MEBT Chopper Target Protection Study

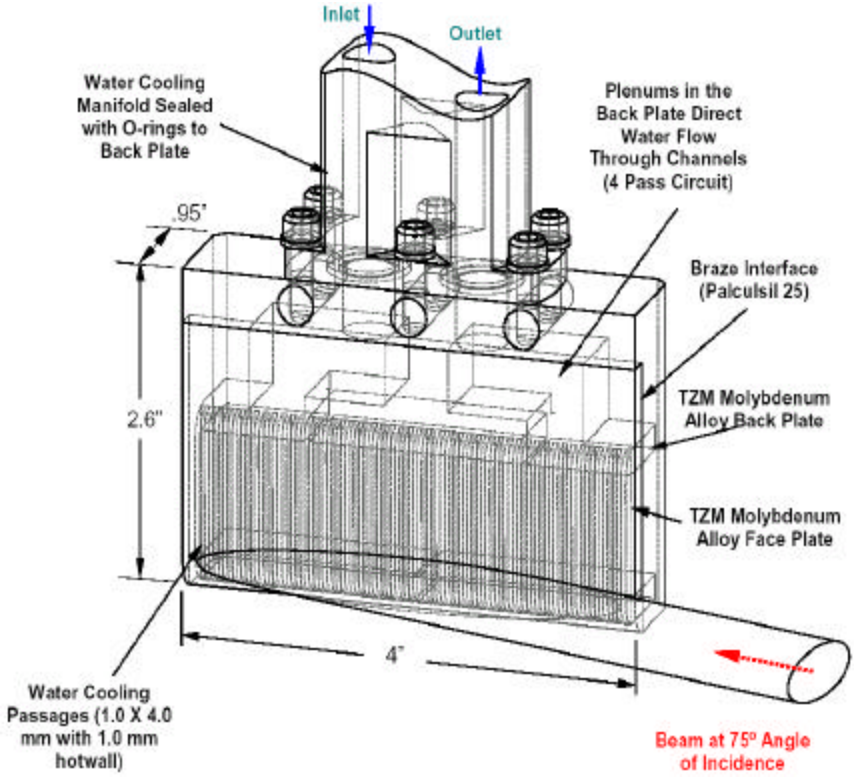
Feb. 25, 2003 Sang-ho Kim

Objective; To provide a guideline to the control & power supply crews for the machine protection

Machine fault condition

- LEBT chopper fail in off + MEBT chopper fail in on; holding time of MEBT chopper power supply is assumed long to look at the beam induced thermal stress only. Full beam loading

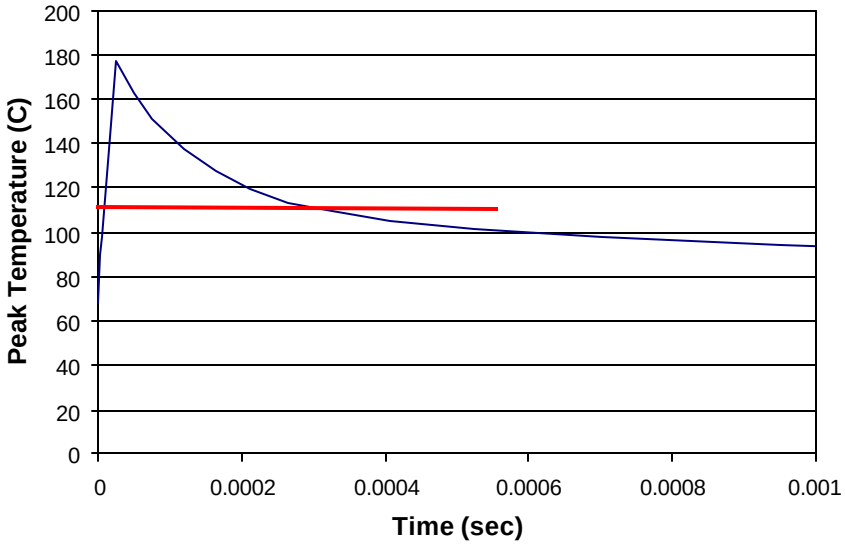
2. MEBT chopper works alone; 300 ns, 1 MHz beam loading on target.



The analysis and experiments shown by LBNL;
In nominal operating condition, which is
LEBT & MEBT choppers work properly and
beam has its nominal size (σx=3.69mm, σy=1.64mm),
MEBT chopper target can handle the 56 mA beam
with sufficient margin (peak temp~200 C, peak
von Mises stress~250 MPa).
And also can handle 500 W average power.
[Daryl Oshatz's analysis; FE-ME-041, LBNL]

The same Ansys input file was used for the following analyses after having same results with Daryl's in the nominal condition to verify the modeling.

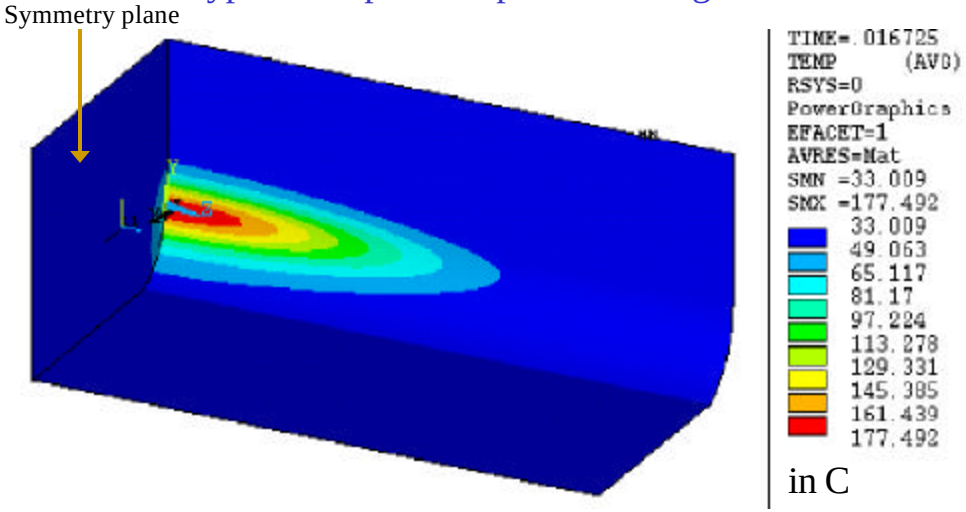
An example of time history of peak temperature
σx=3.69mm, σy=1.64mm, 38 mA for 25μs and gap



Decay time constant of temperature; >200 μs
thermal diffusion is very weak in time < 100 μs
Peak thermal stress is the first criteria we meet
(average power handling capability; rather slower process)
~400 MPa
(~60 % of yield, concerning fatigue, temperature and margin)

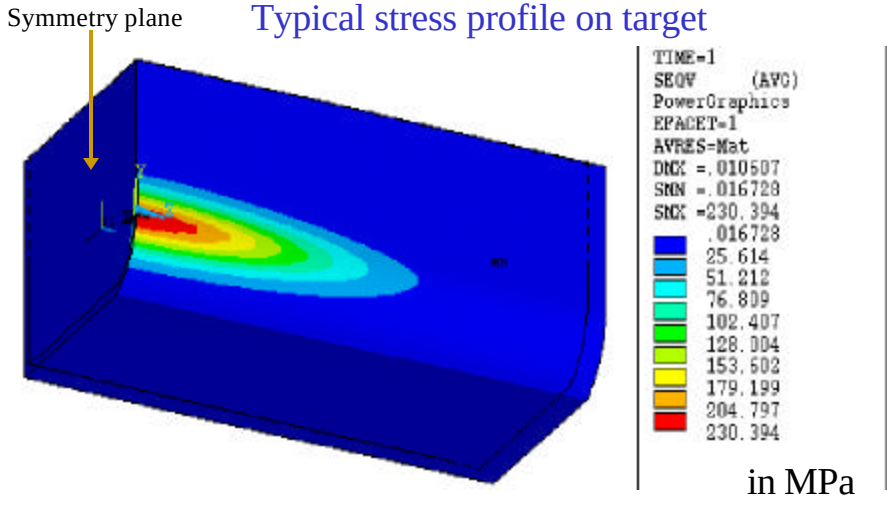
An example of temperature and von Mises stress profiles on Target; σx=3.69mm, σy=1.64mm, 38 mA for 25μs

Typical temperature profile on target

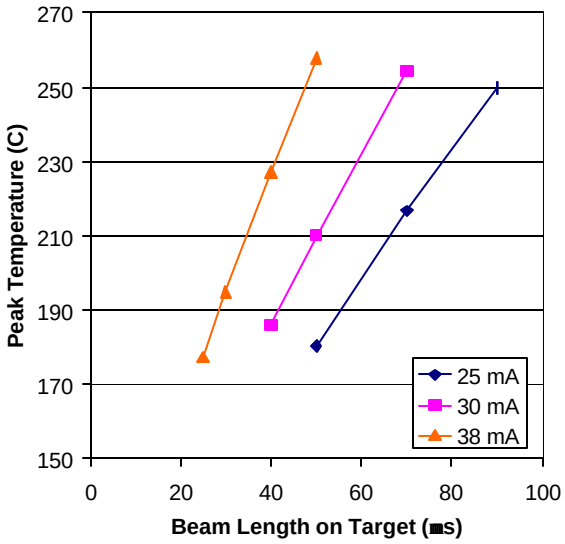


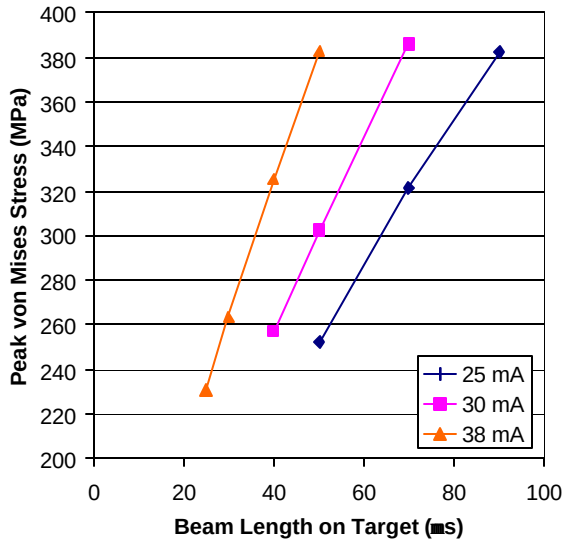
in C

Typical stress profile on target

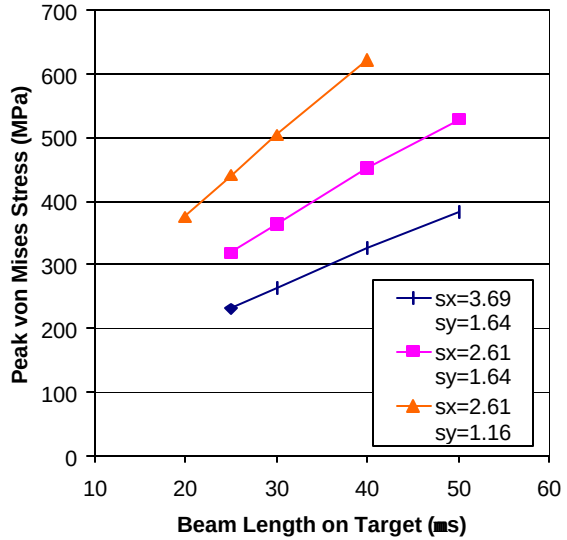


in MPa



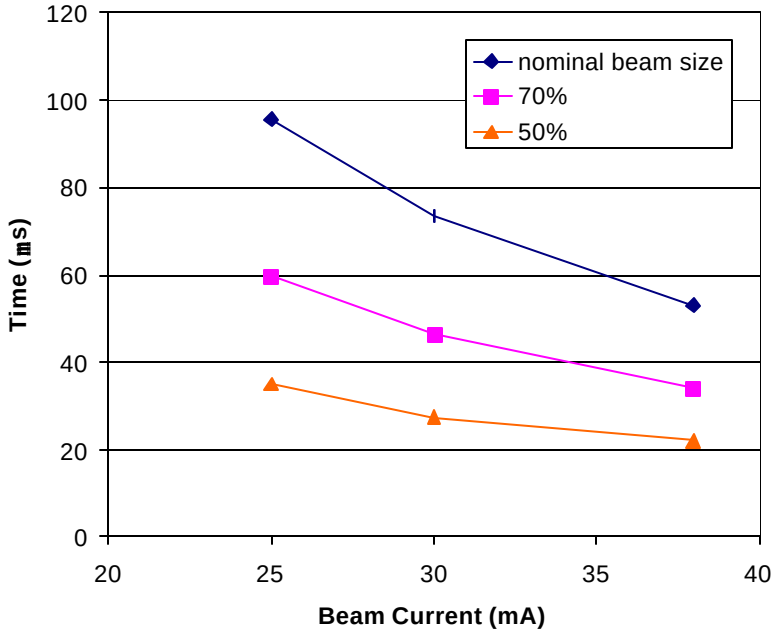


For the nominal beam size



At I_b=38 mA

Time to reach
400 MPa peak stress
(in condition 1)



When the MEBT chopper works alone, ~3 times more durations are allowable than above