Research on Optical Access Network

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Chulalongkorn University

History

Faculty of Engineering was founded in **1913**,
First engineering institution in Thailand.

Chulalongkorn University was established in **1916**.

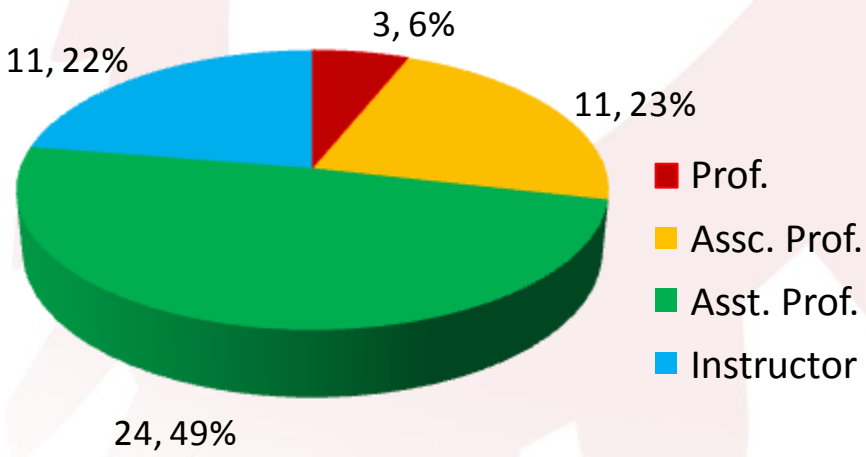
History

- **In 1933**, Professor Dr. Charles M. Son. Gewertz, a Swedish graduate of MIT,
- the first Head of EE Dept
- started a Bachelor's degree program in electrical engineering.

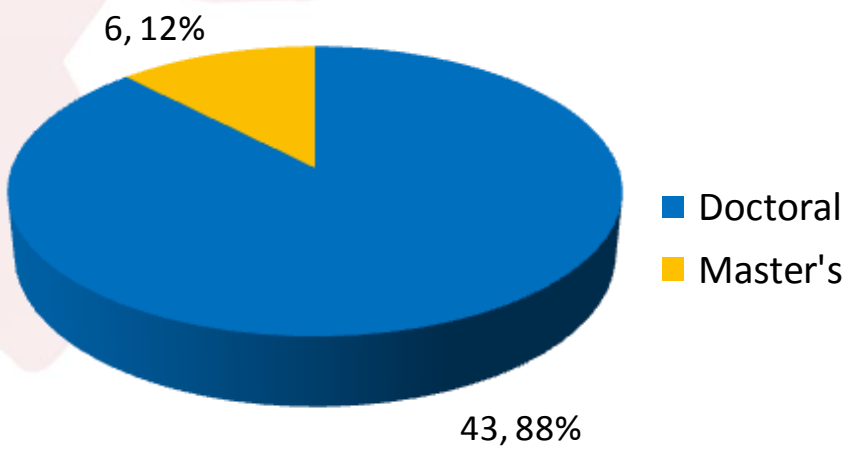
Professor Dr. Charles M. Son Gewertz

EE Faculty: 49 Members

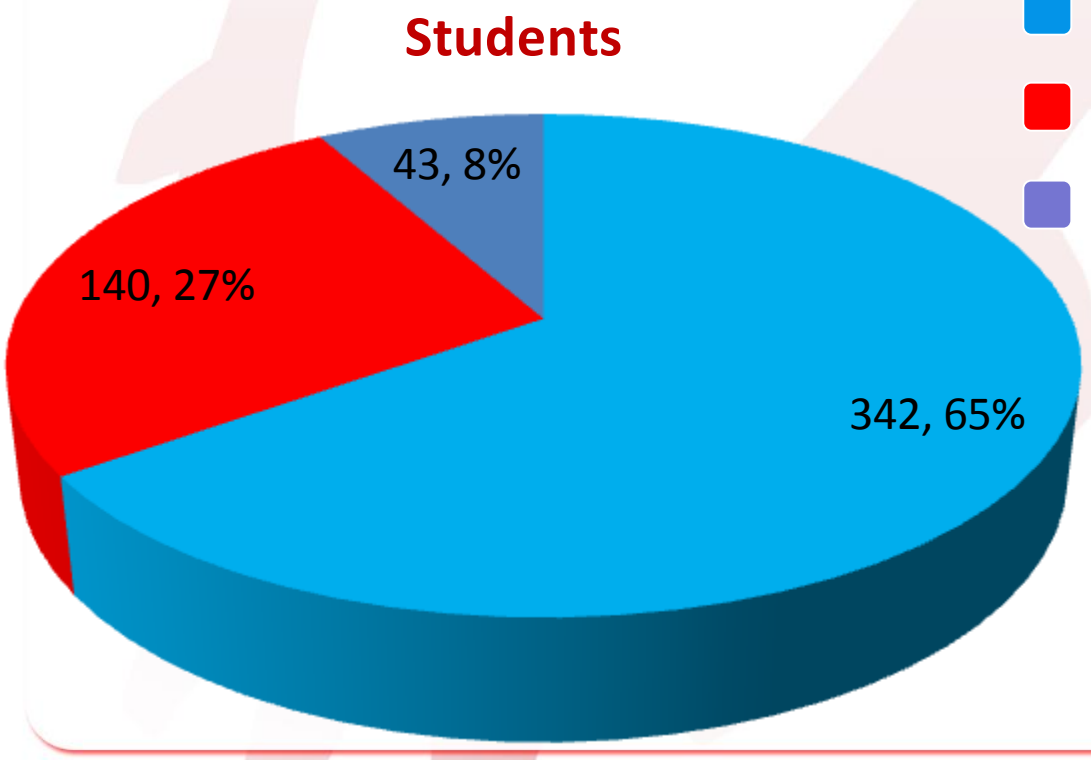
Academic Position



Degree Holders

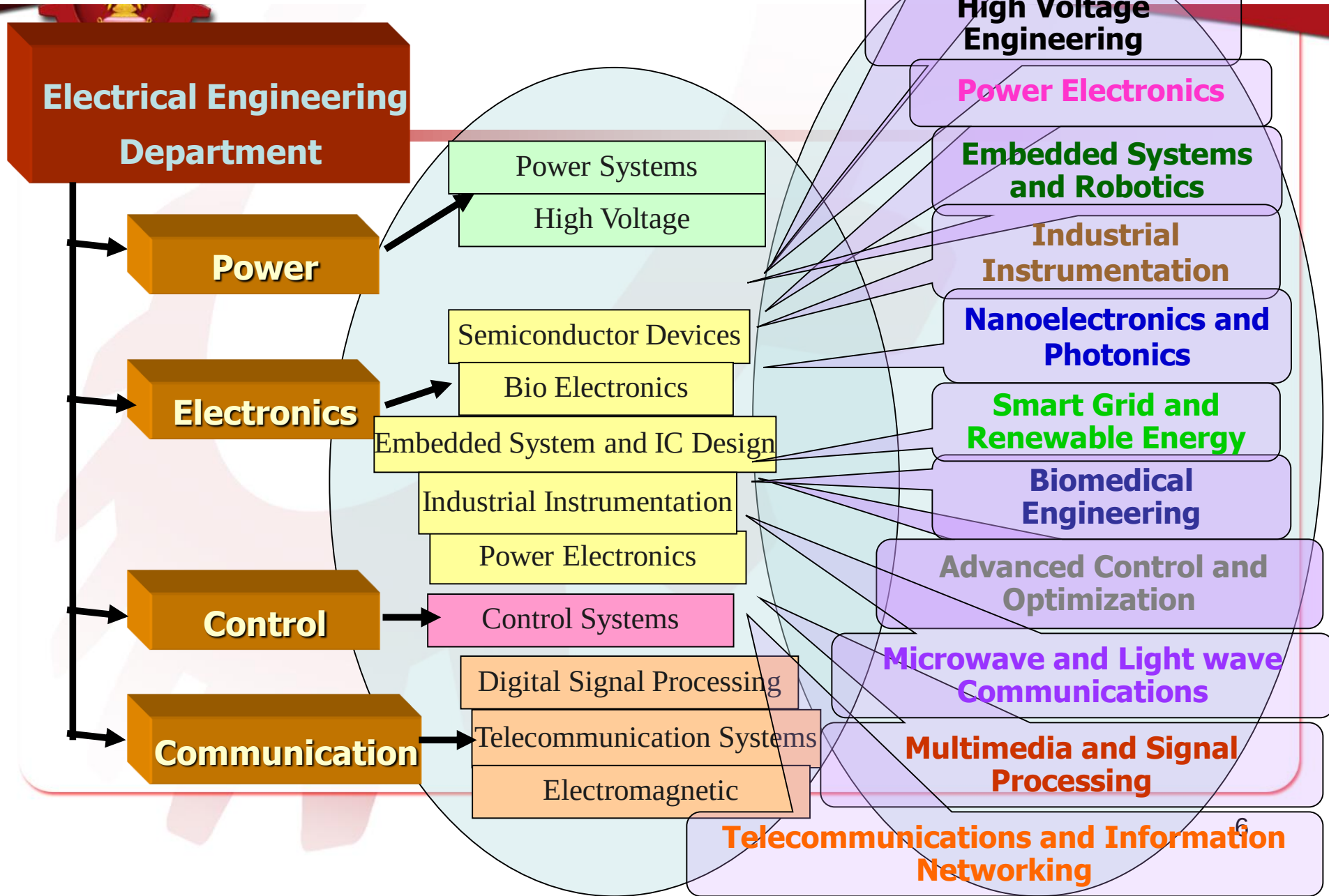


EE Students



Undergraduate	**342**	**(65%)**
Master	**140**	**(27%)**
Doctoral	**43**	**(8%)**
Total	**525**	**(100%)**

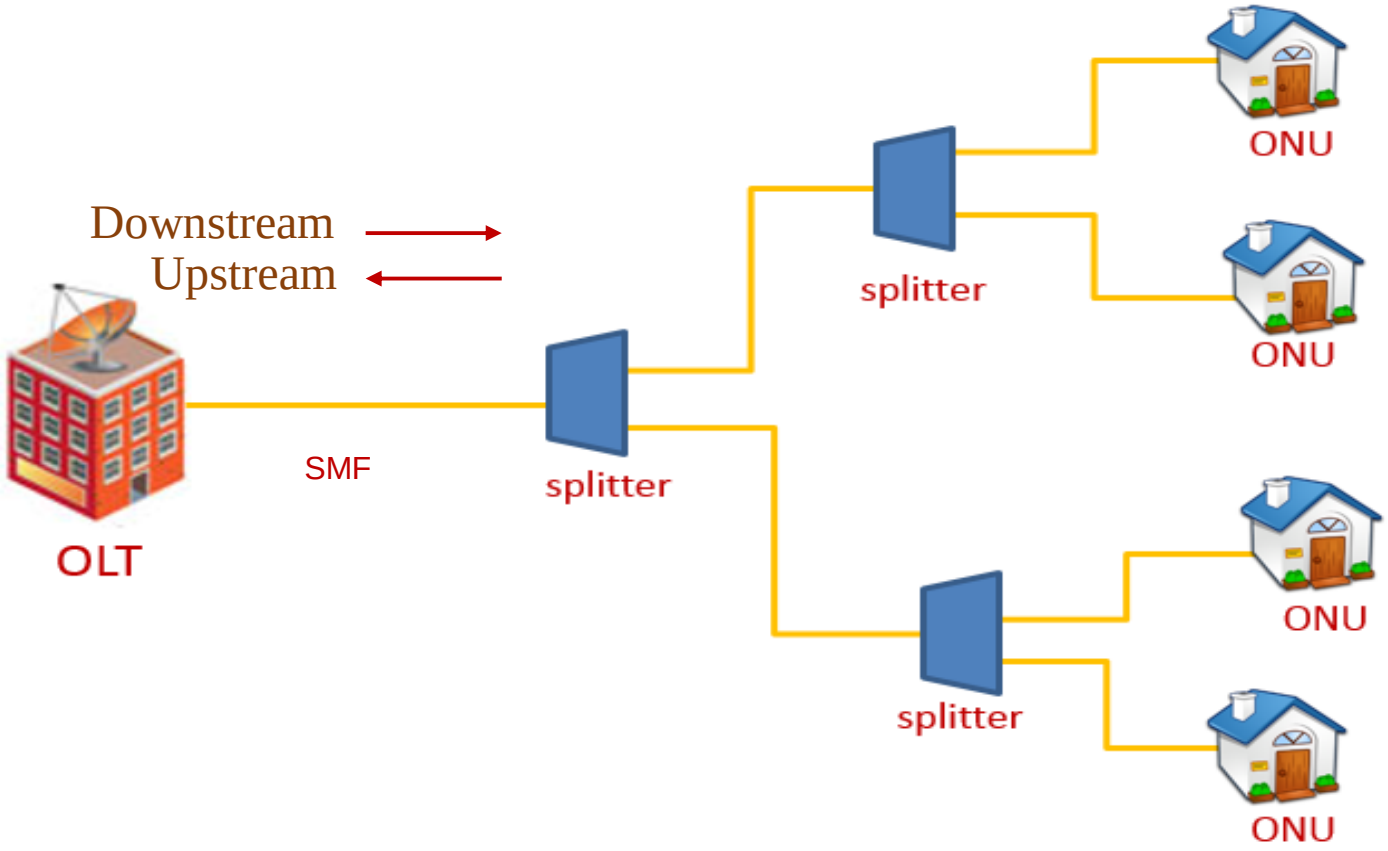
Strategic Research Areas



Research Motivations

- Vast installation of access fibers in Thailand by
  - ISP & Phone operators:
    - TRUE Corporation, AIS (Advanced Info Service), TOT (Telephone Organization of Thailand), 3BB (3 Broadband)
  - Electricity companies:
    - EGAT (Electricity Generating Authority of Thailand), MEA (Metropolitan Electricity Authority), PEA (Provincial Electricity Authority)
  - Military

Passive Optical Network (PON)



OLT: Optical Line Terminal
ONU: Optical Network Unit
SMF: Single Mode Fiber

IEEE vs ITU-T Standard

➢ *IEEE Standard*

Standard	Name	Upstream	Downstream
IEEE 802.3ah [1]	E-PON	1 Gb/s @ 1310 nm	1 Gb/s @ 1490 nm
IEEE 802.3av [2]	**10G-EPON**	**10.3125 Gb/s @ 1270 nm**	**10.3125 Gb/s @ 1577 nm**

➢ *ITU-T Standard*

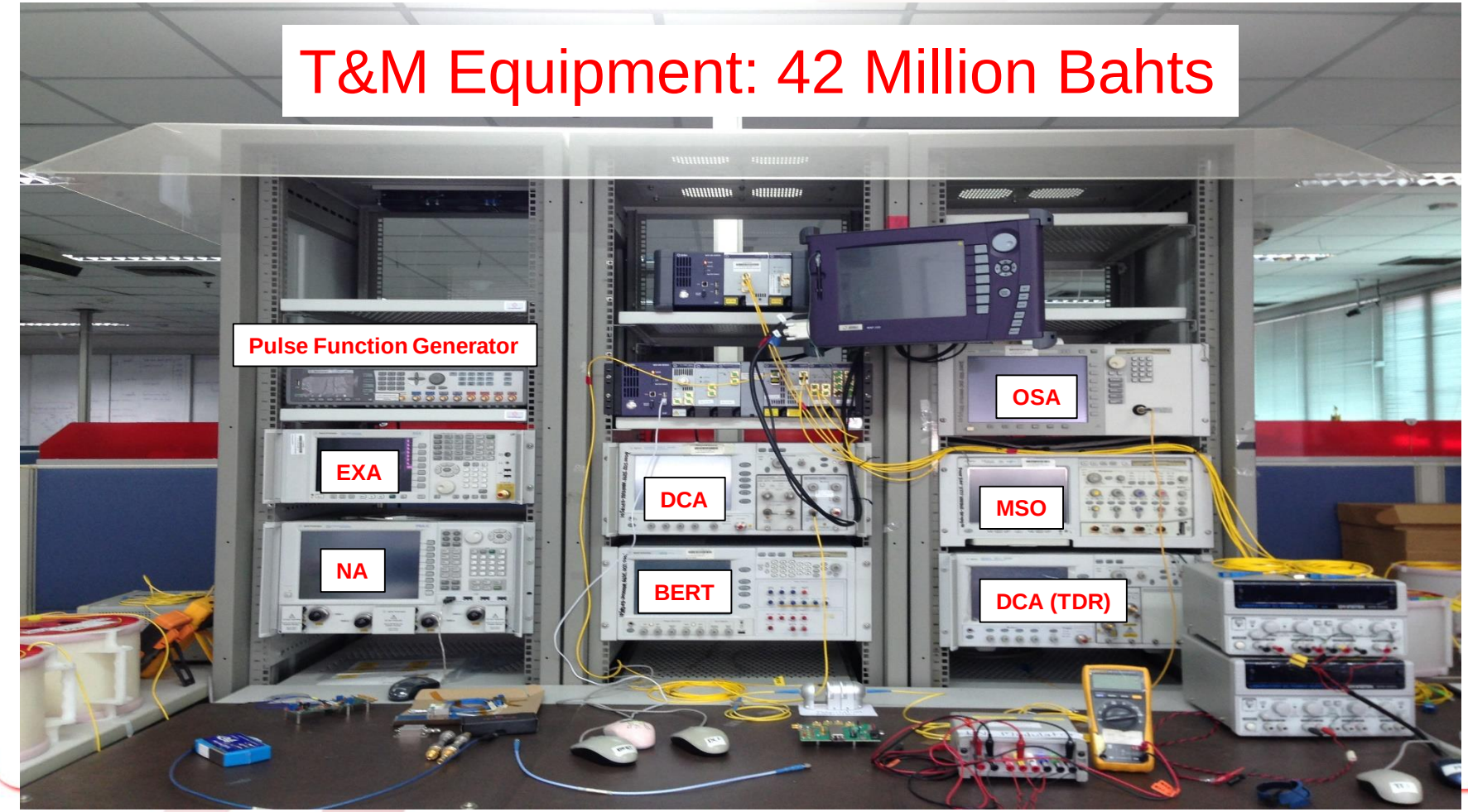
Standard	Name	Upstream	Downstream
ITU-T G.983.1 [3]	BPON	622.08 Mb/s @ 1310 nm	1244.16 Mb/s @ 1490 nm
ITU-T G.984.2 [4]	GPON	2488.32 Mb/s @ 1310 nm	2488.32 Mb/s @ 1490 nm
ITU-T G.987 [5]	**XG-PON**	**10 Gb/s @ 1270 nm**	**10 Gb/s @ 1577 nm**
ITU-T G.989.1 [6]	NG-PON2	40 Gb/s	40 Gb/s

Research targets:

- Wavelength: 1550 nm. ➔ **EDFA (1530 nm -1560 nm)**
- Bit Rate: 10 Gb/s, Distance: Maximum 60 Km SMF (ITU-T G.987)

* Wavelength 1550 nm reserved for CATV (ITU-T G.983.3 [7])

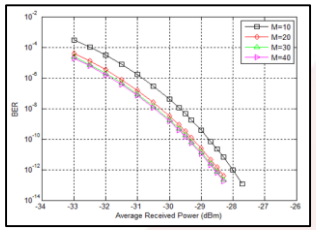
Electro-Magnetic Research Laboratory, Chulalongkorn University, Thailand



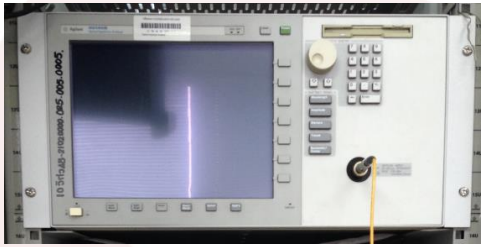
T&M Equipment at CU

13.5 Gb/s BERT (Agilent Tech.)

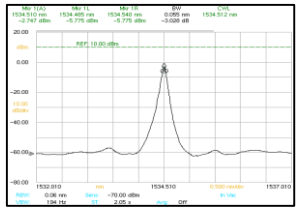
- BER Curve



OSA (Agilent Technologies)

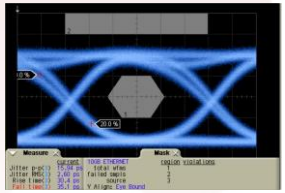


- Optical Spectrum



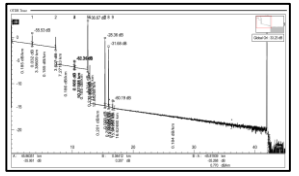
DCA (Agilent Technologies)

- Extinction
- t_r and t_f



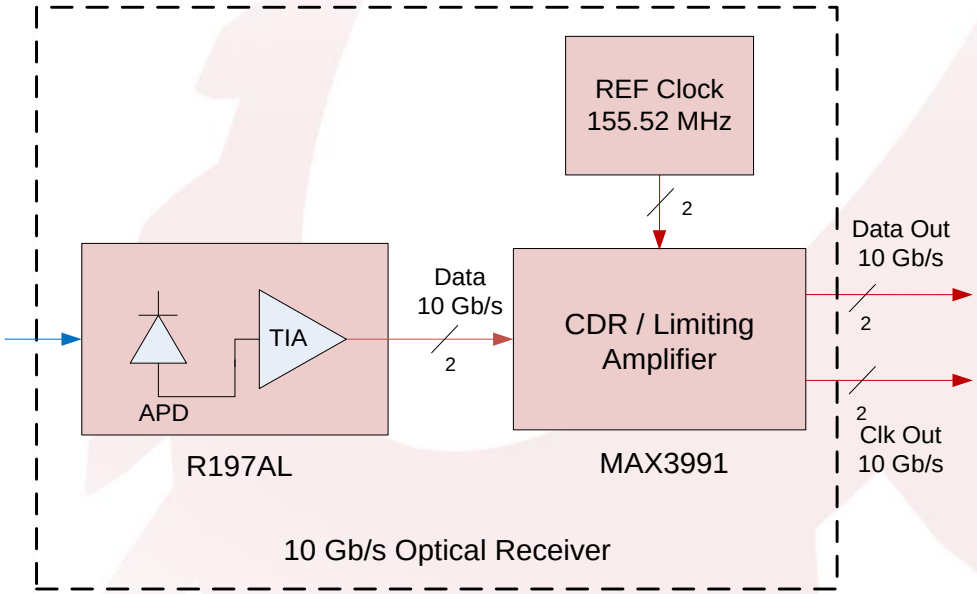
OTDR (JDSU)

- Distance
- Insertion Loss

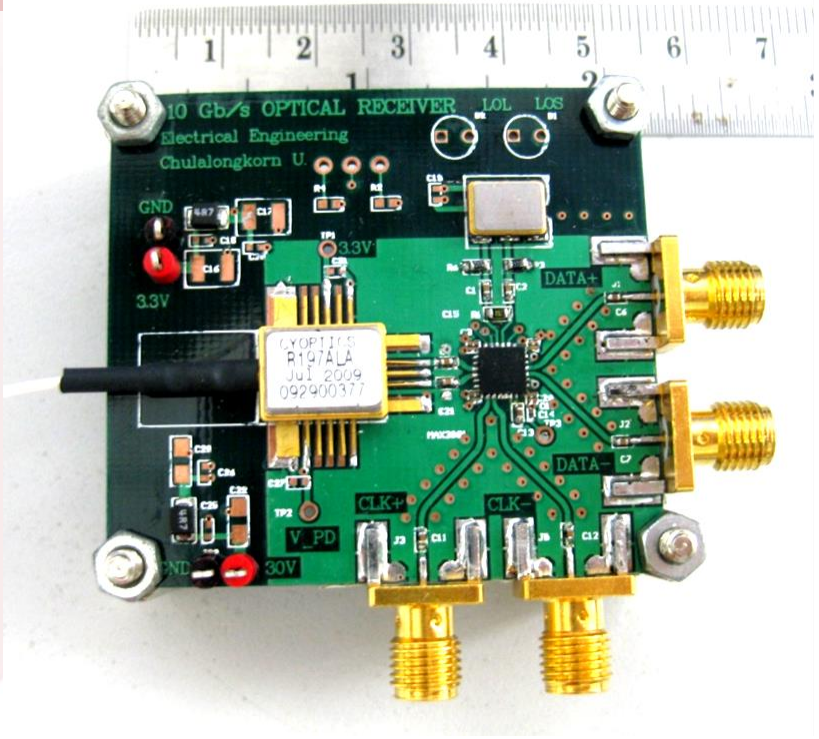


Research scope is limited by devices and Equipment.

10 Gb/s Optical Receiver Prototype

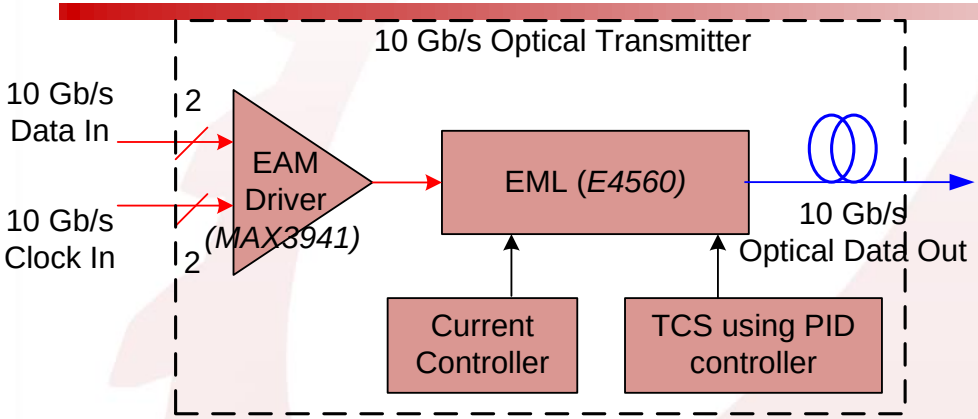


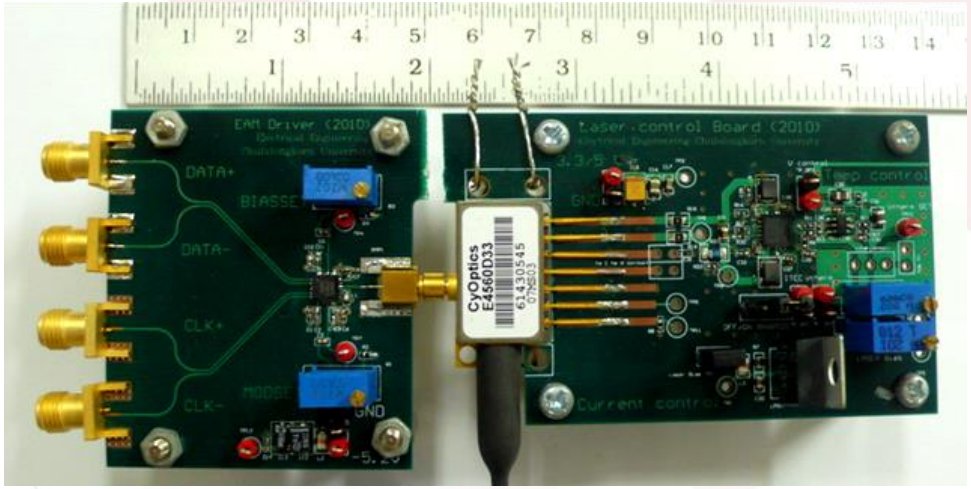
RX Components



RX Prototype

10 Gb/s Tx with TCS

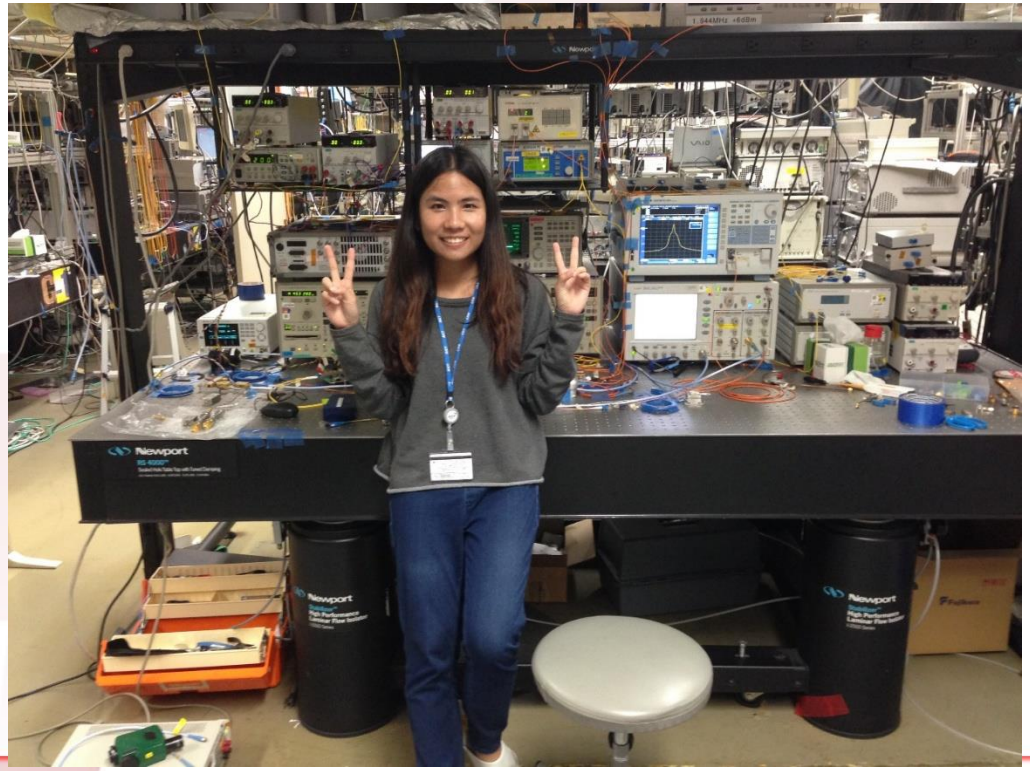




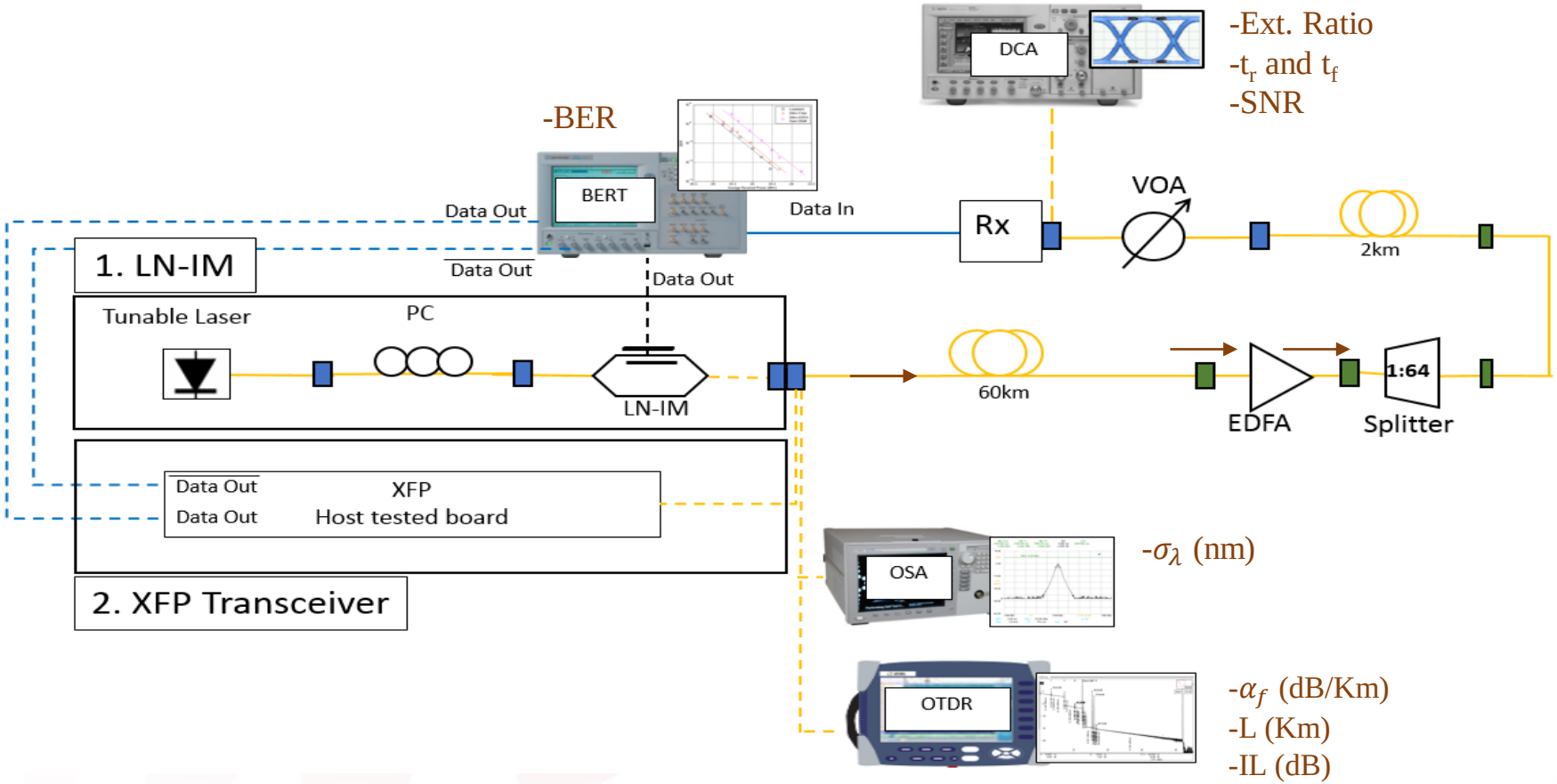
1. EML (Electro-Absorption Modulator Integrated Laser) using *E4560* from *CyOptics*
2. Current Controller using Voltage regulator, *LM317 from National Instruments* and trimpot
3. EAM (Electro-Absorption Modulator) driver using *MAX3941* from *MAXIM*
4. TCS using PID (Proportional Integral Derivative) controller and Bipolar Current Driver , *MAX 8521* from *MAXIM*

Experiments of 10 Gb/s Optical Access Network with Long Reach and A Large Number of Subscribers

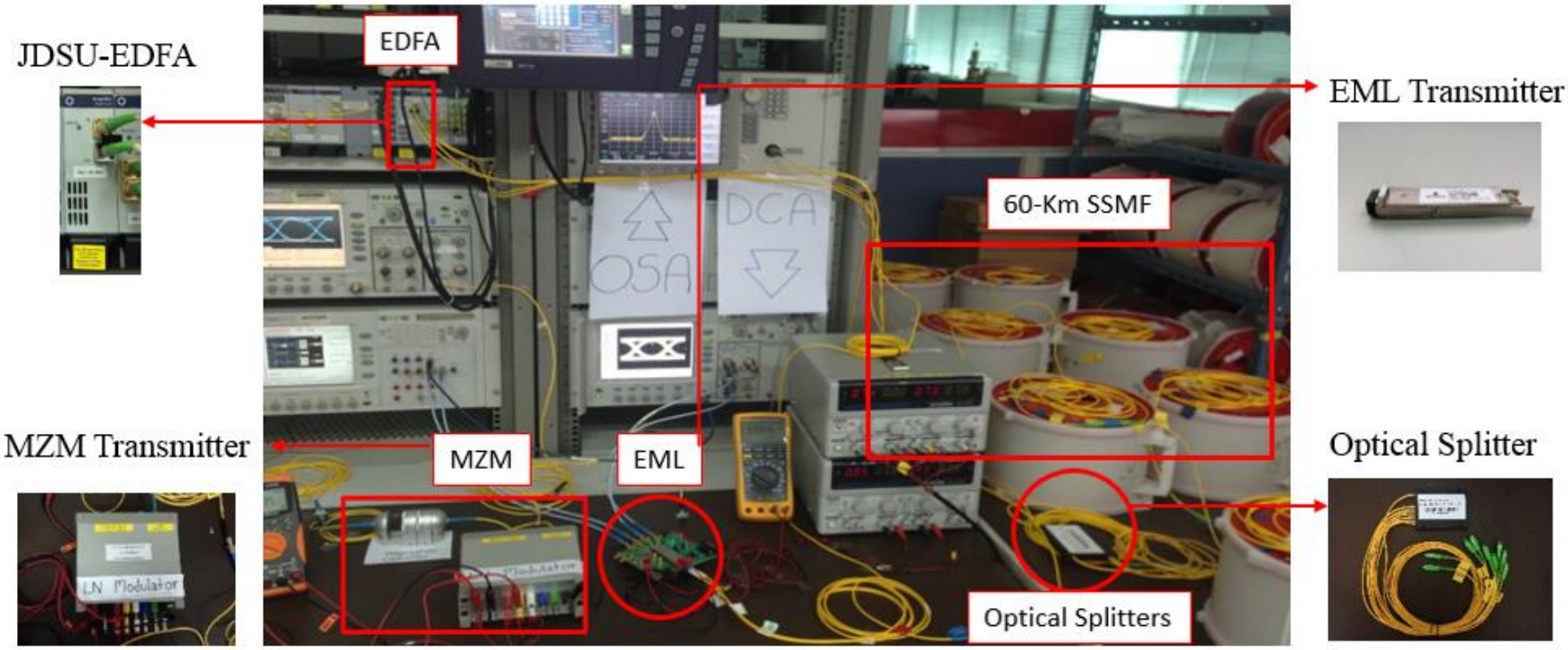
by Miss Budsara Boriboon



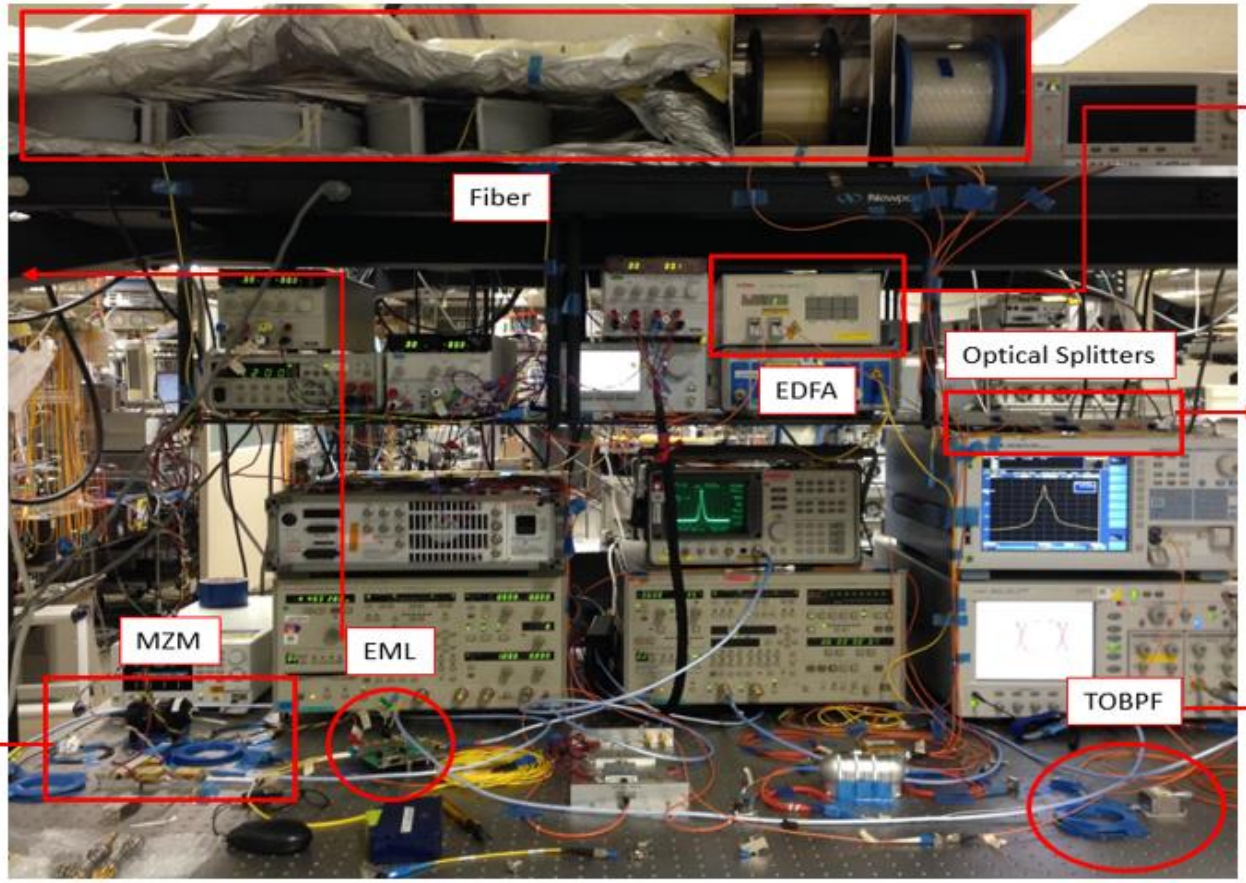
Block Diagram



Experimental Setup @ Electro-Magnetic Research Laboratory, CU, Thailand

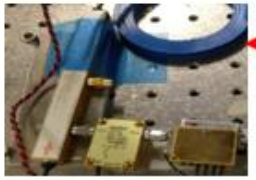


Experimental Setup @ Photonic Network System Lab., NICT, Japan



EML Transmitter

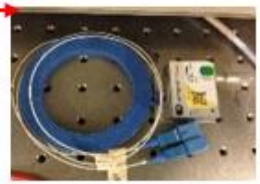
MZM Transmitter



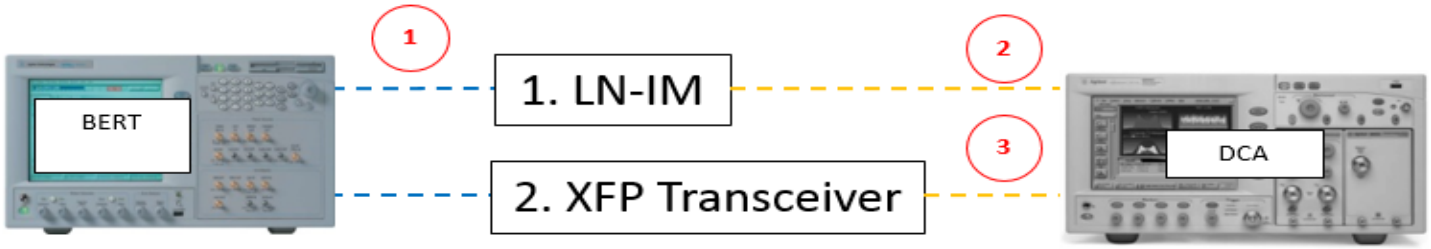
Fitel-EDFA

Optical Splitter

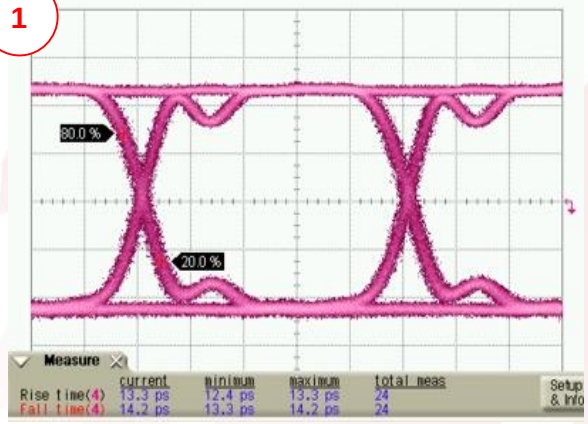
TOBPF



Eye Diagrams

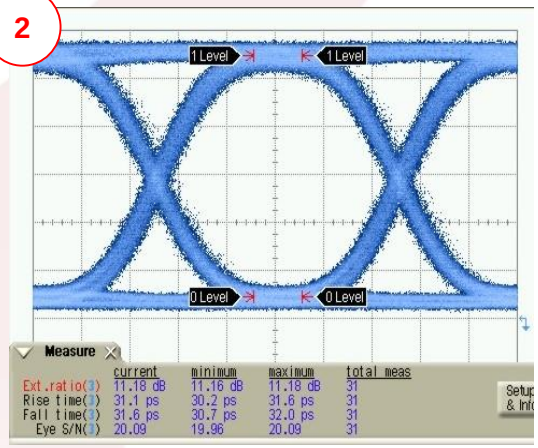


BERT (Electrical Signal)



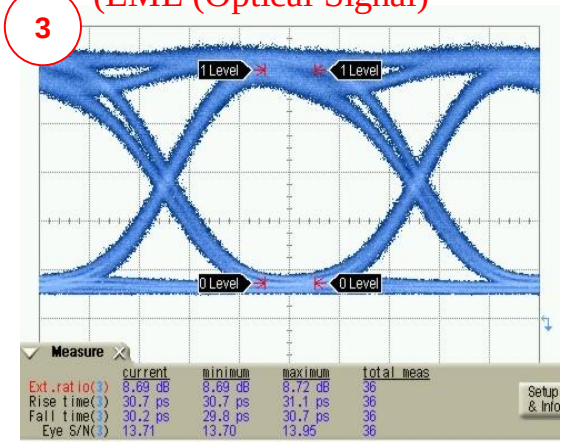
Rise Time 13.3ps
Fall Time 14.2ps

LN-IM (Optical Signal)



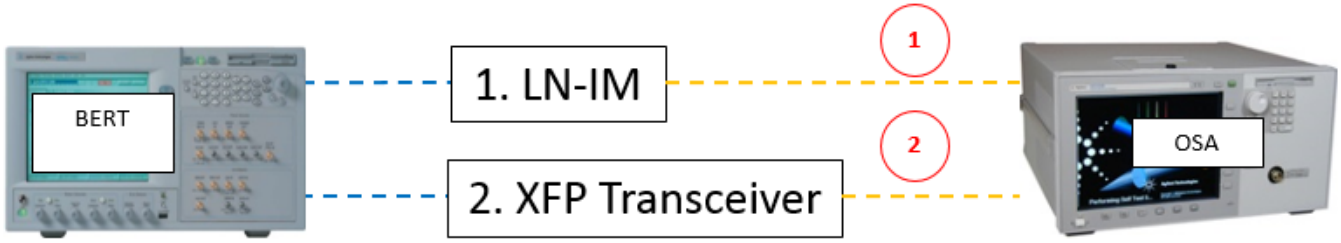
Ext. Ratio: 11.18dB
Rise Time 31.1ps
Fall Time 31.6ps

(EML (Optical Signal)

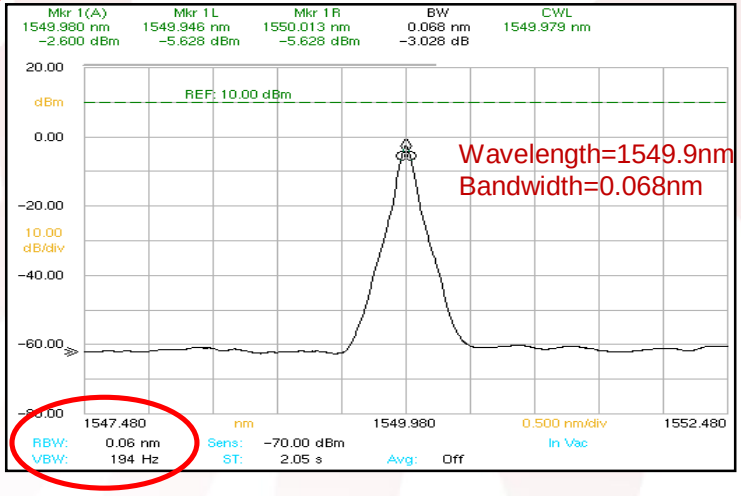


Ext. Ratio: 8.69dB
Rise Time 30.7ps
Fall Time 30.2ps

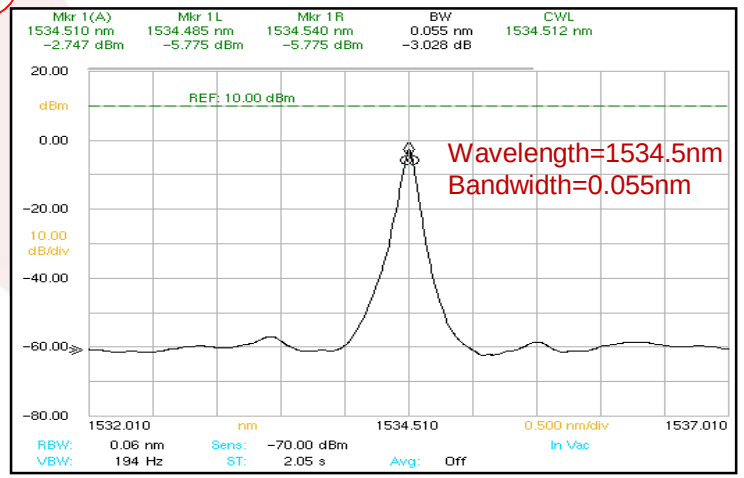
Optical Spectrum



1 LN-IM



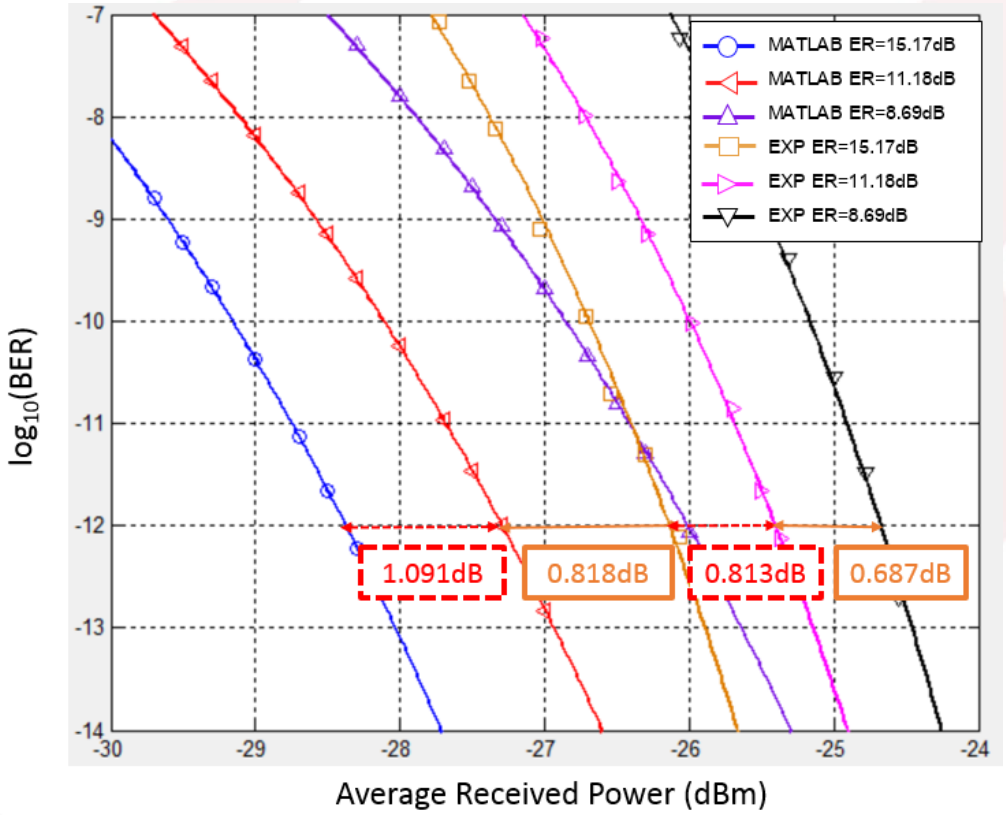
2 XFP Transceiver



-σ_λ (nm): 3-dB Optical Bandwidth

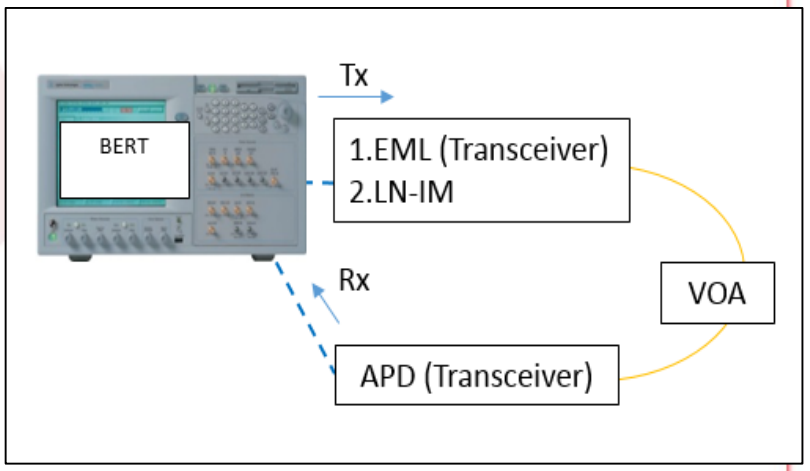
BER Results (1)

Case (1) Extinction Ratio



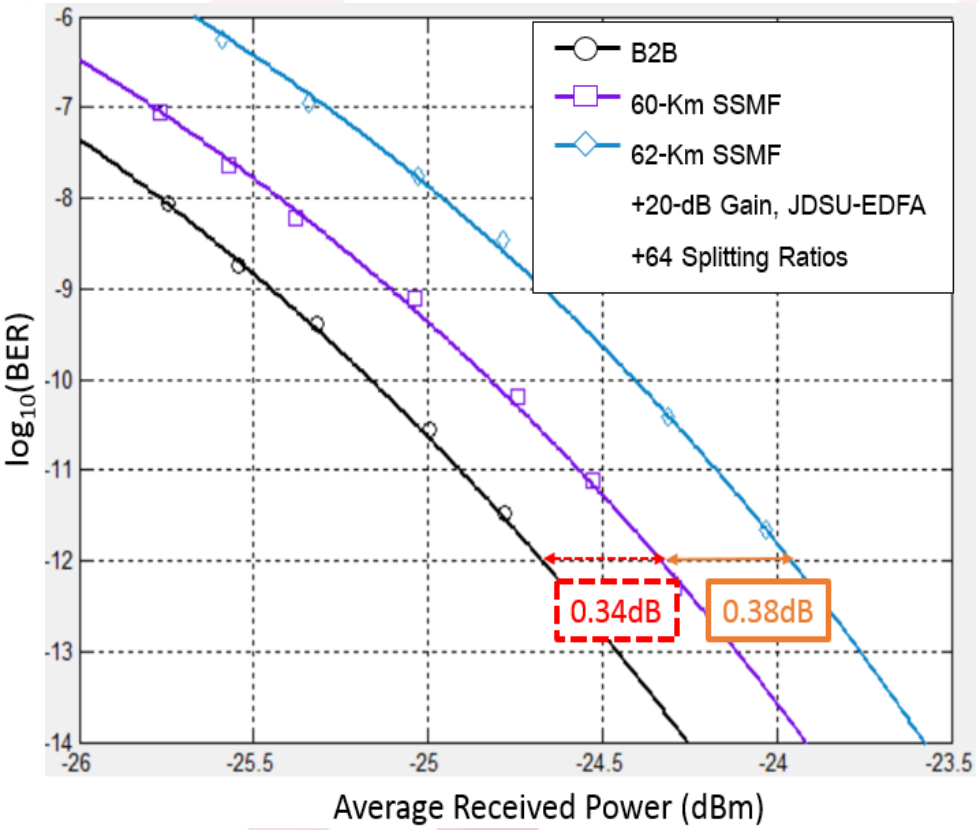
MZM Transmitter
ER: 11.18 dB – 15.17 dB

EML Transmitter
ER: 8.69 dB

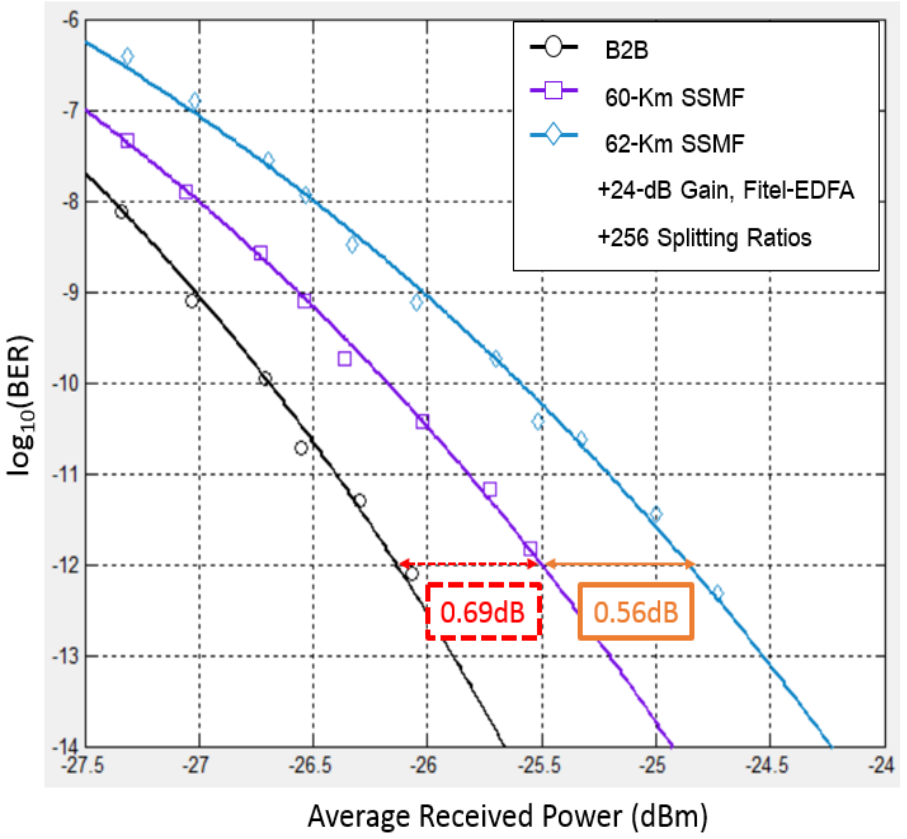


BER Results (2)

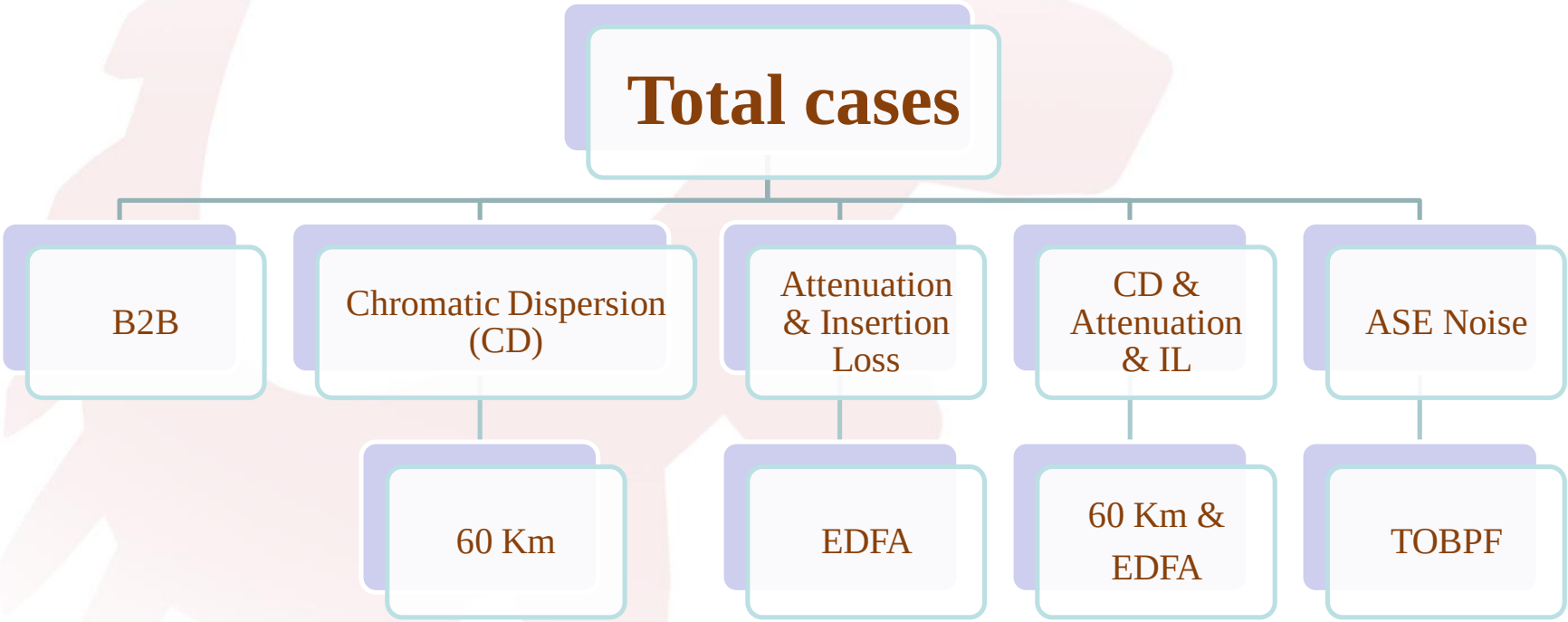
Case (2) EML Transmitter



Case (3) MZM Transmitter



Theoretical Computation in MatLab



Conclusion

- Currently, the rapid and vast installation of access fibers requires more cost-effective networks, other than standard PON.
- In collaboration with NICT, we are able to setup the experimental downstream transmission of 10 Gb/s access network using a commercial EDFA.
- This network can achieve 62 Km over standard SMF and 256 subscribers via the MZM modulator donated by OPTOQUEST, but 64 subscribers via a commercial EML.

MZM: Lithium-Niobate Mach-Zehnder Modulator
EML: Electro-Absorption Modulation Laser

Thank you

Q&A