RAMPEAUTO test on APC cavity

We succeeded in locking the laser on the apc cavity
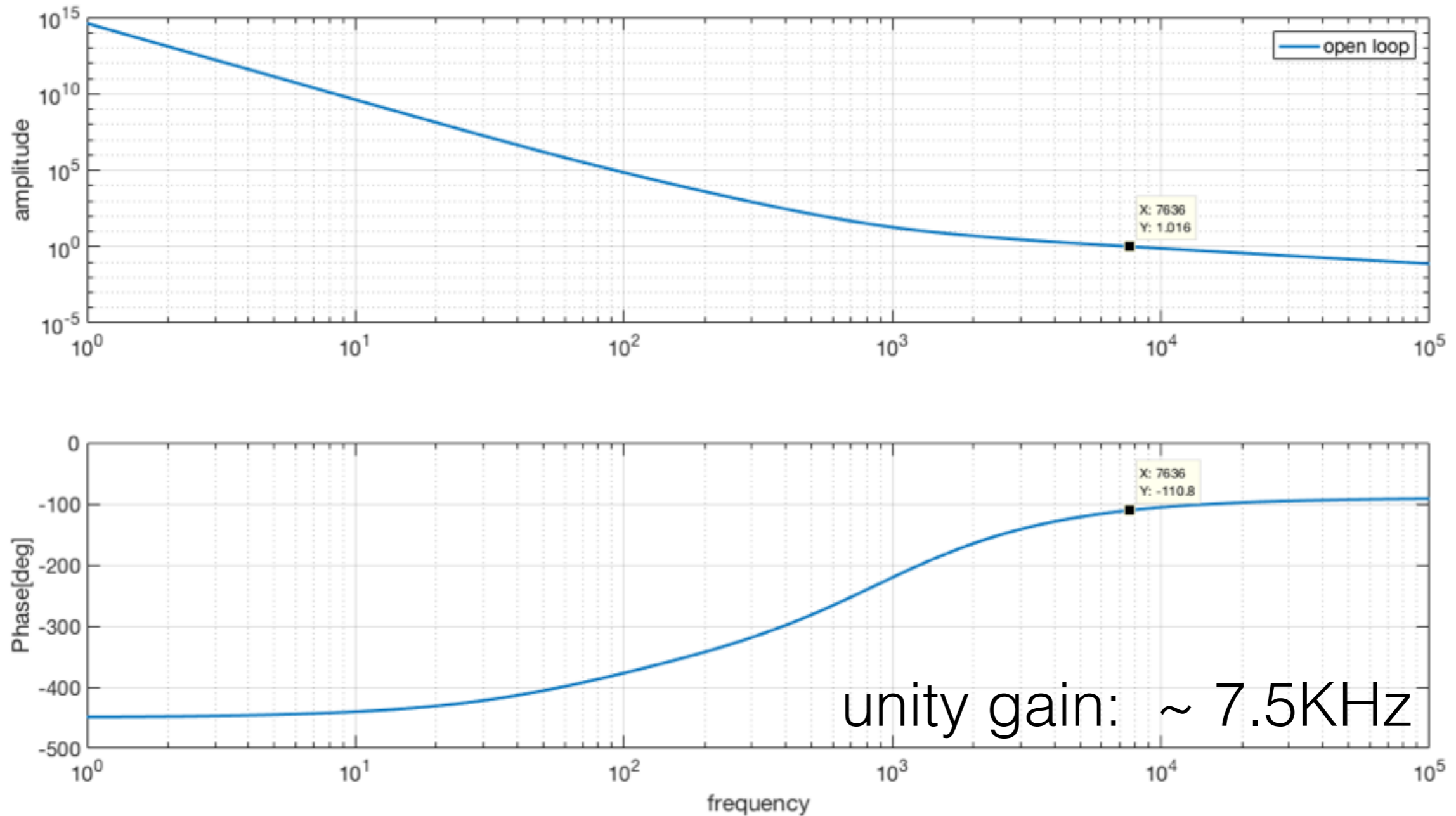
Parameters used for locking

modulation frequency	10 MHz
modulation amplitude	5 V (pp)
	~ 8.7 V (pp)
LO phase shift	-90°

APC and Filter cavity comparison

	APC cavity	fiter cavity
Cavity Pole	5 MHz	1.45 kHz
Optical gain	~ e-10	~ 0.5 e-6
Photodiode gain	0.7 A/W	0.25
Transimedence	220 V/A	16kV/A
piezo gain	1.5e6Hz/V	same?

APC open loop transfer function

unity gain: ~ 7.5KHz

$G_{OL} \propto 1/f^5$ DC $< f <$ 72 Hz

$G_{OL} \propto 1/f^4$ 72 $< f <$ 904 Hz

$G_{OL} \propto 1/f$ 0.904 $< f <$ 30 kHz

to have the same open loop TF
we need to compensate the
pole of the cavity at 1.45 kHz

FILTER CAVITY PARAMETERS RECAP

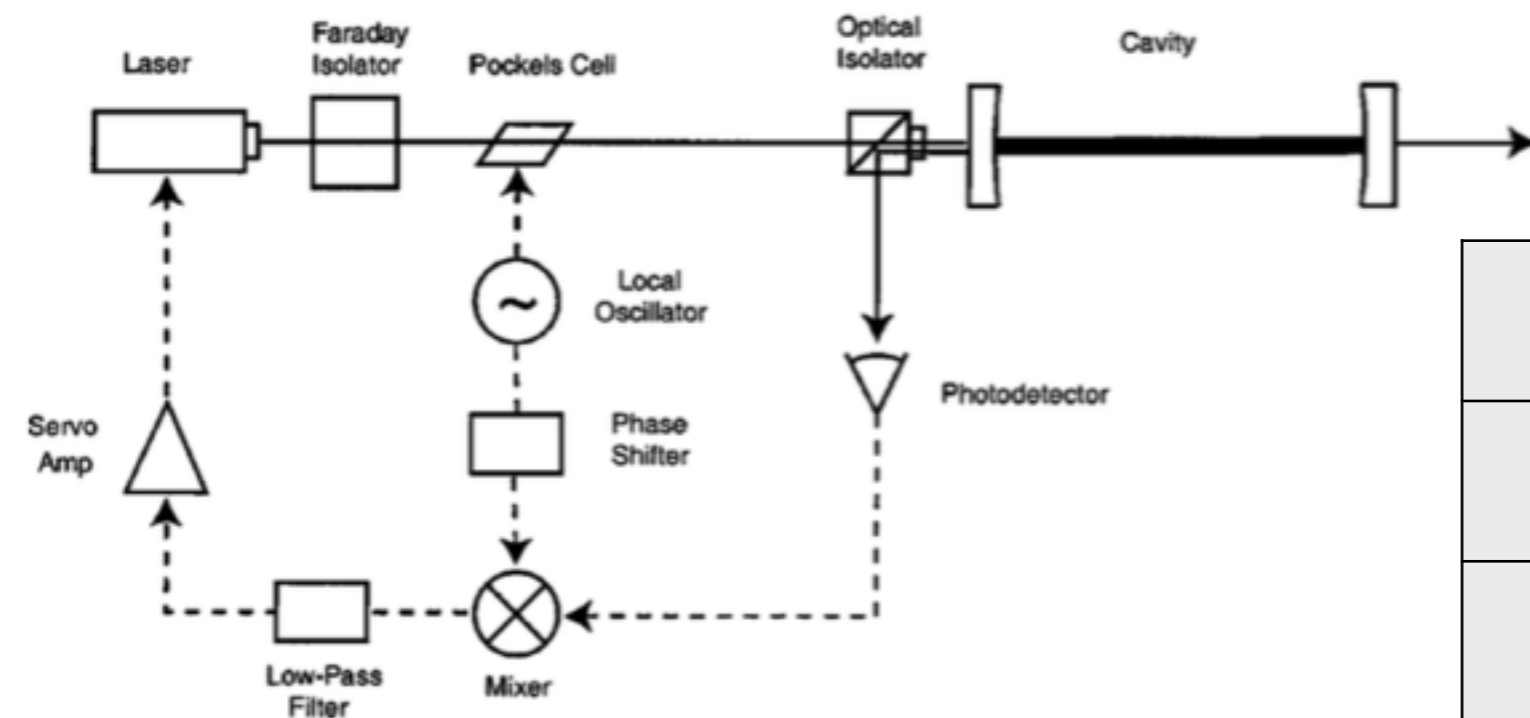| L	300 m
FSR	500 kHz
Finesse	172
line width (FSR/Finesse)	2.9 kHZ
cavity pole	1.45 kHz
V_cav	6 e-6 m/s
T_cross	2.57 e-4 s
V_treshold	1.4 e-5 s

- no ringing expected
- bandwidth for lock acquisition (1/T_cross) = 3.9 kHz

FILTER CAVITY LOOP GAIN

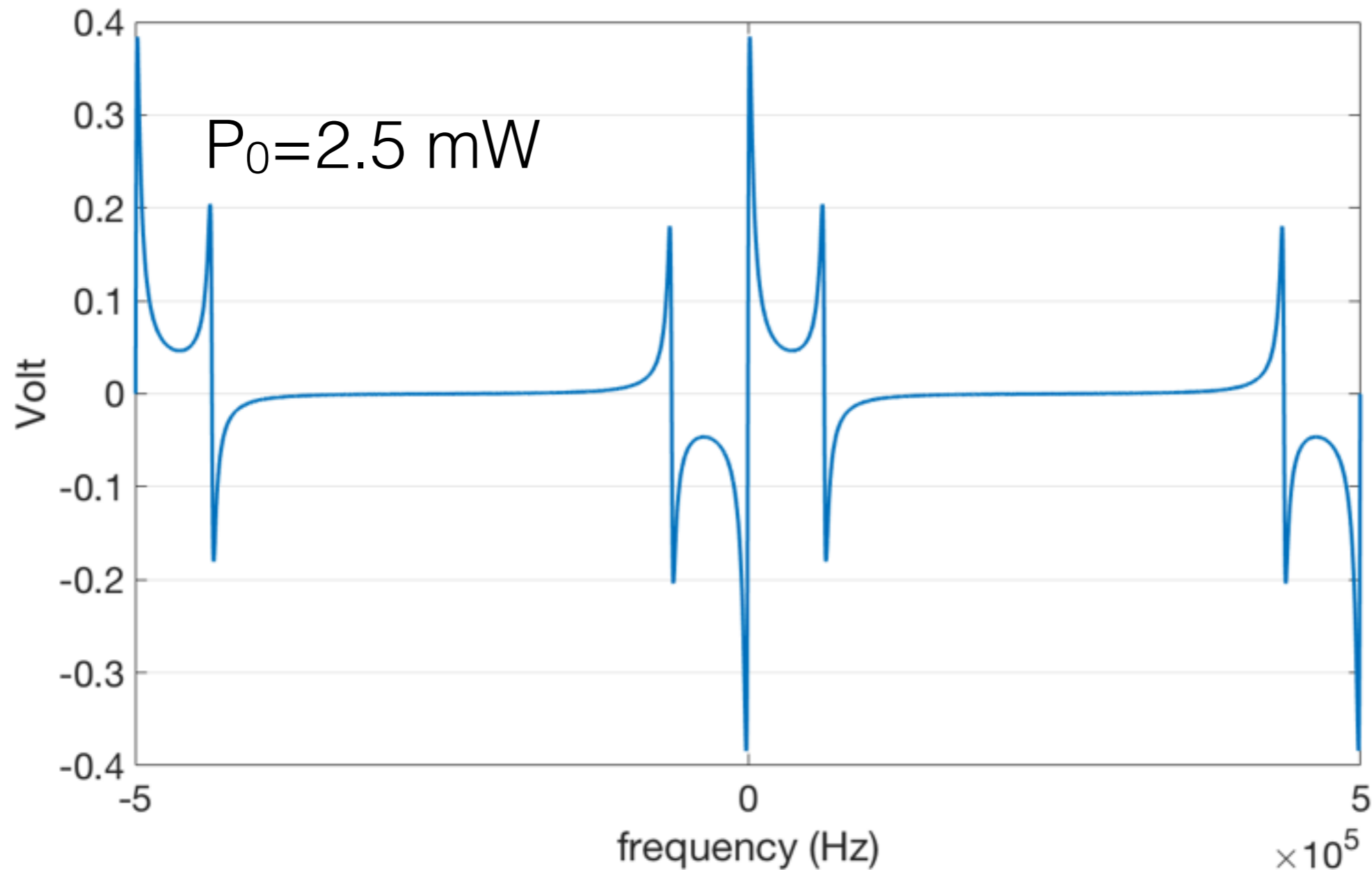$$G_{TOT} = G_{opt}[W/Hz] * G_{PD}[V/W] * G_{MIX}[V/V] * G_{LPF}[V/V] * G_{servo}[V/V] * G_{PZT}[Hz/V]$$

we want UGF about 10 kHz

G_{opt}	e-6 - e-8 W/HZ
G_{PD}	4e3 V/W
G_{MIX}	0.5 V/V
G_{Servo}	
G_{PZT}	1.5e6Hz/V

OPTICAL GAIN

$$G_{\mathrm{OPT}}[W/Hz] = 8\pi P_0 \sqrt{J_0^2(m)J_1^2(m)} \frac{r_2(1-r_1^2)}{FSR \cdot (1-r_1 r_2)^2} = 5.3 \cdot 10^{-5} P_0$$

$P_0 = 2.5$ mW
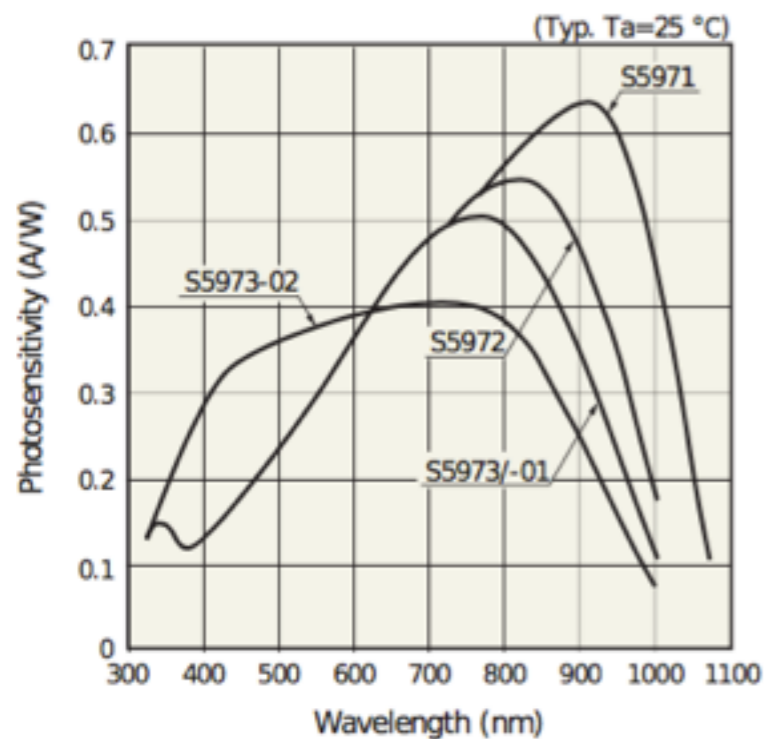
Amplitude error signal at least 200 mV ?

$$G_{\text{OPT}}[W/Hz] = 8\pi P_0 \sqrt{J_0^2(m)J_1^2(m)} \frac{r_2(1-r_1^2)}{FSR \cdot (1-r_1r_2)^2} = 5.3 \cdot 10^{-5} P_0$$
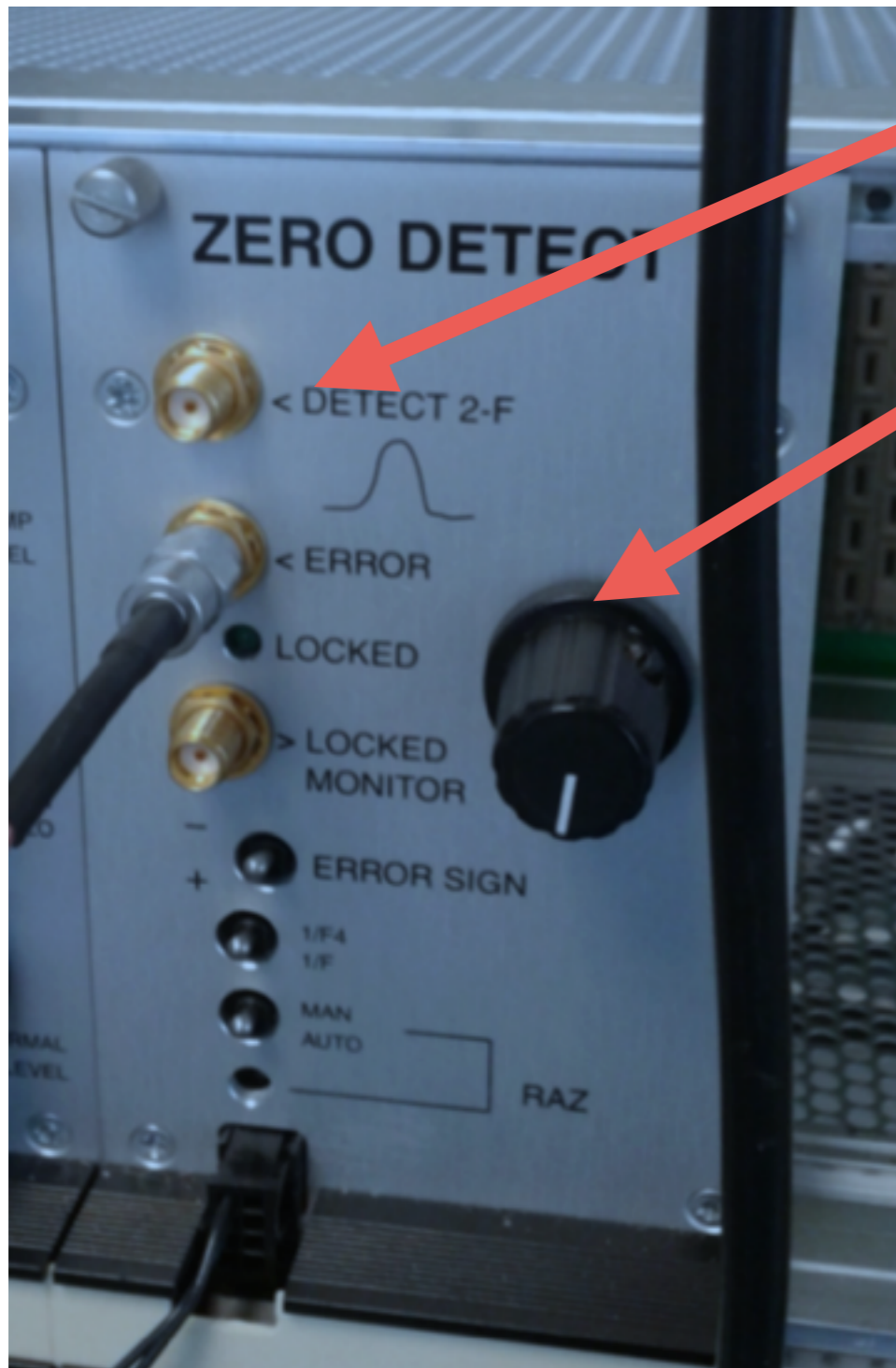
How much power can we send on the photodiode?

PARAMETER	VALUE
Sensor	S5971
Spectral range	320-1060 nm
Peak response (900 nm)	0.65 A/W
Active area diameter	0.8 mm
Bandwidth	~1-100 MHz
Output impedance	50 Ω
Amplifier gain	16 kV/A
Supply voltage	12 V
Maximum laser power (900 nm)	< 100 μW
Saturation (RF output)	10 dBm
Size	40 x 40 x 20 mm

P max allowed to avoid sensor damage ~20 mW @ 532

We were able to acquire the lock automatically using transmitted power

cavity transmission

trimmer to set lock treshold

$$P_{\text{tra}} = \left[\frac{t_1 t_2}{1 - r_1 r_2} \right]^2 P_0 = 0.62 \cdot P_0$$

tentative value of P_0 needed to set the trimmer range