Simulation Results steps

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January 16, 2019

1 Simplest benchmarks results

Table 1: Benchmarks used

Benchmark	# qubits	# gates
$4gt11_{82}$	5	27
$4gt12_{v189}$	6	228
$4gt4_{v072}$	6	258
$4mod5_{bdd287}$	7	70
$4mod5_{v020}$	5	20
alu_{bdd288}	7	84
alu_{v027}	5	36
$decod24_{bdd294}$	6	73
$decod24_{enable126}$	6	338
$graycode6_{47}$	6	5
$ham3_{102}$	3	20
$hwb4_{49}$	5	233
$mod10_{176}$	5	178
$mod5adder_{127}$	6	555
$mod5d1_{63}$	5	22
$mod8_{10177}$	6	440
$one_{twothreev199}$	5	132
$one_{twothreev3101}$	5	70
$rd32_{v066}$	4	34
sf_{274}	6	781
sf_{276}	6	778
$sym6_{145}$	7	3888
$xor5_{254}$	6	7

1.1 4gt11$_{82}$

Table 2: Step 1 results after 1000 iterations

Mapper	# qubits	depth	# gates	# SWAPS	p. success	f	V_Q
No	5	78	84	0	0.96	0.97823066	390
minextendrc	7	226	237	17	0.929	0.92937318	1582
minextend	8	**158**	**228**	**16**	**0.947**	**0.9312172**	1264
base	6	177	**228**	**16**	0.932	0.906571	1062

1.2 4gt12-v1$_{89}$

Table 3: Results after 1000 iterations

Mapper	# qubits	depth	# gates	# SWAPS	p. success	f	V_Q
no	6	416	658	0	0.768	0.66623522	2496
minextendrc	9	1172	**1360**	**78**	0.562	**0.44841106**	10548
minextend	9	**1008**	1549	99	**0.601**	0.40972458	9072
base	6	1069	1423	85	0.517	0.3581228	6414

1.3 4gt4-v0$_{72}$

Table 4: Results after 1000 iterations

Mapper	# qubits	depth	# gates	# SWAPS	p. success	f	V_Q
no	6	442	746	0	0.786	0.68007548	2652
minextendrc	9	1352	1592	94	0.452	**0.37749204**	12168
minextend	8	**963**	1736	110	0.498	0.34067243	7704
base	6	1056	**1547**	**89**	**0.532**	0.35703954	6336

1.4 4mod5-bdd$_{287}$

Table 5: Results after 1000 iterations

Mapper	# qubits	depth	# gates	# SWAPS	p. success	f	V_Q
no	7	147	203	0	0.916	0.87474237	1029
minextendrc	9	436	500	33	0.753	0.65935538	3924
minextend	9	**332**	500	33	**0.798**	**0.69281491**	2988
base	7	334	**419**	**24**	0.776	0.67942877	2338

1.5 4mod5-v0$_{20}$

Table 6: Results after 1000 iterations

Mapper	# qubits	depth	# gates	# SWAPS	p. success	f	V_Q
no	5	53	61	0	0.985	0.97145968	265
minextendrc	9	139	142	9	0.944	**0.9092329**	1251
minextend	8	**128**	160	11	0.938	0.88981602	1024
base	6	133	**119**	**8**	**0.947**	0.89871898	714

1.6 alu$_{bdd288}$

Table 7: Results after 1000 iterations

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	7	247	0	165	0.94	0.89851036	1155
minextendrc	8	571	36	495	**0.847**	**0.78096707**	3960
minextend	8	616	41	383	0.846	0.73109047	3064
base	7	**472**	**25**	**360**	0.841	0.71637503	2520

1.7 alu$_{v027}$

Table 8: Results after 1000 iterations

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	5	107	0	80	0.98	0.96369032	400
minextendrc	9	**278**	**19**	248	**0.959**	**0.92602273**	2232
minextend	10	296	21	**156**	0.944	0.89032214	1560
base	6	**278**	**19**	214	0.915	0.84492332	1284

1.8 decod24$_{bdd294}$

Table 9: Results after 1000 iterations

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	6	207	0	144	0.938	0.91098461	864
minextendrc	9	441	26	407	**0.888**	**0.7749599**	3663
minextend	7	468	29	328	0.816	0.73708015	2296
base	6	**405**	**22**	**300**	0.781	0.71803687	1800

1.9 decod24$_{\textbf{enable126}}$

Table 10: Results after 1000 iterations

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	6	978	0	612	0.894	0.74038417	3672
minextendrc	9	2049	119	1788	**0.831**	**0.57285276**	16092
minextend	10	2184	134	**1440**	0.805	0.50947313	14400
base	6	**1959**	**109**	1446	0.74	0.42630108	8676

1.10 graycode6$_{\textbf{47}}$

Table 11: Results after 1000 iterations

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	6	21	0	32	0.995	0.99332325	192
minextendrc	7	111	10	111	0.991	0.98223938	777
minextend	10	102	9	61	0.987	0.97012132	610
base	6	84	7	82	0.991	0.98075312	492

1.11 ham3$_{\textbf{102}}$

Table 12: Results after 1000 iterations

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	3	61	0	60	0.987	0.98246387	180
minextendrc	4	115	6	127	0.971	0.95999051	508
minextend	4	115	6	121	0.974	0.96288976	484
base	4	106	5	98	0.973	0.95944625	392

1.12 mod10$_{\textbf{176}}$

Table 13: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	5	515	0	327	0.9	0.82976826	1635
minextendrc	7	1199	76	1090	**0.758**	**0.62105388**	7630
minextend	10	1127	68	**687**	0.733	0.60641905	6870
base	6	**983**	**52**	734	0.697	0.56115058	4404

Table 14: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.738	0.59602509
minextendrc	**0.453**	**0.31989048**
minextend	0.443	0.31320313
base	0.372	0.27839542

1.13 mod5adder$_{127}$

Table 15: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	6	1583	0	944	0.71	0.45135226	5664
minextendrc	9	3320	193	2878	0.491	**0.1922222**	25902
minextend	10	3779	244	2667	0.548	0.18165444	26670
base	6	**3248**	**185**	**2378**	**0.591**	0.18911191	14268

Table 16: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.528	0.18188697
minextendrc	0.36	**0.1484162**
minextend	0.399	0.14349585
base	**0.465**	0.12694018

1.14 mod5d1$_{63}$

Table 17: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	5	69	0	59	0.989	0.98368741	295
minextendrc	8	**195**	**14**	209	0.958	0.93474128	1672
minextend	8	**195**	**14**	**136**	**0.969**	**0.93997349**	1088
base	6	**195**	**14**	146	0.95	0.91002595	876

Table 18: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.97	0.95187372
minextendrc	0.901	**0.84099717**
minextend	**0.914**	0.83627787
base	0.892	0.7849484

1.15 mod8$_{10177}$

Table 19: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	6	1270	0	794	0.858	0.70131629	4764
minextendrc	10	**2674**	**156**	2275	**0.52**	**0.39211003**	22750
minextend	10	2827	173	**1761**	0.411	0.29686116	17610
base	6	2773	167	2006	0.335	0.26106507	12036

Table 20: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.698	0.42021822
minextendrc	0.244	0.19792409
minextend	0.123	0.14638911
base	0.068	0.16412249

1.16 $\mathbf{one_{twothreev199}}$

Table 21: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	5	383	0	256	0.832	0.78653106	1280
minextendrc	7	887	56	839	0.633	0.59855522	5873
minextend	10	869	54	**530**	**0.729**	**0.62135956**	5300
base	6	**833**	**50**	609	0.662	0.57083541	3654

Table 22: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.602	0.55524768
minextendrc	0.266	**0.38317882**
minextend	**0.355**	0.33820922
base	0.26	0.31493265

1.17 $\mathbf{one_{twothreev3101}}$

Table 23: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	5	203	0	143	0.937	0.88807716	715
minextendrc	8	464	29	440	**0.746**	0.620299	3520
minextend	8	509	34	**302**	0.732	0.63161506	2416
base	6	**428**	**25**	323	0.742	**0.62081173**	1938

Table 24: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.809	0.69629912
minextendrc	0.411	0.31374806
minextend	0.391	**0.31579028**
base	**0.42**	0.31189591

1.18 $\mathbf{rd32_{v066}}$

Table 25: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	4	102	0	83	0.983	0.97241164	332
minextendrc	7	**219**	**13**	195	0.947	**0.91458844**	1365
minextend	7	228	14	**142**	**0.958**	0.91079208	994
base	5	**219**	**13**	169	0.955	0.90759692	845

Table 26: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.95	0.9176419
minextendrc	0.88	**0.79475368**
minextend	**0.902**	0.77708902
base	0.896	0.77242986

1.19 $\mathbf{sf_{274}}$

Table 27: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	6	2227	0	1359	0.484	0.34974095	8154
minextendrc	7	5116	321	4515	0.0	**0.16778098**	31605
minextend	10	5071	316	**3007**	**0.097**	0.14752778	30070
base	6	**4450**	**247**	3289	0.088	0.15461728	19734

Table 28: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.108	0.16219308
minextendrc	**0.002**	**0.19857107**
minextend	0.0	0.1458942
base	0.0	0.14493197

1.20 $\mathbf{sf_{276}}$

Table 29: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	6	2224	0	1360	0.472	0.30846996	8160
minextendrc	9	4852	292	4103	0.0	**0.16746873**	36927
minextend	10	4807	287	**2747**	**0.092**	0.14342305	27470
base	6	**4447**	**247**	3280	0.089	0.13928494	19680

Table 30: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.034	0.15718296
minextendrc	0.0	**0.22111901**
minextend	0.0	0.15992956
base	0.0	0.14842314

1.21 sym6$_{145}$

Table 31: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	7	11185	0	6759	0.506	0.15429107	47313
minextendrc	8	24658	1497	20984	0.513	**0.22079977**	167872
minextend	10	25756	1619	**14156**	**0.546**	0.12489321	141560
base	7	**21679**	**1166**	15613	0.531	0.12176519	109291

Table 32: Results after 1000 iterations, $t_1 = t_2 = 1000$

Mapper	p. success	f
no	0.513	0.1407412
minextendrc	0.518	**0.24438143**
minextend	**0.543**	0.1533595
base	0.53	0.14274046

1.22 xor5$_{254}$

Table 33: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	# qubits	# gates	# SWAPS	depth	p. success	f	V_Q
no	6	23	0	36	0.995	0.99375935	216
minextendrc	7	68	5	75	0.984	0.9736118	525
minextend	7	68	5	58	0.958	0.94092446	406
base	6	104	9	92	0.942	0.91559086	552

Table 34: Results after 1000 iterations, $t_1 = t_2 = 3000$

Mapper	p. success	f
no	0.984	0.97720823
minextendrc	**0.952**	**0.91998206**
minextend	0.896	0.84674549
base	0.837	0.77312906

2 Correlation and Plots

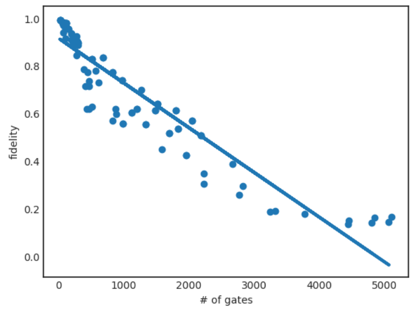
Pearson correlation formula:

$$\rho_{X,Y} = \frac{\mathrm{cov}(X,Y)}{\sigma_X \sigma_Y}$$

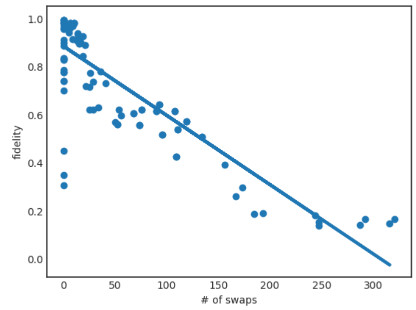
2.1 $t_1 = 3000$

Table 35: Pearson correlation coefficient for decoherence time of $t_1 = 3000$ and measurement error 0f 0.005

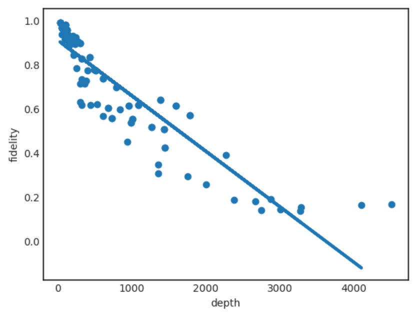
	# of Gates	# of SWAPs	Depth	V_Q
$\rho_{f,Y}$	-0.9360	-0.8614	-0.9091	-0.8728
$\rho_{p_s,Y}$	-0.9257	-0.8700	-0.9060	-0.8680



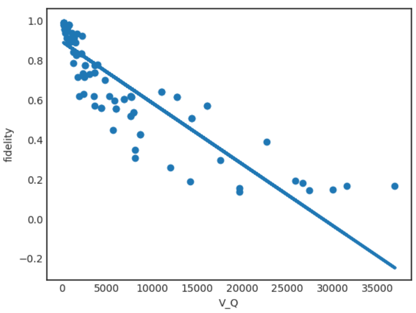
(a) Number of gates



(b) Number of SWAPs

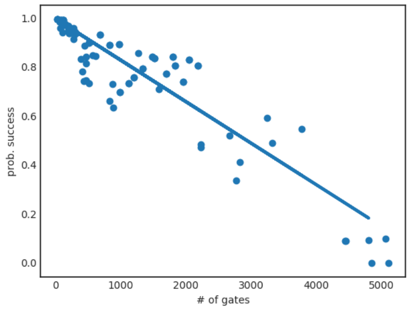


(c) Depth

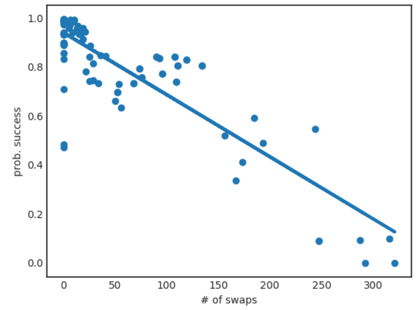


(d) Quantum Volume

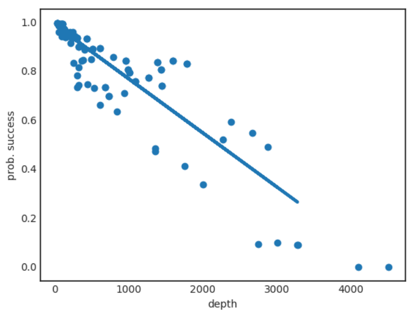
Figure 1: Plotting fidelity against number of gates, swaps, depth and Quantum Volume



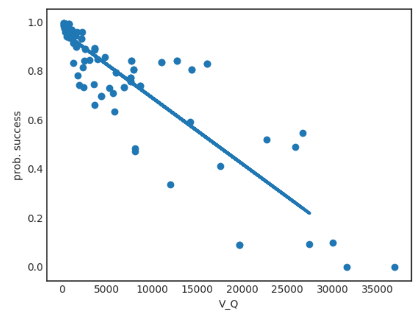
(a) Number of gates



(b) Number of SWAPs



(c) Depth



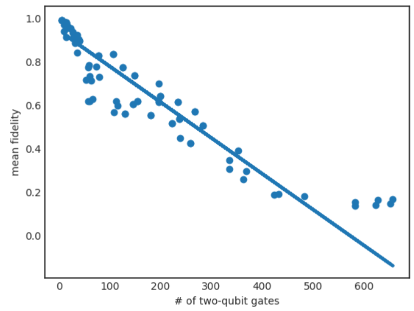
(d) Quantum Volume

Figure 2: Plotting probability of success against number of gates, swaps, depth and Quantum Volume

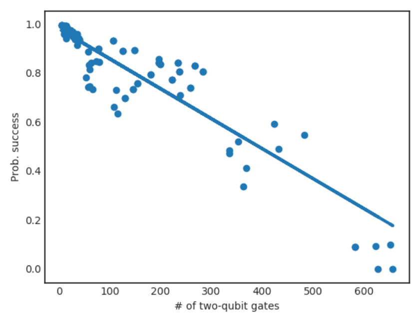
2.1.1 Two-qubit gates

1. Number of two qubit gates

$$\rho_{f,\,\mathrm{2qg}} = -0.9393 \quad \rho_{ps,\,\mathrm{2qg}} = -0.9254$$



(a) Number of two-qubit gates against fidelity



(b) Number of two-qubit gates against fidelity

Figure 3: Two-qubit gates analysis

2. Difference and number of SWAPs

$$\rho_{f',\ 2\text{qg}} = 0.5784$$

3. Proportion of SWAPs

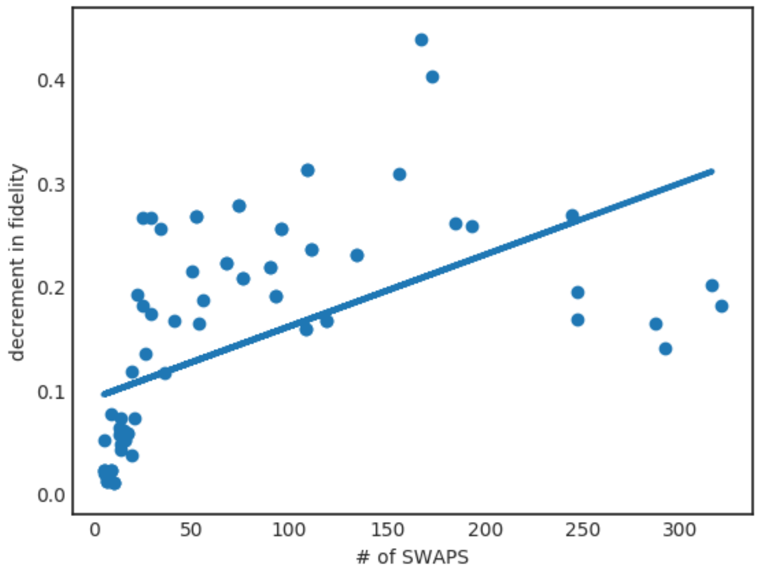
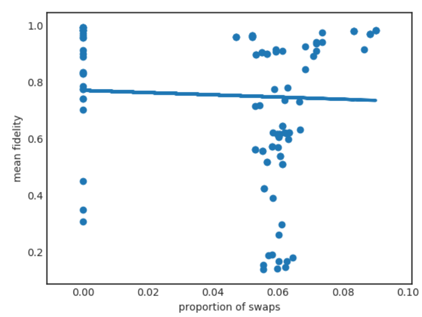
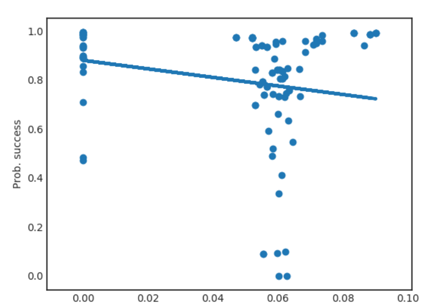


Figure 4: Number of swaps and fidelity difference relationship's



(a) Number of two-qubit gates against fidelity



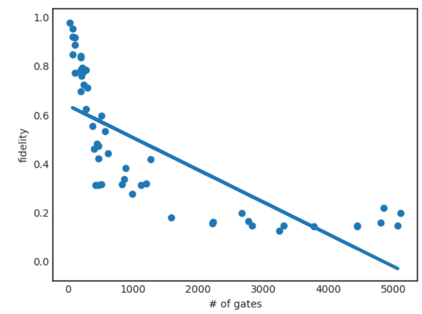
(b) Number of two-qubit gates against fidelity

Figure 5: Proportion of SWAPs analysis

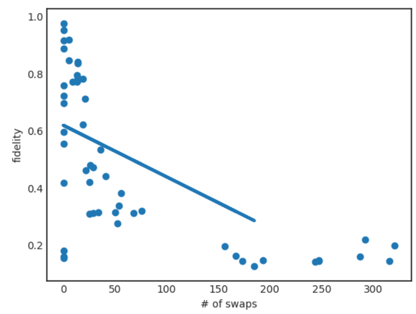
2.2 $t_1 = 1000$

Table 36: Pearson correlation coefficient for decoherence time of $t_1 = 1000$ and measurement error 0f 0.005

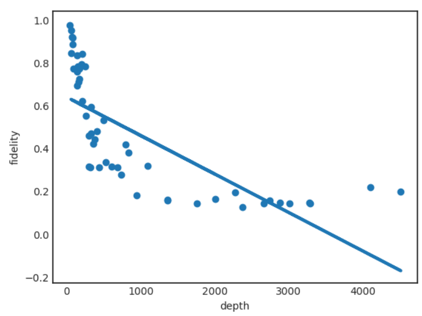
	# of Gates	# of SWAPs	Depth	V_Q
$\rho_{f,Y}$	-0.7637	-0.6658	-0.7354	-0.7029
$\rho_{p_s,Y}$	-0.8341	-0.7484	-0.8076	-0.7686



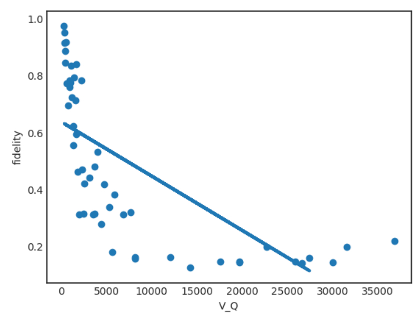
(a) Number of gates



(b) Number of SWAPs

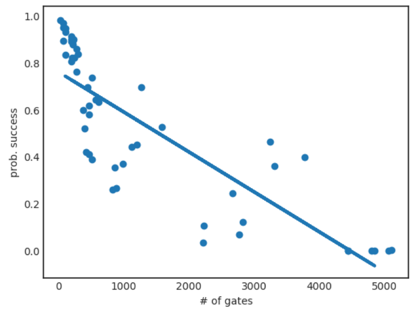


(c) Depth

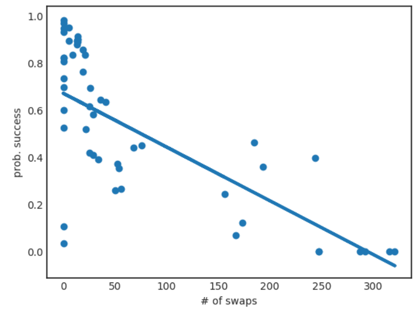


(d) Quantum Volume

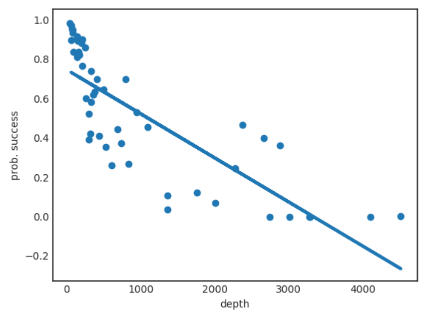
Figure 6: Plotting fidelity against number of gates, swaps, depth and Quantum Volume



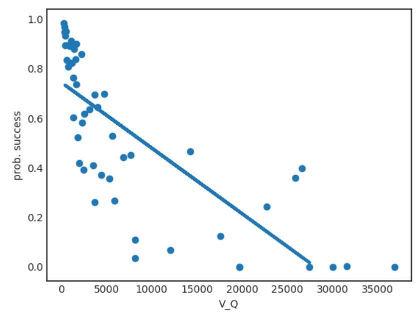
(a) Number of gates



(b) Number of SWAPs



(c) Depth



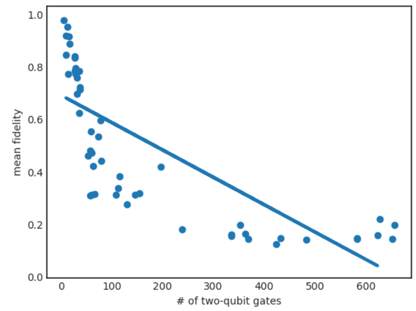
(d) Quantum Volume

Figure 7: Plotting probability of success against number of gates, swaps, depth and Quantum Volume

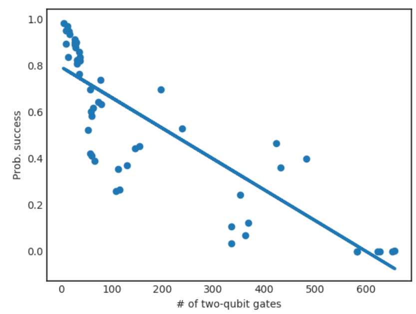
2.2.1 Two-qubit gates

1. Number of two qubit gates

$$\rho_{f,\,\mathrm{2qg}} = -0.7725 \quad \rho_{ps,\,\mathrm{2qg}} = -0.8404$$



(a) Number of two-qubit gates against fidelity



(b) Number of two-qubit gates against fidelity

Figure 8: Two-qubit gates analysis

2. Difference and number of SWAPs

$$\rho_{f',Y} = -0.639791579133524$$

3. Proportion of SWAPs

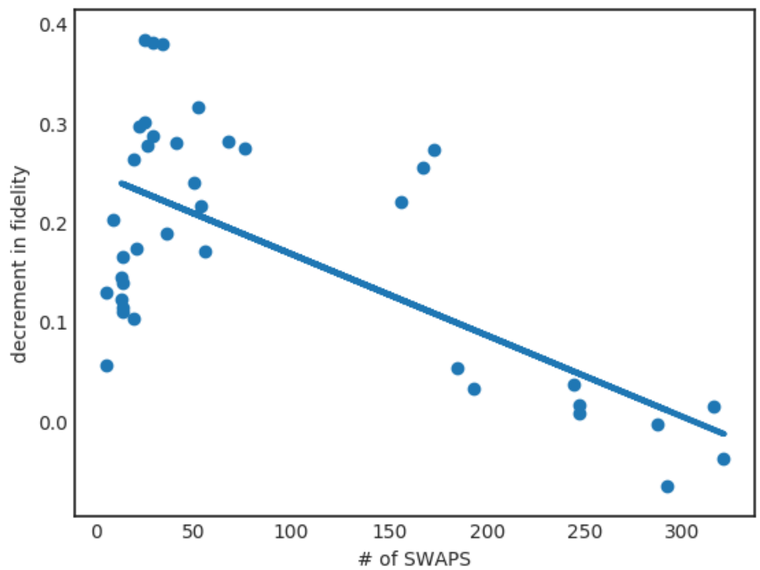
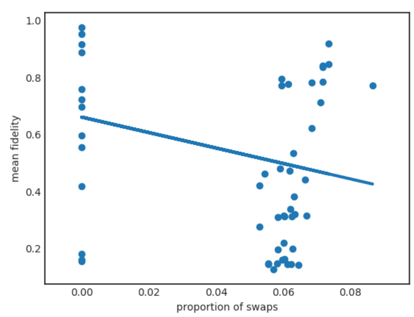
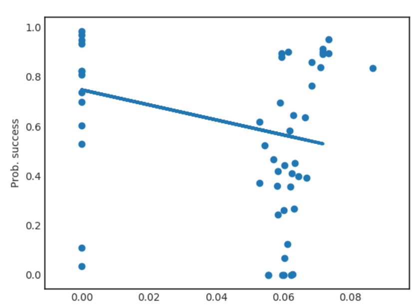


Figure 9: Number of swaps and fidelity difference relationship's



(a) Number of two-qubit gates against fidelity



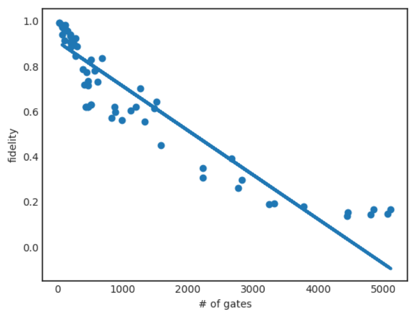
(b) Number of two-qubit gates against fidelity

Figure 10: Proportion of SWAPs analysis

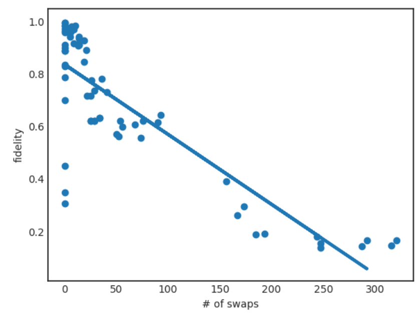
2.3 No measurement error and $t_1 = 3000$

Table 37: Pearson correlation coefficient for decoherence time of $t_1 = 3000$ and probability 0 for the measurement

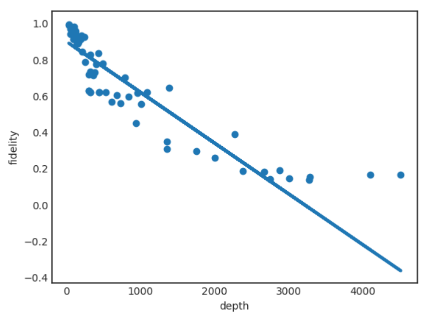
	# of Gates	# of SWAPs	Depth	V_Q
$\rho_{f,Y}$	-0.9246	-0.8482	-0.9012	-0.8697
$\rho_{p_s,Y}$	-0.9495	-0.8972	-0.9334	-0.8985



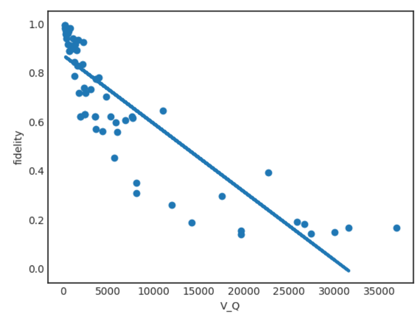
(a) Number of gates



(b) Number of SWAPs

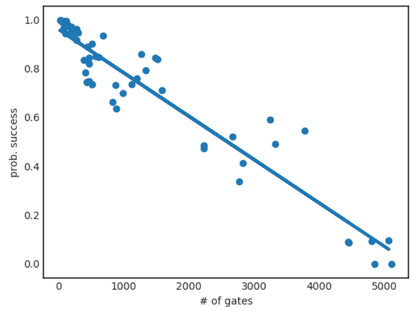


(c) Depth



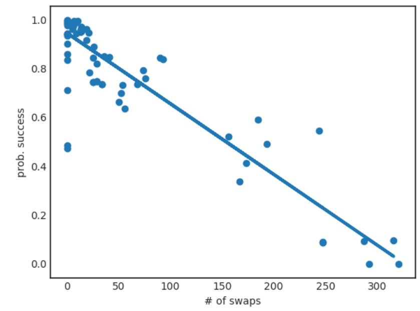
(d) Quantum Volume

Figure 11: Plotting fidelity against number of gates, swaps, depth and Quantum Volume

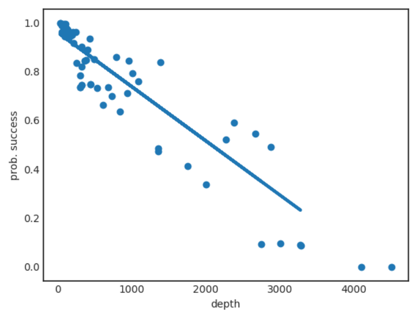


(a) Number of gates

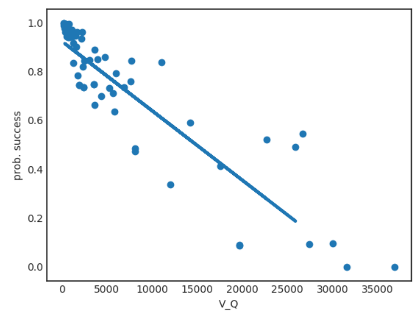
n



(b) Number of SWAPs



(c) Depth



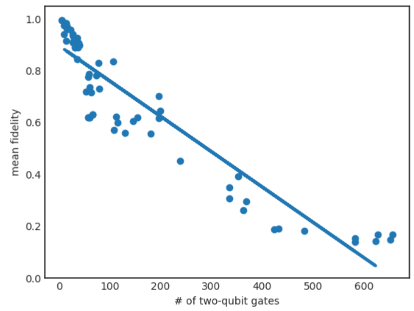
(d) Quantum Volume

Figure 12: Plotting probability of success against number of gates, swaps, depth and Quantum Volume

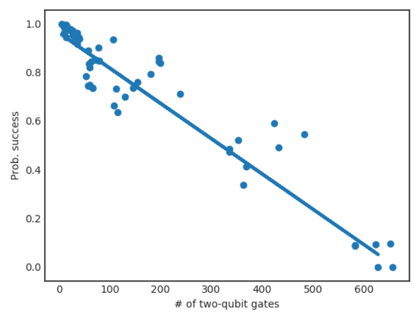
2.3.1 Two-qubit gates analysis

1. Number of two qubit gates

$$\rho_{f,\,\mathrm{2qg}} = -0.9287 \quad \rho_{ps,\,\mathrm{2qg}} = -0.9492$$



(a) Number of two-qubit gates against fidelity



(b) Number of two-qubit gates against fidelity

Figure 13: Two-qubit gates analysis

2. Difference and number of SWAPs

$$\rho_{f',Y} = 0.4445$$

3. Proportion of SWAPs

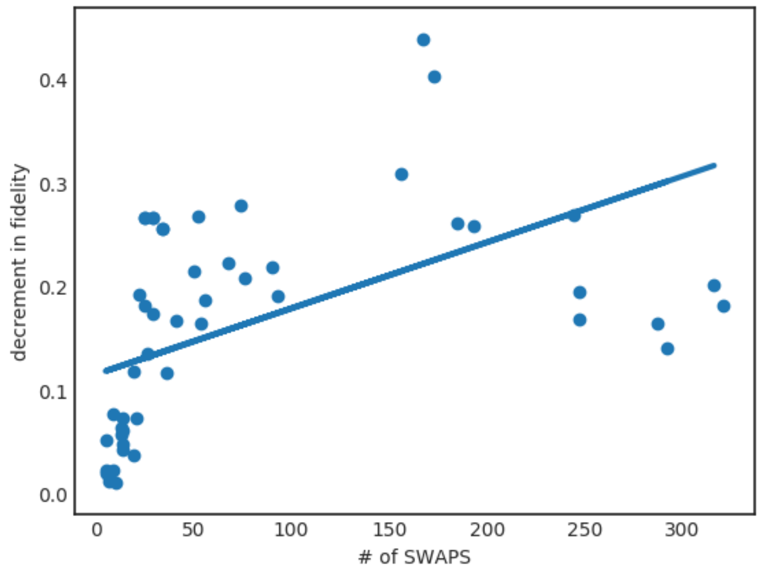
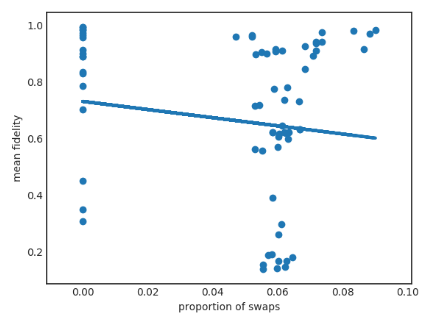
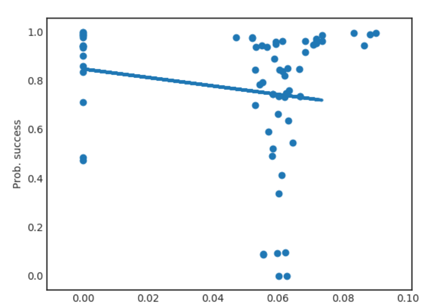


Figure 14: Number of swaps and fidelity difference relationship's



(a) Number of two-qubit gates against fidelity



(b) Number of two-qubit gates against fidelity

Figure 15: Proportion of SWAPs analysis