

***Texas A&M University
US Nuclear Data Program***

***TAMU NSDD CENTER
Report 2021***

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)*
- *2018-2021: NSDD Data Center*
 - *FY18: 67% FTE Mass Chain Evaluation*
 - *FY19-21: 100% FTE Mass Chain Evaluation*
 - *N. Nica (PI, evaluator), J.C. Hardy (retiree, scientific adviser)*

Texas A&M - Cyclotron Institute

Contributions

- *Major Direct Contribution to USNDP/NSDD: Nuclear Data Evaluation*
 - *17 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 , ^{191}Os , ^{193}Ir , ^{197}Pt*
 - *17 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*
 - *21 publications*
- *Texas A&M Medical Radioisotopes*
 - *^{67}Cu , ^{99}Mo*
 - *3 publications*

Mass Chain Evaluation: 280 nuclei, 20 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.Abricola 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 160, 1 (2019)
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 = 153, Nuclear Data Sheets for A = 153*, Nucl.Data Sheets 170, 1 (2020)
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
- 17. [N.Nica](#), *A = 160, Nuclear Data Sheets for A = 160*, Nucl.Data Sheets 176, 1 (2021)
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

Mass Chain Evaluation: 280 nuclei, 20 A-chains

- 16. [N.Nica](#), A =153, *Nuclear Data Sheets for A = 153, Nucl.Data Sheets 170, 1 (2020)*
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
- 17. [N.Nica](#), A =160, *Nuclear Data Sheets for A = 160, Nucl.Data Sheets 176, 1 (2021)*
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
- 18. [N.Nica](#), *Nuclear Data Sheets for A = 147 – submitted to NNDC (FY19), after review (with evaluator)*
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 – submitted to NNDC (FY20), after review (with evaluator)*
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
- 20. [N.Nica](#), *Nuclear Data Sheets for A = 162 – submitted to NNDC (FY21), with reviewer*
17 nuclei: ^{162}Nd , ^{162}Pm , ^{162}Sm , ^{162}Eu , ^{162}Gd , ^{162}Tb , ^{162}Dy , ^{162}Ho , ^{162}Er , ^{162}Tm , ^{162}Yb , ^{162}Lu , ^{162}Hf , ^{162}Ta , ^{162}W , ^{162}Re , ^{162}Os
- 21. [N.Nica](#), *Nuclear Data Sheets for A = 154 – in progress (FY22)*
17 nuclei: ^{154}Ba , ^{154}La , ^{154}Ce , ^{154}Pr , ^{154}Nd , ^{154}Pm , ^{154}Sm , ^{154}Eu , ^{154}Gd , ^{154}Tb , ^{154}Dy , ^{154}Ho , ^{154}Er , ^{154}Tm , ^{154}Yb , ^{154}Lu , ^{154}Hf

ENSDF data evaluation

280 nuclei, 20 A-chains

17 publications

Texas A&M Data Center
A-chain Responsibility:
140, 141, 147, 148, 153, 155, 157, 158, 16

17 publications

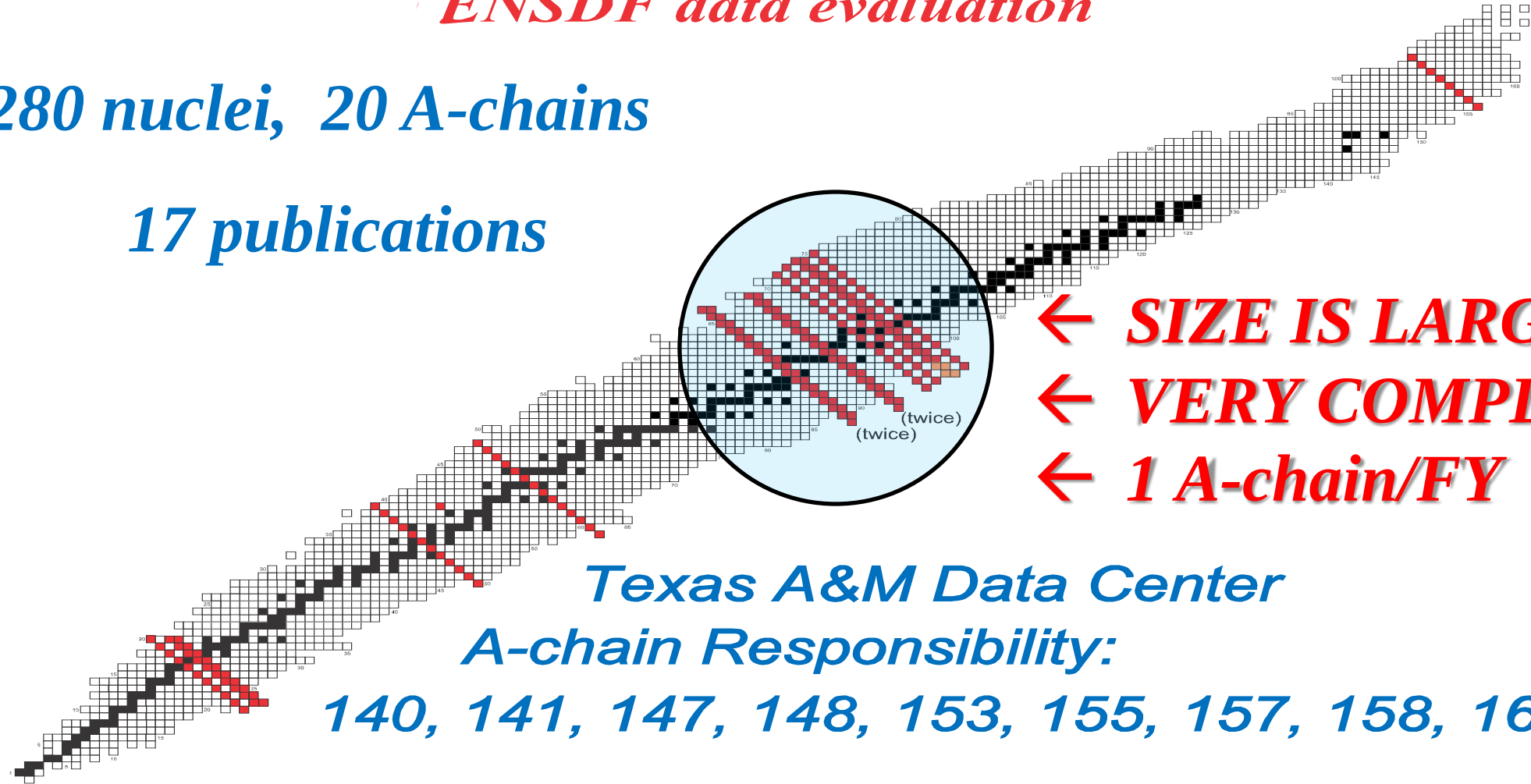
 *Texas A&M Data Center*
A-chain Responsibility:

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

V. Our accomplishments
ENSDF data evaluation

280 nuclei, 20 A-chains

17 publications



← *SIZE IS LARGE!*
← *VERY COMPLX*
← *1 A-chain/FY*

Texas A&M Data Center
A-chain Responsibility:

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

Texas A&M - Cyclotron Institute

- *ICC Precision Measurements*
 - *Published ^{93m}Nb ICC (PRC)*
 - *Last ICC measurement in the series of 10*
 - *Completed 10 ICC measurements*

Hole FO calculations adopted by USNDP, NSDD, DDEP

Search for cases to extend the (93-197) A-number interval

- ^{198m}Au , 115.2 -keV M4, multiple IT γ , $T_{1/2}=2.3$ d: **Very difficult α_K ; Doable α_L**
- ^{58m}Co , 24.9-keV M4, single IT γ , $T_{1/2}=9.1$ h: **Doable α_K**

Texas A&M - Cyclotron Institute

- *β - γ Precision Measurements*

- *New precise half-life measurement for the superallowed β^+ emitter ^{30}P , (Oct 2021)*

Analysis in progress

- *Medical Isotopes, K500 Cyclotron - MARS*

- ^{67}Cu “*A novel approach to medical radioisotope production using inverse kinematics*”,

Published in EPJ Web of Conferences 252, 08002 (2021)

- ^{99}Mo “*Enhanced production of ^{99}Mo in inverse kinematics heavy ion reactions*”,

Published in EPJ Web of Conferences 252, 08003 (2021)

Texas A&M - Cyclotron Institute, FY2021:

- 15. [N.Nica](#), *Nuclear Data Sheets for A =153*, Nucl.Data Sheets (2020) (Dec) **FY2018**
17 nuclei: ^{153}Ba , ^{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
- 16. [N.Nica](#), *Nuclear Data Sheets for A = 160*, Nucl.Data Sheets 176, 1 (2021) **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
- Review: A = 245, Review of full mass chain evaluation
9 nuclei: ^{245}U , ^{245}Pu , ^{245}Am , ^{245}Cm , ^{245}Bk , ^{245}Cf , ^{245}Es , ^{245}Fm , ^{245}Nd
- 18. [N.Nica](#), A = 147 – *After review work*, **FY2019**
16 nuclei: ^{147}I , ^{147}Xe , ^{147}Cs , ^{147}Ba , ^{147}La , ^{147}Ce , ^{147}Pr , ^{147}Nd , ($^{147}\text{Pm-NO}$), ^{147}Sm , ^{147}Eu , ^{147}Gd , ^{147}Tb , ^{147}Dy , ^{147}Ho , ^{147}Er , ^{147}Tm
- 20. [N.Nica](#), *Nuclear Data Sheets for A = 162 – Submitted to NNDC*, **FY2021**
17 nuclei: ^{162}Nd , ^{162}Pm , ^{162}Sm , ^{162}Eu , ^{162}Gd , ^{162}Tb , ^{162}Dy , ^{162}Ho , ^{162}Er , ^{162}Tm , ^{162}Yb , ^{162}Lu , ^{162}Hf , ^{162}Ta , ^{162}W , ^{162}Re , ^{162}Os

Texas A&M - Cyclotron Institute, FY2019

Mass chain evaluations: Statistics

	A=153 Evaluation (published)	A=160 Evaluation (published)	A=141 Evaluation (submitted)	A=162 Evaluation (submitted)	A=147 Evaluation (after review)	A=154 Evaluation (before eval)	A=148 Evaluation (before eval)	A=245 Review
Number of Adopted Levels	1532	1242	1069	1082	1318	1131	1219	-
Number of Adopted Gammas	2983	2503	1886	1704	2168	2395	1937	-
Number of nuclides	17	17	17	17	16	17	16	-
Number of datasets	95	78	97	84	81	84	92	-
Number of lines	26629	22837	17434	19364	20510	20944	17932	-

Mass chains: Review, Updates & Editorial

Mass Chain A153: FY2018

.ens database file	Number of Publications	Increment	CUT Date
A153_old	460		31-Dec-2005
A153_new	485	+25	10-Nov-2017
A153_upd.arv	490	+5	16-Aug-2020, +2y9m

Mass Chain A160: FY2016

.ens database file	Number of Publications	Increment	CUT Date
A160_old	368		1-Jun-2005
A160_new	444	+76	1-Mar-2017
A160_upd.arv	460	+16	20-May-2021, +4y3m

Texas A&M - Cyclotron Institute, FY2021 Publications

Publications USNDP 2021 N. Nica TAMU

- Nucl.Data Sheets 170, 1 (2020)
N.Nica
Nuclear Data Sheets for A=153
- Nucl.Data Sheets 176, 1 (2020)
N.Nica
Nuclear Data Sheets for A=160
- EPJ Web of Conferences 252, 08001 (2021)
Ninel Nica
“Texas A&M US Nuclear Data Program”
- EPJ Web of Conferences 252, 08002 (2021)
Márcia Regina Dias Rodrigues, Victor E. Iacob, **Ninel Nica**, Brian Roeder, Gabriel Tabacaru, Kang Wang, Meixiang Yu, Paulo Zanotti-Fregonara, Justin Mabiala, Jedidiah Romo, Georgios A. Souliotis and Aldo Bonasera,
“A novel approach to medical radioisotope production using inverse kinematics”,
- EPJ Web of Conferences 252, 08003 (2021)
Justin Mabiala, Marcia R. D. Rodrigues, Georgios A. Souliotis, Victor E. Iacob, **Ninel Nica**, Brian Roeder, Gabriel Tabacaru, Kang Wang, Jedidiah Romo, Dustin Scriven, Nolan Tenpas and Aldo Bonasera
“Enhanced production of ^{99}Mo in inverse kinematics heavy ion reactions”

Texas A&M - Cyclotron Institute, FY2021 Conferences

Conferences USNDP 2021 N. Nica TAMU

- **N. Nica**, *"TAMU NSDD Evaluation Center Report 2021"*, 24th Technical Meeting of the NSDD network, IAEA Vienna, May 25, 2021
- **N. Nica**, *"Texas A&M US Nuclear DATA Program @HINPw6"*, Hellenic Institute of Nuclear Physics Workshop (HINPw6), organized by National and Kapodistrian University of Athens, May 14-16, 2021
- **N. Nica**, *"About difficult evaluation decisions-a case study"*, ENSDF 2021 Meeting, Apr 29, 2021, Brookhaven National Laboratory, Upton, NY, USA
- **N. Nica**, *"Texas A&M US Nuclear DATA Program"*, DOE Nuclear Data Program Manager's Inspection at the Texas A&M University Nuclear Data Evaluation Center, Mar 24, 2021, TAMU Cyclotron Institute, College Station, TX, USA
- **N. Nica**, *"Texas A&M US Nuclear DATA Program"*, Virtual Joint Nuclear and Astrophysics Seminar, Feb 26, 2021, TAMU Cyclotron Institute, College Station, TX, USA
- **N. Nica**, *"Texas A&M Evaluation Center Report"*, Nuclear Data Week 2020, USDNP Meeting, Dec 1-4, 2020, Brookhaven National Laboratory, Upton, NY, USA
- **N. Nica**, *"Precision Internal Conversion Coefficients Measurements Follow-up"*, Nuclear Data Week 2020, USDNP Meeting, Dec 1-4, 2020, Brookhaven National Laboratory, Upton, NY, USA

Texas A&M - Cyclotron Institute

FY 2022

- *A-chain evaluation FTE: 100%*
- *A=154 full mass chain evaluation*
- *Review*
- *(Xundl)*
- *3 big A-chains in the publication pipe!*
 - *A=147 with evaluator*
 - *A=141 with evaluator*
 - *A=162 with reviewer*

A-Chain Evaluation Responsibility @Texas A&M University

- ***Responsibility:***

140, 141, 147, 148, 153, 154, 155, 157, 158, 160, 162

- ***Status:***

- ✓ *160 (May 2021)*

- ✓ *153 (Aug 2020)*

- ✓ *155 (Oct-2019)*

- ✓ *140 (Nov 2018)*

- ✓ *158 (Feb 2017)*

- ✓ *157 (Dec 2015)*

- *147 (Nov-2021 – with evaluator)*

- *141 (Sept 2020 – with evaluator)*

- *162 (Mar 2007 – in reviewer)*

- ***FY2022: 154 (May 2008)***

- ***FY2023: 148 (Oct 2013)***

OBS.: 162 and 154 are NOT TAMU RESPONSABILITY

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

Promoting Scientific Research Programs related to data evaluation:

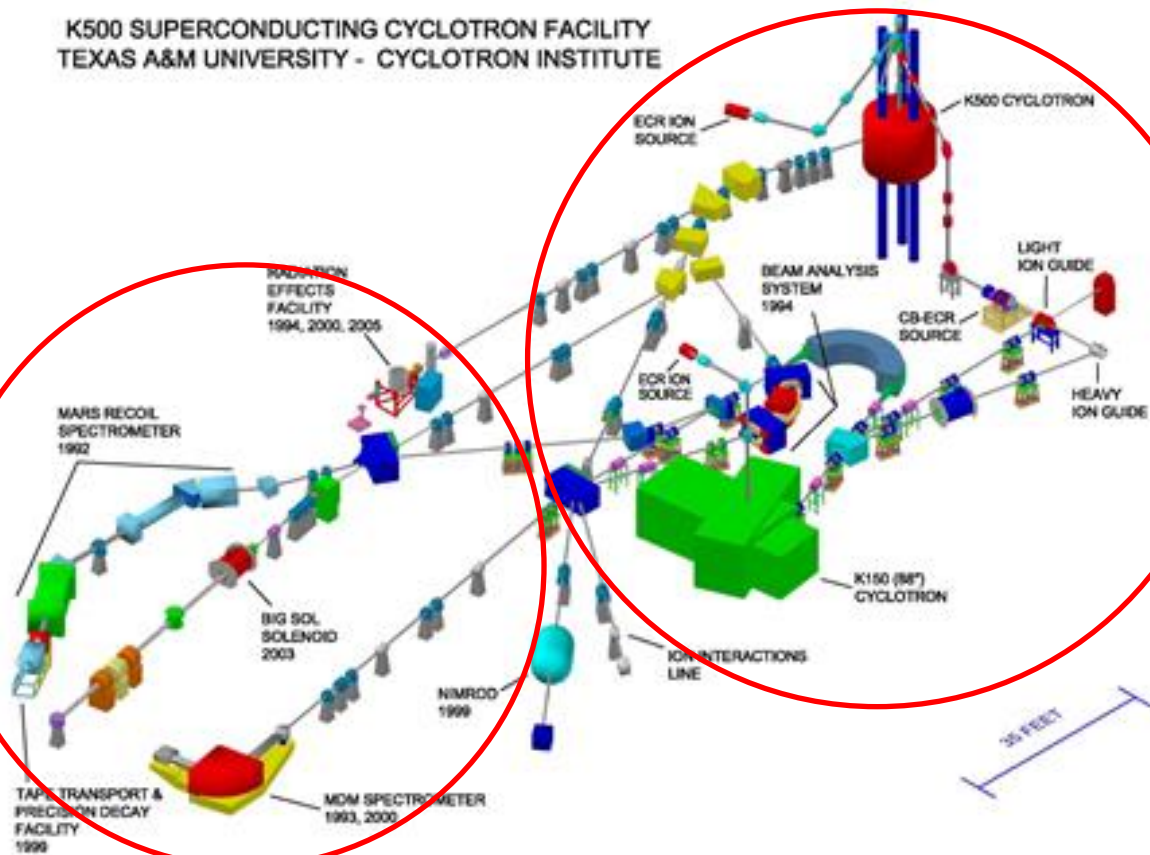
- Possible Follow-up of ICC Measurements (?)*
- Precise half-life measurement for the superallowed β^+ emitter ^{30}P*
- Medial Isotopes Production Tests*
- Promoting original research ideas from reevaluating existing data !*

Texas A&M Evaluation Center Strategic Priorities

- **Continuing ENSDF Mass Chain Evaluation (1 FTE)**
First Strategic Priority according to the Mission Statement.
All other priorities will be strictly subordinated to this purpose
- **Produce experimental nuclear data to aid data evaluation**
Precision Internal Conversion Coefficients Measurements at Cyclotron Institute, Texas A&M University to give USDNP the best approach for ENSDF ICC-calculated values (concluding cases pending on conditions)
- **Produce very precise experimental data for testing Standard Model**
Precision T_{1/2} and BR Measurements at MARS spectrometer of Cyclotron Institute, Texas A&M University
- **Experimental studies of Medical Isotopes**
Invers kinematics methodology, Cyclotron Institute, Texas A&M University
- **Reevaluation of data procedures for basic science and data evaluation**
Level scheme re-concept based on Repeatability, a newly revealed experimental data evidence

Texas A&M Evaluation Center:
Data Evaluation Station at Cyclotron
Radioactive Ion Beam Facility
to assist experiments and
pre-evaluate data

K500 SUPERCONDUCTING CYCLOTRON FACILITY
TEXAS A&M UNIVERSITY - CYCLOTRON INSTITUTE



Focus on the Light-Ion Guide (LIG), the Heavy Ion Guide (HIG) and the Charge-Breeding Electron-Cyclotron-Resonance ion source (CB-ECRIS).

