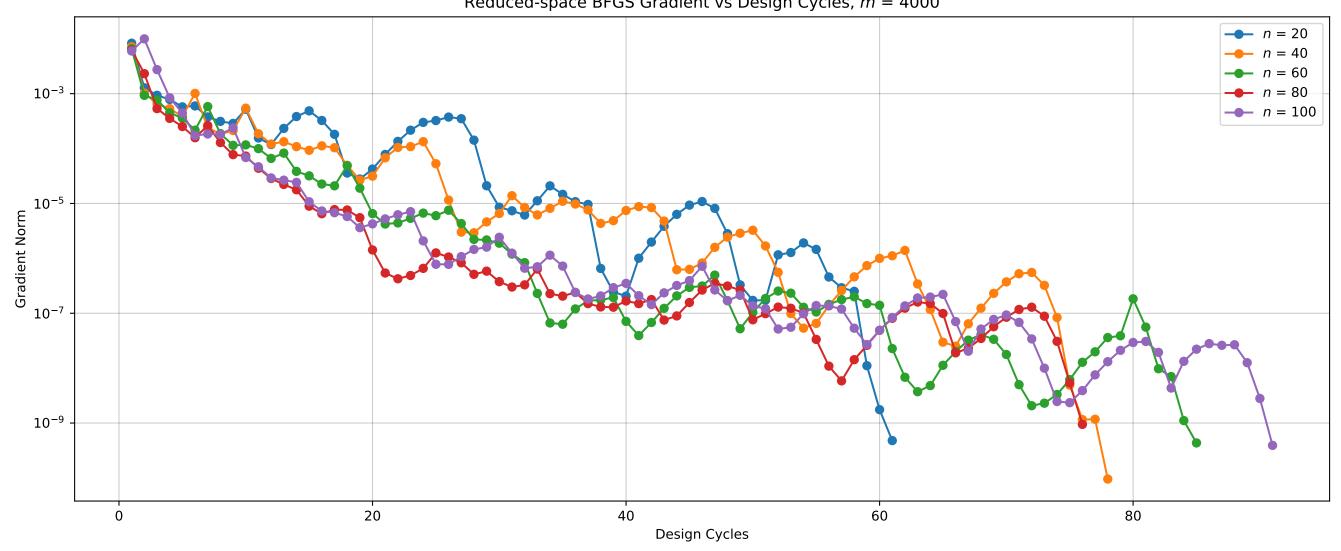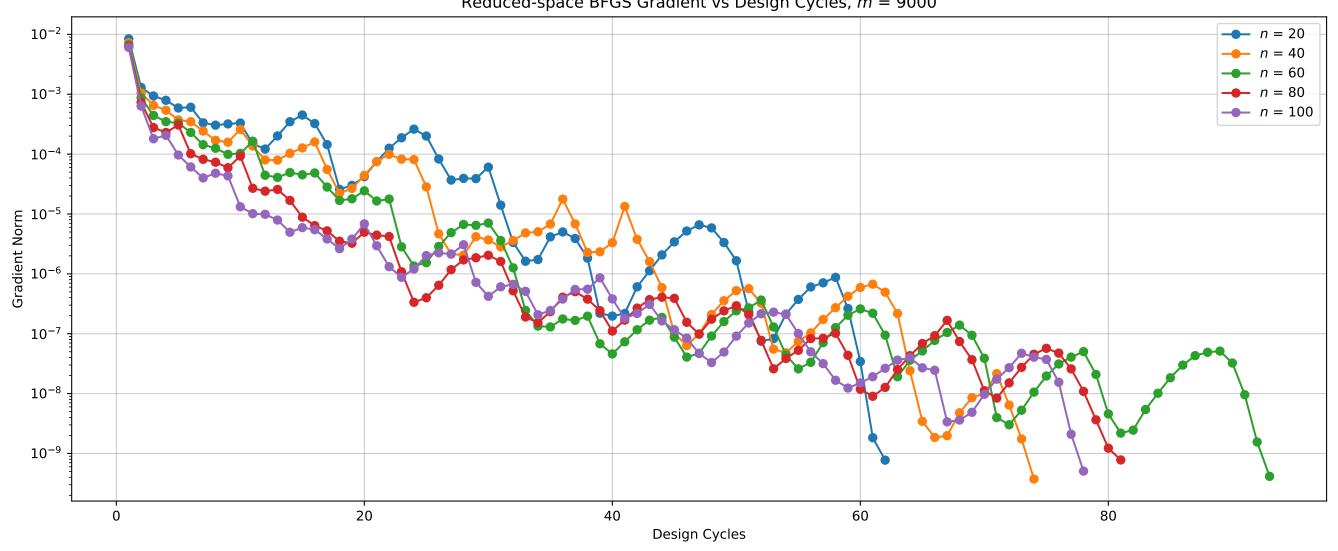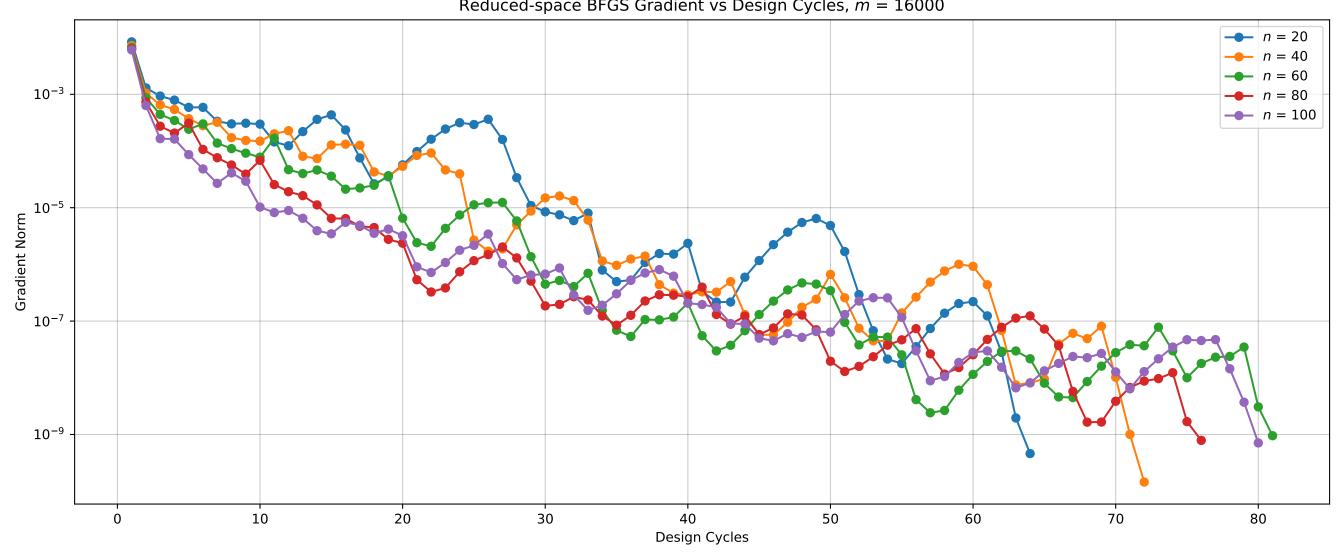Reduced-space BFGS Gradient vs Design Cycles, $m = 4000$

Reduced-space BFGS Gradient vs Design Cycles, $m = 9000$
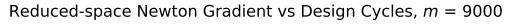
Reduced-space BFGS Gradient vs Design Cycles, $m = 16000$

Reduced-space Newton Gradient vs Design Cycles, $m = 4000$
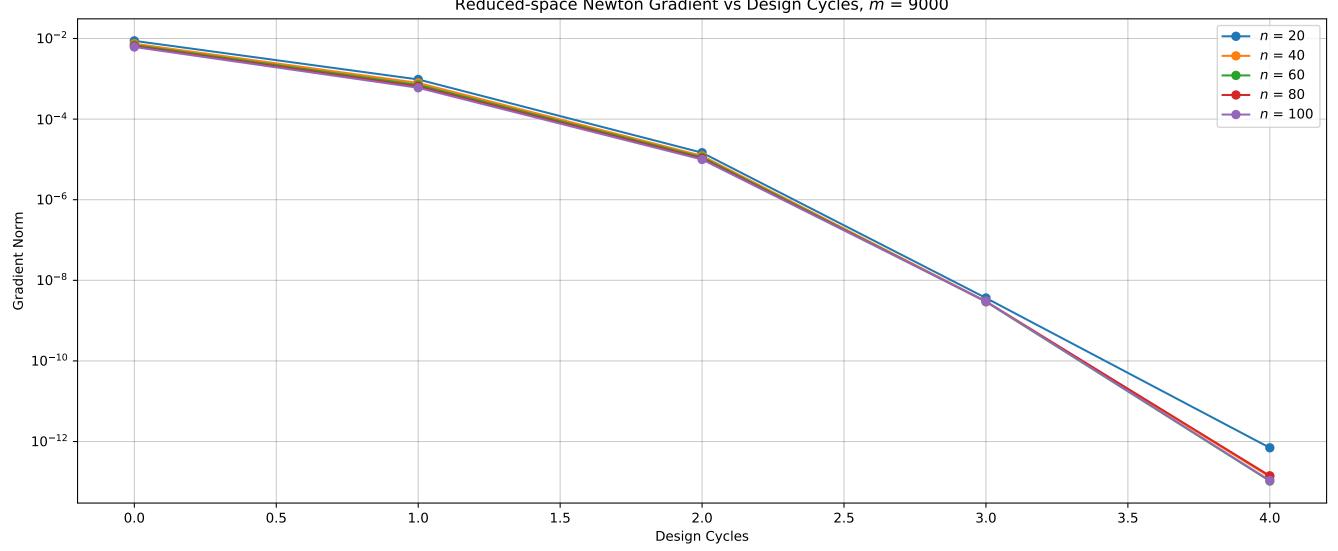
Reduced-space Newton Gradient vs Design Cycles, $m = 9000$

Reduced-space Newton Gradient vs Design Cycles, $m = 16000$

Full-space with $\mathbf{P}_4$ Gradient vs Design Cycles, $m = 4000$

Full-space with $\mathbf{P}_4$ Gradient vs Design Cycles, $m = 9000$

Full-space with $\mathbf{P}_4$ Gradient vs Design Cycles, $m = 16000$

Full-space with $\mathbf{P}_2$ Gradient vs Design Cycles, $m = 4000$

Full-space with $\mathbf{P}_2$ Gradient vs Design Cycles, $m = 9000$

Full-space with $\mathbf{P}_2$ Gradient vs Design Cycles, $m = 16000$

Full-space with $\tilde{\mathbf{P}}_4$ Gradient vs Design Cycles, $m = 4000$

Full-space with $\tilde{\mathbf{P}}_4$ Gradient vs Design Cycles, $m = 9000$
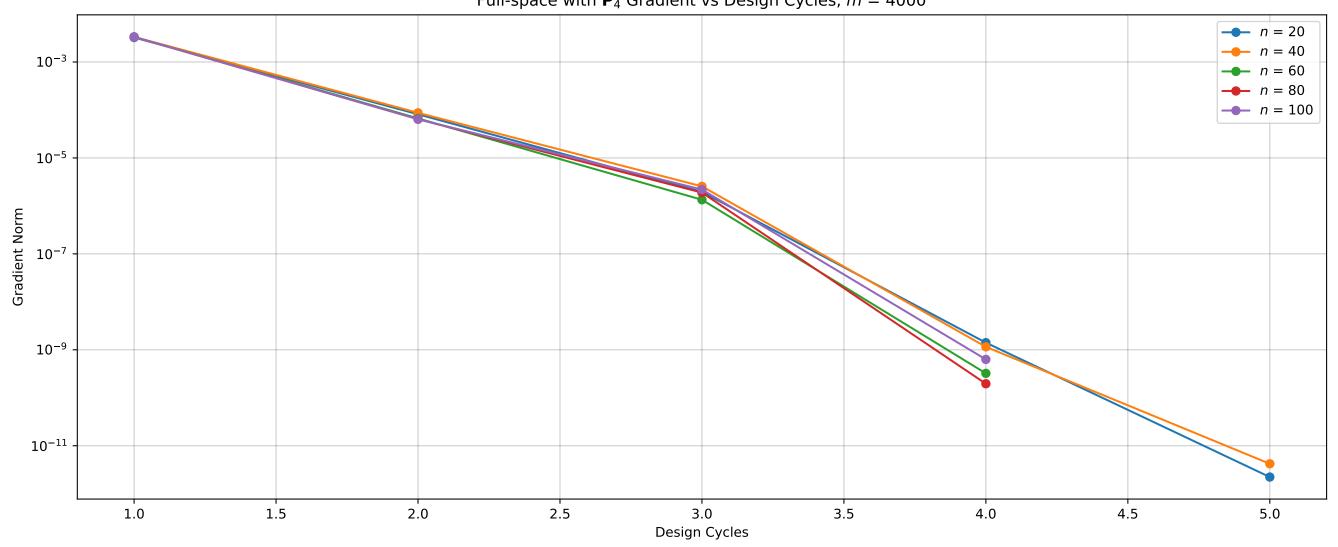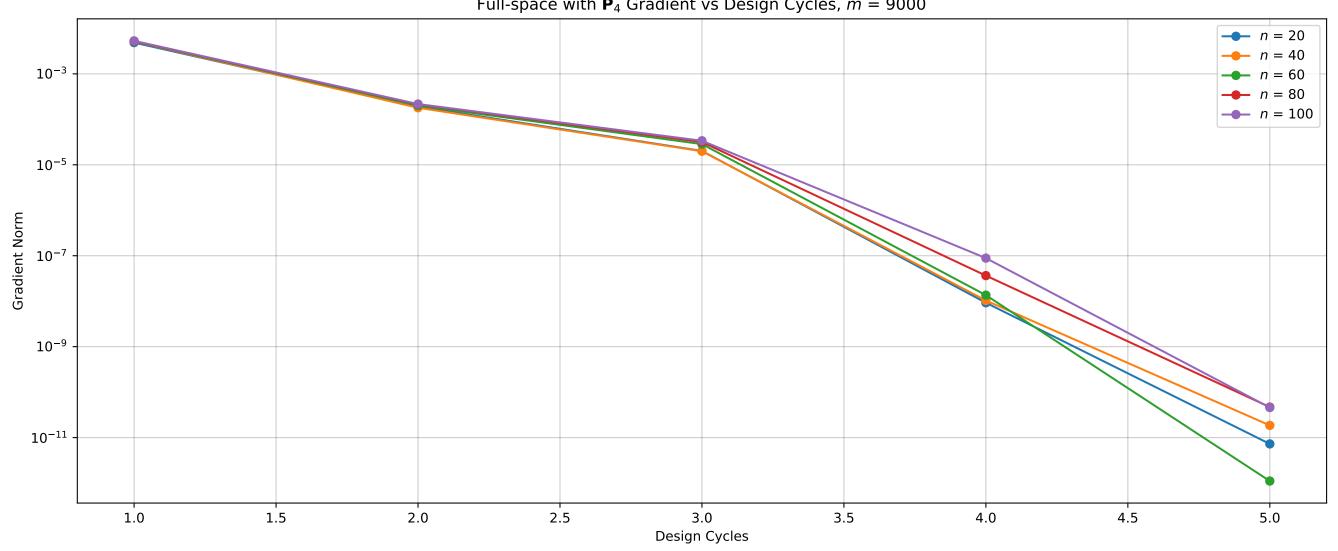
Full-space with $\tilde{\mathbf{P}}_4$ Gradient vs Design Cycles, $m = 16000$
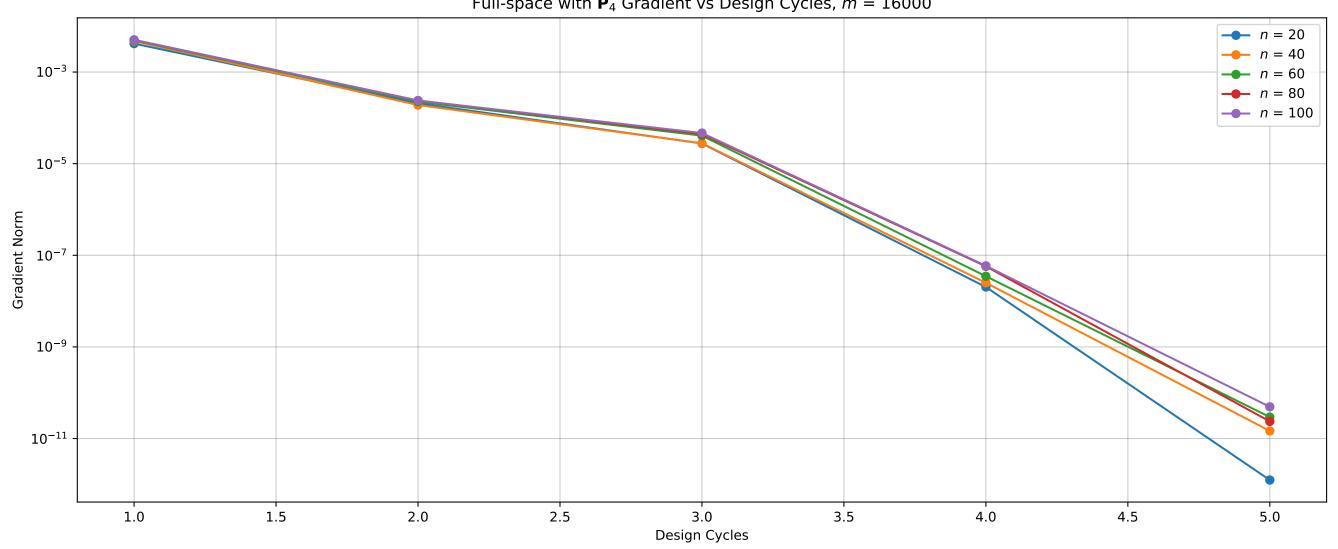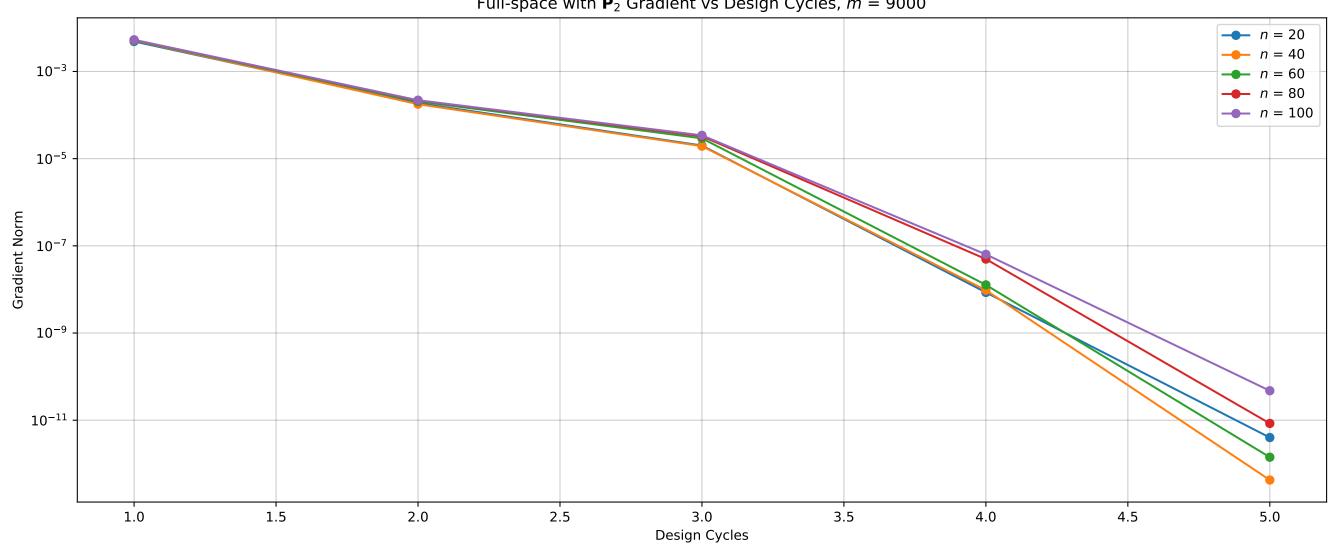
Full-space with $\tilde{\mathbf{P}}_2$ Gradient vs Design Cycles, $m = 4000$

Full-space with $\tilde{\mathbf{P}}_2$ Gradient vs Design Cycles, $m = 9000$

Full-space with $\tilde{\mathbf{P}}_2$ Gradient vs Design Cycles, $m = 16000$

Full-space Gradient vs Subiterations, $m = 4000$

Full-space Gradient vs Subiterations, $m = 9000$
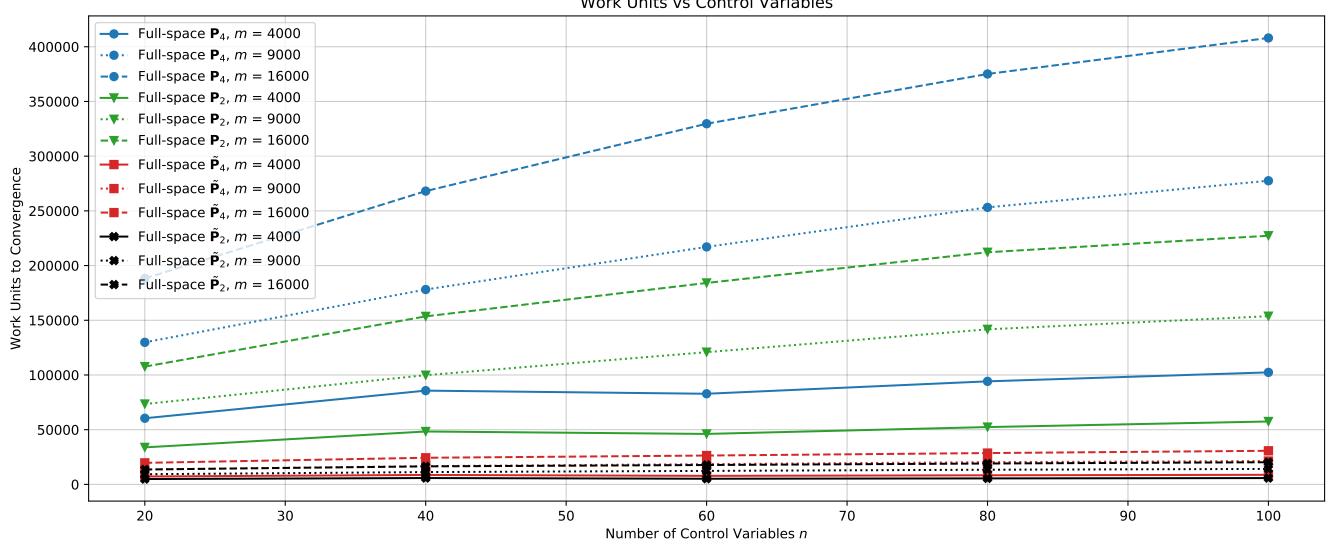
Legend:
- $\mathbf{P}_4$, $n = 20$
- $\mathbf{P}_4$, $n = 60$
- $\mathbf{P}_4$, $n = 100$
- $\mathbf{P}_2$, $n = 20$
- $\mathbf{P}_2$, $n = 60$
- $\mathbf{P}_2$, $n = 100$
- $\tilde{\mathbf{P}}_4$, $n = 20$
- $\tilde{\mathbf{P}}_4$, $n = 60$
- $\tilde{\mathbf{P}}_4$, $n = 100$
- $\tilde{\mathbf{P}}_2$, $n = 20$
- $\tilde{\mathbf{P}}_2$, $n = 60$
- $\tilde{\mathbf{P}}_2$, $n = 100$

x-axis: Number of Subiterations

y-axis: Gradient Norm

Full-space Gradient vs Subiterations, $m = 16000$

Full-space Gradient vs Subiterations

$m = 4000$

$m = 9000$

$m = 16000$

Legend:
- $\mathbf{P}_4$, $n = 20$
- $\mathbf{P}_4$, $n = 60$
- $\mathbf{P}_4$, $n = 100$
- $\mathbf{P}_2$, $n = 20$
- $\mathbf{P}_2$, $n = 60$
- $\mathbf{P}_2$, $n = 100$
- $\tilde{\mathbf{P}}_4$, $n = 20$
- $\tilde{\mathbf{P}}_4$, $n = 60$
- $\tilde{\mathbf{P}}_4$, $n = 100$
- $\tilde{\mathbf{P}}_2$, $n = 20$
- $\tilde{\mathbf{P}}_2$, $n = 60$
- $\tilde{\mathbf{P}}_2$, $n = 100$

Axis labels: Gradient Norm (vertical), Number of subiterations (horizontal)

Full-space Design Cycles vs Control Variables

Work Units vs Control Variables

Total Subiterations vs Control Variables

Legend:
- Full-space $\mathbf{P}_4$, $m = 4000$
- Full-space $\mathbf{P}_4$, $m = 9000$
- Full-space $\mathbf{P}_4$, $m = 16000$
- Full-space $\mathbf{P}_2$, $m = 4000$
- Full-space $\mathbf{P}_2$, $m = 9000$
- Full-space $\mathbf{P}_2$, $m = 16000$
- Full-space $\tilde{\mathbf{P}}_4$, $m = 4000$
- Full-space $\tilde{\mathbf{P}}_4$, $m = 9000$
- Full-space $\tilde{\mathbf{P}}_4$, $m = 16000$
- Full-space $\tilde{\mathbf{P}}_2$, $m = 4000$
- Full-space $\tilde{\mathbf{P}}_2$, $m = 9000$
- Full-space $\tilde{\mathbf{P}}_2$, $m = 16000$

Y-axis: Total Subiterations to Convergence

X-axis: Number of Control Variables n

Work Units vs Control Variables

Legend:
- Reduced-space BFGS, $m = 4000$
- Reduced-space BFGS, $m = 9000$
- Reduced-space BFGS, $m = 16000$
- Reduced-space Newton, $m = 4000$
- Reduced-space Newton, $m = 9000$
- Reduced-space Newton, $m = 16000$

X-axis: Number of Control Variables n

Y-axis: Work units to Convergence

Reduced-space Design Cycles vs Control Variables

Reduced-space Gradient vs Design Cycles

Work Units vs Control Variables

Work Units vs State Variables

Legend:
- Reduced-space Newton, $n = 20$
- Reduced-space Newton, $n = 40$
- Reduced-space Newton, $n = 60$
- Reduced-space Newton, $n = 80$
- Reduced-space Newton, $n = 100$
- Full-space $\tilde{\mathbf{P}}_2$, $n = 20$
- Full-space $\tilde{\mathbf{P}}_2$, $n = 40$
- Full-space $\tilde{\mathbf{P}}_2$, $n = 60$
- Full-space $\tilde{\mathbf{P}}_2$, $n = 80$
- Full-space $\tilde{\mathbf{P}}_2$, $n = 100$

X-axis: Number of State Variables m

Y-axis: Work Units to Convergence