Heavy Ion Driver Model Update*

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ARIES IFE Meeting
LLNL
March 8-9, 2001

* This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.
Modifications have been made to the heavy ion driver systems code

• More design parameters can be varied in a single run to allow more rapid parameter scans – added these:
  – $E =$ total driver energy, MJ
  – $A =$ ion mass, amu
  – $T_f =$ final ion energy, eV
  – $\tau_{\text{min}} =$ minimum pulse duration in accelerator section, s
  – $\tau_f =$ final pulse duration on target after drift compression, s

• Previously, the above were fixed for a given calculation

• Unit costs for near-term (IRE) and long-term (power plant driver) cases have been added
HI driver cost vs driver energy for two different ions and target types

![Graph showing driver cost vs driver energy for two different ions and target types]

- A=85, Close-coupled
- A=133, Close-coupled
- A=85, Full size
- A=133, Full size

R_spot = 1.7 mm typical of close-coupled targets
R_spot = 2.7 mm typical of full sized target
Likely operating space for heavy ion targets

Plot shows target gain curves for 1) fixed case-to-capsule ratio (red) for close-coupled and full sized designs, 2) fixed target yield (green) ranging from 300-500 MJ, and 3) fixed beam spot size (avg.) on target (blue) ranging from 1.5-3.0 mm.
What does it take to get small spot size?

• Driver example: Cs⁺¹ (A = 133), E = 5 MJ, T_f = 2.25 GeV
  – 2 mm spot gives G ~ 100, Y ~ 500 MJ
• Following design variables are examined (reference case values in parenthesis)
  – Initial pulse duration (15 µs)
  – Number of beams (96)
  – Final normalized emittance (2 mm-mrad)
  – Neutralization fraction prior to final focus (98%)
  – Final focus length (6 m)
  – Final focus half angle (9 mrad)
• R_{spot} = 1.9 mm for the reference case values
... many beams and short initial pulse duration

Note: driver cost optimizes at about 100 beams
control of beam emittance growth and high neutralization fraction at final focus
… short final focus length and careful choice of final focus half angle
Relationship between number of beams, emittance and neutralization for a given spot size

Assumes
Cs$^{+1}$
Ed = 5 MJ
Rspot = 2.0 mm
δP/P = 0.1%

Neutralization:
90%
95%
98%

Example:
$\varepsilon_n = 2$ mm-mrad
$f_n = 98\%$ neutralization
requires ~ 80 beams
Next steps for HIF systems modeling (LLNL)

- Improve spot size model to include emittance growth and chromatic aberrations as a function of number of half-lattice periods (from John Barnard)
- Create simplified driver cost and efficiency scaling model from results of detailed code
- Put HYLIFE-II and Osiris cost models into Mathcad
- Combine gain curve, simplified driver, spot size, and chamber cost models to create a new power plant model