CORNING

Passive Optical Technologies to Extend PON Reach

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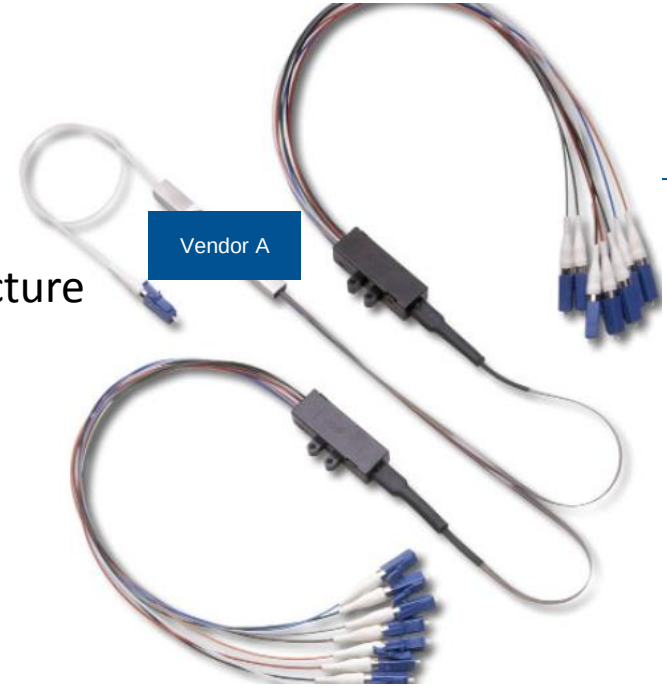
Introduction

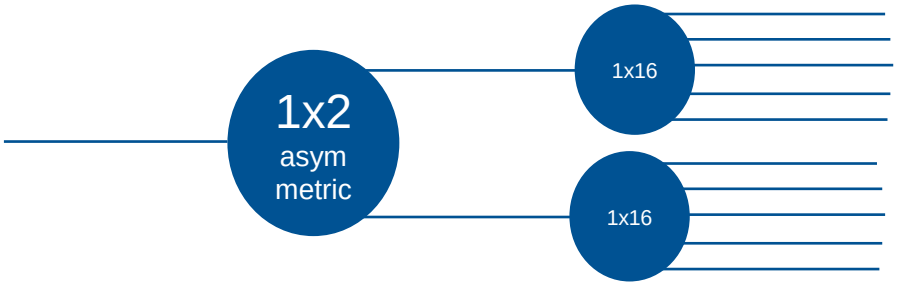
- **There is agreement that majority of ODN links do not exceed 10km: miguelez_3ca_1a_0916.pdf**
- **If some links or some operators require reach longer than 10km, passive optical technologies are there to support. Two examples are proposed:**
  - Asymmetric splitter
  - Dispersion compensation using Gires-Tornois etalon if wavelengths plan in C-band is selected

Asymmetric Splitter

- **Standard 1x32 splitter has about 17…18dB loss.**
  - Usually it is not monolithic, like 1x16 example in the picture



- **Replacing 1x2 splitter to asymmetric one will reduce loss to some customers**
  - Will increase loss to other customers
  - Off-the-shelf splitter ‘asymmetry’ ratios are 5dB, 10dB, etc



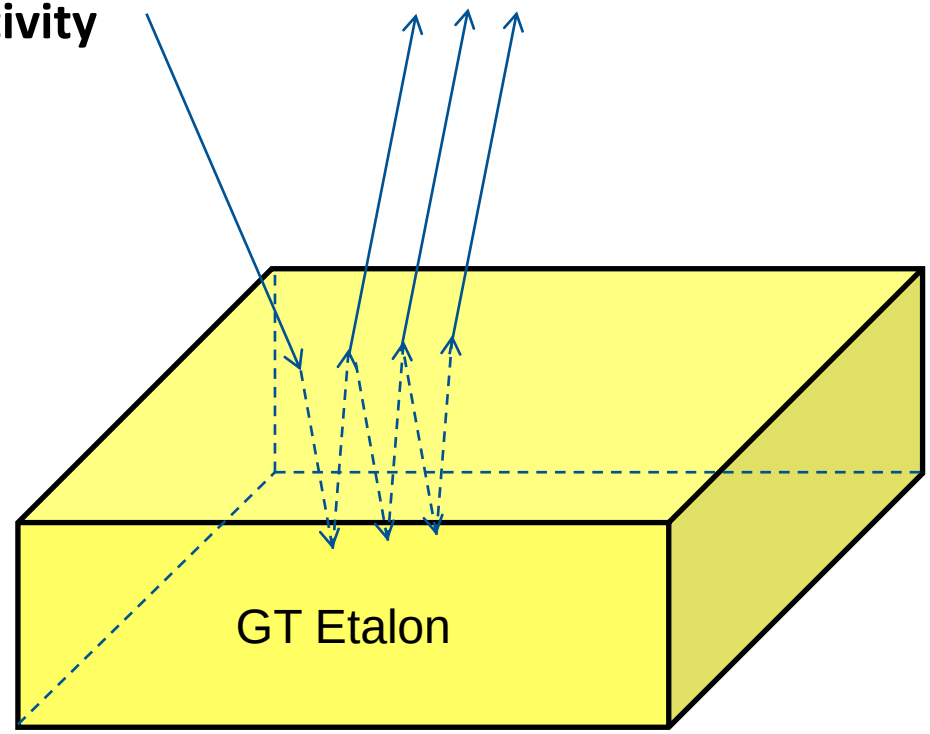
This group will get lower splitter loss like 14-15dB and extended reach

This group will get higher splitter loss like 19-20dB and shortened reach

- **Operation to replace splitter in the (brown) field may take several minutes**

Gires-Tornois Etalon

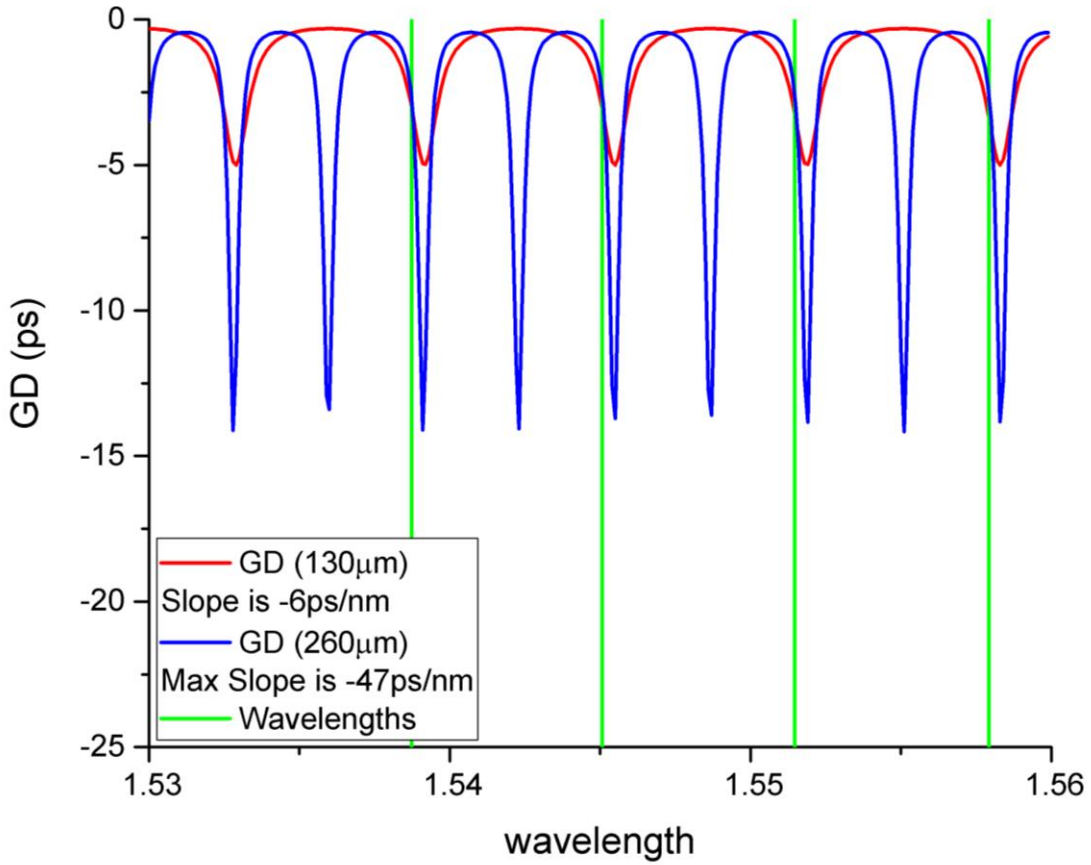
- **Gires-Tornois Etalon (GTE) is a transparent plate with two reflective surfaces, one of which has high reflectivity**



- **Bottom surface is highly reflective, assumed R=1, top surface has lower reflectivity. Multiple reflections create nonlinear phase shift strongly dependent on wavelength**
- **This technology may be alternative to dispersion compensating fiber**

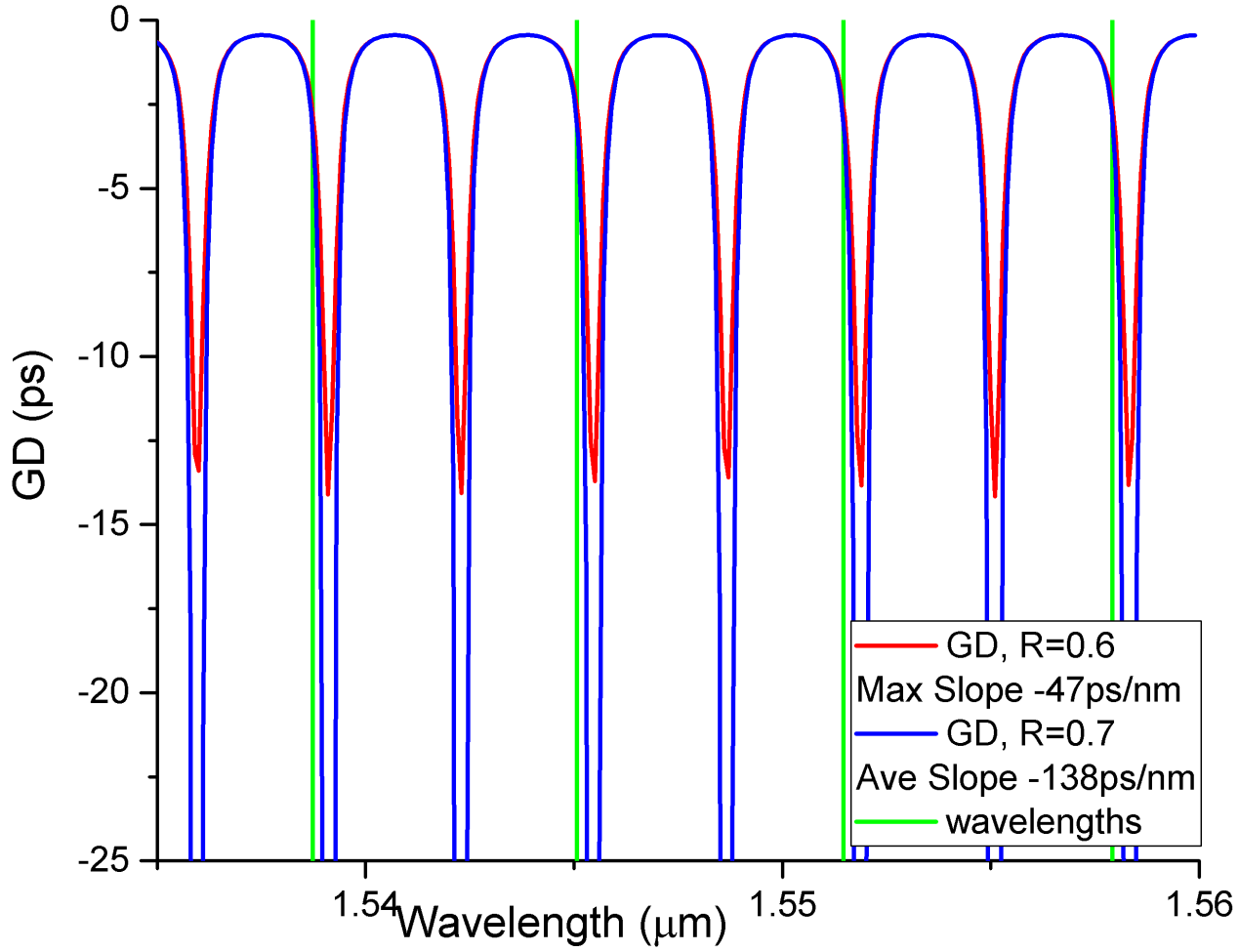
Gires-Tornois Etalon to Compensate Dispersion

- **Plans with wavelengths in C-band are in the race. If this plan is selected and reach exceeds 10km, dispersion compensation is required. Assume plan according to harstead_3ca_3b_0916.pdf**
- **There are three steps to design an etalon.**
- **Step1: thickness. Thickness of the plate determines free spectral range. Two examples show FSR with half and equal to channel spacing**
  - Quartz (n=1.45) is used here



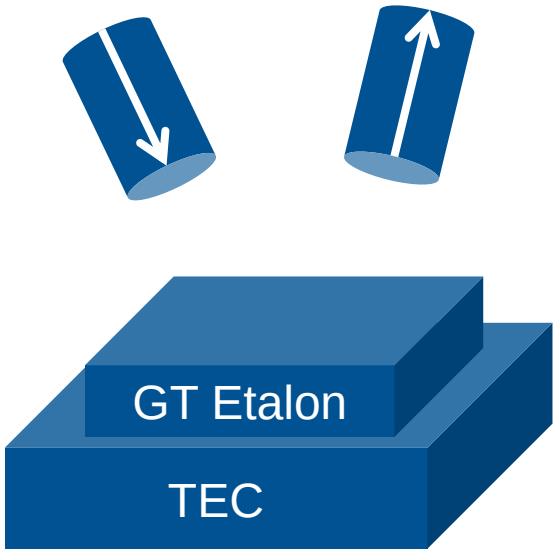
Gires-Tornois Etalon to Compensate Dispersion

- **<u>Step2: reflectivity</u>. Higher reflectivity usually means higher compensation**
  - Dispersion is undercompensated in these examples, perfect match would be -170ps/nm
  - Average dispersion is -138ps/nm over 1 nm window



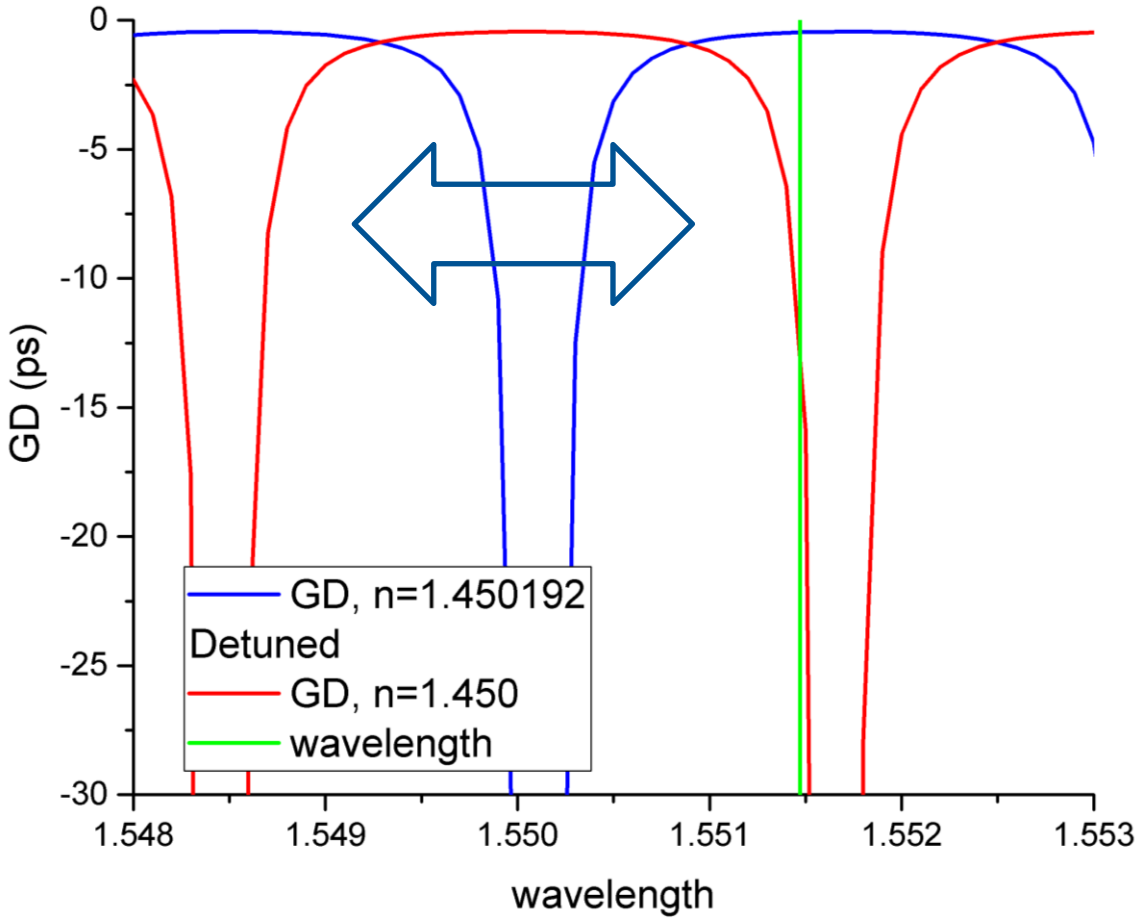
Gires-Tornois Etalon to Compensate Dispersion

- **Materials commonly used for etalons (quartz, silicon) have their refractive indices changing with temperature. That has double effect**
  - Free spectral range is better fit to precise value. That may increase dispersion value if required
  - Wavelength may be better tuned to negative slope curve
- **<u>Step3: tune temperature</u>. In the next slide, the quartz temperature is changed by 15C, with n changed to 1.450192**



Gires-Tornois Etalon to Compensate Dispersion

- **+/- 15C tuning is enough in quartz**
  - If TX wavelength suddenly changes, algorithms exist to retune etalons by TEC to stay on negative slope. Simple monitoring will track slow changes
  - Setting window is ~ 0.5nm. Cascade of two etalons doubles negative slope window
  - Wavelength 1551.47nm used here, slightly different from 1551.72nm
- **Loss of one etalon is 1-2dB**



Gires-Tornois Etalon and Dispersion Compensating Fiber Comparison

	GTE	DCF
Size	millimeters	9.6x9.2 inches
Power supply	TEC required	passive
Loss	1-2dB	1.2dB
Tunability	Tunable, can cover broad range	Fixed, like 10km
Availability	Not off-the-shelf, easy to order	Off-the-shelf

Conclusion

- **Two technologies are presented to be used if longer PON reach is required**
- **Asymmetric splitter will extend reach to a group of customers within PON**
- **GTE or DCF may be used to compensate dispersion if plan with C-band is selected. Three-steps guide to GTE design is proposed**

THANK YOU!