An Optical Receiver Post Processing System for the Integrated Radio and Optical Communications Software Defined Radio Test Bed

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Outline

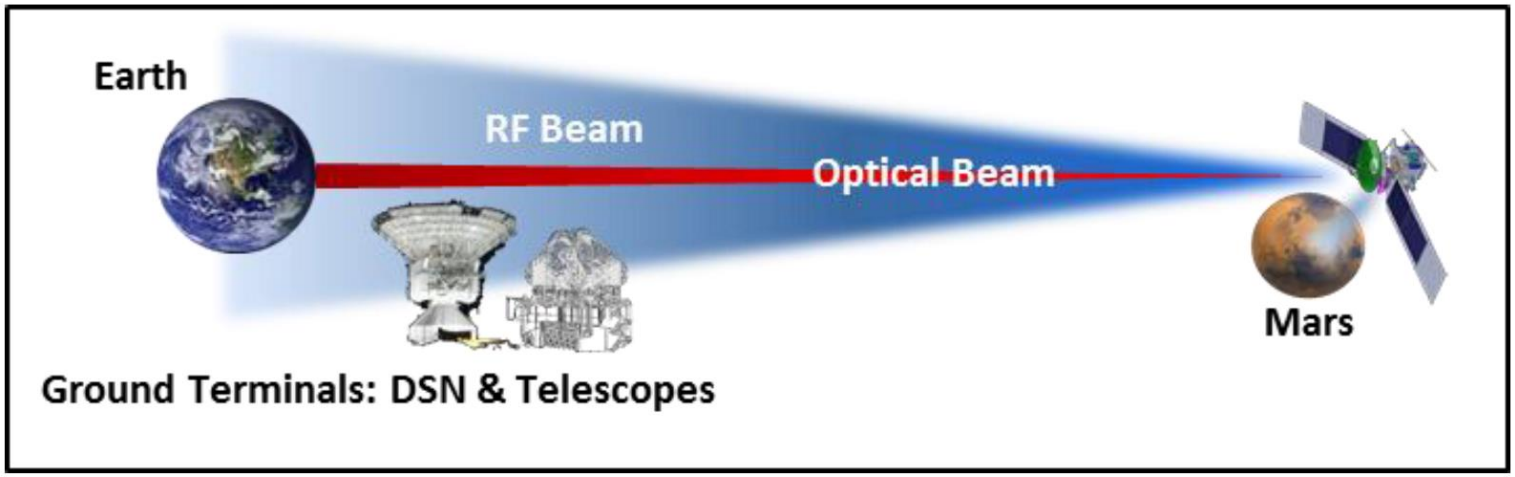
- Integrated Radio and Optical Communications Project Overview
- Optics Subsystem
- Analog Subsystem
- Digital Subsystem
- Testing Results
- Conclusions
- Acknowledgements

RF/Optical Transmitter and Optical Receiver

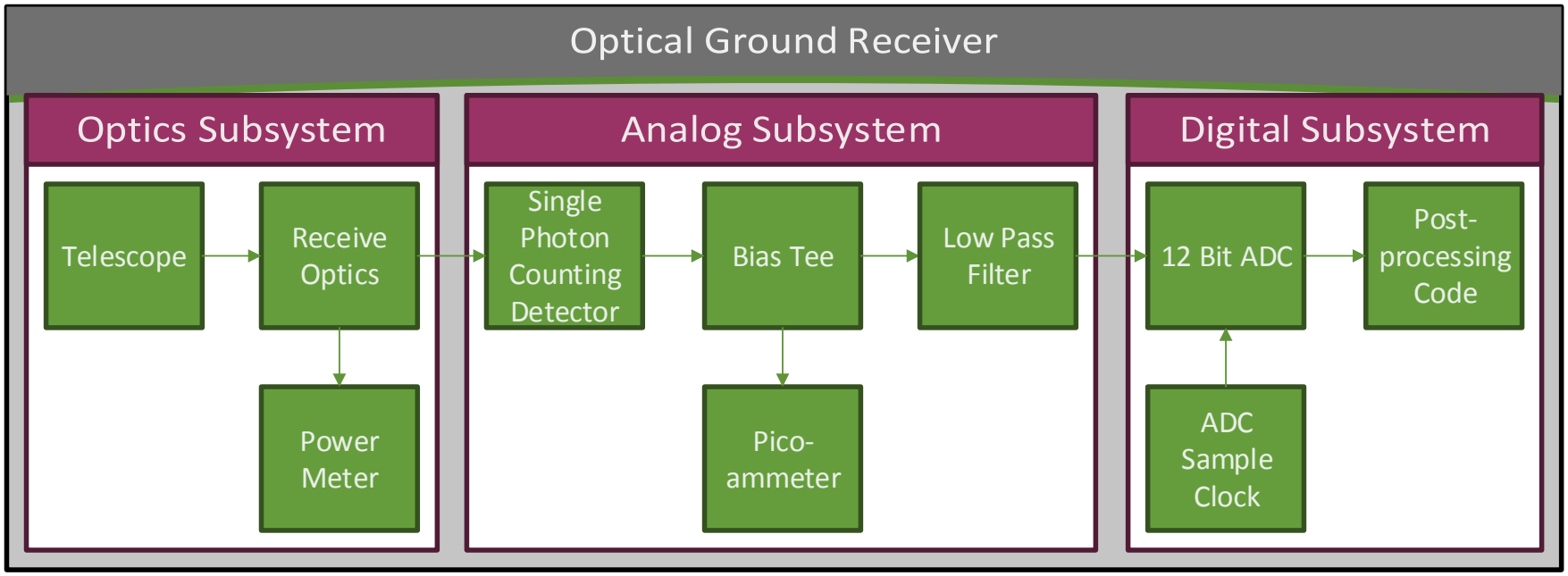
Integrated Radio and Optical Communications Project (iROC) Overview

Description:

- Technology development program for integration of RF and optical deep space communication systems.
- Key areas of development include:
  - RF antenna + optical telescope = teletenna
  - Beaconless (open loop) optical pointing
  - RF/Optical software defined radio

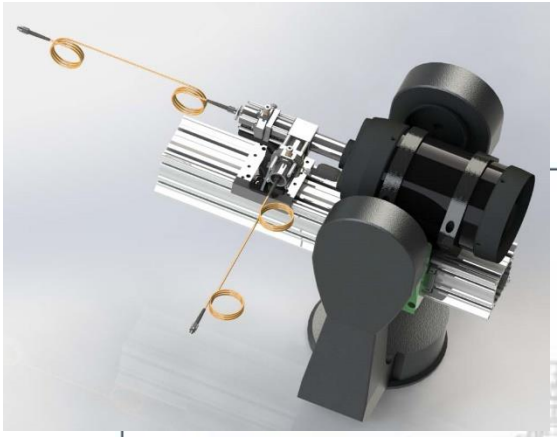


Receiver Architecture Overview



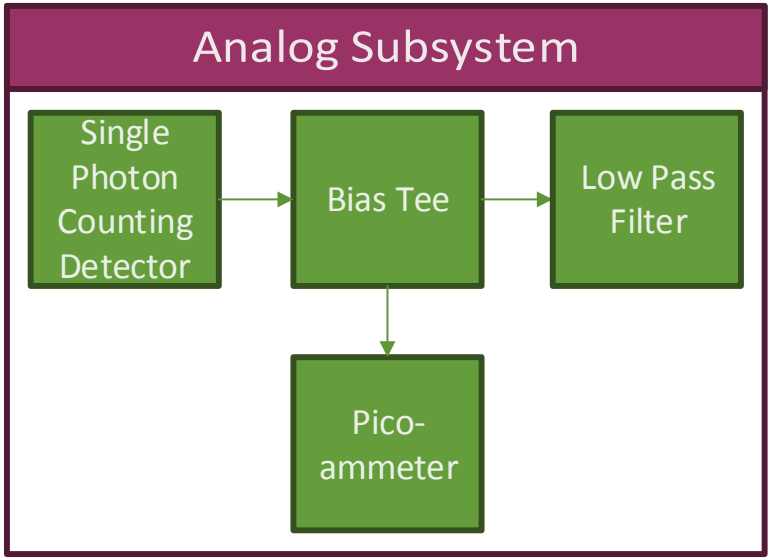
The receiver includes: Optics Subsystem, Analog Subsystem, Digital Subsystem

Optics Subsystem



Light is focused using a Cassegrain telescope, filtered, collimated, and then split (90/10). The splitter allows for monitoring of the received power using a power meter while simultaneously receiving the signal.

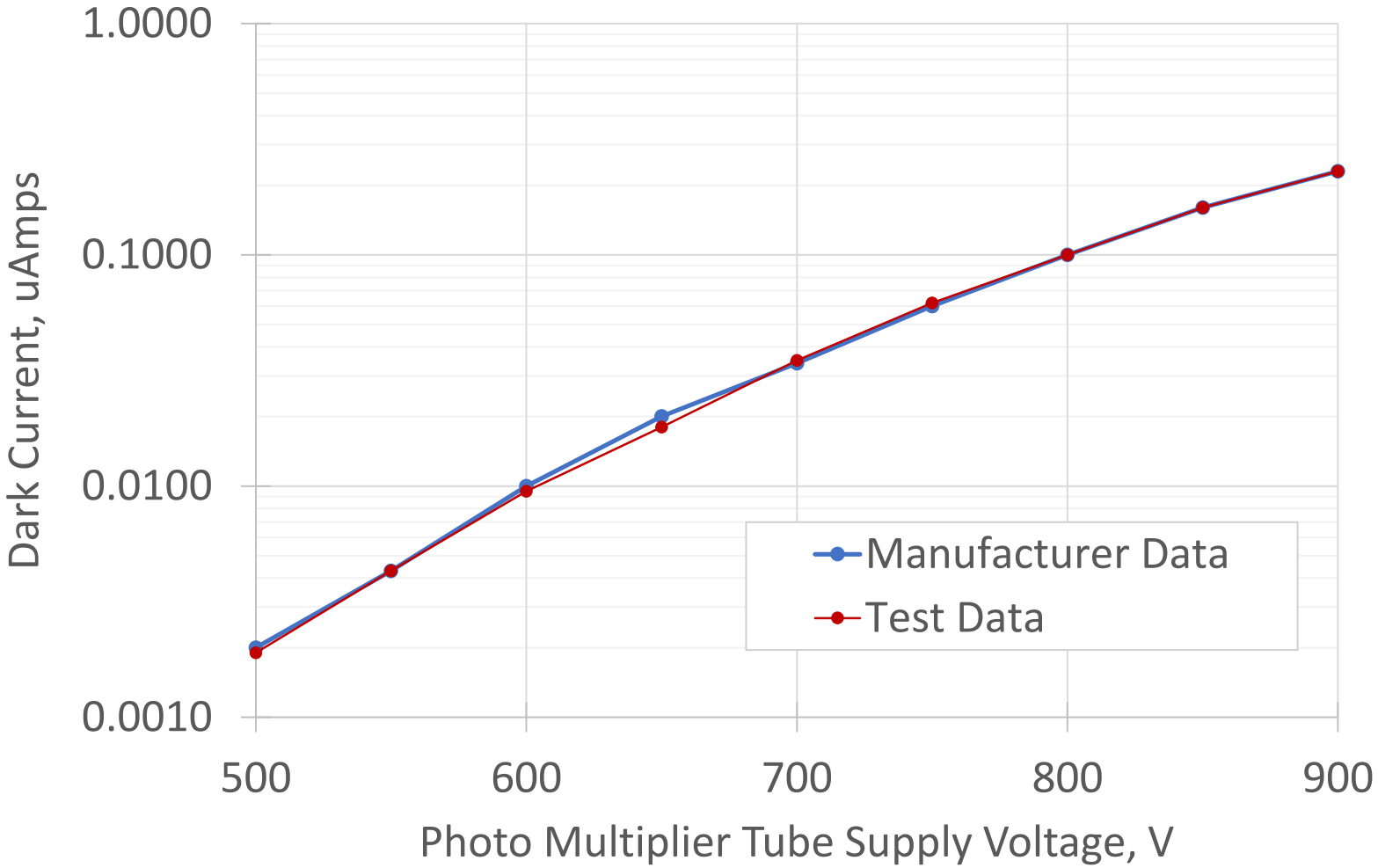
Analog Subsystem



Components:

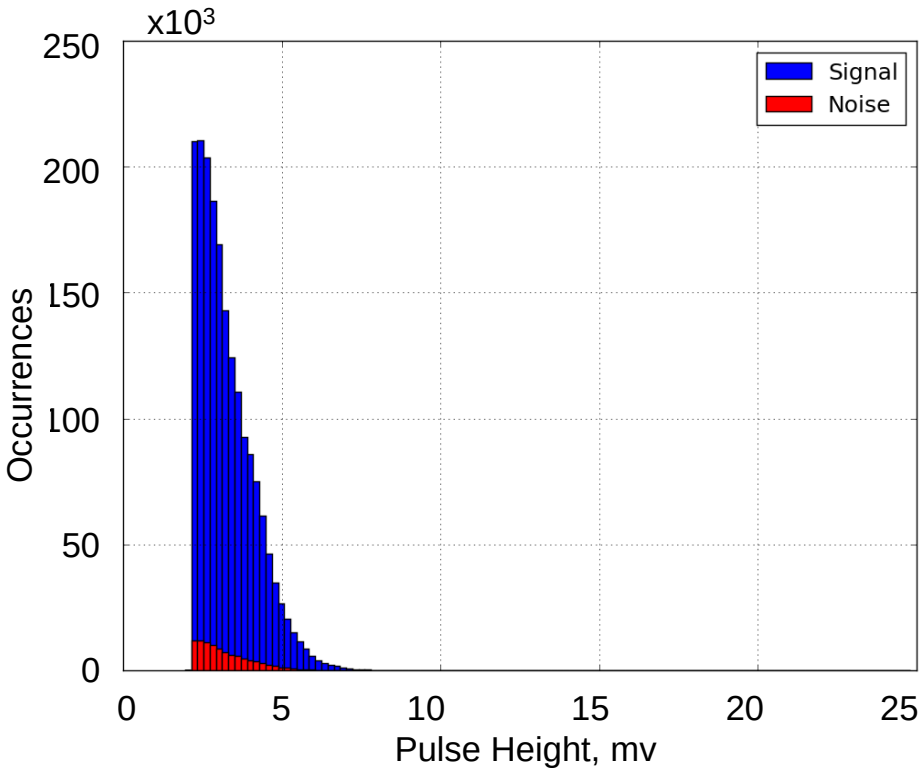
- Photomultiplier Tube (PMT)
- Bias Tee
- Picoammeter
- Low Pass Filter

PMT Dark Current Characterization

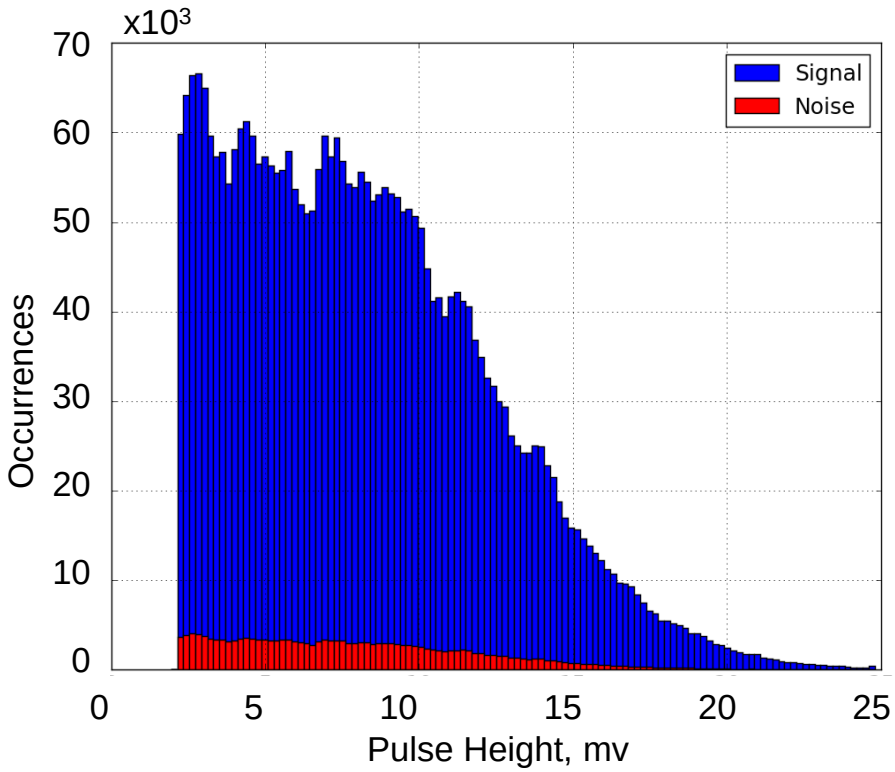


PMT dark current measurement was consistent with the manufacturer test data.

PMT Pulse Height Distribution

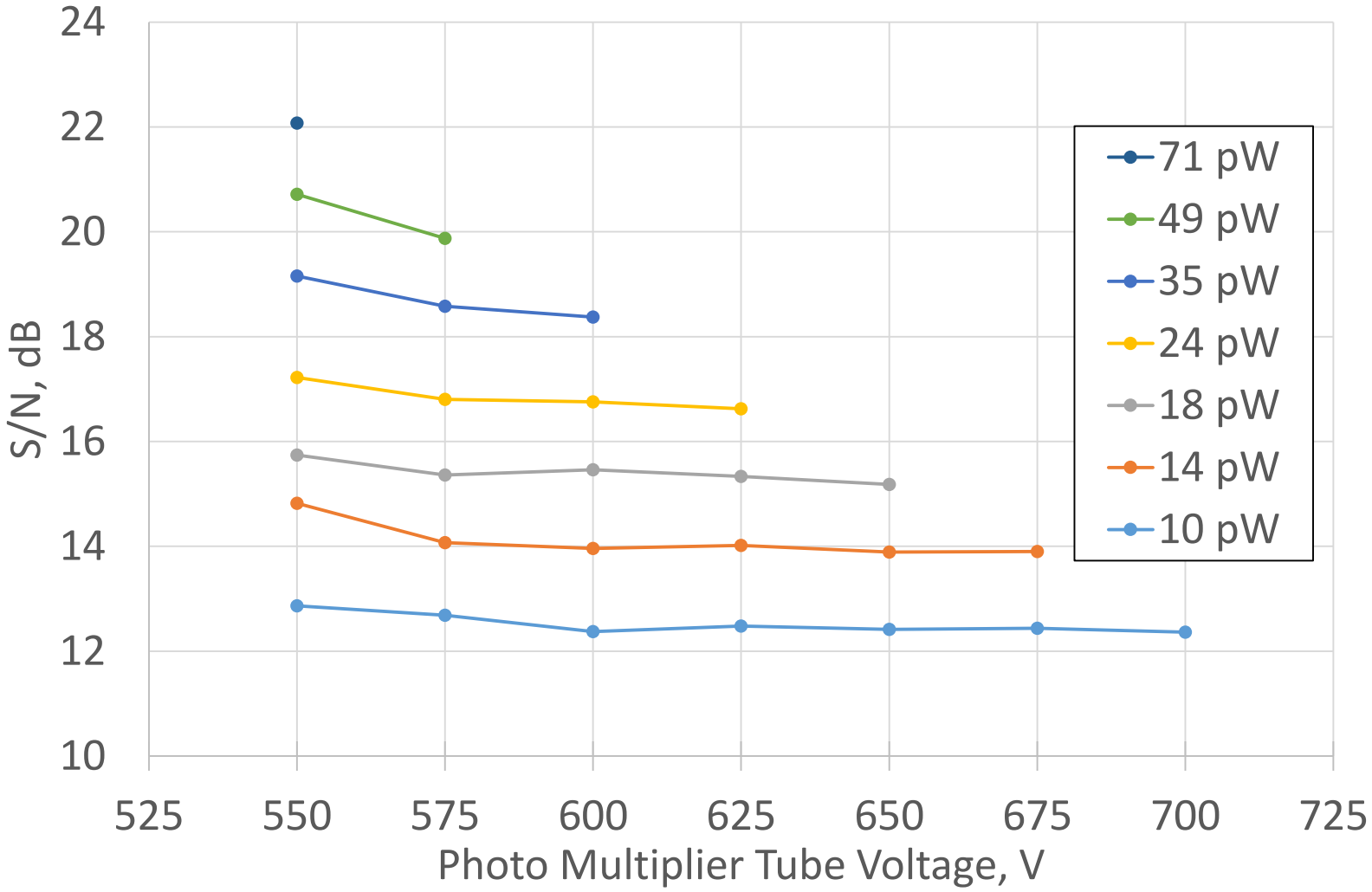


PMT supply voltage = 575 V

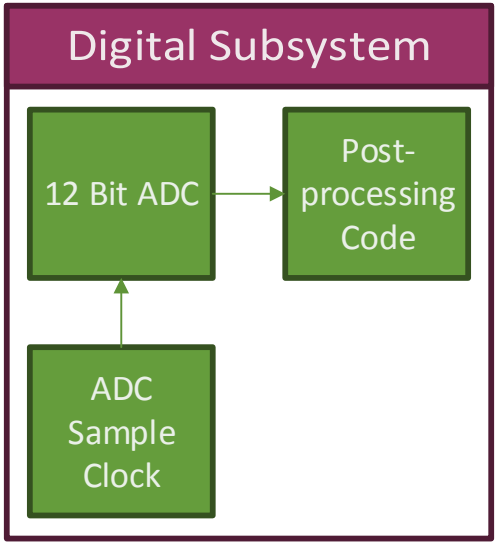


PMT Supply voltage = 675 V

PMT S/N Ratio


24
22
20
18
16
14
12
10
S/N, dB
525
550
575
600
625
650
675
700
725
Photo Multiplier Tube Voltage, V
71 pW
49 pW
35 pW
24 pW
18 pW
14 pW
10 pW

Digital Subsystem



Components:

- 12 bit analog to digital (ADC) converter
- 600 MHz ADC sample clock
- Post processing computer
- SCPPM post processing code
  - SCPPM-16 (serially concatenated pulse position modulation) rate ½
  - Developed by the Jet Propulsion Laboratory for the Lunar Laser Communications Demonstration
  - Modified to include both the frame acquisition sequence and inner symbol guard time

System Capability

Data Samples (GB)	Code Words Processed	Code Word Errors	Code Word Error Rate	K_s (photons/ signal slot)	K_b (photons / slot)	Average PMT Current (μA)	Specified EO Modulator Extinction Ratio
100	43,900	14	0.00032	3.6	0.037	0.91	20 dB
100	43,900	4	0.000091	4.3	0.0025	0.93	>40 dB
100	43,900	292	0.0067	3.3	0.016	~0.9*	>40 dB
250	109,756	270	0.0025	3.4	0.014	~0.9*	>40 dB
1	428	2	0.0047	3.1	0.016	~0.9*	>40 dB

Configuration:

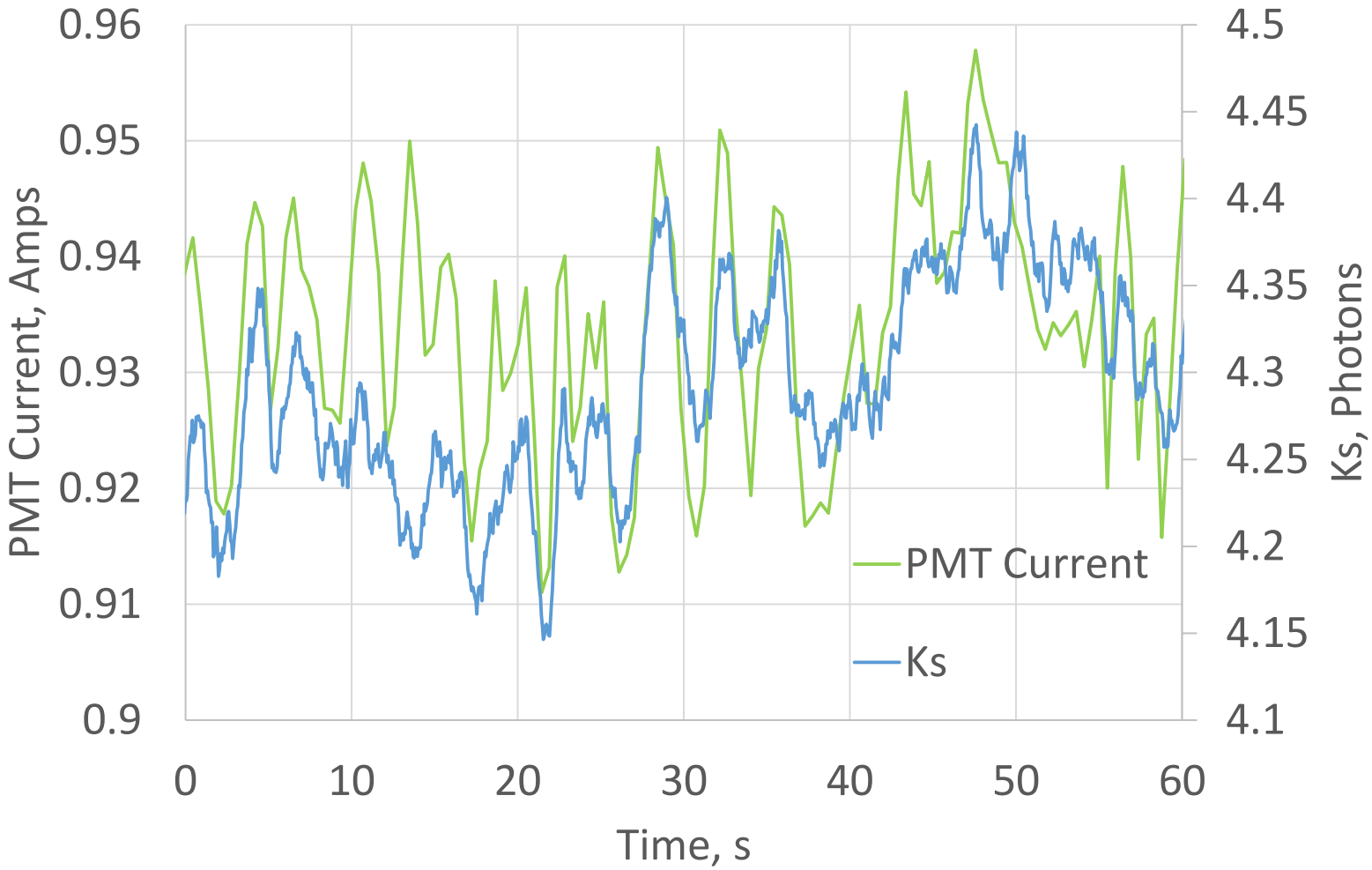
- Modulation: SCPPM-16, rate ½
- Slot clock: 20 MHz (50 ns)
- Data rate: 2 Mbps
- ADC Clock: 600 MHz
- PMT Supply Voltage: 575 Volts

Nomenclature:

- Ks = average signal photon per signal slot
- Kb = average background photon per slot

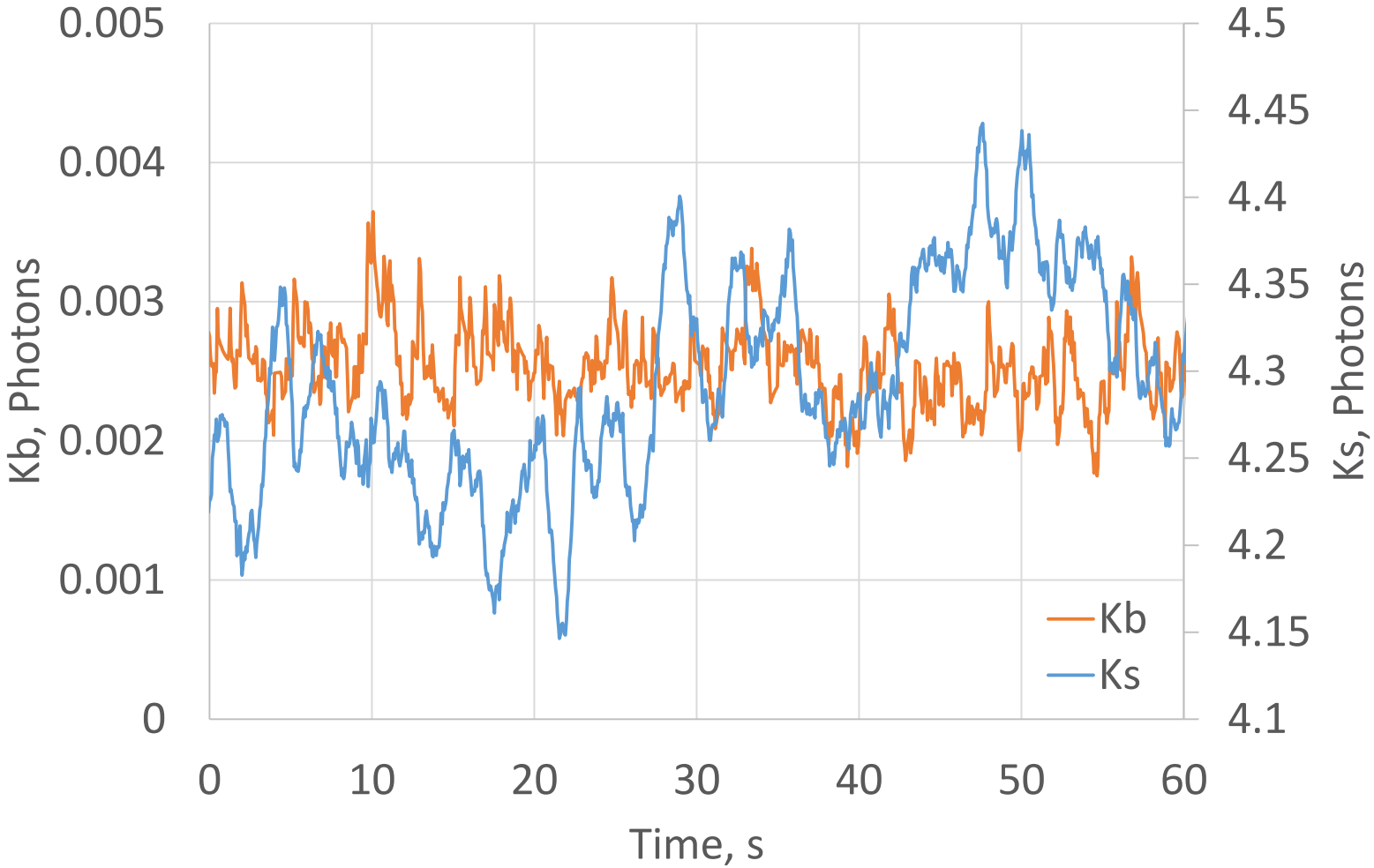
* The PMT current was set to 0.90-0.95 uA as part of the testing procedure, but data was not recorded for the duration of the test.

PMT Current and Ks



- Ks = average signal photon per signal slot

Ks and Kb



- Ks = average signal photon per signal slot
- Kb = average background photon per slot

Conclusions

- A post processing receiver system was developed for an optical SCPPM transmitter.
- The system can post process up to 250 GB of data.
- The receiver system will be used to test future optical SCPPM transmitters under varying conditions.

Acknowledgements

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