TRIUMF - EEC SUBMISSION EEC meeting: 201007S *Original Proposal*	**Exp. No.** S1294 - *Pending (Stage 1)* **Date Submitted:** 2010-06-28 03:58:56

Title of Experiment:

Shell quenching of N=82 shell gap studied through mass measurements of the r-process waiting point ^{130}Cd nucleus

Name of group:

Spokesperson(s) for Group

L. Caceres, H. Savajols, J. Dilling

Current Members of Group:
(name, institution, status, % of research time devoted to experiment)

L. Caceres	GANIL	Research Associate	25%
H. Savajols	GANIL	Research Scientist	10%
J. Dilling	TRIUMF	Research Scientist	10%
S. Ettenauer	University of British Columbia	Student (PhD)	100%
A. Lapierre	TRIUMF	Research Associate	50%
T. Brunner	T.U. Munich	Student (PhD)	50%
P.P.J. Delheij	TRIUMF	Research Scientist	50%
O. Sorlin	GANIL	Senior Research	10%
C. Andreoiu	Simon Fraser University	Assistant Professor	10%
R. Kanungo	Saint Mary's University	Research Associate	10%
M. Dombsky	TRIUMF	Senior Research	10%
P. Bricault	TRIUMF	Senior Research	10%
G. Gwinner	University of Manitoba	Associate Professor	10%
M. Brodeur	University of British Columbia	Research Associate	10%

J. Lassen	TRIUMF	Research Scientist	10%
F. Ames	TRIUMF	Research Scientist	10%
S. Baroni	TRIUMF	Research Associate	10%

Beam Shift Requests:

15 shifts on: TITAN

Basic Information:

Date submitted: 2010-06-28 03:58:56

Date experiment ready:

Summary:

We proposed to performed mass measurement of the neutron-rich 129Cd, 130Cd and 131Cd nuclei in order to extract experimentally the N=82 shell gap at 130Cd. The experimental output will provide relevant information concerning the evolution of the N=82 shell gap which is of outstanding importance to constrain the r-process solar abundances calculations. Additionally, these measurements will provide a benchmark test for the different available mass models which are known to deviate from each other for very exotic nuclei. The newly-commissioned Penning-trap spectrometer TITAN, at TRIUMF-ISAC is an excellent choice for these measurements. We request 15 shifts of beam time.

Plain Text Summary: We proposed to performed mass measurement of the neutron-rich 129Cd, 130Cd and 131Cd nuclei in order to extract experimentally the N=82 shell gap at 130Cd. The experimental output will provide relevant information concerning the evolution of the N=82 shell gap which is of outstanding importance to constrain the r-process solar abundances calculations. Additionally, these measurements will provide a benchmark test for the different available mass models which are known to deviate from each other for very exotic nuclei. The newly-commissioned Penning-trap spectrometer TITAN, at TRIUMF-ISAC is an excellent choice for these measurements. We request 15 shifts of beam time.

Summary of Experiment Results:

Primary Beamline: isac2a

ISAC Facilities

ISAC Facility: TITAN

ISAC-I Facility: Other

ISAC-II Facility: IRIS

Secondary Beam

Isotope: 124-132Cd

Energy: 30-60

Intensity Requested: 200

Minimum Intensity: 50

Maximum Intensity: 1000

Energy Units:

Energy spread-maximum:

Time spread-maximum:

Angular Divergence:

Spot Size: 3x3

Charge Constraints:

Beam Purity: To be determined

Special Characteristics:

Experiment Support

Beam Diagnostics Required:

ILE channeltron; yield station

Signals for Beam Tuning:

number of trapped ions

DAQ Support:

none

TRIUMF Support:

yield station

NSERC:

NSERC:

Other Funding:

Muon Justification:

Safety Issues:

Full suite of TITAN safety reports exists.

TRIUMF EEC NEW RESEARCH PROPOSAL **S1294**

SHELL QUENCHING OF THE N=82 SHELL GAP STUDIED THROUGH MASS MEASUREMENTS OF THE NUCLEI IN THE VICINITY OF THE R-PROCESS WAITING POINT ^{130}CD NUCLEUS

We proposed to perform mass measurement of the neutron-rich ^{129}Cd, ^{130}Cd and ^{131}Cd nuclei in order to extract experimentally the N=82 shell gap at ^{130}Cd. The experimental output will provide relevant information concerning the evolution of the N=82 shell gap which is of outstanding importance to constrain the r-process solar abundances calculations. Additionally, these measurements will provide a benchmark test for the different available mass models which are known to deviate from each other for very exotic nuclei. The newly-commissioned Penning-trap spectrometer TITAN, at TRIUMF-ISAC is an excellent choice for these measurements. We request 15 shifts of beam time.

(a) **Scientific value of the experiment**

The development of the first generation of radioactive beam facilities over the last decade has allowed approaching experimentally nuclei with large N/Z ratio. In particular nuclei in the vicinity of the doubly-magic ^{132}Sn are relevant both for nuclear-structure studies and for their implications in the r-process nucleosynthesis. As the r-process is understood, the nuclei capture neutrons more rapidly than they undergo β-decay, thus moving towards the neutron drip line until the equilibrium between neutron capture and photodissociation is achieved ((n,γ)→(γ,n)). At this point, for each isotopic chain there will be a nucleus with maximum abundance, the so called "waiting point" nucleus. Below ^{132}Sn, the N=82 isotones are calculated to be waiting point nuclei, although the exact path for the r-process nucleosynthesis is not known and it is strongly related to the specific nuclear structure. It has been shown that nuclear-mass calculations including a reduction of the N=82 shell gap yield to an overall improvement in the global solar abundances calculations [Chen95, Pfeiff97]. In particular, the through around A~115 in the solar abundances fit is filled (Figure 1). In ref. [Pfeiff97] the shell quenching was incorporated through an ad-hoc factor that considers the shell evolution caused by neutron excess as predicted by HFB calculations [Do94].

Hartree-Fock-Bogoliubov (HFB) calculations with Skyrme forces predicts a reduction of the N=82 shell gap of about 15-20% from Z=50 to Z=40. The left panel in Figure 2 shows the one-neutron separation energies S_n for the N=82 and N=83 isotopic chains as a function of the neutron number for different parameterization of the forces [Sto05]. For a magic number of particles, the shell gap Δ of an even-even core nucleus is related to the ground-state binding energies (BE) of its odd-even neighbours according to:

$$\Delta(N) = S_n(N+1,Z) - S_n(N,Z) = BE(N+1,Z) - 2 * BE(N,Z) + BE(N-1,Z) \qquad (1)$$

For neutrons and for protons accordingly [Bro01].

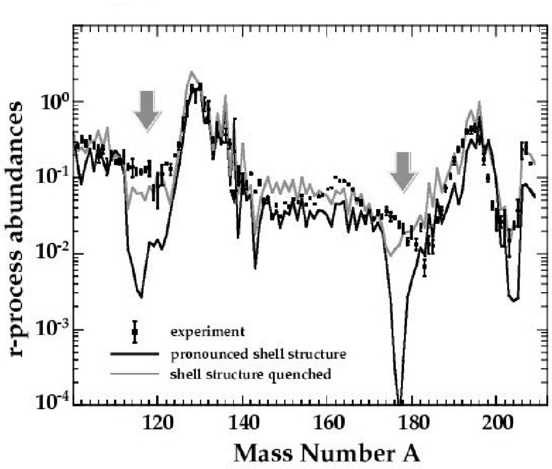
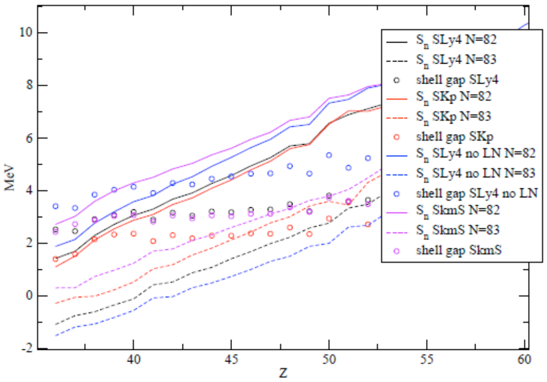


Figure 1: Observed solar abundance distribution compared to two r-process calculations assuming either a pronounced or a quenched N=82 shell gap. A better reproduction of the abundances is obtained when a shell gap is assumed to be quenched [Pfeiff97].



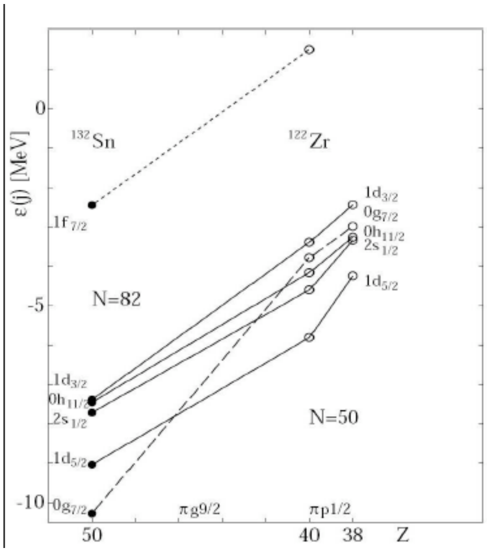


Figure 2: Left; One-neutron separation energies for N=82 and N=83 isotopic chains by HFB models using different Skyrme functionals. The N=82 shell gap corresponds to the energy gap between the N=82 and the N=83 lines.
Right: Evolution of the N=82 shell gap below ^{132}Sn as a function of the atomic number Z. Measured and extrapolated values are indicated by the filled and open circles, respectively [Gr05]. The extrapolation is performed in the shell-model framework.

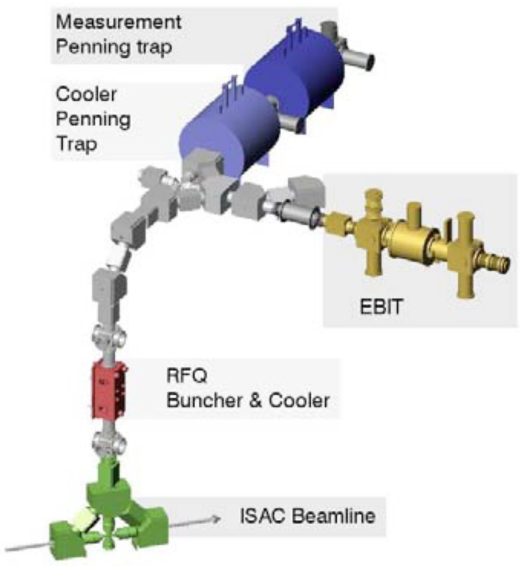
The N=82 shell gap extracted using the Eq. 1 is represented in the Figure 2 with open circles. In the mean-field approach, the reduction of the shell gap has been attributed to the strong interaction between bound orbitals and low-j continuum states [Do94]. The Skyrme functionals are fitted to reproduce observables in stable nuclei and their prediction can differ from each other when approaching the drip line, although the same relative reduction of the shell gap is deduced independent of the parameterization. On the other hand, the evolution of the shell gap could be caused by the monopole migration of the single particle energy (SPE) levels [Ots05]. The right panel in Figure 2 shows the experimental SPE levels in ^{132}Sn (filled circles) and the shell-model extrapolation to lighter nuclei performed by H. Grawe (open circles) [Gr05]. The extrapolation has been performed following the prescription from [Ots05] and employing an interaction determined for a ^{132}Sn core while the interaction of the $\pi(g_{9/2}, p_{1/2})$ levels with the $\nu f_{7/2}$ orbital is extrapolated from the ^{208}Pd region. It is clear from the picture that the N=82 shell gap keeps almost constant with reducing the atomic number.

Up to date, the different experimental results lead to the controversial discussion of the possible reduction of the N=82 shell gap at ^{130}Cd, only two-proton holes below the doubly-magic ^{132}Sn nucleus. From a β-decay experiment of ^{131}Cd [Hann00], it has been found a weak delayed neutron branch of P_n=3.5(1) % which could only be reproduced by calculations using a modify Nilsson potential with a 25 % reduction of the l^2 term. This reduction leads to a quenching of the N=82 shell gap of 1 MeV for ^{131}Cd with respect to a Nilsson model with standard parameters. The adoption of a quenched shell gap is the only way that theory can predict a three-quasiparticle Gamow-Teller transition below the neutron separation energy. This in turn brings to a much smaller beta-delayed neutron emission probability.

On the other hand, opposite interpretation for the reduction of the N=82 shell gap was concluded based on the observation of an isomeric state in ^{130}Cd [Jung07]. The isomeric state at 2130 keV energy is formed by the maximally aligned two proton-holes in the $(g_{9/2})$ orbital as expected by analogy to the 8^+ isomer in ^{98}Cd$_{50}$. The remarkable agreement between experimental results and Shell Model calculations which consider the N=82 shell gap as in ^{132}Sn reveal that there is no evidence of a shell reduction in ^{130}Cd. Moreover, a core excited isomeric state observed in ^{131}In [Gor09] provided for the first time an indirect measurement of the N=82 shell gap at Z=48. A reduction of the N=82 shell gap of 610(100) keV at ^{130}Cd with respect to the size of 4.98(8) MeV at ^{132}Sn [ENSDF] was inferred by means of shell model calculations using a newly derived interaction specially developed to reproduce core excited states in ^{132}Sn and ^{131}In. The experimental results were interpreted in terms of monopole migration without need of any quenching mechanism due to neutron excess.

We proposed to performed mass measurement of the neutron-rich ^{129}Cd, ^{130}Cd and ^{131}Cd nuclei in order to extract experimentally the N=82 shell gap at ^{130}Cd. The experimental outcome will provide confirmation of the reduction of the shell gap quoted in [Gor09] ascribed to the monopole migration or otherwise coupling to the continuum could be the cause of the quenching of the gap. To establish the cause of the reduction of the N=82 shell gap and its size is of outstanding importance to provide the parameters necessary to constrain the r-process solar abundances calculations. Additionally, these measurements will provide a benchmark test for the different available mass models which are known to deviate from each other for very exotic nuclei. Moreover, we propose to extend our measurement to lighter systems, $^{126-128}$Cd, in order confirm the recently measured masses [Breit10].

(b) Description of the experiment



These measurements would be performed with the TITAN setup (left), requiring the RFQ buncher, the EBIT (Electron Beam Ion Trap), and the measurement Penning trap [Dil06]. To make a mass measurement, an ion is injected into the homogeneous field of the TITAN Measurement Penning Trap (MPET) where its specific cyclotron frequency $fc = qB/2\pi m$ is probed and determined using a time-of-flight detection of the ejected ions. The cyclotron frequency is compared to that of a well-known reference mass (generally, a stable species of similar mass, in our case stable Xe isotopes) to provide a measurement. TITAN is operational on-line since August, 2007. At this point the masses of the short-lived radioactive nuclides ^{8}Li and ^{9}Li were measured. Since then, several high quality measurements have been published: ^{8}He [Ryjkov08]; ^{11}Li [Smith08]; ^{11}Be [Ringle09], ^{12}Be [Ettenauer09]. Detailed studies concerning systematic errors and corrections have been carried out [Brodeur10], indicating that measurements on the relative precision level of 2*10-9 are possible with the TITAN system. From the off-line and on-line studies effective efficiency requirements are derived from these measurements, indicting that yields of less than 10/s are sufficient to measure the nuclides in this proposal. A relative mass uncertainty of better than 10−7 is possible in all cases, given statistics.

The expected mass resolution is about δm~60-85 keV for the Cd isotopes for single charge state or δm~ 12 keV for charge state 12 (Kr-noble gas configuration). In both cases the resolution is obtained with 150-200 ms excitation in the trap. The half-lives for the isotopes are between 260, and 70 ms for ^{129,131}Cd. ^{129}Cd has a known isomer, which possibly could be resolved (excitation energy is unknown) or one can let it decay (104ms) in the EBIT and then send the sample to MPET.

(c) **Experimental equipment**: Describe the purpose of all major equipment to be used.
Details of all equipment and services to be supplied by TRIUMF must be provided separately on the Technical Review Form available from the Science Division Office.

Aside from the TITAN setup itself, the only TRIUMF equipment necessary would be the yield station in order to map out the magnetic profile of some of the isobaric contamination in the case of the TRILIS source.

For example at *A* = 130, in addition to ^{130}Cd, there would be ^{130}In and ^{130}Sn. Therefore, isobaric cleaning before the measurements is needed. This could be done with the EBIT and TOF gate (under preparation) or the Giessen Multi-TOF planned to be setup in the Spring 2011. An additional technique is to implement directly after the TRILIS source a fast deflector , which is presently under development at TRIUMF, and is planned to be operational in 2011.
OLIS beam of stable Xe isotopes in standby would be requested.

(d) **Readiness**: Provide a schedule for assembly, construction and testing of equipment. Include equipment to be provided by TRIUMF.

The TITAN setup is currently in running mode. TITAN has already run using all three types of ion sources, measuring masses in the same region. **Since the proposed measurements can be made as of today, we request stage-two approval at this time.**

(e) **Beam time required**: State in terms of number of 12-hour shifts. Show details of the beam time estimates, indicate whether prime-user or parasitic time is involved, and distinguish time required for test and adjustment of apparatus.

The Cd in target expected production for a 2 mA proton beam on 50g/cm^2 U target is shown below together with the Sn and In isotopes.

A	Cd (pps)	In (pps)	Sn (pps)
129	$1.3\ 10^7$	$1.4\ 10^8$	$8.0\ 10^8$
130	$6.7\ 10^6$	$5.5\ 10^7$	$5.8\ 10^8$
131	$1.7\ 10^6$	$2.7\ 10^7$	$2.1\ 10^8$
132	$7.8\ 10^5$	$9.1\ 10^6$	$1.4\ 10^8$

Those numbers have to be scaled regarding the laser ionization efficiency estimated around 5% (conservative number).

We request a total of 15 shifts using the UCx target and the TRILIS source with the breakdown shown below.

Reference masses would be stable Xe-isotopes (128-132) from OLIS performed every 3-4 hours for all runs.

114Cd pilot beam	**0.5**
126Cd	**0.5**
127Cd	**1**
128Cd	**1**
129Cd	**3**
130Cd	**3**
131Cd	**3**
132Cd	**3**
Total	**15 shifts**

(f) **Data analysis**: Give details and state what data processing facilities are to be provided by TRIUMF.

All the necessary analyzing tools are readily available for the TITAN data.

References

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[Pfeiff97] B. Pfeiffer, K. L. Kratz, and F. -K. Thielemann, Z. Phys. A 357, 235 (1997).
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[Jung07] A. Jungclaus et al., Phys. Rev. Lett. 99, 132501 (2007).
[Gor09] M. Górska et al., Phys. Rev. B 672, 313 (2009).
[ENSDF] ENSDF database, http://www.nndc.bln.gov/endsdf/.
[Breit10] M. Breitenfeldt et al., Phys. Rev. C 81, 034313 (2010).
[Aud03] G. Audi, A.H. Wapstra, C. Thibault, Nucl. Phys. A729 (2003) 337
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[Dil06] J. Dilling et al., *Int. J. Mass Spectrom.* 251 (2006) 198
[Ringle09] R. Ringle et al., *Physics Letters B* 675 (2009) 170
[Ryjkov08] V.L. Ryjkov et al., *Physical Review Letters* 101 (2008) 012501
[Smith08] M. Smith et al., *Physical Review Letters* 101 (2008) 202501

For CMMS Experiments, make sure that your detailed information includes:

- a concise summary of the scientific problem under investigation, with appropriate literature references;
- clear justification for the proposed experiments and, specifically, a justification for using μSR/β-NMR techniques
- a description of the experimental techniques to be used, naming the μSR/β-NMR spectrometer(s) or ISAC facilities to be used;
- an analysis of beam time requirements, including a prioritized list of samples;
- Groups with multiple experiments should list all concurrent experiments and proposals, outside of TRIUMF, with an indication of how the personnel effort is to be divided between these activities.

For SAP Experiments, make sure that your detailed information includes:

- an indication of whether you are pursuing Stage 2 approval (beam allocation) at this time;
- if you are, sufficient technical information to demonstrate feasibility to start within two years;
- a clear identification of the facilities to be used and the equipment and services to be supplied by TRIUMF.

TRIUMF EEC NEW RESEARCH PROPOSAL: **S1294**

Spokesperson(S) Publications List for Experiment

L. Cáceres:

Personal contributions :

1.L. Cáceres, M. Górska, A. Jungclaus et al. *Spherical Structure of excited states in 128Cd*, Phys. Rev. C 79, 011301(R) (2009).

2. M. Górska, L. Cáceres et al. *Evolution of the N=82 shell gap below 132Sn inferred from core excited states in 131In82*. Phys. Lett. B. 672, 313 (2009).

3. A.B. Garnsworthy, P.H. Regan, L. C\'aceres et al., *Neutron-Proton Pairing Competition in N=Z Nuclei: Metastable State Decays in the Proton Dripline Nuclei 82Nb and 86Tc*, Phys. Lett. B 660, 326 (2008)

4. A. Jungclaus, L. Cáceres et al., *Observation of Isomeric Decays in the r-Process Waiting-Point Nucleus 130Cd82*, Phys. Rev. Lett. 99, 132501 (2007).

5. P.H. Regan, A.B. Garnsworthy, S. Pietri, L. Cáceres et al., *Isomer spectroscopy using relativistic projectile fragmentation at the N=Z line for A~80-90*, Nucl. Phys. A 787, 491c (2007).

Within the collaboration:

6. O. Wieland et al., *Search for Pygmy Dipole Resonance in 68Ni at 600 MeV/u*. Phys. Rev. Lett. 102, 092502 (2009).

7. Zs. Podolyák et al., *Proton-Hole Excitation in the Closed Shell Nucleus 205Au*, Phys. Lett. B. 672, 116 (2009).

8. Zs. Podolyák et al., *Weakly deformed oblate structure in 198Os*. Phys. Rev C 79, 031305 (2009).

9. L. Chen et al., *Schottky Mass Measurement of the 208Hg Isotope: Implication for the Proton-Neutron Interaction Strenght around Doubly Magic 208Pb*. Phys. Rev. Lett. 102, 122503 (2009).

10. T. Saito et al., *Yrast and Non-yrast 2+ States of 134Ce and 136Nd Populated in Relativistic Coulomb Excitations*. Phys. Lett. B. 669, 19 (2008).

11. S. J. Steer et al., *Single Particle Behavior at N=126; Isomeric Decays in Neutron-Rich 204Pt.*, Phys. Rev. C 78, 061302(R) (2008).

12. R. L. Lozeva et al., *New sub-ns isomer in 125,127,129Sn and isomer systematic of 124-130Sn*, Phys. Rev. C 77, 064313 (2008).

13. P. Doornenbal et al., *Enhanced Strength of the 2→0+ g.s. transition in 114Sn studied via Coulomb Excitation in inverse kinematics*. Phys. Rev. C 78, 031303 (2008)

14. D. Rudolph et al. *Isospin Symmetry and Proton Decay: Identification of the 10+ Isomer in 54Ni.*, Phys. Rev. C 78, 023101 (2008).

15. M. Petrick et al. *Online test of the FRS Ion Catcher at GSI.*, Nucl. Inst. Meth. 266, 4493 (2008).

16. P. Doornenbal et al., *The T=2 mirrors 36Ca and 36S: A test for isospin symmetry of the shell gaps at the driplines.*, Phys. Lett. B 647, 237 (2007).

17. S. Pietri et al., *Recent results in fragmentation isomer spectroscopy with rising.*, Nucl. Inst. Meth. B 261, 1979 (2007).

Conference Proceeding :

1. L. Cáceres et al. *Shell and Shapes in the N=28 Isotones*. Submitted to American Institute of Physics (2010).

2. M. Górska, H. Grawe, L. Cáceres et al. *Nuclear structure addressed at GSI/RISING*., International Journal of Modern Physics E 18, 759 Sp. Iss. (2009).

3. L. Cáceres et al., *Isomer spectroscopy at the N=Z line 82Nb*. Acta Phys. Pol. B 38, 1271 (2007).

4. R. Wadsworth et al., *The NorthWest Frontier: Spectroscopy of N similar to Z nuclei below Mass 100*. Acta. Phys. Pol. B 40, 611 (2009)

5. N. Alkhomashi et al.*β-Delayed and Isomer Spectroscopy of the neutron-rich Ta and W Isotopes.*, Acta. Phys. Pol. B 40, 875 (2009).

6. S. Myalski et al., *Isomeric Ratios for Nuclei with Z=62-67 and A=142-152 produced in the relativistic fragmentation of 208Pb*. Acta. Phys. Pol. B 40, 879 (2009).

7. G.F. Farrelly et al., *Revision of the K-Isomer in 190W*. Acta. Phys. Pol. B 40, 885 (2009).

8. S. J. Steers et al., *Isomeric decay studies in neutron-rich N~126 Nuclei.*, International Journal of Modern Physics E 18, 1002 Sp. Iss. (2009).}

9. D. Rudolph et al., *Evidence for an isomeric 3/2- state in 53Co.*, Eur. Phys. J 36, 131 (2008).

10. G. Neyens et al. *g-factor measurements on relativistic isomeric beams produced by fragmentation and U-fission: the g-RISING project at GSI.*, Acta Phys. Pol. B 38, 1237 (2007).

11. Zs. Podolyak et al., *Isomeric decay studies around 204Pt and 148Tb.*, Eur. Phys. J. Special Topics 150, 165 (2007).

12. S. Pietri et al., *Production cross-sections, spin distributions and isomeric ratios from relativistic projectile fragmentation of 107Ag using RISING.*, Eur. Phys. J. Special Topics 150, 319 (2007).

13. D. Rudolph et al., *Exciting isomers from the first stopped-beam RISING campaign.*, Eur. Phys. J Special Topics 150, 173 (2007).}

14. A.B. Garnsworthy et al., *T=1 and T=0 states in the N=Z=43 nucleus 86Tc.*, Acta Phys. Pol. B 38, 1265 (2007).

15. S. Pietri et al., *First results from the stopped beam isomer RISING campaign at GSI.*, Acta Phys. Pol. B 38, 1255 (2007).

16. S.J. Steer et al., *Identification of isomeric states "south" of 208Pb via projectile fragmentation.*, Acta Phys. Pol. B 38, 1284 (2007).

17. A. Bracco et al., *Coulomb excitations of 68Ni at 600 AMeV.*, Acta Phys. Pol. B 38,1229 (2007).

18. S. Myalski et al., *Isomeric Ratio for the* I^{π}*=8+ Yrast State in 96Pd Produced in the relativistic Fragmentation of 107Ag.*, Acta Phys. Pol. B 38, 1277 (2007).

19. L. Atanasova et al., *The g-factor measurement at RISING: The case of 127Sn.* Proc. Of Nuclear Theory 25th ed, S. Dimitrova, Heron Press, Sofia, Bulgaria (2006).}

20. S. Lakshmi et al., *The g-factor of the 10+ isomer in 128Sn using the RISING setup.*, Proc. Of Nuclear Structure '06 conference on Nuclei at Limits, Oak Ridge, TN, US (2006).

21. S. K. Chamoli et al. *g-factor measurement of 13+ isomeric state in 130Sb with RISING at GSI.*, Proc. Of Nuclear Structure '06 conference on Nuclei at Limits, Oak Ridge, TN, US (2006).

22. R. L. Lozeva et al., *Lifetime and g-factor measurements of isomeric states in Sn isotopes using relativistic fission fragments.* Proc. Of Nuclear Structure '06 conference on Nuclei at Limits, Oak Ridge, TN, US (2006).

23. D. L. Balabanski et al., *First results from the g-RISING campaign: The g-factor of the 19/2+ isomer in 127Sn.*, Proc. of 7th international conference on Radioactive Nuclear Beam, Cortina d'Ampezzo, Italy (2006).

24. P. Doornenbal et al. *RISING: Gamma-ray Spectroscopy with Radioactive Beams at GSI.* Proc. of the TOURS Symposium On Nuclear Physics VI, France (2006).

H. Savajols et al.,

Personal contributions :

- Mass of 11Li from the 1H(11Li, 9Li)3H reaction
  T.Roger, H.Savajols, I.Tanihata, W.Mittig, et al.
  Phys.Rev. C 79, 031603 (2009)
- Global optical model potential for A = 3 projectiles
  D.Y.Pang, P.Roussel-Chomaz, H.Savajols, R.L.Varner, R.Wolski
  Phys.Rev. C 79, 024615 (2009)
- Measurement of two halo neutron tranfer reaction 11Li(p,t)9Li at 3 AMeV
  I.Tanihata, H. Savajols et al.
  Phys.Rev.Lett. 100, 192502 (2008)
- Experimental study of resonance states in 7H and 6H
  M.Caamano, D.Cortina-Gil, W.Mittig, H.Savajols, et al.
  Phys.Rev. C 78, 044001 (2008)
- Design study of a pre-separator for the LINAG super separator spectrometer
  Drouart A, Erdelyi B, Jacquot B, Savajols H.
  Nucl. Inst. Meth. B Volume: 266 Issue: 19-20 Pages: 4162-4166 (2008)
- MAYA: An active-target detector for binary reactions with exotic beams**,**
  Demonchy C.E., Caamano M., Mittig W., Roussel-Chomaz P., Savajols et al.
  Nuclear Instruments and Methods in Physics Research Section A:583 (2007) 341
- Resonance state in ^{7}H
  Caamano M, Cortina-Gil D, Mittig W, Savajols. H, et al.
  Physical Review Letters 99 (6): (2007) 062502
- Mass measurements of neutron-rich nuclei near the N=20 and 28 shell closures
  Jurado B, Savajols H, Mittig W, et al.
  Physics Letters B 649 (1): (2007) 43-48
- Investigation of ^{6}He cluster structures
  L.Giot, P.Roussel-Chomaz, C.E.Demonchy, W.Mittig, H.Savajols, et al.
  Phys.Rev. C **71**, 064311 (2005)
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  Savajols H
  Nuclear Instruments & Methods In Physics Research Section B204 (2003) 146
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  Mittig W, Savajols H, Baiborodin D, et al.
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- Measurement of proton production cross sections with 100MeV deuterons on thin target.
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