Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [VLC Channel Modeling Simulation for Automotive Applications]
Date Submitted: [xx March, 2010]
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Re: []

Abstract: [Results of channel modeling simulation are presented. The impulse response of the LED lighting channel is simulated regarding the Automotive HeadLamp Regulation in several Cross-road Scenarios.]

Purpose: [Comments to IEEE 802.15.7 VLC TG]

VLC Channel Modeling Simulation for Automotive Applications

2010. 03. 16

LED-IT Fusion Technology Research Center (LIFTRC),
Yeungnam University

Contents

- Channel Model in VLC TG
- Channel Model for Automotive Applications
- Channel Modeling Simulation for Automotive Applications
- Discussion
- Conclusions & Further work

Channel Model in VLC TG

- Channel Model in VLC TG
  - Technical Consideration Document (TCD) provides “Types of Channels” for VLC TG.
    - Basic modeling structure
    - Modeling considerations & techniques
    - Typical situation & applications
  - No parameter details are described

- Still no announcement about channel model simulations or measurement results for automotive application scenario in VLC TG as we know…
  - Channel model for other application scenarios are already announced

Channel Model for Automotive Applications

- VLC for Automotive Application
  - Different to other scenarios & even more harsh environment
    - Long range, too many (or few) interferers
    - Different Light Source Characteristics
    - Light distribution is highly Restricted by Regulation

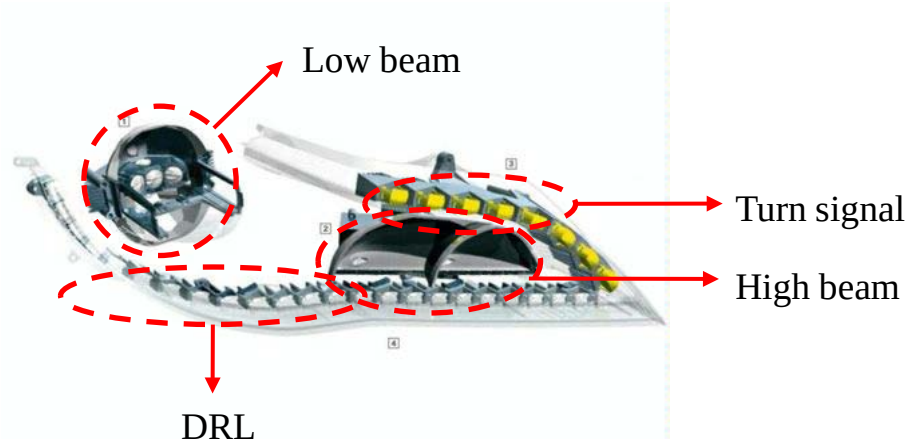
- Our Purpose
  - Provide some insight of deciding channel type for automotive applications based on simulation results
    - Real head lamp modeling
    - Consider regulation distribution for head lamp

Channel Modeling Simulation for Automotive Applications

Automotive HeadLamp Modeling

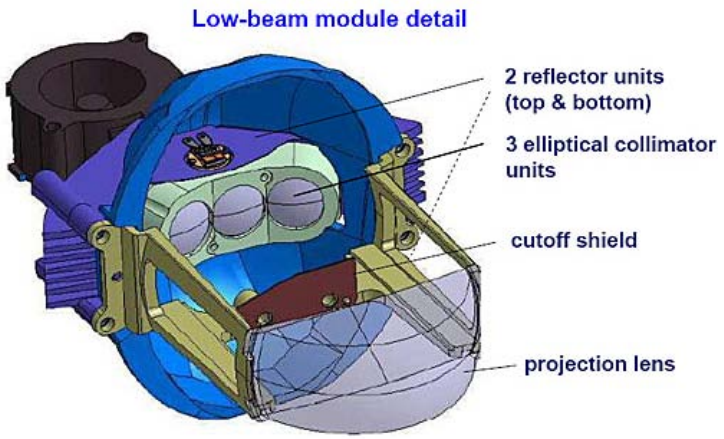
- Reference Model : Audi R8 low beam HeadLamp
- Modeling Tool : CATIA V5
- Simulation Tool : Lightools

Basic Structure of Audi R8 H/L

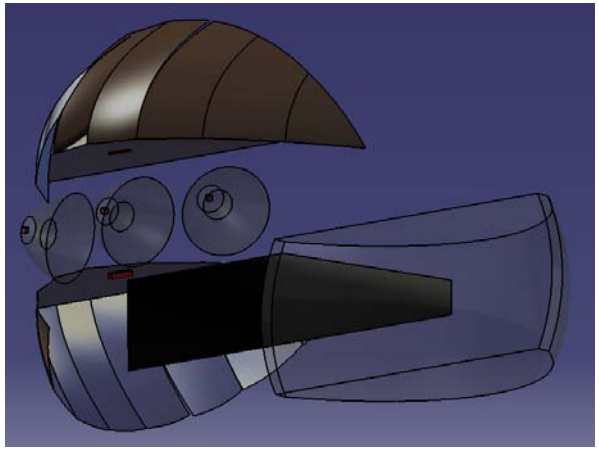


Modeling Data

Products



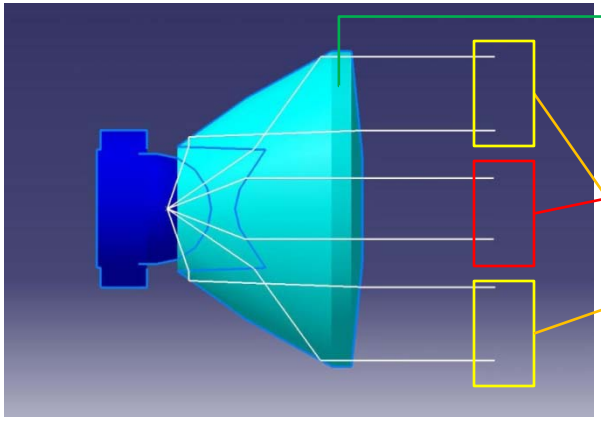
Modeling



- Components Details for Modeling
  - 3 collimator unit & 2 reflector unit
  - LED : (1) Osram Ostar LE UW D1W2 (for 2chip/collimator) → 255lm
    (2) Osram Ostar LE UW D1W4 (for 4chip/reflector) → 550lm
  - # of LED package : 2chip 3EA, 4chip 2EA
  - Lighting Output Power
    - 2chip : 255 lm, 4chip : 550 lm → Total 1865 lm

Light Distribution Design

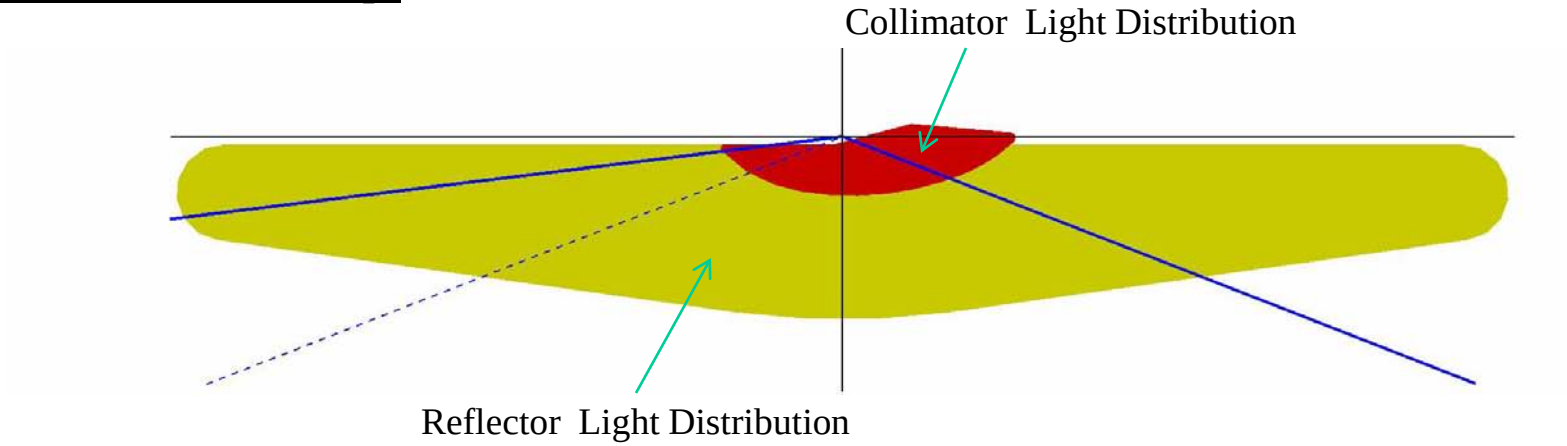
Collimator concept



- Freeform lens
- Light Pattern 1 (Refraction)
- Light Pattern 2 (TIR:Total internal reflection)

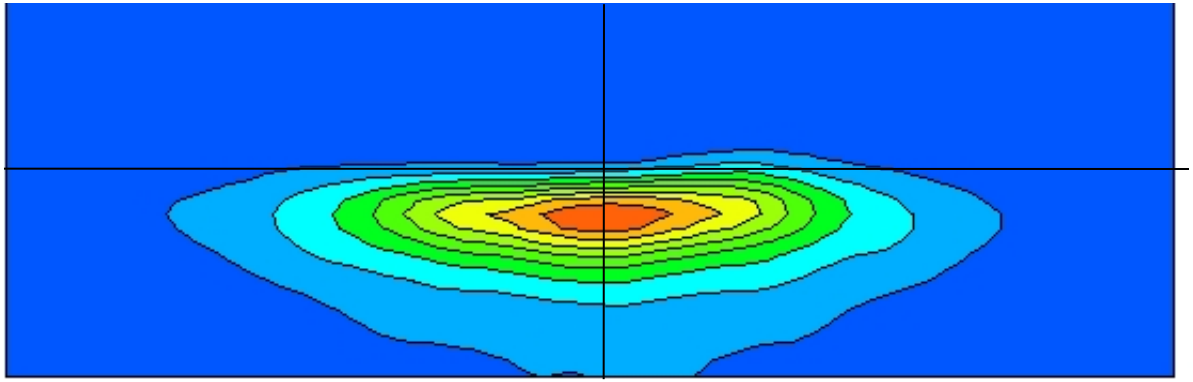
<collimator structure>

Light Distribution Concept

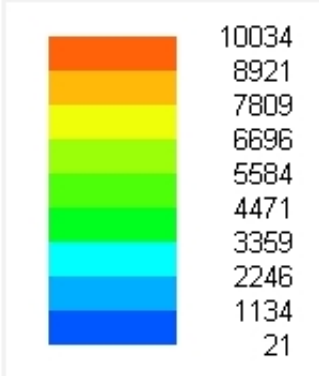


Simulation result

EC Regulation Distribution (Low beam)

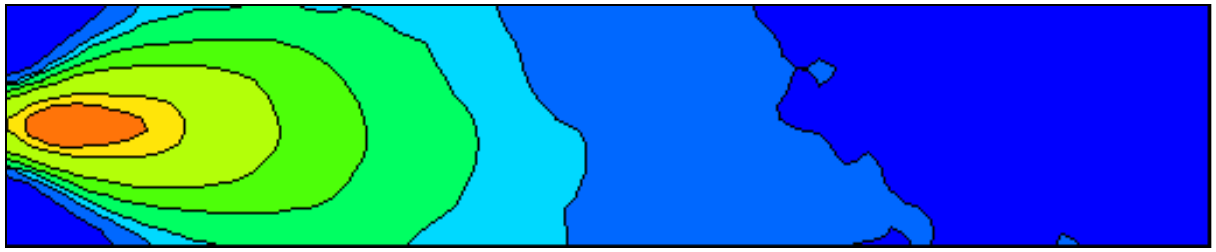


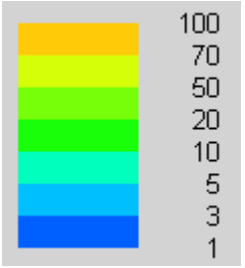
<Unit: Cd>



<Unit: lux>

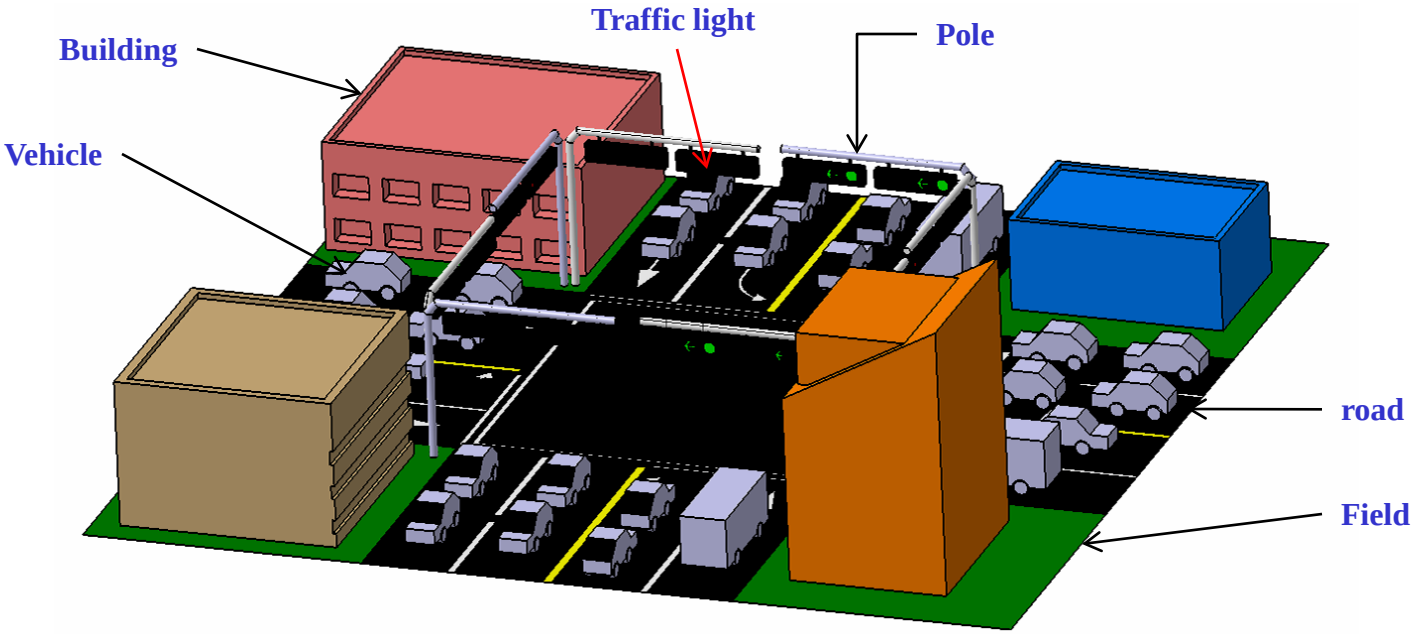
Road Distribution (Low beam)





Channel Modeling Scenario

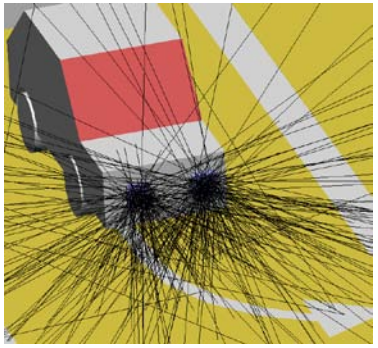
- Scenes are based on Crossroad (Scale 1:1)
- 6 case(Vehicle-to-Vehicle/Traffic-to-Vehicle)



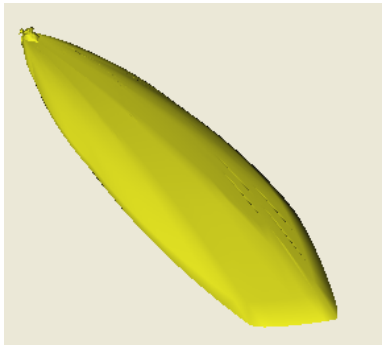
Crossroad modeling

Modeling Parameter

- Light source



Ray tracing



Intensity distribution

• Imported light distribution design
•Total flux: 1356.26 lm

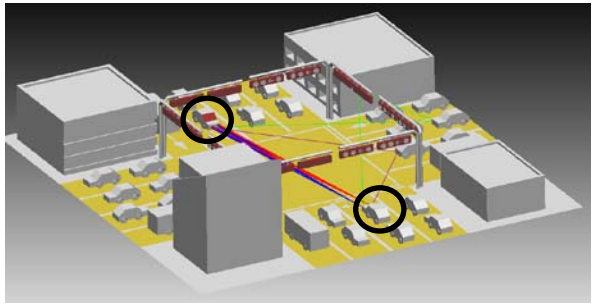
- Optical property

Object	Reflectance
Vehicle	20%(lambertian)
Building	40%(lambertian)
Traffic light	0%(absorption)
Pole	10%(lambertian)
Road	0%(absorption)
Field	30%(lambertian)

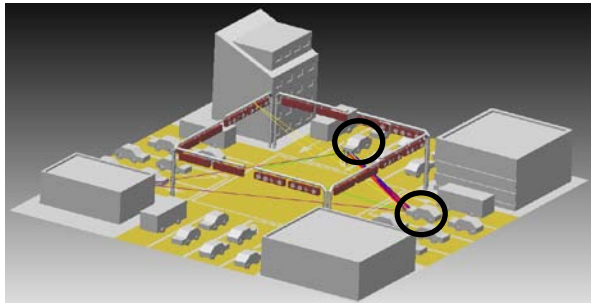
• No specular reflection

Channel Modeling Simulation Results

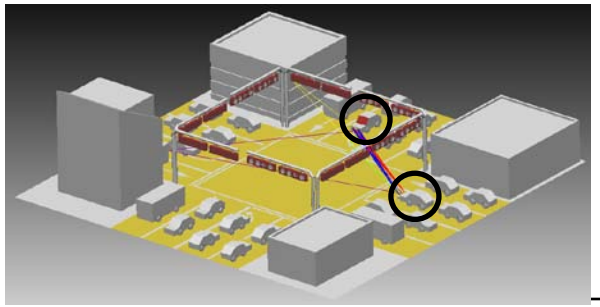
- Scene 1~3
  - Vehicle-to-Vehicle Communication Link



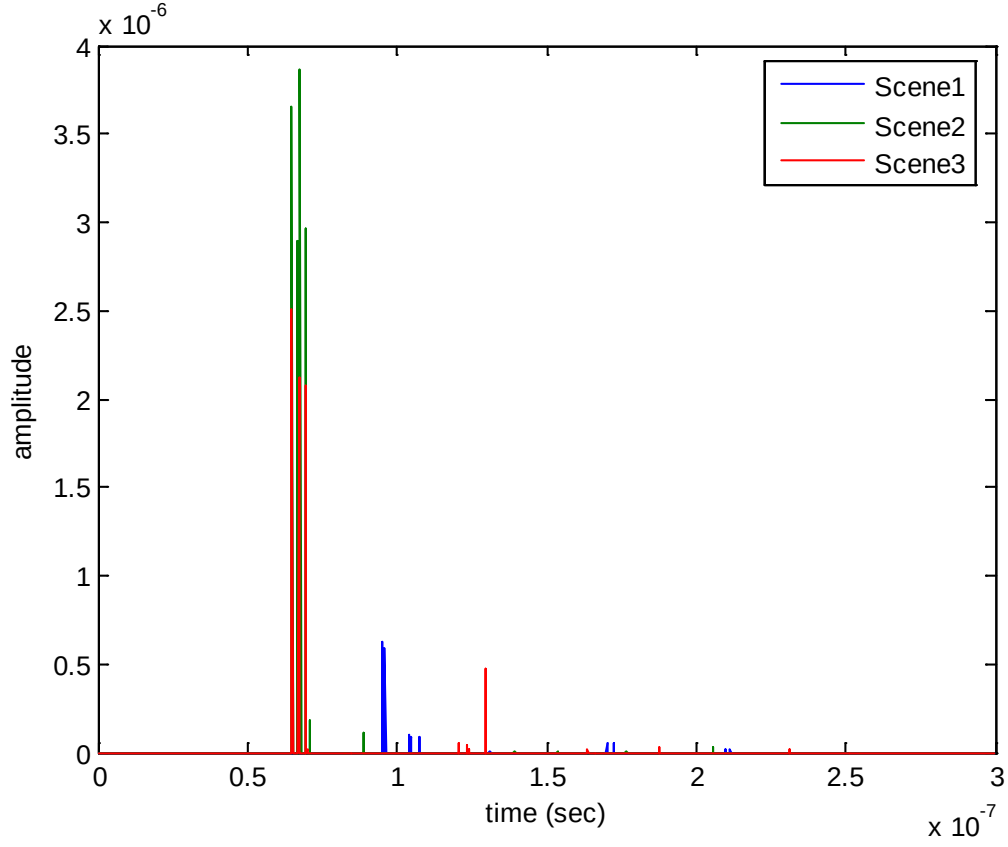
Scene1



Scene2

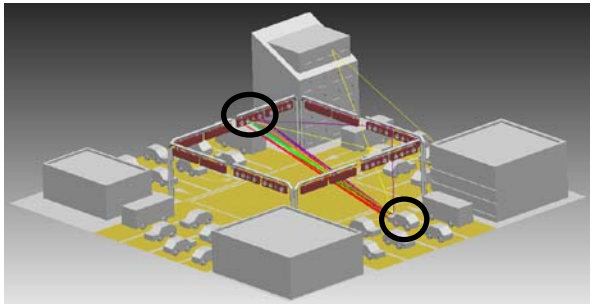


Scene3

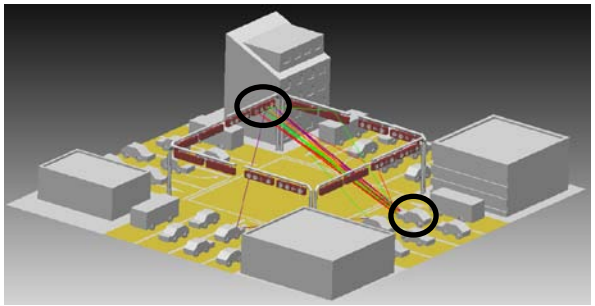


Channel Modeling Simulation Results

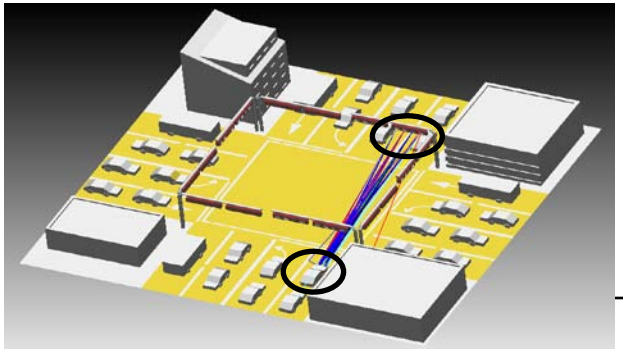
- Scene 4~6
  - Traffic light-to-Vehicle Communication Link



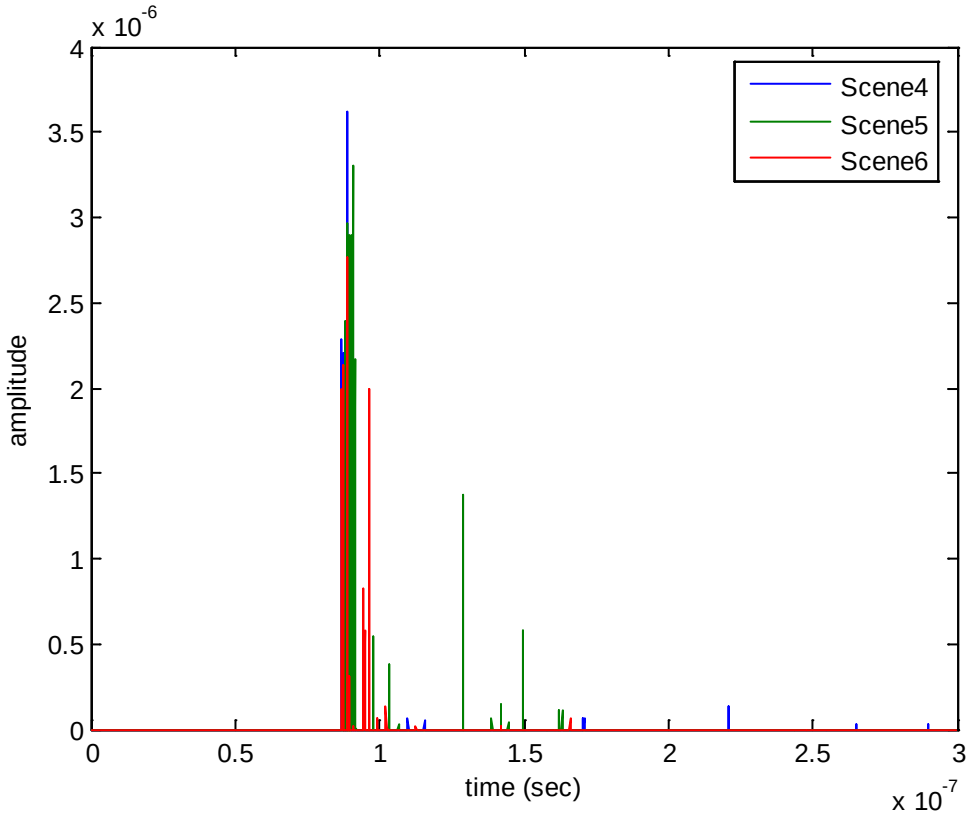
Scene4



Scene5



Scene6



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Discussion

- V2V Communication Link (Scene 1~3)
  - – Dominant Multiple LOS
  - – Negligible multipath components

  →Can be modeled as Multiple LOS Channel

- T2V Communication Link (Scene 4~6)
  - – Multiple LOS + few multipath components

  →Can be modeled as Mixed Channel

Conclusions & Further Work

- Channel modeling simulations in automotive applications
  - Real LED headlamp model based simulations
  - Simulations based on Crossroad Scenes
- Further simulations in given scenario
- Extend to other scenarios
  - Expressway, Metropolitan road, etc…
- Extract statistical channel model & corresponding parameters