Open Source Release of NJOY2016 and NJOY21

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Introduction

NJOY is the standard for nuclear data processing

- Planned as successor to MINX
  Multigroup **I**nterpretation of **N**uclear **X**-Sections

- First publicly released in 1977
  - Radiation Shielding Information Center (RSIC)
  - National Energy Software Center (NESC)
- 10 major releases since 1977
  - Radiation Safety Information Computational Center (RSICC)
- NJOY2012—Feynman Center at Los Alamos National Laboratory

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NJOY2016

Open Source license (3-clause BSD)

Hosted on `GitHub.com`

No export control restrictions

What's New in NJOY2016

- Increase fixed array sizes to accommodate modern data files
- Additional array allocation and array bounds checking
- More robust checking for error conditions and additional error messages
- Relaxed use of internal `sigfig` routine to preserve greater numerical precision

Changes to Doppler Broadening Energy Limits

NJOY2012 picks an upper energy for Doppler broadening as the minimum of:

1. the thnmax value given on card 3 of the BROADR input;
2. the top of the resolve resonance range (E_{max});
3. the lowest threshold reaction; or
4. 1.0 MeV.

	ENDF/B-VII.1	ENDF/B-VIII.0
E_{max} RRR	20 keV	20 keV
Lowest Threshold	40 keV	0.1 keV

In NJOY2016 (and NJOY2012.75+), the entire resolved resonance range is Doppler broadened.

Doppler Broadening Change Consequences

Big-10 critical assembly (ICSBEP: IEU-MET-FAST-007)

- Start with ENDF/B-VII.1-based ACE files
- Replace only ^{238}U
  - One processed with NJOY2012
  - One processed with NJOY2016

	NJOY2012 VII.1	NJOY2012 VIII.0	NJOY2016 VIII.0	Δ_k
Big10 k_{eff}	1.00432 (33)	1.01269 (37)	1.00599 (36)	472 pcm

NJOY21

NJOY for the 21$^{\text{st}}$ Century

Ground-up rewrite of NJOY

NJOY21—NJOY for the 21st Century

- Major update—complete rewrite—of NJOY code base
- Open Source license (3-clause BSD)
  No export control restrictions
- Hosted at github.com/njoy/NJOY21
- Goals:
  1. Maintaining NJOY's image of a trusted/stable processing code;
  2. Easier to:
     - build,
     - verify and validate,
     - interact with, and
     - process nuclear data files.
  3. Flexible; and
  4. Maintainable.

NJOY21 Modularity

- NJOY21 broken into several projects, including:
  - ENDFtk—toolkit for interacting with ENDF files
  - ACEtk—toolkit for interacting with ACE files
  - DimensionalAnalysis—compile time dimensional analysis and unit awareness
  - . . .
- NJOY21 projects can be used independently
- Python interface to NJOY functionality

NJOY21 Features

Backwards Compatibility

- NJOY2016 input decks will work in NJOY21
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- All input variables are checked before processing
- Error messages point directly to invalid input parameter

V&V

- Code tested as created travis-ci.org/njoy
- $>90\%$ test code coverage coveralls.io/github/njoy

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Many other features are coming.

Getting NJOY

Downloading Code

```
# Download the source code
git clone \
  https://github.com/njoy/NJOY21.git
# Configure the build process
cd NJOY21
mkdir bin
cd bin
cmake ../
# Build NJOY21
make
# Test NJOY21
make test
```

Updating Code

```
# Get updates from source
git pull origin
# Build code with updates
cd bin
cmake ../
make
make test
```

Open Source Collaboration

- NJOY has benefited from many external collaborators
- Hosting NJOY on github.com/njoy facilities this process
  - Issues to track requested improvements
  - Pull requests to incorporate external contributions
  - Conversations kept on GitHub for historical record
- Hosting NJOY on github.com/njoy improves response time to feature requests/bug reports.

How to Contribute

Issues

- Feature requests
- Bugs

Contributions

- Bug fixes
- New Implementations

- All contributions are handled via GitHub
- Issues resolved this Spring:
  - "Segmentation fault - invalid memory reference" in acer
  - NaN's at "random" in gfortran builds
- Recent pull requests from external collaborators
  - Fix Bug in PURR related to heating values
    by Dr. Paul Romano at Argonne National Laboratory
  - Changes to run ENDF/B-VIII.beta4 LEAPR inputs
    by Dr. José Ignacio Márquez Damián at Centro Atómico Bariloche (Argentina)

Conclusion

https://njoy.lanl.gov
https://github.com/njoy

- Open Source release of NJOY2016 and NJOY21
- No export control restrictions
- Builds on four decades of nuclear data processing expertise at Los Alamos National Laboratory
- Open Source license/availability is:
  - improving response time to bug fixes
  - facilitating external collaboration
- The future of NJOY is bright