Compact Y-Junction (Doc v1.0):

The following Y-branch is an attempted copy design of that proposed, simulated, fabricated and characterized by Zhang et al. in (PDF is attached):
[1] http://www.opticsinfobase.org/oe/abstract.cfm?uri=oe-21-1-1310

The figure below shows the device fabricated in the paper as well as the GDS of an attempted copy device which uses the matlab curvefitting toolbox with a cubic spline to interpolate the widths given in the paper (the spline fit method was not given but this looks very similar and has similar performance). The spline fit method is given in the matlab function Y_spline.m for the interested designer.

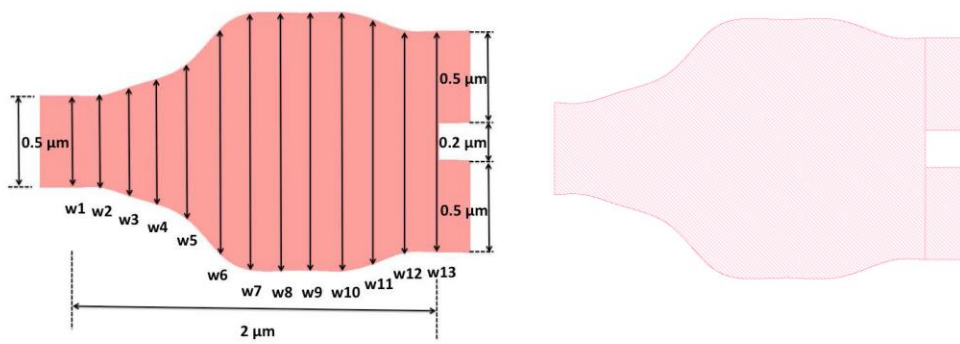

Fig. 1. (a) Y-branch from paper and (b) attempted copy design

The device in [1] was simulated and characterized for TE, but in the PDK we will characterize for TE and TM so users can use it for either polarization. All files necessary to simulate and modify the design are appended for those interested.

In simulation, it was found that the TE spectrum was slightly different than that reported in [1]. In that work, there is a peak transmission obtained between 1540 and 1550 nm. In this work it was found that the transmission spectrum increased monotonically with wavelength. There are two possible reasons for this:

1) It is possible that their spline fit was different and caused this discrepancy, but this is unlikely since even a simple spline (i.e. connect the dots) produces similar results.
2) It is likely that the authors normalized their output power to the “pulse power” in their simulation rather than the input power at each frequency. The pulse power will always be larger at the centre than it is near the bandwidth edges for a given pulse which would explain the features they observed. In our simulation, a field monitor was placed directly after the input mode source and the power was calculated at every frequency to normalize with the output field (with mode overlaps of course – see matlab functions appended).

The following figure shows the simulated transmission of the Y-branch for TE and TM.

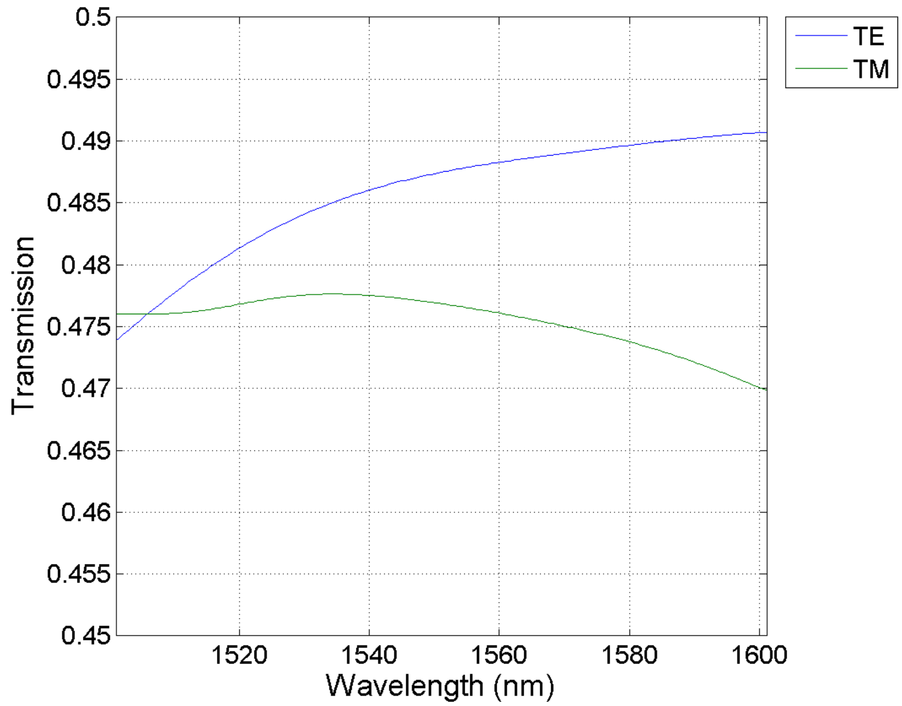

Fig. 2. Simulated transmission spectrum for TE and TM through each arm

In the simulation, a 15 um bend was placed directly at the output of the y-branch and the power was collected in an orthogonal plane to that of the launched power as shown in the following figure (it is suggested that anyone using this device for TE splitting uses a bend/S-bend with a radius of at least ~10um and at least ~XXum for TM to mitigate bending loss *and* transition to straight section loss):

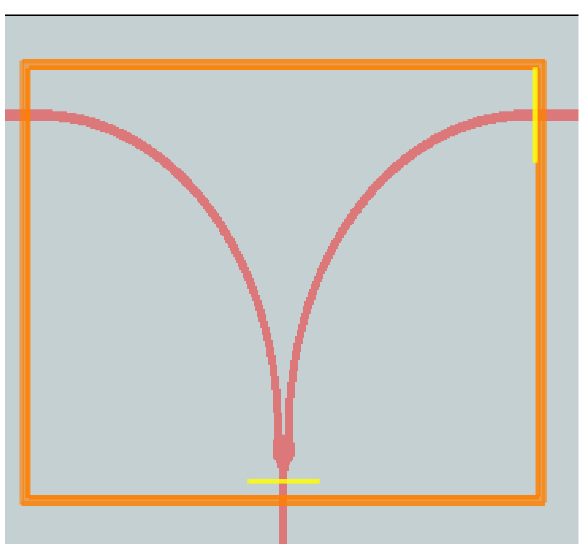

Fig. 3. Top down view of simulation space (without symmetry for clarity)

In addition to simulating the transmission spectrum for a perfect symmetric design, the device was also simulated for TE with large artificial fabrication offsets (waveguide width offset from ideal) as summarized in the following table (Figs on following pages):

Table 1 – Summary of splitting differences for different offsets

Input Width (nm)	Output1 Width (nm)	Output2 Width (nm)	Avg Split diff (rel) (%)	Max Split diff (rel) (%)	Avg Split diff (abs) (%)	Max Split diff (abs) (%)	Avg IL (dB)	Max IL (dB)
500	500	500	0.00	0.00	0.00	0.00	0.10	0.18
500	500	450	7.54	8.85	3.63	4.24	0.16	0.24
500	500	550	6.90	7.99	3.33	3.84	0.09	0.15
450	450	450	0.00	0.00	0.00	0.00	0.14	0.16
450	500	450	8.81	9.81	4.22	4.67	0.10	0.12

T_1 = transmission through output 1 normalized to input power
T_2 = transmission through output 2 normalized to input power
Spectrum from λ = 1500 nm to λ = 1600 nm calculated for all of the above.

$$Avg\ Split\ diff\ (rel) = \frac{\sum_1^N \left(\frac{|T_1 - T_2|}{\min(T_1, T_2)}\right)}{N}, N = number\ of\ wavelength\ samples$$

$$Avg\ Split\ diff\ (abs) = \frac{\sum_1^N \left(\frac{|T_1 - T_2|}{T_1 + T_2}\right)}{N}$$

$$Max\ Split\ diff\ (rel) = \left(\frac{|T_1 - T_2|}{T_1 + T_2}\right)\Bigg|_{|T_1 - T_2| = \max(|T_1 - T_2|)}$$

$$Max\ Split\ diff\ (rel) = \left(\frac{|T_1 - T_2|}{\min(T_1, T_2)}\right)\Bigg|_{|T_1 - T_2| = \max(|T_1 - T_2|)}$$

$$Avg\ IL = \frac{-10\sum_1^N \log(T_1 + T_2)}{N}$$

$$Max\ IL = -10\log(T_1 + T_2)|_{(T_1+T_2) = \min(T_1+T_2)}$$

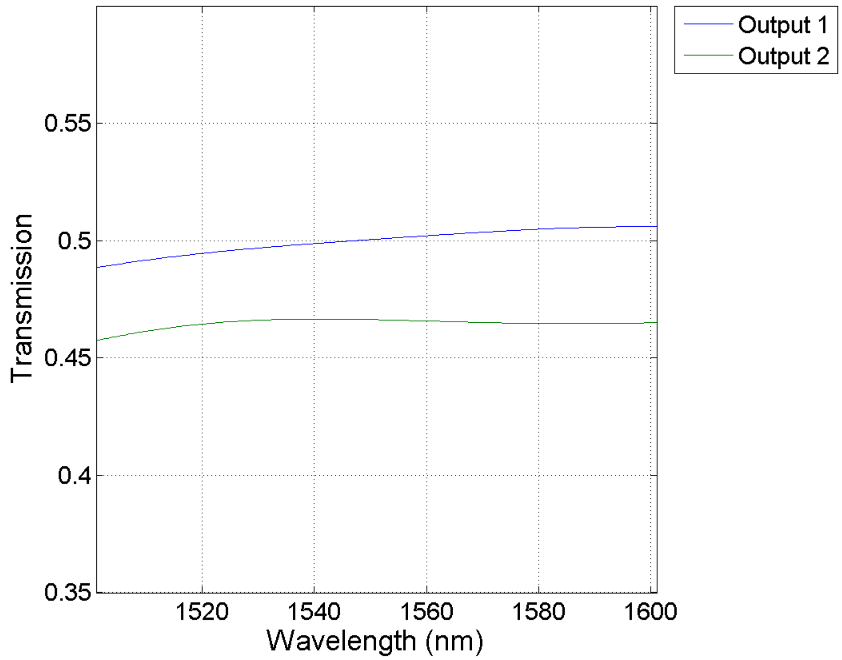

Fig. 4. Simulated transmission spectrum for widths (I,O1,O2)=(500,500,450)nm

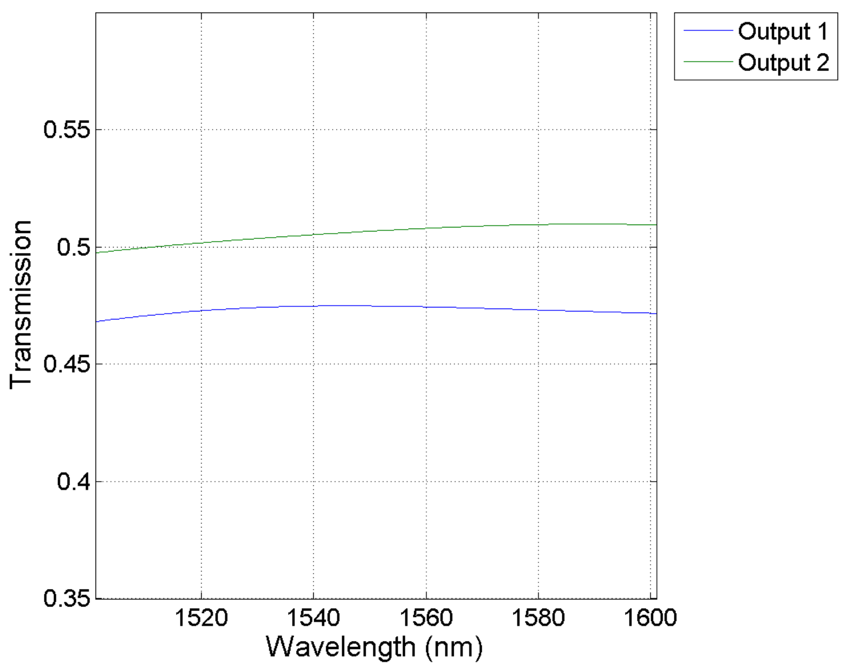

Fig. 4. Simulated transmission spectrum for widths (I,O1,O2)=(500,500,550)nm

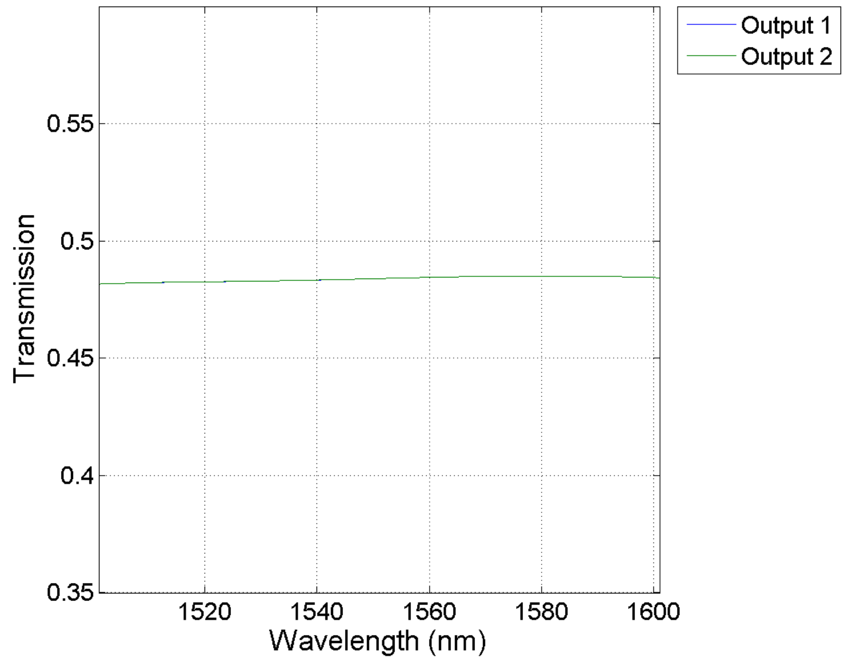

Fig. 4. Simulated transmission spectrum for widths (I,O1,O2)=(450,450,450)nm

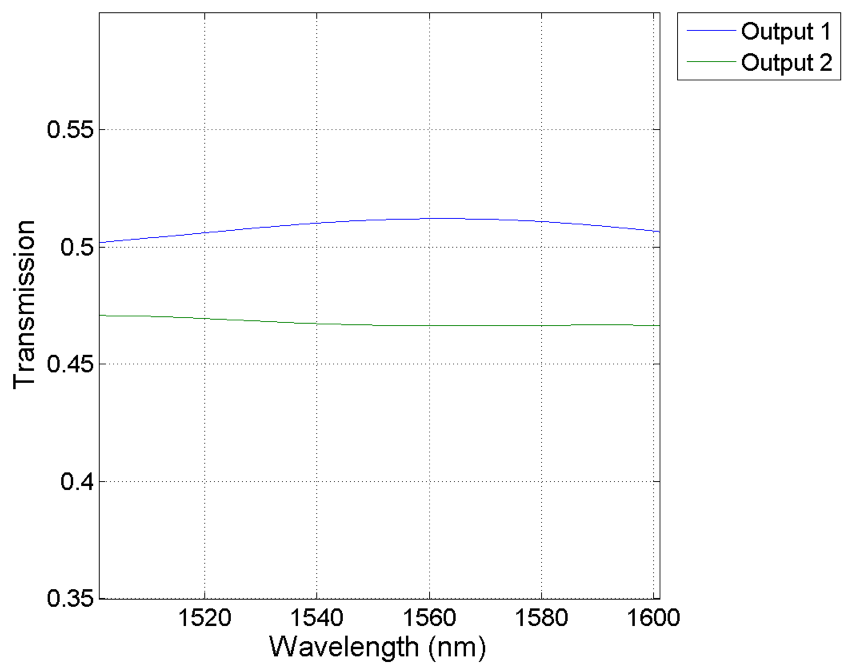

Fig. 4. Simulated transmission spectrum for widths (I,O1,O2)=(450,500,450)nm