D_s decay width and neutrino production summary

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Purpose and Goal

- To calculate the total number of tau neutrinos we need to know the branching ratio for $D_s \rightarrow \tau \nu_\tau$

Method

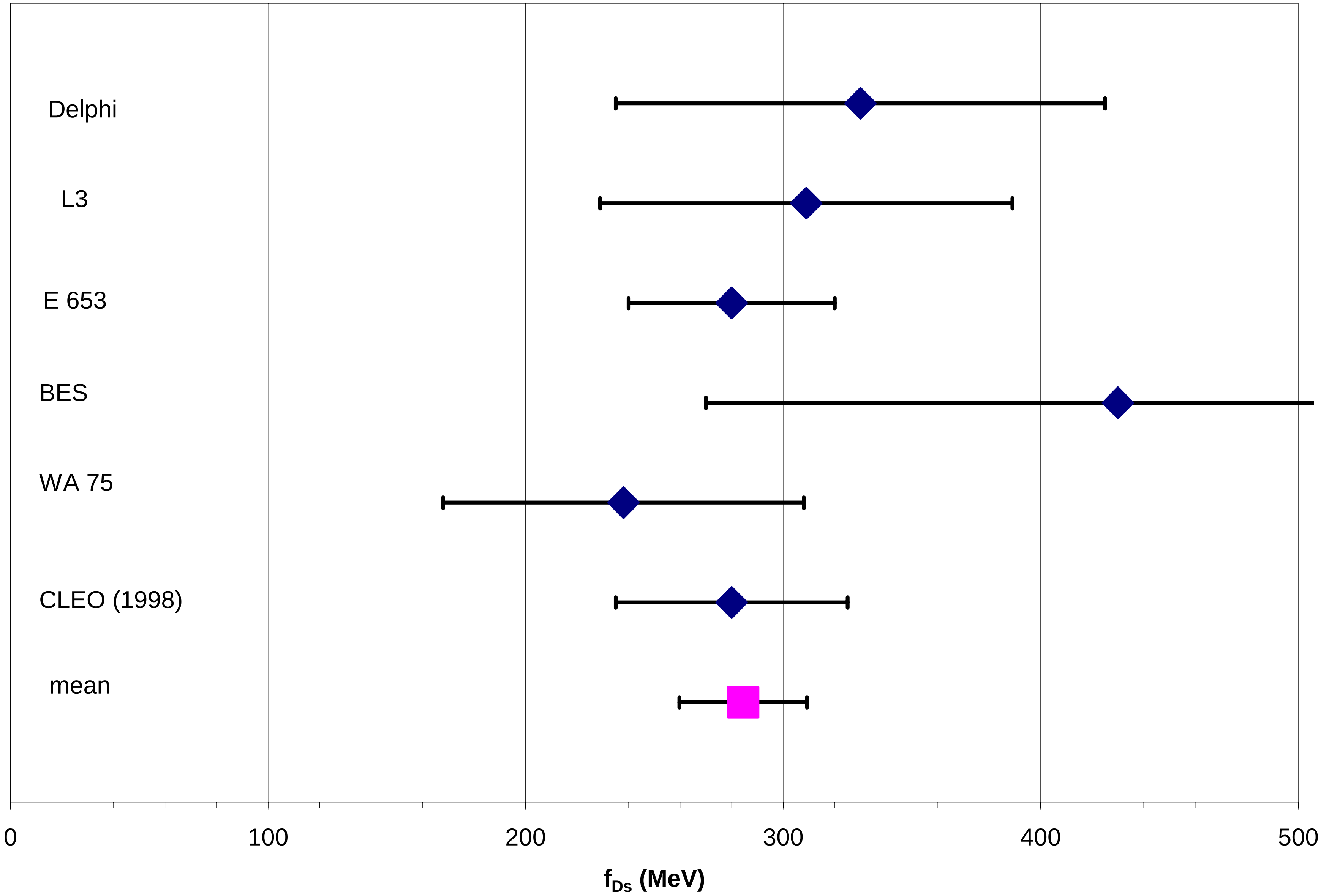
- The D_s decays weakly, much like the pion. The width Γ is given by

$$\Gamma(D_s \to l\nu_l) = \frac{G_F^{\;2}}{8\pi} f_{D_s}^2 m_l^2 M_{D_s} \left(1 - \frac{m_l^2}{M_{D_s}^2}\right) |V_{cs}|^2$$

•G_F: the Fermi coupling constant
•m_l: the lepton mass
•M_{Ds}: the Ds meson mass
•V_{cs}: the CKM matrix element

•f_{Ds}: the decay constant, to be determined by experiment

Measurements of f_{D_s}



Result

- BR($D_s \to \tau\nu_\tau$)=(6.3±0.5)%

- everything put together:
  - neutrino production: $4.7\times10^{-4}\nu_e$/POT, $4.5\times10^{-4}\nu_\mu$/POT, and $1\times10^{-4}\nu_\tau$/POT
  - neutrino flux at the target (prompt only): $5.7\times10^{13}\nu_e$, $5.6\times10^{13}\nu_\mu$, $1.6\times10^{13}\nu_\tau$ ($\sigma\approx30\%$)
  - 13% of the neutrino flux is ν_τ.

Discussion

- The total neutrino flux is a factor of two smaller than what Byron calculated from our data
- The ν_τ fraction is higher
  - due to smaller ν_e and ν_μ flux
- Byron’s calculation from 1998:
  - $1\times10^{-3}\nu_\mu$/POT, but
    - large σ(cc), large P(cc$\rightarrow\nu$), small σ_{tot} , ...
    - use correct values: $5\times10^{-4}\nu_\mu$/POT
- The contribution of nonprompt neutrinos is larger

Expected Prompt neutrino yield

Period	1	2	3	4
# of prompt neutrinos (ν_μ CC only)	98 (35)	109 (39)	321 (115)	399 (143)
# of neutrino candidates (ν_μ CC only)	97 (32)	77 (35)	281 (90)	406 (159)
# of prompt τ neutrinos	12	14	41	51

The calculation does not include efficiencies

Conclusion and Outlook

- The $D_s \rightarrow \tau\nu_\tau$ branching ratio is well understood
- The updated calculation of neutrino yields still gives the same # of neutrinos
  - the contribution of the different D’s changed
  - the flux changed
  - the interaction probability changed
- I am in the process of updating the Monte Carlo