## **List of Figures**

1.1	Schematic diagram of Accelerator Driven Sub-critical System (ADSs)[6]	3
1.2	Schematic diagram of International Thermonuclear Experimental	
	Reactor (ITER) [13]	5
1.3	A chart illustrating various nuclear reactions and their outgoing	
	particle spectra. The tags, D, C and P corresponds to the tags given	
	in Figure 1.4 [18].	6
1.4	Schematic diagram of an outcoming particle spectra contributing	
	from direct (D), compound nucleus (C) and pre-equilibrium (P) reac-	
	tions [18]	7
1.5	A general depiction of nuclear reaction on a target nucleus with	
	neutron being the projectile particle.	8
2.1	A flow chart of nuclear models available in TALYS-1.9 code	19
2.2	Events occurs from the neutron interact history	22
2.3	Flow chart of MCNP code	23
2.4	Program allows predefined or user-specified media.	30
2.5	The program checks to ensure the fractions sum to unity	30
2.6	Generate $Z_{eff}$ as a function of energy	31
2.7	Elect a predefined spectrum or insert a single valued energy of interest.	31
3.1	A schematic diagram of 14UD Pelletron Accelerator installed at	
	BARC-TIFR Facility.	39
3.2	A pictorial view of BARC-Purnima neutron generator facility [23, 24].	41
3.3	A pictorial view of the 6 meter irradiation setup at BARC-TIFR	
	Pelletron accelerator [21]	42
3.4	Schematics of a typical HPGe detector connected to a cooling dewar	
	[28]	44
3.5	A typical recorded spectrum of a standard ${}^{152}Eu \gamma$ -ray source denoted	
	with prominent $\gamma$ -lines	45
3.6	Pictorial view of typical source-detector counting setup at 14 UD	
	Pelletron facility	46
3.7	Pictorial view of a typical detector setup used at Purnima	47
3.8	Measured efficiencies for the detector used for (A) the ${}^{159}Tb(n,\gamma){}^{160}Tb$ ,	
	$^{113}In(n,n')^{113m}In$ , $^{115}In(n,2n)^{114m}In$ , $^{115}In(n,n')^{115m}In$ reaction cross-sections	
	at Pelletron BARC-TIFR, (B) ${}^{181}Ta(n, 2n){}^{180}Ta$ reaction at Purnima,	
	BARC,	47

3.9 A schematic diagram of the target irradiation setup at BARC-TIFR		
Pelletron with <sup><i>nat</i></sup> Li metal foil [21]	56	
3.10 Schematic diagram showing the arrangements used for the neutron irradiation.	57	
3 11 Typical neutron fluxes used for the present measurements repro-		
duced by using the liturature data [74]	59	
3.12 Neutron spectra generated from <sup><i>nat</i></sup> Li(p,n) reaction using 13, 16, 19		
and 22 MeV protons	60	
3.13 Neutron flux correction for the threshold energy reactions where		
$^{27}$ Al(n, $\alpha$ ) <sup>24</sup> Na reaction has threshold energy of 3.24 MeV labeled as A		
and ${}^{115}In(n, 2n){}^{114m}In$ reaction has threshold energy 9.11 MeV labeled		
as B and maximum neutron energy labeled as C	62	
3.14 Typically recorded $\gamma$ -ray spectrum for the Terbium sample $\ldots$	63	
3.15 Typically recorded $\gamma$ -ray spectrum for the Indium sample	63	
3.16 Typically recorded $\gamma$ -ray spectrum for the Tantalum sample $\ldots$	64	
3.17 Comparison of the experimentally measured ${}^{159}Tb(n,\gamma){}^{160}Tb$ reaction		
cross-section with literature data and the theoretical model codes .	64	
3.18 The experimentally measured ${}^{113}$ In(n, n') ${}^{113m}$ In reaction cross-section		
compared with the literature data [4,57–66], and theoretical nuclear		
models of TALYS-1.9 The default value of ldmodel 1 have been		
chosen to fit the present and previous data	66	
3.19 The experimentally measured $^{115}$ In(n, 2n) $^{114m}$ In reaction cross-section		
compared with the literature data [60,64,65,67–72], and theoretical		
nuclear models of TALYS-1.9 The default value of ldmodel 1 have		
been chosen to fit the present and previous data	68	
3.20 The experimentally measured $^{115}$ In(n, n') $^{115m}$ In reaction cross-section		
compared with the literature data [60, 63, 64, 67–69, 73–78], and		
theoretical nuclear models of TALYS-1.9 The default value of ldmodel		
2 have been chosen to fit the present and previous data	69	
3.21 Geometry used to simulate the neutron spectrum by using MCNP		
[32] code	70	
3.22 Excitation function of ${}^{181}Ta(n, 2n){}^{180}Ta$ reaction. A comparison of		
present data with the literature data [13–15, 87, 88] and the theoret-		
ical predictions using the TALYS-1.9 [46] code	72	
4.1 $\gamma$ -ray interaction with atoms	85	
4.2 A typical arrangement of the experimental setup used for the $\gamma$ -ray		
$(^{60}Co)$ measurements	92	
4.3 A cross-sectional view of simulation setup for neutron $(^{252}Cf)$ mea-		
surements obtained from the CAD-based Monte Carlo program:		
SuperMC [43–45]	93	
4.4 Mass attenuation coefficient of prepared concrete samples at ener-		
gies $10^{-2}$ to $10^5$ MeV using XCOM program.	95	
4.5 Mass attenuation coefficient of samples using MCNP code and XCOM		
program	96	
4.6 Comparisons of MCNP, XCOM, and experimental outcomes of sam-		
ples using ${}^{60}Co$ source.	98	

4.7 The effective atomic number of prepared concrete samples using	
Auto- $Z_{eff}$ software and direct method	99
4.8 The effective electron density of prepared concrete samples using	
Auto- $Z_{eff}$ software and direct method	100
4.9 Variation in half-value layer of concrete samples using the XCOM	
program	102
4.10 Variation in tenth value layer of concrete samples using the XCOM	
program	102
4.11 Variation in mean free path of concrete samples using the XCOM	
program	103
4.12 Removal cross-section of concrete samples using the NXcom program	.104
4.13 Comparison of measured removal cross-section of concrete sample	
with literature Bashter [50]	105