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α-, d- p-, γ-, n-TENDL-2019 into GNDS

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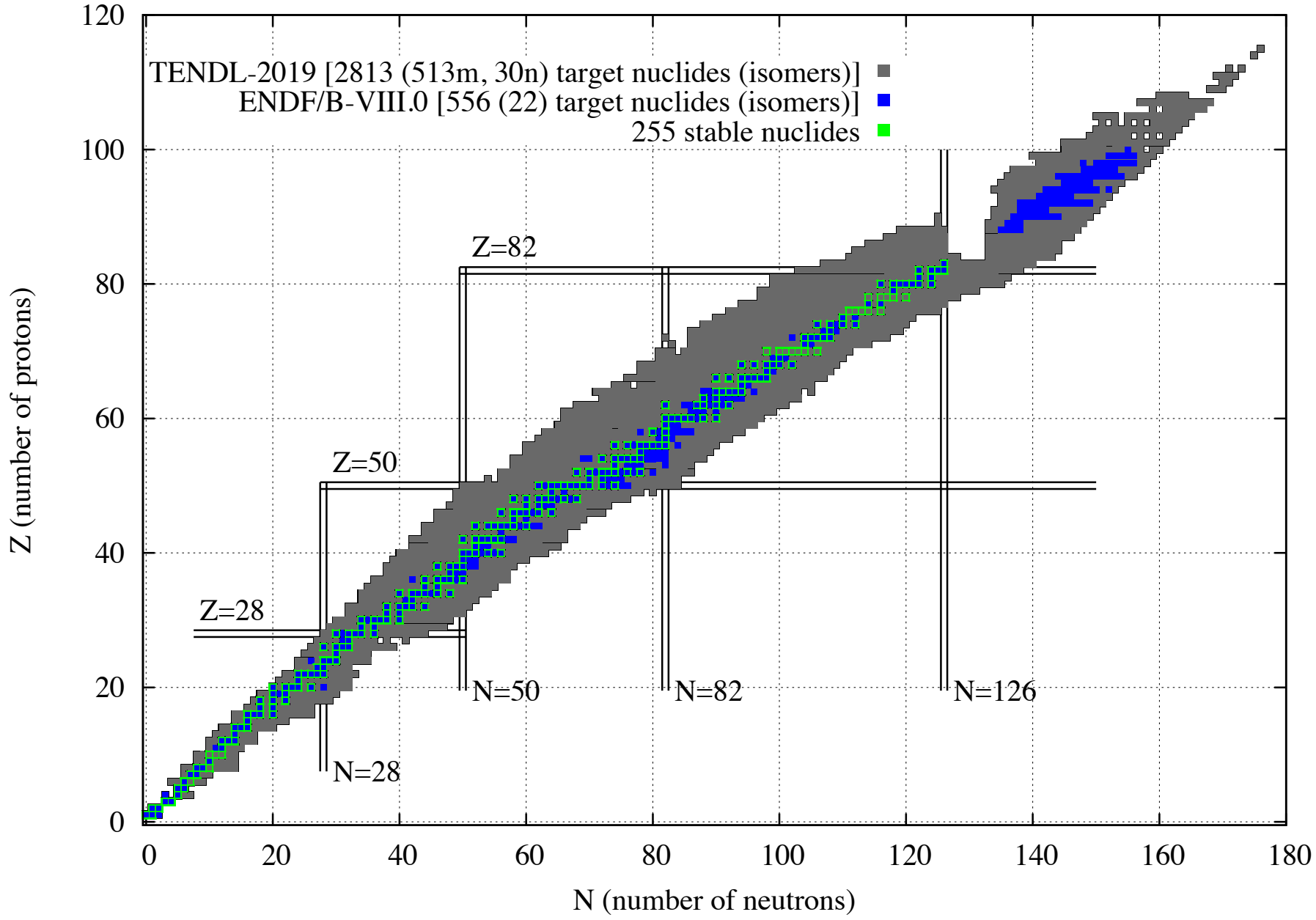
Nuclear landscape: Isotopic targets



TENDL-2019: (release date: December 31, 2019)

TALYS-based evaluated nuclear data library

Home | Reference & us | Citations | Feedback | TALYS

"We believe that our great goal can be achieved with systematism and reproducibility. We are so outside the box, that the box is a point"

How to reference

Sub-library files

1. Neutron
2. Proton
3. Deuteron
4. Triton
5. He3
6. Alpha
7. Gamma

Application libraries & tar files (ENDF, GND, ACE, PENDF...)

V&V

1. FISPACT-II reports
2. FISPACT-II validation
3. keff (S. van der Marck)
4. JANIS book

Random files

1. Random fission yields
2. Random thermal scattering
3. Random ENDF-6 files
4. Random ACE files

TENDL-2019: (release date: December 31, 2019)

Last update: 13 December 2019

TENDL is a nuclear data library which provides the output of the **TALYS** nuclear model code system for direct use in both basic physics and applications. The 10th version is **TENDL-2019**, which is based on both default and adjusted **TALYS** calculations and data from other sources (previous releases can be found here: 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, and 2017).

Up to 2014, TENDL was produced at NRG Petten. Since 2015, TENDL is mainly developped at PSI and the IAEA (Nuclear Data Section). Still, many people contributes to TENDL with the testing and processing of the files.

TENDL contains evaluations for seven types of incident particles, for all isotopes living longer than 1 second: Z=1 ^{1}H to Z=115 ^{291}Mc (about 2800 isotopes), up to 200 MeV, with covariances.

TENDL is not a default or shadow library. Not a single neutron evaluation is based on default calculations. With the HFR approach, all resonances follow statistical hypothesis. For major isotopes, greater care was used during the evaluation process.

All TENDL-2019 neutron files are original except 24. The 24 following files are taken from ENDF/B-VIII: ^{1,2,3}H, ^{3,4}He, ^{6,7}Li, ^{10,11}B, ^{7,9}Be, ^{12,13}C, ^{14,15}N, ^{16,17,18}O, ^{19}F, ^{232}Th, ^{233,235,238}U and ^{239}Pu.

A set of tools, called T6, was used to produce it. T6 stands for TALYS, TEFAL, TASMAN, TARES, TAFIS and TANES. Each code produces a part of the library. Processing tools such NJOY, CALENDF, PREPRO are also used in T6. These codes, and the processing steps are developed by A.J. Koning, D. Rochman and J.Ch. Sublet. Still, the help and feedback of the whole nuclear data, processing and user community is extremely useful. TENDL would not exist without the constructive remarks from all over the world.

α-, d-, p-, γ-, n-TENDL-2019 into GNDS

TENDL-2019 is distributed in many application forms: endf, pendf, ACE, HDF-5, 1102 groupwise with PT tables, elemental,…

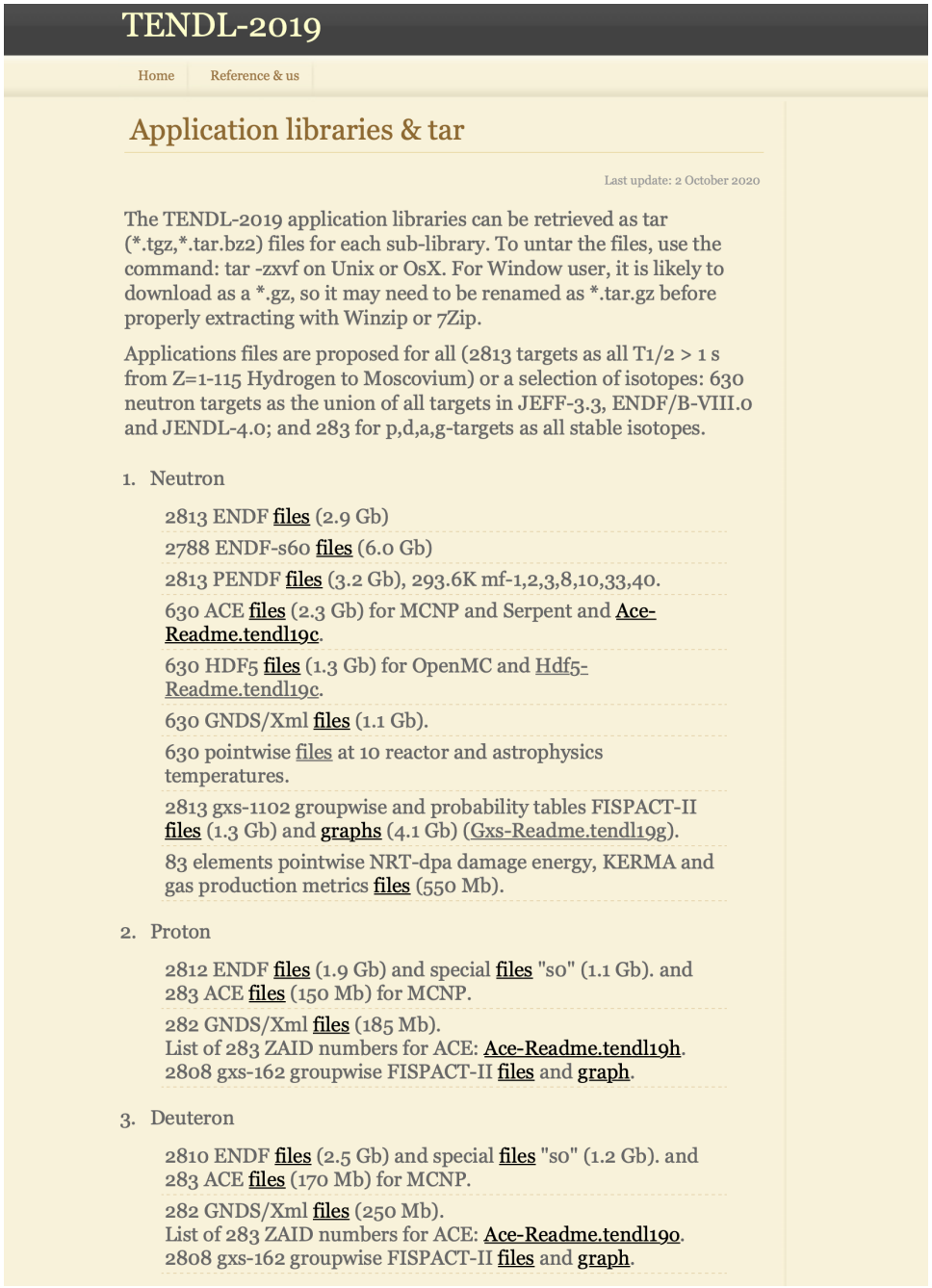
Now including GNDS/Xml for α-, d-, p-, γ- and n-induced

2813 targets in TENDL-2019 but

630 n-induced as the union of all targets existing in JEFF-3.3, ENDF/B-VIII.0 and JENDL-4.0

282 for p-,d-,α-,γ-targets as all stable isotopes

No need to flood the application forms landscape !!



TENDL-2019

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Application libraries & tar

Last update: 2 October 2020

The TENDL-2019 application libraries can be retrieved as tar (*.tgz,*.tar.bz2) files for each sub-library. To untar the files, use the command: tar -zxvf on Unix or OsX. For Window user, it is likely to download as a *.gz, so it may need to be renamed as *.tar.gz before properly extracting with Winzip or 7Zip.

Applications files are proposed for all (2813 targets as all T1/2 > 1 s from Z=1-115 Hydrogen to Moscovium) or a selection of isotopes: 630 neutron targets as the union of all targets in JEFF-3.3, ENDF/B-VIII.0 and JENDL-4.0; and 283 for p,d,a,g-targets as all stable isotopes.

1. Neutron
   - 2813 ENDF files (2.9 Gb)
   - 2788 ENDF-s60 files (6.0 Gb)
   - 2813 PENDF files (3.2 Gb), 293.6K mf-1,2,3,8,10,33,40.
   - 630 ACE files (2.3 Gb) for MCNP and Serpent and Ace-Readme.tendl19c.
   - 630 HDF5 files (1.3 Gb) for OpenMC and Hdf5-Readme.tendl19c.
   - 630 GNDS/Xml files (1.1 Gb).
   - 630 pointwise files at 10 reactor and astrophysics temperatures.
   - 2813 gxs-1102 groupwise and probability tables FISPACT-II files (1.3 Gb) and graphs (4.1 Gb) (Gxs-Readme.tendl19g).
   - 83 elements pointwise NRT-dpa damage energy, KERMA and gas production metrics files (550 Mb).
2. Proton
   - 2812 ENDF files (1.9 Gb) and special files "s0" (1.1 Gb). and 283 ACE files (150 Mb) for MCNP.
   - 282 GNDS/Xml files (185 Mb).
     List of 283 ZAID numbers for ACE: Ace-Readme.tendl19h.
     2808 gxs-162 groupwise FISPACT-II files and graph.
3. Deuteron
   - 2810 ENDF files (2.5 Gb) and special files "s0" (1.2 Gb). and 283 ACE files (170 Mb) for MCNP.
   - 282 GNDS/Xml files (250 Mb).
     List of 283 ZAID numbers for ACE: Ace-Readme.tendl19o.
     2808 gxs-162 groupwise FISPACT-II files and graph.

Tools and methods

- Automatic sequencing with FUDGE-rev4134

- Single line command embedded in a script

```
/opt/Code/fudge-rev4134/bin/rePrint.py  n-$isma[$c1].tendl -v >& output
     echo 'saving output, pendf files'
    mv test.endf6.orig.noLineNumbers  pendf/$isma[$c1]noL
    mv test.endf6.noLineNumbers pendf/$isma[$c1]org
    mv test.endf6-covar.xml gnds/$isma[$c1]-covar.xml          cov-var file
    mv test.endf6.xml gnds/$isma[$c1].xml                      gnds file
    mv output inout/out$isma[$c1]
```

- Verification done through endf6 re-engineering

Clear, comprehensible, output messages!!

2 [3, 4, 33, 34] : MF=4, LTT = 2
51 [3, 4, 12, 14, 33] : MF=4, LTT = 1 : MF=12 LO=2 : ZAP=0 : MF=14
52 [3, 4, 12, 14, 33] : MF=4, LTT = 1 : MF=12 LO=2 : ZAP=0 : MF=14
53 [3, 4, 12, 14, 33] : MF=4, LTT = 1 : MF=12 LO=2 : ZAP=0 : MF=14
54 [3, 4, 12, 14, 33] : MF=4, LTT = 1 : MF=12 LO=2 : ZAP=0 : MF=14
55 [3, 4, 12, 14] : MF=4, LTT = 1 : MF=12 LO=2 : ZAP=0 : MF=14
56 [3, 4, 12, 14] : MF=4, LTT = 1 : MF=12 LO=2 : ZAP=0 : MF=14
57 [3, 4, 12, 14] : MF=4, LTT = 1 : MF=12 LO=2 : ZAP=0 : MF=14
58 [3, 4, 12, 14] : MF=4, LTT = 1 : MF=12 LO=2 : ZAP=0 : MF=14
WARNING: sum of gamma BR's for MT=58 MF=12 is 0.999998999 != 1.0
WARNING: sum of gamma BR's for MT=58 MF=12 is 0.999998999 != 1.0
*****
5 [3, 6, 8] : MF=6 : ZAP=1, LAW=1, LANG=2 : ZAP=1001, LAW=1, LANG=2 : ZAP=1002, LAW=1, LANG=2 : ZAP=1003, LAW=1, LANG=2 : ZAP=2003, LAW=1, LANG=2 : ZAP=2004, LAW=1, LANG=2 : ZAP=3006, LAW=1, LANG=1 : ZAP=3007, LAW=1, LANG=1 : ZAP=3008, LAW=1, LANG=1 : ZAP=3009, LAW=1, LANG=1 : ZAP=3010, LAW=1, LANG=1 : ZAP=3011,
****
LAW=1, LANG=1 : ZAP=9021, LAW=1, LANG=1 : ZAP=9022, LAW=1, LANG=1 : ZAP=9023, LAW=1, LANG=1 : ZAP=9024, LAW=1, LANG=1 : ZAP=10016, LAW=1, LANG=1 : ZAP=10017, LAW=1, LANG=1 : ZAP=10018, LAW=1, LANG=1 : ZAP=10019, LAW=1, LANG=1 : ZAP=10020, LAW=1, LANG=1 : ZAP=10021, LAW=1, LANG=1 : ZAP=10022, LAW=1, LANG=1 : ZAP=10023, LAW=1, LANG=1 : ZAP=10024, LAW=1, LANG=1 : ZAP=10025, LAW=1, LANG=1 : ZAP=11018, LAW=1, LANG=1 : ZAP=11019, LAW=1, LANG=1 : ZAP=11020, LAW=1, LANG=1 : ZAP=11021, LAW=1, LANG=1 : ZAP=11022, LAW=1, LANG=1 : ZAP=11023, LAW=1, LANG=1 : ZAP=11024, LAW=1, LANG=1 : ZAP=11025, LAW=1, LANG=1 : ZAP=11026, LAW=1, LANG=1 : ZAP=12020, LAW=1, LANG=1 : ZAP=12021, LAW=1, LANG=1 : ZAP=12022, LAW=1, LANG=1 : ZAP=12023, LAW=1, LANG=1 : ZAP=12024, LAW=1, LANG=1 : ZAP=12025, LAW=1, LANG=1 : ZAP=12026, LAW=1, LANG=1 : ZAP=12027, LAW=1, LANG=1 : ZAP=13022, LAW=1, LANG=1 : ZAP=13023, LAW=1, LANG=1 : ZAP=13024, LAW=1, LANG=1 : ZAP=13024, LAW=1, LANG=1 : ZAP=13025, LAW=1, LANG=1 : ZAP=13026, LAW=1, LANG=1 : ZAP=13026, LAW=1, LANG=1 : ZAP=13027, LAW=1, LANG=1 : ZAP=13028, LAW=1, LANG=1 : ZAP=0, LAW=1, LANG=1
Reading resonances (MF=2 MT=151)
Reading covariances (MFs 33,34,40)
WARNING: MT59 MF12 level energy 4054599.0 differs from MF3 value 4054600.0. Setting to MF12 value.
WARNING: MT59 MF12 level energy 4054599.0 differs from MF3 value 4054600.0. Setting to MF12 value.
Reconstructing resonances
From 0.000010 to 845000.000000 eV, reconstructing using RMatrix (approximation Reich Moore)
8149 points were added (for total of 20084) to achieve tolerance of 0.1%

Findings and applied corrections: n- induced

outAm240:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outBk245:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outBk246:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outBk247:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outBk248:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outCf246:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outCf248:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outCf253:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outCm240:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outCm244:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outCm247:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outNp234:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outNp235:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outPa229:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outPa230:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outPu237:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outPu238:MF1 MT455 claims 6 delayed neutron groups, but MF5 MT455 claims 8 groups
outPu246:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outRa223:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outRa224:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outRa225:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outRa226:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups
outTh231:MF1 MT455 claims 1 delayed neutron groups, but MF5 MT455 claims 6 groups

inout/outBe007: WARNING: MF=4 data for non-neutron product: MTs = [600, 601, 650, 800]
inout/outO016: WARNING: MF=4 data for non-neutron product: MTs = [600, 601, 602, 603, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 800, 801, 802, 803]
inout/outTh232: WARNING: MF=4 data for non-neutron product: MTs = [600, 800]
inout/outU235: WARNING: MF=4 data for non-neutron product: MTs = [800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835]
inout/outU238: WARNING: MF=4 data for non-neutron product: MTs = [800]

But then the 5 above targets are ENDF/B-VIII.0 originals

Findings and applied corrections: n- induced

outAg106m: WARNING: MF8 residual level energy = 0.0 for level 1 of ZA = 47106 not close to MF9's value = 89659.7 for MT = 4
outAg107: WARNING: MF8 residual level energy = 0.0 for level 0 of ZA = 47107 not close to MF10's value = 93125.0 for MT = 4
outAg108: WARNING: MF8 residual level energy = 0.0 for level 0 of ZA = 47108 not close to MF10's value = 79140.0 for MT = 4
outAg109: WARNING: MF8 residual level energy = 0.0 for level 0 of ZA = 47109 not close to MF10's value = 88034.0 for MT = 4
outAg110: WARNING: MF8 residual level energy = 0.0 for level 0 of ZA = 47110 not close to MF10's value = 1112.0 for MT = 4
outAg110m: WARNING: MF8 residual level energy = 0.0 for level 2 of ZA = 47110 not close to MF9's value = 117590.0 for MT = 4

for all of the metastable targets, the problem was with the QI value in MF=9 for inelastic scattering back to the ground state. The files originally had QI = 0, but since the final product is in the ground state QI should equal QM.

```
sed -e 's/0.000000+0-2.283050+5      13026         0         1/0.000000+0 0.000000+0      13026         0         1/g'  n-Al026.tendl > n-Al026.tendl.new
```

```
sed -e 's/ 0.000000+0-2.283050+5      13026         0         0         1132240  4    2/ 0.000000+0 0.000000+0      13026         0         0         1132240  4    2/g'  n-Al026.tendl.new > n-Al026.tendl
```

inout/outBi210: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outCa041: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outCe144: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outNi056: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outNi057: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outNi059: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outPb204: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outPo210: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outTi044: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!
inout/outZn064: WARNING: MT107 lumped sum covariance is present, but no reactions are included in the sum!

Findings and applied corrections: n- induced

- In all 173 + 38 (over 630) original n-TENDL-2019 files format corrected prior to translation into GNDS
- Mainly, but not only due to metastable as target data forms
- Findings passed to next version of TEFAL
- Results for Fe056

-rw-r--r-- 10474783 Jun 18 08:27 gnds/Fe056.xml
-rw-r--r-- 296669 Jun 18 08:27 gnds/Fe056-covar.xml

- GNDS forms demonstrate a feature that occurs in application forms: separate but consistant files

The temperature dependent forms are suplied at 10 temperatures, whilst the temperature independent form are supplied only once. The data for all 630 evaliations are included in each of the 11 compressed tarball and individually. Each of the compressed file are between 100-500 Mbytes, they must be uncompressed. To use complete evaluations, at any given temperature one must fisrt combine the two parts: temperature dependent and temperature independant using the PREPRO/MERGER code.

Reactors physics temperatures

#	List	Download
1	0° Kelvin	tarball:369Mb
2	293.6° Kelvin	tarball:317Mb
3	600° Kelvin	tarball:290Mb
4	900° Kelvin	tarball:275Mb
5	1200° Kelvin	tarball:264Mb

Astrophysics temperatures

#	List	Download
1	1 eV	tarball:101Mb
2	1 KeV	tarball:223Mb
3	5 keV	tarball:240Mb
4	30 keV	tarball:256Mb
5	80 keV	tarball:263Mb

Temperatures independant

#	List	Download
1	MFOther	tarball:542Mb

α-, d- p-, γ- induced

- 283 or 282 ? Ta180m, 0.012% and 7.1e15 a
- Some exception

inout/outB011:Exception: data not in ascending order at index 4 and 5

- Fixes

diff orig-gnd/g-C012.tendl fixed-gnd/g-C012.tendl

< 1.812858+6 4.680047-8 0.000000+0-2.721512+6 0.000000+0 0.000000+0 625 6 5 1958

> 1.812858+6 4.680047-8 0.000000+0 2.721512+6 0.000000+0 0.000000+0 625 6 5 1958

- Warning MF8 for p-, d-, a- induced

outAg107: residual level energy = 0.0 for level 0 of ZA = 47107 not close to MF10's value = 93125.0 for MT = 103

outAg107: residual level energy = 0.0 for level 0 of ZA = 47107 not close to MF10's value = 93125.0 for MT = 104

outAg107: residual level energy = 0.0 for level 0 of ZA = 47107 not close to MF10's value = 93125.0 for MT = 107

α-, d- p-, γ- induced

- Warning MF=8

outU235: residual level energy = 0.0 for level 0 of ZA = 92235 not close to MF10's value = 77.0 for MT = 107

Inconsistency for the U235m ELFS in TALYS

Recurrent ENDF-6 issue: ELFS, isomer numeric 1,2,3 or m, n, o across the mf's plane

- γ-induced: 7 files corrected
- α- induced: 50 files corrected
- p-induced: 47 files corrected
- d-induced: 48 files corrected

- All files available at https://tendl.web.psi.ch/tendl_2019/tar.html

GNDS

- It is worth noting that ENDF-6 to GNDS form translation still reveals ENDF-6 errata
  - Some glitches stems from the fact that ENDF-6 forms are not consistant across the mf's plane
  - Some glitches have not been picked up by the legacy checker codes: fizcon, psyche, checkr !!
  - They will induce differences in application forms
- It is worth remembering that the TENDL-2019 forms chosen to be translated were the explicit s30 ones
- Now a days we see a need for endf6-to-gnds translation however TAGNDS is the way ahead as it opens more data forms
- FUDGE is a multi-task, multi-step amazing tool

Thank you for your attention!

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