$$f_{pulse} = \frac{1}{t_{round}} = \frac{c}{2r}$$

Table 1: Pulse frequency for both modes of operation

Pulse Frequncy	AM	HDM
Maximum altitude	$8\,km$	$0.5\,km$
Roundtrip time	$53.3\,\mu s$	$3.33\,\mu s$
Pulse frequency	$18.8\,kHz$	$300\,kHz$
PPS_B	$7.21 \cdot 10^{12}$	

$$I_\lambda = \frac{2hc^2}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda kT}} - 1}$$

Table 2: Calculation of sun irradiation

Sun irradiation	
h	$6.63 \cdot 10^{-34}\,Js$
c	$3.00 \cdot 10^{8}\,m/s$
k	$1.38 \cdot 10^{-23}\,j/K$
λ	$850.00\,nm$
T	$5.78\,kK$
I_λ	$1.51 \cdot 10^{13}\,W/m^3$

$$P_B = I_\lambda B_\lambda S \frac{r_{sun}^2}{r_{europa}^2}$$

Table 3: Calculation of background power on target area on Europa

Background power	
I_λ	$1.51 \cdot 10^{13}\,W/M^3$
B_λ	$10.00\,nm$
Surface area	$15625.00\,m^2$
r_{sun}	$6.96 \cdot 10^{5}\,km$
r_{europa}	$7.79 \cdot 10^{8}\,km$
P_B	$1.89\,kW$

$$P'_B = \frac{P_B R_{europa} D_l L_f L_l}{2r^2}$$

Table 4: Pulse frequency for both modes of operation

effective noise power	
P_B	$1.89\,kW$
r	$500.00\,m$
R_{europa}	$35.00\,\%$
Diameter lens (D_l)	$50.00\,mm$
opacity filter (L_f)	$50.00\,\%$
opacity optics (L_l)	$14.60\,\%$
$P_B 2$	$4.82\,\mu W$

$$E_{photon} = \frac{hc}{\lambda}$$

Table 5: Pulse frequency for both modes of operation

energy of photon	
h	$6.63 \cdot 10^{-34}\,Js$
c	$3.00 \cdot 10^{8}\,m/s$
λ	$850.00\,nm$
E_{photon}	$2.34 \cdot 10^{-19}\,J$

$$PPS_B = \frac{P'_B \cdot PDP}{E_{photon}}$$

Table 6: Pulse frequency for both modes of operation

PPS for background photons	
$P_B 2$	$4.82\,\mu W$
E_{photon}	$2.34 \cdot 10^{-19}\,J$
PDP	$35.00\,\%$
PPS_B	$7.21 \cdot 10^{12}$

$$FWHM = 2.35\sqrt{\frac{s\sigma_s^2 + n\sigma_n^2}{(s+n)pulses}}$$

$$C = (\frac{FWHM}{2.35})^2 \cdot pulses \cdot \frac{\text{surface area}}{\text{max surface area}}$$

$$PPS_S/SPAD = n\frac{\sigma_n^2 - C}{C - \sigma_s^2}$$

$$P_{av} = \frac{PPS_S/SPAD \cdot P_B \cdot \text{No. SPADs}}{PPS_B}$$

$$P_{peak} = \frac{P_{av}}{f_{pulse} \cdot \text{FWHM}_{laser}}$$

Table 7: Pulse frequency for both modes of operation

Scanning Power	square	square	line	line
No. SPADs	6250000	6250000	10000	10000
pulse/s	1	300000	625	300000
Window	$3.33\,\mu s$	$3.33\,\mu s$	$3.33\,\mu s$	$3.33\,\mu s$
exposure time	$3.33\,\mu s$	$1.00\,s$	$2.08\,ms$	$1.00\,s$
Surface Area	$15625\,m^2$	$15625\,m^2$	$25\,m^2$	$25\,m^2$
PPS_B	$2.40 \cdot 10^7$	$7.21 \cdot 10^{12}$	$2.40 \cdot 10^7$	$1.15 \cdot 10^{10}$
DCR	$4.17 \cdot 10^3$	$1.25 \cdot 10^9$	$4.17 \cdot 10^3$	$2.00 \cdot 10^6$
PPS_{B+N}	$2.40 \cdot 10^7$	$7.21 \cdot 10^{12}$	$2.40 \cdot 10^7$	$1.15 \cdot 10^{10}$
$PPS_{B+N}/SPAD$	3.84	$1.15 \cdot 10^6$	$2.40 \cdot 10^3$	$1.15 \cdot 10^6$
$PPS_S/SPAD$	$1.95 \cdot 10^8$	$1.76 \cdot 10^8$	$1.22 \cdot 10^{11}$	$1.11 \cdot 10^{11}$
P_{av}	$318.66\,kW$	$288.04\,kW$	$318.66\,kW$	$289.98\,kW$
P_{peak}	$3.19 \cdot 10^{15}\,W$	$9.60 \cdot 10^9\,W$	$5.10 \cdot 10^{12}\,W$	$9.67 \cdot 10^9\,W$
threshold (γ)	2	70	5	70
$PPS_{B+N}/SPAD$	$2.56 \cdot 10^{-8}$	$9.49 \cdot 10^{-2}$	$3.67 \cdot 10^{-5}$	$9.49 \cdot 10^{-2}$
$PPS_S/SPAD$	1.30	$1.45 \cdot 10^1$	$1.86 \cdot 10^3$	$9.12 \cdot 10^3$
P_{av}	$2.12\,mW$	$23.70\,mW$	$4.87\,mW$	$23.86\,mW$
P_{peak}	$2.12 \cdot 10^7\,W$	$7.90 \cdot 10^2\,W$	$7.79 \cdot 10^4\,W$	$7.95 \cdot 10^2\,W$