

# Laser Ion Sources : Resonance Ionization Schemes

LA3NET study task

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## **Problem 1** *Building Ionization Schemes*

Consider two RILIS laser installations (**A** and **B**) located at different RIB facilities. For each installation choose a suitable element from the list provided and build up a feasible (preferably optimal) laser ionization scheme using the atomic spectral line databases that are available online:

**R. L. Kurucz database:** <http://www.cfa.harvard.edu/amp/ampdata/kurucz23/sekur.html>

**NIST database:** [http://physics.nist.gov/PhysRefData/ASD/lines\\_form.html](http://physics.nist.gov/PhysRefData/ASD/lines_form.html)

**Facility A** - Thick target ISOLDE type facility with high temperature target, transfer line and 30 mm long, 3 mm diameter hot tungsten cavity ionizer tube ( $T = 2200$  K).

- **Pump Laser 1**  
Nd:YAG  
60 W at 532 nm  
10 kHz repetition rate  
180 ns pulse length
- **Pump Laser 2**  
Nd:YAG  
80 W at 532 nm  
10 kHz repetition rate  
10 ns pulse length
- **2 x Ti:Sa lasers**  
ISOLDE RILIS specification  
2nd, 3rd or 4th harmonics
- **3 x Sirah CREDO Dye lasers**  
2nd or 3rd harmonics

**Facility B** - Thin ( $\text{mg}/\text{cm}^2$ ) target and gas catcher system with laser ionization inside a 500 mbar Ar gas cell.

- **Pump Laser**  
2 synchronized excimer lasers  
200 mJ per pulse at 308 nm  
200 Hz repetition rate  
15 ns pulse length
- **2 x dye lasers with amplifiers and 2nd harmonic generation**

For each ionization scheme please describe the laser configuration that must be used. Be careful to properly match the pump lasers with compatible tunable laser systems.

**Two** elements from this list should be chosen and **two** ionization schemes should be made in total.

Hf, Re, Kr, Rn, Rb, Na, Gd, Cr, Ge, Pd.

*Bonus task : If your ionization scheme requires harmonic generation, suggest a suitable nonlinear crystal type and configuration for your laser configuration. If possible download and use the free SNLO software for crystal selection:*

**SNLO download:** <http://www.as-photonics.com/snlo>

*Hint 1:* When selecting an element consider it's feasibility as a candidate for the RIB facility based upon:

- The conditions of the target and ion source system (vapour pressures for the chosen element, the means of atom extraction from the target, laser/atom interaction conditions, competing ionization mechanisms).
- The capabilities of the laser system (tuning range, tunable laser efficiency, laser power).

*Hint 2:* For selecting convenient excitation steps consider aspects such as laser tuning ranges, harmonic generation efficiencies and expected populations of low lying atomic states.

*Hint 3:* The necessary supplementary information (laser tuning ranges, typical tunable laser efficiencies, harmonic generation efficiencies etc.) are included in the lecture slides.

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