Comparison of Polar Decoders with Existing LDPC and Turbo Decoders

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  - Provably achieve capacity of some channels
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We humbly attempt to, at least partially, answer these questions.

Comparison Methodology

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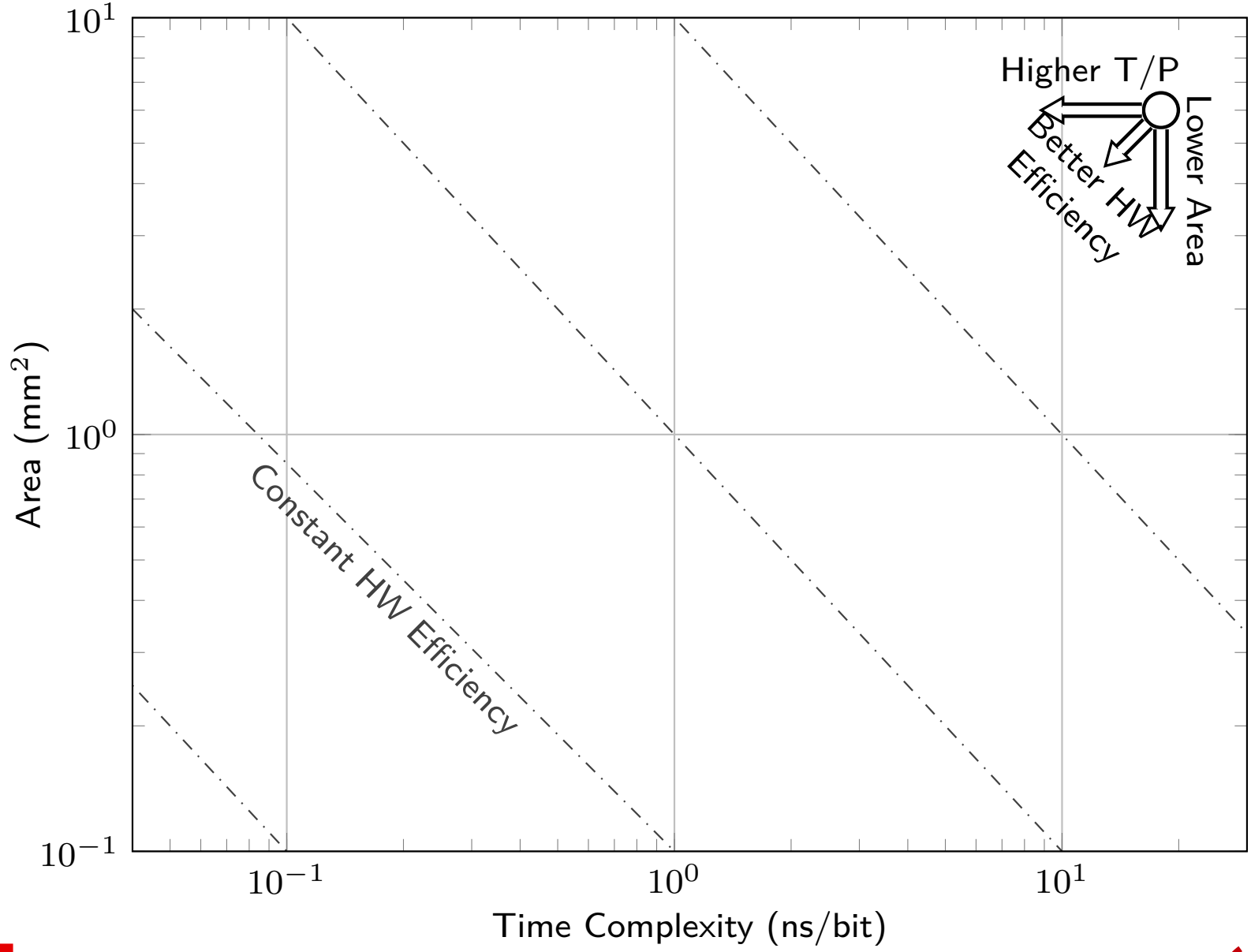
It remains an "Apples Vs Oranges" comparison but it at least provides a ballpark figure.

State of Affairs – Polar Decoders from the Lit.



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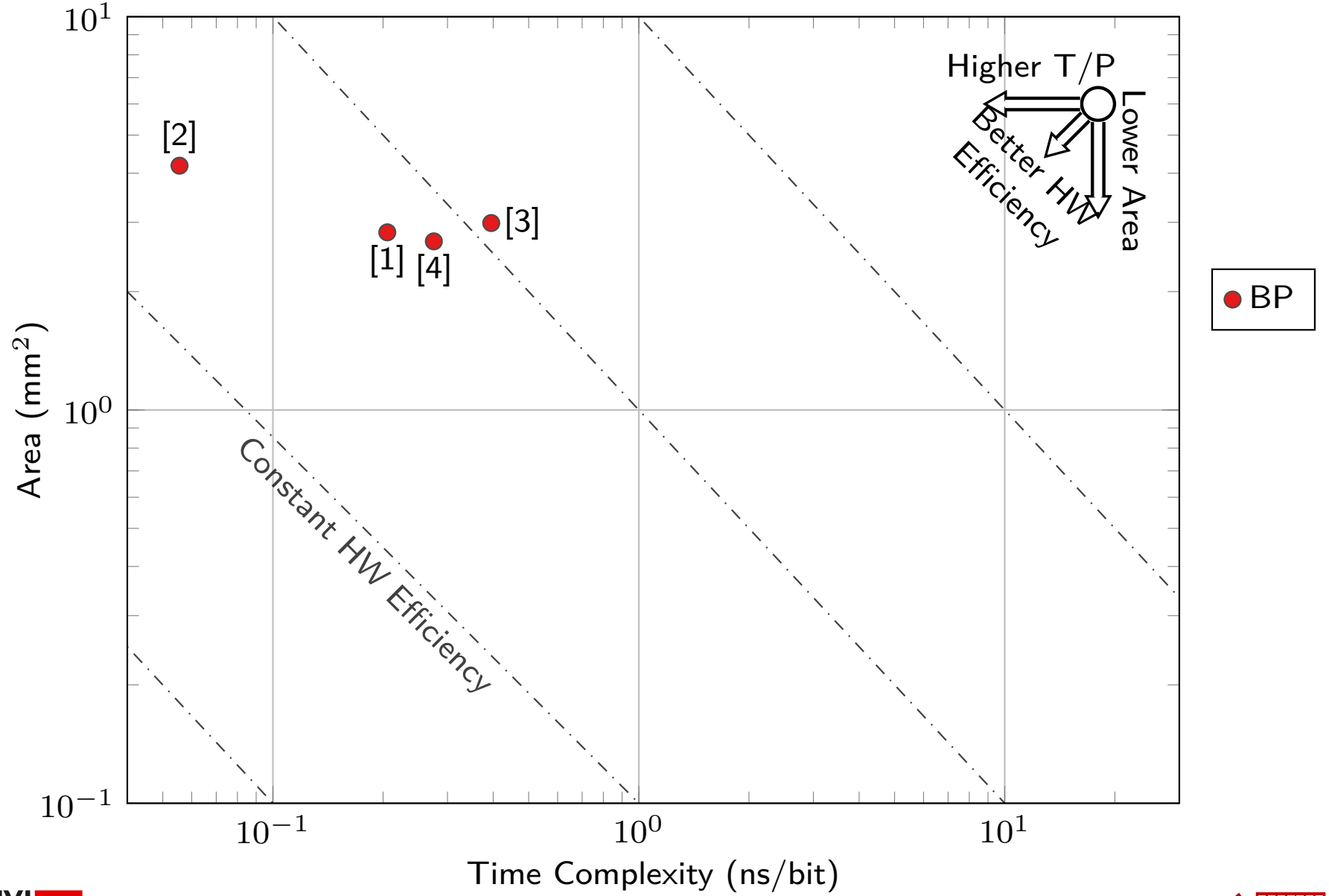

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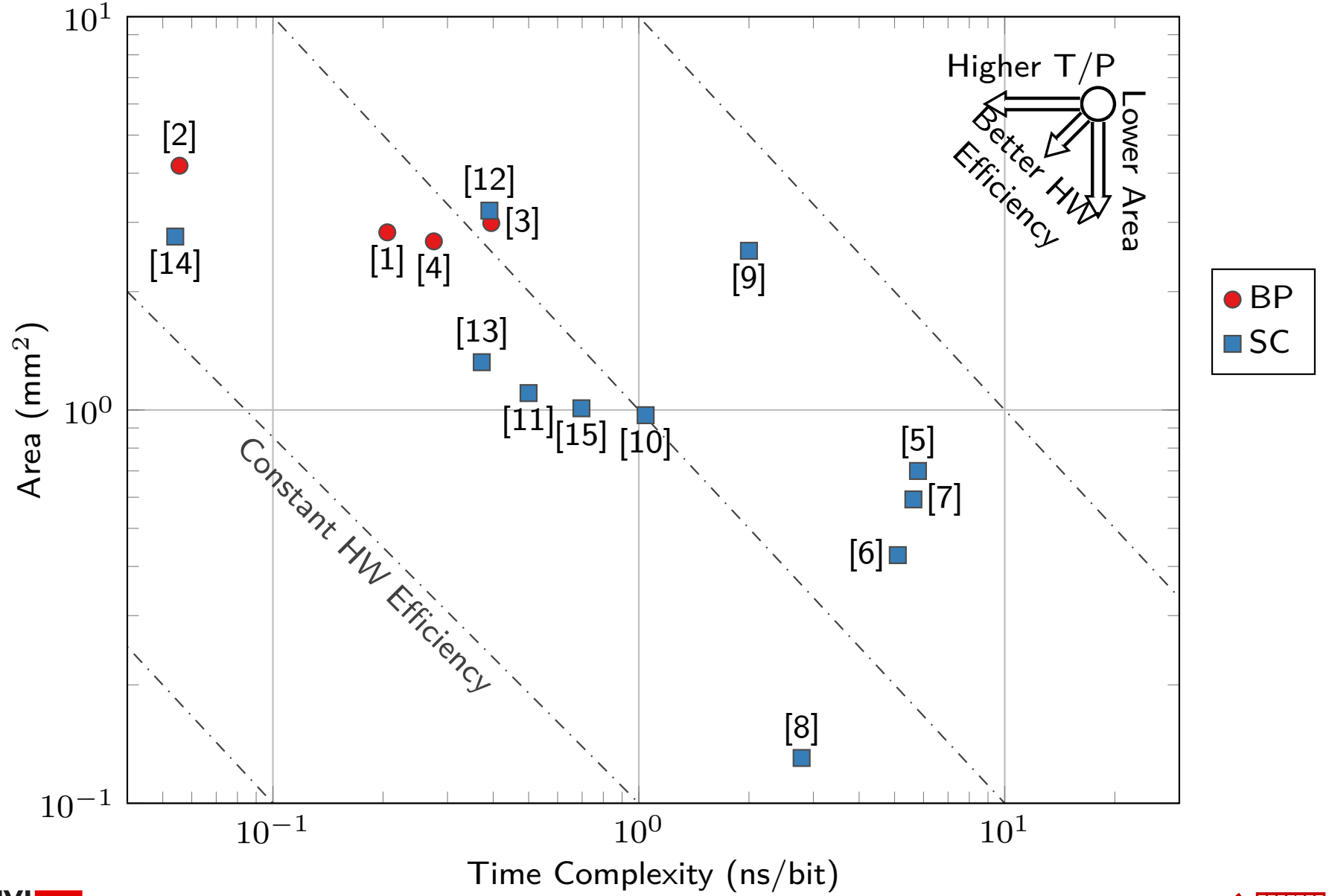

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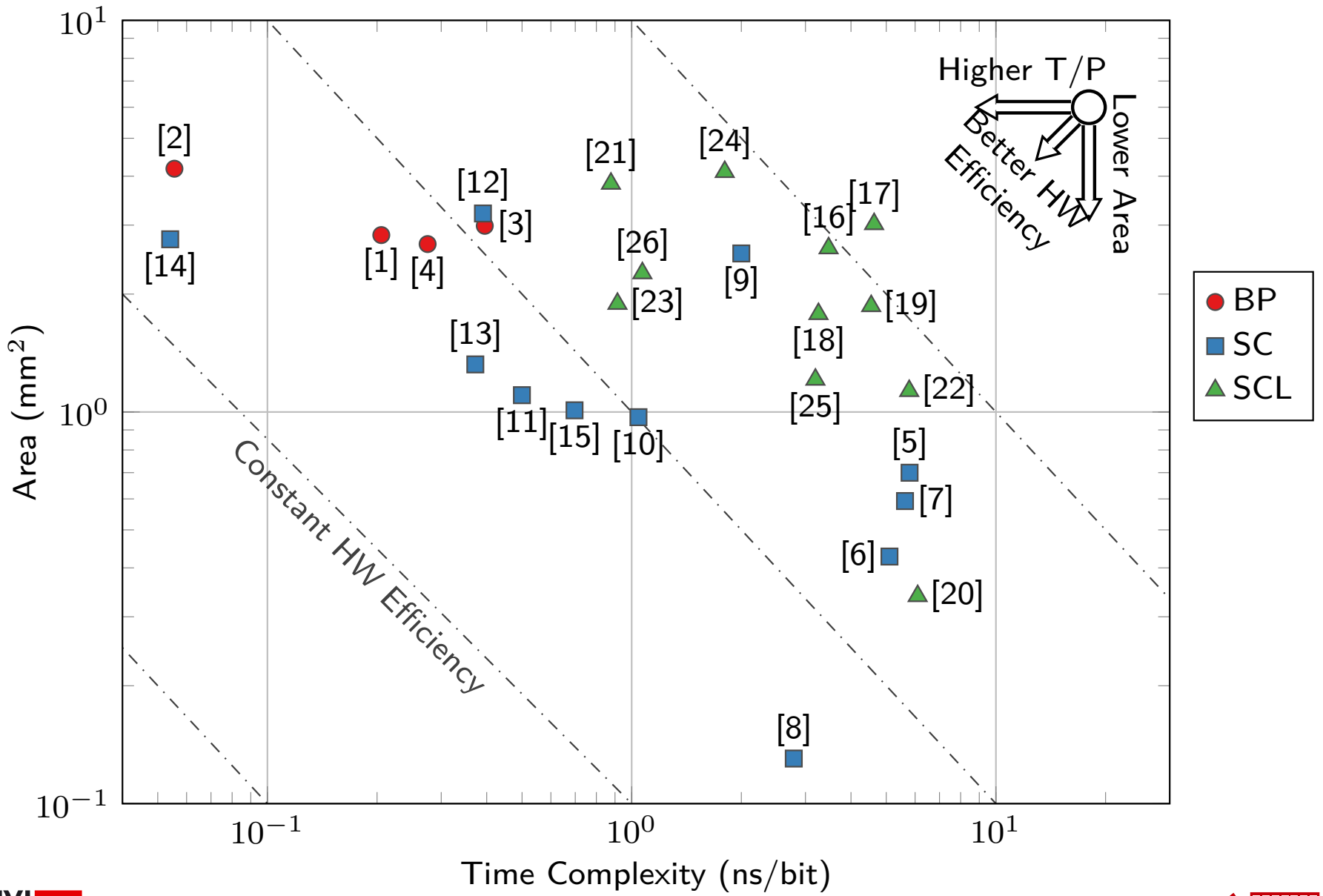
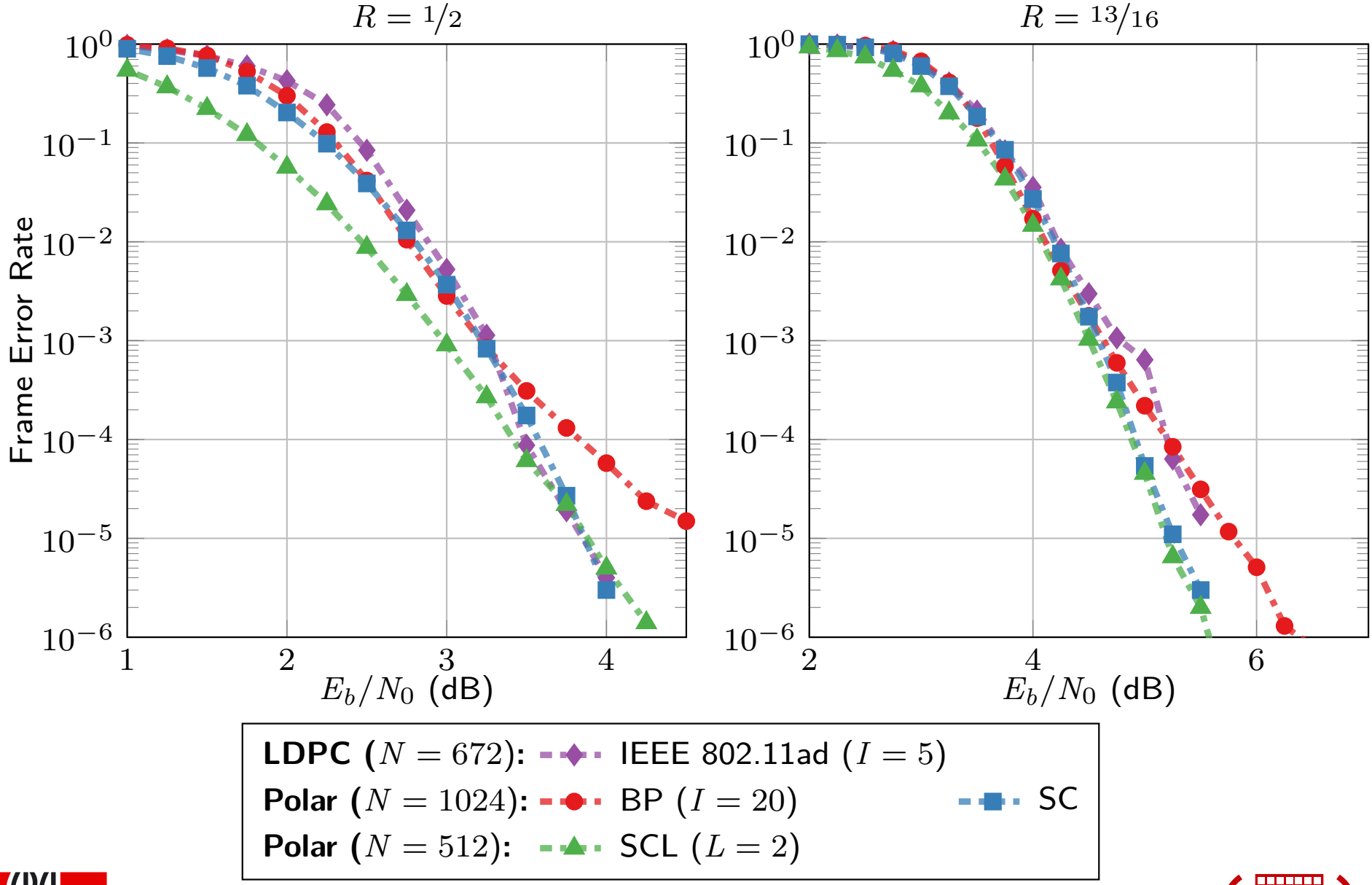


Polar Codes Vs. IEEE 802.11ad LDPC Codes



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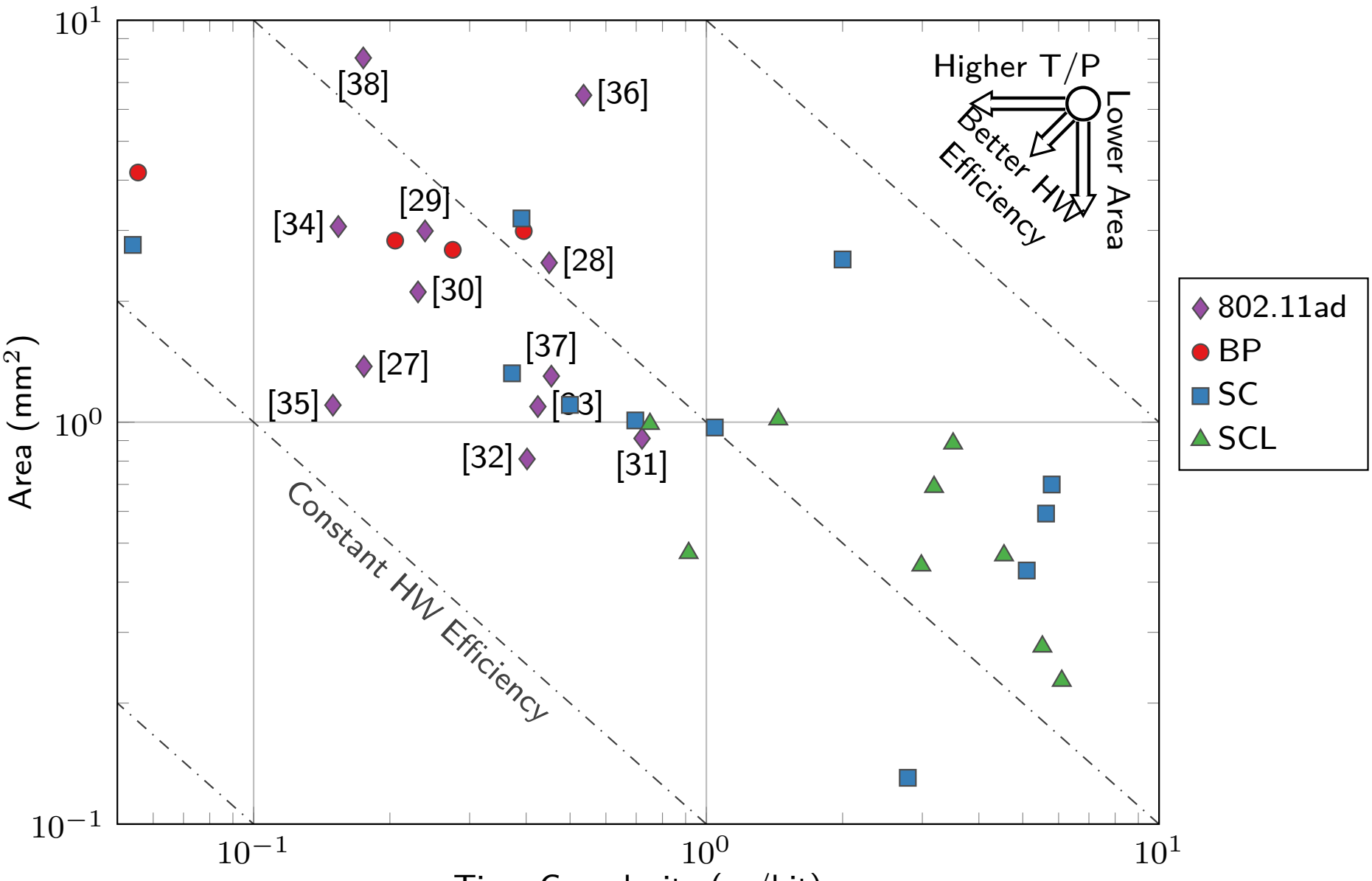
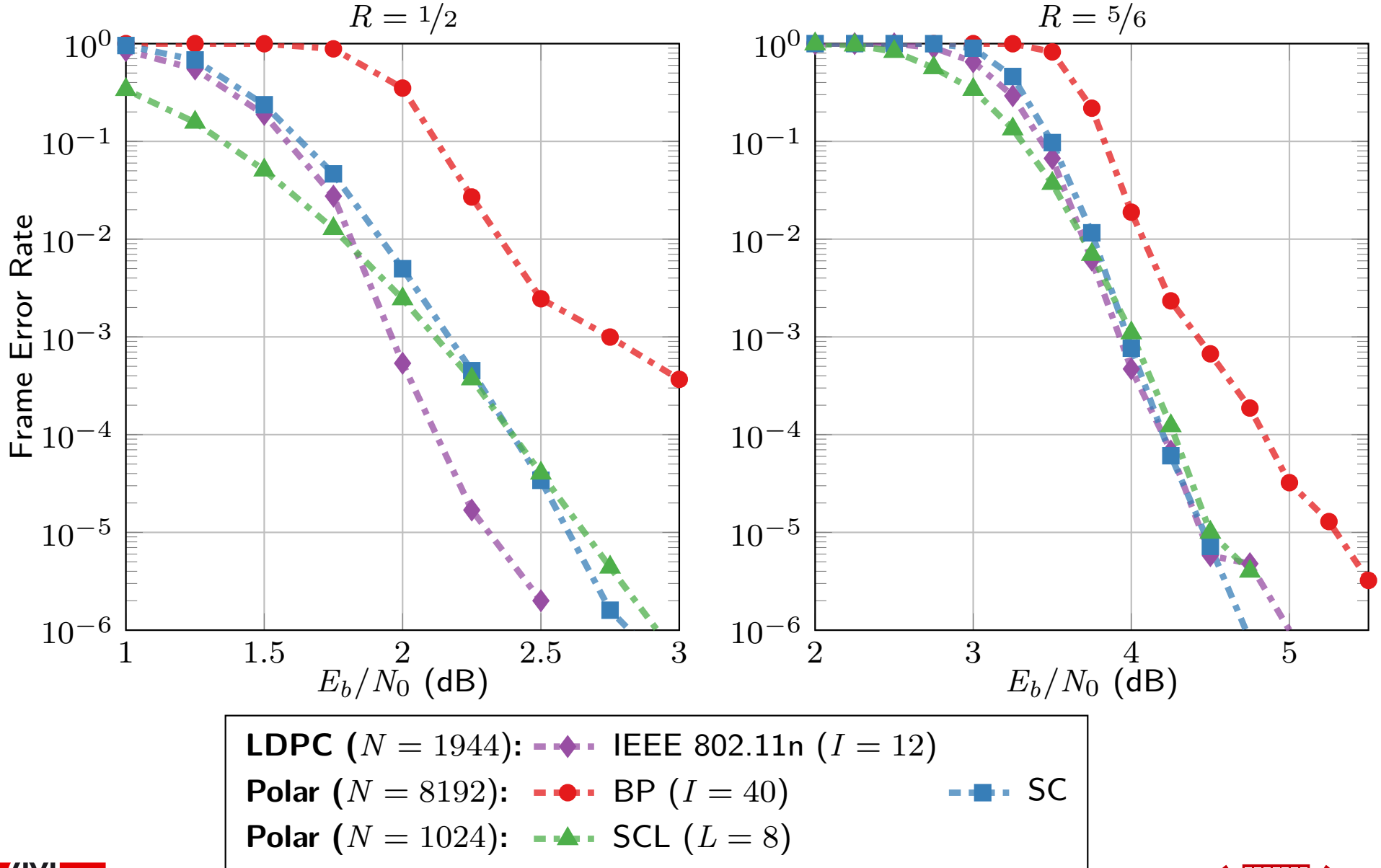


Polar Codes Vs. IEEE 802.11n LDPC Codes



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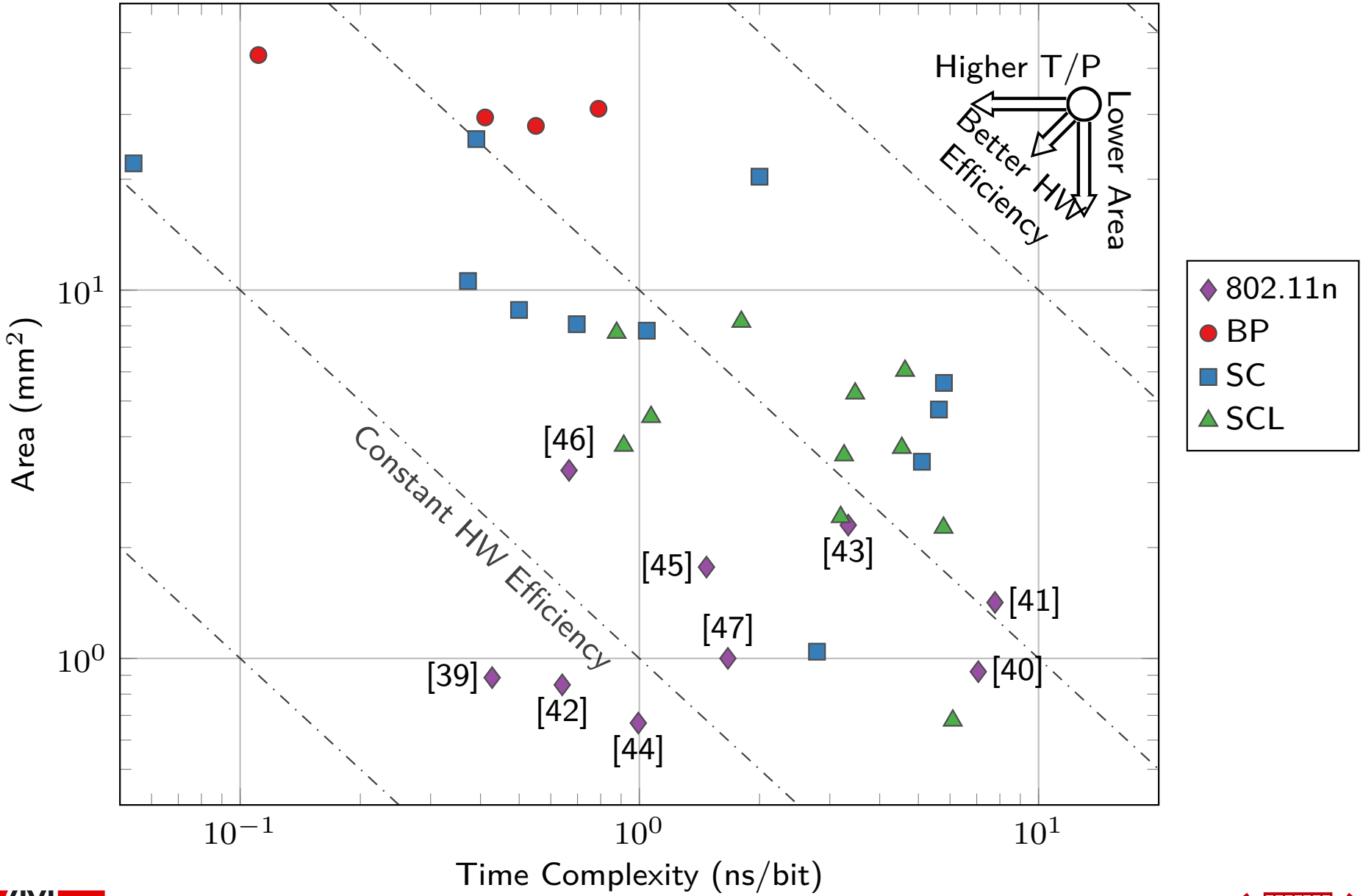
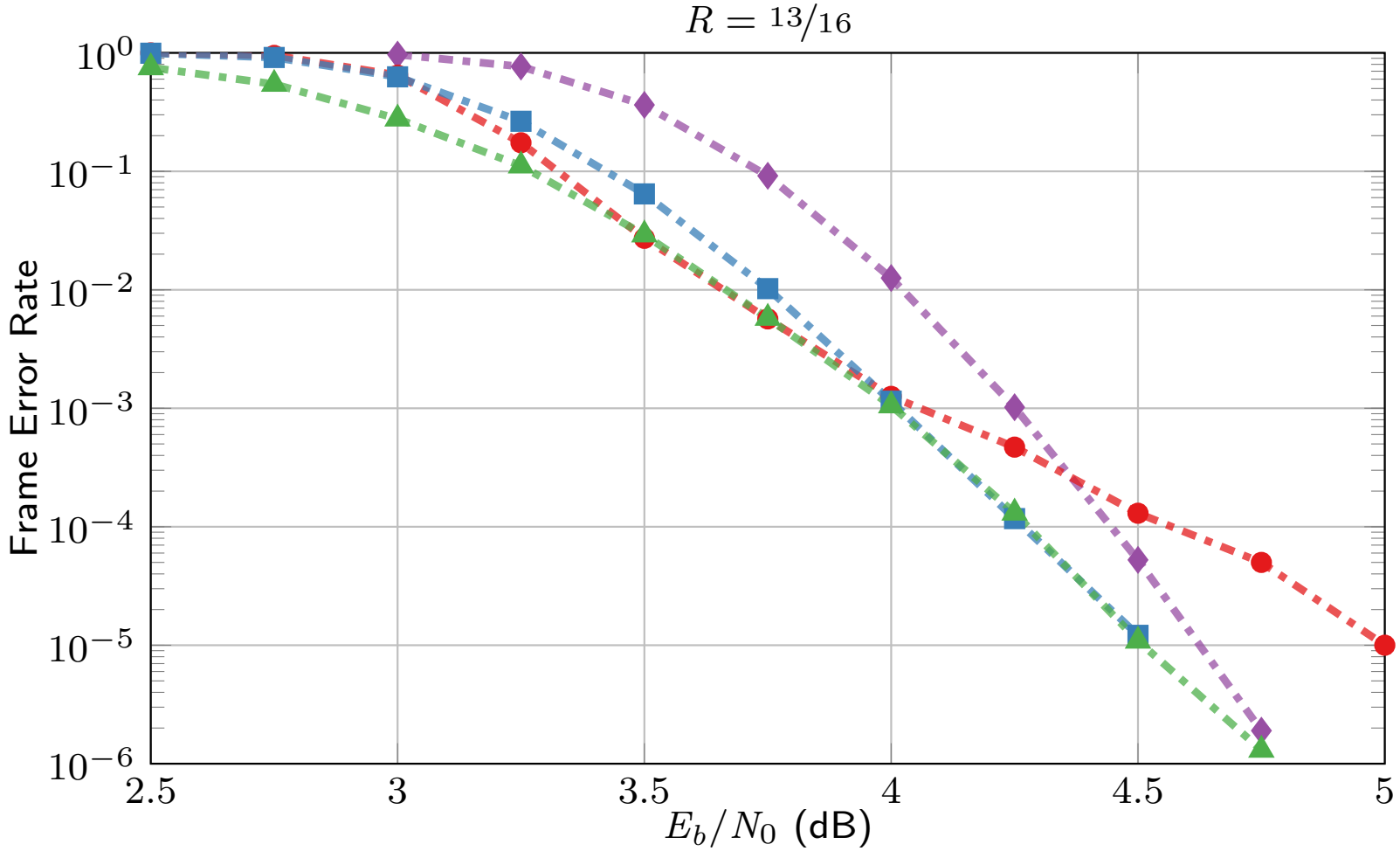


Polar Codes Vs. IEEE 802.3an LDPC Codes



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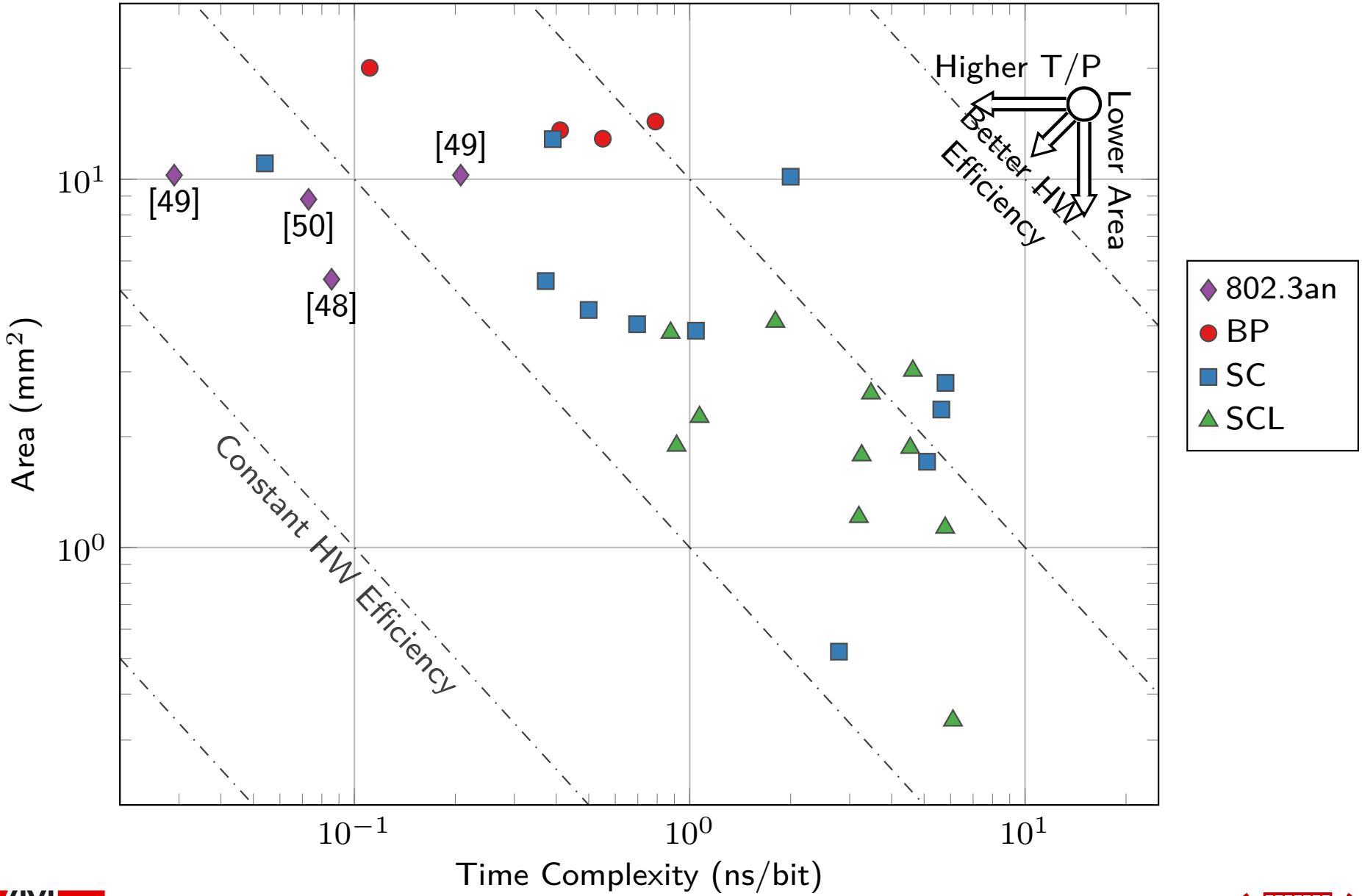
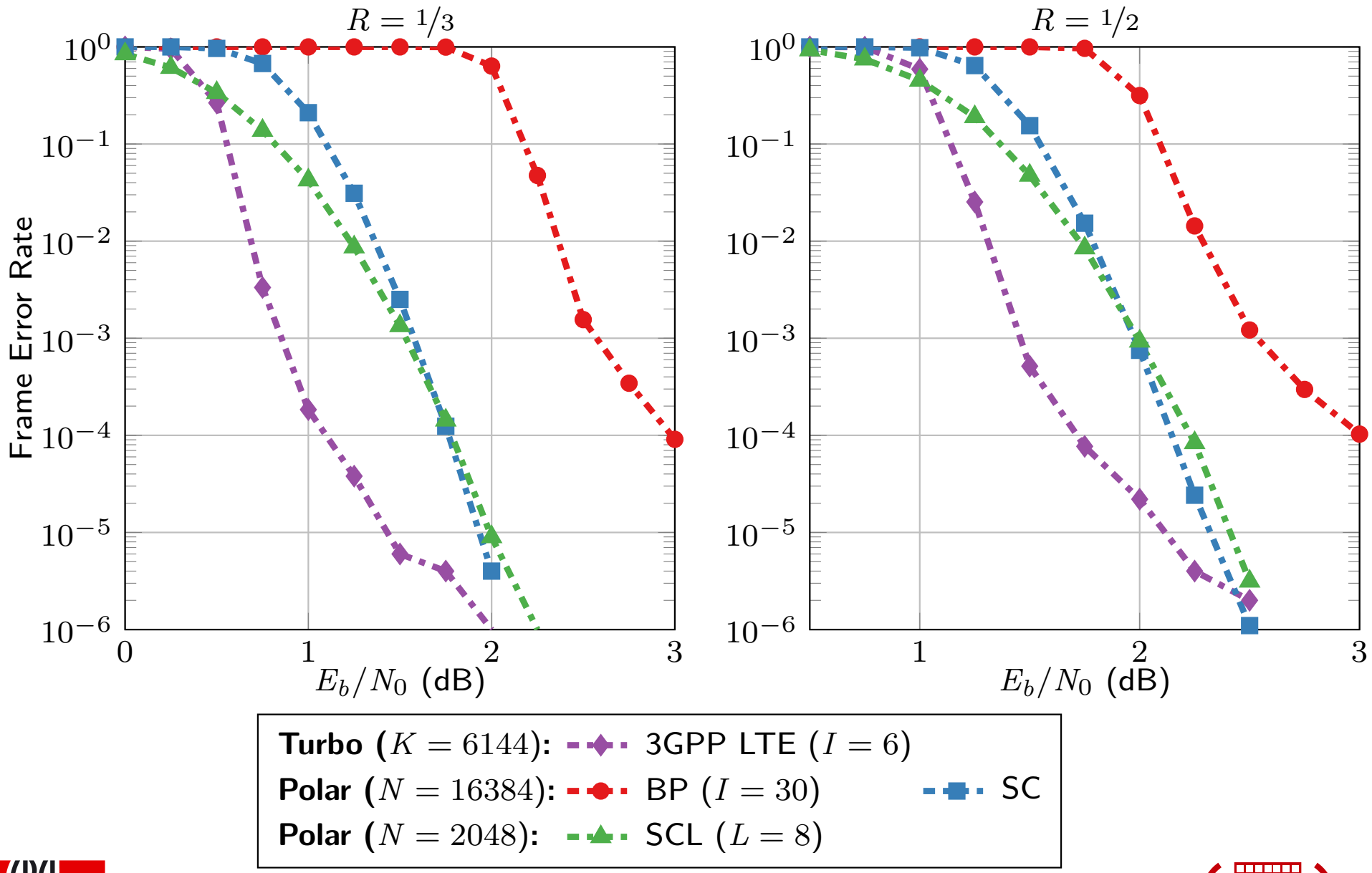


Polar Codes Vs. 3GPP LTE Turbo Codes



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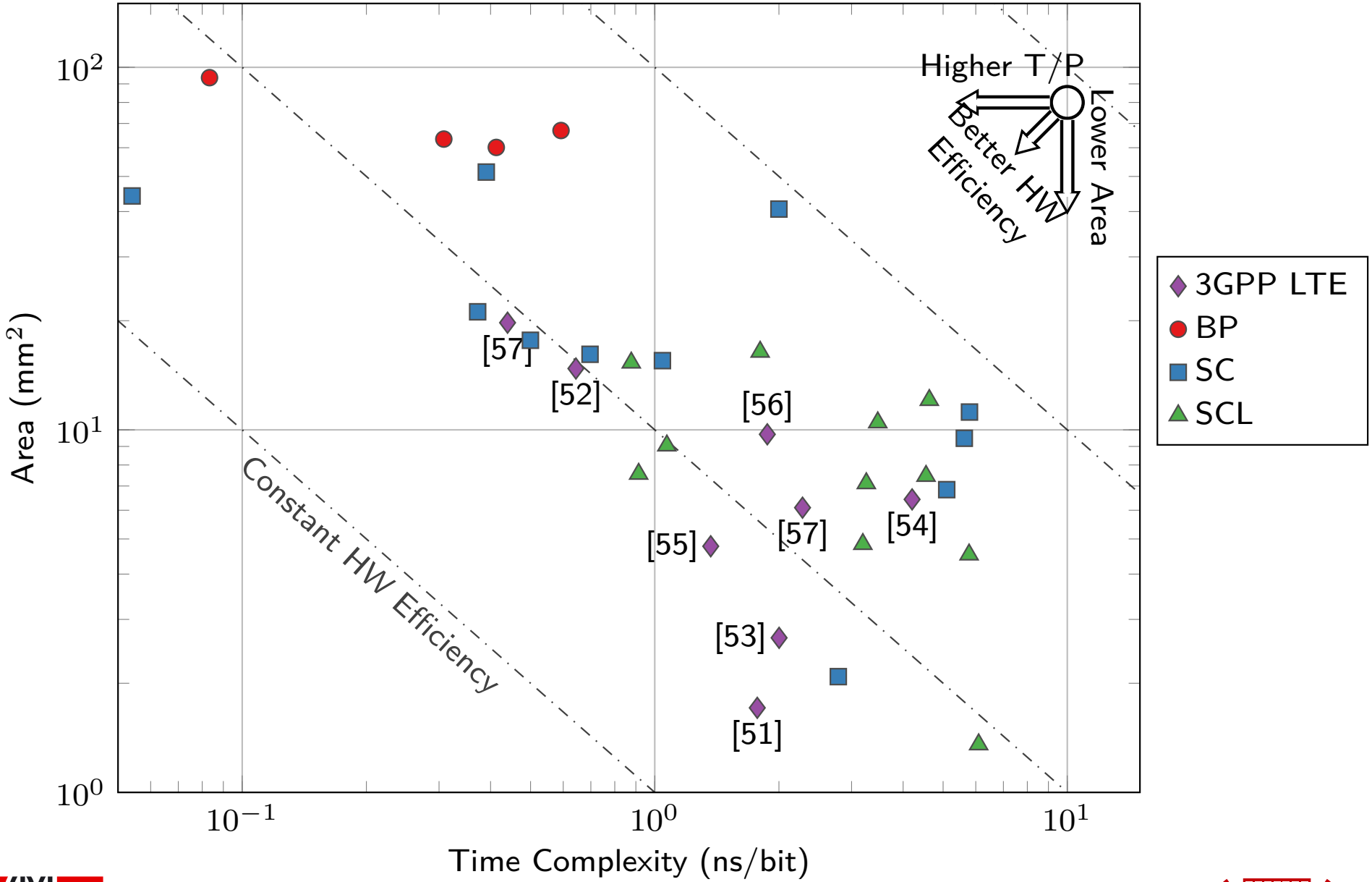

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Thank you for listening! Questions?

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Bonus Slides

SC Decoder Hardware Implementations

Work	Main Contribution	N	Tech. (nm)	Area (mm^2)	Freq. (MHz)	T/P (Mb/s)	Power (mW)
Leroux *et al.* [5]	Linear memory requirement.	1024	65	0.36	500	239	n/a
Mishra *et al.* [6]	First ASIC, two-bit decoding.	1024	180	1.71	150	98	67
Leroux *et al.* [7]	Semi-parallel architecture.	1024	65	0.31	500	246	n/a
Fan *et al.* [8]	Efficient partial sum computation.	1024	65	0.07	1010	497	n/a
Yuan *et al.* [9]	Two-bit decoding with precomputation.	1024	45	0.64	750	1000	n/a
Lin *et al.* [10]	SCAN decoder.	1024	90	0.97	571	958	n/a
Che *et al.* [11]	Implementation of fast-SSC decoding.	1024	45	0.28	1040	4004	n/a
Dizdar *et al.* [12]	Single-cycle implementation.	1024	90	3.21	2	2560	191
Giard *et al.* [13]	Fast-SSC decoding for low-rate codes.	1024	65	0.69	600	3720	215
Giard *et al.* [14]	Unrolled decoder implementation.	1024	65	1.44	650	25600	546
Lin *et al.* [15]	Fast-SSC SCAN decoder.	1024	90	1.01	471	1435	n/a

BP Decoder Hardware Implementations

Work	Main Contribution	N	Tech. (nm)	Area (mm^2)	Freq. (MHz)	Max. Iter.	Max. T/P (Mb/s)	Sust. T/P (Mb/s)	Power (mW)
Park *et al.* [1]	Unidirectional schedule.	1024	65	1.48	300	15	4676	2048	478
Yuan *et al.* [2]	Early termination.	1024	45	1.04	500	40	4500	2588	990
Abbas *et al.* [3]	Sub-graph freezing.	1024	45	0.75	197	15	1683	1683	n/a
Lin *et al.* [4]	Adaptive quantization.	1024	65	1.40	769	5	7870	7870	442

SCL Decoder Hardware Implementations ($L = 4$)

Work	Main Contribution	N	Tech. (nm)	Area (mm^2)	Freq. (MHz)	T/P (Mb/s)
Balatsoukas-Stimming *et al.* [16]	First architecture, efficient path copying.	1024	90	2.62	730	288
Lin *et al.* [17]	First CRC-aided decoder.	1024	90	3.02	657	216
Balatsoukas-Stimming *et al.* [18]	LLR-based implementation.	1024	90	1.78	794	307
Fan *et al.* [19]	Low-complexity path metric sorting.	1024	90	n/a	n/a	n/a
Hashemi *et al.* [20]	Reduced memory requirements.	2048	90	1.36	500	164
Lin *et al.* [22]	Efficient memory and metric sorting.	1024	90	1.13	476	173
Lin *et al.* [21]	Fast-SSC decoding with approximations.	1024	90	3.83	403	1140
Xiong *et al.* [23]	Partial ML decoding, flexibility.	1024	90	1.89	409	1094
Yuan *et al.* [24]	Multi-bit decision LL-based decoding.	1024	65	2.14	400	401
Xiong *et al.* [25]	Symbol-based SCL decoding.	1024	90	1.21	500	313
Yuan *et al.* [26]	Multi-bit decision LLR-based decoding.	1024	65	1.18	360	675

IEEE 802.11ad LDPC Decoder Implementations

Work	N	Tech. (nm)	Area (mm^2)	Freq. (MHz)	Schedule	Iter.	T/P (Mb/s)	Voltage (V)	Power (mw)
Shrirani-Mehr *et al.* [27]	672	65	0.72	235	Layered	5	7900	n/a	n/a
Weiner *et al.* [28]	672	65	1.30	150	Flooding	15	3080	0.8	84
Yen *et al.* [29]	672	65	1.56	197	Layered	5	5790	1.0	361
Ajaz *et al.* [30]	672	65	1.10	215	Layered	6	6000	1.1	210
Balatsoukas-Stimming *et al.* [31]	672	40	0.18	850	Layered	5	3120	n/a	n/a
Li *et al.* [32]	672	40	0.16	500	Layered	5	5600	0.9	99
Li *et al.* [33]	672	40	0.22	500	Layered	5	5300	0.9	136
Park *et al.* [34]	672	65	1.60	540	Flooding	10	9000	1.1	783
Ajaz *et al.* [35]	672	65	0.57	400	Layered	7	9250	1.1	273
Weiner *et al.* [36]	672	28	0.63	65	Flooding	15	6000	0.7	38
Li *et al.* [37]	672	28	0.13	400	Layered	3	7070	0.8	54
Li *et al.* [38]	672	28	0.78	470	Layered	5	18400	0.9	166

IEEE 802.11n LDPC Decoder Implementations

Work	N	Tech. (nm)	Area (mm^2)	Freq. (MHz)	Schedule	Iter.	T/P (Mb/s)	Voltage (V)	Power (mW)
Gunnam *et al.* [39]	1944	130	1.85	500	Layered	15	1618	n/a	238
Rovini *et al.* [40]	1944	65	0.48	240	Layered	12	196	1.2	168
Rovini *et al.* [41]	1944	65	0.74	240	Layered	12	178	1.2	234
Studer *et al.* [42]	1944	180	3.39	208	Layered	5	780	n/a	2886
Sun *et al.* [43]	2304	65	1.20	400	Layered	10	415	0.9	180
Jin *et al.* [44]	1944	180	2.67	250	Layered	10	503	1.8	463
Roth *et al.* [45]	1944	90	1.77	346	Layered	10	679	1.0	107
Sun *et al.* [46]	1944	45	0.81	815	Layered	15	3000	n/a	n/a
Meinerzhagen *et al.* [47]	1944	90	1.00	307	Layered	10	600	1.0	88

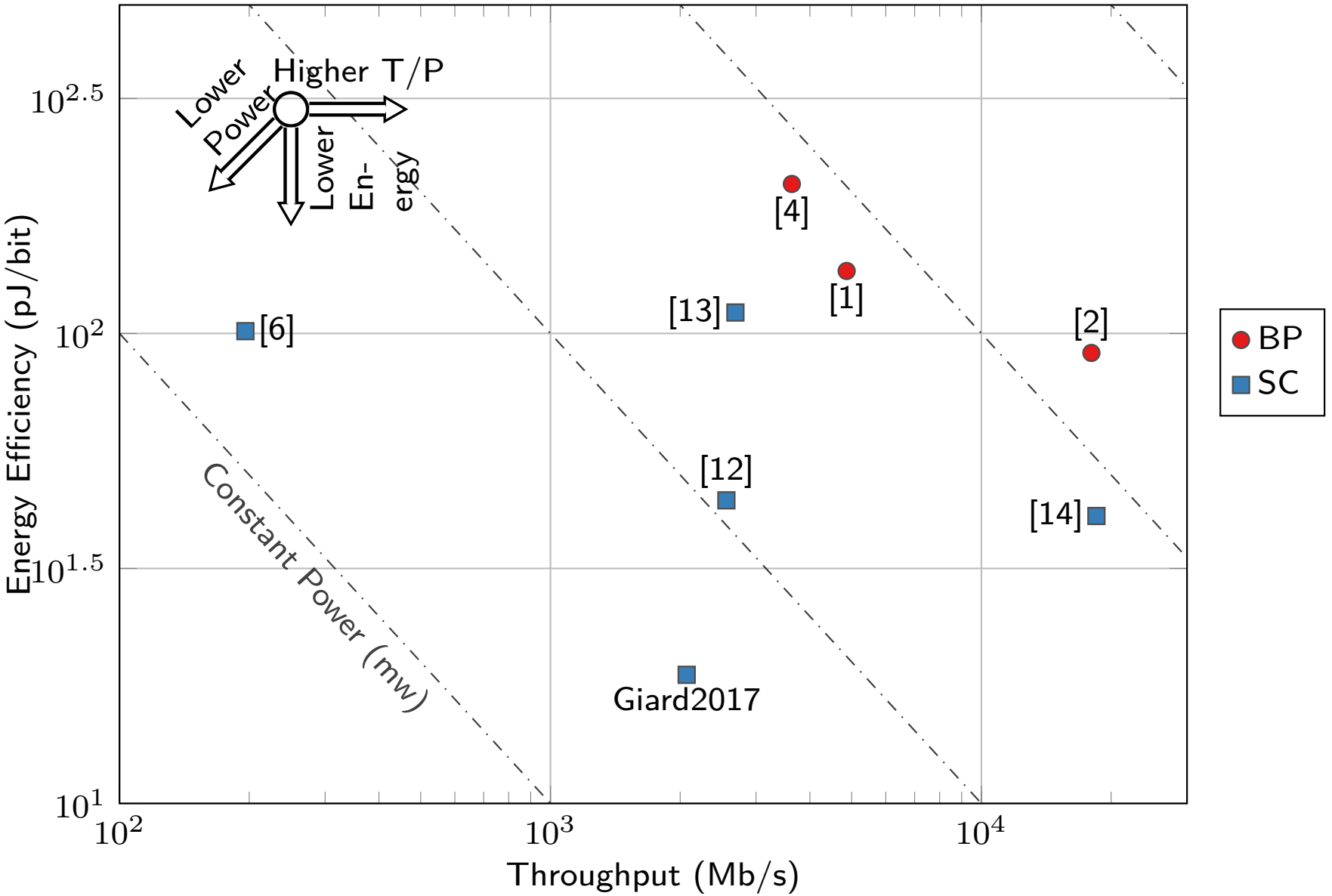
IEEE 802.3an LDPC Decoder Implementations

Work	N	Tech. (nm)	Area (mm^2)	Freq. (MHz)	Schedule	Iter.	T/P (Mb/s)	Voltage (V)	Power (mW)
Cevrero *et al.* [48]	2048	90	5.35	137	Layered	4	11690	1.2	1559
Zhang *et al.* [49]	2048	65	5.35	100	Flooding	8	6670	0.7	144
Zhang *et al.* [49]	2048	65	5.35	700	Flooding	8	47700	1.2	2800
Bao *et al.* [50]	2048	130	18.40	278	Layered	5	9480	1.2	774

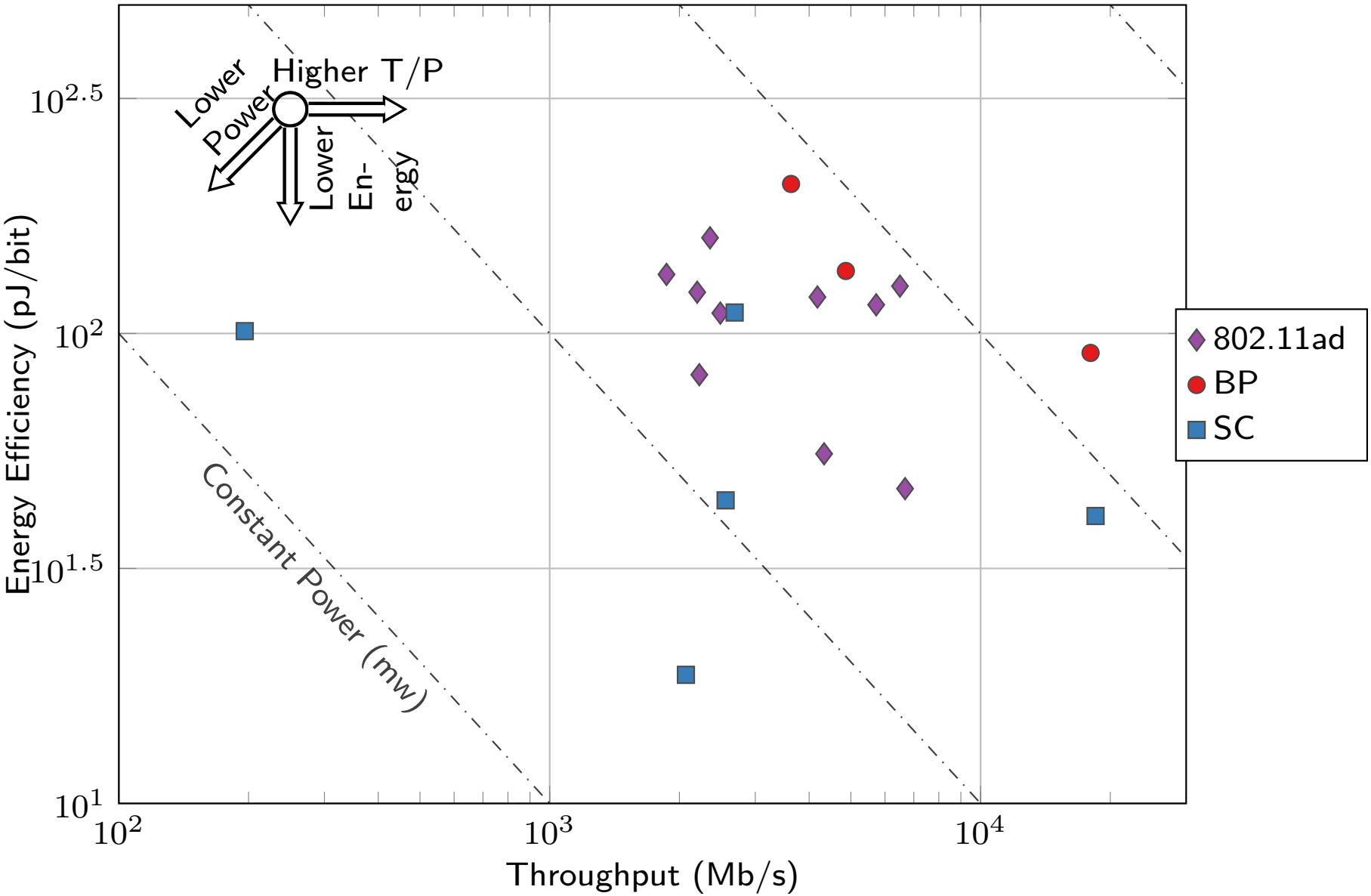
3GPP LTE Turbo Decoder Implementations

Work	K	Tech. (nm)	Area (mm^2)	Freq. (MHz)	Iter.	T/P (Mb/s)	Voltage (V)	Power (mW)
Studer *et al.* [51]	6144	130	3.57	n/a	6	391	1.2	789
Ilnseher *et al.* [52]	6144	65	7.70	450	6	2150	1.1	n/a
Chen *et al.* [53]	6144	65	1.39	512	6	692	1.2	635
Lin *et al.* [54]	6144	40	1.27	252	6	535	0.9	218
Belfanti *et al.* [55]	6144	65	2.49	410	6	1013	1.2	966
Shrestha *et al.* [56]	6144	45	2.43	600	6	1067	0.8	870
Wang *et al.* [57]	6144	90	6.10	625	8	438	1.0	272
Wang *et al.* [57]	6144	90	19.75	625	8	2274	1.0	1450

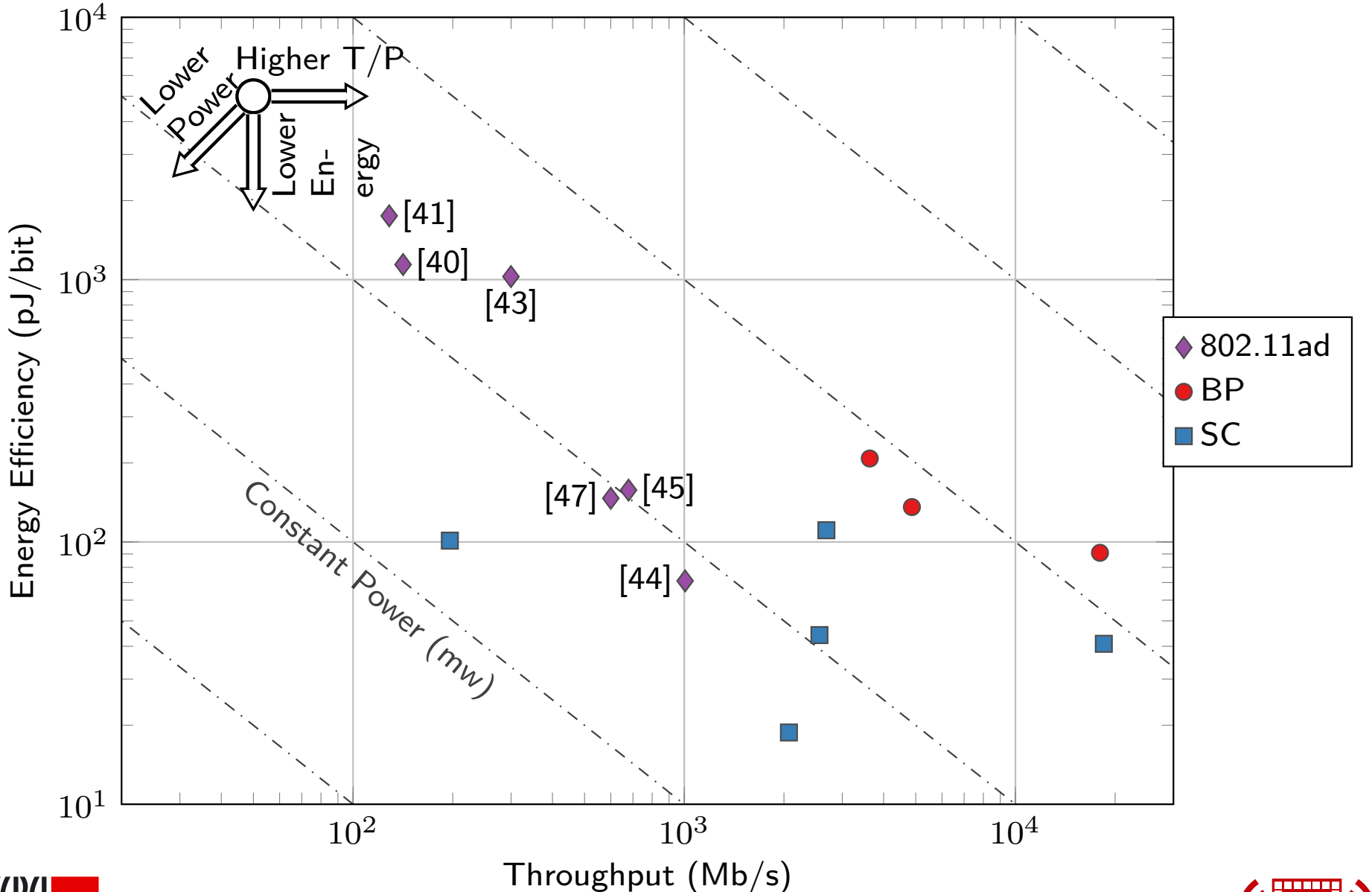
T/P Vs. Energy Eff. for Various Polar Decoders



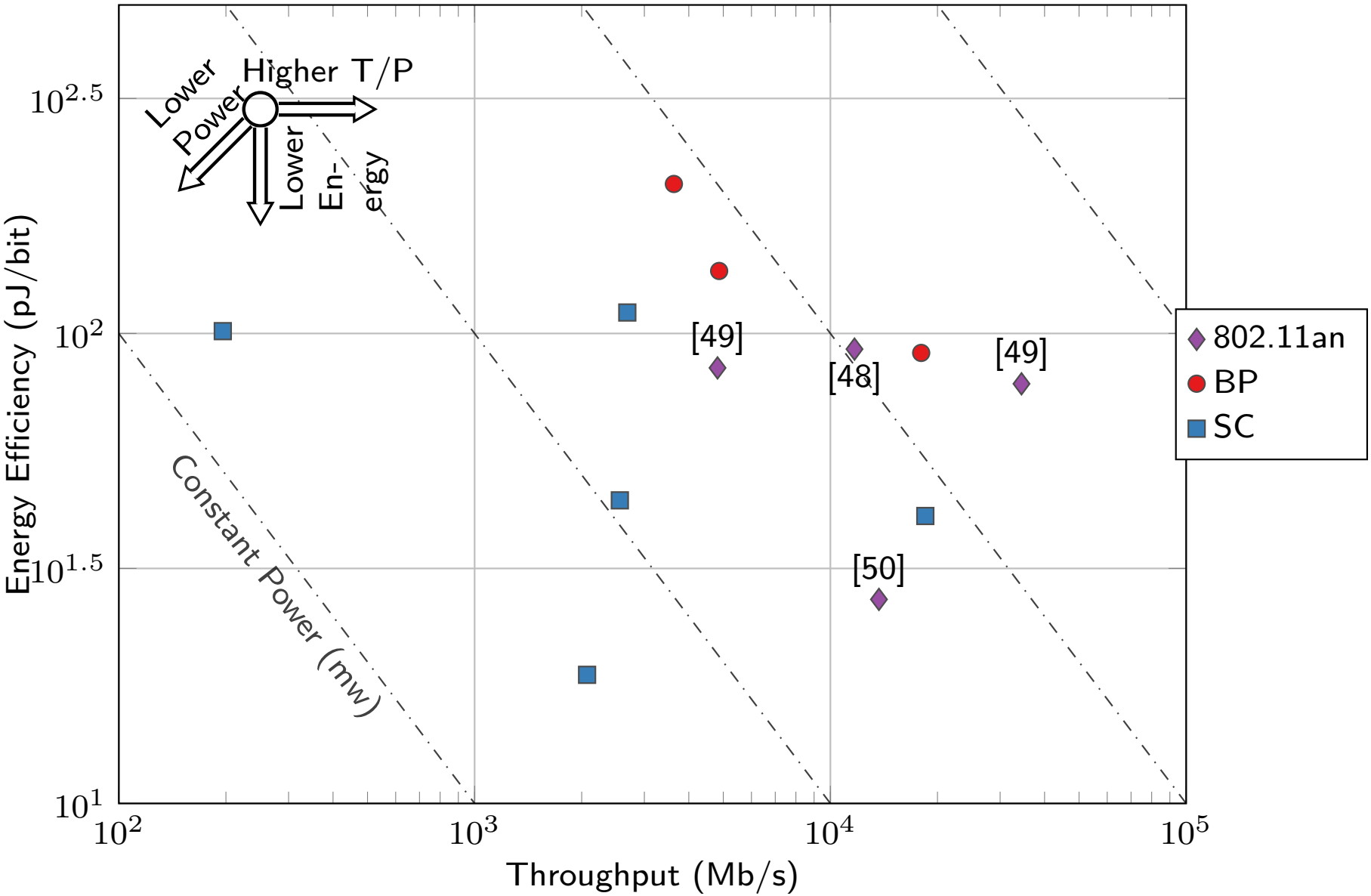
T/P Vs. Energy Eff. – IEEE 802.11ad LDPC



T/P Vs. Energy Eff. – IEEE 802.11n LDPC



T/P Vs. Energy Eff. – IEEE 802.3an LDPC



T/P Vs. Energy Eff. – 3GPP LTE Turbo