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Gang Chen, Zhengyuan Xu

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14. ABSTRACT
This is the interim progress peport of agreement number: W911NF-09-1-0293. Research topic is "Performance Limits of Non-Line-of-Sight Optical Communications". Report Period is August 2011 to January 2012. During this report period, the following have been achieved:
1. Developed a long distance UV channel test bed.
2. Proposed a Neighbor Discovery Protocol for UV network.

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Report Title

Performance Limits of Non-Line-of-Sight UV Communications

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1. Developed a long distance UV channel test bed.
2. Proposed a Neighbor Discovery Protocol for UV network.
3. Modeled long distance NLOS UV channel
4. Designed a UV communication system working on USRP software defined radio platform.

Wireless Information Technology Lab, UCR

Performance Limits of Non-Line-of-Sight UV Communications

Progress report
1 August 2011–1 January 2012

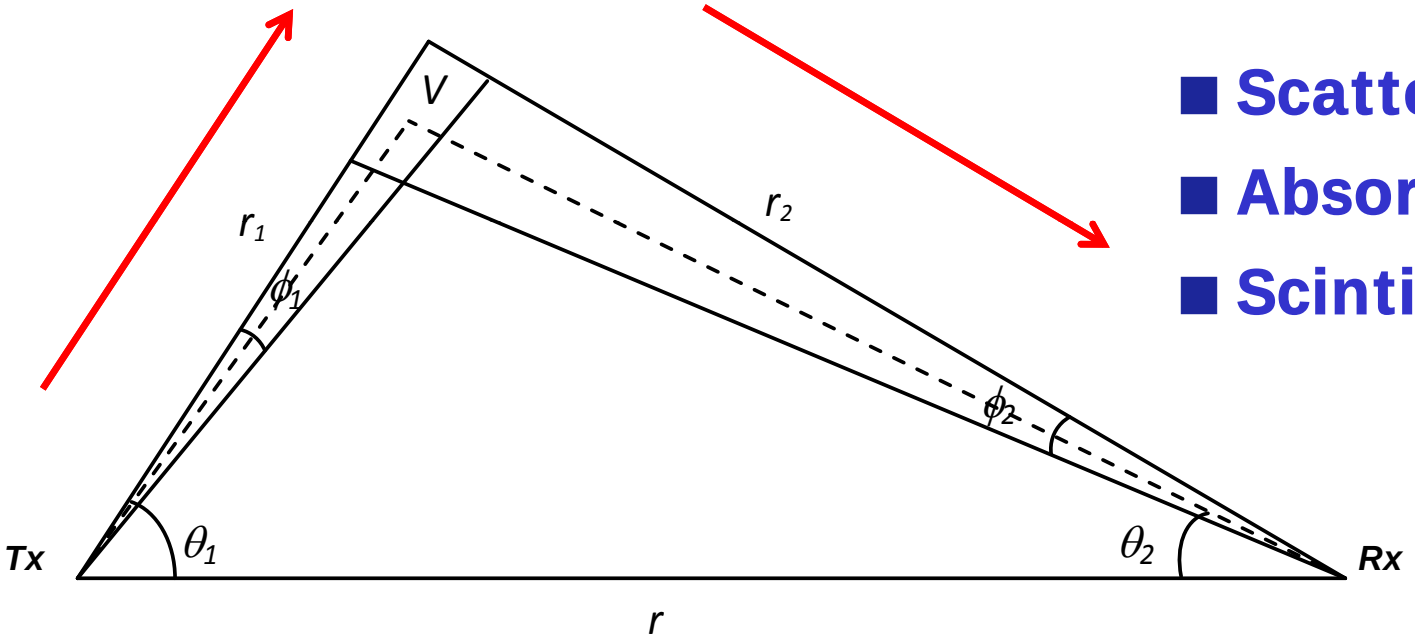
Gang Chen

University of California, Riverside, CA 92521

http://witlab.ee.ucr.edu

gachen@ee.ucr.edu

1. Turbulence modeling for NLOS UV scattering channels



- Scattering
- Absorption
- Scintillation

- NLOS = LOS (Tx -> V) + LOS (V -> Rx)
- LOS path follow LN PDF

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NLOS UV Scintillation Model

Tx -> V: PDF at the common volume

$$f_x(x) = \frac{1}{x\sigma_x\sqrt{2\pi}} \exp\left(-\frac{\left(\ln\frac{x}{E[x]} + \frac{1}{2}\sigma_x^2 \right)^2}{2\sigma_x^2} \right)$$

V -> Rx: assume single scattering

$$f_y(y|x) = \frac{1}{y\sigma_y\sqrt{2\pi}} \exp\left(-\frac{\left(\ln\frac{y}{E[y|x]} + \frac{1}{2}\sigma_y^2 \right)^2}{2\sigma_y^2} \right)$$ **Conditional PDF**

$$f_{x,y}(x,y) = f_y(y|x) f_x(x)$$ **Joint PDF**

$$f_y(y) = \int f_{x,y}(x,y)\,dx$$ **PDF at Rx**

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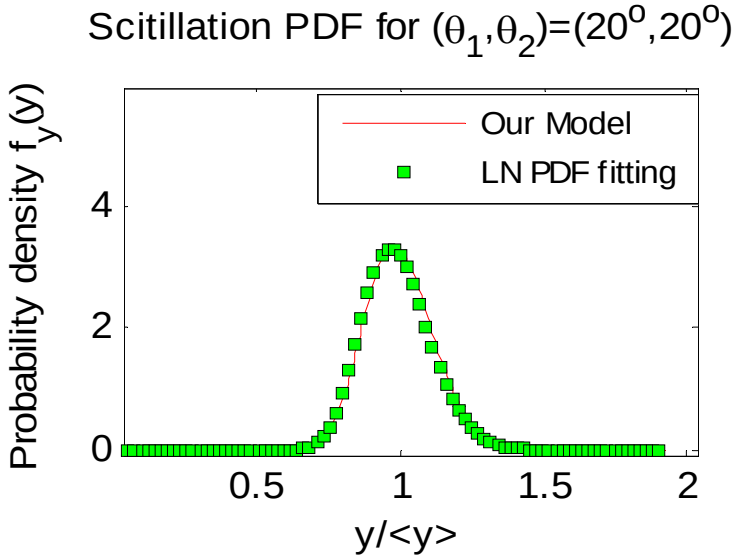
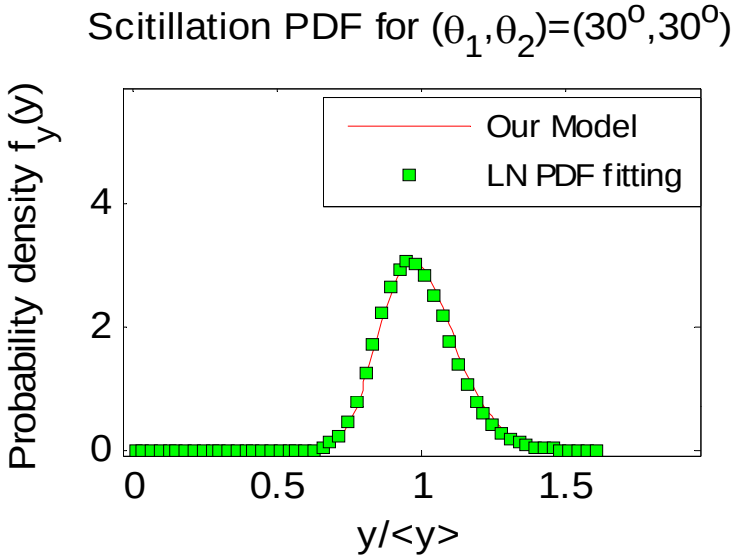
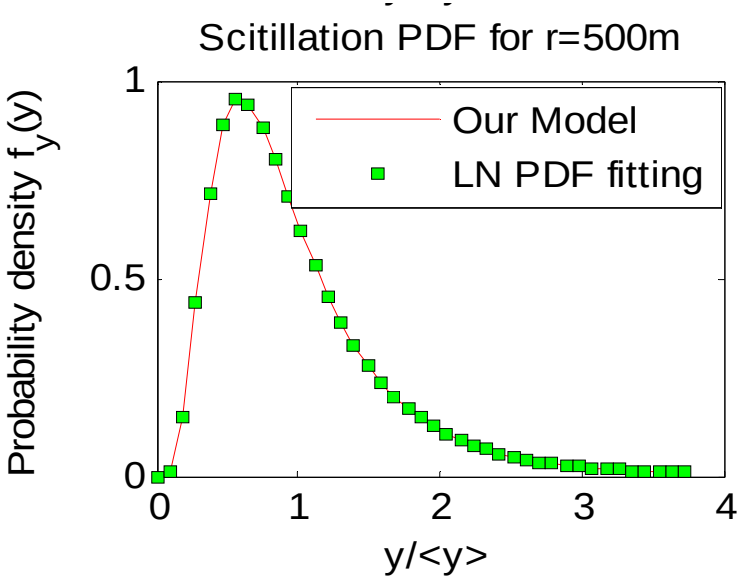
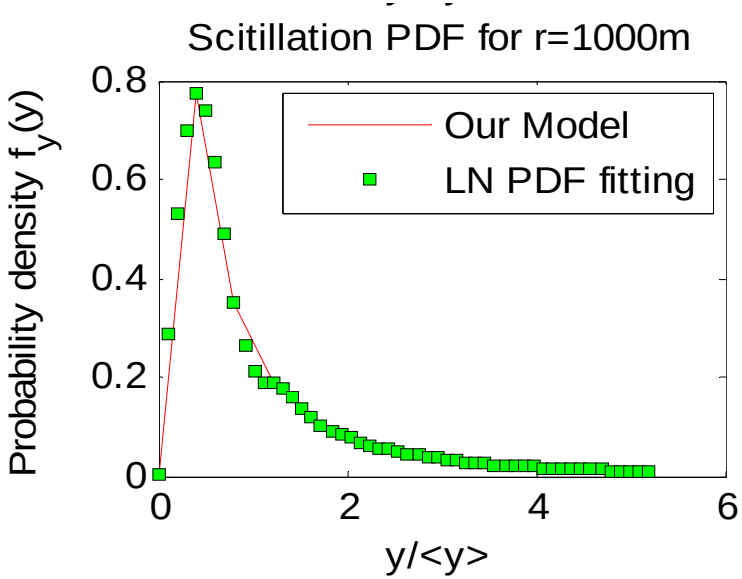
Primary results









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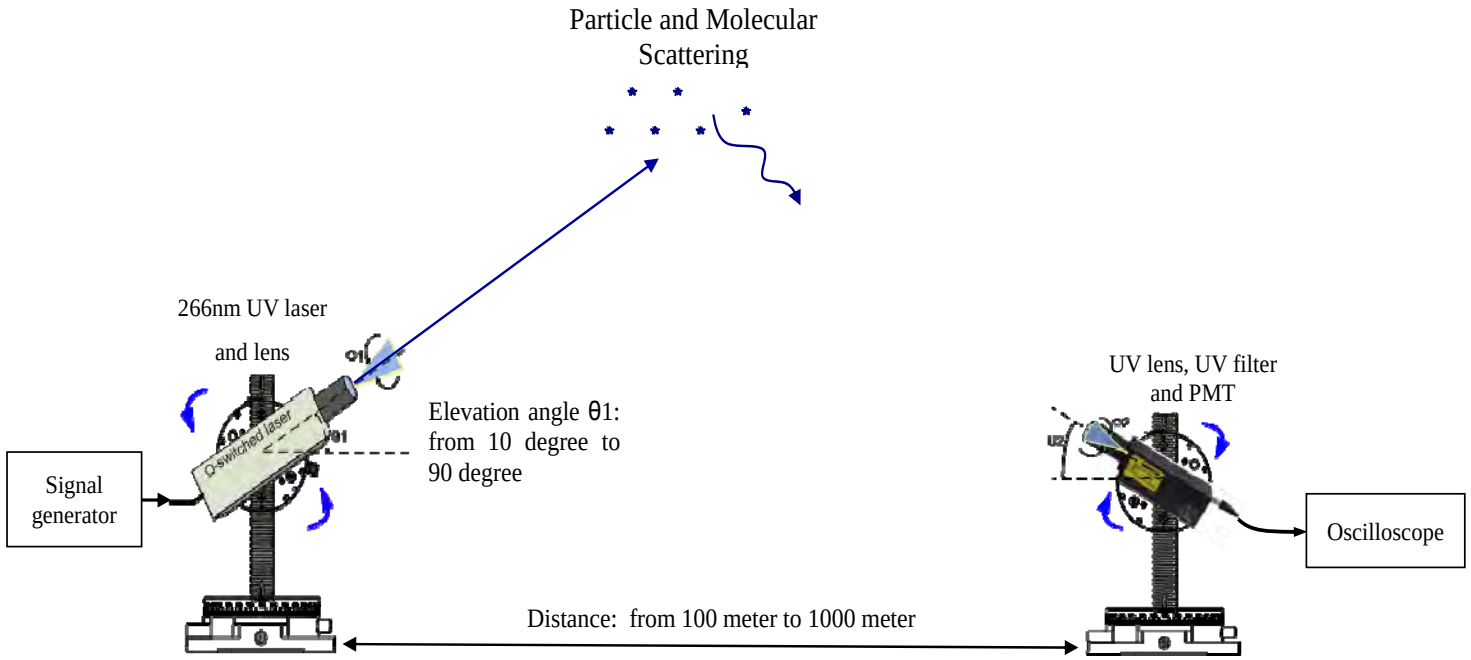
2. UV long distance test bed



Transmitter :Q-switched fourth harmonic Nd:YAG laser at 266nm
15 Hz with pulse width (3-5) ns and energy (3-5) mJ
Rotation angle θ1 10 º – 90 º

Receiver: PMT detector +high speed preamplifier→ 3 GHz oscilloscope
Waveform record

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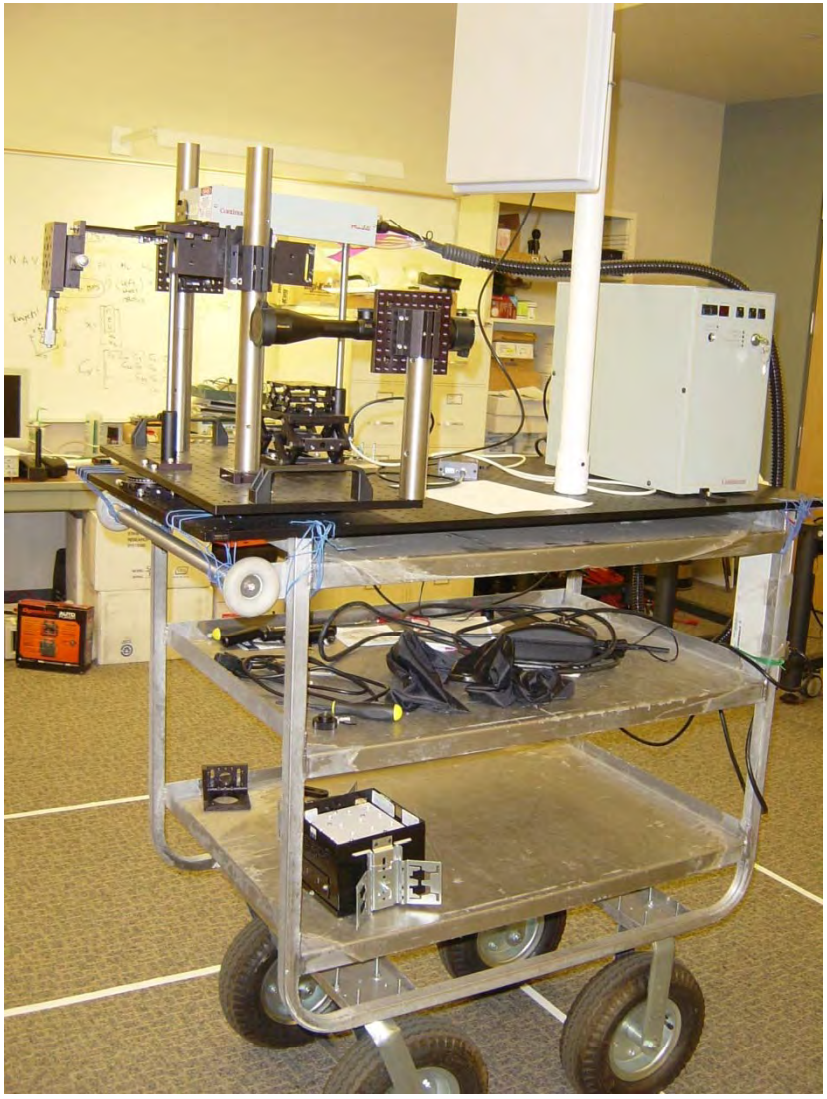
UV test bed picture



Laser Transmitter

PMT+ Osc Recorder

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3. UV system design on SDR platform

SFF-SDR from Lyrtech

- TMS320DM6446 DM SoC
- 128MB DDR2 SDRAM
- Virtex-4 SX35 FPGA
- 125MSPS, 14-bit ADCs
- Dual channel 500MSPS, 16bit DACs

The USRP2 from GNU Radio

- Two 100 MS/s 14-bit ADC
- Two 400 MS/s 16-bit DAC
- Gigabit Ethernet Interface
- 2 Gbps high-speed serial interface
- Modular RF daughter boards
- Fully MIMO capable up to 8 nods
- 1 Megabyte high-speed SRAM

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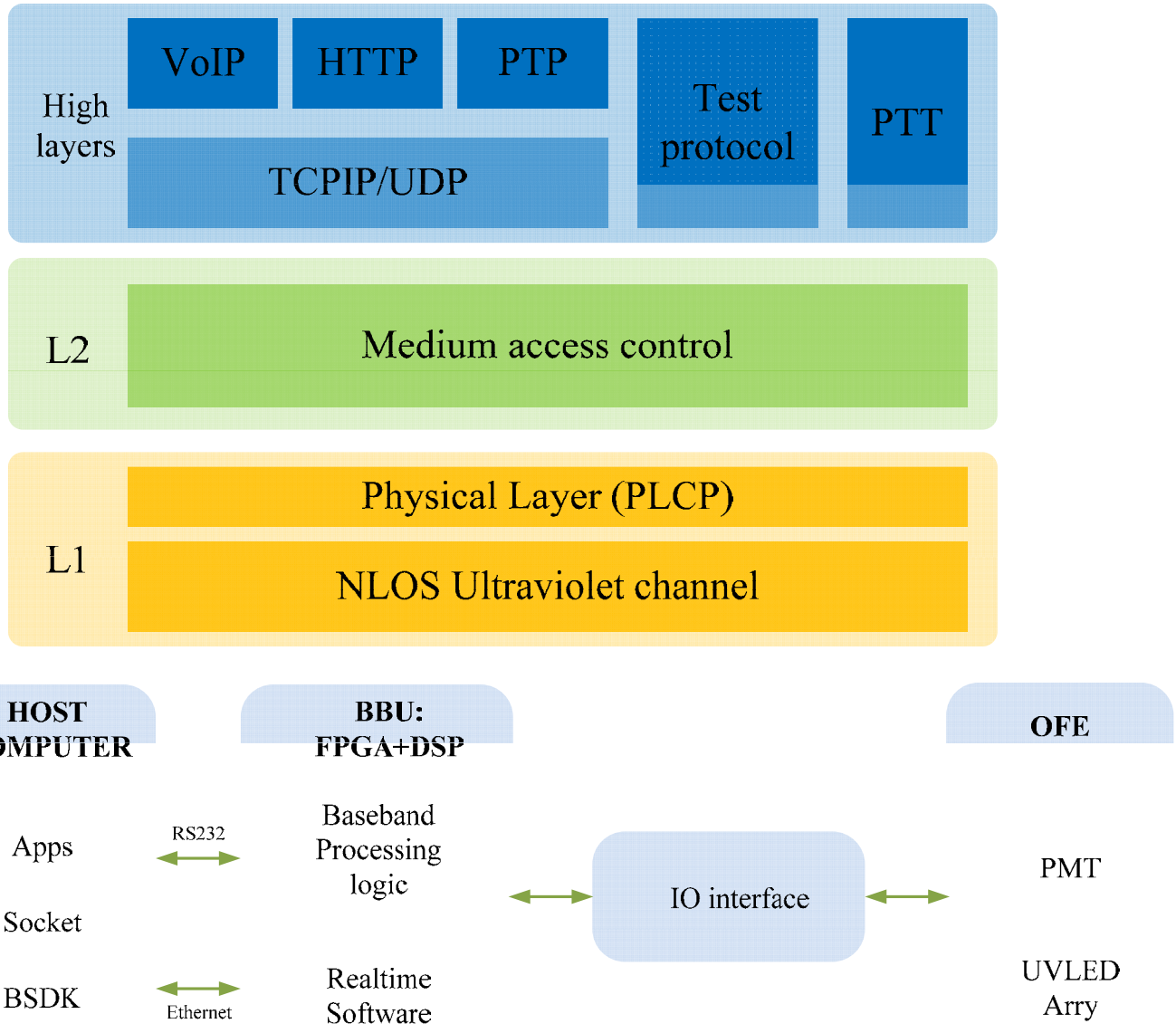
UV on SDR Architecture and Protocol



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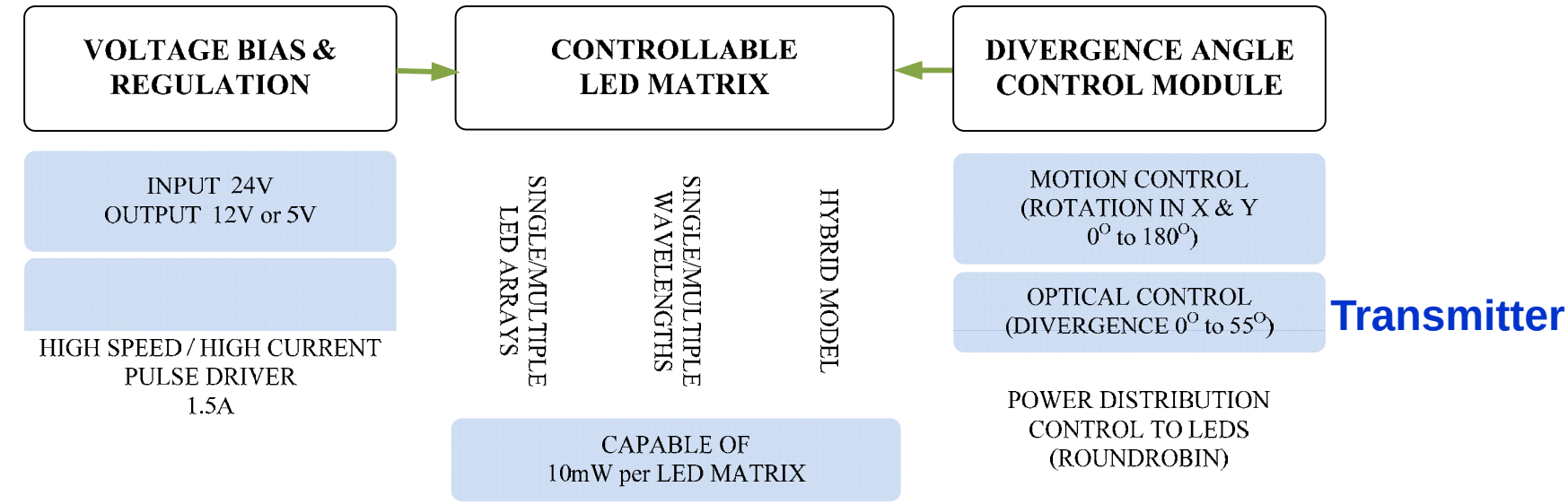
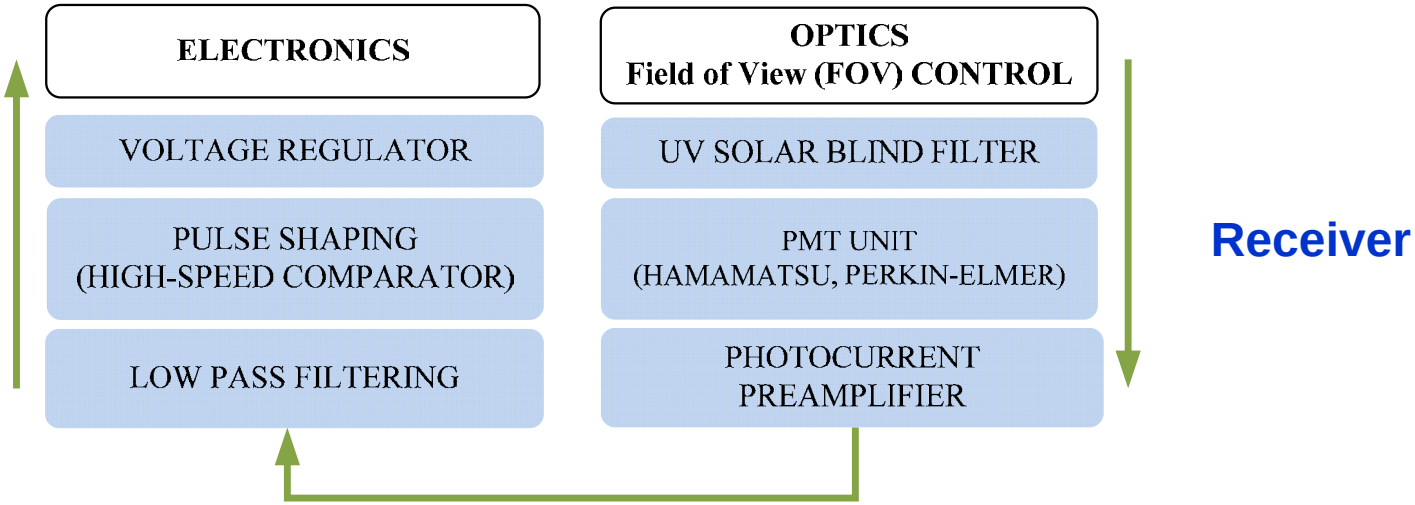
Optical front end design





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Future Work

- Analytical UV long distance model
- UV long distance channel test and model validation
- Multi-node system protocols design
- Implementation UV front end based on USRP software defined radio platform

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