

Status of ENDF/B Delayed Neutron Data

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DN Observations

ENDF/B-VI DN precursor data

Delayed neutron (DN) data were developed largely by Tal England and Mikey C.Brady in the late 1980's.

This was the first effort in describing DN properties using basic nuclear data for the individual precursors. Brady, a student from Texas A&M, focused on DN spectra.

Bob Schenter and Fred Mann of HEDL made significant contributions with their collections of Pn data and with the BETA code, used by Brady to model the spectra for most of the 270-271 precursors then identified.

Karl-Ludwig Kratz, U Mainz, contributed his preliminary results of spectral measurements ---- most requiring low-energy extensions by Brady.

ENDF/B-VI DN precursor data

Other measured spectra were contributed by G. Rudstam.

P_n and H-L values for precursors without measured values were taken mainly from Kratz-Herman systematics.

ENDF/B-VI aggregate fission-system data

Aggregate results were calculated with the CINDER-10 code, using a library including these P_n , H-L, and spectral data with other H-L, branching, and F-P yield data of pre-ENDF/B-VI vintage.

Note that the DN, decay, and F-P yield data activities leading up to the ~1989 release of ENDF/B-VI were not mutually consistent.

Calculated aggregate DN results showed good agreement with accepted $\bar{\nu}_d$ values and with aggregate measured DN spectra.

Temporal DN production rates to 300 s following pulse fission were fit with the common six-group representation --- greater numbers of exponentials were also fit but showed no particular advantage.

The point-reactor kinetics code AIREK-3 was modified (AIREK-10, Perry & Wilson, '85) to follow the temporal DN emission rates of the 271 precursors (plus ~100 additional "precursors"), as well as common six (or more)-group functions and used to show that good results were obtained with the few-group representations relative to 271-precursor results.

Following release of ENDF/B-VI data, applications work with six-group functions showed disappointing results in, for example, reactivity calculations. Earlier ENDF/B releases had used six-group functions from fits to a selected measurement.

Joann Campbell and Greg Spriggs of LANL X-5 produced several reports, one or more offering new 8-group fits with a common set of decay constants. Each fit was made to earlier six (or other)-group fits to various measurements.

A working group in NEA-OECD was established to investigate the status of DN data. Their report identifies, for many fission systems, a single measurement as representative of the system and recommends the Campbell-Spriggs 8-group fixed- λ fit to that measurement.

Arjan Konig, now king of JEF, said in Santa Fe that all of Europe was changing to an 8-group representation.

Present progress

of Kratz & Pfeiffer, Audi '97, and Audi '03. Pn and H-L data for nuclides not having measured values have been taken from the evolving versions of Pfeiffer, Katz and Moller's QRPA model --- the latest identified as treating first-forbidden transitions.

Six-group fits are now made to a surface tracing DN production rates following Unit fission rate for seven irradiations of 0.1ms to 4 h, with decay times to 800 s. Fits to pulse do not well represent the long cooling times for extended irradiation; Fits to long irradiations do not well represent short cooling times following pulse. The fit to a surface force adequate representation at all times -- - rms deviation < 1% and max deviation typically < 1%.

Universal improvement has been achieved using the '94 yields in the CINDER'90 code for aggregate results. This code's library also uses updated H-L and decay branchings for nuclides other than DN precursors, but the case for yields is all but complete. Incremental but significant improvements have been observed with the sequential updating of Pn and H-L data from refinements in measured and modeled Pn and H-L data.

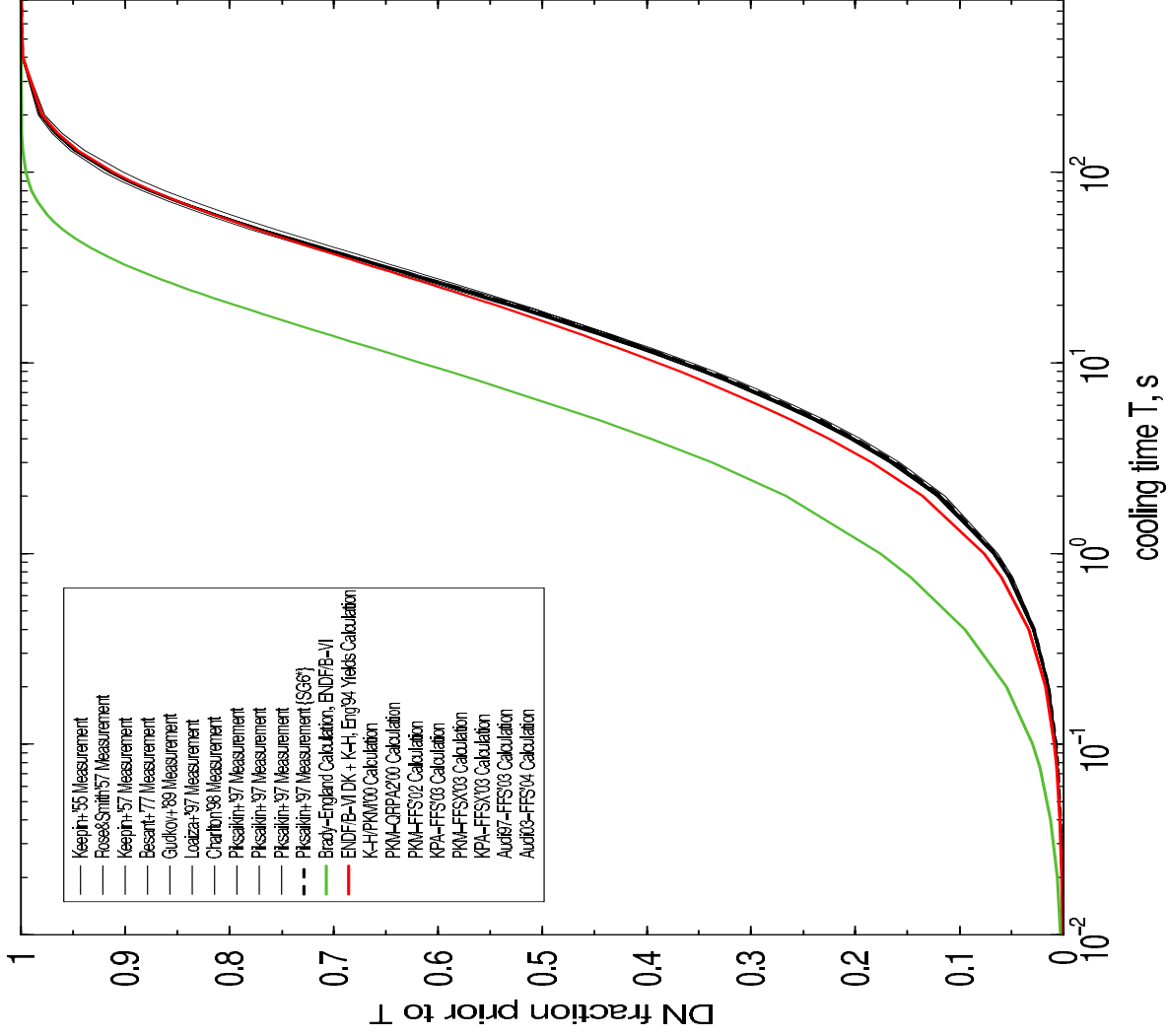
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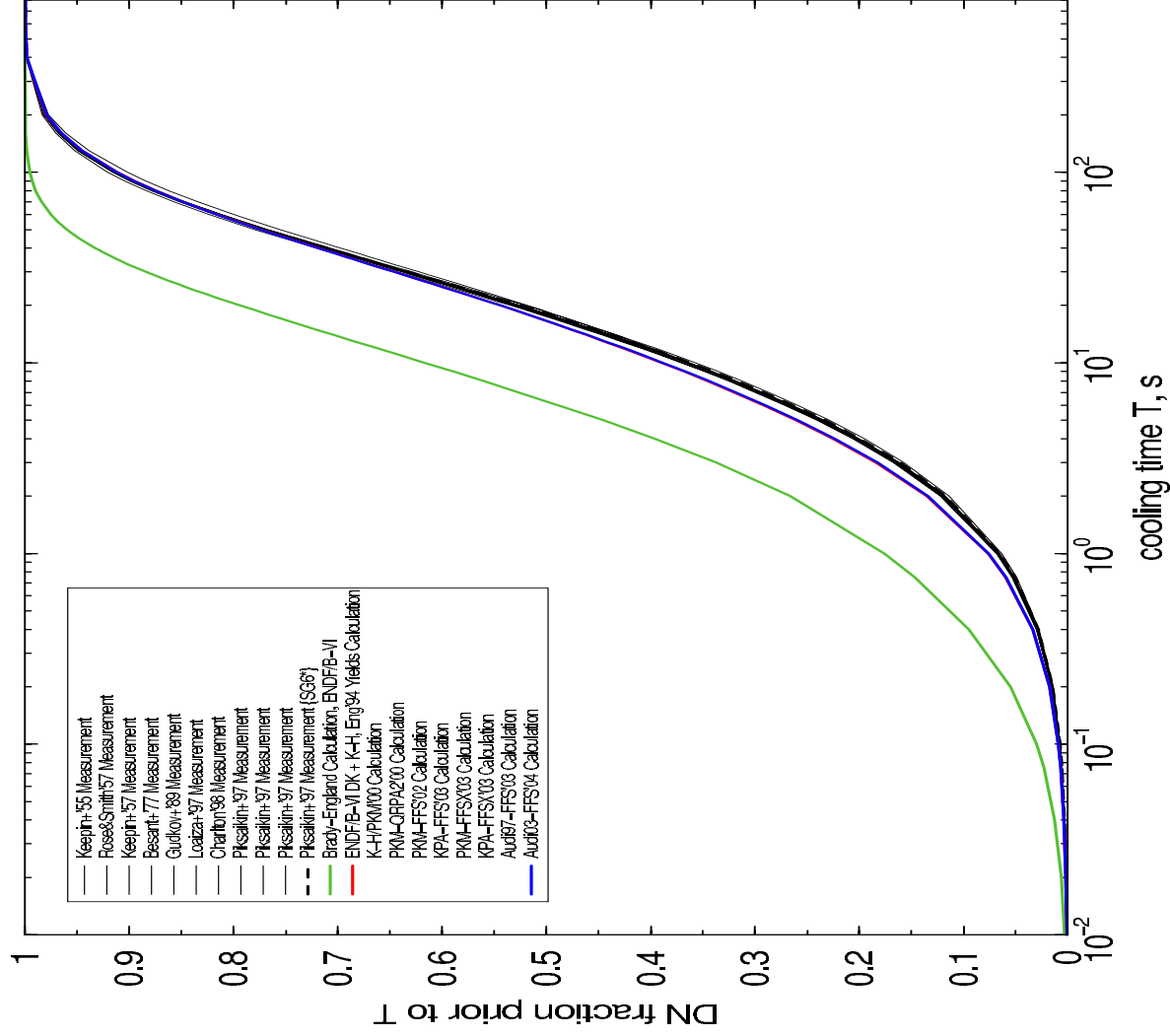
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DN fraction emitted prior to cooling time T following U235 fast fission pulse



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Present progress

Pre-ENDF/B-VII Pu and U evaluations have used '03 fit results with the '89 six-group spectra --- inconsistent λ s but an adequate place holder for the data. ANL testing has shown unimproved β_{eff} , but not surprising.

Future plans:

The number of precursors has grown to more than 400. Spectral data are needed for all. The BETA code appears to be lost --- Brady, Mann, Schener, nor Tal's files hav produce the code and library. New spectral calculations from Moller's beta decay model are most promising. Results are in hand for his '02 code version and will be applied soon. Revisions for his FFS version are Planned for FY05. Brady's allocation method for nuclide data to the six groups will likely be followed.