Power Plant Relevant Parameters Needed to Perform Nuclear Analysis for Dry Wall Concept

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- Parameters categorized according to nuclear subtasks:
  - General
  - Target and first wall neutronics
  - Shielding of FF optics/magnets and insulators
  - Activation of target and chamber

- List of parameters are posted on UW web site:

  http://fti.neep.wisc.edu/FTI/ARIES/AUG2000/nuclear_lae.pdf

  List will be updated as design proceeds and changes will be marked in red

- Currently available laser and HIB target parameters do NOT lead to net electric power of 1000 MW_e

- Nuclear group needs feedback from ARIES-IFE physics and engineering groups before October 1. Please E-mail changes/comments to:
  Laila El-Guebaly (elguebaly@engr.wisc.edu)

Initial List of Parameters (9/18/2000)

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General Parameters:

Driver	Laser (NRL)		HIB (LBNL)	
	Available	Power Plant Relevant*	Available	Power Plant Relevant
Driver energy (MJ)	1.3	~2.4	1.5	~6
Target gain	124	~180	100	~70
Target fusion yield (MJ)	161	~430	150	~430
Rep rate (Hz)	5-7	~6.2	5-7	~6
Fusion power (MW)	~ 1000	≤ 2677#	~ 1000	≤ 2580
Thermal power (MW_{th})	?	≤ 2891#	?	≤ 2790
Thermal efficiency	?	47# - 60%	?	45 - 60%
Driver power (MW_e)	?	< 304#	?	?
Driver efficiency	7.5%	7.5#%	20%	20%
Net electric power (MW_e)	<< 1000	1000	<< 1000	1000
Plant lifetime	40 FPY		40 FPY	
Availability	80%		80%	

* from literature and personal communications
# SOMBRERO parameters for 3.4 MJ laser energy, 118 gain, and 400 MJ yield

Initial List of Parameters (cont.)

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Target Neutronics:	**Laser**	**HIB**
Average neutron source energy	< 14 MeV	TBD
Average gamma source energy	< 6 MeV	TBD
Neutrons per fusion	< 1.05	TBD
Gammas per fusion	< 0.003	TBD
Neutron and gamma source spectra @ burn	Figs 1&2	TBD
FW Neutronics:		
FW radius	6.5 m or TBD	3-6 m or TBD
Neutron wall loading*	3.5 MW/m^2 or TBD	4-16 MW/m^2 or TBD
Candidate FW materials	C/C, SiC/SiC, SiC/C, FS, V	
Max. FW thickness:		
Non-metallic	1 cm	
Metallic	0.5 cm	
FW Lifetime criteria**	dpa, burnup, waste level, stresses, ...	
Blanket thickness#	1 m	
Concrete shield thickness	2 m	
Containment building thickness	2.5 m	

* for 400 MJ yield and 6 Hz

** Materials dependent

Consider one meter thick compatible breeding zone for n reflection.
Candidate breeders: LM and SB for both FS and composites; Li for V

Initial List of Parameters (cont.)

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Shielding of FF optics/magnets and insulators:

	Laser	HIB
Target diameter	1.95 mm	6 mm
# of beams	≥ 60*	2
# of penetrations	≥ 60	4
Penetration diameter	20 cm @ 6.5 m FW	~5 cm @ 3 m FW
FW area occupied by penetrations	< 0.5%	< 0.01%
GIMM location from target	30 m	> 25 m
FFM location from target	50 m	> 50 m
Mirrors f #	50 m	?
Laser beam diameter @ GIMM	~60 cm	?
Laser beam diameter @ FFM	~100 cm	?
GIMM bend angle	≥ 10 degrees	
Mirror thickness	?	
Mirror composition	Al/H_2O (75/25)	
FFM coating material	MgF_2 or ZnS	
Damage limit to GIM and FF mirrors	?	
Quadrupole magnets		HT S/C** ?
Magnet to target distance		~15 m
Magnet center from beam axis		30 cm
Fast n fluence limit to magnet		10^{19} n/cm^2
Fast n fluence limit to spinel insulator#		$4x10^{22}$ n/cm^2

* depends on heating limit to FF mirrors (5-8 J/cm^2)
** YBCO, GFF polyimide, CeO_2, SS, Ag, LN
# $MgAl_2O_4$ insulator for chamber wall and adiabatic lens. Limit is for 3% swelling

Initial List of Parameters (cont.)

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Activation:	**Laser**	**HIB**
Target burn time	50 ps	50 ps
Candidate target coating/ hohlraum	300 Å of Au, W, Pb, Ta, Al, or Ag	Au, Gd, Fe
Target constituents	D, T, CH	D, T, Be, Br
Target configuration	Fig. 3.a	Fig. 3.b
Candidate chamber gases	Xe,Kr,Ne,or Ar	Xe
Gas pressure @ RT	0.5 Torr	5 Torr

Yearly pulse sequence for scheduled maintenance:

Case I*: (mirrors annealed every year):

Irradiation period	9.5 months
Down time	2.5 months

Case II: (mirrors annealed every month):

# of irradiation periods	10
Duration of irradiation period	29 days
Down time between irradiation periods	2 days
Extended end-of-year down time	~2 months

* reference case

Initial List of Parameters (cont.)

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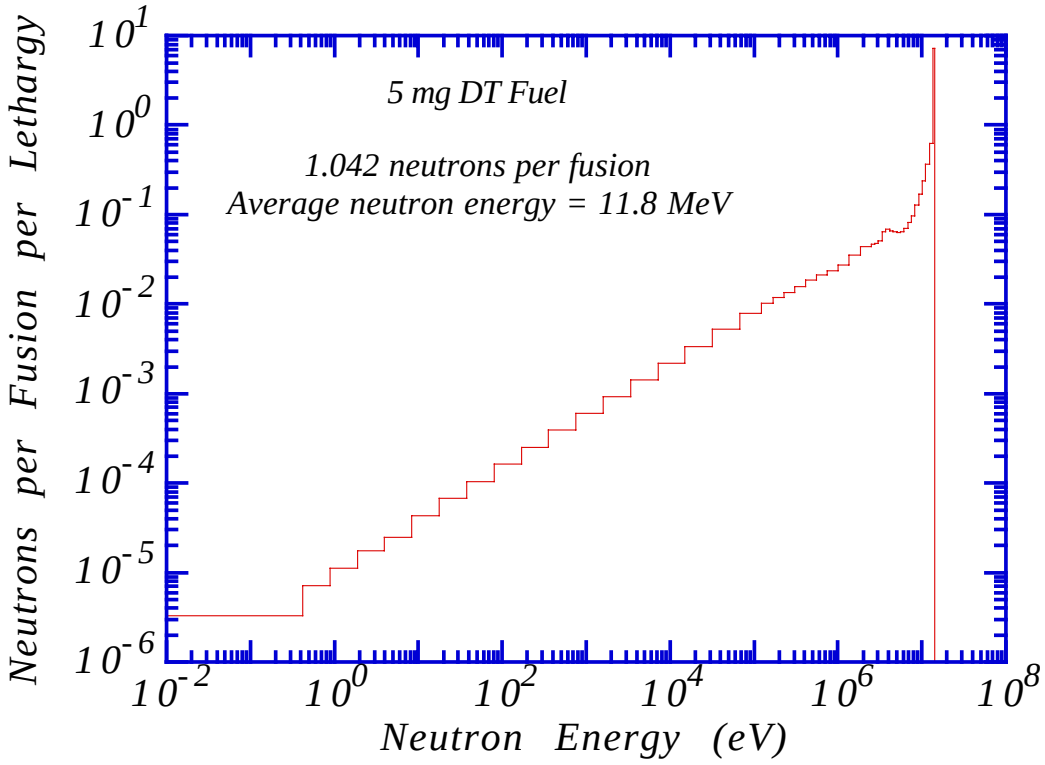

Fig. 1 Neutron source spectrum for LIBRA-SP* target

- Similar spectrum will be generated for Laser and HIB targets

* Light Ion Beam self-pinched design

Initial List of Parameters (cont.)

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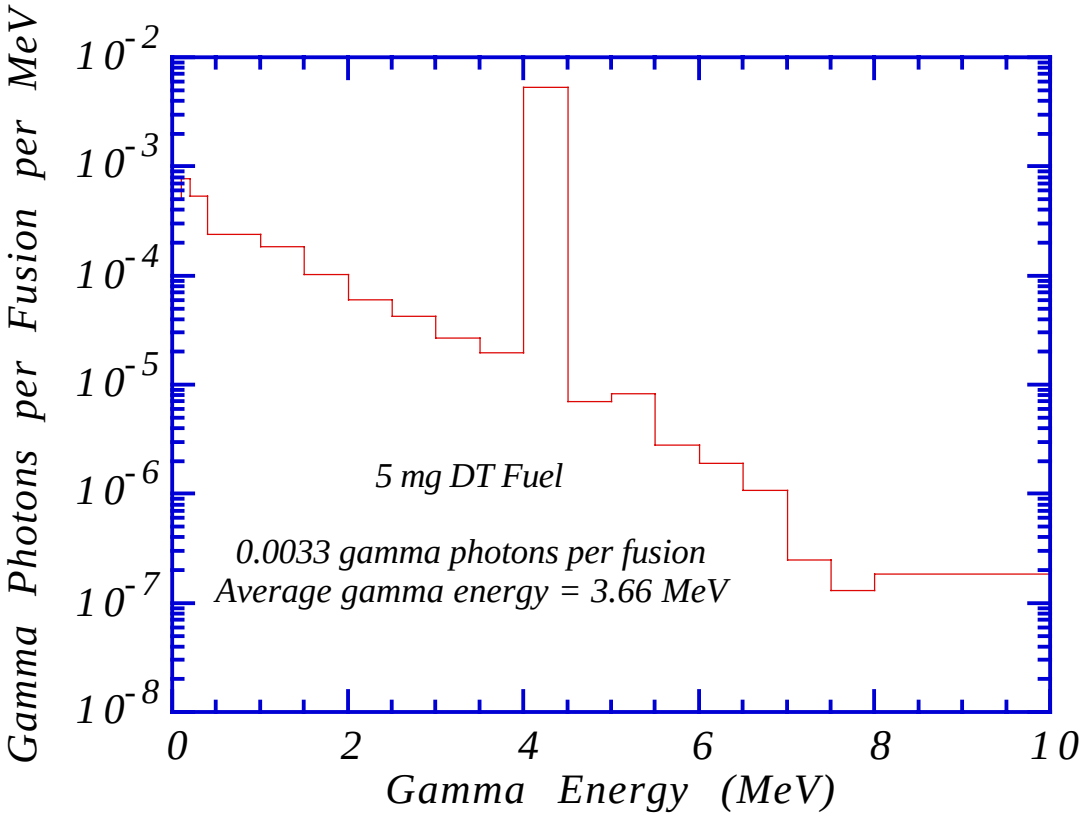

Fig. 2 Gamma source spectrum for LIBRA-SP* target

- Similar spectrum will be generated for Laser and HIB targets

* Light Ion Beam self-pinched design

Initial List of Parameters (cont.)

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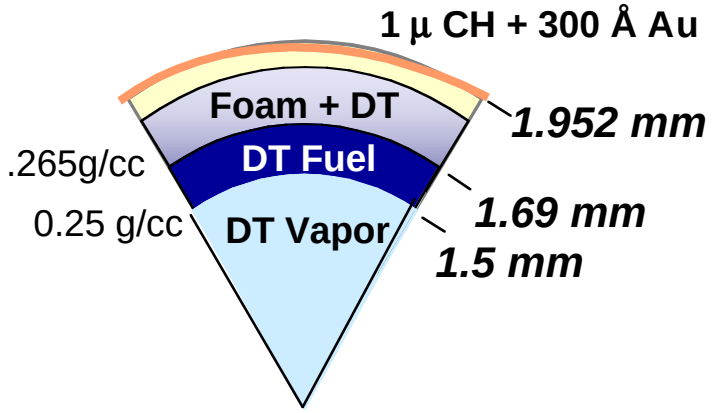

Fig. 3.a Schematic of NRL laser target configuration

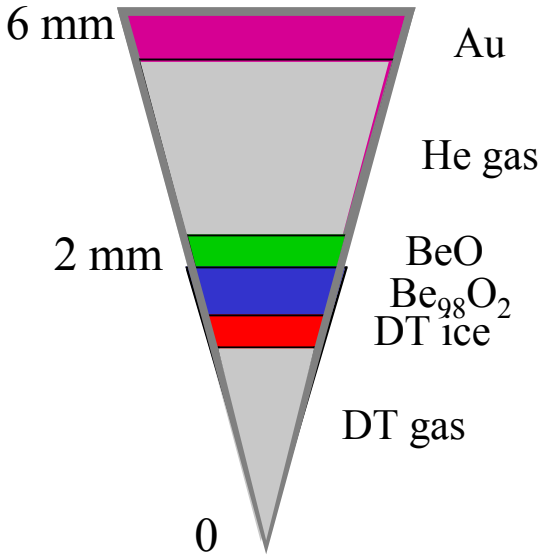

Fig. 3.b Schematic of HIB target configuration