Temporal Response of an Excitation Engineered 1x16 Splitter

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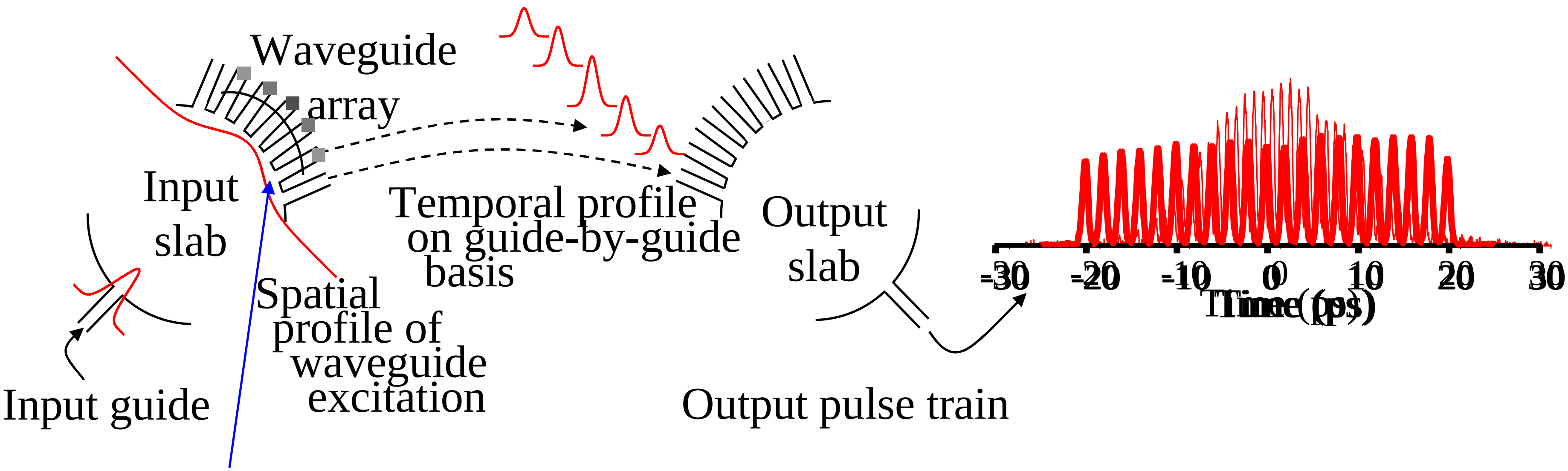
Motivation

- Significant prior work has been performed on the spectral character of PLC's.
- Investigating ultrafast time response of PLC's:
  - RF: Arbitrary millimeter wave electrical signals.
  - Communications: Parallel to serial conversion (OTDM).
- Novel pulse processing functionality has been demonstrated using modified AWG's.
  - Fundamental design constraint is input pulse width < delay spacing/guide
  - Periodic pulse bursts, arbitrary pulse sequences, and repetition rate multiplication demonstrations have been performed.
  - Tailoring the temporal window has been performed via 'loss-engineering' in the waveguide array.
- Here we investigate 'excitation-engineering' schemes for potentially tailoring the temporal window of PLC devices used with short pulse input.

Background

- Arrayed Waveguide Grating (AWG) devices are frequently used in WDM networks as channel multiplexers / demultiplexers.
- We have previously presented a new functionality of AWG devices for generation of periodic time-domain pulse trains.
  - 500 GHz to 1 THz burst repetition rate
  - 'Loss-engineering' employed to generate flat-top pulse trains
  - Application to repetition rate multiplication (~38X → 13.2 GHz to 500 GHz)

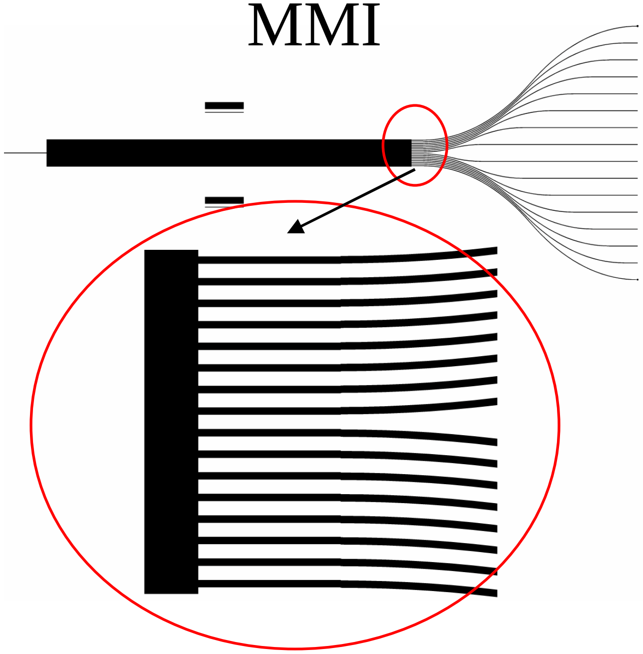


'Excitation-engineering' may lead to decreased insertion loss.

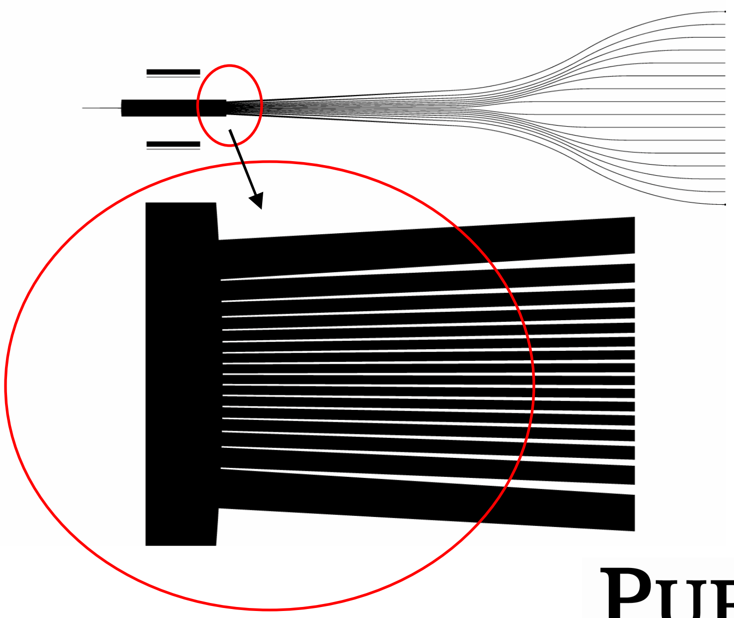
Devices

- Investigate two different ‘excitation-engineered’ structures in the form of a 1X16 splitter.
  - MMI – multi-mode interference splitter.
  - Funnel – modified AWG splitter with waveguide funnels on the outermost guides of the waveguide ‘array’. After the splitter, funnel guide width slowly tapers to standard SM guide width.
- CW and femtosecond pulse sources used to explore splitting ratio as function of wavelength, polarization dependence, dispersion.

MMI

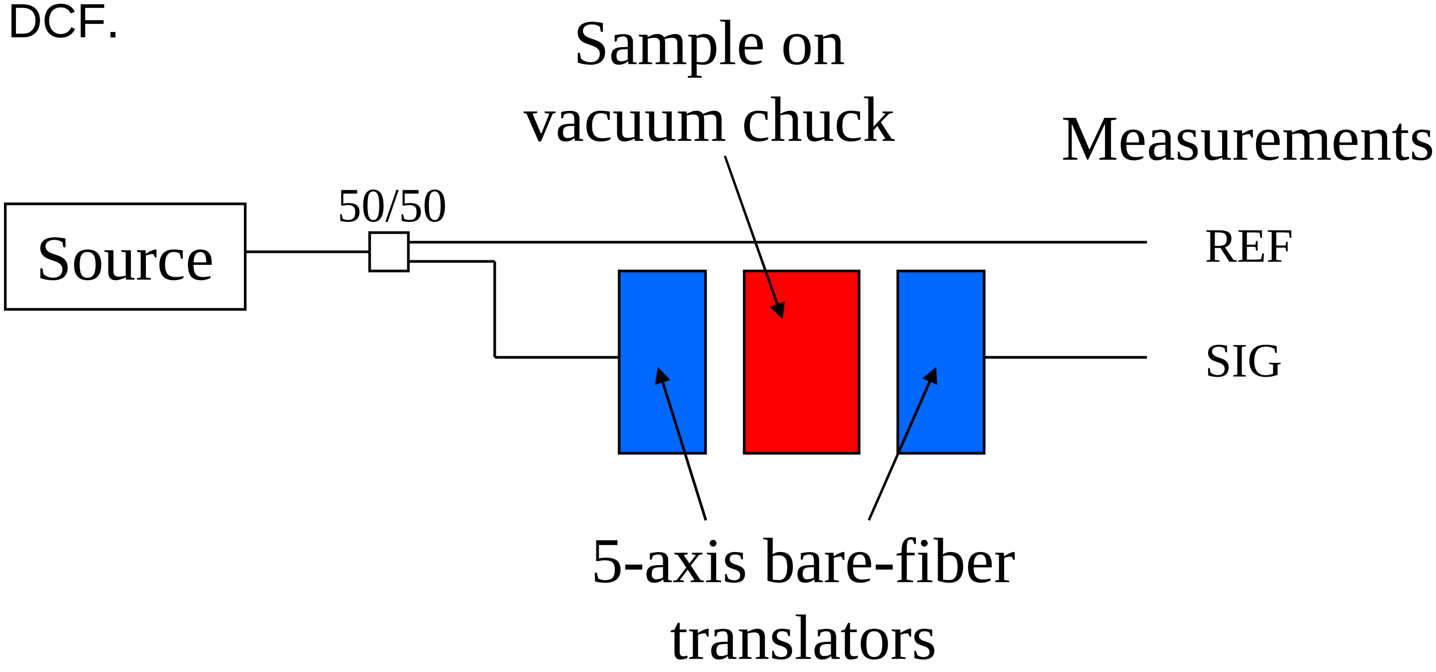


Funnel



Experimental Apparatus

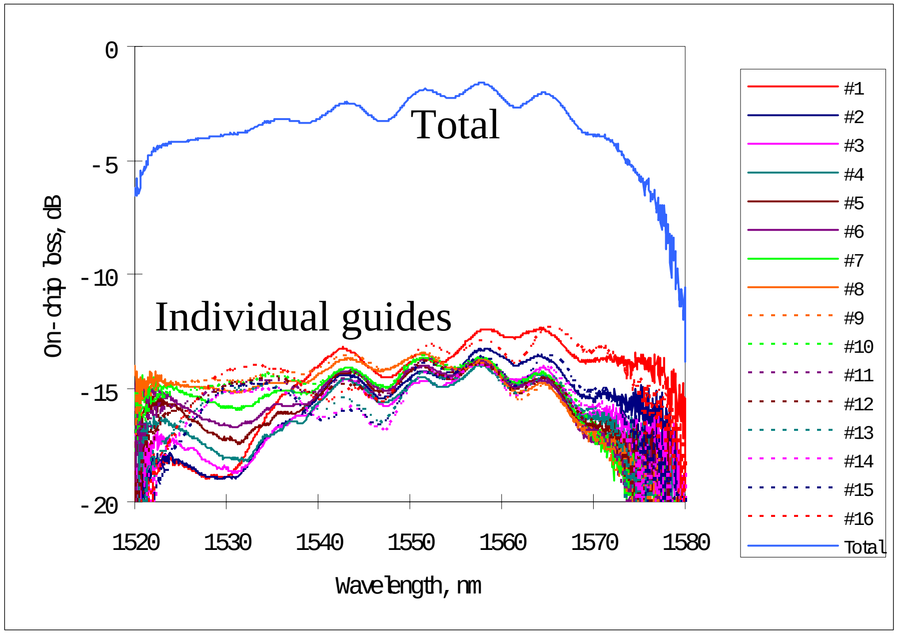
- Bare chip, PLC on Si, not fiberized. All devices on one chip.
- Manual fiber launch stage constructed to flexibly investigate devices.
- Passively modelocked Er fiber laser producing ~80 fs pulses at 1570nm used as short pulse source
  - Fiber links kept as short as possible, and dispersion compensated with DCF.



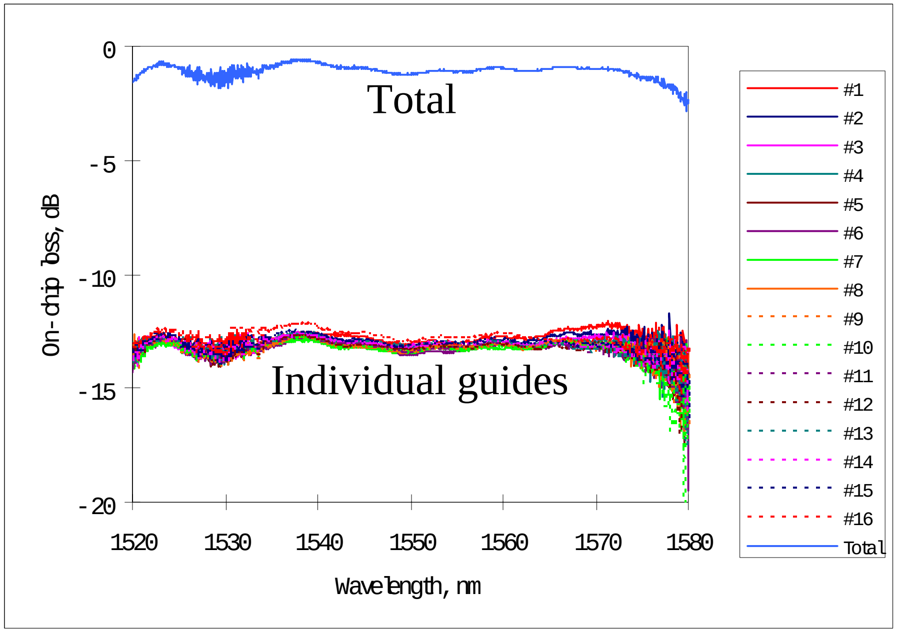
Spectral Dependence

- MMI shows more variation than Funnel, and higher excess loss

MMI



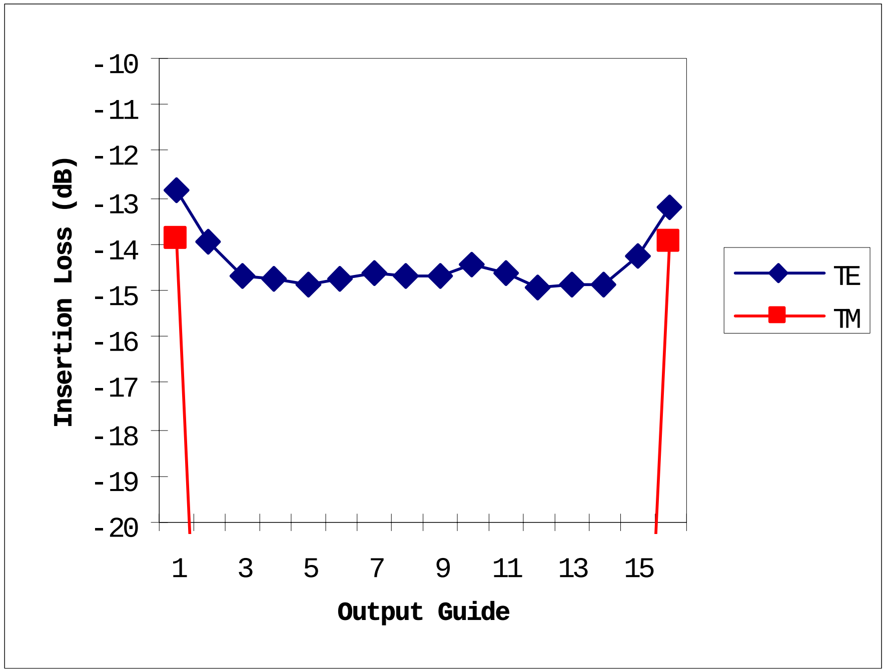
Funnel



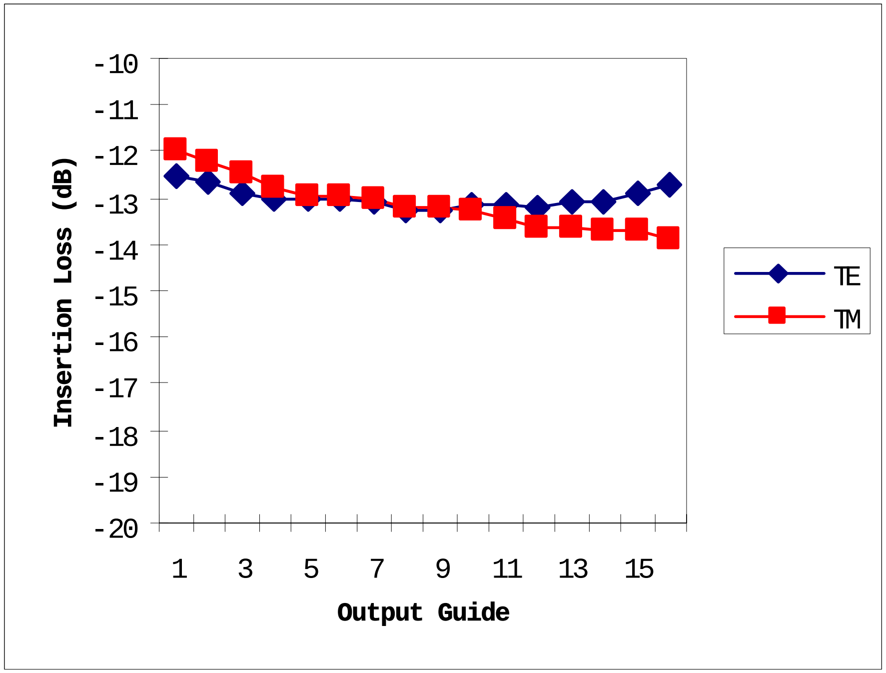
Polarization Dependence

- MMI is highly polarization dependent, funnel is not.

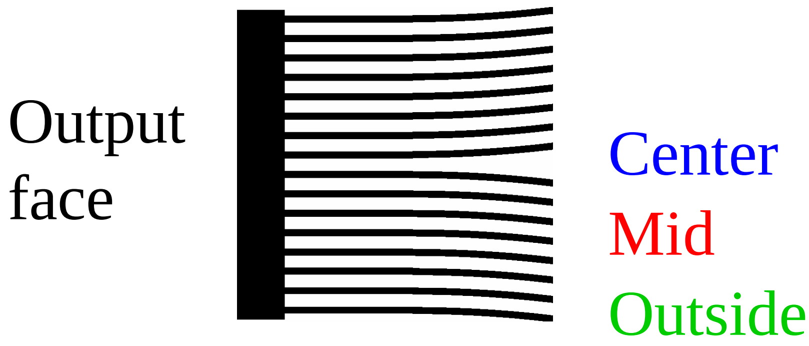
MMI

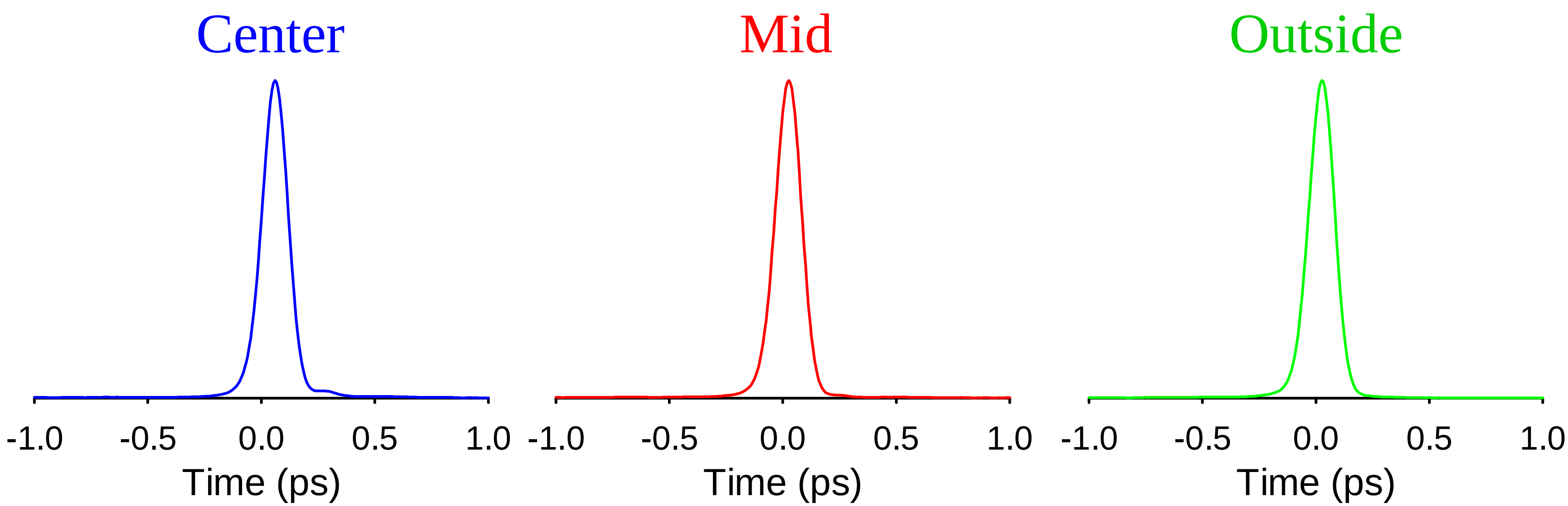


Funnel



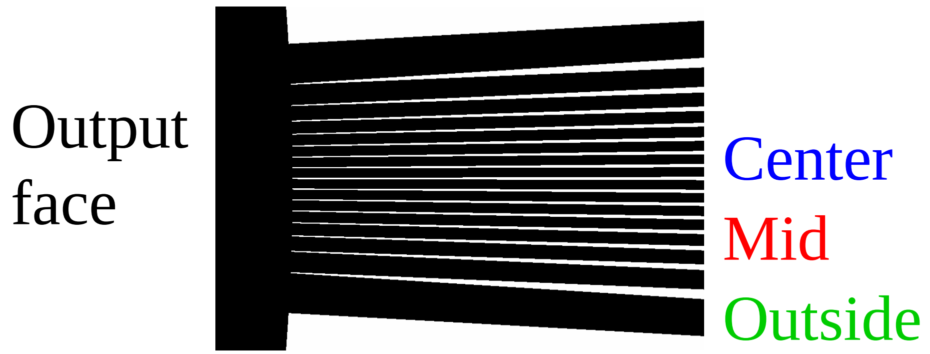
MMI Temporal Response

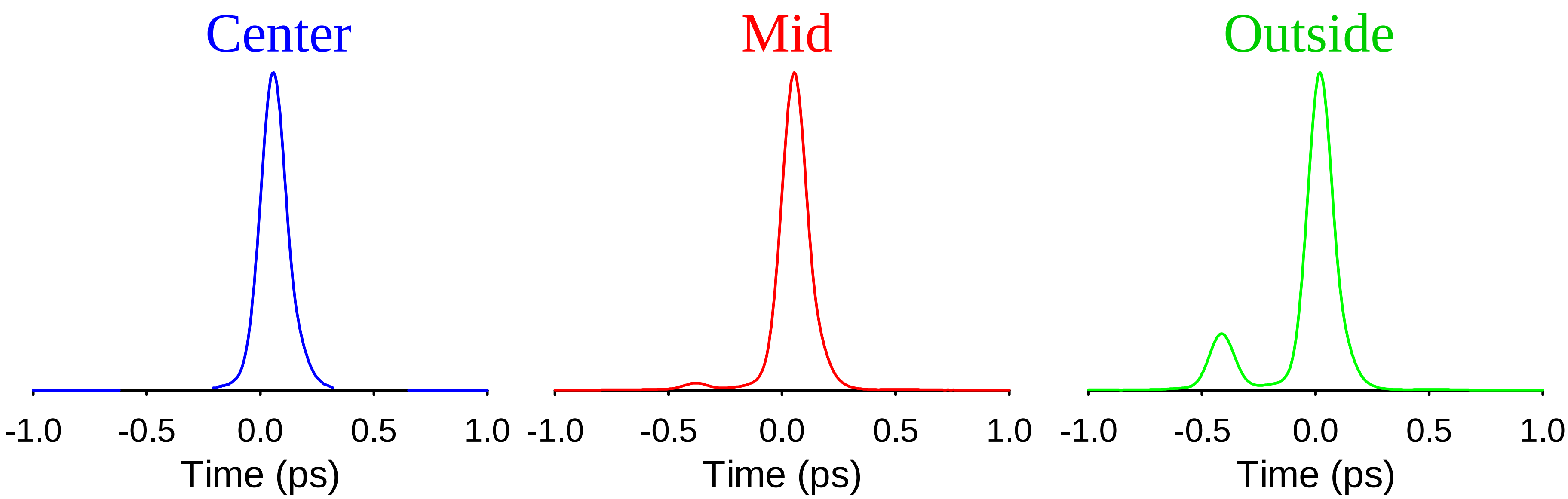




➾ Only slight sign of modal dispersion with ~80 fs pulses

Funnel Temporal Response





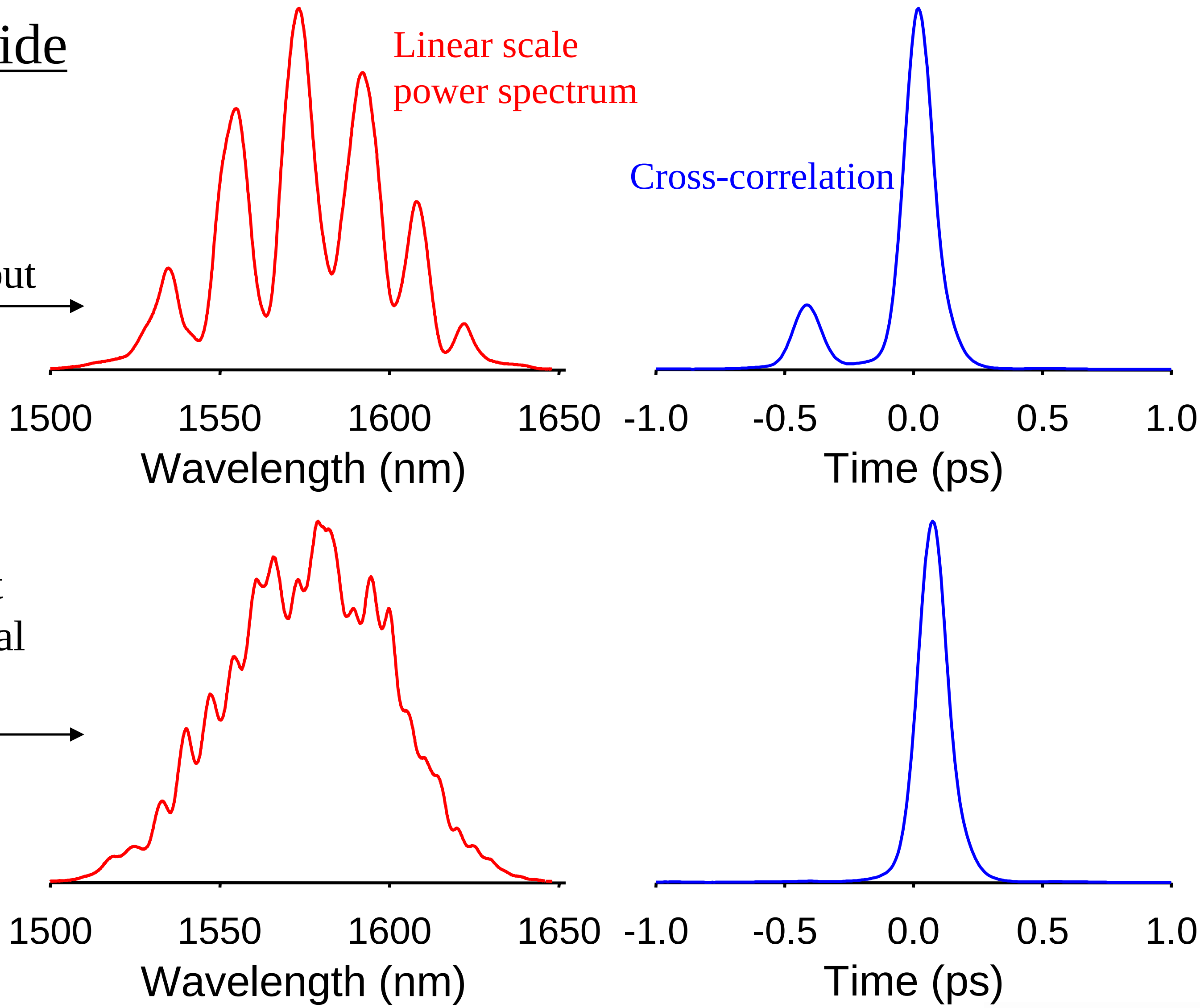
- Replica pulse height magnified on outer guides

Power Spectrum Alignment Diagnostic

<u>Funnel Outer Guide</u>

Alignment
based on linear
power throughput

Input alignment
based on spectral
'cleanliness'



Summary

- Investigated the ultrafast temporal response of 1X16 ‘excitation-engineered’ splitters.
- Goal is to develop alternative technologies that may be applied to ultrafast time-domain pulse processing in integrated-optic devices.
- Both MMI and waveguide-funnel AWG-based splitters were investigated.
- MMI devices do not distort 80 fs pulses, but show nonuniform spectral response and large polarization dependence.
- Funnel devices can exhibit replica pulses on the outermost (widest funnel) guides, but are spectrally uniform and have low polarization dependence.
  - Replica pulses can be minimized with careful input fiber alignment.
  - Broadband source and output spectral monitor provide a simple alignment diagnostic.