Why Neutronics R&D for ITER

*Standard Engineering Practice:

-Perform prototypical experiments to:
a) verify performance, b) obtain measure of safety factor

*Licensing and/or Engineering Review will require credible experimental verification of nuclear performance prediction

*Nuclear Data and Codes have deficiencies

-Neutronics Experiments during the past several years have confirmed this

*Importance

-Nuclear Heating: temperature and many temperature-dependent material properties, tritium diffusion, etc.
Can not use safety factor

-Radioactivity/Decay Heat
Safety, Waste Disposal, Maintenance
Can not use safety factor

-Radiation Shield/Streaming
Protection of Components
Protection of Personnel
Safety Factor is expensive where possible
Safety Factor can not be used in other areas

-Difficulties
-It has become evident that integral measurements for fusion neutronics are difficult
-Need to develop measurement and experimental techniques e.g. nuclear heating

Neutronics R&D for ITER

Key Neutronics Areas

1. Radiation Transport
   Penetrations Shield, Bulk Shield

2. Nuclear Heating

3. Radioactivity

4. [Tritium Heating]
   Test Program, Base Machine?

Required R&D

*Experimental Techniques and Measuring Methods

*Integral Measurements for Penetrations and Bulk Shield

*Integral Measurements for
   -Nuclear Heating
   -Radioactivity
   Concurrent with and/or separate from shield experiments

*Others
   Code Improvement (transport, response)
   -Basic Data Measurement and Evaluation
   -Basic Data Processing and Working Libraries

Leading Neutron Source Facilities*

Facility Intensity	Location	Mode of Operation	Type	Source
FNS	JAERI (Japan)	- Pulsed	-Point	3 x 10^{11} and 5 x 10^{12} n/s
		- Continuous	- Simulated Line Source	3 x 10^{11} n/s
FNG	Frascati (Italy/EC)	- Pulsed - Continuous	- Point	5 x 10^{11} n/s
TUD	Dresden (Germany/EC)	- Pulsed - Continuous	- Point	2 x 10^{11} n/s

Other facilities available:

Switzerland : LOTUS, S ~ 5 x 10^{12} n/s
Japan : OKTAVIAN, Osaka University, S ~ 5 x 10^{11} n/s
Germany : KfK, Karlsruhe, S ~ 10^{9} n/s
Russia : IAE, Kurchatov, Moscow, S ~ 5 x 10^{10} /s
MEPI, Moscow, S ~ 5 x 10^{10} n/s
KPI, Moscow, S ~ 5 x 10^{10} n/s
China : SWINPS, Chengdu, S ~ 10^{9} n/s
USA : ORNL, Oak Ridge, S ~ 10^{10} n/s
FNG, ANL, S ~ 10^{10} n/s
INEL, Idaho, S ~ 10^{8} n/s

Example
Proposed Distribution of Experiments by Facility

(Exact Distribution should be developed based on availability of facility and resources)

FNS (Fusion Neutronics Source):

- Thick Bulk Shield Experiments

Type	No of Expmts.
- W/O Openings/Gaps	12
- W/ Openings/Gaps	12

- In-conjunction measurements on Activation/Afterheat and Nuclear Heating
- Stand-Alone measurements on Activation/Afterheat and Nuclear Heating

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24

FNG (Frascati Neutron Generator):

- Thin Bulk Shield Experiments

Type	No of Expmts.
- W/O Openings/Gaps	6
- W/ Openings/Gaps	6

- In-conjunction measurements on Activation/Afterheat and Nuclear Heating

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12

TUD (Technical University at Dresden):

Type	No of Expmts.
• Biological Shield Experiments	2
• Stand-Alone measurements on activation/Afterheat	
• In- conjunction measurements in the biological shield experiments on nuclear heating and Activation/Afterheat	

2

Other Facilities

e.g. **LOTUS**

Develop schedule based on availability of facilities

US Interests in ITER R&D

(Areas we should go after)

*Lead Party for Analysis and Interpretation of experiments

- -Maintain reference codes and libraries
- -Analyze experiments performed by other parties on a common basis
- -Provide clear interpretation of results

*Lead Party for Development of Measurement and Experimental Techniques for Nuclear Heating and/or Radioactivity/ Decay Heat

*Collaborate with other parties (EC, Japan) on specific areas (Do not limit to one party)

*Support Role in other areas

Remarks on Neutronics R&D for ITER

* Specification of R&D Requirements should evolve from joint reviews by:

1. ITER Designers
2. Neutronics R&D Experts

* Execution of R&D:

-This area is ideal for 25% per party

-A plan should be developed taking into account strengths of each party

-Must encourage collaboration on R&D among parties (bilaterals, trilateral mechanisms do not now exist for ITER)

-Strongly Recommended:

*Analysis of Experiments should be carried out by a group different from the experimental group

*Preferably, there should be a group (party) responsible for analysis and normalization of all experiments

Recent/Near Term Communications

*IEA

-Agreement signed

Maekawa signed this year

-Meeting in Rome (September 92)

*InternationalNeutronics Workshop
(Frascatti, September 92)

-Discussions

-Forming International Workshop

*Expected Meeting in Tokyo

-End of March, 1993