Conventional source update

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March 2011, Eugene, Oregon

Motivation

Conventional e+ sources

Well established

used to be

300Hz scheme

e+ gen. in 60ms rather than 1ms

relax thermal problem for

targets

increase survivability w/ slow rotation targets

Capture section

larger aperture for RF section

larger acc. gradient

worth while looking into feasibility again

Method

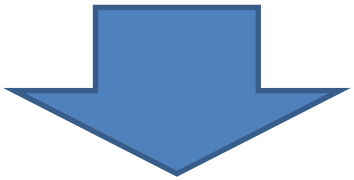
EM shower simulation

e+ yields
Peak Energy Deposit Density (PEDD)
total energy deposit

e+ capture efficiency

# of e+ in the Damping Ring

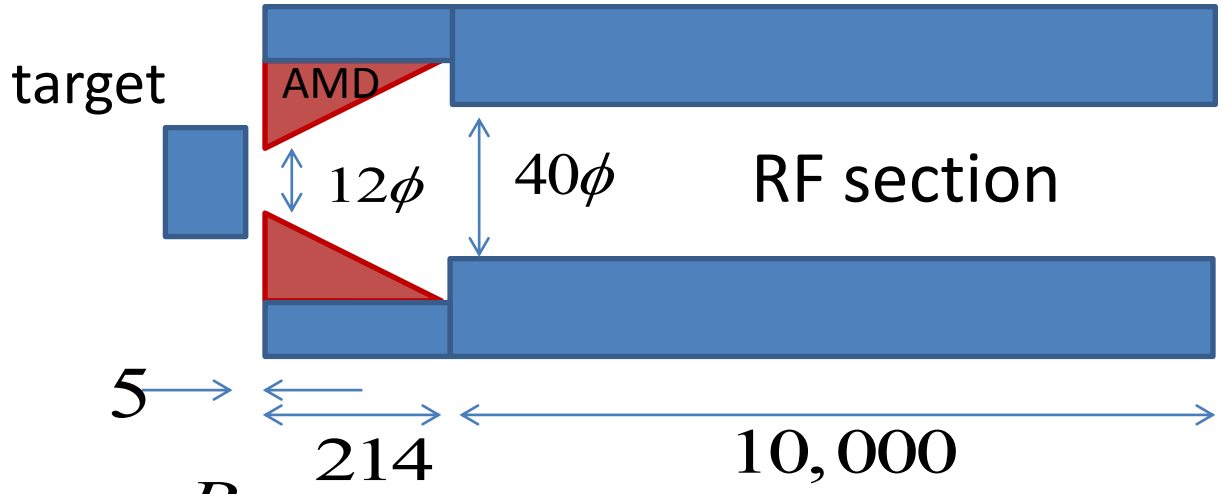
Geant 4 + Empirical formula by CLIC note 465



EM shower and particle tracking w/ Geant 4

Parameters in capture section

300Hz scheme w/ slow rotation target ~ CLIC



$$Bz(z) = \frac{B_0}{1+\mu z} + B_{sol}$$

$$B_0 = 7T$$

$$\mu = 60.1m^{-1}$$

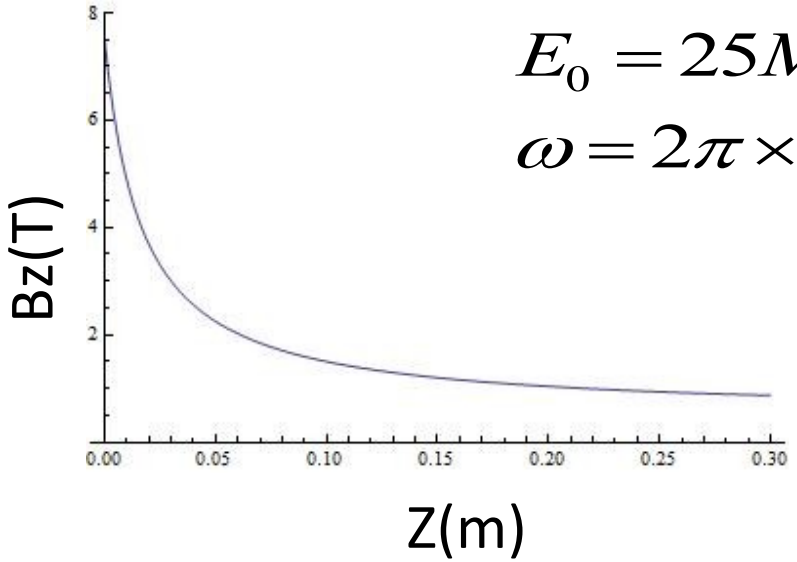
$$B_{sol} = 0.5T$$

$$Br(r,z) = -\frac{1}{2} r \frac{\partial B_z(z)}{\partial z} + \frac{1}{16} r^3 \frac{\partial^3 B_z(z)}{\partial z^3}$$

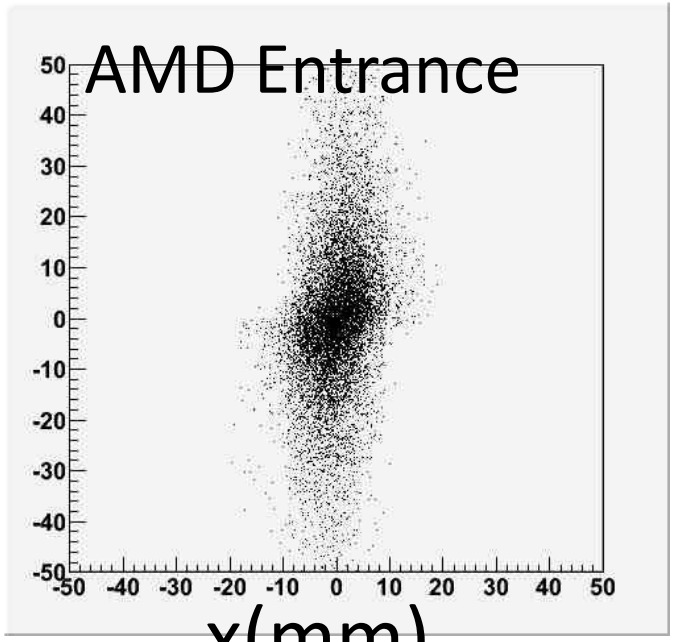
$$Ez = E_0 \cos(kz - \omega t + \varphi)$$

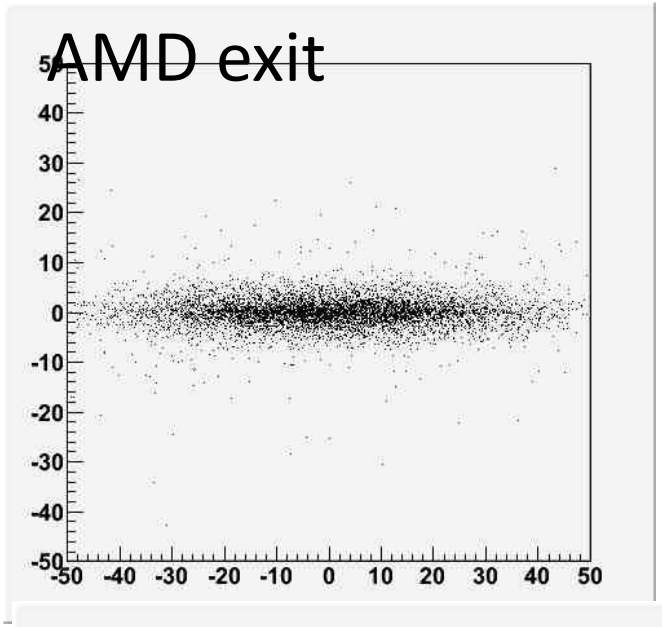
$$E_0 = 25MV/m$$

$$\omega = 2\pi \times 1.3GHz$$



Simulation:Transeverse phase space

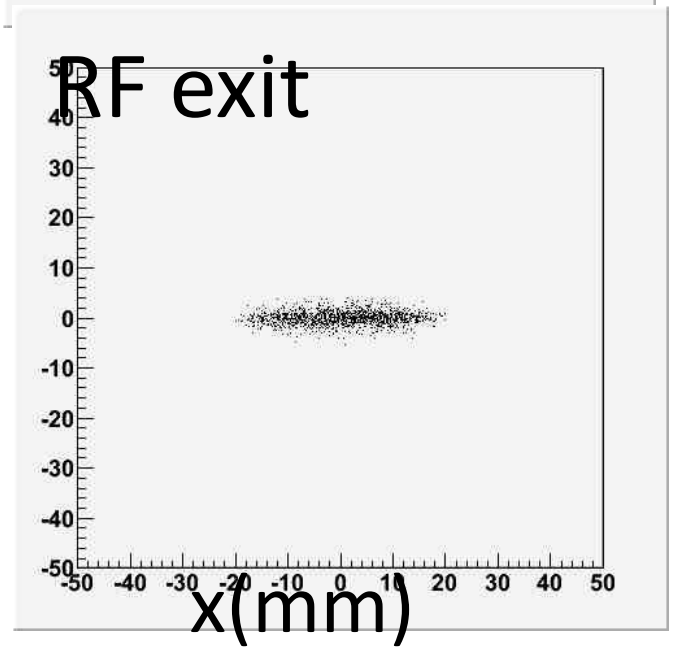




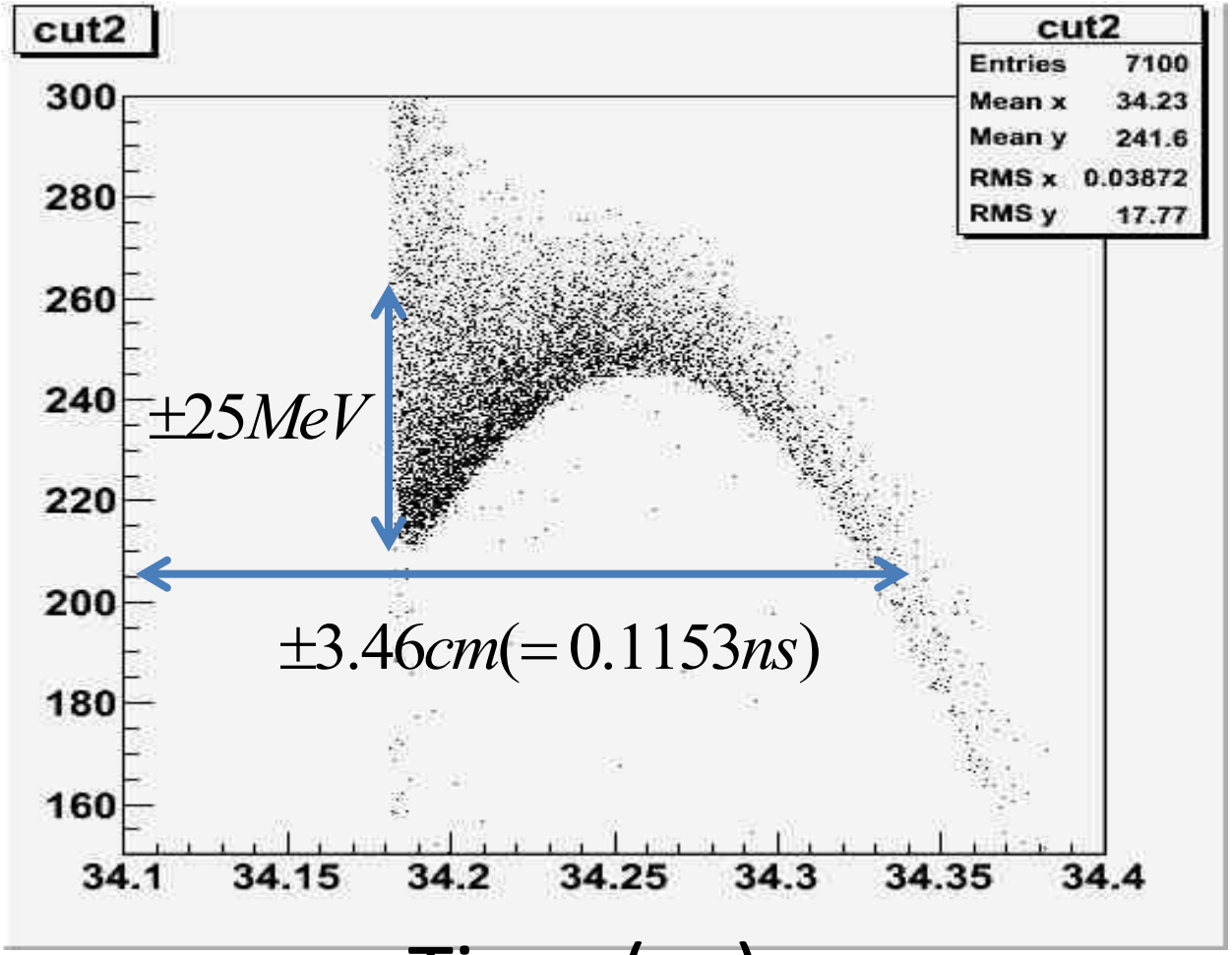
$$A_x = \gamma_x x + 2\alpha_x x(\gamma x') + \beta_x (\gamma x')^2$$

DR transverse acceptance : fron RDR

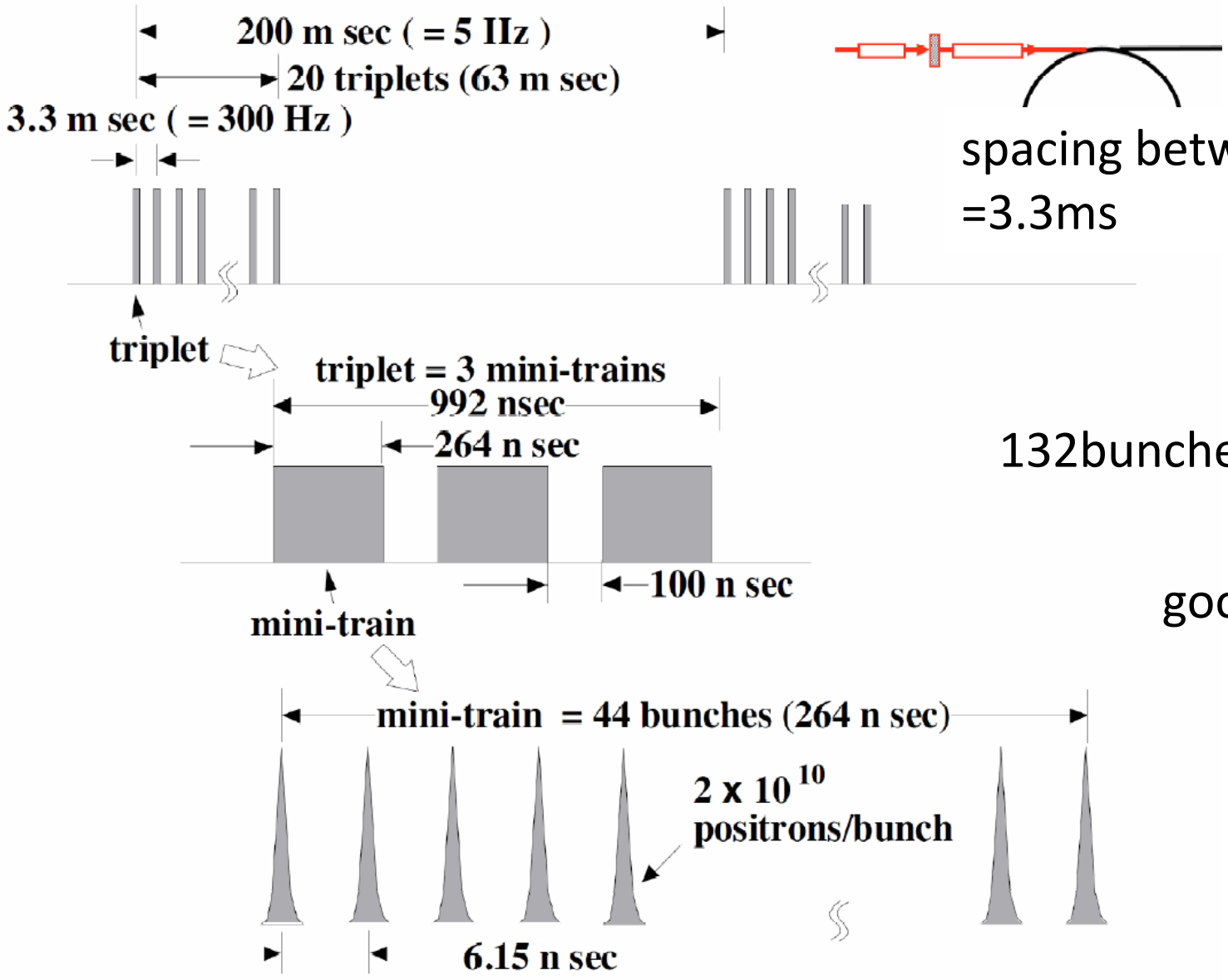
$$A_x + A_y < 90mm \cdot rad$$



Longitudinal phase space



In the case of 300Hz scheme



spacing between triplets =3.3ms

132bunches in 992ns

good for the FC

Assumption

drive electrons

2×10^{10}/bunch

a triplet: 132 bunches 992ns

3.3ms

a train: 20 triplet

= 2640 bunches 63ms

132 bunches

make a shock wave

heat same position on the target

each triplet hits

different position on the target

slow rotation targets

Parameter Plots for 300 Hz scheme

e- directly on to Tungsten

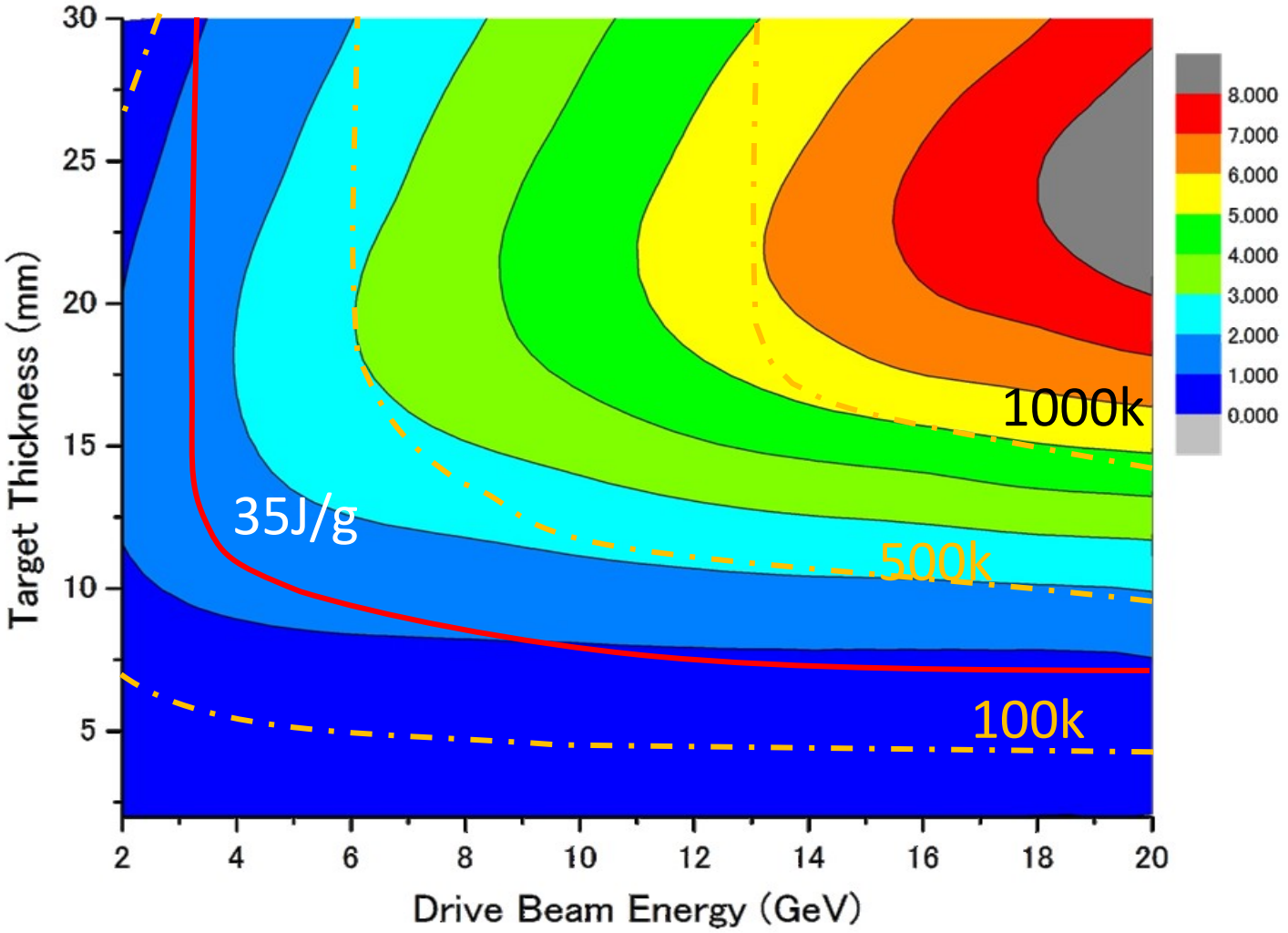
σ=2.5mm

colored band

accepted e+/e-

PEDD J/g

dT max by a triplet



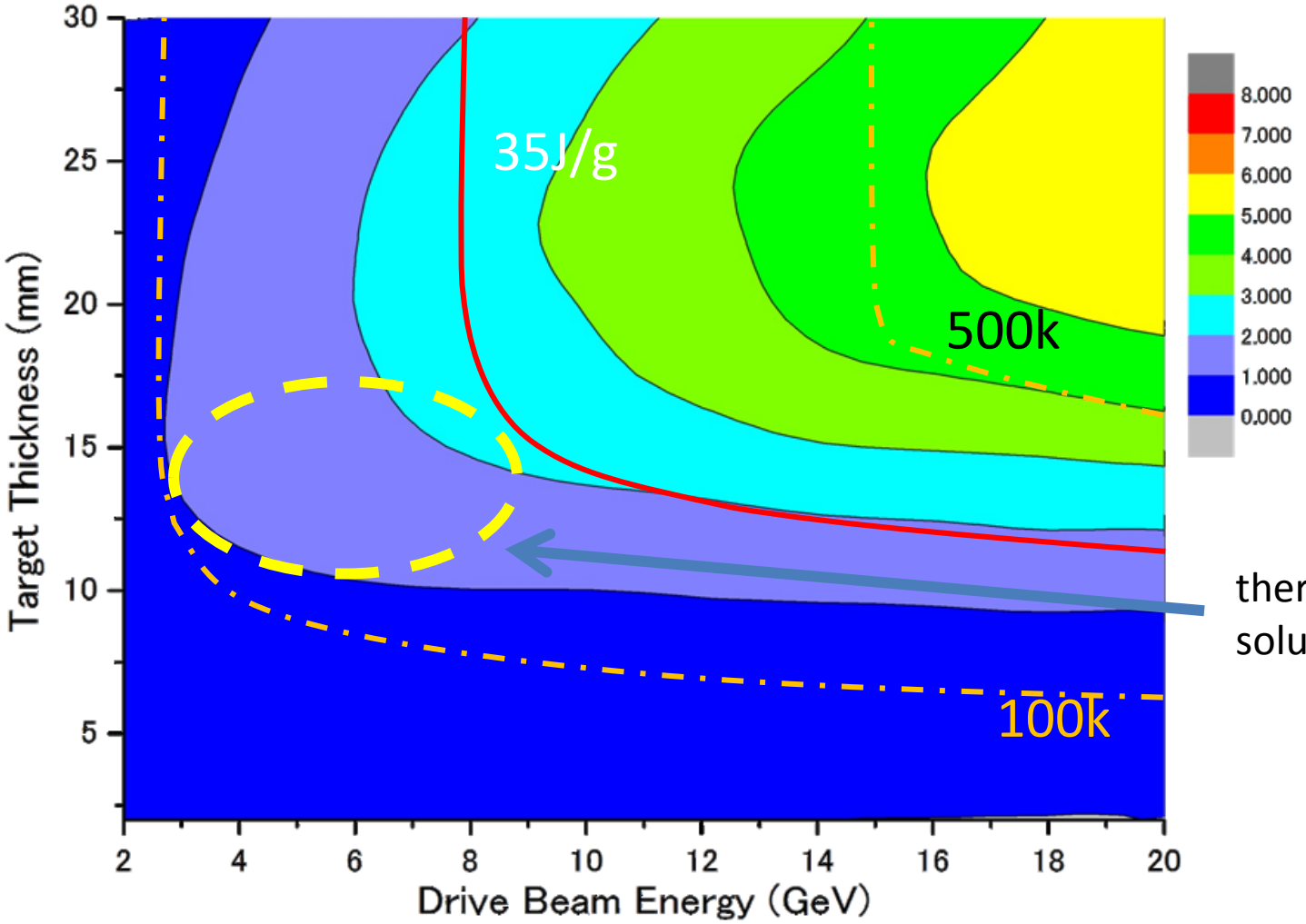
Parameter Plots for 300 Hz scheme

e- directly on to Tungsten

σ=4.0mm

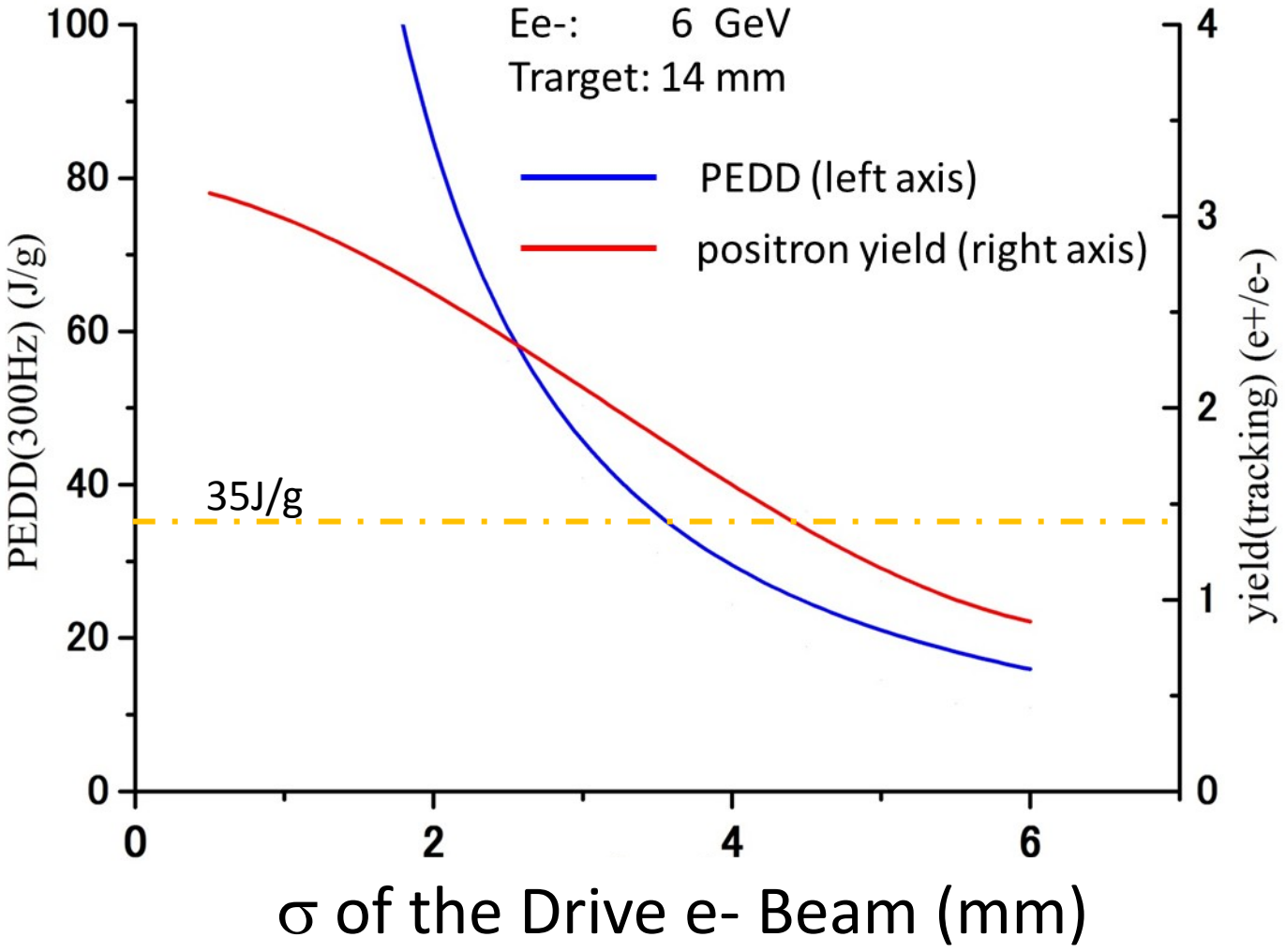
colored band — accepted e+/e- PEDD J/g

dT max by a triplet



there seems to be solutions

Dependence on Drive beam size



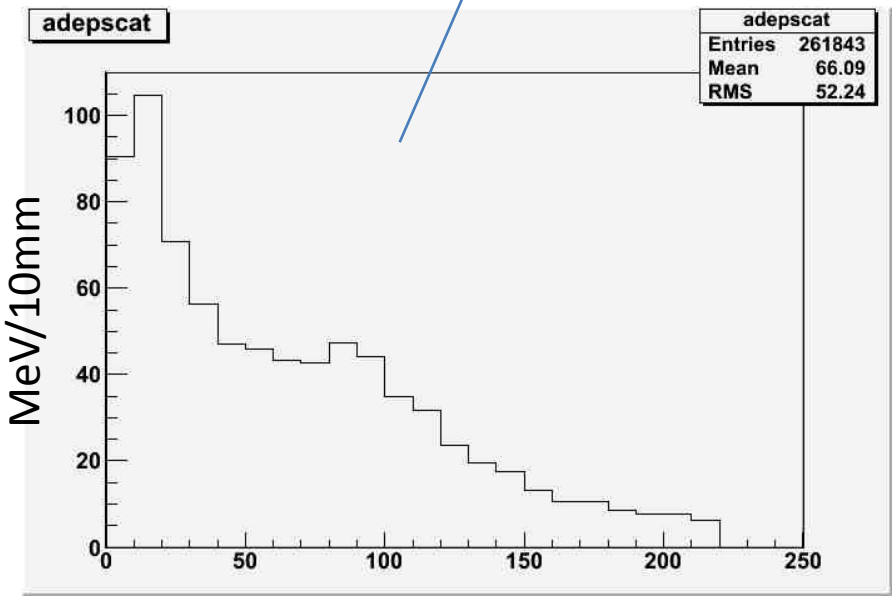
numbers for a reference point

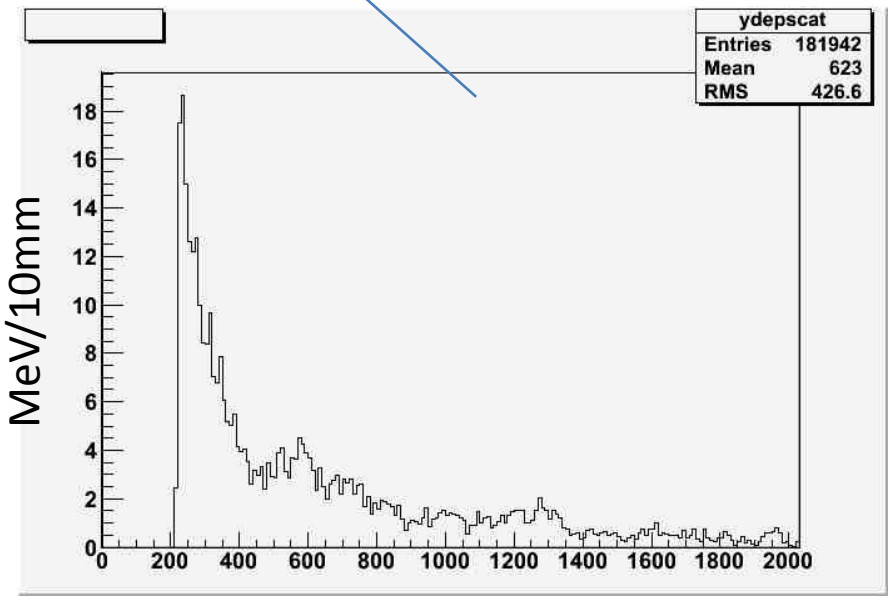
Parameters for target and captures		Parameters for 300Hz scheme	
Drive beam energy	6 GeV	# drive e- /bunch	2×10^{10}
Beam size	4.0 mm (RMS)	# bunches/triplet	132 (in 996ns)
Target material	Tungsten	# bunches/train	2640 (in 63 ms)
Target thickness	14 mm	repetition	5 Hz
Max AMD field	7 T	Results numbers in () are for 300Hz operation	
Taper parameter	60.1/mm	e+ yield	1.6 /e-
AMD length	214 mm	PEDD in the target	1.04 GeV/cm^3/e- (22.7 J/g)
Const. field	0.5 T	E. deposit in the target	823 MeV/e- (35kW)
Max. RF field	25 MV/m	E. deposit in the AMD	780 MeV/e- (33kW)
RF frequency	1.3 GHz	E. deposit in the RF section	470 MeV/e- (20kW)

summary

- Conventional target have solution for ILC with 300Hz scheme
- to go forward
  - heating has to be studied including cooling system
  - shock wave threshold has to be understood particularly under multi bunch condition

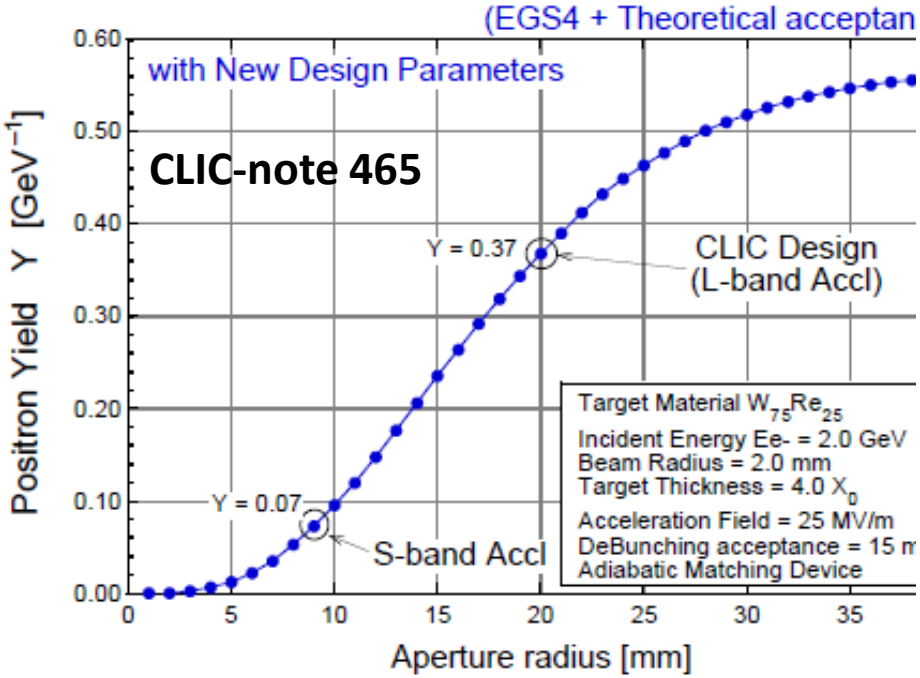
Energy deposit in capture section

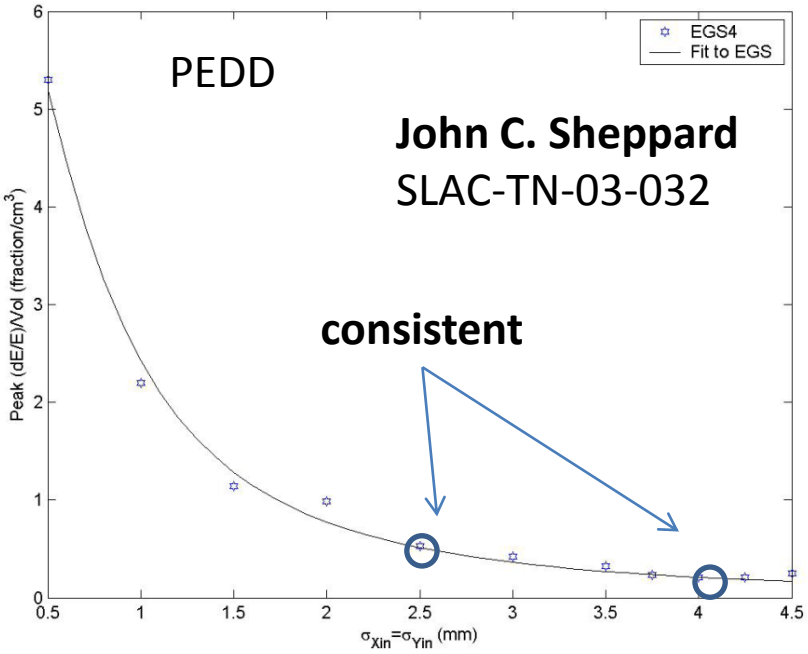




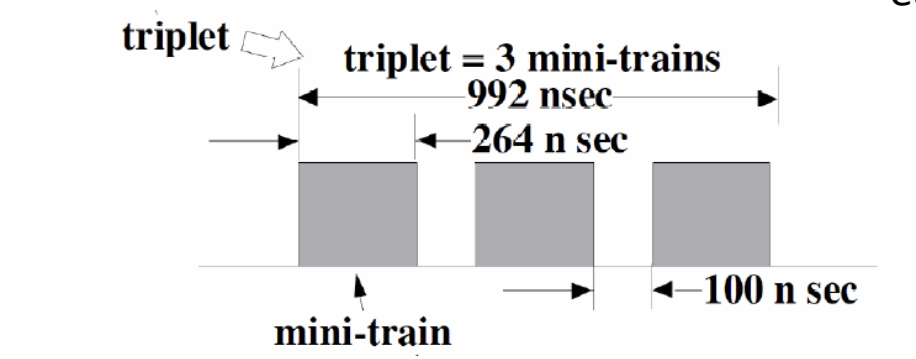
a few comments

- numbers shown here are consistent w/
  - independent calculation by a colleague in KEK and French colleague for Hybrid
- comparison w/ SLC study
  - both assumed AMD but acceptance for linac is;
    - SLC S-band linac ←→ this study (CLIC) L –band



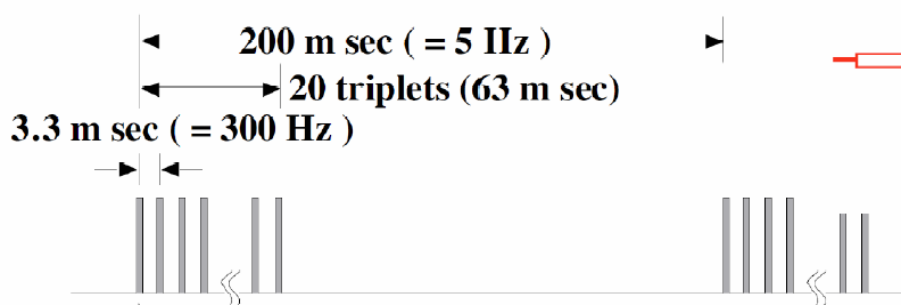


Assumption



each triplet hits different position on the target

elatively low (1~2m/s)rotational target



duration of a triplet ~ dumping time of shock wave

shoter than time scale of thermal dissusion

132 bunches in a triplet contributes both shock wave and thermal damage

Acceptance estimate

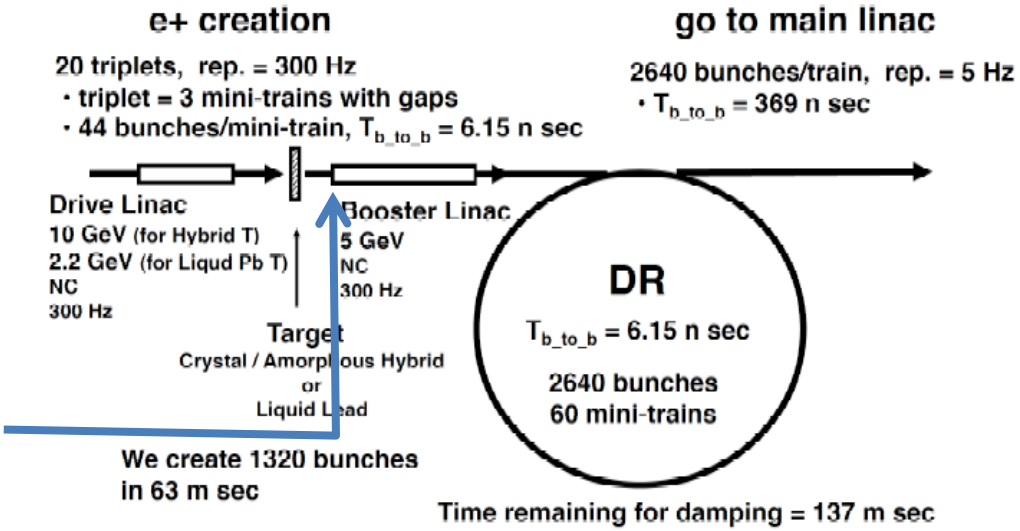
CLIC note 465

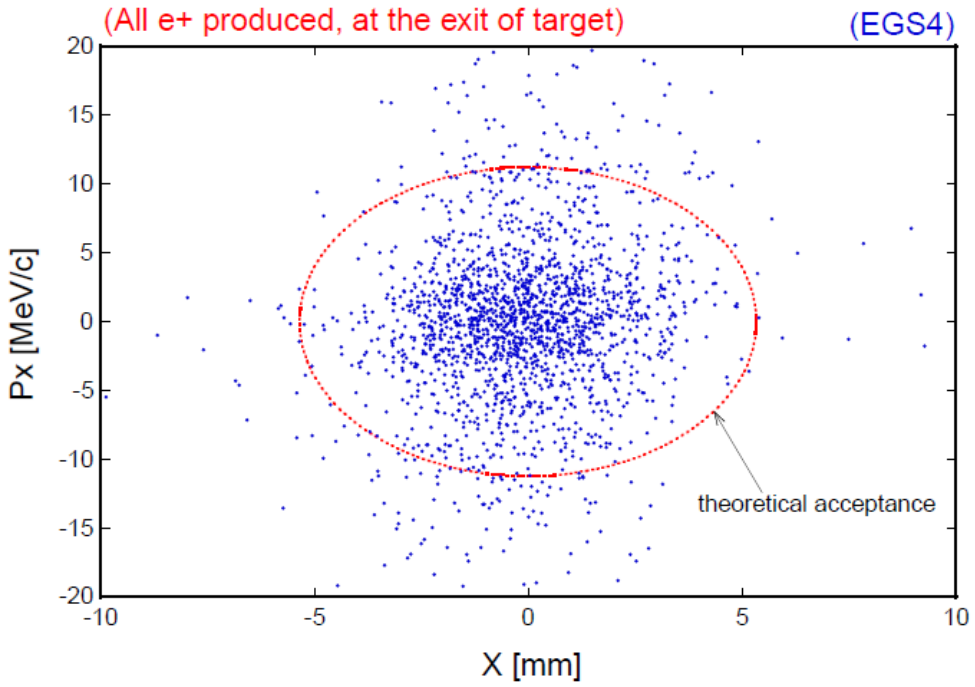
$[r/5.3[mm]]^2 + [pT[MeV]/11]^2 =< 1$

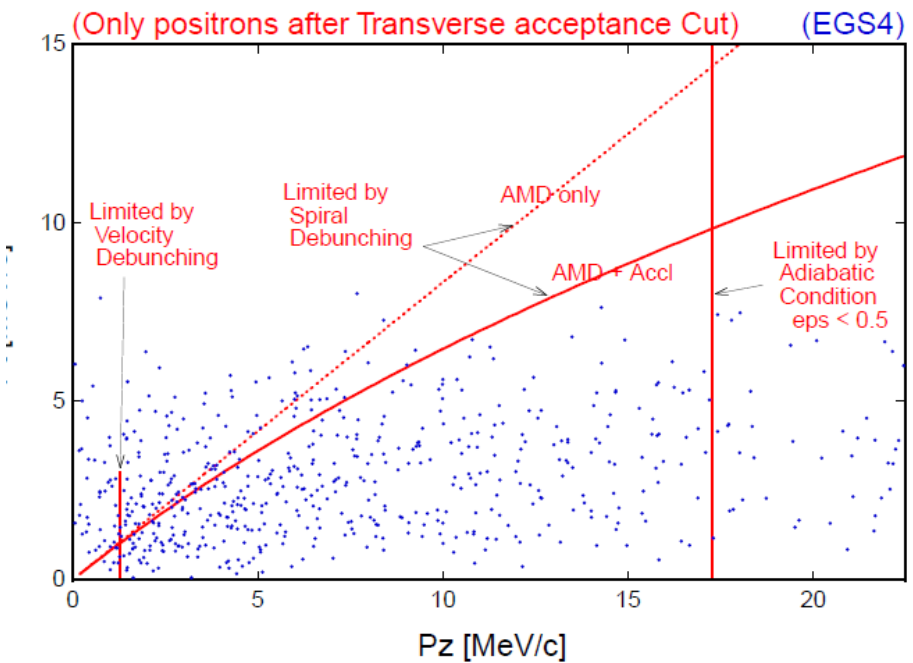
$pT < 0.1875\ MeV/c + 0.625\ pL$

$1.5\ MeV/c < pL < 17.5\ MeV/c$

~# of e+ in DR (or booter linac)







Thermal diffusion

$$T(t) \sim T_0 e^{\alpha t}$$

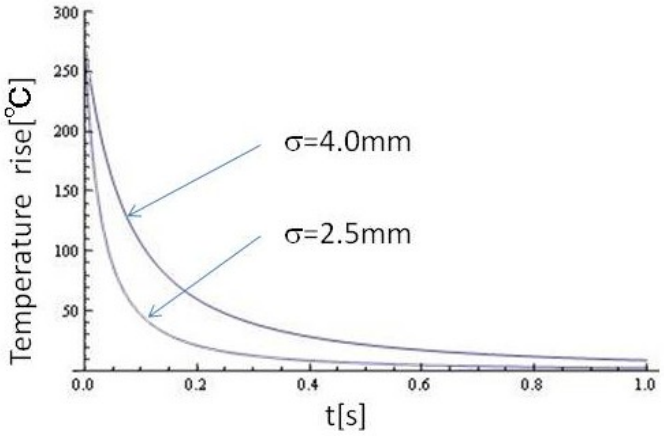
$$\alpha = -\frac{\lambda}{C_V}\beta^2$$

$$\lambda = 174 W/m \cdot K$$

$$C_V = 2.5 \times 10^6 J/m^3 \cdot K$$

time constant of the diffusion depends on beam spot size ~1/β

numerical calculation of thermal diffusion shows



	1D	2D	3D
time constant σ=2.5mm σ=4.0mm	280ms 750ms	80ms 200ms	40ms 100ms

time constant is order of 100ms >> Ttriplet ~1μs

Parameter Plots for 300 Hz scheme w/ clic note formula

e- directly on to Tungsten

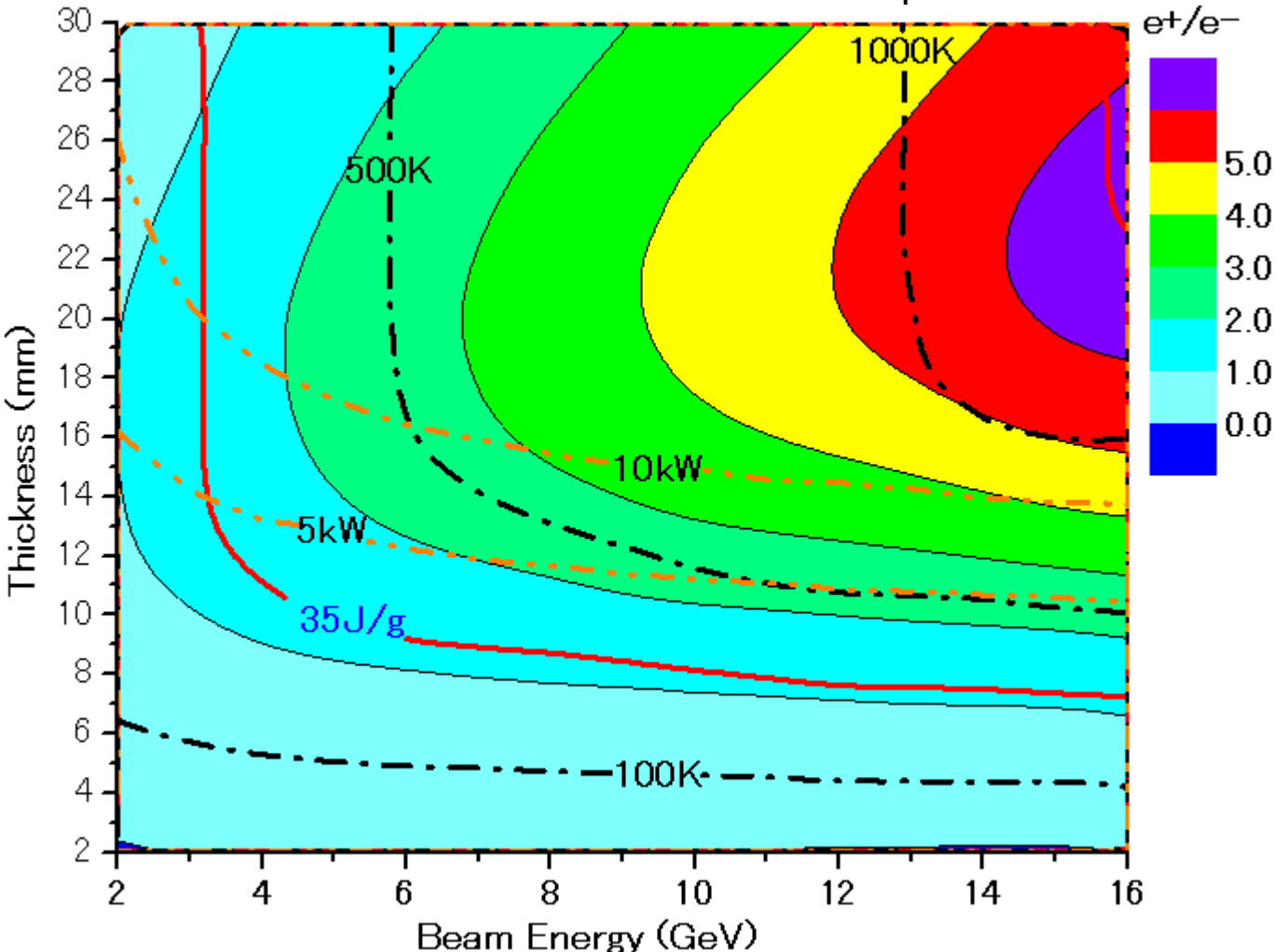
σ=2.5mm

colored band accepted e+/e-

PEDD J/g

dT/triplet (132 bunc)

ToTal deposit kW



Parameter Plots for 300 Hz scheme w/ CLIC note formula

e- directly on to Tungsten

σ=4.0mm