RSIC Newsletter

RADIATION SHIELDING INFORMATION CENTER

OAK RIDGE NATIONAL LABORATORY

OPERATED BY UNION CARBIDE CORPORATION • FOR THE U.S. ATOMIC ENERGY COMMISSION

POST OFFICE BOX X •
OAK RIDGE, TENNESSEE 37831

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Knowledge once gained casts a light
beyond its own immediate boundaries. --- Tyndall

SPECTRUM OF PROMPT GAMMA RAYS FROM THERMAL FISSION OF ^{235}U*

The energy spectrum of gamma rays from the fission of ^{235}U is necessary for reactor shielding and heating calculations. The data generally used for this purpose were obtained from a preliminary evaluation in 1958 of partial results from an experiment which used a multiple-crystal scintillation spectrometer operated in ~60 nsec coincidence with a fission chamber exposed to thermal neutrons from the Oak Ridge National Laboratory BSF thermal column, reported by Maienschein et al. at the 1958 Geneva Conference. Since that preliminary publication, additional fission data were accumulated, extensive spectrometer calibrations were performed, more detailed background corrections were made, and the effects of non-unique spectrometer response have been unfolded properly using the FERD system of W. R. Burrus. The resulting data presented here should be used in preference to that presented at Geneva.

Figure 1 illustrates the spectrum for the energy region from 0.3 to 7 MeV, with the upper and lower 2/3 confidence limit shown by the two lines (straight lines join the points output by the unfolding procedure). Some of the 1958 data are shown as points for comparison, and indicate that in some energy regions the earlier analysis had systematic difficulties causing errors in the range 10-20%. Table I lists the numbers of photons observed in various broad energy intervals. In the figure and table the spacing between the upper and lower confidence limits includes propagated "counting statistics" as well as uncertainties inherent in the unfolding process, but does not include systematic

*The data presented here will appear in the paper by R. W. Peelle, W. Zobel, and F. C. Maienschein in Trans. Am. Nucl. Soc. 12(1) (1969). We are grateful to them for making the data available prior to publication.

uncertainties amounting to ~6%. The resolution associated with the plotted data is ~1.5 times larger than the interval between the vertices on the lines representing the confidence limits. Examination of the raw pulse-height spectra with its narrower resolution did not reveal more structure.

Work is continuing to clarify the uncertainties and to derive spectral results from additional data covering the range from .01 to .80 MeV.

Table I. Fission Gamma-Ray Intensities in Broad Energy Groups[a]

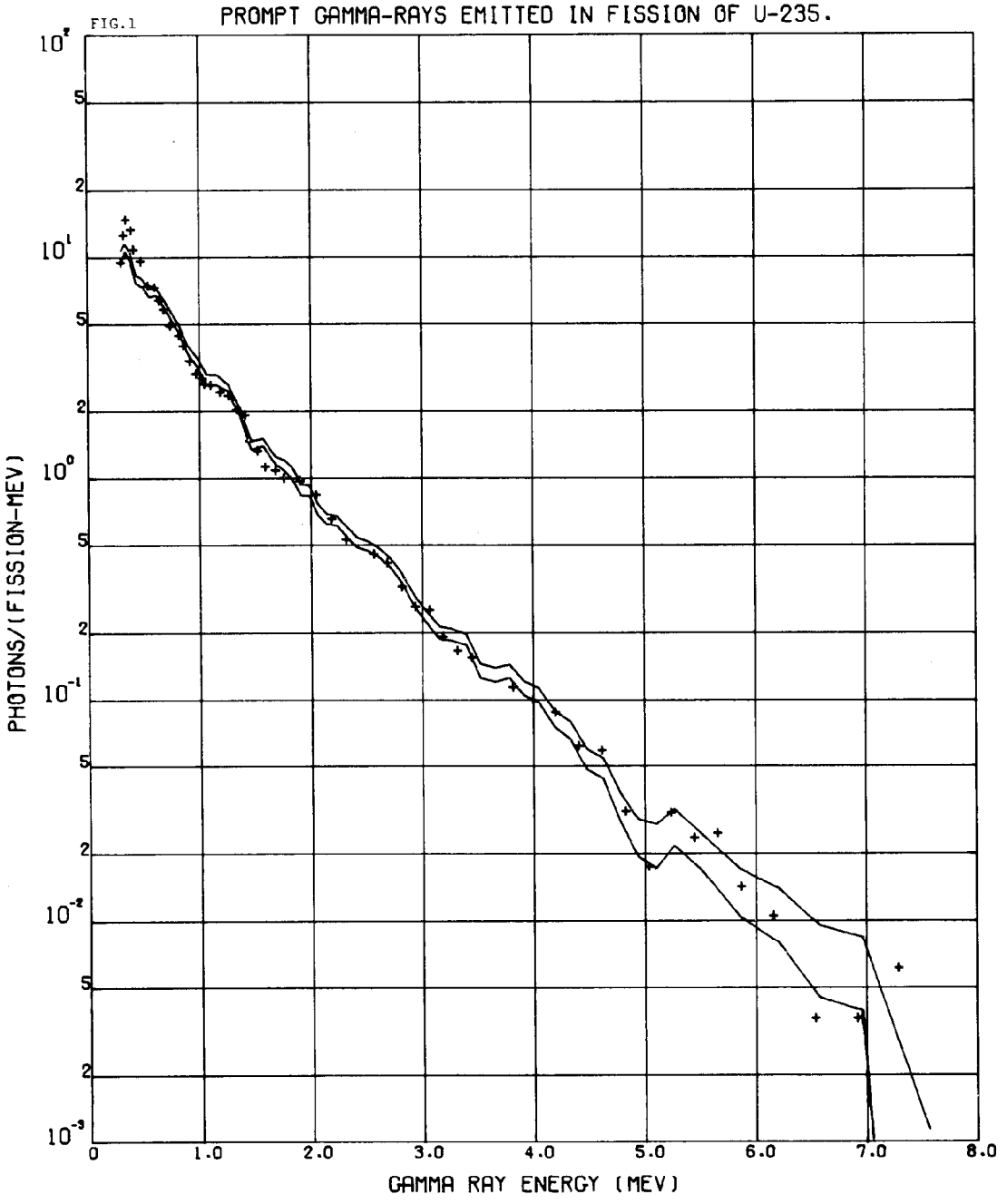
Energy Range (MeV)	Photon/Fission	MeV/Fission
0.3 - 1.0	4.55 ± .2	2.66 ± .1
1.0 - 1.5	1.18 ± .05	1.44 ± .06
1.5 - 2.0	.570 ± .025	.98 ± .04
2.0 - 2.5	.314 ± .017	.70 ± .04
2.5 - 3.0	.194 ± .009	.531 ± .026
3.0 - 4.0	.161 ± .005	.551 ± .015
4.0 - 5.0	.0586 ± .0023	.256 ± .010
5.0 - 6.0	.0197 ± .0023	.107 ± .012
6.0 - 7.2	.0093 ± .0020	.060 ± .012
7.2 -10.5	.0005 ± .0012	.005 ± .012
0.3 -10.5	7.14 ± .23	7.17 ± .10

[a]Listed uncertainties do not include systematic effects, estimated to be ~6%.

RSIC STAFF MEMBER TO VISIT IN EUROPE

Mrs. Betty F. Maskewitz, RSIC Codes Coordinator, will leave May 11 for Europe where she will work with the ENEA Computer Programme Library (ENEA CPL) at Ispra, Varese, Italy, and will also visit at IAEA Headquarters in Vienna and at several nuclear installations on behalf of the Information Center. Johnny Rosen, who heads the ENEA Library, has issued an open invitation to members of the European shielding community to come to Ispra for conferences on shielding codes while Mrs. Maskewitz is there. She will be at the Library from May 22 through June 15.

FIG.1


PROMPT GAMMA-RAYS EMITTED IN FISSION OF U-235.
PHOTONS/(FISSION-MEV)
GAMMA RAY ENERGY (MEV)
10²
5
2
10¹
5
2
10⁰
5
2
10⁻¹
5
2
10⁻²
5
2
10⁻³
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0

SODIUM-23 BACK IN DLC-2

Neutron 99-group cross sections for Sodium-23, based on the Pitterle ENDF/B evaluation, are now available in the RSIC DLC-2 data library. The original set was in error due to a difficulty in the SUPERTOG code.

NEW CODE PACKAGES AVAILABLE

Operable, tested with a sample problem, and available for distribution are the following code packages:

CCC-109/SOSUM — Multigroup Beta and Gamma-Ray Energy Sources from Radioisotope Activities Code, contributed by Atomics International, Canoga Park, California (AI-AEC Memo-12693)

CCC-110/AIRTRANS — Monte Carlo Three-Dimensional Complex Geometry Time-Dependent Shielding Code, contributed by United Nuclear Corporation, White Plains, New York, and Lockheed Missiles and Space Company, Sunnyvale, California - Versions for CDC 1604 and UNIVAC (LMSC/A888747, UNC 5179)

CCC-111/FLORA — Calculation of the Contributions of Fluorescence Radiation, contributed by Douglas Missile and Space Systems Division, Santa Monica, California (DAC-60654)

CCC-112/SAND — Neutron Flux Spectra Determination by Multiple Foil Activation - Iterative Method, contributed by Battelle Northwest Laboratories, Richland, Washington; Atomics International, Canoga Park, California; Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico; TRW Systems Group, TRW, Inc., Redondo Beach, California; and General Electric Company, Santa Barbara, California - Versions for UNIVAC, IBM 360/75, and CDC 6600.
(AFWL-TR 67-41 Vol. I-IV, BNWL-855, Computer Sciences Corp.-Informal Notes)

CCC-113/ATHENA — Monte Carlo Radiation Transport and Gamma-Ray Heating Code in Complex Three-Dimensional Geometries, contributed by United Nuclear Corporation, White Plains, New York, and NASA Lewis Research Center, Cleveland, Ohio (UNC-5148)

CCC-114/SAM-C Monte Carlo Time_Dependent Three-Dimensional Complex Geometry (Combinatorial) Shielding Code System, contributed by Mathematical Applications Group, Inc., White Plains, New York; U. S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland; and U. S. Army Nuclear Defense Laboratory, Edgewood Arsenal, Maryland
(MAGI-6701)

ADDED TO CCC-48/QAD

Brown Engineering Company, Huntsville, Alabama have added their version of QAD (QAD-5K) to the code package, described in BE-TN R1-251. Milo Solomito of Neutron Physics Division, ORNL, contributed his QAD versions as described in ORNL-4181: QAD-P5A, QAD GEOM, QAD-P5A with LiH QAD GEOM Cylindrical and Spherical.

PERSONAL ITEMS

Fritz Schmidt recently completed his work at RSIC and has returned to the Institut für Kernenergetik Universität, Stuttgart, Germany. Fritz prepared a review of the use of concrete as a neutron shield which will be published as ORNL-RSIC-26.

Mrs. Mildred Landay has replaced Mrs. Patti Callaghan Gray as RSIC secretary. Mrs. Landay has been an RSIC staff member for two years.

M. K. Drake, formerly with Gulf General Atomic, is now with the Brookhaven National Laboratory National Neutron Cross Section Center. Marvin is the evaluator of several recently developed cross section libraries of interest to shielders.

Radiation Research Associates have recently moved to 3550 Hulen St., Fort Worth, Texas 76107, phone 817-731-2711.

Congratulations are extended to Richard W. Enz on his promotion to Major, USAF. Dick monitors RSIC on behalf of the Defense Atomic Support Agency.

VISITORS TO RSIC

Visitors to RSIC during the month of March are: Philip Bland, Westinghouse Advanced Reactor Division, Madison, Pa.; Wilbur Bunch, Batelle Northwest Laboratories, Richland, Washington; J. C. Bailey and C. F. Newlon, ORGDP, Union Carbide Nuclear Division, Oak Ridge, Tenn.; Richard B. Waite, Stearns-Roger Corp., Denver, Colo.

APRIL ACCESSION LIST OF LITERATURE

The RSIC is now aware of the literature cited in the following list. This literature has either been obtained by RSIC or has been placed on order. When received, this material will be examined and assigned to various files if suitable for our information system. The accession list is divided into three fields (1) reactor and weapons shielding, (2) space and accelerator shielding, and (3) shielding computer codes. These titles are announced before processing and indexing so that there will be no delay and can serve as a prompt announcement of current literature.

RSIC is not a documentation center. Copies of the literature cited must generally be obtained from the author or from a documentation center such as the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

RSIC maintains a microfiche file of literature entered into its information system. Computer searches of this system (which produces a special bibliography) and duplicate microfiche copies of the literature in our file are available upon request. Naturally, we cannot supply copies of literature which is copyrighted (such as books or journal articles) or whose distribution is restricted. Neither service is yet available for the codes literature.

REACTOR AND WEAPONS SHIELDING

AAEC/TM-474

Inelastic Scattering of Neutrons - Quasi-Compound Nucleus Theory
W. K. Bertram
August 1968

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W. K. Bertram
September 1968

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Calculation of Fast Neutron Flux in Reactor Pressure Tubes and Experimental Facilities
P. C. Barnett
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Evaluated Neutron Cross Sections for Copper-63, Copper-65, and Natural Copper
J. M. Otter, R. S. Hubner, R. W. Campbell, C. L. Dunford, H. Alter
December 1968

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The Nuclear Application of the MAGIC-SAM C Target Analysis Technique to the M60A1 and the MBT-70: Volume IV - Free-Air Neutron and Gamma Fluence and Dose Results from Selected Hypothetical Low-Yield Weapons.
R. A. Marking — U.S. Army Aberdeen Research and Development Center
January 1969 — Army Material Systems Analysis Agency
Aberdeen Proving Ground

AMSAA-TR-9

The Nuclear Application of the MAGIC-SAM C Target Analysis Technique to the M60A1 and the MBT-70: Volume II - Nuclear Element Data.
E. Wiant
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ANL-7462

ENDF/B Neutron Cross-Section Data for Natural Helium (ENDF-125)
E. M. Pennington
October 1968

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Design and Construction of a Radiation Laboratory
C. F. Parrish

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Radiation Shielding for Small Power Sources of 170-, 171-Tm.
S. M. Sanders,Jr.; W. J. Kerrigan; E. L. Albenesius
January 1969

DP-MS-67-120

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C. A. Wilkins, R. D. Kelsch
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Numerical Methods for Reactor Calculations
R. O. Fornaguera
January 1967

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Scattering Process Approach to Neutron Spectrum in Fast Reactor
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J. Mennig, J. T. Marti
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Evaluation of U-235 Cross Sections with Numerical Analysis of Integral Experiments
R. C. Traylor
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Feasibility Study of Using LiF Detectors in a Neutron Flux Integrator
A. S. Lazanoff, J. E. McLaughlin
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Procedures for Estimating the Errors in Neutron Spectra from Bonner Multisphere Measurements
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IKF-21 (In German)

Energy Distribution and Dose Rate of Gamma Rays from Radioactive Clouds on the Earth's Surface
A. Schmidt
September 1968

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Transport Study of Neutron and Photon Attenuation Through Lithium Hydride and Tungsten Spherical Media
J. J. Peoples, D. Fieno
January 1969

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Application of Modified Engineering Method Techniques to Skyshine Radiation Measurements
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Monte Carlo Path Length Selection Routines Based on Some Specific Forms of the Importance Function
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Neutron Fission and Capture Cross-Section Measurements for U-233 in the Energy Region 0.02 to 1 eV
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Determination of the Radiation Field in Nuclear Reactor Shields on the Basis of Measurements with a Restricted Collimated Beam (Part I)
G. Thuro, H. Patzelt
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A Method for the Measurement of Increment Factors for Gamma Radiation in the Energy Region of 0.5 to 15 MeV
W. Futtermenger
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R. Feibig
1967

ORNL-TR-1949 (N69-11283) (Atomkernergie, 12(4),20-24 (1967) (in German))

An Analytic Solution of the Multilayer Problem in the Buildup Calculation
W. Zumach
1967

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Study of the Decay of Photoneutrons in Beryllium After a Fission of Uranium-235
H. Winter, H. Deledicq
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Investigation of Gas Produced by the Nuclear Irradiation of Barytes Concrete Containing a Boron Additive
A. R. Cordero
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A Tabulation of Fission Nuclides VS Selected Time Periods After Fission, Listed in Order of Decreasing Gamma Ray Energy Intensity
J. L. Lemmons, P. O. Matthews
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Monte Carlo Calculation of the Spectrum of Gamma Radiation from a Collimated Co-60 Source
E. E. Morris, A. B. Chilton
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An Empirical Formula for Concrete Slab Penetration by Plane Parallel Gamma-Ray Beams
G. R. Thayer, R. W. Roussin, A. B. Chilton
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A. L. Kaplan
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Experimental Analysis of Interior Partitions, Apertures and Non-uniform Walls
J. Velletri, R. Spring, J. Wagoner, H. Gignilliat
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BETON ZHELEZOBETON, No. 4, 20-21 (1968) (In Russian)

Heavy Plastic Concrete: Material for Radiation Shielding
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DEFEKTOSKOPIYA, No. 5 48-51 (1968) (In Russian)

Spectral Angular Distribution of Cs-137 Gamma Radiation Behind Cylindrical Steel Barriers
P. L. Gruzien, L. A. Drabkin, L. I. Kosarev

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Dose Distributions in Phantoms Exposed to 2.95-MeV Neutrons
C. E. Clifford

HEALTH PHYS., 16, 47-56 (Jan. 1969)

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Ivan Birchall

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Tables - Compendium of Thermal-Neutron-Capture γ-Ray Measurements. Part III. Z=68 to Z=94 (Er to Pu)
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K. Shure, J. A. O'Brien, D. M. Rothberg

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Shielded Gamma-Irradiation Plants
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Multigroup Integral Equation System for the Description of Neutron Transfer
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Angular Distributions of γ-Ray Doses Outside Graphite Containing a 4.43 MeV Source
V. G. Zolotukhin, B. A. Efimenko, E. S. Matusevich, S. S. Omarov

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G. M. Bozin, S. P. Degtyarev, B. I. Sinitsyn, V. V. Tarasov, V. K. Tikhonov, S. G. Tsypin

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THESIS

Experimental Determination of Gamma-Ray Response Functions for the KSU Spectrometer System
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Thesaurus of Engineering and Scientific Terms
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Avail.: Engineers Joint Council, 345 E. 47th St., New York,N.Y.10017

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Radionuclides
P. Sandru, A. Topa
1968 Bucharest, Edit. Acad. Republicii Socialiste Romania

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Handbook on Shielding Against Gamma Radiation of Fission Products
N. G. Gusev (In Russian)
1968 Moscow, Atomizdat

SPACE AND ACCELERATOR SHIELDING

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The Radiation Response of Tissue Equivalent Dosimetry Systems to 60 MeV Proton Beams
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F. P. Cowan
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A. G. Stanley, J. L. Ryan
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Tables for the Determination of the Lateral Shielding Requirements of High Energy Accelerators
K. O'Brien
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High Energy Muon Inelastic Scattering
C. M. Hoffman, A. D. Liberman, E. Engels, Jr., D. C. Imrie, P. G. Innocenti, R. Wilson, C. Zaijde, W. A. Blanpled, D. G. Stairs, D. Drickey
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A Universal Monte Carlo Method for Solution of Electron Transport Problems
S. Wittig
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Scheme of Calculation of Intranuclear Cascades
V. S. Barashenkov, K. K. Gudima, Toneev
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V. S. Barashenkov, K. K. Gudima, V. D. Toneev
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V. E. Dudkin, E. E. Kovalev, N. R. Novikova, V. I. Ostroumov, Iu. V. Potapov, S. S. Skvortsov, L. N. Smirennyi
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J. J. Singh
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High-Energy Muon Transport and the Muon Backstop for a Multi-GeV Proton Accelerator
R. G. Alsmiller, Jr., J. Barish
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R. G. Alsmiller, Jr., J. Barish
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Calculation of the Neutron and Proton Spectra from Thick Targets Bombarded by 450-MeV Protons and Comparison with Experiment
R. G. Alsmiller, Jr., J. W. Wachter, H. S. Moran
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Calculation of the Energy Deposited by Nucleons in a Spherical Phantom and Comparison with Experiment
D. C. Irving, R. G. Alsmiller, Jr., H. S. Moran
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On the Stopping of Fast-Moving Particles in Passage Through Matter
F. Bloch
Trans. January 1968

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Characteristics of the Interaction of High-Energy Nucleons with Nuclei
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E. Hara

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The Effects of Multiple Coulomb Scattering and Range Straggling in Shielding Against Solar-Flare Protons
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Measuring the Spectrum of Scattered Neutrons in a Synchrocyclotron
L. R. Kimel', M. M. Komochkov, V. P. Sidorin, V. N. Smirnitskii, B. S. Sychev

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G. Joseph
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In: Department of Atomic Energy, Symposium on Cosmic Rays, Elementary Particle Physics and Astrophysics, 10th, Aligarh Muslim University, Aligarh, India, December 12-16, 1967, Proceedings

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K. D. Lathrop
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M. E. Battat, D. J. Dudziak, H. R. Hicks
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