Optimization of Protection Collimators

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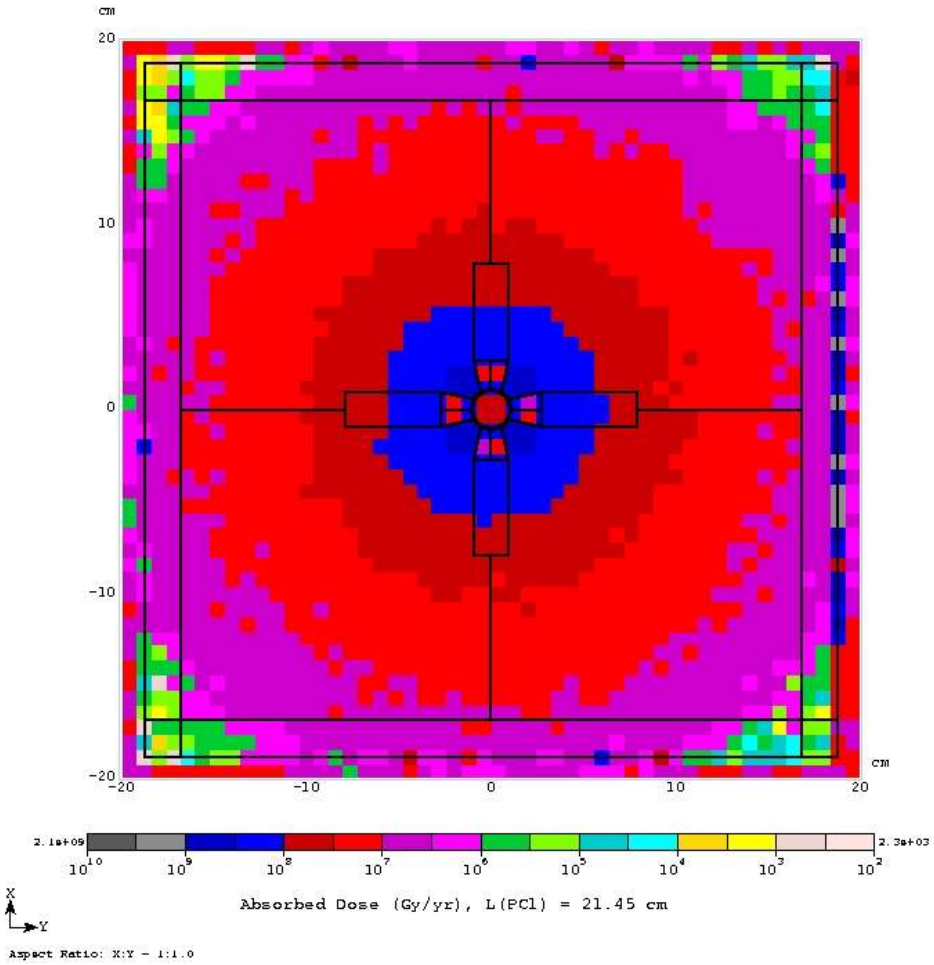
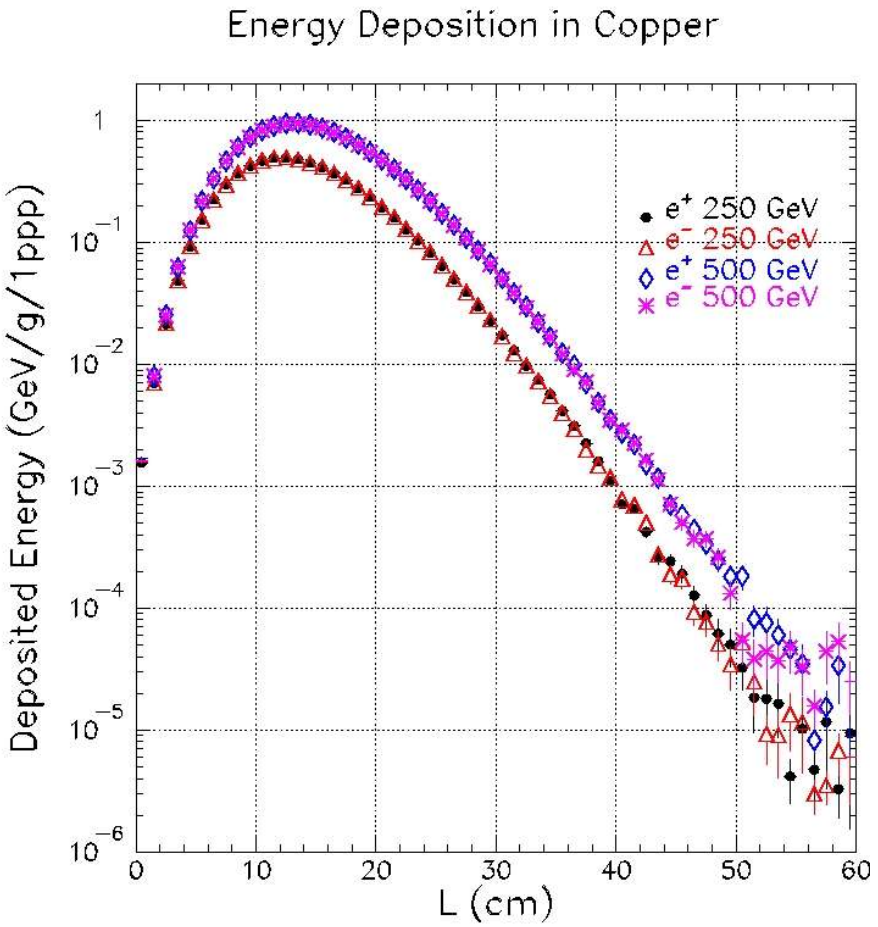
Quadrupole Life Time

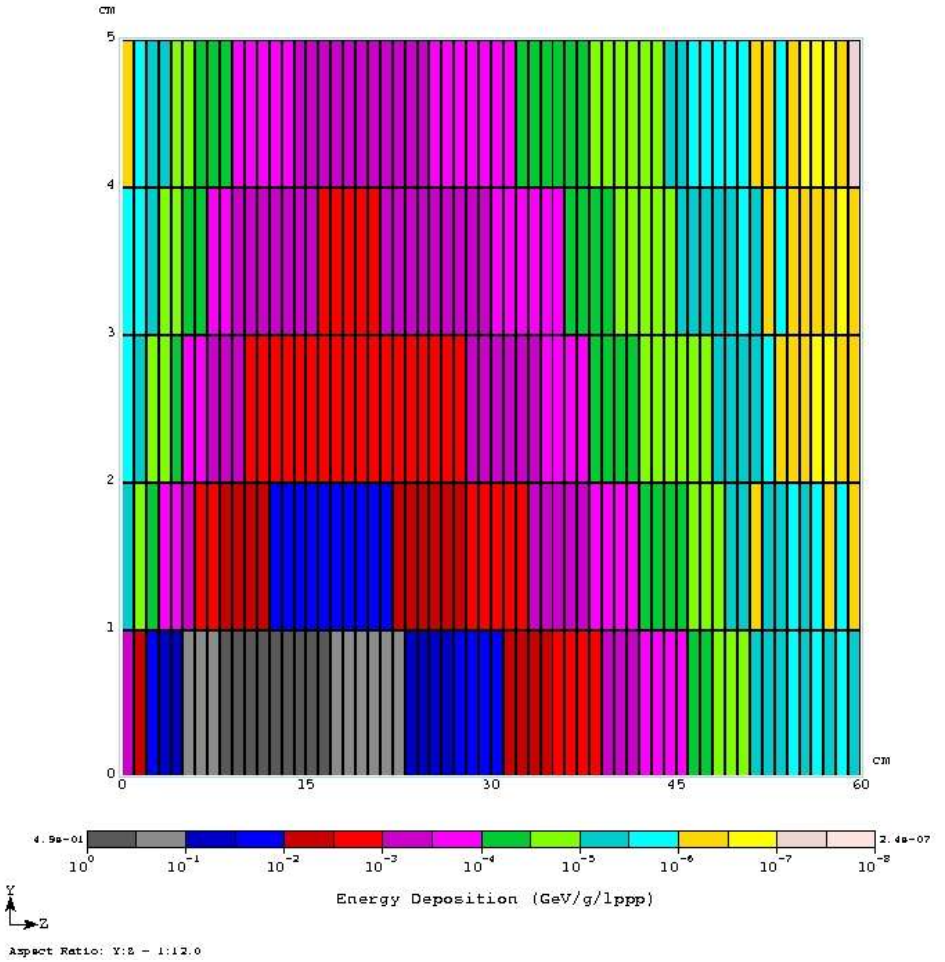


- L(PC1) = 21.45 cm
- P_{γ} = 7.67 ± 0.34 mSv/hr
- Peak absorbed dose in quad coils ~300 MGy/yr (averaged over 2 cm)
- Max absorbed dose 4 MGy (for proton machines)
- Coil life time is ~3 days

Energy Deposition in Solid Copper



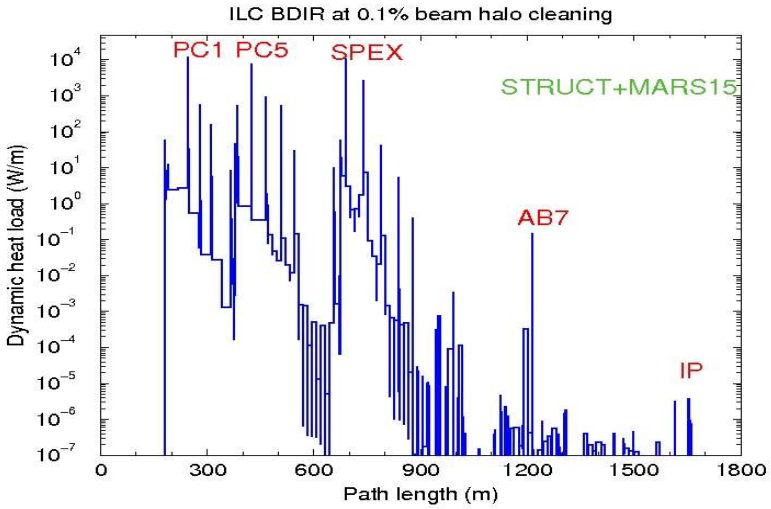
250 GeV Positrons



Bin 1 cm in radius

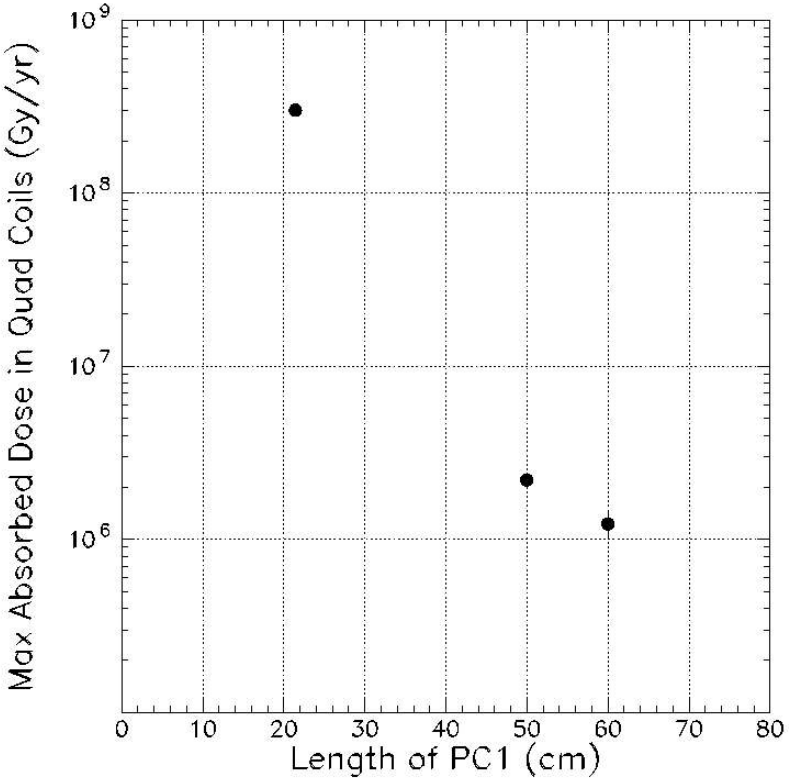
ED in Solid Copper

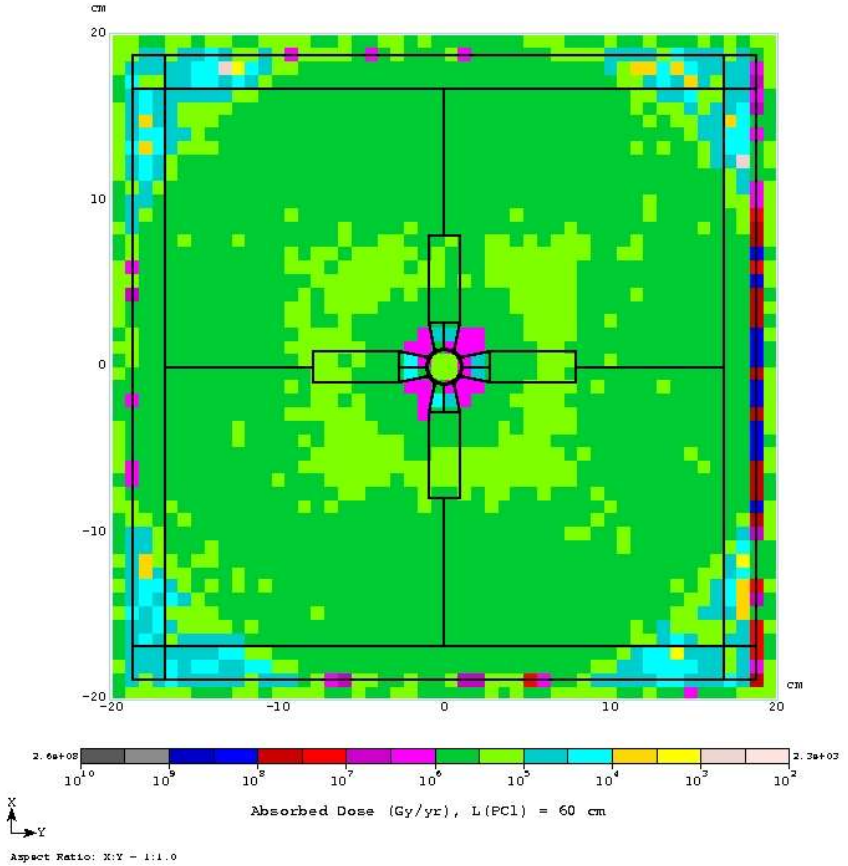
- **In *solid* copper, 3 orders of magnitude difference among the energy deposition in first cm (something like the spoiler SP2) and maximum of EM showers (12-16 cm from front surface)**
- **Looking for 3 orders of magnitude in dose reduction (τ=40 years)**
- **10 cm of copper provides dose reduction of an order of magnitude**
- **Protection collimators should be at least 50 cm long**
- **The protection collimators are not solid, add more length**



- **Dynamic heat load ~50 W/m for SP2, SP4 and SPEX and ~1.0e4 for PC1, PC5, PC8 and PC9**
- **The above numbers are consistent with those for solid copper**
- **Ionization losses for spoilers, EM showers for PC**

ED in Quad (downstream of PC1)





- Dose reduction is smaller than in solid Cu
- 14 years of life time with PC1 60 cm (2.0e+7 sec/yr)
- PC1 shadow is seen

Survivability of Collimators

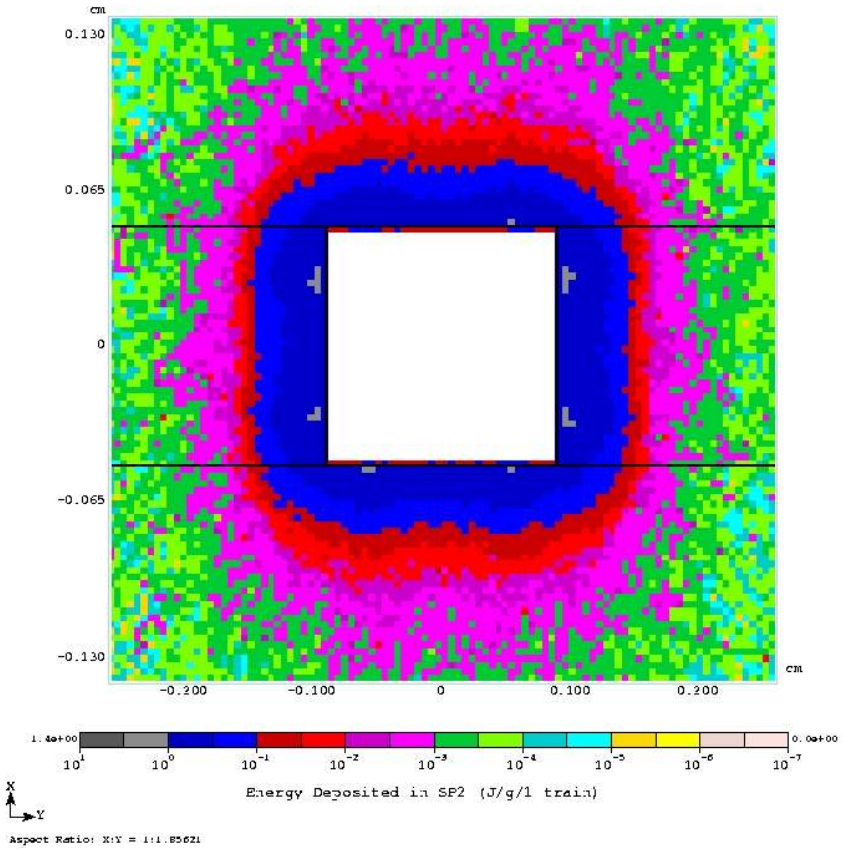
- **Factors that affect the survivability**
  - Temperature (relatively slow, specific time - 1 msec)
  - Stress. Very fast (speed of sound).
- **Normally, one uses ANSYS for stress calculations. Use magic numbers instead for cm scale objects (600 J/g for Cu, 1000 J/g for C, Inconel, Ni)**
- **Use 1 train for temperature studies**
- **Assume that there is no temperature build-up, i.e. 0.2 sec between the trains is long enough to cool the collimators down (might be true enough with active cooling)**

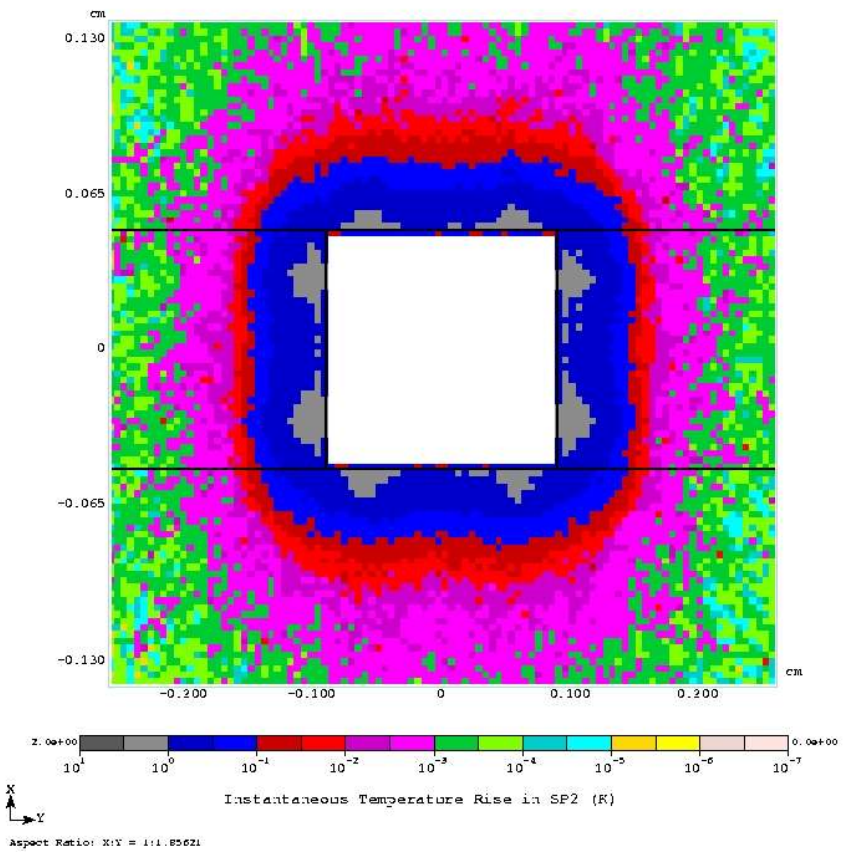
ED and T Rise in SP2

$ED_{max} = 1.366 \pm 0.030$ J/g/1 train

$\Delta T_{max} = 1.951 \pm 0.042$ K

The specific heat is a non-linear function of T

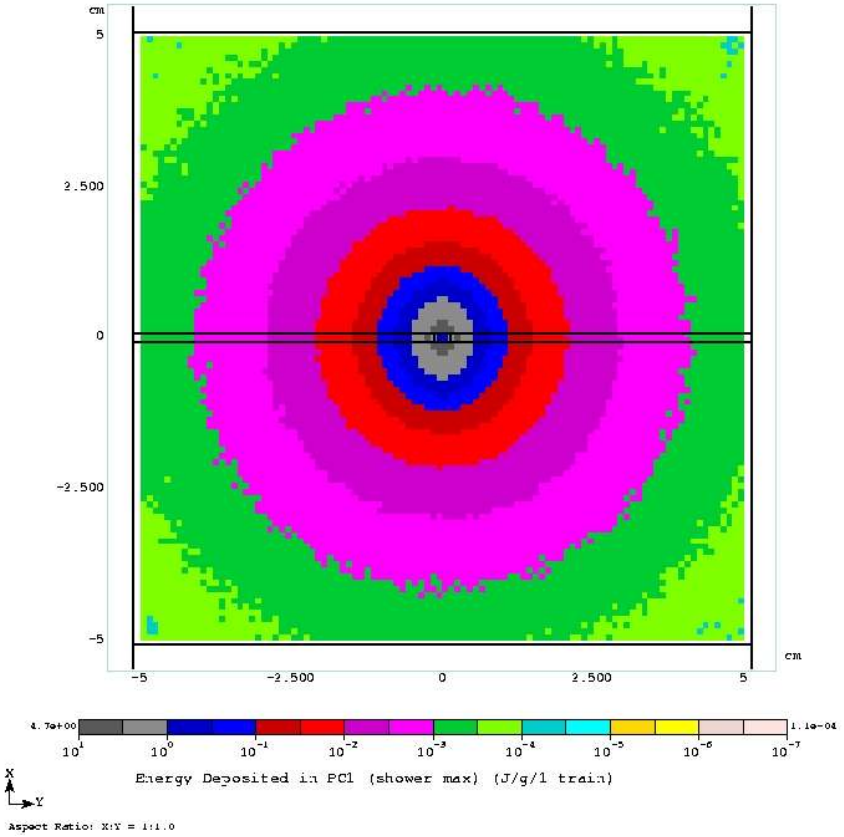


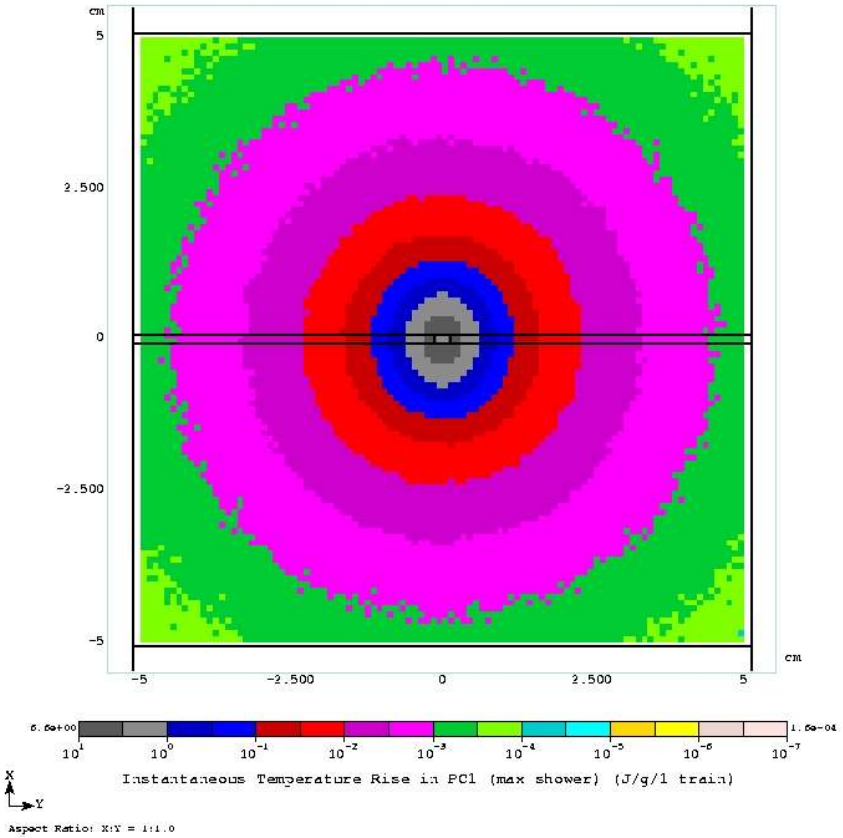


ED and T Rise in PC1 (shower max)

$$ED_{max} = 4.672 \pm 0.003 \text{ J/g/1 train}$$

$$\Delta T_{max} = 6.615 \pm 0.005 \text{ K}$$





Conclusions

- **Protection collimators should be ~60 cm long**
- **Previous results on the dynamic heat load are consistent with the new calculations**
  - ~ 50 W/m in SP2, SP4 and SPEX (dE/dx)
  - ~ 1.0e+4 W/m in PC (EM showers)
- **Temperature and stress in collimators should not be a problem**