row
7. Measure 3 row
8. Measure 4 row

8 measurements
75% E.V. score

Classical brute-force plan



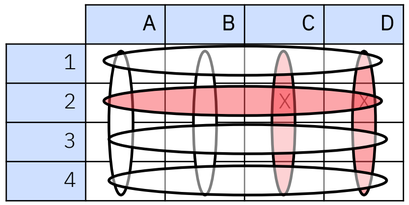
Plan:

1. Measure A1
2. Measure A2
3. Measure A3
4. Measure A4
5. Measure B1
6. Measure B2
7. Measure B3
8. Measure B4
9. Measure C1
10. Measure C2
11. Measure C3
12. Measure C4
13. Measure D1
14. Measure D2
15. Measure D3
16. Measure D4

16 measurements

0% E.V. score

Quantum plan <> superposition



Plan:

1. Measure A column
2. Measure B column
3. Measure C column
4. Measure D column
5. Measure 1 row
6. Measure 2 row
7. Measure 3 row
8. Measure 4 row

8 measurements

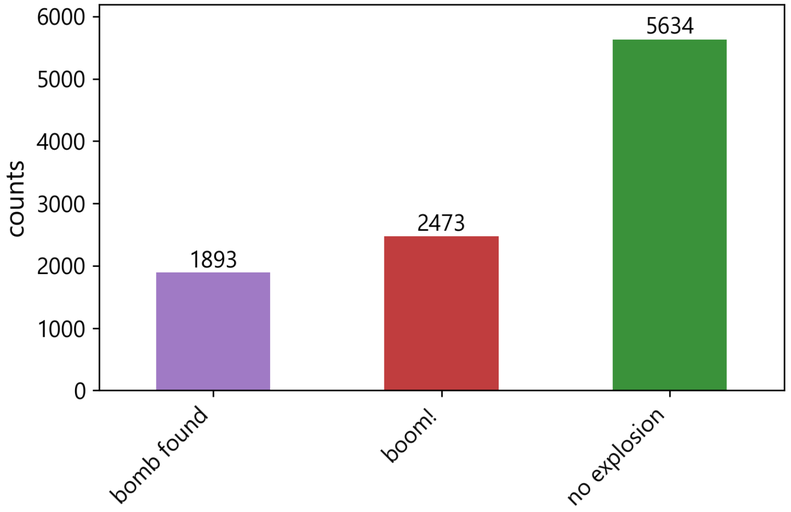
75% E.V. score

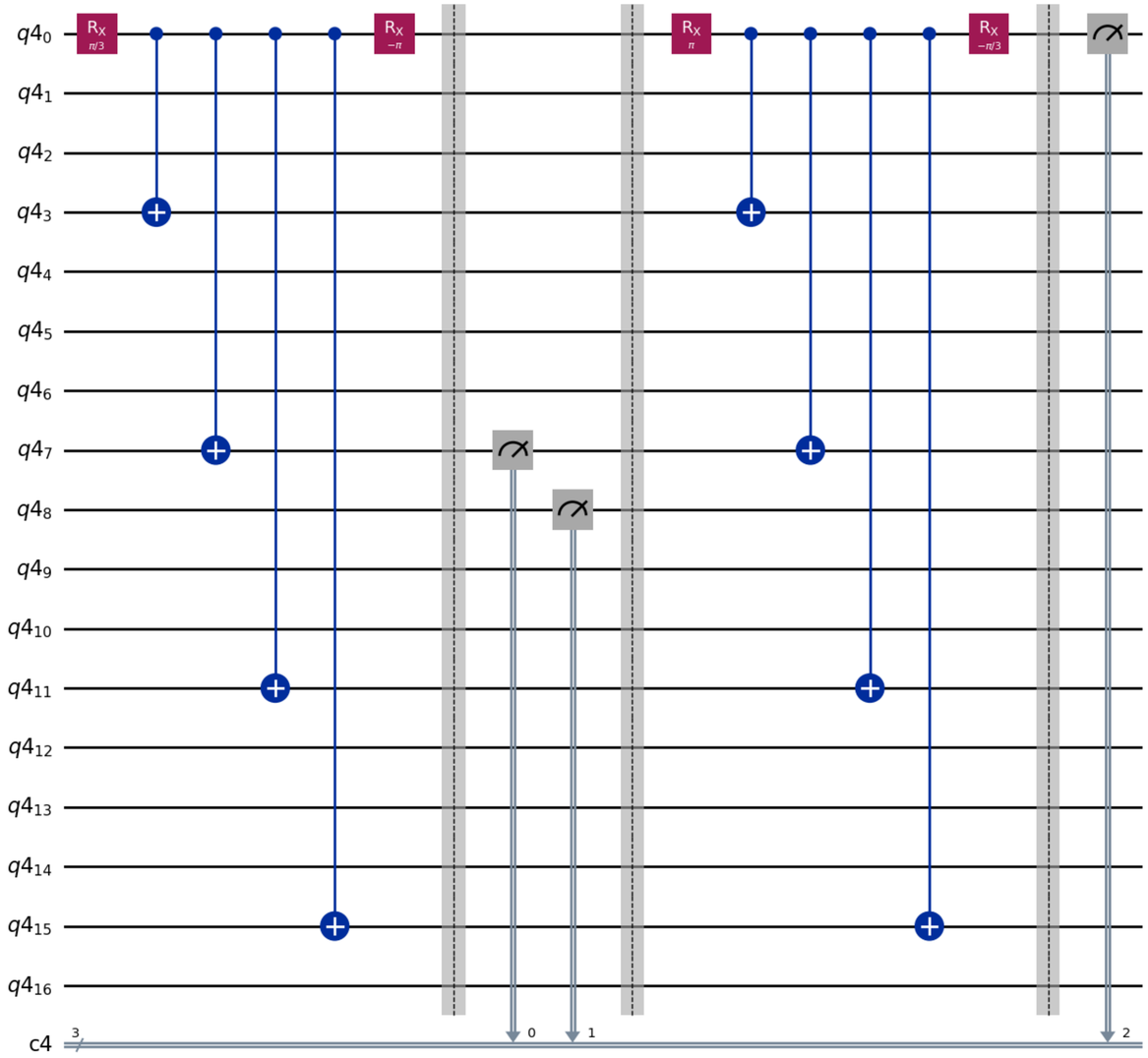
Multiple measurements

	A	B	C	D
1	q1	q2	q3	q4
2	q5	q6	**q7**	**q8**
3	q9	q10	q11	q12
4	q13	q14	q15	q16

Multiple measurements

	A	B	C	D
1	q1	q2	q3	q4
2	q5	q6	**q7**	**q8**
3	q9	q10	q11	q12
4	q13	q14	q15	q16





Battleship score:

Detection / Explosion

x

Measurements / Brute-force