Area #1 Missing Data Effort

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*a passion for discovery*

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Missing Data in EXFOR

- First, I learned about missing data when Viktor's Web Interface refused to produce any plotted data.

- Second, I have heard complaints of F. Kaeppeler, who advised me to compare EXFOR and CINDA.

- Third, as an EXFOR manager I got more familiar with the issue that was caused by multiple reasons

  - Historical reasons

  - EXFOR compilation scope evolution

  - Lack of technical tools and resources in the past

  - Lack of motivation among EXFOR compilers

  - …..

Research Evolution in Area #1

- The largest number of X4 experiments was in the 70ies.
- The overall number of nuclear reaction measurements in the area 1 is 37.16%, area 2 is 34.79%, area 3 is 13.35% and area 4 is 14.70% of the total.
- Hopefully, the LANSCE accelerator upgrade and full implementation of FRIB project will further increase an output for the area 1.
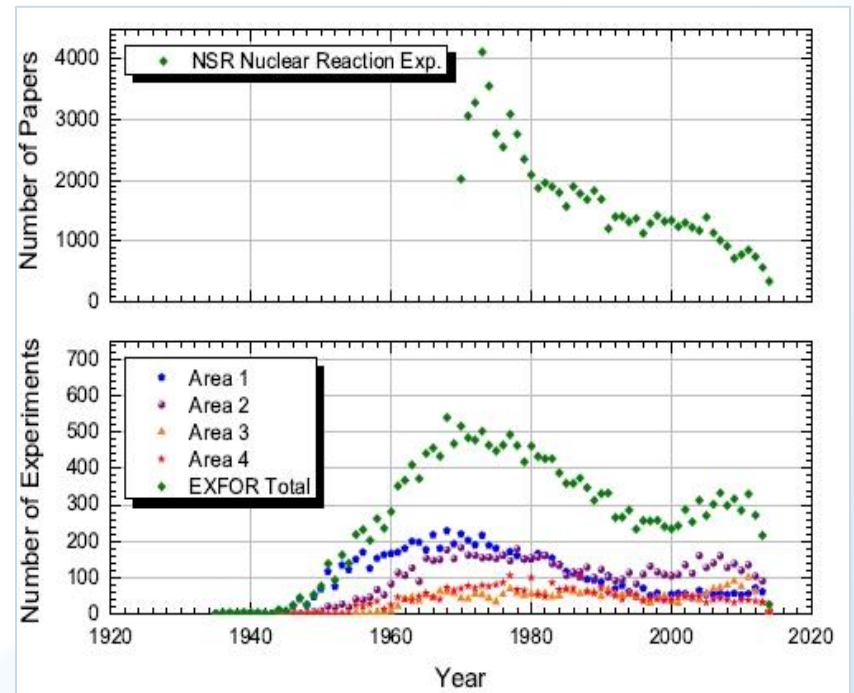
Types of Missing Data

- Completely missing publications
  - Charged particles, proton beams are most easily available while proton-induced reactions are only 19.8% of EXFOR, vs. 48.8% for neutrons ???
  - Photonuclear is only 5.74% of EXFOR ???
  - A small number of neutron papers is still missing
- Existing experimental publications
  - Experimentalists would not always share data, compilers proactively will create empty subentries
    - UNOBT status (5-10%)
    - Missing without UNOBT status (<5%)
  - Compilers fail to create subentries for the existing data because compiler always had a choice during the compilation, i.e. compile resonance parameters but not Maxwellian cross section.
  - Non existing data sets because compilers proactively will make up subentries.

Oak Ridge Data Recovery Effort

- NRDC 2014 action A36: *Establish a mechanism with ORNL to receive the time-of-flight spectra (transmission and reaction yield) measured at ORELA for inclusion to EXFOR.*

- NNDC/ORNL, many thanks to K. Guber:
  - F, Al, Si, Cl, Ti, Fe, Mn, Cr, Ni, K, Sn, Nd and U capture, transmission and fission data sets.
  - Data of J. Harvey and R. Spencer.
  - Data were recovered from DVDs made in 2007; we could not read one of them. The defective DVD will be further evaluated by NNDC because data there are worth millions and millions of dollars!!!

- Entry 13647: 142,144Nd data from ORELA. Many corrections are necessary, no UNOBT.

```
ENTRY          13647   20050720    20050909   20050926        1336
SUBENT       13647001   20050720    20050909   20050926        1336
BIB              13          23
INSTITUTE   (1USAORL,1USADNS)
REFERENCE   (J,PRL,78,2704,1997)
AUTHOR      (K.H.Guber,R.R.Spencer,P.E.Koehler,R.R.Winters)
TITLE       New 142,144Nd(n,gamma) Cross Sections and the s-process
             Origin of the Nd Anomalies in Presolar Meteoric
             Silicon Carbide Grains
FACILITY    (LINAC) ORELA, 40-m flight station.
INC-SOURCE  (EVAP)
SAMPLE      Nd2O3 powder, enriched to >97% in main isotope, and
             pressed into 2.54-cm diameter disks held in thin-
             walled aluminium cans.
DETECTOR    Energy dependence of neutron flux measured with thin
             6Li-loaded glass scintillator.
MONITOR     (3-LI-6(N,T)2-HE-4,,SIG) Energy dependence standard.
             Absolute capture yield calibration done by saturated
             resonance technique using the 197Au(n,gamma)
             4.906-eV cross-section resonance.
CORRECTION  Corrected for background, sample impurities.
ERR-ANALYS  No information
STATUS      Data taken from article.
             No reply to author proof, 97/6/20.
HISTORY     (19970416C)
             (20050720C) DR Format updated and reference corrected
ENDBIB           23
NOCOMMON          0           0
ENDSUBENT        26
SUBENT       13647002     970620              20050926        0000
BIB               2           2
REACTION    (60-ND-142(N,G)60-ND-143,,SIG)
STATUS      Energy dependent data not available.
ENDBIB            2
NOCOMMON          0           0
NODATA            0           0
ENDSUBENT         6
SUBENT       13647003     970620              20050926        0000
BIB               2           2
REACTION    (60-ND-144(N,G)60-ND-145,,SIG)
STATUS      Energy dependent data not available.
ENDBIB            2
NOCOMMON          0           0
NODATA            0           0
ENDSUBENT         6
SUBENT       13647004     970620              20050926        0000
BIB               2           2
REACTION    (60-ND-142(N,G)60-ND-143,,SIG,,SPA,DERIV)
INC-SPECT   Calculated Maxwellian averages from measured data.
ENDBIB            2
NOCOMMON          0           0
DATA              3           6
KT          DATA       DATA-ERR
KEV         MB         MB
 5.0        100.5       3.7
 8.0         75.6       3.0
```

UNOBT for CIELO Project

- NRDC 2014 action A 56: *Try to add numerical data which are not superseded (SPSDD) but still unobtainable (UNOBT) for neutron-induced reaction data published in old literature for 1H, 16O, 56Fe, 235U, 238U and 239Pu.*

- NNDC has considered it as a broader mandate and fixed the following

  - H,C,O,Fe,235,238U, 239Pu neutron- and proton-induced reactions unobt data sets

  - Work on unobt continues; current state on the Web
    - 192 neutron-induced reactions (225 datasets) in area #1 => 136 reactions (151 datasets)
    - 391 all reactions (444 datasets) in area #1 => 280 reactions (312 datasets)

- Comments from other centers???

Missing Photonuclear Publications

- Missing experiments search
  - Find a single missing paper and trace author using NSR web Interface.
  - NSR displays EXFOR links when we have a match.
  - Using this method plenty of data from University of Virginia, Iowa State University electron synchrotrons were discovered, and University of Illinois betatron.
  - We had more experimental facilities in the past!!!
- This approach is universal, could be used to search for missing neutron and charged particle data.
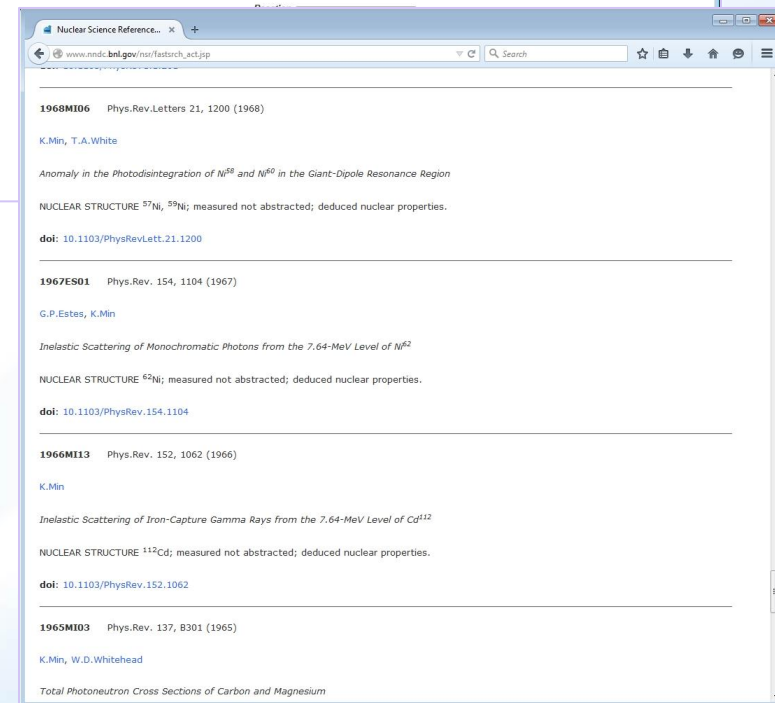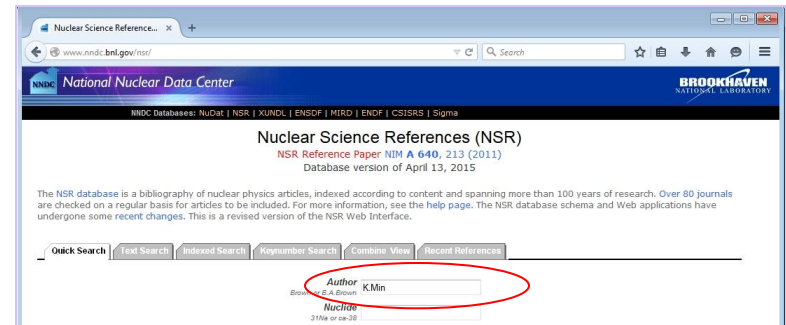
Cooperation with NSR

- Last year, I reported ``*Currently we conduct an exploratory work on importing ~6,000 experimental references from EXFOR in collaboration with the NRDC network."* NSR in the past was a Nuclear Structure References database.

- NRDC 2014 action A84: *(Continuing action) Assess possibility of translation from EXFOR to NSR.*

- V. Zerkin has written a Java code, and started to produce NSR entries in collaboration with J. Totans; each entry is verified by NSR manager:
  - Phys. Rev. Lett. – 32 articles
  - Phys. Rev. D – 6 articles
  - Phys. Lett. B – 23 articles

- It may be ~1% of the total at this point but we will match EXFOR and NSR bibliographies. I hope Viktor will continue to work on this project, this action should continue.

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Conclusions

- EXFOR database is incomplete due to multiple historical and technological reasons.

- We should further work on compilation of missing articles, correct previous entries.

- The work on UNOBT Area #1 entries for CIELO project needs is done.

- Cooperation with NSR is very fruitful.

- Finally, we always have many action items. Consequently, we have to prioritize them and show the results.