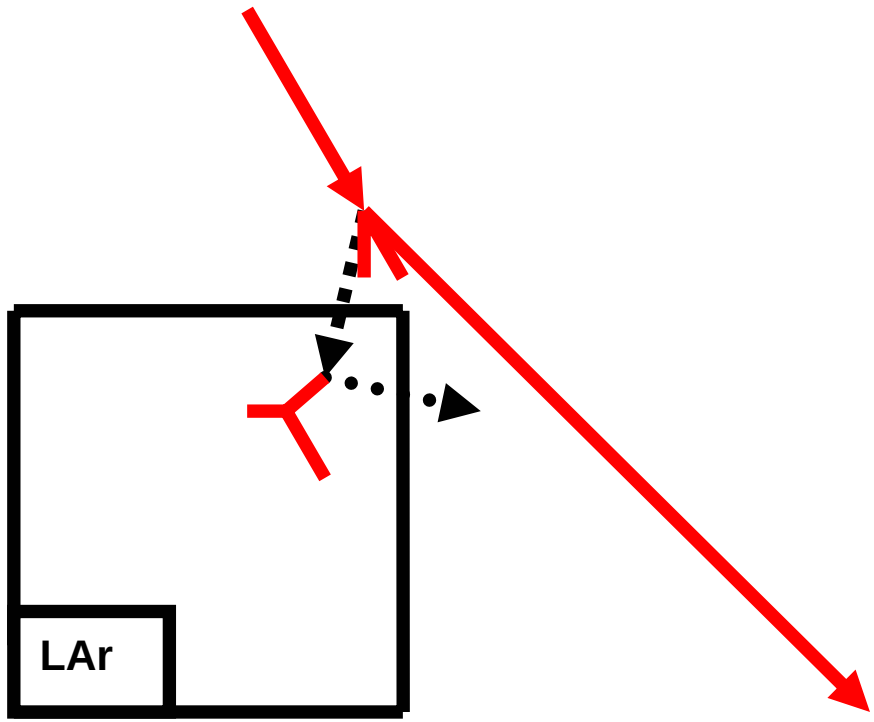
LAr Depth

W. Morse - BNL

LAr at DUSEL

- Dave Cline LAr talk at April 2008 DUSEL Workshop at Lead, S.D.
- Depth determined by $K_L\ p \rightarrow K^+\ n$ background to $p \rightarrow K^+\ \nu$ decay.
- I volunteered to do a “back of the envelope” calculation, ie. not GEANT.
- Another background: K_s regeneration background to $n \rightarrow K_s\ \nu$ decay.

μ rock $\rightarrow \mu K_L x$; $K_L p \rightarrow K^+ n$ or $K_L \rightarrow K_S$



Depth for LAr Detector

- Assume 100kton cylindrical LAr detector
- June 4, 2008 White Paper
- Miland posted it on the web
- 3.5km w.e. gives 0.1 event background in 3 yr live-time for $p \rightarrow K^+ \nu$.
- A. Bueno et al., hep-ph/0701101(2007).
- 3km w.e. gives 0.1 event background in one yr live-time for $p \rightarrow K^+ \nu$.
- Ray Davis experiment was at 4.5km w.e.

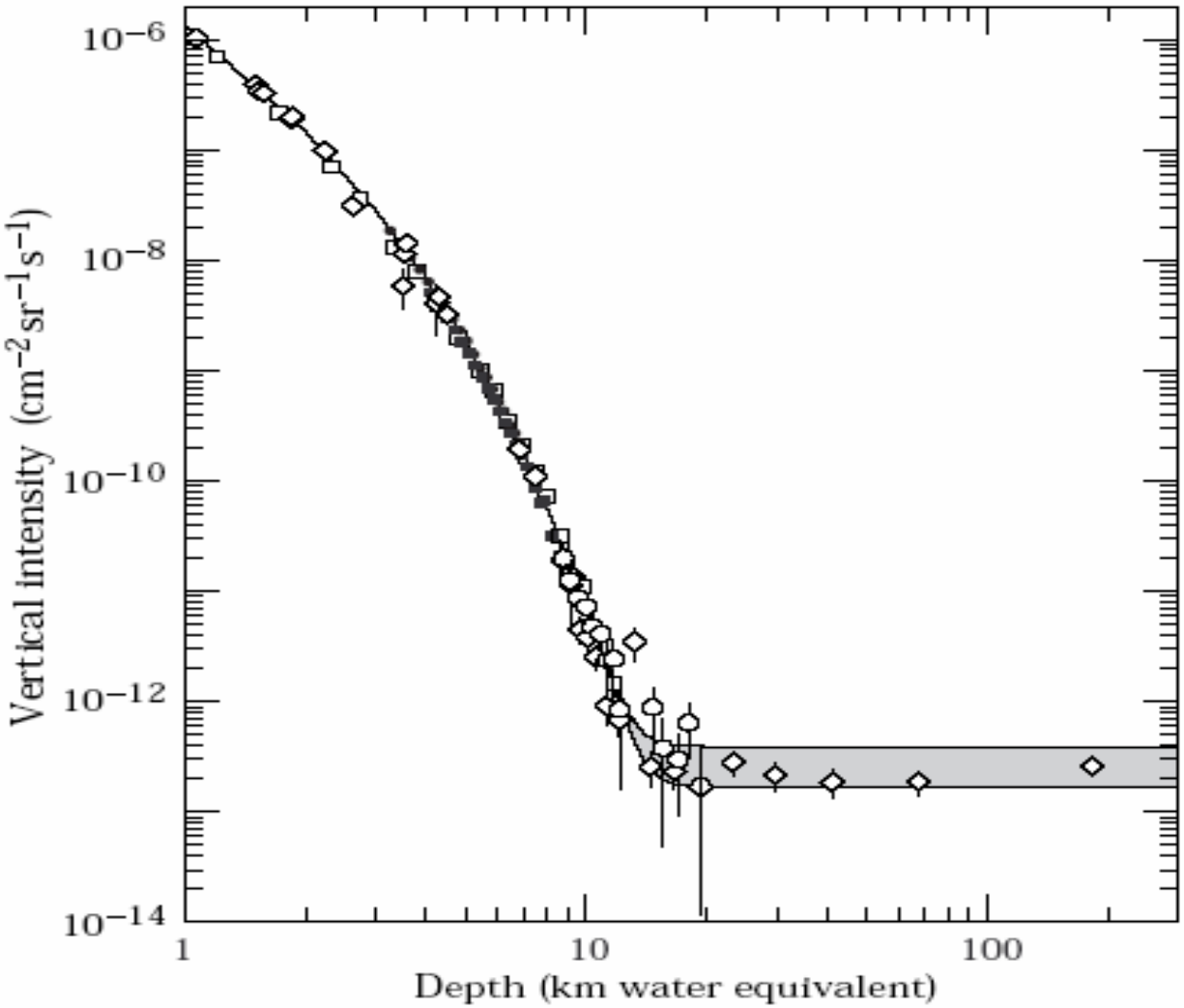
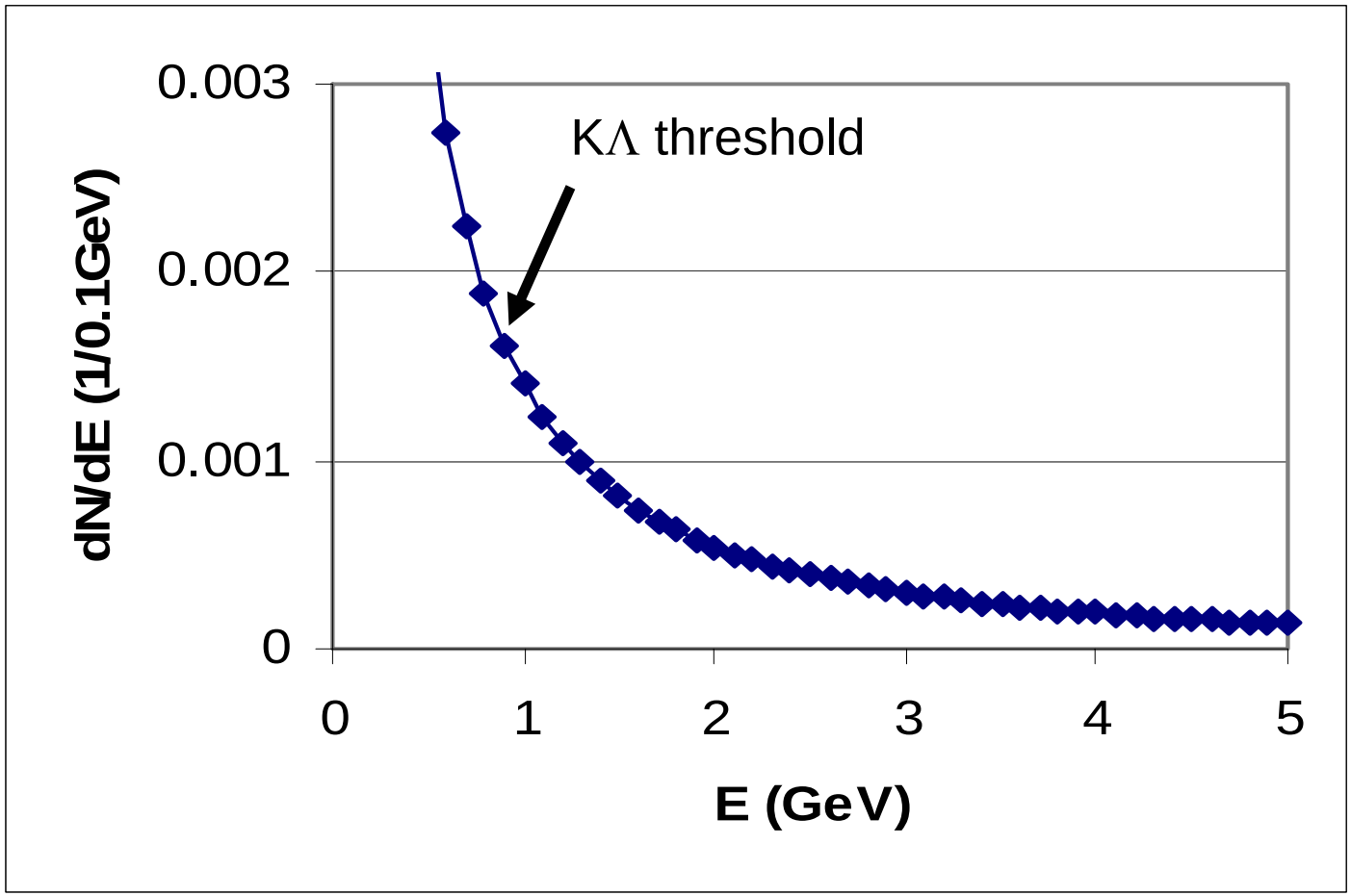


Figure 24.5: Vertical muon intensity vs depth (1 km.w.e. = 10^5 g cm^{-2} of standard rock). The experimental data are from: ◇: the compilations of Crouch [45], □: Baksan [46], ○: LVD [47], •: MACRO [48], ■: Frejus [49]. The shaded area at large depths represents neutrino-induced muons of energy above 2 GeV. The upper line is for horizontal neutrino-induced muons, the lower one for vertically upward muons.

$dN/dE \approx 2\alpha/\pi E\ (\ln 1.4E_\mu/E - \frac{1}{2})$



E_μ>1TeV (2.5km w.e.)

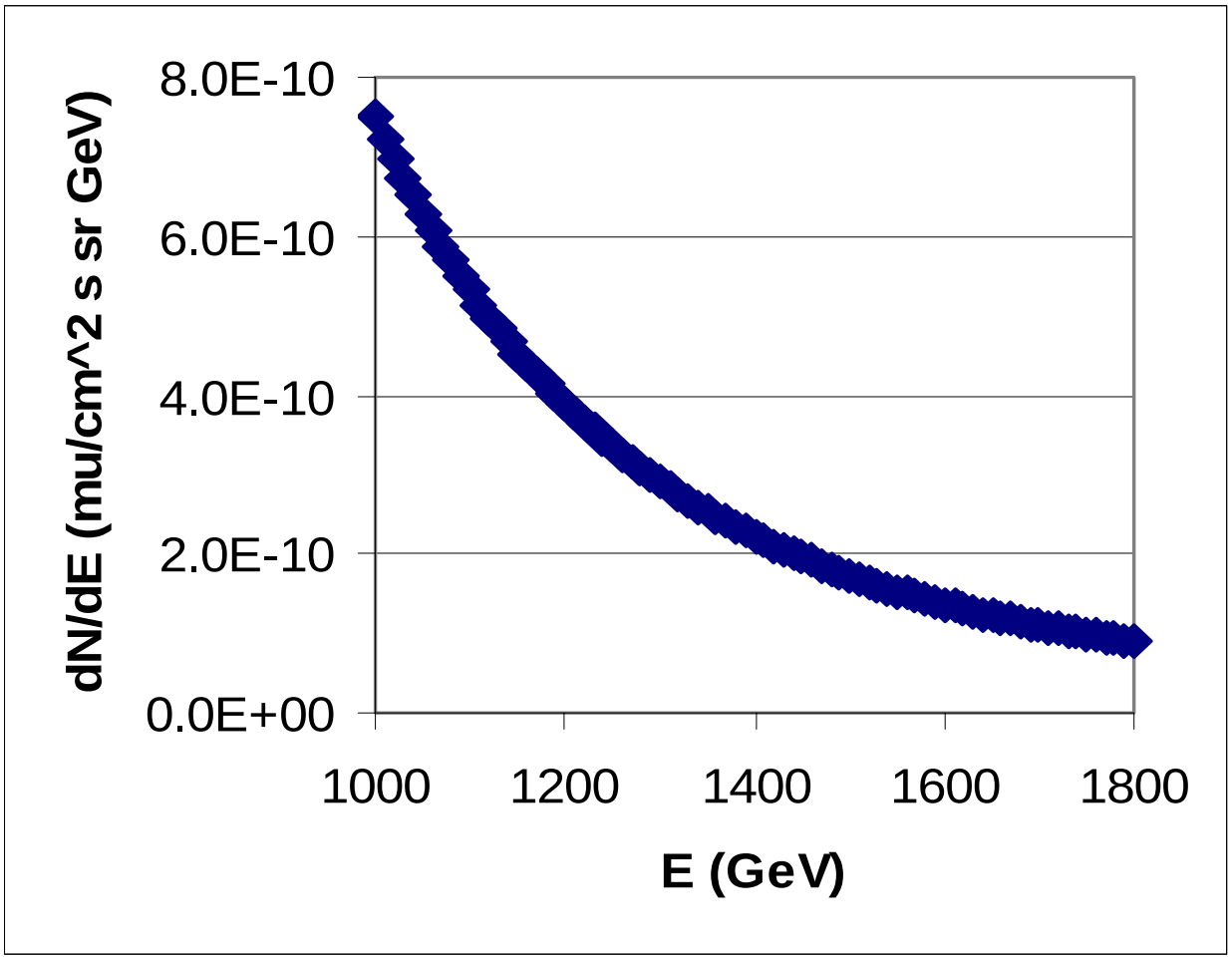
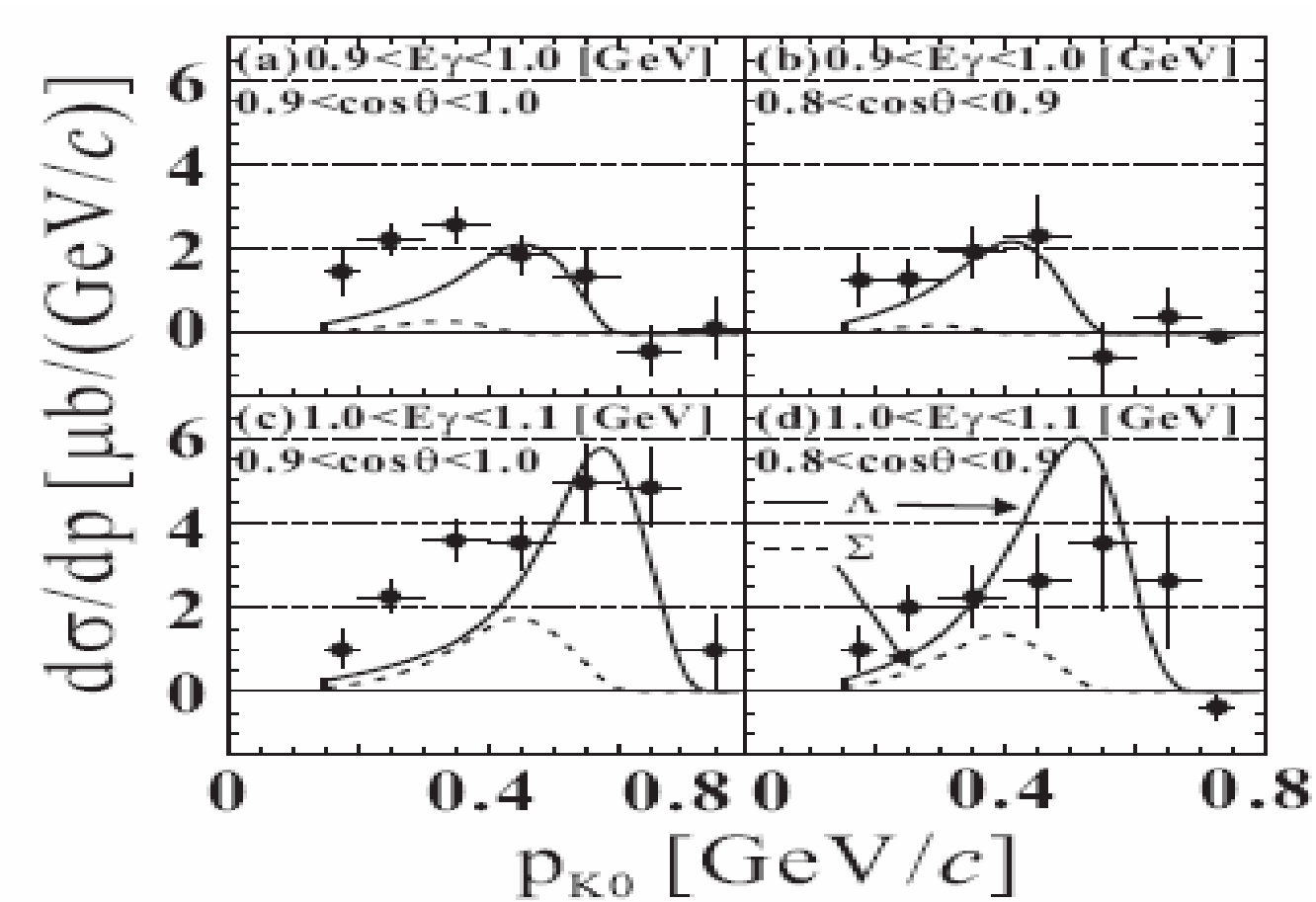
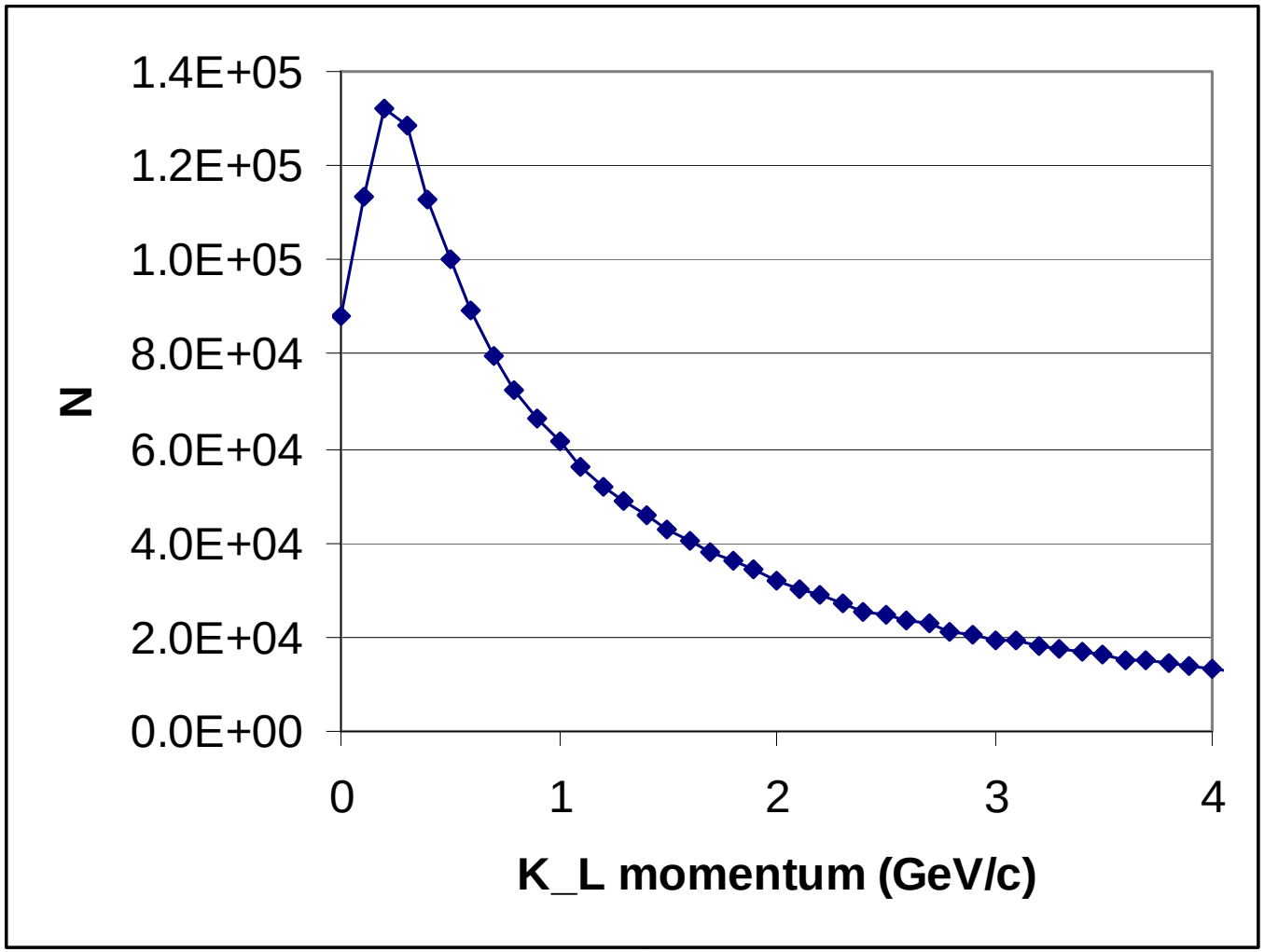


Photo-production of Neutral Kaons on C. Nucl-ex/067022(2006)



K_L from muons



K_L interaction cross-section

Particle	K^-	K_s	K_L	K^+
$c\,\tau$	3.71 m	2.7 cm	15.3 m	3.71 m
state	$u\,\bar{s}$	$d\,\bar{s} - \bar{d}\,s$	$d\,\bar{s} + \bar{d}\,s$	$u\,\bar{s}$

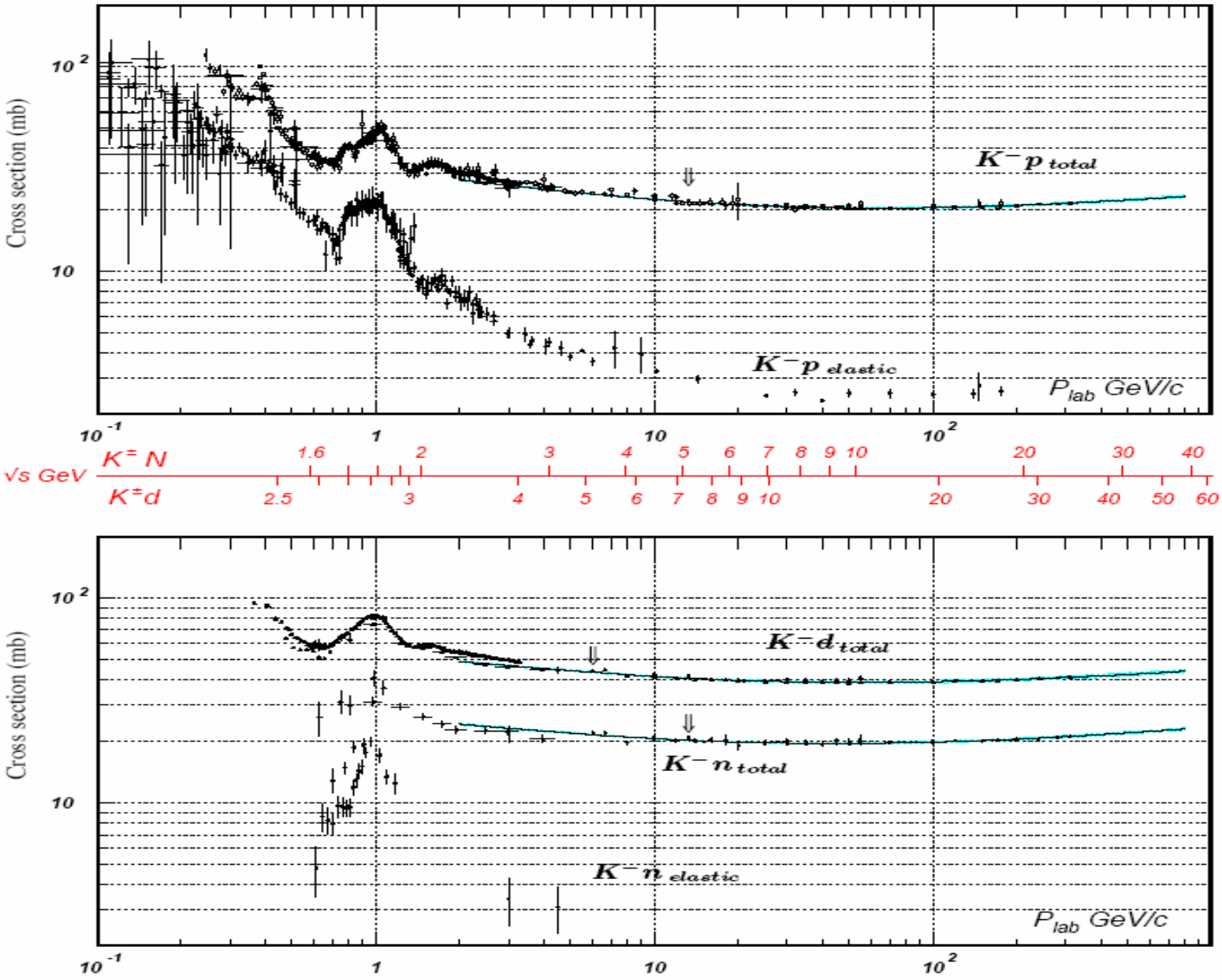


Figure 40.14: Total and elastic cross sections for $K^- p$ and $K^- d$ (total only), and $K^- n$ collisions as a function of laboratory beam momentum and total center-of-mass energy. Corresponding computer-readable data files may be found at `http://pdg.lbl.gov/current/xsect/`. (Courtesy of the COMPAS Group, IHEP, Protvino, August 2005)

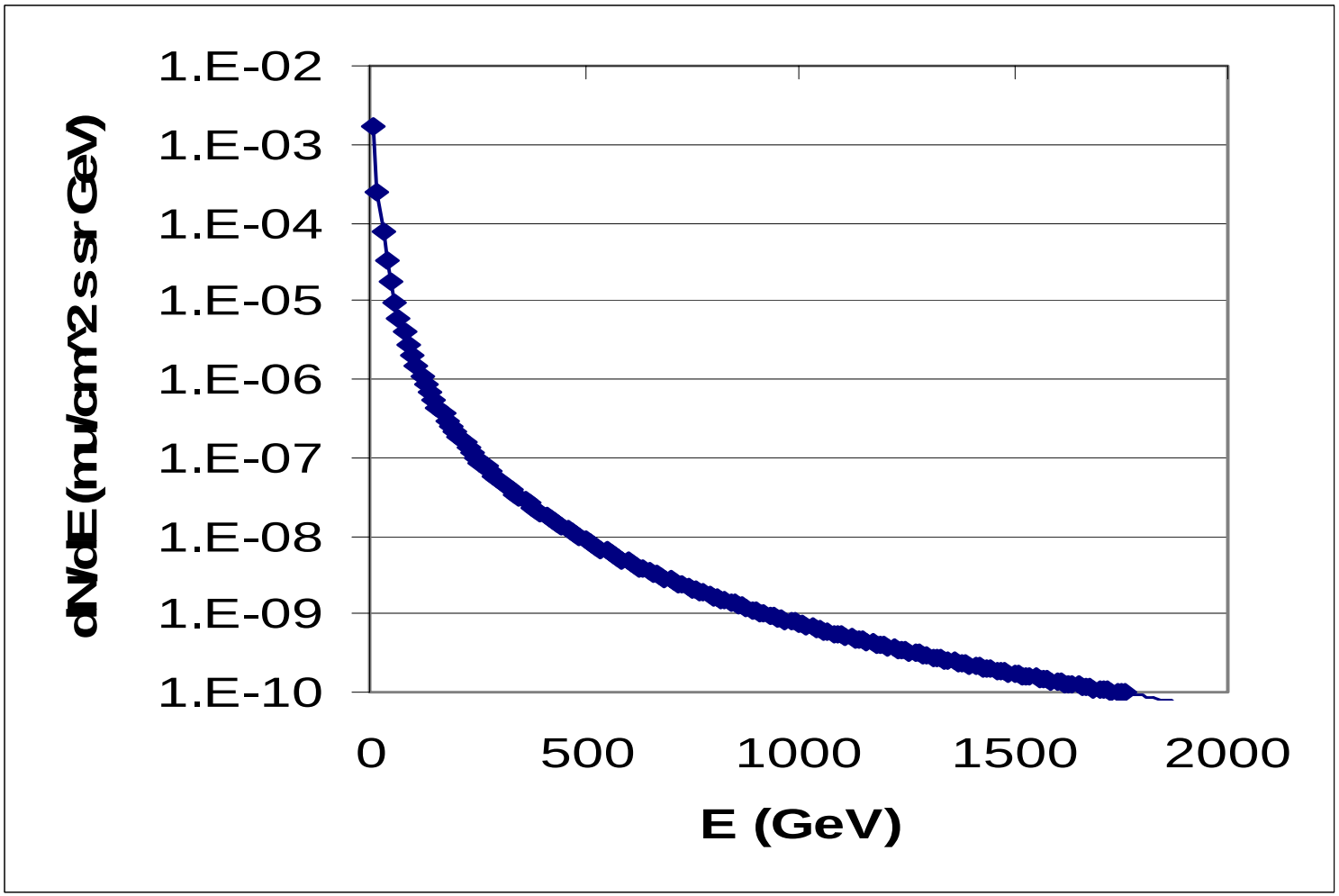
K_L Ar regeneration/ interaction L

- I get 1.1m from the last slide.
- A. Bueno et al. used 0.9m.
- Pretty good agreement.

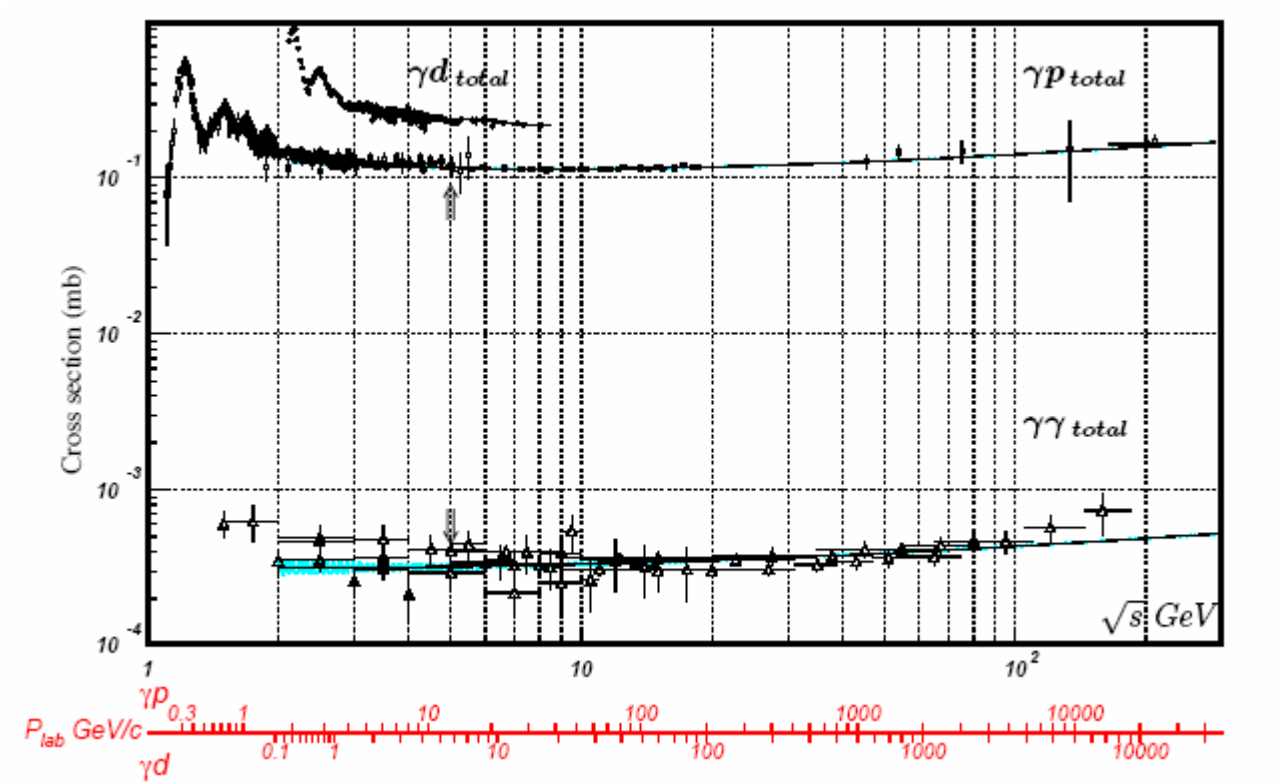
Conclusions

- 3.5km w.e. depth gives:
- 0.1 evt background from K_L p $\rightarrow$ K^+ n in 3 yr live-time for p $\rightarrow$ K^+ ν.
- 0.4 evt background from $K_L \rightarrow K_S$ in 3 yr live-time for n $\rightarrow$ K_s ν.
- A. Bueno et al. also studied sacrificing fiducial volume to reduce background.
- I disagree with this philosophy, …..
- Ray Davis experiment 4.5km w.e.

Extras


1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
0
500
1000
1500
2000
E (GeV)

γp total hadronic cross sections



A. Bueno et al.

- Section IIIE. An active very large area cosmic muon veto.
- 100% efficiency counters of area 10K m^2.

A. Bueno et al. – no muon veto

Depth	Fiducial Mass/Cut
0.5km w.e.	66 kton/ 6.6m
1km w.e.	71 kton/ 5.45m
3km w.e.	90 kton/ 1.8m