

International Nuclear Data Evaluation Network on Light Elements (INDEN-LE)

Introduction

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International Atomic Energy Agency

CM INDEN-LE 2024



R-matrix Codes + INDEN-LE: goals



Exchange of
know how



Compatibility of
R-matrix codes



Interchangeable and
usable resonance
parameters



Shared curated
database



Joint evaluation

➤ Thompson et al., Eur. Phys. Journal A (2017) 72:56

Neutrons 2021-2024

Independent evaluations

New experimental data (n+14N;
alpha+13C; alpha+11B)

170 discussed - feedback from
integral measurements

n+9Be

Gerry Hale, Mark Paris
Helmut Leeb, Thomas Srdinko
Zhenpeng Chen

n+16O

Gerry Hale, Mark Paris
Zhenpeng Chen
James deBoer (13C(alpha,n))
Marco Pigni

n+23Na

Pierre Tamagno

n+15N

Satoshi Kunieda

n+14N

Gerry Hale
James deBoer
Ian Thompson

Charged particles 2021-2024

Independent evaluations:

- $3\text{He}+4\text{He}$ (Thompson – ENDF/B-VIII.1)
- 7Be : Chen, Hale-Paris

Test 2 + Test 3: lead by Ian Thompson

- In progress

7Be : $p+6\text{Li}$; $3\text{He}+4\text{He}$

Group effort

Test 2: fitting statistical methods

Test 3: evaluation

$^{13}\text{C}(\alpha,n)$ (170)

Gerry Hale, Mark Paris

Zhenpeng Chen

James deBoer ($^{13}\text{C}(\alpha,n)$)

Marco Pigni

$^{19}\text{F}(\alpha,n)$

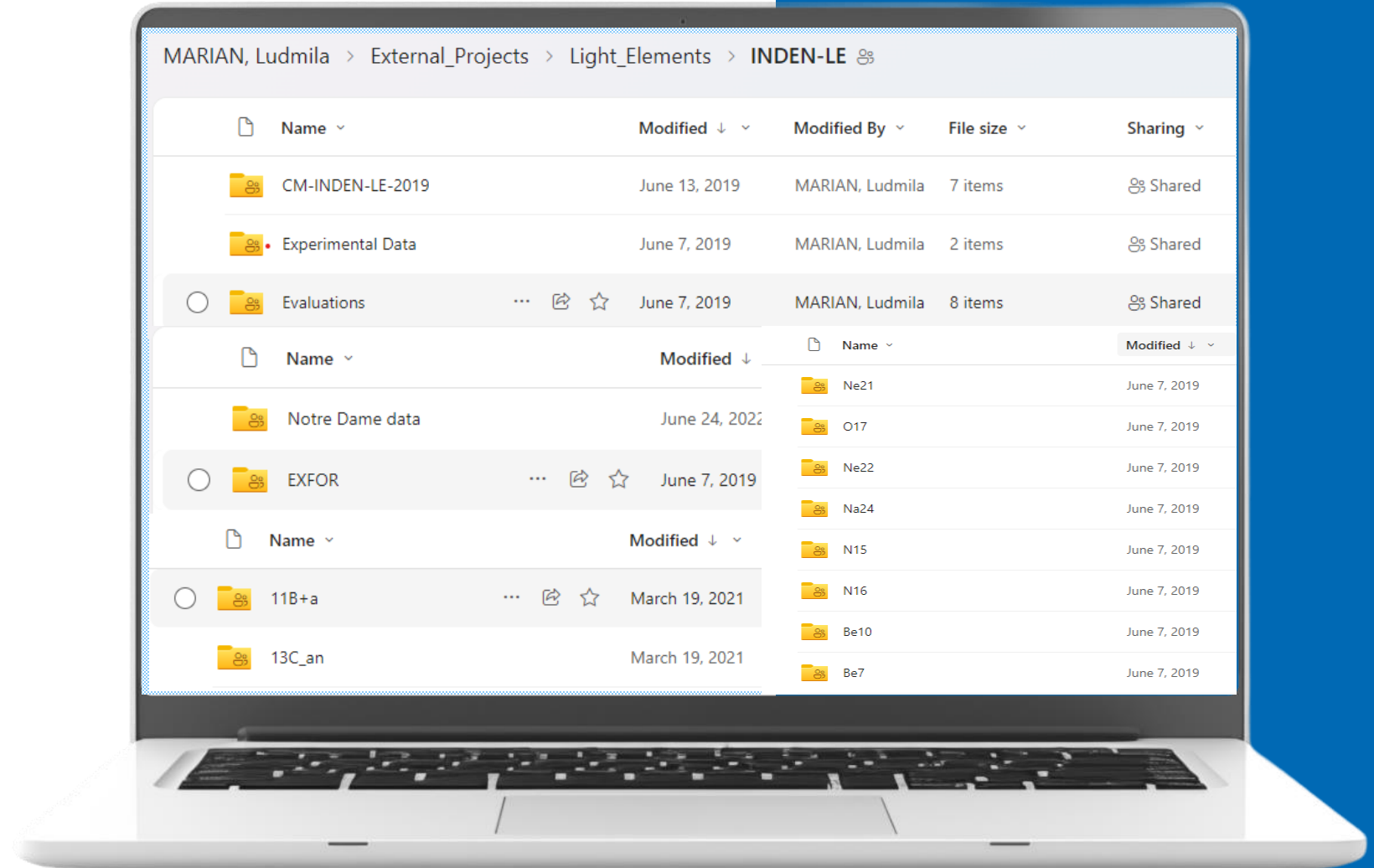
Dimitriou

deBoer

IAEA OneDrive: Light_Elements

Experimental data from
EXFOR and deBoer

Evaluations from Chen,
Thompson, deBoer

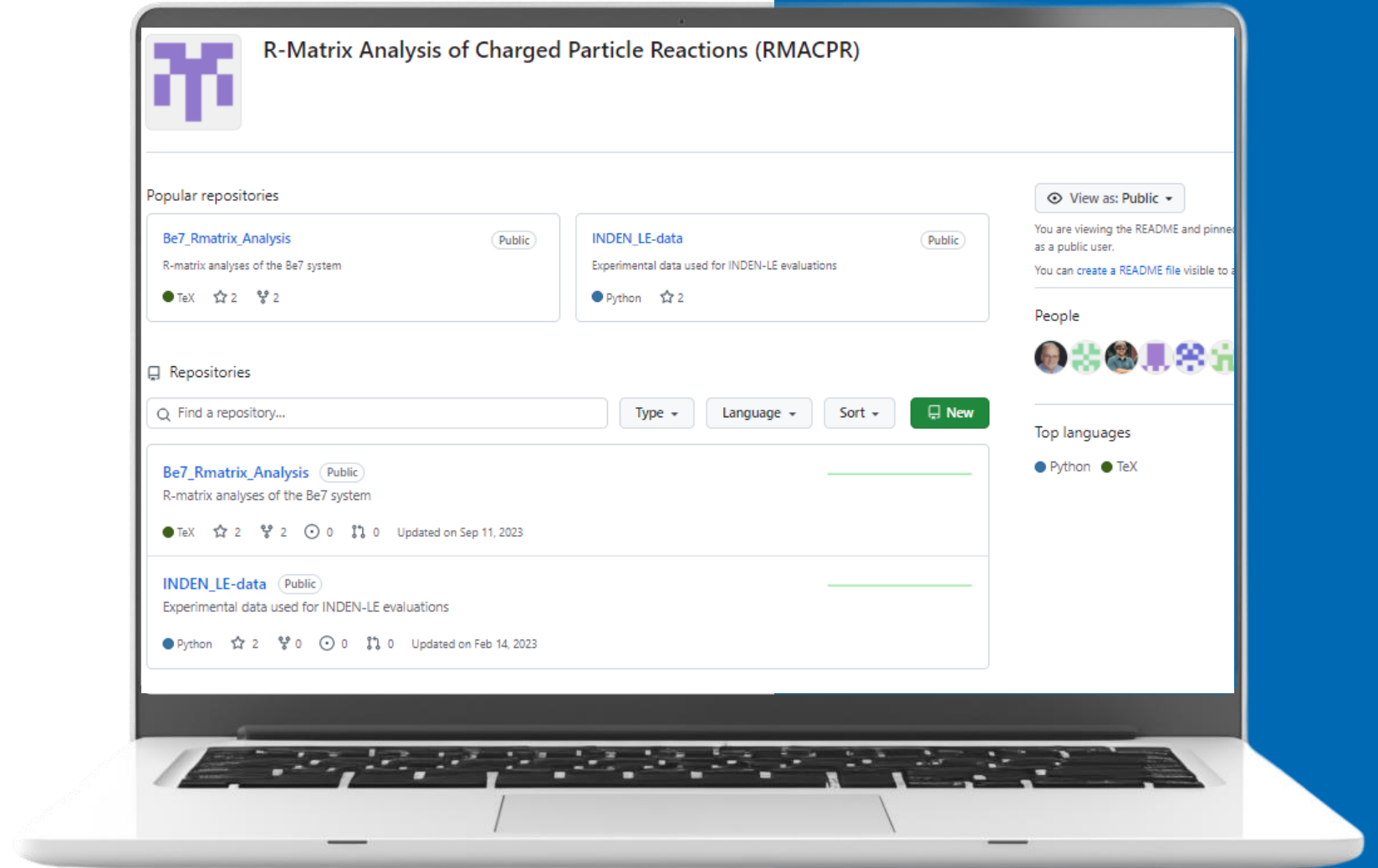


R-matrix Analysis of Charged Particle Reactions (RMACPR)

- Ian Thompson's Github repository
- Experimental data from EXFOR, deBoer, Paris
- Evaluations from Thompson

Github:

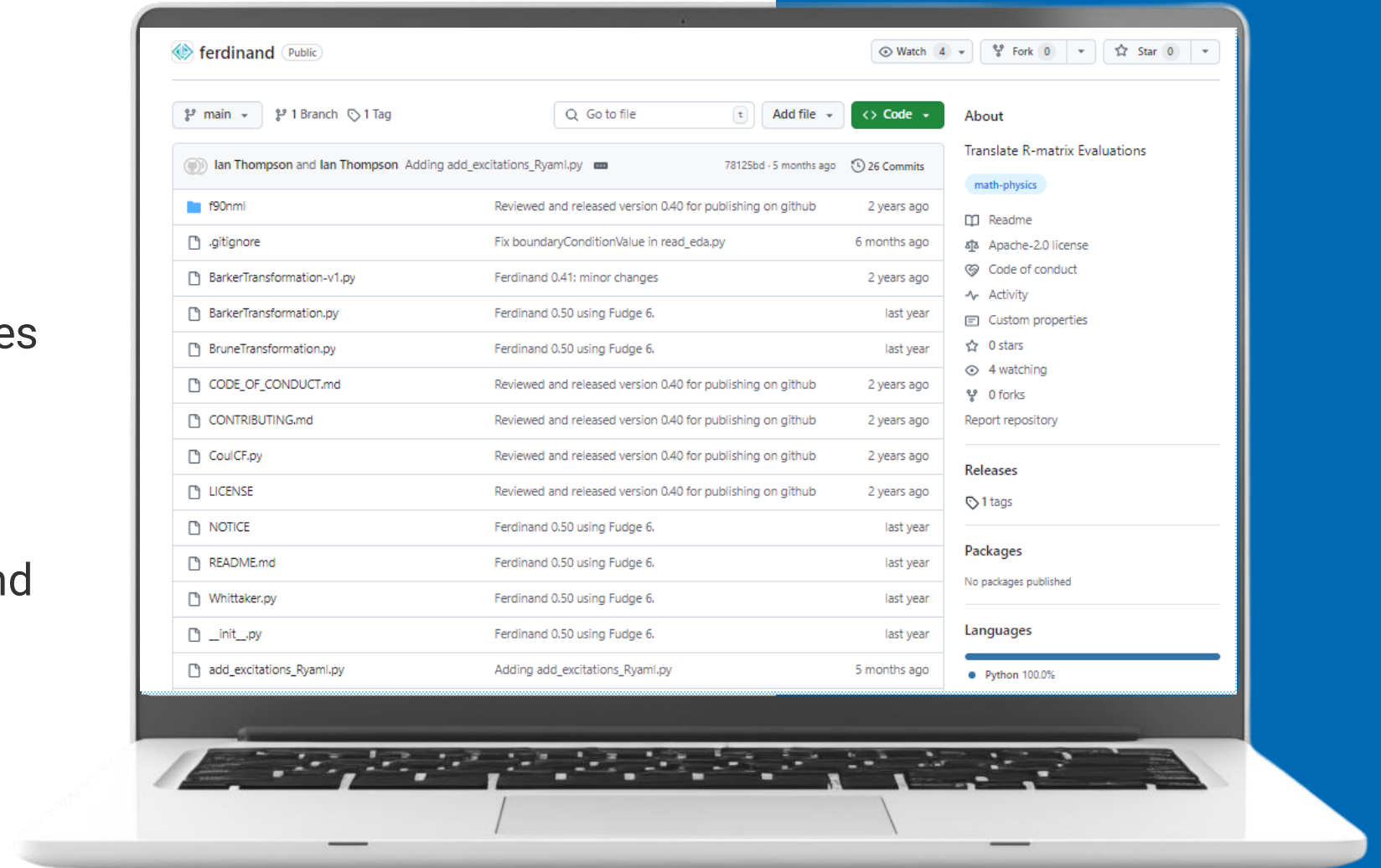
<https://github.com/RMACPR>



Ferdinand code

- By Ian Thompson
- Translating resonance parameters from different bases and different R-matrix codes
- GitHub:

<https://github.com/LLNL/ferdinand>



Test 2: comparison of minimization techniques

Test case: 7Be; Experimental database selected by Hale and deBoer; 1 data set per channel (alpha,el), (p, el), (alpha,p), (p,alpha)

To compare: minima (chi2) and covariance matrices of cross sections and resonance parameters

- The covariance matrix should also contain the normalisations. However, cross correlations between normalization and resonance parameters cannot be treated in ENDF-6 format. A format must be agreed on.
- The bound channels are fixed following Hale's prescription, i.e. using boundary condition for bound state $B = S(E_{\text{bound}})$ and for all others $B = -L$. The matching radii were the same as in Test 1.
- Degrees of freedom: number of experimental points - number of R-matrix parameters - number of unconstrained normalization (unconstrained = no measurement of normalization error)
- Total chi2-value: sum of chi2 for each data set +chi2 for normalization for each data set
- Number of iterations: those with analytical derivatives should estimate their iterations by also taking into account the number of free parameters
- Uncertainties of initial parameters should be specified (without correlations)
- Apart from normalizations, only statistical experimental uncertainties are assumed in Test 2

Test 2 cont'd

Status: as of 21 March 2024

Ian will prepare a YAML file with detailed instructions on how to build the parameter covariance matrices:

- R-matrix parameters in certain order, normalization in certain order and covariance matrix with same order of R-matrix and normalization parameters.
- Define order of experiments.
- Agree if E is in Lab or CM. Whether to provide reduced widths or not.

Code developers will then submit their results, chi2 and covariances accompanied with their YAML file detailing how to read their covariance matrices.

The results of the comparison will be discussed at the next INDEN-LE meeting. Dates to be confirmed.

Ian will also discuss with GNDS team possible ways of accommodating cross-correlations between scaling and resonance parameters in a new format.

Test 3: evaluation of 7Be

All conditions and experimental database detailed in 1 Sept. 2022 document

Status: as of 21 March 2024

Ian submitted $3\text{He}+4\text{He}$ channel evaluation to ENDF/B-VIII.1

James to improve his evaluation

Helmut and Thomas will also perform an evaluation although their priority is $n+9\text{Be}$ system

Marco strongly urges to publish

Experimental data

Previous Experiment Data for the Be7 system

Have we sorted all the experimental data?

Do we have a final experimental database for the evaluation?

- Use *.dat files from de Boer to make 'Test3' calculation
- Still need to specify properties of these files:

projectile	ejectile	residual	file	sys-error	stat-error	norm	group	splitnorms	lab	abserr	scale	filedir	eshift	ecalib	splitshifts
h	h	0	Barnard_aa.dat	5	3	1	E	FALSE	TRUE	TRUE	b	Expt5/	0	0	FALSE
p	h	0	Elwyn_pa.dat	9	-1	1	A	FALSE	TRUE	TRUE	b	Expt5/	0	0	FALSE
p	p	0	Fasoli_pp.dat	-1	1.5	1	E	TRUE	TRUE	TRUE	b	Expt5/	0	0	FALSE
p	p	0	Harrison_pp0.dat	-1	2	2.2	A	FALSE	TRUE	TRUE	b	Expt5/	0	0	FALSE
p	p	1	Harrison_pp1.dat	-1	-1	0.2	A	FALSE	TRUE	TRUE	b	Expt5/	0	0	FALSE
p	h	0	Lin_pa.dat	10	-1	1	A	TRUE	TRUE	TRUE	b	Expt5/	0	0	FALSE
p	p	0	McCray_pp.dat	5	-1	1	E	TRUE	TRUE	TRUE	b	Expt5/	0	0	FALSE
h	h	0	Mohr_aa.dat	-1	5	1	A	TRUE	TRUE	TRUE	b	Expt5/	0	0	FALSE
h	h	0	Spiger-A1094004-lab_aa.dat	1.5	-1	1	E	TRUE	TRUE	TRUE	b	Expt5/	0	0.02	TRUE
h	p	0	Spiger-cm_ap0.dat	1.5	-1	1	A	TRUE	FALSE	TRUE	mb	Expt5/	0	0	FALSE
h	h	0	Tombrello_aa.dat	5	-1	1	E	FALSE	TRUE	TRUE	b	Expt5/	0	0.02	TRUE
a	h	15	LIMIT	4.001506	3.01550116										
p	Li6	2.79	LIMIT	1.008665	6.01347726										

Correct some data:

1. The 9.106 MeV point at 36.999 deg in the Spiger_aa data is not extracted from the plots properly.
2. The Tombrello_aa data (not A1039 but A1295) should have a constant discretization error of 0.5 mb/sr added in quadrature to the per-cent errors for the A1295002 data.
3. The points in Elwyn_pa at $E_p = 2.277$, 2.377 , and 2.476 MeV were not plotted correctly, if checked by Legendre data.

Developments - Discussions



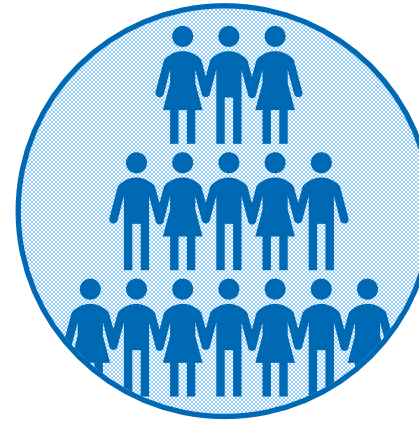
Ian Thompson retired



Redefine goals

Review exercises Test 2
and Test 3

New RMACPR Git repo?
Ferdinand?



New members

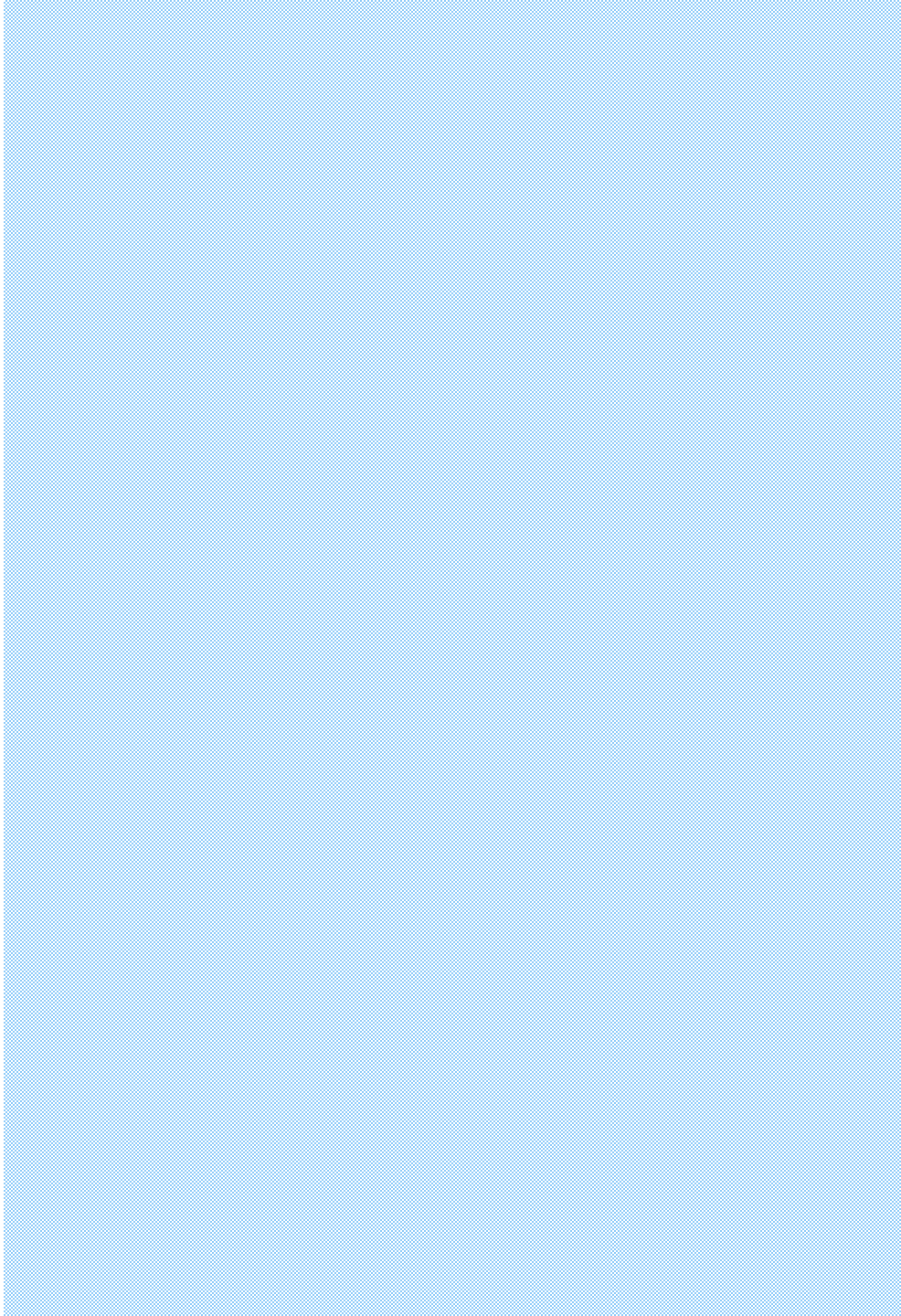


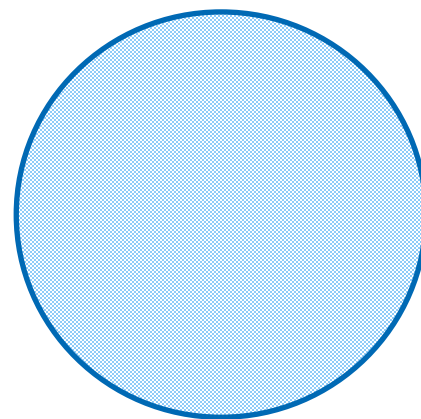
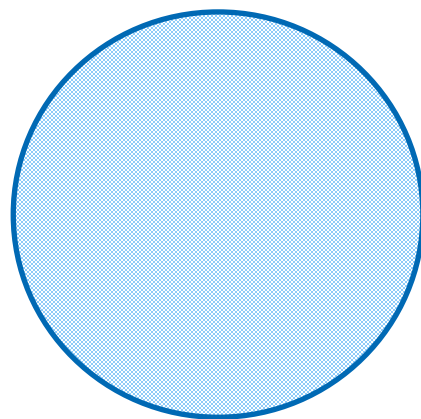
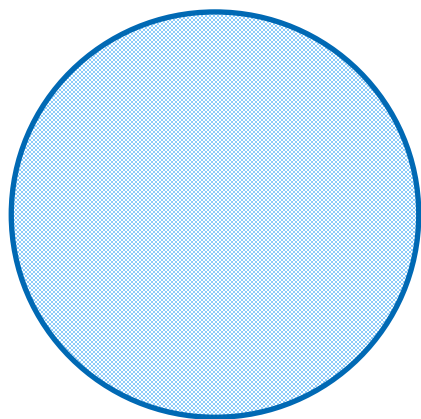
**New goals?
New format?**



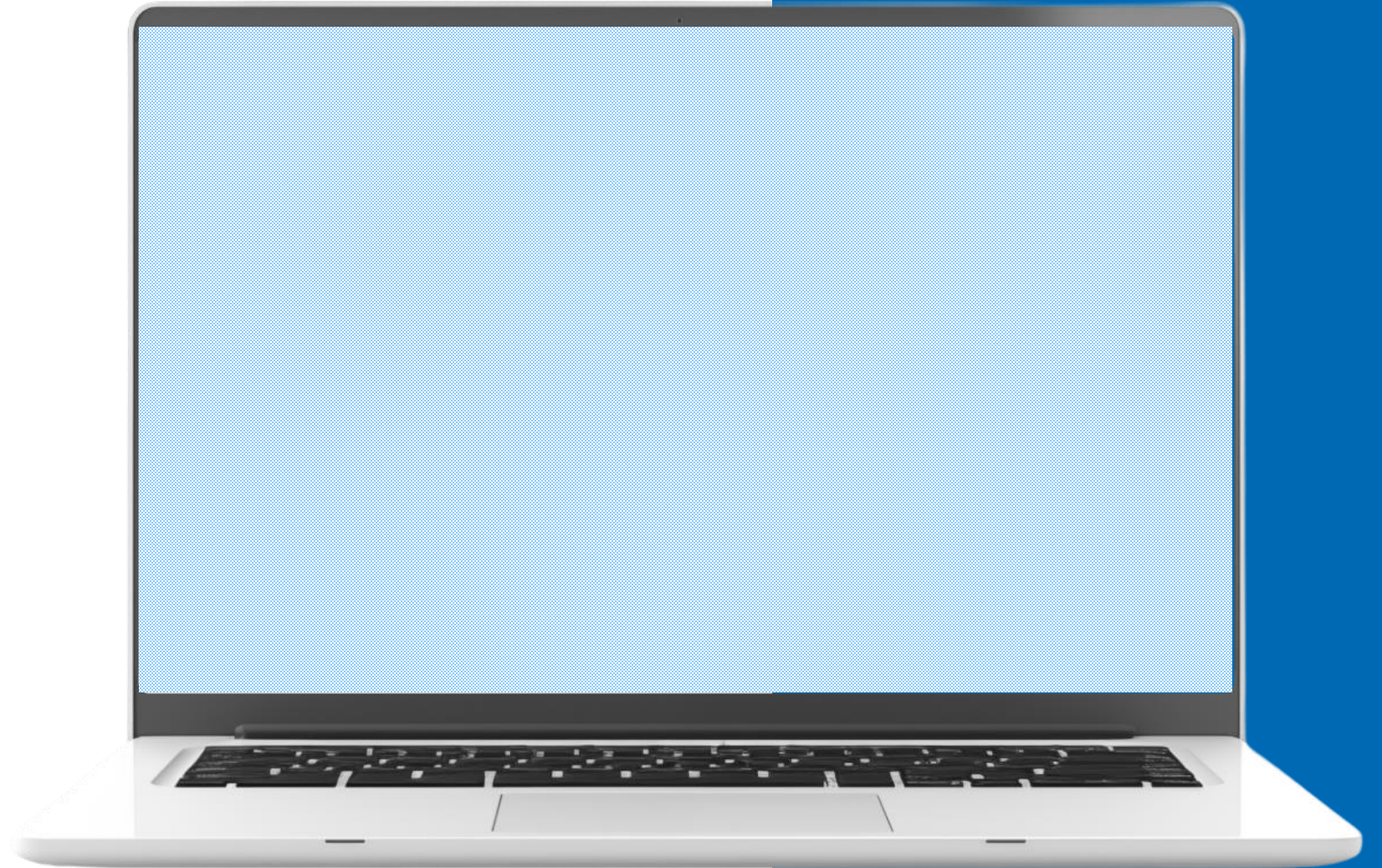
IAEA

P.Dimitriou@iaea.org





Title Here



ENDF/B-VIII.1

- $n+^{19}\text{F}$:
- n,TOT and n,G from JENDL-5;
- (n,INL): Morgan et al 1976

