Exotic Processes at the ν Source

Fritz DeJongh

- Introduction
- Detector concept
- Conclusions

Introduction

I will discuss non–oscillation exotics

In extensions to the SM, the ν can have new fundamental properties:

- Dipole moments (and radiative decays)
  See talk by J. Krane
- New interactions *eg)* $\not{R}$ SUSY
  LSP is unstable

Two possibilities:

- Anomalous ν production in μ decay
- Anomalous lepton production in ν interactions

Experiment at ν source:

- Highest flux
- Disentangle confusion with oscillation signatures

RATE $\propto 1/L^2$
~INDEPENDENT OF E
OR $\propto E$

$P_{osc} \sim 5 \times 10^{-9}$
RATE INDEPENDENT OF
$\propto \frac{1}{E^2}$

Anomalous ν production in μ decay

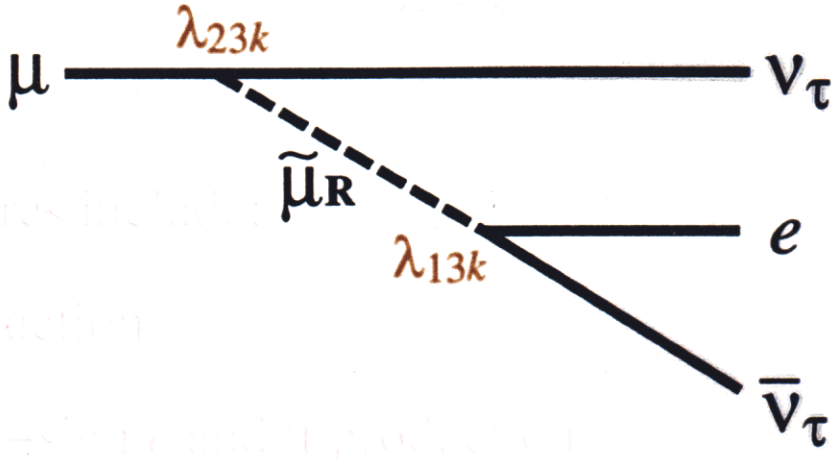
Only limit in PDG:

$$BR(\mu^- \to e^- \nu_e \bar{\nu}_\mu) < 1.2\ \%$$

Would like to be sensitive to:

$$\mu^- \to e^- \nu_x \bar{\nu}_y \quad x,y = e,\mu,\tau \text{ (or } s)$$

eg)



HAS V-A FORM

Allowed at BR = 0.5% level!

WOULD SHIFT MEASURED G_F

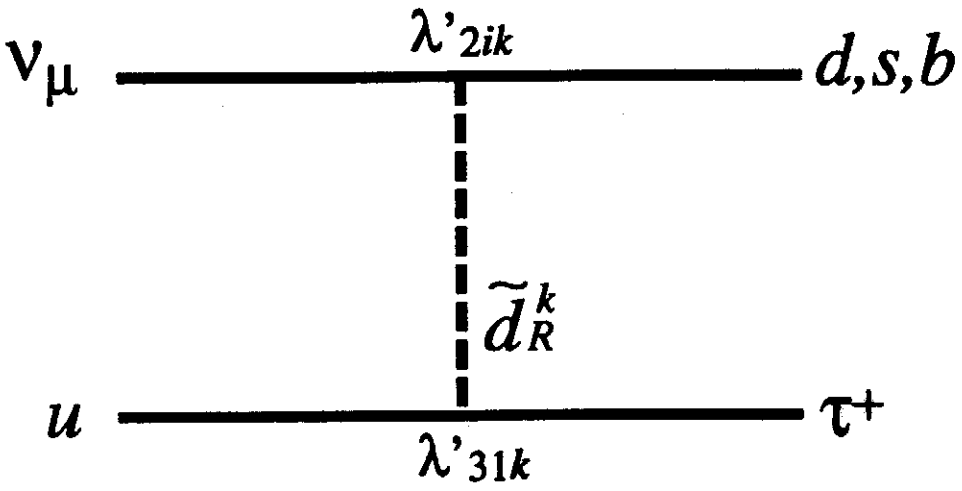
$G_F \propto \frac{1}{\tau_\mu}$ 1 in 10^6

$m_W \propto G_F^{-1/2}$ 0.5% SHIFT OK IN SM

WOULD SHIFT MEASURED V_{ud} τ_β/τ_μ

$|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 0.991 \pm 0.005$

Anomalous lepton production



Signatures include:

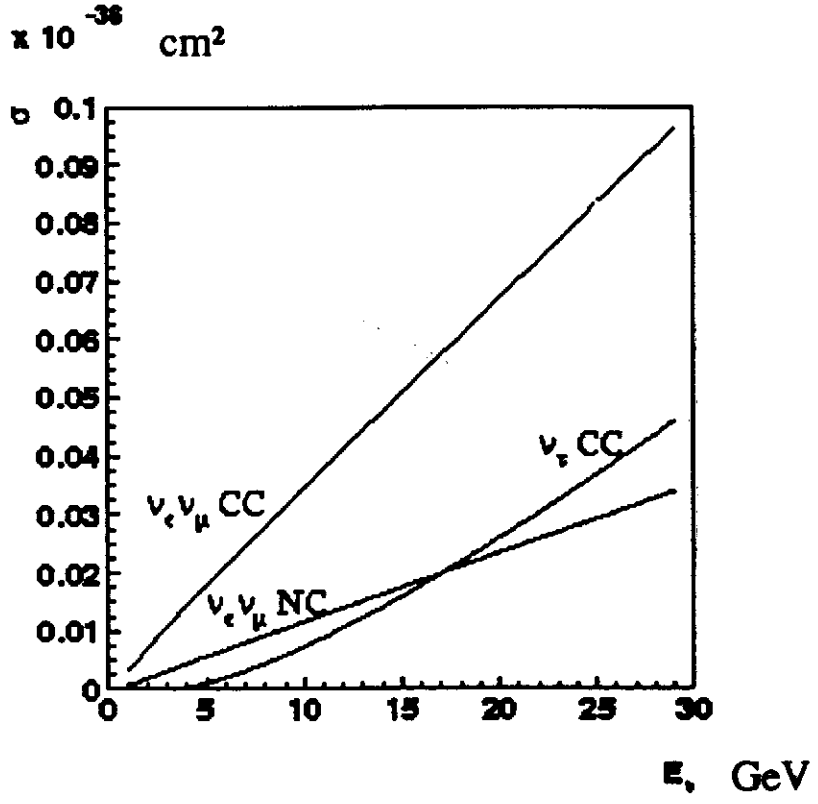
- τ production
- wrong–sign *e* and μ production
- right–sign *e* and μ deficit

Observation of t–channel events could motivate construction of a μ–*p* collider

Energy dependence

Event sample size: roughly E^3

Additional dependence for τ threshold



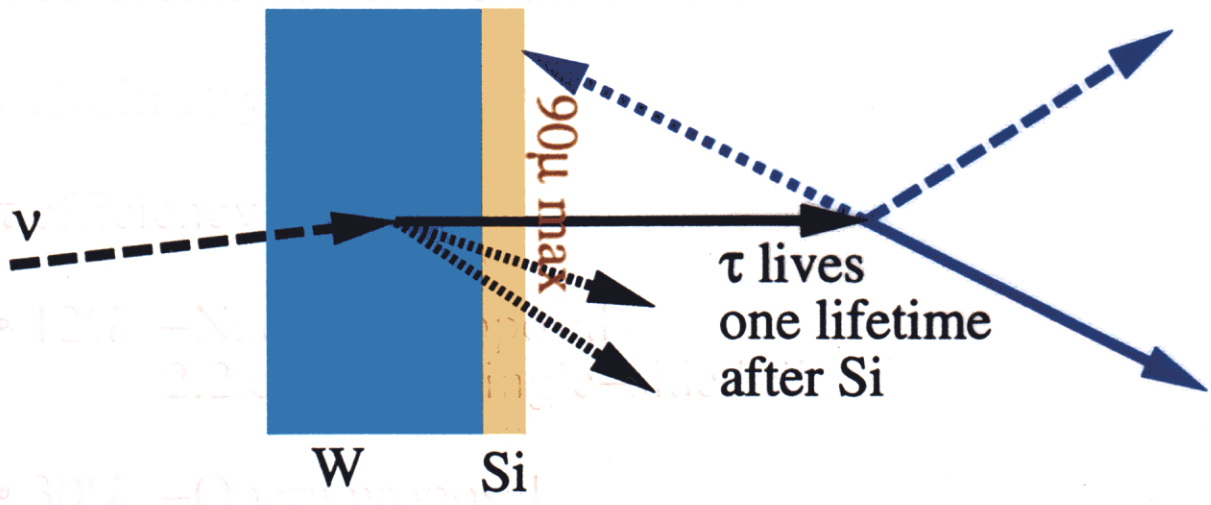
A Detector Concept

Lots of target mass in W sheets.

W is dense → thinner sheets → τ reaches Si

Good for e/γ ID if not too much

Need good hit and impact parameter resolution



Detector Description

5000 units, 20 x 20 cm in cross–section.
Each unit has:

EXTRAPOLATION 35μ/p

- 1 plane of pixels, ~5 micron hit resolution or better

- 1 plane of W, 1.5 mm thick (obtained by optimizing S/sqrt(B)). (0.75 FOR 20 GeV ring)

The Si planes are 4 mm apart. (2 mm for 20 GeV

Solenoidal field for charge and momentum measurement, and μ containment

Calorimetry

τ efficiency between:

- 12% –Nausicaa proposal
  2.2 cm B_4C, single–sided Si

- 30% –Opera proposal
  1 mm lead, double sheets of emulsion

Totals:

5000 units
200 m**2 of Si
1.5 m total length of Si
7.5 m total length of W
5.8 tons of W
0.43 radiation lengths per unit (use for e and gamma ID, but may be too much?)
0.015 interaction lengths per unit / 75 total

For 10^{20} 50 *GeV* muon decays:
7 Billion events

50 events per 15 Hz cycle

⇒ Developing affordable pixel detectors with fast readout may be an issue.

BACKGROUNDS

$\nu N \rightarrow (e, \mu) D^+ + X$

$\hookrightarrow K^0 l \nu$

NC: $D\bar{D}$

EARLY K DECAYS

NUCLEAR SCATTERS

PATTERN RECOGNITION ERRORS

Conclusions

• A compact detector at the ν source, providing both topological and kinematical information, would greatly improve our sensitivity to exotic processes.

• Question: Would such a detector be useful for constraining $\not{R}$ SUSY?

Many detector feasibility questions, *eg)*
• Background level in τ search
• Affordable large area, fast readout pixel detectors (or live with high event overlap) needed for ultimate energy and intensity.

Detector concept is also useful for short–baseline oscillation studies (if LSND confirmed)

A small version of the dectector could be tried in the NUMI beam

STAGE WITH γ- FACTORY

ENTRY LEVEL ⇦ 6 TONS Si strips
20 GeV
10^{19} DECAYS

ULTIMATE LEVEL ⇦ 60 TONS
50 GeV MONOLITHIC PIXELS
10^{21} DECAYS