Measurement of BR($\tau \rightarrow hadrons$)

L3 Beijing Group

Binned Maximum Likelihood Method

Possion Distribution:

$$P(\kappa,\ \lambda) = \frac{\lambda^{\kappa}}{\kappa!} e^{-\lambda} \tag{1}$$

Binned Maximum Likelihood Function:

$$\begin{aligned} \ln L &= \ln \prod_i P(N^i_{obs},\ N^i_{exp}) \\ &= \sum_i \ln[\frac{(N^i_{exp})^{N^i_{obs}}}{N^i_{obs}\ !} e^{-N^i_{exp}}] \end{aligned} \tag{2}$$

$$N^i_{exp} = \mathcal{L}(\sum_j \sigma^j_s \varepsilon^{ij}_s + \sum_k \sigma^k_{bg} \varepsilon^{ik}_{bg})$$

$$max(\ln L) \Longrightarrow \sigma_s$$

where

$$\begin{aligned} \mathcal{L} &: Total\ integrated\ luminosity \\ N^i_{exp} &: MC\ expectation\ in\ i^{th}\ bin \\ N^i_{obs} &: Observed\ events\ in\ i^{th}\ bin \\ \varepsilon^i_s,\ \varepsilon^i_{bg} &: Eff.\ of\ Signal\ and\ BG\ in\ i^{th}\ bin \\ \sigma_s,\ \sigma_{bg} &: Cross\ section\ of\ Signal\ and\ BG \end{aligned}$$

Binned Maximum Likelihood Method

- 1-prong: BR100, BR101, BR102, BR103 $\rightarrow$ need to fit

  NN Distribution: OUTH100, OUTH101, OUTH102

  Likelihood Function:

$$\ln L = \ln(\prod_i P_1(N^i_{obs},\ N^i_{exp}) \prod_i P_2 \prod_i P_3)$$

- 3-prong: BR300, BR301, BR302 $\rightarrow$ need to fit

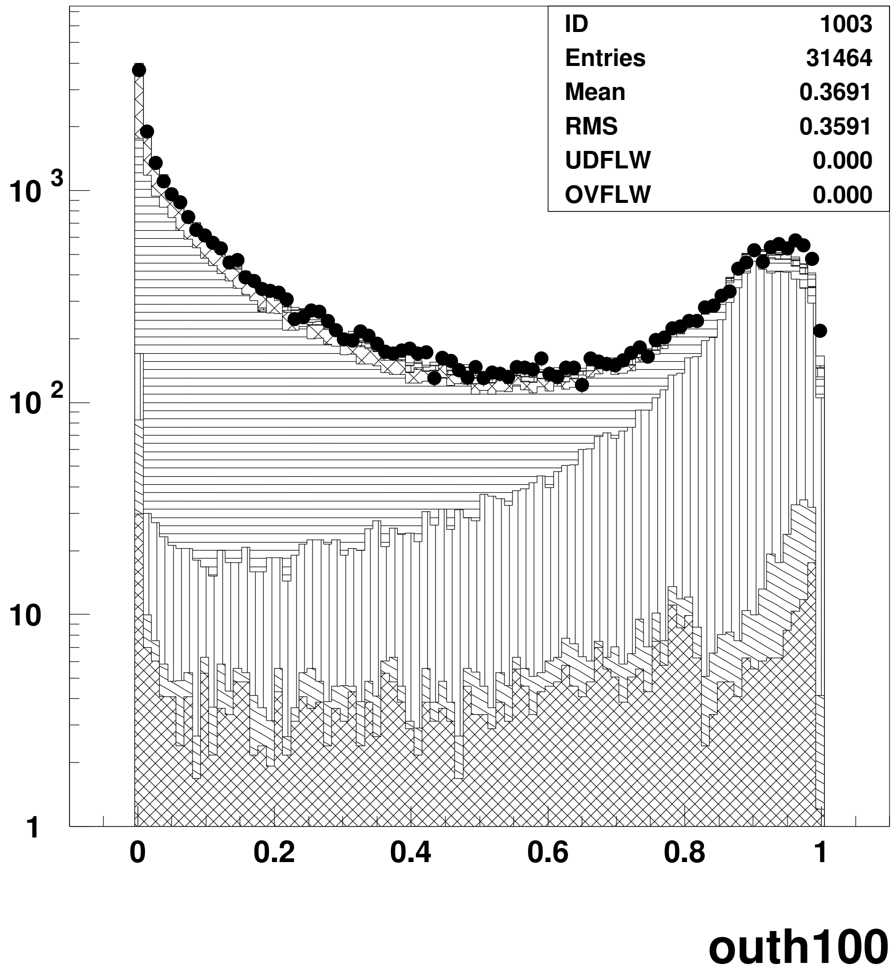
  NN Distribution: OUTH300, OUTH301

  Likelihood Function:

$$\ln L = \ln(\prod_i P_1(N^i_{obs},\ N^i_{exp}) \prod_i P_2)$$

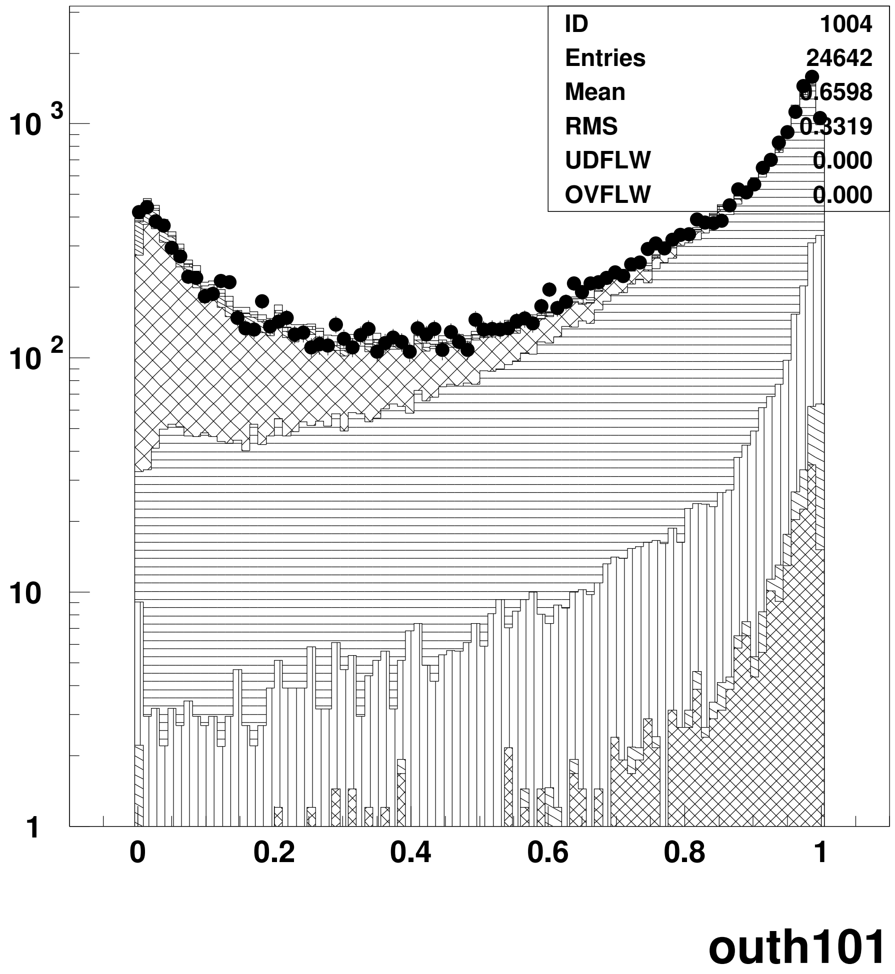
NN Distributions (Data 94)

94 tau to 1prong hadron sample (exc e mu kl)



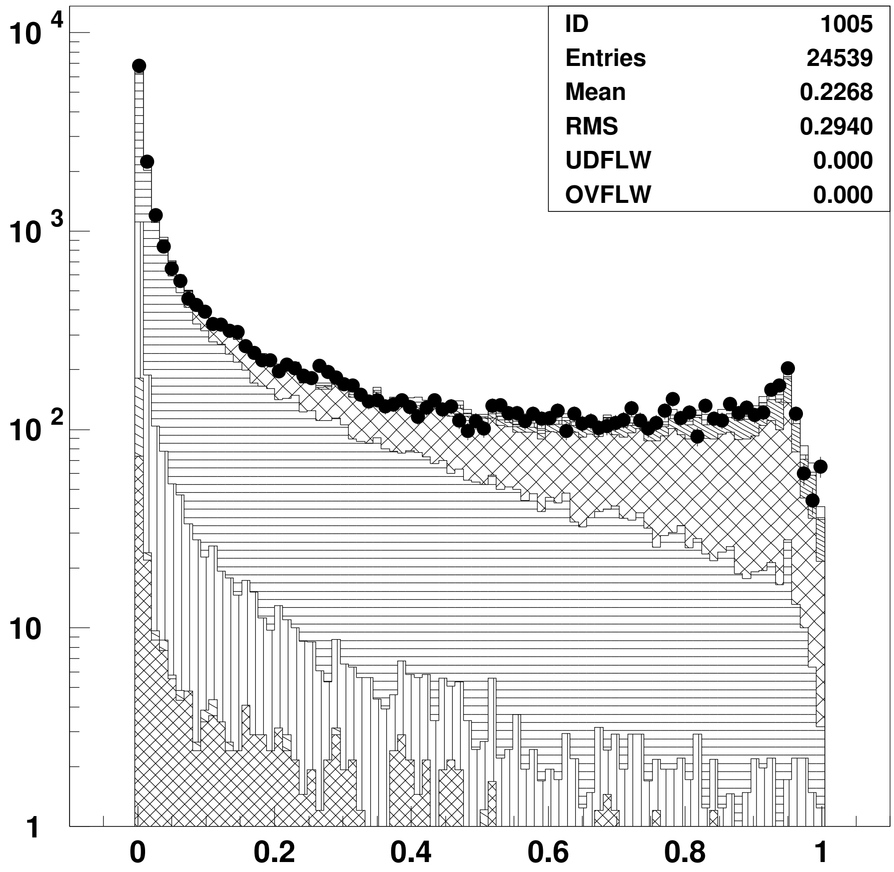
NN Distributions (Data 94)

94 tau to 1prong hadron sample (exc e mu kl)



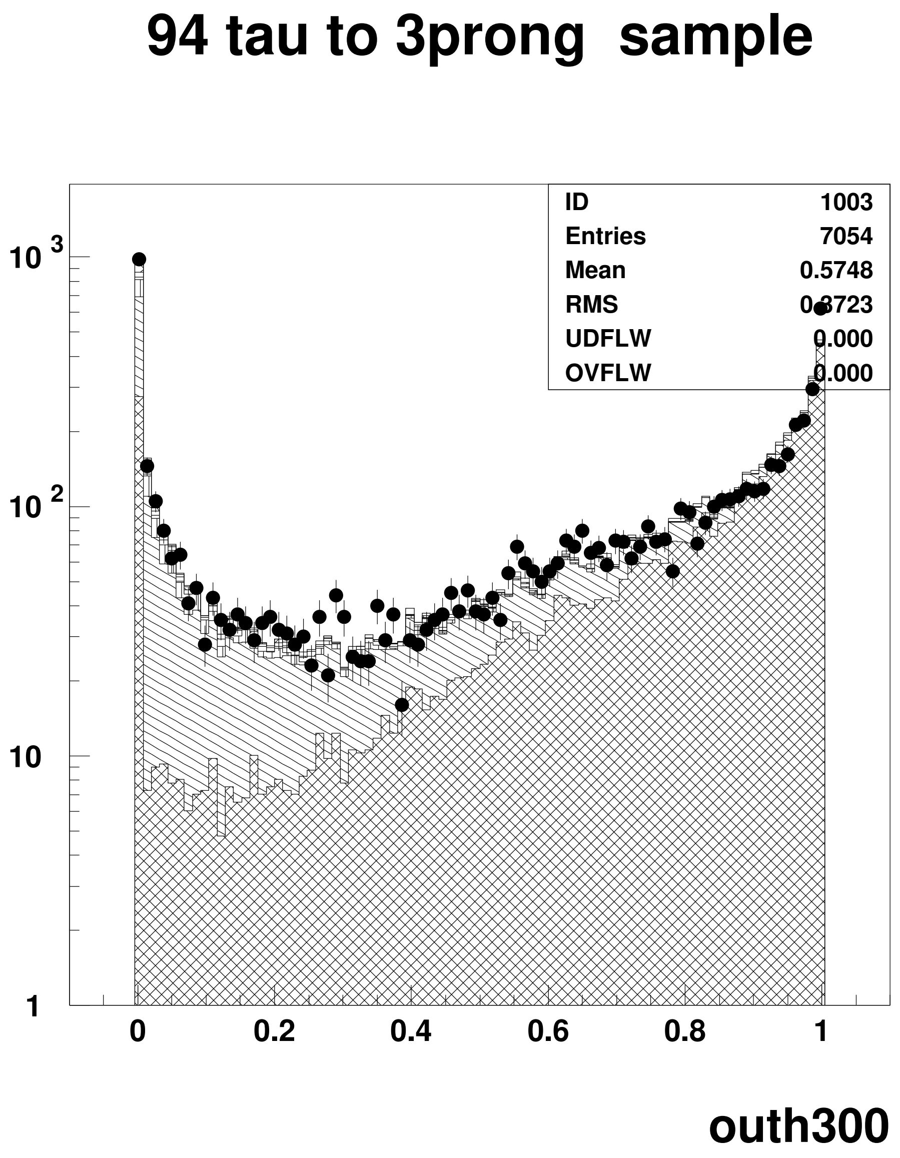
NN Distributions (Data 94)

94 tau to 1prong hadron sample (exc e mu kl)

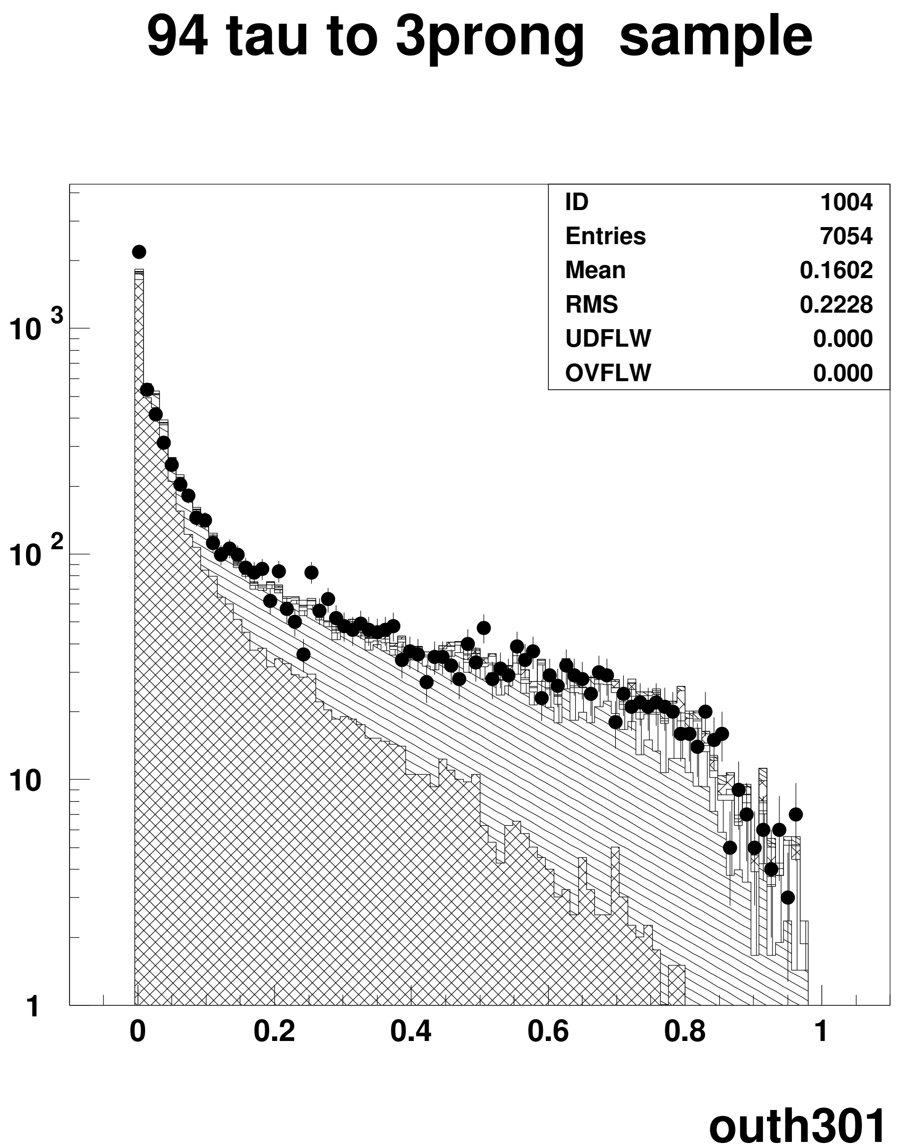


outh102

NN Distributions (Data 94)



NN Distributions (Data 94)



Advantage and Disadvantage ?

- Disadvantage of Traditional method

  different cuts $\rightarrow$ different results

- Advantage of New method

  Don't need to select signal by imposing a set of cuts.

  Don't lose any useful information.

- Disadvantage of New method (problem?)

  different bins $\rightarrow$ different results

- Solution

  ibin = 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

$$BR = \frac{1}{10} \sum_{i=1}^{10} (BR_i)$$

$$\sigma_{BR} = \frac{1}{10} \sum_{i=1}^{10} (\sigma_{BR_i}), \rightarrow \ stat.\ error$$

Root - Mean - Square (RMS) of BR $\rightarrow$ syst. error.

Results

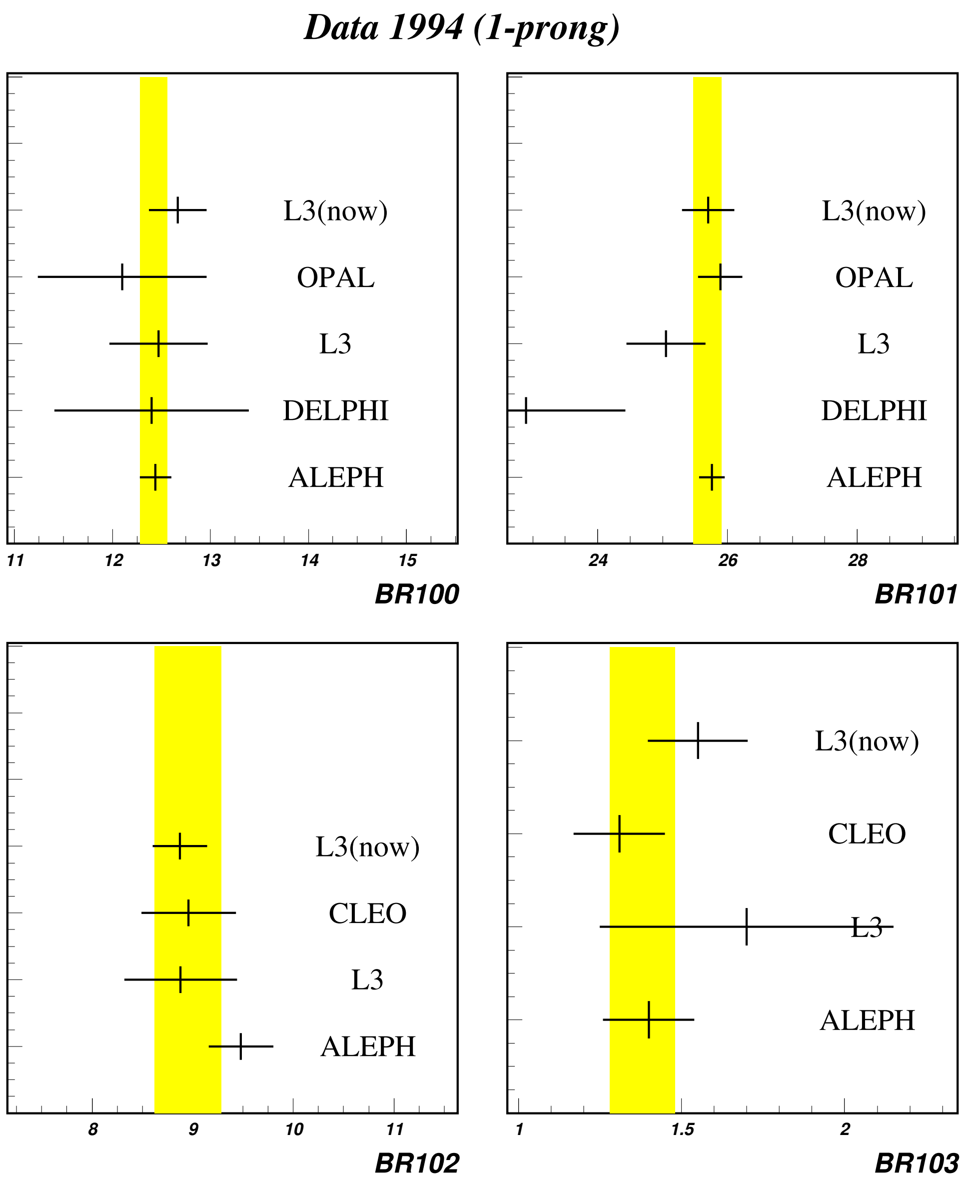


Fig. 1: 1-prong, comparison with other results.

Results

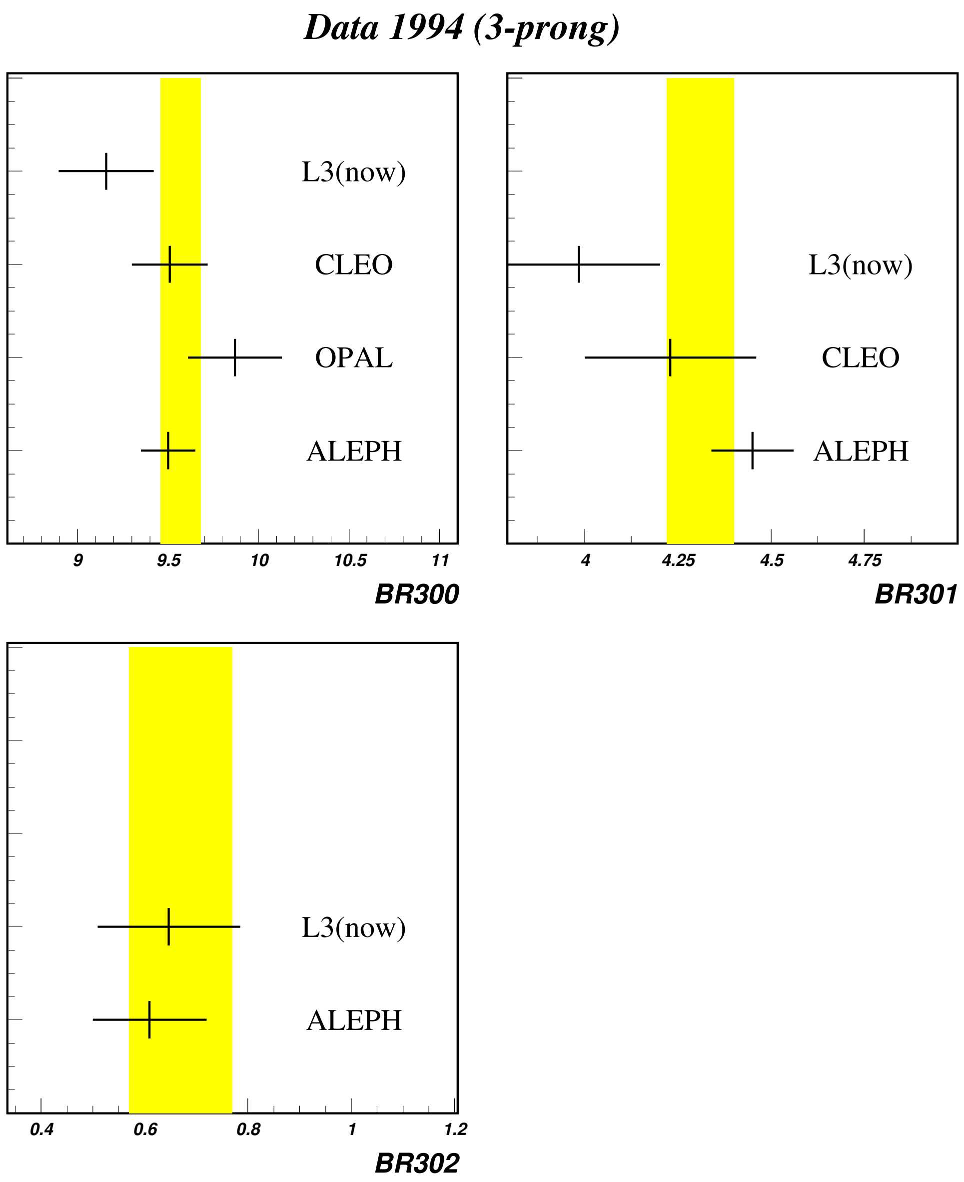


Fig. 2: 3-prong, comparison with other results.

Evaluation of Systematic Error

12.667 25.704 8.873 1.550 9.159 3.985 0.647 – fitted BR

0.187 0.170 0.194 0.129 0.107 0.105 0.067 – stat. error

0.019 0.049 0.087 0.063 0.098 0.165 0.090 – binning

0.021 0.038 0.020 0.007 0.024 0.030 0.011 – lumi (0.1%)

0.087 0.157 0.042 0.022 0.071 0.017 0.006 – xstt (0.45%)

0.008 0.023 0.030 0.016 0.006 0.011 0.006 – bre (1 sigma)

0.023 0.016 0.010 0.001 0.024 0.008 0.010 – brm (1 sigma)

0.040 0.068 0.036 0.024 0.011 0.023 0.007 – brkl (1 sigma)

0.050 0.012 0.043 0.016 0.002 0.002 0.003 – $E_{neutral}$

0.022 0.015 0.000 0.000 0.000 0.000 0.000 – $\theta_{neu-trk}$

0.187 0.311 0.129 0.025 0.200 0.078 0.075 – $Nb01_h$

0.030 0.015 0.028 0.011 0.025 0.024 0.016 – Acco

0.012 0.001 0.021 0.003 0.019 0.010 0.013 – E_{tot}

0.025 0.053 0.060 0.023 0.017 0.008 0.002 – E_{bgo}

0.001 0.002 0.005 0.000 0.025 0.025 0.007 – P_μ

0.224 0.366 0.188 0.083 0.241 0.191 0.121 – sys. error (total)