

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

Table 1: Pulse frequency for both modes of operation

Pulse Frequency	AM	HDM
Maximum altitude	$8\ km$	$0.5\ km$
Roundtrip time	$53.3\ \mu s$	$3.33\ \mu s$
Pulse frequency	$18.8\ kHz$	$300\ kHz$

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

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}	$1.51 \cdot 10^{13}\ W/m^3$

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	$1.89\ W$

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

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

Table 4: Pulse frequency for both modes of operation

effective noise power	
P_B	1.89 W
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_{B2}	4.82 nW

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

Table 5: Pulse frequency for both modes of operation

energy of photon	
h	$6.63 \cdot 10^{-34} J s$
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_{B2}	4.82 nW
E_{photon}	$2.34 \cdot 10^{-19} J$
PDP	35.00 %
PPS_B	$7.21 \cdot 10^9$

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

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

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

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

$$P_{peak} = \frac{P_{av}}{f_{pulse} \cdot FWHM_{laser}}$$

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	$2.40 \cdot 10^4$	$7.21 \cdot 10^9$	$2.40 \cdot 10^4$	$1.15 \cdot 10^7$
DCR	$1.25 \cdot 10^9$	$1.25 \cdot 10^9$	$2.00 \cdot 10^6$	$2.00 \cdot 10^6$
PPS_{B+N}	$1.25 \cdot 10^9$	$8.46 \cdot 10^9$	$2.02 \cdot 10^6$	$1.35 \cdot 10^7$
$PPS_{B+N}/SPAD$	$2.00 \cdot 10^2$	$1.35 \cdot 10^3$	$2.02 \cdot 10^2$	$1.35 \cdot 10^3$
$PPS_S/SPAD$	$1.01 \cdot 10^{10}$	$2.07 \cdot 10^5$	$1.03 \cdot 10^{10}$	$1.30 \cdot 10^8$
P_{av}	$16.58 MW$	$337.94 W$	$26.84 kW$	$340.21 W$
P_{peak}	$1.66 \cdot 10^{17} W$	$1.13 \cdot 10^7 W$	$4.29 \cdot 10^{11} W$	$1.13 \cdot 10^7 W$
threshold (γ)	1	1	1	1
$PPS_{B+N}/SPAD$	1.20	$5.38 \cdot 10^1$	1.23	$5.38 \cdot 10^1$
$PPS_S/SPAD$	$6.06 \cdot 10^7$	$8.22 \cdot 10^3$	$6.21 \cdot 10^7$	$5.17 \cdot 10^6$
P_{av}	$99.17 kW$	$13.44 W$	$162.50 W$	$13.53 W$
P_{peak}	$1.66 \cdot 10^{17} W$	$1.13 \cdot 10^7 W$	$4.29 \cdot 10^{11} W$	$1.13 \cdot 10^7 W$