











we see that RIN is a dominant source of noise for short loop lengths and the detection limit is ultimately limited by the thermo-refractive noise for longer lengths. The modulation frequencies, applied to the phase modulators, for loop lengths above 2m is less than 50MHz.

Figure 5 shows the chip area, rotation sensitivity and loss from waveguide crossings as a function of waveguide center-to-center spacing, for a 10m long and 3 $\mu$ m wide waveguide, as used for ultralow loss 100nm thick Si<sub>3</sub>N<sub>4</sub> waveguide core. In order to reduce the chip area, the spacing needs to be small. However, the number of waveguide crossings to achieve 10m waveguide length also increases, increasing the round-trip loss. The gradual increment in sensitivity comes from the increasing outer loop diameter. We also note that the spacing has a lower limit from the source coherence length. The double layer design helps to bring down the area by a factor of two. However, the waveguide crossing loss, assuming a loss value of 0.02dB/crossing, is high because of the increased number of crossings for the same length. The sensitivity is lower due to the reduced outer loop diameter.

#### 4. Conclusions

We propose and analyze a novel rotation sensor using the hybrid silicon platform, which allows for integration of all the required active and passive optical elements on a chip. The sensor area using a ten meter long waveguide and 50 $\mu$ m waveguide spacing is smaller than 6.5cm<sup>2</sup> for a single layer of Si<sub>3</sub>N<sub>4</sub> waveguide. We derive expressions for RMS noise in detected phase shift signal from various noise sources and compared their respective contributions to the minimum detectable rotation rate. By integrating a broadband source and optimally designing the low loss waveguide loop the impairments due to scattering and reflections can be minimized, to reach detection limits down to 19°/hr/ $\sqrt{\text{Hz}}$  for a loss of 1 dB/m and 4.2°/hr/ $\sqrt{\text{Hz}}$  for a loss of 0.1 dB/m, using a single layer topology.

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