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***Planar Lightwave Circuit  
Technology for Flexible and  
Precision Control over Fiber  
Launch Conditions***

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## » Motivation for Controlling Fiber Launch Conditions

## » Overview of Planar Lightwave Circuit (PLC) based designs for controlling fiber launch

- TOSA with integrated mode conditioner
- Stand alone mode conditioner

## » Fiber launch capabilities of PLC based TOSAs

- Control of launch location
- Control of spot size
- Elliptical spot size launch
- Off-normal angular launch
- Two launch spots

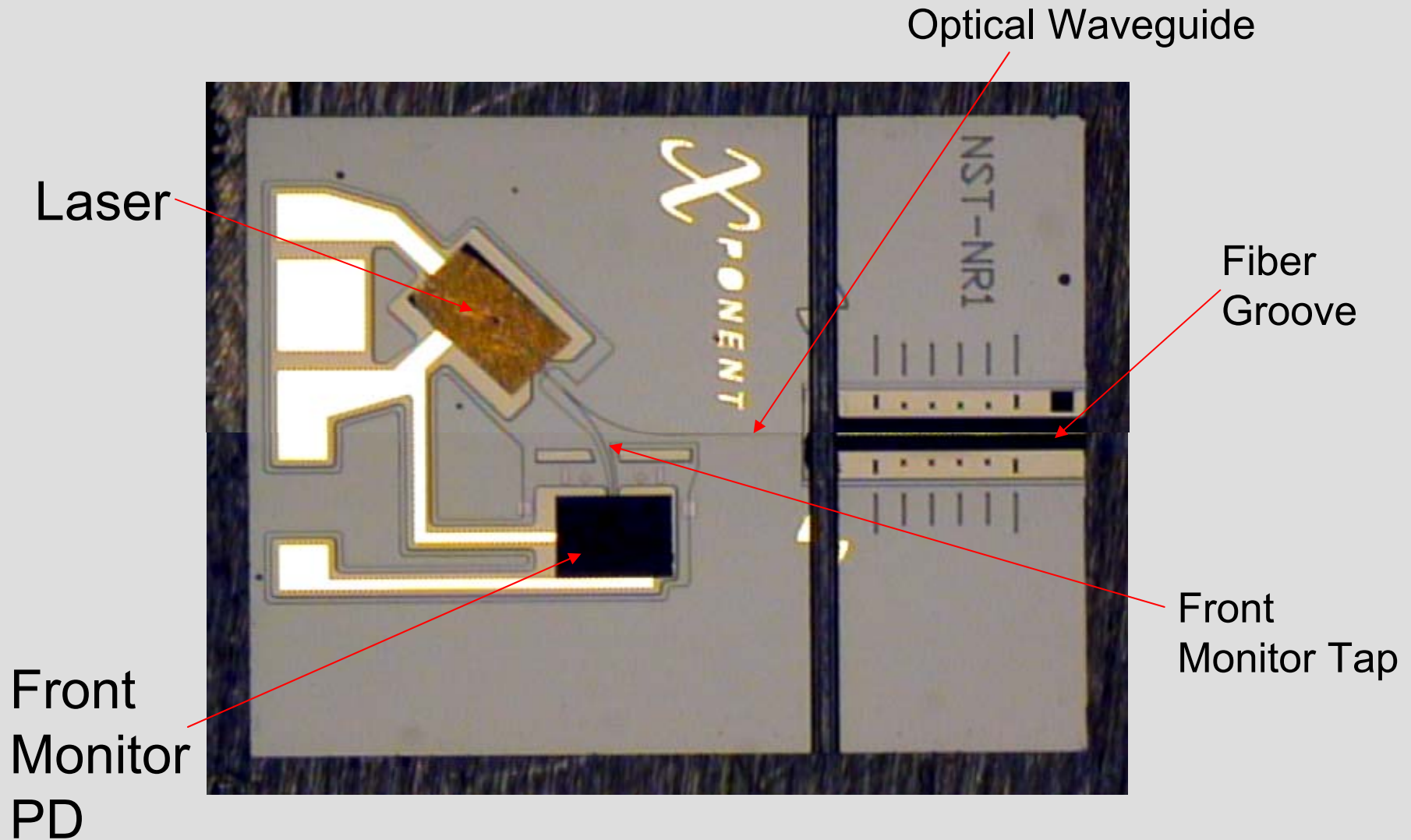
- » **Spatial modes of multimode fiber have varying propagation speeds which can result in pulse spreading**
- » **Spatial modes are mixed at fiber discontinuities, such as splices and connectors**
- » **Fiber bandwidth can be enhanced by controlling the excitation of spatial modes via control of the fiber launch conditions**
- » **Most reports of bandwidth enhancement involve launching at a point radially offset from the center of the core**
- » **PLC technology can easily achieve controlled radially offset launch condition at no cost premium to a centered launch as well as many other launch conditions not readily attainable with alternate approaches**
  - By combining radial offset with angular offset, rays that propagate along nearly circular helical paths can be launched. This is expected to be particularly promising for bandwidth optimization

- » **Low loss optical waveguides**
- » **Optical and electrical interface between laser and PD chips and optical waveguides**
- » **Spot size conversion by tapering of waveguide core dimensions:**
  - Max size approx equal to SMF,
  - Min size about  $2 \times 2 \text{ } \mu\text{m}$ ,
  - Circular or elliptical profiles
- » **Low loss optical splitters and taps**
- » **Alignment of waveguides to precision etched V-grooves:**
  - approx  $1 \text{ } \mu\text{m}$  positional alignment accuracy,
  - approx  $0.02^\circ$  angular alignment

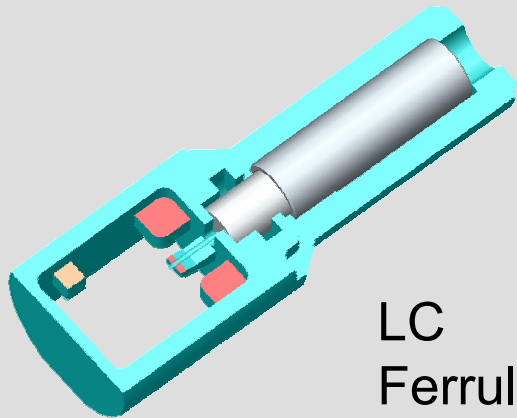
# 1310 nm Fabry-Perot Laser Fiber Ready Optical Assembly



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# PLC Based TOSA Package Cross Section



Optical  
Axis

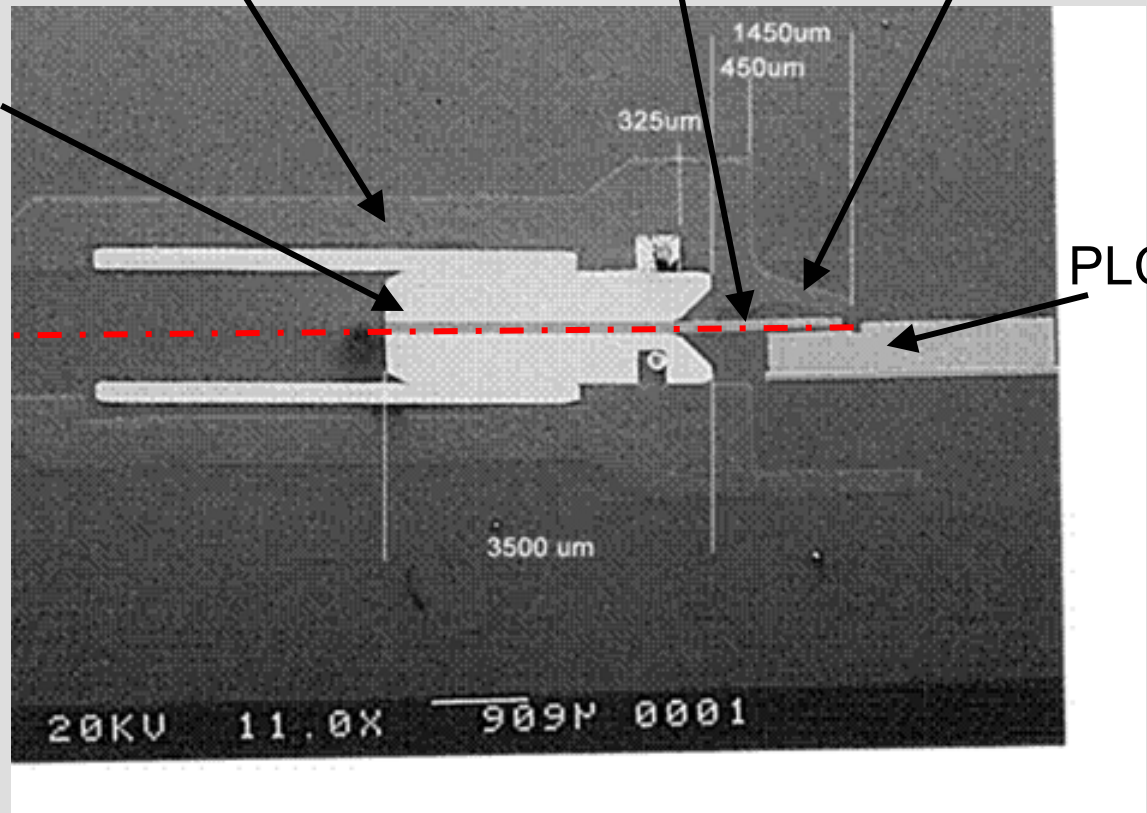
LC  
Ferrule

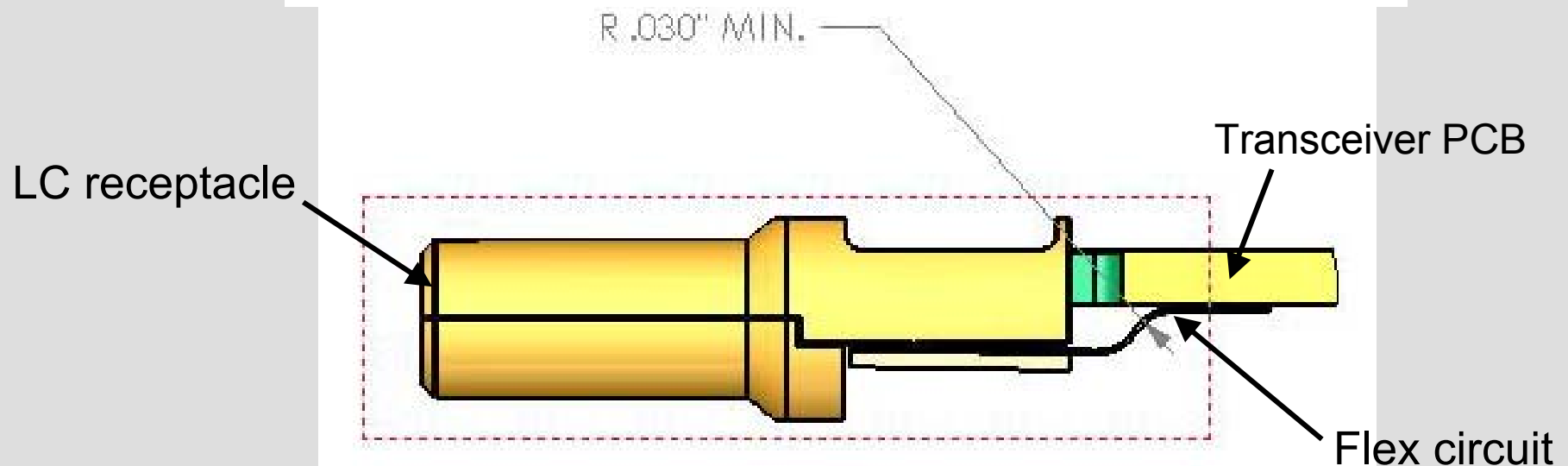
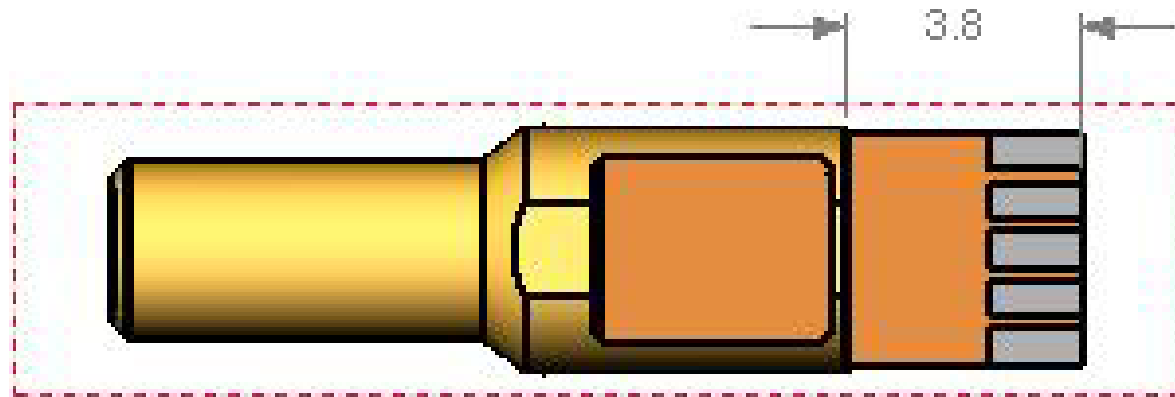
Precision Plastic  
housing

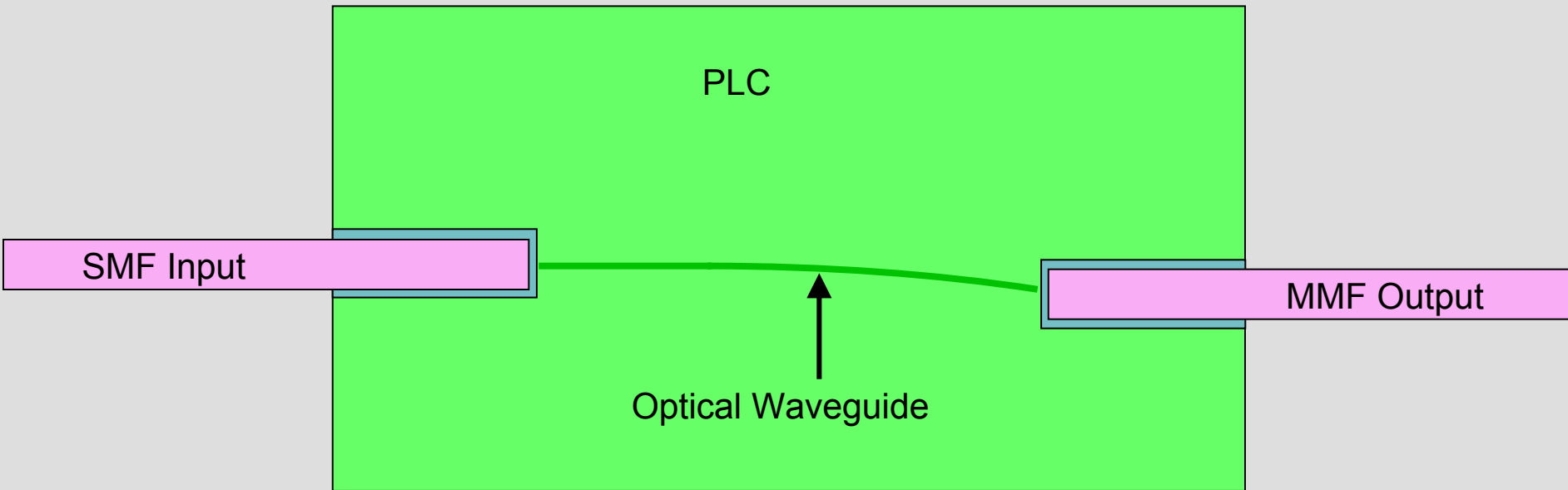
MMF  
Fiber stub

Fiber pusher

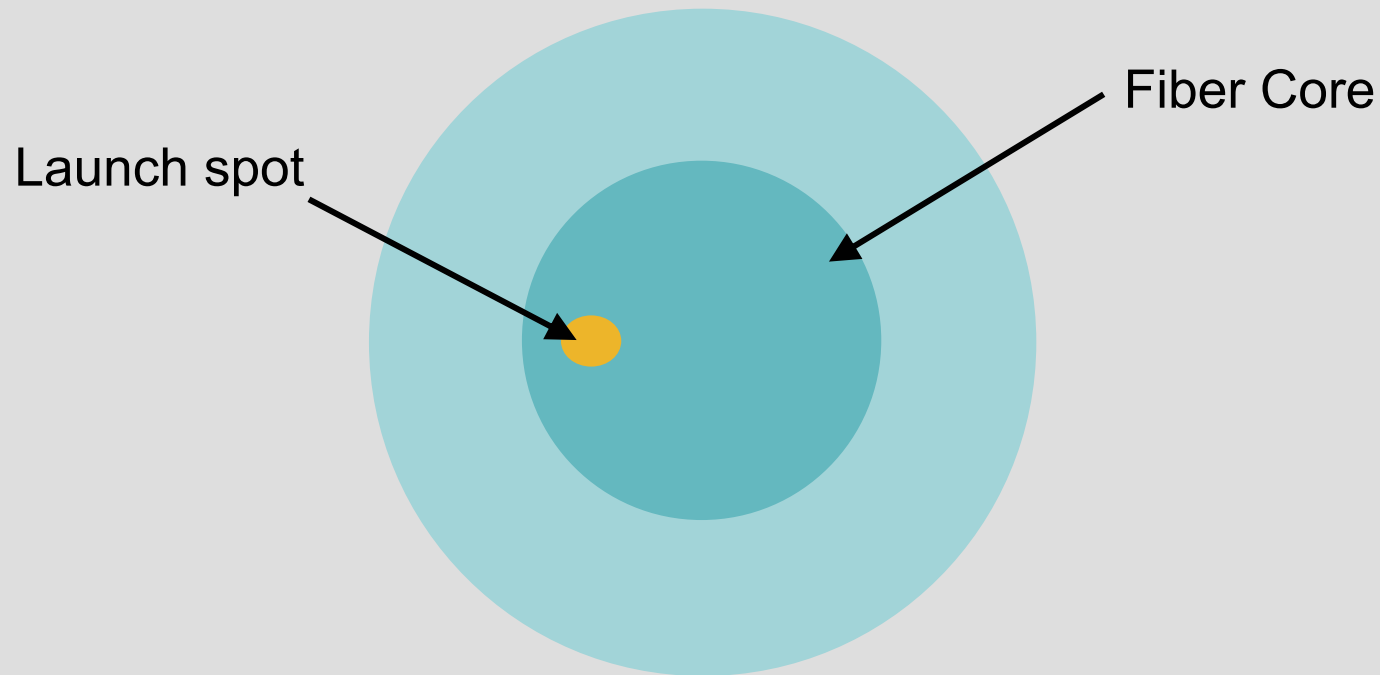
PLC



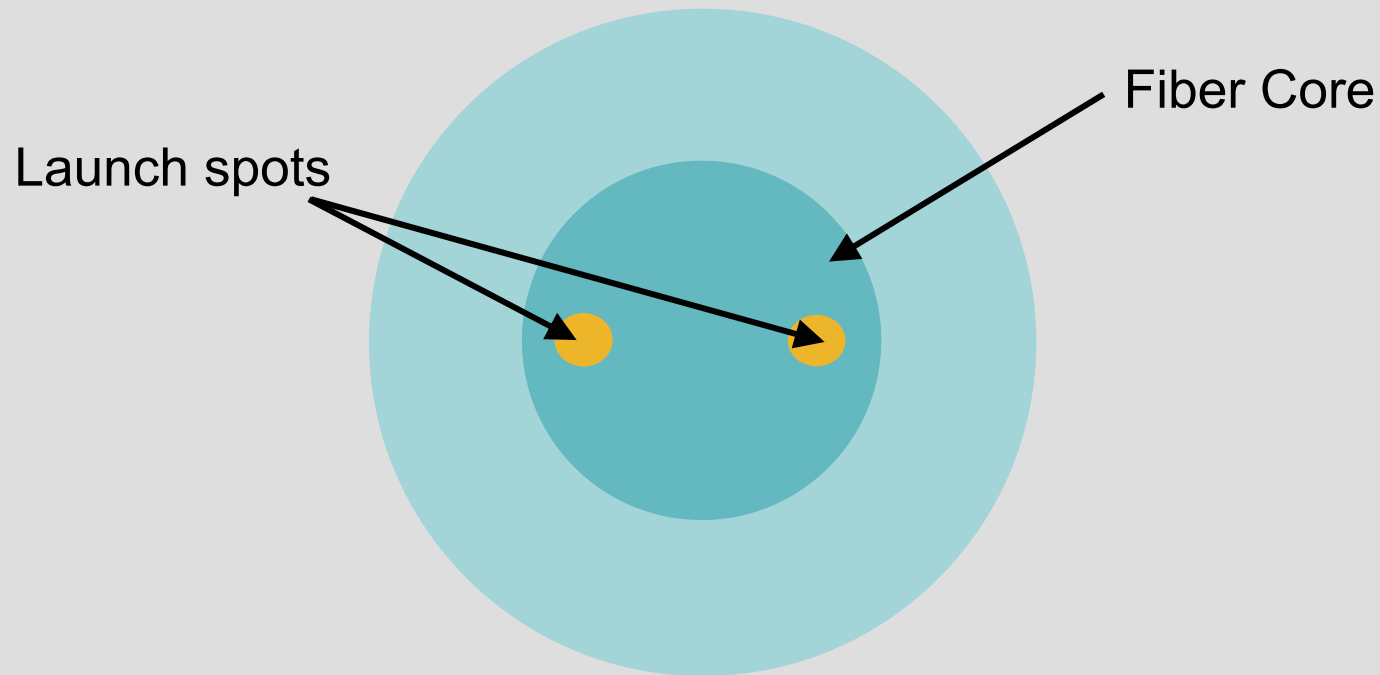




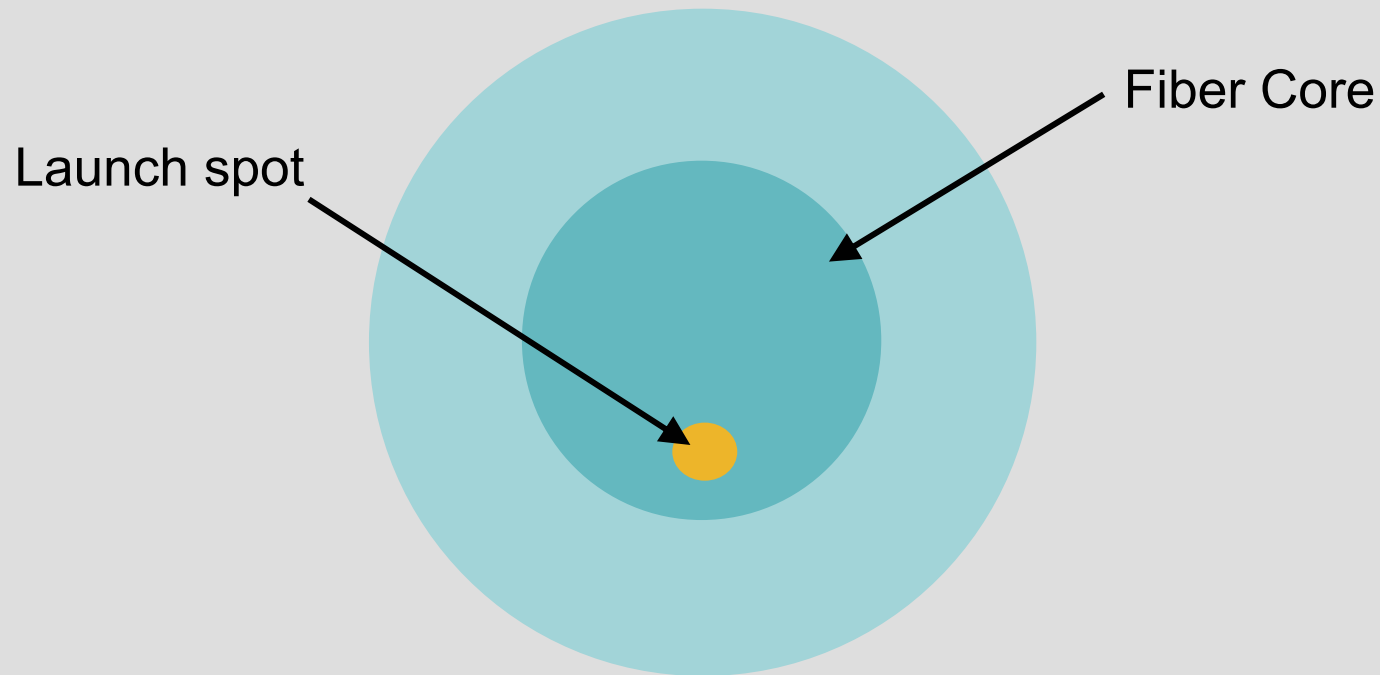




Implemented by offsetting waveguide with respect to V-groove,  
Spot size and angle of incidence can also be independently adjusted



Implemented by waveguide optical splitter and offsetting waveguides with respect to V-groove,  
Spot size and angle of incidence can also be independently adjusted



Implemented by over-sizing or under-sizing V groove width, spot size and angle of incidence can also be independently adjusted  
This configuration with off-normal angle of incidence can produce circular helical propagation

- » Planar Lightwave Circuit technology allows for extremely precise control of fiber launch conditions
- » Spot size, launch position, launch angle can be independently controlled
- » Two (or more) launch spots can be implemented
- » Circular helical propagation can be launched
- » Flexibility and control of launch conditions enables optimization of fiber bandwidth
- » Can be used as stand alone mode conditioner or integrated into TOSA