

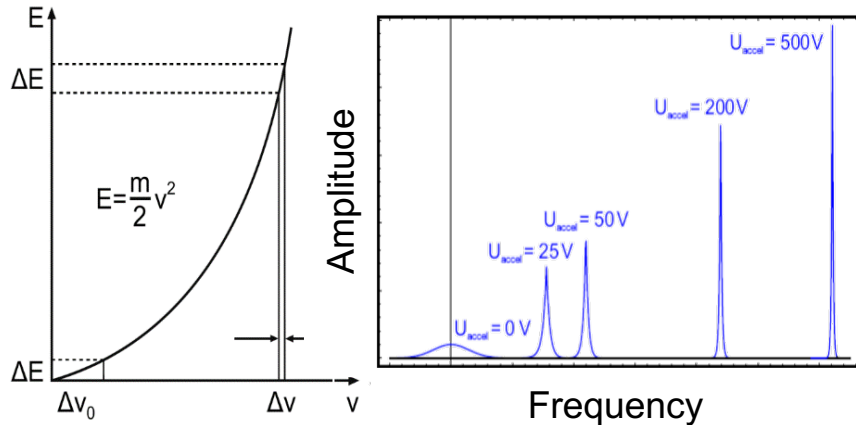
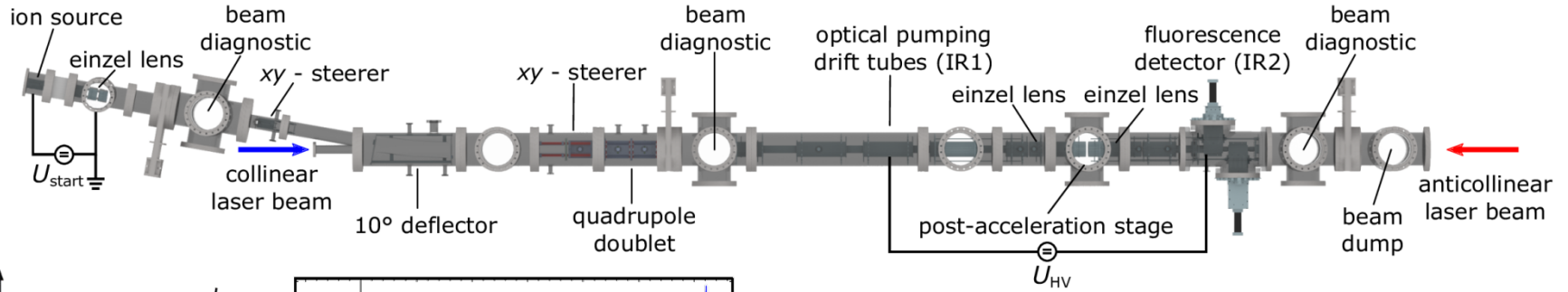
Progress Report on Laser Spectroscopy



Outline

- COALA
 - Fluorescence detection region
 - Laser spectroscopy on neutral Boron
 - Helium like systems
- Argon National Lab
- NSCL / FRIB
 - Neutronium results
 - Ionium results

Setup



Acceleration:

- longitudinal Doppler compression
- high resolution

Doppler tuning

$$\nu_c = \nu_0 \cdot \gamma \cdot (1 + \beta)$$

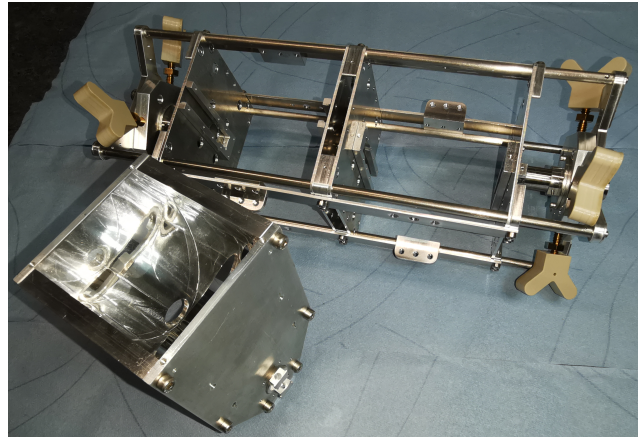
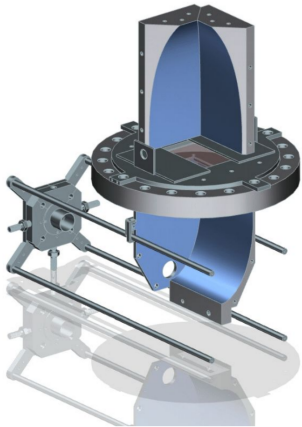
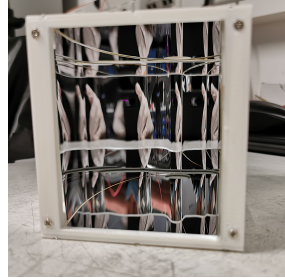
$$\nu_a = \nu_0 \cdot \gamma \cdot (1 - \beta)$$

$$\beta = \beta(U, m),$$

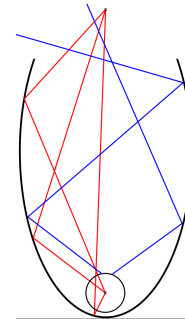
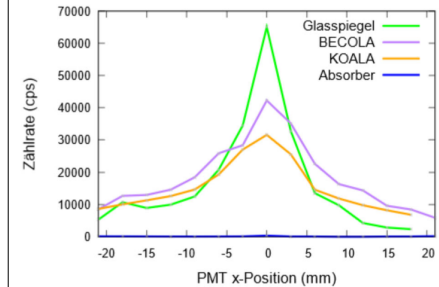
Optimization ongoing for Fluorescence detection region

A01

- New, high-reflective UV mirrors on 50 μ m glass substrates
- Increased performance in the UV
- Better shape – better focus, spatial discrimination between signal and background
- Investigating new possibilities with position-sensitive detection system
- Future implementation at KOALA, BECOLA (MSU), ANL, ...

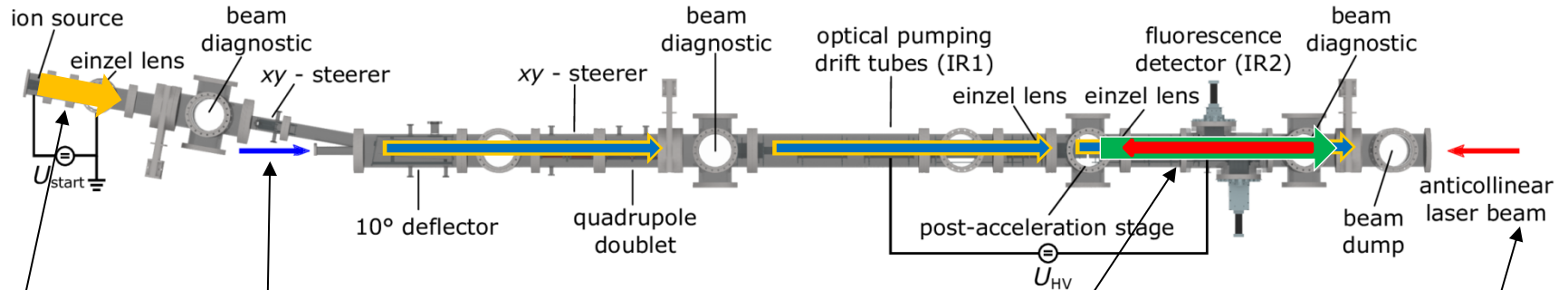


Signal light distribution with different mirror systems



Laser Spectroscopy on neutral Boron

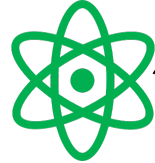
A01



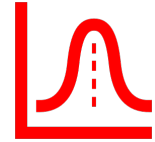
negative ion beam



neutralization laser



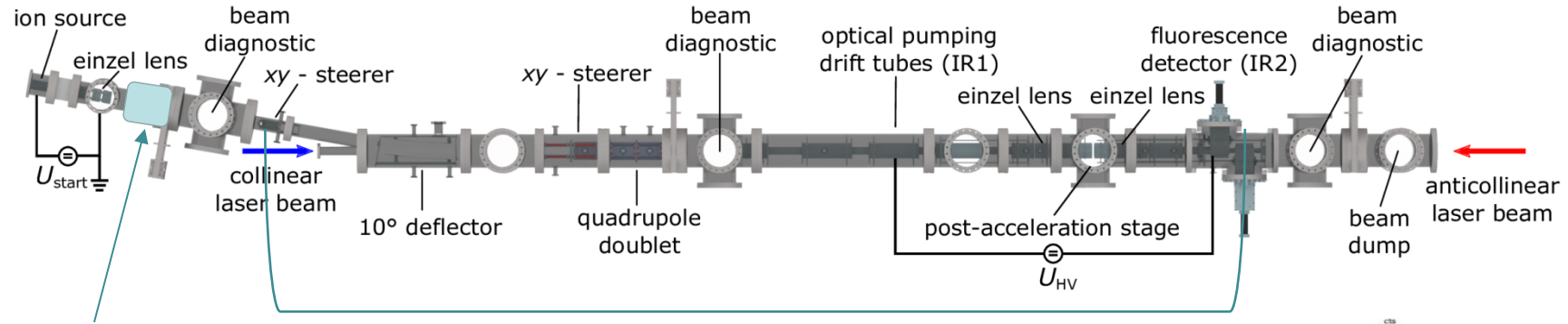
neutral atom beam



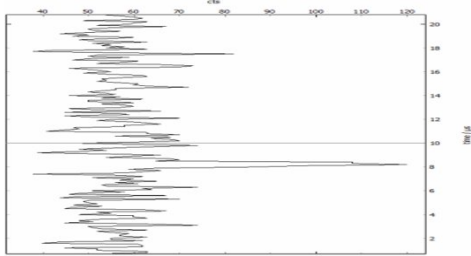
Spectroscopy laser

Improvements

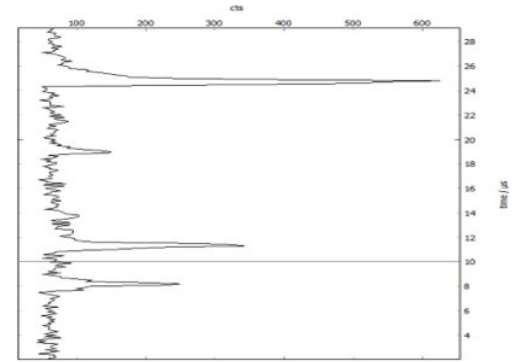
A01



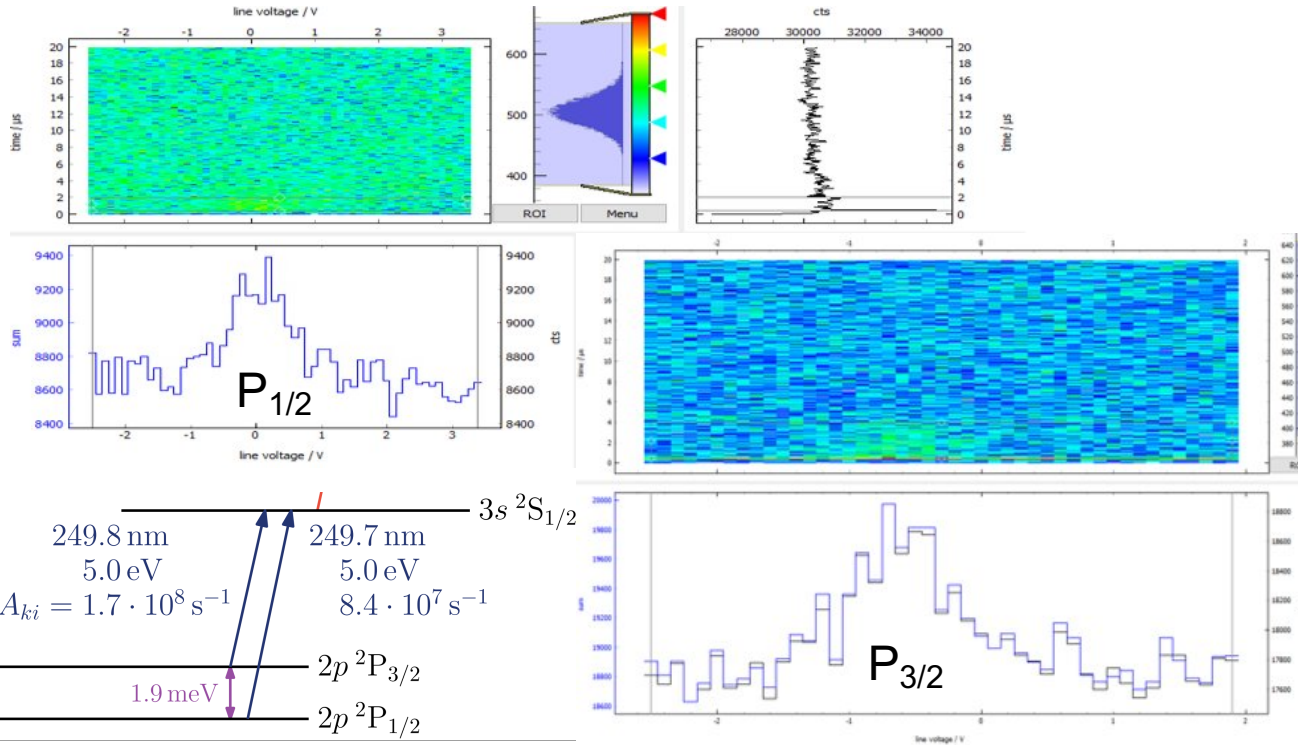
successful installation of a Wien filter



implementation of a Time of Flight measurement station



Resonance of neutral ^{11}B for $P_{1/2}$ and $P_{3/2}$ line



Many opportunities for improvement, easiest:

- Higher repetition rate of neutralization laser
- Higher power of neutralization laser

Investigation of He-like ions



$$\delta\nu_{FS} = \underbrace{-\frac{Ze^2}{6\epsilon_0} \Delta |\Psi_e(0)|^2}_{\text{Electronic Factor}} \times \underbrace{\langle r_c^2 \rangle}_{\text{Nuclear Size}}$$

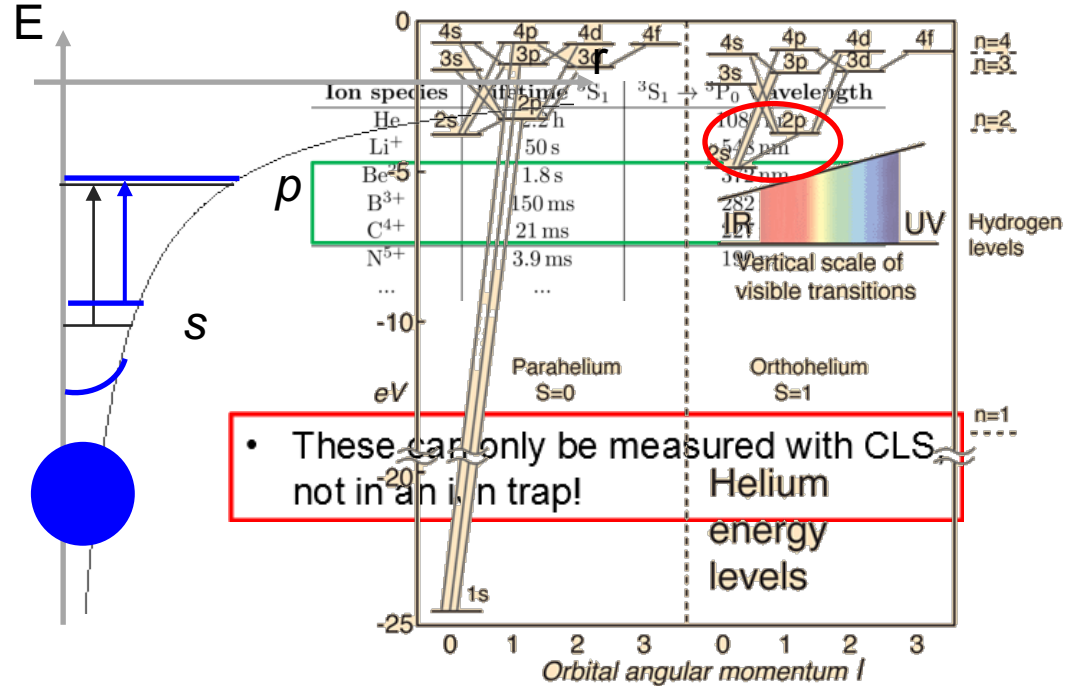
Electronic Factor
(→ Wavefunction) Nuclear Size

$$= F_{i \rightarrow f} \langle r_c^2 \rangle$$

$$\rightarrow \nu_0 = \nu_{\text{point}} + F \times \langle r_c^2 \rangle$$

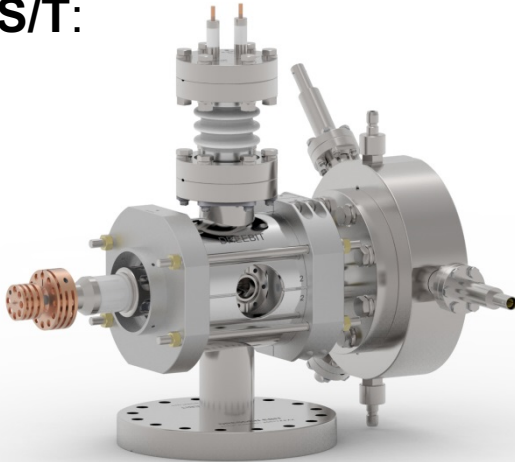
Requirements for Experiment from Theory

- Few electron system where F and ν_{point} can be calculated
→ only light He-like systems feasible



<http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/helium.html>

EBIS/T:



<https://www.dreebit-ibt.com/product/dresden-ebit.html>

- EBIS requested by CRC:
delivered till: July 2021
- until then: prepare beamline
- Start experiment: August 2021

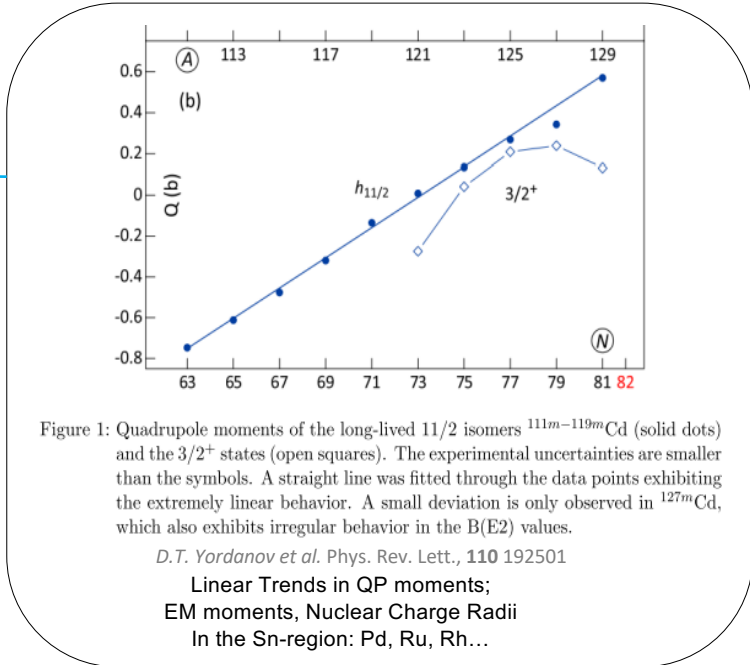
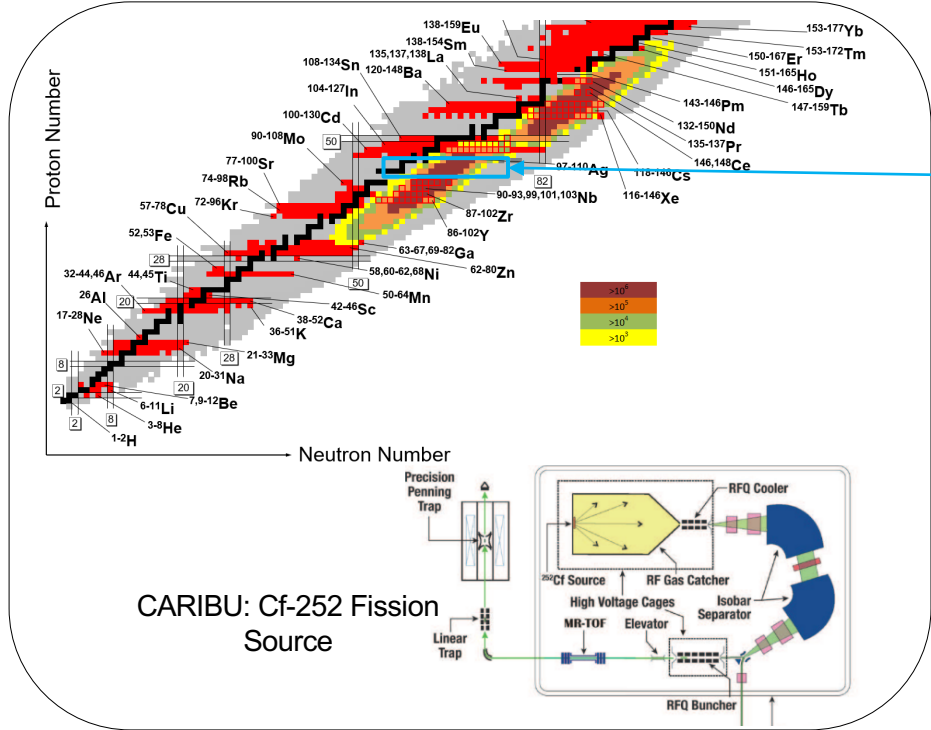


Figure 1: Quadrupole moments of the long-lived 11/2 isomers ^{111m}-^{119m}Cd (solid dots) and the 3/2⁺ states (open squares). The experimental uncertainties are smaller than the symbols. A straight line was fitted through the data points exhibiting the extremely linear behavior. A small deviation is only observed in ^{127m}Cd, which also exhibits irregular behavior in the B(E2) values.

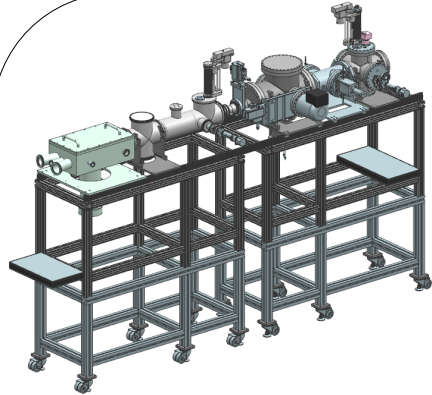
D.T. Yordanov et al. Phys. Rev. Lett., 110 192501

Linear Trends in QP moments;
EM moments, Nuclear Charge Radii
In the Sn-region: Pd, Ru, Rh...

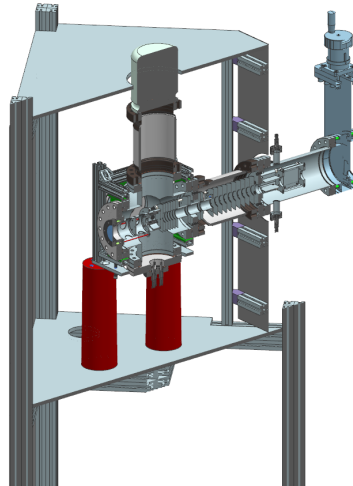
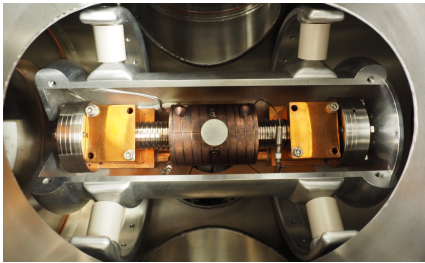
Spectroscopy on Pd: Approved by PAC

Laser spectroscopy at CARIBU

A01



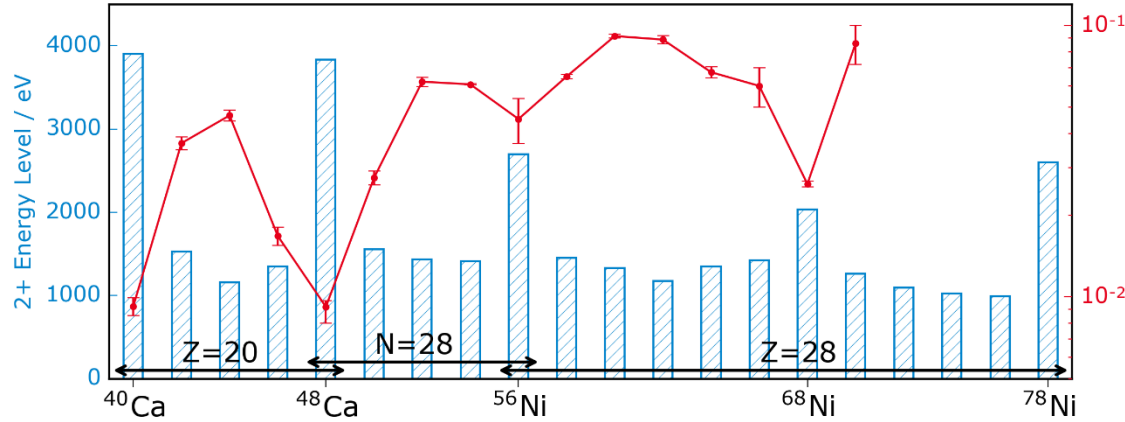
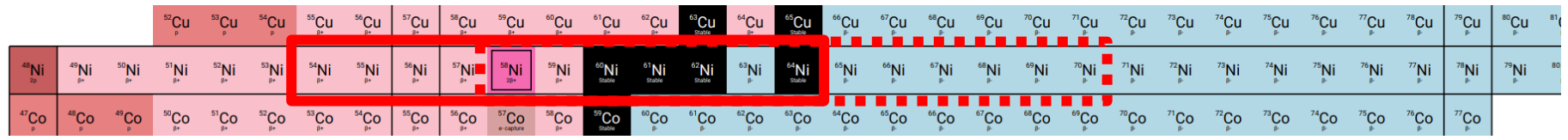
- Laser Spectroscopy beam line commissioned
- New Charge Exchange Cell working (Mg + Na)
- Offline Source (almost) ready to install
- System ready at CARIBU: mid-2021



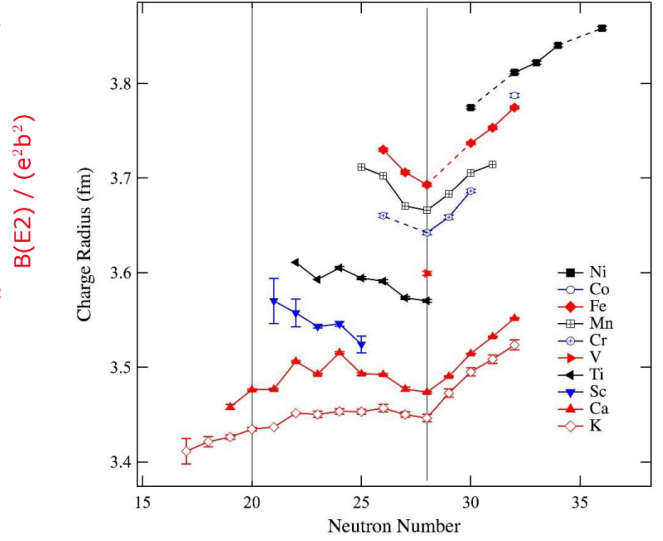
- Laser Spectroscopy System also ready for **Boron-8** in different Cave
- Investigating different (also universal) Molecule-Break-up techniques
- Test Beamtime(s) in 2021 ongoing



NSCL: Neutron Deficient Nickel

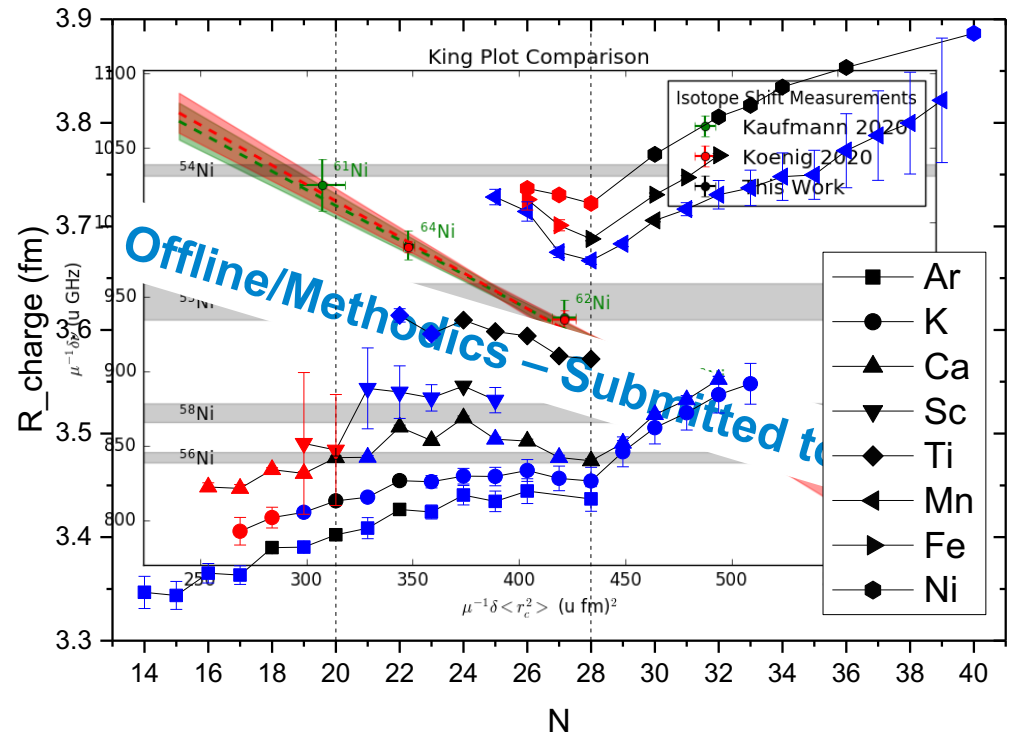
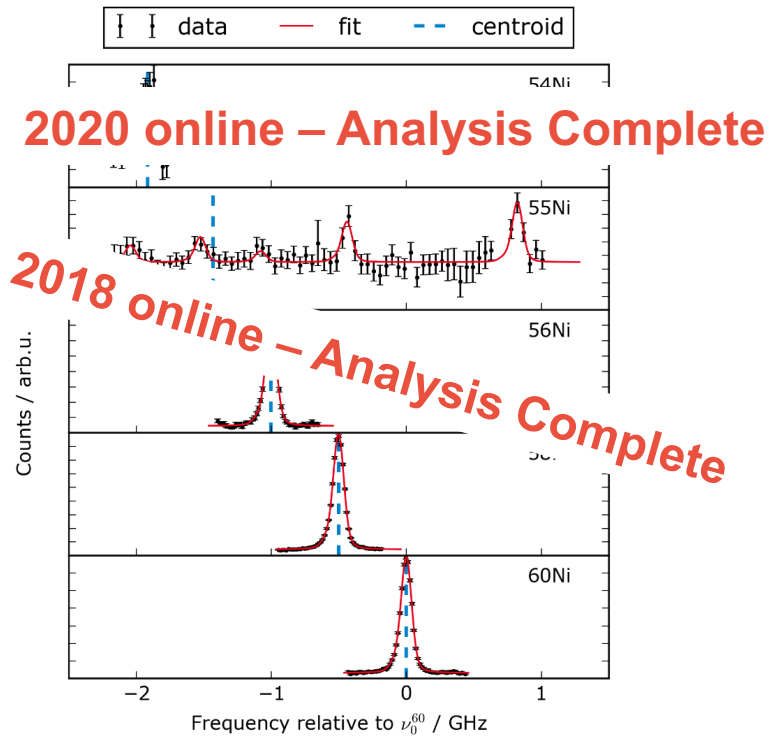


[Data: Atomic Data and Nuclear Data Tables 107 (2016)]

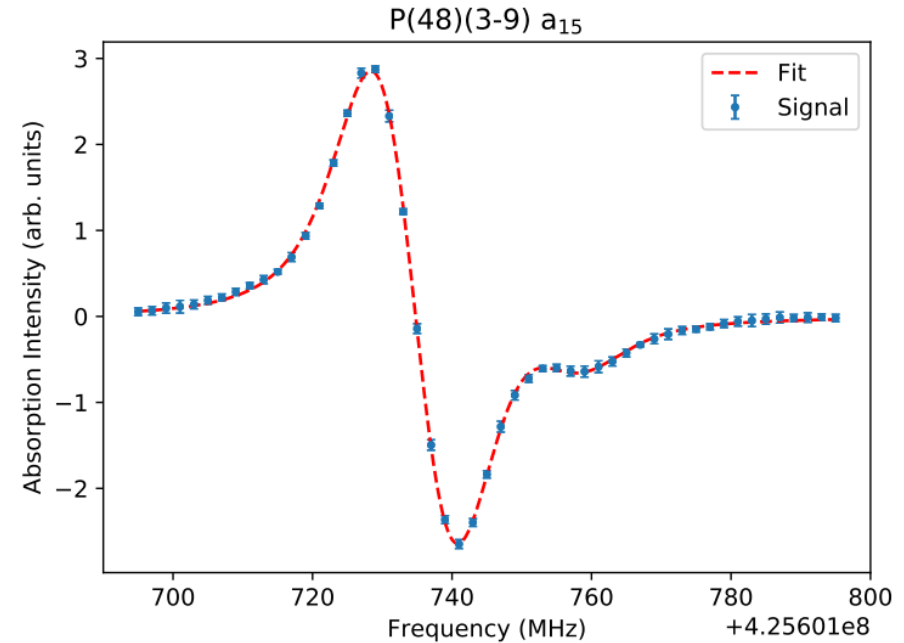
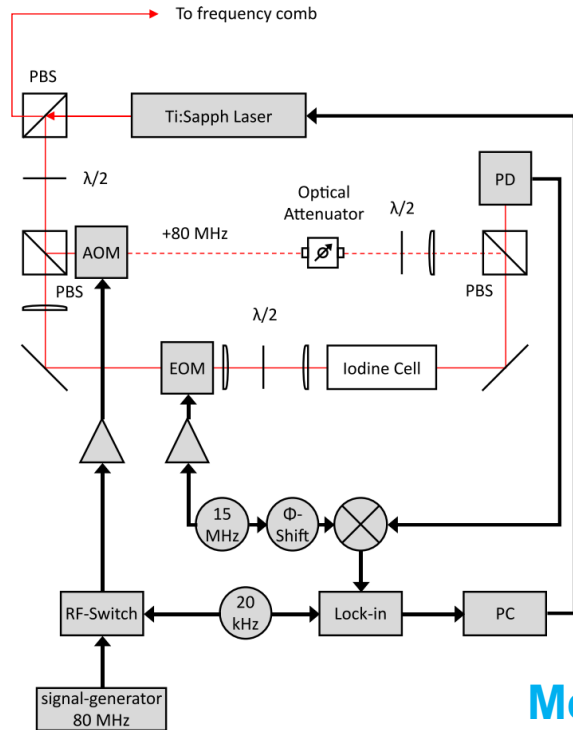


NSCL: Nickel Results

A03



Darmstadt Contributions to the 2020 Corona Beamtime at NSCL



Method submitted to APB

Thank you for your attention

Achievements:

- Improved detection regions
- New measurement principle on atom beams
- King plot analysis submitted
- Nickel results in publishing progress
- Calibration on Iodine in submitted

Outlook:

- He-like Systems start in August
- Pd beamtime in preparation

This work is supported by



Through grant



Thanks to

