Is it Possible to Have a TBR > 1.0 in a Small ICF Materials Test Facility?

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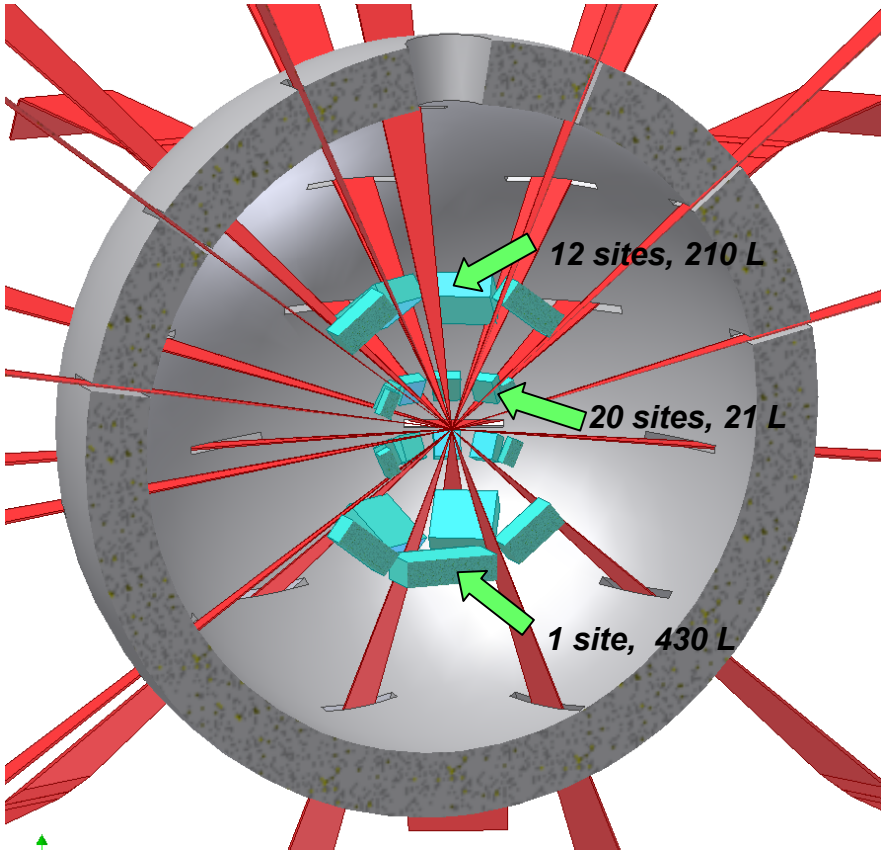
Design Parameters for an ICF Fusion Materials Test Facility

Laser energy:	250 - 500 kJ
Fusion power:	30 -150 MW
Rep Rate:	5 Hz
Energy partitioning	2% x-rays, 28% ions, 70 % neutrons
Chamber radius	5.5 m
NWL @ FW	0.055 - 0.28 MW/m^2



- Test objects at 1 m (50 dpa/y) have total volume of 420 L, area of 4.2 m^2- Coverage fraction 33%

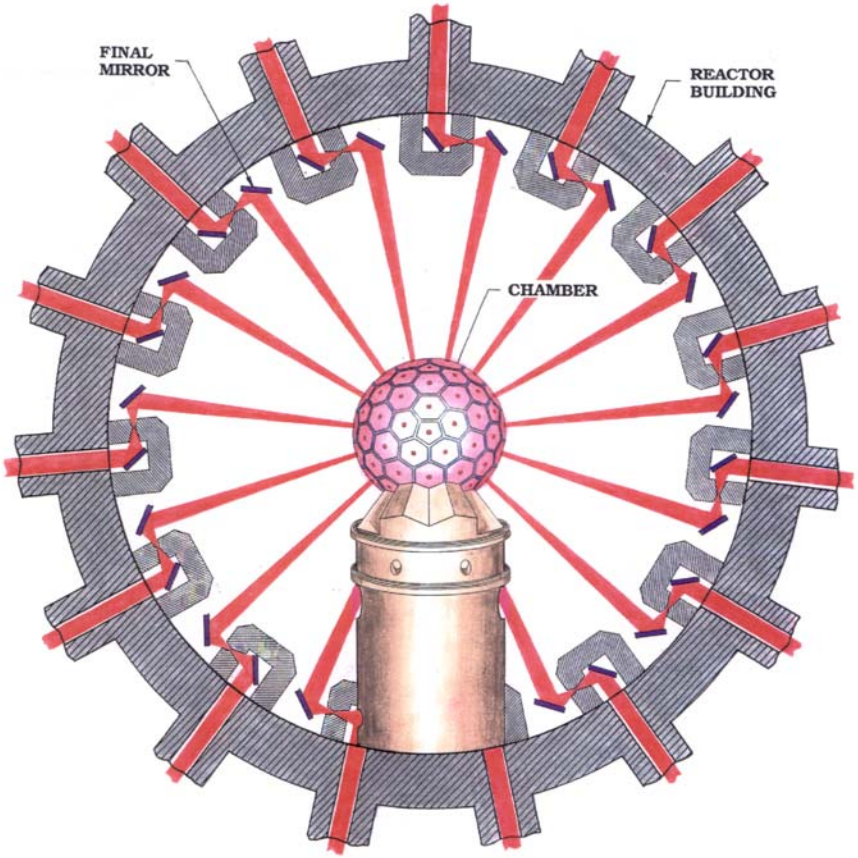
- Test objects at 2 m (12.5 dpa/y) have total volume 2,950 L, area 14.75 m^2 - Coverage fraction 29%

- Adding the 2.3% coverage of beam ports total lost coverage for breeding is ~64% and required local TBR will be ~3! ***Unachievable***

- Eliminating test objects at 1 m requires local TBR of 1.6. ***Feasible***

How Can We Achieve a Local TBR of > 1.6?

- In 1990 the design of a symmetrically illuminated, KrF laser ***tritium production facility*** SIRIUS-T was published.



References:

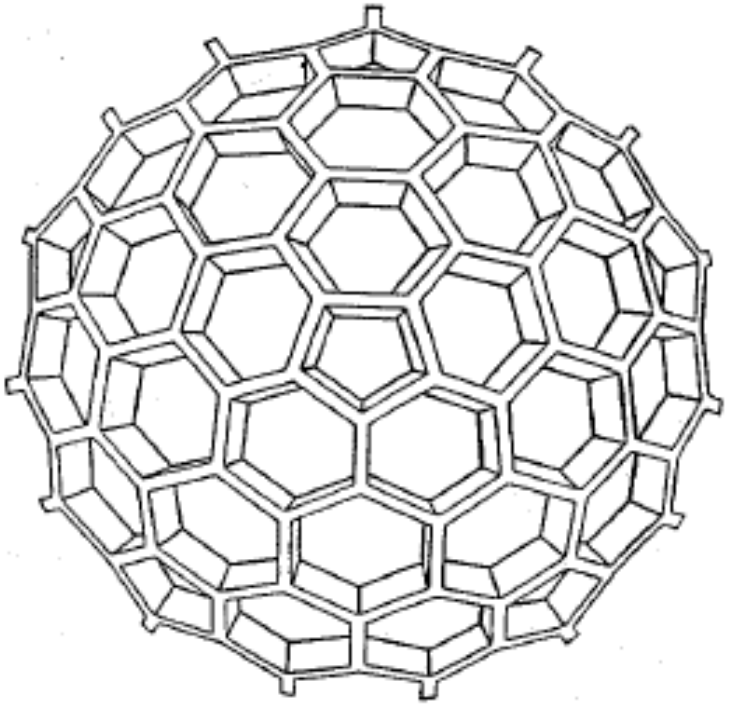
B. Badger et al., "SIRIUS-T, A Study of a Symmetrically Illuminated Inertial Confinement Fusion Tritium Production Facility," University of Wisconsin Fusion Technology Institute Report UWFDM-850 (1990).

Sviatoslavsky, M. Sawan, G. Moses, G. Kulcinski, et al., "SIRIUS-T, An Advanced Tritium Production Facility Utilizing Symmetrically Illuminated Inertial Confinement Fusion," Fusion Technology 19, 634 (1991).

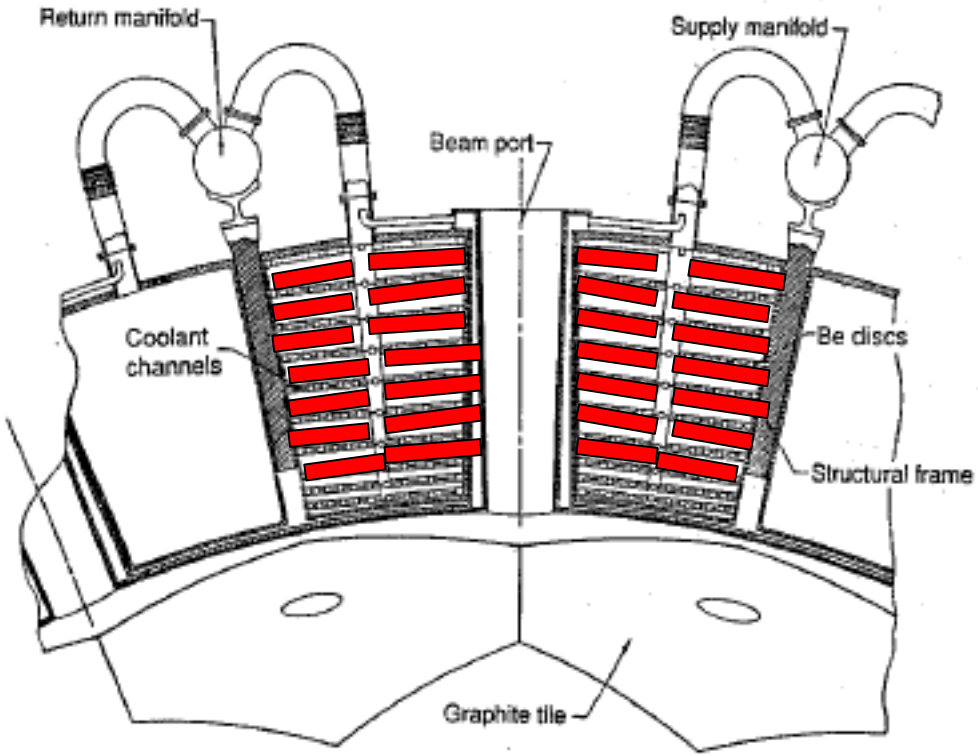
M. Sawan and E. Mogahed, "Neutronics and Thermal Analyses for the Breeding Blanket of the ICF Tritium Production Reactor SIRIUS-T," Fusion Technology 19, 747 (1991).

SIRIUS-T Breeding Blanket Design Can Work for New ICF Test Facility

A spherical structural frame supports 92 blanket modules, each with a beam port in the center

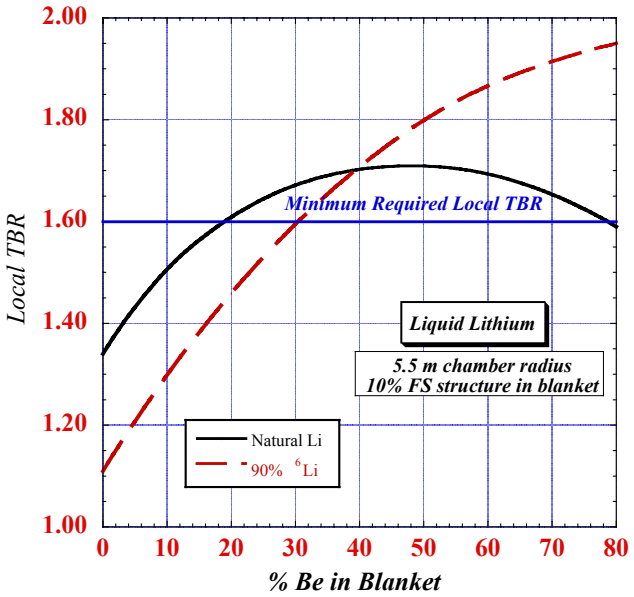


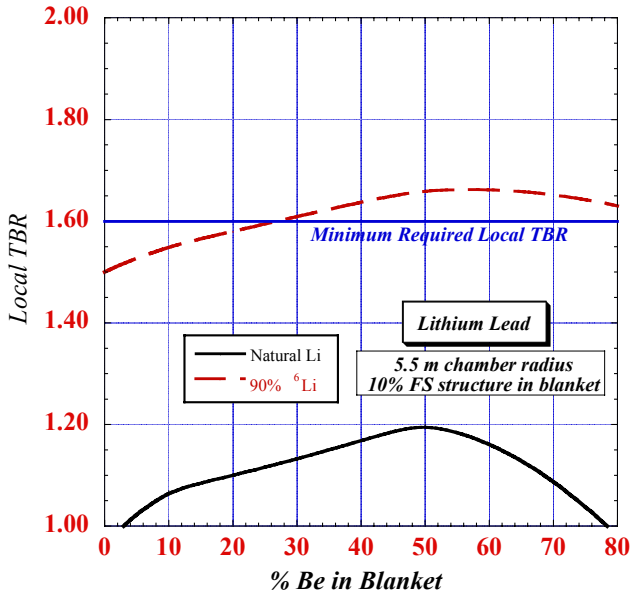
Chamber Structural Frame



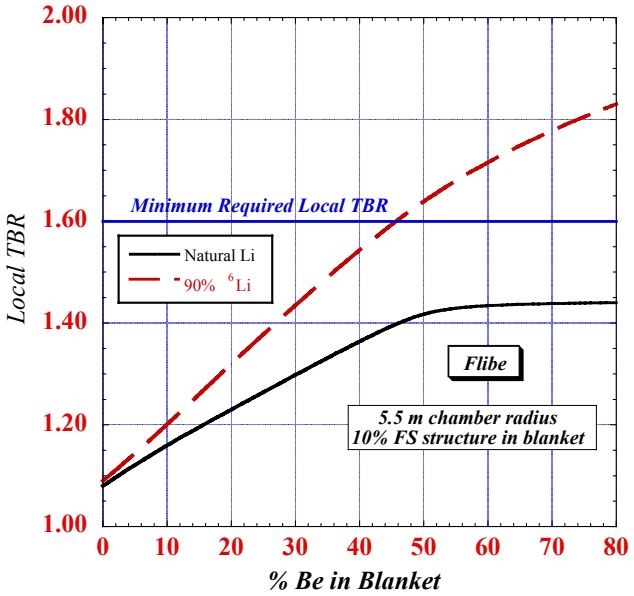
Cross-section of Blanket Module

Could a Local TBR >1.6 be Achieved?





1 m thick blanket with W armor on FS first wall



- Local TBR >1.6 can be achieved by adding Be in blanket (with conservative 10% structure content)
- Li has the highest breeding potential. > 20% Be needed for nat. Li and >30% Be required for enriched Li. Local TBR ~1.95 can be achieved with 80% Be and enriched Li allowing for more testing

- The Li in LiPb and Flibe should be enriched. >30% Be needed for LiPb and >50% Be required for Flibe

Conclusions

- Yes, it is possible to get a TBR >1.0 in a small ICF materials test facility.
- The use of enriched Li and Be can produce a TBR >1.0 if the test modules occupy < 45% of the solid angle surrounding the target.
- The use of natural Li and Be can produce a TBR >1.0 if the test modules occupy < 33% of the solid angle surrounding the target.

Non-Power KrF Fusion Facilities

	Fusion Materials Test Facility	Sirius-M	Sirius-T
Fusion Power-MWt	150	134	1000
Laser Energy-MJ	0.5	1	2
Gain	60	13.4	50
Rep Rate-Hz	5	10	10
Chamber Radius-m	5.5	2	4
Xe Pressure-Torr	??	1	1
FW-MW/m^2	0.28	2	4
Test Chamber-MW/m^2 @ 2 m	2	2	NA
Year Published	2006?	1988	1990