Laser calibration for thermal shock measurement

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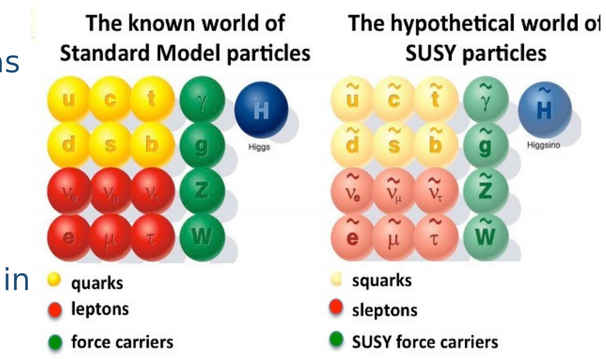
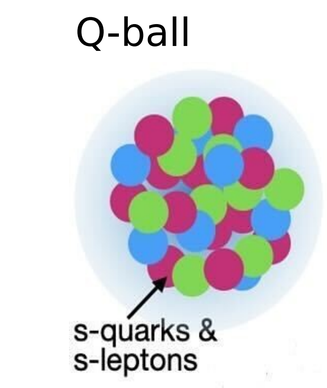
Motivation

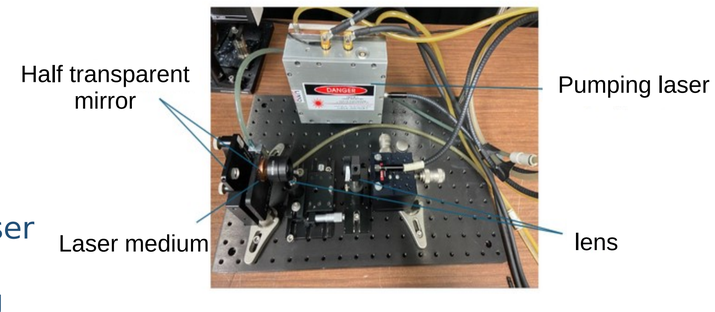
- Search for unknown particles such as Q-ball
- Q-ball are predicted SUSY particles and potential dark mater candidate
- SUSY can fill in the theoretical gaps in the Standard Model.
- Q-ball could produce thermal shock plasma by displacing matter during their propagation, resulting in luminescence
- Q-balls should be detectable by IceCube, however its light emission profile in ice is unknown
- We perform an experiment to study the thermal shock profile in ice
- Here we focus on laser calibration measurements

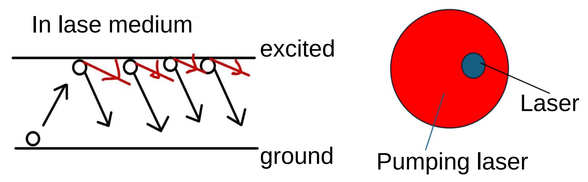


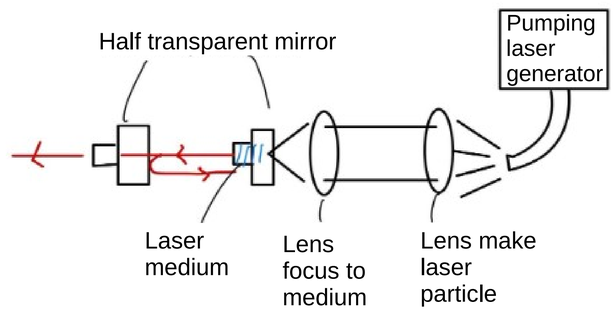


Laser Setup

- Photon from pumping laser pumps electrons to higher energy in the medium.
- Laser triggered by pumping laser
- You can see a laser inside a big pumping laser circle.
- Photodiode used to measure output Intensity and waveforms read via
- Examine the relationship between the laser waveform and the surrounding environment.

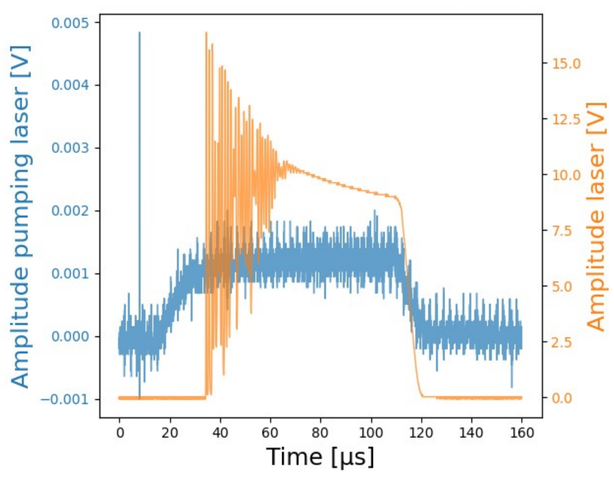


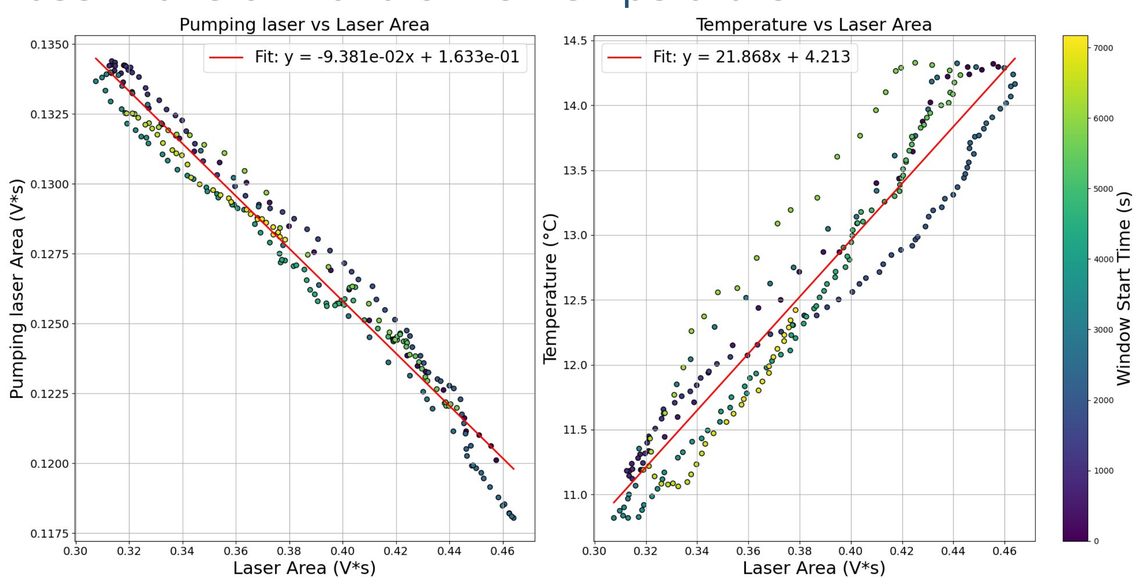




Laser waveform and chiller temperature

Typical waveform of laser and pumping laser.



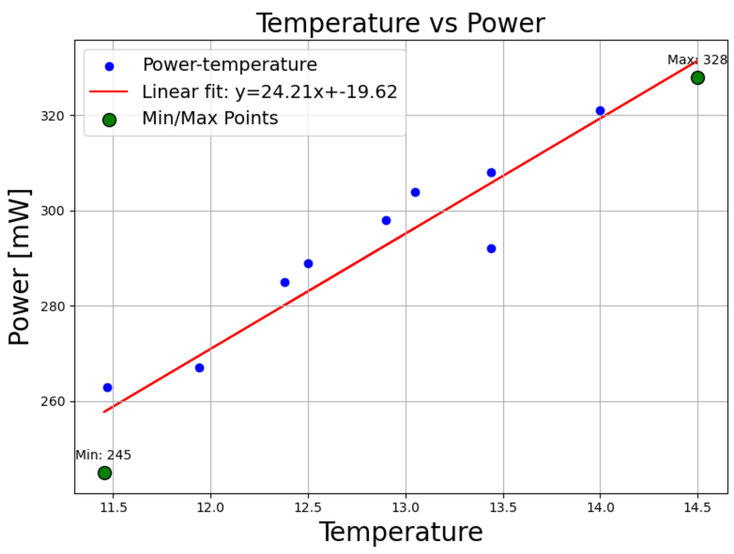


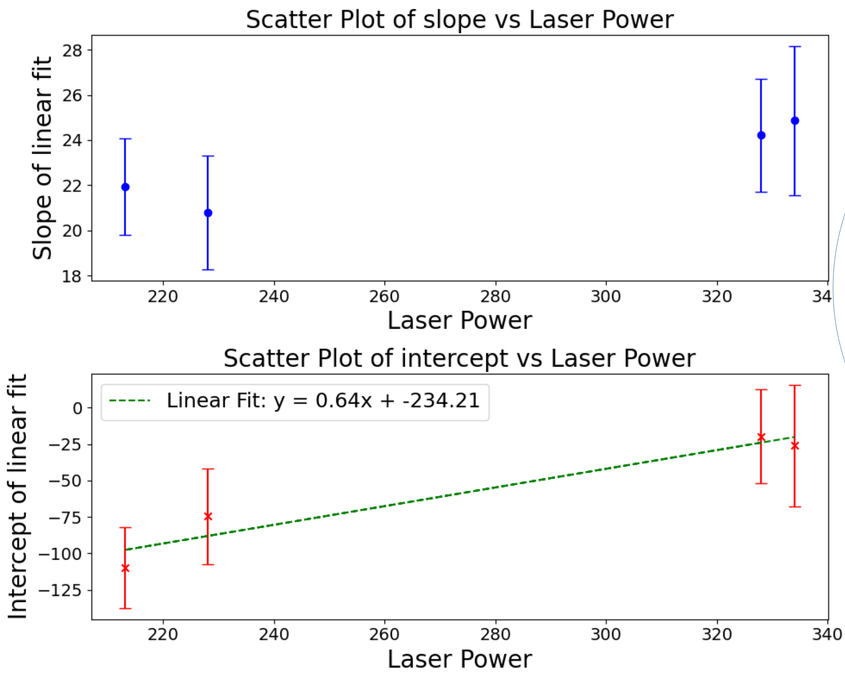
→We are able to predict the power of the laser from the temperature of the chiller..

Left shows relationship between areas of the laser and pumping laser.
Right shows relationship between laser area and chiller temperature

Laser power and chiller temperature

Measured laser power and chiller temperature





Laser Calibration Method

1.Take data of relationship between power and temperature for 2 or 3 min

2. Fit linear model

3. Substitute chiller temperature into this equation to estimate the power

- Plot shows positive correlation between laser power and temperature
- Used linear value like slope and intercept to evaluate for right graph.
- Intercept is linear and slope os almost constant so it can use for predicting power.

Conclusion

- Here we discuss how to calibrate the laser system with respect to external effects and laser power
- Laser Oscillations occur due to variations in chiller temperature
- We employ a linear regression model for the average power development over time as a function of chiller temperature and laser power.

Outlook shooting into ice

- Used PMT for measuring counts due to thermal shock.
- Perform -40C temperature measurements.
- Counts increase significantly while laser are shooting ice.