Strahlungsleistung /-Fluss

$\Phi_E = \frac{N_{ph}}{t} \cdot E_{ph}$ [W] $E_{ph} = h \cdot \nu = h \cdot \frac{c}{\lambda}$

Bestrahlungsstärke

$E_e = \frac{\Phi_{e\,Empf}}{A_{Empf}} \left[\frac{W}{m^2}\right]$

E_{empf}

$\Downarrow$

Ideal $E = \frac{\pi \cdot L_{obj}}{4 k^2}$

real $E = 0{,}65 \cdot \frac{L_{obj}}{k^2} \cdot \Omega_0$

$H_{obj/grau} = \frac{0{,}65 \cdot L_{obj/grau} \cdot \Omega_0 \cdot t}{k^2}$

$H = E \cdot t$

Strahlstärke

$I_e = \frac{\Phi}{\Omega} \left[\frac{W}{sr}\right]$

Raumwinkel [Ω_0]

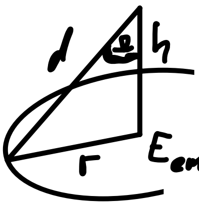
$\Omega = \frac{A_{empf}}{d^2} \cdot \Omega_0$

$E_{empf} = \frac{I_{sen}}{d^2} \cdot \Omega_0 = \frac{\Phi}{A_{empf}} \left[\frac{lm}{m^2}\right] [lx]$

$I_{sen} = E_{empf} \cdot d^2 \cdot \Omega_0^{-1} \left[\frac{lm}{sr}\right] [cd]$

$L_x = \frac{I_x}{A_x} \left[\frac{W}{sr\, m^2}\right]$

$\Phi = E_{empf} \cdot A_{Empf}$ [lm]



E_{max} höhe: $h^2 = \frac{r}{2}$

$E_{empf} = \frac{I_{sen}}{d^2} \cdot \cos(\alpha) \cdot \Omega_0 = \frac{I \cdot h}{d^3} \cdot \Omega_0$

Abbildungsgleichung: $a \to -\infty \quad a' = f'$

$$-\frac{1}{a} + \frac{1}{a'} = \frac{1}{f'}$$

x': Bildseitig / Sensorseitig

$$\beta' = \frac{y'}{y} = \frac{a'}{a} = \frac{f'}{a+f'}$$

x: Objektseitig

$$a' = f'(1-\beta') \qquad a = -f'\left(1-\frac{1}{\beta'}\right)$$

KB: 24×36mm

$$\text{Verlängerungsfaktor} = \left(\frac{a'}{f'}\right)^2 = (1-\beta)^2$$

Auflösungsvermögen:

$$AV = \frac{1}{d_B \cdot u_{min}} = \frac{N_a}{H} = \frac{2}{u'} = \frac{1500}{k_{eff}} = \frac{1500}{k_o \cdot (1-\beta')} \left[\frac{Lp}{mm}\right]$$

$$k = \frac{f'}{D_{EP}} \qquad k_{eff} = \frac{d_{AP}}{D_{AP}} = \frac{f'}{D_{EP}} \cdot \left(1 - \beta' \cdot \frac{D_{EP}}{D_{AP}}\right)$$

$k_{förder} = 1500 \cdot u'$ Beugungsunschärf. $k_{kritisch}$

Betrachtung Bild: $d_B \approx a'$ Print: $d_B = \beta_{repro}\, a'$

deutliches Sehfeld: $d_B = 2 \cdot H = \frac{3}{2} B$ Sehabstand $d_B = 25cm$

Gesichtsfeldwinkel: $2\omega = 2 \cdot \tan^{-1}\left(\frac{d_{diag}}{2 \cdot f'}\right)$

AV Auge: $\omega_{min} = 1' = \frac{1 \cdot \pi}{60 \cdot 180}$ $u_{repro} < 2' \cdot d_B$ $u' = \frac{u_{repro}}{\beta_{repro}}$

Schärfentiefe: $u = D_{EP} \cdot \left|\frac{a}{a_i} - 1\right|$ $u' = -\beta' \cdot u$ $a_{h/v} = \frac{a}{1 \pm \frac{a+f'}{f'^2} \cdot k \cdot u'}$

Hyperfokale Distanz

$$h = -\frac{f'^2}{u' \cdot k} = -\frac{f' \cdot D_{EP}}{u'} \qquad a_{v/h} = \frac{a \cdot h}{h \pm (a+f')}$$

Bei $a = h$: $a_h \to -\infty$ $u = D_{EP}$ $a_v = \frac{h}{2}$

Bei $a \to -\infty$: $a_v = h$ $f' \ll a$: $a_{v/h} = \frac{a \cdot h}{h \pm a}$

Lichtmessung:

$$\frac{k^2}{t} = \frac{E \cdot 10^{\frac{S_{din}}{10}}}{C_L} \qquad 255 < C_L < 415$$

$$C_L = C_R \cdot \frac{\pi}{\rho} \cdot \Omega_0$$

$L_{diffus} = \frac{E \cdot \rho}{\pi \cdot \Omega_0}$ gerichtete Reflexion: $\Phi_r = \rho_{gei}\, \Phi_i \Rightarrow I' = \rho_{gei} \cdot I$

Objektmessung:

$$\frac{k^2}{t} = 0{,}65 \cdot \frac{L_{obj\text{-}grau}}{\frac{H_{grau}}{H_0} \cdot H_m} = \frac{L_{obj\text{-}grau} \cdot 10^{\frac{S_{din}}{10}}}{C_R}$$

$$H_m = \frac{H_0}{10^{\frac{S_{din}}{10}}} \qquad C_R = \frac{\frac{H_{grau}}{H_m} \cdot H_0}{0{,}65 \cdot \Omega_0} \left[\frac{cd\,s}{m^2}\right]$$

$$DIN = 1 + 10 \cdot \lg(ASA)$$

$$SNR = \frac{u}{\sigma(u)} \qquad DR = \frac{u_{max}}{u_{min}} = \frac{u_{max}}{\sigma_{min}}$$

$$S_{iso} = \frac{10\,lxs}{H_{grau}}\Big|_{SNR = 10 \text{ oder } 40}$$

ISO 100: $H_{grau} = 0{,}1$ | max iso bestes Bild

$S_{iso_{sat}} = \frac{78\,lxs}{H_{max}}$ $H_{weiß} = 1$ $H_{max} = 1{,}4$ $H_{grau} = 0{,}18$

$$2^B = 2^{\Delta EV} = \frac{t'}{t_{auto}} = \frac{E'_{mean}}{E'} \cdot \frac{H_{weiß}}{H_{grau}} = \frac{k^2}{t}$$

$t_{max_{Analog}} = \frac{1}{f'}$ $\frac{t_{max\,digital}}{t_{max\,Analog}} = \frac{u'_{digital}}{u'_{analog}}$ $u'_{analog} = \frac{d_{diag}}{1500}$

Belichtungszeit: $t = t_0 \cdot VF \cdot 2^{-\Delta EV}$ $\frac{H_{sat}}{A_{max}} = \frac{H_{soll}}{A_{soll}}$

$A_{max} = u_{max} = (2^{bit} - 1)$, $A_{min} = u_{min} = \sigma_{min}$

$SNR = \frac{u_{max}}{\sigma(u)}$ $DR = \frac{u_{max}}{u_{min}} \hat{=} 20\,dB \lg\left(\frac{u_{max}}{u_{min}}\right)$ [dB]

Mired Wert $\Delta M = M_{Licht} + M_{Filter}$

$$\frac{\tau_1}{\tau_2} = e^{-\frac{c_2}{T}\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)} \qquad M = \frac{10^6}{T} \qquad c_2 = 1{,}4388 \cdot 10^{-2}\, m \cdot K$$

$0\,°C = 273{,}15K$ $\Delta M < 0 \to$ Blauer Filter

Betriebsgesetze für Glühlampen $\frac{X}{X_N} = \left(\frac{U}{U_N}\right)^{\alpha_X}$ $X: \Phi, P, \eta, T, Z$

Lichtausbeute: $\eta = \frac{\Phi}{P_{zu}} \left[\frac{lm}{W}\right]$

OECF: $Y = 255 \cdot \left(\frac{L}{L_{sat}}\right)^{\frac{1}{\gamma}}$

$$\text{Empfindlichkeit} = S_{100} \cdot \frac{L}{L_{sat}} \cdot \frac{\sqrt{2}}{0{,}18} = S_{100} \cdot \left(\frac{Y}{Y_{max}}\right)^{\gamma} \cdot \frac{\sqrt{2}}{0{,}18}$$

$P_{zu} \to$ Schwarzer Strahler

$P_{ab} = P_{em} - P_{absor}$ $\varepsilon(\lambda) = \alpha(\lambda)$

$$L_{e,s}(T) = \frac{5{,}67 \cdot 10^{-8}\, W \cdot T^4}{\pi \cdot \Omega_0\, m^2 K^4}$$

$\leftarrow P_{ab}$

$P_{em} = \varepsilon \cdot \Phi_T$

$P_{absor} = \alpha \cdot \Phi_T$

$P_{reflekt} = (1-\alpha) \cdot \Phi_T$

$$P_{em/absorb} = A \cdot 5{,}67 \cdot 10^{-8} \frac{W}{m^2 K^4} \cdot T^4_{Schw.\,Strh\,/\,Umgeb} \cdot \pi \cdot \Omega_0$$

$$K_{Wien} = 2{,}898 \cdot 10^{-3}\, m \cdot K = 555 \cdot 10^{-9}\, m \cdot T = \lambda_{grün} \cdot T$$

Vollaussteuerung:

$$L_{V,i} = 683 \frac{lm}{W} \cdot L_e(\lambda_i) \cdot V(\lambda_i)$$

Empfindlichkeit $S_i = \frac{A_i}{L_{e,i}}$ $A_i' = A_i \cdot V_i$

$$\frac{V_{\lambda i}}{V_{\lambda j}} = \frac{e^{-\frac{c_2}{T}\left(\frac{1}{\lambda_i} - \frac{1}{\lambda_j}\right)} \cdot \left(\frac{\lambda_j}{\lambda_i}\right)^5}{L_{e,i}/L_{e,j}} = e^{c_2\left(\frac{1}{\lambda_i} - \frac{1}{\lambda_j}\right)\left(\frac{1}{T_{neu}} - \frac{1}{T_{alt}}\right)}$$

$V_{\lambda_3} > V_{\lambda_1} > V_{\lambda_2} \to V_{\lambda_j} := 1$ $K_{xy} = \frac{x}{y} \cdot \frac{L_{e,x}}{L_{e,y}} \cdot \frac{S_x}{S_y}$