

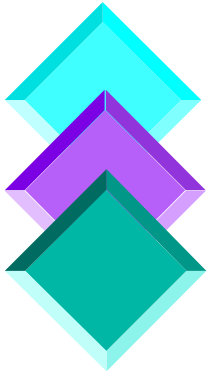
TIA FO-2.2.1 Task Group on Modal Dependence of Bandwidth

7/99 Status Update

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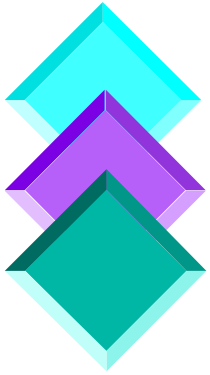
CORNING

July 4, 1999



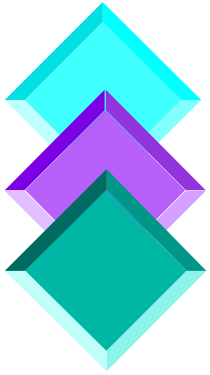
2.2 TG Scope

- ◆ Develop recommendation of system bandwidth prediction methodology for the short haul interconnect application.
- ◆ Determine if a specifiable launch condition exists which provides a better agreement between fiber bandwidth characterization and actual performance.
- ◆ The ultimate goal will be to devise a bandwidth test for fiber which is representative of actual system performance.
- ◆ Transceiver launch distribution test added to scope (e.g. encircled flux). “Typical” transceivers range from overfilled to single-mode.
- ◆ Develop a recommendation for test methods as appropriate.



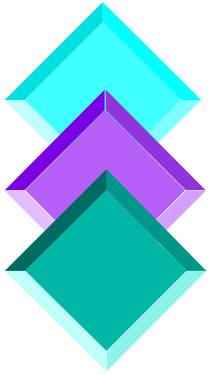
2.2 TG Focus

- ◆ Current short wavelength (850 nm window) sources (e.g. VCSEL and CD laser technology).
- ◆ Initial focus on how fast can operate at 300 m length. Focus shifting to how far at Gigabit speeds (driven partly by measurement ability).
 - 10 Gigabit logical next step
- ◆ 62.5 and 50 μm fiber included with equal priority.
 - Initial focus of development has been 62.5 μm fiber
 - 50 μm fiber should follow quickly
- ◆ Broaden the scope and the breadth / applicability as the group shows success.



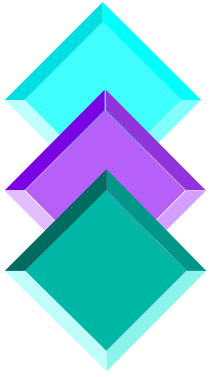
2.2 TG History

- ◆ Task group initiated January 1996
- ◆ Participants identified March 1996
- ◆ Scope developed June 1996
 - Complexity of issues and physics became clear
 - Problem clearly defined to optimize probability of success
- ◆ Initial data showed promise but inconsistency (June, 1996)
- ◆ Inter-laboratory measurement round robin (circa May 1997)
 - Results instrumental in Gigabit Ethernet development - identified impact of centerline error
- ◆ Transceiver launch measurement round robin (June 1998)
 - Inter-laboratory agreement demonstrated for encircled flux
- ◆ Validation experiment initiated (November 1998)



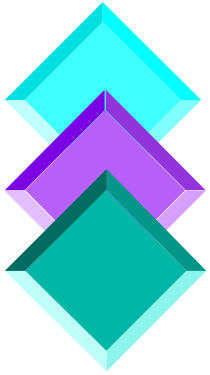
Transceiver Launch Measurement Round Robin (2H98)

- ◆ Development of a new test procedure in progress
 - A Fiber Optic Test Procedure (FOTP) drafted and undergoing review
 - TIA FO-6.5 approved requesting a project number and PN application in progress
- ◆ Additional laboratories (transceiver vendors) participating
 - Measurement system set up by Picolight and Molex and round robin measurements completed
- ◆ Stability data reviewed (e.g. to temperature and voltage)
- ◆ Variability and accuracy data from the validation experiment being analyzed



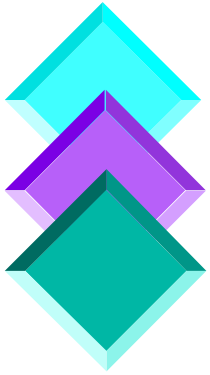
Validation Experiment

- ◆ OBJECTIVE:
 - To confirm that a new, **improved level of system performance** can be achieved using
 - 1) 850 nm sources meeting a **new launch condition criteria** and
 - 2) multimode fiber meeting a **new restricted launch bandwidth requirement**
- ◆ Details
 - 95 fibers contributed by 5 manufacturers (Alcatel, Corning, Lucent, Plasma, and Spectran)
 - Fabricated into 2 cables 1 km in length (Siecor)
 - 69 transceivers contributed by 6 manufacturers (Picolight, Cielo, HP, IBM, Molex, and Siemens) including 12 CD lasers
 - Measured for ISI and EMB by 6 laboratories (Cielo, Corning, HP, IBM, Picolight, and Unisys)
 - Analyzed and orchestrated by NIST



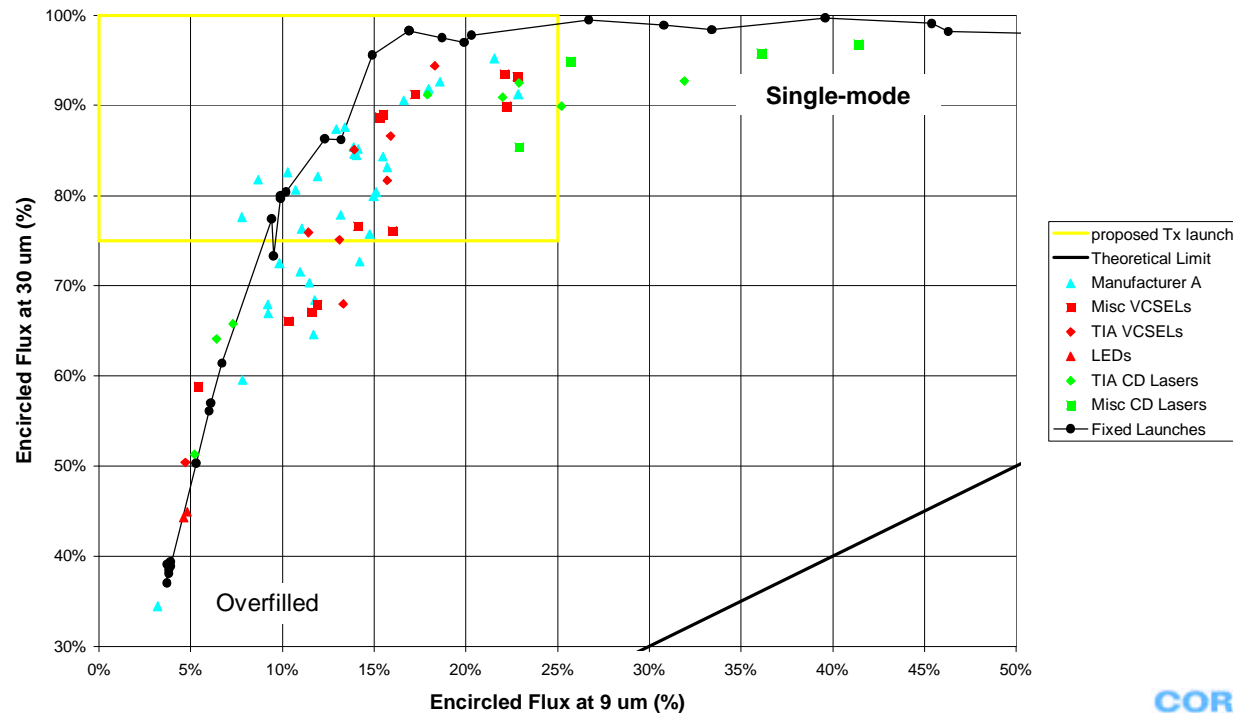
Validation Experiment Output

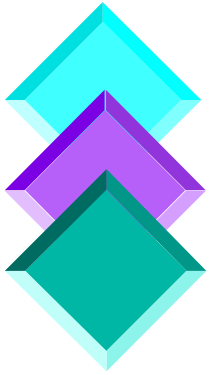
- ◆ Documentation of conclusions and support of task group recommendations
 - Performance improvement given launch conditioning
 - New fiber and transceiver test procedures
- ◆ Fiber Optic Test Procedures (FOTPs) for
 - 1) Transceiver launch / Source near-field
 - Camera method
 - Three level coupled power ratio measurement and
 - 2) Fiber restricted launch bandwidth



Measured Encircled Flux for Miscellaneous Transceivers

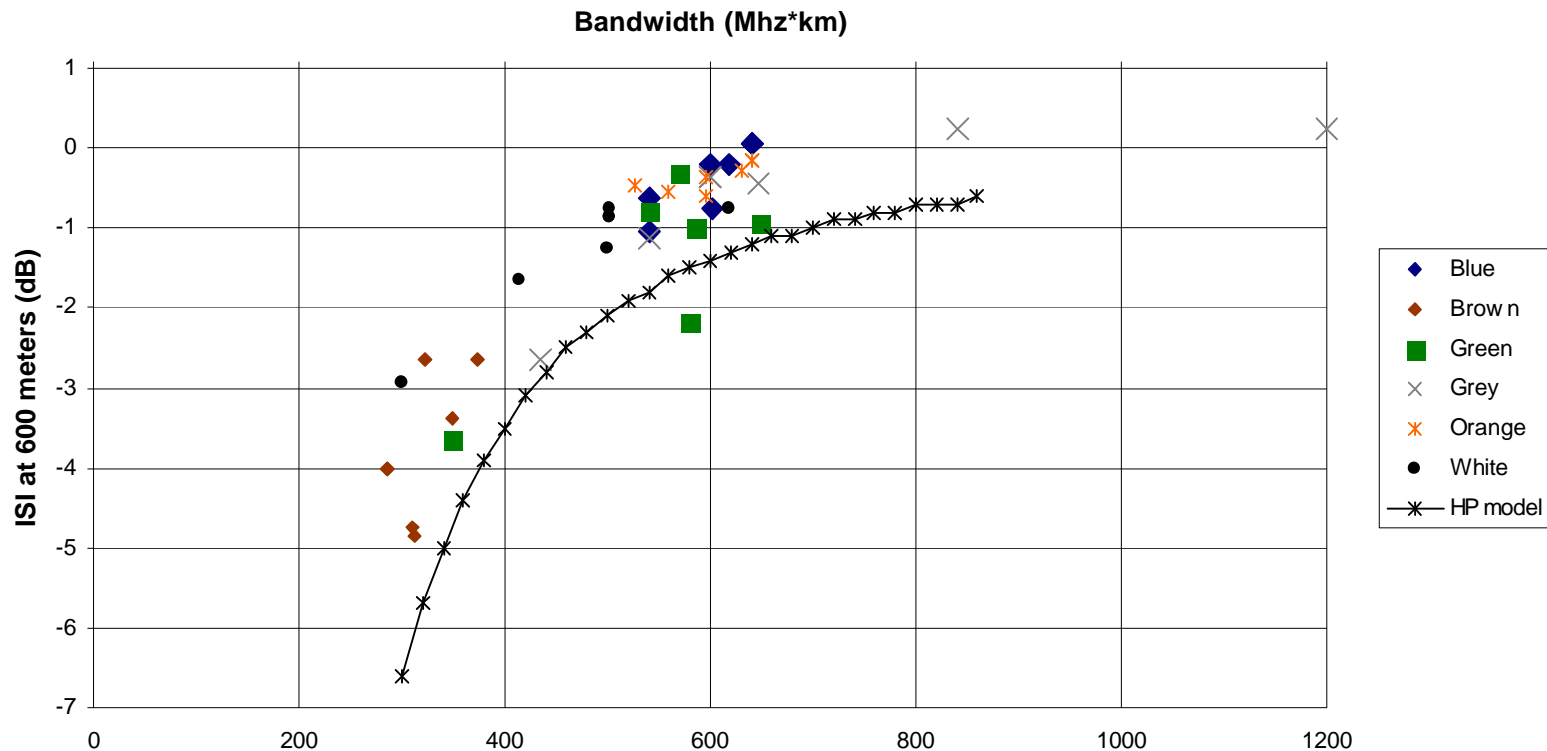
- ◆ Adequacy of encircled flux to characterize launch being confirmed
- ◆ VCSELS and CD Lasers follow the same relationship as the fixed launches.
- ◆ The 30 um and 9 um transceiver requirements are needed to limit both large and small transceiver launches.

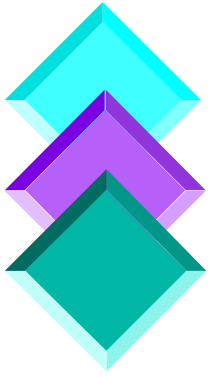




Measured ISI versus Effective Modal Bandwidth (source Corning)

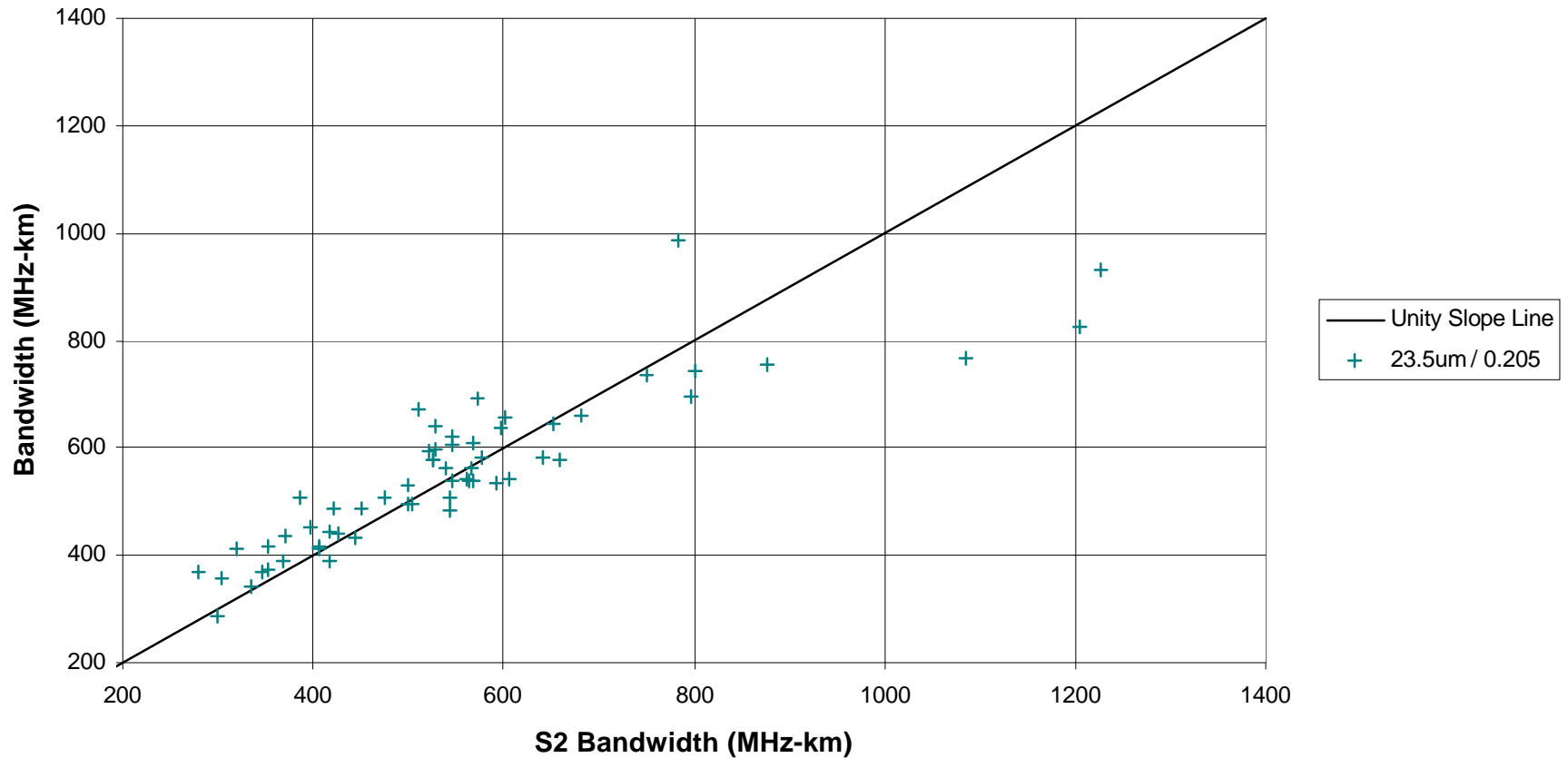
- ◆ Effective Modal Bandwidth (EMB) accurately characterizes the system performance of a transceiver / fiber combination.
- ◆ GbE (HP) model is valid in describing the worst case boundary or limit of ISI as a function of bandwidth

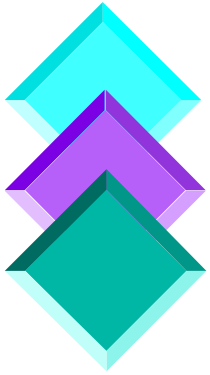




Restricted Launch Bandwidth Recommendation in Progress

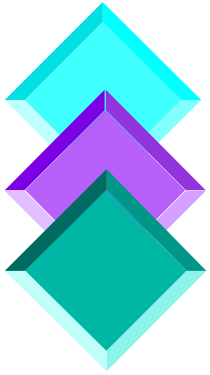
- ◆ Initial results look promising - other alternatives being evaluated
- ◆ Graph shows comparison of TIA Launch Round Robin Transceiver S2 EMB to 23.5 um fixed launch bandwidth





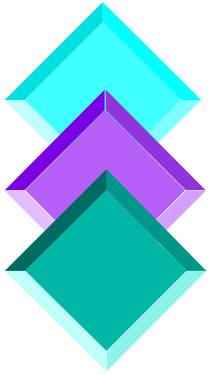
Action Plan for 6/14/99

- ◆ Complete Validation Experiment Testing
 - Finish EMB and ISI measurement
 - Measure cables with new restricted launch bandwidth
- ◆ Analyze Results
 - Determine ability of new restricted launch bandwidth to predict EMB for transceivers which meet the new launch requirements
 - Translate into risk assessment
- ◆ Complete Measurement Development
 - Compare inter-laboratory encircled flux values (accuracy and reproducibility)
 - Ensure adequate agreement to differentiate between transceivers which do and do not meet new requirement
 - Restricted launch bandwidth determination
 - Compare inter-laboratory restricted launch bandwidth (accuracy and reproducibility)



Action Plan for 6/14/99 (continued)

- ◆ Confirm acceptability of new requirements
 - Transceiver launch
 - Fiber restricted launch bandwidth
- ◆ Translate conclusions into a standards recommendation
 - Create FOTPs for
 - 1) Transceiver launch / Source near-field
 - Camera method
 - Three level coupled power ratio measurement and
 - 2) Fiber restricted launch bandwidth
- ◆ Quantify new system performance improvements



Acknowledgments

- ◆ John Schlager and Doug Franzen, NIST - Round Robin Facilitation
- ◆ Barbara Mahnke and Bill Jackman, Siecor - cable fabrication
- ◆ Alcatel, Corning, Lucent, Plasma, and Spectran - fiber contributors
- ◆ Picolight, Cielo, HP, IBM, Molex, Method, and Siemens; and AMP, Fujikura, Honeywell, Vixel - transceiver contributors
- ◆ Cielo, Corning, HP, IBM, Picolight, and Unisys and the validation experiment participants
- ◆ The numerous technical experts participating in the Task Group