HEP II Homework Assignment: Accelerators, Lepton, Jet and Photon Identification

1.) When it was running, the Large Electron-Positron (LEP) collider inhabited the same tunnel as the present day Large Hadron Collider (LHC), which has a circumference of 26.7 km, and bending radius ρ=2668m. If the maximum energy attained by LEP was 108 GeV in each beam, then how much energy was lost to synchrotron light per turn? What is the synchrotron radiation power for a circulating beam of 6 mA?

2.) Consider the following two 5x5 arrays of calorimeter crystals. In each cell, the energy measured is listed in GeV.

a.)

0	$i\phi$=-2	$i\phi$=-1	$i\phi$=0	$i\phi$=1	$i\phi$=2
$i\eta$=2	0	0.1	0.2	0	0.02
$i\eta$=1	0.04	0.03	0.125	0.3	0
$i\eta$=0	0	12	35	0.02	0.04
$i\eta$=-1	0	0.05	0.5	0	0
$i\eta$=-2	1	0.01	0.1	0.04	0

b.)

0	iϕ=-2	iϕ=-1	iϕ=0	iϕ=1	iϕ=2
iη=2	0.02	0.05	0.01	0.04	3
iη=1	7	0.03	0.125	0.035	0
iη=0	2.5	12	27	0.04	0.04
iη=-1	0.03	0.045	5	0.045	0.04
iη=-2	0.045	0	0.2	0	0.06

Calculate $\sigma_{i_\eta i_\eta}$ for each of these sets of crystals (using the log fraction energy weighting and a W_0=4.7). Which of these is more likely to be representative of an true electromagnetic shower (from an electron or photon), as opposed to being from a jet?

3.) The Run II D0 Calorimeter can be primitively parameterized as having a resolution:

$\frac{\sigma_E}{E} = C \oplus \frac{S}{\sqrt{E}} \oplus \frac{N}{E}$, where C=4.2%, S=0.15 GeV$^{1/2}$, and N=0.29 GeV, while its tracker can be primitively parameterized as $\frac{\sigma_{\frac{1}{p_T}}}{\frac{1}{p_T}} = S \oplus Cp_T$, where S = 0.0258, and C=0.00267 GeV^{-1}. If an electron's energy is measured to be 48 GeV in the calorimeter and 55 GeV in the tracker, then what is the uncertainty weighted average transverse momentum? You may assume that this electron is at η=0 for simplicity.