



Tolerance Change in HIB Pulse Duration

-HIB pulse duration & direct drive pellet implosion-

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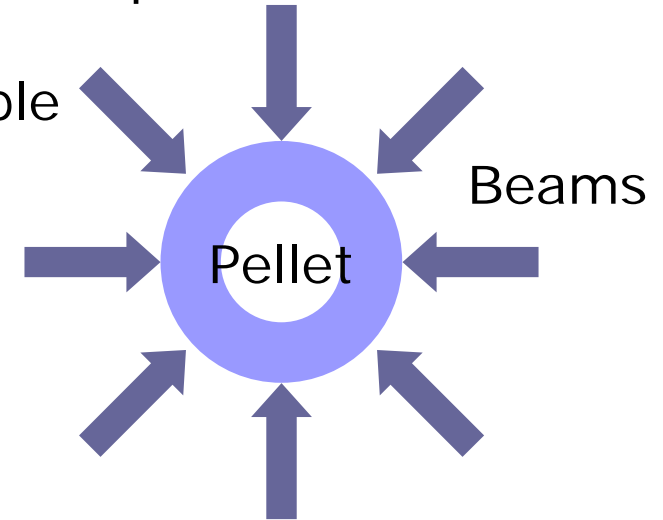
K. Horioka
Dep. Energy Sciences, TIT

US-Japan Workshop, Princeton University, June 11 2004

Beam Illumination to Fuel Pellet

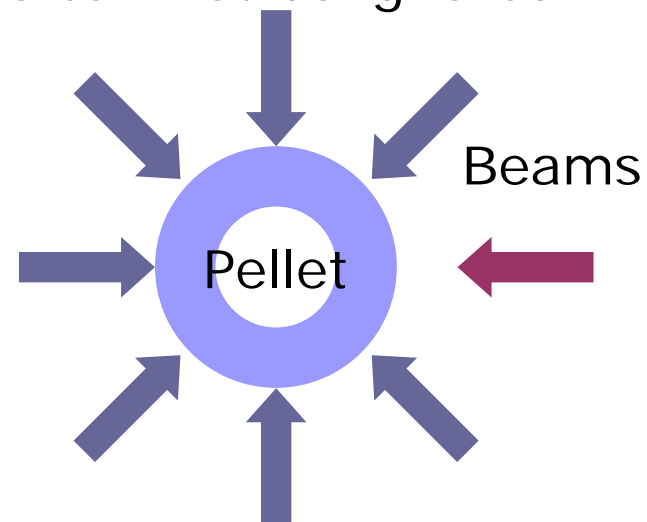
- Beam Illumination Uniformity in Space is Important.

Only a few % nonuniformity is allowable for direct-drive implosion.



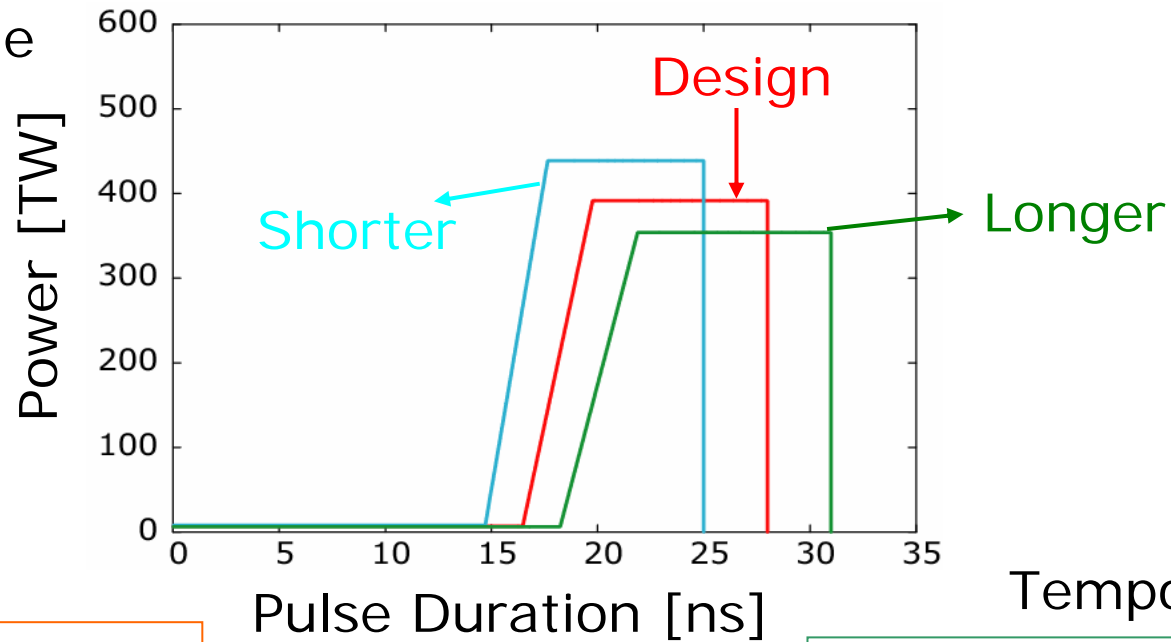
- Beam Illumination Error in Time can not be ignored.

+Timing error at each beam
+ **Pulse duration error**

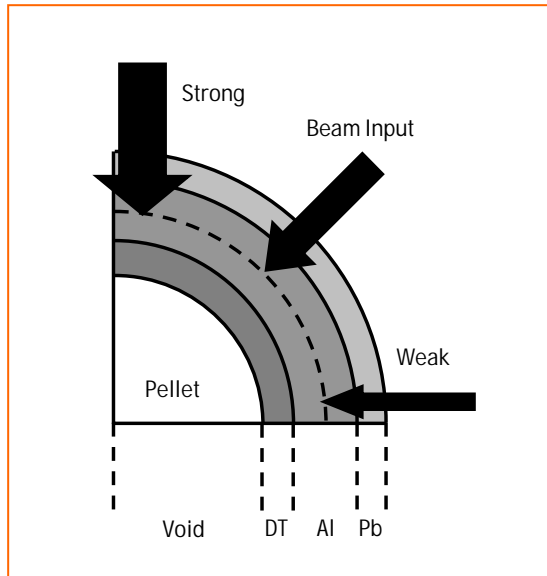


Temporal Error of Beam Pulse Duration

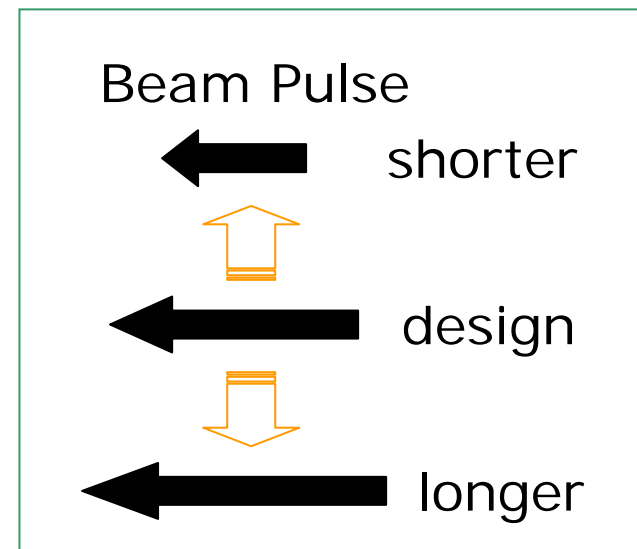
Beam Profile



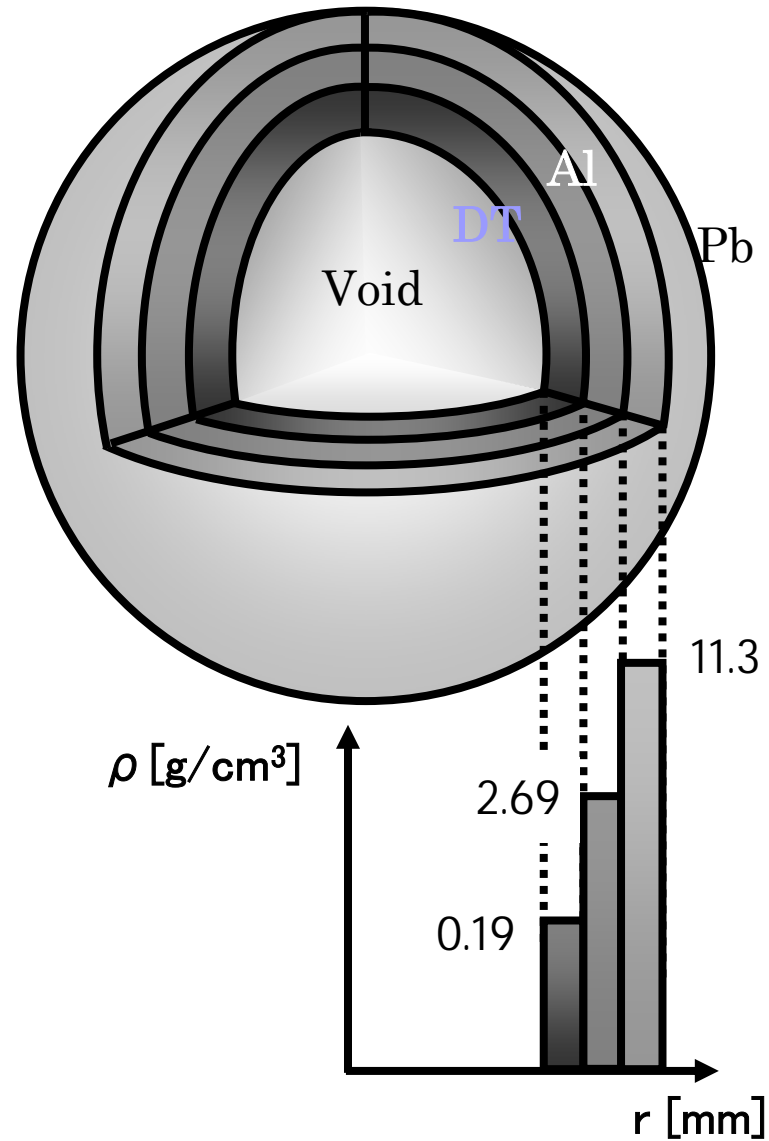
Spatial Error



Temporal Error



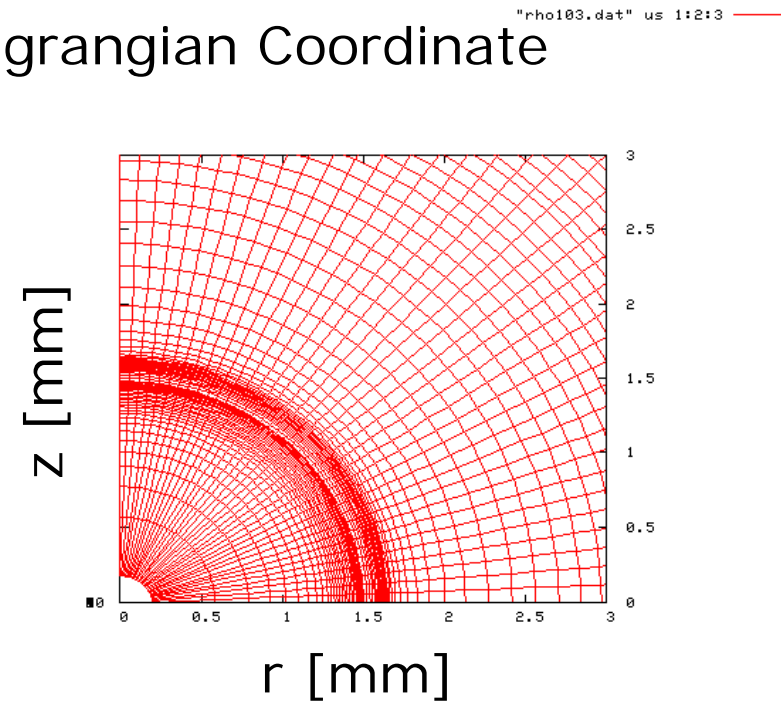
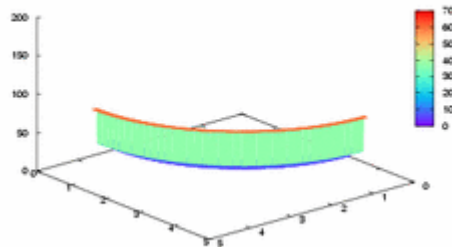
Fuel Pellet Structure for Direct-Drive Implosion



2D Implosion Calculation*

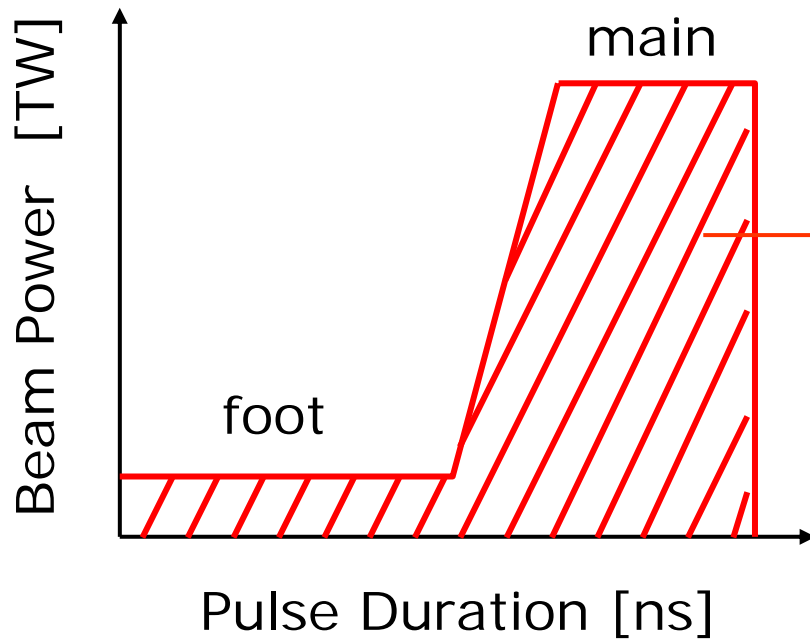
- 2 Temperature ($T_i = T_e$, T_r)
- 2D (r-z) Lagrangian-Lagrangian Coordinate

Density Profile during
Implosion by 2D Simulation



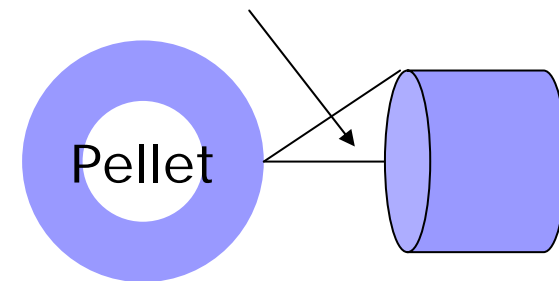
*K.Fujita, T.Kikuchi, D.Takahashi, et al., AIP Conf.Proc.480 (1999) 108.
J.Sasaki, T.Nakamura, Y.Uchida, et al., Jpn.J.Appl.Phys.40 (2001) L968.

Beam Pulse

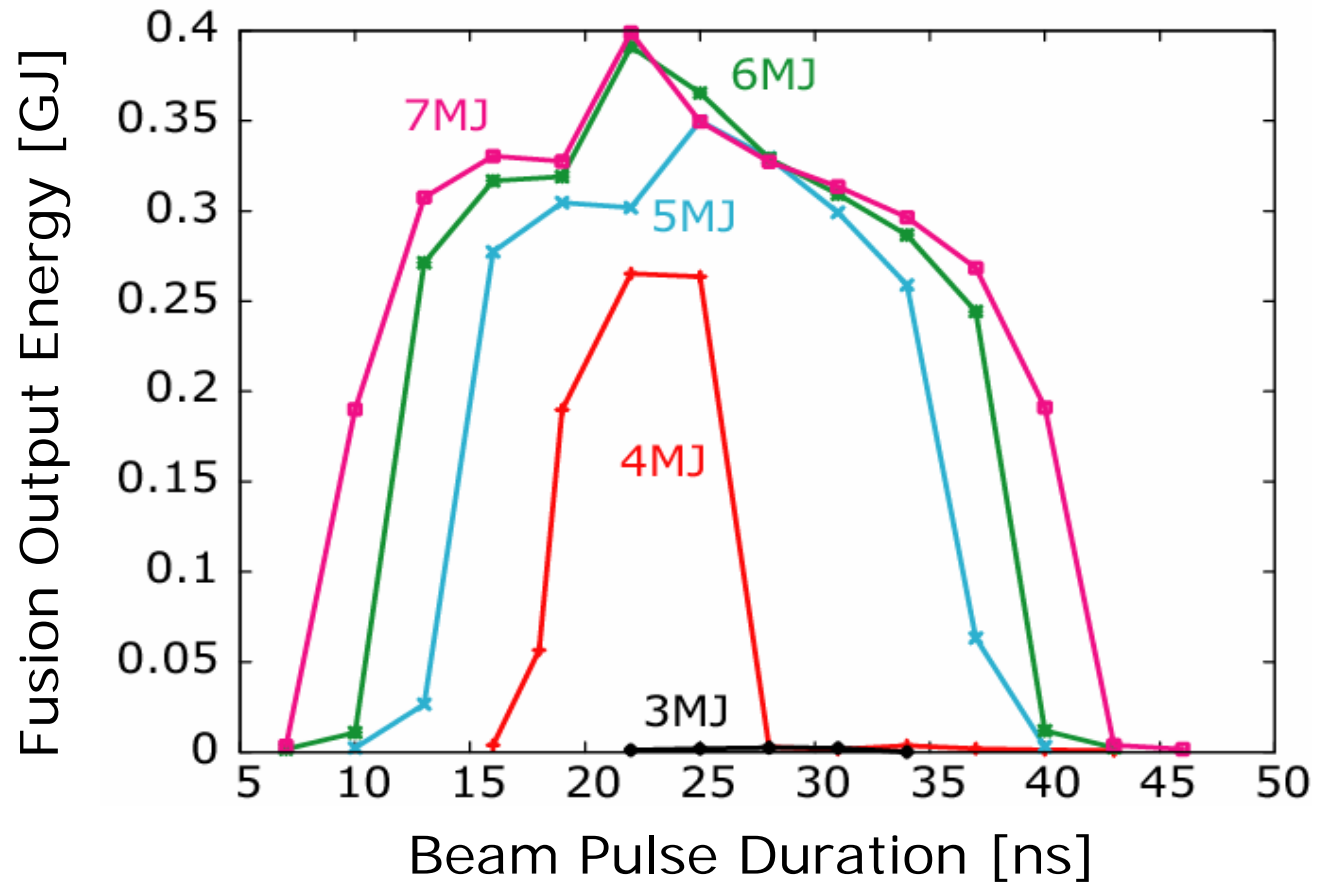


- Beam Ion: Pb⁺
- Particle Energy: 10GeV
- Total Input Energy: 3, 4, 5, 6, 7MJ
- Pulse Duration: Variable
- Incident Angle: 30deg

● foot : main = 1:55 (fixed)

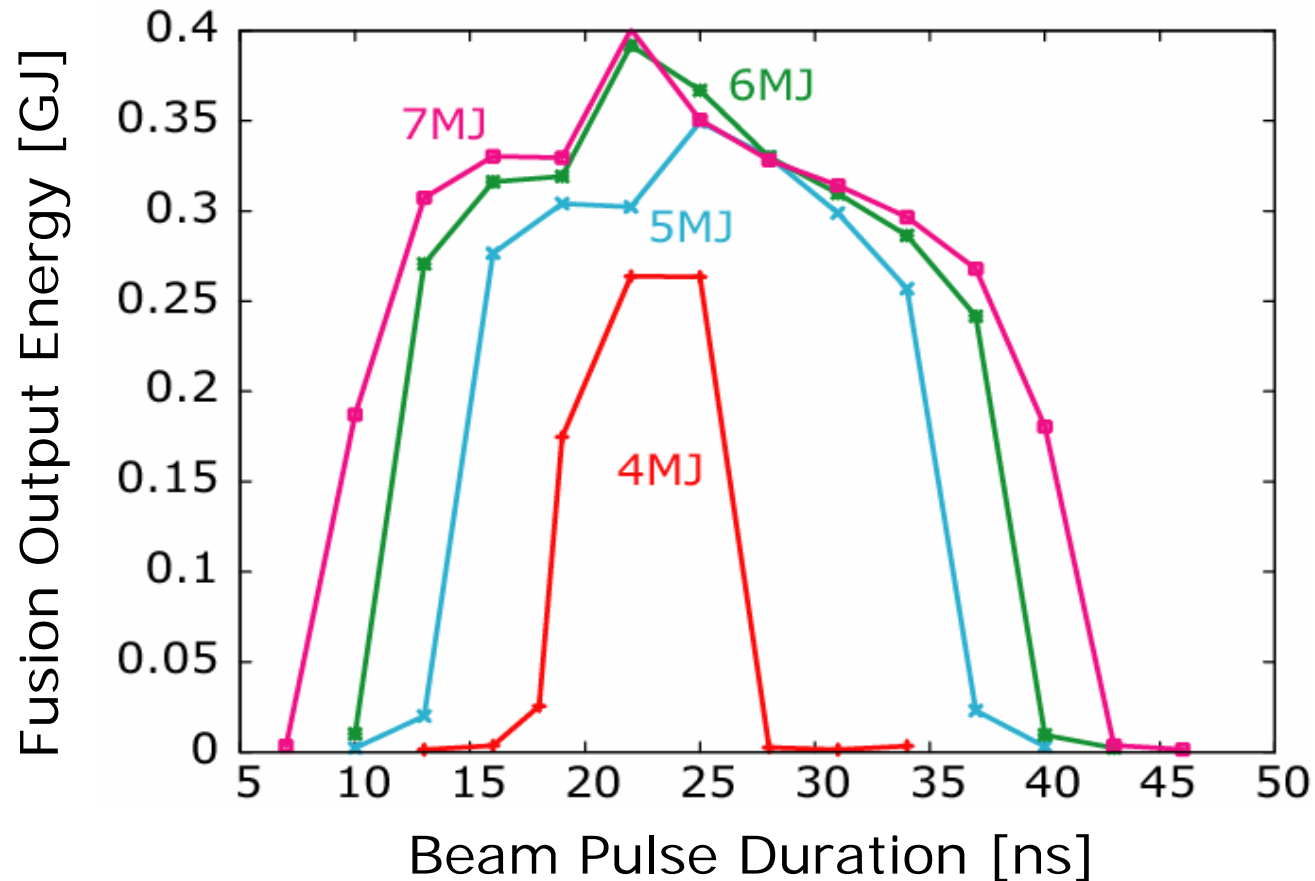


Implosion Calculation Result (Uniform Illumination)



Implosion Calculation Result (Nonuniform Illumination)

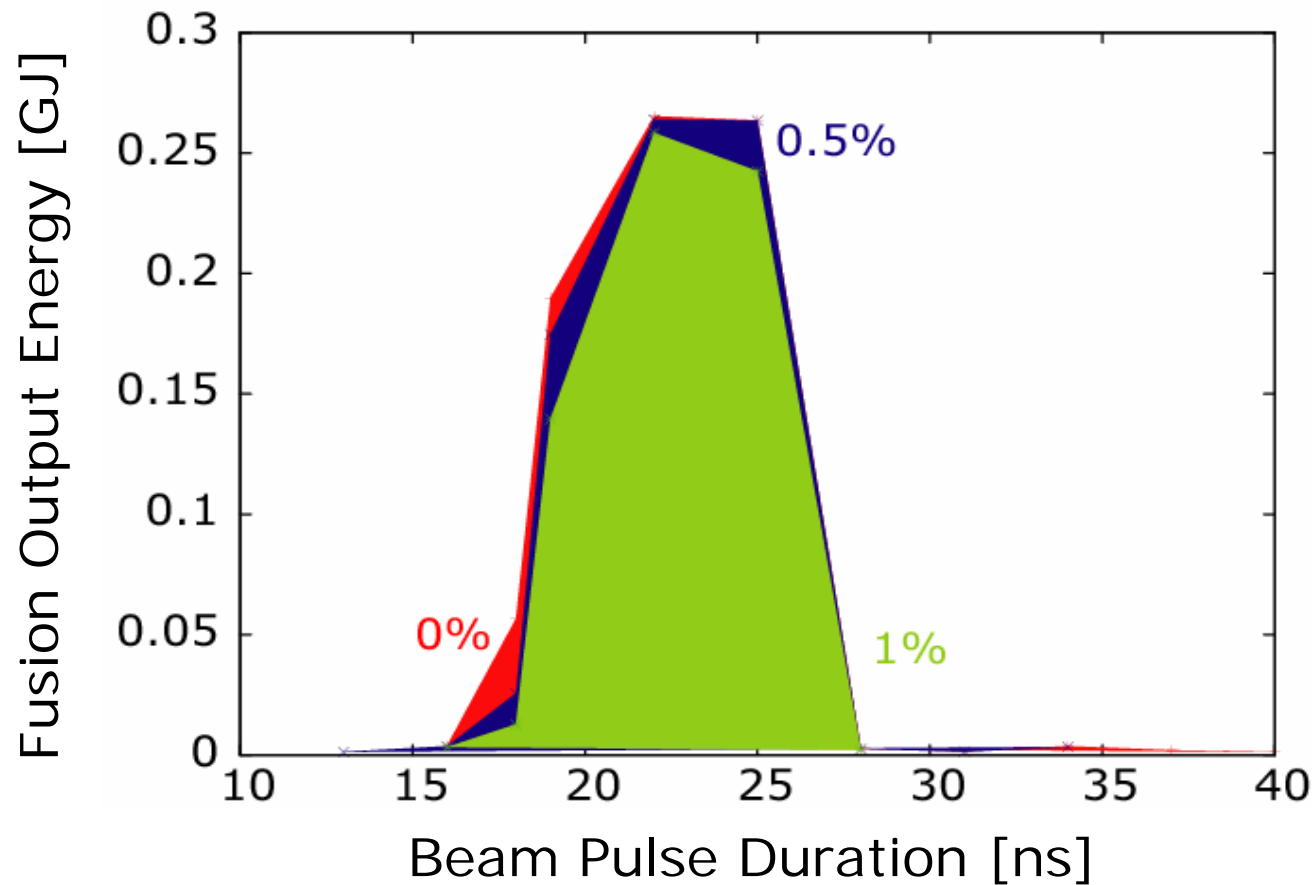
Spatial nonuniformity=0.5% with Mode=2



Similar situation in case of high input energy

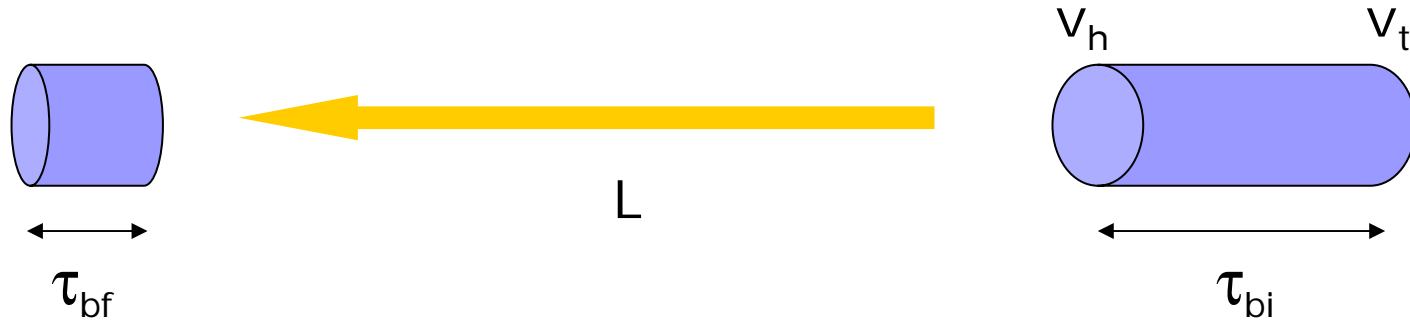
Pulse Duration Dependence with Spatial Nonuniformity

Input Energy=4MJ



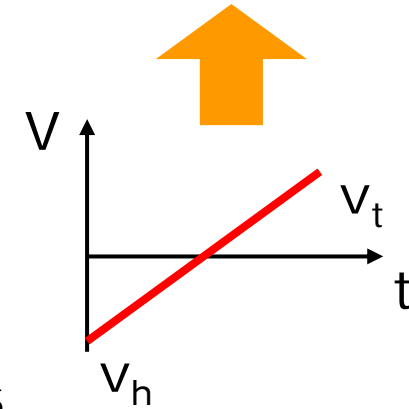
Tolerance becomes small in lower input energy with spatial nonuniformity of beam illumination.

Estimation for Buncher Voltage Accuracy



Final pulse duration roughly,

$$\tau_{bf} = \tau_{bi} + \left(\frac{1}{v_t} - \frac{1}{v_h} \right) L$$



$V_0 = 456\text{MV} \rightarrow \tau_{bf} = 22\text{ns}$

$E_k = 10\text{GeV}@\text{Pb}^+$

$L = 500\text{m}$

$\tau_{bi} = 250\text{ns}$

$V = 444\text{MV} \rightarrow \tau_{bf} = 28\text{ns}$

$V = 464\text{MV} \rightarrow \tau_{bf} = 18\text{ns}$

$\Delta V/V = -2.6 \sim 1.8\%$

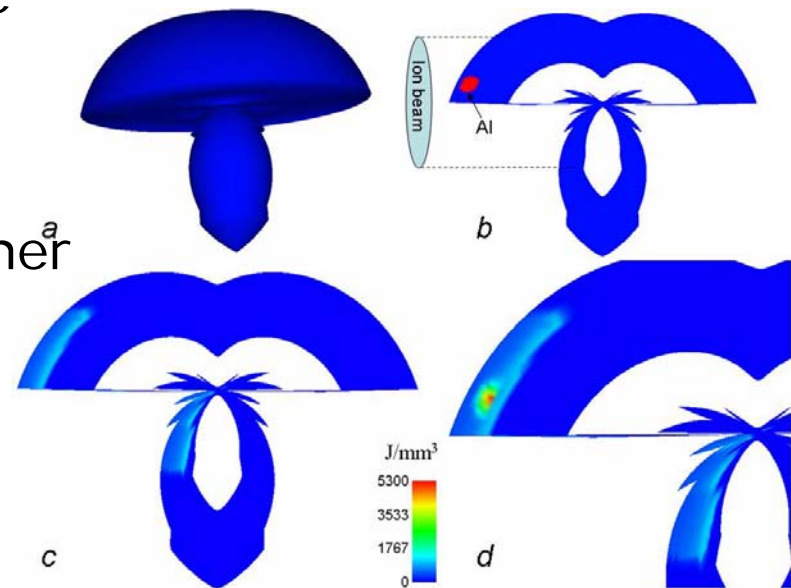


Summary

- Temporal error of beam pulse is considered.
- Pulse duration dependence is investigated using 2D implosion code.
- Larger input energy has larger tolerance in pulse duration error for fusion output Energy.
- Tolerance becomes small in lower input energy with spatial nonuniformity of beam illumination.

In future...

- Detailed Investigations
in case of larger nonuniformity
in optimum pulse duration
- 3D Implosion Simulation
coupled with illumination code
- Timing Error Tolerance
- Requirements in Induction Buncher^a
voltage accuracy
jitter, etc...



Wednesday Afternoon, June 9,
T. Someya, et al., "HIB
Illumination on a Target..."