VP, 17/9/98

PS-I216

and more

I216 - Search for $\nu_\mu \to \nu_e$ at the CERN PS

the PS_ν beam

the basics of the experiment SBL, 825m

its physics reach
full check of LSND claim

Proton requirements

the PS can satisfy them (barely ...)

a much better PS is needed for LBL! 732 km

μ-ring ?

http://choruswww.cern.ch/~pzucchel/loi/ps.ps

EUROPEAN LABORATORY FOR PARTICLE PHYSICS

CERN-SPSC/97-21
SPSC/I 216
October 10, 1997

LETTER OF INTENT
SEARCH FOR $\nu_\mu \rightarrow \nu_e$ OSCILLATION AT THE CERN PS

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Neutrino Physics at a Muon Collider

K.T. McDonald

Princeton U.

17 September 1998

CERN Muon Collider Workshop

Based on

Workshop on Potential for Neutrino Physics at Future Muon Colliders

BNL, 13-14 August, 1998

http://pubweb.bnl.gov/people/bking/nushop/workshop.html

and

Workshop on Physics at the First Muon Collider and at the Front End of the Muon Collider

FNAL, November, 1998

AIP Conf. Proc. **435** (1998) [869 pages]

http://fnphyx-www.fnal.gov/conferences/femcpw97/workshop.html

BEBC - PS 180

(run 1983)

PLB 179 (1986) 307

PSTT7 line 19.2 GeV p

80 cm, 6 mm ø Be target

horn (~opt 2 GeV/c)

~50 m decay length

at 825 m   1.5 GeV = $\langle E_{\nu_\mu} \rangle$

$$\frac{470\ \nu_\mu^{cc}}{14\ \text{tons} \cdot .91\ 10^{19}\ \text{pot}} = 3.7\ 10^{-18}\ \nu^{cc}/p/\text{ton}$$

0.4% $\frac{\nu_e}{\nu_\mu}$ $\langle E_{\nu_e} \rangle \sim 2.5$ GeV

TO BE REFURBISHED

● P216 simulation
○ PS-180 simulation

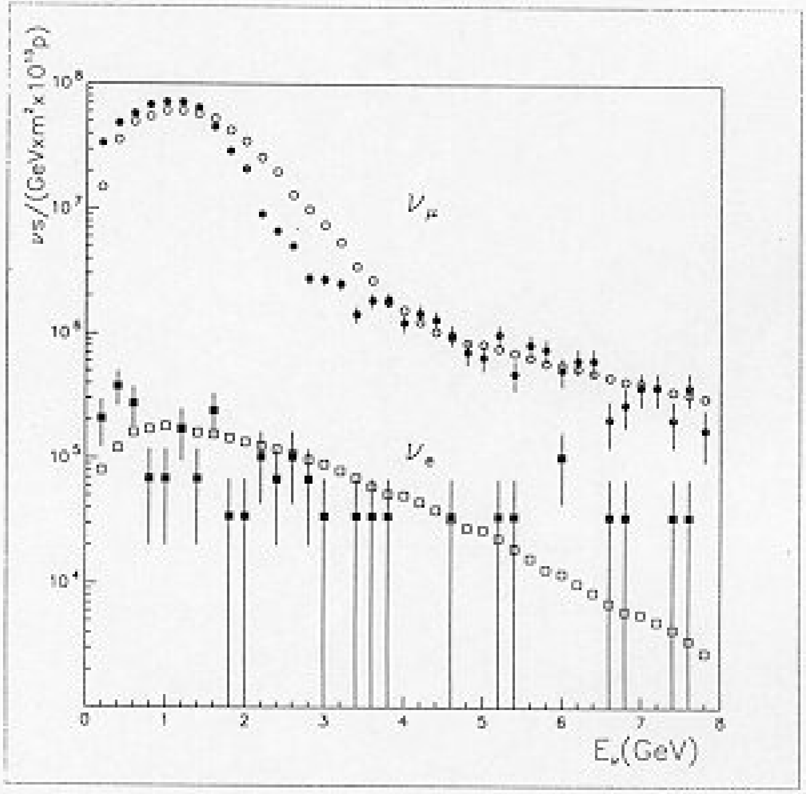

Figure 3: ν_μ (circles) and ν_e (squares) spectra: BEBC simulation (open symbols), this simulation (full symbols).

A new PS LOI

$L/E \sim 1\ eV^2$
$P_{min} \approx 10^{-3}$
check LSND

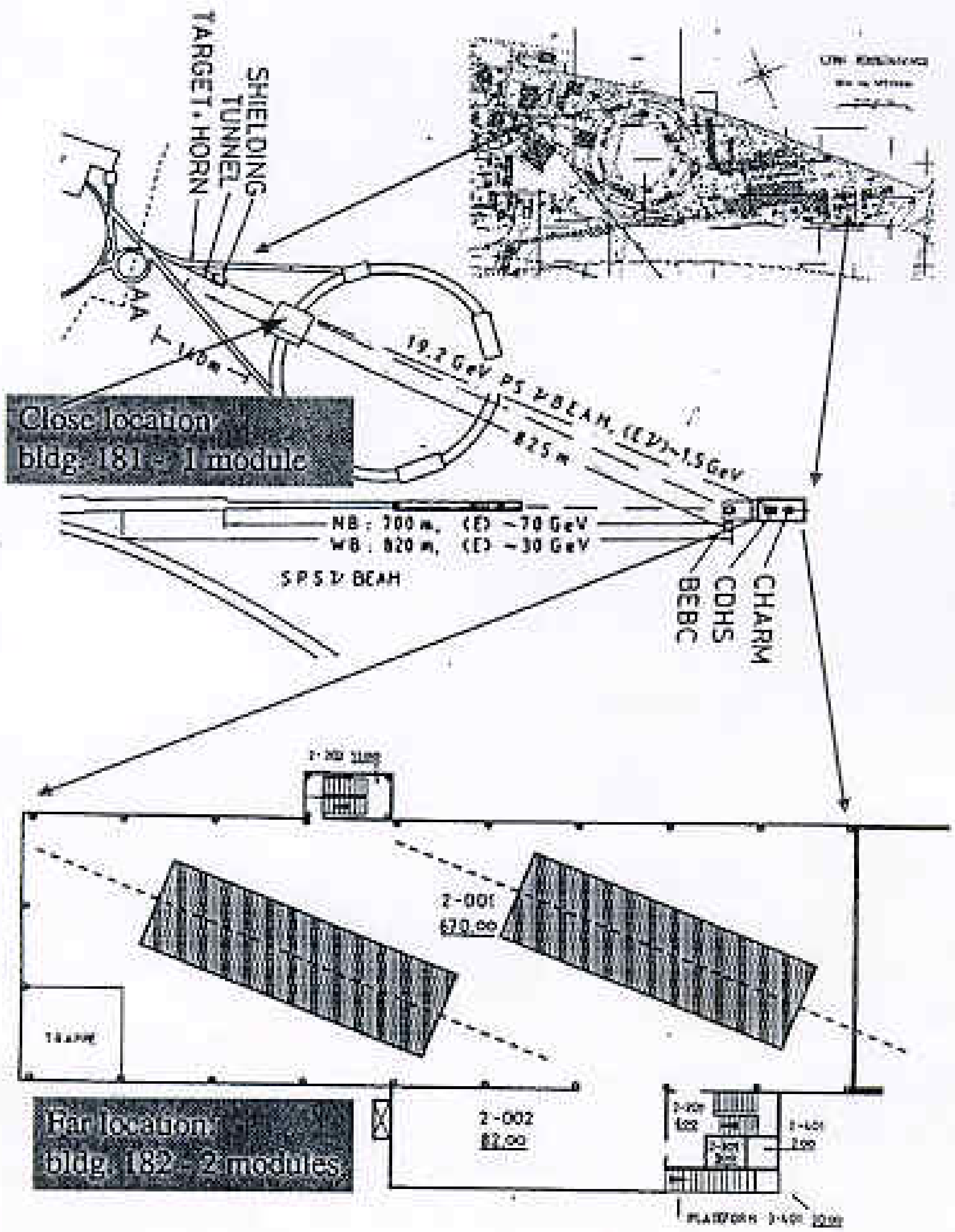

Figure 2: layout of the experiment.

compare ν_e/ν_μ far/close

run 2000 - 2001

$\nu_\mu n \to \mu^- p$

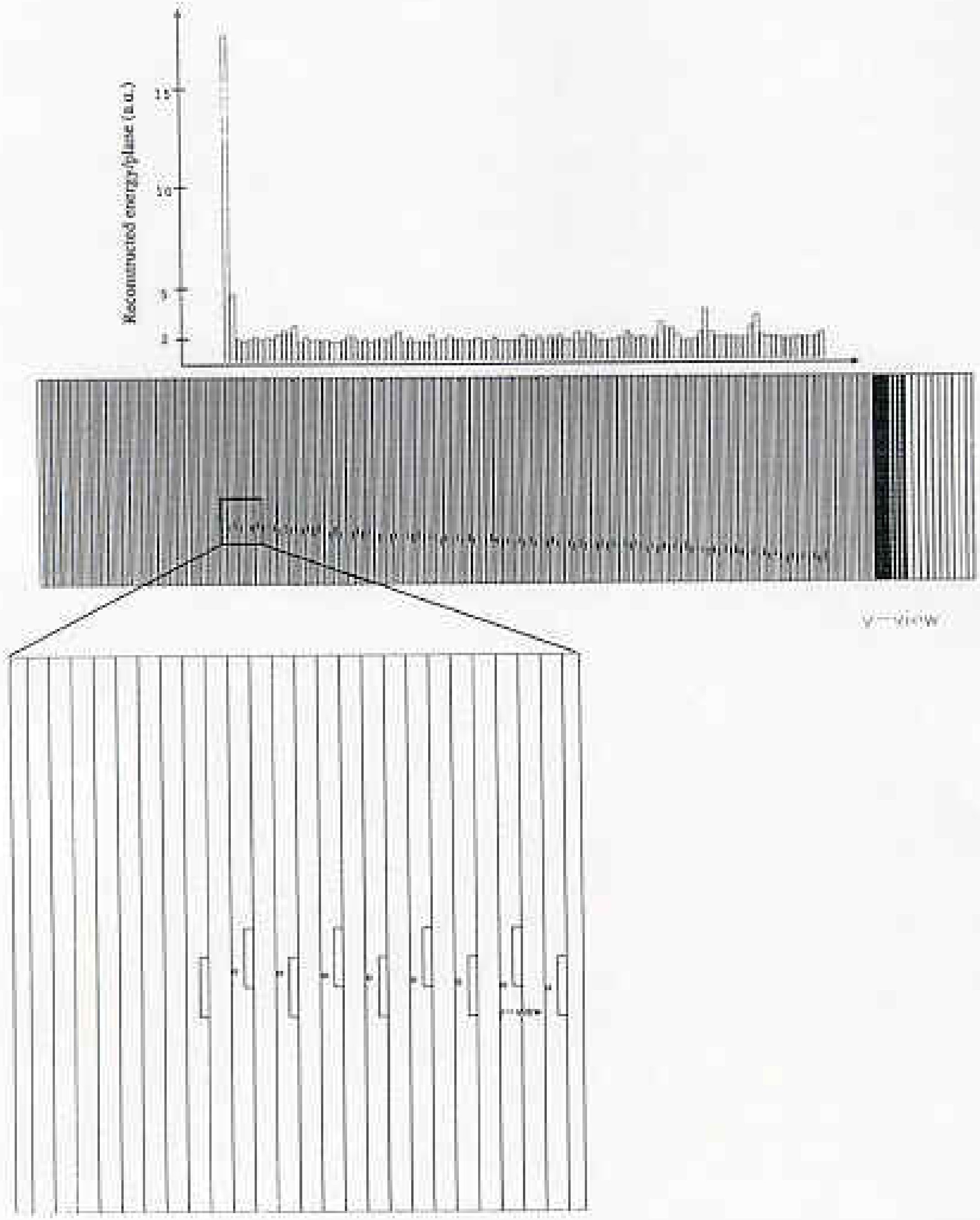

Figure 9: A ν_μ quasi elastic interaction. The energy loss of the proton in the first two scintillator planes is visible.

tracking

fine grain calo + tail catcher

12 X^0

+ μ catcher

300 (streamer Sci) planes

$\nu_e n \to e^- p$

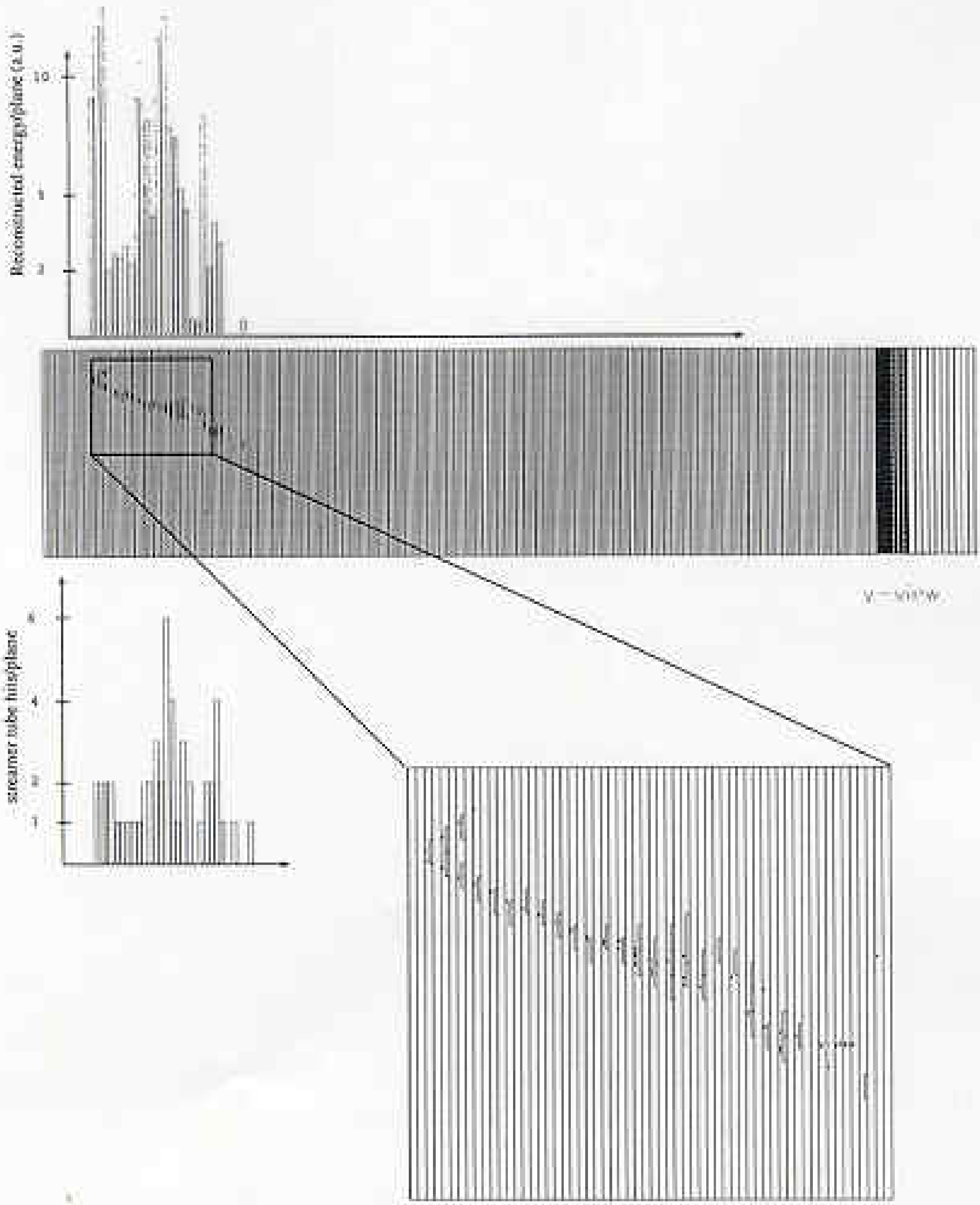

Figure 10: A ν_e quasi elastic interaction. The electron shower is connected to the vertex by a minimum ionizing particle.

want

$2.5 \ 10^{20}$ pot

(2 years)

128 tons close detector (130m)

$2,86 \ 10^{6} \ \nu_e^{QE}$

256 tons far detector (885m)

$1.3 \ 10^{5} \ \nu^{QE}$

assuming

$2.0 \ 10^{-18} \ \nu^{QE}/p/ton$

out of total

$3.7 \ 10^{-18} \ \nu^{cc}/p/ton$

$\nu_\mu \to \nu_e$ 2 years

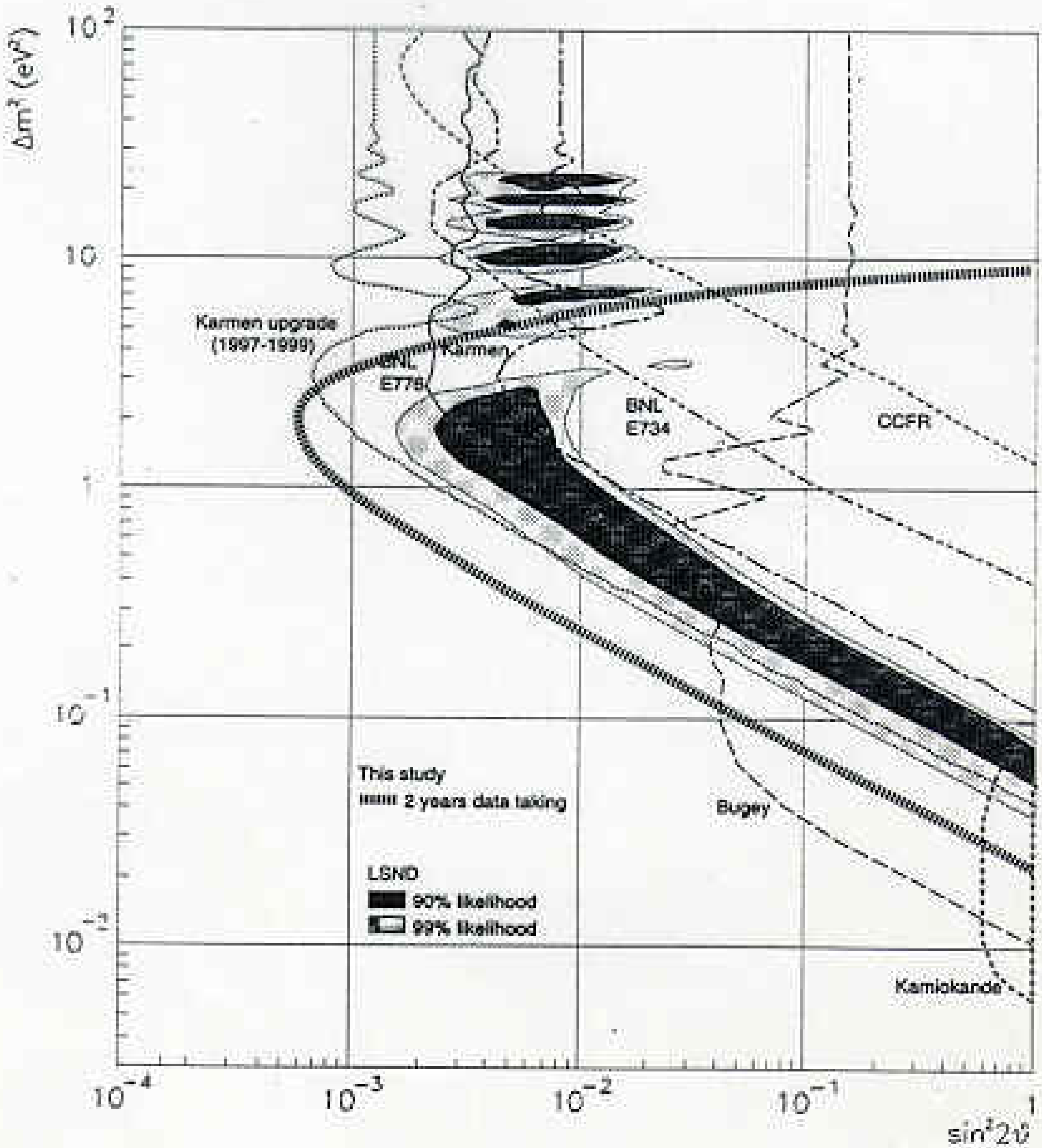

Figure 13: Two detectors $\nu_\mu \to \nu_e$ exclusion plot

$2.5\ 10^{20}$ pot/2 years ?

PSB 1,2 sec cycle $3\ 10^{13}$ p

PS 12 × 1.2 sec supercycle

(show fig)

$$\frac{3.0\ 10^{13}\ p/cycle}{1,2\ s/cycle} = 2,5\ 10^{13}\ p/s$$

so that in 6800 hours (out of 8760)
i.e. 283 days
at 92% efficiency

$2.25\ 10^{7}$ s/yr ⇒ **$5.63\ 10^{20}$ p/yr**

MAX !

BUT **losses** (at best 5%) $1.0\ 10^{13}$ p/s
(at worst 10%) $0.5\ 10^{13}$ p/s

HAVE TO BE KEPT BELOW
$\leq 5\ 10^{11}$ p/s
in the average

favoured
after LHC related
upgrades
PSB → PS at 1.4GeV
lower emittance
lower losses

so that

between **$2.3\ 10^{20}$ p/yr**
or **$1.1\ 10^{20}$**

are available, **to all PS users!**

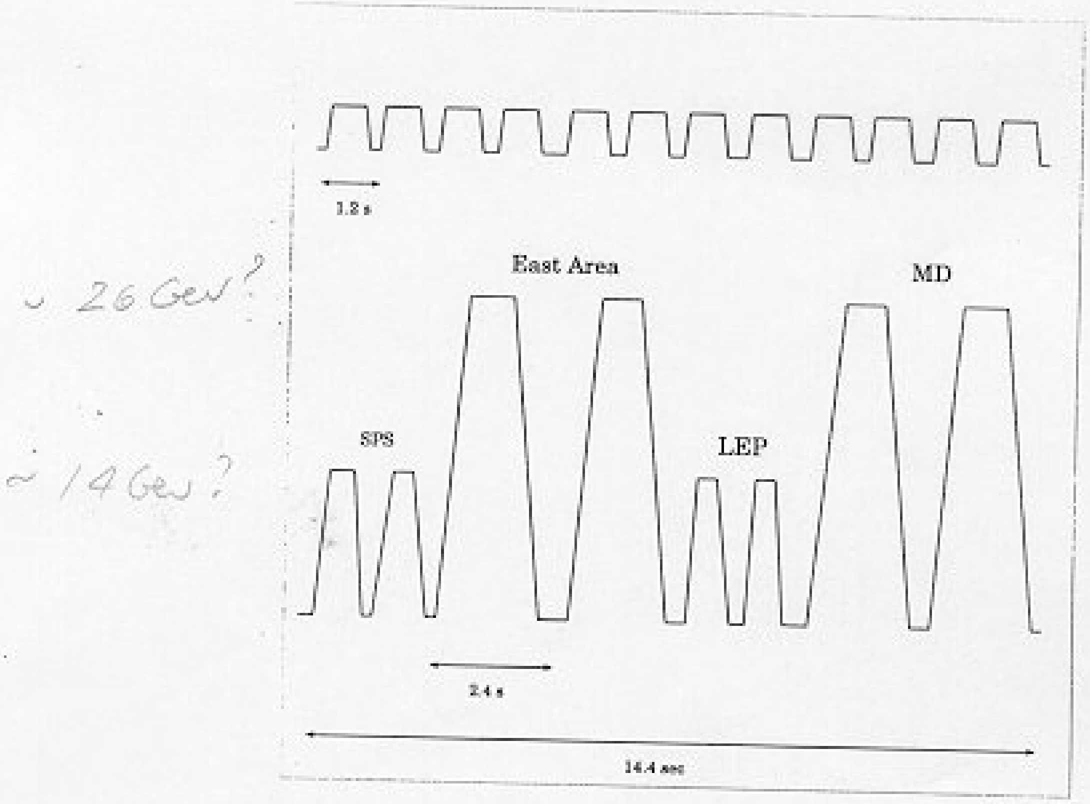

Figure 6: PS supercycle structure.

I-216

3 cycles $\times$ 2.5 10^{13} p/cycle

cycles are hardly shared

$$\frac{7.5 \; 10^{13} \, p}{14.4 \text{ sec}} = 0.52 \; 10^{13} \, p/\text{sec}$$

~ 1.17 10^{20}/yr

about OK (NB 1/2 red limit ?)

a detailed scheme can be worked out

So PS-SBL ν doable (and desirable!)

LBL ν **?**

μ-ring **??**

LBL 732 Km

$3.7 \; 10^{-18} \; \nu^{cc}/p/ton$ @ 825 m

$\Rightarrow 47 \; 10^{-24}$ @ 732 Km

as $\left(\frac{825}{732000}\right)^2 = 1.3 \; 10^{-6}$

will assume

$8 \; 10^{-24}$ @ 732 Km

$.08 \; \nu^{cc}/10^{19}p/Kton$

$.24 \; \nu^{cc}/10^{19}p/Kton$ **if 3x decay Tunnel**

$\times 2.3 \; 10^{20} \; p/yr =$ **$5.4 \; \nu^{cc}/kT/yr$**

$\times 5.6 \; 10^{20} \; p/yr = 13 \; \nu^{cc}/kT/yr$

a much better PS is needed