Young Scientists Poster Session

May 2, 2017

Organized by:
P. Sitzmann
HGS-Hire (H. Büsching, G. Burau)
GSI-FAIR Colloquium (B. Friman, S. Masciocchi)

- 75 posters registered !!

- Reward committee:

  Henner Büsching, Bengt Friman, Christoph Scheidenberger, Lars Schmitt, Jens Stadlmann, Christina Trautmann

- Many visitors !!

  Public could also vote → 65 ballots collected

5 best posters selected

https://indico.gsi.de/conferenceDisplay.py?confId=5895

Paul Scharrer

Helmholtz Institute Mainz,
GSI,
Johannes Gutenberg-Universität Mainz

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Developments on the 1.4 MeV/u pulsed gas stripper cell

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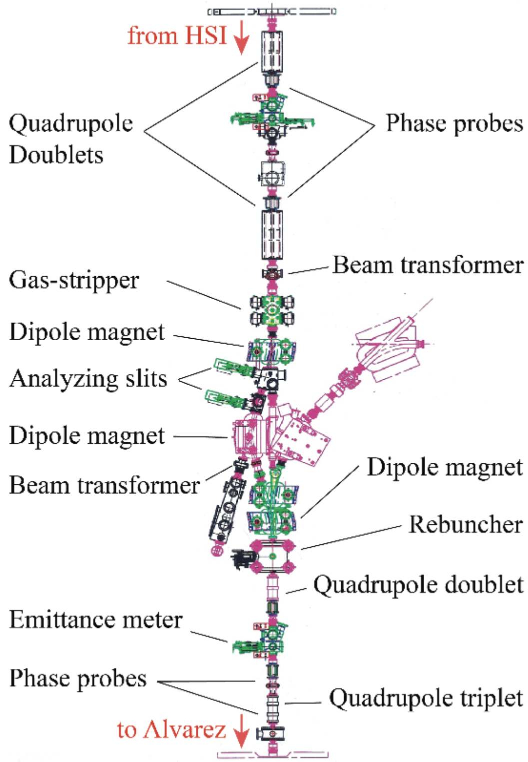
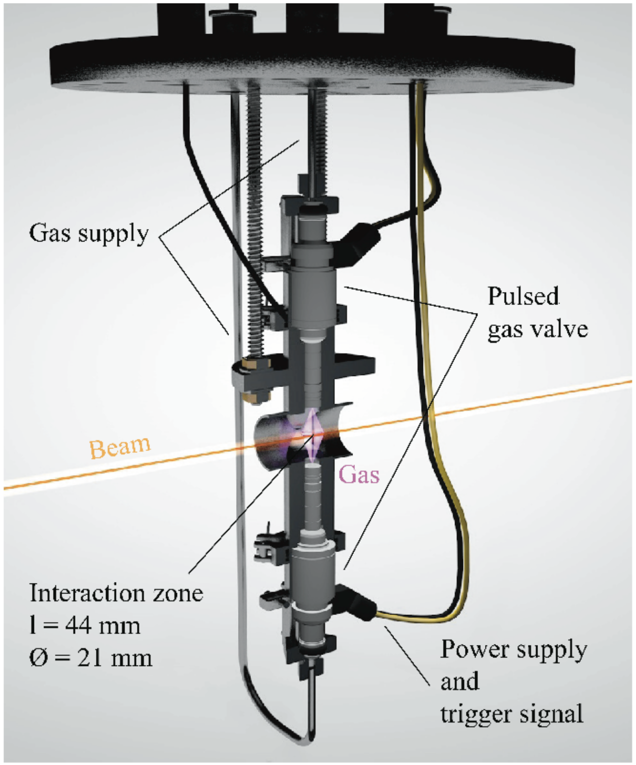
Abstract

- GSI UNILAC will serve as injector for FAIR
- Pulsed gas stripper setup was developed in the course of upgrade program for the UNILAC
- Pulsed gas injection enables practical use of H_2 and He
- Increased $^{238}U^{28+}$ intensities were measured using H_2
- For standard operation at the UNILAC, various different ion beams are used
- Stripping performance of the pulsed gas cell was tested using ^{238}U, ^{209}Bi, ^{50}Ti, and ^{40}Ar beams on H_2, He, and N_2
- Saturated charge state distributions were measured for all ion beams and compared to measurements with the previously existing N_2-jet gas stripper
- Use of H_2 enabled increased average charge states for all utilized ion beams
- More narrow charge state distributions were measured for ^{238}U and ^{209}Bi, allowing for increased beam intensities



GSI UNILAC gas stripper section



Setup of the top flange of the pulsed gas stripper

Premaditya Chhetri
Technische-Universität Darmstadt
GSI

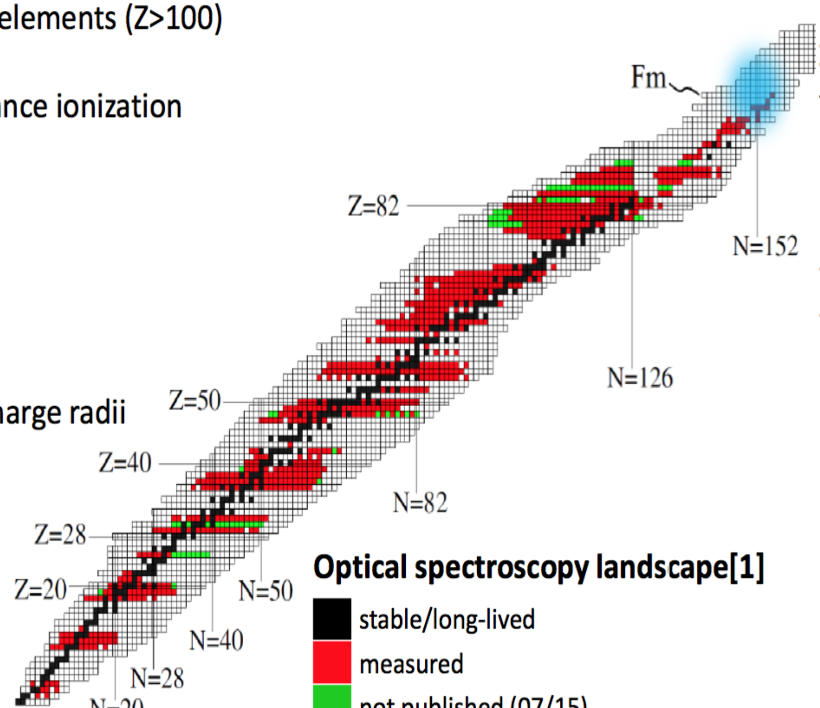
Laser Spectroscopy of the Heaviest Elements at GSI

P. Chhetri[1,2], D. Ackermann[3], H. Backe[4], M. Block[2,4,5], B. Cheal[6], Ch. E. Düllmann[2,4,5], C. Droese[7], J. Even[8], R. Ferrer[9], F. Giacoppo[2,5], S. Götz[2,4,5], F. P.- Hessberger[2,5], O. Kaleja[1,2], J. Khuyagbaatar[2,5], P. Kunz[10], M. Laatiaoui[2,5,9], F. Lautenschläger[1,2], W. Lauth[3], N. Lecesne[2], L. Lens[2,4], E. Minaya-Ramirez[11], A. K. Mistry[2,5], S. Raeder[2,5], Th. Walther[1], A. Yakushev[2,5], Z. Zhang[12]

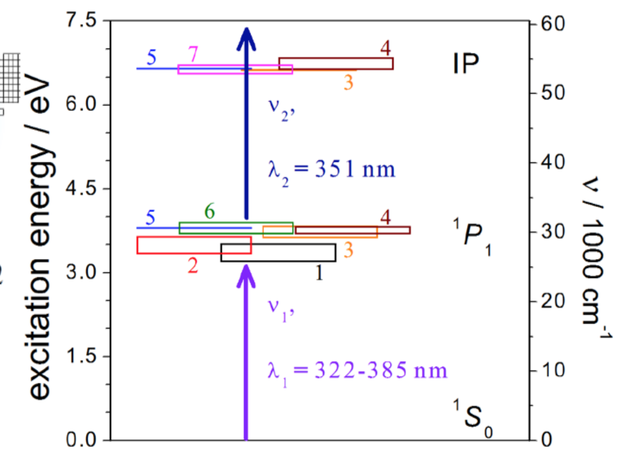
[1] TU Darmstadt, [2] GSI, [3] GANIL, [4] Mainz University, [5] HIM, [6] University of Liverpool, [7] University of Greifswald, [8] KVI-CART, [9] KU Leuven, [10] TRIUMF,, [11] IPNO, [12] IMP

Introduction and motivation

- Explore the atomic structure of transfermium elements (Z>100)
- Search for atomic transitions via 2-step resonance ionization
  - Study of relativistic effects
- Investigation of hyperfine structure
  - Extract nuclear spin and moments
- Study of isotope shifts
  - Extract the changes in mean square charge radii
- Nuclide of interest : ^{254}No (Z=102)
  - Production : ^{208}Pb(^{48}Ca,2n)^{254}No
- Why nobelium?
  - Ground state : [Rn] $5f^{14}7s^2$ $^1S_0$
  - Production cross-section : 2 µb



Optical spectroscopy landscape[1]



Theoretical calculations for nobelium

1,2 : S. Fritzsche, Eur. Phys. J. D 33 (2005) 15
3 : A. Borschevsky et al., Phys. Rev. A 75 (2007) 04514
4 : V. A. Zuaba et al., Phys. Rev. A 90 (2014) 012504
5 : Y. Liu et al., Phys. Rev. A 76 (2007) 062503
6 : P. Indelicato et al., Eur. Phys. J. D 45 (2007) 155
7 : J. Sugar, J. Chem. Phys. 60 (1974) 4103

Joshua Berlin
Goethe University Frankfurt,
GSI

The spectrum of charmed mesons and structure of tetraquark candidates from lattice QCD

Joshua Berlin, Krzysztof Cichy, Martin Kalinowski, Marc Wagner

Motivation

- **Mesons** are bound states of quarks and antiquarks with integer spin $J = 0, 1, 2, \ldots$
- Most mesons are predominantly **quark-antiquark states** ($\bar{q}q$).
- In principle mesons could also be composed of **two quarks and two antiquarks** ("**tetraquarks**", $\bar{q}\bar{q}qq$); in particular for mesons, which are theoretically not well understood, this might be the case.
- The **PANDA** experiment at **FAIR** will investigate many different mesons (different spin J, parity P, quark content u, d, s, c, including several tetraquark candidates), in particular D mesons, D_s mesons and charmonium.
- The theoretical framework to discribe and understand mesons is **QCD**, the quantum field theory of quarks and gluons,
$$\mathcal{L}_{\text{QCD}} = \sum_{q \in \{u,d,s,c,t,b\}} \bar{q}\Big(\gamma_\mu\Big(\partial_\mu - iA_\mu\Big) + m^{(q)}\Big)q + \frac{1}{2g^2}\text{Tr}\Big(F_{\mu\nu}F_{\mu\nu}\Big);$$
the numerical method to solve corresponding equations is **lattice QCD**.

The spectrum of D mesons, D_s mesons and charmonium using $\bar{q}q$ operators

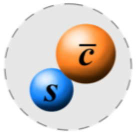
- Computations at
  - different values of the light u/d quark mass ($m_\pi \approx 225 \ldots 470$ MeV),
  - different lattice discretizations,

Why tetraquarks? (example $D^*_{s0}(2317)$)

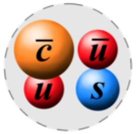
- The masses of charmed scalar mesons D^*_{s0} and D_{s1} are below expectation of typical quark models and lattice computations, e.g. left column
- $D^*_{s0}(2317) - D^*_0(2400)$ mass difference is far too small to account for the s-u/d quark mass difference of 150 ± 30 MeV,
- $D^*_{s2}(2573)$ ist too light to be a radial excitation of the $D^*_{s0}(2317)$.
- Tetraquark interpretation:
  - explains states below the DK and D^*K thresholds naturally,
  - $D^*_{s2}(2573)$ may be a member of a scalar tetraquark multiplet.

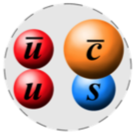
Creation operators for $D^*_{s0}(2317)$

- For our study of $D^*_{s0}(2317)$ we use several operators with identical quantum numbers, which are of rather different structure:
  - Quark-antiquark operator:
$$\mathcal{O}^{q\bar{q}} = \sum_{\mathbf{x}} \Big(\bar{c}_{\mathbf{x}} s_{\mathbf{x}}\Big).$$



  - Mesonic molecule operators (both $D\bar{K}$ and $D_s\pi$):
$$\mathcal{O}^{D\bar{K}\text{ molecule}} = \sum_{\mathbf{x}} \Big(\bar{u}_{\mathbf{x}}\gamma_5 s_{\mathbf{x}}\Big)\Big(\bar{c}_{\mathbf{x}}\gamma_5 u_{\mathbf{x}}\Big)$$
$$\mathcal{O}^{D_s\pi\text{ molecule}} = \sum_{\mathbf{x}} \Big(\bar{u}_{\mathbf{x}}\gamma_5 u_{\mathbf{x}}\Big)\Big(\bar{c}_{\mathbf{x}}\gamma_5 s_{\mathbf{x}}\Big).$$





  - Diquark-antidiquark operator:

Johannes Ding, Diana Jahn
Technische-Universität Darmstadt

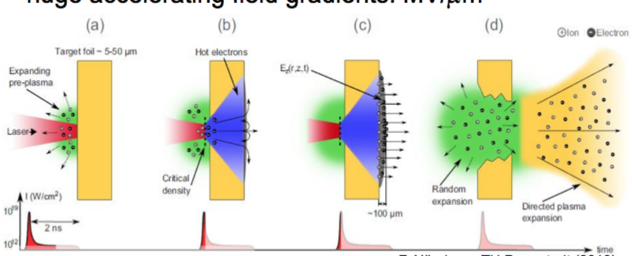
With LIGHT to highest ion beam intensities and shortest ion beam pulses

D. Jahn[3,*], J. Ding[3,**], D. Schumacher[1], S. Busold[2], C. Brabetz[1], A .Blazevic[1,2], F. Kroll[4], V. Bagnoud[1,2] and M. Roth[1]
[1]GSI Helmholtzzentrum für Schwerionenforschung, [2]Helmholtz-Institut Jena, [3]Technische Universität Darmstadt, [4]Helmholtzzentrum Dresden-Rossendorf

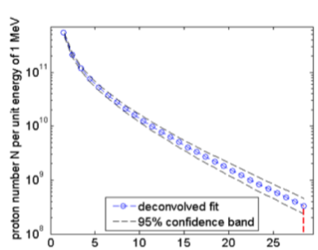
LIGHT

About the project [1,2,3]:
LIGHT stands for Laser Ion Generation, Handling and Transport;
collaboration of TUDa, GSI, Uni Frankfurt, HI Jena, HZDR
proton/ion acceleration driven by the GSI PHELIX laser
beam shaping via conventional accelerator technology

Target Normal Sheath Acceleration (TNSA):
intense ion source: 10^{11} – 10^{13} protons in ~ 1 ps
low emittance: < 0.01 mm mrad transversal, 10^{-4} eV s longitudinal [4,5]
huge accelerating field gradients: MV/µm



TNSA mechanism
F. Nürnberg, TU Darmstadt (2010)



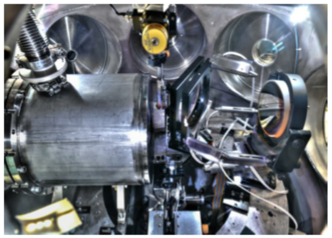
proton energy spectrum at Z6
S. Busold, TU Darmstadt (2014)

LIGHT beamline at Z6 (GSI)

energy capture with a pulsed solenoid

pulsed solenoid

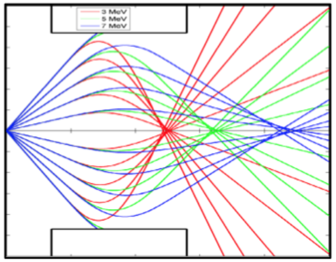
- 40.5 mm clear aperture
- $B_{z,max}$ = 8.7 T
- field characterized and simulated
- discharge time 0.2 ms



photograph of the target chamber

chromatic focusing

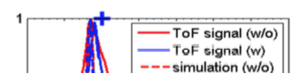
- energy selection by aperture
- B = 7.35 T
- focus at 2.2 m at 9.4 MeV
- $n_p > 10^9$ (9.4 ± 0.5) MeV
- capture efficiency 34%



particle trajectories inside the solenoid

experimental results

- proton bunch at 2.2 m to source
- ToF and dose measurement



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Collective Behaviour of p-rich Nuclei Around A=70

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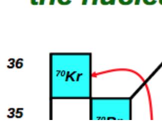
HGS-HIRe for FAIR
Helmholtz Graduate School for Hadron and Ion Research

Introduction

Nuclei in the vicinity of the N=Z line around A=70 exhibit very rapid shape changes due to the isospin symmetry breaking related to charge effects. This leads to differences in excitation energy between analogue states in isobaric multiplets. In this study we probed Coulomb energy differences in the T_z=-1 nucleus ^{70}Kr with respect to its mirror ^{70}Se. Coulomb excitation and knock-out reactions have been used to deliver the $^{70-72}$Kr isotopes in their excited states using the BigRIPS fragment seperator. The experiment was performed at the Radioactive Isotope Beam Factory (RIBF), RIKEN.

$$MED_J = Ex_{J,T_z=-T} - Ex_{J,T_z=+T}$$

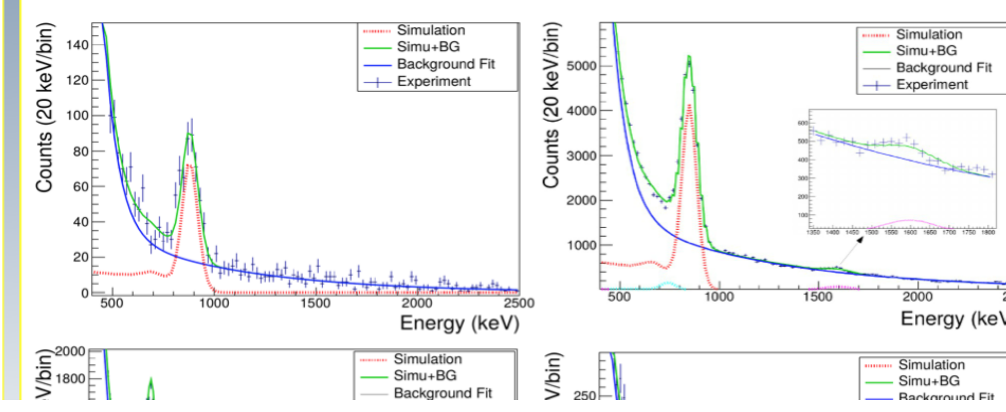
Test the charge symmetry of the nuclear interaction



$$TED_J = Ex_{J,T_z=-T} - Ex_{J,T_z=+T} - 2Ex_{J,T_z=0}$$

Results

The Doppler corrected gamma ray spectra are extracted from fully stripped ejectiles detected in coincidence with the BigRIPS and ZeroDegree spectrometers. The number of the gamma rays emitted as a result of Coulomb excitation are extracted by fitting the line shapes with simulated response functions.



A very special

THANK YOU

to Philipp Sitzmann