

Izgradnja i karakterizacija optičkog pojačala za ultrastabilni didoni laserski sustav

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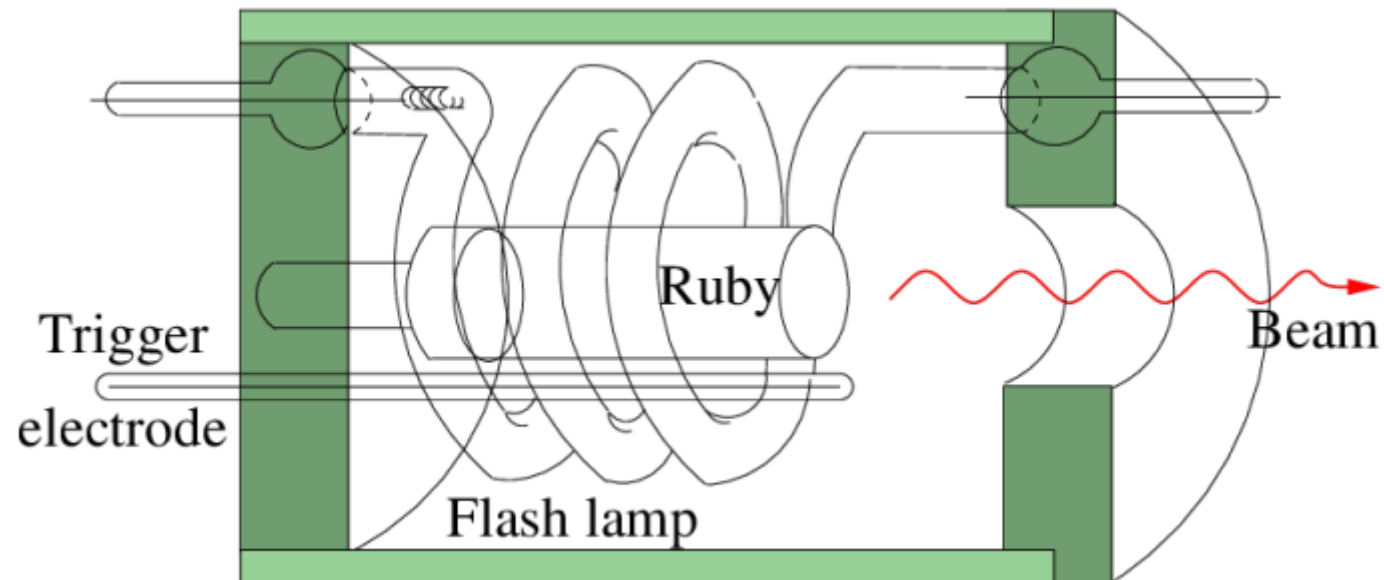
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27. Siječnja 2020.

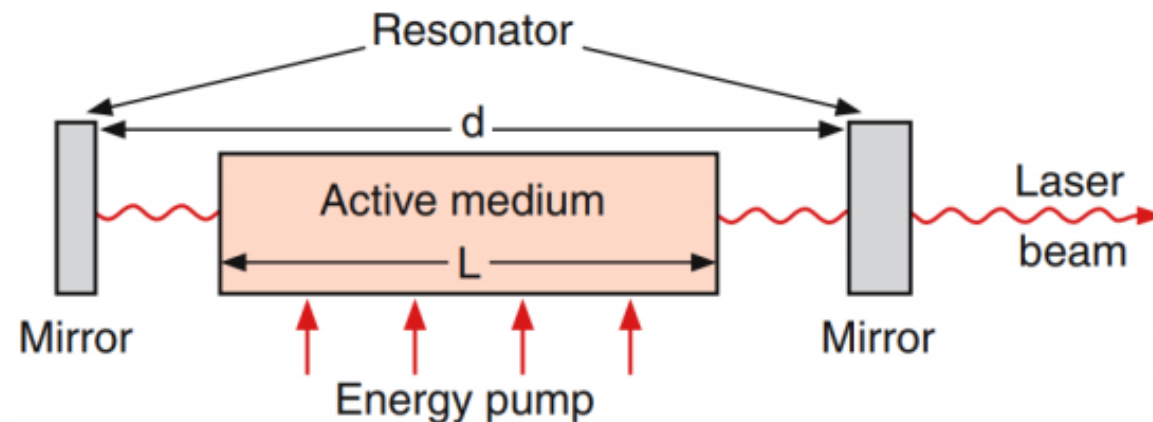
LASER – Light amplification by stimulated emission of radiation

- Prvi laser izgrađen 1960.
- Cilindričan kristal rubina obasjan s lampom
- Zrcala na krajevima zarobljavaju svjetlost

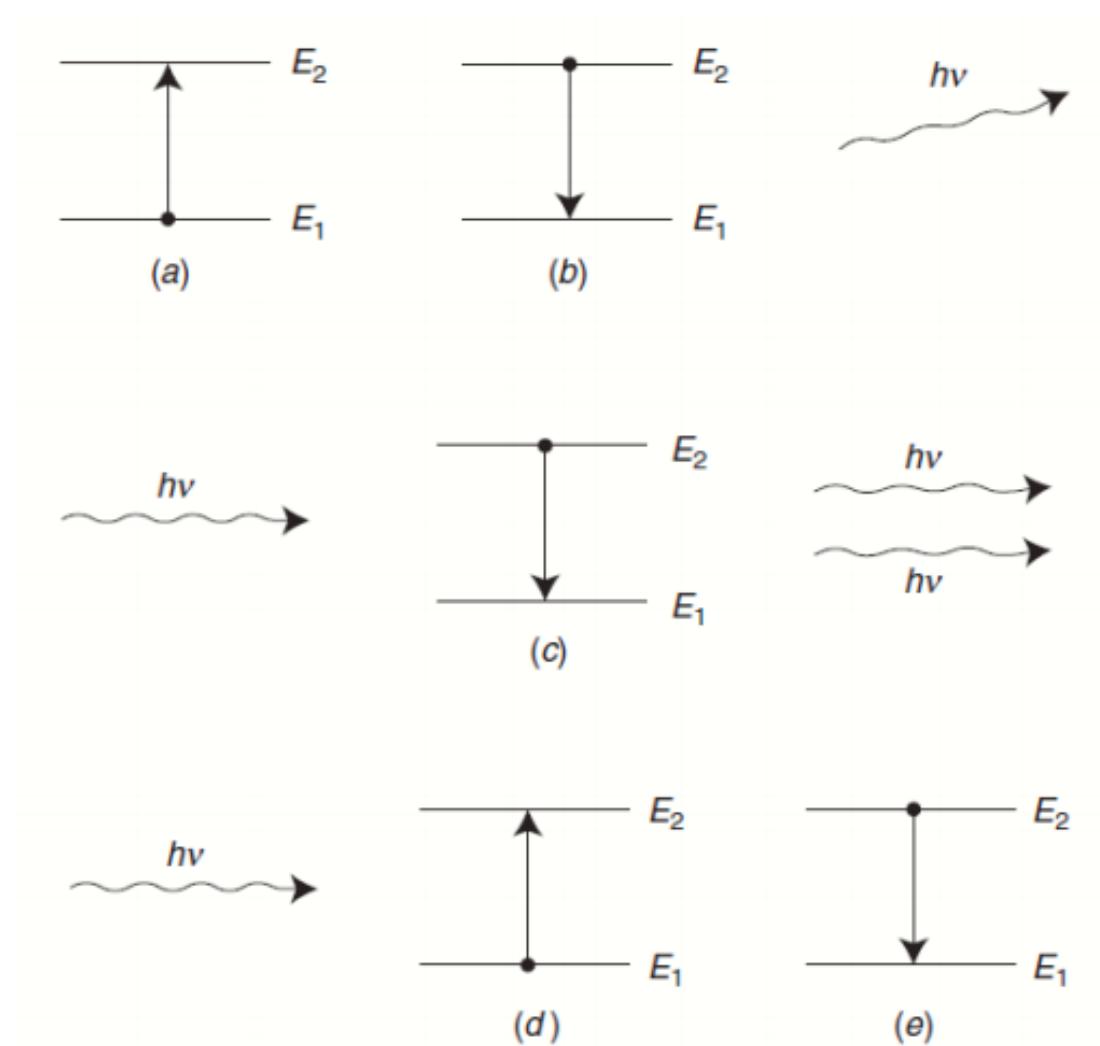


Komponente lasera

- Aktivni medij u laseru može biti svakakvi: plin, tekućina, krutina
- Svim laserima zajedničke su tri komponente:
 1. **Aktivni medij** koji omogućava emisiju svjetlosti
 2. **Energetska pumpa** koja dovodi energiju u sistem
 3. **Optički rezonator** koji zarobljava emitirane fotone

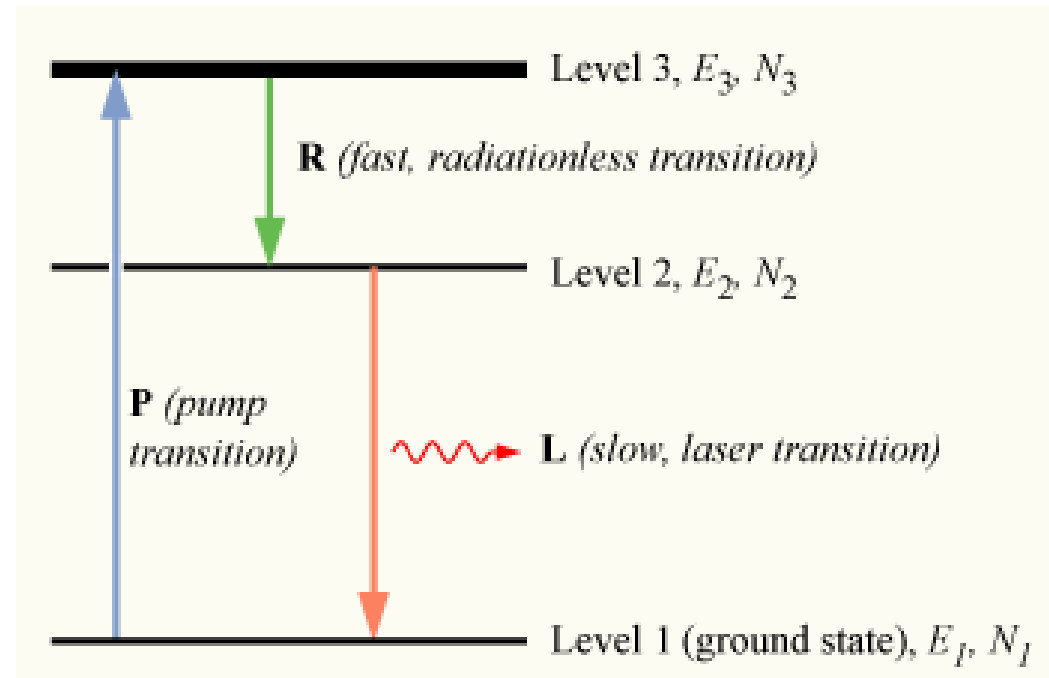


Procesi izmjene energije u laseru



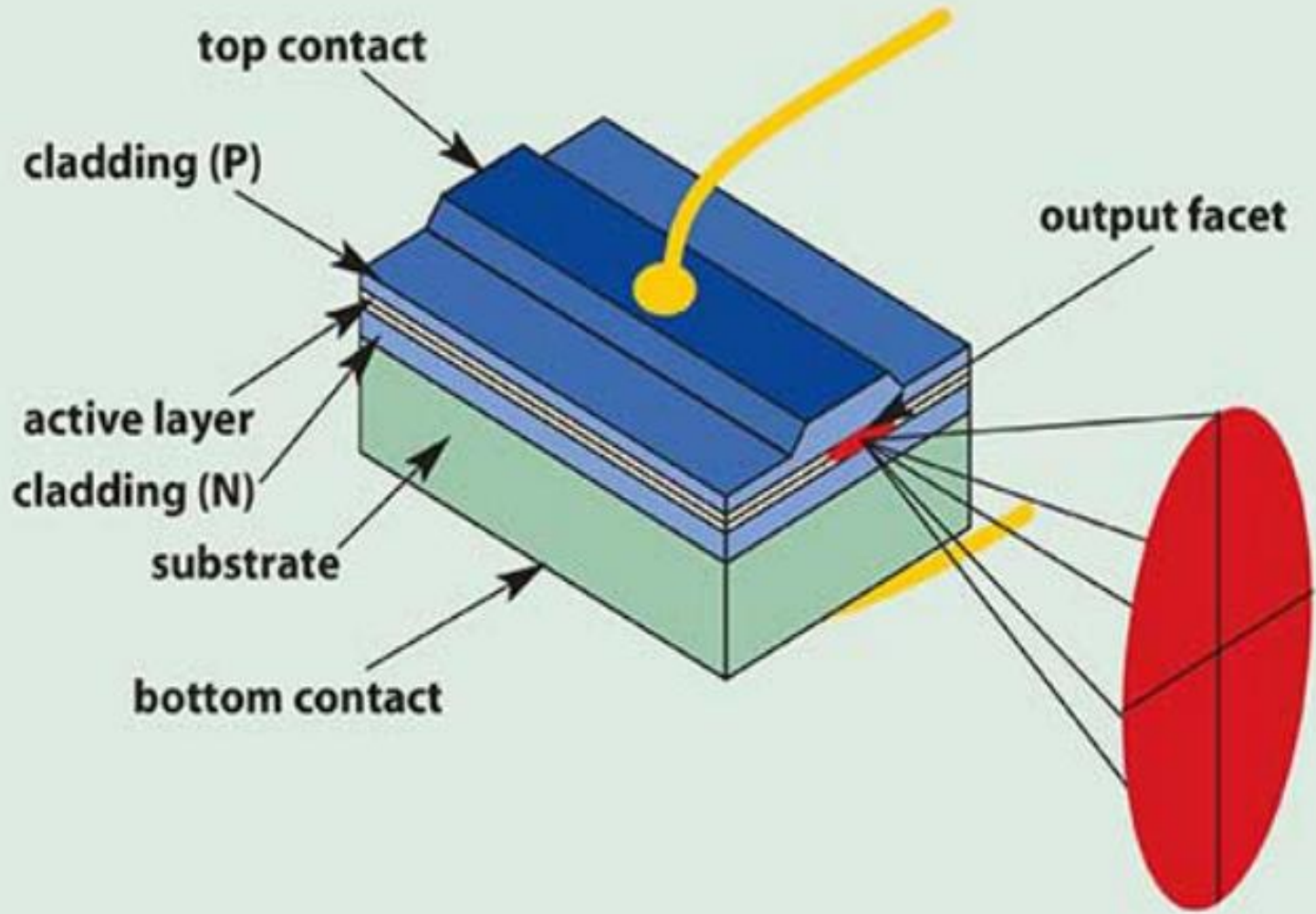
Inverzija populacije

- Za laseriranje potreban uvjet $N_2 > N_1$
- Ne može se postići u 2 level laseru, za 2 level max $N_2 = N_1$
- Potreban još jedan metastabilan nivo

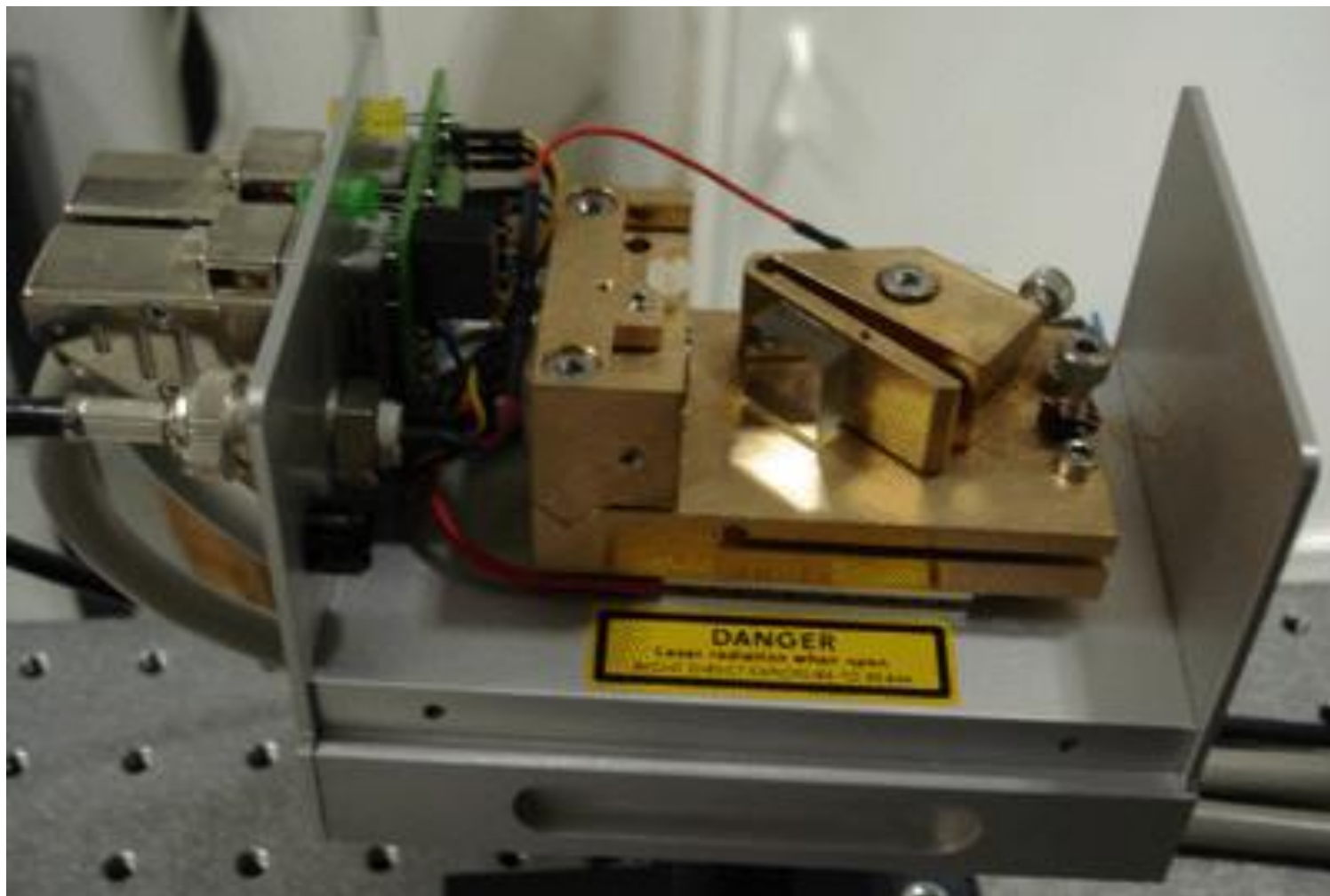


Laserska dioda

- Funkcionira na istom principu kao LED. Zrcala na krajevima diode zarobljavaju fotone koji uzrokuju stimuliranu emisiju
- Dioda PIN tipa s intrinzičnim dijelom zbog max. rekombinacije
- Laserirajuće područje veličine oko 0.5 mm x 0.01 mm
- Stvara koherentnu svjetlost relativno velike snage

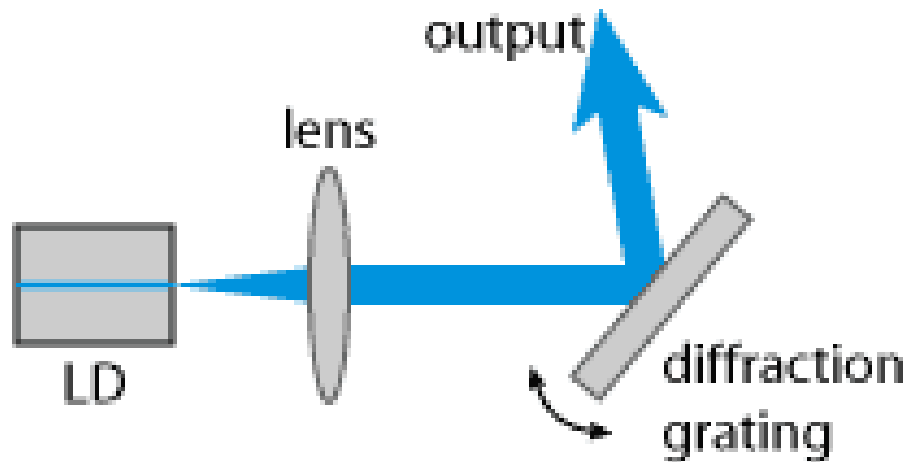


Diodni laser s ECDL

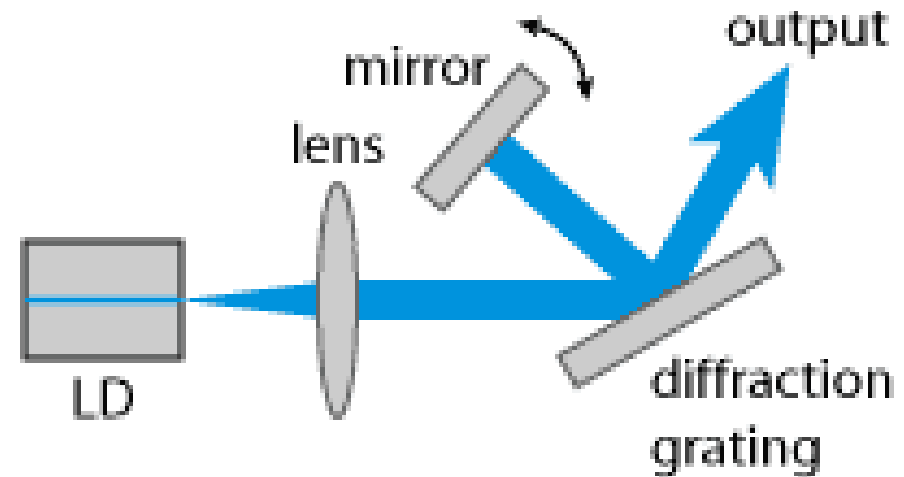


ECDL konfiguracija

- Služi za precizni odabir valne duljine te smanjenje spektralne linije

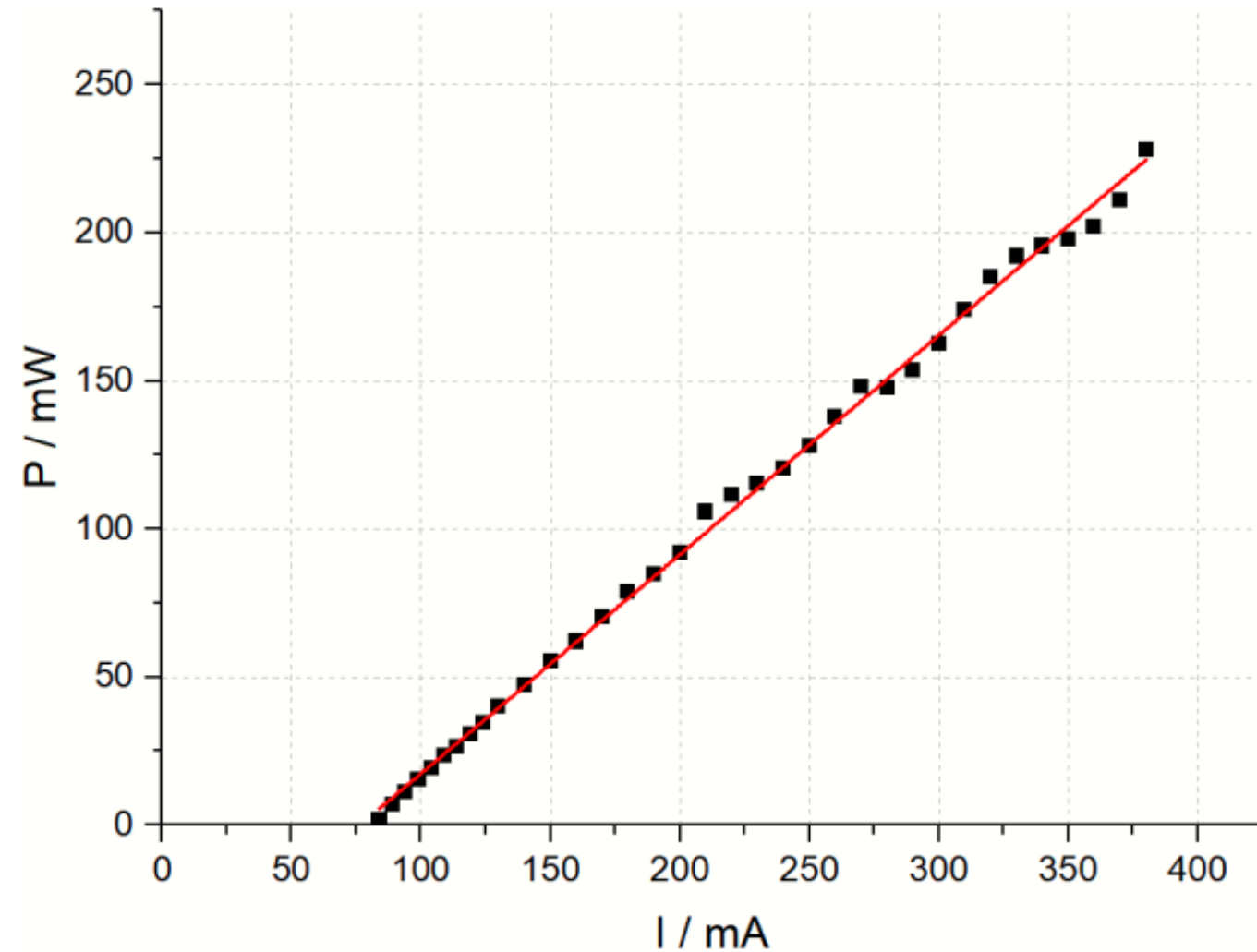


a) Littrow configuration

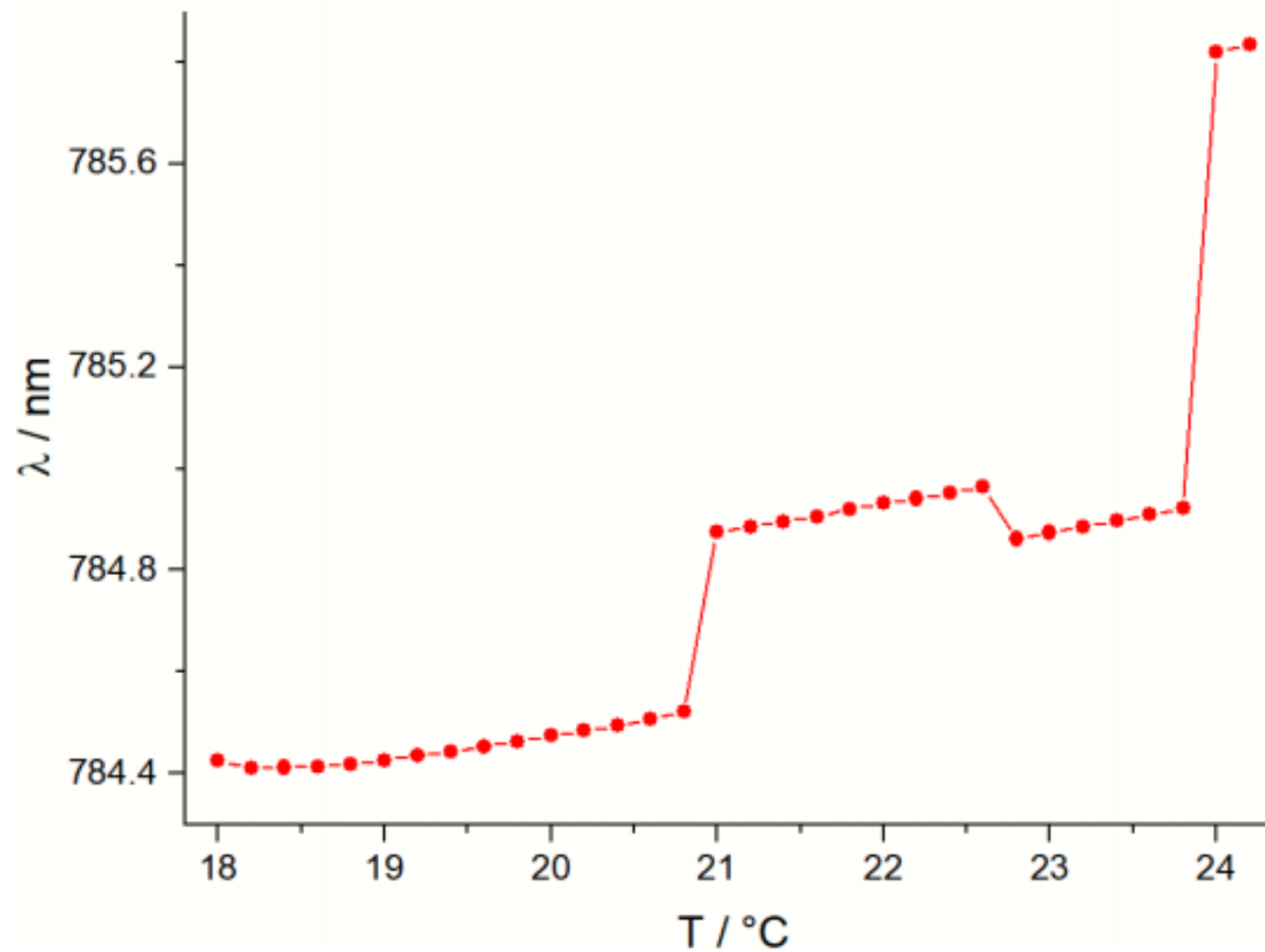


b) Littman-Metcalf configuration

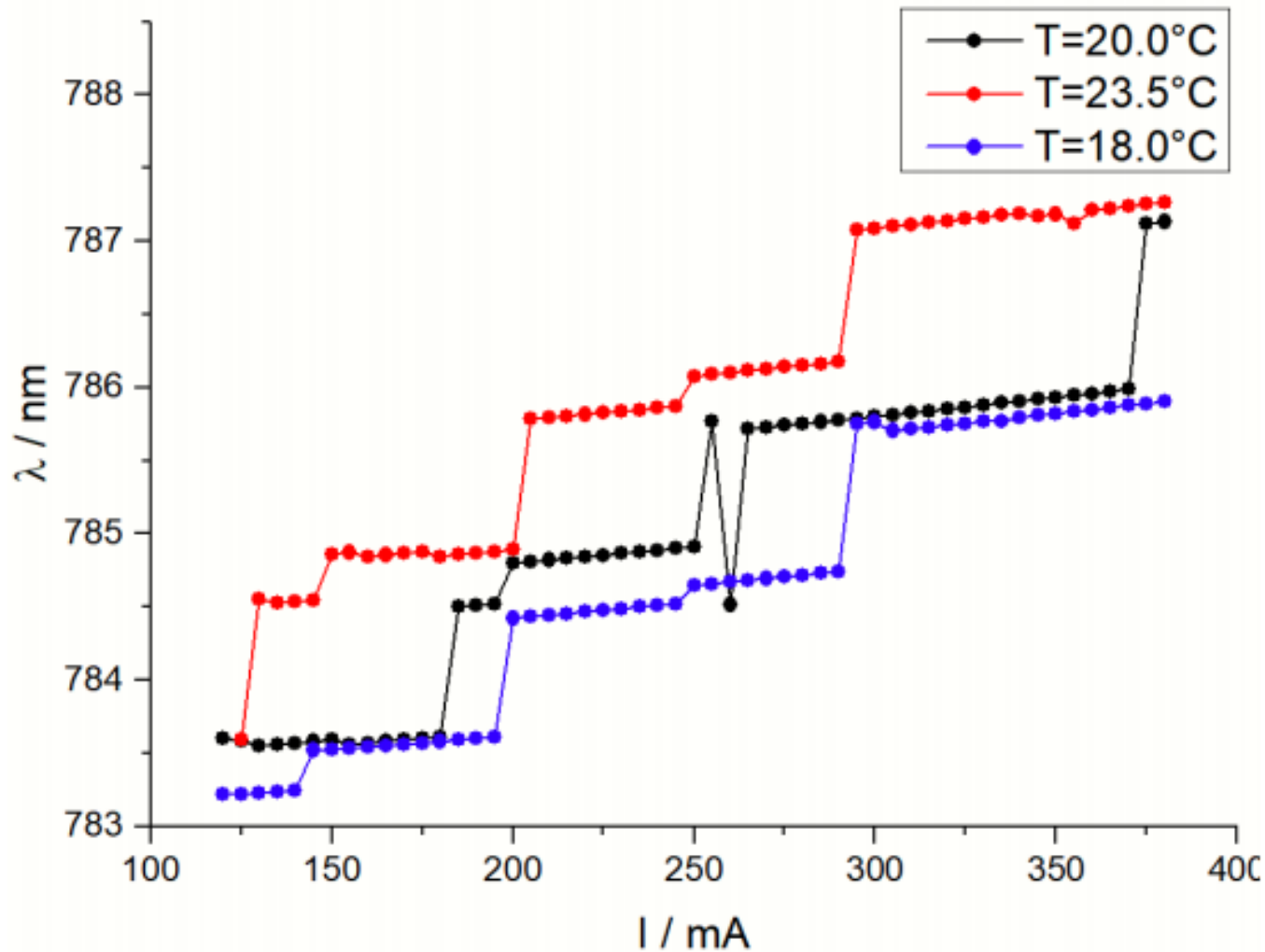
Snaga GaAs lasera ovisno o struji



Valna duljina lasera ovisno o temperaturi



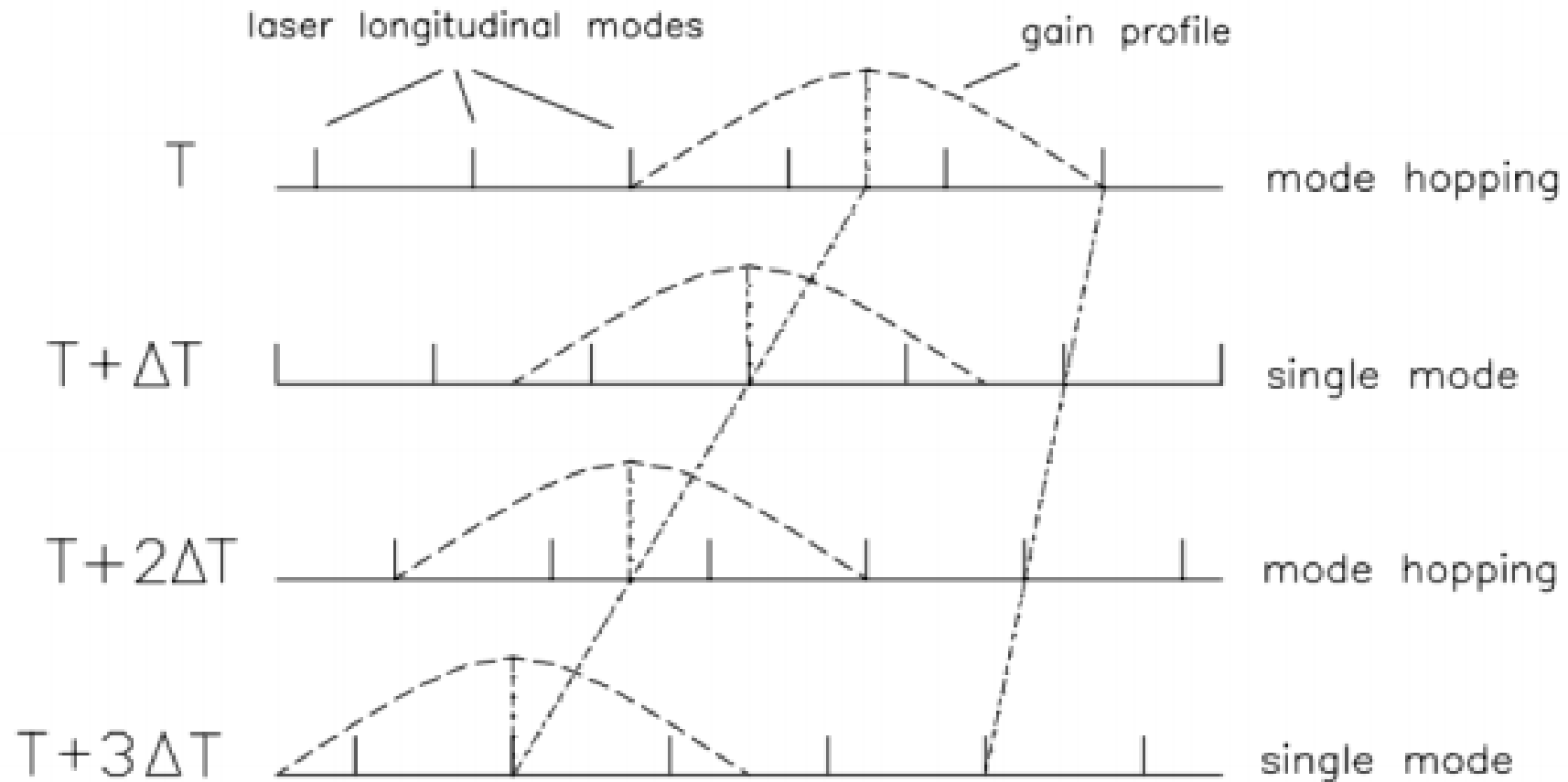
Valna duljine lasera ovisno o struji



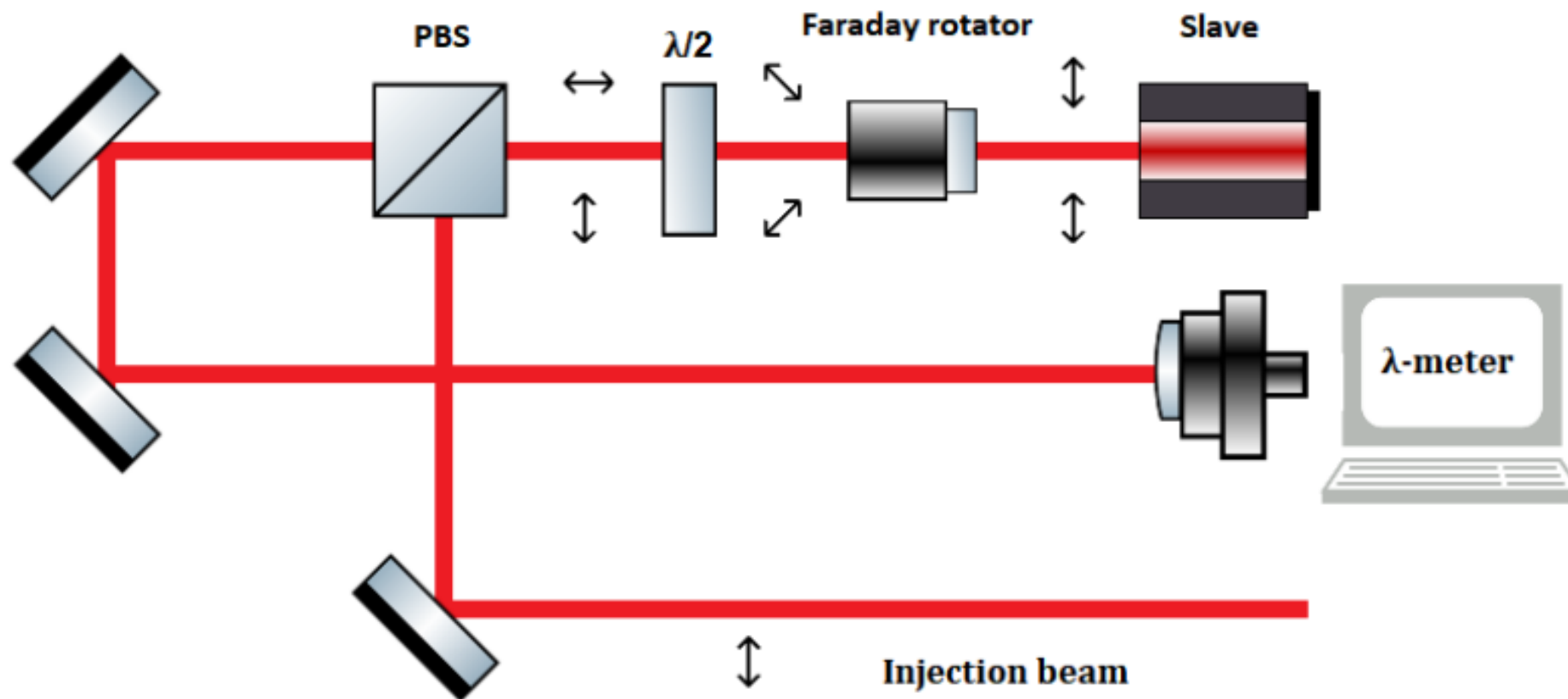
$$\Delta L = \alpha L_0 \Delta T$$

$$E_g = E_g(0) - \frac{\alpha T^2}{T + \beta}$$

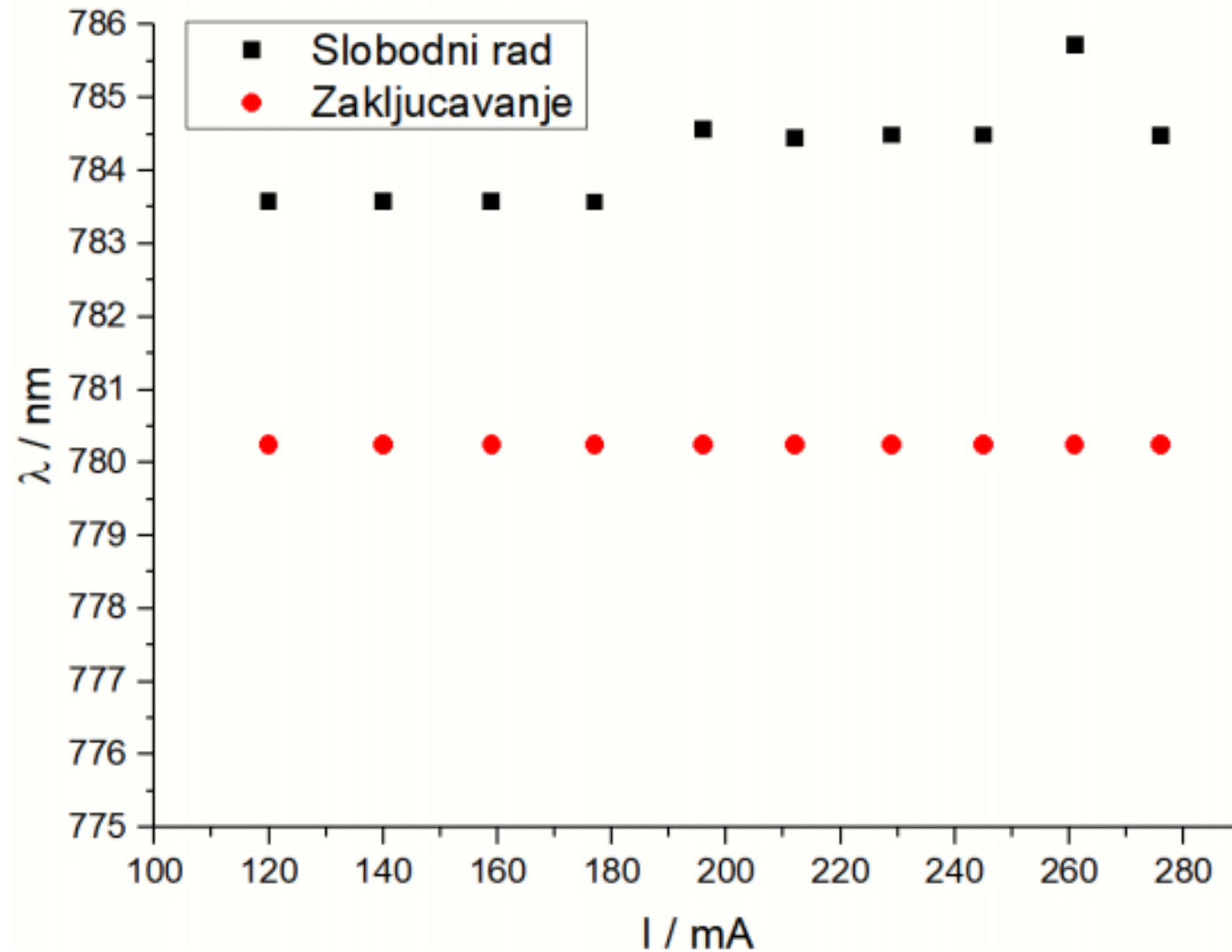
Preskakivanje modova diodnog lasera



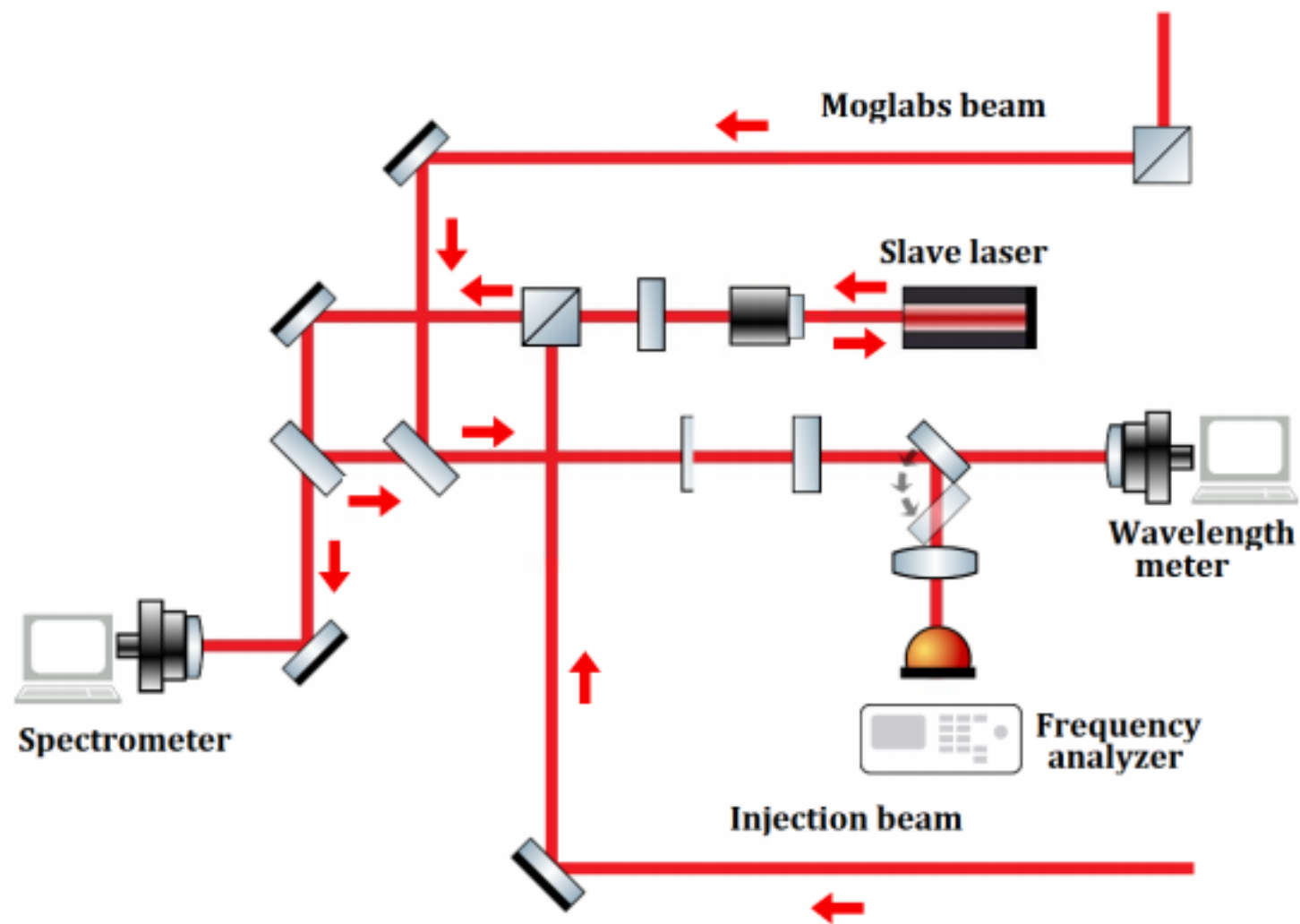
Lokiranje lasera metodom *Injection lock*

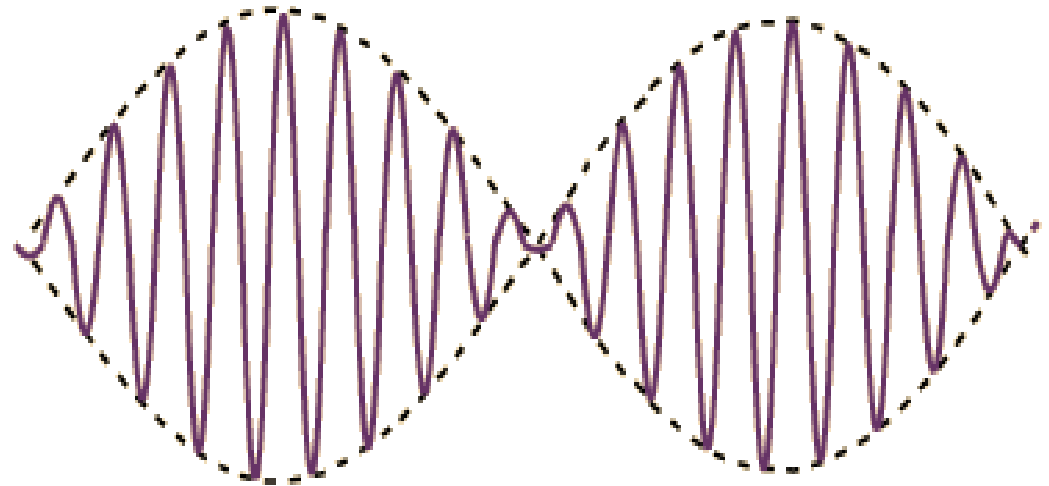
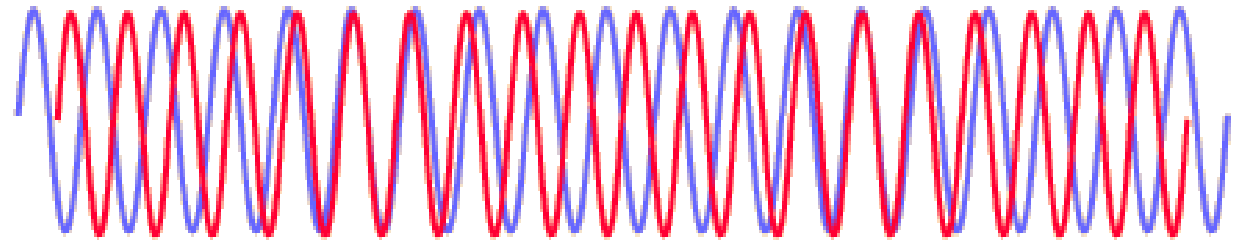


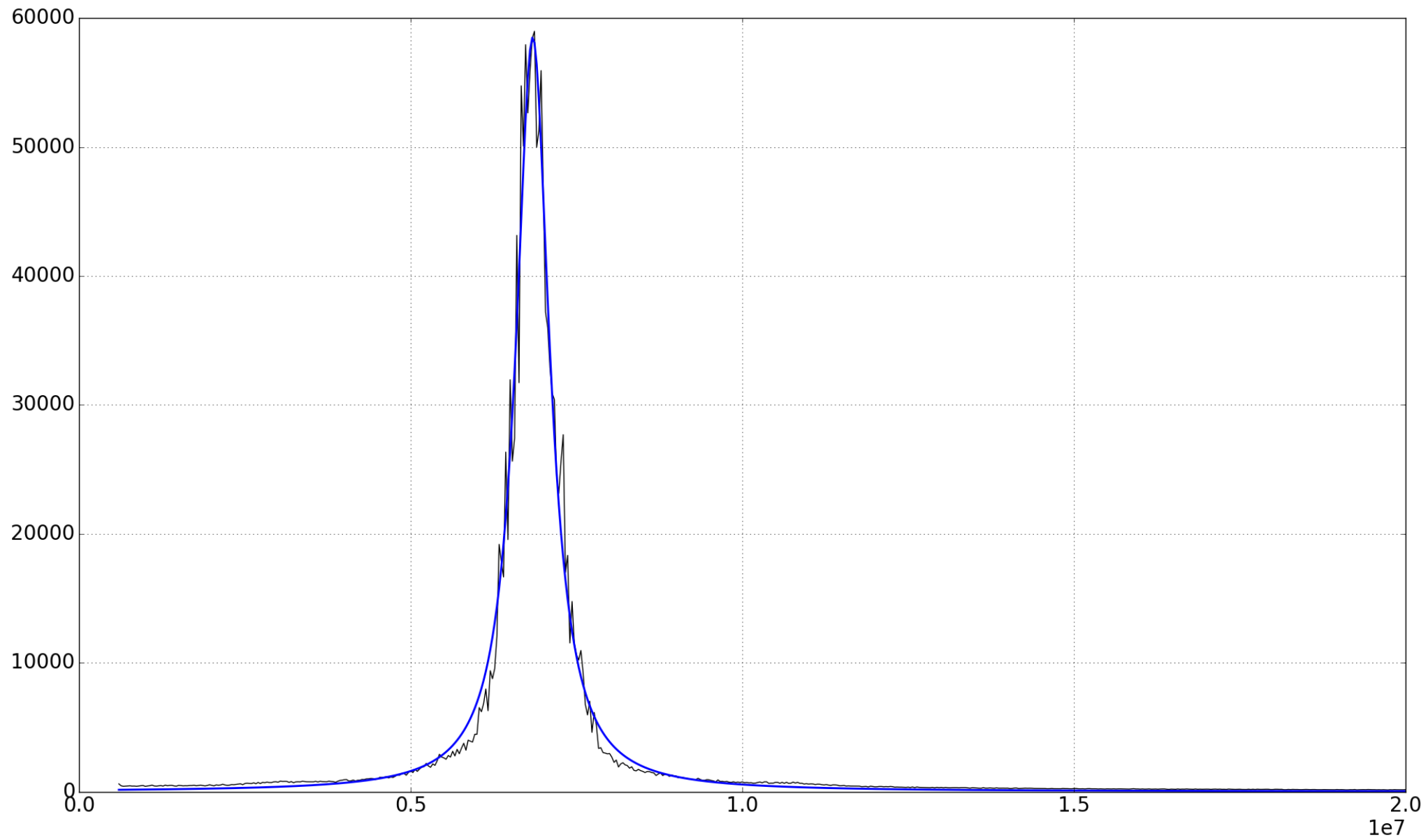
Valna duljina lasera prije i nakon lokiranja



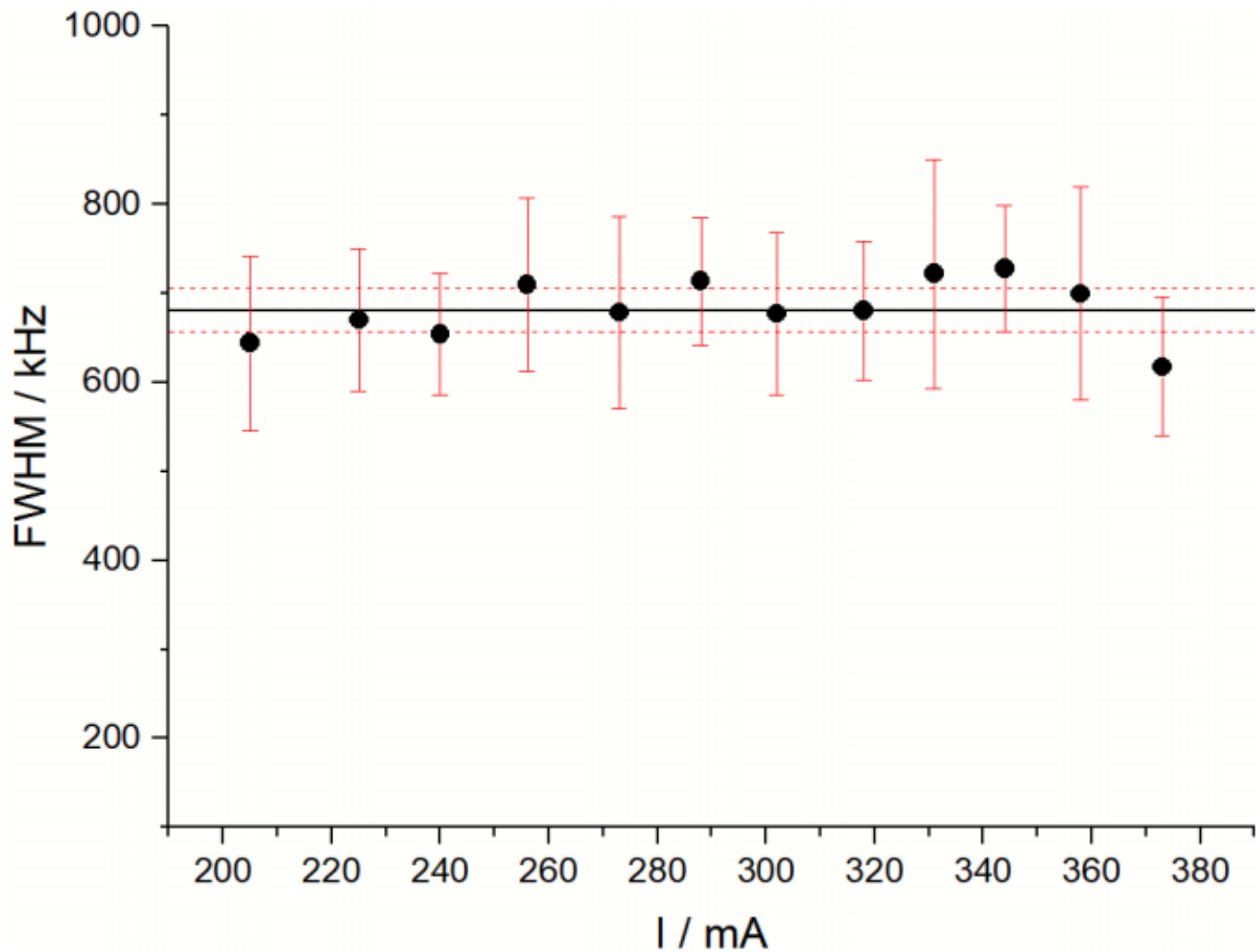
Mjerenje spektralne širine linije lasera







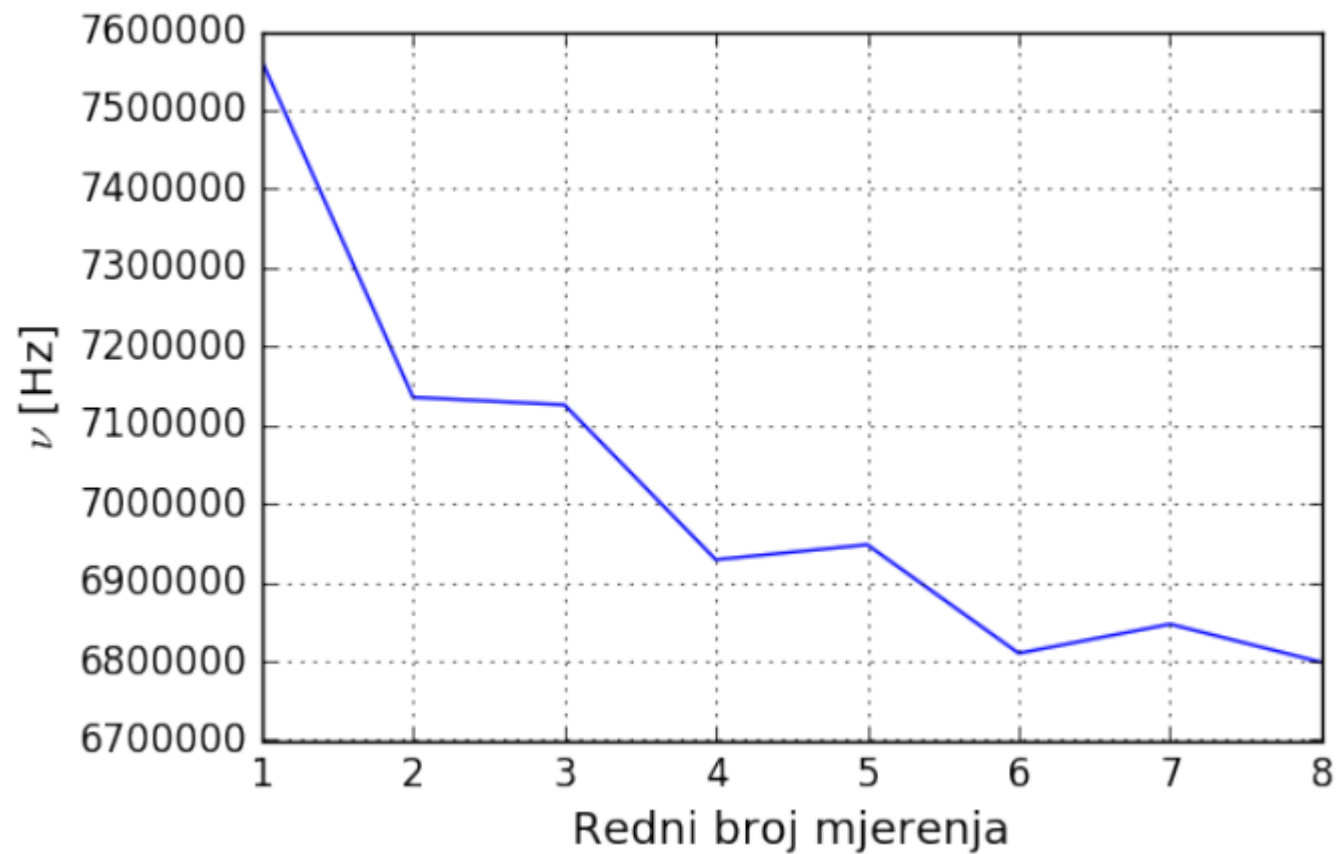
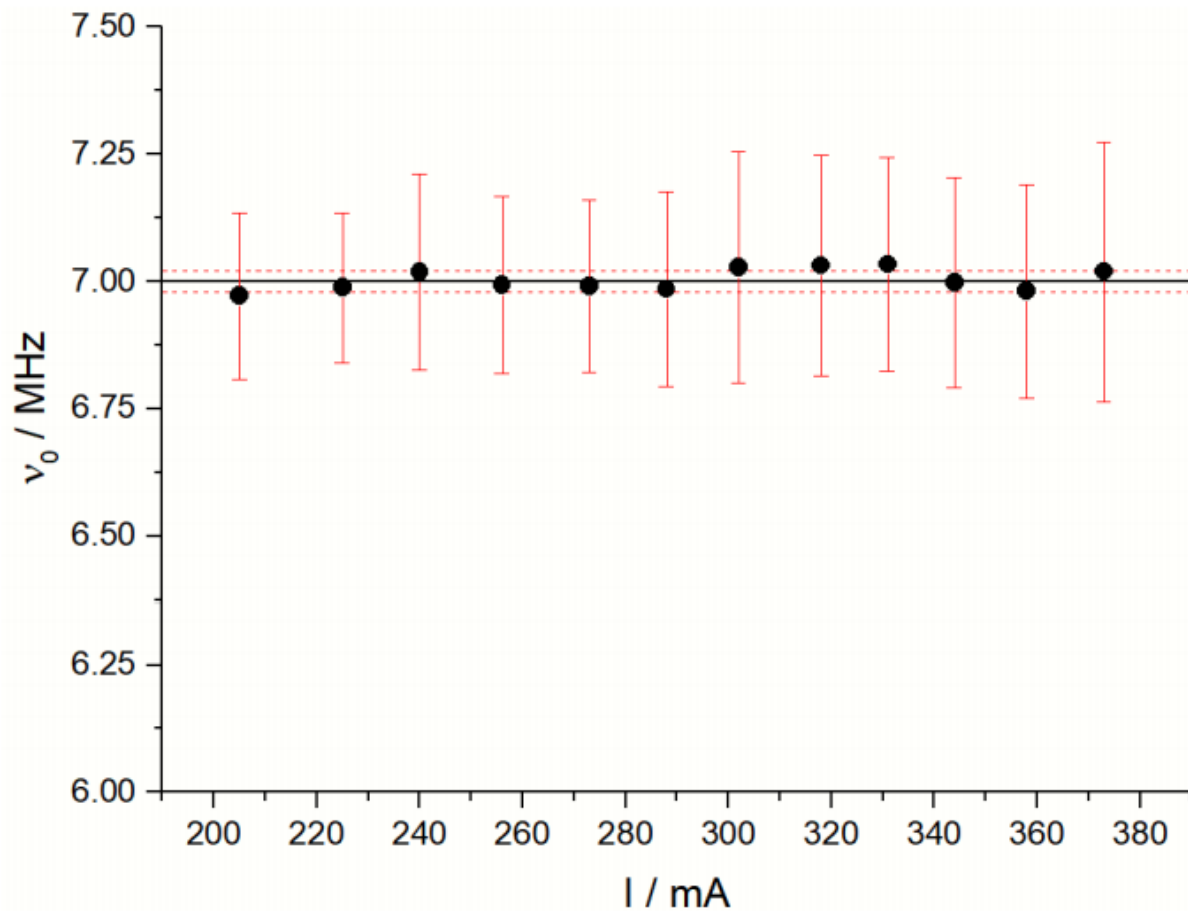
Širina spektralne linije beat signala



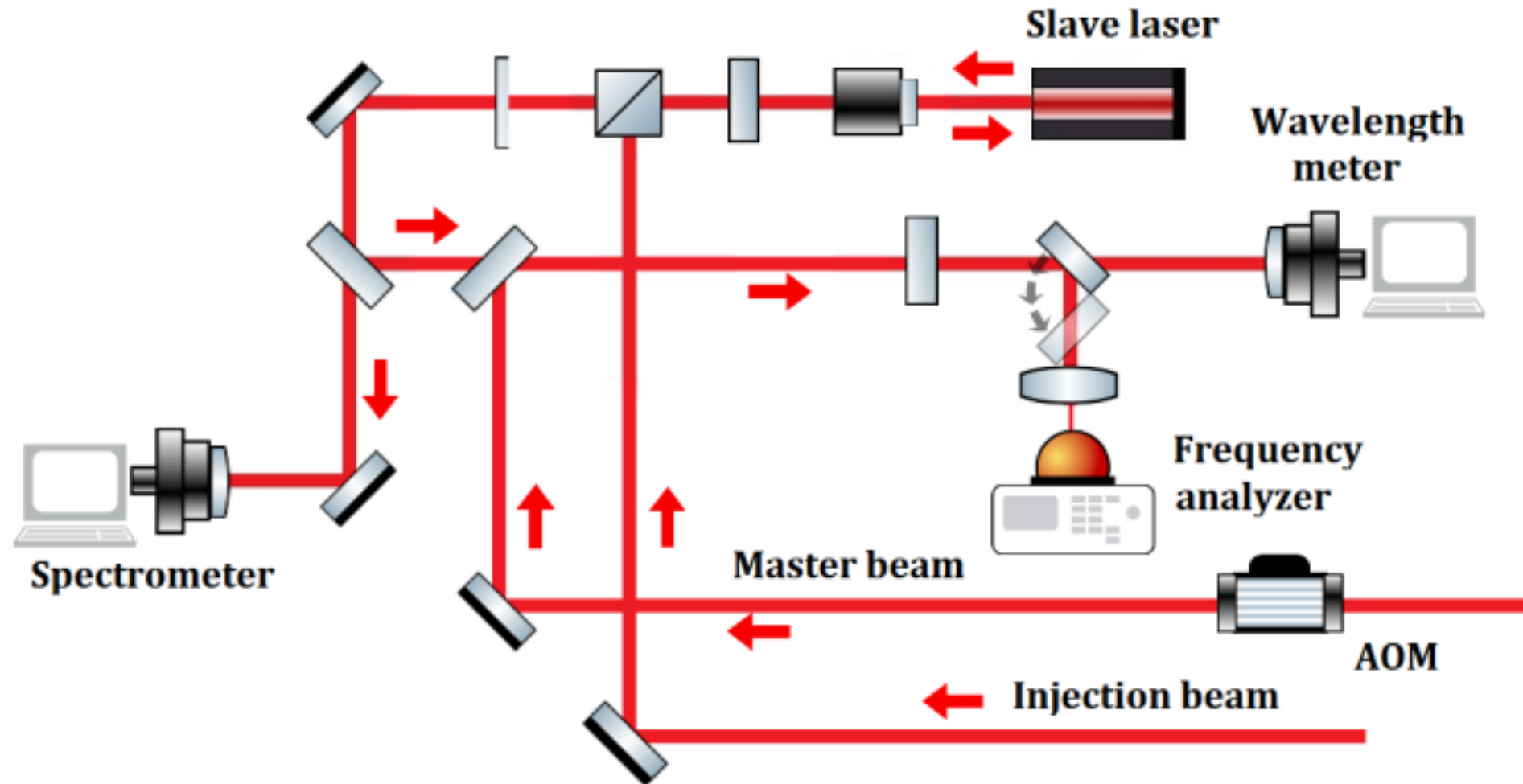
$$\sim \sqrt{\Delta f_1^2 + \Delta f_2^2}$$

$$\Delta f = (681 \pm 25) \text{ kHz}$$

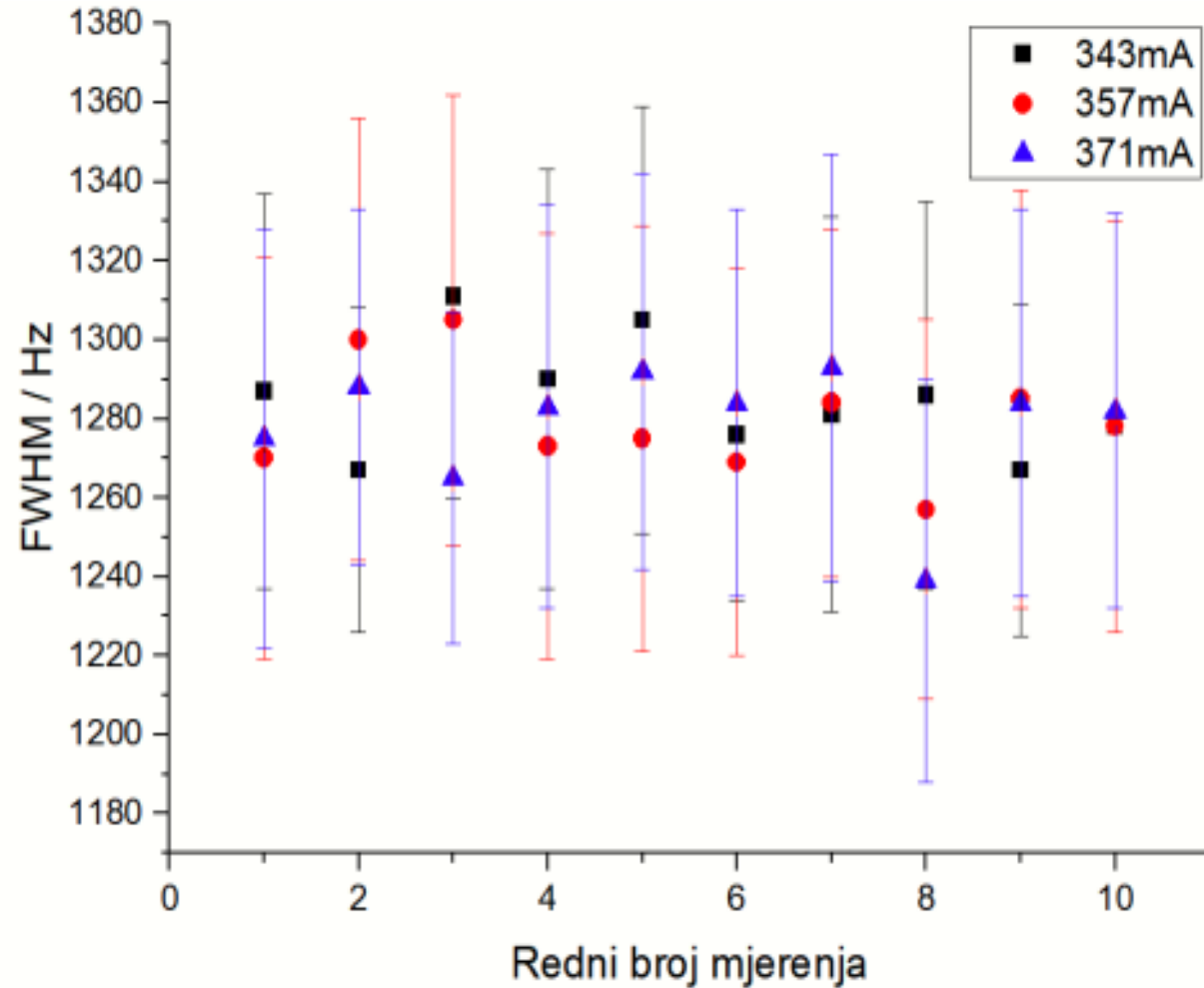
Položaj centra frekvencije udara



Beat frekvencija između master i slave lasera



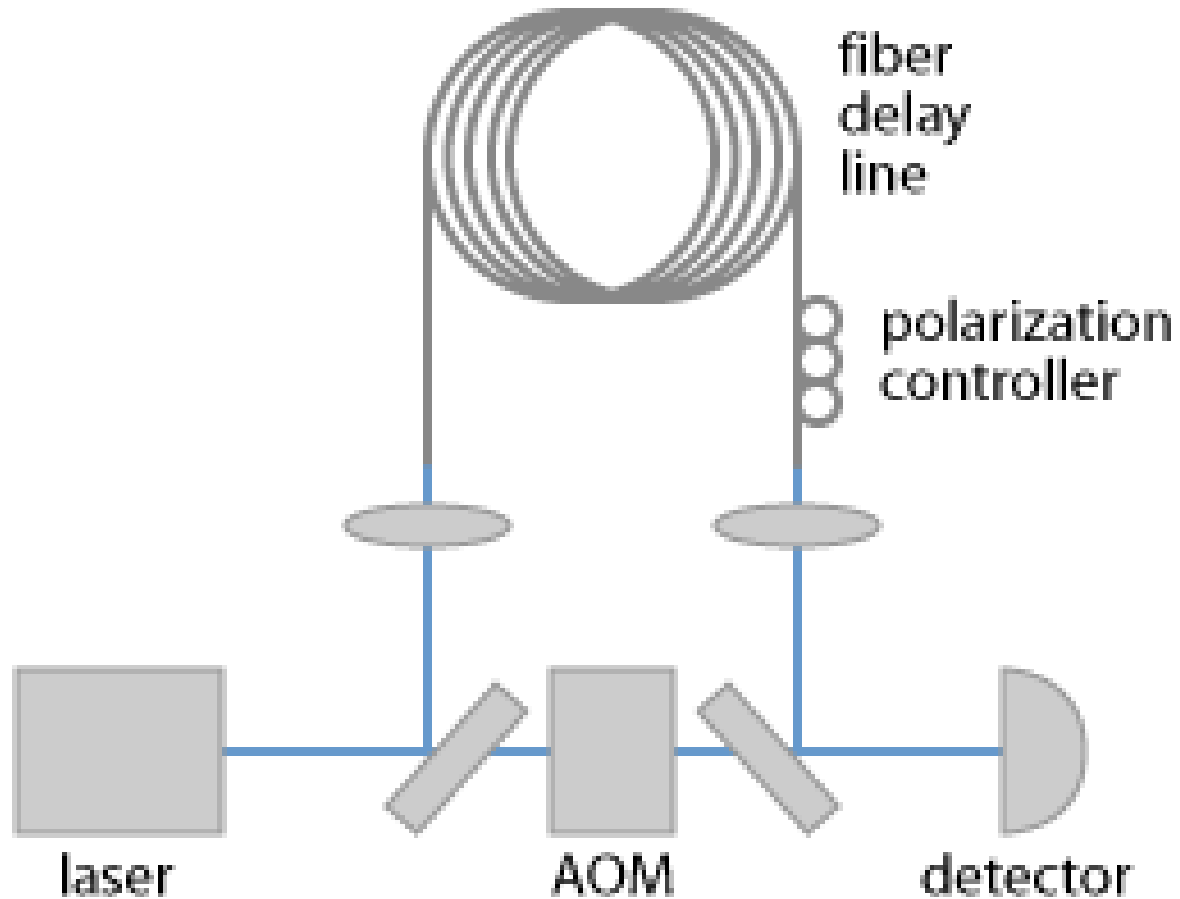
Širina spektralne linije beat frekvencije



$$\sim \sqrt{\Delta f_1^2 + \Delta f_2^2}$$

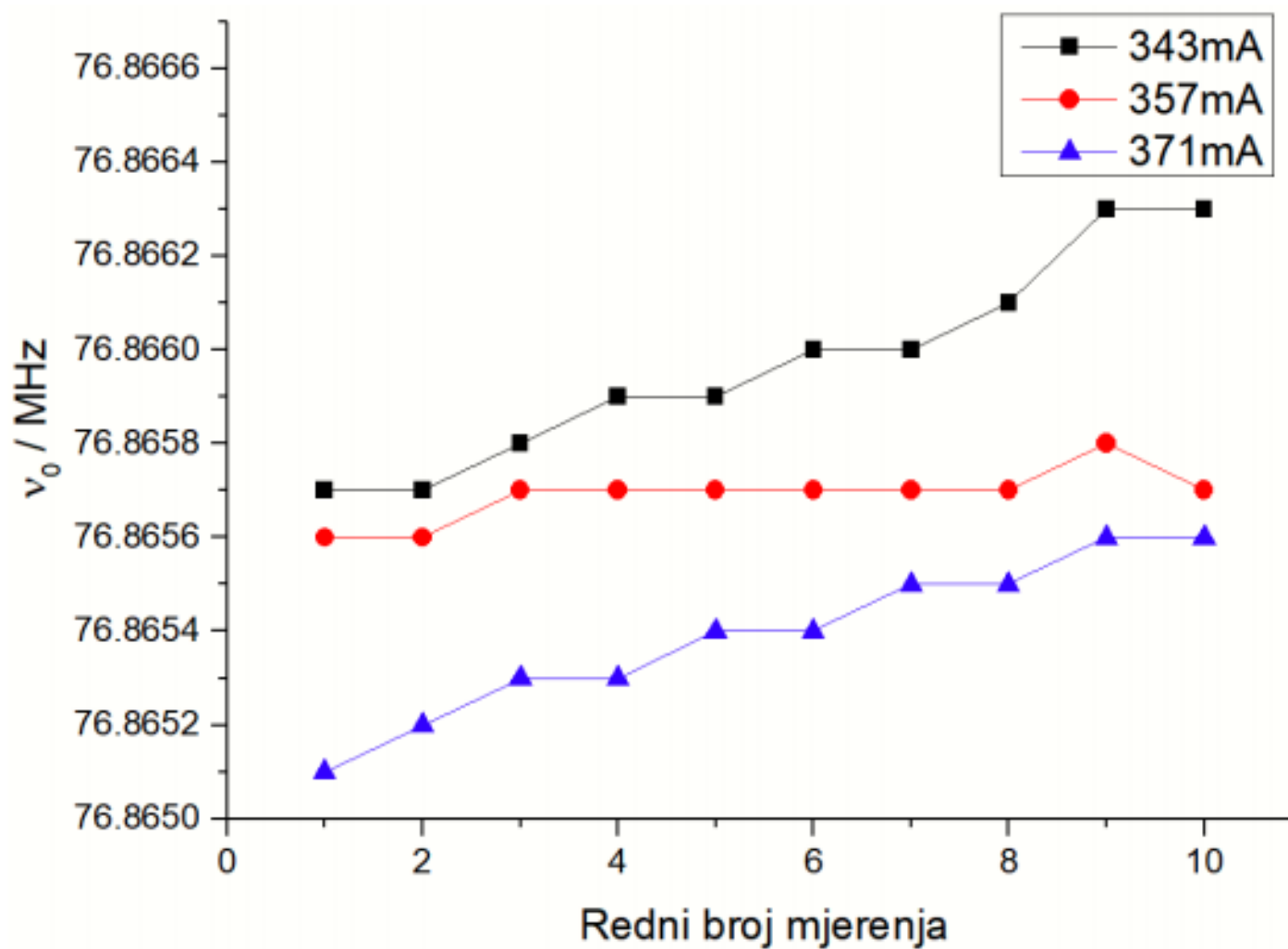
$$\sim 680\sqrt{2}\text{kHz}$$

Self-heterodyne Linewidth Measurement



$$L_{coh} = \frac{c}{\pi \Delta \nu}$$

Položaj centra frekvencije udara master-slave

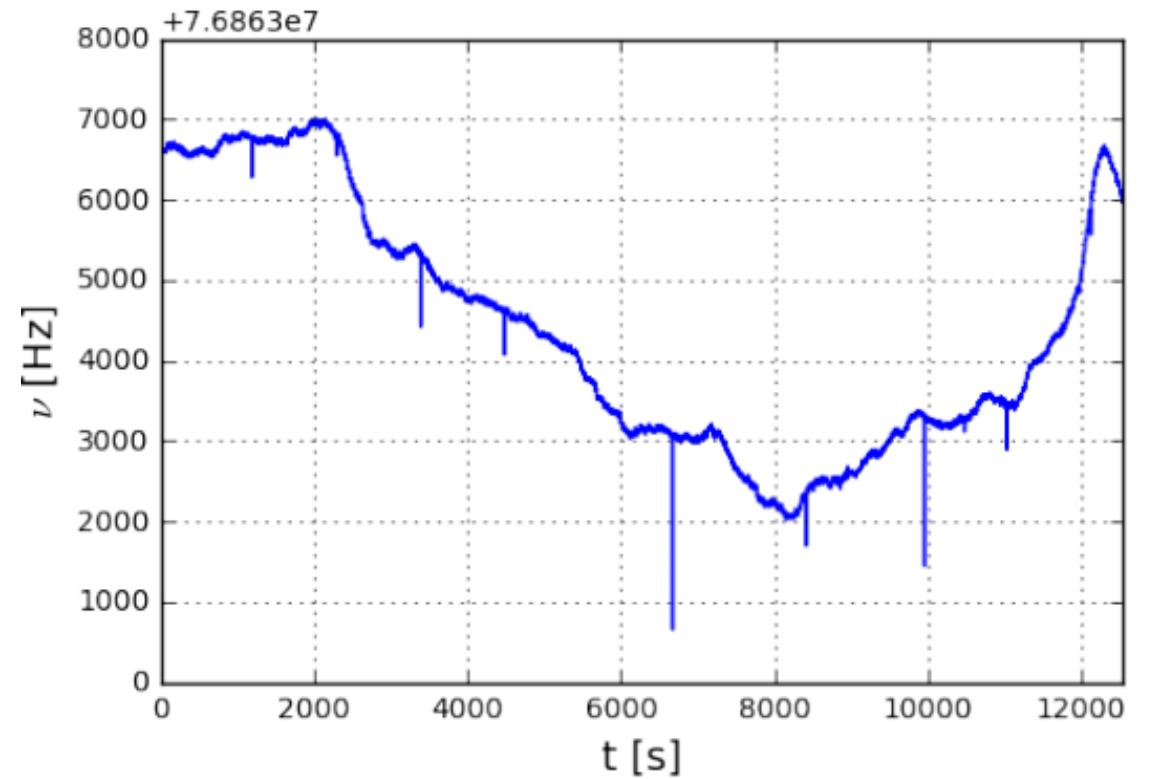
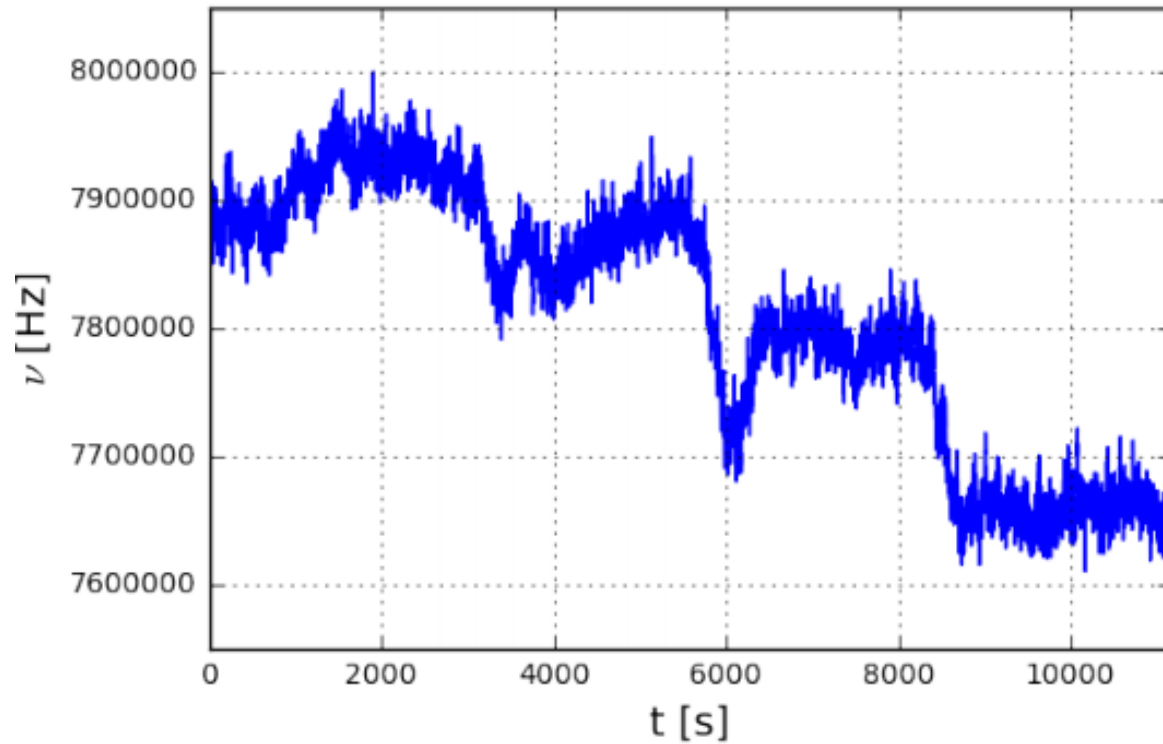


Vremenska stabilnost i Allan devijacija

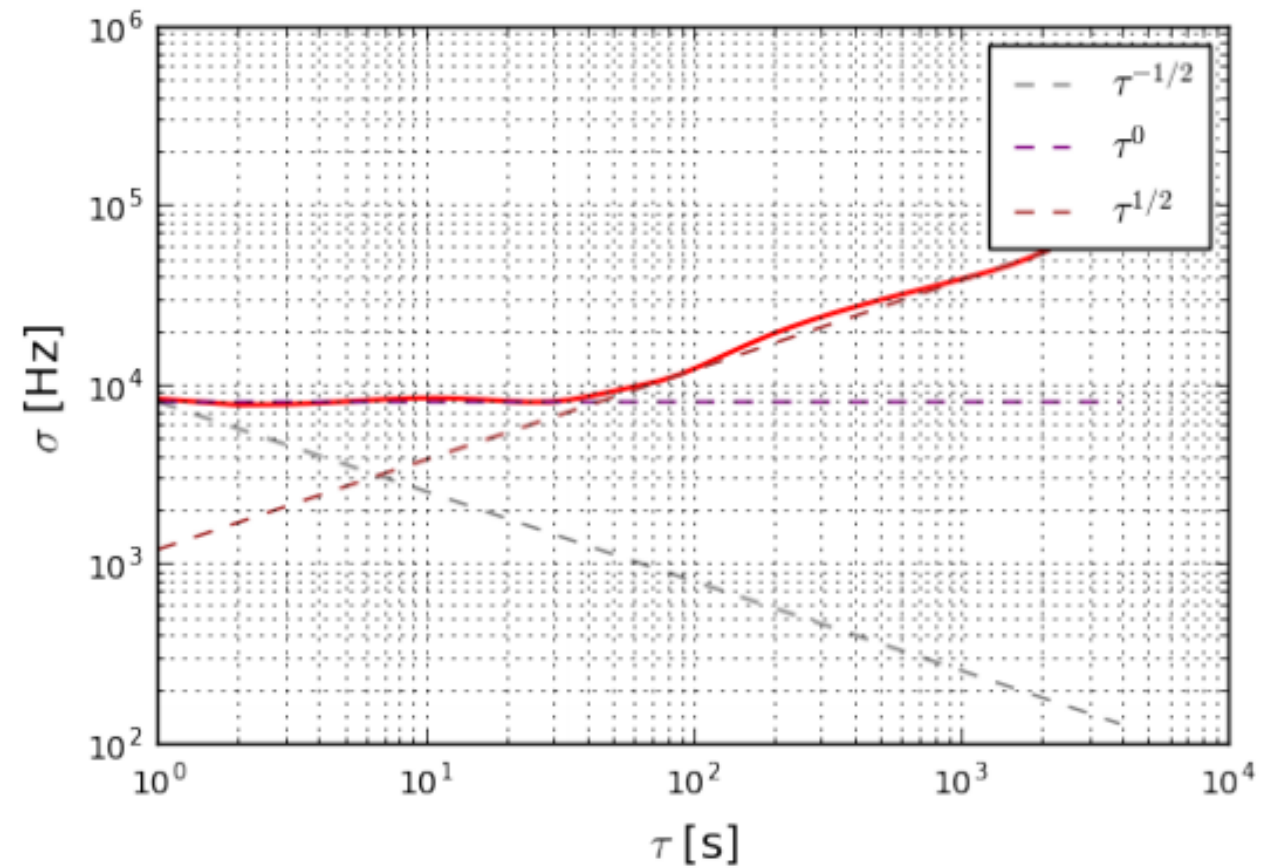
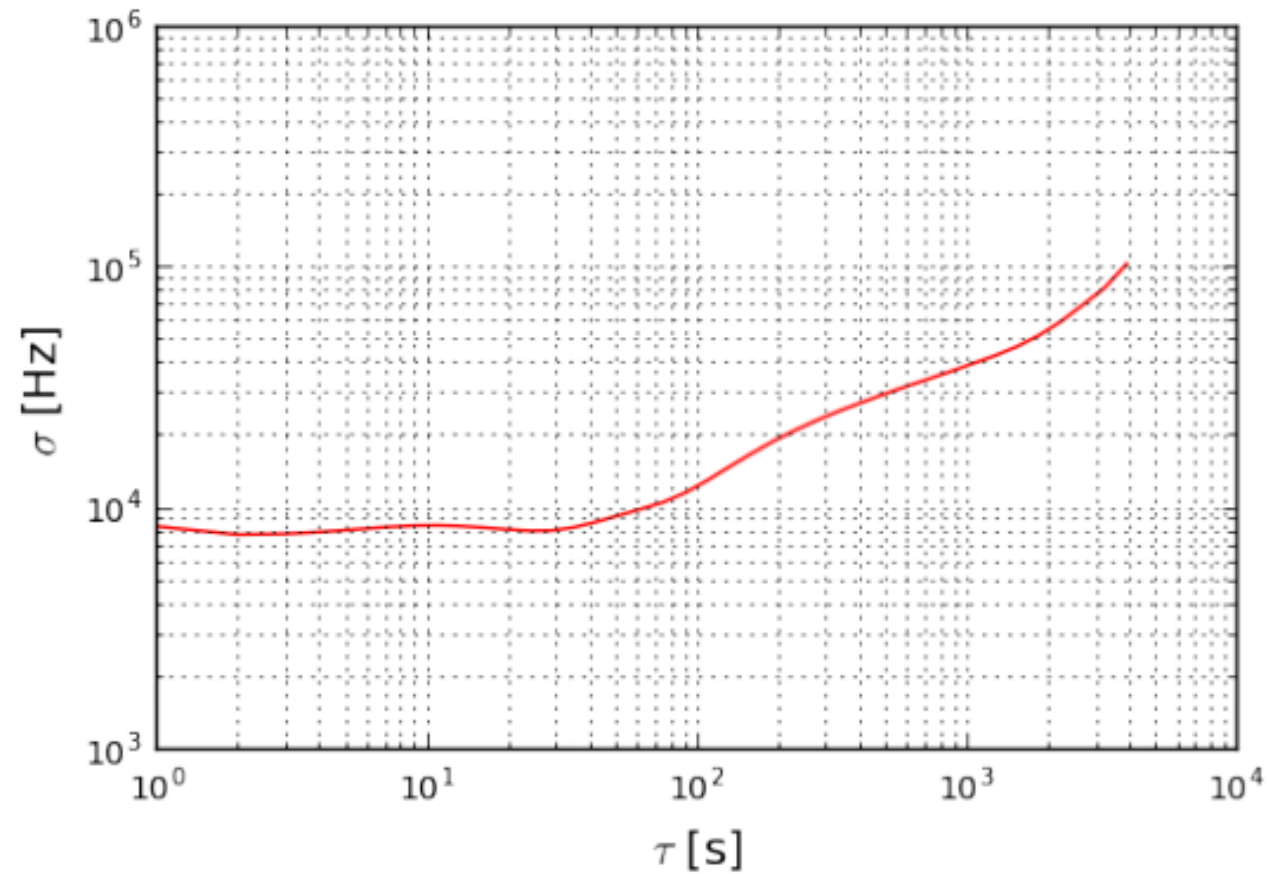
- Mjerena centralna frekvencija udara u ovisnosti o vremenu
- Mjerenje rađeno u rasponu od tri sata
- Izračunata Allan devijacija – ukazuje na pogreške koje dolaze od raznih šumova u uređaju a ne sistematske greške ili drift frekvencije

$$\sigma_v(\tau) = \sqrt{\frac{1}{2} \langle (\bar{v}_{n+1} - \bar{v}_n)^2 \rangle}$$

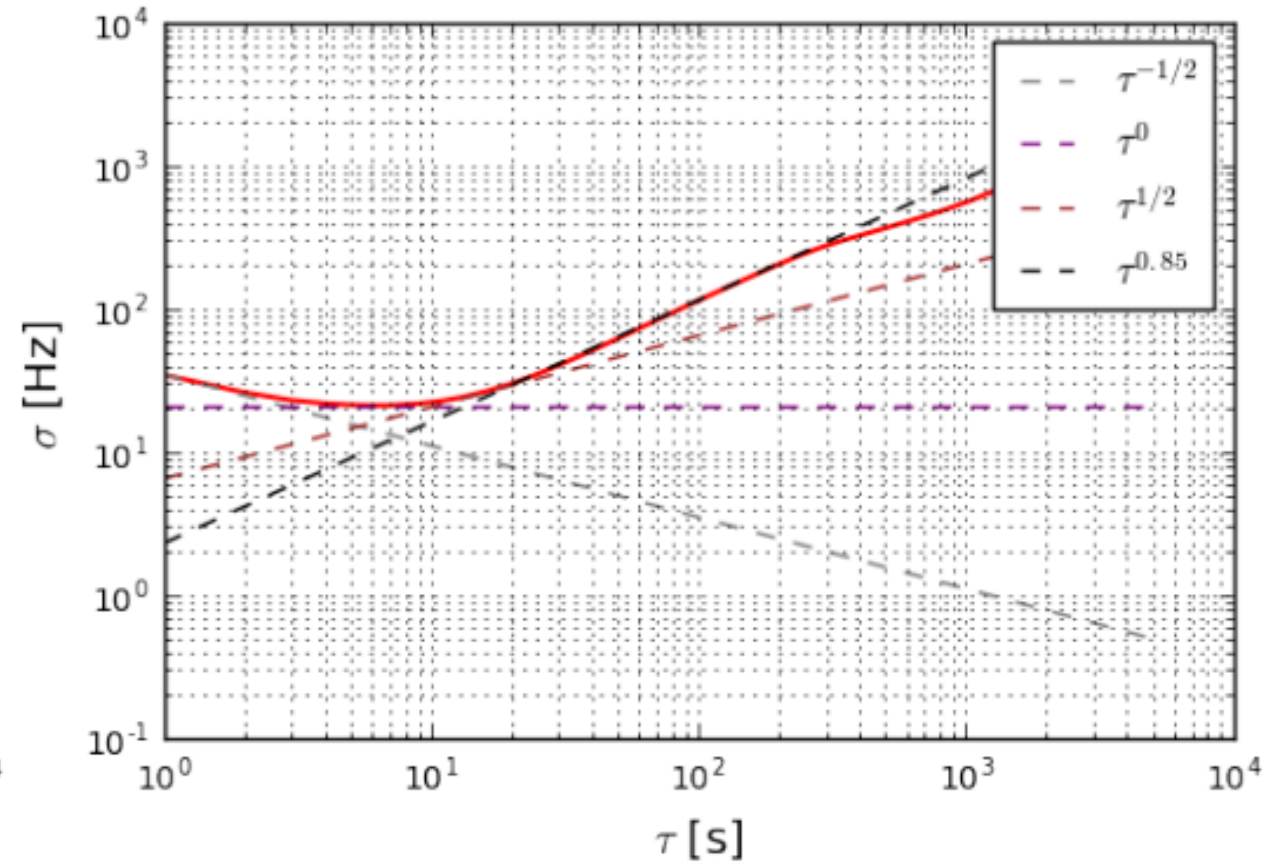
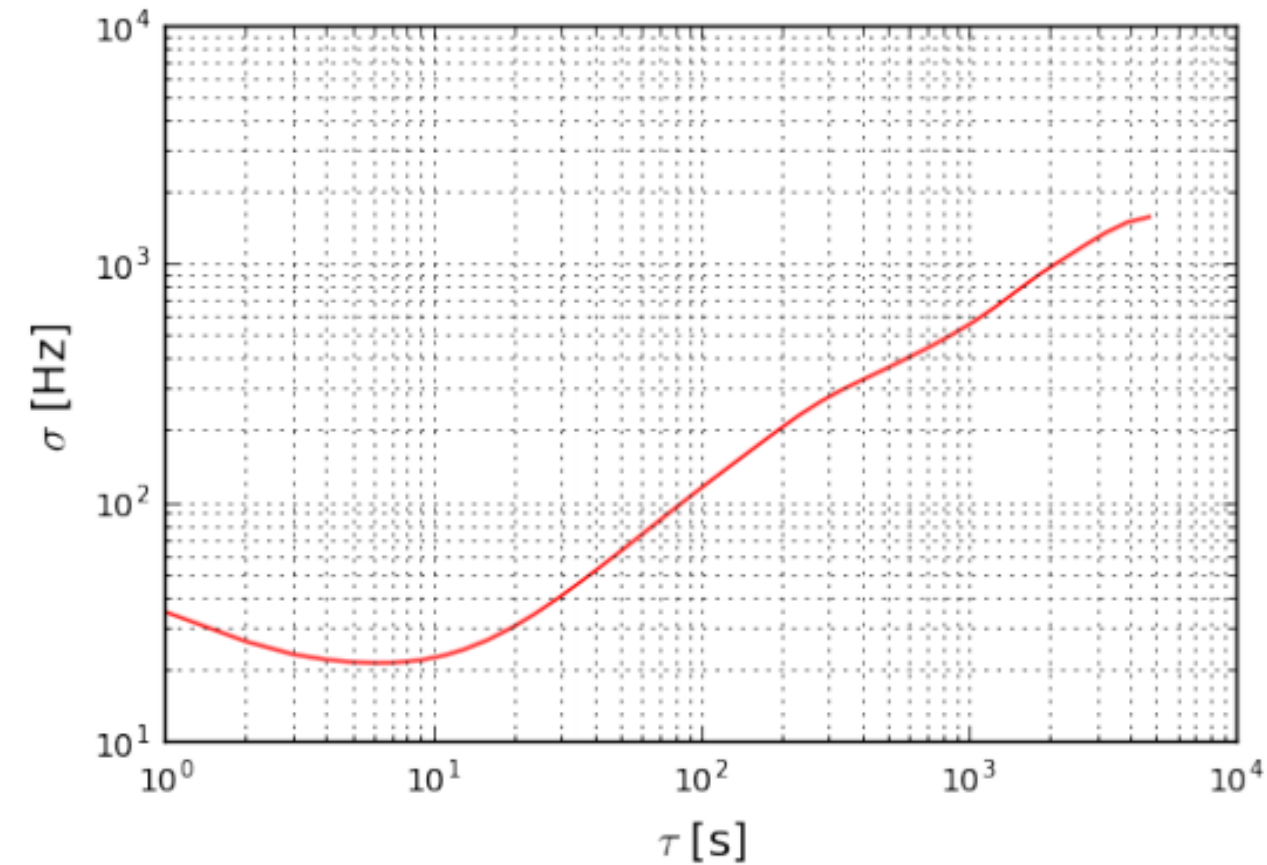
Vremenska stabilnost udara Moglabs-slave te master-slave



Allan devijacija udara Moglabs-slave



Allan devijacija udara master-slave



Hvala na pažnji!