# PDG I

▼ Antilepton + meson

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|---|---|---|---|---|---|---|
| $\tau_1$ | $N \to e^+\pi$ | $B$ | $> 5300\ (n), > 24000\ (p)$ | CL=90% | 459 | |
| $\tau_2$ | $N \to \mu^+\pi$ | $B$ | $> 3500\ (n), > 16000\ (p)$ | CL=90% | 453 | |
| $\tau_3$ | $N \to \nu\pi$ | | $> 1100\ (n), > 390\ (p)$ | CL=90% | 459 | |
| $\tau_4$ | $p \to e^+\eta$ | | $> 10000$ | CL=90% | 309 | |
| $\tau_5$ | $p \to \mu^+\eta$ | | $> 4700$ | CL=90% | 297 | |
| $\tau_6$ | $n \to \nu\eta$ | | $> 158$ | CL=90% | 310 | |
| $\tau_7$ | $N \to e^+\rho$ | | $> 217\ (n), > 720\ (p)$ | CL=90% | 149 | |
| $\tau_8$ | $N \to \mu^+\rho$ | | $> 228\ (n), > 570\ (p)$ | CL=90% | 113 | |
| $\tau_9$ | $N \to \nu\rho$ | | $> 19\ (n), > 162\ (p)$ | CL=90% | 149 | |
| $\tau_{10}$ | $p \to e^+\omega$ | | $> 1600$ | CL=90% | 143 | |
| $\tau_{11}$ | $p \to \mu^+\omega$ | | $> 2800$ | CL=90% | 105 | |
| $\tau_{12}$ | $n \to \nu\omega$ | | $> 108$ | CL=90% | 144 | |
| $\tau_{13}$ | $N \to e^+K$ | $B$ | $> 17\ (n), > 1000\ (p)$ | CL=90% | 339 | |
| $\tau_{14}$ | $p \to e^+K^0_S$ | | | | 337 | |
| $\tau_{15}$ | $p \to e^+K^0_L$ | | | | 337 | |
| $\tau_{16}$ | $N \to \mu^+K$ | $B$ | $> 26\ (n), > 4500\ (p)$ | CL=90% | 329 | |
| $\tau_{17}$ | $p \to \mu^+K^0_S$ | | | | 326 | |
| $\tau_{18}$ | $p \to \mu^+K^0_L$ | | | | 326 | |
| $\tau_{19}$ | $N \to \nu K$ | | $> 86\ (n), > 5900\ (p)$ | CL=90% | 339 | |
| $\tau_{20}$ | $n \to \nu K^0_S$ | | $> 260$ | CL=90% | 338 | |
| $\tau_{21}$ | $p \to e^+K^*(892)^0$ | | $> 84$ | CL=90% | 45 | |
| $\tau_{22}$ | $N \to \nu K^*(892)$ | | $> 78\ (n), > 51\ (p)$ | CL=90% | 45 | |

# PDG II

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|---|---|---|---|---|---|
| $\tau_{42}$ | $p \to e^+\gamma$ | $> 670$ | CL=90% | 469 | ⌄ |
| $\tau_{43}$ | $p \to \mu^+\gamma$ | $> 478$ | CL=90% | 463 | ⌄ |
| $\tau_{44}$ | $n \to \nu\gamma$ | $> 550$ | CL=90% | 470 | ⌄ |
| $\tau_{45}$ | $p \to e^+\gamma\gamma$ | $> 100$ | CL=90% | 469 | ⌄ |
| $\tau_{46}$ | $n \to \nu\gamma\gamma$ | $> 219$ | CL=90% | 470 | ⌄ |

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|---|---|---|---|---|
| $\tau_{62}$ | $N \to e^+$ anything | $> 0.6$ $(n, p)$ | CL=90% | ⌄ |
| $\tau_{63}$ | $N \to \mu^+$ anything | $> 12$ $(n, p)$ | CL=90% | ⌄ |
| $\tau_{64}$ | $N \to \nu$ anything | | | ⌄ |
| $\tau_{65}$ | $N \to e^+\pi^0$ anything | $> 0.6$ $(n, p)$ | CL=90% | ⌄ |
| $\tau_{66}$ | $N \to$ 2 bodies, $\nu$-free | | | ⌄ |

# On which modes should resources be focused?

- **Flagship searches**: $p \to e^+\pi^0$, $p \to K^+\bar{\nu}$
- Other ideas:
  - Limit for $p \to e^+\eta$ pretty good, complementary in SMEFT analysis
    $\hookrightarrow$ motivates complete lattice calculations?
  - Limits for $p \to V\ell^+$, $V = \omega, \rho, \phi, K^*$, currently an order of magnitude worse, is this only due to lack of attention?
  - If not, calculation of matrix elements possible? Resonance enhancement? Complementarity for SMEFT?
  - Photon channels $p \to e^+\gamma$ motivated? [PDG limit outdated]
  - $\ell = \tau$ channels accessible via off-shell process (momentum dependence of $W_0$, $W_1$ known from dispersion relations), $p \to \pi^0\ell^+\nu_\ell\bar{\nu}_\tau$ covered by inclusive limits $p \to \ell^+X$
  - In general: many channels required to probe all possible operators, unrealistic
    $\hookrightarrow$ a few theory-motivated exclusive searches + inclusive searces
  - How viable are inclusive searches experimentally?
  - High-multiplicity actually advantageous for DUNE?
  - Matrix elements for five-quark operators?