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Title: (U) CIELO: Status of 239Pu Evaluation

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CIELO: Status of 239Pu Evaluation

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LANL

^{239}Pu : Some Particular Challenges

- Build on the excellent WPEC subgroup 34 work from CEA & ORNL
- Capture discrepancies. *We're waiting for new DANCE data*
- New PFNS results coming (IAEA CRP etc), Chi-nu
- Inelastic scattering discrepancies between evaluations
- Use of new IAEA Standards, including fission (TPC)
- Other new data that will impact the evaluation – new PFGS data from DANCE; New FPY data from TUNL (impact esp at 14 MeV)

Starter File Using ENDF/B-VII.1+ WPEC Sg34 Work

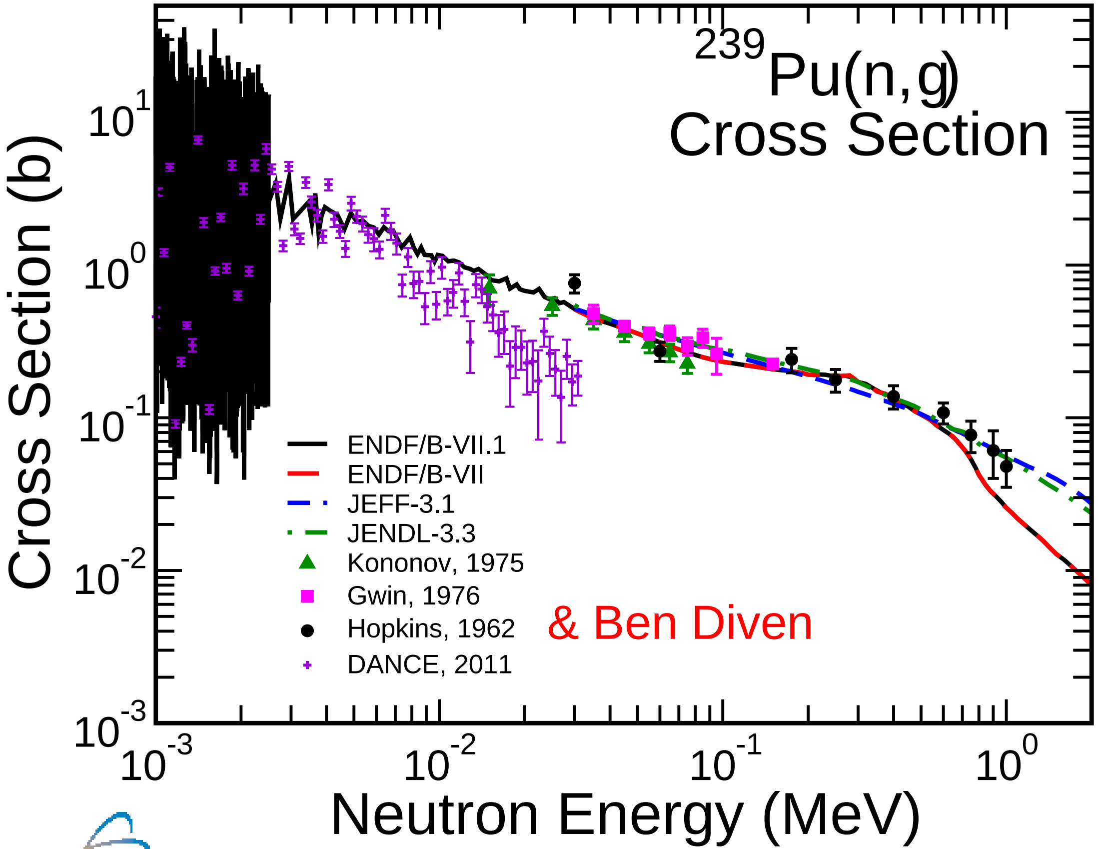
Kawano has made a new starter file, for testing the impact of SG34 in the RR region:

Vii.1 but with:
- sg34 resonances up to 2.5 keV
- file 3 fix for mt18 to zero out cross secs
- jeff3.2 eq jeff3.1.2 (?) Latest nubar up to 650 eV say
- vii.1 chi still

Date Testing Results from Kahler…

Plutonium Capture: Improvements Are Needed

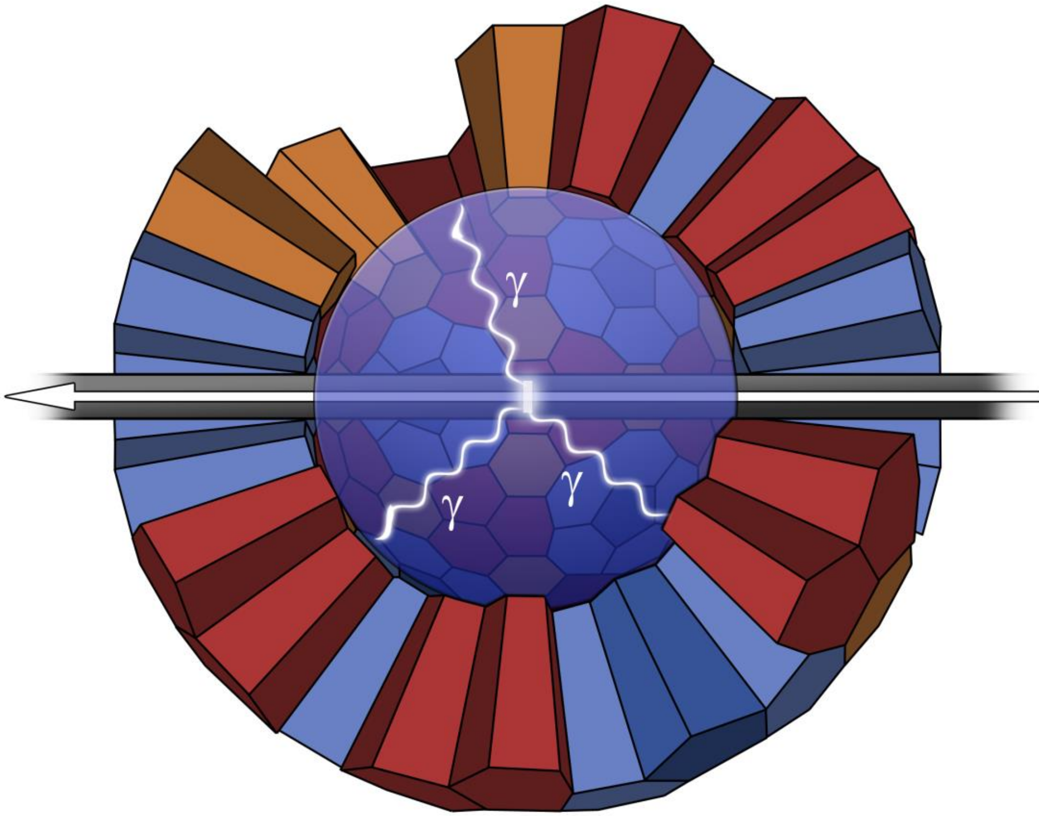
Existing uncertainties >15%



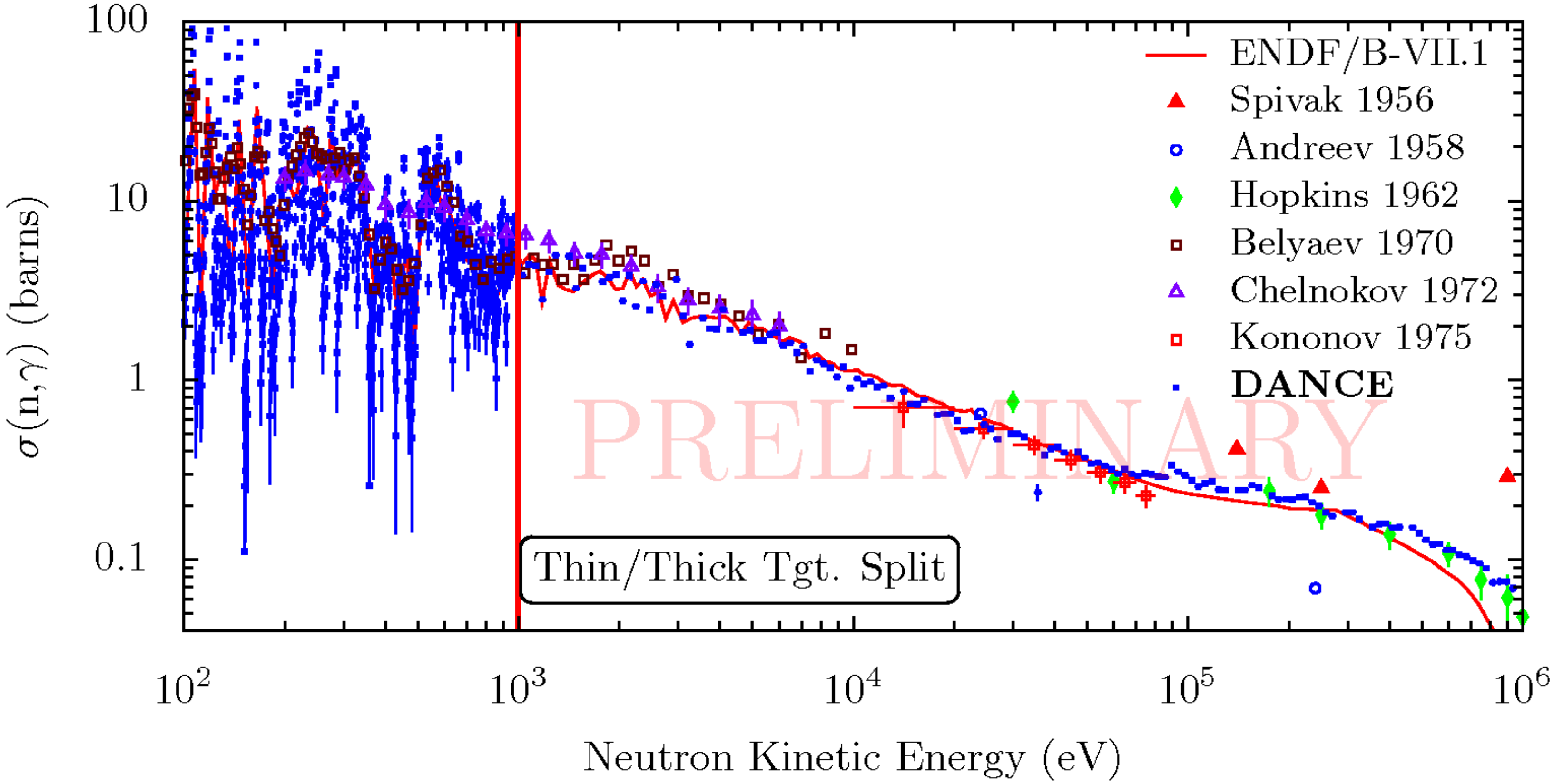
- SG33 & PROFIL (PHENIX) 239Pu(n,g) integral testing suggests B-VII is ~ 10% low over this fast reactor spectrum. Also, Ishikawa's ADJ work suggests JENDL should be raised 5-10%
- DANCE measurements now being analyzed

New Data – Capture Experiments with DANCE (Shea Mosby, Marian Jandel, et al.)

- **160 detector crystals**
- **Digital acquisition system**
- **85% efficient**
- **Radioactive/rare targets**
  - 5 ug target run this year
- **Sophisticated Analysis**
  - Energy / multiplicity
  - Unique Q-value for capture
  - Ratio-to-fission method like M. Jandel PRL 2012



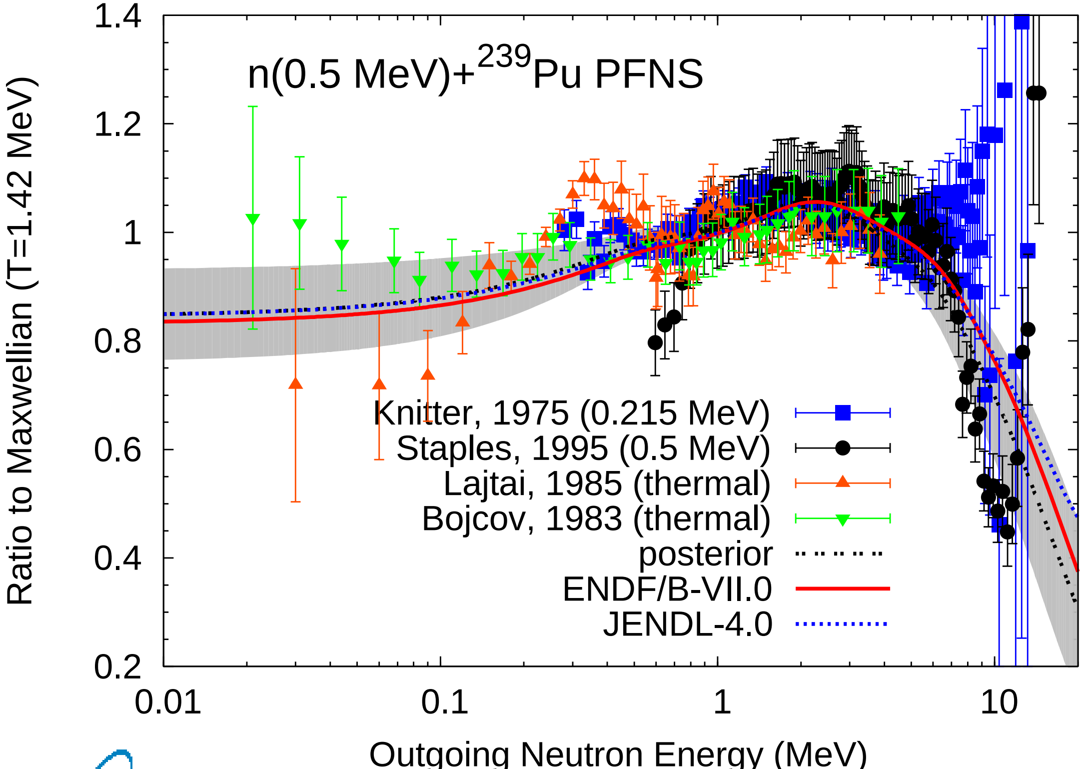
Preliminary Results for ^{239}Pu



- **Backgrounds still being investigated**
- **Expect 4% uncertainty at 10 keV similar to Jandel work on U5**

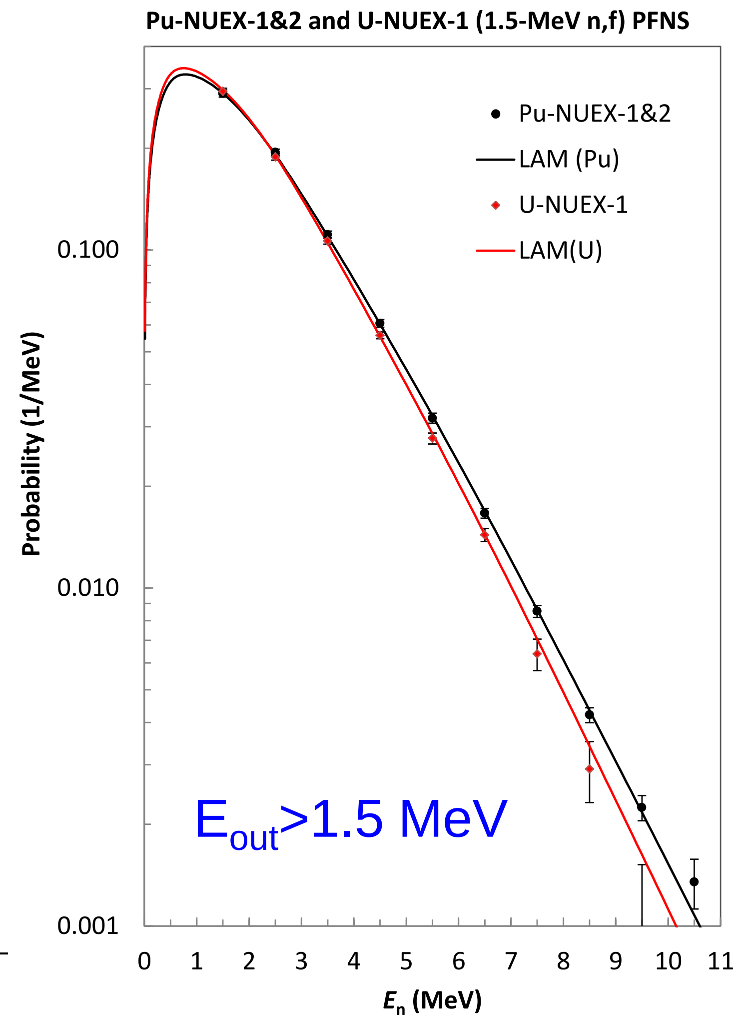
Determining the Prompt Fission Neutron Spectrum (Chi): One of Our Highest Priorities & an IAEA CRP

Large uncertainties below 1 MeV and above 5 MeV impact criticality calculations and (n,2n) transmutations

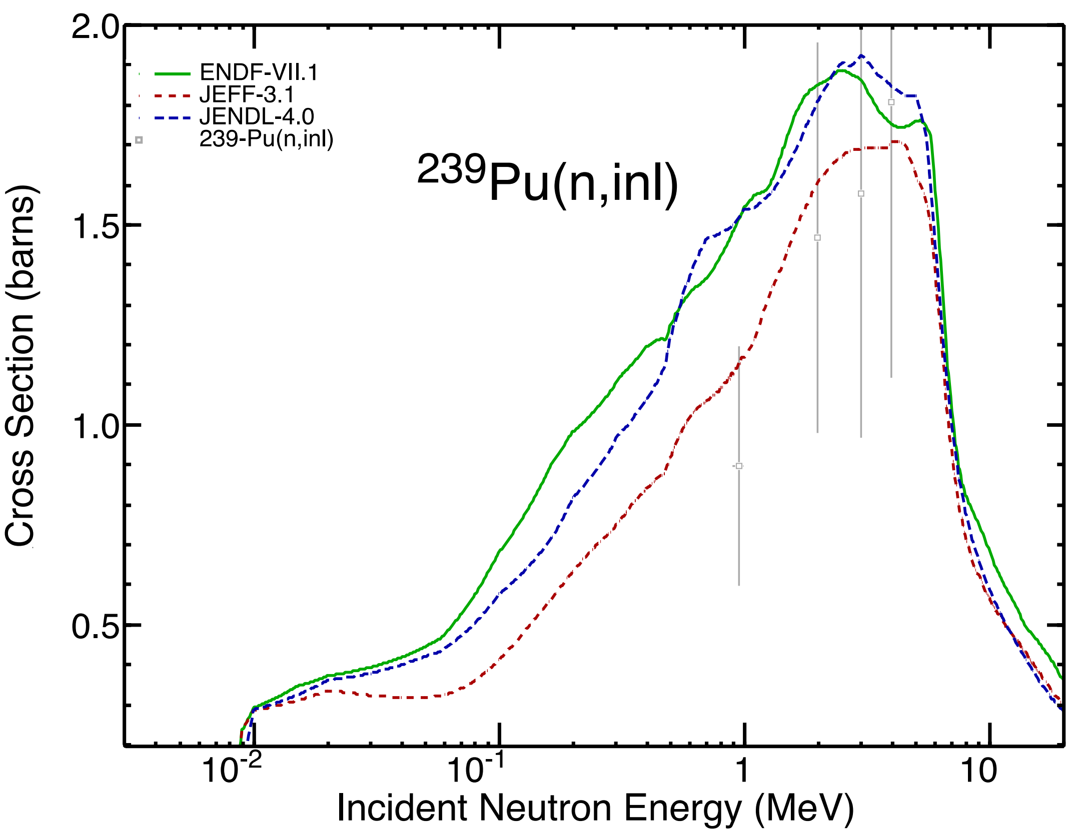


Talou, Vogt

Lestone's talk: ***accurate*** underground NUEX data released by Los Alamos:



Major Advance (4): Actinide Elastic & Inelastic Scattering: Large Discrepancies are Starting to be Resolved



Insights from advanced coupled-channel scattering theory needed

^{238}U: Improvements have been accomplished by Capote, Trkov, using Danon's new RPI data

Dietrich, Thompson & Kawano determined that convergence of CC solutions is slow

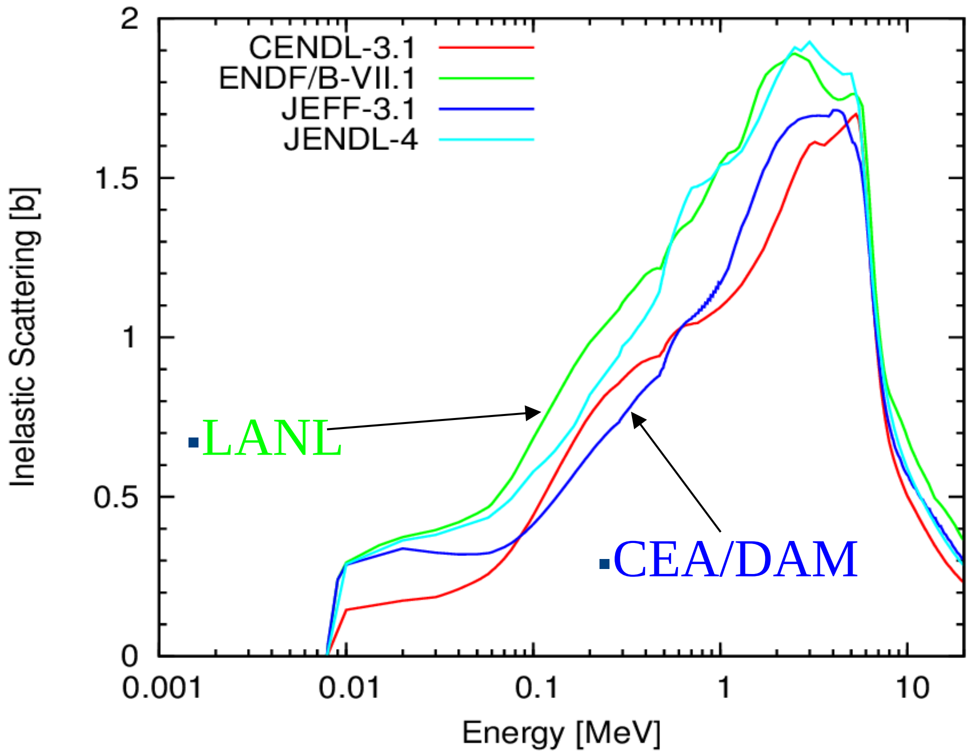
Iwamoto, Romain, & Kawano have all made notable advances

Inelastic Scattering Discrepancy

- **IAEA Technical Meeting on Model Calculation for Major Actinides**
  - Summary report published: INDC(NDS)-0597, R. Capote, et al.

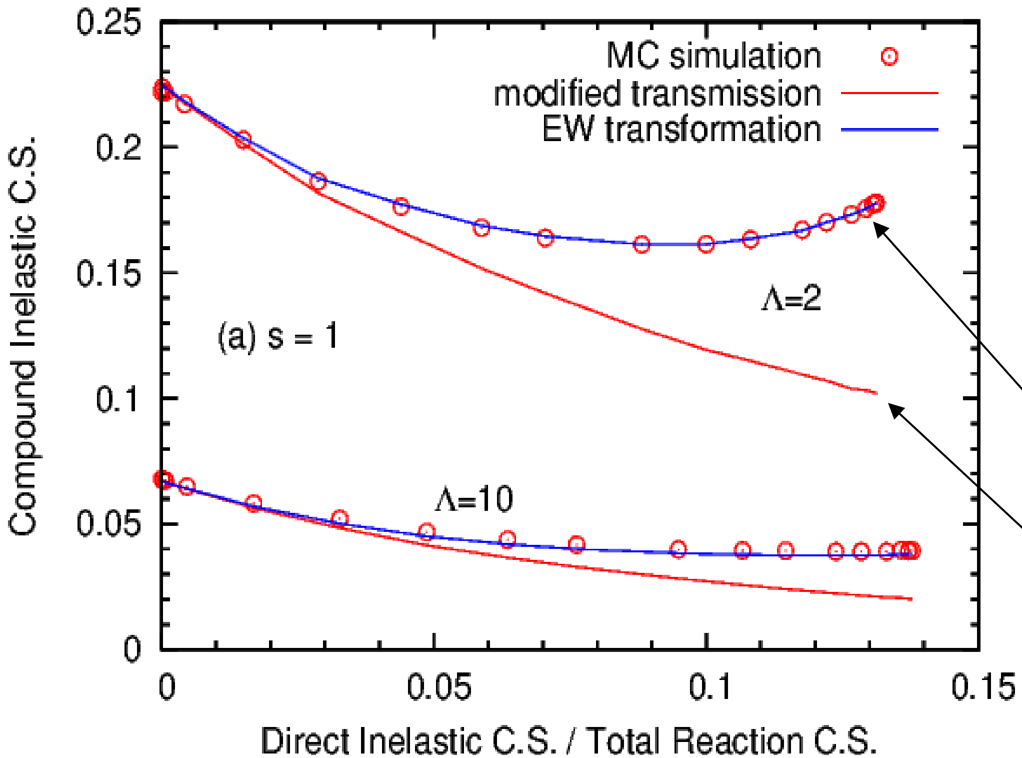
- These two files equally work for Jezebel keff prediction.

- Probably, the difference in the inelastic scattering comes from the optical potential parameters adopted in each library
  - CEA total cross section is higher than ENDF in the 30keV - 500keV range
  - total and absorption cross sections anti-correlated



Compound Inelastic Scattering When Direct Reaction Exists (Kawano et al.)

- **Direct reactions in the Hauser-Feshbach codes are treated in rather approximated way**
  - Calculated inelastic scattering cross sections by all the Hauser-Feshbach codes, like
  - wrong!



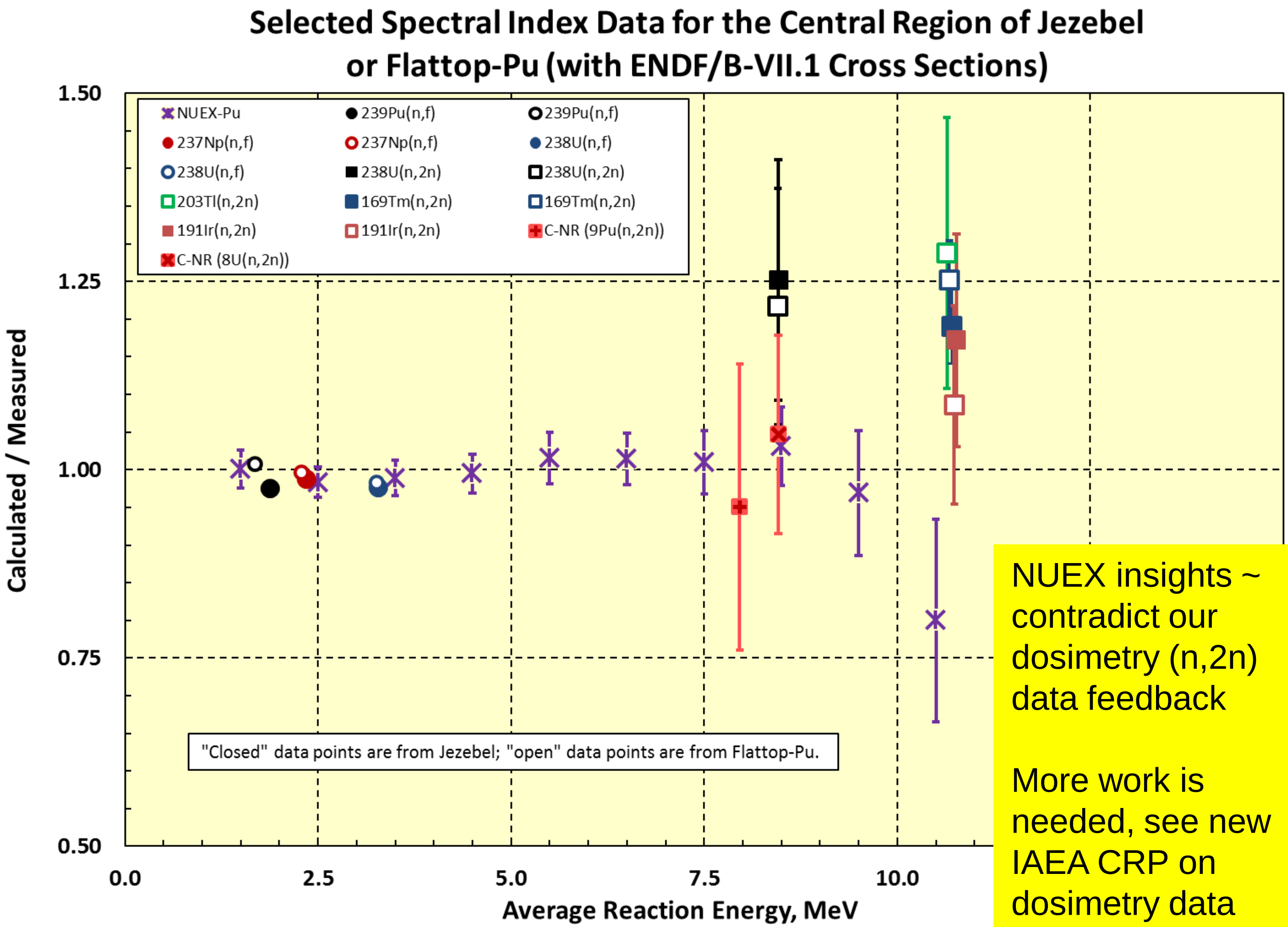
- **Recent development by applying the Gaussian-Orthogonal Ensemble (GOE) at LANL demonstrates a significant under estimation of inelastic scattering, when strongly coupled channels exist**
  - A typical case is U-238(n,n') in the fast energy range

- exact calculation
- approximation in H-F codes

Reaction Rates in Fast Critical Assemblies Provide Integral Test of Prompt Fission Neutron Spectrum & (n,2n) Cross Sections *- Plutonium-239 PFNS Data*

239Pu

With NUEX data added (Lestone)



NUEX insights ~ contradict our dosimetry (n,2n) data feedback

More work is needed, see new IAEA CRP on dosimetry data validation

Backup: In Case You Didn't Think We Have Lots of Work ……

CIELO: Summary of tasks to address:

Actinides: 239Pu, 235U, and 238U - specific issues for each nuclide are noted

Fast Region (keVs and above to 20 MeV) - fission listed separately

Review Overall Goals, as embodied in this document and in LAUR CIELO document

Inelastic and elastic scattering - below a few MeV (eg 7)

- Review existing discrepancies between evaluations
- Collect all available experimental data
- Review various theoretical approaches, as embodied in codes (including HF, Coupled Channels, KKM, ...)
- Discuss and review optical model options
- 238U: dispersive coupled-channels OM developed at IAEA
- Seek consensus on best evaluated reprentation of data
- 238U: 238U Elastic and inelastic scattering data from RPI. Quasi differential available (mainly inelastic) from RPI from from 0.5 MeV up to 20 MeV. - EN
- 235U: New (n,xng) data to be published in PRC by Kerveno et al. (IPHC, Strasbourg (F)) could be useful to model inelastic scattering on first levels, see
- Understand implications from integral data testing on changes in inelastic scattering - especially k-eff and reaction rates (spectral indices for 85/5f etc)
- Assess covariances and implement in ENDF format
- Create ENDF formatted files

Inelastic and elastic scattering - 7-20 MeV

- Review existing discrepancies between evaluations, data, and models (including preequilibrium)
- Collect all available experimental data - including Kammerdiener's data and Baba's (U8) data
- Review various theoretical approaches, as embodied in codes (including preeq, HF, Coupled Channels, KKM, PFNS background, ...)
- Discuss and review optical model options
- Seek consensus on best evaluated reprentation of data - including possible continued use of pseudostates
- Understand implications from integral data testing on changes in inelastic scattering -especially 14 MeV pulsed spheres/transmission data
- Assess covariances and implement in ENDF format
- Create ENDF formatted files

Neutron Capture

- 239Pu: Review discrepancies between evaluations, which exceed 10% at the higher energies
- 235U: Review discrepancies between evaluations, which exceed 25% near 1 KeV (Japan'shigher result) and 10% at the higher energies
- 238U: Consider adopting 238U capture from standards - ENDF/B-VII used this, but with some small differences. Study implications from data testing of
- 238U: Monitor Standards results for any changes, based on new measurements from DANCE, nTOF, Geel
- 239Pu: Review data (very few measurements, especially above 100 keV there is just the LANL Hopkins data); See if DANCE data is available in time
- 235U: Review new DANCE data and RPI data, that appear to corroborate JENDL changes near 1 keV, but point to higher energy changes too
- Review guidance from integral PROFIL data (suggests PU9 and (maybe) U5 from ENDF should be higher), and Wallner AMS data at 25 keV and 420 keV
- Assess model calculations predictions (consisent with above inelastic scattering HF/CC/OM calculations)
- Seek consensus on best evaluated reprentation of data
- Understand implications from integral data testing on changes in capture - especially k-eff and reaction rates (spectral indices for 85/5f etc)
- Assess covariances and implement in ENDF format
- Create ENDF formatted files

n2n

- Discuss data, including discrepancies in rise from threshold, and differences near 14 MeV
- Review existing evaluations (including "GEANIE evaluation" for 239Pu), data , and calculation predictions
- 235U: New (n,xng) data to be published in PRC by Kerveno et al. (IPHC, Strasbourg (F)) could be useful to model n2n scattering, see prelim results in I
- 239Pu: Carefully note insights on n2n making 238Pu from LANL, and discuss contradictory feedback from PROFIL
- Validate any changes against n,2n reaction rates in critical assemblies, eg Fig 57 in NDS112,(2012) ENDF
- Create ENDF file and covariances

Fission (all energies), cross sections, nubar and spectra for n,g

Review Overall Goals, as embodied in this document and in LAUR CIELO document	
Fission Cross Section	
	Seek consensus that we adopt the fission cross section standard from the IAEA group
	Assess implications of adopting standard fission cross section on integral testing
	If IAEA standards team updates their value, use it; this would include any recent/forthcoming fission measurements, eg nTOF, RPI, TPC
	Modeling of fission would occur as part of the above inelastic/capture/n2n activities, but seek consensus that we do not use calculations in th
	238U:Subthreshold fission for 238U – discrepacies between different evaluations. Lead spectrometer measurements near 70 keV suggest a p
prompt nubar	
	Review existing evaluations and experimental data, & review various theoretical approaches; 238U low energy interp fix needed in ENDF
	Seek to use an "unadjusted" nbar in a final evaluation, avoiding the ENDF "tweal" near an MeV that was adopted to better match Jezebel, Go
	Study Koning-Rochman nubar near thermal, from their optimization search (but it's 3 SD below the standards constants value)
	Develop a new evaluation based on a covariance analysis of the data
	Understand implications from integral data testing on changes in nubar - especially k-eff
	Create ENDF formatted files, including covariances
PFNS	Review work of IAEA CRP on PFNS
	Aim to adopt the CRP's recommendation
	Seek consensus on using LANL high-accuracy NUEX Pu9 and U5 data, as published in Dec NDS2011 to help define high-energy spectrum
	Use new PFNS measurements, especially below MeV, coming from LANSCE/Chi-nu in the coming years
	Use guidance on high energy tail of spectrum from dosimetry reactions (new IAEA IRDFF CRP), eg from LANL crits, Russian fast reactor, & CE
	As part of IAEA CRP, advance our theoretical models, and use incorporate other data (new and existing)
	Understand implications from integral data testing on changes in inelastic scattering - especially k-eff and reaction rates in assemblies
	Create ENDF formatted files, including covariances
PFGS	
	Review existing evaluations and experimental data, and various theoretical approaches
	Represent fission gammas separately at all energies, including above 1.09 MeV for U5 and Pu9 (an ENDF drawback), & use new data availabl
	Update PFGS spectra to use modern measurements from DANCE, as well as multiplicity distribution if possible
	Create ENDF formatted files, including covariances
Delayed data	
	Review differences in present evaluatiosn
	Develop plan for work needed
Energy Release	
	Compare energy release data in evaluations, for prompt n, g, fission fragments; and delayed energy release
	Update as necessary - eg ~ MeV level changes are impled for 239Pu from Jandel's DANCE data for 239Pu (but 235U looks good)
	Consider updating energy release incident-energy-depenence based on Lestone's work

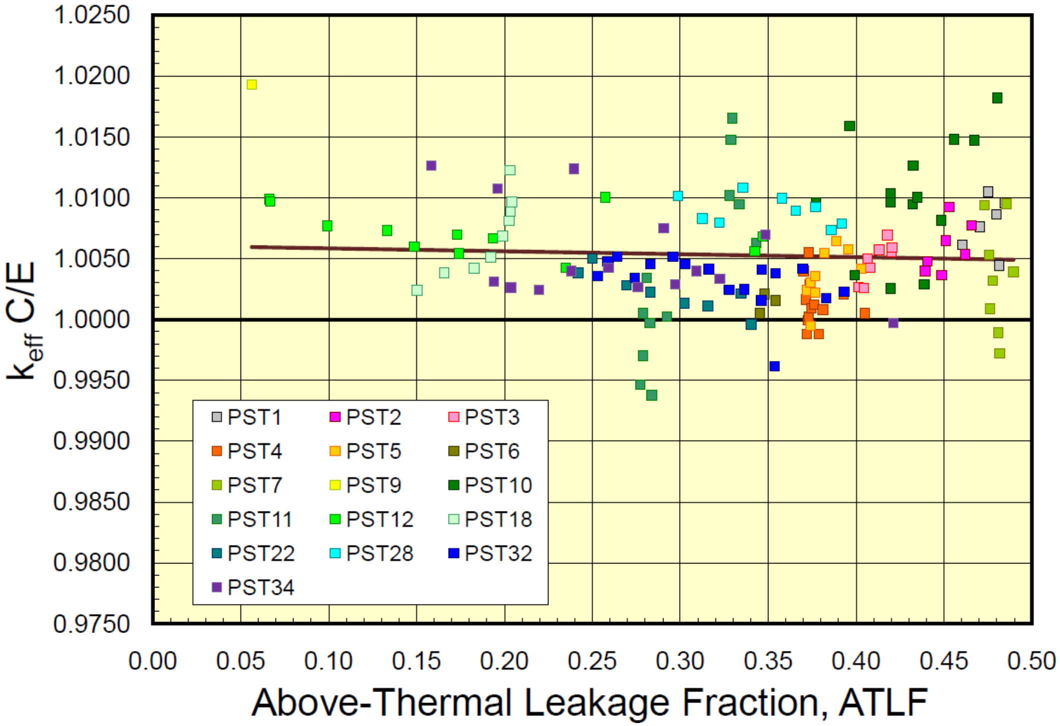
Integral Data Testing and Validation

Review Overall Goals, as embodied in this document and in LAUR CIELO document

- Define suite of critical assembly, reactor, transmission, etc experiments to use in validation assessments, and observables (k-eff, rates, spectral indices)
- 238U: selection of 12 ICSBEP criticality benchmarks sensitive to elastic scattering is available from JSI/IAEA (Trkov, Capote)
- Seek to ensure good performance in data testing, which includes:
- Fast, intermediate, and thermal assemblies, k-eff
- 239Pu: Aim for (Partial?) improvement of longstanding overprediction of thermal Pu solutions
- Modeling spectral indices well in various systems (incl fast), 8f/5f, 9f,5f, 237np-f/5f, 233u-f/5f etc, see Table XXXVIII in VII.1 NDS 2011 paper
- Modeling of post irradiation experiments (PIE) such as PROFIL (CEA) and MANTRA (INL)
- Modeling MOX experiments for mock up of LWR, eg in EOLE, Cadarache
- See if PFNS improvements give improved n2n detector responses in fast crits, eg through a softer PFNS spec aove 10 MeV
- nubar validation using multiplication subcritical measurements
- LLNL pulsed spheres
- Can we obtain improved preductions of intermediate assemblies, eg ZPR at Argonne
- Aim to maintain good prediction of crits, including new as-built high-resolution 3D MCNP Jezebel model?
- Use sensitivity metodologies for assessing changes/improvements by reaction and energy range

Pu-SOL-THERM Benchmarks – I. Prelim LANL testing of new Subgroup 34 resonance results

- **A ~500 pcm bias in calculated PST reactivity is a long-standing issue.**
- **WPEC Sub-Group 34 was tasked with defining a new (better?) set of resolved resonance parameters for ^{239}Pu in an attempt to resolve this issue.**
- **Can define a sub-set of these 150 benchmarks to test revised data files.**



- *Consider benchmark attributes such as (i) ATLF; (ii) ^{239}Pu atom-% in Pu; (iii) Above-Thermal Fission Fraction (ATFF); (iv) H/Pu number density (or gPu per liter) to define this sub-set.*

Pu-SOL-THERM Benchmarks – II. Prelim LANL testing of new Subgroup 34 resonance results

- **A set of seven Pu-SOL-THERM benchmarks have been extracted from the larger set.**
  - PST1.4 & PST12.13 span the ATLF space;
  - PST12.10 & PST34.15 span the ATFF space;
  - PST4.1 & PST18.6 span the ^{239}Pu atom percent space;
  - PST12.10 & PST34.4 span the g Pu per liter space.
- **All benchmark experiments are performed in simple geometry**
  - PST1.4 & PST4.1 are a water-reflected spheres;
  - PST18.6, PST34.4 & PST34.15 are water-reflected cylinders;
  - PST12.10 & PST12.13 are a water-reflected slabs;

Pu-SOL-THERM Benchmarks – III. Prelim LANL testing of new Subgroup 34 resonance results

- The E71 1.00576 k_{calc} average demonstrates that the 7 benchmark subset reflects the larger population.

- Data revisions in the "Leal7a" ^{239}Pu evaluated file have eliminated ~50% of the long-standing k_{calc} bias.

Calculated Eigenvalues[a] for a Selection of PST Assemblies Using Various ^{239}Pu Cross Sections

Assembly	ENDF/B-VII.1	JEFF-3.1.2 [b]	JENDL-4.0 [b]	Leal7a [c] + e71	Leal7a (RR, nu, pfns only) + e71
PST1.4	1.00448	1.00127	1.00588	1.00199	1.00202
PST4.1	1.00383	0.99907	1.00482	1.00044	1.00044
PST9	1.01939	1.01367	1.02510	1.01543	1.01546
PST12.10	1.00412	0.99973	1.00498	1.00083	1.00080
PST12.13	1.00955	1.00468	1.01069	1.00611	1.00620
PST18.6	1.00472	1.00153	1.00557	1.00202	1.00208
PST34.4	1.00258	0.99999	1.00417	0.99922	0.99937
PST34.15	0.99742	0.99563	0.99844	0.99679	0.99707
Average	**1.00576**	**1.00195**	**1.00746**	**1.00285**	**1.00293**

a) MCNP calculations are for 250M histories; stochastic uncertainty is ~5 pcm.
b) JEFF-3.1.2 and JENDL-4.0 ^{239}Pu only; remaining nuclides are ENDF/B-VII.1
c) "LEAL7a" evaluation provides revised resolved resonance parameters coupled to a joint ORNL/CEA evaluated ^{239}Pu file; the "LEAL7a (RR,nu,pfns)" file couples just these data to the existing ENDF/B-VII.1 ^{239}Pu file.

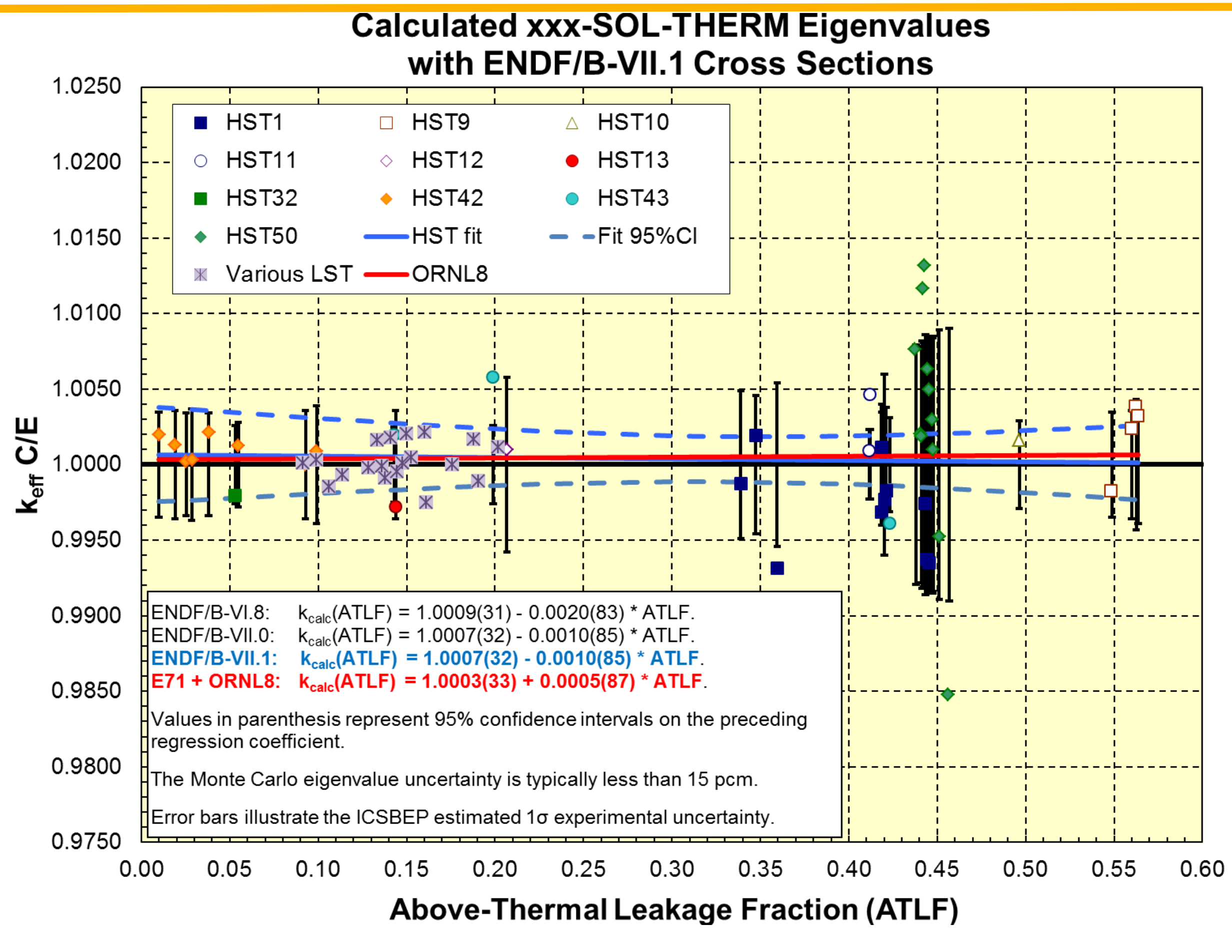
Time-line

- **May 2013: CIELO WPEC Subgroup initiated**
  - Teams identified
- **Nov 2013: NEMEA7-CIELO: Main collaboration kick-off**
  - Refine scope of work, collaborators who will work on tasks
  - Will result in detailed work plans, time line goals, for each nucleus
- **Next 2.5 Years:**
  - Various collaboration meetings, continual email collaborative exchanges
  - engagement with validation data testers continually
  - Incorporate new IAEA standards results (fission, capture, scattering, …)
  - Explore interdependencies on criticality from the 6 CIELO nuclides
- **May 2016:**
  - Document conclusions from CIELO collaborations in WPEC report (& NDS paper?)
  - Create formatted files that embody CIELO's initial conclusions

HST Benchmarks - LANL testing of prelim Res file

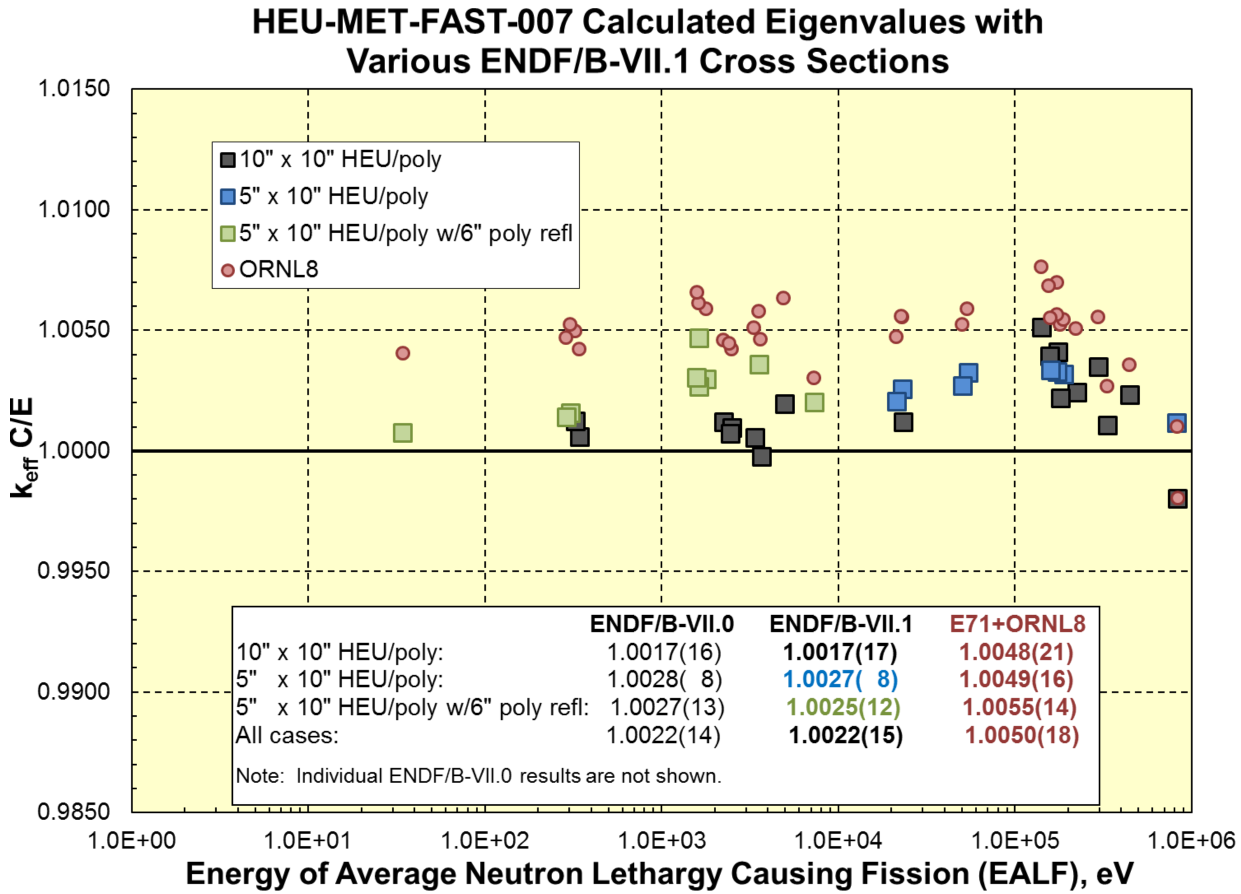
- **Regression fit to HST benchmarks versus ATLF has been excellent since ENDF/B-VI.3 (Lubitz).**

- **This excellent fit is retained with the latest (ORNL8) ^{235}U resolved resonance file.**



HMF7 (HEU + CH_2) : LANL testing of prelim Res file

- HEU + poly system tests xs data over several orders of magnitude.
- E70 & E71 results are near unity at either energy extreme but are biased high in the intermediate energy range.
- This bias is worsened with the latest ORNL8 ^{235}U evaluated file.



	ENDF/B-VII.0	ENDF/B-VII.1	E71+ORNL8
10" x 10" HEU/poly:	1.0017(16)	1.0017(17)	1.0048(21)
5" x 10" HEU/poly:	1.0028(8)	1.0027(8)	1.0049(16)
5" x 10" HEU/poly w/6" poly refl:	1.0027(13)	1.0025(12)	1.0055(14)
All cases:	1.0022(14)	1.0022(15)	1.0050(18)

Reaction Rates in Fast Critical Assemblies Provide Integral Test of Prompt Fission Neutron Spectrum & (n,2n) Cross Sections - *Uranium-235 data*

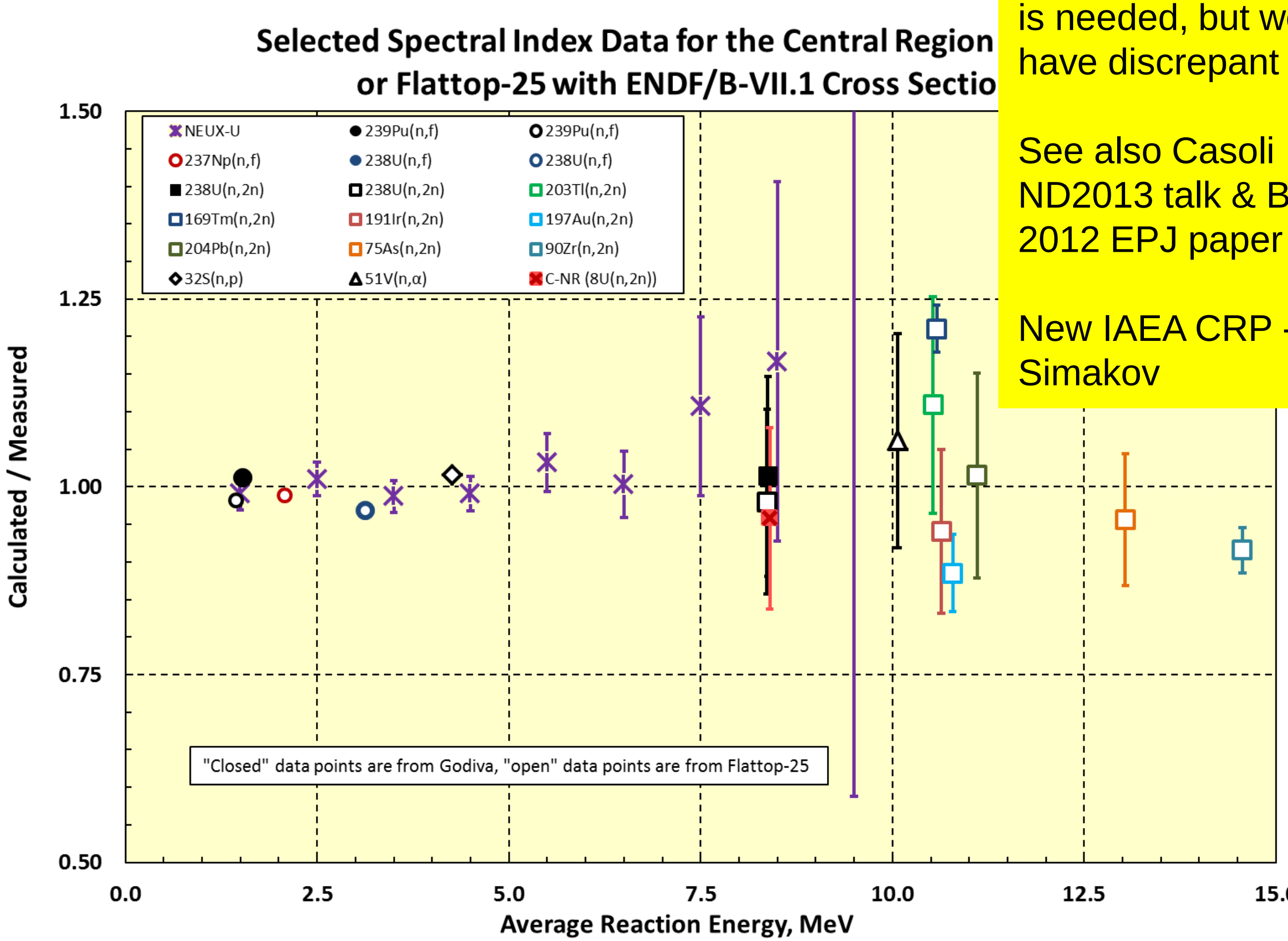
Perhaps suggests a softer ENDF spectrum is needed, but we have discrepant data.

See also Casoli ND2013 talk & Bauge 2012 EPJ paper

New IAEA CRP - Simakov

^{235}U

With NUEX data added (Lestone)



Similar analysis for plutonium systems – see our ND2013 proceedings paper

More Data Testing on Preliminary 235U ORNL Res Rile

k_{calc} Summary for Various Benchmarks and Cross Section Data Sets

GODIVA (HEU-MET-FAST-001)		
Cross Section Set	**Benchmark k_{eff}**	**k_{calc}**
ENDF/B-VII.1	1.000(1)	0.99983(3)
E71 + ORNL8		0.99985(2)
J4 + ORNL8		0.99757(2)
CEA + ORNL8		0.99957(2)
Flattop-25 (HEU-MET-FAST-028)		
ENDF/B-VII.1	1.0000(16)	1.00285(2)
JENDL-4.0		0.99779(9)
E71 + ORNL8		1.00300(13)
J4 + ORNL8		0.99899(13)
CEA + ORNL8		1.00040(13)
Big-10 (IMF7, detailed model)		
ENDF/B-VII.1	1.0045(7)	1.00443(2)
JENDL-4.0		0.99710(7)
E71 + ORNL8		1.00471(8)
J4 + ORNL8		0.99764(11)
CEA + ORNL8		0.99901(11)

More Data Testing on Preliminary 235U ORNL Res Rile

3

	HMI6.1	**HMF6.2**	**HMI6.3**	**HMF72.3**	**HMI6.4**	**HMF72.1**	**HMF73**
Benchmark k_{eff}	0.9977(8)	1.0001(8)	1.0015(9)	1.0016(69)	1.0016(8)	0.9991(24)	1.0004(16)
endf/b-vii.1 ealf	4.93 keV	10.1 keV	23.5 keV	40.8 keV	79.8 keV	223 keV	416 keV
				k_{calc}			
ENDF/B-VII.1	0.99293(2)	0.99690(2)	1.00076(2)	1.01236(2)	1.00730(2)	1.00852(1)	1.00807(2)
ENDF/B-VII.1 + e5 ^{nat}Cu	0.99264(2)	0.99723(2)	1.00168(2)	1.00762(10)	1.00767(2)		0.99663(2)
ENDF/B-VII.1 + mit/ornl ^{63,65}Cu	0.99304(15)	0.99709(15)	1.00086(15)	1.01254(10)	1.00791(15)		1.00720(14)
JENDL-4.0	0.99810(11)	1.00197(11)	1.00428(11)		1.00569(10)		1.00267(9)
E71 + ORNL8	1.00188(2)	1.00616(2)	1.00929(2)	1.01744(10)	1.01196(2)	1.00921(9)	1.00809(1)
J4 + ORNL8	0.99629(2)	0.99987(2)	1.00226(2)		1.00451(2)		1.00276(2)
CEA + ORNL8	0.99578(2)	0.99922(2)	1.00149(2)		1.00390(2)		1.00361(1)

JENDL-4.0 is ^{235}U only; remaining cross sections are endf/b-vii.1.

J4+ORNL8 is the ^{235}U data set; remaining cross sections are endf/b-vii.1.

k_{calc} values with a ~2 pcm uncertainty were run for 2 billion histories and include detailed multigroup tallies.

HMI6 has varying amounts of interstitial carbon; HMF72.1 has interstitial carbon steel (Fe); HMF72.3 has interstitial carbon steel (Fe) and polyethylene; HMF73 is HEU only … all assemblies are surrounded by a thick copper reflector(i.e., HMI6, HMF72 and HMF73 are different flavors of ZEUS).

4

56Fe

General

- Review differences in evaluations. In ENDF/B-VII.1 RR extend up to 850 keV, but pointwise fluctuations extend up to almost 10 MeV.
- Get insights from previous evaluators on tasks to work on. For example, Trkov, Koning, Vonach, Tagesen were involved in the last European Jeff ev
- Optical model and other key modeling parameters

Fast Region

Inelastic and elastic

- Review new data,: RPI has high-res transmission up to 2 MeV, and scattering data ("quasi differential data"), that needs an MCNP calc to compare
- Review new data:Arjan Plompen (Geel) has inelastic data (actually, gamma-production) too measured this year, from 800 keV to 5 MeV.
- Review new data: Schillebeeckx and Trkov's postdoc have made some new measurements, and reviewed existing measurements....
- Review new data: Ron Nelson (LANL) has gamma-production data for iron.
- Review new data: The Grimes et al. Ohio work should be looked at too – it is suggesting a big change for nonelastic, but that our total cross sectio
- IAEA coupled-channel OM work going on for iron.
- Pronyaev – also doing work on inelastic gamma production. At one point this was being considered as a standard (now more likely to use Ti).

Charged-particle production

- Review data, evaluations, and model predictions for (n,alpha) etc
- Data above 20 MeV may be needed too, eg for fusion applications, using new gas-production data from Haight.

Activation xs

- Review/Include activation data needed for fission/fusion

DPA

- Take advantage of insights from new IAEA CRP on damage and DPA

Resonance Region, Resolved and UnResolved Parameters (hundred of keVs and below)

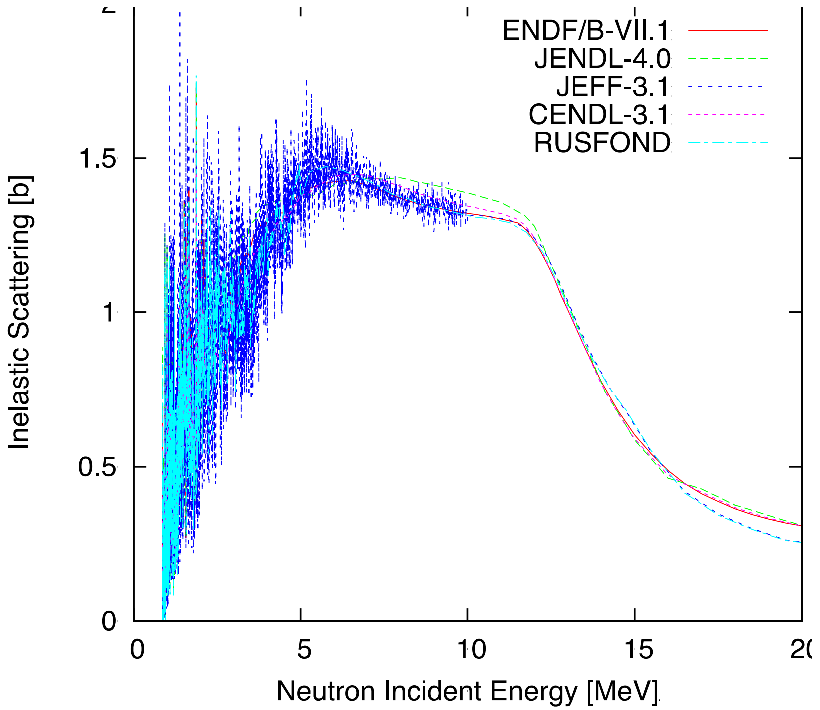
RRR & UR

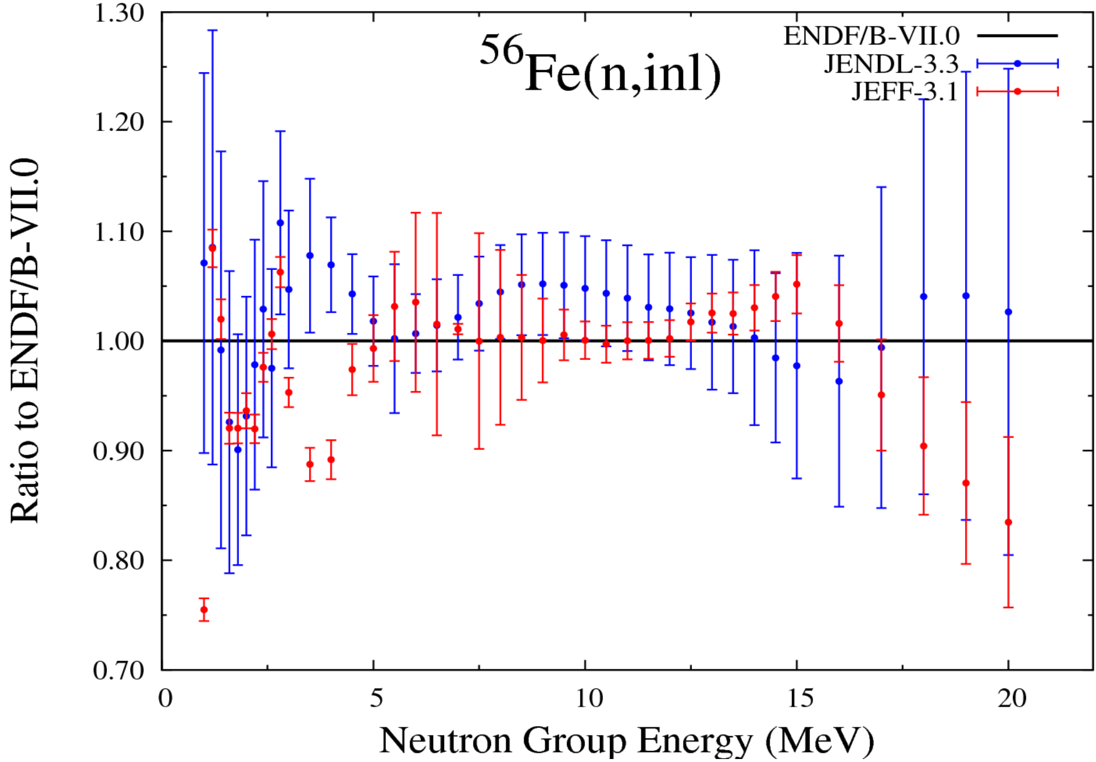
- Review latest evaluation from Luiz Leal

Integral validation

- Define suite of integral tests - critical assemblies, transmission/shielding, reactor experiments, etc
- 17 benchmarks with iron as shielding material (+8 more with stainless steel) are available in the SINBAD database
- Compile feedback from recent testing - eg SG33, fast reactor COMARA experience, etc, Steven VDM's NDS 2012 benchmarking paper (which note
- Andrej Trkov has shielding benchmarks that are relevant too. The euracos benchmark for sinbad.
- Pay attention of Fe-reflected fast critical benchmarks (+ thermal bench from CEA, e.g. PERLE experiments in EOLE)
- Use ZPR3-54, ZPR9-34, ZPR6-10 and possibly CIRANO with reaction rate distributions
- Use sensitivity metodologies for assessing changes/improvements by reaction and energy range

^{56}Fe: Advances Needed in Inelastic Scattering





Herman, Palmiotti

New measurements (IRMM) & SAMMY analyses in resonance region; new Hauser-Feshbach analyses at higher energies

Cecil Lubitz:

“After several “preliminary” months on CIELO it’s clear that we have bitten off a big chunk. Get ready to chew.”

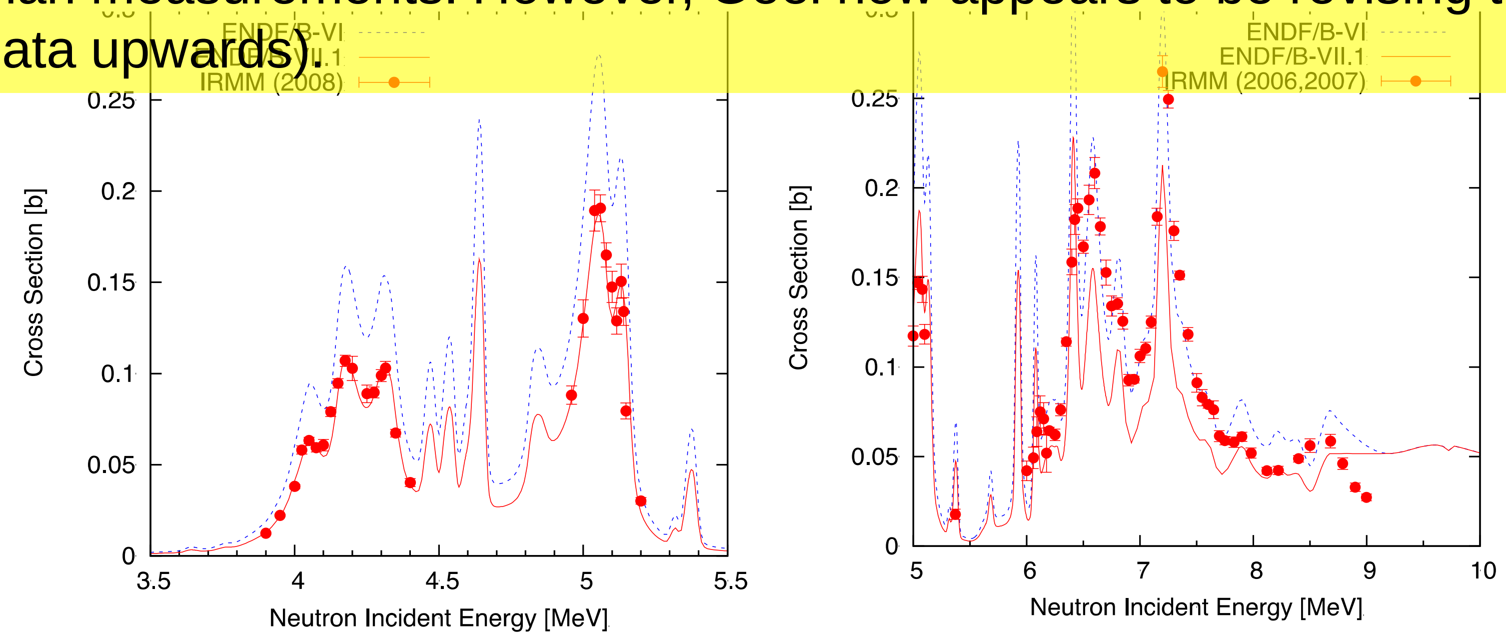
16O

General	
	Intercompare evaluations, and identify goals for a new evaluation
	JENDL is a new work (though adopts ENDF n,a); ENDF (JEFF uses ENDF) is a hydrid of KAPL work < 3.2 MeV, LANL (Hale et al) > 3.2 MeV - assess value of
	The 2005 ORNL work generated a resonance analysis for 16O, full R-matrix. Included angular distributions, n,alpha, and it has never been tested. Needed L
Total, Elastic and inelastic scattering	
	Compare existing evaluations and R-matrix analysis, and defie path forward
	At low energies, assess whether evaluations of elastic scattering indeed need to be lowered by ~3%, as proposed by Plompen, Lubitz, Roubtsov etc
	covariances for mubar: Need reliable anisotopic 16O scattering uncertainties. Palmiotti thinks Gerry's present uncertainties are too small on mubar.
Capture	ENDF adopted JENDL's capture cross section to include resonance contribution - establish consensus to use this
(n,a)	
	Review different evaluations (all largely same as ENDF)
	Review previous data, and agee on scales - eg Bair & Haas had renorm their original data down by ~20%; Are Johnson data the same as these?
	Review new data - Georginis (Geel), Khryachkov (IPPE) - contact physicists working on 13C(a,n) for astrophysics
	The above new data approx confirm ENDF below 6 MeV but point to changes above
	Intercompare R-matrix calcs (Hale, Kunieda, Leal)
	Seek to understand why the above R-matrix evaluations, influenced by total cross sec data, suggest ~30% higher (n,a) than most measurements
	Define an evaluation strategy... If theory contradicts these data, do we use data instead? Or do we conclude theory is right and measurements had a scle er
	Assess whether evaluations (all now based n ENDF) above ~ 6 MeV need changing, if it is concluded new Geel data are more accurate than old Davis data
Integral	Establish suite of integral valdation tests, including k-eff, transmission, etc
	2 benchmarks sensitive to oxygen data (+11 more benchmarks with water) are available in the SINBAD database
	Broomstick experiment
	Following WPEC SG? , With the existing (n,a) evaluations perform well, for the most part, on LEU solutions, Can the new eval perform well too
	(n,a) impact at higher energies: Does this higher energy >6 MeV region impact any applications significantly (maybe medical applications)? Carlson notes M
	check astrophysics constraints on 13C(a,n) reaction rate

^{16}O. Work is Needed to Reconcile R-Matrix Theory & Data & Maintain Criticality and Transmission Performance

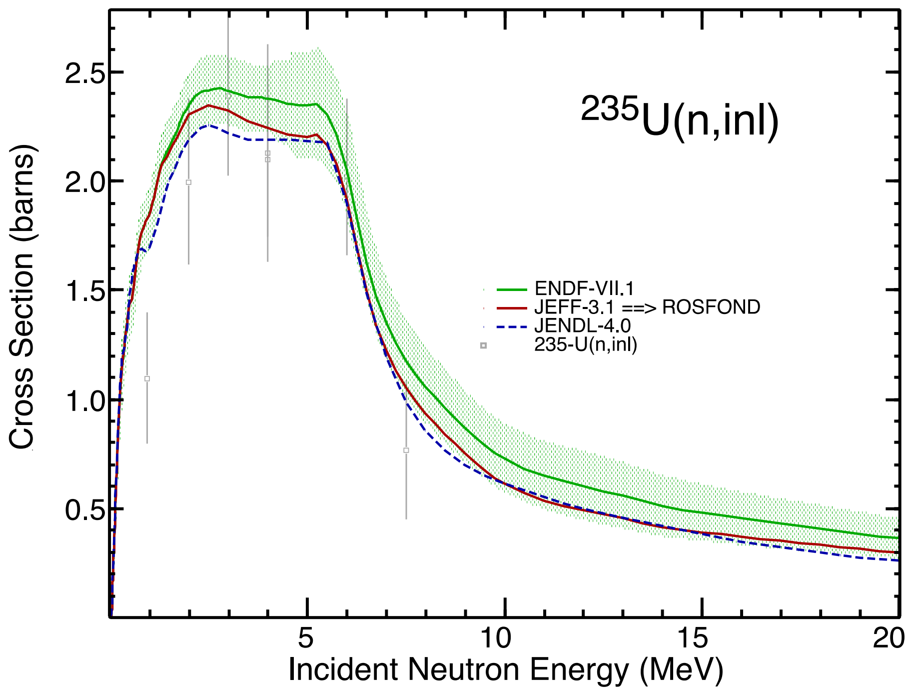
An interesting case of **seemingly discrepant** information coming from *theory* versus *experiment*!

(R-matrix theory + total cross section data seems to suggest a higher (n,a) than measurements. However, Geel now appears to be revising their (n,a) data upwards).



Progress being made by Plompen, Lubitz, Roubstov, Hale, Kunieda, Leal, Moxon, Kopecky … **Could TPC measure?**

Uncertainties & Covariances for CIELO



Talou, with US covariance effort led by Oblozinsky, Smith, Herman, Hoblit:

Talou, Young, Kawano, Rising, Chadwick, DS 112, 3054 (2011)

Covariances are now available in the major evaluated libraries. This allows us to:

-Focus experiment & theory efforts

- Calculate uncertainties on integral neutronic performance

- Provide feedback on cross section updates, via “adjustment” projects (SG33) or “assimilation”

-- We’ll work with the new WPEC subgroup 39

Summary …

Join our CIELO collaboration

Thanks to IRMM & NEA/IAEA for support!

BACKUP SLIDES

MCNP6 Production release, 2013

- MCNP6 = MCNP5 + MCNPX + several new features
- 2 DVD set will contain 5,X & 6 + ENDF 7.1 and > 1 Gbyte of documents
- MCNP 5/X/6 Beta 2 had 2,452 copies sent out in FY12 and more than 11,000 in the last 11 years!
- See "Initial MCNP6 Release Overview" Nuclear Technology, Dec 2012