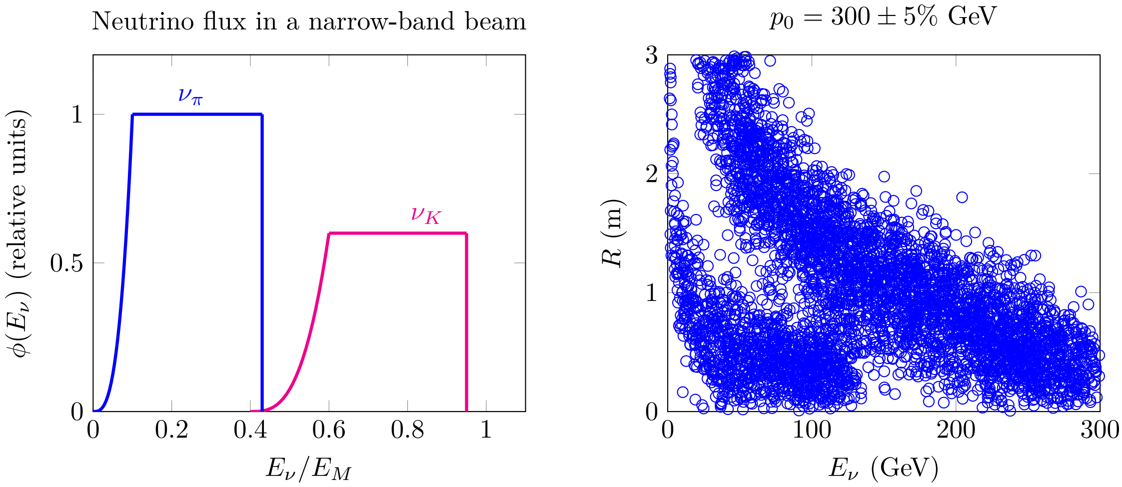

Figure 1: (left) Illustration of the neutrino flux in a narrow band beam. (right) Simulated correlation between the radial position and the neutrino energy.

The Python code used to generate the figure on the right is shown below and available on the repository.

```
import random
import math

# distances in meters
# energies in GeV

# mass of particles in GeV
mmuon=105.7e-3
mproton=938.3e-3
mpion=139.570e-3
mkaon=493.677e-3

# beam parameters
# distance to detector (m)
L=800
# momentum selection NBB (GeV)
p0 = 300
# radius of beam (sigma)
r0 = 0.3
# decay tunnel (m)
decaytunnellength = 300
decaytunnelradius = 1

f = open('narrowbandbeam.dat', 'w')

title = "ENU   R\n"
f.write(title)

for i in range(0,100000):

    pbeam = (1+random.gauss(0, 0.05))*p0
    x0 = random.gauss(0,r0)
    y0 = random.gauss(0,r0)
    rbeam = math.sqrt(x0**2+y0**2)
    if(abs(rbeam) > decaytunnelradius):
        continue

# assume 70% of pions in the beam
    if(random.random()<0.7):
        mmeson = mpion
        tau=26e-9
    else:
        mmeson = mkaon
        tau=12e-9

    ebeam = math.sqrt(pbeam**2+mmeson**2)
    beta = pbeam/ebeam
    gamma = ebeam/mmeson

    decaypoint = -gamma*3e8*tau*math.log(random.random())
    if(decaypoint>decaytunnellength):
        continue

    # maximum energy in meson CMS
    enustar = (mmeson**2 - mmuon**2)/(2*mmeson)

    # decay angle in the meson CMS
```

```
    costhetastar = random.uniform(-1,1)

    # lab quantities
    enu = gamma*enustar*(1+beta*costhetastar)
    costheta = (costhetastar+beta)/(1+beta*costhetastar)
    sintheta = math.sqrt(1-costheta**2)
    tantheta = sintheta/costheta
    phi = 2*math.pi*random.random()
    x = (L-decaypoint)*tantheta*math.cos(phi)+x0
    y = (L-decaypoint)*tantheta*math.sin(phi)+y0
    R = math.sqrt(x**2+y**2)

    if(R<3):
        out = "%f\t%f\n" % (enu,R)
        f.write(out)

f.close()
```