Heavy Ion Driver Model Update*

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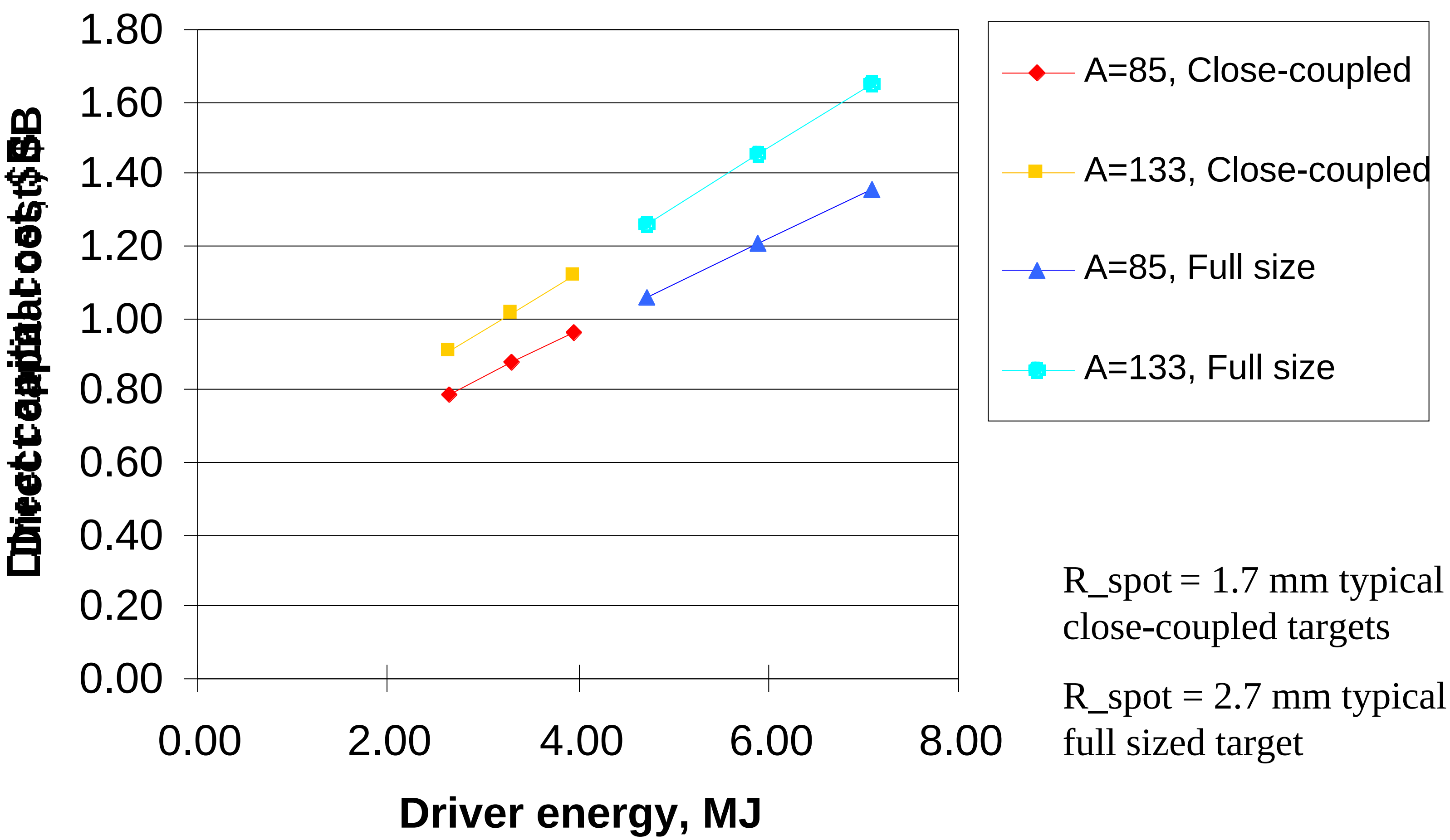
Modifications have been made to the heavy ion driver systems code

- 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
  - τ_{min} = minimum pulse duration in accelerator section, s
  - τ_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

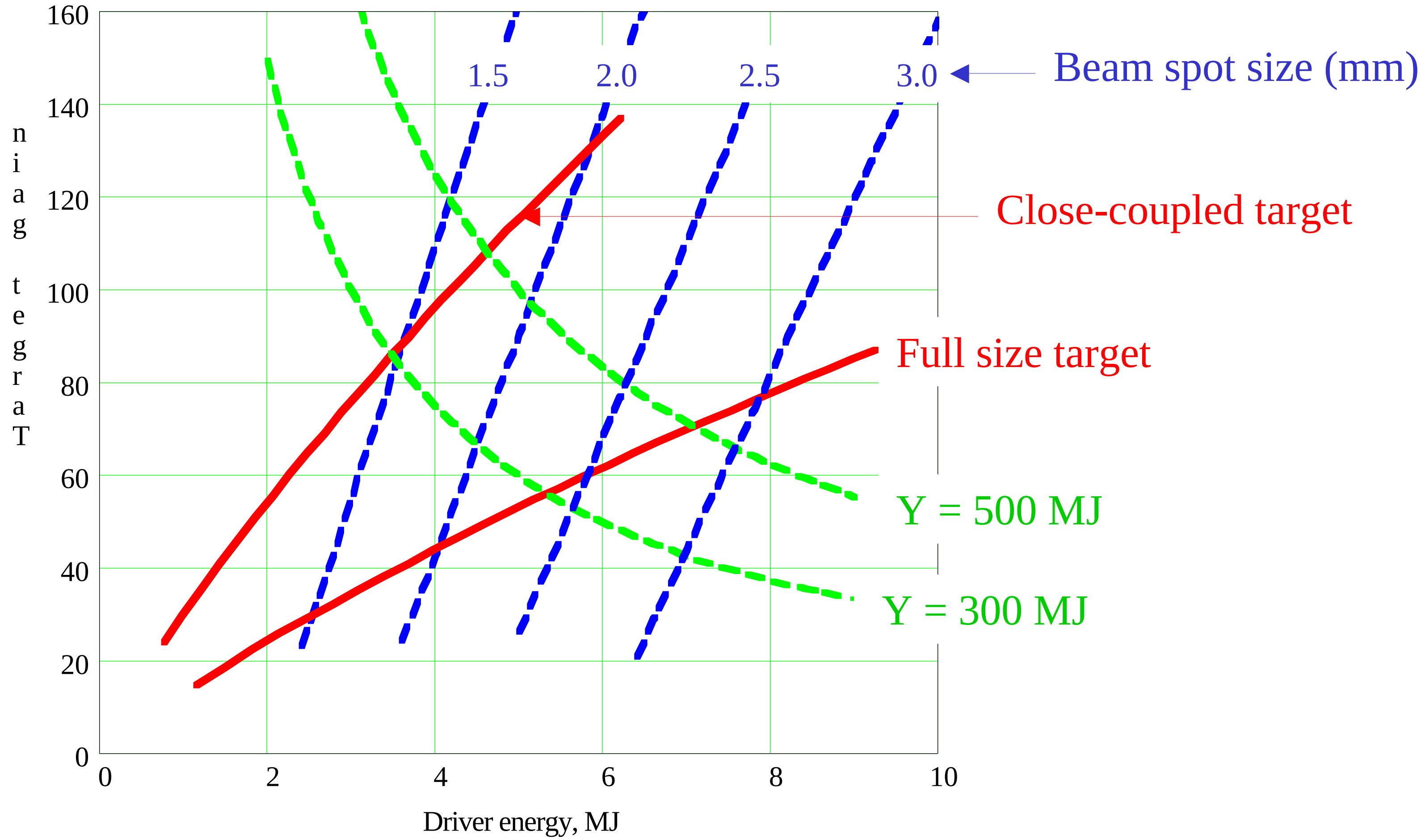
HI driver cost vs driver energy for two different ions and target types



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

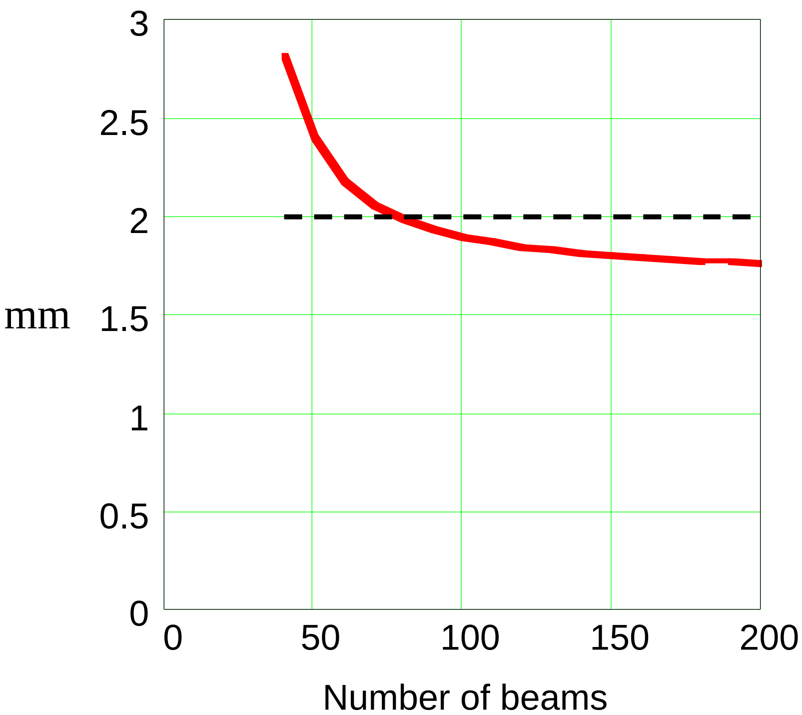


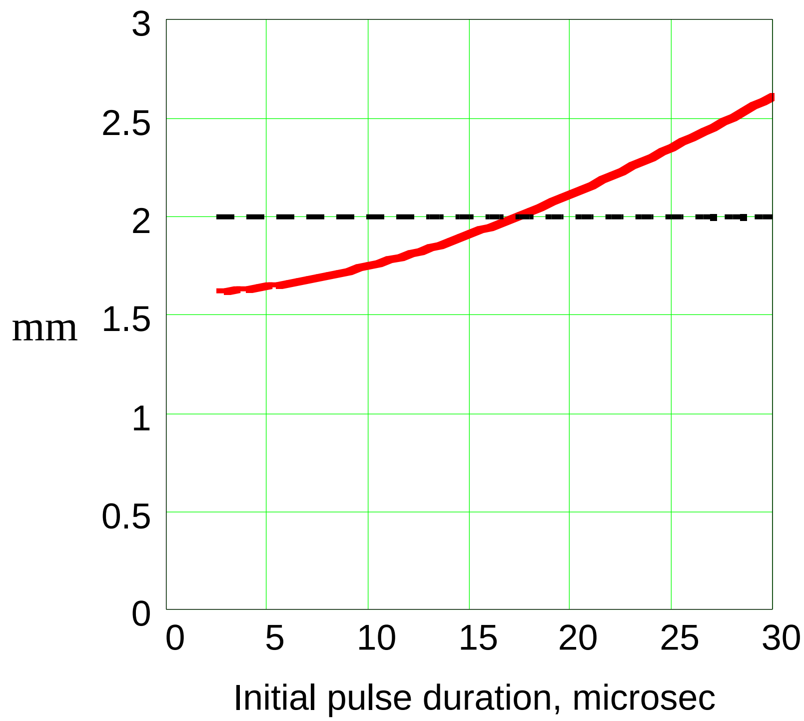
Plot shows target gain curves for 1) fixed case-to-capsule ratio (red) for close-coupled and full sized designs, 2) fixed target yield (green) ranging from 300-500 MJ, and 3) fixed beam spot size (avg.) on target (blue) ranging from 1.5-3.0 mm.

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

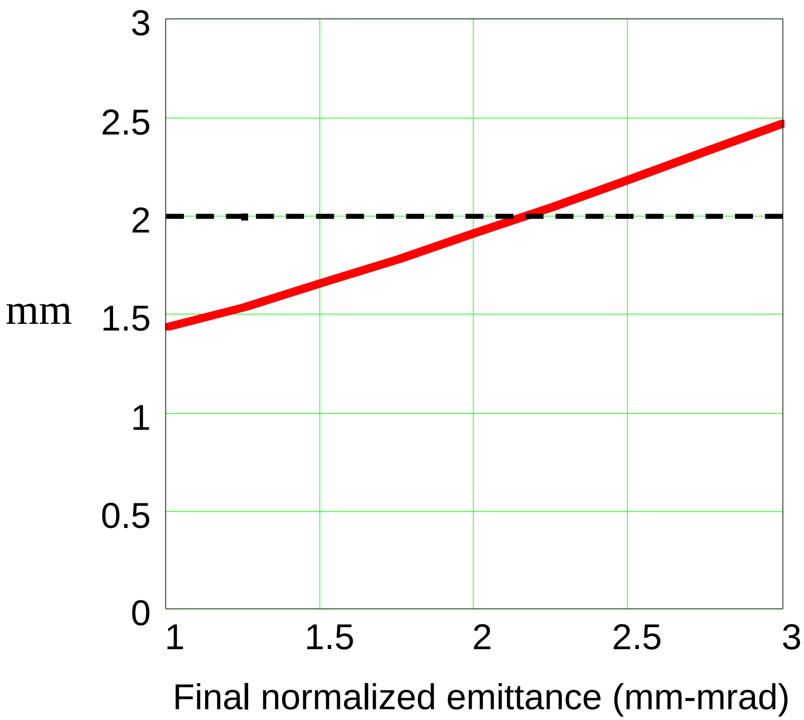
… many beams and short initial pulse duration

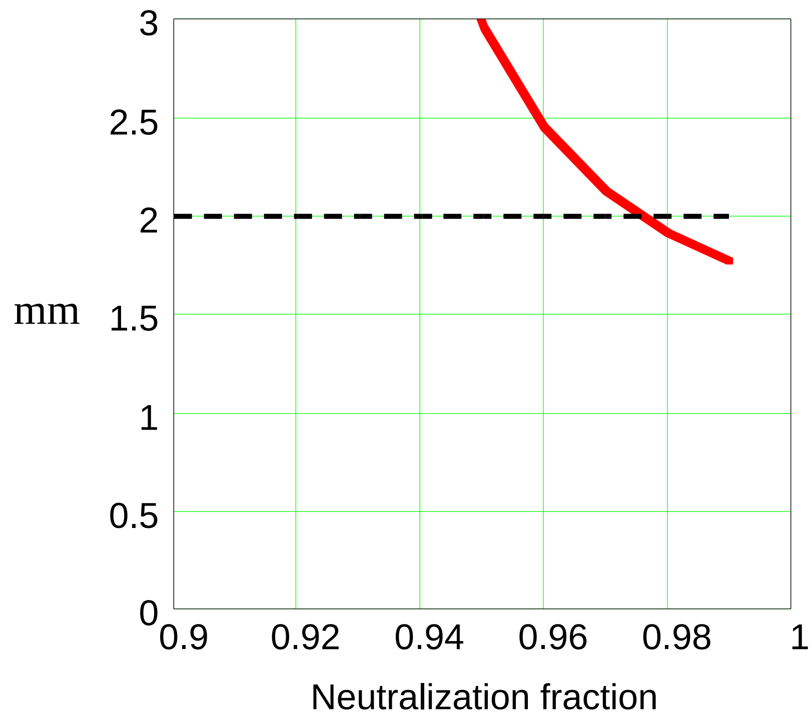




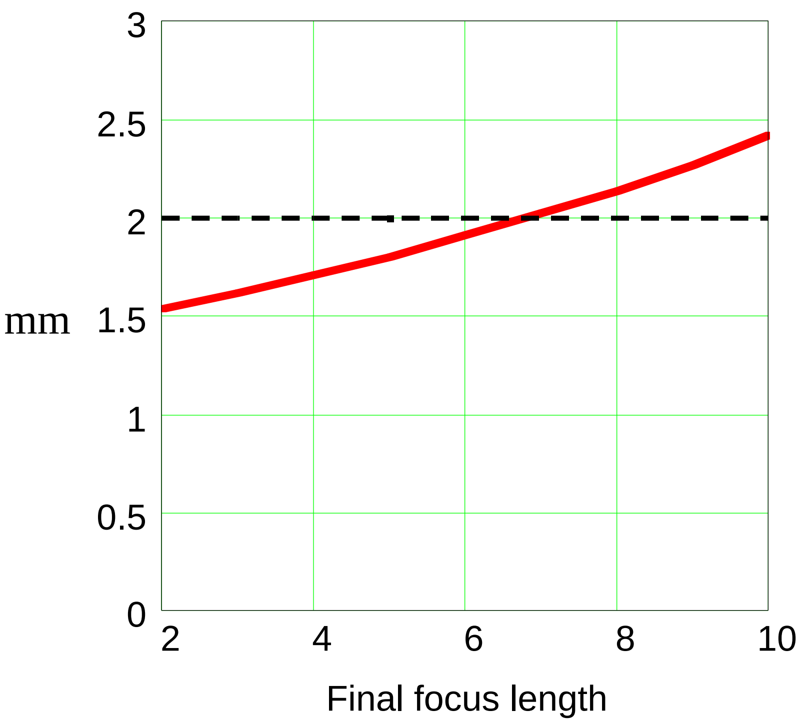
Note: driver cost optimizes at about 100 beams

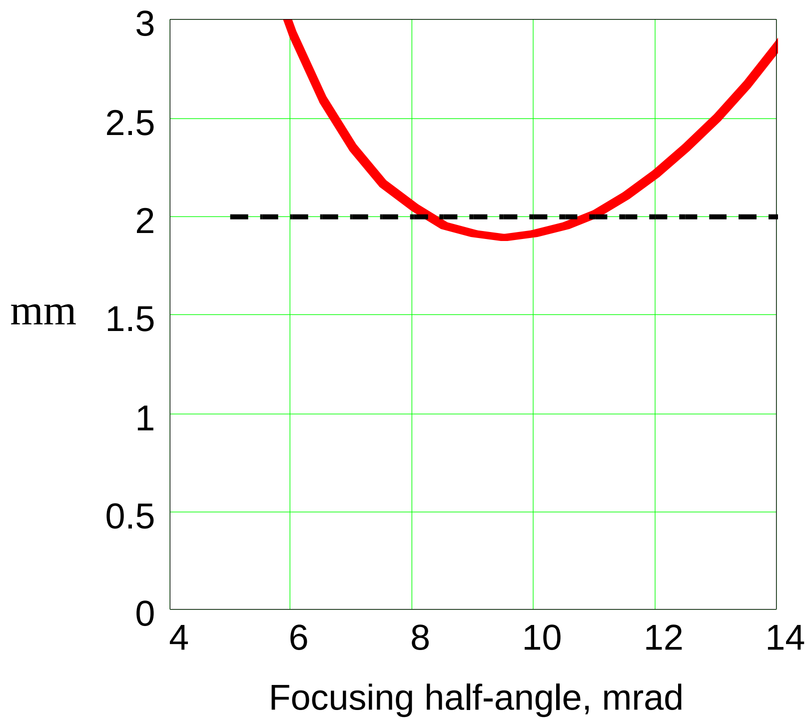
… control of beam emittance growth and high neutralization fraction at final focus



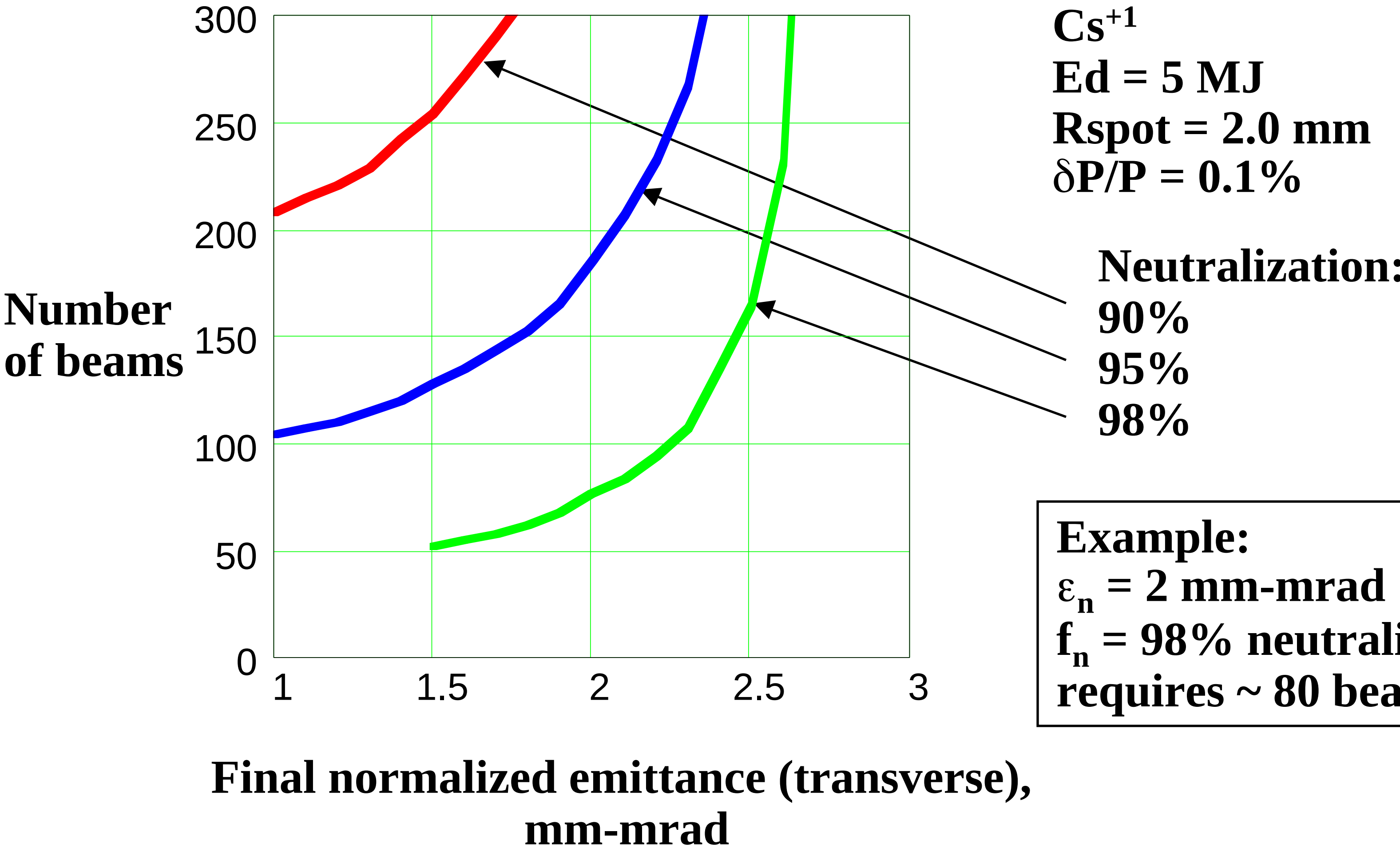


… short final focus length and careful choice of final focus half angle





Relationship between number of beams, emittance and neutralization for a given spot size



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

Example:
ε_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