Texas A&M University
US Nuclear Data Program

TAMU NSDD CENTER
Report 2019

N. Nica

J.C. Hardy

Evaluation of Nuclear Structure and Decay Data OVERVIEW

- ***Scope:***
  - ***Promote and accomplish mass-chain nuclear structure data evaluation at Texas A&M University - Cyclotron Institute as regular activity and foresee future developments.***
  - ***Address gaps in data through targeted experiments***
- ***2005-2017: under contract with BNL/NNDC***
  - ***67% FTE Mass Chain Evaluation***
  - ***N. Nica (PI, evaluator), J.C. Hardy (scientific adviser)***
- ***2018-2019: NSDD Data Center***
  - ***FY2018: 67% FTE Mass Chain Evaluation***
  - ***FY2019: 100% FTE Mass Chain Evaluation***
  - ***N. Nica (PI, evaluator), J.C. Hardy (scientific adviser)***

Texas A&M - Cyclotron Institute Contributions

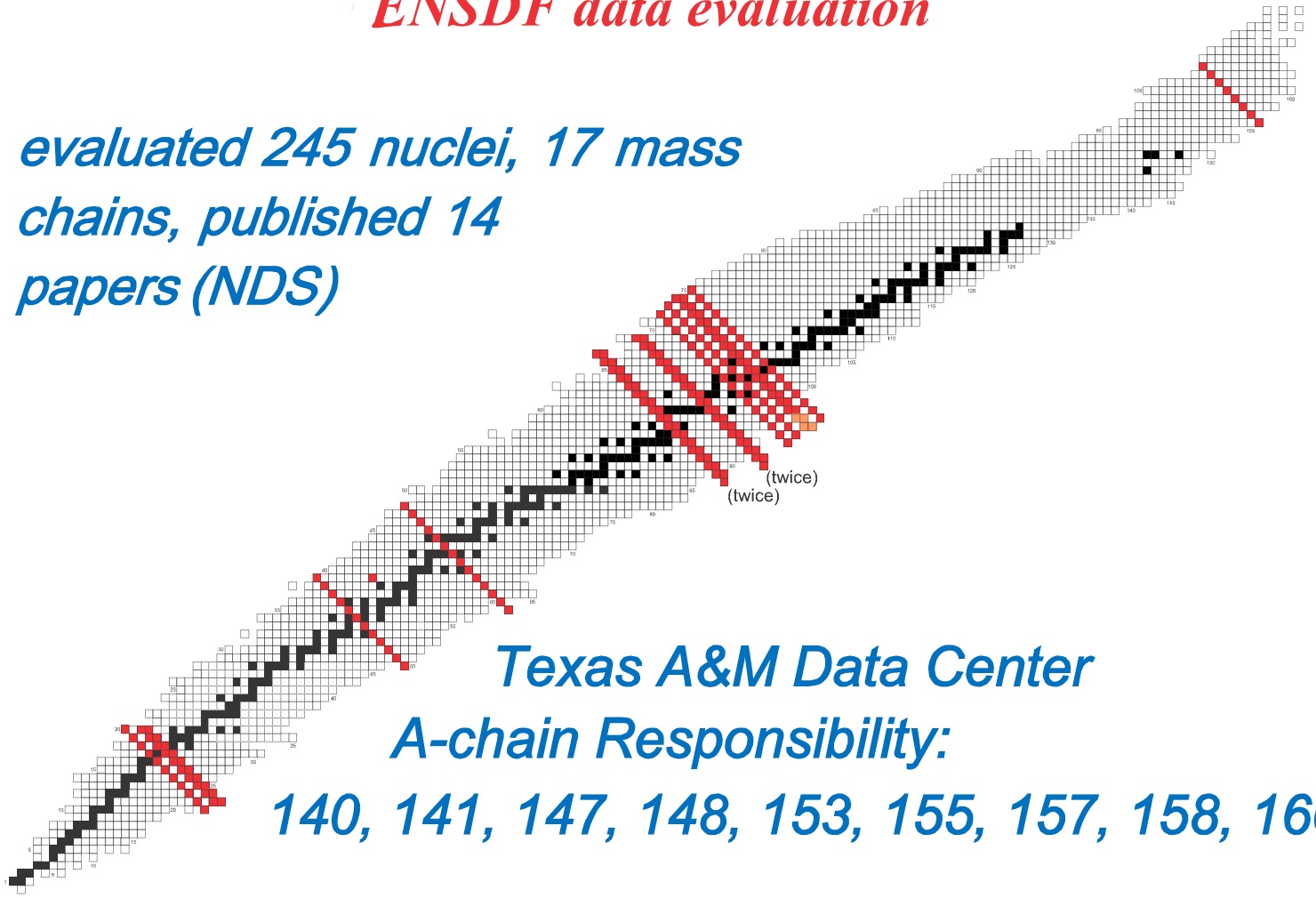
- ***Major Direct Contribution to USNDP/NSDD: Nuclear Data Evaluation***
  - ***14 major publications***
- ***Important Contribution to USNDP/NSDD: Precision ICC Measurements***
  - ***BrIcc adopted the "Frozen Orbitals" calculations***
  - ***^{93}Nb, ^{103}Rh, ^{125}Te, ^{127}Te, ^{111}Cd, ^{119}Sn, ^{134}Cs, ^{137}Ba, ^{197}Pt, ^{191}Os, ^{193}Ir***
  - ***16 major publications***
- ***Texas A&M Contribution to Precision Nuclear Data Production: Precision β-γ Measurements (Standard Model, CKM matrix)***
  - ***$T_{1/2}$, Branching Ratios, Efficiency calibration***
  - ***19 major publications***
- ***Texas A&M Medical Radioisotopes***
  - ***^{67}Cu, ^{99}Mo***
  - ***1 major publication***

Mass Chain Evaluation: *260+ nuclei, 19 A-chains*

- 1. N.Nica, *Nuclear Data Sheets for A = 252*, Nucl.Data Sheets 106, 813 (2005)
  8 nuclei: ^{252}Cm, ^{252}Bk, ^{252}Cf, ^{252}Es, ^{252}Fm, ^{252}Md, ^{252}No, ^{252}Lr
- 2. N.Nica, *Nuclear Data Sheets for A = 140*, Nucl.Data Sheets 108, 1287 (2007)
  16 nuclei: ^{140}Te, ^{140}I, ^{140}Xe, ^{140}Cs, ^{140}Ba, ^{140}La, ^{140}Ce, ^{140}Pr, ^{140}Nd, ^{140}Pm, ^{140}Sm, ^{140}Eu, ^{140}Gd, ^{140}Tb, ^{140}Dy, ^{140}Ho
- 3. D.Abriola *et al.*, *Nuclear Data Sheets for A = 84*, Nucl.Data Sheets 110, 2815 (2009)
  1 nucleus: ^{84}Y
- 4. N.Nica, *Nuclear Data Sheets for A = 147*, Nucl.Data Sheets 110, 749 (2009)
  16 nuclei: ^{147}Xe, ^{147}Cs, ^{147}Ba, ^{147}La, ^{147}Ce, ^{147}Pr, ^{147}Nd, ^{147}Pm, ^{147}Sm, ^{147}Eu, ^{147}Gd, ^{147}Tb, ^{147}Dy, ^{147}Ho, ^{147}Er, ^{147}Tm
- 5. N.Nica, *Nuclear Data Sheets for A = 97*, Nucl.Data Sheets 111, 525 (2010)
  14 nuclei: ^{97}Br, ^{97}Kr, ^{97}Rb, ^{97}Sr, ^{97}Y, ^{97}Zr, ^{97}Nb, ^{97}Mo, ^{97}Tc, ^{97}Ru, ^{97}Rh, ^{97}Pd, ^{97}Ag, ^{97}Cd
- 6. J.Cameron, J.Chen, B.Singh, N.Nica, *Nuclear Data Sheets for A = 37*, Nucl.Data Sheets 113, 365 (2012)
  10 nuclei: ^{37}Na, ^{37}Mg, ^{37}Al, ^{37}Si, ^{37}P, ^{37}S, ^{37}Cl, ^{37}Ar, ^{37}K, ^{37}Ca
- 7. N.Nica, J.Cameron, B.Singh, *Nuclear Data Sheets for A = 36*, Nucl.Data Sheets 113, 1 (2012)
  10 nuclei: ^{36}Na, ^{36}Mg, ^{36}Al, ^{36}Si, ^{36}P, ^{36}S, ^{36}Cl, ^{36}Ar, ^{36}K, ^{36}Ca
- 8. N.Nica, B.Singh, *Nuclear Data Sheets for A = 34*, Nucl.Data Sheets 113, 1563 (2012)
  11 nuclei: ^{34}Ne, ^{34}Na, ^{34}Mg, ^{34}Al, ^{34}Si, ^{34}P, ^{34}S, ^{34}Cl, ^{34}Ar, ^{34}K, ^{34}Ca
- 9. B.Singh, N.Nica, *Nuclear Data Sheets for A = 77*, Nucl.Data Sheets 113, 1115 (2012)
  12 nuclei: ^{77}Ni, ^{77}Cu, ^{77}Zn, ^{77}Ga, ^{77}Ge, ^{77}As, ^{77}Se, ^{77}Br, ^{77}Kr, ^{77}Rb, ^{77}Sr, ^{77}Y
- 10. N.Nica, *Nuclear Data Sheets for A = 148*, Nucl.Data Sheets 117, 1 (2014)
  16 nuclei: ^{148}Xe, ^{148}Cs, ^{148}Ba, ^{148}La, ^{148}Ce, ^{148}Pr, ^{148}Nd, ^{148}Pm, ^{148}Sm, ^{148}Eu, ^{148}Gd, ^{148}Tb, ^{148}Dy, ^{148}Ho, ^{148}Er, ^{148}Tm
- 11. N.Nica, *Nuclear Data Sheets for A = 141*, Nucl.Data Sheets 122, 1 (2014)
  16 nuclei: ^{141}Te, ^{141}I, ^{141}Xe, ^{141}Cs, ^{141}Ba, ^{141}La, ^{141}Ce, ^{141}Pr, ^{141}Nd, ^{141}Pm, ^{141}Sm, ^{141}Eu, ^{141}Gd, ^{141}Tb, ^{141}Dy, ^{141}Ho
- 12. N.Nica, *Nuclear Data Sheets for A = 157*, Nucl.Data Sheets 132, 1 (2016)
  15 nuclei: ^{157}Nd, ^{157}Pm, ^{157}Sm, ^{157}Eu, ^{157}Gd, ^{157}Tb, ^{157}Dy, ^{157}Ho, ^{157}Er, ^{157}Tm, ^{157}Yb, ^{157}Lu, ^{157}Hf, ^{157}Ta, ^{157}W
- 13. N.Nica, *Nuclear Data Sheets for A = 158*, Nucl.Data Sheets 141, 1 (2017)
  15 nuclei: ^{158}Nd, ^{158}Pm, ^{158}Sm, ^{158}Eu, ^{158}Gd, ^{158}Tb, ^{158}Dy, ^{158}Ho, ^{158}Er, ^{158}Tm, ^{158}Yb, ^{158}Lu, ^{158}Hf, ^{158}Ta, ^{158}W
- 14. N.Nica, *Nuclear Data Sheets for A = 140*, Nucl.Data Sheets – Nucl.Data Sheets 154, 1 (2018)
  17 nuclei: ^{140}Sb, ^{140}Te, ^{140}I, ^{140}Xe, ^{140}Cs, ^{140}Ba, ^{140}La, ^{140}Ce, ^{140}Pr, ^{140}Nd, ^{140}Pm, ^{140}Sm, ^{140}Eu, ^{140}Gd, ^{140}Tb, ^{140}Dy, ^{140}Ho
- 15. N.Nica, A =155, *Nuclear Data Sheets for A = 155, Nucl.Data Sheets – sent to Nucl.Data Sheets*
  16 nuclei: ^{155}Ce, ^{155}Pr, ^{155}Nd, ^{155}Pm, ^{155}Sm, ^{155}Eu, ^{155}Gd, ^{155}Tb, ^{155}Dy, ^{155}Ho, ^{155}Er, ^{155}Tm, ^{155}Yb, ^{155}Lu, ^{155}Hf, ^{155}Ta
- 16. N.Nica, A =160, *Nuclear Data Sheets for A = 160, Nucl.Data Sheets – in review (with reviewew)*
  17 nuclei: ^{160}Pr, ^{160}Nd, ^{160}Pm, ^{160}Sm, ^{160}Eu, ^{160}Gd, ^{160}Tb, ^{160}Dy, ^{160}Ho, ^{160}Er, ^{160}Tm, ^{160}Yb, ^{160}Lu, ^{160}Hf, ^{160}Ta, ^{160}W, ^{160}Re
- 17. N.Nica, A =153, *Nuclear Data Sheets for A = 153, Nucl.Data Sheets – in review (with reviewew)*
  16 nuclei: ^{153}La, ^{153}Ce, ^{153}Pr, ^{153}Nd, ^{153}Pm, ^{153}Sm, ^{153}Eu, ^{153}Gd, ^{153}Tb, ^{153}Dy, ^{153}Ho, ^{153}Er, ^{153}Tm, ^{153}Yb, ^{153}Lu, ^{153}Hf
- 18. N.Nica, *Nuclear Data Sheets for A = 147 – submitted to NNDC (FY19)*
  16 nuclei: ^{147}Xe, ^{147}Cs, ^{147}Ba, ^{147}La, ^{147}Ce, ^{147}Pr, ^{147}Nd, (*^{147}Pm Balraj Singh*), ^{147}Sm, ^{147}Eu, ^{147}Gd, ^{147}Tb, ^{147}Dy, ^{147}Ho, ^{147}Er, ^{147}Tm
- 19. N.Nica, *Nuclear Data Sheets for A = 141 – in progress FY20*
  17 nuclei: : ^{141}Sb, ^{141}Te, ^{141}I, ^{141}Xe, ^{141}Cs, ^{141}Ba, ^{141}La, ^{141}Ce, ^{141}Pr, ^{141}Nd, ^{141}Pm, ^{141}Sm, ^{141}Eu, ^{141}Gd, ^{141}Tb, ^{141}Dy, ^{141}Ho

V. Our accomplishments
ENSDF data evaluation

- *evaluated 245 nuclei, 17 mass chains, published 14 papers (NDS)*



Texas A&M Data Center

A-chain Responsibility:

140, 141, 147, 148, 153, 155, 157, 158, 160

TEXAS A&M UNIVERSITY

Texas A&M - Cyclotron Institute

- ***ICC Precision Measurements***
  - ***Completed ^{93m}Nb ICC analysis of HPGe and Si(Li) spectra***
  - ***PRC paper for ^{93m}Nb ICC: to be submitted***
  - ***Last ICC measurement***

- ***Completed 10 ICC measurements***

Hole FO calculations adopted by USNDP, NSDD, DDEP

Texas A&M - Cyclotron Institute

- ***β-γ Precision Measurements***
  - *^{42}Ti ($T_{1/2}$, BR) analysis*

- ***Medical Isotopes***
  - *K500 Cyclotron - MARS : ^{67}Cu published in Appl.Radiat.Isot. 149, 89 (2019)*
  - *K500 Cyclotron - MARS : ^{99}Mo test run analysis in progress*

Texas A&M - Cyclotron Institute, FY2019:

- 14. N.Nica, *Nuclear Data Sheets for A=140*, Nucl.Data Sheets 154, 1(2018) (Dec) *FY2015*
  17 nuclei: ^{140}Sb, ^{140}Te, ^{140}I, ^{140}Xe, ^{140}Cs, ^{140}Ba, ^{140}La, ^{140}Ce, ^{140}Pr, ^{140}Nd, ^{140}Pm, ^{140}Sm, ^{140}Eu, ^{140}Gd, ^{140}Tb, ^{140}Dy, ^{140}Ho,
- 15. N.Nica, *Nuclear Data Sheets for A =155, in print for* Nucl.Data Sheets (2019) (Nov) *FY2016*
  17 nuclei: ^{155}La, ^{155}Ce, ^{155}Pr, ^{155}Nd, ^{155}Pm, ^{155}Sm, ^{155}Eu, ^{155}Gd, ^{155}Tb, ^{155}Dy, ^{155}Ho, ^{155}Er, ^{155}Tm, ^{155}Yb, ^{155}Lu, ^{155}Hf, ^{155}Ta
- 18. N.Nica, A = 147 – 2019: *Submitted to NNDC, FY2019*
  16 nuclei: ^{147}I, ^{147}Xe, ^{147}Cs, ^{147}Ba, ^{147}La, ^{147}Ce, ^{147}Pr, ^{147}Nd, (^{147}Pm-NO), ^{147}Sm, ^{147}Eu, ^{147}Gd, ^{147}Tb, ^{147}Dy, ^{147}Ho, ^{147}Er, ^{147}Tm
- 19. N.Nica, A = 141 – *In progress FY2020*
  17 nuclei: ^{141}Sb, ^{141}Te, ^{141}I, ^{141}Xe, ^{141}Cs, ^{141}Ba, ^{141}La, ^{141}Ce, ^{141}Pr, ^{141}Nd, ^{141}Pm, ^{141}Sm, ^{141}Eu, ^{141}Gd, ^{141}Tb, ^{141}Dy, ^{141}Ho,
- 1. Reviewer=N.Nica, A = 177, Review of full mass chain evaluation
  14 nuclei: ^{177}Er, ^{177}Tm, ^{177}Yb, ^{177}Lu, ^{177}Hf, ^{177}Ta, ^{177}W, ^{177}Re, ^{177}Os, ^{177}Ir, ^{177}Pt, ^{177}Au, ^{177}Hg, ^{177}Tl

- 16. N.Nica, A =160 – 2018: *With reviewer, FY2017*
  17 nuclei: ^{160}Pr, ^{160}Nd, ^{160}Pm, ^{160}Sm, ^{160}Eu, ^{160}Gd, ^{160}Tb, ^{160}Dy, ^{160}Ho, ^{160}Er, ^{160}Tm, ^{160}Yb, ^{160}Lu, ^{160}Hf, ^{160}Ta, ^{160}W, ^{160}Re
- 17. N.Nica, A =153 – 2018: *With reviewer, FY2018*
  17 nuclei: ^{153}La, ^{153}Ce, ^{153}Pr, ^{153}Nd, ^{153}Pm, ^{153}Sm, ^{153}Eu, ^{153}Gd, ^{153}Tb, ^{153}Dy, ^{153}Ho, ^{153}Er, ^{153}Tm, ^{153}Yb, ^{153}Lu, ^{153}Hf

Texas A&M - Cyclotron Institute, FY2019
Mass chain evaluations: Statistics

	A=140 Evaluation	A=155 Evaluation (consider ½)	A=160 Evaluation	A=153 Evaluation	A=147 Evaluation (-BS)	A=141 Evaluation (before)	A=177 Review
Number of Adopted Levels	1371	1182	1216	1459	1318	978	1357
Number of Adopted Gammas	2241	2034	2391	2507	2168	1739	2150
Number of nuclides	17	17	17	17	16	17	14
Number of datasets	103	80	78	94	81	96	64
Number of lines	21460	23364	21212	23808	20510	15026	24444

Mass chains: Review, Updates & Editorial

Mass Chain A155: FY2016

.ens database file	Number of Publications	Increment	CUT Date
A155_old	339		1-Jan-2004
A155_new	368	+29	26-Jan-2016
A155_upd.arv	391	+23	21-Oct-2019, ***+3y9m***

Mass Chain A140, FY2015

.ens database file	Number of Publications	Increment	CUT Date
A140_old	464		1-Feb-2006
A140_new	532	+68	5-Jan-2015
A140_upd.arv	570	+38	20-Nov-2018, ***+3y10m***

Texas A&M - Cyclotron Institute, FY2019
Mass chain evaluations: Publications

Publications USNDP 2019 N. Nica TAMU

- **2019BE23** Phys.Rev. C 100, 015503 (2019)

  M.Bencomo, J.C.Hardy, V.E.Iacob, H.I.Park, L.Chen, V.Horvat, N.Nica, B.T.Roeder, A.Saastamoinen, I.S.Towner

  Precise branching ratio measurement for the superallowed β^+ decay of ^{26}Si: Completion of a second mirror pair

- **2019SO04** Appl.Radiat.Isot. 149, 89 (2019)

  G.A.Souliotis, M.R.D.Rodrigues, K.Wang, V.E.Iacob, N.Nica, B.Roeder, G.Tabacaru, M.Yu, P.Zanotti-Fregonara, A.Bonasera

  A novel approach to medical radioisotope production using inverse kinematics: A successful production test of the theranostic radionuclide ^{67}Cu

- **2018NI14** Phys.Rev. C 98, 054321 (2018)

  N.Nica, J.C.Hardy, V.E.Iacob, V.Horvat, H.I.Park, T.A.Werke, K.J.Glennon, C.M.Folden, V.I.Sabla, J.B.Bryant, X.K.James, M.B.Trzhaskovskaya

  Precise measurement of α_K andα_T for the 39.8-keV E3 transition in ^{103}Rh: Test of internal-conversion theory

- **2018NI16** Nucl.Data Sheets 154, 1 (2018)

  N.Nica

  Nuclear Data Sheets for A=140

Texas A&M - Cyclotron Institute, FY2019
Mass chain evaluations: Conferences

Conferences USNDP 2019 N. Nica TAMU

- **5th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan,** October 23-27, 2018 Hilton Waikoloa Village Waikoloa, HI

  - Precise α_K and α_T Internal Conversion Coefficients Measurements of 39.752(6)-keV E3 Transition in ^{103m}Rh: Test of Internal Conversion Theory (EG.00001)

  - Precise Half-Life Measurement of ^{30}S (FD.00006)

- **23rd Technical Meeting of the NSDD network, 8-12 April 2019**, IAEA Vienna.

  - Texas A&M Center Report
  - ICC Measurement
  - GABS suggestions
  - PANDORA suggestions

- **2019 International Conference on Nuclear Data for Science and Technology, May 19-24, 2019, Beijing**

  - Precise α_K and α_T Internal Conversion Coefficients Measurements of 39.752(6)-keV E3 Transition in ^{103m}Rh: Test of Internal Conversion Theory

- ***Invited Talk*: Nuclear Physics Department, National Institute for Physics and Nuclear Engineering Horia Hulubei Bucharest, Romania, 2 April 2019**

  - Precise α_K and α_T Internal Conversion Coefficients Measurements of 39.752(6)-keV E3 Transition in ^{103m}Rh: Test of Internal Conversion Theory

Texas A&M - Cyclotron Institute
FY 2020

- ***A-chain evaluation FTE: 2020 -> 100%***
- ***A=141 full mass chain evaluation***
- ***Review***
- ***Xundl***
- ***3 big A-chains in the publication pipe!***

A-Chain Evaluation Responsibility @Texas A&M University

- ***Responsibility:***

  140, 141, 147, 148, 153, 155, 157, 158, 160

- ***Status:***

✓ *155 (Oct-2019)*
✓ *140 (Nov 2018)*
✓ *158 (Feb 2017)*
✓ *157 (Dec 2015)*
✓ *148 (Oct 2013)*

➢ *147 (Nov-2018 – submitted)*
➢ *160 (Jun 2005 - with reviewer)*
➢ *153 (Dec 2005 - with reviewer)*
➢ *141 (Jun 2012 – in progress)*

Texas A&M Nuclear Data Program under DOE Grant and NSDD Data Center

Promoting Scientific Research Programs related to data evaluation:

- *Medial Isotopes Production Tests*
- *Promoting original research ideas from reevaluating existing data*