Possible neutrino experiment at CERN PS
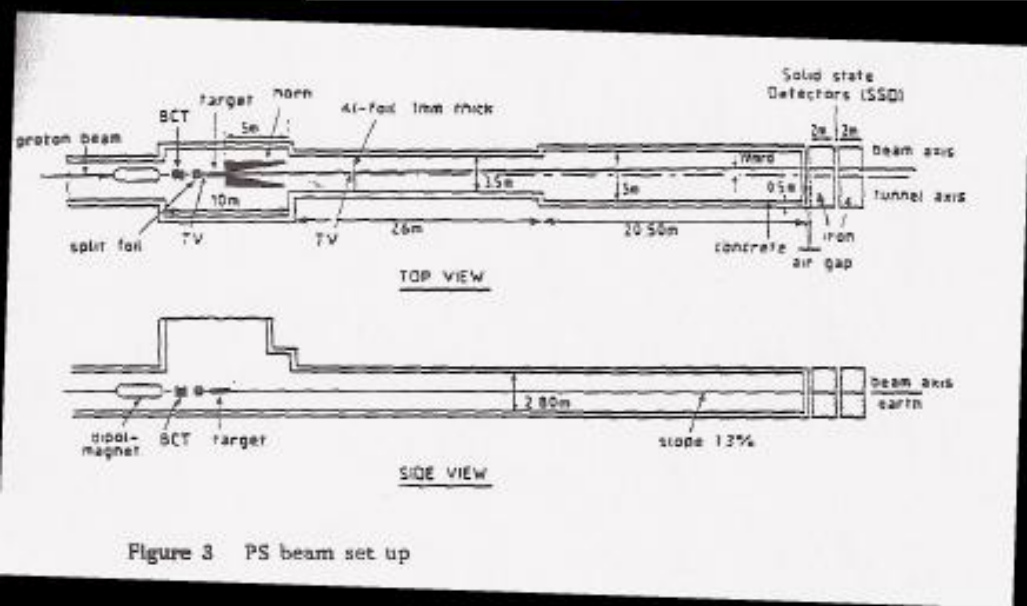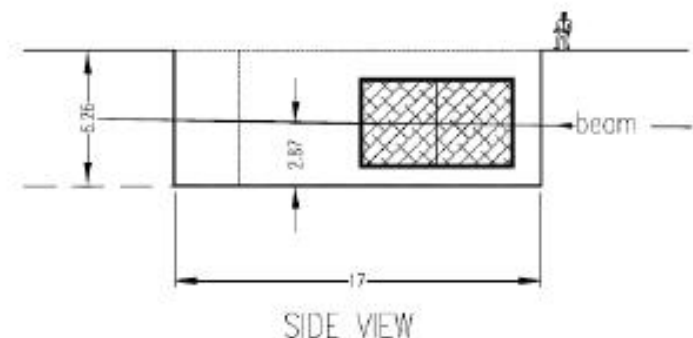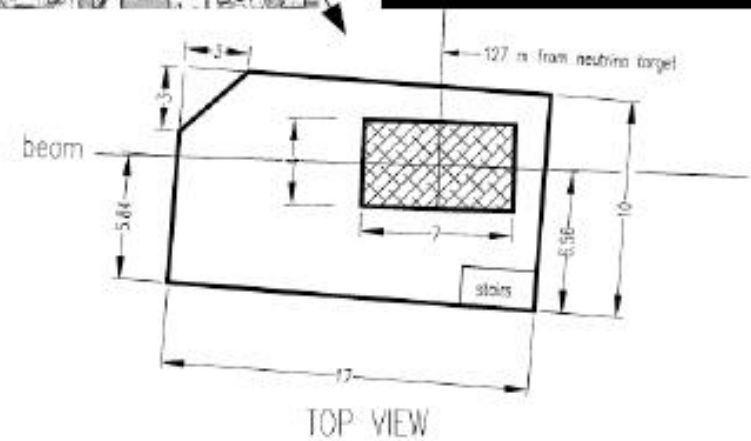
Alain Blondel. EUCARD meeting NEU2012 13 April 2010

1

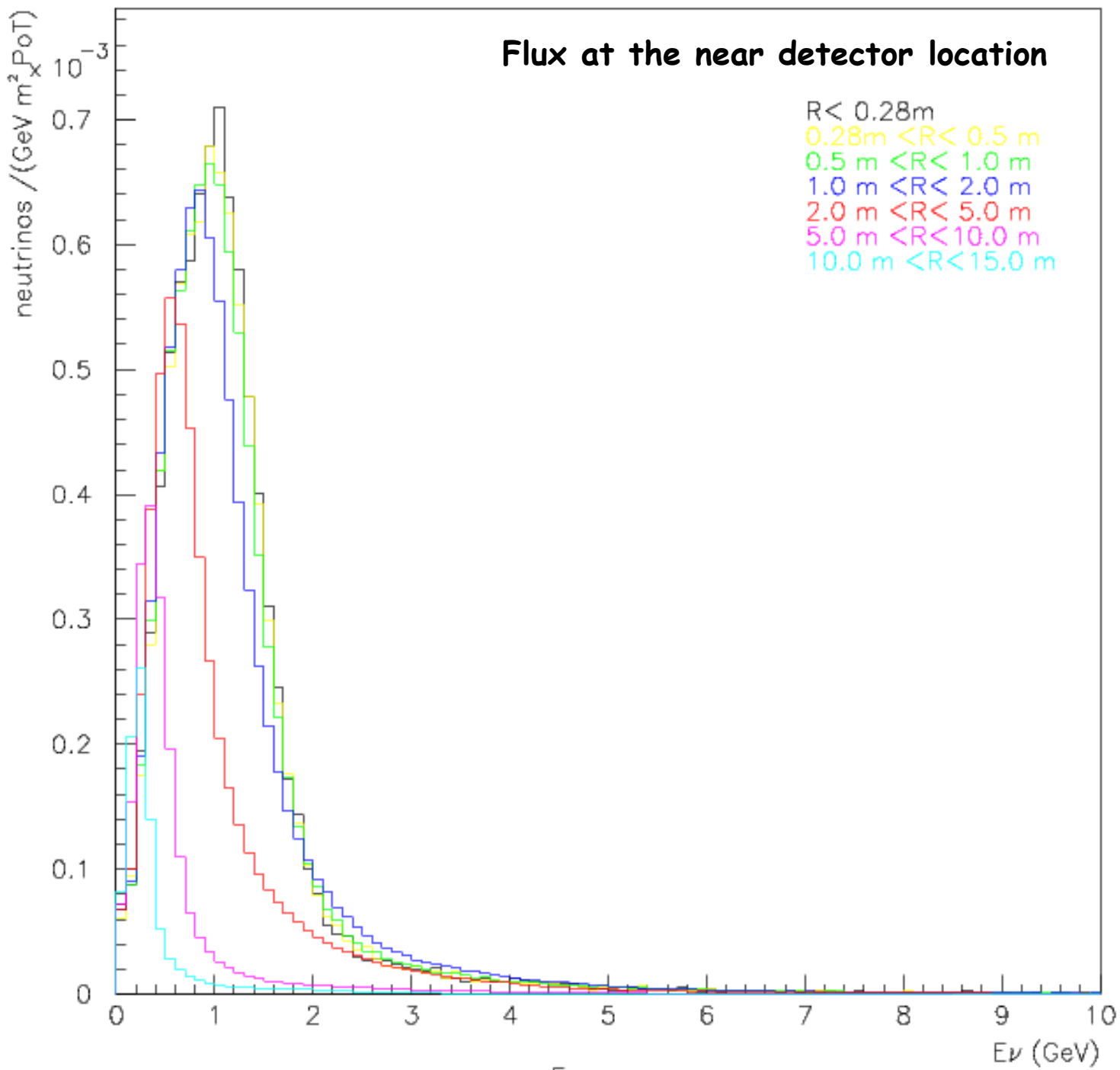# PS neutrino beam layout

Ludovici
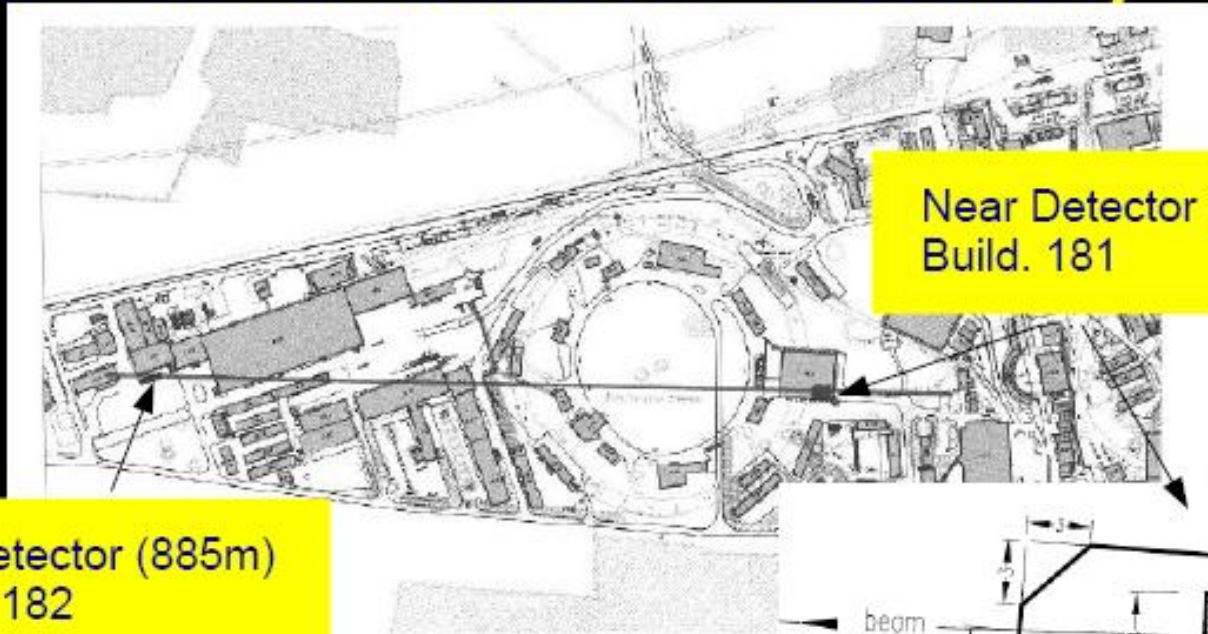
Near Detector (127m)
Build. 181

Far Detector (885m)
Build. 182

Flux at the near detector location

R< 0.28m
0.28m <R< 0.5 m
0.5 m <R< 1.0 m
1.0 m <R< 2.0 m
2.0 m <R< 5.0 m
5.0 m <R<10.0 m
10.0 m <R<15.0 m

Most likely Energy
vs off axis distance
at 127m
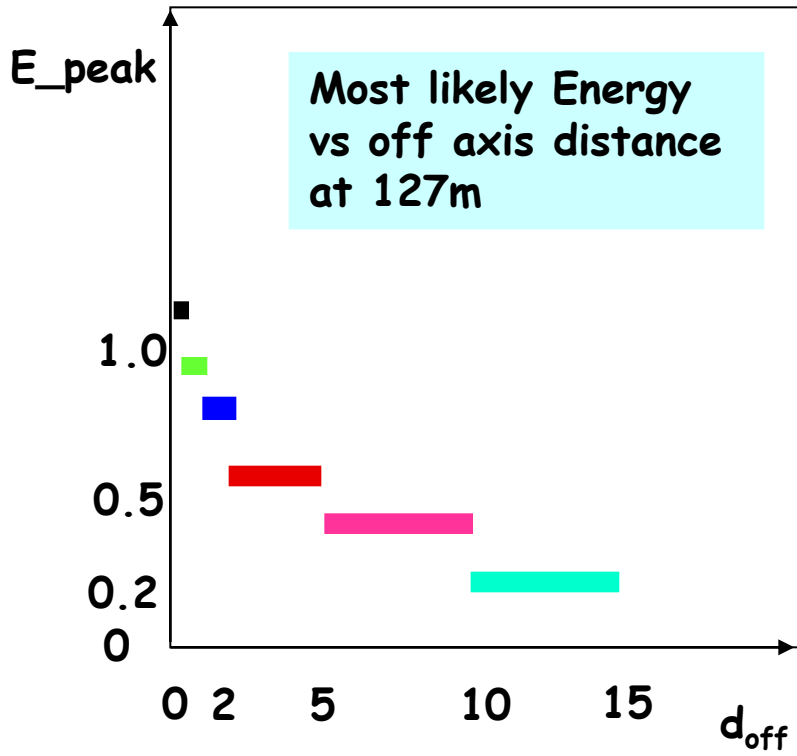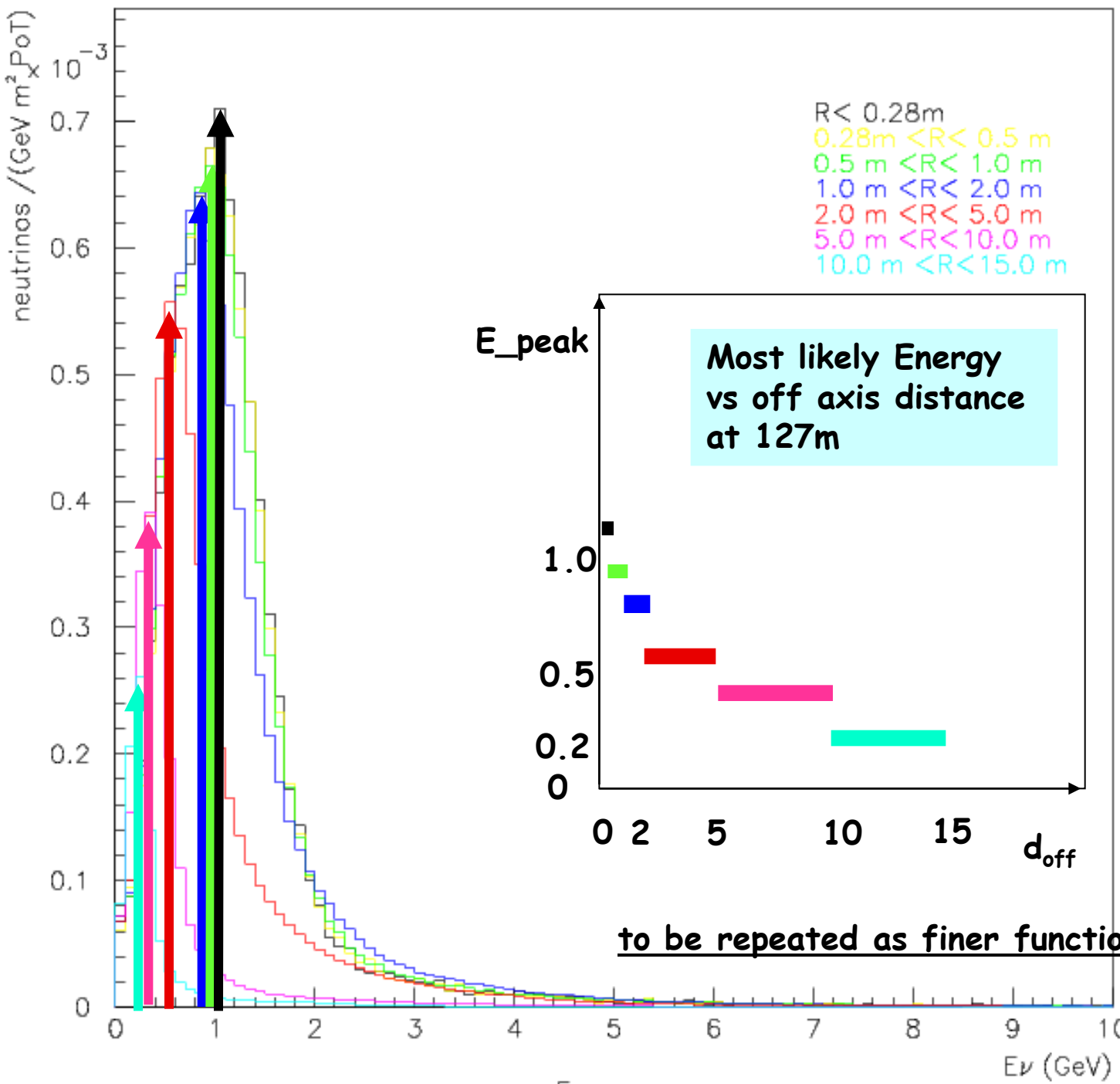
to be repeated as finer function of position

Neutrino Cross Sections

- historical measurements of ν_μ CC cross sections

- low E data are ~30 years old
  - low statistics
  - a lot on D_2
    (not all that relevant for ν osc)

- this is situation have been in for past 30+ years

- luckily has been improving!

MINERvA Quasi-Elastic Cross Section II

- ## CC Quasi-Elastic

Expected MINERvA **CCQE** results including efficiency estimates

statistical errors only

- Free Nucleon
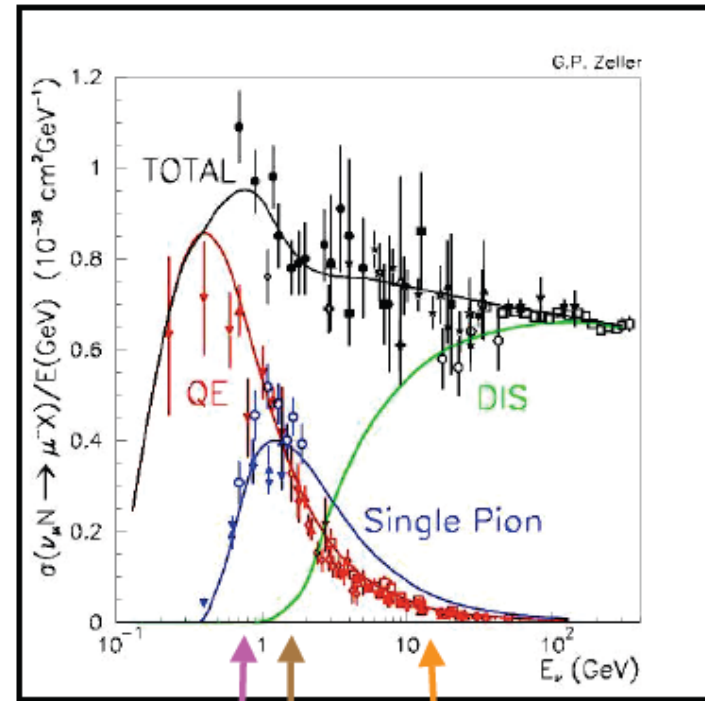- Fermi Gas, C_{12}, E_B=25 MeV
- Fermi Gas C_{12}, E_{BIND}=25 MeV, Bounded FF
- ν Minerva, C_{12}

$\sigma(10^{-38} \text{ cm}^2)$

E_ν (GeV)

$\times 10^{-39}$

σ (cm^2)

— RFG with M_A=1.35 GeV
— RFG with M_A=1.03 GeV
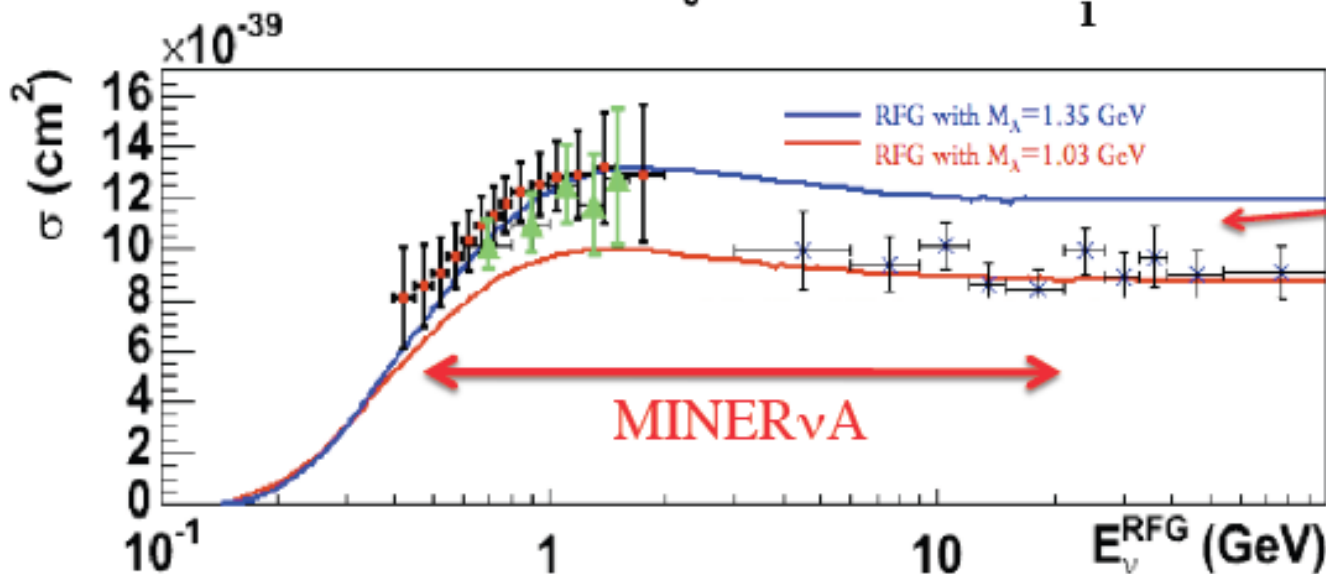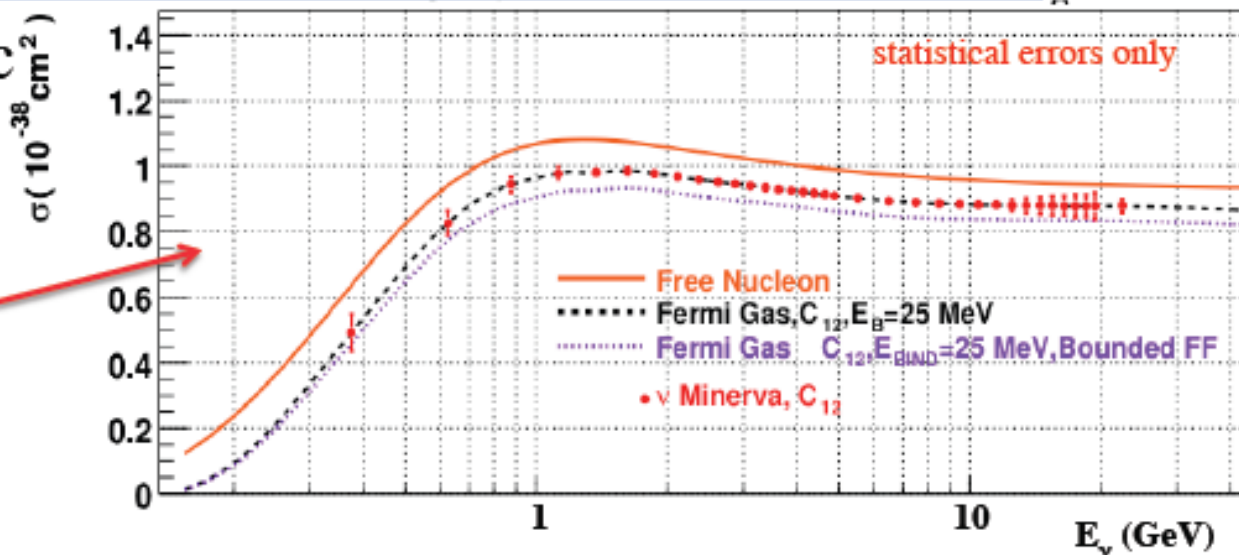
MiniBooNE, SciBooNE, NOMAD CCQE data

MINERvA should resolve this mystery!

MINERνA

E_ν^{RFG} (GeV)

Physics case (three approaches)

1.   perform the LSND oscillation search with two detectors
        ("eliminate any doubt")

     exist a letter of intent from C. Rubbia et al.

2.   perform measurements of cross sections on axis at the far detector
     with a large Liquid argon detector (1 kton) (KEK – ETHZ)

3. perform measurements of cross-sections at the near detector station
   with a 'minerva-like' detector with ability to go >=10m off axis.
    (AIDA follow-up)

   motivation:
   The energy region 200~600 MeV will be only measured so-so
    with MINERvA (low energy tail of the on-axis beam)
     and T2K (low energy tail of 650 MeV off-axis beam)
     in particular: onset of pion production.
    Also good occasion to test detector ideas
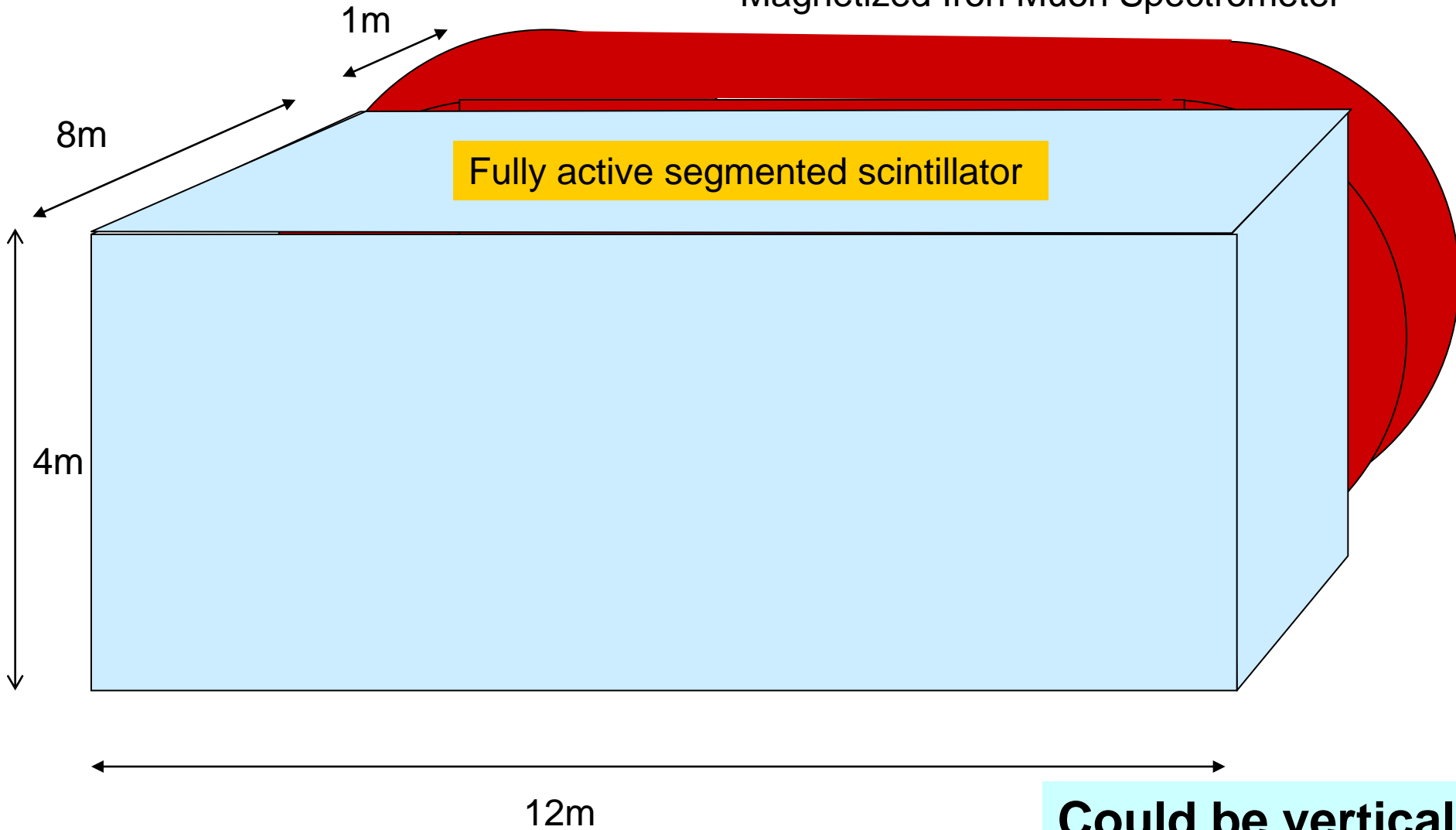   This is the energy range of the SPL/beta beam scenario at CERN

    EOI to be drafted. Some first ideas follow:

Magnetized Iron Muon Spectrometer

1m

8m

Fully active segmented scintillator

4m

12m

Could be vertical

WHAT IS THE FID. VOLUME?

8

Building 181 Occupation

CERN NEG Coating Plant

CERN LHC Magnet Repair Facility

Courtesy of Jose-Miguel Jimenez

Courtesy of Paolo Fessia

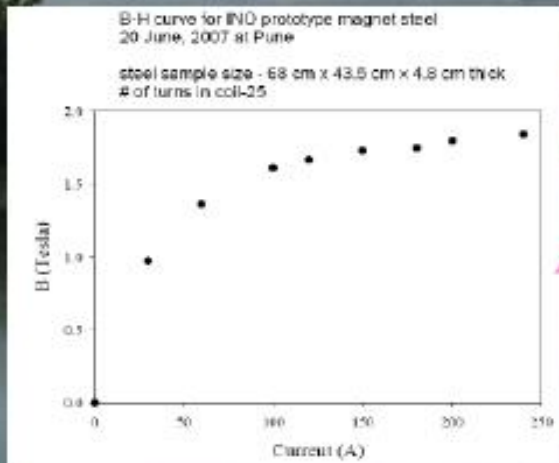Magnetized Iron Muon Spectrometer

1m

I

12 m
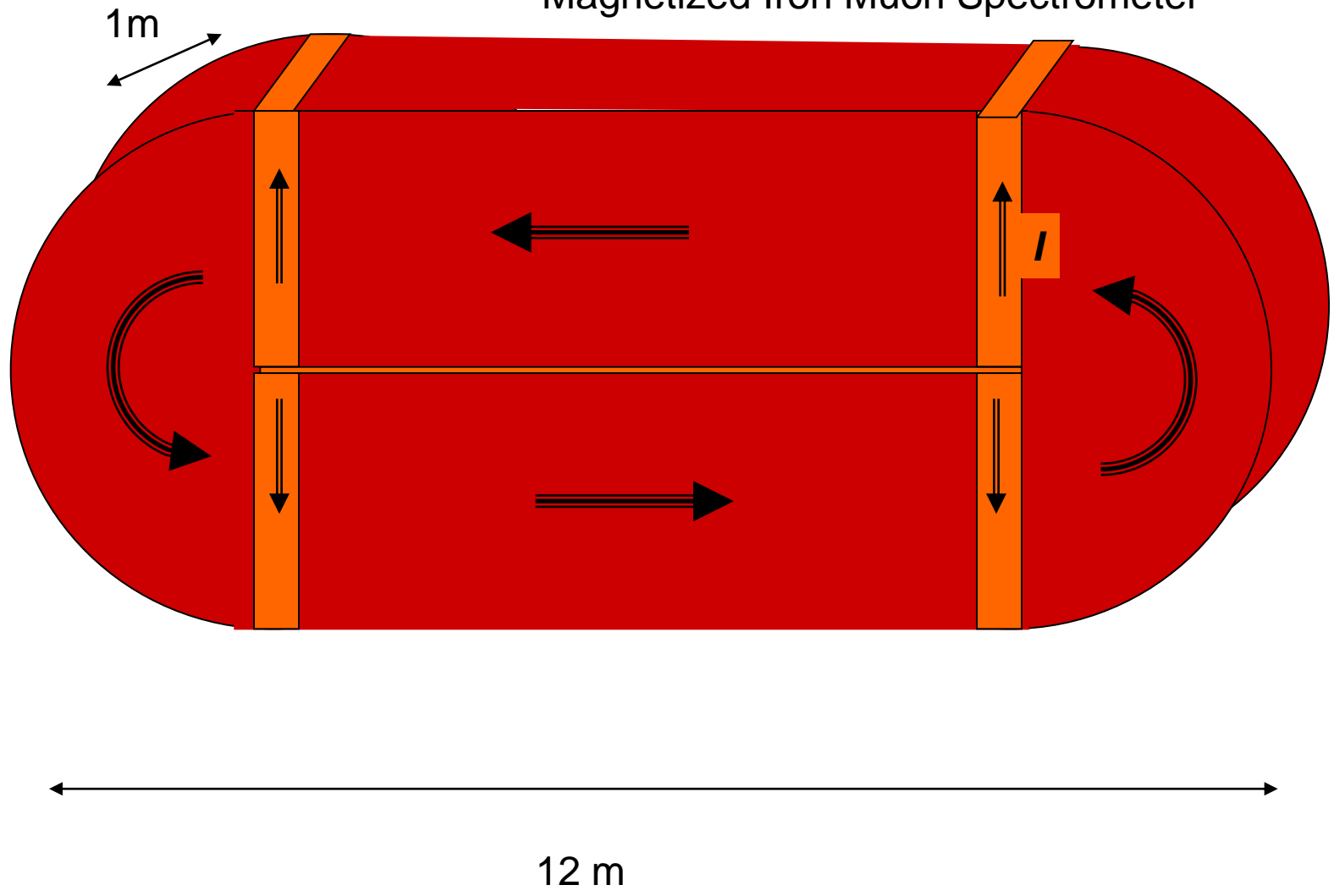
Could be vertical

INO Prototype Magnet now at VECC

22/06/2007

- 12, 1m² RPC layers
- 13 layers of 5 cm thick magnetised iron plates
- About 1000 readout channels

B-H curve for INO prototype magnet steel
20 June, 2007 at Pune

steel sample size - 68 cm x 43.5 cm x 4.8 cm thick
# of turns in coil-25

14

We had several talks describing competences required to construct such a detector.
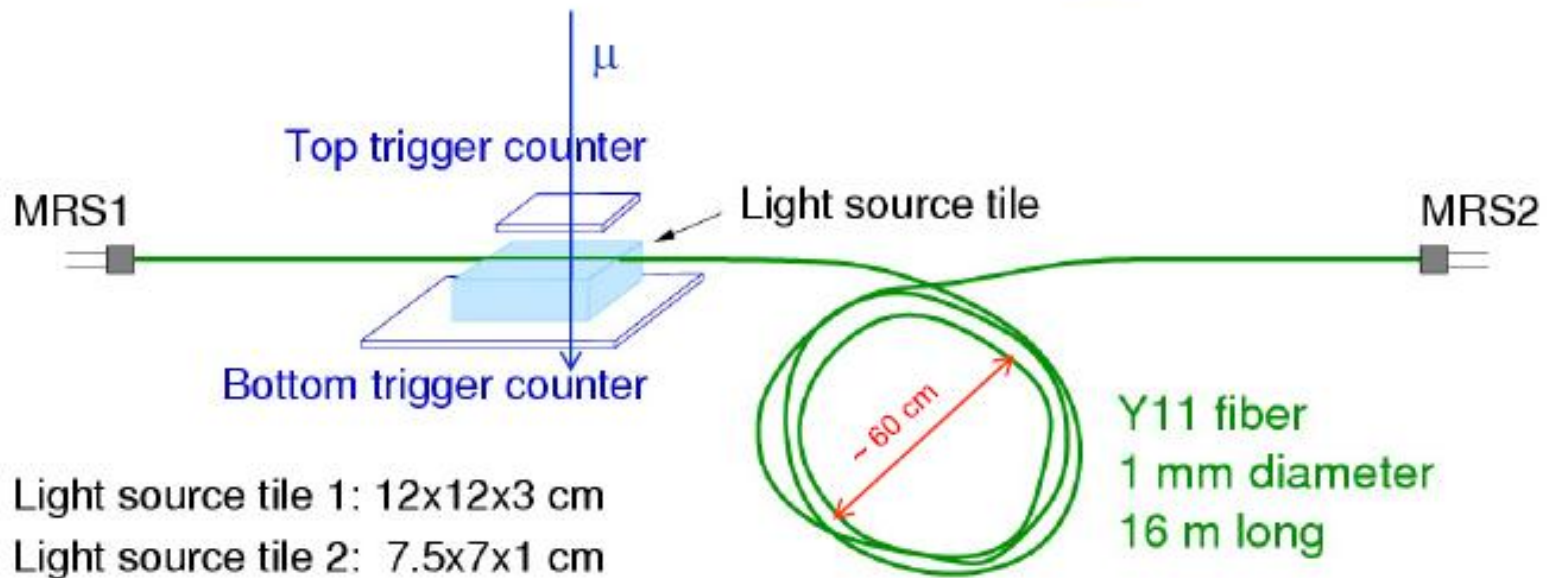
long scintillator:
Yuri Kudenko: light output with 10m of wavelength shifter
Marcos Dracos: 7m long extruded scintillator from OPERA
(missing: Alan Bross on latest developments on TASD)

MPPC readout and electronics:
A.Weber (ND280), M. Prest (MICE EMR), P.Jarron (time resolution)

Measurements with long fibers

Top trigger counter

μ

MRS1   Light source tile   MRS2

Bottom trigger counter

~ 60 cm

Y11 fiber
1 mm diameter
16 m long

Light source tile 1: 12x12x3 cm
Light source tile 2: 7.5x7x1 cm

Measurement of light absorption
in Y11 as a function of wave length

Y11 light absorption
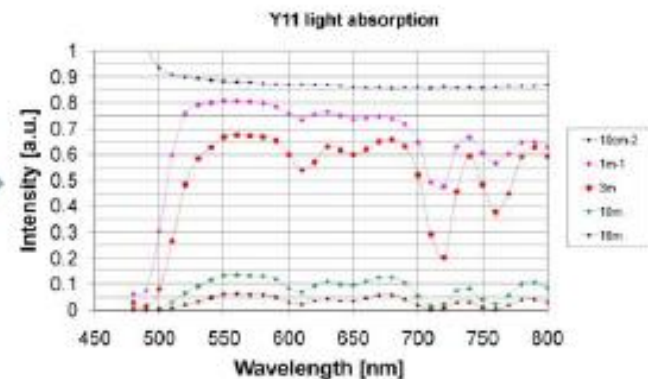
KUDENKO

Light yield

One-end readout
no reflector at far end

L.Y. (p.e./MIP)

$$A_1 exp(-l/L_1) + A_2 exp(-l/L_2)$$
$$L_1 \sim 3\,m \quad L_2 \sim 9\,m$$

length (m)

2 p.e.

3 p.e. with
Al mylar

both-end readout
MRS APD

L.Y. (p.e./MIP)

sun of two ends

14 p.e.

length (m)

Tile 2 → MIP ~ 2 MeV

T = 20 C, dark rate (th=0.5 p.e.) < 500 kHz
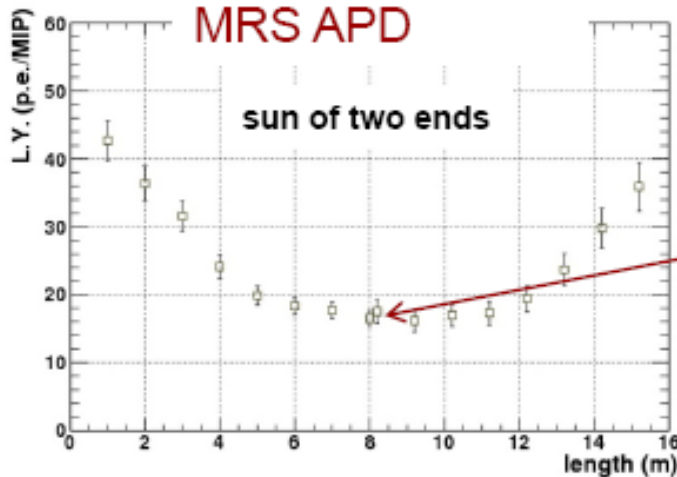
REFLECTOR

1 m long Y11, scintillator 1 cm thick
reflector at free fiber end, one-end readout

l.y./MIP, p.e.

Polished , no reflector   24.4
Polished, teflon tape   33.9
Polished, Al mylar   36.9

KUDENKO

Yury Kudenko   INR-Moscow

A mini-neutrino factory?

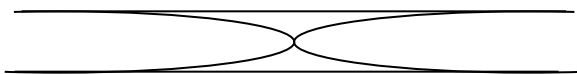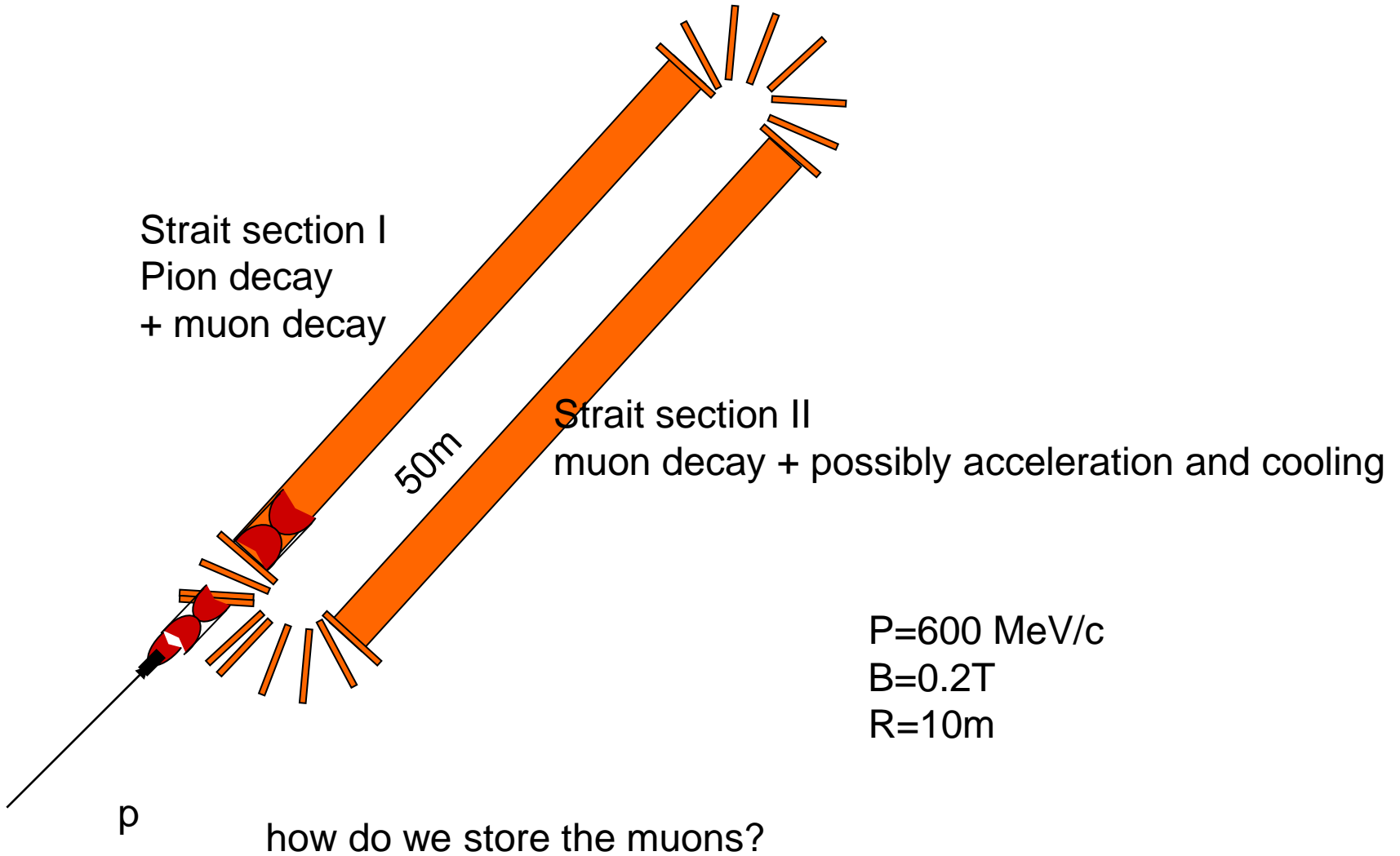so we could measure muon-neutrino AND anti-neutrino cross-sections

what about **electron neutrinos**?

crucial for CP/T asymmetry!

a mini beta beam? (but $E=2Q\gamma$ so we need SPS type rigidity…. ☹

a muon storage ring (mini-neutrino-factory)?

storing 600 MeV muons gives same spectrum as $\gamma=100$ 6He or 18Ne…

Strait section I
Pion decay
+ muon decay

50m

Strait section II
muon decay + possibly acceleration and cooling

P=600 MeV/c
B=0.2T
R=10m

p

how do we store the muons?

Conclusions and next steps

Physics conclusions

there are various communities (3?) with different interests
in the neutrino beam at CERN

-- oscillation measurement in the LSND region (+sterile neutrino)
   using two detector locations
-- cross-section measurements in GeV region in LArg and 1kton LArg detector
   prototype in the far detector location
-- cross sections measurements in light detector (plastic) down to 200 MeV neutrino
   energy with large detector in the near detector location

Next steps

1. need to assemble a 'steering committee' with a few people per country
2. Expression of Interest to CERN
3. generate beam study group across communities and with CERN
4. deepen study: more precisely evaluate detector size needed,
    event numbers, physics precision …
5. THEN see who is interested in doing what