WG5 (BSM) SUMMARY

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FPF THEORY DAYS
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WG leaders: B. Batell, ST
**NEUTRINO BSM PHYSICS**

### a) Neutrino charged-current NSI


\[ \mathcal{L}_{\text{WEFT}} \supset - \frac{2V_{jk}}{v^2} \left\{ [1 + \epsilon_{ij}^{jk}]_{\alpha\beta}(\bar{u}^j \gamma^\mu P_L d^k)(\tilde{e}_\alpha \gamma^\mu P_L \nu_\beta) + [\epsilon_{ij}^{jk}]_{\alpha\beta}(\bar{u}^j \gamma^\mu P_R d^k)(\tilde{e}_\alpha \gamma^\mu P_L \nu_\beta) \right. \\
+ \frac{1}{2} [\epsilon_{ij}^{jk}]_{\alpha\beta}(\bar{u}^j \gamma_5 d^k)(\tilde{e}_\alpha P_L \nu_\beta) - \frac{1}{2} [\epsilon_{ij}^{jk}]_{\alpha\beta}(\bar{u}^j \gamma_5 d^k)(\tilde{e}_\alpha P_L \nu_\beta) \left. \\
+ \frac{1}{4} [\epsilon_{ij}^{jk}]_{\alpha\beta}(\bar{u}^j \sigma^{\mu\nu} P_L d^k)(\tilde{e}_\alpha \sigma^{\mu\nu} P_L \nu_\beta) + \text{h.c.} \right\} \]

### b) Neutrinophilic dark sector


### c) Neutrino oscillations

L.A. Anchordoqui et al, hep-ph/2308.11476

**neutrino-modulino oscillations**

probing SUSY breaking scale

### d) Electromagnetic properties of neutrinos


Talks:
Kevin Kelly
Luis Anchordoqui
Roshan Mammen Abraham
Neutrino flux predictions still have substantial uncertainties.

How to search for new physics then?

Combine multiple observables (energy, pseudorapidity, different flavors).

SM fluxes correlated by the parent meson spectra.

New effects might clearly differ.

\[
L = L_{SM} - \frac{2\nu_{ud}}{v^2} \times (\bar{u} \gamma^\kappa P_{Rd}) \times \left[ \epsilon_{\mu\tau}^{\mu\tau}(\ell_{\mu} \gamma_R P_L \nu_\tau) + \epsilon_{\tau}^{\tau}(\ell_{\tau} \gamma_R P_L \nu_e) \right]
\]

Consider changes to tau neutrino spectrum:

- Effects on production side

Additional interact increase number observed charged τ which is assume equal the number of neutral

Effect approx in energy indepen

Tool available at: https://github.com/makelat/forward-nu-flux-fit
Light long-lived particles (LLPs) remain essential physics target for the operating FASER detector and will also be extended to the FPF.

Further models are explored in the community & connections to more complete models.

Talks: Krzysztof Jodłowski, Huayang Song

- We keep updating tools,

- **FORESEE**
  
  F. Kling, ST, hep-ph/2105.07077

- **Talk: Jean-Loup Tastet, SensCalc tool**
  
PRODUCTION MODES OF LLPS

Talk: Max Fieg

π^0 spectrum
Impact on predicted π^0 → A'γ

Talk: Peter Reimit, ISR & FSR

could be relevant for dark photon search at FASER(2)

Talk: Saeid Foroughi-Abari

Dark Vector Radiation, √s = 14 [TeV]

π^0 → γν

η → γν

θ_{CM} < 1 mrad
**IMPACT ON OTHER FPF SEARCHES**

- Impact of additional prod. modes even more important for stable dark species (even softer dark species matter)

- Potentially significant impact on:
  - dark matter (DM)
  - millicharged particles (mCPs)

- Heavier mesons relevant for HNLs (charm), dark Higgs (B mesons), ...

- Important **cosmological bounds** on sub-GeV millicharged particles with massless $A'$

Emphasize the need to extend the search to larger masses with FORMOSA.
EXPLOITING HIGH-ENERGY IN BSM SEARCHES

- High-energy pp collisions at the LHC open up possibility to directly produce TeV-scale particles
  - Example: quirks
    - Hidden strong force with $m_{\text{quirk}} \gg \Lambda_{\text{hidden}}$
    - Quirks are stable and do not hadronize
    - They are bound by the color string & oscillate around their COM
    - Heavy quirks are slow interactions not consistent with bunch crossing
    - Timing & fancy signatures
      $\rightarrow$ BG free search

- Discussions about muon-induced new physics
  A. Ariga et al, hep-ph/2305.03102

Talk: Jonathan Feng
A. Ariga et al, hep-ph/2108.06748

Talk: Monday session about muons
THANK YOU!