Nuclear Data Activities at LANSCE

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LANSCE-3

WPEC Meeting
Santa Fe, NM

April 12-13, 2001
Progress at LANSCE

- New management
- More beam time -- July - December, 2001
- PAC -- April 18-20, 2001
- Nuclear Data Measurements
- Improved Capabilities
  - Flight paths
  - Detectors
  - Computers
Nuclear Data Measurement Activities at LANSCE

• Completed
  – Total cross sections on 31 materials, $E_n = 5$ to $560$ MeV
  – $^{239}$Pu(n,2n) from (n,xgamma), $E_n =$ threshold to $200$ MeV
  – Oxygen(n,xgamma), $E_n = 4$ to $200$ MeV
  – Spectroscopy

• Data being analyzed
  – (n,xgamma) on $^9$Be, $^{59}$Co, $^{58,60}$Ni, $^{99}$Tc(n,xgamma)
  – (n,xp) and (n,xalpha) on $^{92,94,96}$Mo

• Co-workers from LLNL, Pittsburgh, Notre Dame, Ohio, CEA (France), etc.
Improved Capabilities

- Flight paths
  - Moderated neutrons -- FP14 at Lujan
  - Fast neutrons -- Industrial irradiations

- Detectors
  - FIGARO -- n-gamma coincidences to measure neutron-emission spectra
    - (n,n’gamma)
    - (n,fission)
  - DANCE

- Computers -- MIDAS + ROOT
Total cross sections (LLNL, Ohio U, LANL)

- Nuclei from H to U-
  - 45 materials (31 new)
- $E_n$ from 5 to 560 MeV
- 1% or better absolute accuracy in 1% energy bins -- defines state-of-the-art
- Major addition to data base - old data stopped ~ 30 MeV
- Essential data for neutron transport codes and for nuclear modeling
The $^{239}$Pu(n,2n)$^{238}$Pu reaction cross section is determined from measured partial $\gamma$-ray yields (in red on the right) and theoretical calculations.
Oxygen(n,xgamma) -- example of data
23 gamma-ray transitions for $E_n = 4$ to 200 MeV
(in press)
Improved Capabilities

• Flight paths
  – Moderated neutrons -- FP14 at Lujan
  – Fast neutrons -- Industrial irradiations

• Detectors
  – GEANIE -- (n,xgamma)
  – FIGARO -- n-gamma coincidences to measure neutron-emission spectra
    • (n,n’gamma)
    • (n,fission)
  – DANCE

• Computers -- MIDAS + ROOT
Weapons Neutron Research (WNR)
Target Specifications

Target-2 (Blue Room)
Up to ~ 1 \( \mu \)A proton beam
- Proton induced reactions
- 6 flight paths
- Proton irradiations

Target-4
5 \( \mu \)A proton beam for high-energy neutron spallation source. Typical operation is 35,000 pulses/sec with 1.8 \( \mu \)sec spacing.
- 6 neutron flight paths
- Neutron induced reactions
- Energy spectrum depends on flight path angle
- Determine energy of neutron by time-of-flight
- Neutron irradiations
$^{235,238}\text{U}, ^{239}\text{Pu} (n,xn) (x=1,2,3..)$

- LLNL-LANL joint program
- Measure cross sections for $(n,x\gamma)$ with good resolution
- Relate $(n,x\gamma)$ to $(n,n')$, $(n,2n)$, $(n,3n)$. by nuclear model calculation (Chadwick)
- GEANIE detector array

contacts: J. Becker (LLNL)
R. Nelson (LANL)
FIGARO -- Fast neutron-Induced Gamma-Ray Observer

- High-resolution germanium detectors
- Neutron detectors for n-\(\gamma\) coincidences
- Complementary to GEANIE
  - germanium detectors - but fewer
  - ease scheduling on GEANIE, which is oversubscribed by a factor of 3
- Test bench for new techniques
  - timing
  - conversion-electron spectrometer

Figaro -- Mod 1
MLNSC -- Moderated spallation source

Manuel Lujan Jr. Neutron Scattering Center

Available FP
4, 8, 11a, 12, 13, 15

Moderators
1, 2, 16: high resolution H2O decoupled
3, 4, 5: high intensity H2O decoupled
6, 7, 8: high intensity H2O decoupled
9, 10, 11: H2 @ 20K decoupled
12, 13: H2 @ 20K partially decoupled
14, 15: H2O partially decoupled

LANSCE
Los Alamos Neutron Science Center
DANCE -
Device for Advanced Neutron Capture Experiments

- designed with Karlsruhe group; now in construction
- 162 element “soccer ball” array - $4\pi$
- BaF$_2$ scintillators
- Acts as calorimeter to separate signal from background
- High sensitivity so that small samples ($\sim 1$ mg) (radioactive) can be studied
- $E_n$ from 1 eV to 500 keV