RF ANALOG PHOTONIC APPLICATIONS

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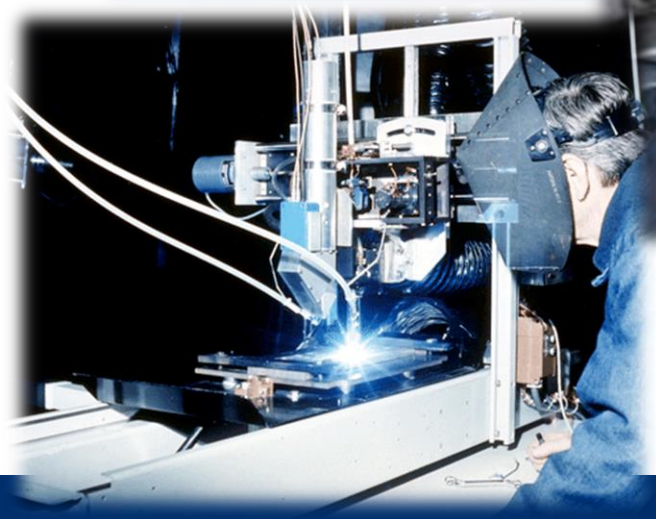
OPTICS AND PHOTONICS PERMEATE DEFENSE

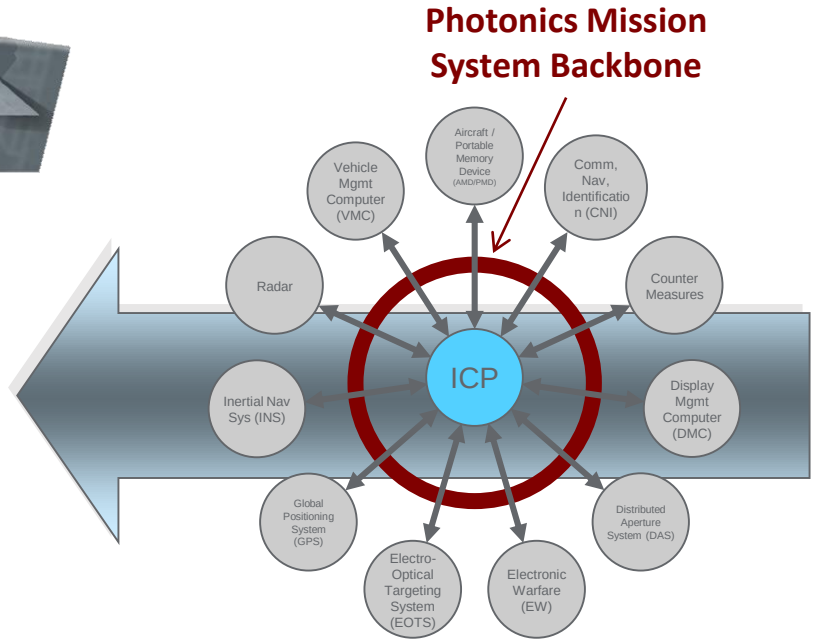
- Imaging and sensing systems
  - LIDAR/Laser Radar (LADAR)
  - Vis/EO/IR imagers
- Information transfer
  - Free space laser communications
  - Fiber network backbones on platforms and terrestrial
  - Analog RF
  - High speed digital networks
- Weapons
  - Directed energy laser
  - Laser target designation
- Displays
- Manufacturing
  - Lasers used for precision construction



MILITARY AIRCRAFT MISSION SYSTEMS

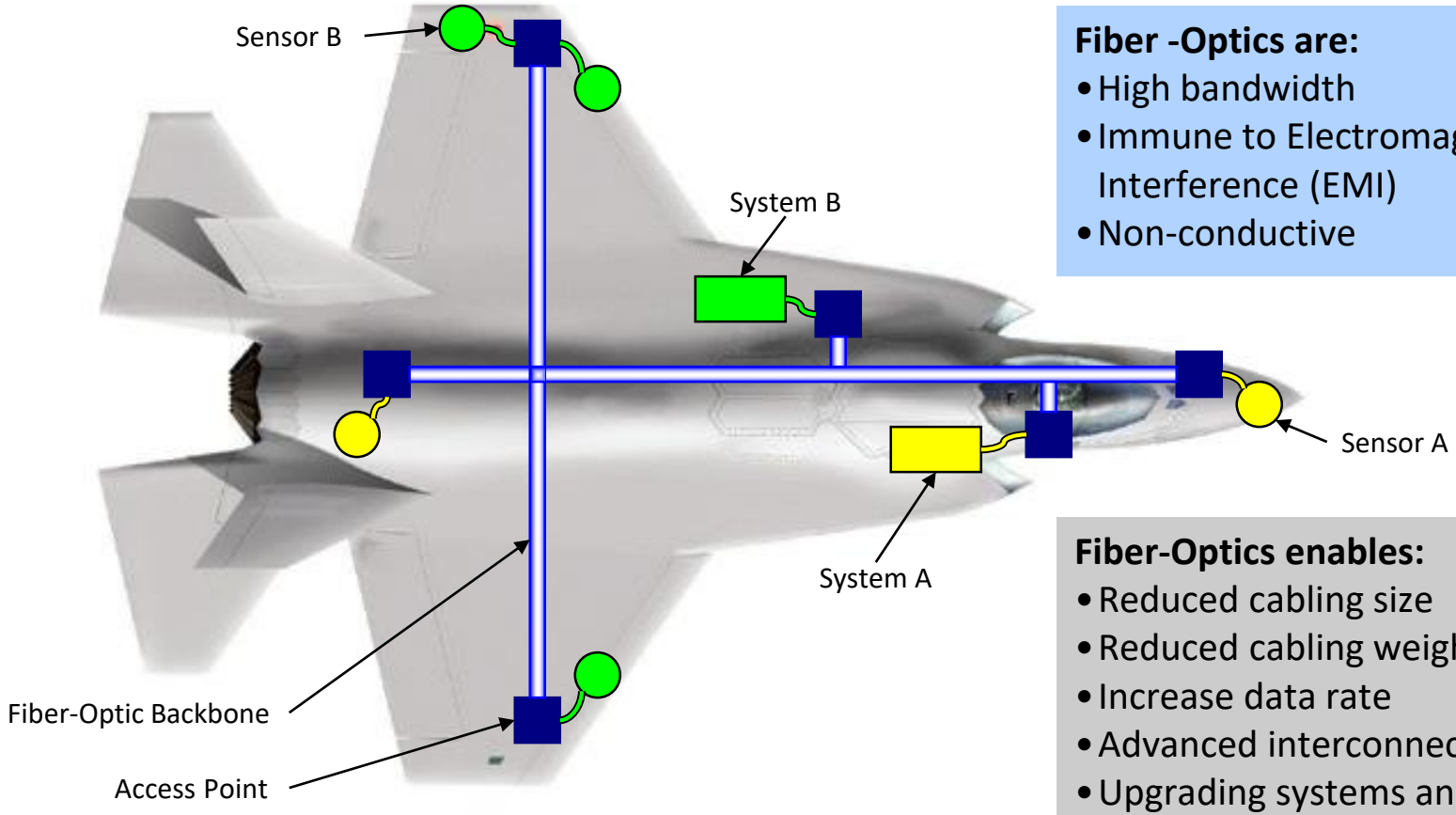
Integrated Core Processor (ICP)

- Mission Systems Sensors
- Cockpit Displays
- Auxiliary Mass Storage
- Remote Interface Units
- Other Subsystems



PHOTONICS ENABLES CAPABILITIES THAT OTHERWISE COULD NOT BE ACHIEVED WITHIN THE SAME SIZE, WEIGHT, AND POWER

FIBER OPTICS DATA BACKBONE



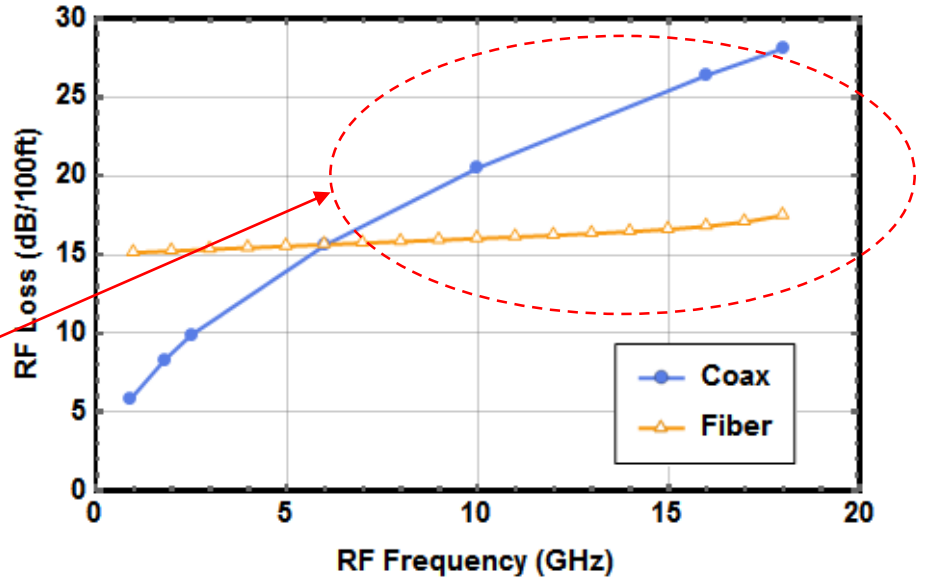
Fiber -Optics are:
- High bandwidth
- Immune to Electromagnetic Interference (EMI)
- Non-conductive

Fiber-Optics enables:
- Reduced cabling size
- Reduced cabling weight
- Increase data rate
- Advanced interconnects
- Upgrading systems and sensors without altering fiber-optic backbone

RF OVER FIBER

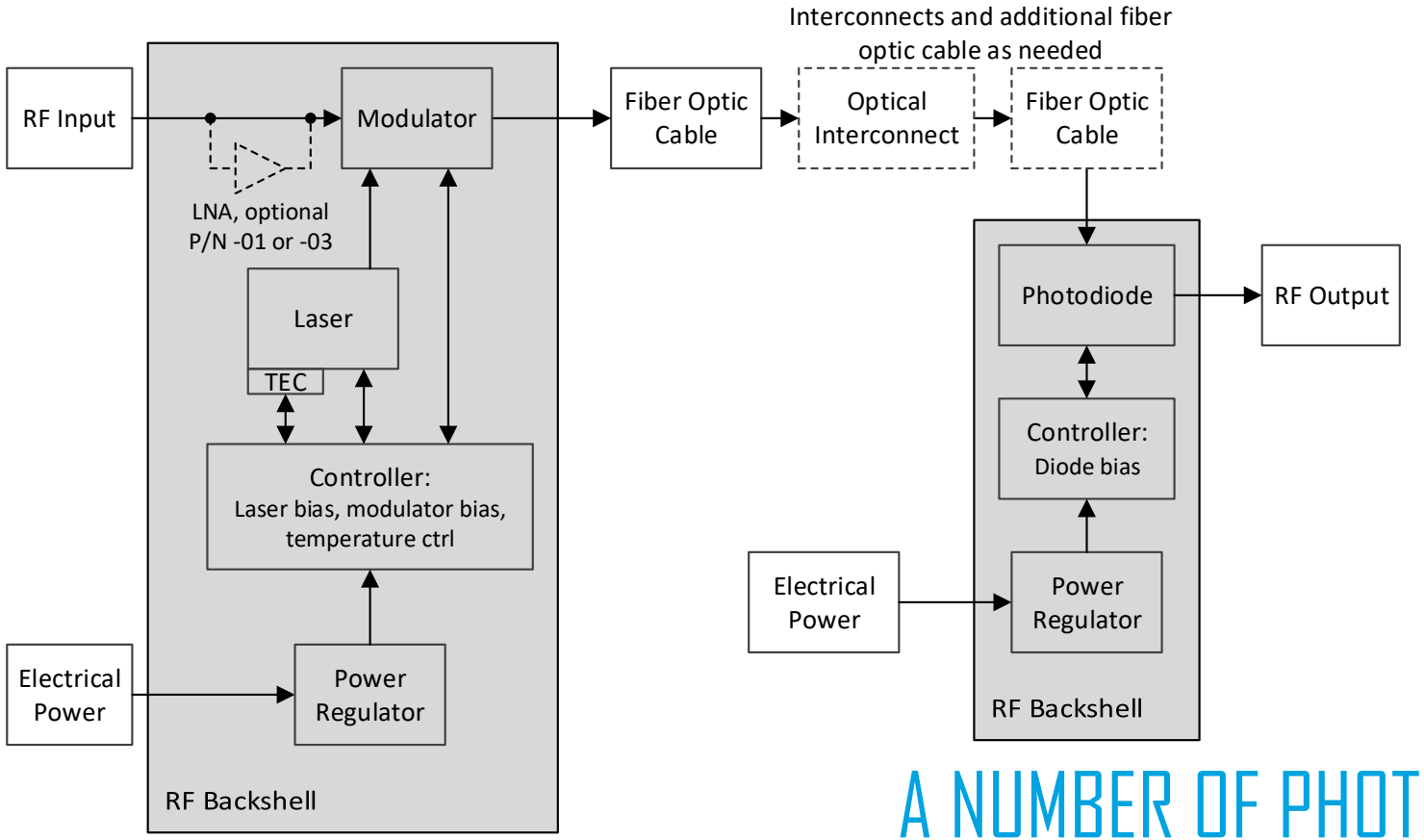
- RF over Fiber benefits
  - Improved distance independence (reduced loss/distance)
  - Reduced CSWaP vs. discrete solution
  - Wider bandwidth
  - EMI immunity
  - Higher reliability

- Current Coax implementations:
  - Limited in distance due to losses
  - Limited in bandwidth due to losses
  - Require equalizers to adapt to frequency dependent losses
  - Are not scalable to higher bandwidths



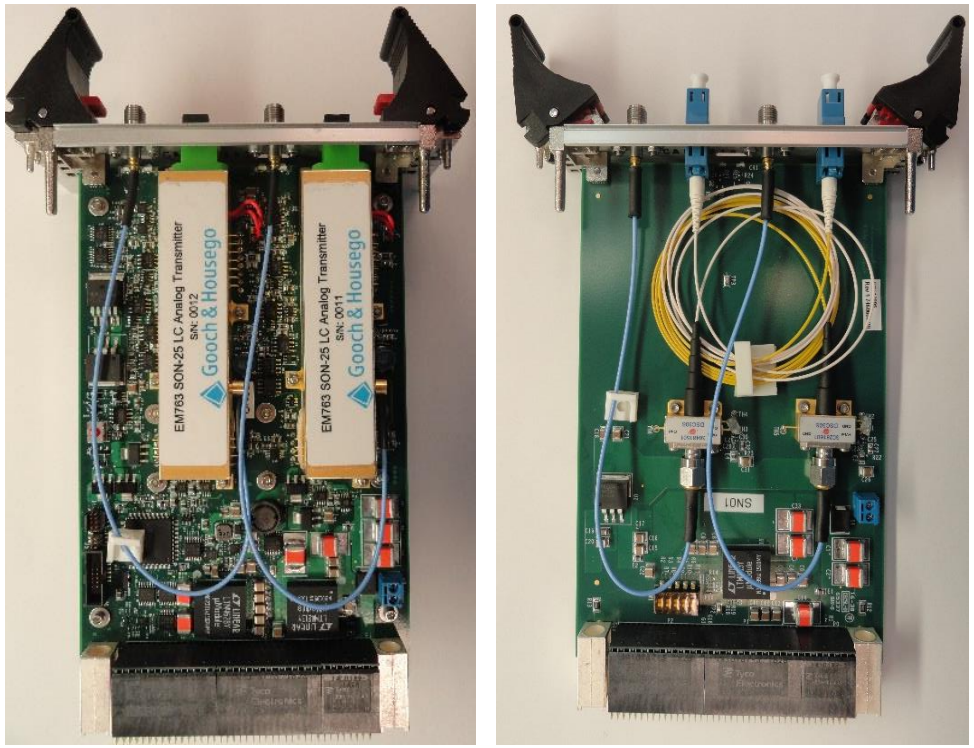
BANDWIDTH, FREQUENCY, AND DISTANCE DRIVE NEED

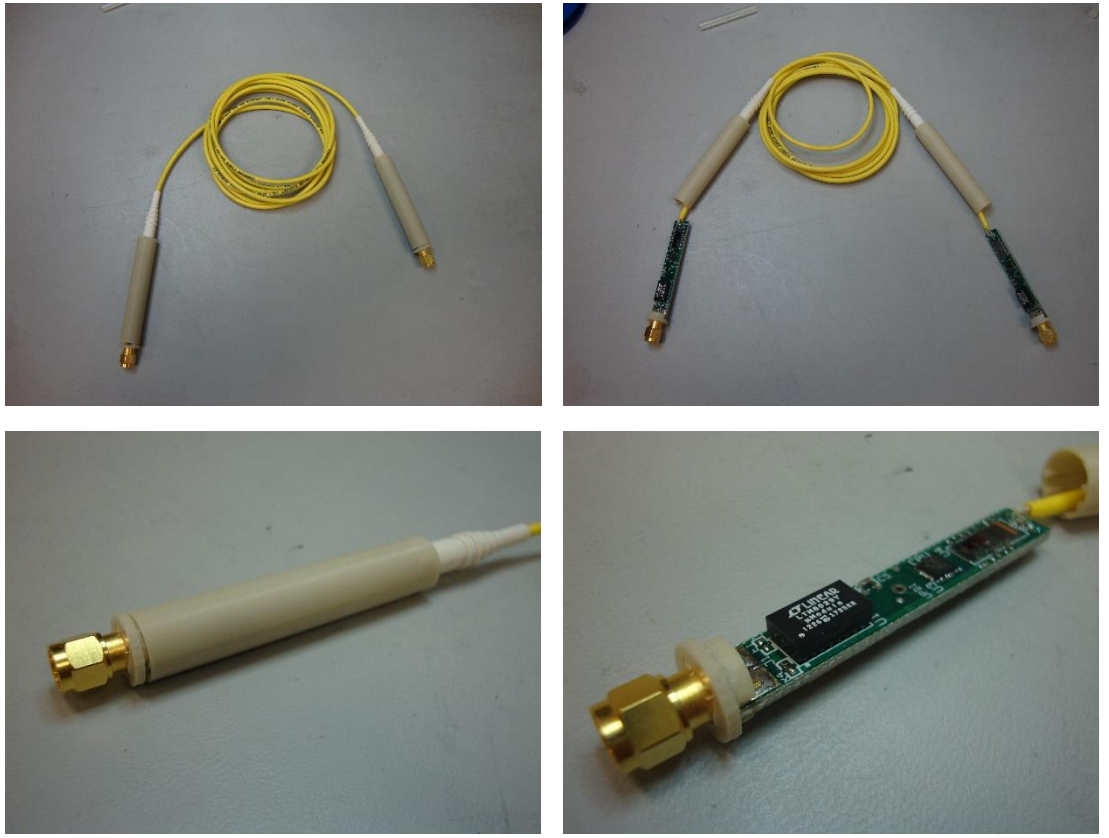
RF OVER FIBER BLOCK DIAGRAM



A NUMBER OF PHOTONIC AND ELECTRONIC COMPONENTS ARE NECESSARY TO IMPLEMENT AN RF OVER FIBER SOLUTION

RF OVER FIBER DISCRETE VS. INTEGRATED SOLUTION PACKAGING



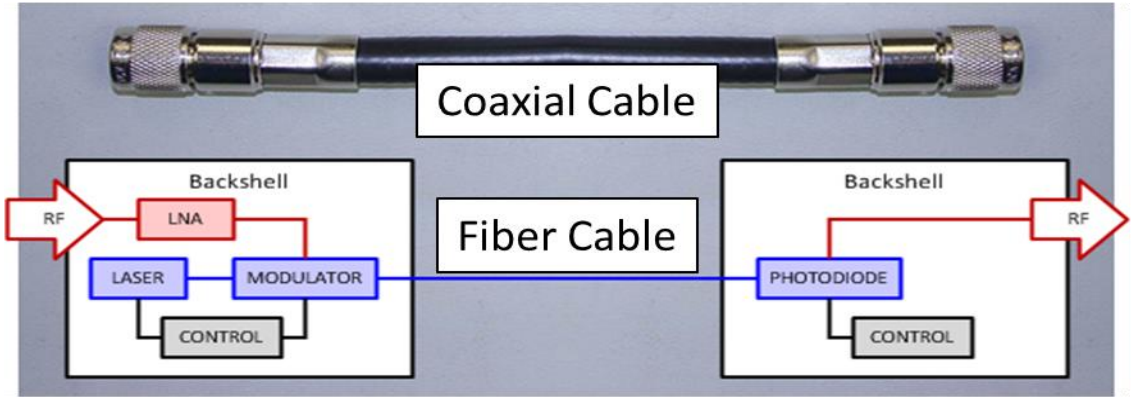


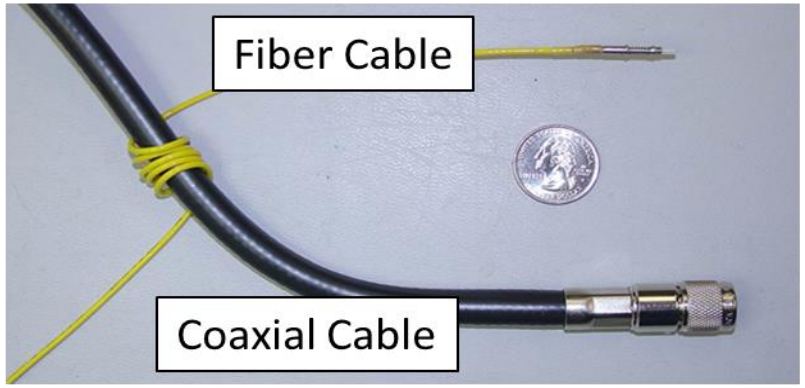
RF OVER FIBER DISCRETE VS. INTEGRATED SOLUTION PERFORMANCE

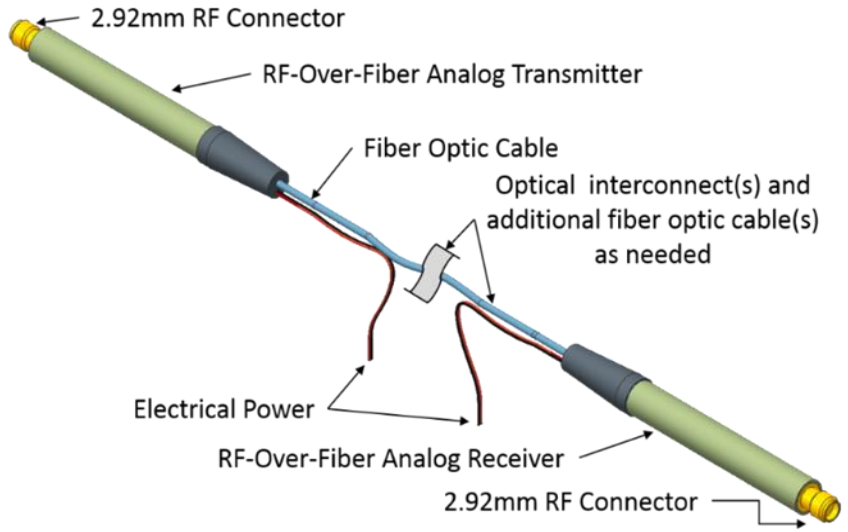
Component	Parameter	Unit	Discrete Components	Integrated		
				Current	Near Term	Long Term
Laser	Power	dBm	20	10	20	23
	RIN	dB/Hz	-155	-145	-160	-170
MZM	Vpi (@ 1 GHz)	V	5	5	4	2
	Vpi (@ 18 GHz)	V	6	8	6	3
	Excess Loss	dB	4.5	6	4	2
Photodiode	Responsivity	A/W	0.8	0.5	0.7	0.8
	Max Linear Current	mA	23	10	20	40
RF Performance	3 dB Bandwidth	GHz	>20	18	27	40
	Gain	dB	-16	-44	-15	2
	Noise Figure	dB	35	50	32	19
	Input 1 dB Compression	dBm	15	16	14	8
	OIP3	dBm	8	-19	8	19
	SFDR	$dB/Hz^{2/3}$	108	100	110	115

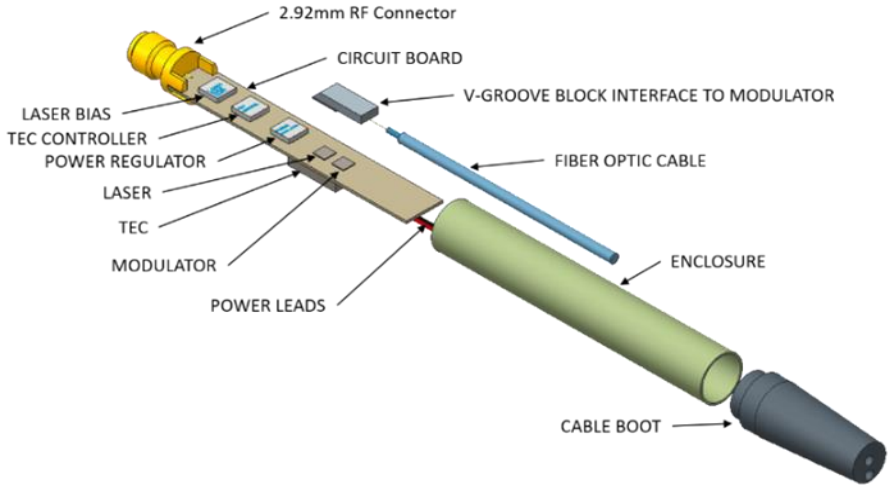
ROADMAP TO ACHIEVE DISCRETE PERFORMANCE WITH CSWAP IMPROVED INTEGRATED SOLUTION

RF ANALOG PHOTONIC LINK USING INTEGRATED PHOTONICS





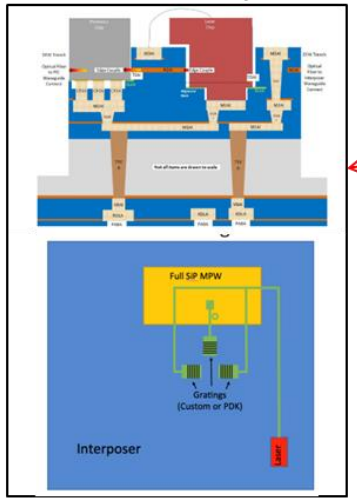


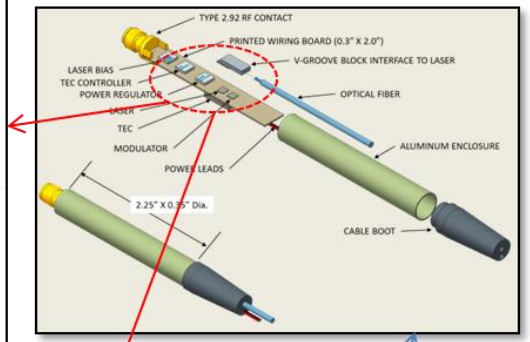


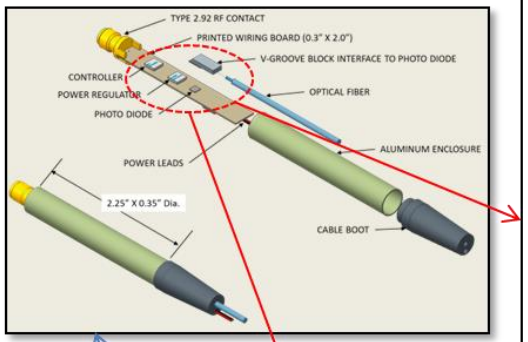
INTEGRATED PHOTONICS – LEVERAGING AIM PHOTONICS

RF over Fiber Implementation

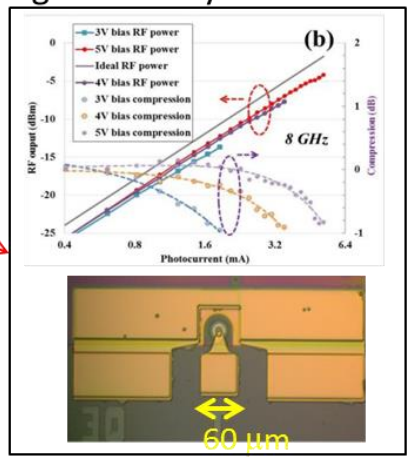
Laser on Interposer



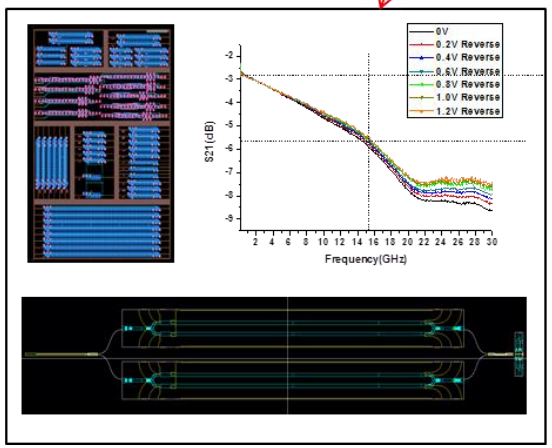


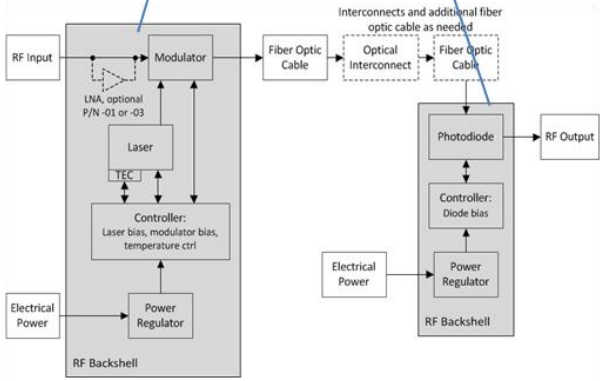


High-Linearity Photodiode

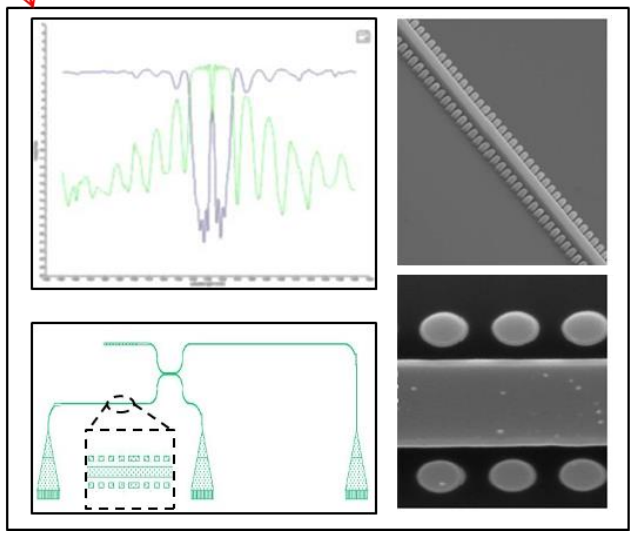


Low Vπ Modulator



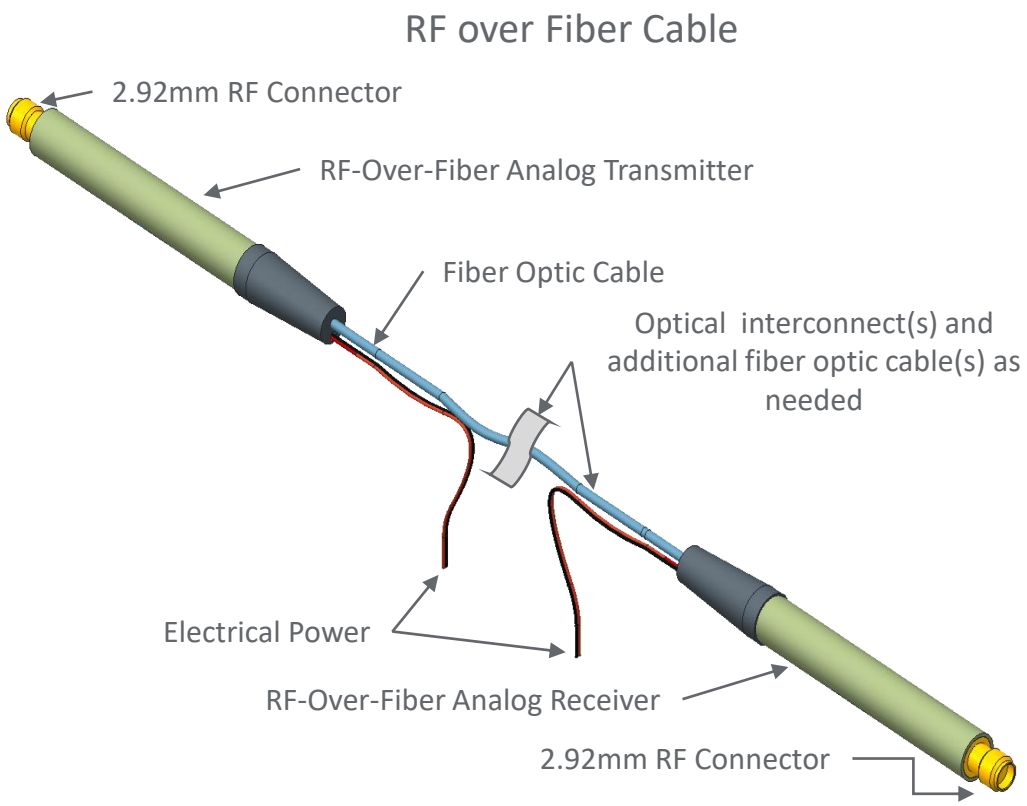


RF Filters



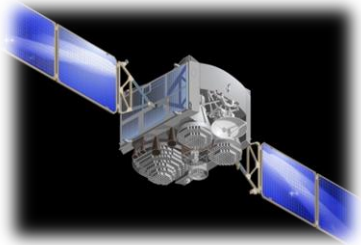
APPLICATIONS OF OPTICAL FIBERS

- Long link spans where coax cable is too costly and/or too heavy.
- Very high RF frequencies or wide bandwidths where the coaxial cable losses are excessive.
- Cases where the aircraft thermal or mechanical environment causes disruption to electrical cable performance or lifetime. This is especially important for phase stable applications.
- Cost of the electrical coaxial cable is excessive for long cable lengths and wide bandwidths.
- System restrictions which limit the number of cables or connectors allowed. The electronic circuitry in fiber optic links can be lower cost and SWaP when multiple signals are required to be carried on a single cable.
- Very low EMI or EMP tolerance or lightning impact tolerance is a system requirement.
- System requirements where repeated motion of the cable is performed such as on a hinged door or access panel or weapon/pod interface cable.



OPERATING ENVIRONMENT

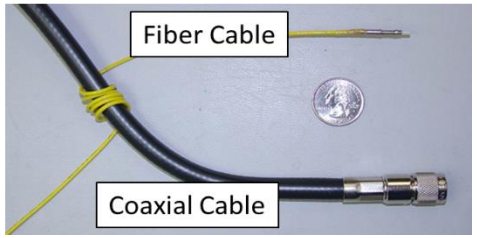
Must perform in…

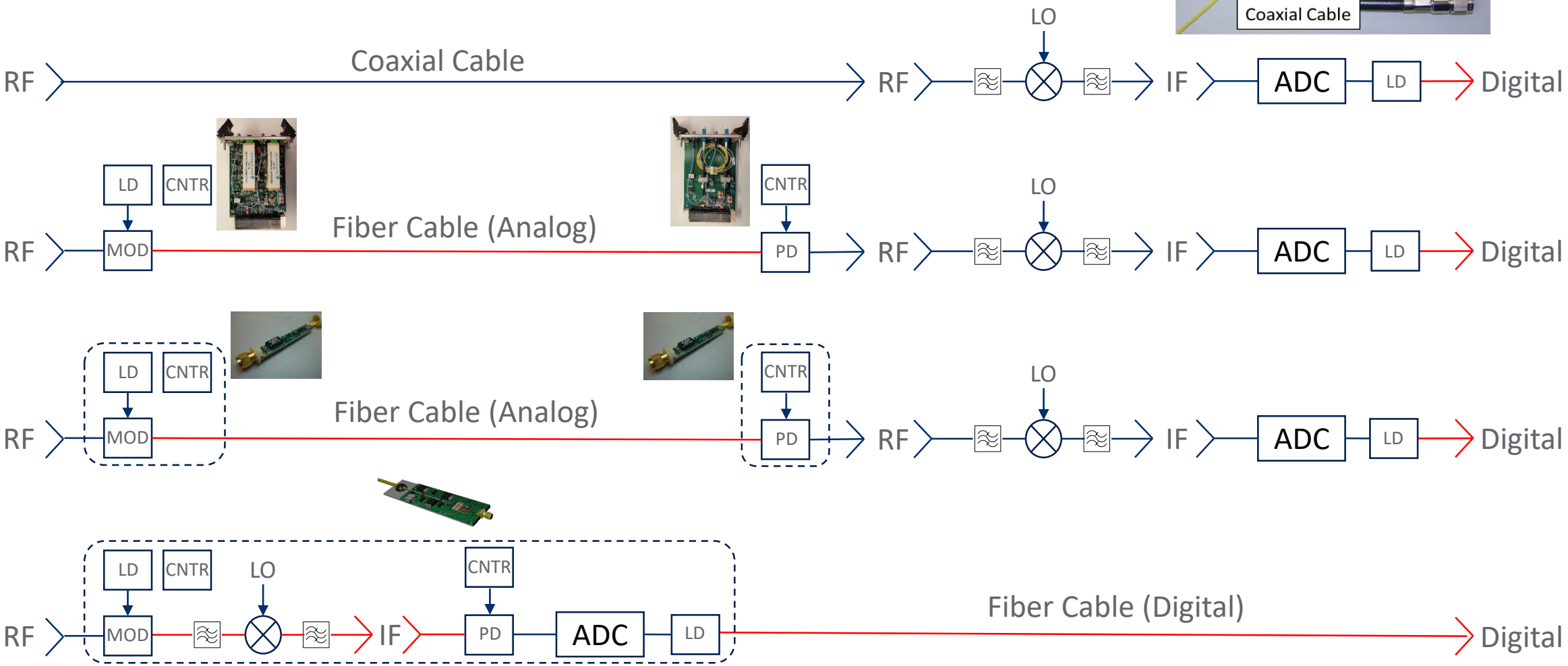


Harsh Environments

Extreme Conditions

RF OVER FIBER IMPLEMENTATION EVOLUTION





QUESTIONS?


LOCKHEED MARTIN