Joint QUASAR and THz Group Workshop on
Accelerator Science and Technology

GSI: Seminar Room Theory Group: 10:30 - 10:40

[5] Investigations into Laser Diode (LD) Self-Mixing

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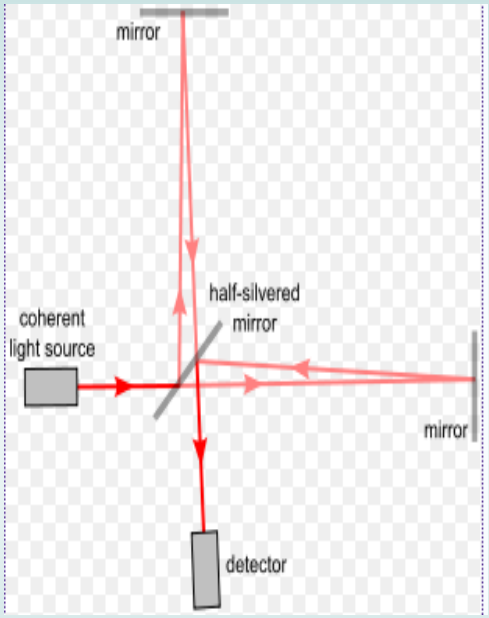
Contents

- **Introduction:**
  - What Laser Diode (LD) Self-mixing involves
  - What we hope to achieve with LD Self-Mixing
- **The experiment so far:**
  - Challenges and how they were overcome
  - The current status of the project with Preliminary results
  - The Importance of Lens Configurations
  - The next stage in the project

Introduction to LD Self-Mixing

- Laser diode produces the beam
- Photo diode measures flux
- Self-aligning detection method, more compact than interferometry



- Can be used to measure the velocity of moving targets.

QUASAR Group Aspirations for Self-Mixing Applications

- Use within cooled vacuum storage rings
- Measuring the velocity of gases
- Determining self-mixing signal variations due to external radiation acting upon beams inside fibres

Experimental Setup

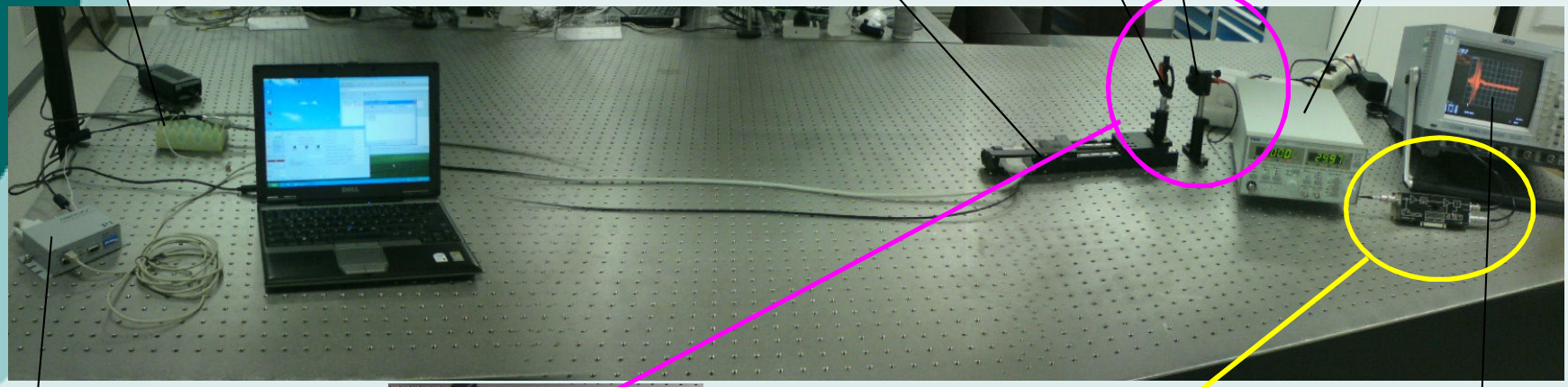
DC motor for the moving stage

PI Moving Stage: M403.4VP

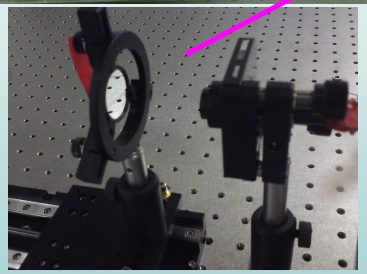
Mirror

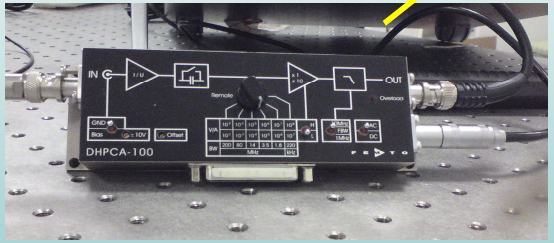
LASER Diode

LASER Controller



Mercury C863 Controller for the moving stage

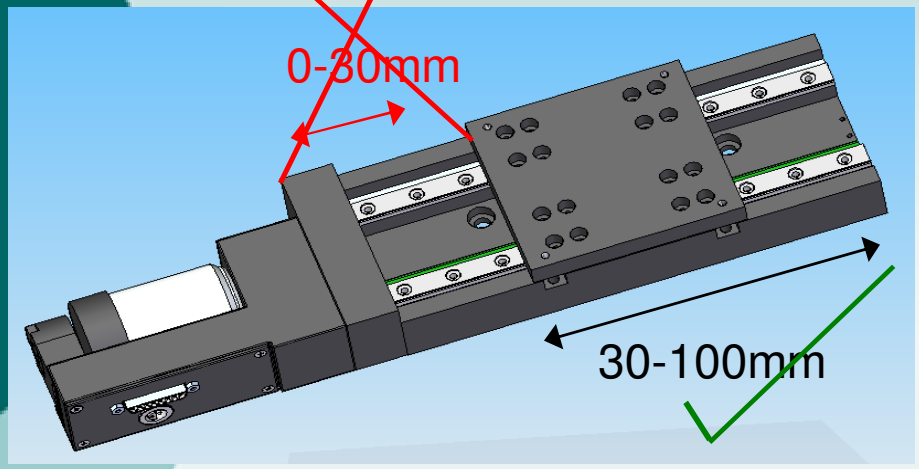


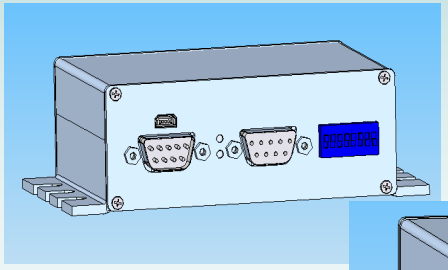


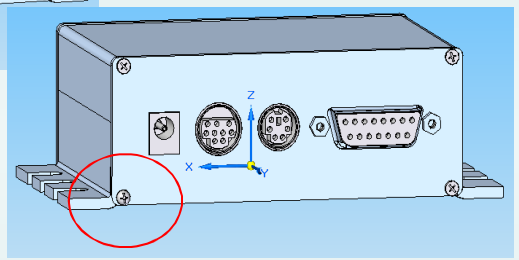
Trans-Impedance Amplifier

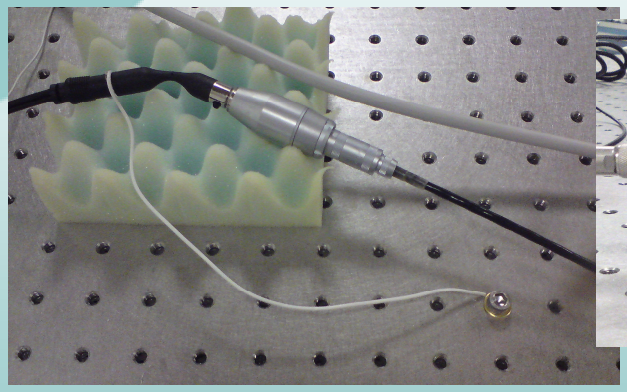
Oscilloscope

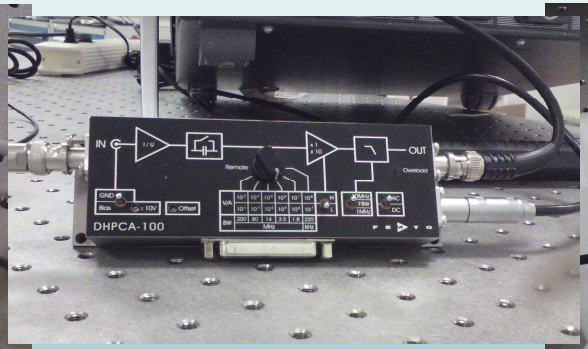
Challenges Encountered during the Project

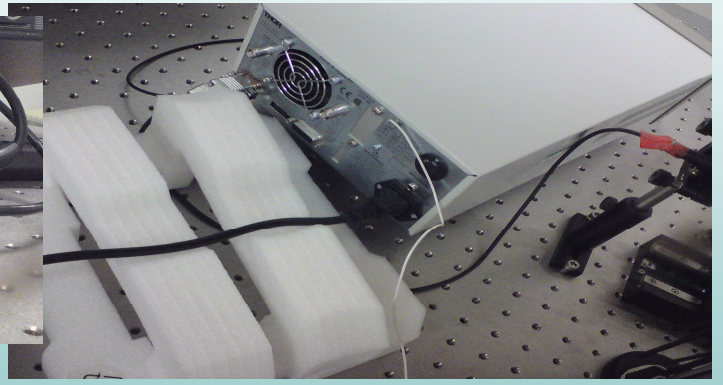






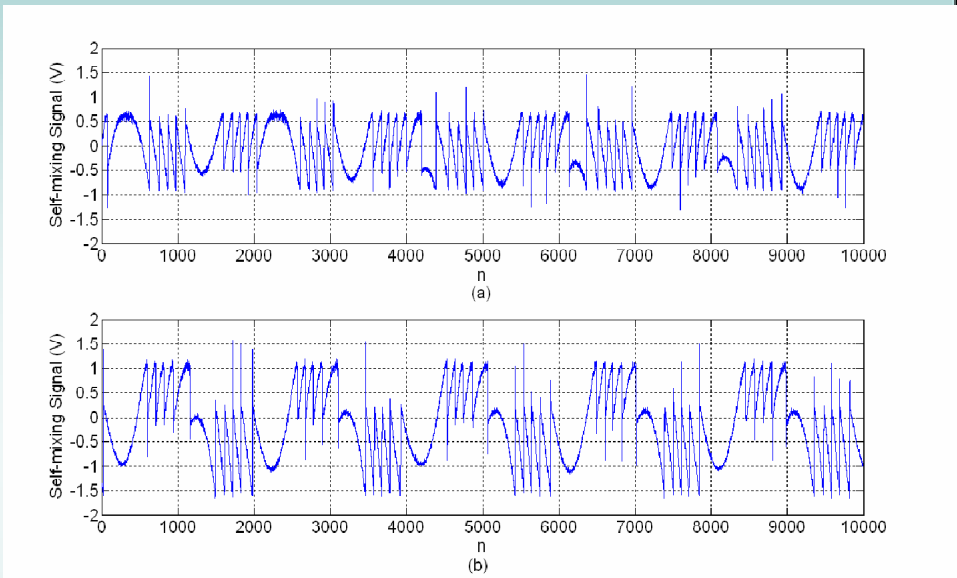


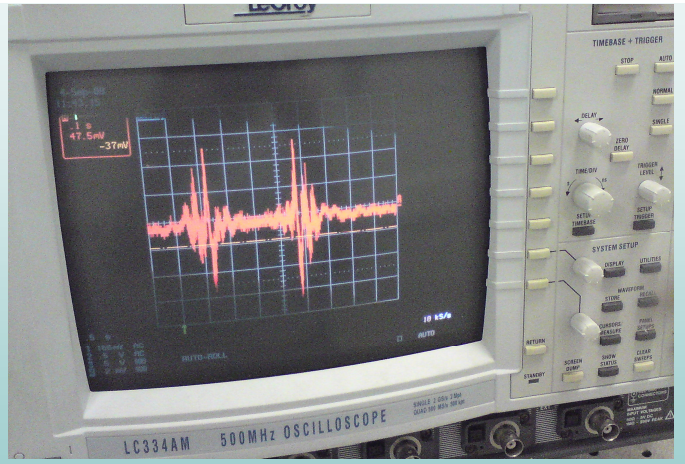




Current Status

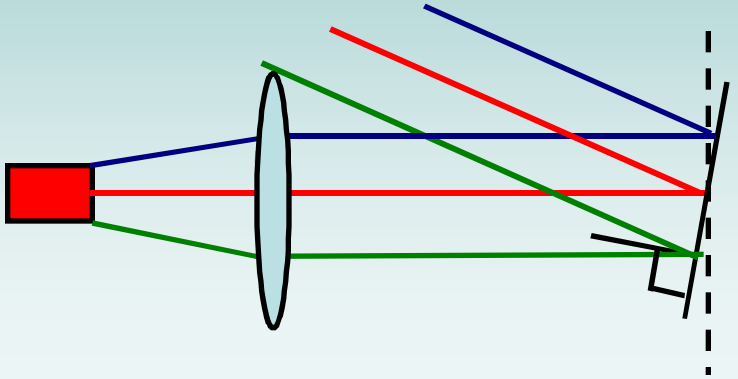
- Red LASER Diode
- Preliminary signals (below)
- Temperature causing an overload?
- Diffusive targets also produce signals

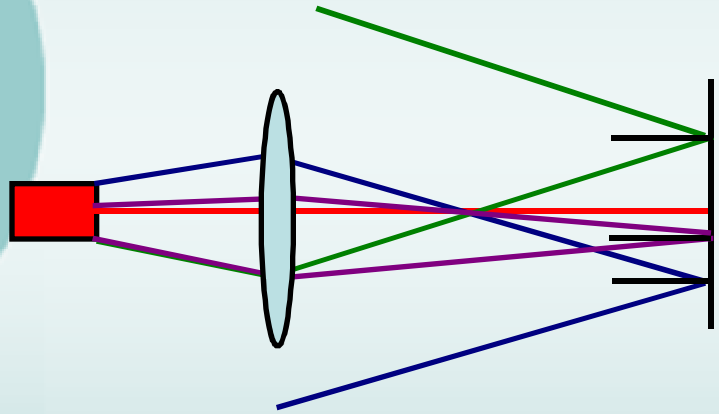




Importance of the Lens Configuration

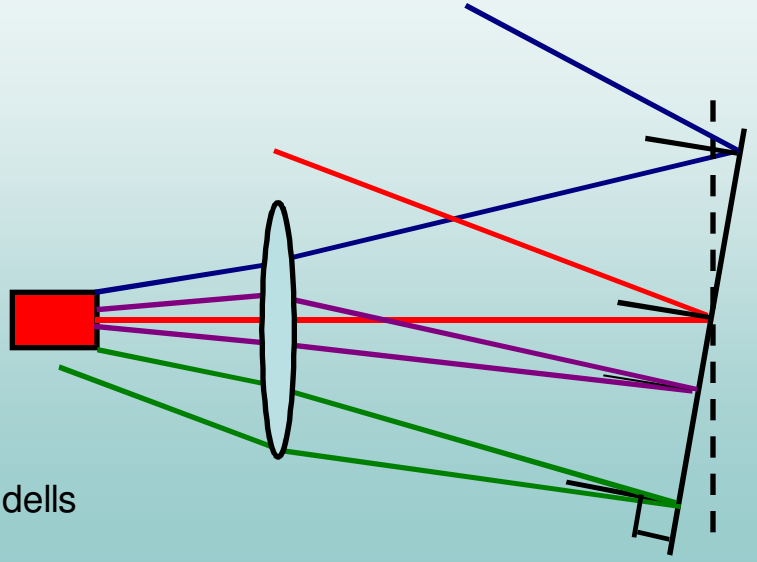
- Collimated beams





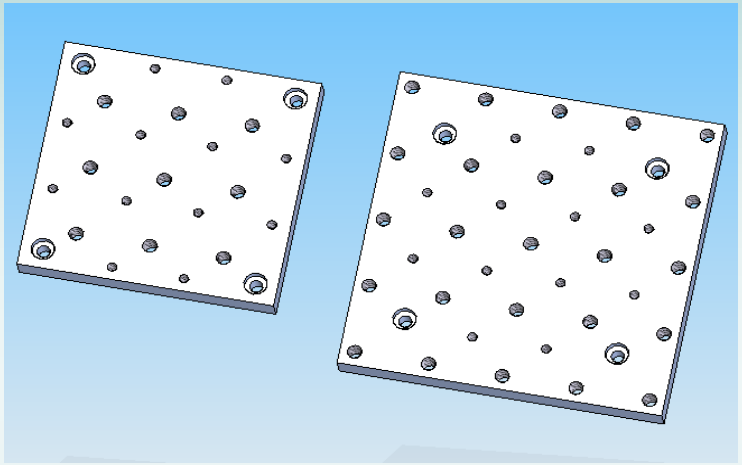
- Converging beams

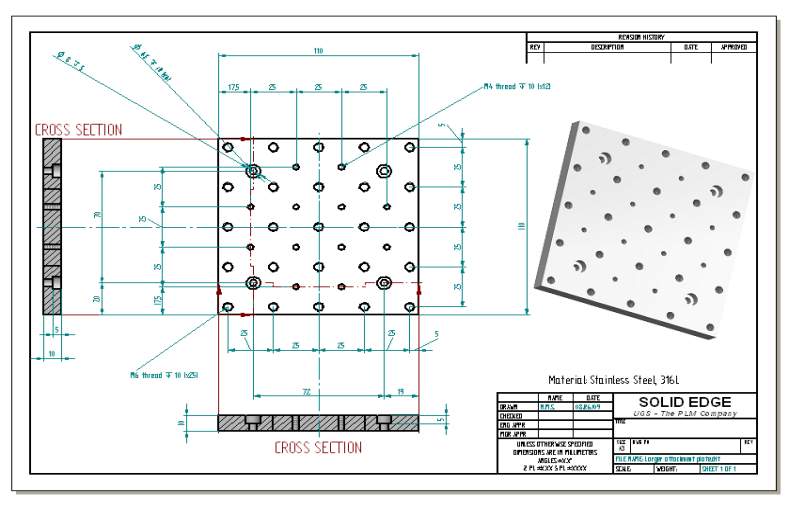
- Diverging beams



The Next Steps to be Taken

- Change the beam from converging to diverging
- Create more feedback in the signal
- Build the adapter plate to allow more flexible target mounting





Summary

- More compact than interferometry
- Overcomes difficulties in distance and velocity measurements
- Opt for diverging beams
- Works for reflecting and rough surfaces
- Ensure the correct equipment is to hand!

References

- Giuliani et al. (2002) *Laser diode self-mixing technique for sensing applications*
- Scalise, Steenbergen & de Mul (2001) *Self-mixing feedback in a laser diode for intra-arterial optical blood velocimetry*
- Lang & Kobayashi (1980) *External Optical Feedback Effects on Semiconductor Injection Laser Properties*
- Wei et al. (2007) *Transition Analysis for Moderate Feedback Self-Mixing Interferometry*
- Rabal &Braga (ed.) *Dynamic Laser Speckle and Applications*
- Giuliani, Bozzi-Pietra & Donati (2002) *Self-mixing laser diode vibrometer*