The Abdus Salam
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United Nations
Educational, Scientific and
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International Atomic Energy Agency

1930-4

Joint ICTP-IAEA Advanced Workshop on Model Codes for Spallation Reactions

4 - 8 February 2008

Introduction and Aim of the Meeting

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Introduction and Aim of the Meeting

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Trieste – Italy, February 4 - 8, 2008

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- The importance of spallation reactions
- The models and state-of-the-art particle transport systems
- Why do we need model validations ?

The importance of spallation reactions
-------- in general --------

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Computer simulation opens up new potentials to study physical and technical issues.

Computer simulation is sometimes the only way to understand the complexity of physical phenomena.

The classical categories – theory and experiment – nowadays are completed by a third catagory – **THE COMPUTER SIMULATION.**

BUT not to misunderstood:

Computer simulation cannot substitute experiments. It extends the field of science and enables experiments in a hypothetical world.

The simulation models used, must be validated against experiments to demonstate their realibility, accuracy, and their predictive power.

The importance of spallation reactions

--------the applications--------(1)

High intensity spallation sources:

SINQ (Switzerland), 0.6 GeV, 1-1.5 MW,

SNS (USA), 1.0 GeV, 1-1.5 MW

JPARC (Japan), 3.0 GeV, 1 MW and 50 GeV hadron facility

ADS, ADTT, waste management, transmutation, benchmark experiments:

e.g. MEGAPIE, MUSE, Race-ISU, YALINA-booster etc.

New accelerator facilities:

e.g. GSI-FAIR, SPIRAL

Materials in high intensity particle fields:

e.g. irradiation facilities, rare isotope production, radiation damage etc.

Safety and radiation protection:

e.g. shielding, radiation fields, dosimetry etc.

The importance of spallation reactions

--------the applications--------(2)

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- Medium and high energy detector development for running or future accelerator projects

- Astrophysics, space science and technology

- IAEA activities in the area of small proton accelerators and their applications

State-of-the-Art
Particle Transport Codes

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	MCNPX	PHITS	FLUKA	GEANT4	MARS
version	2.6	2.09	2006.3	4.9.1	15
institution	LANL	RIST GSI	CERN INFN	CERN INFN KEK/SLAC	FNAL
cost	free	free	free	free	free
manual pages	470	180	390	280	150
language	Fortran90/C	Fortran77	Fortran77	C++	Fortran95/C
parallel processing	yes	yes	yes	yes	yes

web site or contact	
MCNPX	http://mcnpx.lanl.gov/
PHITS	http://rcwww.kek.jp/research/shield/phits.html
FLUKA	http://fluka.org
GEANT4	http://geant4.web.cern.ch/geant4/
MARS	http://www-ap.fnal.gov/MARS/

Physics Models and some Features

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	MCNPX	PHITS	FLUKA	GEANT4	MARS
particles	34	38	68	68	41
energy loss	Bethe-Bloch	id.	id.	id.	id.
scattering	Rossi	Moliere	Moliere	Lewis	Moliere
straggling	Vavilov	Vavilov	custom	Urban	custom
Cherenkov	no	no	yes	yes	no
low energy neutrons	cont. ENDF	cont. ENDF	72 multi-group	cont. ENDF	cont. ENDF
low energy protons	cont. ENDF models	models models	models models	models models	models models
used models e.g.	Bertini ISABEL INCL/CEM LAQGSM FLUKA89	Bertini GEMJAM JAM/JQMD >3GeV	PEANUT DPMJET Glauber neutrinos	Bertini INCL ABLA GEM GHEISHA	CEM LAQGSM DPMJET
other features					
delayed decay of	$n's$ / $\gamma's$	$n's$	$\beta's$ / $\gamma's$	$\alpha's$ / $\beta's$ / $\gamma's$	$\gamma's$
eigenvalue	yes	no	no	no	no
burnup	yes	no	no	no	no
fields E, B	yes	yes	yes	yes	yes

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Other well - known particle tranport systems

name	purpose of the system	main authors
CALOR	calorimeter design / spallation sources	Gabriel et al.
EA-MC	ADS and energy amplifying	Kadi et al.
HERMES	spallation sources / calorimeter design	Cloth et al.
LCS	spallation sources / general purpose	Prael et al.
SHIELD	general purpose / spallation	Sobolevsky et al.
TIERCE	general purpose / spallation	Bersillon et al.

Examples of Event generators

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INC (intra-nuclear-cascade ≤3 GeV)	QMD
Bertini	JQMD
CEM	QMD-SDM
INCL	QMD, BUU
ISABEL	SMM

Evaporation and fission

ABLA / ABRABLA	GEM
ALICE / ASH	GEMINI
EVAP-versions	JULIAN /PACE
ORNL-fission	RAL-fission

Intra-nuclear-cascade + evaporation

BRIC / DISCA / MICRES

Aim of the Workshop

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Demonstration and discussion of the state-of-the-art INCE /QMD event generators

- **Model dependent and critical parameters, validity and deficiency etc.**
- **What model could be named as standard model in the energy range between 0.1 up to 3.0 GeV ?**

Is it a dream to have only one model ??

Presentations of recent thin target experiments

- **Double differential cross sections, reaction rates, multiplicities, excitation functions, residuals etc.**
- **Availability of the experimental data, corrections, accuracy etc.**

Aim of the Workshop

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Discussion, definition /or establish a BENCHMARK on spallation reactions of ‚thin' targets

- Defining the experimental data, which data should be used ?
- Which experiments ?
- Making a selection !!
- What is the best format to distribute the data ?
- Who should be responsible on collecting the data and will retrieve/disseminate them?
- Figures of merit
- How much time is needed to finish and to present the BENCHMARK at a follow-up workshop?
- Who will participate ??