Calculation Methods of Luminous Intensity Distributions from Ray Files by using Different Solid Angles

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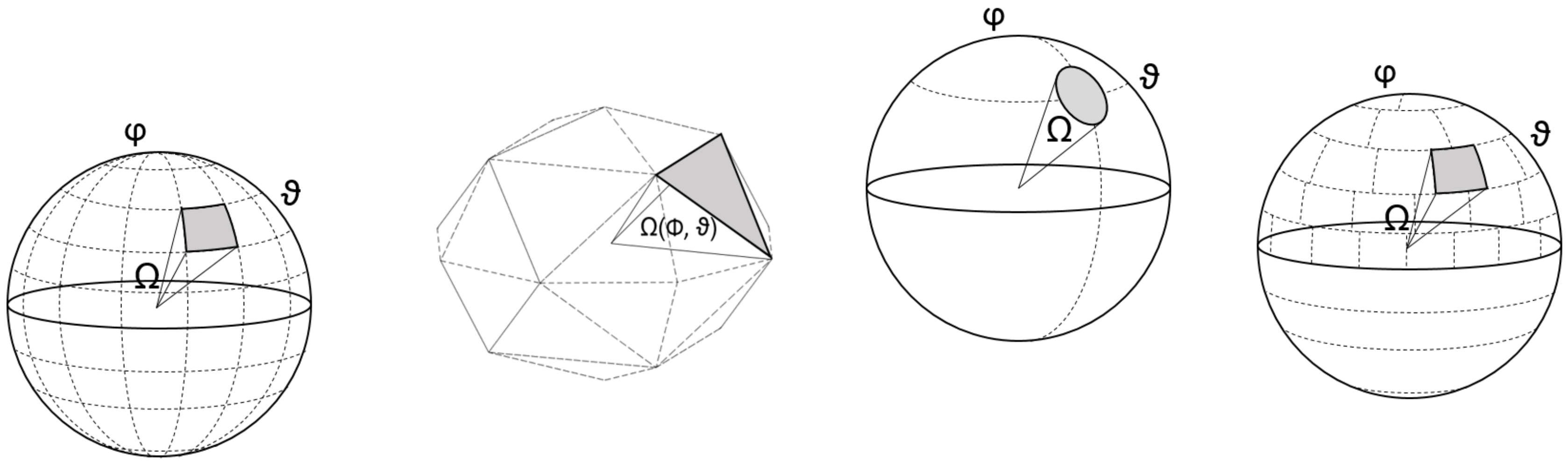
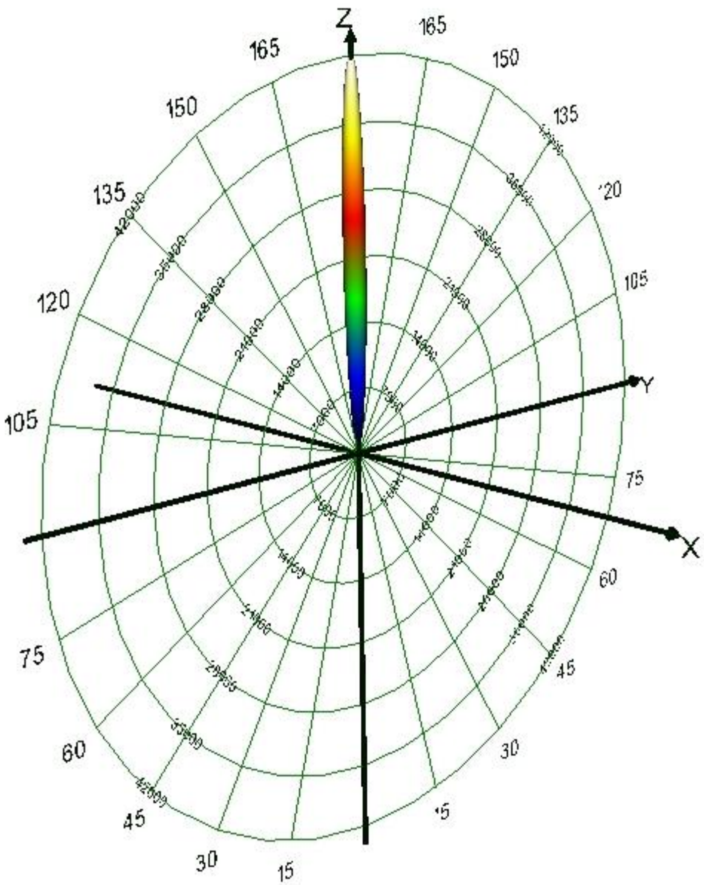
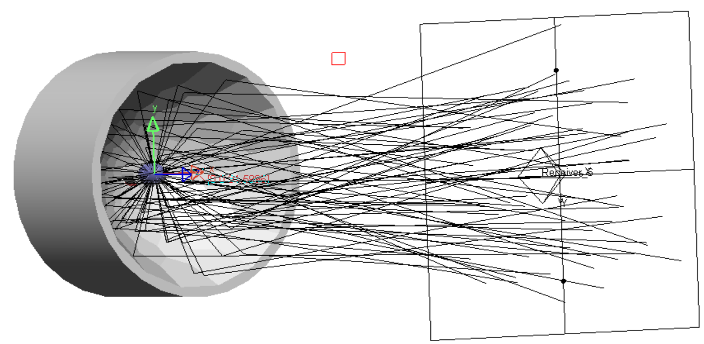


Motivation

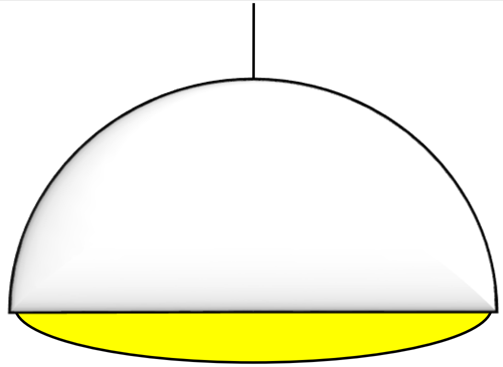


Luminous Intensity Distribution



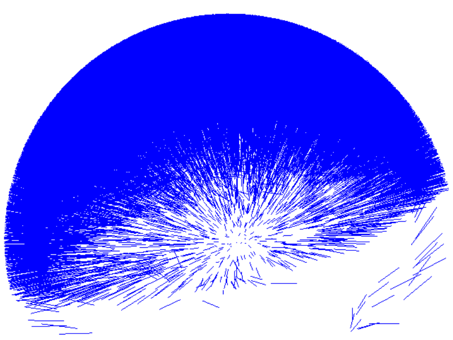
Ray file

Motivation



Near field:
Luminance

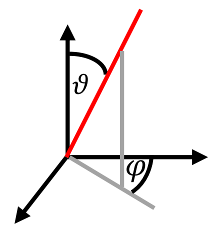
$L(x, y, z, \varphi, \vartheta)$



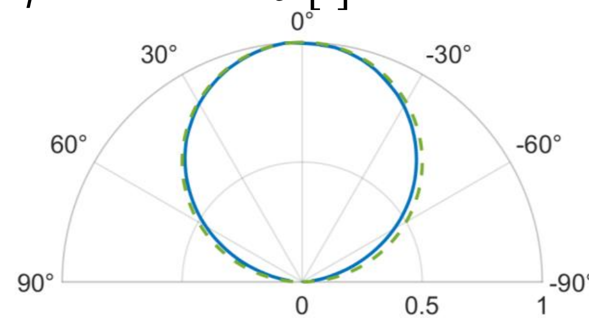
$L = \frac{d^2\Phi}{\cos(\varepsilon')dA \cdot d\Omega} \quad I = \frac{d\Phi}{d\Omega}$

Far field:
Luminous Intensity Distribution

$I(\varphi, \vartheta)$



$\varphi = const.$ $\quad \vartheta$ [°]



I/I_{max}

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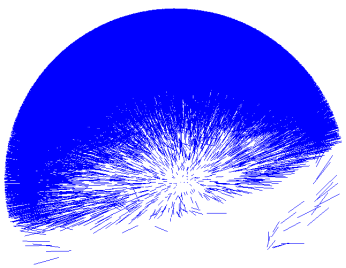
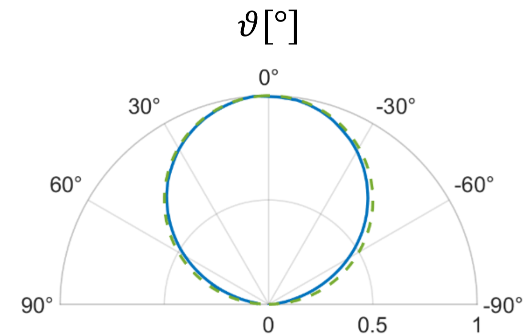
LID calculation of near field data

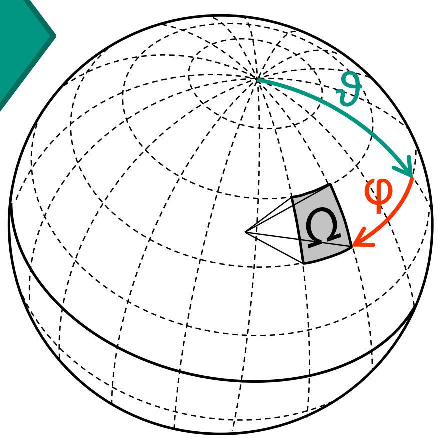


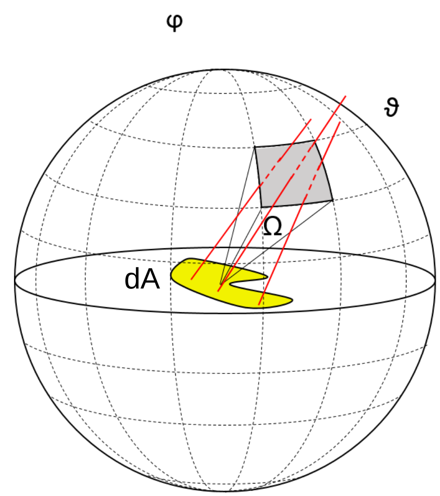
$L(x, y, z, \varphi, \vartheta)$

$$L = \frac{d^2\Phi}{\cos(\varepsilon')\,dA \cdot d\Omega} \qquad I = \frac{d\Phi}{d\Omega}$$



$I(\varphi, \vartheta)$





$d\Omega$

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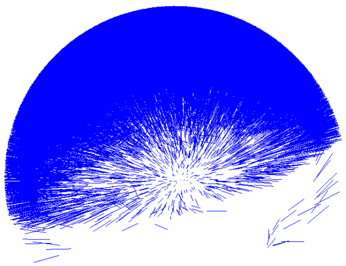
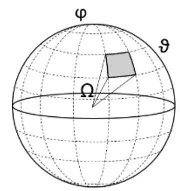
LID calculation of near field data

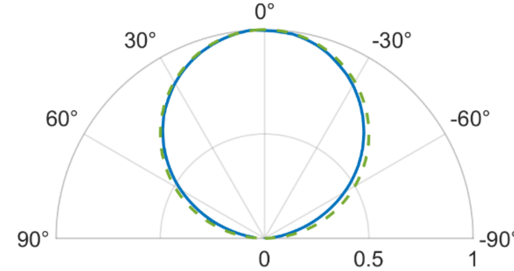
- Influence parameters:



$L(x, y, z, \varphi, \vartheta)$

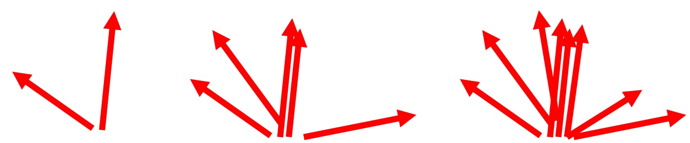
$$L = \frac{\mathrm{d}^2\Phi}{\cos(\varepsilon')\mathrm{d}A \cdot \mathrm{d}\Omega} \quad I = \frac{\mathrm{d}\Phi}{\mathrm{d}\Omega}$$



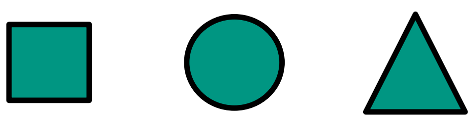


$I(\varphi, \vartheta)$

- Number of rays M (stochastic uncertainty)



- Shape of the solid angle



- Resolution/size of the solid angle

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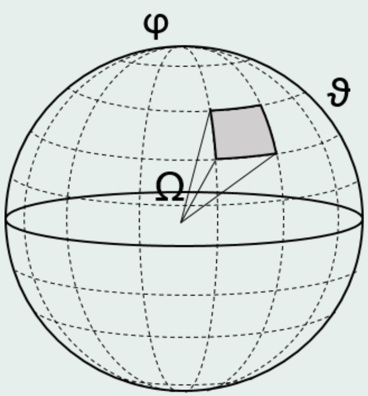
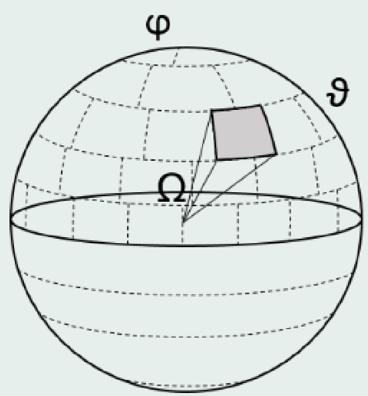
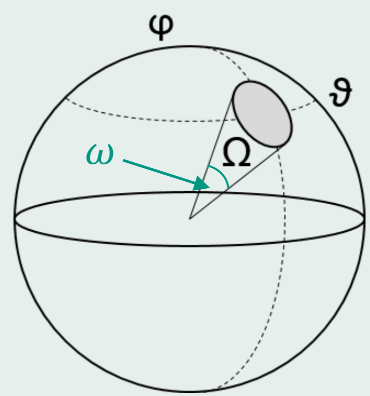
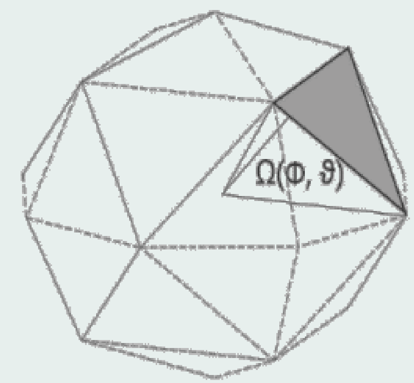
LID calculation of near field data

- Different types of solid angles

Cartesian polar coordinates		Canonical solid angle	Triangulated solid angle
Angle constant	Solid angle constant		
			
• Resolution $(d\varphi, d\vartheta)$ • Standard • $\mathrm{d}\Omega \neq$ const	• Number of solid angles N • Almost $\mathrm{d}\Omega$ = const	• Opening angle ω • Perfect shape • $\mathrm{d}\Omega$ = const • Overlapping/incom-plete space cover	• Number of solid angles N • Dynamic solid angle

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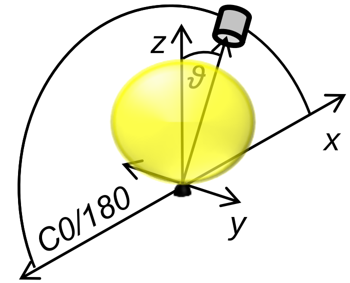
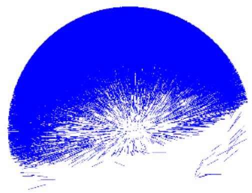
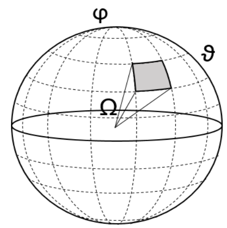
Calculation results



- Point light source, $M \approx 25$ million, $N \approx 1000$



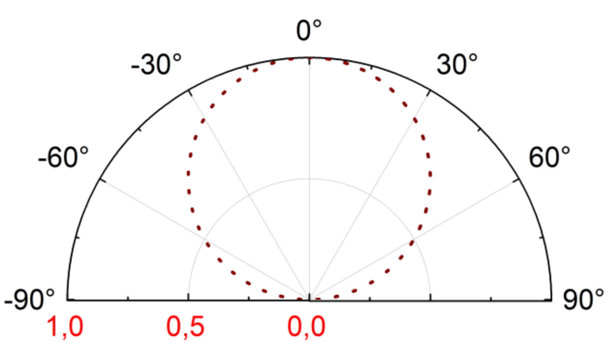


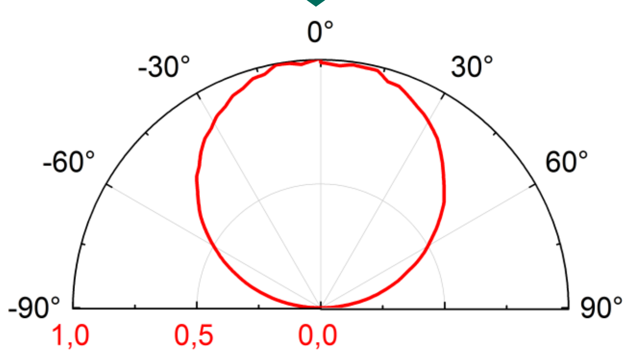
$$I_{ana} = I_0 \cos(\vartheta)$$

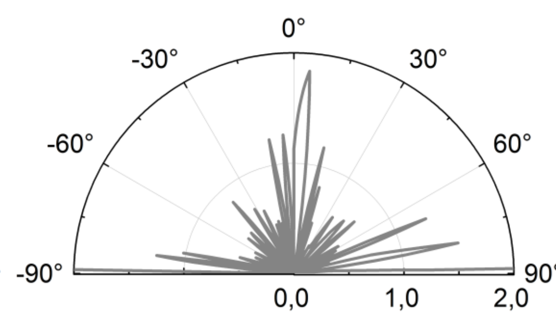
$$I_{num}$$

Deviation

$$\epsilon = \left| \frac{I_{ana} - I_{num}}{I_{ana}} \right|$$







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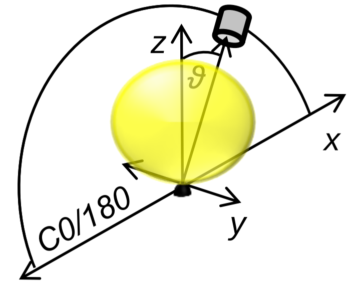
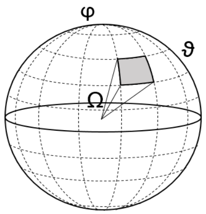
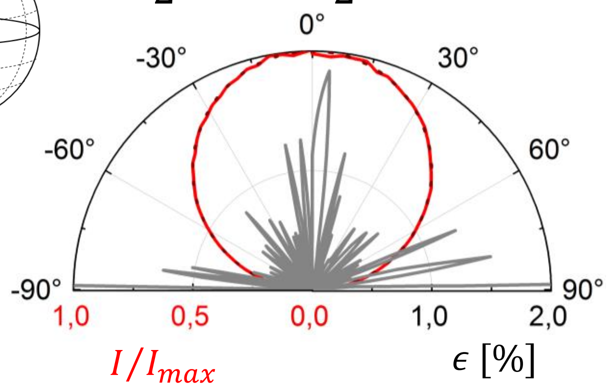
Calculation results

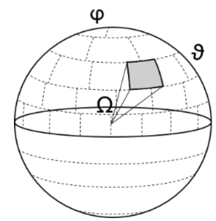
- Point light source, $M \approx 25$ million



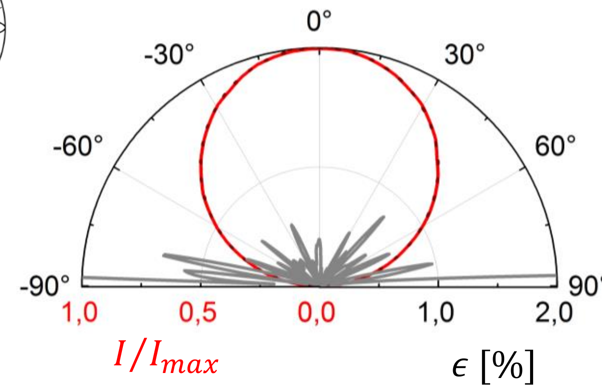


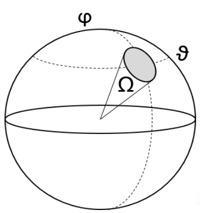
$N: \frac{\varphi \times \vartheta}{2} = \frac{30 \times 60}{2} = 900$



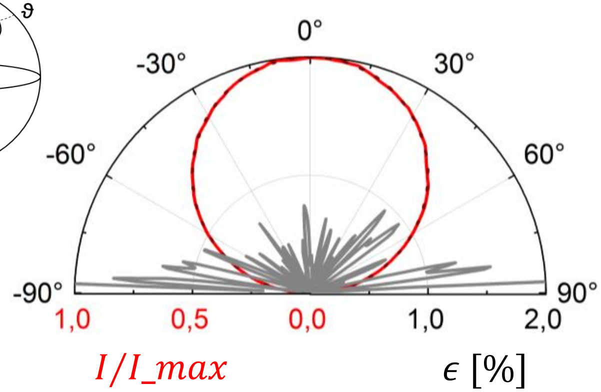


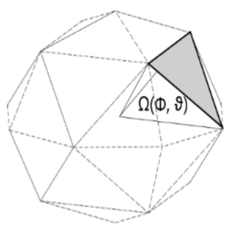
$N = 1000$



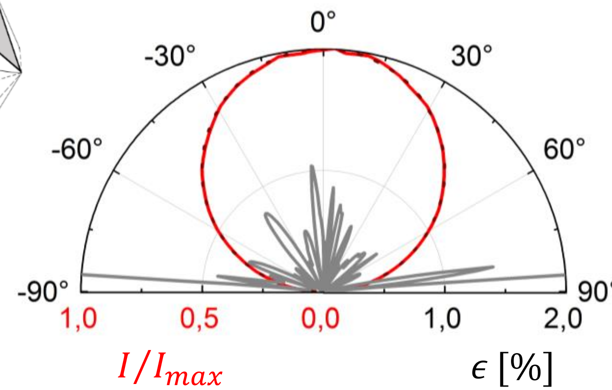


$N: \omega = 6.36°$



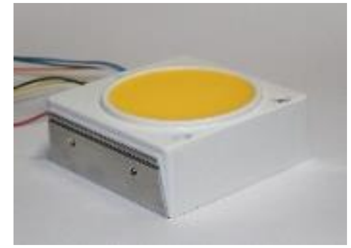


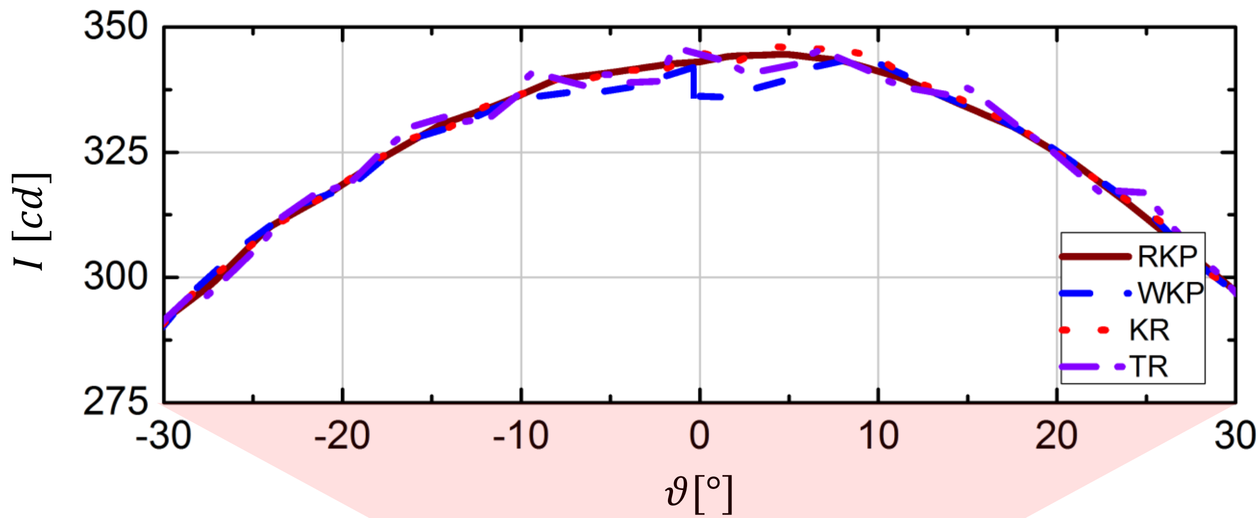
$N = 943$

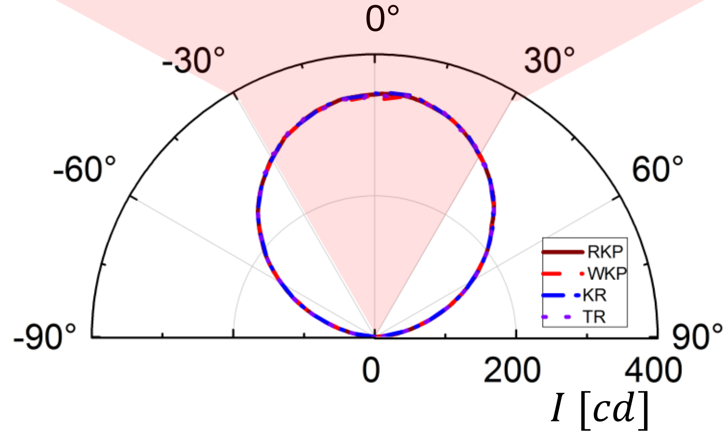


Calculation results

- Real lambertian light source, $M \approx 25$ million





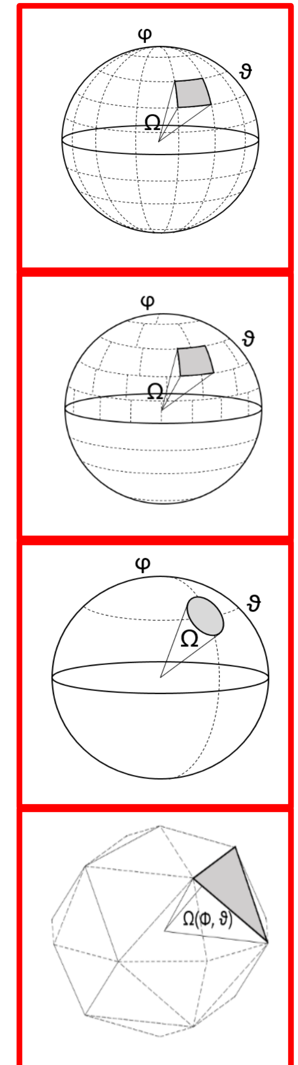


$$N_a\colon \frac{\varphi \times \vartheta}{2} = \frac{65 \times 60}{2} = 1950$$

$$N_b = 2000$$

$$N_c\colon\ \omega = 4.55°$$

$$N_d = 2058$$



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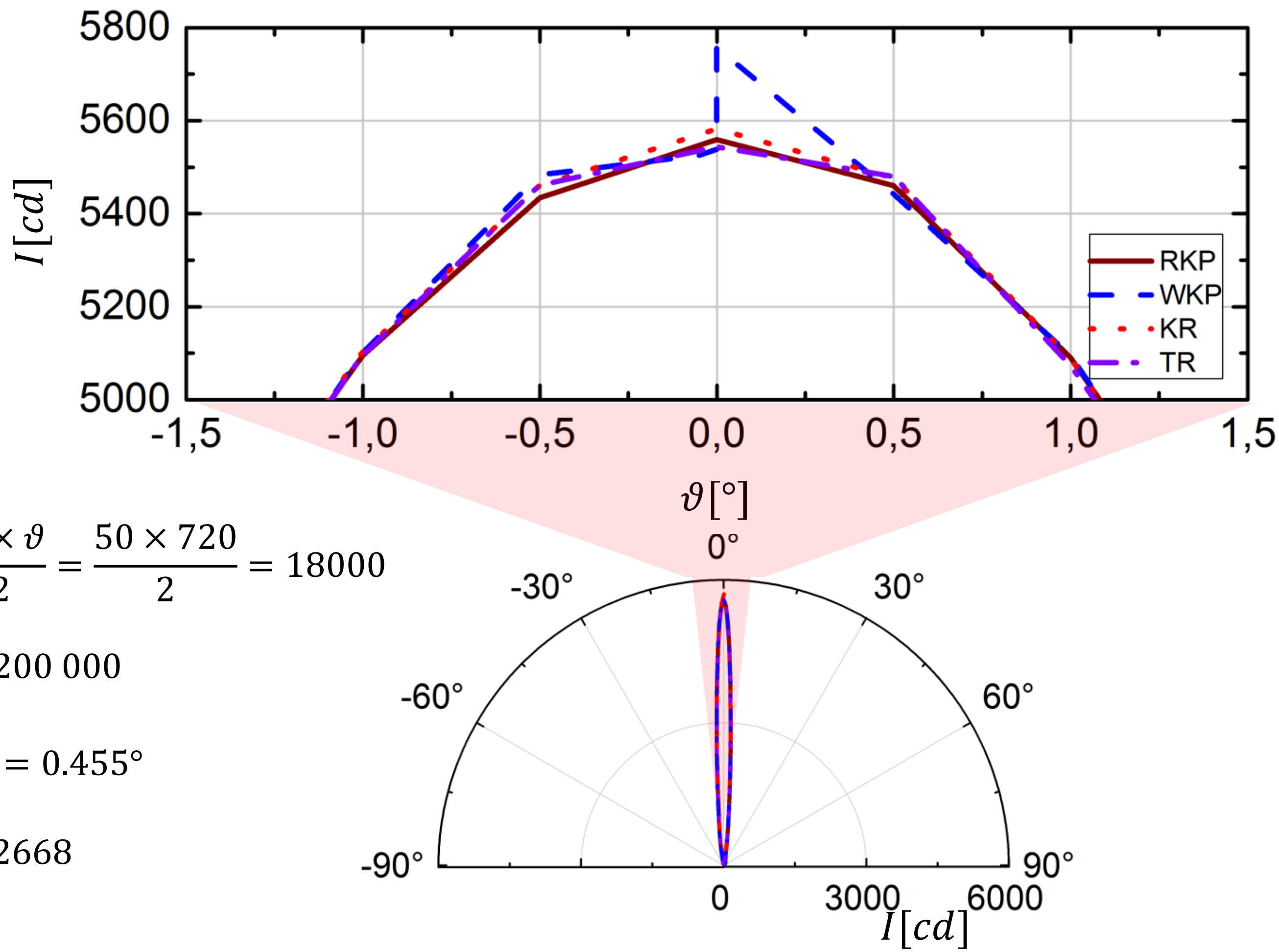
Calculation results

- Real narrow beam flash light, $M \approx 25$ million

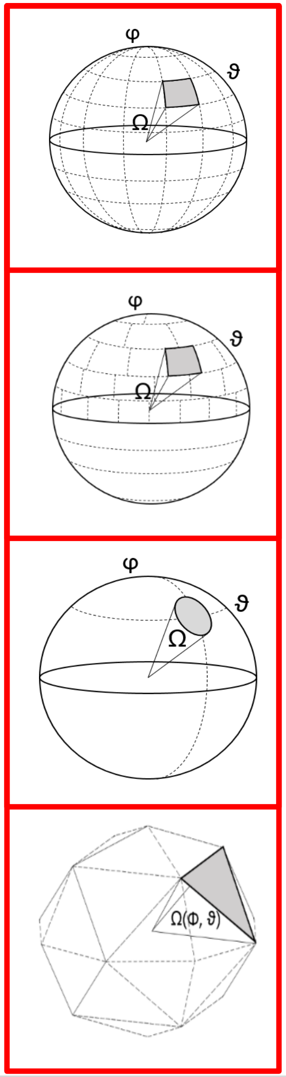


$$N_a\colon \frac{\varphi \times \vartheta}{2} = \frac{50 \times 720}{2} = 18000$$

$$N_b = 200\,000$$

$$N_c\colon \omega = 0.455°$$

$$N_d = 2668$$



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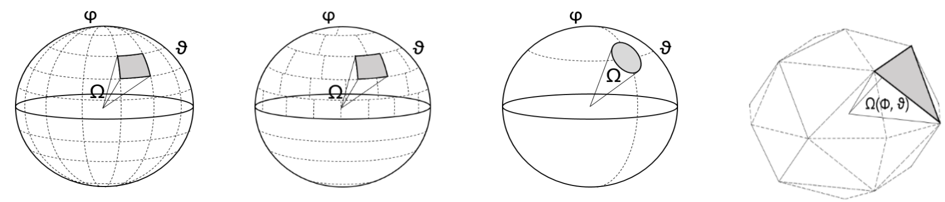
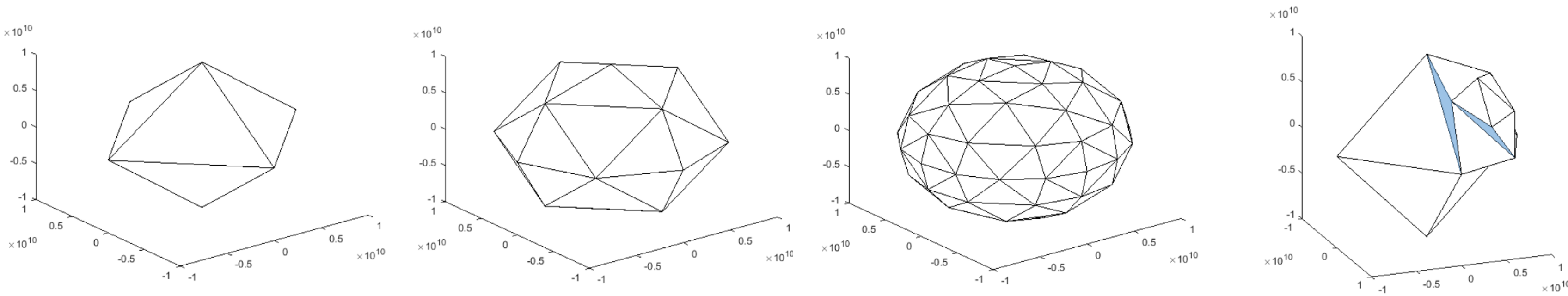
Comparison



	a	b	c	D
Calculation speed	+	+	-	o
Uniform solid angle size	-	+	+	o
Dynamic solid angle disposition	o	o	o	+
Unique space cover	+	+	-	+
Pseudo-LID calculation	+	+	+	-

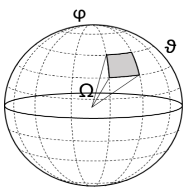


Conclusion

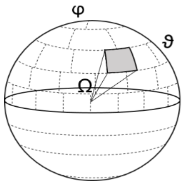
- LID calculation possible with all types of solid angle

- Every solid angle types has their own advantages and limitations

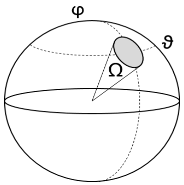
  - Fastest — very unshaped



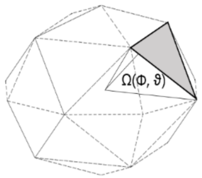
  - Fast & good solid angle shape — bad for narrow beam LID



  - Perfect solid angle shape — slow & space cover



  - Dynamic — no Pseudo-LID calculation



Thank you for your attention

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