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HEAVY-ION FUSION SYSTEM ASSESSMENT PROJECT: Quarterly Status Report, January 1-March 31, 1986.

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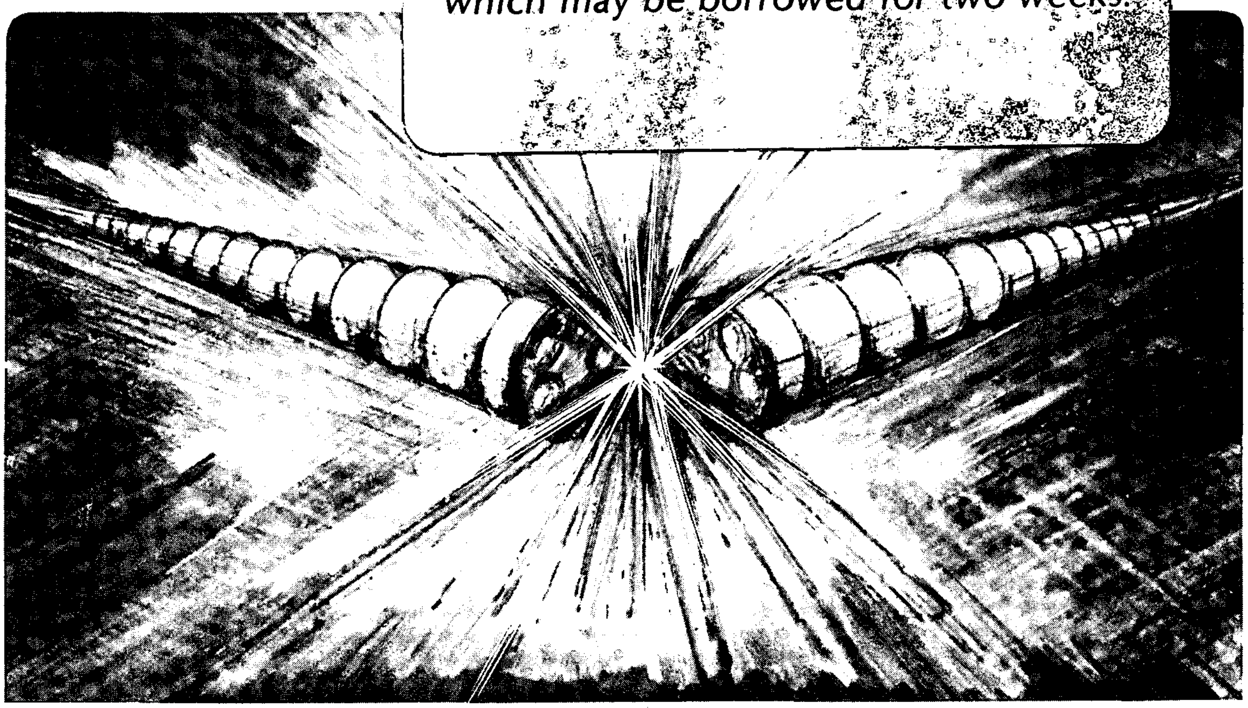

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HEAVY-ION FUSION SYSTEM ASSESSMENT PROJECT*

Quarterly Status Report, Jan.-Mar. 1986

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SYSTEM STUDY ACTIVITY

During the 1986 winter quarter, our efforts concentrated on the completion of the accerator system model and its incorporation into the system code ICCAMO developed at MacDonnell Douglas Co. This effort involved making a large number of runs with the accelerator design code LIACEP, analysing of the results, and communicating with MacDonnell Douglas. These runs extend the parameter space already incorporated into the system code and also cross check the system results which have been obtained. There have also been substantial modifications and extensions of the code model for the final focus and transport region of an HIF driver. This was necessitated by the observation that early ICCAMO results were giving unreasonably low predictions for the number and cost of beam lines. The reasons for this behavior are now understood and have been corrected. The initial ICCAMO runs reported to the full system study team in January incorporated the charge state +3 data we have previously described, and a significant C.O.E. reduction was achieved, as expected. At the time of that meeting, model changes were still being incorporated. However, their predicted effect was small.

The strategy of our accelerator cost analysis was based on an assumed target yield for a given fusion power. From these two parameters we then determined the required accelerator output beam parameters. We then varied some of the accelerator design parameters such as the number of beamlets, the undepressed tune, and the depressed tune. We found the minimum cost accelerator consists of 16 beamlets in the high voltage region (>200 MV) using the mass 200, charge state +3 ions. For the low voltage region (3MV < V < 200 MV) we found a cost savings could be achieved using 64 beamlets. The characteristics, performance and cost (in 1979 dollars), of the accelerator section of the driver are shown below in Table I. The costs of these accelerators for a given target yield are about half those obtained using the more conservative designs based on ion charge state +1. The cost of the accelerators using charge state +3 were then scaled from 1979 to 1985 dollars. These costs escalated 30% for the 300 MJ target yield case to 22% for the 1200 MJ target case. This escalation is probably an overestimate as the accelerator designs were not re-optimized for the new cost algorithms.

Table I. Accelerator Output Characteristics, Efficiencies and 1979$ Costs for 300, 600, and 1200 MJ Target Yields and 3000 MW Fusion Power using 200 amu, q = +3 Ions.
$\Phi = 1.0$ MV/m; $\sigma_0 = 85°$
Initial Voltage = 3 MV; Spot Radius = $0.1 \times W^{1/3}$ cm
Range = R (gm/cm^2); N = 16 beamlets, $V>V_c$

Yield, MJ	300	600	1200
Energy, (W) MJ	2.91	4.25	6.57
Gain (G)	103	141	183
$r^{3/2}R$, 10^3 cm$^{-1/2}$g	7.2	10.4	15.9
Emittance (ε_n), µm-rad	7.15	8.65	10.8
Ion Kinetic Energy, (E_i), GeV	10.12	11.46	13.24
Pulse Repetition Frequency, Hertz	10	5	2.5
64 Beamlet Cost to 50 MV, M$	108	124	162
64 to 16 Beamlet Transition Voltage (V_c), MV	133	160	180
ε_n/σ, µm-rad/degree, $V<V_c$	1.1	0.82	1.1
Depressed Tune (σ), $V>V_c$, degrees	7.5	10.5	10
Total Length, km	1.97	2.22	2.57
Total Efficiency (η)%	26.9	28.7	29.0
ηG	27.7	40.6	52.9
Total Cost, M$ (1979$)	551.5	633.1	748.7
Total Cost, M$ (1985$)	710.	790.	750.
Escalation, %	30	24	22

Several publications based on preliminary system study results have been recently completed and are appended here.

REFERENCES

1. Jack Hovingh, V. O. Brady, A. Faltens, D. Keefe, and E. P. Lee, "The Cost of Induction Linac Driver for Inertial fusion for Various Target Yields," Proceedings of the International Symposium on Heavy Ion Fusion, May 27-29, 1986, Washington, D.C., LBL-21350, HI-FAN-318, May, 1986.

2. J. Hovingh, V. O. Brady, A. Faltens, and E. P. Lee, "A Comparison of the Design and Costs of Induction Linac Drivers for Inertial Fusion Using Ions of Differing Mass," presented at the 1986 Annual Meeting of the American Nuclear Society, Reno, NV, June 15-19, 1986, LBL-20979, January, 1986.

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