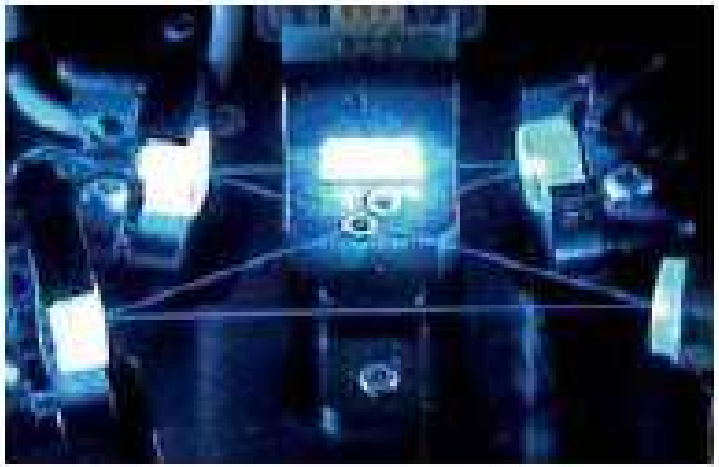
Laser System for Spectroscopy of $^{209}Bi^{82+}$ @ 243.9 nm

Status Report

Atome Photonen Quanten

TECHNISCHE UNIVERSITÄT DARMSTADT



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Institute for Applied Physics
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SPECTRAP Meeting 2nd of July 2008

Overview

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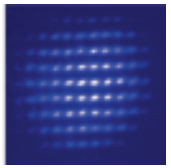
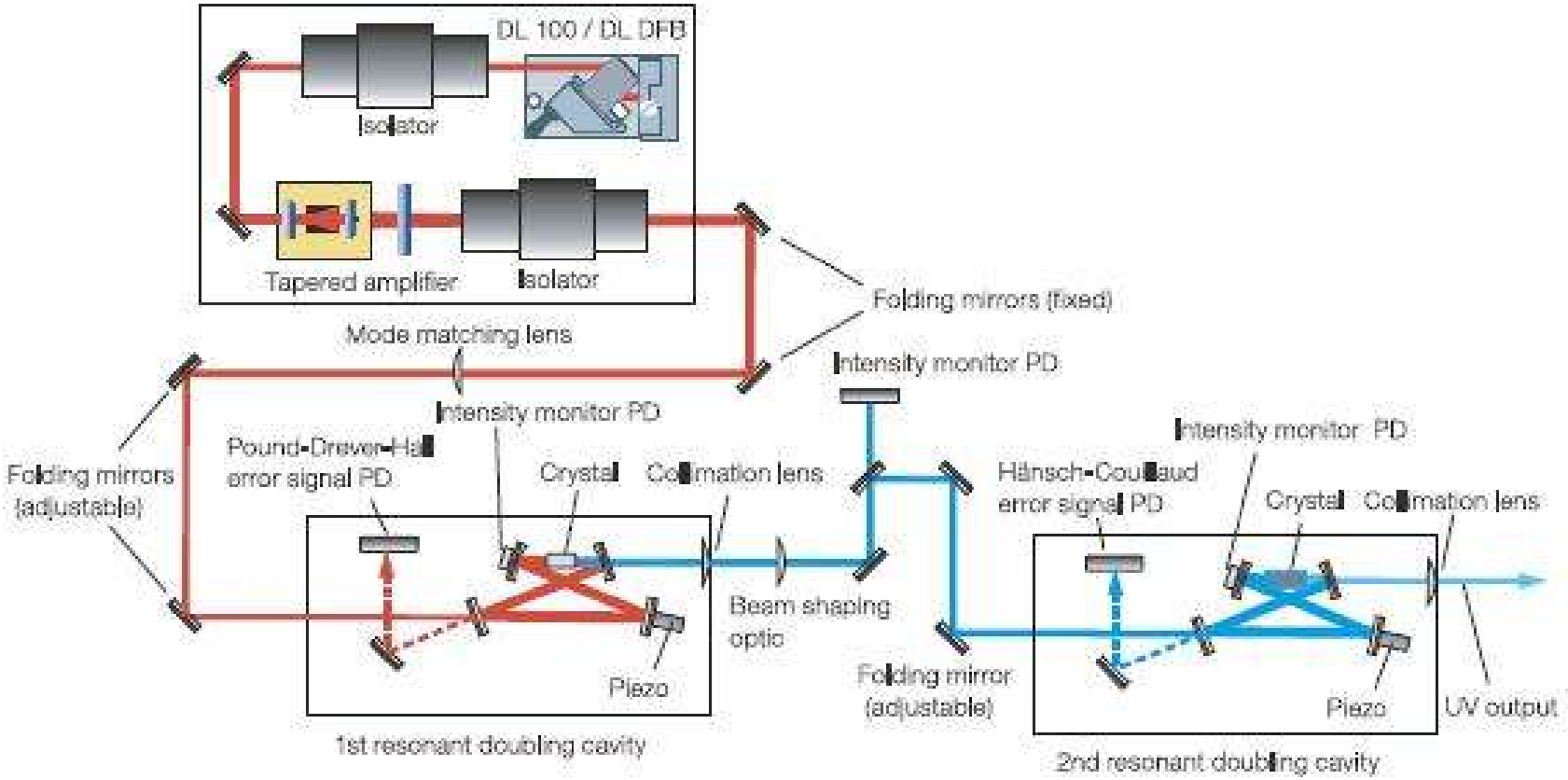


- commercial UV laser system @ 243.9 nm based on a frequency quadrupled MOPA @ 976 nm

- frequency stabilization scheme:
  - DL @ 780 nm locked on Rb-D2 line
  - transfer cavity locked on DL @ 780 nm
  - MOPA system locked on the transfer cavity

- outlook: test of the laser system under experimental conditions

Reminder: Toptica laser system TA-FHG-110



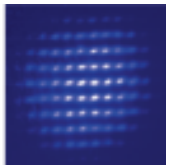
Setup for fourth harmonic generation, involving two cascaded doubling stages.

Toptica laser system TA-FHG-110: Specifications

- output power of MOPA system: 1000 mW @ 976 nm
- output power UV: 15 mW @ 241 – 246 nm (confirmed during installation)

  29 mW @ 243,9 nm (measured during installation)
- Mode-hop free scan range in UV: 25 GHz (during installation: 40 GHz)
- linewidth of UV-light: < 4 MHz over 5 µs

Toptica laser system TA-FHG-110: Some remarks on the specifications



- the demanded specifications are fully met
- no verification of the linewidth yet
  ⇨ characterization when IR FPI is ready
- acoustic noise affects Hänsch-Couillaud-lock of 2nd doubling cavity
  ⇨ acoustic isolation box around UV laser system recommended

Frequency stabilization to transfer cavity: Scheme I

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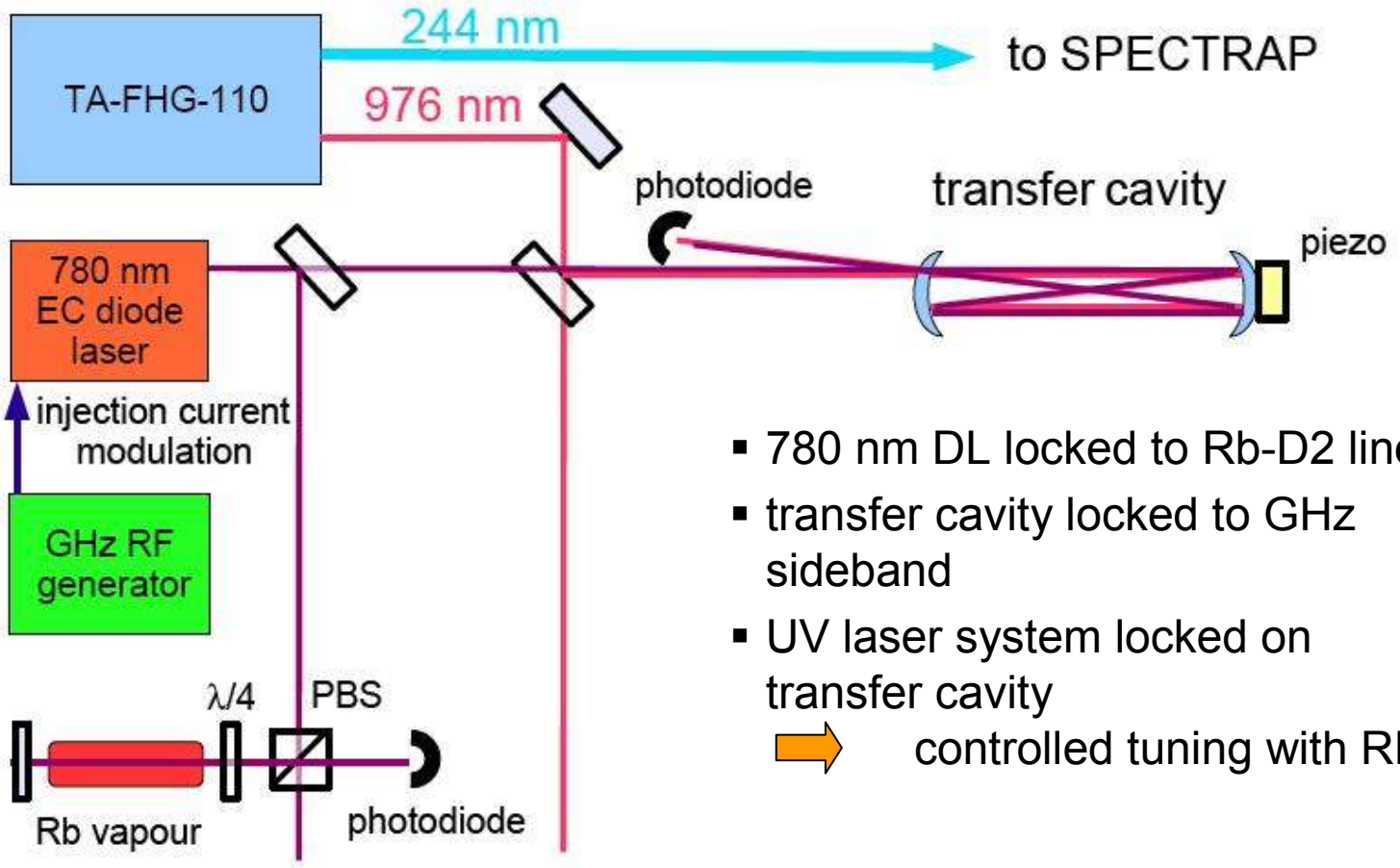

- 780 nm DL locked to Rb-D2 line
- transfer cavity locked to GHz sideband
- UV laser system locked on transfer cavity

  ⇨ controlled tuning with RF

Remarks on stabilization scheme I

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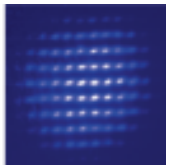

design, implementation and testing of RF side band generation:

- works in principle
- usable side band signal from 2 to 8 GHz with smooth amplitude change
- detection with lock-in amplifier
  - ⇨ better signal to noise ratio
  - ⇨ error signal for locking

drawbacks:

- short transfer cavity necessary (FSR about 10 GHz)
- finesse cannot be low ⇨ no efficient detection of side band signal

⇨ switch to 2nd scheme to lock transfer cavity with adjustable offset frequency

Frequency stabilization to transfer cavity: Scheme II

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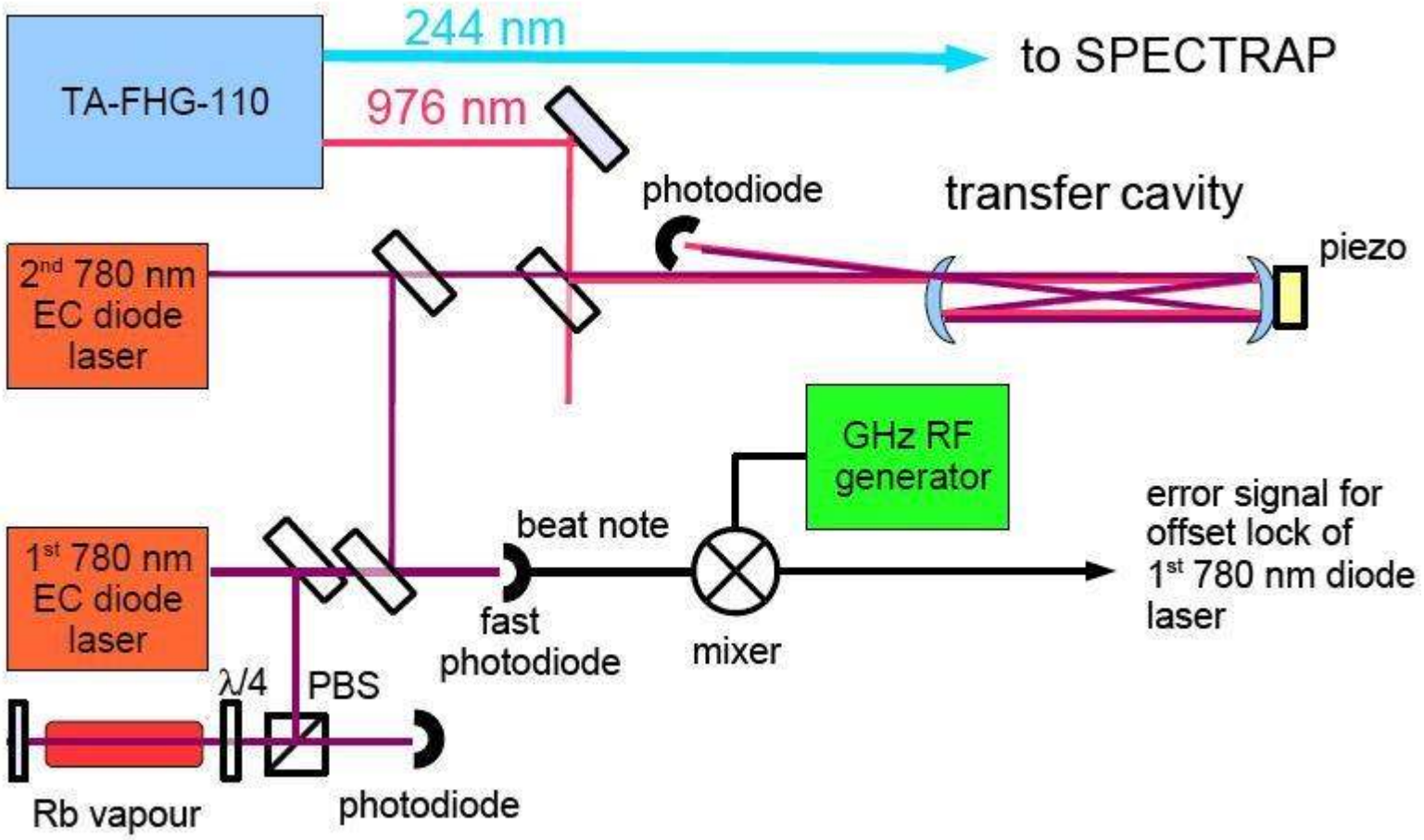
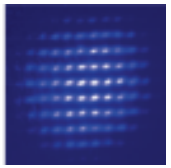


Details of scheme II



- 1st 780 nm DL locked on Rb-D2 line
- 2nd 780 nm DL locked on 1st with offset lock
  - ⇒ beat note on a fast photodiode is measured
  - ⇒ beat signal is mixed with a GHz RF signal
  - ⇒ difference frequency is devided by 64
  - ⇒ devided signal is converted to a DC voltage by frequency to voltage converter
  - ⇒ linear ramp with flexible lock point is generated
- transfer cavity is locked on 2nd DL with side-of-fringe lock
- UV laser system is locked on transfer cavity with side-of-fringe lock

⇒ UV frequency tunable with change of the mixing GHz radio frequency

Remarks on stabilization scheme II

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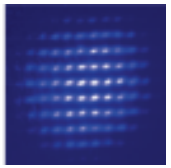

presently:

- installation of 2nd external cavity DL @ 780 nm
- frequency offset lock electronics is ordered or built respectively
- mechanical design of the transfer cavity has been finished and its construction is nearly completed
- cavity mirror substrates have been ordered and delivered 2 weeks ago
  ⇨ inhouse Ag coating has been tested
- side-of-fringe lock electronics is ready

⇨ hopefully most of the work will be done within the next four weeks!

Outlook: Test of the laser system under experimental conditions

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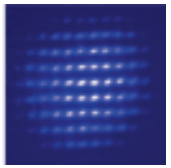

necessary:

- characterization of frequency stabilization of the whole laser system
- check of frequency stabilization

possible test: spectroscopy with hollow cathode lamps

⇨ search for atomic transitions near 243.9 nm

⇨ possible test candidate: Pt @ 244 nm