Qiskit Advocate Mentorship Program

# Timeline debugger for the Qiskit transpiler

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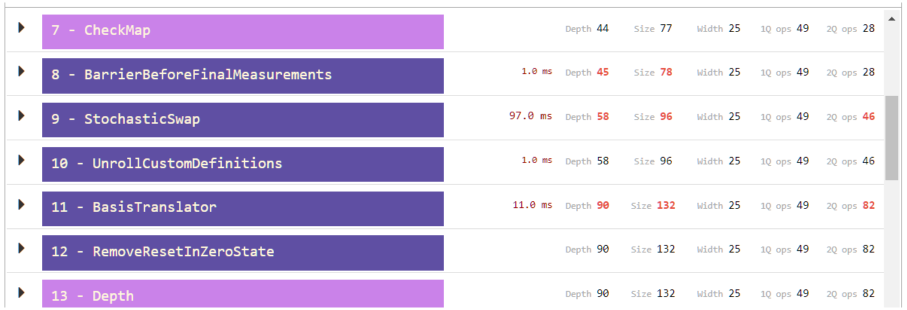
# What is Transpiler Debugger

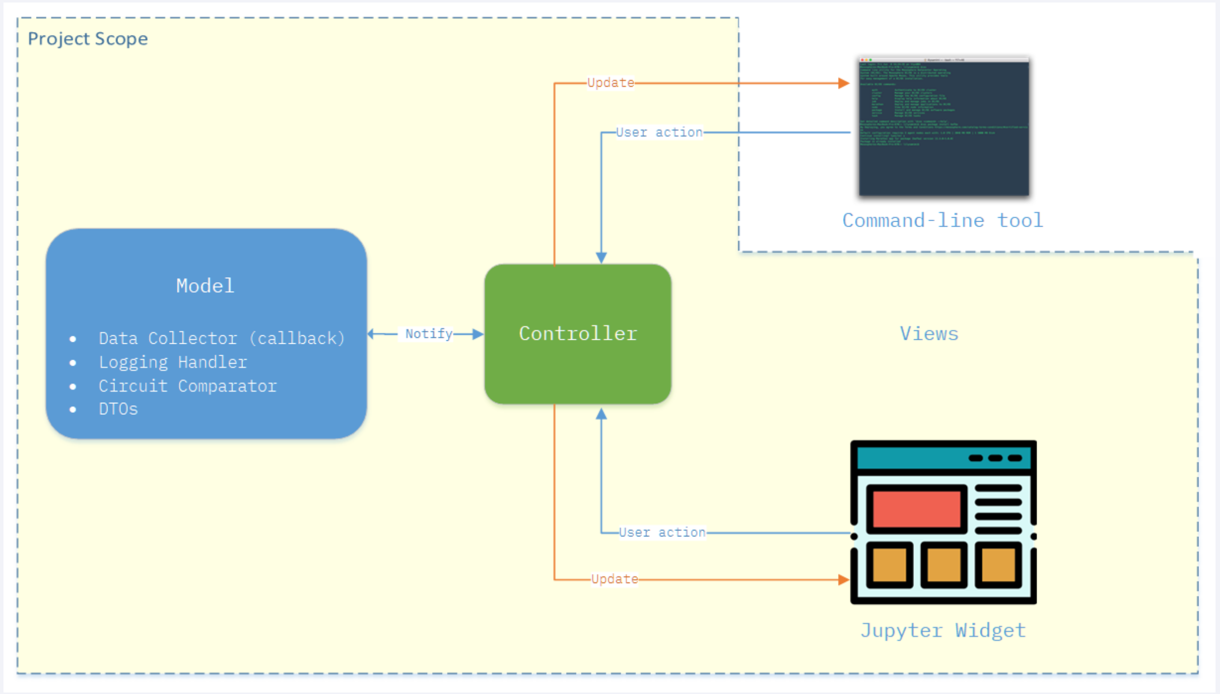
- Provides users with an understandable interface to interact with the transpiler.
- Helping users to find which passes are responsible for the large changes in overall circuit properties: depth, basis, duration, or seeing these properties (and their changes pass by pass)
- Helping users to understand the transpilation process (which passes ran when, were responsible for which changes to a circuit, …)
- Guiding users during debugging sessions by collecting all the data they need to investigate the issue, identify the root cause, and fix it.



| | | | | | | |
|---|---|---|---|---|---|---|
| 7 - CheckMap | | Depth 44 | Size 77 | Width 25 | 1Q ops 49 | 2Q ops 28 |
| 8 - BarrierBeforeFinalMeasurements | 1.0 ms | Depth 45 | Size 78 | Width 25 | 1Q ops 49 | 2Q ops 28 |
| 9 - StochasticSwap | 97.0 ms | Depth 58 | Size 96 | Width 25 | 1Q ops 49 | 2Q ops 46 |
| 10 - UnrollCustomDefinitions | 1.0 ms | Depth 58 | Size 96 | Width 25 | 1Q ops 49 | 2Q ops 46 |
| 11 - BasisTranslator | 11.0 ms | Depth 90 | Size 132 | Width 25 | 1Q ops 49 | 2Q ops 82 |
| 12 - RemoveResetInZeroState | | Depth 90 | Size 132 | Width 25 | 1Q ops 49 | 2Q ops 82 |
| 13 - Depth | | Depth 90 | Size 132 | Width 25 | 1Q ops 49 | 2Q ops 82 |

# Overall Architecture

- We used Model-View-Controller architectural pattern so that more views can be easily supported in the future.
- This version comes with one view only: a Jupyter Widget.
- A future version can support a command-line debugger by adding the view class only!



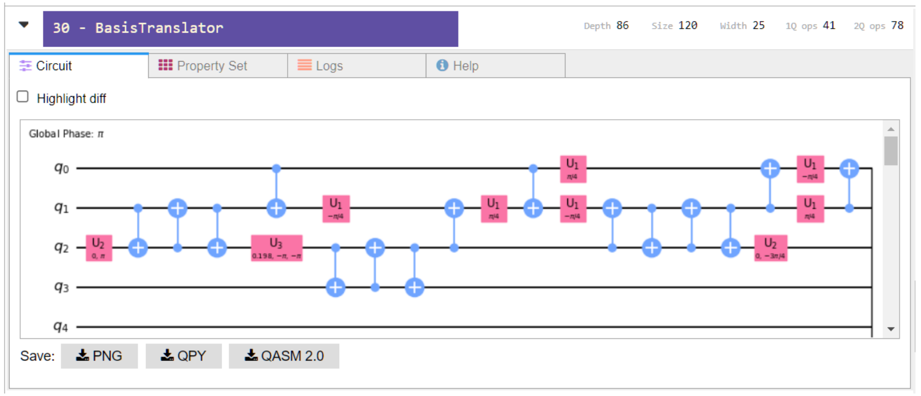
## Scalability

– **Lazy-loading**

- During transpilation, the debugger collects the data. Only minor processing is done at this stage to display the passes and their basic information.
- When the user expands a pass, the circuit plot is generated, and the log messages are formatted.
- Passes circuits are compared only when user asks for it.

– **Content limitation**:

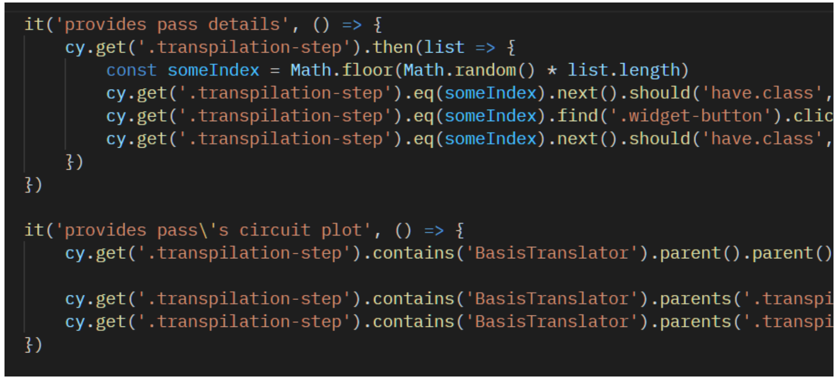
- Circuit plot is displayed only if its depth < 300.
- Large property values (e.g., list with > 2000 items) are truncated.


30 - BasisTranslator

Depth 86 Size 120 Width 25 1Q ops 41 2Q ops 78

# Testing

- We used Cypress as a UI testing automation tool.
- Cypress testing scripts are written in JavaScript.
- Cypress Test Runner runs these scripts by automating the browser and generating the necessary UI events such as keystrokes and mouse clicks, and observes the changes that result in the user interface, to validate that the observable behavior is correct.



```javascript
it('provides pass details', () => {
    cy.get('.transpilation-step').then(list => {
        const someIndex = Math.floor(Math.random() * list.length)
        cy.get('.transpilation-step').eq(someIndex).next().should('have.class',
        cy.get('.transpilation-step').eq(someIndex).find('.widget-button').clic
        cy.get('.transpilation-step').eq(someIndex).next().should('have.class',
    })
})

it('provides pass\'s circuit plot', () => {
    cy.get('.transpilation-step').contains('BasisTranslator').parent().parent()

    cy.get('.transpilation-step').contains('BasisTranslator').parents('.transpi
    cy.get('.transpilation-step').contains('BasisTranslator').parents('.transpi
})
```

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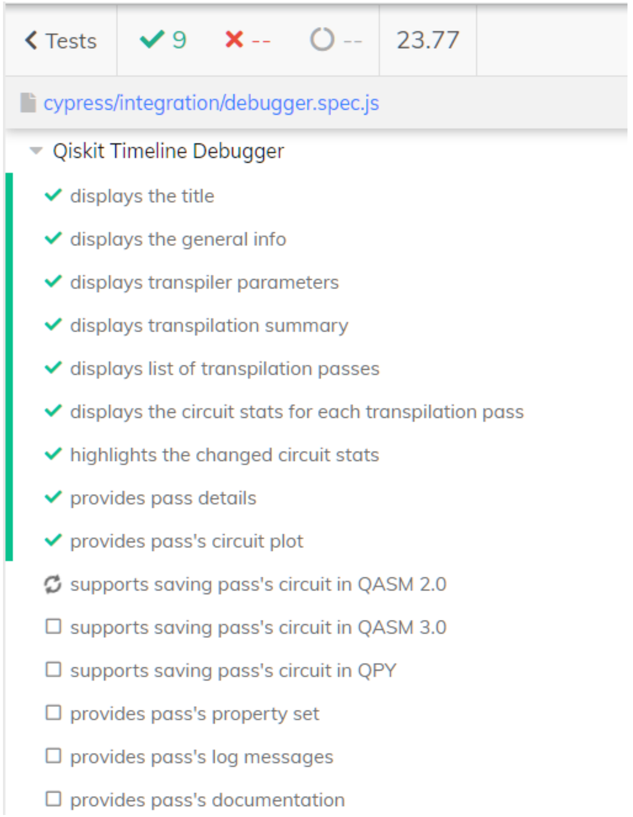

cypress/integration/debugger.spec.js

Qiskit Timeline Debugger

- ✓ displays the title
- ✓ displays the general info
- ✓ displays transpiler parameters
- ✓ displays transpilation summary
- ✓ displays list of transpilation passes
- ✓ displays the circuit stats for each transpilation pass
- ✓ highlights the changed circuit stats
- ✓ provides pass details
- ✓ provides pass's circuit plot
- supports saving pass's circuit in QASM 2.0
- ☐ supports saving pass's circuit in QASM 3.0
- ☐ supports saving pass's circuit in QPY
- ☐ provides pass's property set
- ☐ provides pass's log messages
- ☐ provides pass's documentation

Qiskit

# Thank You!