Supporting Information

Realization of advanced passive silicon photonic devices with subwavelength-grating structures developed by efficient inverse design

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Section S1. The details of the inverse-designed 6-channel mode (de)multiplexer

In Table S1, the design flow details are given. For each stage, we present the information of the electromagnetic (EM) solver, optimization data-set type, section number, as well the sample dimension which is the dimension of the optimization data-set setting. In the whole design flow, the optimization region length is fixed to 15 μm, and the *FOM* definition stays the same. The *FOMs* of the initial individual and the optimized result of each stage are given in Table S1. The computation cost details are also shown in Table S1. The total computation time of each stage is the product of generation population, simulation time of one- individual, and optimization generation.

The air-slot device was successfully designed with 6 optimization stages and total computational time of 247.1 hours. The Stage-4 optimization result of the air-slot device was used as initial individual to design the SiO_2-filled device. The SiO_2-filled device was successfully designed within extra 5 stages of optimization costing 297.1 hours. In Table S2, the detail geometric parameters of the final designed SiO_2-filled 6-channel mode (de)multiplexer is given.

Table S1 The details of the 6-channel mode (de)multiplexer design flow.

Device Type	Stage	EM Solver (mesh type)[a)]	Optimization data-set type[b)]	Section number	Sample size	FOM (dB)		Computational cost			
						Start	End	Generation population	One-individual time (hour)[c)]	Generations	Stage time (hour)
Air-slot	1	EME	1[†]	6	84	10.936	0.822	17	0.012	291	59.4
	2	EME		12	156	0.822	0.424	19	0.012	93	21.2
	3	FDTD(1)[*]				0.977	0.801		0.021	33	13.2
	4	FDTD(1)	2	12	167	0.801	0.691		0.021	71	28.3
Air-slot	5	FDTD(2)	2	12	167	0.610	0.577	19	0.323	6	36.8
	6	FDTD(2)		24	323	0.577	0.548	21	0.323	13	88.2
SiO_2-filled	5	FDTD(1)	2	12	167	1.274	0.697	19	0.021	37	14.8
	6	FDTD(2)		24	323	0.666	0.620	21	0.323	7	47.5
	7	FDTD(1)				0.674	0.603		0.021	25	11.0
	8	FDTD(2)				0.589	0.578		0.323	4	27.1
	9	FDTD(2)				0.807	0.623		0.323	29	196.7

Notes:

a) For the mesh of FDTD solver, Type 1: 10 mesh points per effective-wavelength scale, Type 2: 14 mesh points per effective-wavelength scale.

b) Type 1: the data-set is defined as $\boldsymbol{S}_{\mathbf{total}}=[\boldsymbol{D}_1, \boldsymbol{D}_2\ldots\boldsymbol{D}_n, \boldsymbol{D}_{n+1}]$, the length array is given by $\boldsymbol{L}=[l_1,l_2\ldots l_n]=[1,2,\ldots,n]\cdot(L_n/n)$, $L_n = 15$ μm. Type 2: the data-set is defined as $\boldsymbol{S}_{\mathbf{total}}=[\boldsymbol{D}_1, \boldsymbol{D}_2\ldots, \boldsymbol{D}_n, \boldsymbol{D}_{n+1}, l_1, \ldots, l_{n-1}]$, $L_n = 15$μm.

c) One-individual time was measured on the personal computer with performance parameters given in **Methods** of main text. For EME and FDTD methods, simulation of one sample needs one run and six runs of solvers, respectively.

Table S2 The detail geometric parameters of the final designed SiO_2-filled 6-channel mode (de)multiplexer (unit: μm).

Optimization Region Parameters in lateral direction														Optimization Region Parameters in lengthwise direction		Else parameters	
d_{mn}		n															
		1	2	3	4	5	6	7	8	9	10	11	12				
	1	2.844	0.195	0.093	0.435	0.158	0.17	0.16	0.493	0.163	0.436	0.089	0.408				
	2	2.694	0.199	0.168	0.364	0.161	0.261	0.243	0.453	0.152	0.401	0.096	0.435	l_1	0.655	w_{in}	2.3
	3	2.545	0.159	0.278	0.266	0.164	0.406	0.36	0.395	0.142	0.369	0.083	0.486	l_2	1.246	d_{in0}	4.4
	4	2.418	0.15	0.303	0.208	0.165	0.5	0.412	0.373	0.158	0.449	0.078	0.562	l_3	1.869	w_{out}	0.5
	5	2.301	0.145	0.351	0.145	0.139	0.629	0.463	0.304	0.152	0.478	0.107	0.637	l_4	2.543	d_{out0}	0.9
	6	2.258	0.196	0.328	0.224	0.171	0.603	0.45	0.332	0.214	0.44	0.098	0.578	l_5	3.142	d_{out}	1.4
	7	2.229	0.294	0.275	0.353	0.181	0.53	0.387	0.321	0.249	0.424	0.106	0.55	l_6	3.750	l_{in}	2
	8	2.202	0.31	0.289	0.418	0.245	0.472	0.292	0.379	0.266	0.373	0.16	0.491	l_7	4.382	l_{out}	1
	9	2.167	0.372	0.27	0.482	0.357	0.406	0.2	0.413	0.298	0.376	0.197	0.414	l_8	5.009		
	10	2.06	0.384	0.344	0.514	0.35	0.378	0.261	0.361	0.373	0.308	0.288	0.402	l_9	5.629		
	11	1.946	0.422	0.407	0.577	0.382	0.337	0.281	0.333	0.45	0.285	0.401	0.398	l_{10}	6.263		
	12	1.823	0.454	0.496	0.538	0.345	0.352	0.315	0.344	0.499	0.339	0.511	0.436	l_{11}	6.889		
m	13	1.723	0.499	0.58	0.496	0.298	0.322	0.354	0.35	0.595	0.42	0.632	0.444	l_{12}	7.507		
	14	1.589	0.578	0.566	0.456	0.332	0.303	0.415	0.391	0.645	0.446	0.642	0.487	l_{13}	8.134		
	15	1.475	0.585	0.563	0.398	0.385	0.322	0.48	0.384	0.747	0.492	0.652	0.489	l_{14}	8.743		
	16	1.347	0.644	0.538	0.367	0.454	0.353	0.567	0.446	0.705	0.453	0.662	0.45	l_{15}	9.402		
	17	1.268	0.682	0.527	0.317	0.486	0.381	0.626	0.49	0.694	0.452	0.648	0.427	l_{16}	10.010		
	18	1.178	0.621	0.595	0.328	0.535	0.415	0.727	0.445	0.623	0.464	0.683	0.441	l_{17}	10.620		
	19	1.068	0.574	0.669	0.359	0.574	0.414	0.793	0.471	0.587	0.492	0.716	0.435	l_{18}	11.230		
	20	0.959	0.534	0.699	0.381	0.697	0.395	0.841	0.504	0.586	0.499	0.739	0.478	l_{19}	11.871		
	21	0.853	0.544	0.743	0.369	0.776	0.382	0.887	0.535	0.603	0.51	0.751	0.511	l_{20}	12.484		
	22	0.792	0.539	0.75	0.45	0.777	0.43	0.844	0.556	0.668	0.46	0.795	0.542	l_{21}	13.110		
	23	0.728	0.535	0.751	0.528	0.788	0.464	0.818	0.589	0.76	0.426	0.837	0.541	l_{22}	13.745		
	24	0.713	0.528	0.707	0.555	0.789	0.581	0.764	0.609	0.796	0.464	0.842	0.603	l_{23}	14.374		
	25	0.716	0.519	0.702	0.564	0.806	0.655	0.712	0.65	0.82	0.466	0.818	0.654	l_{24}	15.000		

Section S2. The details of the inverse-designed 90° hybrid

In the design flow, we used two versions of *FOM* definition. The version 1 FOM_{V1} consists of a transmission term FOM_T and a phase term FOM_{phase}, which are respectively given by

$$FOM_T = \frac{-10\log_{10}\left(1-\sqrt{\sum_{i=3}^{6}\left(\left|S_{i1}\right|^2-25\%\right)}\right)-10\log_{10}\left(1-\sqrt{\sum_{i=3}^{6}\left(\left|S_{i2}\right|^2-25\%\right)}\right)}{2}, \quad (S1)$$

$$FOM_{Phase} = \min\left\{-10\log_{10}(1-\left\|\left[\theta_3-\theta_6,\theta_4-\theta_6,\theta_5-\theta_6\right]-\boldsymbol{V}_p\right\|)\right\}, \quad (S2)$$

where $\boldsymbol{V}_p$ is the reference phase vector, $\boldsymbol{V}_p \in$ {[−90°, 90°, 180°], [−90°, 180°, 90°], [90°,−90°, 180°], [90°, 180°,− 90°], [180°,−90°, 90°], [180°, 90°, −90°]}. One has $FOM_{V1}=FOM_T+FOM_{phase}$. Here only the central wavelength of 1.55 μm is considered. In an improved version, the excess loss term FOM_{EL} and the imbalance term FOM_{IM} are used to replace FOM_T:

$$FOM_{EL} = -10\log_{10}\frac{\sum_{i=3}^{6}\left(\left|S_{i1}\right|^2+\left|S_{i2}\right|^2\right)}{2}, \quad (S3)$$

$$FOM_{IM} = -10\log_{10}\left(\frac{\min\{|S_{ij}|^2\}}{\max\{|S_{ij}|^2\}}\right), \text{ (i=3,4,5,6, j=1,2).} \quad \text{(S4)}$$

The total *FOM* is $FOM_{total}=FOM_{EL}+FOM_{IM}+FOM_{phase}$ for a single wavelength. The final *FOM* is given by the mean of FOM_{total} at five wavelength points: $FOM_{V2} = \overline{FOM_{total}(\lambda)}$, $\lambda_i \in$ {1530, 1540, 1550, 1560, 1570}nm. The design flow starts from a regular linear initial structure by using an EME method. The EME method can obtain the transfer matrix by one-run costing only 36 seconds for single wavelength. To get more accurate result, the FDTD solver was used latter. In the fast-simulation-mesh, there are 10 mesh points per effective-wavelength scale. The simulation of one sample consisting of two runs of the FDTD solver costs ~1.63 minutes. In the high-accuracy-mesh, there are 14 mesh points per effective-wavelength scale, and the local mesh refinements were adopted. In this case, the total simulation time of one sample is ~13.23 minutes. The performance confirmation of the final designed device was carried by FDTD solver with very dense meshes (34 mesh points per effective-wavelength scale); The simulation results are shown in Fig. 4(b)-4(d).

First, the air-slot device was designed. After total 299 generations of iterations, the *FOM* reaches 0.392 dB within total simulation time of ~199.4 hours. Then a SiO_2-filled device was designed using this result as initial sample. The design flow includes total 165 generations of iterations, costing total simulation time of ~278.83 hours. The final *FOM* is 1.189 dB.

The geometric parameters of the final device are given in Table S3. As Fig. 2(a) shows, d_{mn} denotes the spacings in *yz*-cross-sections of the optimization region. The final device has a 64-section optimization region with 65 cross-sections. l_1~l_{63}, the length of the optimization region l_{64} is fixed to 10 μm. Since there are two input waveguides, the parameter d_{in} is added to denote the axle wire spacing of the input waveguides (Fig. 4(a)). The parameters $\{w_{in}, d_{in0}, d_{in}, w_{out}, d_{out0}, d_{out}, l_{in}, l_{out}\}$ are included in the optimization data-set. The SWG period and fill factor are respectively P=0.2 μm and ff=0.5.

Table S3 The detail geometric parameters of the final designed SiO_2-filled 90° hybrid (unit: μm).

		Optimization Region Parameters in y-direction								Optimization Region Parameters in x-direction		Else parameters	
d_{mn}		n											
		1	2	3	4	5	6	7	8				
m	1	1.791	0.631	0.141	0.952	0.232	0.764	0.192	0.794				
	2	1.773	0.643	0.160	0.907	0.211	0.756	0.204	0.774	l_1	0.154	w_{in}	0.986
	3	1.758	0.641	0.182	0.866	0.197	0.739	0.209	0.769	l_2	0.310	d_{in0}	2.494
	4	1.739	0.653	0.199	0.832	0.180	0.728	0.219	0.758	l_3	0.471	d_{in}	1.999
	5	1.724	0.664	0.215	0.792	0.160	0.716	0.224	0.739	l_4	0.633	w_{out}	0.526
	6	1.701	0.679	0.239	0.752	0.143	0.724	0.245	0.732	l_5	0.790	d_{out0}	1.382
	7	1.689	0.693	0.266	0.709	0.128	0.730	0.257	0.706	l_6	0.949	d_{out}	1.396
	8	1.672	0.721	0.289	0.667	0.107	0.736	0.273	0.687	l_7	1.106	l_{in}	2.018
	9	1.652	0.743	0.310	0.625	0.090	0.732	0.287	0.661	l_8	1.260	l_{out}	1.012
	10	1.641	0.743	0.321	0.604	0.090	0.724	0.292	0.668	l_9	1.426		
	11	1.630	0.739	0.334	0.582	0.088	0.712	0.301	0.666	l_{10}	1.588		
	12	1.623	0.742	0.348	0.559	0.083	0.707	0.299	0.662	l_{11}	1.756		
	13	1.624	0.744	0.360	0.526	0.083	0.694	0.300	0.663	l_{12}	1.916		
	14	1.617	0.741	0.380	0.503	0.082	0.691	0.317	0.659	l_{13}	2.059		
	15	1.606	0.744	0.394	0.477	0.080	0.688	0.339	0.651	l_{14}	2.208		
	16	1.607	0.753	0.411	0.439	0.079	0.676	0.354	0.647	l_{15}	2.349		
	17	1.599	0.755	0.426	0.412	0.081	0.665	0.366	0.639	l_{16}	2.489		
	18	1.591	0.728	0.421	0.441	0.114	0.670	0.399	0.640	l_{17}	2.650		
	19	1.593	0.710	0.415	0.469	0.154	0.679	0.431	0.642	l_{18}	2.811		
	20	1.592	0.689	0.410	0.504	0.181	0.684	0.452	0.646	l_{19}	2.963		
	21	1.592	0.669	0.402	0.534	0.228	0.696	0.476	0.641	l_{20}	3.118		
	22	1.588	0.656	0.392	0.560	0.261	0.692	0.508	0.658	l_{21}	3.277		
	23	1.579	0.634	0.384	0.592	0.290	0.694	0.533	0.672	l_{22}	3.427		
	24	1.581	0.615	0.383	0.627	0.320	0.688	0.561	0.673	l_{23}	3.573		
	25	1.573	0.589	0.385	0.665	0.352	0.686	0.586	0.690	l_{24}	3.722		
	26	1.537	0.585	0.408	0.682	0.400	0.686	0.587	0.699	l_{25}	3.881		
	27	1.502	0.577	0.431	0.703	0.443	0.689	0.592	0.710	l_{26}	4.021		
	28	1.461	0.567	0.459	0.731	0.508	0.685	0.591	0.711	l_{27}	4.179		
	29	1.418	0.551	0.488	0.752	0.556	0.672	0.596	0.713	l_{28}	4.328		
	30	1.384	0.534	0.509	0.790	0.605	0.660	0.596	0.721	l_{29}	4.492		
	31	1.353	0.517	0.521	0.820	0.642	0.647	0.597	0.727	l_{30}	4.657		
	32	1.324	0.498	0.541	0.849	0.692	0.642	0.588	0.726	l_{31}	4.812		
	33	1.287	0.476	0.556	0.880	0.736	0.627	0.588	0.727	l_{32}	4.971		
	34	1.303	0.474	0.583	0.841	0.730	0.616	0.590	0.717	l_{33}	5.127		
	35	1.320	0.472	0.605	0.809	0.713	0.605	0.600	0.699	l_{34}	5.293		
	36	1.335	0.481	0.632	0.777	0.697	0.599	0.611	0.688	l_{35}	5.446		
	37	1.349	0.474	0.658	0.742	0.687	0.591	0.621	0.672	l_{36}	5.604		
	38	1.369	0.474	0.669	0.717	0.673	0.565	0.635	0.641	l_{37}	5.768		
	39	1.394	0.464	0.679	0.676	0.665	0.543	0.656	0.610	l_{38}	5.934		
	40	1.425	0.458	0.705	0.641	0.646	0.531	0.676	0.589	l_{39}	6.095		
	41	1.447	0.453	0.719	0.615	0.635	0.509	0.705	0.558	l_{40}	6.249		
	42	1.443	0.458	0.762	0.588	0.621	0.523	0.704	0.562	l_{41}	6.394		
	43	1.438	0.467	0.807	0.557	0.615	0.521	0.711	0.569	l_{42}	6.541		
	44	1.435	0.470	0.851	0.524	0.605	0.526	0.711	0.568	l_{43}	6.691		
	45	1.424	0.479	0.890	0.498	0.604	0.518	0.720	0.575	l_{44}	6.843		
	46	1.406	0.493	0.930	0.460	0.601	0.530	0.720	0.576	l_{45}	7.005		

	47	1.392	0.506	0.962	0.418	0.601	0.534	0.733	0.575	l_{46}	7.168		
	48	1.366	0.530	0.998	0.381	0.594	0.550	0.745	0.583	l_{47}	7.337		
	49	1.350	0.549	1.027	0.353	0.596	0.553	0.757	0.589	l_{48}	7.502		
	50	1.343	0.540	1.028	0.358	0.625	0.533	0.738	0.554	l_{49}	7.655		
	51	1.343	0.537	1.020	0.379	0.655	0.509	0.723	0.523	l_{50}	7.811		
	52	1.340	0.522	1.004	0.394	0.674	0.482	0.699	0.502	l_{51}	7.963		
	53	1.343	0.511	0.990	0.401	0.694	0.453	0.673	0.469	l_{52}	8.124		
	54	1.342	0.512	0.975	0.411	0.719	0.440	0.666	0.443	l_{53}	8.282		
	55	1.337	0.513	0.956	0.414	0.745	0.422	0.655	0.415	l_{54}	8.440		
	56	1.333	0.509	0.938	0.429	0.766	0.415	0.648	0.391	l_{55}	8.598		
	57	1.331	0.513	0.924	0.438	0.787	0.401	0.633	0.367	l_{56}	8.753		
	58	1.306	0.504	0.923	0.472	0.809	0.393	0.643	0.367	l_{57}	8.916		
	59	1.298	0.487	0.917	0.500	0.821	0.388	0.643	0.358	l_{58}	9.077		
	60	1.277	0.477	0.912	0.528	0.842	0.371	0.645	0.348	l_{59}	9.233		
	61	1.265	0.473	0.908	0.565	0.856	0.358	0.647	0.342	l_{60}	9.387		
	62	1.242	0.458	0.902	0.586	0.868	0.362	0.642	0.337	l_{61}	9.543		
	63	1.225	0.445	0.898	0.601	0.890	0.369	0.646	0.330	l_{62}	9.693		
	64	1.204	0.438	0.889	0.621	0.906	0.375	0.644	0.317	l_{63}	9.845		
	65	1.185	0.423	0.889	0.641	0.933	0.376	0.646	0.303	l_{64}	10.000		

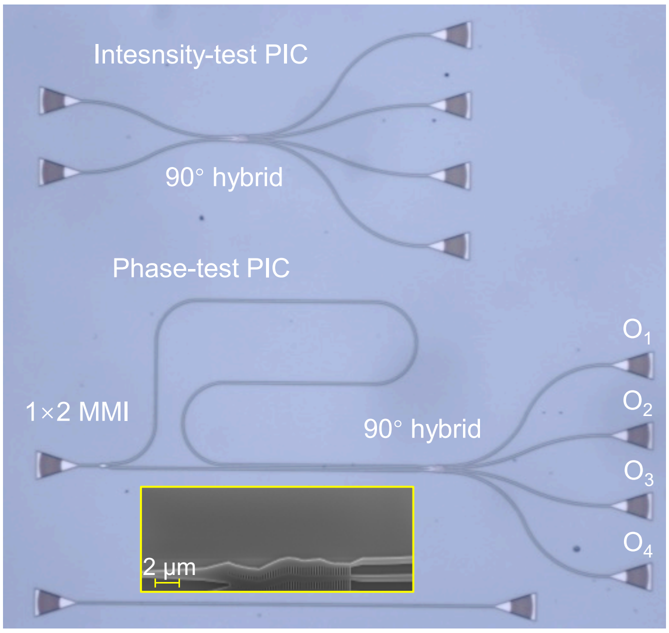

Fig. S1 The fabricated PICs for SiO_2-filled 90° hybrid. Microscope picture for the fabrication silicon intensity-test PIC and phase-test PIC with the SiO_2-filled 90° hybrid, inset: SEM image of a 90° hybrid.

Section S3. The details of the inverse-designed two-channel wavelength demultiplexer

The design details are introduced as follows. The *FOM* is initially given by

$$FOM = \frac{-10\log_{10}\left[\prod_{i=1}^{a}\left|S_{21}(\lambda_i)\right|^2 \prod_{j=1}^{b}\left|S_{31}(\lambda_j)\right|^2\right]}{a+b}, \tag{S5}$$

$\lambda_i \in$ {1470, 1490, 1510, 1530, 1550, 1570 } nm, a=6, $\lambda_j \in$ {1290, 1310, 1330} nm, b=3. To obtain the high extinction ratio performance, we introduce a crosstalk term to *FOM*,

$$FOM = \frac{-10\log_{10}\left[\prod_{i=1}^{a}|S_{21}(\lambda_i)|^2\prod_{j=1}^{b}|S_{31}(\lambda_j)|^2\right]}{a+b} + \frac{-10\log_{10}\left[\prod_{i=1}^{a}(1-|S_{31}(\lambda_i)|^2)\prod_{j=1}^{b}(1-|S_{21}(\lambda_j)|^2)\right]}{a+b}, \quad \text{(S6)}$$

Only 3D-FDTD solver is used for electromagnetic (EM) numerical simulation. For each sample, the mode coupling coefficients at different wavelengths can be obtained by one-run of the FDTD solver. Through the design flow, two mesh configurations were used. In the fast-simulation-mesh, there are 10 mesh points per effective-wavelength scale. The simulation of one sample consisting of two runs of EM solver costs ~1 minutes. In the high-accuracy-mesh, there are 18 mesh points per effective-wavelength scale, and the local mesh refinements were adopted. In this case, the simulation of one sample costs ~10.5 minutes. The performance confirmation of the final designed device was carried by FDTD solver with very dense meshes (26 mesh points per effective-wavelength scale with local mesh refinements); The simulation results are shown in Fig. 6(b)-6(c).

The design starts from an initial symmetric Y-branch structure. First, the air-slot device was designed. The optimization region length L is initially set to 6 μm at the beginning of the design flow, and manually is changed to 9 μm by a structure extension manipulation. The final designed SiO_2-filled device has L of 10.457 μm. The SWG period P was once set as a variable in optimization data-set, and finally set to fixed value of 0.184 μm. The SWG fill factor is ff=0.5.

After 380 generations of iterations, the *FOM* reaches 0.87 dB within total simulation time of ~ 93.6 hours. Then a SiO_2-filled device was designed using this result as initial sample. The design flow includes 76 generations of iterations, costing total simulation time of ~ 209.0 hours. The final *FOM* is 0.687 dB. The geometric parameters of the final device are given in Table S4.

Table S4 The detail geometric parameters of the final designed SiO_2-filled wavelength demultiplexer (unit: μm).

Optimization Region Parameters in y-direction						Optimization Region Parameters in x-direction		Else parameters	
d_{mn}		n							
		1	2	3	4				
m	1	1.371	0.953	0.267	0.459				
	2	1.307	0.916	0.280	0.414	l_1	0.152	w_{in}	1.4
	3	1.246	0.887	0.286	0.377	l_2	0.292	d_{in}	2.006
	4	1.194	0.809	0.299	0.433	l_3	0.536	w_{out}	0.5
	5	1.106	0.809	0.281	0.454	l_4	0.692	d_{out0}	1.303
	6	1.027	0.785	0.257	0.459	l_5	0.853	d_{out}	1.699
	7	0.973	0.740	0.226	0.494	l_6	1.026	l_{in}	1.0
	8	0.906	0.708	0.162	0.546	l_7	1.195	l_{out}	1.0
	9	0.859	0.695	0.178	0.584	l_8	1.339		
	10	0.812	0.681	0.183	0.624	l_9	1.490		
	11	0.781	0.684	0.233	0.680	l_{10}	1.636		
	12	0.744	0.693	0.265	0.726	l_{11}	1.788		
	13	0.710	0.684	0.336	0.694	l_{12}	1.923		
	14	0.676	0.679	0.404	0.681	l_{13}	2.061		
	15	0.640	0.681	0.482	0.653	l_{14}	2.183		
	16	0.611	0.678	0.549	0.627	l_{15}	2.310		
	17	0.559	0.678	0.571	0.669	l_{16}	2.466		
	18	0.511	0.680	0.594	0.707	l_{17}	2.613		
	19	0.463	0.686	0.629	0.763	l_{18}	2.773		
	20	0.419	0.683	0.660	0.819	l_{19}	2.926		
	21	0.399	0.686	0.720	0.793	l_{20}	3.077		
	22	0.384	0.671	0.776	0.774	l_{21}	3.232		
	23	0.380	0.654	0.842	0.751	l_{22}	3.392		
	24	0.374	0.646	0.906	0.741	l_{23}	3.549		
	25	0.434	0.621	0.947	0.706	l_{24}	3.741		
	26	0.506	0.606	0.975	0.679	l_{25}	3.925		
	27	0.557	0.557	1.033	0.654	l_{26}	4.100		
	28	0.624	0.521	1.067	0.627	l_{27}	4.277		
	29	0.653	0.505	1.110	0.599	l_{28}	4.487		
	30	0.692	0.480	1.157	0.575	l_{29}	4.686		
	31	0.741	0.459	1.171	0.558	l_{30}	4.875		
	32	0.786	0.437	1.203	0.537	l_{31}	5.068		
	33	0.887	0.389	1.187	0.541	l_{32}	5.257		
	34	0.986	0.328	1.171	0.553	l_{33}	5.452		
	35	1.078	0.282	1.134	0.549	l_{34}	5.639		
	36	1.165	0.225	1.107	0.564	l_{35}	5.824		
	37	1.206	0.231	1.114	0.558	l_{36}	6.013		
	38	1.243	0.234	1.121	0.563	l_{37}	6.198		
	39	1.282	0.257	1.116	0.568	l_{38}	6.381		
	40	1.309	0.259	1.113	0.583	l_{39}	6.568		
	41	1.310	0.262	1.125	0.587	l_{40}	6.708		
	42	1.310	0.265	1.143	0.598	l_{41}	6.846		
	43	1.287	0.263	1.160	0.596	l_{42}	6.987		
	44	1.275	0.271	1.182	0.607	l_{43}	7.133		
	45	1.264	0.283	1.171	0.596	l_{44}	7.365		
	46	1.273	0.302	1.129	0.589	l_{45}	7.605		

47	1.273	0.309	1.118	0.597	l_{46}	7.727			
48	1.268	0.306	1.106	0.597	l_{47}	7.851			
49	1.278	0.299	1.086	0.625	l_{48}	8.105			
50	1.270	0.300	1.095	0.608	l_{49}	8.235			
51	1.278	0.313	1.092	0.588	l_{50}	8.355			
52	1.297	0.311	1.101	0.573	l_{51}	8.486			
53	1.320	0.319	1.106	0.554	l_{52}	8.623			
54	1.312	0.317	1.140	0.581	l_{53}	8.857			
55	1.302	0.309	1.158	0.620	l_{54}	9.090			
56	1.292	0.303	1.188	0.637	l_{55}	9.318			
57	1.276	0.300	1.208	0.659	l_{56}	9.544			
58	1.263	0.310	1.198	0.653	l_{57}	9.767			
59	1.247	0.319	1.192	0.637	l_{58}	9.987			
60	1.242	0.326	1.182	0.618	l_{59}	10.223			
61	1.224	0.329	1.157	0.602	l_{60}	10.457			