

Status of Calibration and Measurement Activities of KRISS in Fiber Optics

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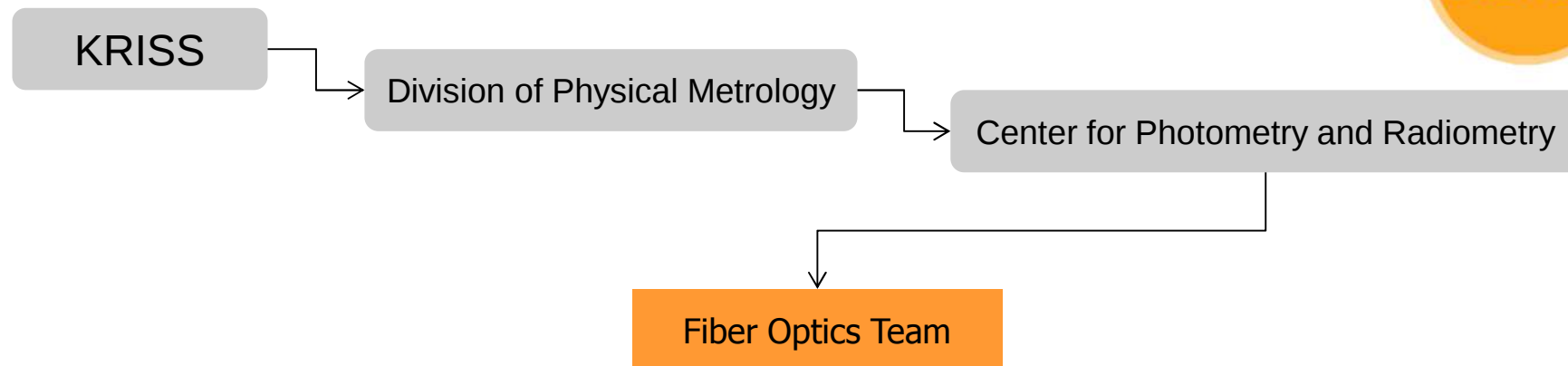
KRISS

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KRISS Fiber Optics Team



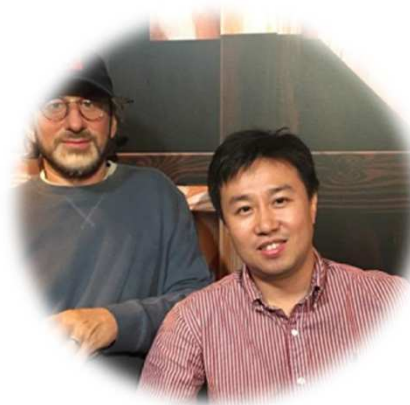
Dr. Seung Kwan Kim

- Project leader
- Fiber optic power
- Polarization



Dr. Kee-Suk Hong

- Optical fiber length
- Optical fiber attenuation
- Single photon source



Dr. Sun Do Lim

- Return loss
- Dispersion
- Mid-IR fiber source



Mr. Ki-Lyong Jeong

- Calibration and Testing
- Customer liaison

History



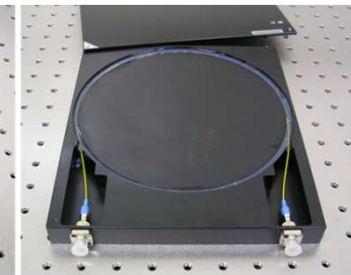
- 2003 Fiber optic power responsivity scale at 1310 nm and 1550 nm
- 2005 Optical fiber length, attenuation scale and reference standard
- 2006 PMD, PDL scale and reference standard
- 2006 Informal bilateral comparison on PMD with NIST
- 2006~2014 Piloting APMP TCPR SC on fiber optic power responsivity (1310 nm, 1550 nm)
- 2011 Informal bilateral comparison on fiber power with NIST
- 2012~2014 Participating in EMRP MIQC project
- 2014 Fiber optic power responsivity scale at 1625 nm
- 2014~ Tunable fiber laser at 2 μm range, OPO in 2.5 μm ~ 3.5 μm , OPO in 5 μm ~ 8 μm
- 2015~ Piloting APMP TCPR SC on optical fiber length (1310 nm, 1550 nm)
- 2016~ Participating in COOMET SC on polarization mode dispersion

Service Items



- Calibration

- Fiber optic power meter / Optical power meter
- Optical fiber length reference
- Optical fiber attenuation reference
- Optical spectrum analyzer
- Return loss reference
- Polarization mode dispersion analyzer
- Polarization dependent loss reference
- Variable optical attenuator



- Test

- Fiber optic source (LASER, LED)



Service Status

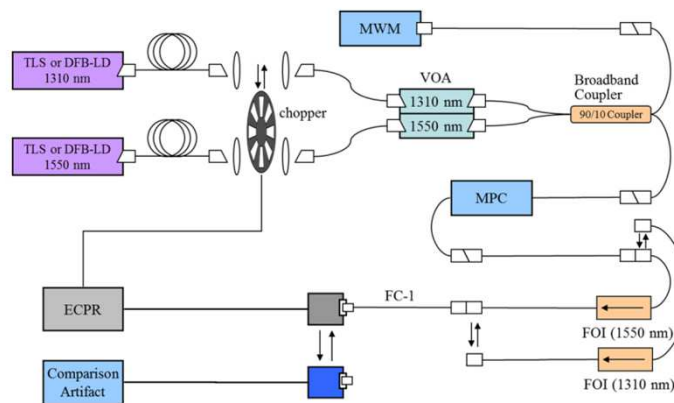


Calibration Item	2010	2011	2012	2013	2014	2015	2016
Fiber optic power meter	12	14	18	17	14	12	4
Variable optical attenuator	7	3	8	11	9	6	4
Optical fiber length reference	5	10	10	5	10	7	5
Optical fiber attenuation reference	5	7	9	5	8	5	3
Return loss reference	1	1	3		2	2	2
OTDR	7			1			
Optical spectrum analyzer		2	2	1		1	
PMD reference	1		1				
PMD analyzer	1		1				
PDL reference	1				1		
Fiber optic source (test)	5		6		2	1	
Total number	45	37	58	40	46	34	18

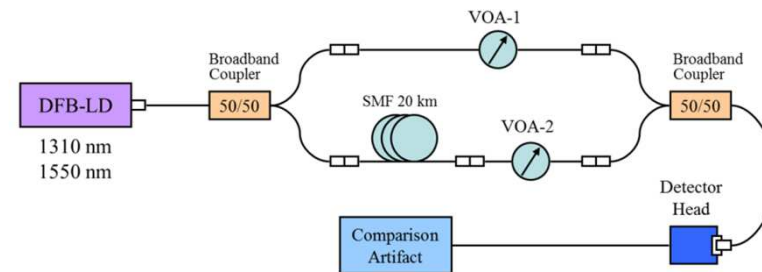
Standard Setup (1/3)

Fiber optic power responsivity

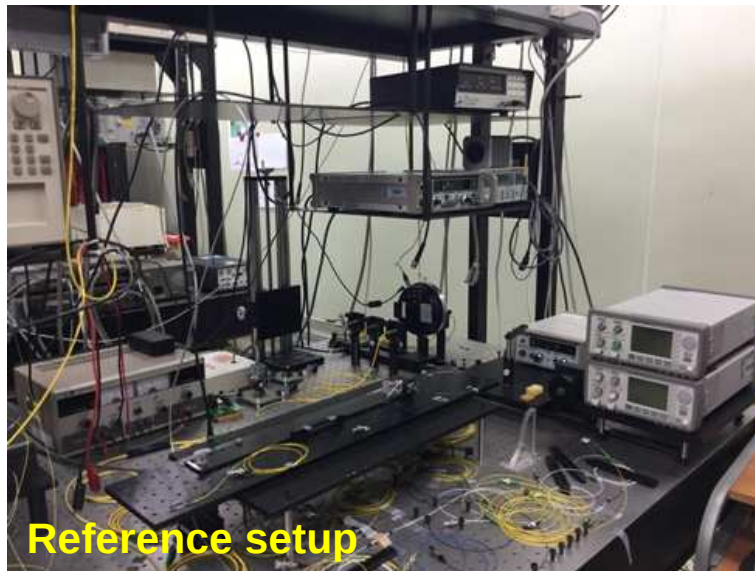
Absolute Power (-10 dBm)



Linearity (-60 dBm ~ 5 dBm)



Recently we added 1625 nm.



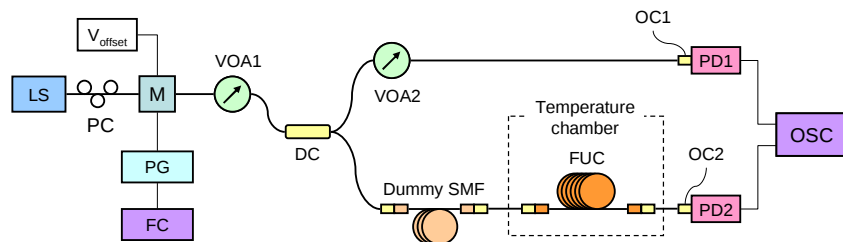
Reference setup



Calibration service facility

Standard Setup (2/3)

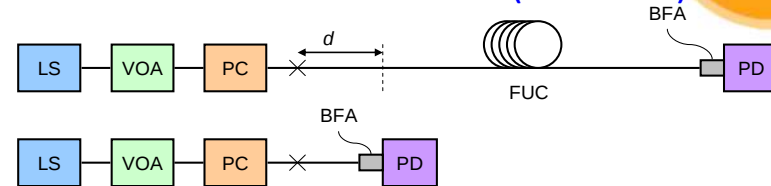
Optical fiber length (Time of Flight)



DC, directional coupler; FC, frequency counter; LS, laser source; M, modulator; OC, optical connector
OSC, oscilloscope; PD, photo-detector; PG, pulse generator; VOA, variable optical attenuator

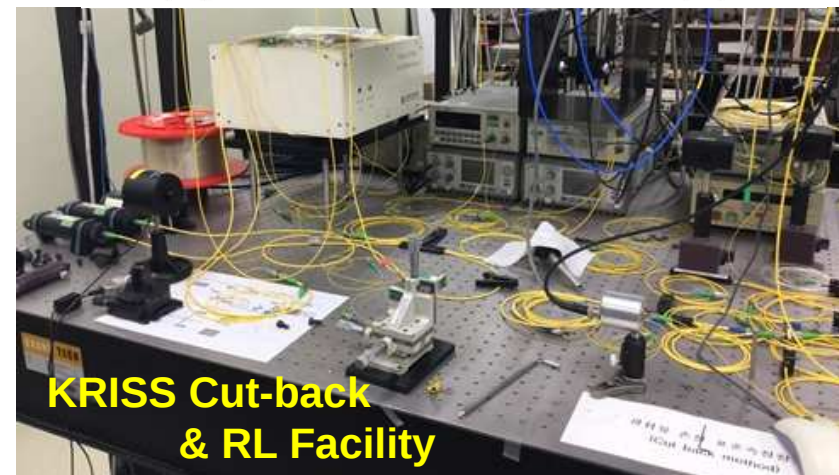
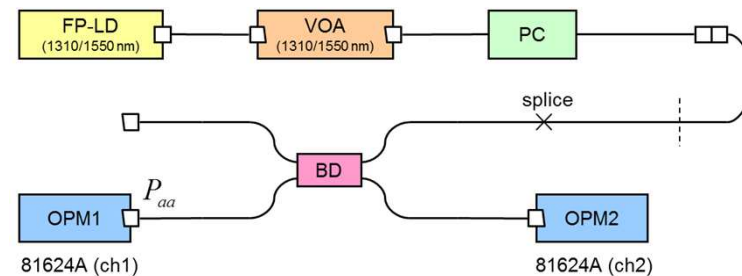


Optical fiber attenuation (Cut-back)



BFA, bare fiber adaptor; LS, laser source; PC, polarization controller; PD, photo-detector
VOA, variable optical attenuator

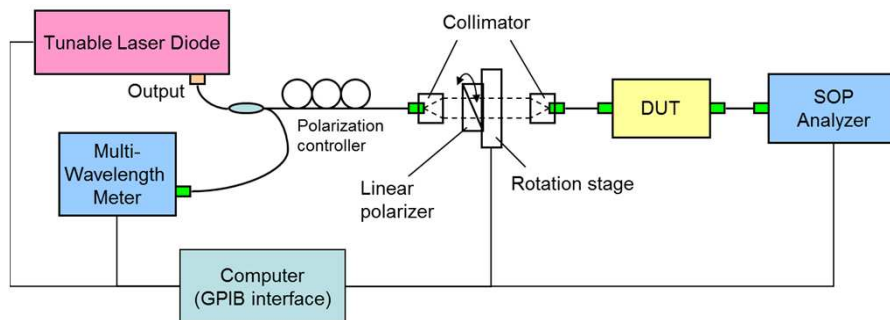
Return loss (Opt. Cont. Wave Refl.)



Standard Setup (3/3)

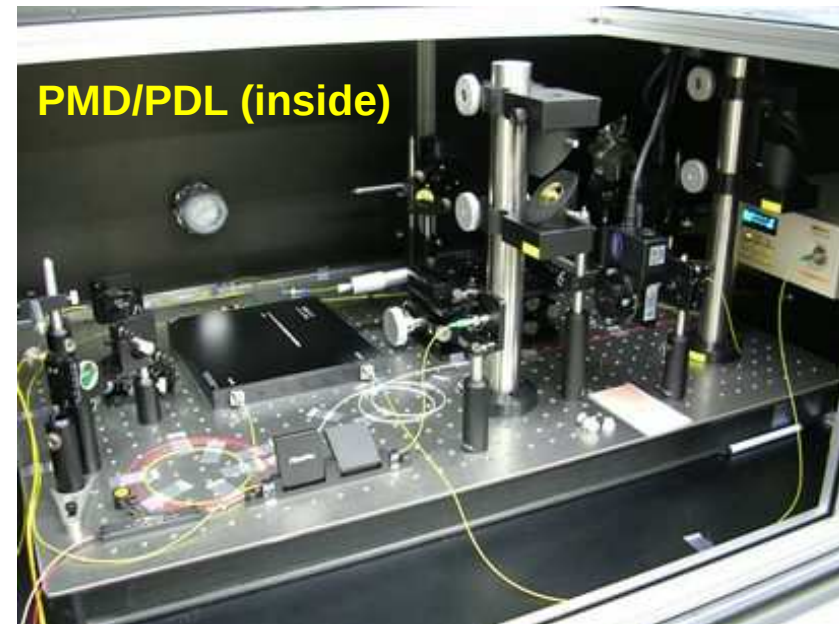
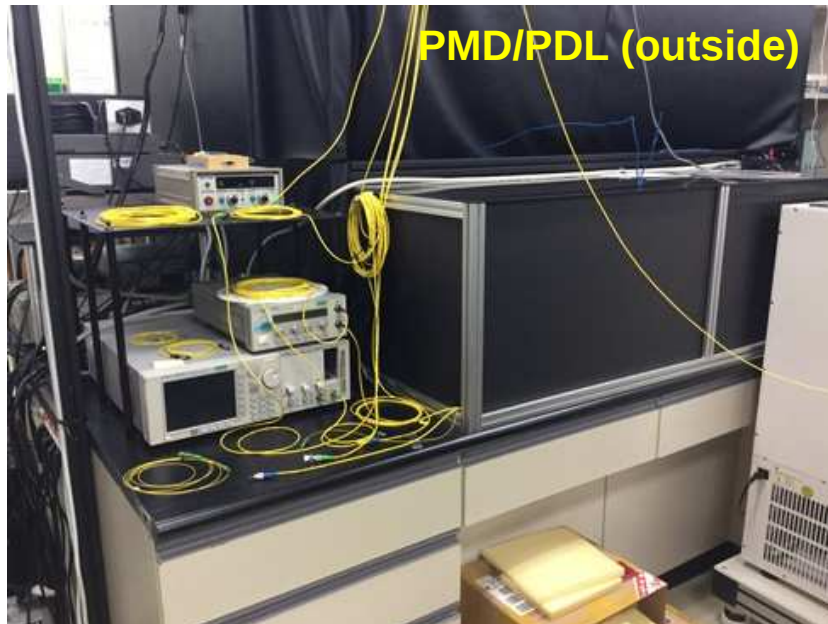
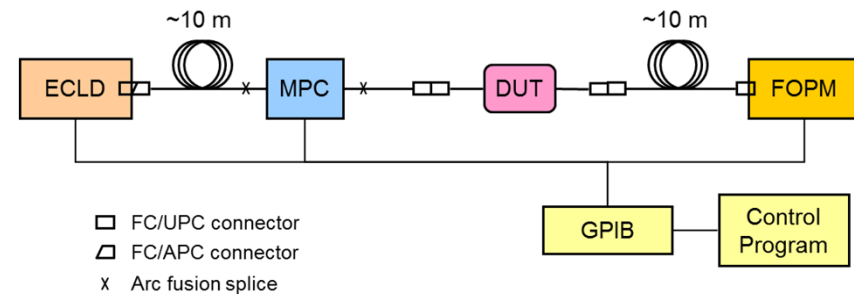
Polarization Mode Dispersion

- JME method



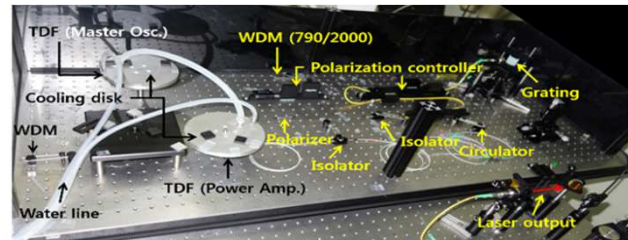
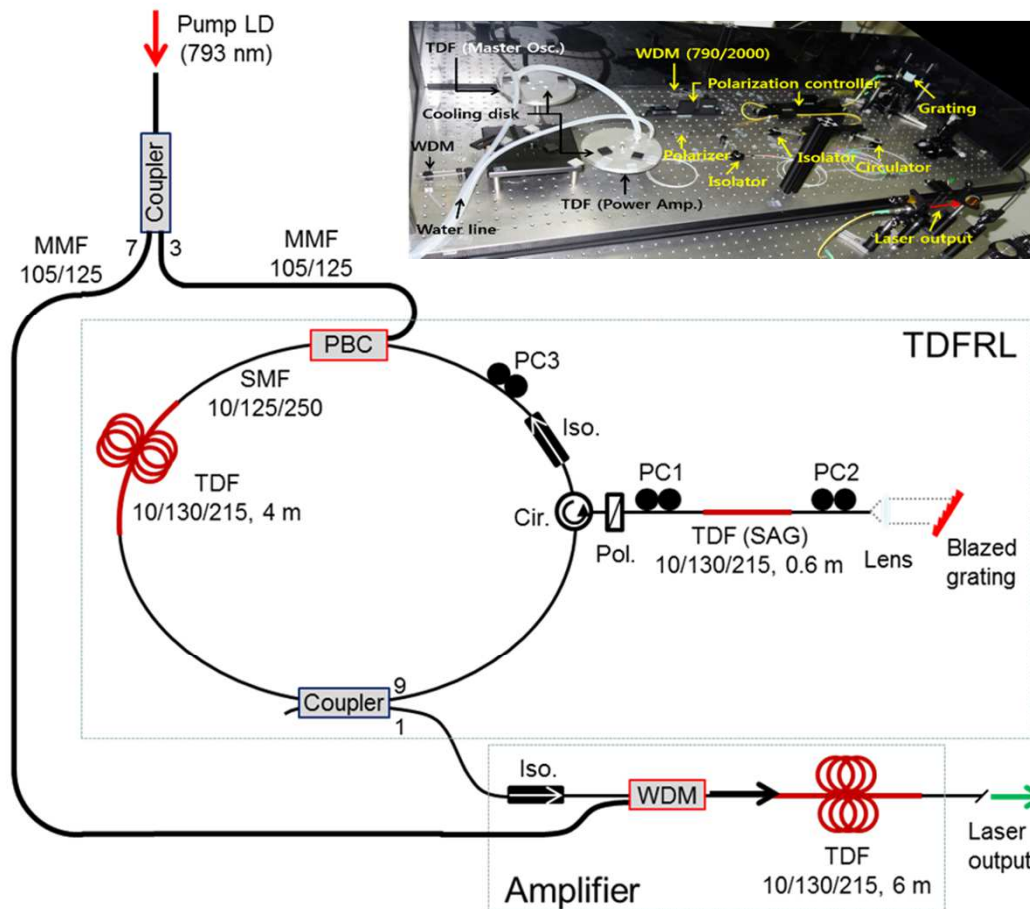
Polarization Dependent Loss

- pol. scanning method

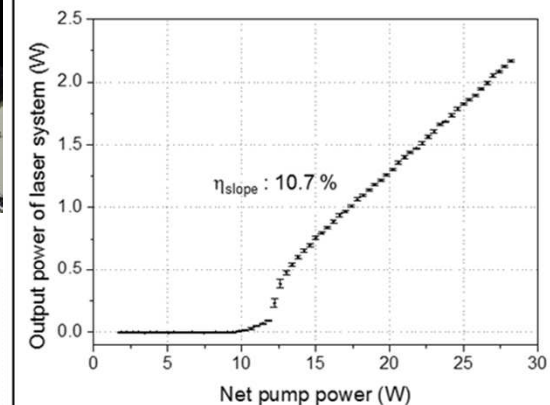


Current Research (1/4)

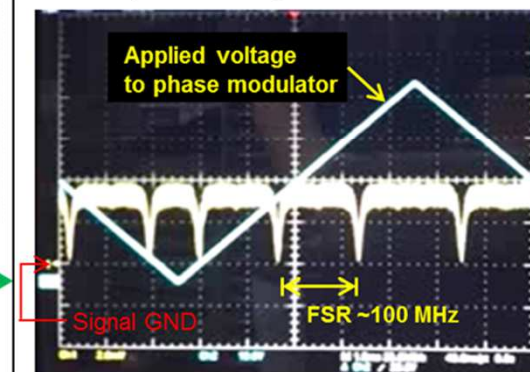
2 μm band tunable fiber laser (single longitudinal mode)



◆ TDFRL + Amp. power scalability



◆ Temporal stability

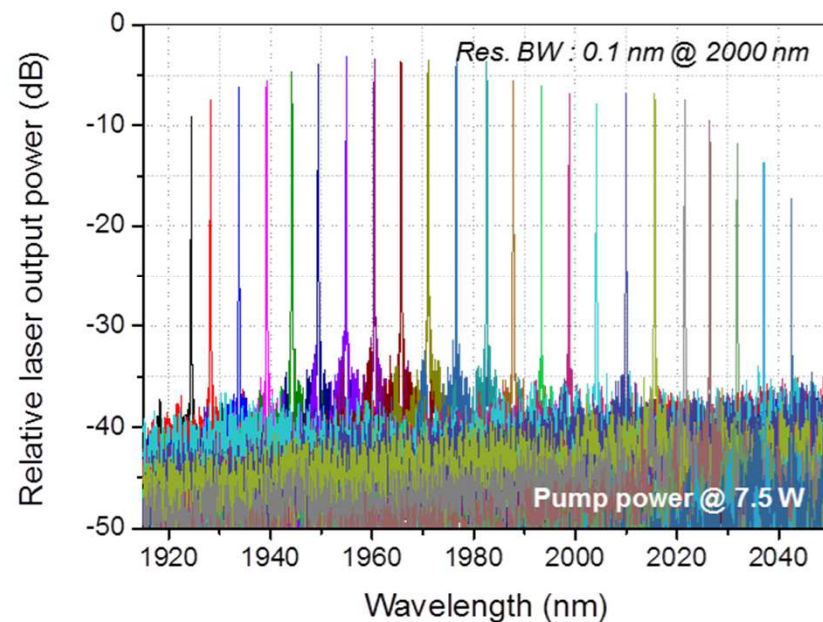


LD: Laser Diode, MMF: Multi-Mode Fiber, PBC: Pump Beam Combiner, SMF: Single Mode Fiber, SAG: Saturable Absorption Grating
TDF: Thulium-Doped Fiber, PC: Polarization Controller, Iso.: Optical Isolator, Cir.: Optical Circulator, Pol.: In-line optical polarizer.

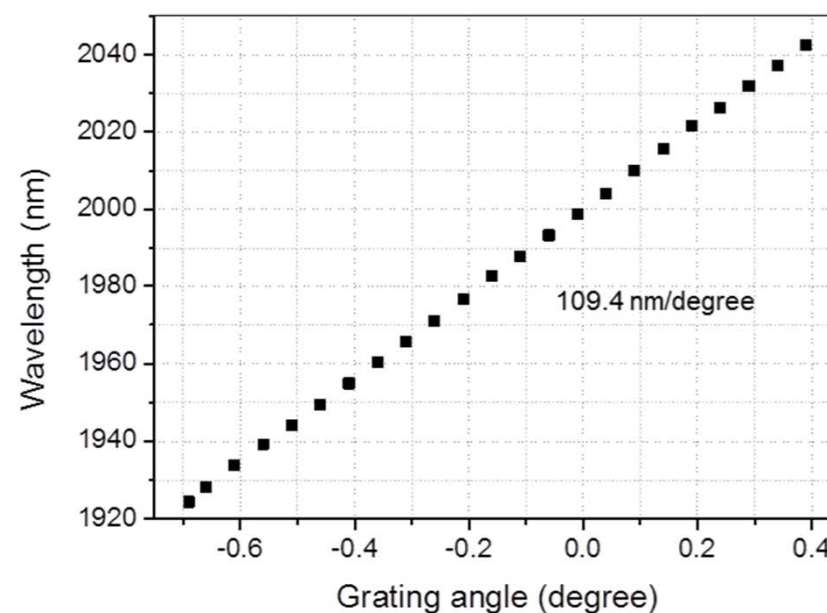
Current Research (2/4)

2 μm band tunable fiber laser:
wavelength tunability ≥ 120 nm

Laser output spectra (by Thorlabs OSA205)



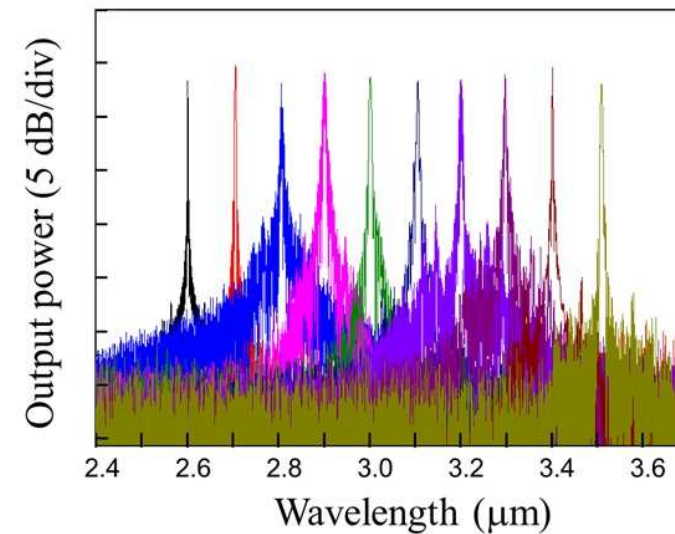
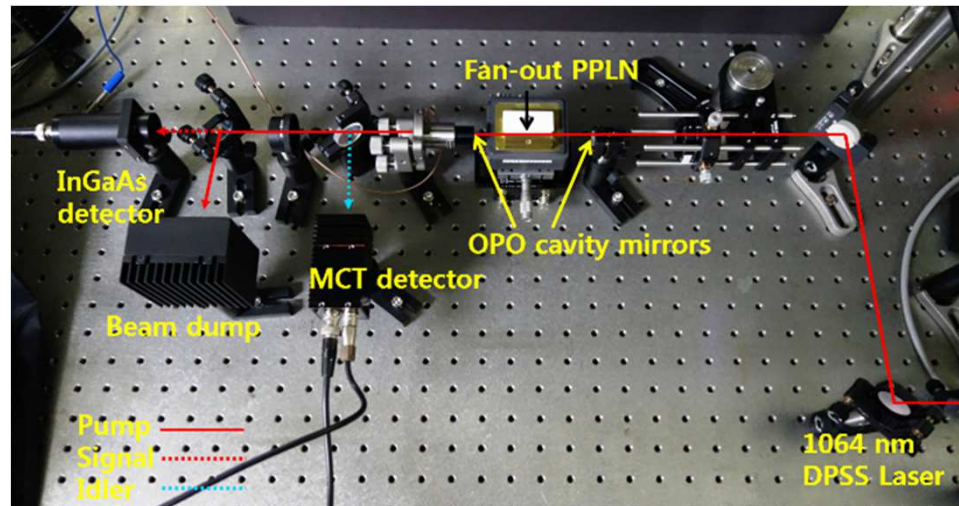
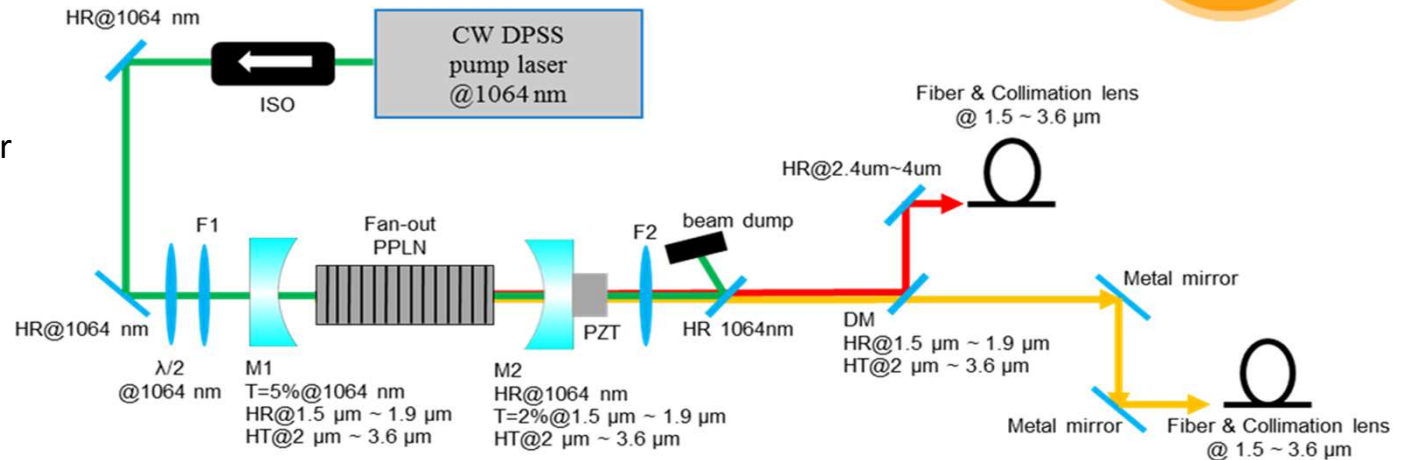
Wavelength tunability



Current Research (3/4)

■ MIR-OPO (1)

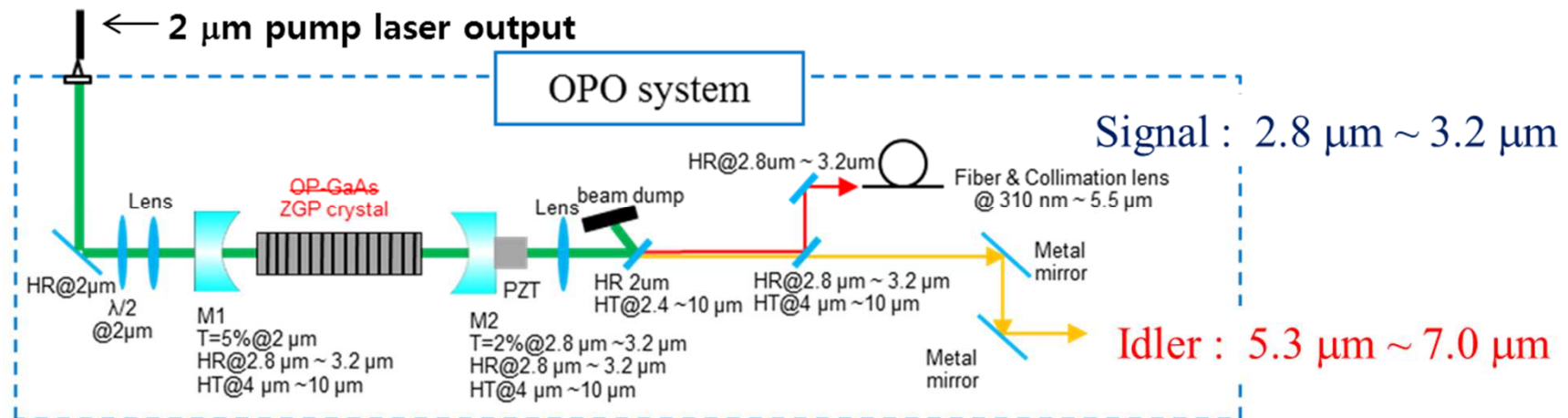
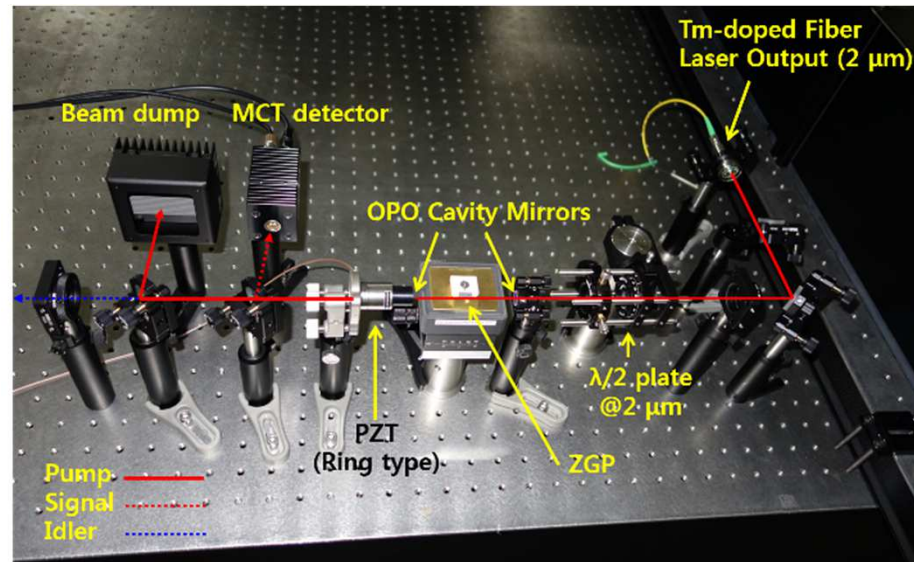
- MgO:PPLN
- Pump: 1064 nm DPSS Laser
- Signal: $1.5\ \mu\text{m} \sim 1.9\ \mu\text{m}$
- Idler: $2.5\ \mu\text{m} \sim 3.5\ \mu\text{m}$



Current Research (4/4)

■ MIR-OPO (2)

- ZGP
- Pump: 2 μm Fiber Laser
- Signal: 2.8 μm ~ 3.2 μm
- Idler: 5.3 μm ~ 7.0 μm



Collaboration Issues



- High power optical power meter
- Multimode fiber power meter
- References for Multimode OTDR
- Fiber optics in Mid-IR band

**Thank you very much for your kind
attention!**

