Heavy Neutral Leptons @ Kaon Facilities

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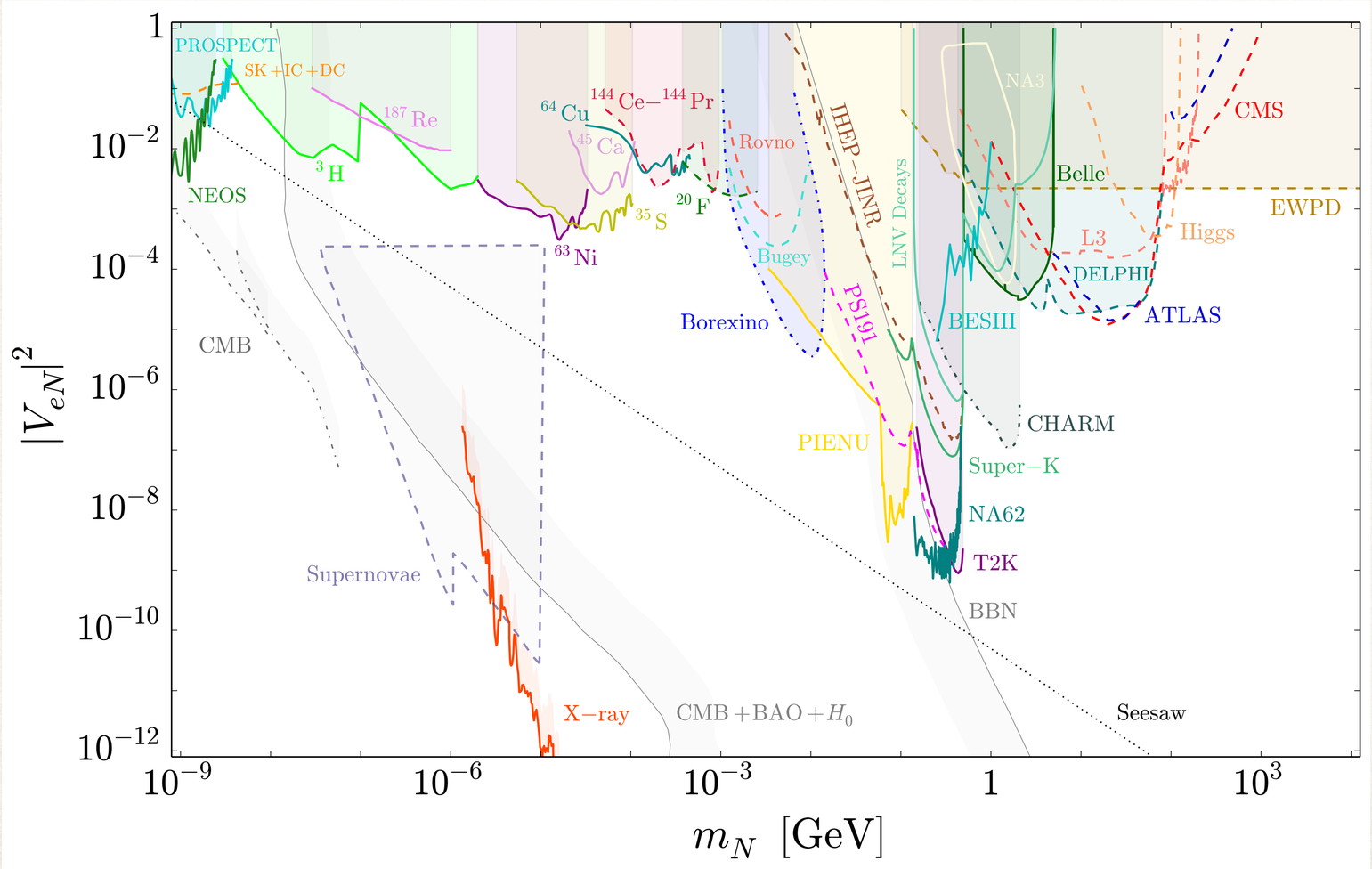
Typical Model Phenomenology

- Assume a fourth neutrino exists with some mass m_N
- Mixing with SM neutrinos (4x4) allows for three new mixing angles, $\{U_{eN},\ U_{\mu N},\ U_{\tau N}\}$



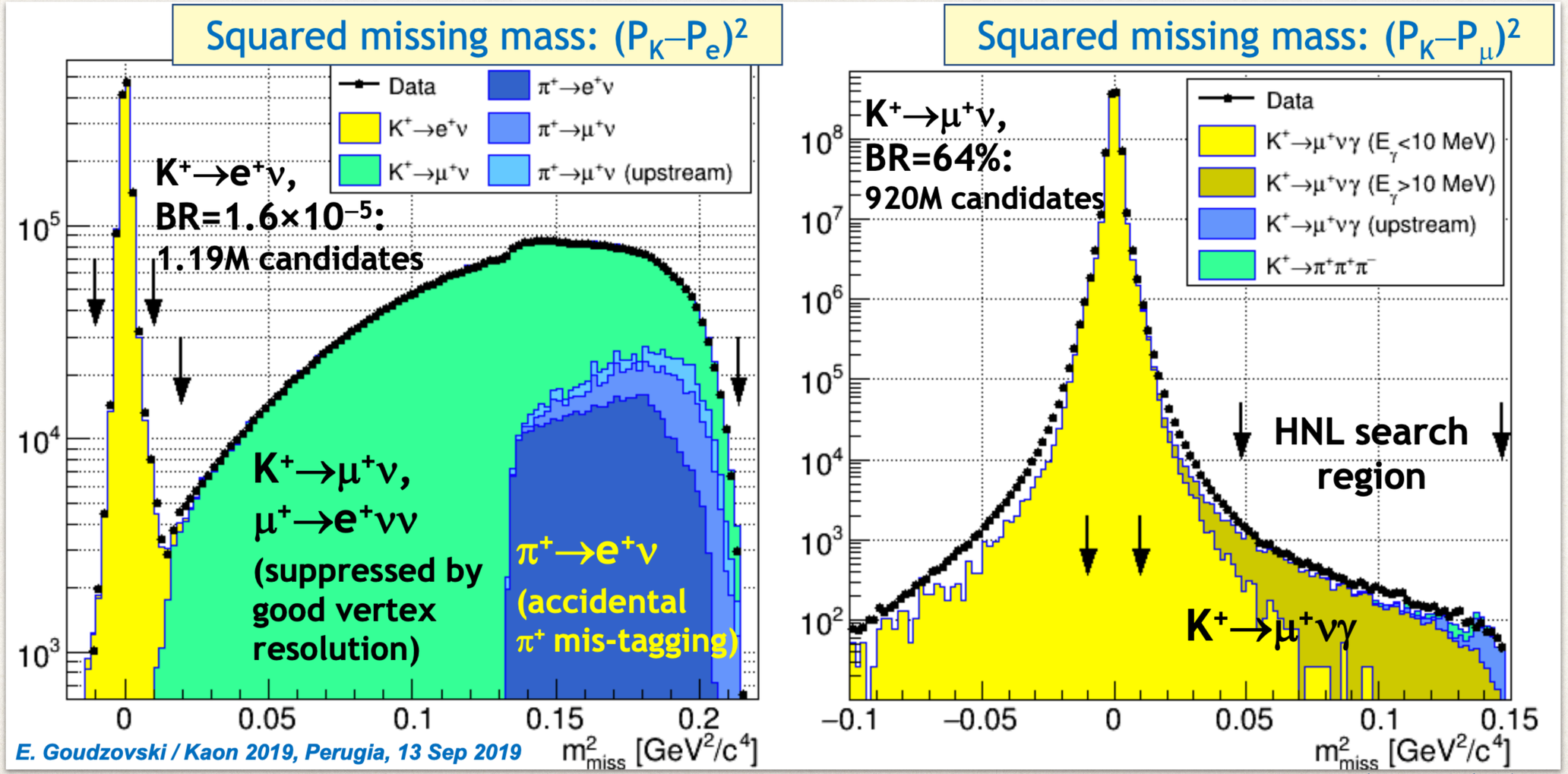
Any process with SM neutrino emission can be studied to search for N emission, if kinematically accessible

Bolton et al, [1912.03058]

PDG Live Constraints: link

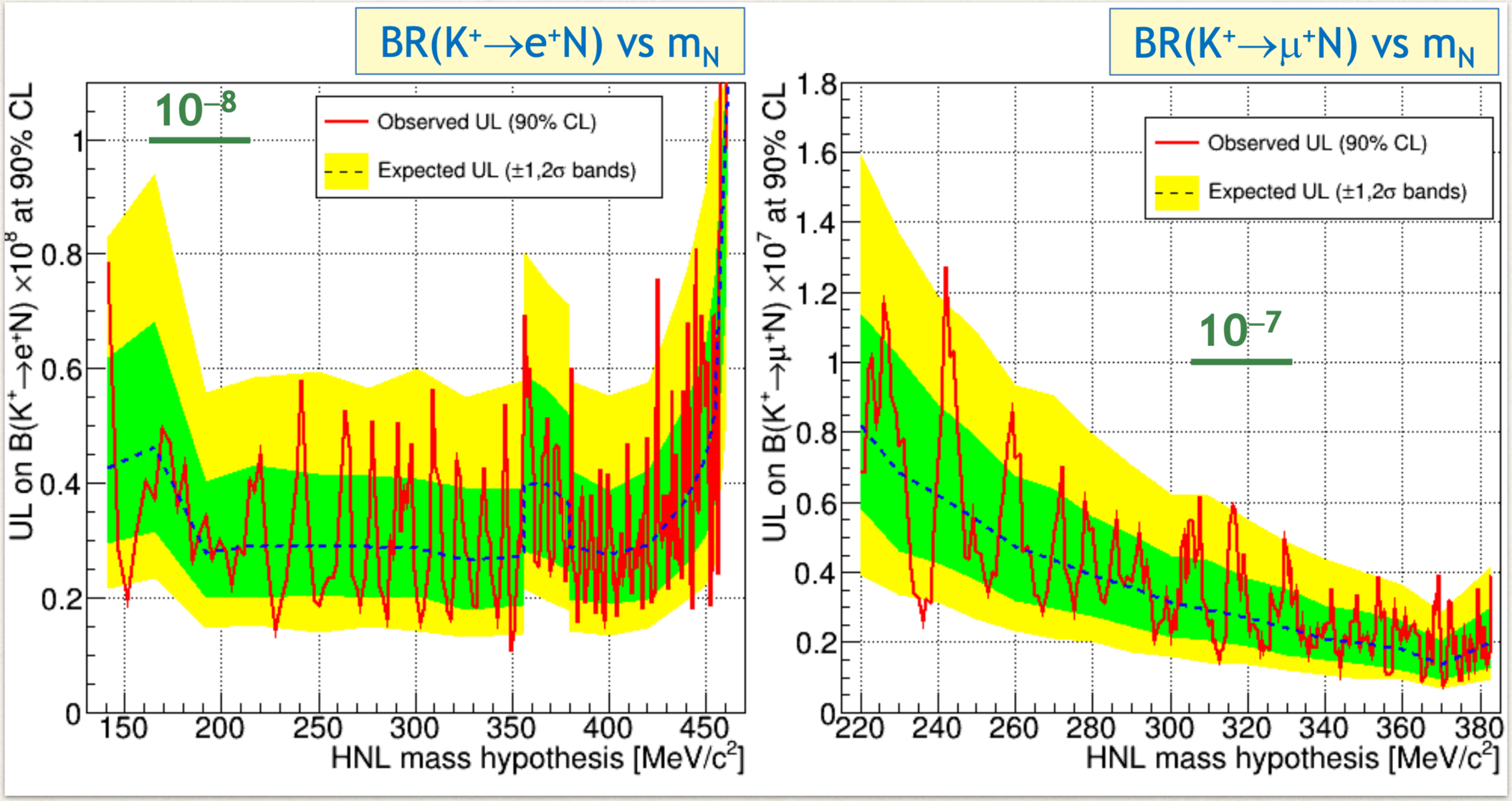
Two-Body Searches (NA62, etc.)

- NA62 has searches for two-body decays into a charged lepton and missing mass: allows for searches for $K^+ \to e^+ N,\ K^+ \to \mu^+ N$



Link to Slides

Resulting Branching Fraction Constraints



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Other Channels/Next Steps

Three-Body Kaon Decays

$$K^+ \to \pi^0 e^+ N \qquad\qquad K^+ \to \pi^0 \mu^+ N$$

- NA62 could identify these as a single charged lepton, two photons, and missing mass. SM branching fractions for these processes are several percent.

Displaced N Decay

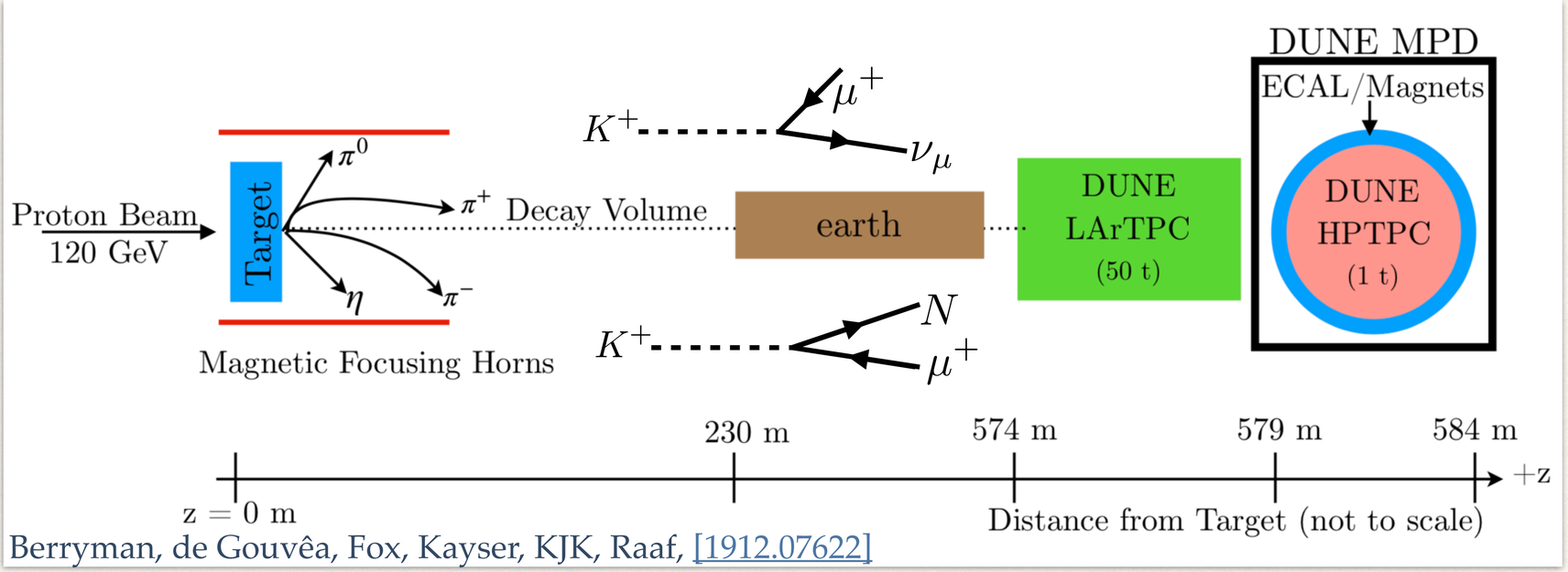
- If the Heavy Neutral Lepton is not very long-lived*, it could decay inside the detector, leaving a relatively striking signature:

$$K^+ \to e^+ N,\ N \to e^- \pi^+$$
$$K^+ \to e^+ N,\ N \to e^+ \pi^- \qquad \text{(if N is a Majorana Fermion)}$$

*in minimal HNL models, N is long-lived. This idea requires new interactions with N, such as charging it under (B-L) to shorten the lifetime. E.g. [1604.06099], [1903.07589]

How broadly defined is “Kaon Factory”

- Other experiments, like neutrino facilities, can search for displaced decays of HNL:



Berryman, de Gouvêa, Fox, Kayser, KJK, Raaf, [1912.07622]

- Sensitivity has been explored in upcoming DUNE experiment — searches have been carried out in the MicroBooNE [1911.10545] and T2K [1902.07598] experiments already.

- Does this fall in the scope of this paper?