Laser frequency determination and stabilisation at IGISOL

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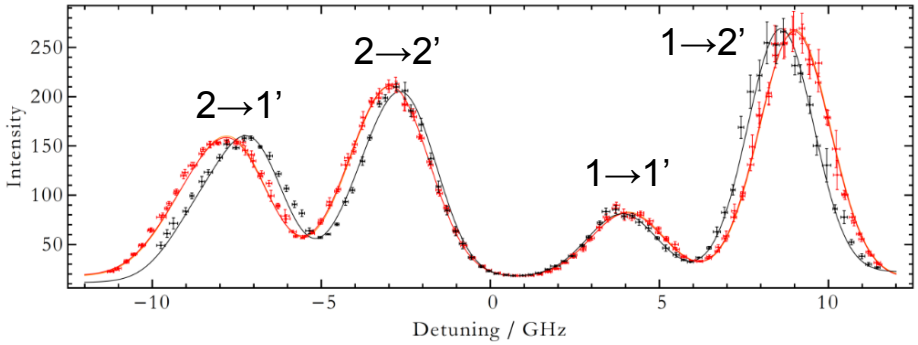
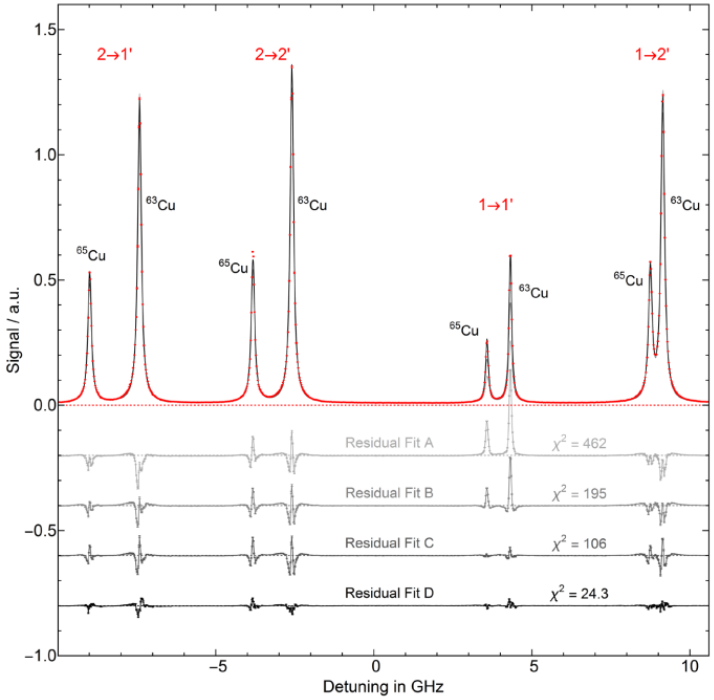
Overview

- Motivation
- Characterisation of Fabry-Pérot interferometers (FPI)
- Frequency stabilisation
- Conclusion

Motivation

- Frequency determination with scanning FPIs for work with Dual-etalon Ti:Sa and Injection-locked Ti:Sa laser



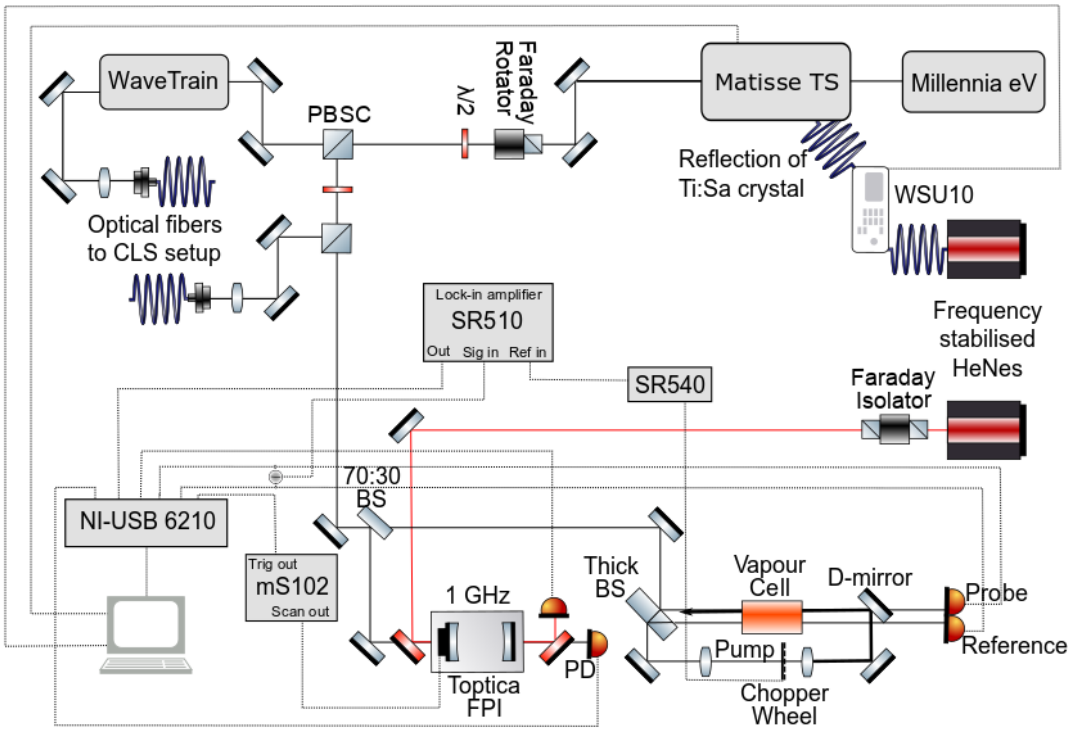


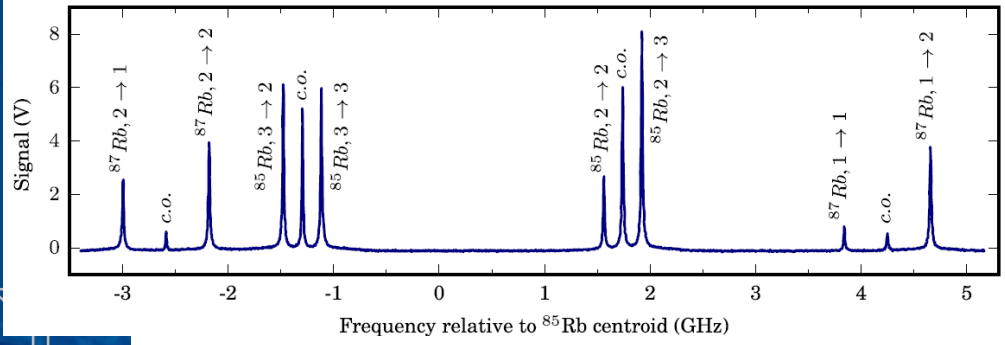
- Frequency stabilisation for collinear laser spectroscopy (voltage scanning)

V. Sonnenschein et al., Laser Physics 27 (2017) 085701

V. Sonnenschein et al., Hyp Int 227 (2014) 113

Characterisation of FPIs



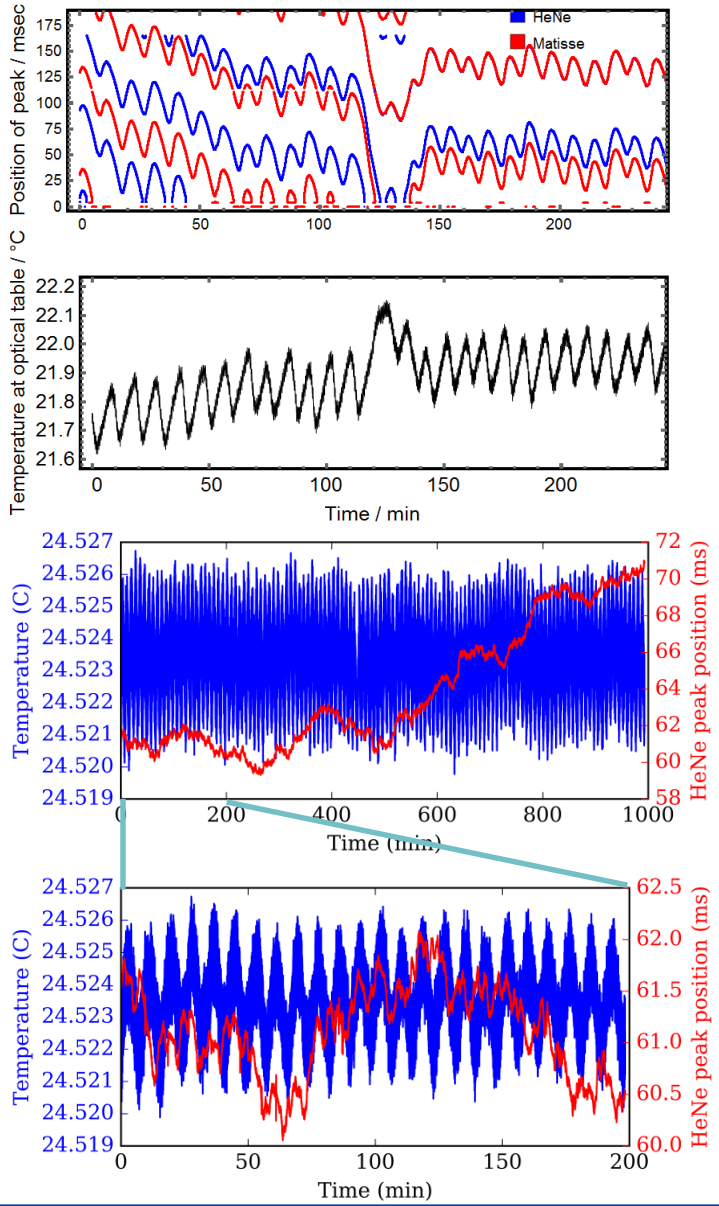


1. Calculate Ti:Sa frequency change based on HeNe and Ti:Sa fringe position differences
2. Determine FSR by fitting hyperfine spectrum with fixed parameters but common scaling factor

S. Geldhof et al., Hyp Int 238 (2017) 7

Characterisation of FPIs

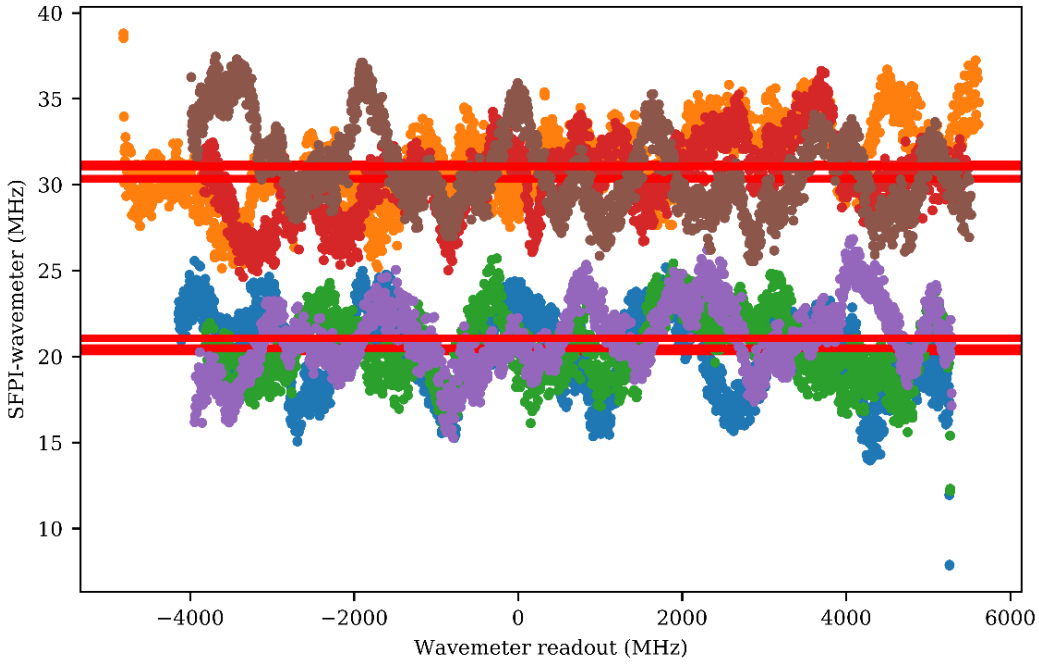
- FSR calibration:
  - 0.998604(14)[4000] GHz for commercial FPI
  - 3.46571(5)[500] GHz for home-built FPI
- Large systematic errors due to temperature fluctuations
- Temperature stabilisation added to commercial FPI
- FSR re-measured → systematic uncertainty down to 1.9 MHz



S. Geldhof et al., Hyp Int 238 (2017) 7

Frequency determination

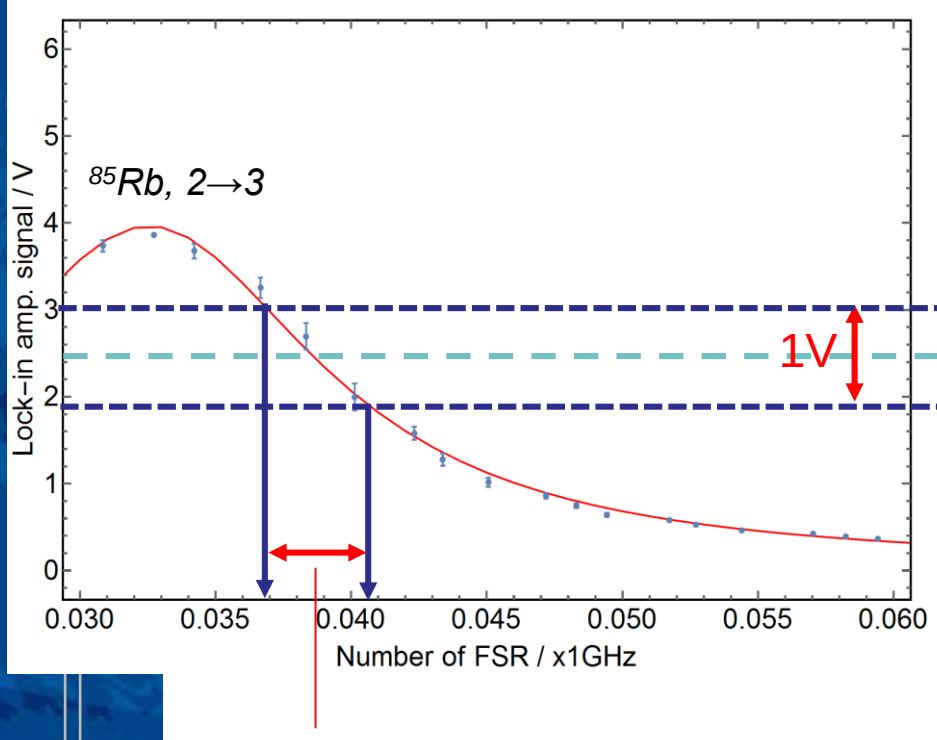
- Difference between frequency calculated using FPI and wavemeter readout

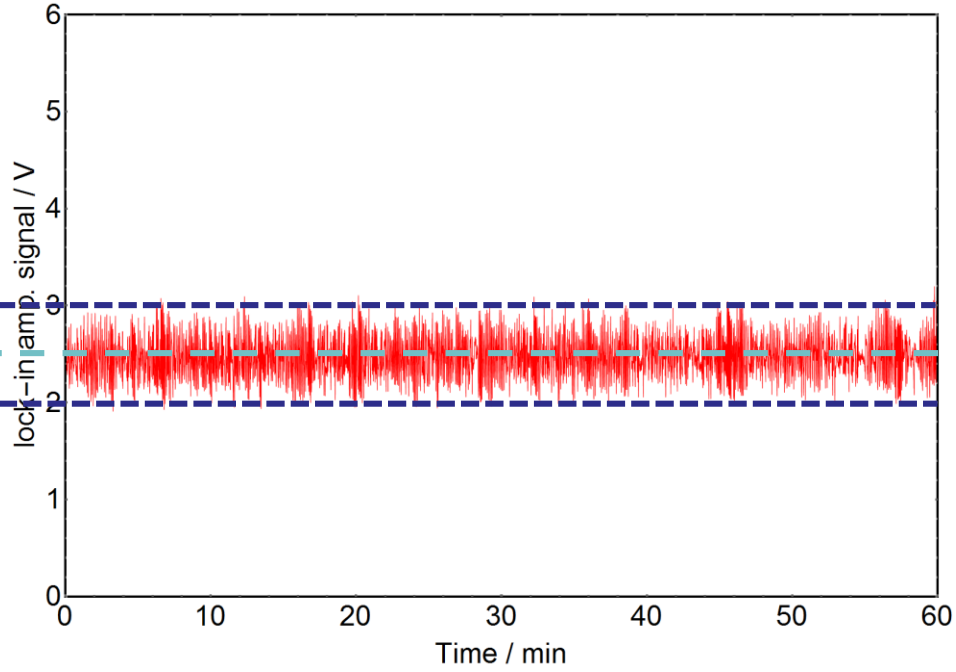


→ No repeatable pattern discernible

Frequency stabilisation

- Started with stabilisation of Matisse Ti:Sa laser to Rb HFS peak
- Choose set point → lock position on side of peak
- PID feedback loop to piezo mirror in reference cell

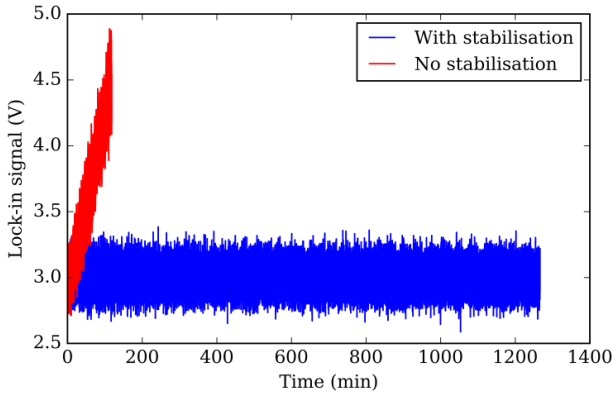




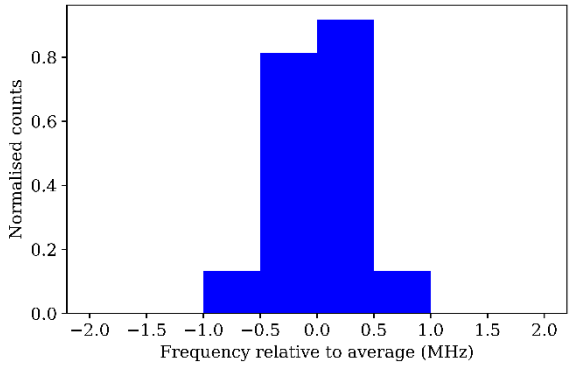
Frequency stabilisation

- Comparison with and without stabilisation to ^{85}Rb transition

0.4V = 2.8 MHz

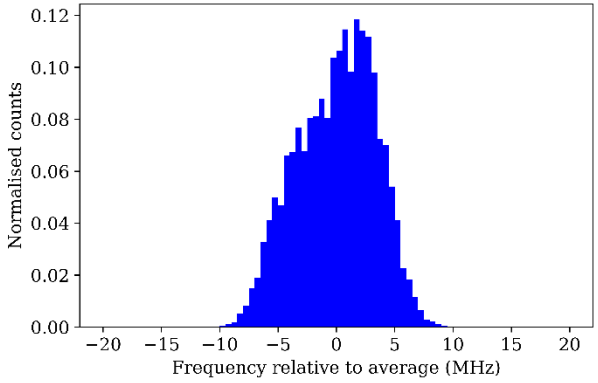


- Stabilisation to WSU10 wavemeter → within 1 MHz

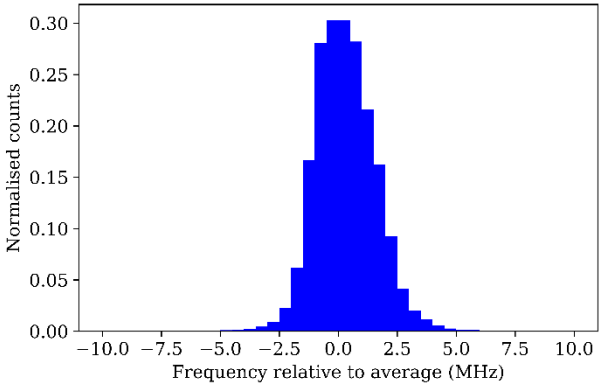


- Stabilisation of cw dye laser:

to iodine absorption line



to wavemeter



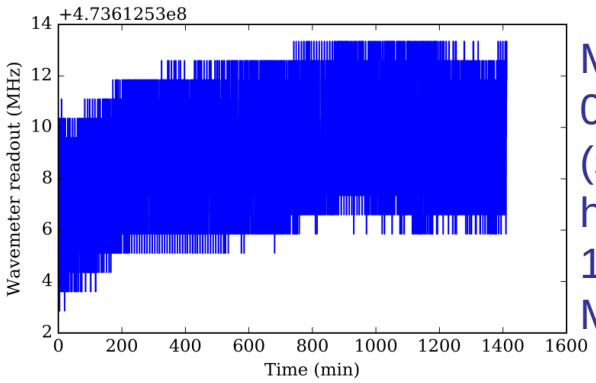
Frequency stabilisation

- Calibration tests

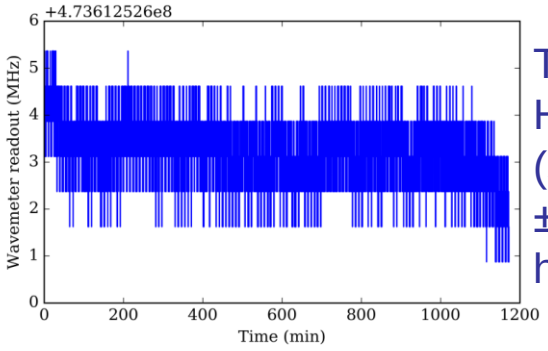
Calibration to	Rb D1 centroid shift (MHz)	Rb D2 centroid shift (MHz)
HeNe	-86	-79
Rb HFS peak	-0.7	-0.5

→ problem with HeNe calibration or calibration non-linear

- Checking HeNe frequency stability



Melles Griot 05-STP-912 (specs: 1-8 hours ±1 MHz, 1 month ±10 MHz)



Thorlabs HRS015B (specs: 1 hour ±2 MHz, 8 hours ±3 MHz)

Conclusion

- Two characterised FPIs available for frequency determination
- Stabilisation to wavemeter of both cw Ti:Sa laser and cw dye laser implemented
- Precision and stability currently reached sufficient for applications in Jyväskylä
- Questions related to the calibration remaining
  - Plans to investigate linearity of wavemeter by scanning over the iodine absorption spectrum

Thank you

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