# Pulse Class Documentation

Quantum Simulation Toolkit

April 11, 2025

## 1 Overview

The `Pulse` class models time-dependent laser parameters for quantum simulations:

- $\Omega(t)$: Rabi frequency (MHz)
- $\phi(t)$: Phase (radians)
- $\delta(t)$: Detuning (MHz)

## 2 Class Features

- Independent configuration of $\Omega$, $\phi$, and $\delta$
- Pre-built waveform shapes: `constant`, `gaussian`, `linear`
- Custom mathematical functions support
- Integrated visualization

## 3 Initialization

```
pulse = Pulse()  # No required arguments
```

## 4 Configuration Methods

Configure parameters independently using:

```
pulse.set_omega(shape: str, **kwargs)
pulse.set_phi(shape: str, **kwargs)
pulse.set_delta(shape: str, **kwargs)
```

### 4.1 Supported Waveform Types

| Shape | Parameters | Description |
|---|---|---|
| `constant` | `value: float` | Fixed value |
| `gaussian` | `amp, t0, sigma: float` | Gaussian pulse |
| `linear` | `slope, intercept: float` | Linear ramp |
| `custom` | `func: Callable` | User-defined function |

## 5 Visualization

Plot parameters over time:

```
pulse.plot(t_range=(0, 5), num_points=200)
```

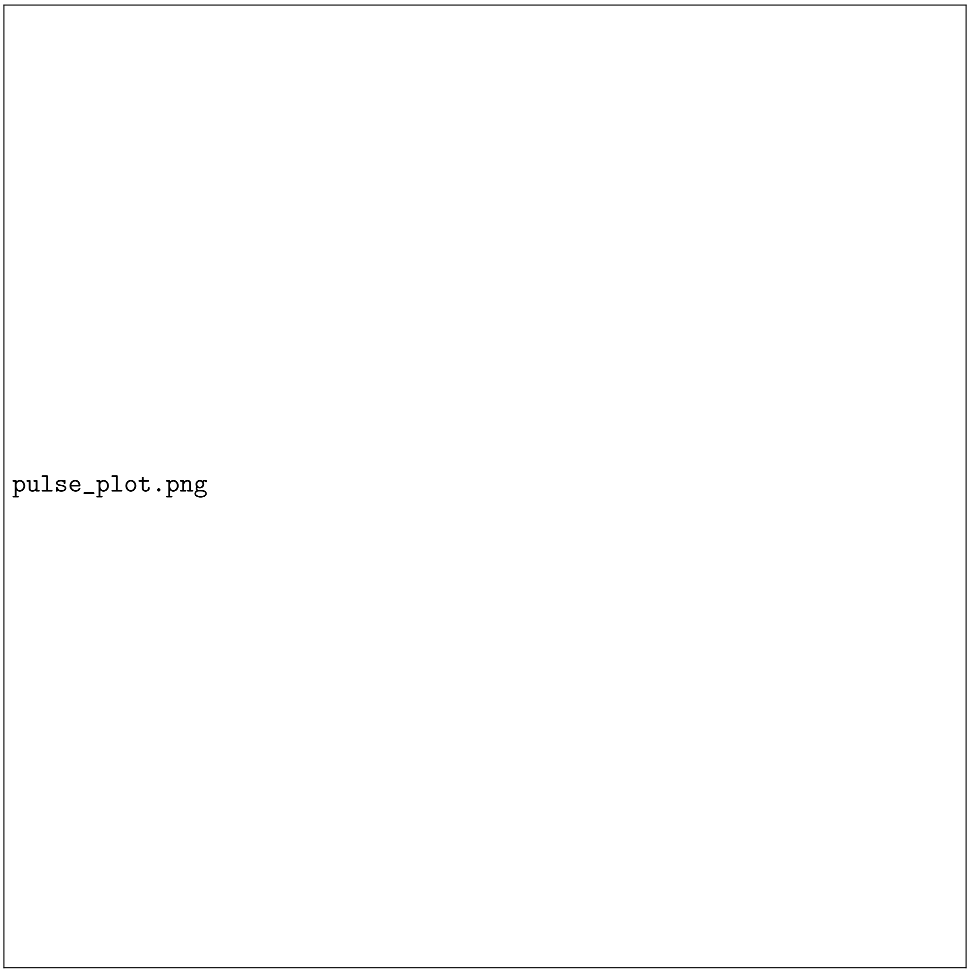

Figure 1: Sample pulse visualization showing Gaussian $\Omega(t)$, linear $\phi(t)$, and constant $\delta(t)$

# 6 Example Usage

## 6.1 Basic Configuration

```
pulse = Pulse()
pulse.set_omega('gaussian', amp=10.0, t0=2.5, sigma=0.5)
pulse.set_phi('linear', slope=np.pi/2, intercept=0.0)
pulse.set_delta('constant', value=1.0)
```

## 6.2 Custom Waveform

```
# Custom delta(t) = sin(2 *0.5*t)
pulse.set_delta('custom',
                func=lambda t, p: np.sin(2*np.pi*0.5*t))
```

# Notes

- Time units: microseconds ($\mu$s)
- Frequency units: MHz for $\Omega$ and $\delta$
- Phase values not automatically wrapped to $2\pi$
- Custom functions must accept `(t, params)` arguments