

STATUS OF THE US EFFORT
ON US/JAPAN COOPERATION
ON FUSION NEUTRONICS

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US/JAPAN WORKSHOP
ON FUSION NEUTRONICS
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A. ANALYTICAL EFFORT

• NEUTRON CROSS-SECTION LIBRARIES AND CODE DEVELOPMENT

- UCLA HAD SUGGESTED TO LANL A NEUTRON CROSS-SECTION LIBRARY WITH GROUP STRUCTURE BOUNDARIES THAT ARE COMMON IN MATX6 (187-g), VITAMIN/E (174-g), ANL46 (46-g), MATXS6 (80-g) AND MATXS5 (30-g)
- THE LIBRARY, UC/LA, WAS GENERATED AT LANL (74-g) BASED ON THIS GROUP STRUCTURE WITH ENDF/B-V DATA.
- THE LIBRARY ALSO INCLUDES TRANSFER MATRICES AND COVARIANCE DATA FOR PARTIAL CROSS-SECTIONS REQUIRED FOR CROSS-SECTION SENSITIVITY/UNCERTAINTY ANALYSIS.
- COVARIANCE DATA WERE GENERATED FOR 14 MATERIALS RELEVANT TO THE FNS EXPERIMENTS: ^1H , ^6Li , ^7Li , ^9Be , NATC, ^{14}N , ^{16}O , ^{23}Na , ^{27}Al , SI, CR, FE, NI, PB
- AN OPTION WAS ADDED TO TRIDENT-CTR FINITE ELEMENT CODE TO ACCEPT SOURCE INPUT BY ENERGY AND ANGLE. THE CODE WAS THOUGHT TO BE ADAPTABLE FOR ANALYSIS IN 2-D MODELING OF FNS EXPERIMENTS. DIFFICULTIES WERE ENCOUNTERED. DOT 4.3 WAS USED INSTEAD.
- MODIFICATION TO ADEQUATELY TREAT THE TRANSFER CROSS-SECTION TYPE [E.G., (N,2N), (N,N')...] FOR UNCERTAINTY ANALYSIS WAS COMPLETED IN SENSIT. ADOPTION OF MODIFICATION TO SENSIT-2D CODE IS IN PROGRESS.
- THE VITAMIN/E LIBRARY (174-g) WAS RECENTLY RELEASED. IT INCLUDES THE LATEST EVALUATION FOR BERYLLIUM THAT ADEQUATELY ACCOUNTS FOR THE $\text{Be}(N,2N)$ CROSS-SECTION BASED ON YOUNG AND STEWART'S EVALUATION.

• CALCULATIONAL BENCHMARKS

- FOUR CALCULATIONAL BENCHMARKS HAVE BEEN CHOSEN BY JAERI AND THE US FOR BASIC DATA AND CODES INTERCOMPARISON. THE TASK WAS COMPLETED.

- ITEM FOR COMPARISON ARE:
 - T_6 AND T_7 PRODUCTION RATES
 - ANGULAR FLUXES AT BOUNDARIES
 - SPECTRUM AT SELECTED LOCATIONS
 - REACTION RATES OF VARIOUS MATERIALS
[E.G., $^{235}\text{U}(\text{N},\text{F},)$, $^{238}\text{U}(\text{N},\text{F},)$, $^{232}\text{Th}(\text{N},\text{F},)$, $^{237}\text{Nb}(\text{N},\text{F},)$,
 $^{58}\text{Ni}(\text{N},\text{P},)$, $^{58}\text{Ni}(\text{N},2\text{N},)$, $^{27}\text{Al}(\text{N},\alpha,)$, $^{197}\text{Au}(\text{N},\gamma,)$,
 $^{197}\text{Au}(\text{N},\text{P},)$]

- COMPARISON WAS CARRIED OUT USING COMMON CODES AND DATA (ANISM, DOT 3.5, MORSE-CG AND ENDF/B-IV DATA).

- ANOTHER INTERCOMPARISON WAS MADE USING CODES AND DATA DEVELOPED INDIVIDUALLY IN EACH COUNTRY.

- RESULTS SHOW:
 - DIFFERENCES IN T_6 BETWEEN US AND JAERI RESULTS AS LARGE AS 10%
 - OTHER DIFFERENCES IN ANGULAR FLUX SPECTRA AT BOUNDARIES WERE FOUND FOR C, BE

- PRE- AND POST ANALYSIS FOR PHASE I AND II EXPERIMENTS

- (A) PHASE I

- EXPERIMENT #1

- POST ANALYSIS HAS BEEN CARRIED OUT FOR EXPERIMENT #1, PHASE IA (REFERENCE CASE) USING LATEST DATA (ENDF/B-V) AND DOT 4.3 CODE.
- T_7 PRODUCTION RATE GIVES EXCELLENT AGREEMENT WITH EXPERIMENTAL DATA.
- RESULTS FOR T_6 ARE WITHIN 10-20% OF EXPERIMENTAL DATA. FURTHER IMPROVEMENT IS NEEDED (CORRECTION FOR SELF-SHIELDING OF SAMPLE SEALING).
- AGREEMENT FOR OTHER REACTION RATES IS REASONABLE EXCEPT FOR $^{197}\text{Au}(n,\gamma)$.

- BERYLLIUM EXPERIMENT

- THREE EXPERIMENTS WERE CONDUCTED AT JAERI USING THE ANL LOANED BE (5-CM BE, 10-CM BE, 5-CM Li_2O , + 5-CM BE).
- DETAILED ANALYSIS HAS BEEN CARRIED OUT TO THE BE SANDWICHED EXPERIMENT USING BE ENDF/B-V DATA (VERSION 1).
- ANALYSIS WITH BE ENDF/B-V (VERSION 2) DATA IS IN PROGRESS.
- ANALYSIS HAS REVEALED BETTER AGREEMENT WITH T_6 LI-GLASS METHOD EXPERIMENTAL RESULTS. HOWEVER, THE REASONS FOR THE 7% DIFFERENCE NEEDS TO BE INVESTIGATED. Li_2O PELLET RESULTS GIVE POOR AGREEMENT.
- DISCREPANCIES IN SOME OTHER REACTION RATES ARE LARGE [E.G., $^{58}\text{Ni}(n,p)$, $^{93}\text{Nb}(n,2n)$]. THESE DISCREPANCIES NEED TO BE RESOLVED DURING THIS WORKSHOP.
- CONTINUATION ON PHASE I EXPERIMENTS (PHASE IB) WILL BE DISCUSSED DURING THE WORKSHOP.

(B) PHASE II EXPERIMENTS

- PRE-ANALYSIS FOR PHASE II EXPERIMENTS HAS BEEN COMPLETED.

- PRE-ANALYSIS CONCENTRATED ON THE FOLLOWING ITEMS:
 - DETERMINE REQUIRED THICKNESS AND MATERIAL
 - IMPACT OF SUPPORTING MATERIAL ON T_6 AND T_7 PROFILES
 - STUDY VARIATION IN TPR PROFILES WITH VARIOUS STRUCTURAL MATERIAL VOLUME FRACTION AND SINTERING AIDS
 - IMPACT OF BEAM DUCT HOLE SIZE ON TPR PROFILES
 - IMPACT OF CONTAINER SIZE AND DIMENSION ON TPR PROFILES
 - IMPACT OF NEUTRON ROOM RETURN ON THESE PROFILES

- FINAL ANALYSIS WILL BE CARRIED OUT UPON FINALIZING SIZE, MATERIAL, GEOMETRY, STRUCTURAL SUPPORT AND OTHER DETAILS.

B. MEASUREMENTS, INSTRUMENTATION

(1) TRITIUM BREEDING MEASUREMENTS 1983/1984

ANL METHOD USES LITHIUM METAL DISCS ENCAPSULATED IN 0.005 IN. ALUMINUM. CAPSULE AND DISC ARE MELTED IN A FURNACE IN THE PRESENCE OF CARRIER H_2 , EXCESS H_2 IS USED TO SWEEP OUT EVOLVED 3H_2 . THE GAS IS PASSED OVER HOT CuO , OXIDIZED AND TRAPPED IN A LN_2 TRAP.

- YIELD TYPICALLY 99%+.
- ALIQUOT OF 2 CC TRITIATED WATER SAMPLE IS MIXED WITH 18 CC SCINTILLATING GEL.
- AUTOMATED COUNTING IN STANDARD 20 CC VIALS; COMPARISON WITH NBS STANDARD.
- METHOD HAS BEEN VERIFIED WITH DISCS IRRADIATED IN CALIBRATED THERMAL FLUX (ATSR REACTOR, ANL).

1983: Li_2O

1984: Li_2O WITH BE MULTIPLIER REGION.

- APPROXIMATELY 60 DISCS, NATURAL, 7 ENRICHED AND 6 ENRICHED WERE IRRADIATED IN EACH EXPERIMENT.
- RESULTS IN 3H ATOMS PER INCIDENT NEUTRON PER GRAM OF PURE ISOTOPE.

DEVELOPMENT OF METHOD:

- TIME REQUIRED PER DISC WAS REDUCED WHILE MAINTAINING ACCURACY.
- COUNTING FACILITY BACKGROUND WAS SOMEWHAT REDUCED.

(2) NEUTRON SPECTROSCOPY - 1983

ANL SCHEME USES PROTON-RECOIL PROPORTIONAL COUNTERS WITH PULSE SHAPE RECOGNITION (REJECTION OF WALL EFFECT AND END EFFECT, GAMMA RADIATION).

- METHOD HAS BEEN DEMONSTRATED IN CRITICAL ASSEMBLY SPECTROSCOPY.
- ENERGY RANGE FROM 10 MeV THROUGH 1 MeV (APPROXIMATE).
- PRELIMINARY RESULTS (1983).

DEVELOPMENT OF METHOD:

- NON-SATURABLE PREAMPLIFIER ELIMINATES AFTEREFFECT FROM 14 MeV RECOILS.
- ON-LINE PC DATA PROCESSING.
- ELIMINATION OF TEMPERATURE AND HUMIDITY EFFECTS THROUGH ENCAPSULATION.
- NOISE REDUCTION THROUGH COMPONENT MATCHING AND PACKAGING.
- REDUCTION OF WALL RECOILS THROUGH A LINER.

C. STATUS OF Li_2CO_3 FABRICATION

- BOTH SODIUM CARBONATE AND POTASSIUM CARBONATE USED AS SINTERING AIDS.

- FABRICATED DENSITY ~ 87%.

- RAW MATERIAL IS ON ORDER.

- COATING IS NEEDED TO PREVENT RELEASE OF FISSION RECOIL TRITIUM.
 - SEVERAL COATINGS BEING CONSIDERED.
 - ~ 100 μm THICK.

- CLAMPING METHOD FOR BLOCKS DEVISED.

- SUPPORT STRUCTURE FOR BLOCKS DEVISED.

- FABRICATION OF BLOCKS TO BE COMPLETED BY OCT. '85.

- ALL FABRICATION TO BE COMPLETE BY JAN. '86.