Report from Task 4 Group

Chaired by Yu Sun

Attendees: (alphabetical order)

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Sudeep Bhoja	David Cunningham	John Ewen
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Jonathan Ingham	Jonathan King	Joerg Kropp
Paul Kolesar	Jim Morris	Tremont Miao
Simon Meadowcraft	Petar Pepeljugoshki	Rick Pimpinella
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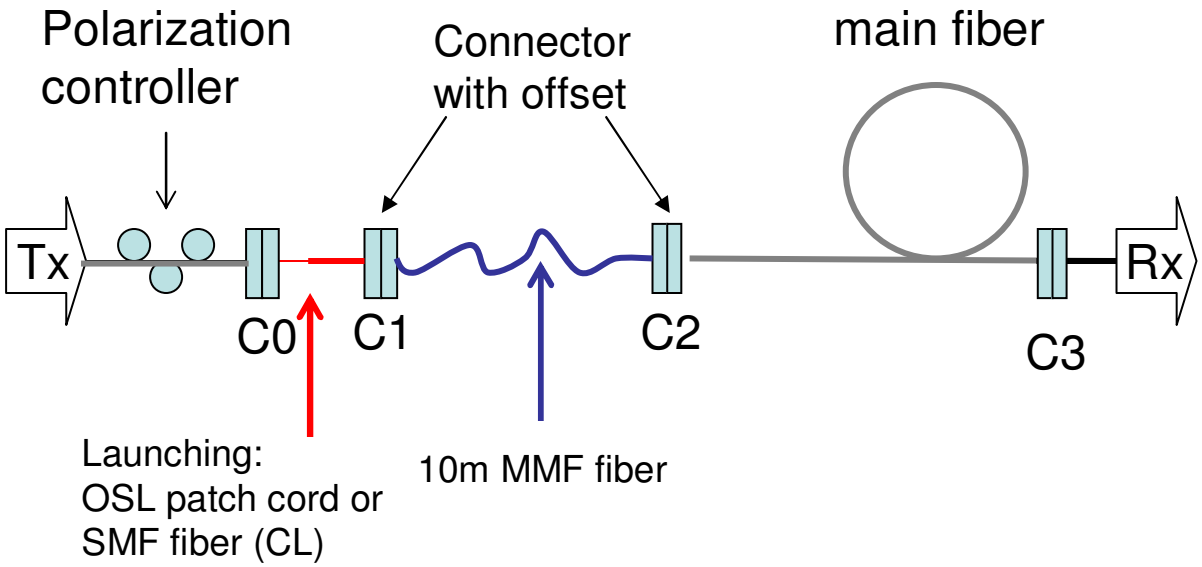
Activities in Task 4 Group

- Parameters and link setup in the simulation are agreed
- The pulse shape variation due to input light polarization was explored
  - Agilent and Infineon will give detailed presentations
- PIE metrics of Cambridge 108 fibers were calculated
  - Details are included in a separate presentation
- How to simulate the polarization effect and connector offset was discussed, however, task 4 has not reached an agreement yet
  - Opinion 1: adopt TIA method directly
  - Opinion 2: Assumptions used in TIA study is not accurate for 10 Gb/s system and an update is necessary

Proposed simulation link and parameters



1. Reference the task 2 group proposed link model and C1, C2 and C3 are connectors considered in the simulation.

Worst case	7 μ m	7 μ m	4 μ m
Average case	5 μ m	5 μ m	4 μ m

2. As the first step, two connectors C1 and C2 should be considered.

Worst case	7 μ m	7 μ m
Average case	5 μ m	5 μ m

Connector simulation I

Summary of TIA method*

Assumption:

1. The mode coupling between mode groups is completely absent
2. Coupling within a group is 100%.
3. The coupled power from modes in the previous fiber to the same mode in the second fiber is added incoherently

Formulas:

(1) Mode coupling coefficient $$a_{l',m',v'}^{l,m,v}(\mathbf{r}) = \int_A d^2\mathbf{x}\Psi_{l',m',v'}^{*}(\mathbf{x})\Psi_{l,m,v}(\mathbf{x}-\mathbf{r})$$

(2) Power coupling coefficient $$w_{l',m',v'}^{out} = \sum_{l,m,v} w_{l,m,v}^{in}\left|a_{l',m',v'}^{l,m,v}(\mathbf{r})\right|^2$$

$$w_{l,m,v}^{in} = \frac{w_u^{in}}{N_u}$$

* P. Pepeljugoski, S. Golowich, A. J. Ritger, P. Kolesar and A. Risteski, “Modeling and simulation of next-generation multimode fiber links,” J. Lightwave Technol., vol 21, no. 5, pp. 1242–1255, 2003.

Connector simulation II

Motivation of update TIA method

TIA method worked very well in 1Gb/s Ethernet study.

However

1. The length scale of 100% mode mixing in a modal group is much longer than the first MMF in the proposed link.
   - ✓100% mode mixing artificially expands the beam size at the end of a short fiber
   - ✓The power coupled to the second fiber maybe redistributed, causing the change of pulse shape
2. The energy transfer among modal groups observed experimentally can not be resembled using TIA method

Connector simulation III

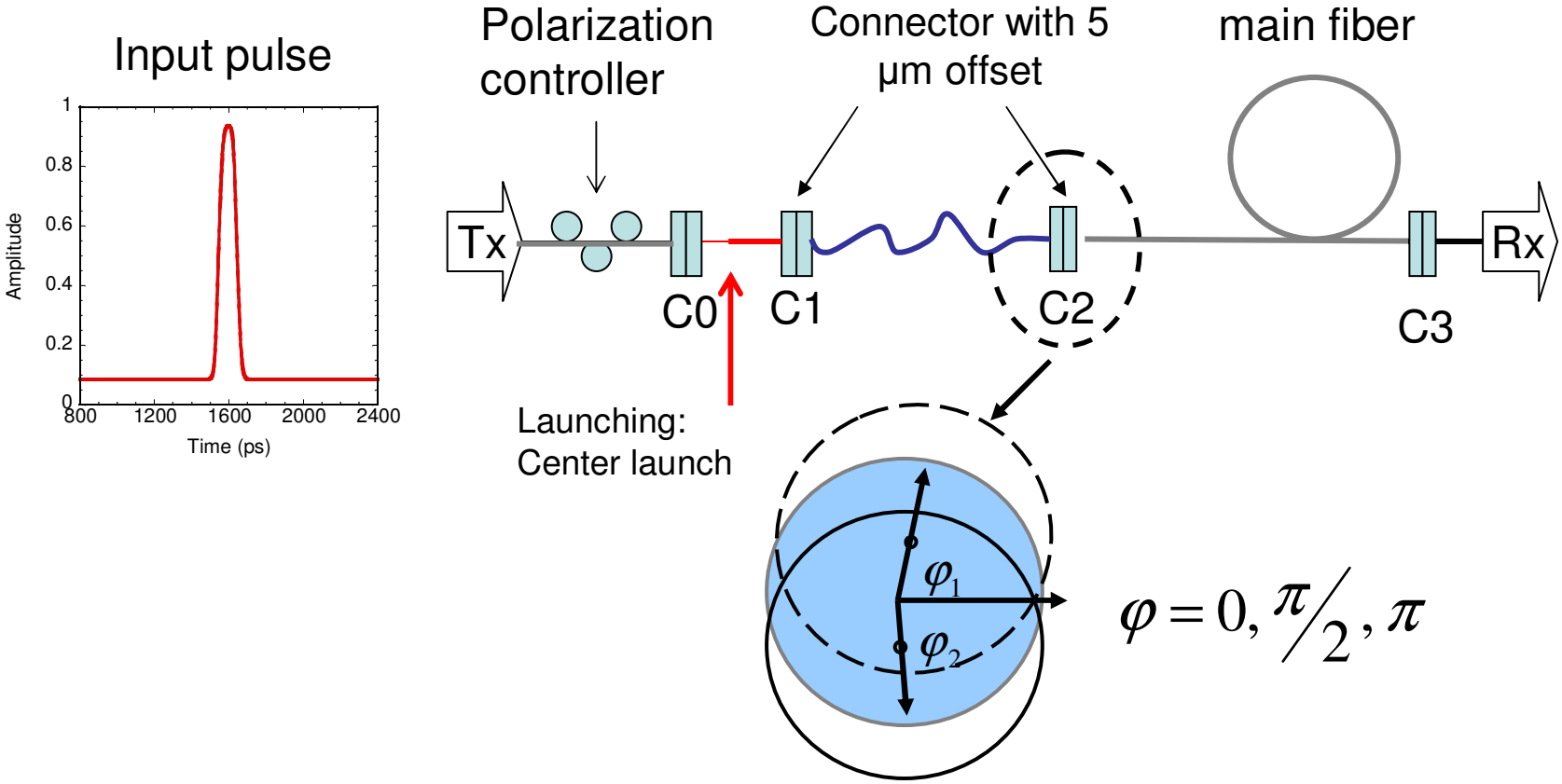
Proposed update of TIA method

- Due to the short length of the first MMF in the proposed link, modes within one modal group need to be treated individually.
- The modal field profile at the end of first MMF varies with time and the possible speckle patterns need to be considered individually.
- The overlap of modal fields at the connector depends on the relative location of the offset center to the reference coordinates and the pulse response will change accordingly

Connector simulation IV

Comparison of TIA method and proposed update*

Simulation setup

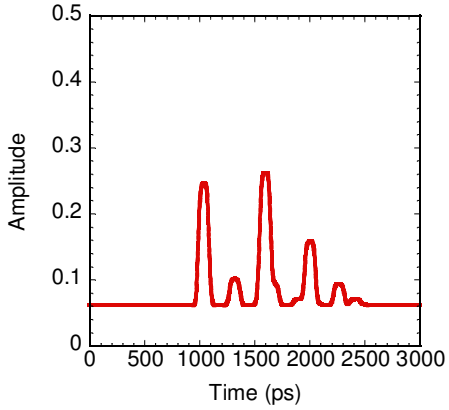


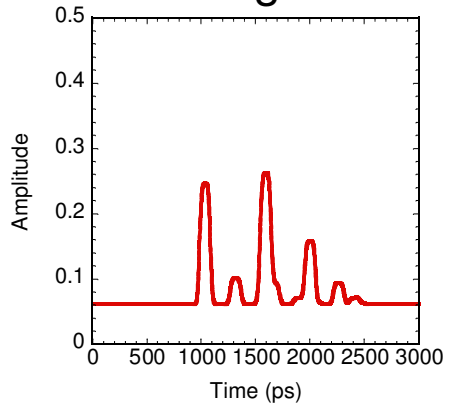
*http://grouper.ieee.org/groups/802/3/aq/public/upload/SimulationofConnecters_sun.pdf

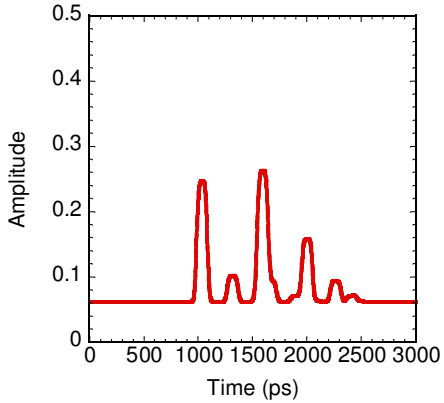
Connector simulation V

Comparison of TIA method and proposed update*

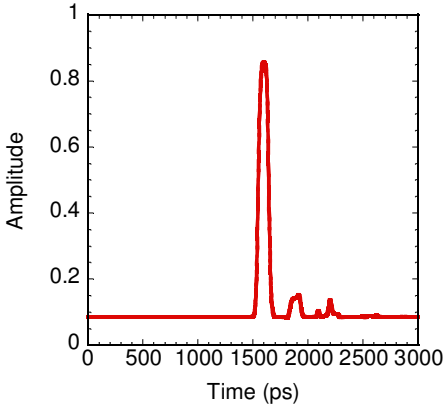
Results using TIA method

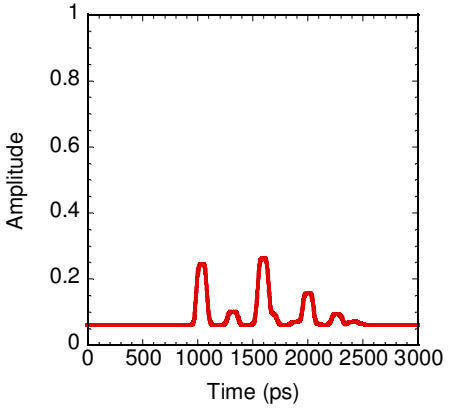


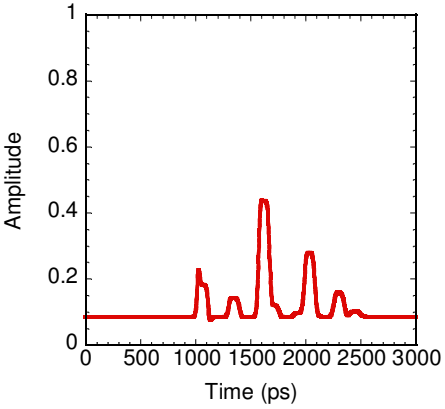




Results using proposed update method







*http://grouper.ieee.org/groups/802/3/aq/public/upload/SimulationofConnecters_sun.pdf

Future work

Any comments and suggestions are welcomed

1. Task 4 group needs to research an agreement on how to simulate the polarization dependency and connector offset

2. OM3 fibers need to be investigated

3. Monte Carlo simulation needs to be included in Task 4 group study